Freightliner COE & 120 Conventional Service Manual

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AIR BRAKE SYSTEM TROUBLESHOOTING

GENERAL INFORMATION

This troubleshooting guide is designed to help locate causes of problems originating in the air brake system. The corrective measures given are not intended to replace the detailed service information found in other sections of this manual or in the component manufacturer's service manuals.

Before attempting to isolate the causes of an air brake system problem, do the following:

1. Check the operation of the air compressor. Refer to the engine manufacturer's service manual.

   Check the pressure levels of the air reservoirs. Refer to the vehicle driver's manual.

2. Be sure that all relay valves are operating. For instructions, refer to the vehicle maintenance manual.

3. Check the operation of the brake chambers as instructed in the vehicle maintenance manual.

4. Examine all tubing for kinks, dents, and other damage. Replace damaged tubing.

5. Examine all hoses for cracks, drying out, overheating, and other damage. Replace damaged hoses.

6. Examine all air line fittings. Tighten loose connections; replace fittings that are damaged. For instructions, refer to the applicable section in this manual.

7. Examine leaking pipe connections for cracks or thread damage; replace as needed. If there is no damage, retighten the fitting. For instructions, refer to the applicable section in this manual.

SAFETY PRECAUTIONS

Compression and storage of air in the air brake system is comparable to the energy in a coiled spring: when released, it may be hazardous. Because of this, certain precautions are required:

1. Chock the tires. This will prevent accidental rolling of the vehicle when air is released from the brake system.

2. Don't disconnect pressurized hoses because they will whip as air escapes from the line. Drain the air system before disconnecting the air hoses.

3. When draining the air system, do not look into the air jets or direct them toward anyone: dirt particles or sludge may be carried in the air stream.

4. As air pressure is drained and the parking/emergency brakes apply, keep your hands away from the brake chamber push rods and parking brake chambers, which will activate automatically with the loss of pressure. This also applies to the service brake system.

WARNING: Follow the manufacturer's procedures while working on any air device so as to avoid injury or damage from parts which, when released, are subject to mechanical (spring) or pneumatic propulsion. Failure to take all necessary precautions during servicing of the air brake system can result in personal injury.

AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Does Not Slow Down Quickly Enough When Brakes Are Applied	The vehicle is overloaded.	Observe the recommended maximum load limits.
	There is low air pressure in the brake system (below, approximately 60 psi [413 kPa]).	The drain cock on the air reservoir was left open; close the drain cock.
		Check the compressor output pressure; correct as necessary.
		Check the setting of the air governor with an accurate test gauge. Adjust the air governor to the recommended specification.
	The application air lines are leaking excessively.	Check the application air line, brake valve, and the service and spring brake chambers for air leaks. Repair or replace the damaged component(s).
	Brake valve delivery pressure is below normal.	Lubricate the brake valve parts; overhaul the unit, if necessary.
	Wear or glazing of the brake linings is present.	Install new brake linings on the brake shoes on both sides of the axle.
	Adjustment or lubrication of the brakes is needed.	Adjust or lubricate the brakes.
	The automatic slack adjusters (if so equipped) are not operating.	Lubricate the automatic slack adjusters and check for binding, damaged, or inoperative slack adjuster parts. Replace damaged or inoperative parts, or eliminate the cause of the binding.
	The cam has flipped over.	Replace the linings and the cam on each end of the axle.

(Continued on next page)

AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Does Not Slow Down Quickly Enough When Brakes Are Applied (Continued)	Flat spots or dents on the roller surface were caused by skidding of the roller or improper handling of the wheel bearing during installation.	Clean, then inspect the bearing rollers. Replace the bearing if damaged. Insure that the bearings to be installed are sufficiently lubricated as outlined in the 10 or 11 Group of the Freightliner Maintenance and Lube Manual.
	One or more of the brake drums is broken or cracked.	Replace the brake drum(s).
	Improper size brake linings were installed.	Replace the brake linings with the recommended size.
	Improper size brake chambers were installed.	Replace the brake chambers with the recommended size.
	A camshaft bracket or chamber mounting bracket is bent or broken.	Replace the camshaft bracket or chamber mounting bracket.
	The non-pressure plate of the service brake is damaged.	Replace the non-pressure plate.
	The brake chamber mounting stud nuts or brake chamber mounting bracket is loose.	Tighten the brake chamber to its mounting bracket or the mounting bracket to the foundation brake housing.
	There is a ruptured diaphragm in the service brake.	Replace the diaphragm.
Service Brakes Release Too Slowly	The brake shoe anchor pins are frozen.	Inspect the anchor pins. If damaged, replace them; if not damaged, lubricate them.
	Lubrication of the brake system components is inadequate.	Lubricate those components requiring periodic lubrication.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Service Brakes Release Too Slowly (Continued)	The brake foot valve stop bolt may be improperly set.	Reset the stop bolt.
	The brake foot valve is not returning to the fully released position.	Check for obstructions which might prevent the brake foot valve from returning to the fully released position. Remove any obstructions.
	The exhaust port of the brake foot valve or quick-release valve is plugged.	Clear the exhaust port of obstructions.
	The brake foot valve or quick-release valve is inoperative.	Overhaul or replace the inoperative valve, as needed.
	The camshaft and bushings are binding.	Clean and lubricate the camshaft bushings.
	The brake shoe return spring is weak or broken.	Replace the spring.
	Flat spots or dents on the roller surface were caused by skidding of the roller or improper handling of the wheel bearing during installation.	Clean, then inspect the bearing rollers. Replace the bearing if damaged. Insure that the bearings to be installed are sufficiently lubricated as outlined in the 10 or 11 Group of the Freightliner Maintenance and Lube Manual.
Service Brakes Do Not Apply or Apply Too Slowly	Lubrication of the foundation brake assembly is needed.	Lubricate those components requiring periodic lubrication.
	There is insufficient air pressure in the brake system.	Check all parts of the air pressure system for leaks or inoperative components.
	The brake foot valve or relay valve is inoperative.	Repair or replace the brake foot valve or relay valve.
	The camshaft bushings are binding.	Clean and lubricate the camshaft bushings.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Service Brakes Apply When the Spring Brakes Are Released With Air Pressure	The air supply lines to the brake chamber have been reversed.	Reverse the connections of the brake chamber air lines.
	There is a leaking push rod seal between the spring brake and the service brake.	Replace the push rod seal.
	The braking mechanism is binding.	Lubricate the brake mechanism and make sure all parts are aligned with each other and are securely fastened.
		Check for obstructions; remove any obstructions.
Service Brakes Do Not Release	The brake shoes are incorrectly adjusted.	Adjust the brakes. Also, make sure the slack adjuster is operating correctly. If not, overhaul or replace the slack adjuster.
	The brake foot valve may not be in the fully released position.	Lubricate the brake foot valve if needed. Check the setting of the brake foot valve stop bolt.
	The brake foot valve is inoperative.	Overhaul or replace the brake foot valve.
	There is a restriction in the tubing, hose, or exhaust port of the brake foot valve or quick-release valve.	Check for bends or obstructions on the exhaust side of the service brakes. Remove any obstructions; plumb the air lines so that bends are minimal.
	A broken power spring may be blocking the spring brake piston movement.	Replace the power spring or replace the spring brake assembly, whichever is recommended by the spring brake manufacturer.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Service Brakes Grab or Pull	There is not enough weight on the vehicle (under-loaded).	Excessive brake sensitivity will be reduced as weight is added to the vehicle.
	Grease has saturated the brake linings or the linings are glazed.	Install new linings on both axle brake shoes. Clean the brake drums.
	A brake drum is out-of-round to unacceptable limits.	Turn the brake drum(s), if possible. If the maximum allowable diameter of the brake drum(s) has been exceeded, replace the drum. Also, turn or replace the other drum on the axle. For turning the drum(s), refer to the brake manufacturer's service manual.
	A brake shoe is distorted or broken.	Replace the brake shoe. Install new linings on both sets of axle brake shoes.
	If equipped with cam brakes, there is a flat or dent on the S-head camshaft or on the cam roller(s).	Replace the damaged component(s).
	A brake spider is loose.	Tighten the mounting bolts or replace the brake spider.
	The brake linings are loose.	Since looseness results in uneven wear of the linings, install new linings on both sets of axle brake shoes.
	The brake foot valve is inoperative.	Overhaul or replace the brake foot valve, as needed.
	The brake mechanism is binding.	Lubricate the brake mechanism and make sure all parts are aligned with each other and are securely fastened.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Service Brakes Grab or Pull (Continued)	One or more drums is scored or broken.	Replace both brake drums.
	Lubrication of the brake system components is inadequate.	Lubricate those components requiring periodic lubrication.
	A matched set of brake linings was not used. Different friction codes or different brands of brake linings were used.	Install a new matched set of brake linings. Clean or replace the drums, or turn the drums. For turning the drums, refer to the brake manufacturer's service manual.
	The clevis pin or camshaft is binding at one or more wheels.	Clean and lubricate the camshaft bushings.
	A slack adjuster is damaged.	Replace the damaged component.
	Adjustment of the brakes on one axle is uneven.	Adjust the brakes.
	The air chamber push rods or slack adjusters are a different length.	Replace the components with the correct size and material.
Uneven Service Brakes	The wrong brake linings were installed, or the linings were not replaced in pairs.	Replace the brake linings with the recommended size. Install new linings on both sets of axle brake shoes.
	Grease has saturated the brake linings or the linings are glazed.	Install new linings on both axle brake shoes. Clean the brake drums.
	The return spring for the brake shoe release or the service brake has broken.	Replace all broken springs.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Uneven Service Brakes (Continued)	The brake drum is out-of-round to unacceptable limits.	Turn the brake drum(s), if possible. If the maximum allowable diameter of the brake drum(s) has been exceeded, replace the drum. Also, turn or replace the other drum on the axle. For turning the drum(s), refer to the brake manufacturer's service manual.
	A service brake chamber diaphragm is leaking.	Tighten the clamp ring. If leaks persist, replace the service brake diaphragm.
	The wheel bearings are out of adjustment.	Adjust the wheel bearings, or replace them if damaged. For instructions, refer to the 10 or 11 Group of the Freightliner Maintenance and Lube Manual.
	A brake spider is damaged.	Replace the brake spider.
	The brake shoes are bent or stretched.	Replace the axle brake shoes on each wheel.
	Grease, oil, or dirt is on the linings.	Replace the linings on each set of axle brake shoes. Clean the brake drums.
Dragging Service Brake	The service brake return spring is broken.	Replace the service brake return spring.
	The service-application air is not exhausting or not exhausting fast enough, due to blockage in the control valve, the quick-release valve, or the limiting and quick-release valve.	Test the air system valves for leakage and operation.
	A brake shoe retracting spring is broken.	Replace the brake shoe retracting spring.
	Binding is occurring in the camshaft linkage.	Lubricate the camshaft linkage. Replace bent or broken parts.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Insufficient Spring Brake Application When Dash Control Valve Is Activated	The spring brake is not set for full stroke.	Adjust the brakes.
	There is a ruptured spring brake diaphragm or ineffective piston seal.	Replace the diaphragm or spring brake piston seal.
	A power spring is broken.	Replace the power spring or replace the spring brake assembly, whichever is recommended by the spring brake manufacturer.
	A power spring in a spring brake is manually caged.	Release the power spring by screwing in the release bolt.
Dragging Brakes Due to Spring Brake Mechanism	The system air pressure is insufficient to fully release the spring brake.	Be sure that all air lines are clear. Check that the air governor cutout settings meet recommended specifications.
	A spring brake diaphragm is ruptured or a piston seal is ineffective.	Replace the diaphragm or spring brake piston seal.
	There is a broken return spring in the spring brake (double-diaphragm type brake chambers only).	Replace the spring brake return spring.
Air Pressure Will Not Rise to Normal	The air pressure gauge(s) on the dash is registering inaccurately.	Check the dash gauge with an accurate test gauge. Replace the dash gauge(s) as needed.
	There is excessive leakage (not including the air compressor).	Check all valves, air lines, and connections for leakage. Repair or replace valves and lines until leakage is eliminated.
	The compressor is inoperative (including excessive leakage of the compressor).	Rebuild or replace the compressor.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Air Pressure Will Not Rise to Normal (Continued)	The air reservoir drain cock has been left open.	Close the drain cock.
	The air governor cutout setting is not adjusted correctly.	Check the setting with an accurate test gauge, then adjust the air governor to the recommended specification.
	There is inadequate clearance at the compressor unloading valve.	Repair or adjust the compressor at the unloading valve.
	If so equipped, the compressor drive belt is slipping.	Adjust or replace the compressor drive belt.
	Carbon is building up in the compressor cylinder head or discharge line.	Remove the carbon. If disassembly is not recommended by the compressor manufacturer, replace the air compressor with a factory-rebuilt or a new unit.
Air Pressure Rises Above Normal	The air reservoir pressure dash gauge is inaccurate.	Check the dash gauge with an accurate test gauge. Replace the dash gauge, as needed.
	The compressor air governor is out of adjustment.	Check the setting with an accurate test gauge, then adjust the air governor to the recommended specification.
	The air governor is not operating.	Repair or replace the air governor.
	There is too much clearance at the air compressor unloading valve.	Repair or adjust the compressor at the unloading valve.
	The air compressor unloading valve is stuck in the closed position.	

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Air Pressure Rises Above Normal (Continued)	The air compressor unloading valve cavities or the unloading valve passage is blocked with carbon.	Repair or adjust the compressor at the unloading valve.
Air Pressure Drops Quickly With the Engine Stopped and the Brakes Released	The brake foot valve is leaking.	Repair or replace the brake foot valve.
	The air compressor discharge valve is leaking.	Repair or replace the discharge valve. If disassembly is not recommended by the compressor manufacturer, replace the air compressor with a factory-rebuilt or a new unit.
	The air governor is leaking.	Repair or replace the air governor.
Air Pressure Drops Quickly With the Engine Stopped and the Brakes Fully Applied	A service or spring brake chamber is leaking.	Tighten the clamp ring(s). If leaks persist, replace the diaphragm(s) or assembly.
	The brake foot valve or relay valve is leaking.	Repair or replace the component(s) or assembly.
Compressor Knocks (Continuously or Intermittently)	There is a loose drive pulley, belt, coupling, or gear (as indicated).	Tighten or replace the component. If applicable, inspect the pulley shaft for damage. Replace the shaft, if damaged.
	Backlash is present in the compressor drive gears on the drive coupling.	Repair or replace the compressor drive gears or drive coupling.
	The air compressor bearings are damaged or worn.	Replace the bearings.
	There are carbon deposits in the compressor cylinder head.	Remove the carbon deposits or replace the compressor.

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AIR BRAKE SYSTEM TROUBLESHOOTING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Safety Valve Activates	The safety valve is out of adjustment.	Adjust the safety valve, or install a new one.
	There is excessive air pressure in the brake system.	Refer to the problem area, "Air Pressure Rises Above Normal."
	Draining of the air reservoirs needs to be performed more often.	Drain the air reservoirs daily.
Oil or Water in the Brake System	Excessive oil is passing through the air compressor.	Rebuild or replace the compressor.
	If so equipped, the air compressor air strainer is dirty.	Clean the strainer or install a new one.

AIR LINES AND FITTINGS

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AIR LINES AND FITTINGS

SERVICE OPERATIONS

INSTALLING AIR LINES

Nylon Tubes (Refer to **Figs. 1** and **2**)

When installing a nylon tube, be careful not to bend it past its minimum bend radius. For minimum bend radius values, refer to **Table 1** in "Specifications."

CAUTION: If the tubing is bent to a radius smaller than the specified minimum bend radius, it may kink and shut off normal airflow to the component.

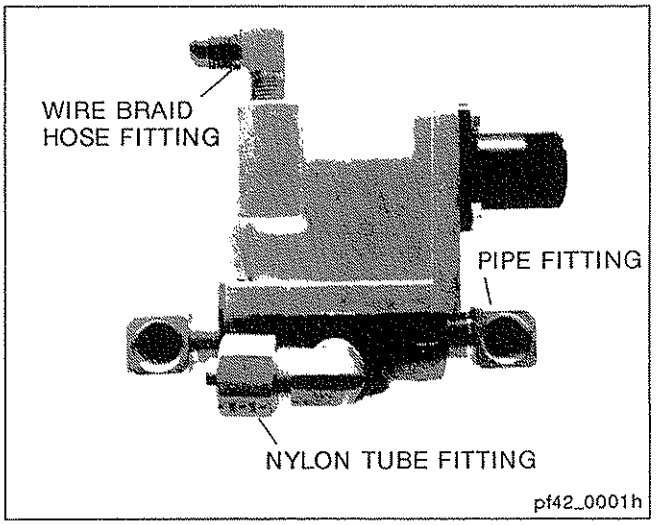


Fig. 1, Tube and Hose Fittings (for reference only)

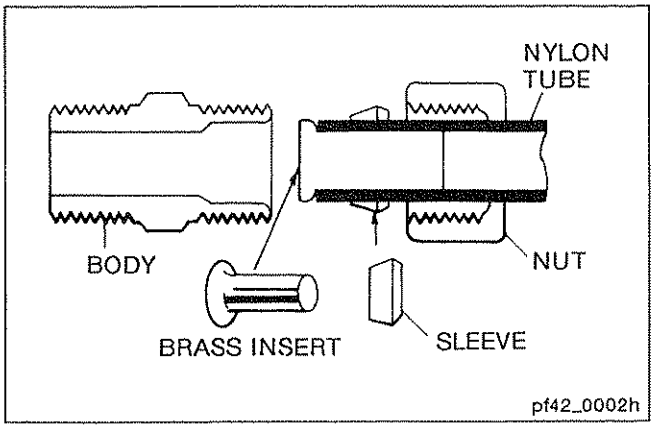


Fig. 2, Nylon Tube Fitting

1. Cut the end of the tubing smooth and square.
2. Make sure the nylon tubing ends and fittings are free of grease and debris. If the tubing is crimped or otherwise damaged, replace it with new tubing.
3. Install a new sleeve in the nut.
4. Insert the squared end of the tubing in the fitting, until it bottoms in the body of the fitting. See **Fig. 3.**
5. Tighten the nut finger-tight. Then, using two wrenches to prevent twisting of the tube, tighten the nut the number of turns shown in **Table 2**, "Specifications," or until one thread shows on the fitting body.

Wire Braid Hoses (Refer to **Fig. 1**)

When installing a wire braid hose, be careful not to bend it past its minimum bend radius. For minimum bend radius values, refer to **Tables 3** and **4**, "Specifications."

CAUTION: If the hose is bent to a radius smaller than the specified minimum bend radius, it may kink and shut off normal airflow to the component.

Make sure the wire braid hose assembly is free of grease and dirt. Replace the assembly if the hose or fitting is crimped or otherwise damaged.

Install the hose and tighten the nut finger-tight. Then, using two wrenches to prevent twisting of the hose, tighten the nut until it seats solidly. Tighten the nut one-sixth turn more.

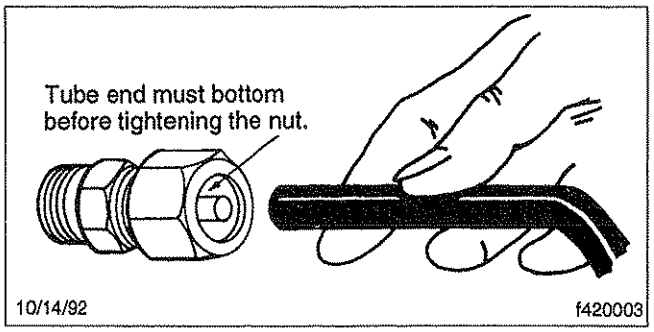


Fig. 3, Installing Nylon Tubing

AIR LINES AND FITTINGS

INSTALLING FITTINGS

Brass and Steel Pipe Fittings (Refer to Fig. 1)

For brass pipe fittings, both male and female parts, tighten as follows:

1. Make sure the fittings are free of grease, dirt, and old sealant. Apply liquid Loctite® Hydraulic Sealant (brown), or an equivalent, to the threads, then tighten securely, finger-tight.

NOTE: Always apply the sealant to the external thread, so that any excess will be scraped off externally rather than internally to the joint.

2. For fittings that must be positioned, tighten one additional turn from finger-tight using a wrench. Then, continue tightening until the fitting is correctly positioned.

   For fittings that do not require positioning, tighten 1-1/2 additional turns from finger-tight.

Copper Tube Fittings

For copper tube fittings, tighten the nut finger-tight. Then, using two wrenches to prevent twisting of the tube, tighten the nut the number of turns shown in **Table 5**, "Specifications."

Tube and Pipe Fittings on Plastic Components

For tightening specifications, refer to **Table 6**, "Specifications."

SPECIFICATIONS

NYLON TUBE			
Number	**Inside Diameter (inches)**	**Outside Diameter (inches)**	**Minimum Bend Radius inches (mm)**
4	0.170	1/4	1.00 (25)
6	0.251	3/8	1.50 (38)
8	0.376	1/2	2.00 (51)
10	0.439	5/8	2.50 (64)
12	0.566	3/4	3.00 (76)

Table 1

NYLON TUBE	
Tube Size (inches)	**Additional Turns from Hand-Tight**
1/4	3
3/8 or 1/2	4
5/8 or 3/4	3-1/2

Table 2

"211" WIRE BRAID (MEDIUM PRESSURE) HOSE*			
Number	**Inside Diameter (inches)**	**Outside Diameter (inches)**	**Minimum Bend Radius inches (mm)**
4	3/16	0.52	3.00 (76)
5	1/4	0.58	3.38 (86)
6	5/16	0.67	4.00 (102)
8	13/32	0.77	4.63 (118)
10	1/2	0.92	5.50 (140)
12	5/8	1.08	6.50 (165)
16	7/8	1.23	7.38 (187)
20	1-1/8	1.50	9.00 (229)

* "211" hose is identified by part number and size (for example, part numbers 211-4, 211-5, and so on).

Table 3

"213" WIRE BRAID (DIESEL) HOSE*			
Number	**Inside Diameter (inches)**	**Outside Diameter (inches)**	**Minimum Bend Radius inches (mm)**
4	3/16	0.49	0.75 (19)
5	1/4	0.55	1.00 (25)
6	5/16	0.62	1.25 (32)
8	13/32	0.74	1.75 (44)
10	1/2	0.83	2.25 (57)
12	5/8	0.96	2.75 (70)
16	7/8	1.21	3.50 (89)
20	1-1/8	1.49	4.50 (114)

* "213" hose is identified by two green stripes 180 degrees apart, part numbers, and size (for example, part numbers 213-4, 213-5, and so on).

Table 4

AIR LINES AND FITTINGS

SPEICIFICATIONS (Continued)

COPPER TUBE FITTINGS			
Number	Outside Diameter (inches)	Additional Turns from Hand-Tight	
		Compression	Threaded Sleeve
2 3 4	1/8 3/16 1/4	1-1/4	1-1/2
5	5/16	1-3/4	
6 8 10 12 16 20	3/8 1/2 5/8 3/4 1 1-1/4	2-1/4	

Table 5

TUBE AND PIPE FITTINGS ON PLASTIC COMPONENTS			
Description	Port Size (inches)	Torque	
		lbf·in (N·cm)	lbf·ft (N·m)
Midland Quick Release Valve	3/8	60-90 (680-1020)*	—
	1/2	—	13-17 (18-23)*
Bendix MV-2/MV-3 Valve	1/4	—	10 (14)

* Tighten to the lower torque value. Then, if needed, turn the fittings to allow for the proper routing of the air lines.

Table 6

GENERAL INFORMATION

The Sealco 6300 moisture ejection valve is designed to keep the air in the dry tank dry by automatically removing sludge and water from the wet tank each time the brakes are applied. The moisture ejection valve is connected into the air system with two lines, one from the wet tank, and the other from the unloader side of the governor. If the moisture ejection valve should fail to operate or leak beyond the limits set in the Freightliner Maintenance Manual, it should be removed, disassembled, cleaned, inspected, repaired, assembled, and installed in accordance with the procedures found in this subject. A failed moisture ejection valve will allow moisture to build up in the wet tank which in turn could reach the dry tank, and then travel into the air brake system where it could cause braking failure. A leaking moisture ejection valve allows wet tank leakdown which in turn can cause premature wear on the air compressor during vehicle operation as the air compressor continues to run to maintain wet tank air pressure. See "SPECIFICATIONS" for the Sealco 6300 moisture ejection valve plumbing diagram.

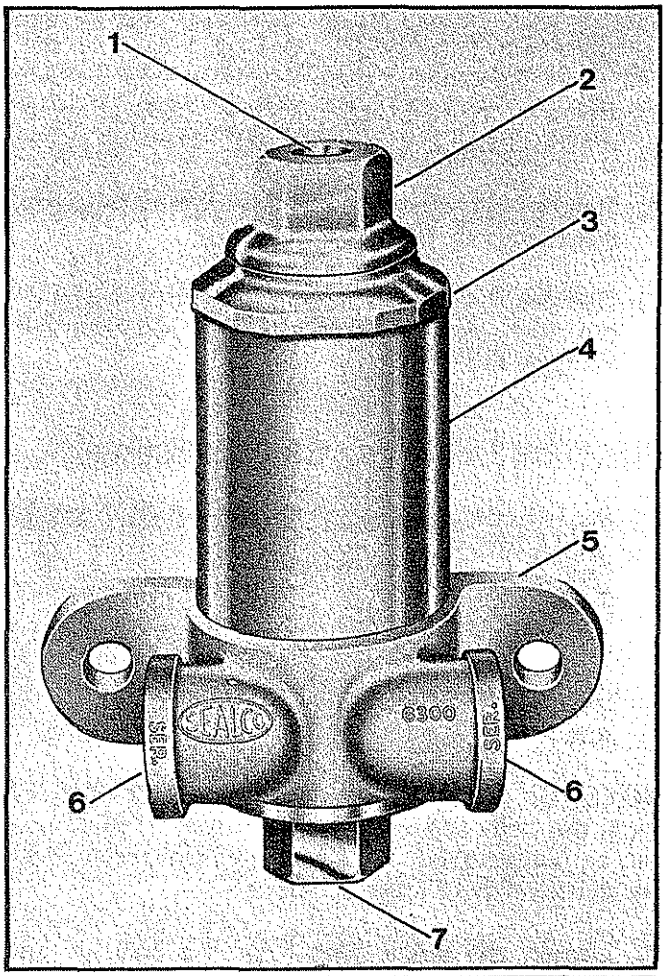
An alternate method of connection is to route the line from the unloader side of the governor to an application relay valve before going to the application side of the Sealco 6300 moisture ejection valve.

PRINCIPLES OF OPERATION

When the service brakes are applied, the applied air pressure in the range of 15-25 psi, and above, forces the actuator and plunger upward, compressing the spring, raising the inlet seat, and allowing ejection. The wet tank compressed air reservoir pressure forces fluid and air mixture from the bottom of the wet tank to pass the inlet seat downward into a fluid holding chamber where it passes through the actuator top through the exhaust outlet into the atmosphere. Release of the service brake application permits the pressure of the trapped mixture to force the actuator downward until the inlet seat seats on the guide post which cuts off the ejection cycle. The moisture ejection valve then remains closed until the next application cycle from the governor unloader or application relay valve. (Figs. 1 & 2)

SERVICE OPERATIONS

The Sealco 6300 moisture ejection valve should be removed, disassembled, cleaned, inspected, repaired, assembled, and reinstalled when so indicated by the tests set forth in the Freightliner Maintenance Manual. Use the following procedures to remove and repair.



1. Reservoir Inlet
2. Upper Cap
3. Guide Post
4. Column
5. Body Casting
6. Application Line Inlet (2 places)
7. Exhaust Outlet, or Discharge Line (if used)

Fig. 1 Sealco 6300 Ejector, Assembled View

MOISTURE EJECTION VALVE REMOVAL

1. Safely block the vehicle, and open the drain cocks to bleed the air from the wet and dry compressed air reservoirs. See "SPECIFICATIONS" for the Sealco 6300 moisture ejection valve plumbing diagram.

2. Remove the application lines from the moisture ejection valve (Fig. 1).

3. Remove the discharge line (if used) from the moisture ejection valve exhaust port. (Fig. 1)

4. Remove the reservoir inlet line from the moisture ejection valve. (Fig. 1)

5. Remove the two nuts and bolts which clamp the moisture ejection valve to the vehicle frame. Remove the valve.

MOISTURE EJECTION VALVE DISASSEMBLY

1. Remove the upper cap (Fig. 2, Ref. 2) from the guide post (Fig. 2, Ref. 5), and remove the spring (Fig. 2, Ref. 3) from the top of the inlet seat (Fig. 2, Ref. 15).

2. Remove the lower body (Fig. 2, Ref. 11) from the body casting (Fig. 2, Ref. 20) and remove the actuator (Fig. 2, Ref. 6) from the body casting.

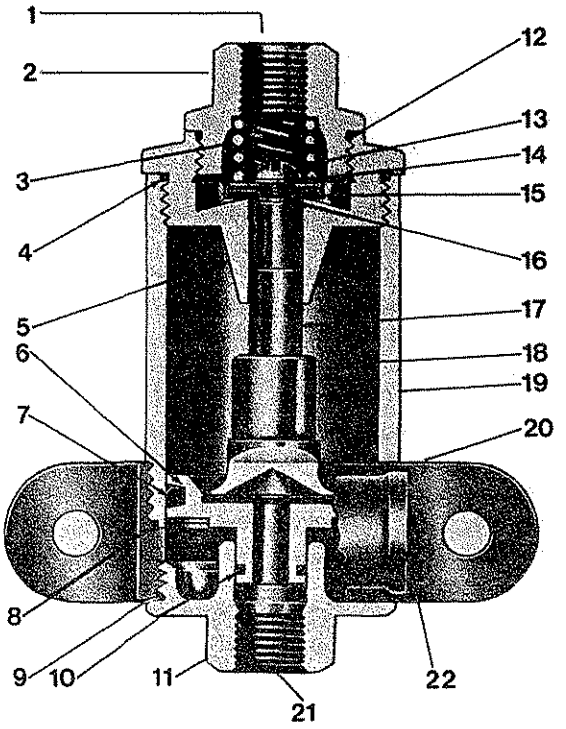
NOTE: Do not remove the column (Fig. 2, Ref. 19) from the body casting, as the moisture ejection valve can be disassembled and cleaned, or repaired without the disassembly of these two parts.

3. Loosen the guide post from the column and remove the inlet seat screw (Fig. 2, Ref. 13), inlet seat screw lockwasher (Fig. 2, Ref. 14), inlet seat (Fig. 2, Ref. 15), and washer (Fig. 2, Ref. 16) from the plunger (Fig. 2, Ref. 17).

4. Remove the plunger from the guide post, and remove the guide post from the column.

5. Remove the actuator large O-ring (Fig. 2, Ref. 7) and actuator small O-ring (Fig. 2, Ref. 10) from the actuator.

6. Remove the upper cap gasket (Fig. 2, Ref. 12) from the upper cap, the guide post gasket (Fig. 2, Ref. 4) from the guide post, and the lower body gasket (Fig. 2, Ref. 9) from the lower body.



1. Reservoir Inlet
2. Upper Cap
3. Spring
4. Guide Post Gasket
5. Guide Post
6. Actuator
7. Actuator Large O-Ring
8. Column Gasket
9. Lower Body Gasket
10. Actuator Small O-Ring
11. Lower Body
12. Upper Cap Gasket
13. Screw, Inlet Seat
14. Lockwasher, Inlet Seat Screw
15. Inlet Seat
16. Washer
17. Plunger
18. Fluid Holding Chamber
19. Column
20. Body Casting
21. Exhaust Outlet
22. Application Line Inlet (2 places)

Fig. 2 Sealco 6300 Ejector, Cutaway View

MOISTURE EJECTION VALVE CLEANING INSPECTING AND LUBRICATING

1. Wash all component parts of the disassembled moisture ejection valve in a clean soap and water bath. Dry the component parts of the disassembled moisture ejection valve with compressed air.

CAUTION: Use eye protection when using compressed air to clean or dry component parts as permanent harm to eyes from flying debris could result without eye protection.

2. Inspect upper cap, spring, guide post, actuator, lower body, screw, lockwasher, inlet seat, washer, plunger, and column and body casting assembly for damaged O-ring or gasket seats, nicks, and scored metal surfaces. Replace any damaged part which has nicks and scored metal surfaces with a new part. Replace parts that have damaged O-ring or gasket seats with new equivalent parts.

3. Lubricate all O-ring grooves, gaskets, gasket seats, and cylinder bores which contact the O-ring seals with light grease (NLGI 1) or SAE 30 wt. lubricating oil.

MOISTURE EJECTION VALVE ASSEMBLY

1. Install the plunger (Fig. 2, Ref. 17) through the guide post (Fig. 2, Ref. 5).

2. Arrange the inlet seat screw lockwasher (Fig. 2, Ref. 14), the inlet seat with its rubber side up (Fig. 2, Ref. 15), and washer (Fig. 2, Ref. 16) onto the inlet seat screw (Fig. 2, Ref. 13).

3. Install the inlet seat screw and arranged parts into the plunger, and tighten the inlet seat screw to 25 in-lbs of torque.

4. Install the guide post gasket (Fig. 2, Ref. 4) onto the guide post.

5. Lubricate the guide post gasket with light grease (NLGI 1) or SAE 30 wt. lubricating oil, and install the guide post and plunger assembly into the column (Fig. 2, Ref. 19). Tighten the guide post to 40 ft-lbs of torque.

6. Install the upper cap gasket (Fig. 2, Ref. 12) onto the upper cap (Fig. 2, Ref. 2).

7. Lubricate the upper cap gasket with light grease (NLGI 1) or SAE 30 wt. lubricating oil; install spring (Fig. 2, Ref. 3) over inlet seat (Fig. 2, Ref. 15), and then install upper cap into guide post. While holding the guide post, tighten the upper cap to 25 ft-lbs of torque.

8. Lubricate the actuator large O-ring (Fig. 2, Ref. 7) and the actuator small O-ring (Fig. 2, Ref. 10) with light grease (NLGI 1) or SAE 30 wt. lubricating oil, then install the actuator large O-ring and the actuator small O-ring onto the actuator (Fig. 2, Ref. 6).

9. Install the actuator into the body casting (Fig. 2, Ref. 20) and column (Fig. 2, Ref. 19) assembly.

10. Lubricate the lower body gasket (Fig. 2, Ref. 9) with light grease (NLGI 1) or SAE 30 wt. lubricating oil, then install the lower body gasket onto the lower body (Fig. 2, Ref. 11).

11. Install the lower body into the body casting (Fig. 2, Ref. 20), and tighten the lower body to 20 ft-lbs of torque.

MOISTURE EJECTION VALVE LEAK TESTING

1. Connect an air supply line to the reservoir inlet of the moisture ejection valve (Fig. 1).

2. Apply 120 psi air pressure to the reservoir inlet while immersing the moisture ejection valve into water to observe for air leakage. Do not leave immersed longer than 30 seconds.

3. Any pressure leakage is not acceptable. If moisture ejection valve leaks air, repeat steps listed under "MOISTURE EJECTION VALVE DISASSEMBLY" and "MOISTURE EJECTION VALVE ASSEMBLY," found in this subject, and test again for pressure leakage. Repeat these steps until leakage is eliminated. If leakage persists, install new moisture ejection valve.

4. Cease application of air pressure, then remove the air supply line from the reservoir inlet (Fig. 1) of the moisture ejection valve.

5. Connect an air supply line to one of the application line inlets on the moisture ejection valve (Fig. 1). Plug the unused application inlet for the purposes of this test.

6. Apply 120 psi air pressure to the application inlet, and immerse the moisture ejection valve into water to observe for air leakage. Do not leave immersed longer than 30 seconds.

7. Any pressure leakage is not acceptable. If moisture ejection valve leaks air, repeat steps listed under "MOISTURE EJECTION VALVE DISASSEMBLY" and "MOISTURE EJECTION VALVE ASSEMBLY" found in this subject, and test again for pressure leakage. Repeat these steps until leakage is eliminated. If leakage persists, install new moisture ejection valve.

8. Cease application of air pressure to the application inlet, and remove the air supply line from the application inlet (Fig. 1) of the moisture ejection valve. Remove the plug from the unused application inlet which was plugged in step 5.

MOISTURE EJECTION VALVE INSTALLATION

1. Install the two nuts and bolts which clamp the moisture ejection valve to the vehicle frame, and tighten the nuts to 13 to 15 ft-lbs of torque.

2. Install the reservoir inlet line to the moisture ejection valve (Fig. 1). Tighten the fitting finger tight. Then tighten two and one-half full turns past hand tight.

3. Install the discharge line (if used) to the moisture ejection valve exhaust port (Fig. 1). Tighten the fitting finger tight. Then with a wrench, tighten two and one-half full turns past hand tight.

4. Install the application lines to the moisture ejection valve (Fig. 1). Tighten the fittings finger tight. Then tighten two and one-half full turns past hand tight.

5. Close the wet and dry compressed air reservoir drain cocks, and start the vehicle engine so that the air compressor will refill the wet and dry compressed air reservoirs with air.

6. When air pressure in the reservoirs reaches 100 psi gauged pressure, apply leak test soap-water solution to the application line and reservoir inlet line at the moisture ejection valve, while someone applies the service brakes to cycle the moisture ejection valve. Check the fittings for air leaks. The formation of bubbles more than one inch in diameter in sixty seconds is unacceptable. Retighten fittings and test again. If fittings still leak at unacceptable levels, remove the offending connecting air lines, and replace with new ones. Retest until leakage is non-existent, or is within the tolerance given above.

WARNING: Use eye protection when using compressed air to check the functioning of the moisture ejection valve, as permanent harm to eyes from flying debris could result without such protection. Stay clear from the front of the moisture ejection valve exhaust port, since moisture, scale, or other debris will be ejected with force when the air brakes are cycled.

7. Stop the vehicle engine.

8. Examine the air pressure gauge; if the air loss through the valve is in excess of 1 lb. per minute at 100 psi in either the applied or unapplied position, the moisture ejection valve should be removed, disassembled, repaired, assembled, installed, and tested again. If the moisture ejection valve still has more than 1 lb. per minute at 100 psi air loss, remove the moisture ejection valve and replace it with a new one.

9. Start the vehicle engine.

10. Unblock the vehicle when air line testing is completed, and vehicle has 105-120 psi reservoir pressure for new vehicles, or 90-105 psi reservoir pressure for older vehicles. Installation is complete.

SPECIFICATIONS

Sealco 6300 Moisture Ejection Valve Plumbing Diagram

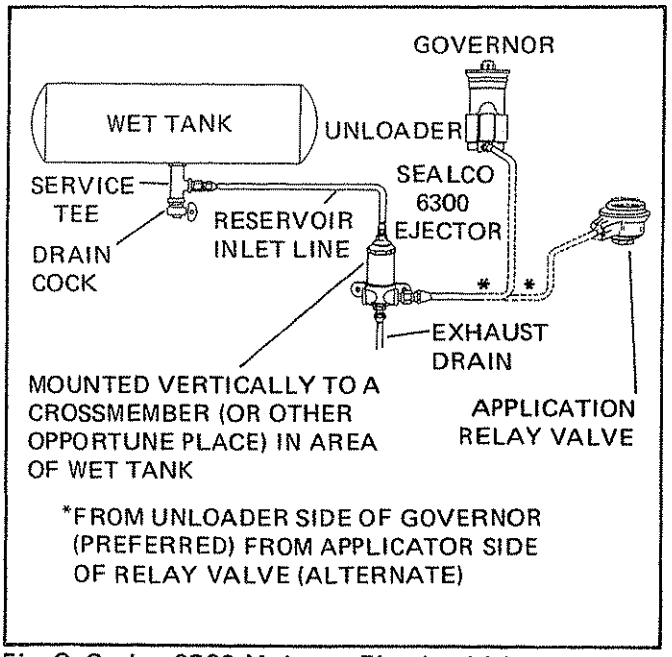


Fig. 3 Sealco 6300 Moisture Ejection Valve Plumbing Diagram

GENERAL INFORMATION

The Brakemaster "George" Model 4008 moisture ejection valve (Fig. 1) is designed to keep the air in the dry tank dry by automatically removing sludge and water from the wet tank. The moisture ejection valve can be plumbed to cycle when the brakes are applied or when the governor unloader operates.

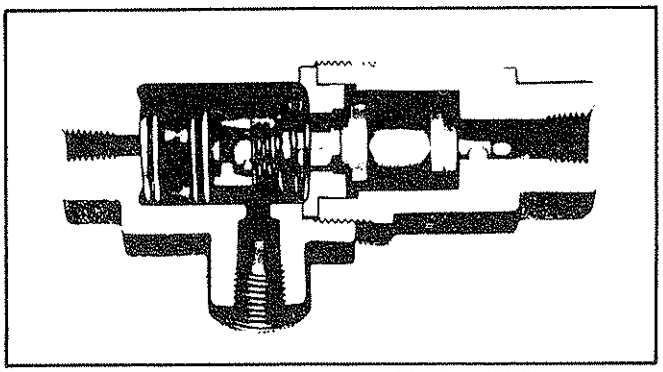


Fig. 1, Brakemaster "George" Model 4008 Moisture Ejection Valve, In Stable State

The moisture ejection valve is plumbed into the air system with two lines; one running from the wet tank (compressed air reservoir), and the other either from the brake treadle application valve or the unloader side of the governor.

A failed moisture ejection valve will allow moisture to build up in the wet tank which in turn could reach the dry tank, and then travel into the air brake system where it could cause braking failure.

A leaking moisture ejection valve allows wet tank leakdown which in turn can cause premature wear of the air compressor during vehicle operation as the air compressor continues to run to maintain wet tank air pressure.

WARNING: Serious air pressure leakage from the moisture ejection valve, or the connecting lines to the moisture ejection valve can cause brake failure through loss of brake air pressure on brake application, which in turn can cause a hazardous operating condition.

PRINCIPLES OF OPERATION

OPERATION WHEN EJECTION VALVE IS PLUMBED TO CYCLE BY SERVICE BRAKE APPLICATION

A service brake application of 15-25 psi and above, forces the piston to compress the spring and move the spindle away from seat number one to open the reservoir inlet. The wet tank air pressure forces fluid and air mixture from the bottom of the wet tank through the reservoir inlet, then through the moisture ejector and out the discharge outlet.

Continued force on the piston compresses the spring still more, until the spindle seats on seat number two in the spindle body, which cuts-off the ejection operation by closing the reservoir inlet.

When the service brake is released the piston pressure is released, which allows the spring to expand. The spindle then unseats from seat number two in the spindle body, allowing the moisture ejection valve to eject, until the spindle seats on seat number one cutting off the ejection cycle.

The moisture ejection valve then remains in a stable state until the next application cycle. (See Figs. 1, 2, & 3).

OPERATION WHEN EJECTION VALVE IS PLUMBED TO CYCLE BY GOVERNOR UNLOADER APPLICATION

The operation of the moisture ejection valve is the same as the description under "OPERATION WHEN EJECTION VALVE IS PLUMBED TO CYCLE BY SERVICE BRAKE APPLICATION" except that the operating air pressure of 15-25 psi and above comes from the governor unloader.

SERVICE OPERATIONS

Use the following procedures to service the moisture ejection valve if found to be inoperative or leaking. See group 12 of the White Freightliner Maintenance Manual for operation and leak testing procedures.

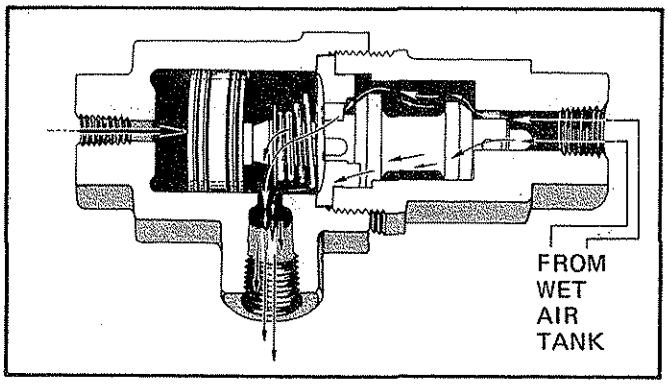


Fig. 2, Brakemaster "George" Model 4008 Moisture Ejection Valve, In Ejection Mode

MOISTURE EJECTION VALVE REMOVAL

1. Safely block the vehicle with chock blocks, and open the drain cocks to bleed the air from the wet and dry compressed air reservoirs. (See Fig. 4 for Brakemaster "George" Model 4008 Moisture Ejection Valve Plumbing Diagram.)

2. Remove the application line from the moisture ejection valve operating line inlet (Fig. 3, Ref. 1).

NOTE: The application line is from the brake treadle application valve or the governor unloader.

3. Remove the discharge line (if the moisture ejection valve has one) from the moisture ejection valve discharge outlet (Fig. 3, Ref. 2).

4. Remove the Brakemaster "George" Model 4008 moisture ejection valve from the service tee at the bottom of the wet tank (Fig. 4).

MOISTURE EJECTION VALVE DISASSEMBLY

1. Place the moisture ejection valve cap (Fig. 3, Ref. 3) in a vise for disassembly, then remove the spindle body (Fig. 3, Ref. 13) from the cap.

NOTE: The spindle assembly consisting of the spindle (Fig. 3, Ref. 11), seat number one (Fig. 3, Ref. 8), gasket (Fig.3, Ref. 9), spring (Fig. 3, Ref. 7), and retaining ring (Fig. 3, Ref. 6) can drop out of the cap when the spindle body is removed.

2. Remove the spindle assembly from the cap.

3. Using a small tool such as a screwdriver push out the piston and U-cup seal assembly (Fig. 3, Refs. 4 & 5) from the cap.

4. Remove the retaining ring (Fig. 3, Ref. 6) from the retaining ring groove (Fig. 3, Ref. 10) on the spindle (Fig. 3, Ref. 11), then remove the spring (Fig. 3, Ref. 7), seat number one (Fig. 3, Ref. 8), and gasket (Fig. 3, Ref. 9) from the spindle.

5. Remove the U-cup seal (Fig. 3, Ref. 5) from the piston (Fig. 3, Ref. 4).

MOISTURE EJECTION VALVE CLEANING AND INSPECTION

1. Wash all component parts of the disassembled moisture ejection valve in a clean soap and water bath. Dry the component parts of the disassembled moisture ejection valve with compressed air.

CAUTION: Use eye protection when using compressed air to clean or dry component parts as permanent harm to eyes from flying debris could result without such protection.

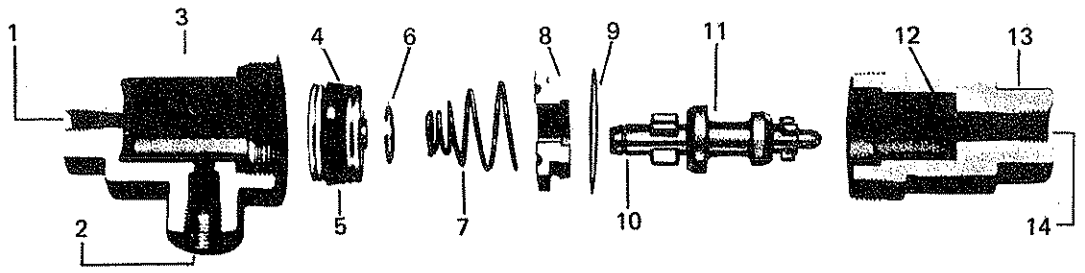
2. Examine the U-cup seal (Fig. 3, Ref. 5). If it is cracked, deteriorated, or damaged, replace it with a new one.

3. Inspect the sealing face of seat one (Fig. 3, Ref. 8), and seat number two (Fig. 3, Ref. 12) in the spindle body. If the sealing faces are corroded, polish them with 500 compound to ensure a tight seal between the spindle, seat number one, and seat number two. If the sealing face of seat number one or seat number two is nicked, or pitted, replace seat number one and the spindle body with new parts.

4. Inspect the spindle (Fig. 3, Ref. 11) for nicks, or damage to the sealing faces which could cause leakage. Replace a damaged spindle with a new one.

5. Inspect the gasket (Fig. 3, Ref. 9) for cuts, breaks, or damage. Replace a cut, broken, or damaged gasket with a new one.

6. Inspect the spring (Fig. 3, Ref. 7). Install a new spring if the present one is broken or corroded.



1. Operating Line Inlet
2. Discharge Outlet
3. Cap
4. Piston
5. U-Cup Seal
6. Retaining Ring
7. Spring
8. Seat Number One
9. Gasket
10. Retaining Ring Groove
11. Spindle
12. Seat Number Two
13. Spindle Body
14. Reservoir Inlet

Fig. 3, Brakemaster "George" Model 4008 Moisture Ejection Valve, Exploded View

7. Inspect the piston (Fig. 3, Ref. 4). Replace the piston with a new one if it is cracked, pitted, or damaged.

MOISTURE EJECTION VALVE ASSEMBLY

1. Install the U-cup seal (Fig. 3, Ref. 5) onto the piston (Fig. 3, Ref. 4).

NOTE: The U-cup seal is installed so that the cup portion will fill with applied air pressure and seal against the inner wall of the cap (Fig. 3, Ref. 3) when the piston is installed. (See Figs. 2 & 3.)

2. Install the gasket (Fig. 3, Ref. 9) onto seat number one (Fig. 3, Ref. 8), then install seat number one onto the spindle (Fig. 3, Ref. 11). Install, and compress the spring (Fig. 3, Ref. 7) onto the spindle, then install the retaining ring (Fig. 3, Ref. 6) into the retaining ring groove (Fig. 3, Ref. 10) on the spindle.

3. Install the piston and U-cup seal assembly (Fig. 3, Refs. 4 & 5) into the cap (Fig. 3, Ref. 3).

4. Install the spindle assembly into the cap.

5. Place the moisture ejection valve cap (Fig. 3, Ref. 3) in a vise for assembly, then install the spindle body (Fig. 3, Ref. 13) into the cap. Tighten the spindle body finger tight. Then, with a wrench, tighten the spindle body two and one-half full turns past hand tight.

MOISTURE EJECTION VALVE INSTALLATION

1. Install the Brakemaster "George" Model 4008 moisture ejection valve onto the service tee at the bottom of the wet tank (Fig. 4). Tighten the moisture ejection valve hand tight, then tighten with a wrench until a solid feeling is reached; then tighten one sixth turn more. Do not overtighten.

NOTE: The final position of the moisture ejection valve should be as in Fig. 4, with the discharge outlet (Fig. 3, Ref. 2) pointed downward from the wet tank. Adjust to obtain this position.

2. If equipped with a discharge line, install it into the moisture ejection valve discharge outlet (Fig. 3, Ref. 2). (See Fig. 4 for Brakemaster "George" Model 4008 Moisture Ejection Valve Plumbing Diagram.) Tighten the discharge line fitting hand tight, then tighten with a wrench until a solid feeling is reached; then tighten one sixth turn more. Do not overtighten.

3. Install the application line (from the brake treadle valve, or from the governor unloader) into the moisture ejection valve operating line inlet (Fig. 3, Ref. 1). Tighten the application line fitting hand tight, then tighten with a wrench until a solid feeling is reached; then tighten one sixth turn more. Do not overtighten.

4. Close the drain cocks to the wet and dry compressed air reservoirs. Start the vehicle engine to pressurize the air system.

5. Leak test the application line and wet tank inlet fitting at the moisture ejection valve with a leak testing soap water solution, while someone applies the brakes to cycle the moisture ejection valve.

   If the moisture ejection valve is plumbed to cycle when the governor unloads, then continue brake applications until the governor unloads to start the air compressor.

   Check the fittings for air leaks; bubble formation of more than one inch bubbles in three seconds or less is unacceptable. Retighten fittings and test again.

   If fittings still leak at unacceptable levels, remove the offending connecting air lines, and replace with new ones. Retest until leaks are no longer present.

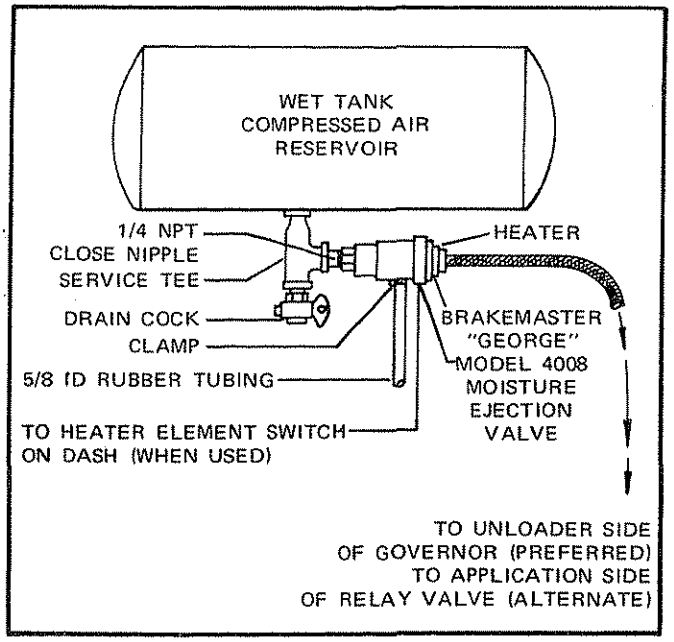


Fig. 4, Brakemaster "George" Model 4008
Moisture Ejection Valve Plumbing Diagram

WARNING: Use eye protection when checking the functioning of the moisture ejection valve, as permanent harm to eyes could result due to moisture, scale or other debris being ejected with force when the brakes are cycled.

6. Remove chock blocks from the vehicle.

GENERAL DESCRIPTION

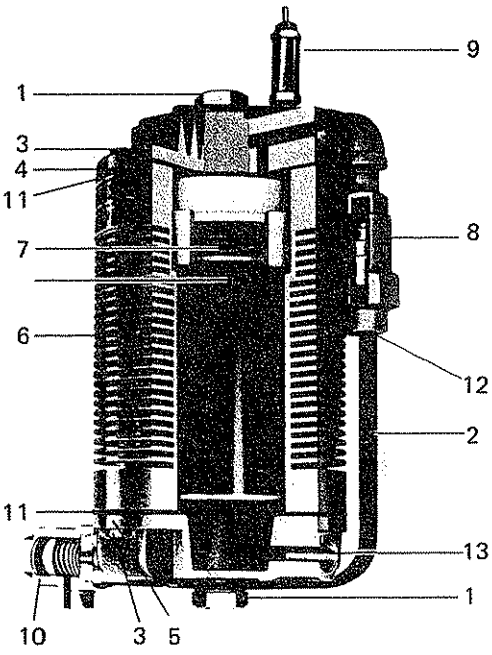
The Brakemaster aftercooler is a heat transfer device mounted between the air compressor and the reservoir. It cools the compressed air to ambient temperature before the air enters the air brake system. Model 1500 is a larger size version of the Model 900; there are no service differences between the two models.

A

PRINCIPLES OF OPERATION

The temperature drop of the air entering the cooler condenses the moisture and oil vapors in the compressed air into liquids. The automatic unloader at the base of the aftercooler discharges these liquids and unloads both the air compressor and aftercooler to atmospheric pressure at every air compressor start cycle. This permits the compressor to start each cycle against atmospheric pressure instead of the reservoir pressure. The aftercooler is equipped with a pressure safety valve of various manufacturers as it is not a Brakemaster installed item. This safety valve releases at 150±5 psi, and is installed on the top of the aftercooler housing. See Fig. 1 for nomenclature and cross section view of the aftercooler.

A



1. Capscrews
2. Hanger Bracket
3. Capscrews
4. Top Cap
5. Bottom Cap
6. Aftercooler Body
7. Filter Cup & Stainless Steel Element
8. Check Valve Assembly
9. Safety Valve Assembly
10. Unloader Assembly
11. Gasket(s)
12. Check Valve Outlet
13. Compressor Line Inlet

Fig. 1, Brakemaster Aftercooler, Cutaway View

SERVICE OPERATIONS

The Brakemaster aftercooler needs servicing only if it fails to eject, or if it leaks air at the unloader. If either or both of these failures occur, the aftercooler should be removed, disassembled, cleaned, inspected, assembled, and installed in accordance with the following procedures.

AFTERCOOLER REMOVAL

1. Safely block the vehicle wheels, then open the wet and dry air reservoir drain cocks. Leave them open until all air pressure has bled off, and drainage stops.

WARNING: The aftercooler must be made safe by draining the air system. Working on a pressurized air system can result in equipment damage and personal injury. Use eye protection when draining the air reservoirs as permanent harm to eyes from flying debris could result without eye protection.

2. Disconnect the air line from the governor to the unloader (Fig. 2, Ref. 1); from the compressor to the aftercooler (Fig. 2, Ref. 2); and from the check valve to the wet tank (Fig. 2, Ref. 3). (See also Fig. 1.)

3. Remove the top and bottom capscrews (Fig. 1, Ref. 1) that attach the aftercooler to the hanger bracket (Fig. 1, Ref. 2).

NOTE: When these top and bottom capscrews are removed, the aftercooler can be removed from the hanger bracket for disassembly.

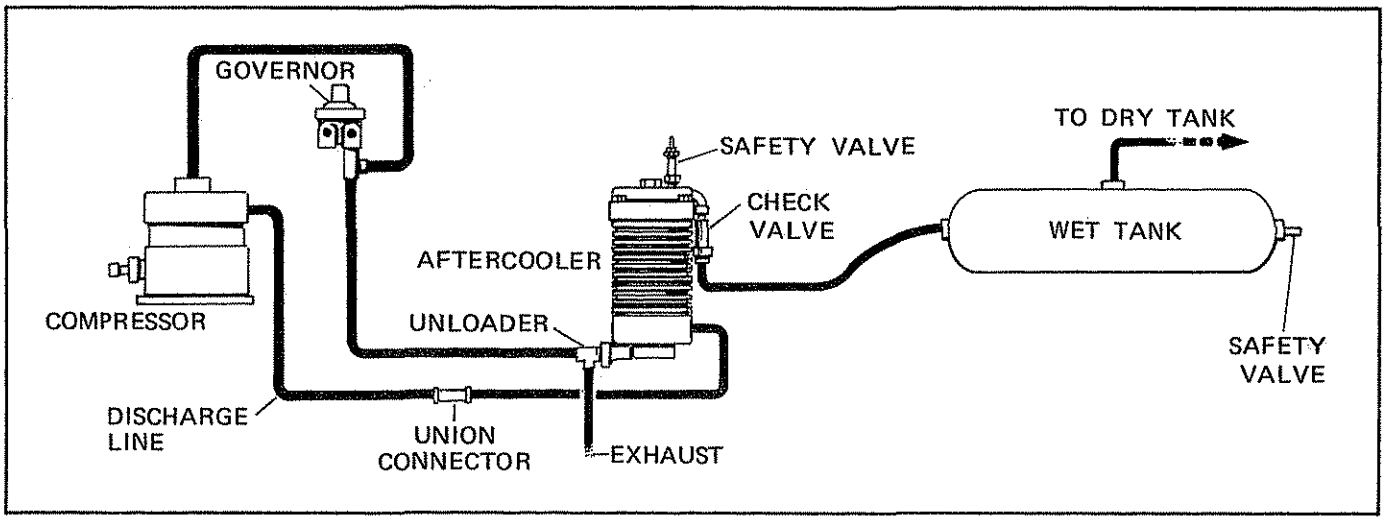


Fig. 2, Aftercooler Air Piping Diagram

DISASSEMBLY OF THE AFTERCOOLER

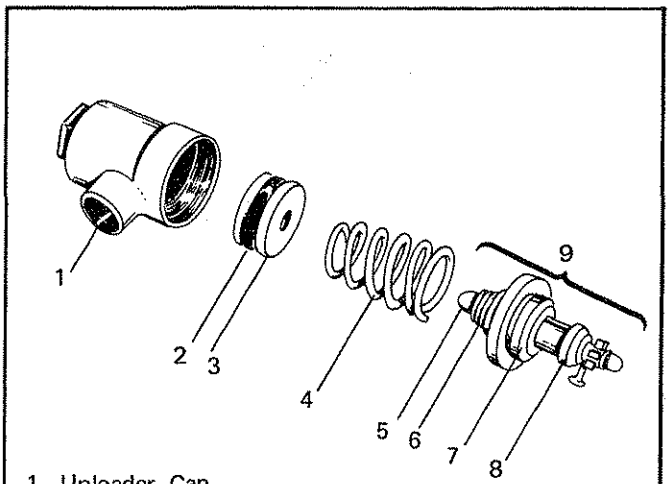
1. Remove the sixteen capscrews (Fig. 1, Ref. 3) from the top and bottom caps (Fig. 1, Refs. 4 & 5).
2. Remove the top and bottom caps (Fig. 1, Refs. 4 & 5) from the aftercooler body (Fig. 1, Ref. 6).
3. Remove the filter cup assembly with the stainless steel filter element (Fig. 1, Ref. 7) from the top of the aftercooler body (Fig. 1, Ref. 6).
4. Remove the check valve assembly (Fig. 1, Ref. 8) from the top cap (Fig. 1, Ref. 4).
5. Remove the safety valve assembly (Fig. 1, Ref. 9) from the top cap.
6. Remove the unloader assembly (Fig. 1, Ref. 10) from the bottom cap (Fig. 1, Ref. 5).
7. Wash all removed components, except the unloader assembly, and the safety valve assembly, in a clean soap and water bath. Dry with compressed air.

WARNING: Use eye protection such as safety glasses when using compressed air to clean or dry components as permanent harm to eyes from flying debris could result without such protection.

8. Inspect all components for breaks, cracks, or other damage which could cause aftercooler failure. Replace any damaged components with new ones.

DISASSEMBLY OF THE UNLOADER

1. Remove the unloader piston (Fig. 3, Ref. 3), large unloader spring (Fig. 3, Ref. 4), and unloader valve assembly (Fig. 3, Ref. 9) from the unloader cap (Fig. 3, Ref. 1).



1. Unloader Cap
2. Unloader U-cup Seal
3. Unloader Piston
4. Large Unloader Spring
5. Unloader Spindle
6. Small Unloader Spring
7. Unloader Seat Ring
8. Unloader Retaining Ring
9. Unloader Valve Assembly

Fig. 3, Unloader, Exploded View

2. Remove the unloader retaining ring (Fig. 3, Ref. 8) from the unloader spindle (Fig. 3, Ref. 5), and remove the unloader spindle from the unloader seat ring (Fig. 3, Ref. 7).

3. Remove the small unloader spring (Fig. 3, Ref. 6) from the unloader spindle (Fig. 3, Ref. 5). A

4. Wash all unloader valve assembly components, the unloader cap, the unloader piston, and the large unloader spring in a clean soap and water bath. Air blow dry with compressed air.

WARNING: Use eye protection when using compressed air to clean or dry components in order to prevent permanent harm to eyes from flying debris.

5. Inspect all unloader components for cracks, breaks, or other damage. Replace any damaged unloader components with new ones.

SAFETY VALVE ASSEMBLY TEST

1. Attach a compressed air hose with a pressure gauge and control petcock to the safety valve assembly (Fig. 4).

2. Clamp the safety valve in a vise with the pressure relief outlet (Fig. 4) pointed downward. Tie down the compressed air hose. A

WARNING: Use eye protection when using compressed air to test the safety valve. Without this protection, flying debris could cause permanent eye damage when the safety valve releases pressure.

3. Apply compressed air slowly at 160 psi to the safety valve. The safety valve should release pressure at a gauged pressure of 150±5 psi.

4. Cease applying compressed air to the safety valve at 160 psi. The safety valve should close at 135±10 psi gauged pressure.

5. If the safety valve meets the requirements of steps 3 and 4, above, it can continue to be used. If the safety valve does not meet these requirements, it should be replaced with a new safety valve.

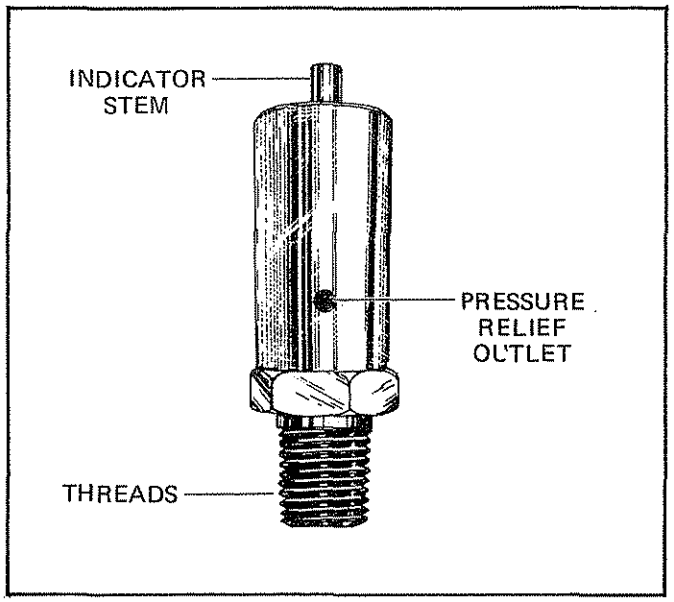


Fig. 4, Typical Safety Valve

ASSEMBLY OF THE UNLOADER

1. Install the small unloader spring (Fig. 3, Ref. 6) onto the unloader spindle (Fig. 3, Ref. 5).

2. Install the unloader spindle into the unloader seat ring (Fig. 3, Ref. 7), and install the unloader retaining ring (Fig. 3, Ref. 8) onto the unloader spindle.

3. Install the unloader valve assembly (Fig. 3, Ref. 9), large unloader spring (Fig. 3, Ref. 4), and unloader piston (Fig. 3, Ref. 3) into the unloader cap (Fig. 3, Ref. 1), then install unloader cap (Fig. 3, Ref. 1) onto the bottom cap (Fig. 1, Ref. 5). Tighten the unloader cap to 8 - 10 ft-lbs.

NOTE: The unloader cap outlet opening (exhaust) should be facing downward after tightening procedure.

ASSEMBLY OF THE AFTERCOOLER

1. Install the check valve assembly (Fig. 1, Ref. 8) onto the top cap (Fig. 1, Ref. 4), and tighten the check valve assembly hand tight. Then, with a wrench, tighten two and one-half full turns past hand tight.

2. Install the filter cup assembly with the stainless steel filter element (Fig. 1, Ref. 7) into the top of the aftercooler body (Fig. 1, Ref. 6).

3. Install the top and bottom caps (Fig. 1, Refs. 4 & 5) onto the aftercooler body using new gaskets (Fig. 1, Ref. 11).

CAUTION: Reuse of old gaskets on the top and bottom caps can cause aftercooler failure. New gaskets should be used.

4. Install the sixteen capscrews (Fig. 1, Ref. 3) into the top and bottom caps (Fig. 1, Refs. 4 & 5). Tighten capscrews to 12 to 15 ft-lbs.

5. Test the assembled aftercooler for air leaks.

   .1 Plug the check valve outlet (Fig. 1, Ref. 12).

   .2 Apply a compressed air pressure of 60 to 130 psi through the compressor line inlet (Fig. 1, Ref. 13).

WARNING: Use eye protection when using compressed air to check component operation as permanent harm to eyes from flying debris could result without such protection.

   .3 Apply soap water test solution on the top and bottom gaskets, and the unloader valve assembly. Formation of a one inch bubble in three seconds or less is unacceptable. If no bubbles form, check by visual and audio means to see or hear if air is escaping at too fast a rate to form bubbles. Such leaks are unacceptable. If unacceptable leaks are present, remove the aftercooler from the test setup and repeat steps listed under "ASSEMBLY OF THE UNLOADER" and "ASSEMBLY OF THE AFTERCOOLER."

   Test again. Repeat this procedure until leaks have been eliminated. If leaks persist, install a new aftercooler. If no leaks are present, proceed to step 5.4.

   .4 To test the check valve for air leakage, remove the air line to the compressor inlet (Fig. 1, Ref. 13). Apply a compressed air pressure of 60 to 130 psi to the outlet side of the check valve (Fig. 1, Ref. 12). Apply soap-water test solution to the compressor inlet line opening. Bubble formation of a one inch bubble in three seconds or less is unacceptable. If no bubbles form, check by visual and audio means to see or hear if air is escaping at too fast a rate to form bubbles. Such leaks are unacceptable. If such leaks are present, remove the aftercooler from the test setup and repeat steps listed under "ASSEMBLY OF THE UNLOADER" and "ASSEMBLY OF THE AFTERCOOLER." Test again. Repeat this procedure until leaks have been eliminated. If leaks persist, install a new aftercooler. If no leaks are present, testing is completed.

AFTERCOOLER INSTALLATION

1. Attach the aftercooler to the hanger bracket (Fig. 1, Ref. 2) with the top and bottom capscrews (Fig. 1, Ref. 1). Tighten the capscrews to 14 ft-lbs.

2. Connect the air lines from the governor to the unloader (Fig. 2, Ref. 1); from the compressor to the aftercooler (Fig. 2, Ref. 2), and from the check valve to the wet tank (Fig. 2, Ref. 3). Tighten air lines hand tight, then wrench tighten until a solid feeling is reached; then tighten one sixth turn more. Do not overtighten.

3. Close the wet and dry air reservoir drain cocks, and start the vehicle to pressurize the wet and dry air reservoirs. When the air pressure reaches the safe level in the wet and dry air reservoirs for brake application, remove the safety blocks from the vehicle wheels. The safe level for air pressure is 105-120 psi on newer vehicles, and 90-105 psi on older vehicles.

NOTE: The aftercooler location should allow free circulation of cool air around the body fins. The compressor discharge line should be a minimum of 1/2" O.D. uncovered tubing, not less than 24" long, and not more than 30" long to the anchor connection. The flexible hose from the anchor connection to the aftercooler should be No. 10 size and not over 36" long. Do not paint the aftercooler body assembly. Painting of the body assembly will destroy the heat radiating capabilities of the unit, and cause inefficient operation.

TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTIONS
Check valve leaks.	Foreign material under valve seat.	Remove foreign material from under seat.
	Seat surfaces pitted or worn.	Remove the check valve. Disassemble valve, clean parts. Repair or replace broken, cracked, or worn parts. Test unit for leaks as covered in "ASSEMBLY OF THE AFTERCOOLER."
Pulsating leak at aftercooler unloader port.	Compressor unloader valve leaking.	Check the compressor unloader valve and repair or replace.
	Weak aftercooler unloader valve spring.	Install new aftercooler unloader valve spring and spring seat.
	Carbon or foreign material under aftercooler unloader valve seat.	Remove carbon or foreign material from aftercooler unloader seat surface.

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

GENERAL DESCRIPTION

The CR Brakemaster air dryer (Fig. 1) is a heat exchanger air dryer. Mounted vertically between the air compressor and the supply reservoir, the air dryer receives hot compressed air, which it cools and filters before sending it to the supply reservoir. With this process, the air dryer curbs the accumulation of dirt and moisture in the vehicle air system.

The air dryer consists of a one-piece aluminum body with integral external fins designed to increase the surface area available for heat transfer. The top cap of the air dryer houses a pressure release safety valve and an outlet port. A check valve is incorporated into the outlet port.

The bottom cap houses three ports. The inlet port, located in the side of the bottom cap, receives air from the compressor. The unloader port, located near the bottom of the cap, houses a valve assembly and is connected to the air governor unloader port. The exhaust port, located in the bottom of the end cap, is where the collected moisture and contaminants are expelled from the unit.

Air dryers manufactured after January 1, 1979, are equipped with a 50 watt, 12 volt thermostatically controlled cartridge-type heater, or an optional 50 watt, 24 volt heater. Air dryers manufactured before January 1, 1979, were optionally equipped with a non-thermostatic, wrap-around, strap-type heater.

PRINCIPLES OF OPERATION

Hot compressed air, arriving from the air compressor, enters the CR Brakemaster through the inlet port located near the bottom of the unit. As the hot air is forced upward into the narrow channel between the deflector and the finned air dryer walls, the air temperature is reduced to near ambient. The resulting condensation of oil and water vapor settles into the sump. Once the cooled air reaches the top of the unit, it is filtered through

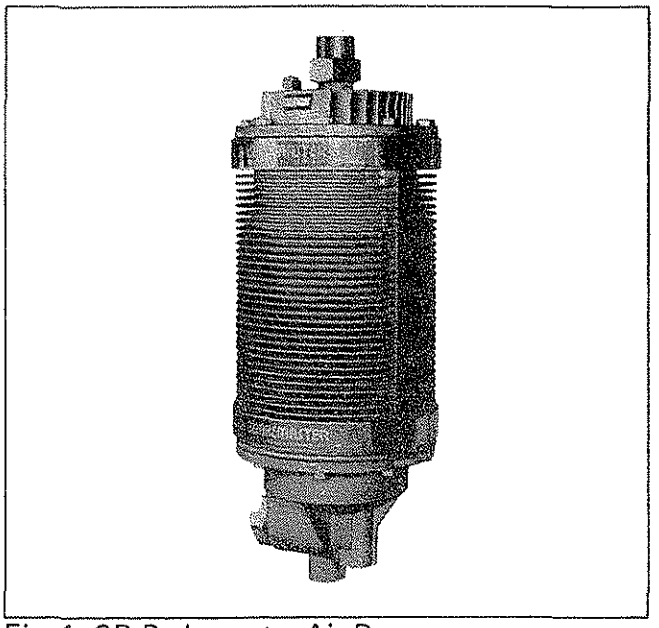


Fig. 1, CR Brakemaster Air Dryer

a mass of fine, stainless steel wires, which remove microscopic carbon and other solid particles from the air. The air then passes to the supply reservoir through the air dryer outlet port.

When the air compressor reaches the air governor cut-out point (120 psi [827 kPa]), the air dryer unloader valve opens automatically, due to air pressure from the governor valve. This rapid change causes a backrush of air through the air filter, which forces the accumulated solids and contaminants out through the exhaust port. The air dryer is then ready for the next cycle.

After each operation of the unloader valve, the system between the air compressor and air dryer is reduced to atmospheric pressure. Thus, the air compressor starts each cycle pumping against atmospheric pressure.

SERVICE OPERATIONS

IMPORTANT: If the air compressor is rebuilt or replaced, or if the CR Brakemaster is moved from one vehicle to another, it is recommended that it be completely disassembled and cleaned.

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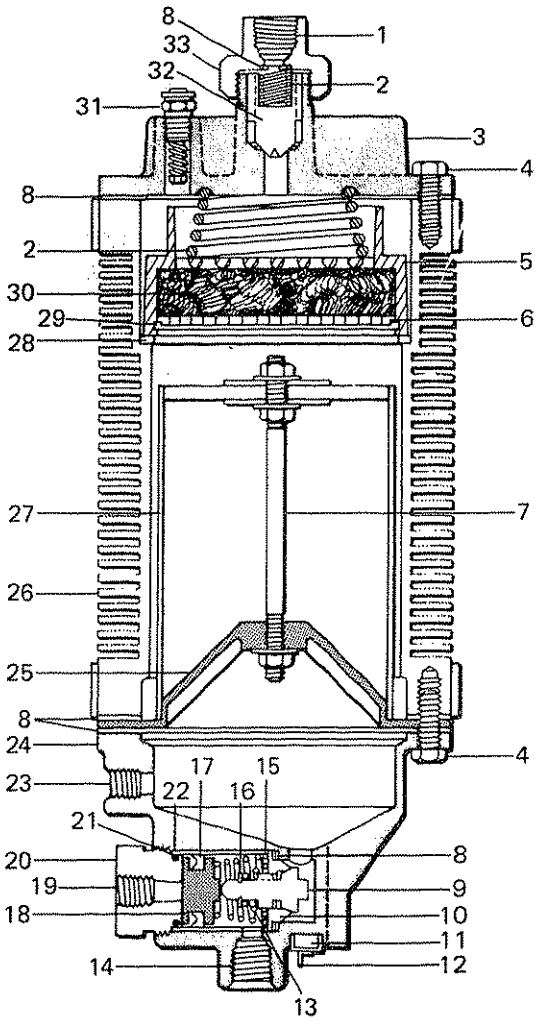
CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68



1. Outlet Port
2. Spring
3. Top Cap
4. Capscrew
5. Filter Cup
6. Strainer
7. Support Rod Assembly
8. Gasket(s)
9. Unloader Spindle
10. Seat Ring
11. Heater
12. Thermostat
13. Small Spring
14. Exhaust Port
15. Large Spring
16. Retaining Ring
17. U-Cup
18. Unloader Piston
19. Unloader Port
20. Unloader Nut
21. O-Ring
22. Unloader Valve Sleeve
23. Inlet Port
24. Bottom Cap
25. Mounting Plate
26. Body
27. Deflector
28. Packing Ring
29. V-Spring
30. Filter
31. Safety Valve
32. Spindle
33. Nut

Fig. 2, CR Brakemaster Air Dryer Nomenclature

PREPARATION FOR SERVICING

1. Apply the spring parking brakes, then chock block the vehicle tires.

2. Drain the air from the air reservoirs.

3. Release the air pressure in the line leading from the unloader port of the air dryer by slowly loosening the fitting.

WARNING: If caution is not used when loosening this fitting, the line can whip, resulting in possible personal injury or causing the air stream to direct dirt and sludge particles toward persons in the area.

CAUTION: When removing the air line from the unloader port, secure the unloader nut with a wrench to prevent turning the unloader nut. See Fig. 2. Turning the unloader nut will alter the alignment of the holes in the exhaust port and unloader valve sleeve, and render the air dryer inoperative.

4. Clean the CR Brakemaster and the area surrounding the air dryer to reduce the possibility

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

of introducing dirt, oil, or other road grime into the air brake system.

CR BRAKEMASTER REMOVAL AND INSTALLATION

Removal

NOTE: If the air dryer is located on the vehicle in a position where service operations may be safely and easily performed, removal is not necessary unless the unit is to be replaced.

1. Follow the procedures listed under the heading, "PREPARATION FOR SERVICING," in this subject.
2. Disconnect the electrical line from the air dryer heater, if so equipped.
3. Disconnect the air lines from the CR Brakemaster, marking the lines for later assembly.
4. Remove the nuts and bolts on the mounting bracket which mount the air dryer to the vehicle.

Installation

1. Position the air dryer on the vehicle, then install the fasteners which mount the unit to the vehicle. If SAE Grade 5 fasteners are used, tighten them to 55-65 ft-lbs (75-88 N·m). If SAE Grade 8 fasteners are used, tighten them to 80-90 ft-lbs (109-122 N·m). Refer to Fig. 3 to determine what grade fasteners are used.

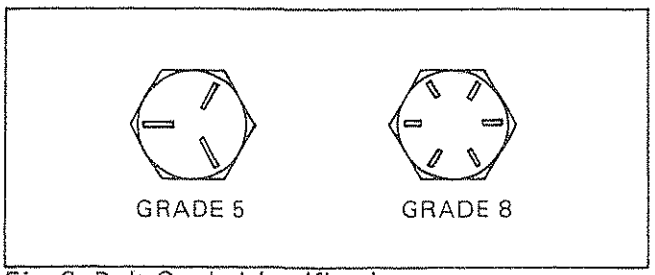


Fig. 3, Bolt Grade Identification

2. Insure that the air lines are free of grease and dirt, and replace any line or fitting which is crimped or damaged.
3. Connect the air lines to the CR Brakemaster as previously marked, or as shown in Fig. 8 located under "SPECIFICATIONS," in this subject. Tighten the nut on each fitting finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more.

CAUTION: When connecting the air line to the CR Brakemaster unloader port, secure the unloader nut with a wrench to prevent turning the unloader nut. Turning the unloader nut will alter the alignment of the holes in the exhaust port and unloader sleeve, and render the air dryer inoperative.

4. If so equipped, connect the electrical line to the air dryer heater.
5. Perform the "OPERATING TESTS," in this subject, after installation of the CR Brakemaster on the vehicle and before placing the vehicle in service.

UNLOADER VALVE ASSEMBLY SERVICING (Refer to Fig. 2)

1. Follow the procedures listed under the heading, "PREPARATION FOR SERVICING," in this subject.
2. If the air dryer is still mounted on the vehicle, disconnect the electrical line from the heater, if so equipped. Disconnect the air lines from the inlet and unloader ports, marking the lines for later assembly.
3. Remove the unloader nut.

WARNING: The unloader nut is spring loaded. While removing it from the unloader port, moderate pressure must be applied by hand to prevent the nut from ejecting as the large spring inside the unloader port uncoils. Failure to apply moderate pressure may result in personal injury.

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

4. Remove the unloader valve assembly (Fig. 4) from the unloader port.

NOTE: If there is an excessive accumulation of oil in the unloader valve assembly, the air compressor should be checked and serviced following the instructions given in the 01 Group of this manual and the Freightliner Maintenance and Lube Manual, or by referring to the applicable air compressor manufacturer's maintenance manual.

5. Clean the unloader valve assembly with a commercial solvent, then examine the assembly for nicks, wrinkles, or axial scratches. If the unloader valve sleeve, or any other part of the unloader valve assembly, is nicked, wrinkled, or has axial scratches, the unloader valve assembly should be replaced.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

NOTE: The unloader spindle, seat ring, small spring, and retaining ring are a mated assembly and should not be disassembled.

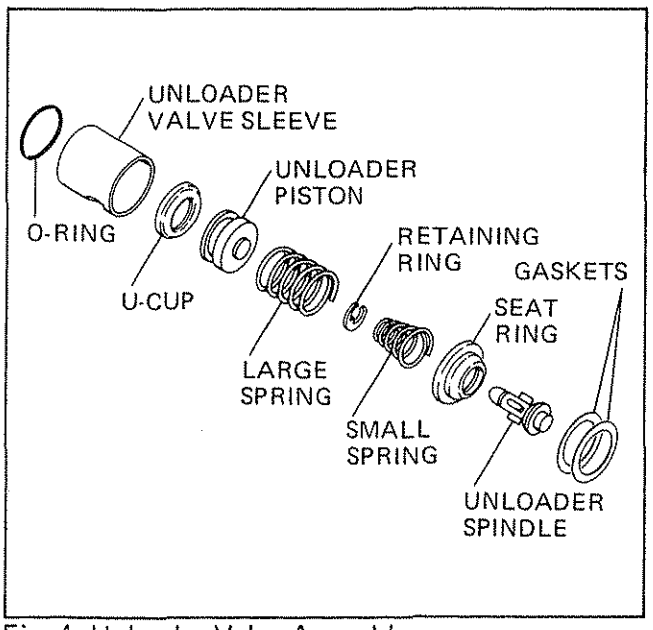


Fig. 4, Unloader Valve Assembly

6. Place the two copper gaskets together and lightly coat the exposed surfaces with grease. Use a multi-purpose, high temperature grease that is resistant to water, steam, and alkali.

7. Place the gaskets on the side of the seat ring opposite the small spring. Place the gaskets and seat ring into the unloader port, gasket end first.

8. Install the unloader valve sleeve into the unloader port, with the 1/2" diameter cross hole near the seat ring. Insert the large spring into the unloader valve sleeve, with the larger diameter coil resting against the seat ring.

9. Install the U-cup in the groove of the unloader piston with the lips of the U-cup facing away from the spring seat. When installing the U-cup, do not use sharp tools that may mar or score the parts. Insert the unloader piston and U-cup into the unloader sleeve, with the unloader piston resting against the large spring.

10. Install the O-ring on the end of the unloader nut, then lightly grease the O-ring. Apply a non-hardening sealing compound to the threads of the unloader nut.

11. Insert a 1/2" (12.7 mm) diameter rod into the exhaust port, and through the 1/2" diameter cross hole of the unloader valve sleeve. This will assure alignment of the holes while the unloader nut is tightened.

CAUTION: If the exhaust port and the cross hole of the unloader valve sleeve are not aligned, the air dryer will not operate.

12. Install the unloader nut, then, with the rod in place in the exhaust port, tighten the nut to 60 ft-lbs (81 N·m). Remove the rod from the exhaust port.

CAUTION: Do not overtighten the unloader nut. To do so will result in damage to the unloader valve assembly.

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

13. If the CR Brakemaster was removed from the vehicle, install it on the vehicle following the procedures given under the heading, "CR BRAKEMASTER INSTALLATION," in this subject.

    If the unit is still mounted on the vehicle, connect the air lines to the air dryer as previously marked, or as shown in Fig. 8 located under "SPECIFICATIONS," in this subject. Tighten the nut on each fitting finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more.

CAUTION: When reinstalling the air line to the air dryer unloader port, secure the unloader nut with a wrench to prevent turning the unloader nut. Turning the unloader nut will alter the alignment of the holes in the exhaust port and unloader valve sleeve, and render the air dryer inoperative.

14. If so equipped, connect the electrical line to the heater.

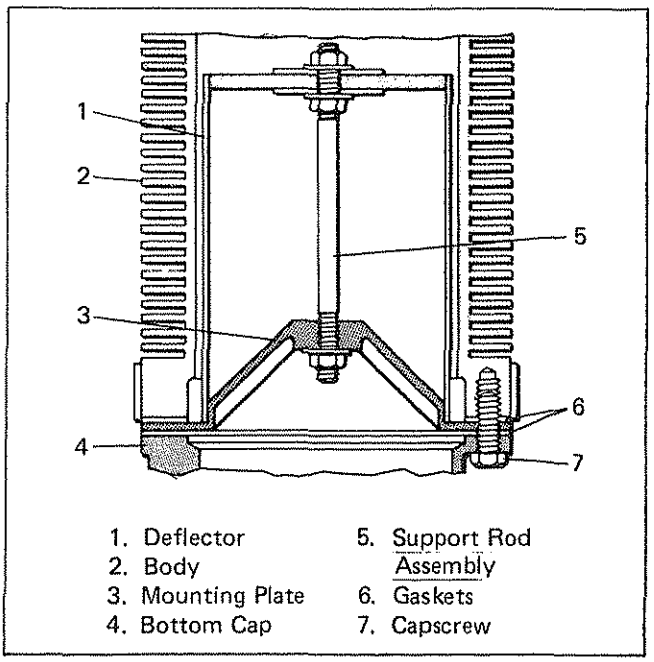
15. Perform the "OPERATING TESTS," in this subject, after servicing the air dryer and before placing the vehicle in service.

DEFLECTOR ASSEMBLY REPLACEMENT
(Refer to Fig. 5)

1. Follow the procedures listed under the heading, "PREPARATION FOR SERVICING," in this subject.

2. If the CR Brakemaster is still mounted on the vehicle, disconnect the electrical line from the heater, if so equipped. Disconnect the air lines from the inlet and unloader ports, marking the lines for later assembly.

3. Remove the eight capscrews holding the bottom cap to the body of the air dryer. Remove the bottom cap and the deflector, discarding the deflector.



1. Deflector
2. Body
3. Mounting Plate
4. Bottom Cap
5. Support Rod Assembly
6. Gaskets
7. Capscrew

Fig. 5, Deflector Assembly

NOTE: On some models, the deflector is attached to the bottom cap. If this is the case, the deflector should be removed from the bottom cap by removing and discarding the four screws that hold the deflector to the bottom cap. Also remove and discard the feet of the bottom cap (to which the deflector was attached).

4. Carefully remove all traces of gasket material from the gasket surfaces of the bottom cap and of the air dryer body. Do not scratch or mar the gasket surfaces. Discard the old gaskets.

5. Using a commercial solvent, clean the bottom cap and the inside of the CR Brakemaster body.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

6. Place a new gasket on the top surface of the new deflector mounting plate, and place another new gasket on the gasket surface of the bottom cap.

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

7. Align the bolt holes, then insert the deflector assembly inside the Brakemaster body. Position the bottom cap against the bottom gasket surface of the deflector mounting plate.

NOTE: The use of a gasket sealant is not recommended.

8. Insert the eight capscrews that attach the bottom cap to the body and the deflector assembly. Tighten the capscrews alternately and evenly to 15 ft-lbs (20 N·m).

NOTE: If the unit was previously equipped with the old style deflector which was attached to the bottom cap, use the eight longer capscrews that are available in the replacement kit to attach the bottom cap to the air dryer body and the deflector assembly.

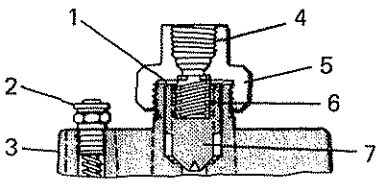
9. If the CR Brakemaster was removed from the vehicle, install it on the vehicle following the procedures given under the heading, "CR BRAKEMASTER INSTALLATION," in this subject.

   If the unit is still mounted on the vehicle, connect the air lines to the air dryer as previously marked or as shown in Fig. 8 located under "SPECIFICATIONS," in this subject. Tighten the nut on each fitting finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more.

CAUTION: When connecting the air line to the unloader port, secure the unloader nut with a wrench to prevent turning the unloader nut. Turning the unloader nut will alter the alignment of the holes in the exhaust port and unloader valve sleeve, and render the air dryer inoperative.

10. If so equipped, connect the electrical line to the heater.

11. Perform the "OPERATING TESTS," in this subject, after servicing the CR Brakemaster and before placing the vehicle in service.



1. Gasket
2. Safety Valve
3. Top Cap
4. Outlet Port
5. Nut
6. Spring
7. Spindle

Fig. 6, Check Valve Assembly

CHECK VALVE ASSEMBLY REPLACEMENT (Refer to Fig. 6)

1. Follow the procedures listed under the heading, "PREPARATION FOR SERVICING," in this subject.

2. If the CR Brakemaster is still mounted on the vehicle, disconnect the air line from the outlet port, marking the line for later assembly.

3. Remove the nut from the outlet port.

WARNING: This nut is spring loaded. While removing it from the outlet port, moderate pressure must be applied by hand to prevent the nut from ejecting as the spring inside the outlet port uncoils. Failure to apply moderate pressure may result in personal injury.

4. Remove and discard the copper gaskets, spring, and spindle.

5. Using a commercial solvent, clean the inside and the outside of the outlet port area of the air dryer, also clean the nut removed from the outlet port. Let the area dry before installing the new parts.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

6. Position the spindle in the outlet port, tapered end down, then install the spring in the spindle.

7. Install the copper gaskets in the nut removed from the outlet port, then rub a small quantity of grease on the gaskets to help them keep their position in the nut. Use a multi-purpose, high temperature grease that is resistant to water, steam, and alkali. Install the nut onto the outlet port, tightening to 60 ft-lbs (81 N·m).

8. If the CR Brakemaster was removed from the vehicle, install it on the vehicle following the procedures given under the heading, "CR BRAKEMASTER INSTALLATION," in this subject.

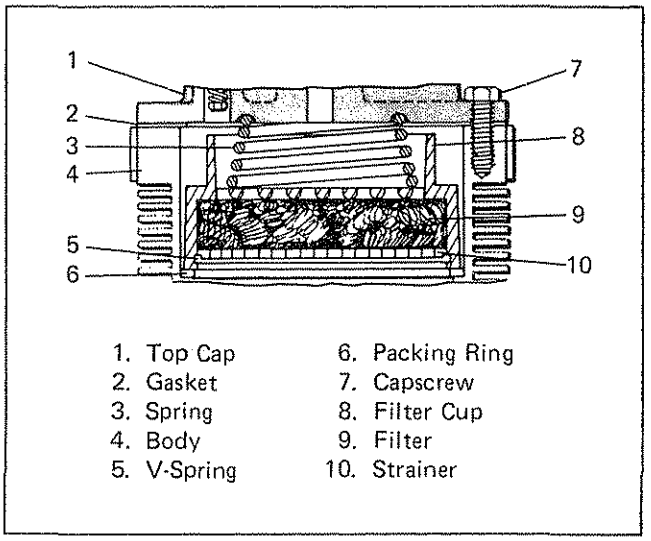
   If the unit is still mounted on the vehicle, connect the air line to the outlet port, as previously marked or as shown in Fig. 8 located under "SPECIFICATIONS," in this subject. Tighten the nut on the fitting finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more. Using the same procedures, also tighten the fitting at the unloader port that was loosened during the "PREPARATION FOR SERVICING" procedures.

CAUTION: When connecting the air line to the unloader port, secure the unloader nut with a wrench to prevent turning the unloader nut. Turning the unloader nut will alter the alignment of the holes in the exhaust port and unloader valve sleeve, and render the air dryer inoperative.

9. Perform the "OPERATING TESTS," in this subject, after servicing the air dryer and before placing the vehicle in service.

SAFETY VALVE REPLACEMENT

CR Brakemaster recommends that the safety valve not be removed from the top cap. If the safety valve has been removed, replace the valve with a new safety valve. Apply a non-hardening sealant to the threads of the top cap before installing the new safety valve.



1. Top Cap
2. Gasket
3. Spring
4. Body
5. V-Spring
6. Packing Ring
7. Capscrew
8. Filter Cup
9. Filter
10. Strainer

Fig. 7, Filter Assembly

FILTER ASSEMBLY SERVICING
(Refer to Fig. 7)

1. Follow the procedures listed under the heading, "PREPARATION FOR SERVICING," in this subject.

2. If the air dryer is still mounted on the vehicle, disconnect the air line from the outlet port, marking the line for later assembly.

3. Remove the eight capscrews holding the top cap to the body of the air dryer, then remove the top cap from the body of the air dryer.

WARNING: The top cap of the air dryer is spring loaded to approximately 40 lbs (18 kg). While removing the top cap from the body of the air dryer, pressure must be applied by hand to prevent the top cap from ejecting as the spring beneath the top cap uncoils. Failure to apply pressure may result in personal injury.

4. Carefully remove all traces of gasket material from the gasket surfaces of the top cap and of

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

the air dryer body. Do not scratch or score the gasket surfaces. Discard the gasket.

5. Using a commercial solvent, clean the top cap.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

6. Remove the complete filter assembly from the body of the air dryer.

7. Discard the packing ring and the filter. If the filter assembly is to be replaced, also discard the filter cup, strainer, and V-spring, then proceed to step 10. If the filter assembly is not to be replaced, proceed to step 8.

8. Using a commercial solvent, wash the strainer and filter cup. Then, place the new filter in the filter cup, stretching the filter slightly to fill the space in the filter cup.

9. Install the strainer on the filter, with the flat face of the strainer towards the filter. Then, install the V-spring to hold the assembly together.

10. Install the packing ring on the ledge of the body of the air dryer. Install the filter assembly, V-spring down, into the body. The filter assembly must rest on the packing ring.

11. Install the spring with the larger diameter coil against the top of the filter assembly. Position the new gasket on the body.

NOTE: Do not use a gasket cement on the gasket.

12. Install the top cap on the body of the air dryer, making sure the small diameter coil on the spring fits into the groove in the top cap.

13. Compress the spring, then install four of the capscrews evenly around the top cap of the Brakemaster. The capscrews should be engaged at least three full turns before releasing pressure on the spring. Install the remaining four capscrews by hand.

14. Alternately tighten all eight capscrews to 15 ft-lbs (20 N·m).

15. If the CR Brakemaster was removed from the vehicle, install it on the vehicle following the procedures given under the heading, "CR BRAKEMASTER INSTALLATION," in this subject.

    If the unit is still mounted on the vehicle, connect the air line to the outlet port, as previously marked or as shown in Fig. 8 located under "SPECIFICATIONS," in this subject. Tighten the nut on the fitting finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more. Using the same procedures, also tighten the fitting at the unloader port that was loosened during the "PREPARATION FOR SERVICING" procedures.

CAUTION: When connecting the air line to the unloader port, secure the unloader nut with a wrench to prevent turning the unloader nut. Turning the unloader nut will alter the alignment of the holes in the exhaust port and unloader valve sleeve, and render the air dryer inoperative.

16. Perform the "OPERATING TESTS," in this subject, after servicing the air dryer and before placing the vehicle in service.

HEATER REPLACEMENT

Cartridge-Type Heater

1. Follow the procedures listed under the heading, "PREPARATION FOR SERVICING," in this subject.

2. If the air dryer is still mounted on the vehicle, disconnect the electrical line from the heater.

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

3. On the bottom cap, loosen the screw that holds the heater, then remove the two small screws that hold the thermostat. Remove and discard the heater and the thermostat.

4. Install the new heater into the hole from which the old heater was removed, then tighten the screw that holds it in place.

5. Install the new thermostat into the hole from which the old thermostat was removed, then install and tighten the two screws that hold it in place.

6. If the unit was removed from the vehicle, install it on the vehicle following the procedures given under the heading, "CR BRAKEMASTER INSTALLATION," in this subject.

   If the air dryer is still mounted on the vehicle, connect the electrical line to the heater.

7. Perform the "OPERATING TESTS," in this subject, after servicing the air dryer and before placing the vehicle in service.

Strap-Type Heater

NOTE: CR Brakemasters manufactured before January 1, 1979, were optionally equipped with a non-thermostatic, wrap-around, strap-type heater. This heater may be replaced with a similar heater, or with the thermostatically controlled, cartridge-type heater included as standard equipment on all units manufactured since January 1, 1979. If a cartridge-type heater is desired on an air dryer manufactured before January 1, 1979, a new deflector assembly and bottom cap (which contains an unloader valve assembly and cartridge-type heater) must be installed. Refer to the heading, "DEFLECTOR ASSEMBLY REPLACEMENT," in this subject, for installation instructions.

1. Follow the procedures listed under the heading, "PREPARATION FOR SERVICING," in this subject.

2. If the unit is still mounted on the vehicle, disconnect the electrical line from the heater.

3. Remove the screw attaching the heater to the bottom cap, then remove and discard the heater. Using a commercial solvent, clean the semi-circular boss farthest from the unloader nut.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

4. Position the new heater on the boss with the mounting flange against the fin on the bottom cap. Install and tighten the screw that holds the heater in place.

NOTE: If a heater is being installed on an air dryer for the first time, a 3/32" (2.38 mm) hole will have to be drilled in the fin at the location indicated by the mounting flange of the heater.

5. If the CR Brakemaster was removed from the vehicle, install it on the vehicle following the procedures given under the heading, "CR BRAKEMASTER INSTALLATION," in this subject.

   If the air dryer is still mounted on the vehicle, connect the electrical line to the heater.

NOTE: The strap-type heater is not thermostatically controlled. If a heater is being installed on an air dryer for the first time, CR Brakemaster recommends connecting the electrical line to a toggle switch in the cab for manual operation by the driver. (This will insure that the heater does not operate more than is necessary.

6. Perform the "OPERATING TESTS," in this subject, after servicing the air dryer and before placing the vehicle in service.

OPERATING TESTS

1. Start the vehicle engine and build the air pressure to 120 psi (827 kPa). Using a soap and

water solution, check all fittings and gasketed surfaces for air leaks, and correct as necessary.

2. Force the air compressor to cycle several times, then check the temperature at the inlet and outlet ports of the air dryer by placing a hand near each of the port areas. The inlet port should be warmer than the outlet port, and the outlet port should be at or slightly above ambient temperature. If both ports are at the same temperature, the deflector assembly of the air dryer may require servicing.

WARNING: Since the vehicle is stationary, the air dryer will become warmer than it would during normal operation. Use care to prevent skin burns when checking the temperature of the air dryer.

3. Hold a clean shop towel under the exhaust port. When the air compressor stops cycling, air and water should be exhausted into the shop towel. If the CR Brakemaster does not unload when the air compressor stops cycling, or if oily or dirty water is exhausted when the unit unloads, refer to the "TROUBLESHOOTING" section of this subject.

4. After the Brakemaster has exhausted, and before the air compressor starts cycling again, hold a hand under the exhaust port. If air is flowing out of the exhaust port, the check valve located in the outlet port of the air dryer may be stuck open, and require servicing. If air is flowing out of the exhaust port after the air compressor starts pumping, the unloader valve assembly of the air dryer is stuck open, and requires servicing.

NOTE: When the air compressor is building pressure, the check valve at the CR Brakemaster outlet port should open and close rapidly. This rapid opening and closing may produce a normal rattling sound.

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Air Continually Exhausts From The Exhaust Port When The Air Compressor Is In The Stand-By Mode	Air dryer outlet port check valve stuck open.	Clean or replace the check valve assembly.
System Air Pressure Drops Rapidly	Loose or damaged fittings.	Tighten or replace the loose or damaged fittings.
	Damaged hoses, tubing, or air reservoir.	Repair or replace the damaged items.
	Air dryer outlet port check valve stuck open.	Clean or replace the check valve assembly.
Air Compressor Goes Into Stand-By Mode But Cycles Rapidly	Loose or damaged fittings.	Tighten or replace the loose or damaged fittings.
	Damaged hoses, tubing, or air reservoir.	Repair or replace the damaged items.
	Air dryer outlet port check valve stuck open.	Clean or replace the check valve assembly.
	Damaged seal or sleeve in unloader valve assembly.	Replace the unloader valve assembly.
Air Flows From The Exhaust Port When The Air Compressor Is Attempting To Build-Up Air Pressure	Unloader valve is stuck open or damaged.	Replace the unloader valve assembly.
	Dirt or foreign material is stuck in the unloader valve.	Clean or replace the unloader valve assembly.
Air Compressor Runs Continuously (System Pressure Will Not Build-Up)	Loose or damaged fittings.	Tighten or replace the loose or damaged fittings.
	Damaged hoses, tubing, or air reservoir.	Repair or replace the damaged items.
	Air compressor requires servicing or replacement.	Rebuild or replace the air compressor.
	Unloader valve stuck open.	Clean or replace the unloader valve assembly.

(Continued on next page)

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Air Compressor Runs Continuously (System Pressure Will Not Build-Up) (Cont.)	Air compressor capacity is too low for the vehicle.	Install a larger air compressor.
	Line between the air compressor and the air dryer is blocked.	Replace the line or remove the blockage.
	Air dryer outlet port check valve is stuck closed.	Replace the check valve assembly.
	Air governor requires servicing or replacement.	Repair or replace the air governor.
	Line between the air compressor and the air governor is blocked.	Remove the blockage, or replace the line.
Air Dryer Does Not Unload When The Air Compressor Goes Into The Stand-By Mode	Line between the air governor and the air dryer unloader port is missing, loose, or damaged.	Install or replace the air line, or tighten the fittings.
	Unloader valve assembly components worn.	Replace the unloader valve assembly.
	Ice has formed in the unloader valve assembly.	Shorten the line between the air governor and the air dryer unloader port, or install a heater.
	Heater inoperative.	Replace the heater or check the electrical connections.
Safety Valve Opens	Air dryer outlet port check valve is stuck closed.	Replace the check valve assembly.
	Air brake system downstream from the air dryer is blocked.	Remove the blockage or replace the necessary components.
	Air compressor governor valve is inoperative.	Replace the air compressor governor valve.
	Safety valve is inoperative.	Replace the safety valve.

(Continued on next page)

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Water Exhausted From The Air Dryer Contains Oil Or Soot	Air compressor requires servicing or replacement.	Rebuild or replace the air compressor.
No Water Is Exhausted During The Unloading Cycle	Insufficient moisture in the ambient air.	No correction necessary.
		See "Air Dryer Does Not Cool The Air Properly."
Air Dryer Does Not Cool The Air Properly	Air dryer is covered with dirt or paint.	Steam clean the air dryer or remove the paint.
	Deflector is damaged or broken.	Replace the deflector assembly.
	Copper tubing from the air compressor to the air dryer inlet port is too short.	Increase the length of copper tubing. (36 inches [914 mm] maximum length allowable.)
	Air dryer is mounted too near heat producing or heat dissipating equipment, or located where it cannot be cooled by the ambient air.	Relocate the unit. Refer to the Freightliner Service Department for specifications.
Water Exhausted By The Air Dryer Is Brownish, Or Brown Particles Are Exhausted	Deflector is damaged or broken.	Replace the deflector assembly.

BRAKE CONTROL 12
32-12301

CR BRAKEMASTER AIR DRYERS, MODELS 62 AND 68

SPECIFICATIONS

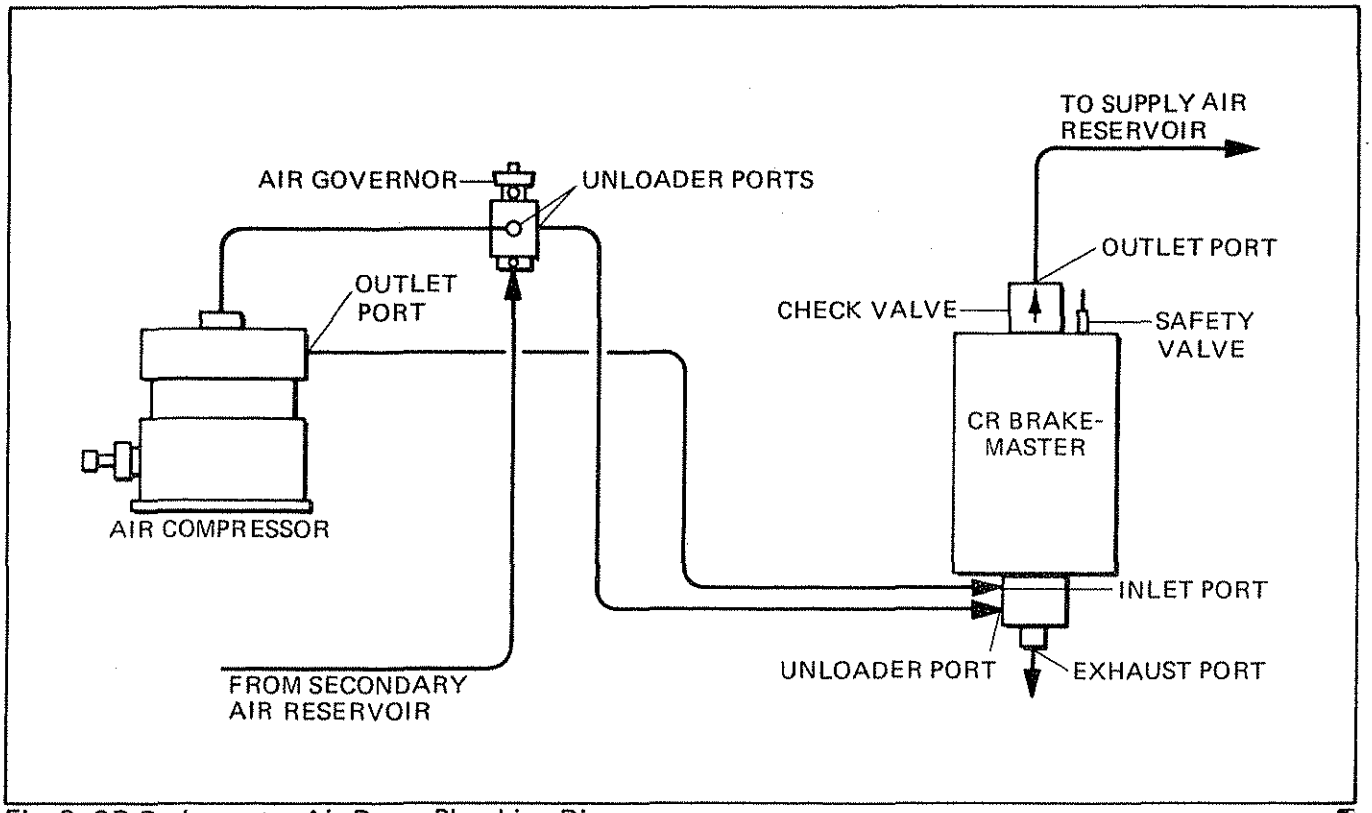


Fig. 8, CR Brakemaster Air Dryer Plumbing Diagram

ANCHORLOK AIR DRYER, MODELS DA-085-252P AND DH85-252

GENERAL DESCRIPTION

The Anchorlok air dryer (Fig. 1) is installed in the vehicle air system in place of the standard supply reservoir, or wet tank. It combines the functions of a standard wet tank, an aftercooler, and a moisture ejector.

The aluminum air dryer body is finned for more efficient heat dissipation. An aluminum liner circulates the warm air from the air compressor against the sides of the air dryer, thus cooling the air and condensing any moisture. The air dryer also has an integral automatic ejector valve that eliminates contaminants from the air dryer.

There are two Anchorlok air dryer models installed on Freightliner vehicles. Model DA-085-252P air dryers have the inlet port located in the center of the air dryer end cover; model DH85-252 air dryers have the inlet port located at the automatic ejector valve.

PRINCIPLES OF OPERATION

Hot air, saturated with oil, water, and other contaminants from the air compressor, enters the inlet port of the air dryer. The hot air flows between the liner and the finned aluminum body. See Fig. 2. The liner prohibits the heat from flowing inward, and instead forces the heat outward, toward the aluminum body.

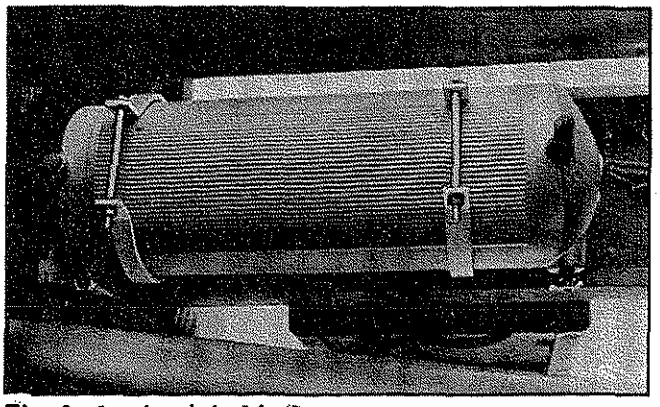


Fig. 1, Anchorlok Air Dryer

As the heat dissipates, the oil and water condense into sludge, which collects in the bottom of the air dryer near the automatic ejector valve. The automatic ejector valve is actuated by the air governor. When the air compressor cuts in, air pressure from the unloader port of the air governor enters the automatic ejector valve, forcing the sludge into the valve. When the air compressor cuts out, the valve opens, expelling the sludge through the drain tube into the atmosphere.

SERVICE OPERATIONS

AUTOMATIC EJECTOR VALVE SERVICING

1. Apply the spring parking brakes, then chock the vehicle tires. Drain the air from the air reservoirs.

2. Disconnect the air line from the automatic ejector valve that connects the automatic ejector valve to the air governor. Plug the line to prevent dirt or foreign material from entering the line.

3. Remove the four allen head capscrews from the automatic ejector valve assembly, then remove the automatic ejector valve assembly from the air dryer. See Fig. 3.

   If only the valve base can be removed from the air dryer, the air dryer is equipped with the

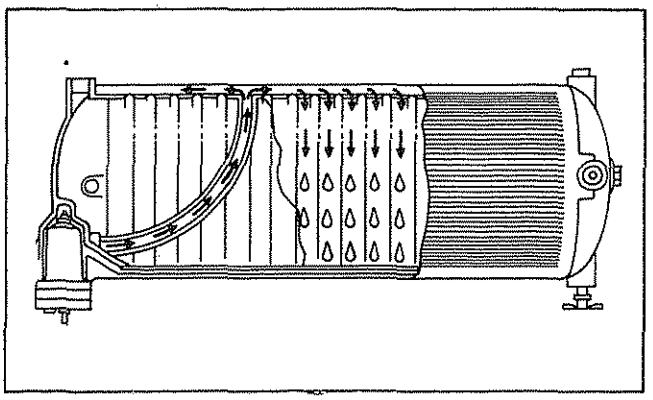


Fig. 2

ANCHORLOK AIR DRYER, MODELS DA-085-252P AND DH85-252

automatic ejector valve assembly shown in Fig. 4. If so equipped, parts of the automatic ejector valve must be discarded and replaced with a cartridge assembly. For instructions, proceed to step 3.1. If the air dryer is equipped with the automatic ejector valve assembly shown in Fig. 3, proceed to step 4.

.1 Remove the snapring from the lower end of the plunger, then remove the plunger plate. It may be necessary to pry out the plunger plate, using screwdrivers under opposite ends of the plate.

.2 Remove the capscrews that secure the plunger assembly in the air dryer, then remove the plunger assembly. Be sure to catch the ejector valve spring when it drops out. Discard the plunger assembly, plunger plate, and the ejector valve spring.

4. Remove the cartridge assembly from the base assembly by removing the two self-tapping screws. See Fig. 5. Check the O-ring for wear, replacing if necessary.

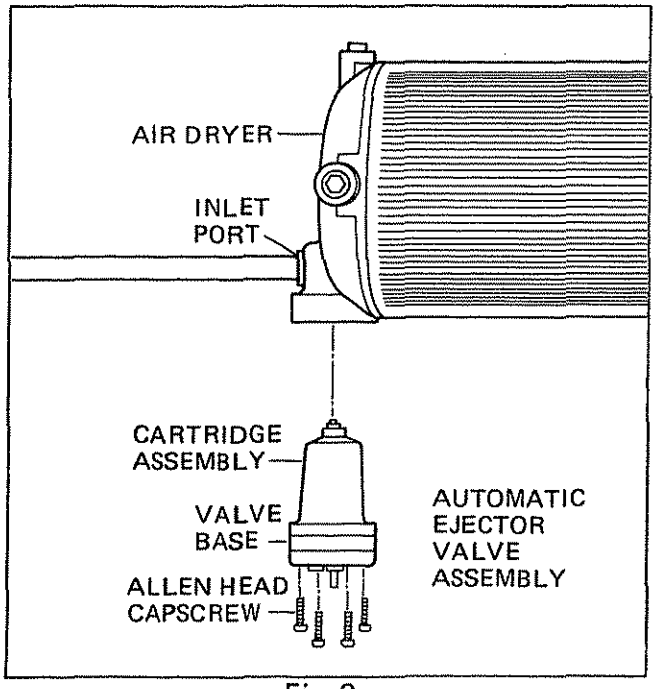
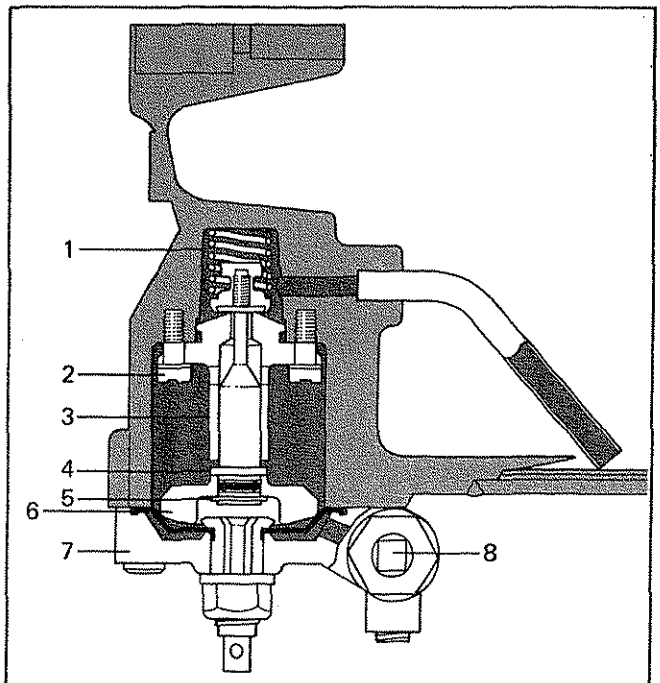


Fig. 3



1. Ejector Valve Spring
2. Capscrew
3. Plunger Guide
4. Plunger
5. Snapring
6. Plunger Plate
7. Valve Base
8. Plug

Fig. 4

5. Remove the nylon nut and washer from the base assembly, then remove the drain tube, sleeve, and diaphragm. See Fig. 6. Check the diaphragm for wear, replacing if necessary.

6. Clean the automatic ejector valve cavity and the disassembled parts, using kerosene or an alkaline cleaner.

WARNING: Kerosene, and many commercial cleaning solvents, are flammable, toxic, and can cause severe skin irritation. When using kerosene or commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

7. Install the diaphragm, sleeve, and drain tube in the base assembly, as shown in Fig. 6, then install and tighten the washer and the nylon nut.

ANCHORLOK AIR DRYER, MODELS DA-085-252P AND DH85-252

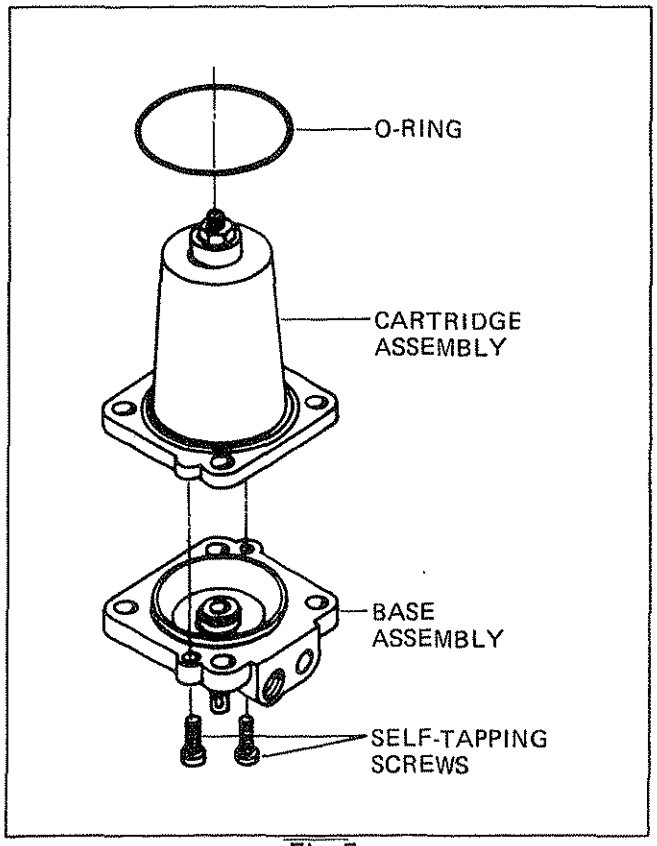


Fig. 5

8. Lubricate the O-ring with a silicone-type grease, then install the O-ring. Place the cartridge assembly on the base assembly, then install and tighten the two self-tapping screws. See Fig. 5.

9. Install the automatic ejector valve in the air dryer, as shown in Fig. 3, then install and tighten the four Allen head capscrews.

10. Remove the plug from the air governor unloader line, then connect the line to the port in the automatic ejector valve. Tighten the line as specified in the 12 Group of the Freightliner Maintenance and Lube Manual.

11. Start the engine, and allow the air pressure to build. After the air governor cuts out the air compressor, drain air from the air reservoirs. Watch the automatic ejector valve to make sure it ejects when the air governor cuts in the air compressor (100 psi [689 kPa]). If the automatic ejector valve fails to operate, or if air leaks are present, replace the O-ring and the diaphragm. If the O-ring and the diaphragm have been replaced, and the automatic ejector valve still fails to operate, replace the cartridge assembly.

AIR DRYER REMOVAL AND INSTALLATION

Removal

1. Apply the spring parking brakes, then chock the vehicle tires. Drain the air from the air reservoirs.

2. Disconnect all air lines from the air dryer, marking them for later installation. Plug the lines to prevent dirt or foreign material from entering the lines. Disconnect the electrical lines, if so equipped, from the air dryer heater.

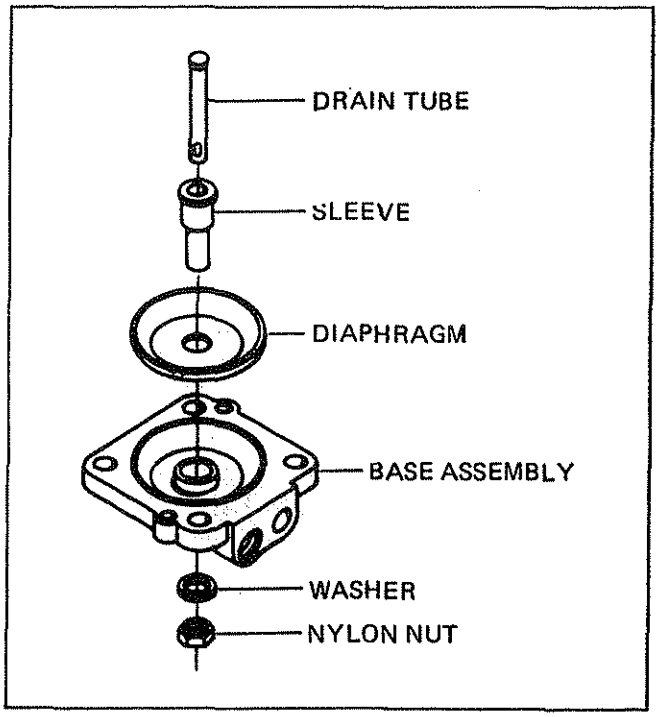


Fig. 6

ANCHORLOK AIR DRYER, MODELS DA-085-252P AND DH85-252

3. Loosen the fasteners on the air dryer mounting clamps, then remove the air dryer from the vehicle.

Installation

1. Pour one cup of clean water in the outlet port of the air dryer, as shown in Fig. 7, for a later installation check.

2. Place the air dryer in the mounting clamps, with the automatic ejector valve pointed directly toward the ground. Tighten the air dryer mounting clamp fasteners to 10 ft-lbs (14 N·m).

3. If installing a new air dryer, install fittings in the ports, tightening them to 25 ± 5 ft-lbs (34 ± 7 N·m).

4. Remove the plugs from the air lines, then connect all air lines to the air dryer, as previously marked, or as shown in Fig. 8, under "SPECIFICATIONS." Connect the electrical lines, if so equipped, to the air dryer heater.

5. Start the engine, and allow the air pressure to build. After the air governor cuts out the air compressor, drain air from the air reservoirs. Watch the automatic ejector valve to make sure it ejects the water when the air governor cuts in the air compressor (100 psi [689 kPa]). If the automatic ejector valve fails to eject the water, insure that the air lines are installed as shown in Fig. 8, under "SPECIFICATIONS." If the automatic ejector valve still fails to eject the water, repair the automatic ejector valve as instructed in this subject.

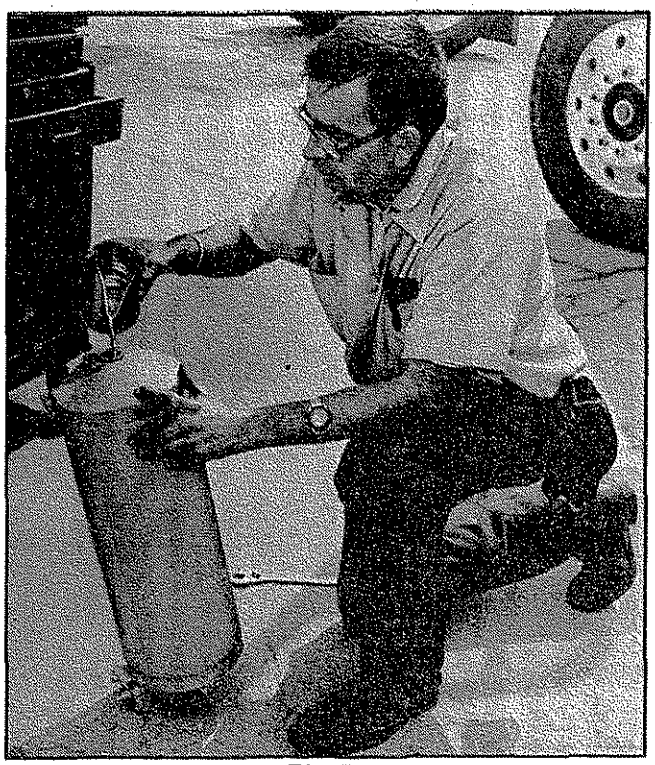


Fig. 7

ANCHORLOK AIR DRYER, MODELS DA-085-252P AND DH85-252

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Automatic Ejector Valve Will Not Operate Properly	Maintenance procedures not followed.	Refer to the 12 Group of the Freightliner Maintenance and Lube Manual for maintenance procedures.
	Automatic ejector valve dirty or sticky.	Clean or replace the valve, as necessary.
	Air dryer not plumbed correctly.	Check the plumbing of the air lines, and correct if necessary.
	Diaphragm cracked or slipped out-of-place.	Replace the diaphragm.
	Cartridge assembly worn, or plunger bent.	Replace the cartridge assembly.
	Air governor requires servicing or replacement.	Repair or replace the air governor.
Carbon Build-Up Air Inlet Port	Air compressor requires servicing or replacement.	Repair the air compressor, or, if disassembly is not recommended by the air compressor manufacturer, replace the air compressor with a factory rebuilt or a new unit. The air dryer should be steam cleaned or flushed to remove carbon particles.

Service

FREIGHTLINER

BENDIX AD-1 AND AD-2 AIR DRYERS

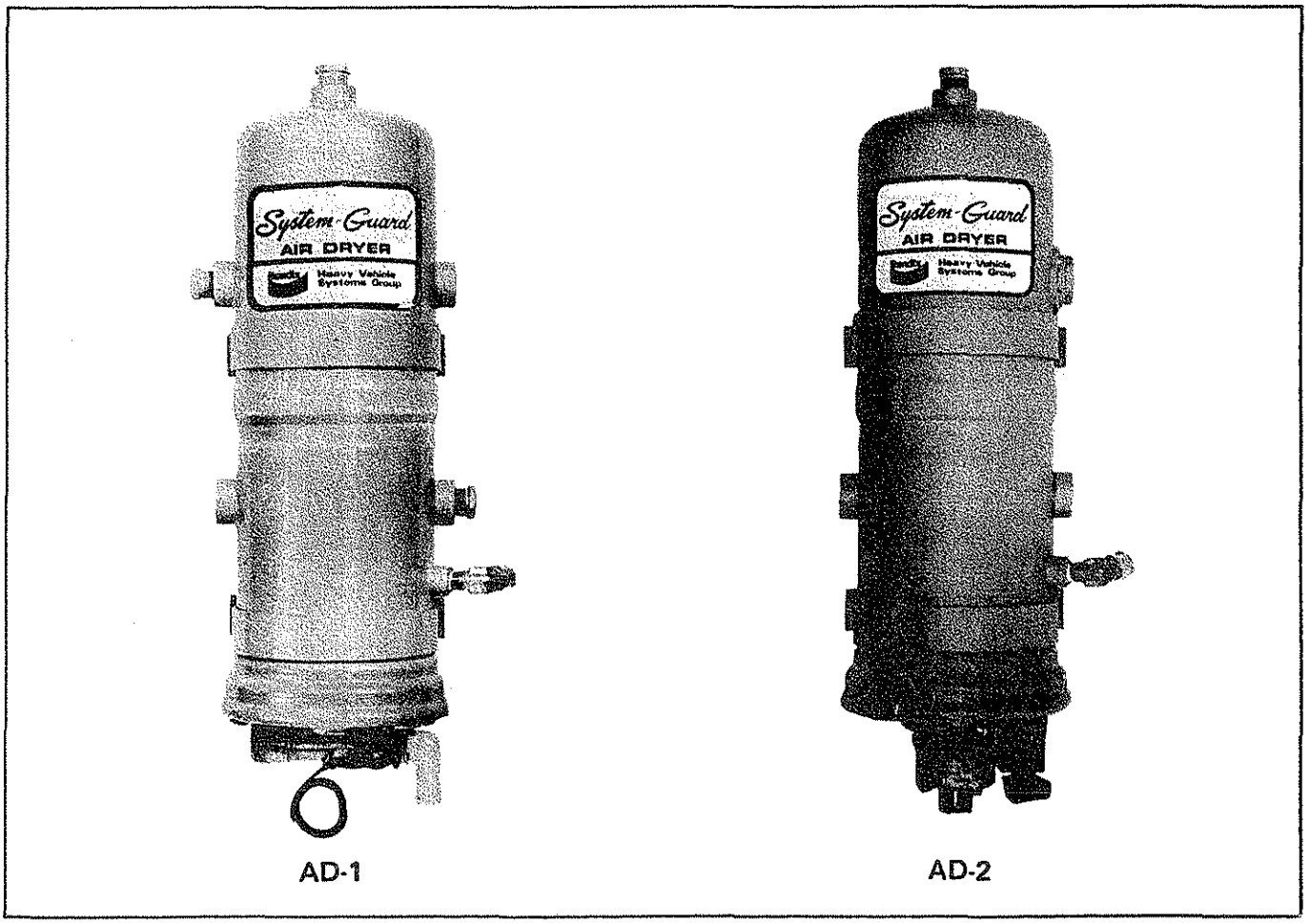
GENERAL DESCRIPTION

The Bendix AD-1 and AD-2 air dryers (Fig. 1) collect contaminants and remove moisture from the air before the air reaches the supply air reservoir.

The air dryer is vertically mounted between the air compressor and the supply air reservoir, and consists of two cylindrical steel stampings welded together. Two inlet ports, one outlet port (with an integral single check valve), one exhaust port, one purge valve port, and one port for the addition of purge volume are provided in the AD-2 air dryer. The AD-1 air dryer also has one exhaust port, one purge valve port, and one port for the addition of purge volume, along with two inlet ports and three outlet ports. Each air dryer has a safety valve mounted in the housing assembly that releases at 150 psi (1034 kPa), providing protection against an excessive pressure build-up within the housing.

A desiccant sealing plate is located in the middle of the housing assembly, and divides the purge volume area in the top half of the air dryer, from the desiccant cartridge in the lower half of the air dryer. The desiccant sealing plate is serviceable, and houses a replaceable ball-type single check valve and a purge orifice.

The desiccant cartridge, and pleated paper oil filter below it, are removable, and comprise a complete serviceable unit. The desiccant cartridge contains a drying substance comprised of desiccant beads,



AD-1 AD-2

Fig. 1, Bendix AD-1 And AD-2 Air Dryers

BENDIX AD-1 AND AD-2 AIR DRYERS

which are collectively referred to as the "drying bed." The 2 1/2 pounds (1 kg) of desiccant beads present in the desiccant cartridge have about 5 million square feet (465 000 square meters) of area due to the large number of submicroscopic cavities in each bead. These desiccant beads collect moisture from the air as the air passes through the desiccant cartridge. Two perforated steel plates hold the desiccant beads in place.

The end cover of the air dryer houses the purge valve and exhaust ports, and, on the AD-2 air dryer, a nonserviceable heater and thermostat assembly. A serviceable heater and thermostat assembly is optional on the AD-1 air dryer. Both heater and thermostat assemblies are 60 watt, and may be either 12 or 24 volt DC assemblies. Both assemblies have an operating range between 50°F and 85°F (10°C and 29°C).

PRINCIPLES OF OPERATION

CHARGE (OR COMPRESSION) CYCLE

During the charge (compression) cycle (Fig. 2) of the air compressor, air from the compressor enters the air dryer at the inlet port. When the air, along with the water and contaminants, enters the air dryer, the velocity of the air declines substantially. The air then flows toward the bottom of the air dryer, where much of the moisture in the air drops to the bottom, or sump, of the air dryer.

At the bottom of the air dryer, the air flow changes direction and passes upward through the oil filter. The oil filter removes some oil and contaminants, but does not remove the water vapor. The filtered air and water vapor pass through the desiccant cartridge, and the desiccant

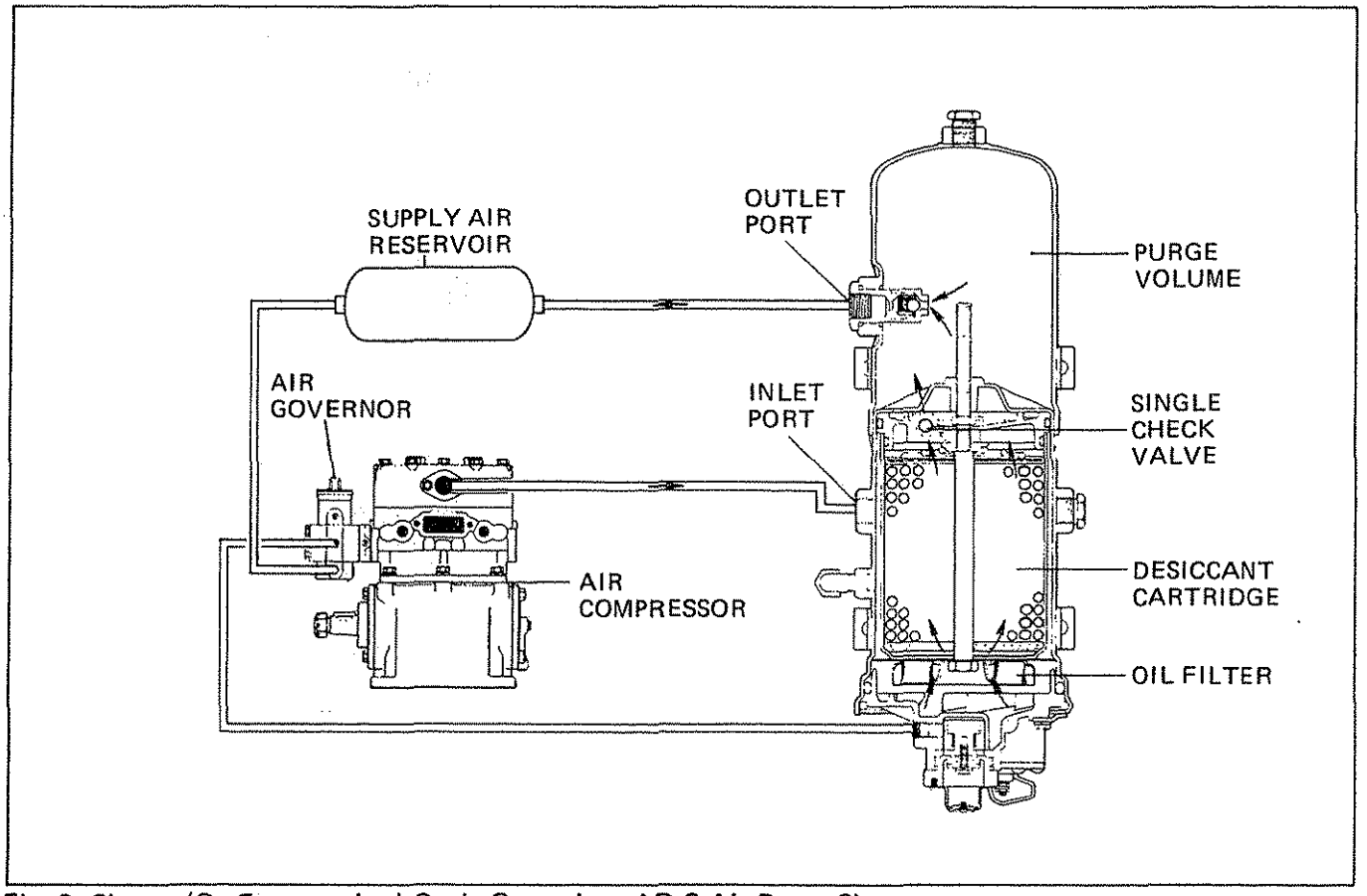


Fig. 2, Charge (Or Compression) Cycle Operation; AD-2 Air Dryer Shown

BENDIX AD-1 AND AD-2 AIR DRYERS

beads remove the water vapor from the air. The unsaturated dry air then travels through the ball-type single check valve and moves into the purge volume (or storage area). From the purge volume, the air flows out the outlet port and into the supply air reservoir.

PURGE CYCLE (Refer to Fig. 3)

When the air pressure in the system reaches approximately 120 psi (827 kPa), the air governor will cut-out the air compressor. Air from the air governor unloader port then enters the purge valve port and unseats the purge valve. The exhaust port opens, and contaminants in the dryer sump are forced past the open exhaust port into the atmosphere.

The dried air in the purge volume then flows down, through the purge orifice, and crosses the desiccant cartridge, drying the desiccant beads. The purge cycle takes approximately 12-15 seconds, after which the desiccant cartridge is ready for another charge cycle.

SERVICE OPERATIONS

NOTE: If the air dryer is located on the vehicle in a position where service operations may be safely and easily performed, removal is not necessary unless the unit is to be replaced.

AIR DRYER REMOVAL AND INSTALLATION

Removal

1. Apply the parking brakes, then chock block the vehicle tires.

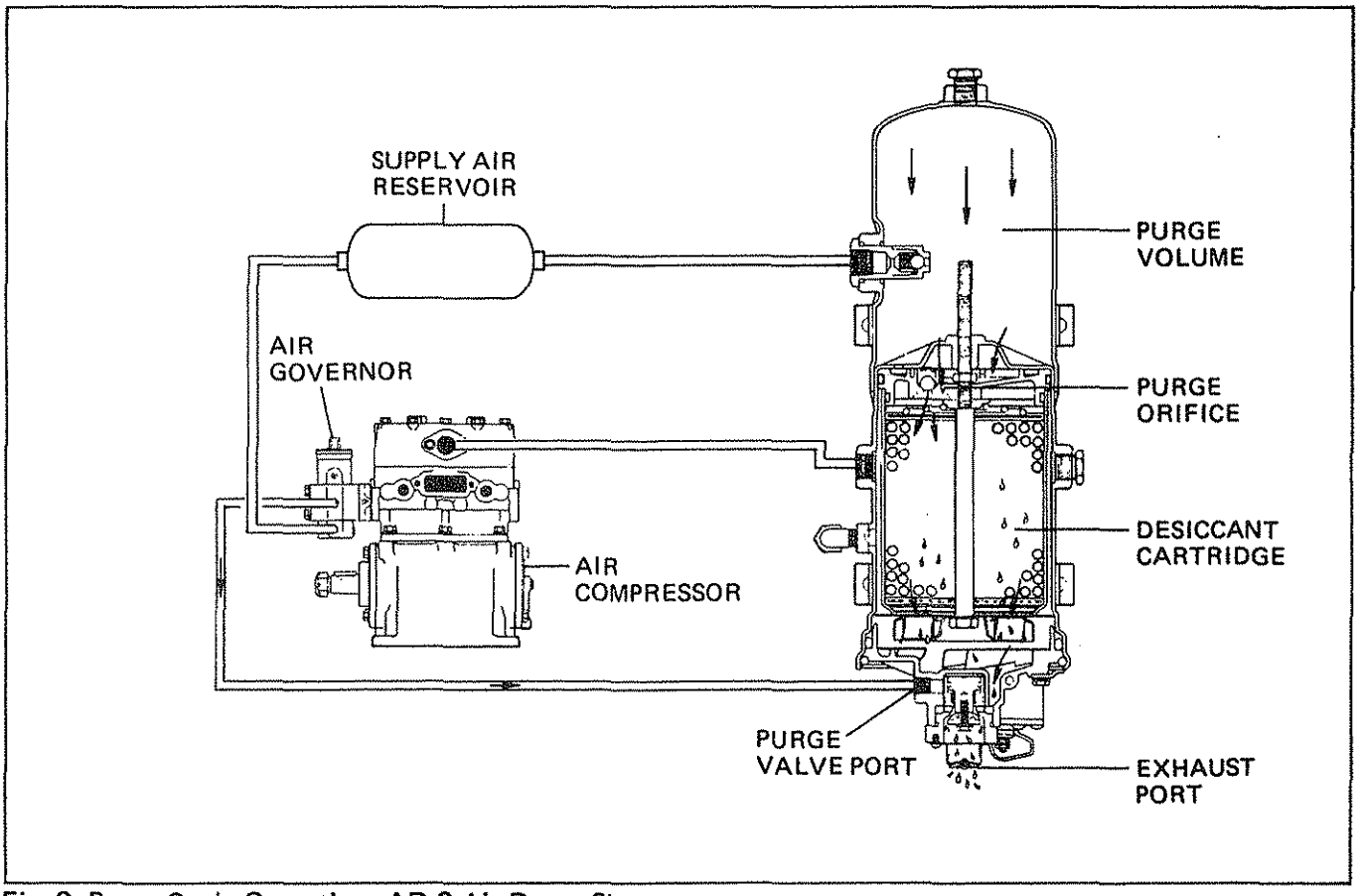


Fig. 3, Purge Cycle Operation; AD-2 Air Dryer Shown

BENDIX AD-1 AND AD-2 AIR DRYERS

2. Drain the air from the air reservoirs.

3. Disconnect the electrical line from the air dryer heater, if so equipped.

4. Disconnect the air lines from the air dryer, marking the lines for later assembly.

WARNING: When disconnecting the air line from the purge valve port of the air dryer, the line may still be under pressure. If caution is not used, the line can whip, resulting in possible personal injury or causing the air stream to direct dirt or sludge particles toward persons in the area.

5. Remove the nuts and bolts on the air dryer mounting bracket that mount the air dryer to the vehicle. Remove the air dryer from the vehicle.

Installation

1. Position the air dryer on the vehicle, then install the nuts and bolts. If SAE Grade 5 3/8-16 fasteners are used, tighten them to 20-25 ft-lbs (27-34 N·m). If SAE Grade 5 7/16-14 fasteners are used, tighten them to 35-45 ft-lbs (47-61 N·m).

2. Insure that the air lines are free of grease and dirt, and replace any line having crimps or other damage present in the line or fitting.

3. Connect the air lines to the air dryer as previously marked, or as shown in Fig. 21 located under "SPECIFICATIONS," in this subject. Tighten the nut on each fitting finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more.

4. If so equipped, connect the electrical line to the air dryer heater. Remove the chock blocks from the vehicle tires.

DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT (See Fig. 4)

NOTE: The desiccant cartridge should be rebuilt or replaced at the periodic maintenance interval given in the 12 Group of the Freightliner Maintenance and Lube Manual. Only the current revision desiccant cartridges can be rebuilt. Current revision desiccant cartridges (Fig. 5) are identified by the Bendix trademark "BW" stamped in the hex head of the cartridge bolt, and by the letters and number "AD-2" displayed on the bottom face of the oil filter. If an older revision desiccant cartridge is removed from the air dryer, it should be replaced with a current revision desiccant cartridge.

1. If the air dryer has been removed from the vehicle for servicing, proceed to step 3. If the air dryer is to be serviced on the vehicle, apply the parking brakes, then chock block the vehicle tires. Drain the air from the air reservoirs.

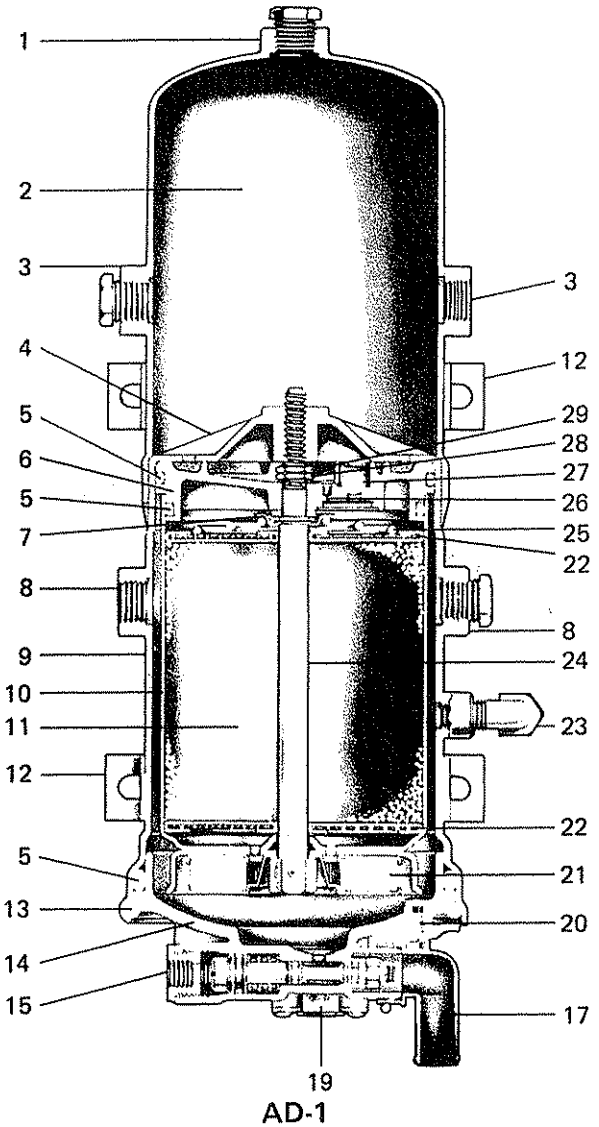
2. Disconnect the electrical line from the air dryer heater, if so equipped. Then, disconnect the air line from the purge valve port on the end cover of the air dryer. Mark the line for later assembly.

WARNING: When disconnecting the air line from the air dryer, the line may still be under pressure. If caution is not used, the line can whip, resulting in possible personal injury or causing the air stream to direct dirt or sludge particles toward persons in the area.

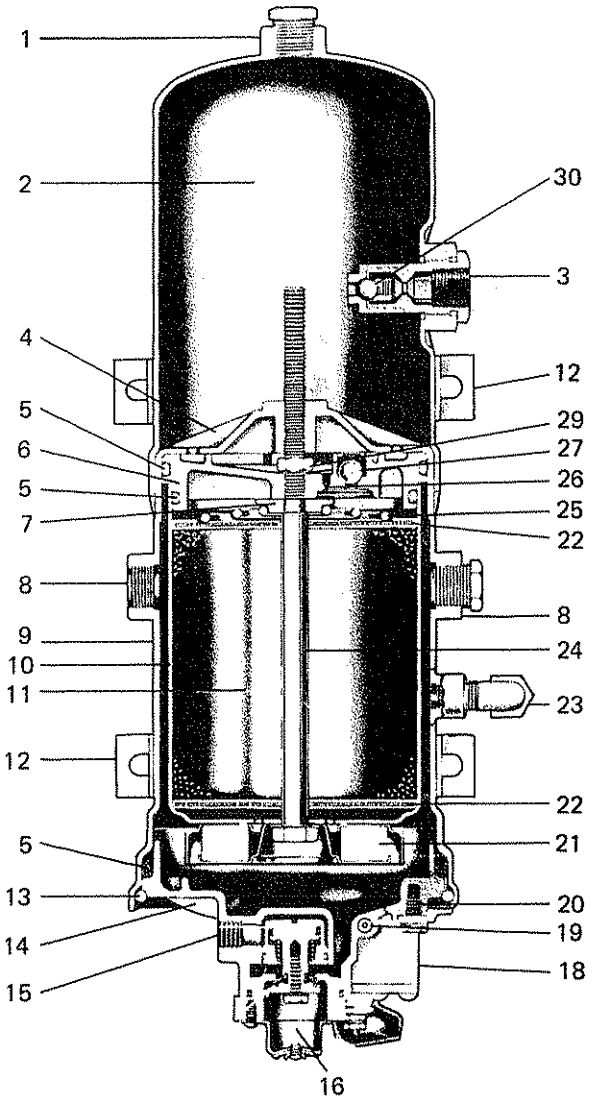
3. Remove the three capscrews and retaining clamps on the end cover.

4. Locate the notch on the bottom edge of the air dryer housing. While pushing the end cover up, into the dryer, insert the blade of a screwdriver into the notch, and slowly pry out the retainer ring. Remove the end cover assembly, setting it aside for later installation. If the purge valve assembly in the end cover is to be rebuilt, refer to the heading, "AD-2 PURGE VALVE ASSEMBLY REBUILDING," or "AD-1 PURGE

BENDIX AD-1 AND AD-2 AIR DRYERS



AD-1



AD-2

1. Purge Volume Port
2. Purge Volume
3. Outlet Port
4. Plate
5. O-Ring
6. Desiccant Sealing Plate
7. Spring Retainer
8. Inlet Port
9. Air Dryer Housing
10. Desiccant Cartridge Shell
11. Desiccant Beads
12. Mounting Bracket
13. Retainer Ring
14. End Cover
15. Purge Valve Port
16. Exhaust Port (AD-2 Only)
17. Exhaust Deflector (AD-1 Only)
18. Thermostat (AD-2 Only)
19. Heater
20. Capscrew
21. Oil Filter
22. Perforated Plate
23. Safety Valve
24. Cartridge Bolt
25. Spring
26. Purge Orifice
27. Ball-Type Single Check Valve
28. Jam Nut
29. Locknut
30. Single Check Valve (AD-2 Only)

Fig. 4, Bendix AD-1 And AD-2 Air Dryer Nomenclature

BENDIX AD-1 AND AD-2 AIR DRYERS

Fig. 5

VALVE ASSEMBLY REBUILDING," in this subject.

5. Using a 3/4 inch socket wrench, remove the desiccant cartridge. The desiccant sealing plate should come out with the desiccant cartridge.

6. Separate the desiccant sealing plate from the desiccant cartridge by removing either the single hex locknut (shown in Fig. 4, AD-2 air dryer), the thin locknut and jamnut (shown in Fig. 4, AD-1 air dryer), or the retaining ring (not shown). Bendix Corporation recommends replacing all nonmetallic parts of the desiccant sealing plate when rebuilding or replacing the desiccant cartridge. For service operations on the desiccant sealing plate, refer to the heading, "DESICCANT SEALING PLATE REBUILDING," in this subject.

7. If replacing the desiccant cartridge, proceed to step 8. If rebuilding the desiccant cartridge:

.1 Remove the spring retainer, spring, and cartridge bolt from the desiccant cartridge, setting them aside for later assembly. Remove and discard the two perforated plates, the old desiccant material, and the oil filter.

.2 Insert one of the new perforated plates into the desiccant cartridge shell, with the felt side of the perforated plate up. See Fig. 6. Make sure that the perforated plate rests firmly in the bottom of the desiccant cartridge shell.

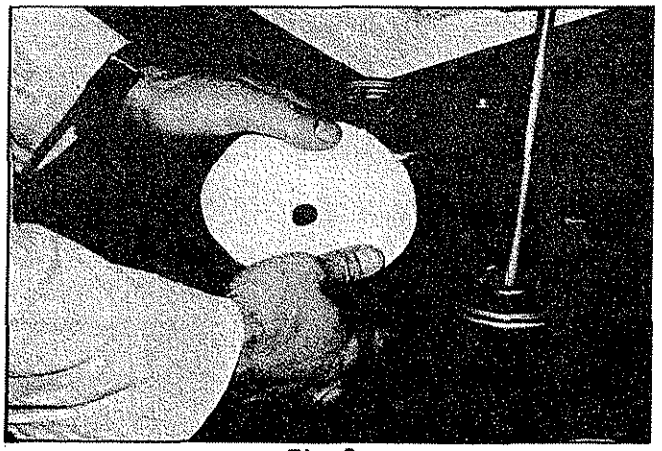


Fig. 6

.3 Slide the oil filter over the cartridge bolt so that the gasket surface of the oil filter will face the desiccant cartridge shell. See Fig. 7.

.4 With the oil filter on the cartridge bolt, install the cartridge bolt into the bottom of the desiccant cartridge shell. See Fig. 8. The cartridge bolt should go through the center hole on the perforated plate in the bottom of the desiccant cartridge shell.

.5 Pour the entire package of new desiccant beads into the desiccant cartridge shell, making sure no desiccant beads are lost. See Fig. 9. Handle the desiccant cartridge carefully so that the cartridge bolt does not fall out.

BENDIX AD-1 AND AD-2 AIR DRYERS

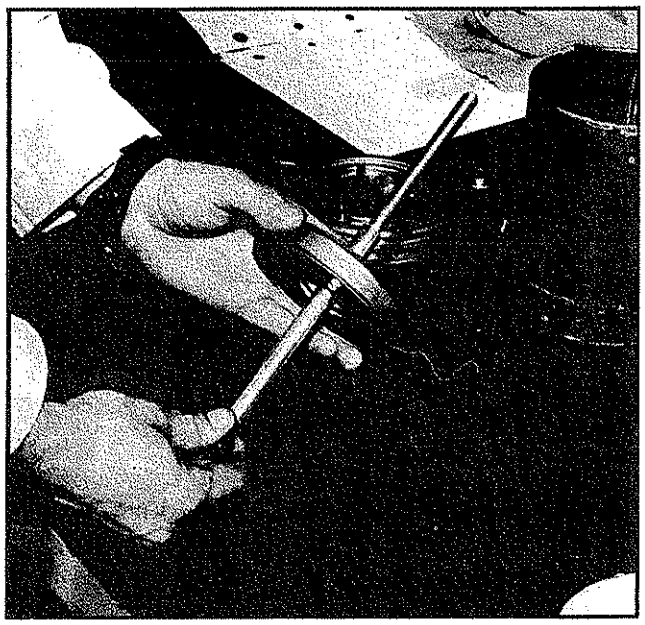


Fig. 7

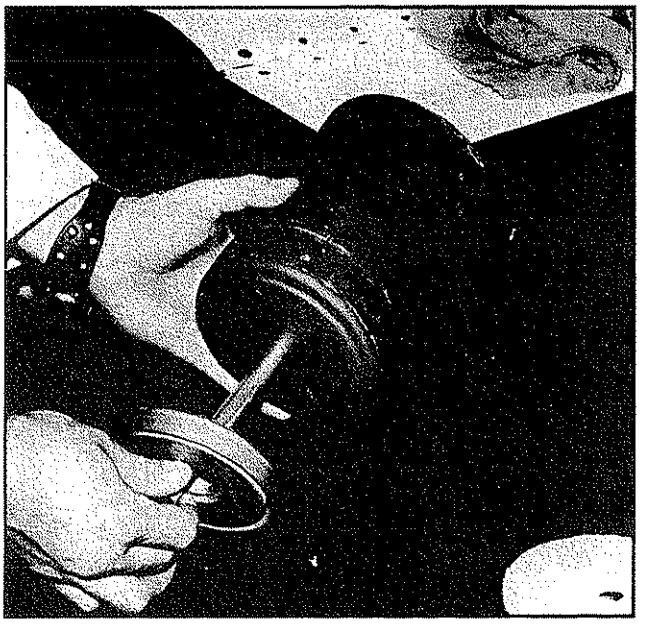


Fig. 8

.6 Level the desiccant beads, then install the second perforated plate, felt side down. Make sure the shoulder of the cartridge bolt is centered in the desiccant cartridge, and extends slightly above the top of the perforated plate, as shown in Fig. 10.

NOTE: If the shoulder of the cartridge bolt does not extend above the perforated plate, tap the side of the desiccant cartridge to settle the desiccant beads into place.

.7 Set the conical spring on top of the perforated plate, with the large diameter end of the spring next to the perforated plate. Place the spring retainer on top of the spring, as shown in Fig. 11. Proceed to step 9.

8. Carefully remove the locknut from the cartridge bolt of the new desiccant cartridge, using an 11/16 inch open end or box wrench. Do not allow the cartridge bolt to slip out of the desiccant cartridge after the locknut has been removed. Make sure the shoulder of the cartridge bolt is centered in the desiccant cartridge, and extends slightly above the top of the perforated plate. If the shoulder of the cartridge bolt does not extend above the perforated plate, tap the side of the desiccant cartridge to settle the desiccant beads into place.

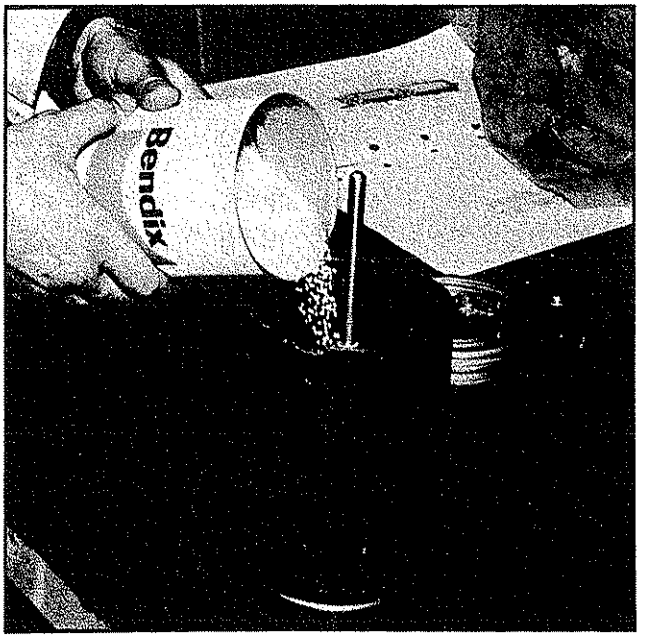


Fig. 9

BENDIX AD-1 AND AD-2 AIR DRYERS

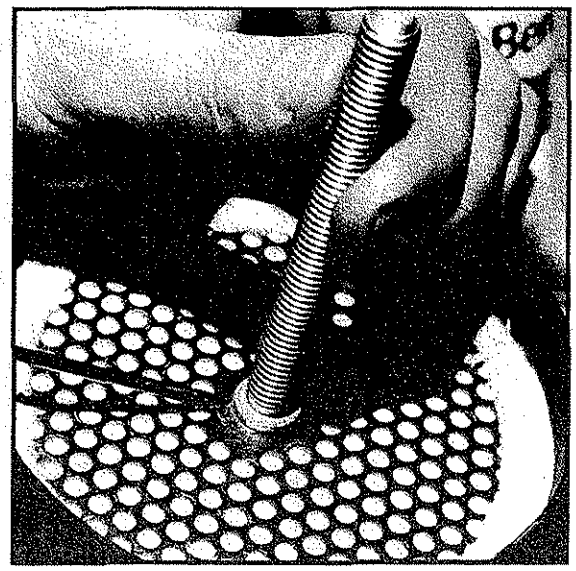


Fig. 10

9. Install the previously rebuilt desiccant sealing plate onto the cartridge bolt, with the ball-type single check valve retaining clip facing away from the desiccant cartridge.

10. Using an 11/16 inch open end or box wrench, install the locknut on the cartridge bolt, tightening it until the spring is compressed to approximately half its free-standing height. See Fig. 12.

11. Slowly turn the cartridge, and tap the side of the desiccant cartridge with a plastic mallet, as shown in Fig. 13. This allows the desiccant material to settle properly into place. Continue to tighten the nut, making sure all items are properly aligned, until the shoulder of the desiccant sealing plate rests against the cartridge shell, as shown in Fig. 14.

12. Using a clean, dry cloth, clean the inside of the air dryer housing. If a quality commercial solvent is needed to clean the inside of the air dryer housing, make sure that no residue of the solvent is left in the housing.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

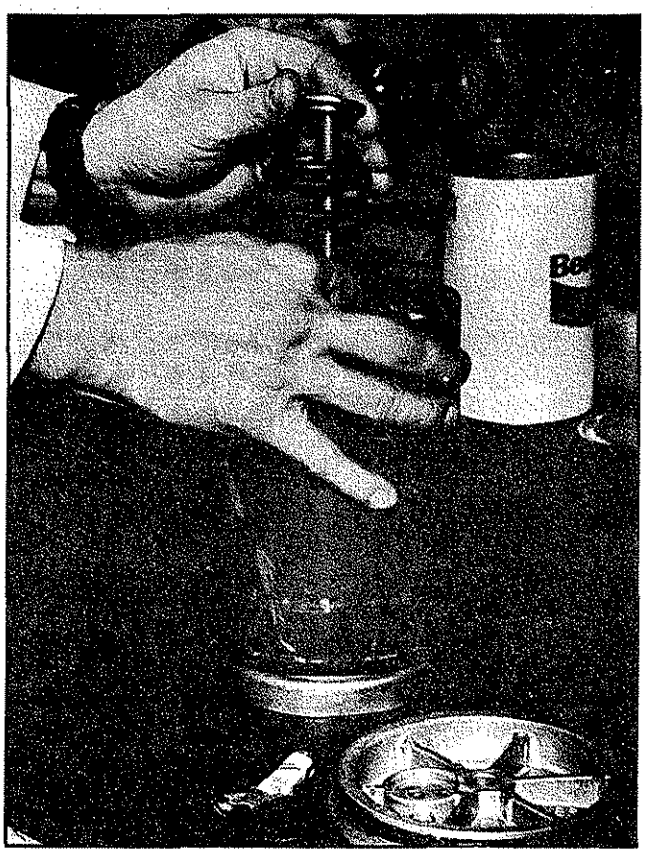


Fig. 11

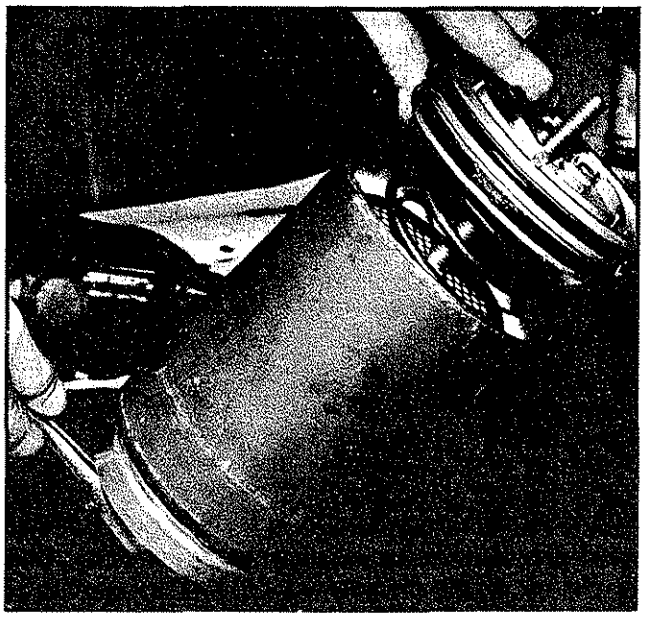


Fig. 12

BENDIX AD-1 AND AD-2 AIR DRYERS

Fig. 13

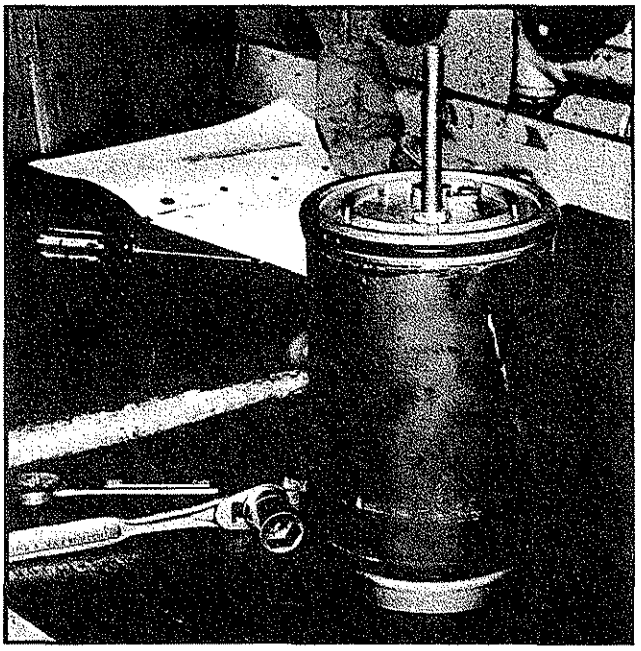


Fig. 14

13. Check the O-rings of the desiccant sealing plate to be sure they are lubricated with a film of barium-base grease. Install the desiccant sealing plate and desiccant cartridge into the air dryer housing, desiccant sealing plate first. Engage the cartridge bolt into the plate located in the center of the air dryer housing, then tighten the cartridge bolt to 32 ft-lbs (43 N·m).

14. Check the end cover assembly O-ring to be sure it is clean and lubricated with a film of barium-base grease. Install the end cover assembly into the air dryer housing.

15. Position the end cover so that the purge valve port is even with the inlet port, and approximately 180° opposite the safety valve. Pushing the end cover up into the air dryer housing, install the retainer ring under the bottom edge of the air dryer housing. The gap in the retainer ring must be within one inch (25 mm) of the notch on the bottom edge of the air dryer housing.

16. Position the three retaining clamps in place. Lubricate the threads of the three capscrews that hold the clamps in place, then install them, tightening them until the retaining clamps are held firmly in place.

17. If the air dryer was removed from the vehicle, install the air dryer following the instructions given under the heading, "AIR DRYER REMOVAL AND INSTALLATION," in this subject.

    If the air dryer is still mounted on the vehicle, connect the air line from the air governor unloader port to the purge valve port, as previously marked, or as shown in Fig. 21 located under "SPECIFICATIONS," in this subject. Install the hose, and tighten the nut finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more. If so equipped, connect the electrical line to the air dryer heater.

18. Remove the chock blocks from the vehicle tires.

BENDIX AD-1 AND AD-2 AIR DRYERS

DESICCANT SEALING PLATE REBUILDING

NOTE: If the desiccant sealing plate has not been removed from the air dryer, perform steps 1 through 6 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject.

1. Remove and discard the two O-rings from the desiccant sealing plate.
2. Remove the ball-type single check valve screw and retaining clip, then remove and discard the ball-type single check valve.
3. Clean the desiccant sealing plate thoroughly, using a quality commercial solvent, and make sure the purge orifice and check valve seat are clean.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

4. Install a new ball-type single check valve, then install and tighten the retaining clip and screw. See Fig. 15.

Fig. 15

5. Thoroughly lubricate the two new O-rings with a barium-base grease, then install them in their respective grooves on the sealing plate, as shown in Fig. 16.

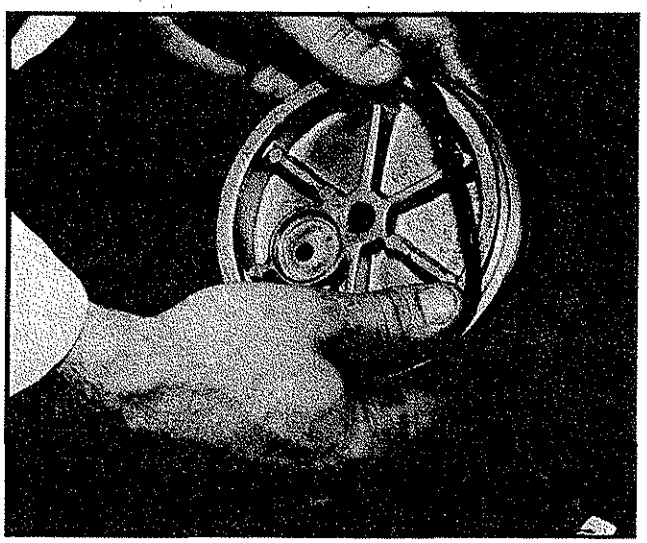


Fig. 16

6. Set the desiccant sealing plate aside for later installation on the desiccant cartridge. If the desiccant cartridge is not being rebuilt or replaced, perform steps 9 through 18 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject, to install the desiccant sealing plate in the air dryer.

AD-2 PURGE VALVE ASSEMBLY REBUILDING (Refer to Figs. 17 and 18)

NOTE: Do not remove the thermostat cover from the heater and thermostat assembly in the AD-2 end cover. The heater and thermostat assembly is not serviceable. Should the heater and thermostat assembly become inoperative, the end cover must be replaced.

1. If the end cover assembly has not been removed from the AD-2 air dryer, perform steps 1 through 4 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject.

BENDIX AD-1 AND AD-2 AIR DRYERS

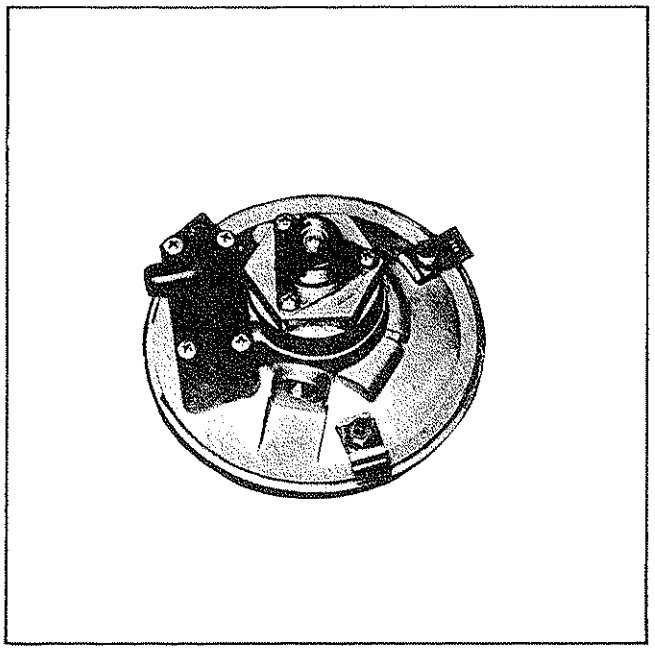


Fig. 17, AD-2 End Cover Assembly

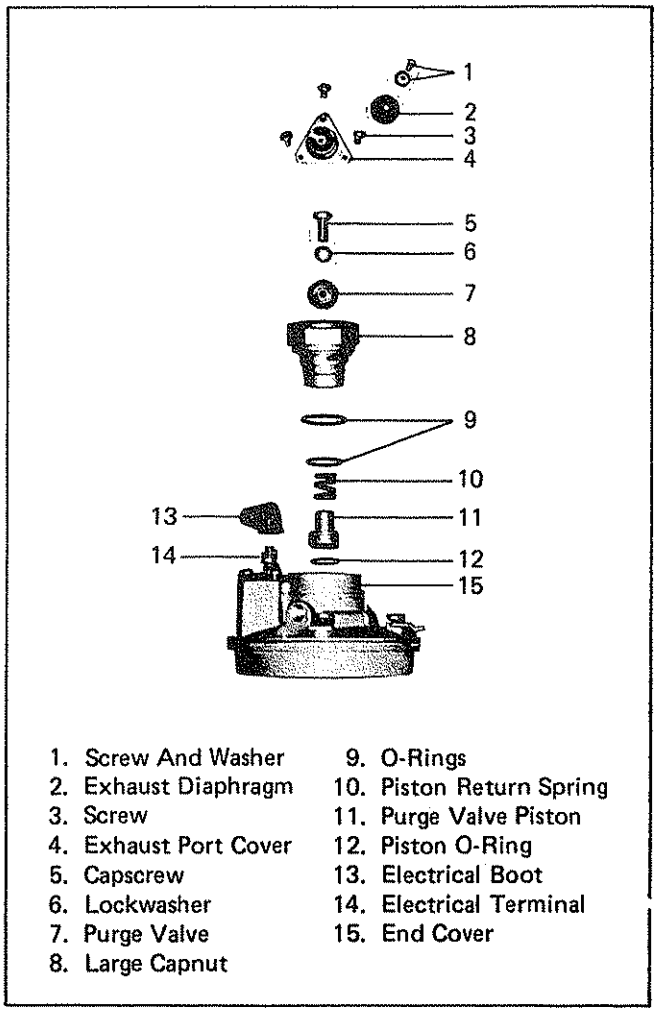
2. Thoroughly clean the end cover exterior, using a commercial solvent. Remove and discard the large O-ring around the end cover assembly.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

3. Remove the screw that secures the exhaust diaphragm to the exhaust port cover. Separate the diaphragm, washer, and screw, then discard the diaphragm.

4. Remove the three screws securing the exhaust port cover to the end cover assembly, then remove the exhaust port cover.

5. Remove the purge valve assembly from the end cover by removing the large capnut below the exhaust port cover. See Fig. 19. Discard both O-rings around the capnut. Using a 7/16" socket wrench and a large screwdriver, remove the capscrew located inside the capnut that holds the assembly together.



1. Screw And Washer
2. Exhaust Diaphragm
3. Screw
4. Exhaust Port Cover
5. Capscrew
6. Lockwasher
7. Purge Valve
8. Large Capnut
9. O-Rings
10. Piston Return Spring
11. Purge Valve Piston
12. Piston O-Ring
13. Electrical Boot
14. Electrical Terminal
15. End Cover

Fig. 18, AD-2 End Cover Assembly, Exploded View

6. Separate the capscrew, lockwasher, purge valve, purge valve piston, piston O-ring, and the piston return spring. Discard the purge valve, the piston O-ring, and the piston return spring.

7. Wash all remaining parts in a commercial solvent, making sure all surfaces, bores, ports, and passages are clean and dry before assembly.

8. Using a barium-base grease, lubricate the new piston O-ring, then install it on the purge valve piston.

BENDIX AD-1 AND AD-2 AIR DRYERS

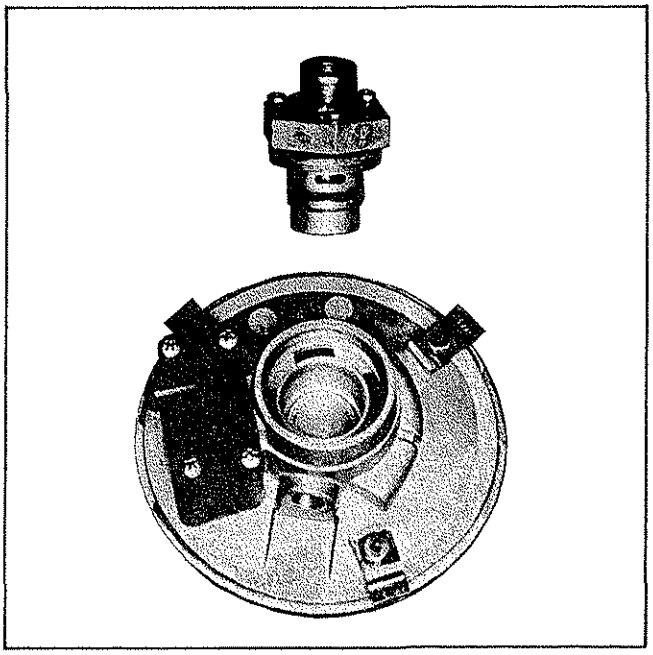


Fig. 19

9. Lubricate the piston bore, then install the purge valve piston and piston return spring into the capnut.

10. Install the purge valve in the capnut so that the rubber portion of the purge valve rests on the metal seat of the capnut. Using the capscrew and lockwasher, secure the purge valve to the piston. Tighten the capscrew to 50 in-lbs (6 N·m).

11. Lubricate the two new O-rings with a barium-base grease, then install them on the capnut.

12. Lubricate the capnut threads and the capnut bore in the end cover, then install the capnut, tightening it to 15-21 ft-lbs (20-28 N·m).

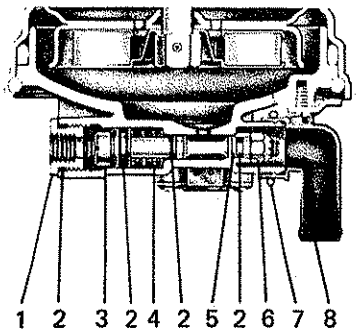
13. Use the three screws removed in step 4 to secure the exhaust port cover to the purge valve capnut, then use the single screw and washer removed in step 3 to secure the exhaust diaphragm to the exhaust port cover.

14. Lubricate the large O-ring with a barium-base grease, then install it around the end cover assembly.

15. Set the end cover assembly aside for later installation on the air dryer. If the desiccant cartridge or desiccant sealing plate is not being rebuilt or replaced, install the end cover assembly on the air dryer following the instructions given in steps 14 through 18 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject.

AD-1 PURGE VALVE ASSEMBLY REBUILDING
(Refer to Fig. 20)

1. If the end cover assembly has not been removed from the AD-1 air dryer, perform steps 1 through 4 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject.



1. Capnut
2. O-Ring
3. Plunger
4. Spring
5. Purge Valve
6. Self-Locking Nut
7. Hose Clamp
8. Exhaust Elbow

Fig. 20, AD-1 End Cover Assembly Nomenclature

2. Thoroughly clean the end cover exterior, using a commercial solvent. Remove and discard the large O-ring around the end cover.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

BENDIX AD-1 AND AD-2 AIR DRYERS

3. Remove the hose clamp and exhaust elbow.

4. Remove the capnut and capnut O-ring from the purge valve port, discarding the capnut O-ring.

5. Place the handle of a large screwdriver in a vise, and secure it. Place the blade of the screwdriver through the purge valve port into the slot in the plunger, and hold the plunger securely in place. Then, remove the self-locking nut from the opposite end of the plunger.

6. Remove the plunger, spring, and purge valve from the end cover, discarding the purge valve. Remove and discard the three O-rings from the plunger.

7. Clean and inspect the plunger bore, the purge valve seat, and the plunger. If visible damage is present, replace the end cover assembly.

NOTE: The AD-1 end cover assembly is no longer available as a replacement part for the AD-1 air dryer. If the AD-1 end cover assembly must be replaced, an AD-2 end cover assembly can be installed on the AD-1 air dryer, with no modifications necessary to either part.

8. Lubricate the new O-rings with a barium-base grease, then install them on the plunger and on the capnut. Lubricate the plunger bore, then install the spring and plunger into the bore through the purge valve port end of the bore.

9. From the opposite end of the plunger bore, install the valve on the plunger, making certain the chamfered end of the valve is in contact with the metal seat of the plunger body.

10. Place the handle of a large screwdriver in a vise, and secure it. Compress the plunger into the plunger bore, then place the blade of the screwdriver in the slot in the plunger and hold the plunger securely in place. Install the self-locking nut, tightening it to 50-65 in-lbs (6-7 N·m). Install the hose clamp and exhaust elbow.

11. Install the capnut in the purge valve port end of the bore, then tighten it to 125-150 in-lbs (14-28 N·m). Lubricate and install the large O-ring around the end cover assembly.

12. Set the end cover assembly aside for later installation on the air dryer. If the desiccant cartridge or desiccant sealing plate is not being rebuilt or replaced, install the end cover assembly on the air dryer following the instructions given in steps 14 through 18 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject.

AD-1 HEATER AND THERMOSTAT REPLACEMENT

1. If the AD-1 end cover assembly has not been removed from the AD-1 air dryer, perform steps 1 through 4 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject.

2. Remove the thermostat retainer and the thermostat, then remove the square-cut sealing ring at the bottom of the thermostat bore. Inspect the thermostat bore for corrosion. If necessary, clean the thermostat bore with a commercial solvent. Then, remove the screw, heater retaining clip, O-ring, and heater element. Inspect the heater bore for corrosion and, if necessary, clean it with a commercial solvent.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

NOTE: If the thermostat bore, or heater bore, is corroded, the end cover assembly must be replaced. The AD-1 end cover assembly is no longer available as a replacement part for the AD-1 air dryer. If the AD-1 end cover assembly must be replaced, an AD-2 end cover assembly can be installed on the AD-1 air dryer, with no modifi-

BENDIX AD-1 AND AD-2 AIR DRYERS

cations necessary to either part. Proceed to steps 14 through 18 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject, for end cover assembly installation instructions.

3. Install the new heater element and O-ring, securing it in the end cover with the heater retaining clip and screw.

4. Install the square-cut sealing ring in the bottom of the thermostat bore. Install the new thermostat, metal side down, in the thermostat bore. Secure it in place using the thermostat retainer and the two screws.

5. Set the end cover assembly aside for later installation on the air dryer. If the desiccant cartridge or desiccant sealing plate is not being rebuilt or replaced, install the end cover assembly on the air dryer following the instructions given in steps 14 through 18 under the heading, "DESICCANT CARTRIDGE REBUILDING OR REPLACEMENT," in this subject.

AD-2 OUTLET PORT SINGLE CHECK VALVE ASSEMBLY REBUILDING

1. If the air dryer has been removed from the vehicle, proceed to step 3. If the air dryer is still mounted on the vehicle, apply the parking brakes, then chock block the vehicle tires. Drain the air from the air reservoirs.

2. Disconnect the air line from the outlet port of the air dryer. Mark the line for later assembly.

3. Remove the single check valve assembly from the outlet port. Remove and discard the O-ring from the external threaded portion of the outlet port.

4. Disassemble the check valve assembly by unscrewing the body halves. Note the positions of the parts removed. Discard the rubber ball valve, check valve spring, and metal seal washer.

5. Wash all parts in a commercial solvent, making sure all surfaces are clean and dry prior to assembly. Coat all parts with a film of barium-base lubricant.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

6. Install the new rubber ball valve, check valve spring, and metal seal washer, then screw together the body halves, tightening them to 17-19 ft-lbs (23-26 N·m).

7. Install a new O-ring in the external threaded portion of the outlet port, then install the check valve in the outlet port.

8. If the air dryer was removed from the vehicle, install it using the instructions given under the heading, "AIR DRYER REMOVAL AND INSTALLATION," in this subject.

   If the air dryer is still mounted on the vehicle, connect the air line to the outlet port of the air dryer, as previously marked, or as shown in Fig. 21 located under "SPECIFICATIONS," in this subject. Install the hose, and tighten the nut finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more.

9. Remove the chock blocks from the vehicle tires.

BENDIX AD-1 AND AD-2 AIR DRYERS

SPECIFICATIONS

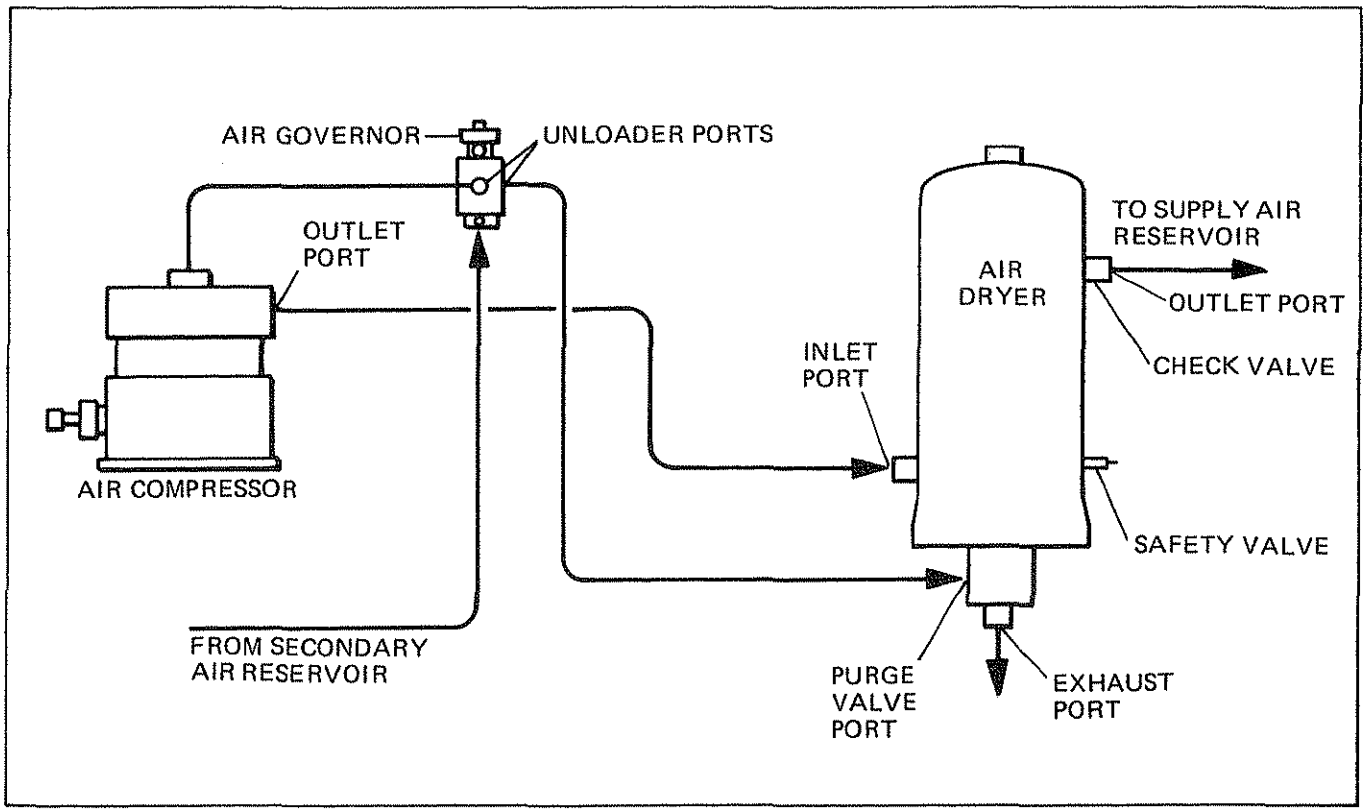
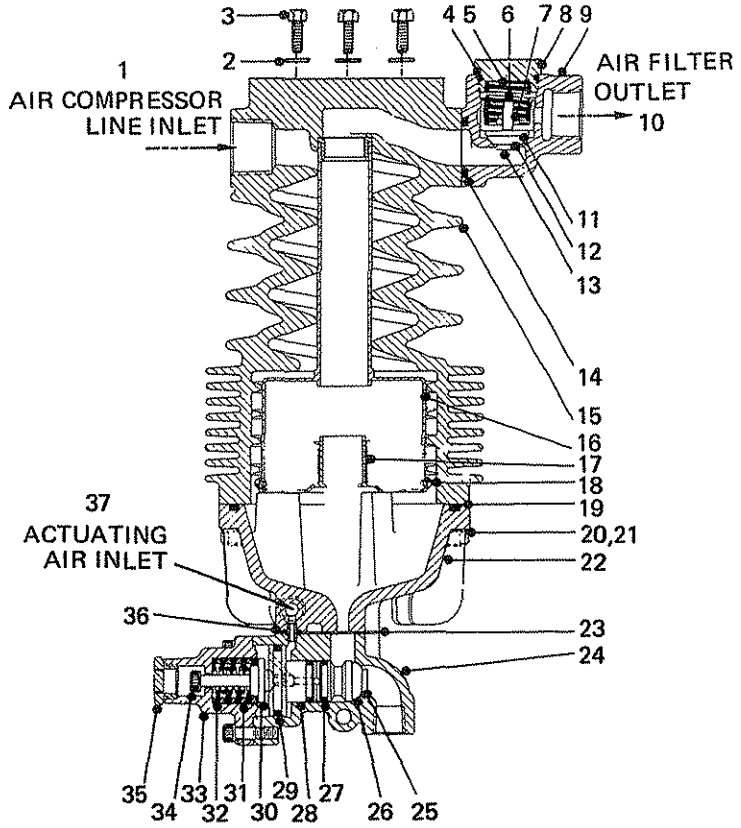


Fig. 21, Bendix AD-1 And AD-2 Air Dryer Plumbing Diagram

GENERAL DESCRIPTION

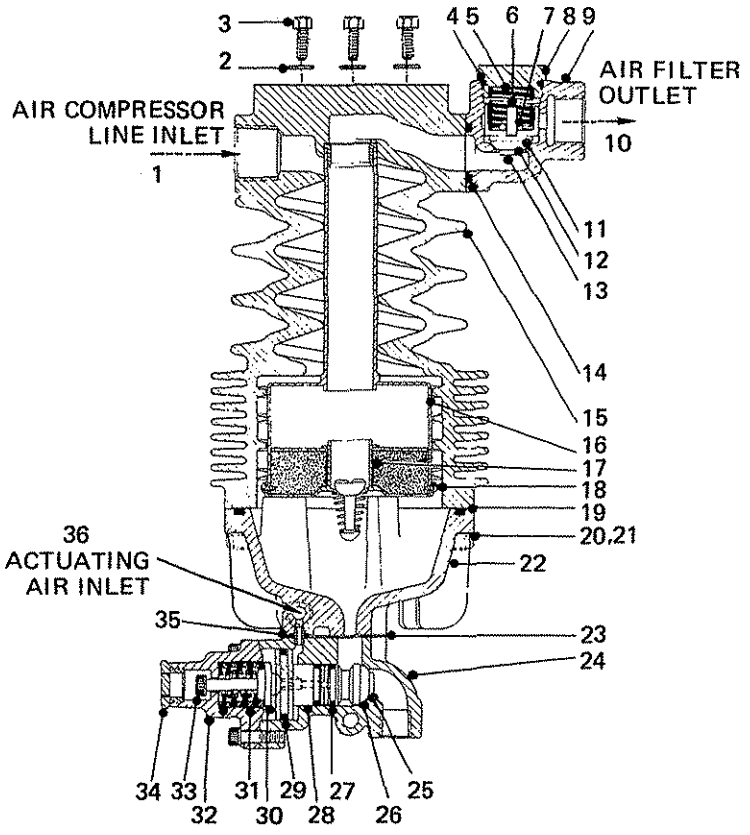
The Salem Centrifugal Air Filter Model 918-007,or 918-011 is a heat transfer device mounted between the air compressor and wet tank. It supplies sufficient radiation to cool the compressed air to ambient temperature. It is designed to internally route the compressed air in such a manner as to precipitate heavy particles and moisture into a sump where they are periodically ejected.

The Salem Centrifugal Air Filter Model 918-007, or 918-011 has a cast aluminum housing with a helix designed on the upper separator body, and cooling fins on the lower separator body. Both the helix and cooling fins encircle the separator body to supply radiation cooling to the interior. The (separator body) interior is open, and a discharge tube is inserted which encloses the inner portion. This creates a circular winding passage called a helix. Below the discharge tube is a wider housing which fits close to the inside wall of the separator body called a deflector. The deflector on the Model 918-007 contains a stainless steel wool scrubber or filter, while on the Model 918-011 there is no scrubber. On the bottom of the unit is a teflon coated sump, or bottom cap, and an ejector, or discharge valve.



1. Air Compressor Inlet
2. Mounting Bracket Capscrew Lockwasher
3. Mounting Bracket Capscrew
4. Check Valve Spring Cap Seal
5. Check Valve Spring
6. Check Valve Wing
7. Check Valve Wing Locknut
8. Check Valve Spring Cap
9. Check Valve Body
10. Wet Tank Outlet
11. Check Valve Wing Locknut
12. Check Valve Seat
13. Check Valve Seat Screw
14. Check Valve/Separator Body Seal
15. Separator Body
16. Deflector
17. Deflector Cap & Scrubber
18. Deflector Capscrew
19. Bottom Cap Seal
20. Bottom Cap Lockwasher
21. Bottom Cap Nut
22. Bottom Cap
23. Discharge Valve Seal
24. Discharge Valve Body
25. Dishcarge Valve Seat Screw
26. Discharge Valve Seat
27. Discharge Valve Seal
28. Discharge Valve Piston
29. Discharge Valve Piston Seal
30. Discharge Valve Spring Seat Washer
31. Discharge Valve Large Spring
32. Discharge Valve Spring Cap
33. Discharge Valve Shoulder Bolt
34. Discharge Valve Dirt Cap
35. Discharge Valve/Bottom Cap Seal
36. Actuating Line From Governor

Fig. 1, Salem Centrifugal Air Filter Model 918-011, Cutaway View



1. Air Compressor Inlet
2. Mounting Bracket Capscrew Lockwasher
3. Mounting Bracket Capscrew
4. Check Valve Spring Cap Seal
5. Check Valve Spring
6. Check Valve Wing
7. Check Valve Wing Locknut
8. Check Valve Spring Cap
9. Check Valve Body
10. Wet Tank Outlet
11. Check Valve Wing Locknut
12. Check Valve Seat
13. Check Valve Seat Screw
14. Check Valve/Separator Body Seal
15. Separator Body
16. Deflector
17. Deflector Cap
18. Deflector Capscrew
19. Bottom Cap Seal
20. Bottom Cap Lockwasher
21. Bottom Cap Nut
22. Bottom Cap
23. Discharge Valve Seal
24. Discharge Valve Body
25. Discharge Valve Seat Screw
26. Discharge Valve Seat
27. Discharge Valve Seal
28. Discharge Piston
29. Discharge Valve Piston Seal
30. Discharge Valve Spring Seat Washer
31. Discharge Valve Large Spring
32. Discharge Valve Small Spring
33. Discharge Valve Spring Cap
34. Discharge Valve Shoulder Bolt
35. Discharge Valve Dirt Cap
36. Discharge Valve/Bottom Cap Seal
37. Actuating Line From Governor

Fig. 2, Salem Centrifugal Air Filter Model918-007, Cutaway View

PRINCIPLES OF OPERATION

The compressed air from the air compressor enters the unit at the top, flows through the helix around the discharge tube, and the centrifugal force created by this air flow spins out heavy particles and drops of liquid. Below the helix, the compressed air is forced outward and down along the wall of the finned area of the separator body by the deflector, where it cools enough to condense out oil and moisture droplets.

The condensed liquids drain into the bottom cap, while the compressed air then flows upward through the scrubber on the Model 918-007, or upward through the deflector cap on the Model 918-011. More particles are removed, then the cleaned, cooled compressed air continues up the discharge tube through the check valve, and into the wet tank.

When the air compressor cuts out, the discharge valve opens to discharge the accumulated droplets of oil and moisture. Upon opening, the pressure in the interior of the unit blows downward cleaning the scrubber in the Model 918-007, or the deflector in the Model 918-011, and the sump area of collected contaminants. The unit is thus cleaned and ready for another charging of the compressed air system, whereupon it will repeat the above cycle.

SERVICE OPERATIONS

The Salem Centrifugal Air Filter should be removed, disassembled, cleaned, assembled, and installed when transferring the unit to another vehicle, or if there has been an air compressor failure.

REMOVAL

1. Block the vehicle wheels, then drain the air out of the wet and dry tanks.

WARNING: Use eye protection when draining wet and dry tanks, as flying debris could cause permanent harm to unprotected eyes.

2. Disconnect the air line that runs from the governor to the actuating air inlet (Fig. 1, Ref. 37) of the air filter.

3. Disconnect the air line that runs from the air compressor to the air filter inlet (Fig. 1, Ref. 1).

4. Disconnect the air line that runs from the air filter outlet (Fig. 1, Ref. 10) to the wet tank.

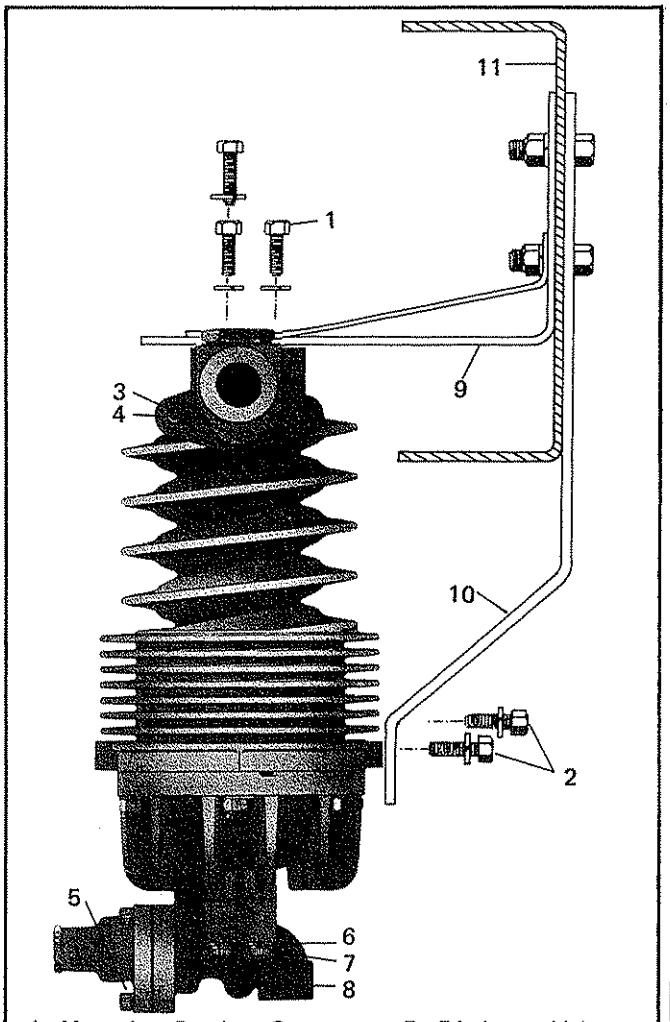
5. Remove the mounting bracket capscrews (Fig. 3, Ref. 1) and support bracket capscrews (Fig. 3, Ref. 2) which hold the air filter to the mounting bracket and support bracket. Remove the air filter from the vehicle.

DISASSEMBLY OF THE AIR FILTER

1. Remove the four bottom discharge valve capscrews (Fig. 3, Ref. 7) and discharge valve lockwashers (Fig. 3, Ref. 6) which hold the discharge valve body (Fig. 1, Ref. 24) to the bottom cap (Fig. 1, Ref. 22). Remove the discharge valve body from the bottom cap.

2. Loosen the check valve spring cap (Fig. 1, Ref. 8) on the check valve body (Fig. 1, Ref. 9), but do not remove.

3. Remove the two check valve nuts (Fig. 3, Ref. 4) and check valve lockwashers (Fig. 3, Ref. 3) which hold the check valve body (Fig. 1, Ref. 9) to the separator body (Fig. 1, Ref. 15). Support the check valve body to prevent damage to the check valve/separator body seal (Fig. 1, Ref. 14), then remove the check valve body from the separator body.



1. Mounting Bracket Capscrews
2. Support Bracket Capscrews
3. Check Valve Lockwasher (2)
4. Check Valve Nut (2)
5. Spring Cap Capscrew (3)
6. Discharge Valve Lockwasher (4)
7. Discharge Valve Capscrew (4)
8. Dirt Cover
9. Mounting Bracket
10. Support Bracket
11. Frame Rail

Fig. 3, Salem Centrifugal Air Filter Model 918-011 Side View

4. Remove the six bottom cap nuts (Fig. 1, Ref. 21) and bottom cap lockwashers (Fig. 1, Ref. 20) which hold the bottom cap (Fig. 1, Ref. 22) to the separator body, then remove the bottom cap from the separator body.

5. Remove the deflector unit (Fig. 1, Ref. 16) from the separator body, then remove the three deflector capscrews (Fig. 1, Ref. 18) from the deflector.

NOTE: On the Model 918-007, removal of the three deflector capscrews allows disassembly of the scrubber element, and on the Model 918-011 allows disassembly of the deflector cap for further cleaning.

DISASSEMBLY OF THE DISCHARGE VALVE

1. Remove the discharge valve dirt cap (Fig. 1, Ref. 35) from the discharge valve spring cap (Fig. 1, Ref. 33).

2. Remove the three spring cap capscrews (Fig. 3, Ref. 5) from the discharge valve spring cap (Fig. 1, Ref. 33) and discharge valve body (Fig. 1, Ref. 24), then remove the discharge valve spring cap from the discharge valve body.

3. Thread one of the spring cap capscrews (Fig. 3, Ref. 5) into the discharge valve seat, then pull the valve seat (Fig. 1, Ref. 26) from the discharge valve body.

4. Remove the discharge valve seat screw (Fig. 1, Ref. 25) from the discharge valve seat (Fig. 1, Ref. 26), then remove the discharge valve seat from the discharge valve piston (Fig. 1, Ref. 28).

5. Remove the discharge valve shoulder bolts (Fig. 1, Ref. 34) from the discharge valve spring seat washer (Fig. 1, Ref. 30), then remove the discharge valve large spring (Fig. 1, Ref. 31) and the discharge valve small spring (Fig. 1, Ref. 32) from the discharge valve shoulder bolt.

NOTE: On the Model 918-007, there is only a discharge valve large spring (Fig. 2, Ref. 31) to be removed from the discharge valve shoulder bolt (Fig. 2, Ref. 33).

DISASSEMBLY OF THE CHECK VALVE

1. Remove the check valve spring cap (Fig. 1, Ref. 8) from the check valve body (Fig. 1, Ref. 9), then remove the check valve spring (Fig. 1, Ref. 5) and the check valve seat (Fig. 1, Ref. 12) from the check valve body.

2. Remove the check valve wing locknut (Fig. 1, Ref. 7) from the check valve wing (Fig. 1, Ref. 6).

3. Remove the check valve seat screw (Fig. 1, Ref. 13) from the check valve seat (Fig. 1, Ref. 12), then remove the check valve seat from the check valve wing.

CLEANING AND INSPECTING THE AIR FILTER, DISCHARGE VALVE, AND CHECK VALVE

1. Wash all disassembled parts in a clean soap and water bath, and air blow the parts dry with compressed air.

WARNING: use eye protection such as safety glasses when drying parts with compressed air as permanent harm to unprotected eyes could be caused by flying debris.

2. Inspect the three seals on the discharge valve (Fig. 1, Refs. 27 & 29). If the old seals are cracked, broken, or deteriorated, replace them with new seals.

3. Inspect the discharge valve seal (Fig. 1, Ref. 23) which seals the joint between the bottom cap (Fig. 1, Ref. 22) and the discharge valve body (Fig. 1, Ref. 24). Replace the old discharge valve seal with a new one if the old one is cracked, broken, or deteriorated.

4. Inspect the discharge valve/bottom cap seal (Fig. 1, Ref. 36) between the bottom cap (Fig. 1, Ref. 22) and the discharge valve body (Fig. 1, Ref. 24). If the old discharge valve/bottom cap seal is cracked, broken, or deteriorated, replace it with a new one.

5. Inspect the bottom cap seal (Fig. 1, Ref. 19) between the bottom cap and the separator body, the check valve spring cap seal (Fig. 1, Ref. 4) and the check valve/separator body seal (Fig. 1, Ref. 14). If the old seals are cracked, broken, or deteriorated, replace them with new seals.

6. Inspect the discharge valve seat (Fig. 1, Ref. 26) and the check valve seat (Fig. 1, Ref. 12). If the valve seats are cracked, broken, or damaged, replace them with new valve seats.

7. Inspect all the metal parts of the air filter. If any parts are fractured, broken, or corroded beyond useful life, replace them with new parts.

ASSEMBLY OF THE CHECK VALVE

1. Install the check valve seat (Fig. 1, Ref. 12) into the check valve wing (Fig. 1, Ref. 6), and install the check valve seat screw (Fig. 1, Ref. 13) into the check valve seat. Tighten the check valve seat screw to 15 to 20 in-lbs.

2. Install the check valve wing locknut (Fig. 1, Ref. 7) onto the check valve wing (Fig. 1, Ref. 6), and tighten the check valve wing locknut to 20 to 25 in-lbs.

3. Install the check valve seat (Fig. 1, Ref. 12) and the check valve spring (Fig. 1, Ref. 5) into the check valve body, then install the check valve spring cap (Fig. 1, Ref. 8) into the check valve body (Fig. 1, Ref. 9). Tighten the spring cap to 25 to 30 in-lbs.

ASSEMBLY OF THE DISCHARGE VALVE

1. Assemble the discharge valve small spring (Fig. 1, Ref. 32) and discharge valve large spring (Fig. 1, Ref. 31) onto the discharge valve shoulder bolt (Fig. 1, Ref. 34) then install the discharge valve shoulder bolt into the discharge valve spring seat washer (Fig. 1, Ref. 30). Tighten the discharge valve shoulder bolt to 3 to 4 ft-lbs.

NOTE: On the Model 918-007 there is only a discharge valve large spring (Fig. 2, Ref. 31) to be installed onto the discharge valve shoulder bolt (Fig. 2, Ref. 33).

2. Install the discharge valve seat (Fig. 1, Ref. 26) onto the discharge valve piston (Fig. 1, Ref. 28) then install the discharge valve seat screw (Fig. 1, Ref. 25) into the discharge valve seat. Tighten the discharge valve seat screw to 25 to 30 in-lbs.

3. Using one of the spring cap capscrews (Fig. 3, Ref. 5) push the discharge valve seat (Fig. 1, Ref. 26) into the discharge valve body (Fig. 1, Ref. 24). Remove the spring cap capscrew from the discharge valve seat.

4. Align the discharge valve spring cap (Fig. 1, Ref. 33) and the discharge valve body (Fig. 1, Ref. 24), then install the three spring cap capscrews (Fig. 3, Ref. 3) into the spring cap and discharge valve body. Tighten the capscrews to 36 to 48 in-lbs.

NOTE: On Model 918-007, the discharge valve spring cap (Fig. 2, Ref. 32) has a vent hole which must be clear for correct air filter operation. On Model 918-011 the vent holes are located in the discharge valve dirt cap. Be sure these vent holes are open.

5. Install the discharge valve dirt cap (Fig. 1, Ref. 35) onto the discharge valve spring cap (Fig. 1, Ref. 33). Tighten the discharge valve dirt cap to 8 to 10 in-lbs.

ASSEMBLY OF THE AIR FILTER

1. Install the three deflector capscrews (Fig. 1, Ref. 18) into the deflector (Fig. 1, Ref. 16). On Model 918-007 insert the scrubber element into the deflector. Then install the deflector unit into the separator body (Fig. 1, Ref. 15). Tighten the deflector capscrews to 7 to 8 in-lbs.

2. Install the bottom cap (Fig. 1, Ref. 22) onto the separator body (Fig. 1, Ref. 15), then install the six bottom cap nuts (Fig. 1, Ref. 21) and bottom cap lockwashers (Fig. 1, Ref. 20) which hold the bottom cap to the separator body. Tighten the six bottom cap nuts to 5 to 6 ft-lbs.

3. Install the check valve body (Fig. 1, Ref. 9) onto the separator body. Install the two check valve nuts (Fig. 3, Ref. 2) and check valve lockwashers (Fig. 3, Ref. 1). Tighten the two check valve nuts to 5 to 6 ft-lbs.

4. Install the discharge valve body (Fig. 1, Ref. 24) onto the bottom cap (Fig. 1, Ref. 22). Install the four bottom discharge valve capscrews (Fig. 3, Ref. 4) which hold the discharge valve body onto the bottom cap. Tighten the four discharge valve capscrews to 6 to 7 ft-lbs.

INSTALLATION

1. Locate the air filter onto the air filter mounting bracket. Install the three mounting bracket capscrews (Fig. 1, Ref. 3) and mounting bracket lockwashers (Fig. 1, Ref. 2) that hold the air filter to the air filter mounting bracket. Tighten the three capscrews to 13 to 15 ft-lbs.

2. Connect the air line that runs from the air filter to the wet tank, to the air filter outlet (Fig. 1, Ref. 10). Tighten hand tight, then wrench tighten until a solid feeling is encountered; then tighten one sixth turn more. Do not overtighten.

3. Connect the air inlet line that runs from the air compressor to the air filter inlet (Fig. 1, Ref. 1),

to the air filter inlet. Tighten hand tight, then wrench tighten until a solid feeling is encountered; then tighten one sixth turn more. Do not overtighten.

4. Connect the air line to the air filter that runs from the governor to the actuating air inlet (Fig. 1, Ref. 37). Tighten hand tight, then wrench tighten until a solid feeling is encountered; then tighten one sixth turn more. Do not overtighten.

5. Start the vehicle and pressurize the wet and dry tanks to 105 - 120 psi gauged pressure.

6. Check for air leaks by coating the connecting air line fittings or connections with a soap/water solution. Formation of a one inch diameter bubble in 60 seconds or more is acceptable leakage. Formation of a one inch bubble in less than 60 seconds is unacceptable. Formation of bubbles larger than 1 inch in 60 seconds is also unacceptable. Make certain by listening and feeling that air is not escaping at too fast a rate to permit bubble formation. Such leakage is unacceptable. Remove the leaking air line or air filter, repair, install, and test again according to the procedures found in this subject.

7. Remove the safety block(s) when the wet and dry tanks reach brake application pressure (90-105 psi gauged pressure for older vehicles, 105-120 psi gauged pressure for newer vehicles).

SPECIFICATIONS

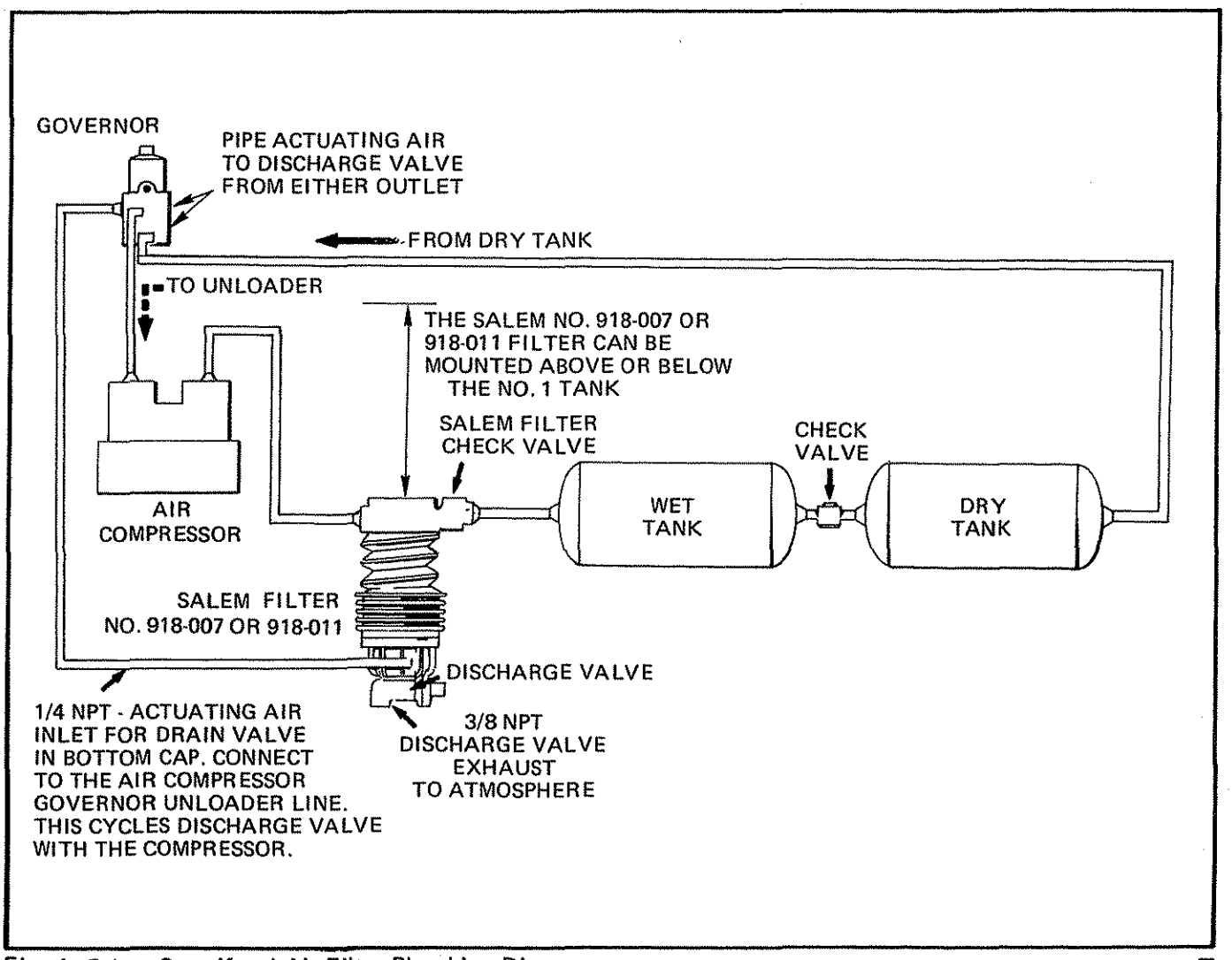


Fig. 4, Salem Centrifugal Air Filter Plumbing Diagram

AIR GOVERNOR, BENDIX MODEL D-2

GENERAL DESCRIPTION

The governor (Fig. 1), operating in conjunction with the compressor unloading mechanism, automatically controls the air pressure in the air brake or air supply system between the desired, predetermined maximum and minimum pressures. Normal air pressure in all Freightliner vehicles is 95 to 125 psi (655 to 862 kPa). The compressor runs continually while the engine runs, but the actual compression of air is controlled by the governor actuating the compressor unloading mechanism which stops or starts compression when the maximum or minimum reservoir pressures are reached. The D-2 governor has a piston upon which air pressure acts to overcome the pressure setting spring, and control the inlet and exhaust valve to either admit or exhaust air to or from the compressor unloading mechanism.

D-2 governors are provided with mounting holes which allow for direct mounting to the compressor.

Porting consists of 3 reservoir ports (1/8-inch [3mm] NPT), 3 unloader ports (1/8-inch [3 mm] NPT), and 1 exhaust port (1/8-inch [3 mm] NPT).

PRINCIPLES OF OPERATION

Reservoir air pressure enters the D-2 governor at one of its reservoir ports, and acts on the area of the piston and beneath the inlet and exhaust valve. See Fig. 2. As the air pressure builds up, the piston moves against the resistance of the pressure-setting spring. The piston and inlet and exhaust valve move up when the reservoir air pressure reaches the cut-out setting of the governor. The exhaust stem seats on the inlet and exhaust valve, and then the inlet passage opens. Reservoir air pressure then flows by the open inlet valve, through the passage in the piston, and out the unloader port to the compressor unloading mechanism. Air also flows around the piston, and acts upon the additional area of the piston. This additive force, which results from a larger area on the piston, assures a positive action and fully opens the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston will be reduced so that the pressure-setting spring will move the piston down. The inlet valve will close and the exhaust will open. With

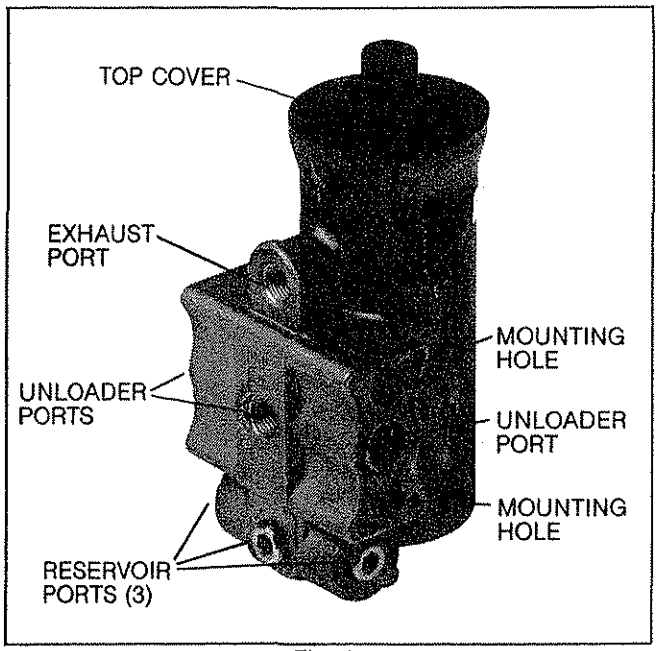
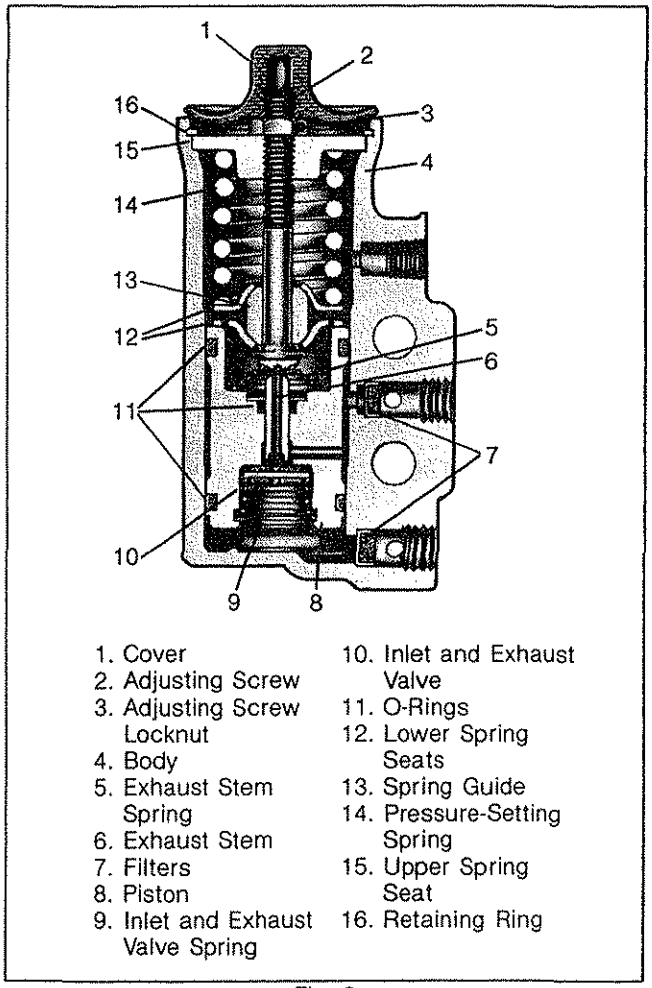


Fig. 1



1. Cover
2. Adjusting Screw
3. Adjusting Screw Locknut
4. Body
5. Exhaust Stem Spring
6. Exhaust Stem
7. Filters
8. Piston
9. Inlet and Exhaust Valve Spring
10. Inlet and Exhaust Valve
11. O-Rings
12. Lower Spring Seats
13. Spring Guide
14. Pressure-Setting Spring
15. Upper Spring Seat
16. Retaining Ring

Fig. 2

AIR GOVERNOR, BENDIX MODEL D-2

the exhaust open, the air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

SERVICE OPERATIONS

The following tests should be performed whenever the vehicle air pressure is incorrect and the causes are unknown.

OPERATING TEST

1. Set the parking brakes and chock the tires. Tilt the cab or hood to expose the governor. For instructions, refer to the Freightliner Driver's Manual.
2. Start the vehicle engine, and build up air pressure in the air brake system.
3. Check the pressure registered by the dash gauge or a test gauge at the time the governor cuts out, stopping the compression of air by the compressor. The cut-out pressure should be 115 to 125 psi (783 to 852 kPa).
4. With the engine still running, make a series of brake applications to reduce the air pressure, and observe at what pressure the governor cuts in the compressor. The cut-in pressure should be 95 to 100 psi (655 to 690 kPa).
5. If either the cut-out or cut-in pressures are incorrect, proceed to "GOVERNOR ADJUSTING."

NOTE: Never condemn or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash gauge that is registering accurately.

LEAKAGE TESTS

The leakage tests on the governor should be in both the cut-in and cut-out positions.

1. With the compressor in the cut-in position, apply a soap solution to the governor exhaust port. See Fig. 1. A slight bubble leakage is permitted. Excessive leakage indicates a faulty inlet valve or lower piston O-ring.
2. With the compressor in the cut-out position, apply a soap solution to the governor exhaust port. See Fig. 1. A slight bubble leakage is permitted. Excessive leakage indicates a faulty exhaust valve seat, stem, O-ring, or upper piston O-ring.

If the governor does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired using genuine Bendix parts and the instructions in this subject.

3. Return the cab or hood to the operating position, and remove the chocks from the tires.

GOVERNOR ADJUSTING

If the pressure settings of the governor are inaccurate, or if it is necessary that they be changed, proceed as follows:

1. Set the parking brakes and chock the tires. Tilt the cab or hood to expose the governor. For instructions, refer to the Freightliner Driver's Manual.
2. Remove the top cover from the governor, and loosen the adjusting-screw locknut. See Fig. 2.
3. To raise the pressure settings, turn the adjusting screw counterclockwise.

   To lower the pressure setting, turn the adjusting screw clockwise.

NOTE: The pressure range between cut-in and cut-out is not adjustable.

   If these adjustments do not correct the pressure settings, repair or replace the governor using the instructions in this subject.

4. Tighten the adjusting-screw locknut, and install the top cover.
5. Return the cab or hood to the operating position, and remove the chocks from the tires.

GOVERNOR REMOVAL, DISASSEMBLY, CLEANING AND INSPECTING, ASSEMBLY, AND INSTALLATION

Removal (Refer to Fig. 3)

1. Chock the tires, and drain the air brake system. Tilt the cab or hood to expose the governor. For instructions, refer to the Freightliner Driver's Manual.
2. Disconnect the reservoir and unloader port air lines. Mark the lines for later assembly reference. Cap the air lines tightly to keep out contaminants.
3. Remove the governor mounting bolts, and remove the governor.

Disassembly (Refer to Fig. 2)

1. Clean the governor exterior of road dirt and grease.

AIR GOVERNOR, BENDIX MODEL D-2

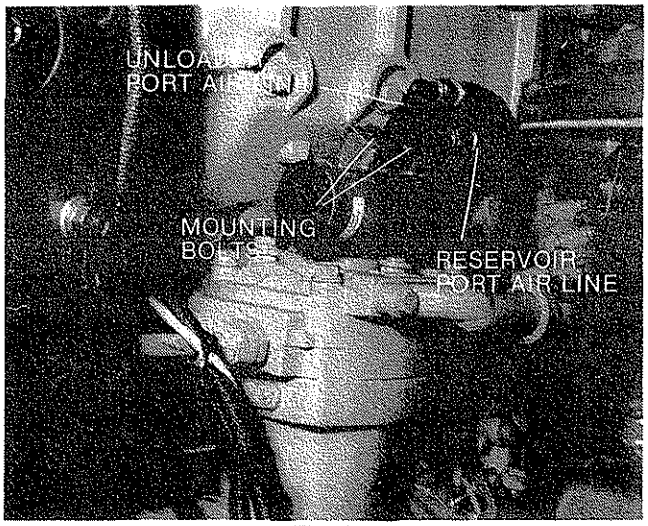


Fig. 3

2. Unscrew the top cover (Ref. 1).
3. With a pair of retaining ring pliers, remove the spring assembly retaining ring (Ref. 16).
4. Remove the adjusting screw (Ref. 2) and spring assembly.
5. Remove the locknut (Ref. 3), then the hex-shaped upper spring seat (Ref. 15) from the adjusting screw.
6. Remove the pressure-setting spring (Ref. 14), lower spring seat (Ref. 12), spring guide (Ref. 13), and the other lower spring seat (Ref. 12) from the adjusting screw.
7. Remove the exhaust stem and its spring from the top of the piston. With the body in the inverted position, tap lightly and remove the piston.
8. Remove the inlet and exhaust valve spring (Ref. 9) and the valve (Ref. 10) from the piston.
9. Remove the two piston O-rings (Ref. 11), and with a hooked wire, remove the exhaust stem O-ring (Ref. 11).
10. Clean or remove the unloader and reservoir port filters (Ref. 7).

Cleaning and Inspecting

1. Clean all metal parts in mineral spirits.
2. Wipe all rubber parts dry, using a clean cloth.
3. Inspect the governor body for cracks or other damage. Be particularly careful that all air passages in the body, filters, exhaust stem, and piston are not obstructed.
4. Check the springs for cracks, distortion, or corrosion.
5. Replace all parts which are worn or damaged.

Assembly (Refer to Fig. 2)

Prior to assembly, lubricate the lower body bore, the top of the piston, the piston grooves, piston O-rings, and the spring guide and adjusting screw with Dow Corning 55-M pneumatic grease, or equivalent.

1. Install the exhaust stem O-ring (Ref. 11) in its groove in the stem bore of the piston.
2. Install the upper and lower piston O-rings (Ref. 11).
3. Drop the inlet and exhaust valve (Ref. 10) into place at the bottom of the piston.
4. Install the inlet and exhaust valve spring (Ref. 9) with the small end against the valve. Press the spring down until the larger coiled end snaps into the groove inside the piston.
5. Position the exhaust stem spring (Ref. 5) over the exhaust stem. Carefully press the stem into the stem bore of the piston.
6. Install the piston in the body.
7. Install one lower spring seat (Ref. 12), spring guide (Ref. 13), the other lower spring seat (Ref. 12), pressure-setting spring (Ref. 14), and the hex-shaped upper spring seat (Ref. 15) on the adjusting screw, in that order. Screw the upper spring seat (Ref. 15) down until the dimension from the top of the seat to the bottom of the stem head is approximately 1-7/8 inches (48 mm).
8. Install the locknut (Ref. 3).
9. Before placing the adjusting screw and stem assembly in the governor body, check that the exhaust stem (Ref. 6) and its spring are in place in the piston.
10. Install the adjusting screw (Ref. 2) and spring assembly, and the retaining ring (Ref. 16).

Installation

1. Clean the mounting pad on both the compressor and the governor block, and be sure the compressor unloading port is clear and clean.

AIR GOVERNOR, BENDIX MODEL D-2

2. Using a new governor mounting gasket, install the governor and governor mounting bolts. Tighten the bolts 11 to 15 lbf·ft (15 to 20 N·m).
3. Clean the connecting lines after removing the caps, and apply Loctite® 242, or equivalent sealant in small quantities, to the reservoir and unloader fittings.

CAUTION: Make sure excess sealant does not get inside the fittings. Loose material inside the plumbing may clog the governor or other components causing damage.

4. Connect the reservoir and unloader port air lines as referenced earlier. Tighten the fittings 11 to 13 lbf·ft (15 to 18 N·m).
5. Perform the operating and leakage tests under "OPERATING TESTS," and "LEAKAGE TESTS."
6. After the tests have been completed and the governor is operating properly, screw the top cover on tightly until it seals the body against the entrance of any foreign matter.
7. If necessary, install new filters (Ref. 7) in the reservoir and unloader ports. These cup-shaped filters can be installed with the head of a pencil.
8. Return the cab or hood to the operating position, and remove the chocks from the tires.

AIR RESERVOIR

GENERAL INFORMATION

Air reservoirs serve two main purposes:

1. They store compressed air used to apply the brakes and operate other air-powered devices, such as window lifts, windshield wipers, and seats.
2. They provide a place where air, heated during compression, can cool and water vapor can condense into a liquid. Also, air reservoirs collect small amounts of oil passed by the compressor.

Each vehicle is equipped with three or four air reservoirs, depending on how many rear axles are installed. On all vehicles, each reservoir is identified as one of three types: supply, primary, and secondary.

A supply reservoir receives compressed air directly from the compressor. Also referred to as the wet tank, its functions are to collect most of the water and oil condensate from the air, and to feed air to the other reservoirs. At the outlet port of the supply reservoir (the port leading to the primary reservoir) is a safety valve, which protects the air system against excessive air pressure build-up. The supply reservoir is usually mounted on the right-hand frame rail.

Primary reservoirs are air sources for the brakes on the rear axles. One or two primary reservoirs are installed on a vehicle, depending on the number of rear axles and the air system configuration. At the inlet port of the primary reservoir is an inline check valve. The check valve allows air flow in one direction only, and prevents air flow in the reverse direction in case there is a drop in upstream air pressure. Each primary reservoir is usually mounted behind the supply reservoir on the right-hand frame rail.

A secondary reservoir is the air source for the front axle brakes. It is usually mounted on the left-hand frame rail, and, like the primary reservoir, is equipped with an inline check valve.

Since September 1987, the secondary reservoir supplies air to a pressure protection valve. This valve prevents complete loss of secondary air pressure if there is an air leak in any non-brake accessory.

All air reservoirs are equipped with drain valves to eject the water and oil emulsion from the tanks. Refer to the appropriate driver's manual for procedures and intervals covering air system draining.

SERVICE OPERATIONS

LEAKAGE TESTS

NOTE: If equipped with an automatic moisture-ejection valve, refer elsewhere in this group for leak testing.

Be sure the air system is fully charged. Using a soap solution or leak detector, check for leaks on the outside surfaces of the reservoirs and drain valves. No leakage is permitted.

If leaks exist at the drain valve, note if they occur at the joint of the valve and coupler, or through the valve body. Proceed to "Drain Valve Replacement and Leak Elimination."

If leaks occur on the surfaces of the air reservoir, replace the tank; refer to "Air Reservoir Replacement."

DRAIN VALVE REPLACEMENT AND LEAK ELIMINATION

NOTE: If equipped with an automatic moisture-ejection valve, refer elsewhere in this group for instructions.

1. Apply the parking brakes, and chock the tires.
2. Drain the air system, using the instructions in the appropriate driver's manual.
3. Using two wrenches (hold the coupler in place with one of them), unscrew the drain valve from the coupler. Clean off the threads inside the coupler on the reservoir, removing all sludge and sealant build-up.

   Obtain a new drain valve if leaks occurred through the body of the valve.

   If leaks occurred at the joint of the drain valve and coupler, clean off the sludge and sealant from the threads of the valve. Check for damaged threads on the valve and inside the coupler. Replace damaged parts. If no damage exists, leakage was probably due to inadequate tightening of the drain valve in the coupler.
4. Apply Loctite®, or an equivalent sealant, to the end threads of the drain valve or coupler, as applicable, and install finger-tight. Tighten one and one-half additional turns (use two wrenches if installing the drain valve).
5. Perform a leak test after completing the installation. If leaks occur at the joint of the drain valve and

AIR RESERVOIR

coupler, tighten the valve up to one additional turn to stop the leaks.

6. Remove the chocks from the tires.

AIR RESERVOIR REPLACEMENT

1. Apply the parking brakes, and chock the tires.
2. Drain the air system, using the instructions in the appropriate driver's manual.
3. Reference all reservoir air lines, couplers, and valves for later assembly; disconnect the components. Cap the exposed ports tightly to keep out contaminants. If access is limited, remove the components after removing the reservoir from its mount (step 4).
4. Remove the reservoir strap fasteners. Remove the reservoir.
5. If access is limited, perform step 6 first. If not, place a new reservoir in the mount, and install the strap fasteners. On two-piece straps (**Fig. 1**), tighten the nuts 20 to 25 lbf·ft (27 to 34 N·m). On one-piece straps (**Fig. 2**), tighten the weld nut bolt 30 to 40 lbf·ft (41 to 54 N·m).
6. As referenced earlier, connect all air lines, couplers, and valves to the new reservoir, removing the caps as each component is installed. Tighten the connections as instructed in Group 12 of the Freightliner *COE and 120 Conventional Maintenance Manual*.
7. Remove the chocks from the tires.

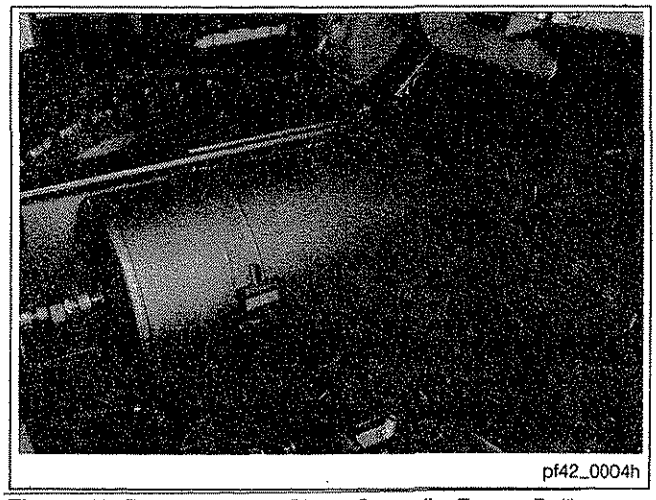


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Fig. 1, Air Reservoir, Two-Piece Strap (In Frame Rail) Mounting

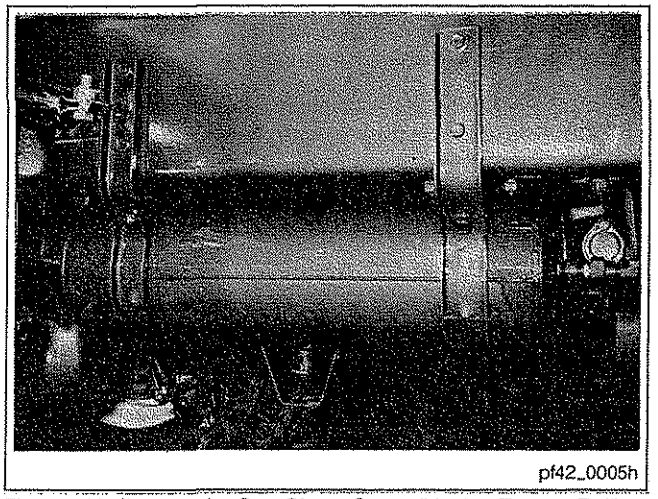

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Fig. 2, Air Reservoir, One-Piece Strap (Under Frame Rail) Mounting

PRESSURE RELIEF VALVE, BENDIX OR TRAMEC

SUBJECT CONTENTS

Topic **Page Number**

General Description

Principles of Operation

Service Operations

Operating and Leakage Checks 1
Removal and Installation 2

PRESSURE RELIEF VALVE, BENDIX OR TRAMEC

GENERAL DESCRIPTION

The pressure relief valve (**Fig. 1**) protects the air brake system against excessive air pressure build-up. The valve has a spring-loaded cap and O-ring assembly which will exhaust air from the reservoir, if pressure rises above the valve's pressure setting. This setting is determined by the force of the spring.

PRINCIPLES OF OPERATION

To illustrate the operation of the pressure relief valve, note that the governor cut-out pressure on all Freightliner vehicles is set at a maximum 125 psi (862 kPa). A pressure relief valve with a setting of 150 psi (1034 kPa) is then used. Should system pressure rise to approximately 150 psi (1034 kPa), air pressure will force the cap and O-ring assembly off its seat, and allow the reservoir pressure to vent to the atmosphere. See **Fig. 2.**

When the reservoir pressure decreases sufficiently; the spring force will seat the cap and O-ring assembly, sealing off reservoir pressure. This will occur at approximately 135 psi (931 kPa) for the 150 psi (1034 kPa) valve. Note that the desired pressure setting of the pressure relief valve is determined by the governor cut-out pressure. The opening and closing pressures of the pressure relief valve should always be higher than the governor cut-out pressure setting.

Normally, the pressure relief valve remains inoperative and only functions if, for any reason, the reservoir pressure rises above the setting of the valve. Constant exhausting of the pressure relief valve can be caused by a faulty pressure relief valve, faulty governor, faulty compressor unloading mechanism, or a combination of any of the preceding.

SERVICE OPERATIONS

OPERATING AND LEAKAGE CHECKS

Operating Check (Refer to **Fig. 3**)

With air pressure built up in the system, proceed as follows:

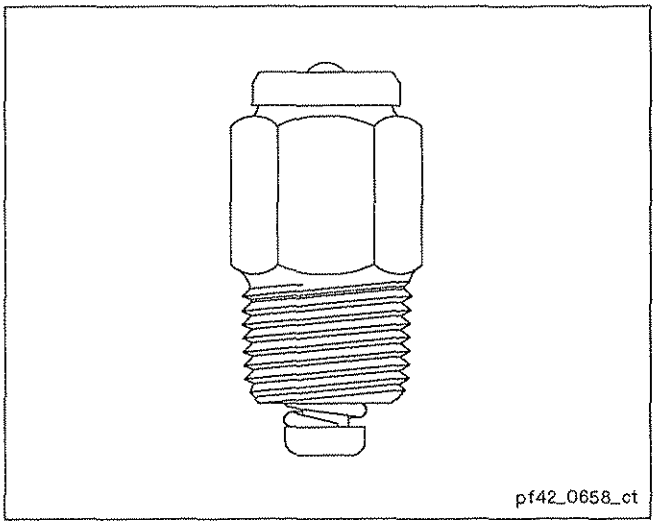


Fig. 1

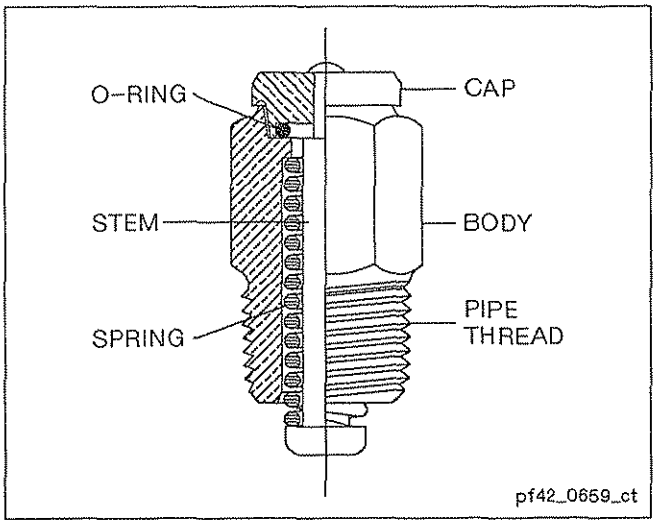


Fig. 2

WARNING: Wear safety goggles when exhausting the air system because debris could fly out at high speed. Failure to take all necessary precautions could result in personal injury.

1. With your index finger and thumb, pull the cap of the valve, removing the spring load from the O-ring. Air should exhaust from the valve.
2. Release the cap; the airflow should stop.

PRESSURE RELIEF VALVE, BENDIX OR TRAMEC

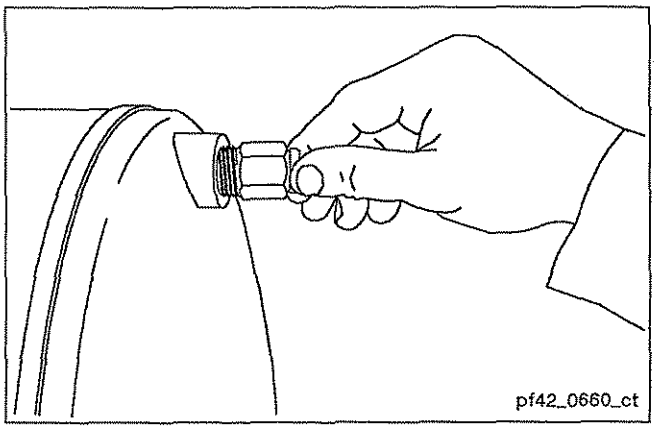


Fig. 3

Failure of a valve to pass the operating test indicates the valve should be replaced, using the instructions in this section.

Leakage Check

Coat the exhaust port with a soap solution. Leakage resulting in a 1-inch (2.5-cm) bubble in 5 seconds is permitted. Excessive leakage indicates dirt in the valve or a faulty O-ring or seat. The valve should be replaced, using the instructions in this section.

REMOVAL AND INSTALLATION

Removal

1. Chock the tires, and drain the air reservoirs.
2. Using a wrench, unscrew the valve from the reservoir. See **Fig. 4**.

Installation

1. Apply a small quantity of Loctite® 242, or an equivalent sealant, to the valve threads.

WARNING: Make sure that excess sealant does not get inside either the male or female fittings. This would allow loose foreign material inside the plumbing, and may clog a valve. This could result in an unexpected loss of brake control, which could cause property damage or personal injury.

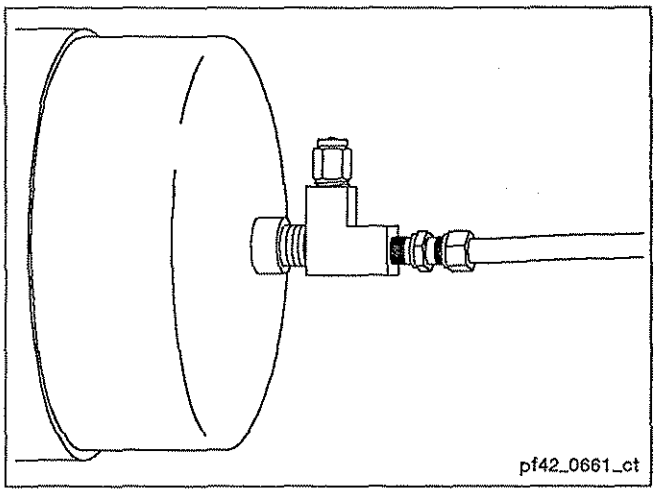


Fig. 4

2. Install the valve and tighten it finger-tight. With a wrench, tighten it 1-1/2 additional turns past finger-tight.
3. Perform the operating and leakage checks on the valve and the valve fitting. For instructions, refer to "Operating and Leakage Checks."

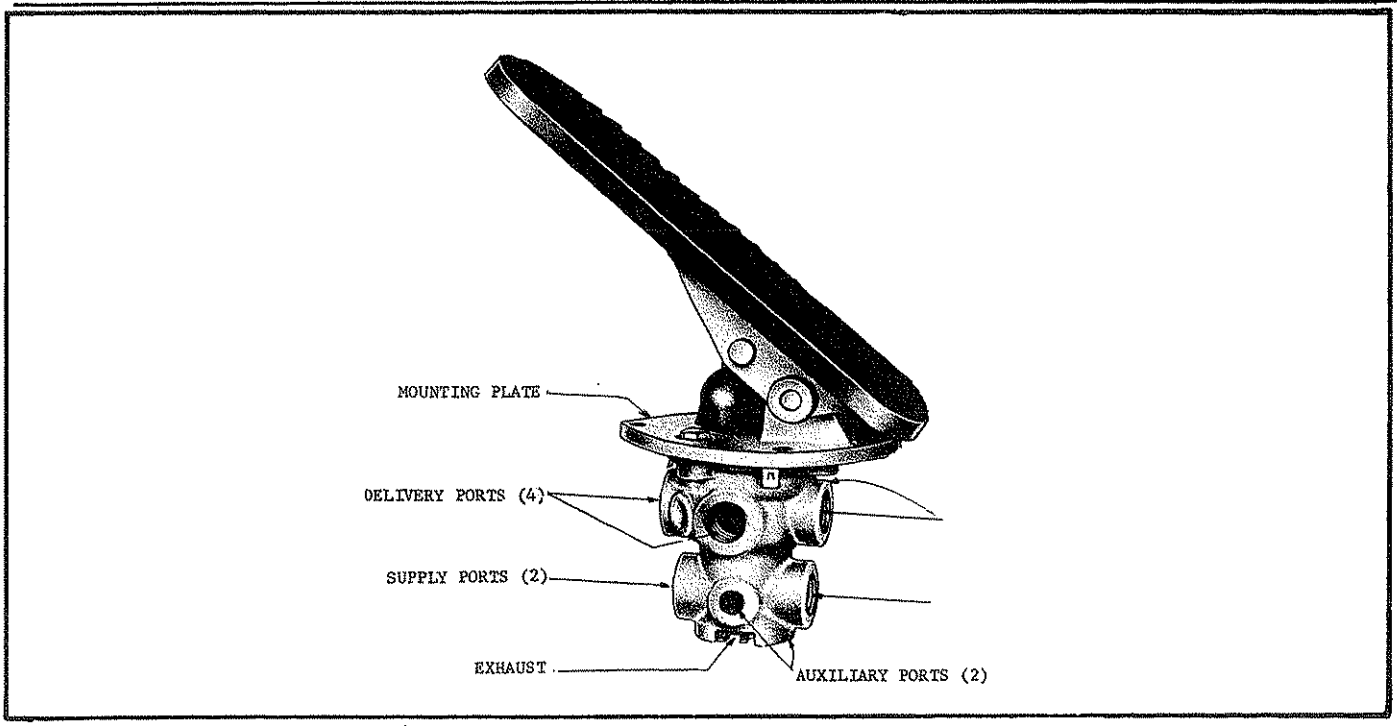


Fig. 1 Brake Valve Exterior

GENERAL DESCRIPTION

The brake valve (Fig. 1) is the control unit of the brake system, providing the driver with a means of applying or releasing the vehicle brakes. The valve is a treadle-operated foot valve; movement of the treadle controls the amount of air pressure delivered to, or released from, the vehicle brake actuators.

The model E-2 brake valve differs from other Bendix-Westinghouse brake valves in that it employs a rubber spring confined in a retainer to produce a brake "feel". In this design, overall valve length is reduced, and plunger travel is about one-third of the E-1 brake valve. (Fig. 2)

The model E-3 brake valve also contains a rubber spring, but differs from the E-2 brake valve in that it uses a different piston (Fig. 3) to give a wider range of graduation, similar to the E-1 valve. An identification washer located under the retaining ring in the exhaust port at the bottom of the valve provides an easy means of identifying the brake valves.

The E-2 and E-3 brake valves have an insert type inlet and exhaust valve which can easily be removed without disconnecting air lines to the valve. There is an exhaust check valve in the bottom of the insert which provides additional protection by preventing foreign matter from entering the valve interior through its exhaust ports.

The valves have two optional supply ports, and four delivery ports. There are two auxiliary ports in the supply portion of the valves to accommodate manifold connections for accessory air devices. Some E-2 and E-3 valves are supplied with an exhaust extension normally used to connect an exhaust carry-off line.

PRINCIPLES OF OPERATION

When the treadle is depressed by the driver, force is exerted on the plunger through the rubber graduating spring, and to the piston. The piston moves down, and its stem, which is the exhaust seat, closes the exhaust port. As the exhaust port closes, the inlet valve moves off its seat. Air pressure from the reservoir then flows in through the inlet valve and

out the delivery ports to the brake actuators, applying the brakes.

When the air pressure in the cavity beneath the piston (the air pressure being delivered to the brake actuators) equals the mechanical force on the top of the piston, the piston raises, and the inlet valve closes. This cuts off any further supply of air from the supply line through the valve after the desired application pressure has been reached. The exhaust remains closed, preventing any escape of this air pressure through the exhaust port.

When applications in the above average pressure ranges are made, the valve reaches a balanced position as the air pressure beneath the piston equals the effort exerted by the driver's foot on the treadle. When the piston is pressed all the way down, the inlet valve remains open and full reservoir pressure is delivered to the actuators.

If the treadle application is released, and mechanical force removed from the top of the piston, the air pressure beneath the piston lifts the piston. This action opens the exhaust port of the valve, and air pressure is exhausted from the brake actuators through the quick release and/or relay valves.

SERVICE OPERATIONS

SERVICEABILITY TESTS

Operation

Check the delivery pressure of the brake valve, using a test gauge which is known to be accurate. Depress the treadle to several positions, between the fully released and fully applied positions. Check the pressure registered on the gauge to see that it varies proportionately with the movement of the brake valve treadle.

When the treadle is in the fully applied position, the reading on the test gauge should be approximately that of the full reservoir pressure. The reading on the test gauge should fall off to zero within ½ second from the time the application is released.

Leakage

1. With the valve fully released, soap test the exhaust port for leakage. No leakage is permissable.

2. Make and hold a high pressure application. Coat the exhaust port and the top of the valve with a soap solution. No leakage is permissable.

IMPORTANT: If the brake valve does not function as described in Operation, above, or if leakage occurs, it must be rebuilt or replaced with a new or rebuilt valve. Failure to repair or replace such valves could result in a hazardous operating condition.

REMOVAL

1. Block or hold vehicle by means other than air brakes. Failure to do so could result in a dangerous workshop environment.

2. Open the drain cocks, and exhaust air pressure from the air brake system.

3. Disconnect air lines from the brake valve.

4. Remove mounting bolts, then remove brake valve.

NOTE: The inlet and exhaust valve assembly, referred to as the E-2 or E-3 insert, can be removed and replaced by removing the retaining ring, and pulling out the insert. This can normally be accomplished without disturbing the valve mounting or air lines. Before removing the insert, it is important that the vehicle air system be drained.

DISASSEMBLY

Complete E-2 or E-3 Brake Valve

1. Remove the three mounting bolts.

2. Remove and disassemble treadle

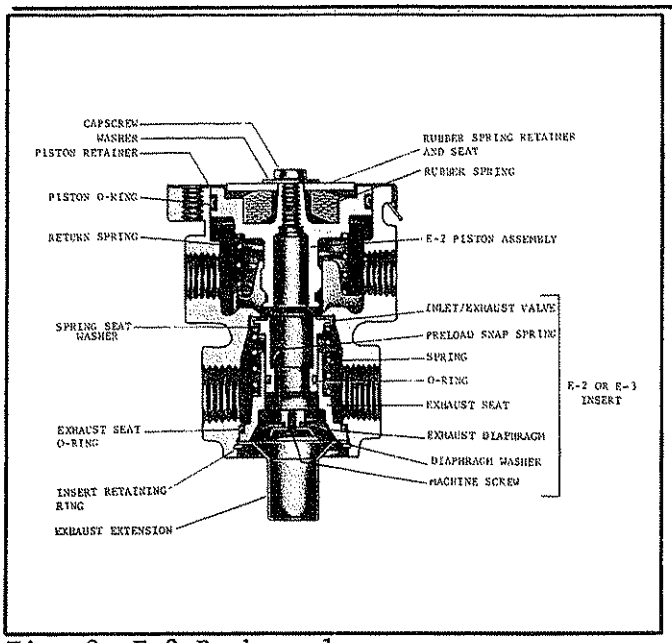


Fig. 2 E-2 Brake valve

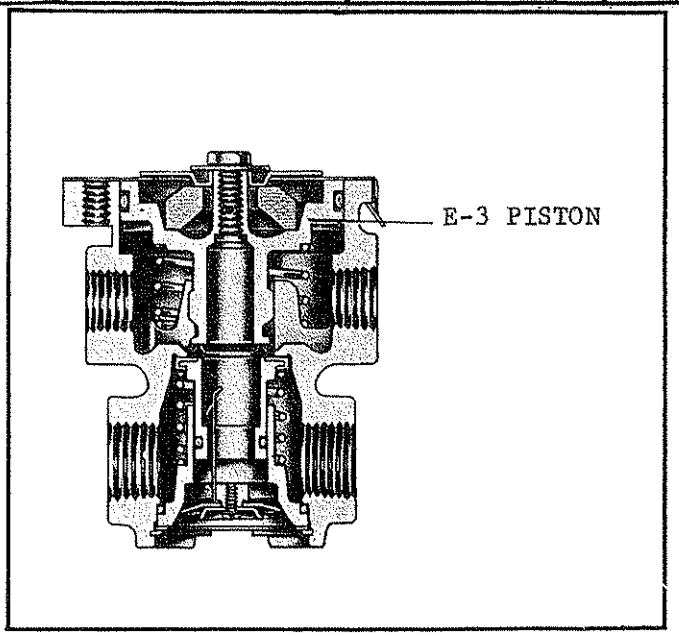


Fig. 3 E-3 Brake Valve

actuating mechanism including roller, roller pin, fulcrum, pin, boot and plunger. (not shown)

Basic E-2 or E-3 Brake Valve

1. Depress piston assembly and hold while removing piston retainer. (Fig. 2)
2. Remove piston assembly and return spring from body. (Fig. 2)
3. Remove O-ring from piston. (Fig. 2)
4. Remove capscrew from top of piston assembly. (Fig. 2)
5. Remove washer, rubber spring seat, and rubber spring. (Fig. 2)

E-2 or E-3 Insert

1. Depress and hold prongs of insert retaining ring with pliers and remove.
2. Remove exhaust extension, if present.
3. Remove inlet and exhaust valve insert.
4. Remove exhaust seat O-ring. (Fig. 2)
5. Remove machine screw, diaphragm washer, and diaphragm from exhaust check valve seat. (Fig. 2)
6. Depress and hold inlet and exhaust valve insert and remove preload snap spring.
7. Remove spring seat washer and O-ring from inlet/exhaust valve. (Fig. 2)

CLEANING AND INSPECTION

1. Wash all metal parts in clean solvent and dry. Wipe all rubber parts clean and dry.
2. Inspect all parts for wear or deterioration.
3. Inspect valve and valve seats for nicks and burrs.
4. Check springs for cracks, distortion, or corrosion.
5. Inspect exhaust check diaphragm for flexibility, wear, and deterioration.
6. Replace all parts which are found to be worn, damaged, stiff or deteriorated.

WARNING: Failure to replace defective parts, as described above, could result

in a hazardous operating condition.

ASSEMBLY

Basic Valve

1. Lubricate the piston and valve bores and O-rings. (Fig. 2)
2. Position rubber spring in piston.
3. Install spring retainer, washer, and capscrew. Tighten screw to approximately 50 in-lbs torque. (Fig. 2)
4. Install piston O-ring. (Fig. 2)
5. Place piston return spring in valve body. (Fig. 2)
6. Install piston assembly, using care not to damage piston O-ring. (Fig. 2)
7. Install piston retainer. Make sure its prongs snap over groove in the valve body. (Fig. 2)

E-2 or E-3 Insert

1. Position inlet valve preload spring in exhaust seat. (Fig. 2)
2. Install exhaust check diaphragm, diaphragm washer (lips pointing out) and machine screw with lockwasher. (Fig. 2)
3. Install O-ring and position spring seat washer on inlet and exhaust valve. (Fig. 2)
4. Position valve spring on exhaust seat. (Fig. 2)
5. Install valve with O-ring and spring seat washer. Press the valve down until the preload snaps and holds the valve. (Fig. 2)
6. Install O-ring on exhaust seat. (Fig. 2)
7. Install insert in valve, position shim washer or exhaust extension on insert. (Fig. 2)
8. Press insert, with shim washer or exhaust extension, down and install insert retaining ring. Make sure retaining ring snaps into body grooves locking in the insert. (Fig. 2)

INSTALLATION

1. Clean the air lines leading to the brake valve.
2. Mount the valve, and tighten the mounting bolts.
3. Connect the air lines to the inlets and plug all unused ports.
4. Test the valve as outlined in SERVICEABILITY TESTS.

NOTE: When installing a new or rebuilt E-2 or E-3 insert, precheck movement of the inlet and exhaust valve in the exhaust seat by depressing the insert. Caution should be taken to prevent damage to the inlet and exhaust valve, and to the exhaust seat O-ring, when installing the insert in the valve. After placing the insert in the valve body, depress the exhaust check valve seat and install the retaining ring. Make sure the retaining ring snaps into the body groove.

WARNING: Failure to take the above precautions, and failure to follow the above instructions, could result in damage to the brake valve, which in turn could result in a hazardous operating condition.

TESTING THE REBUILT VALVE

The rebuilt E-2 or E-2 brake valve must pass the SERVICEABILITY TESTS outlined above.

DUAL BRAKE VALVE, BENDIX MODEL E-6

GENERAL DESCRIPTION

The E-6 dual brake valve (Fig. 1) is a floor-mounted, treadle-operated brake valve with two separate supply and delivery circuits for service and secondary braking systems. This provides the driver with a graduated control for applying and releasing the vehicle brakes.

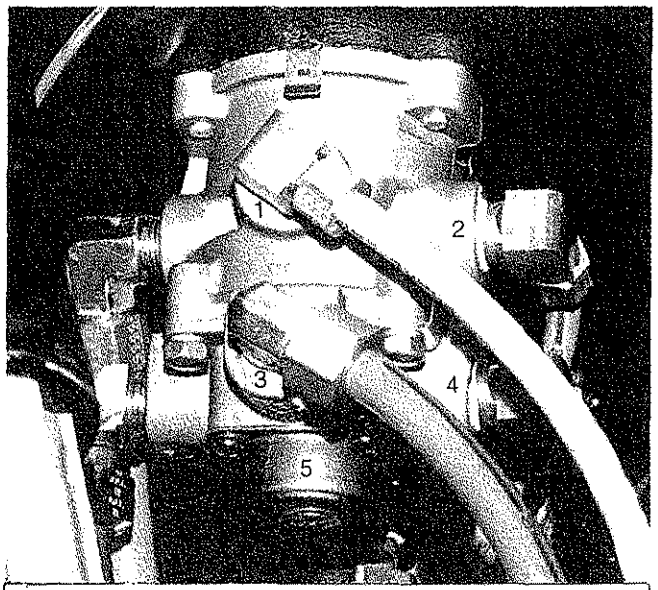
Circuits in the E-6 dual brake valve are identified as follows: The No. 1 circuit portion is that portion of the valve between the spring seat which contacts the plunger and the relay piston; the No. 2 circuit portion is that portion between the relay piston and the exhaust cavity. Refer to Fig. 2.

The No. 1 circuit portion of the valve is similar in operation to a standard single-circuit air brake valve, and under normal operating conditions the No. 2 circuit portion is similar in operation to a relay valve.

Both No. 1 and No. 2 circuit portions of the brake valve use a common exhaust, protected by an exhaust diaphragm.

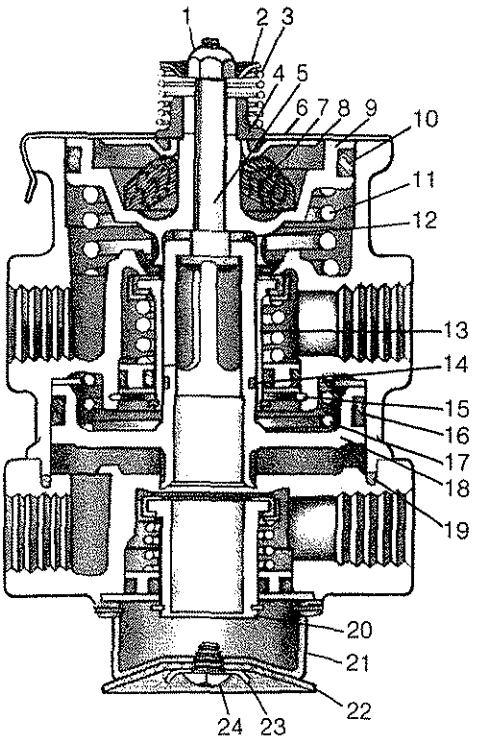
PRINCIPLES OF OPERATION

NOTE: Refer to Fig. 2 when reviewing the following information.



1. Delivery Circuit No. 1 (Primary)
2. Supply Circuit No. 1 (Primary)
3. Delivery Circuit No. 2 (Secondary)
4. Supply Circuit No. 2 (Secondary)
5. Exhaust

Fig. 1, Bendix Model E-6 Dual Brake Valve



1. Locknut
2. Spring Seat
3. Stem Spring
4. Spring Seat Nut
5. Primary Piston Stem
6. No. 1 Piston Retainer
7. Rubber Spring
8. Spring Seat
9. Primary Piston
10. Primary Piston O-Ring
11. Primary Piston Return Spring
12. Small Washer
13. No. 1 Inlet and Exhaust Valve Assembly
14. Small O-Ring
15. Retaining Ring
16. Large O-Ring
17. Relay Piston Spring
18. Relay Piston
19. Rubber Seal Ring
20. No. 2 Inlet and Exhaust Valve Assembly
21. Exhaust Cover
22. Exhaust Diaphragm
23. Washer
24. Phillips Head Screw

Fig. 2, Bendix Model E-6 Dual Brake Valve, Sectional View

DUAL BRAKE VALVE, BENDIX MODEL E-6

APPLYING: NORMAL OPERATION, NO. 1 CIRCUIT PORTION

When the brake treadle is depressed, the plunger exerts force on the spring seat, graduating spring, and the No. 1 piston. The No. 1 piston, which contains the exhaust valve seat, closes the No. 1 exhaust valve. As the exhaust valve closes, the No. 1 inlet valve is moved off its seat allowing No. 1 air to flow out the No. 1 delivery port.

APPLYING: NORMAL OPERATION, NO. 2 CIRCUIT PORTION

When the No. 1 inlet valve is moved off its seat, air passes through the bleed passage and enters the relay piston cavity. The air pressure moves the relay piston—which contains the exhaust seat—and closes the No. 2 exhaust valve. As the No. 2 exhaust valve closes, the No. 2 inlet valve is moved off its seat allowing the No. 2 air to flow out the No. 2 delivery port. Because of the small volume of air required to move the relay piston, action of the No. 2 circuit portion of the valve is almost simultaneous with the No. 1 circuit portion.

APPLYING: LOSS OF AIR IN THE NO. 2 CIRCUIT

If air is lost in the No. 2 circuit, the No. 1 circuit portion continues to function as described in this subject.

APPLYING: LOSS OF AIR IN THE NO. 1 CIRCUIT

If air is lost in the No. 1 circuit, the function will be as follows: As the brake treadle is depressed and no air pressure is present in the No. 1 circuit supply and delivery ports, the No. 1 piston will mechanically move the relay piston allowing the piston to close the No. 2 exhaust valve and open the No. 2 inlet valve, and allow air to flow out the No. 2 delivery port.

BALANCED: NO. 1 CIRCUIT PORTION

When the No. 1 delivery pressure acting on the piston equals the mechanical force of the brake pedal application, the No. 1 piston will move and the No. 1 inlet valve will close, stopping the further flow of air from the No. 1 supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

BALANCED: NO. 2 CIRCUIT PORTION

When the air pressure on the No. 2 side of the relay piston approaches that being delivered on the No. 1 side of the relay piston, the relay piston moves, closing the No. 2 inlet valve and stopping further flow of air from the supply line through the valve. The exhaust remains closed as the No. 2 delivery pressure balances the No. 1 delivery pressure.

When applications in the graduating range are made, a balanced position in the No. 1 portion is reached as the air pressure on the delivery side of the No. 1 piston equals the effort exerted by the driver's foot on the treadle. A balanced position in the No. 2 portion is reached when air pressure on the No. 2 side of the relay piston closely approaches the air pressure on the No. 1 side of the relay piston.

When the brake treadle is fully depressed, both the No. 1 and No. 2 inlet valves remain open, and full reservoir pressure is delivered to the brake chambers.

RELEASING: NO. 1 CIRCUIT PORTION

With the brake treadle released, mechanical force is removed from the spring seat, graduating spring, and the No. 1 piston. Air pressure and spring load move the No. 1 piston, opening the No. 1 exhaust valve, allowing air pressure in the No. 1 delivery line to exhaust out the exhaust port.

RELEASING: NO. 2 CIRCUIT PORTION

With the brake treadle released, air is exhausted from the No. 1 circuit side of the relay piston. Air pressure and spring load move the relay piston, opening the No. 2 exhaust valve allowing air pressure in the No. 2 delivery line to exhaust out the exhaust port.

SERVICE OPERATIONS

OPERATING CHECKS

IMPORTANT: A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit, and although the vehicle air brake system may continue to function, the vehicle should not be operated until the necessary repairs have been made and both braking circuits, including the pneumatic and mechanical devices, are operating normally. Always check the vehicle brake system for proper operation after performing brake work and before returning the vehicle to service.

To check for proper brake valve operation, proceed as follows:

1. Set the parking brakes and chock the tires.
2. Connect test gauges to the service and secondary delivery ports of the brake valve. See Fig. 1.

NOTE: When checking the delivery pressure of both No. 1 (service) and No. 2 (secondary) circuits, use test gauges known to be accurate.

DUAL BRAKE VALVE, BENDIX MODEL E-6

3. Depress the treadle to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauges to see that it varies equally and proportionately with the movement of the brake pedal.
4. Depress the treadle to the fully applied position and release it. After a full application is released, the reading on the test gauges should fall off to zero promptly.

NOTE: The No. 1 circuit delivery pressure will be about 2 psi (14 kPa) greater than the No. 2 circuit delivery pressure with both supply reservoirs at the same pressure. This is normal for this valve.

LEAKAGE CHECK

1. Make and hold a high pressure (80 psi [552 kPa]) application.
2. Coat the exhaust port and body of the valve (Fig. 1) with a soap solution, and check for leakage. The leakage permitted is a one-inch bubble in 3 seconds.

   If the brake valve does not function as described above, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired using the instructions in this subject. In either case, repeat this leakage test before placing the brake valve in service.
3. Remove the chocks from the tires.

BRAKE VALVE REPLACEMENT

1. Chock the tires, and drain all of the air system reservoirs. Tilt the cab or hood to expose the brake valve. For instructions, refer to the Freightliner Driver's Manual.
2. Reference and disconnect all supply and delivery lines at the brake valve. Cap the lines tightly to keep out contaminants.
3. If present, fold back the carpet around the brake treadle mounting plate. Remove the brake valve and treadle assembly from the vehicle by removing the capscrews on the mounting plate. See Fig. 3.
4. Remove the double check valves and elbows from the brake valve. Clean off the old sealant and dirt from the threads of the valves and elbows. Apply small quantities of Loctite® Pipe Sealant (with Teflon® 59241), or an equivalent sealant, to the male fitting threads of the double check valves and elbows.

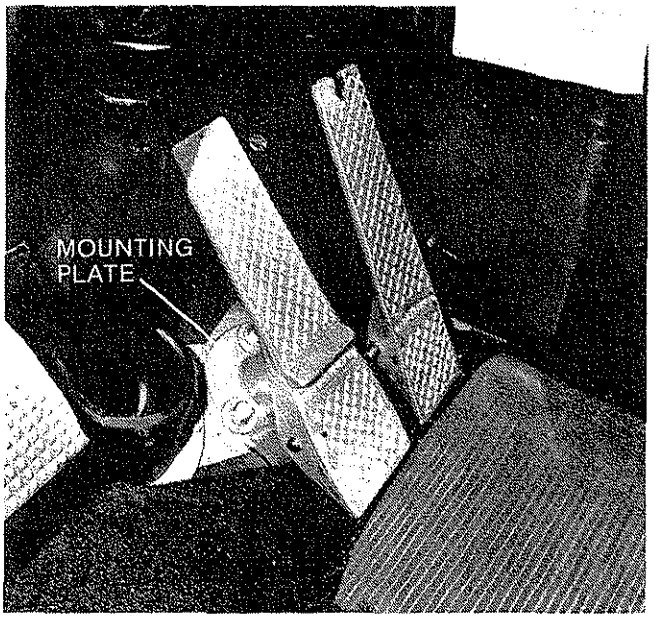


Fig. 3

WARNING: Make sure that excess sealant does not get inside either the male or female fittings. Loose foreign material inside the plumbing may clog a valve, creating a loss of brake control.

5. Attach the double check valves and elbows to the replacement brake valve. Tighten the components finger-tight, then tighten one additional turn with a wrench. Further tighten the valves and elbows, as necessary, until they are properly positioned.
6. Install the brake valve and treadle assembly by installing the three capscrews on the outer bolt circle of the mounting plate. See Fig. 3. If present, place the carpet aroung the mounting plate.
7. Connect the air lines, as referenced earlier, removing the caps as needed. Tighten the nuts finger-tight. Using a wrench, further tighten the nuts until resistance is felt, then tighten one-sixth additional turn. *Do not overtorque.*
8. Return the cab or hood to the operating position, as instructed in the Freightliner Driver's Manual.
9. Perform the operating and leakage checks described earlier.
10. Remove the chocks from the tires.

DUAL BRAKE VALVE, BENDIX MODEL E-6

BRAKE VALVE REMOVAL, DISASSEMBLY, CLEANING AND INSPECTING, ASSEMBLY, AND INSTALLATION

Removal

1. Chock the tires, and drain all of the air system reservoirs. Tilt the cab or hood to expose the brake valve. For instructions, refer to the Freightliner Driver's Manual.
2. Reference and disconnect all supply and delivery lines at the brake valve. Cap the lines tightly to keep out contaminants.
3. If present, fold back the carpet around the brake treadle mounting plate. Remove the brake valve and treadle assembly from the vehicle by removing the capscrews on the mounting plate. See Fig. 3.

Disassembly (Refer to Fig. 2)

1. Remove the two double check valves and the elbows from the brake valve.
2. Remove the Phillips-head screw (Ref. 24) securing the exhaust diaphragm (Ref. 22) and washer (Ref. 23) to the exhaust cover (Ref. 21).
3. Remove the four screws that secure the exhaust cover (Ref. 21) to the lower body.
4. Remove the No. 2 inlet and exhaust valve assembly (Ref. 20) from the lower body.
5. Remove the four hex-head capscrews securing the lower body to the upper body, and separate the body halves.
6. Remove the rubber seal ring (Ref. 19) from the lower body.
7. While applying thumb pressure to the No. 1 piston, lift out and up on the three lock-tabs of the No. 1 piston retainer (Ref. 6).
8. Using a 3/8-inch wrench, hold the locknut (Ref. 1) on the threaded end of the primary piston stem (Ref. 5) in the primary piston (Ref. 9). Insert a screwdriver in the exhaust passage through the center of the valve, and engage the slotted head of the stem.

WARNING: Before proceeding with the disassembly, refer to Fig. 2 and note that the locknut and stem are used to contain the No. 1 piston return spring, spring stem, and the relay piston spring. The combined force of these springs is approximately 50 pounds (222 N), and care must be taken when removing the locknut as the spring forces will be released. It is recommended that the primary piston and relay piston be manually or mechanically contained while the nut and stem are being removed.

9. Using a screwdriver to restrain the stem, remove the locknut (Ref. 1), spring seat (Ref. 2), and the stem spring (Ref. 3).
10. Remove the relay piston (Ref. 18), relay piston spring (Ref. 17), and the primary piston and primary piston return spring (Ref. 11) from the upper body. Use care so as not to nick the seats.

NOTE: Certain E-6 valves do not have a relay piston spring (Ref. 17). If none is found, none should be replaced.

11. Remove the small washer (Ref. 12) found in the cavity in the lower side of the primary piston (Ref. 9). This washer is found only on valves manufactured after October 7, 1976.
12. Disassemble the primary piston by rotating the spring seat nut (Ref. 4) counterclockwise. Separate the spring seat nut, spring seat (Ref. 8), and the rubber spring (Ref. 7), and remove the primary piston O-ring (Ref. 10).
13. Remove the large (Ref. 16) and small (Ref. 14) O-rings from the relay piston (Ref. 18).
14. Remove the retaining ring (Ref. 15) securing the No. 1 inlet and exhaust valve assembly (Ref. 13) in the upper body, and remove the valve assembly.

Cleaning and Inspecting

1. Wash all metal parts in mineral spirits, and dry them.
2. Inspect all parts for excessive wear or deterioration.
3. Inspect the valve seats for nicks or burrs.
4. Check the springs for cracks or corrosion.
5. Replace all rubber parts and any part not found to be serviceable during inspection.

Assembly (Refer to Fig. 2)

Before reassembling, lubricate all O-rings, O-ring grooves, piston bores, and metal to metal moving surfaces with Dow Corning 55-M pneumatic grease, or equivalent.

NOTE: All torques specified in this manual are *assembly* torques, and can be expected to fall off after assembly

DUAL BRAKE VALVE, BENDIX MODEL E-6

is accomplished. *Do not retorque* after initial assembly torques fall.

1. Install the No. 1 inlet and exhaust assembly (Ref. 13) in the upper body, and replace the retaining ring (Ref. 15) to secure it. Be sure the retaining ring is seated completely in its groove.
2. Install the large (Ref. 16) and small (Ref. 14) O-rings on the relay piston (Ref. 18).
3. Install the primary piston O-ring (Ref. 10) in the piston O-ring groove.
4. Install the rubber spring (Ref. 7), concave side down, in the primary piston (Ref. 9), and place the spring seat (Ref. 8), flat side up, over the rubber spring.
5. Install the primary piston spring seat nut (Ref. 4) with its hex closest to the spring seat, and rotate the nut clockwise until the top surface of the spring seat is even with the top surface of the piston. Set this assembly aside.
6. Place the relay piston spring (Ref. 17) (if used) in the concave portion of the relay piston, and install the relay piston through the No. 1 inlet and exhaust assembly (Ref. 13) and into the underside of the upper body.
7. Place a screwdriver, blade up, in a vise. Place the primary piston stem (Ref. 5) in the relay piston and the upper body sub-assembly over the blade of the screwdriver with the blade engaged in the slot in the head of the stem.
8. Place the small washer (Ref. 12) over the stem. This washer should be installed in all valves.
9. Install the primary piston return spring (Ref. 11) in the upper body piston bore.
10. Install the primary piston and rubber spring sub-assembly (steps 4 and 5) over the stem, into the upper body piston bore.
11. Compress the primary and relay pistons into the upper body from either side, and hold them compressed, either manually or mechanically.

WARNING: The combined force of these springs is approximately 50 pounds (222 N), and care must be taken during installation to prevent the spring forces from being released. It is recommended that the primary piston and the relay piston be manually or mechanically contained until the stem and nut are installed.

12. Place the stem spring (Ref. 3) over the spring seat nut (Ref. 4) and the spring seat over the stem.
13. Install the locknut (Ref. 1) on the stem, and torque it 20 to 30 lbf·in (226 to 339 N·cm).
14. Install the No. 1 piston retainer (Ref. 6) over the piston, making certain all three lock-tabs have engaged the outer lip of the body.

Installation

1. Apply a small quantity of Loctite® Pipe Sealant (with Teflon® 59241), or an equivalent sealant, to the male fitting threads of the double check valves and elbows.

WARNING: Make sure that excess sealant does not get inside either the male or female fittings. Loose foreign material inside the plumbing may clog a valve, creating a loss of brake control.

2. Attach the double check valves and elbows to the brake valve. Tighten the components finger-tight, then tighten one additional turn with a wrench. Further tighten the valves and elbows, as necessary, until they are properly positioned.
3. Install the brake valve and treadle assembly by installing the capscrews on the mounting plate. See Fig. 3. If present, place the carpet around the mounting plate.
4. Connect the air lines referenced earlier, and tighten the nuts finger-tight. Tighten the nuts with a wrench until resistance is felt, then tighten one-sixth additional turn. *Do not overtorque.*
5. Return the cab or hood to the operating position, as instructed in the Freightliner Driver's Manual.
6. Perform the operating and leakage checks described earlier.
7. Remove the chocks from the tires.

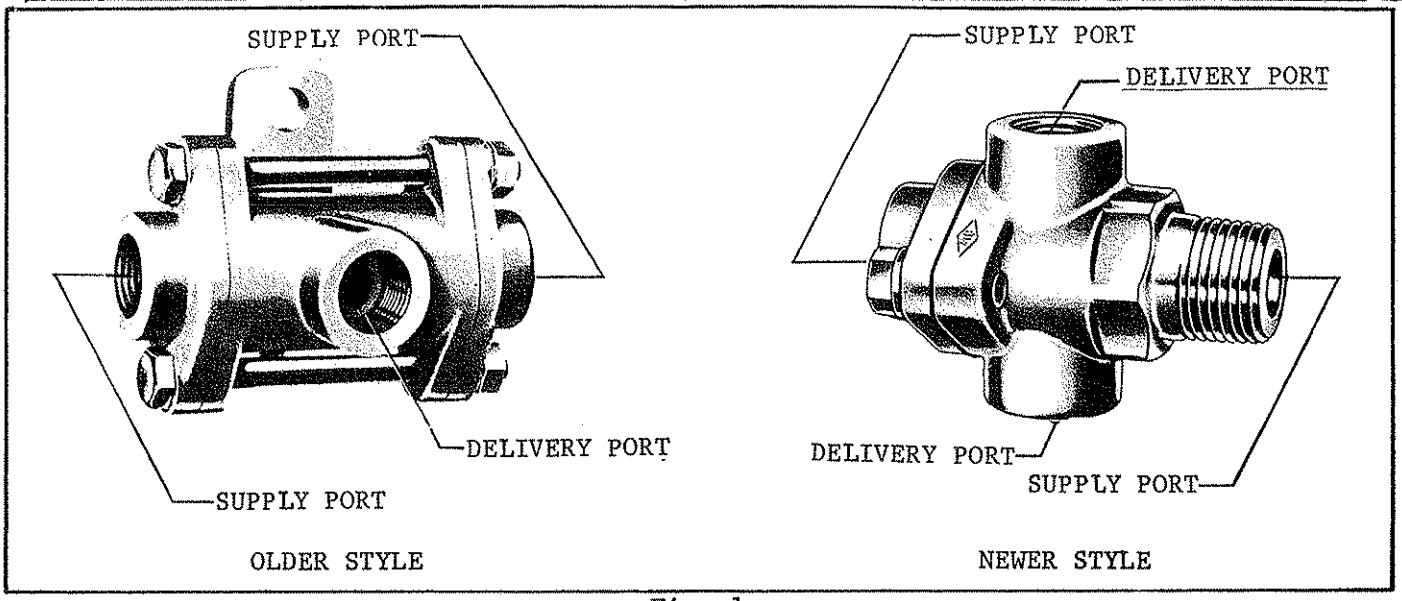


Fig. 1

GENERAL DESCRIPTION

Double check valves are used in the air brake system where air pressure is directed into a common line from either of two supply lines. The purpose of the double check valve is to assure that air pressure flows from the supply source into the common line, and not back into the unused supply line. There are two types of double check valves; the shuttle type (Fig. 1) and the disc type (Fig. 2). There is an older and a newer style of each valve.

The fundamental difference between the two valves is that the shuttle type has a moveable shuttle to seal off the lines not used, whereas the disc type has a moveable disc.

PRINCIPLES OF OPERATION

A double check valve is used when two brake valves are used to control the vehicle brakes, such as in the case of independent trailer brake control equipment. If a double check valve were not used in such cases, and either of the brake valves were moved to the applied position, reservoir pressure would flow out through the open exhaust port of the other brake valve.

As air pressure enters either supply port of the double check valve, the pressure moves the shuttle or the rubber disc to the opposite end, preventing any air escape in that direction but allowing it to flow out the common side port(s) (delivery ports). The same action will take place if the air pressure on one side of the disc or shuttle is higher than the air pressure on the other side, so that it is not necessary for the cavity on one side of the disc or shuttle to be exhausted for the valve to operate. Both types of valves are designed so that it is not possible for the disc or shuttle to block off the opening to the common side connection.

Fig. 3 illustrates the use of a double check valve when a trailer control valve is used to control only the trailer brakes. Each time an application is made, the shuttle or disc in the double check valve seals off the delivery line from the other brake valve, preventing the loss of delivered air through the open exhaust port of the other valve.

SERVICE OPERATIONS

SERVICEABILITY TESTS

When double check valves are used on independent trailer brake control equipment,

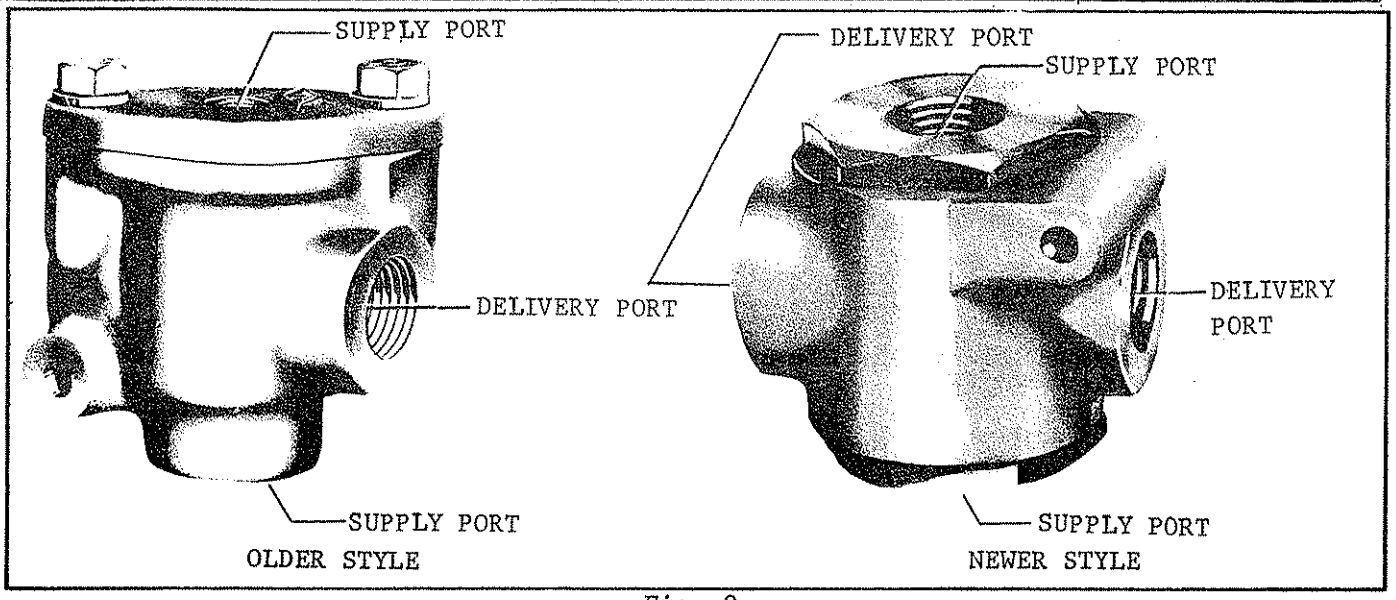


Fig. 2

the following tests must be performed at each brake adjustment. Adjustment intervals can be found in the White Freightliner maintenance manual.

Operation, trailer line applications

1. Make an application with the foot brake valve, and be certain that the brakes apply on both the towing and towed vehicles.
2. Release the foot brake valve. Be sure that the brakes release on both the towing and towed vehicles.
3. Apply the hand brake valve. Make sure that the brakes apply only on the towed vehicle.
4. Release the hand brake valve. Be sure that the brakes release on the towed vehicle.

Leakage, trailer line applications

1. Apply the foot brake valve, and soap test for leakage at the exhaust port of the hand brake valve.

NOTE: An exhaust carry-off line is often connected to the exhaust port of the trailer control valve, in which case it may be necessary to disconnect this line to make the leakage test.

2. Apply the hand brake valve, and soap test for leakage at the exhaust port of the foot brake valve.
3. Leakage of a one inch soap bubble in five seconds is permissable in either of the above tests.

IMPORTANT: If leakage in the above tests exceeds the specification, or if the double check valve does not operate as specified in "Operation" (above), the valve must be replaced, or rebuilt using instructions in this section.

When used for functions other than in the trailer brake line, the double check valve can be tested in the following manner. These tests may be performed at a workbench or on the vehicle, and require two separately controlled air supplies.

Operation, general applications

1. Install an accurate test gauge in the outlet port, or in the line from the outlet port.
2. Apply and release air to one inlet port, and make sure that the gauge registers application and release.
3. Repeat step 2 at the other inlet port.

WARNING: If the gauge shows that the valve is not reacting properly, the valve must be rebuilt or replaced.

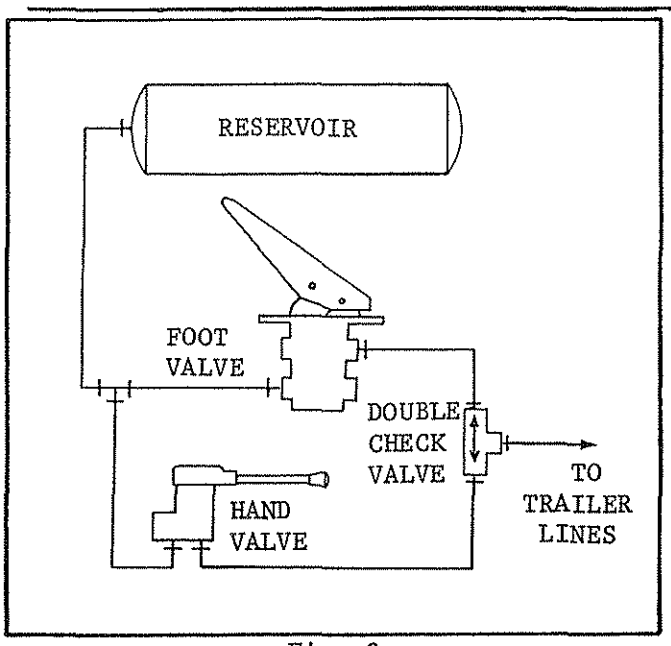


Fig. 3

Leakage, general applications

1. Disconnect line from one inlet port.

2. Apply air to the other inlet port, and coat opposite inlet port with soap solution. Leakage that will form and hold a one inch bubble in five seconds is the maximum allowable.

3. Repeat the above steps while applying air and soap solution to the opposite inlets.

IMPORTANT: If leakage in the above tests exceeds the specification or if the double check valve does not operate as specified in "Operation" (above), the valve must be replaced or rebuilt following the instructions in this section.

WARNING: Failure to conduct serviceability tests, and take corrective action as described above, could result in a hazardous operating condition.

REMOVAL

1. Disconnect all air lines at the double check valve.

2. Remove the double check valve mounting bolt, then remove the valve.

DISASSEMBLY

Parts are shown in the cutaway illustrations of the valves. See Fig. 4 for shuttle type valves and Fig. 5 for disc type.

1. Remove the end cap(s) from the valve.

2. Remove the rubber seal gaskets, or O-rings (if applicable).

3. Remove shuttle and/or shuttle guide, disc and/or disc guide (depending upon type of valve).

CLEANING AND INSPECTION

1. Clean all metal parts in cleaning solvent.

2. Inspect all metal parts for cracks, wear, or deterioration. Replace all cracked, worn, or deteriorated parts.

3. Replace all rubber parts.

WARNING: Failure to replace worn or damaged parts in either type of double check valve could result in a hazardous operating condition.

ASSEMBLY

Parts are shown in the cutaway illustrations. See Fig. 4 for shuttle type valves and Fig. 5 for disc type.

1. Install disc guide and disc or shuttle and shuttle guide.

2. Install O-rings.

3. Install end cap(s).

INSTALLATION

1. Both types of double check valves should be securely bolted to a frame member, and preferably mounted with the end connections in a horizontal plane.

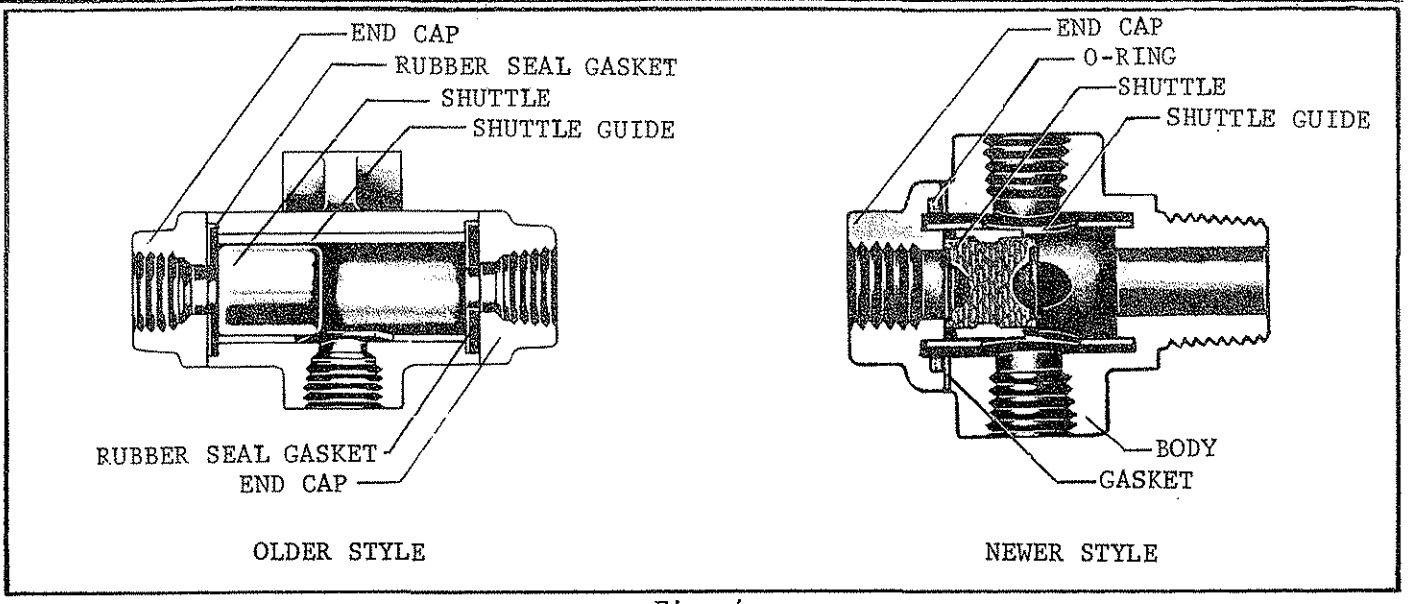


Fig. 4

2. The disc type double check valve should be mounted at or near the service line cut-out cock when used with independent trailer control equipment.

3. Connect air lines from the foot and hand brake valves to the supply connections. The side (delivery) connection of the double check valve should be connected to the service line cut-out cock.

WARNING: Failure to install the double check valve as described above could result in a hazardous operating condition.

TESTING THE REBUILT VALVE

The rebuilt double check valve must pass the operation and leakage tests described in SERVICEABILITY TEST, above. If the rebuilt valve fails to pass these tests, install a new double check valve.

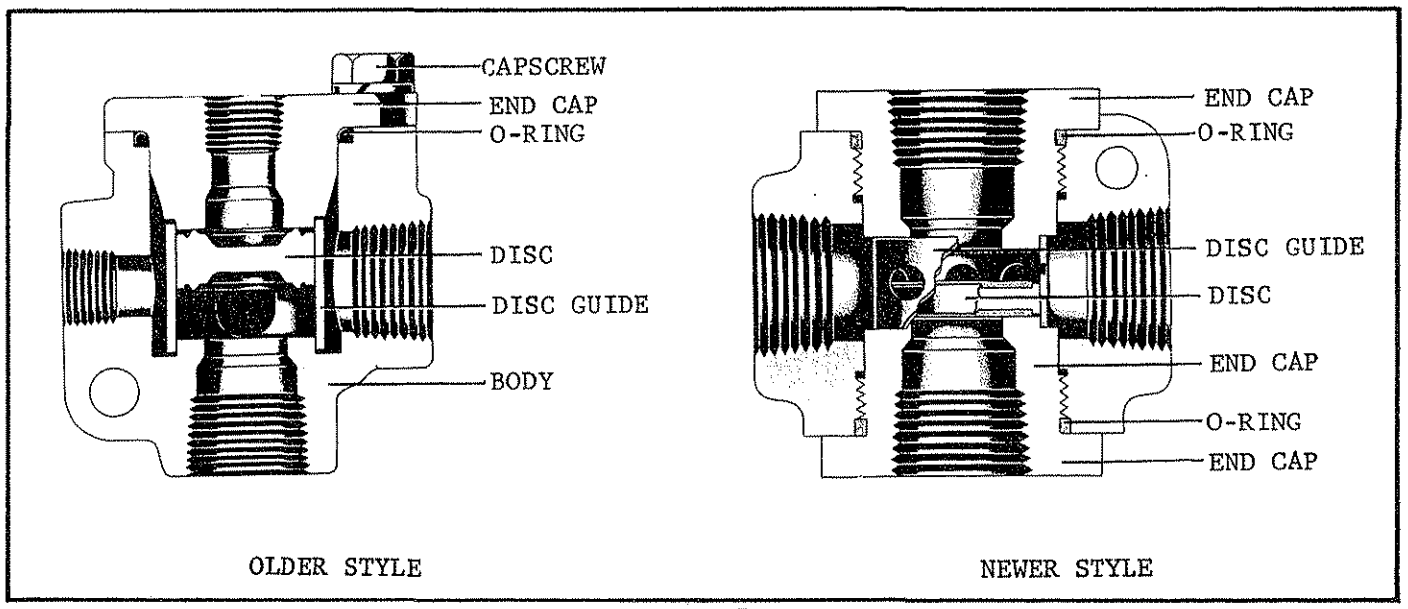


Fig. 5

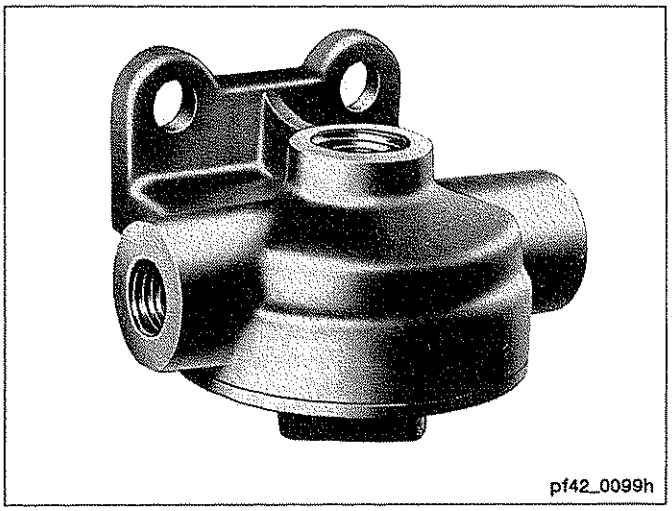


Fig. 1, QR Valve Exterior

GENERAL DESCRIPTION

The quick release valve speeds up the release of air pressure from the brake chambers. When a brake valve application is released, the exhaust of the quick release valve opens and the air pressure from the service brake chambers is exhausted through the quick release valve, rather than exhausting back through the air lines and out through the brake valve. This accelerates the release of the air brakes.

The quick release valve is mounted close to the brake chambers it is to release. The valve should be mounted with its exhaust port pointing down. A line from one of the brake valve delivery ports is connected to the top supply port of the quick release valve; the two side ports are for brake chamber connections. The exhaust port is at the bottom of the valve.

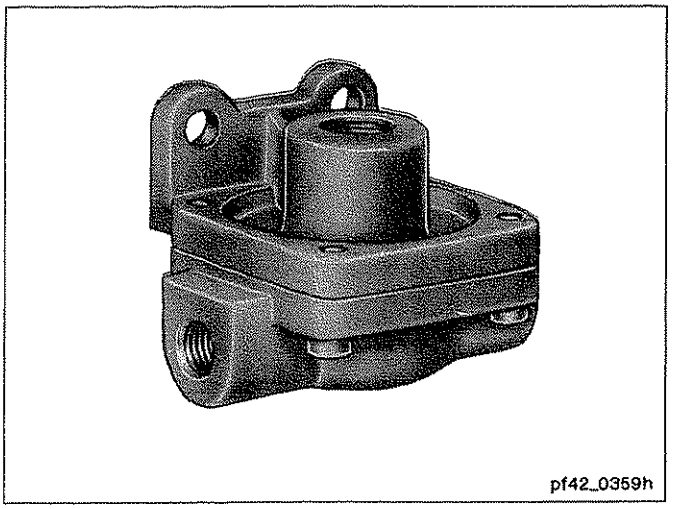


Fig. 2, QR Valve Exterior

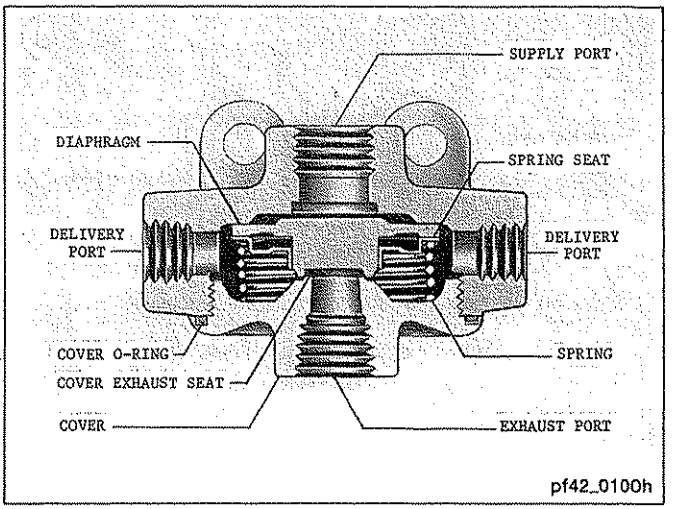


Fig. 3, QR Valve Cutaway

The Model QR valve (Fig. 1) and the Model QR-1 valve (Fig. 2) perform the same function, but differ in that the QR valve employs a spring and spring seat, whereas the QR-1 valve normally does not. (A spring and spring seat are used in the QR-1 valve only in some special cases, for special applications.)

PRINCIPLES OF OPERATION

QR MODEL (Fig. 3)

When a brake application is made, air pressure enters the top (supply) port of the quick release valve and moves the diaphragm down. This closes the exhaust port, allowing air pressure to flow around the edges and out the side (delivery) ports to the brake chambers.

As soon as the brake chamber pressure beneath the diaphragm equals the air pressure being delivered by the brake valve, the diaphragm spring forces the outer edges of the diaphragm against the body seat. The exhaust port is still sealed by the center portion of the diaphragm. When the brake valve is released, air pressure above the diaphragm is exhausted through the brake valve exhaust port. The pressure

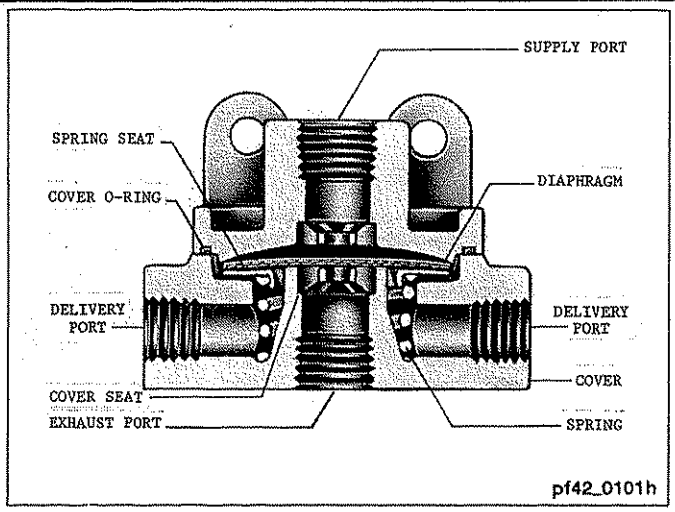


Fig. 4, QR-1 Valve Cutaway

beneath the diaphragm then raises it and the exhaust port opens, allowing brake chamber air pressure to escape directly into the atmosphere, instead of travelling back through the air lines.

QR-1 MODEL (Fig. 4)

When a brake application is made, air pressure enters the top (supply) port of the QR-1 valve, moving the diaphragm down and closing the exhaust port. The edges of the diaphragm are moved down at the same time, allowing air pressure to flow past the edges and out the side (delivery) ports to the brake chambers.

As soon as the brake chamber pressure (beneath the diaphragm) equals the air pressure being delivered by the brake valve, the outer edges will seal against the cover seat. The exhaust port is still sealed by the center portion of the diaphragm. When the brake valve is released, air pressure above the diaphragm is exhausted through the brake valve exhaust port, and the diaphragm raises. This opens the exhaust port, allowing brake chamber pressure to exhaust directly into the atmosphere through the quick release exhaust port.

SERVICE OPERATIONS

SERVICEABILITY TESTS

Operation

1. Make a brake application and make sure that the brake chambers served by the quick release valve actuate.

2. Release the application and make certain that the air pressure in the chambers is quickly released through the exhaust port of the quick release valve.

Leakage

1. Make and hold a brake valve application; and soap test the exhaust port of the quick release valve for leakage. Leakage of a 1 inch soap bubble in 3 seconds is permissable.

2. Coat body and cover with soap solution. No leakage is permissable between body and cover.

IMPORTANT: If the quick release valve does not function as described in Operation, or if leakage exceeds the amount prescribed above, the valve must be repaired, or replaced with a new or rebuilt valve. Failure to do so could result in a hazardous operating condition.

REMOVAL

1. Block or hold the vehicle with means other than air brakes. Failure to do so could result in a hazardous working environment.

2. Drain the air brake system by opening the reservoir drain cocks.

3. Disconnect air lines from the quick release valve.

4. Remove the mounting bolts, then the valve.

DISASSEMBLY

QR Model

1. Remove cover, using wrench on square portion of exhaust port.(Fig. 3)
2. Remove spring, spring seat, and diaphragm.(Fig. 3)
3. Remove cover O-ring.(Fig. 3)

QR-1 Model

1. Remove four screws.
2. Remove spring and spring seat, if valve is so equipped. (Fig. 4)
3. Remove diaphragm. (Fig. 4)
4. Remove cover O-ring. (Fig. 4)

CLEANING AND INSPECTION

1. Clean all parts in cleaning solvent. Wipe rubber parts dry.
2. Inspect diaphragm for wear or deterioration. Pay particular attention to the lower surface that contacts the exhaust seat. Replace diaphragm if worn or deteriorated.
3. Inspect cover O-ring for wear or deterioration. Replace O-ring if worn or deteriorated.
4. Check the cover exhaust seat for pitting or nicks. This seat must be smooth and sharp. If not, use a fine piece of emery cloth to dress the seat.
5. Check the spring and spring seat (if valve is so equipped) for wear or corrosion. Replace worn or corroded parts.

ASSEMBLY

QR Model

1. Position the spring seat over the diaphragm and then position both into the body. (Fig. 3)
2. Position spring in place. Install cover O-ring. (Fig. 3)
3. Install cover and tighten securely. (Fig. 3)

QR-1 Model

1. Position spring and spring seat into body, if valve is so equipped.(Fig. 4)
2. Position diaphragm over spring seat. (Fig. 4)
3. Carefully place cover O-ring in groove. Assemble cover and body.(Fig. 4)
4. Install four screws and tighten evenly and securely.(Fig. 4)

INSTALLATION

1. Mount the quick release valve with mounting bolts, lockwashers, and nuts. Bolt it securely, within 3 feet of the brake chambers.
2. Connect the brake application line to the top (supply port, and brake chamber lines to the side ports. Threads should be coated with a sealing compound.
3. The exhaust port must point down, and must not be restricted.

TESTING THE REBUILT QUICK RELEASE VALVE

The rebuilt valve must pass the Operation and Leakage tests, above. Failure to make certain that rebuilt valves pass these serviceability tests could result in the use of a sub-standard valve, which could, in turn, result in a hazardous operating condition.

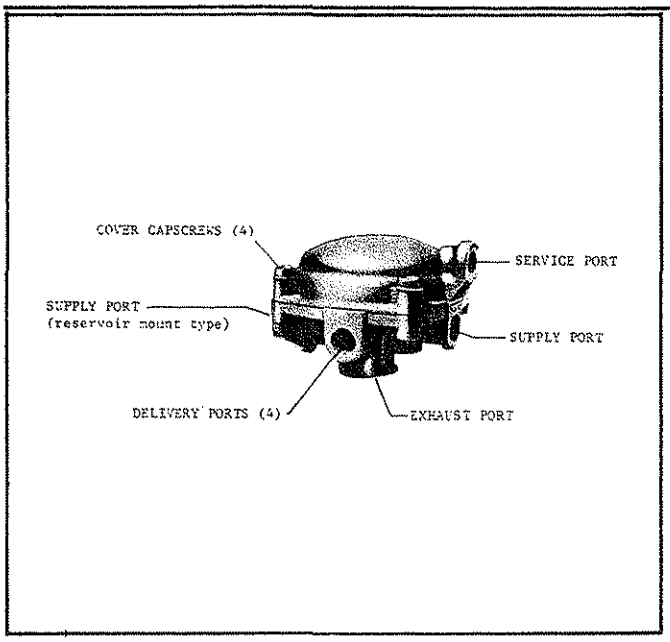


Fig. 1

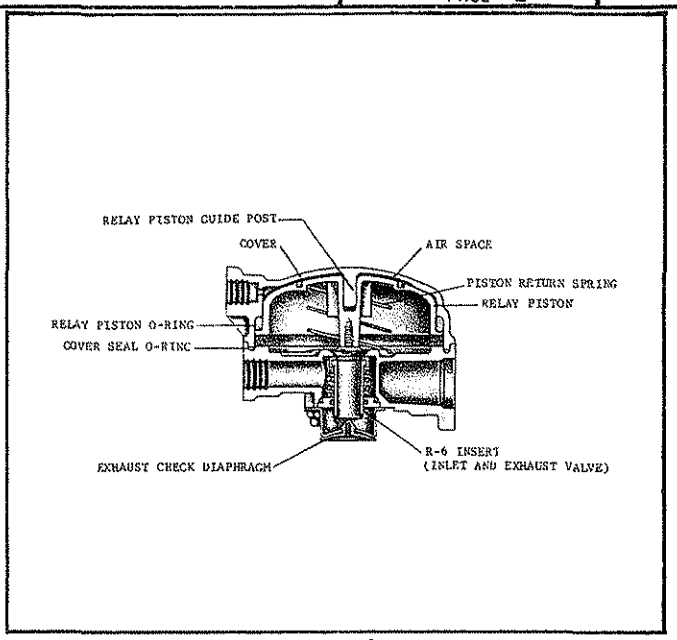


Fig. 2

GENERAL DESCRIPTION

The R-6 relay valve (Fig. 1) functions as a relay station in the air brake system, to speed up the application and release of the brakes. The valve is normally mounted at the rear of the vehicle, where it operates as a remotely controlled brake valve. It delivers the same pressure to the brake chambers as it is receiving from the application valve.

The R-6 relay valve is piston operated and has an insert-type inlet and exhaust valve. (Fig. 2) Remotely mounted valves have one supply port, a service port on the side of the cover, and four delivery ports in the body. Two delivery ports are located on the sides of the body and two out of the bottom. All ports are identified for installation purposes.

PRINCIPLES OF OPERATION

The R-6 relay valve acts rapidly because of the small volume of air required between the cover and piston. (Fig. 2) When the brake valve is applied, air pressure enters this small cavity above the piston through the service port (Fig. 1) and forces the piston down. The exhaust seat moves down with the piston and seats on the inner (exhaust) portion of the inlet and exhaust valve, sealing off the exhaust passage. At the same time the outer (inlet) part of the inlet and exhaust valve moves off its seat, permitting air supply to flow from the reservoir past the open inlet valve and into the brake chambers.

The air pressure being delivered by the open inlet valve is also effective on the bottom area of the relay piston. When this air pressure beneath the piston approaches the pressure being delivered above, the piston spring lifts the piston slightly and the inlet spring returns the inlet valve to its seat. The exhaust remains closed while service line pressure balances delivery pressure.

When the pressure delivered to the R-6 valve is raised, lowered, or completely exhausted, the valve reacts rapidly to these changes. If the brake valve is released, the air above the R-6 is exhausted back through the brake valve. Air below the piston will then lift the piston, moving the exhaust seat off of the exhaust valve, opening the exhaust passage. With the passage open, the air pressure in the brake chambers exhausts out the exhaust port, releasing the brakes.

SERVICE OPERATIONS

SERVICEABILITY TESTS

At each brake adjustment interval, the following tests should be performed. See Maintenance and Lubrication Manual for brake adjustment intervals.

Operation

Make several brake applications and check for prompt application and release of all brake chambers. Brakes should apply within ¼ second and release within ½ second. If not, see TROUBLE SHOOTING, section 32-12220. If the relay valve is found to be the source of slow response, it must be rebuilt or replaced with a new valve.

Leakage

1. With the brake valve in the released position, soap test the exhaust port for inlet valve and guide seal O-ring leakage. Leakage of a three inch soap bubble in three seconds is the maximum permissable.

2. Make and hold a brake application, and soap test the relay valve exhaust port for leakage. Leakage of a three-inch soap bubble in three seconds is the maximum permissible. If larger bubbles are present, or if leakage is too rapid to allow bubble formation, replace the R-6 insert (Fig. 2).

3. If leakage still occurs at the exhaust after the R-6 insert is replaced, the leakage could be at the relay piston O-ring, or possibly at the exhaust seat. (Fig. 3) Continue to hold application and check between cover and body for cover O-ring leakage. No leakage is permissable between body and cover.

IMPORTANT: If the valve does not function as described in Operation, above, or if leakage exceeds the amounts specified in Leakage above, and continues to leak as in step 3, the valve must be replaced with a new or rebuilt valve.

WARNING: Failure to replace a malfunctioning or leaking Relay Valve could result in a hazardous operating condition.

REMOVAL

1. Block and hold vehicle by means other than service brakes.

2. Drain the air system of all air pressure by opening the drain cocks.

3. Disconnect air lines from R-6 relay valve.

4. Remove the valve mounting bolts, then remove the valve.

NOTE: The inlet and exhaust valve assembly (R-6 insert) can usually be removed for service or replacement without disturbing the valve mounting or connecting lines. To do this, first drain all reservoirs, then remove the two exhaust cover capscrews and the cover itself, then pull out the insert. Caution should be used when installing the R-6 insert to prevent nicking the inlet and exhaust valve, or the guide seal O-ring. After the insert is placed in its bore in the body, install the exhaust cover (with exhaust check) and hold in place while tightening the two cover capscrews. See Fig. 3 for identification of parts.

DISASSEMBLY

Complete R-6 Valve

1. Remove the four cover capscrews (Fig. 1) then the cover with the relay piston and return spring. (Fig. 2)

2. Remove relay piston from cover. (Fig. 3)

3. Remove piston O-ring from piston, and cover seal O-ring from body. (Fig. 2)

4. Turn body over and remove exhaust cover capscrews (Fig. 3), exhaust cover, then pull insert from body. (Fig. 2)

5. The exhaust seat in the relay piston and the exhaust check in the exhaust

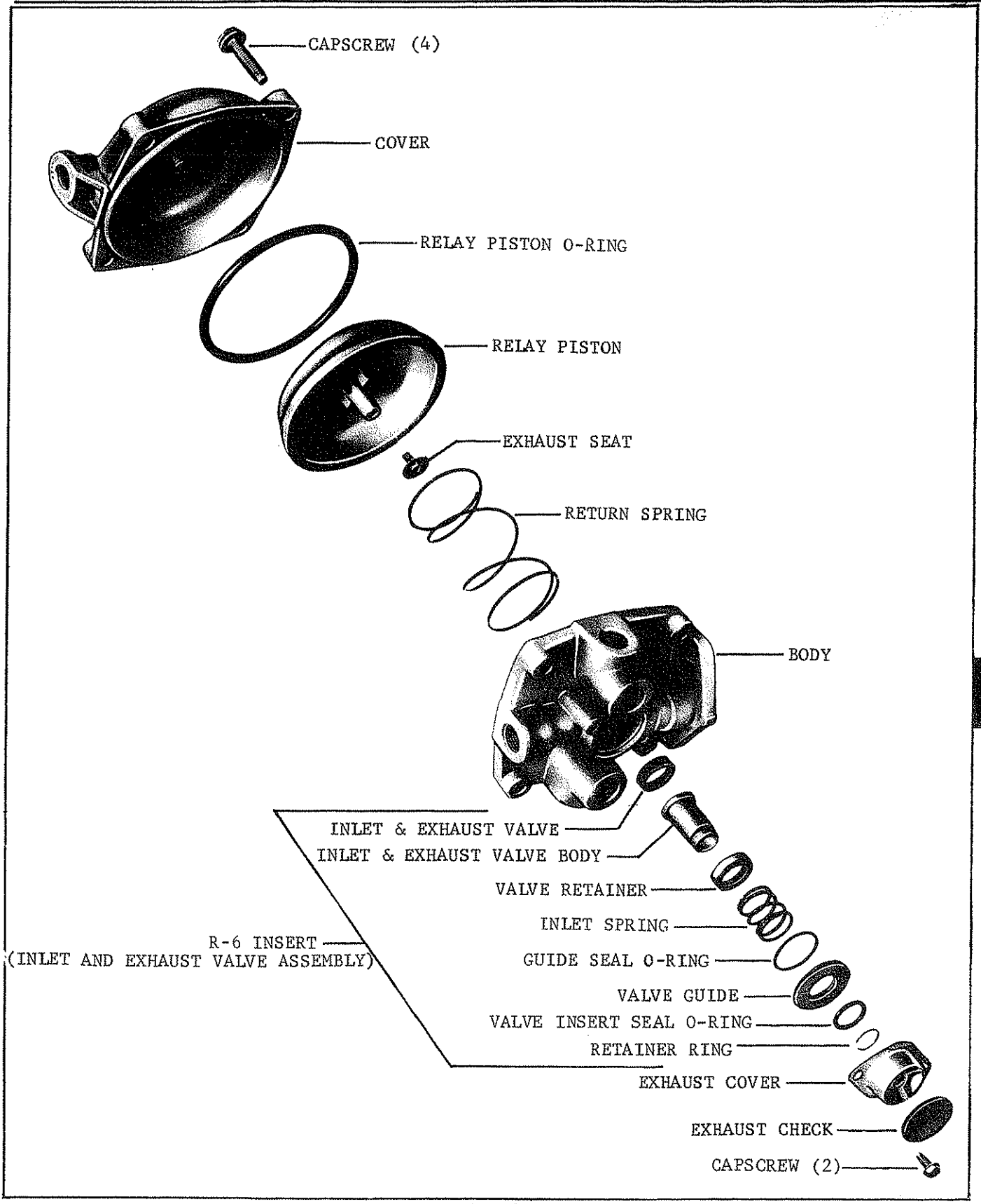

CAPSCREW (4)
COVER
RELAY PISTON O-RING
RELAY PISTON
EXHAUST SEAT
RETURN SPRING
BODY
INLET & EXHAUST VALVE
INLET & EXHAUST VALVE BODY
VALVE RETAINER
INLET SPRING
R-6 INSERT
(INLET AND EXHAUST VALVE ASSEMBLY)
GUIDE SEAL O-RING
VALVE GUIDE
VALVE INSERT SEAL O-RING
RETAINER RING
EXHAUST COVER
EXHAUST CHECK
CAPSCREW (2)

Fig. 3

cover can be removed, but only if they are to be replaced with new parts. (Fig. 3)

R-6 Insert

1. Depress and hold valve guide down against spring tension, and remove valve retainer. (Fig. 3)
2. To remove retainer wire ring, use a sharp instrument and pry one end out of the groove, then remove the ring like a tire rim. (Fig. 3)
3. Remove valve insert seal O-ring, valve guide, spring, and valve retainer. (Fig. 3)
4. Remove snap-on type inlet and exhaust valve from its body. (Fig. 3)
5. Remove valve insert seal O-ring from the valve guide. (Fig. 3)

CLEANING AND INSPECTION

1. Wash all metal parts in clean solvent, and dry them thoroughly. Wipe rubber parts dry.
2. Inspect all parts for wear, damage, or deterioration. Replace worn, damaged, or deteriorated parts.
3. Inspect springs for distortion, corrosion, and cracks. Replace distorted, corroded, or cracked springs.
4. Inspect inlet seat (in body) and exhaust seat for nicks and burrs. The inlet seat can be redressed, and the exhaust seat can be replaced, if damaged.
5. Inspect small choked hole in service port for restrictions. Clear and clean this port to remove dirt or restrictions.

WARNING: Failure to replace worn or damaged parts, as described above, could result in a hazardous operating condition.

ASSEMBLY

General

1. Prior to assembly, lightly lubricate the relay piston guide post with a good lubricant suitable for metal to metal surfaces. (Fig. 2)
2. Lubricate O-rings, cover bore, and inlet body with NLGI grade 1 grease. (Fig. 3)
3. During assembly, hand wrenches should be used, rather than impact wrenches, to tighten the capscrews.

R-6 Insert

1. Stretch inlet and exhaust valve over inlet valve body lip with smooth surface up. (Fig. 3)
2. Position valve retainer down over inlet valve body and valve. (Fig. 3)
3. Place inlet valve spring over inlet and exhaust valve body. (Fig. 3)
4. Install well lubricated valve insert seal O-ring in the inner groove of the valve guide. (Fig. 3)
5. Depress and hold valve guide down against spring and install retainer ring. A 9/16 twelve point socket can be used to push the retainer ring down until it snaps in the groove in the inlet and exhaust valve body. (Fig. 3)
6. Install valve insert seal O-ring. (Fig. 3)

Complete R-6 Valve

1. Position insert in valve body. (Fig. 2)
2. Install exhaust cover and secure with two (2) capscrews. (Fig. 3)
3. Press exhaust check diaphragm into exhaust cover. (Fig. 2)

4. Turn valve over and install lubricated cover seal O-ring in body groove. (Fig. 2)

5. Install relay piston O-ring on piston, then position relay piston in cover. (Fig. 2)

6. Install relay piston return spring over its guide in the body. (Fig. 2)

7. Position the cover and relay piston on body, and with service port in position, push cover and relay piston down over spring so that exhaust seat is centered inside spring. (Fig. 2)

8. Install cover capscrews and tighten evenly. (Fig. 1)

WAGNER RG-2 AIR RELAY QUICK-RELEASE VALVE

GENERAL DESCRIPTION

The Wagner RG-2 air relay quick-release valve (Fig. 1) reduces the reaction time of the service air brake system by relaying each action of the brake foot valve closer to the point of application. The RG-2 valve is centered on the crossmember nearest the brake actuators that it services.

PRINCIPLES OF OPERATION

The valve service port (or control port) is connected to the brake foot valve, and the delivery ports are connected to the brake actuators. The reservoir port connects to the supply air line, which is maintained at the system air pressure (100-120 psi [689-827 kPa]) while the engine is running. See Fig. 1.

When the brake foot valve is depressed, the air pressure applied through the valve service port forces the relay reaction piston down to seat on the inlet-exhaust valve, sealing off the exhaust port. See Fig. 2. The piston then moves further downward, and compresses the inlet-exhaust valve as shown in Fig. 3. This opens the reservoir and delivery ports to allow air pressure to enter the valve and pass through the delivery ports to the brake actuators, applying the service brakes.

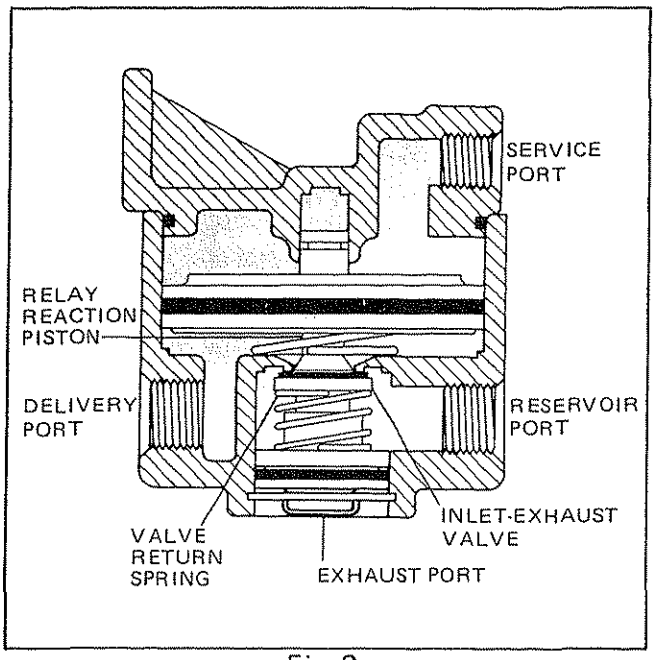


Fig. 2

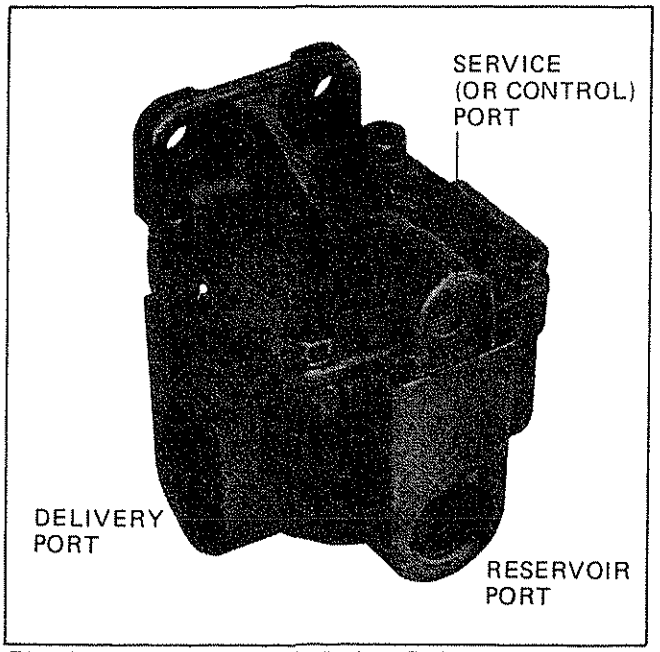


Fig. 1, Wagner RG-2 Air Relay Quick-Release Valve

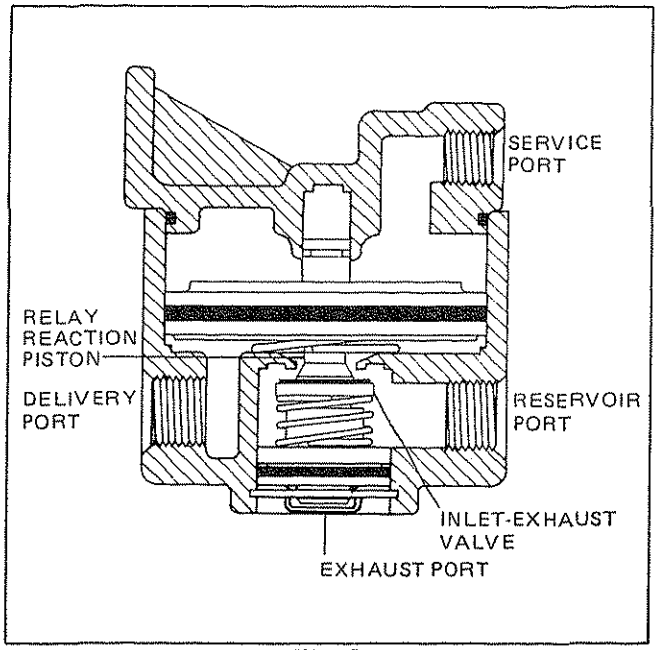


Fig. 3

WAGNER RG-2 AIR RELAY QUICK-RELEASE VALVE

As the air pressure beneath the relay reaction piston becomes equal to the air pressure above the relay reaction piston, the piston returns to a balanced position, and allows the valve return spring to return the inlet-exhaust valve, closing the reservoir and delivery ports. The unit is now poised in a "holding" position for future applying or releasing action, as shown in Fig. 2.

When the brake foot valve is released, the air pressure above the relay reaction piston rapidly escapes, unbalancing the piston. The piston then moves away from the inlet-exhaust valve, opening the exhaust port and releasing the service brakes by releasing the air in the delivery lines directly into the atmosphere. See Fig. 4.

NOTE: For identification purposes, the reservoir and delivery ports are labeled as such on the bottom of the valve. Although two reservoir ports are present, only one is utilized. The other reservoir port is permanently plugged. Figures 2, 3, and 4 are typical representations of quick-release valve operations.

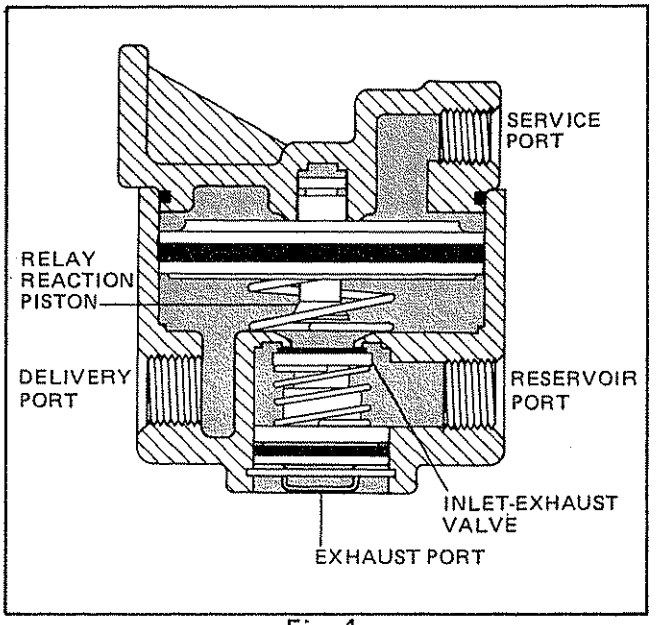


Fig. 4

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial cleaning solvents are flammable and, if ignited, could cause personal injury.

SERVICE OPERATIONS

OPERATING TESTS

The Wagner RG-2 valve does not require maintenance or testing at regular intervals. Instead, the valve is tested each time a brake application is made. Should a time lag in brake application occur, refer to the air brake system troubleshooting section, located in the 12 Group of this manual. If it is determined that the RG-2 valve may be at fault, the valve may be tested for internal leakage as follows:

1. With the engine running and the spring parking brakes applied, chock block the vehicle tires. Release the spring parking brakes.

2. If needed, clean the valve and the surrounding area, using a commercial solvent. Then, apply a soap-water solution to the exhaust port of the valve.

3. Apply the service brakes, and observe the valve. A leak at the exhaust port indicates that the relay reaction piston is not sealing the exhaust port.

4. Release the service brakes. After the air is exhausted from the brakes, leakage at the exhaust port indicates that the inlet-exhaust valve is not sealing the reservoir port.

5. If internal leakage is present, disassemble and service the valve. A slight leakage in the form of slow soap bubbles is permissible.

VALVE DISASSEMBLY, CLEANING AND INSPECTING, AND ASSEMBLY (Refer to Fig. 5)

Disassembly

1. With the engine stopped, activate the spring parking brakes and chock block the vehicle tires. Drain all air reservoirs.

WAGNER RG-2 AIR RELAY QUICK-RELEASE VALVE

2. Disconnect the air lines from the ports on the valve, marking the lines for later assembly. Remove the nuts and bolts attaching the valve to the vehicle, then remove the valve.

3. Remove the four capscrews and lockwashers that hold the valve cover to the valve body. Carefully lift off the valve cover, then lift out the relay reaction piston and the underlying piston return spring. Remove the cover tetra-seal from the valve cover and the piston seal quad ring from the relay reaction piston.

WARNING: Use care when removing the valve cover and the relay reaction piston. The piston return spring is under tension and may burst away from the valve body with sufficient force to cause personal injury or equipment damage.

4. Turn the valve body over, then, using snapring pliers, remove the retainer ring from the exhaust port. Lift out the exhaust shield.

NOTE: It may be necessary to depress the retainer, creating a slack space, in order to allow the exhaust shield to clear the lip on the exhaust port.

5. With the exhaust port facing down, against a solid surface, reach inside the body of the valve, then gently press down on the inlet-exhaust valve assembly, disengaging it from the valve body.

CAUTION: When disengaging the inlet-exhaust valve from the valve body, do not gouge the integral seal located in the top of the valve. If the seal is gouged, it must be replaced.

6. Remove the inlet-exhaust valve assembly from the exhaust port. Separate the inlet-exhaust valve, valve return spring, valve guide, valve guide tetraseal, O-ring, and retainer.

Cleaning And Inspecting

1. Using a commercial solvent, clean the unit, removing all foreign deposits.

WARNING: Do not expose a commercial cleaning solvent to flames or intense heat. Many commercial

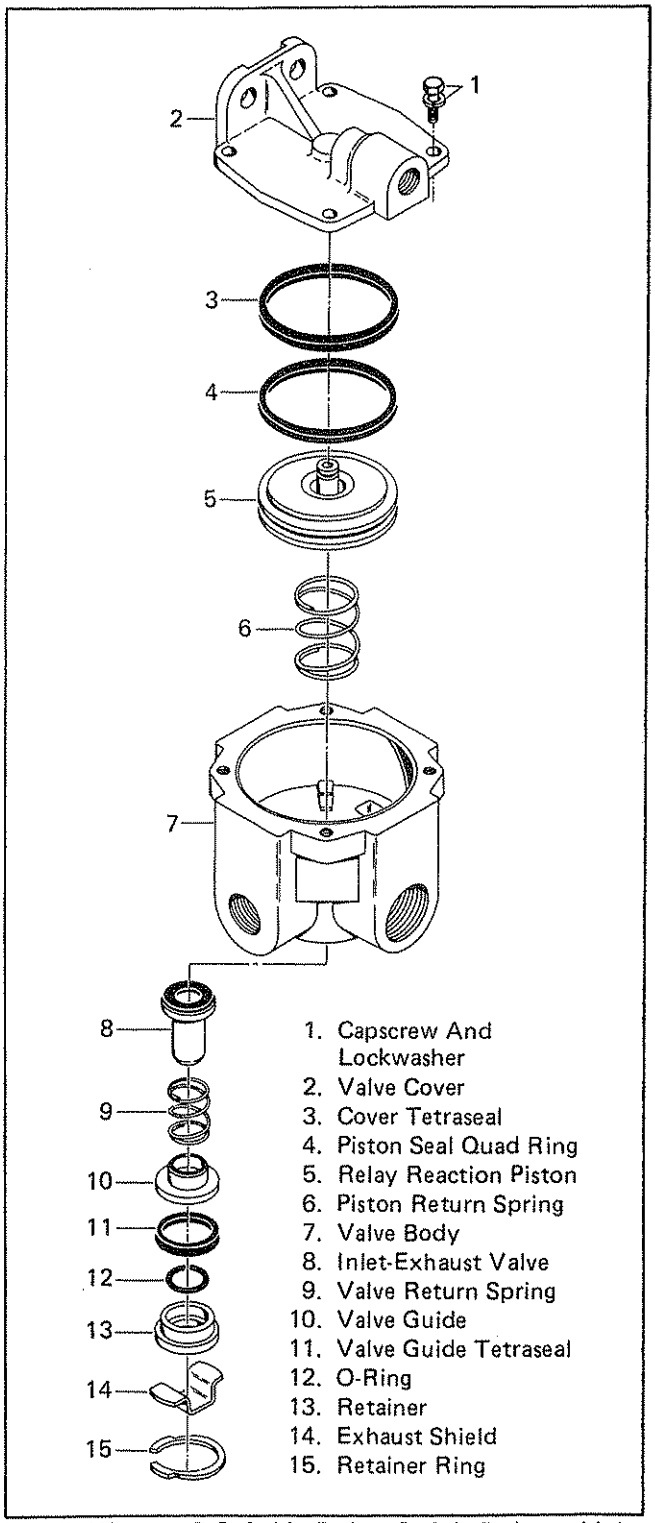


Fig. 5, Wagner RG-2 Air Relay Quick-Release Valve Nomenclature

WAGNER RG-2 AIR RELAY QUICK-RELEASE VALVE

cleaning solvents are flammable and, if ignited, could cause personal injury.

2. Inspect all parts for wear, damage, or deterioration, and replace parts as necessary.

NOTE: When servicing the valve, replace all rubber parts, the inlet-exhaust valve, and the retainer ring, using the seal kit that is available. For a complete overhaul of the valve, also replace the relay reaction piston, piston return spring, valve return spring, valve guide, retainer, and exhaust shield, using a maintenance kit.

Assembly

1. Lubricate the seals and all friction surfaces with Dow Corning 33 grease (medium consistency).

NOTE: Because the seals in the valve are designed to allow for arctic or low temperature operation, Wagner Electric Corporation states that only Dow Corning 33 grease (medium consistency) may be used as a lubricant.

2. Insert the O-ring into the retainer, placing it on the inner lip of the retainer, then place the valve guide tetraseal on the outer lip of the retainer. Position the valve guide on the retainer and the valve guide tetraseal.

3. Place the valve return spring over the valve guide, then slide the inlet-exhaust valve, narrow end first, into the valve return spring, making sure that the inlet-exhaust valve fits inside the valve guide.

4. Insert the inlet-exhaust valve assembly into the exhaust port, inlet-exhaust valve first. Depress the inlet-exhaust valve assembly enough to fit the exhaust shield under the exhaust port lip. Using snapring pliers, install the retainer ring under the exhaust port lip.

5. Position the piston seal quad ring in its groove on the relay reaction piston. Insert the piston return spring, then the relay reaction piston, into the valve body.

6. Position the tetraseal in its groove on the valve cover, then install the valve cover on the valve body. Place the valve cover on the valve body so that the mounting plate on the cover is on the same side of the valve body as the plugged reservoir port.

7. Install the four cover capscrews and lockwashers, tightening them to 4 ft-lbs (6 N·m).

8. Install the valve on the vehicle, using the nuts and bolts removed earlier, then tighten them to 11-15 ft-lbs (15-20 N·m).

9. Connect the air lines as marked earlier, or as shown in Fig. 6 under "SPECIFICATIONS." If wire braid hose is used, tighten the nut finger-tight. Then, using two wrenches to prevent twisting of the hose, further tighten the nut until a solid feeling is encountered. Tighten the nut one-sixth turn more.

   If nylon tubing is used, install the end of the tubing in the fitting until the tubing bottoms in the body of the fitting. Tighten the nut finger-tight. Then, using two wrenches to prevent twisting of the tube, further tighten the nut a minimum of two turns or until no threads show on the fitting body.

IMPORTANT: Always perform the "OPERATING TESTS," listed earlier in this subject, after installation of the Wagner RG-2 relay valve on the vehicle, and before placing the vehicle in service.

WAGNER RG-2 AIR RELAY QUICK-RELEASE VALVE

SPECIFICATIONS

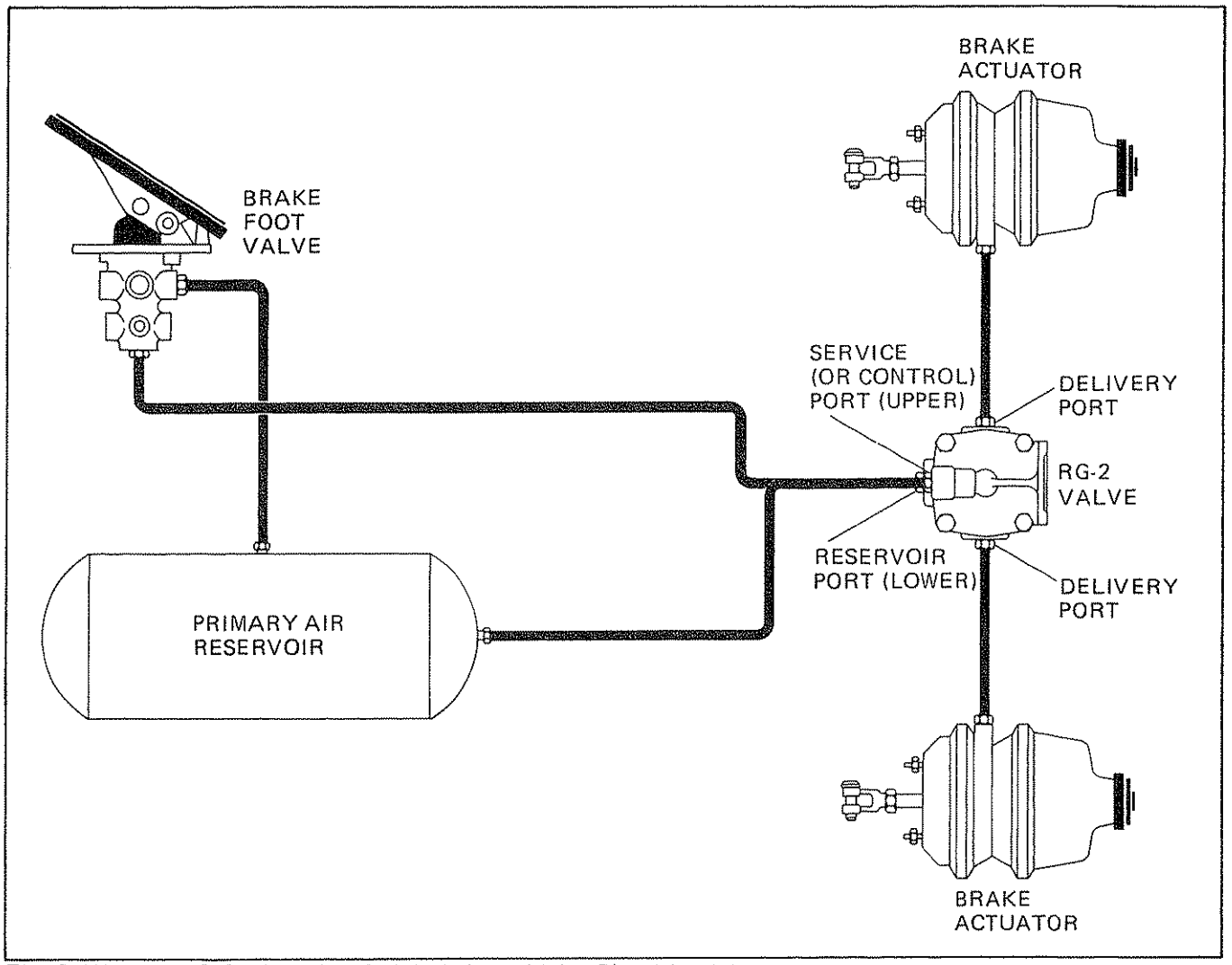


Fig. 6, Wagner RG-2 Air Relay Quick-Release Valve Plumbing Diagram

GENERAL DESCRIPTION

The SR-1 Spring Brake Valve (Fig. 1) is used in dual or "split" air brake systems equipped with spring brake actuators. The function of the SR-1 is to supply a specific, limited hold-off pressure to the spring brakes, and in the event of loss of No. 1 service air pressure, to modulate the spring brakes through the use of the service brake valve.

The valve has four 1/4" American Standard Taper Pipe Thread air connection ports and a diaphragm protected exhaust port. Each air connection port is labeled with embossed letters for identification purposes. Two 5/16" diameter holes are provided in the integral mounting bracket of the valve body.

NOTE: For proper internal drainage, the SR-1 should be mounted with the exhaust port down toward the road surface.

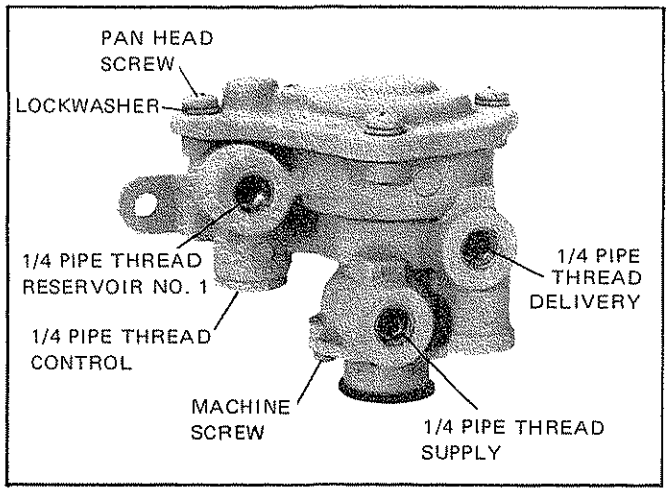


Fig. 1, Exterior View

PRINCIPLES OF OPERATION

INITIAL AIR BRAKE SYSTEM CHARGE

The initial air brake system charge (Fig. 2), from No. 1 (primary system) & No. 2 (secondary system) service reservoirs flows through the park control valve and enters the SR-1 supply port. Air entering the supply port flows past the inlet and exhaust valve (B) to the underside of piston (B) and out the delivery port of the SR-1 to the emergency air connection at the spring brake actuator. Note that the springs above piston (B) force it into contact with inlet and exhaust valve (B). In the position shown, the exhaust is closed and the inlet is open.

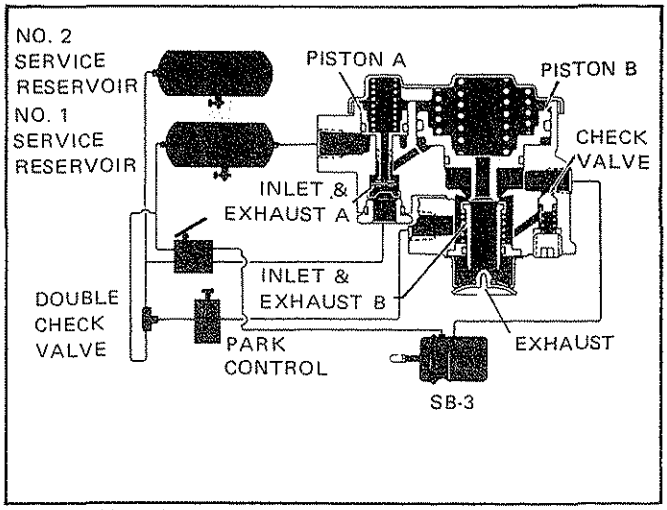


Fig. 2, Charging - Below 55 psi

Air flowing from the No. 1 reservoir only enters the reservoir port of the SR-1. This air remains under piston (A) as system pressure builds. With No. 1 reservoir pressure below approximately 55 psi, the spring above piston (A) forces it into contact with inlet and exhaust valve (B), causing the exhaust to seal and the inlet to open.

AIR BRAKE SYSTEM FULLY CHARGED

With air system pressure above approximately 55 psi in No. 1 & No. 2 service reservoirs (Fig. 3), piston (A) has moved against the force of the spring above it, allowing the inlet of valve (A) to close and opening the hollow exhaust passage through piston (A).

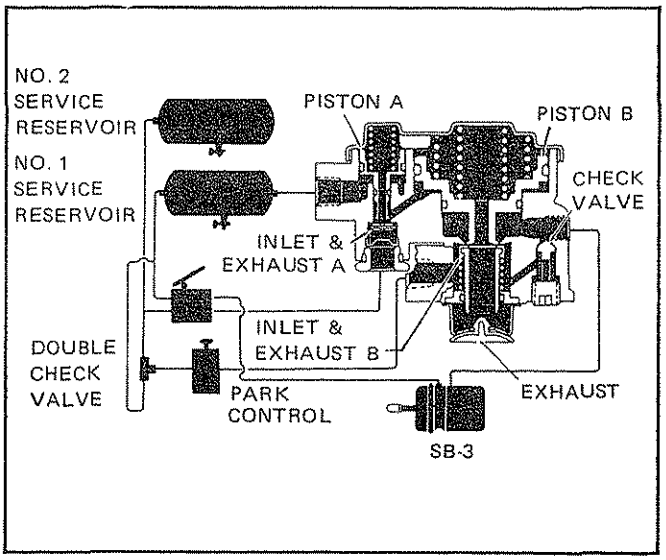


Fig. 3, System Fully Charged

When air pressure beneath piston (B) is approximately 95 psi, piston (B) rises slightly, against the force of the springs above it, allowing the inlet of valve (B) to close. The exhaust through valve (B) remains closed. The closing of the inlet portion of valve (B) traps approximately 95 psi in the hold-off cavity of the spring brake actuators, while allowing full air system pressure to build elsewhere.

NORMAL SERVICE APPLICATION WITH RESERVOIRS 1 & 2 CHARGED

When a service application is made by actuating the dual brake valve (Fig. 4), air from the No. 2 delivery circuit is delivered from the brake valve to the control port, and is stopped at the closed inlet of valve (A). No movement of the SR-1 internal components takes place. Air from the No. 1 delivery circuit of the dual brake valve actuates the service section of the spring brake actuators.

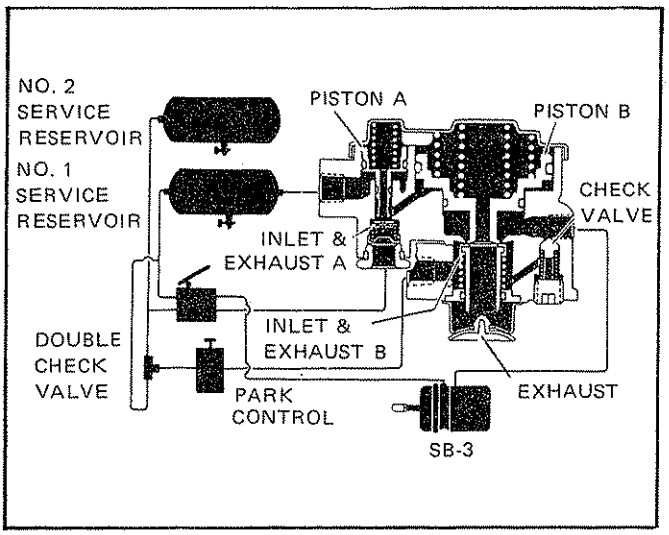


Fig. 4, Normal Service Application

SERVICE APPLICATION WITH LOSS OF NO. 2 RESERVOIR (SECONDARY SYSTEM PRESSURE)

In the event air pressure is lost from No. 2 reservoir (Fig. 5), the No. 1 reservoir as well as the parking control valve will be protected through the action of the double and single check valves in the air system. A service application of the dual air brake valve in this situation results in little or no air being delivered from the No. 2 delivery circuit to the control port of the SR-1. No movement of the SR-1 internal components takes place. Braking is assured, since the No. 1 service reservoir is protected and the No. 1 delivery circuit of the dual brake valve will apply the service section of the spring brake actuators.

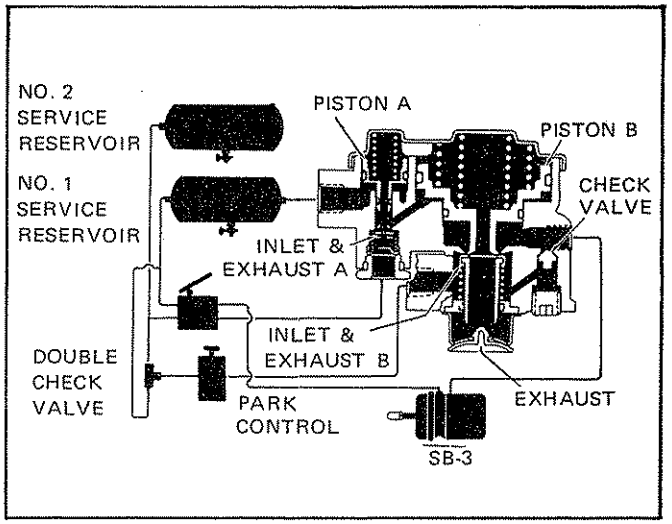


Fig. 5, Service Application - Loss of No. 2 Reservoir

SERVICE APPLICATION WITH LOSS OF NO. 1 RESERVOIR (PRIMARY SYSTEM) PRESSURE

When air pressure in the No. 1 service reservoir falls below approximately 55 psi (Fig. 6), the pressure beneath piston (A) is insufficient to resist the spring force above and piston (A) moves into contact with valve (A). Initial contact between piston (A) and valve (A) closes the hollow exhaust passage of piston (A). Continued movement of the piston opens the inlet of valve (A).

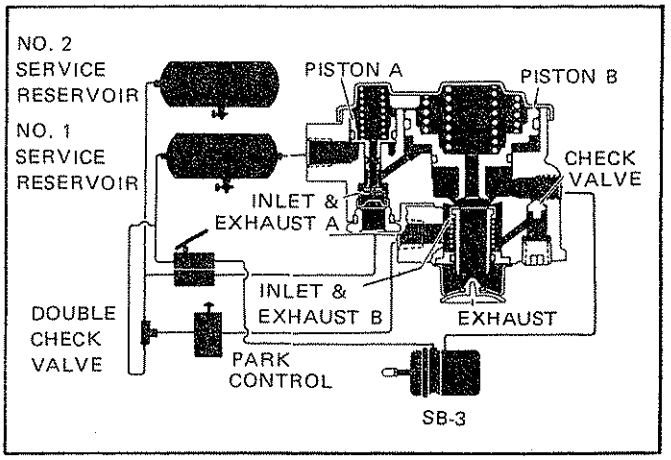


Fig. 6, Service Application - Loss of No. 1 Reservoir

BENDIX-WESTINGHOUSE SR-1 SPRING BRAKE VALVE

The No. 2 service reservoir (secondary system) and the park control valve are protected from pressure loss by the action of the check valves.

When a service application of the dual brake valve is made, air delivered from the No. 2 delivery circuit of the dual brake valve enters the SR-1 control port. Air entering the control port now moves past the inlet of valve A and is conducted through a passage in the body to the underside of piston B. The added force of air pressure beneath piston B, moves up, opening the exhaust of valve B. When the exhaust of valve B opens, air pressure trapped in the emergency section of the spring brake actuator is allowed to escape resulting in a brake application by the emergency section. The amount of air pressure released from the spring brake is in proportion to the amount of air pressure delivered to the control port of the SR-1 by the No. 2 delivery of the dual brake valve.

PARKING BRAKE APPLICATION

With both system No. 1 and No. 2 intact when the park control valve is placed in the "park" or exhaust position (Fig. 7), the SR-1 supply of air pressure and the air pressure in the spring brake actuator cavities is exhausted. The single check valve in the SR-1 assists this exhaust of air pressure from the spring brakes, by allowing the air below piston B to flow back out the open exhaust of the park control valve. When air pressure below piston B has dropped sufficiently, piston B moves down, opening the inlet of valve B, thus providing an additional exhaust passage for air exhausting through the SR-1 from the spring brakes.

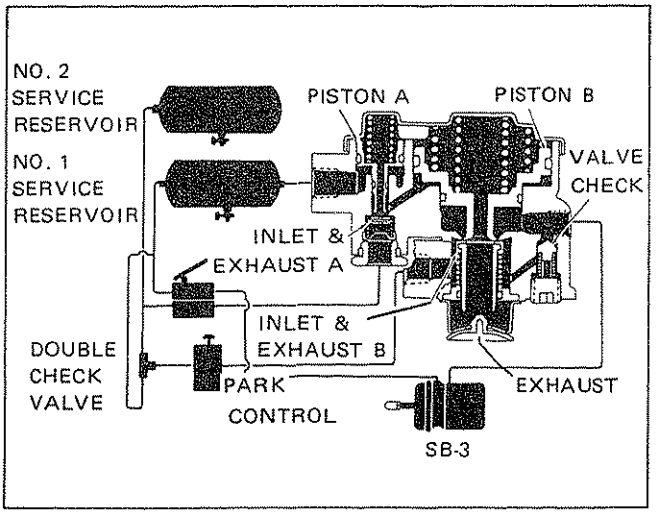


Fig. 7, Park Application

SERVICE OPERATIONS

REMOVAL

1. Prior to removing the SR-1, apply the parking brakes and drain all the vehicle reservoirs.
2. Identify or mark all air lines, then disconnect them from the SR-1.
3. Remove the two mounting bolts from the SR-1, then remove the valve.

DISASSEMBLY (Refer to Fig. 8)

1. Remove the socket head pipe plug.
2. Remove the check valve spring, check valve spring guide, and the check valve.
3. Remove the two phillips head screws (not shown) and the exhaust cover.

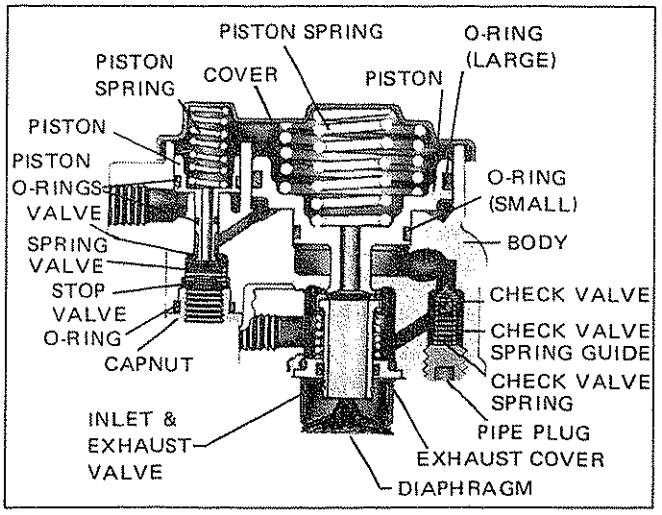


Fig. 8, Sectional View

BENDIX-WESTINGHOUSE SR-1 SPRING BRAKE VALVE

4. Separate the exhaust diaphragm from the exhaust cover.

5. Remove the inlet and exhaust valve assembly B.

6. Remove the capnut, then separate the capnut and O-ring.

7. Remove the valve stop, valve spring and inlet valve A.

CAUTION: The cover is under a spring load, and should be held in a vise or press, while removing the phillips head screws.

8. With the cover and body positioned in a vise or press, remove the four phillips head screws and lockwashers that secure the cover to the body.

9. Remove the cover, then remove the three piston springs.

NOTE: Some SR-1 piece numbers do not have piston spring items.

10. Remove the small piston A and the O-rings.

11. Remove the large piston and the large and small O-rings.

CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent and dry them. Inspect all parts for wear or deterioration. Inspect the valve seats for nicks or burrs. Replace springs that are cracked or corroded. Replace all rubber parts and any part not found to be serviceable during inspection. Use only genuine Bendix replacement parts.

ASSEMBLY (Refer to Fig. 8)

Prior to assembly of the SR-1 spring brake valve, lubricate all O-rings, O-ring grooves, piston bores and metal to metal moving surfaces with the silicone base lubricant packaged in the maintenance kit or use Bendix piece number 291127 packaged in a two ounce tube.

NOTE: All torques specified in the following assembly procedures are *assembly* torques and can be expected to fall off, after assembly is accomplished. *Do not retorque* after initial assembly torques fall.

1. Assemble the check valve, check valve spring guide and check valve spring, then insert them in the body.

2. Apply a pipe sealant to the socket head pipe plug and install it in the body. Tighten to 130-170 lbf·in (1469-1921 N·cm).

3. Place the inlet and exhaust valve assembly B into the valve body.

4. Secure the exhaust cover to the valve body using the two 10-24 phillips screws and their lockwashers.

5. Tighten the screws to 20-30 lbf·in (226-339 N·cm). Insert the exhaust diaphragm into the exhaust cover.

6. Place inlet valve A in the body then install the valve spring and valve stop.

7. Install the O-ring on the capnut, then install the capnut in the body. Tighten to 100-125 lbf·in (1130-1412 N·cm).

8. Install the small and large O-rings on the small diameter piston, then insert the piston in the body.

9. Install the large and small O-rings on the large diameter piston, then insert the piston in the body.

10. Install the three piston springs in their respective pistons.

11. Secure the cover to the body using the four 1/4-20 phillips head screws and lockwashers.

12. Tighten the four screws to 50-80 lbf·in (565-904 N·cm).

BENDIX-WESTINGHOUSE SR-1 SPRING BRAKE VALVE

13. Test the rebuilt SR-1 spring brake valve by using the following operation and leakage tests.

    .1 Block vehicle and hold by means other than vehicle brakes. Charge air brake system to governor cut-out pressure (120 psi [827 kPa]).

    .2 Place parking brake control valve in the "park" position. Observe that the spring brake actuators apply promptly. Install a test gauge known to be accurate into the delivery port of the SR-1 spring brake valve. Place the parking brake control valve in the "release" position. Observe that the spring brake actuators release fully.

    .3 With the parking brake control valve in the "release" position, note the gauge pressure reading. The gauge should read 95 psi (655 kPa). If the pressure reading is different than this, the SR-1 valve must be repaired or replaced.

    .4 Put the parking brake control valve in the "park" position, the gauge reading should drop to zero promptly. A slow release of pressure could indicate faulty operation of the single check valve within the SR-1 valve.

    .5 Place the parking brake control valve in the "release" position; and drain the number one (primary system) service reservoir.

    Apply the foot brake valve several times and note that the pressure reading on the test gauge decreases each time the foot brake valve is applied. After the foot brake valve has been applied several times, the pressure reading on the test gauge will drop to the point where release of the spring brake actuators will no longer occur. This test portion satisfactorily completed shows that the number 2 reservoir (secondary system) is operating correctly by taking over when the number 1 reservoir (primary system) has failed. Close the drain valve on the number 1 reservoir.

    .6 With the air system fully charged and the parking brake control valve in the "release" position, coat the exhaust port and around the SR-1 valve cover with a soap solution.

If the SR-1 spring brake valve does not function as described in the preceeding or if leakage is more than a 1-inch (25 mm) bubble in not less than 5 seconds the manufacturer recommends that it be returned to the nearest Bendix Authorized distributor for a factory remanufactured and guaranteed valve under the Exchange Plan.

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES SUBJECT CONTENTS

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MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

GENERAL INFORMATION

MGM Stopgard® tandem wedge brake chambers (Fig. 1) consist of a service brake chamber and a parking/emergency spring brake chamber. When installed as tandem brake chambers, the service brake section is the lower (smaller) section near the brake spider. The Stopgard® model is also available as a single brake chamber (service brakes only). See Fig. 2.

In the service brake section, the service brake cap (or, as on tandem brake chamber units, the flange case) and non-pressure chamber assembly house a rubber boot, a piston and rod assembly, and a service brake diaphragm. See Fig. 2.

In the parking/emergency brake section, the flange case and the head assembly house a return spring, a pushrod assembly, a parking brake diaphragm, a piston, a power spring, and a release bolt. See Fig. 2.

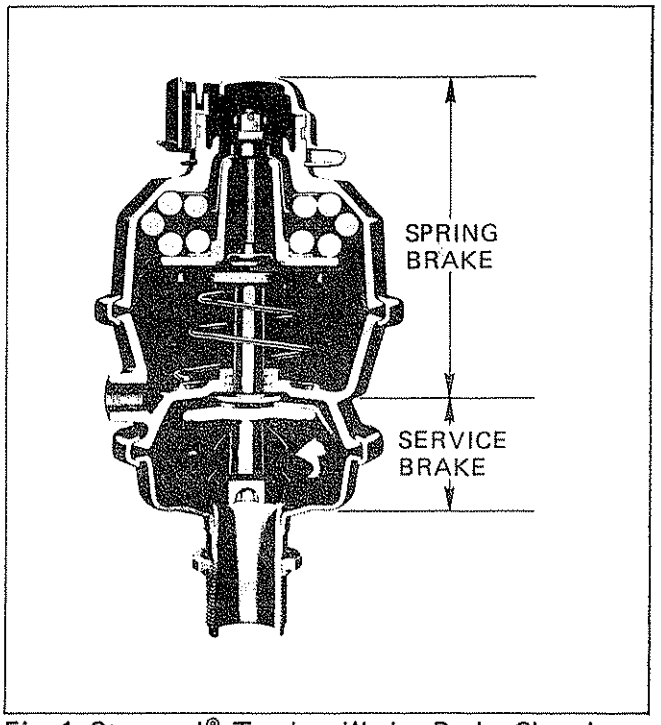


Fig. 1, Stopgard® Tandem Wedge Brake Chambers, Sectional View

PRINCIPLES OF OPERATION

SERVICE BRAKES

As the brake pedal is depressed, air pressure from the air reservoir enters the service brake chamber through an air port. The air pressure acts upon the service brake diaphragm which forces the piston and rod assembly forward (toward the non-pressure chamber). Refer to Figs. 3 and 4.

The motion of the piston and rod assembly causes the steel wedge rod to move. The wedge-shaped tip of the rod is forced between two rollers, which are engaged in corresponding slots in the ends of two plungers. The unslotted portions of the inner ends of the plungers are resting on abutments in the plunger housing. The outer ends of the plungers are engaged with and supporting the brake shoes.

As the wedge head moves deeper between the rollers, the rollers and plungers are spread apart and push the brake shoes outward, against the brake drum.

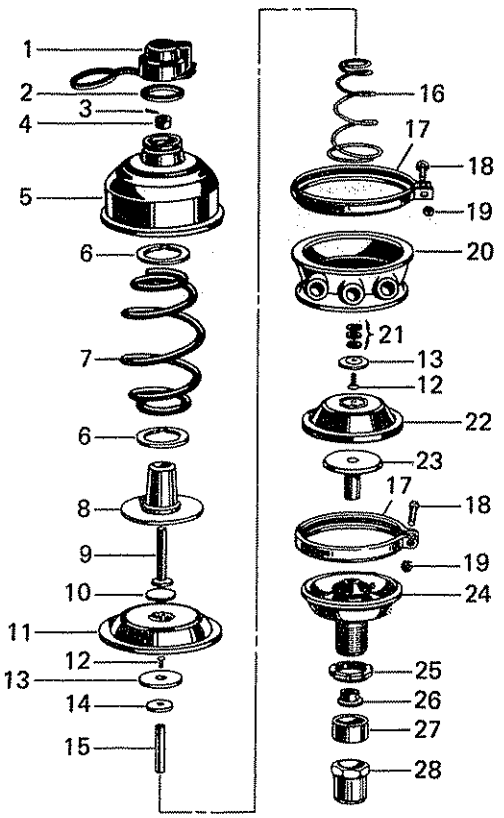
When the brake is released, air is exhausted from the service brake chamber, and the wedge spring returns the wedge rod and the service brake diaphragm to their normal (off) positions.

PARKING/EMERGENCY BRAKES

During parking brake release, air pressure enters the parking brake chamber and acts upon the diaphragm and piston, which fully compresses the power spring. When the power spring is compressed, the parking brakes are released; the service brakes can then be operated at the brake pedal.

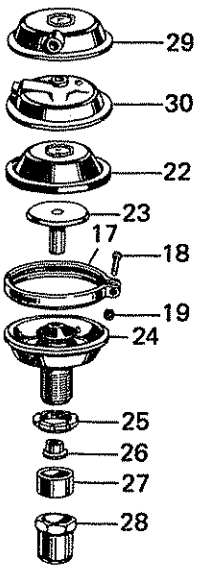
During parking brake application, air is exhausted from the parking brake chamber. The power spring releases, forcing the piston and parking brake diaphragm forward (toward the flange case). The resulting forward motion exerted on the pushrod assembly forces the service brake diaphragm and the service brake piston and rod assembly forward, thus applying the brakes.

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES



SERVICE BRAKE AND PARKING/EMERGENCY BRAKE CHAMBERS

1. Breather Cap
2. Filter
3. Lockpin
4. Release Nut
5. Head Assembly
6. Thrustwasher
7. Power Spring
8. Piston
9. Release Bolt
10. Piston Plug
11. Spring Brake Diaphragm
12. Screw
13. Pushrod Plate
14. Pushrod Guide
15. Pushrod
16. Return Spring
17. Clamp Band
18. Clamp Band Bolt
19. Clamp Band Nut
20. Flange Case
21. Seal And Guide (Kit)
22. Service Brake Diaphragm
23. Piston And Rod
24. Non-Pressure Chamber And Rubber Boot
25. Spanner Nut
26. Guide
27. Tube Protector
28. Collet Nut (Optional)
29. Cap (1 Port Type)
30. Cap (2 Port Type)



SERVICE BRAKE CHAMBERS

Fig. 2, Stopgard® Wedge Brake Chambers

Emergency brake application automatically begins when the air pressure in the brake system drops below approximately 80 psi (551 kPa). Full emergency brake application occurs when the air pressure drops below approximately 40 psi (276 kPa).

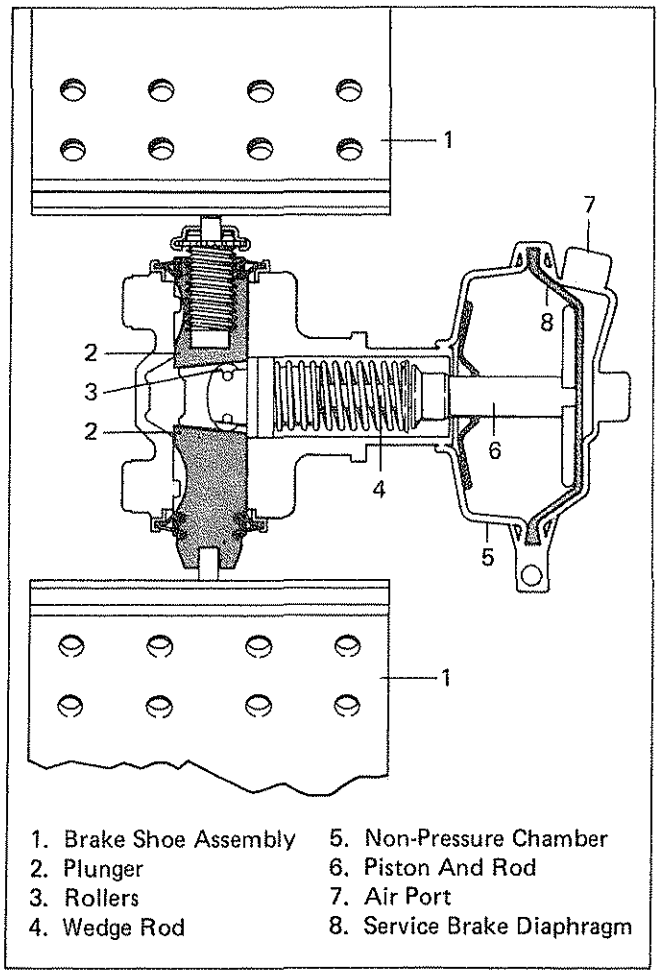
SERVICE OPERATIONS

WARNING: If allowed to release uncontrolled during brake chamber disassembly, the power spring can forcibly hurl brake chamber components, posing a danger to persons in the area. Under no circumstances should tandem brake chambers be disassembled (this includes removal of the spring brake clamp band) without first manually compressing the spring brake power spring. Prior to disassembly operations of tandem brake chambers, always perform the procedures given under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)

1. Chock block the vehicle tires.
2. Unsnap the brake chamber breather cap.

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES



1. Brake Shoe Assembly
2. Plunger
3. Rollers
4. Wedge Rod
5. Non-Pressure Chamber
6. Piston And Rod
7. Air Port
8. Service Brake Diaphragm

Fig. 3, Typical Wedge Service Brake Assembly In The "Off" Position, Sectional View

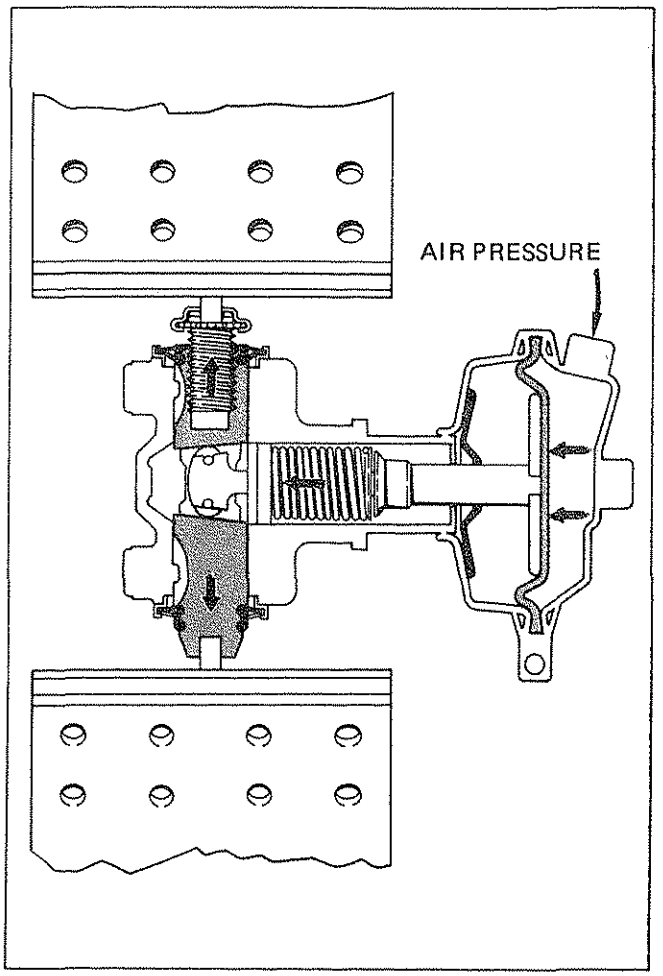


Fig. 4, Typical Wedge Service Brake Assembly In The "On" Position, Sectional View

3. Manually release (power deactivate) the spring brake section by turning the release bolt *COUNTERCLOCKWISE,* using a 3/4 inch wrench (see Fig. 5), until it has extended approximately 1 3/4 inches (44 mm). Do not apply more than 30 ft-lbs (41 N·m) to the release bolt.

NOTE: 80-90 psi (551-620 kPa) air pressure applied to the spring brake air ports will make it easier to unscrew the release bolt. Apply air pressure by releasing the parking brakes.

4. After manual release of the parking brake is completed, exhaust the air pressure from the brake chamber using the parking brake control valve in the cab.

POWER SPRING MANUAL RESET (PARKING BRAKE RESET)

1. If the release bolt threads are dry, coat them with a light film of low temperature moly-type grease.

2. With air pressure applied to the spring brake section (the parking brake control valve is in the "release" position), turn the release bolt *CLOCKWISE* to bottom. See Fig. 5. Tighten to

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

a maximum of 30 ft-lbs (41 N·m). *DO NOT USE AN IMPACT WRENCH.*

3. Snap the breather cap in place. Regardless of the position in which the brake chambers are installed, the drain tab arrow on the breather cap must be pointed down. See Fig. 6.

   The breather cap should be checked periodically. If dirty or clogged, a new breather cap must be installed. Refer to the 12 Group of the Freightliner Maintenance and Lube Manual for maintenance intervals.

CAUTION: If a breather cap is missing or incorrectly installed, road contaminants can adversely affect the operation of the brake chambers. Once inside the chambers, these contaminants cause deterioration of the internal components, thus shortening their lives. Operating the unit without the breather cap in place will void the MGM warranty.

4. Remove the chock blocks from the vehicle tires.

SERVICE BRAKE AND SPRING BRAKE CHAMBERS REMOVAL AND INSTALLATION

Removal (Refer to Fig. 2)

1. Perform all steps given under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

2. Disconnect the air lines at the brake chambers.

3. Using a spanner wrench or flat-end punch, loosen the spanner nut and unscrew the brake chamber(s) from the foundation brake housing. See Fig. 7. (If available, use a spanner nut wrench in place of the punch. See Fig. 8.) Spin off the unit.

NOTE: If the spanner nut is damaged or worn, replace with a new, original equipment nut.

Installation (Refer to Fig. 2)

1. If installing new tandem brake chambers, make sure the power spring is caged before installing (bolt screwed out). For instructions, refer to the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

NOTE: Before installing new tandem brake chambers, make sure the unit has the proper tube length and is the proper unit for the brake foundation on the vehicle. Refer to the current "MGM Master Catalog (Spring Parking Brakes)" for the correct part numbers.

   Screw the brake chamber(s) into the brake spider until the tube bottoms. Rotate the assembly *COUNTERCLOCKWISE* to align the ports, but not over 360 degrees.

2. Tighten the spanner (locking) nut with a spanner wrench or flat-end punch, then apply 90 psi (620 kPa) air pressure to the service brake air port and further tighten the nut to a minimum of 150 ft-lbs (203 N·m).

3. Insure that the air hose fittings are free of grease, dirt, or other debris. Then, apply

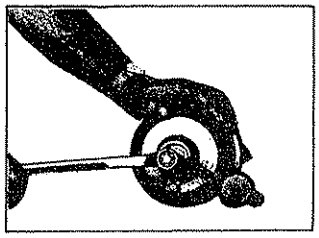


Fig. 5

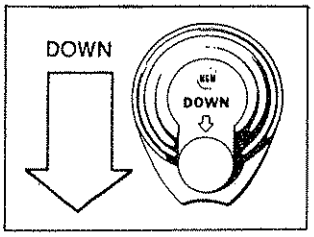


Fig. 6, Breather Cap Position

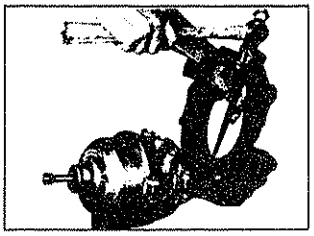


Fig. 7

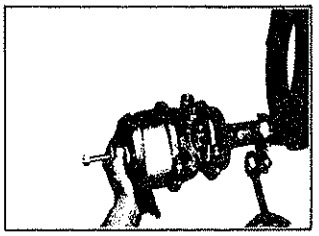


Fig. 8

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

Loctite 242 sealant, or an equivalent, to the fittings, and install. Tighten the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.* Install the air hoses.

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

4. Check for air leaks by performing the leakage tests given in the 12 Group of the Freightliner Maintenance and Lube Manual.

5. Perform all steps given under the heading, "POWER SPRING MANUAL RESET (PARKING BRAKE RESET)," in this subject.

SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT

1. Perform all steps given under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

2. Disconnect the air lines at the brake chambers.

3. Remove the service chamber (bottom) clamp band, as shown in Fig. 9. Then, lift the spring brake assembly (or pressure cap) off the non-pressure chamber assembly. See Fig. 10. Remove the service brake diaphragm.

4. Make sure a new spring brake unit has its power spring caged before installing (bolt screwed out). For instructions, refer to the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

   Install the spring brake assembly (or cap) on the non-pressure chamber assembly with the service brake diaphragm between the two components. See Fig. 10. Check that all sealing surfaces are free of grease and dirt.

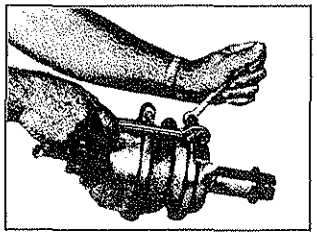


Fig. 9

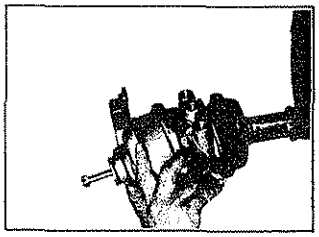


Fig. 10

5. Install the clamp band. Tighten the clamp band nuts to 15-20 ft-lbs (20-27 N·m). Tap the clamp band with a hammer to seat properly, then retorque to 15-20 ft-lbs (20-27 N·m).

6. Insure that the air hose fittings are free of grease, dirt, or other debris. Then, apply Loctite 242 sealant, or an equivalent, to the fittings, and install. Tighten the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.* Install the air hoses.

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

7. Check for air leaks by performing the leakage tests given in the 12 Group of the Freightliner Maintenance and Lube Manual.

8. Perform all steps given under the heading, "POWER SPRING MANUAL RESET (PARKING BRAKE RESET)," in this subject.

SPRING BRAKE DIAPHRAGM REPLACEMENT

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

1. Perform all steps given under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

2. Disconnect the air lines at the brake chambers.

3. Remove the service chamber (bottom) clamp band assembly. Then, lift the spring brake

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

assembly off the non-pressure chamber assembly. See Fig. 10. Remove the service brake diaphragm.

IMPORTANT: Before further disassembly, place the spring brake in a two ton minimum shop press with a minimum 8 inches (203 mm) of relaxing stroke available after light tension is taken up on the head by the press ram. A heavy iron or steel barred shield, or equivalent, should be placed between the operator and the spring brake assembly during disassembly. See Fig. 11.

WARNING: Failure to perform the safeguards above prior to spring brake chamber disassembly creates a hazardous workshop environment. Accidental sudden release of the power spring will cause spring brake components to be hurled with dangerous force; these components could strike persons in the area and cause serious personal injury. Under no circumstances should a spring brake chamber assembly be disassembled without first performing the safeguards described above.

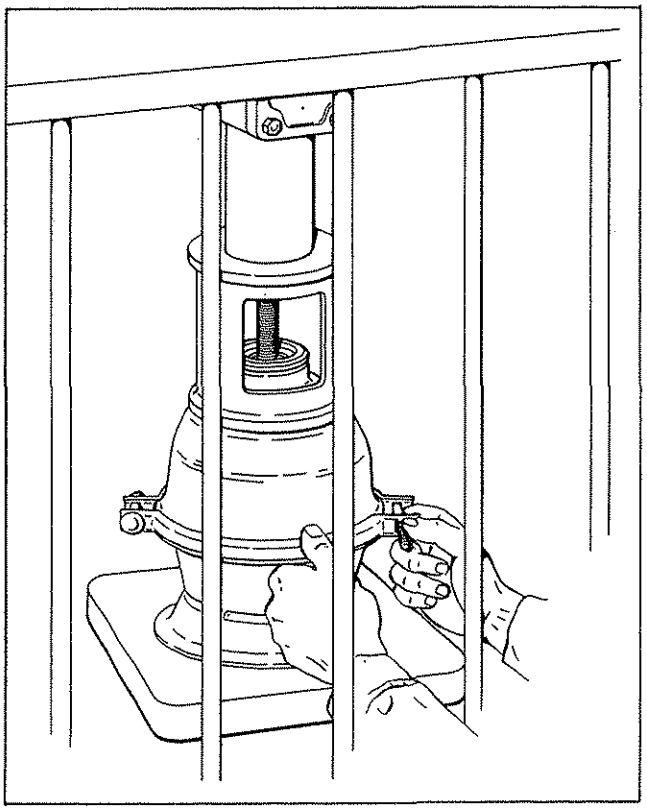


Fig. 11

4. Using a "slit-tube" and "flat-plate" (shown in Fig. 11), apply 2,000 lbs (900 kg) maximum force to compress the unit in an axial direction.

5. Remove the spring brake chamber clamp band bolt nuts and the clamp band while maintaining a constant force with the press. See Fig. 12.

6. Slowly relax pressure on the shop press until the spring brake section can be separated and the spring brake diaphragm can be removed.

WARNING: If tension remains between the ram and the brake chamber, either the unit is not manually released or a failure has occurred in the release mechanism. If the unit is released but pressure is present, continue to relax the press slowly until the spring is fully extended and all parts fall free.

7. Lift off the spring brake head assembly with caution as the power spring is caged between the piston and the head. See Fig. 13.

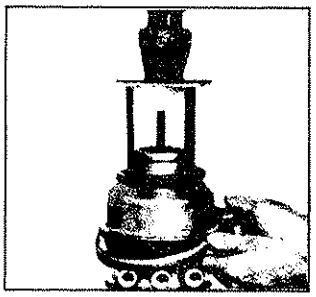


Fig. 12

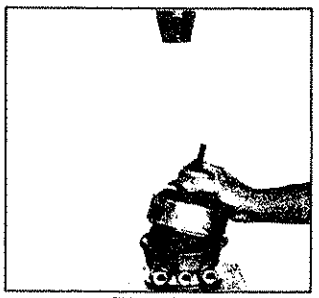


Fig. 13

8. Remove the spring brake diaphragm. While the diaphragm is removed, inspect the inside of the flange case, return spring, pushrod plate, screw and guide rings. If service is required on any of these parts, refer to the heading, "PUSHROD SEAL REPLACEMENT," in this subject.

9. Replace the old diaphragm with a new diaphragm. Place the new diaphragm in the spring chamber head and install onto the flange case.

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10. To reassemble the unit, reverse the disassembly procedure. Tap the clamp band all the way around when tightening the clamp band bolt nuts to insure proper seating (tighten the nuts to 15-20 ft-lbs [20-27 N·m]). After seating with the hammer, retorque to 15-20 ft-lbs (20-27 N·m).

11. Perform steps 4 through 8 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

POWER SPRING REMOVAL AND INSTALLATION

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

Removal

1. Perform steps 1 through 3 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

2. *CHECK FOR A BROKEN POWER SPRING.* Tighten the spring brake clamp band bolt nuts to 15-20 ft-lbs (20-27 N·m) torque and inspect the clamp band to insure it is evenly seated around the spring chamber. Then, screw the release bolt all the way into the unit to release the power spring. Vigorously shake the assembly. Noticeable "rattling" from within the head end of the assembly normally confirms a broken power spring. Further evidence would be revealed by only light resistance when screwing the release bolt down.

3. Even though a broken power spring may have been confirmed, make sure that the spring brake section is completely power-deactivated (that is, the release bolt is completely screwed out).

IMPORTANT: Before further disassembly, place the spring brake in a two ton minimum shop press with a minimum 8 inches (203 mm) of relaxing stroke available after light tension is taken up on the head by the press ram. A heavy iron or steel barred shield, or equivalent, should be placed between the operator and the spring brake assembly during disassembly. See Fig. 11.

WARNING: Failure to perform the safeguards above prior to spring brake chamber disassembly creates a hazardous workshop environment. Accidental sudden release of the power spring will cause spring brake components to be hurled with dangerous force; these components could strike persons in the area and cause serious personal injury. Under no circumstances should a spring brake chamber assembly be disassembled without first performing the safeguards described above.

4. Using a "slit-tube" and "flat-plate" (shown in Fig. 11), apply 2,000 lbs (900 kg) maximum force to compress the unit in an axial direction.

5. While maintaining a constant 2,000 lbs (900 kg) force on the ram on the plate, remove the clamp nuts. See Fig. 11.

6. Remove the clamp ring and very slowly relax pressure on the ram. At this point, there should be no outward pressure from within the chamber and the ram and plate should separate almost at once; if they do, continue disassembly with step 7, below.

WARNING: If tension remains between the ram and the plate, either the unit is not manually released or a failure has occurred in the release mechanism. If the unit is released but pressure is present, continue to relax the press slowly until the power spring is fully extended and all parts fall free.

7. Lift off the head assembly, as shown in Fig. 13. Treat this assembly with caution as the power spring is caged between the piston and the head.

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8. Remove the spring brake diaphragm; replace with a new part, if necessary. While the diaphragm is removed, inspect the inside of the flange case, and also inspect the return spring, pushrod plate, screw, and guide rings. If service is required on any of these parts, refer to the heading, "PUSHROD SEAL REPLACEMENT," in this subject.

9. Using a 1/8 inch diameter punch, knock out the lockpin in the release bolt; make sure the release bolt is supported. See Fig. 14. Then, remove the release nut.

10. Insert the head assembly in the press as shown in Fig. 15. It is important to position one 4-5 inch (100-125 mm) diameter slit-tube under the assembly supporting the piston and another one over the assembly between the head and the flat-plate under the press ram; without these tubes, the final safe disassembly cannot be accomplished. After the press ram touches the plate, the ram must be able to travel a minimum of 8 inches (203 mm) away from the assembly—without this length of travel available, the power spring will not completely relax.

11. Check the assembly for straight alignment in the press and apply 2,000 lbs (900 kg) force on the ram.

12. Using a screwdriver, pop off the piston plug in the center bottom of the piston. See Fig. 15.

13. While maintaining 2,000 lbs (900 kg) force on the ram, use a long, broad-bit screwdriver to unscrew the release bolt until it falls free. See Fig. 16.

14. With the release bolt removed, gradually relax the ram until the head loses contact with the press ram. See Fig. 17. Then, remove the head, as shown in Fig. 18.

15. After disassembly, all parts should be thoroughly washed in clean solvent and visually inspected for wear or damage, as instructed in the 12 Group of the Freightliner Maintenance and Lube Manual. Replace any parts that are worn or damaged.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

Installation (Refer to Fig. 2)

1. Prior to assembly of the spring brake chamber, apply a generous layer of moly-type grease to the inside of the head centerwell, the outside of the piston shank, the inside of the piston shank, and to the release bolt.

2. Place the slit-tube on the press base and position the parts on top in the following order: piston, thrustwasher, spring, thrustwasher, and head, followed by the second slit-tube and the flat-plate. See Fig. 19.

3. Check the straight up-and-down alignment of all parts and then, standing to the side of the

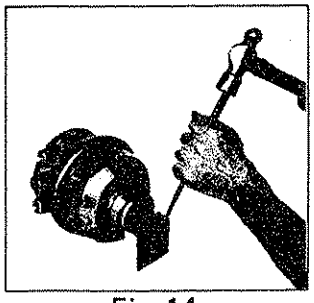
Fig. 14

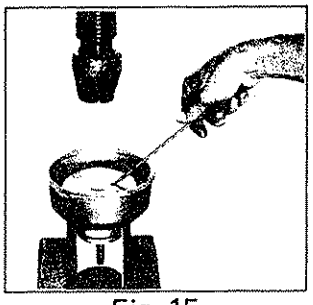
Fig. 15

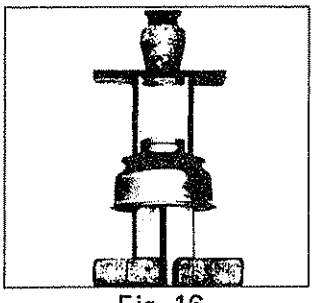
Fig. 16

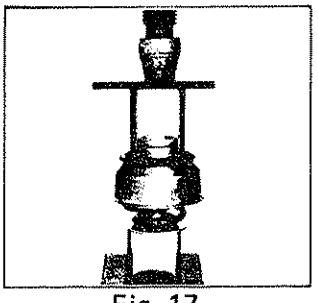
Fig. 17

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

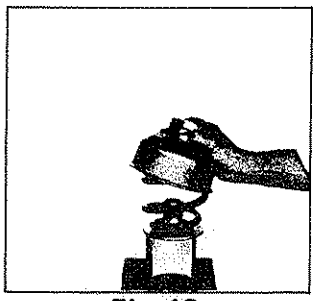

Fig. 18

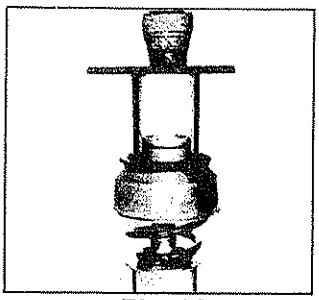

Fig. 19

press, take up tension very slowly on the ram. See Fig. 17. Check the alignment continually as straight-in reassembly is important. If misalignment occurs, relax the press, adjust component alignment, and begin the compression of the power spring again.

4. With the power spring completely compressed between the piston and the head (and with the piston bottomed up inside the head), place the release bolt up through the piston shank. Screw the bolt in until approximately 2 1/2 inches (64 mm) of the bolt extends through the head insert.

5. Relax tension on the ram slowly until the parts separate from the ram.

6. Remove the head assembly from the press and install the release nut on the release bolt. Lock in place with the lockpin. See Fig. 14.

7. Place a new piston plug in the center hole of the piston. Firmly tap the center of the plug with a hammer so it moves over center to a flat attitude. (Hammer flat only.)

8. Install the spring brake diaphragm. Place the diaphragm in the spring brake chamber head and install onto the flange case.

9. To reassemble the unit, reverse the disassembly procedure. Tap the clamp band all the way around when tightening the clamp band bolt nuts to insure proper seating (tighten the clamp band bolt nuts to 15-20 ft-lbs [20-27 N·m]). After seating with the hammer, retorque to 15-20 ft-lbs (20-27 N·m).

10. Perform steps 4 through 8 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

PUSHROD SEAL REPLACEMENT

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

1. Under the heading, "POWER SPRING REMOVAL AND INSTALLATION," perform all steps under the subheading, "REMOVAL."

2. Before the seal can be removed, first remove the pushrod screw, plate, and rod. The pushrod screws are assembled with Loctite and are difficult to remove.

   Removal of the pushrod screw is easiest if it is heated with a propane torch (see Fig. 20) until it can be turned freely with a screwdriver. First, tighten the handle of a Phillips-head screwdriver in a vise, with the blade accessibly extended outward. Heat one screw for approximately 30 seconds. Then, hold either screw into the blade of the screwdriver locked by the

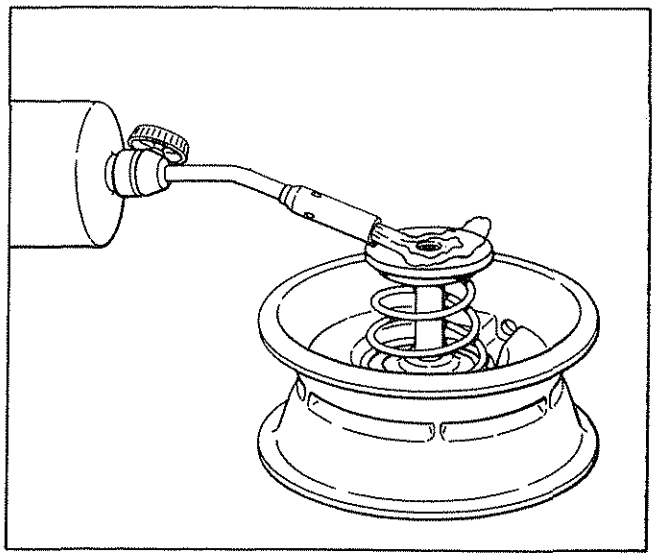

Fig. 20

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

vise. With a second screwdriver, loosen and remove the opposite screw as illustrated in Fig. 21.

IMPORTANT: Hold the case tight against the locked screwdriver and slowly remove pressure after the screw is removed. This will prevent the return spring shown in Fig. 20 from releasing suddenly. All the parts may now be removed from the case.

WARNING: Use gloves while handling parts as they will be hot from the propane torch.

3. Wash all parts thoroughly in clean solvent.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

4. Remove the guide rings (see Fig. 22) and the pushrod seal. This seal can best be removed by inserting a small bladed screwdriver behind the seal in the groove (see Fig. 23) and very carefully prying the seal out of the groove.

5. Clean the seal groove in the flange case. Next, lubricate the groove and the new seal with a moly-base grease. Then, install the seal into the groove. To insure the seal is firmly seated, run a smooth tool around the seal I.D. At the same time, apply outward force.

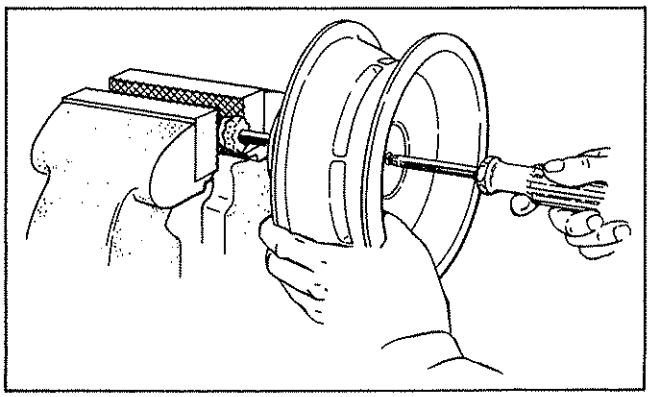

Fig. 21

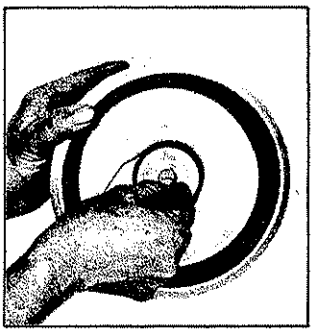

Fig. 22

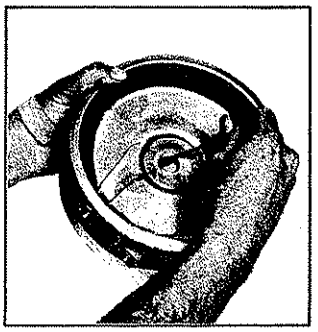

Fig. 23

6. Replace with new guide rings on both sides of the seal. See Fig. 22. The widest flange side always faces away from the seal.

7. If both plates had been removed from the pushrod, assemble the smaller plate onto the rod first. Thoroughly clean and dry all screw threads and the pushrod threaded holes. Apply Loctite to the screw threads, and tighten to 10 ft-lbs (14 N·m).

8. Insert the pushrod with the small plate carefully through the seal to prevent seal damage. Install the return spring in the case, place the return spring guide on the end of the pushrod and compress the spring with the large pushrod plate. The screw holes in the plate return spring guide and pushrod must be aligned; then, install the screw. Again, be sure the threads are clean and dry before applying Loctite to the screw threads.

IMPORTANT: The screws holding the two plates to the pushrod must be tightened to 10 ft-lbs (14 N·m). The screws can be tightened by using the same procedure described in step 2, above.

9. Check the alignment of the return spring to insure it is biased straight between the flange case and the large pushrod plate. Straightness is important for positive sealing.

10. Inspect the diaphragm before further assembly, and replace if worn, damaged, or more than one (1) year old.

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

11. Under the heading, "POWER SPRING REMOVAL AND INSTALLATION," perform all steps under the subheading, "INSTALLATION."

PERIODIC MAINTENANCE AND INSPECTION OF PARTS

Periodic maintenance of the brake chambers is required. In addition, whenever the brake chambers are disassembled (including diaphragm replacement), the parts should be inspected for damage. For maintenance schedules and procedures, and for inspection of brake chamber parts, refer to the 12 Group of the Freightliner Maintenance and Lube Manual.

TROUBLESHOOTING

Refer to the air brake system troubleshooting subject located in the 12 Group of this manual.

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES SUBJECT CONTENTS

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MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

GENERAL INFORMATION

MGM Magnum® tandem cam brake chambers consist of a service brake chamber and a parking/emergency spring brake chamber. See Fig. 1. When installed as tandem brake chambers, the service brake section is the lower (smaller) section near the yoke assembly. The Magnum® model is also available as a single brake chamber (service brakes only). See Fig. 2.

In the service brake section, the pressure cap (or, as on tandem brake chamber units, the cylinder case) and non-pressure chamber house a service return spring, a piston and rod assembly (also referred to as the service brake pushrod assembly), and service brake diaphragm.

In the parking/emergency brake section, the cylinder case and the head house a piston/main seal/felt wiper (or plastic guide ring) assembly, power spring, two thrustwashers, and a release bolt.

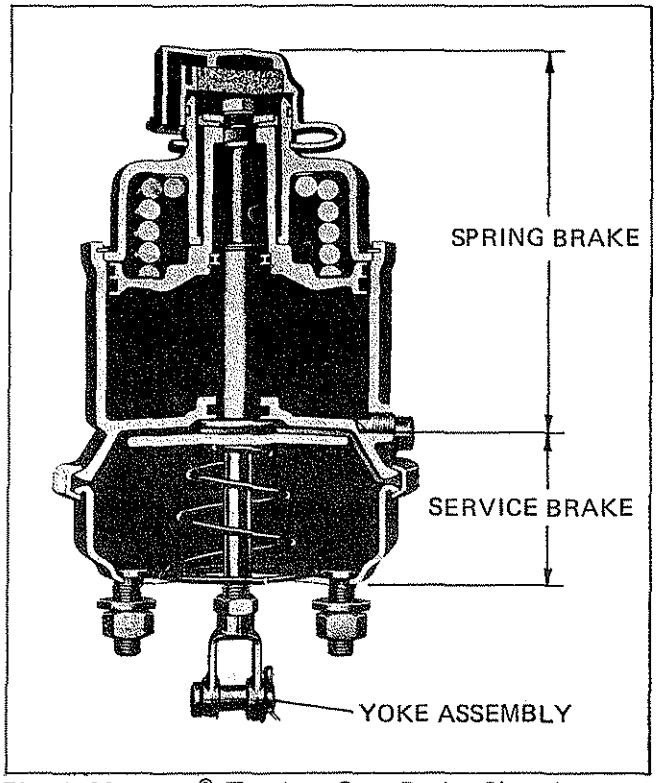


Fig. 1, Magnum® Tandem Cam Brake Chambers, Sectional View

PRINCIPLES OF OPERATION

SERVICE BRAKES

As the brake pedal is depressed, air pressure from the air reservoir enters the service brake chamber through the service brake air port. The air pressure acts upon the diaphragm which forces the piston and rod forward (toward the non-pressure chamber) applying force to the slack adjuster, which rotates the camshaft and applies the brakes.

As the brake pedal is released, air pressure is exhausted from the service brake chamber, and the return spring returns the diaphragm, piston and rod, and slack adjuster to their normal positions, releasing the brakes.

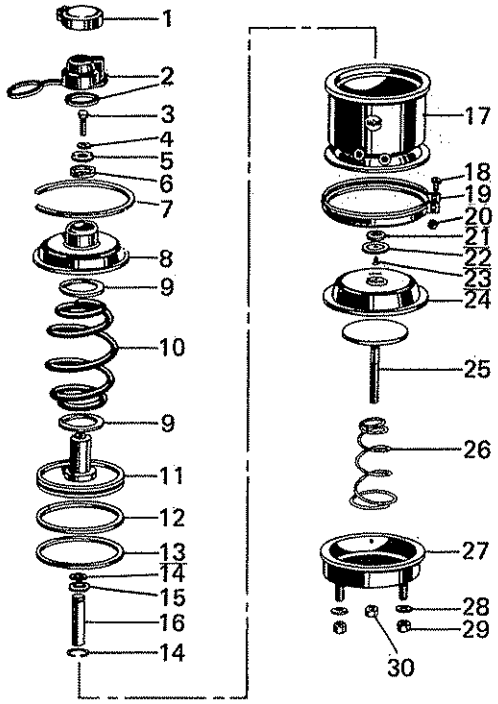
PARKING/EMERGENCY BRAKES

During parking brake release, air pressure enters the parking brake chamber and acts upon the piston and seal, which fully compresses the power spring. When the power spring is compressed, the parking brakes are released; the service brakes can then be operated at the brake pedal.

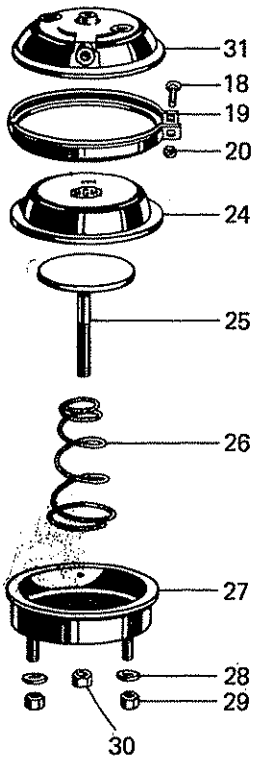
During parking brake application, air is exhausted from the parking brake chamber. The power spring releases, forcing the piston/main seal/felt wiper (or plastic guide ring) assembly forward (toward the service brake chamber). The resulting forward motion exerted on the pushrod assembly forces the service brake diaphragm and the service brake piston and rod assembly forward, thus applying the brakes.

Emergency brake application automatically begins when the air pressure in the brake system drops below approximately 80 psi (551 kPa). Full emergency brake application occurs when the air pressure drops below approximately 40 psi (276 kPa).

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES



SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS



SERVICE BRAKE CHAMBER

1. Breather Cap Assembly, Small
2. Breather Cap Assembly, Large
3. Release Bolt
4. Washer
5. Anti-Explosion Washer
6. Plastic Guide Washer
7. Snapring
8. Head
9. Thrustwasher
10. Power Spring
11. Piston
12. Felt Wiper (Or Plastic Guide Ring)
13. Main Seal
14. Snapring
15. Collar Assembly
16. Pushrod
17. Cylinder Case
18. Clamp Band Bolt
19. Clamp Band
20. Clamp Band Nut
21. Seal
22. Pushrod Plate
23. Screw
24. Diaphragm
25. Service Piston And Rod
26. Return Spring
27. Non-Pressure Chamber
28. Flatwasher
29. Mounting Stud Nut
30. Piston Rod Jam Nut
31. Pressure Cap

Fig. 2, Magnum® Cam Brake Chambers

SERVICE OPERATIONS

WARNING: If allowed to release uncontrolled during brake chamber disassembly, the power spring can forcibly hurl brake chamber components, posing a danger to persons in the area. Under no circumstances should tandem brake chambers be disassembled without first manually releasing the spring brake. Prior to disassembly operations of tandem brake chambers, always perform the procedures given under the heading, "SPRING BRAKE MANUAL RELEASE," in this subject.

SPRING BRAKE MANUAL RELEASE

1. Chock the vehicle tires.

2. Remove the breather cap from the spring brake chamber.

3. Manually release (power deactivate) the spring brake by turning the release bolt *COUNTER-CLOCKWISE* (using a 3/4-inch deep socket wrench), until the release bolt comes out completely. See Fig 3.

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NOTE: The release bolt does not capture the spring. It positions the piston shaft within the piston, and the spring power is transmitted by force on the piston through the release bolt to the piston shaft.

4. After manual release of the parking brake is completed, if not already done, exhaust the air pressure from the brake chamber using the parking brake control valve in the cab.

SPRING BRAKE MANUAL RESET

1. If the release bolt threads are dry, coat them with a light film of low temperature moly-type grease.
2. With air pressure applied to the spring brake section (the parking brake control valve is in the "release" position), turn the release bolt *CLOCKWISE* to bottom. See Fig. 3. Torque to 45-50 ft-lbs (61-68 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.*
3. Snap the breather cap in place with the arrow on the breather cap pointing to the ground. Regardless of the position in which the brake chambers are installed, the drain tab arrow on the breather cap must be pointed down. See Fig. 4.

NOTE: Brakes can be adjusted with the parking brakes released.

The breather cap should be checked periodically. If dirty or clogged, the filter element should be replaced. Refer to the 12 Group of the Freightliner Maintenance and Lube Manual for maintenance intervals.

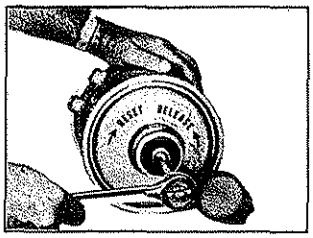

Fig. 3

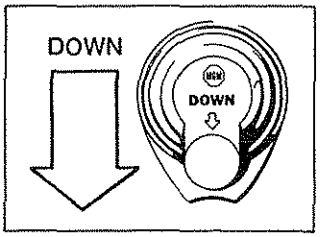

Fig. 4, Breather Cap Position

CAUTION: If a breather cap is missing or incorrectly installed, road contaminants can adversely affect the operation of the brake chambers. Once inside the chambers, these contaminants cause deterioration of the internal components, thus shortening their lives. Operating the unit without the breather cap in place will void the MGM warranty.

4 Remove the chocks from the vehicle tires.

SERVICE BRAKE AND SPRING BRAKE CHAMBERS REMOVAL AND INSTALLATION

Removal

1. Perform all steps given under the heading, "SPRING BRAKE MANUAL RELEASE," in this subject.
2. Disconnect the air lines at the brake chambers.
3. Remove the brake chambers from the vehicle as follows:

   .1 If replacing the service brake section with a new replacement, loosen the piston rod jam nut (Fig. 2, Ref. 30).

   .2 Remove the cotter pin from the yoke pin, then remove the yoke pin from the yoke. Disconnect the yoke from the slack adjuster.

   .3 Remove the nuts and washers from the mounting studs. See Fig. 5. Then, remove the brake chamber from the mounting bracket.

   .4 If replacing the service brake section with a new replacement, remove the yoke and the piston rod jam nut from the piston rod.

Installation

1. If installing new tandem brake chambers, make sure the release bolt is screwed out.

BRAKE CONTROL 12
32-12415

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

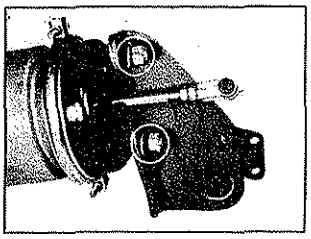

Fig. 5

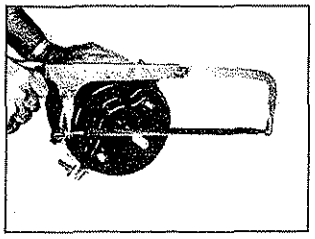

Fig. 6

2. Install the brake chamber on the mounting bracket, making sure the washers are on the outside of the bracket and not against the non-pressure chamber housing. See Fig. 5. Tighten the nuts finger-tight. Then, proceed as follows:

NOTE: If a new service brake chamber is being installed, make sure the piston rod and clevis are the correct length. MGM field service units are furnished with an 8-inch (203 mm) rod. Cut the rod to the same length as the rod on the old unit (with the spring brake section completely released). See Fig. 6. Then, attach the piston rod jam nut and the yoke to the piston rod. The new unit should have the release bolt screwed out to check comparable lengths.

.1 Connect the slack adjuster to the yoke. Then, install the yoke pin. Insert the cotter pin to lock the yoke pin in place. Lock the cotter pin. Make sure that the piston rod engagement with the yoke meets the specifications given in the 12 Group of the Freightliner Maintenance and Lube Manual.

.2 Tighten the mounting stud nuts to 100-115 ft-lbs (136-156 N·m). Then, tighten the piston rod jam nut to approximately 50 ft-lbs (68 N·m), if previously loosened.

3. Insure that the air hose fittings are free of grease, dirt, or other debris. Then, apply Loctite 242 sealant, or an equivalent, to the fittings and install. Torque the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.* Install the air hoses.

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

4. Perform all steps given under the heading, "SPRING BRAKE MANUAL RESET," in this subject.

5. Adjust the brakes. Also, perform the operating and leakage tests as instructed in the 12 Group of the Freightliner Maintenance and Lube Manual.

SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT

1. Perform steps 1 through 3 under the heading, "SPRING BRAKE MANUAL RELEASE," in this subject.

2. To facilitate disassembly, extend the service brake piston rod, either by using service brake air pressure, or manually, by pushing the slack adjuster. Use locking-jaw pliers to lock the service piston rod in place, as shown in Fig. 7.

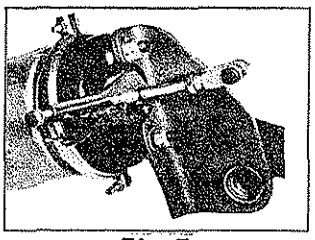

Fig. 7

After the locking-jaw pliers are applied, exhaust the air pressure from the brake chamber using the parking brake control valve in the cab.

3. Disconnect the air lines at the brake chambers.

4. Remove the clamp band. Then, lift the spring brake chamber (or pressure cap) off the non-pressure chamber. Remove the service brake diaphragm.

5. New single unit (spring brake chamber) should have its release bolt screwed out, as instructed under the heading, "SPRING BRAKE MANUAL RELEASE," in this subject.

   Install the spring brake chamber (or pressure cap) on the non-pressure chamber, with the

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

service brake diaphragm between the two components. Check that all sealing surfaces are free of grease and dirt.

6. Install the clamp band. Tighten the clamp band nuts (one- or two-piece clamp bands) to 20-25 ft-lbs (27-34 N·m). Tap the clamp band with a hammer to seat properly. Retorque the clamp band nuts to 20-25 ft-lbs (27-34 N·m).

7. Insure that the air hose fittings are free of grease, dirt, or other debris. Then, apply Loctite 242 sealant, or an equivalent, to the fittings, and install. Torque the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.* Install the air hoses.

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

8. Hold the service brake piston rod in place, either by using service brake air pressure, or by manually pushing the slack adjuster. Then, remove the locking-jaw pliers.

   Allow the return spring inside the service brake chamber to relax either by exhausting the air pressure in the chamber or by easing the pull on the service piston rod.

9. Check for air leaks by performing the leakage tests given in the 12 Group of the Freightliner Maintenance and Lube Manual.

10. Perform all steps given under the heading, "SPRING BRAKE MANUAL RESET," in this subject.

SPRING BRAKE DISASSEMBLY AND ASSEMBLY

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

Disassembly (Refer to Fig. 2)

1. Perform steps 1 through 4 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

IMPORTANT: If a broken power spring is suspected, confirmation can usually be made by screwing the release bolt all the way out of the unit and vigorously shaking the assembly. Noticeable "rattling" from within the head end of the assembly normally confirms a fractured spring.

2. If the spring brake chamber will hold air pressure, inject 85-100 psi (586-689 kPa) into the spring brake inlet from a shop air line. This pressure will raise the piston to the top of the head well and the anti-explosion washer can be unscrewed with a punch. See Fig. 8.

NOTE: If the unit is not capable of holding pressure due to damage or seal failure, the anti-explosion washer will have to be removed with a spanner-type wrench. See Fig. 9. After unscrewing, remove both the washer and the plastic guide washer from inside the head well.

3. If air pressure was used in step 2, above, release the pressure now, and disconnect the air line.

4. Turn the unit over, and remove the screw (see Fig. 10) holding the plate to the pushrod. If the screw resists removal, it may be necessary to grip the pushrod with padded pliers. See Fig. 11.

CAUTION: Do not damage the surface of the pushrod.

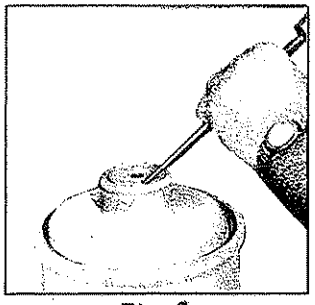

Fig. 8

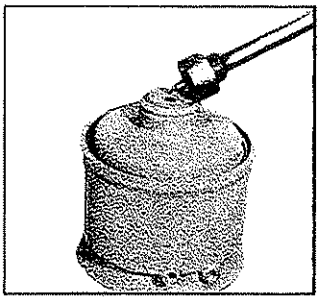

Fig. 9

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

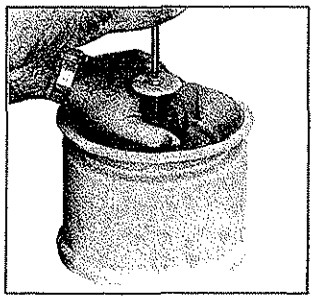

Fig. 10

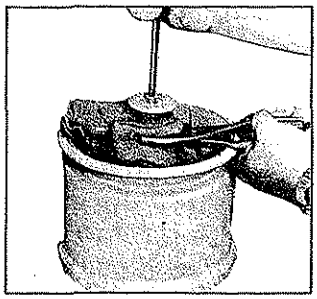

Fig. 11

5. Turn the unit over again and, using a knife or sharp scraping tool, remove all of the weather sealant covering the snapring which retains the head in the cylinder case. See Fig. 12.

IMPORTANT: Before further disassembly, place the spring brake in a two ton minimum shop press with a minimum 6 inches (152 mm) of relaxing stroke available after light tension is taken up on the head by the press ram. Position a piece of flat steel plate between the head and the ram. See Fig. 13. A heavy iron or steel barred shield, or equivalent, should be placed between the operator and the spring brake assembly during disassembly. See Fig. 14.

WARNING: Failure to perform the safeguards above prior to spring brake chamber disassembly creates a hazardous workshop environment. Accidental sudden release of the power spring will cause spring brake components to be hurled with dangerous force; these components could strike persons in the area and cause serious personal injury. Under no circumstances should a spring brake chamber assembly be disassembled without first performing the safeguards described above.

6. Take up light tension of the press ram on the head. Using a sharp pointed tool, find the notched end of the snapring, and remove the snapring from the groove in the cylinder case. See Fig. 15.

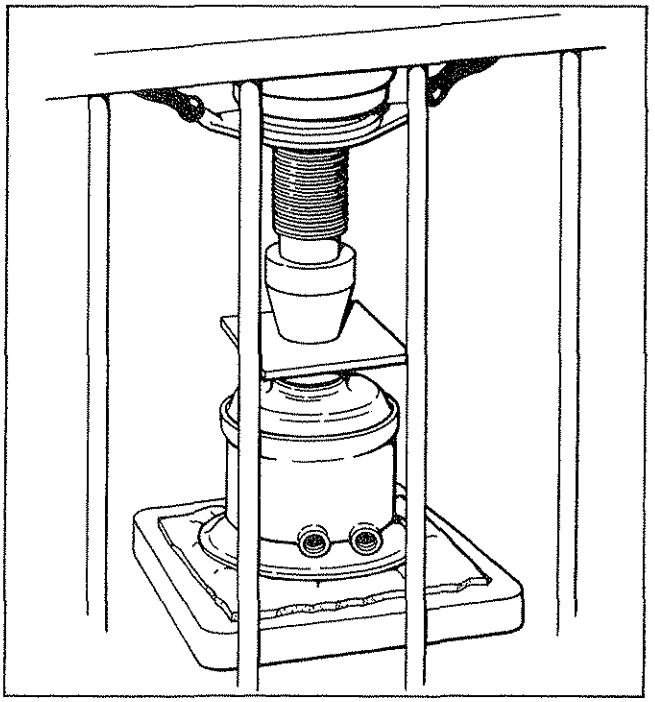

Fig. 14

7. Relax the press slowly. The power spring, if not broken, will push the head out of the cylinder case provided the weather sealant was removed properly. See Fig. 16.

CAUTION: The head may not move out of the case if a broken power spring was confirmed earlier. Even if the spring was confirmed to be broken, the following steps must be taken to further disassemble the unit:

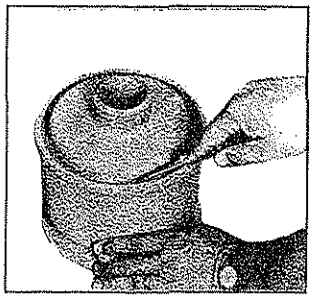

Fig. 12

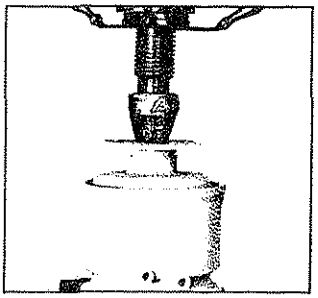

Fig. 13

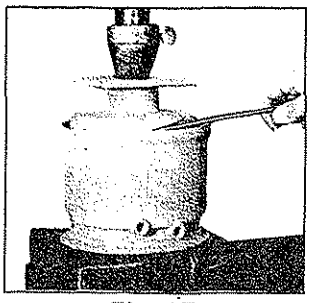

Fig. 15

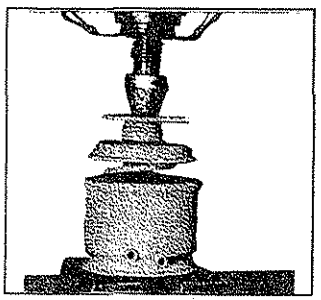

Fig. 16

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

.1 Check to see if any weather sealant is remaining on the side of the case above the snapring groove. The head could be hanging up on any such residue.

.2 Using two sharp-pointed tools and having no more than 1/4 inch (6.4 mm) clearance available between the end of the head and the press ram, attempt to pry-lift the head out of the cylinder case. See Fig. 17.

If the head lifts easily with no pressure against it, the ram can be relaxed and the head lifted off the assembly. If the head still resists upward movement, check for damage to the cylinder case above the snapring groove which could be interfering with the head removal. Do not remove the unit from the press but continue to pry-lift on the head until it begins to move out of the case.

8. Continue to relax the press slowly until the head is free from the press ram. See Fig. 18.

9. Remove the unit from the press and separate the head, thrustwashers, power spring, and cylinder case.

10. To remove the piston from the cylinder case, grasp the shank of the piston, and pull straight out. See Fig. 19.

11. To remove the pushrod from the piston, remove the snapring in the center bottom of the piston and pull the pushrod and seal collar out of the piston. See Fig. 20. If the pushrod and the seal collar resist removal, insert a straight rod or a screwdriver down into the threaded hole at the top of the piston shank and tap the rod to force the pushrod and seal collar out of their receiver hole.

12. Remove the piston seal from the groove on the piston. Remove the felt wiper from the upper groove.

NOTE: Later models will have a plastic guide ring in place of the felt wiper.

13. If the pushrod seal in the bottom of the cylinder case requires service, use a small screwdriver inserted into the groove and behind the seal to pry the seal out of its groove.

NOTE: Later models will have plastic guide rings over the seal groove lands. These are split-rings and easily removed.

14. Using clean solvent, carefully wash all parts.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

Grease and dirt accumulation outside the unit can be scraped or brushed off. On the inside of the unit, any accumulation of grease and dirt should be steam-cleaned off or gently rubbed off. Any light score marks on the cylinder case bore may be carefully smoothed with moist crocus cloth. (Heavy marks will require replacement of the case.) Inspect all parts for wear and damage, and replace as required.

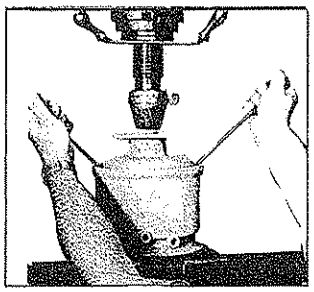

Fig. 17

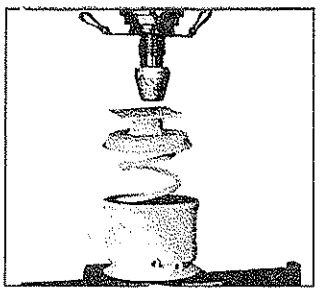

Fig. 18

Fig. 19

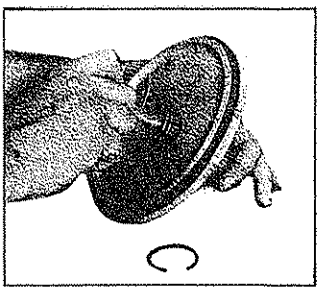

Fig. 20

BRAKE CONTROL 12
32-12415

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

Assembly (Refer to Fig. 2)

1. Lightly lubricate the pushrod seal and the inside of the seal groove in the cylinder case using MGM P/N 506 grease. Do not lubricate excessively. Replace the pushrod seal back into the groove in the cylinder case. See Fig. 21. Care must be taken during this operation not to damage the seal.

   After the seal is replaced, run your forefinger around the inner diameter of the seal to insure proper seating in the groove.

2. If the pushrod collar seal was removed from the piston for service, lubricate the hole in the piston bottom, lubricate the inside O-ring and the outside O-ring on the collar, and lubricate the tip of the threaded end of the pushrod. Press the collar seal, after replacing the pushrod through the collar, back into the piston centerline, and lock in place with the snapring.

3. Lightly lubricate both grooves on the piston. Replace the main seal into the bottom groove with the seal lips facing the same direction as the center pushrod. Generously lubricate the felt wiper on all four sides and gently stretch into the upper groove. Cut off any excess length so the ends will meet in the groove.

NOTE: Never reinstall a used felt wiper after disassembly; always replace a used part with a new part.

Later models will have a plastic guide ring in place of the felt wiper. Clean the guide ring, lightly lubricate, and replace it in the upper groove of the piston.

4. Press the pushrod back up into the piston shank with your hand, and lubricate the tip of the pushrod to assist during later assembly.

5. Using a clean brush or your hand, apply a thin coat of moly-type grease to the inside cylinder case walls. Do not grease to excess as this will only interfere with the ability of the seals to function properly. Walls should have 100 per cent coverage.

6. To reinstall the piston subassembly back into the cylinder case, start at a 45 degree angle (see Fig. 22), and carefully bring the piston to the center position in the cylinder case. See Fig. 23.

   With the piston face parallel to the cylinder case bottom face, press the piston down slowly so that the pushrod enters and passes through the pushrod seal in the cylinder case bottom. When interference of the pushrod and seal is felt, turn the cylinder case over to check the alignment from the bottom of the cylinder case. If mating is correct, continue to press the piston into the cylinder case until the piston bottoms on the bottom of the case.

7. Lubricate the exposed side of the piston and install the parts in the following order: thrustwasher, power spring, thrustwasher, and head. Place the subassembly in the press. See Fig. 18. A shield should be placed between the operator and the brake chamber during assembly, as shown in Fig. 14.

8. With all parts in straight alignment, take up tension on the press slowly. Alignment of the head-to-cylinder-case will have to be watched

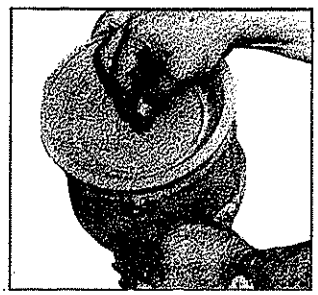
Fig. 21

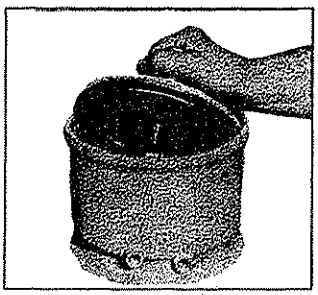
Fig. 22

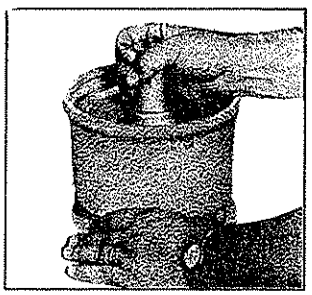
Fig. 23

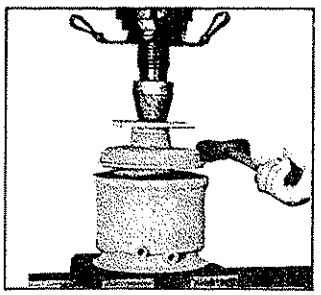
Fig. 24

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

carefully (see Fig. 16) to insure the head meets with the cylinder case properly. See Fig. 13. Continue to compress the head until the snapring groove appears just over the head lip. Slight sideways tapping may be required for mating of parts just as the head enters the case. See Fig. 24.

9. Replace the snapring and, using a punch (see Fig. 25), tap both ends of the snapring to insure complete seating all the way around the cylinder case groove. Visually inspect to double-check the proper seating before removing the unit from the press.

10. Relax the press slightly to make sure the head is retained in the cylinder case. After tension is completely removed from the head by the press ram, remove the assembly to a workbench for final reassembly and leak testing.

11. Insert a screwdriver (see Fig. 26) into the threaded piston hole, and press down while metering air pressure into the spring brake inlet port. Unless the screwdriver holds the pushrod down, the pushrod will be sucked into the cylinder case when the piston moves toward the head. Once the piston has risen within the head well the screwdriver may be removed.

12. Replace the plastic guide washer, and screw on the anti-explosion washer. Tighten the anti-explosion washer securely with a punch by reversing the direction shown in Fig. 8.

13. With the assembly still charged with 100-125 psi (689-861 kPa) air pressure, the following leak tests must be performed:

    .1 Place thumb partially over the release bolt hole, and squirt light oil over the remaining opening. See Fig. 27. If bubbles appear and persist, the pushrod collar seal is defective and will have to be serviced again.

    .2 Squirt light oil around the edge of the guide washer. See Fig. 28. If bubbles appear and persist, the main seal is defective or improperly installed and will have to be serviced again.

    .3 Turn the unit over and squirt light oil around the end of the pushrod. See Fig. 29. If bubbles appear and persist, the pushrod seal is defective and will have to be serviced again.

14. After leak tests are passed, exhaust the air pressure from the unit, and replace the pushrod plate. See Fig. 10. If the screw resists full bottoming, it may be necessary to grip the pushrod with padded pliers. See Fig. 11.

CAUTION: Do not damage the surface of the pushrod during this operation.

15. Reinstall the release bolt (with the washer in place under the head of the bolt). Screw the release bolt into the unit only 1/2 inch (13 mm) as the unit will not be reset until after installation on the vehicle.

16. With clean solvent, wash and remove all traces of oil or grease around the snapring area. Allow the solvent to completely dry off. Then, apply a covering bead of weatherproofing sealant

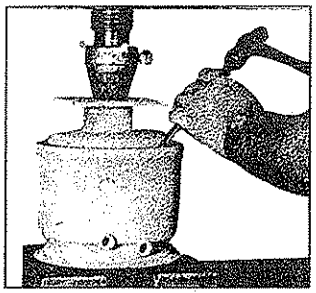

Fig. 25

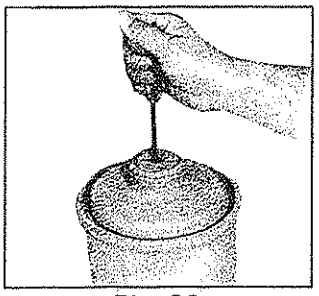

Fig. 26

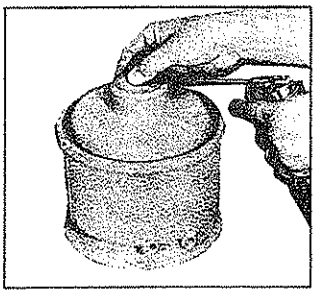

Fig. 27

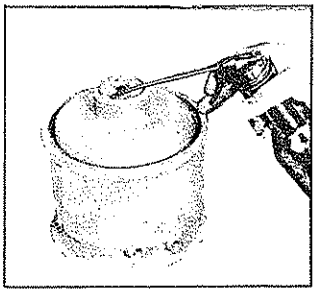

Fig. 28

MGM MAGNUM® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

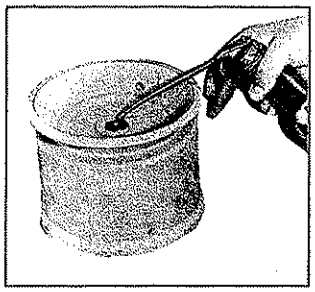

Fig. 29

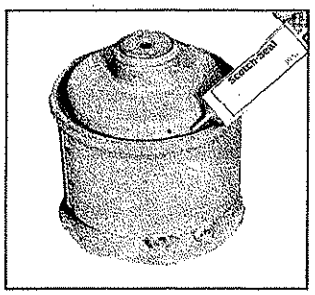

Fig. 30

(such as 3M No. EC-1814, or equivalent) over the snapring so that all joints between the head and the cylinder case are sealed. See Fig. 30.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

Allow the sealant to dry to a film condition.

17. Perform steps 5 through 10 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

PERIODIC MAINTENANCE AND INSPECTION OF PARTS

Periodic maintenance of the brake chambers is required. In addition, whenever the brake chambers are disassembled (including diaphragm replacement), the parts should be inspected for damage. For maintenance schedules and procedures, and for inspection of brake chamber parts, refer to the 12 Group of the Freightliner Maintenance and Lube Manual.

TROUBLESHOOTING

Refer to the air brake system troubleshooting subject located in the 12 Group of this manual.

MGM SHORTSTOP® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES SUBJECT CONTENTS

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TROUBLESHOOTING

MGM SHORTSTOP® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

GENERAL INFORMATION

MGM Shortstop® tandem wedge brake chambers (Fig. 1) consist of a service brake chamber and a parking/emergency spring brake chamber. When installed as tandem brake chambers, the service brake section is the lower (smaller) section near the brake spider. The Shortstop® model is also available as a single brake chamber (service brakes only). See Fig. 2.

In the service brake chamber, the service brake cap (or, as on tandem brake chamber units, the case) and non-pressure chamber assembly house a rubber boot, a piston and rod assembly, and a service brake diaphragm. See Fig. 2.

In the parking/emergency brake chamber, the case and the head house a piston and seal, power spring, and a release bolt. See Fig. 2.

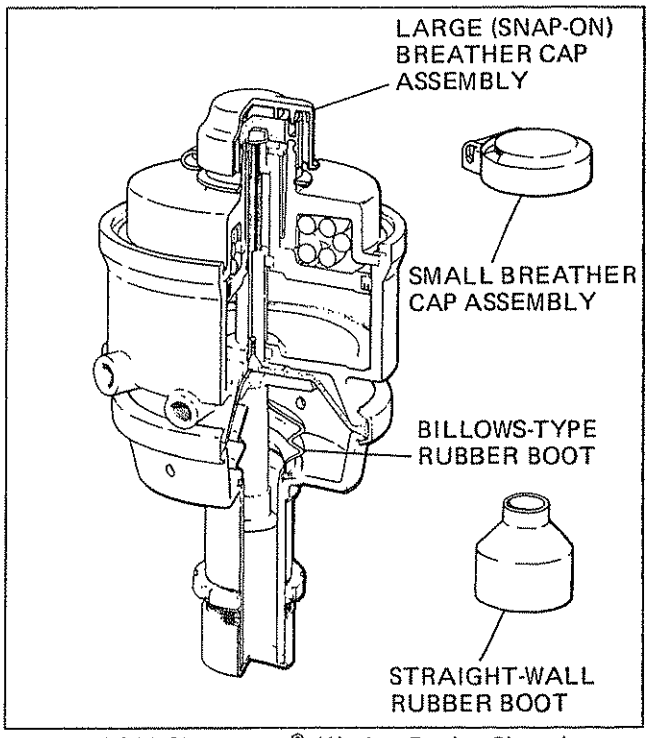


Fig. 1, MGM Shortstop® Wedge Brake Chambers, Sectional View

PRINCIPLES OF OPERATION

SERVICE BRAKES

As the brake pedal is depressed, air pressure from the air reservoir enters the service brake chamber through an air port. The air pressure acts upon the service brake diaphragm which forces the piston and rod assembly forward (toward the non-pressure chamber). Refer to Figs. 3 and 4.

The motion of the piston and rod assembly causes the steel wedge rod to move. The wedge-shaped tip of the rod is forced between two rollers, which are engaged in corresponding slots in the ends of two plungers. The unslotted portions of the inner ends of the plungers are resting on abutments in the plunger housing. The outer ends of the plungers are engaged with and supporting the brake shoes.

As the wedge head moves deeper between the rollers, the rollers and plungers are spread apart and push the brake shoes outward, against the brake drum.

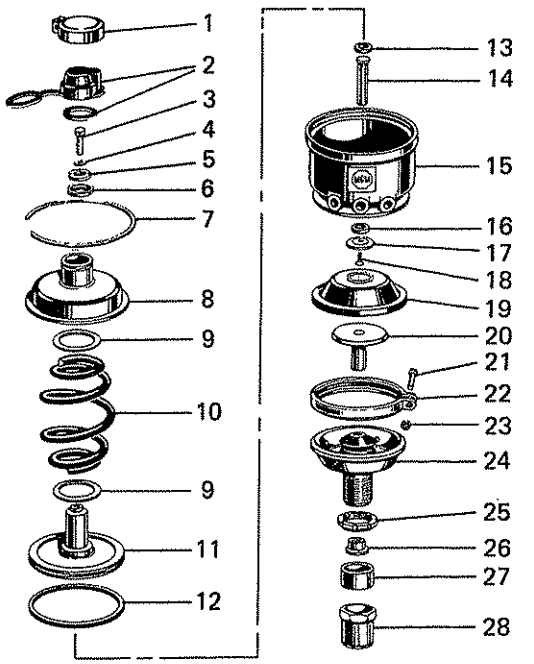
When the brake is released, air is exhausted from the service brake chamber, and the wedge spring returns the wedge rod and the service brake diaphragm to their normal (off) positions.

PARKING/EMERGENCY BRAKES

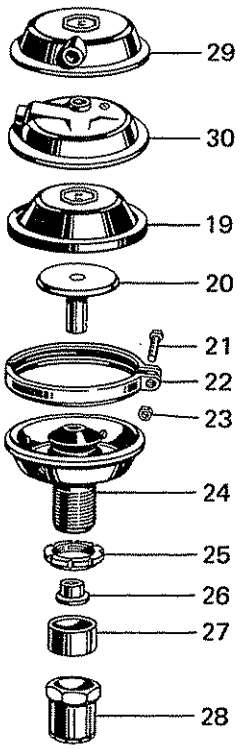
During parking brake release, air pressure enters the parking brake chamber and acts upon the piston and seal, which fully compresses the power spring. When the power spring is compressed, the parking brakes are released; the service brakes can then be operated at the brake pedal.

During parking brake application, air is exhausted from the parking brake chamber. The power spring releases, forcing the piston and seal forward (toward the service brake chamber). The resulting forward motion exerted on the pushrod assembly forces the service brake diaphragm and the service brake piston and rod assembly forward, thus applying the brakes.

MGM SHORTSTOP® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES



SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS



SERVICE BRAKE CHAMBER

1. Breather Cap Assembly (Small)
2. Breather Cap Assembly (Large)
3. Release Bolt
4. Washer
5. Anti-Explosion Washer
6. Plastic Guide Washer
7. Snapring
8. Head
9. Thrustwasher
10. Power Spring
11. Piston
12. Main Seal
13. Pushrod Seal
14. Pushrod
15. Case
16. Case Seal
17. Plate
18. Screw
19. Diaphragm
20. Service Piston And Rod Assembly
21. Clamp Band Bolt
22. Clamp Band
23. Clamp Band Nut
24. Non-Pressure Chamber And Rubber Boot
25. Spanner Nut
26. Wedge Guide (Used With Rockwell Foundation Brakes)
27. Protector
28. Collet Nut (Optional)
29. Cap (1 Port Type)
30. Cap (2 Port Type)

Fig. 2, MGM Shortstop® Wedge Brake Chambers

Emergency brake application automatically begins when the air pressure in the brake system drops below approximately 80 psi (551 kPa). Full emergency brake application occurs when the air pressure drops below approximately 40 psi (276 kPa).

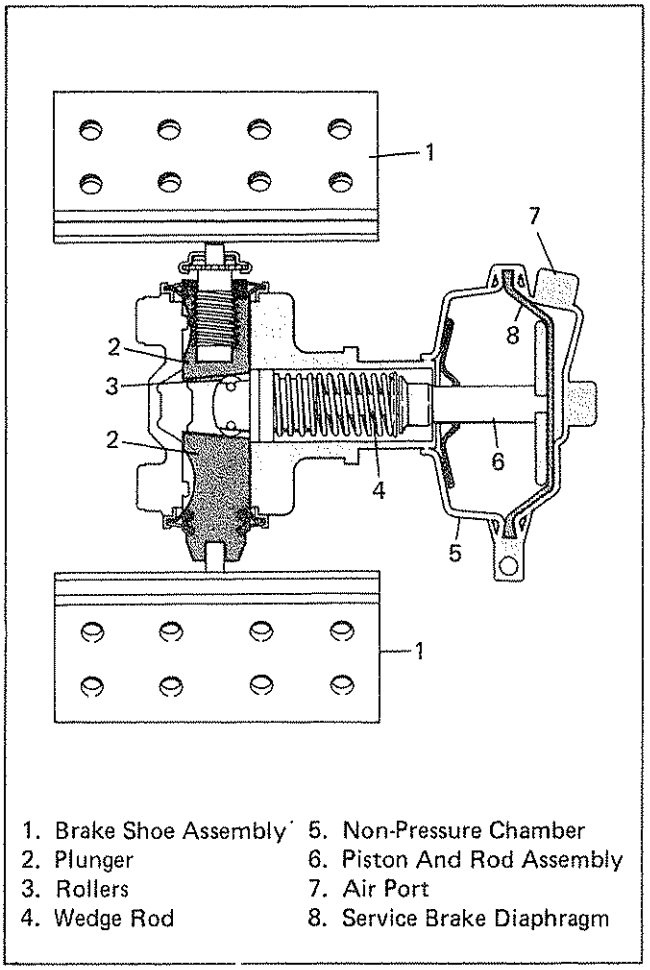
SERVICE OPERATIONS

WARNING: If allowed to release uncontrolled during brake chamber disassembly, the power spring can forcibly hurl brake chamber components, posing a danger to persons in the area. Under no circumstances should tandem brake chambers be disassembled without first manually releasing the spring brake. Prior to disassembly operations of tandem brake chambers, always perform the procedures given under the heading, "SPRING BRAKE MANUAL RELEASE," in this subject.

SPRING BRAKE MANUAL RELEASE

1. Chock the vehicle tires.
2. Remove the brake chamber breather cap.

MGM SHORTSTOP® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES



1. Brake Shoe Assembly
2. Plunger
3. Rollers
4. Wedge Rod
5. Non-Pressure Chamber
6. Piston And Rod Assembly
7. Air Port
8. Service Brake Diaphragm

Fig. 3, Typical Wedge Service Brake Assembly In The Off Position, Sectional View

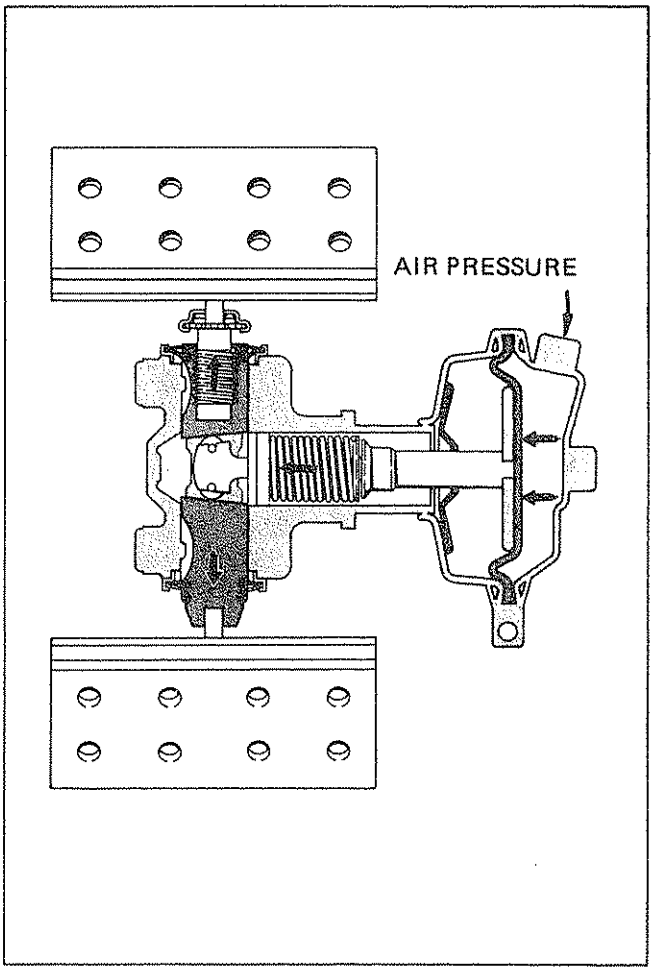


Fig. 4, Typical Wedge Service Brake Assembly In The On Position, Sectional View

3. Manually release (power deactivate) the spring brake chamber by turning the release bolt *COUNTERCLOCKWISE* using a 9/16-inch deep socket wrench, until the bolt screws out completely. See Fig. 5.

NOTE: The Shortstop® does not capture the spring. It positions the piston shaft within the piston and the spring power is transmitted by force on the piston through release bolt to piston shaft.

4. After manual release of the spring brake chamber is completed, if not already done, exhaust the air pressure from the brake chamber using the parking brake control valve in the cab.

SPRING BRAKE MANUAL RESET

1. If the release bolt threads are dry, coat them with a light film of low temperature moly-type grease.

2. With air pressure applied to the spring brake chamber air port (the parking brake control valve is in the "release" position), turn the

MGM SHORTSTOP® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

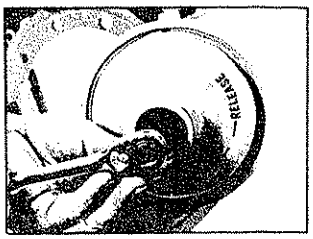


Fig. 5

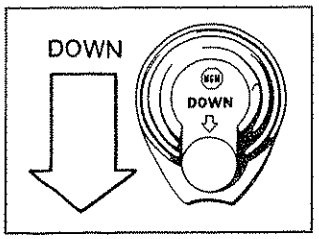


Fig. 6, Breather Cap Position

release bolt *CLOCKWISE* to bottom. See Fig. 5. Torque to 20-30 ft-lbs (27-41 N·m). *DO NOT USE AN IMPACT WRENCH.*

3. Install the breather cap in place. For snap-on breather caps, regardless of the position in which the brake chambers are installed, the drain tab arrow on the breather cap must be pointed down. See Fig. 6.

   The breather cap should be checked periodically. If dirty or clogged, the filter element should be cleaned or replaced, or a new breather cap installed. Refer to the 12 Group of the Freightliner Maintenance and Lube Manual for maintenance intervals.

CAUTION: If a breather cap is missing or incorrectly installed, road contaminants can adversely affect the operation of the brake chambers. Once inside the chambers, these contaminants cause deterioration of the internal components, thus shortening their lives. Operating the unit without the breather cap in place will void the MGM warranty.

4. Remove the chocks from the vehicle tires.

SERVICE BRAKE AND SPRING BRAKE CHAMBERS REMOVAL AND INSTALLATION

Removal (Refer to Fig. 2)

1. Perform all steps given under the heading, "SPRING BRAKE MANUAL RELEASE," in this subject.

2. Remove the air lines.

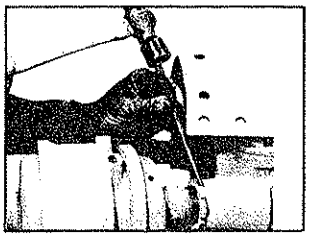


Fig. 7

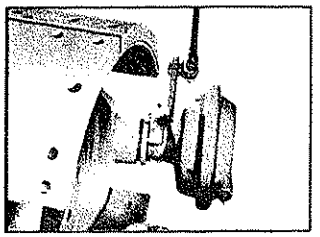


Fig. 8

3. Using a flat-end punch (Fig. 7), loosen the spanner nut, and unscrew the brake chamber from the foundation brake housing. If available, use a spanner nut wrench (Fig. 8) in place of the punch. Spin off the unit.

Installation (Refer to Fig. 2)

1. If installing new tandem brake chambers, make sure the unit has the release bolt screwed out.

NOTE: Before installing new tandem brake chambers, make sure the unit has the proper tube length and is the proper unit for the brake foundation on the vehicle. Refer to the current "MGM Master Catalog (Spring Parking Brakes)" for the correct part numbers.

2. Screw the brake chamber into the brake spider until the tube bottoms. Rotate the assembly *COUNTERCLOCKWISE* to align the ports, but not over 360 degrees.

3. Tighten the spanner (locking) nut, then apply 90 psi (620 kPa) air pressure to the service brake air port, and further tighten the nut to 150 ft-lbs (203 N·m). See Fig. 8.

4. Install the air lines, fittings, and tighten; insure that the fittings are free of grease, dirt, or other debris. Then, apply Loctite 242 sealant, or an equivalent, to the fittings. Torque the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.*

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

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5. Check for air leaks by performing the leakage tests given in the 12 Group of the Freightliner Maintenance and Lube Manual.

6. Perform all steps given under the heading, "SPRING BRAKE MANUAL RESET," in this subject.

SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT

1. Perform all steps given under the heading, "SPRING BRAKE MANUAL RELEASE," in this subject.

2. Disconnect all air lines leading to the brake chamber(s).

3. Using a 1/2-inch wrench, loosen the clamp band nut (see Fig. 9), and remove the clamp band bolt.

4. Holding the spring brake with one hand, spread the clamp band just enough to separate the spring brake from the service brake chamber. See Fig. 10.

5. When originally assembled at the MGM factory, the diaphragm was glued to the service brake piston. Peel the diaphragm off the piston and inspect the diaphragm for damage or wear.

6. Check to see the service piston and rod assembly is properly mated with the wedge assembly in the foundation brake housing. See Fig. 11.

7. Clean all inside surfaces of the service brake chamber and the diaphragm side of the spring brake chamber.

8. Inspect the boot in the service brake chamber, and replace, if damaged or worn. Replace the boot using the following instructions:

   .1 Remove the piston and rod assembly and the boot from the non-pressure chamber. Inspect the piston and rod assembly for damage or wear. Replace the part(s), as required.

   .2 Thoroughly clean the inside surfaces of the non-pressure chamber. Scrape away any old glue from around the mounting tube neck.

   .3 Apply MGM P/N 406 adhesive, or an equivalent, to the tube neck and to the base of the non-pressure chamber in the area of the tube only. See Fig. 12. Also apply a thin coat of adhesive to the bottom flange of the boot. Allow the adhesive on both parts to dry to a "tacky" condition.

   .4 Reposition the boot over the tube neck (see Fig. 13) making absolutely sure the boot is properly positioned and mated to the tube. Allow to dry for a minimum of two hours.

   .5 Install the piston and rod assembly through the centerhole in the boot, making sure the top head on the boot mates with the groove cut into the piston shaft. See Fig. 14. Early MGM models had the "straight-wall boot," shown in Fig. 1 and 14, while all present models have the "billows-type boot," shown in Fig. 1 and 13. These two parts are interchangeable.

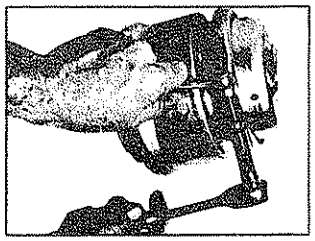

Fig. 9

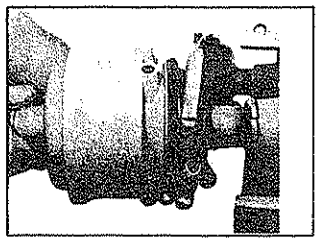

Fig. 10

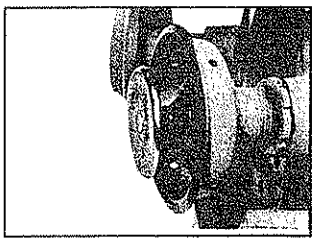

Fig. 11

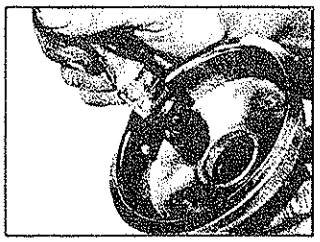

Fig. 12

MGM SHORTSTOP® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, WEDGE BRAKES

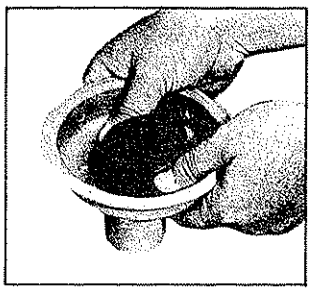

Fig. 13

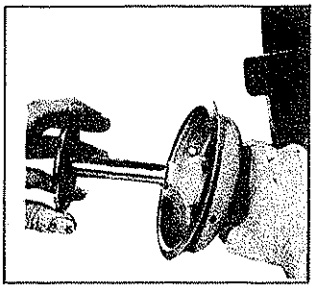

Fig. 14

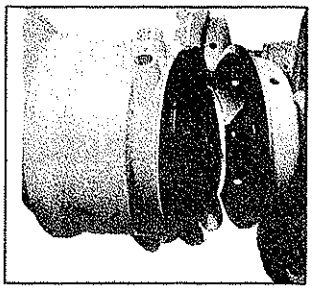

Fig. 15

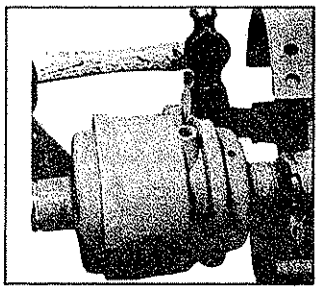

Fig. 16

NOTE: On chambers for Rockwell foundation brakes, the plastic wedge guide (see Fig. 2, Ref. 26) must be installed on the end of the piston shaft inside the mounting tube after mating the piston shaft with the boot.

9. Check to see the screw holding the plate to the spring brake pushrod is securely tight.

10. Lay the new diaphragm in the diaphragm-side of the spring brake, and place the unit back on the non-pressure chamber. See Fig. 15.

11. Spread the clamp band just enough to reposition over mating parts (see Fig. 10), and make sure the air inlets are positioned properly to reconnect the air lines.

12. Replace the clamp band bolt and secure with the nut. The acorn-side of this nut must face the clamp ear. See Fig. 9.

13. After initial tightening (15-20 ft-lbs [20-27 N·m]) of the clamp band nut, tap the circumference of the clamp band with a hammer (see Fig. 16) to insure proper seating of mating parts. Then, retighten the clamp band nut to 15-20 ft-lbs (20-27 N·m).

14. Reconnect the air lines to the proper inlets; insure that the fittings are free of grease, dirt, or other debris. Then, apply Loctite 242 sealant, or an equivalent, to the fittings. Torque the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.*

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

15. Check for air leaks by performing the leakage tests given in the 12 Group of the Freightliner Maintenance and Lube Manual.

16. Perform all steps given under the heading, "SPRING BRAKE MANUAL RESET," in this subject.

17. Actuate the service brake from the driver's seat several times to insure proper brake chamber operation.

18. With the spring brakes in the *PARK* position, check to make sure the spanner nut is securely tight (150 ft-lbs [203 N·m]). See Fig. 8.

19. After releasing the spring brake with air pressure, recheck the torque on the clamp band nut.

SPRING BRAKE DISASSEMBLY AND ASSEMBLY

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

Disassembly (Refer to Fig. 2)

1. Perform steps 1 through 4 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

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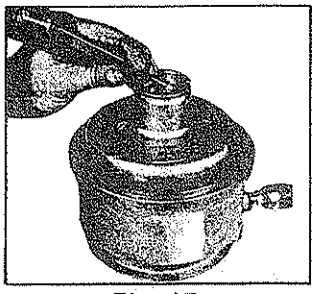

Fig. 17

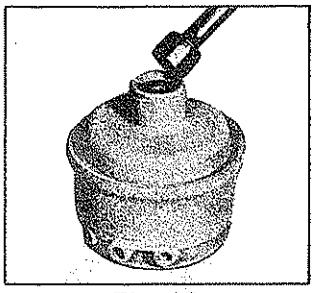

Fig. 18

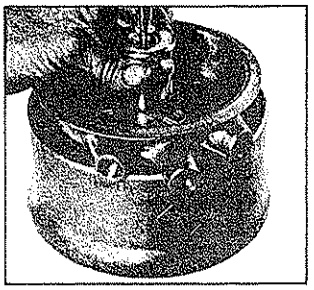

Fig. 19

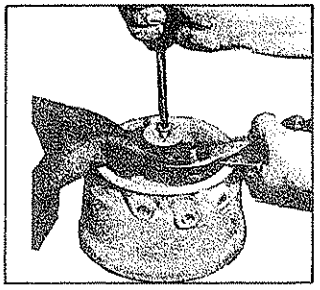

Fig. 20

2. Make sure the unit is manually released, and remove the release bolt and washer from the assembly.

3. *CHECK FOR A BROKEN POWER SPRING.* Vigorously shake the assembly. Noticeable "rattling" from within the head end of the assembly normally confirms a broken power spring.

4. If the spring brake will hold air pressure, inject 85-100 psi (586-689 kPa) into the spring brake inlet from a shop air line. This pressure will raise the piston to the top of the head well, and the anti-explosion washer can be unscrewed with a punch. See Fig. 17.

NOTE: If the unit is *NOT* capable of holding pressure due to damage or seal failure, the anti-explosion washer may have to be removed with a spanner-type wrench. See Fig. 18.

5. Remove both the washer and the plastic guide washer from the unit, and, if air pressure was used in step 4, release the pressure at this time, and disconnect the air line.

6. Turn the unit over, and remove the screw holding the plate to the pushrod. See Fig. 19. If the screw resists removal, it may be necessary to grip the pushrod with padded pliers. See Fig. 20.

CAUTION: Do not damage the surface of the pushrod.

7. Turn the unit over again, and, using a knife or sharp scraping tool, remove all of the weather sealant covering the snapring which retains the head in the case. See Fig. 21.

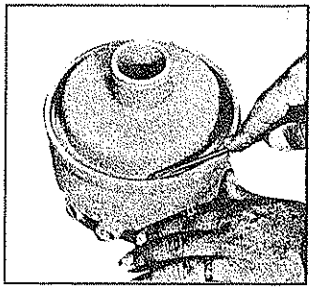

Fig. 21

IMPORTANT: Before further disassembly, place the spring brake in a two ton minimum shop press with a minimum 4 inches (102 mm) of relaxing stroke available after light tension is taken up on the head by the press ram. A heavy iron or steel barred shield, or equivalent, should be placed between the operator and the spring brake assembly during disassembly. See Fig. 22.

WARNING: Failure to perform the safeguards above prior to spring brake chamber disassembly creates a hazardous workshop environment. Accidental sudden release of the power spring will cause spring brake components to be hurled with dangerous force; these components could strike persons in the area and cause serious personal injury. Under no circumstances should a spring brake chamber assembly be disassembled without first performing the safeguards described above.

8. Take up light tension of the press ram on the head. Using a sharp pointed tool, find the notched end of the snapring and remove the snapring from the groove in the case. See Fig. 23.

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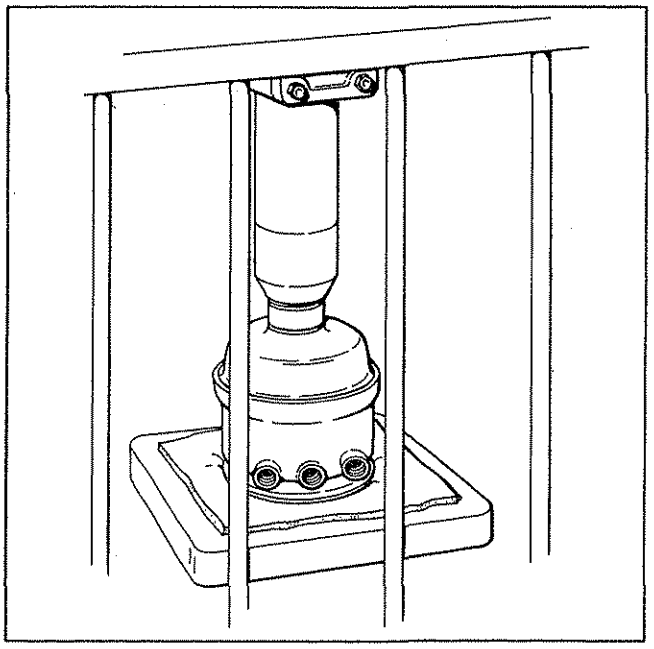

Fig. 22

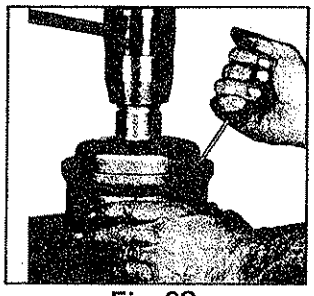

Fig. 23

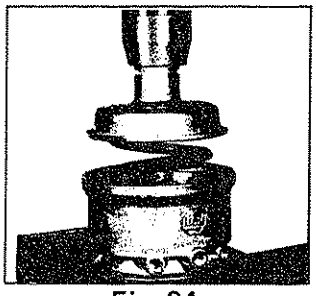

Fig. 24

9. Relax the press slowly. The power spring, if not broken, will push the head out of the case provided the weather sealant was removed properly. See Fig. 24.

CAUTION: The head may not move out of the case if a broken power spring was confirmed earlier. Even if the spring was confirmed to be broken, the following steps must be taken to further disassemble the unit:

.1 Check to see if any weather sealant is remaining on the side of the case above the snapring groove. The head could be hanging up on any such residue.

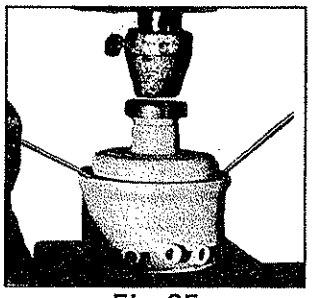

Fig. 25

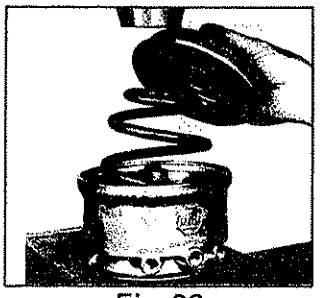

Fig. 26

.2 Using two sharp-pointed tools and having no more than 1/4 inch (6 mm) clearance available between the end of the head and the press ram, attempt to pry-lift the head out of the case. See Fig. 25. If the head lifts easily with no pressure against it, the ram can be relaxed and the head lifted off the assembly. If the head still resists upward movement, check for damage to the case above the snapring groove which could be interfering with the head removal. Do not remove the unit from the press but continue to pry-lift on the head until it begins to move out of the case.

10. Continue to relax the press slowly until the head is free from the press ram. See Fig. 26.

11. Remove the unit from the press and separate the head, thrustwashers, power spring, and case.

12. To remove the piston from the case, grasp the shank of the piston and pull straight out of the case.

13. Remove the main seal from the piston groove. To remove the pushrod from the piston in order to service the pushrod and/or the push-rod seal in the piston, clamp the piston in a vise and insert the screwdriver into the release bolt hole. At the same time as bending the pushrod out of the sealed hole, use the screwdriver to push on the head of the pushrod. See Fig. 27.

14. If the seal in the bottom of the case (or, the same seal in the bottom of the piston) requires replacement, use a small screwdriver inserted

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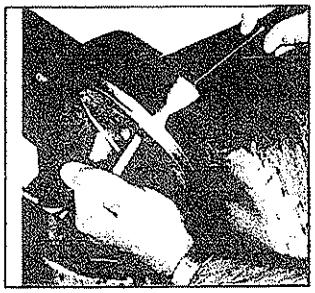

Fig. 27

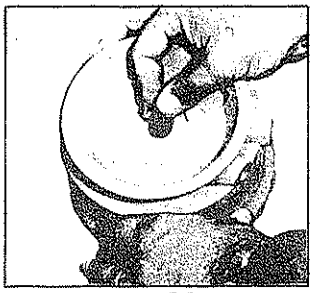

Fig. 28

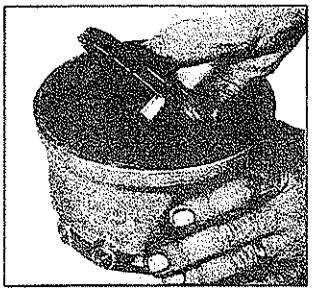

Fig. 29

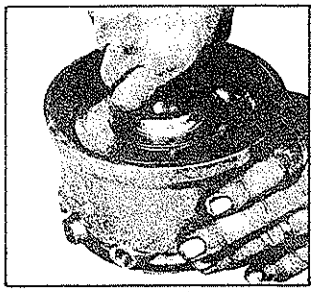

Fig. 30

into the groove behind the seal to pry out of the retaining groove. Use caution not to damage the machined sealing surfaces inside the seal groove.

15. Using clean solvent, carefully wash all parts.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

Grease and dirt accumulation outside of the unit can be scraped or brushed off. On the inside of the unit any accumulation should be steam-cleaned off or gently rubbed off. Any light score marks on the case bore may be carefully smoothed with moist crocus cloth. Heavy marks will require replacement of the case. Inspect all parts for wear and damage. Replace as required.

Assembly (Refer to Fig. 2)

1. Lightly lubricate the pushrod seal and the inside of the seal groove in the case with MGM P/N 506 grease, or equivalent. Do not lubricate excessively. Replace the pushrod seal back into the groove in the case. See Fig. 28. Care must be taken not to damage the seal.

   After the seal is replaced, run your forefinger around the inner diameter of the seal to insure proper seating in the groove.

2. If the seal in the bottom of the piston was removed, replace it by following the instructions in step 1, above. Then, lubricate the head end of the pushrod and work it back through the installed seal. After insertion, work the pushrod up and down to insure proper seating.

3. Lightly lubricate the groove on the outside of the piston. Replace the main seal in this groove.

4. Press the pushrod back up into the piston shank with your hand, and lubricate the tip of the pushrod to assist in later assembly.

5. Using a clean brush or your hand, apply a thin coat of grease to the inside case walls. Do not grease to excess as this will interfere with the ability of the seal to function.

6. To replace the piston subassembly back into the case, start at a 45 degree angle (see Fig. 29), and carefully bring the piston to the center position in the case. See Fig. 30. With the piston face parallel to the case bottom face, press the piston down slowly so that the pushrod enters and passes through the pushrod seal in the case bottom. When interference of the pushrod and seal is felt, turn the case over to check the alignment from the bottom side of the case. If mating is correct, continue to press the piston into the case until the piston bottoms on the bottom of the case.

7. Lubricate the exposed side of the piston and install the parts in the following order: thrustwasher, power spring, thrustwasher, and

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head. Place the subassembly in the press. See Fig. 26. It is recommended that a shield be placed between the operator and the brake chamber during assembly, as shown in Fig. 22.

8. With all parts in straight alignment, take up tension on the press slowly. Alignment of the head-to-case will have to be watched carefully (Fig. 24) to insure that the head mates properly with the case.

   Continue to compress the head until the snapring groove appears just over the head lip. Slight sideways tapping on the head may be necessary for mating of parts just as the head re-enters the case.

9. Replace the snapring, and, using a punch (see Fig. 31), tap both ends of the snapring to insure complete seating all the way around the case groove. Visually inspect to double-check uniform seating of the snapring.

10. Relax the press slightly to make sure the head is retained in the case. After tension is completely removed from the head by the press ram, remove the assembly to a workbench for final reassembly and leak-testing.

11. Insert a screwdriver (see Fig. 32) into the threaded piston hole and press down on the screwdriver while metering air pressure into the spring brake inlet. Unless the pushrod is held down with a screwdriver during this operation, it will be sucked into the case as the piston rises within the unit. Once the piston has risen to the top of the head, the screwdriver may be removed.

12. Replace the guide washer and screw on the anti-explosion washer. Tighten the anti-explosion washer securely with a punch. See Fig. 17.

13. With the assembly still charged with a minimum 100 psi (689 kPa) air pressure, the following leak tests must be conducted:

    .1 Place thumb partially over the release bolt hole and squirt light oil over the remaining opening. If bubbles appear and persist, the pushrod seal in the bottom of the piston is defective and will have to be serviced again.

    .2 Squirt light oil around the edge of the guide washer. See Fig. 33. If bubbles appear and persist, the main seal on the piston is defective or improperly installed and must be serviced again.

    .3 Turn the unit over and squirt light oil around the end of the pushrod. See Fig. 34. If bubbles appear and persist, the seal is defective and must be serviced.

14. After the leak tests are passed, ex' aust the air pressure from the unit and replace the pushrod plate. See Fig. 19. If the screw resists full bottoming, it may be necessary to grip the pushrod with padded pliers. See Fig. 20.

CAUTION: Do not damage the surface of the pushrod during this operation. Make absolutely sure the screw is securely tightened.

15. Replace the release bolt with washer in place under the head of the bolt. Screw the release

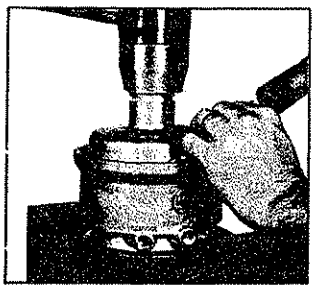

Fig. 31

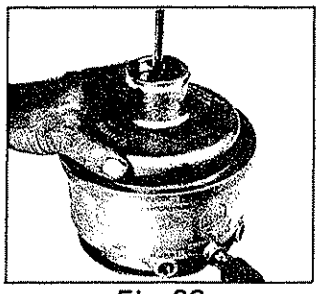

Fig. 32

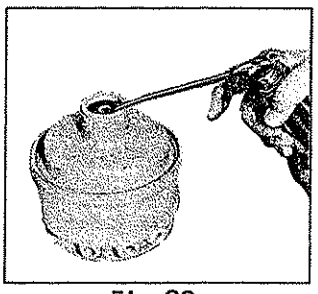

Fig. 33

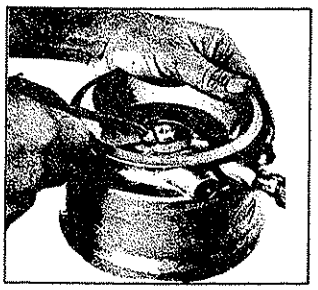

Fig. 34

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bolt into the unit only 1/2 inch (13 mm) as the unit will not be "reset" until after installation on the vehicle.

16. With clean solvent, wash and remove all traces of oil or grease around the snapring area.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

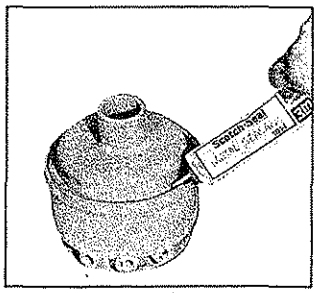

Fig. 35

Allow the solvent to completely dry off. Then, apply a covering bead of weather-proofing sealant, such as 3M No. EC-1814 (same as MGM P/N 306 sealant), or equivalent, over the snapring so that all joints between the head and the case are sealed. See Fig. 35. Allow the sealant to completely dry.

17. Perform steps 10 through 19 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject. (Perform steps 5 through 19 under the same heading if the service brake diaphragm requires replacement.)

PERIODIC MAINTENANCE AND INSPECTION OF PARTS

Periodic maintenance of the brake chambers is required. In addition, whenever the brake chambers are disassembled (including diaphragm replacement), the parts should be inspected for damage. For maintenance schedules and procedures, and for inspection of brake chamber parts, refer to the 12 Group of the Freightliner Maintenance and Lube Manual.

TROUBLESHOOTING

Refer to the air brake system troubleshooting subject located in the 12 Group of this manual.

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES SUBJECT CONTENTS

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TROUBLESHOOTING

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

GENERAL INFORMATION

MGM Stopgard® tandem cam brake chambers consist of a service brake chamber and a parking/emergency spring brake chamber. See Fig. 1. When installed as tandem brake chambers, the service brake section is the lower (smaller) section near the yoke assembly. The Stopgard® model is also available as a single brake chamber (service brakes only). See Fig. 2.

In the service brake section, the pressure cap (or, as on tandem brake chamber units, the flange case) and non-pressure chamber house a service return spring, piston and rod assembly (also referred to as the pushrod assembly), and service brake diaphragm. See Fig. 2.

In the parking/emergency brake section, the flange case and the head house a return spring, a pushrod assembly, a parking brake diaphragm, a piston, a power spring, and a release bolt. See Fig. 2.

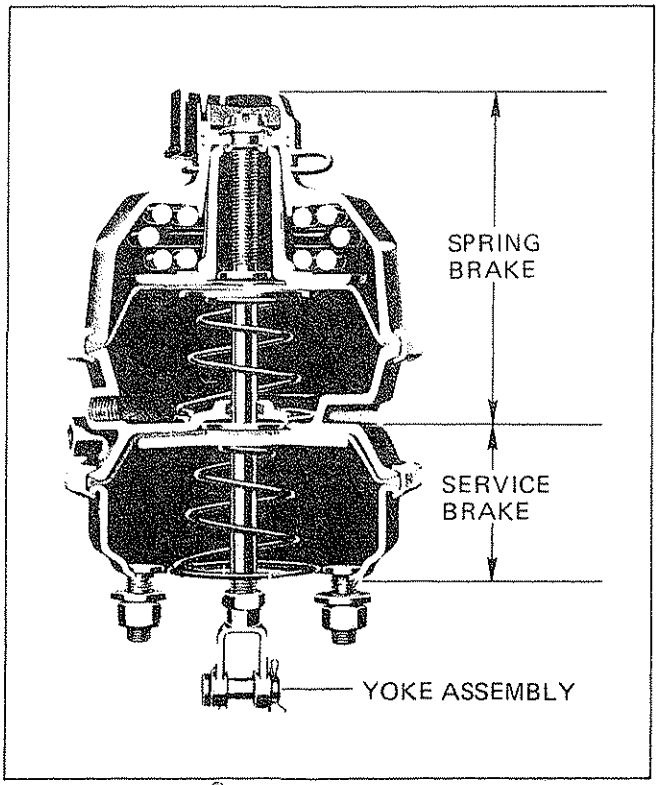

Fig. 1, Stopgard® Tandem Cam Brake Chambers, Sectional View

PRINCIPLES OF OPERATION

SERVICE BRAKES

As the brake pedal is depressed, air pressure from the air reservoir enters the service brake chamber through the service brake air port. The air pressure acts upon the service diaphragm which forces the piston and rod forward (toward the non-pressure chamber) applying force to the slack adjuster, which rotates the camshaft and applies the brakes.

As the brake pedal is released, air pressure is exhausted from the service brake chamber and the return spring returns the diaphragm, piston and rod, and slack adjuster to their normal positions, releasing the brakes.

PARKING/EMERGENCY BRAKES

During parking brake release, air pressure enters the parking brake chamber and acts upon the diaphragm and piston, which fully compresses the power spring. When the power spring is compressed, the parking brakes are released; the service brakes can then be operated at the brake pedal.

During parking brake application, air is exhausted from the parking brake chamber. The power spring releases, forcing the piston and parking brake diaphragm forward (toward the flange case). The resulting forward motion exerted on the pushrod assembly forces the service brake diaphragm and the service brake piston and rod assembly forward, thus applying the brakes.

Emergency brake application automatically begins when the air pressure in the brake system drops below approximately 80 psi (551 kPa). Full emergency brake application occurs when the air pressure drops below approximately 40 psi (276 kPa).

SERVICE OPERATIONS

WARNING: If allowed to release uncontrolled during brake chamber disassembly, the power

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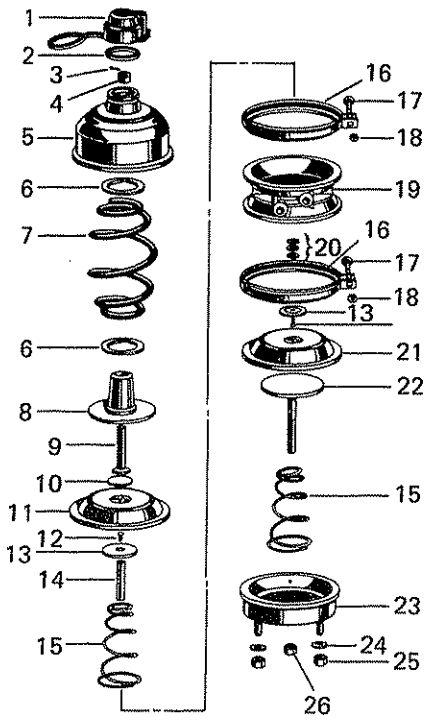
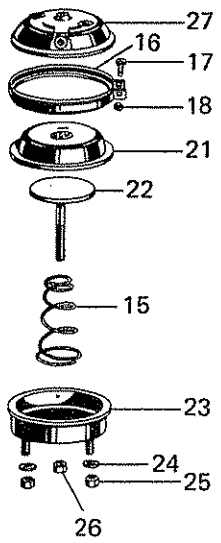


SERVICE BRAKE AND PARKING/EMERGENCY BRAKE CHAMBERS

1. Breather Cap
2. Filter
3. Lockpin
4. Release Nut
5. Head Assembly
6. Thrustwasher
7. Power Spring
8. Piston
9. Release Bolt
10. Piston Plug
11. Spring Brake Diaphragm
12. Screw
13. Pushrod Plate
14. Pushrod
15. Return Spring
16. Clamp Band
17. Clamp Band Bolt
18. Clamp Band Bolt Nut
19. Flange Case
20. Seal And Guide (Kit)
21. Service Brake Diaphragm
22. Piston And Rod
23. Non-Pressure Chamber
24. Washer
25. Mounting Stud Nut
26. Piston Rod Jam Nut
27. Pressure Cap



SERVICE BRAKE CHAMBER

Fig. 2, Stopgard® Cam Brake Chambers

spring can forcibly hurl brake chamber components, posing a danger to persons in the area. Under no circumstances should tandem brake chambers be disassembled (this includes removal of the spring brake clamp band) without first manually compressing the spring brake power spring. Prior to disassembly operations of tandem brake chambers, always perform the procedures given under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)

1. Chock block the vehicle tires.

2. Remove the breather cap from the spring brake chamber.

3. Turn the release bolt *COUNTERCLOCKWISE,* using a 15/16 inch wrench (see Fig. 3), until the power spring is fully caged. While performing this operation, the service brake chamber piston rod must retract the same approximate distance the release bolt is extended out, as tabulated below:

   2 1/4 to 2 1/2 inches (57 to 64 mm) for Types 24 and 30 chambers.

   2 3/4 to 3 inches (70 to 76 mm) for Type 36 chambers.

NOTE: Do not apply more than 50 ft-lbs (68 N·m) torque to the release bolt and do not use an impact wrench. For easier release, apply 90-100 psi (620-689 kPa) air pressure to the spring brake air port. Apply air pressure by releasing the parking brakes.

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

4. Exhaust the air pressure after the power spring has been caged to complete manual release of the spring brake chamber.

POWER SPRING MANUAL RESET (PARKING BRAKE RESET)

1. If the release bolt threads are dry, coat them with a light film of low temperature moly-type grease.

2. With air applied to the spring brake section (the parking brake control valve is in the "release" position), turn the release bolt *CLOCKWISE* until the bolt is fully engaged into the unit and the slotted nut bottoms out on the head insert. See Fig. 3. Tighten to 45-50 ft-lbs (61-68 N·m). *DO NOT USE AN IMPACT WRENCH.*

3. Snap the breather cap in place with the arrow on the breather cap pointing to the ground. Regardless of the position in which the brake chambers are installed, the drain tab arrow on the breather cap must be pointed down. See Fig. 4.

NOTE: Brakes can be adjusted with the parking brake spring caged (manually released).

The breather cap should be checked periodically. If dirty or clogged, the filter element should be replaced. Refer to the 12 Group of the Freightliner Maintenance and Lube Manual for maintenance intervals.

CAUTION: If a breather cap is missing or incorrectly installed, road contaminants can adversely affect the operation of the brake chambers. Once inside the chambers, these contaminants cause deterioration of the internal components, thus shortening their lives. Operating the unit without the breather cap in place will void the MGM warranty.

4. Remove the chock blocks from the vehicle tires.

SERVICE BRAKE AND SPRING BRAKE CHAMBERS REMOVAL AND INSTALLATION

Removal (Refer to Fig. 2)

1. Perform all steps given under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

2. Disconnect the air lines at the brake chambers.

3. Remove the brake chambers from the vehicle as follows:

   .1 If replacing the service brake section with a new replacement, loosen the piston rod jam nut.

   .2 Remove the cotter pin from the yoke pin, then remove the yoke pin from the yoke. Disconnect the yoke from the slack adjuster.

   .3 Remove the nuts and washers from the mounting studs. See Fig. 5. Then, remove the brake chambers from the mounting bracket.

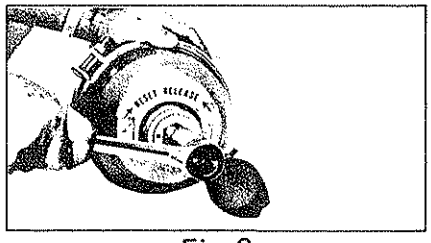


Fig. 3

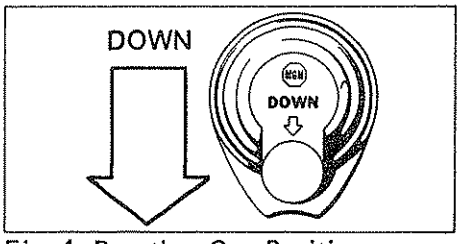


Fig. 4, Breather Cap Position

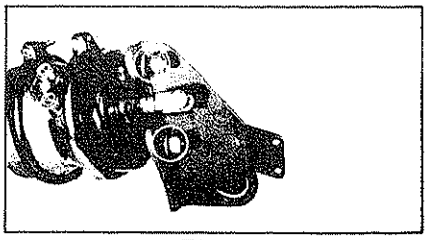


Fig. 5

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

.4 If replacing the service brake section with a new replacement, remove the yoke and the piston rod jam nut from the piston rod.

Installation (Refer to Fig. 2)

1. If installing new tandem brake chambers, make sure the power spring is caged before installing (release bolt screwed out).

2. Install the brake chambers on the mounting bracket, making sure that the washers are installed directly under the nuts (outside the mounting bracket). Tighten the nuts finger-tight. Then, proceed as follows:

NOTE: If a new service brake chamber is being installed, make sure the piston rod and clevis are the correct length. MGM field service units are furnished with an 8 inch (203 mm) rod. Cut the rod to the same length as the rod on the old unit (with the spring brake section completely released; see Fig. 6). Then, attach the piston rod jam nut and the yoke to the piston rod. The new unit should have the release bolt fully extended outward.

.1 Connect the slack adjuster to the yoke, then install the yoke pin. Insert the cotter pin to lock the yoke pin in place. Make sure that the piston rod engagement with the yoke meets the specifications given in the 12 Group of the Freightliner Maintenance and Lube Manual.

.2 Tighten the mounting stud nuts (see Fig. 5) to 100-115 ft-lbs (136-156 N·m). Then, tighten the piston rod jam nut to approximately 50 ft-lbs (68 N·m), if previously loosened.

3. Insure that the air hose fittings are free of grease, dirt, or other debris. Then, apply Loctite 242 sealant, or an equivalent, to the fittings, and install. Torque the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.* Install the air hoses.

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

4. Perform all steps given under the heading, "POWER SPRING MANUAL RESET (PARKING BRAKE RESET)," in this subject.

5. Insure that the angle formed by the centerline of the piston rod and slack adjuster is greater than 90° in the brakes-released position and approaches 90° in the brakes-applied position. Refer to the 12 Group of the Freightliner Maintenance and Lube Manual for detailed information. Also, perform the operating and leakage tests as instructed in the 12 Group of the Freightliner Maintenance and Lube Manual.

SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT

1. Perform steps 1 through 3 under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

2. To facilitate disassembly, extend the service brake piston rod, either by using service brake air pressure, or manually, by pushing the slack adjuster. Use locking-jaw pliers to lock the service piston rod in place, as shown in Fig. 7.

   After the locking-jaw pliers are applied, exhaust the air pressure from the brake chambers using the parking brake control valve in the cab.

3. Disconnect the air lines at the brake chambers.

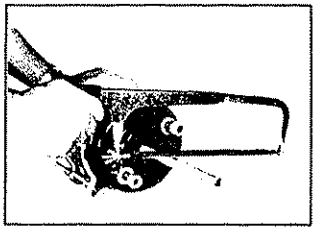


Fig. 6

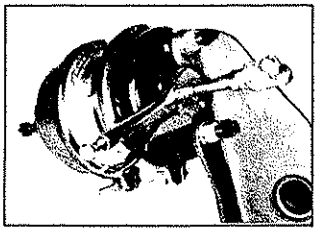


Fig. 7

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

4. Remove the service brake chamber clamp band (the clamp band closest to the mounting bolts). Then, lift the spring brake chamber (or pressure cap) off the non-pressure chamber. Remove the service brake diaphragm.

5. New single unit (spring brake chamber) should have its release bolt fully extended outward, as instructed under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

   Install the spring brake chamber (or pressure cap) on the non-pressure chamber, with the service brake diaphragm between the two components. Check that all sealing surfaces are free of grease and dirt.

6. Install the clamp band. Tap the clamp band all the way around when tightening the clamp band nuts to insure proper seating. Tighten the clamp band nuts (one- or two-piece clamp bands) to 20-25 ft-lbs (27-34 N·m).

7. Insure that the air hose fittings are free of grease, dirt, or other debris. Then, apply Loctite 242 sealant, or an equivalent, to the fittings, and install. Torque the fittings to 25 ft-lbs (34 N·m) maximum. *DO NOT USE AN IMPACT WRENCH.* Install the air hoses.

NOTE: Air hoses should be tightened to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

8. Hold the service brake piston rod in place, either by using service brake air pressure, or by manually pushing the slack adjuster. Then, release the locking-jaw pliers from the service brake piston rod.

   Allow the return spring inside the service brake chamber to relax either by exhausting the air pressure in the chamber or by easing the pull on the service piston rod.

9. Check for air leaks by performing the leakage tests given in the 12 Group of the Freightliner Maintenance and Lube Manual.

10. Perform all steps given under the heading, "POWER SPRING MANUAL RESET (PARKING BRAKE RESET)," in this subject.

SPRING BRAKE DIAPHRAGM REPLACEMENT

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

1. Perform steps 1 through 4 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

2. Check for a broken power spring. Inspect the clamp band to insure it is evenly seated around the spring brake chamber, and tighten the spring brake clamp band bolt nuts to 20-25 ft-lbs (27-34 N·m). Then, screw the release bolt clockwise all the way into the unit to release the power spring. Vigorously shake the assembly. Noticeable "rattling" from within the head end of the assembly normally confirms a broken power spring. Further evidence would be revealed by only light resistance when screwing the release bolt down.

   If a broken power spring is suspected, either replace the single unit (spring brake chamber) with an identical model or perform the steps given under the heading, "POWER SPRING REMOVAL AND INSTALLATION," in this subject.

3. If the power spring is not broken, then manually release the power spring using the instructions given under the heading, "POWER SPRING MANUAL COMPRESSION (PARKING BRAKE RELEASE)," in this subject.

IMPORTANT: Before further disassembly, place the spring brake in a two ton minimum shop press with a minimum 8 inches (203 mm) of relaxing stroke available after light tension is taken up on the head by the press ram. A heavy iron or steel barred shield, or equivalent, should be placed

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

between the operator and the spring brake assembly during disassembly. See Fig. 8.

WARNING: Failure to perform the safeguards above prior to spring brake chamber disassembly creates a hazardous workshop environment. Accidental sudden release of the power spring will cause spring brake components to be hurled with dangerous force; these components could strike persons in the area and cause serious personal injury. Under no circumstances should a spring brake chamber assembly be disassembled without first performing the safeguards described above.

4. Using a "slit-tube" and "flat-plate" (shown in Fig. 8), apply 2,500 lbs (1125 kg) maximum force to compress the unit in line with the rod.

5. Remove the clamp band bolt nuts and the clamp band. See Fig. 9.

6. Slowly relax pressure on the shop press until the spring brake section can be separated and the spring brake diaphragm can be removed. See Fig. 10.

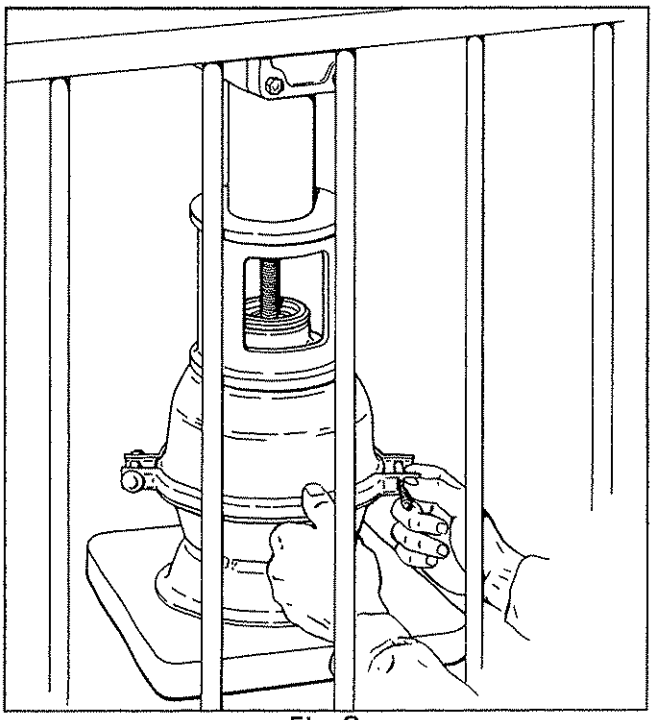


Fig. 8

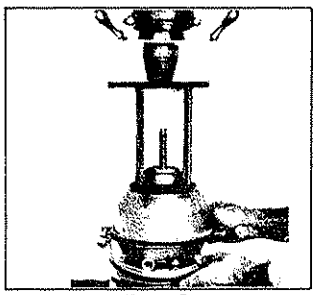


Fig. 9

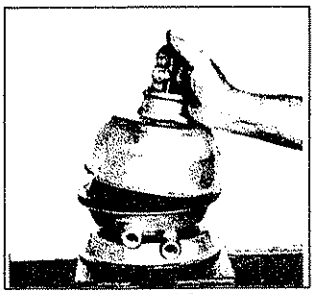


Fig. 10

WARNING: If tension remains between the ram and the brake chamber, either the unit is not manually released or a failure has occurred in the release mechanism. If the unit is released but pressure is present, continue to relax the press slowly until the spring is fully extended and all parts fall free.

7. Lift off the spring brake head assembly with caution as the power spring is caged between the piston and the head.

8. Remove the spring brake diaphragm. While the diaphragm is removed, inspect the inside of the flange case, return spring, pushrod plate, screw, and guide rings. If service is required on any of these parts, proceed to the heading, "PUSH-ROD SEAL REPLACEMENT," in this subject.

9. Replace the old diaphragm with a new diaphragm. Place the new diaphragm in the spring brake chamber head and install onto the flange case.

10. To reassemble the unit, reverse the disassembly procedure, except apply 600-800 lbs (270-360 kg) of force to compress the diaphragm between the two housings. With the diaphragm compressed, the clamp band can now be easily assembled onto the unit. Tap the clamp band all the way around when tightening the clamp band nuts to insure proper seating. Tighten the nuts to 20-25 ft-lbs (27-34 N·m).

11. Perform steps 5 through 10 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

POWER SPRING REMOVAL AND INSTALLATION

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

Removal

1. To remove the head, perform steps 1 through 8 under the heading, "SPRING BRAKE DIAPHRAGM REPLACEMENT," in this subject.

2. Using a 1/8 inch diameter punch, support the release bolt and knock out the lockpin in the release bolt, as illustrated in Fig. 11. Then, remove the slotted release nut.

3. Using a screwdriver, pop off the piston plug in the center bottom of the piston. See Fig. 12.

4. Insert the head assembly in the press, as shown in Fig. 13. It is important to position one 4-5 inch (100-125 mm) diameter slit-tube under the assembly supporting the piston and another one over the assembly between the head and the flat-plate under the press ram; without these tubes, the final safe disassembly cannot be accomplished.

   After the press ram touches the plate, the ram must be able to travel a minimum of 8 inches (203 mm) away from the assembly—without this length of travel available, the power spring will not completely relax.

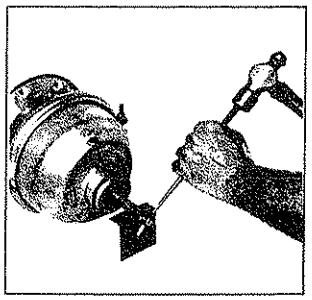


Fig. 11

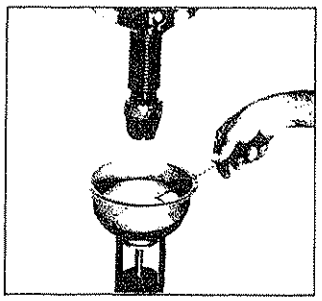


Fig. 12

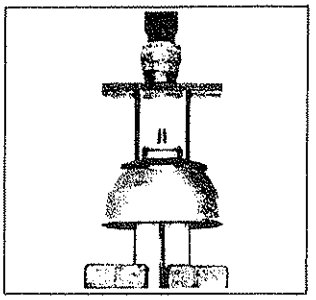


Fig. 13

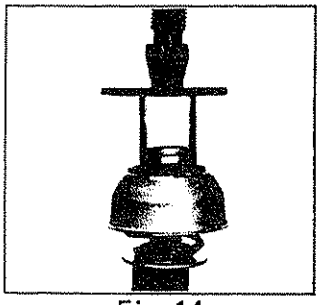


Fig. 14

5. Check the assembly for straight alignment in the press and apply 2,500 lbs (1125 kg) of force to compress the unit in line with the release bolt.

6. Using a long, broad-bit screwdriver, unscrew the release bolt until it falls free. Refer to Fig. 14.

7. With the release bolt removed, gradually relax the ram until the head loses contact with the press ram. See Fig. 15. Then, remove the head, as shown in Fig. 16.

8. After disassembly, all parts should be thoroughly washed in clean solvent and visually inspected for wear or damage, as instructed in the 12 Group of the Freightliner Maintenance and Lube Manual. Replace any parts that are worn or damaged.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

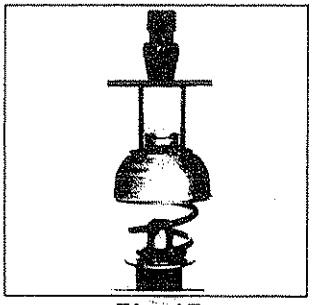


Fig. 15

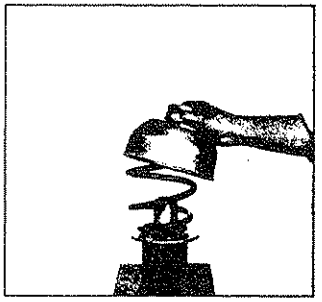


Fig. 16

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MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

Installation

1. Prior to assembly of the spring brake chamber, apply a generous layer of moly-type grease to the inside of the head centerwell, the outside of the piston shank, the inside of the piston shank, and to the release bolt.

2. Place the slit-tube on the press base and position the parts on top in the following order: piston, thrustwasher, spring, thrustwasher, and head, followed by the second slit-tube and the flat-plate. Sheet rubber may be inserted between the brake piston and the press plate to prevent slipping.

3. Check the straight up-and-down alignment of all parts and then, standing to the side of the press, take up tension very slowly on the ram. See Fig. 15. Check the alignment continually as straight-in reassembly is important. If misalignment occurs, relax the press and begin the compression of the power spring again. A maximum force of 2,500 lbs (1125 kg) will be required to compress the power spring.

4. With the power spring completely compressed between the piston and the head (and with the piston bottomed up inside the head), place the release bolt up through the piston shank. See Fig. 13. Screw the bolt in until approximately 3 inches (76 mm) of the bolt extends through the head insert.

5. Relax tension on the ram slowly until the parts separate from the ram.

6. Remove the head assembly from the press and install the release nut on the release bolt. Lock in place with the lockpin. See Fig. 11.

7. Place a new piston plug in the center hole of the piston. Firmly tap the center of the plug with a hammer so it moves over center to a flat attitude. See Fig. 17. (Hammer flat only.)

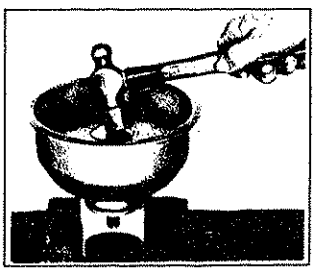

Fig. 17

8. Perform steps 5 through 10 under the heading, "SERVICE BRAKE DIAPHRAGM REPLACEMENT OR SPRING BRAKE CHAMBER REPLACEMENT," in this subject.

PUSHROD SEAL REPLACEMENT

CAUTION: Do not attempt to disassemble the power spring section while the unit is on the vehicle.

1. Under the heading, "POWER SPRING REMOVAL AND INSTALLATION," perform all steps under the subheading, "REMOVAL."

2. Before the seal can be removed, first remove the pushrod screw, plate, and rod. The pushrod screws are assembled with Loctite and are difficult to remove.

   Removal of the pushrod screw is easiest if it is heated with a propane torch (see Fig. 18) until it can be turned freely with a screwdriver.

   First, tighten the handle of a Phillips-head screwdriver in a vise, with the blade accessibly extended outward. Heat one screw for approximately 30 seconds. Then, hold either screw into the blade of the screwdriver locked by the vise. With a second screwdriver, loosen and remove the opposite screw as illustrated in Fig. 19.

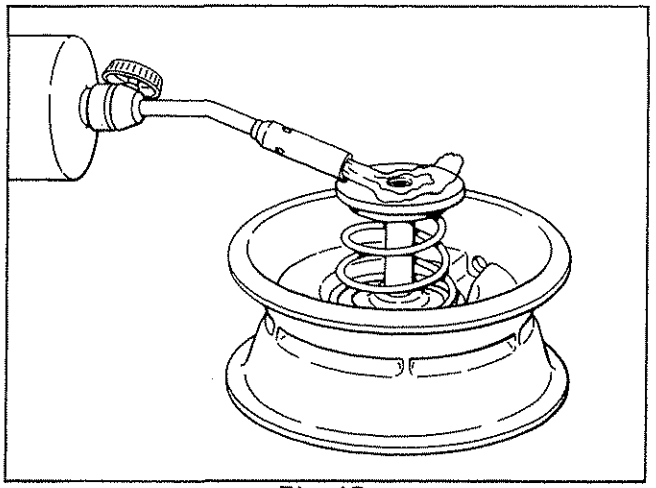

Fig. 18

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

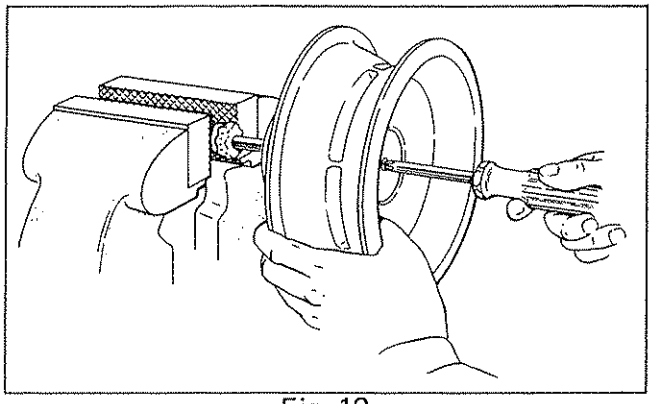

Fig. 19

IMPORTANT: Hold the case tight against the locked screwdriver and slowly remove pressure after the screw is removed. This will prevent the return spring shown in Fig. 18 from releasing suddenly. All the parts may now be removed from the case.

WARNING: Use gloves when handling the parts since they will be hot from the propane torch.

3. Wash all parts thoroughly in clean solvent.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

4. Remove the guide rings (see Fig. 20) and the pushrod seal. The seal can best be removed by inserting a small-bladed screwdriver behind the seal in the groove and very carefully prying the seal out of the groove as illustrated in Fig. 21.

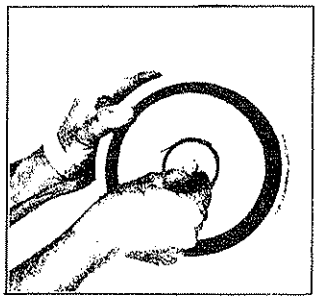

Fig. 20

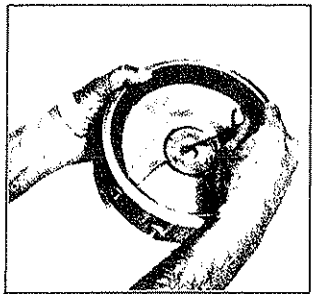

Fig. 21

5. Clean the seal groove in the case. Next, lubricate the groove and the new seal with a moly-base grease. Then, install the seal into the groove. To insure the seal is firmly seated, run your finger around the seal I.D. At the same time, apply outward force.

6. Install new white plastic guide rings, as shown in Fig. 20, on both sides of the seal. The widest flange side always faces away from the seal. Align the skive cuts approximately 180° apart.

7. If both plates had been removed from the pushrod, assemble the smaller plate onto the rod first. Thoroughly clean and dry all screw threads and the pushrod threaded holes. Apply Loctite to the screw thread, and tighten to 15 ft-lbs (20 N·m).

8. Insert the pushrod with the small plate carefully through the seal to prevent seal damage. Install the return spring in the case, place the return spring guide on the end of the pushrod and compress the spring with the large pushrod plate. The screw holes in the plate, return spring guide, and pushrod must be aligned; then, install the screw. Again, be sure the threads are clean and dry before applying Loctite to the screw thread.

IMPORTANT: The screws holding the two plates to the pushrod must be tightened to 15 ft-lbs (20 N·m). The screws can be tightened by using the same procedure described in step 2, above.

9. Check the alignment of the return spring to insure it is biased straight between the flange case and the large pushrod plate. Straightness is important for positive sealing.

10. Inspect the diaphragm before further assembly and replace if worn, damaged, or more than one (1) year old.

11. Under the heading, "POWER SPRING REMOVAL AND INSTALLATION," perform all steps under the subheading, "INSTALLATION."

BRAKE CONTROL 12
32-12425

MGM STOPGARD® SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS, CAM BRAKES

PERIODIC MAINTENANCE AND INSPECTION OF PARTS

Periodic maintenance of the brake chambers is required. In addition, whenever the brake chambers are disassembled (including diaphragm replacement), the parts should be inspected for damage. For maintenance schedules and procedures, and for inspection of brake chamber parts, refer to the 12 Group of the Freightliner Maintenance and Lube Manual.

TROUBLESHOOTING

Refer to the air brake system troubleshooting subject located in the 12 Group of this manual.

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS SUBJECT CONTENTS

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ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

GENERAL DESCRIPTION

The Anchorlok S-Cam brake chambers consist of a service brake chamber and a parking/emergency brake chamber. When installed as tandem brake chambers, as shown in Fig. 1, the service brake chamber is the section nearest the brake. The Anchorlok S-Cam brake chamber is also available as a single service brake chamber. See Fig. 2.

PRINCIPLES OF OPERATION

SERVICE BRAKES

Applying pressure to the brake pedal allows compressed air to enter the service brake chamber above the diaphragm. See Fig. 3. Movement of the diaphragm forces the service brake pushrod assembly downward, applying the brakes by means of the slack adjuster and camshaft. When the brake pedal is released, air is exhausted from the service brake chamber, and the return spring assists in moving the diaphragm and pushrod to the "off" position, releasing the brakes. See Fig. 4.

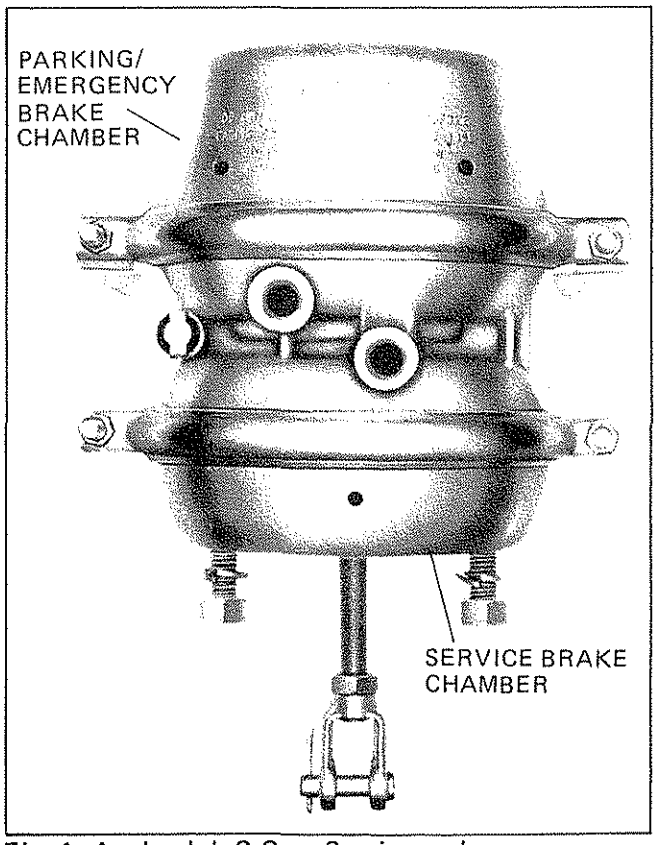


Fig. 1, Anchorlok S-Cam Service and Parking/Emergency Brake Chambers

PARKING/EMERGENCY BRAKES

During vehicle operation, air pressure enters the parking/emergency brake chamber below the diaphragm. This air pressure forces the diaphragm upward against the pressure plate to compress the

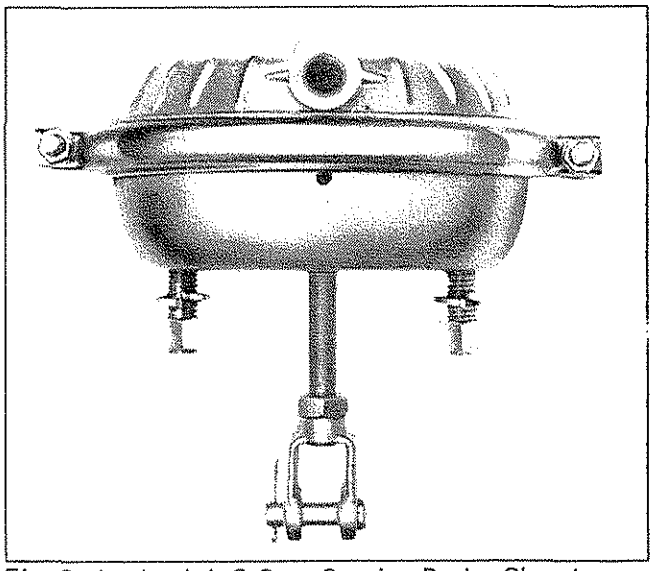


Fig. 2, Anchorlok S-Cam Service Brake Chamber

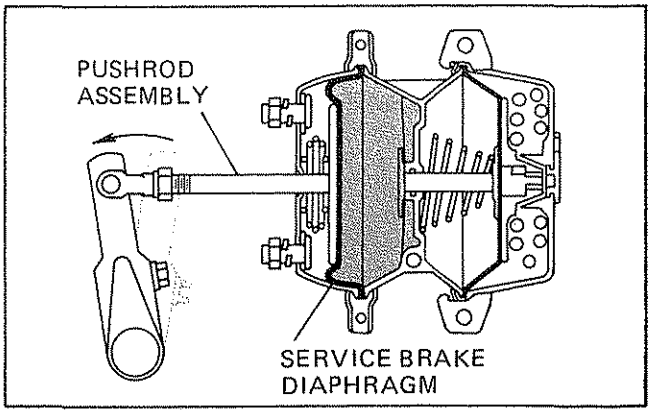


Fig. 3, Service Brake Applied

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

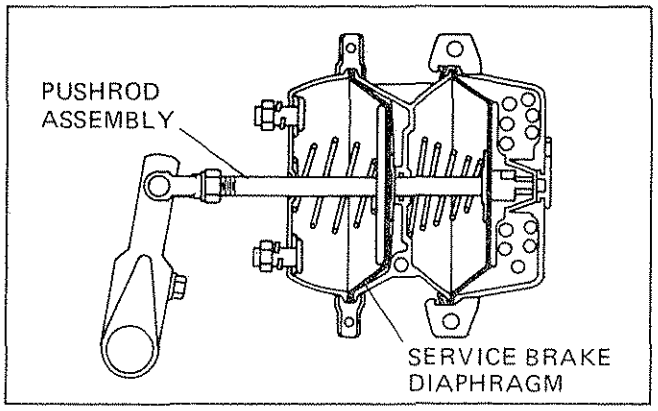


Fig. 4, Service Brakes Released

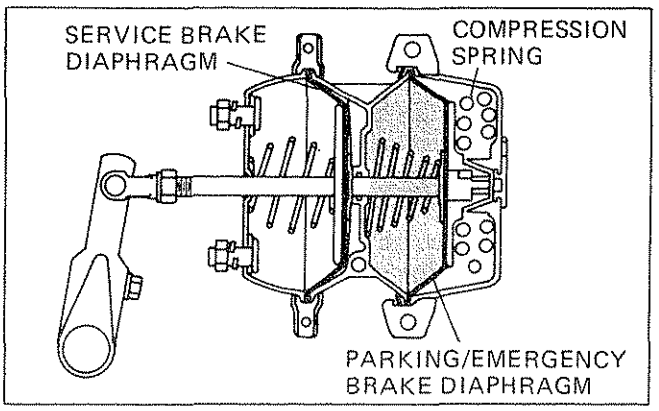


Fig. 5, Parking/Emergency Brakes Released

compression spring and hold the parking/emergency brake off. See Fig. 5. In routine vehicle parking, a control valve in the cab exhausts air from the parking/emergency brake chamber. This allows the compression spring to extend and apply the brakes. See Fig. 6.

Emergency brake application begins when air pressure in the service brake reservoir drops below approximately 60-65 psi (413-448 kPa). Maximum spring brake force is applied when air is entirely exhausted from the parking/emergency brake chamber. The cause of the air pressure loss must be determined and corrected before the vehicle may be operated.

When a vehicle has come to an emergency stop due to air loss in the service brake system, the spring brake may be released by manually compressing the compression spring with a special parking/emergency brake release stud, as shown in Figs. 7 thru 11.

WARNING: Do not operate the vehicle when the parking/emergency brakes are manually released. Before manually releasing the parking/emergency brakes, make connection to a towing vehicle, or block the wheels. After correcting the brake system problems, reset the parking/emergency brakes before resuming normal vehicle operation. See Fig. 10.

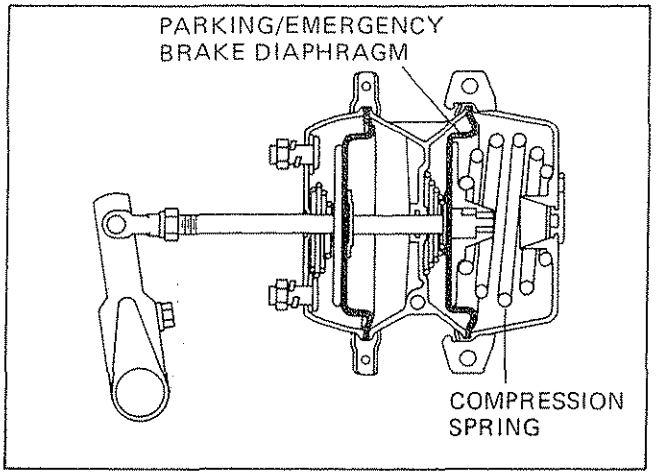


Fig. 6, Parking/Emergency Brakes Applied

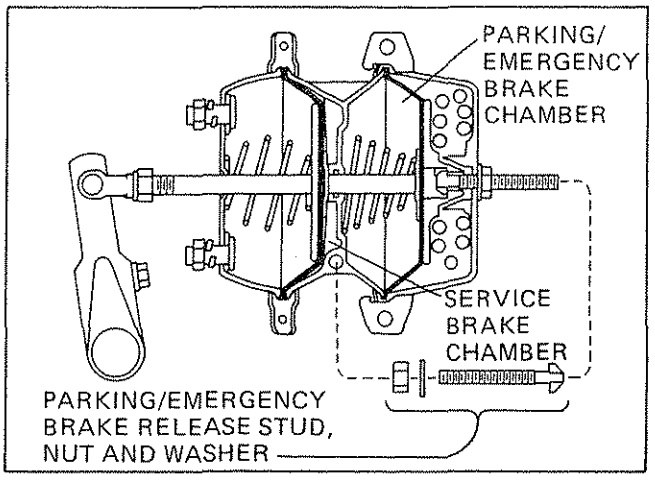


Fig. 7, Parking/Emergency Brakes Manually Released

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

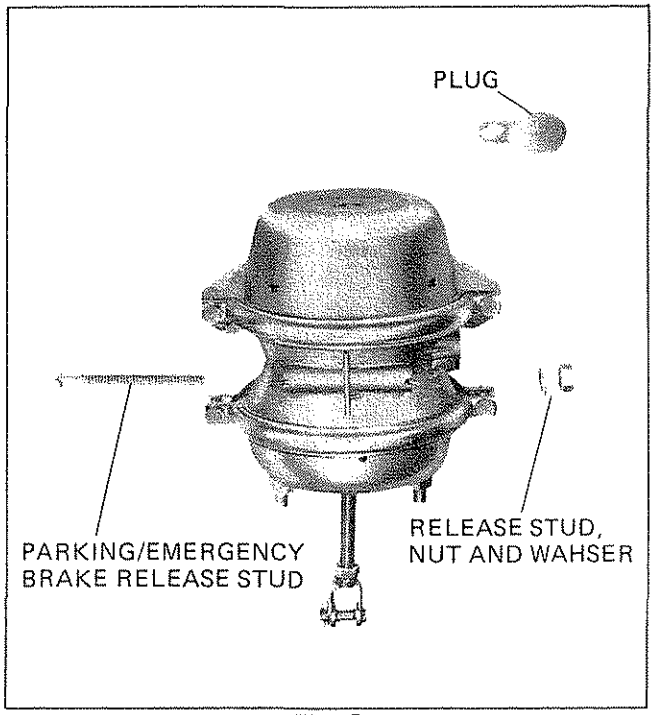


Fig. 8

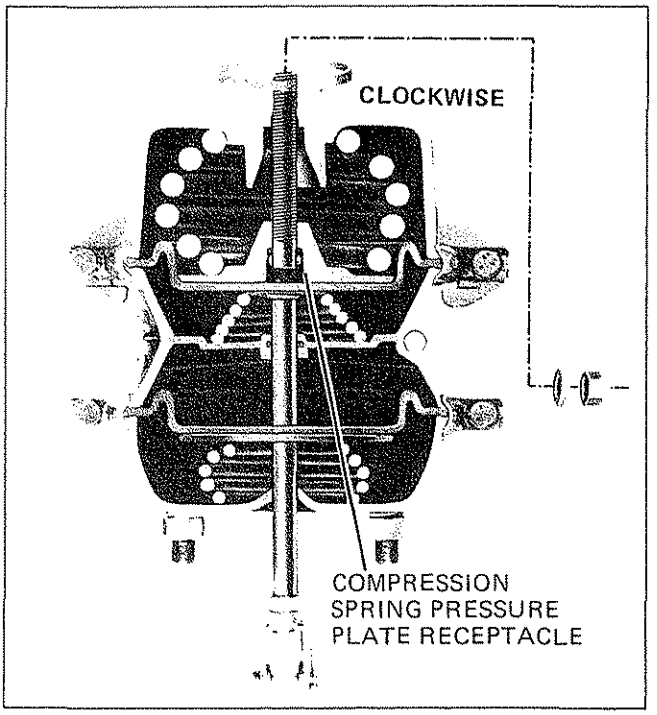


Fig. 9

SERVICE OPERATIONS

WARNING: If allowed to release uncontrolled during brake chamber disassembly, the compression spring can forcibly hurl brake chamber components, posing a danger to persons in the area. Under no circumstances should the service or parking/emergency brake chambers be disassembled without first manually releasing the parking/emergency brake. Prior to disassembling the service and parking/emergency brake chambers, always perform the procedures given under the heading, "PARKING/EMERGENCY BRAKE MANUAL RELEASE."

PARKING/EMERGENCY BRAKE MANUAL RELEASE

1. Chock the vehicle tires.

2. Remove the parking/emergency brake release stud from its pocket on the side of the adapter housing, then remove the plug. See Fig. 8. Insert the parking/emergency brake release stud into the compression spring pressure plate receptacle.

3. Turn the stud one-quarter turn clockwise to seat the cross-pin of the parking/emergency brake release stud into the compression spring pressure plate receptacle, as shown in Fig. 9. Install the washer and nut onto the stud.

4. Turn the parking/emergency brake release stud nut with a wrench until the compression spring is fully caged. See Figs. 10 and 11. Tighten the parking/emergency brake release stud nut a maximum of 50 ft-lbs (68 N·m).

NOTE: Power air wrenches can create hazardous (excessive) torques.

WARNING: Do not attempt further disassembly if any of the following conditions are present:

.1 The cross-pin on the parking/emergency brake release stud fails to engage in the compression spring pressure plate receptacle.

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

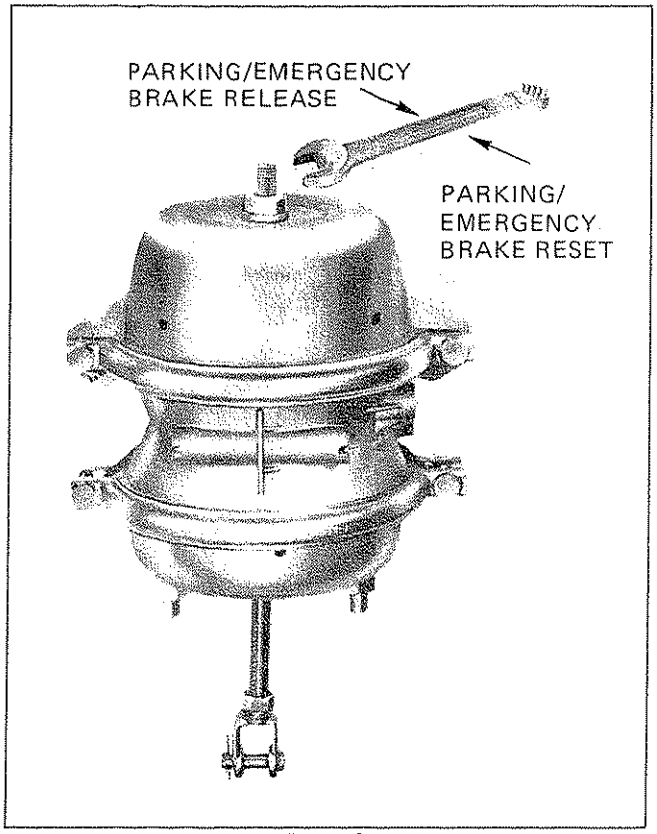


Fig. 10

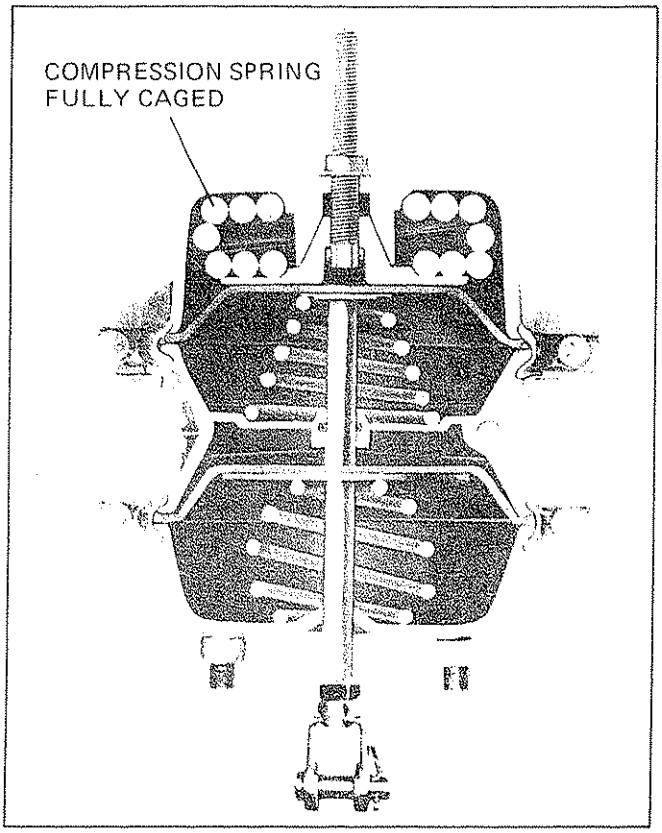


Fig. 11

.2 No tension is felt on the stud while tightening the parking/emergency brake release stud nut.

.3 No movement of the service brake pushrod takes place while tightening the parking/emergency brake release stud nut.

The presence of any of these conditions indicates that the parking/emergency brake has not been released. A brake chamber with a damaged manual parking/emergency brake release mechanism must be carefully removed as a unit from the vehicle, and a new or factory rebuilt unit installed.

PARKING/EMERGENCY BRAKE MANUAL RESET

1. Make certain that the clamp ring assemblies are firmly in place and the securing nuts are tightened to 25-35 ft-lbs (34-47 N·m) before the parking/emergency brake release stud assembly is removed.

WARNING: Failure to insure that the clamp ring assemblies are firmly in place, and the securing nuts are tightened to 25-35 ft-lbs (34-47 N·m), could allow the compression spring to release uncontrolled, forcibly hurling brake chamber components and posing a danger to persons in the area.

2. Using a wrench, back off the release stud nut, thus allowing the compression spring to extend back into the parking/emergency brake chamber. See Fig. 10.

3. When the compression spring is fully extended, force will no longer be felt on the parking/emergency brake release stud nut. Remove the nut and washer, then turn the parking/emergency brake release stud one-quarter turn

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

counterclockwise to release the cross-pin of the parking/emergency brake release stud from the receptacle in the compression spring pressure plate. See Fig. 12. Remove the parking/emergency brake release stud from the parking/emergency brake chamber.

4. Place the parking/emergency brake release stud into its pocket on the adapter housing. See Fig. 8. Install the washer and nut on the end, then tighten the nut securely.

5. Place the plug into the hole in the parking/emergency brake chamber.

BRAKE CHAMBER REMOVAL AND INSTALLATION

Removal

1. Chock the vehicle tires, then drain the air from the air reservoirs. Disconnect the air lines from the brake chambers, marking the lines for later assembly. Take care to prevent dirt or grease from entering the lines or the fittings.

2. If removing the service and parking/emergency brake chambers, manually release the compression spring. For instructions, refer to "PARKING/EMERGENCY BRAKE MANUAL RELEASE."

3. Remove the cotter pin from the clevis pin, then remove the clevis pin from the clevis. See Fig. 13.

4. Remove the brake chamber mounting stud nuts and lockwashers. Remove the brake chamber assembly from the vehicle.

Installation

1. Cut the new service brake push rod to the same length as the rod on the old unit.

2. Place the brake chamber on the mounting bracket with the chamber mounting studs in position through the mounting bracket holes.

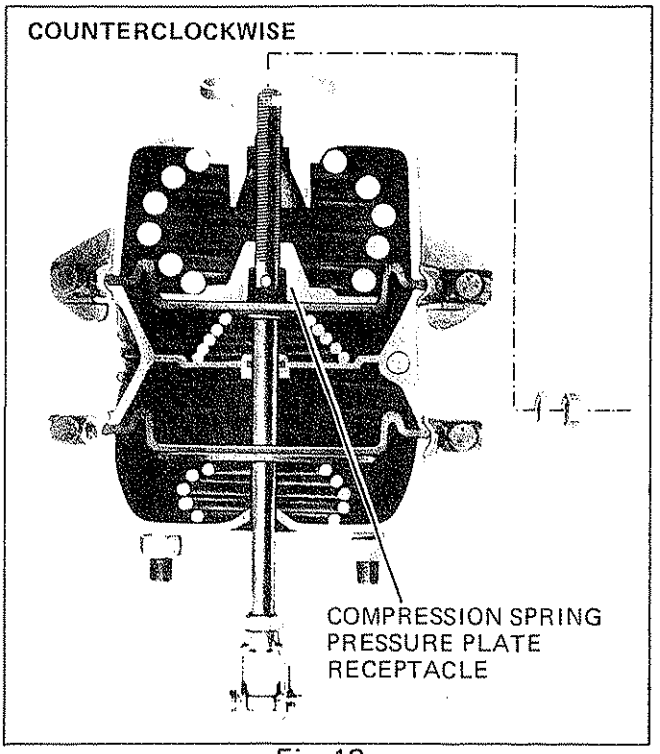


Fig. 12

3. Install the lockwashers and nuts. Tighten the stud nuts to 150 ft-lbs (203 N·m).

4. Insert the clevis pin in the clevis, then install and lock a new cotter pin in the clevis pin. See Fig. 13.

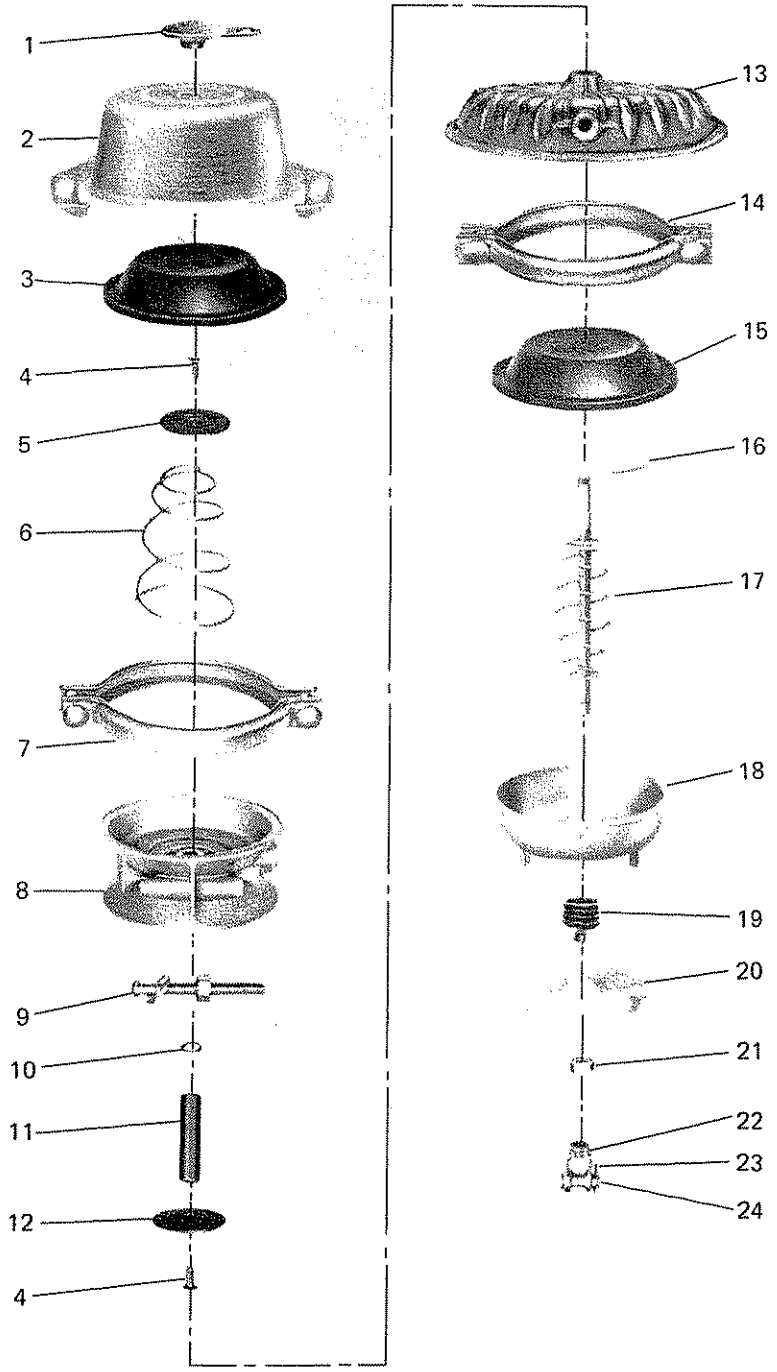
WARNING: Failure to install and lock a new cotter pin could allow disengagement of the pushrod from the slack adjuster, resulting in a loss of braking ability.

5. If installing service and parking/emergency brake chambers, release the brake chamber compression spring. For instructions, refer to "PARKING/EMERGENCY BRAKE MANUAL RESET."

WARNING: Operating the vehicle with the compression spring caged by the release stud assembly can result in the loss of parking and emergency braking ability.

BRAKE CONTROL 12
32-12430

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS



1. Plug
2. Compression Spring Subassembly Housing
3. Parking/Emergency Brake Diaphragm
4. Nylok Screw
5. Adapter Pushrod Upper Plate
6. Adapter Pushrod Return Spring
7. Parking/Emergency Brake Clamp Ring Assembly
8. Parking/Emergency Brake Adapter
9. Parking/Emergency Brake Release Stud Assembly
10. Adapter Pushrod Seal O-ring
11. Adapter Pushrod
12. Adapter Pushrod Lower Plate
13. Service Brake Pressure Chamber (if so equipped)
14. Service Brake Clamp Ring Assembly
15. Service Brake Diaphragm
16. Service Brake Pushrod
17. Service Brake Return Spring
18. Service Brake Housing
19. Dust Boot
20. Dust Boot Retainer Plate
21. Clevis Jam Nut
22. Clevis Assembly
23. Cotter Pin
24. Clevis Pin

Fig. 13, Anchorlok S-Cam Service and Parking/Emergency Brake Chamber

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

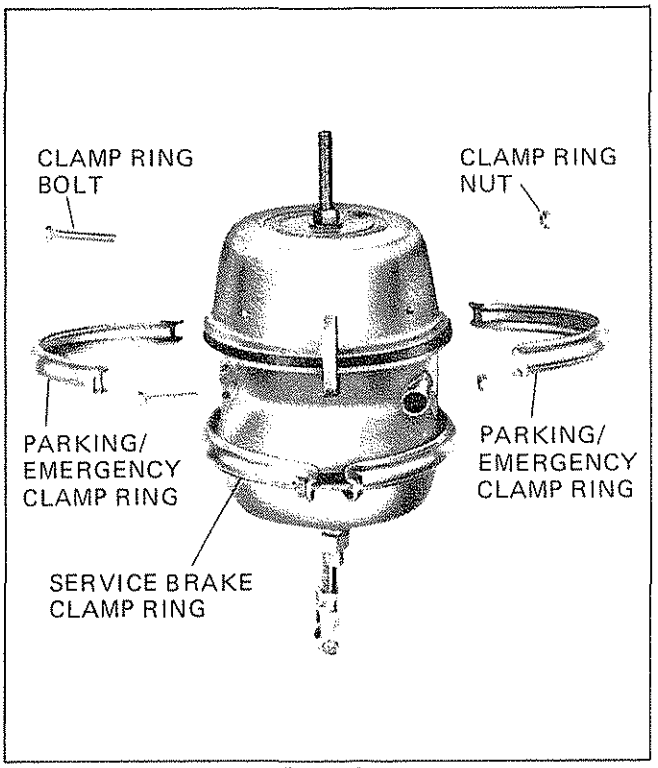


Fig. 14

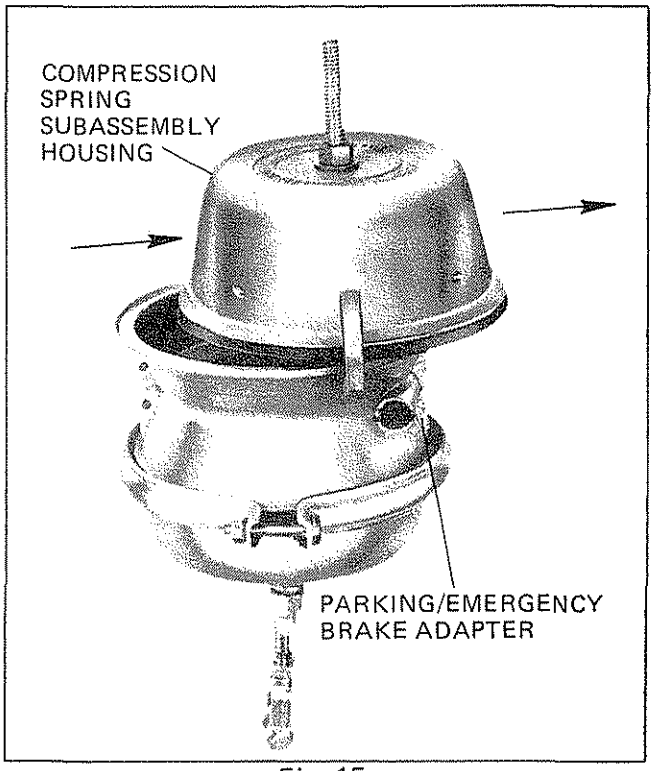


Fig. 15

6. Connect the lines to the brake chambers as previously marked. Tighten the fittings as described in the 12 Group of the Freightliner Maintenance and Lube Manual.

7. Perform the inspection procedures given in the 12 Group of the Freightliner Maintenance and Lube Manual before operating the vehicle.

8. Remove the chocks from the vehicle tires.

BRAKE CHAMBER DISASSEMBLY, CLEANING AND INSPECTING, AND ASSEMBLY (Refer to Fig. 13)

Disassembly

1. Remove the brake chamber from the vehicle. For instructions, refer to "BRAKE CHAMBER REMOVAL AND INSTALLATION." If servicing the service and parking/emergency brake chambers, proceed to step 2. If servicing a single service brake chamber, proceed to step 11.

2. After performing the steps described under "PARKING/EMERGENCY BRAKE MANUAL RELEASE," loosen the nuts on the parking/emergency brake clamp ring. Remove the clamp ring assembly, shown in Fig. 14, then slide the compression spring subassembly housing from the parking/emergency brake adapter. See Fig. 15.

3. Remove the parking/emergency brake diaphragm.

4. Store the compression spring subassembly, shown in Fig. 16, where it will be protected from dropping, jarring, or other action that could cause accidental release of the compression spring.

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

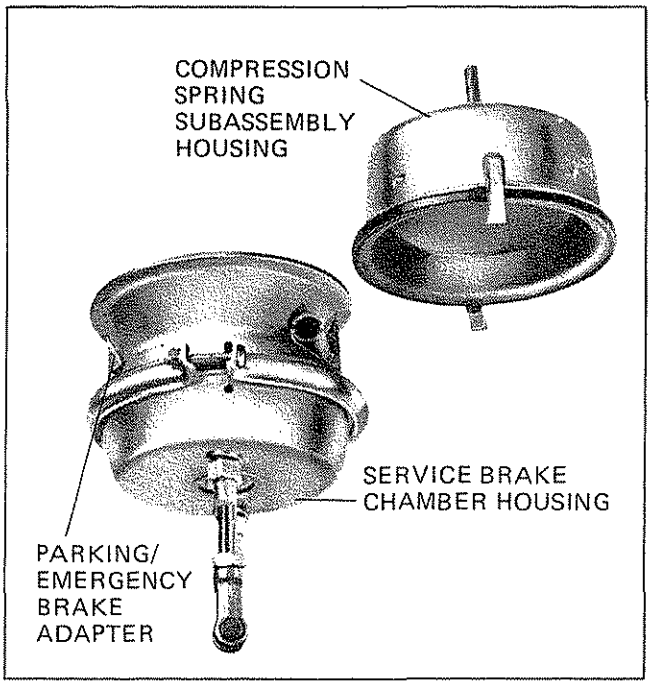


Fig. 16

WARNING: Do not attempt to disassemble the compression spring subassembly. Disassembling the compression spring subassembly may allow the sudden release of the compression spring, resulting in serious personal injury. If the compression spring subassembly is damaged, Anchorlok states that it must be replaced with a new or factory rebuilt unit.

5. Clamp a pair of vise-grip pliers onto the service brake pushrod at the base of the service brake housing. This will prevent the service brake pushrod from being drawn into the service brake return spring when the service brake clamp ring assembly is removed.

6. Supporting the parking/emergency brake adapter in one hand, loosen the nuts on the service brake clamp ring. Spread the ring enough to permit the separation of the parking/ emergency brake adapter from the service brake housing. Remove the parking/emergency brake adapter and service brake clamp ring assembly from the service brake housing.

7. Position the parking/emergency brake adapter over a 1-1/2 inch (38 mm) block to support the bottom of the adapter pushrod. Compress the adapter pushrod return spring by hand while removing the Nylok screw from the adapter pushrod upper plate.

8. Gently release the adapter pushrod return spring, and remove it together with the adapter pushrod upper plate.

9. Remove the adapter pushrod through the bottom of the parking/emergency brake adapter. Remove the Nylok screw, then remove the adapter pushrod lower plate from the adapter pushrod.

10. Remove the adapter pushrod seal by inserting a small-bladed screwdriver behind the seal and carefully prying it out of the groove. Take special care to prevent damage to the adapter pushrod guide surfaces in the parking/emergency brake adapter and/or the seal groove. Proceed to step 13.

11. Clamp a pair of vise-grip pliers onto the service brake pushrod at the base of the service brake housing. This will prevent the service brake pushrod from being drawn into the service brake housing by the service brake return spring when the service brake clamp ring is removed.

12. Loosen the nuts on the service brake clamp ring. Spread the ring enough to separate the service brake pressure chamber from the service brake housing. Remove the service brake pressure chamber, together with the service brake clamp ring.

13. Remove the service brake diaphragm.

14. Loosen the clevis jam nut, then unscrew the clevis from the end of the service brake pushrod.

15. Position the service brake chamber on a clean, flat surface with the housing opening downward and the clevis end of the pushrod pointing

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

upward. Compress the service brake return spring by pressing down on the service brake housing. Remove the vise-grip pliers from the service brake pushrod, then gently release the pressure from the service brake housing.

16. Remove the dust boot retainer plate and dust boot from the service brake chamber.

17. Remove the service brake pushrod and return spring from the service brake housing.

Cleaning and Inspecting

Clean and inspect all parts. For instructions, refer to the 12 Group of the Freightliner Maintenance and Lube Manual.

Assembly

1. Before assembly, lubricate all inside surfaces with a low-temperature moly-type lubricant. If servicing the service and parking/emergency brake chambers, proceed to step 2. If servicing a single service brake chamber, proceed to step 5.

2. Insert the adapter pushrod seal into the groove in the parking/emergency brake adapter, taking care to prevent damage to the seal of the pushrod guide surfaces.

3. Coat the Nylok screw with Loctite, then secure the adapter pushrod lower plate to the adapter pushrod with the Nylok screw. Take special care to prevent damage to the adapter pushrod surface. Lubricate the adapter pushrod and insert it carefully through the adapter pushrod seal from the service brake side of the parking/emergency brake adapter.

4. Position the parking/emergency brake adapter over a 1-1/2 inch (38 mm) block to support the bottom of the adapter pushrod. Place the adapter pushrod return spring, large end down, over the adapter pushrod. Position the adapter pushrod upper plate on top of the adapter pushrod return spring and press it down until it touches the adapter pushrod. Coat the Nylok screw with Loctite, then secure the adapter pushrod upper plate to the adapter pushrod with the Nylok screw.

5. Slide the service brake return spring over the service brake pushrod shaft, then insert the shaft through the service brake housing.

6. Position the service brake chamber on a clean, flat surface with the housing opening downward and the clevis end of the pushrod pointing upward. Compress the service brake return spring by pressing downward on the service brake housing. Clamp a pair of vise-grip pliers onto the service brake pushrod at the base of the service brake housing to maintain compression of the service brake return spring.

7. Place the service brake diaphragm over the service brake pushrod. On service and parking/emergency brake chambers, position the parking/emergency brake adapter over the diaphragm, on top of the service brake chamber. On single service brake chambers, position the service brake pressure chamber over the diaphragm. Make certain that the housing flanges are aligned with the service brake diaphragm flange.

8. Install the service brake clamp ring assembly over the flanges. Tighten the clamp ring nuts to 25-35 ft-lbs (34-47 N·m), then use a soft hammer to tap the circumference of the clamp ring to further ensure seating. Tighten the clamp ring nuts again to 25-35 ft-lbs (34-47 N·m).

9. Remove the vise-grip pliers from the service brake pushrod.

10. Install the dust boot and the dust boot retaining plate over the end of the service brake pushrod, then install the clevis jam nut, and the clevis assembly on the pushrod end. If servicing a single service brake chamber, proceed to step 13.

11. Place the parking/emergency brake diaphragm into the compression spring subassembly

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

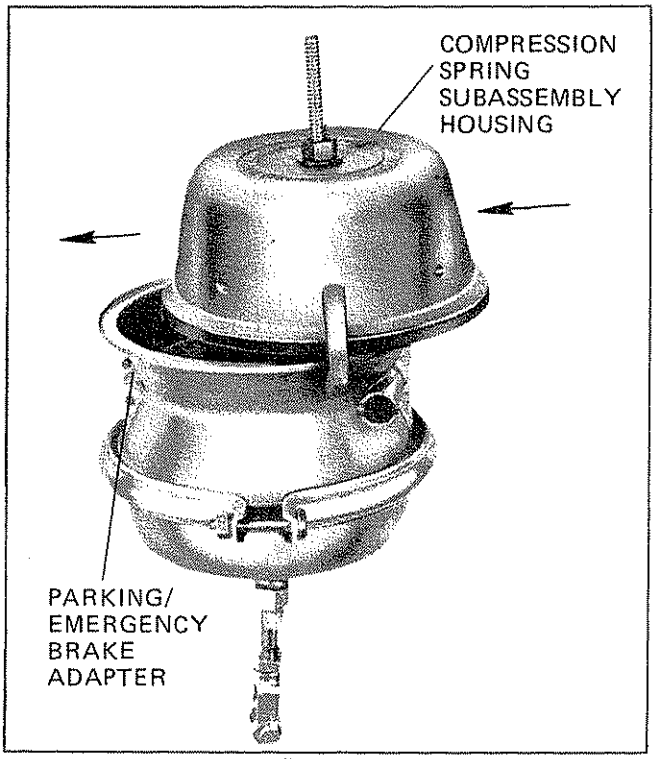


Fig. 17

housing. Slide the compression spring subassembly housing onto the parking/emergency brake adapter, as shown in Fig. 17. Make certain that the housing flanges are aligned with the parking/emergency brake diaphragm flange.

12. Install the parking/emergency brake clamp ring over the flange. See Fig. 14. Tighten the clamp ring nuts to 25-35 ft-lbs (34-47 N·m), then use a soft hammer to tap the circumference of the clamp ring to further ensure seating of the ring. Tighten the clamp ring nuts again to 25-35 ft-lbs (34-47 N·m).

13. Attach an air line to the service brake inlet, and apply 100-125 psi (689-861 kPa) air pressure. Soap test the service brake clamp ring area to verify a leak-free assembly. If a leak is discovered, disassemble the unit, then position and assemble the parts. If leaking persists, disassemble the unit and inspect for damaged parts. Replace damaged parts with new ones, and assemble, using the instructions given in this subject. Test for leaks until the unit tests out leak-free. If leakage persists, install a new or factory rebuilt service brake chamber assembly. If servicing a single service brake chamber, proceed to step 15.

14. Attach an air line to the parking/emergency brake inlet, and apply 100-125 psi (689-861 kPa) air pressure. Soap test the parking/emergency brake clamp ring area to verify a leak-free assembly. If a leak is discovered, disassemble the unit, then position and assemble the parts. If leaking persists, disassemble the unit and inspect for damaged parts. Replace damaged parts with new ones, and assemble, using the instructions given in this subject. Test for leaks until the unit tests out leak-free. If leakage persists, install a new or factory rebuilt parking/emergency brake chamber assembly.

15. Install the brake chamber on the vehicle. For instructions, refer to "BRAKE CHAMBER REMOVAL AND INSTALLATION."

PARKING/EMERGENCY BRAKE OR SERVICE BRAKE DIAPHRAGM REPLACEMENT

NOTE: If, during replacement of the parking/emergency brake or service brake diaphragm, it is discovered that other components of the brake chamber require servicing, refer to "BRAKE CHAMBER DISASSEMBLY, CLEANING AND INSPECTING, AND ASSEMBLY," for instructions.

1. Chock the vehicle tires, then drain the air from the air reservoirs. Disconnect the air lines from the brake chambers, marking the lines for later assembly. Take care to prevent dirt or grease from entering the lines or the fittings.

2. If servicing a single service brake chamber, proceed to step 7. If servicing the service and parking/emergency brake chambers, manually compress the compression spring. For instructions, refer to "PARKING/EMERGENCY BRAKE MANUAL RELEASE."

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

3. After performing the steps described under "PARKING/EMERGENCY BRAKE MANUAL RELEASE," loosen the nuts on the parking/emergency brake clamp ring. Remove the clamp ring assembly, shown in Fig. 14, then slide the compression spring subassembly housing from the parking/emergency brake adapter. See Fig. 15.

4. Remove the parking/emergency brake diaphragm.

5. Place the new parking/emergency brake diaphragm into the compression spring housing. Slide the compression spring subassembly housing onto the parking/emergency brake adapter, as shown in Fig. 17. Make certain that the housing flanges are aligned with the parking/emergency brake diaphragm flange.

6. Install the parking/emergency brake clamp ring over the flange. See Fig. 14. Tighten the clamp ring nuts to 25-35 ft-lbs (34-47 N·m), then use a soft hammer to tap the circumference of the clamp ring to further ensure seating of the ring. Tighten the clamp ring nuts again to 25-35 ft-lbs (34-47 N·m).

7. Clamp a pair of vise-grip pliers onto the service brake pushrod at the base of the service brake housing. This will prevent the service brake pushrod from being drawn into the service brake return spring, when the service brake clamp ring assembly is removed.

8. Supporting the compression spring subassembly housing, or service brake pressure chamber, as equipped, with one hand, loosen the nuts on the service brake clamp ring. Spread the ring enough to separate the parking/emergency brake adapter, or service brake pressure chamber, from the service brake housing. Remove the parking/emergency brake portion, or service brake pressure chamber, from the service brake housing. See Fig. 15.

9. Remove the service brake diaphragm.

10. Clean the internal parts of the service brake housing with a cleaning solvent, then lubricate all inside surfaces with a low-temperature moly-type lubricant.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

11. Place the new service brake diaphragm over the service brake pushrod. Position the parking/emergency brake portion, or service brake pressure chamber, as equipped, over the diaphragm, on top of the service brake housing. Make certain that the housing flanges are aligned with the diaphragm flange.

12. Install the service brake clamp ring assembly over the flanges. Tighten the clamp ring nuts to 25-35 ft-lbs (34-47 N·m), then use a soft hammer to tap the circumference of the clamp ring to further ensure seating. Tighten the clamp ring nuts again to 25-35 ft-lbs (34-47 N·m).

13. Remove the vise-grip pliers from the service brake pushrod.

14. Attach an air line to the service brake inlet, and apply 100-125 psi (689-861 kPa) air pressure. Soap test the service brake clamp ring area to verify a leak-free assembly. If a leak is discovered, disassemble the unit, then position and assemble the parts. If leaking persists, disassemble the unit and inspect for damaged parts. Replace damaged parts with new ones, and assemble, using the instructions given in this subject. Test for leaks until the unit tests out leak-free. If leakage persists, install a new or factory rebuilt brake service chamber assembly. If servicing a single service brake chamber, proceed to step 17.

15. Attach an air line to the parking/emergency brake inlet, and apply 100-125 psi (689-861 kPa) air pressure. Soap test the parking/emergency brake clamp ring area to verify a leak-free assembly. If a leak is discovered, disassemble the unit, then position and assemble

ANCHORLOK S-CAM SERVICE AND PARKING/EMERGENCY BRAKE CHAMBERS

the parts. If leaking persists, disassemble the unit and inspect for damaged parts. Replace damaged parts with new ones, and assemble, using the instructions given in this subject. Test for leaks until the unit tests out leak-free. If leakage persists, install a new or factory rebuilt parking/emergency brake chamber assembly.

16. Release the brake chamber compression spring. For instructions, refer to "PARKING/EMERGENCY BRAKE MANUAL RESET."

WARNING: Operating the vehicle with the compression spring manually compressed will result in the loss of parking and emergency braking ability.

17. Connect the lines to the brake chambers as previously marked. Tighten the fittings as described in the 12 Group of the Freightliner Maintenance and Lube Manual.

18. Perform the inspection procedures given in the 12 Group of the Freightliner Maintenance and Lube Manual before operating the vehicle.

19. Remove the chocks from the vehicle tires.

TROUBLESHOOTING

Refer to the air brake system troubleshooting subject located in the 12 Group of this manual.

GENERAL INFORMATION

The Berg service brake actuator may be used by itself, for routine vehicle braking; or it may be used in combination with the Berg Shur-Brake spring brake actuator, for routine braking plus parking and emergency braking. Fig. 1 shows the combined service and spring brake actuator. Operation and maintenance of the spring brake chamber is covered in subject 32-12530. With the combined actuator unit, the brakes can be applied by two separate and distinct systems: (1) by the service brake chamber, through the application of air pressure controlled by the brake pedal, or (2) by the spring brake chamber, through the exhaustion of air pressure, either through the parking brake control valve in the cab or through accidental loss of air from the service brake system. If there is insufficient air pressure in the service brake system, the vehicle cannot be moved without first manually releasing the spring brake. Refer to Fig. 2 for parts identification guide.

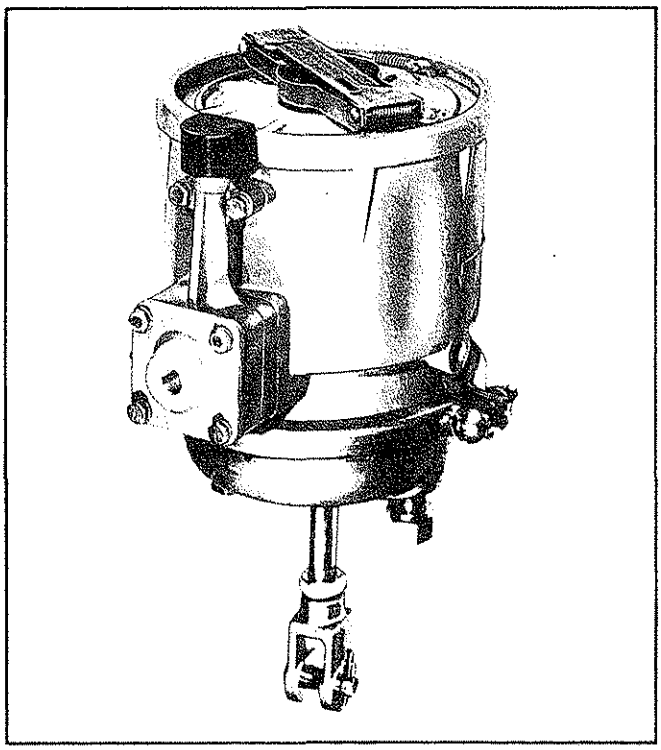


Fig. 1

PRINCIPLES OF OPERATION

The service brake is operated by means of the foot brake control valve in the cab of the vehicle. The service brake pushrod is actuated by an air-retaining diaphragm held in place between the spring brake housing and the service brake housing by means of a clamp ring assembly. Air pressure from the service brake system enters the service brake chamber above the diaphragm and exerts a force on the service brake pushrod, which in turn forces the brake shoes against the drum through the slack adjuster and the "S-cam" mechanism. When the brake pedal is released, air is exhausted from the service brake chamber, and the return spring moves the diaphragm, pushrod and brake linkage to the "off" position, releasing the brakes (Fig. 2).

SERVICE OPERATIONS

INSPECTION

At each brake adjustment interval, the following checks should be made. Refer to the maintenance schedules in the Freightliner Maintenance Manual for adjustment intervals.

1. Visually inspect the exterior of the Shur-Brake actuator for damage from outside sources. Replace any damaged parts immediately.

2. On units equipped with spring brakes, make certain that the emergency release mechanism is intact and in good operating condition, free from binding or stripped threads.

3. Make certain that the clamp ring assembly is securely in place and the clamp ring nuts tightened to 25-35 ft-lbs torque.

WARNING: On units equipped with spring brakes, never loosen the brake actuator clamp ring assembly unless the power spring is manually compressed by the emergency release mechanism. Loosening the clamp ring without first manually compressing the power spring could result in a hazardous working condition.

4. Make certain that the service brake pushrod is not binding or misaligned from the service brake chamber to the slack adjuster.

5. Make certain that the clevis pin is in the clevis and secured with a locked cotter pin.

6. Inspect air line(s) and fittings leading to the actuator for damage and tightness. Tighten any

1. Clevis
2. Jam Nut, Clevis
3. Service Brake Housing
4. Service Brake Return Spring
5. Service Brake Diaphragm
6. Clamp Ring Assembly
7. Service Brake Pushrod
8. Mounting Stud Lockwasher (2)
9. Mounting Stud Nut (2)
10. Cotter Pin
11. Clevis Pin
12. Clamp Ring Nut (2)
13. Clamp Ring Lockwasher (2)
14. Clamp Ring Carriage Bolt (2)
15. Rear Cover Plate O-Ring Seal (Outer)
16. Piston O-Ring Seal
17. Rear Cover Plate O-Ring Seal (Inner)
18. Release Nut Snap Ring
19. Emergency Release Handle
20. Release Nut
21. Release Nut Retaining Pin
22. Rear Cover Plate
23. Spring Brake Power Spring
24. Rear Cover Plate Retaining Ring (Half)
25. Retaining Ring Separator Spring
26. Spring Brake Housing Cylinder
27. Check Valve Snap Ring
28. Quick Release Valve Boot
29. Check Valve Washer
30. Check Valve Spring
31. Check Ball
32. Power Spring Vent O-Ring Seal
33. Tooth Washer
34. Spring Brake Piston
35. Emergency Release Bolt
36. Quick Release Valve Cover Capscrews (2)
37. Quick Release Valve Cover O-Ring Seal
38. Quick Release Valve Diaphragm
39. Push Pad Screw
40. Spring Brake Port O-Ring Seal
41. Quick Release Valve Cover
42. Quick Release Valve Cover Capscrews (2)
43. Quick Release Valve Casting
44. Piston Shaft Bushing O-Ring (Inner)
45. Piston Shaft Bushing O-Ring (Outer)
46. Spring Brake Push Pad
47. Spring Brake Piston Shaft
48. Pipe Plug
49. Bushing Retainer Cap Screws (4)
50. Nylon Piston Shaft Bushing
51. Bushing Retainer Cap
52. Piston "U" Seal
53. Nylon Glide Ring
54. Spring Brake Piston Nut
55. Rear Cover Plate Retaining Ring (Half)
56. Quick Release Valve Capscrews (2)
57. Quick Release Valve Lockwashers (6)

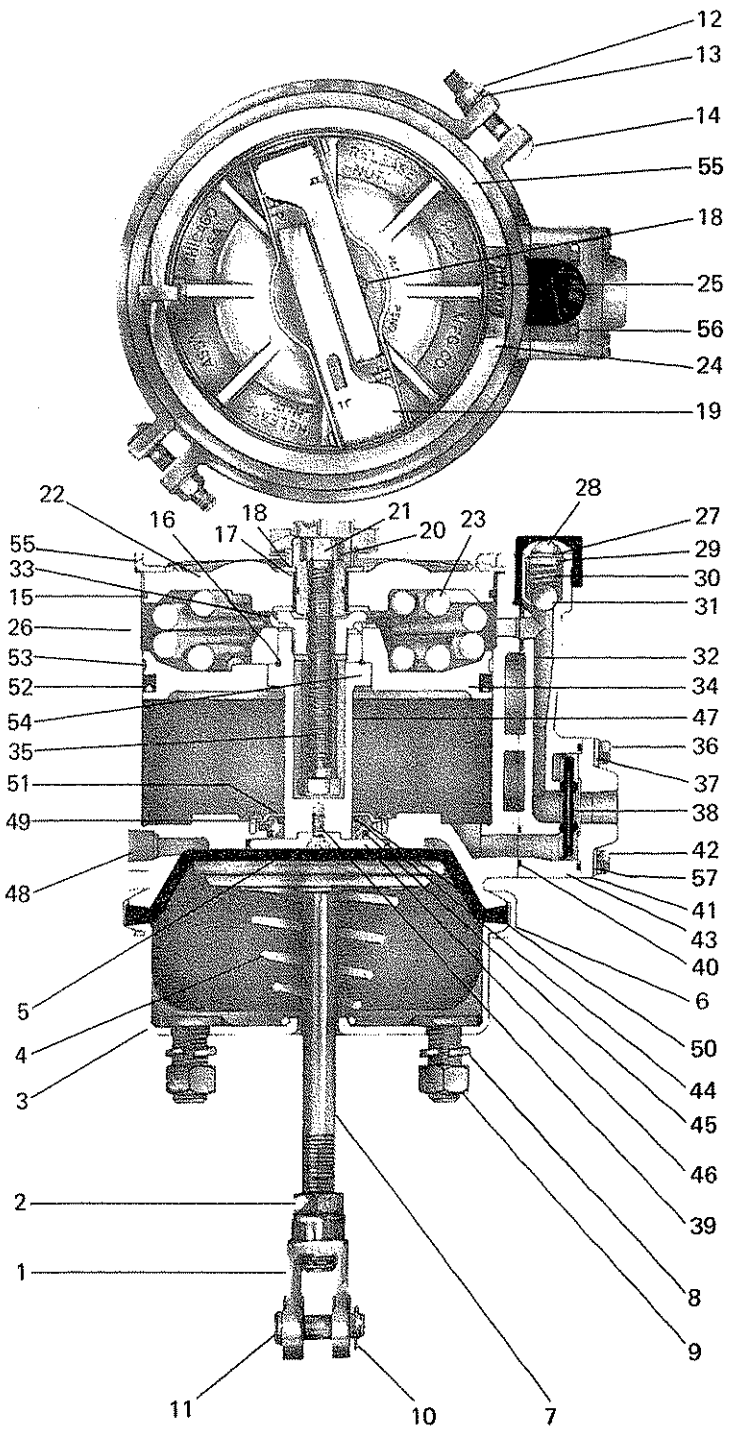


Fig. 2

loose air lines and fittings to stop leakage. Replace any damaged air lines and/or fittings immediately.

7. Make certain that the Shur-Brake mounting stud nuts are secure and tightened to 150 ft-lbs torque.

WARNING: Failure to carry out any of the above checks could result in a hazardous operating condition.

GENERAL REPAIR INSTRUCTIONS

Fig. 2 is a sectional view of the combined Berg Shur-Brake service and spring brake actuator unit, together with a parts identification guide. Refer to Fig. 2 for the location and identification of all parts.

1. All spring brakes contain a large preloaded power spring to provide the force necessary to stop and hold a heavily laden vehicle. Actuator units equipped with spring brakes should be handled with extreme care and caution at all times to prevent accidental release of the power spring.

2. On units equipped with spring brakes, *always* follow complete "POWER SPRING MANUAL COMPRESSION (SPRING BRAKE RELEASE)" instructions before any disassembly operation.

3. After disassembly, wash disassembled parts thoroughly in cleaning solvent.

4. After cleaning, examine all parts for wear, deterioration or other damage. Replace all parts on which wear, damage or deterioration is present.

5. Before reassembly, lubricate all inside surfaces with molybdenum disulfide grease.

6. Use *extreme caution* when disassembling any spring brake. Follow instructions carefully and precisely. *Do not take short cuts.*

WARNING: Failure to comply with the above recommendations could result in a hazardous workshop environment and/or a hazardous vehicle operating condition.

POWER SPRING MANUAL COMPRESSION (SPRING BRAKE RELEASE)

Refer to Fig. 2 for parts identification guide.

1. Block the wheels to prevent vehicle movement while the brake actuators are being serviced.

WARNING: Failure to block the vehicle wheels could result in a hazardous working condition.

2. If possible, charge the spring brake chamber with at least 60 psi air pressure. This will reduce the manual effort required to rotate the emergency release handle.

WARNING: When manually releasing the spring brake, stay clear of the rear of the spring brake unit. Accidental release of the power spring because of damaged or improperly seated parts could result in serious personal injury.

3. Unfold the handle on the emergency release mechanism (Fig. 3). Rotate the emergency release handle in a clockwise direction until the brake is released and the power spring is fully compressed. At that time, the handle will turn no further, and the release bolt will project approximately 2" through the rear cover plate. Release air pressure (if used) from the spring brake chamber by depressing foot brake pedal repeatedly until air pressure has been exhausted from system.

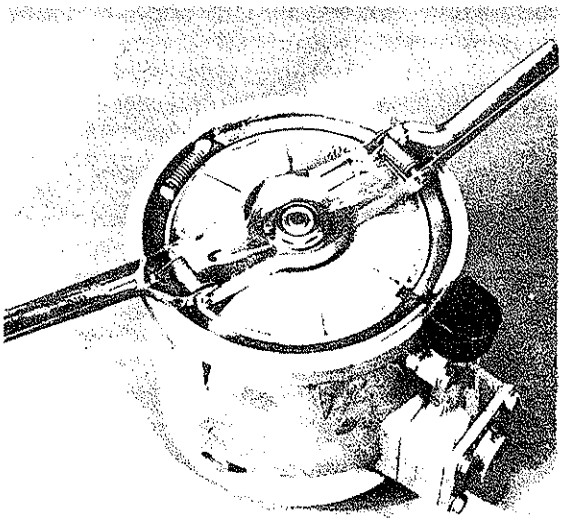


Fig. 3

WARNING: Do not attempt to disassemble the spring brake actuator if the power spring is not fully compressed. Any attempt to do so exposes the mechanic to extreme personal danger. A brake actuator with a defective manual spring brake release mechanism should be removed as a unit and a new or rebuilt unit installed.

POWER SPRING MANUAL RELEASE (SPRING BRAKE RESET)

Refer to Fig. 2 for parts identification guide.

1. Make certain that the clamp ring assembly is firmly in place and the securing nuts are torqued to 25-35 ft-lbs. Make sure the rear cover plate retaining ring halves are seated in the groove in the spring brake housing.

WARNING: Failure to ensure that the clamp ring is firmly in place with the securing nuts torqued to specifications and that the rear cover plate retaining ring halves are seated could result in a hazardous working condition and/or a hazardous vehicle operating condition. When resetting the spring brake, stay clear of the rear of the spring brake unit. Accidental release of the power spring could result in severe personal injury.

2. If possible, charge the spring brake chamber with at least 60 psi air pressure. This will reduce the manual effort required to rotate the emergency release handle.

3. Unfold the handle on the emergency release mechanism and rotate it in a counterclockwise direction until the top of the release bolt is flush with the hex nut on the handle as shown in Fig. 3. Fold the handle down.

4. Release air pressure (if used) from the spring brake chamber.

REMOVAL OF THE BRAKE ACTUATOR FROM VEHICLE

Refer to Fig. 2 for parts identification guide.

1. On units equipped with spring brakes, manually compress the power spring following prior "POWER SPRING MANUAL COMPRESSION" instructions.
2. With the vehicle wheels safety blocked, release the air pressure from the system by opening wet tank draw valve then disconnect all air lines leading to the brake actuator. Take special care to prevent dirt or grease from entering the air lines or fittings.
3. Remove the cotter pin from the clevis pin, then remove the clevis pin from the clevis.
4. Remove the mounting stud nuts and lockwashers. The brake actuator is now free to be removed from the vehicle.

DISASSEMBLY OF THE SERVICE BRAKE ACTUATOR

IMPORTANT: The following instructions for disassembly of the Shur-Brake service brake actuator apply to service performed with the unit removed from the vehicle. Removal of the brake actuator from the vehicle, however, is not absolutely necessary unless the service brake pushrod and pushrod return spring are to be serviced. If replacement of the service brake diaphragm is to be performed with the brake actuator unit installed on the vehicle, follow "SERVICE BRAKE DIAPHRAGM REPLACEMENT" instructions.

1. Follow prior "REMOVAL OF THE BRAKE ACTUATOR FROM VEHICLE" instructions.
2. Clamp a pair of vise grip pliers to the service brake pushrod at the base of the service brake housing. This will prevent the pushrod from being drawn into the service brake housing by the service brake return spring when the clamp ring is removed.

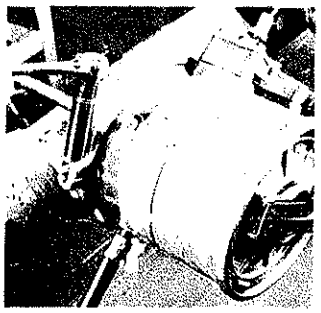


Fig. 4

3. Loosen the nuts on the service brake clamp ring. Spread the ring enough to separate the spring brake actuator (on units equipped with

spring brakes) or the service brake pressure housing (on units without spring brakes) from the service brake housing. (Fig. 4) Remove the spring brake actuator or service brake pressure chamber together with the service brake clamp ring.

4. Remove the service brake diaphragm.

5. Unlock the clevis jam nut, then unscrew the clevis from the end of the service brake pushrod.

6. Position the service brake actuator on a clean, flat surface with the housing opening downward and the clevis end of the pushrod pointing upward. Compress the service brake return spring by pressing down on the service brake housing. Remove the vise-grip pliers from the pushrod, then gently release the pressure from the service brake housing.

7. Remove the service brake pushrod, and return spring from the service brake housing.

8. Thoroughly clean all parts with cleaning solvent. Carefully examine all parts for wear, deterioration or other damage. Replace any defective parts.

ASSEMBLY OF THE SERVICE BRAKE ACTUATOR

Refer to Fig. 2 for parts identification guide.

1. Before assembly, generously coat all parts, and lubricate all inside surfaces with molybdenum disulfide grease.

2. Slide the service brake return spring over the pushrod shaft, with the larger end of the spring against the pushrod plate, then insert the shaft through the service brake housing.

3. Position the service brake subassembly on a clean, flat surface with the housing opening downward, and the clevis end of the pushrod pointing upward. Compress the service brake return spring by pressing downward on the service brake housing. Clamp a pair of vise-grip pliers to the service brake pushrod at the base of the service brake housing to maintain compression of the return spring.

4. Place the service brake diaphragm over the service brake pushrod. On units equipped with spring brakes, position the spring brake actuator over the diaphragm, on top of the service brake actuator. On units without spring brakes, position the service brake pressure chamber over the diaphragm. Align the housing flanges with the diaphragm lip.

5. Install the service brake clamp ring over the flanges. Make certain that the lockwashers are in place on the clamp ring carriage bolts. Tighten the clamp ring nuts to 25-35 ft-lbs torque, then, with a soft hammer, tap the circumference of the clamp ring to further ensure seating. Retighten the clamp ring nuts to 25-35 ft-lbs torque.

6. Remove the vise-grip pliers from the service brake pushrod, then install the clevis and jam nut on the pushrod end.

7. Attach an air line to the service brake inlet and apply 100-125 psi air pressure. Soap test the service brake clamp ring area to verify leak-free assembly. If a leak is discovered, disassemble the unit, reposition the parts and reassemble. If the leaking persists, disassemble and inspect for damaged parts. Replace any worn, damaged or defective parts with new ones. Repeat the soap test. If leaking is still present install a new or rebuilt actuator unit.

INSTALLATION OF THE BRAKE ACTUATOR ON VEHICLE

Refer to Fig. 2 for parts identification guide.

1. Place the brake actuator unit on the mounting bracket with the mounting studs in position through the mounting holes.

2. Install the lockwashers and nuts on the mounting studs. Tighten the stud nuts to 150 ft-lbs torque.

3. Insert the clevis pin in the clevis, then install the cotter pin in the clevis pin. Lock the cotter pin in place.

WARNING: Failure to install and lock the cotter pin could result in a hazardous operating condition.

4. On units equipped with spring brakes, follow prior "POWER SPRING MANUAL RELEASE" instructions.

WARNING: Operating a vehicle with the power spring compressed could result in a hazardous operating condition, since the parking brake and emergency brake are inoperable when the power spring is compressed.

5. Taking care to prevent dirt or grease from entering the air line(s) or fittings, connect the air line(s) to the inlet(s) as marked on the actuator housing.

6. Adjust the slack adjuster and S-cam linkage, following adjustment instructions in Group 11 of the White Freightliner Service Manual.

7. Follow prior "INSPECTION" instructions before operating the vehicle.

WARNING: Failure to fully inspect the brake system following shop service could result in a hazardous vehicle operating condition.

SERVICE BRAKE DIAPHRAGM REPLACEMENT

Refer to Fig. 2 for parts identification guide.

IMPORTANT: The following instructions apply to service performed with the unit mounted on the vehicle. If the service brake pushrod and return spring are to be serviced, follow prior "DISASSEMBLY OF THE SERVICE BRAKE ACTUATOR" instructions.

1. Block the wheels to prevent vehicle movement, then release the air from the air brake system.

WARNING: Failure to block the wheels and release the air pressure from the system could result in a hazardous working condition.

2. On units equipped with spring brakes, follow prior "POWER SPRING MANUAL COMPRESSION (SPRING BRAKE RELEASE)" instructions.

3. Taking care to prevent dirt or grease from entering the air lines or fittings, disconnect all air lines leading to the brake actuator.

4. Loosen the nuts on the service brake clamp ring. Spread the ring enough to separate the spring brake actuator (on units equipped with spring brakes) or the service brake pressure housing (on units without spring brakes) from the service brake housing. Remove the spring brake actuator or service brake pressure chamber, together with the service brake clamp ring.

5. Remove the service brake diaphragm.

6. Clean the internal parts of the service brake actuator with cleaning solvent, then lubricate all inside surfaces with molybdenum disulfide grease.

7. Place the service brake diaphragm over the service brake pushrod. On units equipped with spring brakes, position the spring brake actuator over the diaphragm, on top of the service brake actuator. On units without spring brakes, position the service brake pressure chamber over the diaphragm. Align the housing flanges with the diaphragm lip.

8. Install the service brake clamp ring over the flanges. Make certain that the lockwashers are in place on the clamp ring carriage bolts. Tighten the clamp ring nuts to 25-35 ft-lbs torque, then, with a soft hammer, tap the circumference of the clamp ring to further ensure seating. Retighten the clamp ring nuts to 25-35 ft-lbs torque.

9. Attach an air line to the service brake inlet and apply 100-125 psi air pressure. Soap test the clamp ring area to verify leak-free assembly. If a leak is discovered, disassemble the unit, reposition the parts and reassemble. If the leaking persists, disassemble and inspect for damaged parts. Replace any defective parts with new ones. Repeat the soap test. If leaking is still present, install a new or rebuilt actuator unit.

10. On units equipped with spring brakes follow prior "POWER SPRING MANUAL RELEASE" (SPRING BRAKE RESET) instructions.

WARNING: Operating the vehicle with the power spring compressed could result in a hazardous operating condition, since the parking and emergency brake is inoperable when the power spring is compressed.

11. Taking special care to prevent dirt or grease from entering line(s) or fittings, connect the air line(s) to the inlet(s), as marked on the actuator housing.

12. Adjust the slack adjuster and S-cam linkage, following instructions in Group 11 of the White Freightliner Service Manual.

13. Follow prior "INSPECTION" instructions before operating the vehicle.

WARNING: Failure to fully inspect the brake system before operating the vehicle could result in a hazardous operating condition.

LUBRICATION

Regular lubrication of the Shur-Brake actuator is not required. However, if the unit is disassembled, all parts should be cleaned with cleaning solvent, and a thin coating of molybdenum disulfide grease applied to all inside parts and surfaces.

TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Service brakes fail to apply or apply slowly.	Leaking diaphragm.	Check for leaks around the pushrod opening in the service brake housing when the service brake is applied. If leaking is present, replace the diaphragm.
	Blocked or leaking lines in the service brake system.	Check air lines, valves and connections for restrictions and leaks. Tighten loose fittings, unblock restricted lines, and replace damaged parts.
	Improperly adjusted slack adjuster in the "S-cam" linkage.	Refer to Section 11 in the Freightliner Service Manual for adjustement procedure.
	Worn linings or drums.	Refer to Section 11 in the Freightliner Service Manual for service instructions on drums and linings.
	Loose or damaged clamp ring on the service brake housing.	Attach an air line to the service brake inlet and apply a pressure of 100-125 psi. Soap test the service brake clamp ring area to verify leak-free assembly. If a leak is discovered, disassemble the unit, reposition the parts and reassemble. If the leaking persists, disassemble and inspect for damaged parts. Replace damaged parts with new ones.
	Low service brake line pressure caused by malfunctioning brake foot control valve and/or air compression.	Refer to Section 12 in the Freightliner Service Manual for service instructions on the brake foot control valve, and Section 01 for service instructions on the compressor.
Service brakes slow in releasing.	"S-cam" linkage binding.	Check for worn, damaged or deteriorated parts. in the linkage. Check for lubrication. Replace defective parts, and lubricate dry linkage.
	Malfunctioning spring brake unit.	Refer to Subject 32-12530 in the Freightliner Service Manual for service instructions on the spring brake unit.

MIDLAND-ROSS SERVICE BRAKE CHAMBER

GENERAL DESCRIPTION

Brake chambers are used to convert compressed air energy into mechanical force and motion necessary to apply the brakes. Two of these units are used to operate the brakes on each axle.

The brake chamber consists of two dished metal sections, namely, the cover assembly and the body assembly, which are separated by a nylon-neoprene diaphragm. The brake chamber assemblies are held together by a metal two-segment clamp ring. See Fig. 1.

In front of the diaphragm are the body, push rod assembly, and a push rod spring. The threaded push rod assembly extends through the bottom of the body for connection to the yoke. See Fig. 2.

Different size brake chambers are identified by numbers which specify the effective area of the diaphragm. For example, a type 30 brake chamber has 30 square inches of effective area.

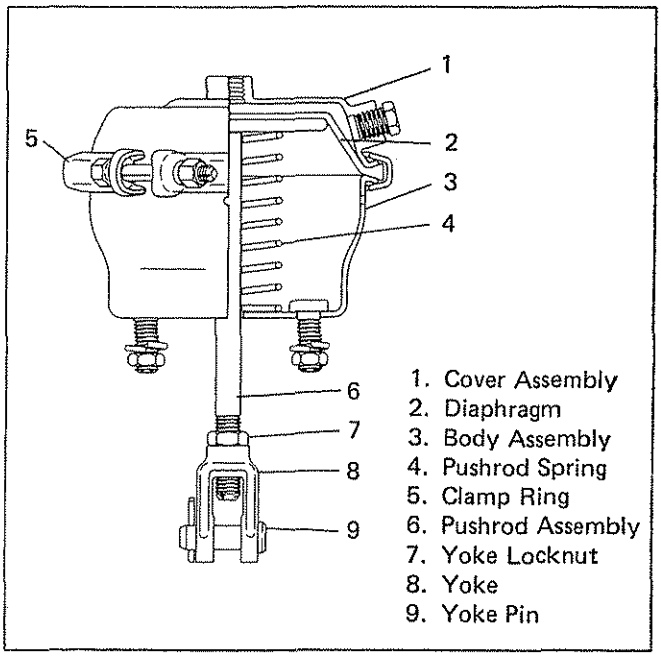


Fig. 1, Sectional View

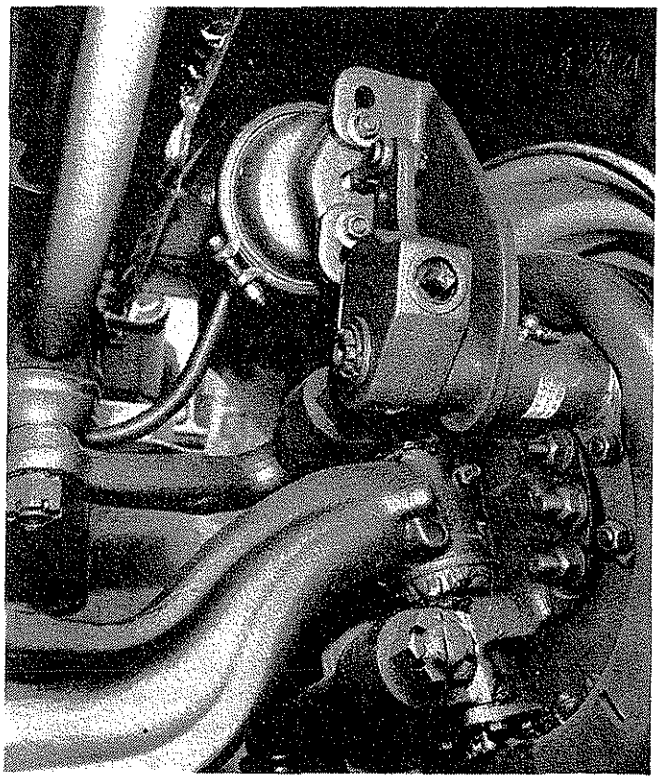


Fig. 2

PRINCIPLES OF OPERATION

The greater the air pressure admitted to the brake chamber, the greater the force applied by the push rod. Push rod force is determined by multiplying the delivered air pressure by the effective diaphragm area. For example, if 60 psi (413 kPa) is admitted to a type 30 brake chamber, the lineal force on the end of the push rod is approximately 1800 pounds (810 kg).

When the brake pedal is moved to apply the brakes, air pressure from the brake valve passes through the port in the brake chamber cover to move the diaphragm, and push rod assembly forward, compressing the spring, and applying mechanical force to rotate the slack adjuster, applying the brakes.

When the brake pedal is moved to the brake release position, air pressure behind the diaphragm exhausts through the quick release valve. The spring then returns the push rod assembly and diaphragm back to their previous positions.

BRAKE CONTROL 12
32-12445

MIDLAND-ROSS SERVICE BRAKE CHAMBER

SERVICE OPERATIONS

OPERATING AND LEAKAGE TESTS

NOTE: For these tests, the air system must be pressurized to 80 psi (551 kPa).

Operating Test

1. Chock the vehicle tires.
2. Apply the brakes, and observe that the push rods move out promptly and without binding.
3. Release the brakes, and observe that the push rods return to the released position promptly and without binding.
4. Check the push rod travel. The push rod travel should be as short as possible without the brakes dragging. If necessary, adjust the travel of the push rod at the slack adjuster. For instructions, refer to the 10 Group of the Freightliner Maintenance and Lube Manual.

Leakage Test

1. Make and hold a full brake application.
2. Using a soap solution, coat the clamp rings. If excessive leakage is detected, tighten the clamp rings only enough to reduce the leakage. *Do not overtighten,* as this can distort the flange sealing surface or the clamp rings.

NOTE: Leakage exceeding a 1-inch (25 mm) soap bubble within five seconds is excessive leakage.

3. Coat the area around the push rod hole. No leakage is permitted. If leakage is detected, replace the diaphragm.

DIAPHRAGM REPLACEMENT (Refer to Fig. 1)

The following steps are for service of a leaking brake chamber *diaphragm only.* If any other problems are noted with the brake chamber, refer to "BRAKE CHAMBER REMOVAL," and "BRAKE CHAMBER DISASSEMBLY, INSPECTION AND CLEANING, AND ASSEMBLY."

1. Chock the vehicle tires.
2. Release the air pressure in all reservoirs, and air lines.

WARNING: When draining the air system, do not look into the air jets or direct them toward another person, as dirt or sludge particles may be entrained in the airstream. Hoses which contain air pressure should not be disconnected since they may whip as air escapes from the line. Follow the manufacturers' recommended procedures in working on any air device so as to avoid injury or damage from parts which when released, are subject to mechanical (spring), or pneumatic propulsion. Failure to take all necessary precautions during service operations of the air brake system can cause personal injury.

3. Back the slack adjuster off and pull out the push rod (Fig. 1), clamping the rod at the chamber body. The push rod should be protected so that it will not be damaged.
4. Using a marking pen, mark a reference line on the chamber parts so that they may be assembled in the same relationship. See Fig. 3.
5. Remove the clamp rings by completely removing one bolt and locknut and loosening the other.
6. Remove the cover assembly and replace the diaphragm.
7. Position the cover assembly and clamp rings (aligned with the reference mark), and install

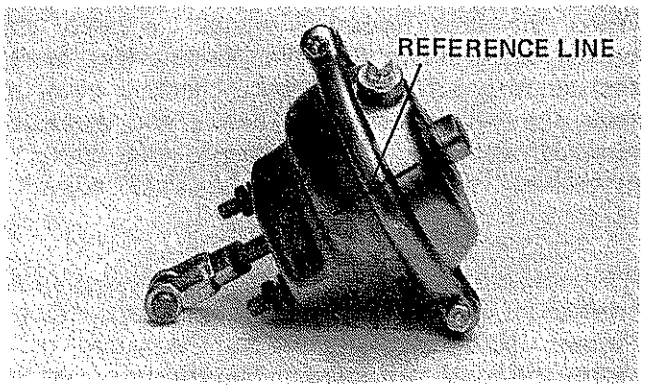


Fig. 3

MIDLAND-ROSS SERVICE BRAKE CHAMBER

the clamp ring nuts and bolts. Tighten these nuts evenly to eliminate leakage.

8. Release the grip on the pushrod.

9. Whenever a brake chamber is removed or disassembled, perform the tests given under "OPERATING AND LEAKAGE TESTS."

10. Check the angle formed by the centerline of the push rod and the slack adjuster. This angle should be greater than 90° in the released position, and approach 90° at the fully applied position. See Fig. 4. For adjustment instructions, refer to the 10 Group of the Freightliner Maintenance and Lube Manual.

11. Remove the chocks from the vehicle tires.

BRAKE CHAMBER REMOVAL

1. Chock the vehicle tires.

2. Release the air pressure in all reservoirs, and air lines.

WARNING: When draining the air system, do not look into the air jets or direct them toward another person, as dirt or sludge particles may be entrained in the airstream. Hoses which contain air pressure should not be disconnected since they may whip as air escapes from the line. Follow the manufacturers' recommended procedures in working on any air device so as to avoid injury or damage from parts which when released, are subject to mechanical (spring), or pneumatic propulsion. Failure to take all necessary precautions during service operations of the air brake system can cause personal injury.

3. Disconnect the air line from the chamber.

4. Remove the yoke pin from the slack adjuster.

5. Remove the brake chamber from the vehicle.

BRAKE CHAMBER DISASSEMBLY, INSPECTION AND CLEANING, AND ASSEMBLY

Disassembly (Refer to Fig. 1)

NOTE: If the brake chamber is to be dismantled without removing the body assembly from the vehicle, the slack adjuster should be backed off.

1. Clean the exterior of the brake chamber. Using a marking pen, mark a reference line on the chamber parts so that they may be assembled in the same relationship. See Fig. 3.

2. Pull out the push rod, then clamp it at the chamber body. The push rod should be protected so that it will not be damaged.

3. Remove the clamp ring by completely removing one bolt and nut and loosening the other.

4. Remove the clamp rings.

5. Remove the cover assembly and the diaphragm.

6. Remove the yoke locknut and yoke from the push rod and release the grip on the push rod being careful to contain the push rod assembly and body until the return spring is relaxed.

7. Remove the push rod assembly and spring.

Inspection and Cleaning

1. Clean all metal parts with cleaning solvent.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

2. Inspect the cover and the body for dents. Replace either one if the dents are too deep to be bumped out.

3. Inspect the diaphragm for wear or deterioration and replace if necessary. Otherwise, replace annually.

MIDLAND-ROSS SERVICE BRAKE CHAMBER

4. Inspect and replace those parts which are not considered serviceable.

Assembly (Refer to Fig. 1)

1. Stand the push rod assembly upright on a flat surface (if the chamber was removed from the vehicle).

2. Place the return spring on the push rod.

3. Place the body on the push rod assembly, and press the body down against the tension of the spring until the body bottoms out on the flat surface. Clamp the rod at the body, making sure to protect the rod from damage. Insert the push rod assembly through the body and clamp the rod, if the body was not removed from the vehicle.

4. Place the diaphragm in the body.

5. Place the cover assembly over the diaphragm, and align with the reference mark.

6. Install the clamp rings (aligned with the reference mark), and install the nuts and bolts. Tighten these nuts evenly to eliminate leakage.

7. Install the yoke locknut and yoke, and release the grip on the push rod.

8. If the brake chamber was disassembled and assembled without removing it from the vehicle, perform the tests under "OPERATING AND LEAKAGE TESTS."

BRAKE CHAMBER INSTALLATION

1. Mount the brake chamber on the mounting bracket. Install the washers and nuts over the mounting studs, then tighten the nuts to 40-50 ft-lbs (54-68 N·m).

2. Connect the yoke pin to the slack adjuster.

3. Check the angle formed by the centerline of the push rod and the slack adjuster. This angle should be greater than 90° in the released position, and approach 90° at the fully applied position. See Fig. 4. For adjustment instructions, refer to the 10 Group of the Freightliner Maintenance and Lube Manual.

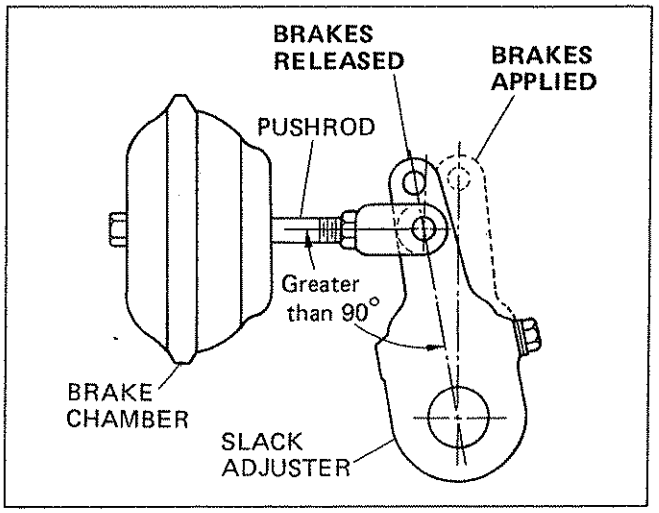


Fig. 4, Pushrod to Slack Adjuster Angle

4. Connect the air line to the chamber as follows:

   .1 Check to be sure hoses are properly supported and, if necessary, clamped to provide proper clearance.

   .2 Before connecting the air line to the brake chamber, make sure that the fittings are clean and free of foreign matter.

   .3 Connect the air line assembly as follows: Tighten the nut finger-tight; further tighten the nut (using a wrench) until a solid feeling is encountered, then tighten the nut one-sixth turn more.

5. Whenever a brake chamber is removed or disassembled, or whenever a new chamber is installed, perform the tests given under "OPERATING AND LEAKAGE TESTS."

6. Remove the chocks from the vehicle tires.

MIDLAND-ROSS SERVICE BRAKE CHAMBER

PREVENTIVE MAINTENANCE

Periodic maintenance of the brake chamber is required in order to ensure dependable operation. For instructions, refer to the 12 Group of the Freightliner Maintenance and Lube Manual.

TROUBLESHOOTING

For troubleshooting information, refer to "AIR BRAKE SYSTEM TROUBLESHOOTING," in the 12 Group of this manual.

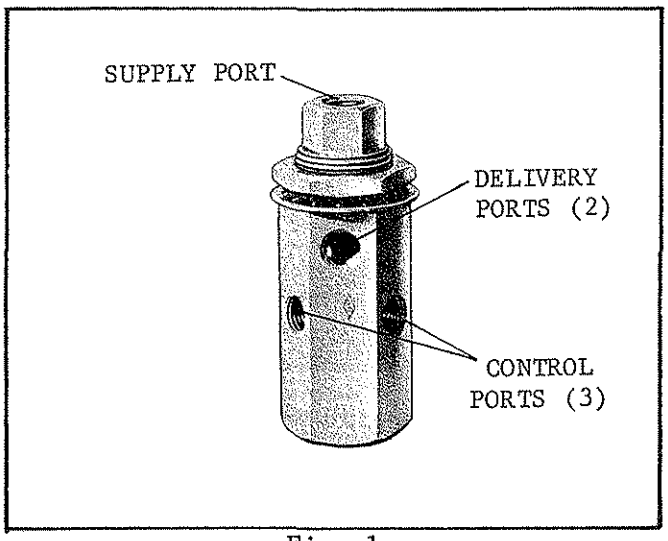


Fig. 1

GENERAL DESCRIPTION

The TR-2 inversion valve (Fig. 1) is used in combination with the DD-3 actuators, a third (isolated) reservoir, and a dash control valve in the Bendix-Westinghouse parking/emergency system. When the control valve is operated, the inversion valve operates, permitting air in the isolated reservoir to apply the brakes. The inversion valve also operates automatically when the air pressure drops to a predetermined level.

The TR-2 inversion valve employs a 1 1/4" diameter hole mounting. The valve serves as a manifold, having a total of seven (7) 1/4" pipe ports; three (3) control ports, two (2) delivery ports, one (1) supply port, and one (1) exhaust port. The exhaust port is protected by a diaphragm.

PRINCIPLES OF OPERATION

PARKING BRAKES OFF

With no service brake system air pressure, the inversion valve inlet valve is open and its exhaust is closed. On initial build-up, as air enters the isolated reservoir to which the inversion valve supply port is connected, it will pass by the open inlet and out the delivery ports. When service brake system air pressure reaches 50 to 60 psi, the control valve can be operated, and air will then pass from the control valve to the inversion valve. This air flows in one of the control ports and exerts a force on the inversion valve piston. At a pressure between 60 and 70 psi, the piston moves against the resistance of the two (2) piston springs. The piston exhaust seat moves away from the inlet and exhaust valve, opening the exhaust passage. The inlet valve spring, and supply air at the inlet valve, will cause it to seat. Air at the inversion valve delivery ports will now exhaust through the inversion valve exhaust port.

PARKING

The air at the inversion valve control ports is exhausted through the control valve exhaust when it is operated to the "Park" position. The piston springs will then cause the piston to move, seating on the inlet and exhaust valve. This will close the inversion valve exhaust port. The inlet valve is moved off its seat by the piston exhaust seat, so supply air from the isolated reservoir will pass by the open inlet, and out the delivery ports.

When the application is released by actuating the control valve to the release position, air passes into the inversion valve control port. The piston moves away from the inlet and exhaust valve, opening the inlet valve closes and air in the delivery ports will exhaust through the center of the piston and out the inversion valve exhaust port.

EMERGENCY

When air pressure in the service system, which is the pressure being delivered to the control port, drops to approximately 50 to 60 psi, the inversion valve reacts as if air pressure to the control ports has been cut off. The sequence of application and release events from that point on is the same as "PARKING".

SERVICE OPERATIONS

SERVICEABILITY TESTS

Operation

1. With air pressure up to governor cut-out pressure and the brakes released, operate the control valve to apply the brakes. Make certain the brakes apply.

2. Operate the control valve to release the parking brake application, and make certain that the delivered air from the inversion valve is released through the inversion valve exhaust port. The operation of the control valve will not necessarily complete the release of the brakes. A service brake application of 60-70 psi after operation of the control valve is necessary to complete brake release with DD-3 actuators.

Leakage

1. Start leakage tests with system pressure up to governor cut-out, and with brakes released.

2. Soap test the inversion valve to inspect for leakage. If any leakage occurs, it could be past the large piston O-ring, the piston stem O-ring, or the inlet valve or its seat. Leakage must not exceed a one-inch soap bubble in 3 seconds.

3. While the inversion valve is still in the above position, soap test the capnut for leakage past the seal ring. No leakage should occur.

4. Actuate dash control valve, applying parking brakes. Check the inversion valve exhaust for leaks at the exhaust seat. A one-inch soap bubble in three seconds is the maximum allowable.

IMPORTANT: If the valve does not operate as described in "Operation", above, or if leakage exceeds the amounts specified, the valve must be rebuilt or replaced with a new or rebuilt valve.

WARNING: Failure to repair or replace a leaking or malfunctioning inversion valve could result in a hazardous operating condition.

REMOVAL

1. Block and hold vehicle by means other than air brakes. Failure to do so could result in a hazardous work area.

2. Drain service and isolated reservoir air supplies by opening drain cocks.

3. Disconnect the air lines from the inversion valve.

4. Remove inversion valve mounting nut and remove valve.

DISASSEMBLY

1. Remove capnut with O-ring, and remove O-ring from capnut. (Fig. 2)

2. Remove inlet and exhaust valve spring and inlet and exhaust valve. (Fig. 2)

3. Remove exhaust check valve diaphragm capscrew with lockwasher, then remove diaphragm washer and diaphragm. (Fig. 2)

4. With a pair of retaining ring pliers, carefully remove retaining ring. (Fig. 2)

5. Remove cover plate and two (2) piston springs.

6. Remove piston with O-rings. (Fig. 2)

7. Remove piston O-rings from piston. (Fig. 2)

CLEANING AND INSPECTION

1. Wash all metal parts in clean solvent. Rubber parts should be wiped clean; Do not wash rubber parts in solvent.

2. Inspect all parts for wear, damage, or

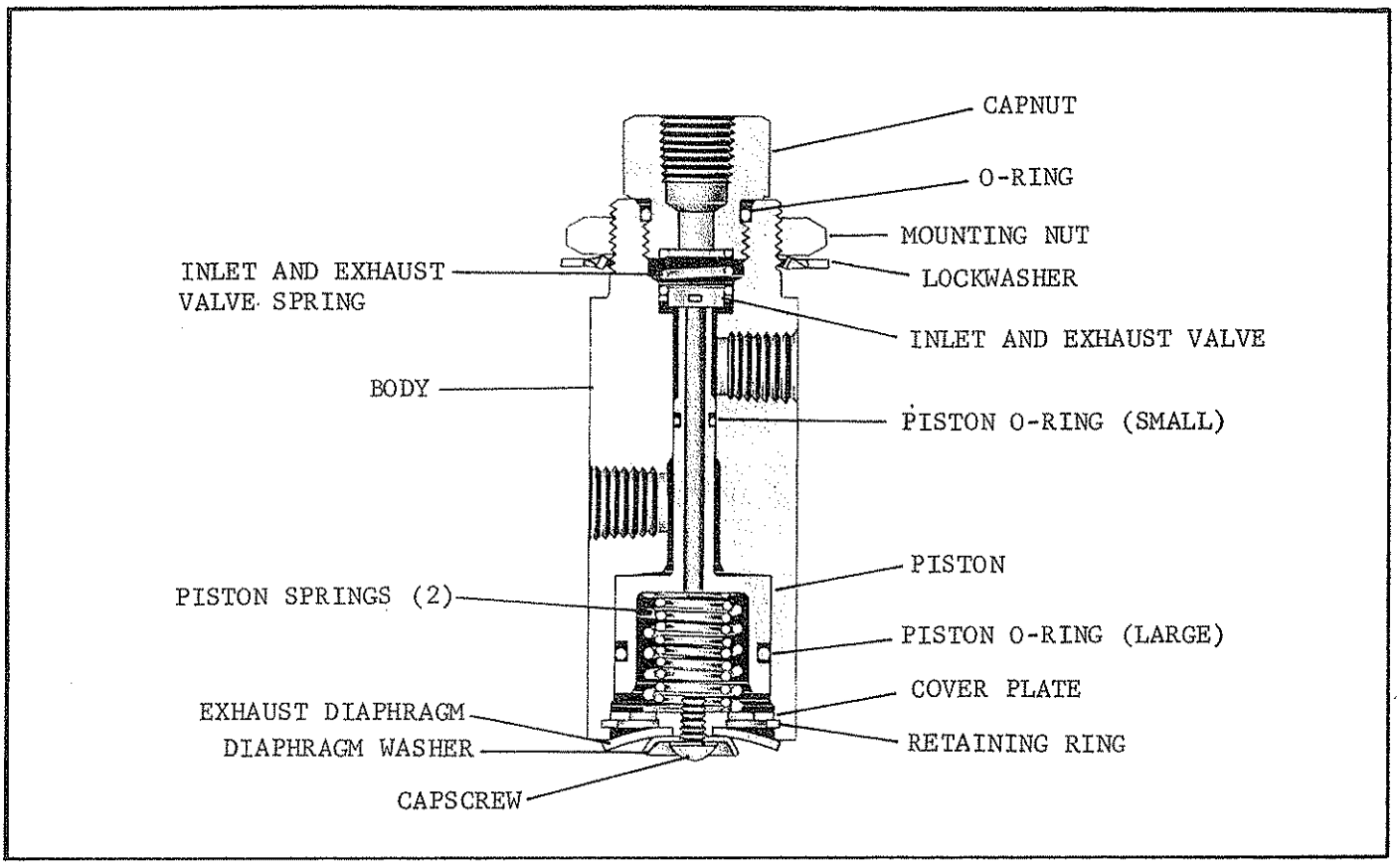


Fig. 2

deterioration. Replace worn, damaged, or deteriorated parts.

3. Check springs for cracks, corrosion, or distortion. Replace cracked, corroded, or distorted springs.

4. Inspect piston and its exhaust seat, body bores, and inlet valve seat for nicks or burrs. Replace any parts on which nicks or burrs are present.

WARNING: Failure to replace parts, as described above, could result in a hazardous operating condition.

ASSEMBLY

1. Before assembling the valve, lubricate the piston, O-rings, and body bores with N.L.G.I. Grade #1 lubricant.

2. Install piston O-rings on piston. (Fig. 2)

3. Install piston, with O-rings, in valve body. (Fig. 2)

4. Position piston springs, cover plate, and retaining ring in piston in that order. Press the cover plate and retaining ring down and snap the ring into the body groove with a pair of retaining ring pliers. (Fig. 2)

5. Install the exhaust diaphragm and diaphragm washer and secure with capscrew. (Fig. 2)

6. Position the inlet and exhaust valve in its bore. (Fig. 2)

7. Place the valve spring down over the inlet and exhaust valve. (Fig. 2)

8. Install the O-ring on the capnut. (Fig. 2)

9. Install the capnut with O-ring and tighten securely. (Fig. 2)

INSTALLATION

1. Clean all air lines that connect to the valve.

2. Mount valve securely with mounting nut and lockwasher.

3. Connect air lines.

TESTING THE REBUILT TR-2 INVERSION VALVE

The rebuilt inversion valve must pass the SERVICEABILITY TESTS, previously described. Failure to subject the rebuilt valve to these tests, and failure to make sure that the valve passes these tests, could result in a hazardous operating condition.

GENERAL INFORMATION

The air-sealed Shur-Brake is an air operated, axle mounted brake actuating unit. The complete unit (Fig. 1) consists of two separate chambers, the service brake chamber and the spring brake chamber, joined together by means of a clamp ring. Operation and maintenance of the service brake actuator is covered in Subject 32-12435 in the Freightliner Service Manual. The spring brake chamber is completely sealed to prevent the admission of outside air. The unit is designed so that under any condition of operation, all areas of the spring brake chamber are under a slight positive pressure to keep surrounding air, with its natural impurities, from entering the spring brake chamber.

With the Berg Shur-Brake actuator unit, the brakes can be applied by two separate and distinct systems: (1) by the service brake chamber, through the application of air pressure controlled by the brake pedal, or (2) by the spring brake chamber, through the exhaustion of air pressure, either through the parking brake control valve in the cab or through accidental loss of air from the service brake system. If there is insufficient air pressure in the air brake system, the vehicle cannot be moved without first manually releasing the spring brake. Refer to Fig. 2 for parts identification guide.

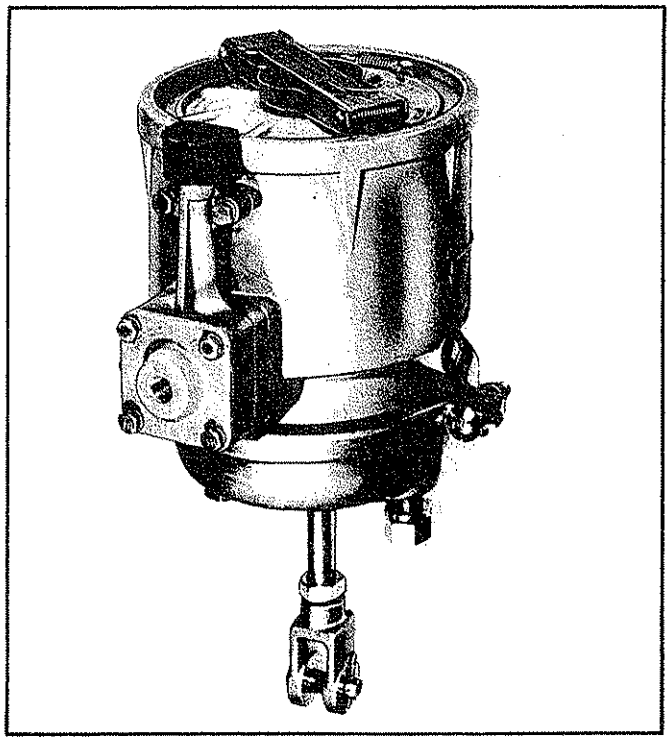


Fig. 1.

PRINCIPLES OF OPERATION

COMBINED PARKING AND EMERGENCY BRAKE

The spring brake contains a piston, behind which is a barrel-shaped power spring. Affixed to this piston is a shaft that extends into the service brake chamber, through an air-tight bushing, and bears against the diaphragm surface, so that the power spring force can be applied to the brake shoes through the pushrod, slack adjuster and camshaft mechanisms any time there is insufficient air pressure acting on the piston face to compress and contain the power spring forces. Air pressure acting on the piston face moves the piston and compresses the power spring to release the force from the brake shoes. See Fig. 2 for a sectional view and parts descriptions. A

Air pressure is supplied to the spring brake chamber from the air brake system reservoir through a control valve. This air pressure may be released from the spring brake chamber by means of a control valve in the cab to positively apply the spring brake when the vehicle is parked. When the parking brake control valve is in the released position, the pressure in the spring brake chamber is equal to the air pressure in the service brake system. If pressure decreases in the air brake system due to air leaks or usage, the pressure in the spring brake chamber will bleed off at the exhaust port through the quick release valve. When vehicle service brake system pressure drops below approximately 60 psi, the power spring overcomes that pressure and extends against the piston mechanism to apply the brakes.

The spring brake is completely sealed to prevent admission of atmospheric air under any condition of operation. An integral quick release valve in the spring brake supply port controls the flow of air in the spring brake chamber, so that under brake application conditions, air pressure from the piston is directed to the back side of the piston. In this way, no outside air is sucked into the spring brake chamber to displace the increased volume caused by piston movement. Excess air pressure is exhausted to the atmosphere through a one-way check valve, so arranged to shut off under any back-flow condition. Under spring brake release conditions, the quick release valve at the spring brake chamber port directs air pressure to the pressure side of the piston and, as the air pressure moves the piston against the force of the spring, the displaced air on the spring side of the piston is exhausted to the atmosphere through the one-way check valve. In this way, the spring side of A

1. Clevis
2. Jam Nut, Clevis
3. Service Brake Housing
4. Service Brake Return Spring
5. Service Brake Disphragm
6. Clamp Ring Assembly
7. Service Brake Pushrod
8. Mounting Stud Lockwasher (2)
9. Mounting Stud Nut (2)
10. Cotter Pin
11. Clevis Pin
12. Clamp Ring Nut (2)
13. Clamp Ring Lockwasher (2)
14. Clamp Ring Carriage Bolt (2)
15. Rear Cover Plate O-Ring Seal (Outer)
16. Piston O-Ring Seal
17. Rear Cover Plate O-Ring Seal (Inner)
18. Release Nut Snap Ring
19. Emergency Release Handle
20. Release Nut
21. Release Nut Retaining Pin
22. Rear Cover Plate
23. Spring Brake Ppower Spring
24. Rear Cover Plate Retaining Ring (Half)
25. Retaining Ring Separator Spring
26. Spring Brake Housing Cylinder
27. Check Valve Snap Ring
28. Quick Release Valve Boot
29. Check Valve Washer
30. Check Valve Spring
31. Check Ball
32. Power Spring Vent O-Ring Seal
33. Tooth Washer
34. Spring Brake Piston
35. Emergency Release Bolt
36. Quick Release Valve Cover Capscrews (2)
37. Quick Release Valve Cover O-Ring Seal
38. Quick Release Valve Disphragm
39. Push Pad Screw
40. Spring Brake Port O-Ring Seal
41. Quick Release Valve Cover
42. Quick Release Valve Cover Capscrews (2)
43. Quick Release Valve Casting
44. Piston Shaft Bushing O-Ring (Inner)
45. Piston Shaft Bushing O-Ring (Outer)
46. Spring Brake Push Pad
47. Spring Brake Piston Shaft
48. Pipe Plug
49. Bushing Retainer Cap Screws (4)
50. Nylon Piston Shaft Bushing
51. Bushing Retainer Cap
52. Piston "U" Seal
53. Nylon Glide Ring
54. Spring Brake Piston Nut
55. Rear Cover Plate Retaining Ring (Half)
56. Quick Release Valve Capscrews (2)
57. Quick Release Valve Lockwashers (6)

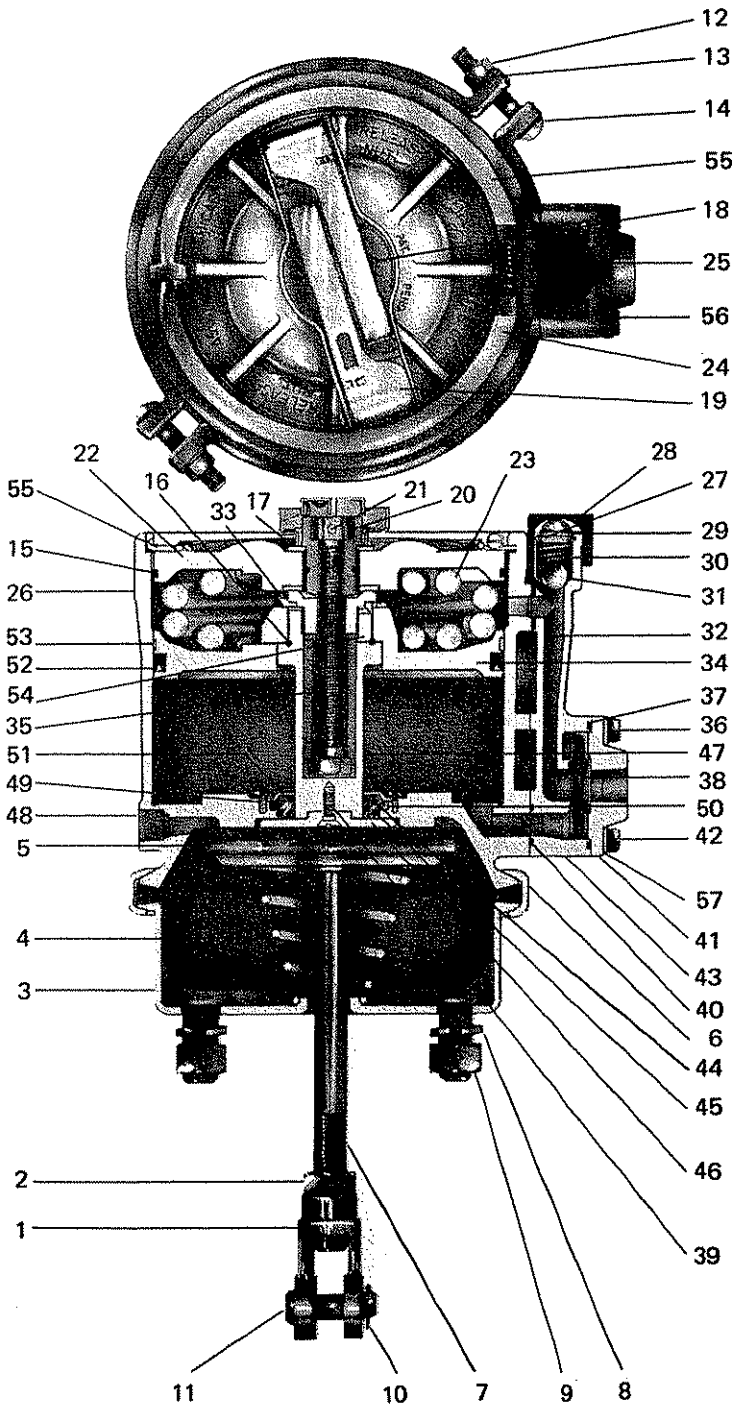


Fig. 2

the piston always has a slight residual pressure equal to the check valve spring force. This slight positive pressure, along with the mechanical seals, acts to exclude from the spring brake chamber all outside air along with the impurities it may contain. Exclusion of this foreign material decreases wear on seal surfaces, cylinder bores, machined surfaces and rubber seals, thus prolonging the life of the unit.

EMERGENCY RELEASE FUNCTION

Although some vehicles are equipped with an optional emergency release reservoir system that can be used for the release of the spring brake in the event of a failure in the air brake system, every Shur-Brake actuator has additional provisions for manual release. When the manual release system is used, it locks the power spring in a compressed state so that the spring brake will not apply on conditions of low pressure.

WARNING: Do not attempt to operate the vehicle with the spring brakes manually released. Attempting to operate a vehicle while the spring brakes are manually released could result in a hazardous operating condition, since the manual release mechanism renders the spring brake inoperable.

SERVICE OPERATIONS

INSPECTION

At each brake adjustment interval, the following checks should be made. Refer to the maintenance schedules in the Maintenance Manual for intervals.

1. Visually inspect the exterior of the Shur-Brake actuator for damage from outside sources. Replace any damaged parts immediately.

2. Make certain that the emergency release mechanism is intact and in good operating condition, free from binding or stripped threads.

3. Make certain that the clamp ring assembly is securely in place and the clamp ring nuts tightened to 25-35 ft-lbs torque.

WARNING: Never loosen the brake actuator clamp ring assembly unless the power spring is manually compressed by the emergency manual release mechanism. Loosening the clamp ring without first manually compressing the power spring could result in a hazardous working condition.

4. Make certain that the service brake pushrod is not binding or misaligned from the service brake chamber to the slack adjuster.

5. Make certain that the clevis pin is in place in the clevis and secured with a locked cotter pin. A

6. Inspect air lines and fittings leading to the actuator for damage and tightness. Tighten any loose air lines and fittings to stop leakage. Replace all damaged air lines and/or fittings immediately.

7. Make certain that the Shur-Brake mounting stud nuts are secure and tightened to 150 ft-lbs torque.

IMPORTANT: Once a year, spring brakes used in vehicles engaged in over-the-road operations should be disassembled, inspected and lubricated. Particular attention should be given to piston seals and glide rings, cover O-ring seal, nylon bushings and the quick release diaphragm. If the vehicle is engaged in operations that require repeated parking brake applications, or in off-road operations involving particularly adverse conditions, the above preventative maintenance program should be conducted more frequently, according to the degree of severity of usage and adverse conditions encountered.

WARNING: Failure to carry out any of the above checks could result in a hazardous operating condition.

GENERAL REPAIR INSTRUCTIONS

Figure 2 is a sectional view of the Berg Shur-Brake actuator together with a parts identification guide. Refer to Fig. 2 for the location and identification of all parts.

1. All spring brakes contain a large pre-loaded power spring to provide the force necessary to stop and hold heavily laden vehicles. Spring brake actuator units should be handled with extreme care and caution at all times to prevent accidental release of the power spring. A

2. *Always* follow complete "POWER SPRING MANUAL COMPRESSION (SPRING BRAKE RELEASE)" instructions before any disassembly operation.

3. After disassembly, wash disassembled parts thoroughly in cleaning solvent.

4. After cleaning, examine all parts for wear, deterioration or other damage. Replace all parts on which wear, damage or deterioration is present.

5. Before reassembly, lubricate all inside surfaces with molybdenum disulfide grease.

6. Use *extreme caution* when disassembling any spring brake. Follow instructions carefully and precisely. *Do not take shortcuts.*

WARNING: Failure to comply with the above recommendations could result in a hazardous workshop environment and/or a hazardous vehicle operating condition.

POWER SPRING MANUAL COMPRESSION (SPRING BRAKE RELEASE)

Refer to Fig. 2 for parts identification guide.

1. Block the wheels to prevent movement of the vehicle while the brake actuators are being serviced.

WARNING: Failure to block the vehicle wheels could result in a hazardous working condition.

2. If possible, charge the spring brake chamber with at least 60 psi air pressure. This will reduce the manual effort required to rotate the emergency release handle.

WARNING: When manually releasing the spring brake, stay clear of the rear of the spring brake unit. Accidental release of the power spring because of damaged or improperly seated parts could result in severe personal injury.

3. Unfold the handle on the emergency release mechanism. Refer to Fig. 3. Rotate the emergency release handle in a clockwise direction until the spring brake is released and the power spring is fully compressed. At that time, the handle will turn no further, and the release bolt will project approximately 2 inches through the rear cover plate as in Fig. 6. Release air pressure (if used) from the spring brake chamber.

WARNING: Do not attempt to disassemble the spring brake actuator if the power spring is not fully compressed. Any attempt to do so exposes the mechanic to extreme personal danger. A brake actuator with a defective manual spring brake release mechanism should be removed as a unit and a new or rebuilt unit installed.

POWER SPRING MANUAL RELEASE (SPRING BRAKE RESET) A

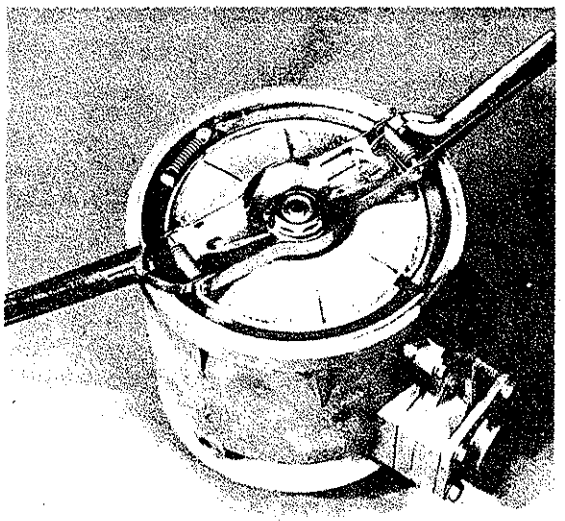
Refer to Fig. 2 for parts identification guide.

1. Make certain that the clamp ring assembly is firmly in place and the securing nuts are torqued to specifications. Make sure the rear cover plate retaining ring halves are seating in the groove in the spring brake housing.

WARNING: Failure to ensure that the clamp ring is firmly in place with the clamp ring nuts torqued to specifications and that the rear cover plate retaining ring halves are seated could result in a hazardous working condition, and a hazardous vehicle operating condition. When resetting the spring brake, stay clear of the rear of the spring brake unit. Accidental release of the power spring could result in severe personal injury.

2. If possible, charge the spring brake chamber with at least 60 psi air pressure. This will reduce the manual effort required to rotate the emergency release handle.

3. Unfold the handle on the emergency release mechanism and rotate it in a counterclockwise direction until the top of the release bolt is flush with the hex nut on the handle as shown in Fig. 3. Fold the handle down as in Fig. 1.



A

Fig. 3

4. Release air pressure (if used) from the spring brake chamber.

A REMOVAL OF THE BRAKE ACTUATOR FROM THE VEHICLE

Refer to Fig. 2 for parts identification guide.

1. Manually compress the power spring following prior "POWER SPRING MANUAL COMPRESSION" instructions.

2. With the vehicle wheels safely blocked, release the air pressure from the system, then disconnect all air lines leading to the brake actuator. Take special care to avoid allowing dirt or grease to enter the air lines or fittings.

3. Remove the cotter pin from the clevis pin, then remove the clevis pin from the clevis.

4. Remove the mounting stud nuts and lockwashers. The brake actuator is now free to be removed.

DISASSEMBLY OF SPRING BRAKE ACTUATOR

Refer to Fig. 2 for parts identification guide.

The following instructions for disassembly of the Shur-Brake spring brake actuator apply to service after the unit has been removed from the vehicle, although it is not absolutely necessary that it be removed. If service is to be performed on the spring brake actuator while it is mounted on the vehicle, it is necessary to follow steps 1 and 2 of prior "REMOVAL OF THE BRAKE ACTUATOR FROM THE VEHICLE" instructions before continuing.

WARNING: Make certain that the power spring has been fully compressed before attempting to disassemble the spring brake actuator. Failure to do so could result in an extremely hazardous workshop A **condition.**

1. Clamp a pair of vise-grip pliers to the service brake pushrod at the base of the service brake housing. This will prevent the pushrod from being drawn into the service brake housing by the service brake return spring when the clamp ring is removed.

2. Supporting the spring brake actuator with one hand, loosen the clamp ring nuts. Spread the ring enough to separate the spring brake actuator from the service brake housing. Remove the spring brake actuator and clamp ring.

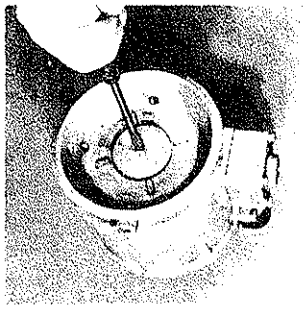


Fig. 4

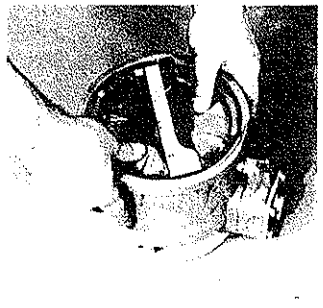


Fig. 5

3. Refer to Fig. 4. Position the spring brake actuator with the service brake cavity facing upward. Remove the pushrod screw from the center of the spring brake push pad. Remove the push pad.

4. Refer to Fig. 5. Turn the spring brake actuator unit over, so that the emergency release handle faces upward. Depress the rear cover plate assembly approximately 1/8 inches to facilitate the removal of the rear cover plate retaining ring halves from the spring brake housing cylinder.

5. Refer to Fig. 6. Insert a screwdriver under the retaining ring separator spring, and snap it free. Remove the retaining ring separator spring and the two halves of the retaining ring.

6. Refer to Fig. 7. Apply pressure to the end of the spring brake piston shaft at the center of the service brake cavity until the rear cover plate has been forced away from the spring brake housing cylinder. Lift the rear cover plate, together with the power spring and piston subassembly (Fig. 11) out of the spring brake housing cylinder.

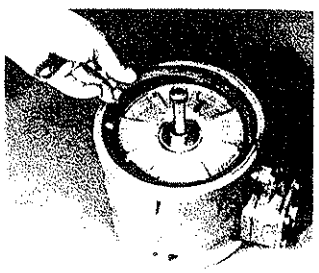


Fig. 6

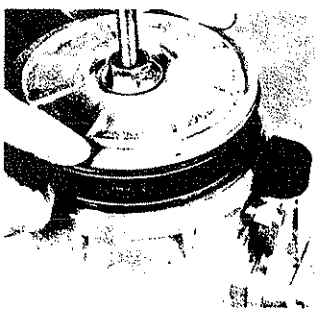


Fig. 7

WARNING: Always use EXTREME CAUTION when handling the power spring assembly shown in Fig. 11. Accidental release of the power spring could result in serious personal injury.

7. Refer to Fig. 11. Remove the outer O-ring seal from the rear cover plate. Remove the "U" seal and the nylon glide ring from the piston assembly, taking care to avoid disturbing the power spring.

IMPORTANT: Do not attempt any further disassembly of the piston and power spring subassembly (Fig. 11). To do so without special tools and equipment exposes the mechanic to extreme hazard. If any parts within the piston and power spring subassembly are defective, the entire subassembly should be replaced with a new or rebuilt unit.

8. Refer to Fig. 8. Remove the four bushing retainer capscrews in the base of the spring brake housing cylinder, then remove the bushing retainer cap. Remove the nylon piston shaft bushing from the spring brake housing cylinder.

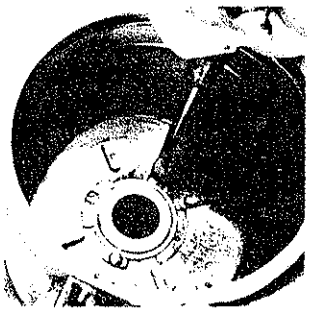


Fig. 8

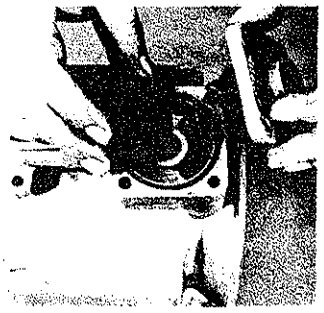


Fig. 9

9. Refer to Fig. 9. Remove the six capscrews from the quick release valve subassembly on the side of the spring brake housing cylinder. Remove the quick release valve subassembly, the quick release valve cover and the quick release valve diaphragm. Remove the quick release valve cover O-ring seal from its groove in the quick release valve casting.

10. Refer to Fig. 10. Remove the quick release valve boot from the end of the quick release valve casting, then remove the check valve snap ring, washer, spring and check ball. Remove the O-ring seals from the mounting face of the quick release valve casting.

11. Clean all parts thoroughly in cleaning solvent. Carefully examine all seals, the quick release valve diaphragm and check ball, the nylon glide ring, and nylon piston shaft bushing for any signs of wear, deterioration or other damage. Replace any defective parts with new ones.

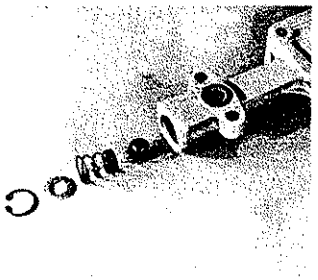


Fig. 10

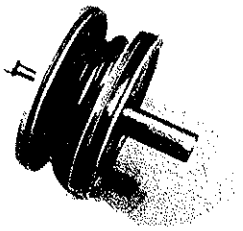


Fig. 11

12. Carefully inspect the spring brake piston lands and cylinder bore for scuff marks or scoring. Minor damage may be rubbed out with a fine emery or crocus cloth. If deep scuffing or gouges are present, the damaged parts must be replaced.

ASSEMBLY OF THE SPRING BRAKE ACTUATOR

Refer to Fig. 2 for parts identification guide.

1. Before assembly, generously coat all parts, and lubricate all inside surfaces with molybdenum disulfide grease.

2. Refer to Fig. 12. Install the two O-ring seals on the nylon piston shaft bushing, then insert the bushing into the hole at the bottom of the spring brake cylinder housing, taking care that the O-rings are not pinched or displaced.

3. Refer to Fig. 13. Cover the nylon piston shaft bushing with the bushing retainer cap, and secure

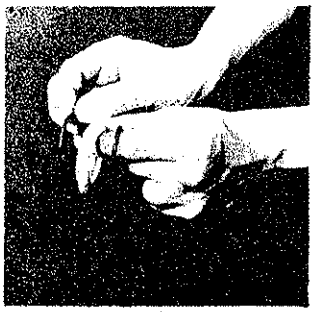


Fig. 12

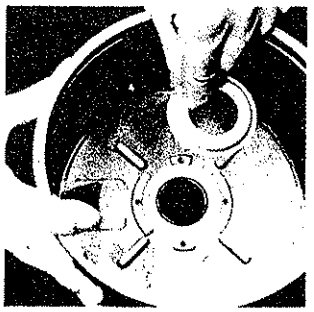


Fig. 13

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it in place with the four bushing retainer capscrews. Refer to Fig. 8.

4. Refer to Fig. 11. Install the rear cover plate outer O-ring seal in the groove on the rear cover plate. Install the "U" seal and nylon glide ring on the spring brake piston.

WARNING: Exercise EXTREME CARE when handling the piston-power spring subassembly (Fig. 11). Accidental release of the power spring could result in serious personal injury.

5. Refer to Fig. 14. Holding the nylon glide ring in its groove on the spring brake piston, insert the piston into the housing cylinder bore. Line up the key boss on the cover plate with the key way in the housing cylinder. Keep the piston-power spring subassembly square with the cylinder bore, so that the piston shaft is aligned with the nylon bushing bore.

Fig. 14

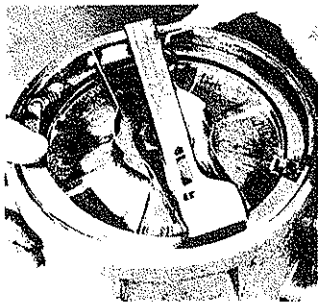

Fig. 15

6. Refer to Fig. 5. Push the piston-power spring subassembly into the cylinder housing, guiding the piston shaft through the nylon bushing. Take care not to disturb the seals on the piston, rear cover plate or nylon piston shaft bushing. Push the rear cover plate down so that its top surface is approximately 1/8 inch below the bottom of the retaining ring groove.

7. Refer to Fig. 15. Install the two rear cover retaining ring sections in the retaining ring groove, making certain that the retaining ring section with the key is engaged in both the key boss in the rear cover plate and the key way in the spring brake housing cylinder. Insert the retaining ring separator spring between the sections of the retaining ring to hold the ring firmly in the groove.

WARNING: Make certain that the retaining ring is fully engaged in the groove. An improperly seated rear cover plate retaining ring could result in a hazardous workshop environment, and a hazardous vehicle operating condition, since it could cause accidental release of the power spring.

8. Refer to Fig. 10. Install the check ball, the check valve spring (small end first), the check valve flat washer and the check valve retaining ring into the quick release valve casting. Make certain that the retaining ring is firmly in its groove, then replace the quick release valve boot.

9. Install the two O-ring seals in the mounting face of the quick release valve casting. Using the two shortest of the six quick release valve mounting capscrews, secure the quick release valve to the spring brake housing cylinder.

10. Insert the quick release valve cover O-ring seal into the groove on the quick release valve diaphragm housing. Install the diaphragm in its bore, taking care that the lips around the circumference of the diaphragm face down toward the bore. Make certain that the lips do not become folded back during installation.

11. Refer to Fig. 9. Place the quick release valve diaphragm cover over the quick release valve diaphragm bore and secure it in place with the four remaining capscrews. The two longest capscrews go in the holes nearest the spring brake clamp ring flange.

12. Apply air pressure to the spring brake port in the quick release valve cover, so that the piston shaft extending into the service brake chamber is fully retracted into the spring brake chamber. Soap test the areas around the quick release valve cover, around the nylon piston shaft bushing in the service brake chamber, and the exhaust port in the quick release valve casting. If air leakage is present, disassemble the unit, reposition the parts and reassemble. If leakage persists, disassemble and inspect for worn, deteriorated or otherwise damaged parts. Replace defective parts with new ones.

WARNING: Stay clear of the rear of the spring brake unit when conducting the pressure test. Accidental release of the power spring because of defective or improperly seated parts could result in severe personal injury.

13. Refer to Fig. 4. Position the spring brake actuator with the service brake cavity facing upward, then install the push pad on the end of the spring brake piston shaft. Secure it in place with the push pad screw.

14. Make certain that the service brake diaphragm is in place over the service brake pushrod, then position the spring brake assembly over the diaphragm, on top of the service brake housing. Check around the clamping diameter to make sure that the service brake housing flange, the diaphragm and the spring brake housing flange are concentric and aligned.

15. Install the clamp ring over the flanges. Make certain that the lockwashers are on the clamp ring carriage bolts. Tighten the clamp ring nuts to 25-35 ft-lbs torque, then, with a soft hammer, tap the circumference of the clamp ring to further ensure seating. Retighten the clamp ring nuts to 25-35 ft-lbs torque.

16. Attach an air line to the service brake inlet and apply a 100-125 psi air pressure. Soap test the clamp ring area to verify leak-free assembly. If a leak is discovered, disassemble the unit, reposition the parts and reassemble. If the leaking persists, disassemble and inspect for damaged parts. Replace defective parts with new ones. Repeat the soap test. If leaking is still present, install a new or rebuilt actuator unit.

INSTALLATION OF THE BRAKE ACTUATOR ON THE VEHICLE

Refer to Fig. 2 for parts identification guide.

1. Place the brake actuator unit on the mounting bracket with the mounting studs in position through the mounting bracket holes.

2. Install the lockwashers and nuts on the mounting studs. Tighten the stud nuts on 150 ft-lbs torque.

3. Insert the clevis pin in the clevis, then install the cotter pin in the clevis pin. Lock the cotter pin in place.

WARNING: Failure to install and lock the cotter pin could result in a hazardous operating condition.

4. Follow prior "POWER SPRING MANUAL RELEASE" instructions.

WARNING: Operating a vehicle with the power spring compressed could result in a hazardous operating condition, since the parking brake and emergency brake is inoperable when the power spring is compressed.

5. Taking care to prevent dirt or grease from entering the air lines, or fittings, connect the air lines to the inlets as marked on the actuator housing.

6. Adjust the slack adjuster and S-cam linkage, following adjustment instructions in Section 11 of the Freightliner Service Manual.

7. Follow prior "INSPECTION" instructions before operating the vehicle.

WARNING: Failure to fully inspect the brake system following servicing could result in a hazardous vehicle operating condition.

LUBRICATION

Regular lubrication of the Shur-Brake actuator is not required. However, if the unit is disassembled, all parts should be cleaned with cleaning solvent; and molybdenum disulfide grease should be applied to all interior parts and surfaces.

TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTIONS
Spring brakes fail to release.	Insufficient vehicle air pressure.	Check air pressure gauge for a minimum of 60 psi. If air pressure is low and the compressor is operating, check for leaks in the system. Repair any leaks and tighten loose fittings.
	Air leaks in the spring brake air systems.	Check all fittings, valves and air lines for leaks. Repair leaks and tighten loose fittings.
	Restrictions in air lines, or faulty control valve in the spring brake air system.	Disconnect air line at the spring brake port on the actuator and check for air flow (with the control valve in the cab in the released position). If there is no air flow, clean any dirt from the air lines and replace any defective parts.
	Air leaks at the quick release valve diaphragm.	Check for air leakage past the one-way check valve at the spring brake exhaust port. If leakage is present, remove the quick release valve diaphragm and inspect the rubber surfaces for nicks or tears. Replace the diaphragm if it is damaged.
	Air leaking at the spring brake piston "U" seal.	Check for air leakage past the one-way check valve at the spring brake exhaust port. If the quick release valve diaphragm is in good condition and not leaking, disassemble the spring brake unit and check the piston "U" seal. Replace worn or damaged seals with new ones.
	Jammed or stuck power spring mechanism.	If the above steps indicate (1) a minimum air pressure of 60 psi, (2) no leaks or loose or dam aged fittings, and (3) no restrictions in air lines, then the power spring mechanism is defective. Replace the spring brake actuator with a new or rebuilt unit.
Spring brakes cannot be manually released.	Release bolt stripped.	Release bolt does not project through the rear cover plate when the emergency release handle is rotated in the clockwise direction. Remove the spring brake unit and replace it with a new or rebuilt unit.
	Release bolt, locking nut and release handle locked together.	The release handle and release bolt turn as a unit when the handle is rotated. Remove the spring brake unit and replace it with a new or rebuilt unit.

TROUBLE SHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTIONS
Spring brakes fail to apply.	Restrictions in the spring brake air system.	Disconnect the air line from the spring brake port on the quick release valve. If the spring brake then applies, check for restrictions or defective parts in the spring brake air lines, control valves or connections. Unblock restricted lines, and replace defective parts with new parts.
	Excessive slack in the S-cam linkage.	Adjust the slack adjuster travel. Refer to Section 11 in the Freightliner Service Manual for adjustment procedure.
	Jammed or frozen power spring mechanism.	If there are no restrictions in the spring brake air system, and there is no excessive slack in the S-cam linkage, then the power spring is defective. Remove the spring brake unit and replace it with a new or rebuilt unit.
Spring brakes apply with insufficient braking force.	Improperly adjusted slack adjuster in the S-cam linkage.	Adjust the slack adjuster. Refer to Section 11 in the Freightliner Service Manual for adjustment procedure.
	Worn linings and drums.	Refer to Section 11 in the Freightliner Service Manual for service instructions on drums and linings.
	Broken power spring or binding power spring mechanism.	If the S-cam is in adjustment and the brake drums and linings are not worn beyond the acceptable limits outlined in Section 11 in the Freightliner Service Manual, then the power spring mechanism is defective. Remove the spring brake unit and install a new or rebuilt unit.
Moisture or dirt in the spring brake chamber.	Damaged rear cover plate O-ring seal.	Check for air leakage between the rear cover plate and the spring brake housing cylinder as the spring brake control valve is moved to the released position. If leakage is present, install a new rear cover plate O-ring seal.
	Damaged release bolt O-ring seal.	Check for air leakage past the release bolt threads as the spring brake control valve is moved to the released position. If leakage is present, remove the power spring subassembly and replace it with a new or rebuilt unit.

TROUBLE SHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTIONS
Air leaks at the spring brake chamber.	Quick release valve diaphragm does not seal.	With the vehicle engine running in order to maintain a constant service brake system air pressure, check for air seepage at the spring brake exhaust port. Remove the quick release valve diaphragm and inspect the rubber surfaces for nicks or tears. Replace damaged diaphragm with new diaphragm. Inspect metal seating surfaces in the quick release valve body casting for nicks or gouges. If damaged, replace the quick release valve casting.
	Damaged or worn piston "U" seal.	Check for air leakage past the one-way check valve at the spring brake exhaust port. If the quick release valve diaphragm is in good condition and not leaking, disassemble the spring brake unit and check the piston "U" seal. Replace worn or damaged piston "U" seal with a new "U" seal.
	Worn or damaged O-rings on the nylon piston shaft bushing.	Check for air leakage at the service brake port on the actuator housing when the spring brake chamber is charged with a minimum of 60 psi air pressure. Check also for air leakage at the exhaust port on the quick release valve when the servcie brake chamber is charged with a minimum of 60 psi air pressure. If leakage is present, replace the O-rings on the nylon piston shaft bushings with new O-rings.

BENDIX MV-2 BRAKE CONTROL MODULE

GENERAL DESCRIPTION

The MV-2 Control Module is an integrated control assembly mounted in the control panel. See Fig. 1. The bodies for the module, as well as "spool" inserts, are molded of a non-metallic, non-corrosive material. The assembly consists of two push-pull valves and a dual-circuit supply valve which shuttles at a pre-set pressure differential. The valve spool inserts, as well as the dual-circuit supply valve spool and shuttle, may be removed from the valve bodies without disconnecting the air lines.

The MV-2 Module provides: tractor protection control; trailer service air supply; system park; trailer park only; trailer charge with tractor spring brakes applied (tractor park only); and supply reservoir selection.

The MV-2 includes a spring-loaded, dual-circuit supply valve, which selects the primary air reservoir as the air source for both control valves, unless the pressure in the primary air reservoir falls more than 30 psi (207 kPa) below that of the secondary air reservoir. Then, the dual circuit supply valve will shuttle and establish the secondary air reservoir as the air source. An auxiliary air delivery port, which receives its air supply from the dual circuit supply valve, provides an air source for the constant air cab junction block. All air connections are located at the bottom of the valves, including the auxiliary air delivery port. See Fig. 2.

The trailer air supply valve, as shown in Fig. 1, actuated by the red knob, delivers air to the trailer supply line, and also will trip automatically and shut off the trailer supply if pressure decreases to 40 ± 5 psi (276 ± 28 kPa).

NOTE: The primary air reservoir is the reservoir that supplies the rear tractor axle(s). The secondary air reservoir is the reservoir that supplies the front axle.

The parking brake valve, as shown in Fig. 1, actuated by the yellow knob, controls the spring

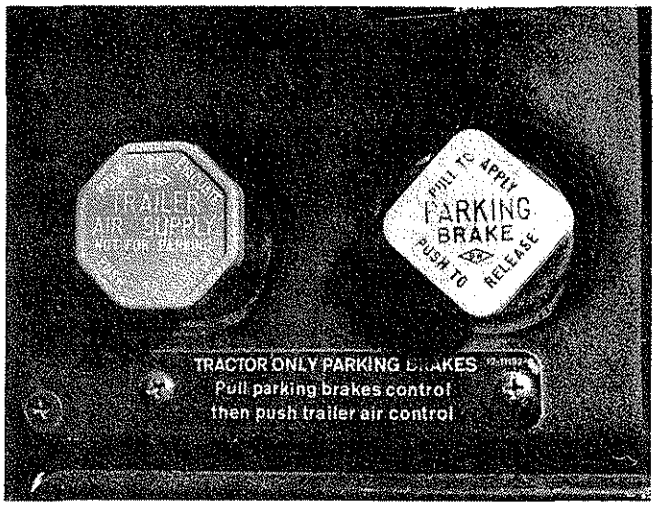

Fig. 1

parking brakes on the tractor, and when exhausted, simultaneously causes the trailer supply valve to trip and exhaust, thus applying both the tractor and the trailer parking brakes as required by Federal Regulations. The trailer parking brakes may be independently released by pushing only the trailer air supply valve (red) knob in.

PRINCIPLES OF OPERATION

INITIAL CHARGE

With both the primary and the secondary systems completely discharged, both knobs are out. See Fig. 3. When system pressure reaches 65 psi (448 kPa), the red knob (trailer air supply) may be pushed in, and should stay in, charging the trailer system and releasing the trailer parking brakes. See Fig. 4. The yellow knob (parking brake) may now be pushed in, which will supply air to the tractor parking brakes, releasing them.

NORMAL OPERATING POSITION

When both knobs are pushed in, air is supplied to the trailer and the tractor parking brakes; all parking brakes are released. See Fig. 5. This is the normal operating mode.

BRAKE CONTROL
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BENDIX MV-2 BRAKE CONTROL MODULE

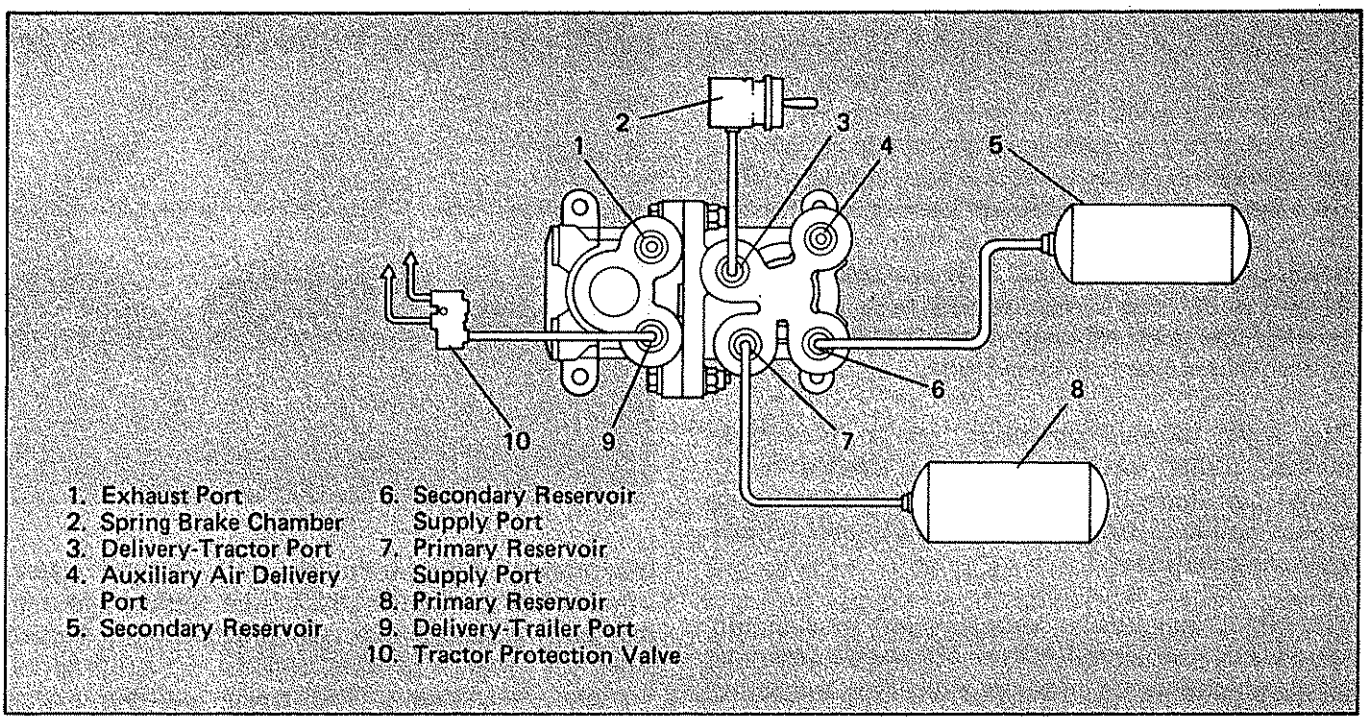


Fig. 2, Brake Control Module Air Connections

ACTUATION OF TRAILER PARK OR EMERGENCY BRAKES

To actuate the trailer parking brakes only, the red knob is pulled out, exhausting the trailer supply line. The trailer parking brakes are now applied, either by emergency air or parking brakes, depending on the type of trailer system. This mode would be used to uncouple from the trailer, and during bobtail operation. See Fig. 6.

SYSTEM PARK

With both knobs in, the parking brakes on both the tractor and the trailer may be actuated by pulling the yellow (parking brake) knob out. This exhausts the air from the tractor parking brakes and simultaneously causes the red (trailer air supply) knob to pop out, applying the trailer parking brakes. (This complies with federal regulations that one control must apply all the parking brakes on the vehicle.) See Fig. 3.

TRAILER CHARGE

If both valves are out, parking the combination vehicle, and it is desired to recharge the trailer (leaving only the tractor parking brakes applied), the red knob may be pushed in, repressurizing the trailer supply line. This mode might also be used to park a combination vehicle with air actuated emergency brakes on the trailer to provide demonstrated parking capability with tractor spring brakes only. See Fig. 4.

AUTOMATIC APPLICATION

If air pressure drops in both the primary and the secondary systems, at 40 ± 5 psi (276 ± 34 kPa), the red knob (trailer air supply valve) will automatically pop out, applying the emergency or parking brakes on the trailer. If the red knob is held in manually and the pressure decreases to 30 ± 5 psi (207 ± 34 kPa), a tripper piston within the trailer control spool will move upward, exhausting the trailer supply, and applying the trailer parking

BENDIX MV-2 BRAKE CONTROL MODULE

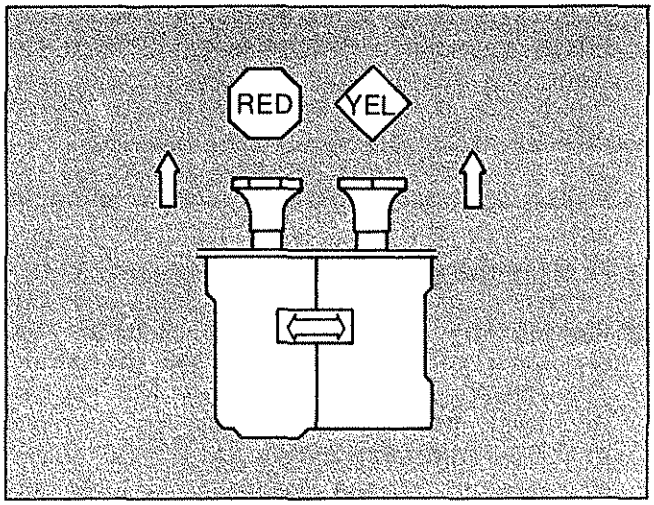


Fig. 3, Total System Park

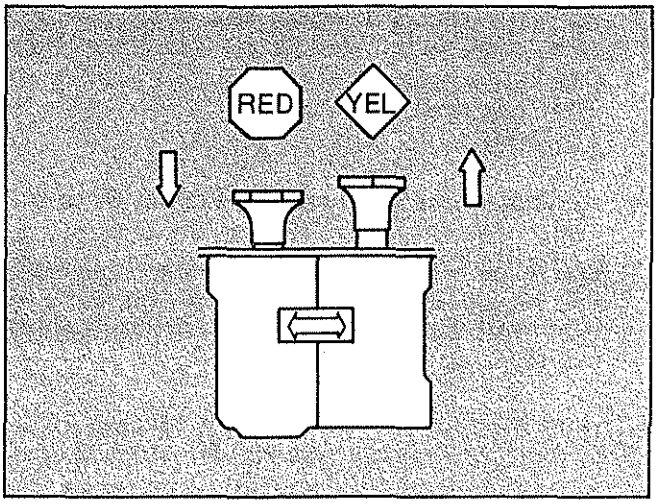


Fig. 4, Charged Trailer with Tractor Parked

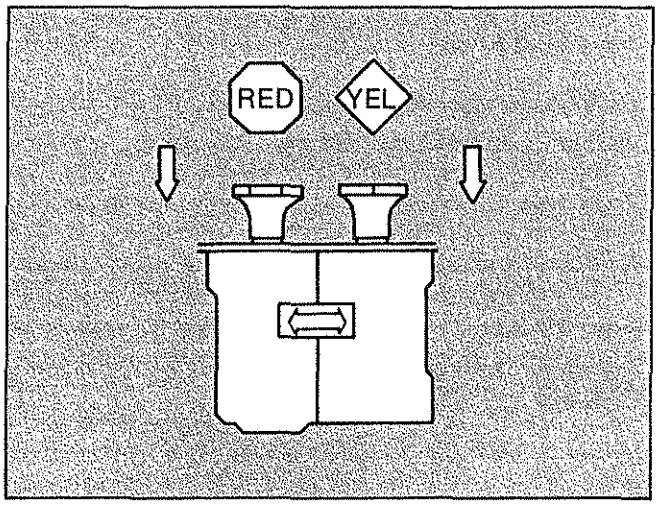


Fig. 5, Normal Operating Position

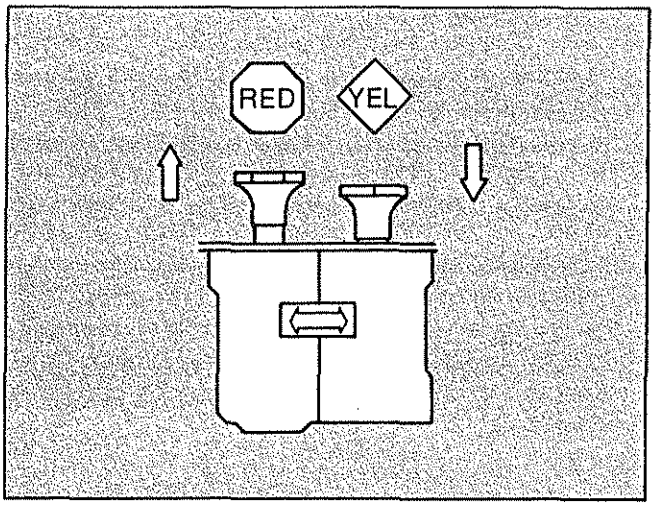


Fig. 6, Parked Trailer with Tractor Released

brakes. If air pressure drops in both the primary and the secondary systems, the yellow (parking brake) knob will pop out at approximately 20-30 psi (138-207 kPa), applying the tractor parking brakes.

A warning buzzer and light are activated when pressure in either the primary or the secondary system drops below 64-76 psi (441-524 kPa).

SERVICE OPERATIONS

OPERATING TESTS

With the air brake system charged to 65 psi (448 kPa), check for leaks, and repair or replace components as needed, using the instructions given in the following.

1. Charge the air brake system to 65 psi (448 kPa), and check for leakage between the body seals, the body, and cover plates. No leakage is permitted.

BENDIX MV-2 BRAKE CONTROL MODULE

2. With the supply pressure still at 65 psi (448 kPa), push in the red knob. The knob must stay in. Leakage at the exhaust port (see Fig. 2) must not exceed a 1-inch (25 mm) bubble in 5 seconds.

3. Develop a leak in the line delivering air to the trailer supply circuit. The red knob must pop out at 40 ± 5 psi (276 ± 34 kPa) and maintain the supply pressure. Leakage at the exhaust port must not exceed a 1-inch (25 mm) bubble in 5 seconds.

4. Hold the red knob in and again develop a leak in the supply circuit (see Fig. 2). Air must start to escape from the exhaust port when the trailer supply line pressure reaches 30 ± 5 psi (207 ± 34 kPa).

5. Release the red knob and rebuild the supply pressure to at least 40 psi (276 kPa). Push in the yellow knob; the yellow knob must remain in. Leakage at the exhaust port should not exceed a 1-inch (25 mm) bubble in 5 seconds.

6. Develop a leak in the tractor spring brake delivery circuit. The yellow knob must pop out at 25 ± 5 psi (172 ± 34 kPa) and maintain supply pressure. Leakage at the exhaust port should not exceed a 1-inch (25 mm) bubble in 5 seconds.

7. Charge the system to 120 psi (827 kPa), and push both knobs in. Pull the red knob out. The yellow knob must remain in.

8. Push the red knob in and pull the yellow knob out. The red knob must pop out almost instantaneously.

9. Install a gauge to monitor tractor spring brake delivery pressure. Apply 120 psi (827 kPa) to the primary and secondary air reservoirs. Push in the yellow knob. Delivery pressure should equal the pressure in the primary air reservoir. Reduce the pressure in the primary air reservoir. Delivery pressure and the primary air reservoir pressure should descend together to 90-105 psi (620-723 kPa), at which point the dual-circuit supply valve shuttle should switch to equal the secondary air reservoir and delivery pressure should increase to the secondary air reservoir pressure. After the primary air reservoir pressure is reduced to zero, there should not be audible leakage at the primary air reservoir opening. Close the leak which had been created in the primary air reservoir.

10. Leaving the yellow knob in, recharge the secondary air reservoir to 120 psi (827 kPa). The delivery pressure should also read 120 psi (827 kPa). Recharge the primary air reservoir to 100 psi (689 kPa). Slowly vent the secondary air reservoir. As the secondary air reservoir pressure and the delivery line pressure descend, pressure should stabilize at approximately 100 psi (689 kPa).

11. Close all vents or leakage points and charge both reservoirs to 120 psi (827 kPa). Position the red knob out and the yellow knob in. Develop a leak in the spring brake delivery line (see Fig. 2) and hold the yellow knob in. The primary air reservoir pressure must reduce to zero and the secondary air reservoir pressure to 20-30 psi (138-207 kPa). The dual-circuit supply valve shuttle should cycle several times during this leak-down period.

SPOOL REMOVAL AND REPLACEMENT
(Refer to Fig. 7)

It is recommended that the valve be serviced by replacing the complete spool assemblies.

1. Chock the tires or otherwise secure the vehicle and drain all the air reservoirs. It should be unnecessary to remove the control module from the vehicle. Remove the panel, to expose the valve cover plates. It is recommended that the valve be serviced by replacing the complete spool assemblies.

BENDIX MV-2 BRAKE CONTROL MODULE

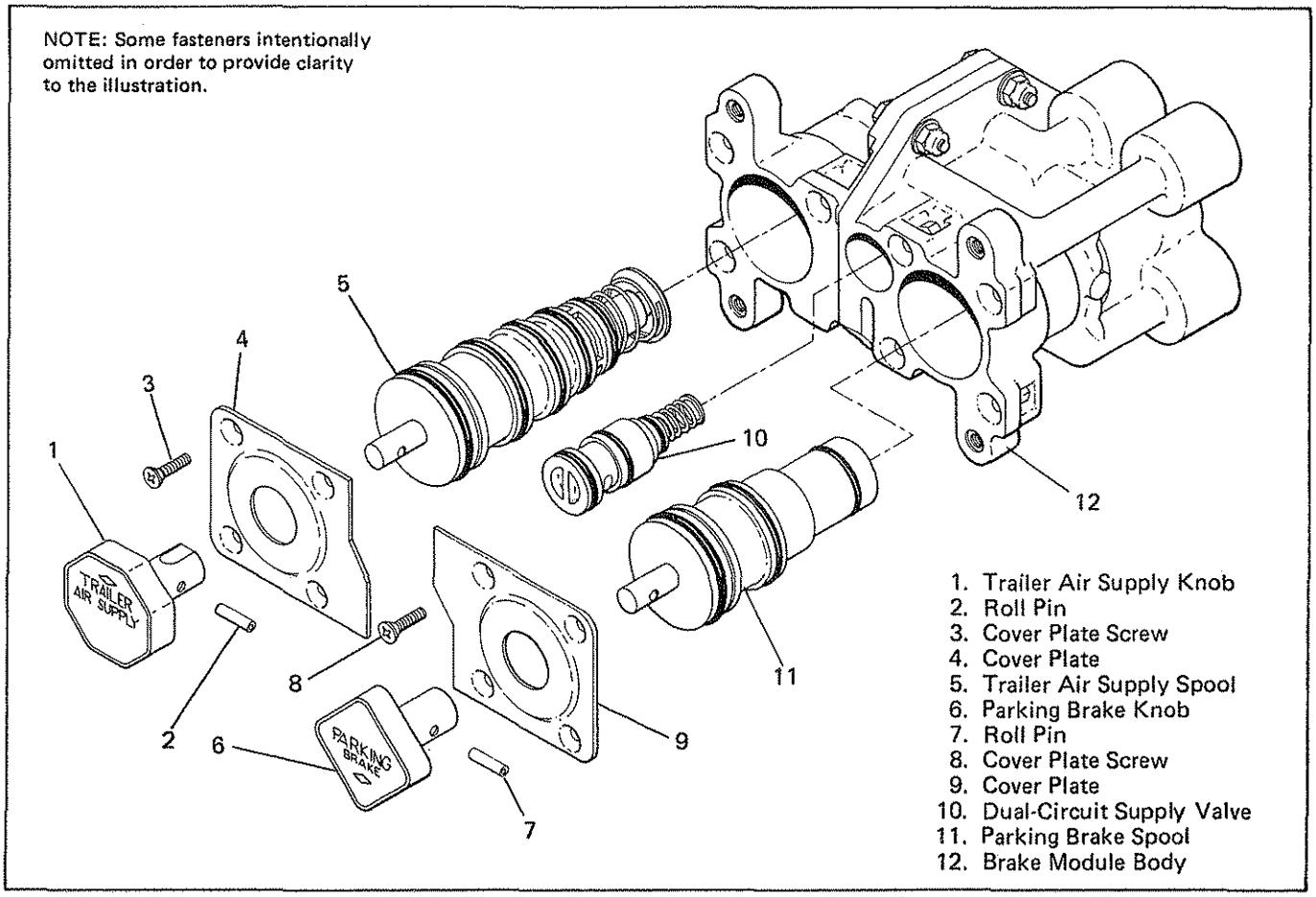


Fig. 7

NOTE: The dual-circuit supply valve is located behind the cover plate surrounding the parking brake valve knob. Do not remove the dual-circuit supply valve unless it is to be serviced.

2. Remove the cover plate screws (four in each cover) and cover.

3. Carefully pull the spool assemblies out of their respective body bores by pulling on the knobs.

4. Using a hammer and punch, remove the roll pins which retain the knobs on the spool stems, and remove the knobs and cover plates.

CAUTION: When removing the roll pin from the knob, do not place the spool assembly in a vise. To do so could distort the spool assembly.

5. Old lubricant should be wiped off parts to be reused and the bores of the control module body wiped out with a clean dry cloth. The O-rings and all sliding surfaces should be lubricated with Bendix BW-650-M Silicone Lubricant (291126) or equivalent.

CAUTION: The non-metallic components which comprise most of the parts of the control module should not be immersed in any solvent-type cleaner.

6. Place the cover plates over each plunger stem. The cover plates are identical and are installed convex side up.

7. Place the red knob on the longer spool (for trailer air supply), matching the groove in the

BENDIX MV-2 BRAKE CONTROL MODULE

knob with the tongue in the cover plate (where applicable). Using a hammer and punch, secure the knob with the knob roll pin.

CAUTION: Do not place the spool assembly in a vise. To do so could distort the spool assembly.

8. Place the yellow knob on the shorter spool (for tractor air supply), matching knob and cover (where applicable) and securing with the knob roll pin as before.

If old spools are being used, the O-rings and all sliding surfaces should be lubricated with Bendix BW-650-M Silicone Lubricant.

NOTE: If new service replacement spools are being installed, they will be pre-lubricated, and a new roll pin will be found in each spool package.

9. Insert the shorter spool assembly (yellow knob) in the tractor supply bore (housing with the dual supply valve). If the entire valve assembly has been removed, position the assembly so that the tractor control body housing is at 3 o'clock. With the open bore (trailer supply) at 9 o'clock, rotate the knob until the wording on the top-center is horizontally readable. The stepped side of the cover plate should be covering the dual-circuit supply valve. Secure the plate with the four, flat-head Phillips screws; then torque to 25 in-lbs (280 N·cm).

   Insert the longer spool assembly (red knob) in the remaining bore. The stepped sides of the cover plates should key with each other when the remaining, four, flat-head screws are torqued to 25 in-lbs (280 N·cm).

10. Install the panel that surrounds the control knobs.

11. Remove the chocks from the tires.

IMPORTANT: Always perform the "OPERATING TESTS" in this subject, after servicing the MV-2 brake control module, and before operation of the vehicle.

DUAL-CIRCUIT SUPPLY VALVE SERVICING

The dual circuit supply valve feature may be serviced by replacing four O-rings and one spring. A maintenance kit is available for servicing the dual-circuit supply valve. Refer to the Freightliner Parts Book for parts information.

1. Chock the tires, then drain all air reservoirs.

2. Remove the panel surrounding the control knobs in order to gain access to the valve cover plates.

3. Remove the cover plate screws from the cover plate surrounding the yellow knob. See Fig. 7. Then, carefully pull the parking brake valve spool assembly out of the body bore by pulling on the knob.

4. Using needle nose pliers, grasp the cover of the dual-circuit supply valve (located alongside the empty body bore), twist, and pull the dual-circuit supply valve out. The shuttle return spring and shuttle should come out with the spool.

5. Remove the shuttle return spring, shuttle, and four O-rings, and discard the spring and four O-rings. See Fig. 8. Clean the inside of the body bore with a clean, dry cloth, and remove the old lubricant from the spool and shuttle.

CAUTION: Do not use a solvent type cleaner, as this may result in damage to the components of the control module.

6. Lubricate the dual-circuit supply valve body bore, new O-rings, shuttle, and spool with Bendix BW-650-M Silicone Lubricant (291126) Dow Corning 55-M or equivalent. Place the new shuttle return spring in the body bore.

7. Install the new O-rings on the shuttle and on the valve spool, and insert the small end of the shuttle into the spool. Refer to Fig. 8.

BENDIX MV-2 BRAKE CONTROL MODULE

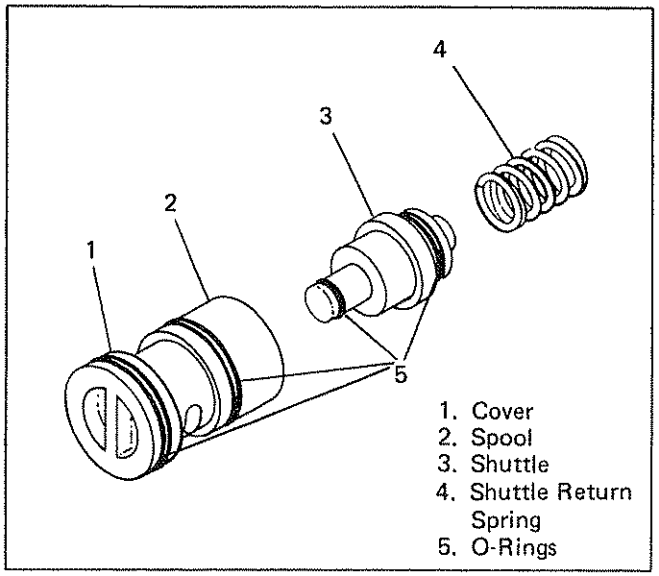


Fig. 8, Dual-Circuit Supply Valve

8. Insert the dual-circuit supply valve assembly into the body bore, and press it flush with the top of the body bore.

9. Insert the parking brake valve spool assembly in the body bore, then rotate the knob until the wording on the knob is horizontally readable. The notched side of the cover plate should cover the dual-circuit supply valve.

10. Secure the cover plate with the four, cover plate screws, tightening them to 25 in-lbs (280 N·cm).

11. Install the panel that surrounds the control knobs.

12. Remove the chocks from the tires.

IMPORTANT: Always perform the "OPERATING TESTS," in this subject, after servicing the MV-2 brake control module, and before operation of the vehicle.

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-7

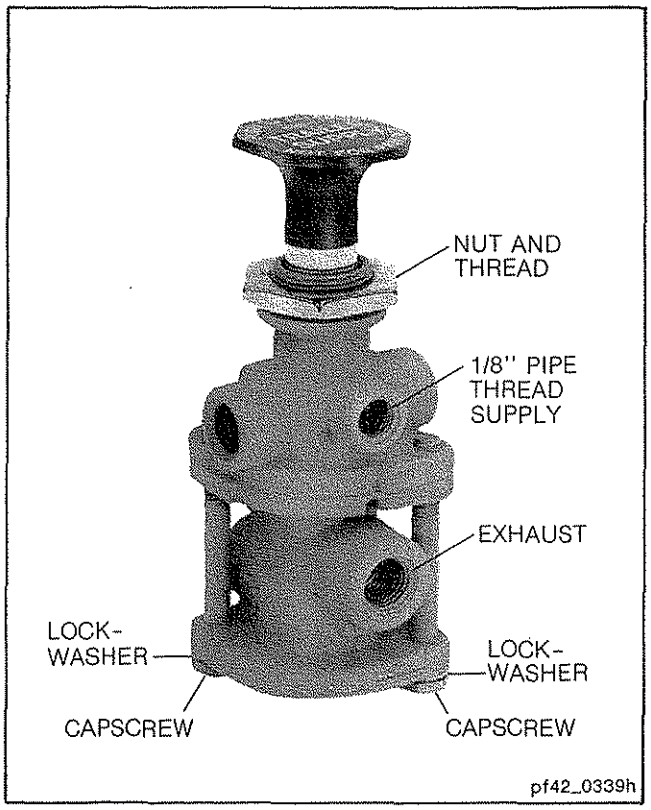


Fig. 1, PP-7 Trailer Air Supply Valve

GENERAL DESCRIPTION

The PP-7 trailer supply valve (Fig. 1) provides in-cab control for the tractor protection system and functions in conjunction with the tractor-trailer parking brake control valve. It is responsible for synchronizing the tractor and trailer parking and emergency brakes.

It is essentially a combination of two non-modulating, on-off control valves in a single package.

Each of the four pipe-tapped ports of the PP-7 are identified with cast-in, raised letters. The supply and control ports have 1/8-inch NPTF dry seal pipe threads while the delivery and exhaust ports have 1/4-inch NPTF dry seal pipe threads.

PRINCIPLES OF OPERATION

The PP-7 trailer supply valve is a panel mounted, push-pull operated control valve. The button of the PP-7 valve must be manually pushed in to charge the trailer with air, but will automatically pop out and exhaust if supply air is below 40 psi (276 kPa). 50 psi (345 kPa) or greater supply air pressure is required for the button to remain in after it is pushed in, and it will remain in until the supply air pressure falls below 40 psi (276 kPa), or until the valve is manually acutated.

With less than 50 psi (345 kPa) system air pressure (Fig. 2), the button of the PP-7 valve will be out and the

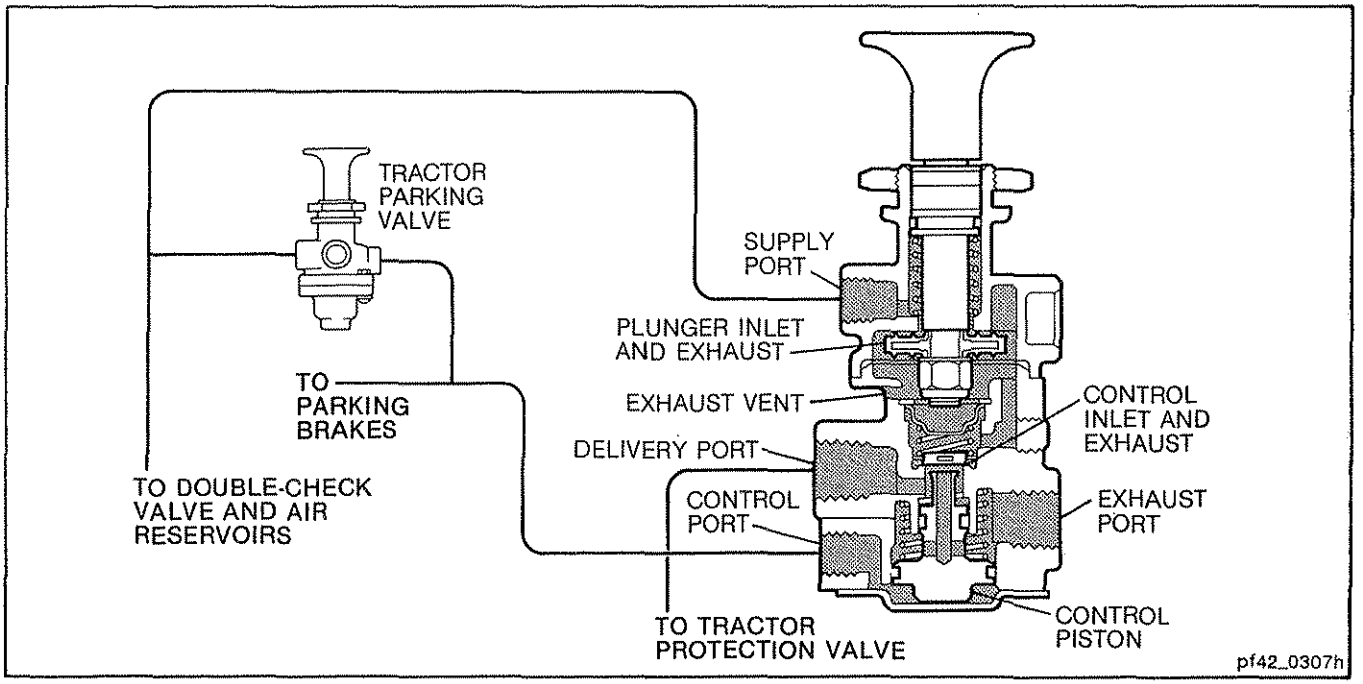


Fig. 2, PP-7 Valve With Less Than 50 psi (345 kPa) System Pressure

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-7

tractor-trailer parking brake control valve will not deliver air to the control port of the PP-7 valve. In this condition, supply air cannot flow past the closed plunger inlet, and the plunger exhaust valve is off its seat. With no air pressure on the control port, the control inlet is seated and the exhaust passage through the control piston is open.

If the driver holds the button of the PP-7 valve in after supply air pressure has dropped below the 40 psi (276 kPa) automatic pop-out pressure, the control piston will move into the exhaust position when control port pressure falls below 20 psi (138 kPa).

When system air pressure is greater than 50 psi (345 kPa) (Fig. 3), the button of the PP-7 valve can be pushed in and it will stay in. If the vehicle is in the running condition (parking brake released), the tractor-trailer parking brake control valve will be delivering system air pressure to the control port of the PP-7 valve.

With the button of the PP-7 valve pushed in, the plunger inlet will be open and the exhaust valve will be seated, sealing the exhaust vent. Supply air is permitted to flow through the body to the control inlet and exhaust valve. With the tractor-trailer parking brake control valve delivering full system pressure to the control port of the PP-7 valve, the control piston moves into contact with the control valve, closing the exhaust passage through the piston and opening the inlet. Opening the control inlet permits supply air to flow out the delivery port of the PP-7 valve.

NOTE: If the vehicle parking brakes are applied and system air pressure is above 50 psi (345 kPa), the tractor-trailer parking control valve will not be delivering air to the PP-7 control port and the control inlet valve will be closed. In this case, no air will be flowing from the delivery port of the PP-7 valve.

Prior to disconnecting the trailer from the tractor, the button of the PP-7 valve is pulled out by the operator. This will shut off the air supply to the trailer without bleeding down the tractor air system. Pulling the button closes the plunger inlet and unseats the exhaust valve (Fig. 4). Air that was flowing out the delivery port returns to the PP-7 valve and is exhausted from the vent in the midsection of the PP-7 valve.

NOTE: If the parking brakes were applied prior to pulling the PP-7 button, no delivery air would be present to exhaust. Delivery air would have been exhausted when the parking brakes were applied.

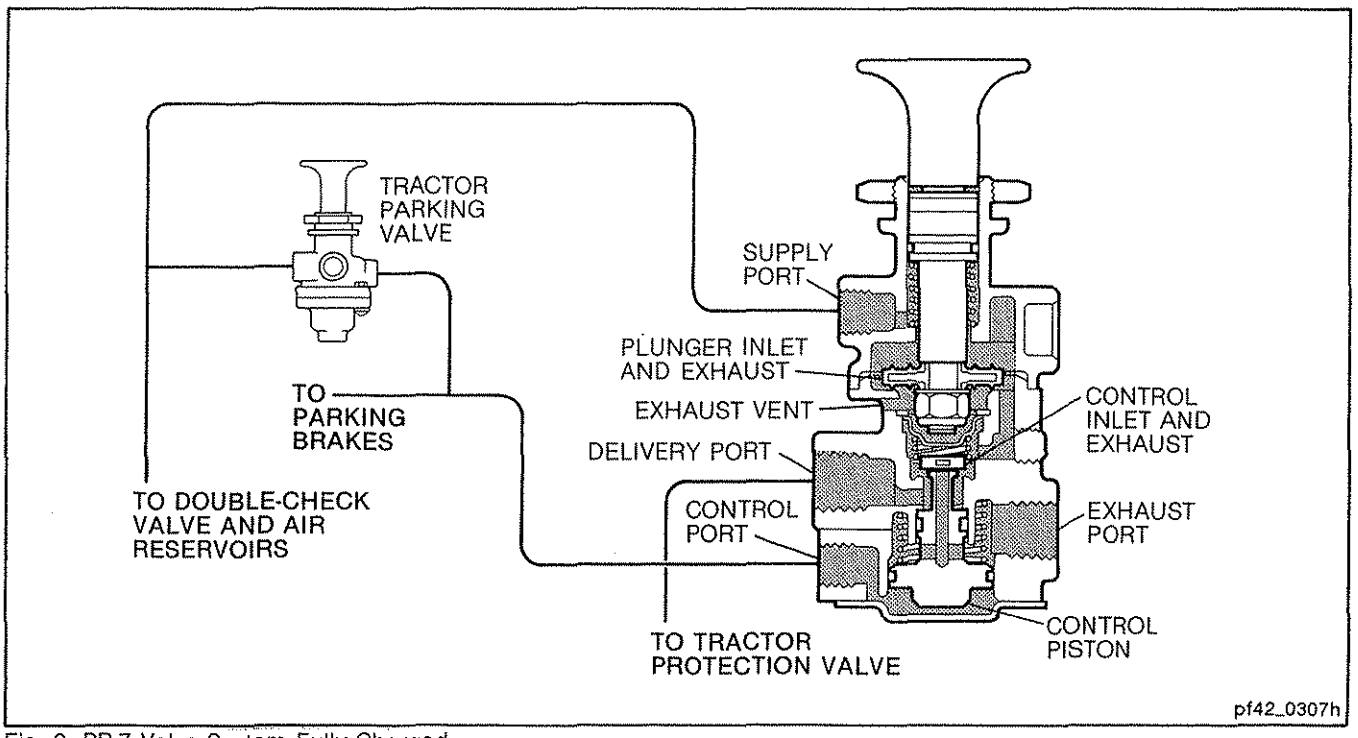


Fig. 3, PP-7 Valve System Fully Charged

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-7

In the event of trailer breakaway or a sudden complete failure of the trailer supply line, the button of the PP-7 will pop out. In this situation the air pressure retained in the tractor air system should be within approximately 10 psi (69 kPa) of the registered air pressure just prior to the breakaway or failure. The reason for this reaction is that air escaping from the failed supply line cannot be replaced through the supply port of the PP-7 valve as fast as it is being lost. The rapid loss of air pressure within the PP-7 valve results in a momentary reduction below the 40 psi (276 kPa) pop out pressure of the PP-7 plunger.

If a leak develops that is not as severe as a broken line, the PP-7 button will pop out when air pressure in the supply line falls below 40 psi (276 kPa).

During a parking brake application (Fig. 5), the tractor-trailer parking brake control valve removes air pressure from the control port of the PP-7, which cuts off the air supply to the trailer. The button of the PP-7 valve remains in.

With air pressure removed from the control port of the PP-7 valve, the control piston moves away from the control inlet and exhaust valve. The inlet valve seats and the exhaust passage through the control piston is open. Air at the delivery port of the PP-7 valve is exhausted at the exhaust port of the PP-7 valve.

SERVICE OPERATIONS

OPERATING AND LEAKAGE CHECKS

To perform the following test, an accurate vehicle test gauge installed in a spare hose coupling is required. The vehicle dash gauge(s) should be checked for accuracy against the test gauge prior to making these tests.

1. Apply the parking brakes, and chock the tires.
2. With the PP-7 trailer supply valve button out and the tractor-trailer parking brake control valve in the "brakes applied" position, build the air system pressure to governor cut-out (125 psi [862 kPa]).
3. Apply a soap solution to the exhaust vent and the plunger stem of the PP-7 valve to check for leakage. Leakage must not exceed a 1-inch bubble in 5 seconds at either point.
4. Push in the control button of the PP-7 and apply a soap solution to the exhaust vent and the exhaust port. Leakage should not exceed a 1-inch bubble in 5 seconds at either point.

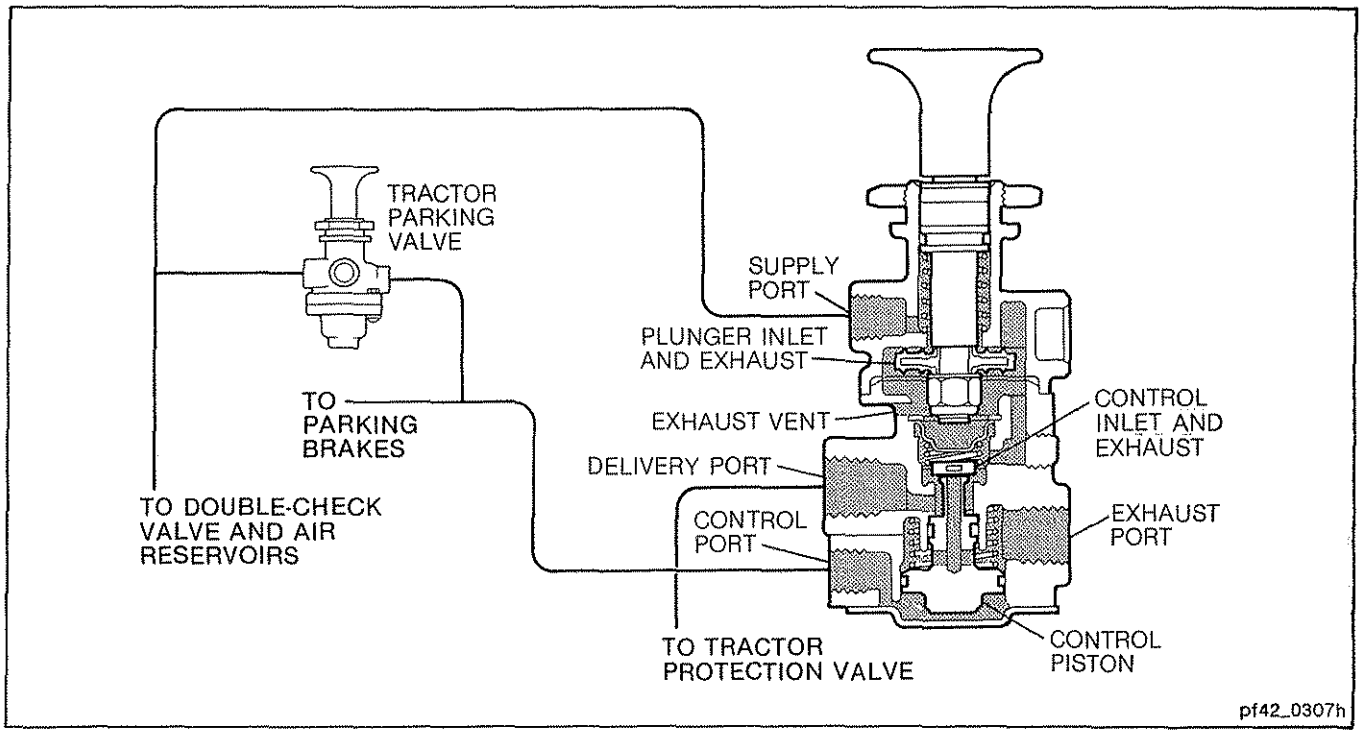


Fig. 4, PP-7 Valve Manual Emergency (Button Pulled Out)

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-7

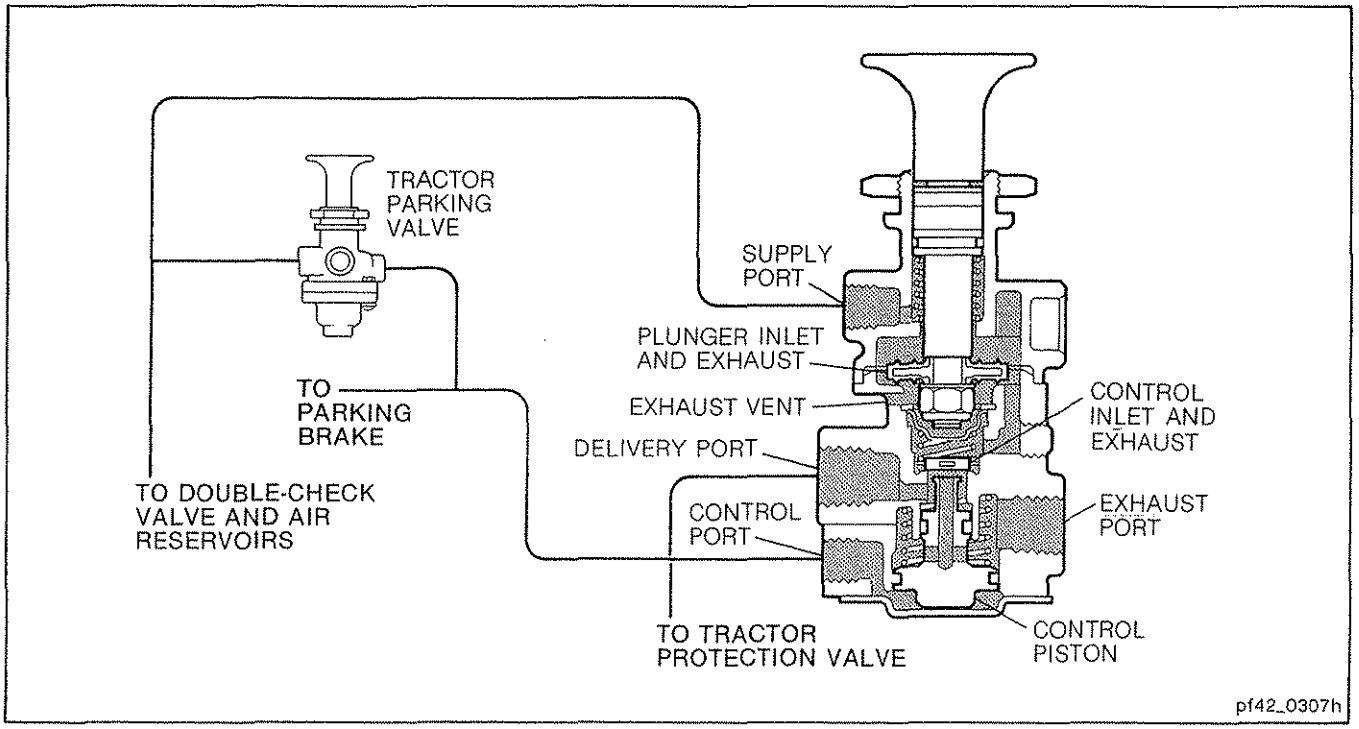


Fig. 5, PP-7 Valve, Park Application

5. Install the test gauge and coupling on the tractor-trailer supply coupling (tractor emergency hose coupling) at the rear of the tractor.

6. Have someone place the tractor-trailer parking brake control valve in the "brakes released" position, and observe an immediate rise in pressure on the test gauge. The pressure registered on the test gauge should equal dash gauge or system pressure.

7. Apply a soap solution to the exhaust port of the PP-7 valve. Leakage should not exceed a 1-inch bubble in 5 seconds.

8. With the tractor air system at governor cut-out pressure (125 psi [862 kPa]), shut off the engine and note the dash gauge pressure. Quickly disconnect the test gauge and hose coupling from the tractor-trailer supply line coupling. Leakage from the tractor-trailer supply line should cease immediately and the button of the PP-7 valve should be out. Dash gauge air pressure after performing the preceding test should be within approximately 10 psi (69 kPa) of the initial pressure.

9. Reconnect the test gauge to the tractor-trailer supply line and depress the button of the PP-7 valve. Open the drain cocks of the No. 1 and No. 2 service reservoirs slightly. Note at what pressure (descending) the button of the PP-7 pops out and exhausts the tractor-trailer supply line. This should occur between 20-45 psi (138-310 kPa) air system pressure.

IMPORTANT: If the PP-7 trailer supply valve fails to function as described above, or if leakage is excessive, it is recommended that it be returned to the nearest Bendix authorized outlet for a factory remanufactured valve. If this is not possible, the valve should be repaired using only genuine Bendix replacement parts. For part numbers, refer to the Freightliner Parts Book.

VALVE REPLACEMENT

1. Apply the parking brakes, and chock the tires. Completely drain the air system.

2. Remove the screws attaching the push-pull air brake valves panel to the dash control panel. Lift the panel to a serviceable level.

3. Disconnect all of the air lines leading to and from the PP-7 valve, and mark them for later assembly reference. Cap the air lines tightly to keep out contaminants.

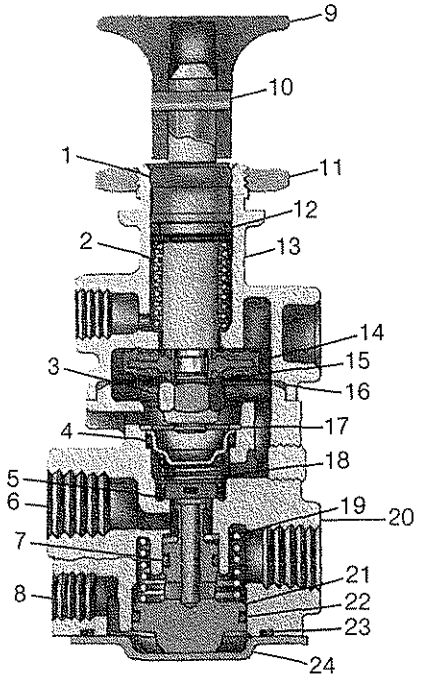
TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-7

4. Using a drift pin punch, remove the spirol pin (Fig. 6, Ref. 10) which secures the button to the plunger. Remove the button.
5. Using a 1-5/16 inch wrench, remove the special thin nut which secures the PP-7 valve to the panel, and remove the valve.
6. Place the new PP-7 valve in the panel mounting hole. Install and tighten the special thin nut.
7. Install the button on the valve, and attach it with the button spirol pin.
8. Remove the caps from the air lines. Connect the air lines to the PP-7 valve, as previously marked. Connect the nylon tube hose fittings to the elbow fittings in the valve ports, and tighten the nuts finger-tight. Then, using a wrench, tighten the nuts a minimum of two turns, or until no thread shows on the fittings.
9. Place the push-pull air brake valves panel on the dash control panel. Install and tighten the attaching screws.

VALVE REMOVAL, DISASSEMBLY, CLEANING AND INSPECTION, ASSEMBLY, AND INSTALLATION

Removal

1. Apply the parking brakes, and chock the tires. Completely drain the air system.
2. Remove the screws attaching the push-pull air brake valves panel to the dash control panel. Lift the panel to a serviceable level.
3. Disconnect all of the air lines leading to and from the PP-7 valve, and mark them for later assembly reference. Cap the air lines tightly to keep out contaminants.
4. Using a drift pin punch, remove the spirol pin (Fig. 6, Ref. 10) which secures the button to the plunger. Remove the button.
5. Using a 1-5/16 inch wrench, remove the special thin nut which secures the PP-7 valve to the panel, and remove the valve.



1. Plunger
2. Plunger Return Spring
3. Hex Nut
4. O-Ring
5. Inlet and Exhaust Valve
6. Delivery Port 1/4" Pipe Thread
7. O-Ring
8. Control Port 1/8" Pipe Thread
9. Button
10. Spirol Pin
11. Thin Nut
12. O-Ring
13. Upper Body
14. Inlet and Exhaust Valve
15. Tru Arc Retaining Ring
16. Sealing Ring (Square Cut)
17. O-Ring Retainer
18. Inlet and Exhaust Valve Return Spring
19. Spring
20. Lower Body
21. Piston
22. Large O-Ring
23. End Plate O-Ring
24. End Plate

pf42_0118h

Fig. 6, PP-7 Trailer Air Supply Valve

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-7

Disassembly (Refer to Fig. 6)

1. Remove the PP-7 valve from the vehicle. For instructions, refer to "Removal," under this heading.
2. Mark the upper and lower body halves to show their relationship to each other.
3. Remove the two 1/4-20 capscrews that secure the lower valve body to the upper valve body, using a 7/16-inch wrench. Separate the two body halves.
4. Remove and discard the square cut sealing ring (Ref. 16) between the upper and lower body halves.
5. Remove the end plate (Ref. 24) and O-ring (Ref. 23) from the lower body and discard the O-ring.
6. Remove the control piston (Ref. 21) and piston return spring (Ref 19).
7. Remove the large (Ref. 22) and small diameter (Ref. 7) O-rings from the piston and discard them.
8. Remove the internal tru arc retaining ring (Ref. 15) from the lower body.
9. Remove the O-ring retainer (Ref. 17), then remove and discard the O-ring (Ref. 4).
10. Remove the inlet and exhaust valve, and the return spring (Ref. 18).
11. Using a 7/16-inch wrench, remove the special (ESNA) hex nut (Ref. 3) from the plunger inlet exhaust valve and washer.
12. Remove the plunger inlet and exhaust valve (Ref. 14), and washer.
13. Remove the plunger (Ref. 1) and the plunger return spring (Ref. 2) from the body.
14. Remove and discard the plunger O-ring (Ref. 12).

Cleaning and Inspection

1. Clean all metal parts in a good commercial solvent making sure all ports, passages, and bores are clean and open.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

2. Dry the parts thoroughly, and inspect the plunger and piston bores for scratches and nicks.
3. It is recommended that all non-metallic parts and springs be replaced, using only genuine Bendix replacements.

Assembly (Refer to Fig. 6)

Prior to assembly, all internal bores and all non-metallic parts should be coated with a film of silicone lubricant, Bendix part number 291126, or equivalent.

1. Install the control inlet exhaust valve (Ref. 5) and the return spring (Ref. 18) in the lower body.
2. Install the O-ring (Ref. 4) in the body, then the O-ring retainer (Ref. 17) and the tru arc retainer (Ref. 15).
3. Install the end plate O-ring (Ref. 23) in the oval groove in the lower body.
4. Install the plunger O-ring (Ref. 12), and place the plunger return spring (Ref. 2) and plunger (Ref. 1) in the upper body.
5. Depress the plunger until the threaded portion extends sufficiently to install the plunger inlet and exhaust valve (Ref. 14), the valve washer, and special hex nut (Ref. 3). Tighten the special hex nut 30 to 40 lbf·in (339 to 452 N·cm).
6. Install the square cut seal ring (Ref. 16) in the upper body.
7. Install the large (Ref. 22) and small diameter O-rings (Ref. 7) on the control piston (Ref. 21).
8. Place the upper and lower bodies together taking care to align the marks made during disassembly.
9. Install the control piston return spring (Ref. 19) and the control piston in the lower body.
10. Install the end plate (Ref. 24) on the lower body, and secure it with the two 1/4-20 capscrews.
11. Tighten the capscrews 30 to 40 lbf·in (339-452 N·cm).
12. Install the PP-7 valve in the control panel. For instructions, refer to "Installation," under this heading.
13. Test the rebuilt unit. For instructions, refer to "OPERATING AND LEAKAGE CHECKS."

Installation

1. Place the PP-7 valve in the panel mounting hole. Install and tighten the special thin nut.

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-7

2. Install the button on the valve, and attach it with the button spirol pin.
3. Remove the caps from the air lines. Connect the air lines to the PP-7 valve, as previously marked. Connect the nylon tube hose fittings to the elbow fittings in the valve ports, and tighten the nuts finger-tight. Then, using a wrench, tighten the nuts a minimum of two turns, or until no thread shows on the fittings.
4. Place the push-pull air brake valves panel on the dash control panel. Install and tighten the attaching screws.

TRACTOR PROTECTION VALVE, BENDIX MODEL TP-3

GENERAL DESCRIPTION

The Bendix TP-3 tractor protection valve is mounted either in the frame rail channel (Fig. 1), the air tower assembly center mounting bracket, the air tower hose tenna assembly, in the tunnel (for COEs), or other locations. An air hose from the dash-mounted trailer air supply valve connects to the TP-3 valve tractor emergency port. An air hose from the foot and hand brake valves connects to the TP-3 valve tractor service port. The tractor-to-trailer air brake hoses are connected to the TP-3 valve trailer emergency port and trailer service port. See Fig. 2.

PRINCIPLES OF OPERATION

When the trailer air supply valve is open, air flows through the TP-3 valve emergency ports (Fig. 2) to the trailer air brake system, and releases the trailer parking brakes. The air within the TP-3 valve exerts pressure on a plunger, which unseats an inlet valve, and opens the service ports. See Fig. 3. This allows service application of the trailer air brakes.

A minimum pressure of approximately 45 psi (310 kPa) on the plunger is required to open the inlet valve. Whenever the air supply is shut off (at the trailer air supply valve), or the pressure drops below the minimum, the inlet valve seats and closes the service ports, and the trailer parking brakes are applied.

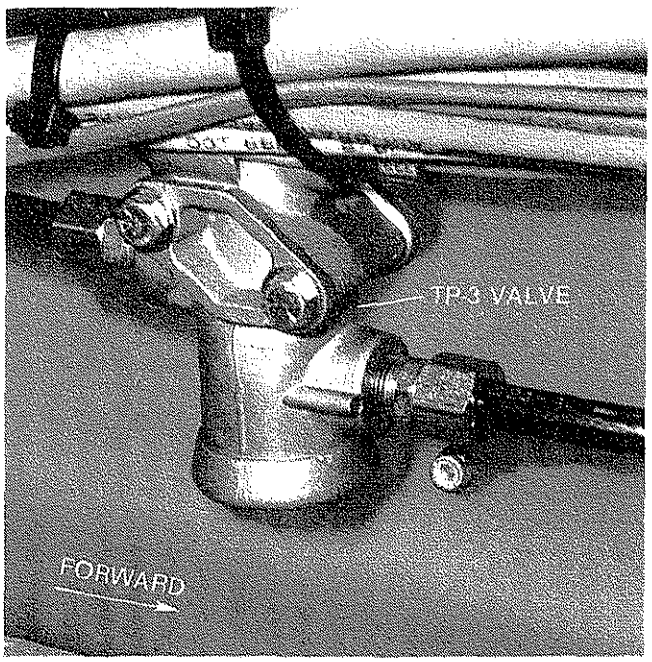


Fig. 1

SERVICE OPERATIONS

OPERATING AND LEAKAGE TESTS

1. Chock the tires. Place the trailer air supply valve in the emergency position and disconnect the trailer supply and service couplings. Apply a soap-water solution to the hose couplings.
2. With tractor reservoirs charged to at least 100 psi (689 kPa) make and hold a full service brake application. Leakage at either tractor hose coupling should not exceed a 1-inch (25 mm) bubble in 5 seconds.
3. Connect the trailer supply or emergency line hose coupling, and place the trailer supply valve in the "run" position. Leakage at the "service" coupling should not exceed a 1-inch (25 mm) bubble in 5 seconds.
4. Connect the service coupling, and make and hold a full service brake application. Leakage at the diaphragm end of the TP-3 valve should not exceed a 1-inch (25 mm) bubble in 3 seconds.

IMPORTANT: If the TP-3 valve does not function as described in the above tests, or if leakage is excessive, it is recommended that it be returned to the nearest Bendix HVSG (Heavy Vehicle Systems Group) authorized distributor for a factory rebuilt valve. If this is not

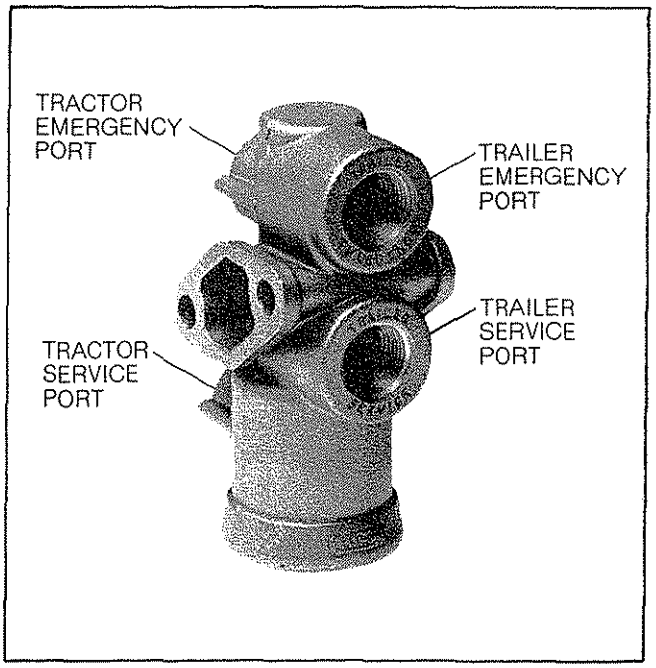
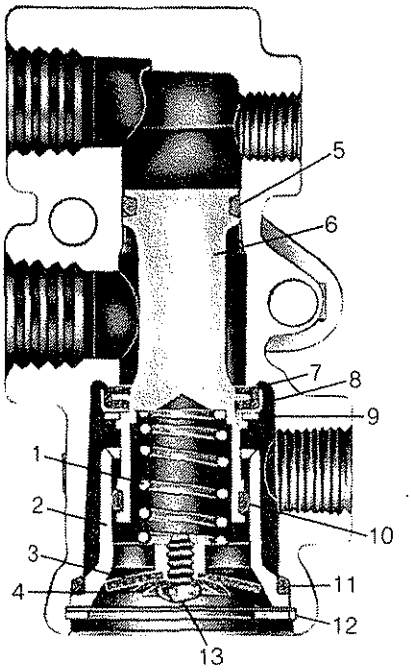


Fig. 2 Bendix TP-3 Tractor Protection Valve

TRACTOR PROTECTION VALVE, BENDIX MODEL TP-3



1. Valve Spring
2. Diaphragm Seat
3. Diaphragm
4. Diaphragm Washer
5. Plunger O-Ring
6. Plunger
7. Inlet valve
8. Valve Retainer
9. Valve Retainer Ring
10. Plunger O-Ring
11. Diaphragm Seat O-Ring
12. Diaphragm Seat Retainer Ring
13. Capscrew

Fig. 3, TP-3 Valve With an Inlet Valve Opening Pressure of 45 psi (310 kPa)

possible, the valve should be repaired using genuine Bendix HVSG parts, and the instructions given in this subject.

VALVE REPLACEMENT

1. Apply the parking brakes, and chock the tires.
2. Remove the trailer hose assemblies from the TP-3 valve. Disconnect the tractor service and supply lines. Mark the lines for later assembly reference. Cap the air lines tightly to keep out contaminants.
3. Remove the fasteners attaching the TP-3 valve to the vehicle, and remove the TP-3 valve.
4. Place the new TP-3 valve on the vehicle, and attach with the bolts, washers, and nuts. Tighten the nuts 11 to 15 lbf·ft (15 to 20 N·m).
5. The delivery line from the trailer air supply valve is connected to the tractor emergency port of the TP-3 valve. The delivery line from the brake valve (or double check valve) is connected to the tractor service port of the TP-3 valve. Trailer hose assemblies are installed in the trailer emergency and trailer service ports of the TP-3 valve. Also see the plumbing diagram, Fig. 4, under "SPECIFICATIONS." Remove the caps from the air lines, and depending on the type of air hose, use the following instructions to connect the air hoses to the TP-3 valve:

   If equipped with nylon tube hoses, connect the hose fittings to the valve ports, and tighten the nuts finger-tight. Then, using a wrench, tighten the nuts a minimum of two turns, or until no threads show on the fittings.

   If equipped with wire braid hoses, connect the hose fittings to the valve port, and hand-tighten the nut. Using a wrench, tighten the nuts until resistance is felt. Tighten one-sixth turn more. Do not overtighten.

VALVE REMOVAL, DISASSEMBLY, CLEANING AND INSPECTING, ASSEMBLY, AND INSTALLATION

Removal

1. Apply the parking brakes, and chock the tires.
2. Remove the trailer hose assemblies from the TP-3 valve. Disconnect the tractor service and supply lines. Mark the lines for later assembly reference. Cap the air lines tightly to keep out contaminants.

TRACTOR PROTECTION VALVE, BENDIX MODEL TP-3

3. Remove the fasteners attaching the TP-3 valve to the vehicle, and remove the TP-3 valve.

Disassembly (Refer to Fig. 3)

1. Remove the valve from the vehicle. For instructions, refer to "Removal," under this heading.
2. Remove the diaphragm seat retainer ring (Ref. 12) while holding the diaphragm seat (Ref. 2) in the valve body.
3. Remove the date code ring while still holding the diaphragm seat in the body.
4. Allow the seat to rise until valve spring force is no longer present.
5. Remove the diaphragm seat assembly, and the valve spring and plunger assembly.
6. Remove the diaphragm seat O-ring (Ref. 11), Phillips capscrew (Ref. 13), washer (Ref. 4), and diaphragm.
7. Remove the valve retainer ring (Ref. 9), valve retainer (Ref. 8), inlet valve (Ref. 7), and the O-rings (Refs. 5 and 10) from the plunger.

Cleaning and Inspection

1. Wash metal parts in mineral spirits, and then dry.
2. Inspect the seat in the body for nicks and burrs. Redress, if damaged. Inspect the plunger bore for scores or scratches. It should be smooth and clean.
3. Check the spring for distortion, corrosion, and cracks.
4. Replace all rubber parts and other parts not considered serviceable.

Assembly (Refer to Fig. 3)

1. Lubricate all O-rings and all sliding surfaces with silicone lubricant, Bendix part number 291126, or equivalent.
2. Install the inlet valve (Ref. 7) on the plunger (Ref. 6).
3. Position and force the valve retainer (Ref. 8) down over the inlet valve.
4. Install the valve retainer ring (Ref. 9) beneath the inlet valve retainer.
5. Install both plunger O-rings (Refs. 5 and 10) in the proper grooves.
6. Place the plunger and valve assembly in the valve body.
7. Install the Phillips head capscrew (Ref. 13), diaphragm washer (cup side up) (Ref. 4), and diaphragm (Ref. 3) into the diaphragm seat (Ref. 2).
8. Place the inlet valve spring (Ref. 1) into the plunger.
9. Install the diaphragm seat O-ring (Ref. 11) in the body.
10. Position the diaphragm seat assembly over the spring and plunger assembly, and force into the body.
11. Replace the date code washer and install the diaphragm seat retaining ring, making sure the retaining ring snaps fully into the groove.
12. Install the TP-3 valve on the vehicle. For instructions, refer to "Installation," under this heading.
13. Perform the operating and leakage checks. For instructions, refer to "OPERATING AND LEAKAGE TESTS."

Installation

1. Place the TP-3 valve on the vehicle, and attach with the bolts, washers, and nuts. Tighten the nuts 11 to 15 lbf·ft (15 to 20 N·m).
2. The delivery line from the trailer air supply valve is connected to the tractor emergency port of the TP-3 valve. The delivery line from the brake valve (or double check valve) is connected to the tractor service port of the TP-3 valve. Trailer hose assemblies are installed in the trailer emergency and trailer service ports of the TP-3 valve. Also see the plumbing diagram, Fig. 4, under "SPECIFICATIONS." Remove the caps from the air lines, and depending on the type of air hose, use the following instructions to connect the air hoses to the TP-3 valve:

   If equipped with nylon tube air hoses, connect the hose fittings to the valve ports, and tighten the nuts finger-tight. Then, using a wrench, tighten the nuts a minimum of two turns, or until no threads show on the fitting.

   If equipped with wire braid hoses, connect the hose fittings to the valve port, and hand-tighten the nuts. Using a wrench, tighten the nuts until resistance is felt. Tighten one-sixth turn more. Do not overtighten.

TRACTOR PROTECTION VALVE, BENDIX MODEL TP-3

SPECIFICATIONS

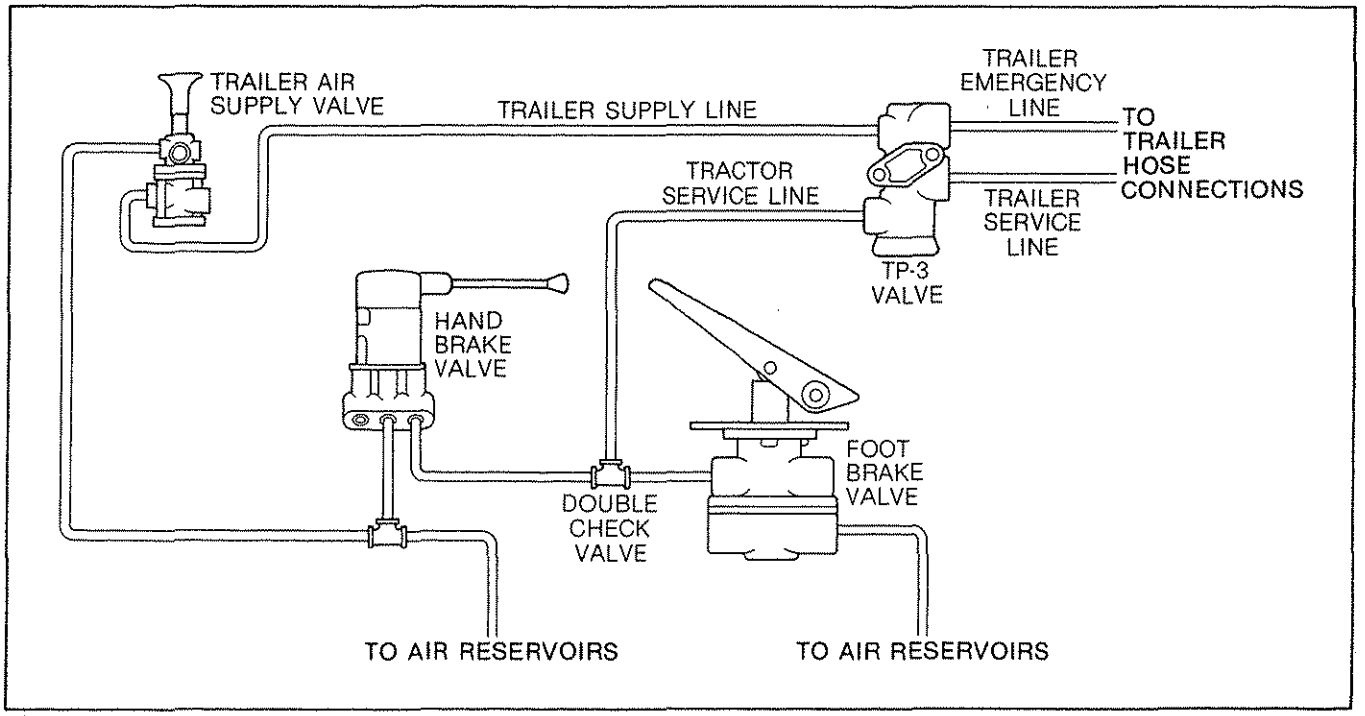


Fig. 4, Plumbing Diagram

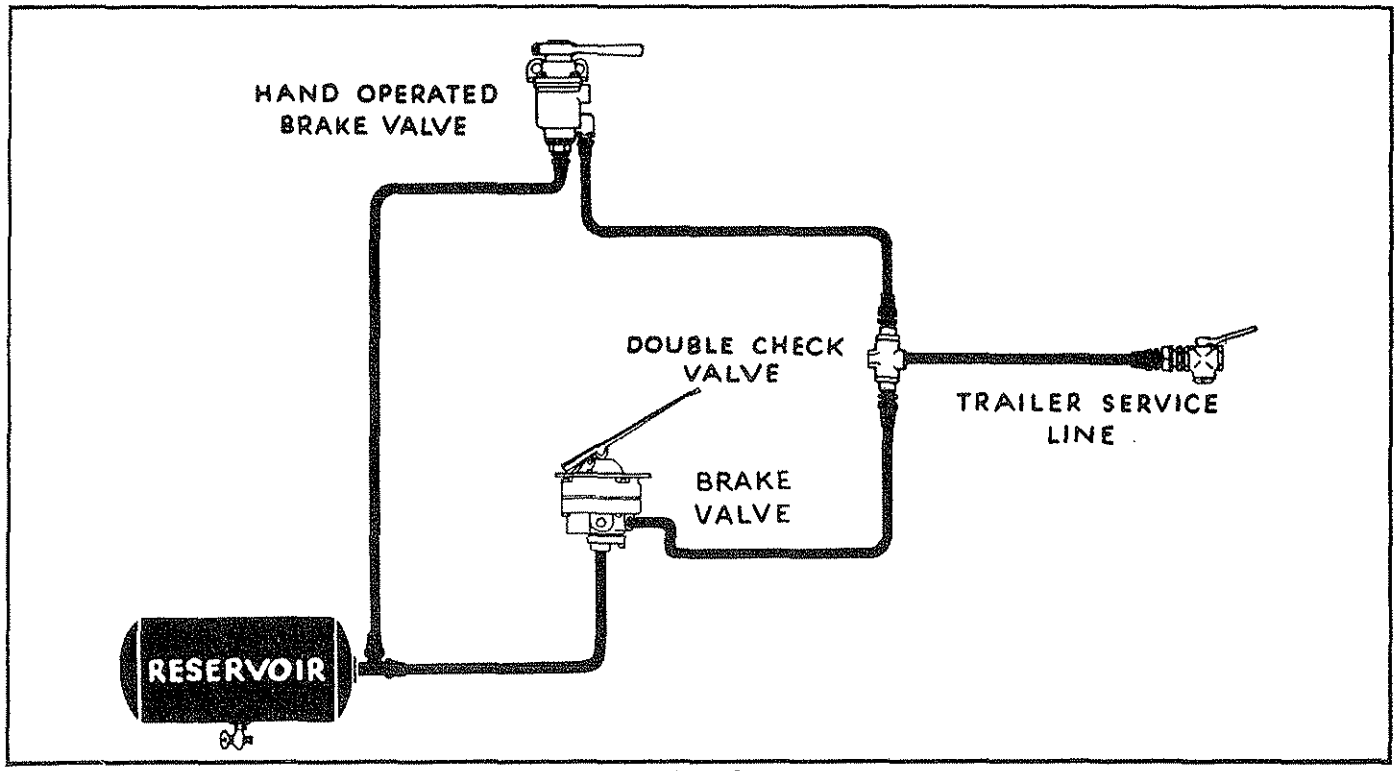


Fig. 1

GENERAL DESCRIPTION

Air brake systems for trucks towing trailers or for tractor units pulling semi-trailers include a hand-operated brake valve and a double check valve in addition to the standard foot brake valve and related equipment. (Fig. 1) This is installed to allow the driver independent control of the trailer brakes, which can be useful when adverse road conditions are encountered.

The double check valve directs the flow of compressed air to the trailer service line when either the foot operated or hand operated brake valve is applied. If a double check valve was not used, and either the hand valve or foot valve were applied, air pressure from the reservoir would escape through the open exhaust port of the other brake valve. When a double check valve is used, and one of the brake valves is applied, the double check valve closes off the line to the other valve, preventing air loss through the open exhaust port of that valve. For information on the double check valve, see Service Manual section 32-12355.

The TC-2 valve (Fig. 2) is normally used as the hand control valve for the trailer brakes, but is occassionally used for tractor brakes, or wherever a graduated, hand-controlled air application is desired. The TC-2 valve may be mounted on the steering column, the dash, or the driver's side of the tunnel.

WARNING: Do not use the hand control valve to apply the trailer brakes for parking. It is not designed for this purpose. If the air bleeds out of the trailer air tank, the vehicle could roll causing serious consequences.

PRINCIPLES OF OPERATION

When the handle is moved clockwise from the released position, force is exerted on the pressure graduating spring through the action of the cam and cam follower. The force of the spring on the piston causes it to move down. The exhaust seat, in the center of the piston, contacts the the exhaust valve and closes the exhaust passage in the piston. The continued

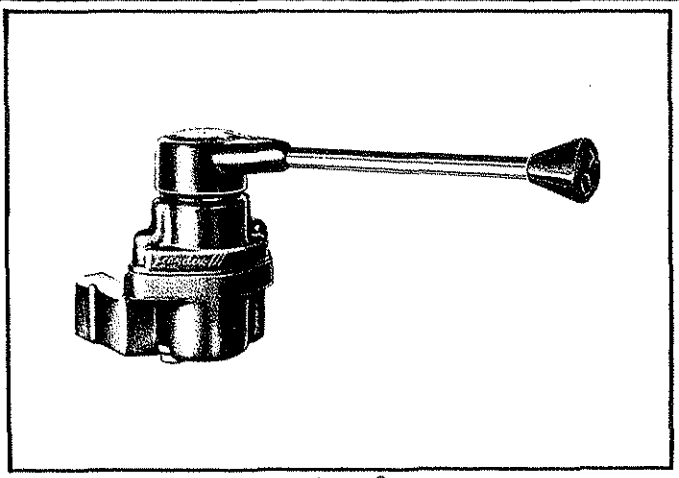


Fig. 2

downward movement of the piston moves the inlet valve off its seat. Reservoir air pressure flows by the open inlet valve and out the delivery port, through the service lines, applying the brakes.

While retarding the vehicle with the hand valve application, the inlet air pressure is also acting on the bottom area of the piston. As the force of the air pressure beneath the piston balances the force of the depressed graduating spring above, the piston lifts slightly and the inlet valve returns to its seat. The exhaust valve remains seated so the flow of air through the valve is stopped and air pressure in the service line is held.

When the handle is moved in a counter-clockwise direction, the force above the piston is decreased. The air passage beneath the piston will then lift the piston, moving the exhaust seat away from the exhaust valve. With the exhaust passage open, air pressure in the service line will exhaust out the exhaust port of the valve, releasing the brakes.

SERVICE OPERATIONS

SERVICEABILITY TESTS

Operation Test

1. Check the delivery pressure of the TC-2 valve by connecting an accurate pressure gauge to the trailer delivery line. When the handle is moved to the fully applied position, the valve should deliver between 75 and 85 psi. (The above is standard; there are valves which deliver higher or lower pressures, installed by request.)

2. Move the valve to several positions between fully applied and released positions, and make sure that the test gauge pressure varies accordingly.

Leakage Test

1. Soap test for inlet valve leakage at the exhaust port while the valve is in the released position.

2. Hold the valve in the applied position and soap test for exhaust valve or piston O-ring leakage at the valve exhaust port.

3. Leakage of a three-inch soap bubble in three seconds is the maximum amount permissable, in either test.

IMPORTANT: If the valve does not function as described in Operation, above, or if leakage exceeds the amount specified, the valve must be repaired or replaced with a new valve. A

REMOVAL

1. Block and hold vehicle by means other than air brakes.

WARNING: Failure to do so could result in a hazardous work area.

2. Drain the air system, by opening the reservoir drain cocks.

3. Disconnect air lines from the valve ports.

4. Remove mounting fasteners. The valve is now free for removal. On column mounted hand valves, the fasteners are bolts in the mounting clamp. If dash mounted, the valve is fastened with capscrews. Tunnel mounted valves are attached with nuts onto mounting bracket studs. A

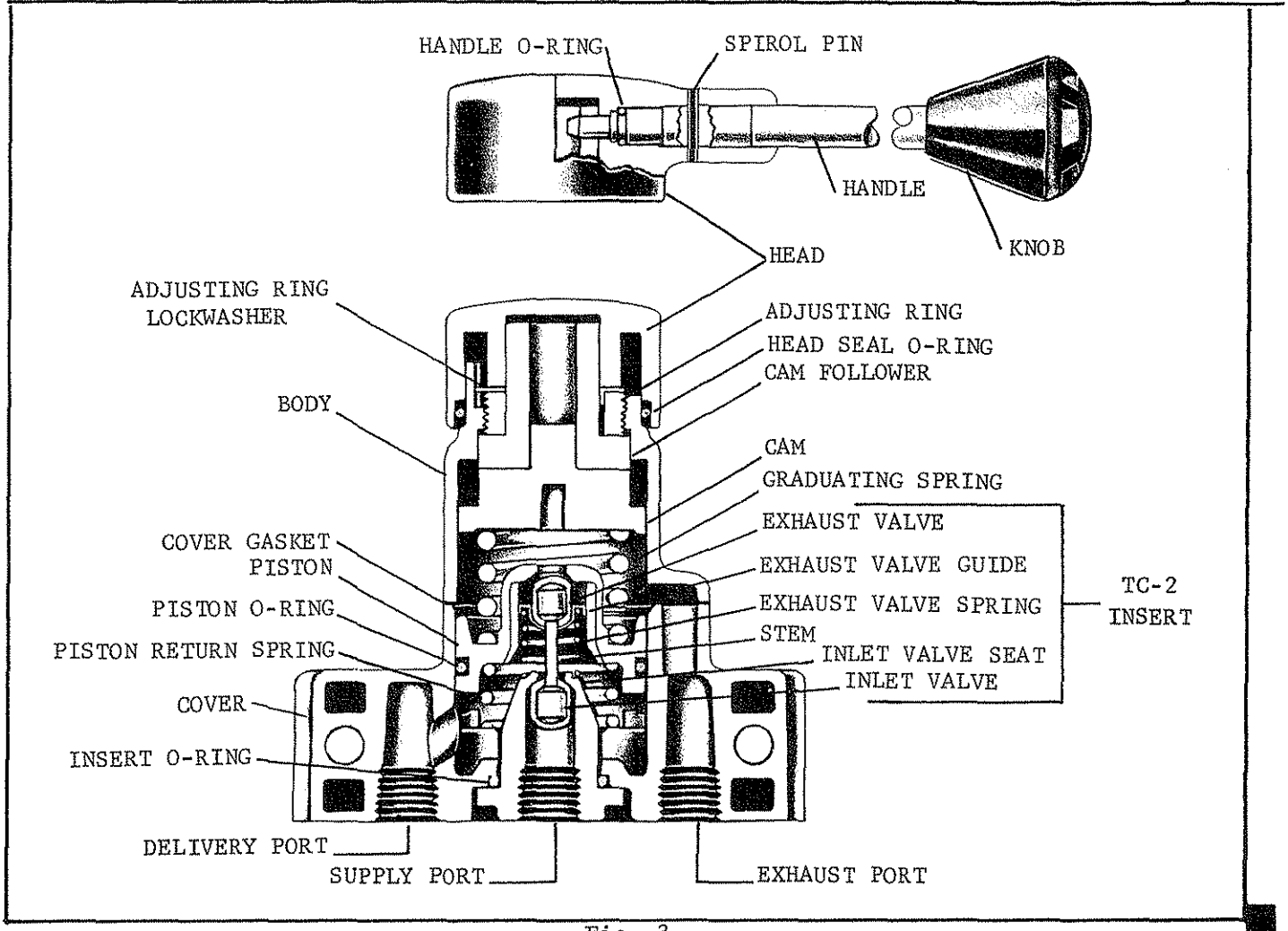


Fig. 3

A DISASSEMBLY

1. Drive out the spirol pin in the handle, and remove the handle, head, and head seal O-ring. (Fig. 3)

2. Remove the handle O-ring (Fig. 3)

3. Remove the adjusting ring lockwasher. (Fig. 3)

4. Remove the capscrews that attach the cover to the body. Separate the cover from the body. (Fig. 3)

5. Remove the cover gasket and the graduating spring. (Fig. 3)

A 6. Remove the cam and the cam follower from the cover. (Fig. 3)

7. Unscrew and remove the adjusting ring. (Fig. 3)

8. Remove the piston and the piston return spring from the body. (Fig. 3)

9. Remove the piston O-ring. (Fig. 3)

10. Remove inlet and exhaust insert screws and lockwashers, then remove insert O-ring. (Fig. 3)

11. The inlet and exhaust valve insert can be disassembled if necessary. First insert some object, such as a capscrew, in the supply port to hold the inlet valve on its seat. (Fig.3)

12. Depress the exhaust valve guide, and spring, and remove the exhaust valve.

13. Remove the stem with the inlet valve from the inlet seat, and remove inlet valve from stem. (Fig. 3)

INSPECTION

1. Clean all metal parts in cleaning solvent. Do not immerse rubber parts in solvent; wipe them clean and dry.

2. Inspect valve seats for nicks or burrs, and remove any deposits. Replace nicked or burred parts.

3. Inspect all springs and other metal parts for distortion, cracks, or corrosion. Replace distorted, cracked or corroded parts with new parts.

4. Inspect all rubber parts for wear or deterioration. If wear or deterioration is present, install new parts.

ASSEMBLY

1. Before assembling the TC-2 valve, lubricate the body and cover bores, cam and cam follower, piston O-ring, and cover top with good lubricant meeting N.L.G.I. Grade 1. (Fig. 3)

2. Press the inlet valve onto the stem. A little water in the boot valve or some soap on the stem will make it easier to press on the inlet valve. (Fig. 3)

3. Place the stem, with the inlet valve installed, in the inlet seat. Insert some object, such as a capscrew, in the supply port to hold the inlet valve up against its seat. (Fig. 3)

4. Position exhaust valve spring, and exhaust valve guide. (Fig. 3)

5. Depress guide and spring, then press exhaust valve onto stem. (Fig. 3)

6. Place insert O-ring over insert seat, and install inlet and exhaust insert with capscrews and lockwashers. Tighten capscrews, 60 to 80 in-lbs. (Fig. 3)

7. Install piston return spring.(Fig. 3)

8. Install piston O-ring on piston, and install piston in body. (Fig. 3) A

9. Install adjusting ring in cover and screw it down until it is flush with the top of the cover. (Fig. 3)

10. Place cam follower and cam in cover. (Fig. 3)

11. Position graduating spring and gasket in body. (Fig. 3)

12. Attach cover to body, tightening capscrews evenly to 100 - 140 in-lbs. (Fig. 3)

13. Install adjusting ring lockwasher, head seal O-ring, and head. (Fig. 3)

14. Before installing the handle and spirol pin, the rebuilt valve should be tested and adjusted, if facilities are available. If no facilities are available, tests and adjustments can be made on the vehicle. (See SERVICEABILITY TESTS AND ADJUSTMENT sections.) A

INSTALLATION

1. Clean air lines leading to and from valve.

2. Mount valve as it was prior to removal. Tighten mounting fasteners evenly, to avoid bending or breaking valve body or supporting member. Tighten fasteners securely.

3. Connect air hoses to supply, delivery, and exhaust ports.

TESTING THE REBUILT TC-2 VALVE

The rebuilt valve must pass the Operation and Leakage tests, detailed in the "SERVICEABILITY TESTS" section. Failure to pass these tests could result in an unsafe vehicle. A

ADJUSTMENT

The standard TC-2 valve should deliver a

maximum pressure between 75 and 85 psi. There are a few exceptions in special valves. If the delivered pressure does not fall within this range, it can be adjusted by removing the head and the adjusting ring lockwasher, then turning the adjusting ring to raise or lower the delivered pressure. Turning the adjusting ring clockwise raises the delivered pressure. Turning the adjusting ring counterclockwise lowers the delivered pressure.

A

A spanner wrench can be used to rotate the adjusting ring, but if a spanner wrench is not available, a small screwdriver may be used in one of the inner notches of the ring. One notch equals approximately 5 psi.

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-3

GENERAL DESCRIPTION

The Bendix PP-3 trailer air supply valve is a push-pull, button-operated valve, and is installed in the control panel. An air hose from the air reservoir connects to the supply port of the PP-3 valve. The delivery hose to the tractor protection valve is connected to the PP-3 valve delivery port. See Fig. 1. The PP-3 valve works in conjunction with the tractor protection valve to supply pressurized air to the trailer brake system.

PRINCIPLES OF OPERATION

When the PP-3 valve button is pushed in, the inlet and exhaust valve (within the PP-3 valve) opens, allowing pressurized air to flow out the delivery port to the tractor protection valve and trailer air system. The button will remain in when there is 50 psi (345 kPa) of air pressure in the supply line. When the button is pulled out, the air pressure is exhausted out the PP-3 valve exhaust port. The inlet and exhaust valve is closed, shutting off the air supply to the tractor protection valve and trailer system, causing the trailer parking brakes to apply.

If there is a loss of air pressure in the vehicle or trailer air system because of leakage, and the PP-3 valve button is not pulled out, the PP-3 valve will automatically pop out and close when the air pressure drops below 40 psi (276 kPa). If the button is manually held in, and the air pressure drops to 30 psi (207 kPa), the tripper piston (within the valve) will move and open the tripper exhaust. Air is exhausted through the tripper exhaust, causing the trailer parking brakes to apply.

SERVICE OPERATIONS

OPERATING AND LEAKAGE TESTS

To make the following operating and leakage checks, an accurate test gauge installed in a spare hose coupling is required. The vehicle dash gauge should be checked for accuracy against the test gauge prior to making these tests.

1. Apply the parking brakes, and chock the tires.
2. Drain the vehicle air system. Close the drain cocks.
3. Connect the assembled hose coupling and test gauge in the tractor emergency hose coupling. Start the engine and build up system pressure.
4. As reservoir pressure builds up there should be no pressure reading on the test gauge. When system pressure reaches the 30 to 40 psi (207 to 276 kPa) range on the dash gauge, make and hold a foot or hand valve application and observe that no air escapes at the open trailer service hose coupling.
5. When system pressure reaches approximately 60 psi (413 kPa), the PP-3 valve button should be pushed in. System pressure should show at once on the test gauge connected in the emergency line, and the button of the PP-3 valve should remain in without being held.
6. Build the system pressure up to approximately 100 psi (689 kPa), then stop the engine. With the engine stopped, wait momentarily, then notice that the dash gauge and test gauge pressure readings equal. While still in this position, make a foot or hand valve application, and observe that air is delivered out the open trailer service coupling.
7. With the PP-3 valve button still in, check for leakage at the PP-3 valve exhaust and tripper exhaust ports. Leakage should not exceed a 1-inch (25 mm) bubble in five seconds at either point.
8. With the PP-3 valve button still in, check for leakage at the tractor protection valve exhaust and open service coupling. Leakage should not be more than a 1-inch (25 mm) bubble in five seconds at either point.
9. Pull the PP-3 valve button out. Pressure on the test gauge connected in the emergency line should

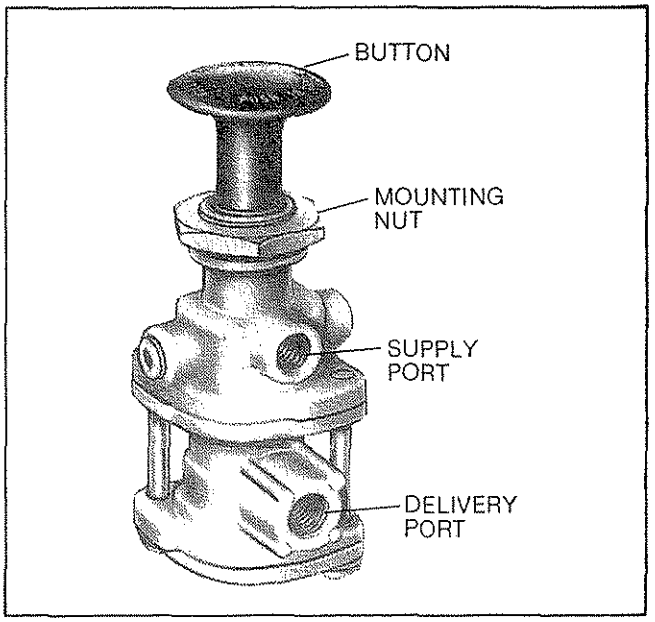


Fig. 1

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-3

drop to zero. Make and hold a hand valve application, and observe that air delivered at the open service coupling does not exceed a 1-inch (25 mm) bubble in five seconds. Release the foot or hand valve application.

IMPORTANT: If the PP-3 valve does not function as described in the above tests, or if leakage is excessive, it is recommended that it be returned to the nearest Bendix HVSG (Heavy Vehicle Systems Group) authorized distributor for a factory rebuilt valve. If this is not possible, the valve should be repaired using genuine Bendix HVSG parts, and the instructions given in this subject.

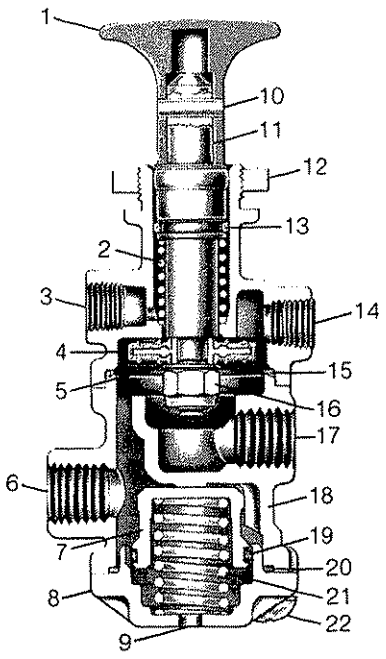
VALVE REPLACEMENT

1. Apply the parking brakes, and chock the tires. Drain the air system.
2. Remove the screws attaching the push-pull air brake valves panel to the control panel. Lift the panel to a serviceable level.
3. Disconnect the supply and delivery lines from the PP-3 valve. Mark the lines for later assembly reference. Cap the air lines tightly to keep out contaminants.
4. Drive out the PP-3 button spirol pin (Fig. 2, Ref 10), and remove the button. Remove the PP-3 valve mounting nut, then remove the PP-3 valve from the panel.
5. The supply line from the tractor reservoir is connected to the supply port of the PP-3 valve. The delivery line to the tractor protection valve emergency port is connected to the PP-3 valve delivery port.

   Remove the caps from the air lines. Connect the nylon tube hose fittings to the elbow fittings in the valve ports, and tighten the nuts finger-tight. Then, using a wrench, tighten the nuts a minimum of two turns, or until no threads show on the fittings.

IMPORTANT: The PP-3 valve exhaust port and tripper exhaust must be open. Two ports marked "Del" on the upper PP-3 control valve body are plugged, and must remain plugged.

6. Place the PP-3 valve in the panel mounting hole. Install and tighten the valve mounting nut.
7. Install the button on the valve, and attach with the button spirol pin.
8. Place the panel on the control panel dash. Install and tighten the attaching screws.



1. Button
2. Plunger Spring
3. Supply Port
4. Inlet and Exhaust Valve
5. Washer
6. Delivery Port
7. Tripper Piston
8. Cover
9. Tripper Exhaust
10. Spirol Pin
11. Plunger
12. Mounting Nut
13. Plunger O-Ring
14. Pipe Plug
15. Upper and Lower Body Seal O-Ring
16. Inlet and Exhaust Valve Nut
17. Exhaust Port
18. Lower Body
19. Tripper Piston Cover Seal O-Ring
20. Cover Seal O-Ring
21. Tripper Spring
22. Lower Body Capscrews

Fig. 2, PP-3 Trailer Air Supply Control Valve

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-3

VALVE REMOVAL, DISASSEMBLY, CLEANING AND INSPECTION, ASSEMBLY, AND INSTALLATION

Removal

1. Apply the parking brakes, and chock the tires. Drain the air system.
2. Remove the screws attaching the push-pull air brake valves panel to the control panel. Lift the panel to a serviceable level.
3. Disconnect the supply and delivery lines from the PP-3 valve. Mark the lines for later assembly reference. Cap the air lines tightly to keep out contaminants.
4. Drive out the PP-3 button spirol pin (Fig. 2, Ref. 10), and remove the button. Remove the PP-3 valve mounting nut, then remove the PP-3 valve from the panel.

Disassembly (Refer to Fig. 2)

1. Remove the valve from the vehicle. For instructions, refer to "Removal," under this heading.
2. Remove the two lower body capscrews (Ref. 22) and lockwashers, then the lower body with the cover.
3. Remove the cover with the tripper piston from the lower body.
4. Remove the tripper piston and tripper spring from the cover.
5. Remove the tripper piston and cover seal O-rings.
6. Insert a rod or punch in the upper plunger pin hole, and hold the plunger from turning while the inlet and exhaust valve nut is removed.
7. Remove the washer and the inlet and exhaust valve.
8. Pull the plunger from the upper body.
9. Remove the plunger spring and O-ring (Ref. 13).
10. Remove the upper body seal ring. Do not remove the plugs from the ports marked "Del" in the upper body.

Cleaning and Inspection

1. Wash all metal parts in mineral spirits, and then dry.
2. Make sure the supply port in the PP-3 valve upper body, tripper by-pass slot, and tripper exhaust port in the cover are thoroughly cleaned and unrestricted.
3. Inspect all parts for excessive wear or deterioration.
4. Inspect the seats in the upper and lower body for nicks and burrs. Redress seats if damaged.
5. Inspect the plunger and tripper piston bores in the bodies and cover for deep scratches or nicks. They should be smooth and clean.
6. Check the springs for distortion, corrosion, and cracks.
7. Replace all parts not considered serviceable during these inspections, especially the O-rings and valves.

Assembly (Refer to Fig. 2)

1. Lubricate all O-rings and bearing surfaces with silicone lubricant, Bendix part number 291126, or equivalent.
2. Install the plunger O-ring.
3. Position the plunger spring in the upper body, then press the plunger down inside the spring in the body.
4. Place the inlet and exhaust valve, then the washer (Ref. 5), over the threaded, protruding end of the plunger.
5. Install and tighten the valve self-locking nut. Tighten the nut 30 to 40 lbf·in (339 to 452 N·cm).
6. Place the upper and lower body seal O-ring (Ref. 15) in place.
7. Install the tripper piston O-ring (Ref. 19).
8. Position the cover seal O-ring (Ref. 20) on the cover.
9. Position the tripper spring in the cover, then press the tripper spring down over the spring and into the cover bore.
10. Place the cover with the tripper installed into the lower body.
11. Fasten the lower body and cover assembly to the upper assembly with the capscrews and lockwashers. Tighten the capscrews evenly and securely.
12. Install the PP-3 valve in the control panel. For instructions, refer to "Installation," under this heading.
13. Perform the operating and leakage checks. For instructions, refer to "OPERATING AND LEAKAGE TESTS."

TRAILER AIR SUPPLY VALVE, BENDIX MODEL PP-3

Installation

1. The supply line from the tractor reservoir is connected to the supply port of the PP-3 valve. The delivery line to the tractor protection valve emergency port is connected to the PP-3 valve delivery port.

   Remove the caps from the air lines. Connect the nylon tube hose fittings to the elbow fittings in the valve ports, and tighten the nuts finger-tight. Then, using a wrench, tighten the nuts a minimum of two turns, or until no threads show on the fittings.

IMPORTANT: The PP-3 valve exhaust port and tripper exhaust must be open. Two ports marked "Del" on the upper PP-3 control valve body are plugged, and must remain plugged.

2. Place the PP-3 valve in the panel mounting hole. Install and tighten the valve mounting nut.
3. Install the button on the valve, and attach with the button spirol pin.
4. Place the panel on the control panel dash. Install and tighten the attaching screws.

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

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- Electronic Control Unit 2
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WABCO® ANTILOCK BRAKING SYSTEM (ABS)

GENERAL DESCRIPTION (Refer to Fig. 1)

The WABCO Antilock Braking System (ABS) is an electronic wheel speed monitoring and control system that works with the standard air brake system. ABS passively monitors vehicle wheel speed at all times, and controls wheel speed during an emergency or reduced-traction stop. In normal braking applications, the standard air brake system is in effect.

ABS includes signal-generating tone wheels and sensors located in the wheel hubs of each axle. The sensors transmit vehicle wheel speed information to an electronic control unit. According to programmed specifications, the control unit signals the appropriate solenoid control valve to increase, reduce, or maintain air pressure supply in the brake chamber. This prevents front and rear wheel lockup, and ensures steering control and a reduced braking distance during emergency braking situations.

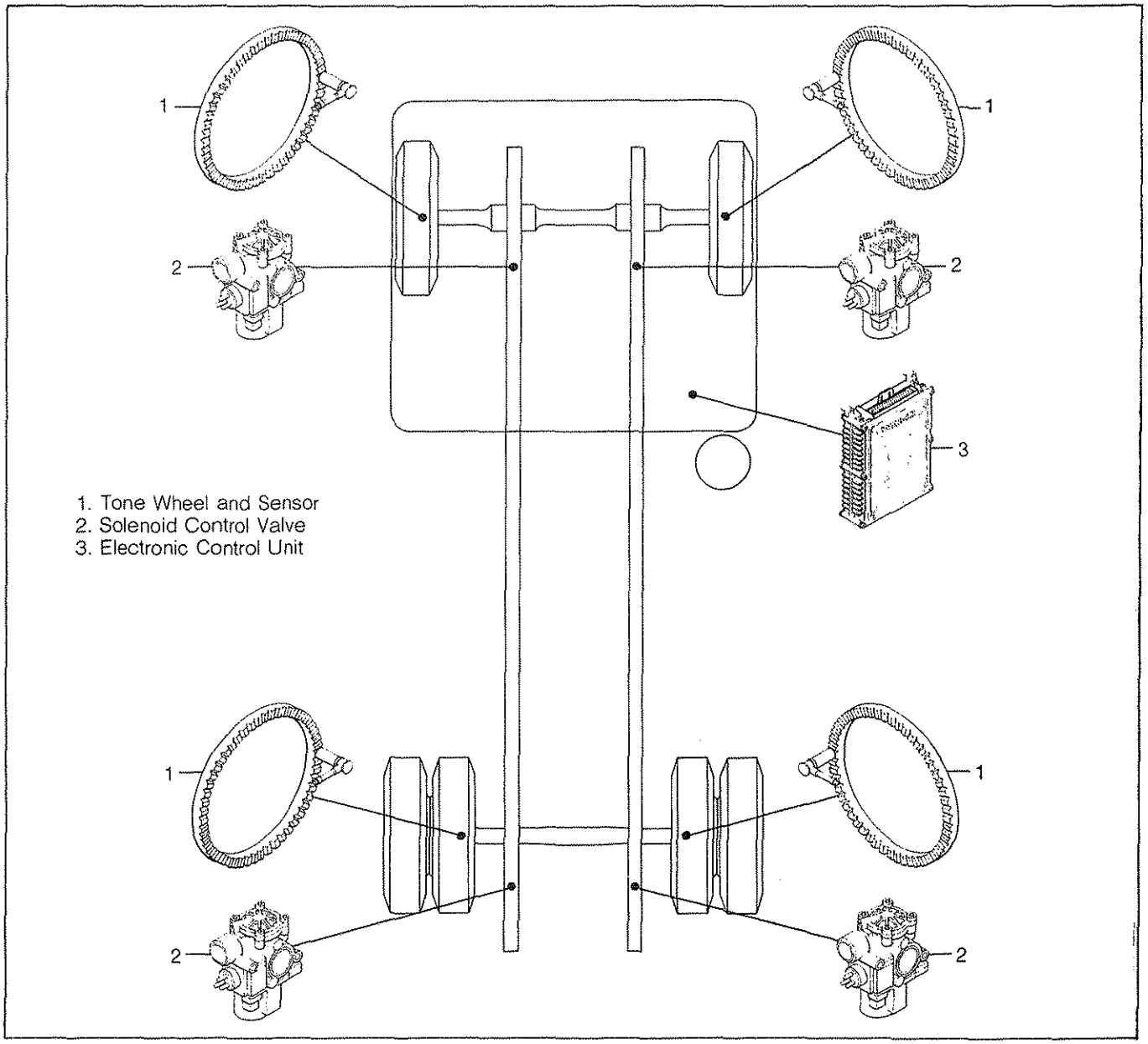

Fig. 1, Location of ABS Components, Four-Channel System

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

PRINCIPLES OF OPERATION

The ABS electronic control unit (Fig. 2) is a digital microcomputer that serves as the information processing and command center for the antilock braking system. The control unit receives and processes vehicle wheel speed information from the sensors. During emergency brake applications, the control unit regulates the braking force applied to each wheel by sending control signals to the solenoid control valves (Fig. 3).

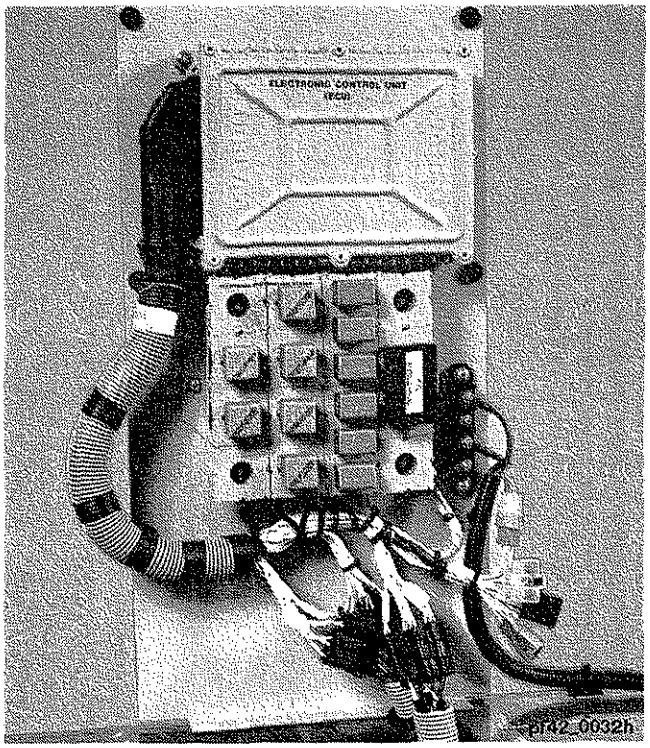

Fig. 2

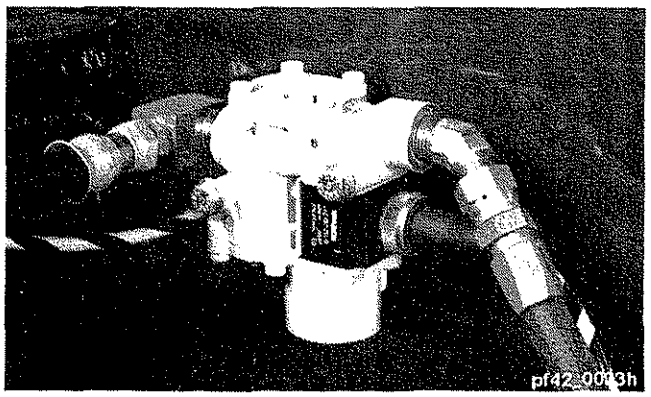

Fig. 3

ABS MAJOR COMPONENTS

Wheel Speed Sensor

The wheel speed sensors use pulse feedback from 100-tooth tone wheels located in the front and rear axle wheel hubs. When the vehicle is moving, the gaps and teeth of the tone wheel cause pulses in a magnetic field created by the sensor. The pulses are sent to the electronic control unit.

There are two types of wheel speed sensors. The first has a conical internal pole pin, the second has a cylindrical internal pole pin. Refer to Fig. 4. The external shape of the two sensors is identical, but the sensor with the conical pole pin can be identified by an imprinted K (See Fig. 5) or by the internal resistance. The internal resistance for sensors with conical pole pins is 1650 to

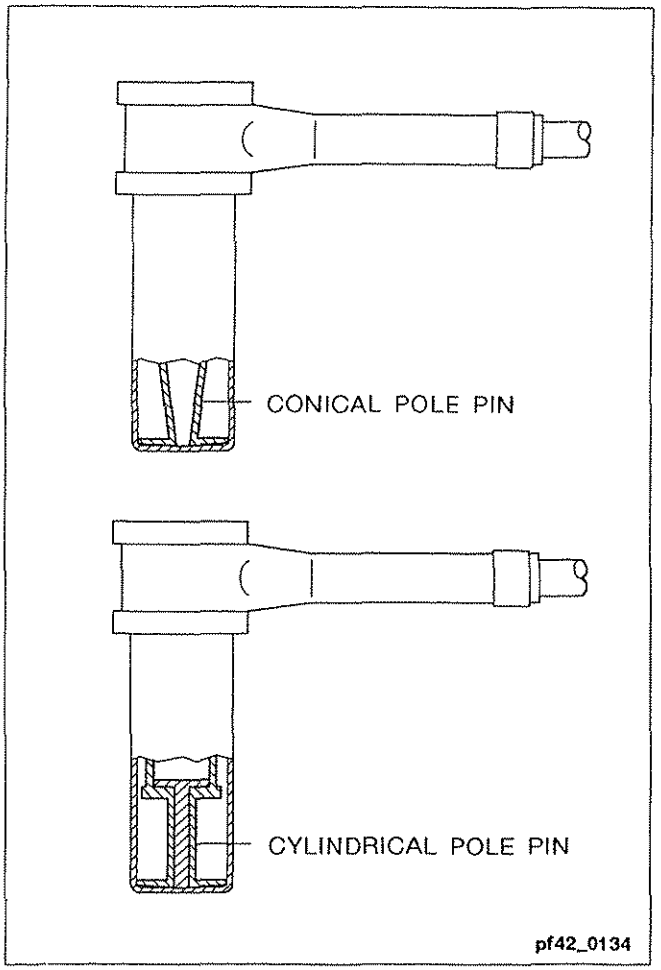

Fig. 4

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

1750 ohms (1.65 to 1.75 kilo ohms). The internal resistance for sensors with cylindrical pole pins is 1200 to 1360 ohms (1.20 to 1.36 kilo ohms).

It is acceptable to mix the two types of sensors in an ABS system.

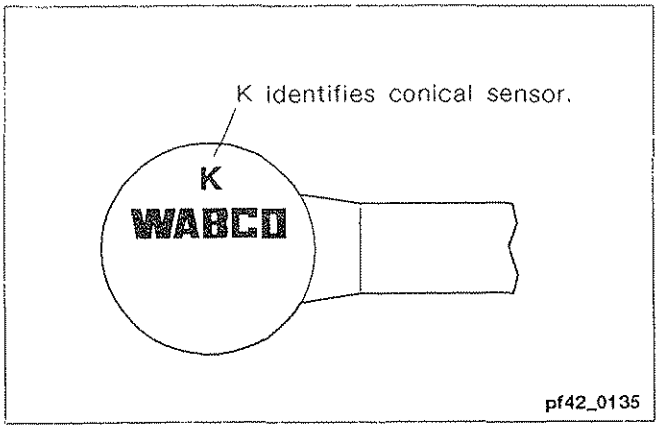

Fig. 5

Electronic Control Unit

The electronic control unit, located behind the passenger seat, receives pulses from the speed sensor through an input circuit. A main circuit, which contains a single-chip microcomputer, interprets the speed sensor signals and calculates wheel speed and a vehicle reference speed. If the calculations indicate wheel lockup, the main circuit signals the appropriate solenoid control valve to decrease braking pressure.

The electronic control unit also has a safety circuit that constantly monitors the wheel sensors, solenoid control valves, and the electrical circuitry. After the engine is started, the tractor warning light (TRAC ABS) comes on. See **Fig. 6**, Ref. A. Once the vehicle moves faster than 4 mph (6 km/h), the warning light goes out if all of the tractor's ABS components are working.

If equipped with the tractor and trailer ABS system, the vehicle also has two trailer warning lights: one labelled TRLR ABS and the other TRLR W/O ABS (see **Fig. 6**, Refs. B and C).

After the engine is started, the TRLR ABS light comes on if the trailer is equipped with the WABCO ABS system and if it is correctly connected to the tractor. Once the vehicle moves faster than 4 mph (6 km/h), the TRLR ABS warning light goes out if all of the trailer's ABS components are working.

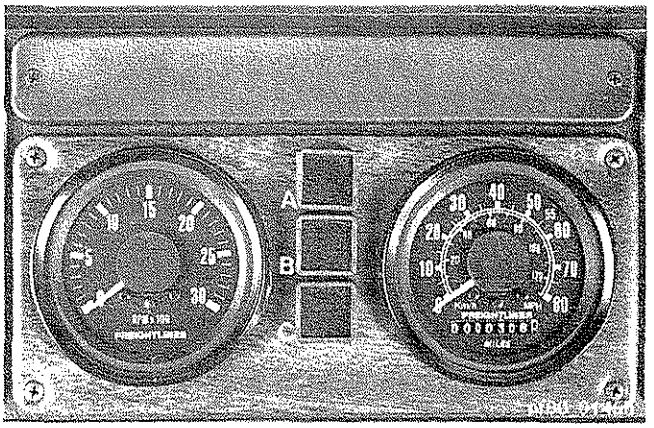

Fig. 6

After the engine is started, the TRLR W/O ABS light comes on if

A. the trailer is not equipped with an antilock system;

B. the trailer is equipped with an antilock system that is not distributed by WABCO;

C. the trailer is equipped with the WABCO antilock system, but it is not connected correctly to the tractor.

The TRLR W/O ABS warning light goes out after the parking brake is released.

IMPORTANT: If any of the ABS warning lights do not work as described above, repair the ABS system. Refer to "Troubleshooting" for fault diagnosis.

The WABCO ABS system combines one front-axle control channel with either one rear axle (the four-channel system) or two rear axles (the six-channel system) to form one control circuit. For example, the sensor and solenoid control valve on the left side of the front axle form a control circuit with the sensor(s) and solenoid control valve(s) on the right side of the rear axle(s). If, during vehicle operation, the safety circuit senses a failure in any part of the ABS system (a sensor, solenoid control valve, wiring connection, short circuit, etc.), the tractor warning light (TRAC ABS) comes on, and the control circuit where the failure occurred is switched to normal braking action. The remaining control circuit will retain the ABS effect. Even if the ABS system is completely inoperative, normal braking is maintained. The vehicle is not disabled.

Solenoid Control Valve

The solenoid control valves are attached to the frame rails near the brake chambers. Depending on the signal received from the electronic control unit, the control valve

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

prevents wheel lockup by reducing, maintaining, or increasing brake chamber air pressure. During normal braking applications, compressed air flows freely to the brake chamber through the control valve.

If the electronic control unit signals indicate wheel lockup, air pressure is reduced in the brake chamber. As shown in Fig. 7, solenoid valve 1 opens allowing compressed air to enter the inlet chamber and pilot chamber 1.

At the same time, solenoid valve 1 closes the exhaust chamber preventing the escape of air from the inlet chamber to atmosphere. Compressed air in the inlet chamber is forced into pilot chamber 1, closing diaphragm valve 1; this prevents air passage to the delivery chamber. Solenoid valve 2 also opens allowing air to vent from pilot chamber 2 through the exhaust port. Complete venting of all air in the delivery chamber occurs as diaphragm valve 2 opens.

As wheel speed increases, the control valve alternately increases, then maintains brake pressure until the proper wheel speed is obtained, or until wheel lockup occurs and the control cycle starts again.

During the pressure increase cycle (Fig. 8), both solenoid valves are closed. Compressed air entering through the inlet chamber forces diaphragm valve 1 open, allowing air to pass through the delivery chamber into the brake chamber. At the same time, pressure within the control valve keeps diaphragm valve 2 closed, preventing air from releasing through the exhaust port.

If maintaining brake air pressure (Fig. 9), solenoid valve 1 opens and compressed air passes from the inlet chamber into pilot chamber 1. Both of the diaphragm valves are forced closed, sealing the delivery chamber and maintaining brake air pressure.

SERVICE OPERATIONS

WHEEL SPEED SENSOR REPLACEMENT

Front Axle

1. Chock the rear tires to prevent vehicle movement. Set the parking brakes.
2. Twist the sensor, if necessary, and remove it from the steering knuckle (Fig. 10).
3. Remove the sensor cable from the steering knuckle top cap.
4. Disconnect the sensor cable from the chassis harness.
5. Remove the clamping bushing from the steering knuckle.
6. Connect the sensor cable to the chassis harness.
7. Attach the sensor cable to the steering knuckle top cap.

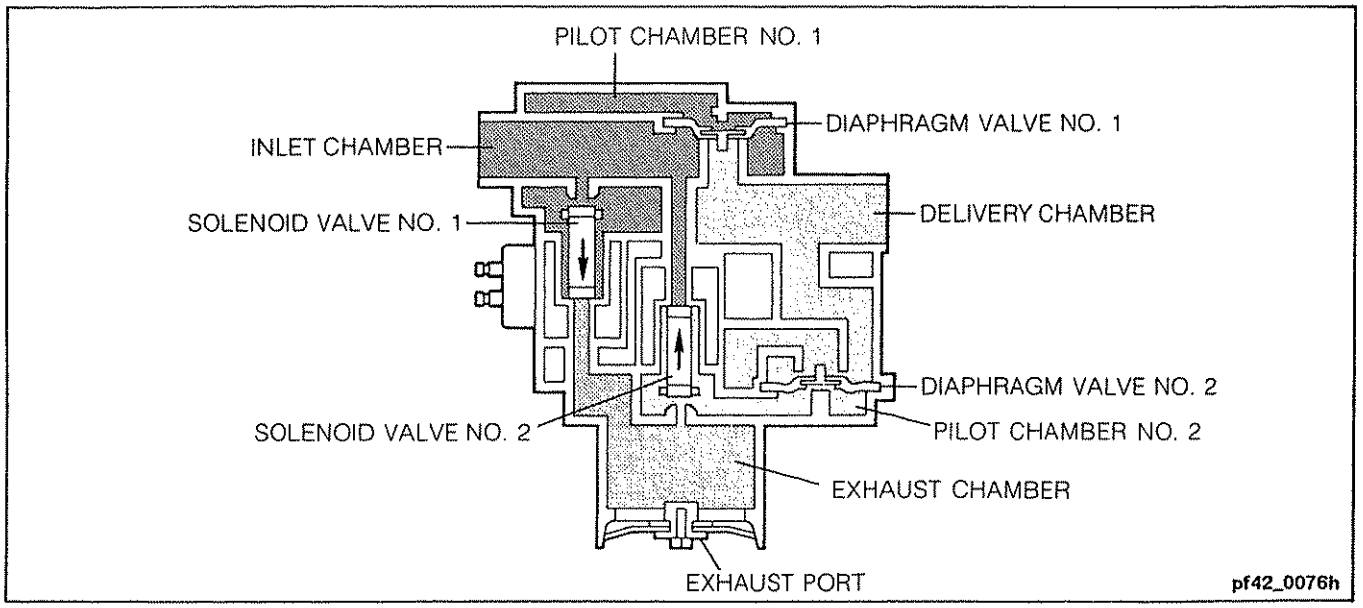

Fig. 7

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8. Press the clamping bushing into the brake spider hole until it stops.
9. Coat the sensor with Mobil HP, Valvoline EP 633, Penzoil 707L, Kluber Staburags NBU 30 PTM, or an equivalent. Press the sensor into the clamping bushing until it is stopped by the tone wheel.
10. Remove the chocks from the rear tires.

Rear Axle

1. Chock the front tires to prevent vehicle movement. Set the parking brakes.
2. Raise the rear of the vehicle until the tires clear the ground. Place safety stands under the axle.
3. Back off the slack adjuster to release the rear axle brake shoes.

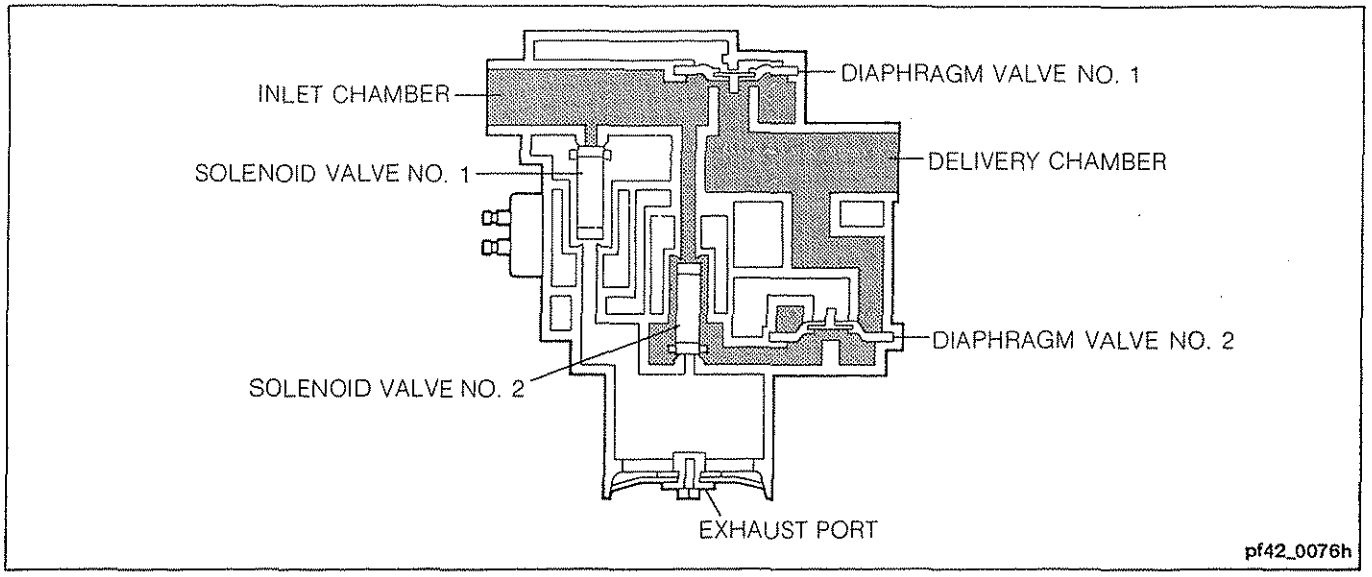

Fig. 8

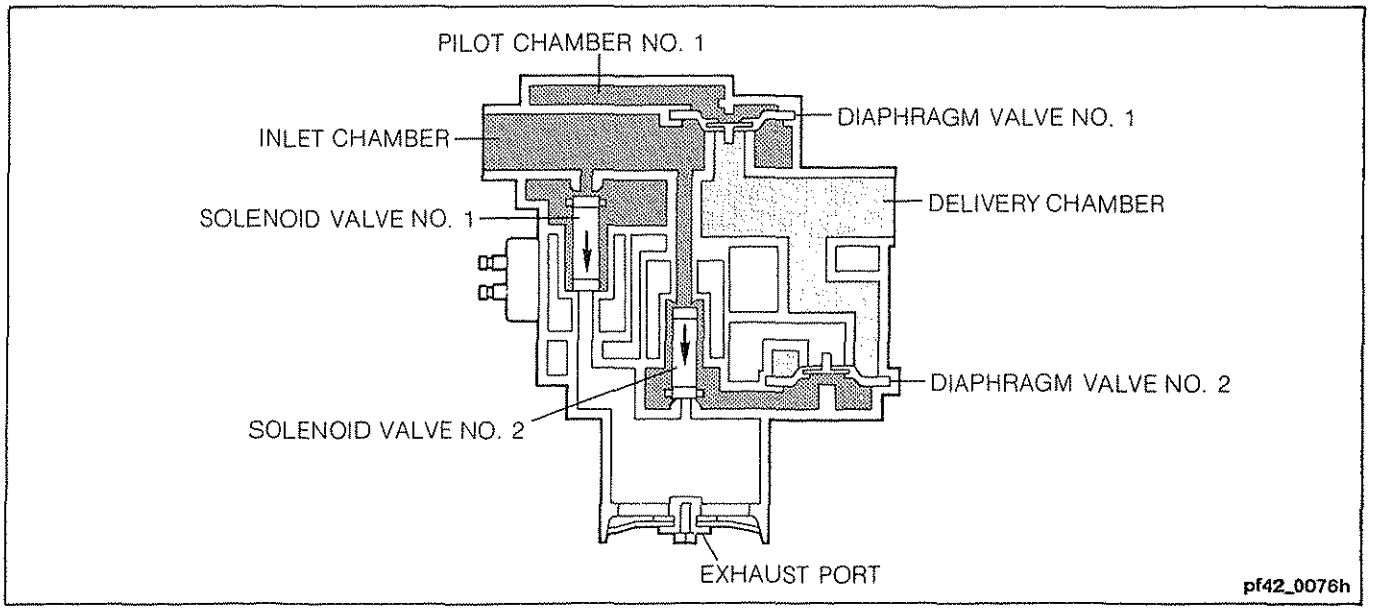

Fig. 9

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

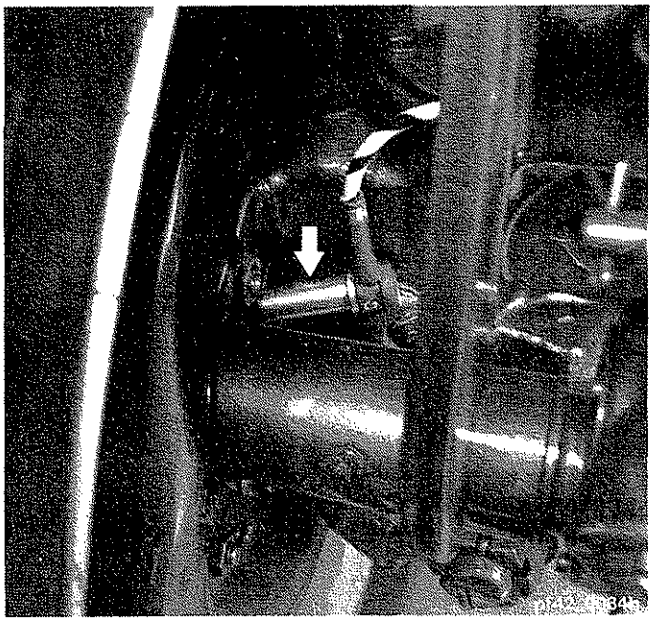

Fig. 10

4. Remove the wheel and tire assembly from the rear axle. For instructions, refer to Group 13.
5. Remove the brake drum. For instructions, refer to Group 11.
6. Twist the sensor, if necessary, and remove it from the mounting block in the axle housing.
7. Remove the clamping bushing.
8. Remove the capscrew that attaches the sensor cable and the hose clamp to the axle tube.
9. Disconnect the sensor cable from the chassis harness.
10. Connect the sensor cable to the chassis harness.
11. Attach the hose clamp and sensor cable to the axle tube located between the backing plate and the spring plate.
12. Press the clamping bushing into the mounting block until it stops.
13. Push the sensor into the clamping bushing until it is stopped by the tone wheel.
14. Install the brake drum on the wheel hub.
15. Adjust the rear axle brakes. For instructions, refer to Group 11 of the *COE and 120 Conventional Maintenance Manual*.
16. Install the wheel and tire assembly, and tighten the wheel nuts. Use the tightening sequence and torque values listed in Group 13.
17. Remove the safety stands, lower the vehicle, and remove the chocks from the front tires.

SOLENOID CONTROL VALVE REPLACEMENT

1. Chock the front and rear tires.
2. Release the pressure from the air reservoirs.
3. Disconnect the wiring from the solenoid control valve.
4. Disconnect the air supply line (Fig. 11, Ref. 1) and the air discharge line (Ref. 2).

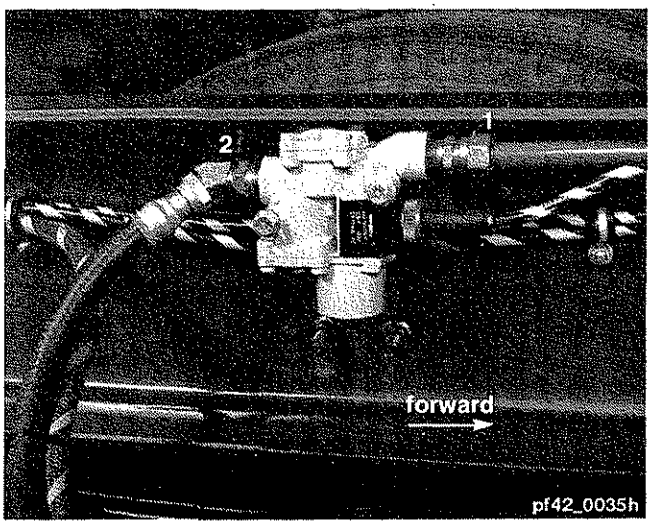

Fig. 11

5. Remove the two mounting capscrews and nuts.
6. Remove the solenoid control valve.
7. Install the solenoid valve using the above instructions in reverse order. Tighten the mounting nuts 18 lbf·ft (24 N·m).

TROUBLESHOOTING

ANTILOCK BRAKING SYSTEM TESTS

A test unit and adaptor (see **Fig. 12**), distributed by WABCO, are available to troubleshoot all of the ABS system, except the electronic control unit. Replace the control unit if no system faults are found after all of the troubleshooting tests are completed, *and* if the tractor warning light remains on after the vehicle is moving faster than 4 mph (6 km/h).

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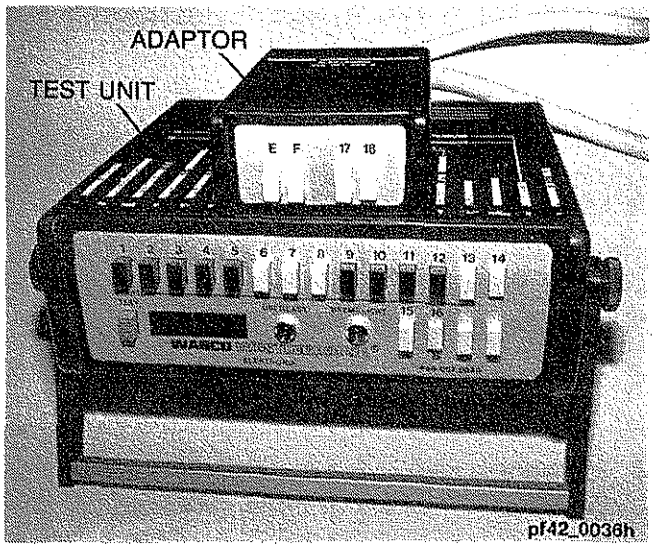

Fig. 12

The adaptor (part number 446 007 238 0), plugs into the control unit and the test unit (part number 446 007 02 0).

Before troubleshooting with the test unit and adaptor, check all fuses in the control unit panel, and replace if necessary. Make sure that a charged 12 volt battery is available (the ABS system needs at least 8 volts to work).

ABS system wiring diagrams are provided in Figs. 29 through 32, Specifications.

IMPORTANT: Do the troubleshooting tests in the exact order provided below. If a fault is found with any component of the ABS system during the tests, correct it, then repeat all tests beginning with "Testing the Test Unit and Adaptor."

NOTE: The key switch must be turned on for all of the troubleshooting tests; do not turn it off.

Testing the Test Unit and Adaptor (Refer to Fig. 13)

1. Connect the test unit and adaptor to the ABS system.
2. Turn on the ignition switch.
3. Press button 1 on the test unit. Check that the test unit brake light (Bremslicht) is on.
4. Press the button at the rear of the adaptor. The test unit brake light should go out.

   After releasing the adaptor button, the test unit brake light should come on, and remain on for the remaining tests.

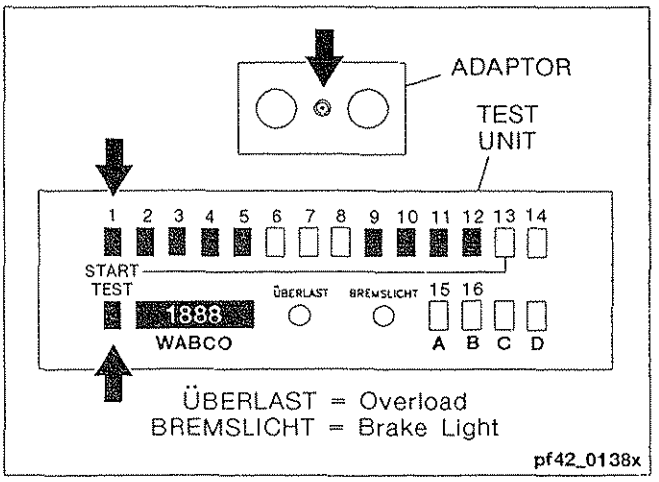

Fig. 13

5. On the test unit, press button 1 and the "start test" button at the same time. The digital display should read 1888.

   If the test unit displays a different number or no number, either the unit is not working or there is an open circuit in the valve relay power supply.

Test 1: Testing the Circuitry of the Warning Lamp Relay and the Valve Relay Coils (Refer to Fig. 14)

1. Make sure that the ignition switch is on.
2. Press button 1 on the test unit. The digital display should show a number from 330 to 660 milliamps.

   If the digital display is blank, there is no power supply to the test unit and adaptor.

   If the display number is 000 to 329 milliamps, the warning lamp relay is not working, or there is an open circuit in the wiring.

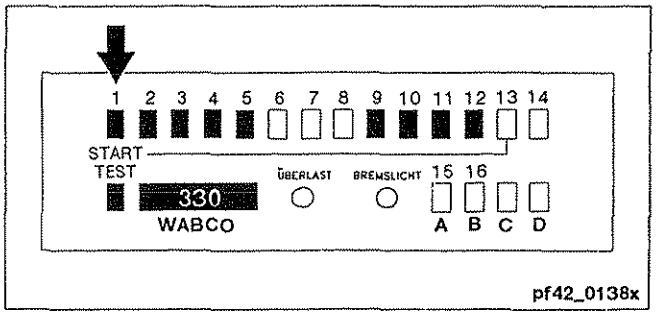

Fig. 14

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If the overload light (Uberlast) comes on, or if the display shows a number from 661 to 1999 milliamps, a short circuit exists in the warning lamp relay, or in either (or both) of the valve relays.

If the problems described in this step occur, troubleshooting tests 2 through 5 will isolate the system fault.

Test 2: Testing the Voltage Output of Valve Relay 1 (Refer to Fig. 15)

1. Make sure that the ignition switch is on.
2. Press button 2 on the test unit. The digital display should show a number from 10.35 to 16.8 volts.

   If the digital display is blank, or shows a number from 00.0 to 10.30 volts, valve relay 1 is not working, wiring to the relay is shorted or open, or the vehicle batteries need charging or replacement.

CAUTION: Before charging the batteries, disconnect the electronic control unit. This will prevent power surges and possible component damage in the electronic control unit.

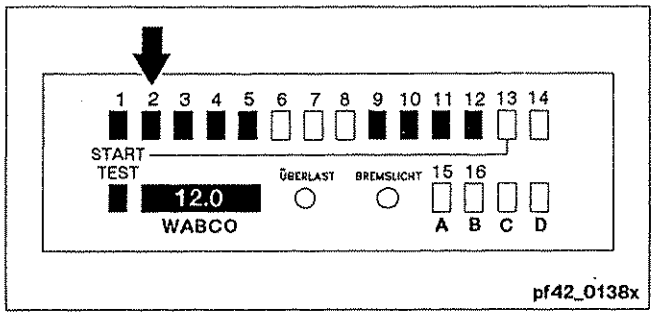

Fig. 15

Test 3: Testing Voltage Supply to Valve Relay 2 (Refer to Fig. 16)

1. Make sure that the ignition switch is on.

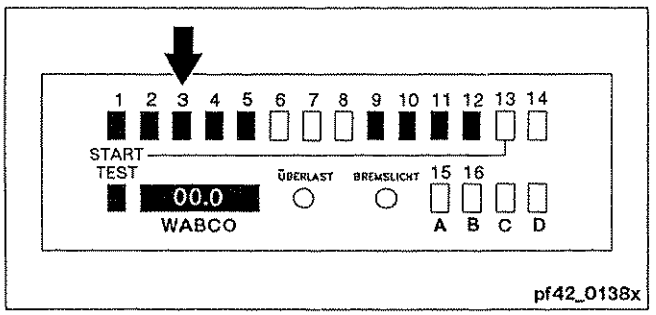

Fig. 16

2. Press button 3 on the test unit. The digital display should show a number from 00.0 to 00.3 volt.

   If the digital display is blank, or shows a number from 00.4 to 16.8 volts, the contacts of valve relay 2 are sticking, wiring to valve relay 1 is shorted or open, or there is no power supply to the test unit and adaptor.

Test 4: Testing the Voltage Output of Valve Relay 2 (Refer to Fig. 17)

1. Make sure that the ignition switch is on.
2. Press button 4 on the test unit. The digital display should show a number from 10.35 to 16.8 volts, and the tractor warning light (TRAC ABS) should be on.

   If the digital display is blank, or shows a number from 00.0 to 10.3 volts, either valve relay 2 is not working, wiring to the relay is shorted or open, there is no power supply to the test unit and adaptor, or the vehicle batteries need charging or replacement.

CAUTION: Before charging the batteries, disconnect the electronic control unit. This will prevent power surges and possible component damage in the electronic control unit.

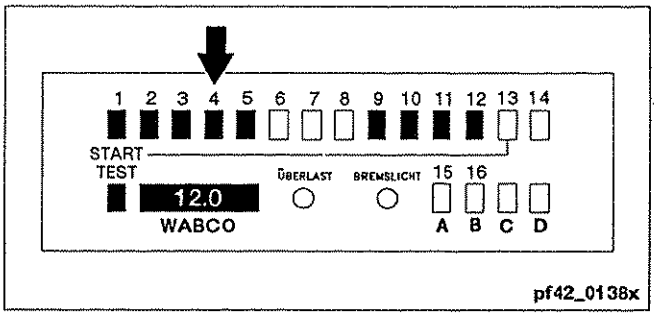

Fig. 17

Test 5: Testing Voltage Supply to Valve Relay 1 (Refer to Fig. 18)

1. Make sure that the ignition switch is on.
2. Press button 5 on the test unit. The digital display should show a number from 00.0 to 00.3 volt, and the tractor warning light (TRAC ABS) should be on.

   If the digital display is blank, or shows a number from 00.4 to 16.8 volts, the contacts of valve relay 1 are sticking, wiring to the warning light relay is shorted or open, wiring to relay valve 2 is shorted or open, or there is no power supply to the test unit and adaptor.

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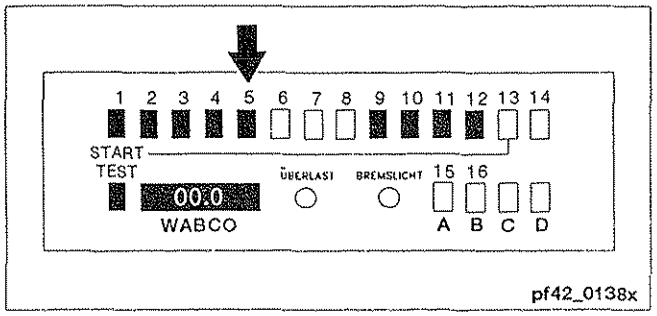

Fig. 18

Test 6: Testing the Coil Resistance of the Solenoid Control Valves' Inlet and Outlet Valves

1. Make sure that the ignition switch is on.
2. Test each solenoid valve. The correct digital display reading for each control valve is a number from 2.0 to 5.0 ohms. If the display reading is not 2.0 to 5.0 ohms, go to step 3. Test each solenoid valve as follows:

   .1 Left side of front axle—press button 6 and button A on the test unit. See Fig. 19.

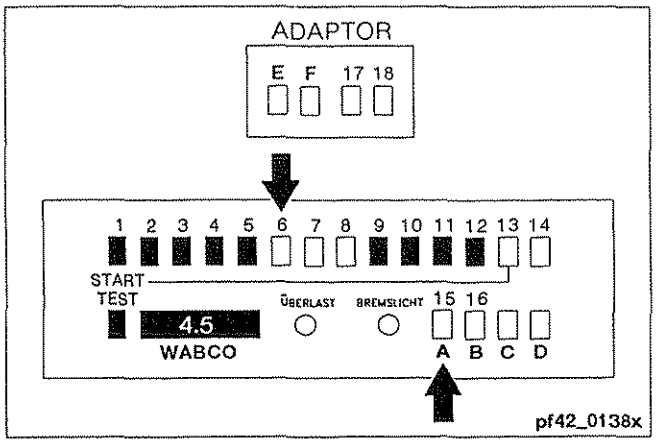

Fig. 19

   .2 Right side of front axle—press button 6 and button B on the test unit.

   .3 Left side of forward-rear axle—press button 6 and button D on the test unit; also, press button F on the adaptor.

   .4 Right side of forward-rear axle—press button 6 and button D on the test unit; also, press button E on the adaptor.

   .5 Left side of rearmost axle (on six-channel systems)—press button 6 and button C on the test unit.

   .6 Right side of rearmost axle (on six-channel systems)—press button 6 and button D on the test unit.

3. If the display reading is not 2.0 to 5.0 ohms, use the following fault readings to isolate and correct the problem:

   0.0 to 1.9 ohms—means poor circuit connections, a shorted solenoid valve winding, or a short circuit.

   5.1 to 19.9 ohms—means a broken coil or an open circuit.

   1.—means that the solenoid control valve is not connected to the wiring harness, there is an open circuit in the wiring, or that the solenoid control valve needs replacement.

Test 7: Testing the Coil Resistance of the Wheel Speed Sensors

1. Make sure that the ignition switch is on.
2. Test each speed sensor. The correct digital display reading for sensors with cylindrical internal pole pins is 1000 to 1600 ohms (1.00 to 1.60 kilo ohms). The correct display reading for sensors with conical pole pins is 1370 to 1990 ohms (1.37 to 1.99 kilo ohms). If the display reading is not within the range for the type of wheel speed sensor being tested, go to step 3. Test each sensor as follows:

   .1 Left side of front axle—press button 7 and button A on the test unit. See Fig. 20.

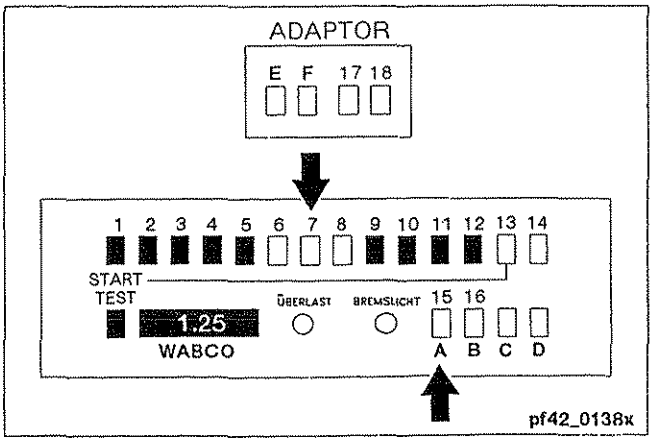

Fig. 20

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.2 Right side of front axle—press button 7 and button B on the test unit.

.3 Left side of forward-rear axle—press button 7 and button D on the test unit; also, press button F on the adaptor.

.4 Right side of forward-rear axle—press button 7 and button D on the test unit; also, press button E on the adaptor.

.5 Left side of rearmost axle (on six-channel systems)—press button 7 and button C on the test unit.

.6 Right side of rearmost axle (on six-channel systems)—press button 7 and button D on the test unit.

3. If the display reading is not within the range specified for the type of speed sensor being tested, use the following fault readings to isolate and correct the problem:

   For sensors with conical pole pins:

   0.00 to 1360 ohms (0.00 to 1.36 kilo ohm)—means poor circuit connections, or a shorted sensor winding.

   1.0—means an open circuit in either the sensor, or in wiring to the sensor.

   For sensors with cylindrical pole pins:

   0.00 to 990.0 ohms (0.00 to 0.99 kilo ohm)—means poor circuit connections, or a shorted sensor winding.

   1610 to 1990 ohms (1.61 to 1.99 kilo ohms)—means poor circuit connections, or that the sensor needs replacement.

   1.0—means an open circuit in either the sensor, or in wiring to the sensor.

Test 8: Testing the Contact Resistance of the Sensor Coil and Wiring to Vehicle Ground

1. Make sure that the ignition switch is on.
2. Test each speed sensor. The correct digital display reading for each sensor is a number from 30.0 to 1. If the display reading is not 30.0 to 1, go to step 3. Test each sensor as follows:

   .1 Left side of front axle—press button 8 and button A on the test unit. See Fig. 21.

   .2 Right side of front axle—press button 8 and button B on the test unit.

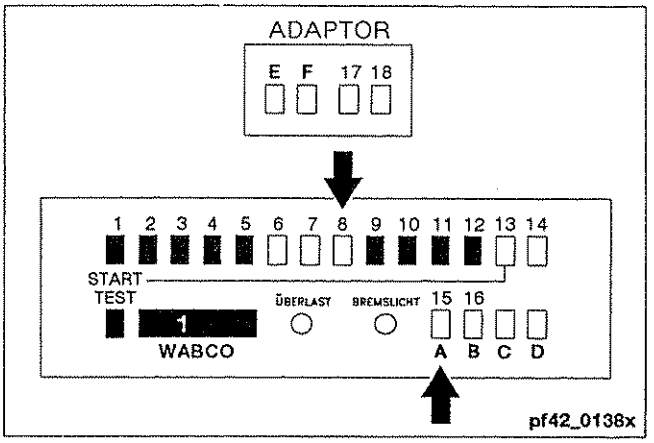

Fig. 21

   .3 Left side of forward-rear axle—press button 8 and button D on the test unit; also, press button F on the adaptor.

   .4 Right side of forward-rear axle—press button 8 and button D on the test unit; also, press button E on the adaptor.

   .5 Left side of rearmost axle (on six-channel systems)—press button 8 and button C on the test unit.

   .6 Right side of rearmost axle (on six-channel systems)—press button 8 and button D on the test unit.

3. If the display reading is 00.0 to 29.9 kilo ohms, either the speed sensor or the wiring to the speed sensor needs replacing.

Test 9: Testing the Engine Brake Relay

1. Make sure that all of the buttons on the test unit and adaptor are released (not pressed in).

NOTE: If equipped with a Cummins engine PACE Control System and engine brake, turn off the cruise control.

2. Start the engine.
3. Turn on the engine brake toggle switches (up position).
4. If the engine brake does not work, check the wiring and wiring connections, both toggle switches, and the ABS engine brake relay.
5. Press button 9 on the test unit. See Fig. 22. The engine brake should not work.

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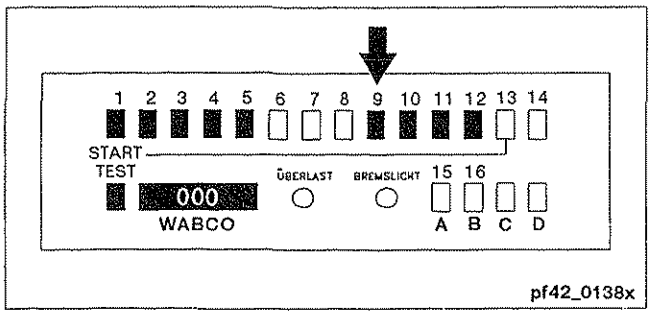


Fig. 22

If the engine brake is still working after pressing button 9, check the wiring and wiring connections, and the ABS engine brake relay.

NOTE: The ABS engine brake relay is an additional on/off switch for the engine brake. If the engine brake does not work, perform Test 9 to check the ABS engine brake relay.

Test 10: Testing the Tractor Warning Light Relay on Vehicles With Drive Slip Control (DSC)

Test 11: Testing the Tractor Warning Light Activation On Vehicles With Drive Slip Control (DSC)

NOTE: Tests 10 and 11 (and test buttons 10 and 11) are not currently used. Drive slip control will be available as an option in the near future.

Test 12: Testing the Tractor Warning Light

1. Make sure that the ignition switch is on.
2. Push button 12 on the test unit. See Fig. 23. The digital display should show a number from 10.8 to 16.0 volts, and the tractor warning light (TRAC ABS) should be off.

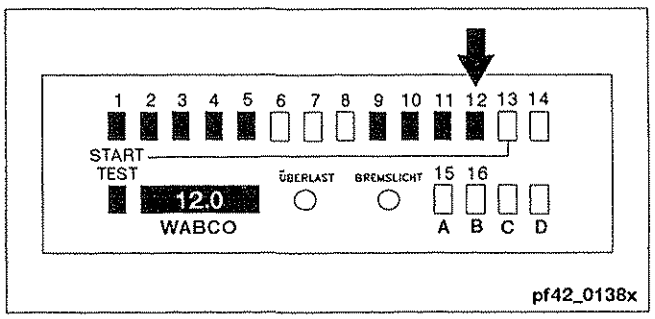


Fig. 23

If the TRAC ABS light is on and the digital display reading is 00.0 to 10.7 volts, either there is a short or open in the wiring to the warning light or warning light relay, or the warning light relay needs replacing.

Test 13: Testing Solenoid Control Valve Operation

1. Chock the rear tires to prevent vehicle movement. Release the parking brakes.
2. If necessary, start the engine and build system air pressure to at least 100 psi (689 kPa). Shut down the engine, but leave the ignition switch on.
3. Test each solenoid control valve. Have a person watch the solenoid control valve and brake chamber being tested. With the brake pedal fully depressed, the following cycle should occur as the test button is pressed and released: compressed air enters the brake chamber and the push rod extends as the brake engages; the solenoid control valve partially exhausts air and the push rod partially retracts; the solenoid control valve completely exhausts air and the push rod retracts all the way; air pressure increases in the brake chamber and the push rod starts to extend; full air pressure enters the brake chamber and the push rod extends as the brake engages.

   Also, after pressing the "start test" button, the correct digital display reading for each control valve is 1. At the finish of the brake cycling, the correct reading is a number from 000 to 003. If any different numbers are displayed, or if the brake does not cycle as described, go to step 4.

   Test each solenoid control valve as follows:

   .1 Left side of front axle—press button 13 and button A on the test unit. See Fig. 24. Depress the brake pedal (the brake light on the test unit should come on), then press the "start test" button on the test unit.

   .2 Right side of front axle—press button 13 and button B on the test unit. Depress the brake pedal (the brake light on the test unit should come on), then press the "start test" button on the test unit.

   .3 Left side of forward-rear axle—press button 13 and button D on the test unit; also, press button F on the adaptor. Depress the brake pedal (the brake light on the test unit should come on), then press the "start test" button on the test unit.

   .4 Right side of forward-rear axle—press button 13 and button D on the test unit; also, press button E on the adaptor. Depress the brake pedal (the brake light on the test unit should come on), then press the "start test" button on the test unit.

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

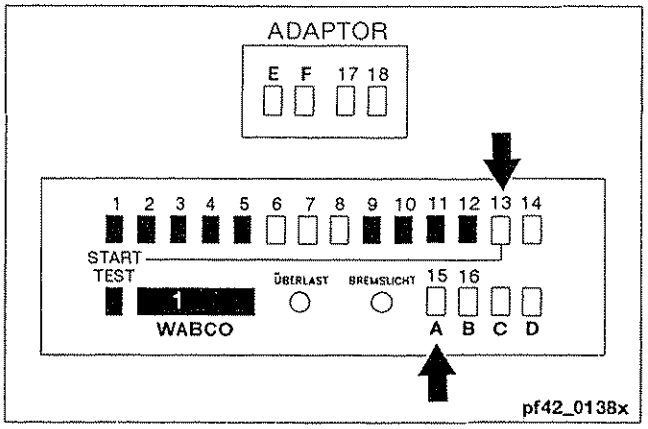


Fig. 24

.5 Left side of rearmost axle (on six-channel systems)—press button 13 and button C on the test unit. Depress the brake pedal (the brake light on the test unit should come on), then press the "start test" button on the test unit.

.6 Right side of rearmost axle (on six-channel systems)—press button 13 and button D on the test unit. Depress the brake pedal (the brake light on the test unit should come on), then press the "start test" button on the test unit.

4. If the brake does not cycle as described in step 3, or if the digital readings are incorrect, either the electrical lines of two solenoid control valves are crossed (check by pressing the individual wheel buttons on the test unit); the air supply and discharge lines are crossed; the electrical connector at the solenoid control valve is not correctly plugged in; or the control valve needs replacing.

Test 14: Testing Speed Sensor Operation

1. Make sure that the ignition switch is on.
2. For each sensor tested, raise the vehicle until the tire clears the ground. Place safety stands under the axle.
3. Chock each wheel that is not being tested to prevent them from turning. Release the parking brakes.
4. Test each wheel speed sensor by spinning the wheel one-half revolution-per-second (allow only the wheel being tested to spin). The correct digital display reading for each sensor is 050 to 1999 millivolts for sensors with cylindrical internal pole pins, and 100 to 1999 millivolts for sensors with conical pole pins. If the reading is not within the range specified for the type of sensor being tested, go to step 5. Test each sensor as follows:

.1 Left side of front axle—spin the tire; press button 14 and button A on the test unit. See Fig. 25.

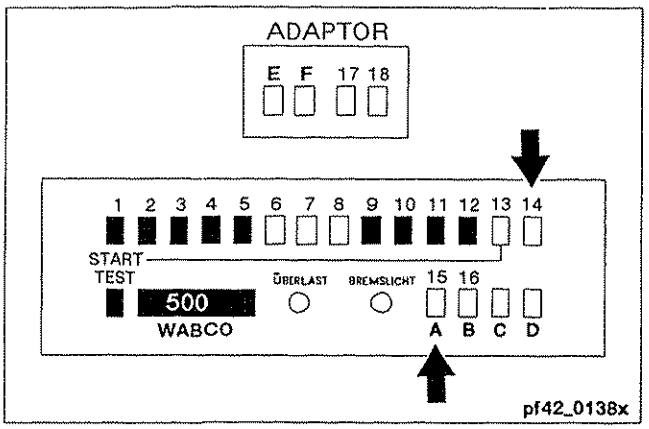


Fig. 25

.2 Right side of front axle—spin the tire; press button 14 and button B on the test unit.

.3 Left side of forward-rear axle—spin the tire; press button 14 and button D on the test unit; also, press button F on the adaptor.

.4 Right side of forward-rear axle—spin the tire; press button 14 and button D on the test unit; also, press button E on the adaptor.

.5 Left side of rearmost axle (on six-channel systems)—spin the tire; press button 14 and button C on the test unit.

.6 Right side of rearmost axle (on six-channel systems)—spin the tire; press button 14 and button D on the test unit.

5. If the display reading is not within the range specified for the type of sensor being tested, either the sensor is not pushed up against the tone wheel, the wrong tone wheel is installed, or sensor electrical wires are crossed (check by pressing the individual wheel buttons on the test unit.)

Test 15: Part I—Testing the Information Module and the Brake Light Relay on Vehicles equipped With a Trailer ABS Connection

1. Disconnect adaptor 446 007 238 0 from the electronic control unit and the test unit. Do not connect the 35 pin connector to the electronic control unit.

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

2. Make sure that the ignition switch is on. Set the parking brakes.
3. Check that the TRLR W/O ABS light on the dashboard is off.

   If the TRLR W/O ABS light comes on, there is an open or short in the information module wiring or wiring connectors; or the information module needs replacement.
4. Plug ABS test light adaptor 884 900 602 0 into the trailer plug at the rear of the cab (see Fig. 26).

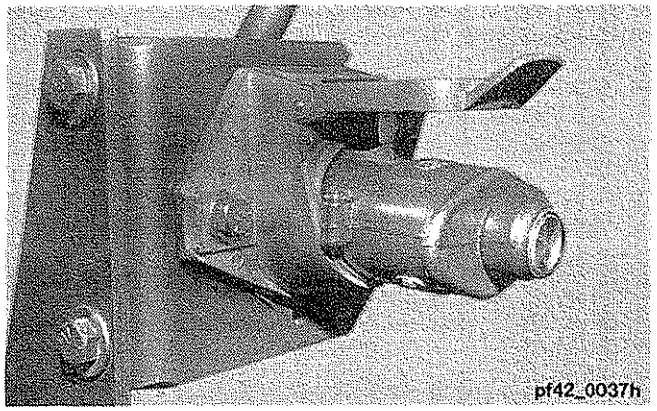


Fig. 26

5. Check the TRLR W/O ABS light on the dashboard; it should be on. If the TRLR W/O ABS light is off, check the information module wiring, the brake light relay, and the wiring or wiring connectors.
6. Depress the brake pedal. Check the ABS test light at the rear of the cab; it should be on.

   If the test light is not on, check the wiring to the 7-way tractor plug, and check the test light bulb.

Test 15: Part II—Testing the Information Module and the Trailer's Electrical Supply on Vehicles Equipped With a Trailer ABS Connection (Refer to Fig. 27)

1. Using the orange test cable 884 900 564 0, connect the test unit to the ABS trailer plug at the rear of the cab. Make sure that test light adaptor 884 900 602 0 is connected to the 7-way tractor plug.
2. Make sure that the ignition switch is on.
3. Press buttons 14 and 15 on the test unit. The digital display should show a number from 9.7 to 15.7 volts, and the TRLR W/O ABS light should be off.

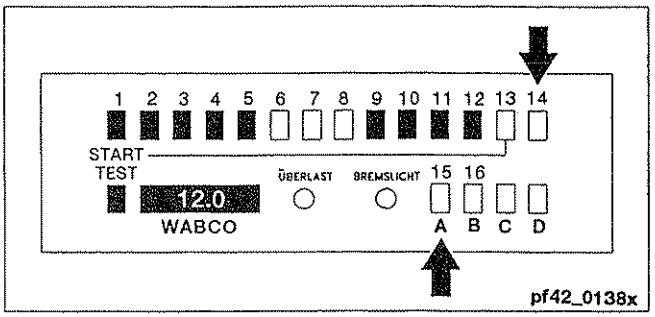


Fig. 27

   If the TRLR W/O ABS light is on and the digital display does not show a number from 9.7 to 15.7 volts, check the information module wiring.

   If the TRLR W/O ABS light is on and the digital display is correct, replace the information module.

   If the digital display shows a number from 00.0 to 9.6, there is an open or short in the wiring, or in the wiring connections.

   If the digital display shows a number from 000 to 157, there is no connection to ground at contact 4 of the trailer socket.

Test 16: Testing the Trailer Warning Light on Vehicles Equipped With a Trailer ABS Connection (Refer to Fig. 28)

1. Make sure that the ignition switch is on.
2. Disconnect ABS test light adaptor 884 900 602 0 from the 7-way tractor plug.
3. Press buttons 14 and 16 on the test unit. The digital display should show a number from 9.7 to 15.7, and the TRLR ABS light should be on.

   If the digital display shows a number from 00.0 to 9.6, there is an open or short in the wiring, or in the wiring connections.

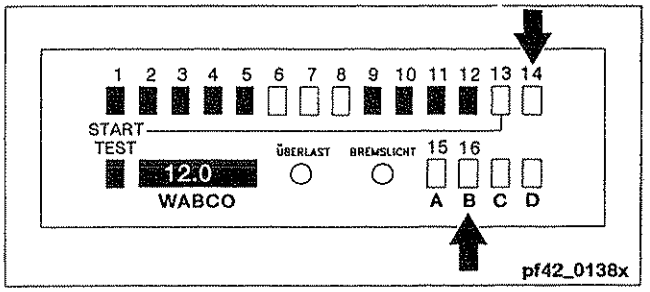


Fig. 28

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

If the digital display shows a number from 000 to 157, there is no connection to ground at contact 4 of the ABS trailer socket.

If the test unit overload (Uberlast) light comes on, there is a crossed connection at contact 5 of the ABS trailer socket.

Final Tests

NOTE: Disconnect the ABS test unit. Then, depending on the type of ABS installation, do one of the following tests.

Tractor Equipped With ABS, but Without the Trailer ABS Connection

1. Attach the 35 pin connector to the electronic control unit.
2. Start the engine.
3. Accelerate the vehicle. At a speed of 4 mph (6 km/h), the TRAC ABS warning light should go out.

   If the TRAC ABS warning light stays on, replace the electronic control unit and repeat this test.

Tractor Equipped With the Trailer ABS Connection, but Trailer Without ABS

1. Attach the 35 pin connector to the electronic control unit.
2. Connect the 7-way trailer plug to the trailer socket at the rear of the cab. If a trailer is not available, connect ABS test light adaptor 884 900 602 0 at the rear of the cab.
3. Start the engine. The TRLR W/O ABS and TRAC ABS warning lights should come on.

   If the TRLR W/O ABS light does not come on after the engine is started, check the trailer plug connection, trailer brake lights, and the wiring to the trailer brake lights.
4. Release the parking brake. The TRLR W/O ABS warning light should go out.
5. Accelerate the vehicle. At a speed of 4 mph (6 km/h), the TRAC ABS warning light should go out.

   If the TRAC ABS warning light stays on, replace the electronic control unit and repeat this test.

Tractor Equipped With the Trailer ABS Connection, and Trailer Equipped With ABS

1. Attach the 35 pin connector to the electronic control unit.
2. Connect the 7-way trailer plug to the trailer socket at the rear of the cab.
3. Start the engine. The TRLR ABS and TRAC ABS lights should come on.

   If the TRLR ABS light does not come on, check the connection of the trailer plug at the rear of the cab, the trailer brake lights, and the wiring to the trailer brake lights.
4. Accelerate the vehicle. At a speed of 4 mph (6 km/h), the TRAC ABS and TRLR ABS warning lights should go out.

   If the TRAC ABS warning light stays on, replace the electronic control unit and repeat this test.

   If the TRLR ABS light does not go out, check the trailer's ABS system.

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

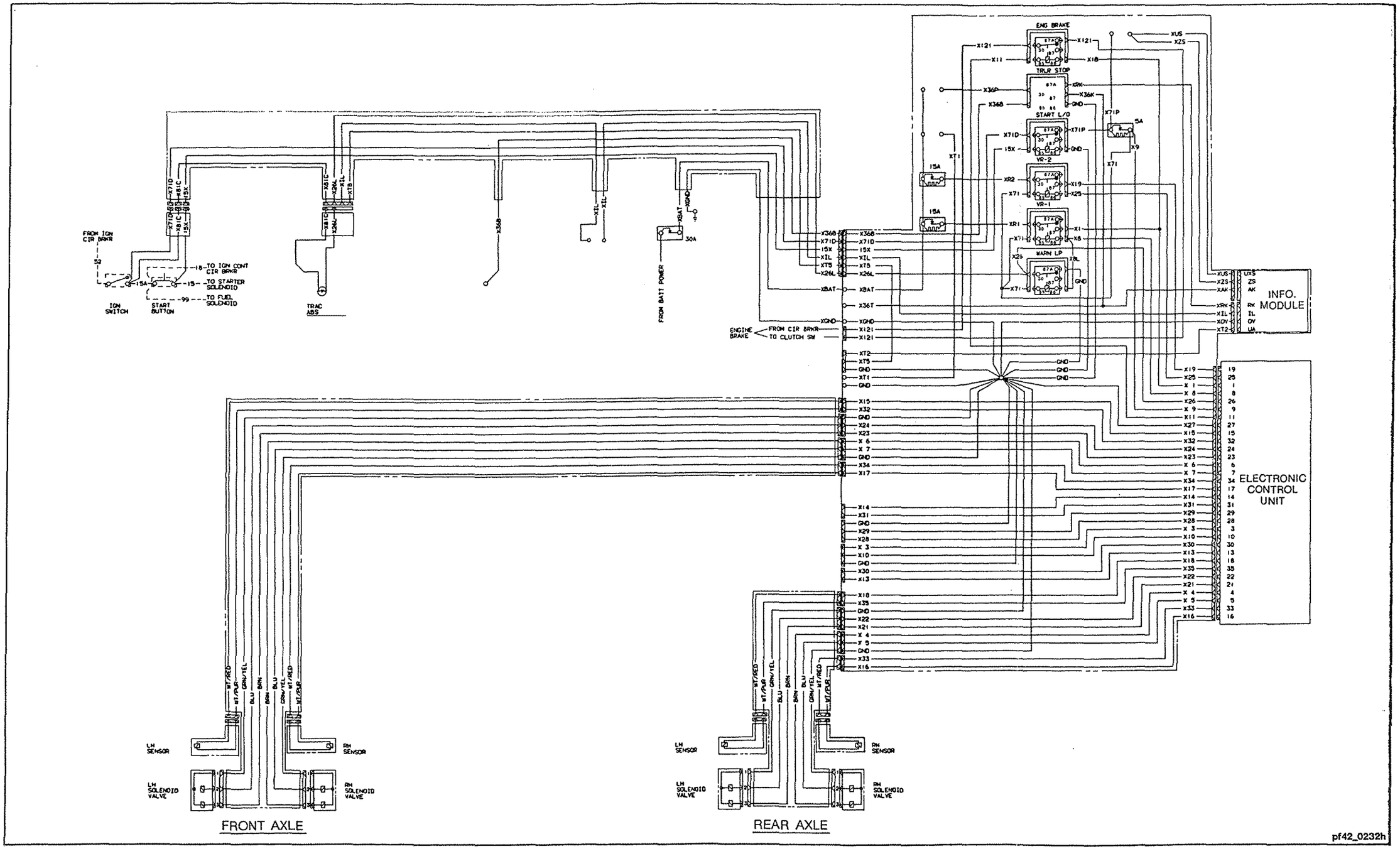


Fig. 29, Wiring Diagram for the Four-Channel System Without a Trailer Connection

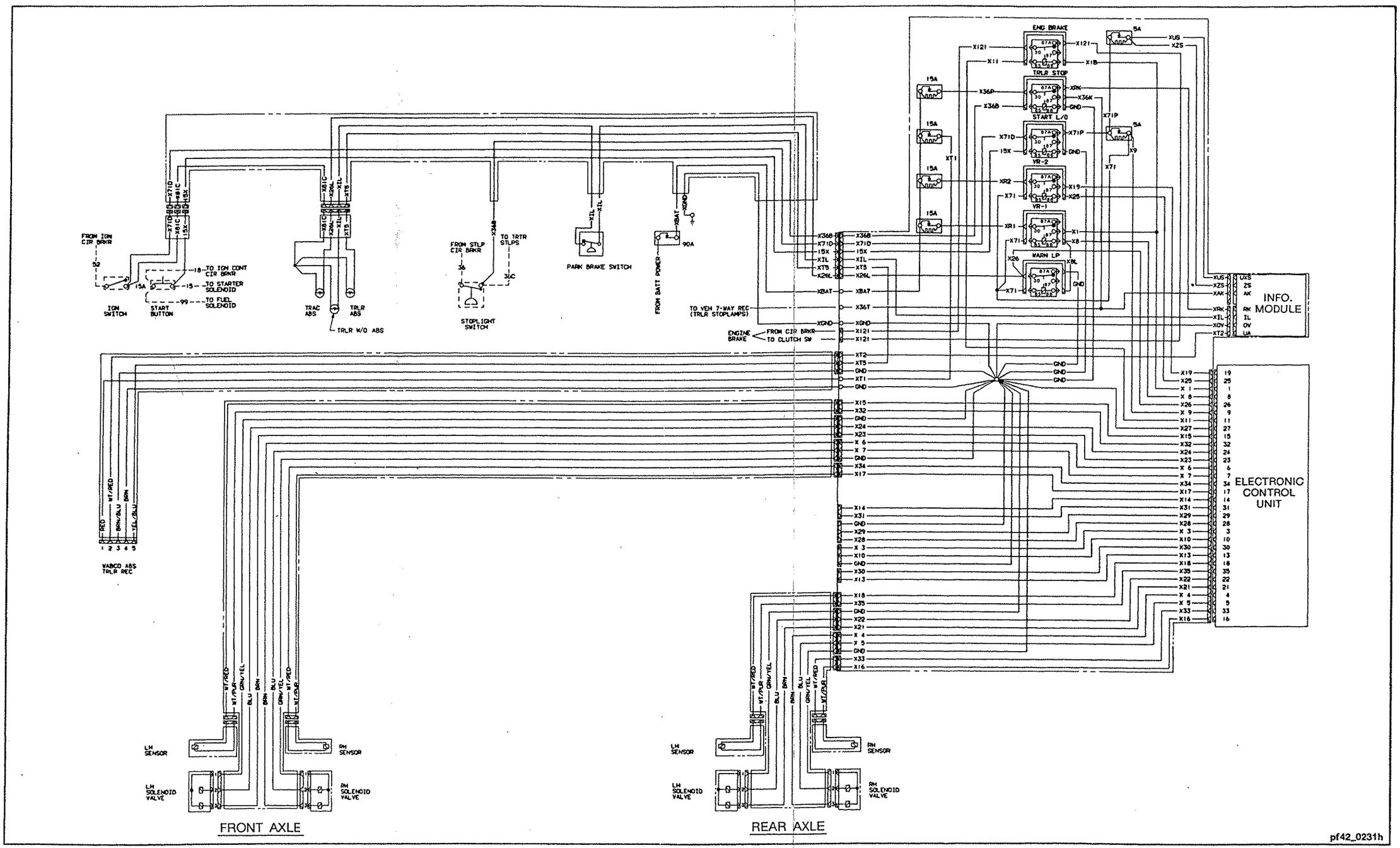


Fig. 30, Wiring Diagram for the Four-Channel System With a Trailer Connection

WABCO® ANTILOCK BRAKING SYSTEM (ABS)

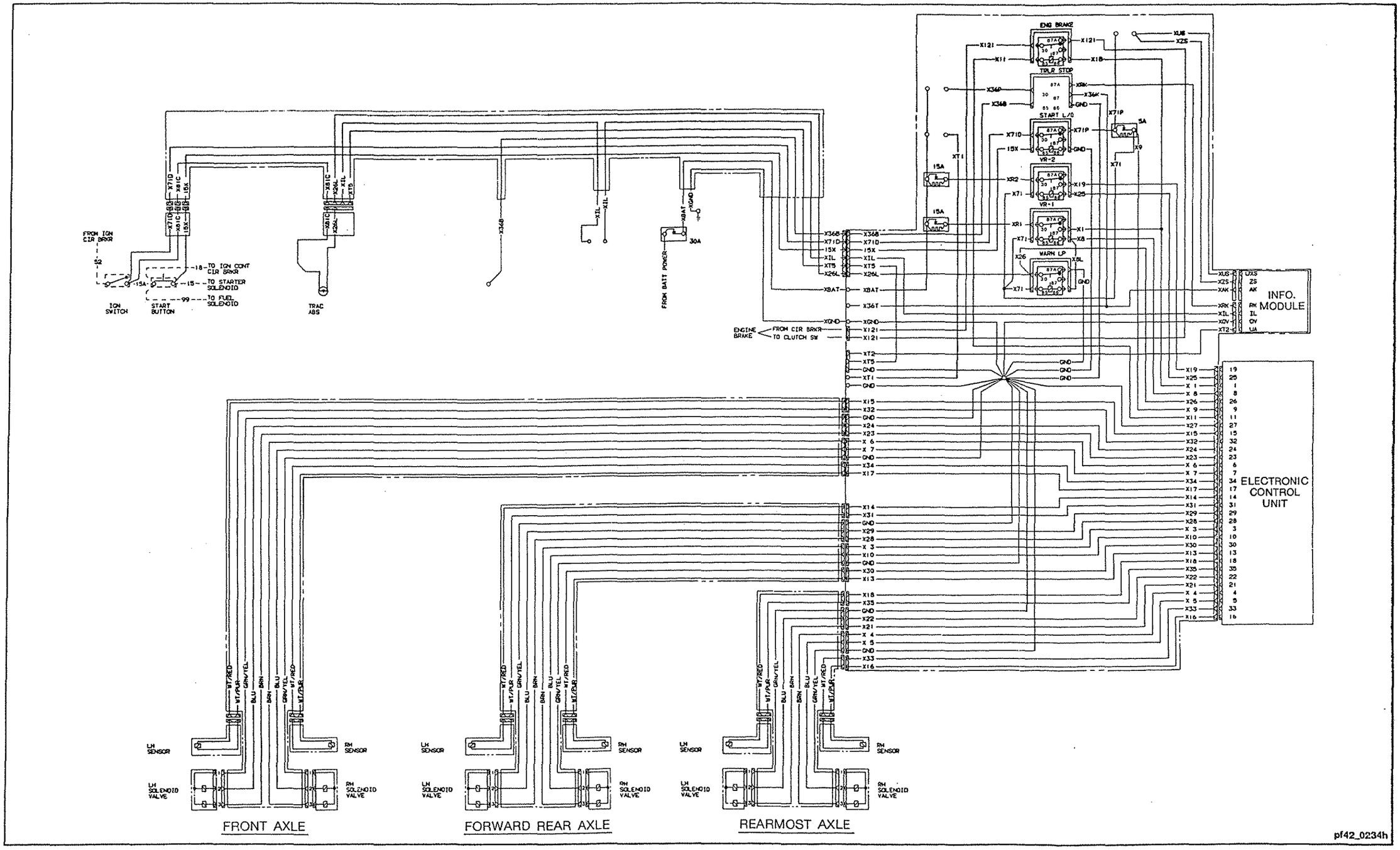


Fig. 31, Wiring Diagram for the Six-Channel System Without a Trailer Connection

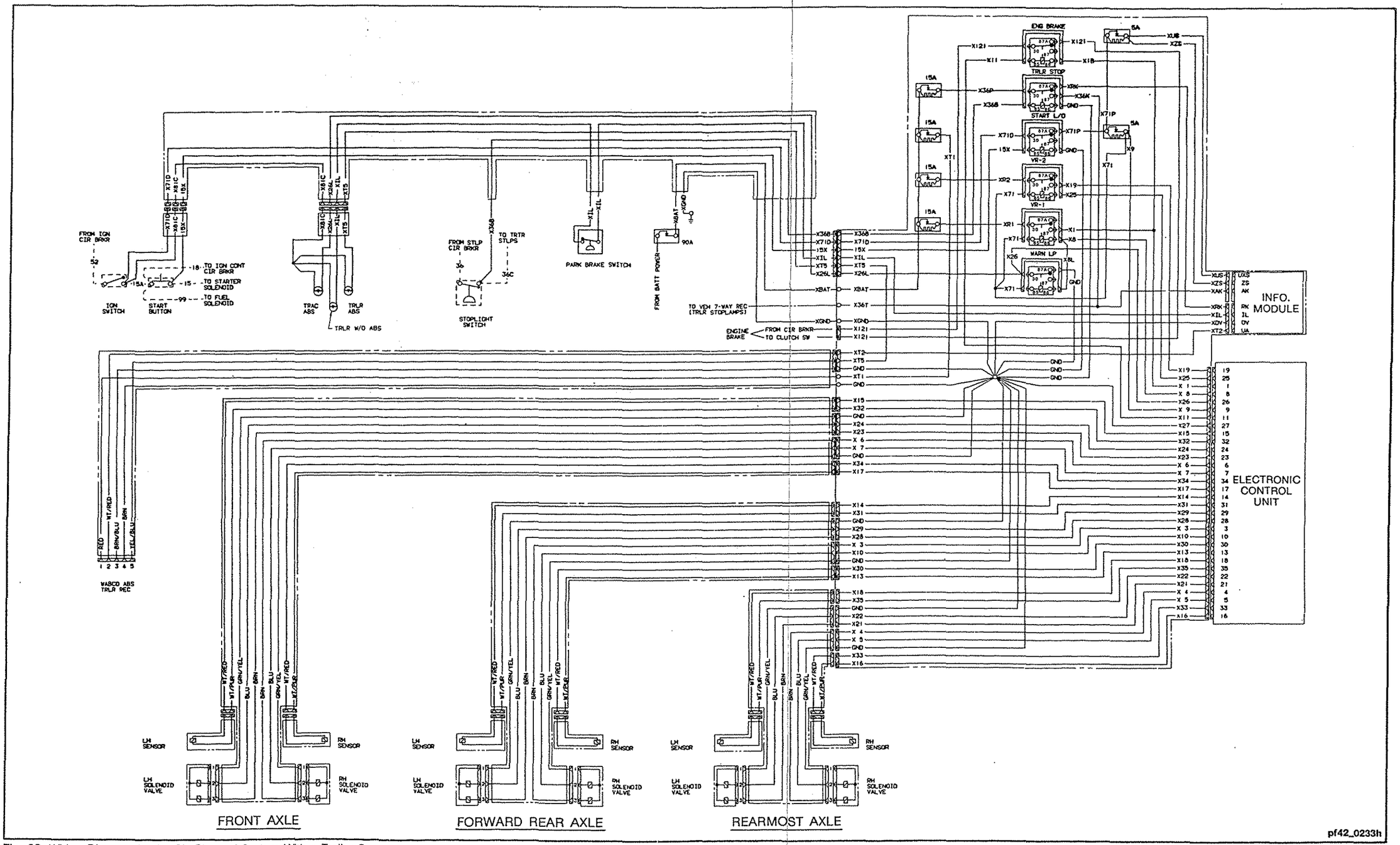


Fig. 32, Wiring Diagram for the Six-Channel System With a Trailer Connection

DUAL AIR BRAKE AND ANTILOCK SYSTEM PLUMBING LIMITATIONS

GENERAL INFORMATION

In order to maintain the quality and performance of the Freightliner FMVSS 121 braking system, it is mandatory that field replacement of hoses and fittings be in strict compliance with factory approved parts. Unless exempted herein, use only the nylon tubing, fittings, and hoses that are shown in the plumbing diagrams of this manual. Refer to the Freightliner parts book for part numbers of all brake components. For ease of troubleshooting, maintain the nylon tubing colors throughout the vehicle as shown in the plumbing diagrams of this manual.

Specific ports have been provided in the Freightliner FMVSS 121 brake plumbing system for tapping of air that might be needed for purposes other than that of braking; such as air for air seats, air windows, air shifting devices, windshield wipers, etc. Tapping air pressure lines at any location other than those specifically provided for this purpose could adversely affect the air brake timing, and subsequently result in slower brake application times.

WARNING: Failure to comply with the above could unfavorably affect the performance of the brake system. Do not substitute parts; do not tap air from any part of the air brake system other than those ports specifically designated for this purpose. Read further in this text for additional details.

HOSES AND TUBING

Only the hoses and tubing, (or SAE equivalent) specified in the Freightliner parts book should be used for replacement parts. No deviations, or substitutions in specifications are permissible. Hoses and tubing must be connected, as shown in the diagrams given in this manual. Size of tubing and hose must not be changed in servicing.

FITTINGS

Use only those fittings (note exceptions below) that are shown in the plumbing diagrams of this manual. Refer to the Freightliner parts book for part numbers. Some deviations in fittings are permitted, they are given in Table 1, located under "SPECIFICATIONS."

FITTINGS USED IN CAB INTERIOR PLUMBING

Size of the fittings used in the cab interior plumbing must be strictly maintained. Their contour or form, however, may be changed as required.

FITTING DEVIATIONS ACCEPTABLE IN CHASSIS PLUMBING

Use fittings as shown on the plumbing diagrams in this manual. Refer to the Freightliner parts book for part numbers. No deviations are permissible except those given in Table 1, located under "SPECIFICATIONS."

AIR PRESSURE SOURCE FOR NON-AIR BRAKE REQUIREMENTS

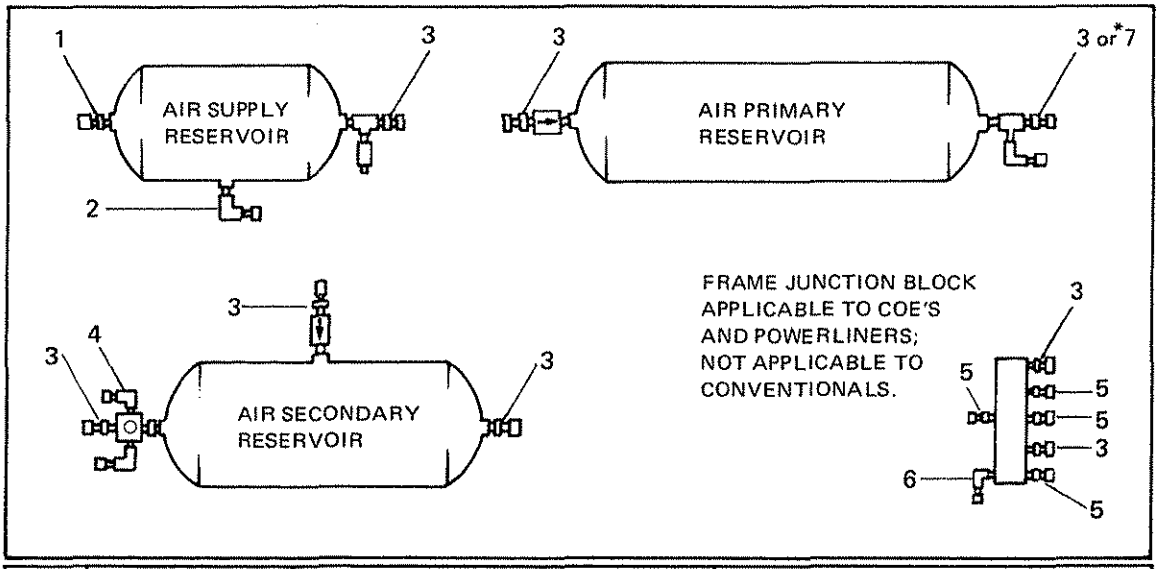
Three air pressure sources have been provided for all non-brake air supply. Air must *not* be taken from any other location. The permissible sources for tapping air for use in applications other than the brake system are as follows:

1. Cab constant air junction block: This air source is supplied by both the primary and the secondary system. It can be used for non-air brake requirements such as the air throttle, air seat, windshield washer, windshield wiper, air horn, etc. It can be used for other requirements, where this source is more practical to use.
2. Port number 3 of the forward frame air junction block: This port in this junction block (located on the left frame rail) is supplied by the primary system and can be used for non-brake air requirements in the forward section of the vehicle.
3. Air junction block on the forward end of the secondary air reservoir, located on the left frame rail: This junction block can be used for tapping non-brake air requirements in the area of the transmission and the rear portions of the vehicle.

WARNING: Tapping of brake system air from any location other than those listed above could decrease overall brake performance and increase stopping distances. REPEAT: If air is required for any accessory purpose, use only the sources provided as listed above.

DUAL AIR BRAKE AND ANTILOCK SYSTEM PLUMBING LIMITATIONS

SPECIFICATIONS



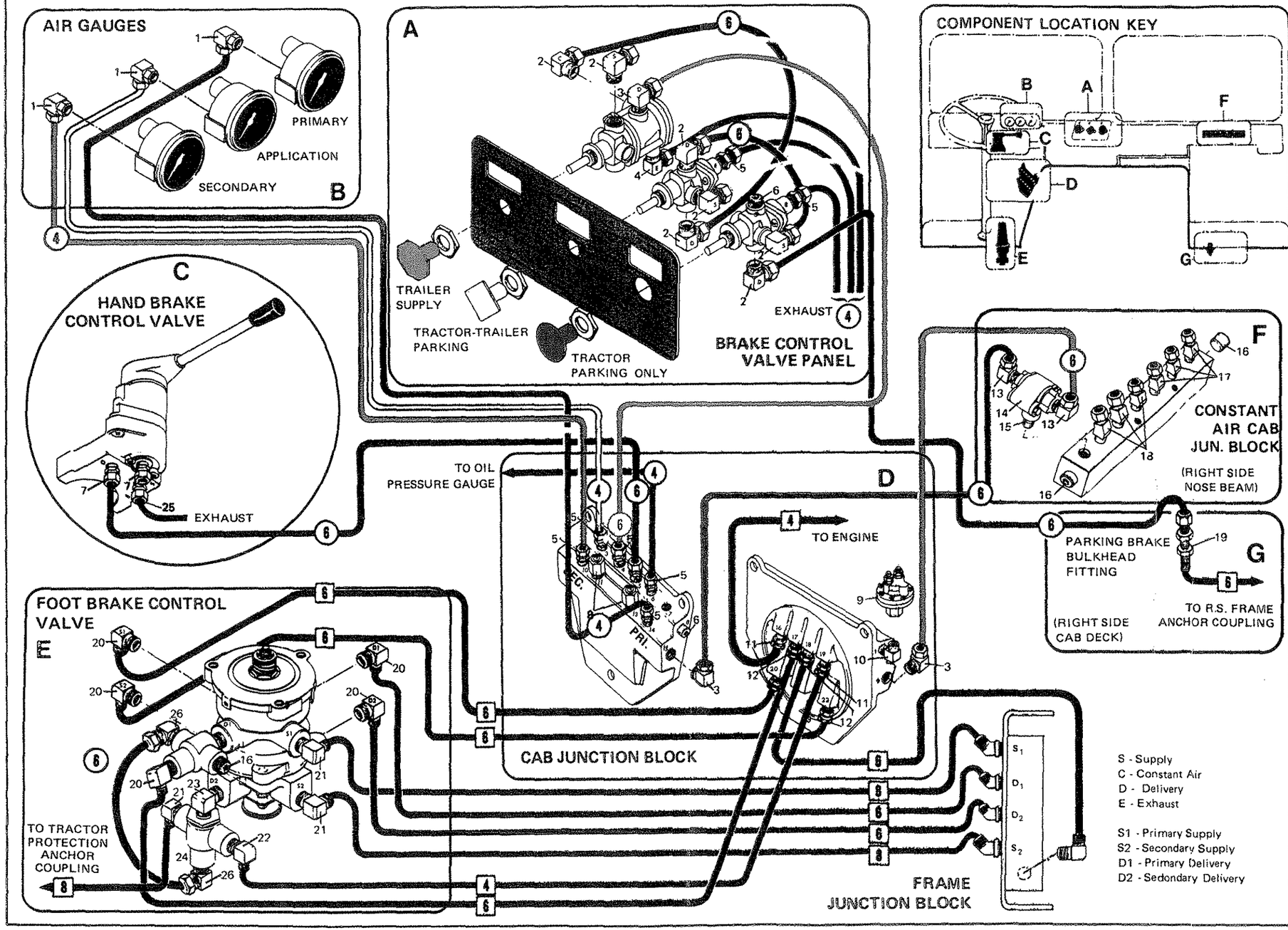
REF NO	APPLICATION		PREFERRED FITTING		ACCEPTABLE SUBSTITUTE(S)	
	NYLON TUBING	WIRE BRAID HOSE	DESCRIPTION	SIZE	DESCRIPTION	SIZE
1	NA	X	Male Connector, SAE 45° Flare	1/2NPTF-3/4 Hose	45° Male Elbow, 45° Flare	1/2NPT-3/4 Hose
2	X	NA	90° Male Elbow	1/2NPT-5/8NT	Male Coupling	1/2NPT-5/8NT
					45° Male Elbow	1/2NPT-5/8NT
	NA	X	90° Male Elbow, SAE 45° Flare	1/2NPT-1/2 Hose	Male Connector	1/2NPTF-1/2 Hose
					45° Male Elbow, SAE 45° Flare	1/2NPT-1/2 Hose
3	X	NA	Male Coupling	1/2NPT-5/8NT	45° Male Elbow	1/2NPT-5/8NT
	NA	X	Male Connector, SAE 45° Flare	1/2NPTF-1/2 Hose	45° Male Elbow, SAE 45° Flare	1/2NPT-1/2 Hose
4	NA	X	90° Male Elbow, SAE 45° Flare	1/4NPT-1/4 Hose	Male Connector, SAE 45° Flare	1/4NPTF-1/4 Hose
					45° Male Elbow, SAE 45° Flare	1/4NPT-1/4 Hose
5	X	NA	Male Coupling	1/4NPT-3/8NT	45° Male Elbow	1/4NPT-3/8NT
	NA	X	Male Connector, SAE 45° Flare	1/4NPTF-3/8 Hose	45° Male Elbow, SAE 45° Flare	1/4NPT-3/8 Hose
6	NA	X	90° Male Elbow, SAE 45° Flare	1/4NPT-3/8 Hose	Male Connector, SAE 45° Flare	1/4NPTF-3/8 Hose
					45° Male Elbow, SAE 45° Flare	1/4NPT-3/8 Hose
*7	X	NA	Male Coupling	1/2NPT-1/2NT	No Acceptable Substitute	None
	NA	X	Male Connector, SAE 45° Flare	1/2NPTF-1/2 Hose	45° Male Elbow, SAE 45° Flare	1/2NPT-1/2 Hose

NA = Not Applicable * Ref. 7 Applicable to Conventional Trucks only (not tractors)

Table 1, Permissible Fitting Deviations

AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. SINGLE DRIVE TRACTOR, WITH FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12640



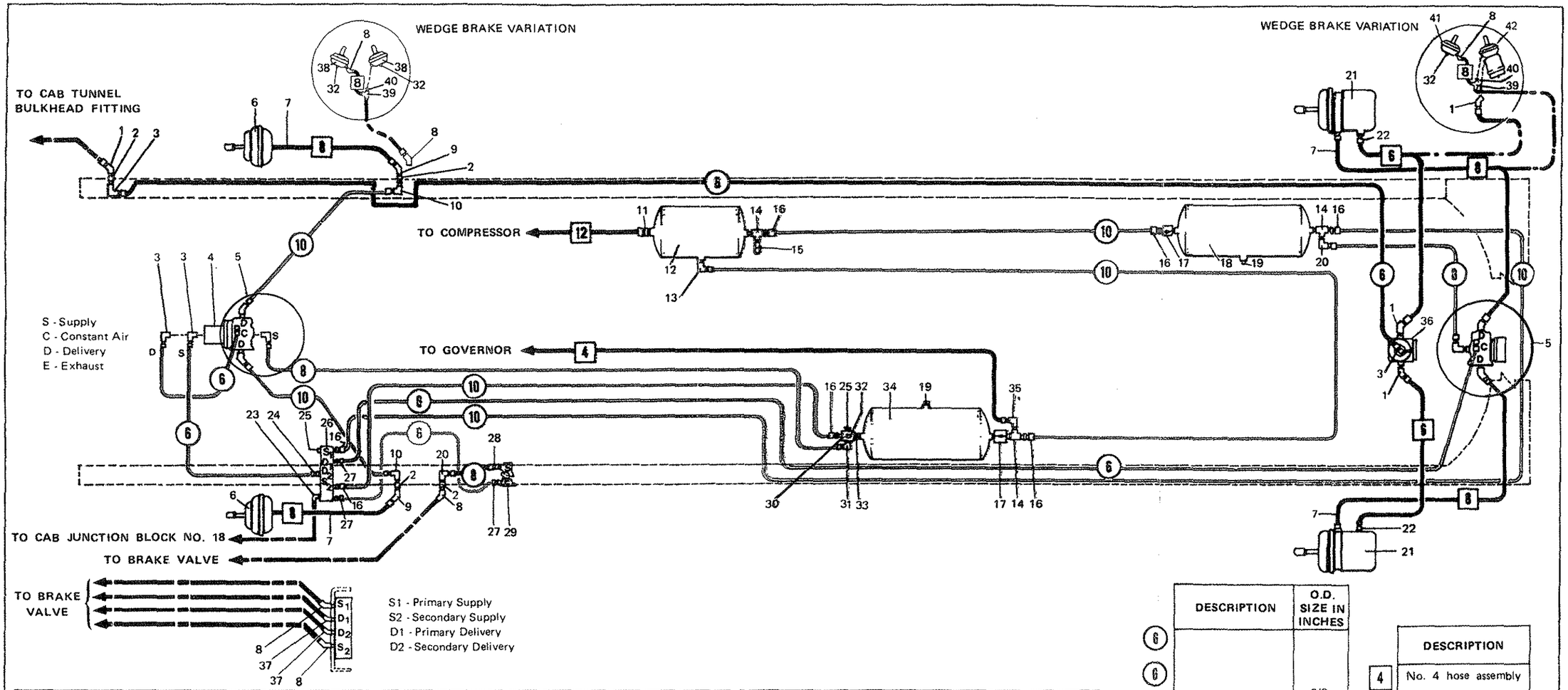
	COLOR	DESCRIPTION	O.D. SIZE IN INCHES
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6	Red		
6	Yellow		
6	Orange		
6	Green		
4	Black	No. 4 hose assembly	
6	Black	No. 6 hose assembly	
8	Black	No. 8 hose assembly equiv. to SAE J1402 Type E	

REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT 3/8NT
8	Low Air Pressure Switch	—
9	Stoplight Switch	—
10	90° Male Elbow	1/8NPT
11	Male Connector 45° flare	1/8NPT - 1/4
12	Male Connector 45° flare	1/4NPT - 3/8
13	90° Male Elbow	3/8NPT - 3/8NT
14	Two-way Check Valve	—
15	Hex Nipple	3/8NPT
16	Plug	3/8NPT
17	45° Male Elbow	1/8NPT - 1/4NT
18	45° Male Elbow	1/4NPT - 3/8NT
19	Bulkhead Fitting	3/8flare - 3/8NT
20	90° Male Elbow	3/8NPT - 3/8
21	90° Male Elbow	3/8NPT - 1/2
22	90° Male Elbow	3/8NPT - 1/4
23	90° Street Elbow	3/8NPT
24	Double Check Valve	—
25	Male Coupling	1/4NPT - 1/4NT
26	90° Male Elbow	3/8NPT - 3/8NT

CAB DIAGRAM
COE Tractor D12-10513 ENG. CHG. LTR. C

AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. SINGLE DRIVE TRACTOR, WITH FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12640



REF NO	DESCRIPTION	SIZE
1	45° Male Elbow, 45° Flare	3/8 NPT - 3/8 Hose
2	Anchor Coupling	3/8 NPT
3	90° Male Elbow	3/8 NPT - 3/8 NT
4	Ratio Valve	———
5	See Antilock Diagram	———
6	Front Axle Serv. Chamb.	———
7	Air Brake Hose	———
8	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
9	45° Street Elbow	3/8 NPT - 3/8 NPT
10	90° Male Elbow	3/8 NPT - 5/8 NT
11	Male Connector 45° Flare	1/2 NPT - 3/4 Hose
12	Air Reservoir (Supply)	———
13	90° Male Elbow	1/2 NPT - 5/8 NT
14	Street Tee - Special	———

REF NO	DESCRIPTION	SIZE
15	Air Safety Valve	———
16	Male Coupling	1/2 NPT - 5/8 NT
17	Single Check Valve	———
18	Air Reservoir (Primary)	———
19	Plug	1/2 NPT
20	90° Male Elbow	3/8 NPT - 1/2 NT
21	Rear Axle Serv. & Park. Chamb.	———
22	Male Connector, 45° Flare	3/8 NPT - 3/8 Hose
23	90° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
24	Male Coupling	3/8 NPT - 3/8 NT
25	Plug	1/4 NPT
26	Frame Junction Block (Front)	———
27	Male Coupling.	1/4 NPT - 3/8 NT
28	Male Coupling	3/8 NPT - 1/2 NT

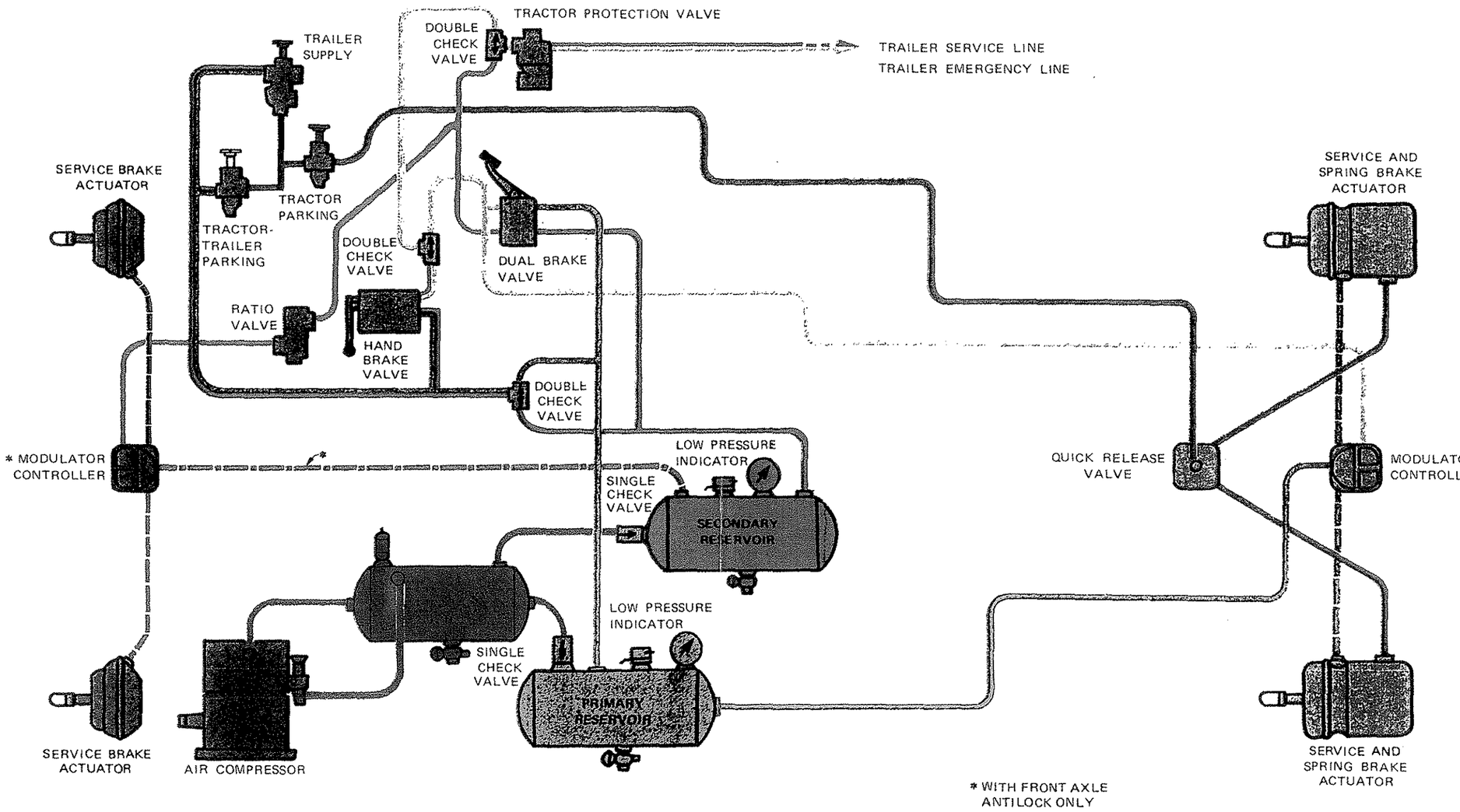
REF NO	DESCRIPTION	SIZE
29	Tractor Protection Valve	———
30	Air Reservoir Junction Block	———
31	90° Male Elbow	1/4 NPT - 1/2 NT
32	Plug	3/8 NPT
33	Nipple, Hex	1/2 NPT
34	Air Reservoir (Secondary)	———
35	90° Male Elbow, 45° Flare	3/8 NPT - 1/4 Hose
36	Quick Release Valve	———
37	45° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
38	Front Axle Serv. Chamb.	———
39	Male Run Tee, 45° Flare	3/8 NPT - 1/2 Hose
40	Adapter, Hex	3/8 NPT - 1/4 NPT
41	Rear Axle Serv. Chamb.	———
42	Rear Axle Serv. & Park. Chamb.	———

	DESCRIPTION	O.D. SIZE IN INCHES
6	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
8		1/2
10		5/8

	DESCRIPTION
4	No. 4 hose assembly
6	No. 6 hose assembly
8	No. 8 hose assembly
10	No. 10 hose assembly
12	No. 12 hose assembly equiv. to SAE J1402 Type E

CHASSIS DIAGRAM
C.O.E. Single Tractor D12-10516
ENG. CHG. LTR. F

AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. SINGLE DRIVE TRACTOR, WITH FRONT AXLE ANTILOCK



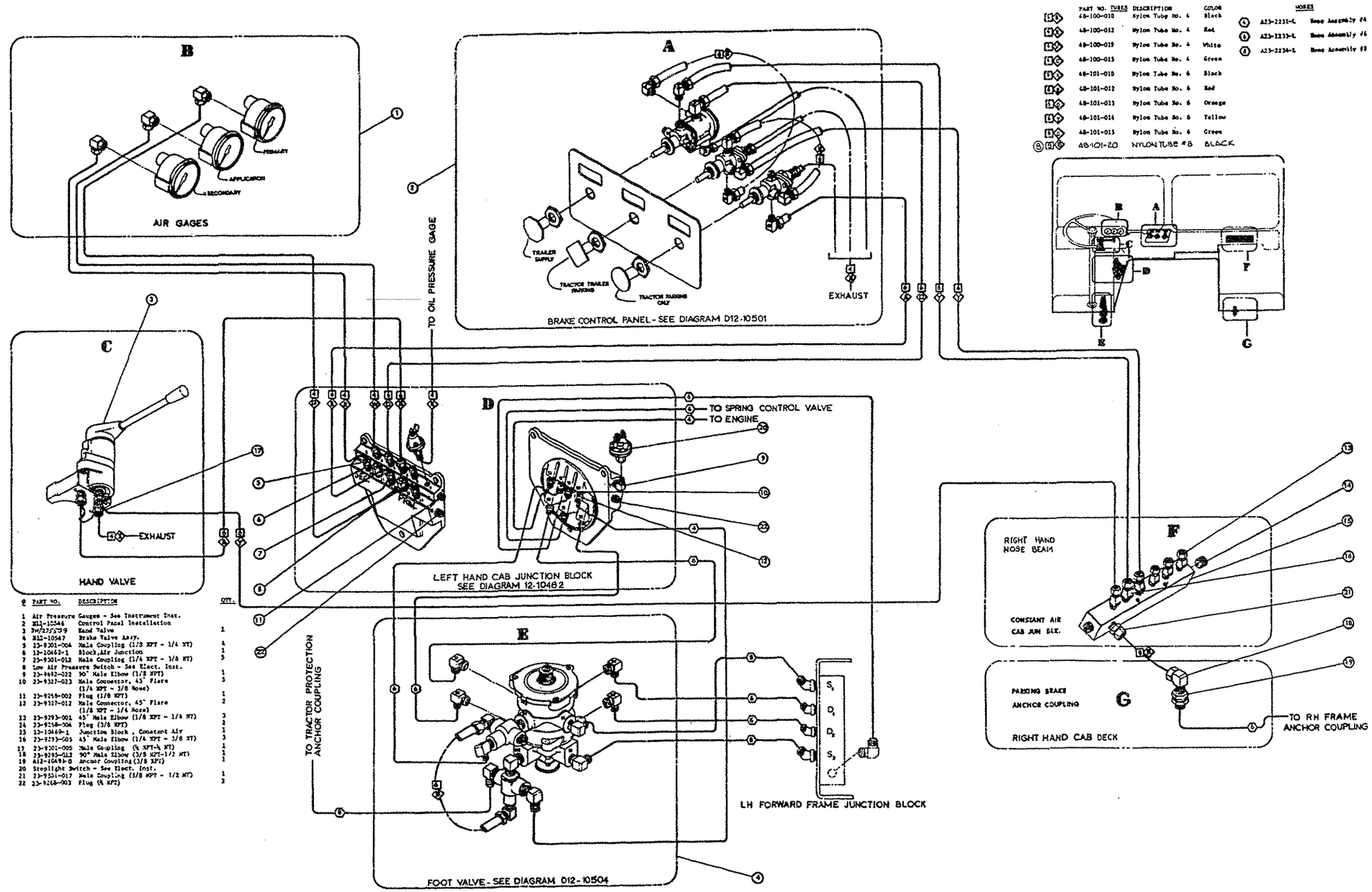
COLOR KEY

- Supply System Air Pressure
- Primary System Air Pressure
- Primary System Service Brake Application Air Pressure
- Primary System Application Control Air Pressure
- Secondary System Air Pressure
- Secondary System Application Control Air Pressure
- Primary or Secondary System Air Pressure
- Secondary System Service Brake Application Air Pressure
- Primary or Secondary System Application Control Air Pressure
- Trailer Air Supply System
- Tractor Parking Brake System
- Secondary System Air Pressure With Front Axle Antilock Only

SCHEMATIC DIAGRAM
Single Tractor Air Brake (D12-10515)
ENG. CHG. LTR. B

COE SINGLE DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CAB DIAGRAM D12-10535, CHG. LTR. D



#	PART NO.	DESCRIPTION	QTY.
1		Air Pressure Gauges - See Instrument Inst.	
2	A12-12546	Control Panel Installation	
3	3W/225379	Knob Valve	1
4	A12-10547	Brake Valve Assy.	
5	23-9201-004	Male Coupling (1/8 NPT - 1/4 MT)	4
6	12-10462-1	Block,Air Junction	1
7	23-9201-012	Male Coupling (1/4 NPT - 3/8 MT)	5
8		Low Air Pressure Switch - See Elect. Inst.	
9	23-9492-022	90° Male Elbow (1/8 NPT)	1
10	23-9327-023	Male Connector, 45° Flare (1/4 NPT - 3/8 Hose)	5
11	23-9259-002	Plug (1/8 NPT)	1
12	23-9327-012	Male Connector, 45° Flare (1/8 NPT - 1/4 Hose)	2
13	23-9293-001	45° Male Elbow (1/8 NPT - 1/4 MT)	3
14	23-9258-004	Plug (3/8 NPT)	2
15	12-10469-1	Junction Block , Constant Air	1
16	23-9293-005	45° Male Elbow (1/4 NPT - 3/8 MT)	3
17	23-9201-005	Male Coupling (¼ NPT-¼ MT)	1
18	23-9260-018	90° Male Elbow (3/8 NPT-1/2 MT)	1
19	A12-10491-D	Anchor Coupling (3/8 NPT)	1
20		Stoplight Switch - See Elect. Inst.	
21	23-9201-017	Male Coupling (3/8 NPT - 1/2 MT)	1
22	23-9268-003	Plug (¼ NPT)	2

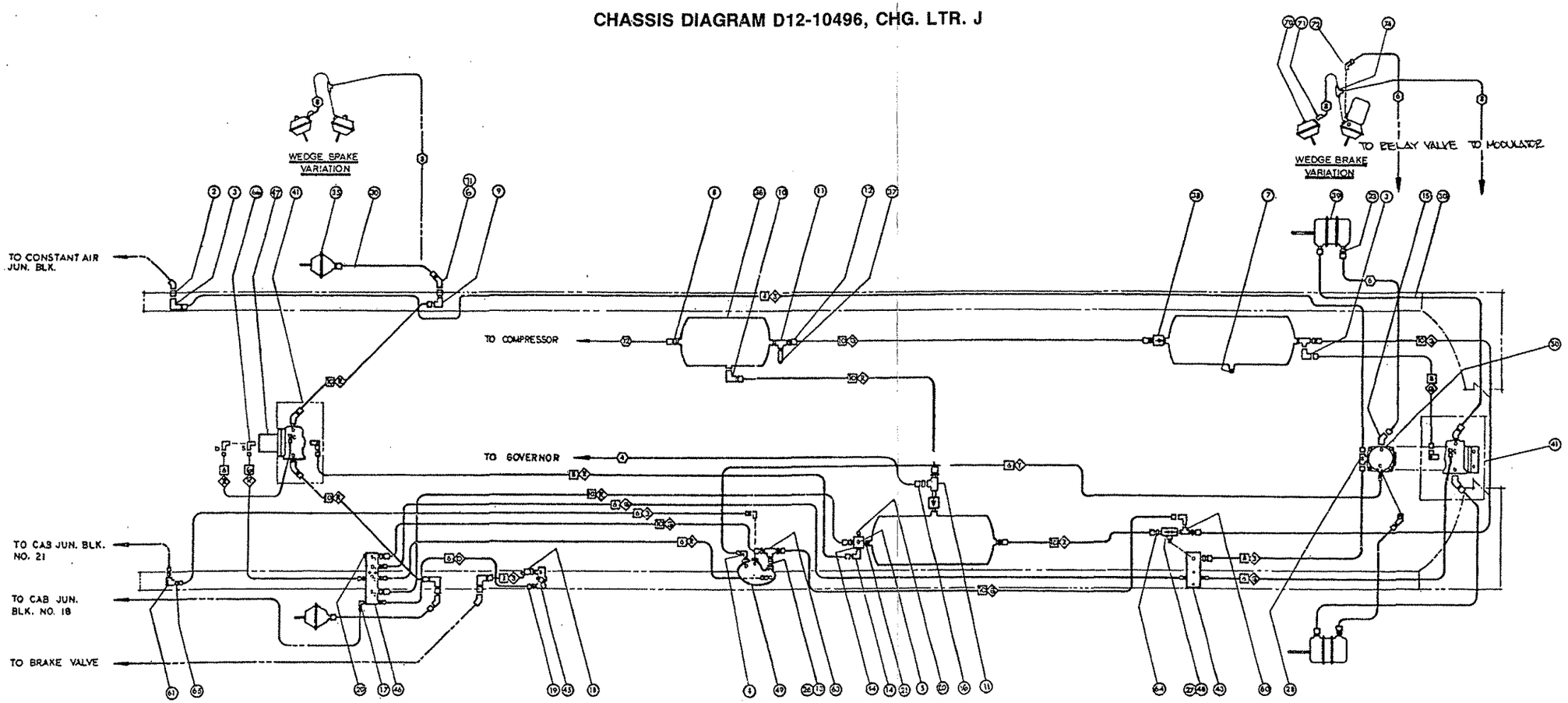
#	PART NO. TUBES	DESCRIPTION	COLOR
1	48-100-010	Nylon Tube No. 4	Black
2	48-100-012	Nylon Tube No. 4	Red
3	48-100-019	Nylon Tube No. 4	White
4	48-100-015	Nylon Tube No. 4	Green
5	48-101-010	Nylon Tube No. 6	Black
6	48-101-012	Nylon Tube No. 6	Red
7	48-101-013	Nylon Tube No. 6	Orange
8	48-101-014	Nylon Tube No. 6	Yellow
9	48-101-015	Nylon Tube No. 6	Green
10	48-101-20	NYLON TUBE #8	BLACK

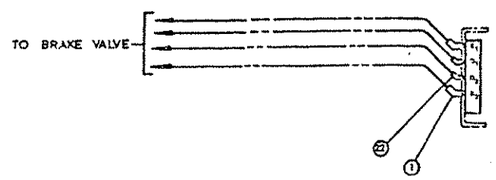
#	HOSES	
4	A23-2232-L	Hose Assembly #4
5	A23-2233-L	Hose Assembly #5
6	A23-2234-L	Hose Assembly #8

BRAKE CONTROL 12
32-12644

COE SINGLE DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CHASSIS DIAGRAM D12-10496, CHG. LTR. J





FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	3
2	A12-10491-0	Anchor Coupling 3/8 NPT	4
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	3
4	23-9295-007	90° Male Elbow (¼ NPT - 3/8 NT)	5
5	23-9258-004	Plug (3/8 NPT)	2
6	23-9531-006	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9258-005	Plug (½NPT)	1
8	23-9327-046	Male Connector, 45° Flare (1/2 NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-015	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-12432-0	Street Tee-Special	5
12	23-9301-021	Male Coupling (½ NPT - 5/8 NT)	10
13	23-9309-002	Nipple (½NPT)	1
14	23-9295-011	90 Male Elbow (½NPT-½NT)	1
15	23-9325-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	3
16	23-9321-022	Male Conn., 45° Flare (⅜ NPT - ½ Hose)	1
17	23-9329-023	90° Male Elbow, 45° Flare (½ NPT - 3/8 Hose)	1
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	2
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	6
20	23-9258-003	Plug (¼ NPT)	2
21	23-9530-008	Nipple, Hex (¼ NPT)	1
22	23-9326-023	45° Male Elbow, 45° Flare (¼ NPT - 3/8 Hose)	2
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	3
24			
25			
26	23-9429-402	Reducer (½ NPT - ¼ NPT)	1
27	23-9530-106	Nipple Hex (3/8 NPT)	1
28	23-10319-006	Male Tee (3/8 NPT- ½ NT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	A12-10565	Air Reservoire Inst.	1
37	(SV)284143	Air Safety Valve	1
(W)(G) 38	(W-M)A089455	Single Check Valve	2
39	See Rear Axle Assembly		
40			
41	A12-	See Anti-Lock Inst.	
42			
43	12-10459-1	Frame Jun. Block, Rear	1
44	12-10511-0	Jun. Blk. Air Reservoir	1
45	SR279000	T. P. Valve	1
46	12-10458-1	Frame Junc. Block, Front	1
47	(WAE) A089460	Ratio Valve	1
48	(WA) 639 A	Two-Way Check Valve	1
49	(PW) 286264	Spring Brake Control Valve	1
(H)50	(WA)AE18882	Relay Valve	1

Fittings

#	PART NO.	DESCRIPTION	QTY.
60	23-9313-003	Street Tee (1/8 NPT)	1
61	23-9436-003	Elbow, Anchor (3/8 NPT)	1
62			
63	23-9693-008	Male Tee (¼ NPT)	1
64	23-9301-020	Male Coupling (3/8 NPT-5/8 NT)	2
65	23-9301-013	Male Coupling (3/8 NPT-3/8 NT)	3
66.	23-9275-008	90° MALE ELBOW (⅜ NPT-⅜ NT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	4
(L)	A23-2232-L	Hose Assembly No. 4	
(S)	A23-2233-L	Hose Assembly No. 6	
(J)	A23-2234-L	Hose Assembly No. 8	
(K)	A23-2235-L	Hose Assembly No. 10	
(E)	A23-2236-L	Hose Assembly No. 12	
(S)	48-101-014	Nylon Tube No. 6 Yellow	
(S)	48-101-010	Nylon Tube No. 6 Black	
(S)	48-101-015	Nylon Tube No. 6 Green	
(S)	48-101-013	Nylon Tube No. 6 Orange	
(S)	48-101-012	Nylon Tube No. 6 Red	
(J)	48-101-020	Nylon Tube No. 8 Black	
(J)	48-101-025	Nylon Tube No. 8 Green	
(J)	48-101-022	Nylon Tube No. 8 Red	
(K)	48-101-035	Nylon Tube No. 10 Green	
(K)	48-101-032	Nylon Tube No. 10 Red	

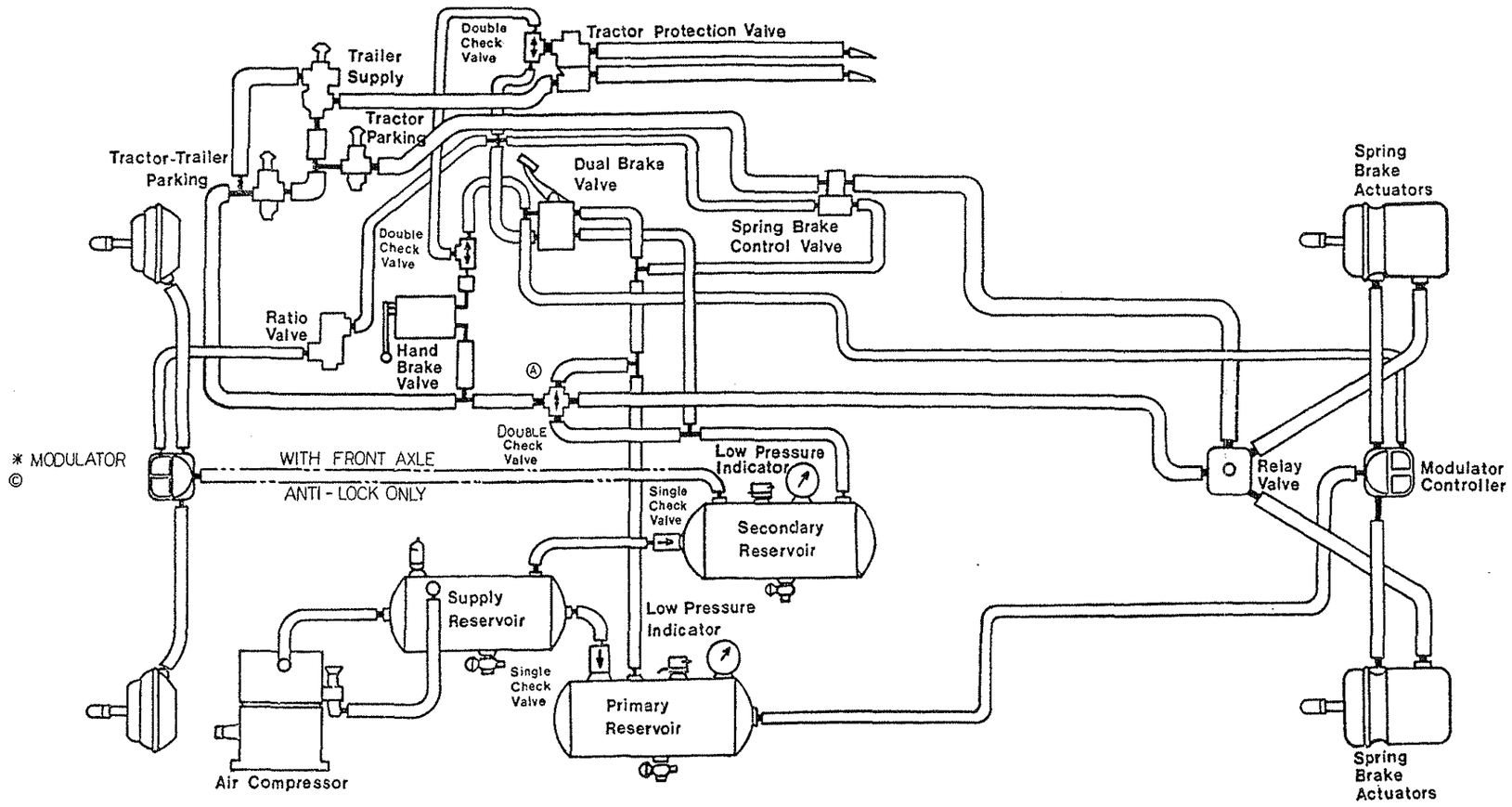
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9258-004	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9325-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
74	23-9494-CA1	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

COE SINGLE DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

SCHEMATIC DIAGRAM D12-10498, CHG. LTR. C

FREIGHTLINER DUAL AIR BRAKE SYSTEM

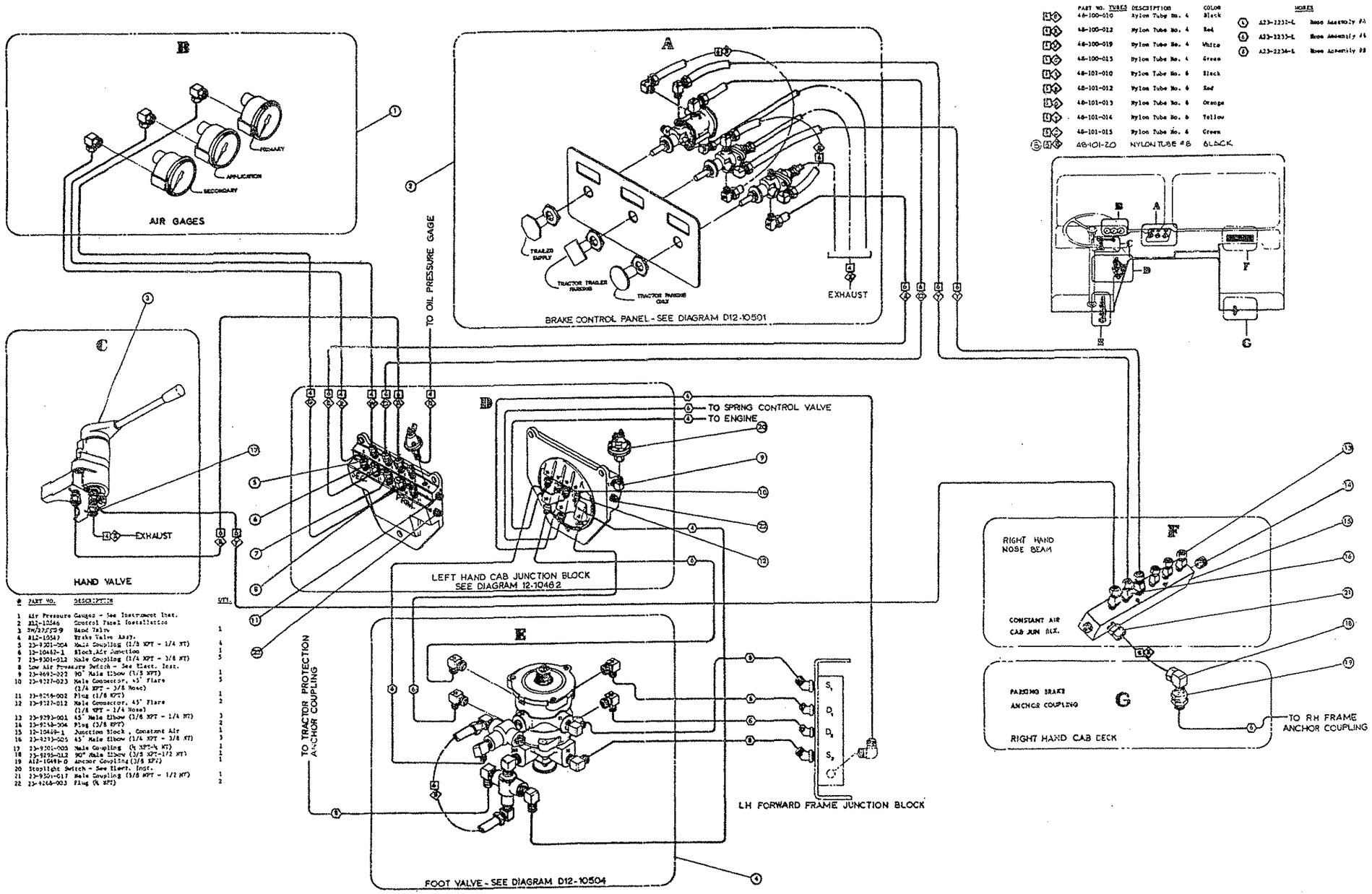


* WITH FRONT AXLE ANTI - LOCK ONLY

©

COE TANDEM DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CAB DIAGRAM D12-10535, CHG. LTR. D



#	PART NO.	DESCRIPTION	QTY.
1		Air Pressure Gauges - See Instrument Inst.	
2	312-12546	Control Panel Installation	
3	3W/2755?9	Hand Valve	1
4	312-10547	Brake Valve Assy.	
5	23-9301-004	Male Coupling (1/8 NPT - 1/4 MT)	4
6	12-10462-1	Block,Air Junction	1
7	23-9301-012	Male Coupling (1/4 NPT - 3/8 MT)	5
8		Low Air Pressure Switch - See Elect. Inst.	
9	23-9693-023	90° Male Elbow (1/8 NPT)	1
10	23-9227-023	Male Connector, 45° Flare (1/4 NPT - 3/8 Hose)	3
11	23-8259-002	Plug (1/8 NPT)	1
12	23-9227-012	Male Connector, 45° Flare (1/8 NPT - 1/4 Hose)	2
13	23-9293-001	45° Male Elbow (1/8 NPT - 1/4 MT)	3
14	23-9258-004	Plug (3/8 NPT)	2
15	12-10469-1	Junction Block , Constant Air	1
16	23-9293-005	45° Male Elbow (1/4 NPT - 3/8 MT)	3
17	23-9301-005	Male Coupling (¼ NPT-¼ MT)	1
18	23-9295-012	90° Male Elbow (3/8 NPT-1/2 MT)	1
19	A12-10469-0	Anchor Coupling (3/8 NPT)	1
20		Stoplight Switch - See Elect. Inst.	
21	23-9301-017	Male Coupling (3/8 NPT - 1/2 MT)	1
22	23-9258-003	Plug (¼ NPT)	2

PART NO. TUBES	DESCRIPTION	COLOR
46-100-010	Nylon Tube No. 4	Black
46-100-012	Nylon Tube No. 4	Red
46-100-019	Nylon Tube No. 4	White
46-100-015	Nylon Tube No. 4	Green
46-101-010	Nylon Tube No. 6	Black
46-101-012	Nylon Tube No. 6	Red
46-101-013	Nylon Tube No. 6	Orange
46-101-014	Nylon Tube No. 6	Yellow
46-101-015	Nylon Tube No. 6	Green
46-101-20	NYLON TUBE #8	BLACK

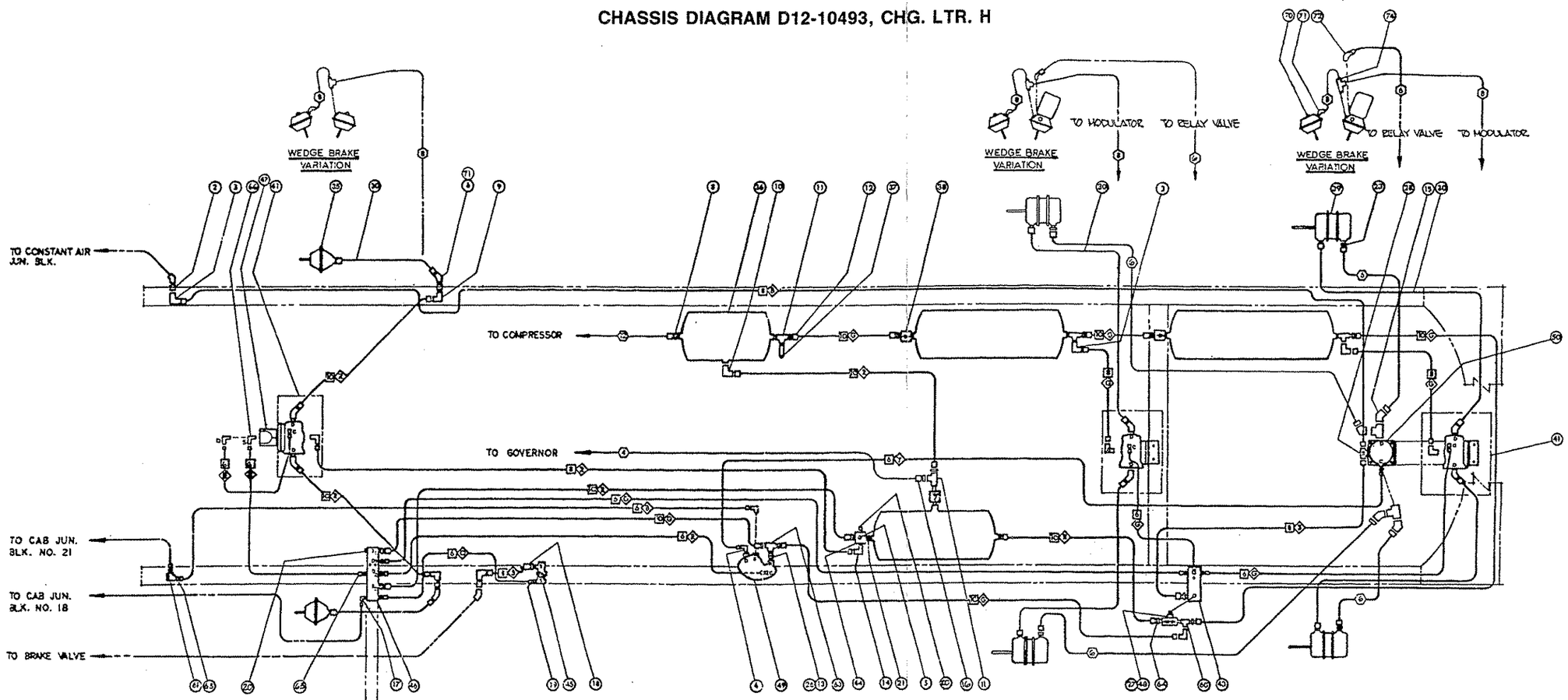
HOSES

L	A23-12232-L	Hose Assembly #4
6	A23-12233-L	Hose Assembly #6
8	A23-12234-L	Hose Assembly #8

BRAKE CONTROL 12
32-12646

COE TANDEM DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CHASSIS DIAGRAM D12-10493, CHG. LTR. H



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1.	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	3
2.	A12-10491-0	Anchor Coupling(3/8 NPT)	4
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	4
4	23-9295-007	90° Male Elbow (¼ NPT - 3/8 NT)	4
5	23-9268-004	Plug (3/8 NPT)	2
6	23-9511-006	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7			
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-015	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee-Special	4
12	23-9301-021	Male Coupling (½ NPT - 3/8 NT)	12
13	23-9209-002	Nipple (¼NPT)	1
14	23-9295-011	90° Male Elbow (¼ NPT-⅜NT)	1
15	23-9316-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9327-052	Male Conn, 45° Flare (⅜ NPT - ½ Hose)	1
17	23-9328-023	90° Male Elbow, 45° Flare (½ NPT - 3/8 Hose)	1
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	1
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	6
20	23-9268-003	Plug (¼ NPT)	½
21	23-9330-028	Nipple, Hex (¼ NPT)	1
22	23-9325-023	45° Male Elbow, 45° Flare (¼ NPT - 3/8 Hose)	2
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	6
24			
25			
26	23-9429-402	Reducer (¼ NPT - ⅛ NPT)	1
27	23-9530-106	Nipple Hex (3/8NPT)	1
28	23-10318-006	Male Tee (3/8 NPT- ½ NT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	A12-10545	Air Reservoirs Inst.	
37	(SW)291413	Air Safety Valve	1
38	(WABCO)108965 5	Single Check Valve	3
39	See Rear Axle Assembly		
40			
41	WL2-	See Anti-Lock Inst.	
42			
43	12-10459-0	Frame Jun. Block, Rear	1
44	12-10511-0	Air Reservoir Junc. Block	1
45	(SW)275000	T. P. Valve	1
46	12-10433-1	Frame Junction Block, Front	1
47	(WAG) A8B0150	Ratio Valve	1
48	(SW) 229 4	Two-Way Check Valve	1
49	(SW) 286364	Spring Brake Control Valve	1
50	(WABCO)AF 7888 2	Relay Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
60	23-9313-003	Street Tee (3/8 NPT)	3
61	23-9496-003	Elbow, Anchor (3/8 NPT)	1
62			
63	23-9693-008	Male Tee (3/8 NPT)	1
64	23-9301-020	Male Coupling (3/8 NPT-5/8 NT)	2
65	23-9301-013	Male Coupling (3/8 NPT-3/8 NT)	5
66	23-9295-008	90° MALE ELBOW (⅜-NPT-⅝ NT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	6
4	A23-2232-L	Hose Assembly No. 6	
5	A23-2233-L	Hose Assembly No. 6	
7	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6	48-101-014	Nylon Tube No. 6 Yellow	
8	48-101-010	Nylon Tube No. 6 Black	
9	48-101-015	Nylon Tube No. 6 Green	
11	48-101-015	Nylon Tube No. 6 Orange	
12	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-025	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-035	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

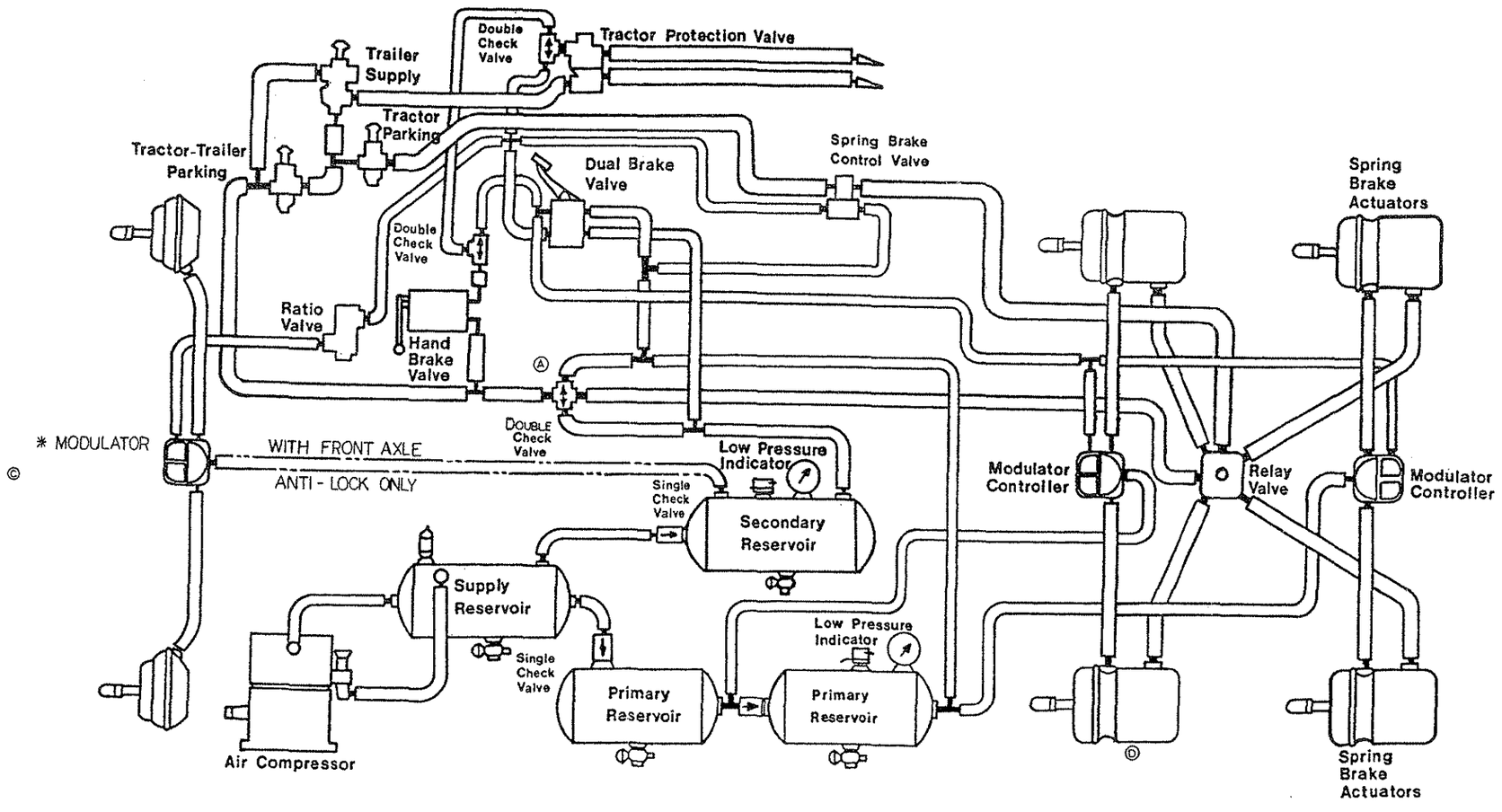
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70.	23-9268-004	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	8
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	8
73	23-9495-003	STREET TEE (⅜ NPT)	2
74	23-9494-001	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

COE TANDEM DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

SCHEMATIC DIAGRAM D12-10497, CHG. LTR. D

FREIGHTLINER DUAL AIR BRAKE SYSTEM



* WITH FRONT AXLE ANTI-LOCK ONLY

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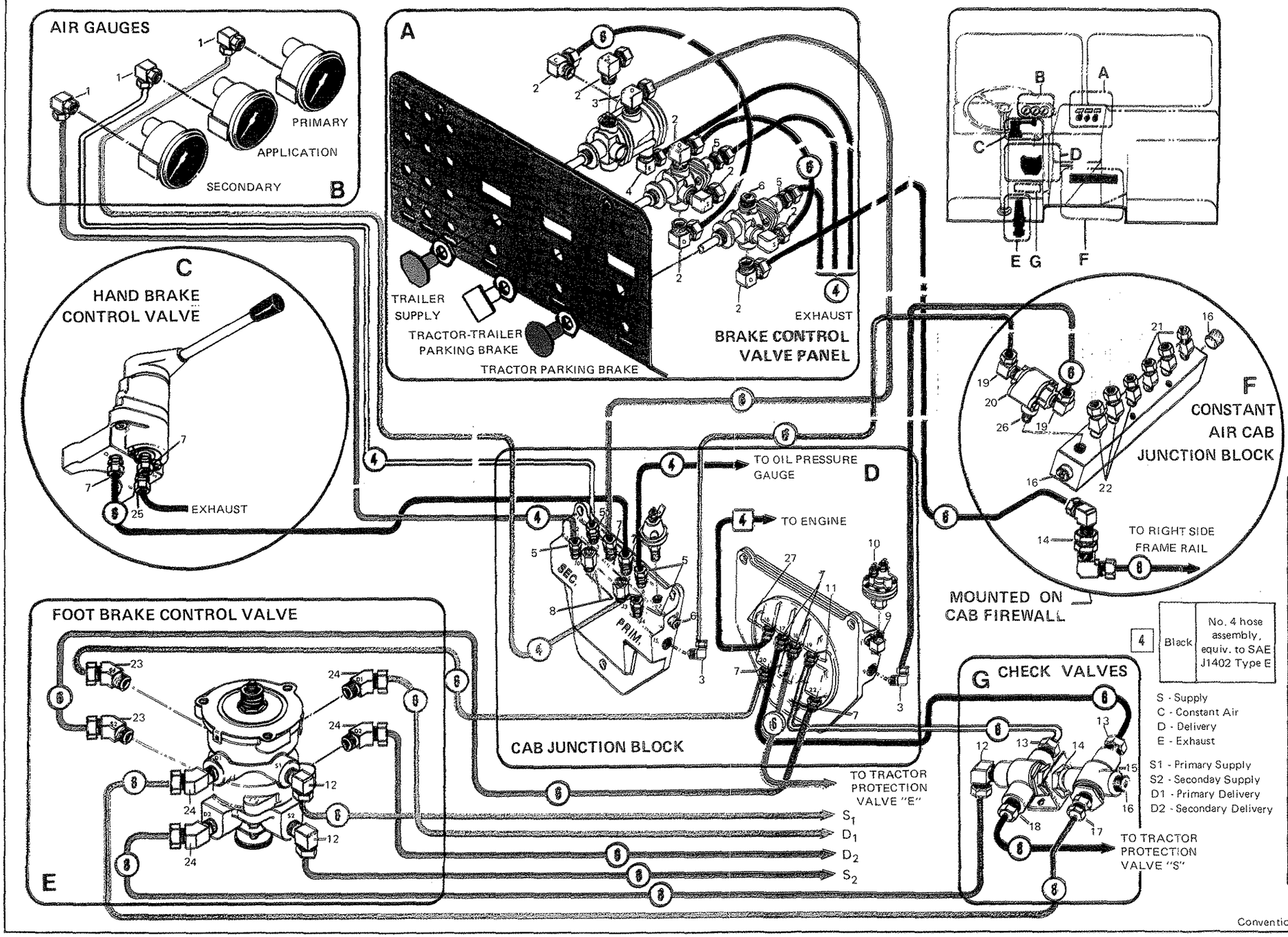


	COLOR	DESCRIPTION	O.D. SIZE IN
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6	Red		
6	Yellow		
6	Orange		
6	Green		
6	White		
8	Black		1/2
8	Red		
8	Green		

REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT - 3/8NT
8	Low Air Pressure Switch	——
9	90° Male Elbow	1/8NPT - 1/8NPT
10	Stoplight Switch	——
11	Male Coupling	1/8NPT - 3/8NT
12	90° Male Elbow	3/8NPT - 1/2NT
13	Male Coupling	3/8NPT - 3/8NT
14	Anchor Coupling	3/8NPT
15	Two-way Check Valve	——
16	Plug	3/8NPT
17	Connector	3/8NPT - 1/2NT
18	Male Coupling	3/8NPT - 1/2NT
19	90° Male Elbow	3/8NPT - 3/8NT
20	Two-way Check Valve	——
21	45° Male Elbow	1/8NPT - 1/4NT
22	45° Male Elbow	1/4NPT - 3/8NT
23	45° Male Elbow	3/8NPT - 3/8NT
24	45° Male Elbow	3/8NPT - 1/2NT
25	Male coupling	1/4NPT - 1/4NT
26	Hex Nipple	3/8NPT
27	Male Connector	1/8NPT-1/4 hose

4	Black	No. 4 hose assembly, equiv. to SAE J1402 Type E

S - Supply
C - Constant Air
D - Delivery
E - Exhaust

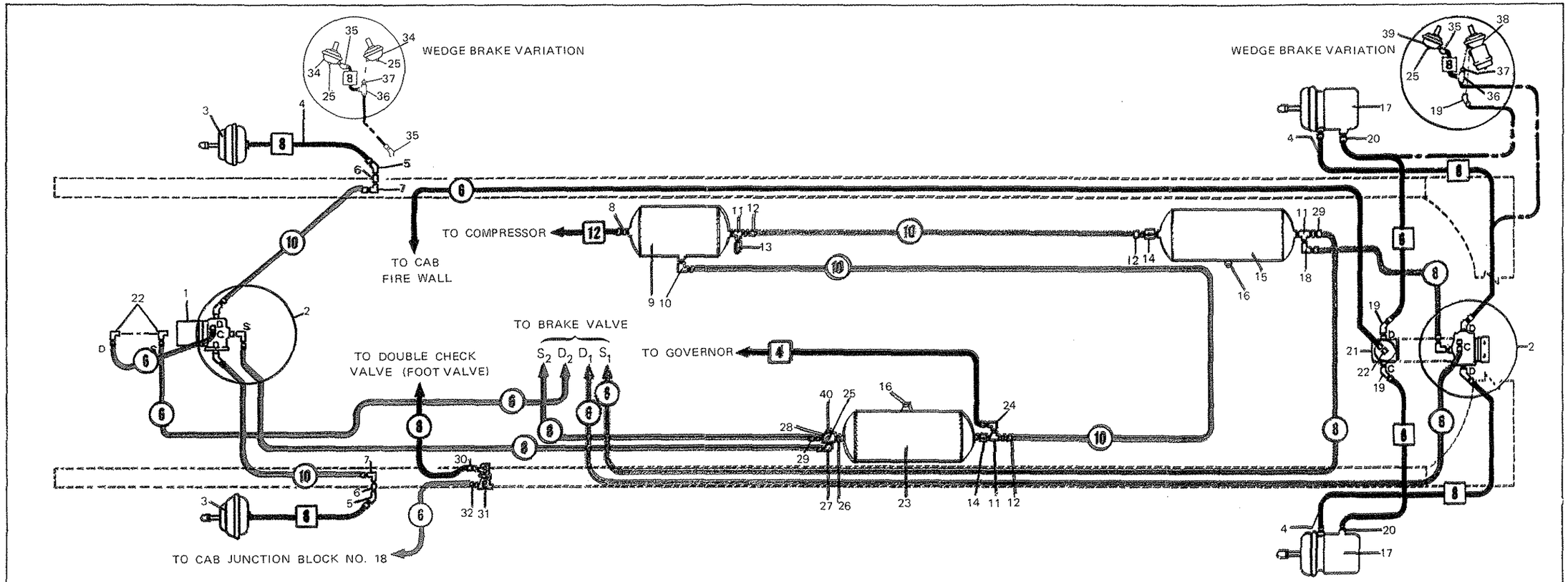
S1 - Primary Supply
S2 - Seconday Supply
D1 - Primary Delivery
D2 - Secondary Delivery

CAB DIAGRAM

Conventional Tractor D12-10529 ENG. CHG. LTR.

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL SINGLE DRIVE TRACTOR, WITH FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12648



REF NO	DESCRIPTION	SIZE
1	Ratio Valve	——
2	See AntiLock Diagram	——
3	Front Axle Service Chamber	——
4	Air Brake Hose	——
5	45° Street Elbow	3/8 NPT - 3/8 NPT
6	Anchor Coupling	3/8 NPT
7	90° Male Elbow	3/8 NPT - 5/8 NT
8	Male Connector, 45° Flare	1/2 NPT - 3/4 Hose
9	Air Reservoir (Supply)	——
10	90° Male Elbow	1/2 NPT - 5/8 NT
11	Street Tee, Special	——
12	Male Coupling	1/2 NPT - 5/8 NT
13	Air Safety Valve	——
14	Single Check Valve	——
15	Air Reservoir (Primary)	——
16	Plug	1/2 NPT
17	Rear Axle Service & Parking Chamber	——
18	90° Male Elbow	3/8 NPT - 1/2 NT
19	45° Male Elbow, 45° Flare	3/8 NPT - 3/8 Hose
20	Male Connector, 45° Flare	3/8 NPT - 3/8 Hose

REF NO	DESCRIPTION	SIZE
21	Quick Release Valve	——
22	90° Male Elbow	3/8 NPT - 3/8 NT
23	Air Reservoir (Secondary)	——
24	90° Male Elbow, 45° Flare	3/8 NPT - 1/4 Hose
25	Plug	3/8 NPT
26	Nipple, Hex	1/2 NPT
27	90° Male Elbow	1/4 NPT - 1/2 NT
28	Air Reservoir Junction Block	——
29	Male Coupling	1/2 NPT - 1/2 NT
30	Male Coupling	3/8 NPT - 1/2 NT
31	Tractor Protection Valve	——
32	Male Coupling	1/4 NPT - 3/8 NT
33	NOT IN USE	——
34	Front Axle Service Chamber	——
35	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
36	Male Run Tee, 45° Flare	3/8 NPT - 1/2 Hose
37	Adapter, Hex	3/8 NPT - 1/4 NPT
38	Rear Axle Service & Parking Chamber	——
39	Rear Axle Service Chamber	——
40	Plug	1/4 NPT

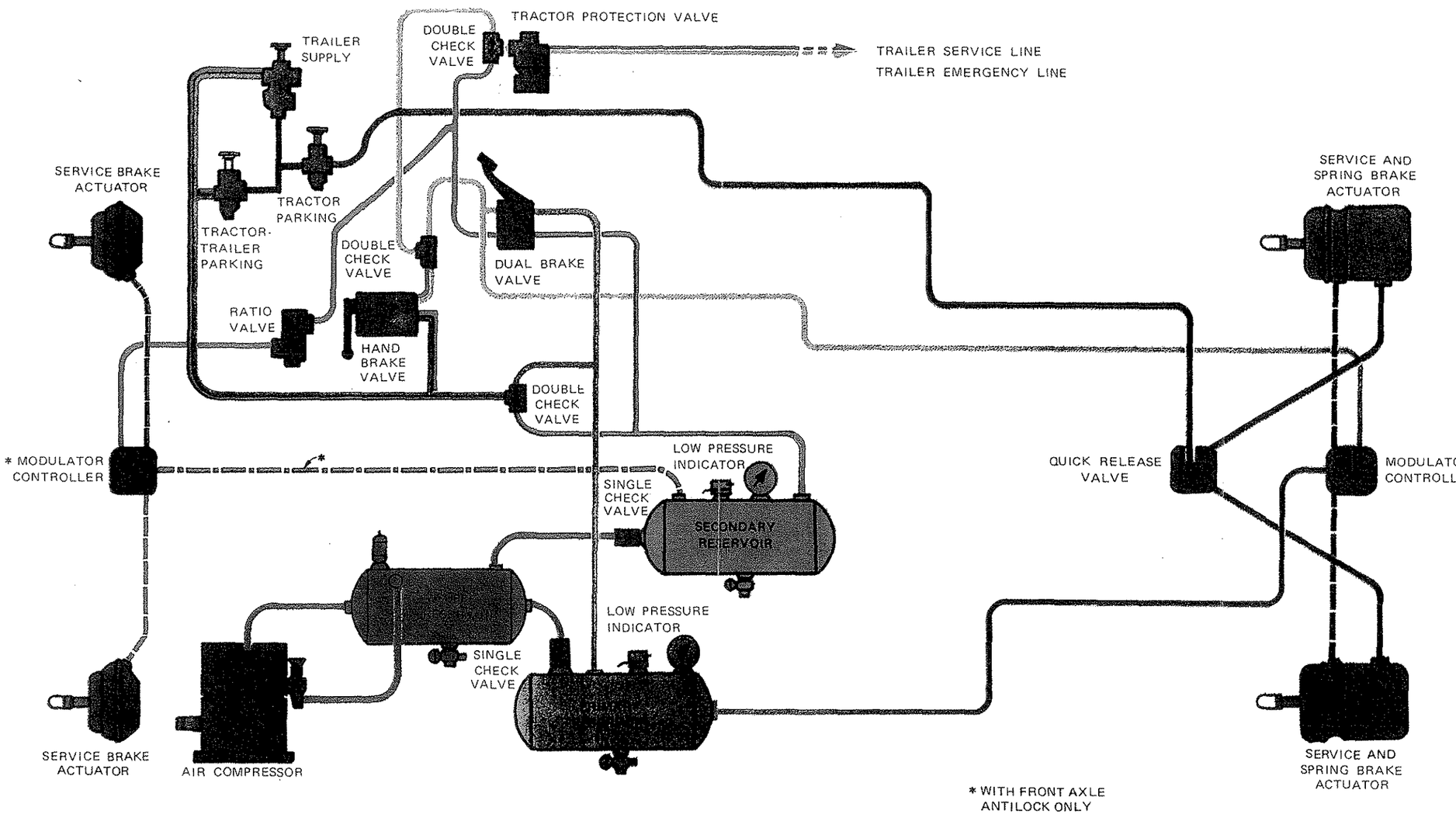
	DESCRIPTION	O.D. SIZE IN INCHES
6	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
8		
10		1/2
12		5/8

S - Supply
C - Constant Air
D - Delivery
E - Exhaust
S1 - Primary Supply
S2 - Secondary Supply
D1 - Primary Delivery
D2 - Secondary Delivery

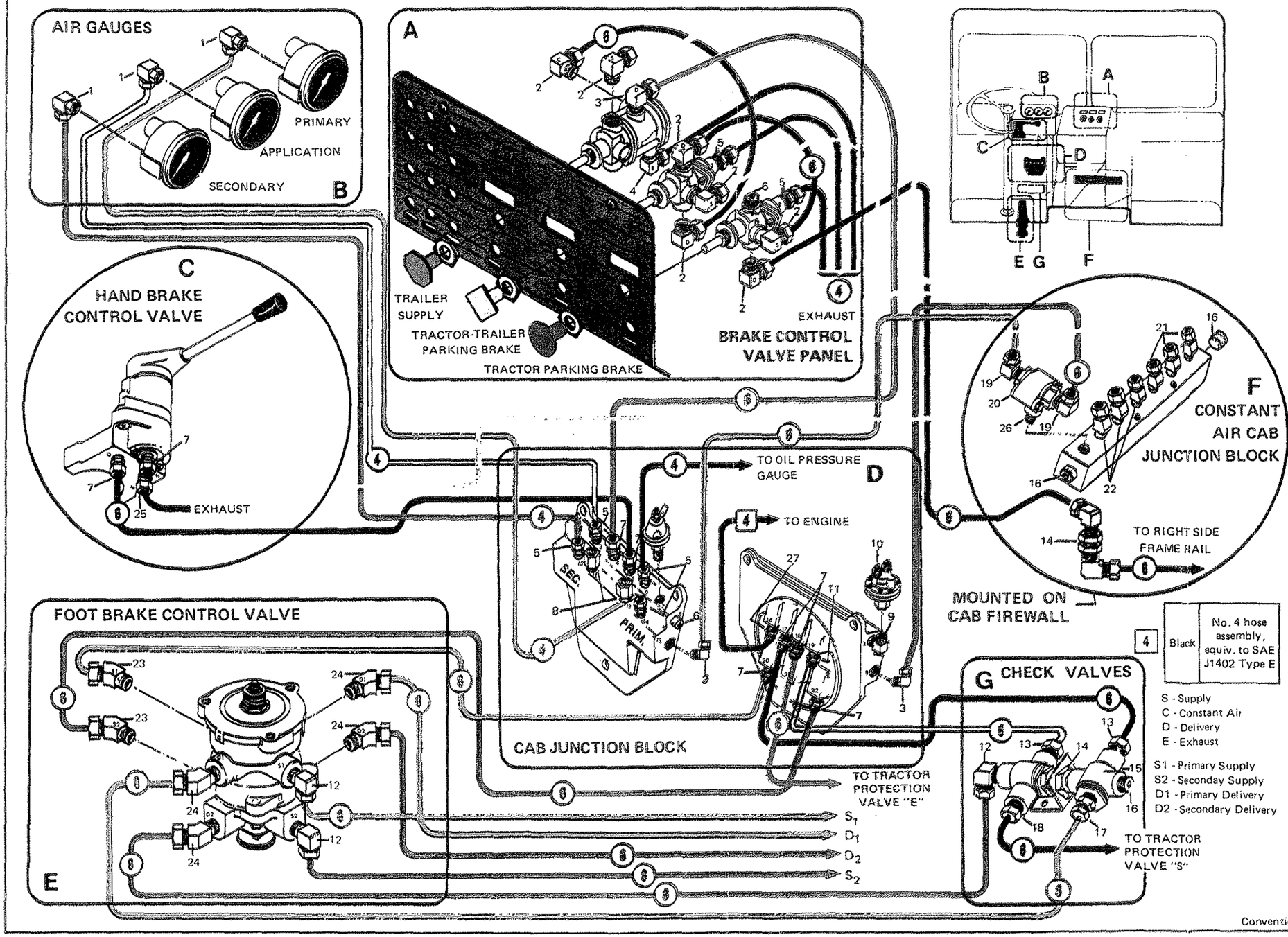
	DESCRIPTION
4	No. 4 hose assembly
6	No. 6 hose assembly
8	No. 8 hose assembly
10	No. 10 hose assembly
12	No. 12 hose assembly equiv. to SAE J1402 Type E

CHASSIS DIAGRAM
Conv. Single Tractor D12-10519
ENG. CHG. LTR. F

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL SINGLE DRIVE TRACTOR, WITH FRONT AXLE ANTILOCK



SCHEMATIC DIAGRAM
Single Tractor Air Brake (D12-10515)
ENG. CHG. LTR. B



	COLOR	DESCRIPTION	O.D. SIZE IN
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6	Red		
6	Yellow		
6	Orange		
6	Green		
6	White		
8	Black		1/2
8	Red		
8	Green		

REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT - 3/8NT
8	Low Air Pressure Switch	——
9	90° Male Elbow	1/8NPT - 1/8NPT
10	Stoplight Switch	——
11	Male Coupling	1/8NPT - 3/8NT
12	90° Male Elbow	3/8NPT - 1/2NT
13	Male Coupling	3/8NPT - 3/8NT
14	Anchor Coupling	3/8NPT
15	Two-way Check Valve	——
16	Plug	3/8NPT
17	Connector	3/8NPT - 1/2NT
18	Male Coupling	3/8NPT - 1/2NT
19	90° Male Elbow	3/8NPT - 3/8NT
20	Two-way Check Valve	——
21	45° Male Elbow	1/8NPT - 1/4NT
22	45° Male Elbow	1/4NPT - 3/8NT
23	45° Male Elbow	3/8NPT - 3/8NT
24	45° Male Elbow	3/8NPT - 1/2NT
25	Male coupling	1/4NPT - 1/4NT
26	Hex Nipple	3/8NPT
27	Male Connector	1/8NPT-1/4 hose

4	Black	No. 4 hose assembly, equiv. to SAE J1402 Type E

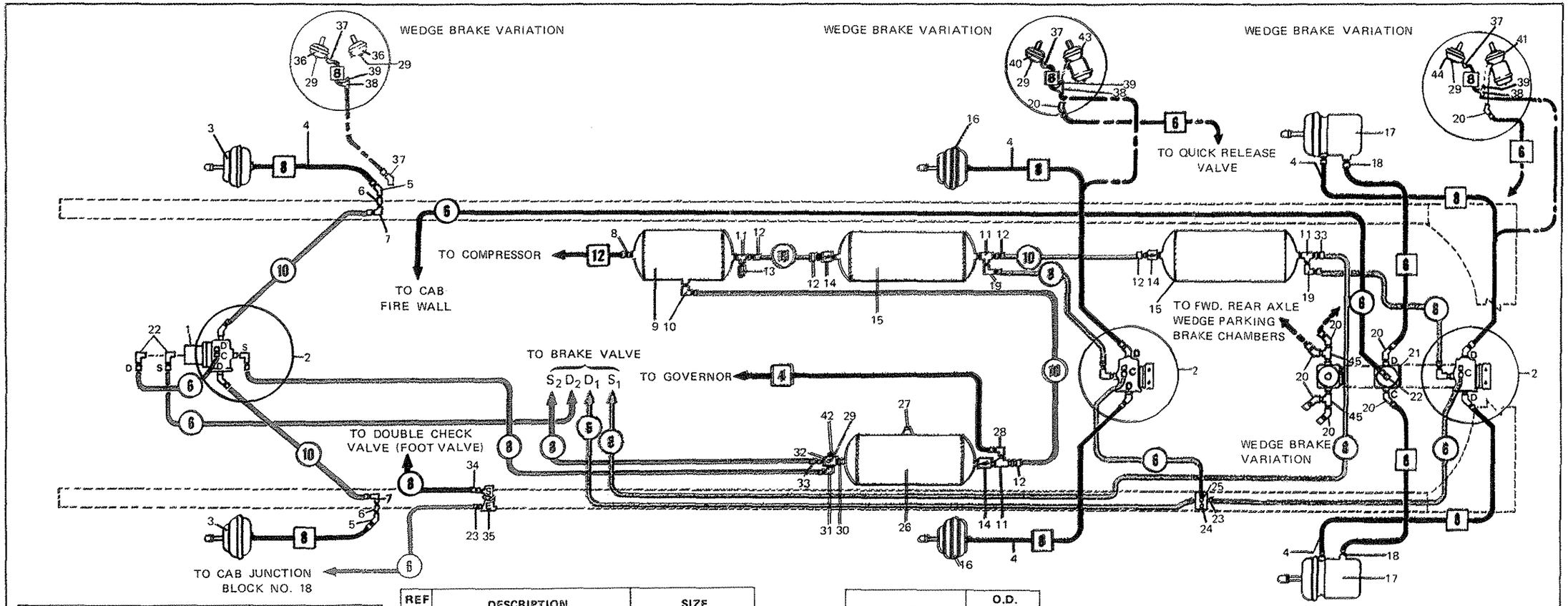
S - Supply
C - Constant Air
D - Delivery
E - Exhaust

S1 - Primary Supply
S2 - Seconday Supply
D1 - Primary Delivery
D2 - Secondary Delivery

CAB DIAGRAM
Conventional Tractor D12-10529 ENG. CHG. LTR.

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL TANDEM DRIVE TRACTOR, WITH FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12650



REF NO	DESCRIPTION	SIZE
1	Ratio Valve	—
2	See AntiLock Diagram	—
3	Front Axle Service Chamber	—
4	Air Brake Hose	—
5	45° Street Elbow	3/8 NPT - 3/8 NPT
6	Anchor Coupling	3/8 NPT
7	90° Male Elbow	3/8 NPT - 5/8 NT
8	Male Connector, 45° Flare	1/2 NPT - 3/4 Hose
9	Air Reservoir (Supply)	—
10	90° Male Elbow	1/2 NPT - 5/8 NT
11	Street Tee, Special	—
12	Male Coupling	1/2 NPT - 5/8 NT
13	Air Safety Valve	—
14	Single Check Valve	—
15	Air Reservoir (Primary)	—
16	Fwd. Rear Axle Service Chamber	—
17	Rear Rear Axle Serv. & Park. Chamb.	—
18	Male Connector, 45° Flare	3/8 NPT - 3/8 Hose
19	90° Male Elbow	3/8 NPT - 1/2 NT
20	45° Male Elbow, 45° Flare	3/8 NPT - 3/8 Hose
21	Quick Release Valve	—
22	90° Male Elbow	3/8 NPT - 3/8 NT

REF NO	DESCRIPTION	SIZE
23	Male Coupling	1/4 NPT - 3/8 NT
24	Frame Junction Block, Rear	—
25	90° Male Elbow	1/4 NPT - 3/8 NT
26	Air Reservoir (Secondary)	—
27	Plug	1/2 NPT
28	90° Male Elbow, 45° Flare	3/8 NPT - 1/4 Hose
29	Plug	3/8 NPT
30	Nipple, Hex.	1/2 NPT
31	90° Male Elbow	1/4 NPT - 1/2 NT
32	Air Reservoir Junction Block	—
33	Male Coupling	1/2 NPT - 1/2 NT
34	Male Coupling	3/8 NPT - 1/2 NT
35	Tractor Protection Valve	—
36	Front Axle Service Chamber	—
37	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
38	Male Run Tee, 45° Flare	3/8 NPT - 1/2 Hose
39	Adapter, Hex	3/8 NPT - 1/4 NPT
40	Fwd. Rear Axle Service Chamber	—
41	Rear Rear Axle Serv. & Park. Chamb.	—
42	Plug	1/4 NPT
43	Fwd. Rear Axle Serv. & Park. Chamb.	—
44	Rear Rear Axle Service Chamber	—
45	Street Tee	3/8 NPT

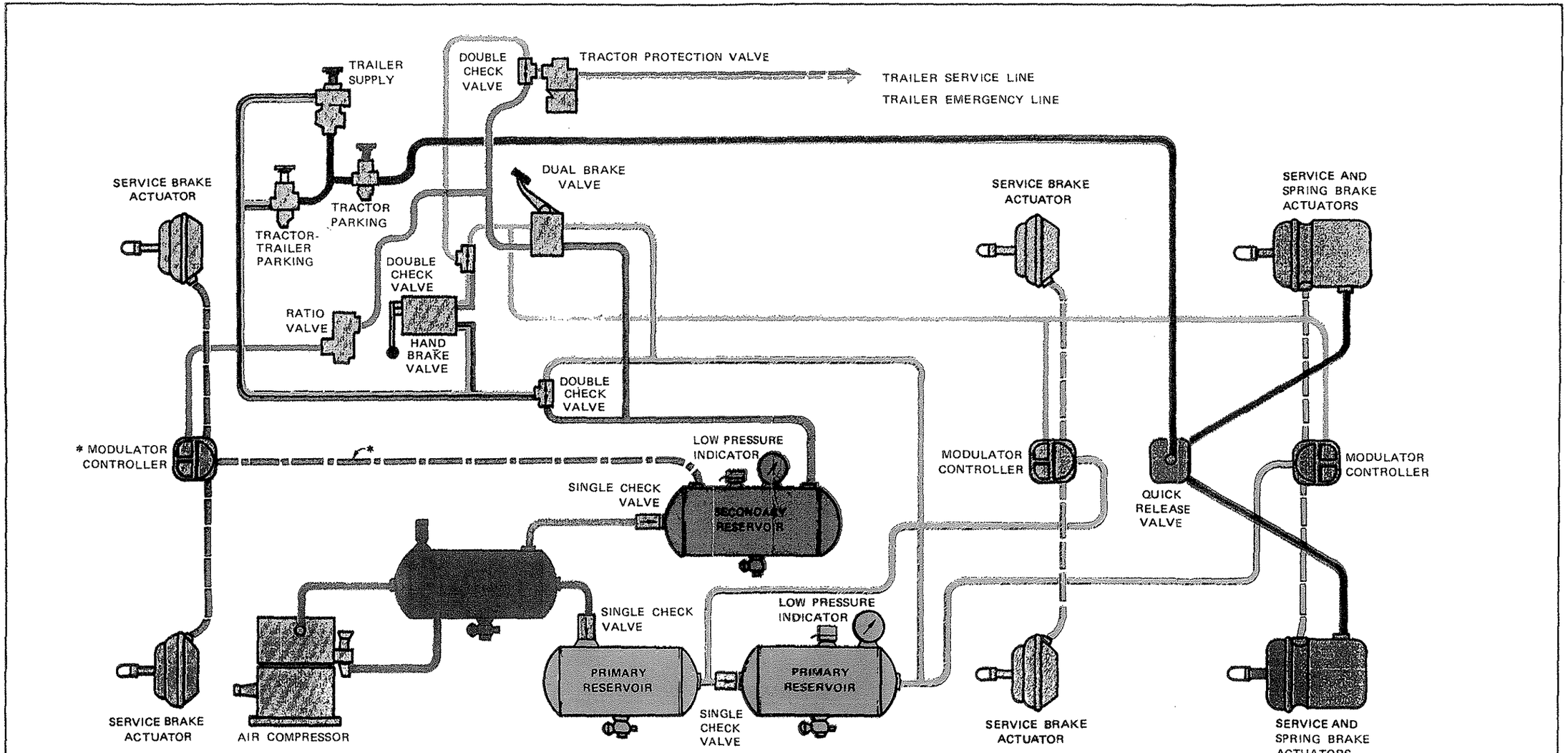
	DESCRIPTION	O.D. SIZE IN INCHES
4	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 38	3/8
6		
8		1/2
10		5/8

	DESCRIPTION
4	No. 4 hose assembly
6	No. 6 hose assembly
8	No. 8 hose assembly
10	No. 10 hose assembly
12	No. 12 hose assembly equiv. to SAE J1402 Type E

S - Supply
C - Constant Air
D - Delivery
E - Exhaust
S1 - Primary Supply
S2 - Secondary Supply
D1 - Primary Delivery
D2 - Secondary Delivery

CHASSIS DIAGRAM
Conv. Tandem Tractor D12-10518
ENG. CHG. LTR. F

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL TANDEM DRIVE TRACTOR, WITH FRONT AXLE ANTILOCK

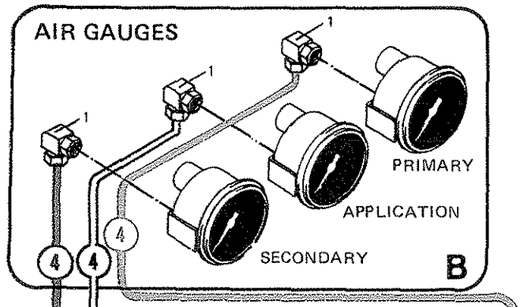


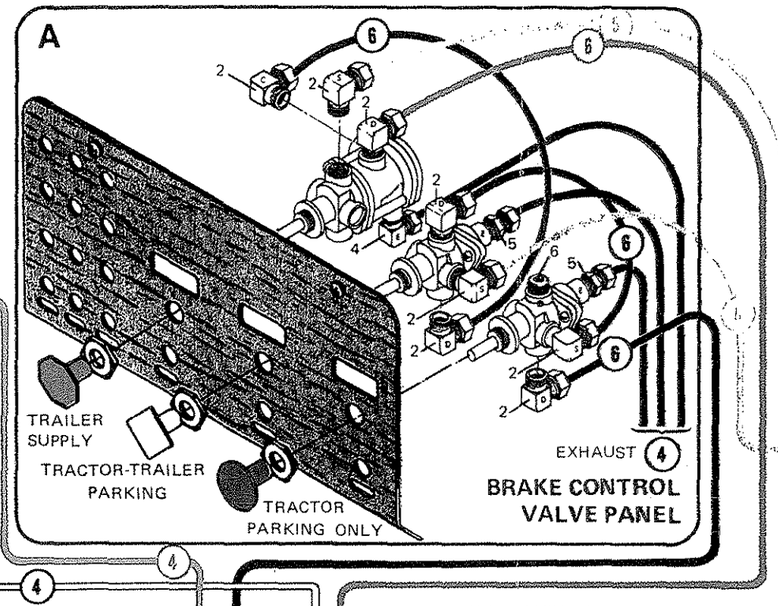
COLOR KEY

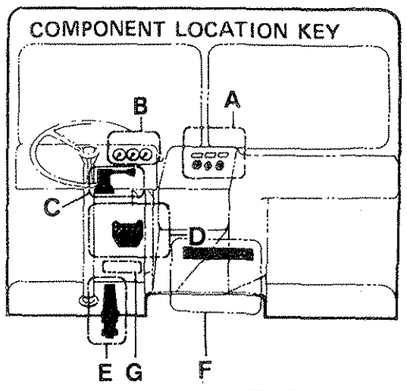
- Supply System Air Pressure
- Primary System Air Pressure
- Primary System Application Control Air Pressure
- Primary System Service Brake Application Air Pressure
- Secondary System Air Pressure
- Secondary System Application Control Air Pressure
- Primary or Secondary System Air Pressure
- Secondary System Service Brake Application Air Pressure
- Primary or Secondary System Application Control Air Pressure
- Trailer Air Supply System
- Tractor Parking Brake System
- Secondary System Air Pressure With Front Axle Antilock Only

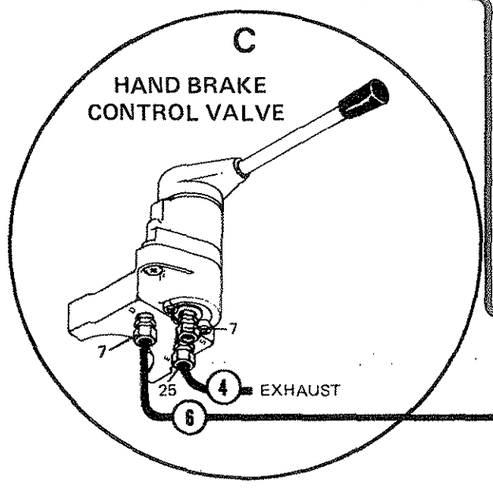
* WITH FRONT AXLE ANTILOCK ONLY

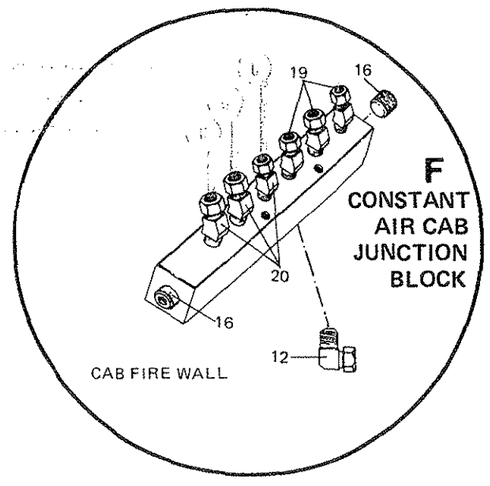
SCHEMATIC DIAGRAM
Tandem Tractor Air Brake (D12-10514)
ENG. CHG. LTR. B

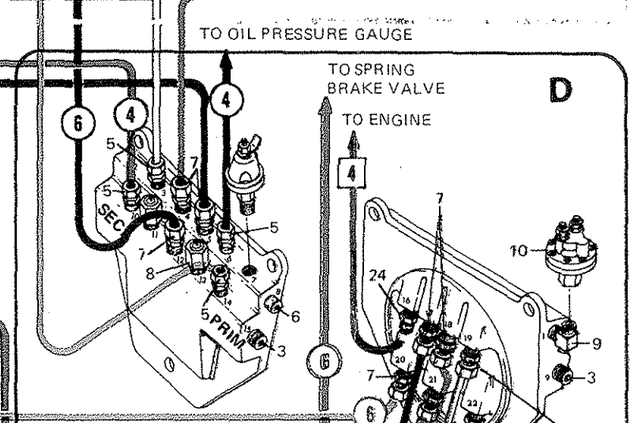


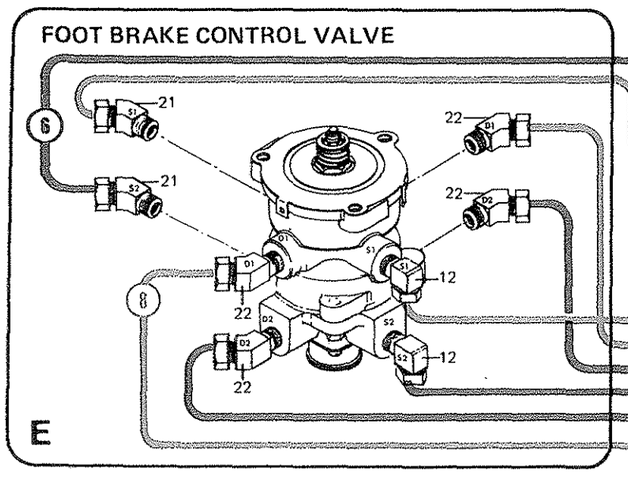


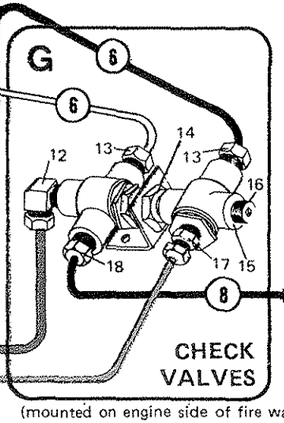












TO TRACTOR PROTECTION VALVE "E"

S_1
D_1
D_2
S_2

TO TRACTOR PROTECTION VALVE "S"

S - Supply
C - Constant Air
D - Delivery
E - Exhaust

S1 - Primary Supply
S2 - Secondary Supply
D1 - Primary Delivery
D2 - Secondary Delivery

	COLOR	DESCRIPTION	O.D. SIZE IN INCHES
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type3B	3/8
6	Red		
6	Orange		
5	Yellow		
6	Green		
6	White		
8	Black		1/2
8	Red		
8	Green		
4	Black	No. 4 hose assembly equiv. to SAE J1402 Type E	

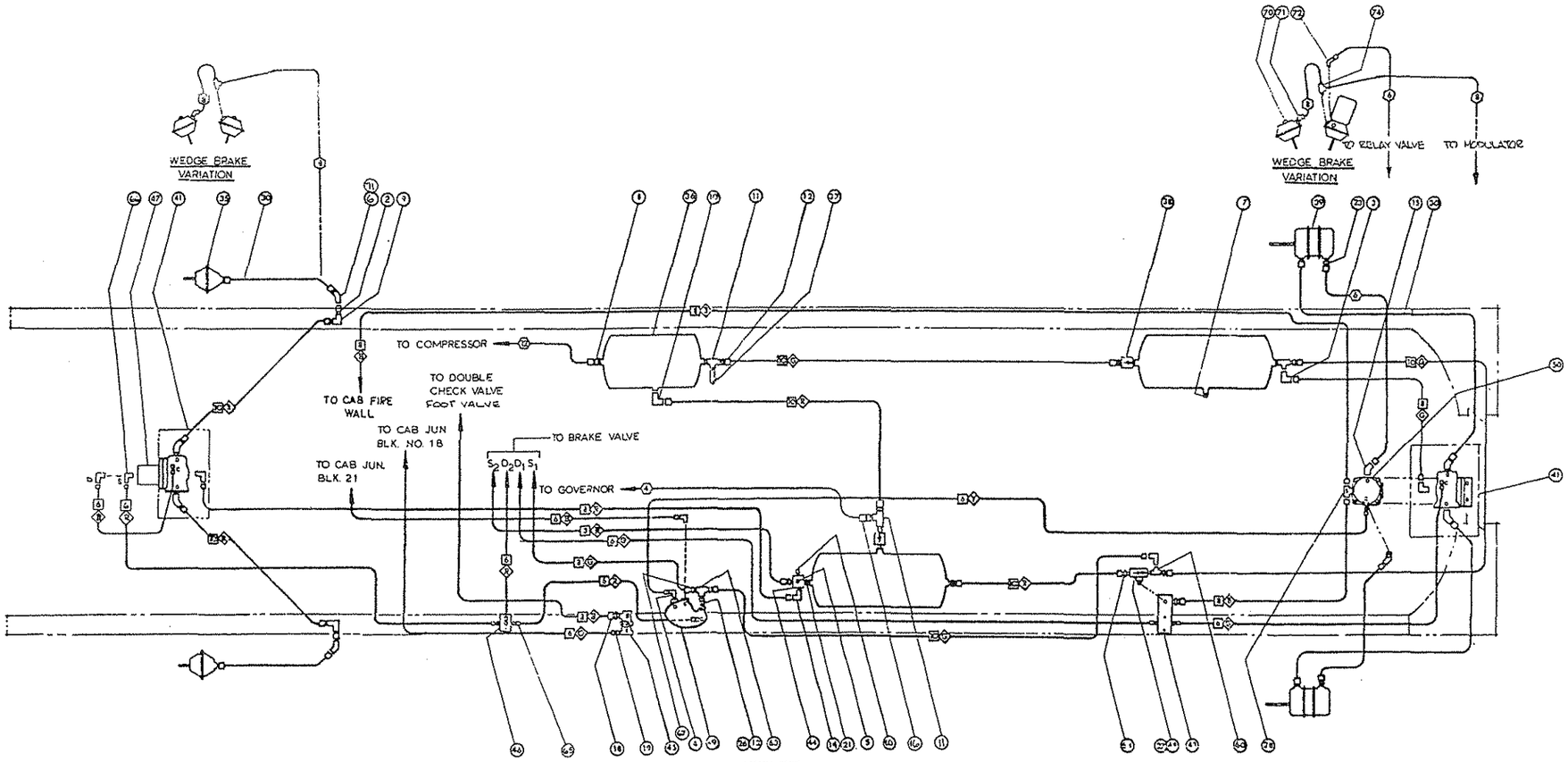
REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	Plug	1/4NPT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT - 3/8NT
8	Low Air Pressure Switch	——
9	90° Male Elbow	1/8NPT
10	Stoplight Switch	——
11	Male Coupling	1/8NPT - 3/8NT
12	90° Male Elbow	3/8NPT - 1/2NT
13	Male Coupling	3/8NPT - 3/8NT
14	Anchor Coupling	3/8NPT
15	Two-way Check Valve	——
16	Plug	3/8NPT
17	Connector	3/8NPT - 1/2NT
18	Male Coupling	3/8NPT - 1/2NT
19	45° Male Elbow	1/8NPT - 1/4NT
20	45° Male Elbow	1/4NPT - 3/8NT
21	45° Male Elbow	3/8NPT - 3/8NT
22	45° Male Elbow	3/8NPT - 1/2NT
23	Male Coupling	1/4NPT - 1/4NT
24	Male Connector	1/8NPT - 1/4Hose

CAB DIAGRAM

Cab Plumbing Conv. Truck D12-10499 ENG. CHG. LTR. A

CONVENTIONAL SINGLE DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CHASSIS DIAGRAM D12-10500, CHG. LTR. H



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1			
2	A12-10491-0	Anchor Coupling 3/8 NPT	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	1
4	23-9231-027	90° Male Elbow (¼ NPT - 3/8 NT)	5
5	23-9268-004	Plug (3/8 NPT)	2
6	23-9551-624	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9268-005	Plug (¼NPT)	1
8	23-9327-046	Male Connector, 45° Flare (1/2 NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-013	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10432-0	Street Tee-Special	1
12	23-9301-031	Male Coupling (½ NPT - 5/8 NT)	5
13	23-9309-002	Nipple (¼ NPT)	1
14	23-9295-011	90 Male Elbow (¼NPT-¼NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9321-052	Male Conn., 45° Flare (⅝ NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	2
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	4
20	23-9294-003	Plug (¼ NPT)	1
21	23-9330-008	Nipple, Hex (¼ NPT)	1
22			
23	23-9327-013	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	2
24			
25	23-9429-102	Reducer (¼ NPT - ¼ NPT)	1
27	23-9330-106	Nipple, Hex (3/8 NPT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	B12-10343	Air Reservoirs Inst.	
37	(AW)294143	Air Safety Valve	1
(N-G) 38	(WAG) A2894455	Single Check Valve	2
39	See Rear Axle Assembly		
40			
41	M12-	See Anti-Lock Inst.	
42			
43	12-10439-1	Frame Jun. Block, Rear	1
44	12-10311-0	Jun. Blk. Air Reservoir	1
45	BW29000	T. P. Valve	1
46	12-10459-3	Frame Junc. Block, Front	1
47	(WAG) A2G610	Ratio Valve	1
48	(GR) 639 A	Two-Way Check Valve	1
49	(SV) 286344	Spring Brake Control Valve	1
(H) 50	(WAG) AE78882	Relay Valve	1

Fittings

24	23-10318-006	Male Tee (3/8 NPT-¼ NT)	1
60	23-9313-003	Street Tee (3/8 NPT)	1
61			
63	23-9693-008	Male Tee (¼ NPT)	1
64	23-9301-010	Male Coupling (3/8 NPT-3/8 NT)	2
65	23-9301-018	Male Coupling (¼ NPT - ¼ NT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
10	A12-10505-0	Air Brake Hose Assembly	4
44	23-9295-003	90° MALE ELBOW (¾NPT-⅝NT)	3
45	23-9301-015	M. COUPLING (¾NPT-⅝NT)	2
(A)	A23-2232-L	Hose Assembly No. 4	
(B)	A23-2233-L	Hose Assembly No. 6	
(C)	A23-2234-L	Hose Assembly No. 8	
(D)	A23-2235-L	Hose Assembly No. 10	
(E)	A23-2236-L	Hose Assembly No. 12	
5 (F)	48-101-014	Nylon Tube No. 6 Yellow	
5 (F)	48-101-010	Nylon Tube No. 6 Black	
5 (F)	48-101-015	Nylon Tube No. 6 Green	
5 (F)	48-101-013	Nylon Tube No. 6 Orange	
5 (F)	48-101-012	Nylon Tube No. 6 Red	
8 (G)	48-101-020	Nylon Tube No. 8 Black	
8 (G)	48-101-025	Nylon Tube No. 8 Green	
8 (G)	48-101-022	Nylon Tube No. 8 Red	
10 (H)	48-101-035	Nylon Tube No. 10 Green	
10 (H)	48-101-032	Nylon Tube No. 10 Red	

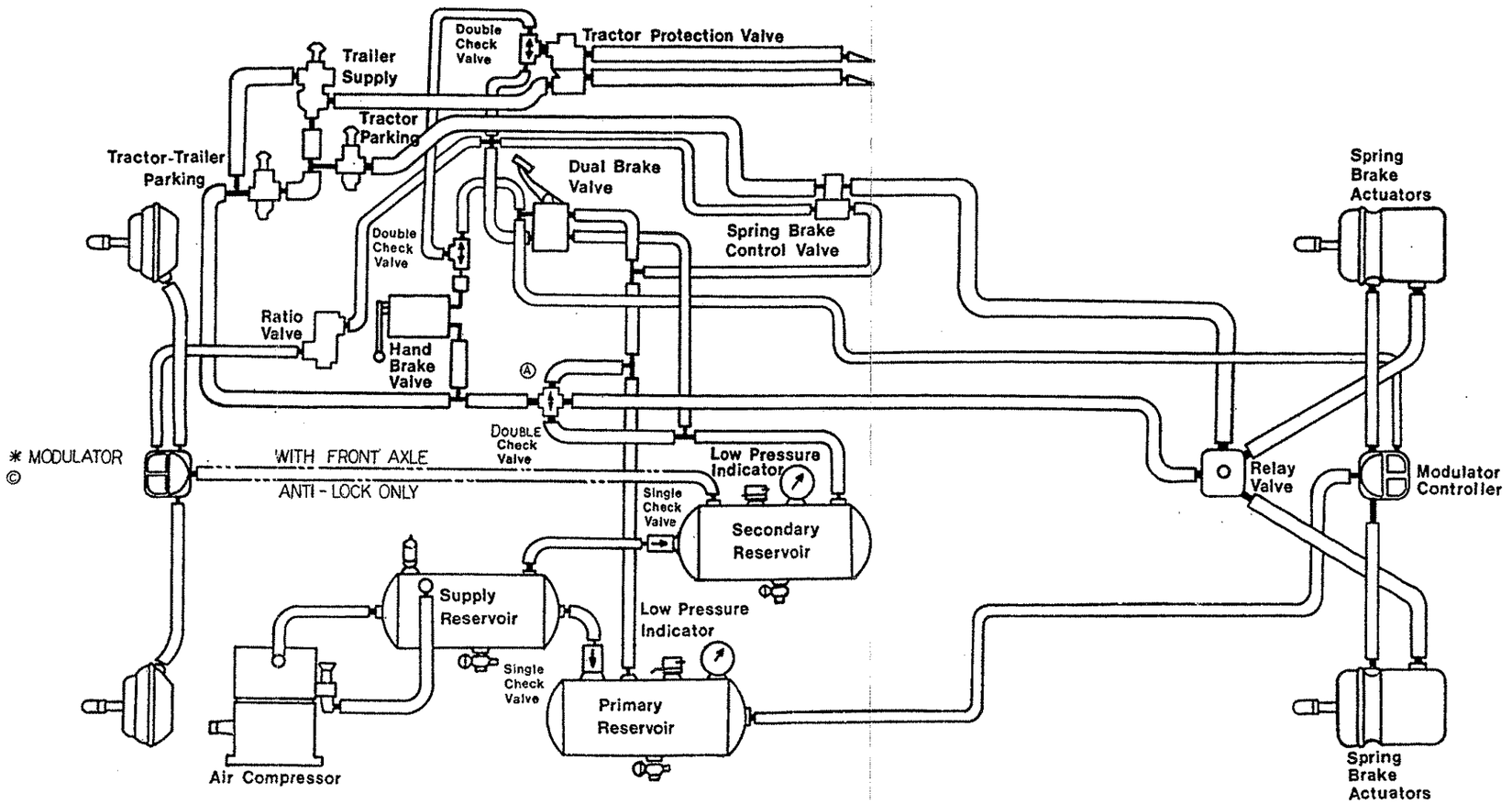
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9268-004	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
74	23-9434-061	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

CONVENTIONAL SINGLE DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

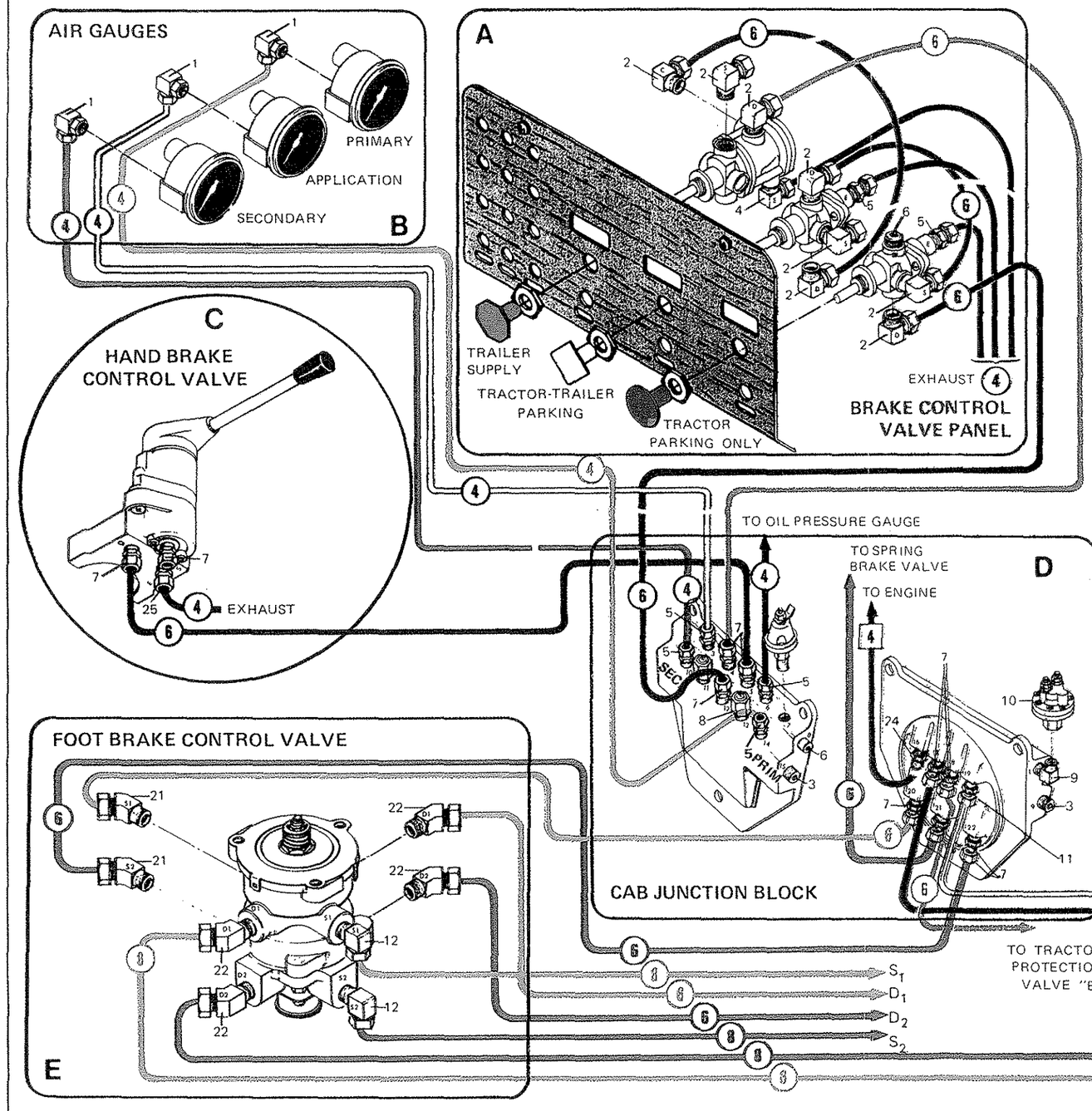
SCHEMATIC DIAGRAM D12-10498, CHG. LTR. C

FREIGHTLINER DUAL AIR BRAKE SYSTEM



* WITH FRONT AXLE ANTI - LOCK ONLY

©



	COLOR	DESCRIPTION	O.D. SIZE IN INCHES
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type3B	3/8
6	Red		
6	Orange		
6	Yellow		
8	Green		
6	White		
8	Black		1/2
8	Red		
8	Green		
4	Black	No. 4 hose assembly equiv. to SAE J1402 Type E	

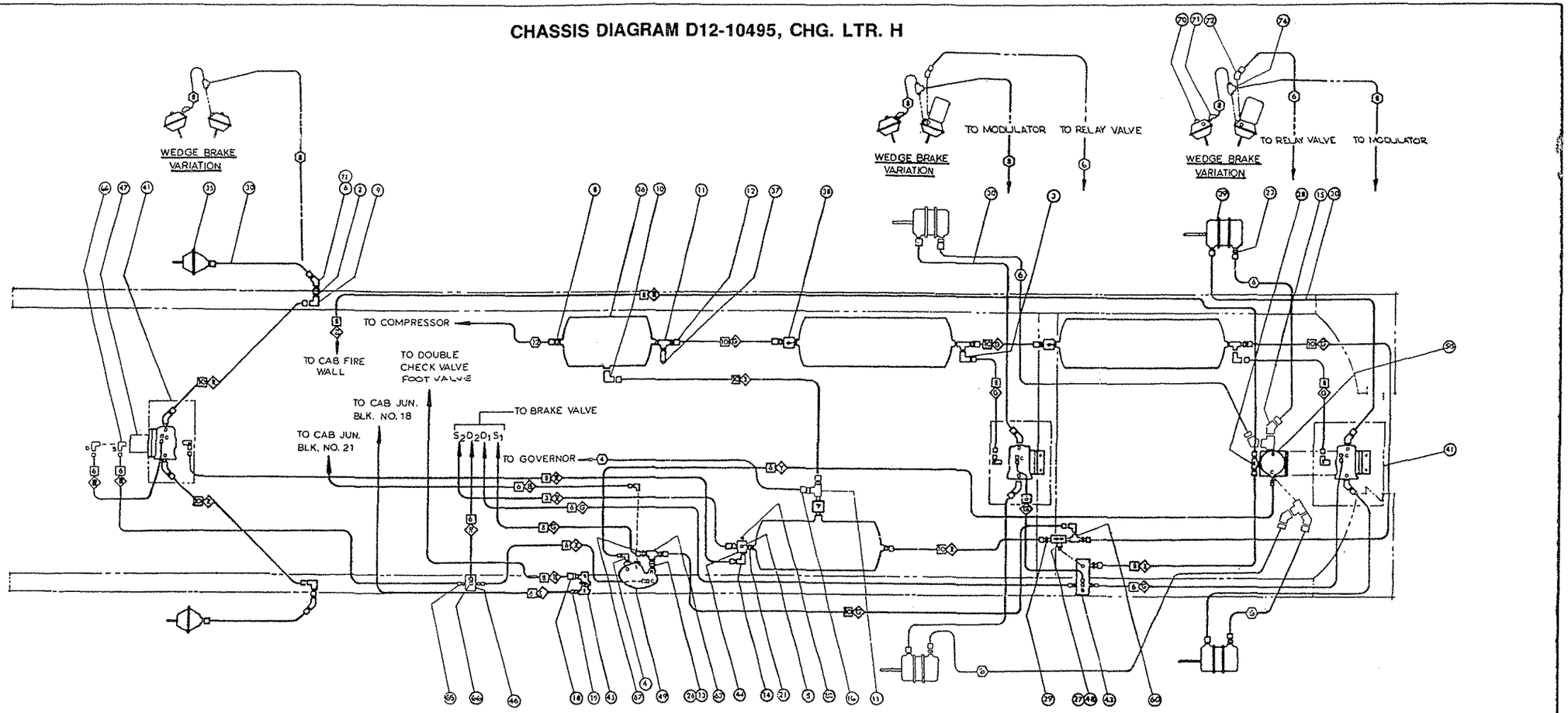
REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	Plug	1/4NPT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT - 3/8NT
8	Low Air Pressure Switch	——
9	90° Male Elbow	1/8NPT
10	Stoplight Switch	——
11	Male Coupling	1/8NPT - 3/8NT
12	90° Male Elbow	3/8NPT - 1/2NT
13	Male Coupling	3/8NPT - 3/8NT
14	Anchor Coupling	3/8NPT
15	Two-way Check Valve	——
16	Plug	3/8NPT
17	Connector	3/8NPT - 1/2NT
18	Male Coupling	3/8NPT - 1/2NT
19	45° Male Elbow	1/8NPT - 1/4NT
20	45° Male Elbow	1/4NPT - 3/8NT
21	45° Male Elbow	3/8NPT - 3/8NT
22	45° Male Elbow	3/8NPT - 1/2NT
23	Male Coupling	1/4NPT - 1/4NT
24	Male Connector	1/8NPT - 1/4Hose

CAB DIAGRAM

Cab Plumbing Conv. Truck D12-10499 ENG. CHG. LTR. A

CONVENTIONAL TANDEM DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CHASSIS DIAGRAM D12-10495, CHG. LTR. H



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1.			
2.	A12-10491-0	Anchor Coupling(3/8 NPT)	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	2
4	23-9295-007	90° Male Elbow (¼ NPT - 3/8 NT)	4
5	23-9268-004	Plug (3/8 NPT)	2
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7			
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-013	90° Male Elbow (¼ NPT - 3/8 NT)	1
11	12-10492-0	Street Tee-Special	4
12	23-9301-021	Male Coupling (½ NPT - 3/8 NT)	8
13	23-9309-002	Nipple (¼ NPT)	1
14	23-9295-011	90° Male Elbow (¼ NPT-½ NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-032	Male Conn., 45° Flare (⅝ NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	1
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	3
20	23-9268-008	Plug (½ NPT)	1
21	23-9530-008	Nipple, Hex. (¼ NPT)	1
22			
23	23-9327-031	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	4
24			
25			
26	23-9429-402	Reducer (¼ NPT - ⅛ NPT)	1
27	23-9530-106	Nipple Hex. (3/8NPT)	1
28	23-10318-006	Male Tee (3/8 NPT- ¼ NT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	A12-10545	Air Reservoire Inst.	1
37 (H)	(BW)234143	Air Safety Valve	1
38 (G)	WABCO/BAGS	Single Check Valve	3
39	See Rear Axle Assembly		
40			
41	M12-	See Anti-Lock Inst.	
42			
43	12-10439-0	Frame Jun. Block, Rear	1
44	12-10511-0	Air Reservoir Junc. Block	1
45	BW279000	T. P. Valve	1
46	12-10439-5	Frame Junction Block, Front	1
47	(RAC) A080960	Ratio Valve	1
48	(BW) 639 4	Two-Way Check Valve	1
49	(BW) 286344	Spring Brake Control Valve	1
50 (M)	WABCO #87...02	Relay Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
29	23-9301-020	Male Coupling (3/8 NPT-5/8 NT)	2
60	23-9313-003	Street Tee (3/8 NPT)	3
61			
62			
63	23-9693-008	Male Tee (1/2 NPT)	1
63	23-9301-018	Male Coupling (½ NPT - ½ NT)	
64	23-9295-008	90° MALE ELBOW (⅛ NPT-⅜ NT)	5
65	23-9301-013	M.COUPLING(⅜NPT-⅜NT)	3

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	6
(1)	A23-2232-L	Hose Assembly No. 4	
(6)	A23-2233-L	Hose Assembly No. 6	
(8)	A23-2234-L	Hose Assembly No. 8	
(10)	A23-2235-L	Hose Assembly No. 10	
(12)	A23-2236-L	Hose Assembly No. 12	
4	48-101-014	Nylon Tube No. 6 Yellow	
6	48-101-010	Nylon Tube No. 6 Black	
6	48-101-015	Nylon Tube No. 6 Green	
6	48-101-013	Nylon Tube No. 6 Orange	
6	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-025	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-035	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

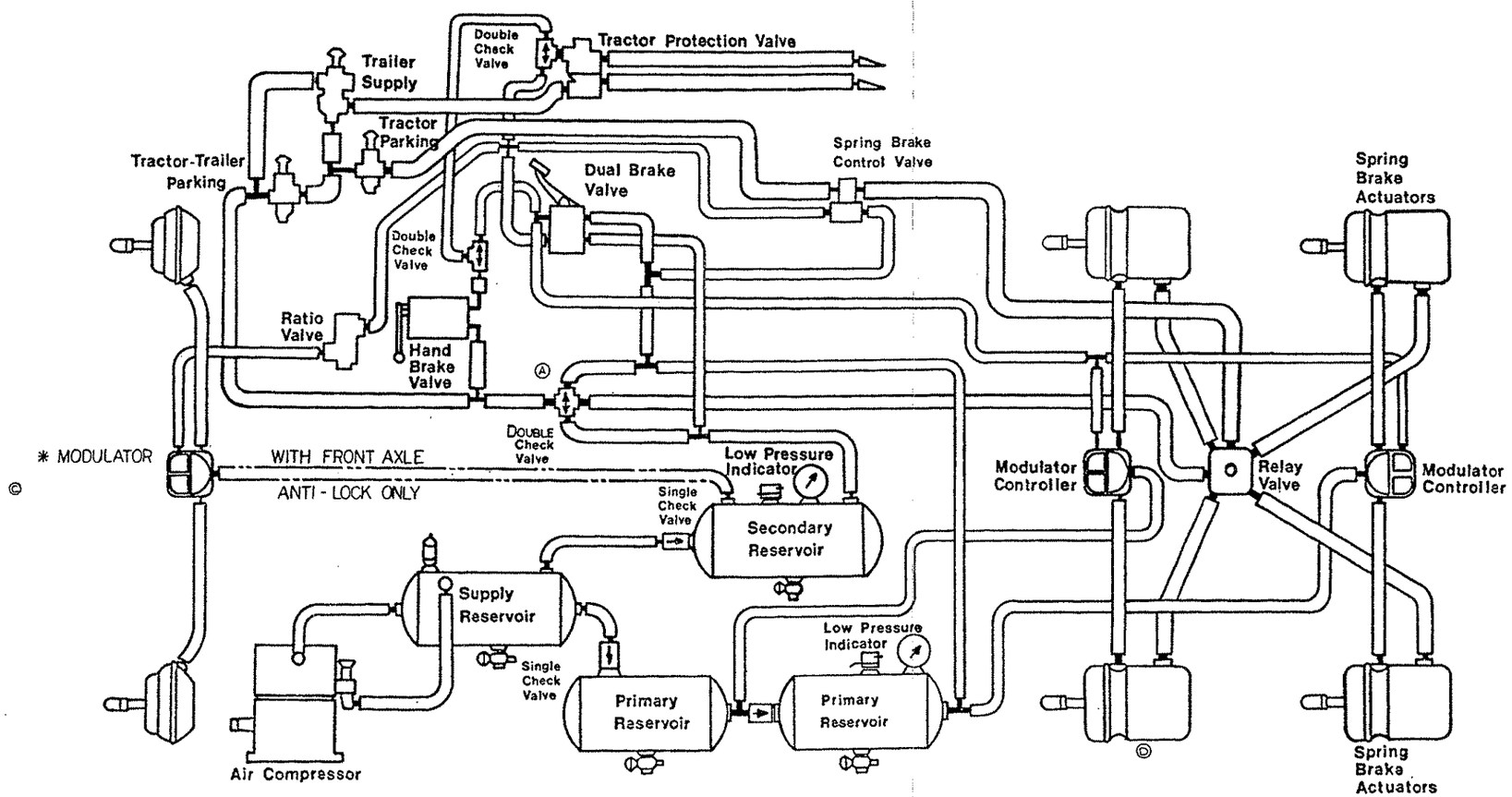
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9268-004	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ¼ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	6
73	23-9315-003	STREET TEE (3/8NPT)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

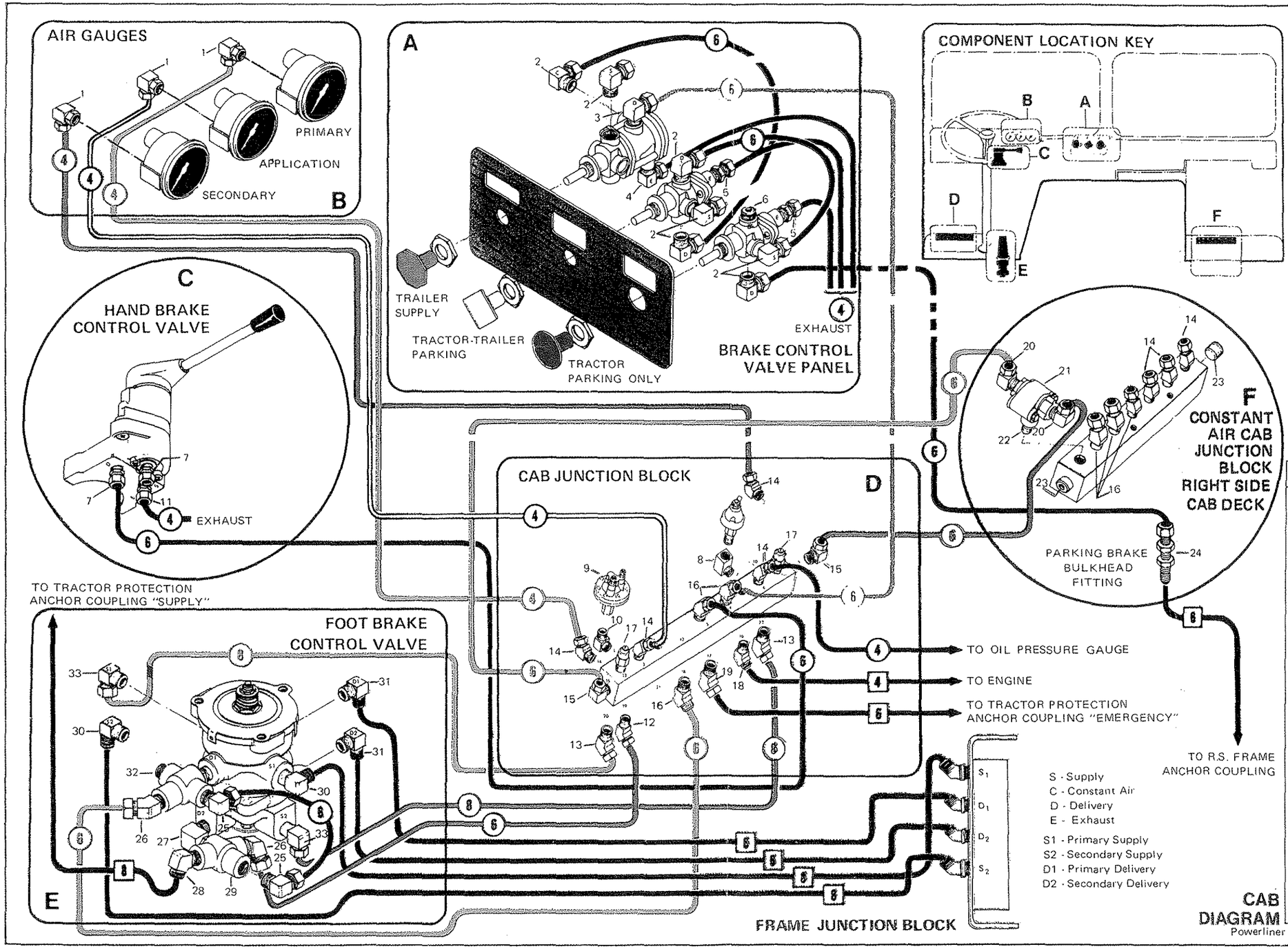
CONVENTIONAL TANDEM DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

SCHEMATIC DIAGRAM D12-10497, CHG. LTR. D

FREIGHTLINER DUAL AIR BRAKE SYSTEM



* WITH FRONT AXLE ANTI-LOCK ONLY



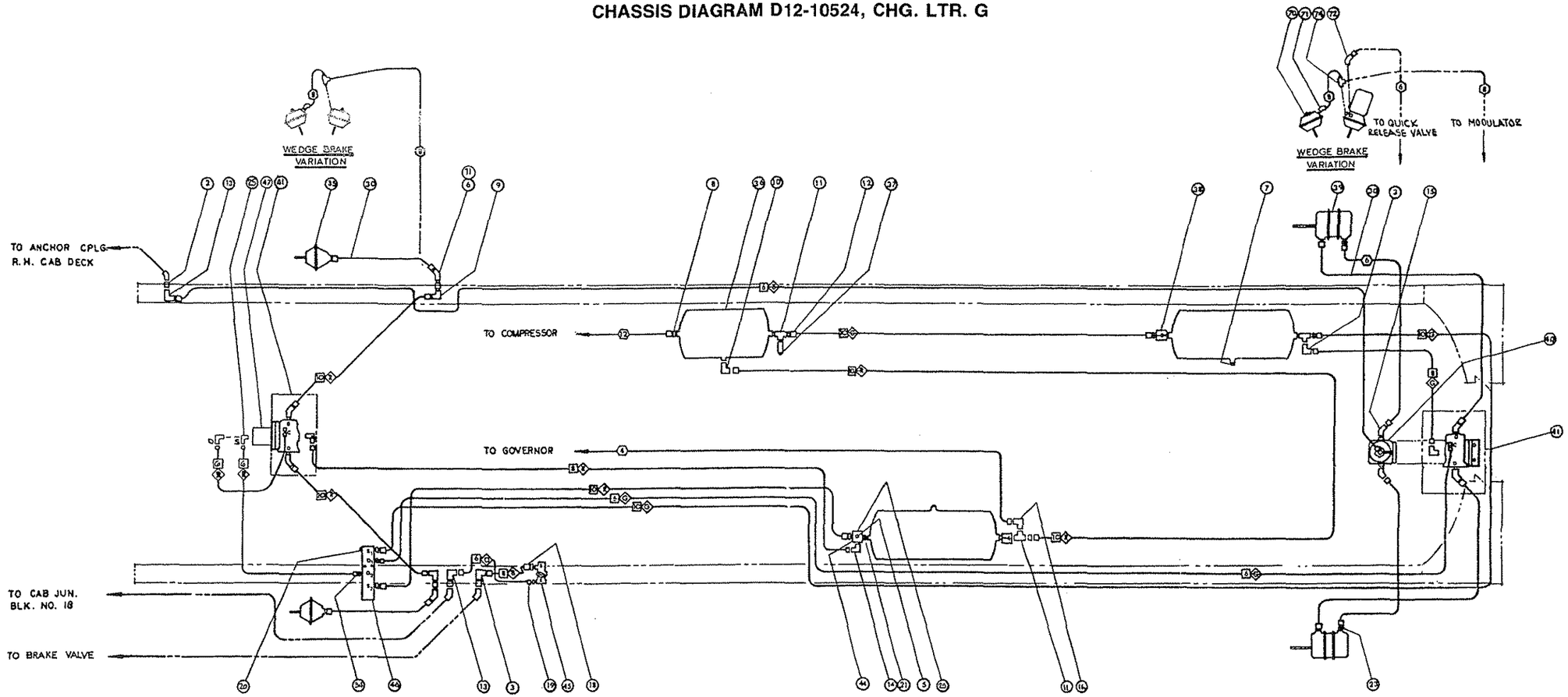
	COLOR	DESCRIPTION	O.D. SIZE IN
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6	Red		
6	Yellow		
6	Orange		
6	Green		
8	Red		1/2
8	Green		
4	Black	No. 4 hose assembly	
6	Black	No. 6 hose assembly	
8	Black	No. 8 hose assembly equiv. to SAE J1402 Type E	

REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT - 3/8NT
8	90° Street Elbow	1/8NPT
9	Stoplight Switch	——
10	90° Male Elbow	1/8NPT - 1/8NPT
11	Male Coupling	1/4NPT - 1/4 NT
12	45° Male Elbow	1/8NPT - 3/8NT
13	45° Male Elbow	3/8NPT - 1/2NT
14	45° Male Elbow	1/8NPT - 1/4NT
15	90° Male Elbow	1/4NPT - 3/8NT
16	45° Male Elbow	1/4NPT - 3/8NT
17	Low Air Pressure Switch	——
18	45° Male Elbow	1/8NPT - 1/4 Hose
19	45° Male Elbow	1/4NPT - 3/8 Hose
20	90° Male Elbow	3/8NPT - 3/8NT
21	Two-way Check Valve	——
22	Hex Nipple	3/8NPT
23	Plug	3/8NPT
24	Bulkhead Fitting 45° flare	3/8 Hose - 3/8NT
25	90° Male Elbow	3/8NPT - 3/8NT
26	45° Male Elbow	3/8NPT - 3/8NT
27	90° Street Elbow	3/8NPT
28	45° Male Elbow	3/8NPT - 1/2 Hose
29	Double Check Valve	——
30	90° Male Elbow	3/8NPT - 1/2 Hose
31	90° Male Elbow	3/8NPT - 3/8 Hose
32	Plug	3/8NPT
33	90° Male Elbow	3/8NPT - 1/2

Powerliner Tractor Cab D12-10551 ENG. CHG. LTR.—

POWERLINER SINGLE DRIVE TRACTOR, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CHASSIS DIAGRAM D12-10524, CHG. LTR. G



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	3
2	A12-10491-0	Anchor Coupling 3/8 NPT	5
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	2
4			
5	23-9268-004	Plug (3/8 NPT)	2
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9268-005	Plug (½NPT)	2
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	2
10	23-9495-015	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee - Special	3
12	23-9301-021	Male Coupling (½ NPT - 5/8 NT)	7
13	23-9295-008	Male Elbow (3/8 NPT-3/8 NT)	3
14	23-9295-011	90° Male Elbow (½PT-½NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9328-032	90° Male Elbow, 45° Flare (⅜ NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	1
19	23-9301-012	Male Coupling (½ NPT - 3/8 NT)	2
20	23-9268-003	Plug (½ NPT)	2
21	23-9530-008	Nipple, Hex (½ NPT)	1
22	23-9326-023	45° Male Elbow, 45° Flare (½ NPT - 3/8 Hose)	2
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	2

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
33	See Front Axle Assembly		
36	A12-10545	Air Reservoirs Inst.	
37	(BW)284141	Air Safety Valve	1
(F) 38	(WIL)WM774	Single Check Valve	2
39	See Rear Axle Assembly		
40	(BW)229859	Quick Release Valve	1
41	A12-	See Anti-Lock Inst.	
42			
43			
44	12-10511-0	Jun. Blk. Air Reservoir	1
45	BW 279000	T. P. Valve	1
46	12-10458-0	Frame Junction Block, Front	1
47	(WAG) AD8050	Ratio Valve	1
25	23-9295-008	90° M. ELBOW(⅜NPT-⅜NT)	2
34	23-9301-013	M. COUPLING(⅜NPT-⅜NT)	1

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	4
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6	48-101-010	Nylon Tube No. 6 Black	
6	48-101-011	Nylon Tube No. 6 Green	
6	48-101-013	Nylon Tube No. 6 Orange	
6	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-021	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-031	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

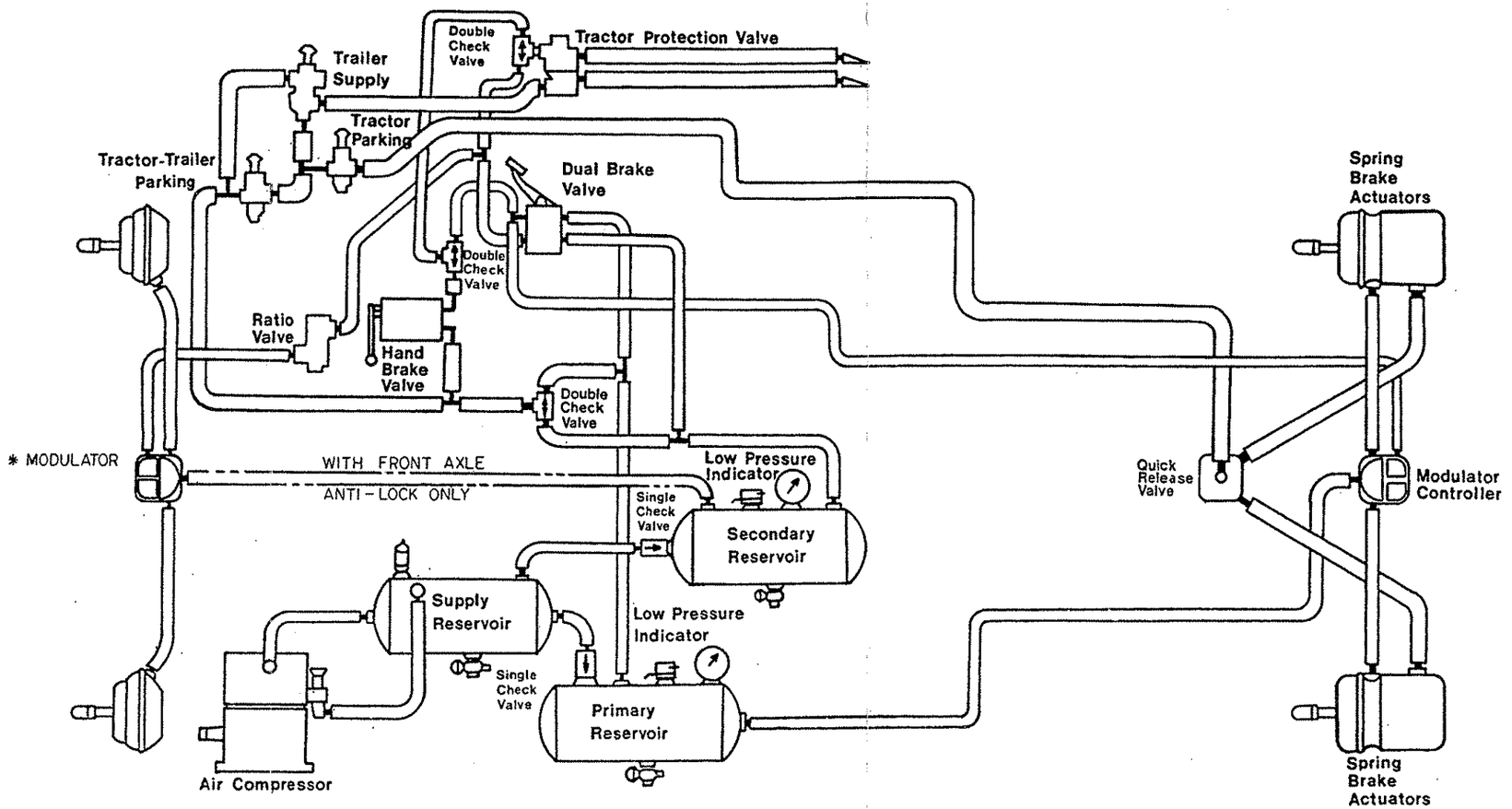
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9268-004	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
74	23-9494-061	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

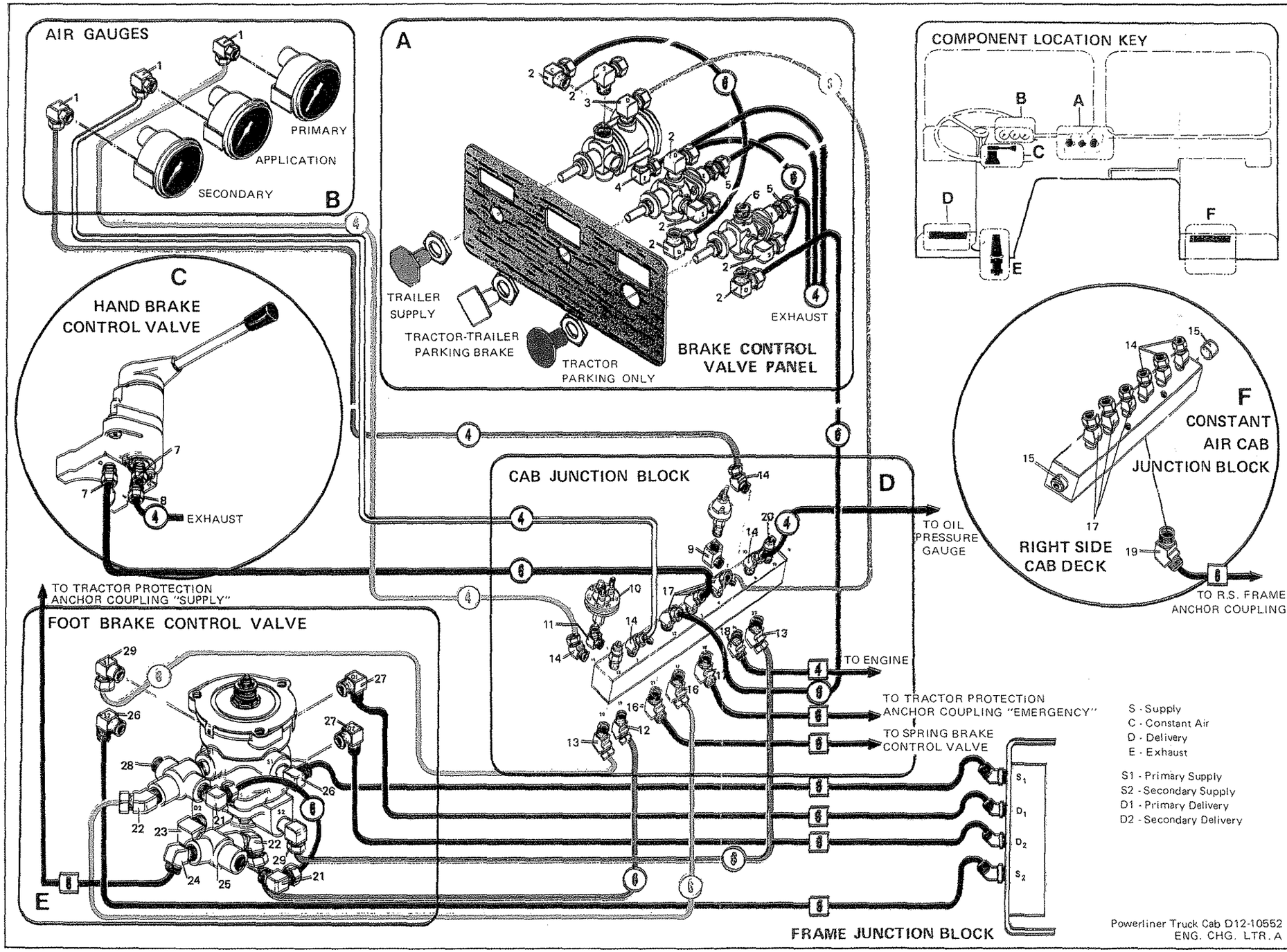
POWERLINER SINGLE DRIVE TRACTOR, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

SCHEMATIC DIAGRAM D12-10515, CHG LTR. B

FREIGHTLINER DUAL AIR BRAKE SYSTEM



* WITH FRONT AXLE ANTI-LOCK ONLY

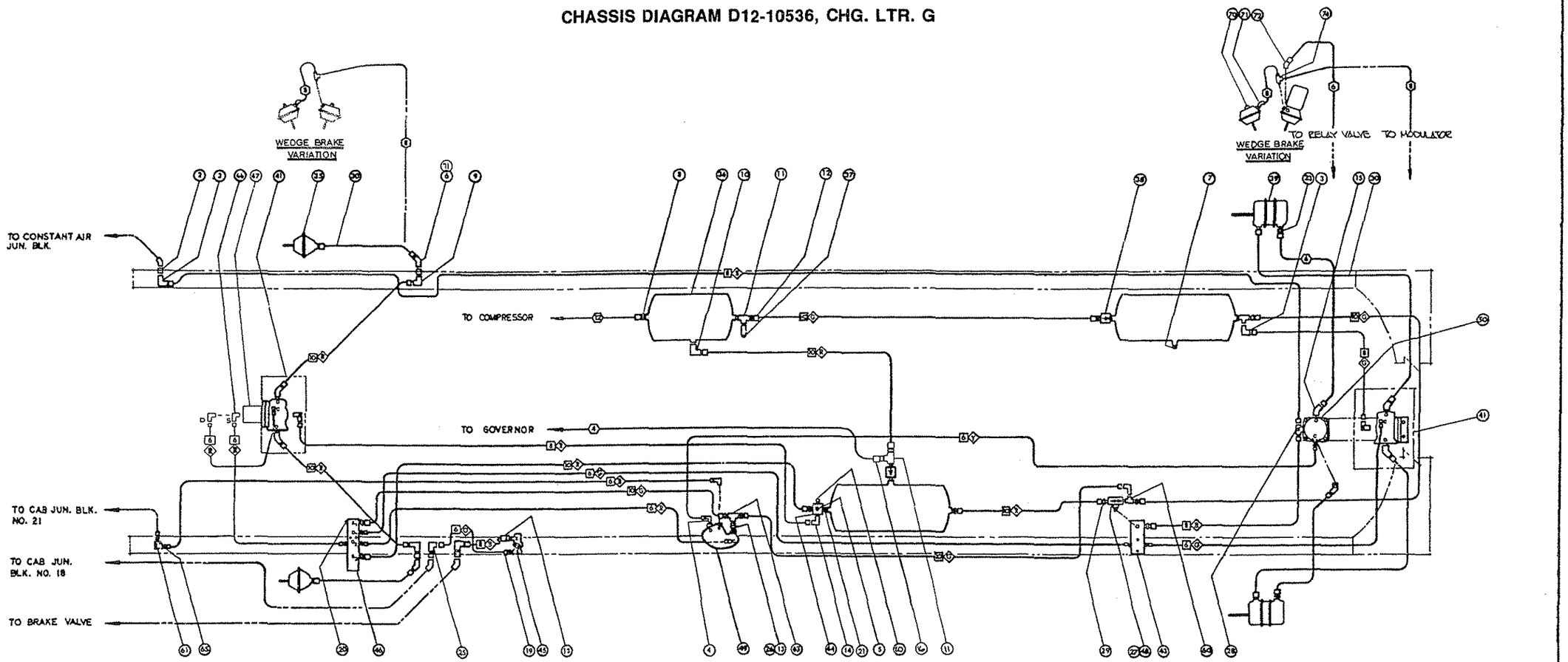


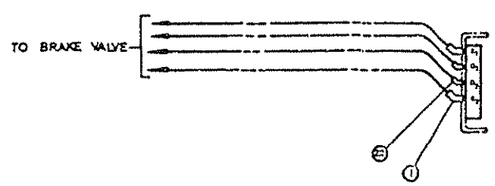
	COLOR	DESCRIPTION	O.D. SIZE IN INCHES
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6	Red		
6	Yellow		
6	Orange		
6	Green		
6	Red		1/2
4	Black	No. 4 hose assembly	
6	Black	No. 6 hose assembly	
8	Black	No. 8 hose assembly equiv. to SAE J1402 Type E	

REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4 NPT - 3/8NT
8	Male Coupling	1/4NPT - 1/4NT
9	90° Street Elbow	1/8NPT
10	Stoplight Switch	——
11	90° Male Elbow	1/8NPT
12	45° Male Elbow	1/8NPT - 3/8NT
13	45° Male Elbow	3/8NPT - 1/2NT
14	45° Male Elbow	1/8NPT - 1/4NT
15	Plug	3/8NPT
16	45° Male Elbow	1/4NPT 3/8 Hose
17	45° Male Elbow	1/4NPT - 3/8NT
18	45° Male Elbow	1/8NPT - 1/4 Hose
19	45° Male Elbow	3/8NPT - 3/8 Hose
20	Low Air Pressure Switch	——
21	90° Male Elbow	3/8NPT - 3/8NT
22	45° Male Elbow	3/8NPT - 3/8NT
23	90° Street Elbow	3/8NPT
24	45° Male Elbow	3/8NPT - 1/2 Hose
25	Double Check Valve	——
26	90° Male Elbow	3/8NPT - 1/2 Hose
27	90° Male Elbow	3/8NPT - 3/8 Hose
28	Plug	3/8NPT
29	90° Male Elbow	3/8NPT - 1/2NT

POWERLINER SINGLE DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CHASSIS DIAGRAM D12-10536, CHG. LTR. G





FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	3
2	A11-10491-0	Anchor Coupling 3/8 NPT	5
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	3
4	23-9295-007	90° Male Elbow (½ NPT - 3/8 NT)	5
5	23-9368-004	Plug (3/8 NPT)	2
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9268-005	Plug (½NPT)	1
8	23-9327-044	Male Connector, 45° Flare (3/8 NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 3/8 NT)	3
10	23-9295-015	90° Male Elbow (½ NPT - 3/8 NT)	1
11	12-10482-0	Street Tee-Special	5
12	23-9301-021	Male Coupling (½ NPT - 3/8 NT)	10
13	23-9309-002	Nipple (½ NPT)	1
14	23-9295-011	90 Male Elbow (½NPT-½NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-032	Male Conn., 45° Flare (⅝ NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	2
19	23-9301-012	Male Coupling (½ NPT _ 3/8 NT)	5
20	23-9368-003	Plug (½ NPT)	2
21	23-9330-008	Nipple, Hex (½ NPT)	1
22	23-9326-023	45° Male Elbow, 45° Flare (½ NPT - 3/8 Hose)	2
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	3
24			
25	23-9295-008	90° Male Elbow (3/8 NPT-3/8 LT)	1
26	23-9429-402	Reducer (½ NPT - ¼ NPT)	1
27	23-9530-106	Nipple Hex. (3/8 NPT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	A12-10545	Air Reservoirs Inst.	1
37	(BW)284143	Air Safety Valve	1
(F) 38	(WAL) WM 774	Single Check Valve	2
39	See Rear Axle Assembly		
40			
41	A12-	See Anti-Lock Inst.	
42			
43	12-10559-1	Frame Jun. Block, Rear	1
44	12-10511-0	Jun. Blk. Air Reservoir	1
45	BW279000	P. P. Valve	1
46	12-10434-1	Frame Junc. Block, Front	1
47	(WAG) AD80-4SO	Ratio Valve	1
48	(BW) 639 A	Two-Way Check Valve	1
49	(BW) 284164	Spring Brake Control Valve	1
50	(BW) E9415O	Relay Valve	1

Fittings

28	23-10318-006	Male Tee (3/8 NPT-½ NT)	1
29	23-9101-020	Male Coupling (3/8 NPT-3/8 NT)	2
60	23-9313-002	Street Tee (3/8 NPT)	1
61	23-9436-003	Elbow, Anchor (3/8 NPT	1
62			
63	23-9593-008	Male Tee (½ NPT)	1
65	23-9101-013	Male Coupling (3/8 NPT- 3/8 NT)	3
44	23-9295-008	90° MALE ELBOW (⅜NPT-½LT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	4
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8.	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6 Y	48-101-014	Nylon Tube No. 6 Yellow	
6 B	48-101-010	Nylon Tube No. 6 Black	
6 G	48-101-015	Nylon Tube No. 6 Green	
6 O	48-101-013	Nylon Tube No. 6 Orange	
6 R	48-101-012	Nylon Tube No. 6 Red	
8 B	48-101-020	Nylon Tube No. 8 Black	
8 G	48-101-025	Nylon Tube No. 8 Green	
8 R	48-101-022	Nylon Tube No. 8 Red	
10 G	48-101-03.	Nylon Tube No. 10 Green	
10 R	48-101-032	Nylon Tube No. 10 Red	

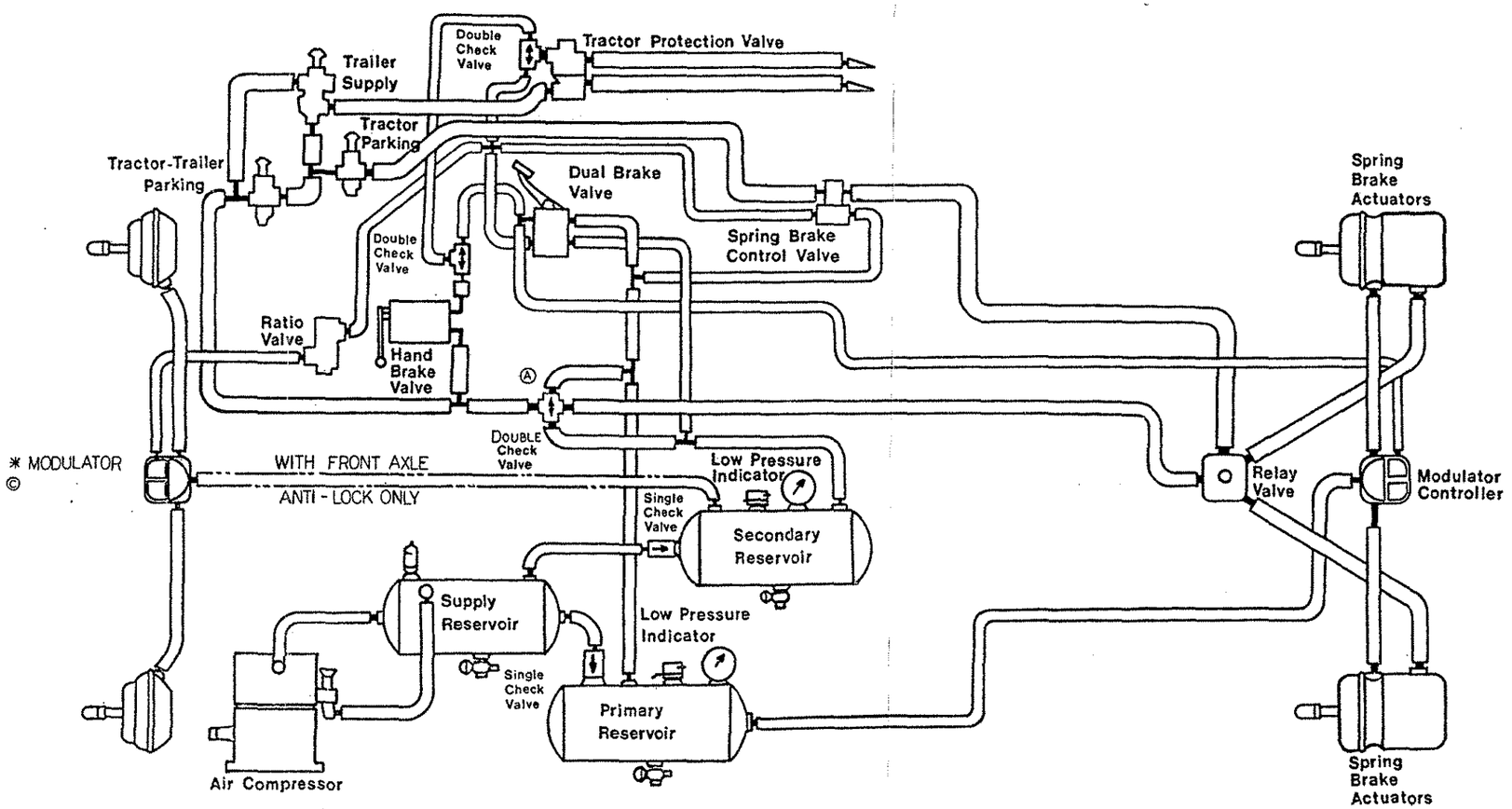
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9268-004	Plug (3/8 NPT)	4
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

POWERLINER SINGLE DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

SCHEMATIC DIAGRAM D12-10498, CHG. LTR. C

FREIGHTLINER DUAL AIR BRAKE SYSTEM



* WITH FRONT AXLE ANTI - LOCK ONLY

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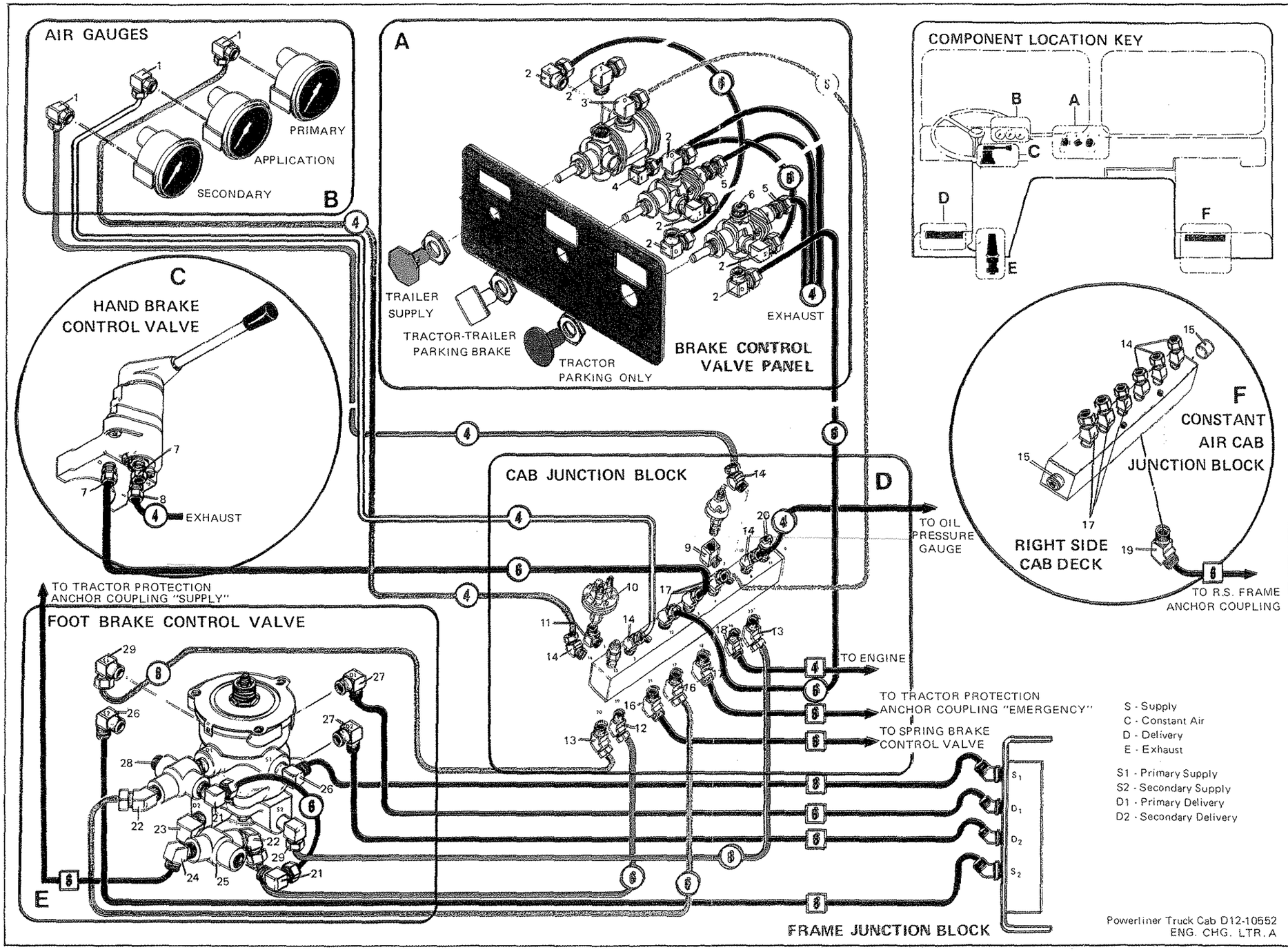


S - Supply
C - Constant Air
D - Delivery
E - Exhaust

S1 - Primary Supply
S2 - Secondary Supply
D1 - Primary Delivery
D2 - Secondary Delivery

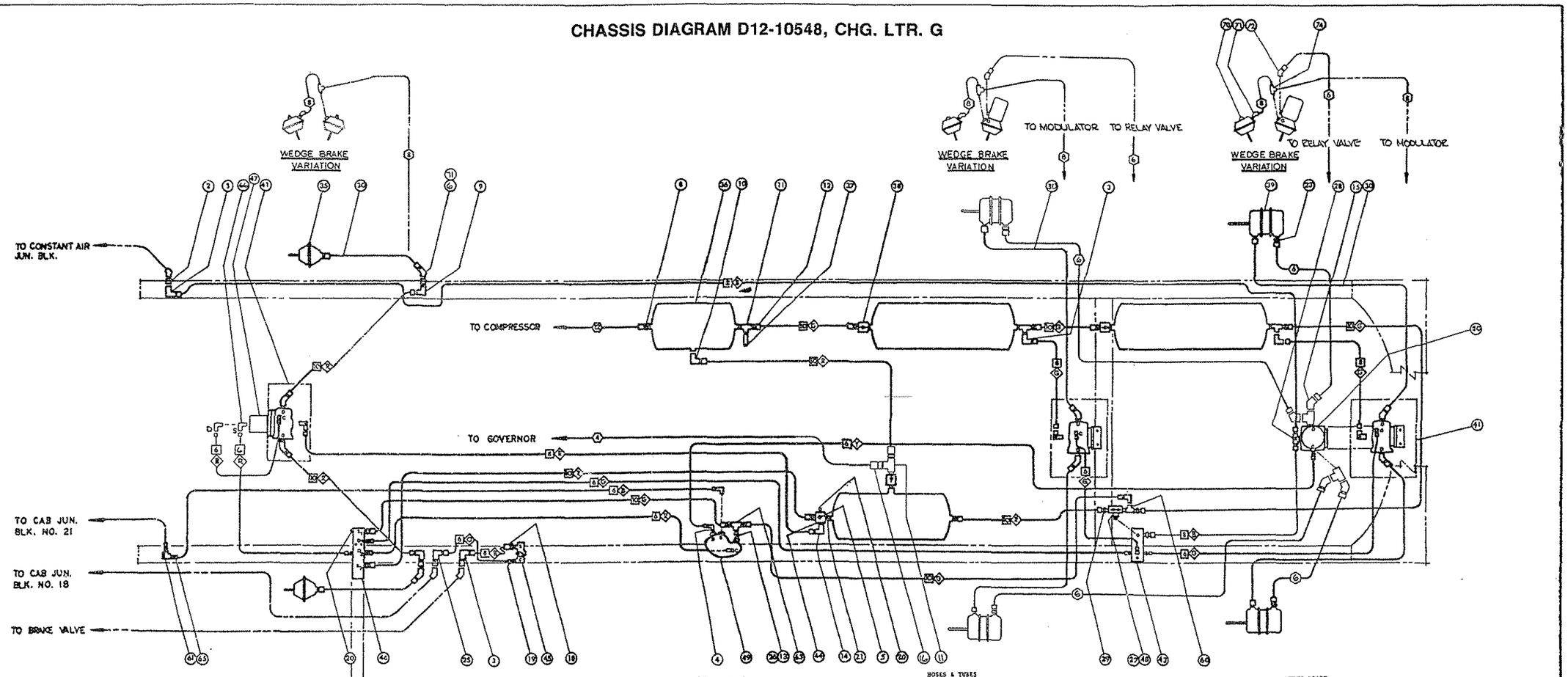
	COLOR	DESCRIPTION	O.D. SIZE IN INCHES
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6	Red		
6	Yellow		
6	Orange		
6	Green		
8	Red		1/2
4	Black	No. 4 hose assembly	
6	Black	No. 6 hose assembly	
8	Black	No. 8 hose assembly equiv. to SAE J1402 Type E	

REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4 NPT - 3/8NT
8	Male Coupling	1/4NPT - 1/4NT
9	90° Street Elbow	1/8NPT
10	Stoplight Switch	——
11	90° Male Elbow	1/8NPT
12	45° Male Elbow	1/8NPT - 3/8NT
13	45° Male Elbow	3/8NPT - 1/2NT
14	45° Male Elbow	1/8NPT - 1/4NT
15	Plug	3/8NPT
16	45° Male Elbow	1/4NPT 3/8 Hose
17	45° Male Elbow	1/4NPT - 3/8NT
18	45° Male Elbow	1/8NPT - 1/4 Hose
19	45° Male Elbow	3/8NPT - 3/8 Hose
20	Low Air Pressure Switch	——
21	90° Male Elbow	3/8NPT - 3/8NT
22	45° Male Elbow	3/8NPT - 3/8NT
23	90° Street Elbow	3/8NPT
24	45° Male Elbow	3/8NPT - 1/2 Hose
25	Double Check Valve	——
26	90° Male Elbow	3/8NPT - 1/2 Hose
27	90° Male Elbow	3/8NPT - 3/8 Hose
28	Plug	3/8NPT
29	90° Male Elbow	3/8NPT - 1/2NT

Powerliner Truck Cab D12-10552
ENG. CHG. LTR. A

POWERLINER TANDEM DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

CHASSIS DIAGRAM D12-10548, CHG. LTR. G



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1.	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	3
2	A12-10491-0	Anchor Coupling (3/8 NPT)	1
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	1
4	23-9295-007	90° Male Elbow (¼ NPT - 3/8 NT)	4
5	23-9268-004	Plug (3/8 NPT)	2
6	23-9511-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7			
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-013	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee-Special	4
12	23-9101-021	Male Coupling (½ NPT - 5/8 NT)	12
13	23-9309-002	Nipple (½ NPT)	1
14	23-9295-011	90° Male Elbow (½ NPT-½ NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	6
16	23-9327-012	Male Conn., 45° Flare (⅜ NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	2
19	23-9301-012	Male Coupling (½ NPT - 3/8 NT)	5
20	23-9268-003	Plug (½ NPT)	1
21	23-9530-008	Nipple, Hex. (½ NPT)	1
22	23-9326-023	45° Male Elbow, 45° Flare (½ NPT - 3/8 Hose)	2
23	23-9327-013	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	5
24			
25	23-9295-008	90° Male Elbow (3/8 NPT-3/8 NT)	1
26	23-9215-402	Reducer (¼ NPT - ⅛ NPT)	1
27	23-9530-106	Nipple Hex (1/8NPT)	1
28	23-10318-008	Male Tee (3/8 NPT- ⅜ NT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35		See Front Axle Assembly	
36	K12-10545	Air Reservoir Inst.	1
37	(BW)284143	Air Safety Valve	1
38	(WIL) WM77-4	Single Check Valve	3
39		See Rear Axle Assembly	
40			
41	K12-	See Anti-Lock Inst.	
42			
43	12-10439-0	Frame Jun. Block, Rear	1
44	12-10511-0	Air Reservoir Junc. Block	1
45	BW279000	T. P. Valve	1
46	12-10438-1	Frame Junction Block, Front	1
47	(WAC) A2801-5-0	Ratio Valve	1
48	(WH) 679 A	Two-Way Check Valve	1
49	(BW) 286344	Spring Brake Control Valve	1
50	(BW) 279720	Relay Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
29	23-9302-020	Male Coupling (3/8 NPT-3/8 NT)	2
60	23-9313-003	Street Tee (3/8 NPT)	3
61	23-9496-003	Elbow, Anchor (3/8 NPT)	1
62			
63	23-9693-008	Male Tee (1/2 NPT)	1
64			
65	23-9301-013	Male Coupling (3/8 NPT-3/8 NT)	5
66	23-9276-008	90° Male Elbow (⅜ NPT-⅜ NPT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	6
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6	48-101-014	Nylon Tube No. 6 Yellow	
6	48-101-010	Nylon Tube No. 6 Black	
6	48-101-015	Nylon Tube No. 6 Green	
6	48-101-013	Nylon Tube No. 6 Orange	
6	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-025	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-035	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

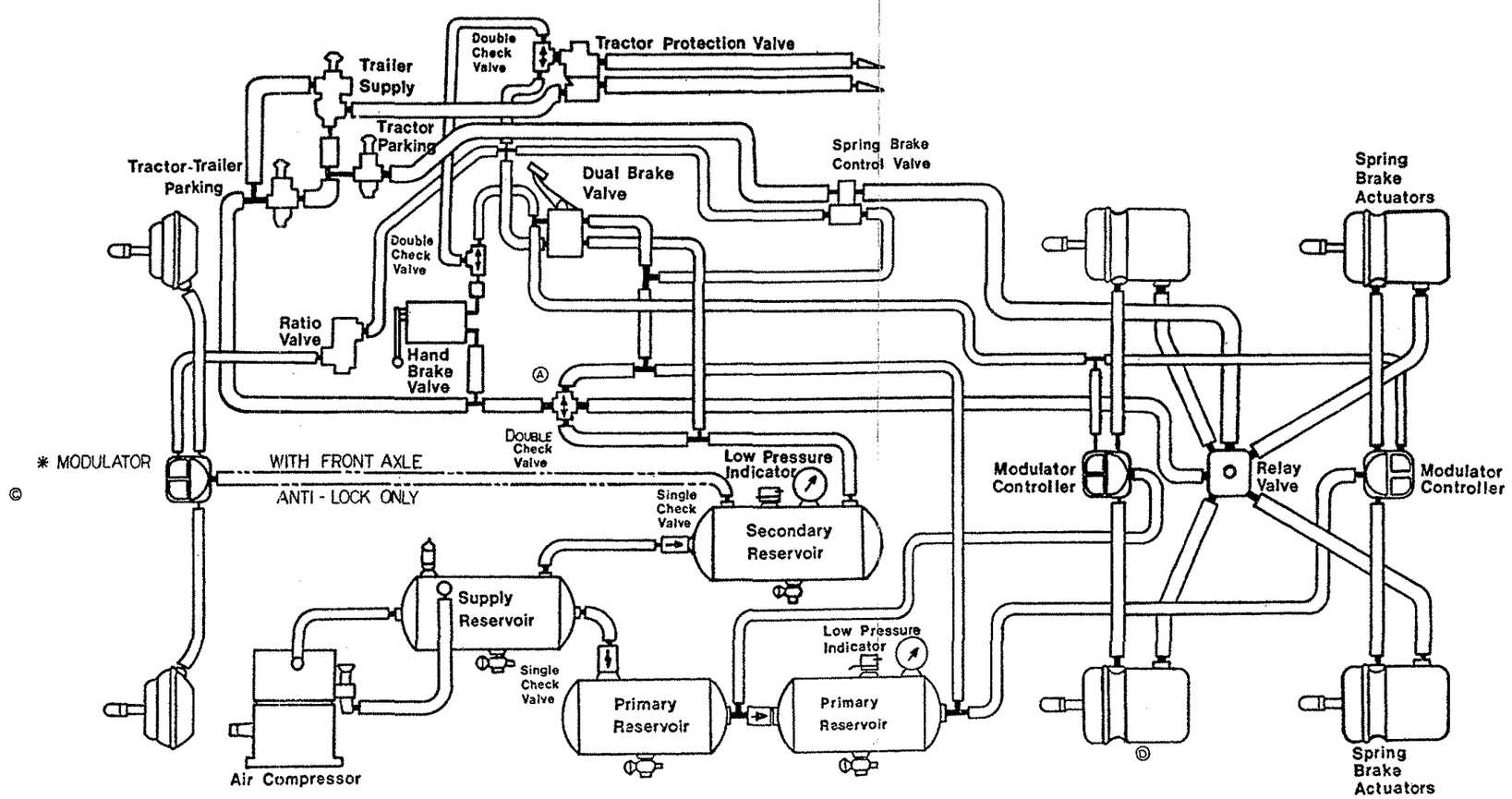
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9268-004	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	8
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	8
73	23-9313-003	STREET TEE (⅜ NPT)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

POWERLINER TANDEM DRIVE TRUCK, W/DUAL AIR BRAKES, PLUMBING DIAGRAM (FMVSS 121)

SCHEMATIC DIAGRAM D12-10497, CHG. LTR. D

FREIGHTLINER DUAL AIR BRAKE SYSTEM



* WITH FRONT AXLE ANTI-LOCK ONLY

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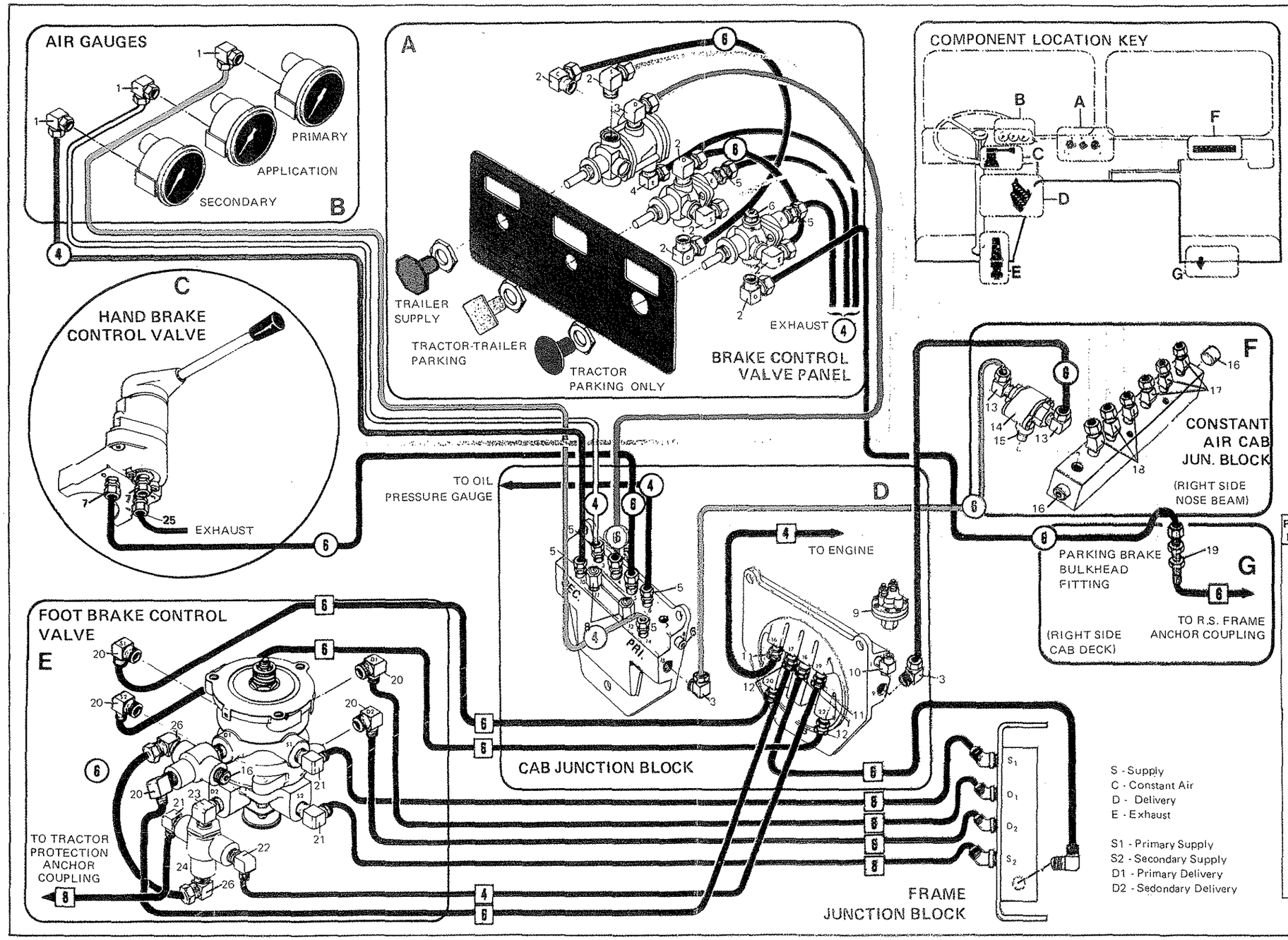
AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. SINGLE DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12664



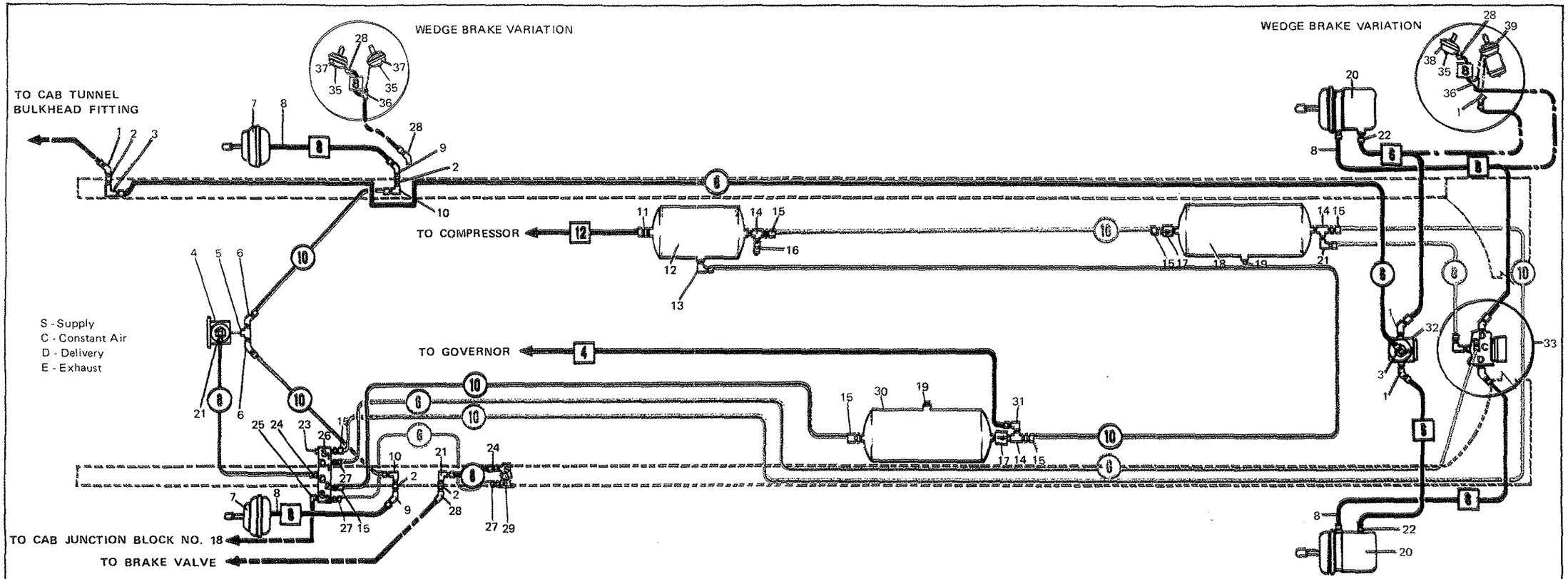
	COLOR	DESCRIPTION	O.D. SIZE IN INCHES
4	Black	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
4	Red		
4	Green		
4	White		
6	Black	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6	Red		
6	Yellow		
6	Orange		
6	Green		
4	Black	No. 4 hose assembly	
6	Black	No. 6 hose assembly	
8	Black	No. 8 hose assembly equiv. to SAE J1402 Type E	

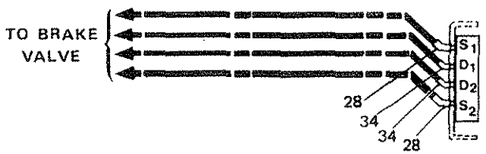
REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT 3/8NT
8	Low Air Pressure Switch	——
9	Stoplight Switch	——
10	90° Male Elbow	1/8NPT
11	Male Connector 45° flare	1/8NPT - 1/4
12	Male Connector 45° flare	1/4NPT - 3/8
13	90° Male Elbow	3/8NPT - 3/8NT
14	Two-way Check Valve	——
15	Hex Nipple	3/8NPT
16	Plug	3/8NPT
17	45° Male Elbow	1/8NPT - 1/4NT
18	45° Male Elbow	1/4NPT - 3/8NT
19	Bulkhead Fitting	3/8flare - 3/8NT
20	90° Male Elbow	3/8NPT - 3/8
21	90° Male Elbow	3/8NPT - 1/2
22	90° Male Elbow	3/8NPT - 1/4
23	90° Street Elbow	3/8NPT
24	Double Check Valve	——
25	Male Coupling	1/4NPT - 1/4NT
26	90° Male Elbow	3/8NPT - 3/8NT

CAB DIAGRAM
COE Tractor D12-10513 ENG. CHG. LTR. C

AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. SINGLE DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12664





S1 - Primary Supply
S2 - Secondary Supply
D1 - Primary Delivery
D2 - Secondary Delivery

REF NO	DESCRIPTION	SIZE
1	45° Male Elbow, 45° Flare	3/8 NPT - 3/8 Hose
2	Anchor Coupling	3/8 NPT
3	90° Male Elbow	3/8 NPT - 3/8 NT
4	Ratio Valve	—
5	Tee, Male Branch	3/8 NPT
6	45° Male Elbow	3/8 NPT - 5/8 NT
7	Front Axle Serv. Chamb.	—
8	Air Brake Hose Assembly	—
9	45 Street Elbow	3/8 NPT - 3/8 NPT
10	90° Male Elbow	3/8 NPT - 5/8 NT
11	Male Connector, 45° Flare	1/2 NPT - 3/4 Hose
12	Air Reservoir (Supply)	—
13	90° Male Elbow	1/2 NPT - 5/8 NT

REF NO	DESCRIPTION	SIZE
14	Street Tee - Special	—
15	Male Coupling	1/2 NPT - 5/8 NT
16	Air Safety Valve	—
17	Single Check Valve	—
18	Air Reservoir (Primary)	—
19	Plug	1/2 NPT
20	Rear Axle Serv. & Park. Chamb.	—
21	90° Male Elbow	3/8 NPT - 1/2 NT
22	Male Connector, 45° Flare	3/8 NPT - 3/8 Hose
23	Plug	1/4 NPT
24	Male Coupling	3/8 NPT - 1/2 NT
25	90° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
26	Frame Junction Block (Front)	—

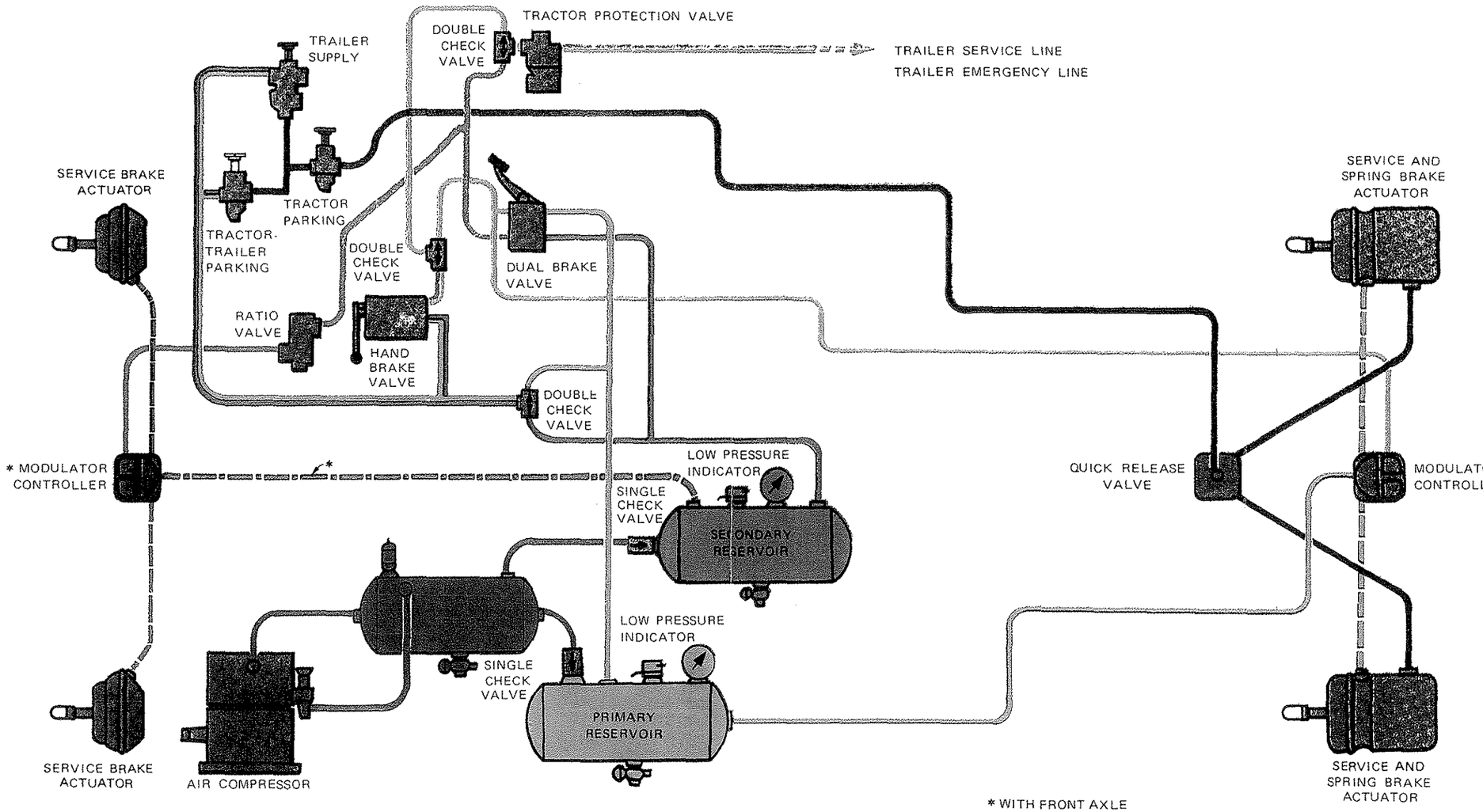
REF NO	DESCRIPTION	SIZE
27	Male Coupling	1/4 NPT - 3/8 NT
28	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
29	Tractor Protection Valve	—
30	Air Reservoir (Secondary)	—
31	90° Male Elbow, 45° Flare	3/8 NPT - 1/4 Hose
32	Quick Release Valve	—
33	See Antilock Diagram	—
34	45° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
35	Plug	3/8 NPT
36	Male Run Tee, 45° Flare	3/8 NPT - 1/2 Hose
37	Front Axle Serv. Chamb.	—
38	Rear Axle Serv. Chamb.	—
39	Rear Axle Serv. & Park. Chamb.	—

	DESCRIPTION	O.D. SIZE IN INCHES
6	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
6		
6		
6		
8		1/2
8		
8		
10		5/8
10		

	DESCRIPTION
4	No. 4 hose assembly
6	No. 6 hose assembly
8	No. 8 hose assembly
10	No. 10 hose assembly
12	No. 12 hose assembly equiv. to SAE J1402 Type E

CHASSIS DIAGRAM
C.O.E. Single Tractor D12-10705
ENG. CHG. LTR. A

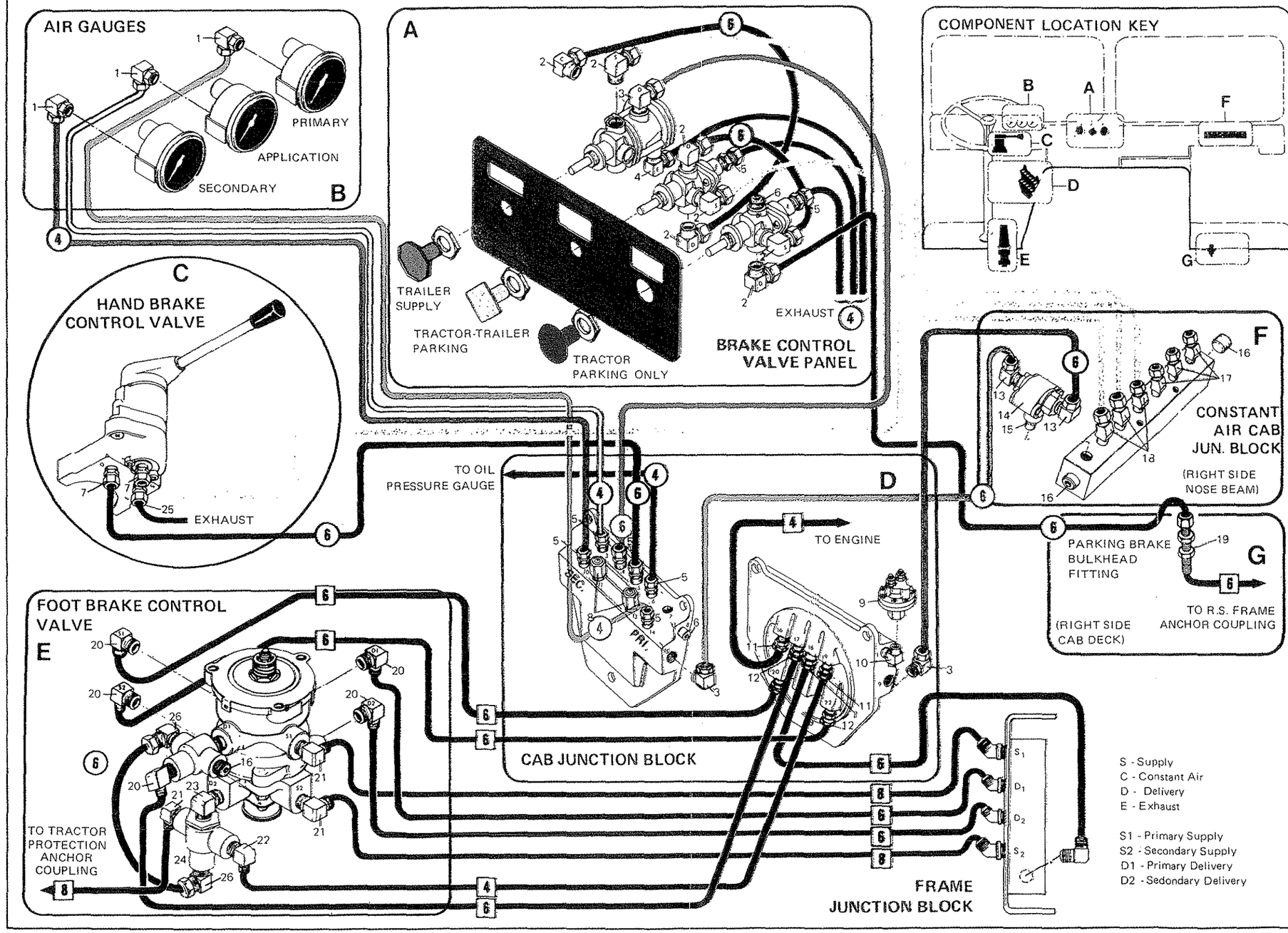
AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. SINGLE DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK



SCHEMATIC DIAGRAM
Single Tractor Air Brake (D12-10515)
ENG. CHG. LTR. B

AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. TANDEM DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12666



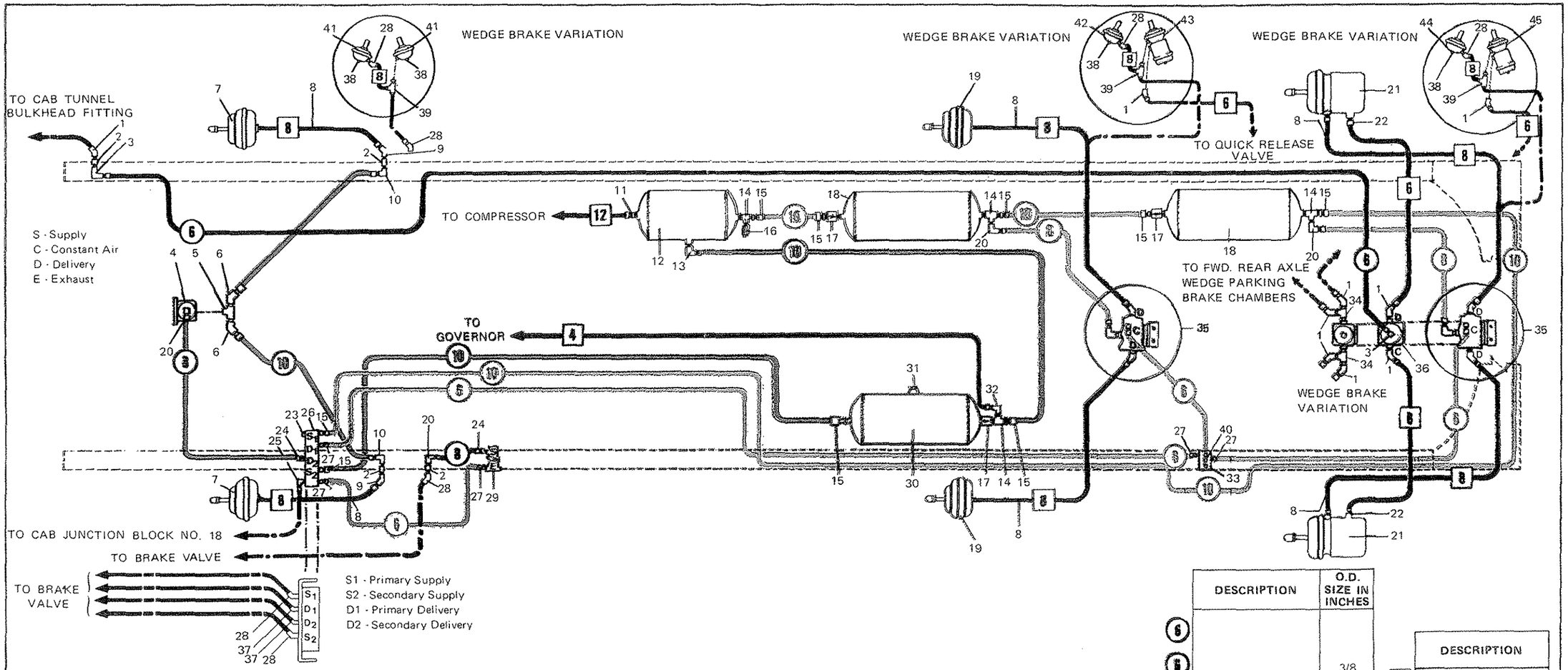
	COLOR	DESCRIPTION	O.D. SIZE IN INCHES
4	Black Red Green White	Air brake system nylon tubing (mono const.) equiv. to SAE J844 Type 3A	1/4
6	Black Red Yellow Orange Green	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
4	Black	No. 4 hose assembly	
6	Black	No. 6 hose assembly	
8	Black	No. 8 hose assembly equiv. to SAE J1402 Type E	

REF NO	DESCRIPTION	SIZE
1	90° Female Elbow	1/8NPT - 1/4NT
2	90° Male Elbow	1/8NPT - 3/8NT
3	90° Male Elbow	1/4NPT - 3/8NT
4	90° Male Elbow	1/4NPT - 1/4NT
5	Male Coupling	1/8NPT - 1/4NT
6	Plug	1/8NPT
7	Male Coupling	1/4NPT 3/8NT
8	Low Air Pressure Switch	——
9	Stoplight Switch	——
10	90° Male Elbow	1/8NPT
11	Male Connector 45° flare	1/8NPT - 1/4
12	Male Connector 45° flare	1/4NPT - 3/8
13	90° Male Elbow	3/8NPT - 3/8NT
14	Two-way Check Valve	——
15	Hex Nipple	3/8NPT
16	Plug	3/8NPT
17	45° Male Elbow	1/8NPT - 1/4NT
18	45° Male Elbow	1/4NPT - 3/8NT
19	Bulkhead Fitting	3/8flare - 3/8NT
20	90° Male Elbow	3/8NPT - 3/8
21	90° Male Elbow	3/8NPT - 1/2
22	90° Male Elbow	3/8NPT - 1/4
23	90° Street Elbow	3/8NPT
24	Double Check Valve	——
25	Male Coupling	1/4NPT - 1/4NT
26	90° Male Elbow	3/8NPT - 3/8NT

CAB DIAGRAM
COE Tractor D12-10513 ENG.CHG.LTR. C

AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. TANDEM DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12666



REF NO	DESCRIPTION	SIZE
1	45° Male Elbow, 45° Flare	3/8 NPT - 3/8 Hose
2	Anchor Coupling	3/8 NPT
3	90° Male Elbow	3/8 NPT - 3/8 NT
4	Ratio Valve	———
5	Tee, Male Branch	3/8 NPT
6	45° Male Elbow	3/8 NPT - 5/8 NT
7	Front Axle Service Chamber	———
8	Air Brake Hose Assembly	———
9	45° Street Elbow	3/8 NPT - 3/8 NPT
10	90° Male Elbow	3/8 NPT - 5/8 NT
11	Male Connector, 45° Flare	1/2 NPT - 3/4 Hose
12	Air Reservoir (Supply)	———
13	90° Male Elbow	1/2 NPT - 5/8 NT
14	Street Tee - Special	———
15	Male Coupling	1/2 NPT - 5/8 NT

REF NO	DESCRIPTION	SIZE
16	Air Safety Valve	———
17	Single Check Valve	———
18	Air Reservoir (Primary)	———
19	Forward Rear Axle Service Chamber	———
20	90° Male Elbow	3/8 NPT - 1/2 NT
21	Rear Rear Axle Serv. & Park. Chamb.	———
22	Male Connector, 45° Flare	3/8 NPT - 3/8 Hose
23	Plug	1/4 NPT
24	Male Coupling	3/8 NPT - 1/2 NT
25	90° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
26	Frame Junction Block (Front)	———
27	Male Coupling	1/4 NPT - 3/8 NT
28	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
29	Tractor Protection Valve	———
30	Air Reservoir (Secondary)	———

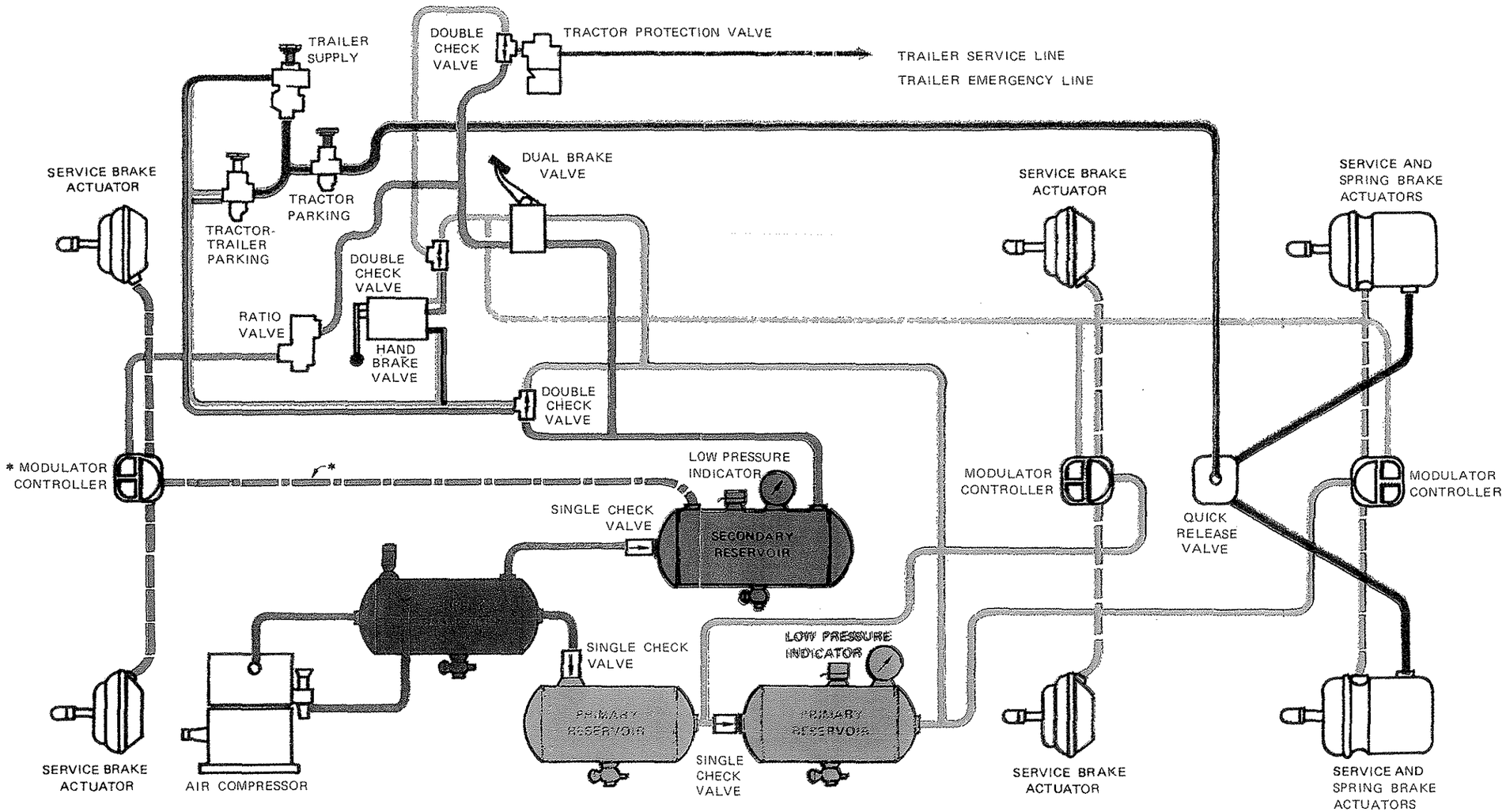
REF NO	DESCRIPTION	SIZE
31	Plug	1/2 NPT
32	90° Male, 45° Flare	3/8 NPT - 1/4 Hose
33	Frame Junction Block (Rear)	———
34	Street Tee	3/8 NPT
35	See Antilock Diagram	———
36	Quick Release Valve	———
37	45° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
38	Plug	3/8 NPT
39	Male Run Tee, 45° Flare	3/8 NPT - 1/2 Hose
40	90° Male Elbow	1/4 NPT - 3/8 NT
41	Front Axle Service Chamb.	———
42	Forward Rear Axle Serv. Chamb.	———
43	Fwd. Rear Axle Serv. & Park. Chamb.	———
44	Rear Rear Axle Serv. Chamb.	———
45	Rear Rear Axle Serv. & Park. Chamb.	———

	DESCRIPTION	O.D. SIZE IN INCHES
6 6 6 6 8 8 8 10 10	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 38	3/8
		1/2
		5/8

	DESCRIPTION
4	No. 4 hose assembly
6	No. 6 hose assembly
8	No. 8 hose assembly
10	No. 10 hose assembly
12	No. 12 hose assembly equiv. to SAE J1402 Type E

CHASSIS DIAGRAM
C.O.E. Tandem Tractor
D12-10727 ENG. CHG. LTR. A

AIR PLUMBING DIAGRAM (FMVSS 121)
C.O.E. TANDEM DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK



COLOR KEY

- Supply System Air Pressure
- Primary System Air Pressure
- Primary System Application Control Air Pressure
- Primary System Service Brake Application Air Pressure
- Secondary System Air Pressure
- Secondary System Application Control Air Pressure
- Primary or Secondary System Air Pressure
- Secondary System Service Brake Application Air Pressure
- Primary or Secondary System Application Control Air Pressure
- Trailer Air Supply System
- Tractor Parking Brake System
- Secondary System Air Pressure With Front Axle Antilock Only

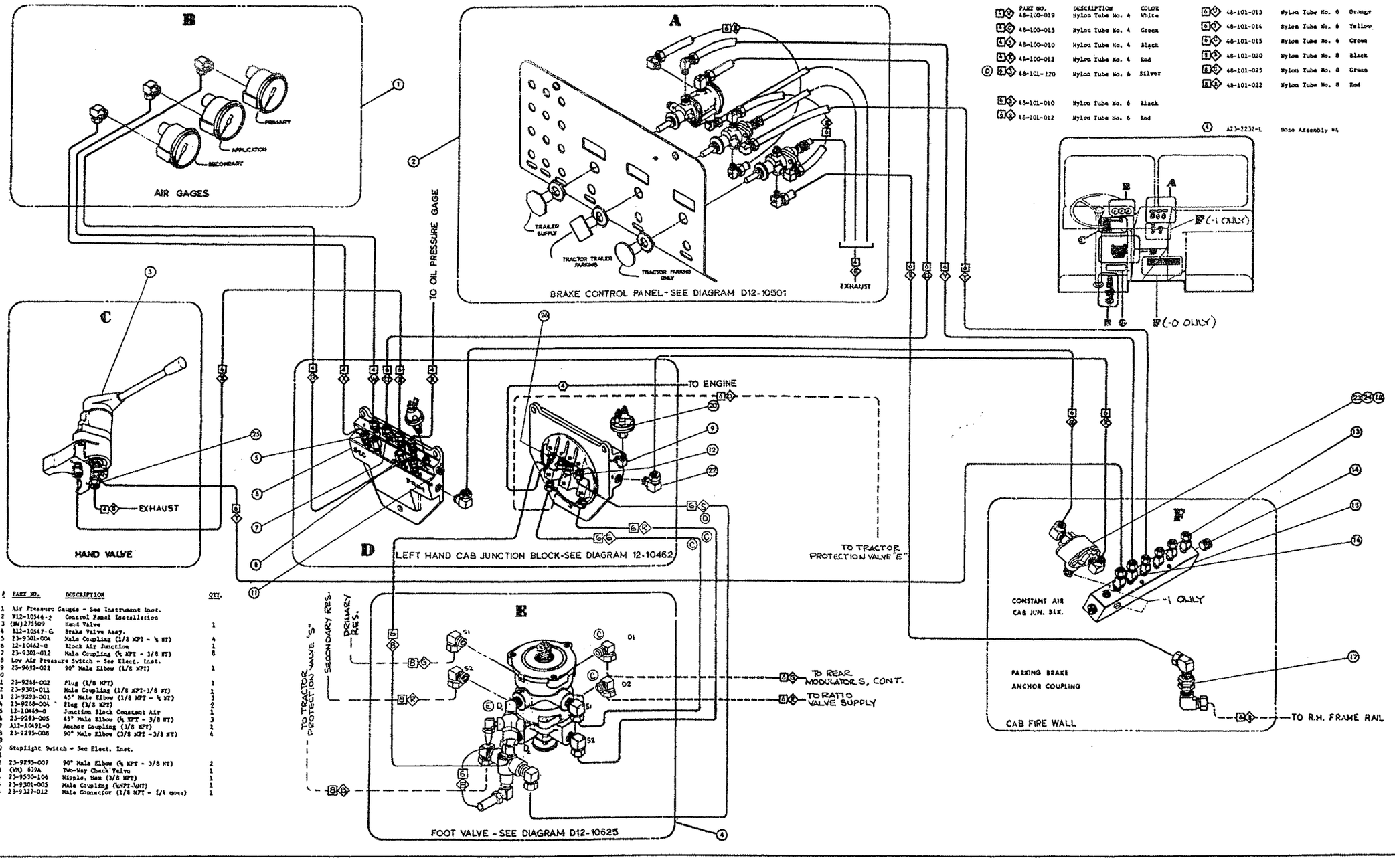
* WITH FRONT AXLE ANTILOCK ONLY

SCHEMATIC DIAGRAM
Tandem Tractor Air Brake (D12-10514)
ENG. CHG. LTR. B

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL SINGLE DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12672

CAB DIAGRAM D12-10677, CHG. LTR. E



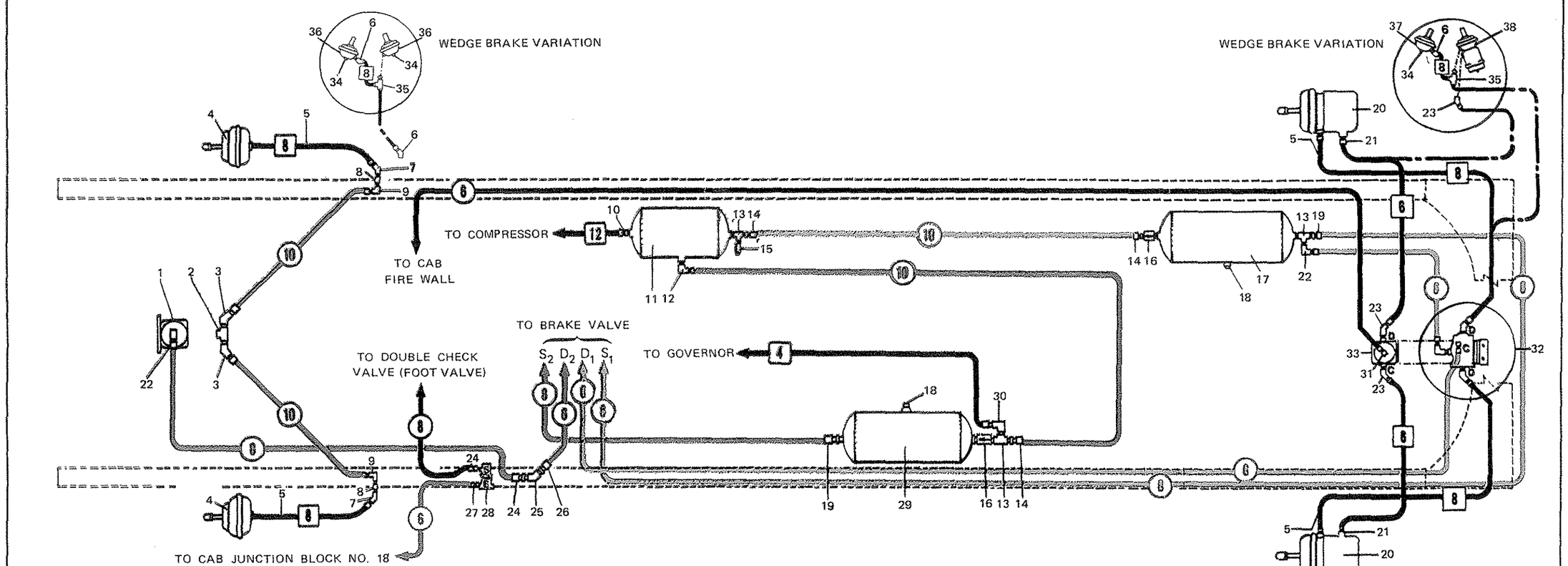
TUBES AND HOSES

	PART NO.	DESCRIPTION	COLOR
A	48-100-019	Nylon Tube No. 4	White
A	48-100-013	Nylon Tube No. 4	Green
A	48-100-010	Nylon Tube No. 4	Black
A	48-100-012	Nylon Tube No. 4	Red
D A	48-101-120	Nylon Tube No. 6	Silver
A	48-101-010	Nylon Tube No. 6	Black
A	48-101-012	Nylon Tube No. 6	Red
A	48-101-013	Nylon Tube No. 6	Orange
A	48-101-014	Nylon Tube No. 6	Yellow
A	48-101-015	Nylon Tube No. 6	Green
A	48-101-020	Nylon Tube No. 8	Black
A	48-101-025	Nylon Tube No. 8	Green
A	48-101-022	Nylon Tube No. 8	Red
4	A23-2232-1	Hose Assembly #4	

#	PART NO.	DESCRIPTION	QTY.
1	Air Pressure Gauges - See Instrument Inst.		
2	M12-10546-2	Control Panel Installation	
3	(BW)275509	Hand Valve	1
4	A12-10547-G	Brake Valve Assy.	
5	23-9301-004	Male Coupling (1/8 NPT - ¼ HT)	4
6	12-10462-0	Block Air Junction	1
7	23-9301-012	Male Coupling (¼ NPT - 3/8 HT)	8
8	Low Air Pressure Switch - See Elect. Inst.		
9	23-9692-022	90° Male Elbow (1/8 NPT)	1
10			
11	23-9258-002	Plug (1/8 NPT)	1
12	23-9301-011	Male Coupling (1/8 NPT-3/8 HT)	1
13	23-9293-001	45° Male Elbow (1/8 NPT - ¼ HT)	3
14	23-9258-004	Plug (3/8 NPT)	2
15	12-10469-0	Junction Block Constant Air	1
16	23-9293-005	45° Male Elbow (¼ NPT - 3/8 HT)	3
17	A12-10491-0	Anchor Coupling (3/8 NPT)	1
18	23-9295-008	90° Male Elbow (3/8 NPT -3/8 HT)	4
19			
20	Stoplight Switch - See Elect. Inst.		
21			
22	23-9293-007	90° Male Elbow (¼ NPT - 3/8 HT)	2
23	(WO) 639A	Two-Way Check Valve	1
24	23-9530-106	Nipple, Hex (3/8 NPT)	1
25	23-9301-005	Male Coupling (½NPT-¼NT)	1
26	23-9327-012	Male Connector (1/8 NPT - 1/4 tube)	1

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL SINGLE DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12672



REF NO	DESCRIPTION	SIZE
1	Ratio Valve	—
2	Tee, Male Branch	3/8 NPT
3	45° Male Elbow	3/8 NPT - 5/8 NT
4	Front Axle Service Chamber	—
5	Air Brake Hose Assembly	—
6	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
7	45° Street Elbow	3/8 NPT - 3/8 NPT
8	Anchor Coupling	3/8 NPT
9	90° Male Elbow	3/8 NPT - 5/8 NT
10	Male Connector, 45° Flare	1/2 NPT - 3/4 Hose
11	Air Reservoir (Supply)	—
12	90° Male Elbow	1/2 NPT - 5/8 NT
13	Street Tee-Special	—
14	Male Coupling	1/2 NPT - 5/8 NT
15	Air Safety Valve	—
16	Single Check Valve	—
17	Air Reservoir (Primary)	—
18	Plug	1/2 NPT
19	Male Coupling	1/2 NPT - 1/2 NT

REF NO	DESCRIPTION	SIZE
20	Rear Axle Serv. & Parking Chamb.	—
21	Male Connector 45° Flare	3/8 NPT - 3/8 Hose
22	90° Male Elbow	3/8 NPT - 1/2 NT
23	45° Male Elbow, 45° Flare	3/8 NPT - 3/8 Hose
24	Male Coupling	3/8 NPT - 1/2 NT
25	Anchor Elbow	3/8 NPT
26	Male Coupling	3/8 NPT - 3/8 NT
27	Male Coupling	1/4 NPT - 3/8 NT
28	Tractor Protection Valve	—
29	Air Supply (Secondary)	—
30	90° Male Elbow, 45° Flare	3/8 NPT - 1/4 Hose
31	90° Male Elbow	3/8 NPT - 3/8 NT
32	See Antilock Diagram	—
33	Quick Release Valve	—
34	Plug	3/8 NPT
35	Male Run Tee, 45° Flare	3/8 NPT - 1/2 Hose
36	Front Axle Service Chamber	—
37	Rear Axle Service Chamber	—
38	Rear Axle Serv. & Parking Chamb.	—

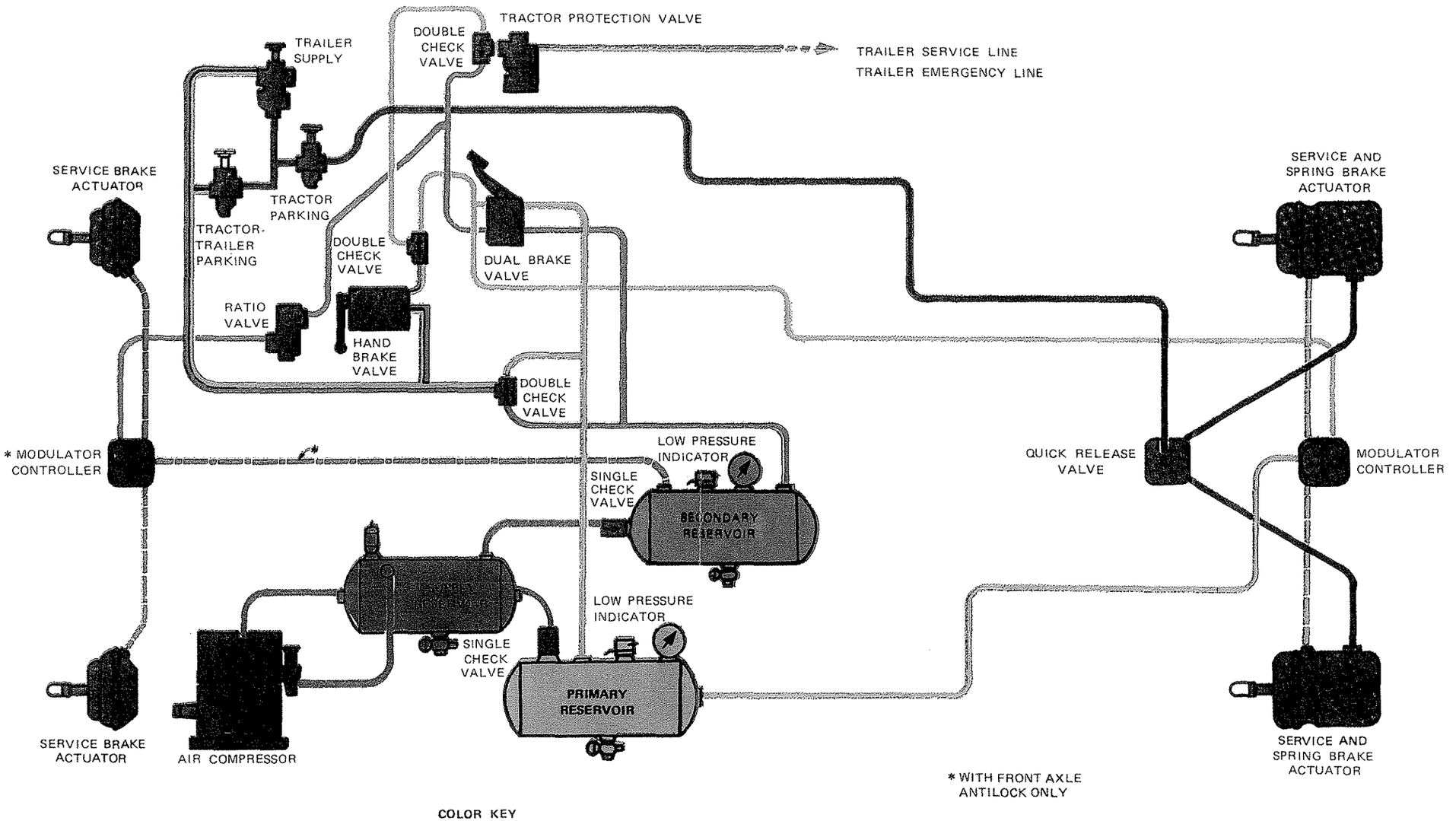
	DESCRIPTION	O.D. SIZE IN INCHES
6, 8, 6, 0	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 3B	3/8
9, 8, 4		1/2
10, 12		5/8

S - Supply
C - Constant Air
D - Delivery
E - Exhaust
S1 - Primary Supply
S2 - Secondary Supply
D1 - Primary Delivery
D2 - Secondary Delivery

	DESCRIPTION
4	No. 4 hose assembly
6	No. 6 hose assembly
8	No. 8 hose assembly
10	No. 10 hose assembly
12	No. 12 hose assembly equiv. to SAE J1402 Type E

CHASSIS DIAGRAM
Conv. Single Tractor D12-10728
ENG. CHG. LTR. A

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL SINGLE DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK



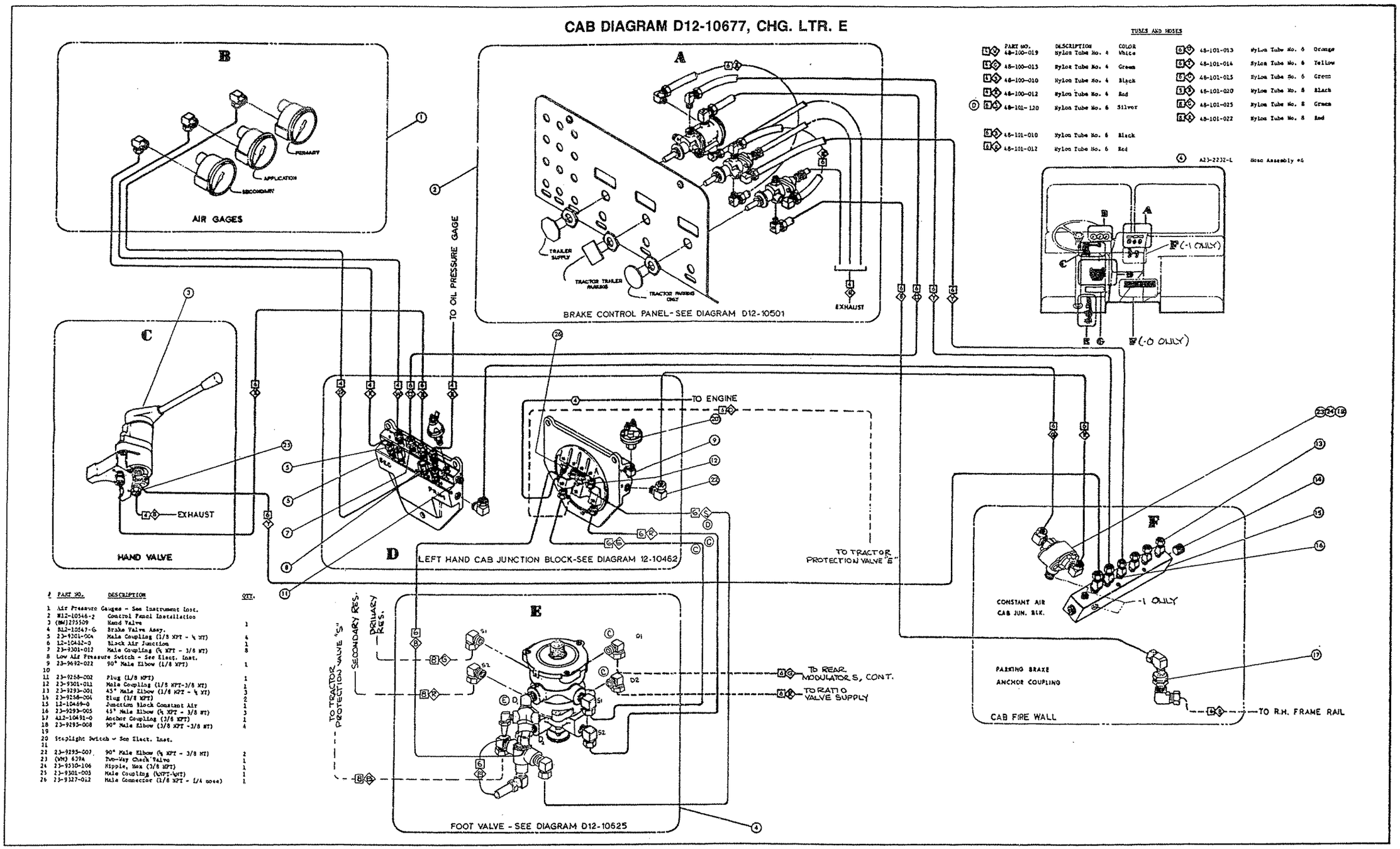
COLOR KEY

- Supply System Air Pressure
- Primary System Air Pressure
- Primary System Service Brake Application Air Pressure
- Primary System Application Control Air Pressure
- Secondary System Air Pressure
- Secondary System Application Control Air Pressure
- Primary or Secondary System Air Pressure
- Secondary System Service Brake Application Air Pressure
- Primary or Secondary System Application Control Air Pressure
- Trailer Air Supply System
- Tractor Parking Brake System
- Secondary System Air Pressure With Front Axle Antilock Only

SCHEMATIC DIAGRAM

Single Tractor Air Brake (D12-10515)
ENG. CHG. LTR. B

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL TANDEM DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK



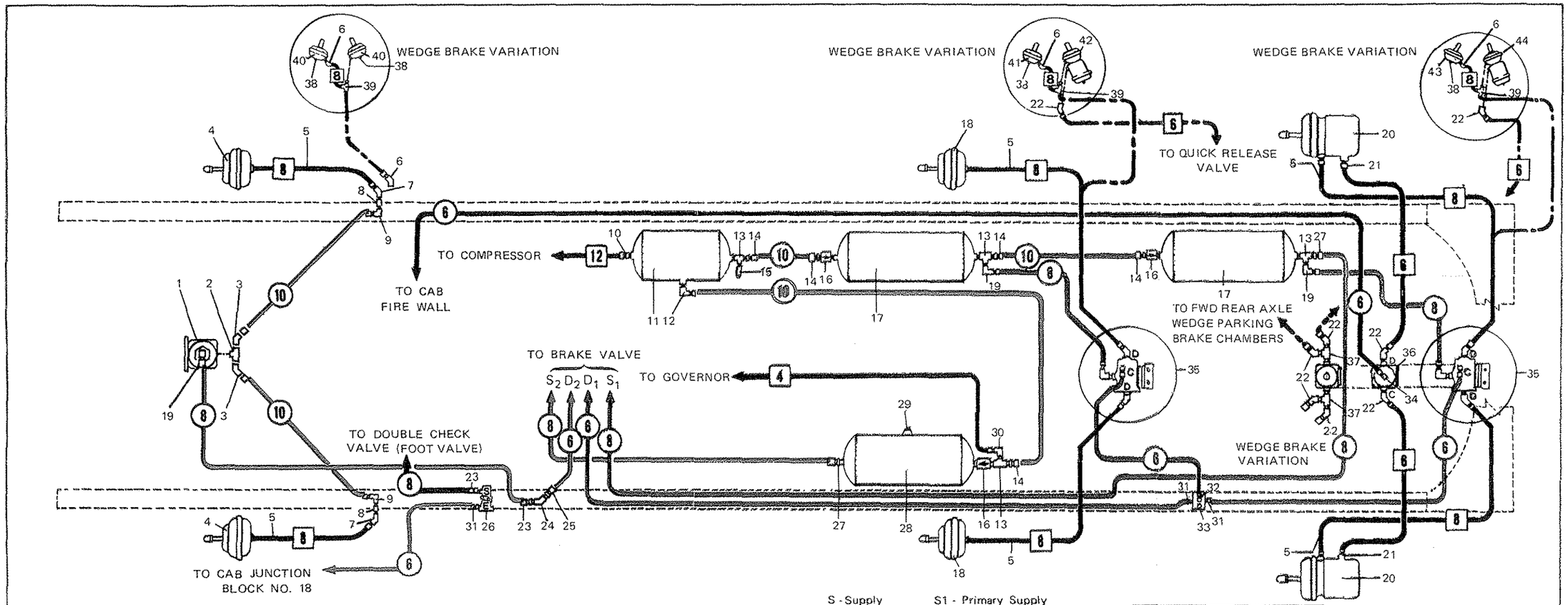
TUBES AND HOSES

	PART NO.	DESCRIPTION	COLOR
	48-100-019	Nylon Tube No. 4	White
	48-100-013	Nylon Tube No. 4	Green
	48-100-010	Nylon Tube No. 4	Black
	48-100-012	Nylon Tube No. 4	Red
D	48-101-120	Nylon Tube No. 6	Silver
	48-101-010	Nylon Tube No. 6	Black
	48-101-012	Nylon Tube No. 6	Red
	48-101-013	Nylon Tube No. 6	Orange
	48-101-014	Nylon Tube No. 6	Yellow
	48-101-015	Nylon Tube No. 6	Green
	48-101-020	Nylon Tube No. 8	Black
	48-101-025	Nylon Tube No. 8	Green
	48-101-022	Nylon Tube No. 8	Red
4	A23-2232-L	Hose Assembly #4	

#	PART NO.	DESCRIPTION	QTY.
1		Air Pressure Gauges - See Instrument Inst.	
2	M12-10546-2	Control Panel Installation	
3	(BM)295509	Hand Valve	1
4	M12-10547-G	Brake Valve Assy.	
5	23-9301-004	Male Coupling (1/8 NPT - ¼ MT)	4
6	12-10432-0	Black Air Junction	1
7	23-9301-012	Male Coupling (¼ NPT - 3/8 MT)	8
8		Low Air Pressure Switch - See Elect. Inst.	
9	23-9692-022	90° Male Elbow (1/8 NPT)	1
10			
11	23-9258-002	Plug (1/8 NPT)	1
12	23-9301-011	Male Coupling (1/8 NPT-3/8 MT)	1
13	23-9293-001	45° Male Elbow (1/8 NPT - ¼ MT)	3
14	23-9258-004	Plug (3/8 NPT)	2
15	12-10469-0	Junction Block Constant Air	1
16	23-9293-005	45° Male Elbow (¼ NPT - 3/8 MT)	3
17	A12-10491-0	Anchor Coupling (3/8 NPT)	1
18	23-9295-008	90° Male Elbow (3/8 NPT -3/8 MT)	4
19			
20		Stoplight Switch - See Elect. Inst.	
21			
22	23-9295-007	90° Male Elbow (¼ NPT - 3/8 MT)	2
23	(VM) 6394	Two-Way Check Valve	1
24	23-9510-106	Nipple, Hex (3/8 NPT)	1
25	23-9301-003	Male Coupling (¼NPT-¼MT)	1
26	23-9327-012	Male Connector (1/8 NPT - 1/4 tube)	1

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL TANDEM DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK

BRAKE CONTROL 12
32-12674



S - Supply
C - Constant Air
D - Delivery
E - Exhaust

S1 - Primary Supply
S2 - Secondary Supply
D1 - Primary Delivery
D2 - Secondary Delivery

REF NO	DESCRIPTION	SIZE
1	Ratio Valve	——
2	Tee, Male Branch	3/8 NPT
3	45° Male Elbow	3/8 NPT - 5/8 NT
4	Front Axle Service Chamber	——
5	Air Brake Hose Assembly	——
6	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
7	45° Street Elbow	3/8 NPT - 3/8 NPT
8	Anchor Coupling	3/8 NPT
9	90° Male Elbow	3/8 NPT - 5/8 NT
10	Male Connector, 45° Flare	1/2 NPT - 3/4 Hose
11	Air Reservoir (Supply)	——
12	90° Male Elbow	1/2 NPT - 5/8 NT
13	Street Tee - Special	——
14	Male Coupling	1/2 NPT - 5/8 NT
15	Air Safety Valve	——

REF NO	DESCRIPTION	SIZE
16	Single Check Valve	——
17	Air Reservoir (Primary)	——
18	Forward Rear Axle Serv. Chamb.	——
19	90° Male Elbow	3/8 NPT - 1/2 NT
20	Rear Rear Axle Serv. & Park. Chamb.	——
21	Male Connector, 45° Flare	3/8 NPT - 3/8 Hose
22	45° Male Elbow 45° Flare	3/8 NPT - 3/8 Hose
23	Male Coupling	3/8 NPT - 1/2 NT
24	Anchor Elbow	3/8 NPT
25	Male Coupling	3/8 NPT - 3/8 NT
26	Tractor Protection Valve	——
27	Male Coupling	1/2 NPT - 1/2 NT
28	Air Reservoir (Secondary)	——
29	Plug	1/2 NPT
30	90° Male Elbow, 45° Flare	3/8 NPT - 1/4 Hose

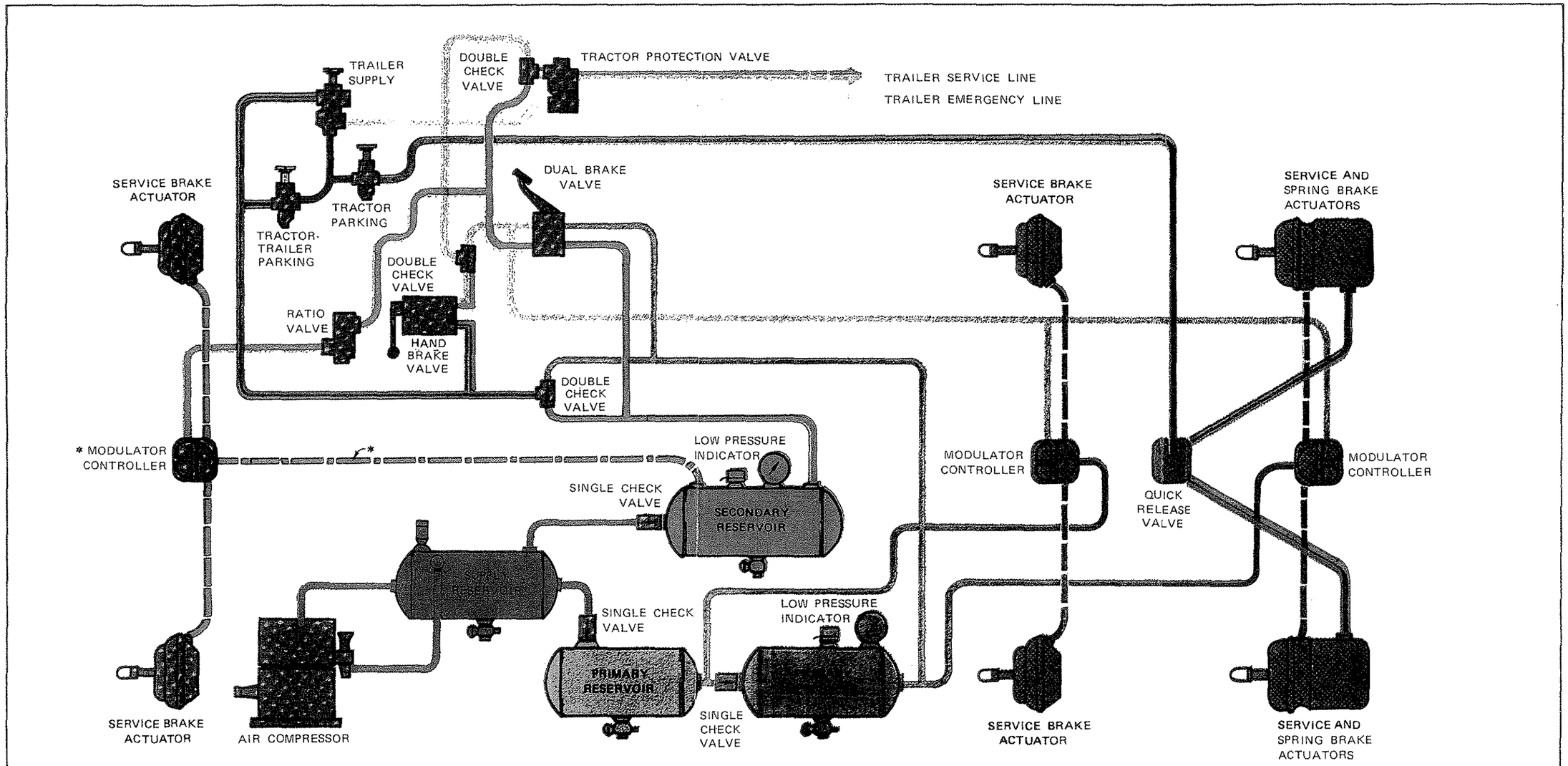
REF NO	DESCRIPTION	SIZE
31	Male Coupling	1/4 NPT - 3/8 NT
32	90° Male Elbow	1/4 NPT - 3/8 NT
33	Frame Junction Block (Rear)	——
34	90° Male Elbow	3/8 NPT - 3/8 NT
35	See Antilock Diagram	——
36	Quick Release Valve	——
37	Street Tee	3/8 NPT
38	Plug	3/8 NPT
39	Male Run Tee, 45° Flare	3/8 NPT - 1/2 Hose
40	Front Axle Service Chamber	——
41	Fwd. Rear Axle Serv. Chamber	——
42	Fwd. Rear Axle Serv. & Park.Chamb.	——
43	Rear Rear Axle Serv. Chamb.	——
44	Rear Rear Axle Serv. & Park. Chamb.	——

	DESCRIPTION	O.D. SIZE IN INCHES
6	Air brake system nylon tubing (reinf. const.) equiv. to SAE J844 Type 38	3/8
8		
8		
8		1/2
8		
10		
10		5/8

	DESCRIPTION
4	No. 4 hose assembly
6	No. 6 hose assembly
8	No. 8 hose assembly
10	No. 10 hose assembly
12	No. 12 hose assembly equiv. to SAE J1402 Type E

CHASSIS DIAGRAM
Conv. Tandem Tractor D12-10729
ENG. CHG. LTR. A

AIR PLUMBING DIAGRAM (FMVSS 121)
CONVENTIONAL TANDEM DRIVE TRACTOR, WITHOUT FRONT AXLE ANTILOCK



COLOR KEY

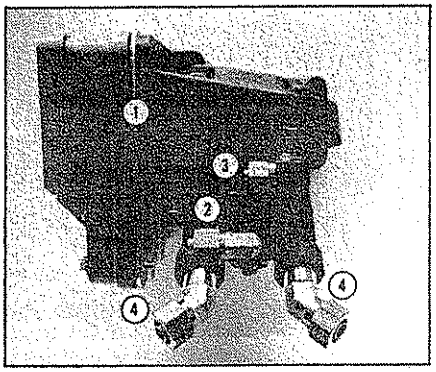
- Supply System Air Pressure
- Primary System Air Pressure
- Primary System Application Control Air Pressure
- Primary System Service Brake Application Air Pressure
- Secondary System Air Pressure
- Secondary System Application Control Air Pressure
- Primary or Secondary System Air Pressure
- Secondary System Service Brake Application Air Pressure
- Primary or Secondary System Application Control Air Pressure
- Trailer Air Supply System
- Tractor Parking Brake System
- Secondary System Air Pressure With Front Axle Antilock Only

* WITH FRONT AXLE ANTILOCK ONLY

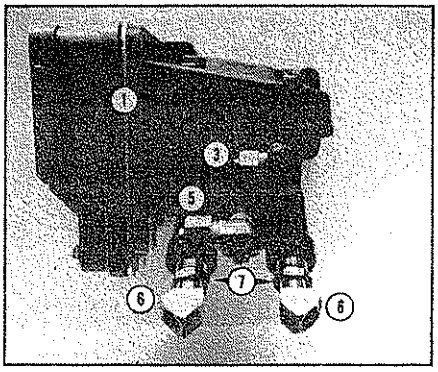
SCHEMATIC DIAGRAM
Tandem Tractor Air Brake (D12-10514)
ENG. CHG. LTR. B

KELSEY-HAYES ANTILOCK SYSTEM PLUMBING DIAGRAM

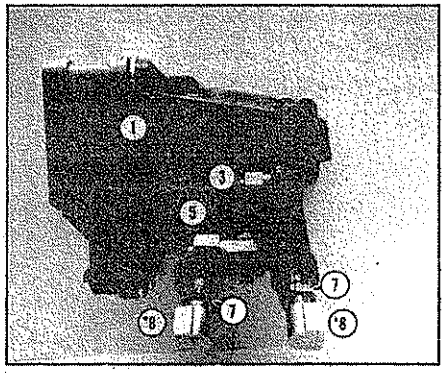
STANDARD NYLON TUBING FITTINGS



Front Axle, Computer and Valve Assembly Fittings



Forward Rear and Rear Rear Axle, Computer and Valve Assy. Fittings



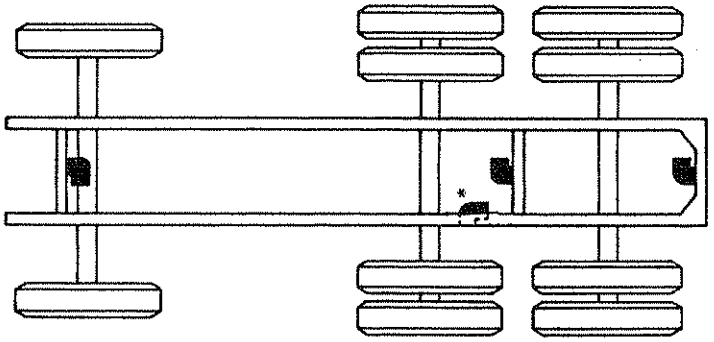
*Frame Rail Mounted Computer and Valve Assembly Fittings

REF. NO.	DESCRIPTION	SIZE
1	Computer and Valve Assembly	
2	90° Male Elbow	1/2 NPT - 1/2 NT
	(Optional) 90° Male Elbow (1/4 NPT - 1/2 NT) and Reducer (1/2 NPT - 1/4 NPT)	
3	90° Male Elbow	1/4 NPT - 3/8 NT
4	45° Elbow	1/2 NPT - 5/8 NT
5	90° Male Elbow	1/2 NPT - 1/2 NT
	(Optional) 90° Male Elbow (3/8 NPT - 1/2 NT) and Reducer (1/2 NPT - 3/8 NPT)	
6	45° Street Elbow	3/8 NPT - 3/8 NPT
7	Reducer	1/2 NPT - 3/8 NPT
*8	90° Male Elbow	3/8 NPT - 3/8 NPT

*Fittings for frame mounted valve, used on all tandem suspensions other than Freightliner, and Page & Page 750.

NOTE: When the Computer and Valve Assembly is installed in the vehicle, the direction the fittings will be pointing may vary from the positions shown above.

COMPUTER AND VALVE ASSEMBLY LOCATION KEY

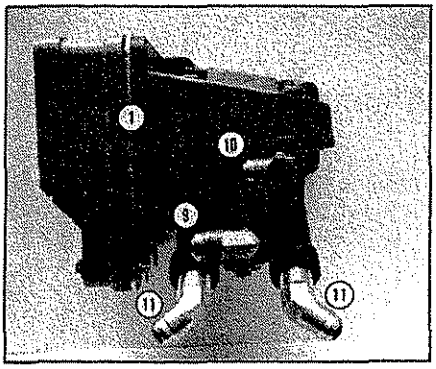


KELSEY HAYES PLUMBING DIAGRAM, D12-10560
ENG. CHG. LTR. E

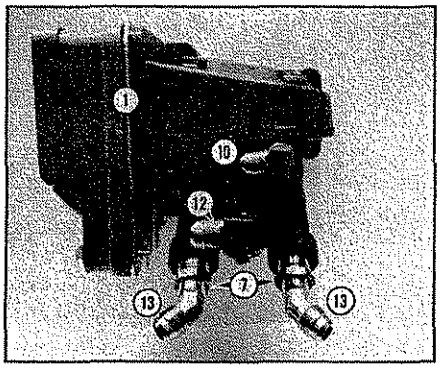
BRAKE CONTROL 12
32-12690

KELSEY-HAYES ANTILOCK SYSTEM PLUMBING DIAGRAM

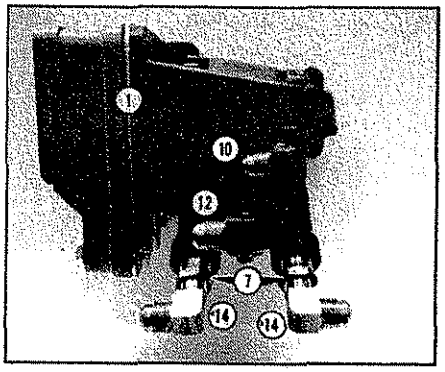
OPTIONAL WIRE BRAID FITTINGS



Front Axle, Computer and Valve Assembly Fittings



Forward Rear and Rear Rear Axle, Computer and Valve Assy. Fittings



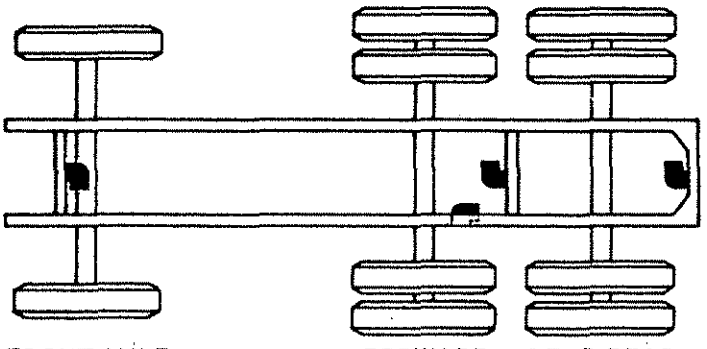
*Frame Rail Mounted Computer and Valve Assembly Fittings

REF. NO.	DESCRIPTION	SIZE
9	90° Male Elbow, 45° Flare	1/2 NPT - 1/2 Hose
	(Optional) 90° Male Elbow, 45° Flare (1/4 NPT - 1/2 Hose) and Reducer (1/2 NPT - 1/4 NPT)	
10	90° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
11	45° Male Elbow, 45° Flare	1/2 NPT - 1/2 Hose
12	90° Male Elbow, 45° Flare	1/2 NPT - 1/2 Hose
	(Optional) 90° Male Elbow, 45° Flare (3/8 NPT - 1/2 Hose) and Reducer (1/2 NPT - 3/8 NPT)	
13	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
*14	90° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose

*Fittings for frame mounted valve, used on all tandem suspensions other than Freightliner, and Page & Page 750.

NOTE: When the Computer and Valve Assembly is installed in the vehicle, the direction the fittings will be pointing may vary from the positions shown above.

COMPUTER AND VALVE ASSEMBLY LOCATION KEY

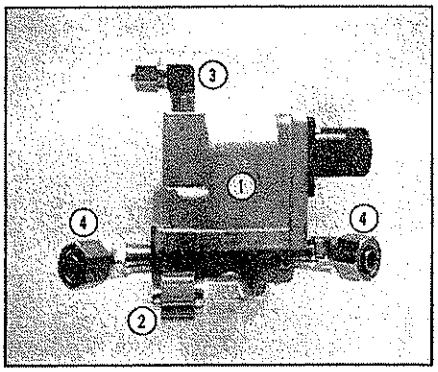


KELSEY HAYES PLUMBING DIAGRAM, D12-10560
ENG. CHG. LTR. E

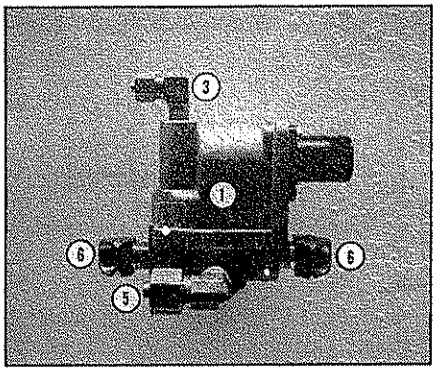
LITHO IN U.S.A.

WAGNER ANTILOCK SYSTEM PLUMBING DIAGRAM

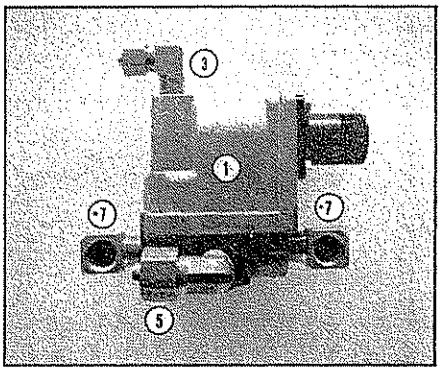
STANDARD NYLON TUBING FITTINGS



Front Axle, Modulator Valve Fittings



Forward Rear and Rear Rear Axle, Modulator Valve Fittings



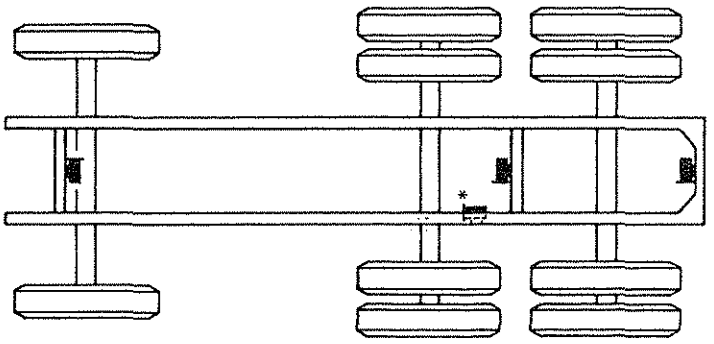
*Frame Rail Mounted Modulator Valve Fittings

REF. NO.	DESCRIPTION	SIZE
1	Air Modulator Valve	—
2	90° Male Elbow	1/2 NPT - 1/2 NT
	(Optional) 90° Male Elbow (1/4 NPT - 1/2 NT) and Reducer (1/2 NPT - 1/4 NPT)	
3	90° Male Elbow	1/4 NPT - 3/8 NT
4	45° Elbow	3/8 NPT - 5/8 NT
5	90° Male Elbow	1/2 NPT - 1/2 NT
	(Optional) 90° Male Elbow (3/8 NPT - 1/2 NT) and Reducer (1/2 NPT - 3/8 NPT)	
6	45° Street Elbow	3/8 NPT - 3/8 NPT
*7	90° Street Elbow	3/8 NPT - 3/8 NPT

*Fittings for frame mounted valve, used on all tandem suspensions other than Freightliner, and page & Page 750.

NOTE: When the Computer and Valve Assembly is installed in the vehicle, the direction the fittings will be pointing may vary from the positions shown above.

AIR MODULATOR VALVE LOCATION KEY

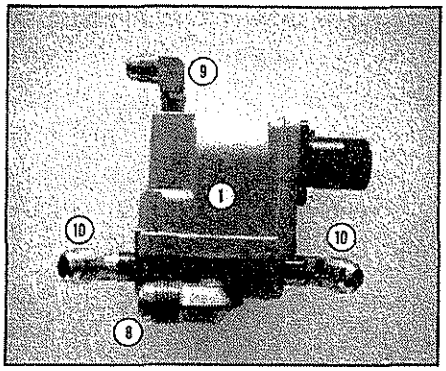


WAGNER PLUMBING DIAGRAM, D12-10554
ENG. CHG. LTR. E

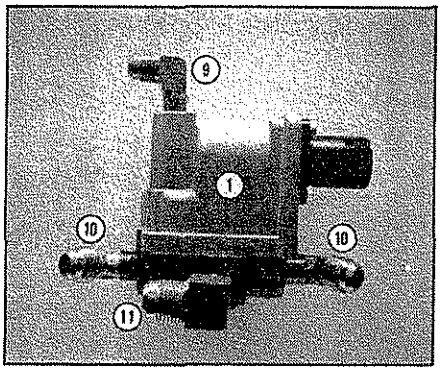
BRAKE CONTROL 12
32-12692

WAGNER ANTILOCK SYSTEM PLUMBING DIAGRAM

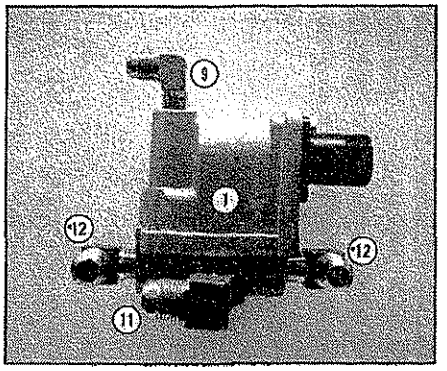
OPTIONAL WIRE BRAID FITTINGS



Front Axle, Modulator Valve Fittings



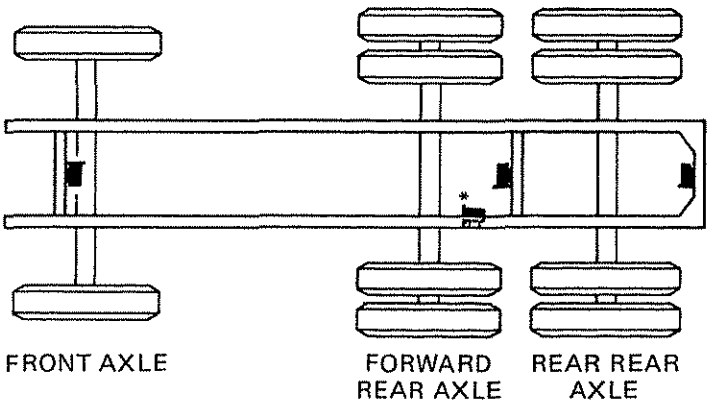
Forward Rear and Rear Rear Axle, Modulator Valve Fittings



*Frame Rail Mounted Modulator Valve Fittings

REF. NO.	DESCRIPTION	SIZE
8	90° Male Elbow, 45° Flare	1/2 NPT - 1/2 Hose
	(Optional) 90° Male Elbow, 45° Flare (1/4 NPT - 1/2 Hose) and Reducer (1/2 NPT - 1/4 NPT)	
9	90° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
10	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
11	90° Male Elbow, 45° Flare	1/2 NPT - 1/2 Hose
	(Optional) 90° Male Elbow, 45° Flare (3/8 NPT - 1/2 Hose) and Reducer (1/2 NPT - 3/8 NPT)	
*12	90° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose

AIR MODULATOR VALVE LOCATION KEY



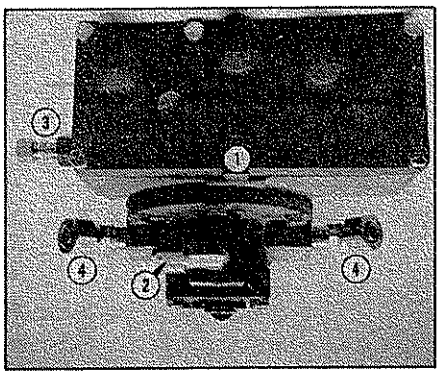
*Fittings for frame mounted valve, used on all tandem suspensions other than Freightliner, and page & Page 750.

NOTE: When the Computer and Valve Assembly is installed in the vehicle, the direction the fittings will be pointing may vary from the positions shown above.

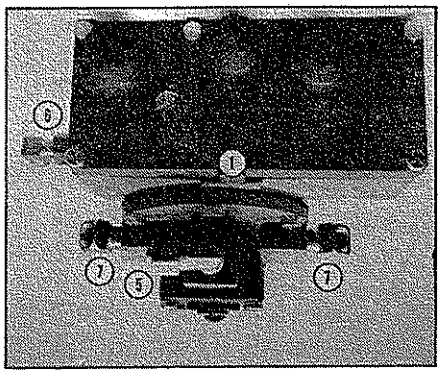
WAGNER PLUMBING DIAGRAM, D12-10554
ENG. CHG. LTR. E

ROCKWELL "SKID-TROL" ANTILOCK SYSTEM PLUMBING DIAGRAM

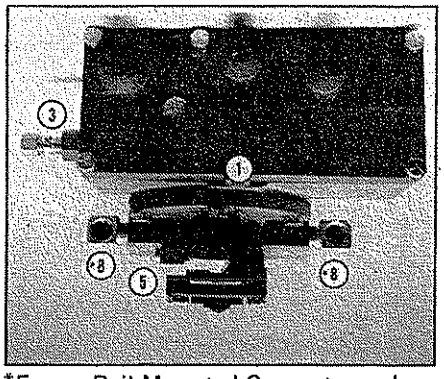
STANDARD NYLON TUBING FITTINGS



Front Axle, Computer and Valve Assembly Fittings



Forward Rear and Rear Rear Axle, Computer and Valve Assy. Fittings



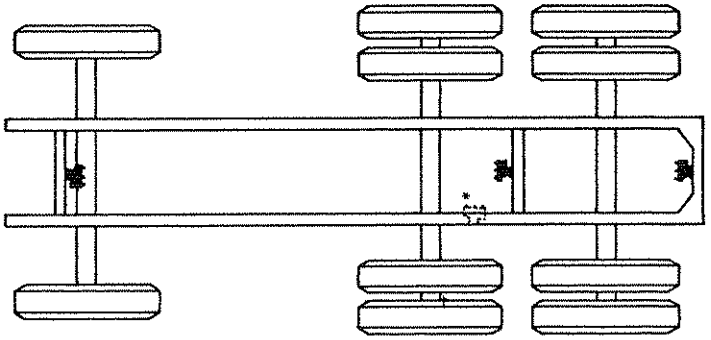
*Frame Rail Mounted Computer and Valve Assembly Fittings

REF. NO.	DESCRIPTION	SIZE
1	Computer and Valve Assembly	—
2	90° Male Elbow	1/2 NPT - 1/2 NT
	(Optional) 90° Male Elbow (1/4 NPT - 1/2 NT) and Reducer (1/2 NPT - 1/4 NPT)	
3	Male Coupling	1/4 NPT - 3/8 NT
4	45° Elbow	3/8 NPT - 5/8 NT
5	90° Male Elbow	1/2 NPT - 1/2 NT
	(Optional) 90° Male Elbow (3/8 NPT - 1/2 NT) and Reducer (1/2 NPT - 3/8 NPT)	
6	90° Male Elbow	1/4 NPT - 3/8 NT
7	45° Street Elbow	3/8 NPT - 3/8 NPT
*8	90° Street Elbow	3/8 NPT - 3/8 NPT

*Fittings for frame mounted valve, used on all tandem suspensions other than Freightliner, and Page & Page 750.

NOTE: When the Computer and Valve Assembly is installed in the vehicle, the direction the fittings will be pointing may vary from the positions shown above.

COMPUTER AND VALVE ASSEMBLY LOCATION KEY

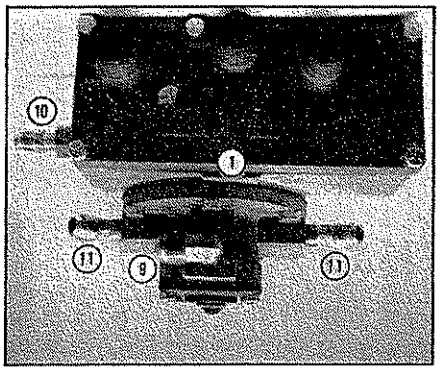


ROCKWELL PLUMBING DIAGRAM, D12-10559
ENG. CHG. LTR. E

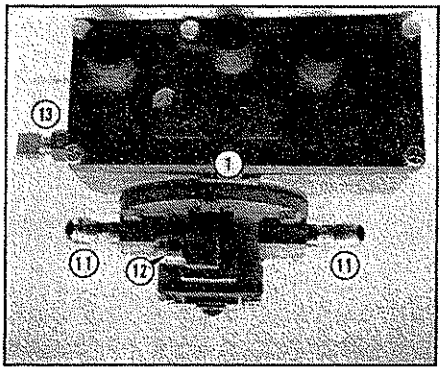
BRAKE CONTROL 12
32-12694

ROCKWELL "SKID-TROL" ANTILOCK SYSTEM PLUMBING DIAGRAM

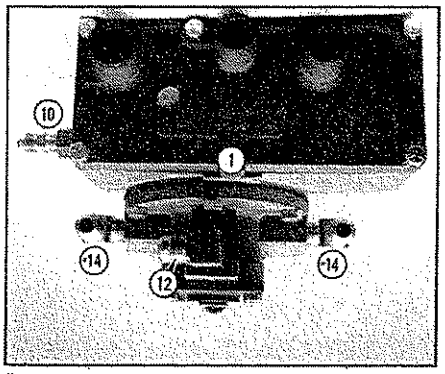
OPTIONAL WIRE BRAID FITTINGS



Front Axle, Computer and Valve Assembly Fittings



Forward Rear and Rear Rear Axle, Computer and Valve Assy. Fittings



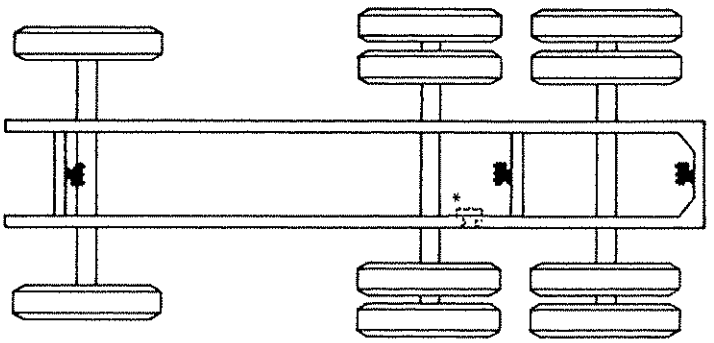
*Frame Rail Mounted Computer and Valve Assembly Fittings

REF. NO.	DESCRIPTION	SIZE
9	90° Male Elbow, 45° Flare	1/2 NPT - 1/2 Hose
	(Optional) 90° Male Elbow, 45° Flare (1/4 NPT - 1/2 Hose) and Reducer (1/2 NPT - 1/4 NPT)	
10	Male Connector, 45° Flare	1/4 NPT - 3/8 Hose
11	45° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose
12	90° Male Elbow, 45° Flare	1/2 NPT - 1/2 Hose
	(Optional) 90° Male Elbow, 45° Flare (3/8 NPT - 1/2 Hose) and Reducer (1/2 NPT - 3/8 NPT)	
13	90° Male Elbow, 45° Flare	1/4 NPT - 3/8 Hose
*14	90° Male Elbow, 45° Flare	3/8 NPT - 1/2 Hose

*Fittings for frame mounted valve, used on all tandem suspensions other than Freightliner, and Page & Page 750.

NOTE: When the Computer and Valve Assembly is installed in the vehicle, the direction the fittings will be pointing may vary from the positions shown above.

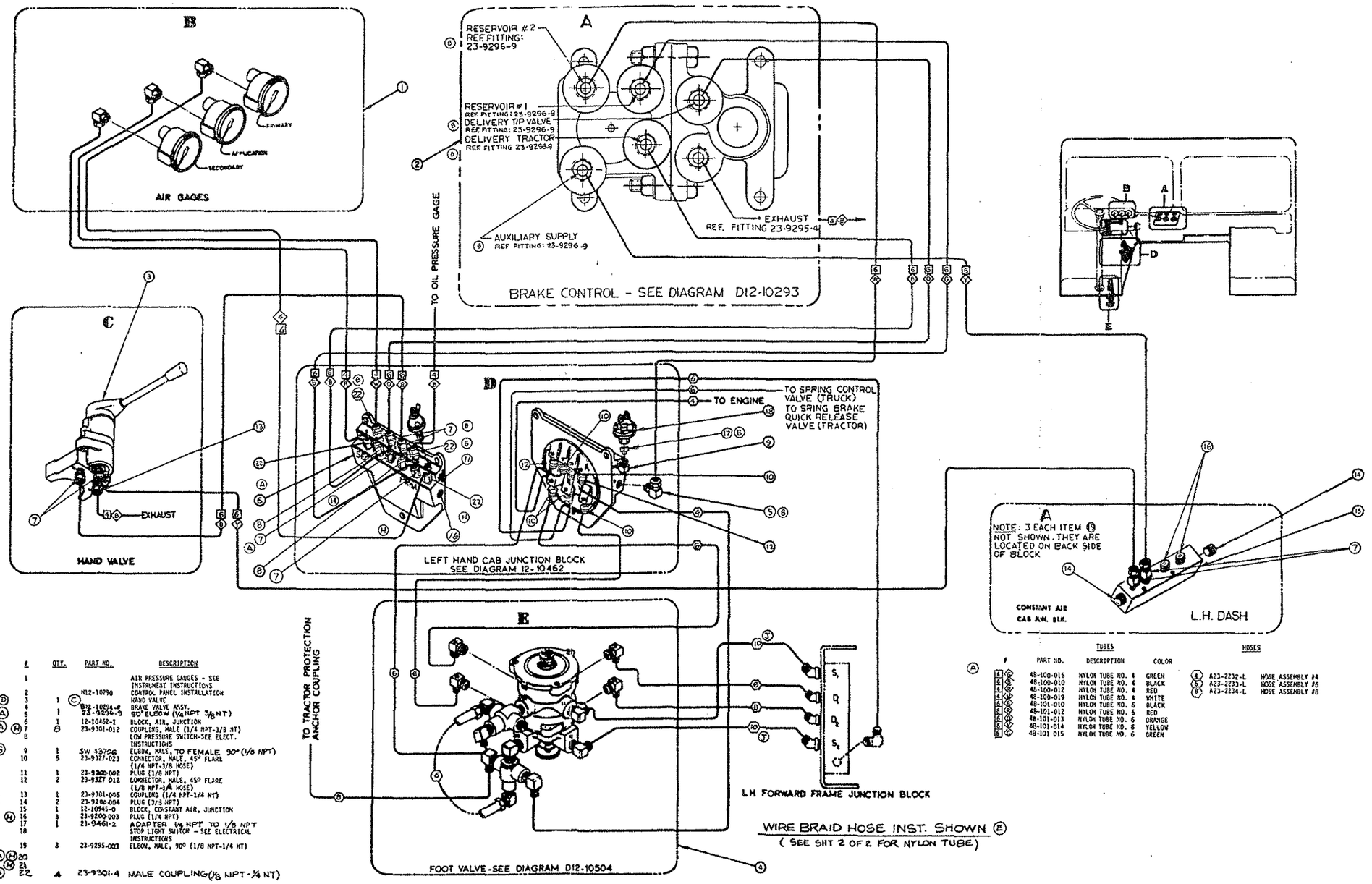
COMPUTER AND VALVE ASSEMBLY LOCATION KEY



ROCKWELL PLUMBING DIAGRAM, D12-10559
ENG. CHG. LTR. E

COE TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-10292, 1 OF 2, CHG. LTR. K, WIRE BRAID HOSE



#	QTY.	PART NO.	DESCRIPTION
1			AIR PRESSURE GAUGES - SEE INSTRUMENT INSTRUCTIONS
2		M12-10790	CONTROL PANEL INSTALLATION
3	1 (C)		HAND VALVE
4		B12-10984-8	BRAKE VALVE ASSY.
5	1	23-9294-9	90° ELBOW (¼ NPT 3/8 NT)
6	1	12-10462-1	BLOCK, AIR, JUNCTION
7	8	23-9301-012	COUPLING, MALE (1/4 NPT-3/8 NT)
8			LOW PRESSURE SWITCH-SEE ELECT. INSTRUCTIONS
9	1	SW 437C6	ELBOW, MALE, TO FEMALE 90° (⅛ NPT)
10	5	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT-3/8 HOSE)
11	1	23-9200-002	PLUG (1/8 NPT)
12	2	23-9327 012	CONNECTOR, MALE, 45° FLARE (1/8 NPT-3/8 HOSE)
13	1	23-9301-015	COUPLING (1/4 NPT-1/4 NT)
14	2	23-9200-004	PLUG (3/8 NPT)
15	1	12-10945-9	BLOCK, CONSTANT AIR, JUNCTION
16	3	23-9200-003	PLUG (1/4 NPT)
17	1	23-9461-2	ADAPTER ⅛ NPT TO ⅛ NPT STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
18			
19	3	23-9295-003	ELBOW, MALE, 90° (1/8 NPT-1/4 NT)
20			
21			
22	4	23-9301-4	MALE COUPLING (⅛ NPT-¼ NT)

(A)

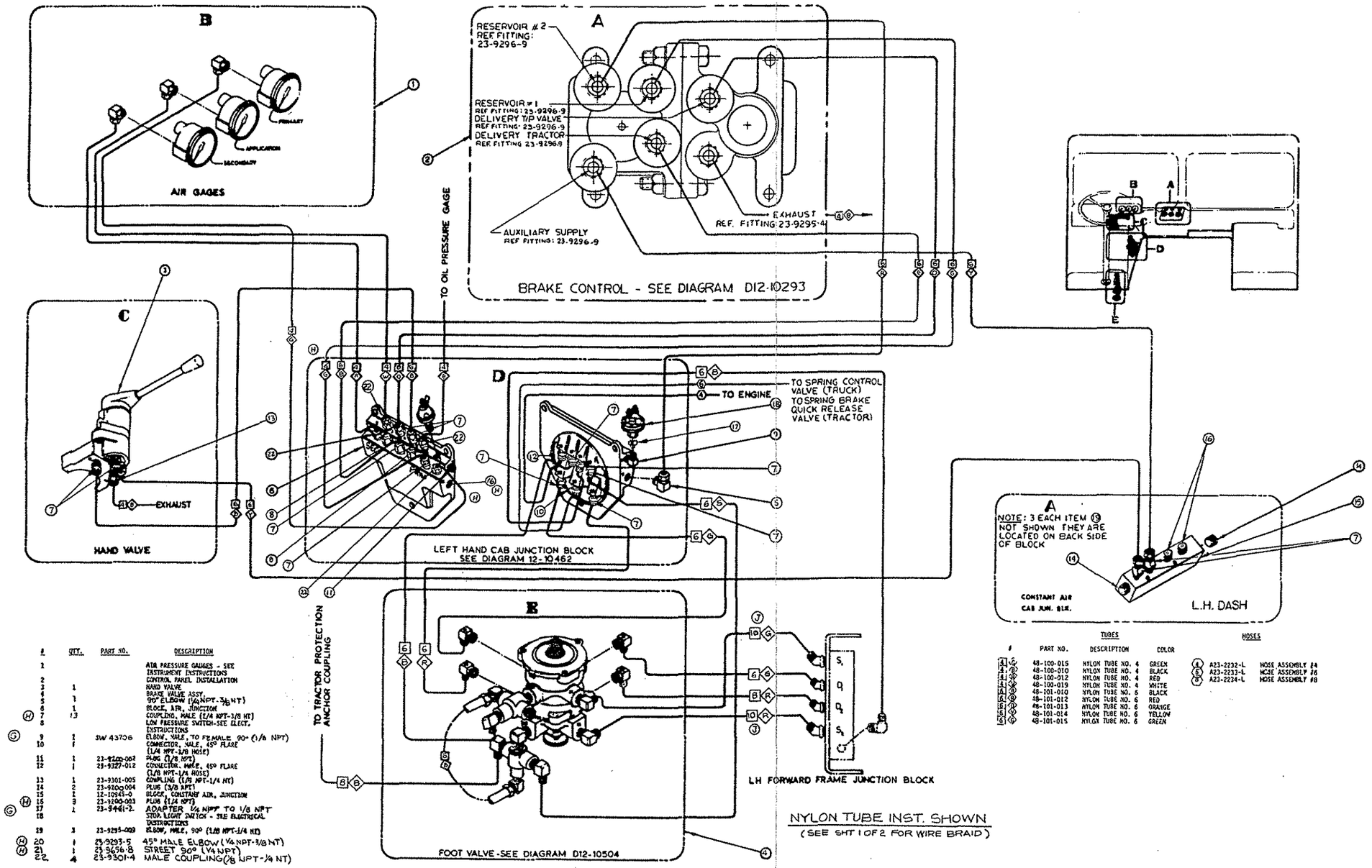
#	PART NO.	DESCRIPTION	COLOR
4	48-100-015	NYLON TUBE NO. 4	GREEN
5	48-100-010	NYLON TUBE NO. 4	BLACK
4	48-100-012	NYLON TUBE NO. 4	RED
4	48-100-019	NYLON TUBE NO. 4	WHITE
5	48-101-010	NYLON TUBE NO. 6	BLACK
5	48-101-012	NYLON TUBE NO. 6	RED
5	48-101-013	NYLON TUBE NO. 6	ORANGE
5	48-101-014	NYLON TUBE NO. 6	YELLOW
5	48-101 015	NYLON TUBE NO. 6	GREEN

HOSES

(4)	A23-2232-L	HOSE ASSEMBLY #4
(5)	A23-2233-L	HOSE ASSEMBLY #6
(6)	A23-2234-L	HOSE ASSEMBLY #8

COE TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-10292, 2 OF 2, CHG. LTR. K, NYLON TUBING



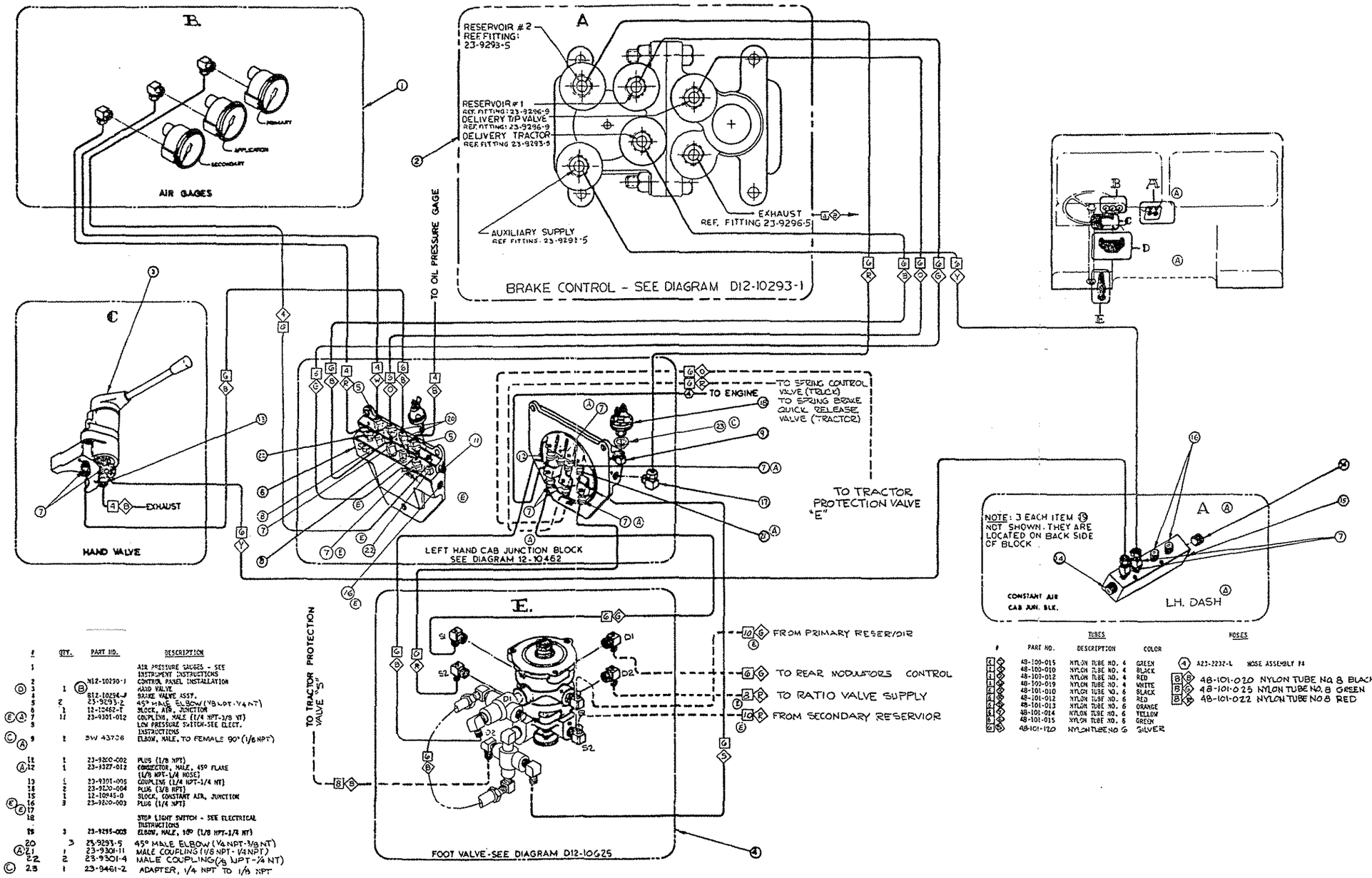
#	QTY.	PART NO.	DESCRIPTION
	1		AIR PRESSURE GAUGES - SEE INSTRUMENT INSTRUCTIONS
	2		CONTROL PANEL INSTALLATION
	3	1	HAND VALVE
	4	1	BRAKE VALVE ASSY.
	5	1	90° ELBOW (1/4 NPT-3/8 NT)
	6	1	BLOCK, AIR, JUNCTION
(H)	7	13	COUPLING, MALE (1/4 NPT-3/8 NT)
	8		LOW PRESSURE SWITCH-SEE ELECT. INSTRUCTIONS
(G)	9	2	ELBOW, MALE, TO FEMALE 90° (1/8 NPT)
	10	1	CONNECTOR, MALE, 45° FLARE (1/4 NPT-3/8 HOSE)
	11	1	23-9200-002 PLUG (1/8 NPT)
	12	1	23-9327-012 CONNECTOR, MALE, 45° FLARE (1/8 NPT-1/4 HOSE)
	13	1	23-9301-005 COUPLING (1/8 NPT-1/4 NT)
	14	2	23-9200-004 PLUG (3/8 NPT)
	15	1	12-10965-0 BLOCK, CONSTANT AIR, JUNCTION
(H)	16	3	23-9200-003 PLUG (1/4 NPT)
(G)	17	1	23-9461-2 ADAPTER 1/4 NPTF TO 1/8 NPT
	18		STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
	19	3	23-9295-003 ELBOW, MALE, 90° (1/8 NPT-1/4 NT)
(H)	20	1	23-9293-5 45° MALE ELBOW (1/4 NPT-3/8 NT)
(H)	21	1	23-9656-8 STREET 90° (1/4 NPT)
	22	4	23-9301-4 MALE COUPLING (3/8 NPT-1/4 NT)

#	PART NO.	TUBES DESCRIPTION	COLOR	HOSES	
1	48-100-015	NYLON TUBE NO. 4	GREEN	A	A23-2232-L HOSE ASSEMBLY #4
2	48-100-010	NYLON TUBE NO. 4	BLACK	B	A23-2233-L HOSE ASSEMBLY #6
3	48-100-012	NYLON TUBE NO. 4	RED	C	A23-2234-L HOSE ASSEMBLY #8
4	48-100-019	NYLON TUBE NO. 4	WHITE		
5	48-101-010	NYLON TUBE NO. 6	BLACK		
6	48-101-012	NYLON TUBE NO. 6	RED		
7	48-101-013	NYLON TUBE NO. 6	ORANGE		
8	48-101-014	NYLON TUBE NO. 6	YELLOW		
9	48-101-015	NYLON TUBE NO. 6	GREEN		

NYLON TUBE INST. SHOWN
(SEE SHT 1 OF 2 FOR WIRE BRAID)

CONVENTIONAL TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-11507, CHG. LTR. F, NYLON TUBING



#	QTY.	PART NO.	DESCRIPTION
1			AIR PRESSURE GAUGES - SEE INSTRUMENT INSTRUCTIONS
2		N12-10290-1	CONTROL PANEL INSTALLATION
(D) 3	1	(B)	HAND VALVE
4		612-10294-J	BRAKE VALVE ASST.
5	2	23-9293-2	45° MALE ELBOW (1/8 NPT-1/4 NT)
6	1	12-10462-F	BLOCK, AIR, JUNCTION
(E)(A) 7	11	23-9301-012	COUPLING, MALE (1/4 NPT-3/8 NT)
8			LOW PRESSURE SWITCH-SEE ELECT. INSTRUCTIONS
(C)(A) 9	1	SW 43706	ELBOW, MALE, TO FEMALE 90° (1/8 NPT)
10	1	23-9200-002	PLUG (1/8 NPT)
(A) 12	1	23-9327-012	CONNECTOR, MALE, 45° FLARE (1/8 NPT-1/4 HOSE)
13	1	23-9301-005	COUPLING (1/4 NPT-1/4 NT)
14	2	23-9200-004	PLUG (3/8 NPT)
15	1	12-10945-0	BLOCK, CONSTANT AIR, JUNCTION
(E) 16	3	23-9200-003	PLUG (1/4 NPT)
(E) 17			
18			STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
19	1	23-9295-003	ELBOW, MALE, 90° (1/8 NPT-1/8 NT)
20	3	23-9293-5	45° MALE ELBOW (1/4 NPT-3/8 NT)
(A) 21	1	23-9301-11	MALE COUPLING (1/8 NPT-1/4 NPT)
22	2	23-9301-4	MALE COUPLING (3/8 NPT-1/4 NT)
(C) 23	1	23-9461-2	ADAPTER, 1/4 NPT TO 1/8 NPT

TUBES

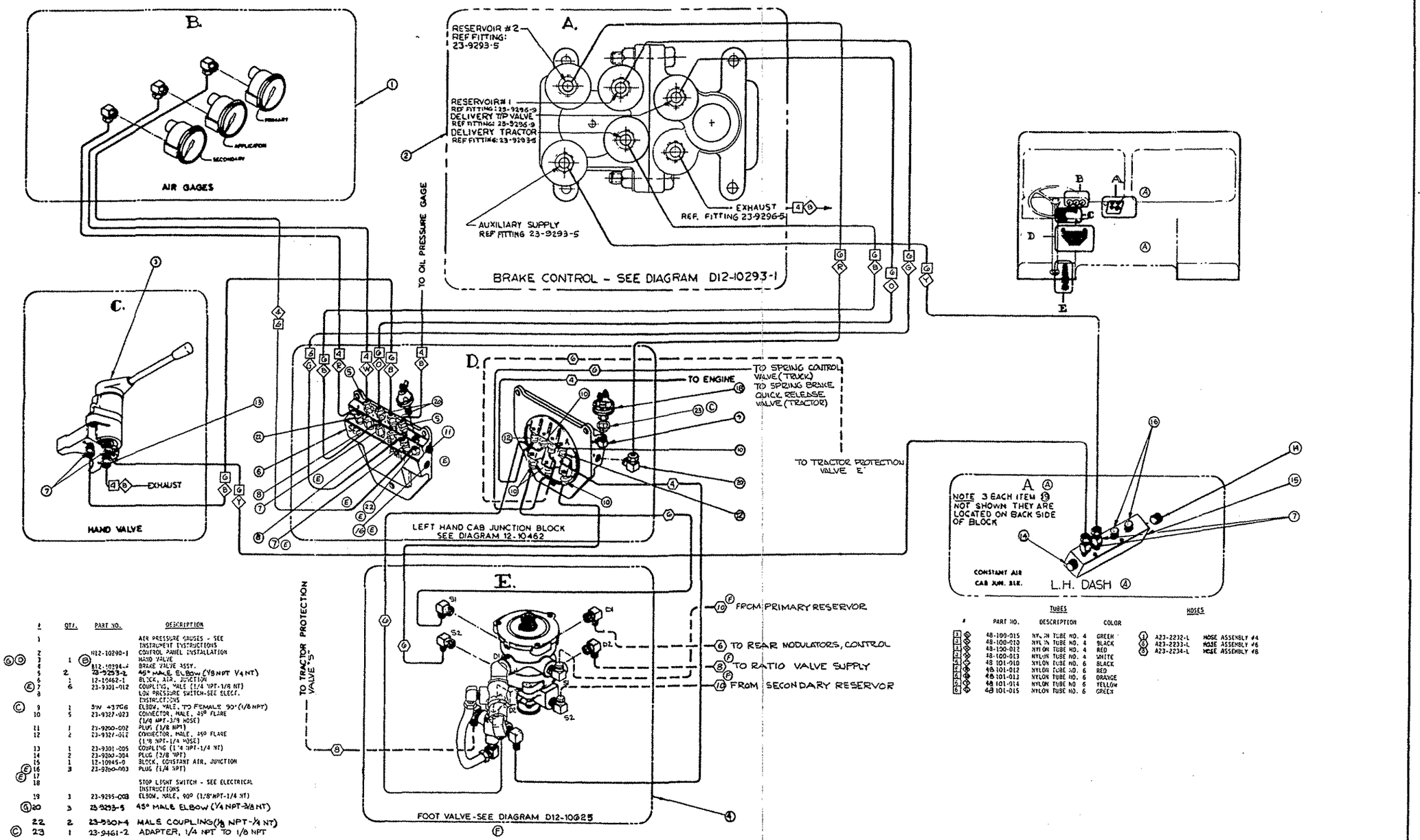
#	PART NO.	DESCRIPTION	COLOR
4	48-100-015	NYLON TUBE NO. 4	GREEN
4	48-100-010	NYLON TUBE NO. 4	BLACK
4	48-100-012	NYLON TUBE NO. 4	RED
4	48-100-019	NYLON TUBE NO. 4	WHITE
6	48-101-010	NYLON TUBE NO. 6	BLACK
6	48-101-012	NYLON TUBE NO. 6	RED
6	48-101-013	NYLON TUBE NO. 6	ORANGE
6	48-101-014	NYLON TUBE NO. 6	YELLOW
6	48-101-015	NYLON TUBE NO. 6	GREEN
6	48-101-120	NYLON TUBE NO 6	SILVER

HOSES

4	A23-2232-L HOSE ASSEMBLY #4
8	48-101-020 NYLON TUBE NO 8 BLACK
8	48-101-025 NYLON TUBE NO. 8 GREEN
8	48-101-022 NYLON TUBE NO 8 RED

CONVENTIONAL TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-11506, CHG. LTR. G, WIRE BRAID HOSE

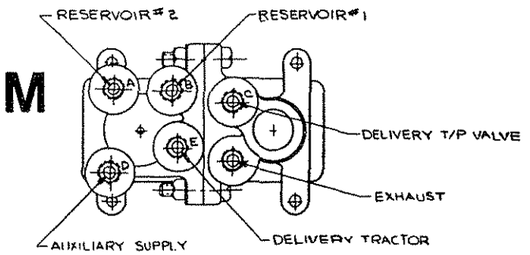


#	QTY.	PART NO.	DESCRIPTION
1			AIR PRESSURE GAUGES - SEE INSTRUMENT INSTRUCTIONS
2		H12-10290-1	CONTROL PANEL INSTALLATION
3	1	B12-10294-2	HAND VALVE
4		B12-10294-2	BRAKE VALVE ASSY.
5	2	23-9253-2	45° MALE ELBOW (V8 NPT V4 NT)
6	1	12-10462-1	BLOCK, AIR, JUNCTION
7	6	23-9301-012	COUPLING, MALE (1/4 NPT-1/8 NT)
8			LOW PRESSURE SWITCH-SEE ELECT. INSTRUCTIONS
9	1	SW 4376G	ELBOW, MALE, TO FEMALE 90° (1/8 NPT)
10	5	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT-3/8 HOSE)
11	1	23-9200-002	PLUG (1/8 NPT)
12	2	23-9327-012	CONNECTOR, MALE, 45° FLARE (1/8 NPT-1/4 HOSE)
13	1	23-9301-005	COUPLING (1/4 NPT-1/8 NT)
14	2	23-9200-004	PLUG (3/8 NPT)
15	1	12-10945-0	BLOCK, CONSTANT AIR, JUNCTION
16	3	23-9760-003	PLUG (1/4 NPT)
17			
18			STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
19	1	23-9295-003	ELBOW, MALE, 90° (1/8"NPT-1/4 NT)
20	3	23-9253-5	45° MALE ELBOW (1/4 NPT-3/8 NT)
22	2	23-9304-4	MALE COUPLING (1/8 NPT-1/4 NT)
23	1	23-9461-2	ADAPTER, 1/4 NPT TO 1/8 NPT

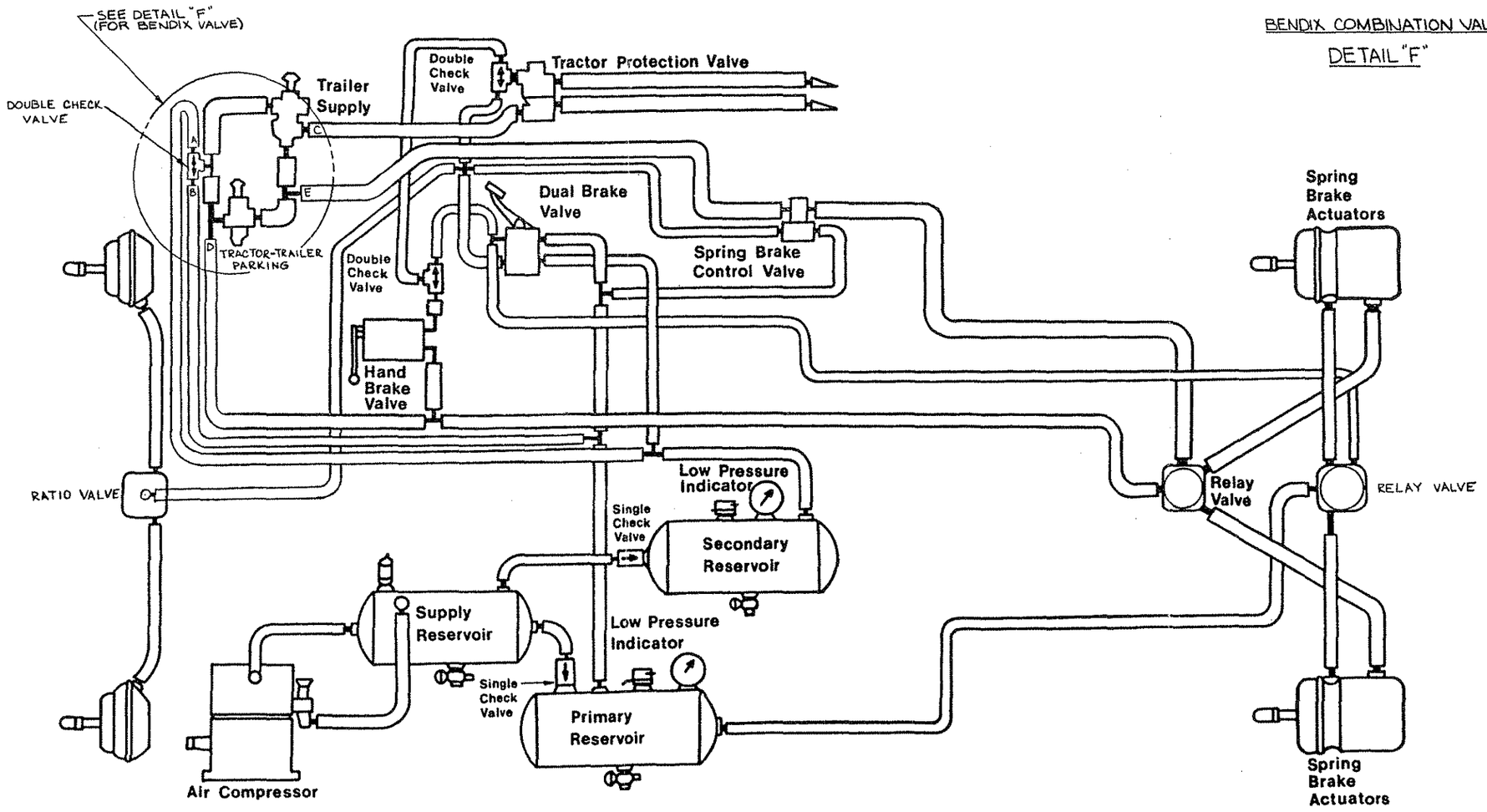
#	TUBES PART NO.	DESCRIPTION	COLOR	HOSES	
4	48-100-015	NYLON TUBE NO. 4	GREEN	1	A23-2232-L HOSE ASSEMBLY #4
5	48-100-010	NYLON TUBE NO. 4	BLACK	2	A23-2233-L HOSE ASSEMBLY #6
6	48-100-012	NYLON TUBE NO. 4	RED	3	A23-2234-L HOSE ASSEMBLY #8
7	48-100-013	NYLON TUBE NO. 4	WHITE		
8	48 101-010	NYLON TUBE NO. 6	BLACK		
9	48-101-012	NYLON TUBE NO. 6	RED		
10	48 101-013	NYLON TUBE NO. 6	ORANGE		
11	48 101-014	NYLON TUBE NO. 6	YELLOW		
12	48 101-015	NYLON TUBE NO. 6	GREEN		

WITHOUT ANTILOCK

FREIGHTLINER DUAL AIR BRAKE SYSTEM



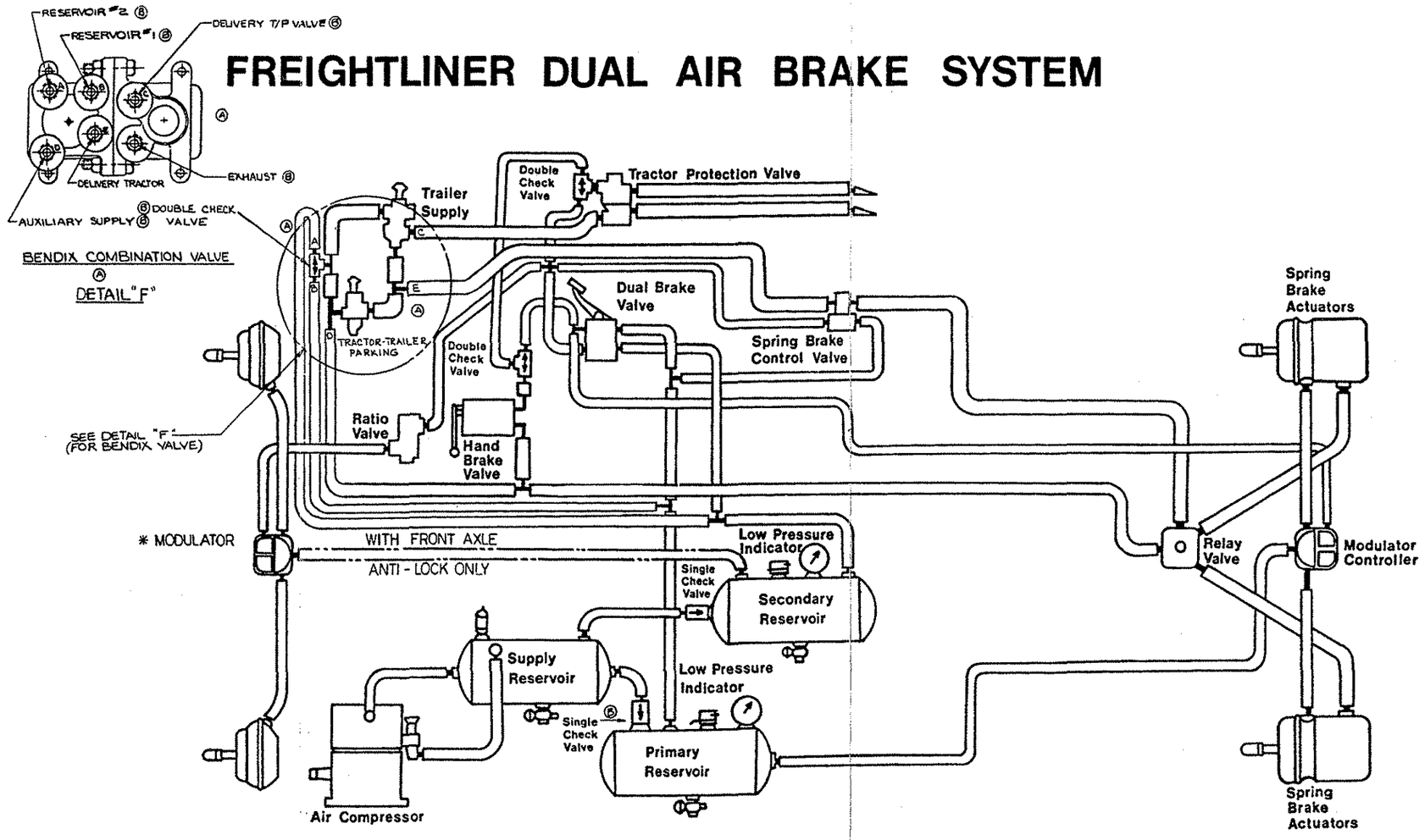
BENDIX COMBINATION VALVE
DETAIL "F"



D12-11177 ENG. CHG. LTR. B

COE AND CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, SCHEMATIC DIAGRAM

DIAGRAM D12-10946, CHG. LTR. C, WITH ANTILOCK



COE AND CONVENTIONAL SINGLE REAR AXLE TRACTOR (FMVSS 121),
OR TRUCK OR TRACTOR (CMVSS 121), SCHEMATIC DIAGRAM

DIAGRAM D12-10949, CHG. LTR. B, WITHOUT ANTILOCK

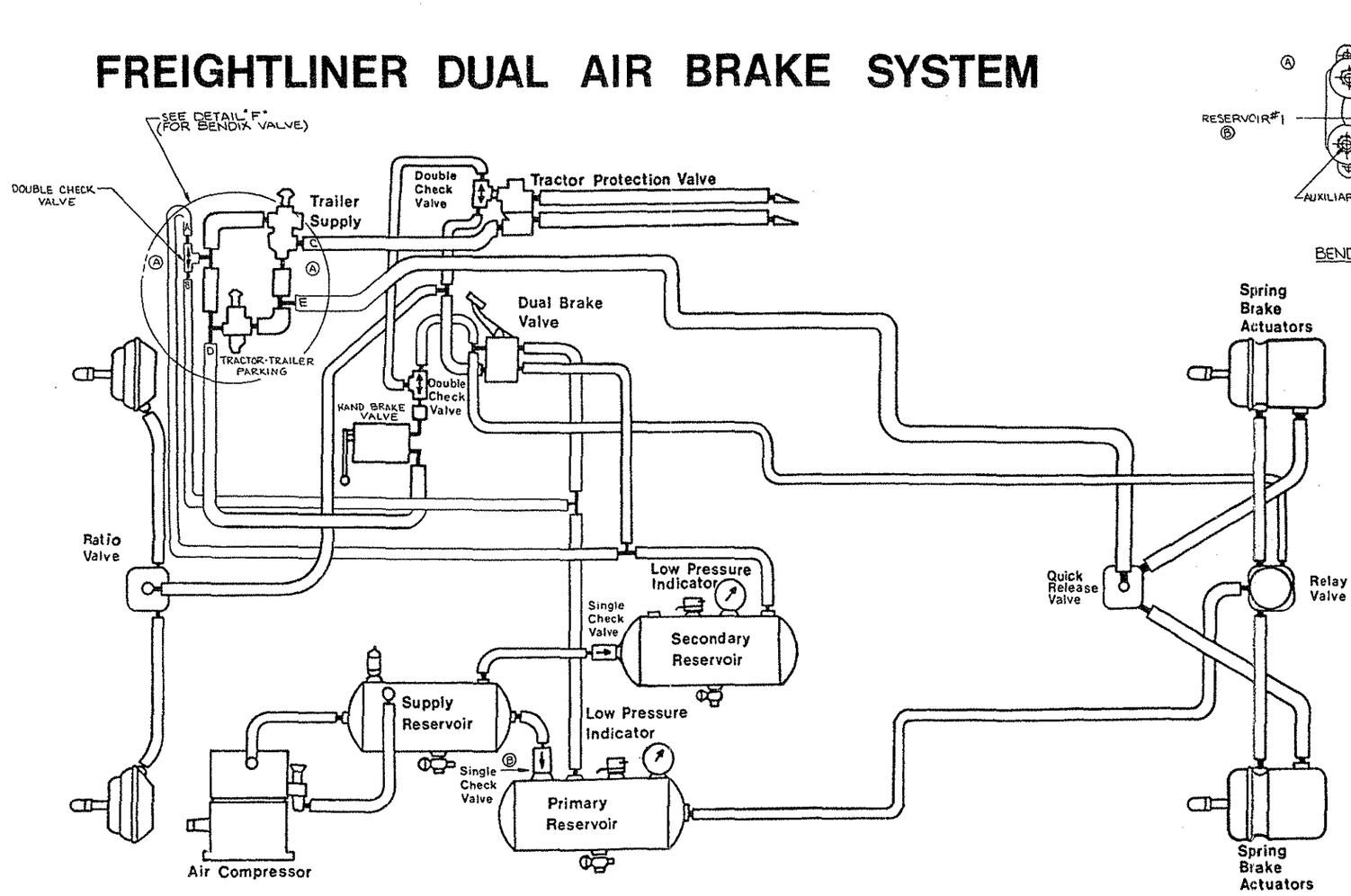
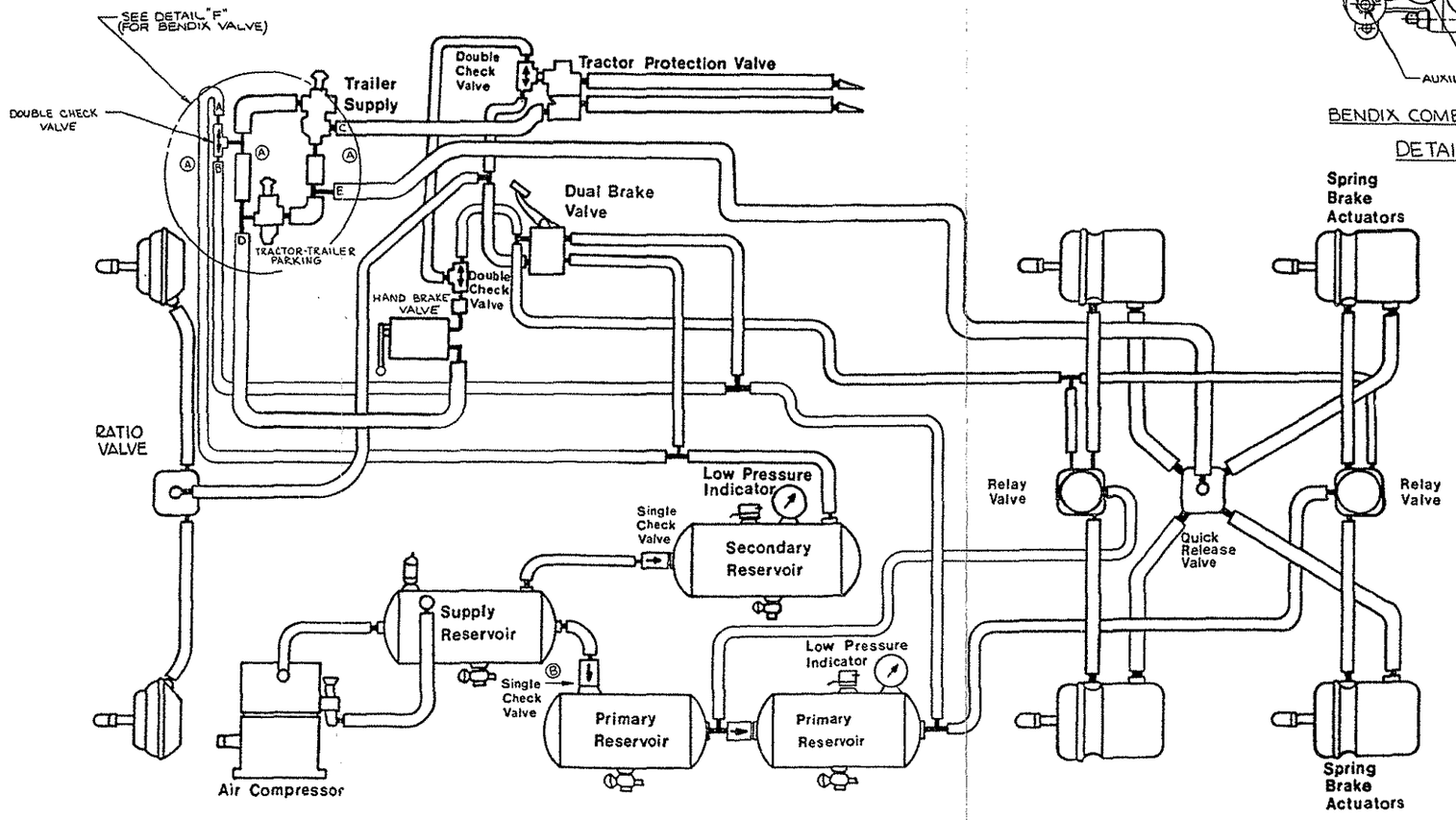
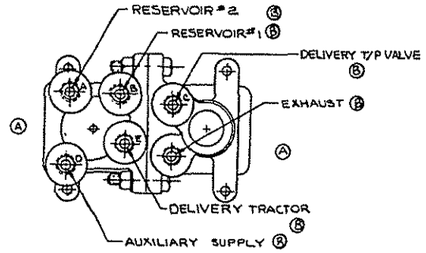


DIAGRAM D12-10951, CHG. LTR. C, WITH FRONT BRAKES, WITHOUT ANTILOCK

FREIGHTLINER DUAL AIR BRAKE SYSTEM



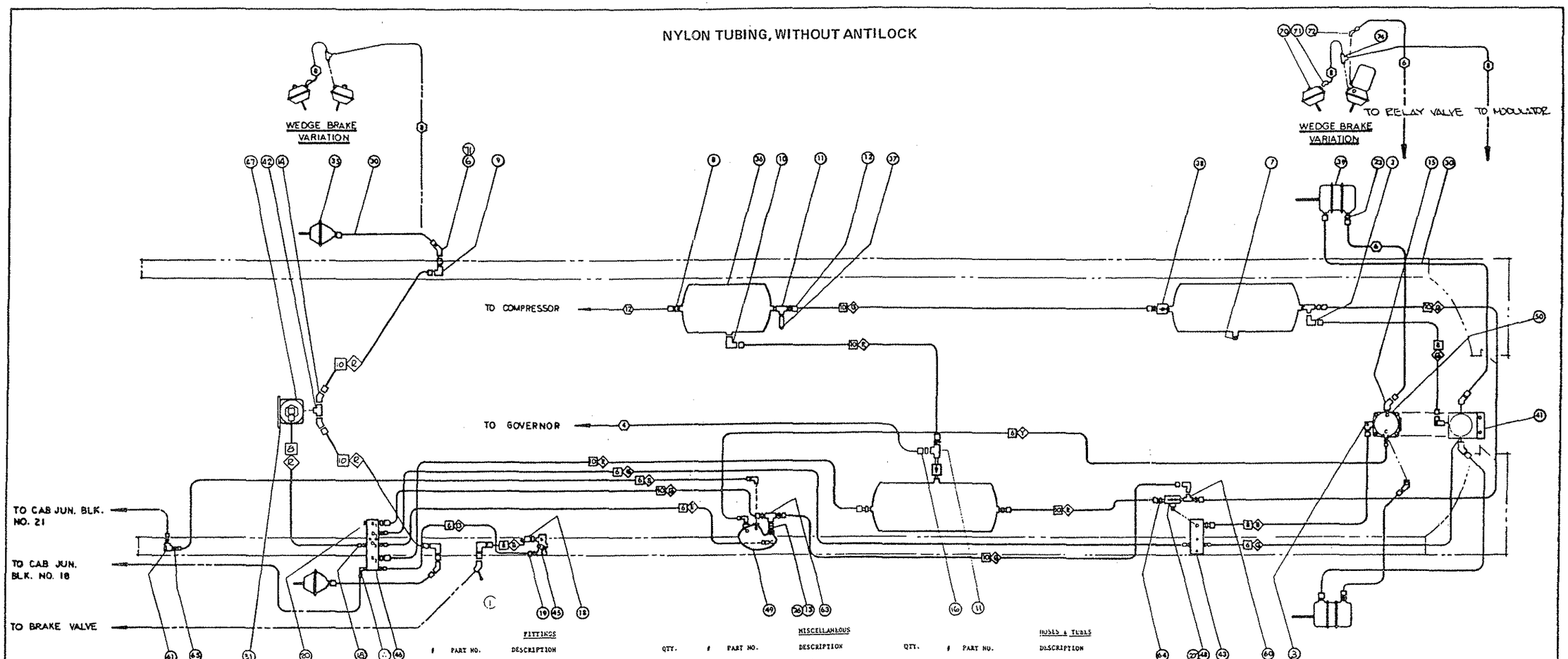


BENDIX COMBINATION VALVE

DETAIL "F"

COE SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12740



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9...-0	45° Male Elbow, (3/8 NPT - ¼ NT)	4
2	A12-10491-0	Anchor Coupling 3/8 MPT	3
3	23-9295-012	90° Male Elbow (3/8 NPT - ¼ NT)	3
4	23-929...-008	90° Male Elbow (¼ NPT - 3/8 NT)	4
5			
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9268-003	Plug (¼NPT)	1
8	23-9327-046	Male Connector, 45° Flare (1/2 NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-015	90° Male Elbow (¼ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee-Special	5
12	23-9301-021	Male Coupling (¼ NPT - 5/8 NT)	10
13	23-9309-002	Nipple (¼NPT)	1
14	23-9295-008	45° Male Elbow (3/8 NPT-¼ NPT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9321-052	Male Conn., 45° Flare (5/8 NPT - ½ Hose)	1
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	1
19	23-9301-012	Male Coupling (¼ NPT _ 3/8 NT)	6
20	23-9268-003	Plug (¼ NPT)	1
21			
22	23-9...-0	45° Male Elbow, (¼ NPT - 3/8 NT)	7
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	3
24			
25			
26	23-9429-402	Reducer (¼ NPT - ¼ NPT)	1
27	23-9530-106	Nipple Hex. (3/8 NPT)	1
28			

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35		See Front Axle Assembly	
36	M12-10545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39		See Rear Axle Assembly	
40			
41	12-10474-0	BRKT MOUNTING	1
42	23-9693-008	TEE, MALE BRANCH (3/8 NPT)	1
43	12-10459-1	Frame Jun. Block, Rear	1
44			
45		2 P. P. Valve	1
46	12-10458-5	Frame Junc. Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	2

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
60	23-9313-003	Street Tee (3/8 NPT)	1
61	23-9496-003	Elbow, Anchor (3/8 NPT)	1
62			
63	23-9693-008	Male Tee (¼ NPT)	1
64	23-9301-020	Male Coupling (3/8 NPT-5/8 NT)	2
65	23-9301-013	Male Coupling (3/8 NPT-3/8 NT)	2
81	12-10476-0	BRACKET, MOUNTING	1

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	4
(4)	A23-2232-L	Hose Assembly No. 4	
(6)	A23-2233-L	Hose Assembly No. 6	
(8)	A23-2234-L	Hose Assembly No. 8	
(10)	A23-2235-L	Hose Assembly No. 10	
(12)	A23-2236-L	Hose Assembly No. 12	
(6)	48-101-014	Nylon Tube No. 6 Yellow	
(6)	48-101-010	Nylon Tube No. 6 Black	
(6)	48-101-015	Nylon Tube No. 6 Green	
(6)	48-101-013	Nylon Tube No. 6 Orange	
(6)	48-101-012	Nylon Tube No. 6 Red	
(8)	48-101-020	Nylon Tube No. 8 Black	
(8)	48-101-025	Nylon Tube No. 8 Green	
(8)	48-101-022	Nylon Tube No. 8 Red	
(10)	48-101-035	Nylon Tube No. 10 Green	
(10)	48-101-032	Nylon Tube No. 10 Red	

MECH. BRAKE VARIATION

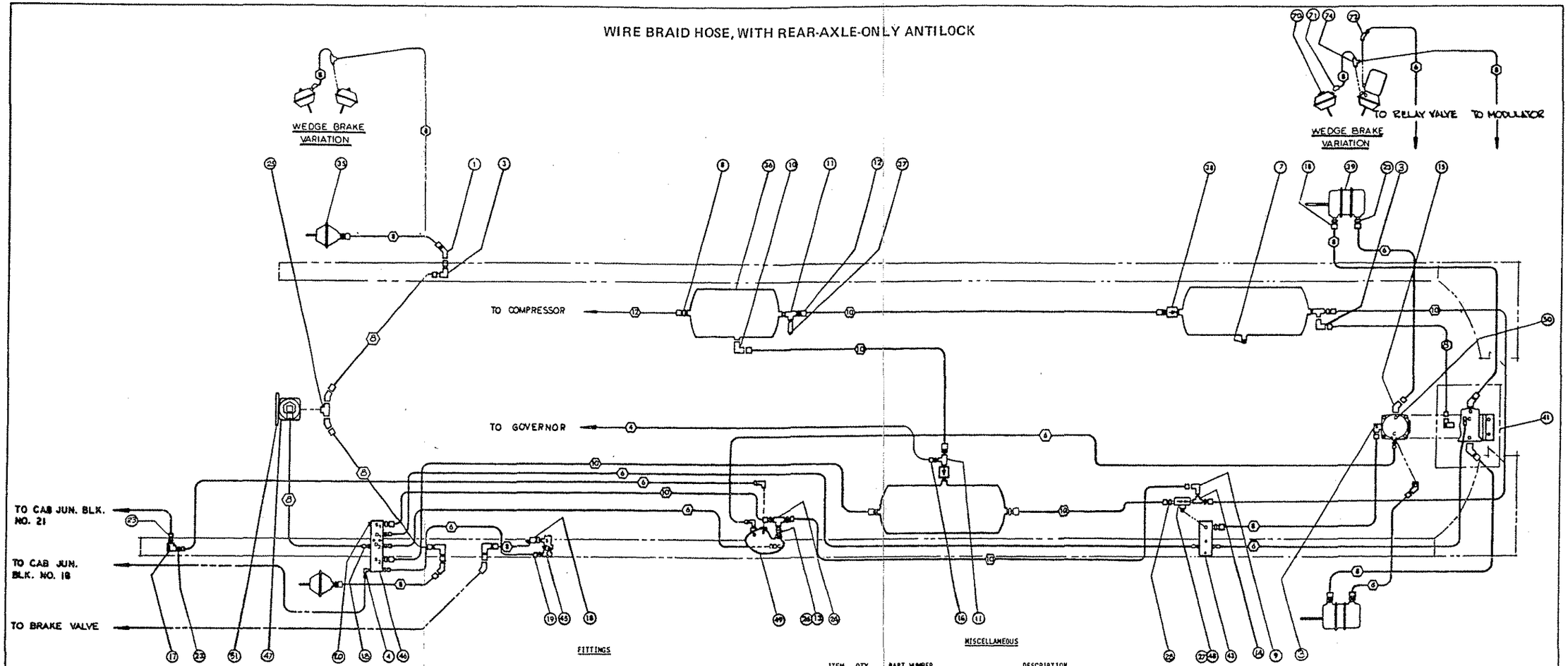
#	PART NO.	DESCRIPTION	QTY.
70	23-9268-004	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

D12-11180 ENG. CHG. LTR. C

Service

BRAKE CONTROL 12
32-12740

COE SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	8	23-9326-034	ELBOW, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	3	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	6	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	4	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	1	23-9328-035	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 5/8 HOSE)
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	3	12-10492-0	TEE, STREET, SPECIAL
12	10	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13	1	23-9309-002	NIPPLE (1/4 NPT)
14	1	23-9313-003	TEE, STREET (3/8 NPT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9327-032	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	7	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	6	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	5	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9693-008	TEE, MALE (1/2 NPT)
25	1	23-9693-006	TEE, MALE, BRANCH (3/8 NPT)
26	1	23-9429-402	REDUCER (1/2 NPT - 1/4 NPT)
27	1	23-9550-106	NIPPLE HEX. (3/8 NPT)
28	2	23-9327-035	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 5/8 HOSE)
29			
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31	1	12-10476-0	BRACKET, MOUNTING
32			
33			
34			
35		SEE FRONT AXLE ASSEMBLY	
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	2		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSEMBLY	
40			
41		SEE ANTI-LOCK INST.	
42			
43	1	12-10459-1	BLOCK, FRAME JUN., REAR
44			
45	1		VALVE, T.P.
46	1	12-10458-5	BLOCK, FRAME JUN., FRONT
47	1		VALVE, RATIO
48	1		VALVE, CHECK, TWO-WAY
49	1		VALVE, CONTROL, SPRING BRAKE
50	1		VALVE, RELAY

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)

HOSES & TUBES

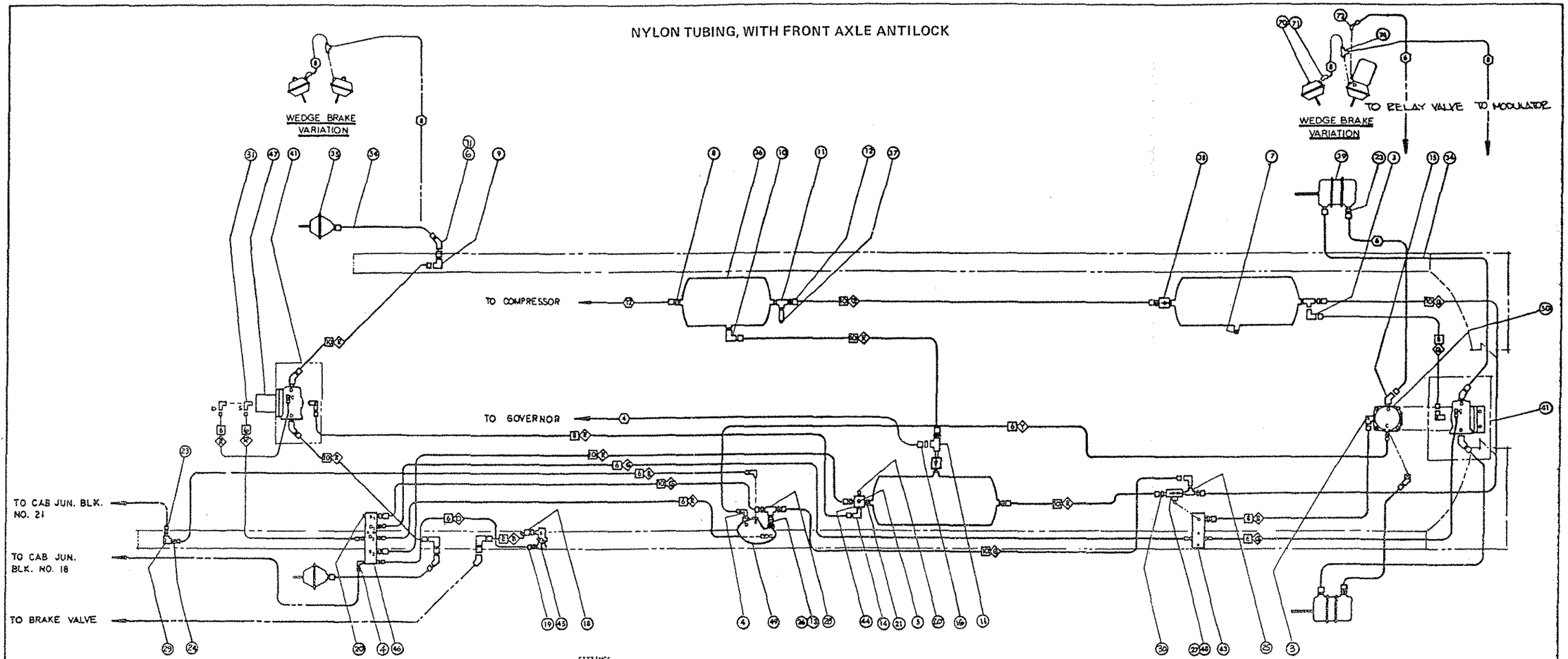
ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSEMBLY NO. 4
6		A23-2233-L	HOSE ASSEMBLY NO. 6
8		A23-2234-L	HOSE ASSEMBLY NO. 8
10		A23-2235-L	HOSE ASSEMBLY NO. 10
12		A23-2236-L	HOSE ASSEMBLY NO. 12

D12-10955 ENG. CHG.. LTR. B

COE SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12740

NYLON TUBING, WITH FRONT AXLE ANTILOCK



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	2	23-9301-020	COUPLING, MALE (3/8 NPT - 5/8 NT)
31	2	23-9295-008	ELBOW, MALE, 90° (3/8 NPT - 3/8 NT)
32			
33			
34	4	A12-10505-000	HOSE ASSY , AIR BRAKE
35		SEE FRONT AXLE ASSY.	
36		M12-10545	INST., AIR RESERVOIR
37	1		VALVE, AIR SAFETY
38	2		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSY.	
40			
41		SEE ANTI-LOCK INST.	
42			
43	1	12-10459-001	JUNCTION BLOCK, FRAME, REAR
44	1	12-10511-000	JUNCTION BLOCK, AIR RESERVOIR
45	1		VALVE, T.P.
46	1	12-10458-005	JUNCTION BLOCK, FRAME, FRONT
47	1		VALVE, RATIO
48	1		VALVE, CHECK, TWO WAY
49	1		VALVE, CONTROL, SPRING BRAKE
50	1		VALVE, RELAY.

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9293-007	ELBOW, MALE 45°, (3/8 NPT - 1/2 NT)
2	3	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	3	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	4	23-9296-005	ELBOW, MALE, 90° (1/4 NPT - 3/8 NT)
5	2	23-9268-004	PLUG (3/8 NPT)
6	2	23-11341-000	ELBOW, 45° ADAPTER (3/8 NPT - 3/8 MPT)
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	3	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	3	12-10492-000	TEE, STREET, SPECIAL
12	10	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13	1	23-9309-002	NIPPLE (1/4 NPT)
14	1	23-9295-011	ELBOW, MALE, 90° (1/2 NPT - 1/2 NT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9327-032	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/4 HOSE)
18	2	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	6	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20	2	23-2268-003	PLUG (1/4 NPT)
21	1	23-9530-008	NIPPLE, HEX (1/2 NPT)
22	1	23-9293-005	ELBOW, MALE, 45°, (1/4 NPT - 3/8 NT)
23	3	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	3	23-9301-013	COUPLING, MALE (3/8 NPT - 3/8 NT)
25	1	23-9313-003	TEE, STREET (3/8 NPT)
26	1	23-9429-402	REDUCER (1/2 NPT - 1/4 NPT)
27	1	23-9530-106	NIPPLE, HEX (3/8 NPT)
28	1	23-9693-008	TEE, MALE (1/2 NPT)
29	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSY #4
6		A23-2233-L	HOSE ASSY #6
8		A23-2234-L	HOSE ASSY #8
10		A23-2235-L	HOSE ASSY #10
12		A23-2236-L	HOSE ASSY #12
6 B		48-101-010	TUBE, NYLON, #6, BLACK
6 G		48-101-015	TUBE, NYLON, #6, GREEN
6 O		48-101-013	TUBE, NYLON #6, ORANGE
6 R		48-101-012	TUBE, NYLON, #6, RED
6 Y		48-101-014	TUBE, NYLON, #6, YELLOW
8 B		48-101-020	TUBE, NYLON, #8, BLACK
8 G		48-101-025	TUBE, NYLON, #8, GREEN
8 R		48-101-022	TUBE, NYLON, #8, RED
10 G		48-101-035	TUBE, NYLON, #10, GREEN
10 R		48-101-032	TUBE, NYLON, #10, RED

WEDGE BRAKE VARIATION

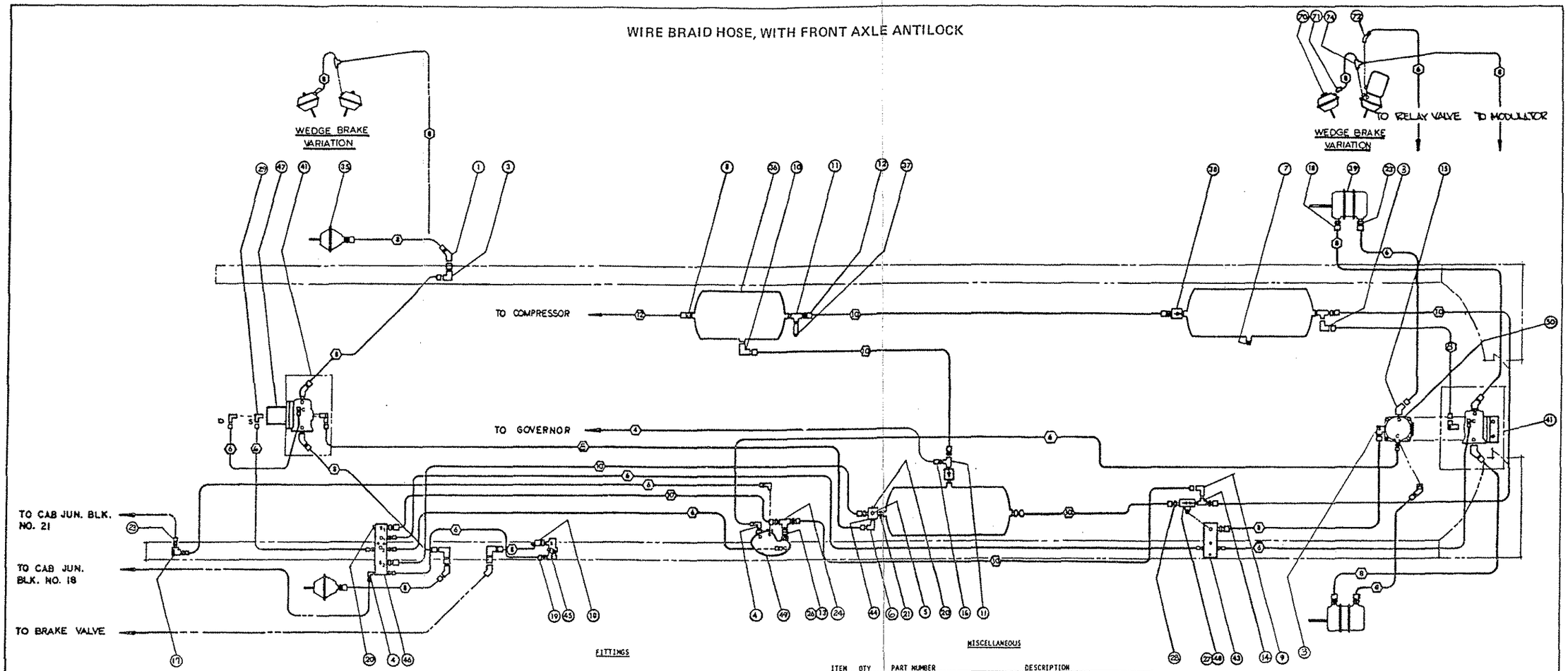
ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

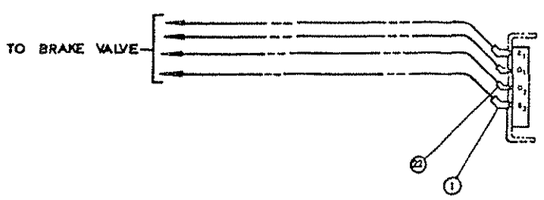
D12-10965 ENG. CHG. LTR. D

Service

BRAKE CONTROL 12
32-12740

COE SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM





FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	5	23-9326-034	ELBOW, MALE, 45° 45° FLARE (3/8 NPT - 1/2 HOSE)
2	3	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	5	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	4	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5	2	23-9268-004	PLUG (3/8 NPT)
6	1	23-9328-024	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 1/2 HOSE)
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	1	23-9328-035	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 5/8 HOSE)
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	3	12-10492-0	TEE, STREET, SPECIAL
12	10	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13	1	23-9309-002	NIPPLE (1/4 NPT)
14	1	23-9313-003	TEE, STREET (3/8 NPT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9321-032	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	6	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	6	23-9327-021	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	2	23-9268-003	PLUG (1/4 NPT)
21	1	23-9530-008	NIPPLE, HEX (1/2 NPT)
22	2	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	6	23-9327-031	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9693-008	TEE, MALE (1/2 NPT)
25			
26	1	23-9429-402	REDUCER (1/2 NPT - 1/4 NPT)
27	1	23-9530-106	NIPPLE, HEX (3/8 NPT)
28	2	23-9327-035	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 5/8 HOSE)
29	2	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31			
32			
33			
34			
35			SEE FRONT AXLE ASSEMBLY
36		W12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	2		VALVE, CHECK, SINGLE
39			SEE REAR AXLE ASSEMBLY
40			
41			SEE ANTI-LOCK INST.
42			
43	1	12-10459-1	BLOCK, FRAME JUM., REAR
44	1	12-10511-0	BLOCK, JUN., AIR RESERVOIR
45	1		VALVE, T.P.
46	1	12-10458-1	BLOCK, FRAME JUM., FRONT
47	1		VALVE, RATIO
48	1		VALVE, CHECK, TWO-WAY
49	1		VALVE, CONTROL, SPRING BRAKE
50	1		VALVE, RELAY

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSEMBLY NO. 4
6		A23-2233-L	HOSE ASSEMBLY NO. 6
8		A23-2234-L	HOSE ASSEMBLY NO. 8
10		A23-2235-L	HOSE ASSEMBLY NO. 10
12		A23-2236-L	HOSE ASSEMBLY NO. 12

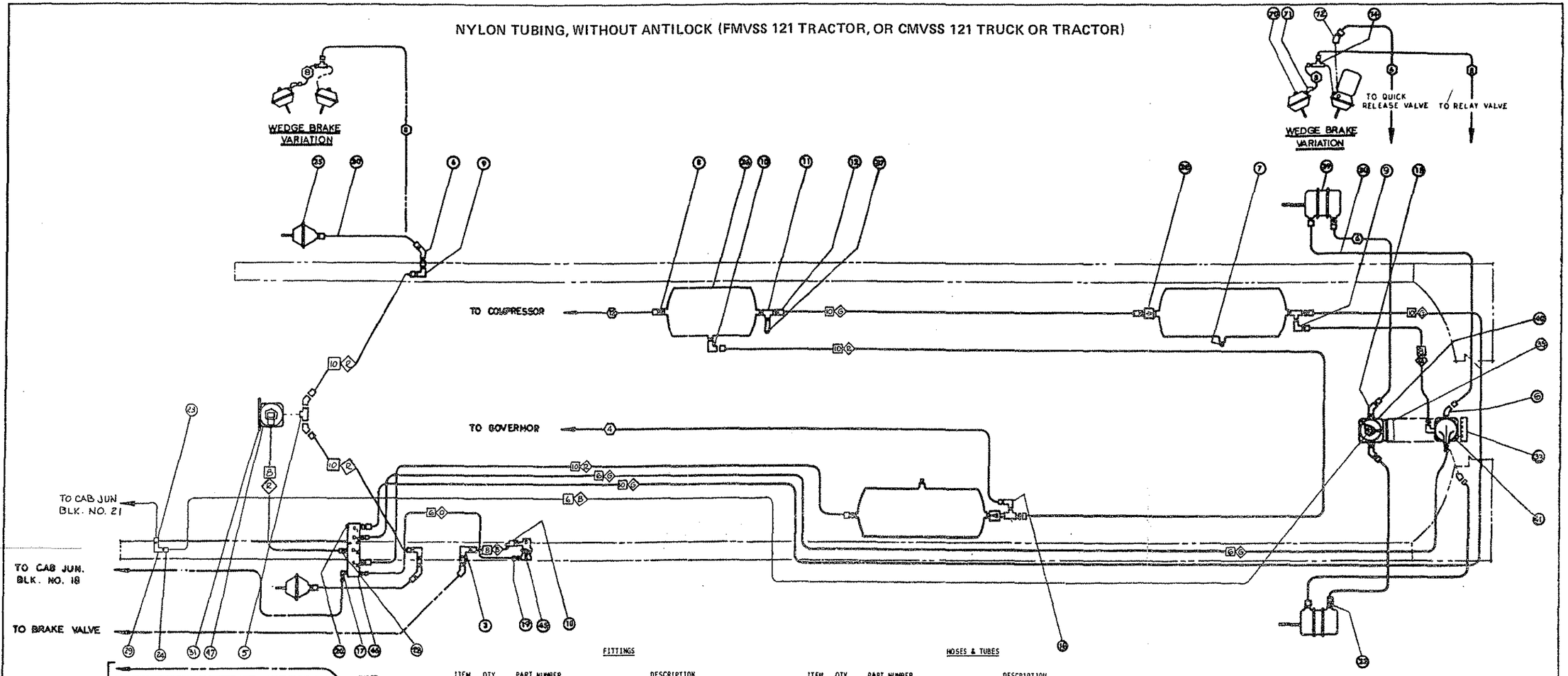
D12-10953 ENG. CHG. LTR. 8

Service

COE SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12742

NYLON TUBING, WITHOUT ANTILOCK (FMVSS 121 TRACTOR, OR CMVSS 121 TRUCK OR TRACTOR)



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	4	A12-10505-000	HOSE ASSY., AIR BRAKE
31	1	12-10476-000	BRKT, MOUNTING
32			
33	2	12-10474-000	BRKT, MOUNTING
34			
35		SEE FRONT AXLE ASSY.	
36		M12-10545	INST., AIR RESERVOIR
37	1		VALVE, AIR SAFETY
38	2		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSY.	
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43			
44			
45	1		VALVE, T.P.
46	1	12-10458-4	JUNCTION BLOCK, FRAME, FRONT
47	1		VALVE, RATIO
48			
49			
50			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9293-007	ELBOW, MALE 45°, (3/8 NPT - 1/2 NT)
2	3	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	2	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4			
5	1	23-9693-006	TEE, MALE, BRANCH (3/8 NPT)
6	4	23-11341-000	ELBOW, 45°, ADAPTER (3/8 NPT - 3/4 UNF)
7	2	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	4	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	3	12-10492-000	TEE, STREET, SPECIAL
12	7	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT - 3/8 NT)
14	2	23-9293-008	ELBOW, MALE, 45° (3/8 NPT - 5/8 NPT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9294-009	ELBOW, MALE, 90°, (1/4 NPT - 3/8 NT)
18	1	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	4	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9293-005	ELBOW, MALE, 45°, (1/4 NPT - 3/8 NT)
23	3	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9301-013	COUPLING, MALE (3/8 NPT - 3/8 NT)
25			
26			
27			
28	1	23-9301-016	COUPLING, MALE (1/4 NPT - 1/2 NT)
29	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSY #4
6		A23-2233-L	HOSE ASSY #6
8		A23-2234-L	HOSE ASSY #8
10		A23-2235-L	HOSE ASSY #10
12		A23-2236-L	HOSE ASSY #12
6 B		48-101-010	TUBE, NYLON, #6, BLACK
6 G		48-101-015	TUBE, NYLON, #6, GREEN
6 O		48-101-013	TUBE, NYLON #6, ORANGE
6 R		48-101-012	TUBE, NYLON, #6, RED
8 B		48-101-020	TUBE, NYLON, #8, BLACK
8 G		48-101-025	TUBE, NYLON, #8, GREEN
8 R		48-101-022	TUBE, NYLON, #8, RED
10 G		48-101-035	TUBE, NYLON, #10, GREEN
10 R		48-101-032	TUBE, NYLON, #10, RED

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10970 ENG. CHG. LTR. D

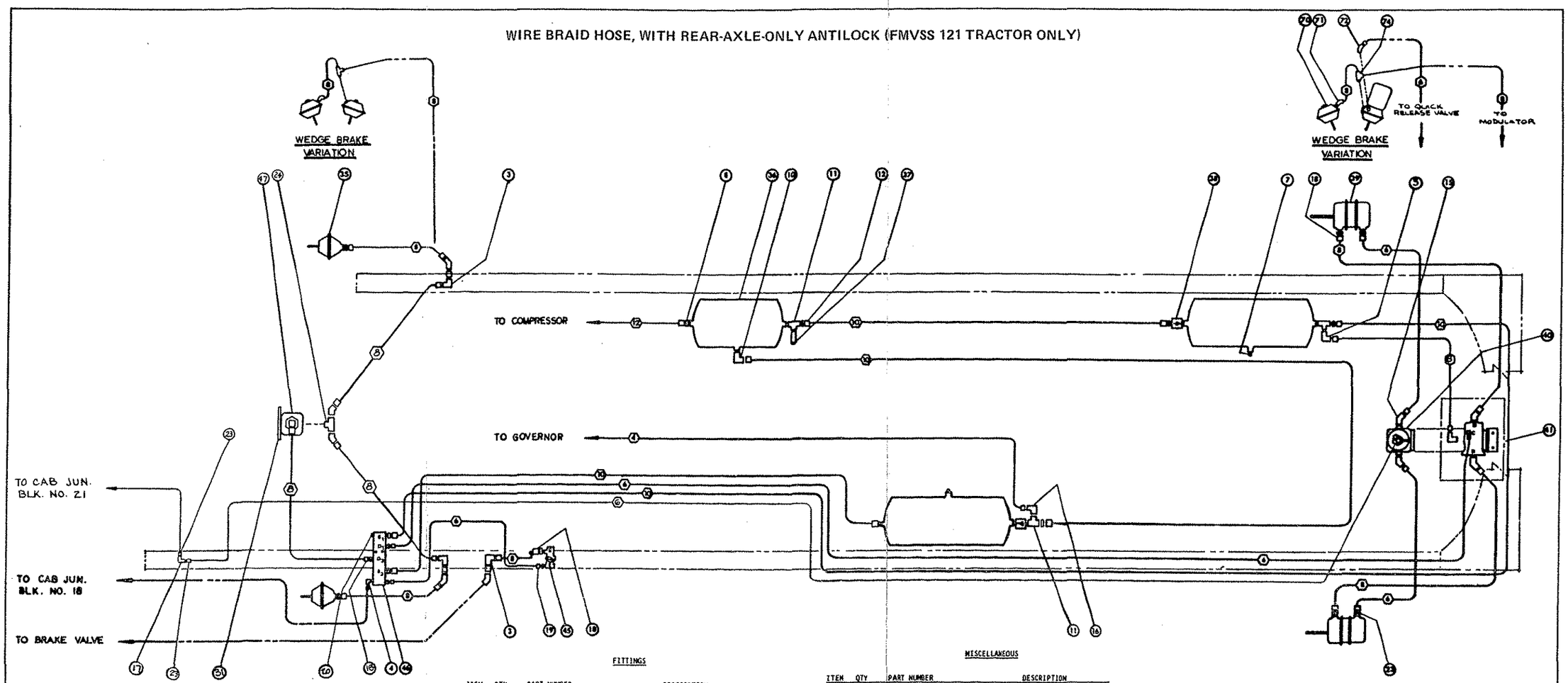
Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12742

COE SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

WIRE BRAID HOSE, WITH REAR-AXLE-ONLY ANTILOCK (FMVSS 121 TRACTOR ONLY)



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	8	23-9326-034	ELBOW, MALE 45° 45° FLARE (3/8 NPT - 1/2 HOSE)
2	3	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	5	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	1	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7	2	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	3	12-10492-0	TEE, STREET, SPECIAL
12	7	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	6	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	3	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	4	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9693-006	TEE, MALE, BRANCH (3/8 NPT)
25	1	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27			
28			
29			
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31	1	12-10476-0	BRACKET, MOUNTING
32			
33			
34			
35		SEE FRONT AXLE ASSEMBLY	
36		N12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	2		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSEMBLY	
40			
41		SEE ANTI-LOCK INST.	
42			
43			
44			
45	1		VALVE, T.P.
46	1	12-10458-◆	BLOCK, FRAME JUN., FRONT
47	1		VALVE, RATIO
48			
49			
50			

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)

HOSES & TUBES

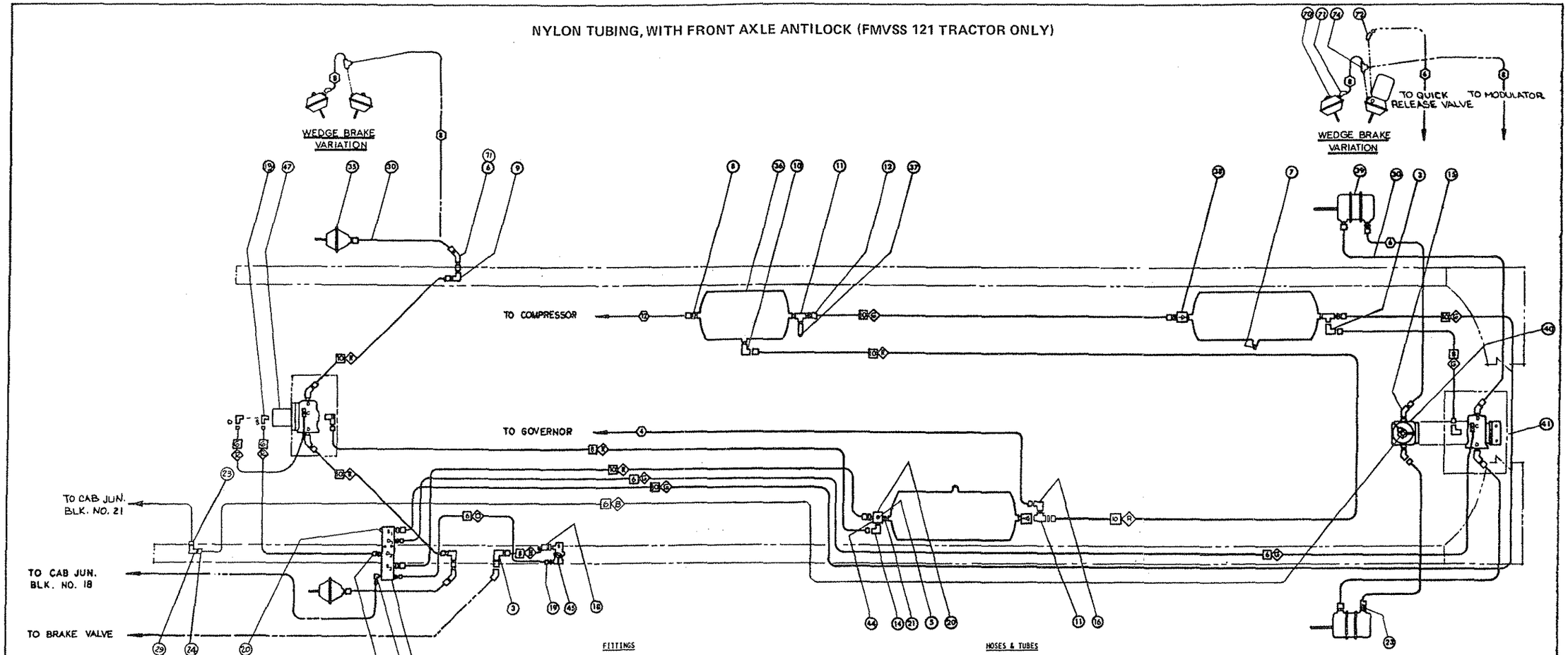
ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSEMBLY NO. 4
6		A23-2233-L	HOSE ASSEMBLY NO. 6
8		A23-2234-L	HOSE ASSEMBLY NO. 8
10		A23-2235-L	HOSE ASSEMBLY NO. 10
12		A23-2236-L	HOSE ASSEMBLY NO. 12

D12-10957 ENG. CHG. LTR. A

COE SINGLE REAR AXLE TRACTOR (FMVSS 121),
OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12742

NYLON TUBING, WITH FRONT AXLE ANTILOCK (FMVSS 121 TRACTOR ONLY)



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	4	A12-10505-000	HOSE ASSY , AIR BRAKE
31			
32			
33			
34			
35		SEE FRONT AXLE ASSY.	
36		N12-10545	INST., AIR RESERVOIR
37	1		VALVE, AIR SAFETY
38	2		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSY.	
40	1		VALVE, QUICK RELEASE
41		SEE ANTI-LOCK INST.	
42			
43			
44	1	12-10511-0	JUNCTION BLOCK, AIR RESERVOIR
45	1		VALVE, T.P.
46	1	12-10458-4	JUNCTION BLOCK, FRAME, FRONT
47	1		VALVE, RATIO
48			
49			
50			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9295-007	ELBOW, MALE 45°, (3/8 NPT - 1/2 NT)
2	3	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	2	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4			
5	2	23-9268-004	PLUG (3/8 NPT)
6	2	23-11341-000	ELBOW, 45° ADAPTER (3/8 NPT - 3/4 NPT)
7	2	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	2	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	3	12-10492-000	TEE, STREET, SPECIAL
12	7	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13	3	23-9295-008	ELBOW, MALE, 90° (3/8 NPT - 3/8 NT)
14	1	23-9295-011	ELBOW, MALE, 90° (1/2 NPT - 1/2 NT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9256-000	ELBOW, MALE, 90°, (1/4 NPT - 3/8 NT)
18	1	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	3	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20	2	23-9268-003	PLUG (1/4 NPT)
21	1	23-9530-008	NIPPLE, HEX (1/2 NPT)
22	1	23-9295-005	ELBOW, MALE, 45°, (1/4 NPT - 3/8 NT)
23	3	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9301-013	COUPLING, MALE (3/8 NPT - 3/8 NT)
25			
26			
27			
28			
29	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSY #4
6		A23-2233-L	HOSE ASSY #6
8		A23-2234-L	HOSE ASSY #8
10		A23-2235-L	HOSE ASSY #10
12		A23-2236-L	HOSE ASSY #12
6 B		48-101-010	TUBE, NYLON, #6, BLACK
6 G		48-101-015	TUBE, NYLON, #6, GREEN
6 O		48-101-013	TUBE, NYLON #6, ORANGE
6 R		48-101-012	TUBE, NYLON, #6, RED
8 B		48-101-020	TUBE, NYLON, #8, BLACK
8 G		48-101-025	TUBE, NYLON, #8, GREEN
8 R		48-101-022	TUBE, NYLON, #8, RED
10 G		48-101-035	TUBE, NYLON, #10, GREEN
10 R		48-101-032	TUBE, NYLON, #10, RED

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10971 ENG. CHG. LTR. C

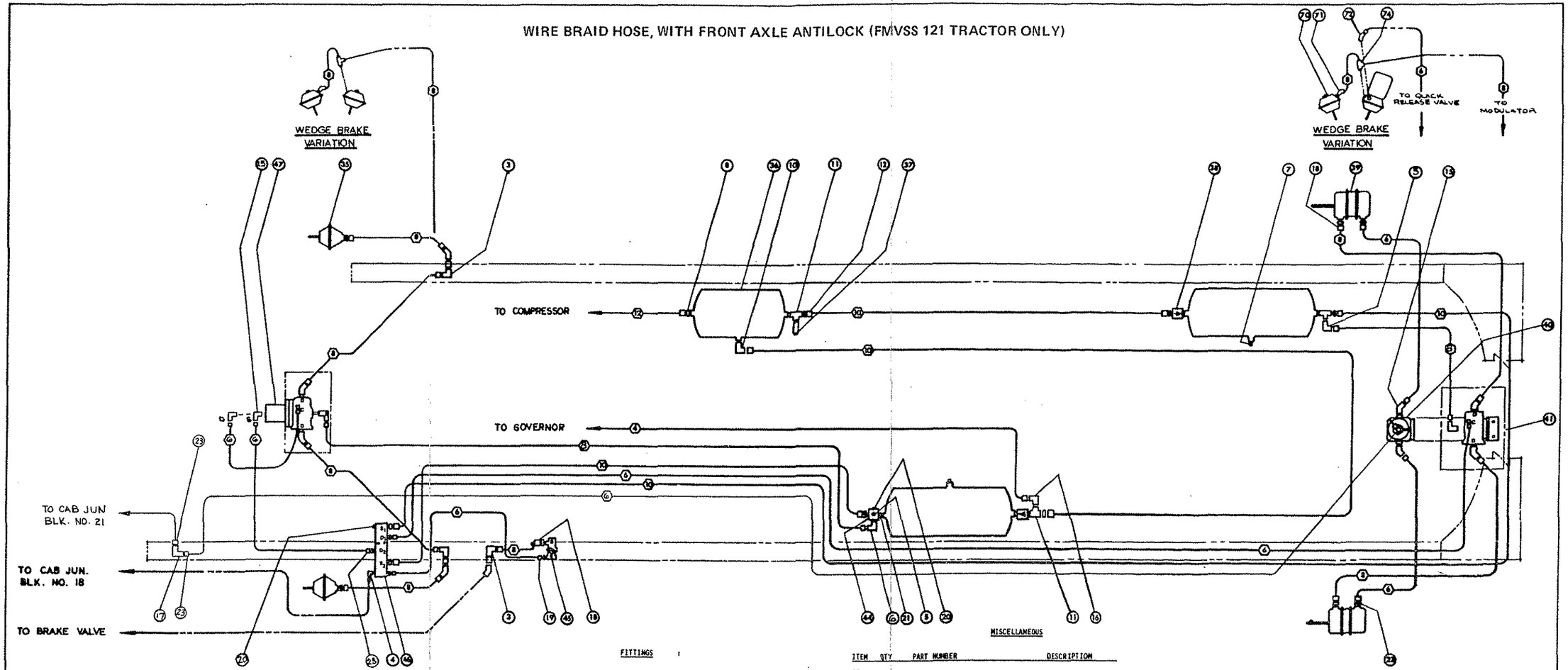
Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12742

COE SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

WIRE BRAID HOSE, WITH FRONT AXLE ANTILOCK (FMVSS 121 TRACTOR ONLY)



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	5	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	3	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	4	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	1	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5	2	23-9268-004	PLUG (3/8 NPT)
6	1	23-9328-024	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 1/2 HOSE)
7	2	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	3	12-10492-0	TEE, STREET, SPECIAL
12	7	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	5	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	3	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	2	23-9268-003	PLUG (1/4 NPT)
21	1	23-9530-008	NIPPLE, HEX (1/2 NPT)
22	2	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	5	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25	3	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27			
28			
29			
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31			
32			
33			
34			
35		SEE FRONT AXLE ASSEMBLY	
36		N12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	2		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSEMBLY	
40	1		VALVE, QUICK RELEASE
41		SEE ANTI-LOCK INST.	
42			
43			
44	1	12-1Q511-0	BLOCK, JUN., AIR RESERVOIR
45	1		VALVE, T.P.
46	1	12-10458-0	BLOCK, FRAME JUN., FRONT
47	1		VALVE, RATIO
48			
49			
50			

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
(4)		A23-2232-L	HOSE ASSEMBLY NO. 4
(6)		A23-2233-L	HOSE ASSEMBLY NO. 6
(8)		A23-2234-L	HOSE ASSEMBLY NO. 8
(10)		A23-2235-L	HOSE ASSEMBLY NO. 10
(12)		A23-2236-L	HOSE ASSEMBLY NO. 12

WEDGE BRAKE VARIATION

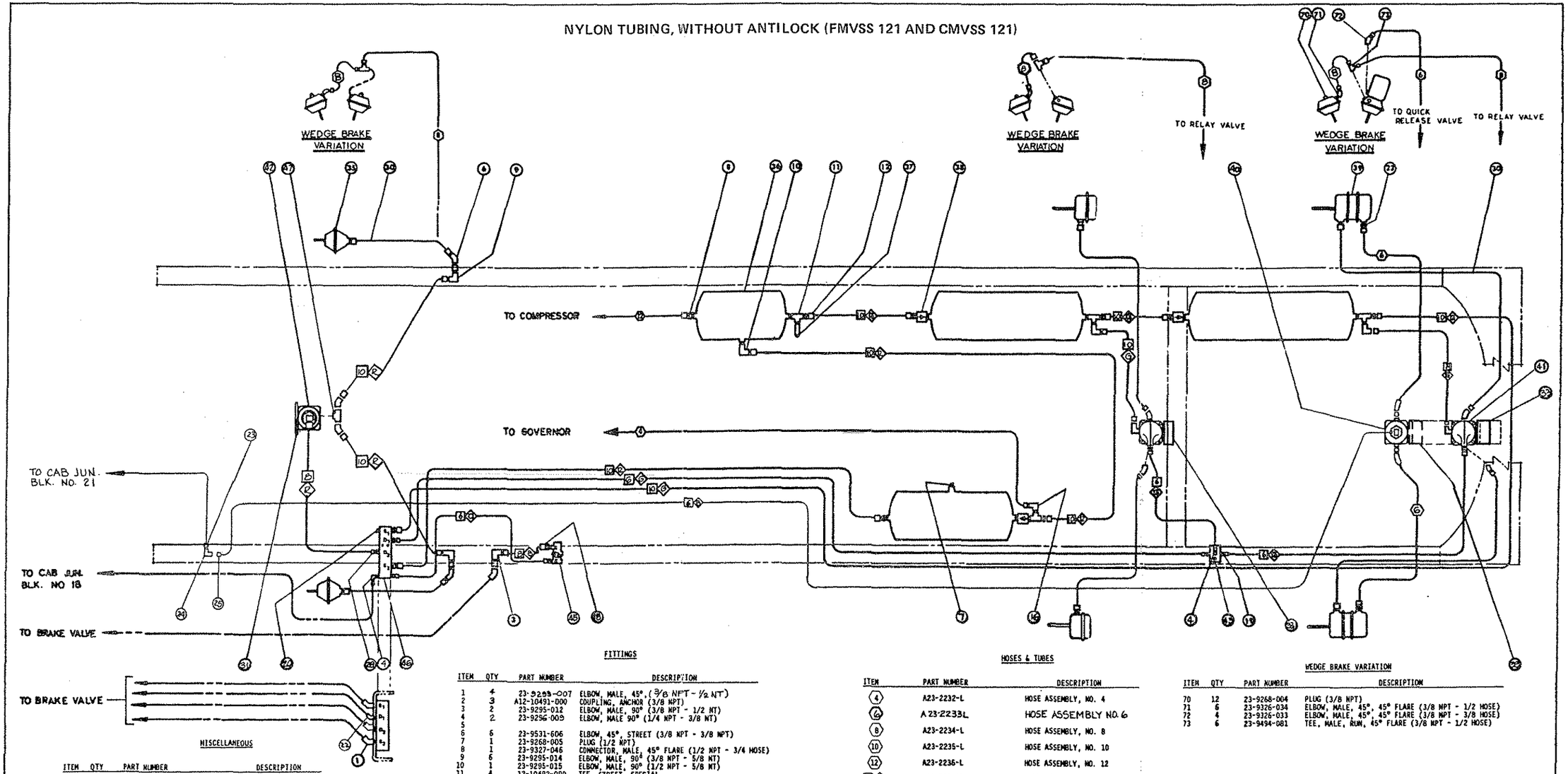
ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10963 ENG. CHG. LTR. A

COE TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12746

NYLON TUBING, WITHOUT ANTILOCK (FMVSS 121 AND CMVSS 121)



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	6	A12-10505-000	HOSE ASSY, AIR BRAKE
31	1	12-10476-000	BRKT, MOUNTING
32			
33	3	12-10474-000	BRKT, MOUNTING
34			
35		SEE FRONT AXLE ASSY.	
36		W12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39		SEE REAR AXLE ASSY.	
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42	1		VALVE, RATIO
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46	1	12-10458-004	JUNCTION BLOCK, FRAME, FRONT
47			
48			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9293-007	ELBOW, MALE, 45°, (3/8 NPT - 1/2 NT)
2	3	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	2	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	2	23-9296-005	ELBOW, MALE 90° (1/4 NPT - 3/8 NT)
5			
6	6	23-9531-606	ELBOW, 45°, STREET (3/8 NPT - 3/8 NPT)
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	6	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	9	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT) - 3/8 NT)
14	2	23-9293-008	ELBOW, MALE, 45° (3/8 NPT - 5/8 NT)
15	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17			
18	1	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	7	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20	1	23-9268-003	PLUG (1/4 NPT)
21	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
22	1	23-9293-005	ELBOW, MALE, 45°, (1/4 NPT - 3/8 NT)
23	3	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
25	1	23-9301-013	MALE COUPLING (3/8 NPT - 3/8 NT)
26			
27			
28	1	23-9301-016	COUPLING, MALE (1/4 NPT - 1/2 NT)
29			

HOSES & TUBES

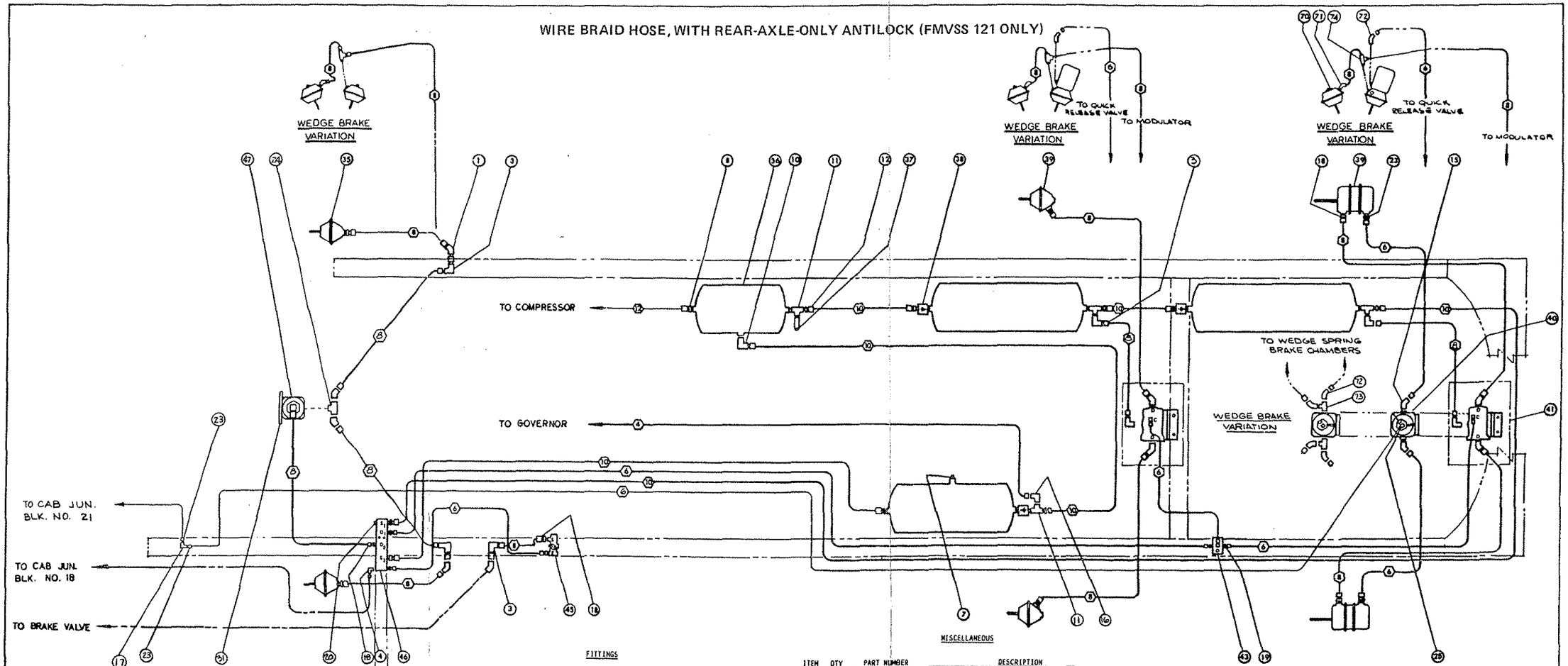
ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233L	HOSE ASSEMBLY NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12
6 8	48-101-010	TUBE, NYLON, NO. 6, BLACK
6 G	48-101-015	TUBE, NYLON, NO. 6, GREEN
6 O	48-101-013	TUBE, NYLON, NO. 6, ORANGE
6 R	48-101-012	TUBE, NYLON, NO. 6, RED
8 8	48-101-020	TUBE, NYLON, NO. 8, BLACK
8 G	48-101-025	TUBE, NYLON, NO. 8, GREEN
8 R	48-101-022	TUBE, NYLON, NO. 8, RED
10 G	48-101-035	TUBE, NYLON, NO. 10, GREEN
10 R	48-101-032	TUBE, NYLON, NO. 10, RED

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9268-004	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11183 ENG. CHG. LTR.C

COE TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	8	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	3	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	6	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	2	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	4	12-10492-0	TEE, STREET, SPECIAL
12	9	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	8	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	5	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	4	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9693-006	TEE, MALE, BRANCH
25	1	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27			
28			
29			
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31	1	12-10476-0	BRACKET, MOUNTING
32			
33			
34			
35		SEE FRONT AXLE ASSEMBLY	
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	3		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSEMBLY	
40	1		VALVE, QUICK RELEASE
41		SEE ANTI-LOCK INST.	
42			
43	1	12-10459-002	BLOCK, FRAME JUN., REAR
44			
45	1		VALVE, T.P.
46	1	12-10458-4	BLOCK, FRAME JUN., FRONT
47	1		VALVE, RATIO
48			
49			
50			

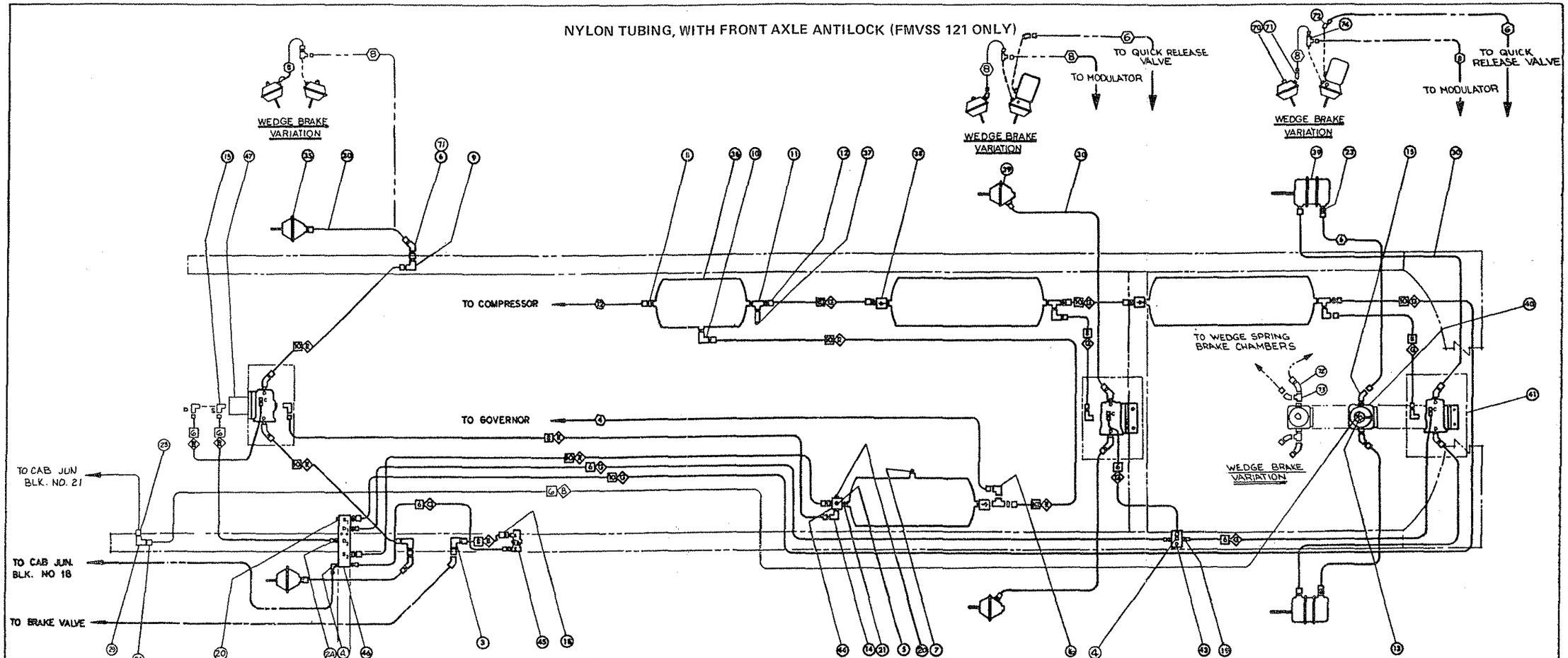
HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSEMBLY NO. 4
6		A23-2233-L	HOSE ASSEMBLY NO. 6
8		A23-2234-L	HOSE ASSEMBLY NO. 8
10		A23-2235-L	HOSE ASSEMBLY NO. 10
12		A23-2236-L	HOSE ASSEMBLY NO. 12

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9268-004	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	8	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	2	23-9312-003	TEE, STREET (3/8 NPT)
74	6	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10958 ENG. CHG. LTR. A



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	6	A12-10505-000	HOSE ASSY., AIR BRAKE
31			
32			
33			
34			
35			SEE FRONT AXLE ASSY.
36		N12-10545	INST., AIR RESERVOIR
37	1		VALVE, AIR SAFETY
38	3		VALVE, CHECK, SINGLE
39			SEE REAR AXLE ASSY.
40	1		VALVE, QUICK RELEASE
41			SEE ANTI-LOCK INST.
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44	1	12-10511-0	JUNCTION BLOCK, AIR RESERVOIR
45	1		VALVE, T.P.
46	1	12-10458-4	JUNCTION BLOCK, FRAME, FRONT
47	1		VALVE, RATIO
48			
49			
50			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9293-007	ELBOW, MALE 45°, (3/8 NPT - 1/2 NT)
2	3	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	3	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	2	23-9295-005	ELBOW, MALE, 90° (1/4 NPT - 3/8 NT)
5	2	23-9268-004	PLUG (3/8 NPT)
6	2	23-11341-000	ELBOW, 45°, ADAPTER (3/8 NPT - 3/4 UNF)
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	2	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	9	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13	3	23-9295-008	ELBOW, MALE, 90° (3/8 NPT - 3/8 NT)
14	2	23-9295-011	ELBOW, MALE, 90° (1/4 NPT - 1/2 NPT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
18	1	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	5	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20	2	23-9268-003	PLUG (1/4 NPT)
21	1	23-9530-008	NIPPLE, HEX (1/2 NPT)
22	1	23-9253-006	ELBOW, MALE, 45°, (1/4 NPT - 3/8 NT)
23	3	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9301-013	COUPLING, MALE (3/8 NPT - 3/8 NT)
25			
26			
27			
28			
29	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSY #4
6		A23-2233-L	HOSE ASSY #6
8		A23-2234-L	HOSE ASSY #8
10		A23-2235-L	HOSE ASSY #10
12		A23-2236-L	HOSE ASSY #12
6 B		48-101-010	TUBE, NYLON, #6, BLACK
6 G		48-101-015	TUBE, NYLON, #6, GREEN
6 O		48-101-013	TUBE, NYLON #6, ORANGE
6 R		48-101-012	TUBE, NYLON, #6, RED
8 B		48-101-020	TUBE, NYLON, #8, BLACK
8 G		48-101-025	TUBE, NYLON, #8, GREEN
8 R		48-101-022	TUBE, NYLON, #8, RED
10 G		48-101-035	TUBE, NYLON, #10, GREEN
10 R		48-101-032	TUBE, NYLON, #10, RED

WEDGE BRAKE VARIATION

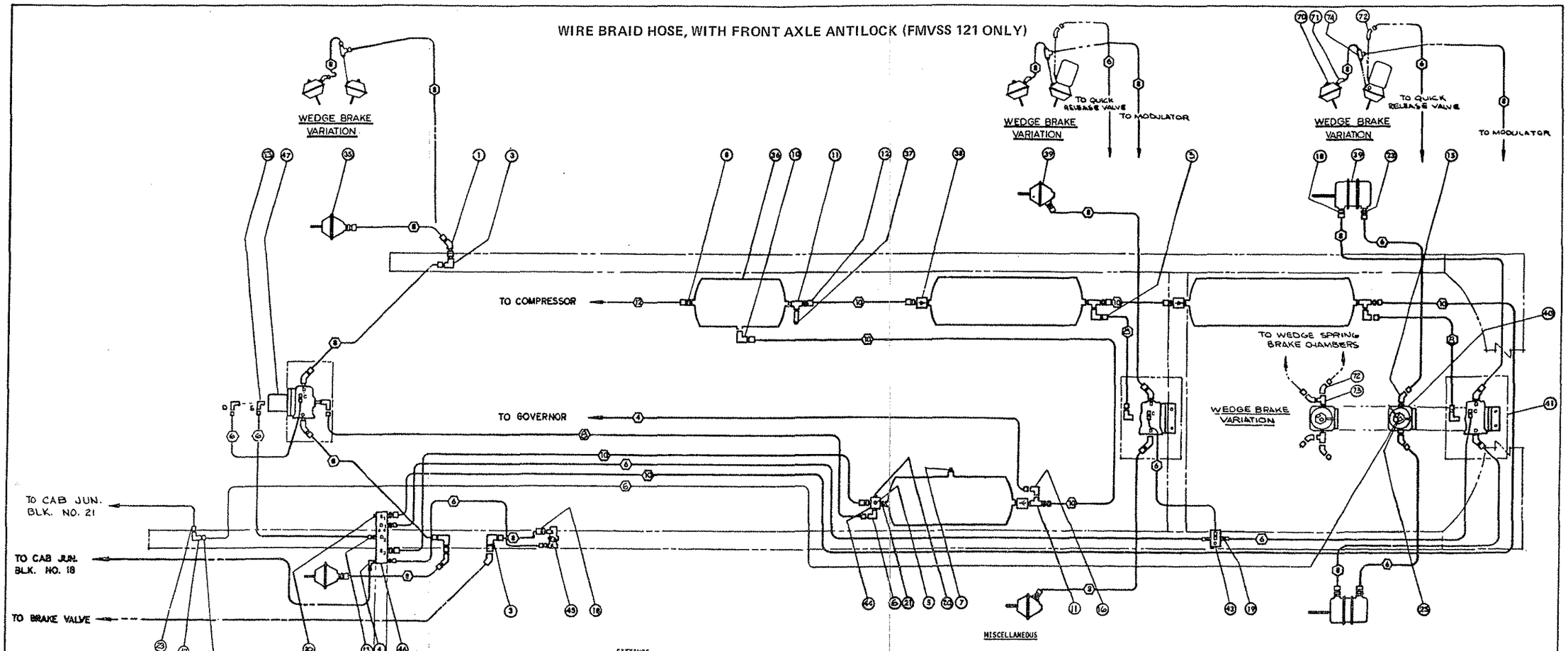
ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9268-004	PLUG (3/8 NPT)
71	8	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	6	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	2	23-9313-003	TEE, STREET (3/8 NPT)
74	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10972 ENG. CHG. LTR.C

Service

BRAKE CONTROL 12
32-12746

COE TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	5	23-9326-034	ELBOW, MALE,45°45° FLARE (3/8 NPT - 1/2 HOSE)
2	3	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	5	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	2	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5	2	23-9268-004	PLUG (3/8 NPT)
6	1	23-9328-024	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 1/2 HOSE)
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	4	12-10492-0	TEE, STREET, SPECIAL
12	5	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE 90° 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	7	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	5	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	2	23-9268-003	PLUG (1/4 NPT)
21	1	23-9530-008	NIPPLE, HEX (1/2 NPT)
22	2	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	5	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25	3	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27			
28			
29			
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31			
32			
33			
34			
35		SEE FRONT AXLE ASSEMBLY	
36		N12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	3		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSEMBLY	
40	1		VALVE, QUICK, RELEASE
41		SEE ANTI-LOCK INST.	
42			
43	1	12-10459-2	BLOCK, FRAME JUN., REAR
44	1	12-10511-0	BLOCK, JUN., AIR RESERVOIR
45	1		VALVE, T.P.
46	1	12-10458-0	BLOCK, FRAME JUN., FRONT
47	1		VALVE, RATIO
48			
49			
50			

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSEMBLY NO. 4
6		A23-2233-L	HOSE ASSEMBLY NO. 6
8		A23-2234-L	HOSE ASSEMBLY NO. 8
10		A23-2235-L	HOSE ASSEMBLY NO. 10
12		A23-2236-L	HOSE ASSEMBLY NO. 12

WEDGE BRAKE VARIATION

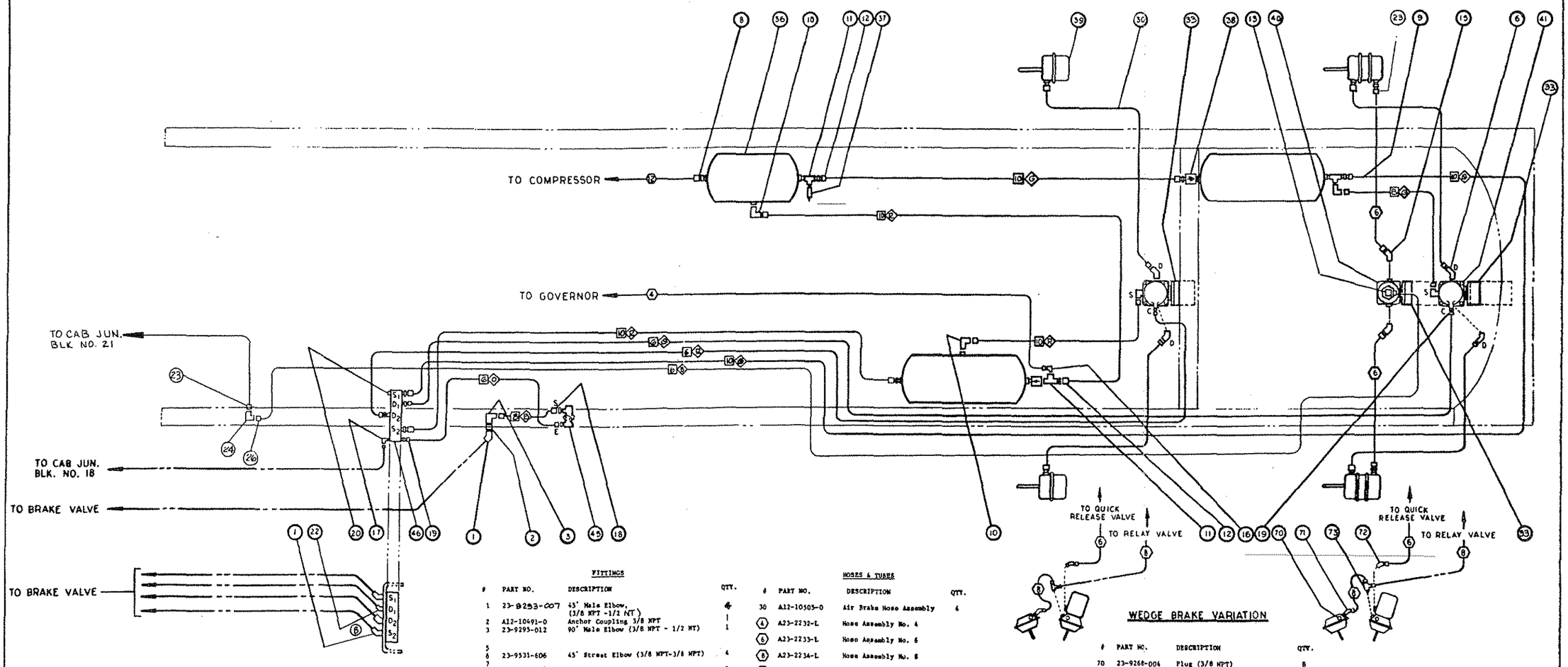
ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9268-004	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	8	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	2	23-9313-003	TEE, STREET (3/8 NPT)
74	6	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10962 ENG. CHG. LTR. A

COE TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12746

NYLON TUBING, WITHOUT FRONT BRAKES, WITHOUT ANTILOCK (CMVSS 121 ONLY)



MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35			
36	M12-10543	Air Reservoirs Inst	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41		Relay Valve,	2
42			
43			
44			
45		T.P. Valve	1
46	12-10458-6	Frame Junction Block, Front	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9283-007	45° Male Elbow, (3/8 NPT -1/2 NT)	4
2	A12-10491-0	Anchor Coupling 3/8 NPT	1
3	23-9293-012	90° Male Elbow (3/8 NPT - 1/2 NT)	1
5			
6	23-9531-606	45° Street Elbow (3/8 NPT-3/8 NPT)	4
7			
8	23-9327-046	Male Connector, 45° Flare (1/2 NPT -3/4 Hose)	1
9	23-9295-014	90° Male Elbow, (3/8 NPT..5/8 NT)	3
10	23-9295-015	90° Male Elbow (½ NPT.- 3/8 NT)	2
11	12-10492-0	Street Tee - Special	1
12	23-9301-021	Male Coupling (1/2 NPT - 3/8 NT)	7
13	23-9295-008	90° Male Elbow (3/8 NPT - 3/8 NT)	1
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (3/8 NPT - 1/4 Hose)	1
17	23-9286-005	90° Male Elbow, (1/4 NPT - 3/8 NT)	1
18	23-9301-017	Male Coupling (3/8 NPT - 1/2 NT)	1
19	23-9301-012	Male Coupling (1/4 NPT - 3/8 NT)	6
20	23-9268-003	Plug (1/4)	1
21			
-22	23-9283-005	45° Male Elbow, (1/4 NPT - 3/8 NT)	1
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	3
24	23-9496-003	ELBOW, ANCHOR (3/8 NPT)	1
26	23-9301-013	MALE COUPLING (5/8 NPT-3/8 NT)	1
27			

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	4
(4)	A23-2232-L	Hose Assembly No. 4	
(6)	A23-2233-L	Hose Assembly No. 6	
(8)	A23-2234-L	Hose Assembly No. 8	
(10)	A23-2235-L	Hose Assembly No. 10	
(12)	A23-2236-L	Hose Assembly No. 12	
6 B	48-101-010	Nylon Tube No. 6 Black	
6 G	48-101-015	Nylon Tube No. 6 Green	
6 O	48-101-013	Nylon Tube No. 6 Orange	
6 R	48-101-012	Nylon Tube No. 6 Red	
8 B	48-101-020	Nylon Tube No. 8 Black	
8 G	48-101-025	Nylon Tube No. 8 Green	
8 R	48-101-022	Nylon Tube No. 8 Red	
10 G	48-101-035	Nylon Tube No. 10 Green	
10 R	48-101-032	Nylon Tube No. 10 Red	
32			
33	12-10474-0	Bracket, Mounting	3

WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9268-004	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - 1/2 Hose)	4
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
73	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - 1/2 Hose)	4

NEXT ASS'Y NUMBER: M12-10702

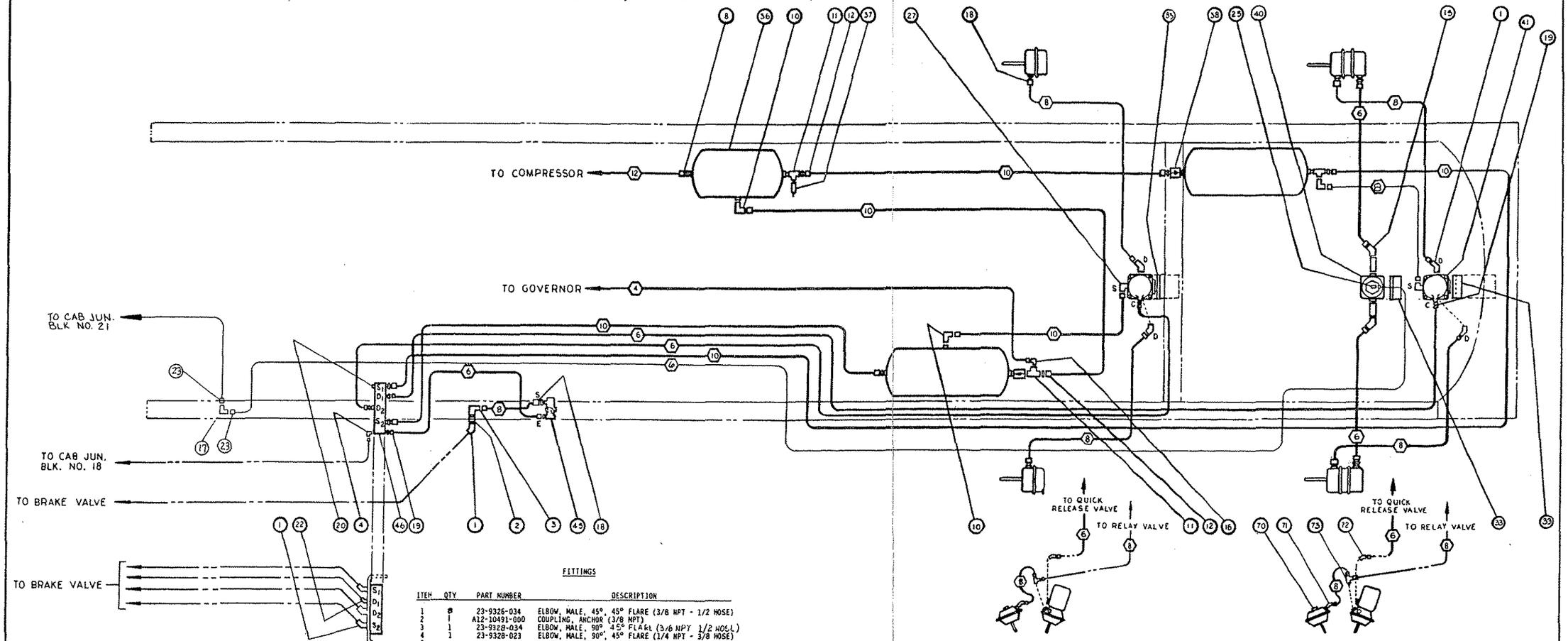
D12-11186 ENG. CHG. LTR. C

Service

BRAKE CONTROL 12
32-12746

COE TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

WIRE BRAID HOSE, WITHOUT FRONT BRAKES, WITHOUT ANTILOCK (CMVSS 121 ONLY)



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30			
31			
32			
33	3	12-10474-000	BRKT, MOUNTING
34			
35			
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	2		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43			
44			
45	1		VALVE, T.P.
46	1	12-10458-004	JUNCTION BLOCK, FRAME, FRONT
47			
48			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	8	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	1	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	1	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	1	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7			
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	2	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	3	12-10492-000	TEE, STREET, SPECIAL
12	7	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	1	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW ANCHOR (3/8 NPT)
18	5	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	6	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	4	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24		23-9313-003	TEE, STREET (3/8 NPT) WEDGE BRAKES ONLY
25	1	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27	3	23-9328-035	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 5/8 HOSE)
28			
29			

HOSES & TUBES

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12

WEDGE BRAKE VARIATION

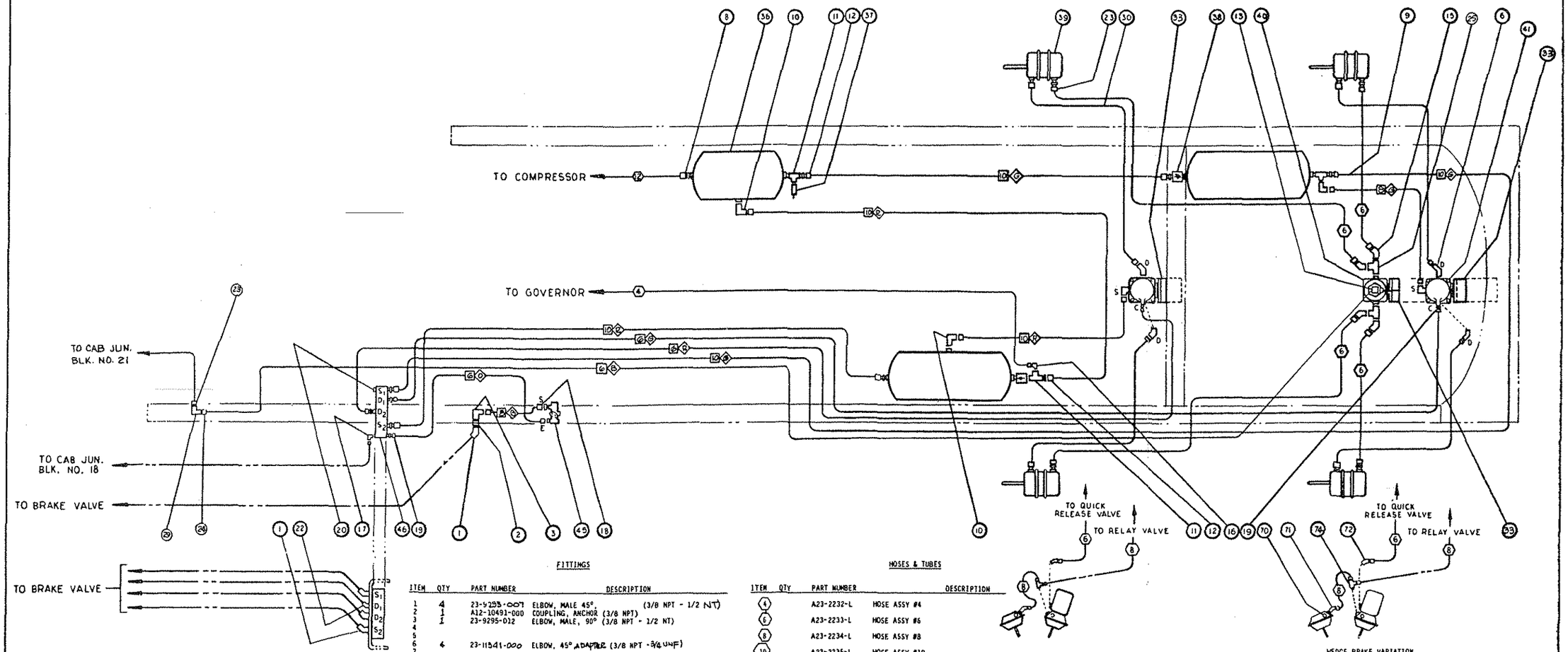
ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	4	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11185 ENG. CHG. LTR. B

COE TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12748

NYLON TUBING, WITHOUT FRONT BRAKES, WITHOUT ANTILOCK



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	4	A12-10505-000	HOSE ASSY., AIR BRAKE
31			
32			
33	3	12-10474-000	BRKT, MOUNTING
34			
35			
36		M12-10545	INST., AIR RESERVOIR
37	1		VALVE, AIR SAFETY
38	2		VALVE, CHECK, SINGLE
39		*EE REAR AXLE ASSY.	
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43			
44			
45	1		VALVE, T.P.
46	1	12-10458-4	JUNCTION BLOCK, FRAME, FRONT
47			
48			
49			
50			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9293-007	ELBOW, MALE 45°, (3/8 NPT - 1/2 NT)
2	1	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	1	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4			
5			
6	4	23-11541-000	ELBOW, 45° ADAPTER (3/8 NPT - 3/8 UNF)
7			
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	3	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	2	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	3	12-10492-000	TEE, STREET, SPECIAL
12	7	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT - 3/8 NT)
14			
15	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9256-009	ELBOW, MALE, 90°, (1/4 NPT - 3/8 NT)
18	1	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	6	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9255-005	ELBOW, MALE, 45°, (1/4 NPT - 3/8 NT)
23	5	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9301-011	COUPLING, MALE (3/8 NPT - 3/8 NT)
25	2	23-9313-003	TEE, STREET (3/8 NPT)
26			
27			
28			
29	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSY #4
6		A23-2233-L	HOSE ASSY #6
8		A23-2234-L	HOSE ASSY #8
10		A23-2235-L	HOSE ASSY #10
12		A23-2236-L	HOSE ASSY #12
6 B		48-101-010	TUBE, NYLON, #6, BLACK
6 G		48-101-015	TUBE, NYLON, #6, GREEN
6 O		48-101-013	TUBE, NYLON #6, ORANGE
6 R		48-101-012	TUBE, NYLON, #6, RED
8 B		48-101-020	TUBE, NYLON, #8, BLACK
8 G		48-101-025	TUBE, NYLON, #8, GREEN
8 R		48-101-022	TUBE, NYLON, #8, RED
10 G		48-101-035	TUBE, NYLON, #10, GREEN
10 R		48-101-032	TUBE, NYLON, #10, RED

WEDGE BRAKE VARIATION

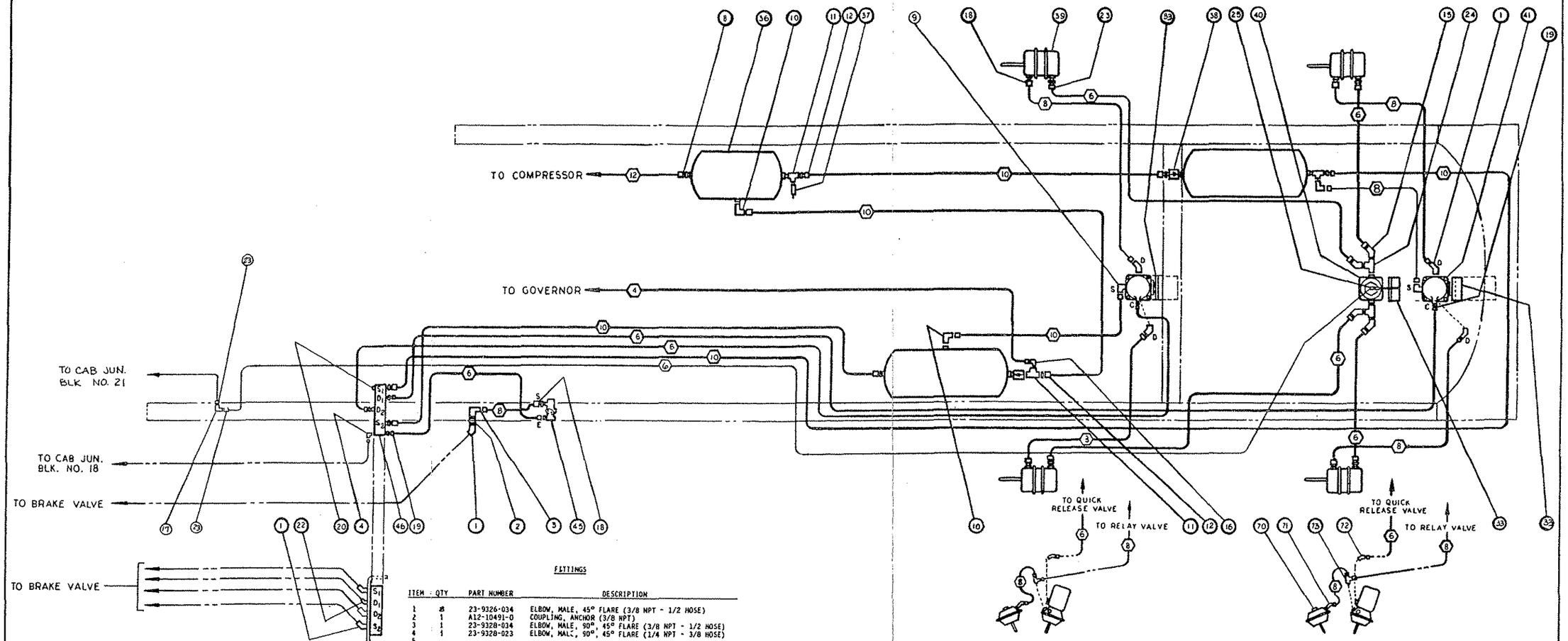
ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	4	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10969 ENG. CHG. LTR. D

BRAKE CONTROL 12
32-12748

COE TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM

WIRE BRAID HOSE, WITHOUT FRONT BRAKES, WITHOUT ANTILOCK



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	#8	23-9326-034	ELBOW, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	1	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	1	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	1	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7			
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	3	23-9328-035	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 5/8 HOSE)
10	2	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	3	12-10492-0	TEE, STREET, SPECIAL
12	7	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	5	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	6	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	6	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9313-003	TEE, STREET (3/8 NPT)
25	1	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27			
28			
29			
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31			
32			
33	3	12-10474-0	BRACKET, MOUNTING
34			
35			
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	2		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSEMBLY	
40	1		VALVE, QUICK, RELEASE
41	2		VALVE, RELAY,
42			
43			
44			
45	1		VALVE, T.P.
46	1	12-10458-*	BLOCK, FRAME JUN., REAR
47			
48			
49			
50			

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
(4)		A23-2232-L	HOSE ASSEMBLY NO. 4
(6)		A23-2233-L	HOSE ASSEMBLY NO. 6
(8)		A23-2234-L	HOSE ASSEMBLY NO. 8
(10)		A23-2235-L	HOSE ASSEMBLY NO. 10
(12)		A23-2236-L	HOSE ASSEMBLY NO. 12

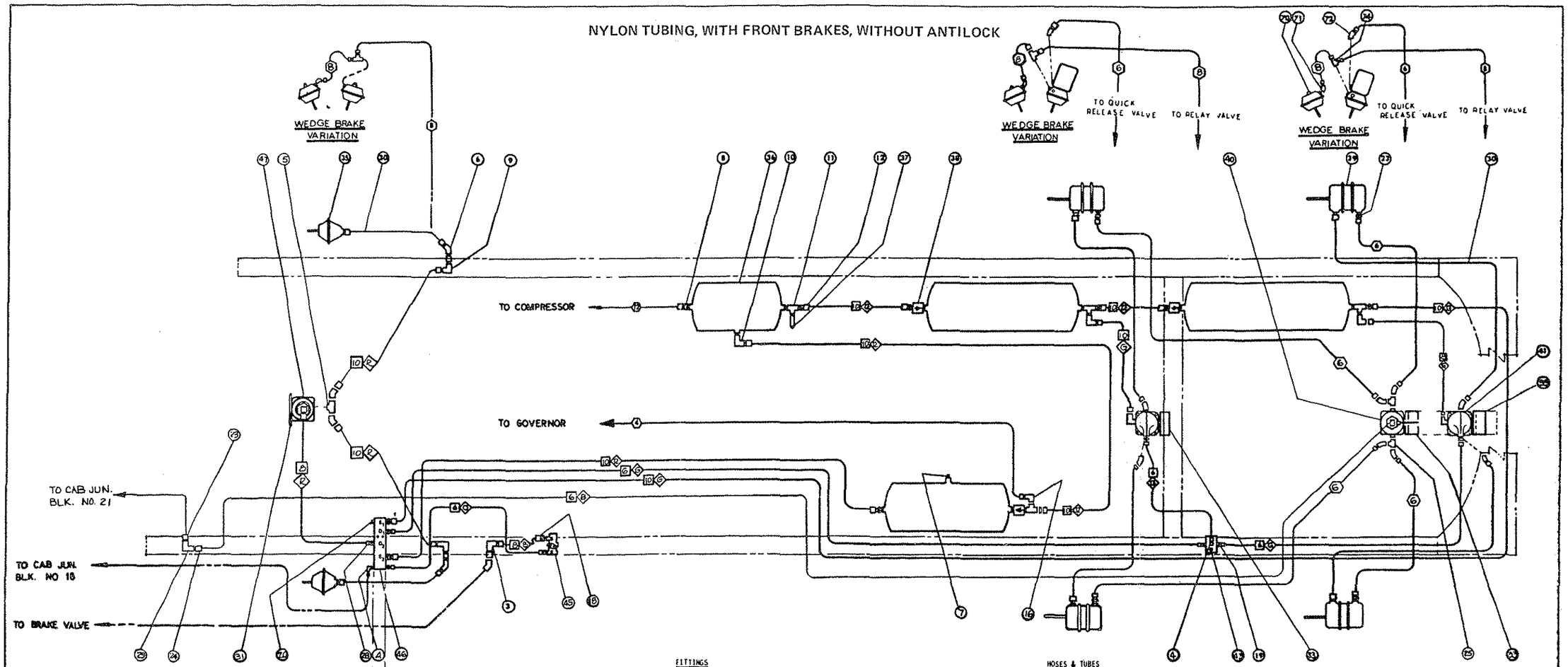
WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9268-004	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	4	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
74			

D12-10960 ENG. CHG. LTR. B

COE TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12748



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	6	A12-10505-000	HOSE ASSY., AIR BRAKE
31	1	12-10476-000	BRKT, MOUNTING
32			
33	3	12-10474-000	BRKT, MOUNTING
34			
35		SEE FRONT AXLE ASSY.	
36		M12-10545	INST., AIR RESERVOIR
37	1		VALVE, AIR SAFETY
38	3		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSY.	
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46	1	12-10458-4	JUNCTION BLOCK, FRAME, FRONT
47	1		VALVE, RATIO
48			
49			
50			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9255-007	ELBOW, MALE 45°, (3/8 NPT - 1/2 NT)
2	3	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	2	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	2	23-9290-005	ELBOW, MALE, 90° (1/4 NPT - 3/8 NT)
5	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
6	6	23-11341-000	ELBOW, 45° ADAPTER (3/8 NPT - 3/4 UNF)
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	6	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	9	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT - 3/8 NT)
14	2	23-9293-008	ELBOW, MALE, 45° (3/8 NPT - 5/8 NPT)
15	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
18	1	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	7	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20	1	23-9268-003	PLUG (1/4 NPT)
21			
22	1	23-9258-005	ELBOW, MALE, 45°, (1/4 NPT - 3/8 NT)
23	5	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	1	23-9301-013	COUPLING, MALE (3/8 NPT - 3/8 NT)
25	2	23-9313-003	TEE, STREET (3/8 NPT)
26			
27			
28	1	23-9301-016	COUPLING, MALE (1/4 NPT - 1/2 NT)
29	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
4		A23-2232-L	HOSE ASSY #4
6		A23-2233-L	HOSE ASSY #6
8		A23-2234-L	HOSE ASSY #8
10		A23-2235-L	HOSE ASSY #10
12		A23-2236-L	HOSE ASSY #12
6 B		48-101-010	TUBE, NYLON, #6, BLACK
6 G		48-101-015	TUBE, NYLON, #6, GREEN
6 O		48-101-013	TUBE, NYLON #6, ORANGE
6 R		48-101-012	TUBE, NYLON, #6, RED
8 B		48-101-020	TUBE, NYLON, #8, BLACK
8 G		48-101-025	TUBE, NYLON, #8, GREEN
8 R		48-101-022	TUBE, NYLON, #8, RED
10 G		48-101-035	TUBE, NYLON, #10, GREEN
10 R		48-101-032	TUBE, NYLON, #10, RED

WEDGE BRAKE VARIATION

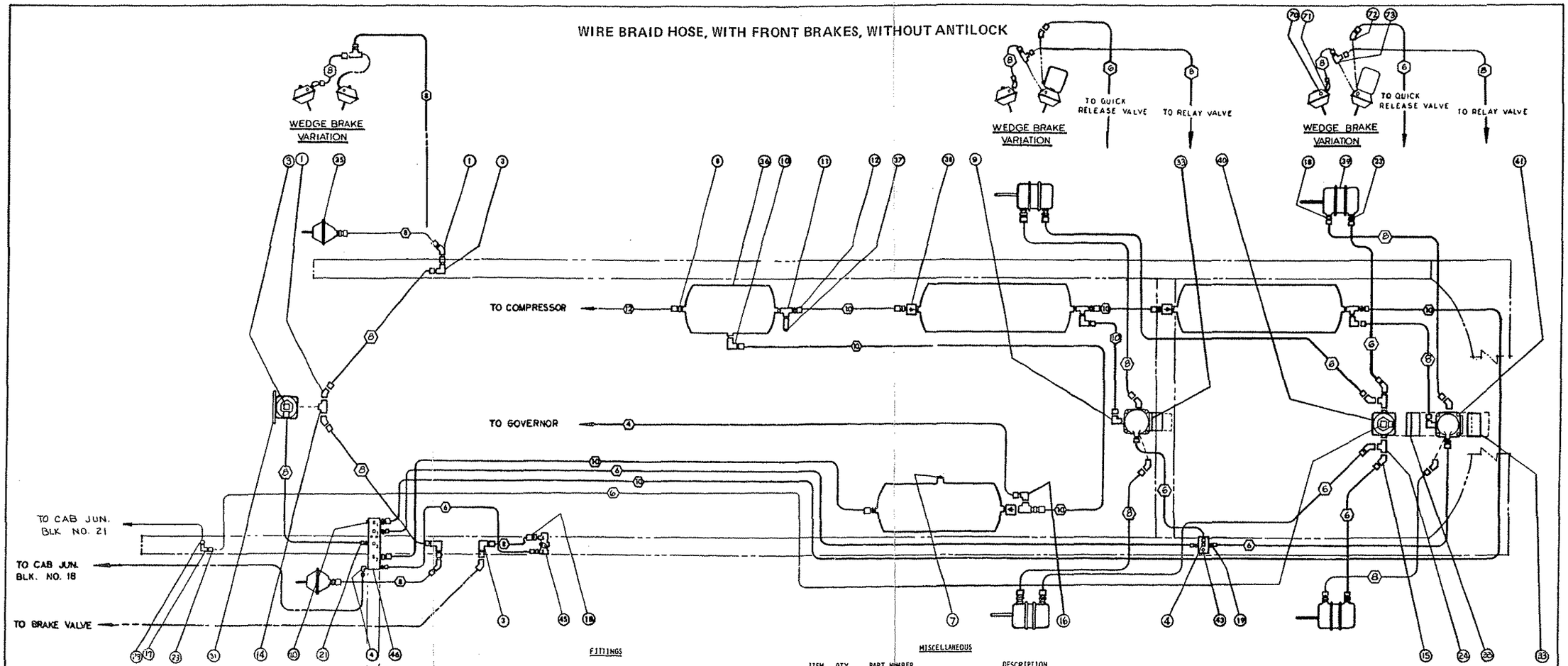
ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9268-004	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73			
74	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-10968 ENG. CHG. LTR. D

Service

BRAKE CONTROL 12
32-12748

COE TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	12	23-9326-034	ELBOW, MALE, 45°45° FLARE (3/8 NPT - 1/2 HOSE)
2	3	A12-10491-0	COUPLING, ANCHOR (3/8 NPT)
3	4	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	2	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7	1	23-9268-005	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	4	23-9328-035	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 5/8 HOSE)
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	4	12-10492-0	TEE, STREET, SPECIAL
12	9	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14	1	23-9693-006	TEE, BRANCH, MALE
15	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17	1	23-9496-003	ELBOW, ANCHOR (3/8 NPT)
18	7	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	7	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20	1	23-9268-003	PLUG (1/4 NPT)
21	1	23-9327-024	CONNECTOR MALE, 45° FLARE (1/4 NPT - 1/2 HOSE)
22	1	23-9326-023	ELBOW, MALE, 45°, 45° FLARE (1/4 NPT - 3/8 HOSE)
23	6	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9313-033	TEE, STREET (3/8 NPT)
25	1	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27			
28			
29			
30			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
31	1	12-10476-0	BRACKET MOUNTING
32			
33	3	12-10474-0	BRACKET, MOUNTING
34			
35		SEE FRONT AXLE ASSEMBLY	
36		N12-10545	AIR RESERVOIRS INST.
37	1		VALVE, SAFETY, AIR
38	3		VALVE, CHECK, SINGLE
39		SEE REAR AXLE ASSEMBLY	
40	1		VALVE, QUICK, RELEASE
41	2		VALVE, RELAY,
42	1		VALVE, RATIO
43	1	12-10455-L	BLOCK, FRAME JUN., REAR
44			
45	1		VALVE, T.P.
46	1	12-10458-4	BLOCK, FRAME JUN., FRONT
47			
48			
49			
50			

HOSES & TUBES

ITEM	QTY	PART NUMBER	DESCRIPTION
(4)		A23-2232-L	HOSE ASSEMBLY NO. 4
(6)		A23-2233-L	HOSE ASSEMBLY NO. 6
(8)		A23-2234-L	HOSE ASSEMBLY NO. 8
(10)		A23-2235-L	HOSE ASSEMBLY NO. 10
(12)		A23-2236-L	HOSE ASSEMBLY NO. 12

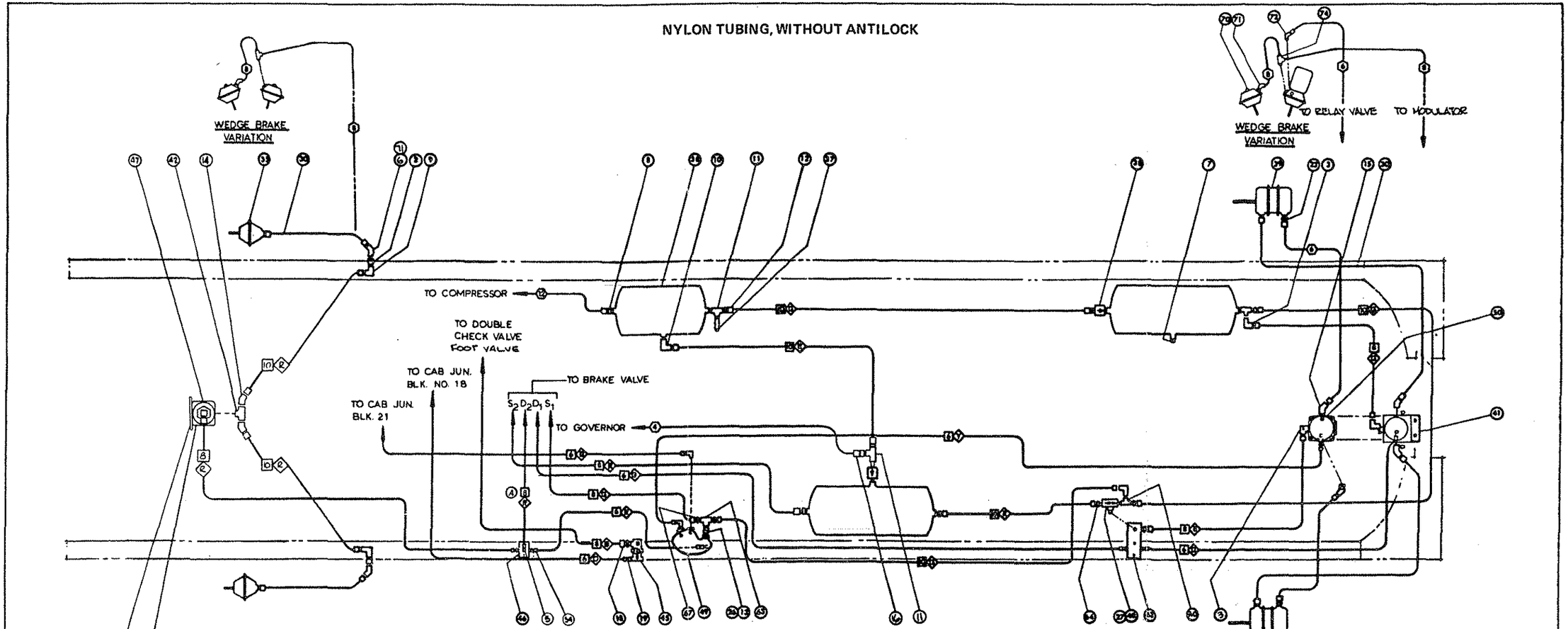
WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9268-004	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, RUN, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
74			

D12-10959 ENG. CHG. LTR. B

CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12750



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1			
2	A12-10491-0	Anchor Coupling 3/8 NPT	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ¼ NT)	3
4	23-9296-5	90° Male Elbow (¼ NPT - 3/8 NT)	5
5	13-9195-008	90° M. ELBOW (3/8 NPT - 3/8 NT)	1
6	23-11341-000	45° ADAPTR Elbow (3/8 NPT - ¾ UNF)	2
7	23-9200-5	Plug (¼NPT)	1
8	23-9327-046	Male Connector, 45° Flare (1/2 NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-015	90° Male Elbow (¼ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee-Special	3
12	23-9301-021	Male Coupling (¼ NPT - 5/8 NT)	4
13	23-9309-002	Nipple (¼ NPT)	1
14	23-9295-008	45° Male Elbow (3/8NPT- 5/8NT)	2
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9321-052	Male Conn., 45° Flare (5/8 NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	3
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	4
20			
21			
22			
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	2
24			
25			
26	23-9429-402	Reducer (¼ NPT - ¼ NPT)	1
27	23-9530-106	Nipple, Hex (3/8 NPT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	A12-10565	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40			
41	12-10474-0	BRKT MOUNTING	2
42	23-9493-006	TEE, MALE, DOMGH (3/8 NPT)	1
43	12-10459-1	Frame Jun. Block, Rear	1
44			
45		Y. P. Valve	1
46	12-10459-3	Frame June. Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	2

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
58			
60	23-9313-003	Street Tee (3/8 NPT)	1
61			
63	23-9493-008	Male Tee (¼ NPT)	1
64	23-9301-020	Male Coupling (3/8 NPT-5/8 NT)	2
67	23-9301-018	Male Coupling (¼ NPT - ½ NT)	2
94	23-9301-013	MALE COUPLING (3/8 NPT - 5/8 NT)	1

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	4
31	12-10470-0	BRACKET, MOUNTING	1
A	A23-2232-L	Hose Assembly No. 4	
B	A23-2233-L	Hose Assembly No. 6	
D	A23-2234-L	Hose Assembly No. 8	
E	A23-2235-L	Hose Assembly No. 10	
F	A23-2236-L	Hose Assembly No. 12	
B	48-101-014	Nylon Tube No. 6 Yellow	
B	48-101-010	Nylon Tube No. 6 Black	
B	48-101-015	Nylon Tube No. 6 Green	
B	48-101-013	Nylon Tube No. 6 Orange	
B	48-101-012	Nylon Tube No. 6 Red	
D	48-101-020	Nylon Tube No. 8 Black	
D	48-101-025	Nylon Tube No. 8 Green	
D	48-101-022	Nylon Tube No. 8 Red	
E	48-101-031	Nylon Tube No. 10 Green	
E	48-101-032	Nylon Tube No. 10 Red	

WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	8
72	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ¼ Hose)	6
73	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
76	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

D12-11504 ENG. CHG. LTR. B

Service

FREIGHTLINER
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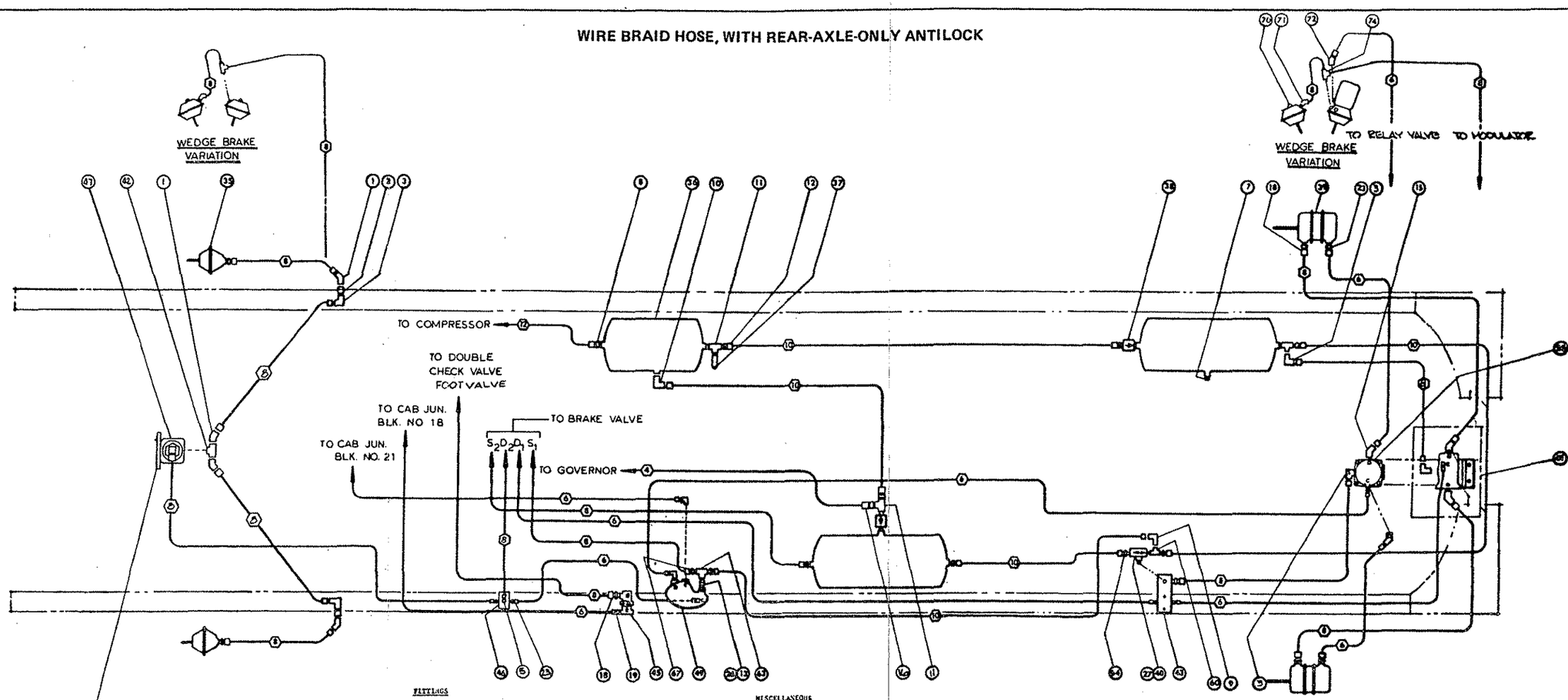
BRAKE CONTROL 12
32-12750

CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

WIRE BRAID HOSE, WITH REAR-AXLE-ONLY ANTILOCK



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	4
2	A12-10491-0	Anchor Coupling(3/8 MPT)	2
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	5
4	23-9328-023	90° Male Elbow, 45° Flare (¼ MPT - 3/8 Hose)	3
5	23-9328-035	90° M. ELBOW, 45° FLARE 3/8 MPT- 5/8 HOSE	1
6			
7	23-9200-S	Plug(¼ MPT)	1
8	23-9327-046	Male Connector, 45° Flare (½ MPT - 3/4 Hose)	1
9	23-9328-033	90° Male Elbow, 45° Flare (3/8 MPT - 3/8 Hose)	1
10	23-9328-045	90° Male Elbow, 45° Flare (½ MPT - 3/8 Hose)	1
11	12-10492-0	Street Tee-Special	1
12	23-9327-045	Male Connector, 45° Flare (½ MPT - 3/8 Hose)	6
13	23-9309-002	Nipple (¼ MPT)	1
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 MPT - 3/8 Hose)	2
16	23-9321-082	Male Conn., 45° Flare (⅜ MPT - ½ Hose)	1
17			
18	23-9327-034	Male Connector, 45° Flare (3/8 MPT - ½ Hose)	7
19	23-9327-023	Male Connector, 45° Flare (¼ MPT - 3/8 Hose)	4
20			
21			
23	23-9327-033	Male Conn., 45° Flare (3/8 MPT - 3/8 Hose)	5

MISCELLANEOUS

	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	M13-40545	Air Reservoire Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40			
41	M13-	See Anti-Lock Inst.	
42	23-9400-006	ELBOW, MALE CONNECTOR (3/8 MPT)	1
43	12-10459-1	Frame Jun. Block, Rear	1
44			
45		T. P. Valve	1
46	12-10458-S	Frame Junc. Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	1

FITTINGS

25			
26	23-9429-402	Reducer (½ MPT - ¼ MPT)	1
27	23-9530-106	Nipple, Hex (3/8 MPT)	1
28			1
60	23-9313-003	Street Tee (3/8 MPT)	1
61			
62			
63	23-9693-008	Male Tee (¼ MPT)	1
66	23-9327-035	Male Connector, 45° Flare (3/8 MPT - 3/8 Hose)	2
67	23-9327-044	Male Connector, 45° Flare (½ MPT - ½ Hose)	2

HOSES

#	PART NO.	DESCRIPTION
4	A23-2292-L	Hose Assembly No. 4
6	A23-2233-L	Hose Assembly No. 6
8	A23-2284-L	Hose Assembly No. 8
10	A23-2295-L	Hose Assembly No. 10
12	A23-2296-L	Hose Assembly No. 12
91	[illegible]	BRACKET, MOUNTING

WEDGE BRAKE VARIATION

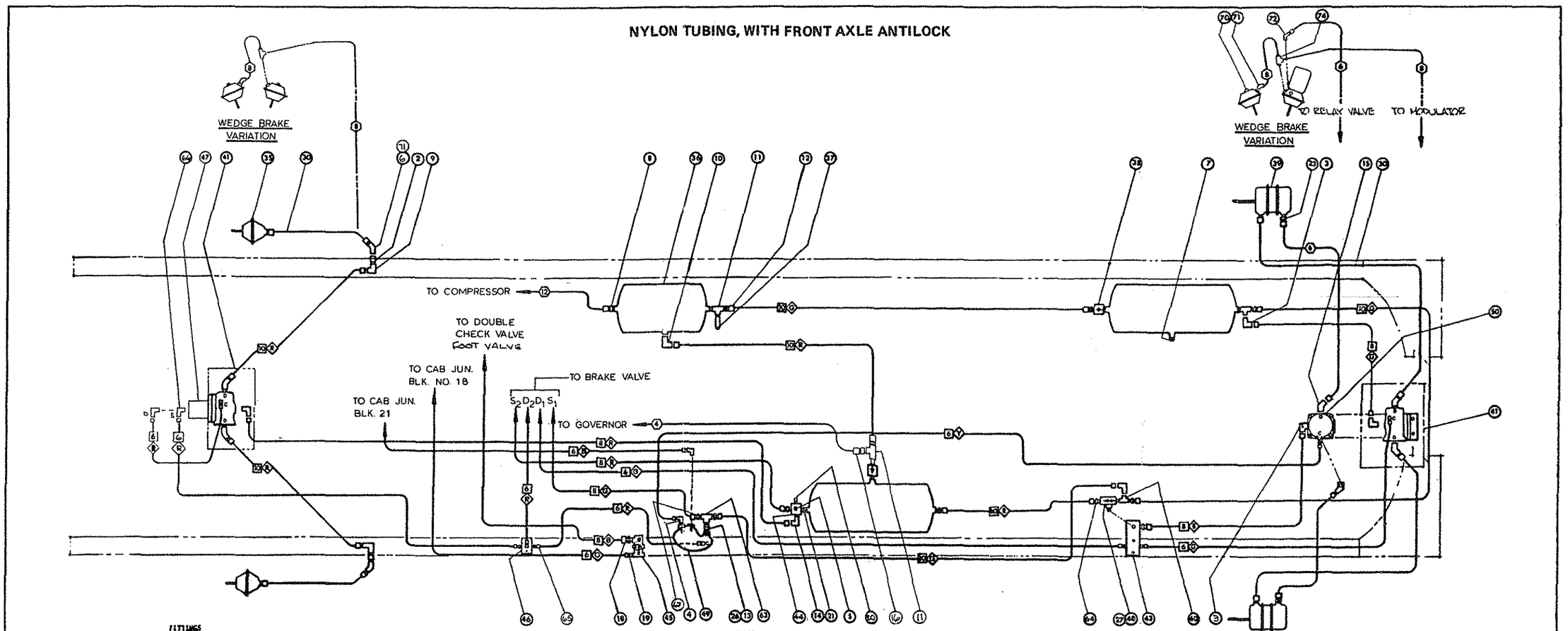
#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug(3/8MPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	4
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 MPT - 3/8 Hose)	2
74	23-9494-061	Male Run Tee, 45° Flare (3/8 MPT - ½ Hose)	4

D12-11490 ENG. CHG. LTR. A

CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12750

NYLON TUBING, WITH FRONT AXLE ANTILOCK



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1			
2	A12-10491-0	Anchor Coupling 3/8 NPT	1
3	23-9295-012	90° Male Elbow (3/8 NPT - ¼ NT)	6
4	23-9296-5	90° Male Elbow (⅜ NPT - 3/8 NT)	3
5	23-9200-4	Plug (3/8 NPT)	2
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9200-5	Plug (½PT)	1
8	23-9327-04	Male Connector, 45° Flare (1/2 NPT - 3/4 Hose)	1
9	23-9295-064	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-013	90° Male Elbow (¼ NPT - 5/8 NT)	1
11	23-10492-0	Street Tee-Special	3
12	23-9281-021	Male Coupling (¼ NPT - 5/8 NT)	4
13	23-9308-002	Nipple (¼ NPT)	1
14	23-9295-011	90 Male Elbow (¼NPT-¼NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9321-8x2	Male Conn., 45° Flare (⅜ NPT - ¼ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ¼ NT)	2
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	4
20	23-9200-3	Plug (¼ NPT)	1
21	23-9530-006	Nipple, Hex (¼ NPT)	1
22			
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	2
24			
25			
26	23-9429-402	Reducer (¼ NPT - ¼ NPT)	1
27	23-9530-106	Nipple, Hex (3/8 NPT)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	550-14545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40			
41	M12-	See Anti-Lock Inst.	
42			
43	12-10459-1	Frame Jun. Block, Rear	1
44	12-10511-0	Jun. Blk. Air Reservoir	1
45		T. P. Valve	1
46	12-10459-5	Frame Junc. Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	1

Fittings

58			
60	23-9313-003	Street Tee (3/8 NPT)	1
61			
63	23-9693-008	Male Tee (¼ NPT)	1
64	23-9301-020	Male Coupling (3/8 NPT-3/8 NT)	2
67	23-9301-018	Male Coupling (⅜ NPT - ¼ NT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	4
66	23-9296-008	90° MALE ELBOW (⅜NPT-3/8NT)	3
65	23-9301-013	M. COUPLING (⅜NPT-⅜NT)	2
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6	48-101-014	Nylon Tube No. 6 Yellow	
6	48-101-010	Nylon Tube No. 6 Black	
6	48-101-015	Nylon Tube No. 6 Green	
6	48-101-013	Nylon Tube No. 6 Orange	
6	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-025	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-035	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

WEDGE BRAKE VARIATION

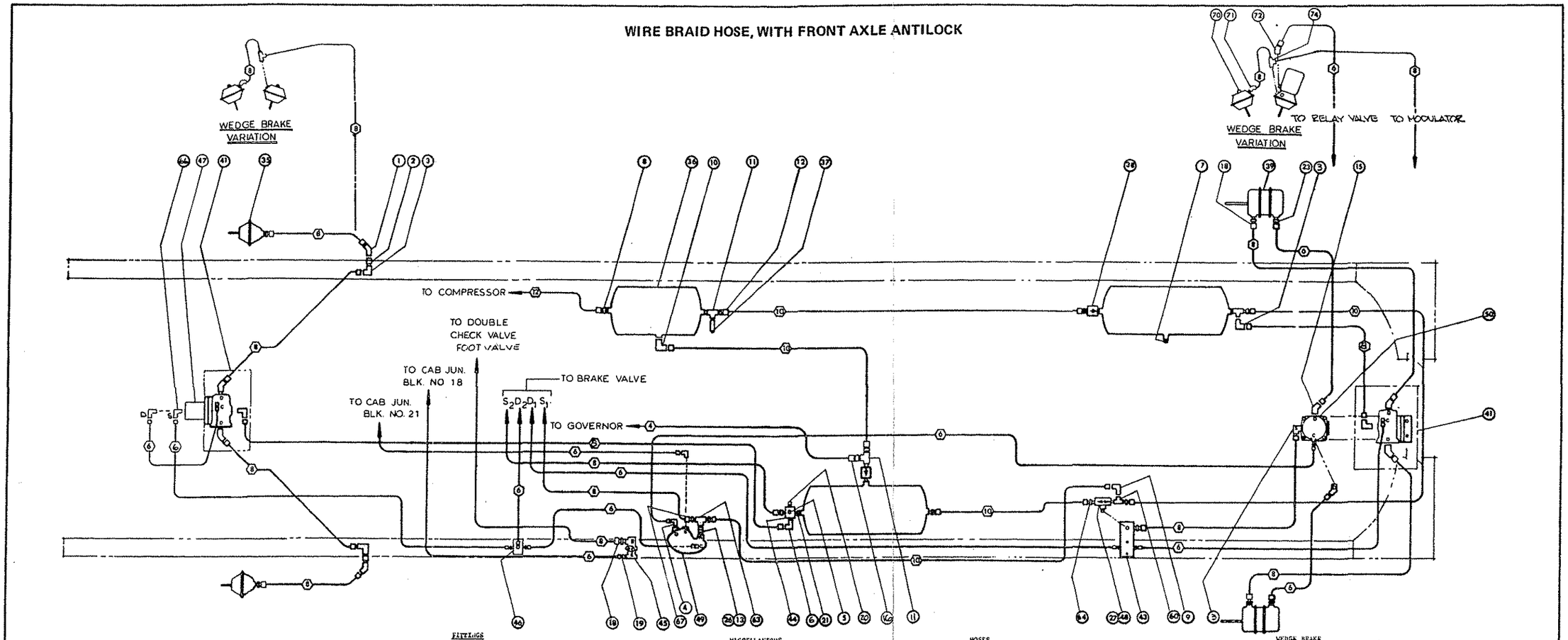
	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-0[illegible]	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

D12-11477 ENG. CHG. LTR. A

Service

BRAKE CONTROL 12
32-12750

CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM



FITTINGS

#	PART NO.	DESCRIPTION	QTY
1	23-9326-034	45° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	2
2	A12-10491-0	Anchor Coupling (3/8 MPT)	2
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	4
4	23-9328-023	90° Male Elbow, 45° Flare (¼ MPT - 3/8 Hose)	3
5	23-9200-4	Plug (3/8 MPT)	2
6	23-9326-044	90° MALE ELBOW, 45° FLARE (½ MPT - ½ HOSE)	1
7	23-9200-5	Plug (½ MPT)	1
8	23-9327-046	Male Connector, 45° Flare (½ MPT - 3/4 Hose)	1
9	23-9328-035	90° Male Elbow, 45° Flare (3/8 MPT - 5/8 Hose)	1
10	23-9328-045	90° Male Elbow, 45° Flare (½ MPT - 5/8 Hose)	1
11	12-10492-0	Street Tee-Spestal	3
12	23-9327-045	Male Connector, 45° Flare (½ MPT - 5/8 Hose)	6
13	23-9309-002	Nipple (½ MPT)	1
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 MPT - 3/8 Hose)	2
16	23-9327-032	Male Conn., 45° Flare (⅜ MPT - ½ Hose)	1
17			
18	23-9327-034	Male Connector, 45° Flare (3/8 MPT - ½ Hose)	6
19	23-9327-023	Male Connector, 45° Flare (¼ MPT - 3/8 Hose)	4
20	23-9200-3	Plug (¼ MPT)	1
21	23-9330-008	Nipple, Hex (¼ MPT)	2
23	23-9327-033	Male Conn., 45° Flare (3/8 MPT - 3/8 Hose)	4

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	M12-10545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40			
41	N12-	See Anti-Lock Inst.	
42			1
43	12-10459-1	Frame Jun. Block, Rear	1
44	12-10511-0	Jun. Blk. Air Reservoir	1
45		T. P. Valve	1
46	12-10459-3	Frame Junc. Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	1

FITTINGS

25			
26	23-9429-402	Reducer (½ MPT - ¼ MPT)	1
27	23-9530-106	Nipple, Hex (3/8 MPT)	1
28			
60	23-9313-003	Runner Tee (3/8 MPT)	1
61			
62			
63	23-9693-008	Male Tee (¼ MPT)	1
66	23-9327-035	Male Connector, 45° Flare (3/8 MPT - 5/8 Hose)	2
67	23-9327-044	Male Connector, 45° Flare (½ MPT - ½ Hose)	1

HOSES

#	PART NO.	DESCRIPTION
(4)	A23-2232-L	Hose Assembly No. 4
(6)	A23-2233-L	Hose Assembly No. 6
(8)	A23-2234-L	Hose Assembly No. 8
(10)	A23-2235-L	Hose Assembly No. 10
(12)	A23-2236-L	Hose Assembly No. 12

--	23-9328-033	90° MALE ELBOW, 45° FLARE (3/8 MPT - 3/8 HOSE)	5

WEDGE BRAKE VARIATION

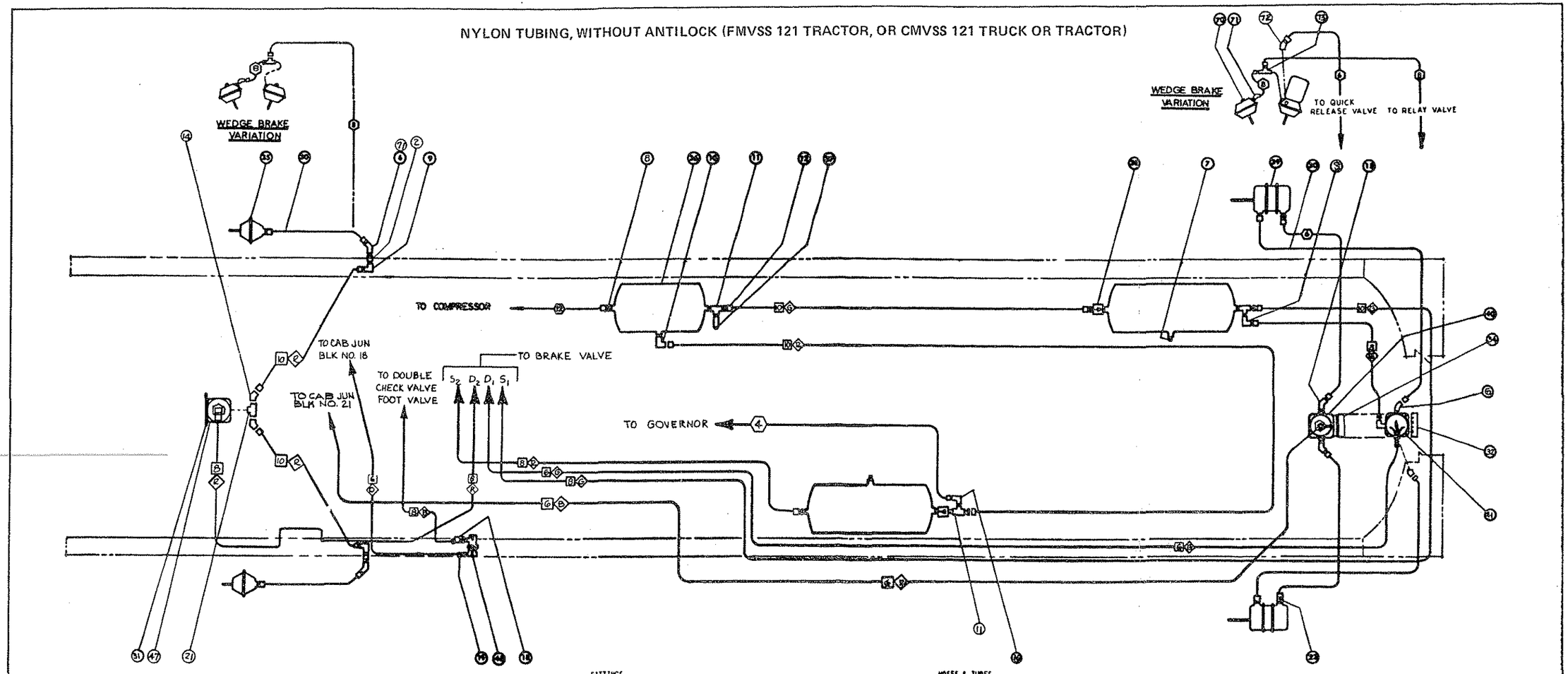
#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 MPT)	8
73	23-9326-034	45° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	4
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 MPT - 3/8 Hose)	2
74	23-9494-042	Male Run Tee, 45° Flare (3/8 MPT - ½ Hose)	4

D12-11482 ENG. CHG. LTR. A

CONVENTIONAL SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12752

NYLON TUBING, WITHOUT ANTILOCK (FMVSS 121 TRACTOR, OR CMVSS 121 TRUCK OR TRACTOR)



MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	4	A12-10505-000	HOSE ASSY, AIR BRAKE
31	1	12-10476-000	BRKT, MOUNTING
32			
33			
34	2	) -0474-000	BRKT, MOUNTING
35	SEE FRONT AXLE ASSY.		
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	2		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	1		VALVE, RELAY
42			
43			
44			
45	1		VALVE, T.P.
46			
47	1		VALVE, RATIO
48			

FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1			
2	2	A12-10491-000	COUPLING, ANCHOR (3/8 Hₒ
3	2	23-9295-012	ELBOW, MALE, 90° (3/8 NPT , NT)
4			
5			
6	2	23-9531-606	ELBOW, 45°, STREET (3/8 NPT - 3/8 NPT)
7	2	23-9200-8	PLUG (1/2 NPT)
8	1	23-9327-044	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	2	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	3	12-10492-000	TEE, STREET, SPECIAL
12	3	23-9301-021	COUPLING, MALE (1/2 NPT - 5/8 NT)
13			
14	2	23-9293-008	ELBOW, MALE, 45° (3/8 NPT - 5/8 NT)
15	3	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17			
18	2	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	1	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20			
21	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT - 3/8 NT)
26	2	23-9301-018	COUPLING, MALE (1/2 NPT - 1/2 NT)
27			
28			
29			

HOSES & TUBES

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12
6 B	48-101-010	TUBE, NYLON, NO. 6, BLACK
6 G	48-101-015	TUBE, NYLON, NO. 6, GREEN
6 O	48-101-013	TUBE, NYLON, NO. 6, ORANGE
6 R	48-101-012	TUBE, NYLON, NO. 6, RED
8 B	48-101-020	TUBE, NYLON, NO. 8, BLACK
8 G	48-101-025	TUBE, NYLON, NO. 8, GREEN
8 R	48-101-022	TUBE, NYLON, NO. 8, RED
10 G	48-101-035	TUBE, NYLON, NO. 10, GREEN
10 R	48-101-032	TUBE, NYLON, NO. 10, RED

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9200-4	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	4	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11492 ENG. CHG. LTR. A

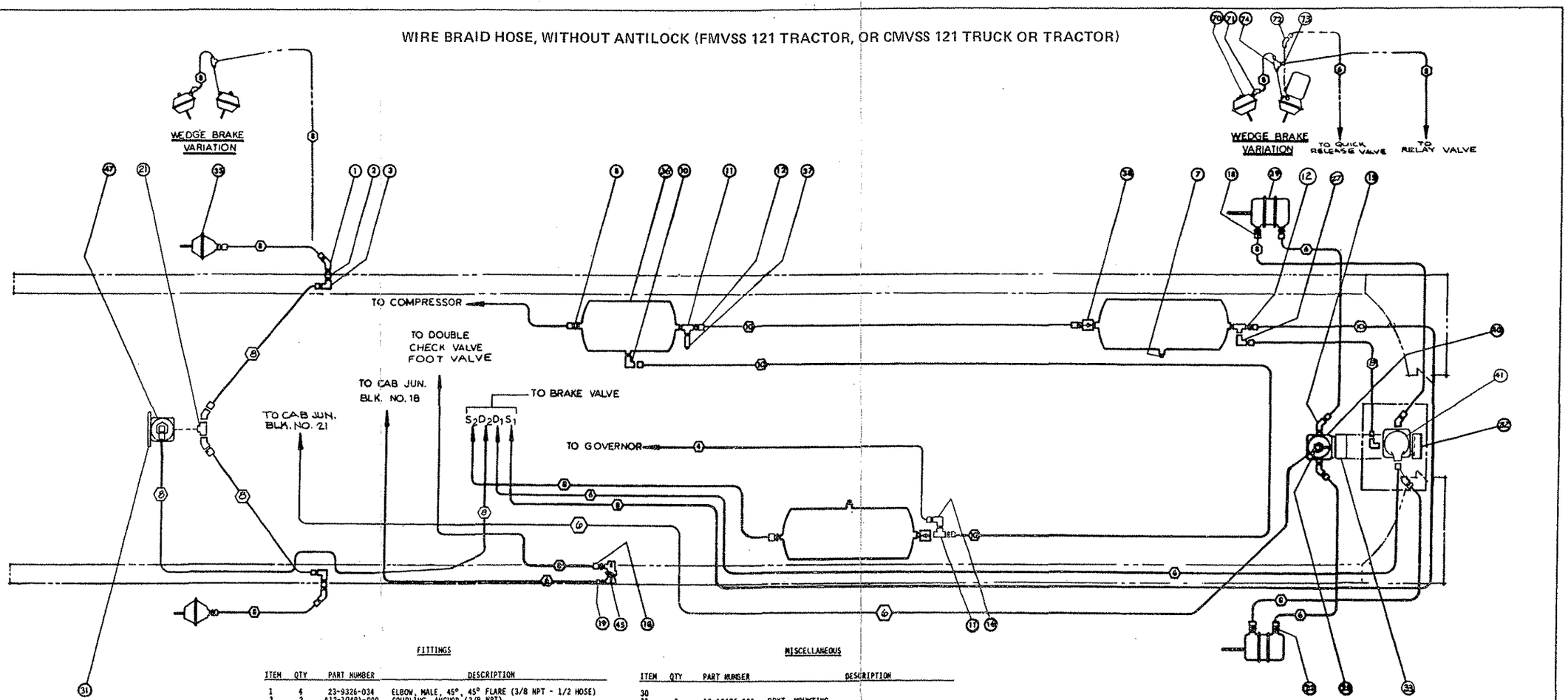
Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12752

CONVENTIONAL SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

WIRE BRAID HOSE, WITHOUT ANTILOCK (FMVSS 121 TRACTOR, OR CMVSS 121 TRUCK OR TRACTOR)



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	4	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4			
5			
6	2	23-9327-044	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 1/2 HOSE)
7	2	23-9200-5	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	3	12-10492-000	TEE, STREET, SPECIAL
12	3	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17			
18	6	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	5	23-9327-023	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
20			
21	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25	2	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26			
27	2	23-9328-035	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 5/8 HOSE)
28	1	23-9327-024	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 1/2 HOSE)
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30			
31	1	12-10476-000	BRKT, MOUNTING
32			
33	2	12-10474-000	BRKT, MOUNTING
34			
35	SEE FRONT AXLE ASSY.		
36		N12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	2		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	1		VALVE, RELAY,
42			
43			
44			
45	1		VALVE, T.P.
46			
47	1		VALVE, RATIO

HOSES & TUBES

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12

WEDGE BRAKE VARIATION

WEDGE BRAKE VARIATION

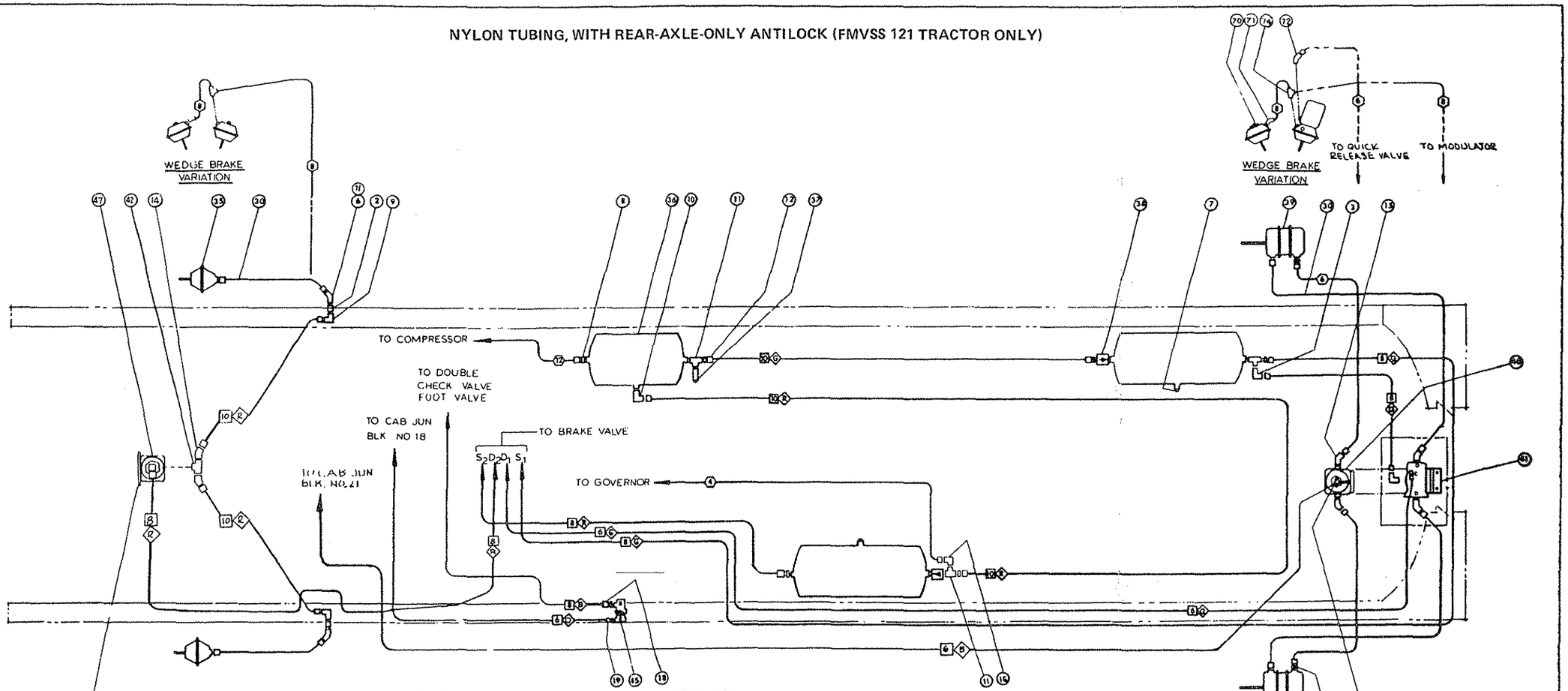
ITEM	QTY	PART NUMBER	DESCRIPTION
70	8	23-9200-4	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	4	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11497 ENG. CHG. LTR. A

CONVENTIONAL SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12752

NYLON TUBING, WITH REAR-AXLE-ONLY ANTILOCK (FMVSS 121 TRACTOR ONLY)



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1			
2	A12-10491-0	Anchor Coupling 3/8 NPT	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	2
4			
5			
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9200-5	Plug (½NPT)	2
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	1
10	23-9295-015	90° Male Elbow (½ NPT - 3/8 NT)	1
11	12-10492-0	Street Tee-Special	3
12	23-9301-021	Male Coupling (½ NPT - 3/8 NT)	3
13			
14	23-9295-008	45° Male Elbow (3/8 NPT-3/8NT)	2
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	2
19	23-9301-012	Male Coupling (½ NPT - 3/8 NT)	1
20			
21			
22			
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	2

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	M12-10545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	M12-	See Anti-Lock Inst.	
42	23-9493-006	TEE, MALE BRANCH (3/8 NPT)	1
43			
44			
45		T. P. Valve	1
46			
47		Ratio Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
24			
25	23-9295-008	90° Male Elbow (3/8 NPT-3/8 NT)	1
67	23-9301-018	Male Coupling, (½ NPT- ½ NT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY
30	A12-10505-0	Air Brake Hose Assembly	
31	12-10476-0	BRACKET, MOUNTING	
A			
A			
4	A23-2232-L	Hose Assembly No. 4	1
6	A23-2233-L	Hose Assembly No. 6	4
8	A23-2234-L	Hose Assembly No. 8	1
10	A23-2235-L	Hose Assembly No. 10	4
12	A23-2236-L	Hose Assembly No. 12	1
R	48-101-010	Nylon Tube No. 6 Black	
R	48-101-015	Nylon Tube No. 6 Green	
R	48-101-013	Nylon Tube No. 6 Orange	
R	48-101-012	Nylon Tube No. 6 Red	
R	48-101-020	Nylon Tube No. 8 Black	
R	48-101-025	Nylon Tube No. 8 Green	
R	48-101-022	Nylon Tube No. 8 Red	
R	48-101-035	Nylon Tube No. 10 Green	
R	48-101-032	Nylon Tube No. 10 Red	

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

D12-11484 ENG. CHG. LTR. A

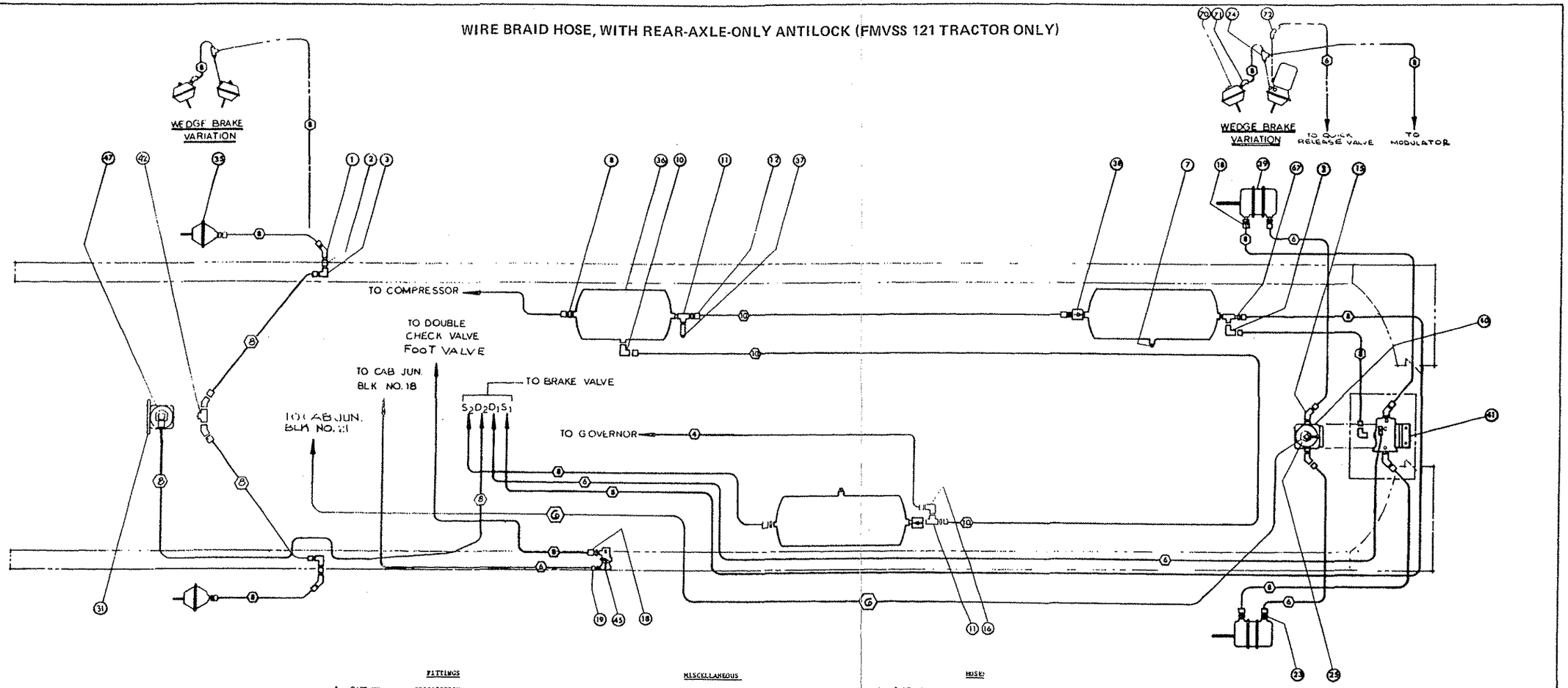
Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12752

CONVENTIONAL SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

WIRE BRAID HOSE, WITH REAR-AXLE-ONLY ANTILOCK (FMVSS 121 TRACTOR ONLY)



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9328-034	45° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	4
2	A12-10491-0	Anchor Coupling (3/8 MPT)	2
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 MPT-½ Hose)	4
7	23-[illegible]-5	Plug (½ MPT)	2
8	23-9327-046	Male Connector, 45° Flare (½ MPT - 3/4 Hose)	1
9			
10	23-9328-043	90° Male Elbow, 45° Flare (½ MPT - 5/8 Hose)	1
11	12-10492-0	Street Tee- Special	3
12	23-9327-045	Male Connector, 45° Flare (½ MPT - 5/8 Hose)	3
13			
14			
15	23-9328-033	45° Male Elbow, 45° Flare (3/8 MPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	1
17			
18	23-9327-036	Male Connector, 45° Flare (3/8 MPT - ½ Hose)	6

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	M12-10545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	M12-	See Anti-Lock Inst.	
42	15-5493-006	TEE, MALE BRANCH (3/8 MPT)	1
43			
45		T. P. Valve	1
46			
47		Ratio Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
19	23-9327-023	Male Connector, 45° Flare (½ MPT - 3/8 Hose)	1
23	23-9327-033	Male Conn., 45° Flare (3/8 MPT - 3/8 Hose)	8
24			
25	23-9328-033	90° Male Elbow, 45° Flare (3/8 MPT-3/8 Hose)	1
67	23-9327-046	Male Conn., 45° Flare (½ MPT - ½ Hose,	2

HOSE:

#	PART NO.	DESCRIPTION
4	A23-2232-L	Hose Assembly No. 4
6	A23-2233-L	Hose Assembly No. 6
8	A23-2234-L	Hose Assembly No. 8
10	A23-2235-L	Hose Assembly No. 10
12	A23-2236-L	Hose Assembly No. 12

31 . 12-10476 0 BRKT, MNTG

WEDGE BRAKE VARIATION

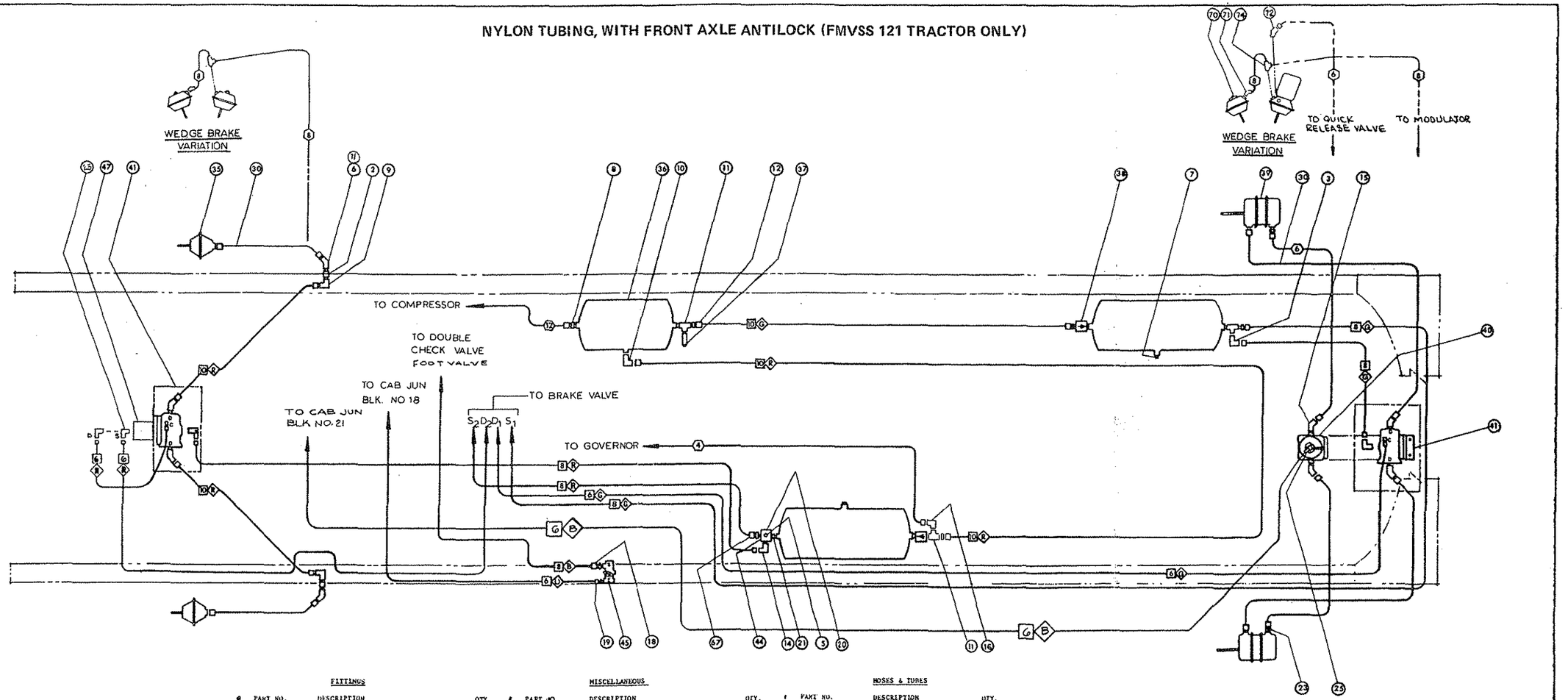
#	PART NO.	DESCRIPTION	QTY.
70	23-9203-4	Plug (3/8 MPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 MPT - ½ Hose)	4
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 MPT - 3/8 Hose)	2
74	23-9494-041	Male Run Tee, 45° Flare (3/8 MPT - ½ Hose)	4

D12-11488 ENG. CHG. LTR. A

CONVENTIONAL SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12752

NYLON TUBING, WITH FRONT AXLE ANTILOCK (FMVSS 121 TRACTOR ONLY)



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1			
2	A12-10491-0	Anchor Coupling 3/8 NPT	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	1
4			
5	23-9200-4	Plug (3/8NPT)	2
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7	23-9200-5	Plug (½NPT)	2
8	23-9327-066	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	2
10	23-9295-015	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee-Special	3
12	23-9301-021	Male Coupling (½ NPT - 5/8 NT)	3
13			
14	23-9295-011	90° Male Elbow (½NPT-½NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	1
19	23-9301-012	Male Coupling (½ NPT - 3/8 NT)	1
20	23-9200-3	Plug (3/8 NPT)	1
21	23-9530-008	Nipple, Hex (½ NPT)	1
22			
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	2

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	N12-10565	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	N12-	See Anti-Lock Inst.	1
43			
44	12-10511-0	Jun. Blk. Air Reservoir	1
45		T. P. Valve	1
46			1
47		Ratio Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
24			
25	23-9295-008	90° Male Elbow (3/8 NPT-3/8 NT)	5
67	23-9301-018	Male Coupling, (½ NPT- ½ NT).	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10501-0	Air Brake Hose Assembly	4
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6	48-101-010	Nylon Tube No. 6 Black	
6	48-101-015	Nylon Tube No. 6 Green	
6	48-101-013	Nylon Tube No. 6 Orange	
6	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-025	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-035	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	4

D12-11479 ENG. CHG. LTR. A

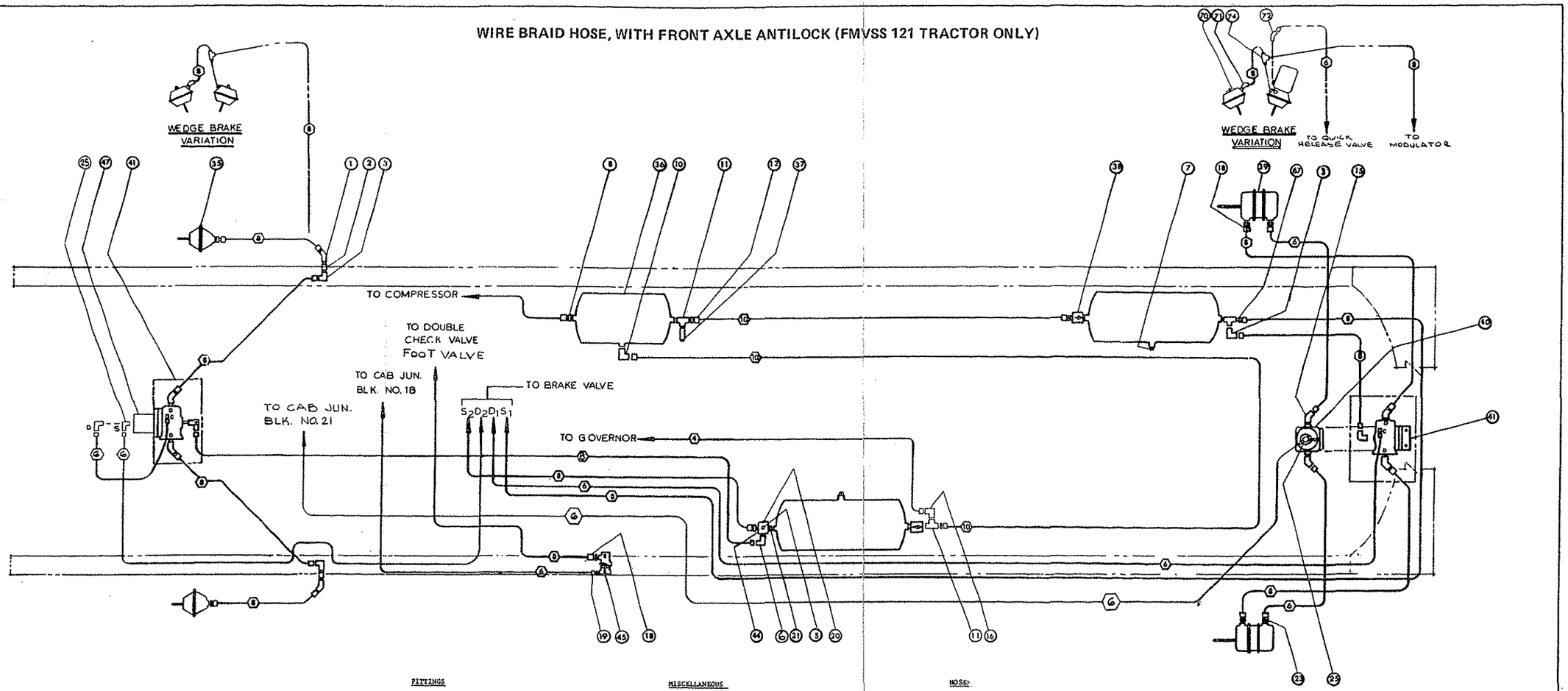
Service

FREIGHTLINER
FREIGHTLINER CORPORATION

BRAKE CONTROL 12
32-12752

CONVENTIONAL SINGLE REAR AXLE TRACTOR (FMVSS 121), OR TRUCK OR TRACTOR (CMVSS 121), CHASSIS DIAGRAM

WIRE BRAID HOSE, WITH FRONT AXLE ANTILOCK (FMVSS 121 TRACTOR ONLY)



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9328-034	45° Male Elbow, 45° Flare (3/8 NPT - ¼ Hose)	2
2	A12-10491-0	Anchor Coupling(3/8 NPT)	2
3	23-9328-034	90° Male Elbow,45° Flare (3/8 NPT-¼ Hose)	5
4			
5	23-9200-4	Plug (3/8 NPT)	2
6	23-9328-014	90° Male Elbow, 45° Flare (¼ NPT - ¼ Hose)	1
7	23-9200-5	Plug (½ NPT)	2
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9			
10	23-9328-045	90° Male Elbow, 45° Flare (½ NPT - 5/8 Hose)	1
11	12-10492-0	Street Tee- Special	1
12	23-9327-045	Male Connector, 45° Flare (½ NPT - 5/8 Hose)	3
13			
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (3/8 NPT - ¼ Hose)	1
17			
18	23-9327-034	Male Connector, 45° Flare (3/8 NPT - ¼ Hose)	5

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	N12-10545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	2
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	N12-	See Anti-Lock Inst.	1
43			
44	12-10511-0	Jun. Blk. Air Reservoir	1
45		T. P. Valve	1
46			
47		Ratio Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
19	23-9327-023	Male Connector, 45° Flare (¼ NPT - 3/8 Hose)	1
20	23-9200-3	PLUG (1/4 NPT)	1
21	23-9530-008	Nipple, Hex (¼ NPT)	1
22			
23	23-9327-033	Male Conn., 45° Flare (3/8 NPT - 3/8 Hose)	2
24			
25	23-9328-033	90° Male Elbow, 45° Flare (3/8 NPT-3/8 Hose)	3
67	23-9327-044	Male Conn., 45° Flare (½ NPT - ½ Hose,	2

HOSES

#	PART NO.	DESCRIPTION
4	A23-2232-L	Hose Assembly No. 4
6	A23-2233-L	Hose Assembly No. 6
8	A23-2234-L	Hose Assembly No. 8
10	A23-2235-L	Hose Assembly No. 10
12	A23-2236-L	Hose Assembly No. 12

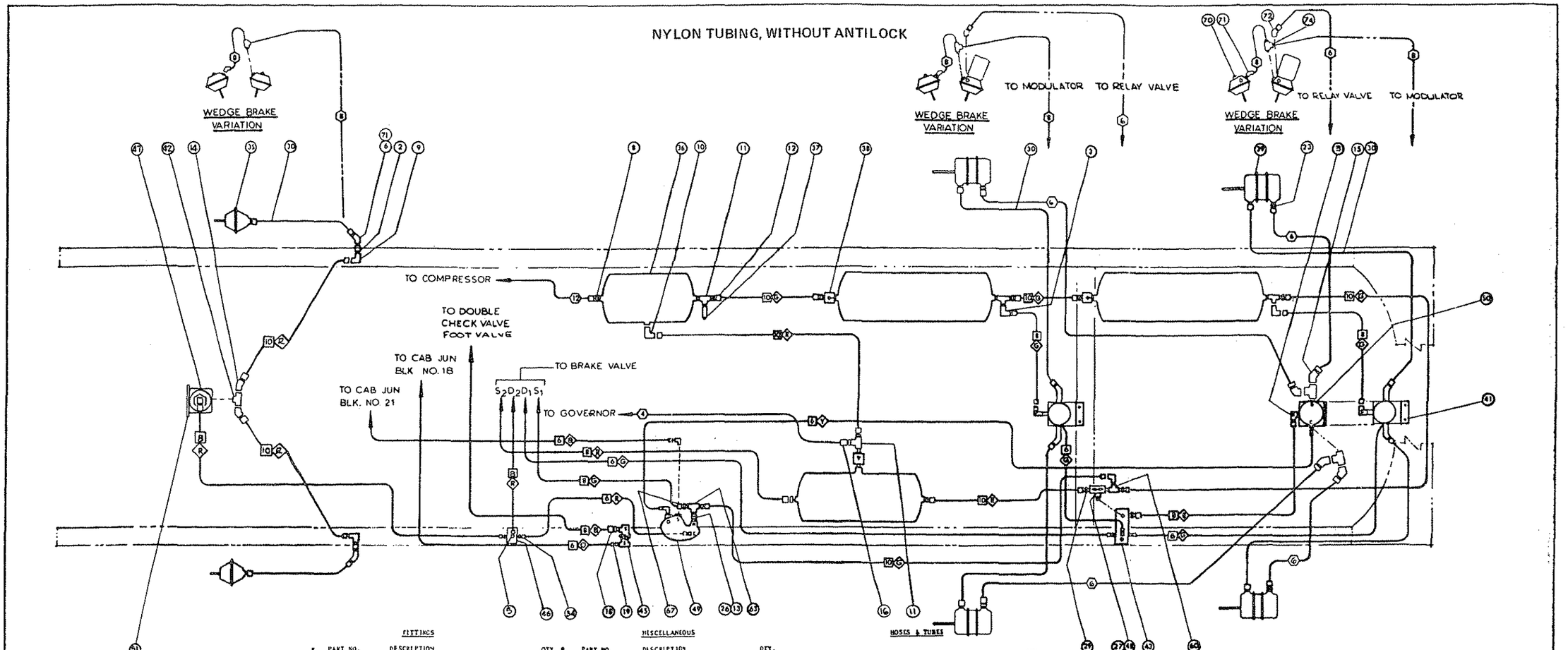
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	8
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ¼ Hose)	4
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ¼ Hose)	4

D12-11480 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12754



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1.			
2.	A12-10491-0	Anchor Coupling (3/8 NPT)	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ½ NT)	4
4	23-9296-8	90° Male Elbow (½ NPT - 3/8 NT)	4
5	23-9295-008	90° M. ELBOW(3/8 NPT - 3/8 NT)	4
6	23-11541-000	45° ADAPTR Elbow (3/8 NPT - ¾ UNF)	2
7			
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-015	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee-Special	4
12	23-9301-011	Male Coupling (½ NPT - 5/8 NT)	3
13	23-9309-002	Nipple (½ NPT)	1
14	23-9295-008	45° Male Elbow (3/8 NPT - 5/8 NT)	2
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-052	Male Conn., 45° Flare (⅜ NPT - ¼ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	3
19	23-9301-012	Male Coupling (½ NPT - 3/8 NT)	4
20			
21			
22			
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	4
24			
25			
26	23-9429-402	Reducer (½ NPT - ¼ NPT)	1
27	1-9530-106	Nipple Hex. (3/8NPT)	1
28			

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35		See Front Axle Assembly	
36		Air Reservoirs Inst.	
37	(BW)284143	Air Safety Valve	1
38		Single Check Valve	3
39		See Rear Axle Assembly	
40			
41	12-10474-0	BRKT MOUNTING	3
42	23-9693-004	TEE, MALE BRANCH (3/8 NPT)	1
43	12-10459-0	Frame Jun. Block, Rear	1
44			
45		T. P. Valve	1
46	12-10459-5	Frame Junction Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
59	23-9301-020	Male Coupling (3/8 NPT-5/8 NT)	2
60	23-9313-003	Street Tee (3/8 NPT)	1
61			
62			
63	23-9493-008	Male Tee (1/2 NPT)	1
67	23-9301-018	Male Coupling (¼ NPT - ½ NT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10503-0	Air Brake Hose Assembly	6
31	12-10476-0	BRACKET, MOUNTING	1
34	23-9301-013	MALE COUPLING, ½NPT-⅝ NT	1
(C)	A23-2232-L	Hose Assembly No. 6	
(G)	A23-2233-L	Hose Assembly No. 6	
(H)	A23-2234-L	Hose Assembly No. 8	
(J)	A23-2235-L	Hose Assembly No. 10	
(K)	A23-2236-L	Hose Assembly No. 12	
R	48-101-014	Nylon Tube No. 6 Yellow	
S	48-101-010	Nylon Tube No. 6 Black	
T	48-101-013	Nylon Tube No. 6 Green	
U	48-101-013	Nylon Tube No. 6 Orange	
V	48-101-012	Nylon Tube No. 6 Red	
W	48-101-020	Nylon Tube No. 8 Black	
X	48-101-025	Nylon Tube No. 8 Green	
Y	48-101-022	Nylon Tube No. 8 Red	
Z	48-101-035	Nylon Tube No. 10 Green	
ZA	48-101-032	Nylon Tube No. 10 Red	

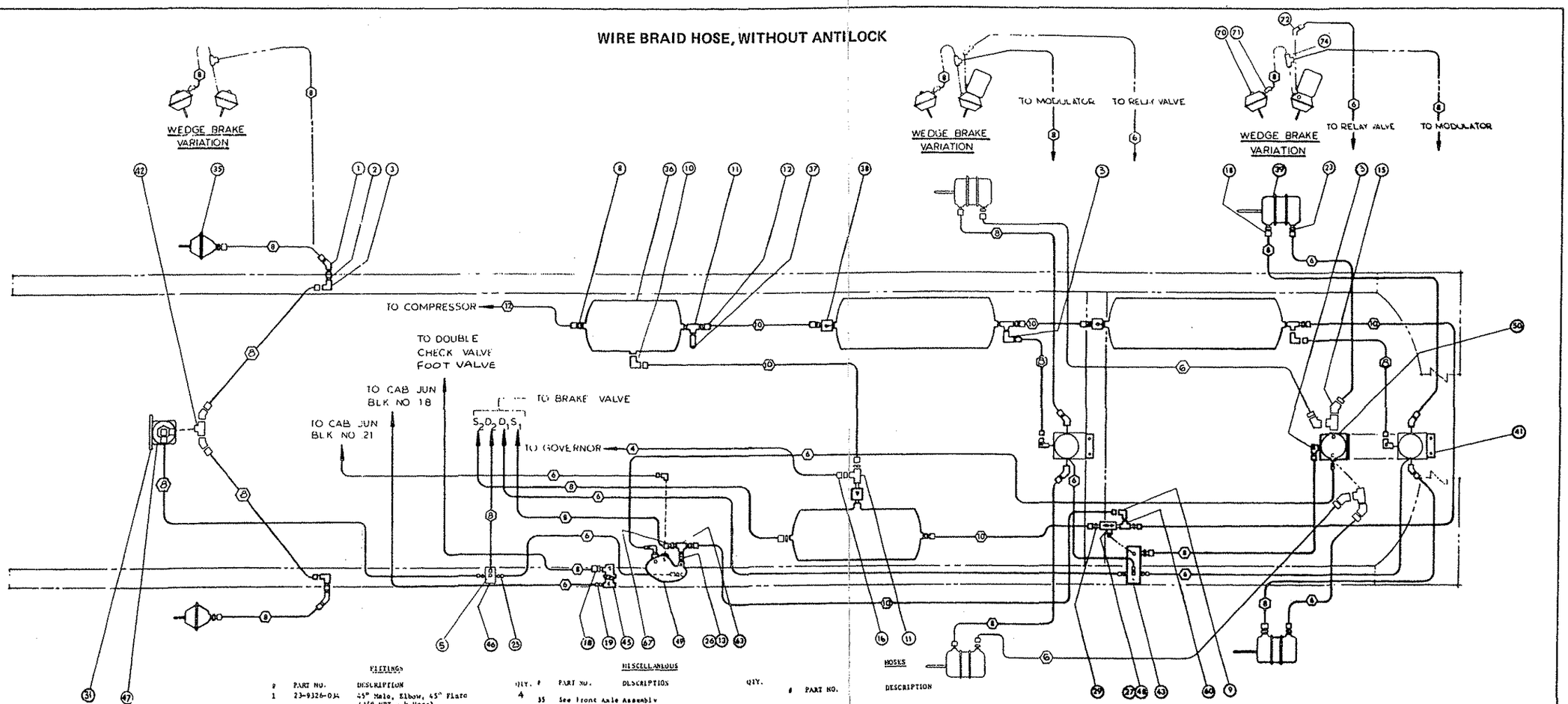
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	8
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
73			
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

D12-11505 ENG. CHG. LTR. B

BRAKE CONTROL 12
32-12754

CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male, Elbow, 45° Flare (3/8 NPT - ½ Hose)	4
2	A12-10491-0	Anchor Coupling (3/8 NPT)	2
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	4
4	23-9328-023	90° Male Elbow, 45° Flare (¼ NPT - 3/8 Hose)	4
5	23-9328-33	90° MALE ELBOW, 45° FLARE 5/8 NPT - 5/8 HOSE	1
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9328-035	90° Male Elbow, 45° Flare (3/8 NPT - 5/8 Hose)	1
10	23-9328-045	90° Male Elbow, 45° Flare (½ NPT - 5/8 Hose)	1
11	12-10492-0	Street Tee-Special	4
12	23-9327-045	Male Connector, 45° Flare (½ NPT - 5/8 Hose)	8
13	23-9309-002	Nipple (¼ NPT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-082	Male Conn., 45° Flare (¼ NPT - ½ Hose)	1
18	23-9327-034	Male Connector, 45° Flare (3/8 NPT - ½ Hose)	9
19	23-9327-023	Male Connector, 45° Flare (½ NPT - 3/8 Hose)	4
20			
22			
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	5

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	M12-10565	Air Reservoir Inst.	
37		Air Safety Valve	1
38		Single Check Valve	3
39	See Rear Axle Assembly		
40			
41	12-10474	BRKT MOUNTING	3
42	23-9493-006	TEE, MALE BRANCH	1
43	12-10439-0	Frame Jun. Block, Rear	1
45		T. P. Valve	1
46	12-10459-3	Frame Junction Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	3

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
25			
26	23-9429-402	Reducer (¼ NPT-¼ NPT)	1
27	23-9530-10b	Nipple Hex. (3/8 NPT)	1
28			
29	23-9327-015	Male Connector, 45° Flare (3/8 NPT - 5/8 Hose)	2
60	23-9313-001	Street Tee (3/8 NPT)	3
61			
62			
63	23-9693-008	Male Tee (1/2 NPT)	1
66			
67	23-9327-044	Male Conn., 45° Flare (¼ NPT - ½ Hose.	2

HOSES

#	PART NO.
4	A23-2232-L
6	A23-2233-L
8	A23-2234-L
10	A23-2235-L
12	A23-2236-L

DESCRIPTION

Hose Assembly No. 4
Hose Assembly No. 6
Hose Assembly No. 8
Hose Assembly No. 10
Hose Assembly No. 12

PART NO	DESCRIPTION	QTY
31 12-10476-0	BRACKET, MOUNTING	1

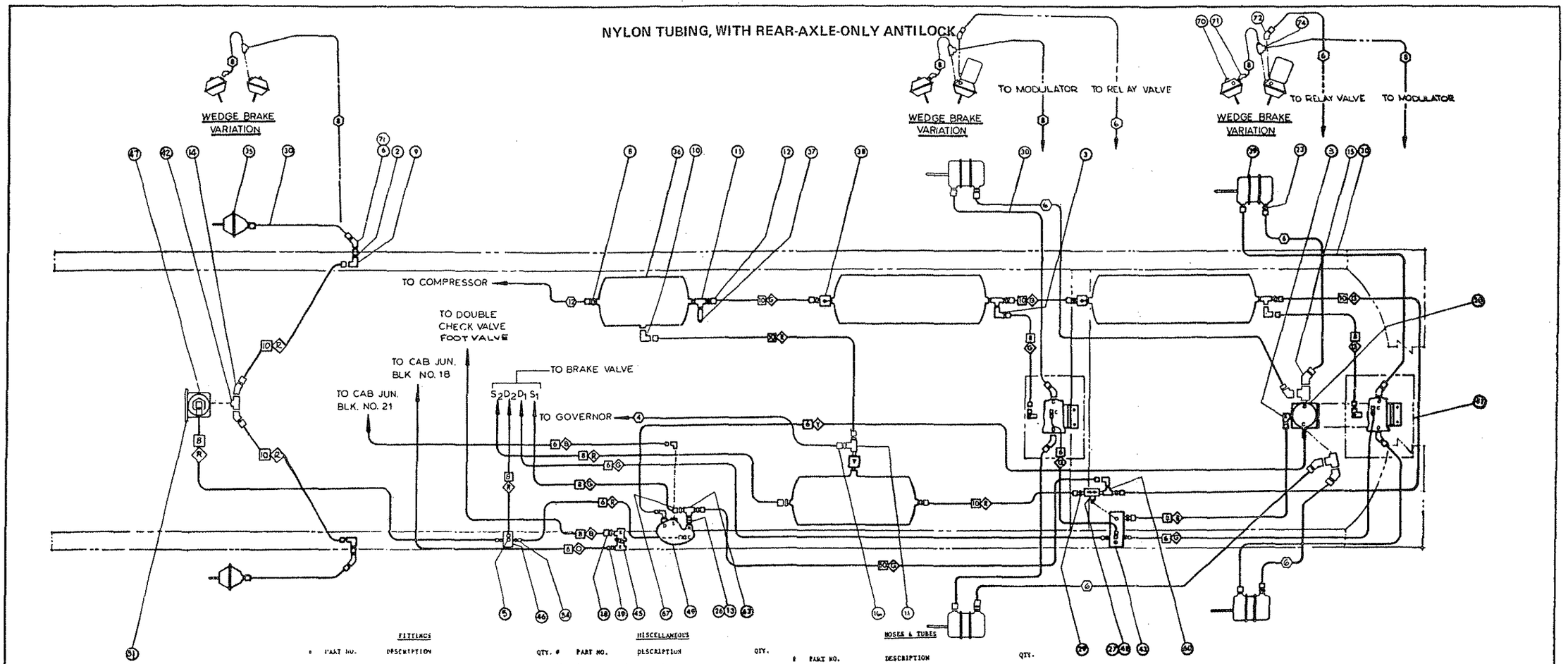
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	4
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	4
73			
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

D12-11503 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12754



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1.			
2.	A12-10491-0	Anchor Coupling(3/8 NPT)	2
3	23-9293-012	90° Male Elbow (3/8 NPT - ½ NT)	4
4	23-9200-8	90° Male Elbow (½ NPT - 3/8 NT)	4
5	23-9295-008	90° M. ELBOW (3/4 NPT - 3/8 NT)	1
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7			
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9293-016	90° Male Elbow (3/8 NPT - 3/8 NT)	9
10	23-9293-013	90° Male Elbow (½ NPT - 3/8 NT)	1
11	12-10492-0	Street Tee-Special	4
12	23-9301-021	Male Coupling (½ NPT - 3/8 NT)	8
13	23-9309-002	Nipple (½ NPT)	1
14	23-9293-008	45° Male Elbow (1/8 NPT-3/8 NT)	2
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-082	Male Conn., 45° Flare (3/8 NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	3
19	23-9301-022	Male Coupling (½ NPT - 3/8 NT)	4
20			
21			
22			
23	23-9827-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	4
24			
25			
26	23-9429-402	Reducer (½ NPT - ¼ NPT)	1
27	23-9530-106	Nipple Hex. (3/8NPT)	1
28			

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	H12-10545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	1
39	See Rear Axle Assembly		
40			
41	H12-	See Anti-Lock Inst.	
42	23-9665-006	TEE, MALE (3/4ANGA (3/8 NPT)	1
43	12-10459-0	Frame Jun. Block, Rear	1
44			
45		T. P. Valve	1
46	12-10459-5	Frame Junction Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve Relay Valve	1
50			

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
29	23-9301-020	Male Coupling (3/8 NPT-3/8 NT)	2
60	23-9313-003	Street Tee (3/8 NPT)	1
61			
62			
63	23-9693-008	Male Tee (1/2 NPT)	1
67	23-9301-018	Male Coupling (¼ NPT - ½ NT)	2

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10305-0	Air Brake Hose Assembly	6
31	12-10476-0	BRACKET, MOUNTING	1
54	23-9301-013	MALE COUPLING, ½NPT- ½ NT	1
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
R	48-101-014	Nylon Tube No. 6 Yellow	
B	48-101-010	Nylon Tube No. 6 Black	
G	48-101-015	Nylon Tube No. 6 Green	
O	48-101-013	Nylon Tube No. 6 Orange	
R	48-101-012	Nylon Tube No. 6 Red	
B	48-101-020	Nylon Tube No. 8 Black	
G	48-101-025	Nylon Tube No. 8 Green	
R	48-101-022	Nylon Tube No. 8 Red	
G	48-101-033	Nylon Tube No. 10 Green	
R	48-101-032	Nylon Tube No. 10 Red	

WEDGE BRAKE VARIATION

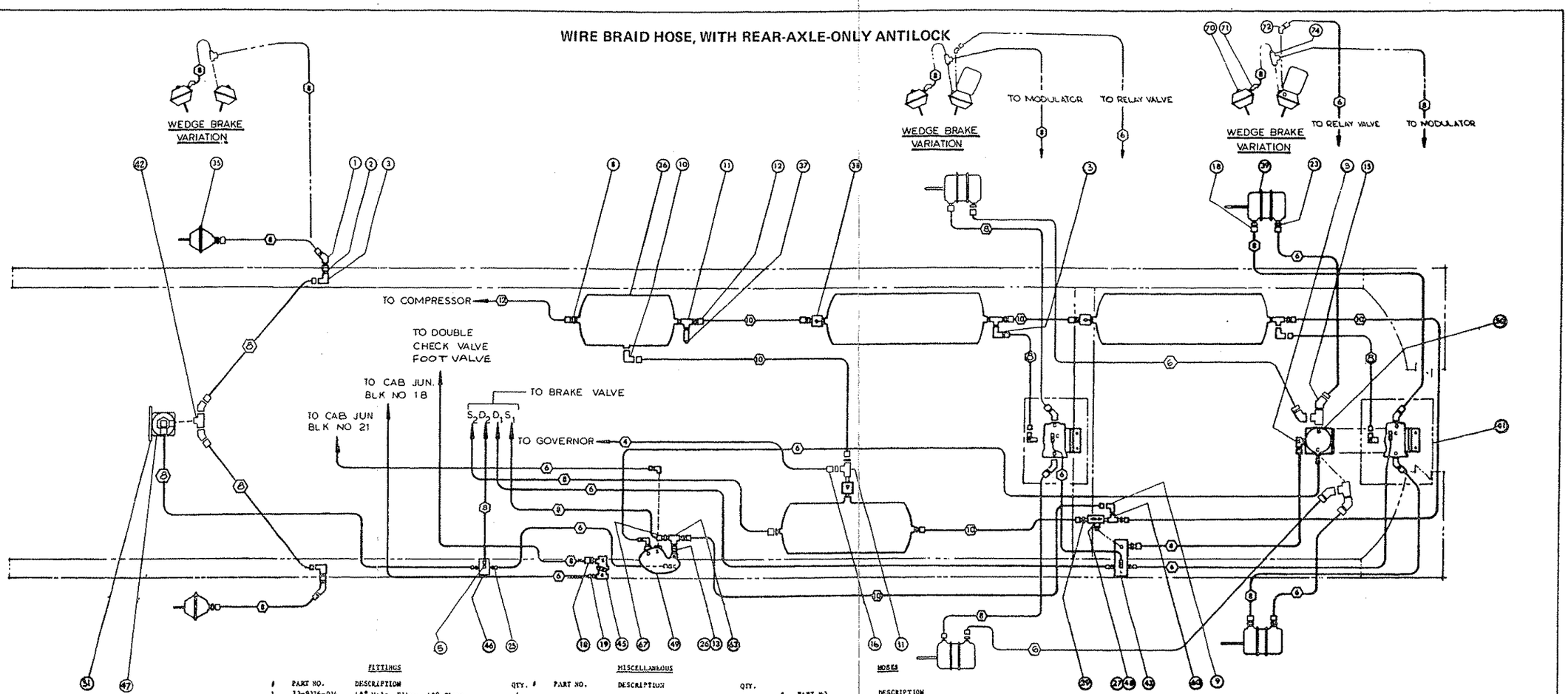
#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
73			
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

D12-11487 ENG. CHG. LTR. A

Service

BRAKE CONTROL 12
32-12754

CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male, Elbow, 45° Flare (3/8 NPT - ½ Hose)	4
2	A12-10491-0	Anchor Coupling (3/8 NPT)	2
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	6
4	23-9328-023	90° Male Elbow, 45° Flare (¼ NPT - 3/8 Hose)	4
5	23-9328-33	90° MALE ELBOW, 45° FLARE 3/8 NPT - 5/8 HOSE	1
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9328-035	90° Male Elbow, 45° Flare (3/8 NPT - 5/8 Hose)	1
10	23-9328-045	90° Male Elbow, 45° Flare (½ NPT - 5/8 Hose)	1
11	12-10492-0	Street Tee-Special	4
12	23-9327-045	Male Connector, 45° Flare (½ NPT - 5/8 Hose)	8
13	23-9309-002	Nipple (¼ NPT)	1
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-032	Male Conn., 45° Flare (⅜ NPT - ½ Hose)	1
18	23-9327-034	Male Connector, 45° Flare (3/8 NPT - ½ Hose)	9
19	23-9327-023	Male Connector, 45° Flare (¼ NPT - 3/8 Hose)	4
20			
22			
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	5

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35		See Front Axle Assembly	
36	M12-10545	Air Reservoirs Inst.	2
37		Air Safety Valve	1
38		Single Check Valve	1
39		See Rear Axle Assembly	
40			
41	M12-	See Anti-Lock Inst.	1
42	23-5693-006	TEE, MALE BRANCH	1
43	12-10459-0	Frame Jun. Block, Rear	1
45		T. P. Valve	1
46	12-10459-3	Frame Junction Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
25			
26	23-9429-402	Reducer (¼ NPT-¼ NPT)	1
27	23-9530-106	Nipple Hex. (3/8 NPT)	1
28			
29	23-9327-035	Male Connector, 45° Flare (3/8 NPT - 5/8 Hose)	2
60	23-9313-003	Street Tee (3/8 NPT)	5
61			
62			
63	23-9693-008	Male Tee (1/2 NPT)	1
66			
67	23-9327-044	Male Conn., 45° Flare (¾ NPT - ½ Hose.	2

#	PART NO.
4	A23-2232-L
6	A23-2233-L
8	A23-2234-L
10	A23-2235-L
12	A23-2236-L

HOSES

DESCRIPTION
Hose Assembly No. 4
Hose Assembly No. 6
Hose Assembly No. 8
Hose Assembly No. 10
Hose Assembly No. 12

PART NO.	DESCRIPTION	QTY
31 12-10476-0	BRACKET, MOUNTING	1

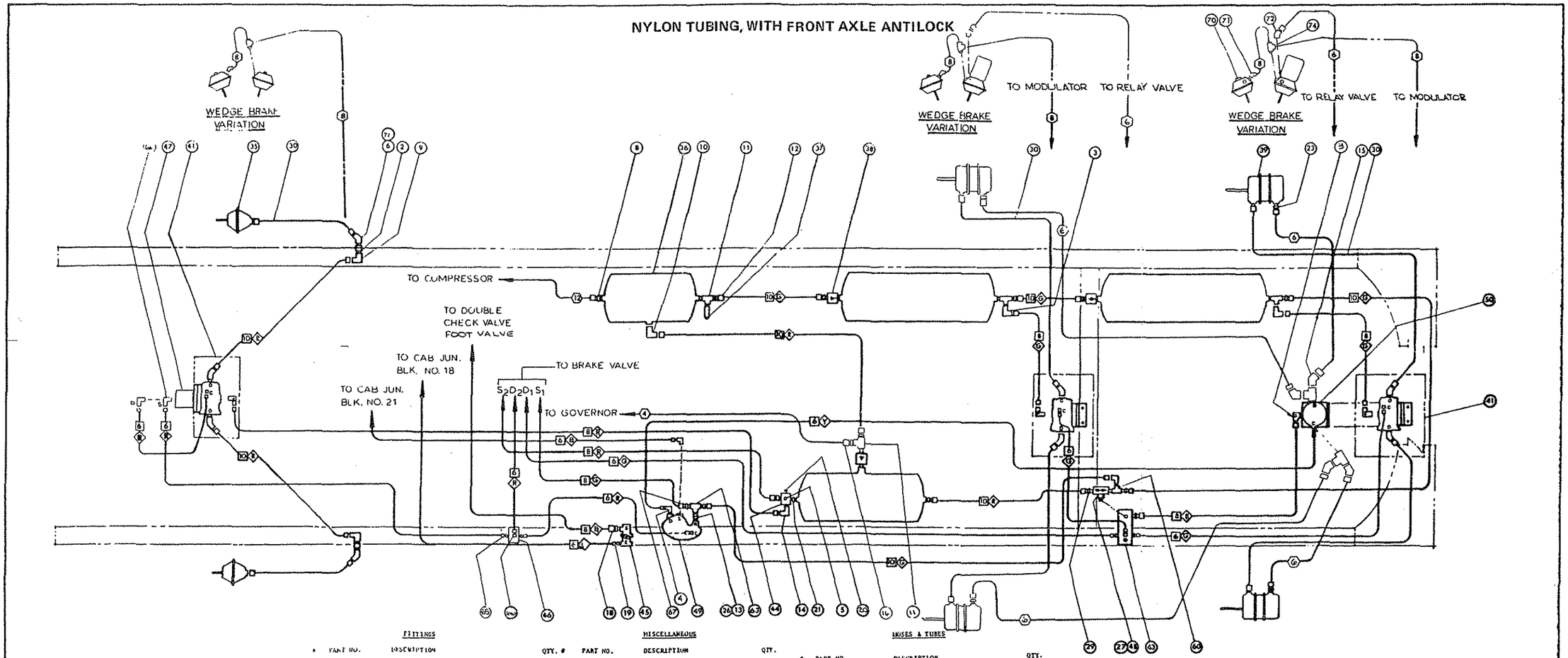
WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	4
73			
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

D12-11491 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12754



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1.			
2.	A12-10491-0	Anchor Coupling(3/8 NPT)	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ¼ NT)	3
4	23-9296-9	90° Male Elbow (¼ NPT - 3/8 NT)	4
5	23-9200-4	Plug (3/8 NPT)	2
6	23-9531-606	45° Street Elbow (3/8 NPT - 3/8 NPT)	2
7			
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	3
10	23-9295-015	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee-Special	4
12	23-9301-021	Male Coupling (½ NPT - 5/8 NT)	8
13	23-9309-002	Nipple (¼ NPT)	1
14	23-9295-011	90° Male Elbow (¼ NPT-¼ NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-052	Male Conn., 45° Flare (½ NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	2
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	5
20	23-9200-5	Plug (½ NPT)	1
21	23-9530-008	Nipple, Hex. (¼ NPT)	1
22			
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	4
24			
25			
26	23-9429-402	Reducer (½ NPT - ¼ NPT)	1
27	23-9530-106	Nipple Hex. (3/8NPT)	1
28			

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35		See Front Axle Assembly	
36	M12-10565	Air Reservoire Inst.	
37		Air Safety Valve	1
38		Single Check Valve	3
39		See Rear Axle Assembly	
40			
41	M12-	See Anti-Lock Inst.	
42			
43	12-10459-0	Frame Jun. Block, Rear	1
44	12-10511-0	Air Reservoir Junc. Block	1
45		T. P. Valve	1
46	12-10459-[illegible]	Frame Junction Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
29	23-9301-020	Male Coupling (3/8 NPT-5/8 NT)	2
60	23-9313-003	Street Tee (3/8 NPT)	3
61			
62			
63	23-9693-008	Male Tee (3/2 NPT)	1
67	23-9301-014	Male Coupling (½ NPT - ¼ NT)	
66	23-9295-008	90° MALE ELBOW (½ NPT-5/8 NT)	3
68	23-9301-013	M.COUPLING(5/8NPT-5/8NT)	3

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air Brake Hose Assembly	6
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6	48-101-014	Nylon Tube No. 6 Yellow	
6	48-101-010	Nylon Tube No. 6 Black	
6	48-101-015	Nylon Tube Nr. 6 Green	
6	48-101-013	Nylon Tube No. 6 Orange	
6	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-025	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-035	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	2
71	23-9326-024	45° Male Elbow, 45° Flare (3/8 NPT- ¼ Hose)	2
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	2
73	23-9313-003	Street Tee (3/8 NPT)	2
74	23-9494-021	Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	2

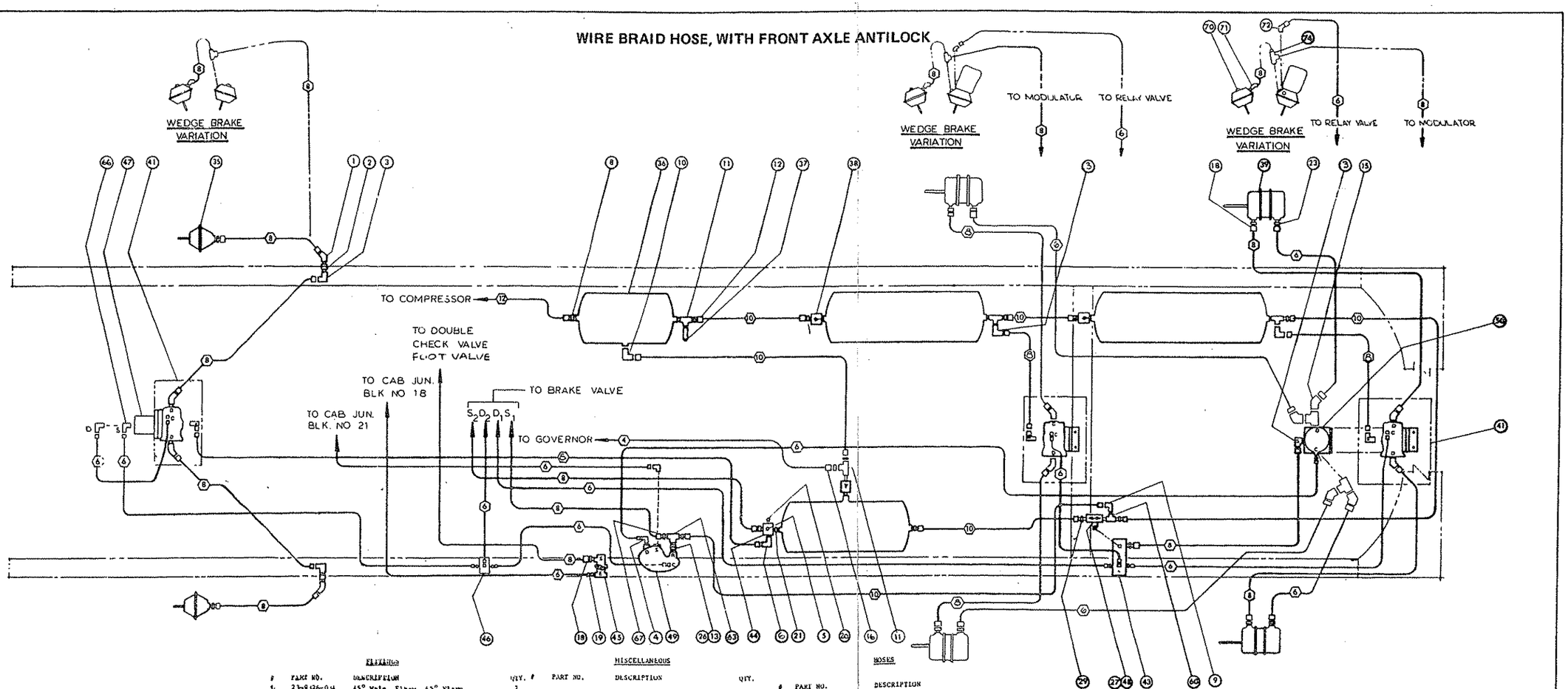
D12-11476 ENG. CHG. LTR. A

Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12754

CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male, Elbow, 45° Flare (3/8 NPT - ½ Hose)	1
2	A13-10491-0	Anchor Coupling (3/8 NPT)	2
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	5
4	23-9328-033	90° Male Elbow, 45° Flare (¼ NPT - 3/8 Hose)	4
5	23-9200-4	Plug (1/4 NPT)	2
6	23-9328-054	90° MALE ELBOW, 45° FLARE (¼ NPT - ½ HOSE)	1
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9	23-9328-035	90° Male Elbow, 45° Flare (3/8 NPT - 5/8 Hose)	1
10	23-9328-045	90° Male Elbow, 45° Flare (½ NPT - 5/8 Hose)	1
11	12-10492-0	Street Tee-Special	4
12	23-9327-045	Male Connector, 45° Flare (½ NPT - 5/8 Hose)	8
13	23-9309-002	Nipple (¼ NPT)	1
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	4
16	23-9327-032	Male Conn., 45° Flare (¼ NPT - ¼ Hose)	1
17	23-9327-034	Male Connector, 45° Flare (3/8 NPT - ½ Hose)	8
18	23-9327-033	Male Connector, 45° Flare (¼ NPT - 3/8 Hose)	4
20	23-9200-3	Plug (¼ NPT)	1
21	23-9330-008	Nipple, Hex. (¼ NPT)	1
22			
23	23-9323-032	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	6

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	M12-10345	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	1
39	See Rear Axle Assembly		
40			
41	M12-	Sew Anti-Lock Inst.	
42			
43	12-10459-0	Frame Jun. Block, Rear	1
44	12-10511-0	Air Reservoir Junc. Block	1
45		T. P. Valve	1
46	12-10459-½	Frame Junction Block, Front	1
47		Ratio Valve	1
48		Two-Way Check Valve	1
49		Spring Brake Control Valve	1
50		Relay Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
25			
26	23-9429-402	Reducer (¼ NPT-¼ NPT)	1
27	23-9530-106	Nipple Hex. (3/8 NPT)	1
28			
29	23-9327-035	Male Connector, 45° Flare (3/8 NPT - 5/8 Hose)	2
60	23-9313-003	Street Tee (3/8 NPT)	3
61			
62			3
63	23-9697-008	Male Tee (3/8 NPT)	1
67	23-9327-044	Male Conn., 45° Flare (½ NPT - ½ Hose)	2

HOSES

#	PART NO.	DESCRIPTION
4	A23-2232-L	Hose Assembly No. 4
6	A23-2233-L	Hose Assembly No. 6
8	A23-2234-L	Hose Assembly No. 8
10	A23-2235-L	Hose Assembly No. 10
12	A23-2236-L	Hose Assembly No. 12

66 23-9328-053 90° MALE ELBOW 45° FLARE (½ NPT - 5/8 HOSE)

WEDGE BRAKE VARIATION

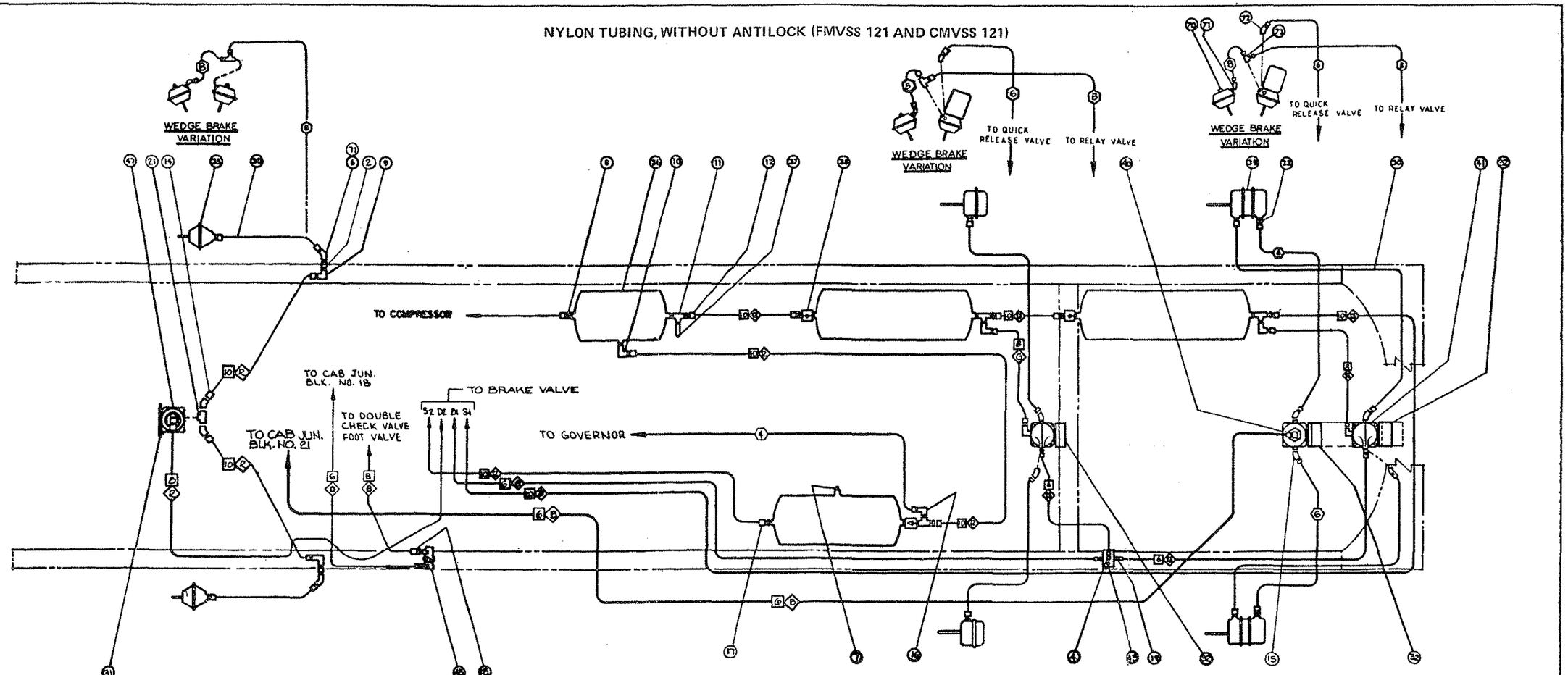
	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	8
73	23-9313-003	STREET TEE (3/8 NPT)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

D12-11483 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRACTOR,
FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12756

NYLON TUBING, WITHOUT ANTILOCK (FMVSS 121 AND CMVSS 121)



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1			
2	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	3	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	1	23-9296-9	ELBOW, MALE, 90° (1/4 NPT - 3/8 NT)
5			
6	2	23-9531-606	ELBOW, 45°, STREET (3/8 NPT - 3/8 NPT)
7	1	23-9200-6	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	2	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9301-021	COUPLING, MALE
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT) - 3/8 NT)
14	2	23-9293-008	ELBOW, MALE, 45° (3/8 NPT - 5/8 NT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17	2	23-9301-018	COUPLING, MALE (1/2 NPT - 1/2 NT)
18	2	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	1	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20			
21	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25			
26			
27			
28			
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	6	A12-10505-000	HOSE ASSY, AIR BRAKE
31	1	12-10476-000	BRKT, MOUNTING
32			
33			
34	3	12-10474	BRKT, MOUNTING
35	SEE FRONT AXLE ASSY.		
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46	1	12-10458-000	JUNCTION BLOCK, FRAME, FRONT
47	1		VALVE, RATIO
48			

HOSES & TUBES

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12
6 B	48-101-010	TUBE, NYLON, NO. 6, BLACK
6 G	48-101-015	TUBE, NYLON, NO. 6, GREEN
6 O	48-101-013	TUBE, NYLON, NO. 6, ORANGE
6 R	48-101-012	TUBE, NYLON, NO. 6, RED
8 B	48-101-020	TUBE, NYLON, NO. 8, BLACK
8 G	48-101-025	TUBE, NYLON, NO. 8, GREEN
8 R	48-101-022	TUBE, NYLON, NO. 8, RED
10 G	48-101-035	TUBE, NYLON, NO. 10, GREEN
10 R	48-101-032	TUBE, NYLON, NO. 10, RED

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-061	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

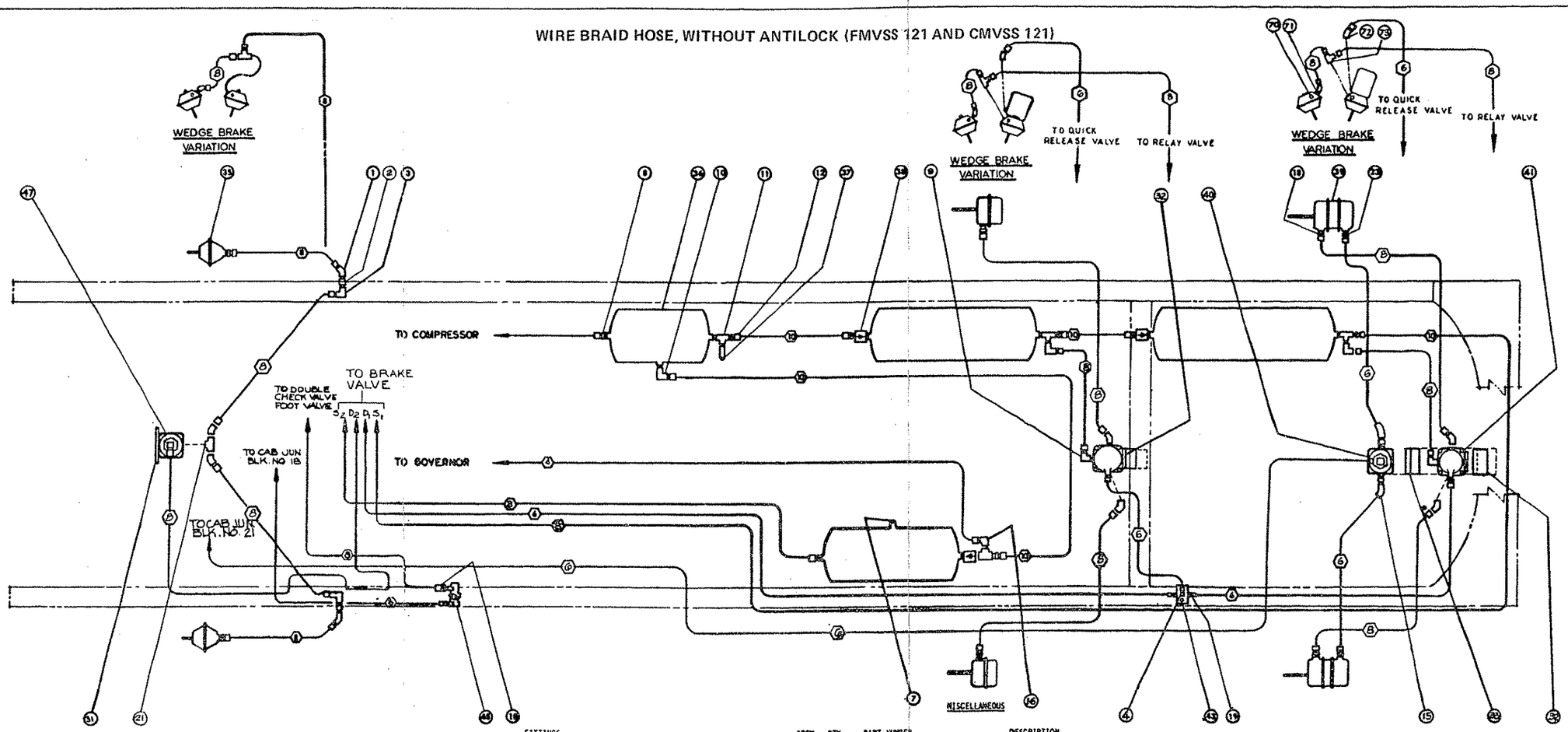
D12-11493 ENG. CHG. LTR. A

Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12756

CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	5	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	2	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7	1	23-9200-5	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/4 HOSE)
17			
18	8	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	3	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20			
21	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
22			
23	4	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25	2	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26	1	23-9327-044	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 1/2 HOSE)
27			
28			
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30			
31	1	12-10476-000	BRKT, MOUNTING
32			
33	3	12-10474-000	BRACE MOUNTING
34			
35	SEE FRONT AXLE ASSY.		
36	N12-10545		AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY.
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46			
47	1		VALVE, RATIO
48			

ITEM	PART NUMBER	DESCRIPTION
(4)	A23-2232-L	HOSE ASSEMBLY, NO. 4
(6)	A23-2235-L	HOSE ASSEMBLY, NO. 6
(8)	A23-2234-L	HOSE ASSEMBLY, NO. 8
(10)	A23-2235-L	HOSE ASSEMBLY, NO. 10
(12)	A23-2236-L	HOSE ASSEMBLY, NO. 12

WEDGE BRAKE VARIATION

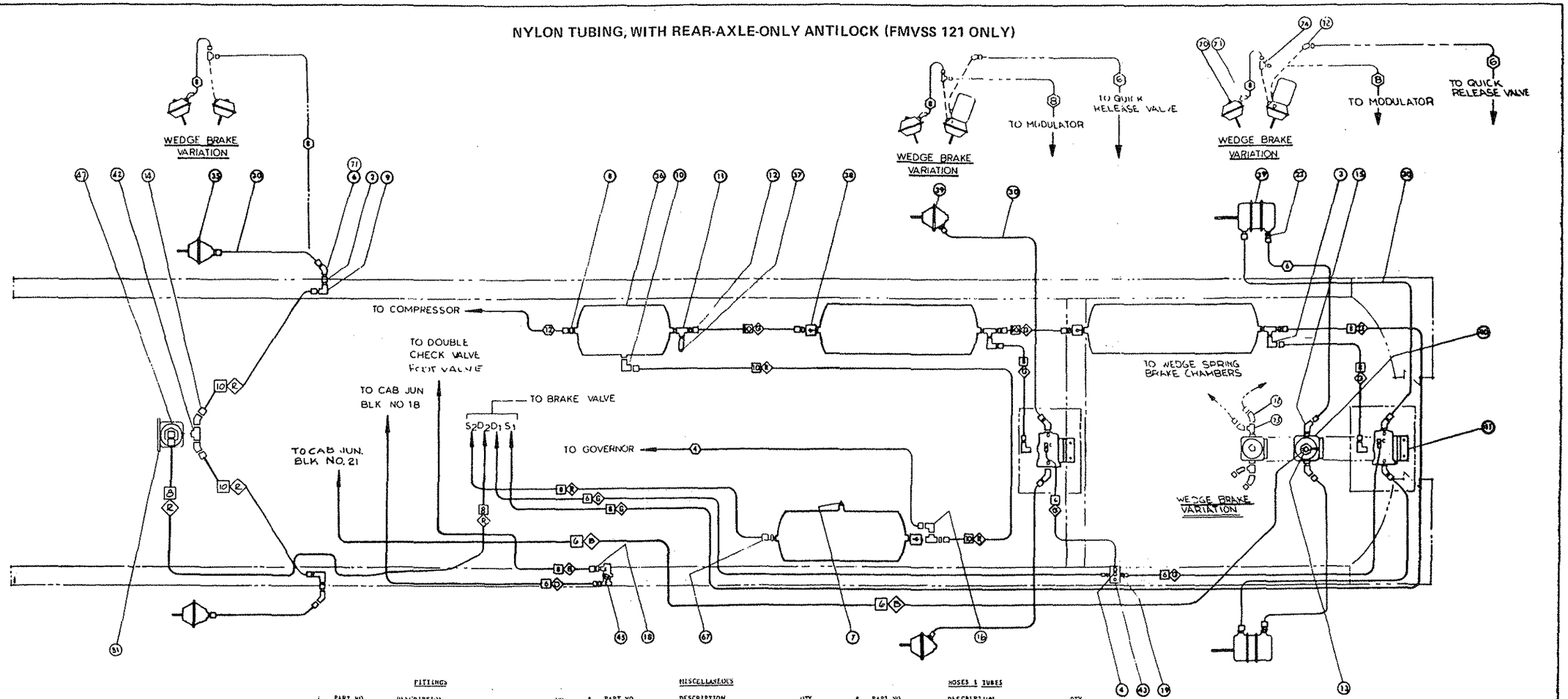
ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11495 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12756

NYLON TUBING, WITH REAR-AXLE-ONLY ANTILOCK (FMVSS 121 ONLY)



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1			
2	A12-10491-0	Anchor Coupling(3/8 NPT)	2
3	23-9295 012	90° Male Elbow (3/8 NPT - ½ NT)	5
4	23-9296-9	90° Male Elbow (¼ NPT - 3/8 NT)	1
5			
6	23-9331-006	45° Street Elbow (3/8 NPT-3/8 NPT)	2
7	23-9220-5	Plug (1/2 NPT)	1
8	23-9327-046	Male Connector, 45° Flare (¼ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	2
10	23-9295-015	90° Male Elbow (¼ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee- Special	4
12	23-9301-021	Male Coupling (¼ NPT - 5/8 NT)	5
13	23-9295-008	90° Male Elbow (3/8 NPT-3/8 NT)	1
14	23-9295 006	45° Male Elbow (3/8 NPT - ½ NT)	1
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-052	90° Male Elbow, 45° Flare (⅜ NPT - ¼ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	1
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	3
20			
21			
22			
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	2
67	23-9301-018	Male Coupling, (¼ NPT - ¼ NT)	2

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	A12-10543	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	3
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	A12-	See Anti-Lock Inst.	
42	23-9693-006	TEE, MALE RUN/ELL (3/8 NPT)	1
43	12-10459-2	Frame Junction Block, Rear	1
44			
45		T. P. Valve	1
46			
47		Ratio Valve	1
81	12-10476-0	BRACKET, MOUNTING	

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10503-0	Air Brake Hose Assembly	6
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	
6	48-101-010	Nylon Tube No. 6 Black	
6	48-101-015	Nylon Tube No. 6 Green	
6	48-101-013	Nylon Tube No. 6 Orange	
6	48-101-012	Nylon Tube No. 6 Red	
8	48-101-020	Nylon Tube No. 8 Black	
8	48-101-025	Nylon Tube No. 8 Green	
8	48-101-022	Nylon Tube No. 8 Red	
10	48-101-035	Nylon Tube No. 10 Green	
10	48-101-032	Nylon Tube No. 10 Red	

WEDGE BRAKE VARIATION

#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ¼ Hose)	8
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	8
73	23-9313-003	STREET TEE (⅜ NPT)	2
74	23-9694-081	Male Run Tee, 45° Flare (3/8 NPT - ¼ Hose)	6

D12-11485 ENG. CHG. LTR. A

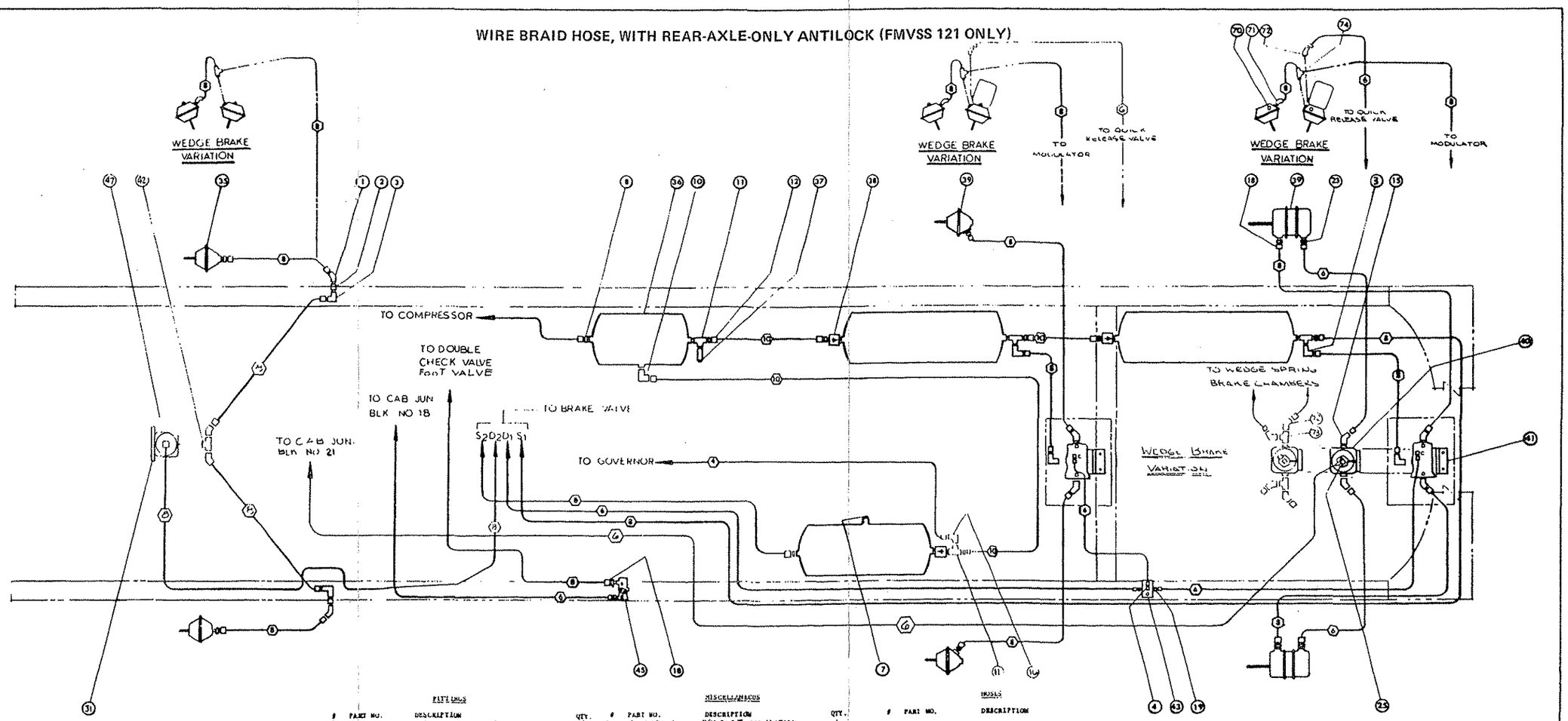
Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12756

CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

WIRE BRAID HOSE, WITH REAR-AXLE-ONLY ANTILOCK (FMVSS 121 ONLY)



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	4
2	A12-10491-0	Anchor Coupling (3/8 NPT)	1
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	5
4	23-9328-023	90° Male Elbow, 45° Flare (¼ NPT - 3/8 Hose)	1
5			
7	43-[illegible]	Plug (1/2 NPT)	1
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9			
10	23-9328-045	90° Male Elbow, 45° Flare (½ NPT - 5/8 Hose)	1
11	12-10492-0	Breast Tee-Special	4
12	23-9327-045	Male Connector, 45° Flare (½ NPT - 5/8 Hose)	3
13			
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (⅜ NPT - ¼ Hose)	1
17			
18	23-9327-034	Male Connector, 45° Flare (3/8 NPT - ½ Hose)	6
19	23-9327-023	Male Connector, 45° Flare (¼ NPT - 3/8 Hose)	1

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
31	12-10476-B	BRACKET, MOUNTING	1
33	See Front Axle Assembly		
36	M12-10543	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	1
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	M12-	See Anti-Lock Inst.	
42	23-9695-006	TEE, MALE BRANCH (3/8 NPT)	1
43	12-10459-2	Frame Junction Block, Rear	1
45		T. P. Valve	1
46			
47		Ratio Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	5
25	23-9328-033	90° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	1
97	23-9327-044	Male Connector, 45° Flare (½ NPT - ½ Hose)	2

HOSES

#	PART NO.	DESCRIPTION
4	A23-2232-L	Hose Assembly No. 4
6	A23-2233-L	Hose Assembly No. 6
8	A23-2234-L	Hose Assembly No. 8
10	A23-2235-L	Hose Assembly No. 10
12	A23-2236-L	Hose Assembly No. 12

WEDGE BRAKE VARIATION

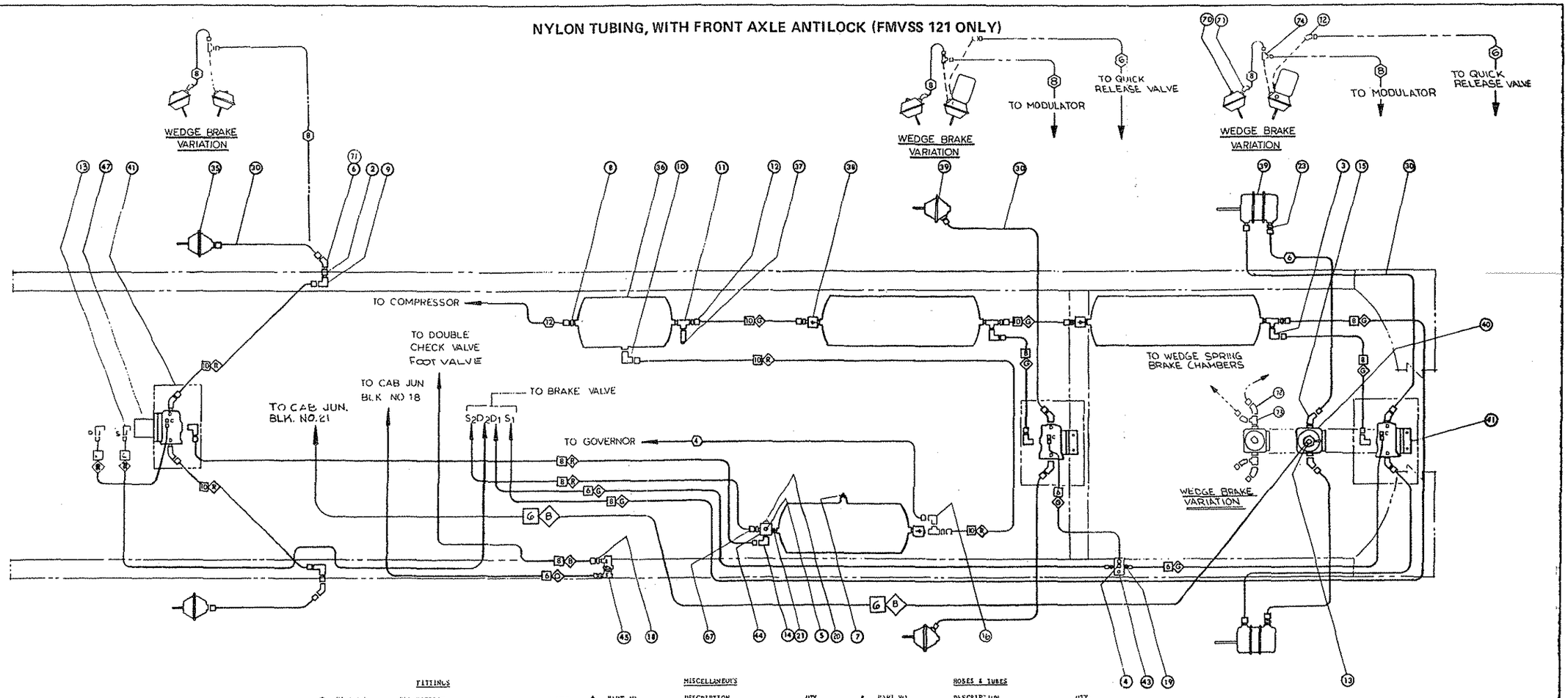
#	PART NO.	DESCRIPTION	QTY.
70	23-[illegible]-4	Plug (1/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	8
73	23-9513-003	Street Tee 3/8 NPT	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

D12-11489 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRACTOR,
FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12756

NYLON TUBING, WITH FRONT AXLE ANTILOCK (FMVSS 121 ONLY)



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1			
2	A12-10491-0	Anchor Coupling(3/8 NPT)	2
3	23-9295-012	90° Male Elbow (3/8 NPT - ¼ NT)	2
4	23-9295-007	90° Male Elbow (¼ NPT - 3/8 NT)	1
5	23-9200-4	Plug (3/8 NPT)	2
6	23-9331-M16	45° Street Elbow (3/8 NPT-1/8 NPT)	2
7	23-9200-5	Plug (1/2 NPT)	1
8	23-9327-046	Male Connector, 45° Flare (¼ NPT - 3/4 Hose)	1
9	23-9295-014	90° Male Elbow (3/8 NPT - 5/8 NT)	2
10	23-9295-015	90° Male Elbow (½ NPT - 5/8 NT)	1
11	12-10492-0	Street Tee- Special	4
12	23-9301-021	Male Coupling (½ NPT - 5/8 NT)	5
13	23-9295-008	90° Male Elbow (3/8 NPT-3/8 NT)	5
14	23-9295-011	90° Male Elbow (½ NPT ½ NT)	1
15	23-9328-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (¼ NPT - ½ Hose)	1
17			
18	23-9301-017	Male Coupling (3/8 NPT - ½ NT)	1
19	23-9301-012	Male Coupling (¼ NPT - 3/8 NT)	13
20	23-9320-3	Plug (¼)	1
21	23-9500-008	Nipple, Hex. (½ NPT)	1
22			
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	2
67	23-9301-018	Male Coupling, (½ NPT - ½ NT)	2

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	B12-10565	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	1
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	N12-	See Anti-Lock Inst.	
42			
43	12-10459-2	Frame Junction Block, Rear	1
44	12-10511-0	Air Reservoir Jun. Block	1
45		T. P. Valve	1
46			
47		Ratio Valve	1

HOSES & TUBES

#	PART NO.	DESCRIPTION	QTY.
30	A12-10505-0	Air brake Hose Assembly	6
(4)	A23-22332-L	Hose Assembly No. 4	
(6)	A23-22333-L	Hose Assembly No. 6	
(8)	A23-22334-L	Hose Assembly No. 8	
(10)	A23-22335-L	Hose Assembly No. 10	
(12)	A23-22336-L	Hose Assembly No. 12	
6R	48-101-010	Nylon Tube No. 6 Black	
6G	48-101-015	Nylon Tube No. 6 Green	
6O	48-101-013	Nylon Tube No. 6 Orange	
6R	48-101-012	Nylon Tube No. 6 Red	
8R	48-101-020	Nylon Tube No. 8 Black	
8G	48-101-025	Nylon Tube No. 8 Green	
8R	48-101-022	Nylon Tube No. 8 Red	
10G	48-101-035	Nylon Tube No. 10 Green	
10R	48-101-032	Nylon Tube No. 10 Red	

WEDGE BRAKE VARIATION

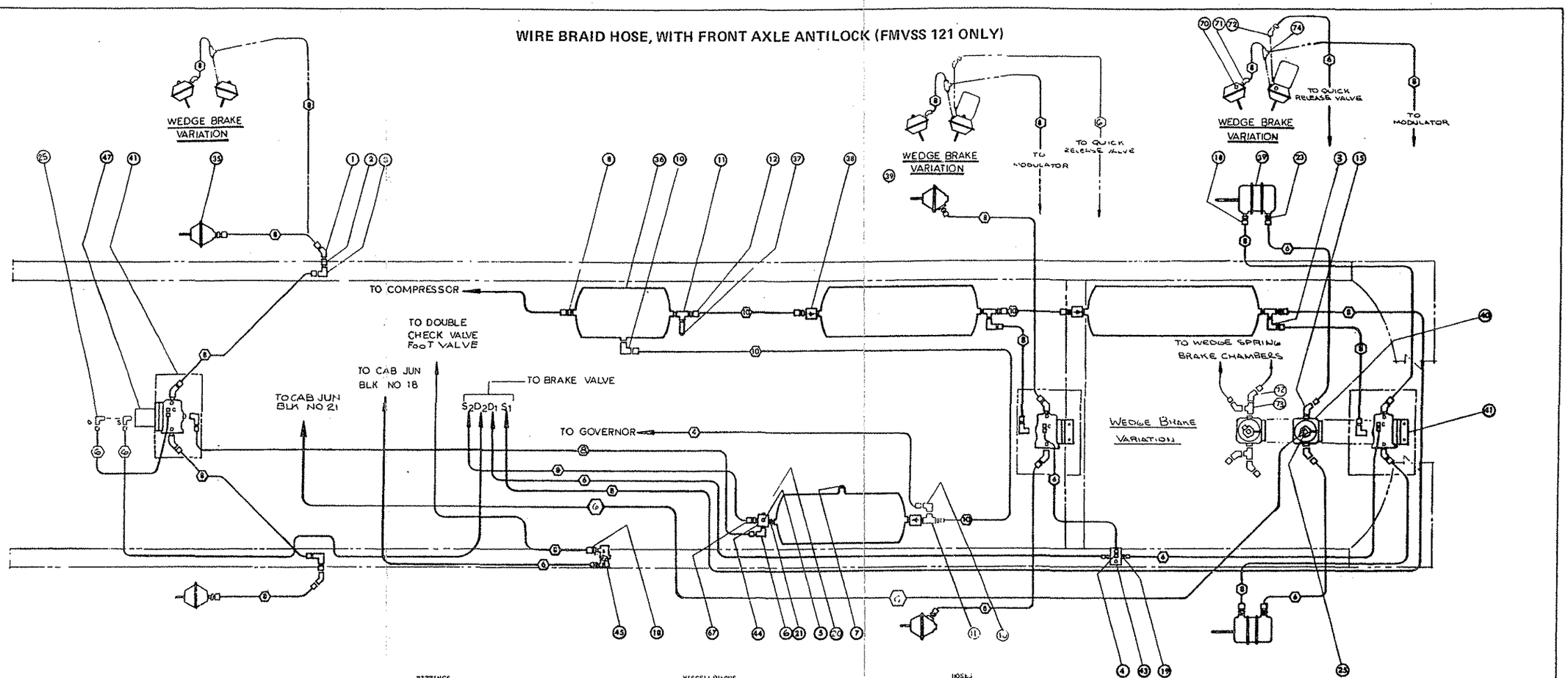
#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	11
72	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ¼ Hose)	8
73	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT- 3/8 Hose)	8
73	23-9313-003	STREET TEE (3/8 NPT)	2
74	23-9494-081	Male Run Tee, 45° Flare (3/8 NPT - ¼ Hose)	6

D12-11478 ENG. CHG. LTR. A

Service

BRAKE CONTROL 12
32-12756

CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM



FITTINGS

#	PART NO.	DESCRIPTION	QTY.
1	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT- ½ Hose)	2
2	A12-10491-0	Anchor Coupling (3/8 NPT)	2
3	23-9328-034	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	4
4	23-9328-023	90° Male Elbow, 45° Flare (¼ NPT - 3/8 Hose)	1
5	23-9200-4	Plug (3/8 NPT)	2
6	23-9328-024	90° Male Elbow, 45° Flare (¼ NPT - 1/2 Hose)	1
7	23-9200-5	Plug (1/2 NPT)	1
8	23-9327-046	Male Connector, 45° Flare (½ NPT - 3/4 Hose)	1
9			
10	23-9328-045	90° Male Elbow, 45° Flare (½ NPT - 5/8 Hose)	1
11	12-10492-0	Street Tee-Special	4
12	23-9327-045	Male Connector, 45° Flare (½ NPT - 5/8 Hose)	5
13			
14			
15	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	2
16	23-9328-032	90° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	1
17			
18	23-9327-034	Male Connector, 45° Flare (3/8 NPT - ½ Hose)	7
19	23-9327-023	Male Connector, 45° Flare (¼ NPT - 3/8 Hose)	3

MISCELLANEOUS

#	PART NO.	DESCRIPTION	QTY.
35	See Front Axle Assembly		
36	M12-10545	Air Reservoirs Inst.	
37		Air Safety Valve	1
38		Single Check Valve	3
39	See Rear Axle Assembly		
40		Quick Release Valve	1
41	M12-	See Anti-Lock Inst.	
42			
43	12-10459-2	Frame Junction Block, Rear	1
44	12-10511-0	Air Reservoir Jun. Block	1
45		T. P. Valve	1
46			
47		Ratio Valve	1

FITTINGS

#	PART NO.	DESCRIPTION	QTY.
20	23-9200-3	Plug (¼)	1
21	23-9530-008	Nipple, Hex. (¼ NPT)	1
22			
23	23-9327-033	Male Connector, 45° Flare (3/8 NPT - 3/8 Hose)	1
25	23-9328-033	90° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	3
67	23-9327-044	Male Connector, 45° Flare (¼ NPT - ½ Hose)	2

HOSES

#	PART NO.	DESCRIPTION	QTY
4	A23-2232-L	Hose Assembly No. 4	
6	A23-2233-L	Hose Assembly No. 6	
8	A23-2234-L	Hose Assembly No. 8	
10	A23-2235-L	Hose Assembly No. 10	
12	A23-2236-L	Hose Assembly No. 12	

WEDGE BRAKE VARIATION

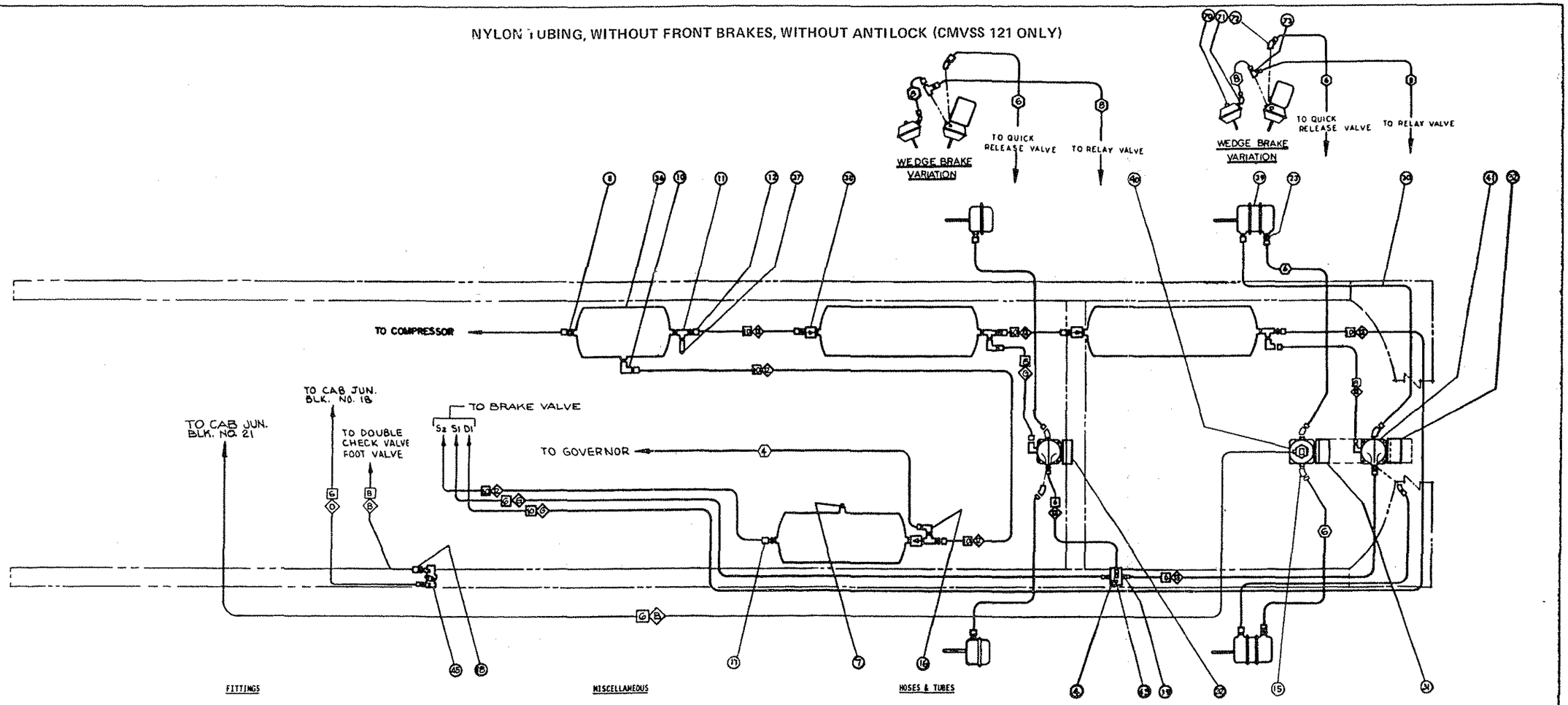
#	PART NO.	DESCRIPTION	QTY.
70	23-9200-4	Plug (3/8 NPT)	12
71	23-9326-034	45° Male Elbow, 45° Flare (3/8 NPT - ½ Hose)	6
72	23-9326-033	45° Male Elbow, 45° Flare (3/8 NPT - 3/8 Hose)	6
73	23-9313-003	STREET Tee 3/8 NPT	2
74	23-9494-021	Male Run Tee, 45° Flare (3/8 NPT - ½ Hose)	6

D12-11481 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRACTOR,
FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12756

NYLON TUBING, WITHOUT FRONT BRAKES, WITHOUT ANTILOCK (CMVSS 121 ONLY)



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1			
2			
3	3	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	1	23-9296-9	ELBOW, MALE, 90° (1/4 NPT - 3/8 NT)
5			
6			
7	1	23-9200-5	PLUG (1/2 NPT)
8			
9	2	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9301-021	COUPLING, MALE
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT) - 3/8 NT)
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17	2	23-9301-018	COUPLING, MALE (1/2 NPT - 1/2 NT)
18	2	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	3	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20			
21			
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25			
26			
27			
28			
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	4	A12-10505-000	HOSE ASSY, AIR BRAKE
31	3	12-10474-000	BRKT MOUNTING
32			
33	1		ANCHOR ELBOW, 3/8 NPT
34			
35			
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46	1	12-10458-000	JUNCTION BLOCK, FRAME, FRONT
47			
48			

HOSES & TUBES

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L.	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12
6 B	48-101-010	TUBE, NYLON, NO. 6, BLACK
6 G	48-101-015	TUBE, NYLON, NO. 6, GREEN
6 O	48-101-013	TUBE, NYLON, NO. 6, ORANGE
6 R	48-101-012	TUBE, NYLON, NO. 6, RED
8 B	48-101-020	TUBE, NYLON, NO. 8, BLACK
8 G	48-101-025	TUBE, NYLON, NO. 8, GREEN
8 R	48-101-022	TUBE, NYLON, NO. 8, RED
10 G	48-101-035	TUBE, NYLON, NO. 10, GREEN
10 R	48-101-032	TUBE, NYLON, NO. 10, RED

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

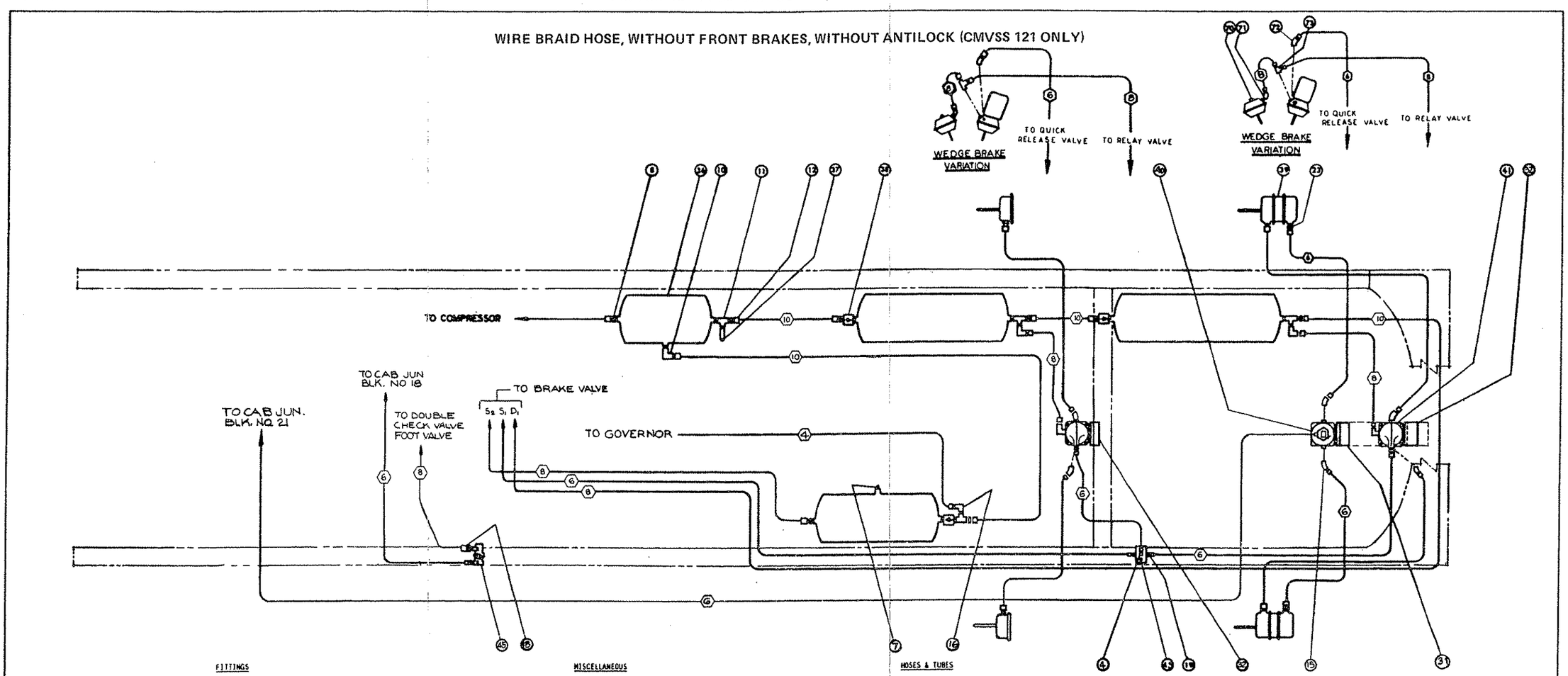
D12-11501 ENG. CHG. LTR. A

Service

FREIGHTLINER
FREIGHTLINER CORPORATION®

BRAKE CONTROL 12
32-12756

CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121 AND CMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1			
2			
3			
4	1	23-9526-025	ELBOW, MALE, 90° 45° FLARE(1/4 NPT -1/8 HOSE)
5			
6	2	23-9531-606	ELBOW, 45°, STREET (3/8 NPT - 3/8 NPT)
7	1	23-9200-35	PLUG (1/2 NPT)
8	2	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9528 045	ELBOW, MALE, 90° 45° FLARE (1/2 NPT - 5/8 HOSE)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9327-045	CONNECTOR MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17			
18	6	23-9327-034	CONNECTOR MALE, 45° FLARE (5/8 NPT - 1/2 HOSE)
19	3	23-9327-023	CONNECTOR MALE, 45° FRARE (1/4 NPT - 1/8 HOSE)
20			
21			
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24			
25			
26			
27			
28			
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30			
31	3	12-10474-000	BRKT MOUNTING
32			
33			
34			
35			
36		N12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46			
47			
48			

HOSES & TUBES

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12

WEDGE BRAKE VARIATION

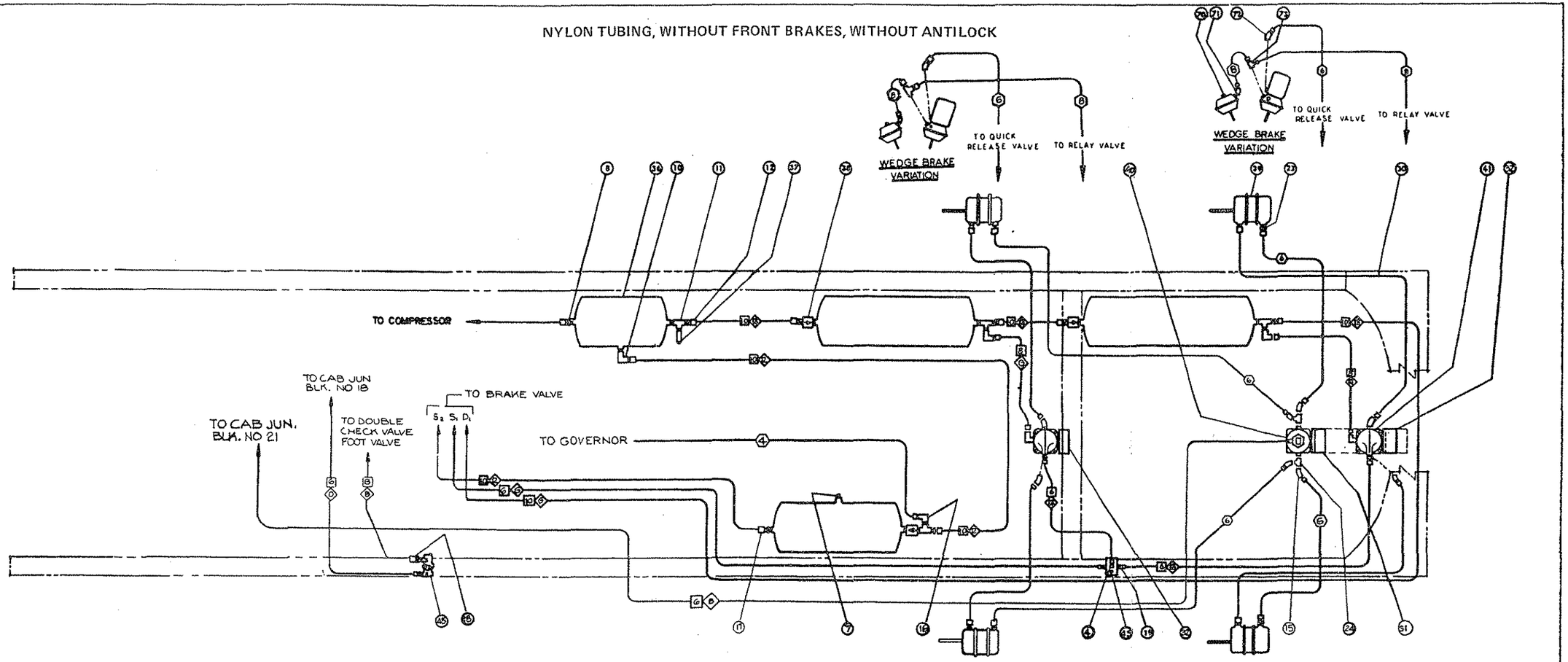
ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11498 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12758

NYLON TUBING, WITHOUT FRONT BRAKES, WITHOUT ANTILOCK



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1			
2			
3	3	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	1	23-9296-9	ELBOW, MALE, 90° (1/4 NPT - 3/8 NT)
5			
6			
7	1	23-9200-5	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9301-021	COUPLING, MALE
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT) - 3/8 NT)
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17	2	23-9301-018	COUPLING, MALE (1/2 NPT - 1/2 NT)
18	2	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	3	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20			
21			
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9313-303	TEE, STREET, (3/8 NPT)
25			
26			
27			
28			
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	4	A12-10505-000	HOSE ASSY, AIR BRAKE
31	3	12-10474-000	BRKT, MOUNTING
32			
33			
34			
35			
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46			
47			
48			

HOSES & TUBES

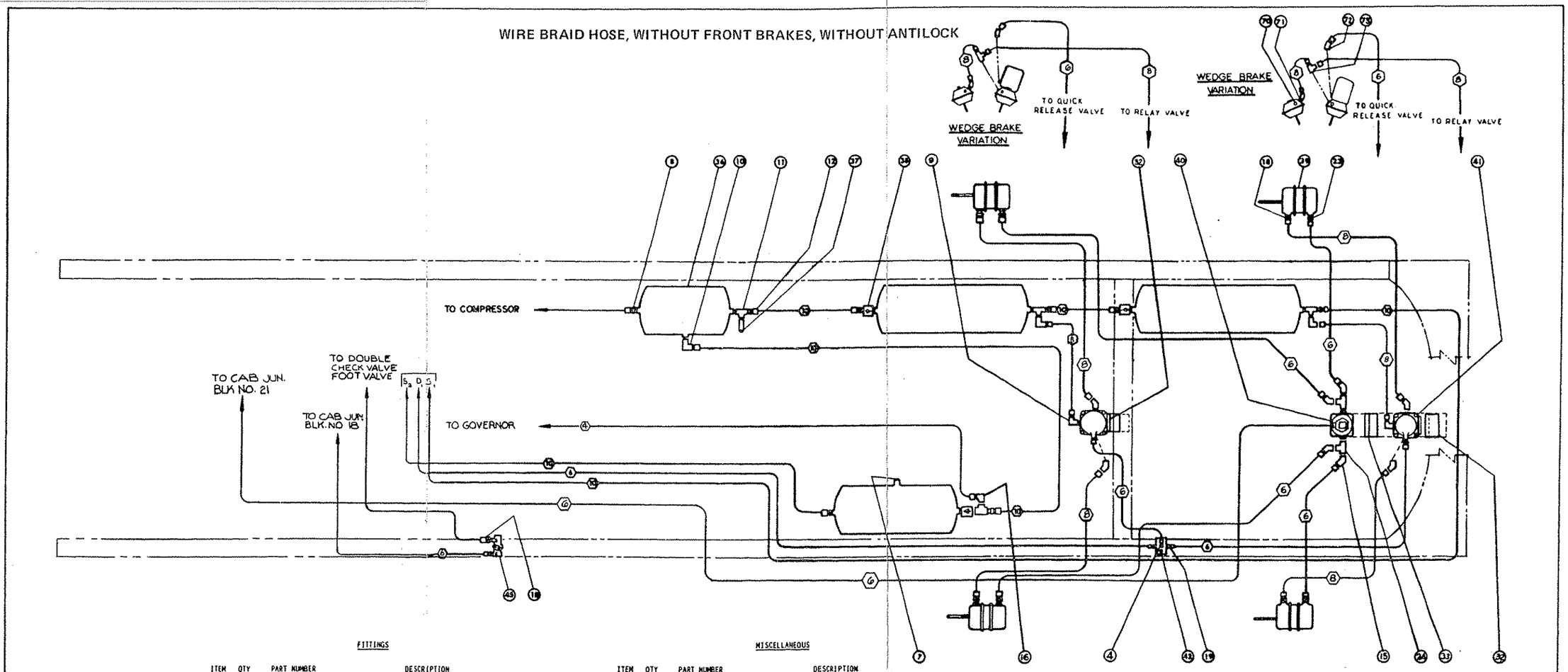
ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12
6 B	48-101-010	TUBE, NYLON, NO. 6, BLACK
6 G	48-101-015	TUBE, NYLON, NO. 6, GREEN
6 O	48-101-013	TUBE, NYLON, NO. 6, ORANGE
6 R	48-101-012	TUBE, NYLON, NO. 6, RED
8 B	48-101-020	TUBE, NYLON, NO. 8, BLACK
8 G	48-101-025	TUBE, NYLON, NO. 8, GREEN
8 R	48-101-022	TUBE, NYLON, NO. 8, RED
10 G	48-101-035	TUBE, NYLON, NO. 10, GREEN
10 R	48-101-032	TUBE, NYLON, NO. 10, RED

WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11499 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
2			
3	3	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	2	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7	1	23-9200-5	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17			
18	8	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	3	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20			
21			
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9313-003	TEE, STREET (3/8 NPT)
25	2	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26	1	23-9327-044	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 1/2 HOSE)
27			
28			
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30			
31			
32			
33	3	12-10474-000	BRKT, MOUNTING
34			
35			
36		M12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38			VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41			VALVE, RELAY,
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46			
47			
48			

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-223 -L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12

WEDGE BRAKE VARIATION

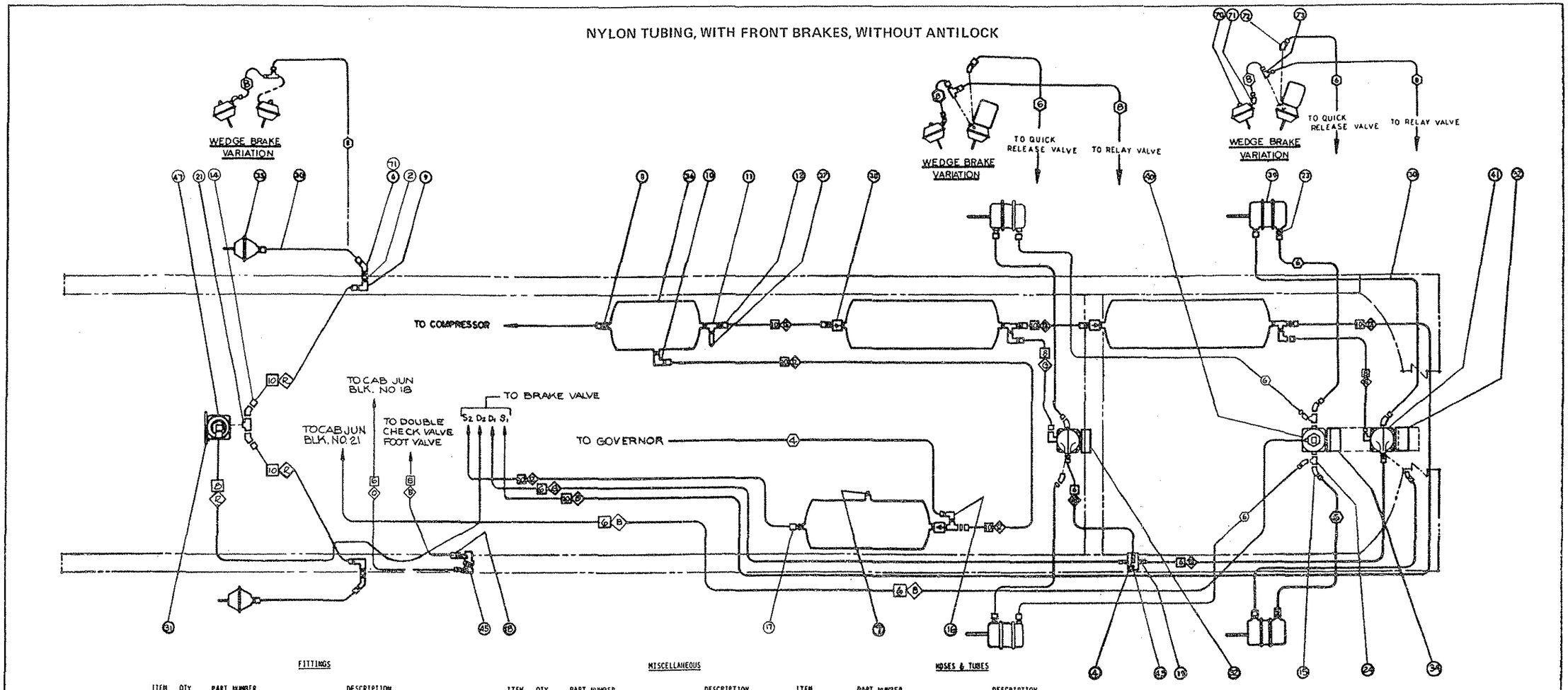
ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11500 ENG. CHG. LTR. A

CONVENTIONAL TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM

BRAKE CONTROL 12
32-12758

NYLON TUBING, WITH FRONT BRAKES, WITHOUT ANTILOCK



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1			
2	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	3	23-9295-012	ELBOW, MALE, 90° (3/8 NPT - 1/2 NT)
4	1	23-9296-9	ELBOW, MALE, 90° (1/4 NPT - 3/8 NT)
5			
6	2	23-9531-606	ELBOW, 45°, STREET (3/8 NPT - 3/8 NPT)
7	1	23-9200-6	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9	2	23-9295-014	ELBOW, MALE, 90° (3/8 NPT - 5/8 NT)
10	1	23-9295-015	ELBOW, MALE, 90° (1/2 NPT - 5/8 NT)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9301-021	COUPLING, MALE
13	1	23-9295-008	ELBOW, MALE, 90° (3/8 NPT) - 3/8 NT)
14	2	23-9293-008	ELBOW, MALE, 45° (3/8 NPT - 5/8 NT)
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17	2	23-9301-018	COUPLING, MALE (1/2 NPT - 1/2 NT)
18	2	23-9301-017	COUPLING, MALE (3/8 NPT - 1/2 NT)
19	3	23-9301-012	COUPLING, MALE (1/4 NPT - 3/8 NT)
20			
21	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9313-003	TEE, STREET, (3/8 NPT)
25			
26			
27			
28			
29			

MISCELLANEOUS

ITEM	QTY	PART NUMBER	DESCRIPTION
30	6	A12-10505-000	HOSE ASSY, AIR BRAKE
31	1	12-10476-000	BRKT, MOUNTING
32			
33			
34	3	12 10474 000	BRKT, MOUNTING
35	SEE FRONT AXLE ASSY.		
36		H12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY.
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46			
47	1		VALVE, RATIO
48			

HOSES & TUBES

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-2233-L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2236-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12
6 B	48-101-010	TUBE, NYLON, NO. 6, BLACK
6 G	48-101-015	TUBE, NYLON, NO. 6, GREEN
6 O	48-101-013	TUBE, NYLON, NO. 6, ORANGE
6 R	48-101-012	TUBE, NYLON, NO. 6, RED
8 B	48-101-020	TUBE, NYLON, NO. 8, BLACK
8 G	48-101-025	TUBE, NYLON, NO. 8, GREEN
8 R	48-101-022	TUBE, NYLON, NO. 8, RED
10 G	48-101-035	TUBE, NYLON, NO. 10, GREEN
10 R	48-101-032	TUBE, NYLON, NO. 10, RED

WEDGE BRAKE VARIATION

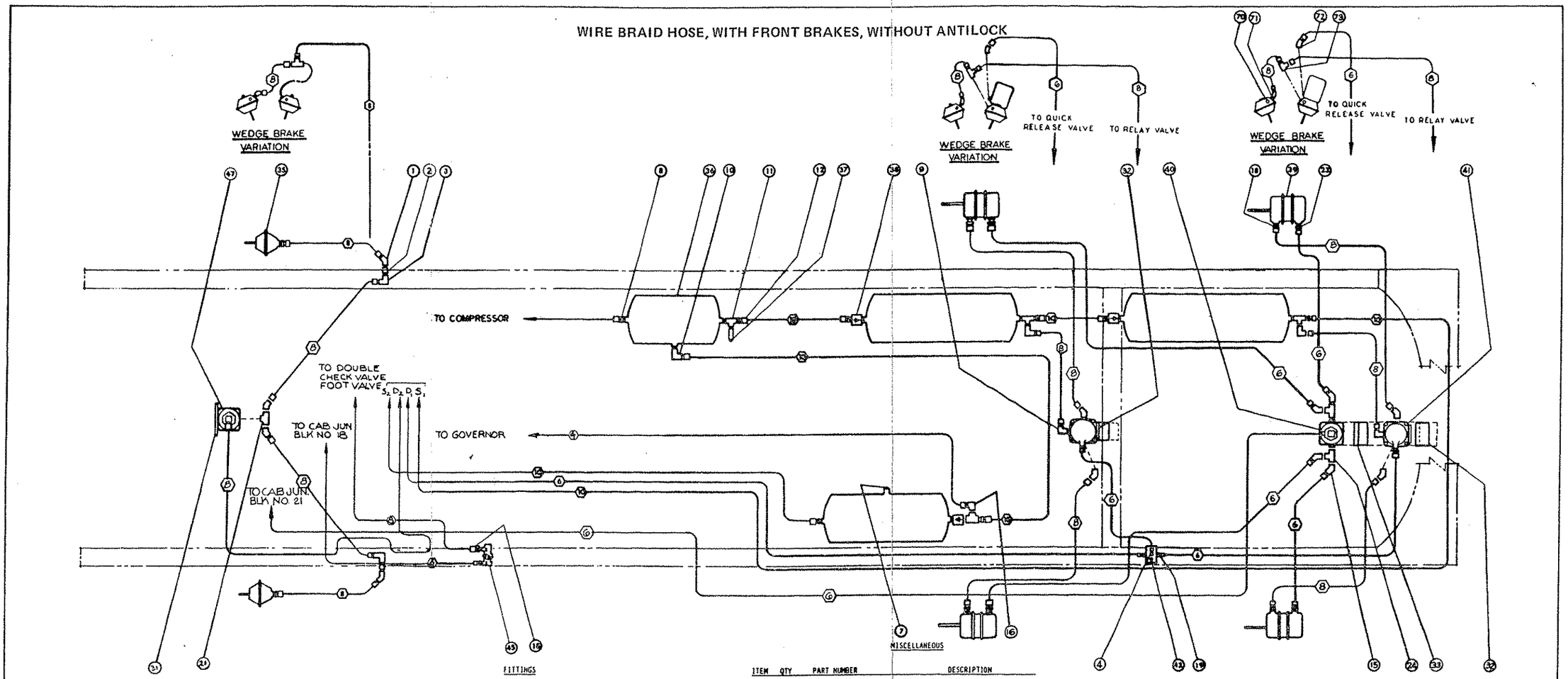
ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-001	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11494 ENG. CHG. LTR. A

Service

BRAKE CONTROL 12
32-12758

CONVENTIONAL TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM



FITTINGS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
2	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
3	5	23-9328-034	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
4	2	23-9328-023	ELBOW, MALE, 90°, 45° FLARE (1/4 NPT - 3/8 HOSE)
5			
6			
7	1	23-9200-5	PLUG (1/2 NPT)
8	1	23-9327-046	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 3/4 HOSE)
9			
10	1	23-9328-045	ELBOW, MALE, 90°, 45° FLARE (1/2 NPT - 5/8 HOSE)
11	4	12-10492-000	TEE, STREET, SPECIAL
12	5	23-9327-045	CONNECTOR, MALE, 45° FLARE (1/2 NPT - 5/8 HOSE)
13			
14			
15	2	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
16	1	23-9328-032	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 1/2 HOSE)
17			
18	8	23-9327-034	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 1/2 HOSE)
19	3	23-9327-023	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 3/8 HOSE)
20			
21	1	23-9693-006	TEE, MALE BRANCH (3/8 NPT)
22			
23	2	23-9327-033	CONNECTOR, MALE, 45° FLARE (3/8 NPT - 3/8 HOSE)
24	2	23-9513-005	TEE, STREET (3/8 NPT)
25	2	23-9328-033	ELBOW, MALE, 90°, 45° FLARE (3/8 NPT - 3/8 HOSE)
26	1	23-9327-044	CONNECTOR, MALE, 45° FLARE (1/4 NPT - 1/2 HOSE)
27			
28			
29			

ITEM	QTY	PART NUMBER	DESCRIPTION
30			
31	1	12-10476-000	BRKT, MOUNTING
32			
33	8	12-10474-000	BRKT, MOUNTING
34			
35	SEE FRONT AXLE ASSY.		
36		N12-10545	AIR RESERVOIRS INST.
37	1		VALVE, AIR SAFETY
38	3		VALVE, SINGLE CHECK
39	SEE REAR AXLE ASSY.		
40	1		VALVE, QUICK RELEASE
41	2		VALVE, RELAY,
42			
43	1	12-10459-002	JUNCTION BLOCK, FRAME, REAR
44			
45	1		VALVE, T.P.
46			
47	1		VALVE, RATIO
48			

ITEM	PART NUMBER	DESCRIPTION
4	A23-2232-L	HOSE ASSEMBLY, NO. 4
6	A23-223 -L	HOSE ASSEMBLY, NO. 6
8	A23-2234-L	HOSE ASSEMBLY, NO. 8
10	A23-2235-L	HOSE ASSEMBLY, NO. 10
12	A23-2236-L	HOSE ASSEMBLY, NO. 12

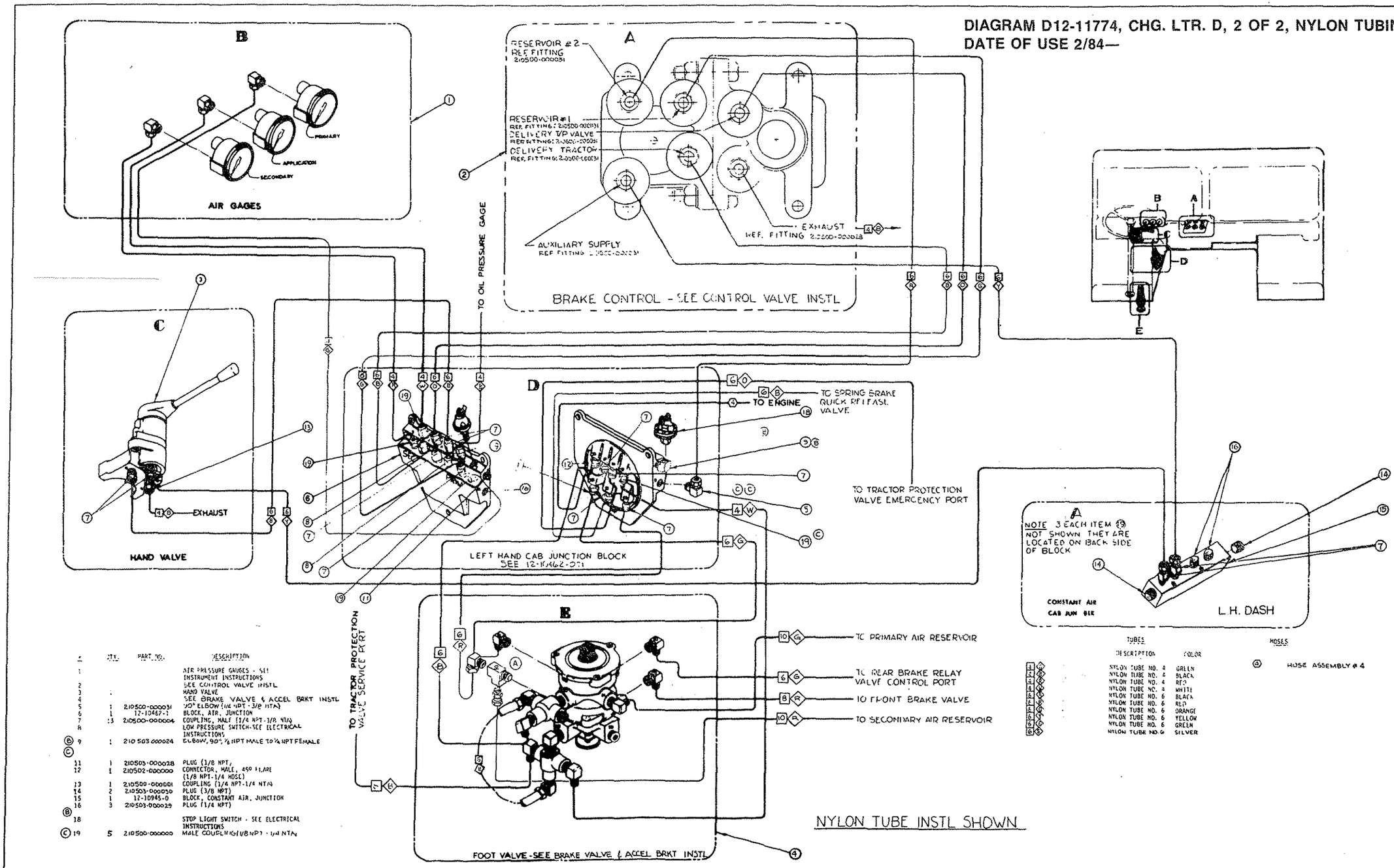
WEDGE BRAKE VARIATION

ITEM	QTY	PART NUMBER	DESCRIPTION
70	12	23-9200-4	PLUG (3/8 NPT)
71	6	23-9326-034	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 1/2 HOSE)
72	4	23-9326-033	ELBOW, MALE, 45°, 45° FLARE (3/8 NPT - 3/8 HOSE)
73	6	23-9494-081	TEE, MALE, RUN, 45° FLARE (3/8 NPT - 1/2 HOSE)

D12-11496 ENG. CHG. LTR. A

COE TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-11774, CHG. LTR. D, 2 OF 2, NYLON TUBING, DATE OF USE 2/84—

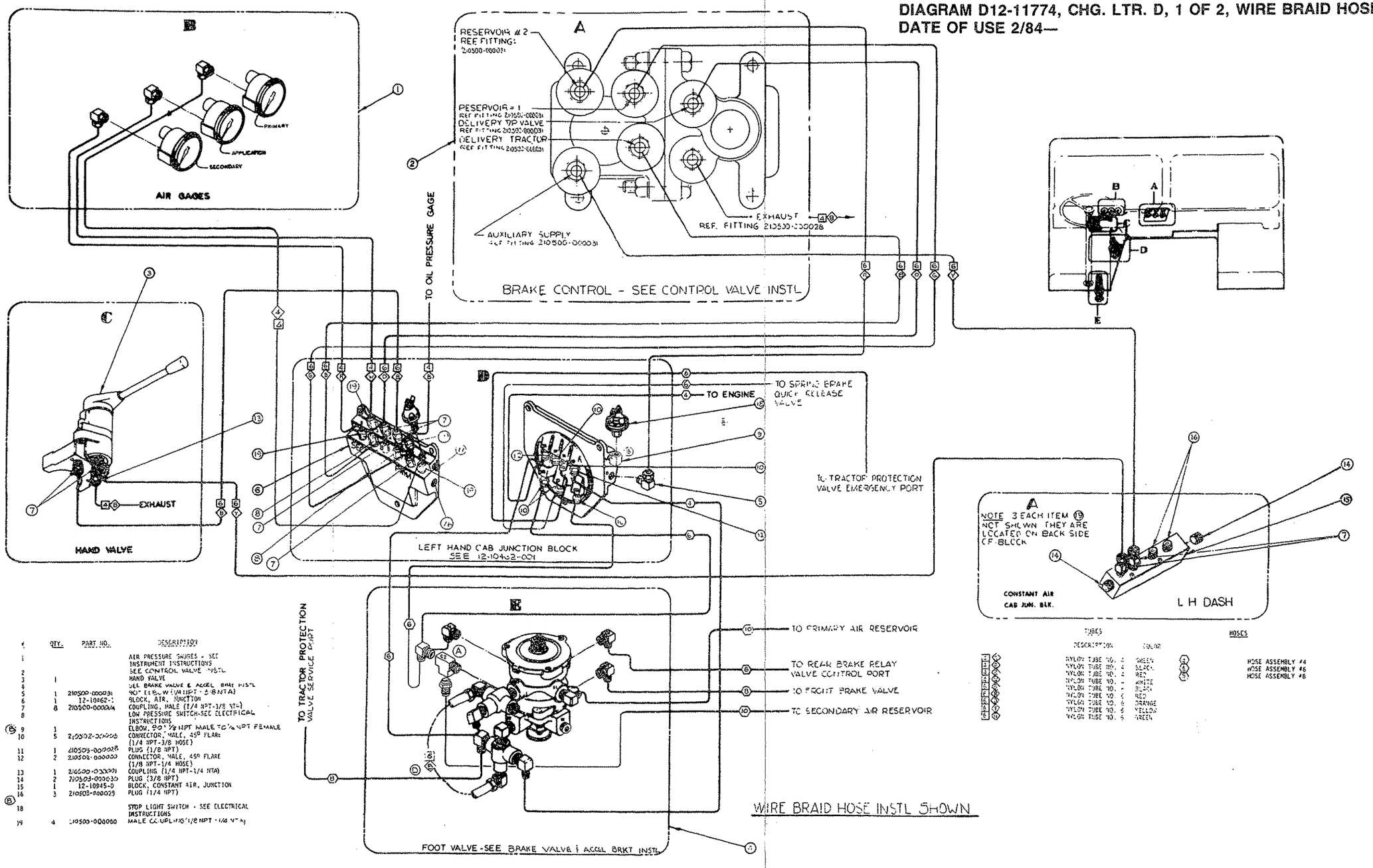


▲	QTY.	PART NO.	DESCRIPTION
	1		AIR PRESSURE GAUGES - SEE INSTRUMENT INSTRUCTIONS
	2		SEE CONTROL VALVE INSTL
	3		HAND VALVE
	4		SEE BRAKE VALVE & ACCEL BRKT INSTL
	5	1 210502-000031	90° ELBOW (1/4 NPT - 3/8 NTA)
	6	1 12-10467-1	BLOCK, AIR, JUNCTION
	7	13 210500-000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
	8		LOW PRESSURE SWITCH-SEE ELECTRICAL INSTRUCTIONS
(B)	9	1 210503-000024	ELBOW, 90° 1/8 NPT MALE TO 1/4 NPT FEMALE
(C)			
	11	1 210503-000028	PLUG (1/8 NPT)
	12	1 210502-000000	CONNECTOR, MALE, 45° FLARE (1/8 NPT-1/4 HOSE)
	13	1 210500-000001	COUPLING (1/4 NPT-1/4 NTA)
	14	2 210503-000030	PLUG (3/8 NPT)
	15	1 12-10945-0	BLOCK, CONSTANT AIR, JUNCTION
	16	3 210503-000029	PLUG (1/4 NPT)
(B)	18		STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
(C)	19	5 210500-000000	MALE COUPLING (1/8 NPT - 1/4 NTA)

TUBES		HOSES
DESCRIPTION	COLOR	
NYLON TUBE NO. 4	GREEN	④ HOSE ASSEMBLY # 4
NYLON TUBE NO. 4	BLACK	
NYLON TUBE NO. 4	RED	
NYLON TUBE NO. 4	WHITE	
NYLON TUBE NO. 6	BLACK	
NYLON TUBE NO. 6	RED	
NYLON TUBE NO. 6	ORANGE	
NYLON TUBE NO. 6	YELLOW	
NYLON TUBE NO. 6	GREEN	
NYLON TUBE NO. 6	SILVER	

COE TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-11774, CHG. LTR. D, 1 OF 2, WIRE BRAID HOSE, DATE OF USE 2/84—

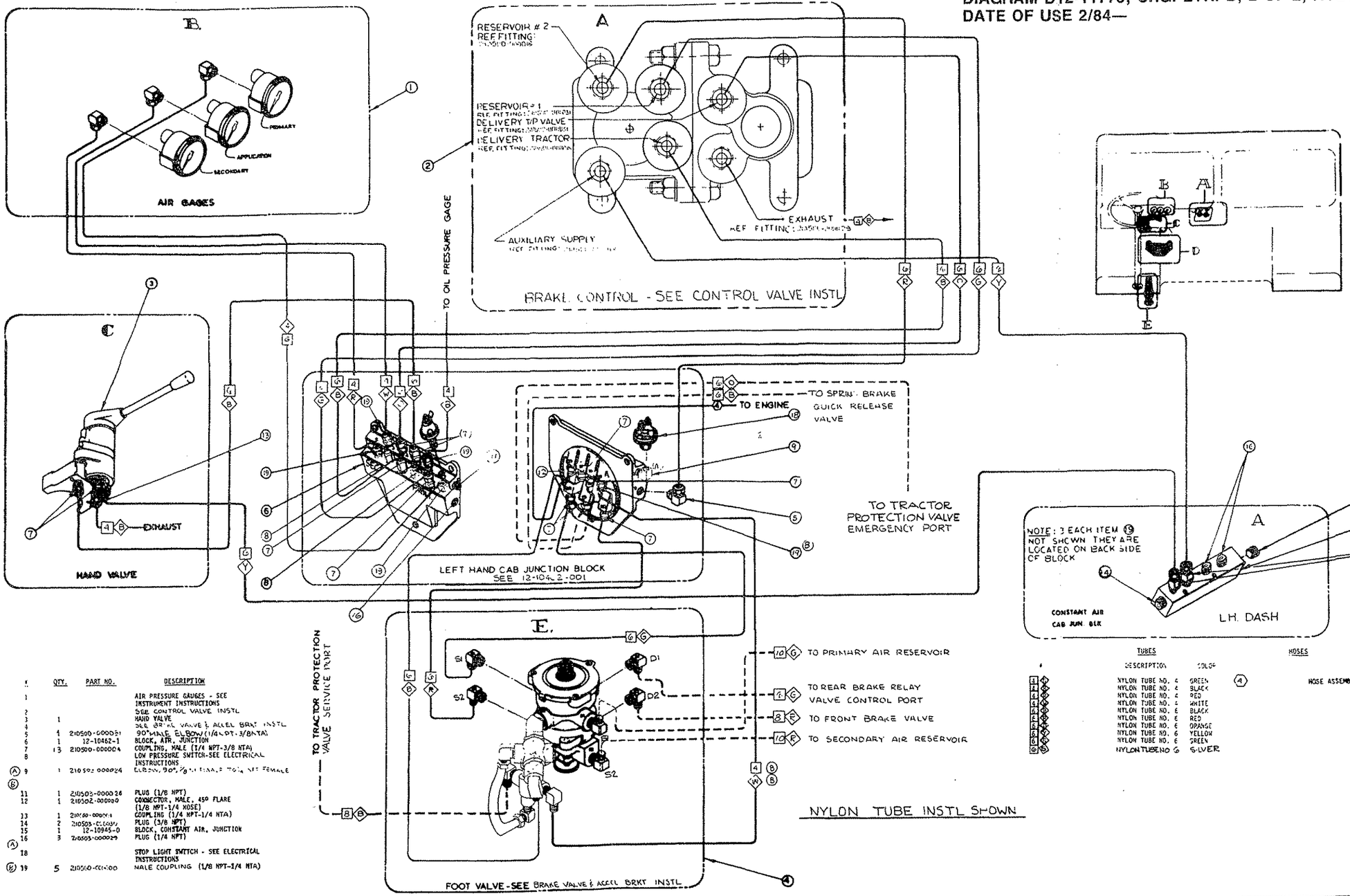


#	QTY.	PART NO.	DESCRIPTION
1			AIR PRESSURE GAUGES - SEE INSTRUMENT INSTRUCTIONS
2			SEE CONTROL VALVE INSTL
3	1		HAND VALVE
4			SEE BRAKE VALVE & ACCEL BRKT INSTL
5	1	210500-000031	90° ELBOW (1/4 NPT - 3/8 NTA)
6	1	12-10862-1	BLOCK, AIR, JUNCTION
7	8	210500-000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
8			LOW PRESSURE SWITCH-SEE ELECTRICAL INSTRUCTIONS
(5) 9	1		ELBOW, 90° 1/8 NPT MALE TO 1/8 NPT FEMALE
10	5	210502-000006	CONNECTOR, MALE, 45° FLARE (1/4 NPT-3/8 HOSE)
11	1	210503-000028	PLUG (1/8 NPT)
12	2	210502-000003	CONNECTOR, MALE, 45° FLARE (1/8 NPT-1/4 HOSE)
13	1	210500-000001	COUPLING (1/4 NPT-1/4 NTA)
14	2	210503-000030	PLUG (3/8 NPT)
15	1	12-10945-0	BLOCK, CONSTANT AIR, JUNCTION
16	3	210503-000029	PLUG (1/4 NPT)
(5) 18			STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
19	4	210500-000080	MALE COUPLING (1/8 NPT - 1/4 NTA)

TUBES		HOSES	
DESCRIPTION	COLOR		
NYLON TUBE NO. 4	GREEN	(4)	HOSE ASSEMBLY #4
NYLON TUBE NO. 6	BLACK	(6)	HOSE ASSEMBLY #6
NYLON TUBE NO. 8	RED	(8)	HOSE ASSEMBLY #8
NYLON TUBE NO. 10	WHITE		
NYLON TUBE NO. 12	BLACK		
NYLON TUBE NO. 16	RED		
NYLON TUBE NO. 4	ORANGE		
NYLON TUBE NO. 8	YELLOW		
NYLON TUBE NO. 6	GREEN		

120 CONVENTIONAL TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-11775, CHG. LTR. B, 2 OF 2, NYLON TUBING, DATE OF USE 2/84—

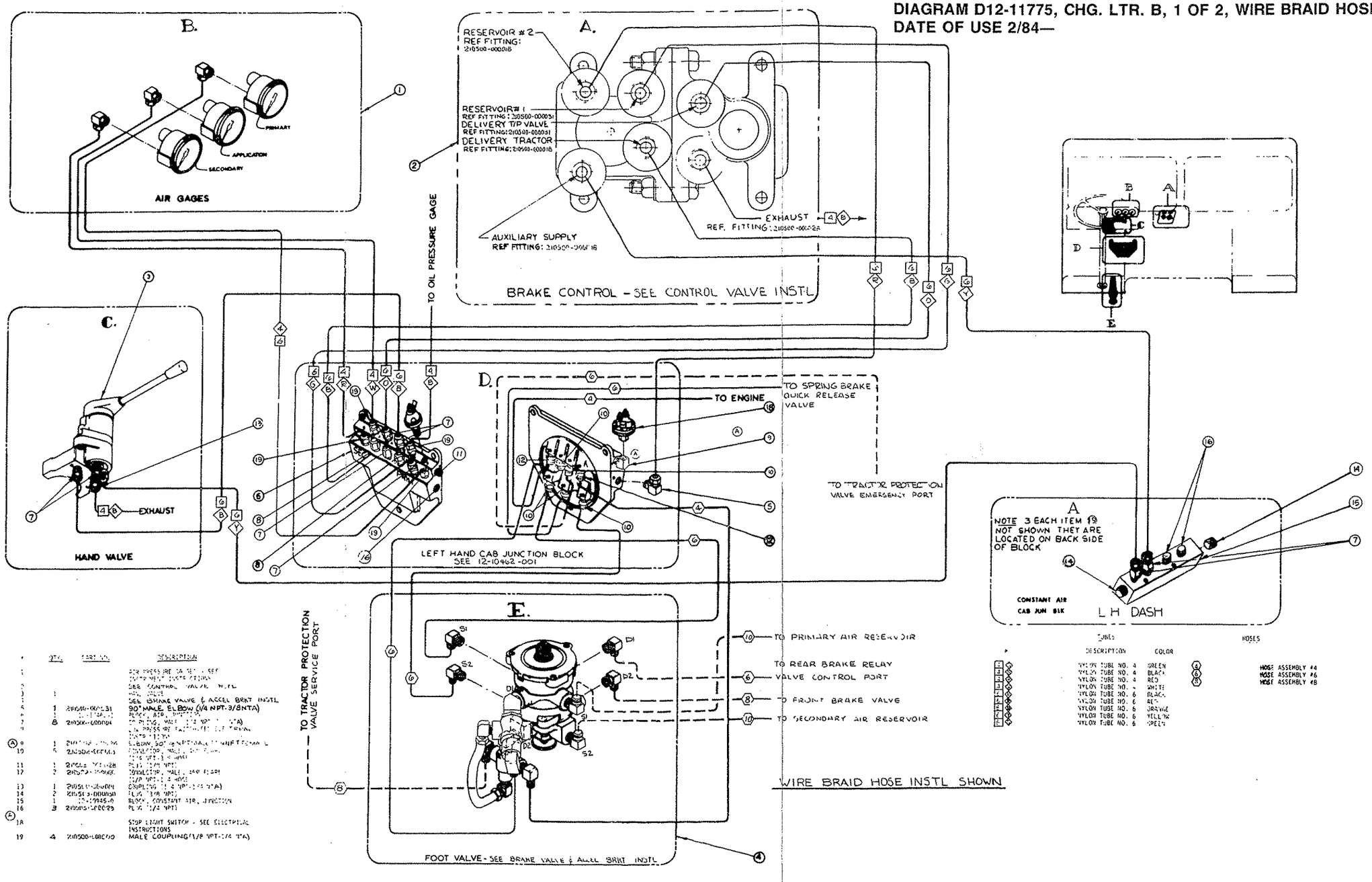


#	QTY.	PART NO.	DESCRIPTION
1			AIR PRESSURE GAUGES - SEE INSTRUMENT INSTRUCTIONS
2			SEE CONTROL VALVE INSTL
3	1		HAND VALVE
4			SEE BRAKE VALVE & ACCEL BRKT INSTL
5	1	210500-000051	90° MALE ELBOW (1/4 NPT-3/8 NTA)
6	1	12-10462-1	BLOCK, AIR, JUNCTION
7	13	210500-000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
8			LOW PRESSURE SWITCH-SEE ELECTRICAL INSTRUCTIONS
(A) 9	1	210502-000024	ELBOW, 90°, 3/8 MALE TO 1/4 NPT FEMALE
(B)			
11	1	210503-000026	PLUG (1/8 NPT)
12	1	210502-000030	CONNECTOR, MALE, 45° FLARE (1/8 NPT-1/4 HOSE)
13	1	210500-000014	COUPLING (1/4 NPT-1/4 NTA)
14	2	210503-000032	PLUG (3/8 NPT)
15	1	12-10945-0	BLOCK, CONSTANT AIR, JUNCTION
(A) 16	3	210503-000029	PLUG (1/4 NPT)
18			STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
(B) 19	5	210500-000100	MALE COUPLING (1/8 NPT-1/4 NTA)

TUBES		HOSES
DESCRIPTION	COLOR	
NYLON TUBE NO. 4	GREEN	(A) HOSE ASSEMBLY #4
NYLON TUBE NO. 4	BLACK	
NYLON TUBE NO. 4	RED	
NYLON TUBE NO. 4	WHITE	
NYLON TUBE NO. 6	BLACK	
NYLON TUBE NO. 6	RED	
NYLON TUBE NO. 6	ORANGE	
NYLON TUBE NO. 6	YELLOW	
NYLON TUBE NO. 6	GREEN	
NYLON TUBE NO 6	SILVER	

120 CONVENTIONAL TRUCK AND TRACTOR CAB DIAGRAM

DIAGRAM D12-11775, CHG. LTR. B, 1 OF 2, WIRE BRAID HOSE, DATE OF USE 2/84—

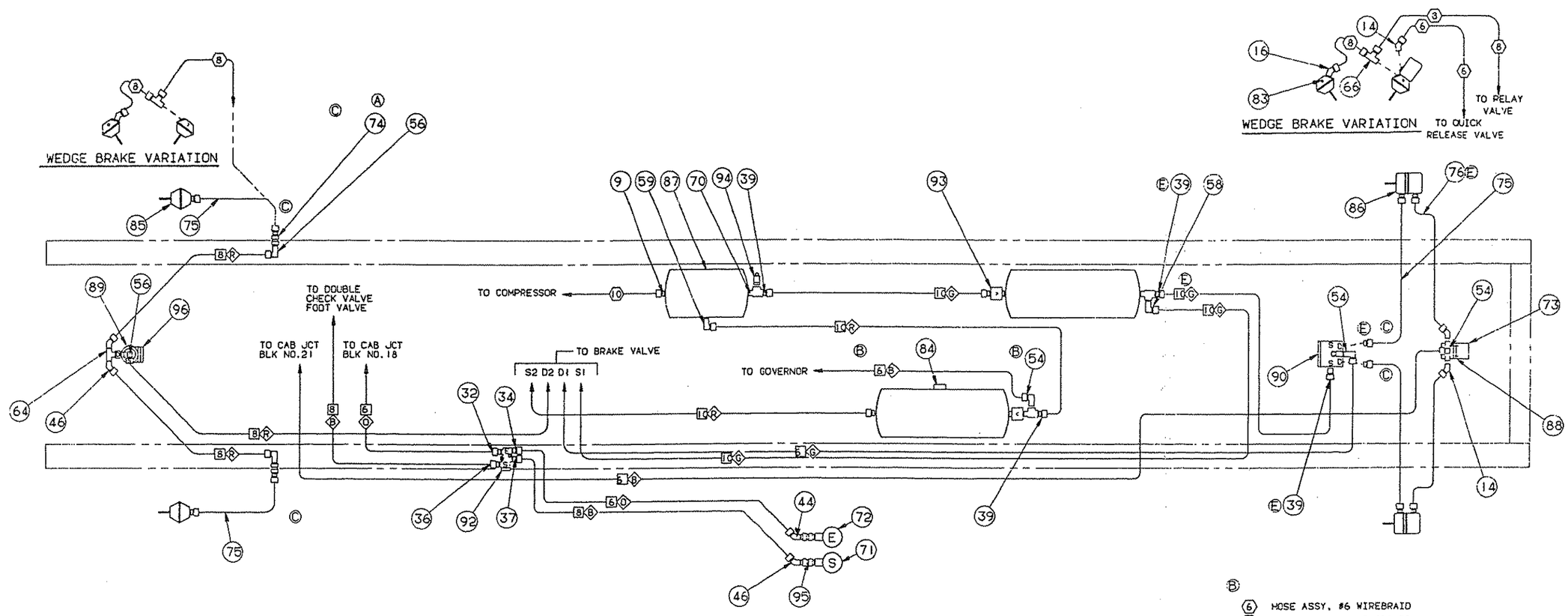


#	QTY.	PART NO.	DESCRIPTION
1			AIR PRESSURE GA SEE [illegible]
2			BRK CONTROL VALVE INSTL
3	1		HAND VALVE
4			SEE BRAKE VALVE & ACCEL BRKT INSTL
5	1	210500-000031	90° MALE ELBOW (1/4 NPT-3/8NTA)
6	1	[illegible]	BLACK, AIR, [illegible]
7	8	210500-000004	[illegible]
8			[illegible]
9			[illegible]
(A) 9	1	[illegible]	ELBOW, 90° [illegible]
10	5	210500-000045	[illegible]
11	1	210500-000028	PLUG 1/4 NPT
12	2	210500-000006	CONNECTOR, MALE, 3/8 FLOM [illegible]
13	1	210500-000004	COUPLING [illegible]
14	2	210500-000050	PLUG 3/8 NPT
15	1	10-17945-0	BLOCK, CONSTANT AIR, JUNCTION
16	3	210500-000029	PLUG 1/2 NPT
(A) 18			STOP LIGHT SWITCH - SEE ELECTRICAL INSTRUCTIONS
19	4	210500-000040	MALE COUPLING 1/8 NPT-1/4 NTA

#	TUBES DESCRIPTION	COLOR	HOSES	
1	NYLON TUBE NO. 4	GREEN	(4)	HOSE ASSEMBLY #4
2	NYLON TUBE NO. 4	BLACK	(6)	HOSE ASSEMBLY #6
3	NYLON TUBE NO. 4	RED	(8)	HOSE ASSEMBLY #8
4	NYLON TUBE NO. -	WHITE		
5	NYLON TUBE NO. 6	BLACK		
6	NYLON TUBE NO. 6	RED		
7	NYLON TUBE NO. 6	ORANGE		
8	NYLON TUBE NO. 6	YELLOW		
9	NYLON TUBE NO. 6	GREEN		

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11758, CHG. LTR. E, NYLON TUBING, DATE OF USE 2/84 TO 10/86



ITEM #	QTY	PART #	DESCRIPTION
(E)			
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
(B)			
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
34	1	210500 000006	COUPLING, MALE (1/2 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
37	1	210500 000009	COUPLING, MALE (1/2 NPT-1/2 NTA)
(E) 39	6	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
44	1	210500 000019	ELB, MALE, 45° (3/8 NPT-3/8 NTA)
(A) 46	3	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
(B) 54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
(A) 56	3	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
64	1	210503 000017	TEE, MALE BRANCH (3/8 NPT)
66	REF	210502 000030	TEE, MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
(E) 70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
75	4	A12-10505- #	HOSE ASSY, AIR BRAKE
76	2	A12-11921- #	HOSE ASSY, AIR BRAKE
(E)(D)(C)			
(A) 83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

(B)

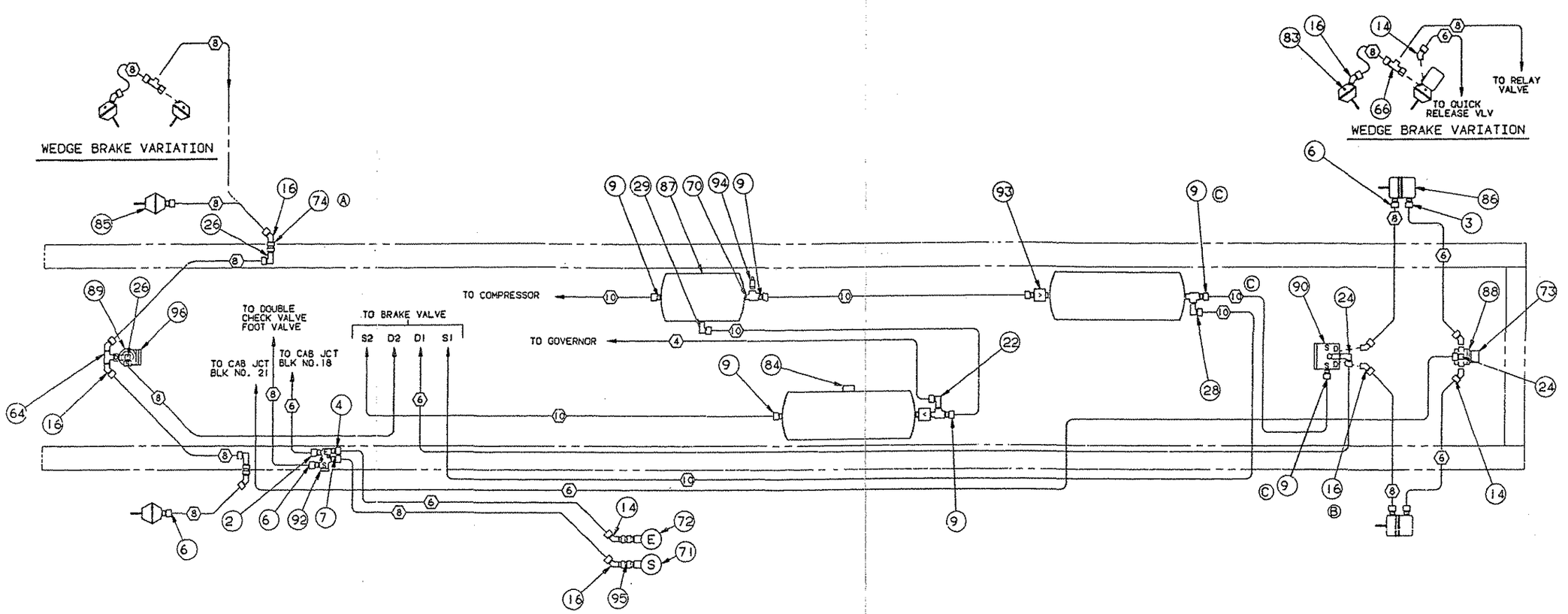
- (6) HOSE ASSY, #6 WIREBRAID
- (8) HOSE ASSY, #8 WIREBRAID
- (E) (10) HOSE ASSY, #10 WIREBRAID
- (6)(B) TUBE, NYLON NO.6 BLACK
- (6)(G) TUBE, NYLON NO.6 GREEN
- (6)(O) TUBE, NYLON NO.6 ORANGE
- (6)(R) TUBE, NYLON NO.6 RED
- (8)(B) TUBE, NYLON NO.8 BLACK
- (8)(R) TUBE, NYLON NO.8 RED
- (10)(G) TUBE, NYLON NO.10 GREEN
- (10)(R) TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12764

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11756, CHG. LTR. C, WIRE BRAID HOSE, DATE OF USE 2/84 TO 10/86



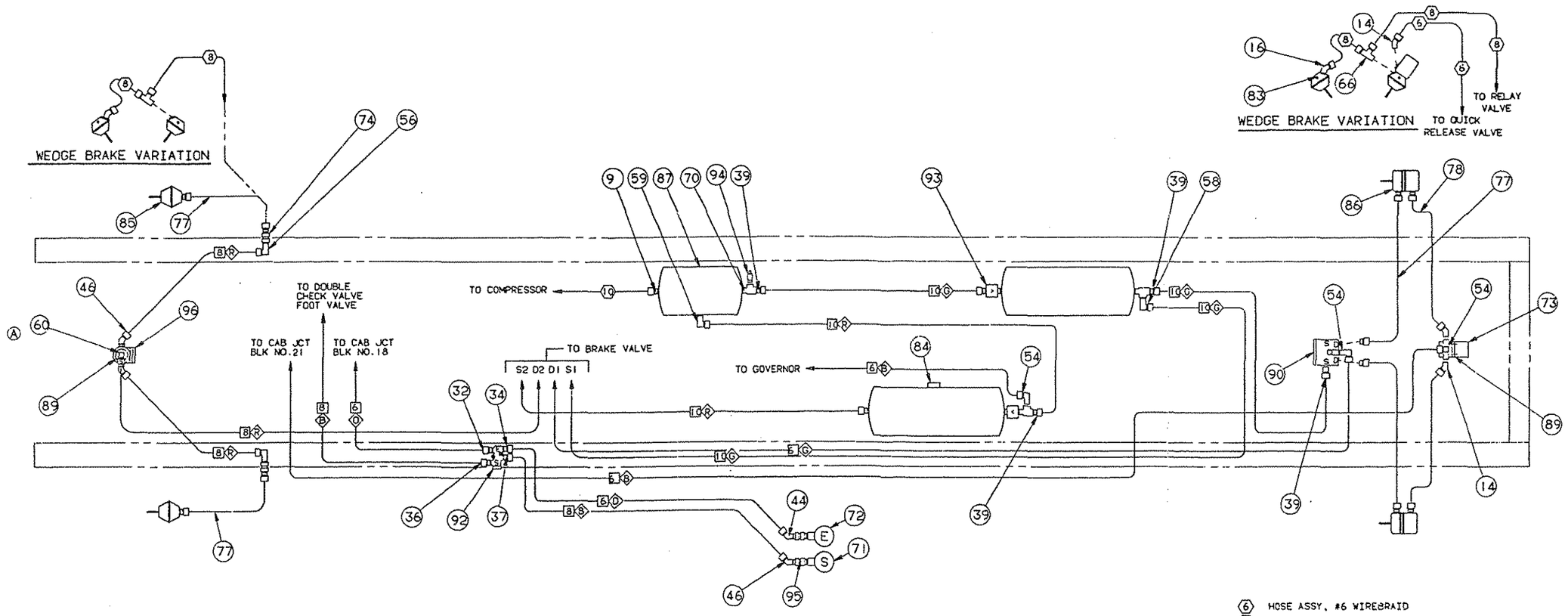
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
4	1	210502 000005	CONN,MALE,45° FLARE (1/2 NPT-3/8 HOSE)
(A) 6	5	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
7	1	210502 000008	CONN,MALE,45° FLARE (1/2 NPT-1/2 HOSE)
(C) 9	7	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
(C)			
14	3	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
(B) 16	7	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
(A) 26	3	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
64	1	210503 000017	TEE,MALE BRANCH (3/8 NPT)
65	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
(B) 70	3	210503 000037	TEE, STREET, SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
83	REF	210503 000030	PLUG,(3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

(4)	HOSE ASSY, NO. 4
(6)	HOSE ASSY, NO. 6
(8)	HOSE ASSY, NO. 8
(10)	HOSE ASSY, NO.10
(1)	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12044, CHG. LTR. A, NYLON TUBING, DATE OF USE 10/86—



ITEM #	QTY	PART #	DESCRIPTION
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
34	1	210500 000006	COUPLING, MALE (1/2 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
37	1	210500 000009	COUPLING, MALE (1/2 NPT-1/2 NTA)
39	6	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
44	1	210500 000019	ELB, MALE, 45° (3/8 NPT-3/8 NTA)
46	3	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
⊛ 56	2	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
⊛ 60	1	210500 000036	ELB, MALE, 90° (1/2 NPT-1/2 NTA)
66	REF	210502 000030	TEE, MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
77	4	A12-10505- #	HOSE ASSY, AIR BRAKE
78	2	A12-11921- #	HOSE ASSY, AIR BRAKE
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

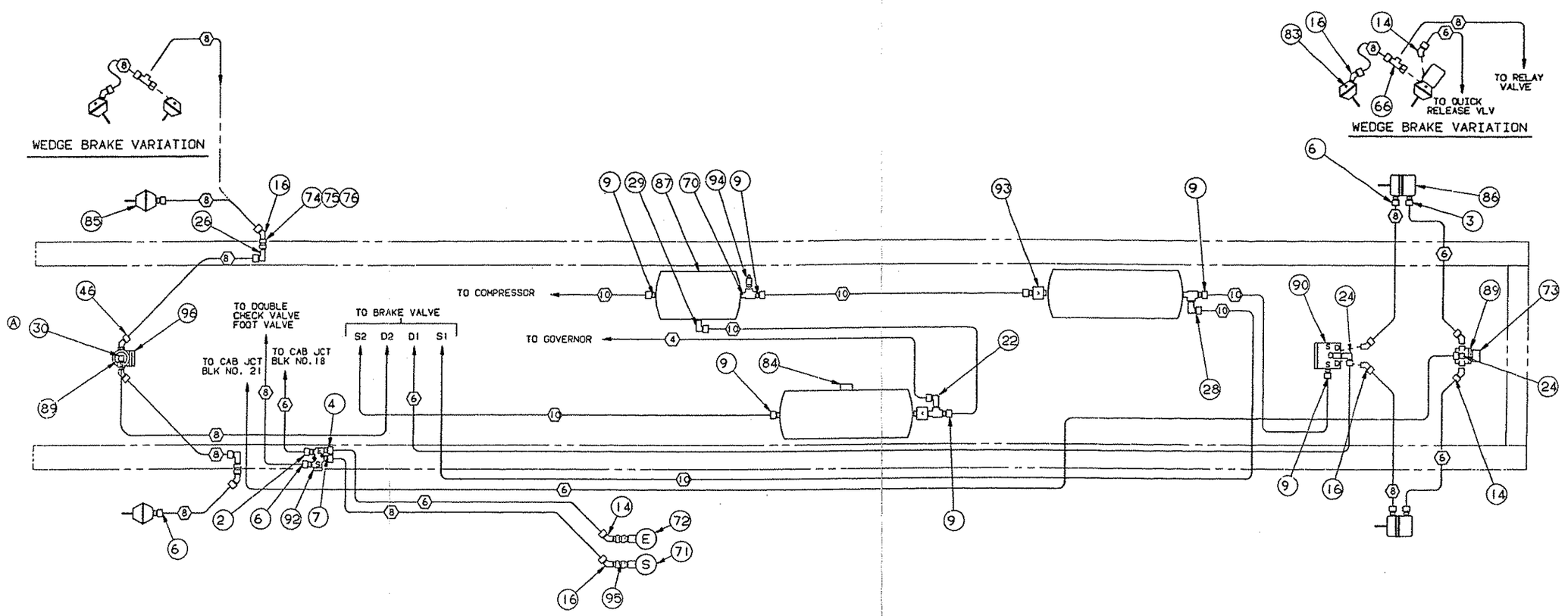
- (6) HOSE ASSY, #6 WIREBRAID
- (8) HOSE ASSY, #8 WIREBRAID
- (10) HOSE ASSY, #10 WIREBRAID
- 5 (8) TUBE, NYLON NO.6 BLACK
- 6 (6) TUBE, NYLON NO.6 GREEN
- 6 (6) TUBE, NYLON NO.6 ORANGE
- 6 (8) TUBE, NYLON NO.6 RED
- 8 (8) TUBE, NYLON NO.8 BLACK
- 8 (8) TUBE, NYLON NO.8 RED
- 10 (6) TUBE, NYLON NO.10 GREEN
- 14 (8) TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12764

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12046, CHG. LTR. A, WIRE BRAID HOSE, DATE OF USE 10/86—



ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
4	1	210502 000005	CONN,MALE,45° FLARE (1/2 NPT-3/8 HOSE)
6	5	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
7	1	210502 000008	CONN,MALE,45° FLARE (1/2 NPT-1/2 HOSE)
9	7	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	3	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	7	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
① 26	2	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
① 30	1	210502 000043	ELB, MALE, 90°, 45° FLARE (1/2 NPT-1/2 HOSE)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

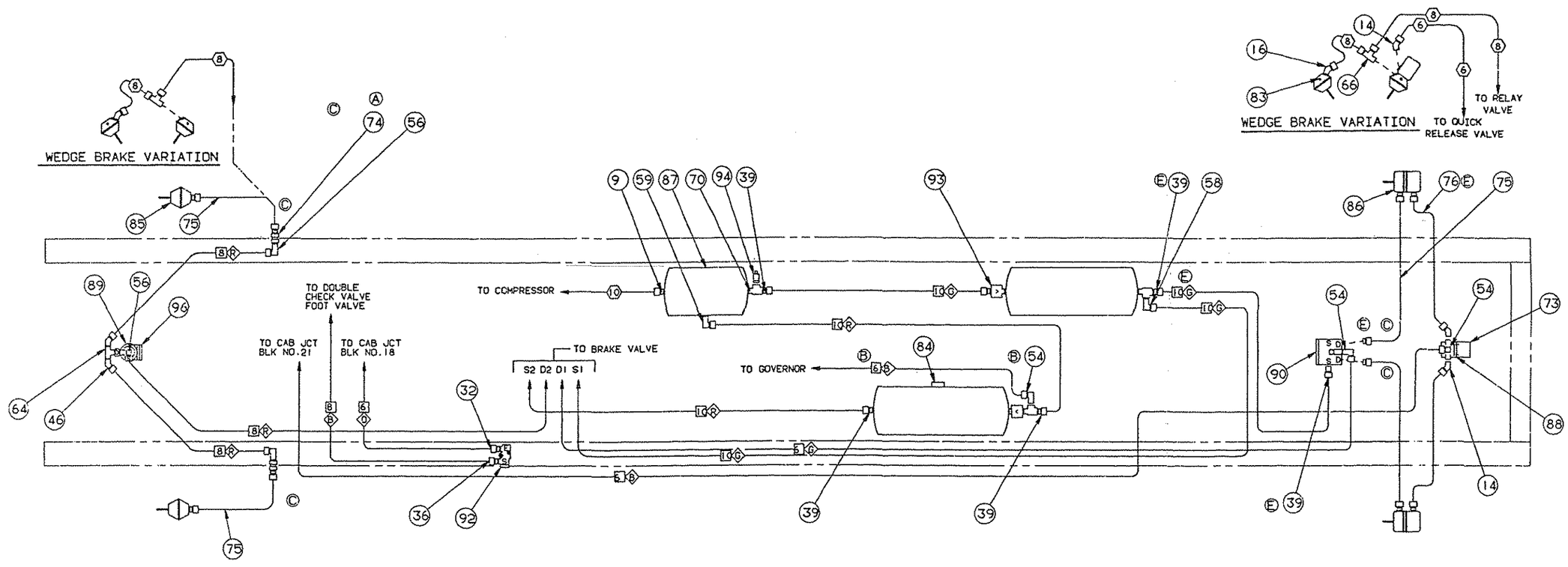
ITEM #	QTY	PART #	DESCRIPTION
70	3	210503 000037	TEE, STREET, SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
83	REF	210503 000030	PLUG,(3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

④ HOSE ASSY, NO. 4
⑥ HOSE ASSY, NO. 6
⑧ HOSE ASSY, NO. 8
⑩ HOSE ASSY, NO.10

① QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11757, CHG. LTR. E, NYLON TUBING, DATE OF USE 2/84 TO 10/86



ITEM #	QTY	PART #	DESCRIPTION
(E) 9	1	210502 000011	CONN.MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
(B) 32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
39	6	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
(E)(A) 46	2	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
(B)(A) 54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
56	3	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
64	1	210503 000017	TEE,MALE BRANCH (3/8 NPT)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
(E) 70	3	210503 000037	TEE, STREET SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
75	4	A12-10505- #	HOSE ASSY, AIR BRAKE
(E) 76	2	A12-11921- #	HOSE ASSY, AIR BRAKE
(E)(D)(C) (A) 83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

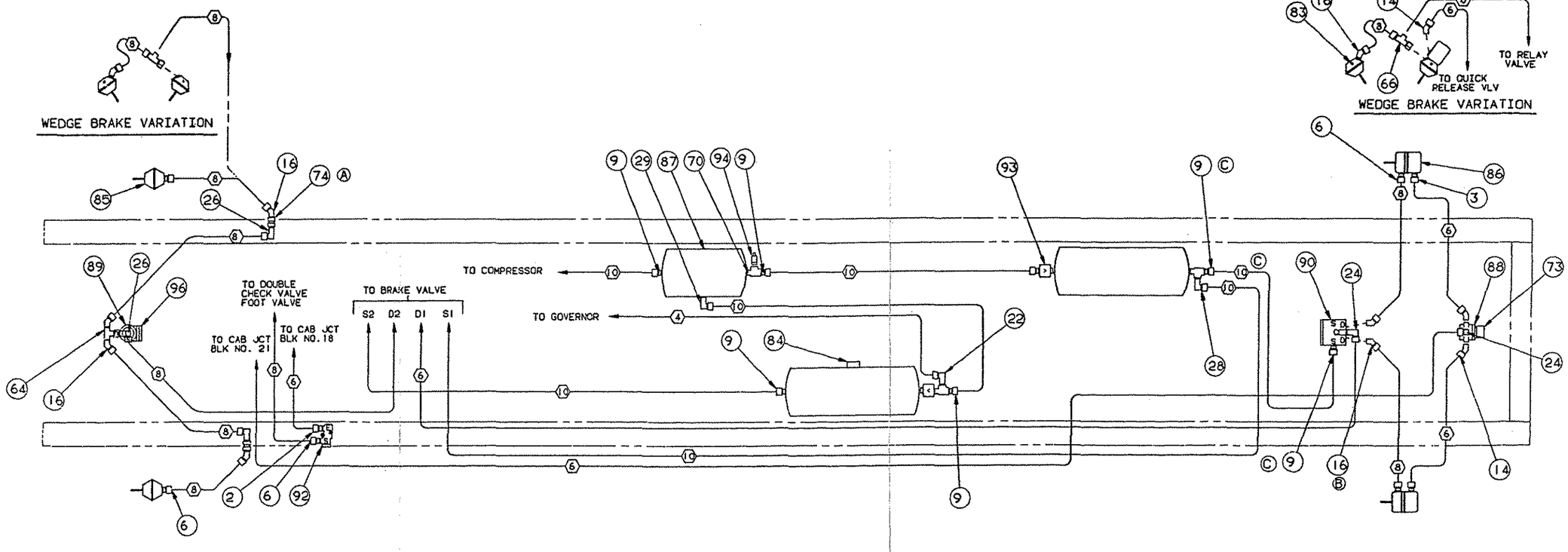
(B)
- (6) HOSE ASSY, #6 WIREBRAID
- (8) HOSE ASSY, #8 WIREBRAID
- (B) (10) HOSE ASSY, #10 WIREBRAID
- 6 8 TUBE, NYLON NO.6 BLACK
- 6 8 TUBE, NYLON NO.6 GREEN
- 6 10 TUBE, NYLON NO.6 ORANGE
- 6 8 TUBE, NYLON NO.6 RED
- 8 8 TUBE, NYLON NO.8 BLACK
- 8 8 TUBE, NYLON NO.8 RED
- 10 10 TUBE, NYLON NO.10 GREEN
- 10 8 TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12766

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11755, CHG. LTR. C, WIRE BRAID HOSE, DATE OF USE 2/84 TO 10/86



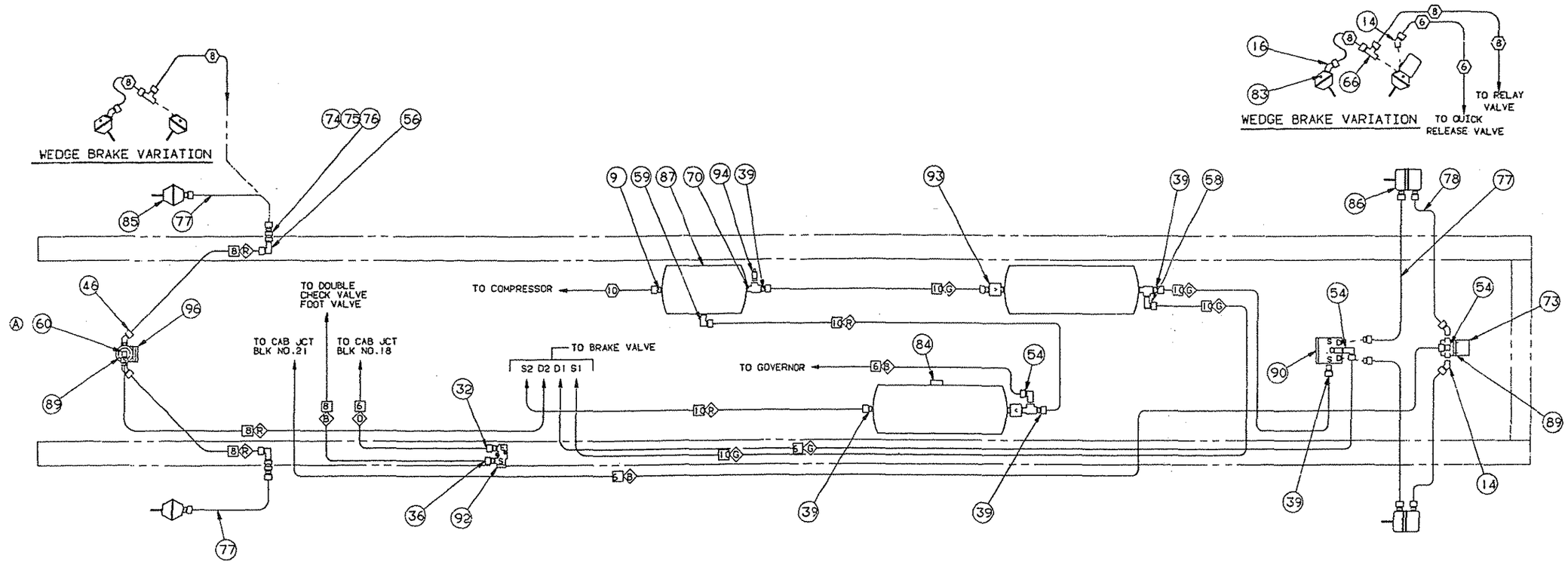
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
Ⓐ 6	5	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
Ⓒ 9	7	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
Ⓒ 14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
Ⓑ 16	6	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
Ⓐ 26	3	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
64	1	210503 000017	TEE,MALE BRANCH (3/8 NPT)

ITEM #	QTY	PART #	DESCRIPTION
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
Ⓑ 70	3	210503 000037	TEE, STREET, SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
Ⓐ 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
83	REF	210503 000030	PLUG,(3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

④	HOSE ASSY, NO. 4
⑥	HOSE ASSY, NO. 6
⑧	HOSE ASSY, NO. 8
⑩	HOSE ASSY, NO.10
△1	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12038, CHG. LTR. A, NYLON TUBING, DATE OF USE 10/86—



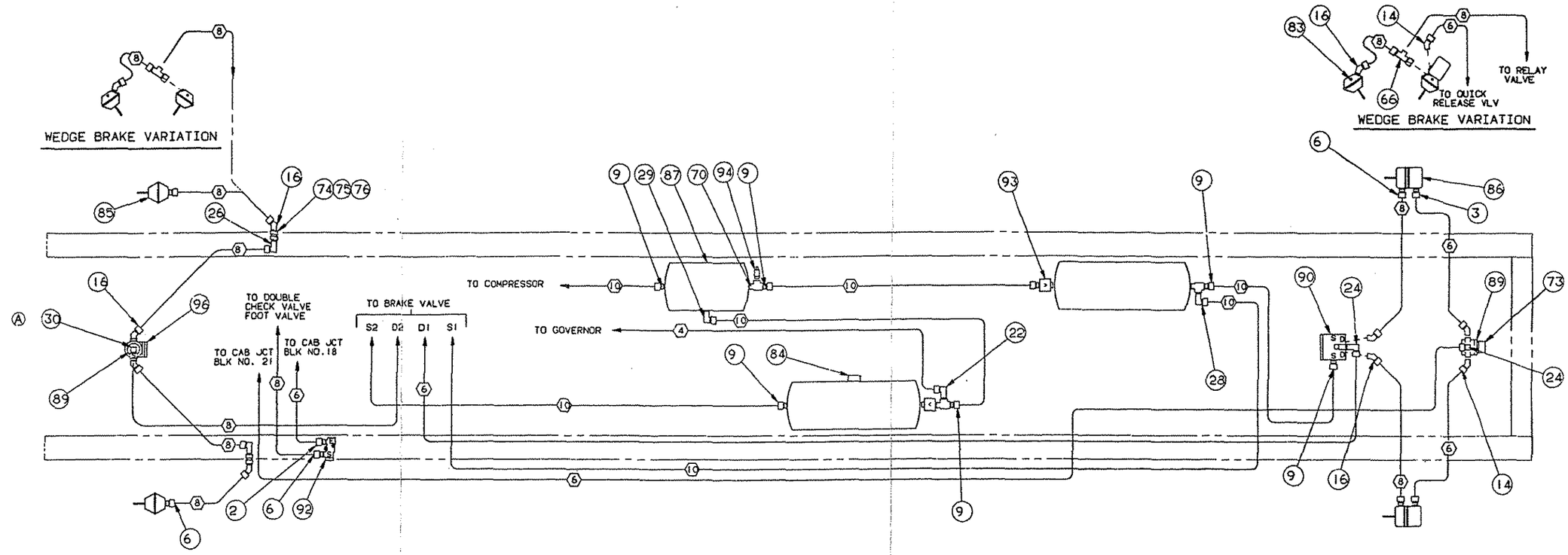
ITEM #	QTY	PART #	DESCRIPTION
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
39	6	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
46	2	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
⑥ 56	2	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
⑥ 60	1	210500 000036	ELB, MALE, 90° (1/2 NPT-1/2 NTA)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
70	3	210503 000037	TEE, STREET SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
77	4	A12-10505- #	HOSE ASSY, AIR BRAKE
78	2	A12-11921- #	HOSE ASSY, AIR BRAKE
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

⑥	HOSE ASSY, #6 WIREBRAID
⑧	HOSE ASSY, #8 WIREBRAID
⑩	HOSE ASSY, #10 WIREBRAID
⑥B	TUBE, NYLON NO.6 BLACK
⑥G	TUBE, NYLON NO.6 GREEN
⑥O	TUBE, NYLON NO.6 ORANGE
⑥R	TUBE, NYLON NO.6 RED
⑧B	TUBE, NYLON NO.8 BLACK
⑧R	TUBE, NYLON NO.8 RED
⑩G	TUBE, NYLON NO.10 GREEN
⑩R	TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL SINGLE REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12040, CHG. LTR. A, WIRE BRAID HOSE, DATE OF USE 10/86—



ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
6	5	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
9	7	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	6	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
⑧ 26	2	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
⑩ 30	1	210502 000043	ELB, MALE, 90°, 45° FLARE (1/2 NPT-1/2 HOSE)

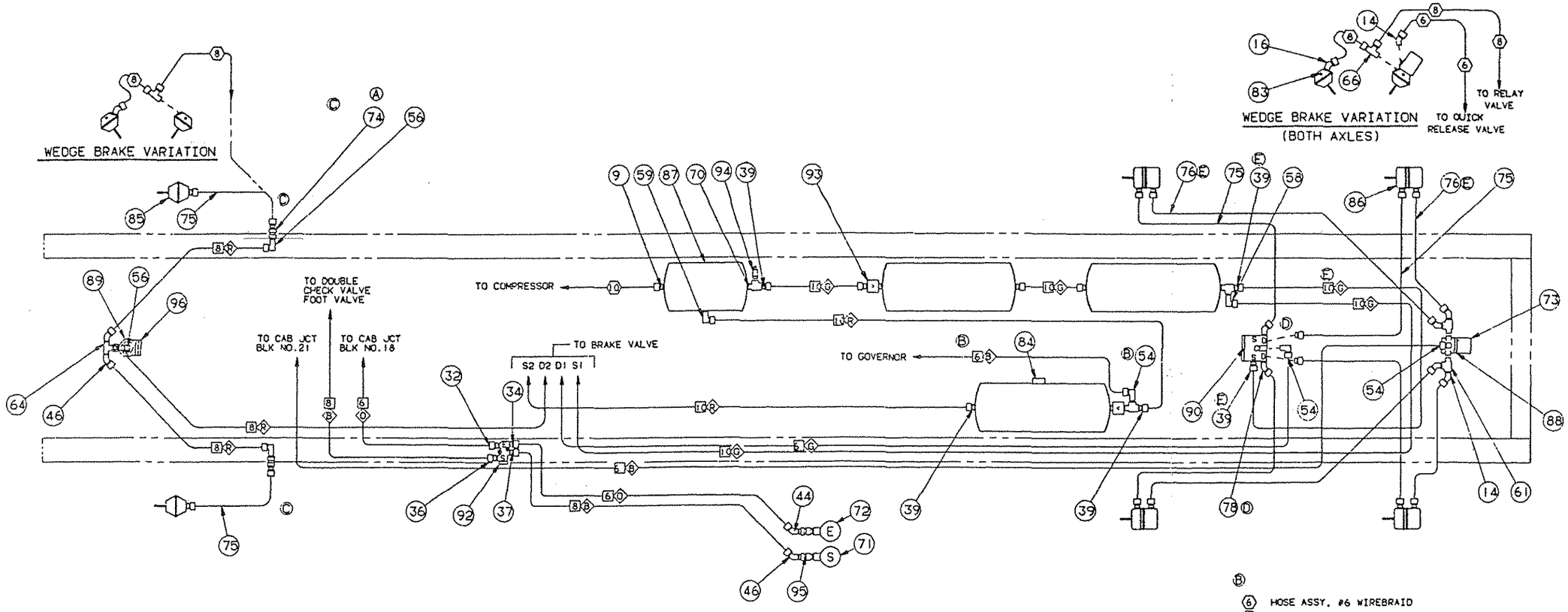
ITEM #	QTY	PART #	DESCRIPTION
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
70	3	210503 000037	TEE, STREET, SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
83	REF	210503 000030	PLUG,(3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

④ HOSE ASSY, NO. 4
⑥ HOSE ASSY, NO. 6
⑧ HOSE ASSY, NO. 8
⑩ HOSE ASSY, NO.10

△1 QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11754, CHG. LTR. F, NYLON TUBING, DATE OF USE 2/84 TO 10/86



ITEM #	QTY	PART #	DESCRIPTION
(E)			
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	4	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
(B)			
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
34	1	210500 000006	COUPLING, MALE (1/2 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
37	1	210500 000009	COUPLING, MALE (1/2 NPT-1/2 NTA)
(E) 39	8	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
44	1	210500 000019	ELB, MALE, 45° (3/8 NPT-3/8 NTA)
(B)(A) 46	3	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
(B) 54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
(A) 56	3	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
61	2	210503 000020	TEE,STREET
(D)			
64	1	210503 000017	TEE,MALE BRANCH (3/8 NPT)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
(D) 70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
75	6	A12-10505- #	HOSE ASSY, AIR BRAKE
(E) 76	4	A12-11921- #	HOSE ASSY, AIR BRAKE
(E)(D)(C) 78	2	23-11341-000	ELBOW,ADAPTER,45° (3/8 NPT-3/4 UNF)
(A) 83	REF	210503 000030	PLUG (3/8 NPT)
(A) 84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

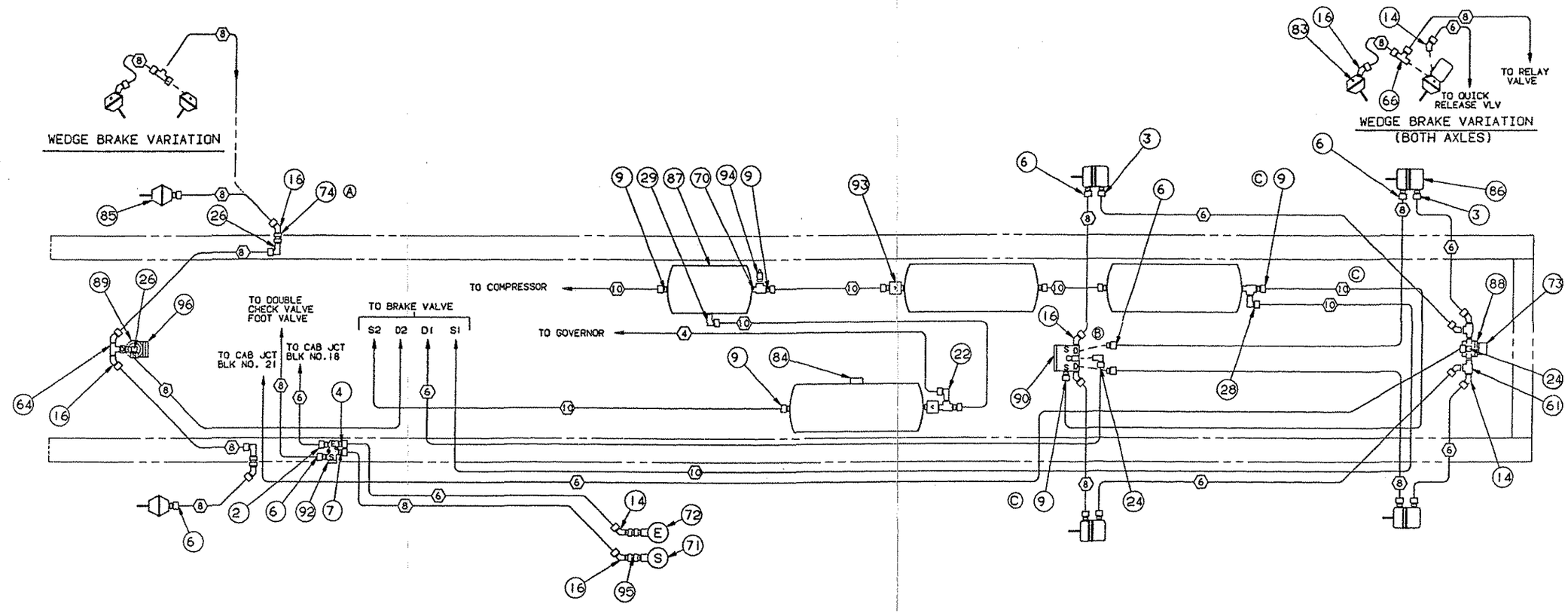
(B)

(6)	HOSE ASSY, #6 WIREBRAID
(8)	HOSE ASSY, #8 WIREBRAID
(B)(10)	HOSE ASSY, #10 WIREBRAID
(5)(G)	TUBE, NYLON NO.6 BLACK
(6)(G)	TUBE, NYLON NO.6 GREEN
(6)(O)	TUBE, NYLON NO.6 ORANGE
(6)(R)	TUBE, NYLON NO.6 RED
(8)(G)	TUBE, NYLON NO.8 BLACK
(8)(G)	TUBE, NYLON NO.8 GREEN
(8)(R)	TUBE, NYLON NO.8 RED
(10)(G)	TUBE, NYLON NO.10 GREEN
(10)(R)	TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11752, CHG. LTR. C, WIRE BRAID HOSE, DATE OF USE 2/84 TO 10/86



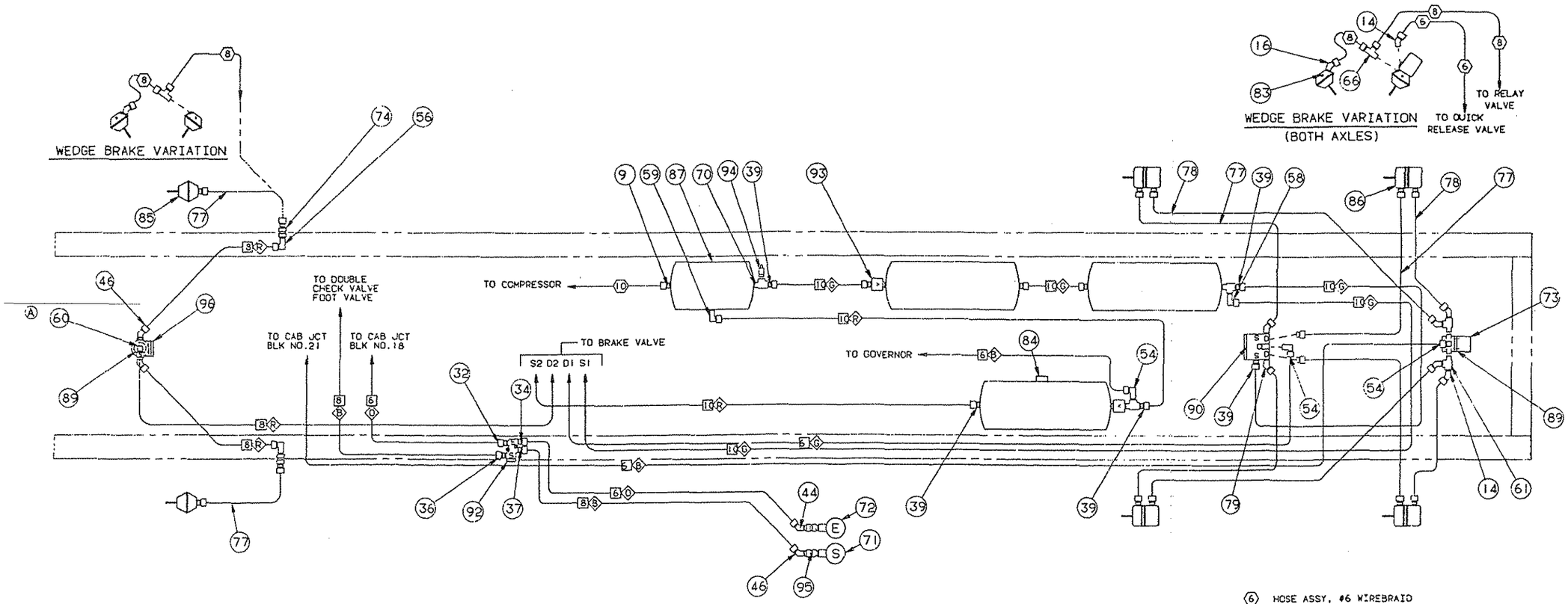
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	4	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
4	1	210502 000005	CONN,MALE,45° FLARE (1/2 NPT-3/8 HOSE)
(B)(A) 6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
7	1	210502 000008	CONN,MALE,45° FLARE (1/2 NPT-1/2 HOSE)
(C) 9	9	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	5	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
(B) 16	7	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
(A) 26	3	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
61	2	210503 000020	TEE,STREET
(B) 64	1	210503 000017	TEE,MALE BRANCH (3/8 NPT)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
(B) 70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

(4)	HOSE ASSY, NO. 4
(6)	HOSE ASSY, NO. 6
(8)	HOSE ASSY, NO. 8
(10)	HOSE ASSY, NO.10
(1)	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12045, CHG. LTR. A, NYLON TUBING, DATE OF USE 10/86—



ITEM #	QTY	PART #	DESCRIPTION
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	4	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
34	1	210500 000006	COUPLING, MALE (1/2 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
37	1	210500 000009	COUPLING, MALE (1/2 NPT-1/2 NTA)
39	8	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
44	1	210500 000019	ELB, MALE, 45° (3/8 NPT-3/8 NTA)
46	3	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
&56	2	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
&60	1	210500 000036	ELB, MALE, 90° (1/2 NPT-1/2 NTA)
61	2	210503 000020	TEE,STREET
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
77	6	A12-10505- #	HOSE ASSY, AIR BRAKE
78	4	A12-11921- #	HOSE ASSY, AIR BRAKE
79	2	23-11341-000	ELBOW,ADAPTER,45°(3/8 NPT-3/4 UNF)
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

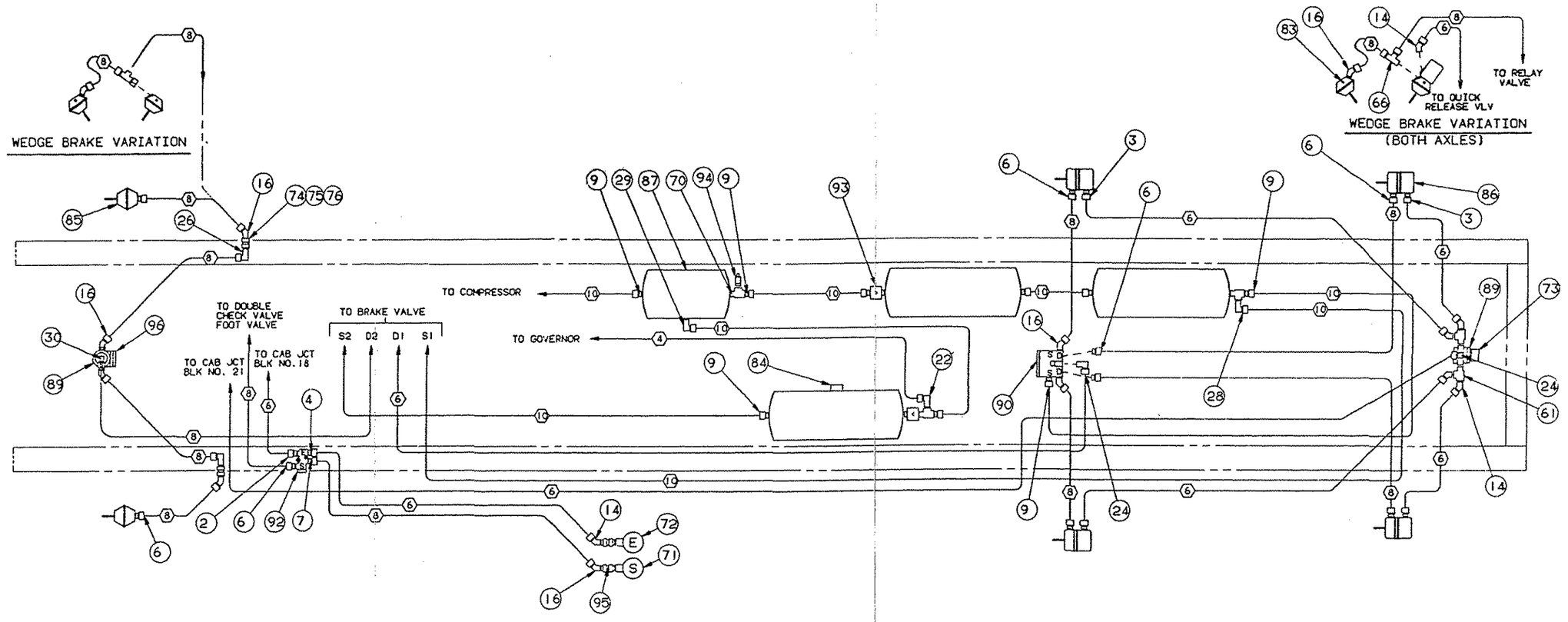
- (6) HOSE ASSY, #6 WIREBRAID
- (8) HOSE ASSY, #8 WIREBRAID
- (10) HOSE ASSY, #10 WIREBRAID
- [6](B) TUBE, NYLON NO.6 BLACK
- [6](G) TUBE, NYLON NO.6 GREEN
- [6](O) TUBE, NYLON NO.6 ORANGE
- [6](R) TUBE, NYLON NO.6 RED
- [8](B) TUBE, NYLON NO.8 BLACK
- [8](G) TUBE, NYLON NO.8 GREEN
- [8](R) TUBE, NYLON NO.8 RED
- [10](G) TUBE, NYLON NO.10 GREEN
- [10](R) TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR SFD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12768

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12047, CHG. LTR. A, WIRE BRAID HOSE, DATE OF USE 10/86—

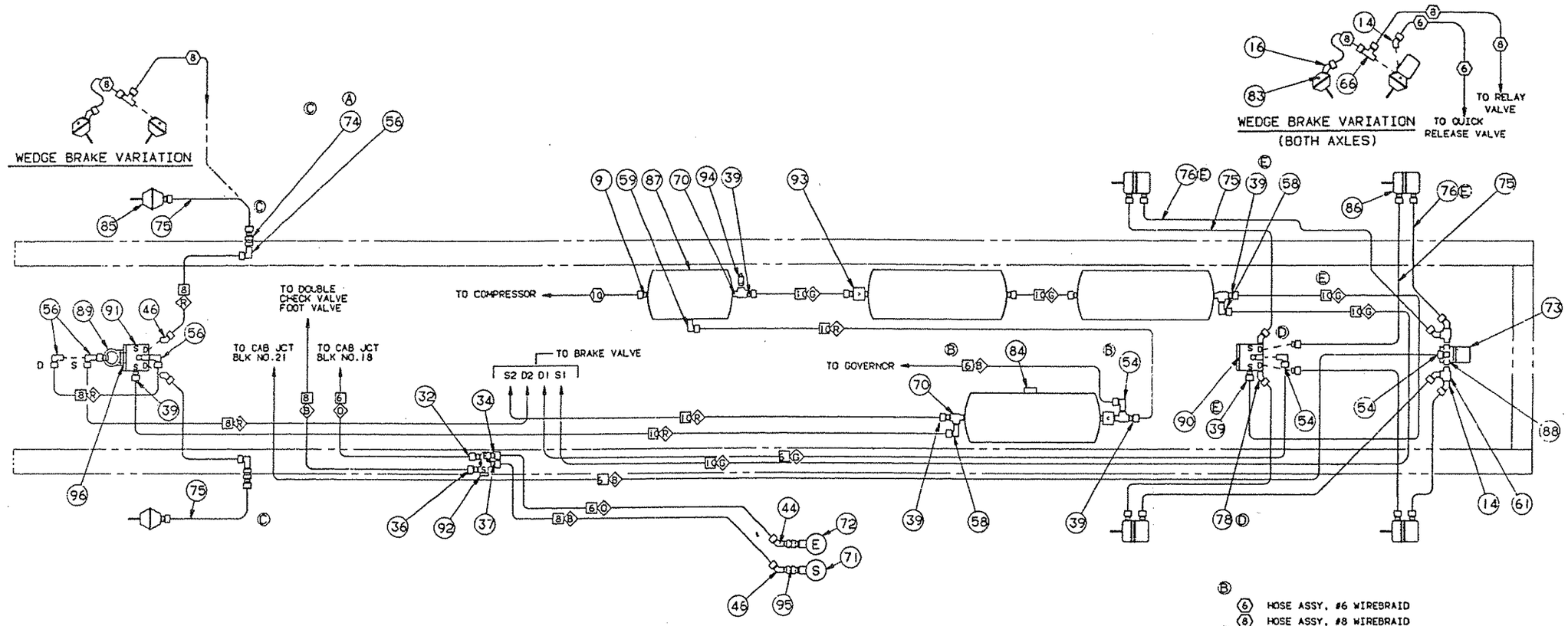


ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	4	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
4	1	210502 000005	CONN,MALE,45° FLARE (1/2 NPT-3/8 HOSE)
6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
7	1	210502 000008	CONN,MALE,45° FLARE (1/2 NPT-1/2 HOSE)
9	9	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	5	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	7	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
① 26	2	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
① 30	1	210502 000043	ELB, MALE, 90°, 45° FLARE (1/2 NPT-1/2 HOSE)
61	2	210503 000020	TEE,STREET
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

④	HOSE ASSY, NO. 4
⑥	HOSE ASSY, NO. 6
⑧	HOSE ASSY, NO. 8
⑩	HOSE ASSY, NO.10
①	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11766, CHG. LTR. F, NYLON TUBING, DATE OF USE 2/84 TO 10/86



ITEM #	QTY	PART #	DESCRIPTION
(E)			
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	4	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
(B)			
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
34	1	210500 000006	COUPLING, MALE (1/2 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
37	1	210500 000009	COUPLING, MALE (1/2 NPT-1/2 NTA)
(E)(D) 39	9	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
(E)(D) 44	1	210500 000019	ELB, MALE, 45° (3/8 NPT-3/8 NTA)
(B)(A) 46	3	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
(B)(A) 54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
(A) 56	5	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	2	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
61	2	210503 000020	TEE,STREET
(D) 66	REF	210503 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

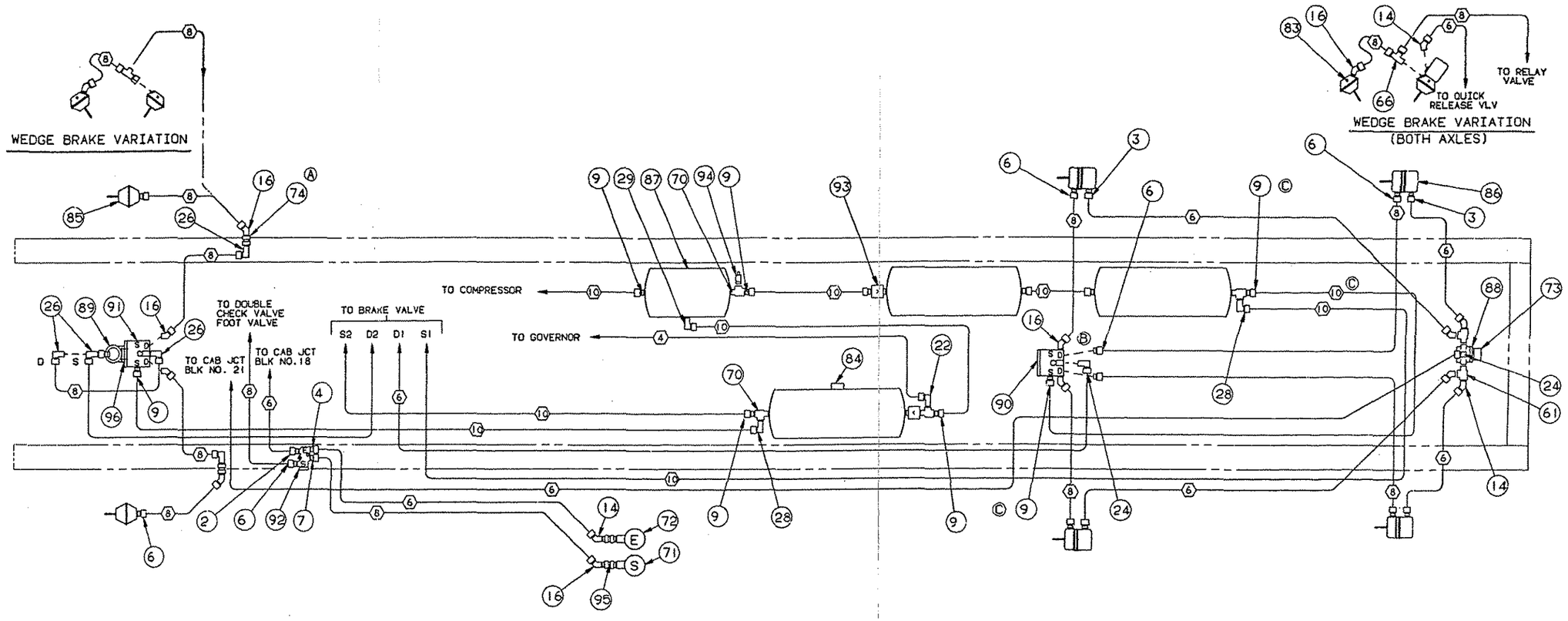
ITEM #	QTY	PART #	DESCRIPTION
(D) 70	4	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
75	6	A12-10505- #	HOSE ASSY, AIR BRAKE
76	4	A12-11921- #	HOSE ASSY, AIR BRAKE
(E)(D)(C) 78	2	23-11341-000	ELBOW,ADAPTER,45°(3/8 NPT-3/4 UNF)
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

(B)
- (6) HOSE ASSY, #6 WIREBRAID
- (8) HOSE ASSY, #8 WIREBRAID
- (B) (10) HOSE ASSY, #10 WIREBRAID
- (6)(B) TUBE, NYLON NO.6 BLACK
- (6)(G) TUBE, NYLON NO.6 GREEN
- (6)(O) TUBE, NYLON NO.6 ORANGE
- (6)(R) TUBE, NYLON NO.6 RED
- (8)(B) TUBE, NYLON NO.8 BLACK
- (8)(G) TUBE, NYLON NO.8 GREEN
- (8)(R) TUBE, NYLON NO.8 RED
- (10)(G) TUBE, NYLON NO.10 GREEN
- (10)(R) TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11764, CHG. LTR. C, WIRE BRAID HOSE, DATE OF USE 2/84 TO 10/86



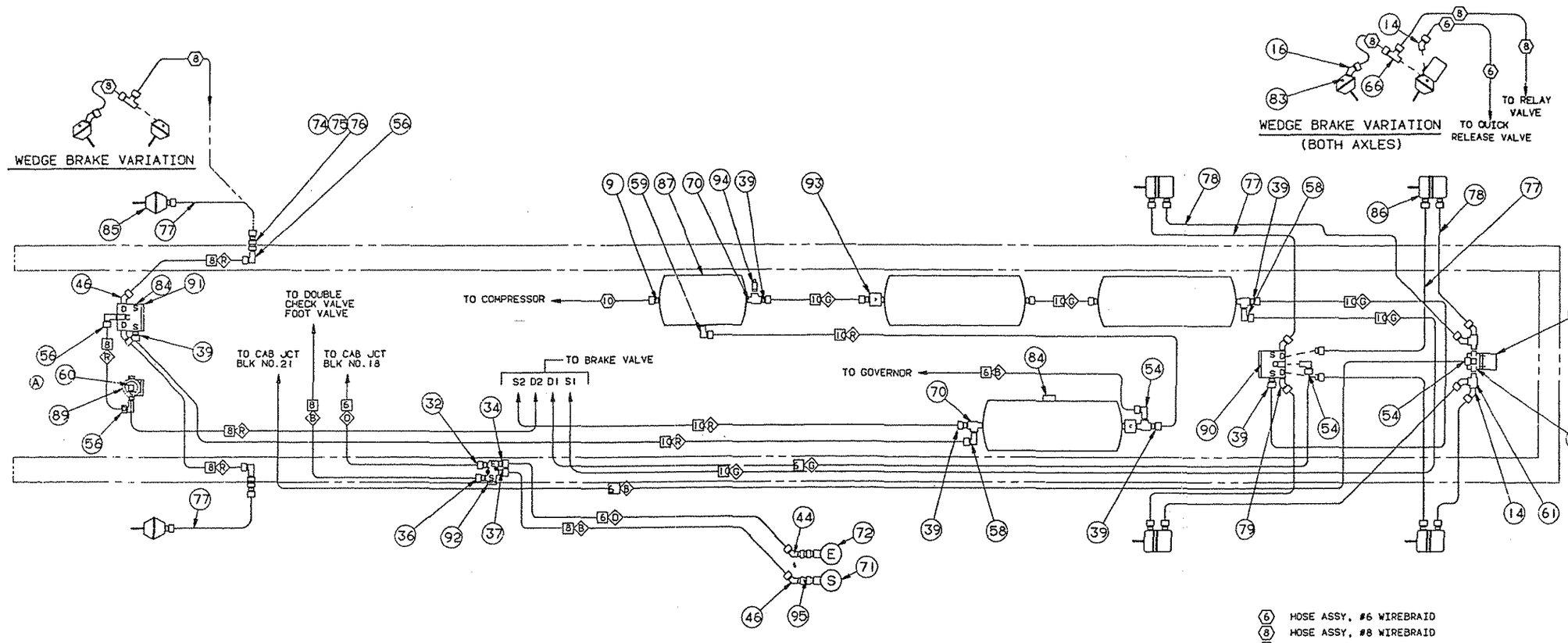
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	4	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
4	1	210502 000005	CONN,MALE,45° FLARE (1/2 NPT-3/8 HOSE)
Ⓑ Ⓐ 6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
7	1	210502 000008	CONN,MALE,45° FLARE (1/2 NPT-1/2 HOSE)
Ⓒ 9	10	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
Ⓒ			
14	5	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
Ⓑ 16	7	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
Ⓐ 26	5	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	2	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
61	2	210503 000020	TEE,STREET
Ⓑ			
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
Ⓑ 70	4	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
Ⓐ 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

(4)	HOSE ASSY, NO. 4
(6)	HOSE ASSY, NO. 6
(8)	HOSE ASSY, NO. 8
(10)	HOSE ASSY, NO.10
(1)	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12048, CHG. LTR. A, NYLON TUBING, DATE OF USE 10/86—



ITEM #	QTY	PART #	DESCRIPTION
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	4	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
34	1	210500 000006	COUPLING, MALE (1/2 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
37	1	210500 000009	COUPLING, MALE (1/2 NPT-1/2 NTA)
39	9	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
44	1	210500 000019	ELB, MALE, 45° (3/8 NPT-3/8 NTA)
46	3	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
⑥56	4	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	2	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
⑥60	1	210500 000036	ELB, MALE, 90° (1/2 NPT-1/2 NTA)
61	2	210503 000020	TEE,STREET
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

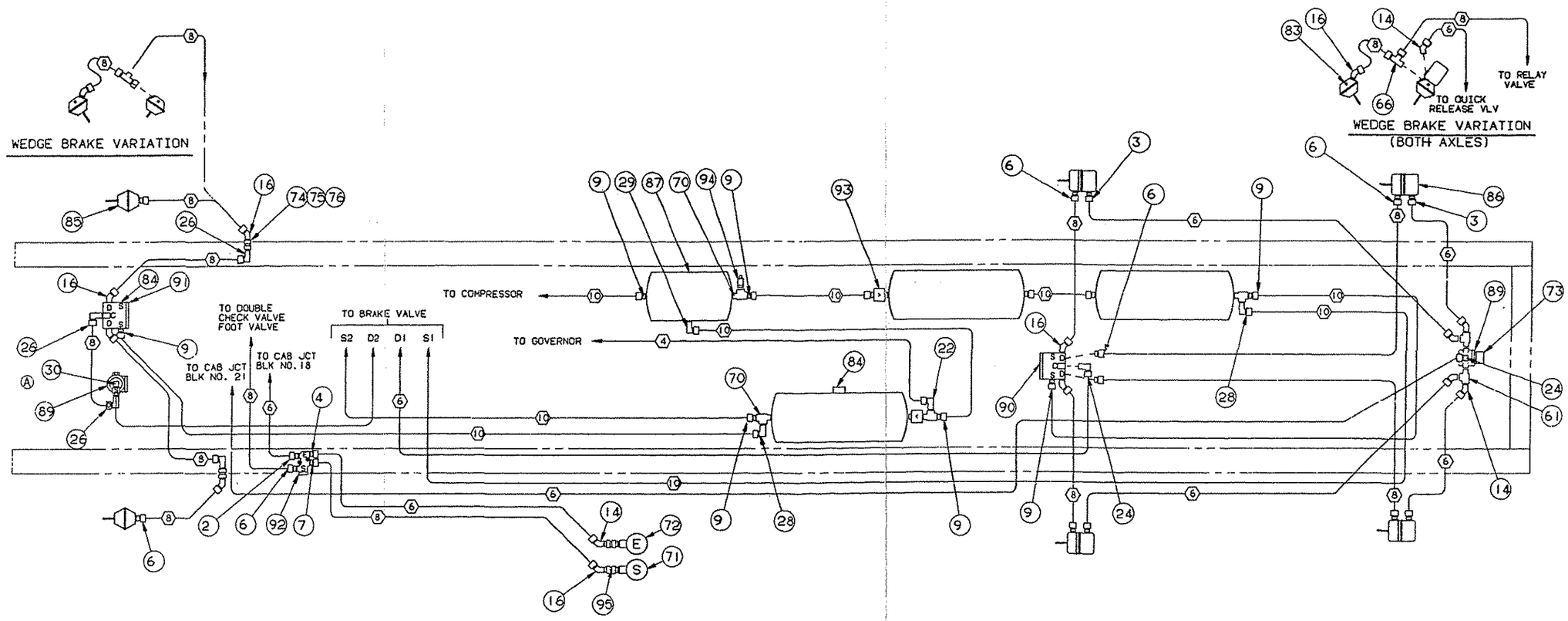
ITEM #	QTY	PART #	DESCRIPTION
70	4	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
74	2	12-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
77	6	A12-10505- #	HOSE ASSY, AIR BRAKE
78	4	A12-11921- #	HOSE ASSY, AIR BRAKE
79	2	23-11341-000	ELBOW,ADAPTER,45° (3/8 NPT-3/4 UNF)
83	REF	210503 000030	PLUG (3/8 NPT)
84	2	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

(6)	HOSE ASSY, #6 WIREBRAID
(8)	HOSE ASSY, #8 WIREBRAID
(10)	HOSE ASSY, #10 WIREBRAID
6 B	TUBE, NYLON NO.6 BLACK
6 G	TUBE, NYLON NO.6 GREEN
6 O	TUBE, NYLON NO.6 ORANGE
6 R	TUBE, NYLON NO.6 RED
8 B	TUBE, NYLON NO.8 BLACK
8 G	TUBE, NYLON NO.8 GREEN
8 R	TUBE, NYLON NO.8 RED
10 G	TUBE, NYLON NO.10 GREEN
10 R	TUBE, NYLON NO.10 RED
(1)	QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12770

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12049, CHG. LTR. A, WIRE BRAID HOSE, DATE OF USE 10/86—



ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	4	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
4	1	210502 000005	CONN,MALE,45° FLARE (1/2 NPT-3/8 HOSE)
6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
7	1	210502 000008	CONN,MALE,45° FLARE (1/2 NPT-1/2 HOSE)
9	10	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	5	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	7	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
①25	4	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	2	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
①30	1	210502 000043	ELB, MALE, 90°, 45° FLARE (1/2 NPT-1/2 HOSE)
61	2	210503 000020	TEE,STREET
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

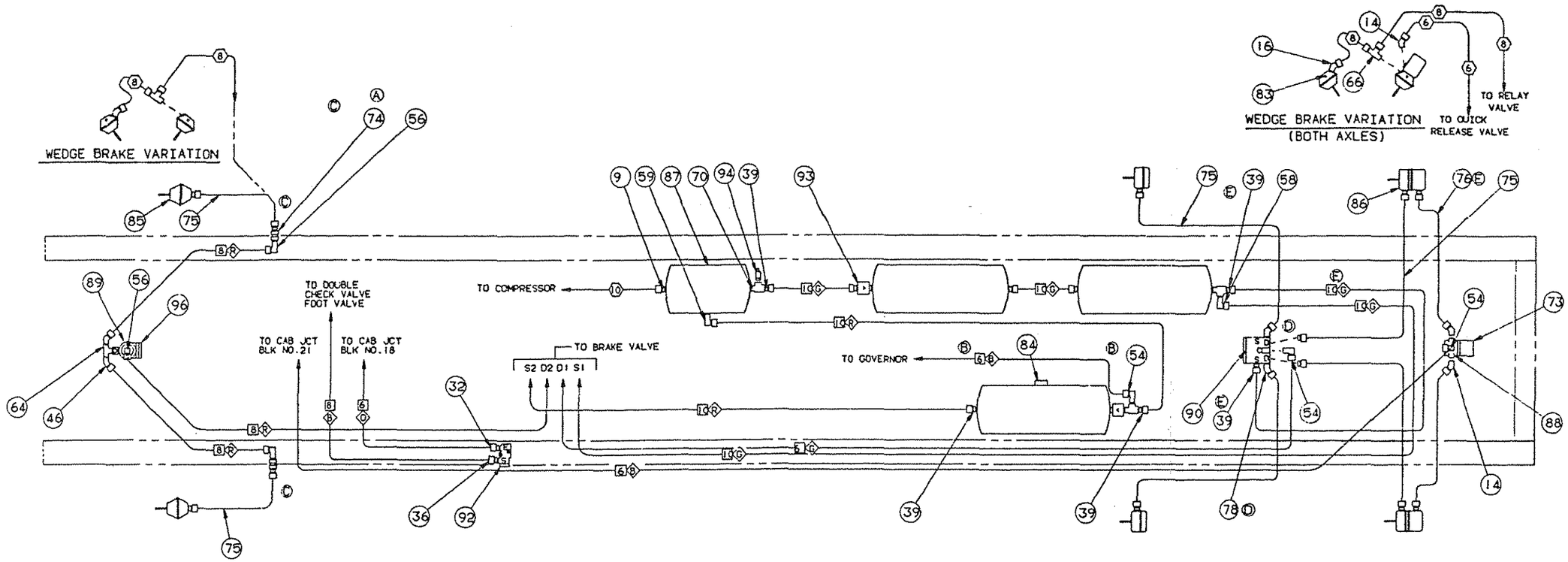
ITEM #	QTY	PART #	DESCRIPTION
70	4	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
74	2	12-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
83	REF	210503 000030	PLUG (3/8 NPT)
84	2	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD
96			SEE CHASSIS PLUMBING INST

④ HOSE ASSY. NO. 4
⑥ HOSE ASSY. NO. 6
⑧ HOSE ASSY. NO. 8
⑩ HOSE ASSY. NO.10

① QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11753, CHG. LTR. F, NYLON TUBING, DATE OF USE 2/84 TO 10/86



ITEM #	QTY	PART #	DESCRIPTION
(E)			
9	1	210502 000011	CONN.MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
(B)			
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
(E) 39	8	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
(A) 46	2	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
(B) 54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
(A) 56	3	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
(D)			
64	1	210503 000017	TEE,MALE BRANCH (3/8 NPT)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

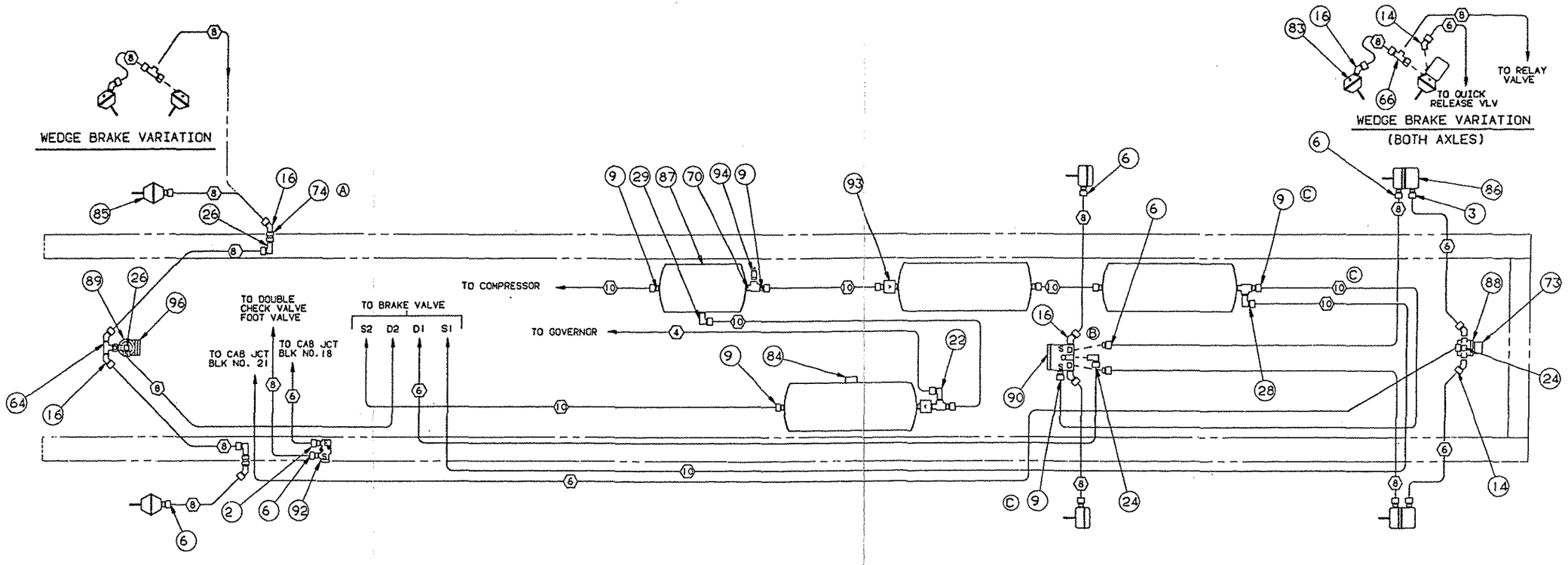
ITEM #	QTY	PART #	DESCRIPTION
(D) 70	3	210503 000037	TEE, STREET SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
75	6	A12-10505- #	HOSE ASSY, AIR BRAKE
(E) 76	2	A12-11921- #	HOSE ASSY, AIR BRAKE
(F)(D)(C) 78	2	23-11341-000	ELBOW,ADAPTER,45° (3/8 NPT-3/4 UNF)
(A) 83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

(B)
- (6) HOSE ASSY, #6 WIREBRAID
- (8) HOSE ASSY, #8 WIREBRAID
- (B) (10) HOSE ASSY, #10 WIREBRAID
- 6-B TUBE, NYLON NO.6 BLACK
- 6-C TUBE, NYLON NO.6 GREEN
- 6-O TUBE, NYLON NO.6 ORANGE
- 6-R TUBE, NYLON NO.6 RED
- 8-B TUBE, NYLON NO.8 BLACK
- 8-C TUBE, NYLON NO.8 GREEN
- 8-R TUBE, NYLON NO.8 RED
- 10-C TUBE, NYLON NO.10 GREEN
- 10-R TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11751, CHG. LTR. C, WIRE BRAID HOSE, DATE OF USE 2/84 TO 10/86



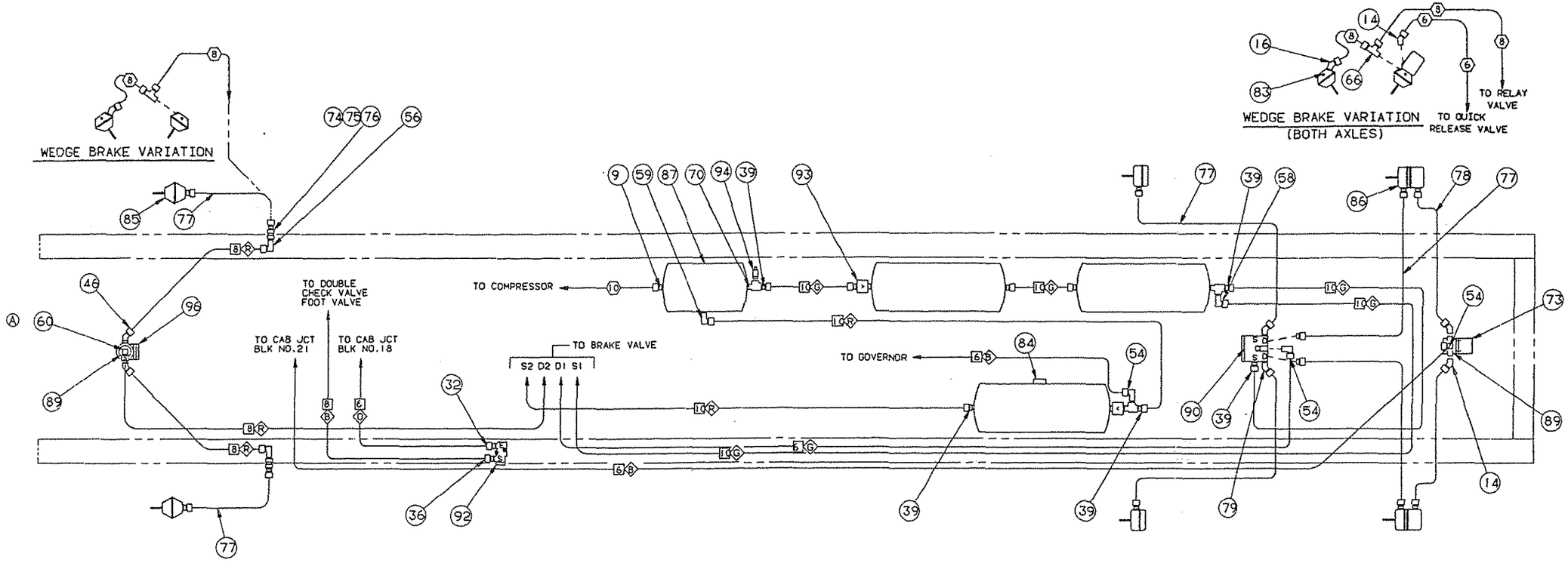
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
(B)(A) 6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
(C) 9	9	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
(B) 16	6	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
(A) 26	3	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
(B) 64	1	210503 000017	TEE,MALE BRANCH (3/8 NPT)

ITEM #	QTY	PART #	DESCRIPTION
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
(B) 70	3	210503 000037	TEE, STREET, SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
83	REF	210503 000030	PLUG,(3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

(4)	HOSE ASSY, NO. 4
(6)	HOSE ASSY, NO. 6
(8)	HOSE ASSY, NO. 8
(10)	HOSE ASSY, NO.10
(1)	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12039, CHG. LTR. A, NYLON TUBING, DATE OF USE 10/86—



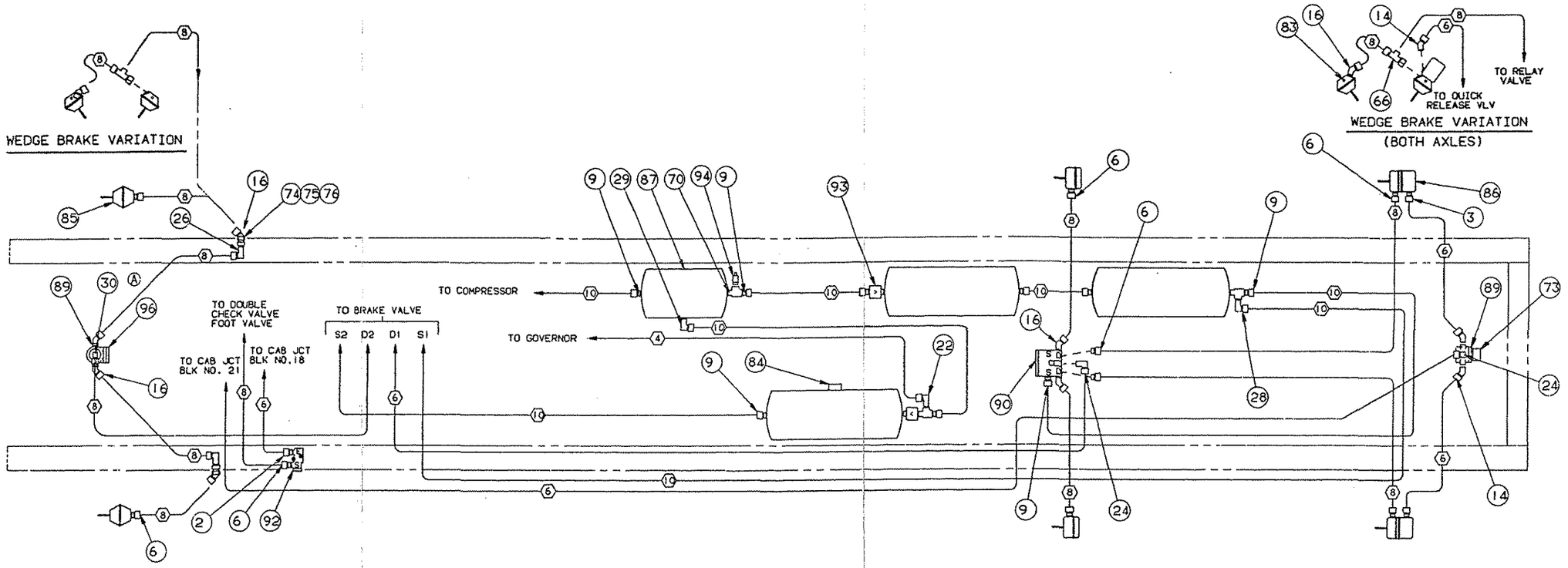
ITEM #	QTY	PART #	DESCRIPTION
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
39	8	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
46	2	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
Ⓐ 56	2	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
Ⓐ 60	1	210500 000036	ELB, MALE, 90° (1/2 NPT-1/2 NTA)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
70	3	210503 000037	TEE, STREET SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
77	6	A12-10505- #	HOSE ASSY, AIR BRAKE
78	2	A12-11921- #	HOSE ASSY, AIR BRAKE
79	2	23-11341-000	ELBOW,ADAPTER,45°(3/8 NPT-3/4 UNF)
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

(6)	HOSE ASSY, #6 WIREBRAID
(8)	HOSE ASSY, #8 WIREBRAID
(10)	HOSE ASSY, #10 WIREBRAID
6 B	TUBE, NYLON NO.6 BLACK
6 G	TUBE, NYLON NO.6 GREEN
6 O	TUBE, NYLON NO.6 ORANGE
6 R	TUBE, NYLON NO.6 RED
8 B	TUBE, NYLON NO.8 BLACK
8 G	TUBE, NYLON NO.8 GREEN
8 R	TUBE, NYLON NO.8 RED
10 G	TUBE, NYLON NO.10 GREEN
10 R	TUBE, NYLON NO.10 RED
(1)	QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12041, CHG. LTR. A, WIRE BRAID HOSE, DATE OF USE 10/86—



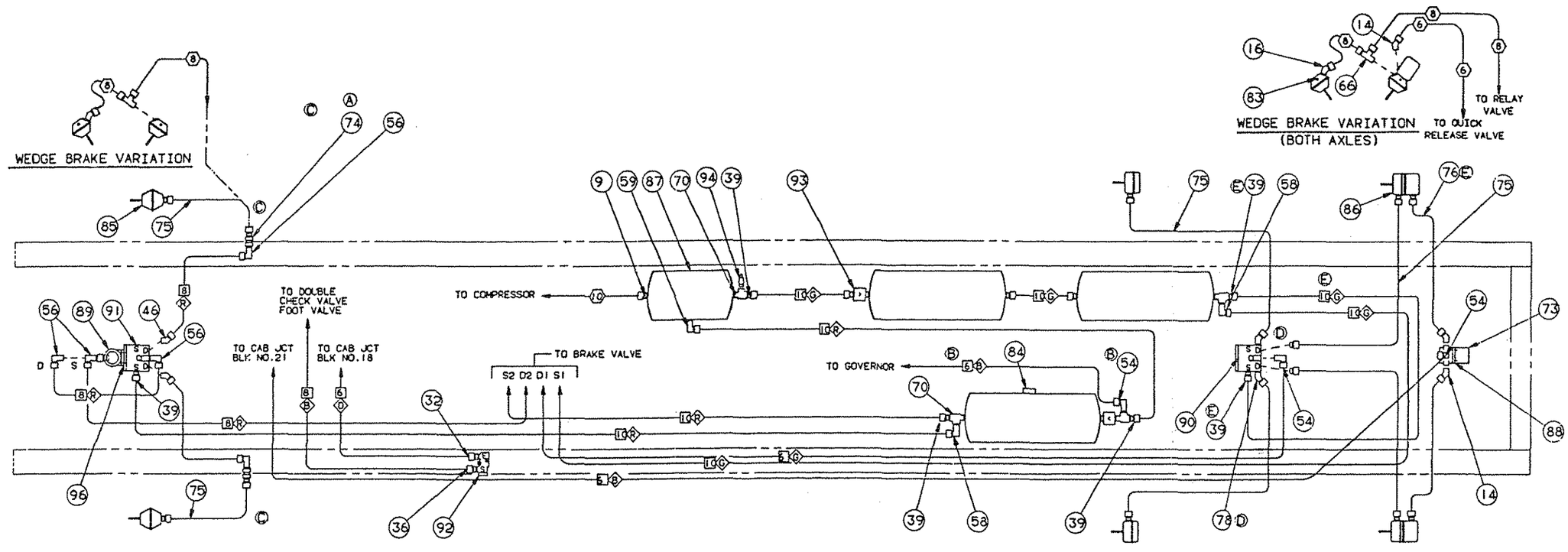
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
9	9	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	6	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
⚠ 26	2	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
⚠ 30	1	210502 000043	ELB, MALE, 90°, 45° FLARE (1/2 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
70	3	210503 000037	TEE, STREET, SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
74	2	12-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
83	REF	210503 000030	PLUG,(3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

④	HOSE ASSY, NO. 4
⑥	HOSE ASSY, NO. 6
⑧	HOSE ASSY, NO. 8
⑩	HOSE ASSY, NO.10
⚠1	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11765, CHG. LTR. F, NYLON TUBING, DATE OF USE 2/84 TO 10/86



ITEM #	QTY	PART #	DESCRIPTION
(E)			
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
(B)			
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
(E) 39	9	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
(E)			
(A) 46	2	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
(B) (A) 54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
(B) (A) 56	5	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	2	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
(D)			
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
(D) 70	4	210503 000037	TEE, STREET SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
(A) 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
75	6	A12-10505- #	HOSE ASSY, AIR BRAKE
(E) 76	2	A12-11921- #	HOSE ASSY, AIR BRAKE
(F) (D) (C) 78	2	23-11341-000	ELBOW,ADAPTER,45° (3/8 NPT-3/4 UNF)
83	REF	210503 000030	PLUG (3/8 NPT)
84	1	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

(B)

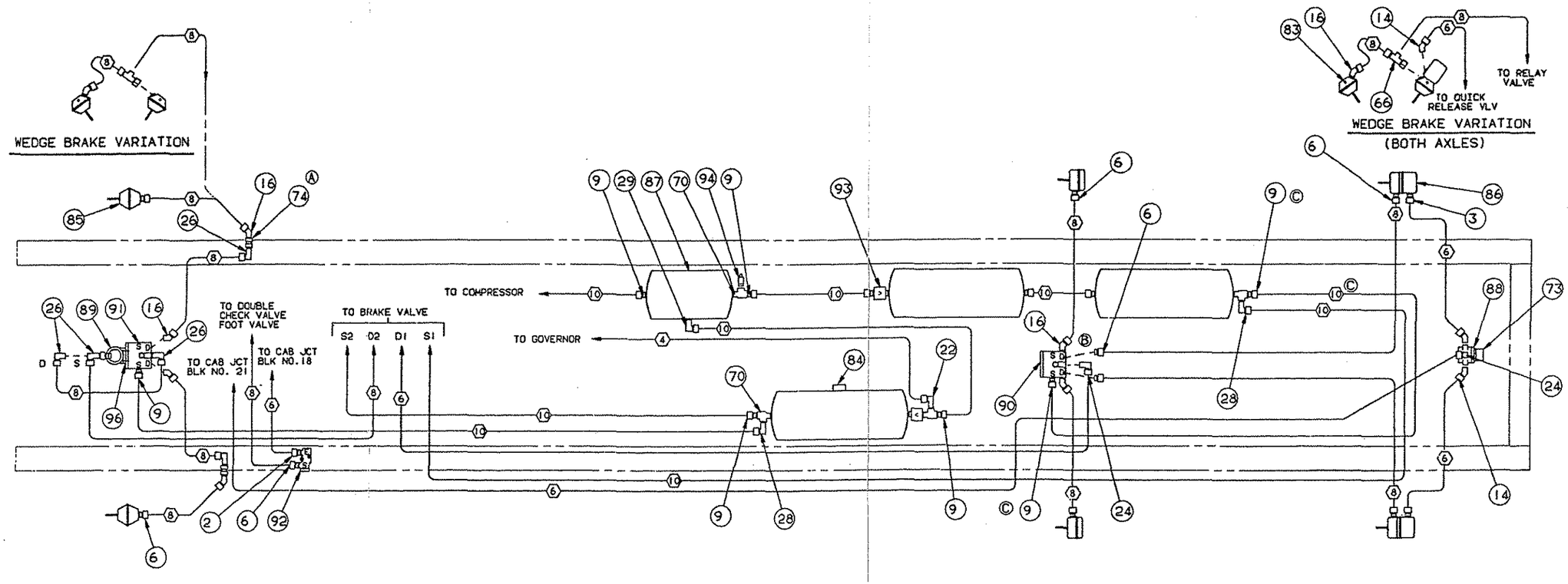
(6)	HOSE ASSY, #6 WIREBRAID
(8)	HOSE ASSY, #8 WIREBRAID
(B) (10)	HOSE ASSY, #10 WIREBRAID
(6) (B)	TUBE, NYLON NO.6 BLACK
(6) (G)	TUBE, NYLON NO.6 GREEN
(6) (O)	TUBE, NYLON NO.6 ORANGE
(6) (R)	TUBE, NYLON NO.6 RED
(8) (B)	TUBE, NYLON NO.8 BLACK
(8) (G)	TUBE, NYLON NO.8 GREEN
(8) (R)	TUBE, NYLON NO.8 RED
(10) (G)	TUBE, NYLON NO.10 GREEN
(10) (R)	TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12774

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11763, CHG. LTR. C, WIRE BRAID HOSE, DATE OF USE 2/84 TO 10/86



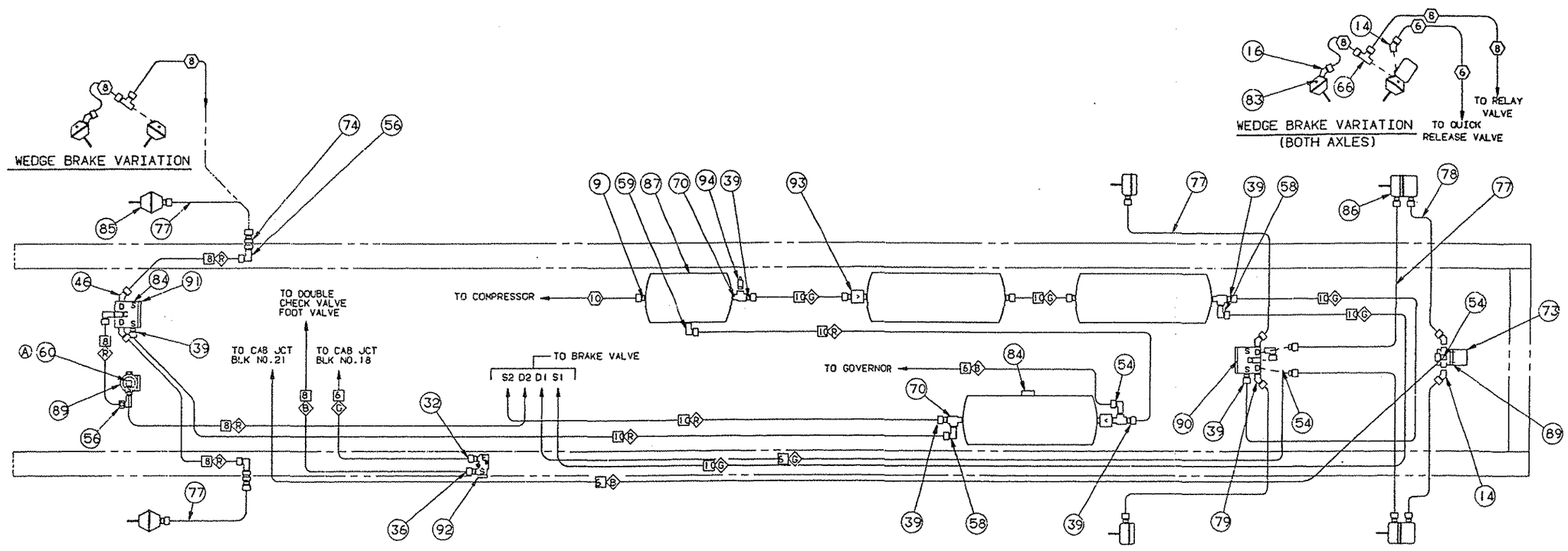
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
B A 6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
C 9 C	10	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
B 16	6	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
A 26	5	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	2	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
B 66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
B 70	4	210503 000037	TEE, STREET, SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
A 74	2	A12-10491-000	COUPLING, ANCHOR (3/8 NPT)
83	REF	210503 000030	PLUG,(3/8 NPT)
84	1	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
89	1		VALVE, RATIO
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

4	HOSE ASSY, NO. 4
6	HOSE ASSY, NO. 6
8	HOSE ASSY, NO. 8
10	HOSE ASSY, NO.10
1	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12042, CHG. LTR. A, NYLON TUBING, DATE OF USE 10/86—



ITEM #	QTY	PART #	DESCRIPTION
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
39	9	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
46	2	210500 000021	ELB, MALE, 45° (3/8 NPT-1/2 NTA)
54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
② 56	4	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	2	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
59	1	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
② 60	1	210500 000036	ELB, MALE, 90° (1/2 NPT-1/2 NTA)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
70	4	210503 000037	TEE, STREET SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
74	2	23-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23- 701-100	WASHER, FLAT
76	2	23-10740-100	NUT, ANCHOR COUPLING
77	6	A12-10505- #	HOSE ASSY, AIR BRAKE
78	2	A12-11921- #	HOSE ASSY, AIR BRAKE
79	2	23-11341-000	ELBOW,ADAPTER,45° (3/8 NPT-3/4 UNF)
83	REF	210503 000030	PLUG (3/8 NPT)
84	2	210503 000031	PLUG (1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

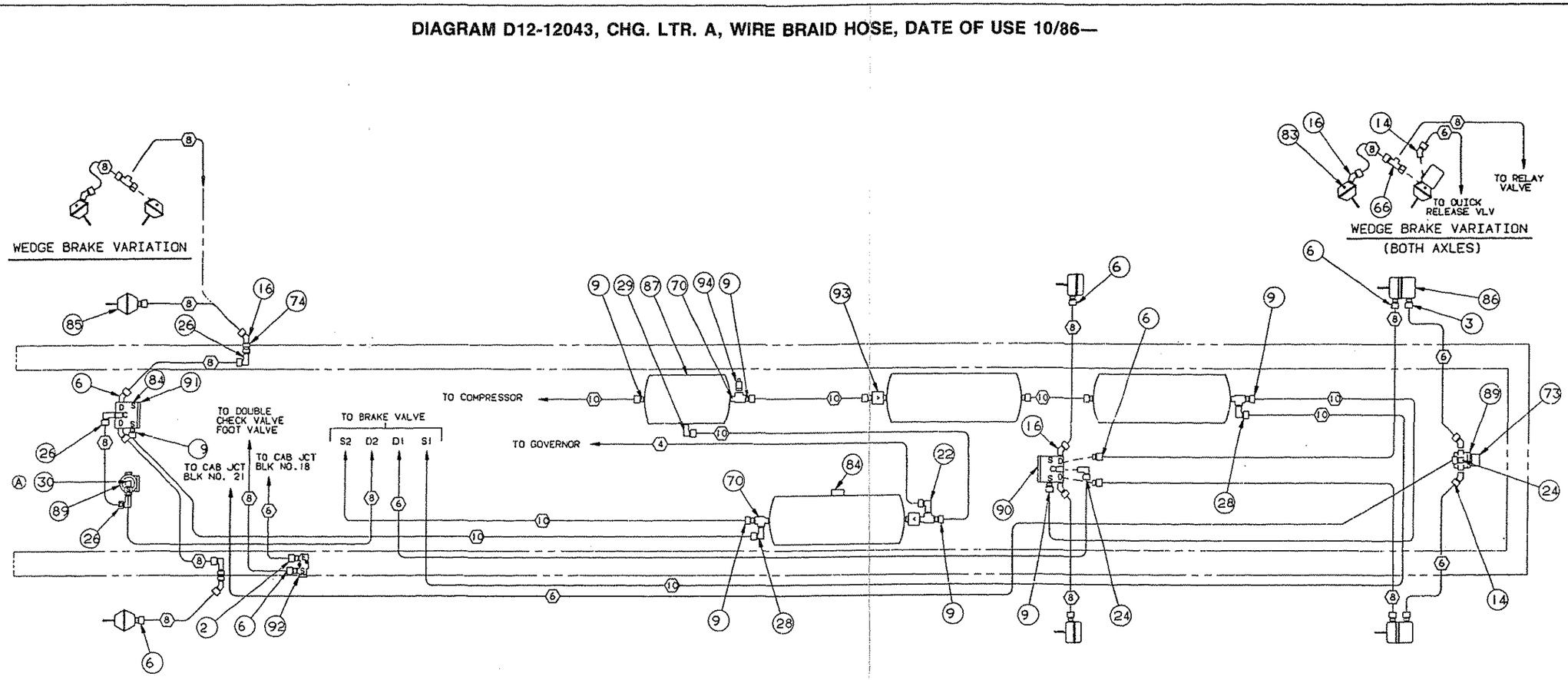
⑥	HOSE ASSY, #6 WIREBRAID
⑧	HOSE ASSY, #8 WIREBRAID
⑩	HOSE ASSY, #10 WIREBRAID
6 B	TUBE, NYLON NO.6 BLACK
6 G	TUBE, NYLON NO.6 GREEN
6 O	TUBE, NYLON NO.6 ORANGE
6 R	TUBE, NYLON NO.6 RED
8 B	TUBE, NYLON NO.8 BLACK
8 G	TUBE, NYLON NO.8 GREEN
8 R	TUBE, NYLON NO.8 RED
10 G	TUBE, NYLON NO.10 GREEN
10 R	TUBE, NYLON NO.10 RED

① QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12774

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, WITH 24- OR 30-INCH FRONT BRAKE CHAMBERS, FMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-12043, CHG. LTR. A, WIRE BRAID HOSE, DATE OF USE 10/86—



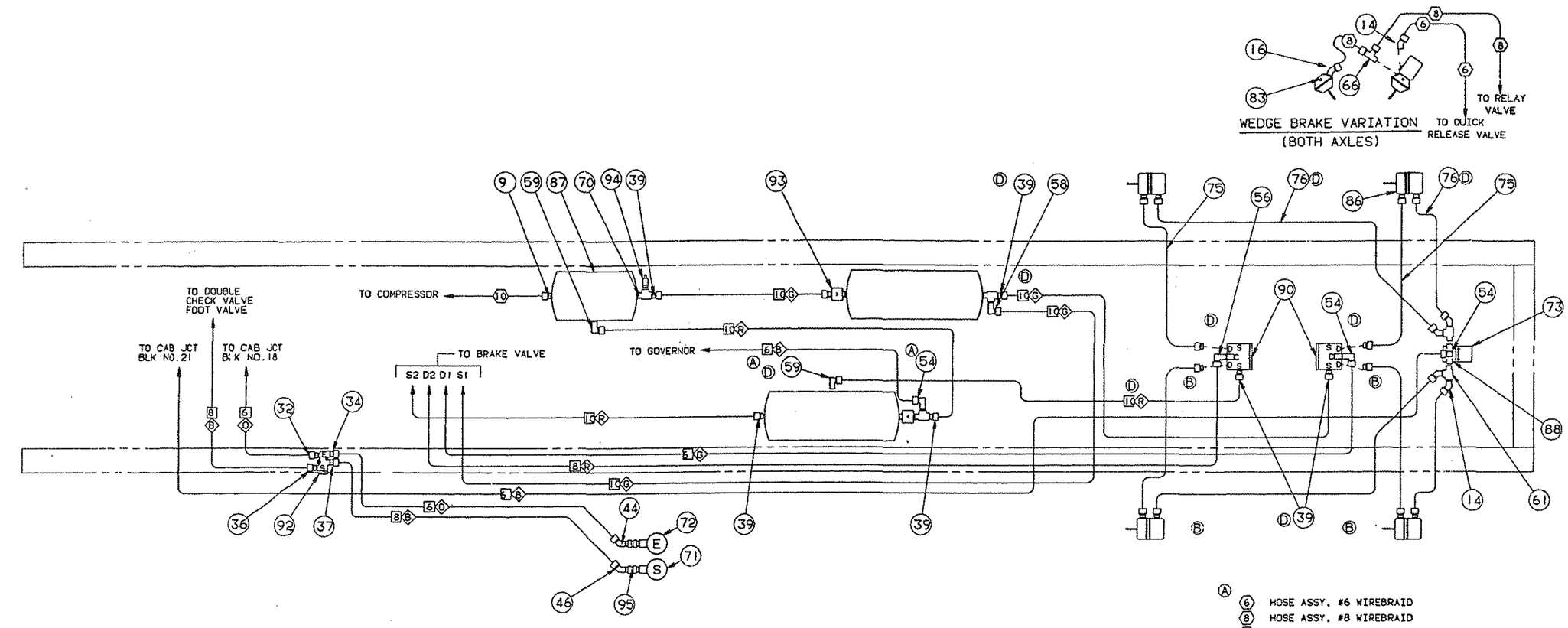
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
6	9	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
9	10	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	6	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°. 45° FLARE (3/8 NPT-3/8 HOSE)
⚠ 26	4	210502 000042	ELB, MALE, 90°. 45° FLARE (3/8 NPT-1/2 HOSE)
28	2	210502 000044	ELB, MALE, 90°. 45° FLARE (3/8 NPT-5/8 HOSE)
29	1	210502 000045	ELB, MALE, 90°. 45° FLARE (1/2 NPT-5/8 HOSE)
⚠ 30	1	210502 000043	ELB, MALE, 90°. 45° FLARE (1/2 NPT-1/2 HOSE)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
70	4	210503 000037	TEE, STREET, SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
74	2	12-11808-003	COUPLING, ANCHOR (3/8 NPT)
75	2	23-00701-100	WASHER, LOCK
76	2	23-10740-100	NUT, ANCHOR COUPLING
83	REF	210503 000030	PLUG,(3/8 NPT)
84	2	210503 000031	PLUG,(1/2 NPT)
85			SEE FRONT AXLE ASSY
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
89	2		VALVE, QUICK RELEASE
90	1		VALVE, RELAY, REAR
91	1		VALVE, RELAY, FRONT
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
96			SEE CHASSIS PLUMBING INST

(4)	HOSE ASSY, NO. 4
(6)	HOSE ASSY, NO. 6
(8)	HOSE ASSY, NO. 8
(10)	HOSE ASSY, NO.10
⚠1	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11762, CHG. LTR. D, NYLON TUBING, DATE OF USE 2/84—



ITEM #	QTY	PART #	DESCRIPTION
Ⓓ 9	1	210502 000011	CONN.MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	4	210502 000018	ELB. MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
Ⓐ 32	1	210500 000004	COUPLING. MALE (1/4 NPT-3/8 NTA)
34	1	210500 000006	COUPLING. MALE (1/2 NPT-3/8 NTA)
36	1	210500 000008	COUPLING. MALE (3/8 NPT-1/2 NTA)
37	1	210500 000009	COUPLING. MALE (1/2 NPT-1/2 NTA)
Ⓓ 39	7	210500 000011	COUPLING. MALE (1/2 NPT-5/8 NTA)
44	1	210500 000019	ELB. MALE, 45° (3/8 NPT-3/8 NTA)
46	1	210500 000021	ELB. MALE, 45° (3/8 NPT-1/2 NTA)
Ⓐ 54	3	210500 000032	ELB. MALE, 90° (3/8 NPT-3/8 NTA)
56	1	210500 000035	ELB. MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB. MALE, 90° (3/8 NPT-5/8 NTA)
Ⓓ 59	2	210500 000038	ELB. MALE, 90° (1/2 NPT-5/8 NTA)
61	2	210503 000020	TEE,STREET
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

ITEM #	QTY	PART #	DESCRIPTION
Ⓓ 70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
75	4	A12-10505- #	HOSE ASSY. AIR BRAKE
Ⓓ 76	4	A12-11921- #	HOSE ASSY. AIR BRAKE
Ⓓ,Ⓒ			
Ⓑ 83	REF	210503 000030	PLUG (3/8 NPT)
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
90	2		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD

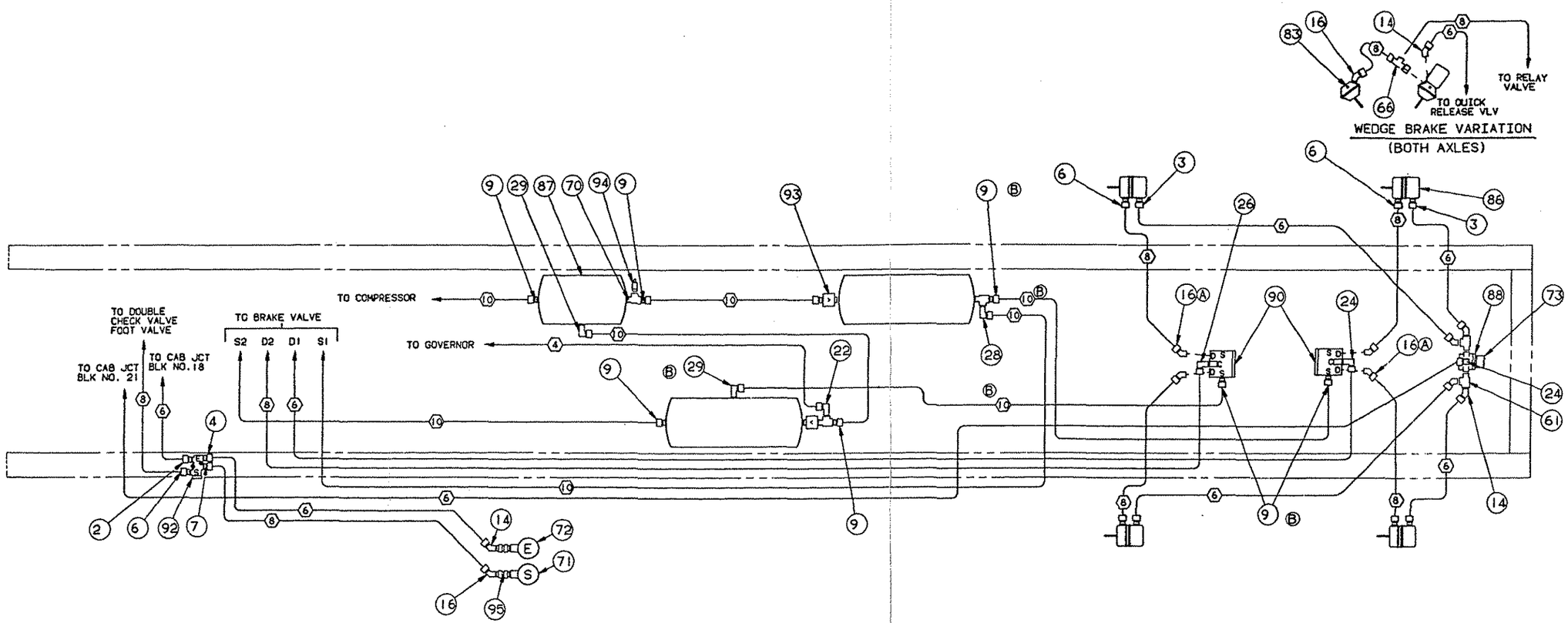
Ⓐ
- (6) HOSE ASSY. #6 WIREBRAID
- (8) HOSE ASSY. #8 WIREBRAID
- Ⓐ (10) HOSE ASSY. #10 WIREBRAID
- [6][B] TUBE, NYLON NO.6 BLACK
- [6][G] TUBE, NYLON NO.6 GREEN
- [6][O] TUBE, NYLON NO.6 ORANGE
- [6][R] TUBE, NYLON NO.6 RED
- [8][B] TUBE, NYLON NO.8 BLACK
- [8][R] TUBE, NYLON NO.8 RED
- [10][G] TUBE, NYLON NO.10 GREEN
- [10][R] TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

BRAKE CONTROL 12
32-12776

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRUCK, CMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11760, CHG. LTR. B, WIRE BRAID HOSE, DATE OF USE 2/84—



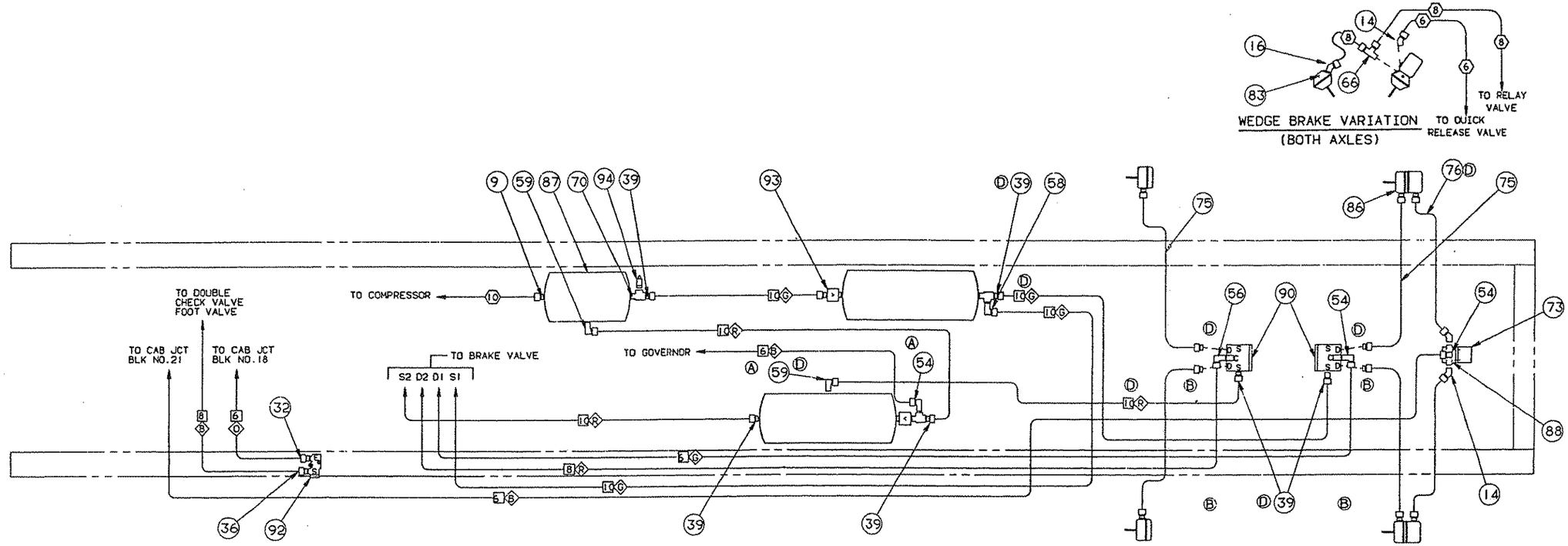
ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	4	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
4	1	210502 000005	CONN,MALE,45° FLARE (1/2 NPT-3/8 HOSE)
6	5	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
7	1	210502 000008	CONN,MALE,45° FLARE (1/2 NPT-1/2 HOSE)
(B) 9	7	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
(B) 14	5	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
(A) 16	5	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
26	1	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
(B) 29	2	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
(B) 61	2	210503 000020	TEE,STREET

ITEM #	QTY	PART #	DESCRIPTION
66	REF	210502 000030	TEE, MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
(A) 70	3	210503 000037	TEE, STREET SPECIAL
71	1	12-09711-000	GLADHAND, SERVICE
72	1	12-09711-001	GLADHAND, EMERGENCY
73	1	12-10474-000	BRACKET, MOUNTING
83	REF	210503 000030	PLUG (3/8 NPT)
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
90	2		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY
95	2		CLAMP, STUD

(4)	HOSE ASSY, NO. 4
(6)	HOSE ASSY, NO. 6
(8)	HOSE ASSY, NO. 8
(10)	HOSE ASSY, NO. 10
(1)	QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, CMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11761, CHG. LTR. D, NYLON TUBING, DATE OF USE 2/84—



ITEM #	QTY	PART #	DESCRIPTION
Ⓓ			
9	1	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
16	REF	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
Ⓐ			
32	1	210500 000004	COUPLING, MALE (1/4 NPT-3/8 NTA)
36	1	210500 000008	COUPLING, MALE (3/8 NPT-1/2 NTA)
Ⓓ 39	7	210500 000011	COUPLING, MALE (1/2 NPT-5/8 NTA)
Ⓐ 54	3	210500 000032	ELB, MALE, 90° (3/8 NPT-3/8 NTA)
56	1	210500 000035	ELB, MALE, 90° (3/8 NPT-1/2 NTA)
58	1	210500 000037	ELB, MALE, 90° (3/8 NPT-5/8 NTA)
Ⓓ 59	2	210500 000038	ELB, MALE, 90° (1/2 NPT-5/8 NTA)
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)

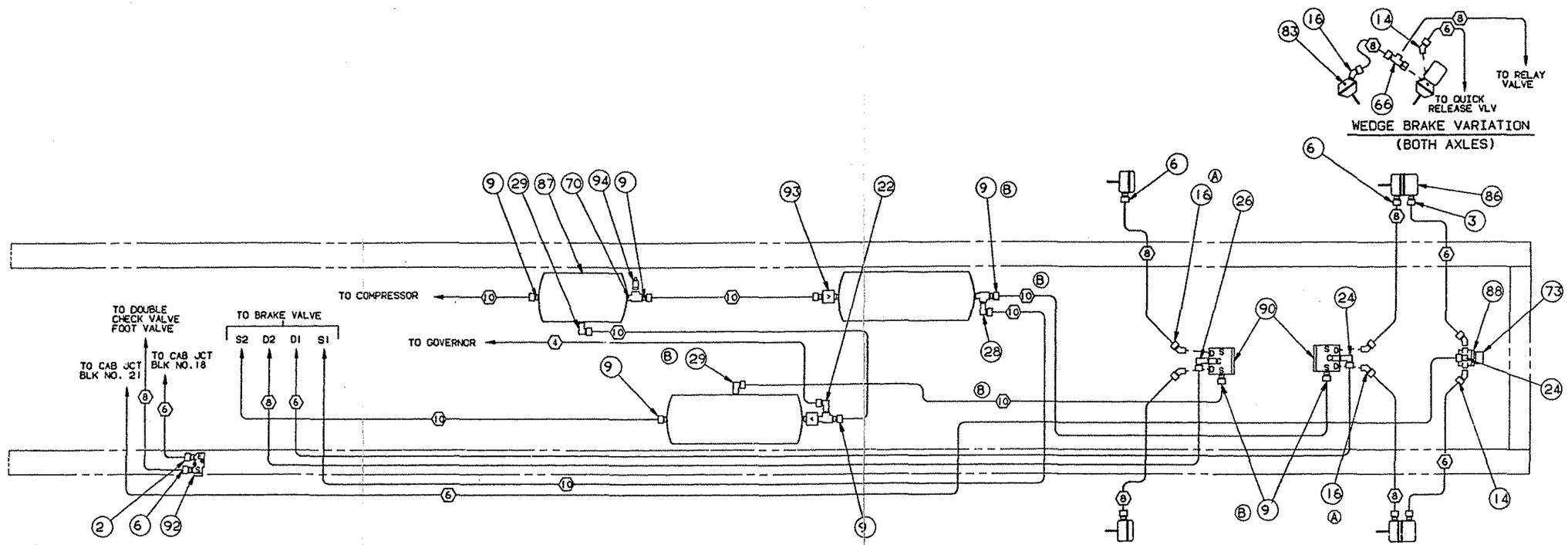
ITEM #	QTY	PART #	DESCRIPTION
Ⓓ 70	3	210503 000037	TEE, STREET SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
75	4	A12-10505- #	HOSE ASSY, AIR BRAKE
Ⓓ 76	2	A12-11921- #	HOSE ASSY, AIR BRAKE
Ⓓ Ⓒ			
Ⓑ 83	REF	210503 000030	PLUG (3/8 NPT)
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
90	2		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY

Ⓐ
- 6 HOSE ASSY, #6 WIREBRAID
- 8 HOSE ASSY, #8 WIREBRAID
- Ⓐ 10 HOSE ASSY, #10 WIREBRAID
- 6 B TUBE, NYLON NO.6 BLACK
- 6 G TUBE, NYLON NO.6 GREEN
- 6 O TUBE, NYLON NO.6 ORANGE
- 6 R TUBE, NYLON NO.6 RED
- 8 B TUBE, NYLON NO.8 BLACK
- 8 R TUBE, NYLON NO.8 RED
- 10 G TUBE, NYLON NO.10 GREEN
- 10 R TUBE, NYLON NO.10 RED

(1) QTY'S ARE SHOWN FOR STD. INSTALLATION ONLY

COE AND 120 CONVENTIONAL TANDEM REAR AXLE TRACTOR, CMVSS 121, CHASSIS DIAGRAM

DIAGRAM D12-11759, CHG. LTR. B, WIRE BRAID HOSE, DATE OF USE 2/84—



ITEM #	QTY	PART #	DESCRIPTION
2	1	210502 000003	CONN,MALE,45° FLARE (1/4 NPT-3/8 HOSE)
3	2	210502 000004	CONN,MALE,45° FLARE (3/8 NPT-3/8 HOSE)
6	5	210502 000007	CONN,MALE,45° FLARE (3/8 NPT-1/2 HOSE)
(B) 9	8	210502 000011	CONN,MALE,45° FLARE (1/2 NPT-5/8 HOSE)
(B)			
14	2	210502 000018	ELB, MALE, 45°, 45° FLARE (3/8 NPT-3/8 HOSE)
(A) 16	4	210502 000019	ELB, MALE, 45°, 45° FLARE (3/8 NPT-1/2 HOSE)
22	1	210502 000037	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/4 HOSE)
24	2	210502 000039	ELB, MALE, 90°, 45° FLARE (3/8 NPT-3/8 HOSE)
26	1	210502 000042	ELB, MALE, 90°, 45° FLARE (3/8 NPT-1/2 HOSE)
28	1	210502 000044	ELB, MALE, 90°, 45° FLARE (3/8 NPT-5/8 HOSE)
(B) 29	2	210502 000045	ELB, MALE, 90°, 45° FLARE (1/2 NPT-5/8 HOSE)
(B)			

ITEM #	QTY	PART #	DESCRIPTION
66	REF	210502 000030	TEE,MALE RUN, 45° FLARE (3/8 NPT-1/2 HOSE)
(A) 70	3	210503 000037	TEE, STREET, SPECIAL
73	1	12-10474-000	BRACKET, MOUNTING
83	REF	210503 000030	PLUG,(3/8 NPT)
86			SEE REAR AXLE ASSY
87			SEE AIR RESERVOIRS INST
88	1		VALVE, QUICK RELEASE
90	2		VALVE, RELAY, REAR
92	1		VALVE, TRACTOR PROTECTION
93	2		VALVE, SINGLE CHECK
94	1		VALVE, AIR SAFETY

(4) HOSE ASSY, NO. 4
(6) HOSE ASSY, NO. 6
(8) HOSE ASSY, NO. 8
(10) HOSE ASSY, NO.10

(1) QUANTITIES ARE SHOWN FOR STD. INSTALLATION ONLY

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MANUAL STEERING GEAR, ROSS MODEL 503 AA172

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MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

GENERAL DESCRIPTION

The steering gear converts the rotary motion of the steering wheel into the straight-line motion needed to turn the front wheels. The Ross model 503 AA172 worm and roller type manual steering gear (Fig. 1) is standard on Freightliner vehicles with 1984 Advancements and manual steering.

The "worm and roller" designations refer to the gears inside the steering gear housing: the worm (or input) shaft and the roller (or output) shaft. Refer to Fig. 2. The ratio of the 503 AA172 model is 32.5:1.

Steering gear model numbers are stamped on an I.D. tag which is attached to the shaft cover. Refer to Fig. 1. Steering gear ratios are stamped on the inside of the housing. The 32.5:1 ratio is stamped "33" in the housing. See Fig. 4.

The worm shaft is secured in the housing by a pair of bearing cage (retainer) assemblies. The worm shaft

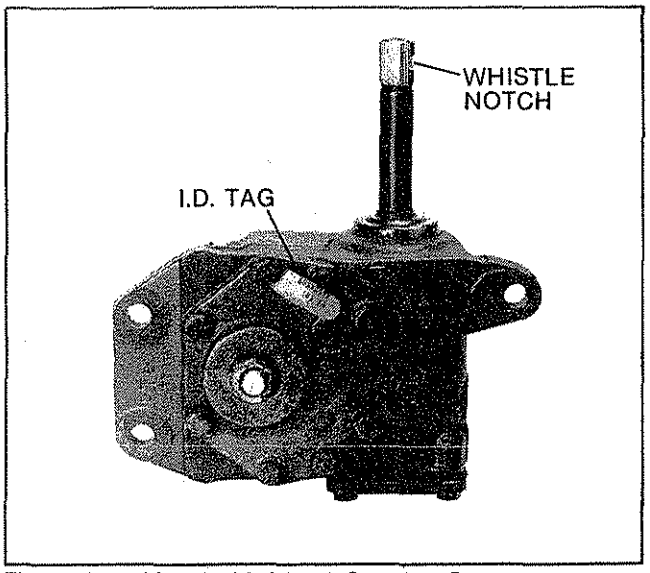
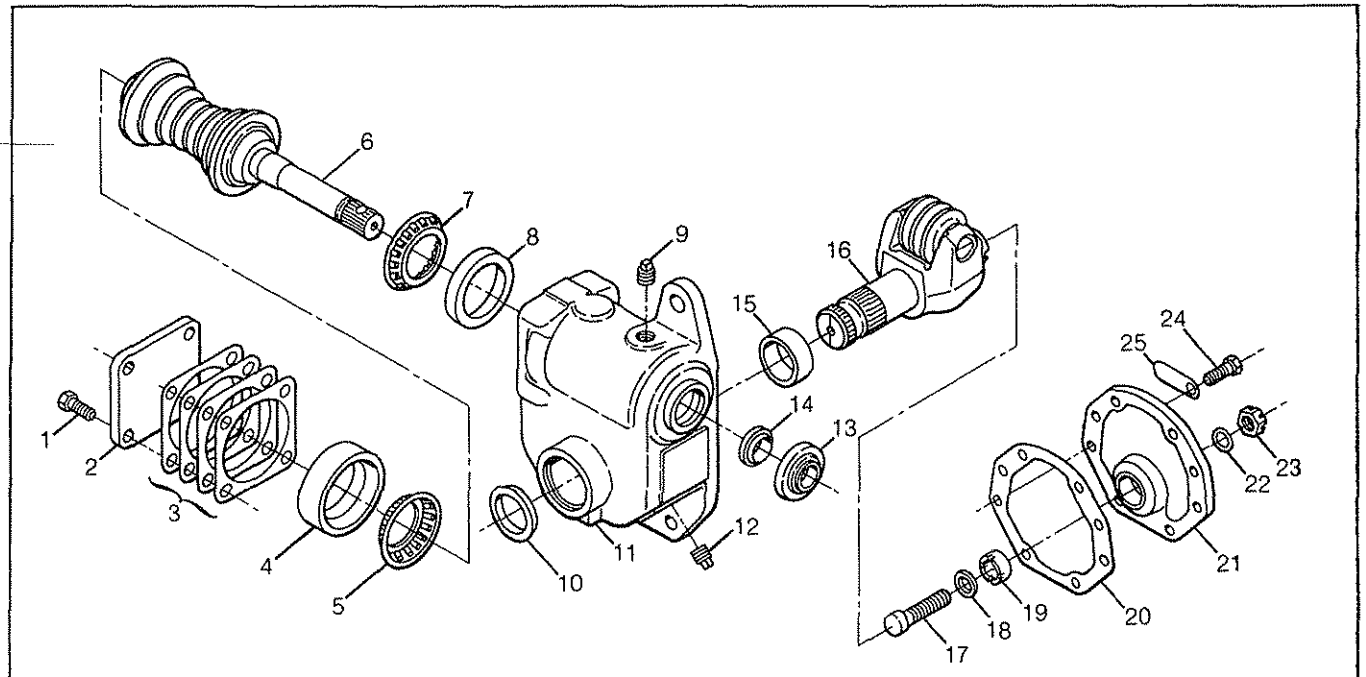


Fig. 1, Ross Model 503 AA172 Steering Gear



1. Worm Cover Screws (4)
2. Worm Cover
3. Worm Cover Shims
4. Bearing Cup
5. Bearing Cage (Retainer) Assembly
6. Worm (Input) Shaft
7. Bearing Cage (Retainer) Assembly
8. Bearing Cup
9. Filler and Vent Plug
10. Roller Shaft Seal
11. Housing
12. Drain Plug
13. Boot
14. Worm Shaft Seal
15. Bushing
16. Roller (Output) Shaft Assembly
17. Adjusting Screw
18. Washer
19. Shaft Cover Bushing
20. Shaft Cover Gasket
21. Shaft Cover
22. O-Ring
23. Adjusting Screw Locknut
24. Shaft Cover Screws (8)
25. Identification Tag

Fig. 2, Steering Gear Assembly

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

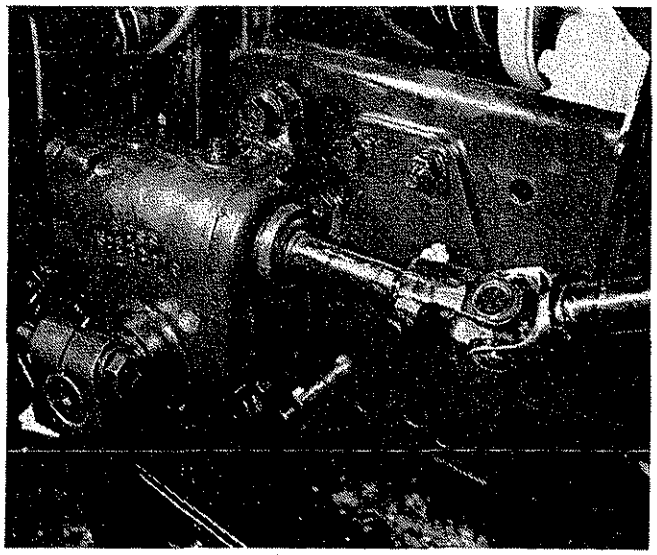


Fig. 3, Manual Steering Gear, Conventional

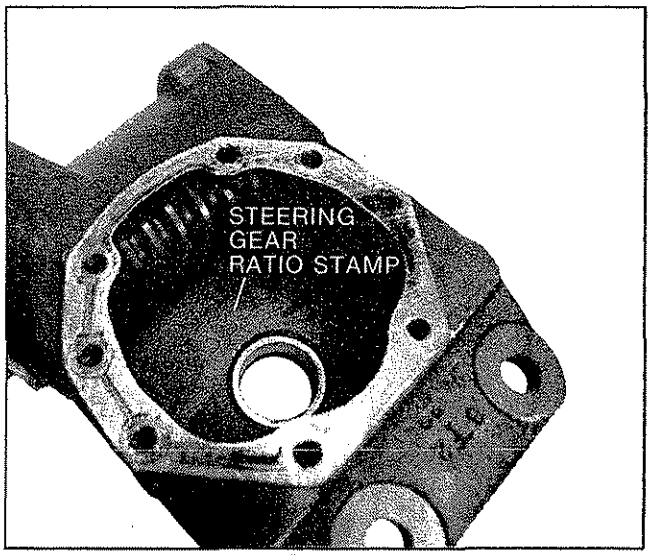


Fig. 4

meshes with a roller tooth which is mounted on the roller shaft shoulder.

The steering gear is designed with integral stops in the housing to limit the travel of the roller shaft and thereby prevent mesh runout of the roller tooth with the worm shaft. These stops are not intended to absorb road shock or act as wheel stops. The vehicle axle stops are designed with a safety factor of several degrees at each end of gear travel (i.e., the travel of the roller shaft) to prevent gear contact with the integral stops in the housing.

Most steering action is performed with the front tires in the straight-ahead position. Thus, in the steering gear, maximum wear occurs at the center portion of the worm shaft tooth. To compensate for wear, backlash is provided in the off-center portions of the tooth.

Backlash is the amount of clearance or free-play between meshing teeth in two gears that will allow rotation of the driven gear (in this case, the roller portion of the roller shaft) in a direction opposite to the driving rotation of a second gear (the worm shaft).

In the Ross model 503 manual steering gear, backlash occurs approximately one-half turn each way from the center portion of the worm shaft and gradually increases to develop the largest amount of backlash at the end of gear travel. This permits adjustment for lost motion in the center position without causing a bind in the off-center travel of the roller shaft.

In the steering gear, elimination of looseness caused by wear in the center portion of the worm shaft tooth is accomplished by means of preload adjustments. Preload adjustments are provided on the worm shaft roller bearings and also the roller shaft mesh.

PRINCIPLES OF OPERATION

When the steering wheel is turned, the force is transmitted to the worm shaft through the steering driveline. The worm shaft tooth, meshed with the roller shaft tooth inside the steering gear housing, causes the roller shaft to turn in the same direction as the worm shaft, but the total output travel is greatly reduced.

The pitman arm is connected to the end of the roller shaft outside the steering gear housing. The pitman arm converts the rotary motion of the roller shaft to lateral motion. The lateral motion is transmitted through the drag link assembly and the steering arms to the steering knuckles. The steering knuckles pivot on the axle center (beam) and cause the wheels to turn.

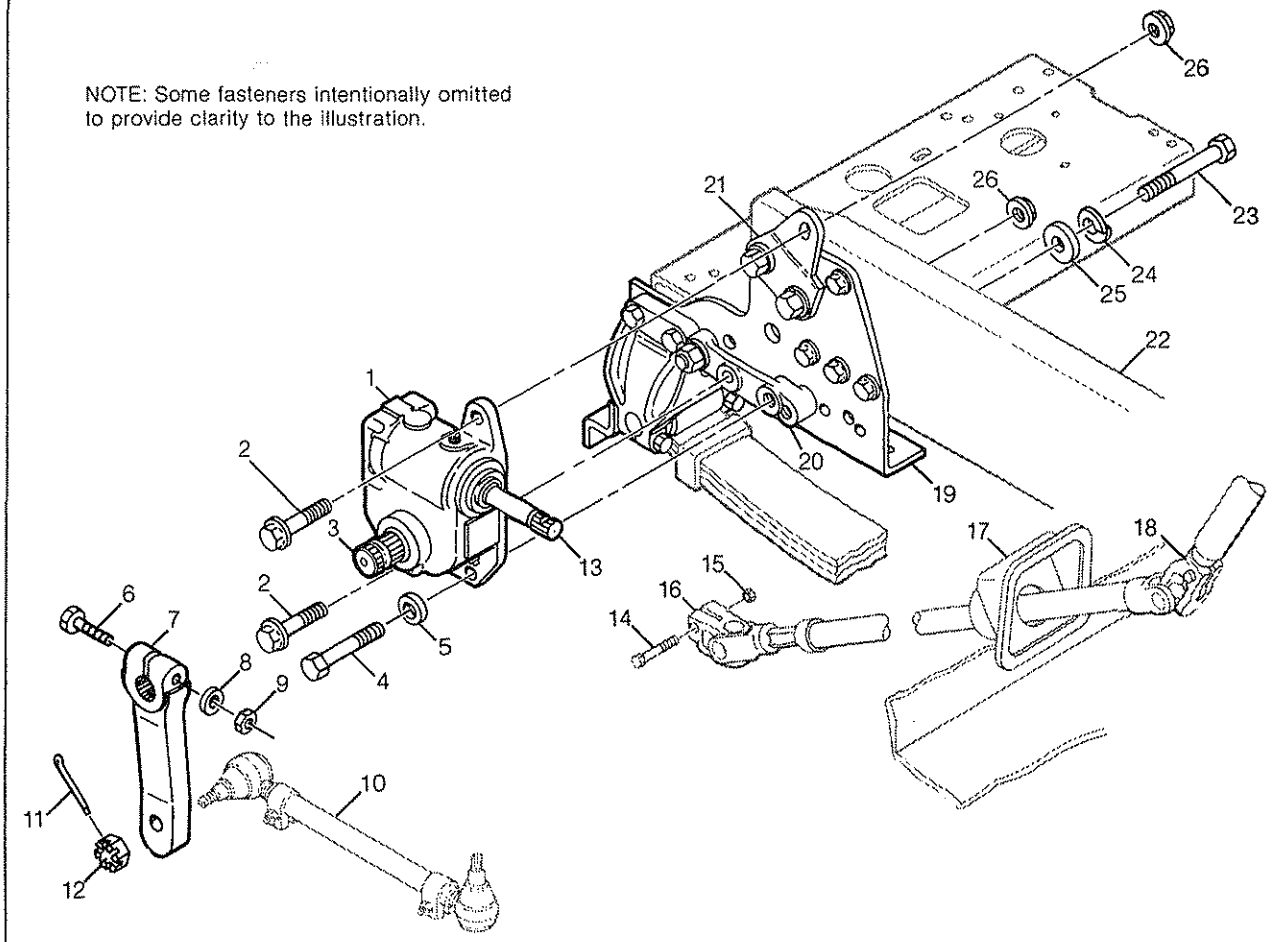
SERVICE OPERATIONS

WARNING: All steering mechanisms are life and limb items. As such, it is imperative that the instructions in this subject are followed to the letter. Failure to observe the procedures set out in this subject may result in loss of steering.

Figs. 5 and 6 illustrate the manual steering installations found on Freightliner vehicles with 1984 Advancements.

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

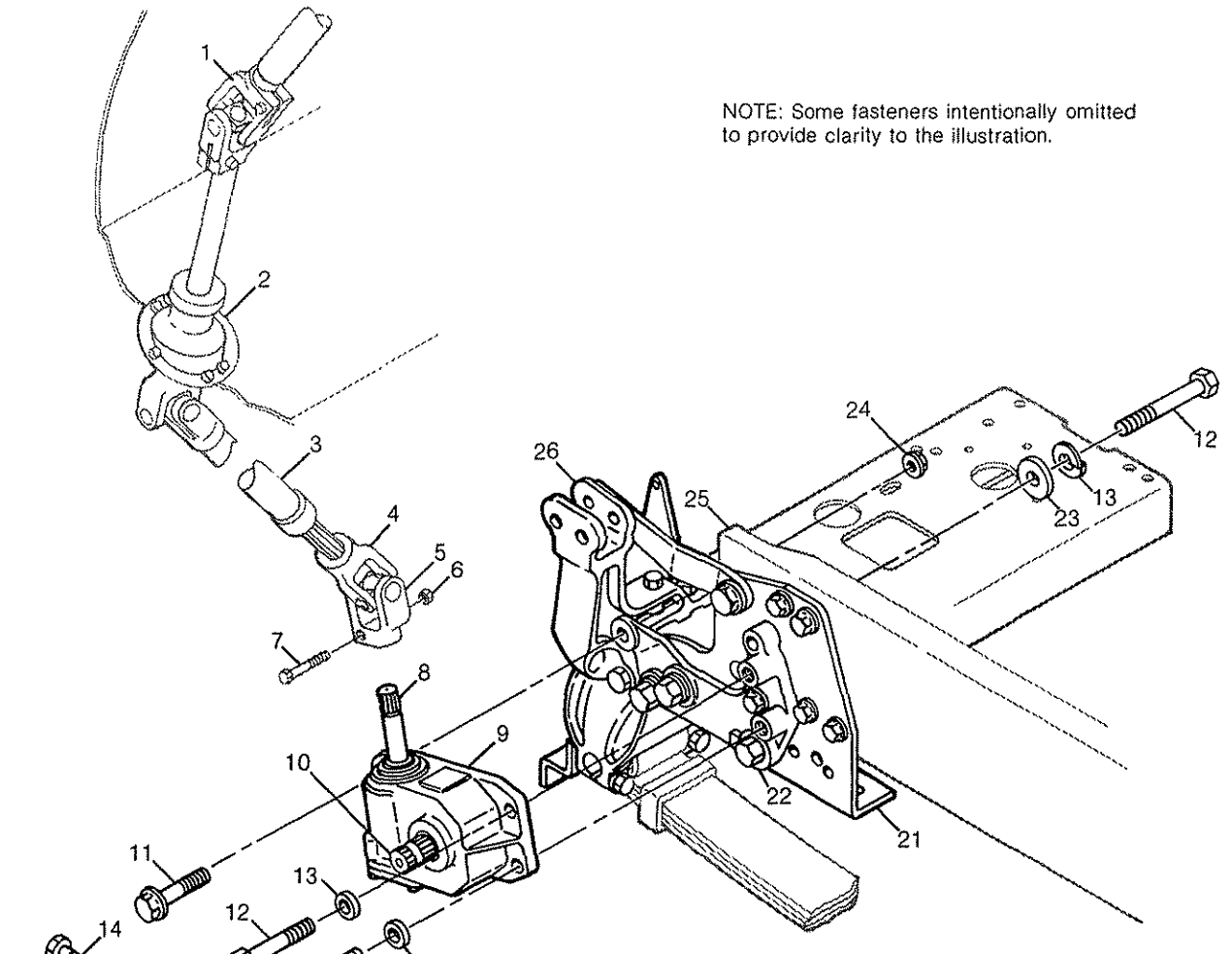
NOTE: Some fasteners intentionally omitted to provide clarity to the illustration.



1. Steering Gear
2. Flanged Mounting Bolt
3. Output (Roller) Shaft
4. Mounting Bolt
5. Washer
6. Pitman Arm Pinch Bolt
7. Pitman Arm
8. Washer
9. Pinch Bolt Nut
10. Drag Link
11. Cotter Pin
12. Castle Nut
13. Input (Worm) Shaft
14. Lower End Yoke Pinch Bolt
15. Pinch Bolt Nut
16. Lower Steering Shaft and Yoke Assembly
17. Steering Column Boot Assembly
18. Upper Steering Driveline End Yoke
19. Frame Extension
20. Lower Mounting Bracket
21. Upper Mounting Bracket
22. Frame
23. Mounting Bolt
24. Lockwasher
25. Spacer
26. Flanged Nut

Fig. 5, Manual Steering Gear Installation, Conventional With 1984 Advancements

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS



1. Upper Steering Driveline End Yoke
2. Deck Bearing Assembly
3. Lower Driveline Tube
4. Lower Driveline Shaft and Yoke Assembly
5. Lower End Yoke
6. Pinch Bolt Nut
7. Lower End Yoke Pinch Bolt
8. Input (Worm) Shaft
9. Steering Gear
10. Output (Roller) Shaft
11. Flanged Mounting Bolt
12. Mounting Bolt
13. Washer
14. Pitman Arm Pinch Bolt
15. Pitman Arm
16. Washer
17. Pinch Bolt Nut
18. Drag Link
19. Cotter Pin
20. Castle Nut
21. Frame Extension
22. Steering Gear Mounting Bracket
23. Spacer
24. Flanged Nut
25. Frame
26. Cab Mounting Bracket

Fig. 6, Manual Steering Gear Installation, COE With 1984 Advancements

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

Refer only to the applicable installation when instructed to do so in the service operations that follow.

CENTRALIZING THE STEERING GEAR

Centralizing the steering gear places the roller (output) shaft in the center of its travel to give the most desireable characteristics during straight-ahead driving. All manual steering gears are centralized at the factory.

In the field, make sure the steering gear is centralized when:

1. Steering gear preload adjustments must be checked.
2. The drag link is serviced or adjusted.

In addition, if the steering gear is removed from the vehicle, the gear must be centralized prior to installation. Instructions for centralizing the steering gear when the gear is removed from the vehicle and when adjustments are made to the drag link are included under the heading "STEERING GEAR INSTALLATION."

Instructions for centralizing the steering gear when preload adjustments are checked are included under the heading "Roller Shaft Total Mesh Preload Adjustment."

STEERING SYSTEM INSPECTION CHECKS

When steering problems exist, the mechanic should first visually inspect the vehicle for road worthiness. Then, if necessary, verify the steering problem by test driving the vehicle or taking a ride with the driver. If the problem only occurs when the vehicle is loaded, the test drive should also be made with the vehicle loaded.

Once the problem is verified, check the simple causes before moving on to the more complicated possibilities. The following inspection checks should be performed in the order given whenever rapid tire wear, hard steering effort, or erratic steering indicate a problem in the steering system.

1. Check the front tires to make sure they are the same size and model. Be sure that they are both equally and adequately inflated. Underinflated tires will cause hard steering. Refer to the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual for tire inflation specifications.
2. If the steering problem only occurs when the vehicle is loaded, make sure the fifth wheel, if so equipped, is adequately lubricated. For instructions, refer to the 22 Group of the Freightliner Mainenance and Lube Manual.
3. Check the steering linkage for loose, damaged, or worn parts. The steering linkage includes the tie rod, steering arms, bushings, and other components that carry movement of the pitman arm to the steering knuckles. The wheels should turn smoothly from stop to stop. For service operations, refer to the 14 Group of this manual and to the front axle manufacturer's service manual.
4. Inspect the drag link, steering driveline, and upper steering column for worn or damaged parts. For service instructions, refer to the 14 Group of this manual.
5. Make sure the steering driveline, especially the universal joints, and portions of the steering linkage are adequately lubricated. Refer to the 14 Group of the Freightliner Maintenance and Lube Manual for instructions.
6. Check the front axle wheel alignment including wheel bearing adjustment, caster and camber angles, and toe-in, using the instructions given in the 10 Group of this manual.
7. Check the rear axle alignment. Rear axle misalignment can cause hard or erratic steering. If needed, align the rear axle(s) using the instructions given in the 11 Group of this manual.
8. Inspect the front axle suspension for worn or damaged parts using the instructions given in the 16 Group of this manual.
9. Before performing the remaining inspection checks below, apply the vehicle parking brakes and chock the rear tires. Raise the vehicle until the front tires clear the floor, then place safety stands under the frame rails. Be sure that the stands will support the weight of the vehicle.
10. With the front tires in the straight-ahead position, turn the steering wheel until motion is detected at the wheels. Align a reference mark on a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels. Measure the lash (free-play) at the steering wheel. See Fig. 7.

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

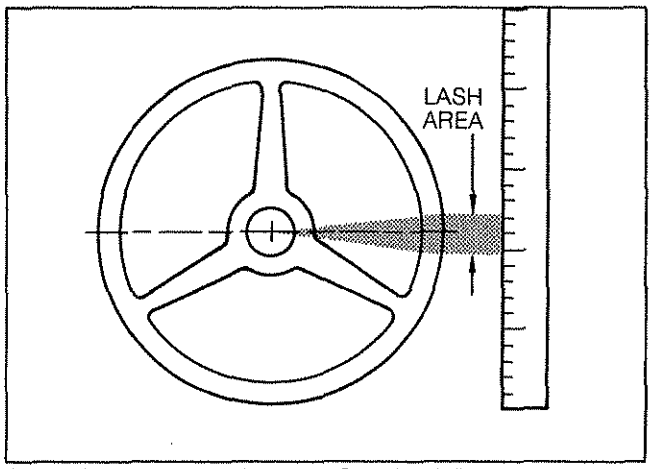


Fig. 7, Measuring Lash at the Steering Wheel

Excessive lash exists if the steering wheel movement exceeds:

2.50 inches (64 mm) for 20-inch steering wheels.

2.75 inches (70 mm) for 22-inch steering wheels.

If there is excessive lash, refer to the troubleshooting section in this subject for possible causes and corrective measures. Eliminate excessive lash.

11. Turn the steering wheel through a full right and full left turn. If the front wheels cannot be turned to the right and left axle steering stops without binding or noticeable interference, one or more of the following may be the cause:

    .1 The worm shaft bearings or the roller shaft mesh are adjusted too tightly. Check the steering gear preload using the instructions given under the headings "WORM SHAFT" and "ROLLER SHAFT."

    .2 The worm shaft or the steering gear roller bearings are worn or damaged. Replace the component(s) using the instructions given under the heading, "Worm Shaft and Bearing Removal From the Housing."

    .3 The roller shaft is worn or damaged. Replace the roller shaft using the instructions given under the heading "Roller Shaft Removal From the Housing."

12. Turn the steering wheel to the straight-ahead driving position. Secure the steering wheel in this position. Move the front tires from side to side. Play in the steering gear bearings will be felt in the drag link ball stud at the pitman arm. If any bearing play exists, adjustments should be made in the following order:

    .1 Adjust the worm shaft bearings.

    .2 Adjust the roller shaft total mesh preload.

    Check the steering gear preload using the instructions given under the headings "WORM SHAFT" and "ROLLER SHAFT."

WARNING: Do not drive the vehicle if there is excessive lash or free-play in the steering gear. Excessive lash is an indication of an improperly adjusted steering gear, or worn or otherwise damaged steering gear components. Driving the vehicle in this condition could ultimately result in a loss of steering control.

13. Remove the safety stands from under the frame rails, then lower the vehicle to the floor. Remove the chocks from the tires.

WORM SHAFT

Worm Shaft Bearing Preload Adjustment Check

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be performed. Apply the vehicle parking brakes and chock the tires.
2. Disconnect the drag link from the pitman arm. For instructions, refer to the applicable subject located in the 14 Group of this manual.
3. Disconnect the steering driveline from the steering gear worm (input) shaft. For instructions, refer to the applicable subject located in the 14 Group of this manual.

CAUTION: If heat must be applied in order to remove the end yoke from the worm shaft, use care not to damage the worm shaft seal. If the seal is damaged during end yoke removal, it must be replaced.

4. Remove the boot cover from the steering gear worm shaft. If damaged during the removal of the end yoke, discard the boot cover.
5. Turn the worm shaft to the end of travel in either direction. You will note that lash (free-play) increases as the shaft is turned away from the center.

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

Check the worm shaft bearing preload *in the lash area,* that is, away from the center of the gear. To perform this check, use an inch-pound torque wrench to rotate the worm shaft back and forth approximately one-quarter of a turn. The output shaft should not turn.

The torque required to rotate the worm shaft in the lash area should be 7 to 14 lbf·in (79 to 158 N·cm) for steering gears without a worm shaft seal installed and 9 to 16 lbf·in (102 to 181 N·cm) for gears in which a worm shaft seal has been installed.

If the worm shaft bearing preload measurement is not within specifications, adjust the preload. For instructions, refer to the heading "Worm Shaft Bearing Preload Adjustment."

If the worm bearing preload falls within specifications, check the roller shaft total mesh preload. For instructions, refer to the heading "Roller Shaft Total Mesh Preload Adjustment Check."

Worm Shaft Bearing Preload Adjustment

(Refer to Fig. 2)

1. If not already done, perform steps 1 through 5 under the heading "Worm Shaft Bearing Preload Adjustment Check."
2. Thoroughly clean the steering gear.
3. Remove the fill plug and the drain plug from the steering gear. Drain the lubricant from the unit. Discard the lubricant.
4. Remove the worm cover screws and the worm cover.
5. If worm shaft preload is loose or under the torque specification required, remove shims.

NOTE: Removal of shims will increase preload; adding shims will decrease preload. The shims may be in five sizes: 0.002, 0.003, 0.005 0.0075, and 0.010 inch. Remove only one shim at a time, but do not remove 0.0075 inch rubber covered shims. The size of the shim to be removed or added will depend on the amount of lash. Use a micrometer to identify the thickness of the shims.

6. Assemble the worm cover and shims.

NOTE: Rubber covered shims (if applicable) must be assembled with the rubber (dark) sides against the housing and the worm cover.

7. Install the worm cover screws. Obtain a light preload before final tightening of the screws.

CAUTION: Do not final torque the screws immediately. Rotate the worm shaft assembly with one hand while slowly tightening the worm cover screws with the other hand to prevent damaging the bearing surfaces if the initial amount of shims is inadequate.

8. Using the tightening sequence shown in Fig. 8, tighten the worm cover screws to a final torque of 45 to 55 lbf·ft (61 to 75 N·m).
9. Check the worm bearing preload using the instructions given under the heading "Worm Shaft Bearing Preload Adjustment Check." If necessary, repeat the adjustment using a different selection of shims.

ROLLER SHAFT

Roller Shaft Total Mesh Preload Adjustment Check

IMPORTANT: Do not check the roller shaft total mesh preload unless the worm shaft bearing preload is known to fall within the specifications given under the heading "Worm Shaft Bearing Preload Adjustment Check." Checking the roller shaft total mesh preload when the worm shaft bearing preload is out of adjustment will result in inaccurate measurements.

1. After making the correct worm shaft bearing preload adjustment, centralize the steering gear by turning the worm shaft through full travel, counting the number of turns required. Starting at the end of travel, turn back half that number of turns. This will place the roller tooth of the roller shaft in the approximate center of the worm tooth.

   Check the alignment mark on the output shaft of the steering gear. If the alignment mark is perpendicular to the worm shaft, the gear is centered. If

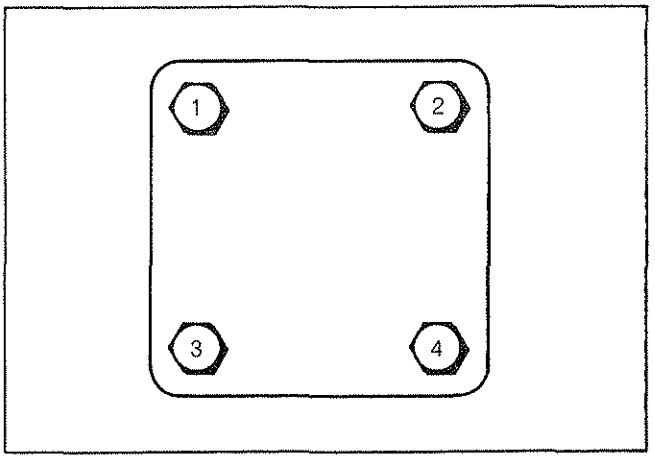


Fig. 8, Worm Cover Screws, Tightening Sequence

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

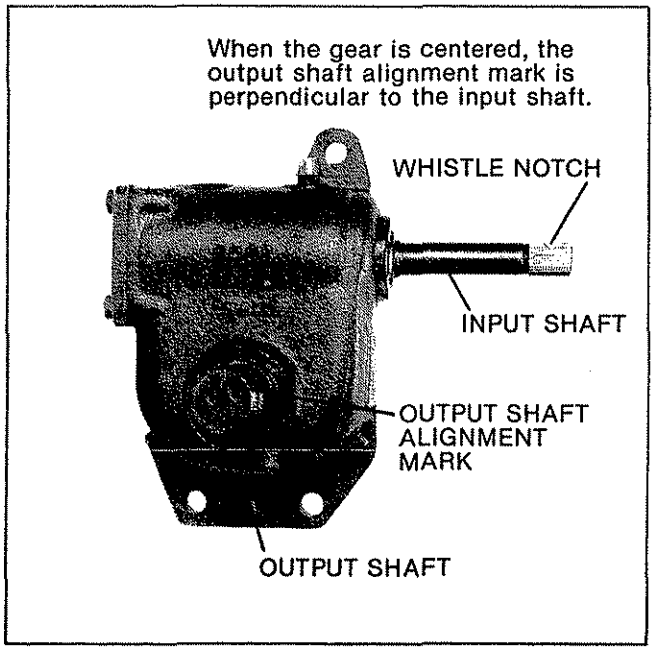


Fig. 9

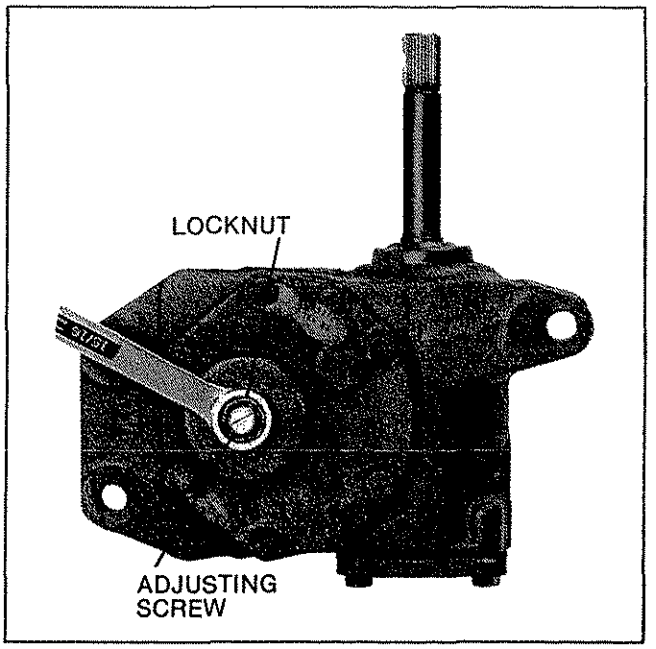


Fig. 10

not, turn the worm shaft backward or forward until the output shaft alignment mark is perpendicular to the worm shaft.

2. Rotate the worm shaft with a torque wrench approximately 180° through the center position. The correct torque is 20 to 31 lbf·in (226 to 350 N·cm) on steering gears without a worm shaft seal installed, and 23 to 34 lbf·in (260 to 384 N·cm) on steering gears with a worm shaft seal installed.

   If the roller shaft total mesh preload is within specifications, proceed to step 3.

   If the roller shaft total mesh preload measurement is not within specifications, adjust the preload. For instructions, refer to the heading "Roller Shaft Total Mesh Preload Adjustment."

3. Perform steps 6 through 11 under the heading "STEERING GEAR INSTALLATION."

Roller Shaft Total Mesh Preload Adjustment

1. Check the roller shaft total mesh preload using the instructions given under the heading "Roller Shaft Total Mesh Preload Adjustment Check."
2. If adjustment is necessary, loosen the adjusting screw locknut. See Fig. 10.

NOTE: Be sure the gear is centered before proceeding to step 3.

3. Turn the slotted adjusting screw clockwise to increase the preload—counterclockwise to decrease the preload—then check the adjustment. See Fig. 11. The correct torque is 20 to 31 lbf·in (226 to 350 N·cm) on steering gears without a worm shaft seal installed, and 23 to 34 lbf·in (260 to 384 N·cm) on steering gears with a worm shaft seal installed.
4. Repeat the procedure until the preload is within specifications.
5. Hold the adjusting screw in place with a screwdriver and tighten the adjusting screw locknut 25 to 40 lbf·ft (34 to 54 N·m).
6. Recheck the preload.
7. Perform steps 5 through 11 under the heading "STEERING GEAR INSTALLATION."

STEERING GEAR REMOVAL

1. Place the front tires in a straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be performed. Apply the vehicle parking brakes and chock the tires.

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

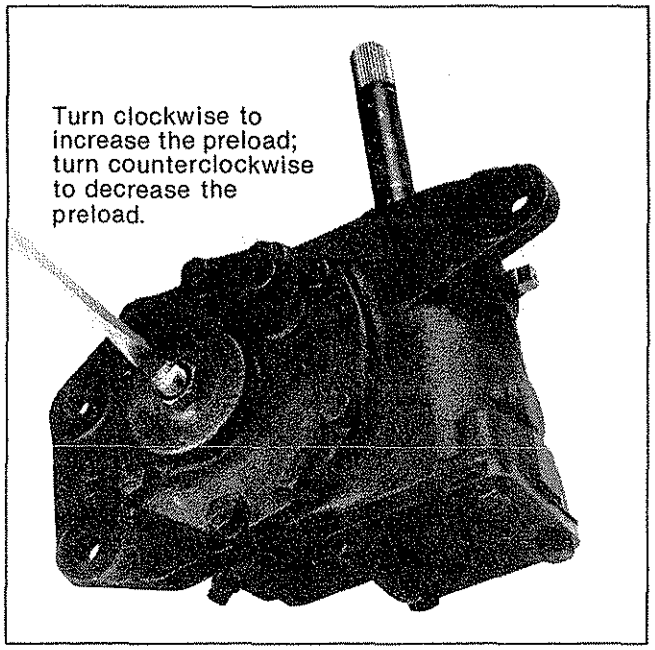


Fig. 11

2. Disconnect the drag link from the pitman arm. For instructions, refer to the applicable subject located in the 14 Group of this manual.

3. Disconnect the steering driveline from the steering gear worm (input) shaft. For instructions, refer to the applicable steering driveline subject located in the 14 Group of this manual.

CAUTION: If heat must be applied in order to remove the end yoke from the worm shaft, use care not to damage the worm shaft seal. If the seal is damaged during end yoke removal, it must be replaced.

4. Remove the boot cover from the steering gear worm shaft. If the boot cover is damaged during the removal of the end yoke, discard it.

5. Remove the pitman arm pinch bolt nut, washer and pinch bolt. Remove the pitman arm. Discard the nut.

CAUTION: Use of a hammer or torch to remove the pitman arm could result in damage to the roller shaft assembly, the housing bearings or the roller shaft seal. Use a suitable puller to remove the pitman arm.

6. Remove the steering gear mounting bolts, lockwashers, and nuts. Remove the steering gear from the vehicle.

CAUTION: The steering gear weighs approximately 80 lbs (36 kg) when dry. Use extreme care when removing, lifting or carrying the steering gear.

STEERING GEAR DISASSEMBLY

Roller Shaft Removal From the Housing

1. Clean the steering gear. Remove the filler plug from the steering gear. Remove the drain plug and drain the lubricant from the unit. Discard the lubricant. Thoroughly clean both plugs.

2. Remove the steering gear from the vehicle. For instructions, refer to the heading "STEERING GEAR REMOVAL."

3. Rotate the worm shaft to place the roller shaft on center or in the straight-ahead position. See Fig. 9.

4. Loosen the adjusting screw locknut. See Fig. 10.

5. Remove the shaft cover screws, as shown in Fig. 12.

6. Remove the roller shaft and shaft cover as one assembly. See Fig. 13. It may be necessary to tap the end of the shaft with a soft mallet to break the shaft cover loose.

7. Remove the shaft cover gasket. See Fig. 13.

8. Disconnect the roller shaft from the shaft cover. While holding the shaft cover, separate the roller

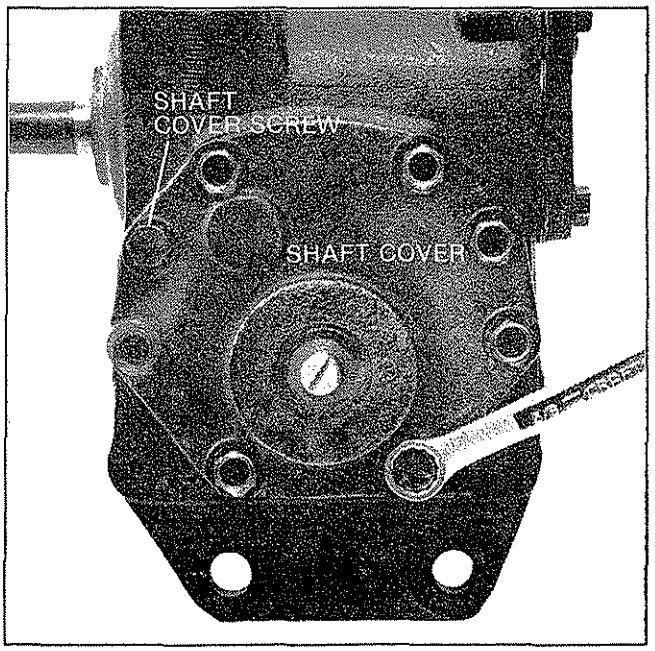


Fig. 12

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

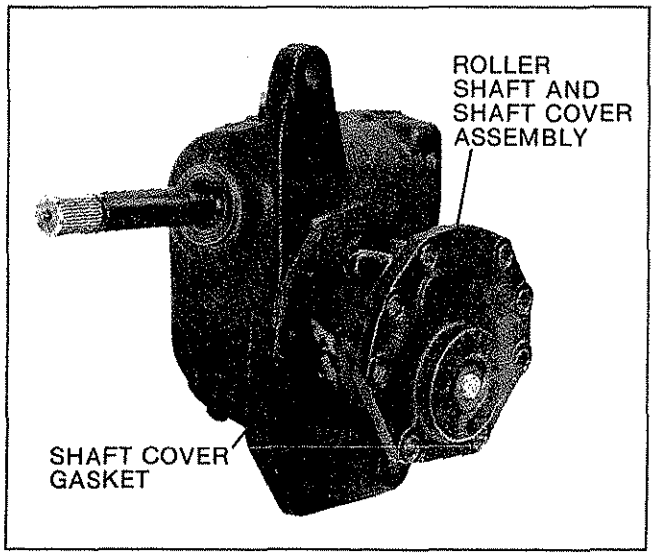


Fig. 13

shaft by removing the adjusting screw locknut and O-ring and turning the adjusting screw clockwise.

9. Remove and discard the roller shaft seal.

Worm Shaft and Bearing Removal From the Housing

1. Remove the roller shaft from the steering gear. For instructions, refer to the heading "Roller Shaft Removal From the Housing."

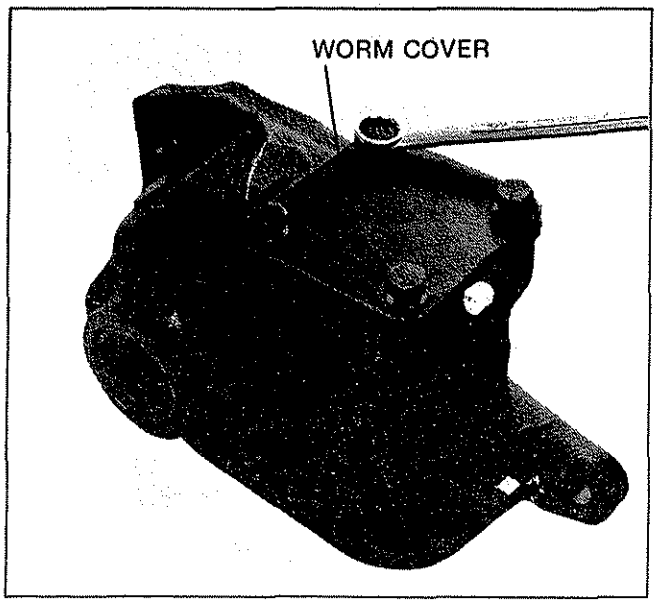


Fig. 14

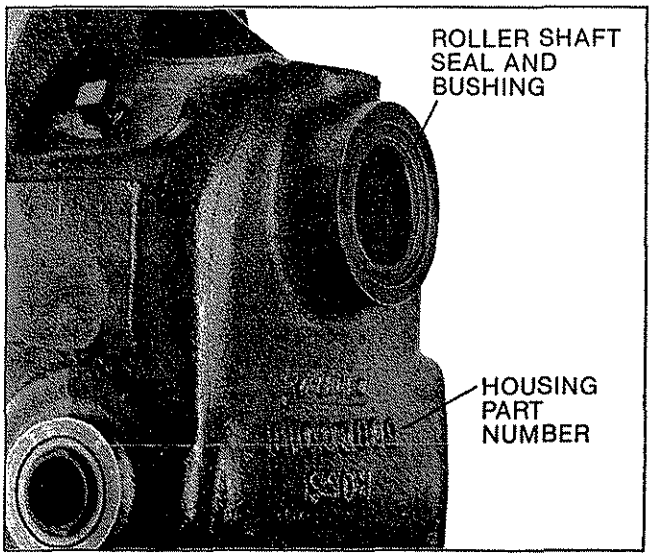


Fig. 15

2. Remove the worm cover screws, as shown in Fig. 14. Then, remove the worm cover.
3. Remove the shims.
4. Remove the bearing cup and the cage (retainer) assembly (see Fig. 16) by pressing on the end of the worm (input) shaft.

NOTE: If the bearing cup cocks during removal, do not use force; tap the bearing cup in place, and repeat the procedure.

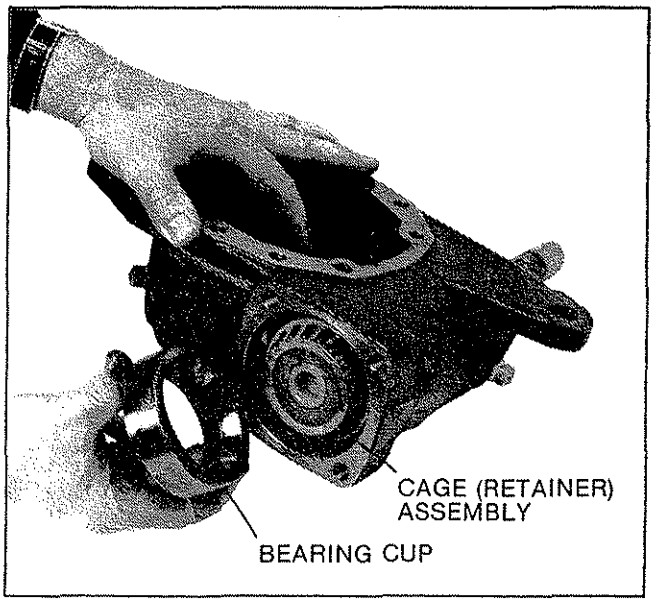


Fig. 16

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

5. Remove the worm shaft assembly.
6. Remove the bearing cage (retainer) assembly.
7. Remove and discard the worm shaft seal.

PARTS INSPECTION AND REPLACEMENT

The use of only genuine factory replacement parts, *in the proper combination* of housing, worm, and roller shaft assembly is necessary when servicing the components of steering gear assemblies to assure proper functional operation.

When the steering gear is serviced, any replacement parts must be matched by part number to the original factory-installed component. Each steering gear housing, worm shaft, and roller shaft is stamped with a part number to ensure correct identification. Replacement parts must be identically matched to these numbers since component size can differ, depending on the steering gear ratio. Refer to the Freightliner Parts Book for the proper combination of steering gear components.

NOTE: The steering gear housing part number is stamped on the outside face of the casting for identification. Refer to Fig. 15. The worm shaft part number is stamped on the end of the finished part (see Fig. 17), and the roller shaft part number is stamped on the top of the roller tooth (see Fig. 18).

NOTE: Ross Gear Division of TRW, Inc. and Freightliner Corporation will not be liable for the malfunction of any steering gear unit and/or assembly which is the result of servicing the steering gear assembly and contains either a non-genuine factory replacement part or contains the wrong combination of components improperly assembled or adjusted per specification.

1. Check the end play of the roller shaft adjusting screw (end play refers to the in-and-out movement of the adjusting screw). If the end play exceeds 0.008 inch (0.200 mm), replace with a new threaded adjusting screw retainer and a thrustwasher, and adjust 0.001 to 0.003 inch (0.030 to 0.080 mm) end play. Carefully stake (2 places) the outer flange of the threaded adjusting screw retainer, using a chisel point punch, into the slots on the end of the roller shaft.

NOTE: Excessive end play of the adjusting screw will be noticeable when making roller shaft total mesh preload adjustment because the turning torque will be uneven (left to right/right to left) when turning the gear across center or to the straight-ahead position.

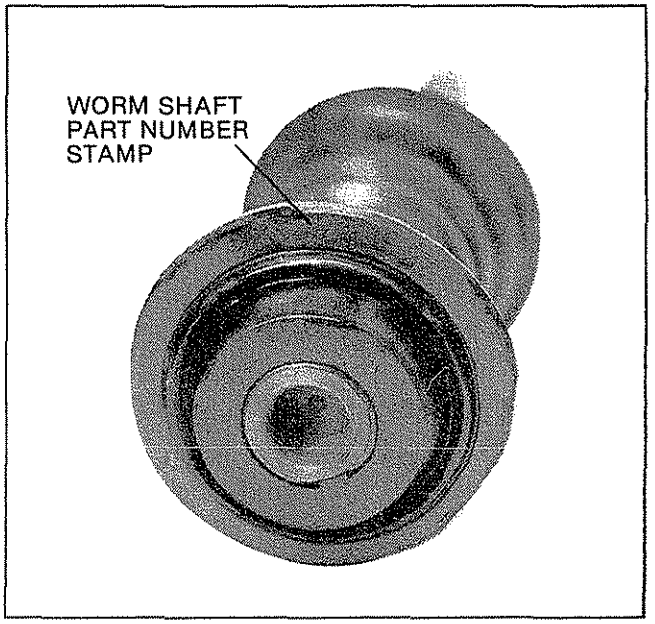


Fig. 17

WARNING: Excessive end play in the adjusting screw will make it impossible to adjust the roller shaft total mesh preload within specifications. Failure to eliminate excessive adjusting screw end play, as instructed above, could ultimately result in a loss of steering control.

2. Check the clearance between the shaft cover bushing and the outboard end of the roller shaft. If the clearance exceeds 0.010 inch (0.030 mm), replace the shaft cover bushing.

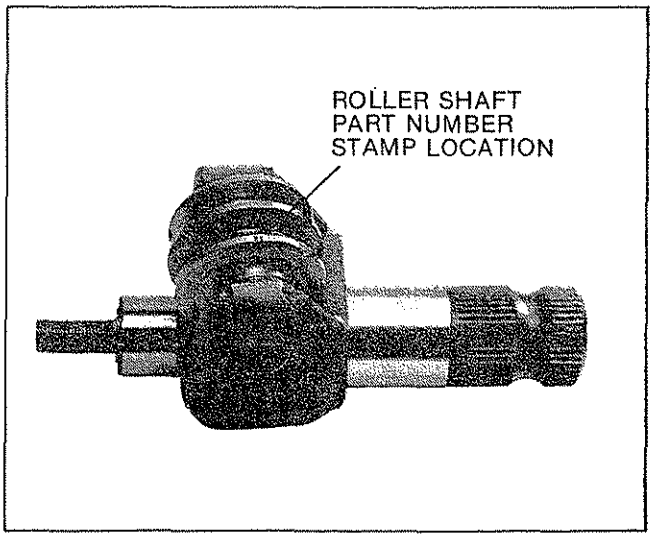


Fig. 18

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

NOTE: Use a piloted mandrel to install the new bushing so that it is flush with the outer face of the bearing boss.

NOTE: If the shaft cover contains a bronze bushing, replace with a new shaft cover and bushing assembly.

3. Insert the roller shaft in the housing, then check the clearance between the inboard end of the roller shaft and the bushing(s).

   If the roller-shaft-to-bushing(s) clearance exceeds 0.010 inch (0.030 mm), replace the bushing(s) as follows:

   .1 Press out the old bushing(s) with a piloted mandrel.

   .2 Install a new housing bushing(s) with a piloted mandrel. Press the bushing(s) into the bore from the outside (refer to Fig. 15) until the outer face of the bushing is flush with the inner face of the seal counterbore.

NOTE: The inside diameter of the new bushing should be 1.750 to 1.751 inches (44.45 to 44.48 mm).

4. Check the bearing cage (retainer) assemblies (Fig. 19) on each end of the worm shaft. Inspect the bearing cups (races), the tapered rollers, and the cages (retainers) for pitting, brinelling, and other damage. If the bearing components are not in good condition, replace them with new assemblies.

NOTE: It is recommended that the bearing components be replaced only in full assemblies. A full assembly includes the cup, the tapered rollers, and the cage.

5. Inspect the roller shaft bushing(s) (Fig. 15) and sealing surfaces for wear and pitting. Also inspect the shaft cover bushing (Fig. 20) for damage. If necessary, the bushing surfaces may be lightly polished with very fine abrasive cloth.

6. Check the roller/tooth portion of the roller shaft (Fig. 21) for freedom of movement, excessive lash, and roughness. Inspect the tooth and splines of the roller shaft for gouges or other damage. Replace the roller shaft assembly, if damaged.

NOTE: Excessive lash (sideplay) should be checked by inserting a feeler gauge between the roller tooth and the shoulder. Refer to Fig. 21. If the clearance exceeds 0.010 inch (0.030 mm), replace the roller shaft.

STEERING GEAR ASSEMBLY

All steering gear internal components must be cleaned and then coated with lubricant before assembly. SAE 90 hypoid gear oil, API Service Classification GL-5, is recommended when ambient temperatures are continuously above 30°F (-1°C); SAE 75 hypoid gear oil, API Service Classification GL-5, is recommended when ambient temperatures are continuously below 30°F (-1°C). Refer to Table 2, located under "SPECIFICATIONS," for additional lubricant information.

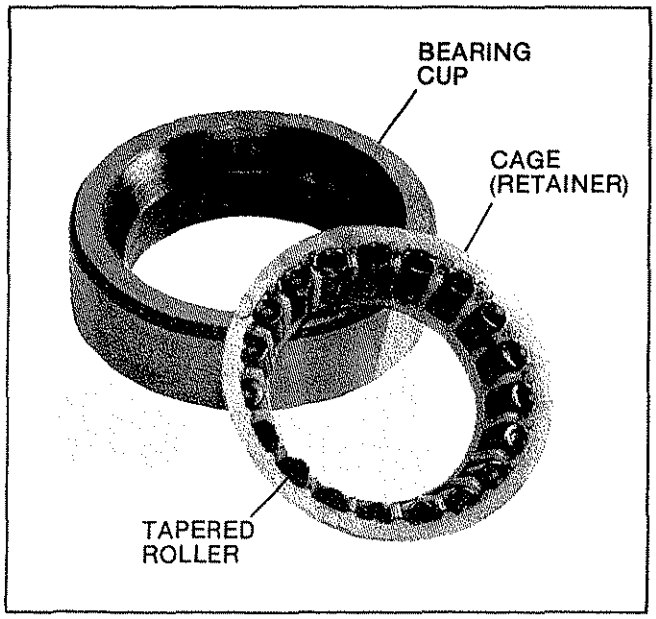


Fig. 19

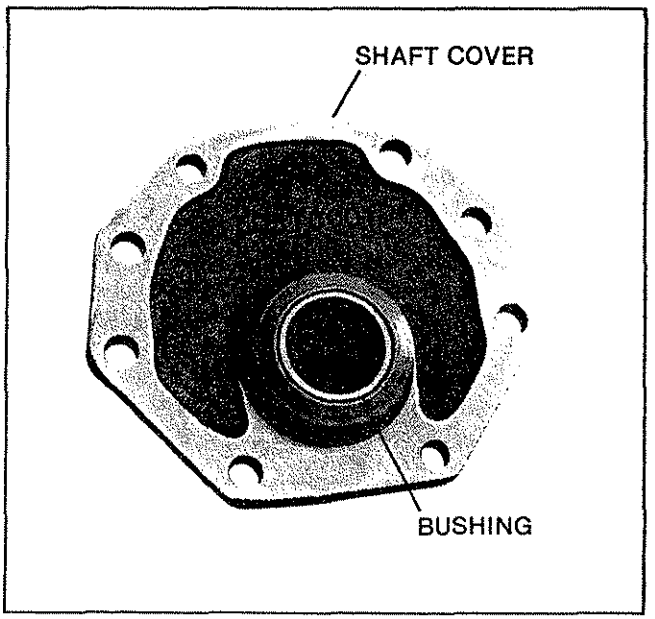


Fig. 20

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

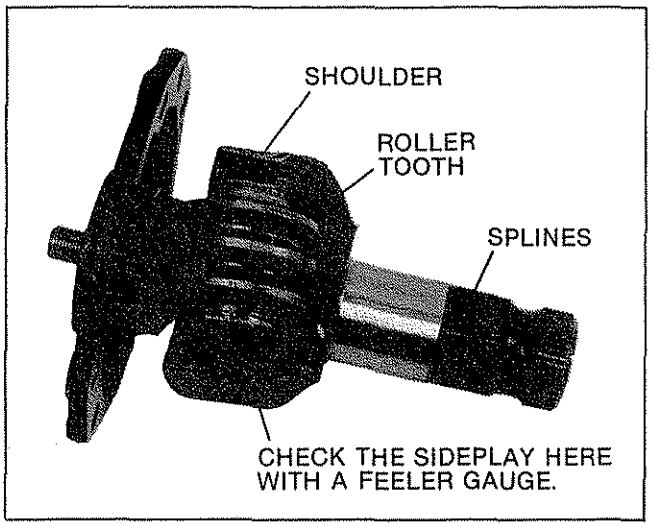


Fig. 21

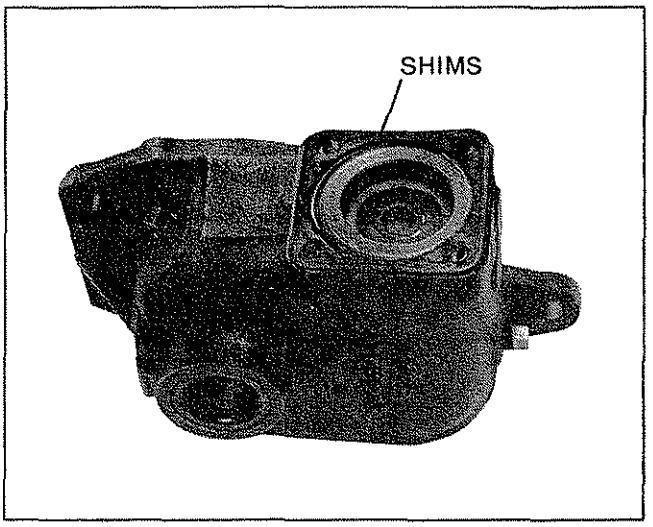


Fig. 22

Worm Shaft and Bearing Installation in the Housing

1. Assemble the bearing cage (retainer) assembly into the bearing cup.
2. Insert the worm shaft assembly in the housing. Use care not to unseat the bearing cage (retainer) assembly previously installed in the bearing cup.
3. Position the lower bearing cage assembly on the worm shaft.
4. Insert the bearing cup in the housing bore. See Fig. 16. Do not use force to seat the cup. If installed correctly, the cup will seat in the bore with minimal effort required.

NOTE: If the bearing cup cocks during installation, do not use force; tap the bearing cup out, and repeat the procedure.

5. Assemble the shims (Fig. 22) and the worm cover.

NOTE: Rubber covered shims (if applicable) must be assembled with the rubber sides against the housing and the worm cover.

6. Install the worm cover screws. See Fig. 23. Tighten the screws finger-tight.

CAUTION: Do not final torque the worm cover screws immediately. Rotate the worm shaft assembly with one hand while slowly tightening the worm cover screws with the other hand to prevent damaging the bearing surfaces if the initial amount of shims is inadequate. Once a light preload is obtained by using a torque gauge, final torque the worm cover screws 45 to 55 lbf·ft (61 to 75 N·m). Tighten the screws using the sequence shown in Fig. 23.

7. *Always recheck the worm shaft preload* after final torquing of the worm cover screws is completed. For instructions, refer to the heading "Worm Shaft Bearing Preload Adjustment Check." If necessary, repeat the adjustment using a different selection of shims.

NOTE: When checking the preload (this step only), use the torque values given for steering gears without a worm shaft seal installed.

Proceed to the heading "Roller Shaft and Cover Installation in the Housing."

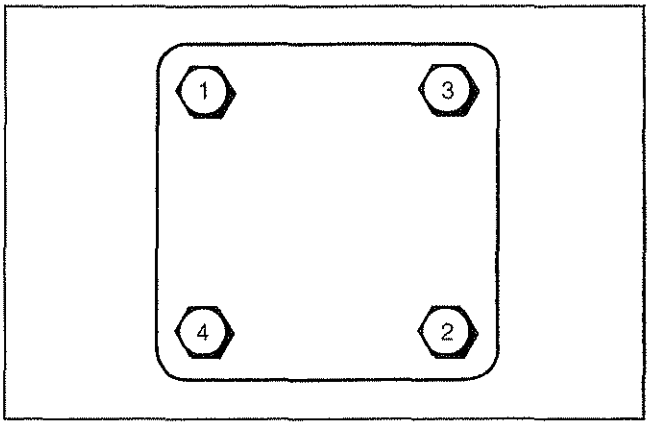


Fig. 23, Worm Cover Screws, Tightening Sequence

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

Roller Shaft and Cover Installation in the Housing

1. Insert the adjusting screw of the roller shaft into the shaft cover from the bearing side of the cover. Install the O-ring and locknut on the adjusting screw. Draw the roller shaft into the bearing until the shaft bottoms in the shaft cover. Then, reverse the adjusting screw rotation one full turn.
2. Position the shaft cover gasket (Fig. 24). Insert the roller shaft and shaft cover assembly.

NOTE: Rotate the worm shaft so that the whistle notch is located as in Fig. 25. The center tooth of the roller shaft must engage the center of the worm gear.

3. Install the shaft cover screws, tightening them finger-tight. Then, rotate the worm shaft to 1/2 turn from *each end* of travel; lash must be present in each position with no perceptible binding.

   Final torque the shaft cover screws 45 to 55 lbf·ft (61 to 75 N·m).

4. Adjust the roller shaft total mesh preload using the instructions given under the heading "Roller Shaft Total Mesh Preload Adjustment."

NOTE: When checking the preload (this step only), use the torque values given for steering gears without a worm shaft seal installed.

6. Carefully press in the new worm and roller shaft seals as follows:

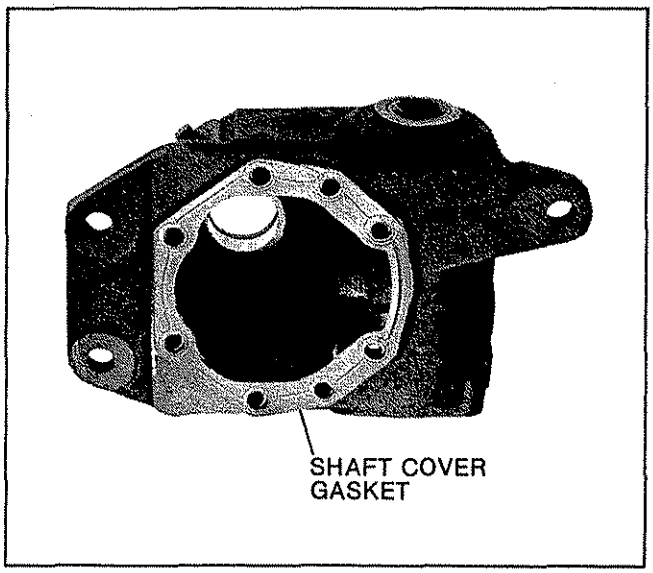
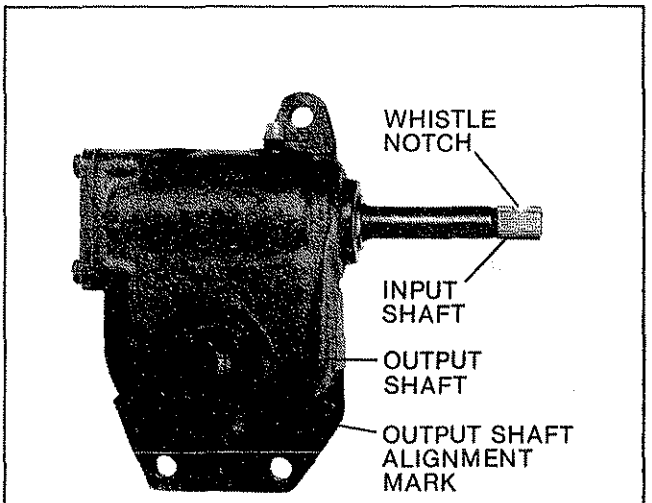


Fig. 24



When the gear is centered, the output shaft alignment mark is perpendicular to the input shaft.

Fig. 25

   .1 Place the lubricated seal in the counterbore with the longest lip facing into the gear.

   .2 Using a mandrel large enough to contact all portions of the seal case (metal retainer), press in the lubricated seal until it bottoms in the counterbore.

7. Install the drain plug in the housing. Tighten the plug 12 to 16 lbf·ft (16 to 22 N·m). Do not fill the housing with lubricant at this time. Lubricant should be added to the steering gear after the unit is installed on the vehicle. See the heading "STEERING GEAR INSTALLATION."

STEERING GEAR INSTALLATION

1. Centralize the steering gear by turning the worm shaft through full travel, counting the number of turns required. Then, starting at the end of travel, turn back half that number of turns.

   Check the alignment mark on the output shaft of the steering gear. If the alignment mark is perpendicular to the worm shaft, the gear is centered. If not, adjust the worm shaft backward or forward until the output shaft alignment mark is perpendicular to the worm shaft. See Fig. 25. Be sure the steering gear remains centralized as remaining operations are performed.

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

2. Place the steering gear on the mounting bracket(s). Install the mounting capscrews, bolts, lockwashers and nuts. Tighten the fasteners to the specifications given in Table 1.

NOTE: The mounting bolts must be periodically checked for tightness. Refer to the 14 Group of the Freightliner Maintenance and Lube Manual for recommended intervals.

3. Install the pitman arm on the steering gear. Be sure the timing marks are aligned.

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. To wedge the slot open, clamp the pitman arm in a vise, with the slot at the top; then, using a ball peen hammer, drive a chisel into the slot. Hold the chisel in place, remove the pitman arm from the vise, and install the pitman arm on the sector shaft. Remove the chisel from the slot.

WARNING: Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise, the chisel may fly loose, which could cause an injury.

4. Install the pitman arm pinch bolt, washer, and a new nut. Tighten the nut 130 lbf·ft (176 N·m).
5. Fill the steering gear with lubricant using the following procedure:
   .1 If not already done, remove the filler plug (and pressure relief fitting) from the steering gear housing. Thoroughly clean the plug.
   .2 Add lubricant until it is within 1/2-inch (12.5 mm) of the filler hole. Refer to Table 2, located under "SPECIFICATIONS," for lubricant recommendations.
   .3 Install the filler plug (and pressure relief fitting) in the steering gear housing, and tighten the plug 12 to 15 lbf·ft (16 to 20 N·m).
6. Position the steering wheel so that the king-spoke—the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside—points directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees). Refer to Fig. 26.
7. Connect the steering driveline to the steering gear worm (input) shaft. Do not decentralize the steering gear.

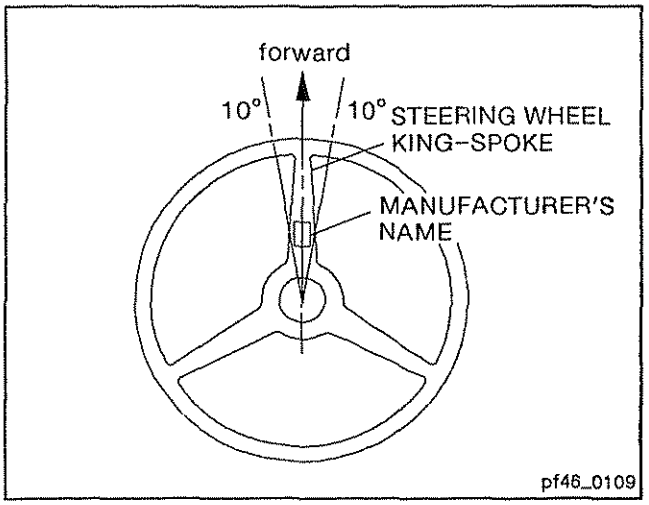


Fig. 26

   For instructions, refer to the applicable steering driveline subject located in the 14 Group of this manual.
8. Install the drag link. Refer to the instructions in the 14 Group of this manual.
9. After the steering driveline has been connected to the steering gear worm shaft, check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10 degrees. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject located in the 14 Group of this manual.

WARNING: Do not turn the worm (input) shaft of the steering gear in order to correct the position of the king-spoke on the steering wheel. To do so will decentralilze the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering.

10. Remove the chocks from the tires.
11. Confirm that adjustments made to the steering system are correct by test driving the vehicle or taking a ride with the driver.

    If, during straight-ahead driving on level road, the steering wheel king-spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees), *it is an indication that the steering gear is not centered*. The probable cause was the failure to ensure that the vehicle's front tires were in the straight-ahead position during repairs to the steering gear.

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

Adjustments should be made as follows:

.1 Note the approximate number of degrees the steering wheel king-spoke points away from the forward position during straight-ahead driving.

.2 Using the instructions given in the 14 Group of this manual, lengthen or shorten the drag link. Each turn of the drag link will indirectly result in partial turning of the steering wheel. All adjustments must result in a centralized steering gear (and correctly positioned steering wheel king-spoke) when the vehicle's front tires are in the straight-ahead position.

.3 Again, test drive the vehicle or take a ride with the driver. Observe that the steering wheel king-spoke points directly toward the front of the vehicle during straight-ahead driving on level road. Repeat the adjustments at the drag link, if needed.

TROUBLESHOOTING

The following troubleshooting information should be used to diagnose steering system problems. For additional troubleshooting information, refer to the front axle wheel alignment subject located in the 10 Group of this manual.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Excessive Lash or Free Play at the Steering Wheel	Steering wheel is loose on the upper steering column.	Inspect the parts for damage caused by the looseness. Replace damaged components. If no damage exists, secure the steering wheel using the instructions given in the 14 Group of this manual.
	Steering gear mounting bolt nuts are loose.	Tighten the nuts to the torque values given under the "SPECIFICATIONS" section of this manual.
	Pitman arm is loose on the roller (output) shaft.	Inspect the pitman arm and the roller (output) shaft splines for damage caused by the looseness. Replace damaged components. If no damage exists, tighten the pitman arm retaining nut to the values given in this subject.
	Steering driveline universal joints are worn.	Replace worn universal joints following the instructions given in the 14 Group of this manual.
	Steering knuckle bushings are worn.	Replace the bushings using the instructions given in the front axle manufacturer's service manual.
	Wheel bearings are worn or require adjustment.	Inspect and adjust the wheel bearings using the instructions given in the 10 Group of this manual. Replace the bearings, if necessary.
	Steering gear parts are worn or the steering gear requires preload adjustments.	Replace worn parts if preload adjustments cannot be made.
	Worn or damaged drag link or tie rod ends.	Repair or replace parts as needed. For instructions, refer to the 14 Group of this manual and to the front axle manufacturer's service manual.

(Continued on next page)

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
No Recovery When Leaving a Turn	Low tire pressure.	Inflate the tires to the specifications given in the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual.
	Binding in the steering driveline universal joints.	Check the universal joints for damage and inadequate lubrication. Correct the condition(s) as instructed in the 14 Groups of this manual and the Freightliner Maintenance and Lube Manual.
	If the vehicle is loaded, an inadequately lubricated fifth wheel.	Lubricate the fifth wheel as instructed in the 22 Group of the Freightliner Maintenance and Lube Manual or the fifth wheel manufacturer's service manual.
	Binding at the steering knuckle kingpins.	Inspect the kingpins and bushings for wear or damage. If needed, replace the components using the instructions given in the front axle manufacturer's service manual. Lubricate the kingpins as instructed in the 10 Group of the Freightliner Maintenance and Lube Manual.
	Steering linkage binding or lack of lubrication.	Replace components, adjust, or lubricate, as required. For instructions, refer to the 14 Group of this manual and to the 10 and 14 Groups of the Freightliner Maintenance and Lube Manual.
	Incorrect front axle alignment.	Align the axle as instructed in the 10 Group of this manual.
	Steering gear parts are worn or steering gear requires preload adjustments.	Replace worn parts if preload adjustments cannot be made.

MANUAL STEERING GEAR, ROSS MODEL 503 AA172, 1984 ADVANCEMENTS

SPECIFICATIONS

DESCRIPTION		BOLT OR NUT SIZE	TORQUE lbf·ft (N·m)
Steering Gear to Mounting Bracket	Capscrew (Tapped Hole)	5/8–11	160 (215) (Special)
	Flanged Type Hexhead Bolt and Nut	5/8–11	190 (260)
Steering Gear Mounting Bracket to Frame Rail	Hexhead Bolt and Nut With Hardened Washer*	5/8–11	125 (170)
		7/8–9	310 (420)
		7/8–14	350 (475)
	Hexhead Bolt (Tapped Hole)*	7/8–14	350 (475)
	Flanged Type Hexhead Bolt and Nut	5/8–11	190 (260)
Worm Cover Screws		7/16–14	45–55 (61–75)
Shaft Cover Screws		7/16–14	45–55 (61–75)
Adjusting Screw Locknut		5/8–18	25–40 (34–54)†
Pitman Arm Pinch Bolt Nut		5/8–18	130 (176)

Table 1, Steering Gear Torque Values

* Torque values are for nuts that are wax coated and cadmium plated, or for hexbolts that have phosphate- and oil-coated threads. Both are used with hardened washers. For dry threads, refer to the Bolt Torque Specification Chart in the *COE & 120 Conventional Maintenance Manual.*

† Tighten while holding screw.

Temperature Continuously Above +30°F (–1°C)	Hypoid Gear Oil SAE 90 API Service Classification GL-5
Temperature Continuously Below +30°F (–1°C)	Hypoid Gear Oil SAE 75 API Service Classification GL-5

Table 2, Steering Gear Lubricants

WARNING: If the vehicle is operated at temperatures below +30°F (–1°C) with SAE 90 weight oil in the steering gear, the steering can gradually become sluggish and resistant to the point where the driver may have difficulty performing an evasive maneuver. WHEN OPERATING IN TEMPERATURES CONTINUOUSLY BELOW +30°F (–1°C), INSTALL SAE 75 WEIGHT OIL.

DESCRIPTION		SPECIFICATION	
		lbf·in (N·cm)	inch (mm)
Worm Shaft Preload Adjustment Check at 70°F (21°C)	Without Worm Shaft Seal Installed	7–14 (80–160)	—
	With Worm Shaft Seal Installed	9–16 (100–180)	—
Roller Shaft Total Mesh Preload Adjustment Check at 70°F (21°C)	Without Worm Shaft Seal Installed	20–31 (220–340)	—
	With Worm Shaft Seal Installed	23–34 (260–380)	—
Shaft-Cover-Bushing-to-Roller-Shaft Maximum Clearance		—	0.010 (0.254)
Roller-Shaft-to-Housing-Bushing(s) Maximum Clearance		—	0.010 (0.254)
Housing Bushing(s) Inside Diameter		—	1.750–1.751 (44.45–44.48)
Roller Shaft Adjusting Screw Maximum End Play		—	0.008 (0.203)
Roller Shaft Tooth/Shoulder Maximum Lash		—	0.010 (0.254)

Table 3, Steering Gear, Ross Model 503, Specifications

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503
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ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

GENERAL DESCRIPTION

The steering gear converts the rotary motion of the steering wheel into the straight-line motion needed to turn the front wheels. The Ross model 503 worm and roller type manual steering gear (Fig. 1) is standard on Freightliner vehicles. Some earlier Freightliner vehicles are equipped with the Ross model 7J worm and roller type manual steering gear.

The "worm and roller" descriptions refer to the gears inside the steering gear housing: the worm (or input) shaft and the roller (or output) shaft. Refer o Fig. 2. The ratio of the 503 model is 32.5:1. he ratio of the 7J model is either 32.5:1 or ∠8.4:1.

Steering gear model numbers are stamped on an I.D. tag which is attached to the shaft cover. Refer to Fig. 3. Steering gear ratios are stamped on the inside of the housing. The 32.5:1 ratio is stamped "33" in the housing (see Fig. 4), and the 28:1 ratio is stamped "28."

The worm shaft is secured in the housing by a pair of bearing cage (retainer) assemblies. The worm shaft meshes with a roller tooth which is mounted on the roller shaft shoulder.

The steering gear is designed with integral stops in the housing to limit the travel of the roller shaft and thereby prevent mesh runout of the roller tooth with the worm shaft. These stops are not intended to absorb road shock or act as wheel stops. The vehicle axle stops are designed with a safety factor of several degrees at each end of gear travel (i.e., the travel of the roller shaft) to prevent gear contact with the integral stops in the housing.

Most steering action is performed with the front tires in the straight-ahead position. Thus, in the steering gear, maximum wear occurs at the center portion of the worm shaft tooth. To compensate for wear, backlash is provided in the off-center portions of the tooth.

Backlash is the amount of clearance or free play between meshing teeth in two gears that will allow

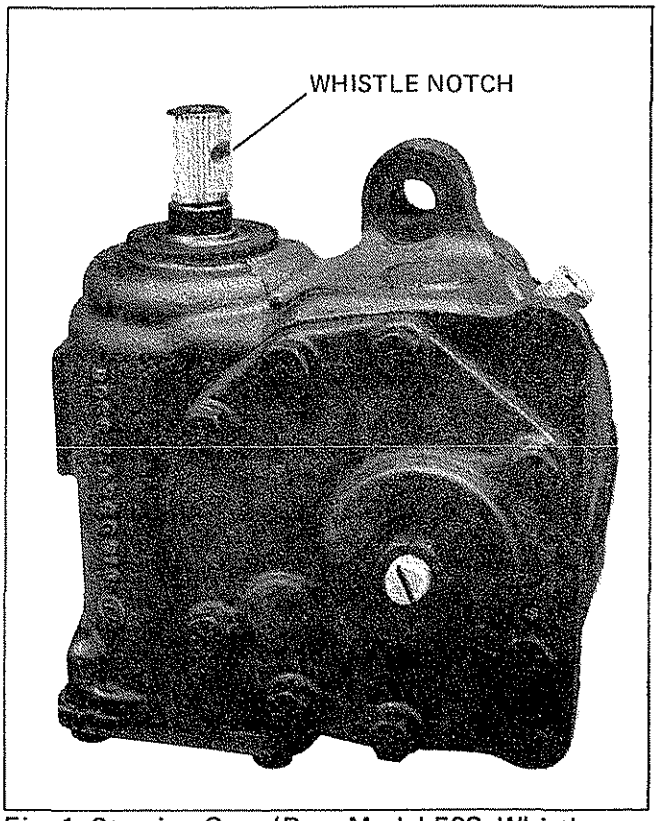


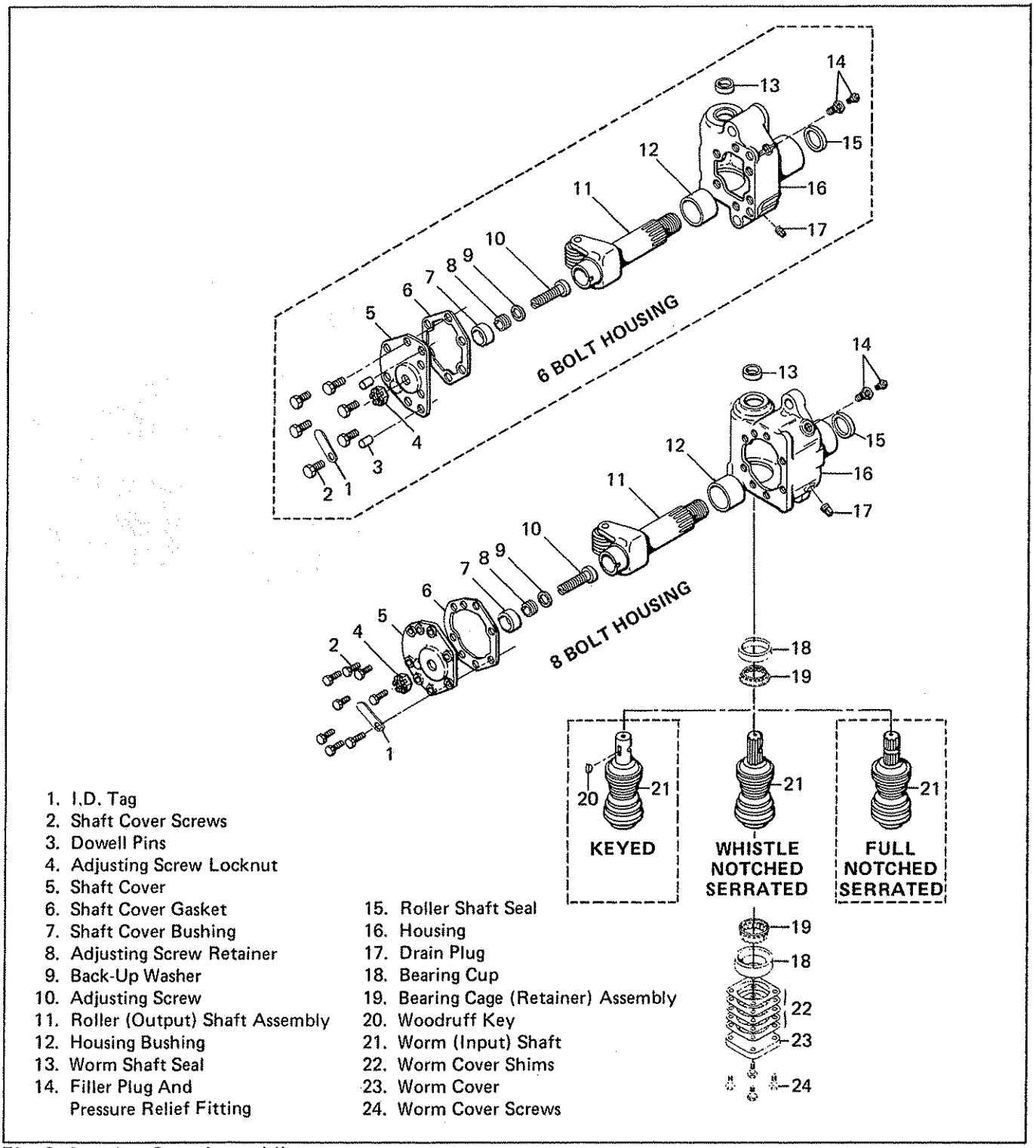
Fig. 1, Steering Gear (Ross Model 503, Whistle Notched Serrated Type)

rotation of the driven gear (in this case, the roller portion of the roller shaft) in a direction opposite to the driving rotation of a second gear (the worm shaft).

In the Ross model 503 or 7J manual steering gear, backlash occurs approximately one-half turn each way from the center portion of the worm shaft and gradually increases to develop the largest amount of backlash at the end of gear travel. This permits adjustment for lost motion in the center position without causing a bind in the off-center travel of the roller shaft.

In the steering gear, elimination of looseness, caused by wear in the center portion of the worm shaft tooth, is accomplished by means of preload adjustments. Preload adjustments are provided for on the worm shaft roller bearings and also the roller shaft mesh.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503



1. I.D. Tag
2. Shaft Cover Screws
3. Dowell Pins
4. Adjusting Screw Locknut
5. Shaft Cover
6. Shaft Cover Gasket
7. Shaft Cover Bushing
8. Adjusting Screw Retainer
9. Back-Up Washer
10. Adjusting Screw
11. Roller (Output) Shaft Assembly
12. Housing Bushing
13. Worm Shaft Seal
14. Filler Plug And Pressure Relief Fitting
15. Roller Shaft Seal
16. Housing
17. Drain Plug
18. Bearing Cup
19. Bearing Cage (Retainer) Assembly
20. Woodruff Key
21. Worm (Input) Shaft
22. Worm Cover Shims
23. Worm Cover
24. Worm Cover Screws

Fig. 2, Steering Gear Assemblies

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

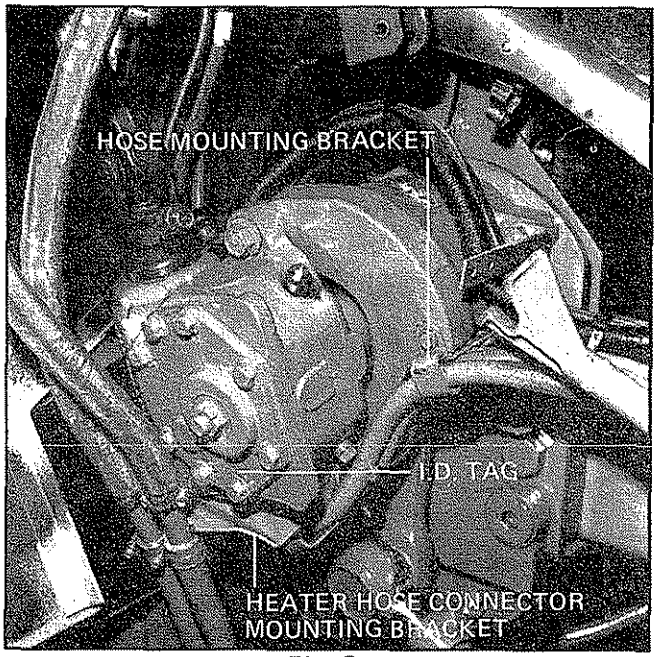


Fig. 3

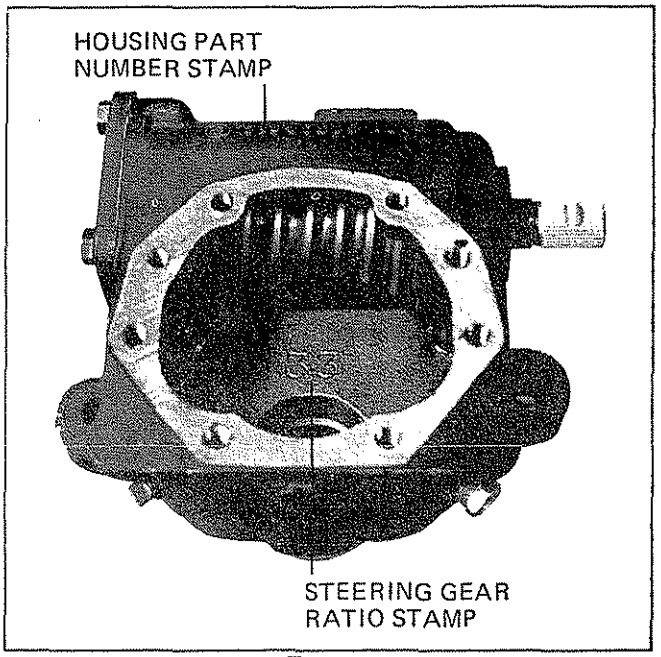


Fig. 4

PRINCIPLES OF OPERATION

When the steering wheel is turned, the force is transmitted to the worm shaft through the steering driveline. The worm shaft tooth, meshed with the roller shaft tooth inside the steering gear housing, causes the roller shaft to turn in the same direction as the worm shaft, but the total output travel is greatly reduced.

Connected to the end of the roller shaft outside the steering gear housing is the pitman arm. The pitman arm converts the rotary motion of the roller shaft to lateral motion. The lateral motion is transmitted through the drag link assembly, the steering arms, and to the steering knuckles, which pivot on the axle center (beam) and cause the wheels to turn.

SERVICE OPERATIONS

WARNING: All steering mechanisms are life and limb items. As such, it is imperative that the instructions in this subject are followed to the letter. Failure to observe the procedures set out in this subject may result in loss of steering.

Figures 5 through 8 illustrate the standard steering installations found on Freightliner vehicle models. Fig. 5 applies to COE vehicles equipped with 21 through 61 series cabs. Fig. 6 applies to COE vehicles equipped with 71 series cabs. Fig. 7 depicts steering installations found on Powerliner vehicles, and Fig. 8 depicts steering installations found on vehicles equipped with Conventional cabs.

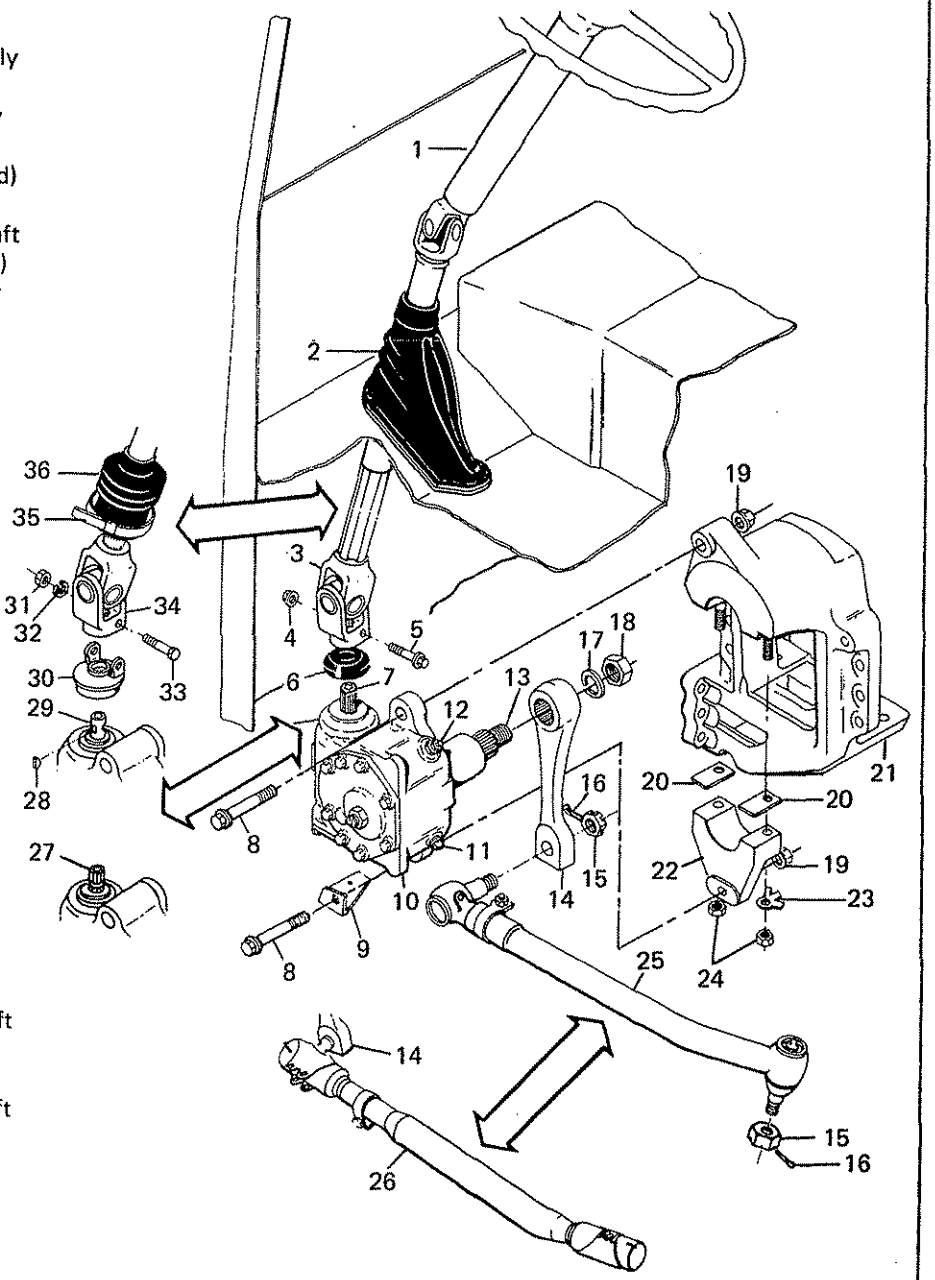
Refer only to the applicable installation when instructed to do so in the service operations that follow.

STEERING SYSTEM INSPECTION CHECKS

When steering problems exist, the mechanic should first visually inspect the vehicle for road worthiness. Then, if necessary, verify the steering problem by test driving the vehicle or taking a ride with the driver. If the problem only occurs when the vehicle is loaded, the test drive should also be made with the vehicle loaded.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

1. Upper Steering Column Assembly
2. Driveline Upper Boot Seal
3. Driveline Lower Yoke Assembly
4. Flanged Nut
5. Lower Yoke Pinch Bolt (Flanged)
6. Boot Cover
7. Steering Gear Worm (Input) Shaft (Whistle Notched Serrated Type)
8. Upper And Lower Steering Gear Mounting Bolts (Flanged)
9. Air Line Bracket
10. Steering Gear Assembly
11. Drain Plug
12. Filler Plug And Pressure Relief Fitting
13. Steering Gear Roller (Output) Shaft
14. Pitman Arm
15. Drag Link Ball Stud Nut
16. Cotter Pin
17. Pitman Arm Lockwasher
18. Pitman Arm Retaining Nut
19. Mounting Bolt Nuts (Flanged)
20. Steering Gear Mounting Cap Shims
21. Steering Gear Mounting Bracket
22. Steering Gear Mounting Cap
23. Locktab Washer
24. Steering Gear Clamp Nuts
25. Vertical-Socket Type Drag Link Assembly
26. Horizontal-Socket Type Drag Link Assembly
27. Steering Gear Worm (Input) Shaft (Full Notched Serrated Type)
28. Woodruff Key
29. Steering Gear Worm (Input) Shaft (Keyed Type)
30. Lower Boot Seal Bracket
31. Nut
32. Lockwasher
33. Lower Yoke Pinch Bolt
34. Driveline Lower Yoke Assembly
35. Lower Boot Seal Tie-Down Strap
36. Driveline Lower Boot Seal

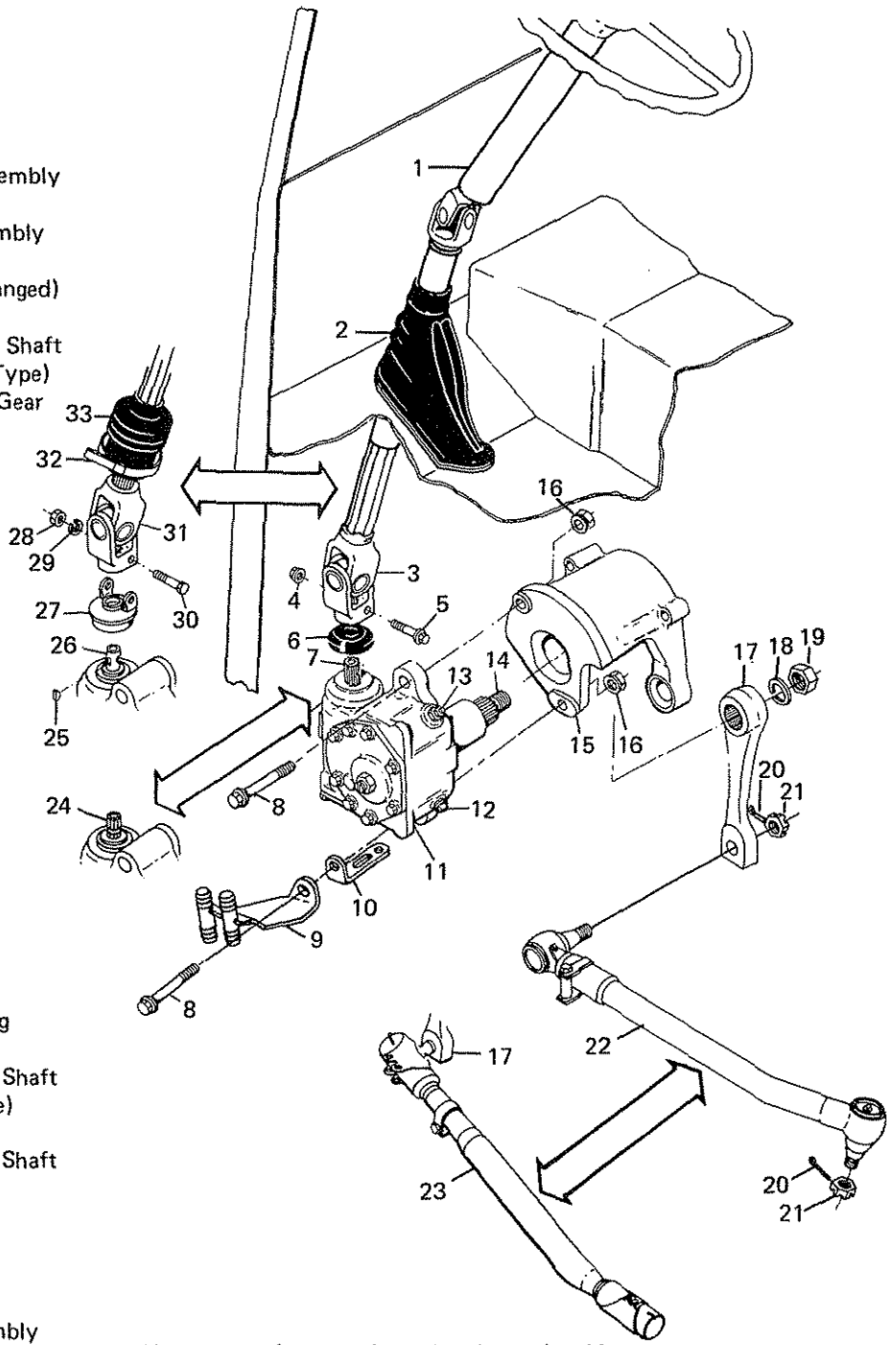


Note: Some fasteners intentionally omitted in order to provide clarity to the illustration.

Fig. 5, Steering Gear Installation, Cab Series 21 Through 61

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

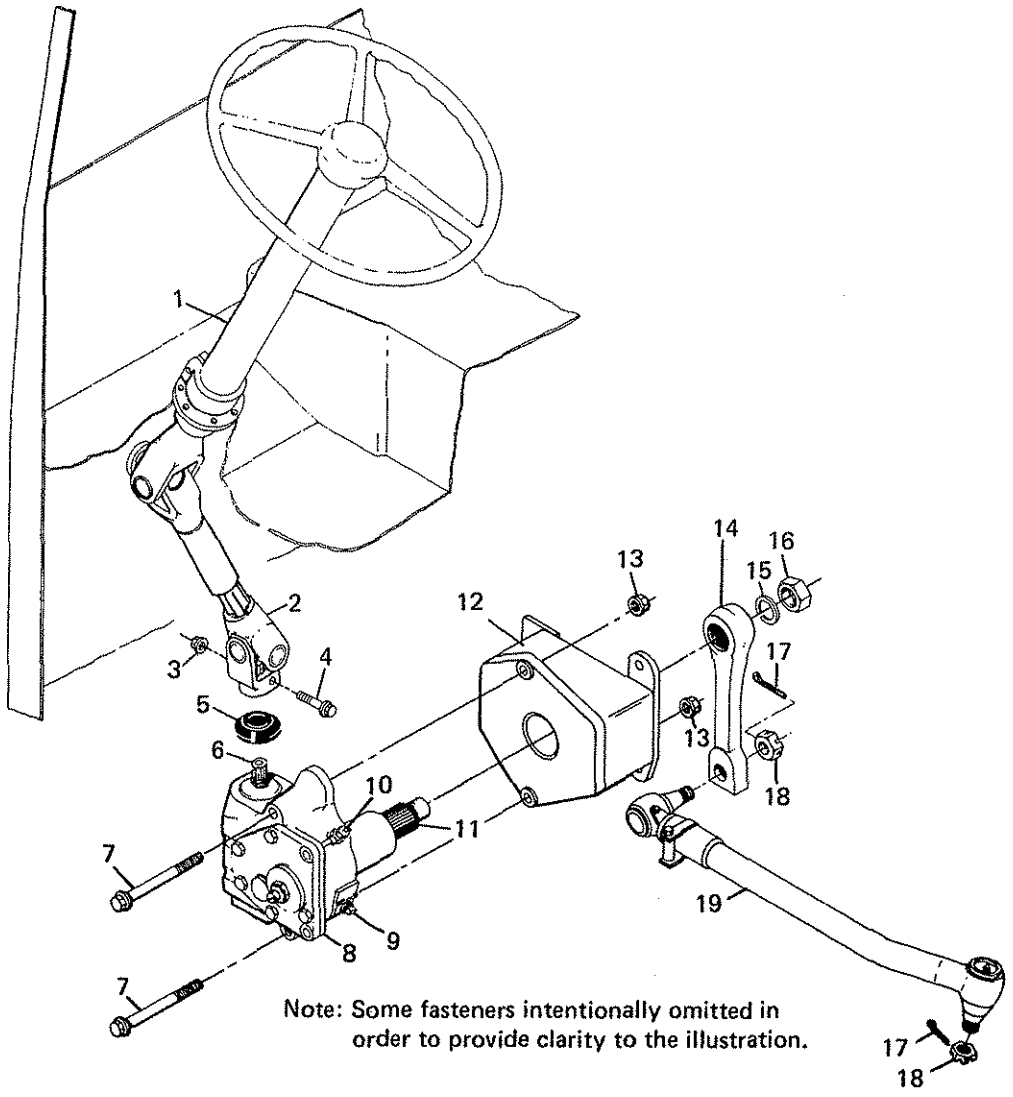
1. Upper Steering Column Assembly
2. Driveline Upper Boot Seal
3. Driveline Lower Yoke Assembly
4. Flanged Nut
5. Lower Yoke Pinch Bolt (Flanged)
6. Boot Cover
7. Steering Gear Worm (Input) Shaft (Whistle Notched Serrated Type)
8. Upper And Lower Steering Gear Mounting Bolts (Flanged)
9. Heater Hose Connector Mounting Bracket
10. Hose Clamp Bracket
11. Steering Gear Assembly
12. Drain Plug
13. Filler Plug And Pressure Relief Fitting
14. Steering Gear Roller (Output) Shaft
15. Steering Gear Mounting Bracket
16. Mounting Bolt Nuts (Flanged)
17. Pitman Arm
18. Pitman Arm Lockwasher
19. Pitman Arm Retaining Nut
20. Cotter Pin
21. Drag Link Ball Stud Nut
22. Vertical-Socket Type Drag Link Assembly
23. Horizontal-Socket Type Drag Link Assembly
24. Steering Gear Worm (Input) Shaft (Full Notched Serrated Type)
25. Woodruff Key
26. Steering Gear Worm (Input) Shaft (Keyed Type)
27. Lower Boot Seal Bracket
28. Nut
29. Lockwasher
30. Lower Yoke Pinch Bolt
31. Driveline Lower Yoke Assembly
32. Lower Boot Seal Tie-Down Strap
33. Driveline Lower Boot Seal



Note: Some fasteners intentionally omitted in order to provide clarity to the illustration.

Fig. 6, Steering Gear Installation, Cab Series 71

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

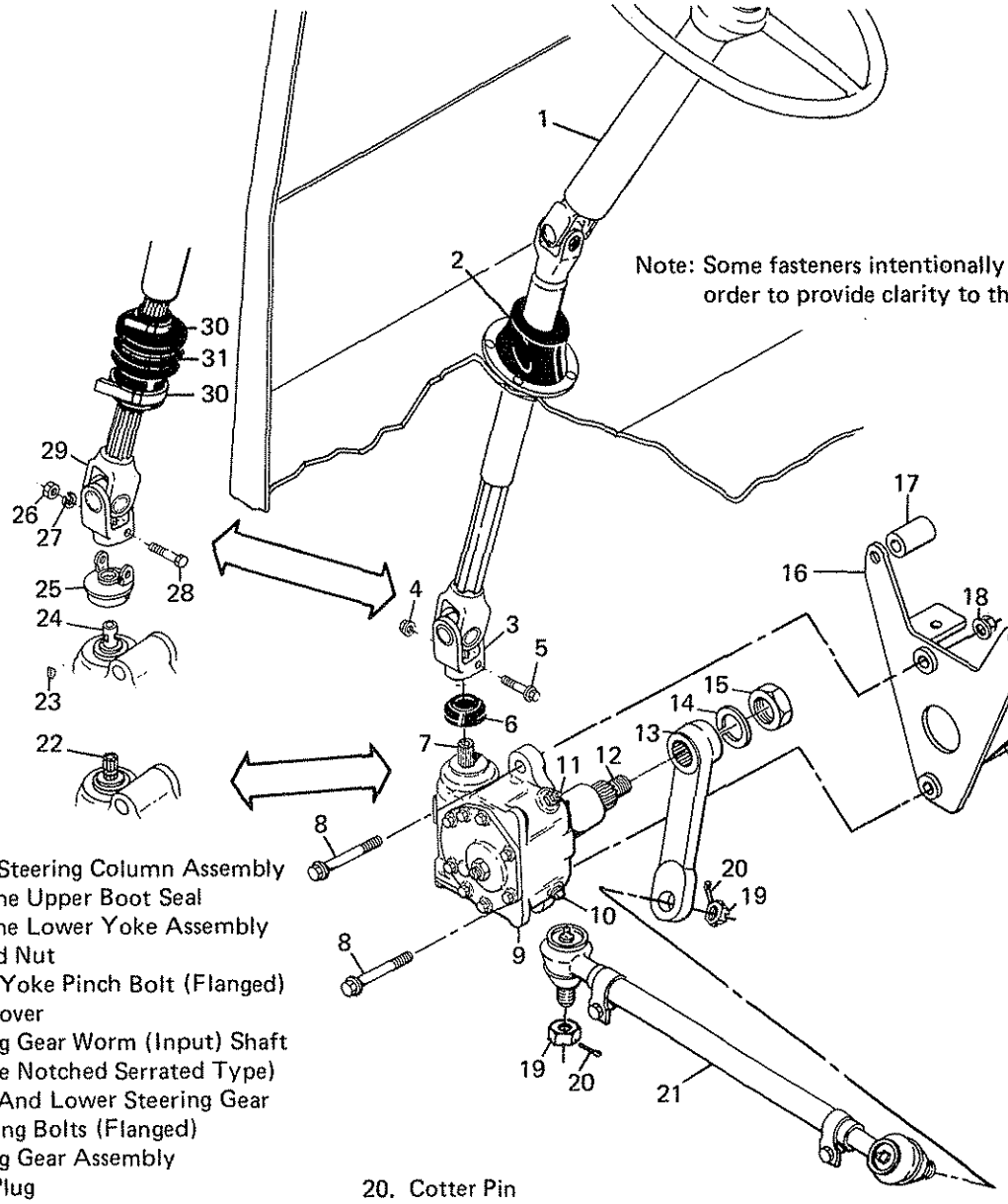


Note: Some fasteners intentionally omitted in order to provide clarity to the illustration.

1. Upper Steering Column Assembly
2. Driveline Lower Yoke Assembly
3. Flanged Nut
4. Lower Yoke Pinch Bolt (Flanged)
5. Boot Cover
6. Steering Gear Worm (Input) Shaft (Full Notched Serrated Type)
7. Upper And Lower Steering Gear Mounting Bolts (Flanged)
8. Steering Gear Assembly
9. Drain Plug
10. Filler Plug And Pressure Relief Fitting
11. Steering Gear Roller (Output) Shaft
12. Steering Gear Mounting Bracket
13. Mounting Bolt Nuts (Flanged)
14. Pitman Arm
15. Pitman Arm Lockwasher
16. Pitman Arm Retaining Nut
17. Cotter Pin
18. Drag Link Ball Stud Nut
19. Vertical-Socket Type Drag Link Assembly

Fig. 7, Steering Gear Installation, Powerliner

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503



1. Upper Steering Column Assembly
2. Driveline Upper Boot Seal
3. Driveline Lower Yoke Assembly
4. Flanged Nut
5. Lower Yoke Pinch Bolt (Flanged)
6. Boot Cover
7. Steering Gear Worm (Input) Shaft (Whistle Notched Serrated Type)
8. Upper And Lower Steering Gear Mounting Bolts (Flanged)
9. Steering Gear Assembly
10. Drain Plug
11. Filler Plug And Pressure Relief Fitting
12. Steering Gear Roller (Output) Shaft
13. Pitman Arm
14. Pitman Arm Lockwasher
15. Pitman Arm Retaining Nut
16. Steering Gear Mounting Bracket
17. Bracket Spacers
18. Mounting Bolt Nuts (Flanged)
19. Drag Link Ball Stud Nut
20. Cotter Pin
21. Vertical-Socket Type Drag Link Assembly
22. Steering Gear Worm (Input) Shaft (Full Notched Serrated Type)
23. Woodruff Key
24. Steering Gear Worm (Input) Shaft (Keyed Type)
25. Lower Boot Seal Bracket
26. Nut
27. Lockwasher
28. Lower Yoke Pinch Bolt
29. Driveline Lower Yoke Assembly
30. Lower Boot Seal Tie-Down Straps
31. Driveline Lower Boot Seal

Fig. 8, Steering Gear Installation, Conventional

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

Once the problem(s) is verified, check the simple causes before moving on to the more complicated possibilities. The following inspection checks should be performed in the order given whenever rapid tire wear, hard steering effort, or erratic steering indicate a problem in the steering system.

1. Check the front tires to make sure they are the same size and model; insure that they are both equally and adequately inflated. Underinflated tires will cause hard steering. Refer to the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual for tire inflation specifications.

2. If the steering problem only occurs when the vehicle is loaded, make sure the fifth wheel, if so equipped, is adequately lubricated. For instructions, refer to the 22 Group of the Freightliner Maintenance and Lube Manual.

3. Check the steering linkage for loose, damaged, or worn parts. The steering linkage includes the tie rod, steering arms, bushings, and other components that carry movement of the pitman arm to the steering knuckles. The wheels should turn smoothly from stop to stop. For service operations, refer to the 14 Group of this manual and to the front axle manufacturer's service manual.

4. Inspect the drag link, steering driveline, and upper steering column for worn or damaged parts. For service instructions, refer to the 14 Group of this manual.

5. Make sure the steering driveline, especially the universal joints, and portions of the steering linkage are adequately lubricated. Refer to the 14 Group of the Freightliner Maintenance and Lube Manual for instructions.

6. Check the front axle wheel alignment including wheel bearing adjustment, caster and camber angles, and toe-in, using the instructions given in the 10 Group of this manual.

7. Check the rear axle alignment. Rear axle misalignment can cause hard or erratic steering. If needed, align the rear axle(s) using the instructions given in the 11 Group of this manual.

8. Inspect the front axle suspension for worn or damaged parts using the instructions given in the 16 Group of this manual.

9. For vehicles equipped with power assist steering systems, perform the operation checks given in the 14 Group of this manual. Repair or replace components as necessary.

10. Before performing the remaining inspection checks below, activate the vehicle parking brakes, then chock block the rear tires. Raise the vehicle until the front tires clear the floor, then place safety stands under the frame rails.

11. With the front tires in the straight-ahead position, turn the steering wheel until motion is detected at the wheels. Align a reference mark on a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels. Measure the lash (free play) at the steering wheel. See Fig. 9.

    Excessive lash exists if the steering wheel movement exceeds:

    2.50 inches (64 mm) for 20-inch steering wheels.

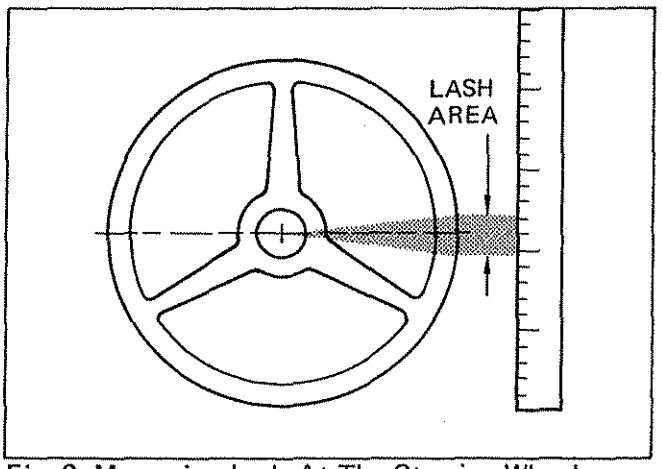


Fig. 9, Measuring Lash At The Steering Wheel

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

2.75 inches (70 mm) for 22-inch steering wheels.

If there is excessive lash, proceed to step 14. Then, refer to the troubleshooting section in this subject for possible causes and corrective measures. Eliminate the excessive lash as necessary.

12. Turn the steering wheel through a full right and full left turn. If the front wheels cannot be turned to the right and left axle steering stops without binding or noticeable interference, one or more of the following may be the cause:

    .1 The worm shaft bearings or the roller shaft mesh are adjusted too tightly. Proceed to step 14. Then, check the steering gear preload using the instructions given under the heading, "STEERING GEAR PRELOAD ADJUSTMENT CHECKS," in this subject.

    .2 The worm shaft or the steering gear roller bearings are worn or damaged. Proceed to step 14. Then, replace the component(s) using the instructions given under the heading, "WORM SHAFT AND BEARING REMOVAL FROM THE HOUSING," in this subject.

    .3 The roller shaft is worn or damaged. Proceed to step 14. Then, replace the roller shaft using the instructions given under the heading, "ROLLER SHAFT REMOVAL FROM THE HOUSING," in this subject.

13. Turn the steering wheel to the straight-ahead driving position. Secure the steering wheel in this position. Shake the front tires from side to side. This will enable any play in the steering gear bearings to be felt at the pitman arm ball. If any bearing play exists, adjustments should be made in the following order:

    .1 Adjust the worm shaft bearings.

    .2 Adjust the roller shaft total mesh preload.

    First, proceed to step 14. Then, check the steering gear preload using the instructions given under the heading, "STEERING GEAR PRELOAD ADJUSTMENT CHECKS," in this subject.

WARNING: Do not drive the vehicle if there is excessive lash or free play in the steering gear. Excessive lash is an indication of an improperly adjusted steering gear, or worn or otherwise damaged steering gear components. Driving the vehicle in this condition could ultimately result in a loss of steering control.

14. Remove the safety stands from under the frame rails, then lower the vehicle to the floor. Remove the chock blocks from the tires.

STEERING GEAR PRELOAD ADJUSTMENT CHECKS

Worm Bearing Preload Adjustment Check

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be performed. Then, activate the vehicle parking brakes and chock block the tires.

2. Disconnect the drag link from the pitman arm. For instructions, refer to the applicable subject located in the 14 Group of this manual.

3. Disconnect the steering driveline from the steering gear worm (input) shaft. For instructions, refer to the applicable subject located in the 14 Group of this manual.

CAUTION: If heat must be applied in order to remove the end yoke from the worm shaft, use care not to damage the worm shaft seal. If the seal is damaged during end yoke removal, it must be replaced.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

4. Remove the boot cover from the steering gear worm shaft. If damaged during the removal of the end yoke, discard the boot cover.

5. If so equipped, slide the lower boot seal bracket up off the steering gear worm shaft, then remove the woodruff key.

6. Turn the worm shaft to the end of travel in either direction. If the vehicle is equipped with a power assist steering system and pitman arm stop, turn the worm shaft so that the pitman arm moves away from the stop. Note the lash (free play) condition between the roller shaft and the worm shaft. *IN THE LASH AREA,* check the worm bearing preload by rotating back and forth (oscillating) the worm shaft approximately one-quarter of a turn.

   The torque required to oscillate the worm shaft in the lash area should be 7-14 in-lbs (.79-1.58 N·m) on steering gears without a worm shaft seal installed, and 9-16 in-lbs (1.01-1.81 N·m) on steering gears with a worm shaft seal installed.

IMPORTANT: *For steering gears that are equipped with aluminum housings,* the preload values above apply only when the steering gear lubricant is stabilized at 70°F (21°C). At other lubricant temperatures, refer to Table 1, located under "SPECIFICATIONS," to calculate worm bearing preload values.

If the worm bearing preload measurement is not within specifications, adjust the preload. For instructions, refer to the heading, "WORM BEARING PRELOAD ADJUSTMENT."

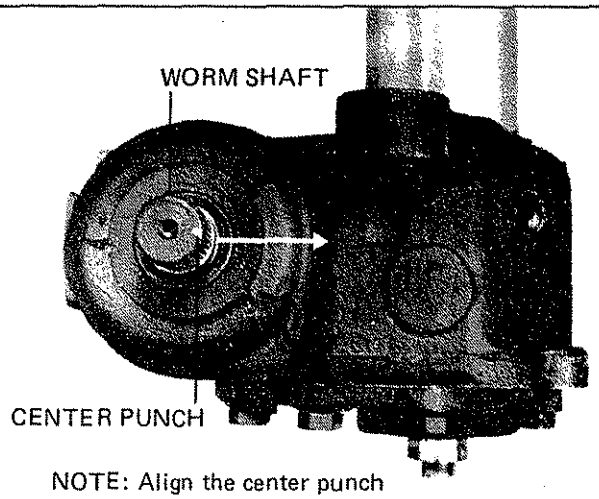
If the worm bearing preload falls within specifications, check the roller shaft total mesh preload. For instructions, refer to the heading, "ROLLER SHAFT TOTAL MESH PRELOAD ADJUSTMENT CHECK."

Roller Shaft Total Mesh Preload Adjustment Check

IMPORTANT: Do not check the roller shaft total mesh preload unless the worm bearing preload is known to fall within the specifications given under the heading, "WORM BEARING PRELOAD ADJUSTMENT CHECK." Checking the roller shaft total mesh preload when the worm bearing preload is out of adjustment will result in inaccurate measurements.

1. After making the correct worm bearing preload adjustment, centralize the steering gear by turning the worm shaft through full travel, counting the number of turns required. Starting at the end of travel, turn back half that number of turns. This will place the roller tooth of the roller shaft in the approximate center of the worm tooth. Continue moving the worm shaft in either direction (but do not exceed a half turn) until the center punch mark on the shaft is pointing directly to the rear of the steering gear. See Fig. 10.

IMPORTANT: For vehicles equipped with power assist steering systems, the mechanic must insure that the pitman arm stop (if so equipped) is not the limiting factor when turning the worm shaft through full travel. If the steering gear mounting bracket is equipped with a pitman arm stop, remove the stop before centralizing the steering gear.



NOTE: Align the center punch AFTER the steering gear has been approximately centralized.

Fig. 10, Steering Gear, Overhead View

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

2. Rotate the worm shaft, with a torque gauge, approximately 180° through the center position. The correct torque is 20-31 in-lbs (2.3-3.5 N·m) on steering gears without a worm shaft seal installed, and 23-34 in-lbs (2.6-3.8 N·m) on steering gears with a worm shaft seal installed.

IMPORTANT: *For steering gears that are equipped with aluminum housings,* the preload values above apply only when the steering gear lubricant is stabilized at 70°F (21°C). At other lubricant temperatures, refer to Table 1, located under "SPECIFICATIONS," to calculate roller shaft total mesh preload values.

If the roller shaft total mesh preload is within specifications, proceed to step 3.

If the roller shaft total mesh preload measurement is not within specifications, adjust the preload. For instructions, refer to the heading, "ROLLER SHAFT TOTAL MESH PRELOAD ADJUSTMENT."

3. Perform steps 7 through 13 under the heading, "STEERING GEAR INSTALLATION," in this subject.

STEERING GEAR PRELOAD ADJUSTMENTS

Worm Bearing Preload Adjustment
(Refer to Fig. 2)

1. If not already done, perform steps 1 through 5 under the heading, "WORM BEARING PRELOAD ADJUSTMENT CHECK," in this subject.

2. Remove the filler plug from the steering gear. Then, remove the drain plug and drain the lubricant from the unit. Discard the lubricant.

3. Remove the worm cover screws. Then, remove the worm cover.

NOTE: On some COE vehicles, a heater hose connector mounting bracket (refer to Figs. 3 and 6) may be located directly under the cover, preventing removal of the screws. Access to the worm cover screws is possible by first loosening or removing the lower steering gear mounting bolt, then moving the bracket and hose assembly out of the way.

4. Remove the shims.

NOTE: The shims may be in five sizes: .002, .003, .005, .0075, and .010 inch. Remove only one shim at a time, but do not remove .0075 inch rubber covered shims. The size of the shim to be removed will depend on the amount of lash. Use a micrometer to identify the thickness of the shims.

5. Assemble the worm cover and shims.

NOTE: Rubber covered shims (if applicable) must be assembled with the rubber (dark) sides against the housing and the worm cover.

6. Install the worm cover screws. Obtain a light preload before final tightening of the screws.

CAUTION: Do not final torque the screws immediately. Rotate the worm shaft assembly with one hand while slowly tightening the worm cover screws with the other hand to prevent damaging the bearing surfaces if the initial amount of shims is inadequate.

7. Using the tightening sequence shown in Fig. 11, tighten the worm cover screws to a final torque of 45-55 ft-lbs (61-75 N·m).

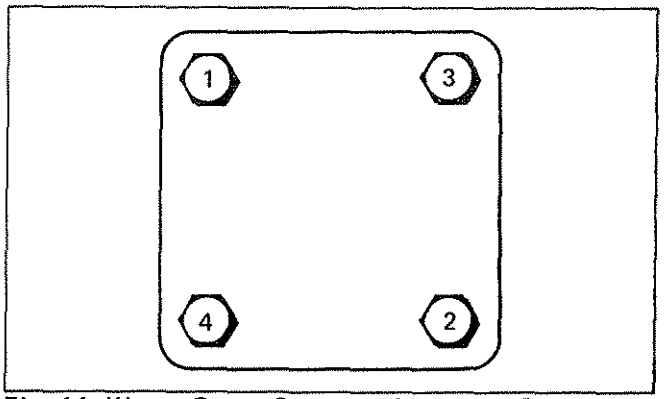


Fig. 11, Worm Cover Screws, Tightening Sequence

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

8. Check the worm bearing preload using the instructions given under the heading, "WORM BEARING PRELOAD ADJUSTMENT CHECK," in this subject. If necessary, repeat the adjustment using a different selection of shims.

NOTE: If a heater hose connector mounting bracket is located under the worm cover, move the bracket and hose assembly in place, then (install and) tighten the steering gear mounting bolt to the applicable torque value given in Table 2, located under "SPECIFICATIONS."

The mounting bolts must be periodically checked for tightness. Refer to the 14 Group of the Freightliner Maintenance and Lube Manual for recommendations.

Proceed to the heading, "ROLLER SHAFT TOTAL MESH PRELOAD ADJUSTMENT."

Roller Shaft Total Mesh Preload Adjustment

1. Check the roller shaft total mesh preload using the instructions given under the heading, "ROLLER SHAFT TOTAL MESH PRELOAD ADJUSTMENT CHECK."

2. Loosen the adjusting screw locknut. See Fig. 12.

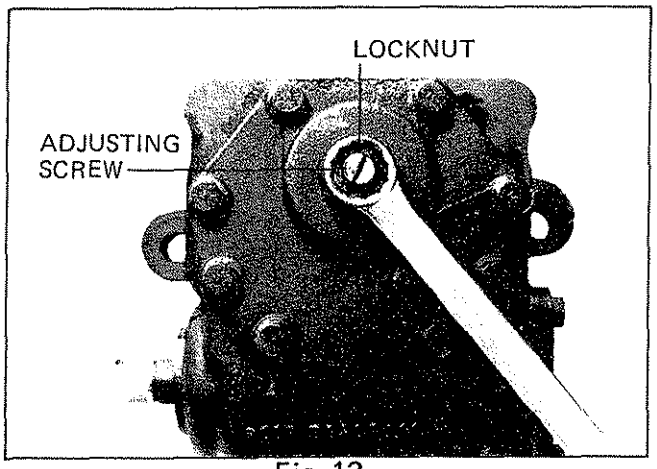


Fig. 12

3. Turn the slotted adjusting screw clockwise to increase the preload—counterclockwise to decrease the preload—then check the adjustment. See Fig. 13. The correct torque is 20-31 in-lbs (2.3-3.5 N·m) on steering gears without a worm shaft seal installed, and 23-34 in-lbs (2.6-3.8 N·m) on steering gears with a worm shaft seal installed.

IMPORTANT: *For steering gears that are equipped with aluminum housings,* the preload values above apply only when the film of lubricant inside the steering gear is stabilized at 70°F (21°C). At other lubricant temperatures, refer to Table 1, located under "SPECIFICATIONS," for roller shaft total mesh preload values.

4. Repeat the procedure until the preload is within specifications.

5. Holding the adjusting screw in place with a screwdriver, tighten the adjusting screw locknut to 25-40 ft-lbs (34-54 N·m).

6. Recheck the preload.

7. Perform steps 6 through 13 under the heading, "STEERING GEAR INSTALLATION," in this subject.

STEERING GEAR REMOVAL

IMPORTANT: The service operations under this heading require the use of a special puller tool (Fig. 14) in order to disengage the pitman arm from the roller shaft of the steering gear. This tool, which can be purchased from Freightliner, consists of part numbers 45-00009 (the puller body) and 45-00010 (the hex bolt).

CAUTION: Other methods of removing the pitman arm from the roller shaft, such as using a hammer or torch, are not recommended. Alternate methods could result in damage to the roller shaft assembly, the housing bearings, and the roller shaft seal.

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

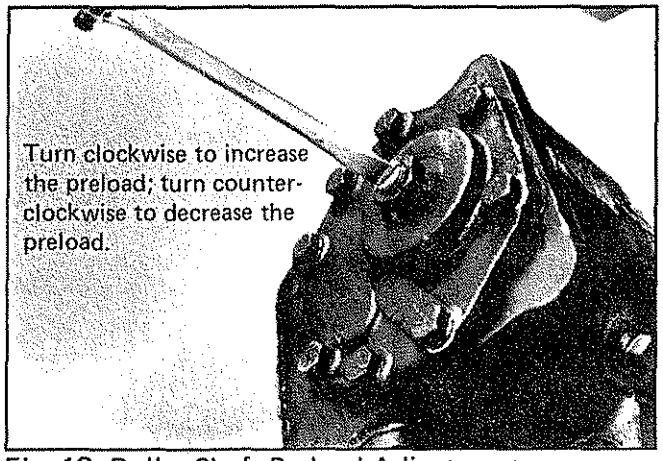


Fig. 13, Roller Shaft Preload Adjustment

straight line for a short distance, stopping at the spot where service operations will be performed. Then, activate the vehicle parking brakes, and chock block the tires.

2. Disconnect the drag link from the pitman arm. For instructions, refer to the applicable subject located in the 14 Group of this manual.

3. Disconnect the steering driveline from the steering gear worm (input) shaft. For instructions, refer to the applicable steering driveline subject located in the 14 Group of this manual.

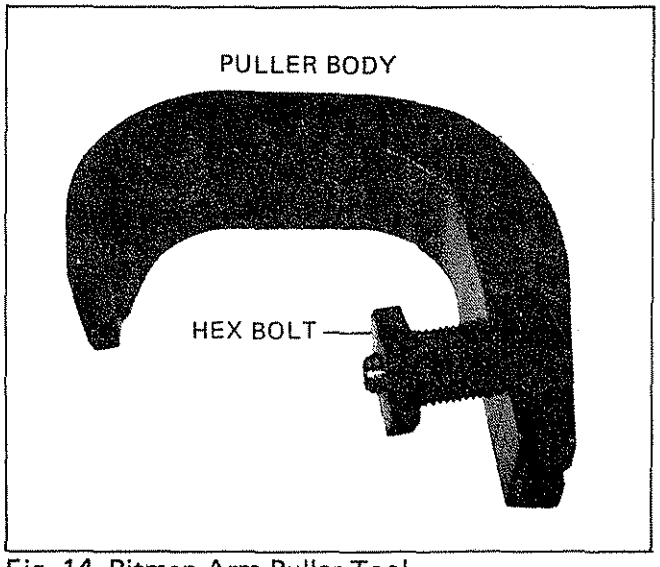


Fig. 14, Pitman Arm Puller Tool

CAUTION: If heat must be applied in order to remove the end yoke from the worm shaft, use care not to damage the worm shaft seal. If the seal is damaged during end yoke removal, it must be replaced.

4. Remove the boot cover from the steering gear worm shaft. If the boot cover is damaged during the removal of the end yoke, discard it.

5. If so equipped, slide the lower boot seal bracket up off the steering gear worm shaft, then remove the woodruff key.

6. For COE vehicles equipped with 21 through 61 series cabs, proceed as follows (refer to Fig. 5):

   .1 Remove the lower steering gear mounting bolt, lockwashers (if used), and nut.

   .2 Remove the two mounting cap clamp nuts and the locktab washers, then remove the mounting cap and, if used, the shims. Note the position of the shims for later assembly reference.

   .3 Remove the upper steering gear mounting bolt, lockwashers (if used), and nut. Remove the steering gear from the vehicle.

   .4 Remove the pitman arm retaining nut and lockwasher from the roller shaft. Then, using a marking pen or paint, reference the position of the pitman arm on the roller shaft. See Fig. 15.

   .5 Install the pitman arm puller tool on the roller shaft and the pitman arm, as shown in Fig. 16. (Prior to installation, bottom the hex bolt in the puller body.) The hex bolt centering boss fits into the roller shaft end, and the small end of the puller body fits behind the pitman arm.

   .6 As shown in Fig. 17, turn the hex bolt of the puller tool counterclockwise. As the hex bolt is turned, tap the free end of the

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

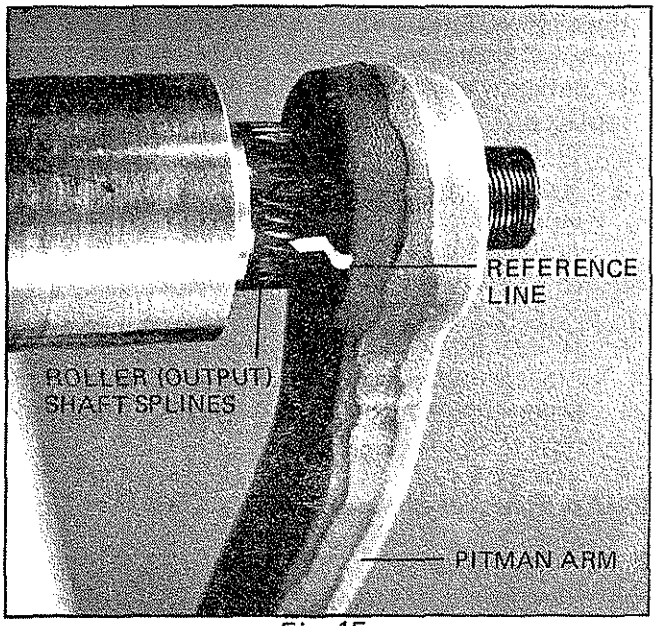


Fig. 15

pitman arm to aid removal from the roller shaft splines. When the hex bolt of the puller tool is completely unscrewed, remove the puller tool, then lightly tap, if necessary, the pitman arm off the roller shaft.

7. For COE vehicles equipped with 71 series cabs, and for Powerliner vehicles and Conventional cab vehicles, proceed as follows (refer to Figs. 6, 7, or 8):

   .1 If applicable, on COE vehicles, remove the hose mounting bracket attached to the steering gear mounting bracket. Refer to Fig. 3. The hose mounting bracket prevents access to the pitman arm retaining nut.

   .2 Using an offset wrench, remove the pitman arm retaining nut and lockwasher from the roller shaft. Then, using a marking pen or paint, reference the position of the pitman arm on the roller shaft, as shown in Fig. 15.

   .3 If necessary (in order to perform step 7.4), loosen the upper and lower steering gear mounting bolts, then move the steering gear to allow maximum clearance between the roller (output) shaft and the frame rail.

   .4 Install the pitman arm puller tool on the roller shaft and the pitman arm. (Prior to installation, bottom the hex bolt in the

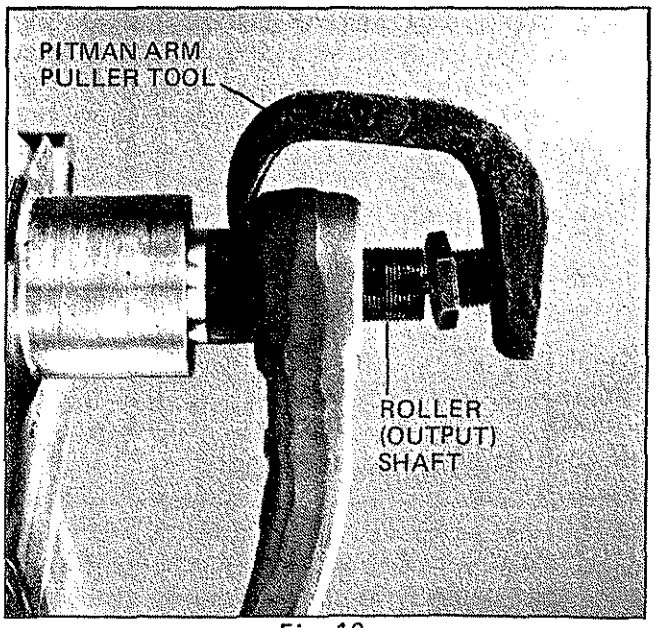


Fig. 16

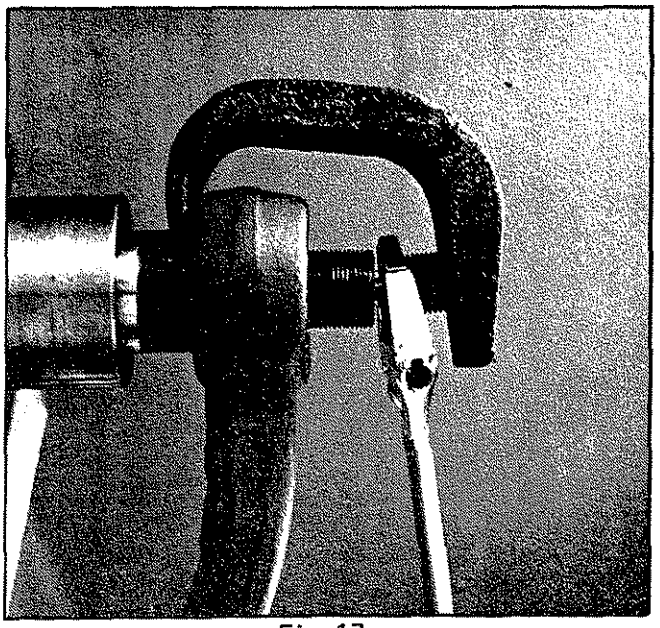


Fig. 17

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puller body.) The hex bolt centering boss fits into the roller shaft end, and the small end of the puller body fits behind the pitman arm. See Fig. 16.

.5 Turn the hex bolt of the puller tool counterclockwise. See Fig. 17. As the hex bolt is turned, tap the free end of the pitman arm to aid removal from the roller shaft splines. When the hex bolt of the puller tool is completely unscrewed, remove the puller tool, then lightly tap, if necessary, the pitman arm off the roller shaft.

.6 Remove the upper and lower steering gear mounting bolts, lockwashers (if used), and nuts, then remove the steering gear, and, if so equipped, the heater hose connector mounting bracket and pitman arm stop bracket from the steering gear mounting bracket.

STEERING GEAR DISASSEMBLY

Roller Shaft Removal From The Housing

1. Remove the steering gear from the vehicle. For instructions, refer to the heading, "STEERING GEAR REMOVAL," in this subject.

2. Remove the filler plug from the steering gear. Then, remove the drain plug and drain the lubricant from the unit. Discard the lubricant. Thoroughly clean both plugs.

3. If so equipped, remove the two dowel pins from the shaft cover.

4. Rotate the worm shaft to place the roller shaft on center or in the straight-ahead position.

5. Loosen the adjusting screw locknut. See Fig. 12.

6. Remove the shaft cover screws, as shown in Fig. 18.

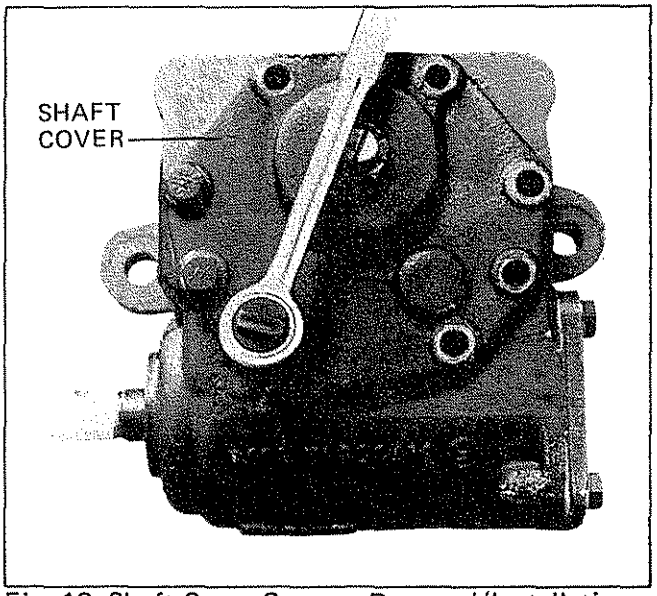

Fig. 18, Shaft Cover Screws, Removal/Installation

7. Remove the roller shaft and shaft cover as one assembly. See Fig. 19. It may be necessary to tap the end of the shaft with a soft mallet to break the shaft cover loose.

8. Remove the shaft cover gasket. See Fig. 19.

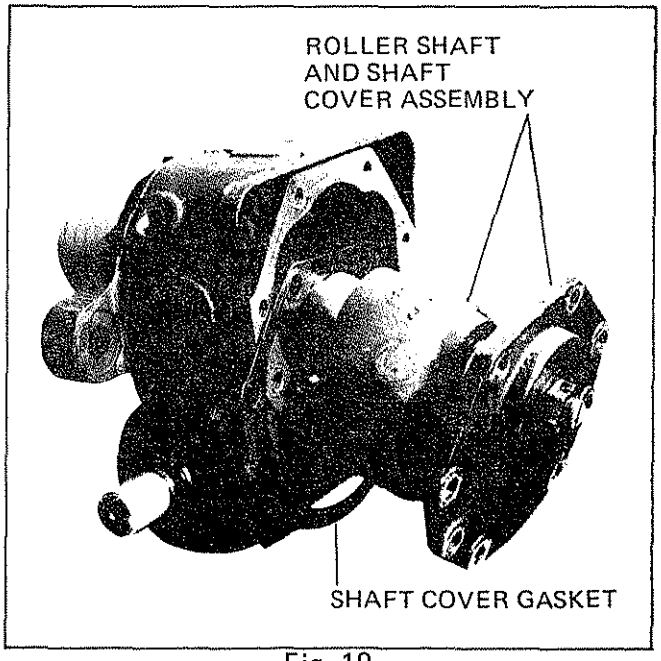

Fig. 19

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9. Disconnect the roller shaft from the shaft cover. While holding the shaft cover, separate the roller shaft by removing the adjusting screw locknut and O-ring and turning the adjusting screw clockwise.

10. Remove and discard the roller shaft seal (Fig. 20).

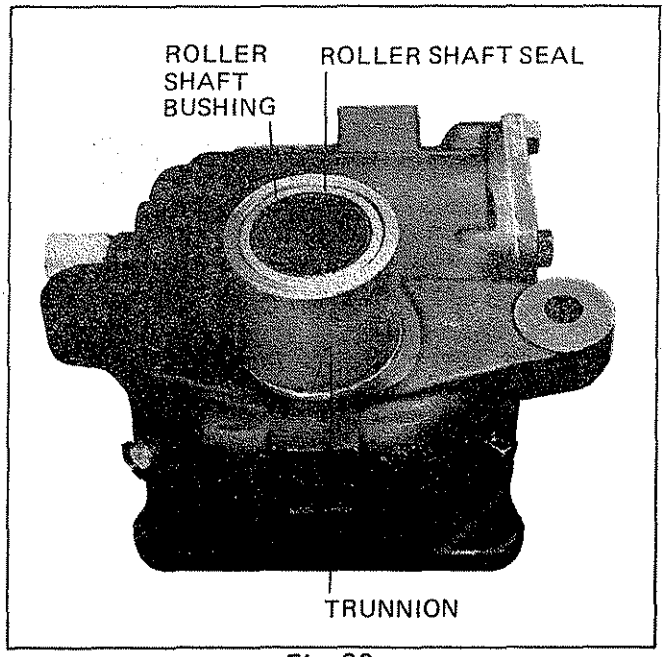

Fig. 20

Worm Shaft And Bearing Removal From The Housing

1. Remove the roller shaft from the steering gear. For instructions, refer to the heading, "ROLLER SHAFT REMOVAL FROM THE HOUSING," in this subject.

2. Remove the worm cover screws, as shown in Fig. 21. Then, remove the worm cover.

3. Remove the shims.

4. Remove the bearing cup and the cage (retainer) assembly (see Fig. 22) by pressing on the end of the worm (input) shaft.

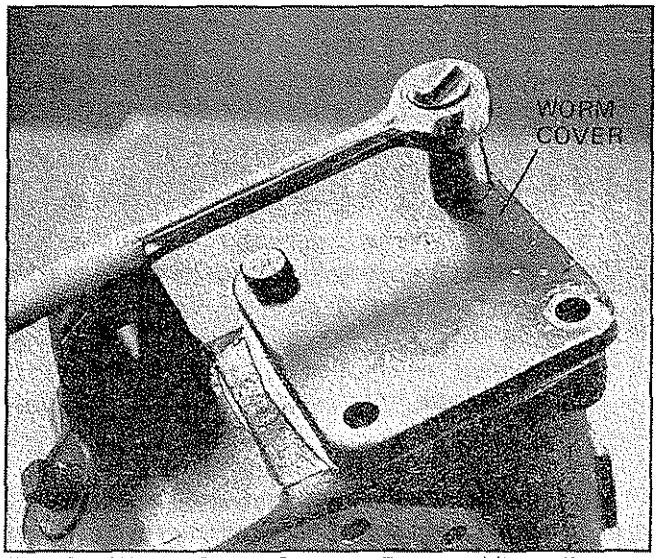

Fig. 21, Worm Cover Screws, Removal/Installation

NOTE: If the bearing cup cocks during removal, do not use force; tap the bearing cup in place, and repeat the procedure.

5. Remove the worm shaft assembly.

6. Remove the bearing cage (retainer) assembly.

7. Remove and discard the worm shaft seal.

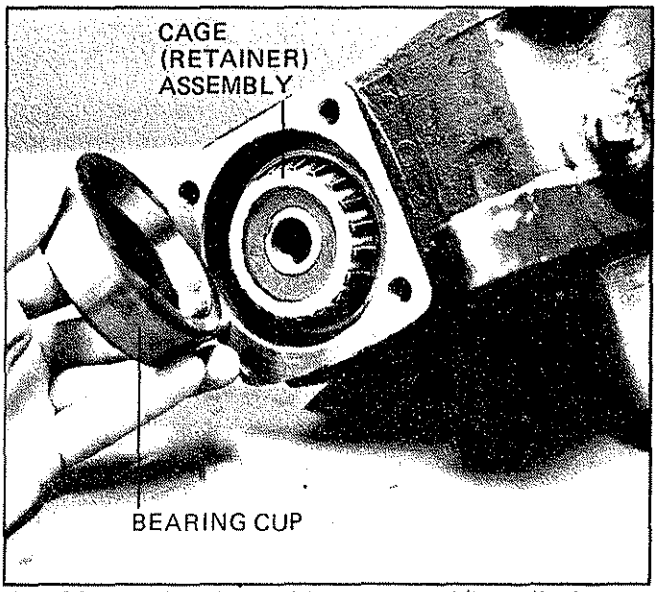

Fig. 22, Bearing Assembly, Removal/Installation

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

PARTS INSPECTION AND REPLACEMENT

The use of only genuine factory replacement parts, *IN THE PROPER COMBINATION* of housing, worm, and roller shaft assembly is necessary when servicing the components of steering gear assemblies to assure proper functional operation.

When the steering gear is serviced, any replacement parts must be matched by part number to the original factory-installed component. Each steering gear housing, worm shaft, and roller shaft is stamped with a part number to insure correct identification. Replacement parts must be identically matched to these numbers since component size can differ, depending on the steering gear ratio. Refer to the Freightliner Parts Book for the proper combination of steering gear components.

NOTE: The steering gear housing part number is stamped on the inside face of the casting for identification. Refer to Fig. 4. The worm shaft part number is stamped on the end of the finished part (see Fig. 23), and the roller shaft part number is stamped on the top of the roller tooth (see Fig. 24).

NOTE: Ross Gear Division of TRW, Inc. and Freightliner Corporation will not be liable for the malfunction of any steering gear unit and/or assembly, which is the result of servicing the steering gear assembly and contains either a non-genuine factory replacement part or contains the wrong combination of components improperly assembled or adjusted per specification.

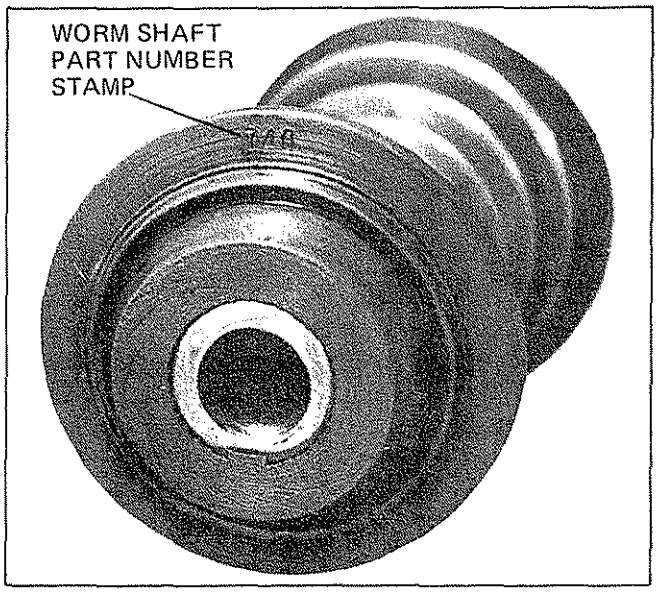

Fig. 23

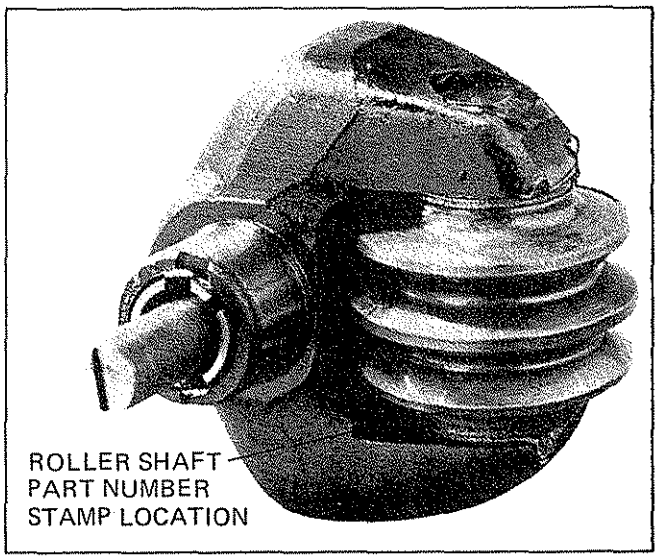

Fig. 24

1. Check the end play of the roller shaft adjusting screw (end play refers to the in-and-out movement of the adjusting screw). If the end play exceeds .008 inch (.200 mm), replace with a new threaded adjusting screw retainer and a thrustwasher, and adjust to .001-.003 inch (.030-.080 mm) end play. Carefully stake (2 places) the outer flange of the threaded adjusting screw retainer, using a chisel point punch, into the slots on the end of the roller shaft.

NOTE: Excessive end play of the adjusting screw will be noticeable when making total mesh preload adjustment because the turning torque will be uneven (left to right/right to left) when turning the gear across center or to the straight-ahead position.

WARNING: Excessive end play in the adjusting screw will make it impossible to adjust the roller shaft total mesh preload within specifications. Failure to eliminate excessive adjusting screw end play, as instructed above, could ultimately result in a loss of steering control.

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2. Check the clearance between the shaft cover bushing and the outboard end of the roller shaft. If the clearance exceeds .010 inch (.030 mm), replace the shaft cover bushing.

NOTE: Use a piloted mandrel to install the new bushing so that it is flush with the outer face of the bearing boss.

NOTE: If the shaft cover contains a bronze bushing, replace with a new shaft cover and bushing assembly.

3. Insert the roller shaft in the housing, then check the clearance between the (inboard) end of the roller shaft and the bushing(s).

   If the roller-shaft-to-bushing(s) clearance exceeds .010 inch (.030 mm), replace the bushing(s) as follows:

   .1 Press out the old bushing(s) with a piloted mandrel.

   .2 Install a new housing bushing(s) with a piloted mandrel. Press the bushing(s) into the bore from the outer end of the trunnion (refer to Fig. 20) until the outer face of the bushing is flush with the inner face of the seal counterbore.

NOTE: The inside diameter of the new bushing should be 1.750-1.751 inches (44.45-44.48 mm).

4. Check the bearing cage (retainer) assemblies (Fig. 25) on each end of the worm shaft. Inspect the bearing cups (races), the tapered rollers, and the cages (retainers) for pitting, brinelling, and other damage. If the bearing components are not in good condition, replace them with new assemblies.

NOTE: It is recommended that the bearing components be replaced only in full assemblies. A full assembly includes the cup, the tapered rollers, and the cage.

5. Inspect the roller shaft bushing(s) (Fig. 20) and sealing surfaces for wear and pitting. Also inspect the shaft cover bushing (Fig. 26) for damage. If necessary, the bushing surfaces may be lightly polished with very fine abrasive cloth.

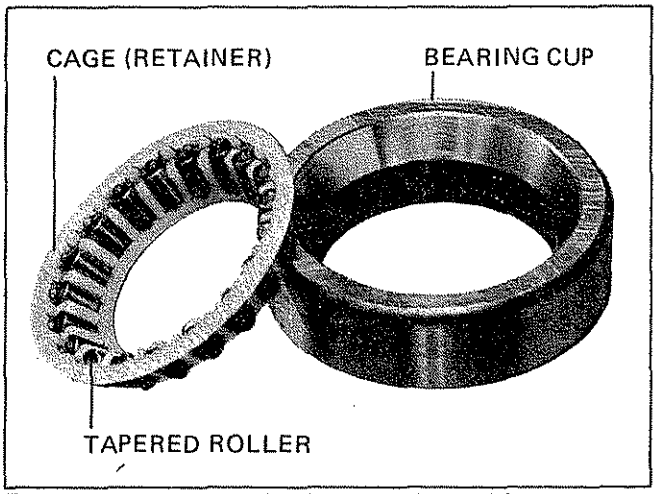

Fig. 25, Tapered Roller Bearing Assembly

6. Check the roller/tooth portion of the roller shaft (Fig. 27) for freedom of movement, excessive lash, and roughness. Inspect the tooth and splines of the roller shaft for gouges or other damage. Replace the roller shaft assembly, if damaged.

NOTE: Excessive lash (sideplay) should be checked by inserting a feeler gauge between the roller tooth and the shoulder. Refer to Fig. 27. If the clearance exceeds .010 inch (.030 mm), replace the roller shaft.

7. If applicable, check the fit of the shaft cover dowel pins. The pins must be a drive fit through the shaft cover and into the housing dowel holes. If it is necessary to repair or replace these dowel pins, machine to the following limits:

	ORIGINAL DOWEL	1ST SERVICE DOWEL
Pin O.D.	.6110"-.6115"	.6260"-.6250"
Ream Size	.6085"-.6100"	.6240"-.6235"

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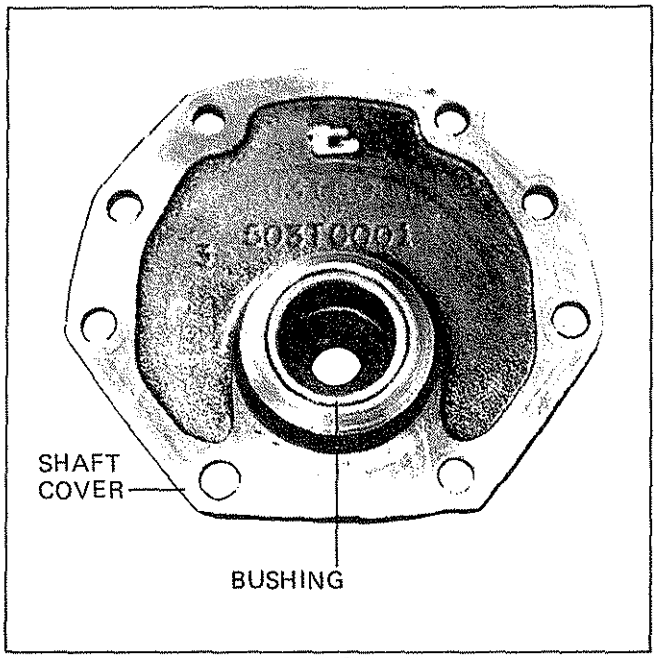

Fig. 26

STEERING GEAR ASSEMBLY

All steering gear internal components must be cleaned and then coated with lubricant before assembly. SAE 90 hypoid gear oil, API Service Classification GL-5, is recommended when ambient temperatures are continuously above 30°F (-1°C); SAE 75 hypoid gear oil, API Service Classification GL-5, is recommended when ambient temperatures are continuously below 30°F (-1°C). Refer to Table 3, located under "SPECIFICATIONS," for additional lubricant information.

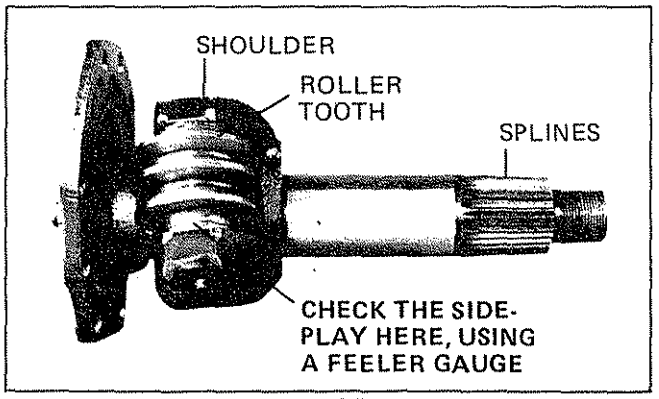

Fig. 27

When assembling a steering gear equipped with an aluminum housing, the workshop temperature should be approximately 70°F (21°C).

Worm Shaft And Bearing Installation In The Housing

1. Assemble the bearing cage (retainer) assembly into the bearing cup.

2. Insert the worm shaft assembly in the housing. Use care not to unseat the bearing cage (retainer) assembly previously installed in the bearing cup.

3. Place the lower bearing cage assembly in place on the worm shaft.

4. Insert the bearing cup in the housing bore. See Fig. 22. Do not use force to seat the cup. If installed correctly, the cup will seat in the bore with minimal effort required.

NOTE: If the bearing cup cocks during installation, do not use force; tap the bearing cup out, and repeat the procedure.

5. Assemble the shims (Fig. 28) and the worm cover.

NOTE: Rubber covered shims (if applicable) must be assembled with the rubber sides against the housing and the worm cover.

6. Install the worm cover screws. See Fig. 21. Tighten the screws finger-tight.

CAUTION: Do not final torque the worm cover screws immediately. Rotate the worm shaft assembly with one hand while slowly tightening the worm cover screws with the other hand to prevent damaging the bearing surfaces if the initial amount of shims is inadequate. Once a light preload is obtained by using a torque gauge, final torque the worm cover screws to 45-55 ft-lbs (61-75 N·m). Tighten the screws using the sequence shown in Fig. 29.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

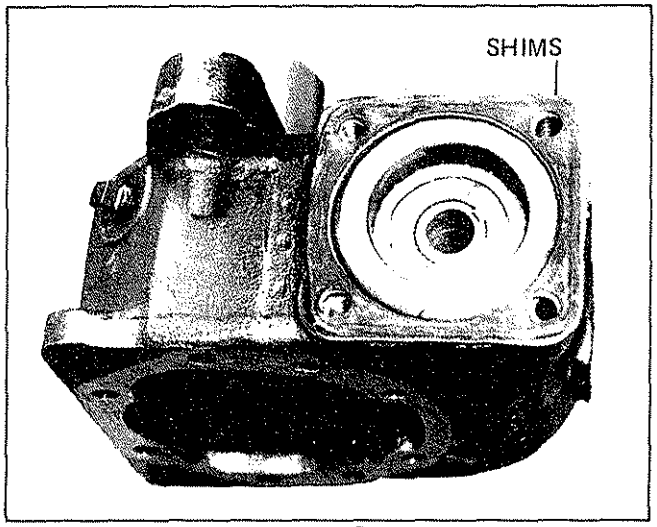

Fig. 28

7. *ALWAYS RECHECK THE WORM SHAFT PRELOAD* after final torquing of the worm cover screws is completed. For instructions, refer to the heading, "WORM BEARING PRELOAD ADJUSTMENT CHECK," in this subject. If necessary, repeat the adjustment using a different selection of shims.

NOTE: When checking the preload (this step only), use the torque values given for steering gears without a worm shaft seal installed.

Proceed to the heading, "ROLLER SHAFT AND COVER INSTALLATION IN THE HOUSING."

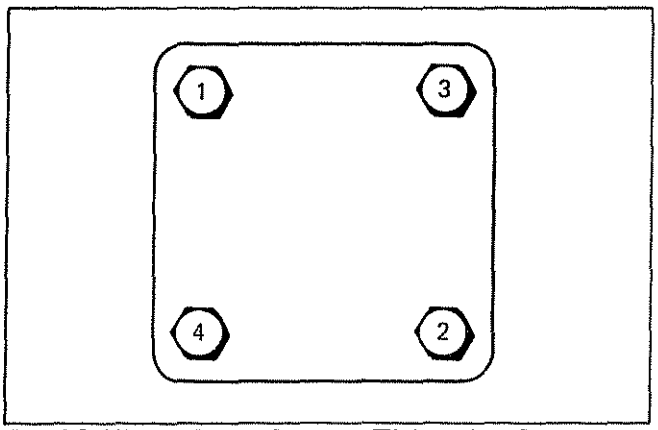

Fig. 29, Worm Cover Screws, Tightening Sequence

Roller Shaft And Cover Installation In The Housing

1. Insert the adjusting screw of the roller shaft into the shaft cover from the bearing side of the cover. Install the O-ring and locknut on the adjusting screw. Draw the roller shaft into the bearing until the shaft bottoms in the shaft cover. Then, reverse the adjusting screw rotation one full turn.

2. Position the shaft cover gasket in place (Fig. 30), then insert the roller shaft and shaft cover assembly in place.

3. Install the shaft cover screws, tightening them finger-tight. Then, rotate the worm shaft to 1/2 turn from *EACH END* of travel; lash must be present, in each position, with no perceptible binding.

   Final torque the shaft cover screws to 45-55 ft-lbs (61-75 N·m).

4. If applicable, install the shaft cover dowel pins. The pins must be a drive fit through the shaft cover and into the housing dowel holes. For additional information, refer to step 7 under the heading, "PARTS INSPECTION AND REPLACEMENT," in this subject.

5. Adjust the roller shaft total mesh preload using the instructions given under the heading,

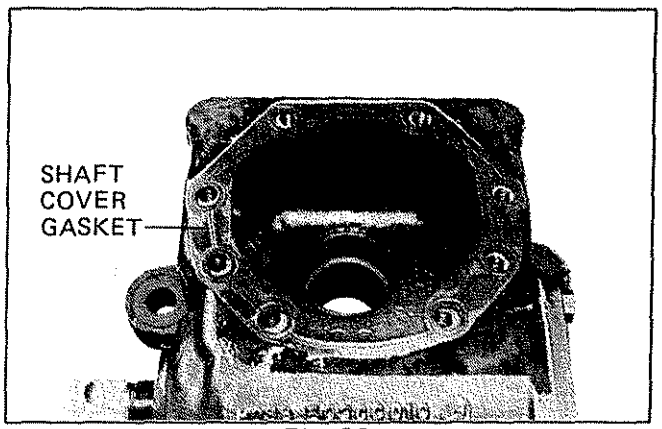

Fig. 30

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"ROLLER SHAFT TOTAL MESH PRELOAD ADJUSTMENT," in this subject.

NOTE: When checking the preload (this step only), use the torque values given for steering gears without a worm shaft seal installed.

6. Carefully press in the new worm and roller shaft seals as follows:

   .1 Place the lubricated seal in the counterbore with the longest lip facing into the gear.

   .2 Using a mandrel large enough to contact all portions of the seal case (metal retainer), press in the lubricated seal until it bottoms in the counterbore.

7. Install the drain plug in the housing. Tighten the plug to 12-16 ft-lbs (16-22 N·m). Do not fill the housing with lubricant at this time. Lubricant should be added to the steering gear after the unit is installed on the vehicle, as instructed under the heading, "STEERING GEAR INSTALLATION," in this subject.

STEERING GEAR INSTALLATION

1. Centralize the steering gear by turning the worm shaft through full travel, counting the number of turns required. Then, starting at the end of travel, turn back half that number of turns. Continue moving the worm shaft in either direction (but do not exceed a half turn) until the center punch mark on the shaft is pointing directly to the rear of the steering gear. See Fig. 31. Make sure the steering gear remains centralized as the service operations progress.

2. For COE vehicles equipped with 21 through 61 series cabs, proceed as follows:

NOTE: For COE vehicles equipped with 71 series cabs, and for Powerliner vehicles and Conventional cab vehicles, proceed to step 5.

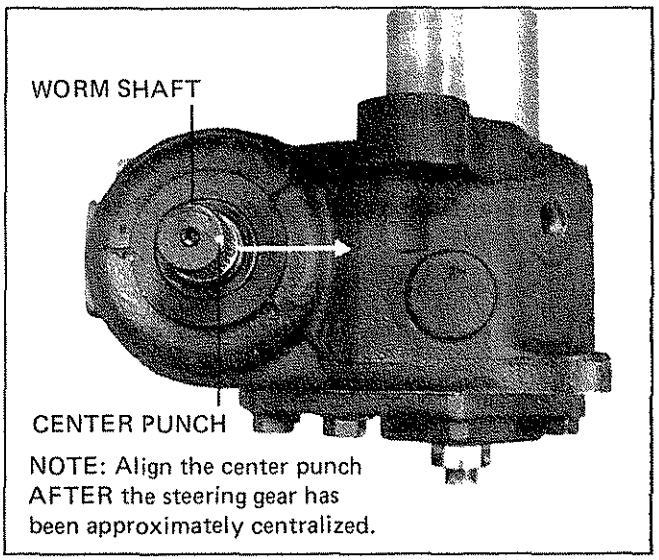

Fig. 31, Steering Gear, Overhead View

Hand-seat the pitman arm on the roller shaft so that the serrations and grooves on both components are lined up, as referenced earlier. If reference marks are not present, perform the following sub-steps before proceeding to step 3:

.1 Place the steering gear in the steering gear mounting bracket. Install the upper steering gear mounting bolt, lockwashers (if used), and nut. Tighten securely.

.2 For horizontal-socket type drag link installations (refer to Fig. 5), hand-seat the pitman arm on the roller shaft splines so that the centerline of the pitman arm is 2° 45′ rearward of the frame's vertical centerline. See Fig. 32.

For vertical-socket type drag link installations (refer to Fig. 5), hand-seat the pitman arm on the roller shaft splines so that the centerline of the pitman arm is 7° 15′ forward of the frame's vertical centerline. See Fig. 33.

.3 Remove the steering gear and pitman arm, as one assembly, from the vehicle (reverse step 2.1).

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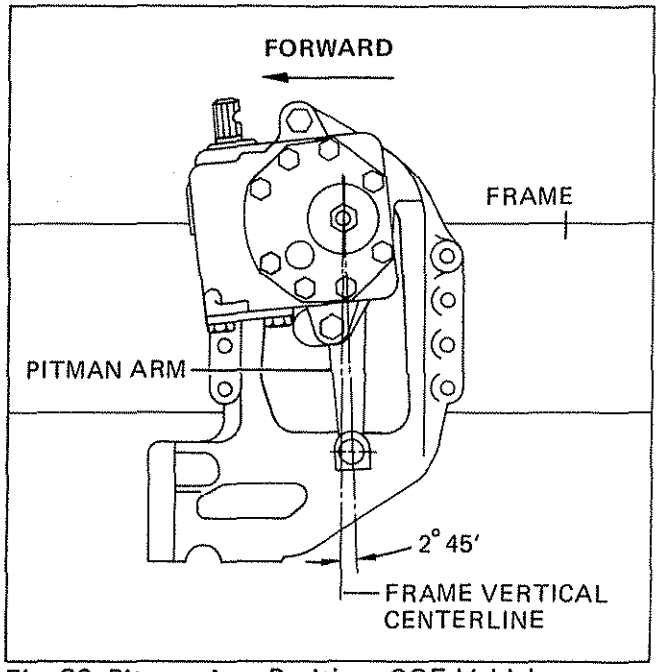

Fig. 32, Pitman Arm Position, COE Vehicle (21-61 Cab Series) Equipped With Horizontal-Socket Type Drag Link

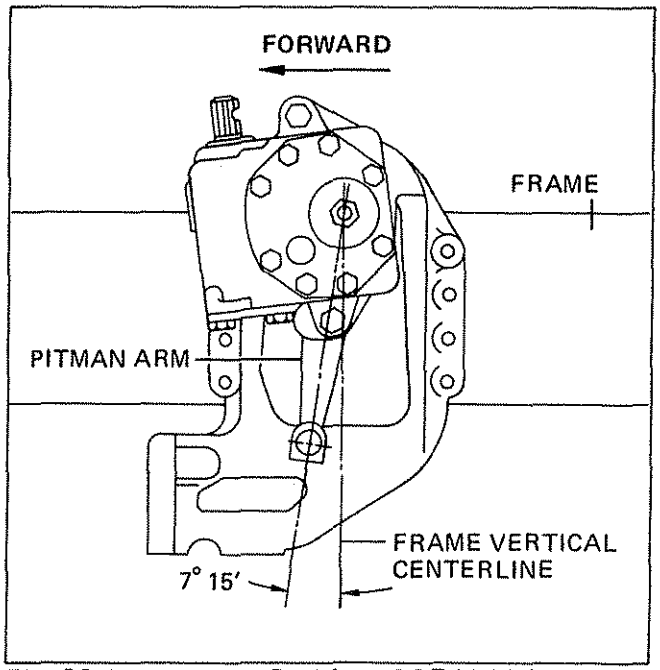

Fig. 33, Pitman Arm Position, COE Vehicle (21-61 Cab Series) Equipped With Vertical-Socket Type Drag Link

3. Install the pitman arm lockwasher and retaining nut. Tighten the nut to 245-255 ft-lbs (332-346 N·m). Referring to Fig. 34, check dimension "A", which should not exceed .31 inch (7.87 mm).

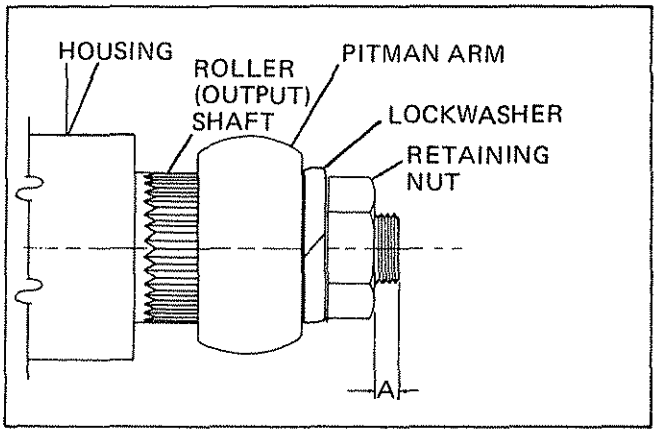

Fig. 34

If dimension "A" exceeds specifications, remove the retaining nut, install a 7DP79 washer, then reinstall the retaining nut. Dimension "A" should not exceed .25 inch (6.35 mm), and should not be less than .06 inch (1.52 mm) with the washer or .19 inch (4.83 mm) without the washer.

If dimension "A" does not meet specifications, the pitman arm, the steering gear roller shaft, or both must be replaced. Replace the component(s), as needed.

WARNING: If dimension "A" exceeds the allowable limits given above, the pitman arm may be too loose on the roller shaft. If dimension "A" is less than the allowable specifications, there may not be adequate roller shaft spline engagement with the pitman arm. Both conditions are unacceptable and, if left uncorrected, could ultimately result in a loss of steering control.

4. (For COE vehicles equipped with 21 through 61 series cabs:)

   .1 Place the steering gear and pitman arm assembly in the steering gear mounting

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bracket. Install the upper steering gear mounting bolt, lockwashers (if used), and nut. Tighten securely, but do not final torque the nut.

.2 If applicable, install the .005 inch shims (as referenced), then install the mounting cap, the locktab washers, and the nuts. Tighten the nuts to 90-95 ft-lbs (122-129 N·m).

.3 Install the lower steering gear mounting bolt, lockwashers (if used), and nut. Tighten securely, but do not final torque the nut.

.4 Test for roller shaft binding by turning the worm shaft to the end of travel in either direction. Then, move the pitman arm upward in the lash (slack) area and allow it to "fall" under its own weight. If it does not fall approximately 1/4 inch (6 mm), the steering gear mounting bracket assembly is clamping the roller shaft trunnion (refer to Fig. 35) too tightly.

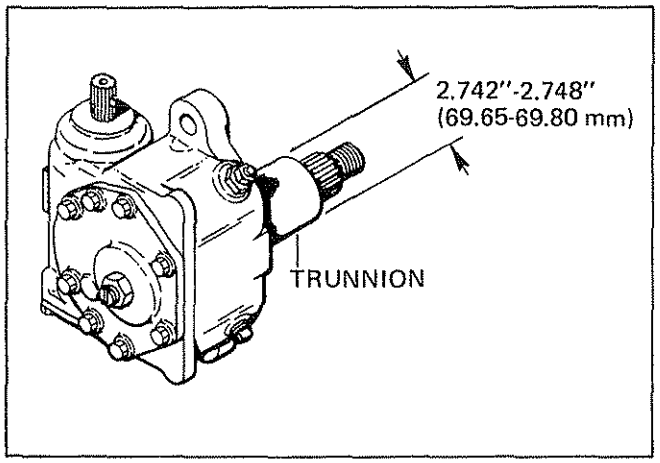


Fig. 35

To correct roller shaft binding, remove the mounting cap and add a .005 inch shim over each mounting cap stud. Repeat step 4.2.

IMPORTANT: Do not install more than two shims per stud, and always use the same number of shims on each stud.

Check for roller shaft binding. If binding occurs, the mounting bracket assembly "bore" diameter (see Fig. 36) may be smaller than the required 2.750-2.752 inches (69.85-69.90 mm) needed to support the roller shaft trunnion which measures 2.742-2.748 inches (69.65-69.80 mm) diameter.

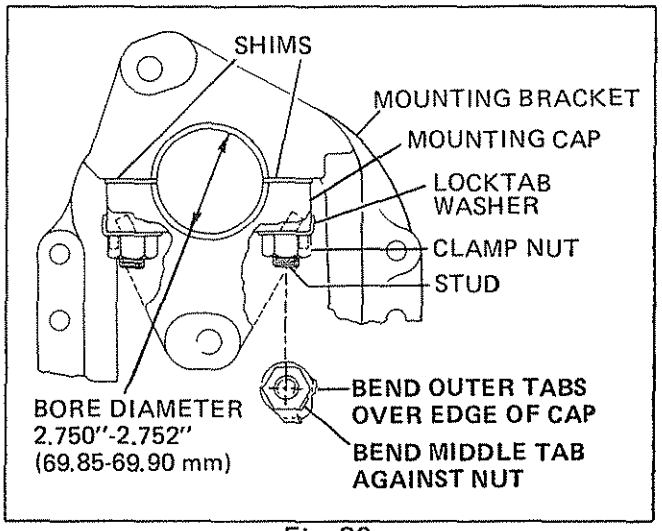


Fig. 36

Replace out-of-round parts and parts that do not fall within acceptable specifications.

.5 When roller shaft binding has been eliminated, make certain the nuts holding the mounting cap in place are tightened to 90-95 ft-lbs (122-129 N·m), then bend the locktab washers as shown in Fig. 36.

.6 Tighten the upper and lower steering gear mounting bolt nuts to the values given in Table 2, located under "SPECIFICATIONS," in this subject.

NOTE: The mounting bolts must be periodically checked for tightness. Refer to the 14 Group of the Freightliner Maintenance and Lube Manual for recommended intervals.

.7 Centralize the steering gear using the instructions given in step 1, under this heading. Proceed to step 6.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

5. For COE vehicles equipped with 71 series cabs, and for Powerliner vehicles and Conventional cab vehicles, proceed as follows:

   .1 Place the steering gear in the steering gear mounting bracket. If so equipped, position the heater hose connector mounting bracket and the pitman arm stop bracket in place, then install the upper and lower mounting bolts and (if used) lockwashers, then start the nuts on the bolts.

   .2 Hand-seat the pitman arm on the roller shaft so that the serrations and grooves on both components are lined up, as referenced earlier. If reference marks are not present, proceed as follows:

   For COE vehicles with 71 series cabs equipped with horizontal-socket type drag link installations (refer to Fig. 6), assemble the pitman arm on the steering gear roller shaft splines with the centerline of the pitman arm 2°·45′ rearward of the frame's vertical centerline. Refer to Fig. 37.

   For COE vehicles with 71 series cabs equipped with vertical-socket type drag link installations (refer to Fig. 6), assemble the pitman arm on the steering gear roller shaft splines with the centerline of the pitman arm 7° 15′ forward of the frame's vertical centerline. Refer to Fig. 38.

   For Conventional cab and Powerliner vehicles, assemble the pitman arm on the steering gear roller shaft splines with the centerline of the pitman arm 5° forward of the frame's vertical centerline. Refer to Fig. 39 (Conventional cab vehicles) or Fig. 40 (Powerliner vehicles).

   .3 Tighten the upper and lower steering gear mounting bolt nuts to the values given in Table 2, located under "SPECIFICATIONS," in this subject.

NOTE: The mounting bolts must be periodically checked for tightness. Refer to the 14 Group of the Freightliner Maintenance and Lube Manual for recommended intervals.

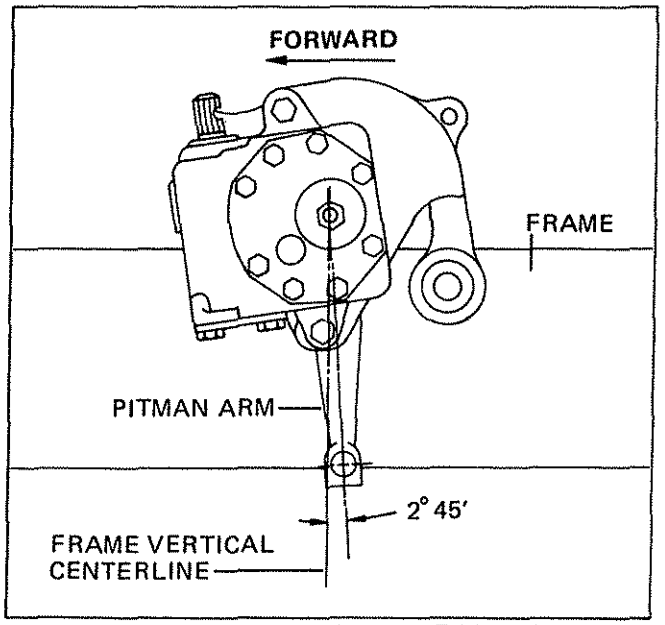


Fig. 37, Pitman Arm Position, COE Vehicle (71 Cab Series) Equipped With Horizontal-Socket Type Drag Link

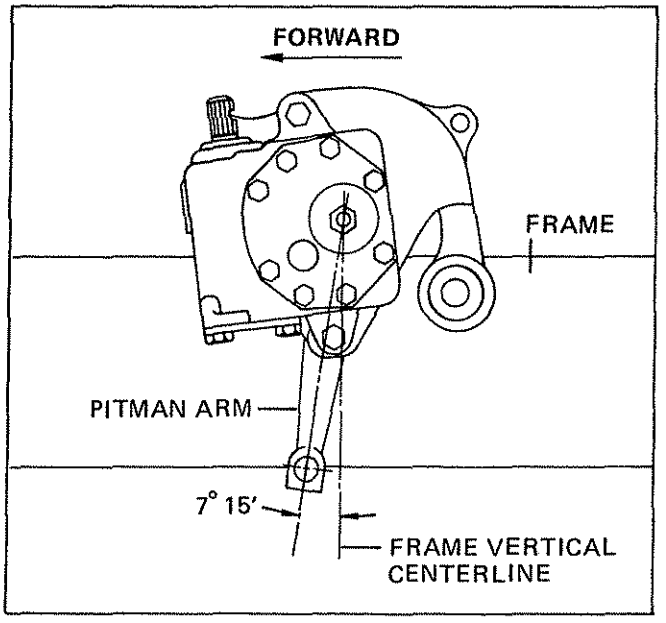


Fig. 38, Pitman Arm Position, COE Vehicle (71 Cab Series) Equipped With Vertical-Socket Type Drag Link

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

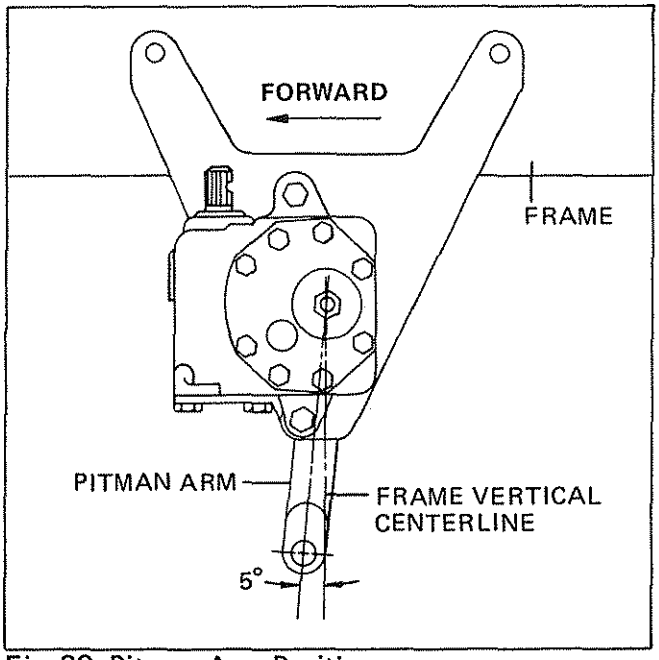


Fig. 39, Pitman Arm Position, Conventional Cab Vehicle

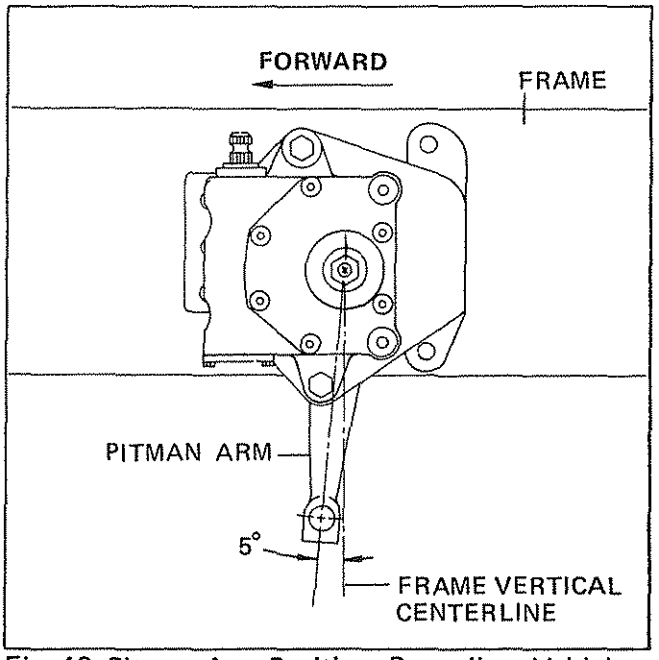


Fig. 40, Pitman Arm Position, Powerliner Vehicle

.4 Install the pitman arm lockwasher and retaining nut. Tighten the nut to 245-255 ft-lbs (332-346 N·m). Referring to Fig. 34, check dimension "A", which should not exceed .31 inch (7.87 mm).

If dimension "A" exceeds specifications, remove the retaining nut, install a 7DP79 washer, then reinstall the retaining nut. Dimension "A" should not exceed .25 inch (6.35 mm), and should not be less than .06 inch (1.52 mm) with the washer or .19 inch (4.83 mm) without the washer.

If dimension "A" does not meet specifications, the pitman arm, the steering gear roller shaft, or both must be replaced. Replace the component(s), as needed.

WARNING: If dimension "A" exceeds the allowable limits given above, the pitman arm may be too loose on the roller shaft. If dimension "A" is less than the allowable specifications, there may not be adequate roller shaft spline engagement with the pitman arm. Both conditions are unacceptable and, if left uncorrected, could ultimately result in a loss of steering control.

6. Fill the steering gear with lubricant using the following procedure:

.1 If not already done, remove the filler plug (and pressure relief fitting) from the steering gear housing. Thoroughly clean the plug.

.2 Add lubricant until it is within 1/2 inch (12.5 mm) of the filler hole. Refer to Table 3, located under "SPECIFICATIONS," for lubricant recommendations.

.3 Install the filler plug (and pressure relief fitting) in the steering gear housing, and tighten the plug to 12-15 ft-lbs (16-20 N·m).

7. Position the steering wheel so that the king-spoke—the narrow spoke on some wheels, or the spoke with the manufacturer's name

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

imprinted on the underside—points directly toward the front of the vehicle (positioned at 12 o'clock ± 10°). Refer to Fig. 41.

8. Connect the steering driveline to the steering gear worm (input) shaft. Do not decentralize the steering gear. Also install the boot cover and, if so equipped, lower boot seal bracket. For instructions, refer to the applicable steering driveline subject located in the 14 Group of this manual.

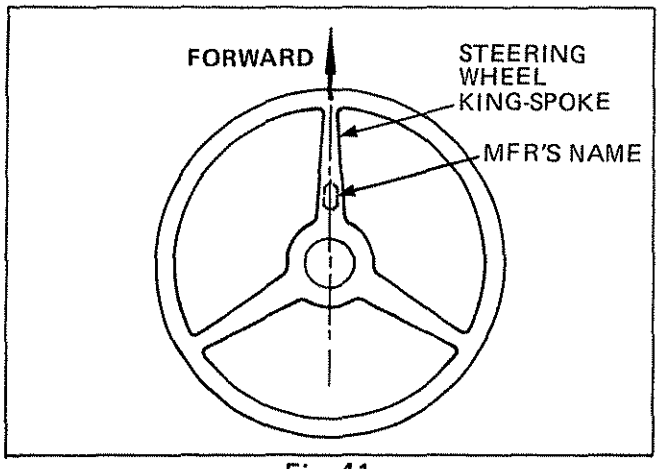


Fig. 41

9. After the steering driveline has been connected to the steering gear worm shaft, check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10°. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject located in the 14 Group of this manual.

IMPORTANT: Some earlier vehicles are equipped with an upper column and jacket assembly on which the steering wheel is attached using a woodruff key. On this type of installation, the steering gear worm shaft may also be keyed. If the king-spoke is not positioned at 12 o'clock ± 10° on this type of installation and adjustments are not possible, the steering wheel and the upper column and jacket wheel tube shaft are mismatched and one or both should be replaced.

WARNING: Do not turn the worm (input) shaft of the steering gear in order to correct the position of the king-spoke on the steering wheel. To do so will decentralize the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering.

10. Connect the drag link to the pitman arm. For instructions, refer to the applicable subject located in the 14 Group of this manual.

WARNING: Do not turn the worm (input) shaft of the steering gear in order to align the pitman arm with the drag link. All adjustments during this procedure should be made at the drag link. To do otherwise will decentralize the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering.

11. If so equipped, attach the hose mounting bracket and hoses to the steering gear mounting bracket. Refer to Fig. 3.

12. Remove the chock blocks from the tires.

13. Confirm that adjustments made to the steering system are correct by test driving the vehicle or taking a ride with the driver.

    If, during straight-ahead driving on level road, the steering wheel king-spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock ± 10°), *it is an indication that the steering gear is decentralized.* The probable cause was the mechanic's failure to insure that the vehicle's front tires were in the straight-ahead position during repairs to the steering gear.

    Adjustments should be made as follows:

    .1 Note the approximate number of degrees the steering wheel king-spoke points away from the forward position during straight-ahead driving.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

.2 Using the instructions given in the 14 Group of this manual, lengthen or shorten the drag link. Each turn of the drag link will indirectly result in partial turning of the steering wheel. All adjustments must result in a centralized steering gear (and correctly positioned steering wheel king-spoke) when the vehicle's front tires are in the straight-ahead position.

.3 Again, test drive the vehicle or take a ride with the driver. Observe that the steering wheel king-spoke points directly toward the front of the vehicle during straight-ahead driving on level road. Repeat the adjustments at the drag link, if needed.

CENTRALIZING THE STEERING GEAR

Centralizing the steering gear places the roller (output) shaft in the center of its travel to give the most desireable characteristics during straight-ahead driving. All manual steering gears are centralized at the factory.

In the field, make sure the steering gear is centralized when:

1. Steering gear preload adjustments must be checked.

2. The drag link is serviced or adjusted.

In addition, if the steering gear is removed from the vehicle, the gear must be centralized prior to installation. Instructions for centralizing the steering gear when the gear is removed from the vehicle and when adjustments are made to the drag link are included under the heading, "STEERING GEAR INSTALLATION," in this subject.

Instructions for centralizing the steering gear when preload adjustments are checked are included under the heading, "STEERING GEAR PRELOAD ADJUSTMENT CHECKS," in this subject.

TROUBLESHOOTING

The following troubleshooting information should be used to diagnose steering system problems. For additional troubleshooting information, refer to the front axle wheel alignment subject located in the 10 Group of this manual.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Excessive Lash Or Free Play At The Steering Wheel	Steering wheel is loose on the upper steering column.	Inspect the parts for damage caused by the looseness. Replace damaged components. If no damage exists, secure the steering wheel in place using the instructions given in the 14 Group of this manual.
	Steering gear mounting bolt nuts are loose.	Tighten the nuts to the torque values given under the "SPECIFICATIONS" section of this subject.
	Pitman arm is loose on the roller (output) shaft.	Inspect the pitman arm and the roller (output) shaft splines for damage caused by the looseness. Replace damaged components. If no damage exists, tighten the pitman arm retaining nut to the values given in this subject.
	Steering driveline universal joints are worn.	Replace worn universal joints following the instructions given in the 14 Group of this manual.
	Steering knuckle bushings are worn.	Replace the bushings using the instructions given in the front axle manufacturer's service manual.
	Wheel bearings are worn or require adjustment.	Inspect and adjust the wheel bearings using the instructions given in the 10 Group of this manual. Replace the bearings, if necessary.
	Steering gear parts are worn or the steering gear requires preload adjustments.	Replace worn parts if preload adjustments cannot be made.
	Worn or damaged drag link or tie rod ends.	Repair or replace parts as needed. For instructions, refer to the 14 Group of this manual and to the front axle manufacturer's service manual.

(Continued on next page)

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
No Recovery When Leaving A Turn	Low tire pressure.	Inflate the tires to the specifications given in the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual.
	Binding in the steering driveline universal joints.	Check the universal joints for damage and inadequate lubrication. Correct the condition(s) as instructed in the 14 Groups of this manual and the Freightliner Maintenance and Lube Manual.
	If the vehicle is loaded, an inadequately lubricated fifth wheel.	Lubricate the fifth wheel as instructed in the 22 Group of the Freightliner Maintenance and Lube Manual or the fifth wheel manufacturer's service manual.
	Binding at the steering knuckle king-pins.	Inspect the king-pins and bushings for wear or damage. If needed, replace the components using the instructions given in the front axle manufacturer's service manual. Lubricate the king-pins as instructed in the 10 Group of the Freightliner Maintenance and Lube Manual.
	Steering linkage binding or lack of lubrication.	Replace components, adjust, or lubricate, as required. For instructions, refer to the 14 Group of this manual and to the 10 and 14 Groups of the Freightliner Maintenance and Lube Manual.
	Incorrect front axle wheel alignment.	Align the wheels as instructed in the 10 Group of this manual.
	Steering gear parts are worn or steering gear requires preload adjustments.	Replace worn parts if preload adjustments cannot be made.

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

SPECIFICATIONS

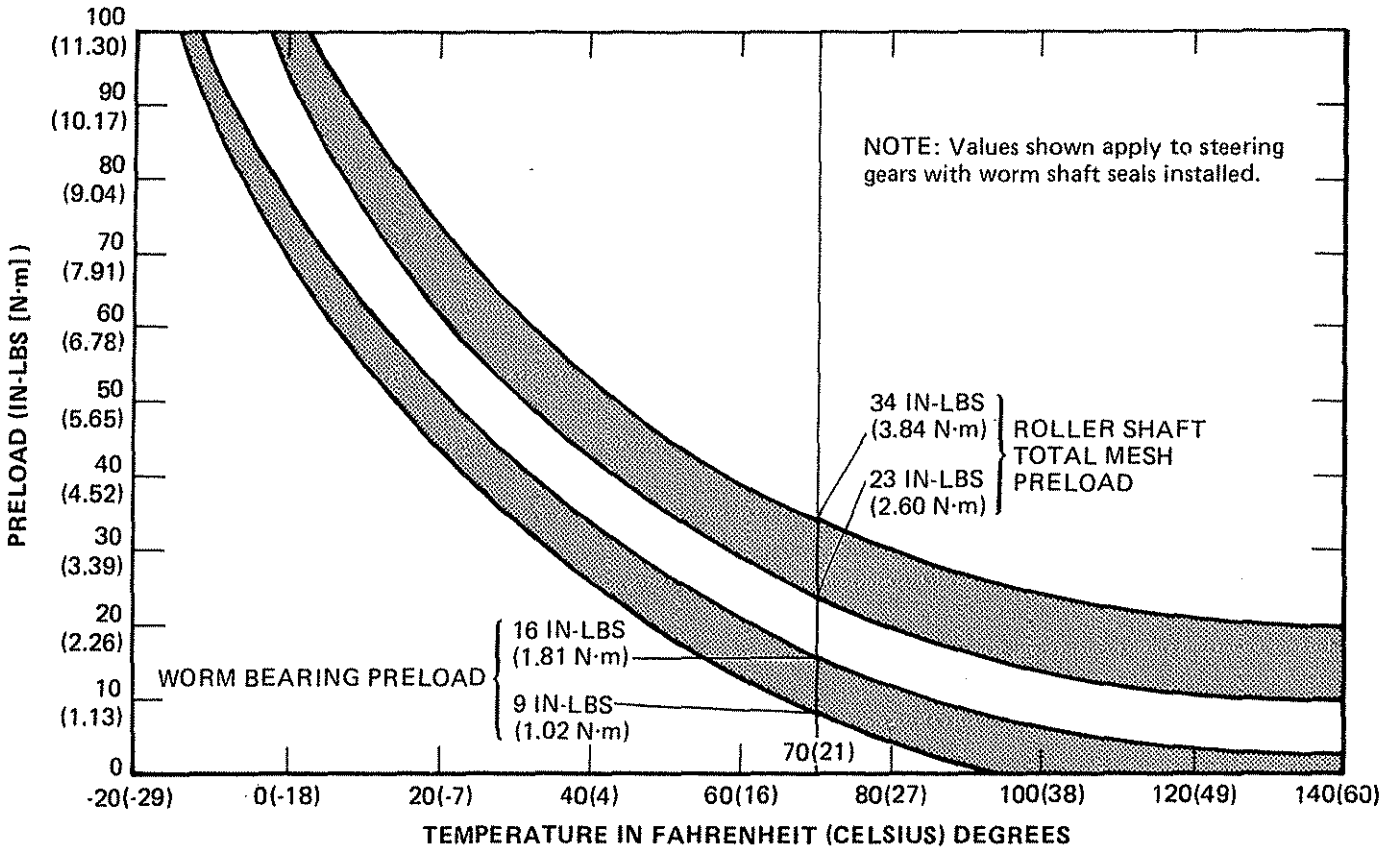


Table 1, Temperature Effects On Preload Measurements (Steering Gears With Aluminum Housings), Lubricant SAE 75 Weight Or SAE 90 Weight

DESCRIPTION		BOLT OR NUT SIZE	TORQUE	
			FT-LBS	N·m
Steering Gear To Mounting Bracket Nuts	Hex Head Bolt And Nut	5/8-18	185	251
	Flanged Type Hex Head Bolt and Nut	5/8-11	150-175	203-237
Mounting Cap Clamp Nuts		5/8-18	90-95	122-129
Worm Cover Screws		7/16-14	45-55	61-75
Shaft Cover Screws		7/16-14	45-55	61-75
Adjusting Screw Locknut		5/8-18	25-40*	34-54*
Pitman Arm Retaining Nut		1 1/8-16	245-255	332-346

*While Holding Screw

Table 2, Steering Gear Torque Specifications

ROSS WORM AND ROLLER TYPE MANUAL STEERING GEAR, MODELS 7J AND 503

SPECIFICATIONS (Continued)

Temperature Continuously Above +30°F (-1°C)	Hypoid Gear Oil SAE90 API Service Classification GL-5
Temperature Continuously Below + 30°F (-1°C)	Hypoid Gear Oil SAE75 API Service Classification GL-5

Table 3, Steering Gear Lubricant Specifications

WARNING: If the vehicle is operated at temperatures below +30°F (-1°C) with SAE 90 weight oil in the steering gear, the steering can gradually become sluggish and resistant to the point where the driver may have difficulty performing an evasive maneuver. WHEN OPERATING IN TEMPERATURES CONTINUOUSLY BELOW +30°F (-1°C), INSTALL THE SAE 75 WEIGHT OIL.

DESCRIPTION			SPECIFICATION
WORM SHAFT PRELOAD ADJUSTMENT CHECK AT 70°F (21°C)	Without Worm Shaft Seal Installed		7-14 in-lbs (.79-1.58 N·m)
	With Worm Shaft Seal Installed		9-16 in-lbs (1.02-1.81 N·m)
ROLLER SHAFT TOTAL MESH PRELOAD ADJUSTMENT CHECK AT 70°F (21°C)	Without Worm Shaft Seal Installed		20-31 in-lbs (2.26-3.51 N·m)
	With Worm Shaft Seal Installed		23-34 in-lbs (2.60-3.84 N·m)
SHAFT-COVER-BUSHING-TO-ROLLER-SHAFT MAXIMUM CLEARANCE			.010" (.254 mm)
ROLLER-SHAFT-TO-HOUSING-BUSHING(S) MAXIMUM CLEARANCE			.010" (.254 mm)
HOUSING BUSHING(S) INSIDE DIAMETER			1.750"-1.751" (44.45-44.48 mm)
SHAFT COVER DOWEL PIN DIMENSIONS	O.E.M.	Pin O.D.	.6110"-.6115"
		Ream Size	.6085"-.6100"
	Service	Pin O.D.	.6250"-.6260"
		Ream Size	.6235"-.6240"
ROLLER SHAFT ADJUSTING SCREW MAXIMUM END PLAY			.008" (.203 mm)
ROLLER SHAFT TOOTH/SHOULDER MAXIMUM LASH			.010" (.254 mm)

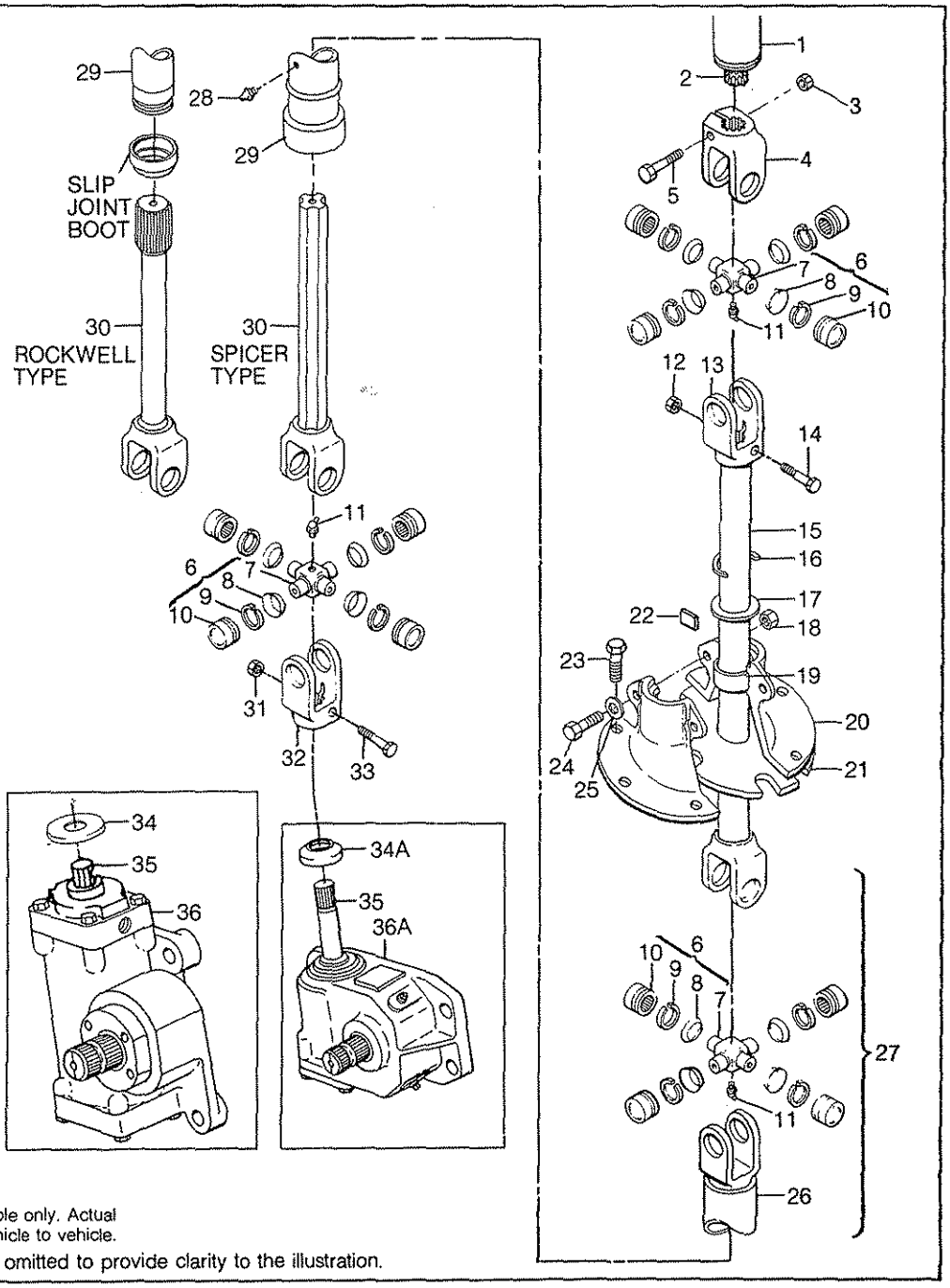
Table 4, Ross Steering Gear, Models 7J & 503, Specifications

STEERING DRIVELINE, COE, 1984 ADVANCEMENTS

GENERAL DESCRIPTION

The steering driveline in Freightliner COEs with 1984 Advancements connects the upper column and jacket assembly to the steering gear. See **Fig. 1**. The driveline shaft consists of three U-joints, an internally-splined tubular upper section, and a mating externally-splined lower section. The slip joint assembly accommodates changes in the position of the cab when the cab is being tilted. It also eases installation and removal of the steering driveline assembly.

1. Upper Column and Jacket Assembly
2. Wheel Tube Shaft
3. Pinch Bolt Nut
4. Upper End Yoke
5. Upper End Yoke Pinch Bolt
6. U-Joint Assembly
7. U-Joint Journal Cross
8. Journal Cross Seal
9. Needle Bearing Cup Snap Ring
10. Needle Bearing Cup
11. Journal Cross Grease Fitting
12. Pinch Bolt Nut
13. Upper Driveline Yoke
14. Upper Driveline Yoke Pinch Bolt
15. Upper Driveline Shaft
16. Crescent Retaining Ring
17. Felt Washer
18. Locknut
19. Deck Bearing
20. Deck Bearing Support Bracket
21. Deck Bearing Gasket
22. Bearing Shim
23. Capscrew
24. Bolt
25. Washer
26. Driveline Tube and Yoke Assembly
27. Intermediate Yoke Assembly
28. Grease Fitting
29. Driveline Tube
30. Lower Driveline Shaft and Yoke Assembly
31. Pinch Bolt Nut
32. Lower End Yoke
33. Lower End Yoke Pinch Bolt
34. Seal Protector
34A. Boot Cover
35. Steering Gear Input Shaft
36. Ross Integral Power Steering Gear*
36A. Ross Manual Steering Gear*

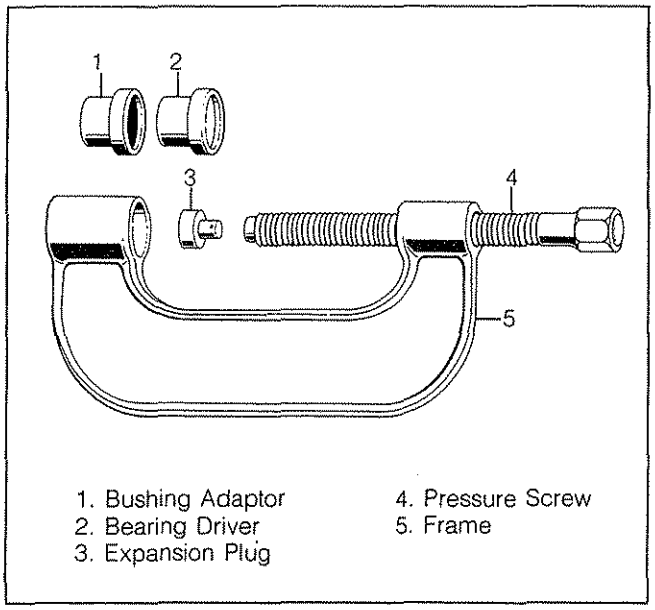


* The steering gear shown is an example only. Actual steering gear models may vary from vehicle to vehicle.

NOTE: Some fasteners intentionally omitted to provide clarity to the illustration.

Fig. 1, Steering Driveline, COE, 1984 Advancements (shown with current deck bearing support bracket)

STEERING DRIVELINE, COE, 1984 ADVANCEMENTS



1. Bushing Adaptor
2. Bearing Driver
3. Expansion Plug
4. Pressure Screw
5. Frame

Fig. 6, Universal Joint Tool Assembly

2. Wearing safety goggles, remove the needle bearing cup snap rings from the needle bearing cups with a screwdriver.
3. Select an expansion plug of slightly smaller diameter than the needle bearing cup and place it on the pressure screw. Then, select a bushing adaptor of slightly larger inside diameter than the needle bearing cup, and place it in the opposite end of the tool frame.
4. Place the driveline tube and yoke assembly on the U-joint tool with the bushing adaptor positioned to receive a needle bearing cup, and the expansion plug aligned with the opposite needle bearing cup.
5. Tighten the pressure screw to press the needle bearing cup out of the driveline tube and yoke assembly; then remove the needle bearing cup. Reverse the driveline tube and yoke assembly and press against the U-joint journal cross to force out the other needle bearing cup.

NOTE: In some cases it may be necessary to give the pressure screw a sharp blow with a brass hammer while it is under pressure to start the cup moving.

6. Remove the driveline tube and yoke assembly from the U-joint tool, then remove the upper end yoke and the journal cross from the driveline tube and yoke assembly.
7. Place the upper end yoke on the U-joint tool with the bushing adaptor positioned to receive a needle bearing cup and the expansion plug against the opposite needle bearing cup.
8. Repeat step 5.
9. Remove the upper end yoke from the U-joint tool, then remove the journal cross from the upper end yoke.
10. Repeat steps 4 through 9 for the lower end yoke and the intermediate yoke assembly.

U-JOINT ASSEMBLY (Refer to Fig. 1)

WARNING: Do not use old snap rings when assembling the U-joints. Used snap rings are often distorted and over-stressed from disassembly. Also, new snap rings must be fully seated in their grooves when assembling the U-joints. Snap rings not fully seated in their grooves could work loose, which could cause a loss of steering control, resulting in injury or property damage.

Assembly of the steering driveline U-joints requires the use of a U-joint tool assembly. See Fig. 6.

1. Clamp the U-joint tool frame into a vise.
2. Select a U-joint tool expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Then, place a bearing driver on the opposite end of the tool.
3. Position the U-joint journal cross in the upper end yoke so that the journal cross grease fitting points toward one of the yoke ears.
4. Make certain the journal cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the upper end yoke on the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.
5. Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint journal cross during the pressing operation to assure free movement.

NOTE: If the needle bearing cups do not seat correctly or if the U-joint binds, give the yoke shoulder near each cup a sharp blow with a brass hammer.

6. Press the needle bearing cup on the screw end of the U-joint tool all the way in until there is enough

STEERING DRIVELINE, COE, 1984 ADVANCEMENTS

clearance to insert a needle bearing cup snap ring, then insert the snap ring. Reverse the upper end yoke on the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snap ring. Insert the snap ring, then remove the upper end yoke from the U-joint tool.

7. With the journal cross lube fitting facing away from the base of the upper end yoke, position the U-joint journal cross and the upper end yoke in the upper driveline yoke.

NOTE: The journal cross grease fitting should face away from the base of the upper end yoke to provide access for lubrication when the steering driveline is installed on the vehicle.

8. Repeat steps 4 through 6 for the upper driveline yoke.

9. Repeat steps 3 through 8 for the lower end yoke and the intermediate yoke assembly. Position the journal cross grease fittings as in **Fig. 1**.

DECK BEARING REPLACEMENT (Refer to **Fig. 1**)

1. Remove the upper driveline yoke pinch bolt nut and pinch bolt. Discard the nut.

2. Remove the upper driveline yoke from the upper driveline shaft.

CAUTION: If heat is used to remove the upper driveline end yoke, be careful not to damage any cab interior components.

NOTE: If the yoke is marked with red paint, or if the yoke cannot be removed by hand, it is secured with adhesive. Heat the base of the upper driveline yoke with a torch until the bond begins to weaken. At 300°F (149°C), the bond will be reduced to half strength.

3. On earlier steering driveline installations, remove the screws and washers that attach the bearing cap to the deck bearing support bracket assembly. Remove the bearing cap. Remove the steering shaft bushing and/or bracket clamp, as equipped. See **Fig. 3**.

   Loosen the capscrews that attach the left half of the deck bearing support bracket to the deck.

   Move the left half of the bracket enough to free the deck bearing, then remove the deck bearing from the driveline shaft.

4. On later model steering driveline installations, remove the bolts, locknuts, and washers that clamp the deck bearing support bracket assembly. Remove the crescent retaining ring and felt washer. See **Fig. 4**.

   Remove the capscrews that attach the two halves of the deck bearing support bracket to the deck. Remove the two halves of the deck bearing support bracket and the gasket.

   Remove the deck bearing from the driveline shaft.

5. Apply a small amount of lubricant on the steering shaft at the bearing seat and install the new deck bearing on the driveline shaft.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

6. Use a wire brush and Loctite Safety Solvent or an equivalent to clean the serrations of the upper driveline yoke and drive shaft.

IMPORTANT: If Loctite Safety Solvent is not available, *clean* solvents, such as trichloroethylene, trichloroethane, perchloroethylene, MEK, acetone, or alcohol can be used. *Do not use* kerosene, gasoline, naphtha, fuel oil, Varsol, or Stoddard solvents.

7. Apply Locquic General Purpose Primer T to the driveline shaft splines.

8. Apply a bead of Loctite No. 680 adhesive to the splines of the intermediate yoke. Slide the yoke onto the shaft.

IMPORTANT: After the yoke has been assembled to the shaft, curing will start immediately and the pinch bolt nut must be tightened within four minutes. If this time is exceeded, the parts must be disassembled, cleaned, and treated again. The assembly must be allowed to cure for thirty minutes before applying steering load pressures.

9. Install the yoke pinch bolt and a new pinch bolt nut. Before tightening the pinch bolt nut, make sure the pinch bolt is centered in the drive shaft notch. The pinch bolt is centered if it can slip in and out of the yoke with ease.

10. Tighten the nut to the torque value specified in **Table 1**.

11. Apply green Torque Seal F-900 to the exposed pinch bolt threads and locknut. Mark the yoke with red paint to indicate that it has been secured with adhesive.

STEERING DRIVELINE, COE, 1984 ADVANCEMENTS

12. On earlier steering driveline installations, place the left half of the deck bearing support bracket in its original position, and tighten the capscrews that attach it to the deck.

13. On later model steering driveline installations, position the deck bearing support halves around the deck bearing. Install, but do not tighten, the bolts, washers, and locknuts. Install the felt washer and crescent retaining ring into the cavity above the deck bearing. Tighten the bolts 15 lbf·ft (20 N·m).

    Install the gasket between the deck and the deck bearing support bracket. Install the deck bearing support bracket capscrews and tighten them 108 lbf·in (1220 N·cm).

14. On *all* steering driveline installations, make sure the deck bearing is seated both in the deck bearing support bracket *and* against the shoulder of the end yoke. See **Fig. 7**. If necessary, loosen the four steering column clamp cap capscrews and adjust the upper column and jacket assembly up or down to position the deck bearing. Tighten the four capscrews 15 lbf·ft (20 N·m).

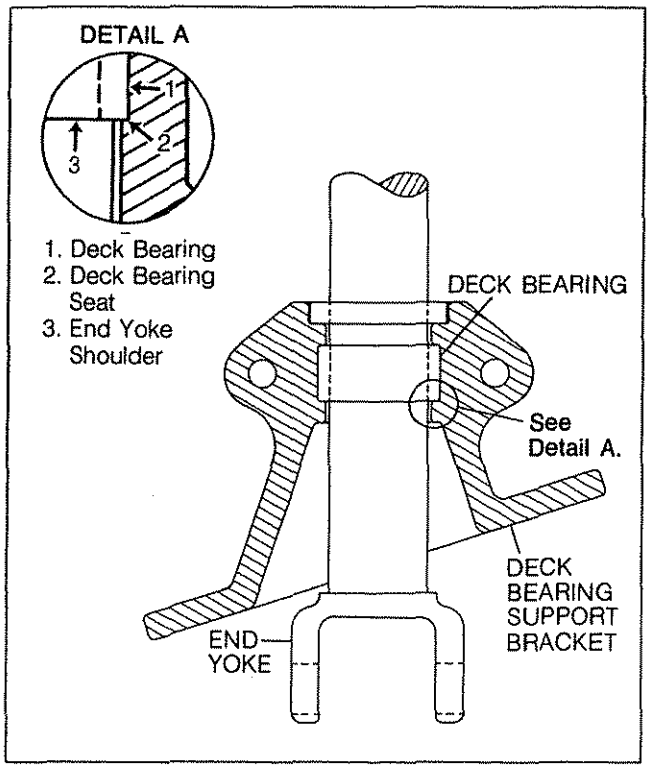


Fig. 7, Deck Bearing

15. On earlier steering driveline installations, install the steering shaft bushing and/or bracket clamp, as equipped. Position the bearing cap on the deck bearing support bracket assembly, and secure it with the washers and panhead screws.

SUPPORT BRACKET CLAMP REPLACEMENT
(Refer to **Fig. 3**)

On earlier steering driveline installations, a clamp (part number 14-10276-000) can be used to stop squeaks in the steering driveline. Squeaks can be caused by the rotation of the entire deck bearing within the support bracket, instead of the outer race remaining stationary while the inner race rotates. The clamp holds the two halves of the deck bearing support bracket to the outer race of the deck bearing, keeping the outer race of the bearing from turning within the housing. A kit, part number N31-01201-001, is available for this procedure.

1. Remove the four screws from the deck bearing support cap. Discard the cap and screws, but save the four washers for later use.

   Remove and discard the nylon steering shaft bushing, if equipped.

2. Lubricate the deck bearing with engine oil of any weight.

3. Position the clamp around the deck bearing housing neck. Install the bolt and one washer through the clamp; then install the second washer and nut from the kit. Tighten the nut finger-tight.

4. Install the new deck bearing cap, part number 14-10058-000, using the washers removed in step 1 and the new screws from the kit. Start the screws, to align them with the holes, but do not tighten them at this time.

5. Tighten the clamp nut 11 to 15 lbf·ft (15 to 20 N·m). Then tighten the four deck-bearing capscrews securely.

6. Turn the steering wheel full-left and full-right several times to ensure that the steering doesn't bind or drag.

STEERING DRIVELINE INSTALLATION
(Refer to **Fig. 1**)

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

STEERING DRIVELINE, COE, 1984 ADVANCEMENTS

1. Thoroughly clean the steering gear input shaft and the upper column and jacket assembly wheel tube shaft with a clean dry cloth. Using a wire brush and Loctite Safety Solvent or an equivalent, clean the splines of the end yokes.

IMPORTANT: If Loctite Safety Solvent is not available, *clean* solvents, such as trichloroethylene, trichloroethane, perchloroethylene, MEK, acetone, or alcohol can be used. *Do not use* kerosene, gasoline, naphtha, fuel oil, Varsol, or Stoddard solvents.

2. Install the driveline tube and yoke assembly through the cab deck cutout.
3. Insert the lower bearing spacer, bearing spring, dust cup, and washer in the lower end of the upper column and jacket assembly. See **Fig. 5**.
4. Apply Locquic General Purpose Primer T to the upper column and jacket assembly wheel tube shaft. Let dry for five minutes.
5. Apply a bead of Loctite No. 680 adhesive to the serrated area of the upper end yoke. Slide the yoke onto the shaft.

NOTE: It may be necessary to apply downward pressure on the steering wheel when installing the yoke to prevent the wheel tube shaft from moving upward in the jacket.

IMPORTANT: After the end yoke has been assembled to the wheel tube shaft, curing will start immediately, and the pinch bolt nut must be tightened within four minutes. If this time is exceeded, the parts must be disassembled, cleaned, and treated again. The U-joint assembly must be allowed to cure for thirty minutes before applying steering load pressures.

6. Install the end yoke pinch bolt and a new pinch bolt nut. Before tightening the pinch bolt nut, make sure the pinch bolt is centered in the upper column and jacket assembly wheel tube shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut 33 lbf·ft (45 N·m).
7. Apply green Torque Seal F-900 to the exposed pinch bolt threads and locknut. Mark the end of the upper column and jacket assembly wheel tube shaft with red paint.
8. On earlier steering driveline installations, apply a bead of 3M Weatherban® No. 101, or equivalent, to the deck on the deck bearing support bracket sealing surface. Using the original fasteners, install the two halves of the deck bearing support bracket.
9. On later model steering driveline installations, position the deck bearing support halves around the deck bearing. Install, but do not tighten, the bolts, washers, and locknuts. Install the felt washer and crescent retaining ring into the cavity above the deck bearing. Tighten the bolts 15 lbf·ft (20 N·m).

   Install the gasket between the deck and the deck bearing support bracket. Install the deck bearing support bracket capscrews and tighten them 108 lbf·in (1220 N·cm).

10. On *all* steering driveline installations, make sure the deck bearing is seated both in the deck bearing support *and* against the shoulder of the end yoke. See **Fig. 7**. If necessary, loosen the four steering column clamp cap capscrews and adjust the upper column and jacket assembly up or down to position the deck bearing. Tighten the clamp cap capscrews 15 lbf·ft (20 N·m).
11. On earlier steering driveline installations, install the steering shaft bushing and/or bracket clamp, as equipped. Position the bearing cap on the deck bearing support bracket assembly, and secure it with the washers and panhead screws.

CAUTION: If the arrow on the driveline shaft yoke is not aligned with the arrow on the driveline tube, the U-joints will be out of phase. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

12. Slide the driveline shaft and yoke assembly into the driveline tube so that the arrows or marks on the driveline shaft yoke and the driveline tube are aligned. See **Fig. 2**. If you cannot find the aligning arrows or marks, refer to **Fig. 8** for correct assembly of the slip joint and U-joint phasing. On Rockwell assemblies, slide the boot from the lower driveline shaft over the end of the driveline tube.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

13. Use a wire brush and Loctite Safety Solvent or an equivalent to clean the serrations of the lower yoke and the input shaft.

IMPORTANT: If Loctite Safety Solvent is not available, *clean* solvents, such as trichloroethylene, trichloroethane,

STEERING DRIVELINE, COE, 1984 ADVANCEMENTS

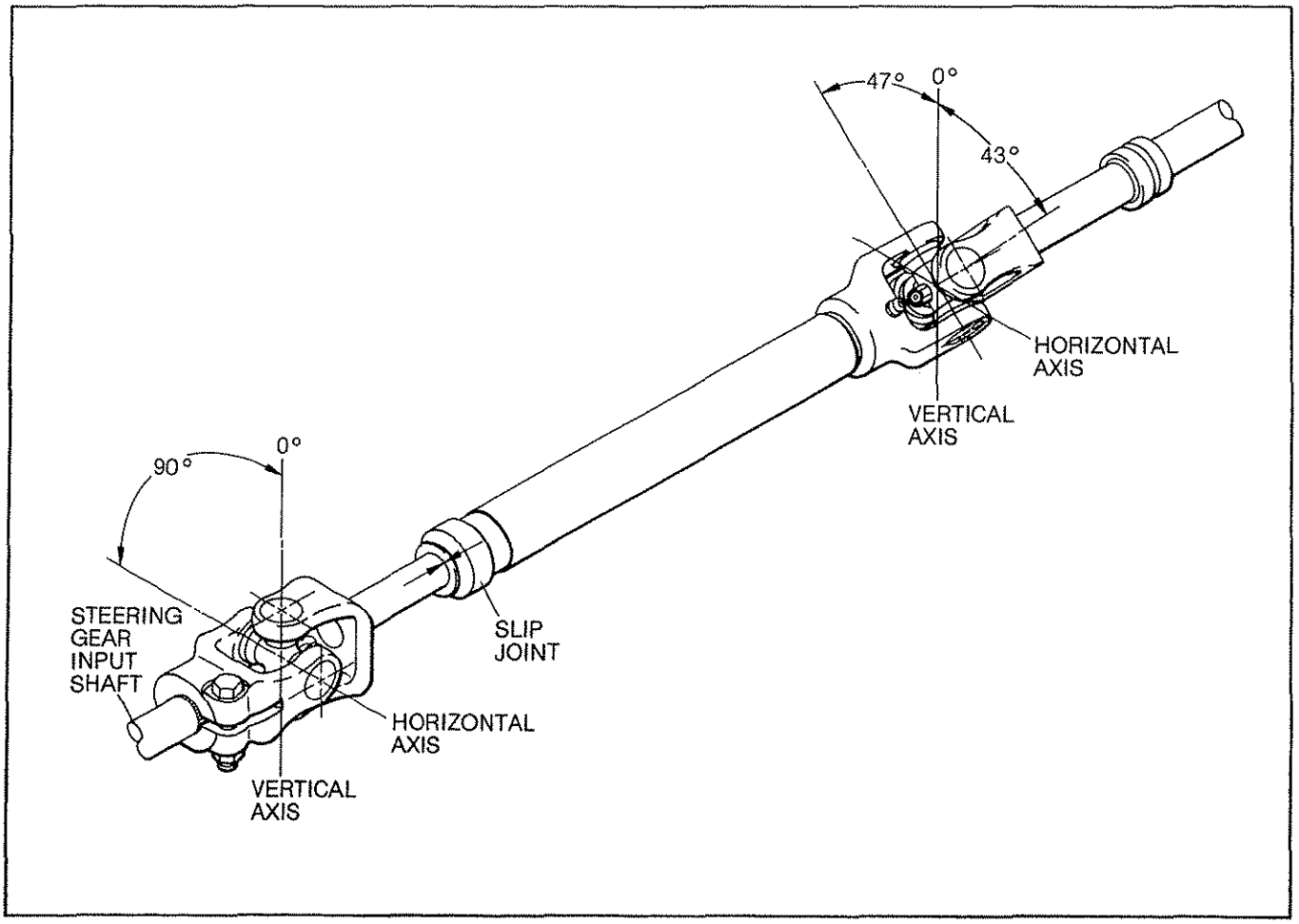


Fig. 8, Driveline U-Joint Phasing

perchloroethylene, MEK, acetone, or alcohol can be used. *Do not use* kerosene, gasoline, naphtha, fuel oil, Varsol, or Stoddard solvents.

14. Line up the cross holes in the lower end yoke with the whistle notch on the steering gear input shaft.
15. Apply Locquic General Purpose Primer T to the steering gear input shaft. Let dry for five minutes.
16. Apply a bead of Loctite No. 680 adhesive to the serrated area of the lower end yoke. Slide the lower end yoke onto the steering gear input shaft. Do not decentralize the steering gear.
17. Install the end yoke pinch bolt and a new pinch bolt nut.

    Before tightening the pinch bolt nut, make sure the pinch bolt is centered in the steering gear shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut 70 lbf·ft (95 N·m).
18. Apply green Torque Seal F-900 to the exposed pinch bolt threads and locknut. Mark the lower end yoke with red paint.
19. Lubricate the U-joints with multipurpose chassis lube until grease appears at the journal cross seals.

WARNING: Do not turn the input shaft of the steering gear to correct the position of the king-spoke on the steering wheel. To do so will decentralize the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering, which could result in injury or property damage.

STEERING DRIVELINE, COE, 1984 ADVANCEMENTS

20. After the steering driveline has been connected to the steering gear input shaft, check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10 degrees when the front tires are in the straight-ahead position. See **Fig. 9**. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject in Group 14 of this manual.

21. Make sure that there is at least 1/4-inch (6 mm) clearance around the steering driveline over its entire length. The brake valve fittings under the cab deck should be positioned as shown in **Fig. 10**. Adjust, if necessary.

22. If any paint has been scraped from the steering driveline, apply touch-up paint as needed.

23. Tilt the cab back to the operating position and secure it. For instructions, refer to the *COE Driver's Manual.*

24. Inject grease into the fitting at the slip joint until grease appears at the lower end of the tube splines.

25. Set the vehicle parking brake, then chock the rear tires to prevent vehicle movement. Raise the vehicle so that the front tires are off the ground, then place safety stands under the frame.

26. Turn the steering wheel through full travel. Check for hard steering or binding. If hard steering or binding is present, check the assembly and installation of the driveline components. If the cause is not the driveline, check for other steering system causes. Refer to the applicable steering gear subject in Group 14 of this manual, or to the applicable steering gear manufacturer's service information.

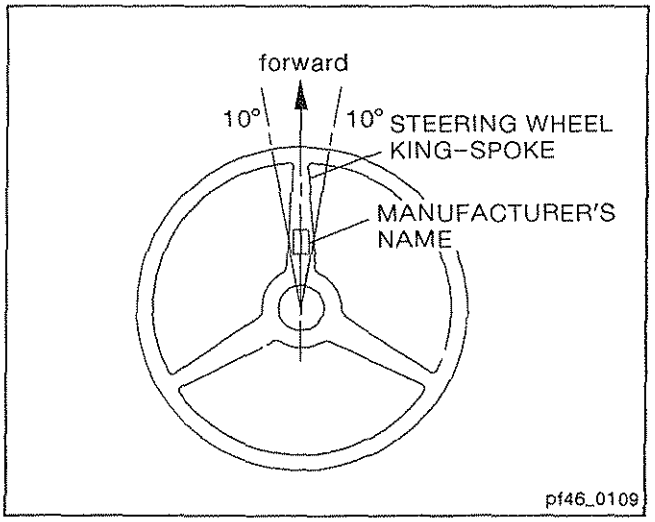
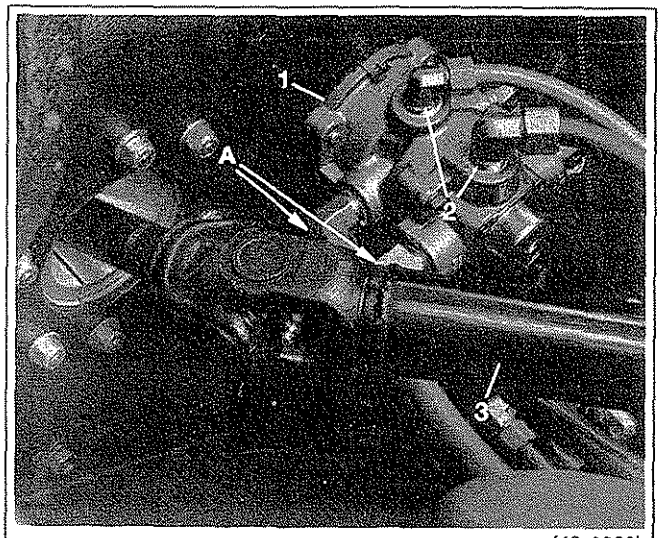


Fig. 9, Steering Wheel Positioning



1. Brake Valve (under cab)
2. Brake Valve Fittings
3. Steering Driveline

A. 1/4" (6 mm) Clearance from driveline.

Fig. 10, Cab Underdeck Hose Routing

WARNING: Driving a vehicle with hard steering or binding in the steering system could result in a hazardous vehicle operating condition, resulting in injury or property damage.

27. Remove the safety stands from under the frame, then lower the vehicle to the ground and remove the chocks from the rear tires.

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SPECIFICATIONS

DESCRIPTION	GRADE	TORQUE*
Upper End Yoke Pinch Bolt Nut (3/8–16)	8	40 lbf·ft (54 N·m)
Lower End Yoke Pinch Bolt Nut (7/16–20)	8	70 lbf·ft (95 N·m)
Upper Driveline Yoke Pinch Bolt Nut, Spicer (7/16–20) Rockwell (3/8–24)	8 8	70 lbf·ft (95 N·m) 45 lbf·ft (61 N·m)
Steering Column Clamp Cap Capscrews (4 qty.)	5	15 lbf·ft (20 N·m)

Table 1, Steering Driveline Torque Values

* Torques are for plain threads. Threads may have residual oil.

STEERING DRIVELINE, COE

GENERAL DESCRIPTION

The manual steering gear driveline in COE vehicles connects the upper column and jacket assembly, by means of a pair of universal joints and a telescoping shaft assembly, to the steering gear. See Fig. 1. The driveline shaft consists of a tubular upper section, that is splined on the inside, to mate with the externally splined lower section. The telescoping shaft assembly accommodates changes in the position of the cab, relative to the vehicle frame, when the cab is being tilted. It also facilitates installation and removal of the steering driveline assembly.

The integral power steering gear driveline in COE vehicles connects the upper column and jacket assembly, by means of universal joints and a telescoping shaft assembly, to the steering gear. See Fig. 2. The driveline shaft consists of an upper shaft and yoke assembly connected to a lower tube and yoke assembly that is splined on the inside. This tube shaft mates with an externally splined shaft and yoke assembly. This telescoping shaft accommodates changes in the position of the cab, relative to the vehicle frame, when the cab is being tilted. It also facilitates installation and removal of the steering driveline assembly.

An integral yoke on the end of each of the driveline shaft sections carries two opposing U-joint needle bearing cups, which are held in place in the yoke by snaprings. The U-joint journal cross rides in these and two other needle bearing cups, which are carried in each of the two end yokes. On some COE vehicles, the upper end yoke is serrated to mate with the upper column and jacket assembly wheel tube shaft, and the lower end yoke is serrated to mate with the steering gear input shaft. Each of the end yokes is secured to its respective shaft with adhesive, and by a pinch bolt which engages a notch in the shaft. On other COE vehicles, the upper end yoke is keyed to mate with the upper column and jacket assembly wheel tube shaft, and the lower end yoke is keyed to mate with the steering gear input shaft. Each of the end yokes is secured to its respective shaft by a pinch bolt, which engages a notch in the shaft.

SERVICE OPERATIONS

If the steering driveline assembly is damaged or needs to be removed for servicing, use the following instructions for removal and replacement.

Fig. 1 shows the three basic manual steering gear driveline installations used on Freightliner COE vehicles. Fig. 1A applies to vehicles equipped with woodruff keyed steering gear input shafts. Fig. 1B applies to vehicles equipped with serrated and full notched steering gear input shafts. Fig. 1C applies to vehicles with serrated and whistle notched steering gear input shafts. When using Fig. 1, refer only to the illustration which relates to the particular vehicle being serviced.

Fig. 2 shows the integral power steering gear driveline installations used on Freightliner COE vehicles equipped with 71 series cabs.

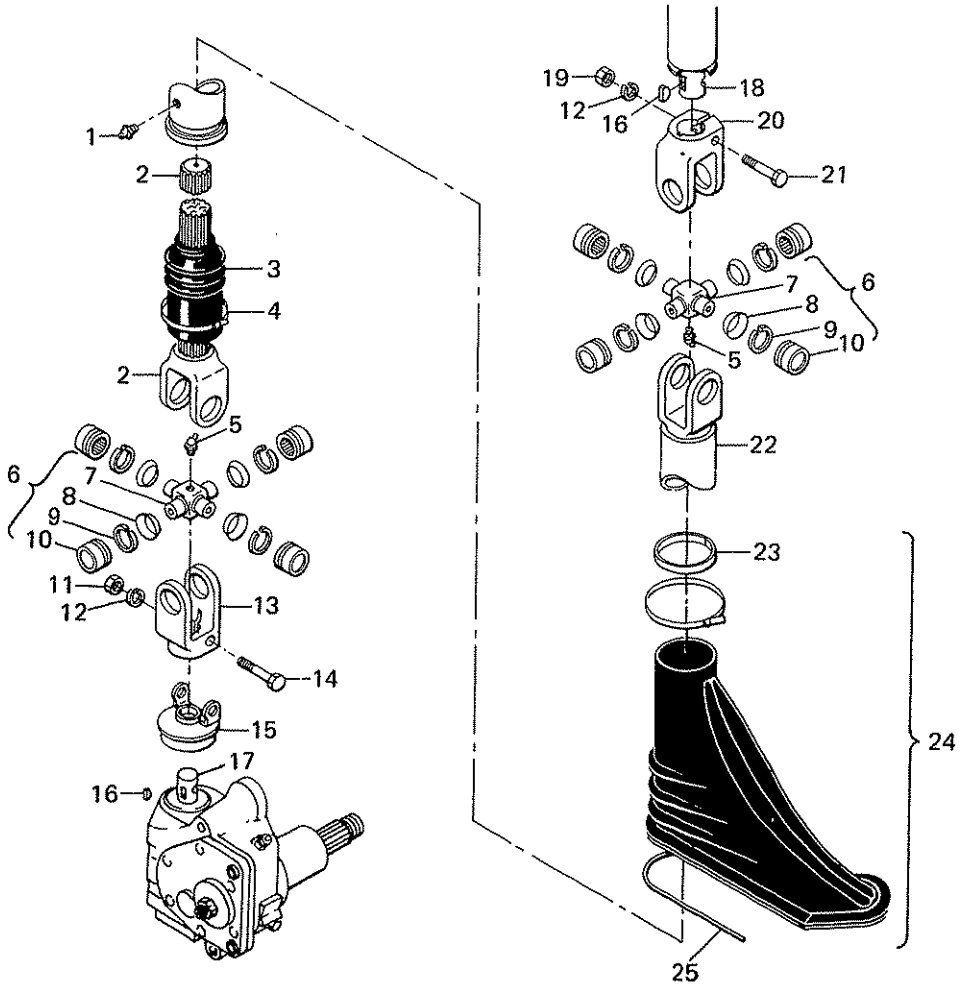
Refer to the applicable steering gear driveline installation figure when instructed to do so in the service operations that follow.

STEERING DRIVELINE REMOVAL
(Refer to Figs. 1 or 2)

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be performed. Then, activate the vehicle parking brakes, and chock the tires.
2. Remove or secure all loose articles in the cab, then tilt the cab following the instructions given in the Freightliner Drivers Manual.
3. If the steering driveline is equipped with a boot seal, remove and discard the boot seal tie-down strap, then slide the boot seal off of the boot seal bracket to expose the lower end yoke.
4. If equipped with a warning tag clipped around the lower end yoke, remove the warning tag by hand.

NOTE: The warning tag shown in Fig. 8 should be located on the lower yoke of manual steering in-

STEERING DRIVELINE, COE

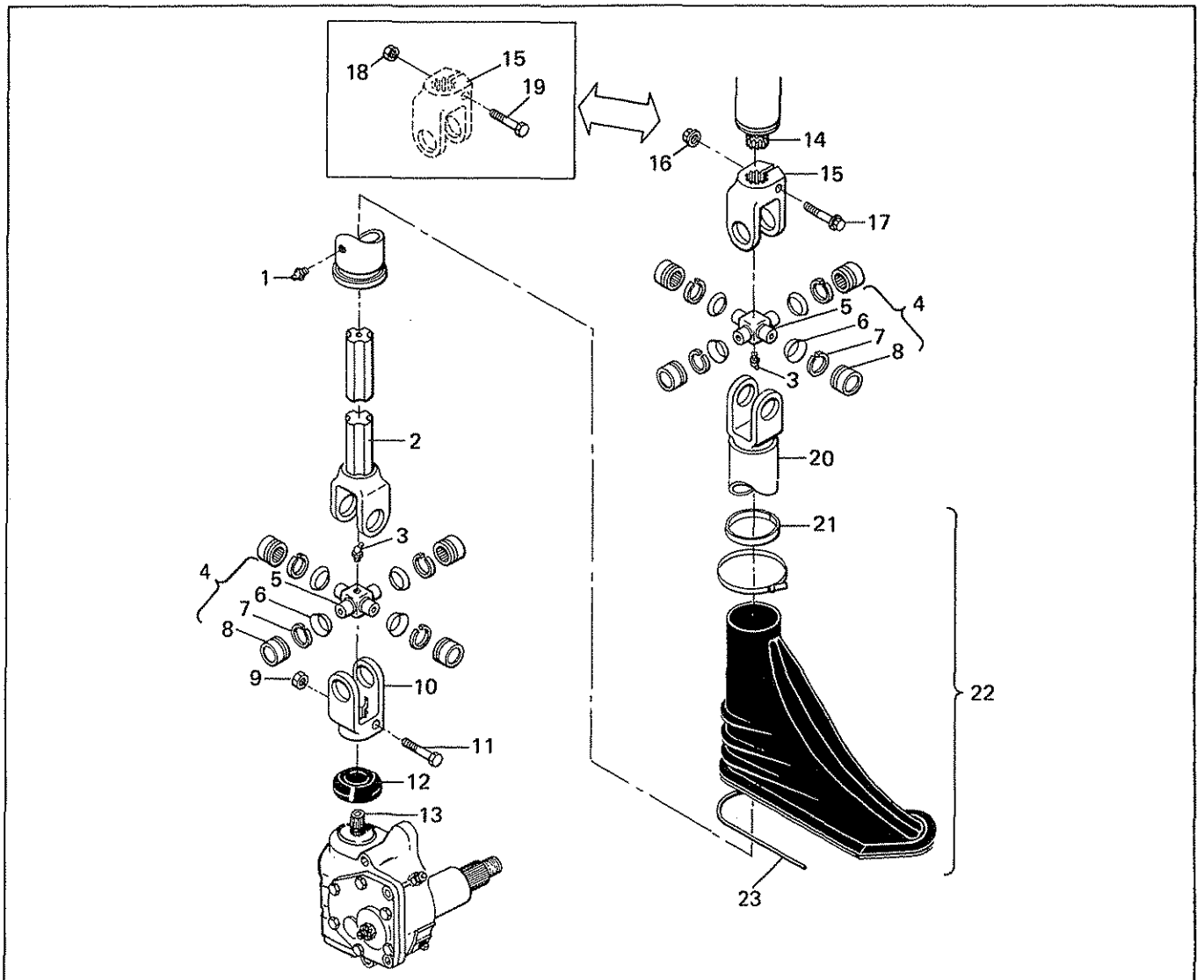


NOTE: Some driveline installations with a keyed type input shaft may be equipped with a serrated type wheel tube shaft.

1. Tube Lube Fitting
2. Driveline Shaft and Yoke Assembly
3. Boot Seal
4. Boot Seal Tie-down Strap
5. Journal Cross Lube Fitting
6. U-joint Assembly
7. U-joint Journal Cross
8. Journal Cross Seal
9. Needle Bearing Cup Snapring
10. Needle Bearing Cup
11. Lower End Yoke Hex Nut
12. Lockwasher
13. Lower End Yoke
14. Lower End Yoke Pinch Bolt, Hex Head Type
15. Boot Seal Bracket
16. Woodruff Key
17. Steering Gear Input Shaft
18. Upper Column and Jacket Assembly Wheel Tube Shaft
19. Upper End Yoke Hex Nut
20. Upper End Yoke
21. Upper End Yoke Pinch Bolt, Hex Head Type
22. Driveline Tube and Yoke Assembly
23. Steering Boot Top Bushing
24. Steering Column Boot Assembly
25. Steering Boot Retainer

Fig. 1A, COE Manual Steering Driveline Installation, Woodruff Keyed and Whistle Notched Input Shaft

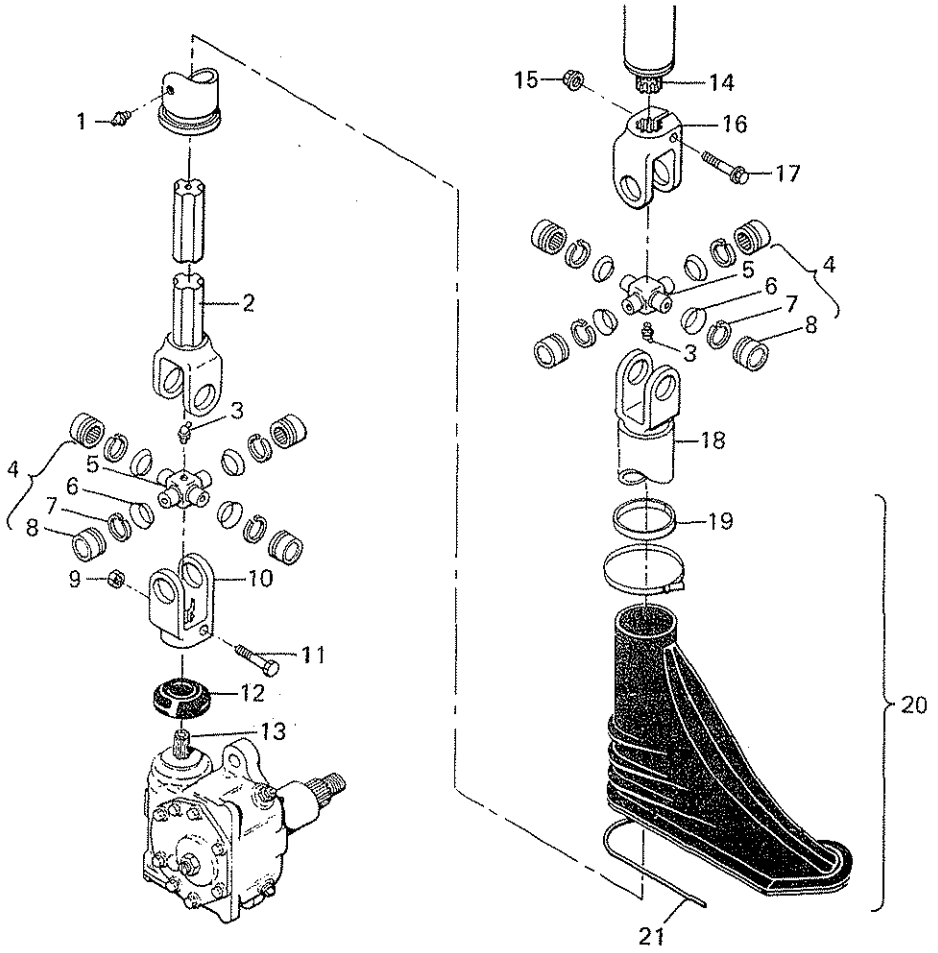
STEERING DRIVELINE, COE



1. Tube Lube Fitting
2. Driveline Shaft and Yoke Assembly
3. Journal Cross Lube Fitting
4. U-joint Assembly
5. U-joint Journal Cross
6. Journal Cross Seal
7. Needle Bearing Cup Snapring
8. Needle Bearing Cup
9. Lower End Yoke Hex Nut
10. Lower End Yoke
11. Lower End Yoke Pinch Bolt, Hex Head Type
12. Boot Cover
13. Steering Gear Input Shaft
14. Upper Column and Jacket Assembly Wheel Tube Shaft
15. Upper End Yoke
16. Upper End Yoke Flanged Nut
17. Upper End Yoke Pinch Bolt, Flanged Hex Head Type
18. Upper End Yoke Hex Nut
19. Upper End Yoke Pinch Bolt, Hex Head Type
20. Driveline Tube and Yoke Assembly
21. Steering Boot Top Bushing
22. Steering Column Boot Assembly
23. Steering Boot Retainer

Fig. 1B, COE Manual Steering Driveline Installation, Serrated and Full Notched Input Shaft

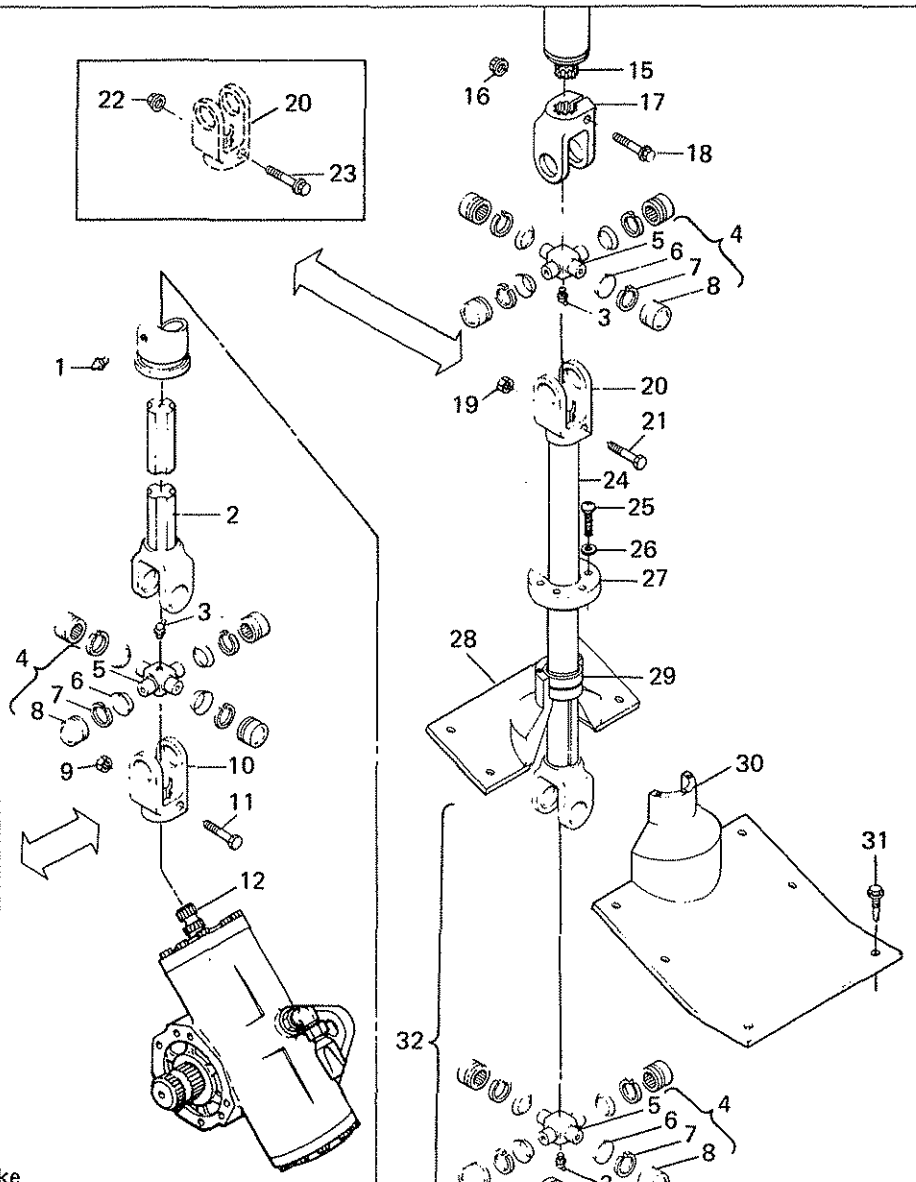
STEERING DRIVELINE, COE



1. Tube Lube Fitting
2. Driveline Shaft and Yoke Assembly
3. Journal Cross Lube Fitting
4. U-joint Assembly
5. U-joint Journal Cross
6. Journal Cross Seal
7. Needle Bearing Cup Snapring
8. Needle Bearing Cup
9. Lower End Yoke Hex Nut
10. Lower End Yoke
11. Lower End Yoke Pinch Bolt, Hex Head Type
12. Boot Cover
13. Steering Gear Input Shaft
14. Upper Column and Jacket Assembly Wheel Tube Shaft
15. Upper End Yoke Flanged Nut
16. Upper End Yoke
17. Upper End Yoke Pinch Bolt, Flanged Hex Head Type
18. Driveline Tube and Yoke Assembly
19. Steering Boot Top Bushing
20. Steering Column Boot Assembly
21. Steering Boot Retainer

Fig. 1C, COE Manual Steering Driveline, Serrated and Whistle Notched Input Shaft

STEERING DRIVELINE, COE



1. Tube Lube Fitting
2. Lower Driveline Shaft and Yoke Assembly
3. Journal Cross Lube Fitting
4. U-joint Assembly
5. U-joint Journal Cross
6. Journal Cross Seal
7. Needle Bearing Cup Snapring
8. Needle Bearing Cup
9. Lower End Yoke Hex Nut
10. Lower End Yoke
11. Lower End Yoke Pinch Bolt, Hex Head Type
12. Steering Gear Input Shaft
13. Lower End Yoke Flanged Nut (For Steering Gear Model Ross HFB70 Only)
14. Lower End Yoke Pinch Bolt, Flanged Hex Head Type (For Steering Gear Model Ross HFB70 Only)
15. Upper Column and Jacket Assembly Wheel Tube Shaft
16. Upper End Yoke Flanged Nut
17. Upper End Yoke
18. Upper End Yoke Pinch Bolt, Flanged Hex Head Type
19. Upper Driveline Shaft End Yoke Hex Nut
20. Upper Driveline Shaft End Yoke
21. Upper Driveline Shaft End Yoke Pinch Bolt, Hex Head Type
22. Upper Driveline Shaft End Yoke Flanged Nut
23. Upper Driveline Shaft End Yoke Pinch Bolt, Flanged Hex Head Type
24. Upper Driveline Shaft
25. Pan Head Screw
26. Washer
27. Bearing Cap
28. Upper Deck Bearing Support Bracket
29. Deck Bearing
30. Lower Deck Bearing Support Bracket
31. Capscrew
32. Intermediate Yoke Assembly
33. Driveline Tube and Yoke Assembly

NOTE: Some fasteners intentionally ommitted in order to provide clarity to the illustration.

NOTE: Steering gear shown is an example only. Actual steering gear models may vary from vehicle to vehicle.

Fig. 2, COE Integral Power Steering Gear Driveline Installation

STEERING DRIVELINE, COE

stallations only. If a warning tag is found on the upper yoke of manual steering installations, it should be removed and discarded. Also, any warning tags (see Fig. 8) found on integral power steering yoke installations, should be removed and discarded.

5. Remove the pinch bolt nut, lockwasher (if used), and pinch bolt from the lower end yoke. Discard the nut. If the lower end yoke *is not* marked with red paint, remove the yoke from the steering gear input shaft. If the lower end yoke *is* marked with red paint, the yoke is secured to the input shaft with adhesive. In addition, if red paint is not visible, but the lower end yoke cannot be removed by hand or with a light application of pressure, the end yoke is secured to the input shaft with adhesive. Heat the base of the lower end yoke with a torch until the bond begins to weaken (at 300°F [149°C] the bond will be reduced to half strength), then remove the yoke from the steering gear input shaft. Do not turn the steering gear input shaft when removing the lower end yoke.

CAUTION: If heat must be applied in order to remove the end yoke from the input shaft, use care not to damage the input shaft seal. If the seal is damaged during end yoke removal, it must be replaced.

6. If equipped with a boot cover, and it is damaged during the removal of the end yoke, replace the boot cover with a new one.

7. Slide the driveline shaft and yoke assembly out of the driveline tube and yoke assembly, then remove the boot seal (if so equipped).

8. Remove the lube fitting located on the lower end of the driveline tube and yoke assembly.

9. Remove the pinch bolt nut, lockwasher (if used), and pinch bolt from the upper end yoke. If the end of the upper column and jacket assembly wheel tube shaft *is not* marked with red paint, remove the upper end yoke from the shaft. If the wheel tube shaft *is* marked with red paint, the yoke is secured to the shaft with adhesive. In addition, if red paint is not visible, but the upper end yoke cannot be removed by hand or with a light application of pressure, the end yoke is secured to the input shaft with adhesive. Heat the base of the upper end yoke with a torch until the bond begins to weaken (at 300°F [149°C] the bond will be reduced to half strength), then remove the yoke from the wheel tube shaft. Collect the washer, dust cup, bearing spring, and lower bearing spacer (serrated wheel tube shafts) or the woodruff key and the tapered bearing spacer sleeve (woodruff keyed wheel tube shafts) as they drop from the end of the upper column and jacket assembly. See Fig. 3.

10. If equipped with a manual steering gear driveline, remove the driveline assembly from the inside of the cab, up and out of the steering column boot assembly.

    If equipped with an integral power steering gear driveline, use the following instructions for removal from the vehicle (see Fig. 2):

    .1 Remove the pan head screws and washers that attach the bearing cap to the deck bearing support bracket assembly.

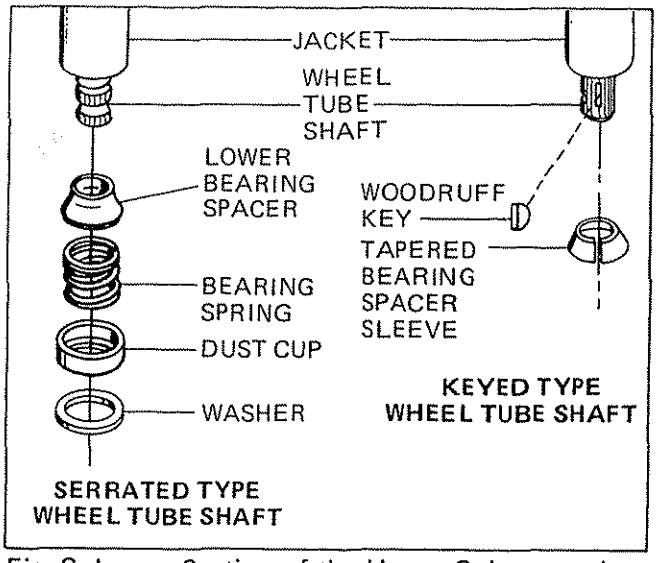


Fig. 3, Lower Section of the Upper Column and Jacket Assembly

STEERING DRIVELINE, COE

.2 Remove the capscrews that attach the upper half of the deck bearing support bracket to the cab floor. Then, lift the bearing cap from the deck bearing support bracket and remove the upper half of the deck bearing support bracket.

.3 Remove the driveline assembly from the inside of the cab, up and out of the cab floor and deck bearing support bracket.

DISASSEMBLY (Refer to Figs. 1 or 2)

Disassembly of the steering driveline U-joints requires the use of a U-joint tool assembly. See Fig. 4.

1. Clamp the U-joint tool frame into a vise.

2. Remove the needle bearing cup snaprings from the needle bearing cups by pushing the open end of the snapring(s) with a screwdriver.

WARNING: When removing snaprings from the needle bearings cups, always wear safety goggles. Snaprings can become potentially harmful projectiles when they are removed.

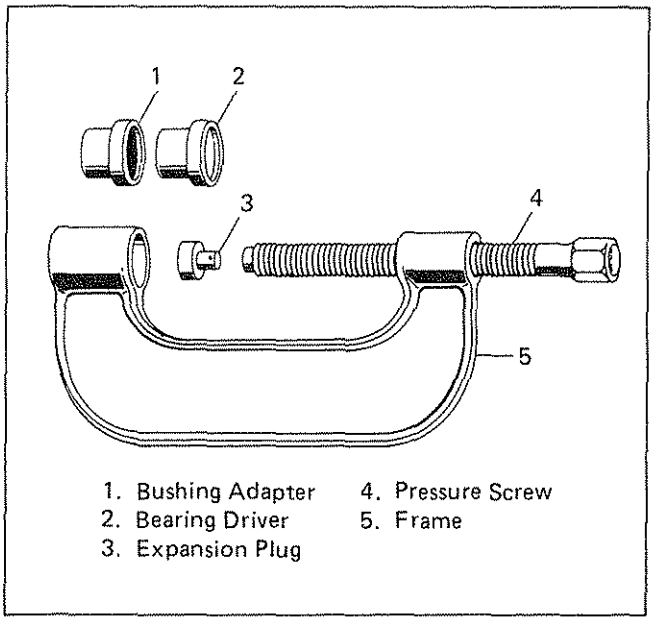


Fig. 4, Universal Joint Tool Assembly

3. Select an expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Then, select a bushing adapter of slightly larger inside diameter than the needle bearing cup, and place it on the opposite end of the tool.

4. Place the driveline tube and yoke assembly on the U-joint tool with the bushing adapter positioned to receive a needle bearing cup and the expansion plug against the opposite needle bearing cup.

5. Tighten the pressure screw to press the needle bearing cup out of the driveline tube and yoke assembly, then remove the needle bearing cup. Reverse the driveline tube and yoke assembly and press against the U-joint journal cross to force out the other needle bearing cup. In stubborn cases it may be necessary to give the pressure screw a sharp rap with a brass hammer while it is under pressure to start the pressing operation.

6. Remove the driveline tube and yoke assembly from the U-joint tool, then remove the upper end yoke and the journal cross from the driveline tube and yoke assembly.

7. Place the upper end yoke on the U-joint tool with the bushing adapter positioned to receive a needle bearing cup and the expansion plug against the opposite needle bearing cup.

8. Tighten the pressure screw to press the needle bearing cup out of the upper end yoke, then remove the needle bearing cup. Reverse the upper end yoke on the U-joint tool and press against the U-joint journal cross to force out the other needle bearing cup. In stubborn cases it may be necessary to give the pressure screw a sharp rap with a brass hammer while it is under pressure to start the pressing operation.

9. Remove the upper end yoke from the U-joint tool, then remove the journal cross from the upper end yoke.

STEERING DRIVELINE, COE

10. Repeat steps 4 through 9 for the driveline shaft and yoke assembly and the lower end yoke, and, if equipped with an integral power steering gear, the intermediate yoke assembly.

ASSEMBLY (Refer to Figs. 1 or 2)

WARNING: Do not use old snaprings when assembling the U-joints. Used snaprings are often distorted and over-stressed from disassembly. Also, new snaprings must be fully seated in their grooves when assembling the U-joints. Snaprings not fully seated in their grooves could work loose, resulting in a loss of steering control.

Assembly of the steering driveline U-joints requires the use of a U-joint tool assembly. See Fig. 4.

1. Clamp the U-joint tool frame into a vise.

2. Select a U-joint tool expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Then, place a bearing driver on the opposite end of the tool.

3. Position the U-joint journal cross in the upper end yoke so that the journal cross lube fitting points towards one of the yoke ears.

4. Make certain the journal cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the upper end yoke on the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.

5. Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint journal cross during the pressing operation to assure free movement. If the needle bearing cups do not seat correctly or if the U-joint binds, give the yoke shoulder near each cup a sharp rap with a brass hammer.

6. Press the needle bearing cup on the screw end of the U-joint tool all the way in until there is enough clearance to insert a needle bearing cup snapring, then insert the snapring. Reverse the upper end yoke on the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snapring. Insert the snapring, then remove the upper end yoke from the U-joint tool.

7. With the journal cross lube fitting facing away from the base of the upper end yoke, position the U-joint journal cross and the upper end yoke in the driveline tube and yoke assembly.

NOTE: The journal cross lube fitting should face away from the base of the upper end yoke to provide access for lubrication when the steering driveline is installed on the vehicle.

8. Make certain that the journal cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the driveline tube and yoke assembly on the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.

9. Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint journal cross during the pressing operation to assure free movement. If the needle bearing cups do not seat correctly or if the U-joint binds, give the yoke shoulder near each cup a sharp rap with a brass hammer.

10. Press the needle bearing cup on the screw end of the U-joint tool all the way in until there is enough clearance to insert a needle bearing cup snapring, then insert the snapring. Reverse the driveline tube and yoke assembly on the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snapring. Insert the snapring, then remove the driveline tube and yoke assembly from the U-joint tool.

STEERING DRIVELINE, COE

11. Repeat steps 3 through 10 for the lower end yoke and the driveline shaft and yoke assembly, and, if equipped with an integral power steering gear, the intermediate yoke assembly.

STEERING DRIVELINE INSTALLATION
(Refer to Figs. 1 or 2)

1. Thoroughly clean the steering gear input shaft and the upper column and jacket assembly wheel tube shaft with a clean dry cloth. Using a wire brush and Loctite Safety Solvent, or an equivalent, clean the serrations of the end yokes and shafts.

IMPORTANT: If Loctite Safety Solvent is not available, CLEAN solvents, such as trichloroethylene, trichloroethane, perchloroethylene, MEK, acetone, or alcohol can be used. DO NOT USE kerosene, gasoline, naptha, fuel oil, Varsol, or Stoddard solvents.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

2. If equipped with a manual steering gear, position the driveline tube and yoke assembly down through the steering column boot assembly.

3. If equipped with an integral power steering gear, position the driveline tube and yoke assembly in the deck bearing support bracket, using the following procedure (see Fig. 2):

   .1 If the caulking sealant around the cab deck cut out is no longer pliable, replace with a new strip of black caulking sealant.

   .2 Insert the driveline tube and yoke assembly through the cab deck cut out and lower deck bearing support bracket.

   .3 Position the driveline deck bearing in the lower deck bearing support bracket with the driveline shaft as high as possible so that the spacer of the upper driveline shaft bottoms on the deck bearing and lower end yoke. See Fig. 5.

   .4 Position the top half of the deck bearing support bracket on the cab deck and against the lower deck bearing support bracket to enclose the deck bearing.

   .5 Secure the top half of the deck bearing support bracket on the cab deck with the attaching capscrews.

   .6 Position the bearing cap on the deck bearing support bracket assembly, and secure with the washers and pan head screws.

IMPORTANT: Make sure the deck bearing is in position in the deck bearing support bracket, and that the steering driveline is as high as possible with the spacer of the upper driveline shaft tight between the deck bearing and lower end yoke. See Fig. 5.

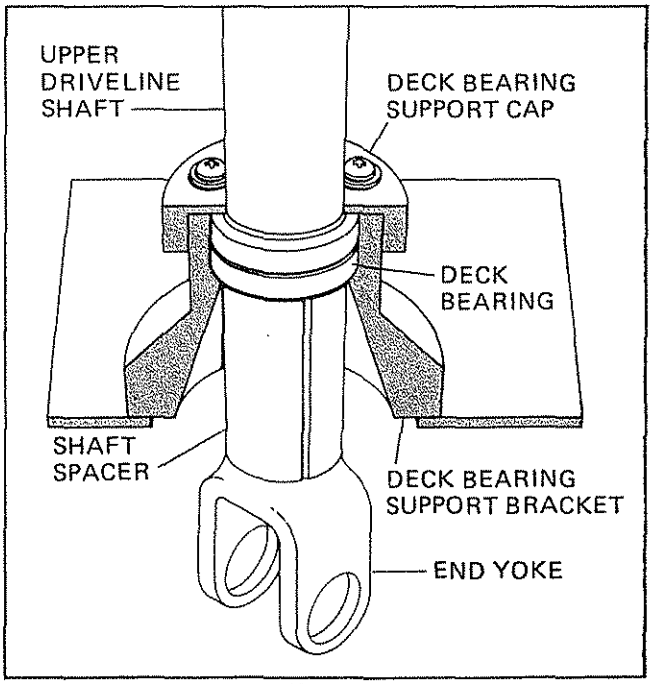


Fig. 5

STEERING DRIVELINE, COE

4. If the upper column and jacket assembly has a keyed wheel tube shaft, make sure the tapered bearing spacer sleeve and woodruff key are in place on the wheel tube shaft. See Fig. 3.

   If the upper column and jacket assembly has a serrated wheel tube shaft, insert the lower bearing spacer, bearing spring, dust cup, and washer in the lower end of the upper column and jacket assembly. See Fig. 3.

5. On vehicles equipped with woodruff keyed type upper column and jacket assembly wheel tube shafts, proceed to step 7.

   On vehicles equipped with serrated type upper column and jacket assembly wheel tube shafts, apply Locquic General Purpose Primer T to the upper column and jacket assembly wheel tube shaft. Let dry for five minutes.

6. Apply a bead of Loctite No. 680 adhesive to the serrated area of the upper end yoke.

IMPORTANT: After the end yoke has been assembled to the wheel tube shaft, curing will start immediately, and the pinch bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. The U-joint assembly must be allowed to cure for thirty minutes before applying steering load pressures.

7. Slide the upper end yoke onto the upper column and jacket assembly wheel tube shaft, then install the end yoke pinch bolt, lockwasher (if used), and pinch bolt nut. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the upper column and jacket assembly wheel tube shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut to the applicable torque value, given in Table 1 located under "SPECIFICATIONS."

8. Apply green Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. If adhesive is used on the upper end yoke, mark the end of the upper column and jacket assembly wheel tube shaft with red paint.

9. If equipped with a boot seal, install the boot seal over the splined shaft on the driveline shaft and yoke assembly.

10. On steering drivelines marked with arrows, slide the driveline shaft and yoke assembly into the driveline tube and yoke assembly so that the arrows on the driveline shaft yoke and the driveline tube are aligned. See Fig. 6.

    On steering drivelines not marked with arrows, slide the driveline shaft and yoke assembly into the driveline tube and yoke assembly so that the end yoke cross holes are parallel to each other, and on the same side of the shaft centerline.

CAUTION: If the arrow on the driveline shaft yoke is not aligned with the arrow on the driveline tube, the U-joints will be out of phase. If not marked with arrows, the end yoke cross holes must be parallel to each other and on the same side of the shaft centerline. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

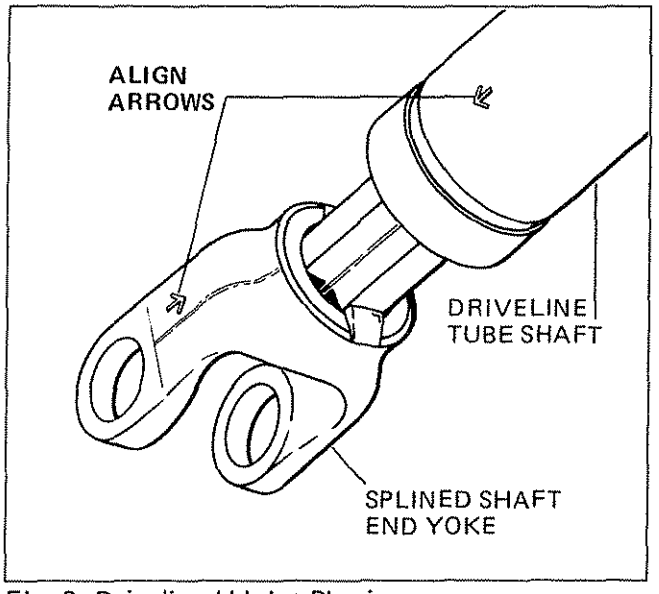


Fig. 6, Driveline U-joint Phasing

STEERING DRIVELINE, COE

11. On vehicles with whistle notched type steering gear input shafts, line up the cross holes in the lower end yoke with the whistle notch on the input shaft.

    On vehicles with full notched type steering gear input shafts, position the steering wheel so that the king-spoke (the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside) points directly toward the front of the vehicle (positioned at 12 o'clock ± 10°). See Fig. 7.

12. On vehicles equipped with woodruff keyed type steering gear input shafts, proceed to step 14.

    On vehicles equipped with serrated type steering gear input shafts, apply Locquic General Purpose Primer T to the steering gear input shaft. Let dry for five minutes.

13. Apply a bead of Loctite No. 680 adhesive to the serrated area of the lower end yoke.

IMPORTANT: After the end yoke has been assembled to the steering gear input shaft, curing will start immediately, and the pinch bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. The U-joint assembly must be allowed to cure for thirty minutes before applying steering load pressures.

14. Slide the lower end yoke onto the steering gear input shaft. Do not decentralize the steering gear. Install the end yoke pinch bolt, lockwasher (if used), and pinch bolt nut. If equipped with a boot seal bracket, install the pinch bolt through the bracket and the lower end yoke. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the steering gear shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut to the applicable torque value, given in Table 1 under "SPECIFICATIONS."

15. Apply green Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. If adhesive is used on the lower end yoke, mark the lower end yoke with red paint.

16. If equipped with a manual steering gear, attach the warning tag by hand, around the lower end yoke, making sure that the label is upright. See Fig. 8.

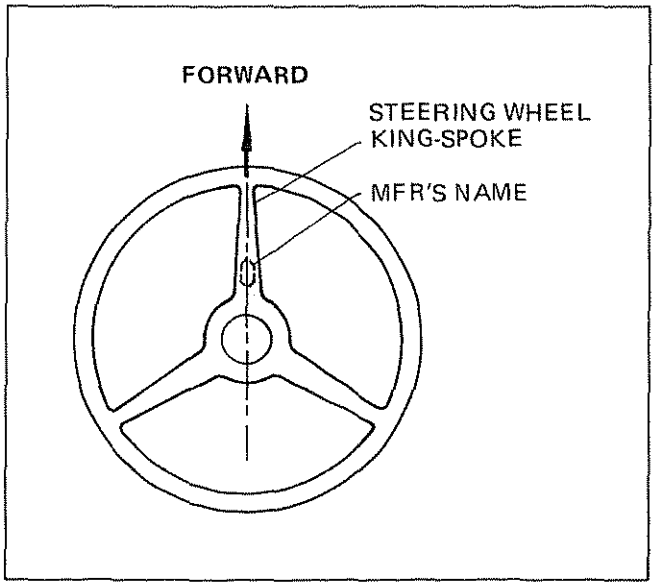


Fig. 7, Steering Wheel Positioning

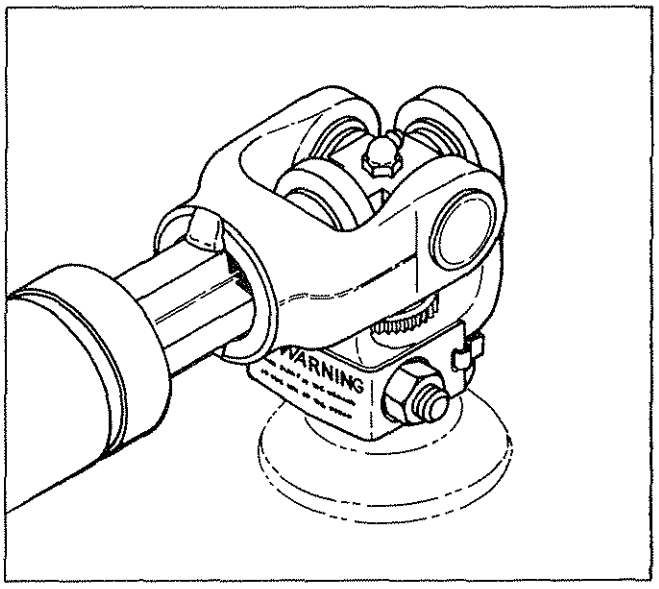


Fig. 8

STEERING DRIVELINE, COE

17. Install the lube fitting in the driveline tube and yoke assembly. Lubricate the driveline tube and U-joints with multipurpose chassis lube until grease appears at the lower end of the tube splines and the journal cross seals.

18. If equipped with a boot seal, slide it down over the boot seal bracket, then install a new plastic boot seal tie-down strap. Trim the end of the boot seal tie-down strap flush with the strap locking sleeve.

WARNING: If equipped with a manual steering gear, do not substitute a metal hose clamp for the plastic tie-down strap that secures the boot seal to the boot seal bracket. The steering driveline could become jammed if a foreign object were to lodge between the steering gear housing and the tightening screw on the hose clamp.

19. After the steering driveline has been connected to the steering gear input shaft, check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10° when the front tires are in the straight-ahead position. See Fig. 7. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject, in the 14 Group of this manual.

IMPORTANT: On some earlier vehicles equipped with an upper column and jacket assembly on which the steering wheel is attached using a woodruff key, the steering gear input shaft may also be keyed. If the king-spoke is not positioned at 12 o'clock ± 10° on this type of installation, and adjustments are not possible, the steering wheel and the upper column and jacket wheel tube shaft are mismatched, and one or both should be replaced.

WARNING: Do not turn the input shaft of the steering gear in order to correct the position of the king-spoke on the steering wheel. To do so will decentralize the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering.

20. Check to make sure that there is at least 1/4-inch (6 mm) clearance around the steering driveline over its entire length. The brake valve fittings under the cab deck should be positioned as shown in Fig. 9. Adjust, if necessary.

21. If any paint has been scraped off from the steering driveline, apply touch-up paint, as needed.

22. Tilt the cab back to the operating position. For instructions, refer to the Freightliner Drivers Manual.

23. Set the vehicle parking brake, then chock the rear tires to prevent vehicle movement. Raise the vehicle so that the front tires are off the ground, then place safety stands under the frame.

24. Turn the steering wheel through full travel, checking for hard steering or binding. If hard steering or binding is present, check the assembly

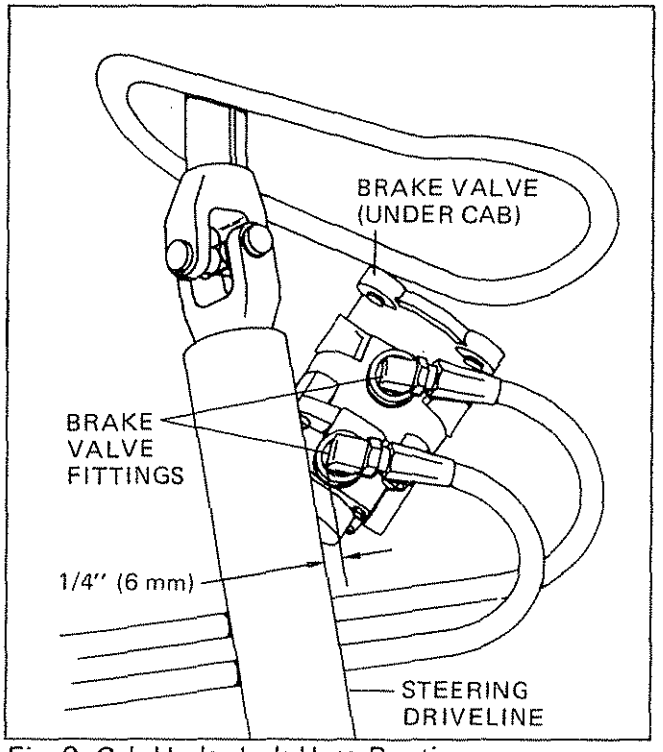


Fig. 9, Cab Underdeck Hose Routing

and installation of the driveline components. If the cause is not the driveline, refer to the applicable steering gear subject in the 14 Group of this manual, or to the applicable steering gear manufacturer's service information, for steering system inspection checks.

WARNING: Driving a vehicle with hard steering or binding in the steering system could result in a hazardous vehicle operating condition.

25. Remove the safety stands from under the frame, then lower the vehicle to the ground and remove the chocks from the rear tires.

STEERING COLUMN BOOT ASSEMBLY REPLACEMENT, MANUAL STEERING GEAR (Refer to Fig. 1)

If the boot assembly is damaged or needs to be removed for service, use the following procedure for replacement.

1. Remove the steering driveline from the vehicle. For instructions, refer to "STEERING DRIVELINE REMOVAL," in this subject.

2. Using a strap, pull the ends of the steering boot retainer together, then remove the retainer from the boot groove.

3. Lift up the floor mat, then pry down the upper lip of the steering column boot assembly until it is below the deck. Remove the steering column boot assembly from the underside of the deck and inspect it for damage or wear. If the steering column boot assembly is damaged or worn, replace it with a new one.

NOTE: The steering column boot is available as part of an assembly only.

4. Position the steering column boot assembly up through the cab deck, engaging the boot lip to the deck.

5. Using a strap, pull the ends of the steering boot retainer together, then position the retainer in the boot and remove the strap.

6. Install the steering driveline in the vehicle. For instructions, refer to "STEERING DRIVELINE INSTALLATION," in this subject.

BOOT SEAL REPLACEMENT, MANUAL STEERING GEAR (Refer to Fig. 1)

If the boot seal is damaged or needs to be removed for service, use the following instructions for replacement.

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be performed. Then, activate the vehicle parking brakes, and chock the tires.

2. Remove or secure all loose articles in the cab, then tilt the cab following the instructions given in the Freightliner Drivers Manual.

3. Remove and discard the boot seal tie-down strap, then slide the boot seal off of the boot seal bracket to expose the lower end yoke.

4. Remove the end yoke pinch bolt nut and lockwasher (if used), from the lower end yoke pinch bolt, then remove the pinch bolt from the yoke. Slide the lower end yoke off of the steering gear input shaft.

5. Slide the driveline shaft and yoke assembly out of the driveline tube and yoke assembly, then remove the boot seal.

6. Install the new boot seal over the splined shaft on the driveline shaft and yoke assembly.

7. On steering drivelines marked with arrows, slide the driveline shaft and yoke assembly into the driveline tube and yoke assembly so that

STEERING DRIVELINE, COE

the arrows on the driveline shaft yoke and the driveline tube are aligned. See Fig. 6.

On steering drivelines not marked with arrows, slide the driveline shaft and yoke assembly into the driveline tube and yoke assembly so that the end yoke cross holes are parallel to each other, and on the same side of the shaft centerline.

CAUTION: If the arrow on the driveline shaft yoke is not aligned with the arrow on the driveline tube, the U-joints will be out of phase. If not marked with arrows, the end yoke cross holes must be parallel to each other and on the same side of the shaft centerline. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

8. Line up the cross holes in the lower end yoke with the whistle notch on the input shaft. Slide the lower end yoke onto the steering gear input shaft. Do not decentralize the steering gear. Install the lockwasher on the end yoke pinch bolt, then install the pinch bolt through the boot seal bracket and the lower end yoke. Install the nut. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the steering gear input shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut to the applicable torque value, given in Table 1 located under "SPECIFICATIONS."

9. Slide the boot seal down over the boot seal bracket, then install a new plastic boot seal tie-down strap. Trim the end of the boot seal tie-down strap flush with the strap locking sleeve.

WARNING: Do not substitute a metal hose clamp for the standard plastic tie-down strap that secures the driveline boot seal to the boot seal bracket. The steering driveline could become jammed if a foreign object were to lodge between the steering gear housing and the tightening screw on the hose clamp.

10. After the steering driveline has been connected to the steering gear input shaft, check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10° when the front tires are in the straight-ahead position. See Fig. 7. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject located in the 14 Group of this manual.

IMPORTANT: If the king-spoke is not positioned at 12 o'clock ± 10° on this type of installation, and adjustments are not possible, the steering wheel and the upper column and jacket wheel tube shaft are mismatched and one or both should be replaced.

WARNING: Do not turn the input shaft of the steering gear in order to correct the position of the king-spoke on the steering wheel. To do so will decentralize the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering.

11. Tilt the cab back to the operating position. For instructions, refer to the Freightliner Drivers Manual.

12. Set the vehicle parking brake, then chock the rear tires to prevent vehicle movement. Raise the vehicle so that the front tires are off the ground, then place safety stands under the frame.

13. Turn the steering wheel through full travel, checking for hard steering or binding. If hard steering or binding is present, check the assembly and installation of the driveline components. If the cause is not the driveline, refer to the applicable steering gear subject in the 14 Group of this manual, or to the applicable steering gear manufacturer's service information, for steering system inspection checks.

WARNING: Driving a vehicle with hard steering or binding in the steering system could result in a hazardous vehicle operating condition.

STEERING DRIVELINE, COE

15. Remove the safety stands from under the frame, then lower the vehicle to the ground and remove the chocks from the rear tires.

DECK BEARING SUPPORT BRACKET REPLACEMENT, INTEGRAL POWER STEERING GEAR (Refer to Fig. 2)

If the deck bearing support bracket is damaged or needs to be removed for service, use the following procedure for replacement.

1. Remove the bearing cap pan head screws and washers that attach the bearing cap to the deck bearing support bracket assembly.

2. Remove the capscrews that attach the upper half of the deck bearing support bracket to the cab deck. Then, lift the bearing cap from the deck bearing support bracket, and remove the upper half of the deck bearing support bracket.

3. Remove the capscrews that attach the lower half of the deck bearing support bracket to the cab deck. Then, remove the lower deck bearing support bracket from the cab deck and the driveline deck bearing.

4. If the caulking sealant around the cab deck cut out is no longer pliable, replace with a new strip of black caulking sealant.

5. Position the lower half of the deck bearing support bracket in alignment with the break in the deck and centered over the deck cut out. The driveline deck bearing should be in position in the lower deck bearing support bracket. Secure with the attaching capscrews.

6. Position the top half of the deck bearing support bracket on the cab deck and against the lower deck bearing support bracket to enclose the driveline deck bearing.

7. Secure the top half of the deck bearing support bracket on the cab deck with the attaching capscrews.

8. Position the bearing cap on the deck bearing support bracket assembly, and secure with the washers and pan head screws.

SPECIFICATIONS

DESCRIPTION		SIZE	GRADE	TORQUE lbf·ft (N·m)
Upper End Yoke Pinch Bolt Nut		3/8-16	G	35-40 (47-54)
		7/16-20	C	75 (102)
		7/16-20	B	40-50 (54-68)
Lower End Yoke Pinch Bolt Nut	All, Except Ross HFB70 Integral Power Steering Gear	7/16-20	C	63-75 (85-102)
		7/16-14	G	65 (88)
	Ross HFB70 Integral Power Steering Gear	3/8-24	C	40-48 (54-65)
		3/8-16	G	35-40 (47-54)
Intermediate End Yoke Pinch Bolt Nut		7/16-20	C	63-75 (85-102)
		7/16-14	G	65 (88)

Table 1, Torque Values

STEERING DRIVELINE, CONVENTIONAL

GENERAL DESCRIPTION

The steering driveline in Conventional vehicles connects the upper column and jacket assembly, through a pair of universal joints and a telescoping shaft, to the steering gear assembly. The driveline shaft consists of a tubular upper section, splined on the inside, to mate with the externally splined lower section. The telescoping shaft will facilitate installation and removal of the steering driveline assembly.

An integral yoke on the end of each of the two driveline shaft sections carries two opposing universal joint needle bearing cups, which are held in place in the yoke by snaprings. The universal joint journal cross rides in these and two other needle bearing cups, which are carried in each of the two end yokes. On some Conventionals, the upper end yoke is serrated to mate with the upper column and jacket assembly wheel tube shaft, and the lower end yoke is serrated to mate with the steering gear input shaft. Each of the end yokes is secured to its respective shaft with adhesive and by a pinch bolt, which engages a notch in the shaft. On other Conventionals, the upper end yoke is keyed to mate with the upper column and jacket assembly wheel tube shaft, and the lower end yoke is keyed to mate with the steering gear inptu shaft. Each of the end yokes is secured to its respective shaft by a pinch bolt, which engages a notch in the shaft.

SERVICE OPERATIONS

Fig. 1 shows the three basic steering driveline installations used on Freightliner Conventional vehicles. Fig. 1A applies to vehicles equipped with woodruff keyed steering gear input shafts. Fig. 1B applies to vehicles equipped with serrated and full notched steering gear input shafts. Fig. 1C applies to vehicles with serrated and whistle notched steering gear input shafts. When using Fig. 1, refer only to the illustration which relates to the particular vehicle being serviced.

STEERING DRIVELINE REMOVAL
(Refer to Fig. 1)

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be performed. Then, activate the vehicle parking brakes, and chock the tires.

2. Release the hood latches on each side of the hood and tilt the hood to the full open position.

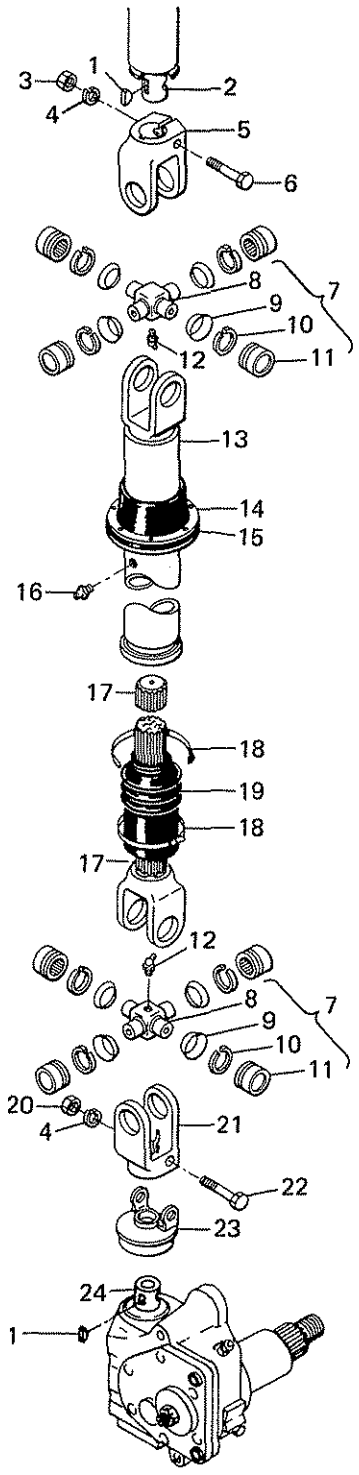
3. If the driveline is equipped with a boot seal, remove and discard the boot seal tie-down strap, then slide the boot seal off of the boot seal bracket to expose the lower end yoke.

4. If equipped with a warning tag clipped around the lower end yoke, remove the warning tag by hand.

NOTE: The warning tag shown in Fig. 6 should be located on the lower yoke of manual steering installations only. If a warning tag is found on the upper yoke of manual steering installations, it should be removed and discarded. Also, any warning tags (see Fig. 6) found on integral power steering yoke installations, should be removed and discarded.

5. Remove the pinch bolt nut, lockwasher (if used), and pinch bolt from the lower end yoke. Discard the nut. If the lower end yoke *is not* marked with red paint, remove the yoke from the steering gear input shaft. If the lower end yoke *is* marked with red paint, the yoke is secured to the input shaft with adhesive. In addition, if red paint is not visible, but the lower end yoke cannot be removed by hand or with a light application of pressure, the end yoke is secured to the input shaft with adhesive. Heat the base of the lower end yoke with a torch until the bond begins to weaken (at 300°F [149°C] the bond will be reduced to half strength), then remove the yoke from the steering gear input shaft. Do not turn the

STEERING DRIVELINE, CONVENTIONAL

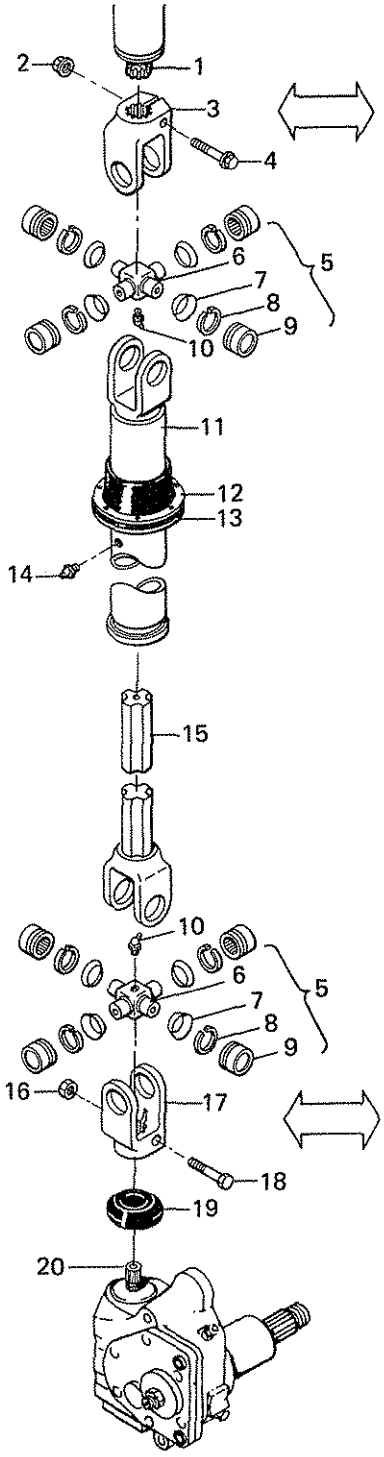


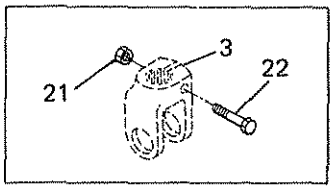
1. Woodruff Key
2. Upper Column and Jacket Assembly Wheel Tube Shaft
3. Upper End Yoke Hex Nut
4. Lockwasher
5. Upper End Yoke
6. Upper End Yoke Pinch Bolt, Hex Head Type
7. U-Joint Assembly
8. U-Joint Journal Cross
9. Journal Cross Seal
10. Needle Bearing Cup Snapring
11. Needle Bearing Cup
12. Journal Cross Lube Fitting
13. Driveline Tube and Yoke Assembly
14. Boot Retainer Ring
15. Deck Boot Assembly
16. Tube Lube Fitting
17. Driveline Shaft and Yoke Assembly
18. Boot Seal Tie-Down Strap
19. Boot Seal
20. Lower End Yoke Hex Nut
21. Lower End Yoke
22. Lower End Yoke Pinch Bolt, Hex Head Type
23. Boot Seal Bracket
24. Steering Gear Input Shaft

NOTE: Some driveline installations with a keyed type input shaft may be equipped with a serrated type wheel tube shaft.

Fig. 1A, Conventional Steering Driveline Installation, Woodruff Keyed and Whistle Notched Input Shaft

STEERING DRIVELINE, CONVENTIONAL





1. Upper Column and Jacket Assembly Wheel Tube Shaft
2. Upper End Yoke Flanged Nut
3. Upper End Yoke
4. Upper End Yoke Pinch Bolt, Flanged Hex Head Type
5. U-Joint Assembly
6. U-Joint Journal Cross
7. Journal Cross Seal
8. Needle Bearing Cup Snapring
9. Needle Bearing Cup
10. Journal Cross Lube Fitting
11. Driveline Tube and Yoke Assembly
12. Boot Retainer Ring
13. Deck Boot Assembly
14. Tube Lube Fitting
15. Driveline Shaft and Yoke Assembly
16. Lower End Yoke Hex Nut
17. Lower End Yoke
18. Lower End Yoke Pinch Bolt, Hex Head Type
19. Boot Cover (Not used on integral power steering gear installations)
20. Steering Gear Input Shaft
21. Upper End Yoke Hex Nut
22. Upper End Yoke Pinch Bolt, Hex Head Type
23. Lower End Yoke Flanged Nut, For Steering Gear Model Ross HFB70 Only
24. Lower End Yoke Pinch Bolt, Flanged Hex Head Type, For Steering Gear Model Ross HFB70 Only

NOTE: Steering gear shown is an example only. Actual steering gear models may vary from vehicle to vehicle.

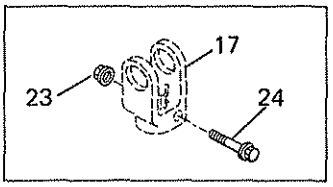
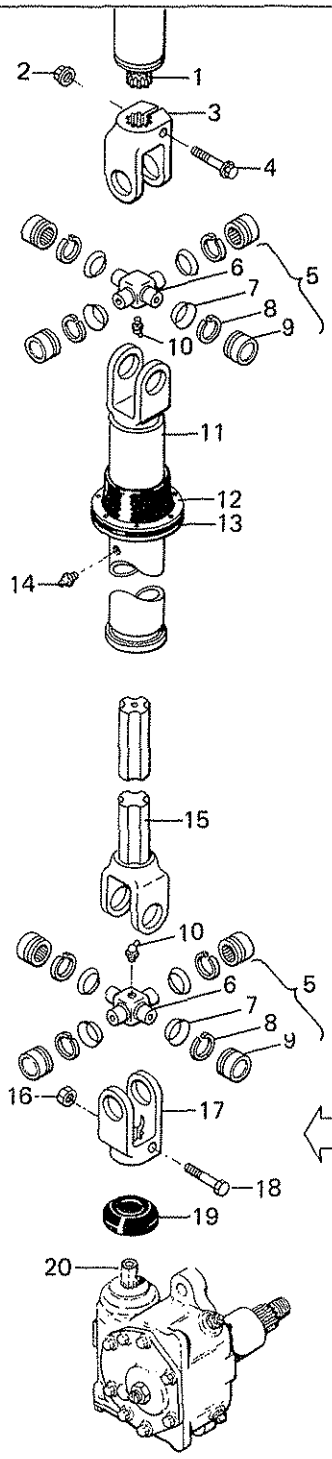


Fig. 1B, Conventional Steering Driveline Installation, Serrated and Full Notched Input Shaft

STEERING DRIVELINE, CONVENTIONAL



1. Upper Column and Jacket Assembly Wheel Tube Shaft
2. Upper End Yoke Flanged Nut
3. Upper End Yoke
4. Upper End Yoke Pinch Bolt, Flanged Hex Head Type
5. U-Joint Assembly
6. U-Joint Journal Cross
7. Journal Cross Seal
8. Needle Bearing Cup Snapring
9. Needle Bearing Cup
10. Journal Cross Lube Fitting
11. Driveline Tube and Yoke Assembly
12. Boot Retainer Ring
13. Deck Boot Assembly
14. Tube Lube Fitting
15. Driveline Shaft and Yoke Assembly
16. Lower End Yoke Hex Nut
17. Lower End Yoke
18. Lower End Yoke Pinch Bolt, Hex Head Type
19. Boot Cover (Not used on integral power steering gear installations)
20. Steering Gear Input Shaft
21. Lower End Yoke Flanged Nut, For Steering Gear Model Ross HFB70 Only
22. Lower End Yoke Pinch Bolt, Flanged Hex Head Type, For Steering Gear Model Ross HFB70 Only

NOTE: Steering gear shown is an example only. Actual steering gear models may vary from vehicle to vehicle.

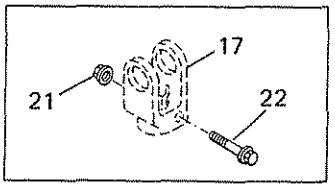


Fig. 1C, Conventional Steering Driveline Installation, Serrated and Whistle Notched Input Shaft

STEERING DRIVELINE, CONVENTIONAL

steering gear input shaft when removing the lower end yoke.

CAUTION: If heat must be applied in order to remove the end yoke from the input shaft, use care not to damage the input shaft seal. If the seal is damaged during end yoke removal, it must be replaced.

6. If equipped with a boot cover, and it is damaged during the removal of the end yoke, replace the boot cover with a new one.

7. Slide the driveline shaft and yoke assembly out of the driveline tube and yoke assembly, then remove the boot seal (if so equipped).

8. Remove the lube fitting located on the lower end of the driveline tube and yoke assembly.

9. Remove the pinch bolt nut, lockwasher (if used), and pinch bolt from the upper end yoke. If the end of the upper column and jacket assembly wheel tube shaft *is not* marked with red paint, remove the upper end yoke from the shaft. If the wheel tube shaft *is* marked with red paint, the yoke is secured to the shaft with adhesive. In addition, if red paint is not visible, but the upper end yoke cannot be removed by hand or with a light application of pressure, the end yoke is secured to the wheel tube shaft with adhesive.

   Heat the base of the upper end yoke with a torch until the bond begins to weaken (at 300°F [149°C] the bond will be reduced to half strength), then remove the yoke from the wheel tube shaft. Collect the washer, dust cup, bearing spring, and lower bearing spacer (serrated wheel tube shafts) or the woodruff key and the tapered bearing spacer sleeve (woodruff keyed wheel tube shafts) as they drop from the end of the upper column and jacket assembly. See Fig. 2.

10. Remove the driveline tube and yoke assembly from the inside of the cab, up and out of the deck boot assembly.

DISASSEMBLY (Refer to Fig. 1)

Disassembly of the steering driveline U-joints requires the use of a U-joint tool assembly (Fig. 3).

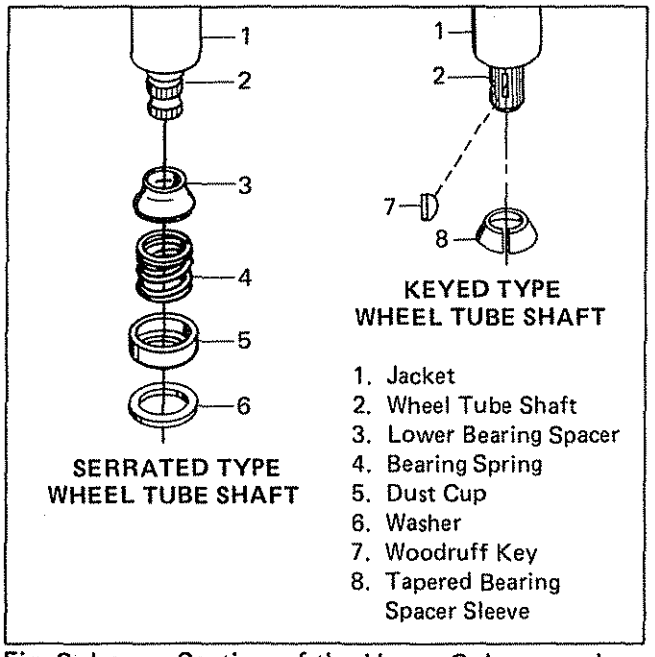


Fig. 2, Lower Section of the Upper Column and Jacket Assembly

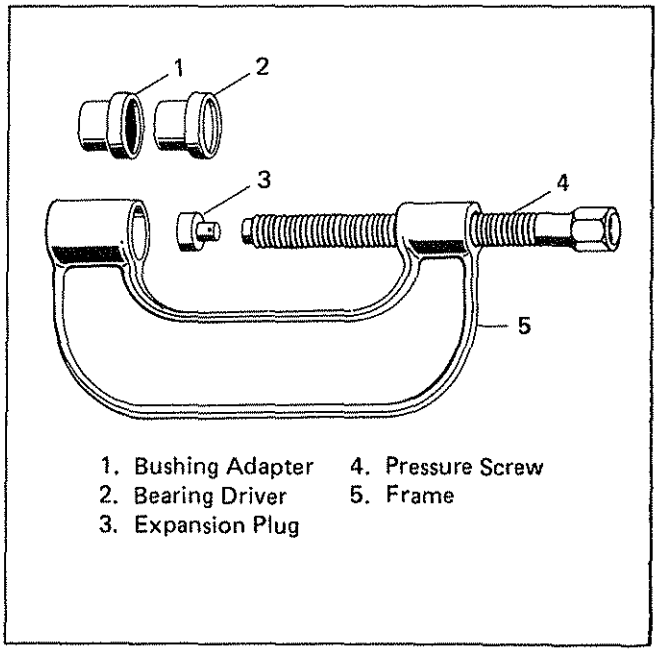


Fig. 3, Universal Joint Tool Assembly

STEERING DRIVELINE, CONVENTIONAL

1. Clamp the U-joint tool frame into a vise.

2. Remove the needle bearing cup snaprings from the needle bearing cups by pushing an open end of the snapring(s) with a screwdriver.

WARNING: When removing snaprings from the needle bearings cups, always wear safety goggles. Snaprings can become potentially harmful projectiles when they are removed.

3. Select an expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Then, select a bushing adapter of slightly larger inside diameter than the needle bearing cup, and place it on the opposite end of the tool.

4. Place the driveline tube and yoke assembly on the U-joint tool with the bushing adapter positioned to receive a needle bearing cup and the expansion plug against the opposite needle bearing cup.

5. Tighten the pressure screw to press the needle bearing cup out of the driveline tube and yoke assembly, then remove the needle bearing cup. Reverse the driveline tube and yoke assembly and press against the U-joint journal cross to force out the other needle bearing cup. In stubborn cases it may be necessary to give the pressure screw a sharp rap with a brass hammer while the screw is under pressure.

6. Remove the driveline tube and yoke assembly from the U-joint tool, then remove the upper end yoke and the journal cross from the driveline tube and yoke assembly.

7. Place the upper end yoke on the U-joint tool with the bushing adapter positioned to receive a needle bearing cup and the expansion plug against the opposite needle bearing cup.

8. Tighten the pressure screw to press the needle bearing cup out of the upper end yoke, then remove the needle bearing cup. Reverse the upper end yoke on the U-joint tool and press against the U-joint journal cross to force out the other needle bearing cup. In stubborn cases it may be necessary to give the pressure screw a sharp rap with a brass hammer while the screw is under pressure.

9. Remove the upper end yoke from the U-joint tool, then remove the journal cross from the upper end yoke.

10. Repeat steps 4 through 9 on the driveline shaft and yoke assembly and the lower end yoke.

ASSEMBLY (Refer to Fig. 1)

WARNING: Do not use old snaprings when assembling the U-joints. Used snaprings are often distorted and over-stressed from disassembly. Also, new snaprings must be fully seated in their grooves when assembling the U-joints. Used snaprings or new snaprings not fully seated in their grooves could work loose, resulting in a hazardous vehicle operating condition.

Assembly of the steering driveline U-joints requires the use of a U-joint tool assembly (Fig. 3).

1. Clamp the U-joint tool frame into a vise.

2. Select a U-joint tool expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Then, place a bearing driver on the opposite end of the tool.

3. Position the U-joint journal cross in the upper end yoke so that the journal cross lube fitting points towards one of the yoke ears.

4. Make certain the journal cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the upper end yoke on the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.

5. Tighten the pressure screw, making sure that both needle bearing cups press straight and true

STEERING DRIVELINE, CONVENTIONAL

into the yoke ears. Work the U-joint journal cross during the pressing operation to assure free movement. If the needle bearing cups do not seat correctly or if the U-joint binds, give the yoke shoulder near each cup a sharp rap with a brass hammer.

6. Press the needle bearing cup on the screw end of the U-joint tool all the way in until there is enough clearance to insert a needle bearing cup snapring, then insert the snapring. Reverse the upper end yoke on the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snapring. Insert the snapring, then remove the upper end yoke from the U-joint tool.

7. With the journal cross lube fitting facing away from the base of the upper end yoke, position the U-joint journal cross and the upper end yoke in the driveline tube and yoke assembly.

NOTE: The journal cross lube fitting should face away from the base of the upper end yoke to provide access for lubrication when the steering driveline is installed on the vehicle.

8. Make certain that the journal cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the driveline tube and yoke assembly on the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.

9. Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint journal cross during the pressing operation to assure free movement. If the needle bearing cups do not seat correctly or if the U-joint binds, give the yoke shoulder near each cup a sharp rap with a brass hammer.

10. Press the needle bearing cup on the screw end of the U-joint tool all the way in until there is enough clearance to insert a needle bearing cup snapring, then insert the snapring. Reverse the driveline tube and yoke assembly on the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snapring. Insert the snapring, then remove the driveline tube and yoke assembly from the U-joint tool.

11. Repeat steps 3 through 10 on the lower end yoke and the driveline shaft and yoke assembly.

STEERING DRIVELINE INSTALLATION
(Refer to Fig. 1)

1. Thoroughly clean the steering gear input shaft and the upper column and jacket assembly wheel tube shaft with a clean dry cloth. Using a wire brush and Loctite Safety Solvent, or an equivalent, clean the serrations of the end yokes and shafts.

IMPORTANT: If Loctite Safety Solvent is not available, CLEAN solvents, such as trichloroethylene, trichloroethane, perchloroethylene, MEK, acetone, or alcohol can be used. DO NOT USE kerosene, gasoline, naptha, fuel oil, Varsol, or Stoddard solvents.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

2. Position the driveline tube and yoke assembly down through the deck boot seal assembly.

3. If the upper column and jacket assembly has a keyed wheel tube shaft, make sure the tapered bearing spacer sleeve and woodruff key are in place on the wheel tube shaft. See Fig. 2.

   If the upper column and jacket assembly has a serrated wheel tube shaft, insert the lower bearing spacer, bearing spring, dust cup, and washer in the lower end of the upper column and jacket assembly. See Fig. 2.

STEERING DRIVELINE, CONVENTIONAL

4. On vehicles equipped with woodruff keyed upper column and jacket assembly wheel tube shafts, proceed to step 6.

   On vehicles equipped with serrated upper column and jacket assembly wheel tube shafts, apply Locquic General Purpose Primer T to the upper column and jacket assembly wheel tube shaft. Let dry for five minutes.

5. Apply a bead of Loctite No. 680 adhesive to the serrated area of the upper end yoke.

IMPORTANT: After the end yoke has been assembled to the wheel tube shaft, curing will start immediately, and the pinch bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. Allow the assembled parts to cure for thirty minutes before applying steering load pressures.

6. Slide the upper end yoke onto the upper column and jacket assembly wheel tube shaft, then install the end yoke pinch bolt, lockwasher (if used), and pinch bolt nut. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the upper column and jacket assembly wheel tube shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut to the applicable torque value, given in Table 1 located under "SPECIFICATIONS."

7. Apply green Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. If adhesive is used on the upper end yoke, mark the end of the upper column and jacket assembly wheel tube shaft with red paint.

8. If equipped with a boot seal, install the boot seal over the splined shaft on the driveline shaft and yoke assembly.

9. On steering drivelines marked with arrows, slide the driveline shaft and yoke assembly into the driveline tube and yoke assembly so that the arrows on the driveline shaft yoke and the driveline tube are aligned. See Fig. 4.

   On steering drivelines not marked with arrows, slide the driveline shaft and yoke assembly into the driveline tube and yoke assembly so that the end yoke cross holes are parallel to each other, and on the same side of the shaft centerline.

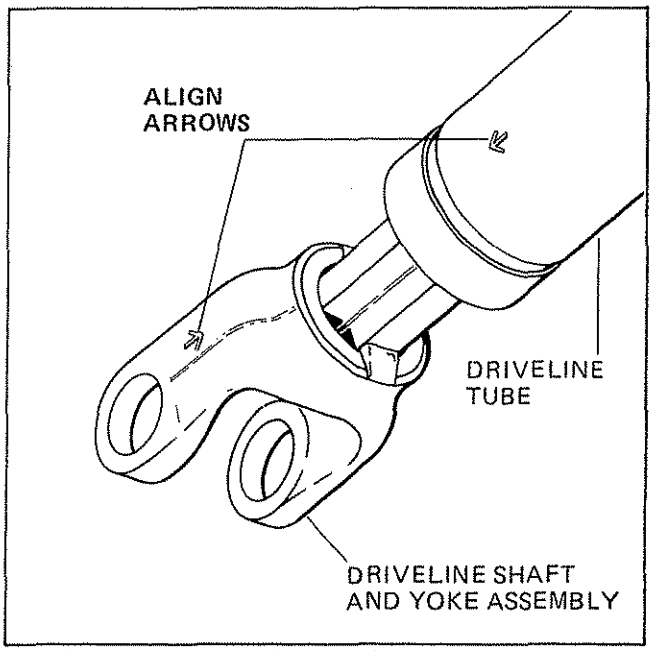


Fig. 4, Driveline U-Joint Phasing

CAUTION: If the arrow on the driveline shaft yoke is not aligned with the arrow on the driveline tube, the U-joints will be out of phase. If not marked with arrows, the end yoke cross holes must be parallel to each other and on the same side of the shaft centerline. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

10. On vehicles with whistle notched steering gear input shafts, line up the cross holes in the lower end yoke with the whistle notch on the input shaft.

    On vehicles with full notched steering gear input shafts, position the steering wheel so that

STEERING DRIVELINE, CONVENTIONAL

the king-spoke (the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside) points directly toward the front of the vehicle (positioned at 12 o'clock ± 10°). See Fig. 5.

11. On vehicles equipped with woodruff keyed steering gear input shafts, proceed to step 13.

    On vehicles equipped with serrated steering gear input shafts, apply Locquic General Purpose Primer T to the steering gear input shaft. Let dry for five minutes.

12. Apply a bead of Loctite No. 680 adhesive to the serrated area of the lower end yoke.

IMPORTANT: After the end yoke has been assembled to the steering gear input shaft, curing will start immediately, and the pinch bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. Allow the assembled parts to cure for thirty minutes before applying steering load pressures.

13. Slide the lower end yoke onto the steering gear input shaft. Do not decentralize the steering gear. Install the end yoke pinch bolt, lockwasher (if used), and pinch bolt nut. If equipped with a boot seal bracket, install the pinch bolt through the bracket and the lower end yoke. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the steering gear input shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut to the applicable torque value, given in Table 1 located under "SPECIFICATIONS."

14. Apply green Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. If adhesive is used on the lower end yoke, mark the lower end yoke with red paint.

15. If equipped with a manual steering gear, attach the warning tag by hand, around the lower end yoke, making sure that the label is upright. See Fig. 6.

16. Install the lube fitting in the driveline tube and yoke assembly. Lubricate the driveline tube and U-joints with multipurpose chassis lube until grease appears at the lower end of the tube splines and the journal cross seals.

17. If equipped with a boot seal, slide it down over the boot seal bracket, then install a new plastic boot seal tie-down strap. Trim the end of the

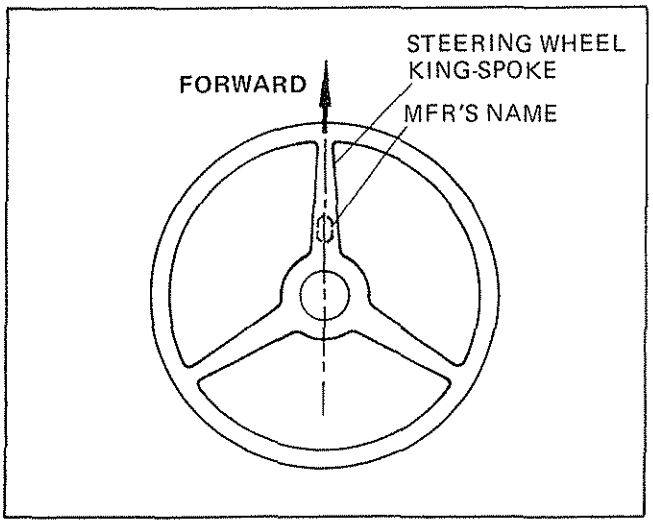


Fig. 5, Steering Wheel Positioning

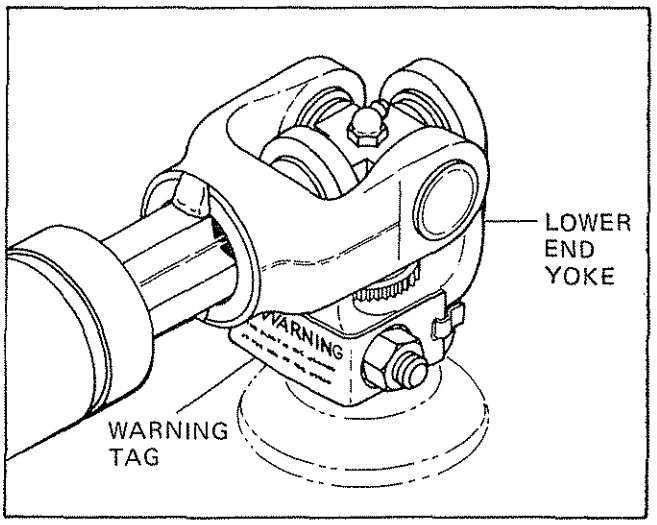


Fig. 6

STEERING DRIVELINE, CONVENTIONAL

boot seal tie-down strap flush with the strap locking sleeve.

WARNING: Do not substitute a metal hose clamp for the plastic tie-down strap that secures the boot seal to the boot seal bracket. The steering driveline could become jammed if a foreign object were to lodge between the steering gear housing and the tightening screw on the hose clamp.

18. After the steering driveline has been connected to the steering gear input shaft, check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10° when the front tires are in the straight-ahead position. See Fig. 5. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject, in the 14 Group of this manual.

IMPORTANT: On some earlier vehicles equipped with an upper column and jacket assembly on which the steering wheel is attached using a woodruff key, the steering gear input shaft may also be keyed. If the king-spoke is not positioned at 12 o'clock ± 10° on this type of installation, and adjustments are not possible, the steering wheel and the upper column and jacket wheel tube shaft are mismatched, and one or both should be replaced.

WARNING: Do not turn the input shaft of the steering gear in order to correct the position of the king-spoke on the steering wheel. To do so will decentralize the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering.

19. Return the hood back to the operating position and secure the hood latches.

20. Set the vehicle parking brake, then chock the rear tires to prevent vehicle movement. Raise the vehicle so that the front tires are off the ground, then place safety stands under the frame.

21. Turn the steering wheel through full travel, checking for hard steering or binding. If hard steering or binding is present, check the assembly and installation of the driveline components. If the cause is not the driveline, refer to the applicable steering gear subject in the 14 Group of this manual, or to the applicable steering gear manufacturer's service information, for steering system inspection checks.

WARNING: Driving a vehicle with hard steering or binding in the steering system could result in a hazardous vehicle operating condition.

22. Remove the safety stands from under the frame, then lower the vehicle to the ground and remove the chocks from the rear tires.

DECK BOOT ASSEMBLY REMOVAL AND INSTALLATION (Refer to Fig. 1)

1. Remove the steering driveline following the instructions given in this subject.

2. Lift up the floor mat, then remove the screws from the boot retainer ring.

3. Remove the boot retainer ring and the deck boot assembly, from the opening in the cab deck, then slide the boot retainer ring off of the boot. Inspect the deck boot for damage or wear and replace if necessary.

4. Position the deck boot assembly over the opening in the cab deck, then place the boot retainer ring over the deck boot assembly. With the holes in the boot and the retainer ring lined up, insert the screws and tighten until the outer lip of the boot is compressed.

5. Install the steering driveline following the instructions given in this subject.

BOOT SEAL REPLACEMENT (Refer to Fig. 1)

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a

STEERING DRIVELINE, CONVENTIONAL

straight line for a short distance, stopping at the spot where service operations will be performed. Release the hood latches on each side of the hood and tilt the hood to the full open position.

2. Remove and discard the boot seal tie-down straps, then slide the boot seal off of the boot seal bracket to expose the lower end yoke.

3. Remove the end yoke pinch bolt nut and lockwasher (if used), from the lower end yoke pinch bolt, then remove the pinch bolt from the yoke. Slide the lower end yoke off of the steering gear input shaft.

4. Slide the driveline shaft and yoke assembly out of the driveline tube and yoke assembly, then remove the boot seal.

5. Install the new boot seal over the driveline shaft and yoke assembly.

6. On steering drivelines marked with arrows, slide the driveline shaft and yoke assembly into the driveline tube and yoke assembly so that the arrows on the driveline shaft yoke and the driveline tube are aligned. See Fig. 4.

   On steering drivelines not marked with arrows, slide the driveline shaft into the driveline tube and yoke assembly so that the end yoke cross holes are parallel to each other, and on the same side of the shaft centerline.

CAUTION: If the arrow on the driveline shaft yoke is not aligned with the arrow on the driveline tube, the U-joints will be out of phase. If not marked with arrows, the end yoke cross holes must be parallel to each other and on the same side of the shaft centerline. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

7. Line up the cross holes in the lower end yoke with the whistle notch on the input shaft. Slide the lower end yoke onto the steering gear input shaft. Do not decentralize the steering gear. Install the pinch bolt through the boot seal bracket and the lower end yoke, then install the lockwasher on the end yoke pinch bolt. Install the nut. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the steering gear shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut to the applicable torque value, given in Table 1 located under "SPECIFICATIONS."

8. Slide the boot seal down over the boot seal bracket, then install a new plastic boot seal tie-down strap. Trim the end of the boot seal tie-down strap flush with the strap locking sleeve.

WARNING: Do not substitute a metal hose clamp for the standard plastic tie-down strap that secures the driveline boot seal to the boot seal bracket. The steering driveline could become jammed if a foreign object were to lodge between the steering gear housing and the tightening screw on the hose clamp.

9. After the steering driveline has been connected to the steering gear input shaft, check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10° when the front tires are in the straight-ahead position. See Fig. 5. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject located in the 14 Group of this manual.

IMPORTANT: If the king-spoke is not positioned at 12 o'clock ± 10° on this type of installation, and adjustments are not possible, the steering wheel and the upper column and jacket wheel tube shaft are mismatched and one or both should be replaced.

WARNING: Do not turn the input shaft of the steering gear in order to correct the position of the king-spoke on the steering wheel. To do so will decentralize the steering gear, which could ulti-

STEERING DRIVELINE, CONVENTIONAL

mately limit the vehicle turning angle in one direction and also cause erratic steering.

10. Return the hood back to the operating position and secure the hood latches.

11. Set the vehicle parking brake, then chock the rear tires to prevent vehicle movement. Raise the vehicle so that the front tires are off the ground, then place safety stands under the frame.

12. Turn the steering wheel through full travel, checking for hard steering or binding. If hard steering or binding is present, check the assembly and installation of the driveline components. If the cause is not the driveline, refer to the applicable steering gear subject in the 14 Group of this manual, or to the applicable steering gear manufacturer's service information, for steering system inspection checks.

WARNING: Driving a vehicle with hard steering or binding in the system could result in a hazardous vehicle operating condition.

13. Remove the safety stands from under the frame, then lower the vehicle to the ground and remove the chocks from the rear tires.

SPECIFICATIONS

DESCRIPTION		SIZE	GRADE	TORQUE lbf·ft (N·m)
Upper End Yoke Pinch Bolt Nut		3/8-16	G	35-40 (47-54)
		7/16-20	C	75 (102)
Lower End Yoke Pinch Bolt Nut	All, Except Ross HFB70 Integral Power Steering Gear	7/16-20	C	63-75 (85-102)
	Ross HFB70 Integral Power Steering Gear	3/8-24	C	40-48 (54-65)
		3/8-16	G	35-40 (47-54)

Table 1, Torque Values

STEERING DRIVELINE, CONVENTIONAL, 1984 ADVANCEMENTS

GENERAL DESCRIPTION

The steering driveline connects the steering column assembly to the steering gear, by means of a telescoping shaft with integral yokes and universal joint crosses at both ends. See **Fig. 1**.

The driveline shaft consists of a tubular upper section, splined on the inside, and an externally splined lower section. The lower section is inserted in the tubular upper section, and slides freely to lengthen and shorten the driveline to allow for movement between the cab and the chassis frame during vehicle operation. The variable length of the steering driveline also allows for driveline installation and removal.

The top end of the upper driveline section and the bottom end of the lower driveline section are equipped with integral yokes. Each yoke is secured to two needle cups of a universal joint cross. The other two cups of each cross are secured to yokes, internally serrated to match the external serrations of the steering column or the steering gear input shaft. The serrated yokes are secured to the shafts with adhesive and a pinch bolt, which engages a notch in the shaft.

The universal joints allow the steering driveline to twist at the angles necessary to transfer the motion of the steering wheel to the steering gear.

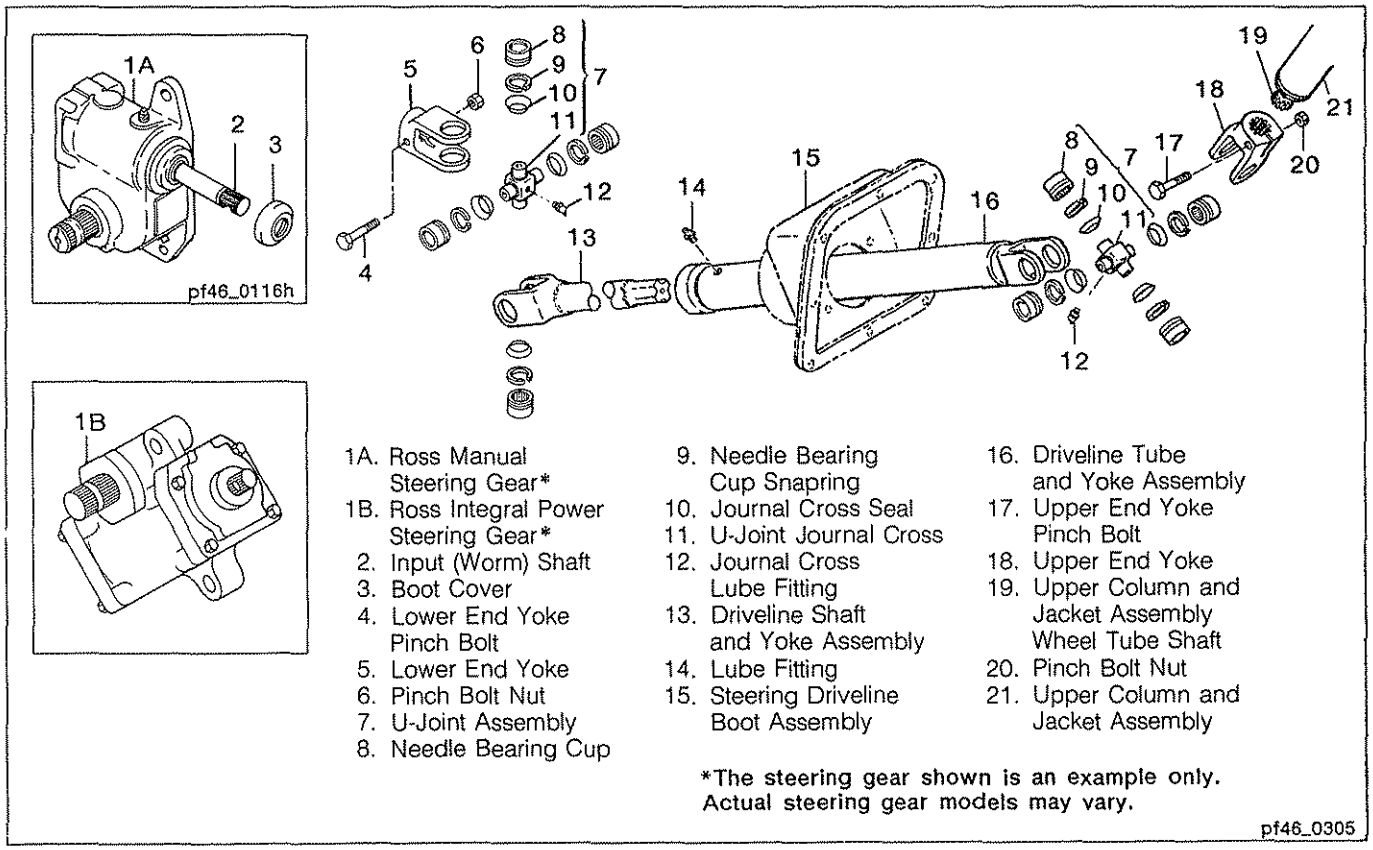
SERVICE OPERATIONS

Figure 1 shows the basic steering driveline installation used on Freightliner Conventionals with 1984 Advancements.

STEERING DRIVELINE REMOVAL (Refer to Fig. 1)

NOTE: You don't need to loosen the upper steering column and jacket or the steering wheel to perform the procedures described here.

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a



1A. Ross Manual Steering Gear*
1B. Ross Integral Power Steering Gear*
2. Input (Worm) Shaft
3. Boot Cover
4. Lower End Yoke Pinch Bolt
5. Lower End Yoke
6. Pinch Bolt Nut
7. U-Joint Assembly
8. Needle Bearing Cup
9. Needle Bearing Cup Snapring
10. Journal Cross Seal
11. U-Joint Journal Cross
12. Journal Cross Lube Fitting
13. Driveline Shaft and Yoke Assembly
14. Lube Fitting
15. Steering Driveline Boot Assembly
16. Driveline Tube and Yoke Assembly
17. Upper End Yoke Pinch Bolt
18. Upper End Yoke
19. Upper Column and Jacket Assembly Wheel Tube Shaft
20. Pinch Bolt Nut
21. Upper Column and Jacket Assembly

***The steering gear shown is an example only. Actual steering gear models may vary.**

pf46_0305

Fig. 1, Steering Driveline, Conventional, 1984 Advancements

STEERING DRIVELINE, CONVENTIONAL, 1984 ADVANCEMENTS

short distance, stopping at the spot where service operations will be performed. Apply the vehicle parking brakes and chock the tires.

2. Release the hood latches on each side of the hood and tilt the hood to the full open position.

3. Remove the pinch-bolt nut and pinch bolt from the lower end yoke. Discard the nut.

4. Remove the yoke from the steering gear input shaft. If the lower end yoke is marked with red paint, or if the lower end yoke cannot be removed by hand or with a light application of pressure, the yoke is secured to the input shaft with adhesive.

   Heat the base of the lower end yoke with a torch until the bond begins to weaken. At 300°F (149°C), the bond will be reduced to half strength. Remove the yoke from the steering gear input shaft. Do not turn the steering gear input shaft when removing the lower end yoke.

   If heat must be applied in order to remove the end yoke from the input shaft, use care not to damage the input shaft seal. If the seal is damaged during end yoke removal, replace it.

5. If equipped with a boot cover, and it is damaged during the removal of the end yoke, replace the boot cover with a new one.

   Slide the driveline shaft and yoke assembly out of the driveline tube and yoke assembly.

6. Remove the pinch-bolt nut and pinch bolt from the upper end yoke. Discard the nut and the bolt.

7. Remove the upper end yoke from the shaft. If the wheel tube shaft is marked with red paint or, if the upper end yoke cannot be removed by hand or with a light application of pressure, the yoke is secured to the shaft with adhesive.

   Heat the base of the upper end yoke with a torch until the bond begins to weaken. At 300°F (149°C), the bond will be reduced to half strength. Remove the yoke from the wheel tube shaft. Collect the washer, dust cup, bearing spring, and lower bearing spacer as they drop from the end of the upper column and jacket assembly. See **Fig. 2**.

8. Push the driveline tube downward through the firewall opening in order to force the boot assembly outward and expose the steering driveline bushing. See **Fig. 3**.

9. Remove the steering driveline bushing from the boot assembly.

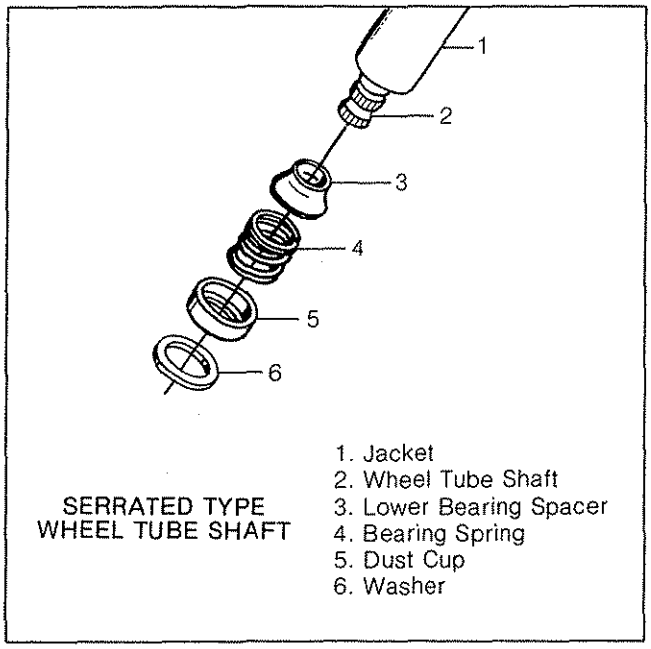


Fig. 2, Lower Section of the Upper Column and Jacket Assembly

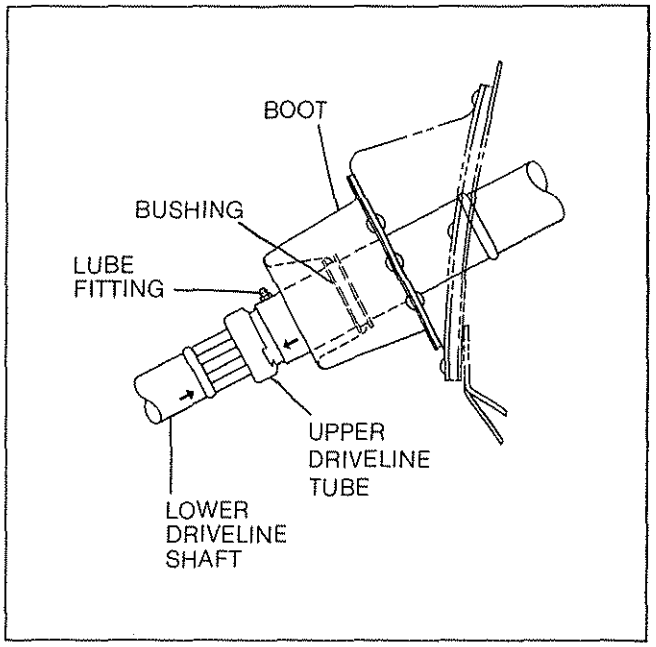


Fig. 3, Steering Driveline Boot Assembly, Conventional

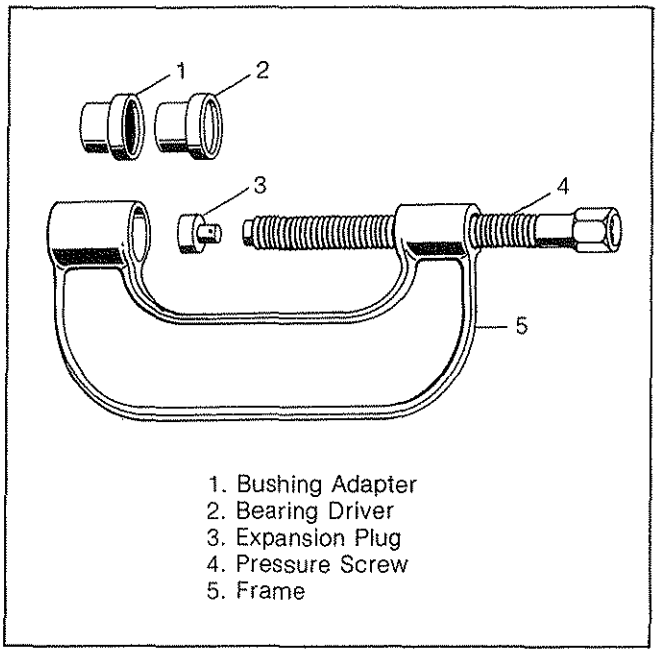
STEERING DRIVELINE, CONVENTIONAL, 1984 ADVANCEMENTS

10. Pull the driveline tube through the firewall (toward the engine) to remove it.

NOTE: By removing the lube fitting, the driveline tube may be removed by pulling it back through the firewall into the cab. See **Fig. 3**.

U-JOINT DISASSEMBLY (Refer to Fig. 1)

Disassembly of the steering driveline U-joints requires the use of a U-joint tool assembly (**Fig. 4**).



1. Bushing Adapter
2. Bearing Driver
3. Expansion Plug
4. Pressure Screw
5. Frame

Fig. 4, Universal Joint Tool Assembly

1. Clamp the U-joint tool frame into a vise.

WARNING: When removing snaprings from the needle bearing cups, always wear safety goggles. Snaprings can become potentially harmful projectiles when they are removed.

2. Remove the needle bearing cup snaprings from the needle bearing cups by pushing an open end of the snaprings with a screwdriver.
3. Select an expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Then, select a bushing adapter of slightly larger inside diameter than the needle bearing cup and place it on the opposite end of the tool.
4. Place the driveline tube and yoke assembly on the U-joint tool. Position the bushing adapter to receive a needle bearing cup and the expansion plug against the opposite needle bearing cup.
5. Tighten the pressure screw to press the needle bearing cup out of the driveline tube and yoke assembly, then remove the needle bearing cup. Reverse the driveline tube and yoke assembly and press against the U-joint journal cross to force out the other needle bearing cup. In some cases it may be necessary to give the pressure screw a sharp blow with a brass hammer while the screw is under pressure.
6. Remove the driveline tube and yoke assembly from the U-joint tool, then remove the upper end yoke and the journal cross from the driveline tube and yoke assembly.
7. Place the upper end yoke on the U-joint tool. Position the bushing adapter to receive a needle bearing cup and the expansion plug against the opposite needle bearing cup.
8. Tighten the pressure screw to press the needle bearing cup out of the upper end yoke, then remove the needle bearing cup. Reverse the upper end yoke on the U-joint tool and press against the U-joint journal cross to force out the other needle bearing cup. In some cases it may be necessary to give the pressure screw a sharp blow with a brass hammer while the screw is under pressure.
9. Remove the upper end yoke from the U-joint tool, then remove the journal cross from the upper end yoke.
10. Repeat steps 4 through 9 on the driveline shaft and yoke assembly and the lower end yoke.

U-JOINT ASSEMBLY (Refer to Fig. 1)

WARNING: Do not use old snaprings when assembling the U-joints. Used snaprings are often distorted and over-stressed from disassembly. Also, snaprings must be fully seated in their grooves when assembling the U-joints. Snaprings not fully seated in their grooves could work loose, resulting in a hazardous vehicle operation condition.

Assembly of the steering driveline U-joints requires the use of a U-joint tool assembly (**Fig. 4**).

1. Clamp the U-joint tool frame into a vise.
2. Select a U-joint tool expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Then place a bearing driver on the opposite end of the tool.

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3. Position the U-joint journal cross in the upper end yoke so that the journal cross lube fitting points toward one of the yoke ears.
4. Make certain the journal cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the upper end yoke on the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.
5. Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint journal cross during the pressing operation to assure free movement. If the needle bearing cups do not seat correctly or if the U-joint binds, give the yoke shoulder near each cup a sharp blow with a brass hammer.
6. Press the needle bearing cup on the screw end of the U-joint tool all the way in until there is enough clearance to insert a needle bearing cup snapring, then insert the snapring. Reverse the upper end yoke on the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snapring. Insert the snapring, then remove the upper end yoke from the U-joint tool.
7. With the journal cross lube fitting facing away from the base of the upper end yoke, position the U-joint journal cross and the upper end yoke in the driveline tube and yoke assembly.

NOTE: The journal cross lube fitting should face away from the base of the upper end yoke to provide access for lubrication when the steering driveline is installed on the vehicle.

8. Make certain the journal cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the driveline tube and yoke assembly on the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.
9. Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint journal cross during the pressing operation to assure free movement. If the needle bearing cups do not seat correctly or if the U-joint binds, give the yoke shoulder near each cup a sharp blow with a brass hammer.
10. Press the needle bearing cup on the screw end of the U-joint tool all the way in until there is enough clearance to insert a needle bearing cup snapring, then insert the snapring. Reverse the driveline tube and yoke assembly on the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snapring. Insert the snapring, then remove the driveline tube and yoke assembly from the U-joint tool.
11. Repeat steps 3 through 10 on the lower end yoke and the driveline shaft and yoke assembly.

STEERING DRIVELINE INSTALLATION

(Refer to Fig. 1)

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

1. Thoroughly clean the steering gear input shaft and the upper column and jacket assembly wheel tube shaft with a clean dry cloth. Using a wire brush and Loctite Safety Solvent, or an equivalent, clean the serrations of the end yokes and shafts.

IMPORTANT: If Loctite Safety Solvent is not available, *clean* solvents, such as trichloroethylene, trichloroethane, perchloroethylene, MEK, acetone, or alcohol can be used. *Do not use* kerosene, gasoline, naptha, fuel oil, Varsol, or Stoddard solvents.

2. Install the driveline tube through the steering driveline boot.
3. Install the steering driveline bushing in the boot.
4. Insert the lower bearing spacer, bearing spring, dust cup, and washer in the lower end of the upper column and jacket assembly. See **Fig. 2**.
5. Apply Locquic General Purpose Primer T to the upper column and jacket assembly wheel tube shaft. Let dry for five minutes.
6. Apply a bead of Loctite No. 680 adhesive to the serrated area of the upper end yoke.

IMPORTANT: After the end yoke has been assembled to the wheel tube shaft, curing will start immediately, and the pinch-bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. Allow the assembled parts to cure for thirty minutes before applying steering load pressures.

7. Slide the upper end yoke onto the upper column and jacket assembly wheel tube shaft, then install the

STEERING DRIVELINE, CONVENTIONAL, 1984 ADVANCEMENTS

new end yoke pinch bolt and a new pinch-bolt nut. Before tightening the end yoke pinch-bolt nut, make sure the end yoke pinch bolt is centered in the upper column and jacket assembly wheel tube shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut 60 lbf·ft (81 N·m).

8. Apply white Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. Mark the end of the upper column and jacket assembly wheel tube shaft with red paint.

9. Slide the lower driveline shaft into the driveline tube so that the arrows on the driveline shaft and the driveline tube are aligned. See **Fig. 5**.

CAUTION: If the arrow on the driveline shaft is not aligned with the arrow on the driveline tube, the U-joints will be out of phase. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

Be sure the front wheels are straight ahead and the steering gear is centered before performing steps 10 through 12.

10. Apply Locquic General Purpose Primer T to the steering gear input shaft. Let dry for five minutes.

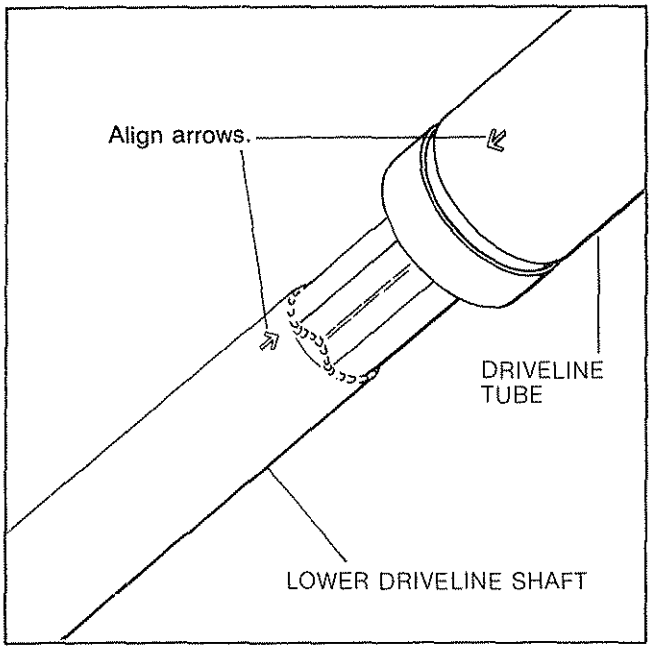

Fig. 5, Driveline U-Joint Phasing

11. Apply a bead of Loctite No. 680 adhesive to the serrated area of the lower end yoke.

IMPORTANT: After the end yoke has been assembled to the steering gear input shaft, curing will start immediately, and the pinch-bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. Allow the assembled parts to cure for thirty minutes before applying steering load pressures.

12. Slide the lower end yoke onto the steering gear input shaft. Do not decentralize the steering gear. Install the new end yoke pinch bolt and a new pinch-bolt nut.

    Before tightening the end yoke pinch-bolt nut, make sure the end yoke pinch bolt is centered in the steering gear input shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the nut to 60 lbf·ft (81 N·m).

13. Apply white Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. Mark the lower end yoke with red paint.

14. Install the lube fitting in the driveline tube and yoke assembly if previously removed. Lubricate the driveline tube and U-joints with multipurpose chassis lube until grease appears at the lower end of the tube splines and the journal cross seals.

15. Check the position of the king-spoke on the steering wheel. The king-spoke should be positioned at 12 o'clock ± 10 degrees when the front tires are in the straight-ahead position. See **Fig. 6**. Adjust the position of the steering wheel on the upper column and jacket assembly, if necessary. For instructions, refer to the applicable upper column and jacket assembly subject in Group 14 of this manual.

WARNING: Do not turn the input shaft of the steering gear in order to correct the position of the king-spoke on the steering wheel. To do so will decentralize the steering gear, which could ultimately limit the vehicle turning angle in one direction and also cause erratic steering.

16. Return the hood to the operating position and secure the hood latches.

17. Apply the vehicle parking brake and chock the rear tires to prevent vehicle movement. Raise the vehicle so that the front tires are off the ground, then place safety stands under the frame.

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18. Turn the steering wheel through full travel, checking for hard steering or binding. If hard steering or binding is present, check the assembly and installation of the driveline components. If the cause is not the driveline, refer to the applicable steering gear subject in Group 14 of this manual, or to the applicable steering gear manufacturer's service information, for steering system inspection checks.

WARNING: All steering mechanisms are life-and-limb items, which must work smoothly, without binding. Steering components that bind must be repaired before operating the vehicle. Otherwise, operating the vehicle could result in loss of vehicle control and possible personal injury and property damage.

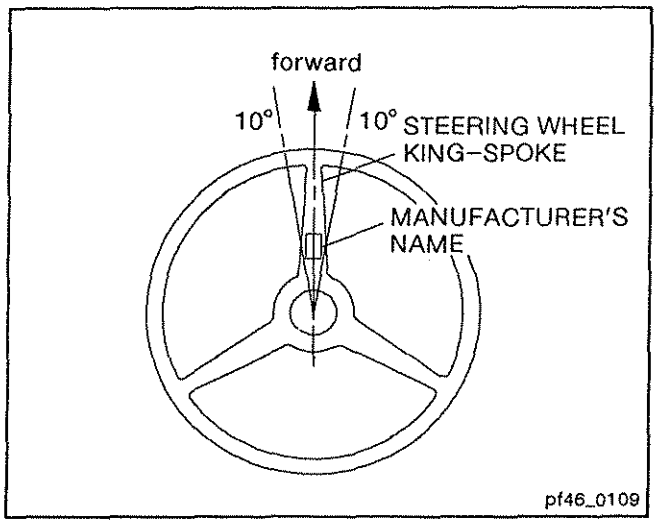


Fig. 6, Steering Wheel Positioning

19. Remove the safety stands from under the frame, then lower the vehicle to the ground and remove the chocks from the rear tires.

STEERING COLUMN BOOT REPLACEMENT

1. Remove the steering driveline following the instructions given in this subject.
2. For vehicles equipped with a cowl-mounted air intake on the driver's side, proceed as follows:
   - .1 Loosen the lower clamp on the air intake.
   - .2 Loosen the upper clamp on the air intake.
   - .3 Remove the air intake tube.
3. Drill out the boot retaining rivets (six rivets).

   Cover the lower duct of the air intake to prevent shavings or other foreign material from entering the air intake system.
4. Use a punch to drive out the rivet shanks.
5. Remove the boot assembly.
6. Position the new boot assembly on the firewall.
7. Secure the boot assembly with 3/16-inch rivets.
8. Install the air intake tube and clamps if previously removed. Tighten the clamps.
9. Install the steering driveline following the instructions given in this subject.

SPECIFICATIONS

Description	Size	Grade	Torque[1] lbf·ft (N·m)
Upper End Yoke Pinch-Bolt Nut	3/8–16	G	60 (81)
Lower End Yoke Pinch Bolt Nut	7/16–20	C	60 (81)

Table 1, Torque Values

[1] These torque values are for fasteners with lubricated or plated threads. For dry threads, see the general torque table in the COE and 120 Conventional Maintenance Manual.

DRAG LINK, COE AND POWERLINER

GENERAL DESCRIPTION

There are two types of drag link assemblies: the vertical-socket and the horizontal-socket.

Two variations of the vertical-socket drag link assembly are used:

1. COEs and Powerliners with manual steering are equipped with a drag link that is adjustable for length. A removable socket ball stud is on the pitman arm end, and a non-removable socket ball stud is on the axle steering arm end. See Fig. 1.
2. COEs with integral power steering are equipped with a drag link that is not adjustable for length. Both socket ball studs are integral parts of the drag link. See Fig. 2.

Horizontal-socket drag link assemblies are used on certain COEs and Powerliners with manual steering, when the socket ball studs are located on the axle steering arm and the pitman arm. The pitman arm end of this drag link is adjustable for length. Each end of the drag link has a socket with an opening for the ball studs to seat. Inside each of the sockets, there is an adjustable bumper assembly. The bumper assembly, after proper adjustment, puts pressure on the ball studs, holding the drag link in position. See Fig. 3.

SERVICE OPERATIONS

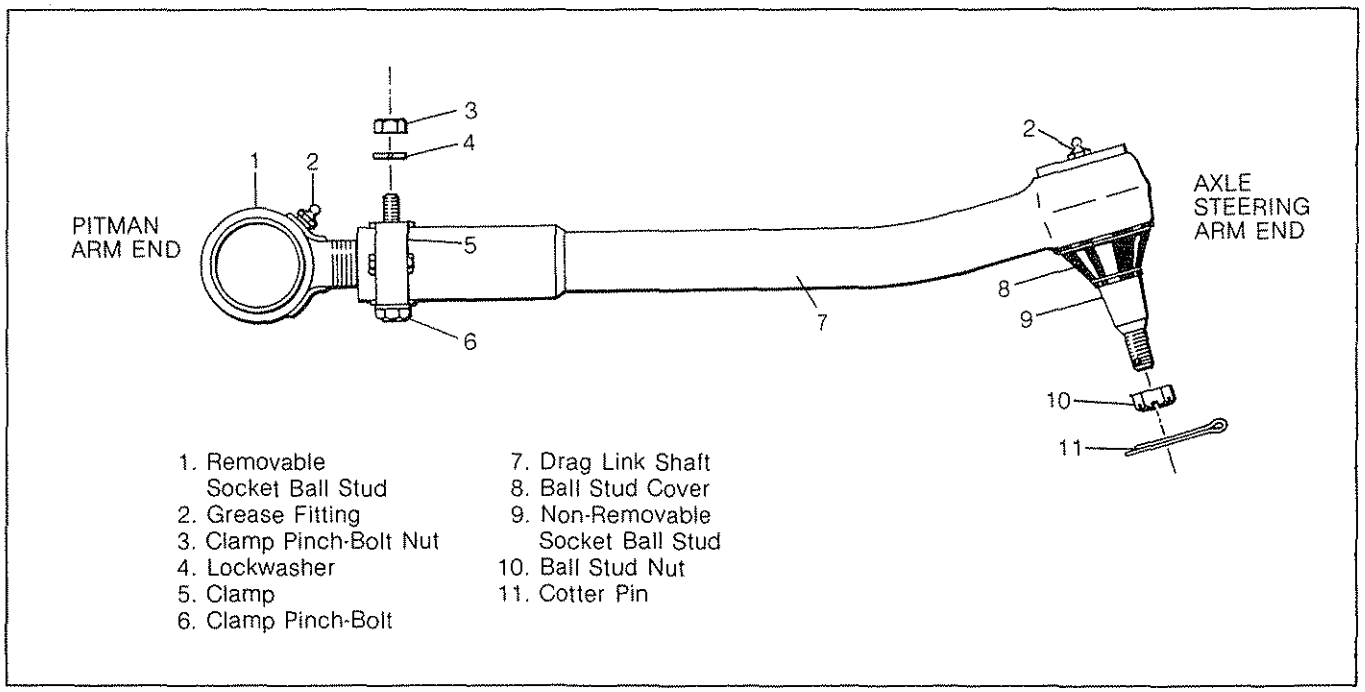
VERTICAL-SOCKET DRAG LINK
REMOVAL AND INSTALLATION

Removal (Refer to Fig. 1 or 2)

1. Position the front tires straight ahead. If possible drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. *Do not turn the steering wheel at any time while the drag link is still attached to both the pitman arm and the axle steering arm.* If the steering wheel is turned, the front tires will not be straight ahead.
2. Apply the parking brakes, and chock the rear tires. Tilt the cab, using the instructions in the Freightliner COE Driver's Manual; but, *do not* turn the steering wheel for the purpose of positioning the steering driveline U-joints, and *do not* tilt the cab beyond the 45-degree position.

NOTE: The steering driveline U-joints do not have to be positioned at 90 degrees to the steering column lower mounting bracket (Fig. 4), as long as the cab is not tilted beyond the 45-degree position.

IMPORTANT: On vehicles equipped with a tilt strut, place the free end of the tilt strut onto the hydraulic



1. Removable Socket Ball Stud
2. Grease Fitting
3. Clamp Pinch-Bolt Nut
4. Lockwasher
5. Clamp
6. Clamp Pinch-Bolt
7. Drag Link Shaft
8. Ball Stud Cover
9. Non-Removable Socket Ball Stud
10. Ball Stud Nut
11. Cotter Pin

Fig. 1, Vertical-Socket Drag Link, Manual Steering, COE and Powerliner

DRAG LINK, COE AND POWERLINER

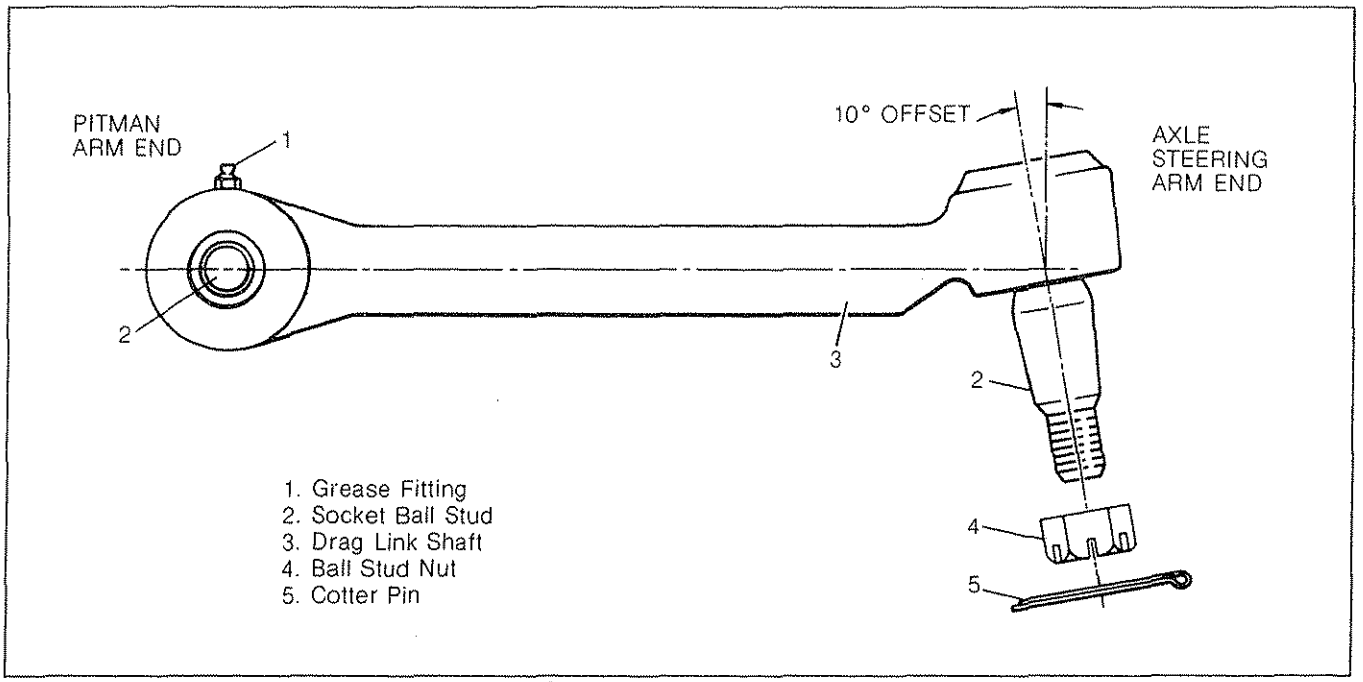


Fig. 2, Vertical-Socket Drag Link, Integral Power Steering, COE

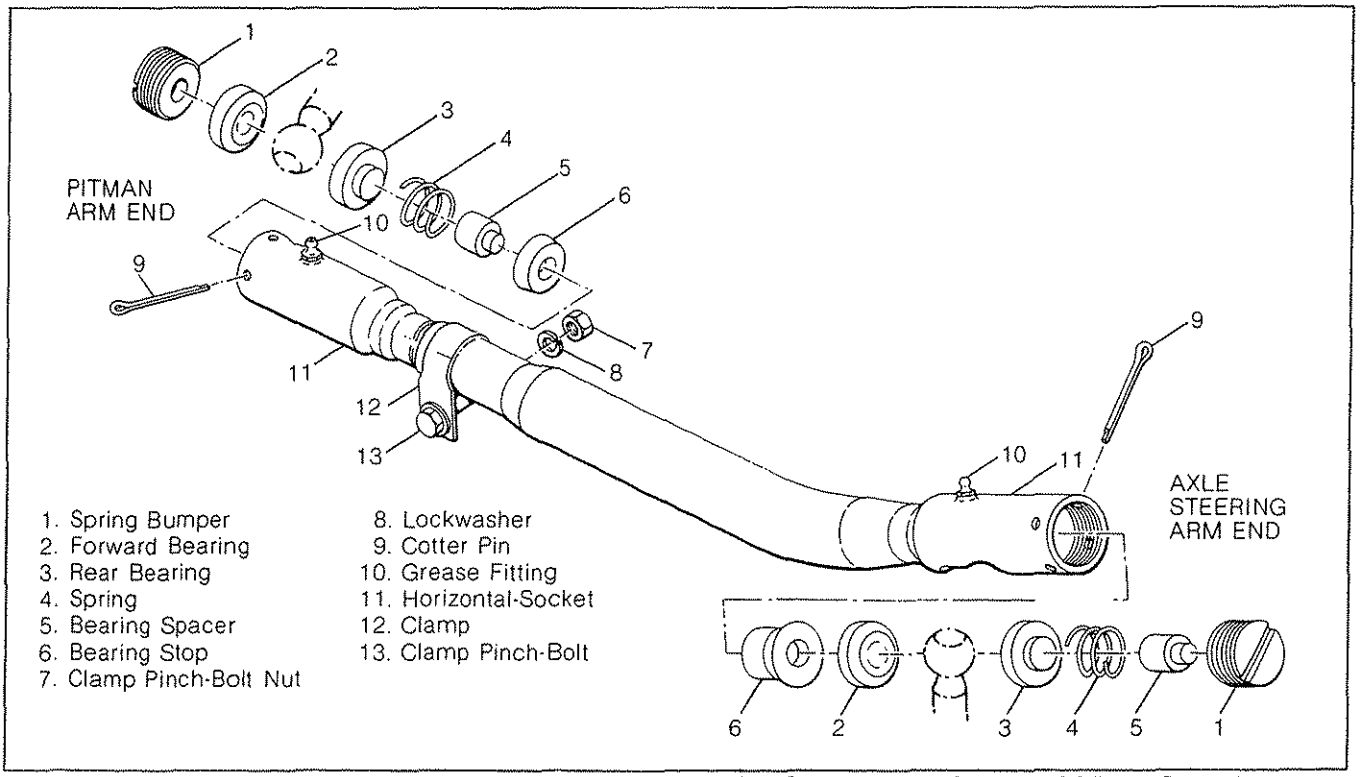
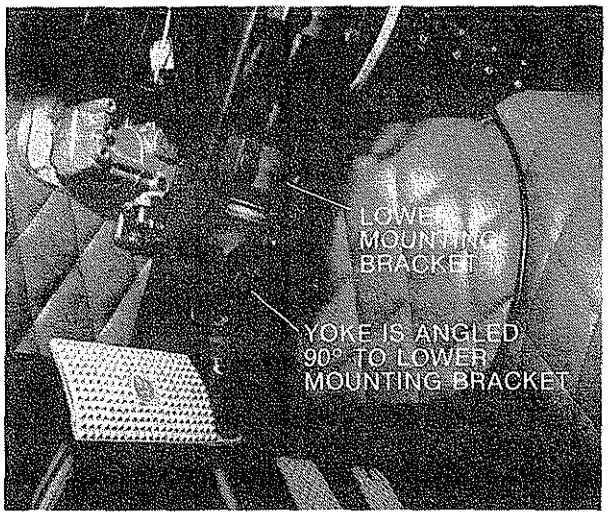
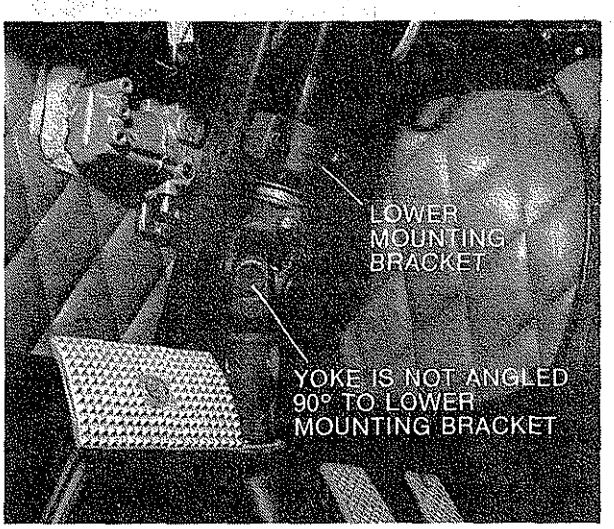


Fig. 3, Horizontal-Socket Drag Link With Remote Mounted Socket Ball Studs, Manual Steering, COE and Powerliner

DRAG LINK, COE AND POWERLINER



U-joint Yoke Position When Cab Is Tilted Beyond 45° Position



U-joint Yoke Position When Cab Is Tilted to 45° or Less

Fig. 4

cylinder rod (see Fig. 5) as soon as the cab reaches the 30-degree position. If the cab is tilted beyond the 30-degree position, place the tilt strut onto the hydraulic cylinder rod, then lower the cab to the 30-degree position, by using the instructions in the Freightliner COE Driver's Manual.

On vehicles equipped with a safety bar, position the safety bar as shown in Fig. 6, as soon as the cab reaches the 45-degree position.

3. Loosen the clamp pinch-bolt nut, if so equipped.
4. At the pitman arm end of the drag link, remove the cotter pin and nut from the socket ball stud. Refer to Fig. 7.
5. At the axle steering arm end of the drag link, remove the cotter pin and nut.
6. Using a ball stud removal tool, disconnect the drag link assembly from the axle steering arm and the pitman arm.

Installation (Refer to Fig. 1 or 2)

1. Apply the parking brakes, and chock the rear tires. Tilt the cab, using the instructions in the Freightliner COE Driver's Manual; but, *do not* turn the steering wheel for the purpose of positioning the steering driveline U-joints, and *do not* tilt the cab beyond the 45-degree position.

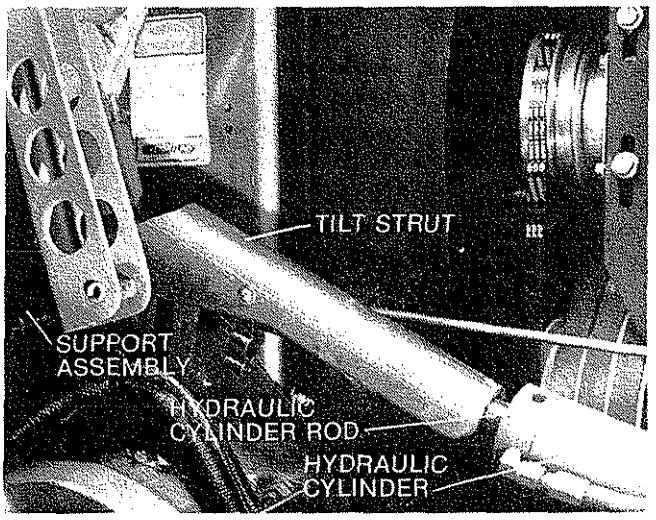


Fig. 5, Tilt Strut Positioned to Cylinder; Cab in 30° Tilted Position

NOTE: The steering driveline U-joints do not have to be positioned at 90 degrees to the steering column lower mounting bracket (Fig. 4), as long as the cab is not tilted beyond the 45-degree position.

IMPORTANT: On vehicles equipped with a tilt strut, place the free end of the tilt strut onto the hydraulic cylinder rod (see Fig. 5) as soon as the cab reaches the 30-degree position. If the cab is tilted beyond the 30-degree position, place the tilt strut onto the hydraulic

DRAG LINK, COE AND POWERLINER

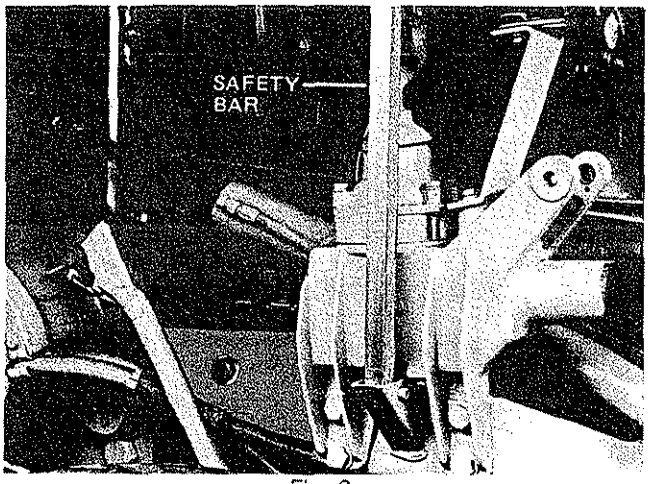


Fig. 6

cylinder rod, then lower the cab to the 30-degree position, by using the instructions in the Freightliner COE Driver's Manual.

On vehicles equipped with a safety bar, position the safety bar as shown in Fig. 6, as soon as the cab reaches the 45-degree position.

2. Before installing the drag link, inspect the drag link shaft, socket ball studs, grease fittings, and ball stud nuts for damage. If a grease fitting or ball stud nut is damaged, replace it.

   On an adjustable drag link, examine the ball stud covers for extreme wear, cuts, or other damage; replace the covers if necessary. If the drag link shaft or axle steering arm socket ball stud is damaged or badly worn, replace the axle steering arm end of the drag link; or, if the pitman arm socket ball stud is damaged or badly worn, replace it.

   On a non-adjustable drag link, if the drag link shaft or either of the socket ball studs are damaged or badly worn, replace the drag link.

3. Connect the pitman arm end of the drag link to the pitman arm. *Be sure the offset end of the drag link is on the axle steering arm end.* Install the ball stud nut on the ball stud at the pitman arm end.

4. When equipped with integral power steering, with the front tires positioned straight-ahead, turn the steering wheel until the axle steering arm ball stud can be inserted in the axle steering arm.

   When equipped with manual steering, with the front tires positioned straight-ahead, turn the steering wheel from lock to lock, counting the number of turns. Turn the steering wheel back, exactly half the number of turns, to approximately center the steering gear. Then, turn the steering wheel, in the direction requiring the least amount of wheel movement, to position the center punch mark, at the top of the input shaft, directly aft on the steering gear centerline. See Fig. 8. Adjust the length of the drag link by turning the axle steering arm end of the drag link shaft, clockwise or counterclockwise, until the ball stud can be seated in the axle steering arm.

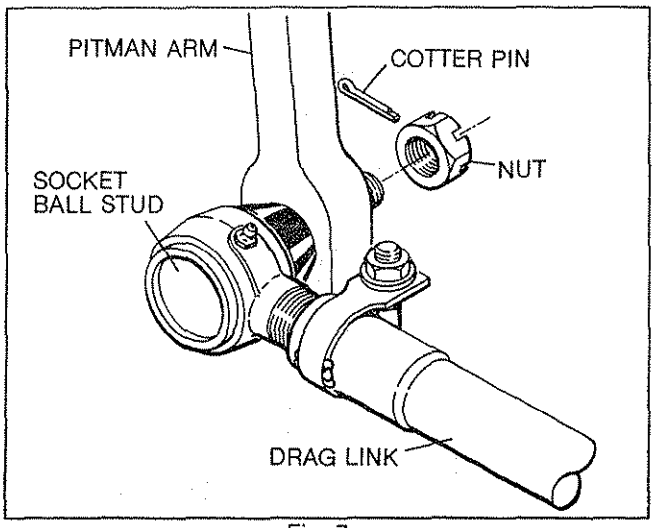


Fig. 7

WARNING: Be sure that a minimum of 1-3/4 inches (45 mm) of thread on the socket ball stud is engaged in the drag link shaft, otherwise, disengagement of the components and loss of steering control could occur.

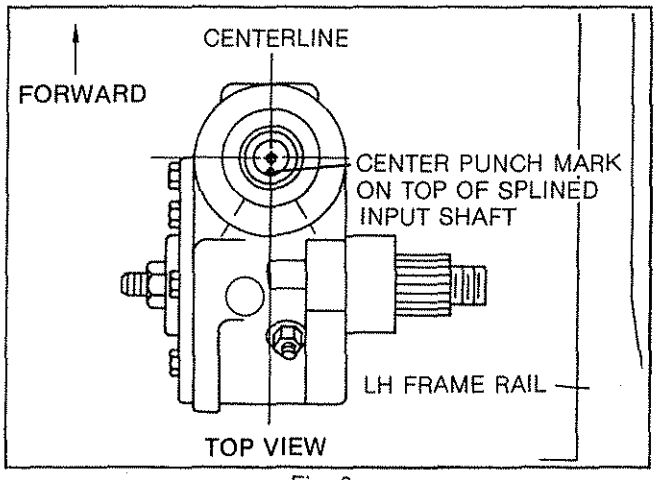


Fig. 8

DRAG LINK, COE AND POWERLINER

5. Seat the ball stud in the axle steering arm, and install the ball stud nut.
6. Tighten both ball stud nuts 100 lbf·ft (136 N·m). If required, continue tightening each nut until a slot on the nut aligns with the hole in the ball stud. *Do not back off the nut when locating the cotter pin hole.*
7. Install new cotter pins through the ball studs and nuts, and lock the cotter pins in place.

WARNING: Failure to install and lock new cotter pins in the ball studs and nuts could result in disengagement of the components and loss of steering control.

8. If so equipped, tighten the clamp pinch-bolt nut 55 lbf·ft (75 N·m).

IMPORTANT: The clamp is welded to the drag link shaft, and is not to be relocated. If any interference occurs, contact the Freightliner Regional Service Office.

9. Wipe the dirt from the grease fittings. Apply chassis grease with a pressure gun, until the old grease is forced out.
10. Tilt the cab to the upright position using the instructions in the Freightliner Driver's Manual. Remove the chocks from the tires.
11. With the front tires positioned straight ahead, check the position of the steering wheel king-spoke. On an unloaded COE or Powerliner, the steering wheel king-spoke must be positioned at 12 o'clock ± 10 degrees. See Fig. 9. If not, the steering wheel must be removed and reinstalled in the correct position. For instructions, refer to the appropriate upper column and jacket assembly subject in the 14 Group of this manual.

HORIZONTAL-SOCKET DRAG LINK
REMOVAL AND INSTALLATION

Removal (Refer to Fig. 3)

1. Position the front tires straight ahead. If possible drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. *Do not turn the steering wheel at any time while the drag link is still attached to both the pitman arm and the axle steering arm.* If the steering wheel is turned, the front tires will not be straight ahead.

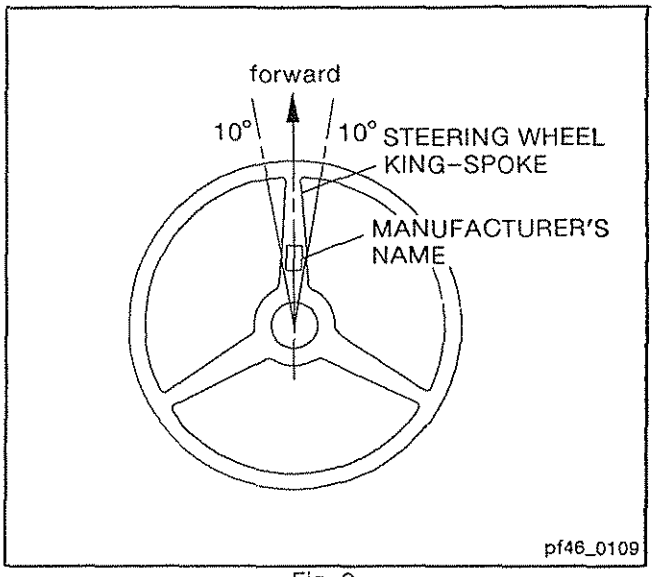


Fig. 9

2. Apply the parking brakes, and chock the rear tires. Tilt the cab, using the instructions in the Freightliner COE Driver's Manual; but, *do not* turn the steering wheel for the purpose of positioning the steering driveline U-joints, and *do not* tilt the cab beyond the 45-degree position.

NOTE: The steering driveline U-joints do not have to be positioned at 90 degrees to the steering column lower mounting bracket (Fig. 4), as long as the cab is not tilted beyond the 45-degree position.

IMPORTANT: On vehicles equipped with a tilt strut, place the free end of the tilt strut onto the hydraulic cylinder rod (see Fig. 5) as soon as the cab reaches the 30-degree position. If the cab is tilted beyond the 30-degree position, place the tilt strut onto the hydraulic cylinder rod, then lower the cab to the 30-degree position, by using the instructions in the Freightliner COE Driver's Manual.

On vehicles equipped with a safety bar, position the safety bar as shown in Fig. 6, as soon as the cab reaches the 45-degree position.

3. Remove the cotter pins from the horizontal-sockets. Loosen the spring bumpers.
4. Remove the drag link assembly.

Installation (Refer to Fig. 3)

1. Apply the parking brakes, and chock the rear tires. Tilt the cab, using the instructions in the Freightliner

DRAG LINK, COE AND POWERLINER

COE Driver's Manual; but, *do not* turn the steering wheel for the purpose of positioning the steering driveline U-joints, and *do not* tilt the cab beyond the 45-degree position.

NOTE: The steering driveline U-joints do not have to be positioned at 90 degrees to the steering column lower mounting bracket (Fig. 4), as long as the cab is not tilted beyond the 45-degree position.

IMPORTANT: On vehicles equipped with a tilt strut, place the free end of the tilt strut onto the hydraulic cylinder rod (see Fig. 5) as soon as the cab reaches the 30-degree position. If the cab is tilted beyond the 30-degree position, place the tilt strut onto the hydraulic cylinder rod, then lower the cab to the 30-degree position, by using the instructions in the Freightliner COE Driver's Manual.

On vehicles equipped with a safety bar, position the safety bar as shown in Fig. 6, as soon as the cab reaches the 45-degree position.

2. On the axle steering arm and the pitman arm, wipe off any dirt or grease from the ball studs. Check the ball studs for flat spots or wear that could cause binding of the drag link while in service. Replace the ball studs, if needed. Refer to the axle manufacturer's service manual or the applicable subject in the 10 Group of this manual.
3. Before installing the drag link, remove and clean the bumper assemblies, and inspect them for damage or wear. Replace the component(s), as needed.

   Check the drag link, grease fittings, and horizontal sockets for damage or wear. Replace the component(s), as needed.
4. Install the new or serviceable bumper assemblies.
5. Install the drag link socket assembly on the pitman arm ball.
6. Tighten the spring bumper at the pitman arm end of the drag link; tighten only until the spring bumper is flush with the end of the socket.
7. Loosen the clamp pinch-bolt nut on the pitman arm end.
8. With the front tires positioned straight-ahead, turn the steering wheel from lock to lock, counting the number of turns. Turn the steering wheel back, exactly half the number of turns, to approximately center the steering gear. Then, turn the steering wheel, in the direction requiring the least amount of wheel movement, to position the center punch mark, at the top of the input shaft, directly aft on the steering gear centerline. See Fig. 8. Shorten or lengthen the drag link by turning the axle steering arm end of the drag link, clockwise or counterclockwise, until the socket can be installed on the axle steering arm ball.

WARNING: Be sure that a minimum of 1-3/4 inches (45 mm) of thread on the socket is engaged in the drag link shaft, otherwise, disengagement of the components and loss of steering control could occur.

   Install the axle steering arm end of the drag link on the axle steering arm ball.
9. Tighten the clamp pinch-bolt nut 55 lbf·ft (75 N·m).
10. Proceed to step 4 under "HORIZONTAL-SOCKET TIGHTNESS ADJUSTMENT."

HORIZONTAL-SOCKET TIGHTNESS ADJUSTMENT

Use the following procedure for adjusting the socket tightness at each end of the horizontal-socket drag link. Refer to Fig. 3.

1. Apply the parking brakes.
2. Chock the rear tires. Tilt the cab, using the instructions in the Freightliner COE Driver's Manual.
3. Remove the cotter pins from both ends of the drag link.
4. Tighten the spring bumpers until the springs compress and the bearings are tight against the bearing stops and bearing spacers.
5. Loosen the spring bumpers one-sixteenth of a turn, so the connections are free.
6. Measure the distance from the outside of the spring bumpers to the end of the housings. This distance should be approximately 1/16 inch (1.5 mm).

   If the distance from the spring bumper to the end of the housing does not comply, proceed as follows:

   .1 Loosen the spring bumpers until the sockets can be removed from the pitman arm ball and axle steering arm ball. Remove the drag link.

   .2 Remove the internal parts from the sockets.

DRAG LINK, COE AND POWERLINER

.3 Clean the bumper assemblies, and inspect for damage or wear. Replace the component(s), as needed.

.4 Wipe away any dirt or grease from the pitman arm ball and the axle steering arm ball. Inspect the balls for flat spots or wear that could cause binding of the drag link while in service. Replace the balls if necessary. Refer to the axle manufacturer's service manual or the applicable axle subject in the 10 Group of this manual.

.5 Install the new or serviceable bumper assemblies in the horizontal-sockets.

.6 Position the horizontal-sockets on the pitman arm ball and axle steering arm ball. Repeat steps 4, 5, and 6.

7. Install new cotter pins through both ends of the drag link, and lock the cotter pins in place. If the cotter pin holes do not line up with the groove in the spring bumper, loosen the spring bumper one-eighth turn, or less, until its groove lines up with the next cotter pin hole.

WARNING: Failure to adjust the spring bumpers as described above, or failure to install and lock new cotter pins, could result in a hazardous steering condition.

8. Wipe the dirt from the grease fittings. Apply chassis grease with a pressure gun, until the old grease is forced out of the ball socket.

9. Tilt the cab to the upright and locked position, using the instructions in the Freightliner COE Driver's Manual.

10. Remove the chocks from the tires.

HORIZONTAL-SOCKET DRAG LINK LENGTH ADJUSTMENT

The steering gear must be centered, and the steering wheel king-spoke must be pointing toward the front of the vehicle (see Fig. 9), when the loaded vehicle is traveling straight forward. If the steering wheel king-spoke is not pointing toward the front of the vehicle, proceed as follows:

1. Position the front tires straight ahead. If possible drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. *Do not turn the steering wheel at any time while the drag link is still attached to both the pitman arm and the axle steering arm.* If the steering wheel is turned, the front tires will not be straight ahead.

2. Apply the parking brakes, and chock the rear tires. Tilt the cab, using the instructions in the Freightliner COE Driver's Manual; but, *do not* turn the steering wheel for the purpose of positioning the steering driveline U-joints, and *do not* tilt the cab beyond the 45-degree position.

NOTE: The steering driveline U-joints do not have to be positioned at 90 degrees to the steering column lower mounting bracket (Fig. 4), as long as the cab is not tilted beyond the 45-degree position.

IMPORTANT: On vehicles equipped with a tilt strut, place the free end of the tilt strut onto the hydraulic cylinder rod (see Fig. 5) as soon as the cab reaches the 30-degree position. If the cab is tilted beyond the 30-degree position, place the tilt strut onto the hydraulic cylinder rod, then lower the cab to the 30-degree position, by using the instructions in the Freightliner COE Driver's Manual.

On vehicles equipped with a safety bar, position the safety bar as shown in Fig. 6, as soon as the cab reaches the 45-degree position.

3. Loosen the clamp pinch-bolt nut, on the pitman arm end of the drag link.

4. At the axle steering arm end of the drag link, remove the cotter pin from the socket. Loosen the spring bumper until the socket can be taken off the axle steering arm ball. Refer to Fig. 3. Remove the socket from the axle steering arm ball.

5. With the front tires positioned straight-ahead, turn the steering wheel from lock to lock, counting the number of turns. Turn the steering wheel back, exactly half the number of turns, to approximately center the steering gear. Then, turn the steering wheel, in the direction requiring the least amount of wheel movement, to position the center punch mark, at the top of the input shaft, directly aft on the steering gear centerline. See Fig. 8.

6. Shorten or lengthen the drag link by turning the axle steering arm end of the drag link, clockwise or counterclockwise, until the socket can be installed on the axle steering arm ball.

NOTE: Rotating the steering wheel 90 degrees counterclockwise, will require lengthening the drag link six turns.

WARNING: Be sure that a minimum of 1-3/4 inches (45 mm) of thread on the socket is engaged in the

DRAG LINK, COE AND POWERLINER

drag link shaft, otherwise, disengagement of the components and loss of steering control could occur.

Install the axle steering arm end of the drag link on the axle steering arm ball.

7. Tighten the clamp pinch-bolt nut 55 lbf·ft (75 N·m).
8. Proceed to step 4 under "HORIZONTAL-SOCKET TIGHTNESS ADJUSTMENT."

DRAG LINK, CONVENTIONAL

GENERAL DESCRIPTION

The vertical-socket drag link assembly used on Conventionals, with manual or power steering, is adjustable for length, and has a removable socket ball stud on each end. See Fig. 1.

SERVICE OPERATIONS

VERTICAL-SOCKET DRAG LINK
REMOVAL AND INSTALLATION

Removal (Refer to Fig. 1)

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. *Do not turn the steering wheel at any time while the drag link is still attached to both the pitman arm and the axle steering arm.* If the steering wheel is turned, the front tires will not be straight ahead.
2. Apply the parking brakes, and chock the rear tires.
3. Release the hood latches, then tilt the hood forward, using the instructions in the Freightliner Conventional Driver's Manual.
4. Loosen the clamp pinch-bolt nuts on both ends of the drag link.
5. At the pitman arm end of the drag link, remove the cotter pin and nut from the socket ball stud. See Fig. 2.
6. Using a ball stud removal tool, disconnect the ball stud from the pitman arm.
7. At the axle steering arm end of the drag link, remove the cotter pin and nut from the socket ball stud.
8. Using a ball stud removal tool, disconnect the ball stud from the axle steering arm, then remove the drag link.

Installation (Refer to Fig. 1)

1. Before installing the drag link, examine the ball stud covers for extreme wear, cuts, or other damage; replace the covers if necessary. Inspect the socket ball studs, ball stud nuts, drag link tube, and grease fittings for wear or damage. Replace the components as necessary.

IMPORTANT: Before installing a new or serviceable drag link, insure that the thread engagement in the drag link tube, of both socket ball studs, is equal within 1/8 inch (3 mm).

2. With the front tires positioned straight-ahead, turn the steering wheel from lock to lock, counting the number of turns. Turn the steering wheel back, exactly half the number of turns, to center the steering gear. Then, on Conventionals with manual steering, turn the steering wheel, in the direction requiring the least amount of wheel movement, to position the center punch, at the top of the input shaft, directly aft on the steering gear centerline. See Fig. 3. Using a marking pen or paint, make an alignment

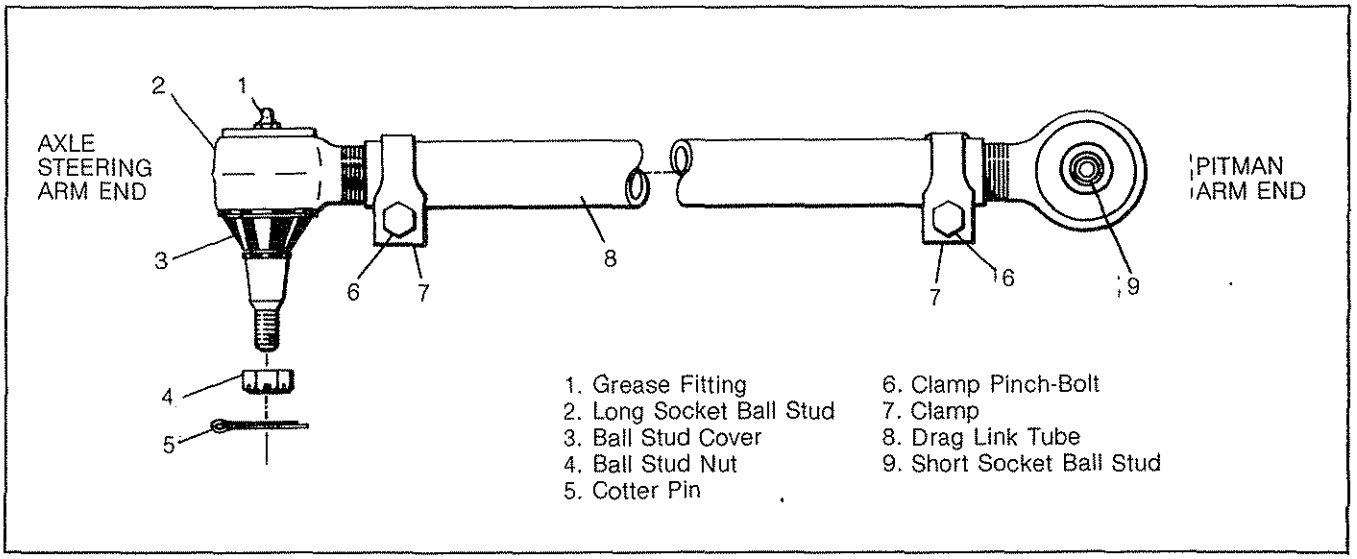


Fig. 1, Vertical-Socket Drag Link, Manual or Power Steering, Conventional

DRAG LINK, CONVENTIONAL

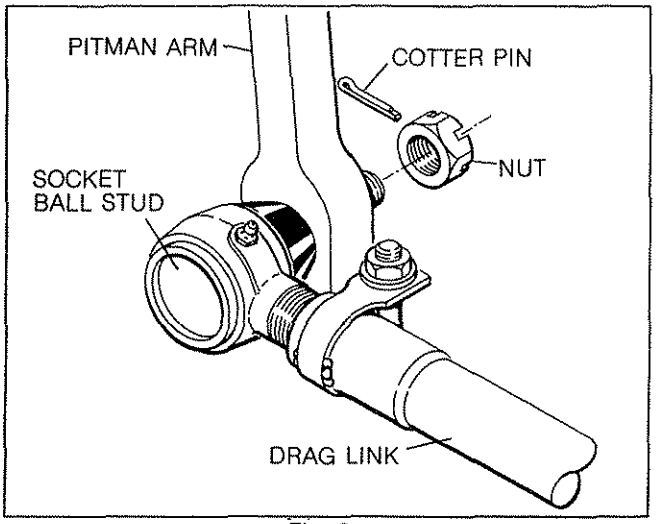


Fig. 2

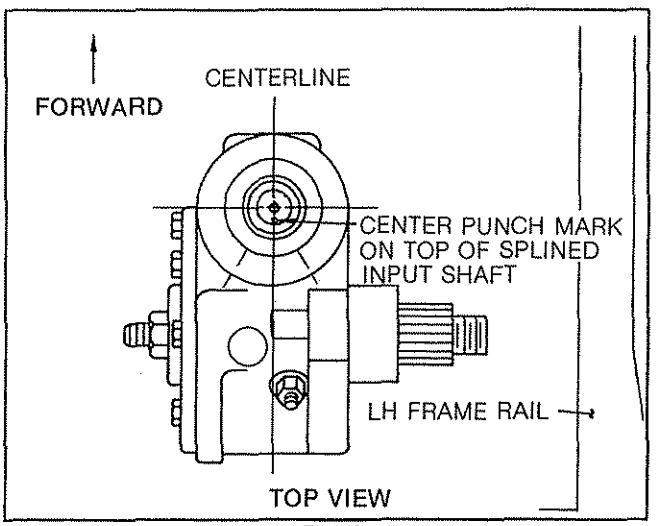


Fig. 3

mark on the pitman arm and steering gear output shaft, that is perpendicular to the centerline of the steering gear input (actuating) shaft.

3. Seat both ends of the drag link assembly on the axle steering arm and the pitman arm. Be sure the socket ball with the longer stud is on the axle steering arm end of the drag link.

IMPORTANT: If the distance between the axle steering arm and the pitman arm is not the same as the distance between the drag link socket ball studs, *do not* turn the socket ball studs or drag link tube, to shorten or lengthen the drag link. Instead, turn the steering wheel to change the distance from the pitman arm to the axle steering arm (the steering gear will be centered at step 6, below).

4. Install the nuts on the ball studs. Tighten the ball stud nuts 100 lbf·ft (136 N·m). If required, continue tightening each nut until a slot on the nut aligns with the hole in the ball stud. *Do not back off the nut when locating the cotter pin hole.*

5. Install new cotter pins through the ball studs and nuts, and lock the cotter pins in place.

WARNING: Failure to install and lock new cotter pins in the ball studs and nuts could result in disengagement of the components and loss of steering control.

6. If needed, adjust the length of the drag link by turning the drag link tube clockwise or counterclockwise, until the pitman arm/output shaft alignment mark is perpendicular to the steering gear input shaft.

WARNING: Be sure that a minumum of 1-3/4 inches (45 mm) of thread on each of the socket ball studs is engaged in the drag link tube, and that the thread engagement of the socket ball studs is equal, to within 1/8 inch (3 mm). Failure to comply could result in disengagement of the components and loss of steering control.

7. Tighten both of the clamp pinch-bolt nuts 55 lbf·ft (75 N·m).

NOTE: If necessary to avoid interference, the clamps may be repositioned by rotating the drag link tube one-half turn in either direction.

8. Wipe the dirt from the grease fittings. Apply chassis grease with a pressure gun, until the old grease is forced out.

9. Tilt the hood to the operating position, and lock the hood latches, using the instructions in the Freightliner Conventional Driver's Manual. Remove the chocks from the tires.

10. With the front tires positioned straight ahead, check the position of the steering wheel king-spoke. On an unloaded Conventional, the steering wheel king-spoke must be positioned at 12 o'clock ± 10 degrees. See Fig. 4. If not, the steering wheel must be removed and reinstalled in the correct position. For instructions,

DRAG LINK, CONVENTIONAL

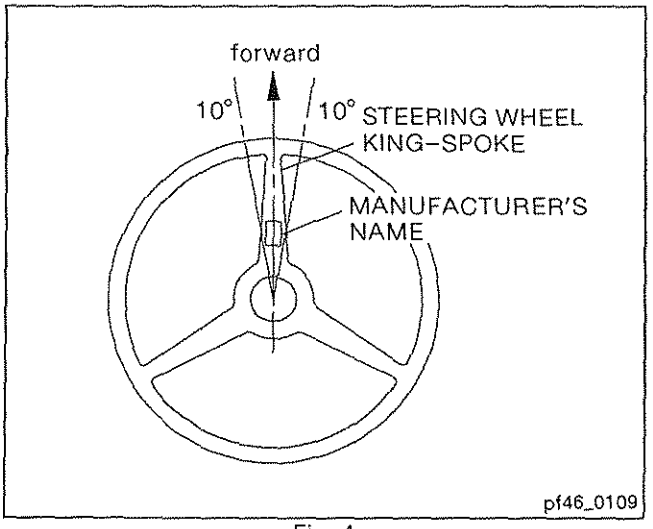


Fig. 4

refer to the appropriate upper column and jacket assembly subject in the 14 Group of this manual.

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GENERAL DESCRIPTION

The drag link assembly connects the pitman arm to the axle steering arm. Either a fixed-length drag link (**Fig. 1**), or an adjustable drag link is installed. Refer to **Tables 1, 2,** and **3** in the "Specifications" section of this subject.

An adjustable drag link (**Fig. 2**) has either one or two movable ball stud assemblies. If equipped with one movable ball stud assembly, the end attached to the pitman arm can be turned in or out to adjust the length of the drag link. If equipped with two movable ball stud assemblies, both ends can be turned in or out to adjust the length of the drag link.

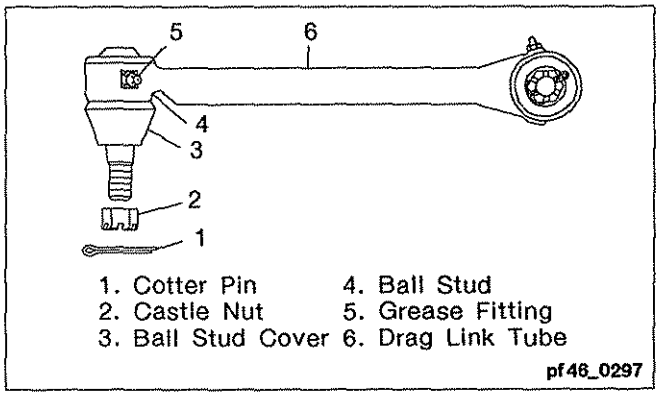

Fig. 1, Fixed-Length Drag Link

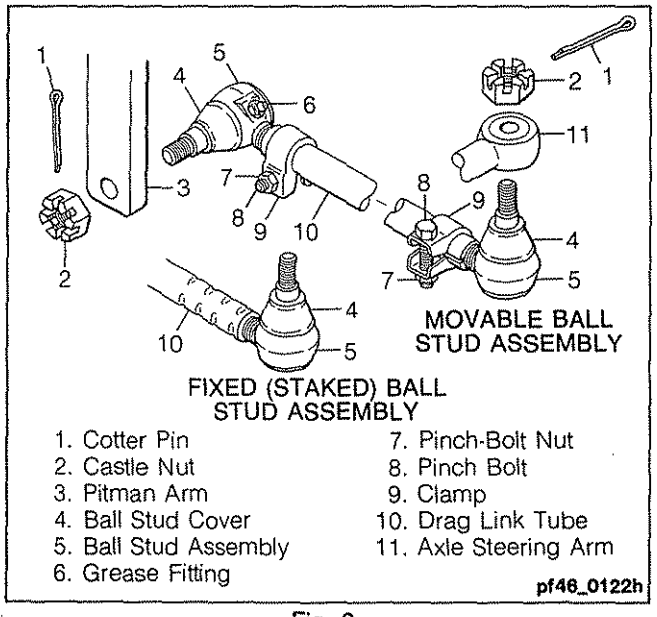

Fig. 2

SERVICE OPERATIONS

DRAG LINK REMOVAL

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service work will be done. *Do not move the tires from the straight-ahead position during these operations.*
2. Set the parking brake and chock the rear tires.
3. Tilt the hood or cab. Follow the instructions in the applicable driver's manual.
4. At both ends of the drag link, remove the cotter pins and castle nuts from the ball studs.
5. Using a ball stud removal tool, remove the ball studs from the pitman arm and the axle steering arm.

SOCKET BALL STUD CHECKING AND INSPECTION

NOTE: Checking ball stud deflection is accurate only for low-end movement socket ball studs; it is not an accurate check for dual-seat socket ball studs. To determine the type of socket ball stud on a drag link, look at the metal dust cap on the back of the socket. If the cap is domed, it is a dual-seat socket ball stud and it is not necessary to check the ball stud deflection. If the socket cap is flat, it is a low-end movement socket ball stud and the deflection check will accurately indicate socket wear.

If equipped with a dual-seat socket ball stud, go to step 2. If equipped with a low-end movement socket ball stud, continue with the following deflection check.

1. Check the ball stud deflection as follows:
   .1 Place one ball stud in a press. Using a dial indicator, measure the distance between the back of the socket dust cap and the end of the socket ball stud. Record the distance. See **Fig. 3**, Ref. *A*.

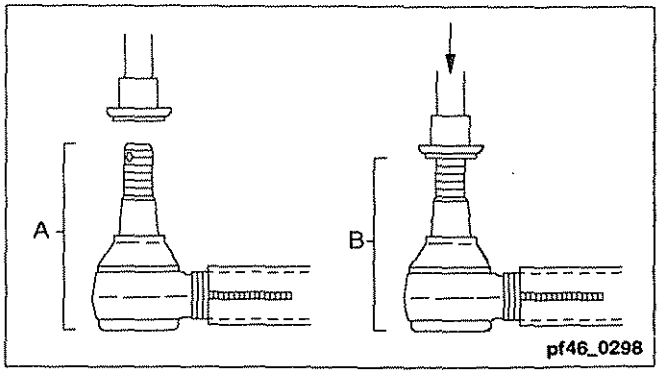

Fig. 3, Checking the Socket Ball Stud Deflection

DRAG LINK, 1984 ADVANCEMENTS

.2 With 750 lb (227 kg) force applied to the socket ball stud, measure the distance in step 1.1 again. See **Fig. 3**, Ref. *B*. The difference between measurements A and B should not be more than 0.06 in (1.5 mm). If the deflection is more, replace the drag link.

If deflection is less than 0.06 in (1.5 mm), repeat steps 1.1 and 1.2 on the other ball stud.

If either of the socket ball studs fail the check, replace the drag link. If both socket ball studs check out okay, go to step 2.

2. Check the ball stud torque as follows:

.1 Secure one of the socket ball studs in a vise. Remove the rubber dust cover.

.2 Place enough washers on the socket ball stud so that you can screw the castle nut down snugly on top of the washers without bottoming out the nut on the stud's threads.

The washers should have an inside diameter small enough that they will not slip to the bottom of the stud and rest on the socket. Refer to **Fig. 4**. If the washers rest on the socket, they will bind between the castle nut and the ball socket, and prevent an accurate torque reading.

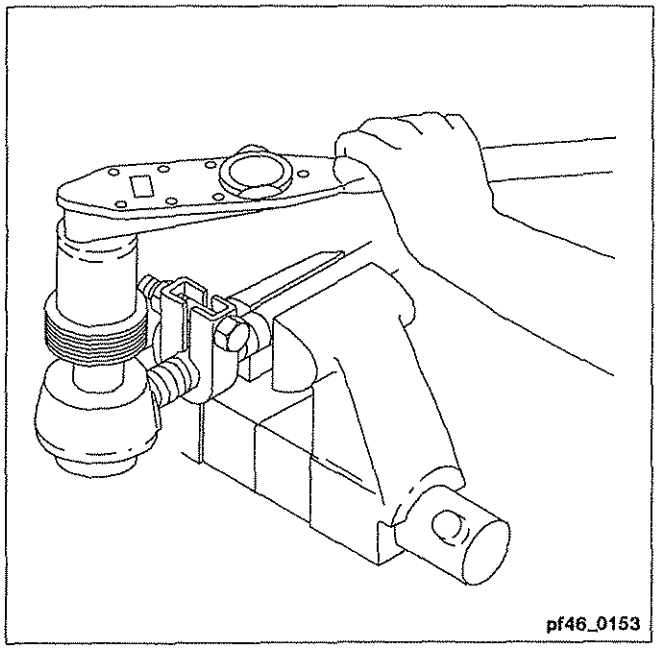

Fig. 4, Checking the Ball Stud Torque

Place a torque wrench over the castle nut (**Fig. 4**), and measure the torque needed to slowly and continuously turn the ball stud in its socket. This torque is known as the "continuous" torque.

If it takes less than 10 lbf·ft (14 N·m) continuous torque to spin the stud in the socket, replace the drag link.

If it takes 10 lbf·ft (14 N·m) or more continuous torque to spin the stud in the socket, remove the torque wrench, nut, and washers. Go to step 3 and inspect the socket ball stud.

3. Inspect the ball stud as follows:

.1 Rotate the ball in the socket. See **Fig. 5**. Look for any sign of metal shavings, pitting, galling or rust on the ball or the edges of the socket. Replace the drag link if any of these conditions exist.

If the socket ball stud spins only at torques of 10 lbf·ft (14 N·m) or more, and if there is no sign of metal shavings, pitting, or galling, install the rubber dust cover and repeat steps 2 and 3 on the socket ball stud at the other end of the drag link.

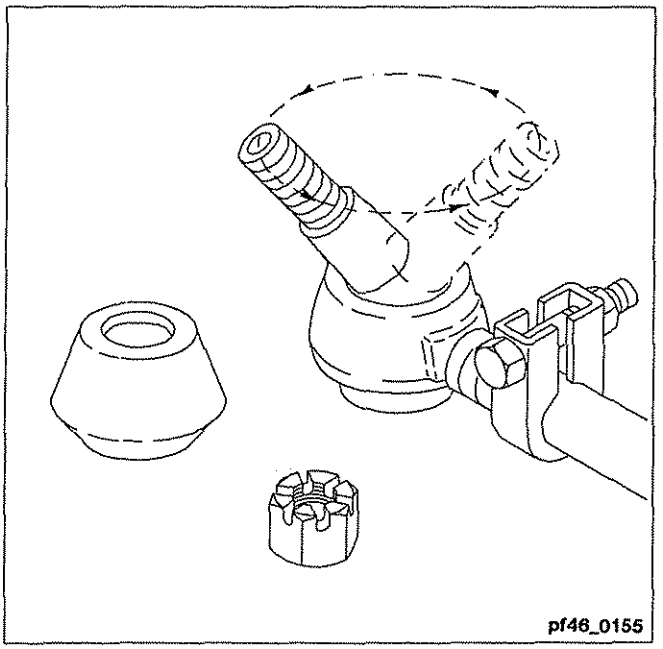

Fig. 5, Inspecting the Ball Stud for Galling

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NOTE: Low-end movement socket ball studs must pass the deflection check, the torque check, and inspection. If either stud fails any of these checks, replace the drag link.

Dual-seat socket ball studs must pass the torque check and inspection. If either stud fails these checks, replace the drag link.

DRAG LINK INSTALLATION

WARNING: Vehicles with a Freightliner FK-120 front axle use a drag link with a fixed (staked) ball stud assembly on the steering arm end. Using an incorrect drag link could lead to axle damage, possibly causing personal injury.

1. Make sure the front tires are positioned straight ahead. Check that the drag link, pitman arm, and axle steering arm are the correct parts for the vehicle. Refer to the Freightliner *Parts Book*.
2. On vehicles with a manual steering gear, center the gear as follows (drag link removed):
   .1 Turn the steering wheel from lock to lock while counting the turns. Turn the steering wheel back exactly half the number of turns.
   .2 Check that the alignment mark on the steering gear output shaft is at a right angle to the input shaft. Also, the bolt groove on the input shaft should be parallel to the output shaft. See Fig. 6.

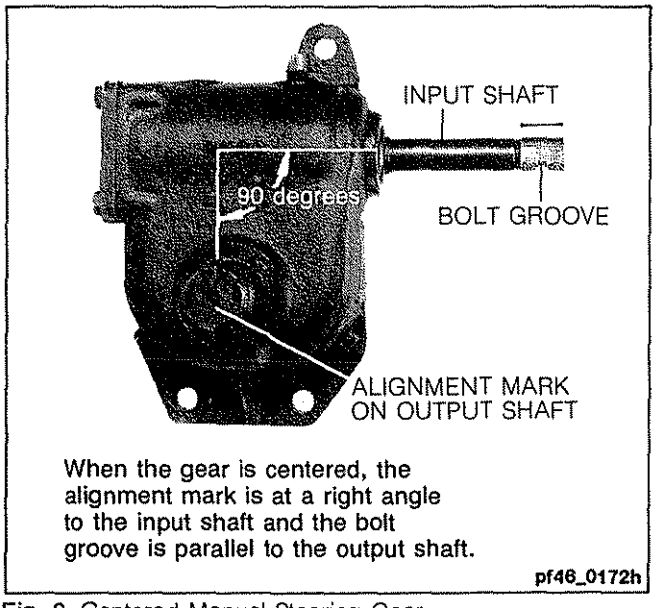

Fig. 6, Centered Manual Steering Gear

If needed, turn the steering wheel until the alignment mark is at a right angle to the input shaft, and the bolt groove is parallel to the output shaft.

3. On adjustable drag links, adjust the length as follows:
   .1 For manual steering gears, turn the ball stud assemblies in or out of the drag link tube so the ball studs fit into the axle steering arm and the pitman arm.
   .2 For power steering gears, turn the ball stud assemblies in or out of the drag link tube so the drag link length meets the specification in Table 1 or 2 in the "Specifications" section of this subject.

   WARNING: On adjustable drag links, failure to make sure that the ball stud assemblies are threaded correctly in the drag link tube could result in disengagement of the components and loss of steering control, possibly causing personal injury.

   .3 On adjustable drag links, make sure that both ball stud assemblies are threaded in the drag link tube at least 1-3/4 inches (45 mm) for 1-1/8 inch diameter thread stems, and at least 2 inches (51 mm) for 1-1/4 inch diameter thread stems. See Fig. 7.

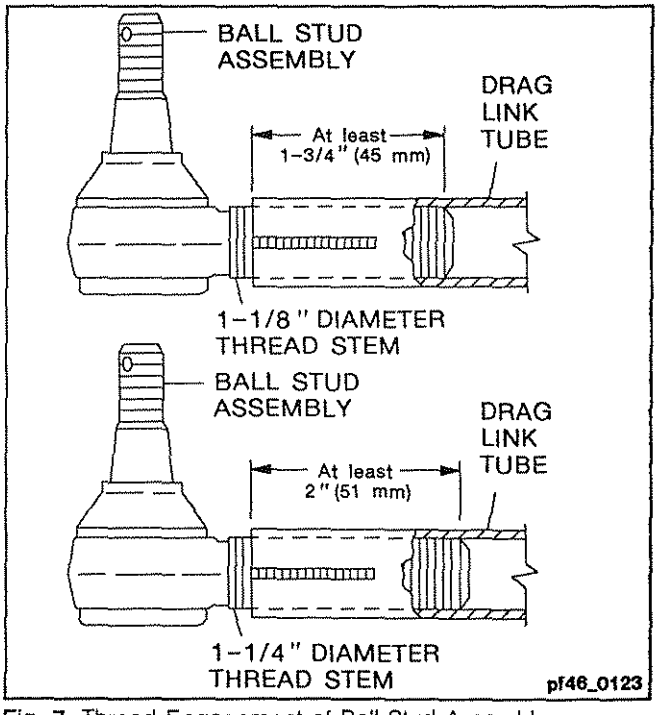

Fig. 7, Thread Engagement of Ball Stud Assembly

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Check that the thread engagement in the drag link tube of both ball stud assemblies is equal to within 1/8 inch (3 mm).

4. Insert the ball studs into the axle steering arm and the pitman arm. For power steering gears, turn the steering wheel as needed to correctly position the pitman arm.

   On Ross power steering gears, the alignment mark on the output shaft must be within 6 degrees of a right angle to the input shaft.

IMPORTANT: To avoid interference between the clamp and the axle beam on adjustable drag links, place the fixed ball stud (if equipped) in the axle steering steering arm.

5. Install the castle nuts on the ball studs. Tighten the nuts 100 lbf·ft (136 N·m). If needed, continue tightening each nut until a slot on the nut aligns with the hole in the ball stud. *Do not back off the nut to locate the cotter pin hole.*

WARNING: Failure to install and lock new cotter pins in the ball studs and nuts could result in disengagement of the components and loss of steering control, possibly causing personal injury.

6. Install new cotter pins through the ball studs and nuts and lock the cotter pins in place.

7. Position adjustable drag links so that both ball studs are centered, with the sockets at right angles to each other. See **Fig. 8**, Refs. *A* and *B*.

   Make sure the clamps, pinch bolts, and nuts won't interfere with other parts. On adjustable drag links with two clamps, reposition the clamps by turning the drag link tube one-half turn in either direction, as needed.

   Tighten the clamp pinch-bolt nuts 55 lbf·ft (75 N·m).

8. Wipe the dirt from the grease fittings. Apply chassis grease with a pressure gun until the old grease is forced out.

9. Make sure the pitman arm angle meets the specification in **Table 1**, **2**, or **3** in the "Specifications" section. Refer to **Fig. 9**. If the pitman arm angle is wrong, check that the pitman arm timing meets the specification in **Table 1**, **2**, or **3** in the "Specifications" section. Refer to **Fig. 10**.

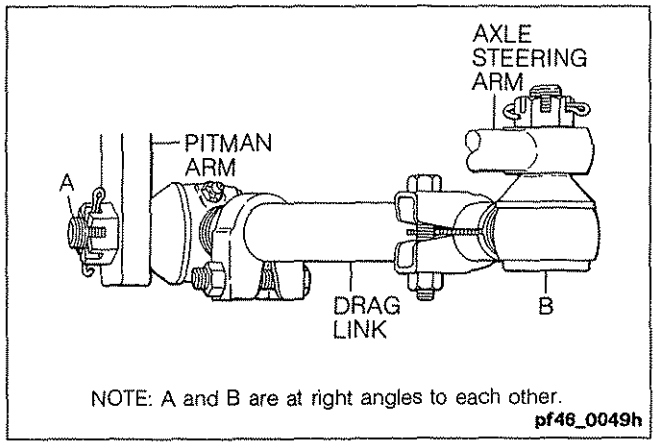

Fig. 8

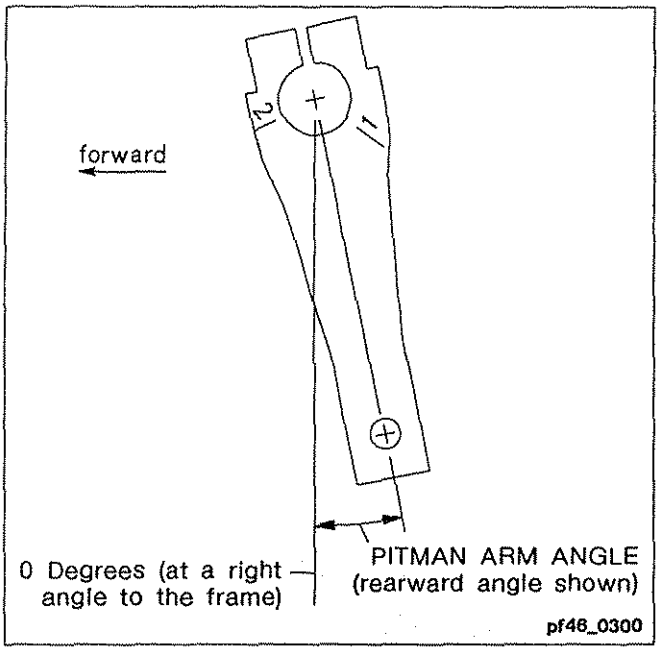

Fig. 9, Pitman Arm Angle

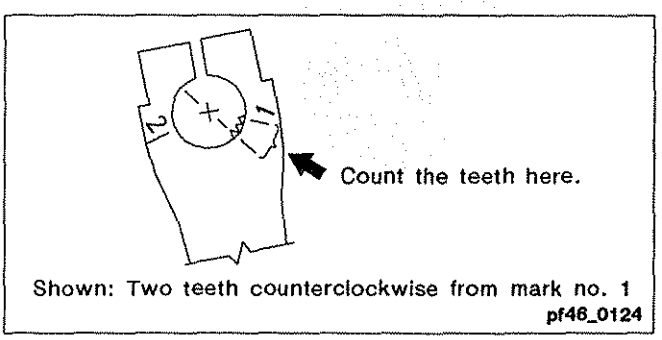

Fig. 10, Pitman Arm Timing

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10. Check the settings on the axle stop, and adjust them if necessary. For instructions, refer to the applicable subject in Group 10 of this manual.
11. For power steering gears, check the settings on the relief valve plungers (Sheppard) or poppet valves (Ross). Adjust them if necessary. For instructions, refer to the applicable subject in Group 14 of this manual.
12. Return the cab or hood to the operating position and secure it. Follow the instructions in the applicable Freightliner driver's manual.
13. Remove the chocks from the rear tires.
14. With the front tires straight ahead, and no load on the vehicle, check the position of the steering wheel king-spoke (**Fig. 11**), or steering wheel spokes (**Fig. 12**). The steering wheel king-spoke should point directly forward, or within 10 degrees on either side of the 12 o'clock position (**Fig. 11**). The steering wheel spokes should be at 4 and 8 o'clock positions, or within ±10 degrees of either side (**Fig. 12**). If not, remove the steering wheel and install it in the correct position. For instructions, refer to the applicable upper column and jacket assembly subject in Group 14.

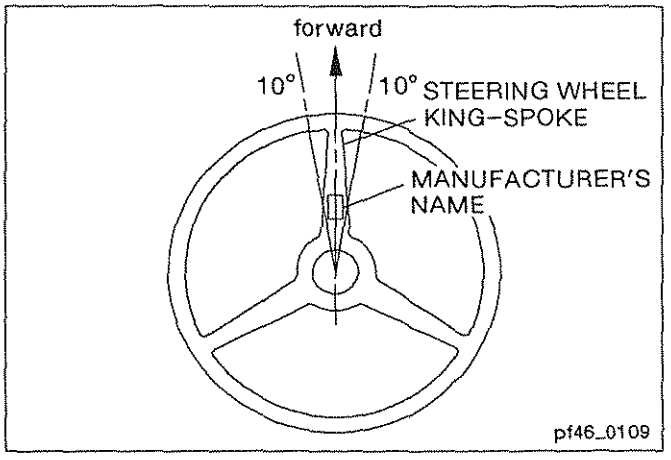


Fig. 11, Steering Wheel Positioning

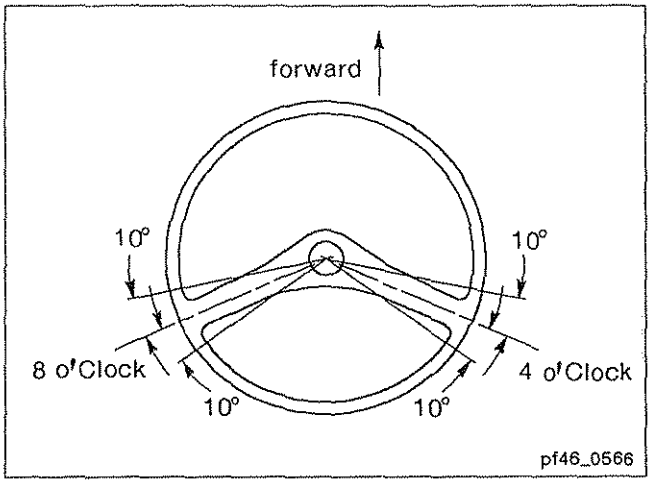


Fig. 12

DRAG LINK, 1984 ADVANCEMENTS

SPECIFICATIONS

Steering Gear	Vehicle	Drag Link Length to Within 1/8" (3 mm)	Pitman Arm Angle (Nominal) (Fig. 9)		Pitman Arm Timing (Fig. 10)
		inches (mm)	Front Suspension to Capacity	Front Suspension at Tare	Teeth Counterclockwise from Mark
Ross HFB64*	COE	18-5/8 (473)	1° 15′ fwd	30′ fwd	0 from no. 2
	120 Conventional: Set-Forward Axle	18-5/8 (473)	30′ fwd	15′ rear	0 from no. 1
	Setback Axle	31-7/8 (810)	11° 0′ rear	10° 0′ rear	0 from no. 1
Ross HFB70	COE	17-5/8 (448)	1° 0′ rear	1° 15′ rear	0 from no. 2
	120 Conventional: Set-Forward Axle	18-1/2 (470)	0°	0°	0 from no. 1
	Setback Axle	32-1/8 (816)	11° 0′ rear	10° 0′ rear	2 from no. 1
Ross 503†	COE	18-7/8 (479)	3° 45′ fwd	3° 0′ fwd	0 from no. 2
	120 Conventional: Set-Forward Axle	19-1/4 (489)	5° 0′ fwd	4° 30′ fwd	0 from no. 1
	Setback Axle	33-1/2 (851)	2° 45′ rear	2° 0′ rear	1 from no. 1
Sheppard 392S	COE	17-5/8 (448)	30′ rear	45′ rear	0 from no. 2
	120 Conventional: Set-Forward Axle	18-3/8 (467)	0°	15′ rear	0 from no. 1
	With Pitman Arm 14-10066-000 or -001	17-1/2 (445)	4° 30′ rear	4° 0′ rear	0 from no. 1
	Setback Axle	32-5/8 (829)	8° 0′ rear	7° 15′ rear	1 from no. 1

Table 1, Adjustable Drag Link Length and Pitman Arm Specifications for Vehicles Built *Before* January 1988

* Does not apply to dual gear installations (HFB64 with RCB64).
† Use only as a check: adjust the drag link as instructed in step 3.1 under "Drag Link Installation."

Steering Gear	Vehicle	Drag Link Length to Within 1/8" (3 mm)	Pitman Arm Angle (Nominal) (Fig. 9)		Pitman Arm Timing Mark
		inches (mm)	Front Suspension to Capacity	Front Suspension at Tare	
Ross HFB70	COE: Set-Forward Axle	17-5/8 (448)	1° 0′ rear	1° 15′ rear	no. 2
	120 Conventional: Set-Forward Axle	18-1/2 (470)	0°	0°	no. 1
	Setback Axle	32-1/8 (816)	11° 0′ rear	10° 0′ rear	no. 1
Ross 503*	COE: Set-Forward Axle	18-7/8 (479)	3° 45′ fwd	3° 0′ fwd	no. 2
	120 Conventional: Set-Forward Axle	19-1/4 (489)	5° 0′ fwd	4° 30′ fwd	no. 1
	Setback Axle	33-1/2 (851)	2° 45′ rear	2° 0′ rear	no. 1
Ross Dual TAS65 & RCB64 (Left Side)	COE: Set-Forward Axle	19-3/8 (492)	4° 0′ fwd	3° 15′ fwd	no. 1
	120 Conventional: Set-Forward Axle	18-3/4 (476)	0°	0° 45′ fwd	no. 1
	Setback Axle	32-1/4 (819)	11° 0′ rear	9° 45′ rear	no. 1
Ross Dual TAS65 & RCB64 (Right Side)	COE: Set-Forward Axle	18-3/4 (476)	0°	0° 45′ fwd	no. 2
	120 Conventional: Set-Forward Axle	18-3/4 (476)	0°	0° 45′ fwd	no. 2
	Setback Axle	32-1/4 (819)	11° 0′ rear	9° 45′ rear	no. 2

Table 2, Adjustable Drag Link Length and Pitman Arm Specifications for Vehicles Built *After* January 1988

* Use only as a check: adjust the drag link as instructed in step 3.1 under "Drag Link Installation."

DRAG LINK, 1984 ADVANCEMENTS

SPECIFICATIONS (Continued)

Steering Gear	Vehicle		Drag Link Length	Pitman Arm Angle (Nominal) (Fig. 9)		Pitman Arm Timing Mark
			inches (mm)	Front Suspension to Capacity	Front Suspension at Tare	
Ross TAS65	COE:	Set-Forward Axle	18-7/8 (479)	2° 45′ fwd	2° 0′ fwd	no. 2
		Setback Axle	40 (1016)	10° 45′ rear	9° 45′ rear	no. 2
	120 Conventional:	Set-Forward Axle	18-7/8 (479)	1° 45′ fwd	1° 15′ rear	no. 1
		Setback Axle	32-5/8 (829)	7° 0′ rear	5° 0′ rear	no. 1
Sheppard M100	COE:	Set-Forward Axle	18-7/8 (479)	6° 0′ fwd	5° 45′ fwd	no. 2
		Setback Axle	40 (1016)	8° 30′ rear	6° 45′ rear	no. 1
	120 Conventional:	Set-Forward Axle	18-7/8 (479)	1° 0′ fwd	45′ fwd	no. 1
		Setback Axle	33-1/2 (851)	4° 15′ rear	3° 0′ rear	no. 1

Table 3, Fixed-Length Drag Link Length and Pitman Arm Specifications for Vehicles Built *After* January 1988

UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32229, COE AND CONVENTIONAL

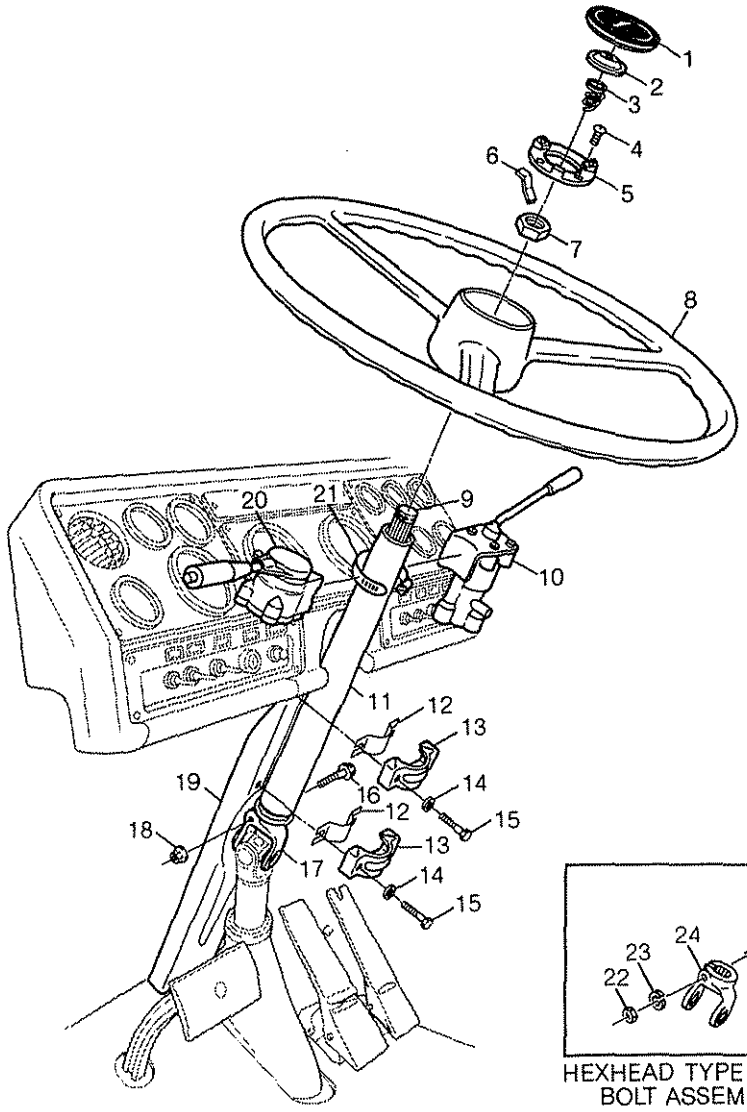
GENERAL DESCRIPTION

The upper column and jacket assembly, Ross model UC32229, used in Freightliner vehicles, consists of a wheel tube shaft, jacket, and jacket bearing assemblies. The wheel tube shaft has a tapered serration on the upper end for the steering wheel, and is serrated on the lower end to connect with the steering driveline U-joint. The upper column and jacket assembly is attached to the dash with steering column clamps.

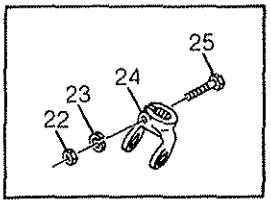
SERVICE OPERATIONS

REMOVAL (Refer to Fig. 1)

1. Turn the steering wheel so that the king-spoke (the narrow spoke on some wheels, or the spoke with



1. Horn Button
2. Contact Cup
3. Horn Button Spring
4. Base Plate Screw
5. Base Plate
6. Contact Spring
7. Wheel Nut
8. Steering Wheel
9. Wheel Tube Shaft
10. Trailer Brake Hand Valve
11. Jacket
12. Spacer
13. Clamp Cap
14. Washer
15. Capscrew
16. End Yoke Pinch Bolt, Flanged
17. Upper End Yoke
18. End Yoke Pinch Bolt Nut, Flanged
19. Dash Mounting Bracket
20. Directional Signal Switch
21. Clamp
22. Hex Nut
23. Lockwasher
24. Upper End Yoke
25. End Yoke Pinch Bolt, Hexhead



HEXHEAD TYPE PINCH BOLT ASSEMBLY

NOTE: Some fasteners intentionally omitted for clarity. COE and Conventional upper column assemblies identical; COE boot assembly shown.

Fig. 1, Upper Column and Jacket Assembly

UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32229, COE AND CONVENTIONAL

the manufacturer's name printed on the underside) is in the 12 o'clock position. See Fig. 2.

2. While pressing lightly on the horn button, turn it counterclockwise to disengage it from the steering wheel. Remove the horn button, the contact cup, and the horn button spring from the hub.
3. Remove the base plate screws, the base plate, and the contact spring from the steering wheel.
4. Remove the wheel nut from the end of the wheel tube shaft (see Fig. 3), then use a puller to remove the steering wheel from the wheel tube shaft.
5. Remove the directional signal switch and the trailer brake hand valve from the upper column and jacket assembly. Disconnect the horn wire from the relay plate. See Fig. 3.
6. Remove the end yoke pinch bolt nut, lockwasher (if used), and pinch bolt from the upper end yoke. If the end of the wheel tube shaft *is not* marked with red paint, remove the upper end yoke from the shaft. If the wheel tube shaft *is* marked with red paint, the yoke is secured to the shaft with adhesive. In addition, if red paint is not visible, and the upper end yoke cannot be removed by hand or with a light application of pressure, the end yoke is secured to the wheel tube shaft with adhesive. Heat the base of the upper end yoke with a torch until the bond begins to weaken (at 300°F [149°C] the bond will be reduced to half strength), then remove the yoke from the wheel tube shaft. Collect the washer, dust cup, bearing spring, and lower bearing spacer as they drop from the end of the jacket. See Fig. 3.

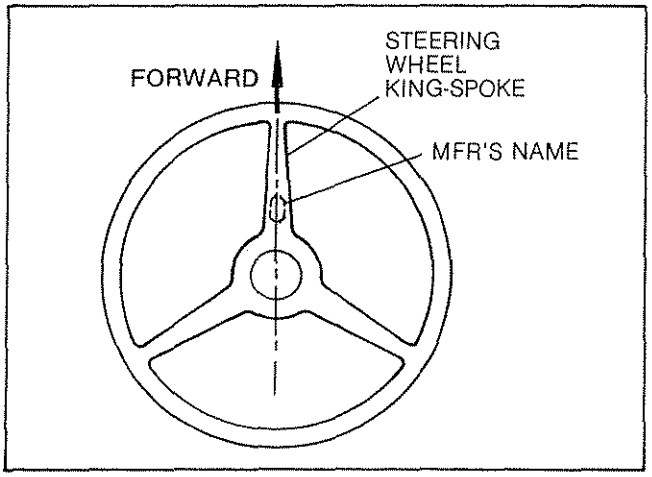


Fig. 2

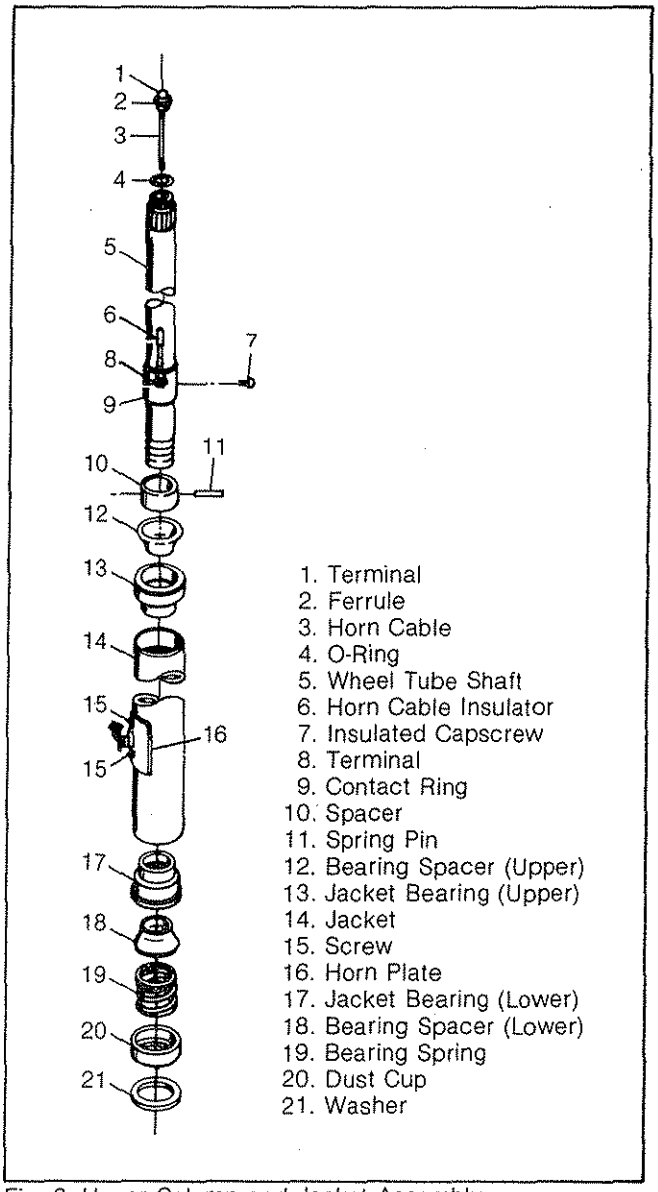


Fig. 3, Upper Column and Jacket Assembly

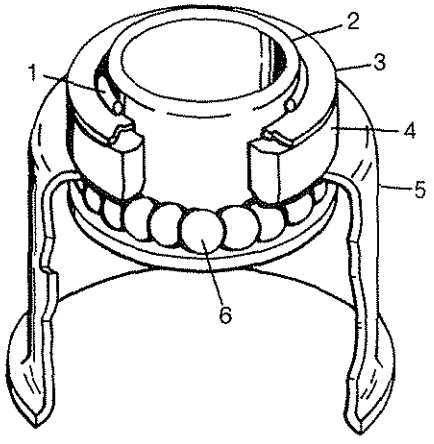
7. Remove the four capscrews, washers, and the two steering column clamp caps that attach the upper column and jacket assembly to the dash mounting bracket. Remove the upper column and jacket assembly from the vehicle.

DISASSEMBLY (Refer to Fig. 3)

1. Remove the two insulated capscrews that secure the horn plate to the jacket. Remove the horn plate.

UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32229, COE AND CONVENTIONAL

3. Insert a small chisel between the lip on the upper jacket bearing and the top of the jacket. Tap the upper jacket bearing out of the jacket.
4. Pull the wheel tube shaft out of the top of the jacket.
5. Remove the tape from around the horn cable. Disconnect the horn cable from the terminal on the contact ring. Remove the horn cable from the wheel tube shaft. Remove the insulated capscrew, then slide the contact ring and the horn cable insulator from the wheel tube shaft.
6. Insert a small chisel between the lip on the lower jacket bearing and the lower end of the jacket. Tap the lower jacket bearing out of the jacket.
7. To disassemble the jacket bearing assemblies, remove the snap ring from the bearing inner cup, then remove the felt pad retainer and the felt pad. Separate the bearing outer cup from the inner cup, and collect the 20 ball bearings as they drop out. See Fig. 4.
8. Clean all dirt and grease from the upper column and jacket assembly parts. Inspect for wear, damage, or deterioration. Check the ball bearings and the bearing cups for chips, cracks, pitting, or other damage. Replace damaged parts with new parts. If any part of the jacket bearing is damaged, discard the entire assembly and install a new one.



1. Snap Ring
2. Bearing Inner Cup
3. Felt Pad Retainer
4. Felt Pad
5. Bearing Outer Cup
6. Ball Bearing

Fig. 4, Jacket Bearing Detail

ASSEMBLY (Refer to Fig. 3)

1. Apply a thick coating of heavy-duty chassis grease to the bearing outer cups. Arrange the 20 ball bearings (see Fig. 4) in each of the bearing outer cups, using the grease to hold them in place. Insert the bearing inner cups through the outer cups, then install the felt pads and felt pad retainers. While holding the bearing inner cup against the ball bearings, install the snap ring in each bearing assembly. See Fig. 4.
2. Place the horn cable insulator on the wheel tube shaft; slip the contact ring over the horn cable insulator. Line up the hole in the contact ring with the hole in the wheel tube shaft, then install the insulated capscrew. Tighten the capscrew to the torque valve in Table 1, under "SPECIFICATIONS." Run the horn cable down through the wheel tube shaft, then attach it to the terminal on the contact ring. Wrap plastic tape around the horn cable and the wheel tube shaft just above the terminal.
3. Insert the lower jacket bearing into the lower end of the jacket; the lip on the jacket bearing should be against the jacket.
4. Carefully lower the wheel tube shaft into the jacket and through the lower jacket bearing. Insert the upper jacket bearing in the top of the jacket; the lip on the jacket bearing should be against the top of the jacket.
5. Install the upper bearing spacer and the spacer sleeve on the upper end of the wheel tube shaft. Drive the spring pin through the spacer sleeve and the wheel tube shaft.
6. Secure the horn plate on the jacket with the two insulated capscrews. Tighten the insulated capscrews to the torque value in Table 1, under "SPECIFICATIONS."

INSTALLATION (Refer to Fig. 1)

1. Place the upper column and jacket assembly against the dash mounting bracket, with the relay plate pointing toward the front of the cab. To hold the upper column and jacket assembly in place, install the steering column clamp caps using the four capscrews and washers. Move the upper column and jacket assembly up or down to achieve a dimension of 1-3/4 to 3-3/4 inches (44 to 83 mm) from the centerline of the lower steering column clamp cap to the lower end of the jacket, with 2-1/4 inches (57 mm) being standard. See Fig. 5. Tighten

UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32229, COE AND CONVENTIONAL

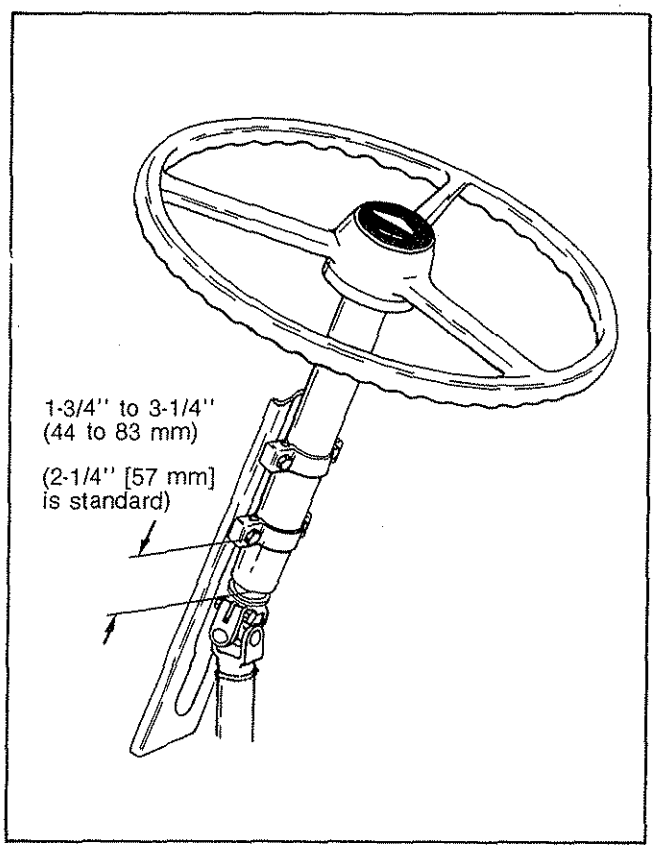


Fig. 5

the capscrews to the torque value in Table 1, under "SPECIFICATIONS."

2. Make sure that both steering driveline end yokes are lined up, with their cross holes parallel and on the same side of the shaft centerline. If the steering driveline end yokes are not correctly positioned, slide the driveline tube and yoke assembly off the driveline shaft and yoke assembly; place it back on the driveline shaft and yoke assembly so that the end yoke cross-holes are parallel and on the same side of the shaft centerline.

CAUTION: When installing the steering driveline, the cross-holes in the two end yokes must be parallel and on the same side of the shaft centerline. Assembling the driveline with the U-joints out of phase could result in binding at the U-joint.

3. Clean the serrated area of the lower end of the wheel tube shaft with a clean dry cloth. Using a wire brush and Loctite® Safety Solvent, or an equivalent, clean the serrations of the end yokes and shafts.

IMPORTANT: If Loctite® Safety Solvent is not available, *clean* solvents, such as trichloroethylene, trichloroethane, perchloroethylene, MEK, acetone, or alcohol can be used. *Do not use* kerosene, gasoline, naptha, fuel oil, Varsol, or Stoddard solvents.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

4. Apply Locquic General Purpose Primer T to the wheel tube shaft. Let dry for five minutes.

5. Insert the lower bearing spacer, bearing spring, dust cup, and washer in the lower end of the upper column and jacket assembly. See Fig. 3.

6. Apply a bead of Loctite® No. 680 adhesive to the serrated area of the upper end yoke.

IMPORTANT: After the end yoke has been assembled on the wheel tube shaft, curing will start immediately, and the pinch bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. Allow the assembled parts to cure for thirty minutes before applying steering load pressures.

7. Slide the upper end yoke onto the wheel tube shaft, then install the end yoke pinch bolt, lockwasher (if used), and pinch bolt nut. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the upper column and jacket assembly wheel tube shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Tighten the pinch bolt nut to the torque value in Table 1, under "SPECIFICATIONS."

8. Apply green Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. Mark the end of the upper column and jacket assembly wheel tube shaft with red paint to identify the use of an adhesive.

9. Connect the horn wire to the relay plate on the upper column and jacket assembly. Install the directional signal switch and the trailer brake hand valve. See Fig. 1.

10. Guide the steering wheel onto the wheel tube shaft.

UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32229, COE AND CONVENTIONAL

11. The steering wheel should be positioned at 12 o'clock ± 10°, as shown in Fig. 2. If the king-spoke is not correctly positioned, remove the steering wheel, then place it back on the wheel tube shaft with the king-spoke in the correct position.
12. Make certain that the upper column and jacket assembly operates smoothly. If not, repeat the service operations.
13. Install the wheel nut on the wheel tube shaft, then tighten it to the torque value in Table 1, under "SPECIFICATIONS." Place the contact spring and base plate in the steering wheel hub; install the base plate screws. Place the horn button spring and the contact cup in the center of the steering wheel hub, then place the horn button over the contact cup. See Fig. 1. Press the horn button down to compress the horn button spring; while the button is depressed, turn it clockwise to lock it in place.

SPECIFICATIONS

DESCRIPTION	TORQUE	
	lbf·in (N·cm)	lbf·ft (N·m)
Contact Ring/Wheel Tube Shaft Insulated Capscrew	22 (249)	
Relay Plate/Jacket Insulated Capscrews (2 qty.)	22 (249)	
Steering Column Clamp Cap Capscrews (4 qty.)		15 (20)
Upper End Yoke Pinch Bolt Nut: 3/8-16, IFI Grade G 7/16-20, IFI Grade B or C		35-40 (47-54) 75 (102)
Wheel Nut, Wheel Tube Shaft		20-25 (27-34)

Table 1

POWERLINER UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32215

GENERAL DESCRIPTION

The upper column and jacket assembly Ross model UC32215, used in Freightliner Powerliner vehicles, consists of the wheel tube shaft, jacket, and jacket bearing assemblies. The wheel tube shaft has a tapered serration on the upper end for the steering wheel, and is serrated on the lower end to connect with the steering driveline U-joint. The upper column and jacket assembly is attached to the dash panel by a mounting bracket, and to the deck by a flange mount.

SERVICE OPERATIONS

REMOVAL (Refer to Fig. 1)

1. Position the steering wheel so that the king-spoke (the narrow spoke on some wheels, or the spoke with the manufacturer's name printed on the underside) is in the 12 o'clock position.

2. Remove or secure all loose articles in the cab, then tilt the cab, following the instructions, given in the Freightliner Drivers Manual.

3. Remove the end yoke pinch bolt nut, lock-washer (if used), and pinch bolt, from the upper end yoke. If the end of the wheel tube shaft *is not* marked with red paint, remove the upper end yoke from the shaft. If the wheel tube shaft *is* marked with red paint, the yoke is secured to the shaft with adhesive. In addition, if red paint is not visible, but the upper end yoke cannot be removed by hand or with a light application of pressure, the end yoke is secured to the wheel tube shaft with adhesive. Heat the base of the upper end yoke with a torch until the bond begins to weaken (at 300°F [149°C] the bond will be reduced to half strength), then remove the yoke off of the wheel tube shaft. Collect the washer, dust cup, bearing spring, and lower bearing spacer, as they drop from the end of the jacket. See Fig. 2.

4. Position the steering driveline so that it will not interfere with the cab when it is tilted back to the operating position, then tilt the cab to the operating position.

5. While pressing lightly on the horn button, turn it counterclockwise to disengage it from the steering wheel. Remove the horn button, the contact cup, and the horn button spring from the hub.

6. Remove the base plate screws, the base plate, and the contact spring from the steering wheel.

7. Remove the locknut from the end of the wheel tube shaft, then use a puller to remove the steering wheel from the wheel tube shaft.

8. Remove the turn signal switch and the trailer brake hand valve from the upper column and jacket assembly. Disconnect the horn wire from the relay plate (see Fig. 2).

9. Remove the flange mount pinch bolt nut, washer, and pinch bolt from the flange mount.

10. Remove the two capscrews and washers from the mounting bracket cap. Then, remove the mounting bracket cap. Lift the upper column and jacket assembly out of the flange mount.

DISASSEMBLY (Refer to Fig. 2)

1. Remove the two insulated capscrews that secure the relay plate to the jacket, then remove the relay plate.

2. Remove the spring pin from the upper end of the wheel tube shaft. Then, remove the spacer sleeve and the upper bearing spacer.

3. Insert a small chisel between the lip on the upper jacket bearing and the top of the jacket. Then, tap the upper jacket bearing out of the jacket.

4. Pull the wheel tube shaft out through the top of the jacket.

POWERLINER UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32215

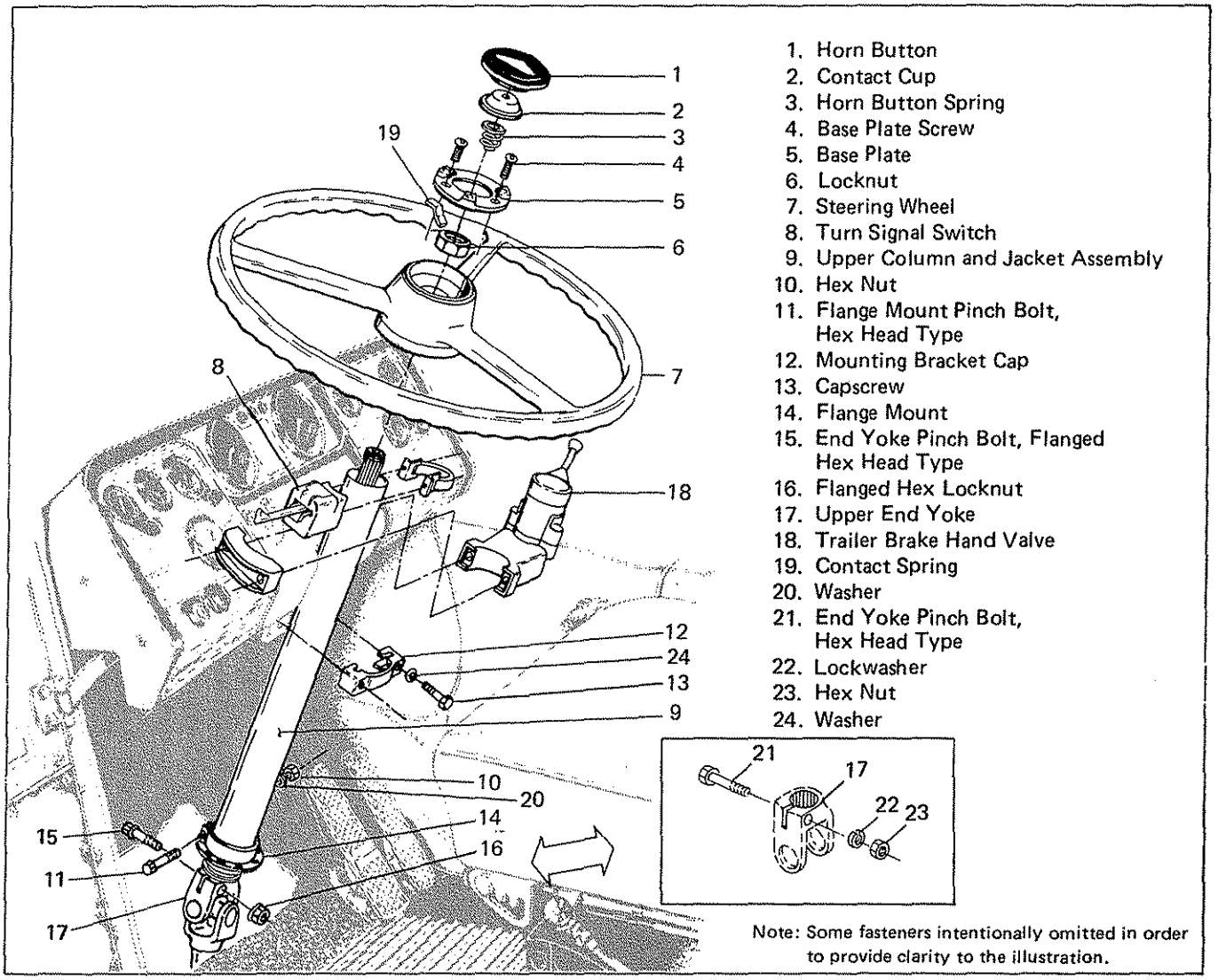


Fig. 1, Upper Column and Jacket Assembly Installation, Powerliner

5. Remove the tape from around the horn cable. Then, disconnect the horn cable from the terminal on the contact ring. Remove the horn cable from the wheel tube shaft. Remove the insulated capscrew, then slide the contact ring and the horn cable insulator from the wheel tube shaft.

6. Insert a small chisel between the lip on the lower jacket bearing and the lower end of the jacket. Then, tap the lower jacket bearing out of the jacket.

7. To disassemble the jacket bearing assemblies, remove the snapring from the bearing inner cup, then remove the felt pad retainer and the felt pad. Separate the bearing outer cup from the inner cup, and collect the 20 ball bearings as they drop out. See Fig. 3.

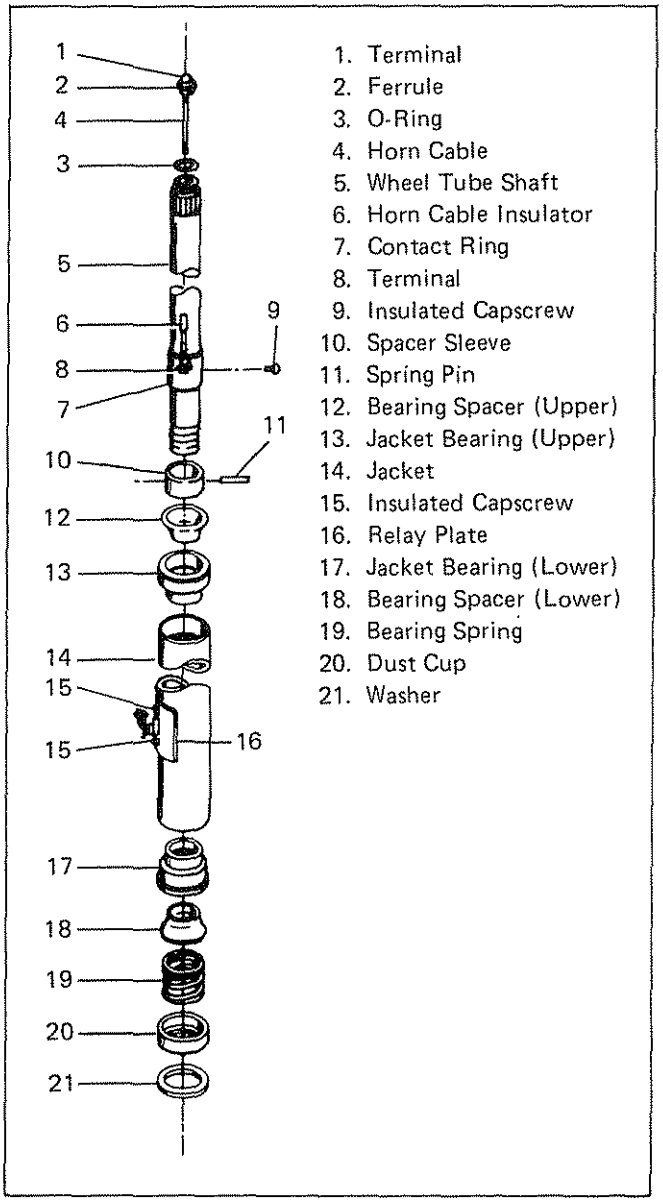
8. Clean all dirt and grease from the upper column and jacket assembly parts. Inspect for wear, damage, or deterioration. Check the ball bearings and the bearing cups for chips, cracks, pitting, or other damage. Replace damaged

POWERLINER UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32215

parts with new parts. If any part of the jacket bearing is found to be damaged, discard the entire bearing assembly and install a new one in its place.

ASSEMBLY (Refer to Fig. 2)

1. Apply a thick coating of heavy duty chassis grease to the bearing surfaces on each of the bearing outer cups. Arrange the 20 ball bearings (see Fig. 3) in each of the bearing outer cups, using the grease to hold them in place. Insert the bearing inner cups through the outer cups, then install the felt pads and felt pad retainers. While holding the bearing inner cup against the ball bearings, install the snapring in each of the bearing assemblies. See Fig. 3.

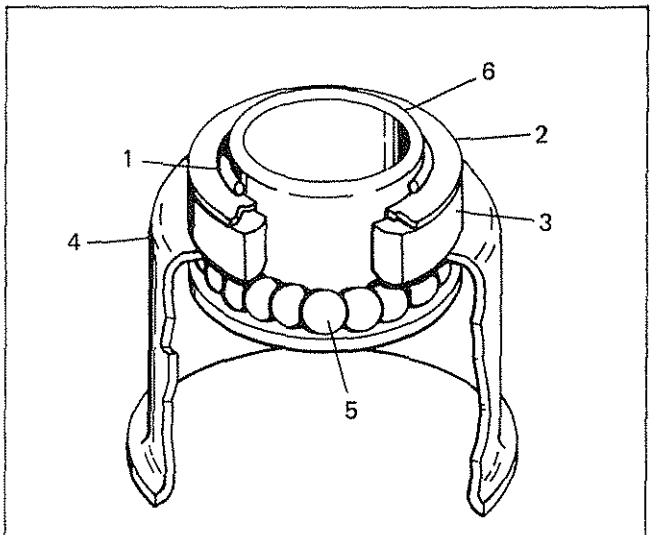


1. Terminal
2. Ferrule
3. O-Ring
4. Horn Cable
5. Wheel Tube Shaft
6. Horn Cable Insulator
7. Contact Ring
8. Terminal
9. Insulated Capscrew
10. Spacer Sleeve
11. Spring Pin
12. Bearing Spacer (Upper)
13. Jacket Bearing (Upper)
14. Jacket
15. Insulated Capscrew
16. Relay Plate
17. Jacket Bearing (Lower)
18. Bearing Spacer (Lower)
19. Bearing Spring
20. Dust Cup
21. Washer

Fig. 2, Upper Column and Jacket Assembly

2. Slip the horn cable insulator on the wheel tube shaft. Then, slip the contact ring over the horn cable insulator. Line up the hole in the contact ring with the hole in the wheel tube shaft, then install the insulated capscrew. Tighten the capscrew to 22 in-lbs (2.5 N·m). Run the horn cable down through the wheel tube shaft, then attach it to the terminal on the contact ring. Wrap plastic tape around the horn cable and the wheel tube shaft just above the terminal.

3. Install the lower jacket bearing into the lower end of the jacket. The lip on the jacket bearing should be against the jacket.



1. Snap Ring
2. Felt Pad Retainer
3. Felt Pad
4. Bearing Outer Cup
5. Ball Bearing
6. Bearing Inner Cup

Fig. 3, Jacket Bearing Detail

POWERLINER UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32215

4. Carefully lower the wheel tube shaft into the jacket and through the lower jacket bearing. Then, install the upper jacket bearing in the top of the jacket. The lip on the jacket bearing should be against the top of the jacket.

5. Install the upper bearing spacer and the spacer sleeve on the upper end of the wheel tube shaft. Then, drive the spring pin through the spacer sleeve and the wheel tube shaft. Then, drive the spring pin through the spacer sleeve and the wheel tube shaft.

6. Secure the relay plate on the jacket with the two insulated capscrews. Tighten the insulated capscrews to 22 in-lbs (2.5 N·m).

INSTALLATION (Refer to Fig. 1)

1. Insert the upper column and jacket assembly through the flange mount with the relay plate pointing toward the front of the cab. Then, position the mounting bracket cap over the upper column and jacket assembly and install the two capscrews and washers. Move the upper column and jacket assembly up or down to achieve a dimension of 9-1/2 to 11-1/4 inches (241 to 286 mm) from the top of the mounting bracket cap to the top of the column jacket with 10-1/4 inches (260 mm) being standard. See Fig. 4. Tighten the capscrews to 15 ft-lbs (20 N·m).

2. Install the flange mount pinch bolt, washer, and pinch bolt nut, on the flange mount, then tighten the nut to 15 ft-lbs (20 N·m).

3. Remove or secure all loose articles in the cab, then tilt the cab following the instructions given in the Freightliner Drivers Manual.

4. Make sure that both steering driveline end yokes are lined up with their cross holes parallel and on the same side of the shaft centerline. If the steering driveline end yokes are not positioned correctly, slide the driveline tube and yoke assembly off of the driveline shaft and yoke assembly, then place it back on the driveline shaft and yoke assembly so that the end yoke cross holes are parallel and on the same side of the shaft centerline.

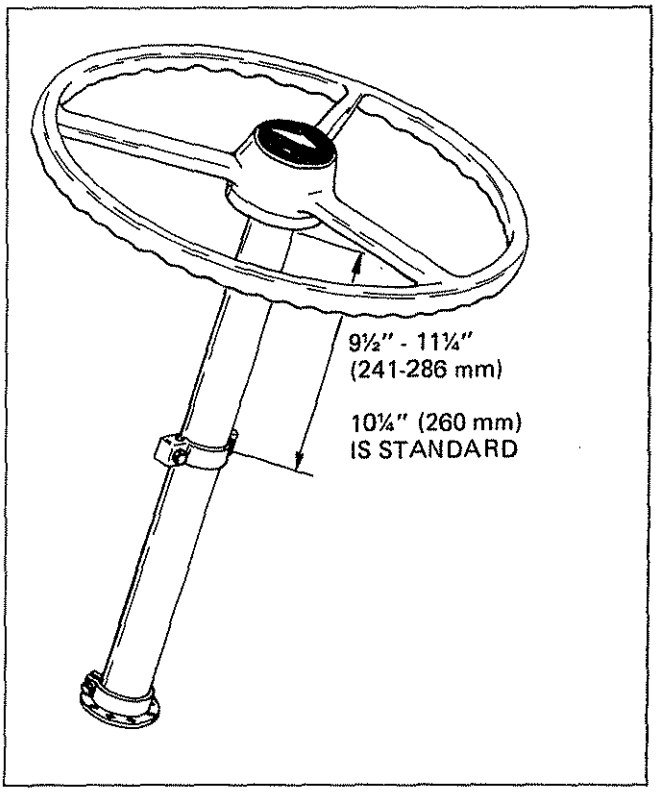


Fig. 4, Upper Column and Jacket Assembly Height Dimension, Powerliner

CAUTION: When installing the steering driveline, the cross holes in the two end yokes must be parallel and on the same side of the shaft centerline. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

5. Clean the serrated area of the lower end of the wheel tube shaft with a clean dry cloth. Using a wire brush and Loctite Safety Solvent, or an equivalent, clean the serrations of the end yokes and shafts.

IMPORTANT: If Loctite Safety Solvent is not available, CLEAN solvents, such as trichloroethylene, trichloroethane, perchloroethylene, MEK, acetone, or alcohol can be used. DO NOT USE kerosene, gasoline, naptha, fuel oil, Varsol, or Stoddard solvents.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin

POWERLINER UPPER COLUMN AND JACKET ASSEMBLY, ROSS UC32215

irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

6. Apply Locquic General Purpose Primer T to the serrated area of the lower end of the wheel tube shaft. Let dry for five minutes.

7. Insert the lower bearing spacer, bearing spring, dust cup, and washer, in the lower end of the upper column and jacket assembly.

8. Apply a bead of Loctite No. 680 adhesive to the serrated area of the upper end yoke.

IMPORTANT: After the end yoke has been assembled on the wheel tube shaft, curing will start immediately, and the pinch bolt nut must be torqued within four minutes. If this time is exceeded, parts must be disassembled, cleaned, and treated again. Allow the assembled parts to cure for thirty minutes before applying steering load pressures.

9. Slide the upper end yoke onto the wheel tube shaft, then install the end yoke pinch bolt, lockwasher (if used), and pinch bolt nut. Before tightening the end yoke pinch bolt nut, make sure the end yoke pinch bolt is centered in the upper column and jacket assembly wheel tube shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. If equipped with a 7/16-20, Grade C nut, tighten the nut to 75 ft-lbs (101 N·m). If equipped with a 3/8-16, Grade G nut, tighten the nut to 35-40 ft-lbs (47-54 N·m).

10. Apply green Torque Seal F-900 to the exposed pinch bolt thread and locknut tips. Mark the end of the upper column and jacket assembly wheel tube shaft with red paint to identify the use of an adhesive.

11. Tilt the cab back to the operating position following the instructions given in the Freightliner Drivers Manual.

12. Connect the horn wire to the relay plate on the upper column and jacket assembly. Then, install the turn signal switch and the trailer brake hand valve. See Fig. 1.

13. Guide the steering wheel onto the wheel tube shaft.

14. The king-spoke (the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside) should be positioned at 12 o'clock ± 10° as shown in Fig. 5. If the king-spoke is not positioned correctly, remove the steering wheel, then guide it back onto the wheel tube shaft with the king-spoke in the forward position.

15. Make certain that the upper column and jacket assembly operates smoothly. If not, repeat the service operations.

16. Install the locknut on the wheel tube shaft, then tighten it to 55-65 ft-lbs (75-88 N·m). Position the contact spring and base plate in the steering wheel hub, then install the base plate screws. Position the horn button spring and the contact cup in the center of the steering wheel hub, then position the horn button over the contact cup. See Fig. 1. Press the horn button down to compress the horn button spring, then while depressed, turn the button clockwise to lock it in place.

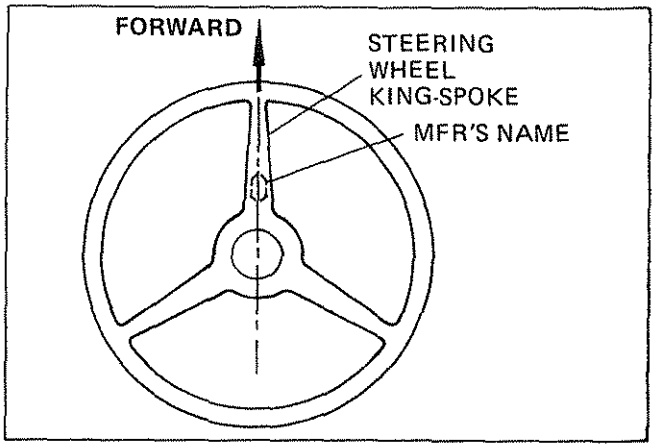


Fig. 5, Steering Wheel Positioning

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

GENERAL INFORMATION

Freightliner vehicles that have hydraulic power steering are equipped with either an integral or a non-integral power steering system. Both systems contain a power steering reservoir, power steering pump, hydraulic lines, a hydraulic (power) cylinder, and a hydraulic control valve.

Integral power steering systems have the hydraulic cylinder and the hydraulic control valve built into the mechanical steering gear.

Non-integral power steering systems have the control valve mounted between the axle steering arm and the pitman arm of the mechanical (manual) steering gear; thus, the control valve is a part of the drag link. The power cylinder is also separate, and may be axle-mounted or frame-mounted.

SERVICE OPERATIONS

This checking, testing, and troubleshooting subject is intended to help in locating the causes of problems that affect, but may or may not originate in the power steering system. Before servicing any hydraulic power steering system, perform the following pre-service checks and hydraulic tests. After servicing the power steering system, perform the post-service checks and hydraulic tests given below.

PRE-SERVICE CHECKS

When steering problems exist, the mechanic should first inspect the vehicle for roadworthiness. Then, if necessary, verify the steering problem by test driving the vehicle, or taking a ride with the driver. If the problem only occurs when the vehicle is loaded, the test drive should also be made with the vehicle loaded.

Once the problem is verified, check the simple possibilities before moving on to the more complicated potential causes. The checks listed below should be made whenever steering problems occur.

A checklist for troubleshooting hydraulic power steering systems, Form SD-94, is available and can be ordered through your dealer. Dealers can order by using Technical Publications Request Form FG-138. An example of the checklist is shown on pages 13 and 14.

1. If the steering problem occurs only when the vehicle is loaded, make sure the fifth wheel, if so equipped, is lubricated. For instructions, refer to the 22 Group of the Freightliner *Maintenance and Lube Manual.*
2. Make sure the power steering reservoir is filled to the correct level, and the filter is not clogged. For fluid level checking instructions, and filter changing instructions, refer to the 14 Group of the Freightliner *Maintenance and Lube Manual.*
3. Place a thermometer in the power steering reservoir, then warm the hydraulic system to normal operating temperature (approximately 140°F [60°C]), by starting the engine and operating it at low idle, while turning the steering wheel through several full left and right turns. With the engine running and the power steering system at operating temperature, turn the steering wheel slowly from stop to stop, while checking the power steering reservoir for frothing or a change in the oil level (an indication that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as necessary.
4. Make sure all hoses that may have been replaced are not misrouted, restricted, or too small in inside diameter. Replace any hoses that are worn or that do not have the same inside diameter as original equipment. Check that each hose routing conforms to the minimum bend radius, and reroute any hose that is kinked or sharply bent. See **Table 1** to find the minimum bend radius for each hose.

Hose Size	Hose Material	Minimum Bend Radius inches (mm)
No. 8	Stratoflex® SF 211	4-5/8 (117)
No. 10	Stratoflex SF 211	5-1/2 (140)
No. 10	Stratoflex SF 213	2-1/4 (57)
No. 16 pump supply	Stratoflex SF 213	3-1/2 (89)
	Stratoflex SF 219	6 (152)

Table 1

5. Check the front tires for proper inflation, irregular wear, or mismatched tires. Check the front wheels for loose wheel nuts, damage, an out-of-round condition, and lateral runout. For instructions, refer to the 13 Group of this manual.
6. Make sure the steering linkage and steering driveline U-joints are lubricated. The steering linkage includes the tie rod, tie-rod ends, knuckle bearings, knuckle bushings, and other components that carry movement of the pitman arm to the steering knuckles. Refer to the 14 Group of the Freightliner *Maintenance and Lube Manual* for instructions.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

7. Check the steering gear mounting bolts for tightness. Also, for vehicles equipped with non-integral power steering having an axle-mounted power cylinder, check the tie-rod clamp for tightness. Refer to the appropriate steering gear subject in the 14 Group of this manual for steering gear mounting torque, and refer to the control valve subject for tie-rod clamp positioning and mounting torque.
8. Check the steering linkage, ball joints, and kingpins for loose, damaged, or worn parts. The wheels must turn smoothly from stop to stop. For inspection and service procedures, refer to the 14 Group of this manual, and, as applicable, to the 10 Group of this manual or to the front axle manufacturer's service manual.
9. Inspect the drag link, steering driveline, and upper steering column for worn or damaged parts. For service instructions, refer to the 14 Group of this manual.
10. Inspect the front axle suspension for worn or damaged parts, using the instructions in the 16 Group of this manual.
11. Check the front axle wheel alignment, including turning angles, wheel bearing adjustment, caster and camber angles, and toe-in, using the instructions in the 10 Group of this manual.
12. Check the rear axle alignment, using the instructions in the 11 Group of this manual. Rear axle misalignment can cause hard or erratic steering.
13. Proceed to "STEERING SYSTEM HYDRAULIC TESTS," and perform the tests as instructed.

NOTE: For further information regarding diagnosis of possible causes of *integral* power steering problems, refer to "TROUBLESHOOTING" in this subject and in the appropriate power steering pump subject in the 14 Group of this manual.

For further information regarding diagnosis of possible causes of *non-integral* power steering problems, refer to the control valve subject and the appropriate power steering pump subject, in the 14 Group of this manual.

POST-SERVICE CHECKS

After power steering components have been worked on, and before the vehicle is placed into service, the following items must be checked.

WARNING: Failure to check the following items could result in damage to the power steering system, which could cause a loss of hydraulic assist.

1. Place a thermometer in the power steering reservoir, then warm the hydraulic system to normal operating temperature (approximately 140°F [60°C]), by starting the engine and operating it at low idle, while turning the steering wheel through several full left and right turns. With the engine running and the power steering system at operating temperature, turn the steering wheel slowly from stop to stop, while checking the power steering reservoir for frothing or a change in the oil level (an indication that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as necessary. Bleed the air from the system.
2. With the engine turned off and warm, check the power steering reservoir fluid level, by using the instructions in the 14 Group of the Freightliner *Maintenance and Lube Manual.*
3. Make sure all hoses that have been replaced are not misrouted, restricted, or too small in inside diameter. Replace any hoses that are worn or that do not have the same inside diameter as original equipment. Reroute any hose that is kinked or sharply bent.
4. At full-left and full-right wheel cuts, be sure the axle stops (on the rear-side of the spindle) are set so there is a minimum clearance of one-half inch (13 mm) between the tires and any components that are attached to the vehicle. If clearance is less than one-half inch (13 mm), reset the axle stops until compliance is achieved, by following the front axle wheel alignment instructions in the 10 Group of this manual.
5. On non-integral power steering installations with an axle-mounted power cylinder, be sure the tie-rod ends are turned slightly out of phase with each other, to limit rotational slack in the tie rod to 10 degrees. If the tie-rod ends are not slightly out of phase with each other, loosen the tie-rod end clamp pinch-bolt nuts. Then, turn the tie-rod ball sockets slightly out of phase with each other. Tighten the tie-rod end clamp pinch-bolt nuts to the appropriate bolt torque specification; refer to the "CHARTS AND SPECIFICATIONS" section of the Freightliner *Maintenance and Lube Manual.*
6. Proceed to "STEERING SYSTEM HYDRAULIC TESTS," and perform the tests as instructed.

STEERING SYSTEM HYDRAULIC TESTS

When troubleshooting, the following tests should be conducted *before* servicing the steering gear, power steering

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

pump, or control valve and hydraulic cylinder (if so equipped). The following tests should be performed *after* all other possible sources of steering problems have been checked, and any problems corrected. Refer to "Pre-Service Checks."

After completing any service operations on the steering gear, power steering pump, or control valve and hydraulic cylinder (if so equipped), check the items listed under "Post-Service Checks," then conduct the following tests.

1. Apply the parking brakes, and chock the rear tires.
2. Install a flow meter kit (with the load valve, pressure gauge, and flow meter in one unit) in the appropriate fluid line, as indicated by the instructions that come with the flow meter. Place a thermometer in the power steering reservoir. See **Fig. 1**.

IMPORTANT: To accurately test the hydraulic system, a flow meter must be used, and a thermometer is recommended.

3. Warm the hydraulic system to normal operating temperature (approximately 140 °F [60 °C]), by starting the engine and operating it at low idle, while turning the steering wheel through several full left and right turns.

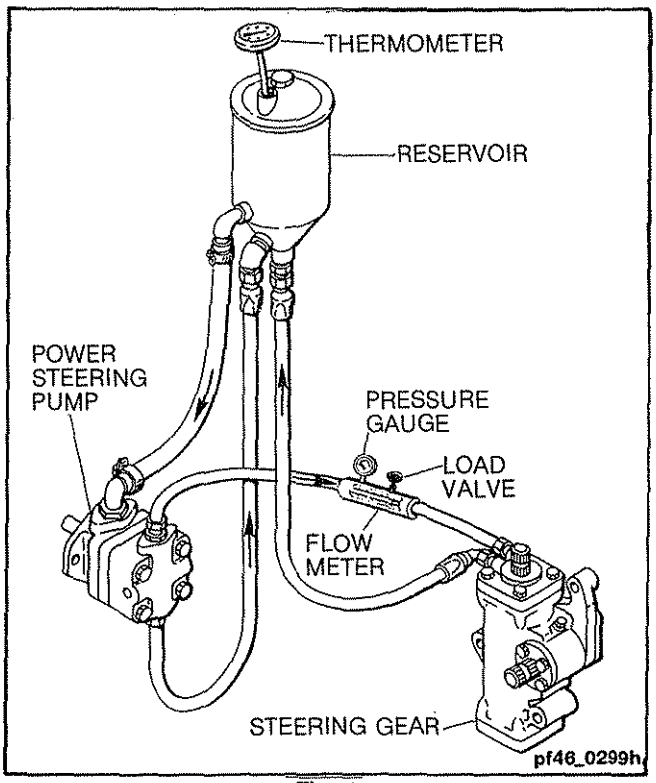


Fig. 1

NOTE: The normal operating temperature is most accurate when checked after two hours of normal operation.

An alternate method of warming the steering system is to start the engine and operate it at low idle, while *partially* closing the load valve on the flow meter until the pressure gauge reads 1000 psi (6890 kPa). Open the load valve when the oil temperature, as indicated on the thermometer, reaches approximately 140 °F (60 °C).

CAUTION: Do not close the load valve completely and leave it closed. Completely closing the load valve causes the power steering pump to operate at relief pressure, and the oil temperature to increase rapidly. At no time allow the oil temperature to exceed 180 °F (82 °C). Run all of the tests at 140 °F (60 °C).

4. Determine at which pressure the power steering pump pressure relief valve opens. With the engine idling, slowly close the load valve, and read the pressure gauge on the flow meter; then immediately open the load valve.

CAUTION: To avoid damaging the pump, do not keep the load valve closed for longer than five seconds.

If the pressure rises rapidly, appears to be uncontrolled, or rises above the applicable maximum pressure relief valve setting (given below), immediately open the load valve.

CAUTION: Constantly observe the pressure gauge while closing the load valve, and while it is closed. A malfunctioning pressure relief valve may allow excessive pressure to build, resulting in severe pump damage or ruptured hoses.

If equipped with a Vickers power steering pump, locate the model number stamped on the power steering pump cover, then refer to **Table 1** under "Specifications" to determine the appropriate pressure relief valve setting.

If equipped with an Eaton power steering pump, locate the part number on the side of the pump. Refer to **Table 1** "Specifications" to determine the appropriate pressure relief valve setting.

If equipped with a Parker Hannifin power steering pump, the pressure relief valve must open at 1100 ±110 psi (7585 ± 758 kPa).

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

If equipped with a Garrison power steering pump, the pressure relief valve must open at 975 to 1100 psi (6723 to 7585 kPa).

If the pressure relief valve fails to open within the above specifications, install a new pressure relief valve, by using the instructions in the 14 Group of this manual, or the applicable hydraulic power steering pump manufacturer's maintenance manual.

Check the operation of the new valve, as instructed above.

5. Check the flow rate of the power steering pump, as follows:

   .1 With the engine idling, the vehicle stationary, and with the full weight of the vehicle on the floor, turn the steering wheel from lock to lock while observing the flow meter. Read and record the flow rate shown by the flow meter. Compare this value with the specified minimum flow rate of 3 gpm (11 Lpm).

   WARNING: The minimum flow rate must not be less than 3 gpm (11 Lpm). Inadequate flow will cause binding, and uneven or intermittently hard steering.

   If the flow rate is inadequate, repair or replace the power steering pump. For instructions, refer to the 14 Group of this manual.

   .2 With the engine idling, fully close the load valve until the pressure gauge indicates that the power steering pump pressure relief valve is open. When the pump relief pressure is reached, the flow rate must be zero gpm. *Immediately open the load valve.* The flow rate must instantly return to the original reading.

   If the original flow rate does not return immediately, the pump is malfunctioning. Repair or replace the pump.

   .3 Increase the engine speed to approximately 1500 rpm, and, without turning the steering wheel, read and record the flow rate. Compare this value with the appropriate maximum flow rate shown in Table 2, under "Specifications."

   WARNING: The maximum flow rate must not exceed the value shown in Table 2. Excessive flow can cause high operating temperatures, and an oversteering condition.

   If the flow rate is excessive, replace the power steering pump's flow control and relief valve. For instructions, refer to the 14 Group of this manual.

   .4 With the engine speed at approximately 1500 rpm, fully close the load valve until the pressure gauge indicates that the power steering pump pressure relief valve is open. When the pump relief pressure is reached, the flow rate must be zero gpm. *Immediately open the load valve.* The flow rate must instantly return to the original reading.

   If the original flow rate does not return immediately, the pump is malfunctioning. Repair or replace the pump.

   .5 Conduct the pump flow test twice more at 1500 rpm, as instructed in step 5.4, above.

6. With the steering wheel stationary, the front wheels in the straight-ahead position, the engine idling, and the load valve open, check the hydraulic system back-pressure. Normal system back-pressure is 40 psi (276 kPa) with the Eaton power steering pump and 70 psi (482 kPa) with all others. The pressure should never exceed 60 psi (414 kPa) with the Eaton pump or 100 psi (690 kPa) with all others.

   Check the power steering system for fluid flow restrictions if both of the following conditions apply:

   - The back-pressure reading at the working temperature of 150°F (66°C) exeeds specifications:

     Eaton power steering pump—50 psi (345 kPa)

     All other power steering pumps—100 psi (690 kPa);

   - The maximum power steering pump flow rate is within the specifications in step 5 above.

   Repair or replace parts, as necessary, by following the instructions in the 14 Group of this manual.

7. Test the steering gear/hydraulic cylinder for internal leakage, as follows:

NOTE: To test the steering gear for internal leakage, you must first prevent the operation of the gear's internal poppet valves (Ross), or relief valve plungers (Sheppard). To test the hydraulic cylinder (Garrison) for internal leakage, you must prevent the piston from reaching the ends of the cylinder. This will allow full pump relief pressure to develop.

.1 To prevent operation of the poppet valves or relief valve plungers, or to prevent the piston from

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

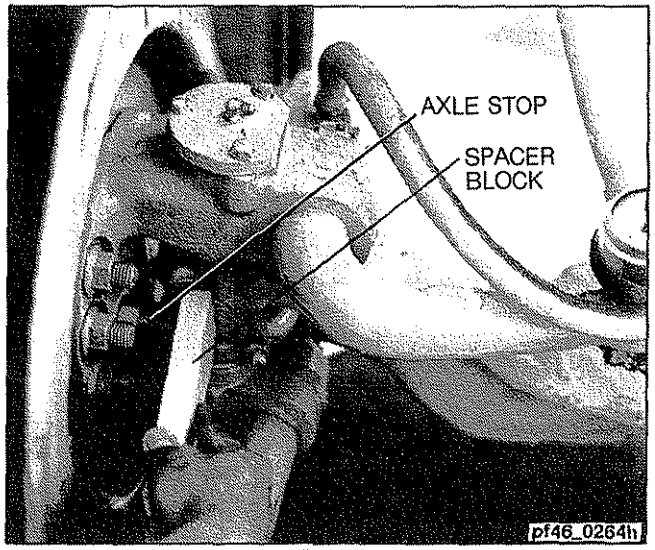


Fig. 2

reaching the end of the hydraulic cylinder, place a steel spacer block between the axle and stop, at one wheel. See **Fig. 2**. The spacer block should be about 1/2-inch (13 mm) thick, and must be long enough to keep your fingers clear.

WARNING: Keep your fingers clear of the axle stops and spacer blocks during this test. Make sure that the spacer block contacts the axle stop squarely. Contact that is not square could break the axle stops, or dangerously eject the spacer block.

.2 With a normal load on the front axle, turn the steering wheel until the axle stop bottoms on the spacer block. Apply 20 pounds (88 N) of force to the rim of the steering wheel (to be sure the steering gear control valve or Garrison control valve is fully closed).

CAUTION: While running this test, do not hold the steering wheel in the full-turn position for longer than 5 seconds at a time, to avoid damaging the pump.

.3 As soon as the pressure gauge indicates that pump relief pressure has been reached, note the steering gear or hydraulic cylinder internal leakage reading on the flow meter.

Refer to **Table 3**, under "Specifications," for the allowable internal leakage for your steering gear or hydraulic cylinder.

.4 Repeat substeps 7.1 through 7.3 for the opposite direction of turn.

If the amount of internal leakage is excessive (in either direction of turn), replace the steering gear components (Ross or Sheppard), or hydraulic cylinder components (Garrison), as necessary. Refer to the appropriate subject in the 14 Group of this manual.

.5 Remove the spacer block. Then, if equipped with integral power steering, proceed to step 8; if equipped with non-integral power steering, proceed to step 9.

8. Check the operation of the steering gear poppet valves (Ross), or relief valve plungers (Sheppard), as follows:

.1 Turn the steering wheel clockwise to the full-lock position (to fully trip the poppet valve or relief valve plunger, at one end of the steering gear), and note the reading on the pressure gauge.

IMPORTANT: When the steering wheel is at the full-lock position, make sure the stop screw on the back of the wheel spindle contacts the axle boss. Failure to maintain contact while adjusting the poppet valve could cause incorrect adjustment.

At the full-lock position, the pressure gauge reading should be a minimum of 200 psi (1379 kPa) less than pump relief pressure.

CAUTION: If power steering pump relief pressure is reached while the steering wheel is at full lock, release the steering wheel from this position. Do not allow the pump relief pressure to be maintained for longer than 5 seconds, or damage to the pump may result.

.2 Turn the steering wheel counterclockwise to the full-lock position, and note the reading on the pressure gauge. Again, the pressure gauge should read a minimum of 200 psi (1379 kPa) less than pump relief pressure.

If the pressure reading is in excess of the above specification, at either of the full-lock positions, adjust the poppet valve or relief valve plunger, using the instructions in the appropriate integral power steering gear subject in the 14 Group of this manual.

9. Remove the flow meter kit and the thermometer. Remove the chocks from the tires.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

TROUBLESHOOTING

A checklist for troubleshooting hydraulic power steering systems, Form SD-94, is available and can be ordered through your dealer. Dealers can order by using Technical Publications Request Form FG-138. An example of the checklist is shown on pages 13 and 14.

The troubleshooting chart below covers *integral power steering systems only*.

For troubleshooting information covering *non-integral* power steering systems, refer to the control valve subject in the 14 Group of this manual.

NOTE: Unless otherwise noted, all of the procedures that must be followed in order to complete the corrections listed in this troubleshooting chart, are located in the 14 Group of this manual.

For further troubleshooting information, refer to the power steering pump subjects in the 14 Group of this manual.

Problem – No Power Steering on Cold Start

Possible Cause	Remedy
The vanes of the power steering pump are not extending.	Increase the engine speed momentarily, to extend the vanes and start the pump action. This is usually a temporary and infrequent occurrence, and is not a cause for pump repair or replacement.

Problem – Steering Input Not Smooth (Seizing, Binding)

Possible Cause	Remedy
U-joints are worn.	Check and replace the U-joints as required.
U-joints are not properly phased.	Check the phasing of the U-joints, and adjust as necessary.
Oil flow is insufficient.	Refer to the problem "No Power Steering on Cold Start." Check the oil flow; minimum oil flow must be 3 gpm (11 Lpm) at idle rpm. Inspect the pump, and repair or replace it as necessary.
Internal leakage in the steering gear.	Check for internal leakage, and replace components as necessary.

Problem – Wheel Cuts Restricted

Possible Cause	Remedy
The poppet valves [Ross] or relief valve plungers [Sheppard] are improperly adjusted.	Adjust the poppet valves, or relief valve plungers.
The pitman arm is positioned improperly.	Center the steering gear, and relocate the pitman arm.
The axle stops are improperly adjusted.	Adjust the axle stops, following the instructions in the 10 Group of this manual.

Problem – No Recovery When Leaving a Turn

Possible Cause	Remedy
Oil flow is insufficient.	Check the oil flow; minimum oil flow must be 3 gpm (11 Lpm) at idle rpm. Inspect the pump, and repair or replace it as necessary.
The tires are under-inflated.	Inflate the tires to the appropriate values in the "CHARTS AND SPECIFICATIONS" section of the Freightliner *Maintenance and Lube Manual.*
The fifth wheel is dry, or there is a poor finish on the fifth wheel or trailer plate.	Lubricate the fifth wheel, using the instructions in the 22 Group of the Freightliner *Maintenance and Lube Manual*, or the fifth wheel manufacturer's service information.
The front axle alignment is not correct.	Align the front axle. Refer to the 10 Group of this manual for instructions.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Problem – No Recovery When Leaving a Turn

Possible Cause	Remedy
The front axle components are binding.	Adjust or replace the front axle components, following the instructions in Group 10 of this manual, or the front axle manufacturer's service information.
The steering column is binding.	Adjust the steering column.
The steering gear is too tight (Ross only).	Adjust the steering gear.
The control valve sleeve (Ross), is tight or incorrectly installed.	Check the control valve sleeve for nicks or burrs. Repair or replace the valve sleeve drive ring and worm shaft as necessary.
The actuating valve (Sheppard) is tight or incorrectly installed.	Replace the piston assembly. Repair or replace the actuating shaft and bearing assembly, as necessary.

Problem – Steering Extremely Light in One or Both Directions

Possible Cause	Remedy
The reversing springs are bent or damaged (Sheppard only).	Replace the piston assembly.

Problem – High Steering Effort in One Direction

Possible Cause	Remedy
Internal leakage in the steering gear is too much.	Check for too much internal leakage, and replace parts as necessary.
Metal or foreign material is lodged in the relief ball seat in the piston of the steering gear.	Remove the piston and clean the relief valve seats, or replace the damaged parts.
There is low flow or low pressure from the pump.	Check the power steering pump flow and pressure. Repair or replace the pump.
Metal or foreign material is lodged in the actuating valve (Sheppard), or the actuating valve is worn or chipped by dirt.	Replace the piston assembly.
The steering gear reversing springs are broken (Sheppard only).	Replace the piston assembly. Check for additional damage, and replace damaged parts as required.
Internal leakage in the steering gear is too much in the high-steering-effort direction (Ross only).	Check for too much internal leakage, and replace the seal ring on the control valve sleeve or the seal on the ball-return-guide cap.

Problem – High Steering Effort in Both Directions

Possible Cause	Remedy
Internal leakage in the steering gear is too much.	Check for too much internal leakage, and replace parts as necessary.
There is low flow or low pressure from the pump.	Check the power steering pump flow and pressure. Repair or replace the pump.
Metal or foreign material is lodged in the actuating valve (Sheppard), or the actuating valve is worn or chipped by dirt.	Replace the piston assembly.
Metal or foreign material is lodged in the relief ball seat in the piston of the steering gear.	Remove the piston and clean the relief valve seats, or replace the damaged parts.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Problem – High Steering Effort in Both Directions (Continued)

Possible Cause	Remedy
The hydraulic fluid volume is low.	Fill the reservoir as required. For lubricant specifications, refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual.*
There is a restriction in the return line, or the return line is too small.	Remove the restriction from the line, or replace it with a larger line, as necessary.
The front axle alignment is not correct.	Align the front axle. Refer to Group 10 of this manual for instructions.
The front axle components are worn or damaged.	Repair or replace kingpins and tie rods. Refer to the applicable front axle manufacturer's service manual, or Group 10 of this manual, for instructions.
Components of the steering system are binding.	Adjust or replace the steering system components.
There is air in the hydraulic system.	Bleed the air from the system. Check for and eliminate any air leaks.
The tires are under-inflated.	Inflate the tires to the applicable values in the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual.*

Problem – Steering Shimmy or Chatter

Possible Cause	Remedy
There is air in the hydraulic system.	Bleed the air from the system. Check for and eliminate any air leaks.
The wheel bearings are improperly adjusted or worn	Inspect and adjust the wheel bearings, following the instructions in Group 10 of this manual. Replace the bearings if necessary.
The wheels are out of balance.	Balance the wheels, drums, and tires.
A tire or wheel is incorrectly mounted.	Check and correct the mounting of the wheels and tires. For instructions, refer to Group 13 of this manual.
One or more tires are badly or unevenly worn.	Replace badly worn and unevenly worn tires, following the instructions in Group 13 of this manual.
The front axle is misaligned.	Align the front axle. Refer to Group 10 of this manual for instructions.
Components in the steering linkage are loose or worn.	Tighten or replace steering linkage components, such as ball sockets on the drag link or axle arm.

Problem – Excessive Freeplay (Lash) at the Steering Wheel

Possible Cause	Remedy
Components in the steering linkage are loose or worn.	Tighten or replace steering linkage components, such as ball sockets on the drag link or axle arm.
The steering gear is loose on the frame rail or mounting bracket, or the mounting bracket is loose on the frame rail.	Remove and clean the steering gear and the mounting bracket. Clean the frame rail, and check the radius of the frame rail to make sure the bracket is not bearing on the radius surface. Check the bracket for wear, and replace it if necessary. Install the bracket and steering gear, tightening the bolts to their correct torque values.
The steering gear is incorrectly adjusted (Ross only).	Adjust the steering gear.
The output shaft bushings or bearings are worn (Sheppard only).	Replace the bushings or bearings. Polish the output shaft to remove bronze deposits, if applicable.
The pitman arm is loose on the sector (output) shaft, or the sector (output) shaft splines are damaged.	Inspect the sector (output) shaft and pitman arm for damage. Replace parts as necessary. Tighten the pitman arm attachment fasteners to their correct torque values.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Problem – Excessive Freeplay (Lash) at the Steering Wheel (Continued)

Possible Cause	Remedy
The pinion gear on the output shaft is damaged (Sheppard).	Replace the pinion gear and the rack piston assembly.
The rack on the piston is damaged (Sheppard).	Replace the rack piston assembly and the pinion gear.
The reversing springs are bent or damaged (Sheppard only).	Check for impact or accident damage. Replace the piston assembly.
The connection is loose between the steering gear input shaft and the lower driveline.	Tighten the connection.
The steering wheel is loose on the upper column shaft.	Tighten the steering wheel shaft nut to the proper torque value.

Problem – Darting or Wandering

Possible Cause	Remedy
The fifth wheel is dry, or there is a poor finish on the fifth wheel or the trailer plate.	Lubricate the fifth wheel, following the instructions in Group 22 of the *COE and 120 Maintenance Manual*, or the fifth wheel manufacturer's service information.
The vehicle is overloaded.	Reduce the load to the gross axle weight rating.
One or more of the tires is damaged, or over- or under-inflated.	Check the tires for out-of-line tread, and replace them if necessary. Inflate the tires to the applicable specifications in the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual*.
The wheel bearings are worn or incorrectly adjusted.	Adjust or replace the wheel bearings, following the instructions in Group 10 of this manual.
The rear axle component fasteners may not be tight.	Check the rear axle components for tightness. For instructions, refer to Group 11 of this manual, or the rear axle manufacturer's service information.
The front axle alignment is not correct.	Align the front axle. Refer to Group 10 of this manual for instructions.
Components in the front end or the steering linkage are loose, worn, or binding.	Check the steering gear mounting for damage, distortion, or looseness. Adjust or replace front end steering components, as needed.
The steering column is binding.	Adjust the steering column.
The steering gear is incorrectly adjusted (Ross only).	Adjust the steering gear.
Oil flow is too much.	Check the oil flow; maximum oil flow must be 6 gpm (23 Lpm). Inspect the pump, and repair or replace if necessary.
There is air in the hydraulic system.	Bleed the air from the system. Check for and eliminate any air leaks.
Components in the steering gear are damaged or worn.	Inspect the steering gear components, and repair or replace them as necessary.
The control valve sleeve (Ross) is tight or incorrectly installed.	Check the control valve sleeve for nicks or burrs. Repair or replace the valve sleeve drive ring, and worm shaft as necessary.
The actuating valve (Sheppard) is too tight or incorrectly installed.	Replace the piston assembly. Repair or replace the actuating shaft and bearing assembly as necessary.

Problem – Erratic Steering or No Steering at All

Possible Cause	Remedy
The power steering pump flow-control and relief-valve assembly is not functioning correctly.	Inspect the power steering pump, and repair it as necessary.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Problem – Abnormal or Too Much Noise

Possible Cause	Remedy
The hydraulic hose lines are in direct contact with the vehicle frame or sheet metal.	Insulate or position the lines away from the frame with grommets, clamps, and brackets.
A noise when steering or when changing directions may indicate that some part is loose and is shifting under load.	Check all the parts for tightness. Tighten all fasteners to their correct torque values.
A change in the normal noise from the power steering pump may indicate that air has entered the system, or that the fluid level is low.	Bleed the air from the system, or fill the reservoir as required. For lubricant specifications, refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual*.
Too much noise from the power steering pump may indicate the entry of foreign material, or that the power steering pump is worn.	Clean and repair, or replace the power steering pump, as required. Check the power steering reservoir filter, and replace it if necessary.

Problem – High Operating Temperatures

Possible Cause	Remedy
The vehicle is overloaded.	Reduce the load to the gross axle weight rating.
An undersized replacement hose, line, or fitting was installed.	Replace any incorrect hoses, lines, or fittings.
A hose or line is kinked or severely bent.	Remove the kink or severe bend by rerouting the hose. Replace the hose if necessary.
The oil flow is too much.	Check the oil flow; maximum oil flow must be 6 gpm (23 Lpm). Inspect the pump, and repair or replace it as necessary.
The poppet valves (Ross), or relief valve plungers (Sheppard) are incorrectly adjusted.	Adjust the poppet valves or the relief valve plungers.

Problem – Too Much Power Steering Pump Pressure With Steering Gear in Neutral Position

Possible Cause	Remedy
The oil return line is pinched, creating high back-pressure.	Relocate the oil return line.
The actuating shaft bearing is damaged (Sheppard only).	Inspect the steering gear parts, and replace damaged parts as required.

Problem – Pressure Relief Does Not Work With the Plungers Fully In

Possible Cause	Remedy
The relief valve plungers are too short (Sheppard only).	Install longer relief valve plungers.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Problem – Oil Leaking at Output (Sector) Shaft

Possible Cause	Remedy
The filter in the power steering reservoir is clogged (creating high system back-pressure) (Sheppard only).	Replace the filter, and decrease the interval between filter changes.
The oil return line is pinched, creating high back-pressure (Sheppard only).	Relocate the oil return line.
The output (sector) shaft seal is damaged.	Replace the output (sector) shaft seal.
The bronze bushings or the bearings are damaged (Sheppard only).	Replace the bronze bushings or the bearings. Replace the output shaft, or polish it to remove bronze deposits, if applicable.

Problem – Oil Leaking at Side Cover Vent Plug

Possible Cause	Remedy
The output (sector) shaft oil seal in the side cover is damaged (Ross only).	Replace the output (sector) shaft seal in the side cover.

Problem – Oil Leaking at Input (Actuating) Shaft

Possible Cause	Remedy
The input (actuating) shaft oil seal is damaged.	Replace the input (actuating) shaft seal.
The seal surface of the input (actuating) shaft is damaged.	Replace the damaged parts.

Problem – Oil Leaking at Hoses or Fittings

Possible Cause	Remedy
The hoses are damaged or the fittings are loose or damaged.	Tighten loose fittings, and replace damaged hoses and fittings.

Problem – Oil is Forced Out of Power Steering Reservoir

Possible Cause	Remedy
Operating temperatures are too high.	Refer to the problem "High Operating Temperatures."
The filter in the power steering reservoir is clogged (creating high system back-pressure).	Replace the filter, and decrease the interval between filter changes.
The poppet valves (Ross) or relief valve plungers (Sheppard) are incorrectly adjusted, causing overheated oil.	Adjust the poppet valves, or relief valve plungers.
There is air in the hydraulic system.	Bleed the air from the system. Check for and eliminate any air leaks.
The power steering pump is damaged (causing cavitation).	Check for and correct a restriction in the supply. Repair the power steering pump.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Problem – Oil is Foaming in the Power Steering Reservoir

Possible Cause	Remedy
Operating temperatures are too high.	Refer to the problem "High Operating Temperatures."
An unapproved oil was added.	Drain, flush, and fill the system, using the correct oil. Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual.*
There is air in the hydraulic system.	Bleed the air from the system. Check for and eliminate any air leaks.
The power steering pump is damaged (causing cavitation).	Check for and correct a restriction in the supply. Repair the power steering pump.

Problem – Oil is Milky or White in Appearance

Possible Cause	Remedy
Water has entered the reservoir through the reservoir venting system.	Clean the reservoir venting system, or replace the reservoir cap assembly. Drain, flush, and fill the system, using the correct oil. Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual* for lubricant specifications.

Problem – Oil is Discolored or Smells Burned

Possible Cause	Remedy
Operating temperatures are too high.	Refer to the problem "High Operating Temperatures."
The interval between oil changes is too long.	Decrease the oil change interval.
An unapproved oil was added.	Drain, flush, and fill the system, using the correct oil. Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual* for lubricant specifications.

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Service

FREIGHTLINER Freightliner Corporation®

CHECKLIST FOR TROUBLESHOOTING HYDRAULIC POWER STEERING SYSTEMS

Date _____ Work Order No. _____

Evaluation Performed By _____ ☐ Dealership ☐ Fleet ☐ Independent

Vehicle Identification

Vehicle Model _____ Chassis No. _____

Date in Service _____ Mileage _____

Mileage when steering problem first occurred _____

Vehicle application _____

Normal steering axle load _____

Steering System Description

Steering Pump Manufacturer _____ Model No. _____

Steering Gear Manufacturer _____ Model No. _____

Steering Assist Cylinder (Where Applicable) Manufacturer _____ Model No. _____

Reservoir Type _____ ☐ Integral with pump ☐ Remote

Reservoir Capacity _____

Type of Fluid: ☐ ATF ☐ 10W ☐ 10W-30 ☐ 10W-40 ☐ Other _____

Description of Steering Complaint

☐ Freeplay (lash) at the steering wheel
☐ High steering effort in both directions
☐ High steering effort in left turn only
☐ High steering effort in right turn only
☐ Excessive heat, 150°F (66°C) over ambient
☐ Pulls to left
☐ Pulls to right
☐ Other (Describe as completely as possible)

☐ Road wander
☐ No recovery
☐ External leak
☐ Shimmy
☐ Darting

_____

_____

_____

Preliminary Checks

Dry fifth wheel _____ ☐ Yes ☐ No

Binding condition at roadwheel with wheels raised off ground _____ ☐ Yes ☐ No

RESERVOIR/FLUID

Fluid Level: ☐ OK ☐ Too low ☐ Too high

Fluid Condition: ☐ OK ☐ Discolored ☐ Odorous ☐ Foamy ☐ Other _____

Filter Condition: ☐ OK ☐ Dirty: Contaminants _____

SD-94 (12/85T)

Fig. 3, Front Side, "Checklist for Troubleshooting Hydraulic Power Steering Systems"

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

Preliminary Checks (Continued)

FRONT TIRES

Matched Set: ☐ Yes ☐ No Inflation Pressure: Left ____ psi (____ kPa)

Unusual Wear: ☐ Yes ☐ No Right ____ psi (____ kPa)

LASH OR LOOSENESS

Draglink: Adjustment threads and ball studs _____ ☐ Yes ☐ No

Tie rod ends: Adjustment threads and ball studs _____ ☐ Yes ☐ No

Kingpins _____ ☐ Yes ☐ No

Steering column driveline _____ ☐ Yes ☐ No

Steering gear worm shaft _____ ☐ Yes ☐ No

Steering gear sector shaft _____ ☐ Yes ☐ No

Pitman arm _____ ☐ Yes ☐ No

Suspension spring bushings _____ ☐ Yes ☐ No

TOTAL TRUCK ALIGNMENT

Toe-in/out _____ Rear axle alignment _____

Caster: Left ____ Right ____ Alignment testing equipment used _____

Camber: Left ____ Right ____

Hydraulic Checks

Stablized power steering fluid temperature _____ ____°F (____°C)

Pump flow at engine idle _____ ____gpm (____Lpm)

Pump flow at above 1500 rpm _____ ____gpm (____Lpm)

Pump relief pressure at idle _____ ____psi (____kPa)

System back-pressure at idle _____ ____psi (____kPa)

Steering gear internal leakage: Left turn ____gpm (____Lpm)

Right turn ____gpm (____Lpm)

Assist cylinder internal leakage (where applicable): Left turn ____gpm (____Lpm)

Right turn ____gpm (____Lpm)

Steering gear poppet valve trip pressure (Ross): Left turn ____psi (____kPa)

Right turn ____psi (____kPa)

Steering gear relief valve plunger trip pressure (Sheppard): Left turn ____psi (____kPa)

Right turn ____psi (____kPa)

Attempted Corrections and Results

_____

_____

_____

_____

Fig. 4, Back Side, "Checklist for Troubleshooting Hydraulic Power Steering Systems"

HYDRAULIC POWER STEERING SYSTEM CHECKING, TESTING, AND TROUBLESHOOTING

SPECIFICATIONS

Pump Model	Part Number	Pressure Relief Valve Setting
Eaton	1410386-000 1410386-001 1412049-000 1412050-000 1412051-000 1412056-000 1412057-000 681 466 35 01 681 466 37 01 681 466 38 01	2000 to 2200 psi (13 790 to 15 168 kPa)
	681 466 19 01 681 466 20 01 681 466 22 01 681 466 25 01	1850 to 2050 psi (12 755 to 14 134 kPa)
Parker Hannifin	—	990 to 1210 psi (6826 to 8343 kPa)
Garrison	—	975 to 1100 psi (6723 to 7585 kPa)
Vickers V20 (F) * * * * - * * (*) (*) 11 - * * * L V20 Series D = 975 to 1100 psi (6723 to 7585 kPa) G = 1575 to 1925 psi (10 859 to 13 272 kPa) V210 - * * - * * * - * * - 12 - L - * V200 Series D = 975 to 1100 psi (6723 to 7585 kPa) G = 1575 to 1925 psi (10 859 to 13 272 kPa)		

Table 1, Power Steering Pump Pressure Relief Valve Settings, by Model

Engine Model	Maximum Pump Flow Rate at 1500 rpm
Cummins Inline (except K-series)	6.25 gpm (23.7 Lpm)
Caterpillar 3306 Caterpillar 3406B Caterpillar 3408 Cummins K-series Cummins V Detroit Diesel V Detroit Series 60	6.00 gpm (22.7 Lpm)
Caterpillar 3406	5.75 gpm (21.8 Lpm)

Table 2, Maximum Pump Flow Rates, by Engine Model

Steering Gear Model	Maximum Allowable Internal Leakage
Ross HFB64	1.0 gpm (3.8 Lpm)
Ross HFB70	1.5 gpm (5.7 Lpm)
Ross TAS65	1.0 gpm (3.8 Lpm)
Sheppard 392S	1.7 gpm (6.4 Lpm)
Sheppard 492S	1.9 gpm (7.2 Lpm)
Garrison Cylinder	0.13 gpm (0.5 Lpm)

Table 3, Maximum Allowable Internal Leakage, by Steering Gear Model

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

GENERAL DESCRIPTION

The power steering control valve is installed in the steering gear end of the drag link. This "valve-in-linkage" type of power steering permits manual steering in the event of power failure. The power steering control valve is furnished with the proper port sizes and reaction area to meet the requirements for various capacities and desired degree of "road feel."

PRINCIPLES OF OPERATION

Turning effort applied to the steering wheel of the vehicle actuates the valve, which in turn directs hydraulic fluid from the pump directly to the cylinder located in the steering linkage.

The valve piston is centered automatically by the hydraulic force against the reaction rings. When the operator's effort at the steering wheel exceeds the hydraulic force at the reaction ring, the control valve is actuated and the hydraulic power is provided for power steering.

Whenever the valve piston is in center (neutral) position the oil pressure at the cylinder ports of the valve is low. Under this condition there is no circulation of oil through the lines to the power cylinder. The oil is circulating, however, from the pump, through the valve and to the reservoir with sufficient pressure only to overcome the resistance due to friction in the valve, lines, and fittings.

When the effort in turning the steering wheel of the vehicle overcomes the centering effect of the force against the reaction rings the valve piston is moved axially to restrict the flow of oil to one of the cylinder ports. At the same instant, the passage in the second cylinder port is opening thus causing an immediate increase in pressure in one of the ports at the power cylinder which supplies power for steering.

While the oil under pressure is entering one end of the cylinder, the oil from the discharge end of the cylinder is returning through the first cylinder port in valve and into the return port, back to the reservoir.

Full pressure in the steering system is obtained with a valve piston travel of thirty-five thousandths (.035" [.90 mm]). The slightest movement of the piston however, causes a pressure differential at the valve cylinder ports. When the effort at the steering wheel is released the valve piston returns to the center position.

Whenever the steered wheels are subjected to shock loads the movement of the steering linkage tends to actuate the valve in the drag link momentarily. This action moves the valve piston axially in the appropriate direction thereby diverting the hydraulic fluid to the proper side of the power cylinder piston to resist the forces of the shock. This blocking action prevents "kickbacks" at the steering wheel and stabilizes the steering.

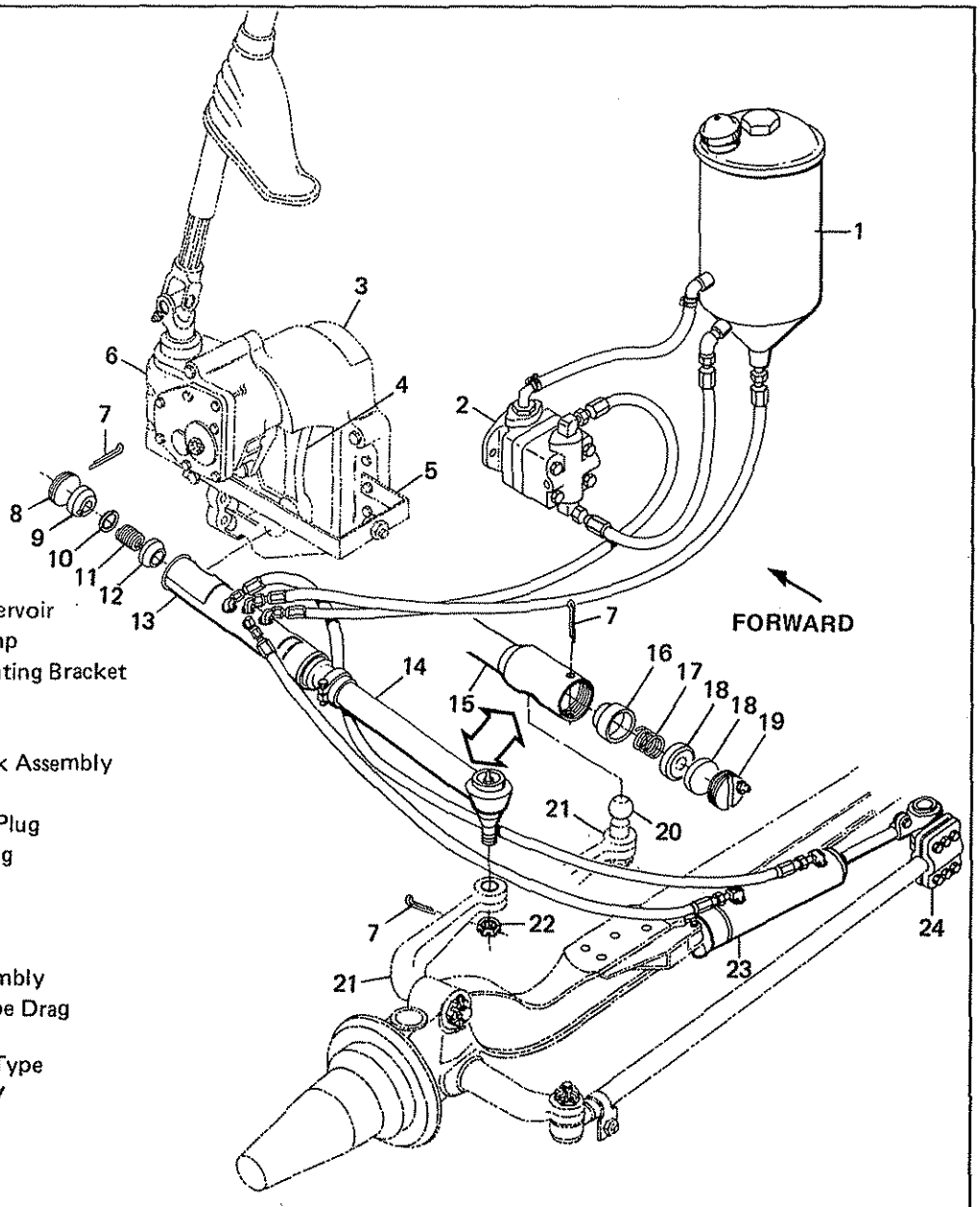
SERVICE OPERATIONS

REMOVAL (Refer to Figs. 1, 2, or 3)

1. Set the vehicle parking brake, then position the front wheels in the straight ahead position.
2. On C.O.E. and Powerliner vehicles, remove or secure all loose articles in the cab. Then, tilt the cab in accordance with the instructions given in this manual.

   On Conventional vehicles, release the hood hold-down latches, then tilt the hood all the way forward.
3. Disconnect the hydraulic lines from the valve. Note the position in which each line is connected to the valve so each can be reassembled in the same position.

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

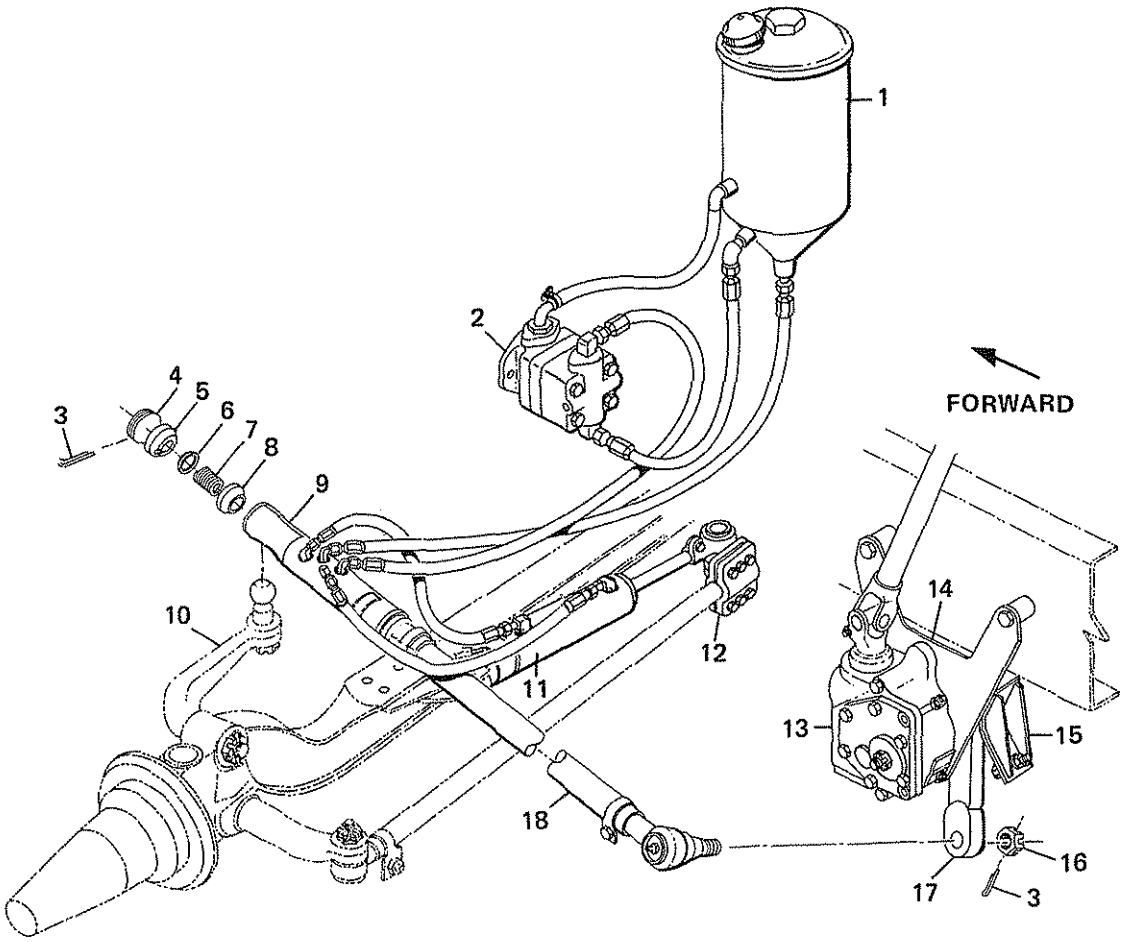


1. Power Steering Reservoir
2. Power Steering Pump
3. Steering Gear Mounting Bracket
4. Pitman Arm
5. Pitman Arm Stop
6. Steering Gear Chuck Assembly
7. Cotter Pin
8. Control Valve End Plug
9. Ball Socket End Plug
10. Plug Washer
11. Spring
12. Ball Seat
13. Control Valve Assembly
14. Vertical-Socket Type Drag Link Assembly
15. Horizontal-Socket Type Drag Link Assembly
16. Retainer
17. Spring
18. Ball Seat
19. End Plug
20. Ball Stud
21. Axle Steering Arm
22. Ball Stud Nut
23. Power Cylinder Assembly
24. Tie-Rod Clamp

NOTE: Some parts and fasteners intentionally omitted in order to provide clarity to the illustration.

Fig. 1, Power Steering Nomenclature (C.O.E. & Powerliner With Axle-Mounted Power Cylinder)

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

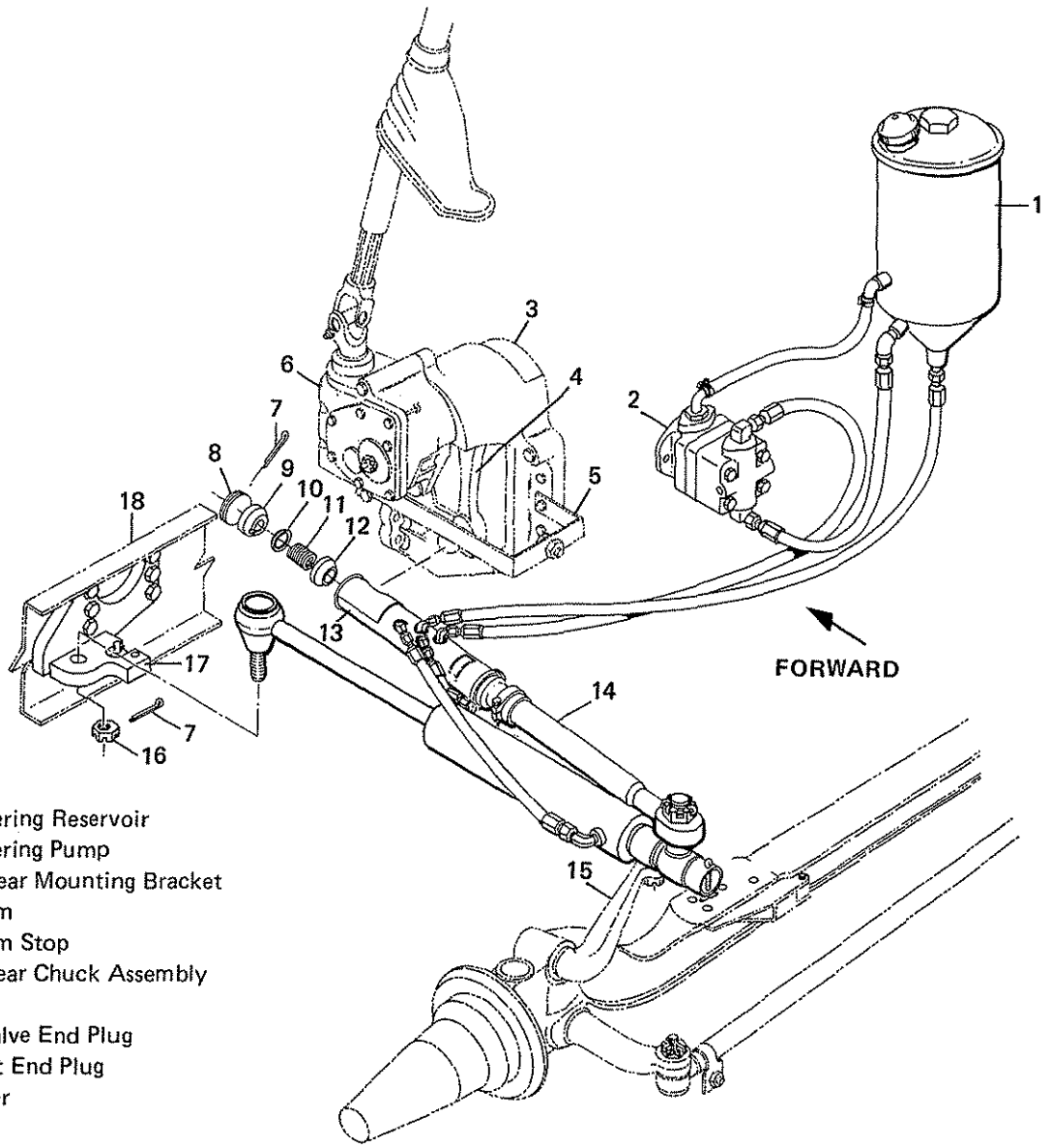


NOTE: Some parts and fasteners intentionally omitted in order to provide clarity to the illustration.

1. Power Steering Reservoir
2. Power Steering Pump
3. Cotter Pin
4. Control Valve End Plug
5. Ball Socket End Plug
6. Plug Washer
7. Spring
8. Ball Seat
9. Control Valve Assembly
10. Axle Steering Arm
11. Power Cylinder Assembly
12. Tie-Rod Clamp
13. Steering Gear Chuck Assembly
14. Steering Gear Mounting Bracket
15. Pitman Arm Stop
16. Ball Stud Nut
17. Pitman Arm
18. Drag Link Assembly

Fig. 2, Power Steering Nomenclature (Conventional With Axle-Mounted Power Cylinder)

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

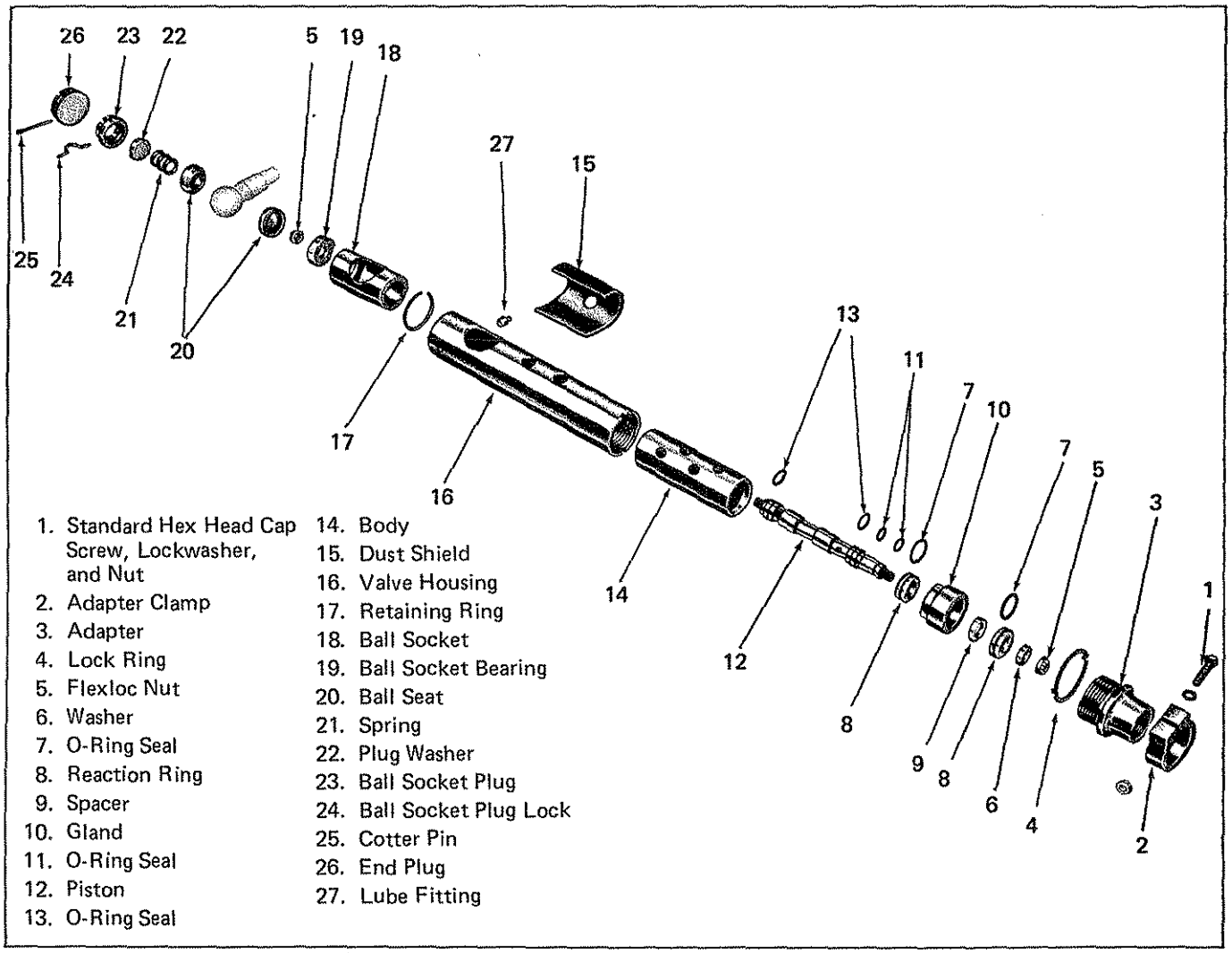


1. Power Steering Reservoir
2. Power Steering Pump
3. Steering Gear Mounting Bracket
4. Pitman Arm
5. Pitman Arm Stop
6. Steering Gear Chuck Assembly
7. Cotter Pin
8. Control Valve End Plug
9. Ball Socket End Plug
10. Plug Washer
11. Spring
12. Ball Seat
13. Control Valve Assembly
14. Drag Link Assembly
15. Axle Steering Arm
16. Ball Stud Nut
17. Power Cylinder Mounting Bracket
18. Bumper

NOTE: Some parts and fasteners intentionally omitted in order to provide clarity to the illustration.

Fig. 3, Power Steering Nomenclature (C.O.E. With Frame-Mounted Power Cylinder)

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES



1. Standard Hex Head Cap Screw, Lockwasher, and Nut
2. Adapter Clamp
3. Adapter
4. Lock Ring
5. Flexloc Nut
6. Washer
7. O-Ring Seal
8. Reaction Ring
9. Spacer
10. Gland
11. O-Ring Seal
12. Piston
13. O-Ring Seal
14. Body
15. Dust Shield
16. Valve Housing
17. Retaining Ring
18. Ball Socket
19. Ball Socket Bearing
20. Ball Seat
21. Spring
22. Plug Washer
23. Ball Socket Plug
24. Ball Socket Plug Lock
25. Cotter Pin
26. End Plug
27. Lube Fitting

Fig. 4, Control Valve Nomenclature

4. To disconnect the valve, remove the cotter pin and end plug. (Fig. 4) Remove the ball socket end plug lock and the socket end plug. (Fig. 4) The valve can now be removed from the steering (pitman) arm of the vehicle.

5. Disconnect the other end of the drag link from the axle steering arm or power cylinder as follows:

   .1 On vehicles equipped with an axle-mounted power cylinder and horizontal-socket type drag link (Fig. 5), remove the cotter pin from the socket; then, loosen the end plug. Remove the socket from the axle steering arm ball.

   .2 On vehicles equipped with an axle-mounted power cylinder and vertical-socket type drag link, remove the cotter pin and ball stud nut from the ball stud, then remove the ball stud from the axle steering arm. Use a ball stud removal tool, if one is available. Otherwise, apply removal pres-

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

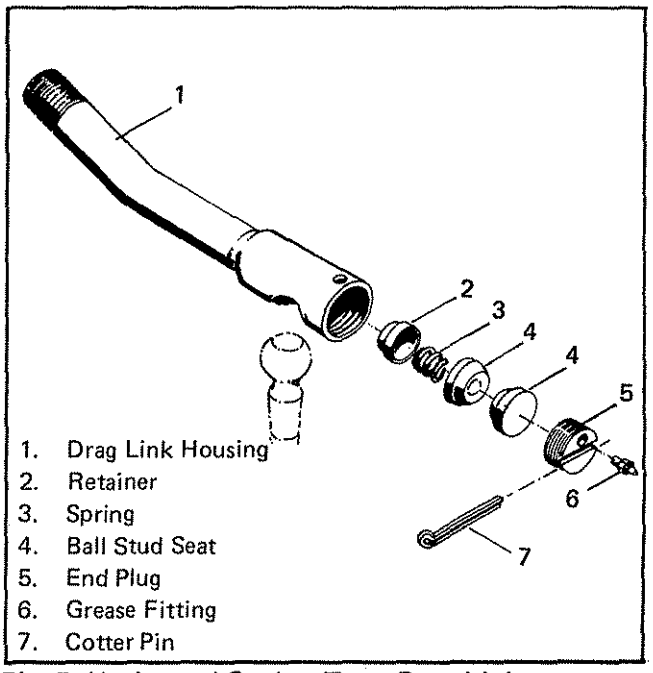


Fig. 5, Horizontal-Socket Type Drag Link

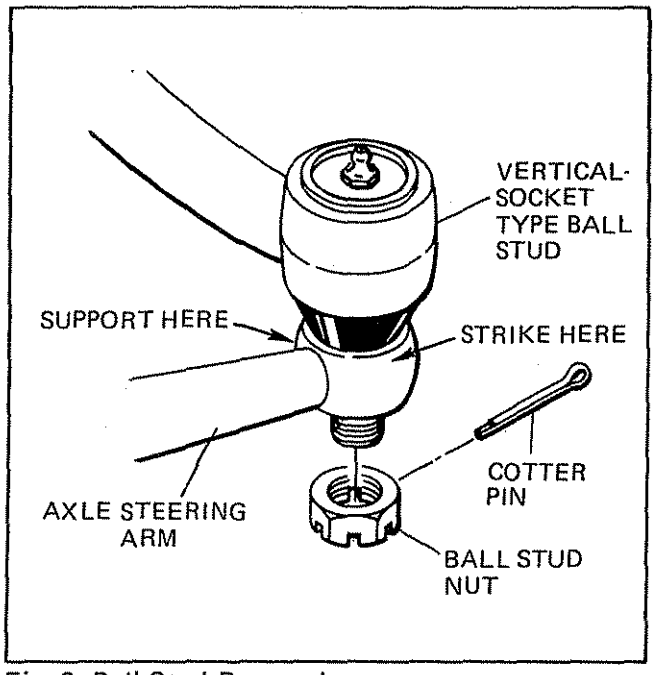


Fig. 6, Ball Stud Removal

sure on the ball stud, and rap the side of the axle steering arm adjacent to the ball stud with a hammer. Support the back side of the axle steering arm with a heavy hammer. (Fig. 6)

.3 On vehicles equipped with a frame-mounted power cylinder, remove the cotter pin and end plug from the power cylinder socket, then remove the ball from the power cylinder. (Fig. 7)

DISASSEMBLY

1. Hold the valve in a vise for disassembly. Clamp only in the center of the housing as this is the heavier section.

2. The lock ring has been crimped into a notch in the drag link adapter. Straighten the ring, then remove the adapter with a pipe wrench.

3. The ball socket must be disassembled before the body can be removed from the housing.

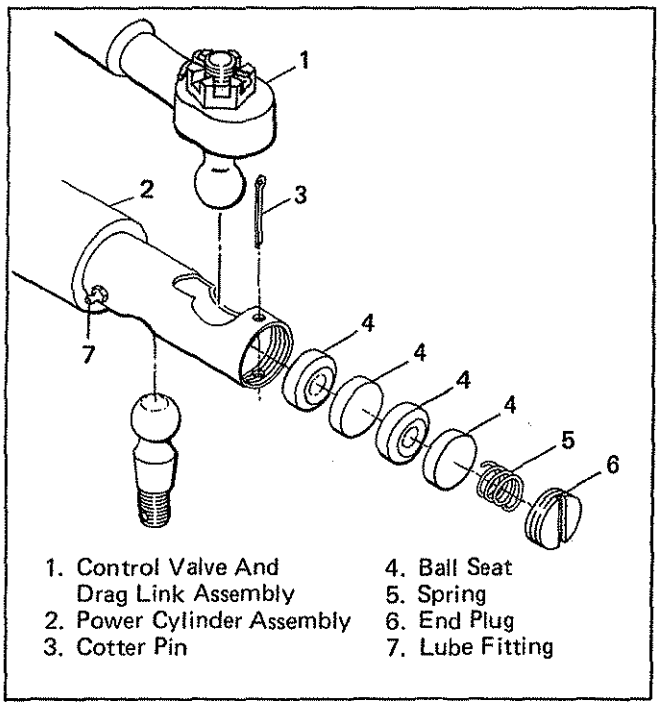


Fig. 7, Frame-Mounted Power Cylinder

Place a punch into oil passage hole in the piston to hold the piston from turning. (Fig. 8)

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

4. Remove the nut from the ball socket end of the piston. This requires a 3/4-inch hex socket and 4-inch (102 mm) extension.

5. Remove the ball socket and ball socket bearing. The valve body assembly can now be removed from the housing (Fig. 9). The housing contains a snap ring that provides a stop for the valve body. It is not necessary to remove this snap ring.

6. To disassemble the valve body and piston, hold it in a vise (Fig. 10). Place a punch in the oil passage hole in the piston to keep it from turning and remove the nut from the gland end of the piston with a 3/4-inch hex socket.

7. Remove the washer, hold the piston in the body and remove the gland, the two reaction rings and the spacer. Do not try to remove the gland and piston together as the O-ring seals on the piston will be damaged in doing so.

8. When removing the piston, first move it toward the gland end of the body just far enough to permit removing the O-ring seal. Then move the piston in the opposite direction just far enough to permit removing the O-ring seal from the other end. Now slide the piston out from the gland end of the body.

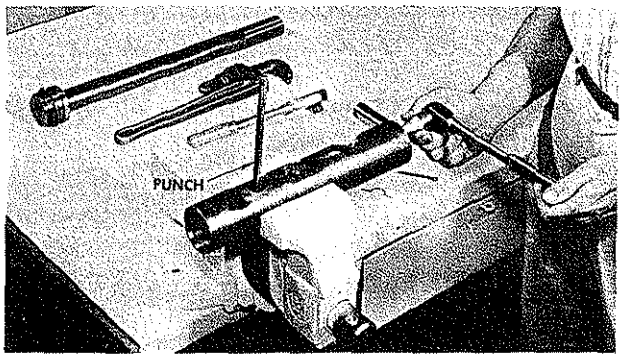


Fig. 8

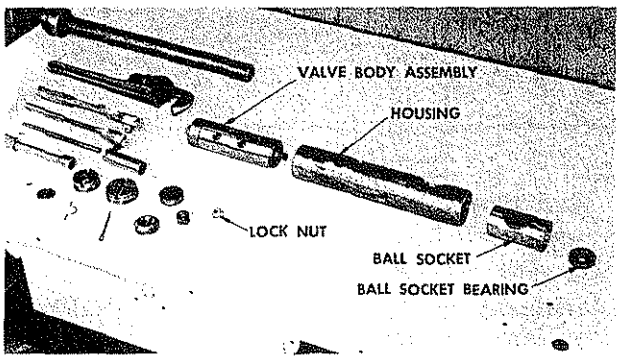


Fig. 9

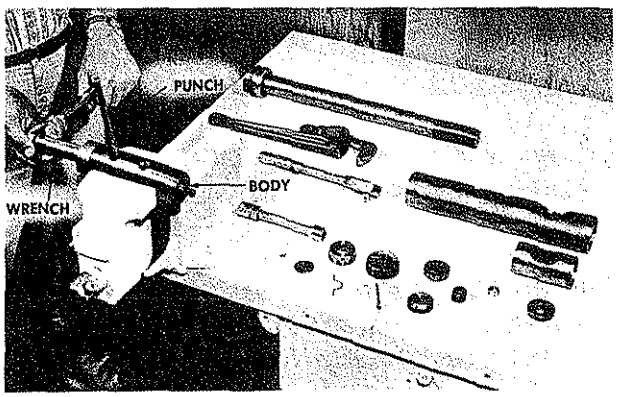


Fig. 10

CLEANING AND INSPECTING

1. Clean and wash all parts thoroughly in solvent or kerosene. Handle the parts separately and carefully to avoid damaging the finished surfaces.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

Wear of parts such as piston, reaction rings and valve body is negligible as these parts operate in circulating oil. It is impractical for a field service shop to attempt to measure wear. Therefore a careful visual inspection of all parts is most important.

2. Examine the surfaces of the piston and the bore of the body for scoring or damage that

GARRISON CONTROL VALVE AND
DRAG LINK ASSEMBLY, G21 SERIES

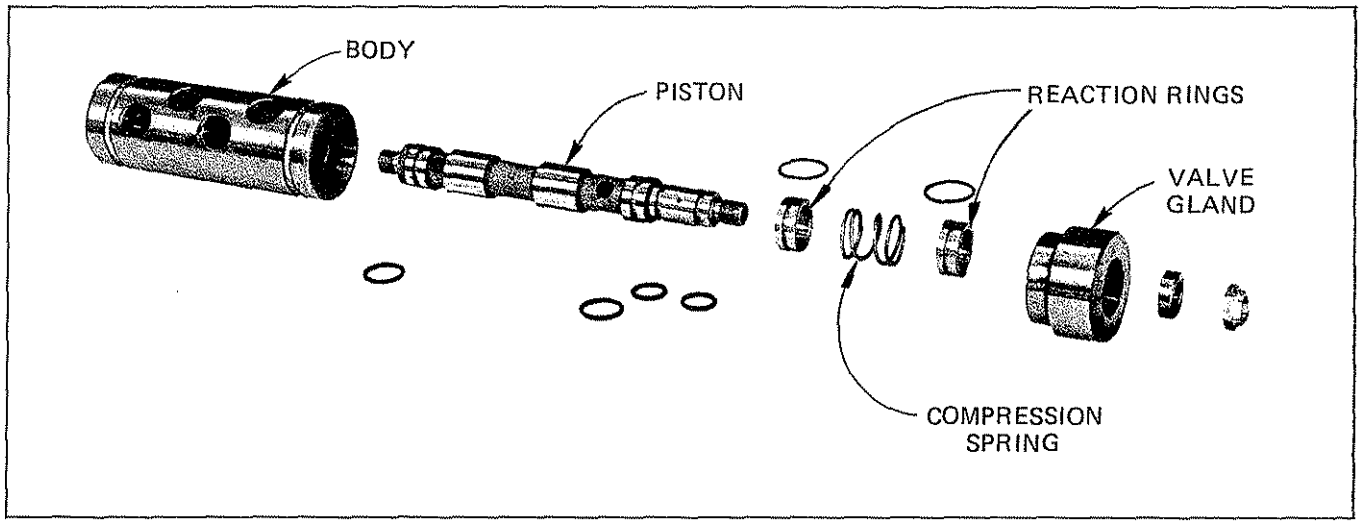


Fig. 11

may have been caused by foreign matter in the fluid. Parts that are badly scored and scratched should be replaced. Light scratches can be removed by polishing with fine crocus cloth. Do not "round-off" or chamfer the port edges of the piston or body. These edges should remain sharp to insure proper sealing. If they are broken the result would be excessive leakage and reduced hydraulic power.

3. O-ring seals should be examined carefully for damage. If surface is rough or cut it should be replaced.

4. Inspect the adapter threads for wear with a vernier caliper on a 2-3 inch (49-74 mm) micrometer and using the following procedure:

   .1 Check the adapter thread outside diameter adjacent to the flange (unused area) to establish a maximum value.

   .2 Check the thread outside diameter over the entire length and around the periphery in several places, and note these values. Compare these values with the maximum value determined in 4.1, above.

   .3 If any reading is 0.010 inch (0.25 mm) below the maximum value, then replace the valve assembly with a new one.

WARNING: Failure to replace the valve assembly with a new one when the adapter threads are worn, can result in a possible disengagement of the adapter from the valve housing, without warning. This, in turn, can result in a loss of vehicle control.

ASSEMBLY

1. Hold the valve body in a vise as illustrated in Fig. 10 and install the valve piston. Insert the piston into the gland end of the body for easy assembly.

2. Install an O-ring on the piston opposite the gland end first and move the piston into the body just far enough to permit installation of an O-ring on the gland end of the piston.

3. Now center the piston on the body by having the shoulder on the gland end of the piston flush with the bottom of the counterbore in the body.

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

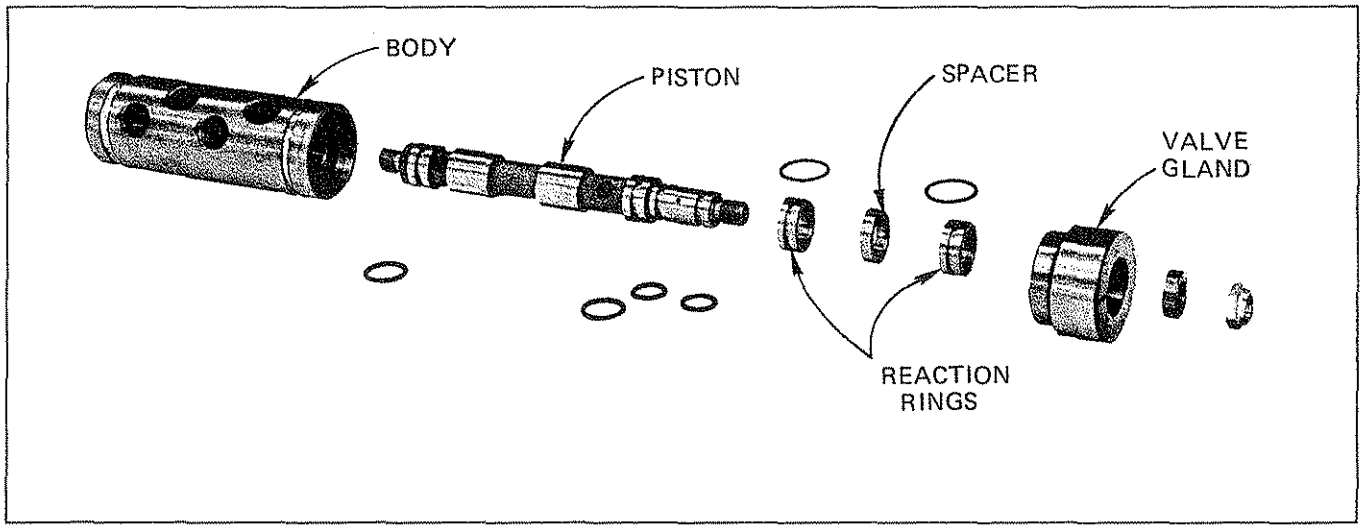


Fig. 12

CAUTION: When installing the O-ring seals on the piston, do not move the piston in the body any farther than is required to assemble the seal. If the seal on the gland end of the piston drops into the cavity in the body, it is likely to be cut or damaged. Apply light lubricating oil to the piston and seals when assembling.

4. Install the two O-ring seals on the gland end of the piston.

5. Install the O-ring seals on the two reaction rings. Install one ring on the piston, then install the gland in the body and the second reaction ring on the end of the piston.

6. If the valve gland is furnished with a compression spring (Fig. 11), install the spring in the gland between the two reaction rings and assemble over the piston.

   If the valve gland is furnished with a spacer (Fig. 12), install the spacer in the gland between the two reaction rings and assemble in the body.

7. Install the washer and nut and torque nut to 18-23 ft-lbs (24-31 N·m). To hold the piston stem from turning while tightening the nut, place a punch in the oil passage hole in the piston as shown in Fig. 10.

8. Place the body assembly in the housing and assemble the drag link adapter with the lock ring and tighten enough to hold the body in position. Be sure the interior of the housing is cleaned and that no obstruction will prevent the body assembly from bearing against the stop ring in the housing. This can be observed through the opening in the housing.

9. Place the assembly in a vise with the ball stud opening in the housing facing upward.

CAUTION: Clamp only in the center of the valve as this is the heavier section.

10. Place the ball socket bearing (Fig. 9) in the ball socket. The counterbored side should face toward the socket opening.

11. Assemble the socket in the housing and secure with a nut. Torque the nut to 30-35 ft-lbs (41-47 N·m).

12. Now tighten the drag link adapter. Torque to 300-600 ft-lbs (407-814 N·m).

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

13. Bend the edge of the lock ring into a slot in the rim of the adapter.

INSTALLATION

1. Place the ball seat in the ball socket and assemble the valve over the ball stud on the vehicle steering (pitman) arm.

2. Assemble the ball seat, spring and ball socket end plug. Tighten the end plug until it "bottoms," then back it off until the nearest set of holes in the socket line up with the slot in the end plug to permit installing the plug lock.

3. Install the drag link on the axle steering arm or power cylinder as follows:

   .1 On vehicles equipped with an axle-mounted power cylinder and horizontal-socket type drag link, loosen the adapter clamp pinch bolt nut. Shorten or lengthen the drag link by turning the drag link assembly clockwise or counterclockwise, respectively, until the drag link ball socket will engage on the axle steering arm ball stud.

   WARNING: When lengthening the drag link, be sure that at least 1-3/4 inches (44 mm) of thread on the drag link assembly is engaged in the adapter clamp area. Failure to comply with this instruction could result in a hazardous vehicle operating condition.

   Place the retainer, spring, and one of the ball stud seats in the ball socket (see Fig. 5), then position the ball socket on the ball stud. Install the other ball stud seat and drag link end plug in the ball socket (see Fig. 5), then tighten the drag link end plug until the spring compresses and the ball stud seats are tight against the retainer. Loosen the drag link end plug 1/16 turn so the connection is just free.

   Measure the distance from the drag link end plug to the end of the drag link housing. This distance should be 1/16-inch (1.6 mm). If this distance varies from 1/16-inch (1.6 mm), remove the end plug, ball stud seats, spring and retainer from the ball socket. Inspect the parts for wear or damage. If worn or damaged, replace with new parts. Assemble the parts to the ball socket as outlined above.

   Check the ball socket for binding in accordance with the instructions given in the 14 Group of this manual.

   After the adjustment is within the above specifications, install a new cotter pin through the end of the drag link assembly, then lock it in place. If the cotter pin holes do not line up, loosen the drag link end plug (1/8 turn or less) until the slot lines up with the next pair of holes.

   .2 On vehicles equipped with an axle-mounted power cylinder and vertical-socket type drag link, loosen the adapter clamp pinch bolt nut.

   Shorten or lengthen the drag link by turning the drag link assembly clockwise or counterclockwise, respectively, until the ball stud will engage in the axle steering arm.

   WARNING: When lengthening the drag link, be sure that at least 1-3/4 inches (44 mm) of thread on the drag link is engaged in the adapter clamp area. Failure to comply with this instruction could result in a hazardous vehicle operating condition.

   Install the ball stud nut on the ball stud, then tighten the nut to 100 ft-lbs (136 N·m). Then, if required, continue tightening the nut until a slot on the nut aligns with the hole in the ball stud.

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

CAUTION: Do not back off the nut when locating the cotter pin hole.

After tightening the ball stud nut, check the ball stud for looseness. If loose, remove the ball stud nut from the ball stud then remove the ball stud from the axle steering arm. Use a ball stud removal tool, if one is available. Otherwise, apply removal pressure on the ball stud, then rap the side of the axle steering arm adjacent to the ball stud with a hammer. Support the back side of the axle steering arm with a heavy hammer. See Fig. 6. Replace the drag link assembly with a new one, then install the drag link on the axle steering arm as outlined above.

Install a new cotter pin through the ball stud and nut, then lock it in place.

WARNING: Failure to install and lock a new cotter pin in the ball stud and nut could result in a hazardous vehicle operating condition.

.3 On vehicles equipped with a frame-mounted power cylinder, loosen the adapter clamp pinch bolt nut. Shorten or lengthen the drag link by turning the drag link assembly clockwise or counterclockwise, respectively, until the drag link ball stud will engage in the power cylinder socket.

WARNING: When lengthening the drag link, be sure that at least 1-3/4 inches (44 mm) of thread on the drag link assembly is engaged in the adapter clamp area. Failure to comply with this instruction could result in a hazardous vehicle operating condition.

Install the end plug in the power cylinder socket. Tighten the end plug until it "bottoms," then back it off until the nearest set of holes in the socket line up with the slot in the end plug to permit installation of the cotter pin. Install a new cotter pin through the socket, then lock it in place.

WARNING: Failure to install and lock a new cotter pin in place could result in a hazardous vehicle operating condition.

4. On Powerliner vehicles, position the adapter clamp and adapter clamp pinch bolt so that the adapter clamp pinch bolt protrusion is away from the tilt cylinder (Fig. 13). This positioning of the adapter clamp and adapter clamp pinch bolt is necessary to prevent interference with the tilt cylinder during steering operations.
5. Tighten the adapter clamp pinch bolt nut to 70-75 ft-lbs (95-101 N·m).
6. Tack weld the adapter clamp at the forward and back edges with a mild steel welding rod. The tack weld must be on one side of the collar split as shown in Fig. 13. Do not tack weld on both sides of the collar split.
7. Attach the hydraulic lines to the valve ports. Lines should be attached to the same ports from which they were originally removed. See Fig. 16, located under "SPECIFICATIONS."

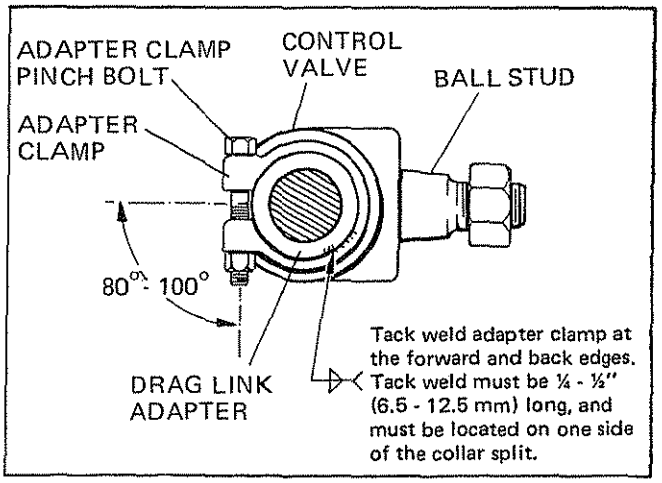


Fig. 13, Adapter Clamp Position

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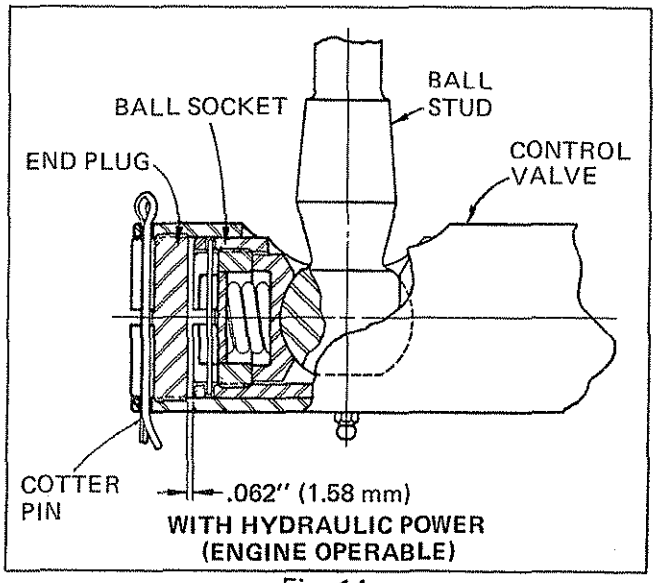


Fig. 14

8. When installing the valve housing end plug, particular attention should be given to positioning it properly. The plug provides a stop to limit and control the outward stroke of the valve piston. There should be .062 inch (1.58 mm) maximum gap between the end of the ball socket and the face of the end plug, when the valve piston is in a neutral and centered position. See Fig. 14.

9. To obtain the proper end plug position, proceed as follows:

   .1 With Hydraulic Power (Engine Operable):

   After the power steering system is installed complete, fill the reservoir up to the full mark on the dipstick. Refer to the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual for lubricant specifications.

   Start the engine to allow the hydraulic fluid to circulate through the system. Have the front axle jacked up so the wheels clear.

   Turn the wheels to full right and full left a few times to allow the power cylinder and the lines to fill. Check the fluid level in the reservoir and refill if necessary.

   Increase the engine speed to about 750 or 800 RPM. The pressure in the hydraulic system will automatically center the valve piston in neutral position.

   Turn the housing end plug inward until there is .062 inch (1.58 mm) gap between the two end plugs. This dimension can be measured by inserting a feeler gage shim (.062 inch [1.58 mm] width) between the plugs through the inspection hole in the valve housing. Remove the gage and continue turning the end plug inward until the nearest set of holes in the housing line up with the slot in the end plug to permit installing the end cotter pin.

   .2 Without Hydraulic Power (Engine Inoperable):

   If the valve is to be installed when it is not possible to operate the engine for hydraulic power, such as described in the preceding paragraph, then the following procedure will apply to make the end plug adjustment.

   Move the valve so the valve piston and ball socket travel inward. Hold the valve against the stop and turn the housing end plug inward until there is .125 inch (3.18 mm) gap between it and the ball socket end plug (Fig. 15). Insert a gage (.125 inch [3.18 mm] width) between the plugs through the inspection hole in the housing to check the measurement.

   Now remove the gage and continue turning the end plug inward until the nearest set of holes in the housing line up with the slot in

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

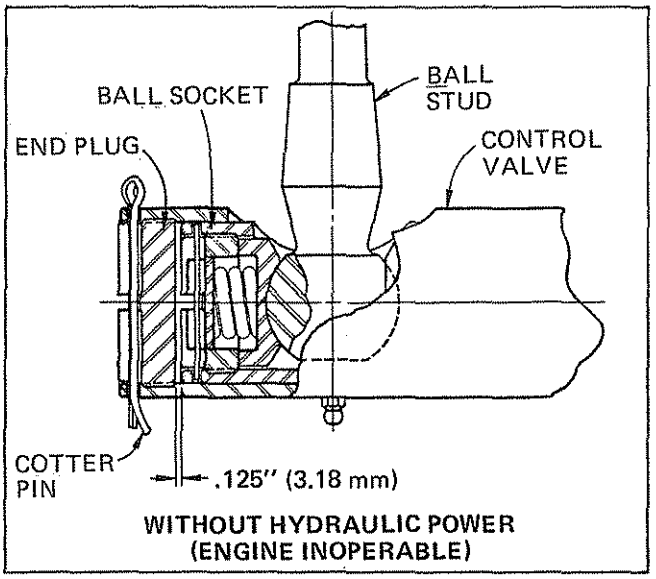


Fig. 15

the end plug to permit installing the end cotter pin.

It is important that the end plug adjustment is properly made to assure that it provides for a stop when the ball socket moves outward. This eliminates the possibility of placing tension on the valve piston when the valve is actuated during steering operation.

10. Always provide a dust shield to cover the ball socket opening.

11. A lubrication fitting is provided for the valve ball socket and stud. Lubricate as regularly as vehicle chassis lubrication servicing.

12. Before placing the vehicle in operation, recheck all line fittings on the valve, power cylinder and pump. Check the end plug in the ball socket on the drag link and on the power cylinder rod. The end plugs should be adjusted properly. First, turn the plug in as far as possible then back it off about one-eighth of a turn to provide a minimum of clearance.

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Hard Steering	Insufficient pump pressure.	Check pump with pressure gage.
	Low oil level.	Refill reservoir and system.
	Sticky relief valve.	Repair or replace relief valve.
	Piston in steering valve sticking.	Overhaul valve as outlined in service instructions.
	Valve piston not traveling full stroke.	Adjust position of end plug per instructions.
	Reaction ring area too high.	Select ring with smaller area.
	Excessive leakage in power cylinder.	Check cylinder for broken piston or rings. Check condition of cylinder wall. Replace if necessary.
	Steering gear not adjusted properly.	Adjust in accordance with the instructions given in the 14 Group of this manual.
	Improper front end alignment.	Align in accordance with the instructions given in the 10 Group of this manual.
No Recovery, From Turn To Straight Ahead	Low pump output.	Check pump output and replace if necessary.
	Piston in steering valve sticking, (prevents centering).	Disassemble valve and inspect for sticking.
	Ball stud adjustment too tight.	Adjust for proper clearance.
	Insufficient wheel caster.	Readjust in accordance with the instructions given in the 10 Group of this manual.
	Steering gear too tight (out of adjustment).	Readjust in accordance with the instructions given in the 14 Group of this manual.

(Continued on next page)

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
No Recovery, From Turn To Straight Ahead (Cont.)	Steering linkage too tight.	Readjust in accordance with the instructions given in the 14 Group of this manual.
Excessive Lost Motion At Steering Wheel	Loose ball socket connections or other linkage connections.	Tighten and readjust.
	Excessive back-lash in steering gear.	Readjust in accordance with the instructions given in the 14 Group of this manual.
	End plug on steering valve not properly positioned.	Make adjustment as outlined in service instructions.
Noise	Low oil level.	Refill system.
	Air in system.	Bleed system by loosening fitting on power cylinder to let air escape. Check all fitting connections for tightness.
	Worn pump.	Repair or replace.
	Hydraulic hose lines in direct contact with vehicles frame or sheet metal.	Insulate lines from frame contact with rubber grommets.
Steering Shimmy Or Chatter	Loose ball socket connections or other linkage connections.	Tighten and readjust.
	Wheels out of balance.	Balance.
	Excessive caster.	Correct and have alignment of front end checked.
	Excessive back-lash in steering gear.	Readjust gear.
	Area of valve reaction rings too low.	Select rings with greater area.

(Continued on next page)

GARRISON CONTROL VALVE AND DRAG LINK ASSEMBLY, G21 SERIES

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Steering Shimmy Or Chatter (Cont.)	Air in system.	Bleed system by loosening fitting on power cylinder to let air escape. Check all fitting connections for tightness, especially pump inlet.

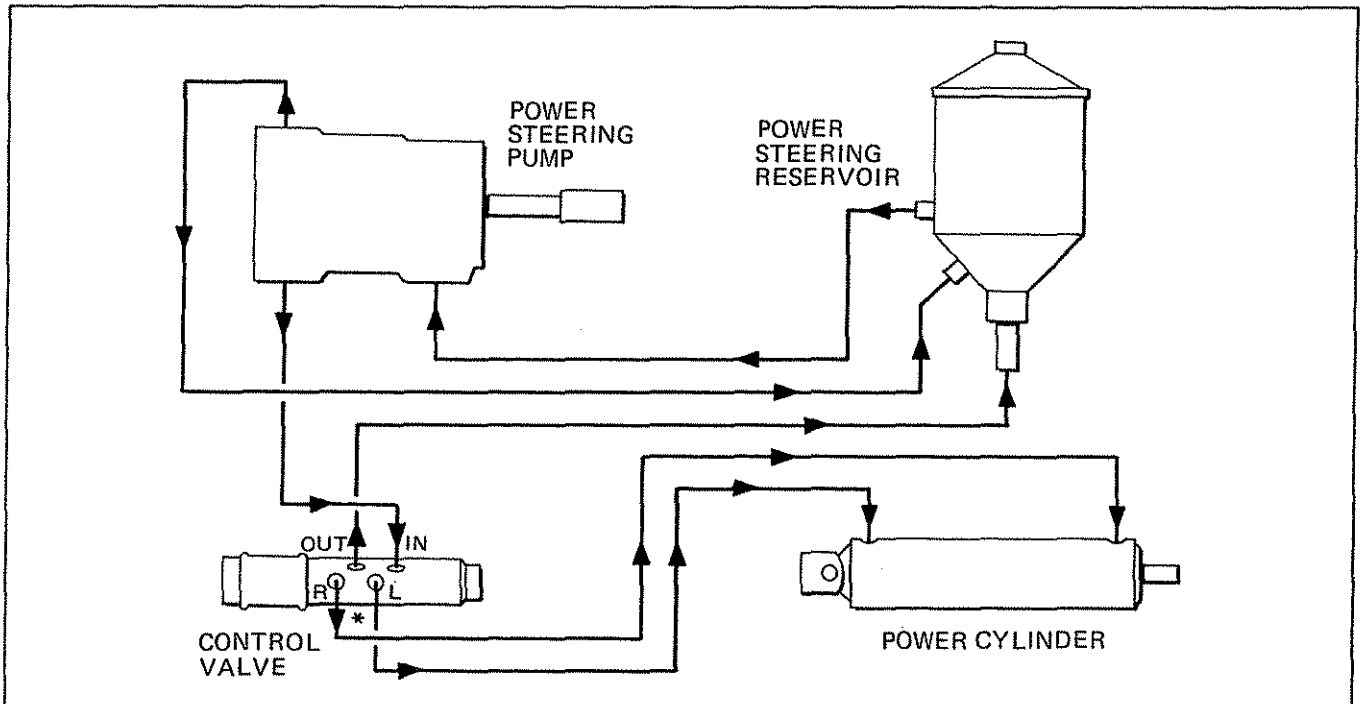
SPECIFICATIONS

DESCRIPTION	TORQUE FT-LBS	TORQUE N·m
Nut (Valve Gland End)	18-23	24-31
Nut (Ball Socket End)	30-35	41-47
Drag Link Adapter	300-600	407-814
Vertical Ball Stud Nut	100	136
Adapter Clamp Pinch Bolt Nut	70-75	95-101

Table 1, Torque Specifications

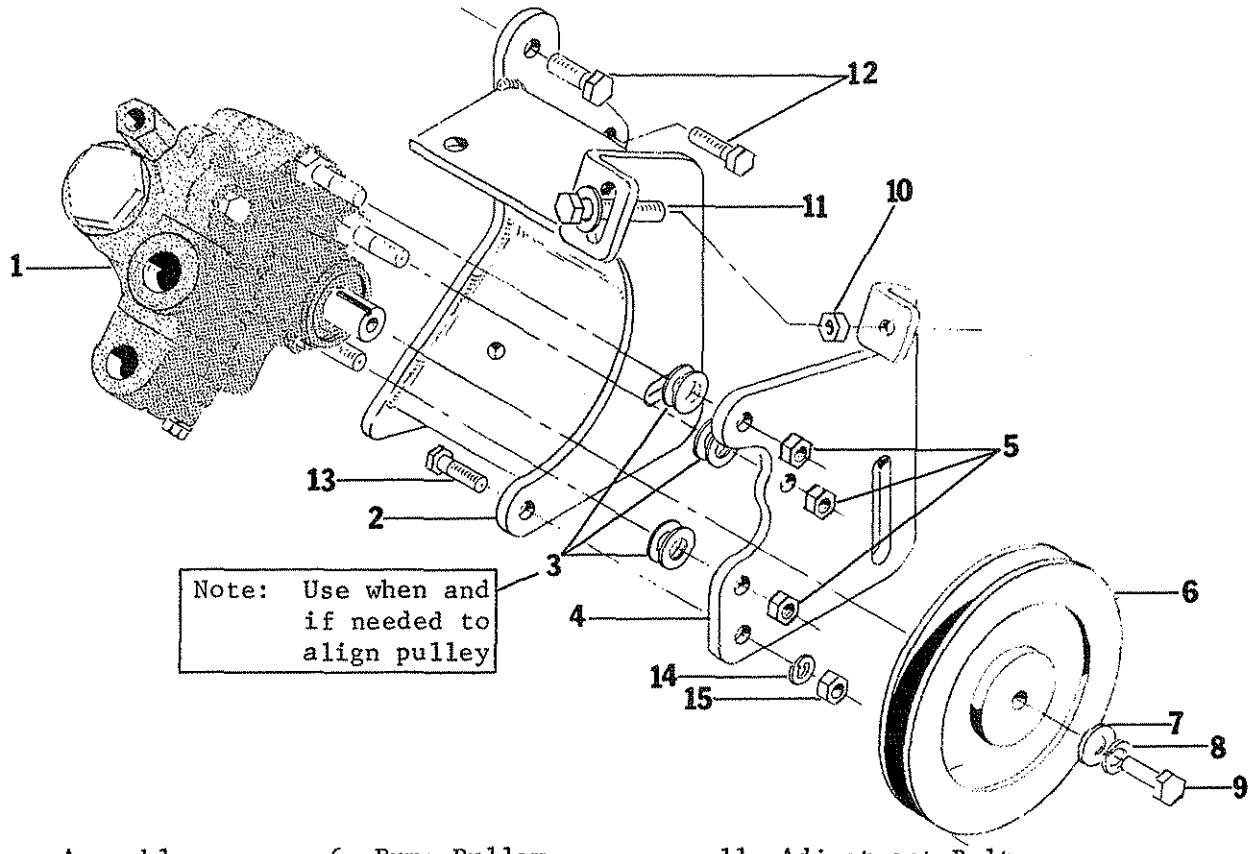
DESCRIPTION	SPECIFICATIONS
Reaction Valve	0.7 sq. in.
Reaction O-Ring Seal	0.7 sq. in.
Reaction Ring	0.7 sq. in.
GPM Piston	5
Valve Body Ports	3/8-18 NPT
Cotter Pin	1/8" x 2"

Table 2, Control Valve Specifications



*NOTE: Connections are reversed on COE vehicles equipped with frame-mounted power cylinder, and on Conventional vehicles equipped with an axle-mounted power cylinder.

Fig. 16, Plumbing Diagram (COE and Powerliner with Axle-Mounted Power Cylinder Shown)



1. Pump Assembly
2. Pump Mtg. Bkt. Assy.
3. Alignment Washers
4. Pump Adj. Plate
5. Pump Mtg. Stud Nuts
6. Pump Pulley
7. Hardened Washer
8. Lockwasher
9. Pulley Mtg. Capscrew
10. Adj. Bolt Lock Nut
11. Adjustment Bolt
12. Mtg. Bracket to Engine Capscrews
13. Adj. Plate to Mtg. Bracket Bolts
14. Lockwashers
15. Adj. Plate to Mtg. Bkt. Bolt Nuts

Fig. 1 Steering Pump Installation

GENERAL DESCRIPTION

A The Garrison power steering pump, model 1841 is a roll-vane type of pump. When the drive shaft turns, the carrier rotates the roll-vanes which follow the surface of a cam ring. Oil from the reservoir is forced along between the roll-vanes and delivered under pressure to the pump outlet. The pump is mounted on the engine with a bracket and is belt driven.

The part number and rating identification for the model 1841 pump is stamped in the top of the body near the inlet manifold. The rating of the pump is as follows:

The dash number following the model number indicates the controlled flow rating.

2 indicates 1.8 to 2.3 gpm @ 1400
3 indicates 3.0 to 3.5 gpm @ 1700
5 indicates 4.25 to 4.75 gpm @ 2000
6 indicates 5.25 to 6.0 gpm @ 2300
8 indicates 7.0 to 8.0 gpm @ 2900

The letter indicates the relief valve setting.

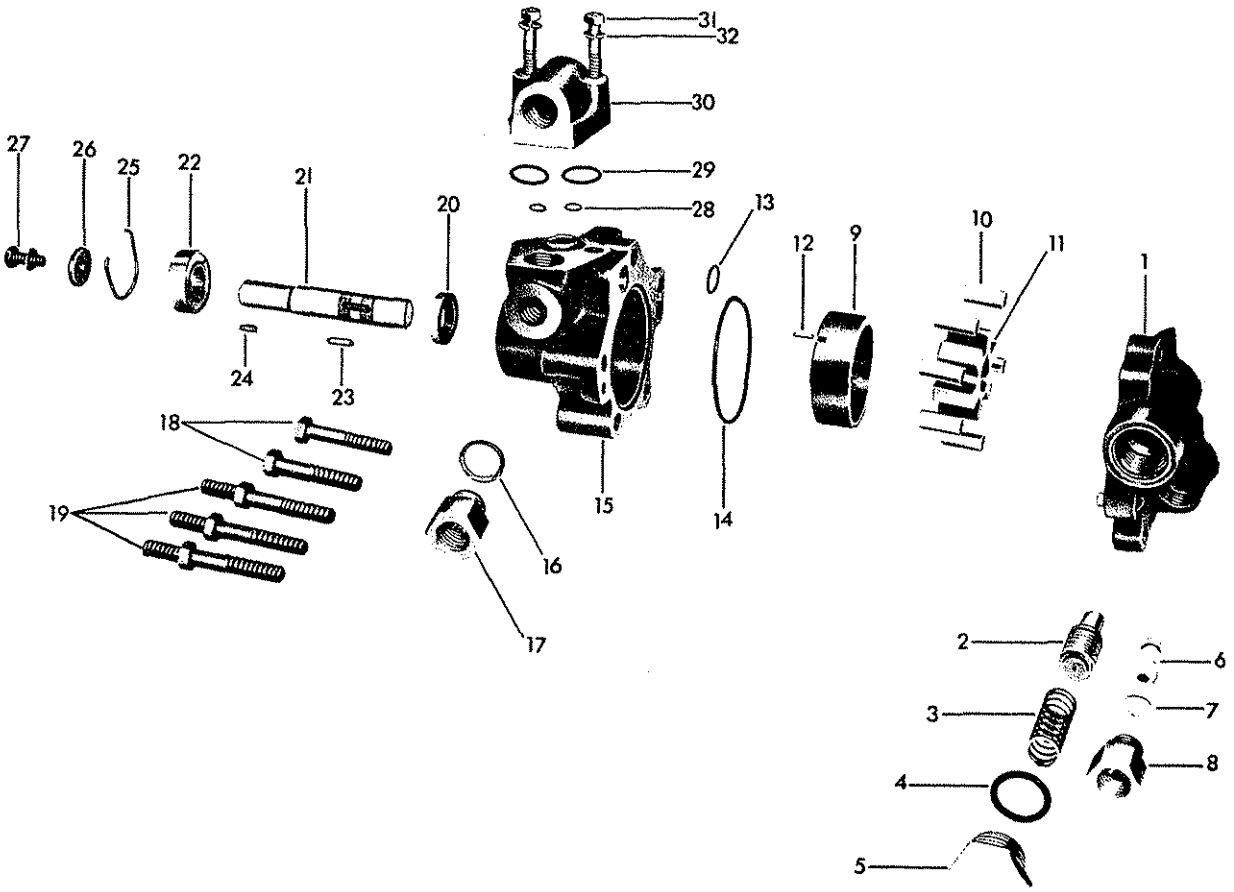
B indicates 975 to 1100 p.s.i. at 3000
D indicates 1100 to 1300 p.s.i. at 3000
E indicates 750 to 900 p.s.i. at 3000

SERVICE OPERATIONS

REMOVAL SEE FIG. 1

1. Disconnect the hydraulic lines from the pump and seal off the lines to prevent the oil from leaking out and dirt entering the lines.

2. On DDE(V-71 series) engines, loosen the alternator adjusting bolt and



1. Cover
2. Flow Control & Relief Valve
3. Valve Spring
4. O-Ring
5. Valve Cap
6. Tube Seat
7. Gasket, Inverted Flare
8. Adapter, Inverted Flare
9. Cam Insert
10. Roll Vane
11. Carrier
12. Dowel Pin, Cam
13. O-Ring, By Pass
14. O-Ring, Body to Cover
15. Body, Bushing & Venturi
16. Gasket, Hose Adapter
17. Adapter
18. Capscrew
19. Mounting Stud
20. Oil Seal
21. Shaft
22. Bearing
23. Drive Pin
24. Woodruff Key
25. Snap Ring
26. Washer
27. Capscrew W/Lockwasher
28. Gasket
29. Gasket
30. Manifold, Pump
31. Capscrew
32. Lockwasher

Fig. 2 Steering Pump Nomenclature

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pivot bolt, then loosen the alternator.

3. Loosen the power steering pump adjusting bolt and pivot bolt, pivot the pump and remove the drive belt(s).

4. Remove the nuts attaching the pump to the mounting bracket, then remove the pump.

DISASSEMBLY SEE FIG. 2

1. Thoroughly clean the exterior of the pump using care so that dirt does not enter the inlet or outlet holes.

2. Remove the capscrews attaching the manifold to the pump.

3. Separate the manifold from the pump and remove the four O-rings.

4. Remove the capscrews and mounting studs attaching the front cover to the pump body assembly.

5. Separate the pump cover from the body, lift the cover vertically from the body to prevent the internal parts from falling out.

6. Remove the O-ring seals from the grooves in the pump body housing.

7. Before removing the carrier, note the carrier position. The carrier has a drive side and must be installed correctly. Remove the rollers from the cam and carrier, then remove the carrier.

8. Remove the ball bearing retainer ring and separate the shaft-bearing subassembly from the pump body.

9. Lift out cam retaining pin.

10. Using caution to prevent damage to the shaft bushing, remove the shaft seal from the pump body.

11. Remove the flow control and relief valve cap, valve spring and valve.

Place these parts where they will not be damaged or contaminated.

INSPECTION AND ASSEMBLY SEE FIG. 2

1. Wash all parts in solvent. Air dry or wipe dry with a clean lint free cloth if air is not available. Lubricate all parts with a light film of oil as they are assembled.

2. Check pump body and cover for wear. Replace either part if surface is scored or worn or if the bushings are worn.

3. Using a seal installation tool, install a new shaft oil seal with the lip toward the pocket. Grease lip of seal with Lubriplate or an equivalent non-hardening grease.

4. Install the cam dowel pin. Inspect the cam for wear and replace if worn or damaged.

5. Position the cam in the pocket with the slot over the dowel pin. Be sure that the cam is all the way in the pocket.

6. Inspect the shaft-bearing subassembly. If the bearing balls are loose or excessive grease has seeped out, replace the bearing.

7. Position the shaft-bearing subassembly in the pump body. Install the bearing retainer ring.

8. Position the carrier drive key in the shaft.

9. Inspect carrier and place in pocket. See Fig. 3 for correct installation of carrier. If it is installed with the driving side reversed, the pump will not operate properly.

10. Inspect the roll-vanes, replace if scored, damaged or out of round. Position the roll-vanes in the carrier.

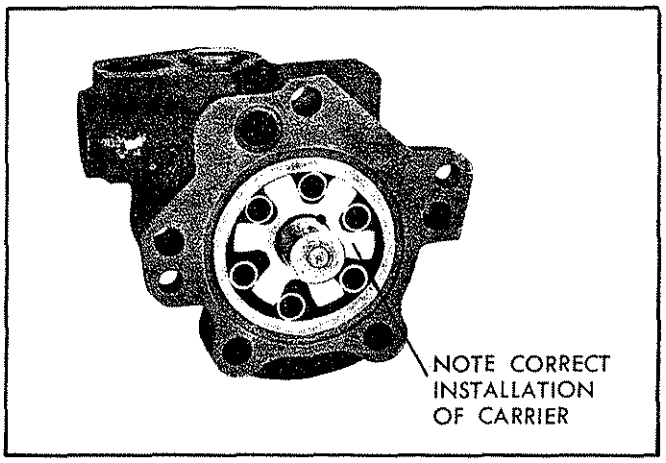

Fig. 3

11. Position a straight edge across the cam surface. Using a feeler gauge, check the end clearance of the carrier and roll-vanes in the pump body. See Fig. 4. If the end clearance exceeds .002, replace carrier and roll-vanes.

12. Carefully inspect the valve assembly and valve bore. Remove all burrs with crocus cloth. Position e the valve in the bore with the exposed ball end inward. Be sure the valve does not stick in the bore. If valve fails to move freely, review service procedure and correct as necessary.

13. When the flow control valve spring is compressed to a height of .82 inch, the spring tension should be 8.5 lbs. ± 1/2 lb. If not, replace with new spring. Install the flow control valve spring in bore.

14. Position a new O-ring on the valve cap, tighten the cap to 30-35 ft. lbs.

15. Position a new by-pass O-ring and body to cover O-ring in the pump body.

16. Position the cover on the pump body and install the capscrews and studs attaching the cover to the pump body. Tighten the capscrews and studs evenly to 20-25 ft-lbs. Be sure the shaft rotates without binding; if binding occurs, review service procedure and correct as required.

17. Install new O-rings in grooves on top of body housing.

18. Position the manifold on top of the body housing and install the capscrews attaching the manifold to the body.

19. Install the woodruff key in the shaft. Position the pulley and washer on the shaft and install the capscrew attaching the pulley to the shaft. Tighten the capscrew to 15-20 ft. lbs.

INSTALLATION SEE FIG. 1

1. Position the pump in the mounting bracket and install the nuts attaching the pump to the mounting bracket. When initially installing the pump, check the pulley alignment and add spacer washers if needed. See Fig. 5. When reinstalling the pump, use the same spacer washers that were originally installed. Tighten the nuts to 25 ft. lbs.

2. Position the drive belt(s) on the pump pulley.

3. On Cummins in-line engines, tighten the drive belt(s) to the values given in Table 3 under SPECIFICATIONS. Use A a Gates belt tension tester or equivalent to measure the force as shown in Fig. 6.

4. On DDE engines, put the alternator in the slack position. Tighten the drive belt(s) snug with the pump adjustment.

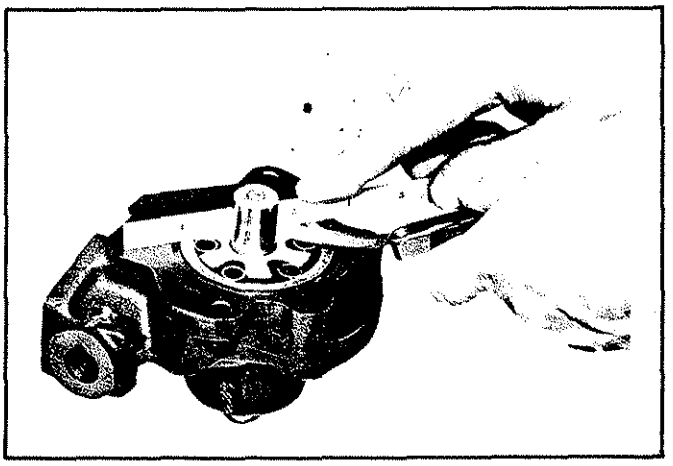

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Fig. 4

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GARRISON ROLL-VANE POWER STEERING PUMP, MODEL 1841

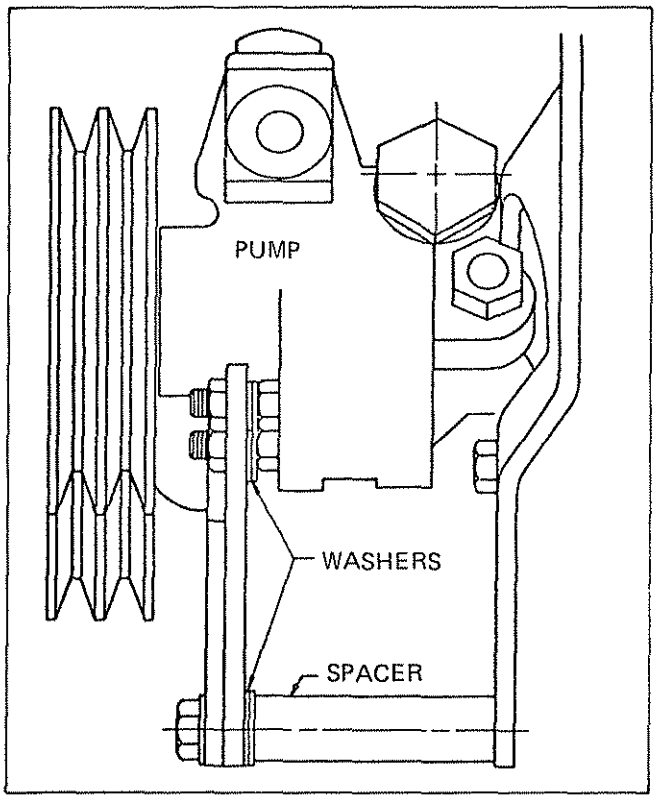


Fig. 5

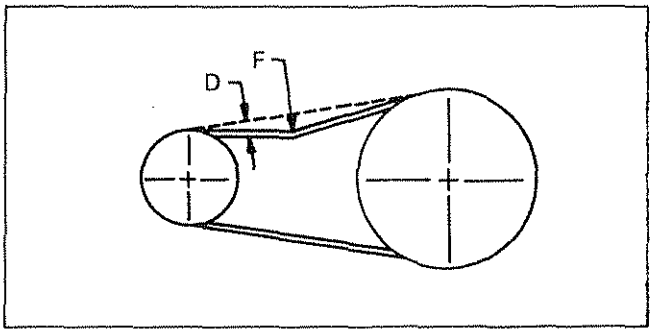


Fig. 6

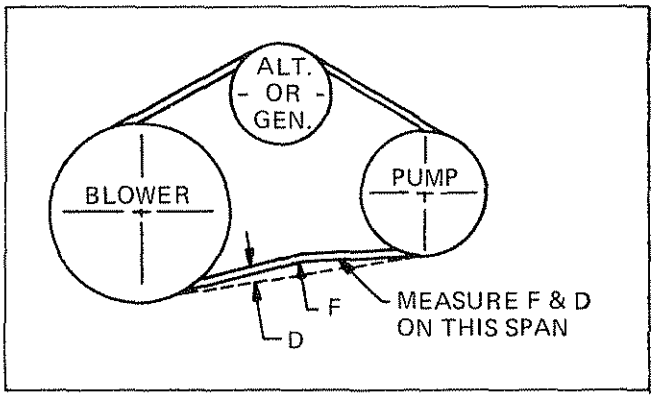


Fig. 7

Using the alternator for final adjustment, tighten the drive belt(s) to the values given in Table 3 under "SPECIFICATIONS." Use a Gates belt tension tester or equivalent to measure the force as shown in Fig. 7.

5. When the pump belt tension is correct, tighten the adjusting bolt to 27 ft-lbs (37 N·m) and the pivot bolts to 42 ft-lbs (57 N·m).

6. Connect the hydraulic lines to the pump. Be sure that the lines are connected to the correct ports.

7. Check and fill the reservoir with the oil recommended on Chart 1 in the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual.

8. Start the engine and run it at low speed, turn the steering wheel to the left and right a few times and check for leaks. Do not hold the wheels against the stops.

9. Stop the engine, correct any leaks, refill the reservoir and check the system using the preoperational check given in the 14 Group of this manual.

WARNING: Failure to follow these above instructions could result in an unsafe operating condition.

LUBRICATION

During assembly of the pump, coat all moving parts and fill the power steering reservoir with the oil recommended on Chart 1 in the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual.

GARRISON ROLL-VANE POWER STEERING PUMP, MODEL 1841

SPECIFICATIONS

PUMP MODEL	FLOW CONTROL RANGE	RELIEF VALVE SETTING
1841 - 5B	4.25 to 4.75 GPM @ 2000 RPM	975 - 1100 PSI @ 3000

Table 1, Pump Specifications

DESCRIPTION	TORQUE	
	FT-LBS	N·m
Power Steering Pump To Mounting Bracket Nuts	25	34
Power Steering Pump Pivot Bolt (Detroit Diesel)	40	54
Power Steering Pump Pivot Bolt (Cummins)	25	34
Power Steering Pump Slot Adjustment Bolts	25	34
Relief Valve Retainer Cap	30-35	41-47
Pump Cover To Pump Body	20-25	27-34
Manifold To Pump Body	30-35	41-47
Pulley To Shaft	15-20	20-27

Table 2, Torque Specifications

APPLICATION	BELT TENSION (F)	BELT DEFLECTION (D)
Cummins NH	4.5 - 6.5 lbs	3/16 inch
Cummins NT	5 - 7 lbs	3/16 inch
Detroit Diesel V-71	3 - 5 lbs	5/32 inch

Table 3, Belt Tension Specifications

GARRISON 2800 SERIES HYDRAULIC CYLINDER

GENERAL DESCRIPTION

The Garrison 2800 series hydraulic cylinder (Fig. 1) is mounted horizontally between the front axle and the steering tie-rod, or, on some COE vehicles, between the front bumper and the axle steering arm. The cylinder is available with either a 2 1/2 inch or a 3 inch diameter bore, depending on the front axle capacity and the operating conditions. Regardless of the diameter of the bore, the recommended working pressure for the cylinder is 1000 psi (6890 kPa), with a maximum intermittent pressure of 1500 psi (10 335 kPa).

Cylinders with a 2 1/2 inch diameter bore have an effective push area of 4.91 in^2 (317 mm^2) and an effective pull area of 4.22 in^2 (272 mm^2). Cylinders with a 3 inch diameter bore have an effective push area of 7.07 in^2 (456 mm^2) and an effective pull area of 6.38 in^2 (412 mm^2).

PRINCIPLES OF OPERATION

The cylinder is connected by hydraulic lines to the power steering control valve and drag link assembly. Turning effort applied to the steering wheel of the vehicle actuates the power steering control valve, which in turn directs hydraulic fluid to one of the ends of the cylinder, depending upon which direction the steering wheel is turned.

When the hydraulic fluid enters the cylinder, it forces the piston and rod assembly toward the other end of the cylinder. This action forces movement of the tie-rod (or axle steering arm), providing a power assist for steering.

SERVICE OPERATIONS

REMOVAL (Refer to Figs. 2, 3, or 4)

1. Set the spring parking brakes, then chock the vehicle tires. Raise the front of the vehicle until the tires clear the ground, then place safety stands under the front axle.

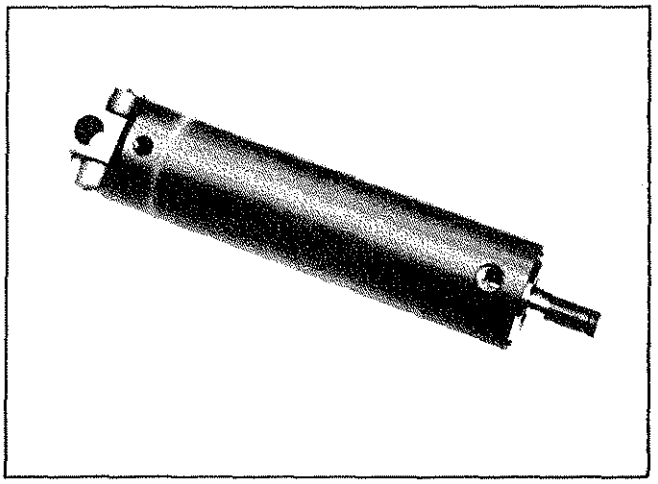


Fig. 1, Garrison 2800 Series Hydraulic Cylinder

2. Clean the area surrounding the ports on the cylinder. Mark the lines for later assembly, then disconnect the lines from the cylinder, plugging them to prevent dirt or foreign material from entering the lines.

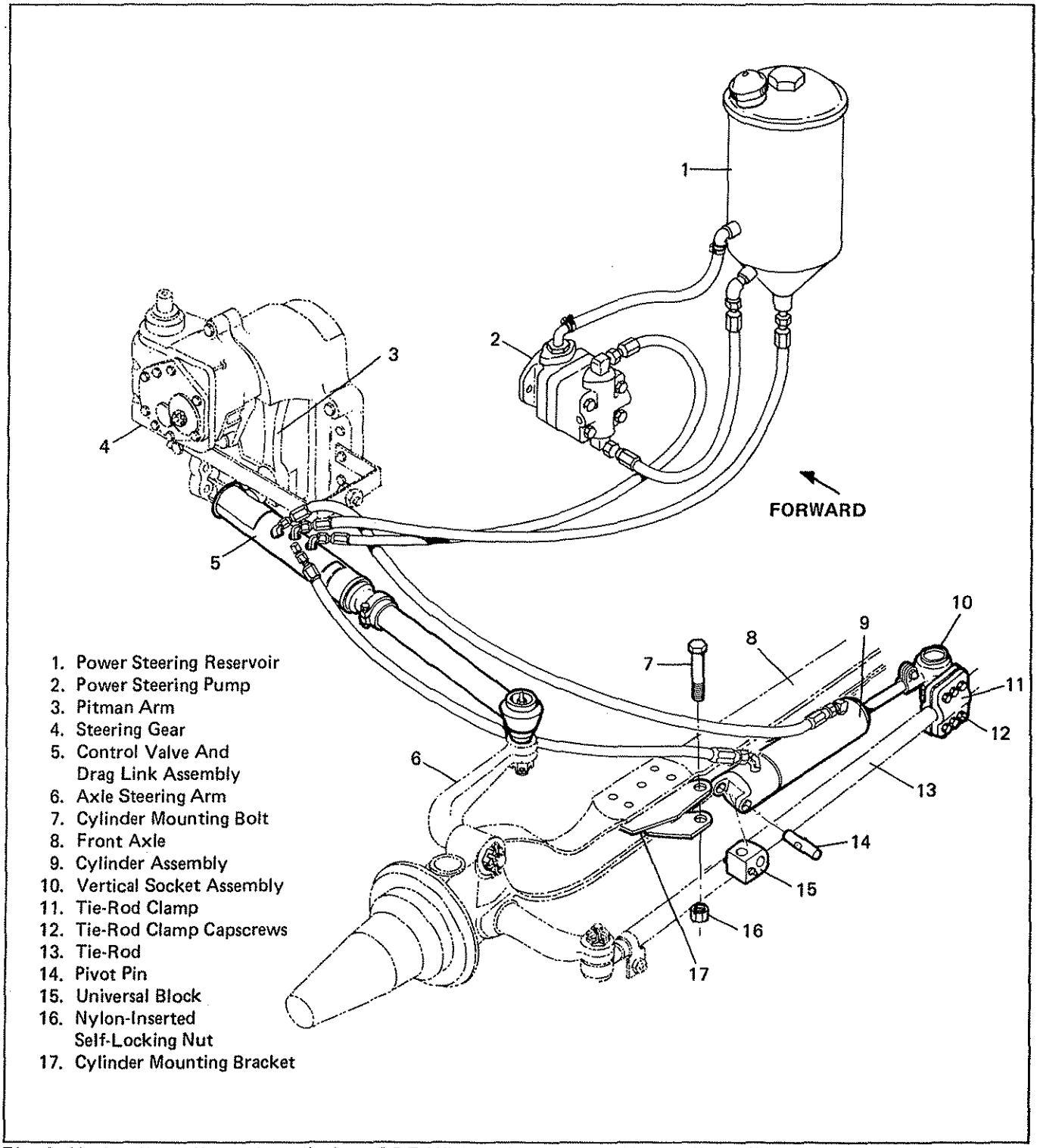
3. Remove the cylinder from the vehicle as follows:

   .1 On vehicles equipped with an axle-mounted hydraulic cylinder, mark the tie-rod on either side of the tie-rod clamp for later assembly reference. Then, remove the capscrews that attach the tie-rod clamp to the tie-rod. Remove the tie-rod clamp from the tie-rod.

   Remove the fasteners attaching the universal block to the cylinder mounting bracket. Remove the cylinder from the vehicle.

   .2 On vehicles equipped with a frame-mounted hydraulic cylinder, remove the cotter pin and end plug from the cylinder socket, then remove the spring and the outer ball seat. See Fig. 5. Remove the control valve and drag link assembly ball from the cylinder socket, then remove the inner ball seats from the cylinder socket. Remove the cylinder from the axle steering arm ball.

GARRISON 2800 SERIES HYDRAULIC CYLINDER



1. Power Steering Reservoir
2. Power Steering Pump
3. Pitman Arm
4. Steering Gear
5. Control Valve And Drag Link Assembly
6. Axle Steering Arm
7. Cylinder Mounting Bolt
8. Front Axle
9. Cylinder Assembly
10. Vertical Socket Assembly
11. Tie-Rod Clamp
12. Tie-Rod Clamp Capscrews
13. Tie-Rod
14. Pivot Pin
15. Universal Block
16. Nylon-Inserted Self-Locking Nut
17. Cylinder Mounting Bracket

Fig. 2, Hydraulic Cylinder Installation, COE With Axle-Mounted Hydraulic Cylinder

GARRISON 2800 SERIES HYDRAULIC CYLINDER

1. Power Steering Reservoir
2. Power Steering Pump
3. Cylinder Mounting Bolt
4. Control Valve And Drag Link Assembly
5. Axle Steering Arm
6. Vertical Socket Assembly
7. Tie-Rod Clamp
8. Tie-Rod Clamp Capscrews
9. Tie-Rod
10. Cylinder Assembly
11. Front Axle
12. Cylinder Mounting Bracket
13. Universal Block
14. Nylon-Inserted Self-Locking Nut
15. Steering Gear
16. Pitman Arm
17. Frame Rail

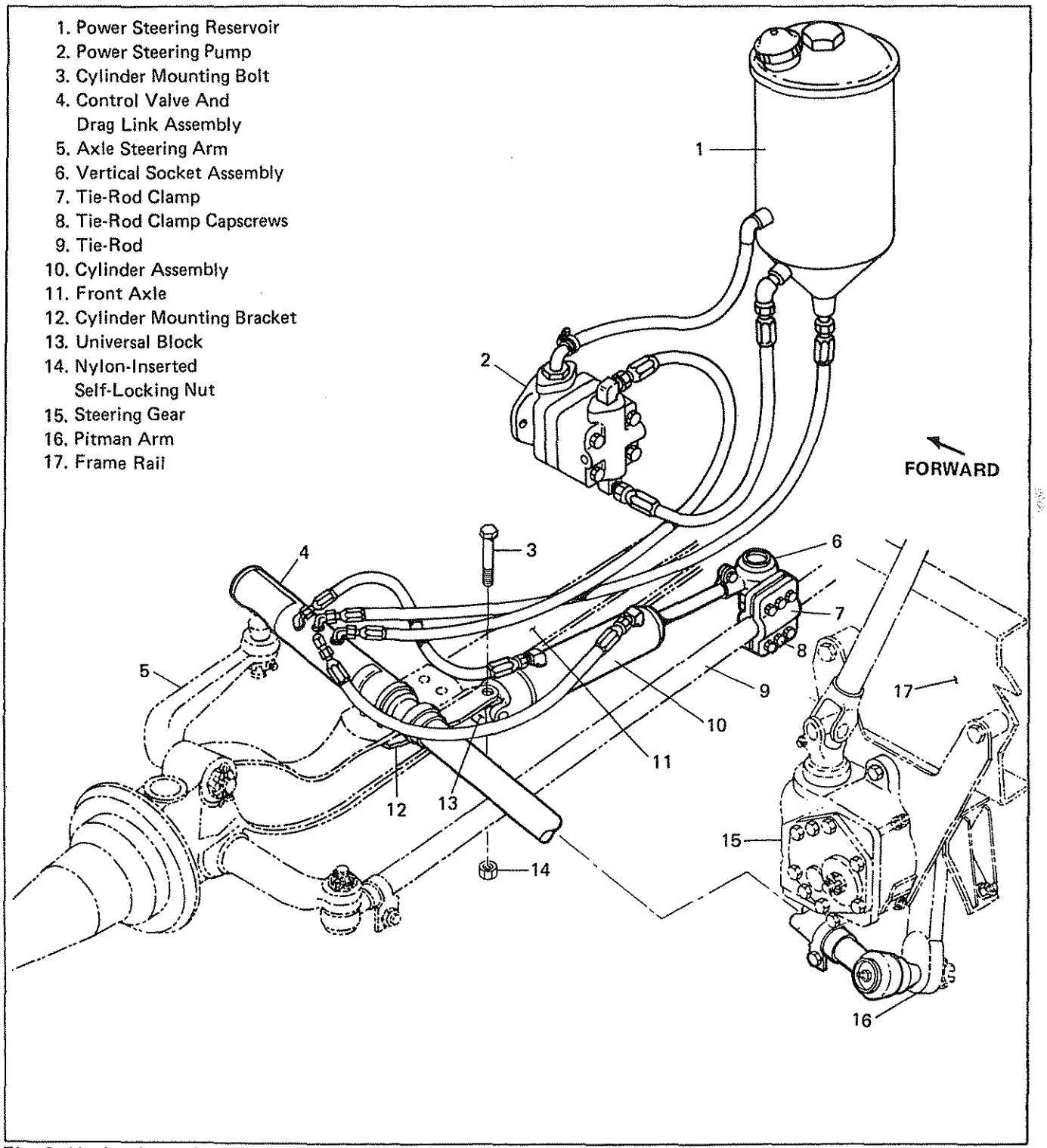
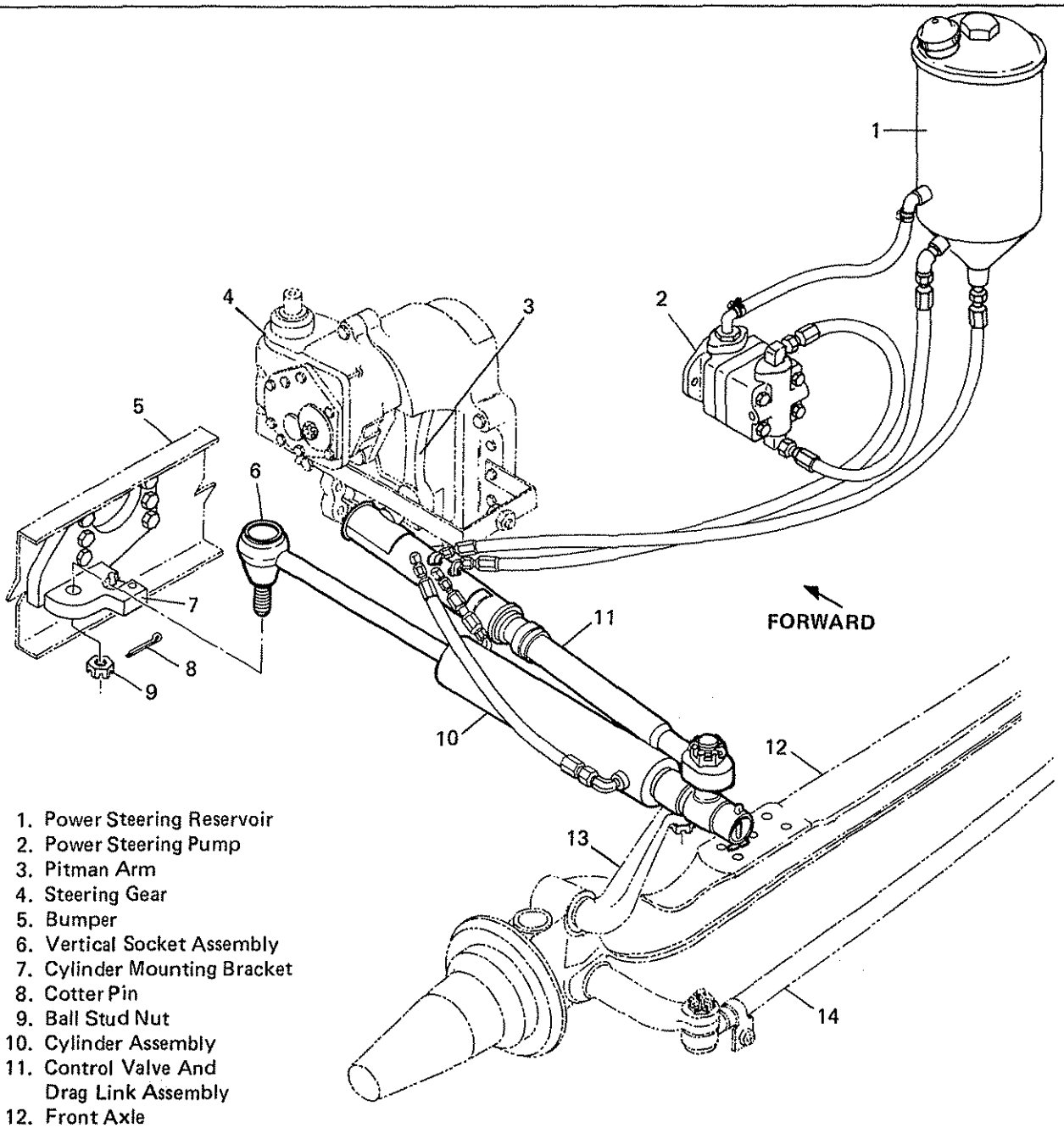


Fig. 3, Hydraulic Cylinder Installation, Conventional With Axle-Mounted Hydraulic Cylinder

GARRISON 2800 SERIES HYDRAULIC CYLINDER



1. Power Steering Reservoir
2. Power Steering Pump
3. Pitman Arm
4. Steering Gear
5. Bumper
6. Vertical Socket Assembly
7. Cylinder Mounting Bracket
8. Cotter Pin
9. Ball Stud Nut
10. Cylinder Assembly
11. Control Valve And Drag Link Assembly
12. Front Axle
13. Axle Steering Arm
14. Tie-Rod

Fig. 4, Hydraulic Cylinder Installation, COE With Frame-Mounted Hydraulic Cylinder

GARRISON 2800 SERIES HYDRAULIC CYLINDER

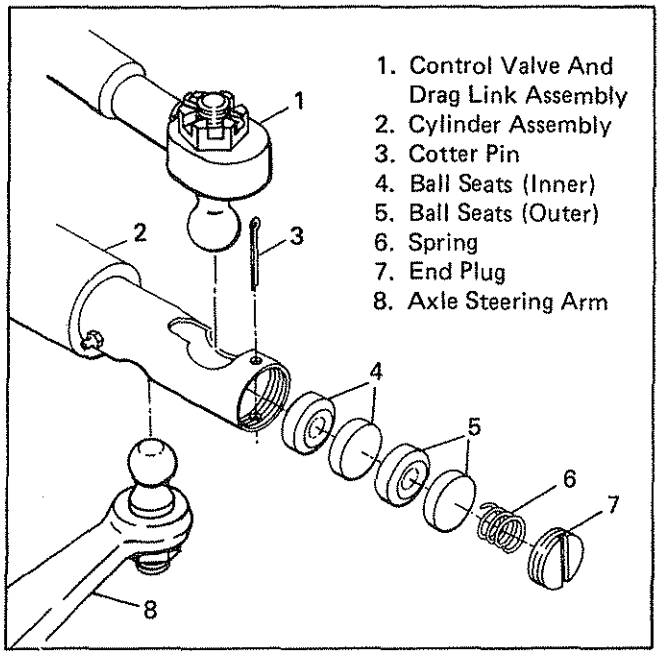


Fig. 5, Frame-Mounted Cylinder

Remove the cotter pin and nut from the vertical socket assembly located on the cylinder mounting bracket. Then, remove the vertical socket assembly using a ball stud removal tool (if available). If a ball stud removal tool is not available, apply removal pressure on the vertical socket assembly, and strike the cylinder bracket assembly in the ball stud area. Remove the cylinder from the vehicle.

DISASSEMBLY (Refer to Fig. 6)

1. Place the cylinder in a loosely clamped vise, then loosen the vertical socket assembly pinch bolt and nut. Remove the vertical socket assembly from the cylinder.

2. Remove the cylinder head snapring, then, push the cylinder head into the cylinder body about 1/2 inch (13 mm), and remove the cylinder body snapring.

3. As a unit, remove the cylinder head and the piston and rod assembly from the cylinder body by pulling the rod out of the cylinder. Remove the cylinder body from the vise.

4. Remove the cylinder head from the cylinder rod, then remove the cylinder head O-ring.

5. Remove the retaining ring from the cylinder head, then remove the "D-W" seal assembly and washer(s).

CLEANING AND INSPECTING (Refer to Fig. 6)

1. Thoroughly clean all parts in a petroleum-base solvent.

WARNING: Petroleum-base solvents may be flammable, toxic, or cause severe skin irritation. When using petroleum-base solvents, always comply with the solvent manufacturer's recommended safety precautions.

2. Examine the piston and piston rings for damage, and replace any worn or badly scored parts.

NOTE: The piston cannot be removed from the rod on those cylinders used in a frame-mounted installation (having a double socket end). If the piston is damaged, the piston and rod must be replaced as a unit.

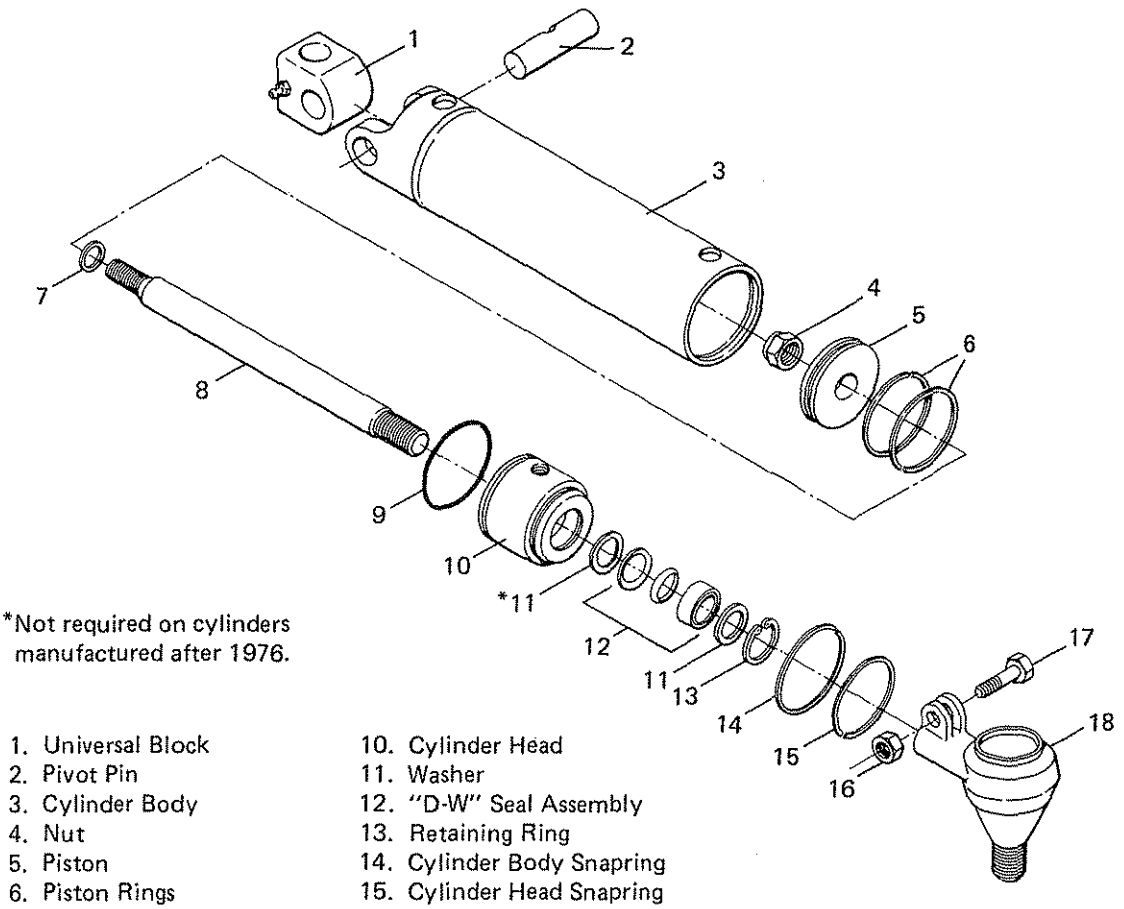
3. Examine the cylinder head O-ring for cuts or abrasions on the outer surface. Replace the O-ring if cuts or abrasions are present.

4. Examine the "D-W" seal assembly for worn, broken, or cut edges. If worn, broken, or cut edges are present, replace the "D-W" seal assembly.

5. Inspect the inner wall of the cylinder body for scoring. Light scratches on the cylinder wall can be removed by buffing with a crocus cloth.

6. On axle-mounted cylinders, check the universal block, cylinder mounting bolt, and pivot pin for wear, and replace worn parts. The cylinder

GARRISON 2800 SERIES HYDRAULIC CYLINDER



*Not required on cylinders manufactured after 1976.

1. Universal Block
2. Pivot Pin
3. Cylinder Body
4. Nut
5. Piston
6. Piston Rings
7. Copper Washer Seal
8. Cylinder Rod
9. Cylinder Head O-Ring
10. Cylinder Head
11. Washer
12. "D-W" Seal Assembly
13. Retaining Ring
14. Cylinder Body Snapring
15. Cylinder Head Snapring
16. Nut
17. Pinch Bolt
18. Vertical Socket Assembly

Fig. 6, Garrison 2800 Series Hydraulic Cylinder Nomenclature

mounting bolt should fit snugly in the universal block, and the pivot pin should fit snugly in the cylinder base and universal block. If free play is present between the universal block and the cylinder mounting bolt or pivot pin, replace the pivot pin and universal block as follows:

.1 Using a punch and hammer (or a press, if one is available), remove and discard the pivot pin from the cylinder base, then remove and discard the universal block.

.2 Place the new universal block in the cylinder base, then position the new pivot pin near one of the openings in the cylinder base. Make sure that the notch in the pivot pin aligns with the cylinder mounting bolt bore in the universal block. See Fig. 7. Using a punch and hammer (or a press, if one is available), install the pivot pin in the cylinder base and universal block.

GARRISON 2800 SERIES HYDRAULIC CYLINDER

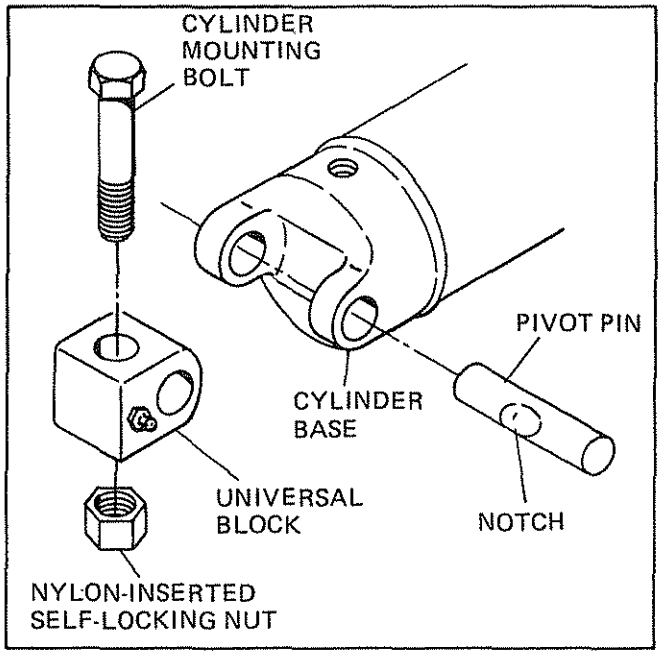


Fig. 7

ASSEMBLY (Refer to Fig. 6)

NOTE: Lubricate all seals and parts before assembly with the same lubricant used to fill the power steering reservoir. Refer to Chart 1, located under the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual, for lubricant specifications.

1. If the piston rings were removed, install new piston rings on the piston, with the ring openings opposite each other. If the piston was removed from the rod, replace the copper washer seal, then install the piston and nut, tightening the nut to 125-130 ft-lbs (170-176 N·m).

2. Using a ring compressor, install the piston and rod assembly in the cylinder body.

3. Position the washer(s) and "D-W" seal assembly in the cylinder head, then install the retaining ring that holds them in place.

4. Install the O-ring on the cylinder head, then lubricate the O-ring.

5. Using a crocus cloth, remove any rough edges from the inside surface of the port located near the cylinder head end of the cylinder body. Then, holding the O-ring firmly against the cylinder head, slowly install the cylinder head in the cylinder body. Use care to prevent damage to the O-ring as it passes the port in the body. Be sure that the port in the cylinder head aligns with the port in the body.

6. Install the cylinder body snapring in the cylinder body, then pull the cylinder rod outward to force the cylinder head against the snapring.

7. Install the cylinder head snapring on the cylinder head.

8. Install the vertical socket assembly on the end of the cylinder rod, engaging the threads of the cylinder rod a minimum of 1 1/2 inches (38 mm). Tighten the nut to 40-45 ft-lbs (54-61 N·m).

WARNING: Failure to engage the threads of the piston rod a minimum of 1 1/2 inches (38 mm), or to tighten the pinch bolt and nut to the specified torque value, could cause disengagement of the vertical socket assembly from the cylinder rod, resulting in a loss of vehicle control.

INSTALLATION (Refer to Figs. 2, 3, or 4)

1. Install the cylinder on the vehicle as follows:

   .1 On vehicles equipped with an axle-mounted hydraulic cylinder, lubricate the universal block at the fittings with a multipurpose chassis grease. Then, position the universal block to the cylinder mounting bracket. With the head of the bolt on top of the mounting bracket, install the bolt and nylon-inserted self-locking nut, tightening the nut to 70-90 ft-lbs (95-122 N·m).

GARRISON 2800 SERIES HYDRAULIC CYLINDER

Move the cylinder back and forth to insure free movement of the universal block within the cylinder mounting bracket.

WARNING: Lubricate the universal block, and do not exceed the given torque value when installing the bolt and nut that hold the universal block to the cylinder mounting bracket. Overtightening of the bolt and nut, or a failure to lubricate the universal block, may cause the universal block and cylinder mounting bracket to bind, preventing proper recovery of the steering system and resulting in difficult handling of the vehicle.

With the steering wheel in a full left turn position, and the cylinder rod fully extended, push the cylinder rod in 1/8 inch (3.2 mm) and place the tie-rod clamp on the tie-rod. Install the capscrews that hold it in place, tightening them to 90 ft-lbs (122 N·m).

NOTE: The tie-rod clamp should be placed at the same point on the tie-rod as previously marked. If the above procedures cause the tie-rod clamp to be placed at a different point on the tie-rod, it is possible that the tie-rod clamp had slipped out of its proper position during operation.

WARNING: When installing the tie-rod clamp on the tie-rod, make sure the cylinder lies in a horizontal plane. Failure to install the cylinder in this position could, during operation, allow an air pocket to develop within the cylinder, resulting in severe vehicle shimmy and difficult handling of the vehicle.

Failure to tighten the tie-rod clamp capscrews to the specified torque value could cause disengagement of the tie-rod clamp from the tie-rod, resulting in a loss of vehicle control.

Turn the steering wheel through a full left and right turn to make sure the cylinder does not contact the axle, tie-rod, or any axle or tie-rod mounted accessories. If contact is made, relocate the cylinder or other axle or tie-rod mounted accessories. Consult the Freightliner Service Department for specifications.

.2 On vehicles equipped with a frame-mounted hydraulic cylinder, place the vertical socket assembly in the cylinder mounting bracket (located on the front bumper). Install the nut, tightening it to 100 ft-lbs (136 N·m). Then, tighten the nut until the slot in the nut aligns with the hole in the ball stud. Install and lock a new cotter pin.

WARNING: Do not back off the nut when aligning the slot in the nut with the hole in the ball stud. Backing off the nut will result in a torque value lower than that specified. Failure to tighten the nut to the specified torque value, or to install and lock a new cotter pin, could cause disengagement of the vertical socket assembly from the cylinder mounting bracket, resulting in a loss of vehicle control.

Place the socket nearest the cylinder on the ball of the axle steering arm, then install the inner ball seats in the cylinder socket. Place the ball of the control valve and drag link assembly in the socket on top of the cylinder, then install the outer ball seats and spring in the cylinder socket. Install the end plug. See Fig. 5. Tighten the end plug until it "bottoms," then back it off until the nearest set of holes in the socket line up with the slot in the end plug. Install and lock a new cotter pin through the socket.

WARNING: Failure to install and lock a new cotter pin could cause disengagement of the cylinder from the axle steering arm, resulting in a loss of vehicle control.

2. Remove the plugs from the hydraulic lines, then connect the lines to the proper ports on the cylinder, as marked earlier, or as shown in Fig. 8 under "SPECIFICATIONS."

GARRISON 2800 SERIES HYDRAULIC CYLINDER

3. Clean the area around the power steering reservoir dipstick (fill cap) with a clean rag, then remove the dipstick (fill cap). Fill the power steering reservoir to the "full" mark on the dipstick. Refer to Chart 1, located under the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lube Manual, for lubricant specifications.

   Let the fluid remain undisturbed for about two minutes, then bleed air from the hydraulic system as follows:

CAUTION: When bleeding air from the hydraulic system, failure to keep the power steering reservoir fluid level maintained at the "full" mark on the dipstick could result in damage to the power steering pump and improper operation of the power steering system.

   .1 Turn the steering wheel through full left and right turns to eliminate any air pockets in the cylinder, adding fluid to the reservoir as needed. Continue this operation until the fluid in the reservoir stops bubbling.

   .2 Start the engine and run it at low idle for two minutes, adding fluid to the reservoir as needed. Then, turn the steering wheel through a full left and right turn. Check the fluid level in the reservoir, adding more fluid if necessary. Check the hoses and fittings for leaks, and replace leaking hoses and tighten loose fittings as necessary. Turn the steering wheel through a full left and right turn again, and check the fluid in the reservoir. Continue this operation until the fluid in the reservoir is maintained at the "full" mark on the dipstick.

   .3 Increase the engine speed to approximately 1500 RPM, and operate at this speed until no air bubbles appear in the reservoir, maintaining the fluid level at the "full" mark on the dipstick. Turn the steering wheel through a full left and right turn.

   .4 Lower the vehicle, then turn the steering wheel through a full left and right turn again. Check the hoses and fittings for leaks, and replace leaking hoses and tighten loose fittings as necessary.

   .5 Check the fluid level in the reservoir, and add more fluid if necessary.

CAUTION: During operation, failure to keep the power steering reservoir fluid level maintained at the "full" mark on the dipstick could result in damage to the power steering pump and improper operation of the power steering system.

4. Complete the operation checks given under the subject "POWER STEERING GENERAL INFORMATION," in this manual, before placing the vehicle in service.

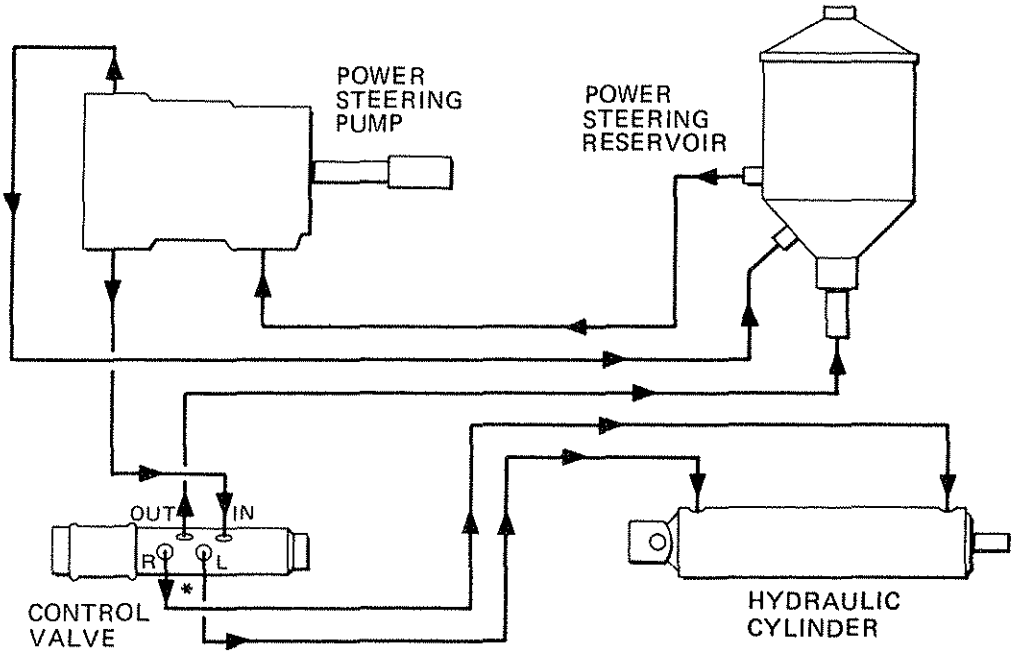
5. Remove the chocks from the vehicle tires.

GARRISON 2800 SERIES HYDRAULIC CYLINDER

SPECIFICATIONS

DESCRIPTION	SIZE	GRADE	TORQUE	
			FT-LBS	N·m
Piston To Cylinder Rod Nut	3/4-16	—	125-130	170-176
Vertical Socket Assembly To Cylinder Rod Nut	3/8-24	C	40-45	54-61
Universal Block To Cylinder Mounting Bracket Nylon-Inserted Self-Locking Nut	7/8-14	B	70-90	95-122
Tie-Rod Clamp Capscrews	1/2-20	—	90	122
Vertical Socket Assembly To Cylinder Mounting Bracket Nut	7/8-14	C	100	136

Table 1, Torque Specifications



*NOTE: Connections are reversed on COE vehicles equipped with a frame-mounted hydraulic cylinder, and on Conventional vehicles equipped with an axle-mounted hydraulic cylinder.

Fig. 8, Plumbing Diagram

VICKERS POWER STEERING PUMP, V200 SERIES

GENERAL DESCRIPTION

Vickers V200 series pumps (Fig. 1) are used to develop hydraulic fluid flow for the operation of mobile equipment. The positive displacement pumping cartridges are the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump size and the speed at which it is driven.

The unit consists principally of a ported body and cover, a drive shaft supported by two ball bearings, a pumping cartridge, and a pressure plate. See Fig. 1. The components of the cartridge are an elliptical cam ring, a slotted rotor splined to fit the drive shaft, and twelve vanes fitted to the rotor slots. As the rotor is driven by the drive shaft, the vanes generate fluid flow by carrying fluid around the elliptical cam ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate to the outlet port in the cover.

The cover contains an integral flow control and relief valve, which limits the fluid flow in the system to a maximum prescribed rate and prevents excessive pressure build-up. Fluid not required in the system is recirculated to the reservoir.

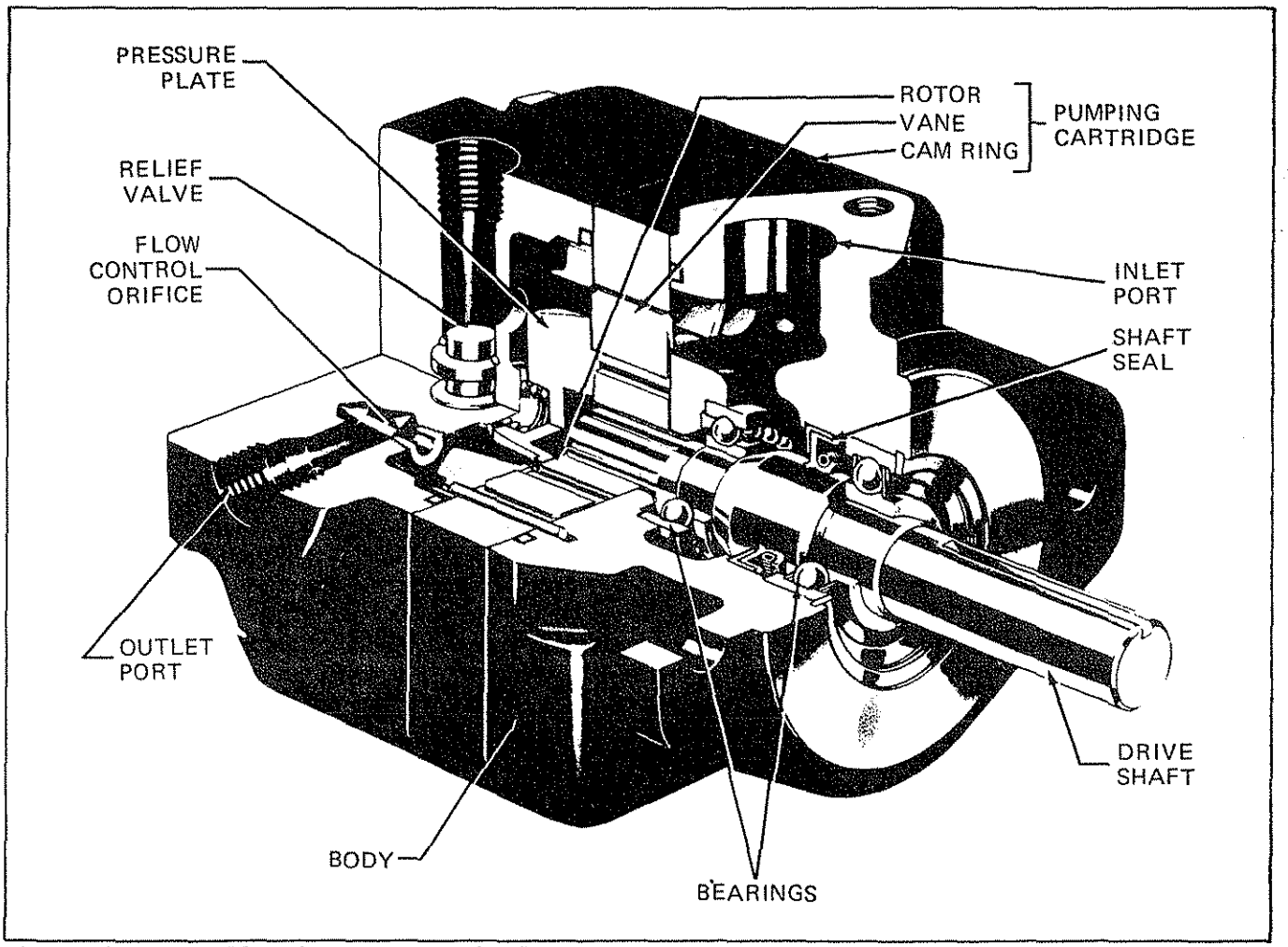


Fig. 1, Vicker's V200 Series Power Steering Pump

VICKERS POWER STEERING PUMP, V200 SERIES

PRINCIPLES OF OPERATION

PUMPING CARTRIDGE

Fluid flow is developed in the pumping cartridge, as shown in Fig. 2. The rotor is driven within the cam ring by the drive shaft, which is coupled to the engine accessory drive. As the rotor turns, centrifugal force on the vanes causes them to follow the elliptical inner surface of the cam ring.

Radial movement of the vanes and turning of the rotor cause the chamber volume between the vanes to increase as the vanes pass the inlet sections of the cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the cam ring. As the outlet section is approached, the ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

HYDRAULIC BALANCE

The pump cam ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft cancel each other out.

PRESSURE PLATE

The pressure plate seals the pumping chamber. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

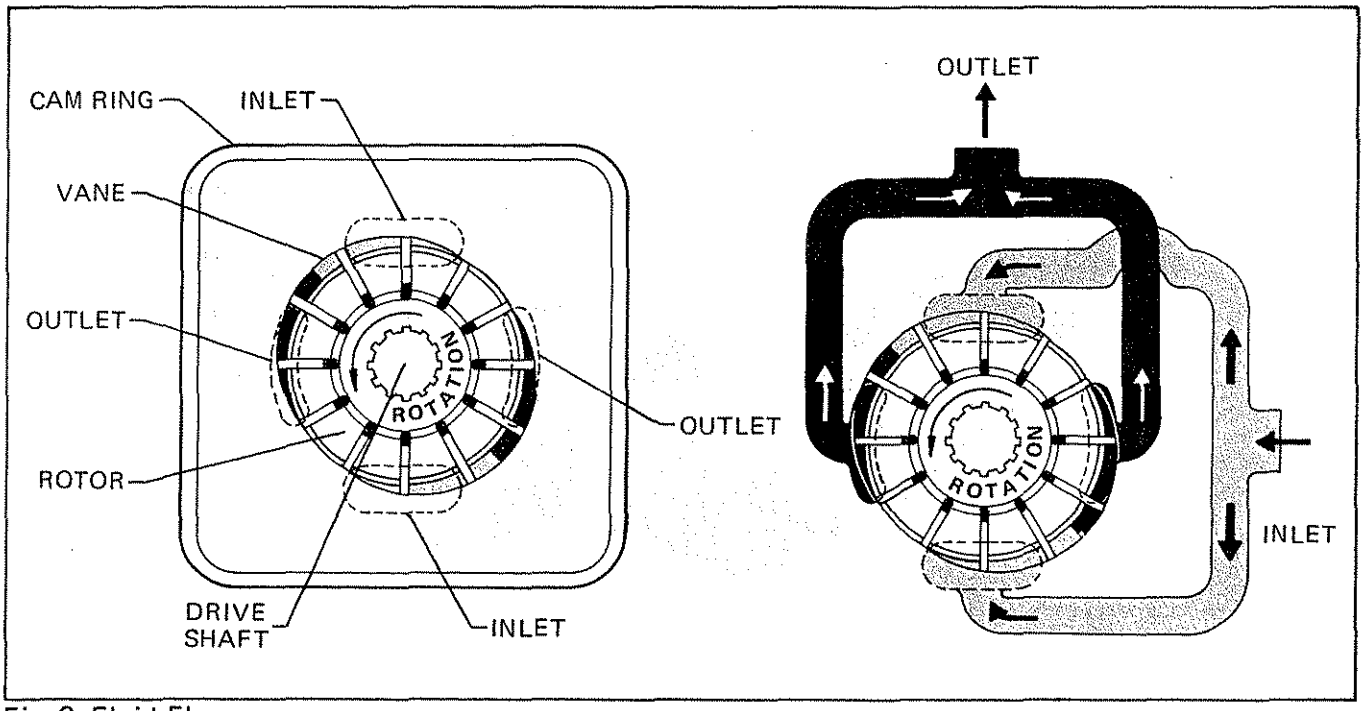


Fig. 2, Fluid Flow

VICKERS POWER STEERING PUMP, V200 SERIES

FLOW CONTROL AND RELIEF VALVE

Maximum pump delivery and maximum system pressure are determined by the integral flow control and relief valve in the cover of the pump. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to reservoir, thus limiting the system pressure to a prescribed maximum.

To determine the system pressure setting for a particular pump, locate the pump model number on the pump cover. This number is explained in Table 2, located under "SPECIFICATIONS."

Figure 3 shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the outlet port through an orifice. Pressure in this chamber equalizes pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the reservoir port by the spool land.

When pump delivery is more than the flow rate determined by the orifice, pressure builds up across the orifice and forces the spool open against the light spring. Excess fluid is throttled past the spool to the reservoir port as shown in Fig. 4.

If pressure in the system builds up to the relief valve setting, the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to the reservoir. This flow through the small sensing orifice causes a pressure drop and prevents pressure in the large spring area from increasing beyond the relief valve setting. As

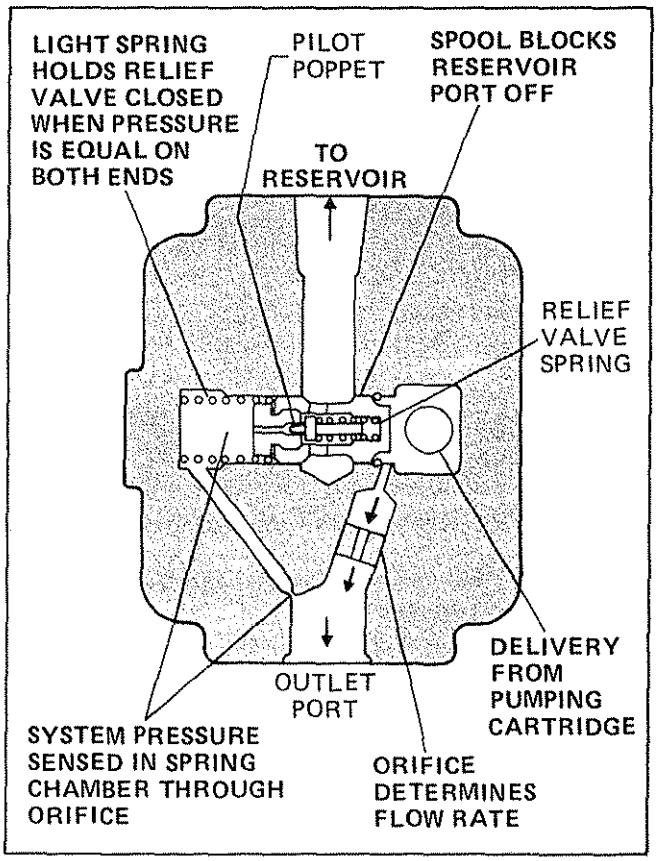


Fig. 3

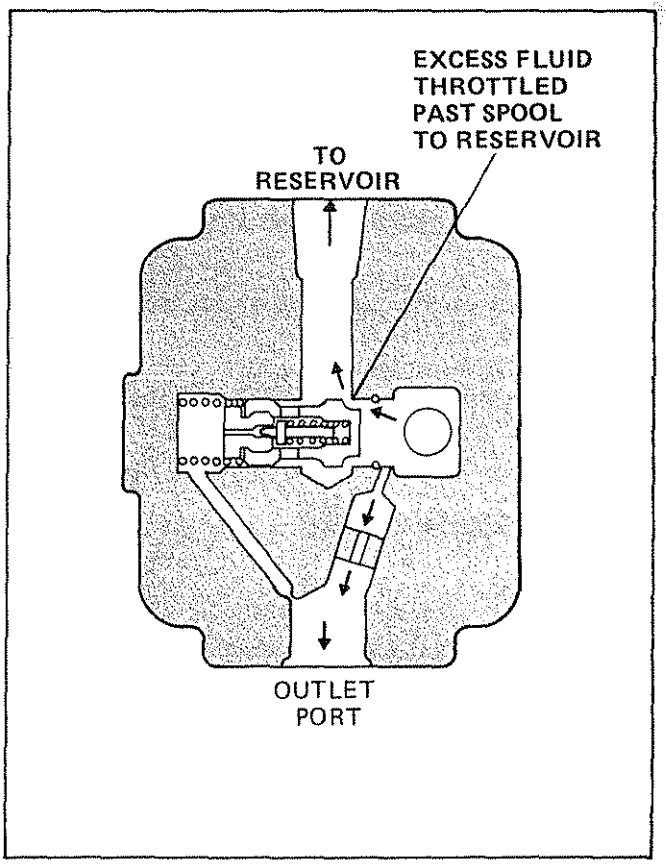


Fig. 4

VICKERS POWER STEERING PUMP, V200 SERIES

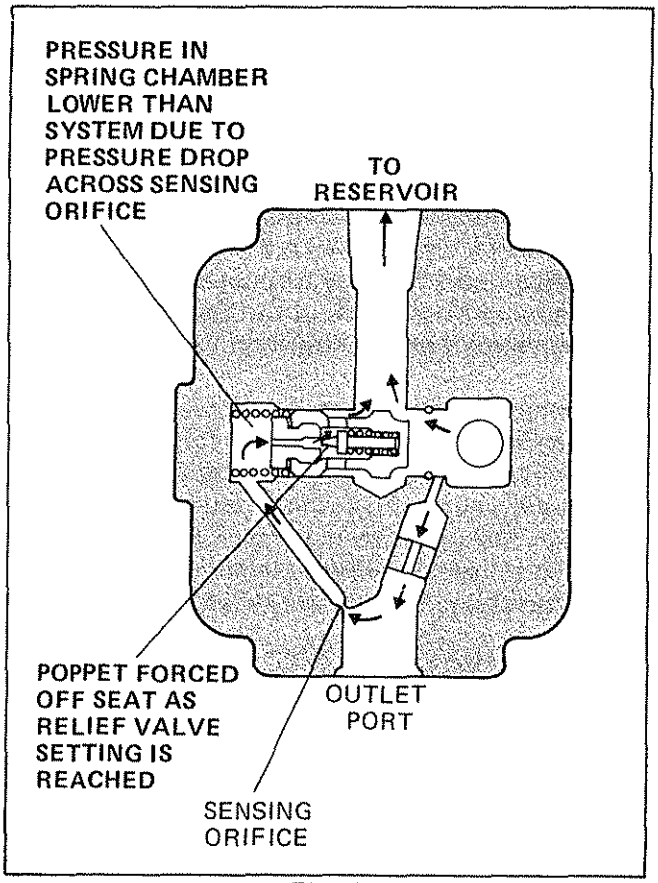


Fig. 5

pressure against the right end of the spool starts to exceed the relief valve setting, the pressure differential forces the spool to the left, against the light spring, porting the full pump flow to the reservoir. See Fig. 5.

SERVICE OPERATIONS

REMOVAL

Cummins And Caterpillar Engines

1. Disconnect all hydraulic lines from the pump, marking the lines for correct assembly later. Seal off the lines and the pump ports to prevent oil from leaking out of the lines and to prevent dirt from entering the lines or the pump.
2. Remove the two nuts or capscrews that attach the pump to the engine accessory drive mounting.
3. Slide the pump out of the shaft coupling, or gear.

Detroit Diesel Engines

1. Disconnect all hydraulic lines from the pump, marking the lines for correct assembly later. Seal off the lines and the pump ports to prevent oil from leaking out of the lines and to prevent dirt from entering the lines or the pump.
2. Remove the nuts attaching the pump to the accessory drive housing. Remove the pump with the drive gear attached.
3. Remove the nut locking the drive gear to the pump shaft. Remove the gear.

DISASSEMBLY (Refer to Fig. 6)

NOTE: Pump bearings are pressed in the bodies or on the shafts and should not be removed unless defective.

Basic Pump

1. Clamp the pump body in a vise, cover end up, and remove the four cover screws. Note the position of the outlet port with respect to the inlet port, then lift off the cover and O-ring.

CAUTION: Do not damage the pump with excessive clamping pressure.

2. Remove the pressure plate and spring. Note the position of the cam ring for correct assembly later. Lift off the cam ring and remove the locating pins.
3. Separate the vanes from the rotor, and remove the rotor from the shaft.

VICKERS POWER STEERING PUMP, V200 SERIES

4. Turn the pump body over, and remove the shaft key and the snapring which retains the outer bearing.

5. Tap with a soft hammer on the cover end of the shaft to force the shaft out of the body.

6. Support the bearing inner race and press the shaft out of the outer bearing.

7. Pull the shaft seal out of the body with a suitable hooked tool, and press out the inner bearing.

Flow Control Cover

Remove the plug in the cover that allows access to the spring and the relief valve subassembly. Remove the spring and the relief valve subassembly.

NOTE: The plug is located 90° clockwise from the outlet port when looking at the cover end of the pump. See Fig. 6.

CAUTION: Do not remove the other plugs located in the cover. The snapring and screen located behind the plugs may be damaged if they are removed from the unit.

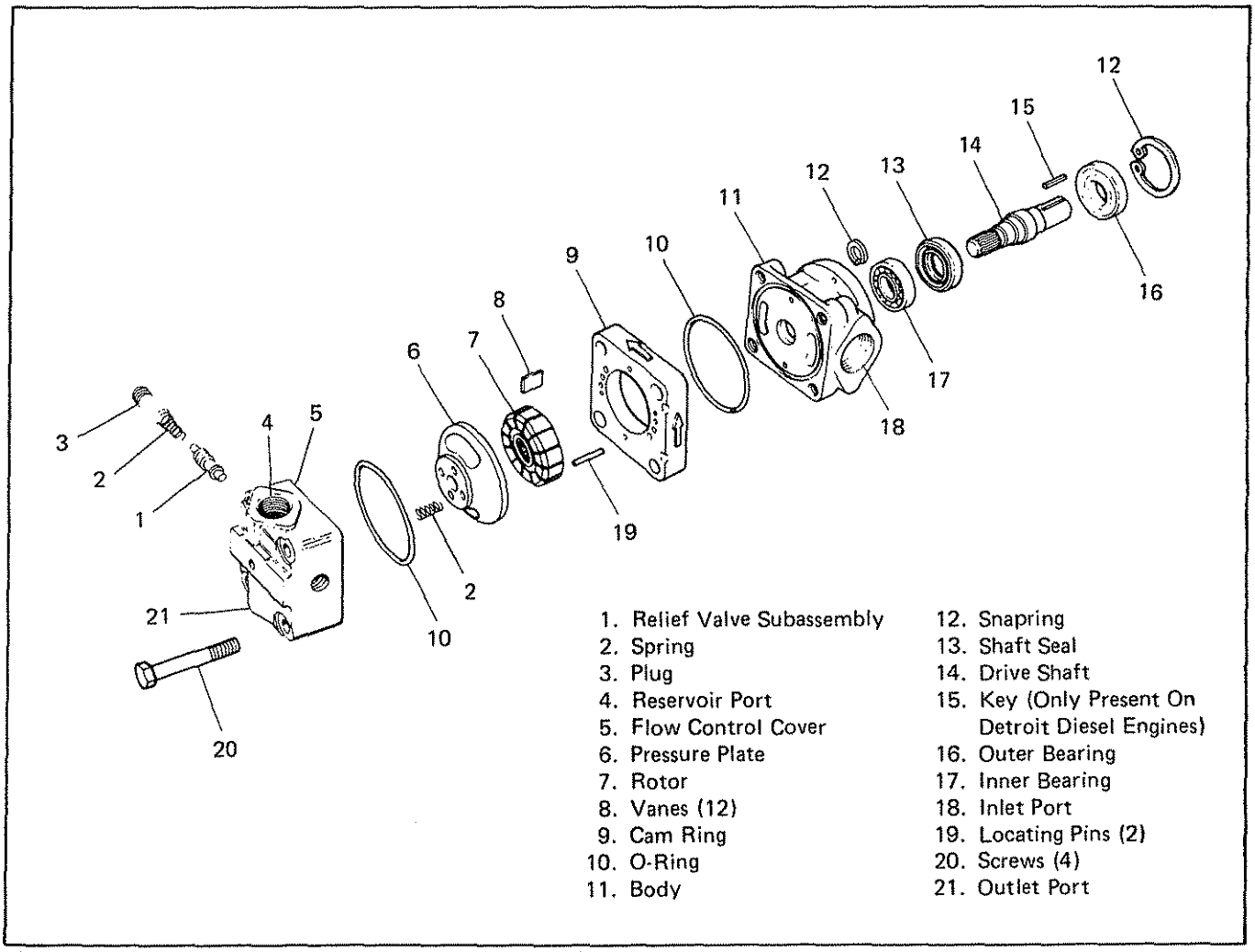


Fig. 6, V200 Series Power Steering Pump Nomenclature

VICKERS POWER STEERING PUMP, V200 SERIES

INSPECTION (Refer to Fig. 6)

1. Discard the used shaft seal and all O-rings. Wash the metal parts in mineral oil solvent, blow them dry with filtered compressed air, and place them on a clean surface for inspection.

CAUTION: All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement more stringent than usual. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spools, orifices, and cover passages.

2. Check the wearing surfaces of the body, pressure plate, cam ring, and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

3. Inspect the vanes for burrs, wear, and excessive play in the rotor slots. Replace the rotor if the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races. Replace worn, loose, or damaged bearings.

5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Check the relief valve subassembly for free movement in the cover bore. Remove burrs from the valve by polishing, but do not round off the corners of the lands. Do not attempt to rework the valve bore. If the bore is damaged, replace the cover.

CAUTION: Do not disassemble the relief valve subassembly. The unit is factory set and could malfunction if disassembled.

ASSEMBLY (Refer to Fig. 6)

General

Coat all parts with hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold O-rings in place during assembly.

IMPORTANT: During handling and shipping of the precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be lightly dressed with a stone prior to installation.

Flow Control Cover

Insert the valve in the bore, small land first. Then install the spring and plug.

Basic Pump

1. Press the shaft into the outer bearing while supporting the bearing inner race. Next, press the inner bearing into the body, using a driver which contacts the outer race only.

NOTE: Before installing the shaft seal, determine the correct position of the sealing lip. See Fig. 7.

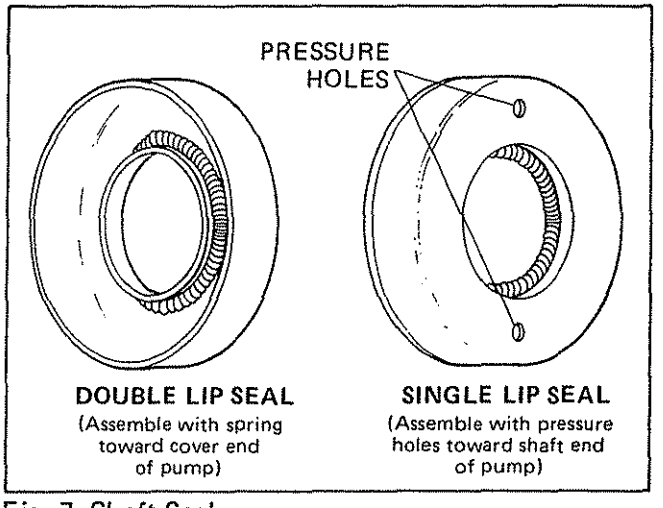


Fig. 7, Shaft Seal

VICKERS POWER STEERING PUMP, V200 SERIES

Double lip seals are installed with the spring toward the pumping cartridge. Single lip seals have two pressure holes, which are installed toward the shaft end of the pump.

2. Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid.

3. Slide the drive shaft into the body until the bearing is seated. Tap lightly on the end of the shaft if necessary. Install the snapring.

NOTE: If the snapring cannot be installed, the inner or outer bearing may not be firmly seated. Make certain both bearings are firmly seated before attempting to install the snapring.

4. Install new O-rings in the body and cover. Insert the cam ring locating pins in the body and install the cam ring so that the arrow on the perimeter points in the proper direction of rotation. See Fig. 8.

NOTE: To determine the proper direction of rotation for a particular pump, locate the pump model number on the pump cover. This number is explained in Table 2, located under "SPECIFICATIONS."

WARNING: Pumps must be driven in the direction of the arrows cast on the pump cam ring. Never drive a pump in the wrong direction of rotation, or seizure may result. This will necessitate expensive repairs and could result in a sudden, unexpected loss of power steering assist.

5. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

6. Place the pressure plate on the locating pins, flat against the cam ring. Use a small amount of petroleum jelly or grease to stick the spring in the recess in the pressure plate.

7. Carefully install the cover with the outlet port in the correct position. Outlet position codes are found in Table 2, located under "SPECIFICATIONS," and are described in Fig. 9.

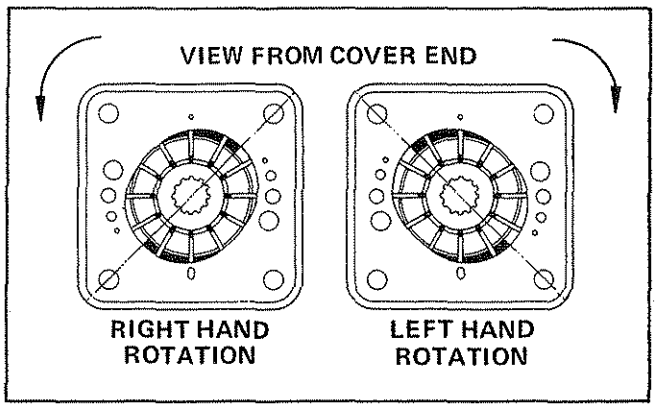


Fig. 8, Cam Ring Positions

8. Install the cover screws and tighten them to 70±5 ft-lbs (95±7 N·m).

9. Turn the shaft through by hand to insure that there is no internal binding. If binding occurs, the cause must be found and corrected before the pump is operated.

WARNING: Failure to correct binding could result in damage to the pump, which could result in a sudden, unexpected loss of power steering assist.

10. Install the shaft key, if present.

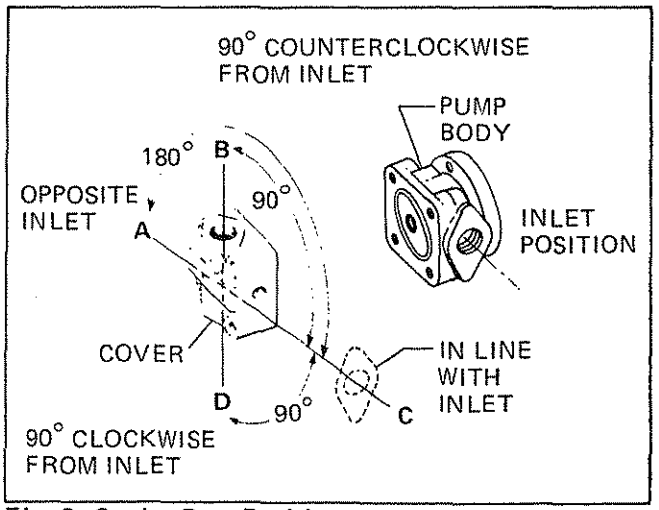


Fig. 9, Outlet Port Positions

VICKERS POWER STEERING PUMP, V200 SERIES

INSTALLATION

General

WARNING: Failure to observe the following recommendations could result in damage to the pump, possibly resulting in a sudden, unexpected loss of power steering assist.

A pilot on the pump mounting flange assures correct mounting and shaft alignment, provided the pilot is firmly seated in the accessory mount of the engine. Care should be exercised in tightening all flange mounting screws to prevent misalignment.

If gaskets are used between flanges, they should be installed carefully so as to lay flat. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

Cummins And Caterpillar Engines

1. Lightly lubricate the shaft for ease of assembly, then slide the shaft into the coupling or gear, lining up the flange holes with those on the adaptor.

CAUTION: Vickers pump shafts are designed to be installed in couplings with a slip fit or a very light tap. Pounding can injure the bearings and cause pump damage, which could result in a sudden, unexpected loss of power steering assist.

2. Install the capscrews or nuts (and lockwashers, if present) attaching the pump to the engine accessory drive mounting. Tighten them to 27-37 ft-lbs (37-50 N·m).

3. Remove the plugs from pump and lines, and make certain no dirt or foreign matter has entered the lines or the pump. Connect the hydraulic lines to the pump as previously marked.

CAUTION: All hydraulic connections must be kept tight. A loose connection in a pressure line will cause fluid to leak out. If fluid becomes so low as to uncover the inlet line opening in the reservoir, extensive damage to the pump may result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

WARNING: Low fluid, resulting in pump damage, or trapped air, resulting in erratic operation, could result in a sudden, unexpected loss of power steering assist.

4. Follow the instructions given under "Starting The Pump After Repairs" in this subject before operating the vehicle.

Detroit Diesel Engines

1. Make sure the shaft key is in place, then slide the gear onto the drive shaft and lock it in place with the shaft nut. Tighten the shaft nut to 90-100 ft-lbs (122-136 N·m).

2. Install the pump, with gear attached, onto the accessory drive adapter. Install the mounting nuts and tighten them to 24 ft-lbs (33 N·m).

3. Remove plugs from pump and lines, and make certain no dirt or foreign matter has entered the lines or the pump. Connect the hydraulic lines to the pump as previously marked.

CAUTION: All hydraulic connections must be kept tight. A loose connection in a pressure line will cause fluid to leak out. If fluid becomes so low as to uncover the inlet line opening in the reservoir, extensive damage to the pump may result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

WARNING: Low fluid, resulting in pump damage, or trapped air, resulting in erratic operation, could result in a sudden, unexpected loss of power steering assist.

VICKERS POWER STEERING PUMP, V200 SERIES

4. Follow the instructions given under "Starting The Pump After Repairs" in this subject before operating the vehicle.

Starting The Pump After Repairs

Fill the power steering reservoir to the full mark, using the fluid recommendations in Table 1 of this section and in the Freightliner Maintenance and Lube Manual. Operate the engine for a few minutes, allowing the pump to prime.

With a minimum drive speed of 600 RPM, a pump should prime almost immediately, if provision is made to initially purge the air from the system. Inlet lines must be tight and free from air leaks. However, it may be necessary to slightly open a fitting on the outlet side of the pump to purge entrapped air.

CAUTION: Failure to prime within a reasonable length of time may result in damage due to lack of lubrication.

After priming the pump, check the power steering reservoir and add more fluid if necessary.

WARNING: A pump wh is running excessively hot or noisy is a potentia ailure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected. Failure to do this could result in a sudden, unexpected loss of power steering assist.

Flexible Hose

The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

Hoses must have enough slack to allow for movement between components, and hoses must be secured to prevent rubbing against moving parts during operation.

WARNING: Failure to follow the above recommendations could result in hose damage, which could result in a sudden, unexpected loss of power steering assist.

SPECIFICATIONS

The following table summarizes oil types recommended for use with Vickers equipment in mobile hydraulic systems by viscosity and service classification.

The temperatures shown in table are cold start-up to maximum operating temperatures. Suitable procedures must be followed to insure adequate lubrication during system warmup.

Where special conditions indicate a need to depart from the recommended oils or operating conditions, see your Sperry Vickers representative.

Hydraulic System Operating Temperature Range (Min* to Max)		SAE Viscosity Designation	American Petroleum Institute (API) Service Classification
°F	°C		
0 to 180	-18 to 82	10W	SE, SC, SD
0 to 210	-18 to 99	10W-30 or 10W-40**	SE, SC, SD
50 to 210	10 to 99	20-20W	SE, SC, SD

Table 1, Hydraulic Fluid Recommendations

*Ambient Start Up Temperatures

**Viscosity index reflects the way viscosity changes with temperature. The smaller the viscosity change, the higher the viscosity index. The viscosity index of hydraulic system oil should not be less than 90. Multiple viscosity oils, such as SAE 10W-30 or 10W-40, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both temporary and permanent decrease in viscosity due to the oil shear encountered in the operating hydraulic system. Accordingly, when such oils are selected, it is desirable to use those with high shear stability to insure that viscosity remains within recommended limits.

VICKERS POWER STEERING PUMP, V200 SERIES

SPECIFICATIONS (Continued)

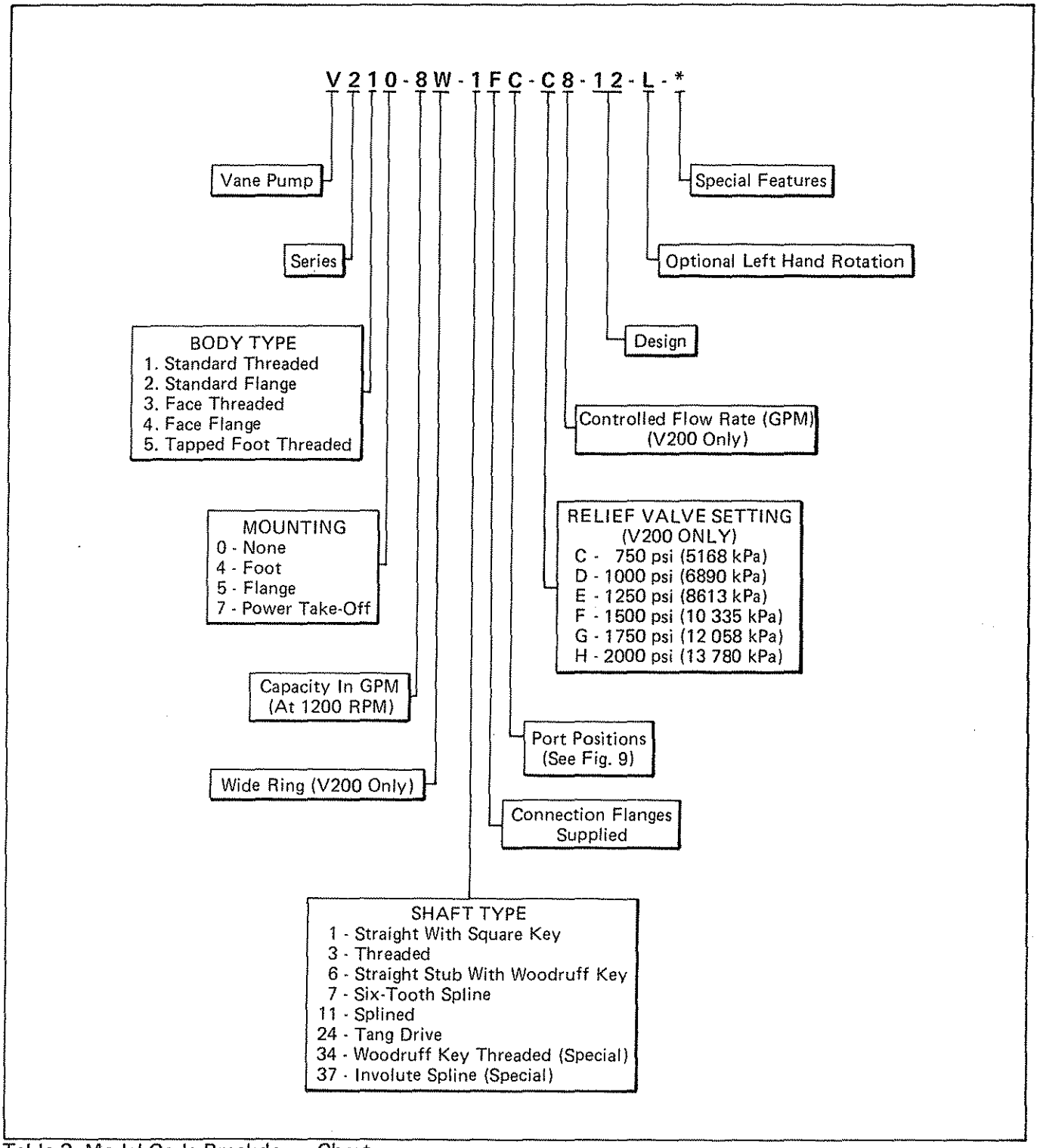


Table 2, Model Code Breakdown Chart

VICKERS POWER STEERING PUMP, V200 SERIES

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Pump Not Delivering Fluid	Driven in the wrong direction of rotation.	The drive direction must be changed immediately to prevent seizure. Fig. 8 shows the correct ring position for each direction of rotation.
	Coupling or shaft sheared or disengaged.	Disassemble the pump and check the shaft and cartridge for damage. Replace the necessary parts.
	Fluid intake pipe in reservoir restricted.	Check all strainers and filters for dirt and sludge. Clean, if necessary.
	Fluid viscosity too heavy to pick up prime.	Completely drain the system. Add new filtered fluid of the proper viscosity. See Table 1 under "SPECIFICATIONS."
	Air leaks at the intake. Pump not priming.	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is at the full mark. Check the minimum drive speed which may be too slow to prime the pump.
	Relief valve stuck open. (Models with integral relief valve only.)	Disassemble the pump and wash the valve and cover in clean solvent. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump.

(Continued on next page)

VICKERS POWER STEERING PUMP, V200 SERIES

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Pump Not Delivering Fluid (Cont.)	Vane(s) stuck in the rotor slot(s).	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. Flush the sys tem and refill it with clean fluid.
Insufficient Pressure Build-Up	Worn parts causing internal leakage of pump delivery.	Replace pump cartridge.
Pump Making Noise	Pump intake partially blocked.	Service the intake strainers. Check the fluid condition and drain and flush the system. Refill with clean fluid.
	Air leaks at the intake or shaft seal. (Oil in reservoir would probably be foamy.)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is at the full mark.

VICKERS POWER STEERING PUMP, V20 SERIES

GENERAL DESCRIPTION

Vickers V20 series pumps (Fig. 1) are used to develop hydraulic fluid flow for the operation of mobile equipment. The positive displacement pumping cartridges are the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump size and the speed at which it is driven.

The unit consists principally of a ported body and cover, with a pumping cartridge supported between a ball bearing and a bushing by the drive shaft. The ball bearing is located in the body and the bushing is pressed into the pressure plate. See Fig. 1. The components of the cartridge are an elliptical cam ring, a slotted rotor splined to fit the drive shaft, and twelve vanes fitted to the rotor slots. As the rotor is driven by the drive shaft, the vanes generate fluid flow by carrying fluid around the elliptical cam ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate to the outlet port in the cover.

The cover contains an integral flow control and relief valve, which limits the fluid flow in the system to a maximum prescribed rate and prevents

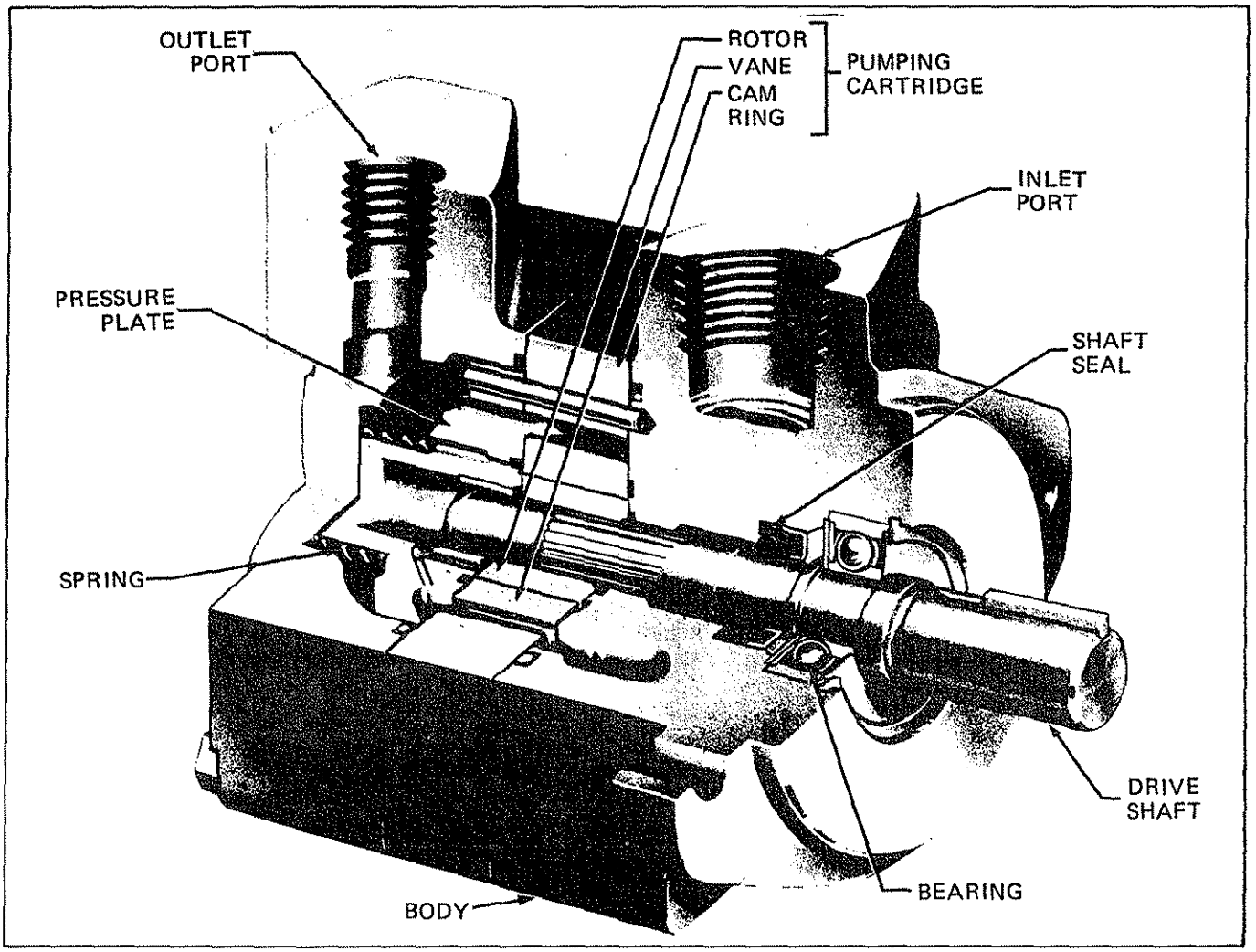


Fig. 1, Vickers V20 Series Power Steering Pump

VICKERS POWER STEERING PUMP, V20 SERIES

excessive pressure build-up. Fluid not required in the system is recirculated to the reservoir.

PRINCIPLES OF OPERATION

PUMPING CARTRIDGE

Fluid flow is developed in the pumping cartridge, as shown in Fig. 2. The rotor is driven within the cam ring by the drive shaft, which is coupled to the engine accessory drive. As the rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the cam ring.

Radial movement of the vanes and turning of the rotor cause the chamber volume between the vanes to increase as the vanes pass the inlet sections of the cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the cam ring. As the outlet section is approached, the cam ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

HYDRAULIC BALANCE

The pump cam ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft are cancelled.

PRESSURE PLATE

The pressure plate seals the pumping chamber. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

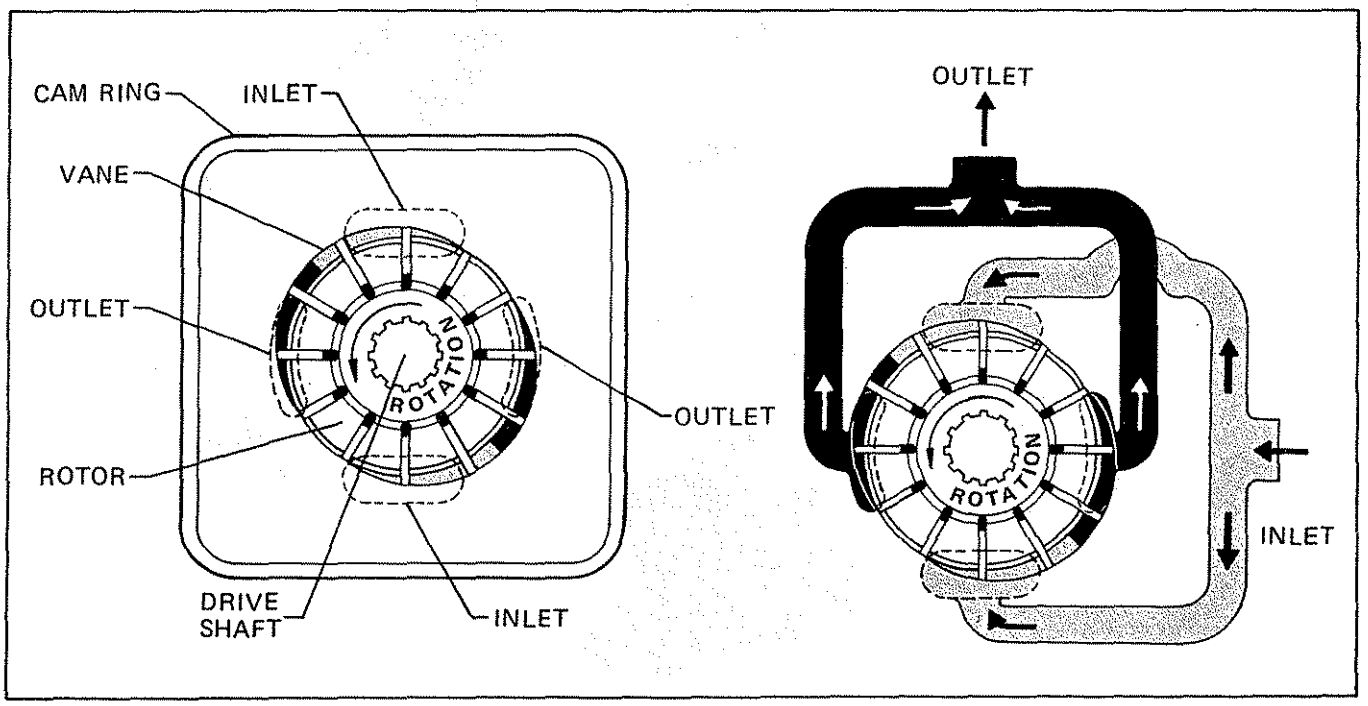


Fig. 2, Fluid Flow

VICKERS POWER STEERING PUMP, V20 SERIES

FLOW CONTROL AND RELIEF VALVE

Maximum flow to the operating circuit and maximum system pressure are determined by the integral flow control and relief valve in the cover of the pump. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to reservoir, thus limiting the system pressure to a pre-determined maximum.

To determine the system pressure setting for a particular pump, locate the pump model number on the pump cover. This number is explained in Table 2, located under "SPECIFICATIONS."

Figure 3 shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds.

The large spring chamber is connected to the outlet port through an orifice. Pressure plus spring load in this chamber slightly exceeds pressure at the other end of the relief valve spool and the spool remains closed. Pump delivery is blocked from the reservoir port by the spool land.

When pump delivery is more than the flow rate determined by the orifice, pressure builds up across the orifice and forces the spool open against the light spring. Excess fluid is throttled past the spool to the reservoir port as shown in Fig. 4.

If pressure in the system builds up to the relief valve setting, the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to the reservoir. This flow through the small sensing orifice, causes a pressure drop and prevents pressure in the large spring area from

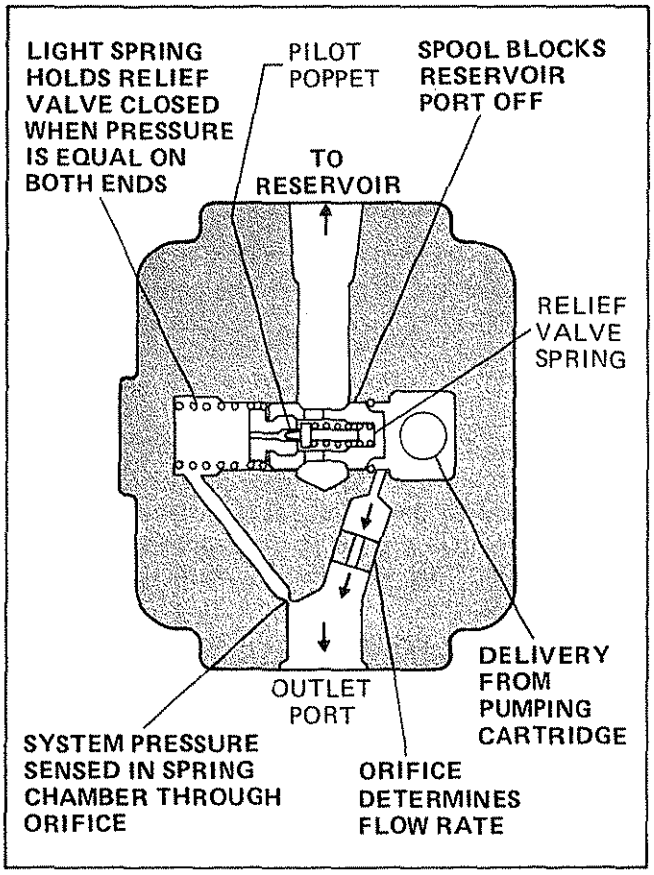


Fig. 3

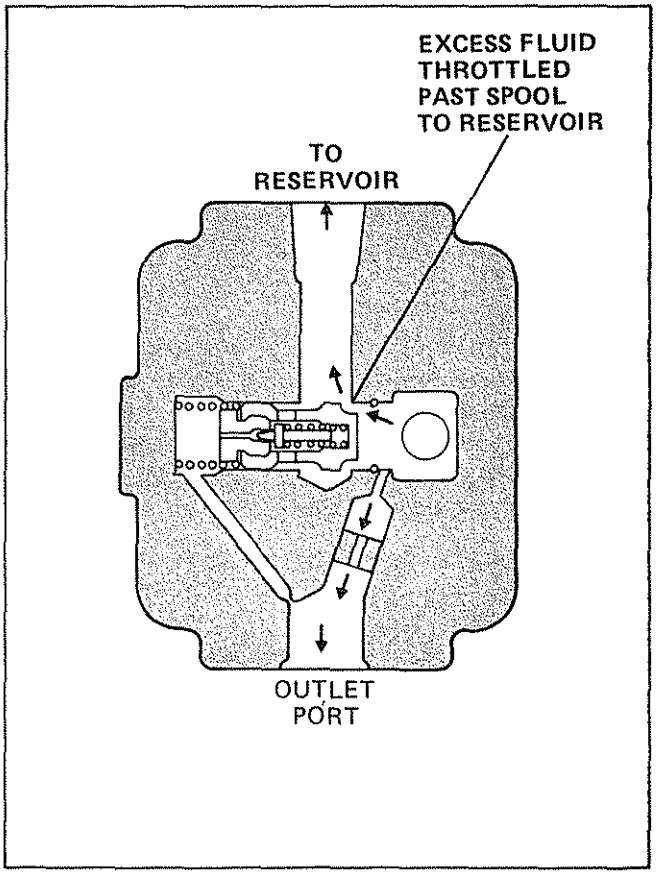


Fig. 4

VICKERS POWER STEERING PUMP, V20 SERIES

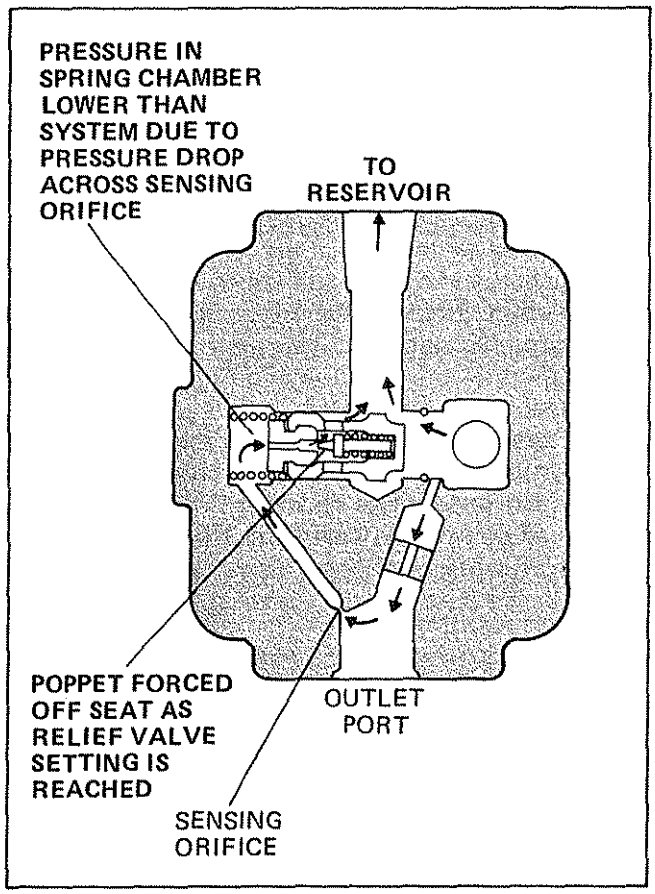


Fig. 5

increasing beyond the relief valve setting. As pressure against the right end of the spool starts to exceed the relief valve setting, the pressure differential forces the spool to the left, against the light spring, porting the full pump flow to the reservoir. See Fig. 5.

SERVICE OPERATIONS

REMOVAL

Cummins And Caterpillar 3406 Engines

1. Disconnect all hydraulic lines from the pump, marking the lines for correct assembly later. Seal off the lines and the pump ports to prevent oil from leaking out of the lines and to prevent dirt from entering the lines or the pump.

2. Remove the two bolts (or nuts) and lockwashers attaching the pump to the engine accessory drive mounting.

3. Slide the pump out of the shaft coupling (or gear). The pump is now ready for disassembly.

Detroit Diesel And Caterpillar 3408 Engines

1. Disconnect all hydraulic lines from the pump, marking the lines for correct assembly later. Seal off the lines and the pump ports to prevent oil from leaking out of the lines and to prevent dirt from entering the lines or the pump.

2. Remove the bolts (or nuts) and lockwashers attaching the pump to the accessory drive housing. Remove the pump with the drive gear attached.

DISASSEMBLY (Refer to Fig. 6)

NOTE: Pump bearings are pressed in the bodies or on the shafts and should not be removed unless defective.

Basic Pump

1. Clamp the pump body in a vise, cover end up, and remove the four cover screws. Note the position of the outlet port with respect to the inlet port, then lift off the cover and O-ring.

CAUTION: Do not damage the pump with excessive clamping pressure.

2. Remove the pressure plate and spring. Note the position of the ring for correct assembly later. Lift off the ring and remove the locating pins.

3. Separate the vanes from the rotor, and remove the rotor from the shaft.

VICKERS POWER STEERING PUMP, V20 SERIES

4. Turn the pump body over, and remove the shaft key and the snapring which retains the bearing.

5. Tap with a soft hammer on the cover end of the shaft to force the shaft out of the body.

6. Remove the small snapring, located on the shaft, behind the bearing. Support the bearing inner race and press the shaft out of the bearing.

7. Pull the shaft seal out of the body with a suitable hooked tool.

Flow Control Cover

Remove the two plugs from the cover, then remove the spring. Insert a suitable tool from the snapring end of the bore. Slide the relief valve subassembly from the cover. Do not remove the snapring.

CAUTION: The snapring may be damaged if it is removed from the unit.

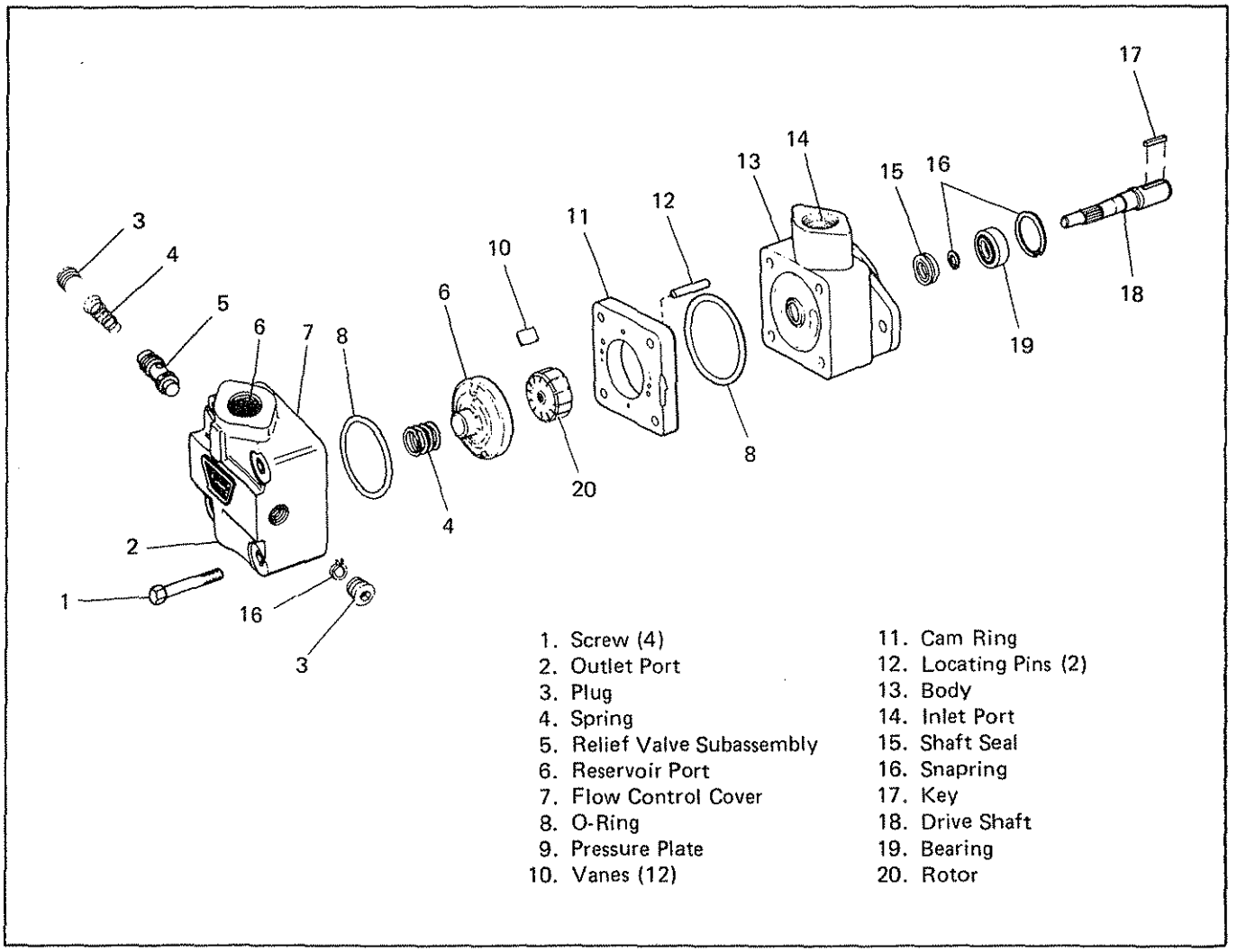


Fig. 6, V20 Series Power Steering Pump Nomenclature

VICKERS POWER STEERING PUMP, V20 SERIES

INSPECTION (Refer to Fig. 6)

1. Discard the used shaft seal and all O-rings. Wash the metal parts in mineral oil solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.

CAUTION: All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement more stringent than usual. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spools, orifices, and cover passages.

2. Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

3. Inspect the vanes for burrs, wear, and excessive play in the rotor slots. Replace the vanes and rotor if the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races. Replace worn, loose or damaged bearings.

5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Check the relief valve subassembly for free movement in the cover bore. Remove burrs from the valve by polishing, but **do not** round off the corners of the lands. **Do not** attempt to rework the valve bore. If the bore is damaged, replace the cover.

CAUTION: Do not disassemble the relief valve subassembly. The unit is factory set and could malfunction if disassembled.

ASSEMBLY (Refer to Fig. 6)

General

Coat all parts with hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold O-rings in place during assembly.

IMPORTANT: During handling and shipping of the precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be lightly dressed with a stone prior to installation.

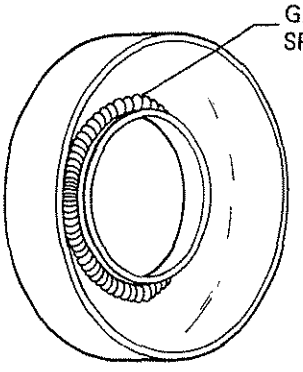
Flow Control Cover

Insert the valve in the bore, small land first. Then install the spring and both pipe plugs.

Basic Pump

1. Press the shaft into the front bearing while supporting the bearing inner race. Install the small snapring on the shaft.

NOTE: Before assembling the shaft seal, determine the correct position of the sealing lip. See Fig. 7.



SHAFT SEAL
(Assemble with spring toward cover end of pump)

Fig. 7, Shaft Seal

VICKERS POWER STEERING PUMP, V20 SERIES

Seals are assembled with the garter spring toward the pumping cartridge.

2. Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid.

3. Slide the drive shaft into the body until the bearing is seated. Tap lightly on the end of the shaft if necessary. Install the snapring.

NOTE: If the snapring cannot be installed, the bearing may not be firmly seated. Make certain the bearing is firmly seated before attempting to install the snapring.

4. Install new O-rings in the body and cover. Insert the ring locating pins in the body and assemble the ring so that the arrow on the perimeter points in the proper direction of rotation. See Fig. 8.

NOTE: To determine the proper direction of rotation for a particular pump, locate the pump model number on the pump cover. This number is explained in Table 2, located under "SPECIFICATIONS."

WARNING: Pumps must be driven in the direction of the arrows cast on the pump ring. Never drive a pump in the wrong direction of rotation, or seizure may result. This will necessitate expensive repairs and could result in a sudden, unexpected loss of power steering assist.

5. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

6. Place the pressure plate on the locating pins, flat against the ring. Place the spring over the pressure plate, then install the cover with the outlet port in the correct position. Outlet position codes are found in Table 2 located under "SPECIFICATIONS," and are described in Fig. 9.

7. Install the cover screws and tighten them to 75-85 ft-lbs (102-115 N·m).

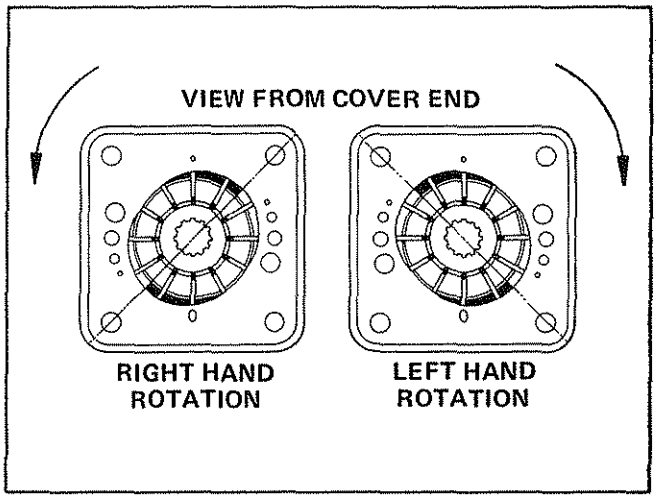


Fig. 8, Cam Ring Positions

8. Rotate the shaft by hand to insure that there is no internal binding. If binding occurs, the cause must be found and corrected before the pump is operated.

WARNING: Failure to correct binding could result in damage to the pump, which could result in a sudden, unexpected loss of power steering assist.

9. Install the shaft key, if present.

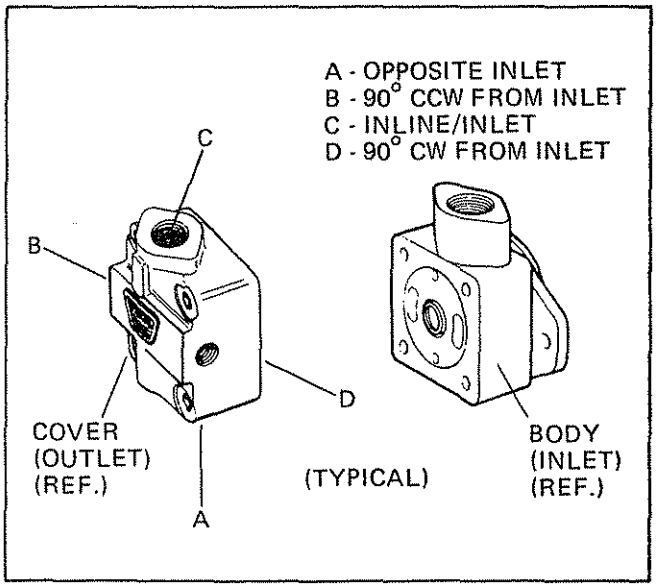


Fig. 9, Outlet Port Positions

VICKERS POWER STEERING PUMP, V20 SERIES

INSTALLATION

General

WARNING: Failure to observe the following recommendations could result in damage to the pump, possibly resulting in a sudden, unexpected loss of power steering assist.

A pilot on the pump mounting flange assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory mount of the engine. Care should be exercised in tightening the mounting screws to prevent misalignment.

If gaskets are used, they should be installed carefully and should lay flat. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

Cummins And Caterpillar 3406 Engines

1. Lightly lubricate the shaft for ease of assembly, then slide the shaft into the coupling (or gear), lining up the flange holes with those on the adapter.

WARNING: Vickers pump shafts are designed to be installed in couplings with a slip fit or a very light tap. Pounding can injure the bearings and cause pump damage, which could result in a sudden, unexpected loss of power steering assist.

2. Install the bolts (or nuts) and lockwashers attaching the pump to the engine accessory drive mounting. Tighten them to 20-30 ft-lbs (27-41 N·m).

3. Remove the plugs from the pump and lines, and make certain no dirt or foreign matter has entered the lines or the pump. Connect the hydraulic lines to the pump as previously marked.

CAUTION: All hydraulic connections must be kept tight. A loose connection in a pressure line will cause fluid to leak out. If fluid becomes so low as to uncover the inlet line opening in the reservoir, extensive damage to the pump may result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

WARNING: Low fluid, resulting in pump damage, or trapped air, resulting in erratic operation, could result in a sudden, unexpected loss of power steering assist.

4. Follow the instructions given under "STARTING THE PUMP AFTER REPAIRS" in this subject before operating the vehicle.

Detroit Diesel And Caterpillar 3408 Engines

1. Make sure the shaft nut on the end of the drive shaft is tightened to 90-100 ft-lbs (122-136 N·m).

2. Install the pump, with gear attached, onto the accessory drive housing. Install the mounting nuts and tighten them to 20-30 ft-lbs (27-41 N·m).

3. Remove the plugs from the pump and lines, and make certain no dirt or foreign matter has entered the lines or the pump. Connect the hydraulic lines to the pump as previously marked.

CAUTION: All hydraulic connections must be kept tight. A loose connection in a pressure line will cause fluid to leak out. If fluid becomes so low as to uncover the inlet line opening in the reservoir, extensive damage to the pump may result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

WARNING: Low fluid, resulting in pump damage, or trapped air, resulting in erratic operation, could result in a sudden, unexpected loss of power steering assist.

4. Follow the instructions given under "STARTING THE PUMP AFTER REPAIRS" in this subject before operating the vehicle.

VICKERS POWER STEERING PUMP, V20 SERIES

Starting The Pump After Repairs

Fill the power steering reservoir to the full mark, using the fluid recommendations in Table 1 of this section and in the Freightliner Maintenance and Lube Manual. Operate the engine for a few minutes, allowing the pump to prime.

With a minimum drive speed of 600 RPM, a pump should prime almost immediately, if provision is made to initially purge the air from the system. Inlet lines must be tight and free from air leaks. However, it may be necessary to slightly open a fitting on the outlet side of the pump to purge entrapped air.

CAUTION: Failure to prime within a reasonable length of time may result in damage due to lack of lubrication.

After priming the pump, check the power steering reservoir and add more fluid if necessary.

WARNING: A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected. Failure to do this could result in a sudden, unexpected loss of power steering assist.

Flexible Hose

The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

Hoses must have enough slack to allow for movement between components. Hoses must be secured to prevent rubbing against moving parts during operation.

WARNING: Failure to follow the above recommendations could result in hose damage, which could result in a sudden, unexpected loss of power steering assist.

SPECIFICATIONS

The following table summarizes oil types recommended for use with Vickers equipment in mobile hydraulic systems by viscosity and service classification.

The temperatures shown in table are cold start-up to maximum operating temperatures. Suitable procedures must be followed to insure adequate lubrication during system warmup.

Where special conditions indicate a need to depart from the recommended oils or operating conditions, see your Sperry Vickers representative.

Hydraulic System Operating Temperature Range (Min* to Max)		SAE Viscosity Designation	American Petroleum Institute (API) Service Classification
°F	°C		
0 to 180	-18 to 82	10W	SE, SC, SD
0 to 210	-18 to 99	10W-30 or 10W-40**	SE, SC, SD
50 to 210	10 to 99	20-20W	SE, SC, SD

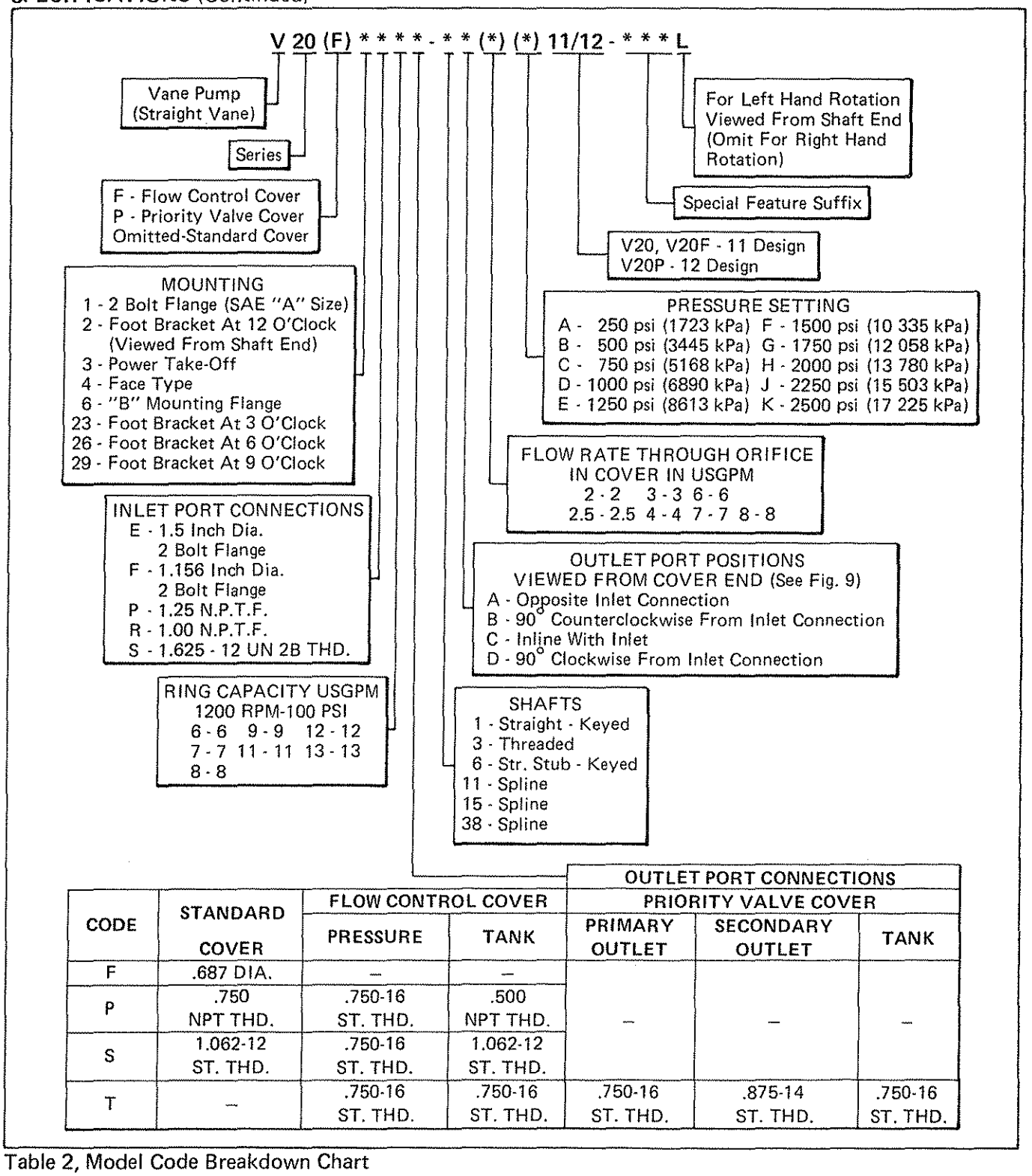
Table 1, Hydraulic Fluid Recommendations

*Ambient Start Up Temperatures

**Viscosity index reflects the way viscosity changes with temperature. The smaller the viscosity change, the higher the viscosity index. The viscosity index of hydraulic system oil should not be less than 90. Multiple viscosity oils, such as SAE 10W-30 or 10W-40, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both temporary and permanent decrease in viscosity due to the oil shear encountered in the operating hydraulic system. Accordingly, when such oils are selected, it is desirable to use those with high shear stability to insure that viscosity remains within recommended limits.

VICKERS POWER STEERING PUMP, V20 SERIES

SPECIFICATIONS (Continued)



CODE	STANDARD COVER	FLOW CONTROL COVER		OUTLET PORT CONNECTIONS PRIORITY VALVE COVER		
		PRESSURE	TANK	PRIMARY OUTLET	SECONDARY OUTLET	TANK
F	.687 DIA.	–	–	–	–	–
P	.750 NPT THD.	.750-16 ST. THD.	.500 NPT THD.			
S	1.062-12 ST. THD.	.750-16 ST. THD.	1.062-12 ST. THD.			
T	–	.750-16 ST. THD.	.750-16 ST. THD.	.750-16 ST. THD.	.875-14 ST. THD.	.750-16 ST. THD.

Table 2, Model Code Breakdown Chart

VICKERS POWER STEERING PUMP, V20 SERIES

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Low Pressure Or Pump Not Delivering Fluid	Driven in the wrong direction of rotation.	The drive direction must be changed immediately to prevent seizure. Fig. 8 shows the correct ring position for each direction of rotation.
	Coupling or shaft sheared or disengaged.	Disassemble the pump and check the shaft and cartridge for damage. Replace the necessary parts.
	Fluid intake pipe in reservoir restricted.	Check all strainers and filters for dirt and sludge. Clean, if necessary.
	Fluid viscosity too heavy to pick up prime.	Completely drain the system. Add new filtered fluid of the proper viscosity. See Table 1 under "SPECIFICATIONS."
	Air leaks at the intake. Pump not priming.	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is at the full mark. Check the minimum drive speed which may be too slow to prime the pump.
	Relief valve stuck open. (Models with integral relief valve only)	Disassemble the pump and wash the valve and the cover in clean solvent. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump.
	Reservoir low on oil.	Fill reservoir to the full mark with clean, filtered fluid. See Table 1 under "SPECIFICATIONS."

(Continued on next page)

VICKERS POWER STEERING PUMP, V20 SERIES

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Low Pressure Or Pump Not Delivering Fluid (Cont.)	Vane(s) stuck in the rotor slot(s).	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. Flush the system and refill it with clean fluid.
	Pump running too slow. (Belt driven installations.)	Change the pulley to the correct size and/or raise the engine speed.
	Worn parts causing internal leakage.	Replace worn parts.
	Broken inlet or pressure line.	Replace the line.
Pump Making Noise	Pump intake partially blocked.	Service the intake strainers. Check the fluid condition and drain and flush the system. Refill with clean fluid.
	Air leaks at the intake or shaft seal. (Oil in reservoir would probably be foamy.)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is at the full mark.
	Reservoir low on oil.	Fill reservoir to the full mark with clean, filtered fluid. See Table 1 under "SPECIFICATIONS."

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

SUBJECT CONTENTS

TOPIC **PAGE NUMBER**

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PRINCIPLES OF OPERATION

SERVICE OPERATIONS

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- Input Shaft Seal Replacement 8

ADJUSTMENTS WITH THE STEERING GEAR ON THE VEHICLE
- Worm Shaft Preload Adjustment 9
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SPECIFICATIONS

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ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

GENERAL DESCRIPTION

The Ross HFB70 integral power steering gear can be installed on vehicles with front axle capacities of up to 16,000 lbs (7264 kg). It is mounted on the vehicle frame rail. See Fig. 1 (Conventionals) or Fig. 2 (COEs). The steering gear assembly incorporates a manual steering mechanism, hydraulic control valve, and a hydraulic power cylinder. The control valve is a rotary design, which directs oil flow from an engine-driven pump to the power cylinder.

PRINCIPLES OF OPERATION

When the steering wheel is turned, force is transmitted from the steering wheel to the steering gear input shaft. A torsion bar, pinned at one end to the input shaft and at the other to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response, the worm shaft, acting through the recirculating ball mechanism, tends to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is turned by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft, to the rack piston, and onto the worm shaft. The internal construction of the steering gear causes the control valve to send high-pressure fluid to the correct power cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents kickback at the steering wheel.

On each end of the rack piston is a poppet (unloading valve). Depending on the direction of turn, one poppet will trip as the steered wheels approach the axle stops. The tripped poppet reduces pressure in the gear, heat generated by the pump, and outside forces acting on the steering linkage.

SERVICE OPERATIONS

WARNING: All steering mechanisms are life and limb items. As such, it is imperative that the instructions in this subject are followed to the letter. Failure to observe the procedures set out in this subject may result in loss of steering.

Special tools (see Table 1, under "SPECIFICATIONS") required for some disassembly and assembly procedures of the steering gear components are available from the Kent-Moore Tool Division, or an affiliated dealer. See Table 1 under "SPECIFICATIONS" before beginning service procedures described here to be sure that required tools are available.

Before servicing the steering gear or power steering pump, refer to the pre-service checks. After performing any service operations on the power steering components, refer to the post-service checks. See the subject covering hydraulic power steering system checking, testing, and troubleshooting in the 14 Group of this manual.

Fig. 3 shows a disassembled HFB70 steering gear. Refer to this figure for parts identification during disassembly of the gear.

REPAIRS WITH THE STEERING GEAR ON THE VEHICLE

IMPORTANT: Thoroughly clean all outside dirt from around the fittings and hose connections.

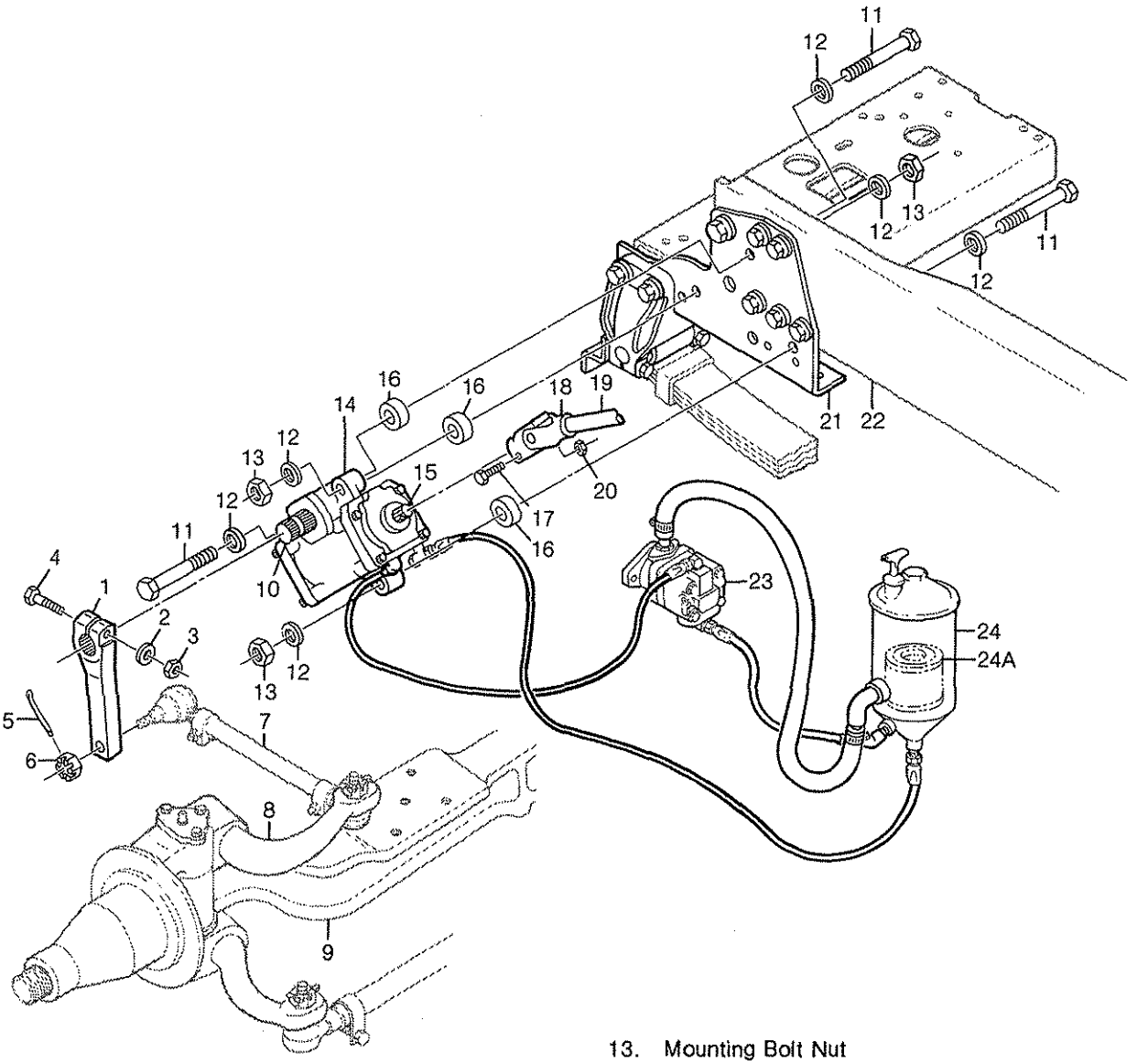
NOTE: For clarity, the figures shown under this heading show the steering gear mounted on a mock-up frame and steering driveline. There may also be slight variations in some installations.

Sector (Output) Shaft Seal Replacement

If you detect a leak in the trunnion cover area, you can remove the trunnion cover with the steering gear on the vehicle to gain access to the sector shaft seal package.

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. Apply the parking brakes and chock the tires.
2. Disconnect the drag link from the pitman arm. For instructions, refer to the 14 Group of this manual.
3. Remove the pitman arm nut and bolt from the pitman arm. If pitman arm to sector shaft alignment marks are not present, use a marking pen or paint to reference the position of the pitman arm on the sector shaft. Using a suitable puller, remove the pitman arm.
4. Remove and discard the trunnion cover dirt and water seal. See Fig. 4.

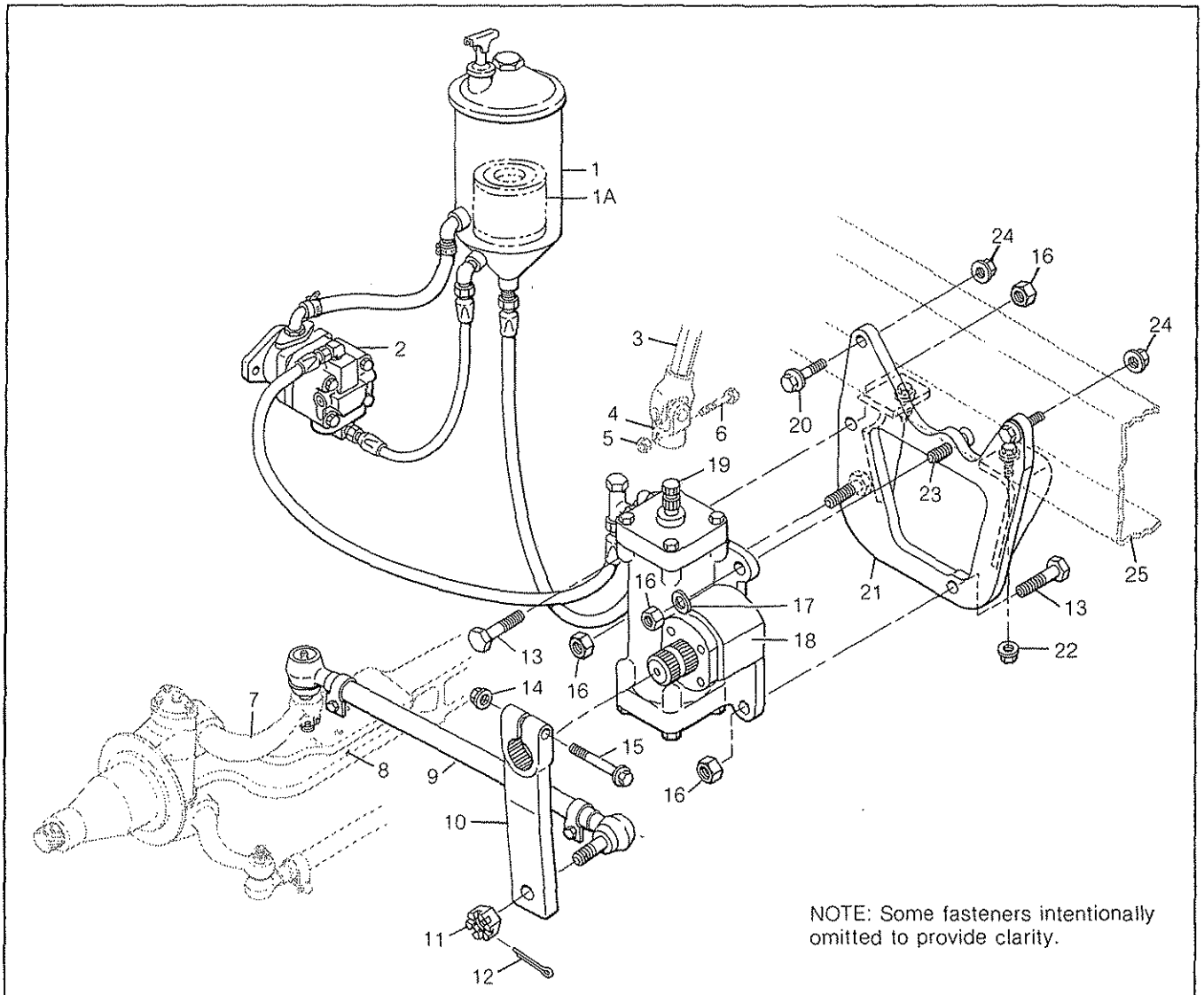
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Pitman Arm
2. Washer
3. Pinch Bolt Nut
4. Pitman Arm Pinch Bolt
5. Cotter Pin
6. Castle Nut
7. Drag Link
8. Axle Steering Arm
9. Front Axle
10. Output (Sector) Shaft
11. Mounting Bolt
12. Washer
13. Mounting Bolt Nut
14. Steering Gear
15. Input (Worm) Shaft
16. Spacer
17. Lower End Yoke Pinch Bolt
18. Lower End Yoke
19. Steering Driveline
20. Pinch Bolt Nut
21. Frame Extension
22. Frame
23. Power Steering Pump
24. Power Steering Reservoir
24A. Filter

Fig. 1, Conventional Integral Power Steering Installation, 1984 Advancements

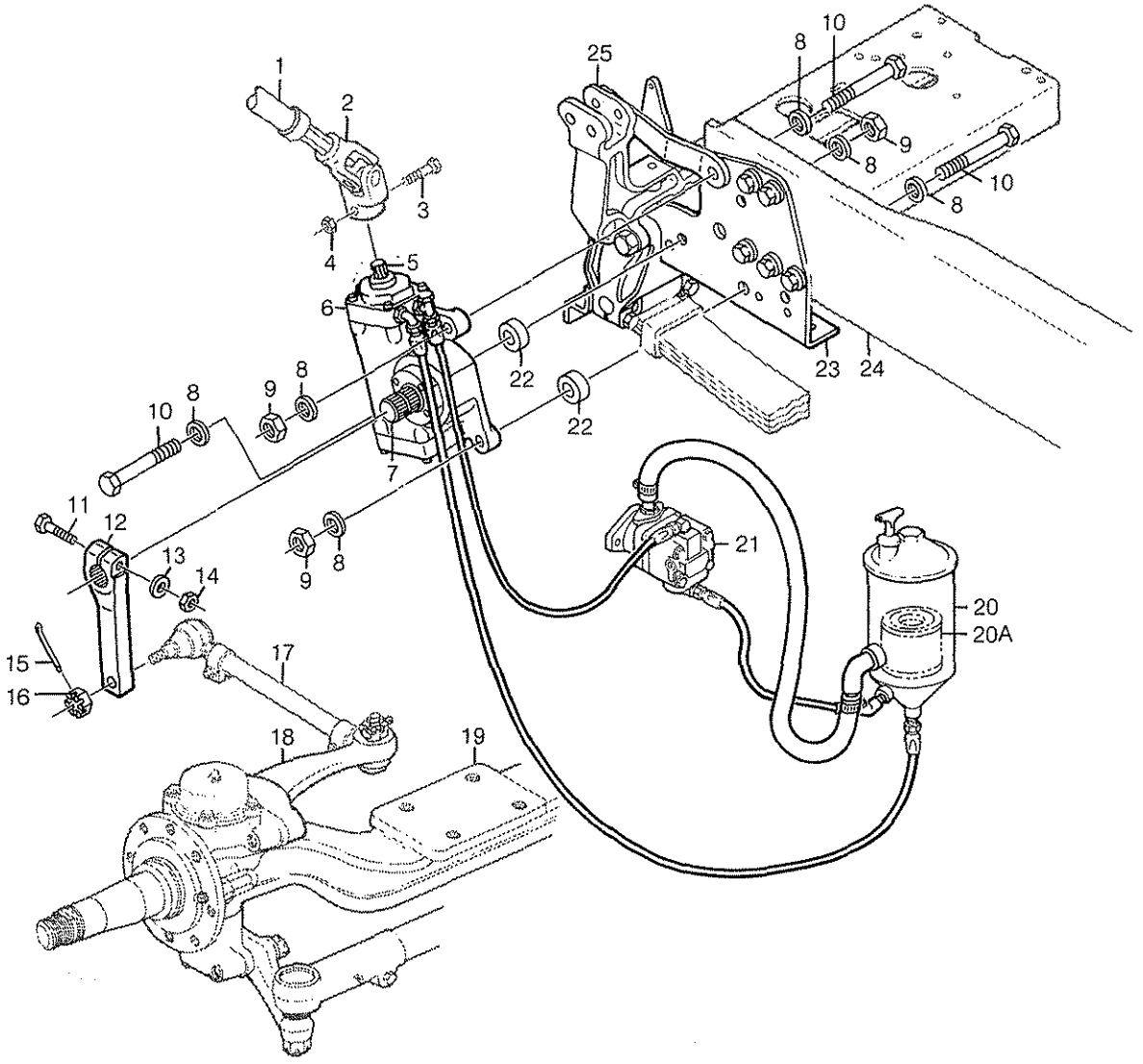
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Power Steering Reservoir
1A. Filter
2. Power Steering Pump
3. Steering Driveline
4. Lower End Yoke
5. Pinch Bolt Nut
6. Lower End Yoke Pinch Bolt
7. Axle Steering Arm
8. Front Axle
9. Drag Link
10. Pitman Arm
11. Castle Nut
12. Cotter Pin
13. Hex Bolt
14. Pitman Arm Pinch Bolt Nut
15. Pitman Arm Pinch Bolt
16. Hex Nut
17. Washer
18. Steering Gear
19. Input (Worm) Shaft
20. Flanged Bolt
21. Steering Gear Bracket
22. Flanged Nut
23. Countersunk Bolt
24. Flanged Nut
25. Frame Rail

Fig. 1A, Conventional Integral Power Steering Installation, Except 1984 Advancements

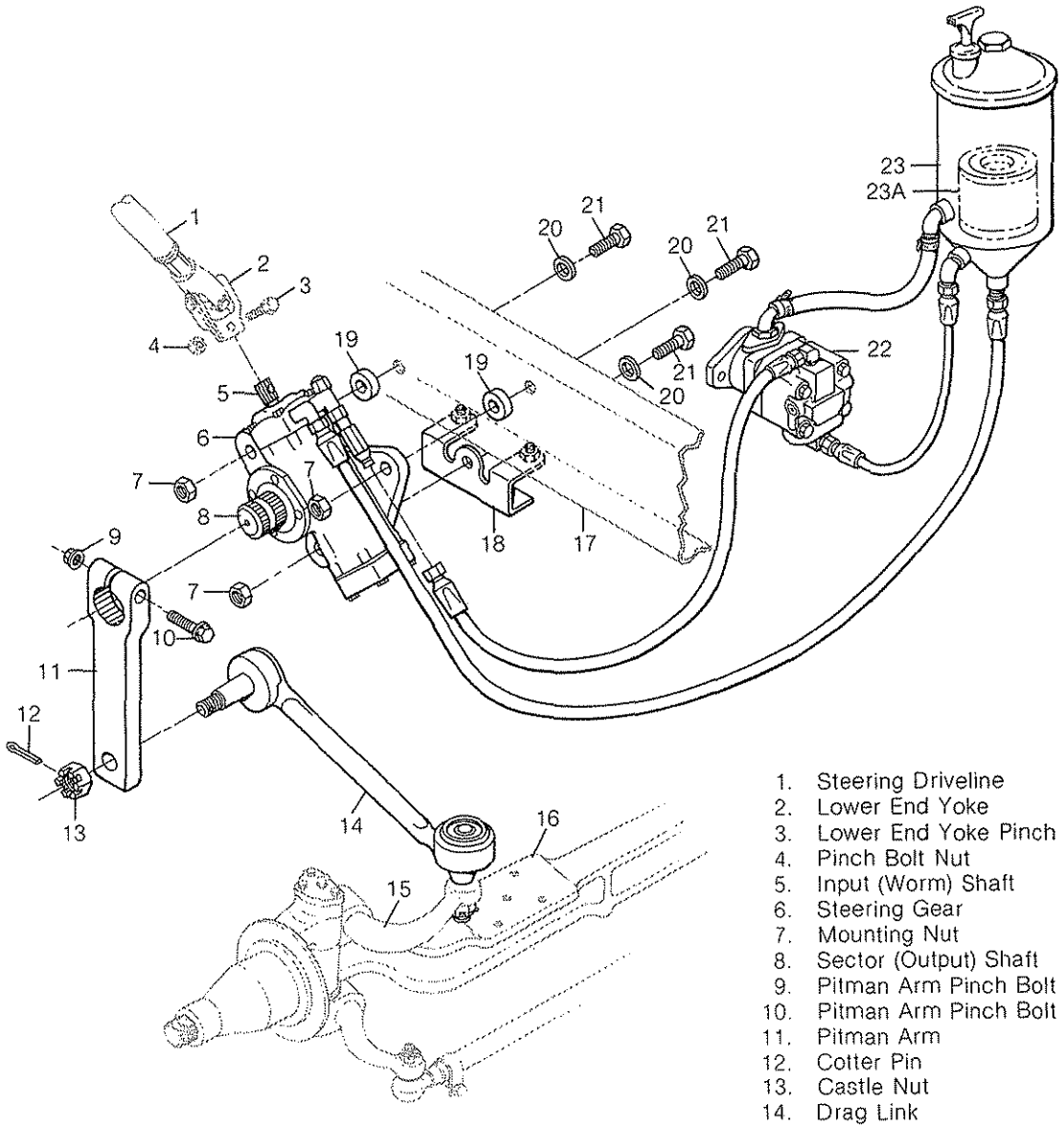
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Output (Sector) Shaft
8. Washer
9. Mounting Bolt Nut
10. Mouting Bolt
11. Pitman Arm Pinch Bolt
12. Pitman Arm
13. Washer
14. Pinch Bolt Nut
15. Cotter Pin
16. Castle Nut
17. Drag Link
18. Axle Steering Arm
19. Axle
20. Power Steering Reservoir
20A. Filter
21. Power Steering Reservoir
22. Spacer
23. Frame Extension
24. Frame
25. Cab Mounting Bracket

Fig. 2, COE Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



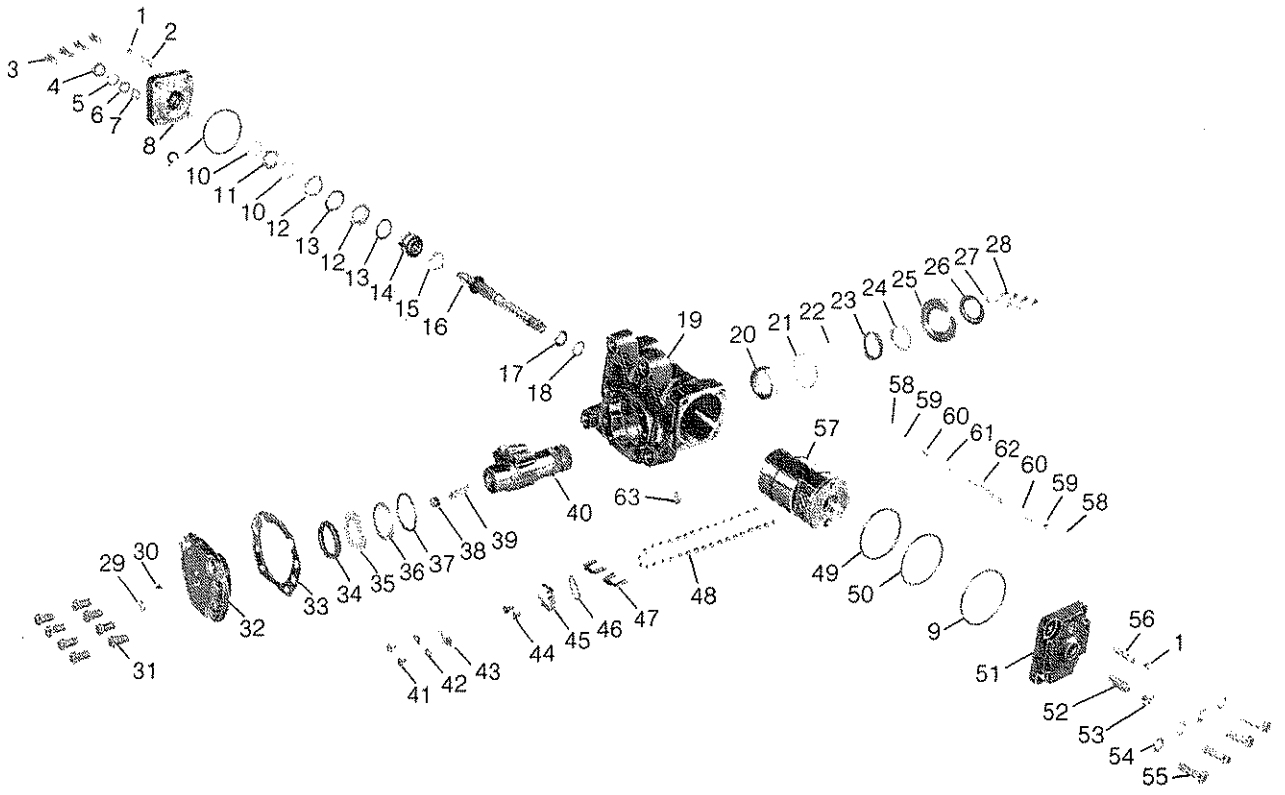
NOTE: Some fasteners intentionally omitted to provide clarity.

1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Mounting Nut
8. Sector (Output) Shaft
9. Pitman Arm Pinch Bolt Nut
10. Pitman Arm Pinch Bolt
11. Pitman Arm
12. Cotter Pin
13. Castle Nut
14. Drag Link
15. Axle Steering Arm
16. Front Axle
17. Frame Rail
18. Steering Gear Bracket
19. Spacer
20. Washer
21. Mounting Bolt
22. Power Steering Pump
23. Power Steering Reservoir

23A. Filter

Fig. 2A, COE Integral Power Steering Installation, Except 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Poppet Screw Jam Nuts
2. Poppet Adjusting Screw
3. Valve Housing Bolts
4. Dirt and Water Seal
5. Retaining Ring
6. Steel Backup Washer
7. Two-Piece Input Shaft Seal
8. Valve Housing
9. End Cover and Valve Housing O-Rings
10. Thrustwashers
11. Thrust Bearing
12. Teflon® Seal Rings
13. Backup O-Rings
14. Valve Sleeve
15. Drive Ring
16. Worm (Input) Shaft
17. Worm Shaft Backup O-Ring
18. Teflon® Worm Shaft Seal
19. Housing
20. Housing Bearing
21. Retaining Ring
22. Trunnion Cover O-Ring
23. Two-Piece Sector Shaft Seal
24. Teflon Backup Washer
25. Trunnion Cover
26. Trunnion Cover Dirt and Water Seal
27. Trunnion Cover Washers
28. Trunnion Cover Bolts
29. Jam Nut
30. Vent Plug
31. Special Ring Head Bolts
32. Side Cover
33. Side Cover Gasket
34. Steel Backup Washer
35. Teflon® Backup Washer
36. Two-Piece Side Cover Seal
37. Retaining Ring
38. Retainer
39. Sector Shaft Adjusting Screw
40. Sector Shaft
41. Hex Head Bolts
42. Lock Tabs
43. Ball Return Guide Clip
44. Allen Head Bolts
45. Ball Return Guide Cap
46. Ball Return Guide Cap Seal
47. Ball Return Guides
48. Balls
49. Rack Piston Backup O-Ring
50. Teflon® Rack Piston Seal
51. End Cover
52. Worm Shaft Preload Adjusting Screw
53. Worm Shaft Adjusting Screw Jam Nut
54. End Cover Washers
55. End Cover Bolts
56. Poppet Adjusting Screw
57. Rack Piston
58. Retaining Rings
59. Poppet Seals
60. Poppets
61. Spacer Rod
62. Spring
63. Bleed Screw*

*On Some Models

Fig. 3, Ross HFB70 Steering Gear

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

5. Clean the non-serrated area of the sector shaft with a fine grade of emery paper as shown in Fig. 5.

6. Remove the four trunnion cover bolts (Fig. 6) and the trunnion cover. Remove and discard the sector shaft seal package, consisting of the Teflon® backup washer, the two-piece sector shaft seal, and the trunnion cover O-ring. See Fig. 7.

7. Clean the trunnion cover with petroleum-based solvent and inspect the seal cavity and sealing face for nicks or corrosion. Replace the trunnion cover with a new one if these conditions exist.

WARNING: Commercial cleaning solvents may be flammable and toxic and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

8. Place the trunnion cover on a bench to install the new seal package. Start with the new Teflon® backup washer. Install the new two-piece sector shaft seal so that the words "OIL SIDE" (Fig. 8) are visible after the seal is in place.

WARNING: The words "OIL SIDE" must be visible after the seal is in place, as shown in Fig. 8. If not, the seal will not function, and a loss of power steering assist may occur.

9. Grease the new trunnion cover O-ring and install it into the cover groove.

10. Cover the serrations of the sector shaft with one layer of masking tape to avoid damaging the seals during trunnion cover installation. See Fig. 9.

11. Install the trunnion cover. See Fig. 10.

12. Install four trunnion cover washers and four trunnion cover bolts. Pack clean Mobil Temp® 1 or 2, or an equivalent grease, around the seal area of the sector shaft. Install a new dirt and water seal using a suitable blunt end drift. See Fig. 11.

13. Tighten the trunnion cover bolts to 15-22 lbf·ft (20-30 N·m) See Fig. 12. Remove the tape from the sector shaft.

14. Attach the pitman arm to the sector shaft. Be sure that the reference mark on the pitman arm aligns with the timing mark on the sector shaft.

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. To wedge the slot open, clamp the pitman arm in a vise with the slot at the top. Use a ball-peen hammer to drive a chisel into the slot. Hold the chisel in place, remove the pitman arm from the vise, and install the pitman arm on the sector shaft. See Fig. 13. Remove the chisel from the slot.

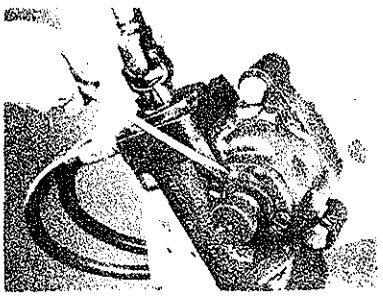


Fig. 4

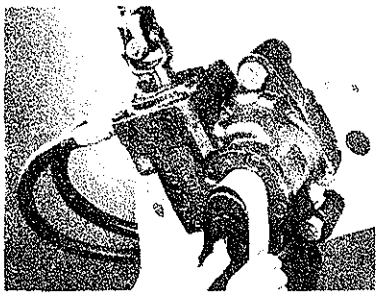


Fig. 5

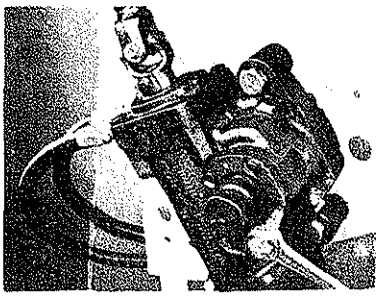


Fig. 6

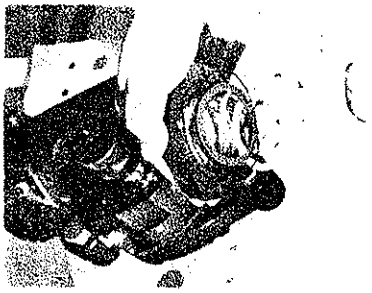


Fig. 7

Fig. 8

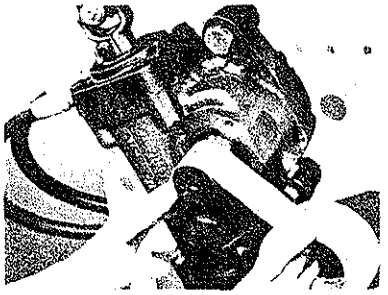


Fig. 9

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

WARNING: Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise, the chisel may fly loose, which could cause an injury.

15. Using a new locknut, insert the pitman arm pinch bolt and nut assembly. See Fig. 14. Tighten the pitman arm to the torque value given in Table 1 under "SPECIFICATIONS."

Input Shaft Seal Replacement

If there is a leak in the input shaft seal, you can usually replace the seal assembly with the steering gear on the vehicle.

1. Disconnect the steering driveline from the steering gear input shaft (Fig. 15). For instructions, refer to the 14 Group of this manual.
2. Clean the non-serrated area around the input shaft with a fine grade of emery paper. See Fig. 16.
3. Remove and plug the return line. See Fig. 17.
4. Remove and discard the dirt and water seal. See Fig. 18.
5. Remove the retaining ring from the input shaft. See Fig. 19.
6. Hold a shop towel over the input shaft and apply shop air pressure to the valve housing return port as shown in Fig. 20.

WARNING: Wear eye protection and be sure to comply with OSHA maximum air pressure requirements. Dust or dirt particles blown by pressurized air can cause serious injury if they contact your eyes.

7. The two-piece input shaft seal and the steel backup washer will pop out of the gear and some fluid will leak out of the gear. See Fig. 21. Discard the two-piece seal. Disconnect the shop air as soon as the seal assembly is out.
8. Apply clean grease to the new input shaft seal assembly and to the input shaft. Install the new two-piece seal (with the flat side up) and the steel backup washer. Use Kent-Moore seal driving tool J28490. See Fig. 22. Install the retaining ring.
9. Pack the area around the input shaft with clean Mobil Temp® 1 or 2 grease, or an equivalent. See Fig. 23.

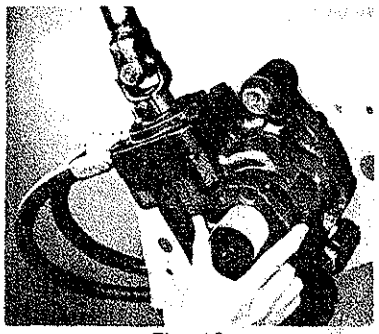


Fig. 10

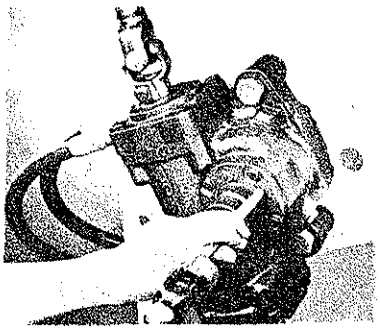


Fig. 11

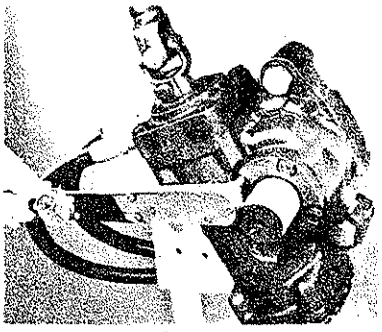


Fig. 12

Fig. 13

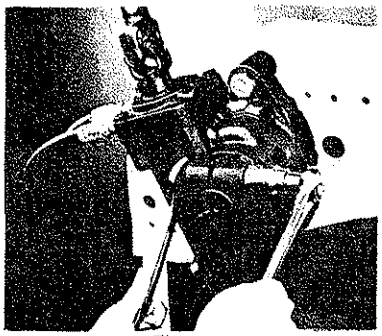


Fig. 14

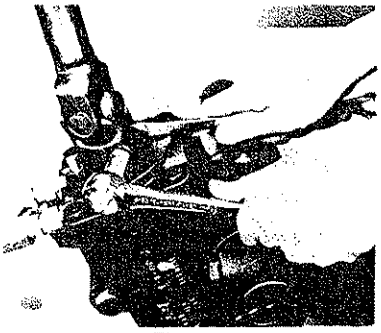


Fig. 15

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

10. Install the new dirt and water seal. See Fig. 24.
11. Remove the plug and connect the return line.
12. Connect the steering driveline to the steering gear input shaft. For instructions, refer to the 14 Group of this manual.
13. Before operating the steering gear, fill the system with the recommended fluid and bleed air from the system. For instructions, refer to "FILLING AND AIR BLEEDING THE SYSTEM."

ADJUSTMENTS WITH THE STEERING GEAR ON THE VEHICLE

You can make two adjustments to the steering gear while it is mounted on the vehicle: the worm shaft preload adjustment, and the poppet valve adjustment. It is also possible to adjust the output (sector) shaft on COEs and Conventionals with 1984 Advancements.

Worm Shaft Preload Adjustment

1. Back off the worm shaft adjusting screw jam nut three turns. See Fig. 25. Back off the worm shaft preload adjusting screw at least one turn. See Fig. 26. Inspect the threads between the jam nut and end cover for foreign material. Clean the threads, if necessary. See Fig. 27.
2. While someone gently moves the steering wheel back and forth about 1 inch (25 mm) total, tighten

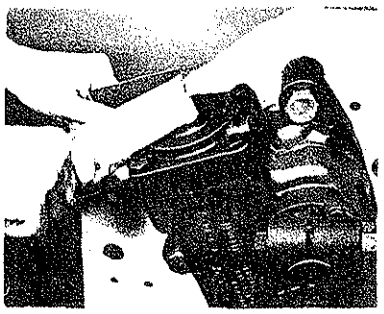


Fig. 16

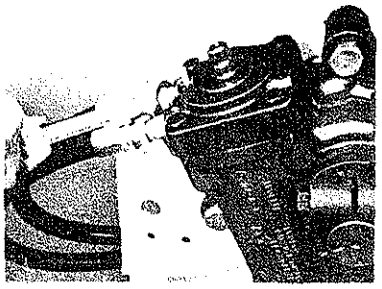


Fig. 17

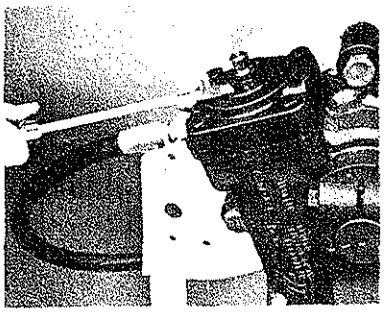


Fig. 18

Fig. 19

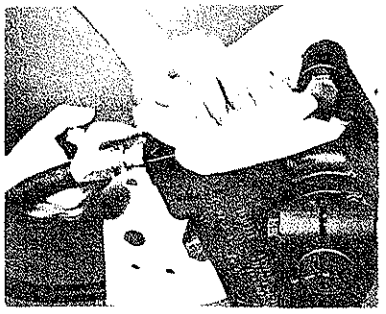


Fig. 20

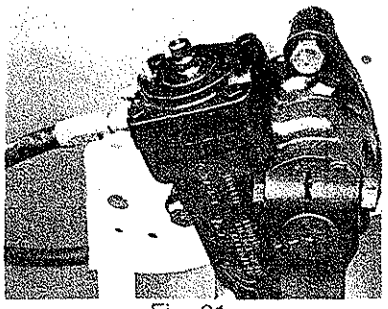


Fig. 21

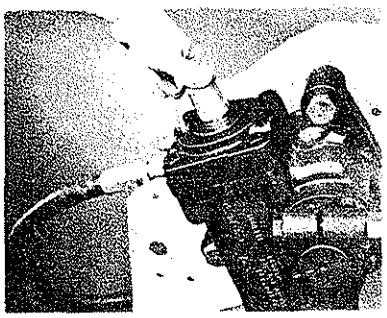


Fig. 22

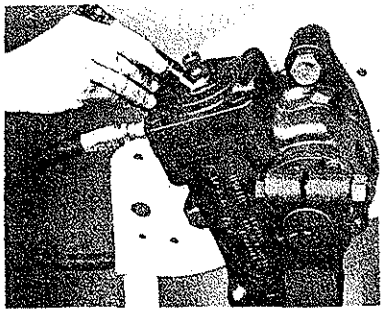


Fig. 23

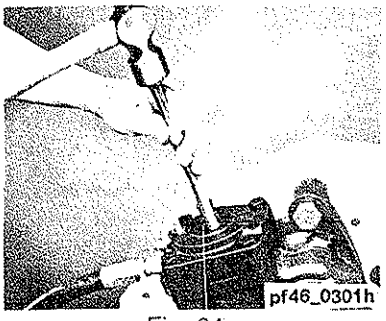


Fig. 24

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the worm shaft preload adjusting screw 60 to 70 lbf·in (680 to 790 N·cm).

NOTE: When tightening the adjusting screw, make sure the worm shaft adjusting screw jam nut does not tighten. See Fig. 28.

3. Tighten the worm shaft adjusting screw jam nut 70 to 80 lbf·ft (95 to 110 N·m). Make sure that the worm shaft preload adjusting screw does not move.

NOTE: If the sealing material in the jam nut has separated, remove the adjusting screw and replace the jam nut with a new one on the non slotted end of the adjusting screw. Position the jam nut so that the seal faces the end cover. Then adjust the assembly as described above.

Poppet Valve Adjustment

1. Check the settings of the axle stops and adjust them if necessary. Refer to Group 10, subject 32-10270, for instructions.
2. Install a flow meter kit (Fig. 29) in the supply line from the pump to the steering gear. Make sure that the flow meter can be pressurized. Warm the reservoir fluid temperature to operating temperature using the method described in subject 32-14500, of this group.
3. Loosen both of the poppet-valve adjusting screw jam nuts.
4. With the engine at idle, have someone turn the steering wheel to the right-turn full-lock position. Note the pressure gauge reading.

CAUTION: As soon as pump relief pressure is reached, release the steering wheel from the full-lock position. At no time should pump relief pressure be maintained for longer than five seconds, or damage to the system may result because of excessive heat build-up. At no time should the oil temperature exceed 180°F (82°C).

NOTE: The right-turn poppet-valve adjusting screw is on the top of the steering gear on all COEs and on Conventionals with 1984 Advancements (Fig. 30). On earlier Conventionals, this screw is on the bottom of the steering gear. See Fig. 31.

With the steering wheel at right-turn full-lock, back out the poppet-valve adjusting screw until the pressure gauge reaches the maximum reading. The pressure reading must be between the minimum 1575 psi (10 800 kPa) and the maximum 1925 psi (13 300 kPa) pump relief pressure.

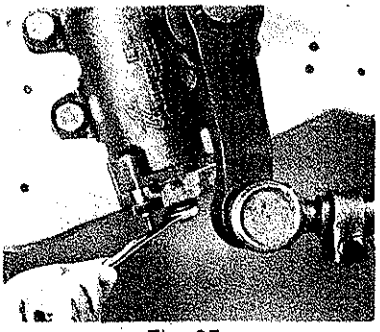

Fig. 25

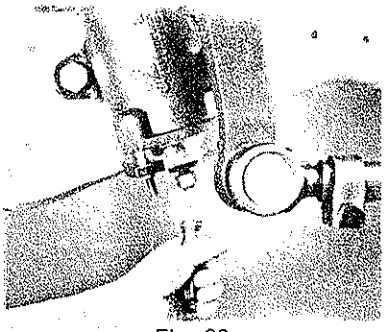

Fig. 26

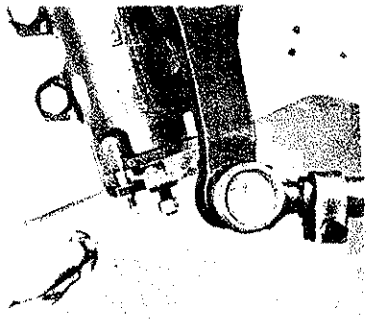

Fig. 27

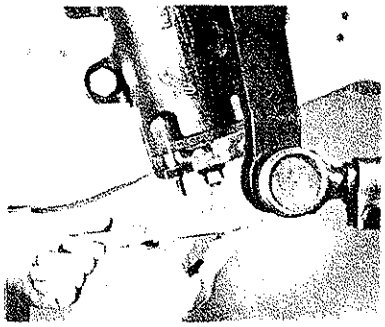

Fig. 28

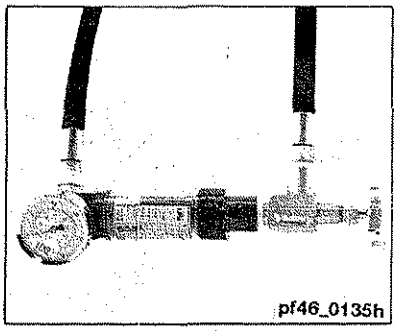

Fig. 29

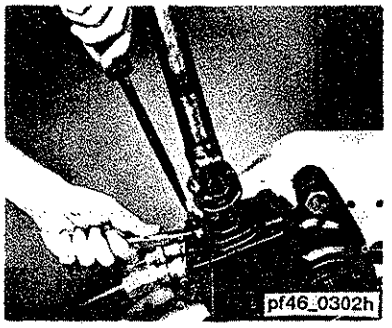

Fig. 30

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Fig. 31

If the system pressure exceeds the 1925 psi (13 300 kPa) maximum pump relief pressure, repair the power steering pump. For instructions, refer to the appropriate subject in this group.

5. With the steering wheel at right-turn full-lock, carefully screw in the poppet-valve adjusting screw until the pressure gauge reading drops 200 to 400 psi (1400 to 2800 kPa) below the maximum pressure reading obtained in step 4.

NOTE: If the vehicle is equipped with an Eaton EFA-12F3 or EFA-12F4 front axle, adjust the poppet valve as follows: With the steering wheel at right-turn full-lock, carefully screw in the poppet-valve adjusting screw until the pressure gauge reads under 500 psi (3400 kPa).

While holding the poppet-valve adjusting screw in place, tighten its jam nut 12 to 18 lbf·ft (16 to 24 N·m).

6. With the engine at idle, have someone turn the steering wheel to the left-turn full-lock position. Repeat steps 4 and 5 (turning full-left instead of full-right) for left-turn poppet-valve adjustment.

NOTE: The left-turn poppet-valve adjusting screw is on the bottom of the steering gear on all COEs and on Conventionals with 1984 Advancements. On earlier Conventionals, this screw is on the top of the steering gear.

Sector (Output) Shaft Adjustment

NOTE: The sector shaft adjusting screw and jam nut are accessible on COEs and Conventionals with 1984 Advancements. On other vehicles, the steering gear must be removed to adjust the sector shaft. For instructions, refer to "Steering Gear Removal."

1. Remove the drag link from the pitman arm. For instructions, refer to the appropriate section in this group.
2. Remove the lower end yoke from the steering gear input shaft. For instructions, refer to the appropriate section in this group.
3. Loosen the sector shaft adjusting screw jam nut.
4. Adjust the sector shaft adjusting screw while rotating the input shaft 90 degrees each direction until input shaft torque reaches 25 to 30 lbf·in (280 to 340 N·cm). See Fig. 142.

NOTE: Use a 12-point socket and an inch-pound torque wrench to rotate the input shaft.

5. Center the steering gear by aligning the sector (output) shaft timing mark halfway between two trunnion cover bolts. The timing mark will be at a right angle to the centerline of the cylinder bore. Back out the sector shaft adjusting screw one turn and note the torque required to rotate the input shaft through 90 degrees each side of center. Move the adjusting screw to provide a rise in torque of 2 to 4 lbf·in (23 to 45 N·cm) at a point within 45 degrees each side of center.

   After tightening the (side cover) jam nut 40 to 45 lbf·ft (54 to 61 N·m), the torque now required to rotate the input shaft must not exceed 28 lbf·in (320 N·cm) at any point in the steering gear travel.

6. Tighten the worm shaft preload adjusting screw 60 to 70 lbf·in (680 to 790 N·cm). Make sure the jam nut does not contact the end cover. Tighten the worm shaft adjusting screw jam nut 70 to 80 lbf·ft (95 to 110 N·m). Make sure the adjusting screw does not move.
7. The torque now required to rotate the input shaft through complete travel should not exceed 50 lbf·in (570 N·cm).

NOTE: 55 lbf·in (620 N·cm) is allowable if fluid is in the gear.

STEERING GEAR REMOVAL (See Fig. 1 or 2)

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. Apply the parking brakes and chock the tires.
2. Clean off dirt from around the fittings and hose connections.

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3. Drain the steering gear assembly. Disconnect all hydraulic lines from the gear, marking the lines for later assembly reference. Seal off the lines and fittings to prevent fluid from leaking out of the lines and to prevent dirt from entering the lines or the gear.
4. Disconnect the drag link from the pitman arm. For instructions, refer to the 14 Group of this manual.
5. Disconnect the steering driveline from the steering gear input shaft. For instructions, refer to the 14 Group of this manual.
6. Remove the pitman arm nut and bolt from the pitman arm. If factory marks are not present, center the steering gear by turning the input shaft through full travel, counting the number of turns from stop to stop. Then, starting at the end of travel, turn the input shaft back half the number of turns. Use a marking pen or paint to mark the pitman arm with a line perpendicular to the input shaft. Remove the pitman arm with a suitable puller.
7. Clean the entire assembly before removing the gear.
8. On COEs, remove the fasteners attaching the steering gear to the frame rail and mounting bracket. Remove the spacers and steering gear. Place the steering gear on a clean surface.

   On Conventionals with 1984 Advancements, remove the fasteners attaching the steering gear to the frame rail. Remove the spacers and the steering gear. On other Conventionals, remove the fasteners attaching the steering gear mounting bracket to the frame rail, then remove the fasteners attaching the mounting bracket to the steering gear. Place the steering gear on a clean surface.

WARNING: The steering gear weighs approximately 110 lbs (50 kg) dry. Exercise caution when removing, lifting, or carrying the steering gear.

STEERING GEAR DISASSEMBLY (Refer to Fig. 3)

Make sure that the steering gear is placed on a clean surface. Clean and dry the gear before disassembly. As the gear is disassembled, clean all parts in a clean, petroleum-based solvent and blow them dry with air. Keep each part separate to avoid nicks and burrs.

CAUTION: Never steam clean or high-pressure wash the hydraulic steering components. Do not force or abuse closely fitted parts.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

1. Position the steering gear in a vise with the gear's worm (input) shaft in a horizontal direction. Rotate the worm shaft to the end of the sector shaft travel. Position the timing mark on the sector shaft in a vertical direction (halfway between two trunnion cover capscrews) so that the gear is in its center of travel. See Fig. 32.
2. Remove any paint or corrosion from the serrated end of the sector shaft, and loosen the jam nut on the sector shaft adjusting screw.
3. Remove and discard the dirt and water seal from the trunnion cover. See Fig. 33.
4. Remove the four bolts from the trunnion cover with a 1/2-inch socket. See Fig. 34. Remove the trunnion cover. See Fig. 35.
5. Tape the serrations and bolt groove of the sector shaft. See Fig. 36.

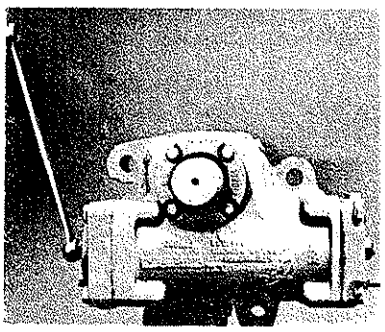
Fig. 32

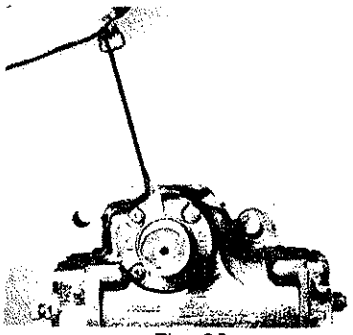
Fig. 33

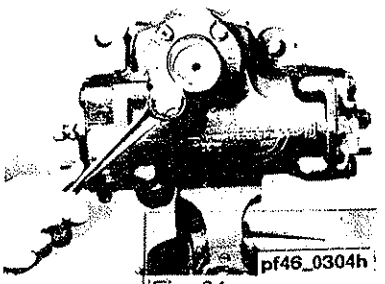

Fig. 34

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6. Prepare for fluid to drain, and remove the eight special ring head bolts from the side cover with a 13/16-inch socket. See Fig. 37.

NOTE: These bolts have a special ring located on the underside of the bolt head for sealing purposes. If you replace a bolt or bolts, use only the *same special type and length of bolts.* See Fig. 38. Refer to the Freightliner Parts Book for correct bolt type.

7. Begin to remove the side cover and sector shaft assembly (Fig. 39), and stop when the bearing rolls are half exposed (Fig. 40). You may use a soft hammer or wooden handle to start the removal of the side cover sector shaft assembly.

IMPORTANT: Take care to remove this assembly slowly, or the assembly may come out too quickly for you to retain the bearing rolls in the race. When the rolls are half exposed, apply grease to the rolls to retain them in the housing bearing. See Fig. 40.

CAUTION: If one or more of the bearing rolls is lost, the entire bearing must be replaced.

8. Finish removing the side cover and sector shaft assembly. If the bearing race is damaged, or if it is necessary to replace the housing bearing, remove the bearing in the following manner: using Kent-Moore bearing mandrel J26743, apply pressure from the side cover opening and press the bearing out through the trunnion cover opening. See Fig. 41. Maintain firm, square contact between the housing and press base to avoid damaging the bearing bore.

CAUTION: If the bearing is cocked while being pressed out, it may burnish the bore, causing it to become oversized and to require replacement of the gear housing.

The bearing may contain 41 or 42 rolls, depending upon the type used. Bearing BR-970 has 41 rolls. Bearing BR-970-1 has 42 rolls. The identification number can be found on the outside edge of the bearing race flange. There is also a set of bearing rolls in the side cover, with either 41 or 42 rolls. The quantity may not be the same as in the housing bearing. Do not mix these rolls.

9. Remove the sector shaft adjusting screw jam nut. See Fig. 42.

10. Screw the sector shaft adjusting screw through the side cover. See Fig. 43. Place the side cover exterior face down and lift the sector shaft out vertically.

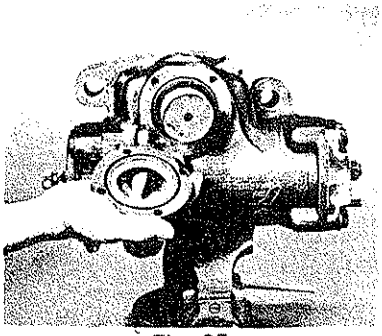


Fig. 35

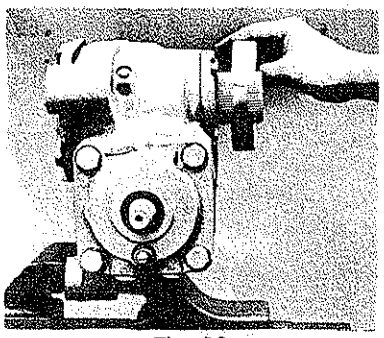


Fig. 36

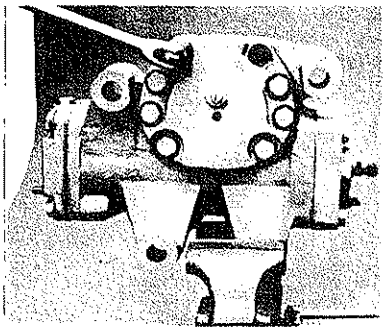


Fig. 37

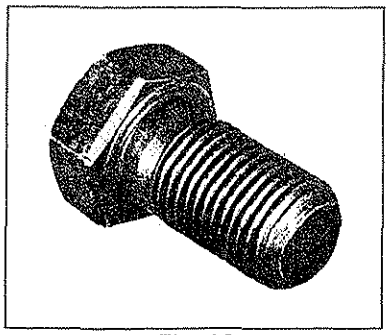


Fig. 38

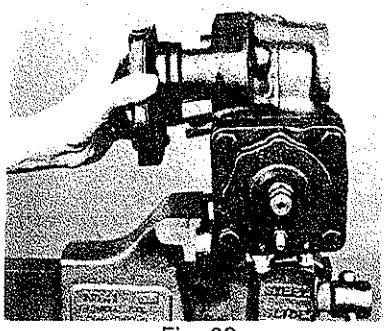


Fig. 39

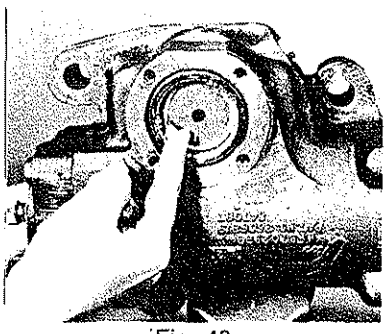


Fig. 40

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

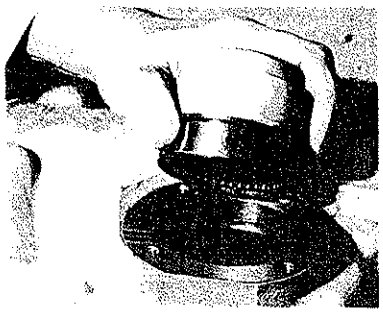


Fig. 41

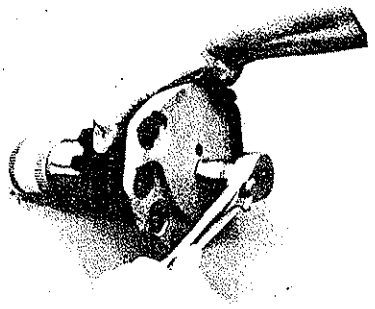


Fig. 42

Fig. 43

NOTE: Doing this will allow the side cover bearings to fall into the side cover cavity, where they may easily be collected. Immediately collect all side cover bearings and count them.

11. Remove the side cover retaining ring (Fig. 44), the two-piece side cover seal, the Teflon® backup washer, and the steel backup washer from the side cover. See Fig. 45. Discard the two-piece seal and Teflon® washer.
12. Remove the trunnion cover O-ring (Fig. 46), the two-piece sector shaft seal, and the Teflon® backup washer from the trunnion cover. See Fig. 47. Discard the seal, washer, and the O-ring.
13. Loosen the worm shaft preload adjusting screw jam nut with a 15/16-inch socket. Loosen the worm shaft preload adjusting screw approximately two turns with a 5/16-inch allen socket or screwdriver. See Fig. 48. Loosen the poppet adjusting screw jam nut and the end cover poppet adjusting screw approximately two turns.
14. Remove the four end cover bolts with a 13/16-inch socket (Fig. 49) and remove the four washers.
15. Remove the end cover. See Fig. 50. Some fluid will drain.
16. Remove and discard the end cover O-ring from the end cover. See Fig. 51.
17. Clean any paint or foreign material from the input shaft with a fine grade of emery paper. See Fig. 52.

Fig. 44

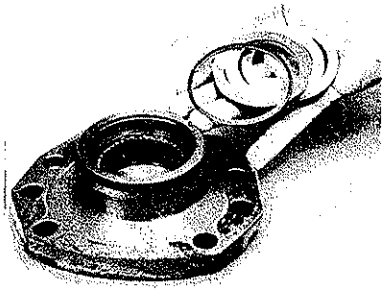


Fig. 45

Fig. 46

Fig. 47

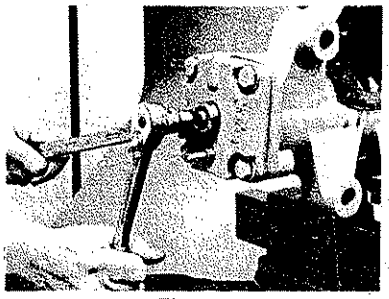


Fig. 48

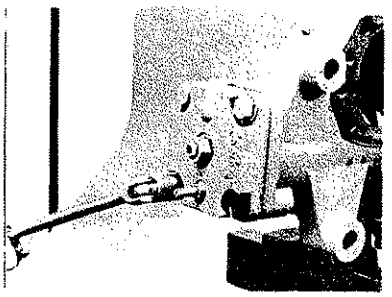


Fig. 49

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

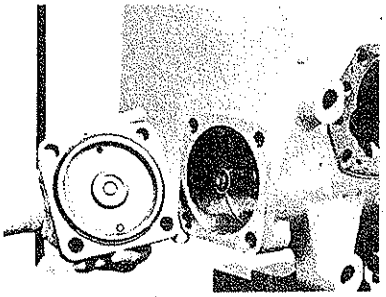


Fig. 50

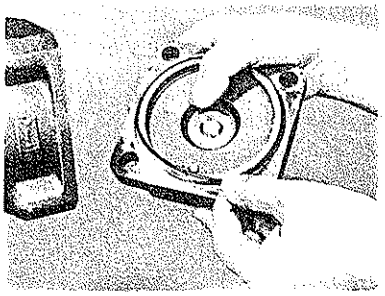


Fig. 51

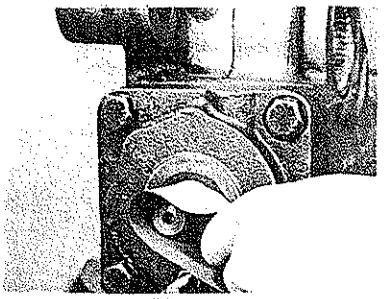


Fig. 52

18. Loosen the poppet adjusting screw jam nut and the poppet adjusting screw in the valve housing approximately two turns.

19. Remove the four valve housing bolts with a 13/16-inch socket. See Fig. 53. Remove the valve housing. See Fig. 54. Some fluid will drain.

NOTE: The valve sleeve will probably remain in the valve housing.

WARNING: Do not disassemble the worm shaft/ input shaft assembly, which includes the worm shaft, input shaft torsion bar, torsion bar pins, drive ring, drive ring retainer, and inner seal. Do not unbend the drive ring retainer tangs which hold the drive ring in place. See Fig. 55. Doing either will alter the valve timing which could cause the vehicle to pull to one side or the other.

20. Remove the valve sleeve from the valve housing. See Fig. 56.

21. Remove the first thrustwasher and the thrust bearing, and then the second thrustwasher from the valve housing. See Fig. 57.

NOTE: The first thrustwasher may stay on the end of the valve sleeve.

22. Remove and discard the valve housing O-ring from the valve housing.

23. Remove and discard the valve housing dirt and water seal. See Fig. 58.

24. Remove the valve housing retaining ring. See Fig. 59.

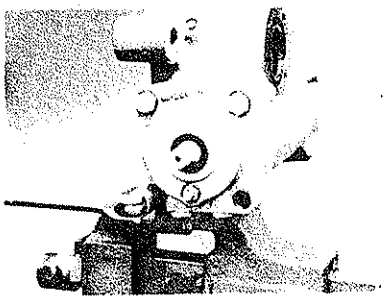


Fig. 53

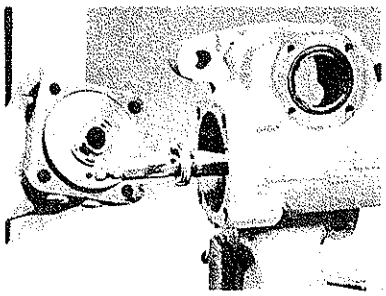


Fig. 54

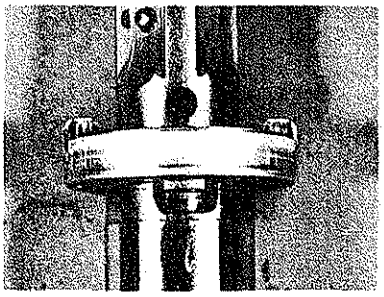


Fig. 55

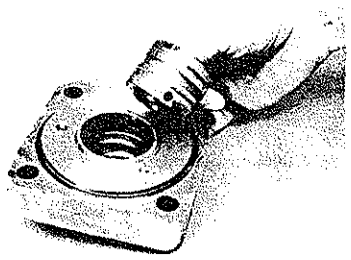


Fig. 56

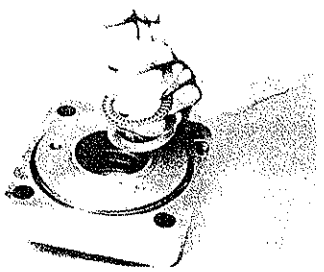


Fig. 57

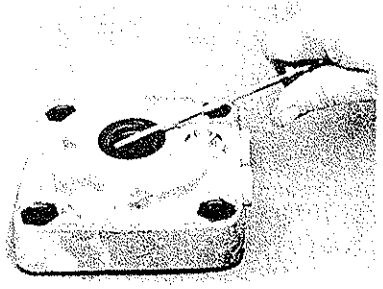


Fig. 58

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

25. Remove the steel backup washer, and the two-piece input shaft seal from the valve housing. See Fig. 60. Discard the seal.
26. Remove and discard the two Teflon® seal rings. See Fig. 61.
27. Remove the two backup O-rings from the valve sleeve grooves. See Fig. 62.
28. Remove the rack piston and worm shaft/input shaft assembly from the gear housing. See Fig. 63.

NOTE: The worm shaft part of the assembly will be inside the rack piston, with the input shaft part of the worm protruding from the rack piston. Take care when removing this assembly from the housing. To prevent the Teflon® rack piston seal from getting caught in the sector shaft cavity, remove the worm shaft rack piston assembly from the long end of the housing.

29. Lay the rack piston and worm shaft assembly on a clean towel to keep the piston from rolling.
30. For models with the ball return guide clip (see Fig. 3, Ref. 43), bend the tangs down on the two locking tabs (Fig. 64), and remove the ball return guide clip (Fig. 65).

    For models with the ball return guide cap (see Fig. 3, Ref. 45) remove the two allen head bolts (Fig. 66) and the ball return guide cap (Fig. 67). Then, remove the ball return guide cap seal.
31. Remove the two ball return guides (Fig. 68) and the balls from the rack piston by rotating the worm shaft until the balls fall out. See Fig. 69.

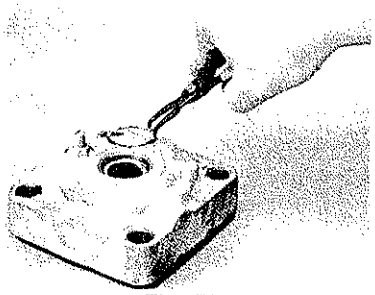


Fig. 59

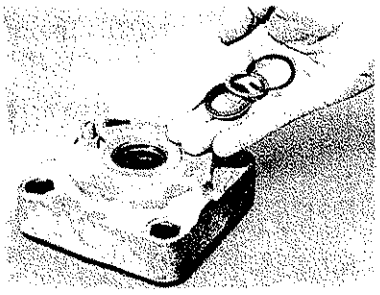


Fig. 60

Fig. 61

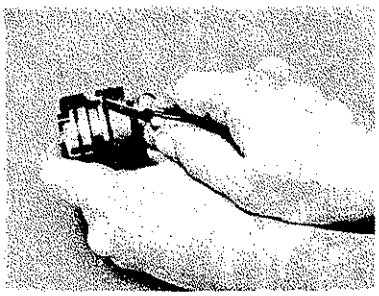


Fig. 62

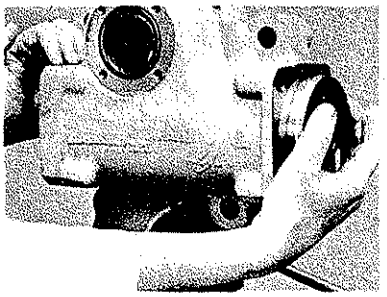


Fig. 63

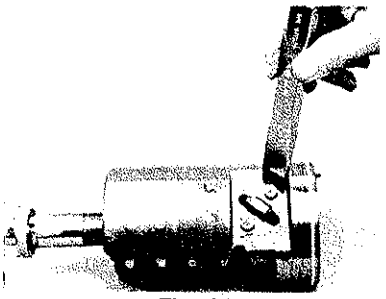


Fig. 64

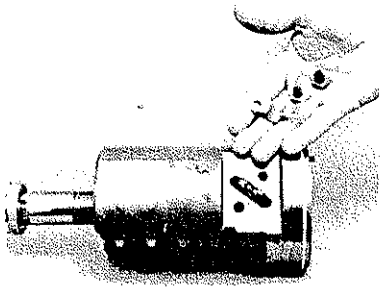


Fig. 65

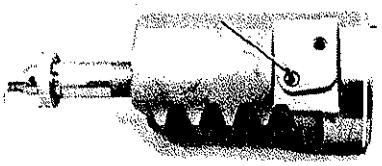


Fig. 66

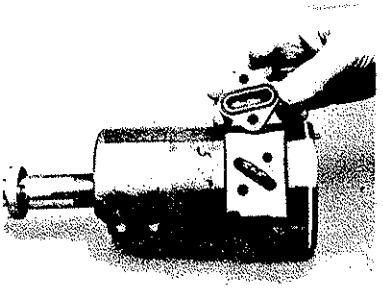


Fig. 67

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

NOTE: The ball return guides are closely fitted with the rack piston and you may have to remove them by carefully inserting a screwdriver between the rack piston and the ball return guides. See the composite picture of both types in Fig. 70.

CAUTION: The assembly contains a set of 34 matched balls, and you must take special care not to lose any. If any balls are lost, a complete, new set of matched balls will be required.

32. Remove the worm shaft from the rack piston. See Fig. 71.
33. Remove and discard the rack piston seal ring. See Fig. 72.
34. Remove and discard the rack piston backup O-ring (Fig. 73) from the rack piston.
35. Remove and discard the worm shaft seal ring. Then, remove and discard the worm shaft O-ring from the worm shaft. See Fig. 74.

CAUTION: This completes the extent that the worm shaft may be disassembled for service. Do not disassemble the worm shaft further.

36. It is not usually required to service the poppet assembly. If required, however, position the rack piston carefully in a vise equipped with soft jaws. Then, remove the two retaining rings (Fig. 75), two poppet seats (Fig. 76), two poppets, nylon spacer rod, and the spring (Fig. 77).

WARNING: Eye protection must be worn when removing the poppets.

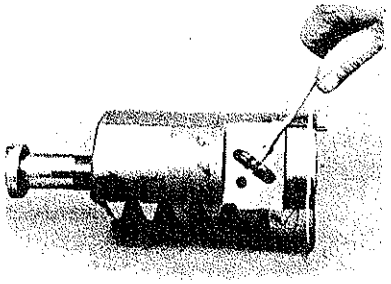


Fig. 68

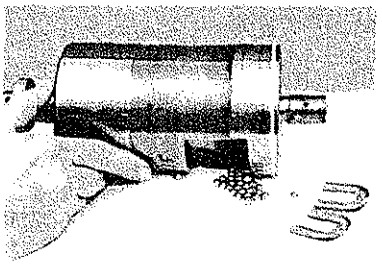


Fig. 69

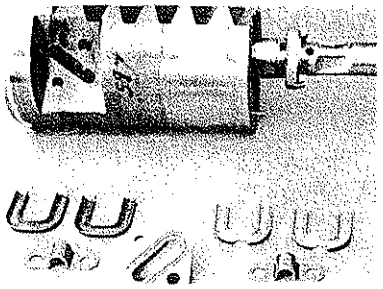


Fig. 70

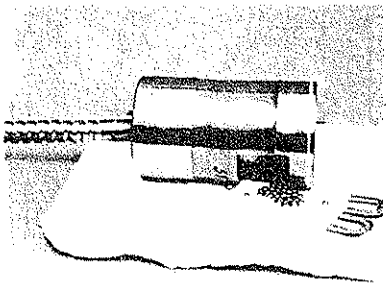


Fig. 71

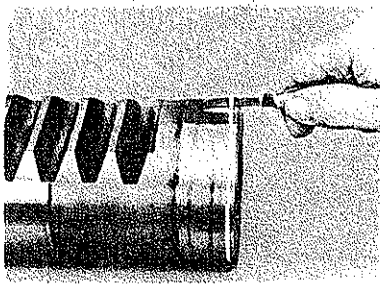


Fig. 72

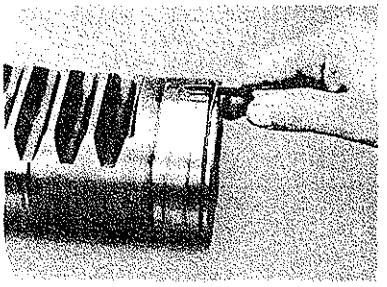


Fig. 73

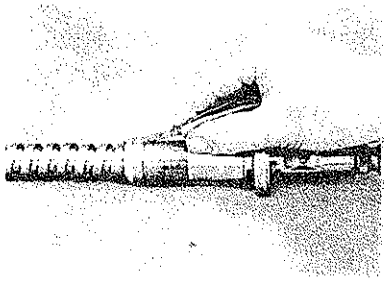


Fig. 74

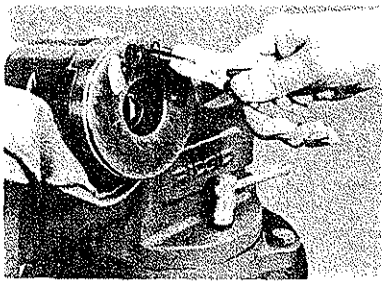


Fig. 75

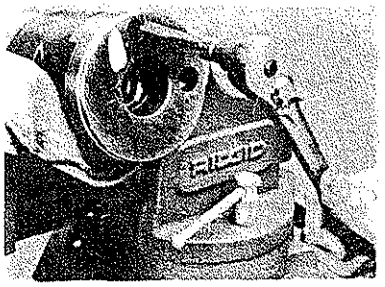


Fig. 76

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

PARTS INSPECTION AND REPLACEMENT

All sealing surfaces and seal cavities must be free from nicks and corrosion. If you detect any nicks or corrosion, you must replace the part to ensure proper sealing. Before you inspect the steering gear, wash all parts in clean, clear solvent and blow dry with air. See Fig. 78.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

1. Inspect the rack piston teeth for cracks and wear. If you can detect a step by running your fingernail horizontally across the teeth surface, replace the rack piston. See Fig. 79.
2. Inspect the rack piston ball track grooves (helical shaped) for brinelling (dents) or spalling (flakes). See Fig. 80. If either condition exists, the rack piston, valve sleeve, sector shaft, and worm shaft must be replaced.
3. Inspect the worm shaft ball-track grooves (helical shaped) for brinelling or spalling. See Fig. 81 for an example of how the ball sits properly on the track and to see normal machine marks on the shaft. Visually inspect the upper input shaft seal area near the serrations for nicks, and run your fingernail edge across the sealing surface to detect steps.

NOTE: The input shaft is pinned to the worm shaft by the torsion bar pin, and the worm shaft/input shaft assembly is flexible at this joint. As a result, the assembly may be slightly bent at this joint. See Fig. 82. This slight bend is normal.

4. Inspect the housing cylinder bore. See Fig. 83. Minor scoring marks running lengthwise through the bore are normal and should not be compared to the scoring that might be found in the cylinder bores of an internal combustion engine. Replace the housing only if it has been tested for internal leakage, and it is determined that the scoring is responsible for the excessive internal leakage (greater than 1.5 gpm [5.7 Lpm]). For test procedures, refer to the hydraulic power steering gear checking, testing, and troubleshooting subject in the 14 Group of this manual.

NOTE: In evaluating this test, make sure that internal leakage exceeding 1.5 gpm (5.7 Lpm) can only be attributed to the housing, and not to the seals in the worm shaft, rack piston, and valve assembly.

5. Check the housing faces for nicks which would prevent proper sealing. Replace the housing if these nicks are present. See Fig. 83.

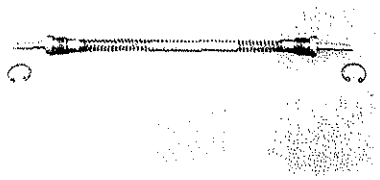


Fig. 77

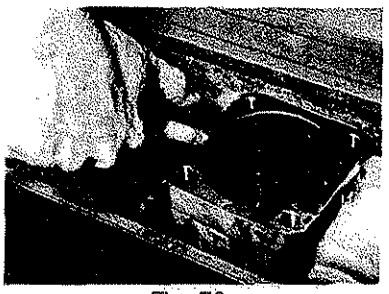


Fig. 78

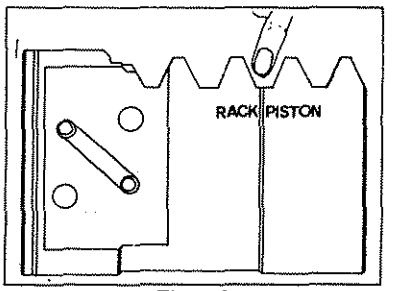


Fig. 79

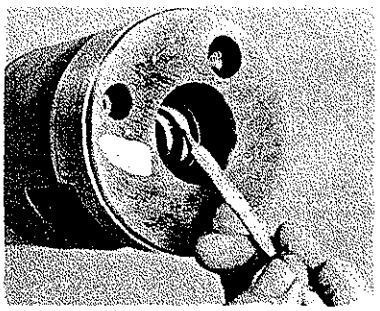


Fig. 80

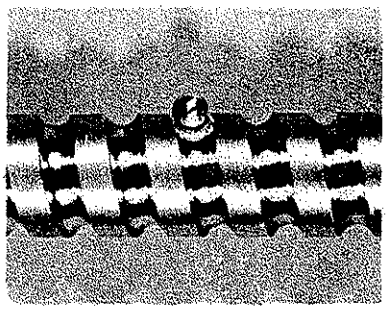


Fig. 81

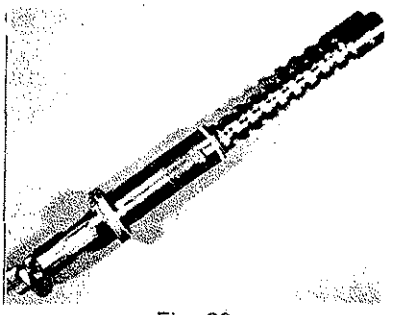


Fig. 82

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

6. Inspect the housing bearing for brinelling or spalling. See Fig. 84. If either condition exists, or if one or more of the rolls is lost, replace the housing bearing. For instructions, refer to step 8, under "STEERING GEAR DISASSEMBLY," then step 2, under "STEERING GEAR ASSEMBLY."

   Inspect the side cover bearing for brinelling or spalling. If the side cover bearing is damaged, replace the complete side cover assembly.

7. Inspect the sector shaft bearing sealing areas for brinelling or spalling. See Fig. 85. Run your fingernail edge across these areas to detect steps. Inspect also for cracks. If any of these conditions exists, replace the sector shaft.

8. Inspect the thrust bearing rollers for any deterioration. Inspect the two thrustwashers for brinelling, spalling, or cracks. See Fig. 87. Replace any part if you detect these conditions.

STEERING GEAR ASSEMBLY (Refer to Fig. 86)

After inspection, clean all parts again in a clean petroleum-based solvent, and blow them dry with air.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

All gaskets, seals, and seal rings, must be replaced with new ones each time the gear is disassembled. Replace those gaskets, seals, and seal rings from any disassembled part. Individual seals, seal rings, and gaskets, as well as complete seal kits (see Fig. 88) are available from Freightliner parts distributors.

1. Using Kent-Moore seal installation tool J26739, assemble the new worm shaft backup O-ring (Fig. 89), then the new Teflon® worm shaft seal into the worm shaft ring groove. See Fig. 90. Compress the seal with the Kent-Moore seal compression tool J26740, and set the worm shaft aside for 10 minutes. See Fig. 91.

CAUTION: Allow for this time to ensure that the ring and seal are properly seated when you assemble the worm shaft into the rack piston. If you do not allow for this time, the seal may break when you put the worm shaft into the rack piston.

2. If required, press the new housing bearing into the housing from the side cover, using Kent-Moore bearing mandrel J26743. See Fig. 92. Care must be taken during this procedure to make certain that the housing is square with the press base and that the bearing is not cocked. Apply a generous amount of clean wheel bearing grease to the bearing race to retain the bearing rolls. Place the bearing rolls into the bearing race. Be sure that you have counted the rolls correctly and have matched the quantity with the correct part number. Grease must retain the rolls.

NOTE: If you are installing bearing BR-970, install 41 rolls. If you are installing bearing BR-970-1, install 42 rolls.

WARNING: The rolls must be in place to ensure proper installation of the bearing. If the rolls are not in place, the bearing race may collapse and fail. The flange may become damaged or broken, causing premature bearing failure. Do not mix the housing bearing rolls with the side cover bearing rolls. Interchanging the rolls could result in bearing or seal failure, which could cause a loss of steering.

3. Install the new rack piston backup O-ring (Fig. 93), and the new Teflon® rack piston seal ring (Fig. 94), into the rack piston ring groove. Do not stretch the rings as you install them. Coat with a liberal amount of grease.

Fig. 83

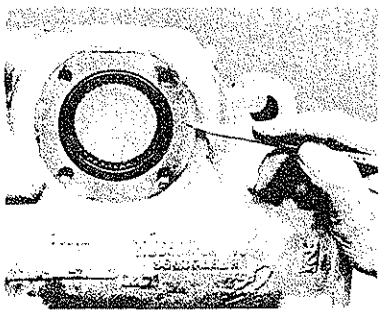


Fig. 84

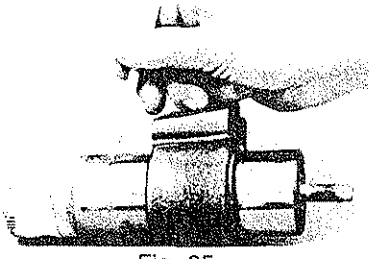
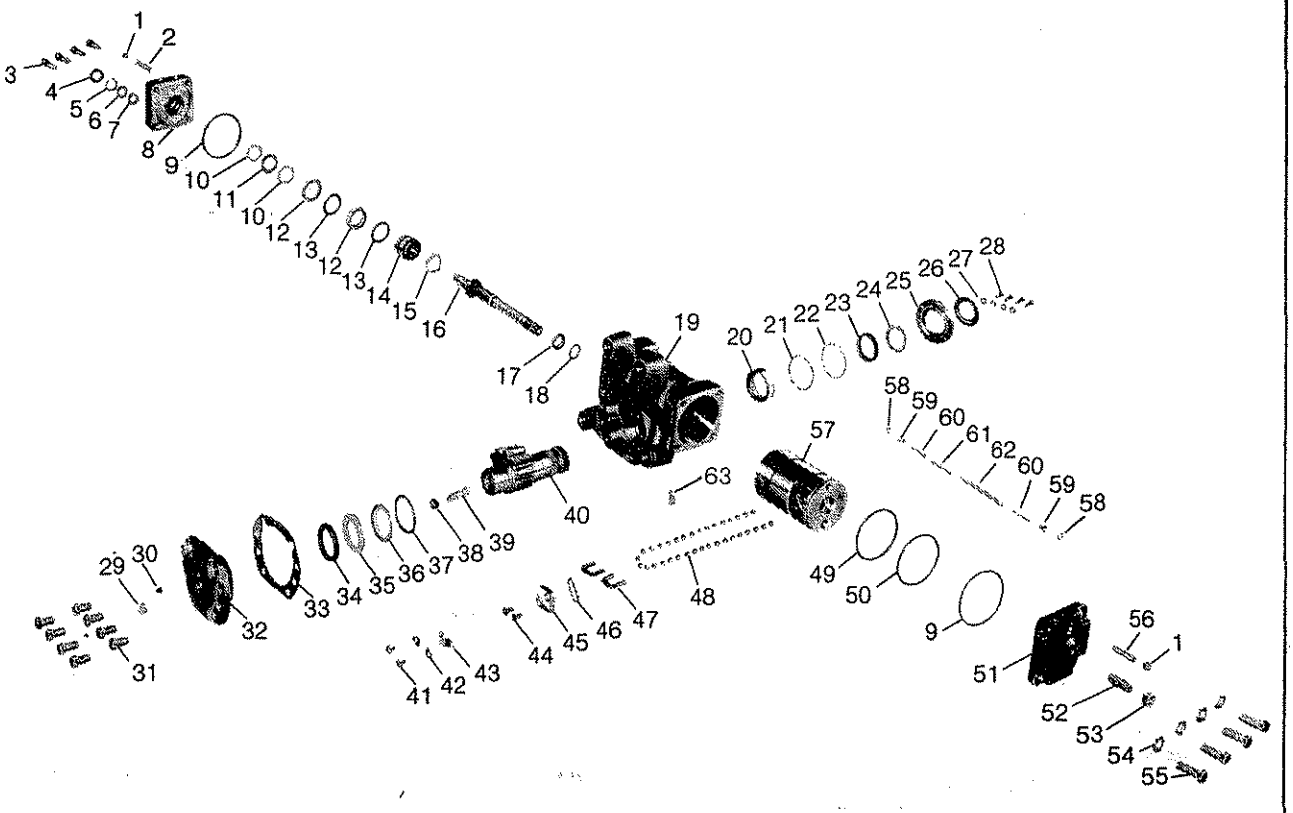


Fig. 85

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Poppet Screw Jam Nuts
2. Poppet Adjusting Screw
3. Valve Housing Bolts
4. Dirt and Water Seal
5. Retaining Ring
6. Steel Backup Washer
7. Two-Piece Input Shaft Seal
8. Valve Housing
9. End Cover and Valve Housing O-Rings
10. Thrustwashers
11. Thrust Bearing
12. Teflon® Seal Rings
13. Backup O-Rings
14. Valve Sleeve
15. Drive Ring
16. Worm (Input) Shaft
17. Worm Shaft Backup O-Ring
18. Teflon® Worm Shaft Seal
19. Housing
20. Housing Bearing
21. Retaining Ring
22. Trunnion Cover O-Ring
23. Two-Piece Sector Shaft Seal
24. Teflon Backup Washer
25. Trunnion Cover
26. Trunnion Cover Dirt and Water Seal
27. Trunnion Cover Washers
28. Trunnion Cover Bolts
29. Jam Nut
30. Vent Plug
31. Special Ring Head Bolts
32. Side Cover
33. Side Cover Gasket
34. Steel Backup Washer
35. Teflon® Backup Washer
36. Two-Piece Side Cover Seal
37. Retaining Ring
38. Retainer
39. Sector Shaft Adjusting Screw
40. Sector Shaft
41. Hex Head Bolts
42. Lock Tabs
43. Ball Return Guide Clip
44. Allen Head Bolts
45. Ball Return Guide Cap
46. Ball Return Guide Cap Seal
47. Ball Return Guides
48. Balls
49. Rack Piston Backup O-Ring
50. Teflon® Rack Piston Seal
51. End Cover
52. Worm Shaft Preload Adjusting Screw
53. Worm Shaft Adjusting Screw Jam Nut
54. End Cover Washers
55. End Cover Bolts
56. Poppet Adjusting Screw
57. Rack Piston
58. Retaining Rings
59. Poppet Seats
60. Poppets
61. Spacer Rod
62. Spring
63. Bleed Screw*

*On Some Models

Fig. 86, Ross HFB70 Steering Gear

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

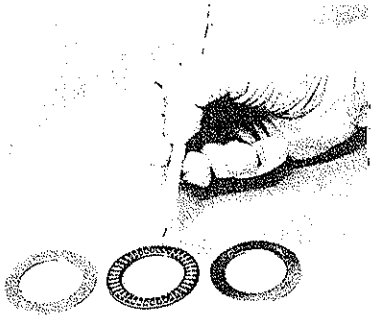


Fig. 87

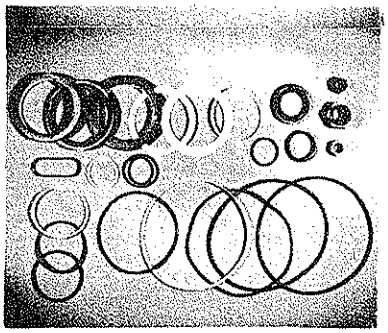


Fig. 88

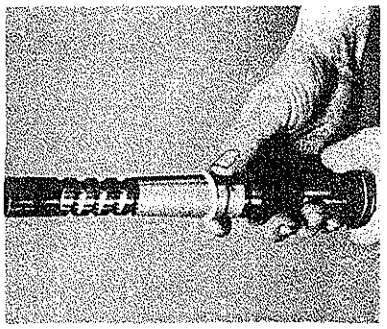


Fig. 89

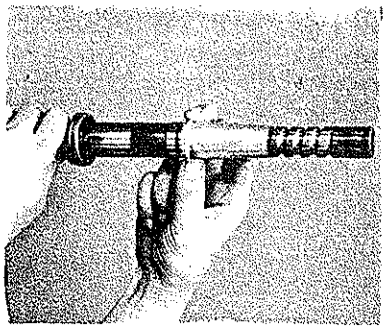


Fig. 90

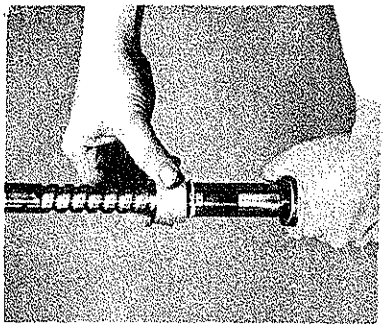


Fig. 91

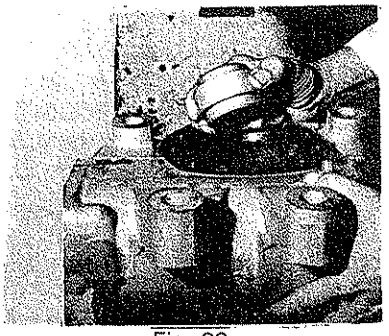


Fig. 92

4. If the poppets were removed, install the poppet assembly into the rack piston in the following order: one poppet seat (Fig. 95); one poppet; the poppet spring (Fig. 96); the nylon spacer rod; the other poppet; and the other poppet seat. Tighten the poppet seats 20 to 25 lbf·ft (27 to 34 N·m). See Fig. 97. Install both retaining rings.

WARNING: Eye protection must be worn as the poppet spring can eject the poppets and poppet seats, and become harmful projectiles.

5. Grease the seal ring cavity in the rack piston and install the worm shaft into the rack piston. See Fig. 98.

IMPORTANT: Steps 6 and 7, below, describe the installation of the rack piston balls, guides, and caps or clips. Read through each step carefully to determine the steps you should follow.

NOTE: If your ball return guides do not have a hole in the top (see Fig. 70), proceed to step 7. If your ball return guides do have a hole in the top (see Fig. 70), proceed to step 6.

6. For ball return guides with a hole in the top (see Fig. 70), proceed as follows:

   .1 Assemble the ball return guides into the rack piston. Make sure that the ball return guides are seated.

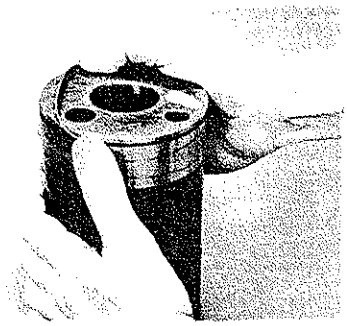


Fig. 93

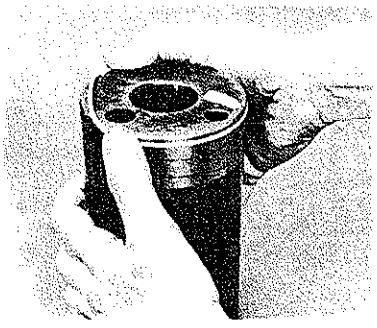


Fig. 94

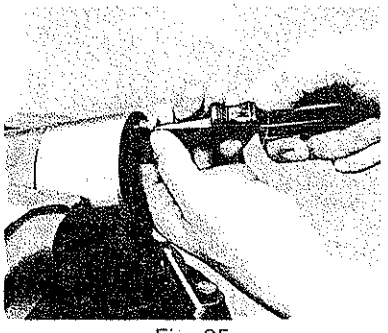


Fig. 95

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

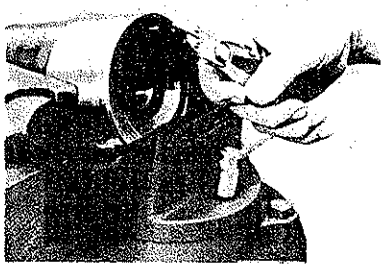


Fig. 96

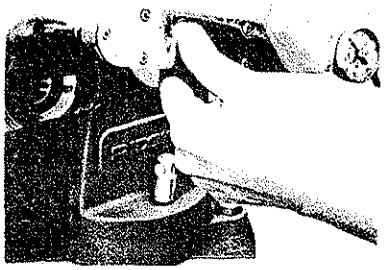


Fig. 97

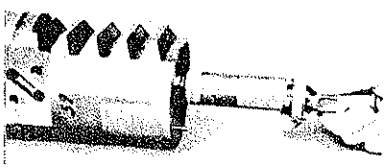


Fig. 98

.2 Assemble the 34 balls into the ball return guides and rack piston. Drop the balls through the hole provided in the ball return guides. As you drop the balls, rotate the worm shaft to pull the balls down into the grooves (Fig. 99). Read the warning, then proceed to step 8.

WARNING: Make sure the ball return guide stays down in while you assemble the balls. Failure to hold the guide down may result in a ball being trapped outside the closed loop. A trapped ball can result in a steering lockup, which could cause an accident.

7. For ball return guides without a hole in the top, proceed as follows:

.1 Insert the eraser end of a pencil into one hole of the rack piston as far as it will go. Drop 22 balls (of the 34 total) into the other hole of the rack piston. See Fig. 100. Turn the worm shaft to advance the balls toward the other hole. You will feel resistance at the pencil after you drop the 22nd ball. At this time, a ball will be visible at the base of each hole. Remove the pencil.

WARNING: Do not turn the worm shaft or allow the rack piston to move after you remove the pencil. If the worm shaft or rack piston moves, a ball may move into the dead track beyond the ball return guides. This can result in a steering lockup, which could cause an accident.

.2 Coat the ball return guides liberally with grease and insert the remaining 12 balls into a guide half (Figs. 101 and 102). Join the guide halves together and install this subassembly into the rack piston. Proceed to step 8.

8. If equipped with the ball return guide clip (see Fig. 65), assemble the ball return guide clip making certain that both bolt hole faces are in full contact with the rack piston surface. Install the two lock tabs and the two hexagon head bolts. Tighten the bolts 15 to 19 lbf·ft (20 to 26 N·m). See Fig. 103. Finish by bending up the lock tabs against the bolt heads. See Fig. 104.

If equipped with the ball return guide cap (see Fig. 67), grease the ball return guide cap seal and place it in the ball return guide cap groove. Assemble the ball return guide cap so that the seal is in full contact with the rack piston surface (Fig. 105). Install the two allen head bolts and tighten them 15 to 19 lbf·ft (20 to 26 N·m). See Fig. 106.

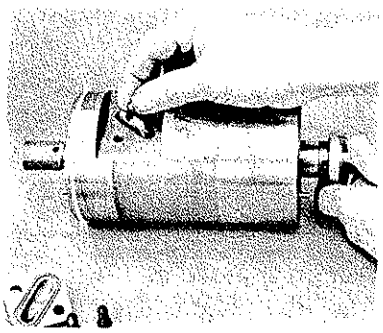


Fig. 99

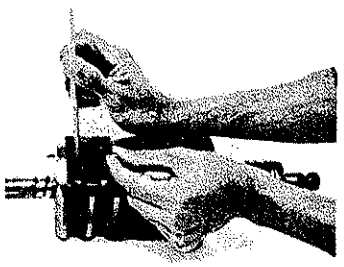


Fig. 100

Fig. 101

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

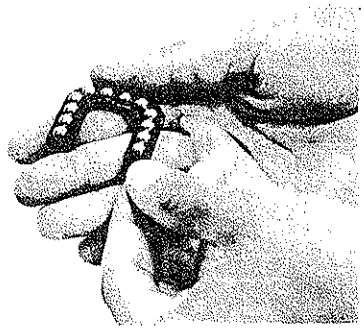


Fig. 102

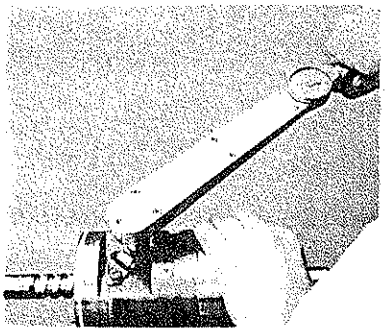


Fig. 103

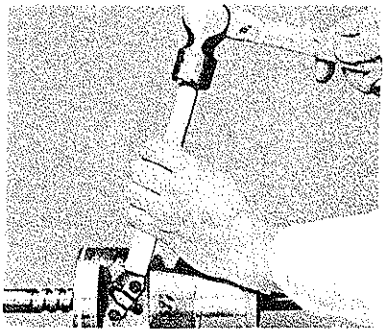


Fig. 104

WARNING: Rotate the worm shaft from end of travel to end of travel, to make certain that you have installed the balls properly. If you cannot rotate the shaft, you will have to remove the balls and assemble them again. If you install the gear on a truck with the shaft unable to rotate, the gear will not function.

9. Apply a generous amount of clean grease to the Teflon® rack piston seal (Fig. 107) and to the housing cylinder bore.

   Install the rack piston and worm shaft assembly into the long end of the gear housing so that the Teflon® rack piston seal goes in last. See Fig. 108.

CAUTION: Be certain that the seal goes into the long end of the housing last. Otherwise, a large section of the seal will be cut, and the vehicle will have no power steering assist.

NOTE: To ease the later assembly of the sector shaft, rotate the rack piston and worm shaft assembly in the housing so that the rack piston teeth are exposed in the sector shaft cavity of the housing.

10. Assemble the worm shaft adjusting screw jam nut onto the solid (nonslotted) end of the worm shaft preload adjusting screw, so that the seal on the jam nut faces the end cover. Assemble one poppet valve adjusting screw jam nut onto the poppet valve adjusting screw and assemble the other poppet valve adjusting screw jam nut onto the other poppet valve adjusting screw in the same manner as described for the worm shaft adjusting screw jam nut and worm shaft preload adjusting screw.

NOTE: The poppet valve adjusting screws may or may not be of the same length. If not the same length, assemble the shorter adjusting screw (Fig. 86, Ref. 56) into the end cover a few turns.

WARNING: If the screws are unequal in length, you must install the shorter screw into the end cover. Otherwise, the poppet assembly may break and cause the steering gear to lock up, possibly resulting in an accident.

11. Assemble the worm shaft preload adjusting screw into the end cover a few turns.

NOTE: Final adjustments for steps 10 and 11 above, will be made later.

12. Apply clean grease to the end cover O-ring groove on the end cover. Install the new end cover O-ring into the end cover O-ring groove. See Fig. 109.

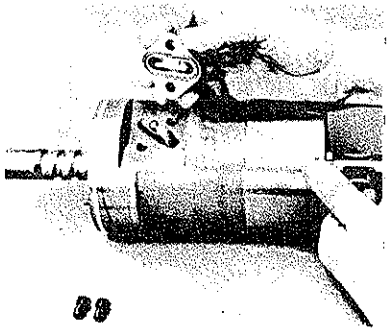


Fig. 105

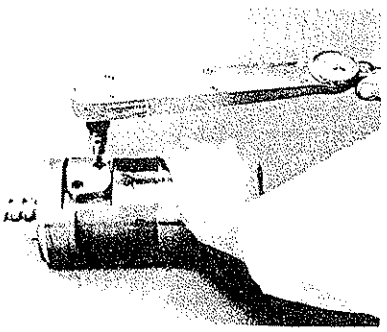


Fig. 106

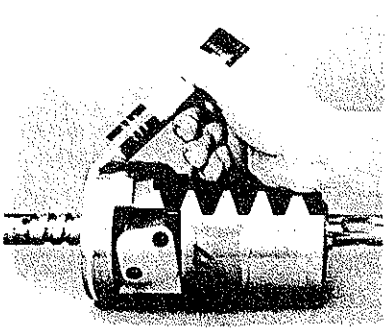


Fig. 107

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

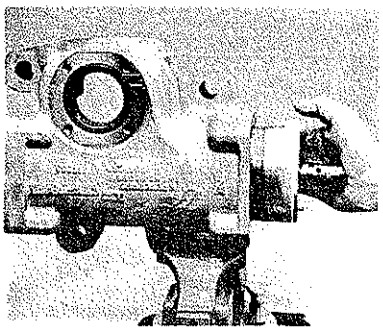


Fig. 108

NOTE: When installed, the end cover O-ring should extend slightly above the machined surface of the end cover.

CAUTION: When performing step 13 below, make sure that the rack piston teeth are fully visible in the sector shaft cavity of the housing. This is necessary to ensure proper location of the poppets, and to ensure that the poppet adjusting screw will contact the poppets.

13. Position the end cover so that the poppet adjusting screw is aligned with the end of the poppet. See Fig. 110.

    Install the four end cover bolts (Fig. 86, Ref. 55) and washers, and tighten the bolts 145 to 155 lbf·ft (197 to 210 N·m). See Fig. 111.

14. Grease the two new backup O-rings and the two new Teflon® seal rings. Using Kent-Moore seal installation tool J26741, assemble the backup O-rings (Fig. 112), then the Teflon® seal rings into the valve sleeve (Fig. 113).

15. Use Kent-Moore compression tool J26742 to compress the Teflon® seal rings. See Fig. 114. Leave the compression tool on for 10 minutes.

CAUTION: If you do not allow for this compression time, the valve sleeve assembly will be difficult to assemble into the valve housing, and the seal may be cut during this assembly.

16. Assemble the poppet valve adjusting screw into the valve housing 4 or 5 turns. Final adjustments will be made later.

17. Apply clean grease to the valve housing O-ring groove. Install the new valve housing O-ring into the valve housing O-ring groove. See Fig. 115.

NOTE: When installed, the valve housing O-ring should extend slightly above the machined surface of the valve housing.

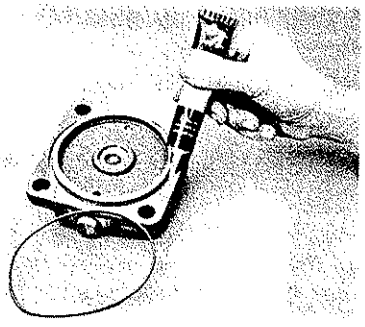


Fig. 109

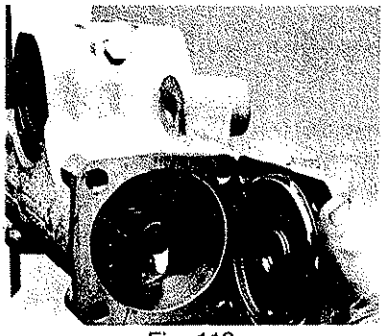


Fig. 110

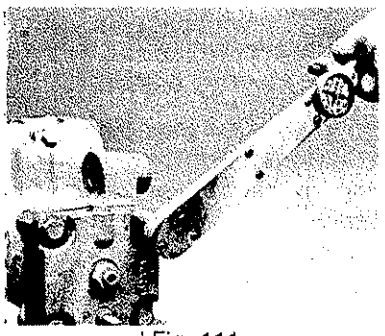


Fig. 111

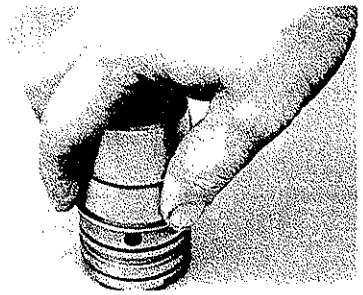


Fig. 112

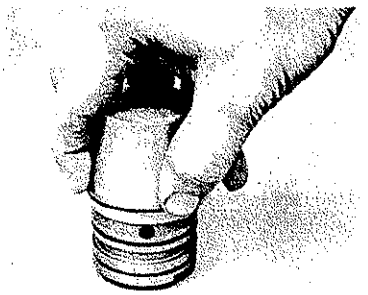


Fig. 113

Fig. 114

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

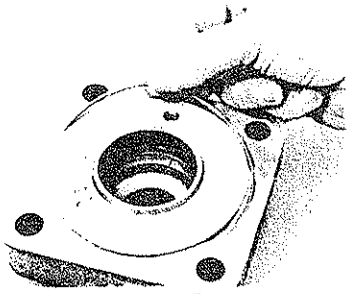


Fig. 115

18. Apply a generous amount of clean grease to one thrustwasher. Install the thrustwasher into the valve housing, making sure to center the thrustwasher. See Fig. 116.

19. Apply a generous amount of clean grease to the thrust bearing. Install the thrust bearing into the valve housing (onto the thrustwasher), making sure to center the bearing on the washer. See Fig. 117.

WARNING: The thrustwasher and thrust bearing must be flat and centered in the counterbore surface (Fig. 118). Otherwise, the thrustwasher could break when you assemble the valve housing into the gear housing. A broken washer could cause uncontrollable steering, possibly resulting in an accident.

20. Remove the Kent-Moore compression tool J26742 from the valve sleeve. Apply more grease to the valve sleeve seals, and grease the thrustwasher face on the end of the valve sleeve without the drive slots. Place the other thrustwasher onto the valve sleeve end without the drive slots. See Fig. 119.

WARNING: This thrustwasher must be secure on the valve sleeve. If not, it can break and cause uncontrollable steering, possibly resulting in an accident.

21. Assemble the valve sleeve with the attached thrustwasher down into the valve housing. See Fig. 120. When the valve sleeve is down in place, it should measure between 0.370- and 0.400-inch (9 and 10 mm) above the face of the valve housing to the end of the valve sleeve nose. See Fig. 121.

WARNING: Do not force the valve sleeve down into the valve housing. Make sure the valve sleeve seal rings are compressed. Incorrect assembly or measurement may cause the thrustwashers or thrust bearing to break during gear operation, which can cause uncontrollable steering, and loss of vehicle control.

23. Position the rack piston so that it is flush with the open end of the gear housing. Rotate the worm

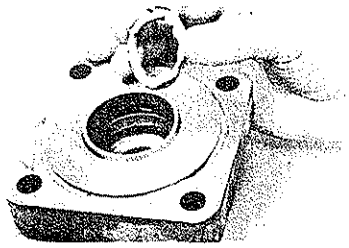


Fig. 116

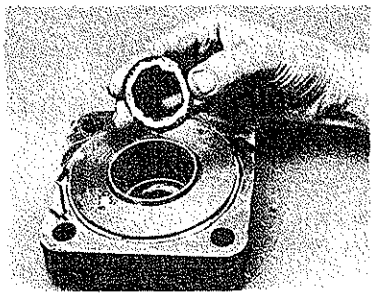


Fig. 117

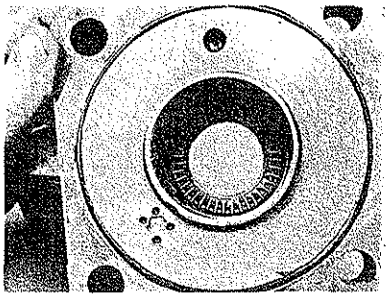


Fig. 118

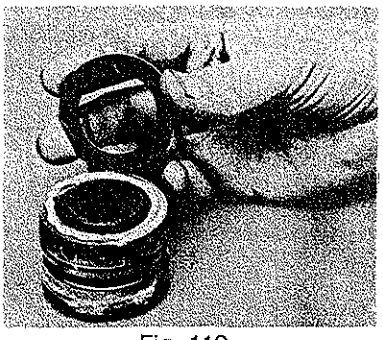


Fig. 119

Fig. 120

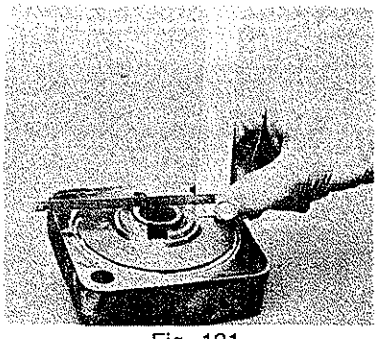


Fig. 121

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

shaft until it extends out of the rack piston as far as it will go.

WARNING: The worm shaft and valve sleeve units are assembled and sold as a matched set. Use only prematched sets for replacement. Never mate an old valve sleeve with a new worm shaft, or an old worm shaft with a new valve sleeve. To do so can damage the gear or injure the driver during operation.

24. Locate the timing mark on the valve sleeve, a faint, punched mark on the chamfered edge of the valve sleeve. See Fig. 122. Locate the scribed timing mark on the worm shaft (see Fig. 55).

    Next, grasp the valve housing and valve sleeve assembly with your thumbs on the valve housing face, and your fingers applying pressure to keep the valve sleeve in the valve housing (Fig. 123). Align the previously located timing marks and place the valve housing and valve sleeve assembly onto the input shaft end of the worm shaft until the drive lugs are fully engaged (Fig. 124).

NOTE: Valve sleeves are identified and matched to the right- or left-hand lead of the worm screw. If the screw has a right-hand thread (that is, goes into the rack piston when turned clockwise), the correct valve spool will have the letter "R" stamped between the seal lands. For a left-hand worm lead (which will come out of the rack piston when turned clockwise), the valve spool has no identifying mark between the seal lands.

WARNING: If an incorrect-hand valve spool is placed on a worm shaft and assembled into the gear, the gear will not function correctly. Rather, the mechanism will malfunction by turning the steering wheel with such force that it could injure the driver.

25. Maintain pressure on the valve end of the valve housing to ensure continued engagement of the drive lugs and thrust bearing package (Fig. 125). While maintaining this pressure, rotate the valve housing to align the poppet adjusting screw with the poppet in the rack piston. Continue applying pressure and rotate the input shaft to bring the valve housing into contact with the gear housing face.

26. Install the four valve housing bolts in the housing. Torque the bolts 145 to 155 lbf·ft (197 to 210 N·m). See Fig. 126.

27. Apply a generous amount of clean *wheel bearing grease* (do not substitute another type of grease) to the bearing race inside the side cover.

CAUTION: Use only wheel bearing grease. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use wheel bearing grease could result in premature bearing wear.

28. Assemble 41 or 42 rolls in the side cover bearing race. Grease must retain the rolls (Fig. 127).

IMPORTANT: You will have 41 or 42 rolls to assemble into the side cover bearing. If equipped with bearing BR-970, assemble 41 rolls. If equipped with bearing BR-970-1, assemble 42 rolls. Do not mix these rolls for the side cover with the rolls for the trunnion cover side of the gear housing.

29. Assemble the steel backup washer, the new Teflon® backup washer, and the new two-piece side cover seal, into the side cover. Assemble the two-piece seal so that the words "OIL SIDE" are visible. See Fig. 128.

WARNING: The words "OIL SIDE" must be visible once the seal is in place. Otherwise, the seal will not function, which could result in a loss of power steering assist.

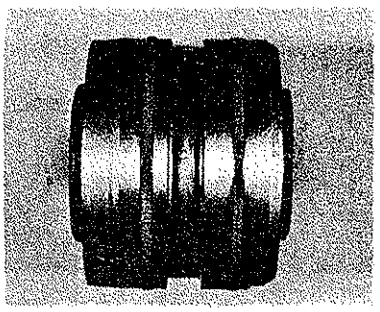


Fig. 122

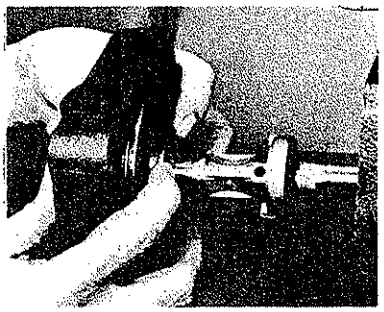


Fig. 123

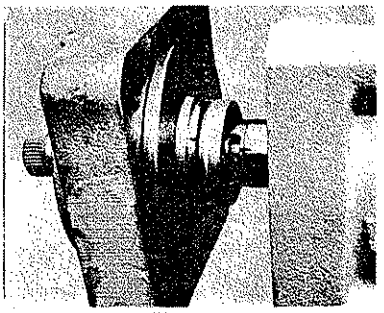


Fig. 124

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

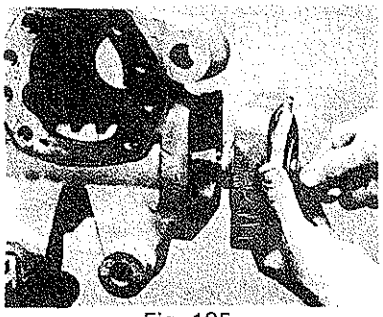


Fig. 125

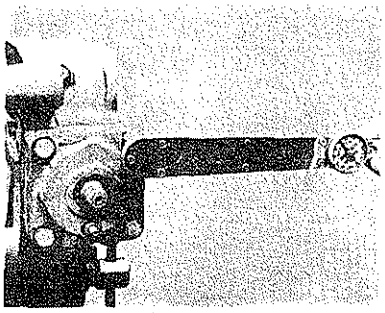


Fig. 126

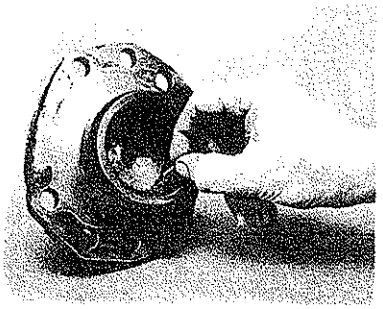


Fig. 127

30. Assemble the side cover retaining ring into the ring groove of the side cover. See Fig. 129.

31. Apply a generous amount of clean grease to the short bearing area of the sector shaft. Insert the sector shaft into the side cover. Screw the sector shaft adjusting screw in the side cover until the screw seats. Then, back out the adjusting screw one turn, so that the side cover rotates freely on the sector shaft. See Fig. 130.

32. Install the jam nut onto the sector shaft adjusting screw a few threads. Final adjustment will be made later.

33. Assemble the vent plug into the hole provided on the side cover. Press the vent plug in flush with the side cover. See Fig. 131.

WARNING: Do not weld or otherwise plug this hole permanently. This is a safety vent which functions only if the side cover seal fails. If the seal fails and the plug cannot vent, the steering gear can lock up or otherwise malfunction, resulting in a loss of steering control.

34. Apply clean grease to the new side cover gasket, and assemble it onto the side cover. See Fig. 132. Apply enough grease to hold the gasket in place.

35. There are four teeth on the rack piston (Fig. 133). Position the tooth space between the second and third teeth in the center of the sector shaft cavity (Fig. 134). This will center the rack piston in the cavity.

CAUTION: If the rack piston is not centered, the gear travel will be severely limited in one direction of travel, and significant internal damage to the steering gear can occur when the gear is operated.

36. Clean off any old tape on the sector shaft serrations. Retape the serrations and bolt groove with one layer of tape. Assemble the sector shaft and side cover assembly into the gear housing, with the center tooth of the sector shaft engaging the tooth space between the second and third teeth on the rack piston. See Fig. 135.

WARNING: As you place the sector shaft through the housing bearing, be careful not to knock out any of the bearing rolls (Fig. 136). Do not pinch the side cover gasket. If the bearing rolls are knocked out, or if the side cover gasket is pinched, premature bearing and seal failure may occur, which could result in a loss of power steering assist.

37. Assemble the eight special ring-head bolts, and tighten them 150 to 170 lbf·ft (203 to 231 N·m).

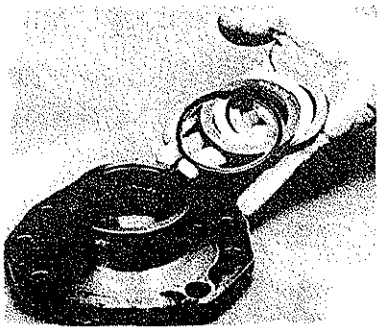


Fig. 128

Fig. 129

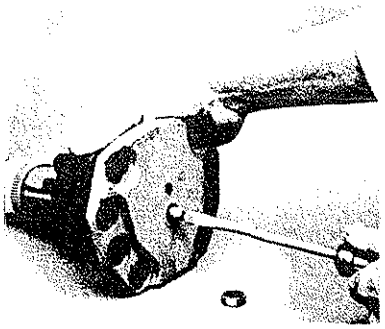


Fig. 130

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

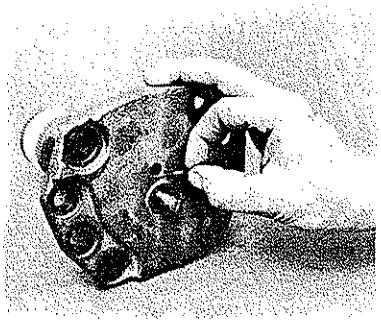


Fig. 131

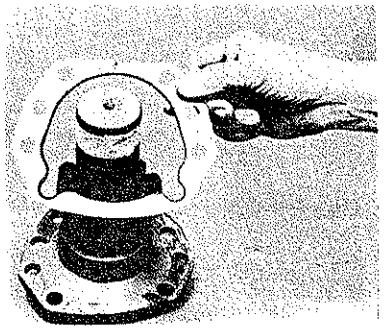


Fig. 132

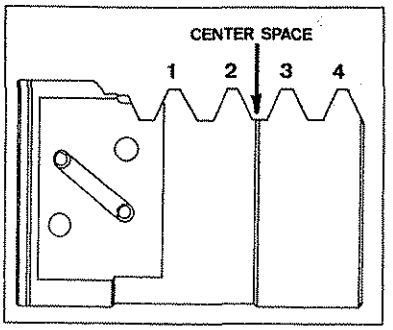


Fig. 133

38. Place the trunnion cover on a bench to install the new seal package. Start with the Teflon® backup washer.
39. Assemble the two-piece sector shaft seal so that the words "OIL SIDE" are visible.

WARNING: The words "OIL SIDE" must be visible. If not, the seal will not function, and a loss of power steering assist may occur. See Fig. 137.

40. Grease the new trunnion cover O-ring, and install it into the trunnion cover O-ring groove.
41. Before installing the trunnion cover and seal assembly onto the housing, visually inspect the housing bearing to ensure that all bearing rolls are properly in place. Then install the trunnion cover (Fig. 138). Install the four trunnion cover bolts, and tighten the bolts 15 to 22 lbf·ft (20 to 30 N·m). See Fig. 139. Pack clean Mobil Temp® 1 or 2 grease or an equivalent around the seal area of the sector shaft. Install a new dirt and water seal using a suitable blunt-end drift.
42. Apply clean grease to the input shaft seal assembly (steel backup washer and two-piece input shaft seal) and to the input shaft. Install the new two-piece input shaft seal (flat side up) and the steel backup washer, using Kent-Moore seal driving tool

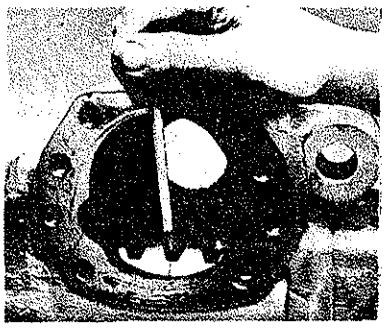


Fig. 134

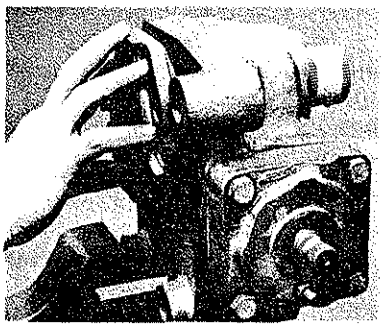


Fig. 135

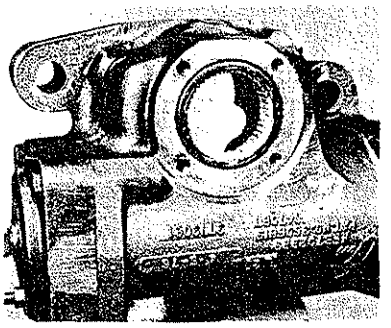


Fig. 136

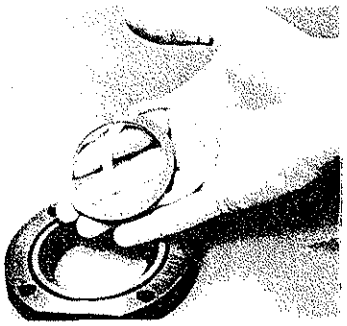


Fig. 137

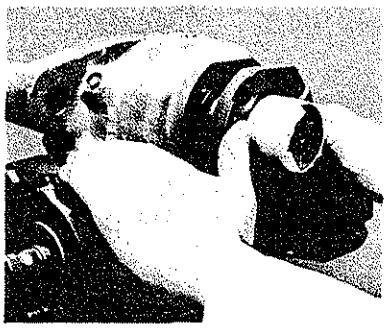


Fig. 138

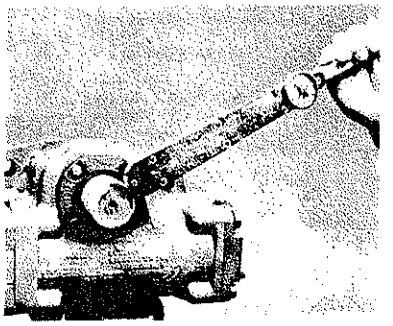


Fig. 139

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

J28490. Install the retaining ring. See **Figs. 140** and **141**.

43. Pack the area around the input shaft with clean Mobil Temp® 1 or 2 grease or an equivalent. Install the dirt and water seal.

FINAL ADJUSTMENTS (Refer to **Fig. 86**)

Before the steering gear can be installed on the vehicle, the final adjustments must be performed as described below.

1. Screw the worm shaft preload adjusting screw finger-tight until it contacts the worm shaft.
2. Adjust the sector shaft adjusting screw while rotating the input shaft 90 degrees each direction until input shaft torque reaches 25 to 30 lbf·in (280 to 340 N·cm). See **Fig. 142**.

NOTE: Use a 12-point socket and an inch-pound torque wrench to rotate the input shaft.

3. Center the steering gear by aligning the sector (output) shaft timing mark halfway between two trunnion cover bolts. The timing mark will be at a right angle to the centerline of the cylinder bore. Back out the sector shaft adjusting screw one turn and note the torque required to rotate the input shaft through 90 degrees each side of center. Move the adjusting screw to provide a rise in torque of 2 to 4 lbf·in (23 to 45 N·cm) at a point within 45 degrees each side of center.

   Tighten the (side cover) jam nut 40 to 45 lbf·ft (54 to 61 N·m). The torque now required to rotate the input shaft must not exceed 28 lbf·in (316 N·cm) at any point in the steering gear travel.

4. Tighten the worm shaft preload adjusting screw 60 to 70 lbf·in (678 to 691 N·cm). Be sure the jam nut does not contact the end cover. Tighten the worm shaft adjusting screw jam nut 70 to 80 lbf·ft (95 to 108 N·m). Be sure the adjusting screw does not move.
5. The torque now required to rotate the input shaft through complete travel should not exceed 50 lbf·in (565 N·cm).

NOTE: 55 lbf·in (621 N·cm) is allowable if fluid is in the gear.

STEERING GEAR INSTALLATION
(Refer to **Fig. 143** or **144**)

1. On COEs with 1984 Advancements, position the steering gear on the steering gear bracket and install two mounting bolts and washers from the inboard side as shown in **Fig. 143**. Install a spacer on the lower mounting bolt. (No spacer is required on the upper bolt, which is installed through the cab mounting bracket.) Install the third mounting bolt, washer and spacer from the outboard side. Install the washers and nuts and tighten the nuts to the torque values in **Table 2**.

   On other COEs, insert the mounting bolts and washers through the frame rail and mounting bracket from the inboard side. Refer to **Fig. 143A**. Install a spacer on each of the bolts. Position the steering gear on the bracket and frame rail. Install the washers and nuts and tighten the nuts to the torque values in **Table 2**.

   On Conventionals with 1984 Advancements, install two mounting bolts and washers from the inboard side as shown in **Fig. 144**. Install a spacer on the two mounting bolts. Position the steering gear on the steering gear bracket. Install the third mounting bolt, washer and spacer from the outboard side. Install the washers and nuts and tighten the nuts to the torque values in **Table 2**.

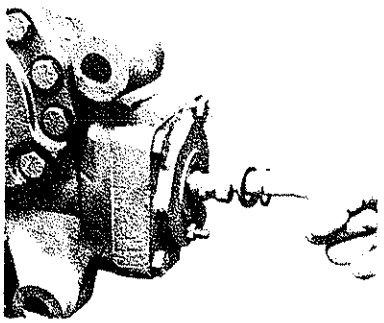


Fig. 140

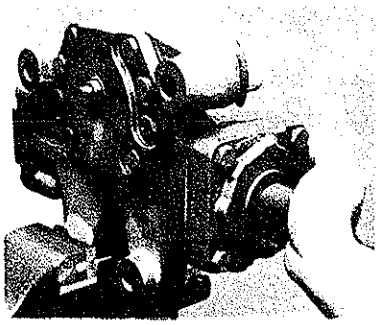


Fig. 141

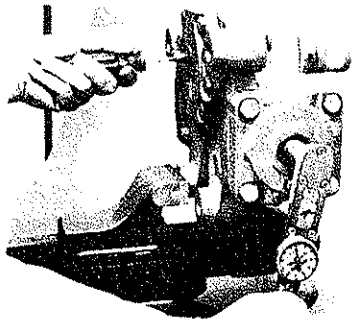
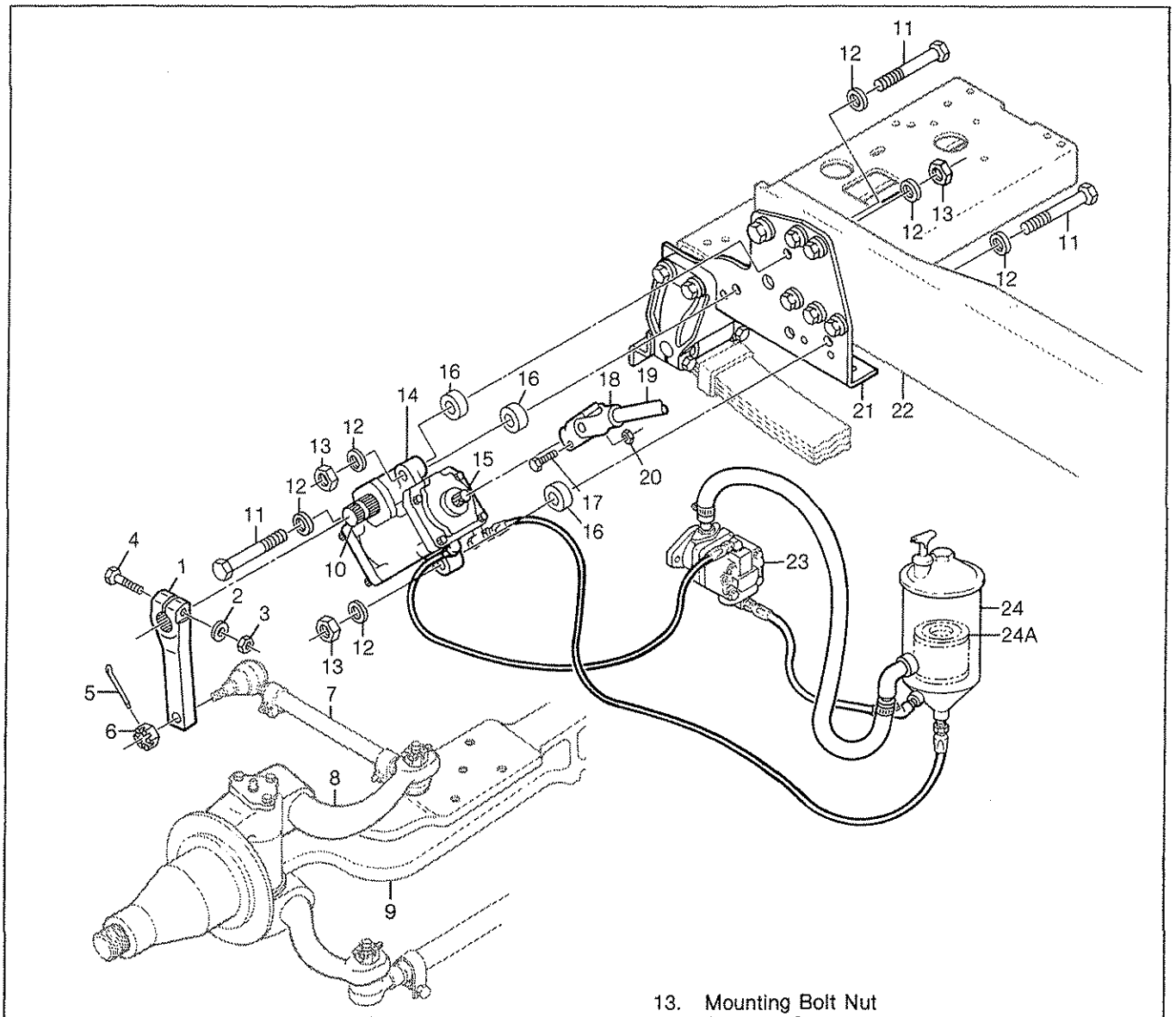


Fig. 142

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

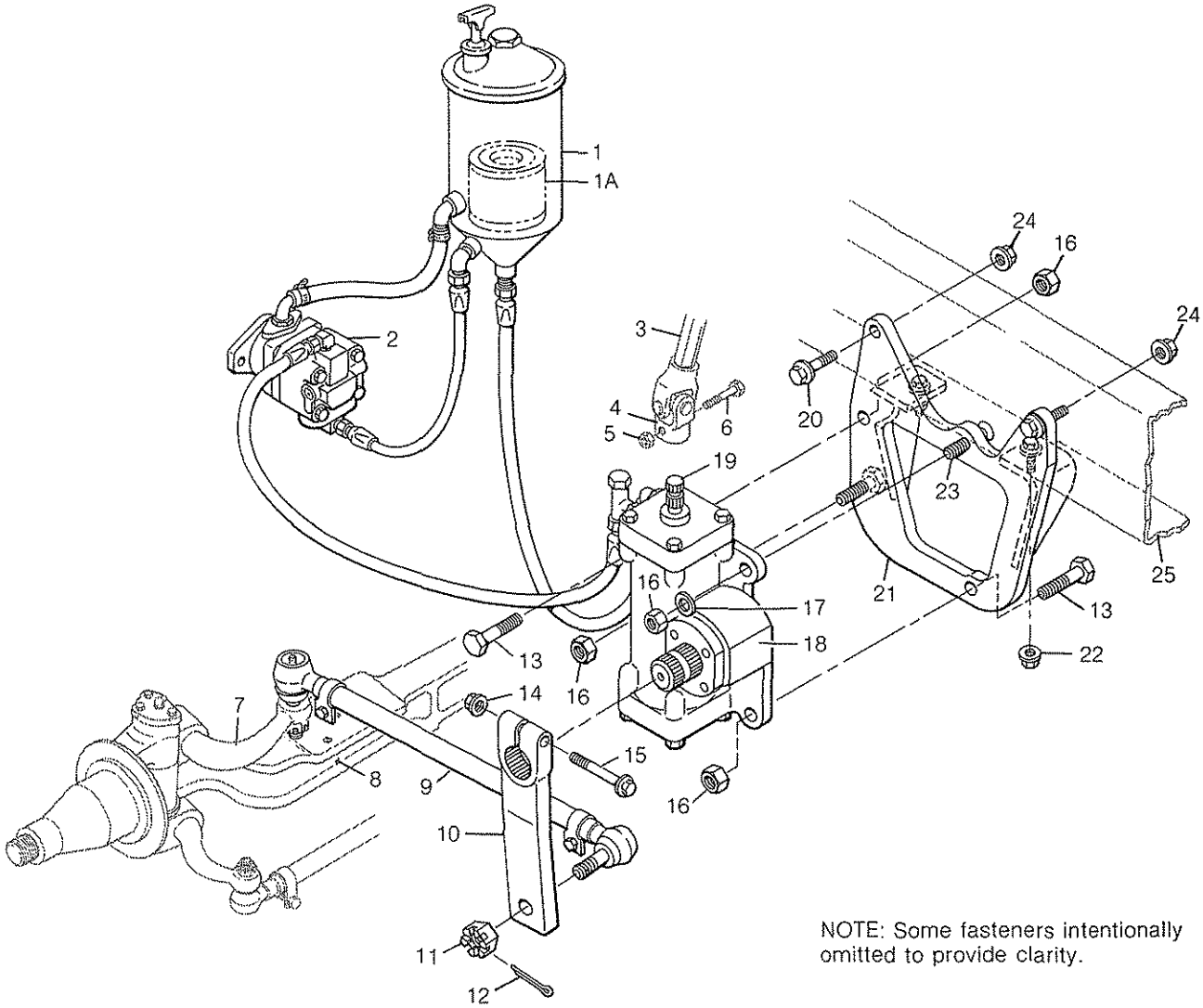


1. Pitman Arm
2. Washer
3. Pinch Bolt Nut
4. Pitman Arm Pinch Bolt
5. Cotter Pin
6. Castle Nut
7. Drag Link
8. Axle Steering Arm
9. Front Axle
10. Output (Sector) Shaft
11. Mounting Bolt
12. Washer
13. Mounting Bolt Nut
14. Steering Gear
15. Input (Worm) Shaft
16. Spacer
17. Lower End Yoke Pinch Bolt
18. Lower End Yoke
19. Steering Driveline
20. Pinch Bolt Nut
21. Frame Extension
22. Frame
23. Power Steering Pump
24. Power Steering Reservoir

24A. Filter

Fig. 143, Conventional Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Power Steering Reservoir
1A. Filter
2. Power Steering Pump
3. Steering Driveline
4. Lower End Yoke
5. Pinch Bolt Nut
6. Lower End Yoke Pinch Bolt
7. Axle Steering Arm
8. Front Axle
9. Drag Link
10. Pitman Arm
11. Castle Nut
12. Cotter Pin
13. Hex Bolt
14. Pitman Arm Pinch Bolt Nut
15. Pitman Arm Pinch Bolt
16. Hex Nut
17. Washer
18. Steering Gear
19. Input (Worm) Shaft
20. Flanged Bolt
21. Steering Gear Bracket
22. Flanged Nut
23. Countersunk Bolt
24. Flanged Nut
25. Frame Rail

Fig. 143A, Conventional Integral Power Steering Installation, Except 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

On other Conventionals, attach the steering gear to the mounting bracket. Refer to Fig. 144A. Tighten the nuts to the torque value in Table 2. Mount the steering gear and bracket on the frame rail and tighten the nuts to the torque values in Table 2.

2. If not previously done, center the steering gear. The sector (output) shaft timing mark must be at a right angle to the steering gear input shaft centerline.
3. Install the pitman arm on the sector (output) shaft, aligning the timing marks.

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. To wedge the slot open, clamp the pitman arm in a vise with the slot at the top. Use a ball-peen hammer to drive a chisel into the slot. Hold the chisel in place, remove the pitman arm from the vise, and install the pitman arm on the sector shaft (Fig. 13). Remove the chisel from the slot.

WARNING: Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise, the chisel could fly loose, which might cause an injury.

4. Install the pitman arm pinch bolt, washer (if applicable), and a new nut. Tighten the nut to the torque value in Table 2.
5. Move the steering wheel so that the king-spoke, the narrow spoke on some wheels or the spoke with the manufacturer's name imprinted on the underside, points directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees). See Fig. 145.

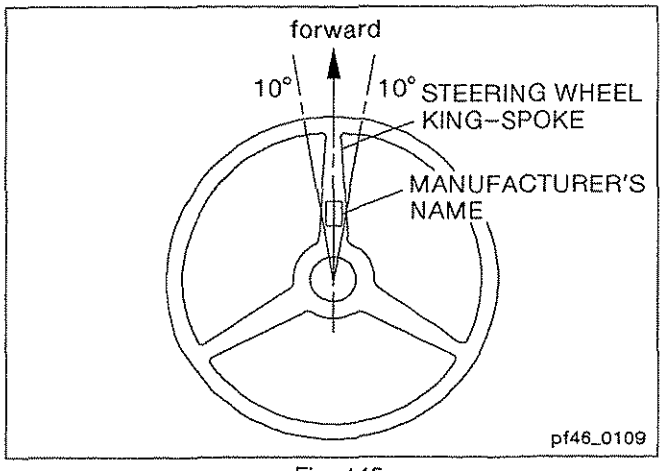


Fig. 145

6. Connect the steering driveline to the steering gear input shaft. For instructions, refer to the appropriate section in this group.
7. Attach the drag link to the pitman arm. For instructions, refer to the appropriate section in this group.
8. Attach the hydraulic line elbow fittings to the steering gear. Tighten the elbow fittings 37 lbf·ft (50 N·m).
9. Remove the plugs from the hydraulic lines. Connect the hydraulic lines to the steering gear as previously marked. Tighten the nut on each fitting finger-tight. Then use a wrench to tighten the nut until resistance is felt. Tighten one-sixth turn more.
10. Fill the power steering gear reservoir with fluid. For instructions, refer to "Filling and Air Bleeding the System."
11. Adjust the poppet adjusting screws. For instructions, refer to "Poppet Valve Adjustment."
12. Test drive the vehicle, or take a ride with the driver. Check the steering wheel king-spoke position. If, while driving straight ahead on a level road, the steering wheel king-spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees), reposition the steering wheel so that the king-spoke points directly toward the front of the vehicle. For instructions, refer to the appropriate section in this group.

FILLING AND AIR BLEEDING THE SYSTEM

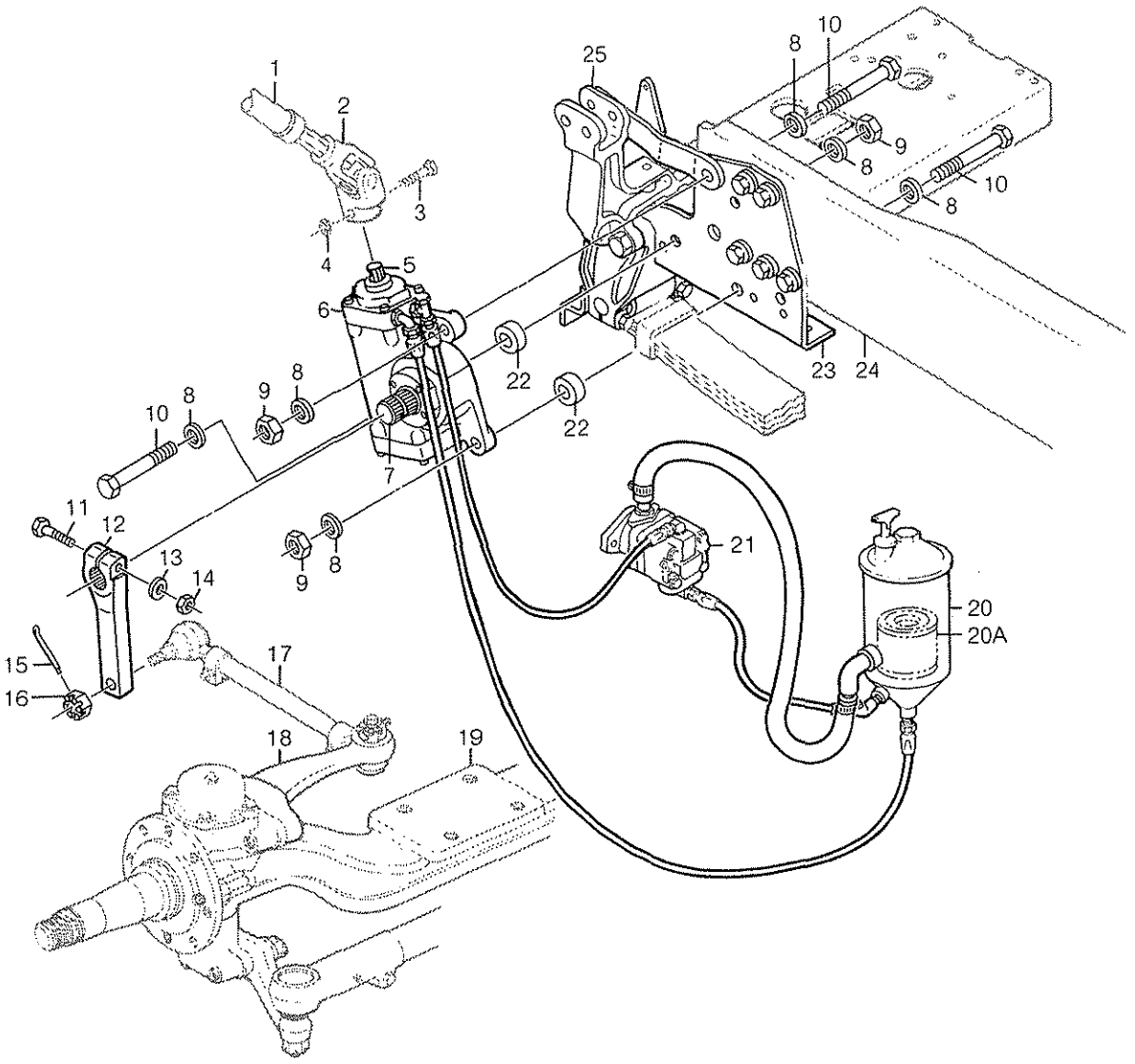
IMPORTANT: For steps 1 and 2, do not turn the steering wheel. Otherwise, air can enter the system.

If the power steering reservoir was drained, replace the reservoir filter before filling the system. For instructions, refer to the Freightliner *Maintenance and Lube Manual.*

1. Fill the power steering reservoir nearly full. For lubricant recommendations, refer to the Charts and Specifications section of the Freightliner *Maintenance and Lube Manual.* Crank the engine for ten seconds without allowing it to start if possible. If the engine does start, shut it down immediately. Check and refill the reservoir. Do this three times, each time checking and refilling the reservoir.

IMPORTANT: Do not let the reservoir fluid level drop significantly. This would allow air to enter the system.

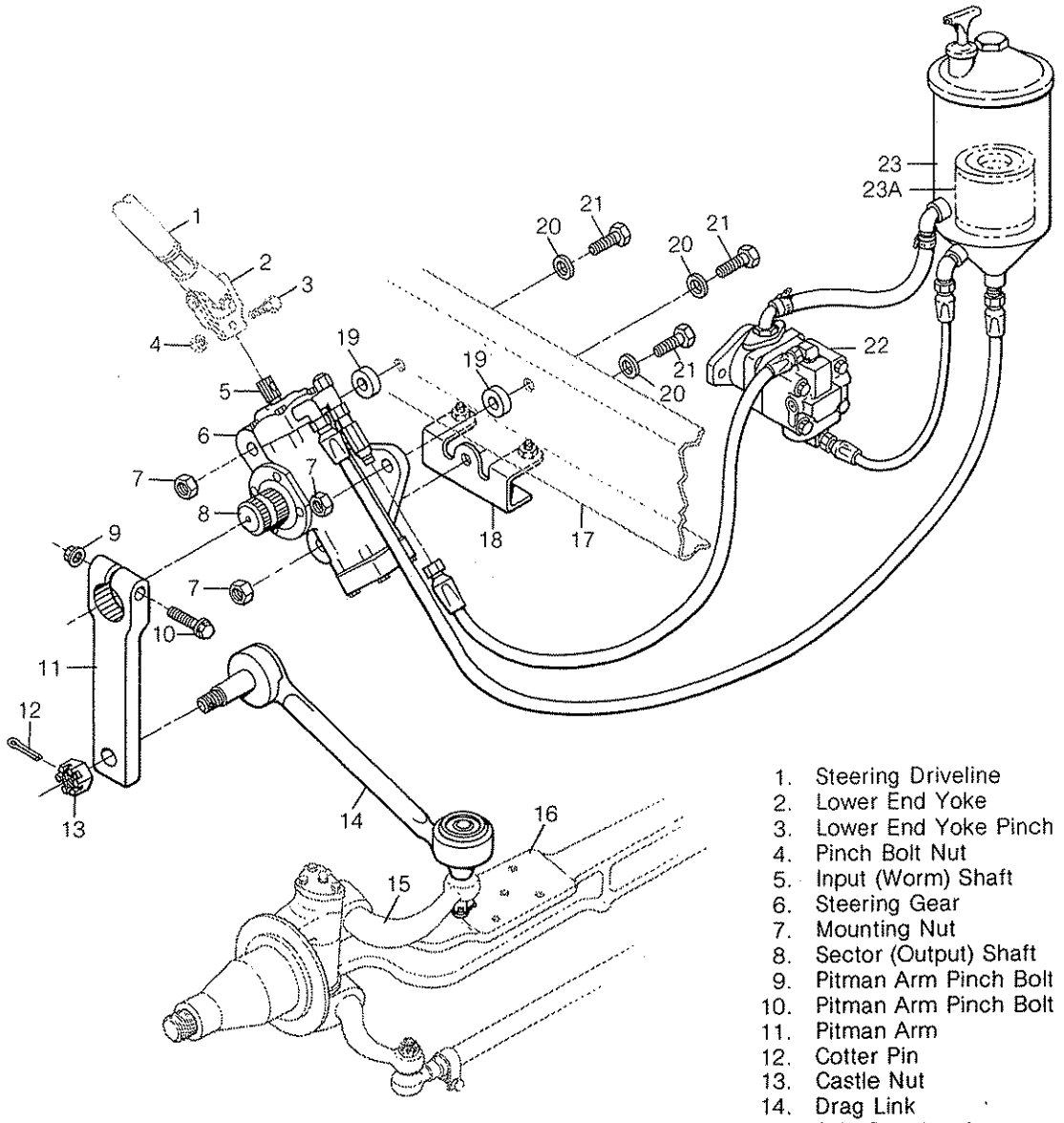
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Output (Sector) Shaft
8. Washer
9. Mounting Bolt Nut
10. Mouting Bolt
11. Pitman Arm Pinch Bolt
12. Pitman Arm
13. Washer
14. Pinch Bolt Nut
15. Cotter Pin
16. Castle Nut
17. Drag Link
18. Axle Steering Arm
19. Axle
20. Power Steering Reservoir
20A. Filter
21. Power Steering Reservoir
22. Spacer
23. Frame Extension
24. Frame
25. Cab Mounting Bracket

Fig. 144, COE Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



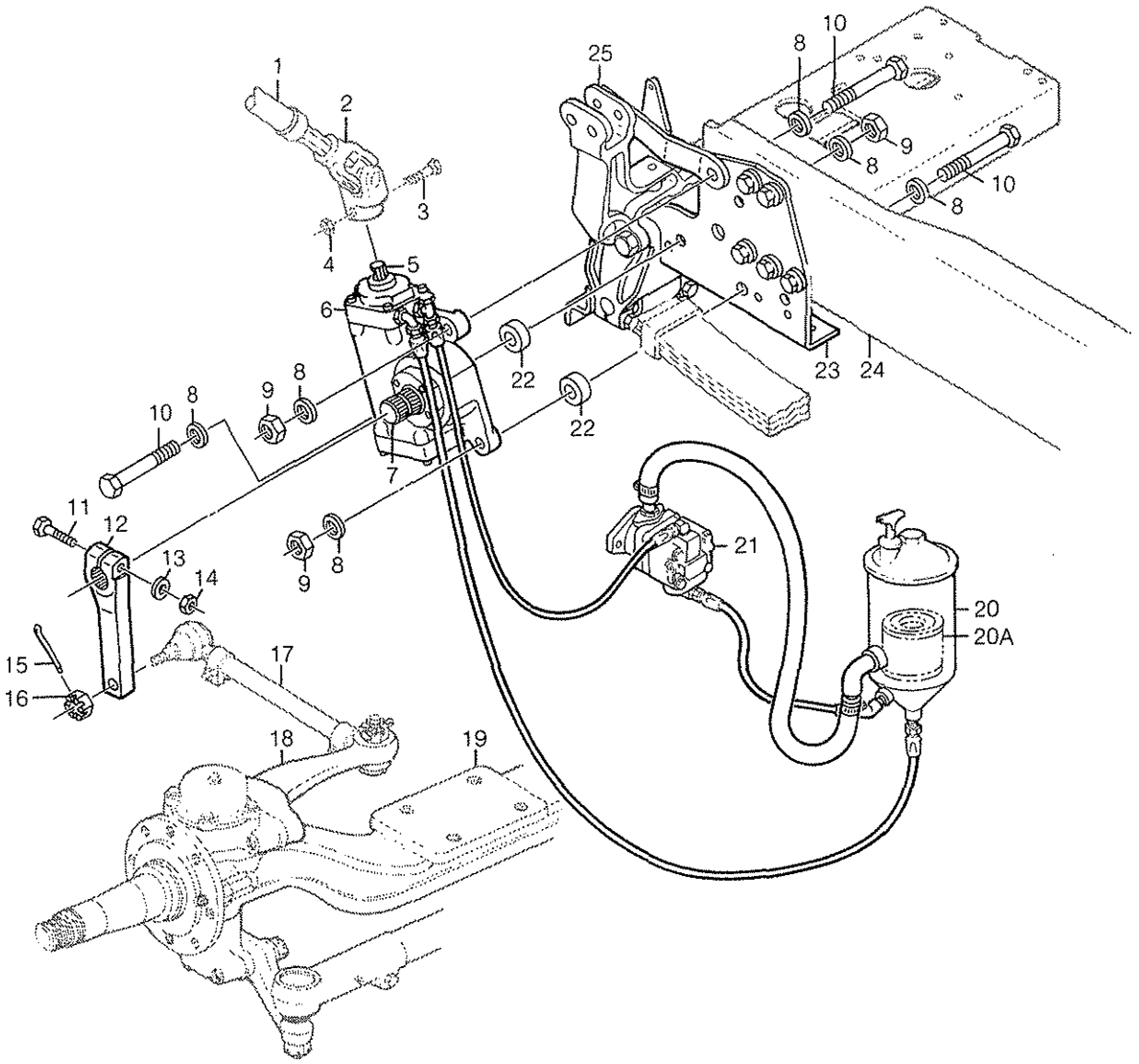
NOTE: Some fasteners intentionally omitted to provide clarity.

1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Mounting Nut
8. Sector (Output) Shaft
9. Pitman Arm Pinch Bolt Nut
10. Pitman Arm Pinch Bolt
11. Pitman Arm
12. Cotter Pin
13. Castle Nut
14. Drag Link
15. Axle Steering Arm
16. Front Axle
17. Frame Rail
18. Steering Gear Bracket
19. Spacer
20. Washer
21. Mounting Bolt
22. Power Steering Pump
23. Power Steering Reservoir

23A. Filter

Fig. 144A, COE Integral Power Steering Installation, Except 1984 Advancements

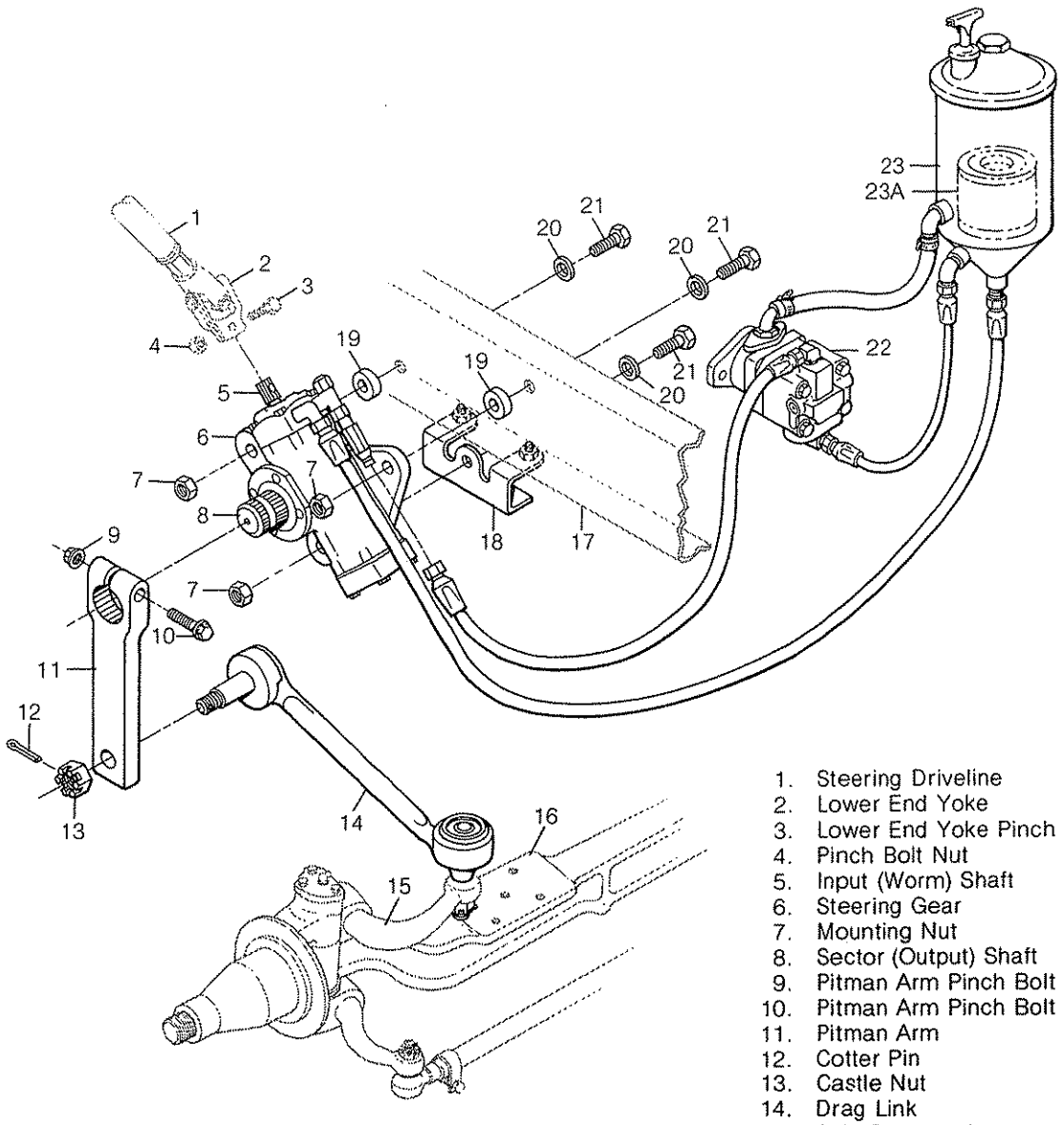
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Output (Sector) Shaft
8. Washer
9. Mounting Bolt Nut
10. Mouting Bolt
11. Pitman Arm Pinch Bolt
12. Pitman Arm
13. Washer
14. Pinch Bolt Nut
15. Cotter Pin
16. Castle Nut
17. Drag Link
18. Axle Steering Arm
19. Axle
20. Power Steering Reservoir
20A. Filter
21. Power Steering Reservoir
22. Spacer
23. Frame Extension
24. Frame
25. Cab Mounting Bracket

Fig. 144, COE Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70



NOTE: Some fasteners intentionally omitted to provide clarity.

1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Mounting Nut
8. Sector (Output) Shaft
9. Pitman Arm Pinch Bolt Nut
10. Pitman Arm Pinch Bolt
11. Pitman Arm
12. Cotter Pin
13. Castle Nut
14. Drag Link
15. Axle Steering Arm
16. Front Axle
17. Frame Rail
18. Steering Gear Bracket
19. Spacer
20. Washer
21. Mounting Bolt
22. Power Steering Pump
23. Power Steering Reservoir

23A. Filter

Fig. 144A, COE Integral Power Steering Installation, Except 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

2. Start the engine and let it idle for two minutes. Shut down the engine and check the reservoir fluid level.

3. Start the engine. Turn the steering wheel full-left and full-right several times. Add fluid to the full line on the dipstick if necessary.

NOTE: Poppets must be adjusted so they relieve pressure at full-right and full-left turns, to remove air from the system. At this time, make sure the poppets are adjusted. Refer to "Poppet Valve Adjustment" for instructions. Then, repeat step 3.

4. If the power steering gear has a manual bleed screw, remove air by following steps 1, 2, and 3. Then, with the engine idling, turn the steering wheel full-left and full-right several times. With the steering gear in neutral (no steering action), loosen the manual bleed screw about one turn. Allow air and aerated fluid to escape until only clear fluid is bleeding out. Tighten the bleed screw. Check and refill the reservoir.

IMPORTANT: Do not turn the steering wheel with the bleed screw loosened. This would allow air to enter the system.

WARNING: Do not loosen or remove an automatic bleed screw when the steering gear is mounted on the vehicle. If it is loosened or removed, there may be a loss of power steering assist in one direction of turn. This could cause a loss of vehicle control and possible personal injury. The automatic bleed screw has a 1/2-inch hexhead or E-10 Torx head.

Once again, turn the steering wheel full-right and full-left, three or four times, with the bleed screw closed. Do this until only clear (nonaerated) fluid escapes when the bleed screw is loosened. Add fluid each time as necessary. Tighten the manual bleed screw 27 to 33 lbf·in (310 to 370 N·cm). Check and refill the reservoir, if necessary, to the full line on the dipstick.

TROUBLESHOOTING

For troubleshooting information, refer to the subject covering hydraulic power steering system troubleshooting, and the subjects covering power steering pumps in this group.

SPECIFICATIONS

KENT-MOORE PART NUMBER[1]	TOOL	APPLICATION
J26739	Seal Installation Tool	Worm Shaft O-Ring and Seal Installation
J26740	Seal Compression Tool	Worm Shaft Seal Installation
J26741	Seal Installation Tool	Valve Sleeve O-Ring and Seal Ring Installation
J26742	Seal Compression Tool	Valve Sleeve Seal Ring Installation
J26743	Bearing Mandrel	Housing Bearing Removal and Installation
J28490	Seal Driving Tool	Input Shaft Seal and Washer Installation

Table 1, Kent-Moore Tools, Kent-Moore Tool Division, 29784 Little Mack, Roseville, MI 48066

[1] For complete HFB70 service tool set, order Kent-Moore part number J26837.

The following special tools are required for some procedures: pressure and flow gauge; inch-pound torque wrench; foot-pound torque wrench.

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB70

SPECIFICATIONS

DESCRIPTION	SIZE	GRADE	TORQUE	
			lbf·ft (N·m)	lbf·in (N·cm)
Trunnion Cover Bolts	5/16–18	—	15–22 (20–30)	—
Worm Shaft Preload Adjusting Screw	—	—	—	60–70 (680–780)
Worm Shaft Adjusting Screw Jam Nut	—	—	70–80 (95–108)	—
Poppet Adjusting Screw Jam Nuts	—	—	12–18 (16–24)	—
Poppet Seats	—	—	20–25 (27–34)	—
Ball Return Guide Clip Hexhead Bolts	—	—	15–19 (20–26)	—
Ball Return Guide Cap Alien Head Bolts	—	—	15–19 (20–26)	—
End Cover Bolts	9/16–18	—	145–155 (197–210)	—
Valve Housing Bolts	9/16–18	—	145–155 (197–210)	—
Sector Shaft Adjusting Screw Jam Nut	—	—	40–45 (54–61)	—
Side Cover Ring-Head Bolts	—	—	150–170 (203–231)	—
Manual Bleed Screw	—	—	—	27–33 (310–370)
Pitman Arm Pinch Bolt Nut	3/4–16	C	230 (312)	—
Steering Gear Mounting Bolt Nuts*	7/8–9	C	310 (420)	—
	7/8–14	C	350 (475)	—
Steering Gear Bracket-to-Frame Rail Mounting Bolt Nuts (Flanged Type)	1/2–13	G	95 (129)	—
	1/2–20	G	110 (149)	—
	5/8–11	G	190 (258)	—
	5/8–18	G	215 (291)	—

Table 2, Fastener Torque Values

* Torque values are for nuts that are wax coated and cadmium plated, or for hexbolts that have phosphate- and oil-coated threads. Both are used with hardened washers. For dry threads, refer to the Bolt Torque Specification Chart in the *COE & 120 Conventional Maintenance Manual.*

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

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SPECIFICATIONS

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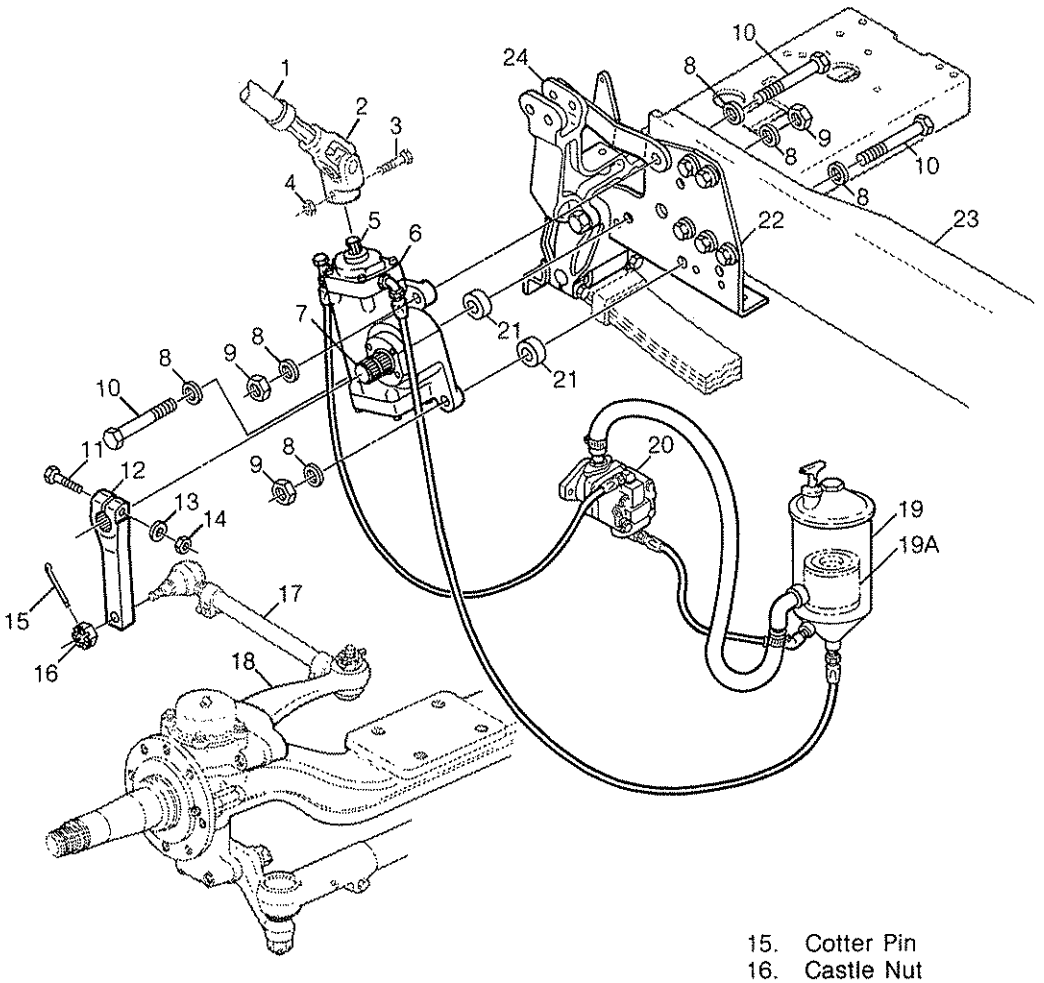
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

GENERAL DESCRIPTION

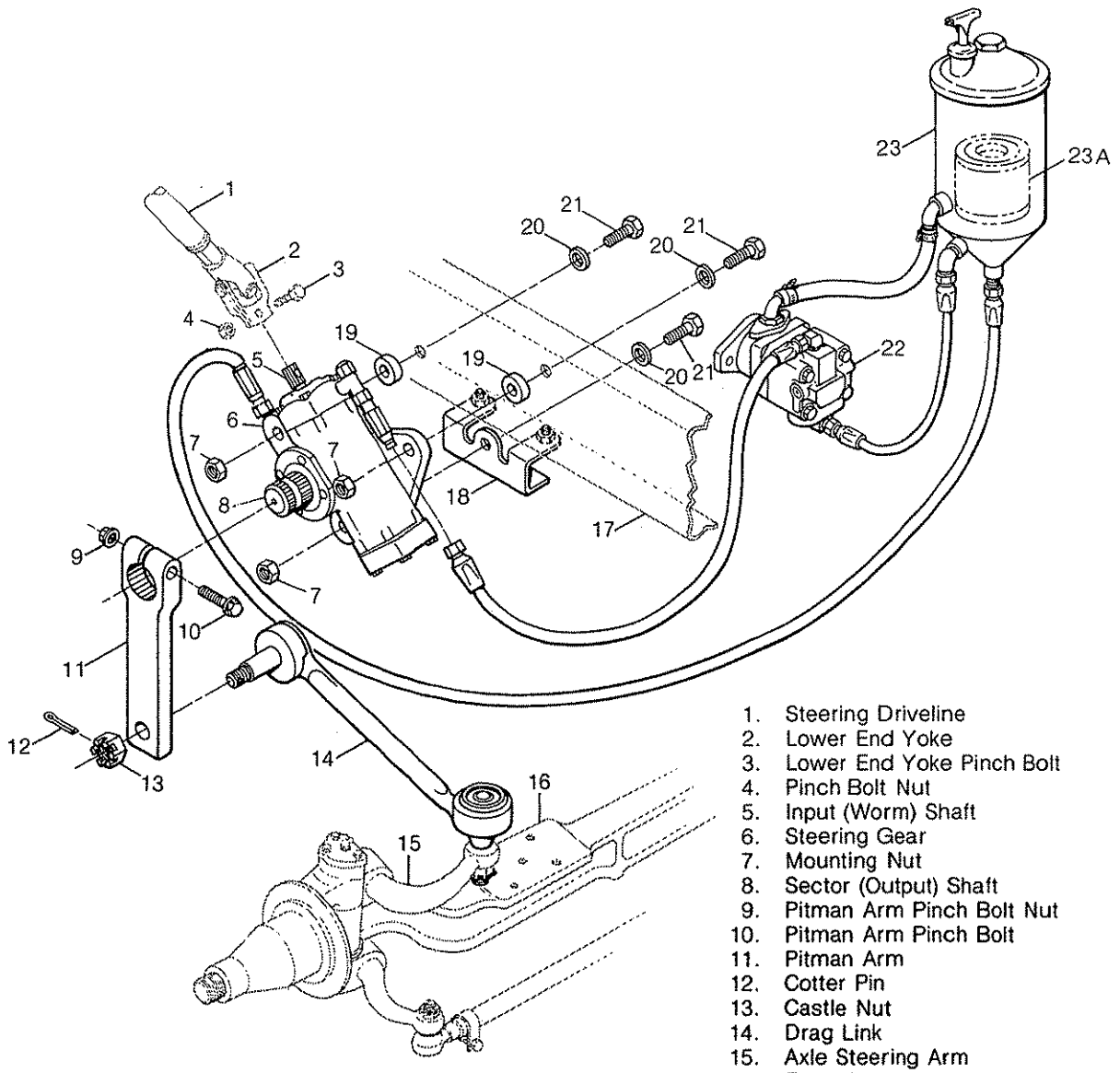
The Ross HFB64 integral power steering gear can be installed on vehicles with front axle capacities up to 12,000 lbs (5443 kg). The steering gear is mounted on the vehicle frame rail. See Fig. 1 and 1A (COEs) or Fig. 2 and 2A (Conventionals). The steering gear incorporates a manual steering mechanism, hydraulic control valve, and a hydraulic power cylinder. The control valve is a rotary design, which directs oil flow from an engine driven pump to the upper or lower cylinder cavity.



1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Sector (Output) Shaft
8. Washer
9. Mounting Nut
10. Mounting Bolt
11. Pitman Arm Pinch Bolt
12. Pitman Arm
13. Washer
14. Pinch Bolt Nut
15. Cotter Pin
16. Castle Nut
17. Drag Link
18. Axle Steering Arm
19. Power Steering Reservoir
19A. Filter
20. Power Steering Pump
21. Spacer
22. Frame Extension
23. Frame
24. Cab Mount

Fig. 1, COE Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



NOTE: Some fasteners intentionally omitted to provide clarity

1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Mounting Nut
8. Sector (Output) Shaft
9. Pitman Arm Pinch Bolt Nut
10. Pitman Arm Pinch Bolt
11. Pitman Arm
12. Cotter Pin
13. Castle Nut
14. Drag Link
15. Axle Steering Arm
16. Front Axle
17. Frame Rail
18. Steering Gear Bracket
19. Spacer
20. Washer
21. Mounting Bolt
22. Power Steering Pump
23. Power Steering Reservoir
23A. Filter

Fig. 1A, COE Integral Power Steering Installation, Except 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

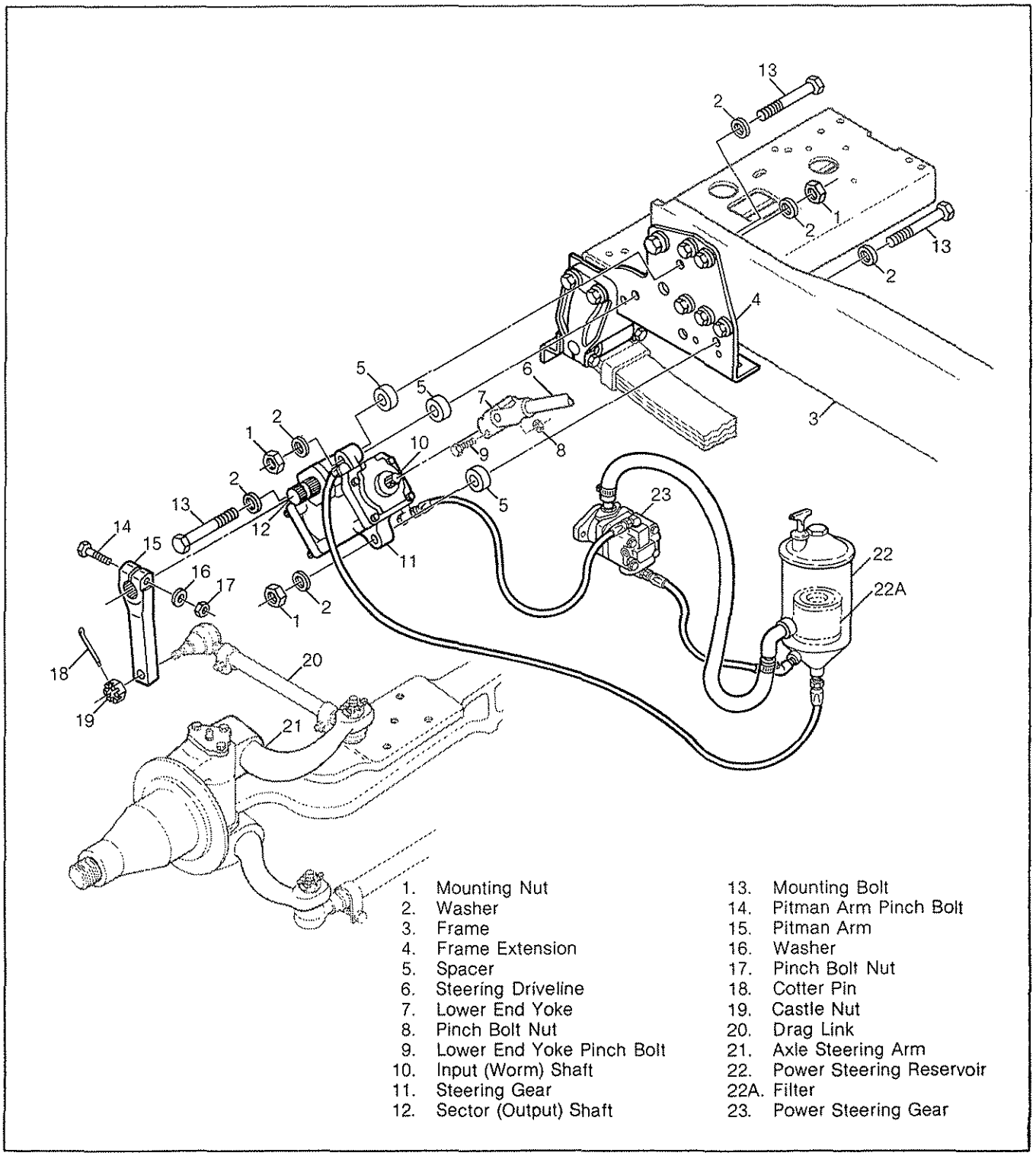
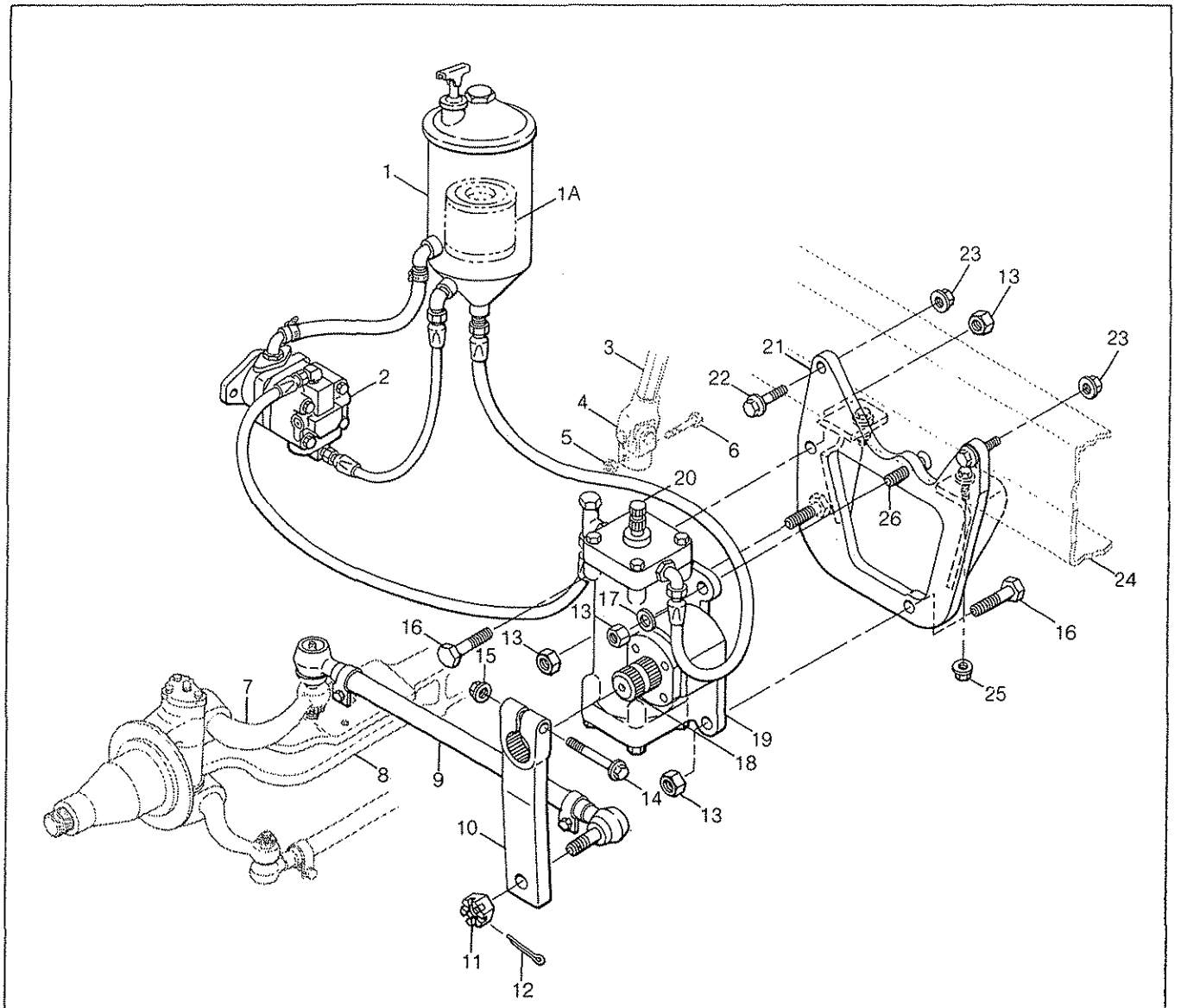


Fig. 2, Conventional Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



1. Power Steering Reservoir
1A. Filter
2. Power Steering Pump
3. Steering Driveline
4. Lower End Yoke
5. Pinch Bolt Nut
6. Lower End Yoke Pinch Bolt
7. Axle Steering Arm
8. Front Axle
9. Drag Link
10. Pitman Arm
11. Castle Nut
12. Cotter Pin
13. Hex Nut
14. Pitman Arm Pinch Bolt
15. Pitman Arm Pinch Bolt Nut
16. Hex Bolt
17. Washer
18. Sector (Output) Shaft
19. Steering Gear
20. Input (Worm) Shaft
21. Steering Gear Bracket
22. Flanged Bolt
23. Flanged Nut
24. Frame Rail
25. Flanged Nut
26. Countersunk Bolt

Fig. 2A, Conventional Integral Power Steering Installation, Except 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

PRINCIPLES OF OPERATION

When the steering wheel is turned, force is transmitted from the steering wheel to the steering gear input shaft. A torsion bar, pinned at one end to the input shaft, and at the other to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response, the worm shaft, acting through the recirculating ball mechanism, tends to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is linked to the steered wheels. Because of this resistance, the torsion bar is turned by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston and onto the worm shaft. The internal construction of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents kickback at the steering wheel.

On each end of the rack piston is a poppet (unloading valve). Depending on the direction of turn, one poppet will trip as the steered wheels approach the axle stops. The tripped poppet reduces pressure in the gear, heat generated by the pump, and outside forces acting on the steering linkage.

SERVICE OPERATIONS

WARNING: All steering mechanisms are life and limb items. As such, it is imperative that the instructions in this subject are followed to the letter. Failure to observe the procedures set out in this subject may result in loss of steering.

Special tools required for some disassembly and assembly procedures of the steering gear components are available from the Kent-Moore Tool Division, or an affiliated dealer.

IMPORTANT: See Table 1 under "SPECIFICATIONS" before beginning service procedures described here to be sure that required tools are available.

Before servicing the steering gear or power steering pump, refer to the pre-service checks. After performing any service operations on power steering components, refer to the post-service checks. See the subject covering hydraulic power steering system checking, testing, and troubleshooting in the 14 Group of this manual.

Fig. 3 shows a disassembled HFB64 steering gear. Refer to this figure for parts identification during disassembly of the gear.

REPAIRS WITH THE STEERING GEAR ON THE VEHICLE

IMPORTANT: Thoroughly clean all outside dirt from around the fittings and hose connections.

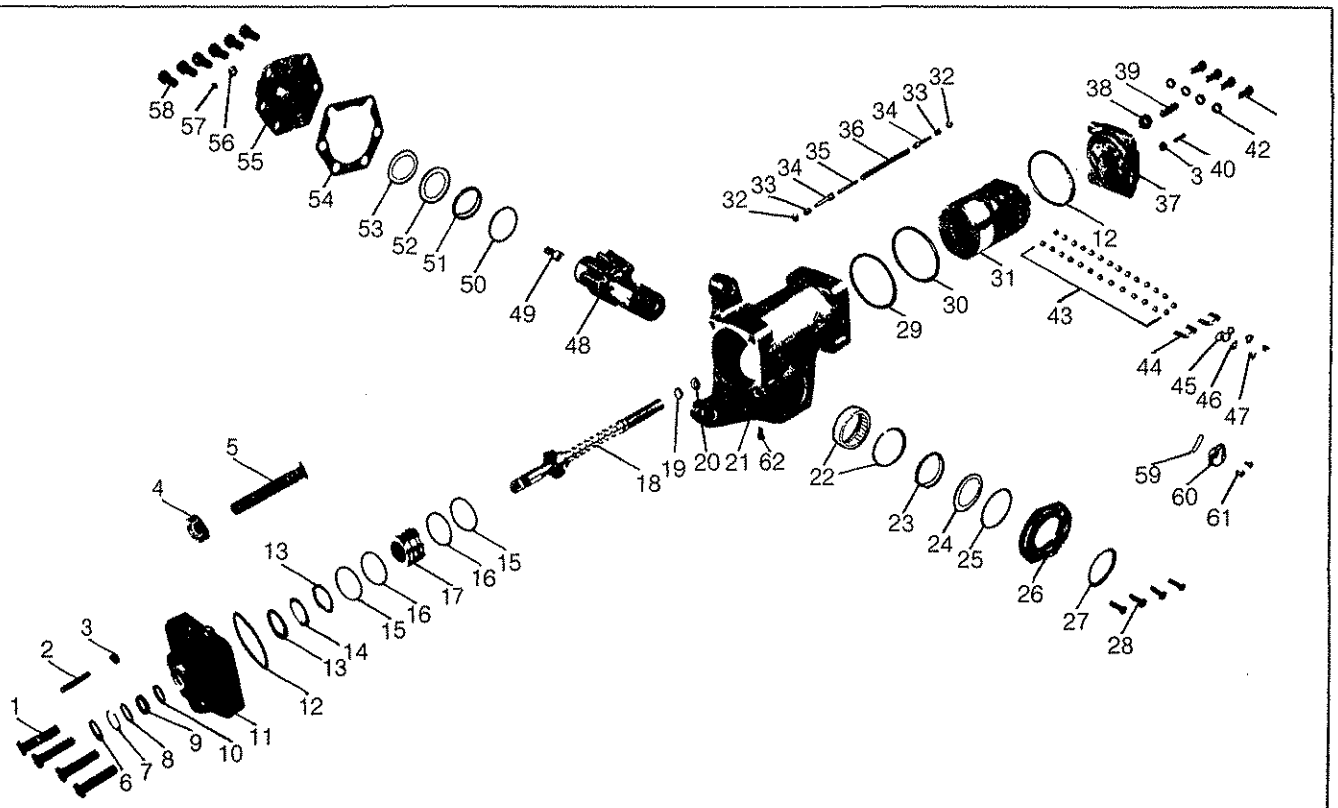
NOTE: For clarity, the figures shown under this heading show the steering gear mounted on a mock-up frame and steering driveline.

Sector (Output) Shaft Seal Replacement

If a leak is detected in the trunnion cover area, remove the trunnion cover and replace the sector shaft seal package as follows:

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. Apply the parking brakes and chock the tires.
2. Disconnect the drag link from the pitman arm. For instructions, refer to the drag link subject in the 14 Group of this manual.
3. Remove the pinch bolt nut, washer (if applicable), and pinch bolt from the pitman arm. Discard the nut. See Fig. 4. If factory alignment marks are not present, use a marking pen or paint to make a reference mark on the pitman arm and the sector shaft. Remove the pitman arm using a suitable puller.
4. Remove and discard the trunnion cover dirt-and-water seal. See Fig. 5.
5. Clean the nonserrated area of the sector shaft with a fine grade of emery paper as shown in Fig. 6. Be sure to remove any paint.
6. Remove the four trunnion cover bolts and trunnion cover as shown in Fig. 7. Remove and discard the sector shaft seal package, consisting of the Teflon® backup washer, the two-piece sector shaft seal, and the trunnion cover O-ring. See Fig. 8.
7. Clean the trunnion cover in petroleum-based solvent and inspect its seal cavity and sealing face for

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



1. Valve Housing Bolt
2. Poppet Adjusting Screw
3. Poppet Adjusting Screw Jam Nut
4. Internal-Allen-Head Poppet Adjusting Screw Jam Nut
5. Internal-Allen-Head Poppet Adjusting Screw
6. Dirt-and-Water Seal
7. Retaining Ring
8. Steel Backup Washer
9. Input Shaft Seal
10. Input Shaft O-Ring
11. Valve Housing
12. O-Ring
13. Thrustwasher
14. Thrust Bearing
15. Teflon® Seal Ring
16. Backup O-Ring
17. Valve Sleeve
18. Worm Shaft/Input Shaft Assembly
19. Worm Shaft Backup O-Ring
20. Teflon® Worm Shaft Seal Ring
21. Gear Housing
22. Housing Bearing and Retaining Ring
23. Two-Piece Sector Shaft Seal
24. Teflon® Backup Washer
25. Trunnion Cover O-Ring
26. Trunnion Cover
27. Dirt-and-Water Seal
28. Trunnion Cover Bolts
29. Teflon® Rack Piston Seal
30. Rack Piston Backup O-Ring
31. Rack Piston
32. Poppet Retaining Ring
33. Poppet Seat
34. Poppet
35. Nylon Spacer Rod
36. Poppet Spring
37. End Cover
38. Worm Shaft Adjusting Screw Jam Nut
39. Worm Shaft Adjusting Screw
40. Poppet Adjusting Screw
41. End Cover Bolts
42. Washers
43. Steel Balls
44. Ball Return Guide
45. Ball Return Guide Clip
46. Locking Tabs
47. Hexhead Bolts
48. Sector Shaft
49. Sector Shaft Adjusting Screw
50. Side Cover Retaining Ring
51. Two-Piece Side Cover Seal
52. Teflon® Backup Washer
53. Steel Backup Washer
54. Side Cover Gasket
55. Side Cover and Bearing Assembly
56. Sector Shaft Adjusting Screw Jam Nut
57. Rubber Plug
58. Special Bolts
59. Ball Return Guide Cap Seal
60. Ball Return Guide Cap
61. Allen-Head or Torx-Head Bolts
62. Manual Bleed Screw*

*On Some Models

Fig. 3, Ross HFB64 Steering Gear

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

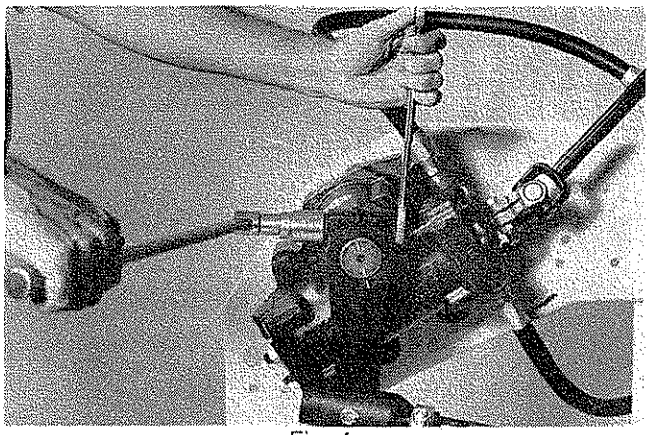


Fig. 4

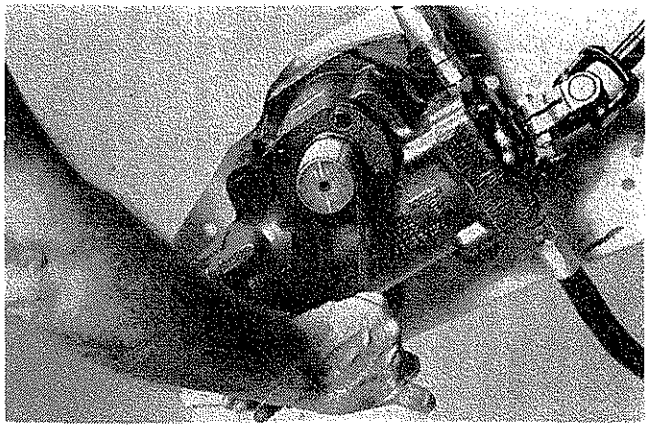


Fig. 6

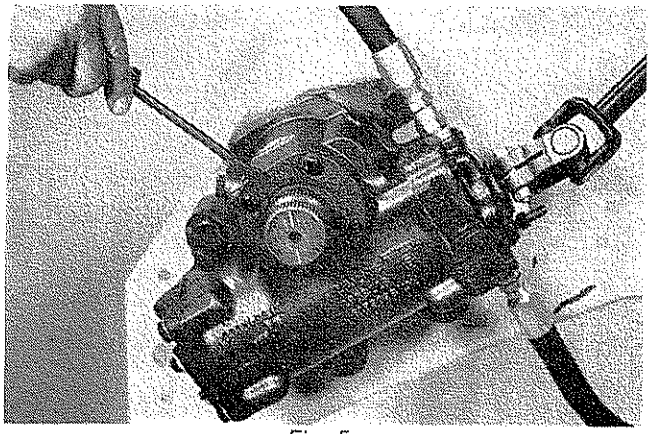


Fig. 5

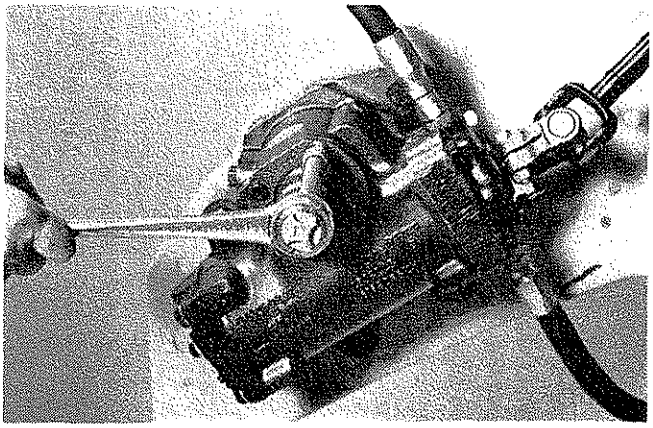


Fig. 7

nicks or corrosion. Replace the trunnion cover with a new one if these conditions exist.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

8. Place the trunnion cover on a bench to install the new seal package. Start with the new Teflon® backup washer. Next, install the new two-piece sector shaft seal so that the words "OIL SIDE" are visible after the seal is in place. See Fig. 9.

WARNING: The words "OIL SIDE" must be visible after the seal is in place, as shown in Fig. 9. If not, the seal will not function, and a loss of power steering assist may occur.

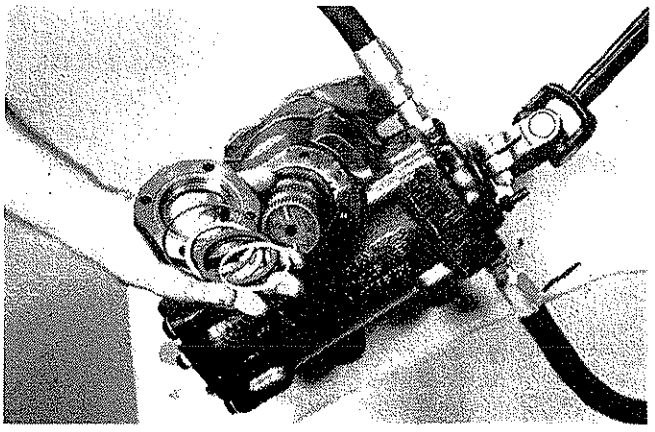


Fig. 8

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

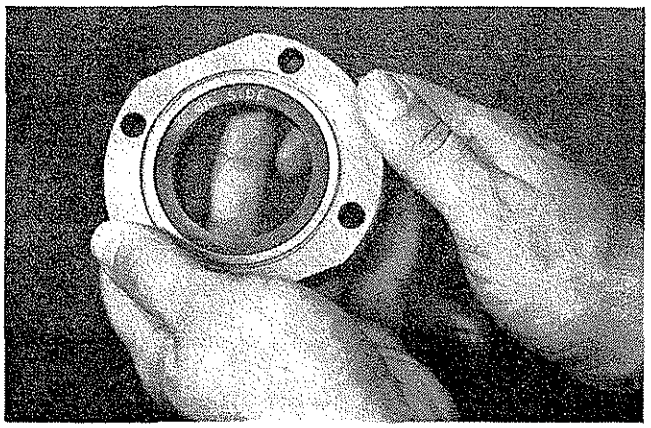


Fig. 9

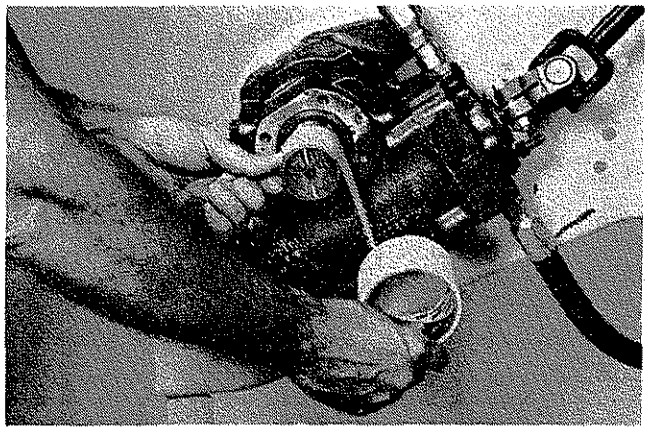


Fig. 10

9. Grease the new trunnion cover O-ring and install it in the cover groove.
10. Cover the serrations of the sector shaft with one layer of masking tape to avoid damaging the seals during trunnion cover installation. See Fig. 10.
11. Install the trunnion cover. See Fig. 11.
12. Install the four trunnion cover bolts. Torque the bolts to 15-22 lbf·ft (20-30 N·m). See Fig. 12. Pack the cavity around the seal area of the sector shaft with Mobil Temp® 1 or 2 grease, or an equivalent. Install a new dirt-and-water seal, using a suitable blunt-ended drift, as shown in Fig. 13. Remove the tape from the sector shaft.
13. Attach the pitman arm to the sector shaft. Be sure that the mark on the pitman arm aligns with the mark on the sector shaft. See Fig. 14.

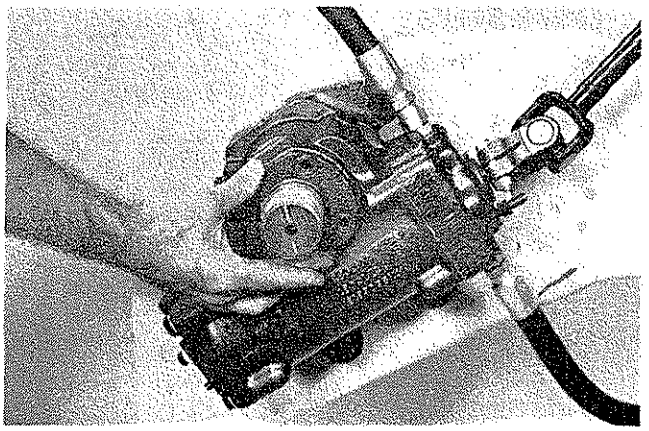


Fig. 11

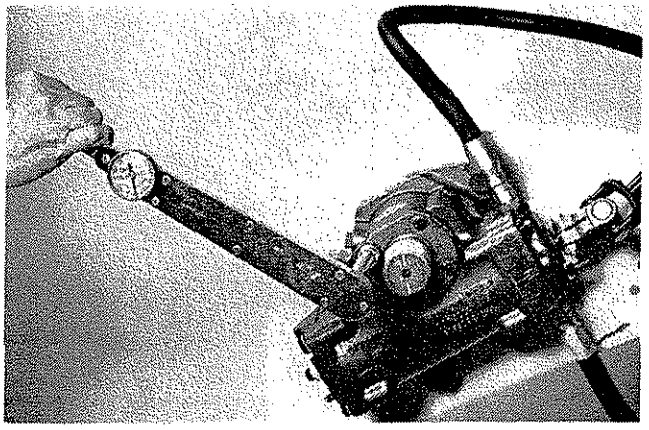


Fig. 12

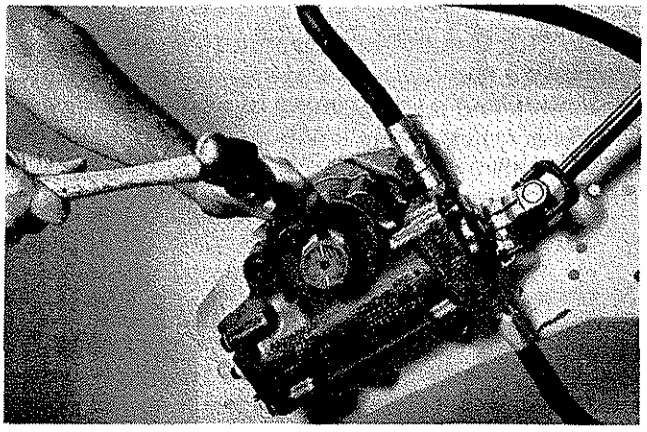


Fig. 13

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

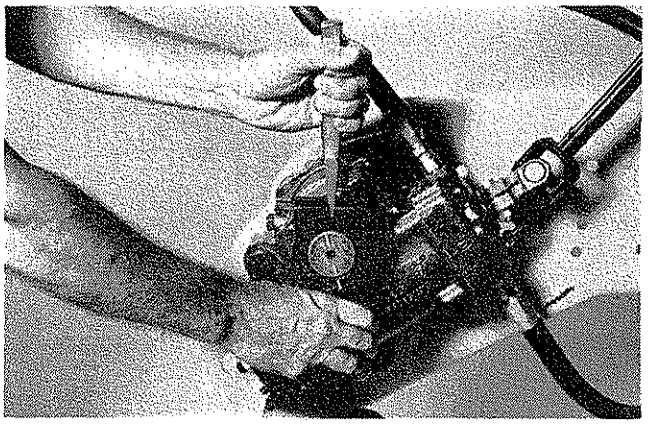


Fig. 14

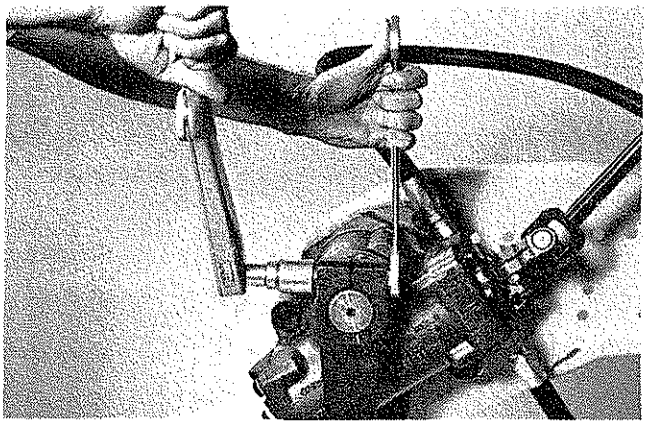


Fig. 15

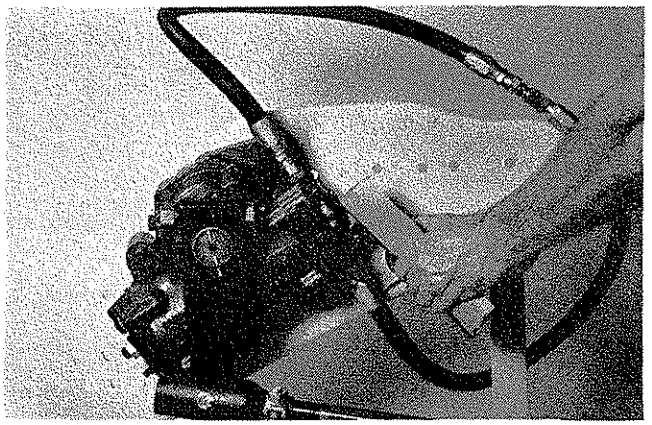


Fig. 16

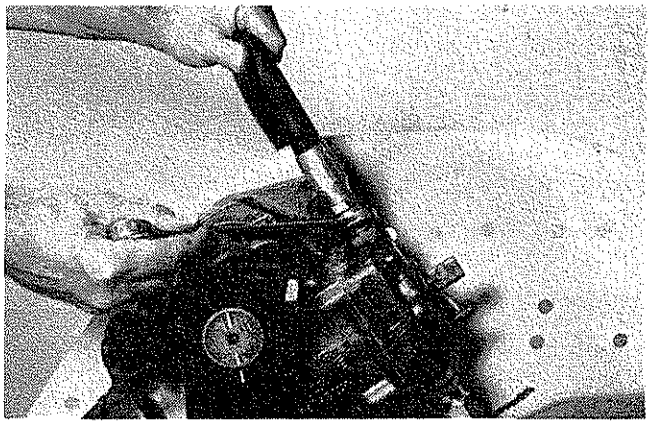


Fig. 17

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. To wedge the slot open, clamp the pitman arm in a vise with the slot at the top; then, using a ball-peen hammer, drive a chisel into the slot. Hold the chisel in place, remove the pitman arm from the vise, and install the pitman arm on the sector shaft. Remove the chisel from the slot.

WARNING: Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise, the chisel may fly loose, which could cause an injury.

14. Install the pitman arm pinch bolt, washer (if applicable), and a new nut. See Fig. 15. Tighten the pinch bolt nut to the torque value given in Table 2 under "SPECIFICATIONS."

Input Shaft Seal Replacement

If there is a leak in the input shaft seal, replace the seal assembly, as follows:

1. Disconnect the steering driveline from the steering gear input shaft. For instructions, refer to the 14 Group of this manual.
2. Clean the area around the input shaft with a fine grade of emery paper. See Fig. 16. Be sure to remove any paint.
3. Remove and plug the return line. See Fig. 17.
4. Remove and discard the dirt-and-water seal. See Fig. 18.
5. Remove the retaining ring from the input shaft. See Fig. 19.

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

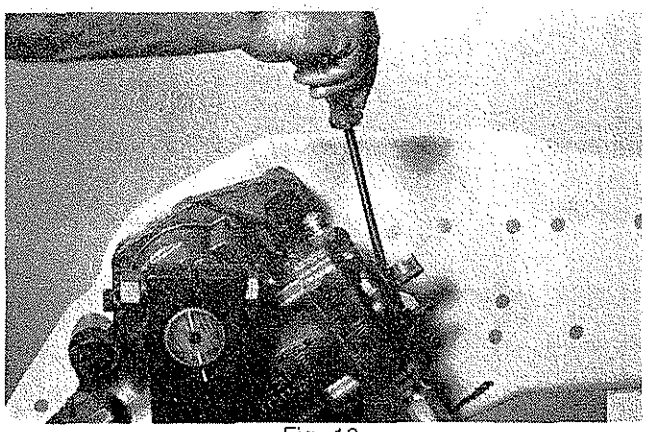


Fig. 18

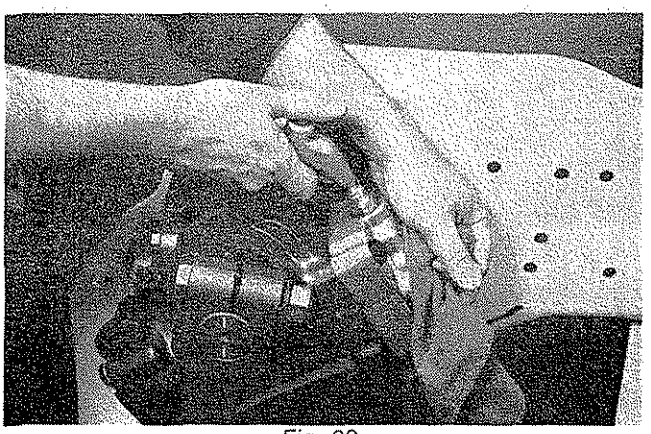


Fig. 20

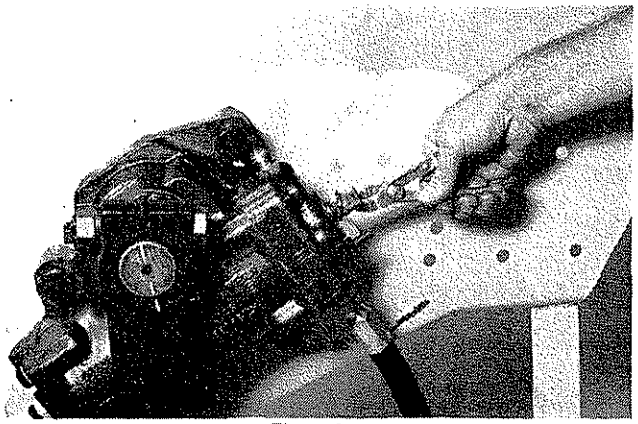


Fig. 19

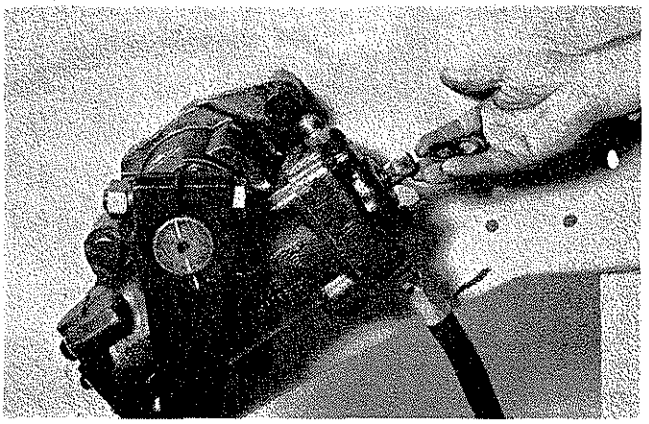


Fig. 21

6. Hold a shop towel over the input shaft and apply shop air pressure to the valve housing return port. See Fig. 20.

WARNING: Wear eye protection and be sure to comply with OSHA maximum air pressure requirements. Dust or dirt particles blown by pressurized air can cause serious injury if they contact your eyes.

The air pressure will force the two-piece input shaft seal and the steel backup washer out of the gear (Fig. 21), and some fluid will leak from the gear. Discard the two-piece seal. Disconnect the shop air as soon as the seal assembly is out.

7. Apply clean grease to a new input shaft seal assembly and input shaft. Install the two-piece seal (with the flat side out) and steel backup washer, using Kent-Moore seal-driving tool J26653. See Fig. 22. Install the retaining ring.

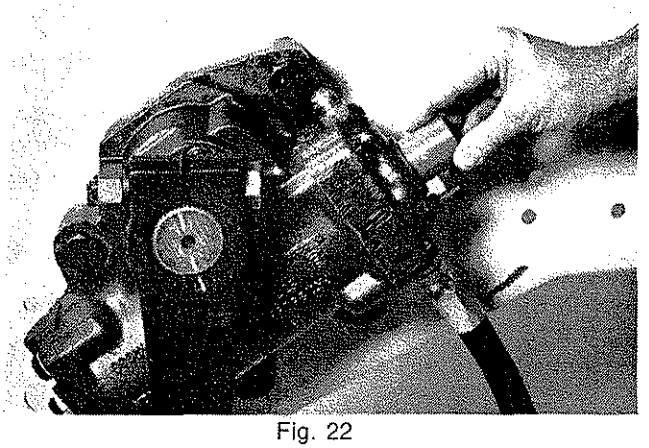


Fig. 22

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

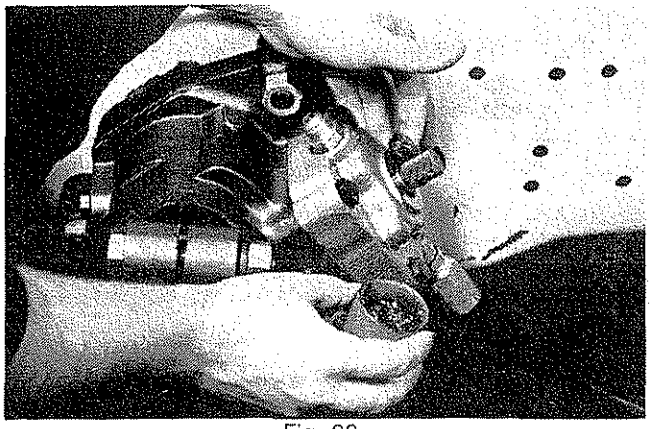


Fig. 23

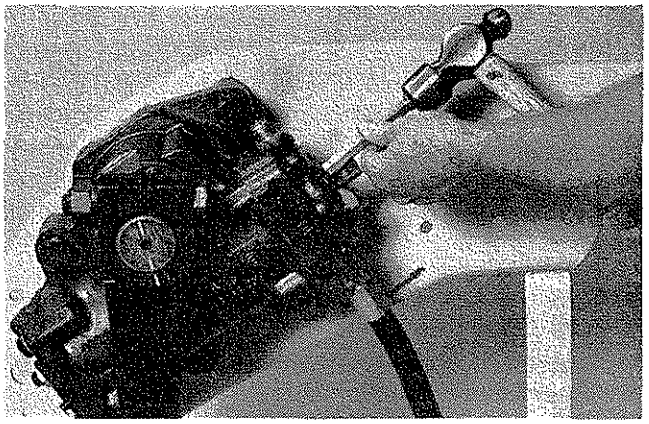


Fig. 24

8. Pack the area around the input shaft with clean Mobil Temp® 1 or 2 grease, or an equivalent. See Fig. 23.
9. Install a new dirt-and-water seal, using Kent-Moore seal-driving tool J26654, or a suitable blunt-ended drift. See Fig. 24.
10. Remove the plug and connect the return line.
11. Connect the steering driveline to the steering gear input shaft. For instructions, refer to the appropriate subject in this group.
12. Before operating the steering gear, fill the system with the recommended fluid and bleed any air from the system. For instructions, refer to "Filling and Air Bleeding the System."

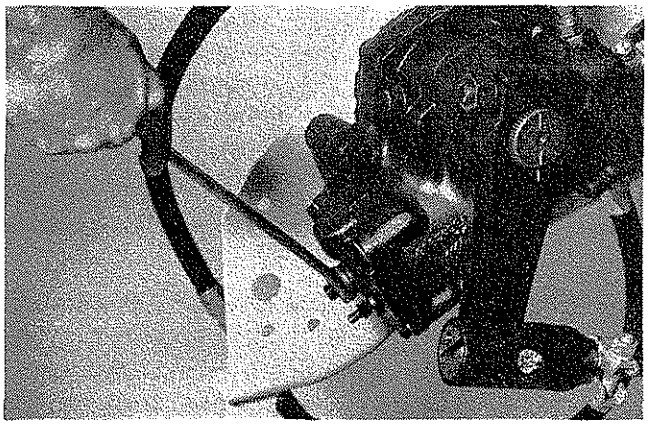


Fig. 25

ADJUSTMENTS WITH THE STEERING GEAR ON THE VEHICLE

Worm Shaft Preload Adjustment

1. Back off the worm shaft adjusting screw jam nut three turns (Fig. 25). Back off the worm shaft preload adjusting screw one turn (Fig. 26). Inspect the threads between the jam nut and the end cover for foreign material. Clean the threads or replace the jam nut if necessary.
2. While someone lightly moves the steering wheel back and forth about 1 inch (2.5 cm) total, tighten the worm shaft preload adjusting screw 60 to 70 lbf·in (680 to 790 N·cm).

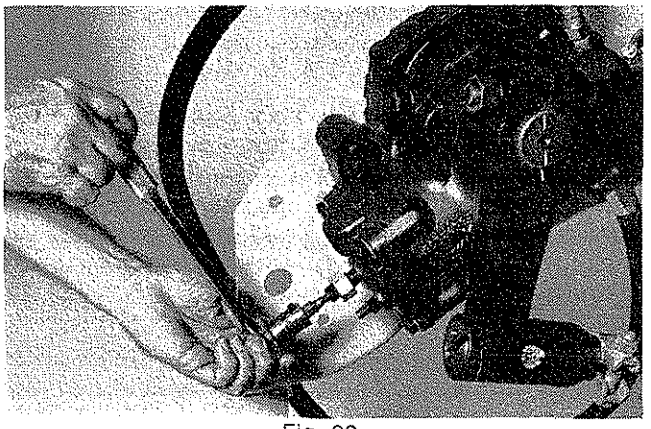


Fig. 26

NOTE: While torquing the adjusting screw, make sure that the worm shaft adjusting screw jam nut does not tighten.

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3. Tighten the worm shaft adjusting screw jam nut 70 to 80 lbf·ft (95 to 108 N·m). Make sure that the worm shaft preload adjusting screw does not move.

NOTE: If the sealing material in the jam nut has separated, remove the adjusting screw and replace the jam nut with a new one. Position the jam nut on the unslotted end of the adjusting screw so that the seal on the jam nut faces the end cover (Fig. 95). Then adjust the assembly as described above.

Poppet Valve Adjustment

1. Check the settings of the axle stops and adjust them if necessary. Refer to Group 10, subject 32-10270, for instructions.
2. Install a flow meter kit in the supply line from the pump to the steering gear. Make sure that the flow meter can be pressurized. Warm the reservoir fluid temperature to operating temperature using the method described in subject 23-14500, of this group.
3. Loosen both of the poppet-valve adjusting screw jam nuts.
4. With the engine at idle, have someone turn the steering wheel to the right-turn full-lock position. Note the pressure gauge reading.

CAUTION: As soon as pump relief pressure is reached, release the steering wheel from the full-lock position. At no time should pump relief pressure be maintained for longer than five seconds, or damage to the system may result because of excessive heat build-up. At no time should the oil temperature exceed 180°F (82°C).

If the steering gear assembly has a 5/16-24 UNF poppet adjusting screw in the valve housing, the adjusting screw cannot be removed from the assembled valve housing because the screw end inside the steering gear housing is enlarged. Attempting to remove this screw by force would damage the adjusting screw and the housing. The adjusting screw can be removed only by following the instructions in the "Steering Gear Disassembly" section.

NOTE: The right-turn poppet-valve adjusting screw is on the top of the steering gear on all COEs and on Conventionals with 1984 Advancements. On earlier Conventionals, this screw is on the bottom of the steering gear.

With the steering wheel at right-turn full-lock, back out the poppet-valve adjusting screw until the pressure gauge reaches the maximum reading. The pressure reading must be between the minimum 1575 psi (10 800 kPa) and the maximum 1925 psi (13 300 kPa) pump relief pressure.

If the system pressure exceeds the 1925 psi (13 300 kPa) maximum pump relief pressure, repair the power steering pump. Refer to the appropriate power steering pump subject in this group for repair instructions.

5. With the steering wheel at right-turn full-lock, carefully screw in the poppet-valve adjusting screw (Fig. 27) until the pressure gauge reading drops 200 to 400 psi (1400 to 2800 kPa) below the maximum pressure reading obtained in step 4. While holding the poppet-valve adjusting screw in place, tighten its jam nut 12 to 18 lbf·ft (16 to 24 N·m).

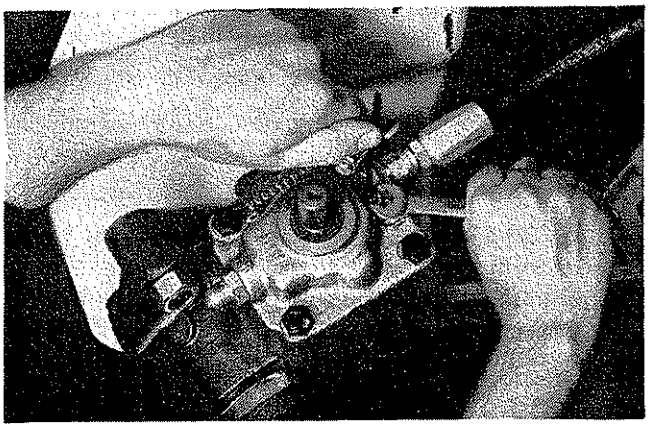

Fig. 27

6. With the engine at idle, have someone turn the steering wheel to the left-turn full-lock position. Repeat steps 4 and 5 (turning full-left instead of full-right) for left-turn poppet-valve adjustment.

NOTE: The left-turn poppet-valve adjusting screw is on the bottom of the steering gear on all COEs and Conventionals with 1984 Advancements. On earlier Conventionals, this screw is on the top of the steering gear.

Sector (Output) Shaft Adjustment

NOTE: This adjustment may be made with the gear mounted on all Conventionals and on COEs with 1984 Advancements.

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On other COEs, the gear must be removed to adjust the sector shaft. Refer to "STEERING GEAR REMOVAL."

1. Disconnect the drag link from the pitman arm. For instructions, refer to the 14 Group of this manual.
2. Position the sector shaft at its center of travel by rotating the input shaft until the alignment mark on the sector shaft is perpendicular to the input shaft centerline. See Fig. 28. If factory alignment marks are not visible, position the sector shaft on its center of travel by turning the input shaft through full travel. Count the number of turns from stop to stop. Then, starting at the end of travel, turn the input shaft back half the number of turns. Using a marking pen or paint, mark the pitman arm and sector shaft with a line perpendicular to the input shaft centerline.

CAUTION: This adjustment must be performed with the sector shaft at its center of travel.

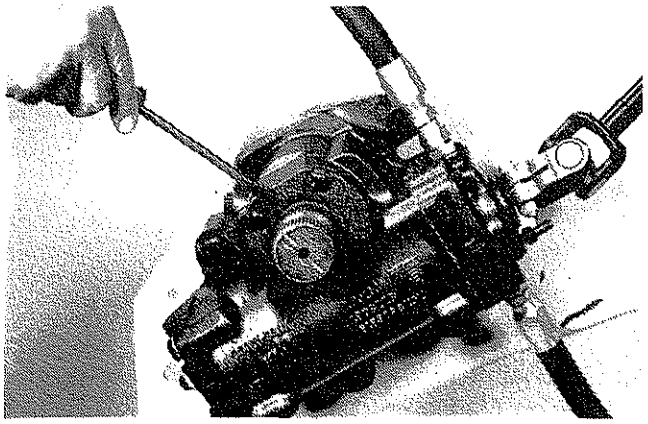

Fig. 28

3. With the sector shaft in the center position, grasp the pitman arm and gently try to move it back and forth in the direction of travel. Finger-tip force is adequate to detect lash (free-play) of a loose sector shaft. There may be *no movement* of the input shaft or sector shaft. If no lash is detected, no adjustment is needed.

   If lash is detected, loosen the jam nut and move the adjusting screw clockwise until the sector shaft and rack piston are in contact. Use no more than 10 lbf·ft (14 N·m) of torque. Then, turn the adjusting screw counterclockwise one turn. At this point, there should be lash at the pitman arm.

4. To adjust, slowly turn the adjusting screw clockwise until no lash is felt at the pitman arm. Hold the adjusting screw in place and tighten the jam nut 40 to 45 lbf·ft (54 to 61 N·m).
5. Recheck the pitman arm for lash. Turn the steering wheel one-quarter turn each side of center. No lash should be felt. If lash exists, repeat steps 2 through 5.
6. If the steering gear was removed, install it in the vehicle, using the procedures under "STEERING GEAR INSTALLATION."
7. Connect the drag link to the pitman arm. For instructions, refer to the 14 Group of this manual.

STEERING GEAR REMOVAL (Refer to Fig. 1 or 2)

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. Apply the vehicle parking brakes and chock the tires.
2. Thoroughly clean all outside dirt from around the fittings and hose connections.
3. Drain the steering gear assembly. Disconnect all hydraulic lines from the gear, marking the lines for later assembly reference. Seal off the lines and the gear fittings to prevent fluid from leaking out of the lines, and to prevent dirt from entering the lines or the gear.
4. Disconnect the drag link from the pitman arm. For instructions, refer to the 14 Group of this manual.
5. Disconnect the steering driveline from the steering gear input shaft. For instructions, refer to the 14 Group of this manual.

WARNING: Do not pound the U-joint or input shaft coupling on or off the input shaft. Internal damage to the steering gear can result.

6. If factory alignment marks on the steering gear output shaft and the pitman arm are not present, center the steering gear by turning the input shaft through full travel. Count the number of turns from stop to stop. Then, starting at the end of travel, turn the input shaft back half the number of turns. Using a marking pen or paint, mark the pitman arm and sector shaft with a line perpendicular to the input shaft centerline.
7. Clean the entire assembly before removing the gear.

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8. On COEs, remove the fasteners attaching the steering gear to the frame rail and mounting bracket. Remove the spacers and the steering gear, and place the steering gear on a clean surface.

   On Conventionals with 1984 Advancements, remove the fasteners attaching the steering gear to the frame rail. Remove the spacers and the steering gear. Place the steering gear on a clean surface.

   On other Conventionals, remove the fasteners attaching the steering gear mounting bracket to the frame rail, then remove the fasteners attaching the mounting bracket to the steering gear. Place the steering gear on a clean surface.

WARNING: The steering gear weighs approximately 80 lbs (36 kg) dry. Use caution when removing, lifting, or carrying the steering gear.

STEERING GEAR DISASSEMBLY (Refer to Fig. 3)

Make sure that the steering gear is placed on a clean surface. Clean and dry the gear before disassembly. As the gear is disassembled, clean all parts in a clean, petroleum-based solvent, and blow them dry only.

CAUTION: Never steam clean or high-pressure wash the hydraulic steering components. Do not force or abuse closely fitted parts.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

Keep each part separate to avoid nicks and burrs. Discard all seals, O-rings, and gaskets and replace them with new parts.

1. Position the gear in a vise, so that the gear's input shaft is horizontal. Rotate the input shaft to position the alignment mark on the sector shaft halfway between two trunnion cover bolts and pointing up. See Fig. 29.
2. Remove the pinch bolt, washer (if applicable), and nut from the pitman arm. Discard the nut. Remove the pitman arm, using a suitable puller.
3. Using a fine grade of emery paper, remove any paint or corrosion from the non-serrated area of the sector shaft. Loosen the sector shaft adjusting screw jam nut.

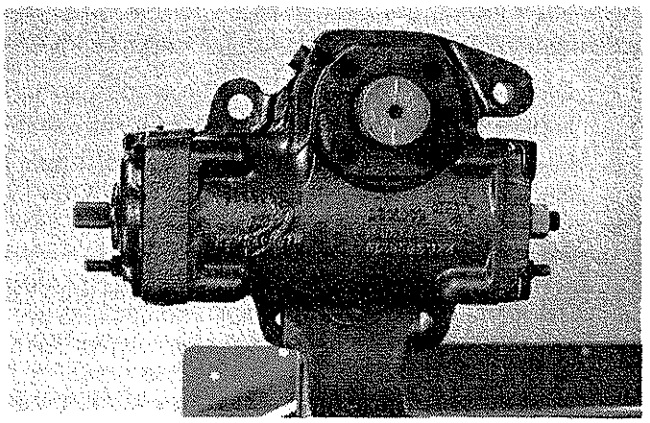

Fig. 29

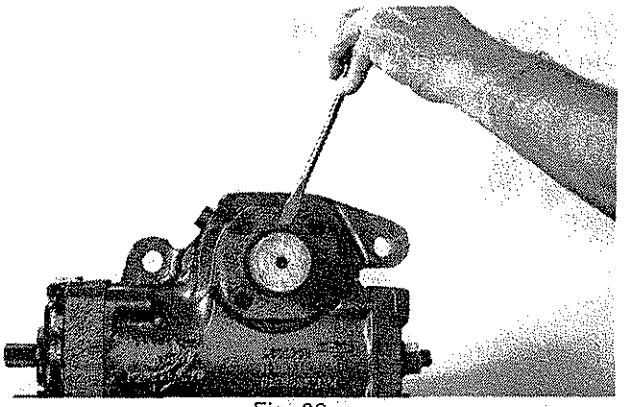

Fig. 30

4. Remove and discard the dirt-and-water seal from the trunnion cover. See Fig. 30.
5. Remove the four trunnion cover bolts. See Fig. 31. Remove the trunnion cover, as shown in Fig. 32. Remove and discard the trunnion cover O-ring, the Teflon® backup washer, and the two-piece sector shaft seal.
6. Tape the serrations and bolt groove of the sector shaft, using *one layer* of masking tape. See Fig. 33.
7. Prepare for fluid to drain, and remove the six special bolts from the side cover. See Fig. 34.

IMPORTANT: These special bolts are equipped with either a ring- or washer-design on the underside of the head. See Fig. 35. If replacing one or more bolts, use bolts of the *same special type and length as those that were removed.* Do not use a substitute. Refer to the Freightliner Parts Book for correct bolt type.

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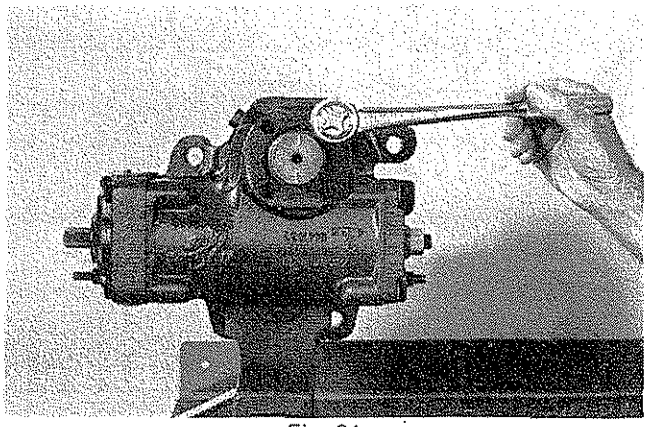

Fig. 31

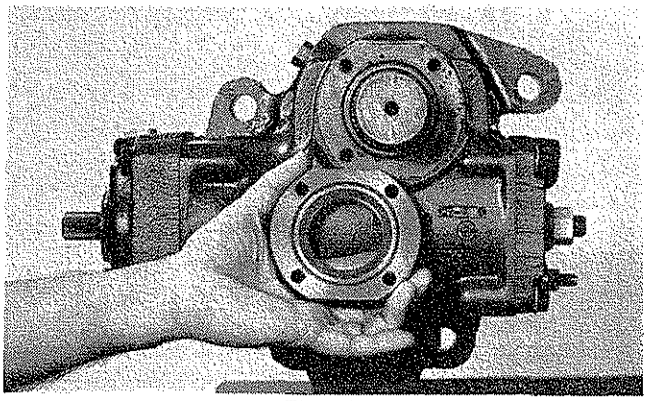

Fig. 32

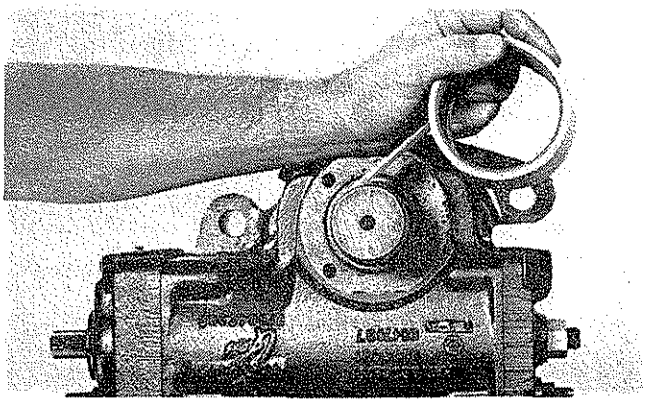

Fig. 33

8. Begin to remove the side cover and sector shaft as an assembly. See Fig. 36. As a means of starting the removal of the side cover and sector shaft assembly, a soft hammer or wooden handle may be used. Stop removal when the bearing rolls in the housing bearing are half exposed. Coat the bearing rolls with grease.

NOTE: The housing bearing may have caged (retained) rolls, which do not require special precautions. This bearing is identified as MR-1688-1.

IMPORTANT: If the bearing rolls are not caged, remove this assembly slowly, or it may come out too quickly to allow the bearing rolls in the housing bearing race to be retained. Follow the shaft end with a Kent-Moore

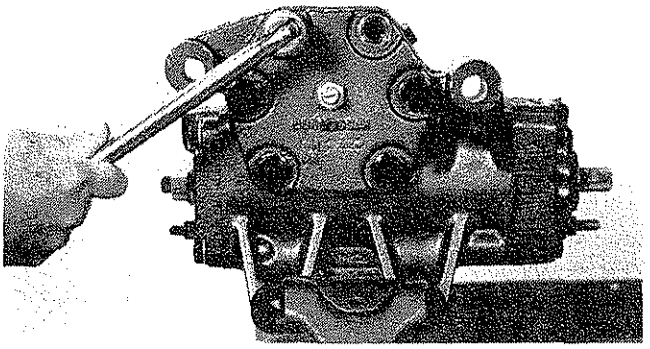

Fig. 34

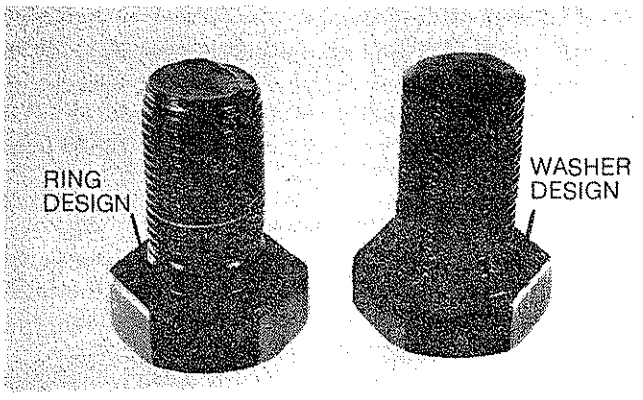

Fig. 35

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

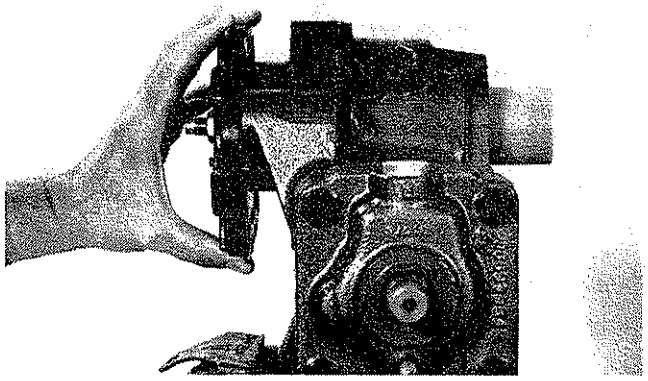

Fig. 36

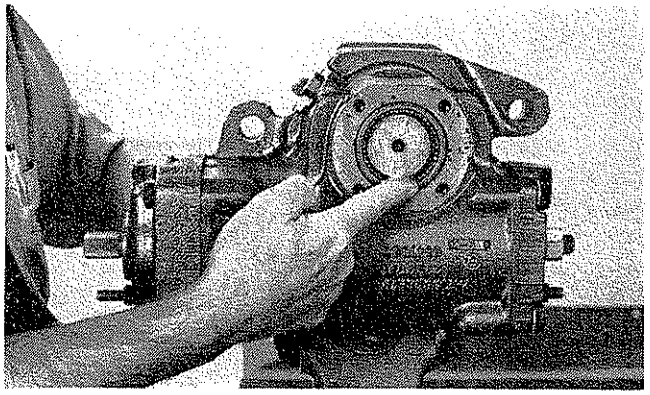

Fig. 37

bearing tool J26738 to retain the rolls; or, when the rolls are half exposed, coat them with grease to retain them in the housing bearing. See Fig. 37.

CAUTION: Be sure that no rolls are lost during disassembly. If one or more of the rolls is lost, the entire bearing must be replaced, as instructed in step 10 below. If the bearing is identified as BR-866-1 or is not identified, there are 44 rolls. If the bearing is identified as F83508, there are 43 rolls.

NOTE: The number on the housing bearing may not be visible while it is in place.

9. Finish removing the side cover and sector shaft as an assembly. Remove and discard the side cover gasket.

10. *Only* if the housing bearing race is damaged, or if one or more of the rolls are lost, should the housing bearing be replaced. Remove the bearing using Kent-Moore bearing mandrel J26738. Apply pressure from the side cover opening and press the bearing and retaining ring out through the trunnion cover opening, away from the cylinder bore. See Fig. 38. Maintain firm, square contact between the housing and press base to avoid damaging the housing bearing bore. Remove the retaining ring from the bearing, and discard the bearing.

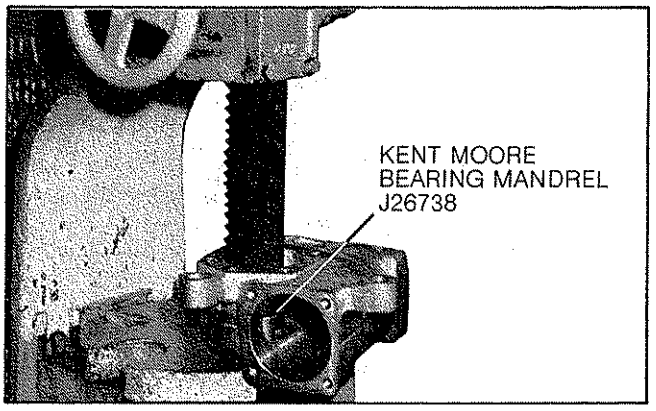

Fig. 38

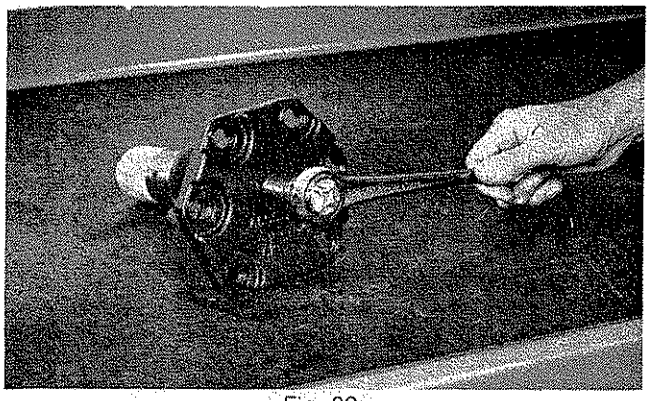

Fig. 39

CAUTION: If the bearing is cocked while pressing it out, it will burnish the bore, causing it to become oversized. Then, the steering gear housing will have to be replaced.

11. Remove the sector shaft adjusting screw jam nut. See Fig. 39.

12. Screw the sector shaft adjusting screw through the side cover. See Fig. 40. Place the side cover exterior-side down and lift the sector shaft out vertically.

Doing this will allow the side cover bearing rolls to fall into the side cover, where they can easily be collected. Immediately collect all of the side cover bearing rolls and count them. The bearing with no

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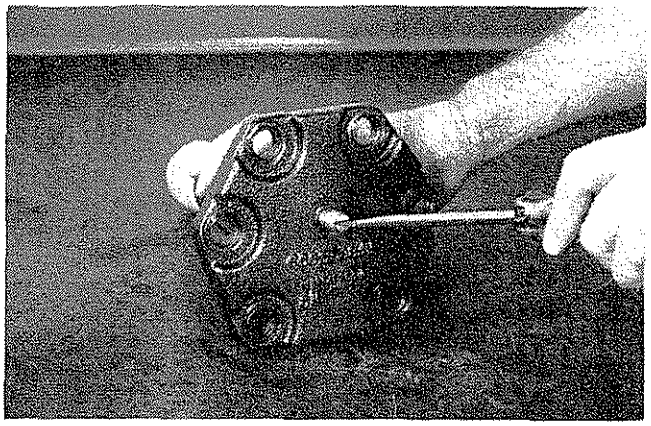


Fig. 40

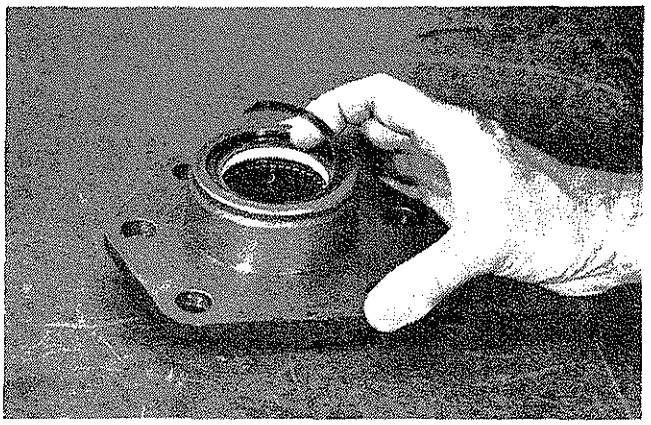


Fig. 41

identification or identified as BR-866-1 will have 44 rolls. The bearing identified as F83508 will have 43 rolls.

NOTE: If the side cover bearing is identified as MR-1688-1, the bearing rolls are caged (retained).

CAUTION: The part number of the bearing in the side cover may not be visible on the surface. Take care not to lose any rolls during disassembly, or the complete side cover assembly will have to be replaced.

WARNING: Do not mix the rolls from the side cover with the rolls from the housing bearing. The bearing race and rolls are a matched set. Interchanging the rolls could result in premature bearing or seal failure, which could cause a loss of power steering.

13. Remove the side cover retaining ring (see Fig. 41), the two-piece side cover seal, the Teflon® backup washer, and the steel backup washer from the side cover. See Fig. 42. Discard the two-piece seal and the Teflon® backup washer. Remove the rubber plug and discard it.

14. Loosen the worm shaft preload adjusting screw jam nut. Loosen the worm shaft preload adjusting screw about two turns. See Fig. 43. Loosen the poppet adjusting screw jam nut and the poppet adjusting screw about two turns.

15. Remove the four end cover bolts and washers. See Fig. 44. Prepare for fluid to drain, then remove the end cover.

16. Remove the end cover O-ring from the groove in the end cover. See Fig. 45.

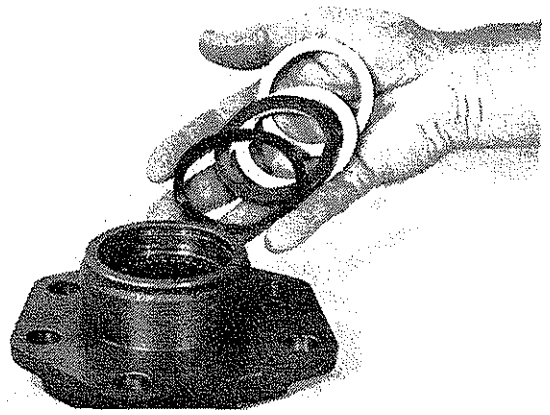


Fig. 42

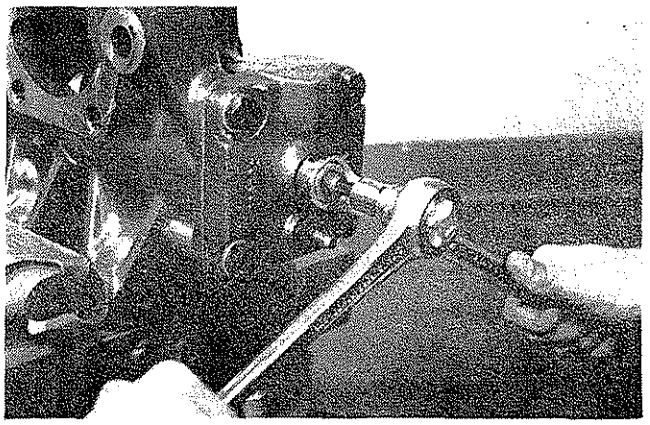


Fig. 43

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

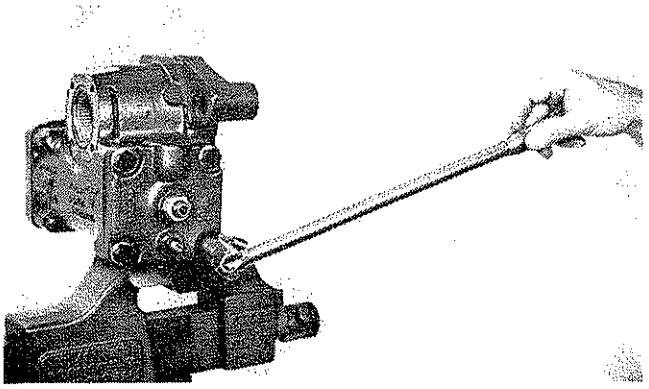


Fig. 44

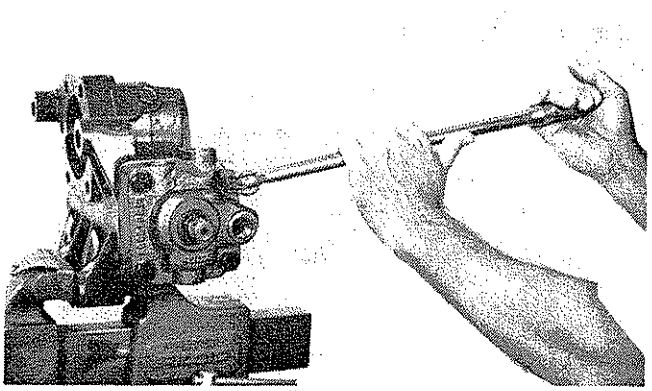


Fig. 46

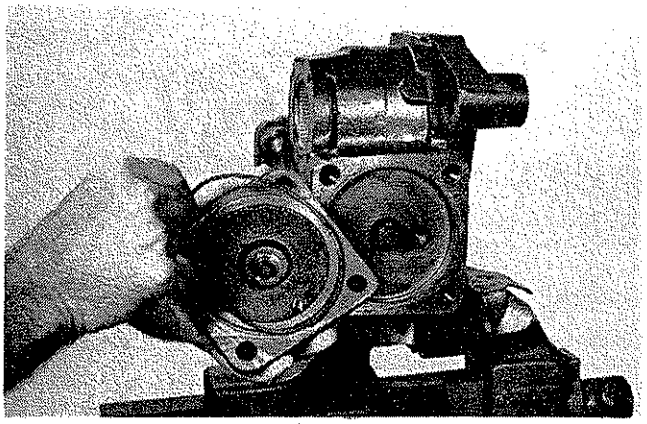


Fig. 45

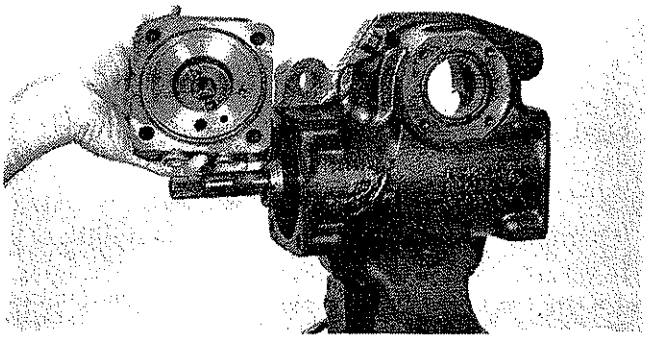


Fig. 47

17. Clean any paint or foreign material from the non-serrated area of the input shaft, using a fine grade of emery paper.
18. Loosen the valve housing poppet adjusting screw jam nut and poppet adjusting screw about two turns.
19. Remove the four valve housing bolts. See Fig. 46. Prepare for some fluid to drain, and remove the valve housing. See Fig. 47.

NOTE: The valve sleeve will probably remain in the valve housing.

WARNING: Do not disassemble the worm shaft/ input shaft, which includes the worm shaft, input shaft, torsion bar, torsion bar pins, drive ring, and drive ring retainer. Do not unbend the drive ring retainer tangs that hold the drive ring in place. See Fig. 48. Doing either will alter the valve timing, which could cause the vehicle to pull to one side.

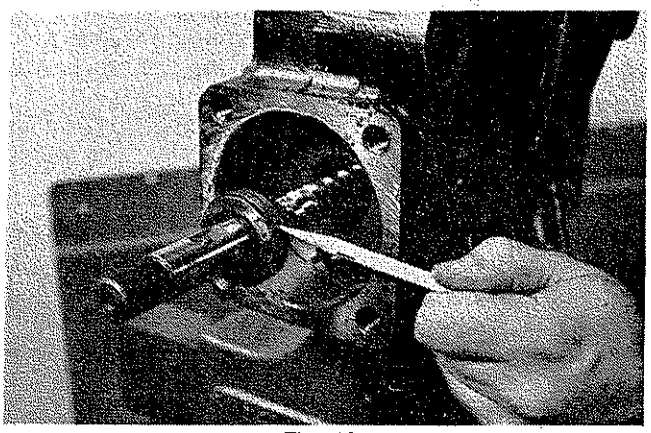


Fig. 48

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

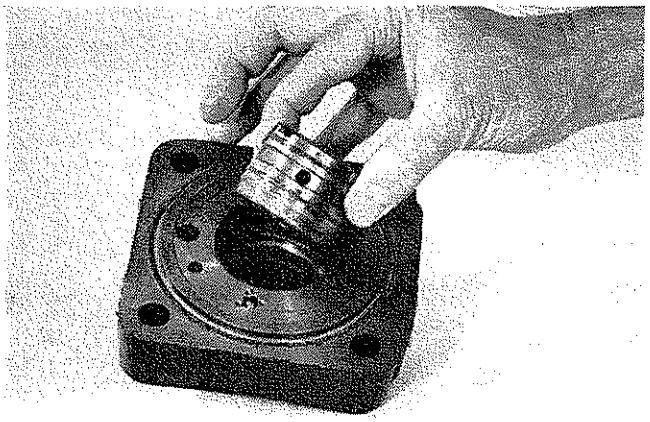


Fig. 49

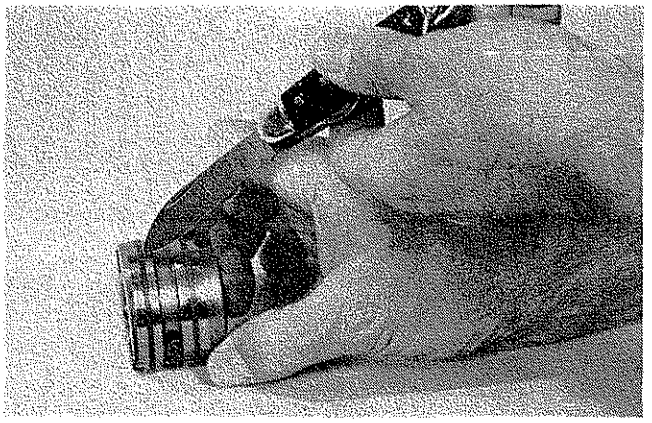


Fig. 51

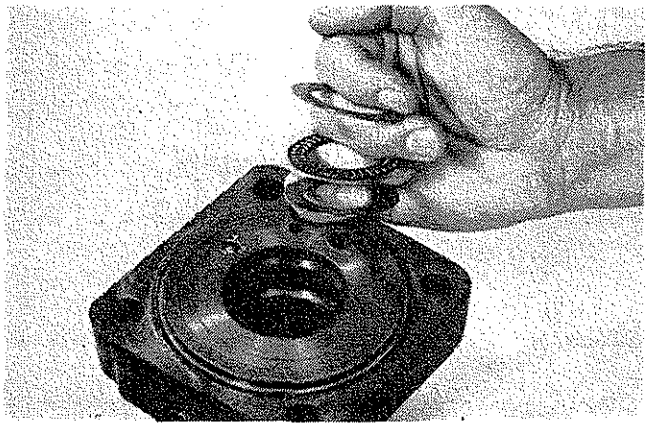


Fig. 50

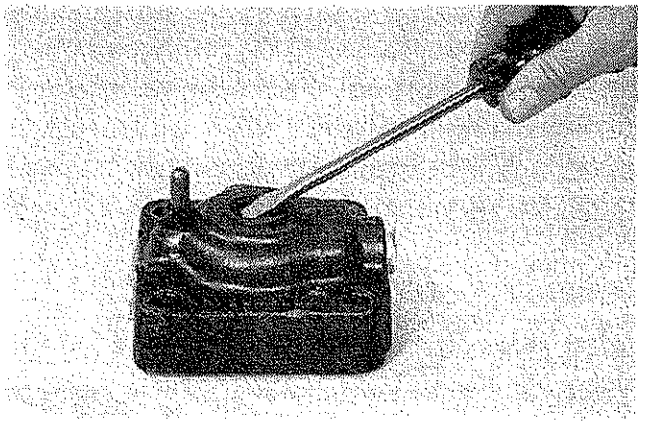


Fig. 52

20. Remove the valve sleeve from the valve housing. See Fig. 49.
21. Remove the first thrustwasher, the thrust bearing, and the second thrustwasher from the valve housing. See Fig. 50.

NOTE: The second thrustwasher may stay on the end of the valve sleeve. If so, remove it from the sleeve.

22. Remove and discard the two Teflon® seal rings from the valve sleeve. See Fig. 51.
23. Remove and discard the two backup O-rings from the grooves in the valve sleeve.
24. Remove and discard the valve housing O-ring from the valve housing.
25. Remove and discard the dirt-and-water seal, as shown in Fig. 52.
26. Remove the retaining ring, as shown in Fig. 53.

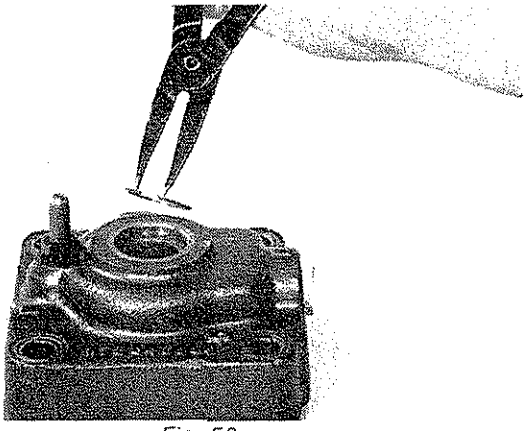


Fig. 53

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

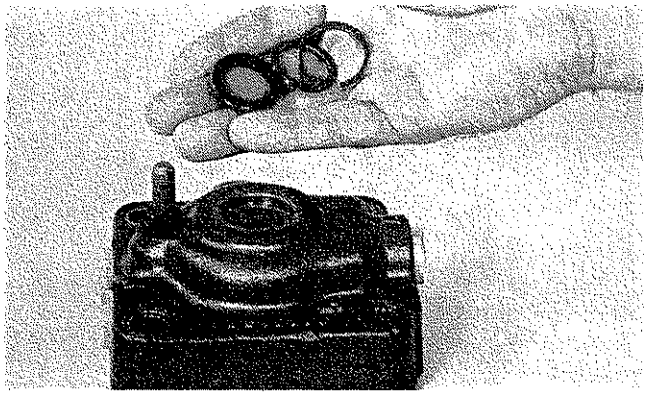


Fig. 54

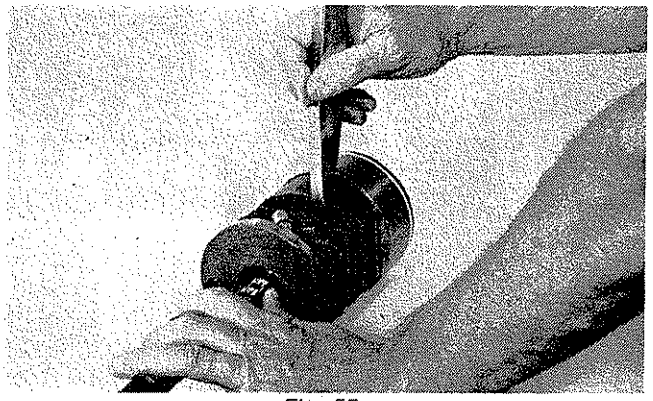


Fig. 55

27. Remove the steel backup washer, the input shaft seal, and the input shaft O-ring from the valve housing. See Fig. 54. Discard the seal and O-ring.

28. Remove the rack piston and worm shaft from the gear housing as an assembly.

NOTE: The worm shaft portion of the assembly will be inside the rack piston, with the input shaft portion of the worm protruding from the rack. Take care when removing this assembly from the housing. To prevent the Teflon® rack piston seal from getting caught in the sector shaft cavity, remove the assembly from the long end of the housing.

Set the rack piston and worm shaft assembly on a clean rag, to keep the piston from rolling.

29. For rack pistons with a ball return guide clip (see Fig. 3, Ref. 45), bend the tangs down on the two locking tabs. See Fig. 55. Remove the two hexhead bolts and the guide clip. See Fig. 56.

If the rack is equipped with a ball return guide cap (see Fig. 3, Ref 60), remove the two Allen-head or Torx-head bolts. See Fig. 57. Remove the ball return guide cap and the ball return cap seal. See Fig. 58.

30. Remove the halves of the ball return guide. See Fig. 59. Then, remove the 27 steel balls from the rack piston by rotating the worm shaft until the balls fall out. See Fig. 60.

NOTE: The ball return guide is closely fitted with the rack piston, and it may be necessary to remove the halves by carefully inserting a screwdriver between the rack and the guide. See the composite picture of both assembly types in Fig. 61.

CAUTION: The 27 steel balls are a matched set. Take care not to lose any of them. If any of the balls are lost, all of them must be replaced with a complete new set.

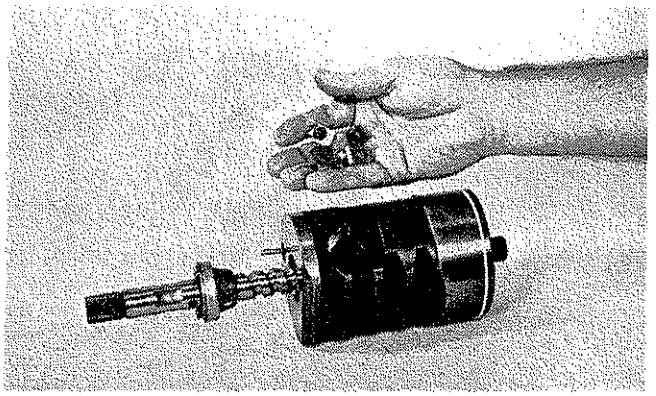


Fig. 56

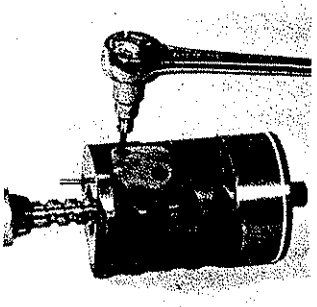


Fig. 57

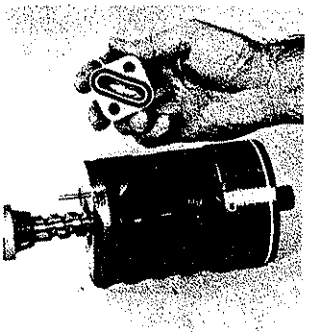


Fig. 58

WARNING: Incorrect matching of balls, worm-screw, and rack piston can result in a loss of steering control.

31. Remove the worm shaft from the rack piston. See Fig. 62.

32. Remove and discard the Teflon® rack piston seal ring and the backup O-ring. See Fig. 63.

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

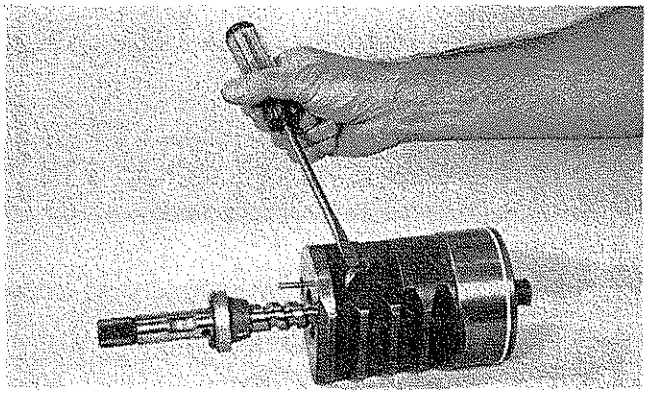


Fig. 59

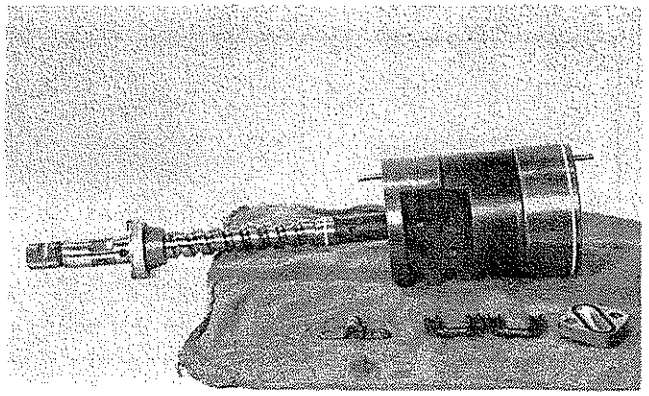


Fig. 62

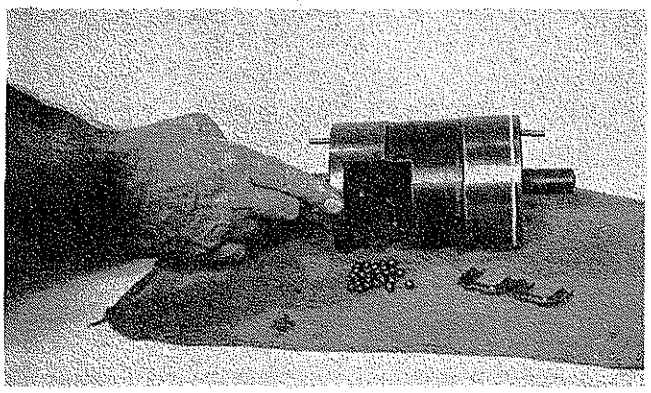


Fig. 60

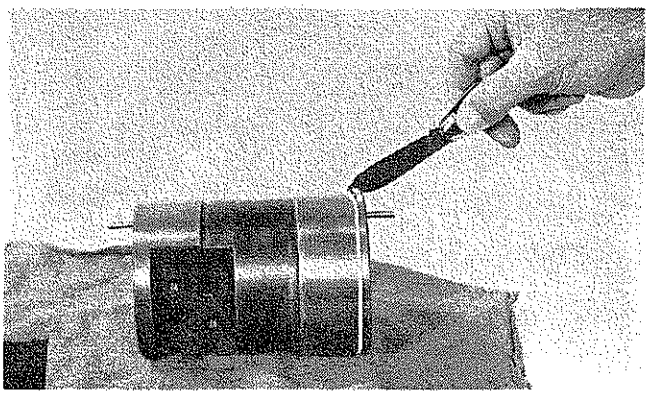


Fig. 63

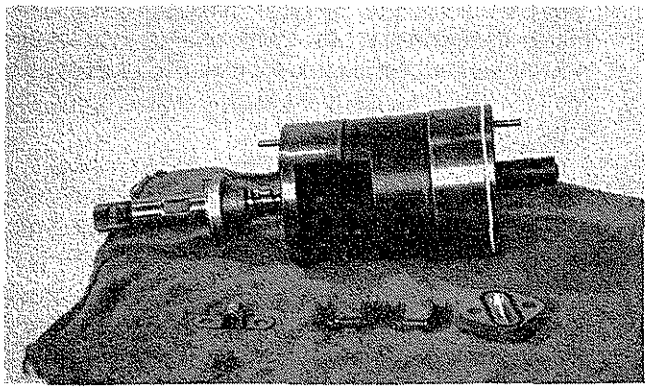


Fig. 61

33. Remove and discard the Teflon® worm shaft seal ring and O-ring. See Fig. 64.
34. Remove the manual bleed screw (see Fig. 3, Ref. 62) from the housing if so equipped.
35. The poppets will usually not require servicing. If it is necessary to service the poppets, position the rack piston in a soft-jawed vise. Remove the two poppet retaining rings (Fig. 65), two poppet seats (Fig. 66), two poppets, the nylon spacer rod, and the poppet spring. See Fig. 67.

WARNING: Eye protection must be worn when removing the poppets.

PARTS INSPECTION AND REPLACEMENT

All sealing surfaces and seal cavities must be free of nicks and corrosion. If any part is nicked or corroded where sealing occurs, the part must be replaced to ensure proper sealing.

Wash all parts in clean petroleum-based solvent. Blow them dry with air.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

1. Inspect the rack piston teeth for cracks and wear. See Fig. 68. If a step can be detected by running

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

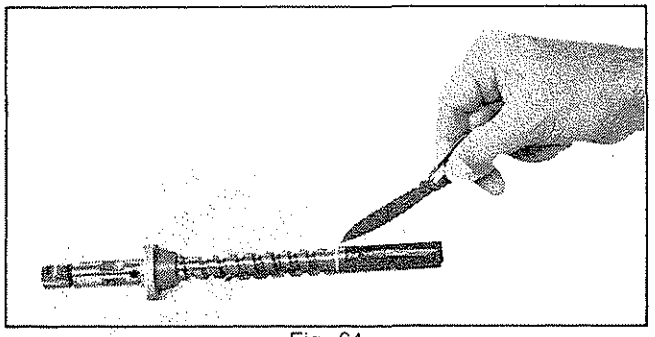


Fig. 64

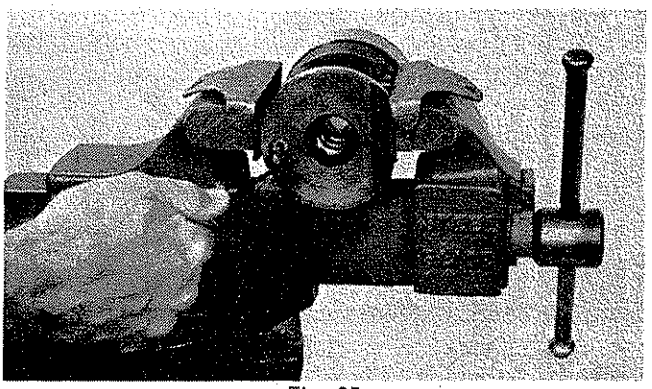


Fig. 65

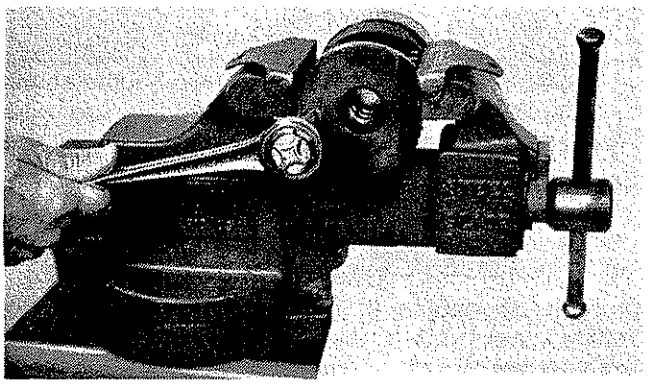


Fig. 66

your fingernail horizontally across the teeth surfaces, both the rack piston and the sector shaft must be replaced.

2. Inspect the rack piston internal ball-track grooves for brinelling (dents) or spalling (flaking). See Fig. 69. If either condition exists, the following parts must be replaced: the rack piston; the worm shaft/input shaft assembly; and the valve sleeve.
3. Inspect the worm shaft ball-track grooves for brinelling or spalling. See Fig. 70. If either condition exists,

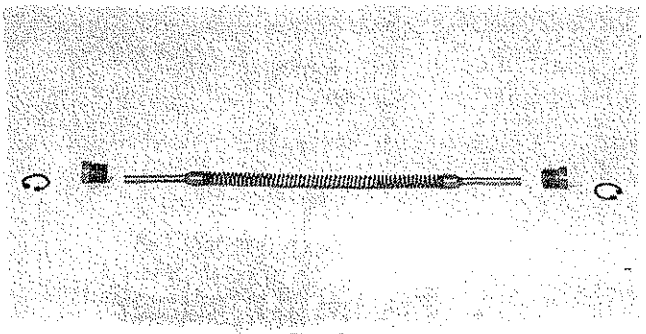


Fig. 67

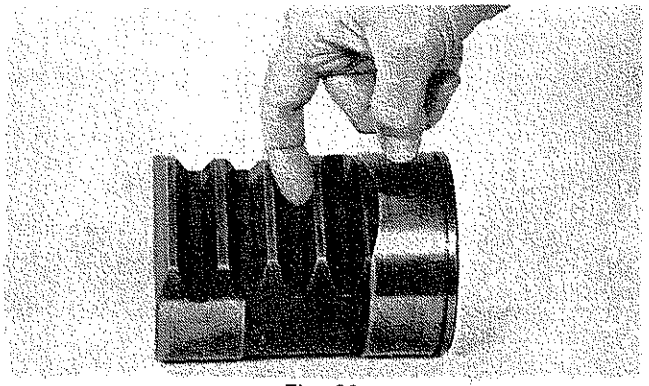


Fig. 68

the following parts must be replaced: the worm shaft/input shaft assembly; the rack piston; and the valve sleeve. Inspect the upper shaft-seal area, near the input shaft serrations, for nicks. Run your fingernail across the sealing surface to detect steps. See Fig. 71.

NOTE: The input shaft is pinned to the worm shaft by the torsion bar pin; the assembly is flexible, and may appear slightly bent at this joint. See Fig. 72. This slight bend is normal.

4. Inspect the housing cylinder bore. See Fig. 73. Minor scoring marks running lengthwise through the bore are normal, and should not be compared to the scoring that might be found in the cylinder bores of an internal combustion engine. Replace the housing only if it has been tested for internal leakage, and it is determined that the scoring is responsible for the excessive internal leakage (greater than 1 gpm [3.8 Lpm]). For test procedures, refer to the hydraulic power steering gear checking, testing, and troubleshooting subject in the 14 Group of this manual.

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

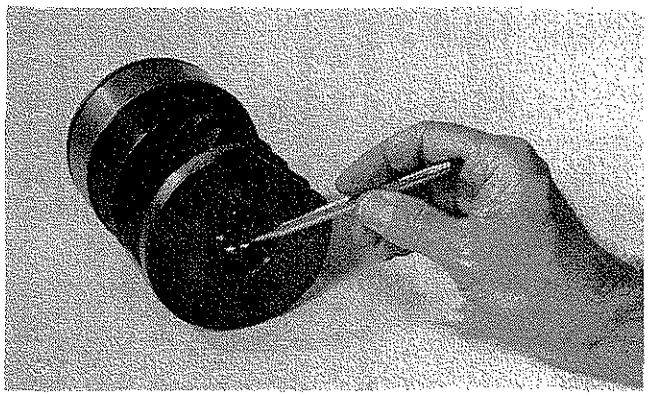


Fig. 69

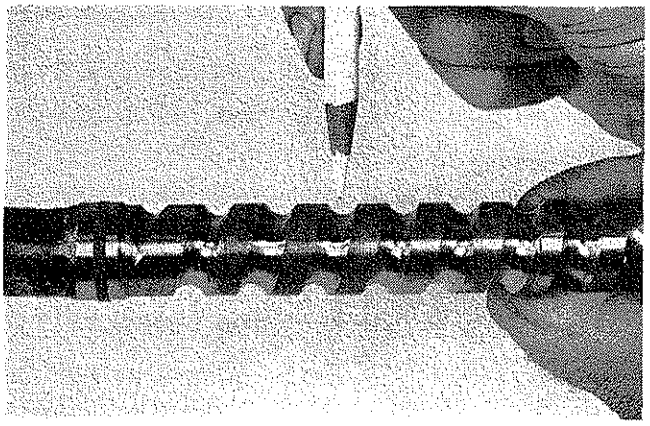


Fig. 70

NOTE: In evaluating this test, make sure that internal leakage exceeding 1 gpm (3.8 Lpm) can only be attributed to the housing, and not to the seals in the worm shaft, rack piston, and valve assembly.

5. Inspect the housing faces for nicks that would prevent proper sealing. See Fig. 74. Replace the gear housing if these nicks are present and cannot be easily removed with a fine-toothed flat file, without changing the dimensional characteristics.

6. Inspect the housing bearing (Fig. 75) for brinelling or spalling. If either condition exists, replace the housing bearing. For instructions, refer to step 10 under "STEERING GEAR DISASSEMBLY;" then step 2 under "STEERING GEAR ASSEMBLY."

   Inspect the side cover bearing (Fig. 76) for brinelling or spalling. If the side cover bearing is damaged, replace the complete side cover assembly.

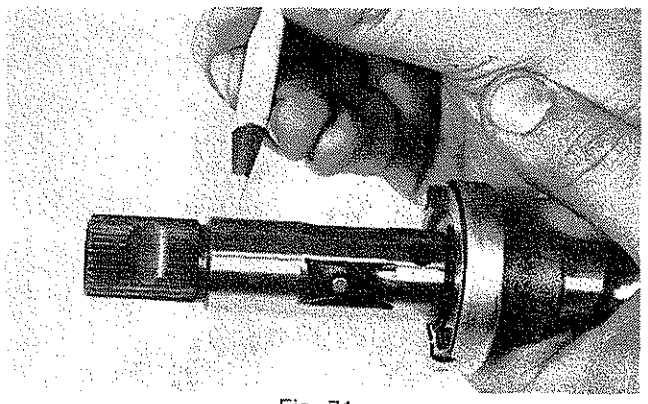


Fig. 71

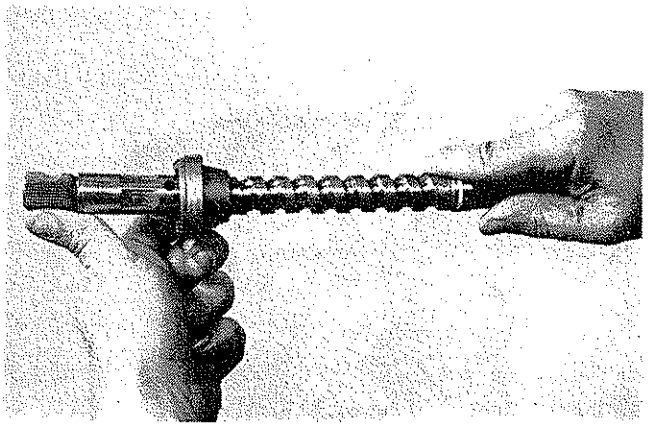


Fig. 72

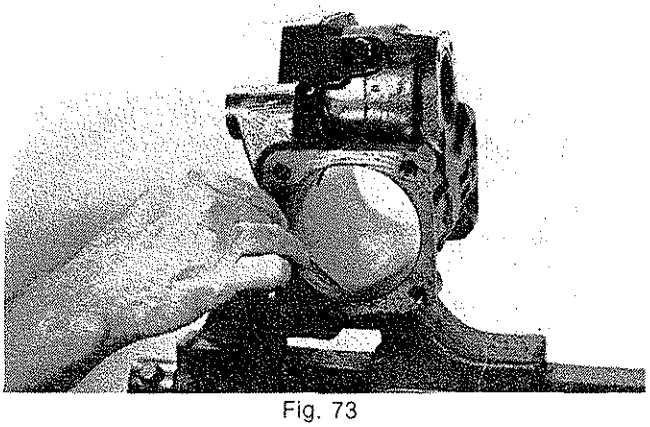


Fig. 73

7. Inspect the sector shaft bearing sealing areas for brinelling or spalling. See Fig. 77. Run your fingernail across these areas to detect steps. Inspect also

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

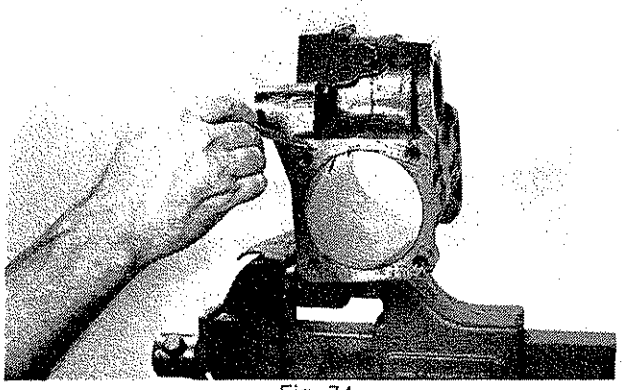


Fig. 74

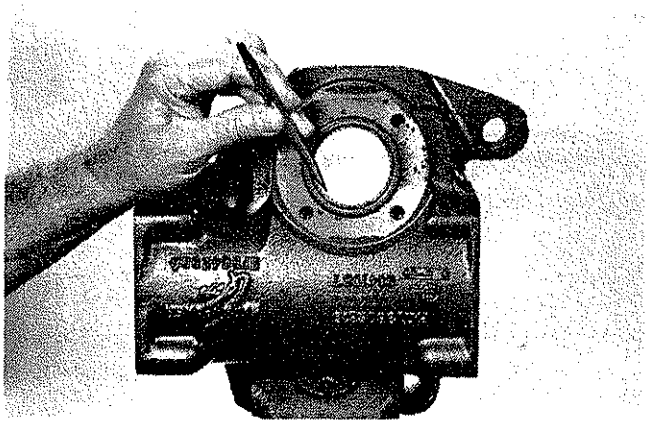


Fig. 75

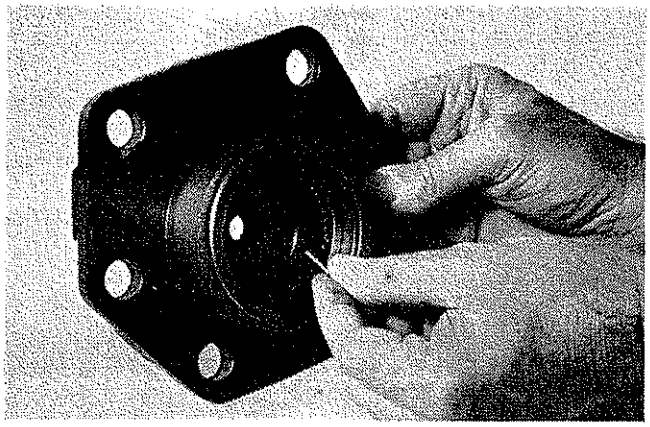


Fig. 76

for cracks. If any of these conditions exist, replace the sector shaft.

8. Inspect the thrust bearing rollers for any deterioration. Inspect the two thrustwashers for brinelling, spalling, or cracks. See Fig. 78. Replace any part if these conditions are detected.

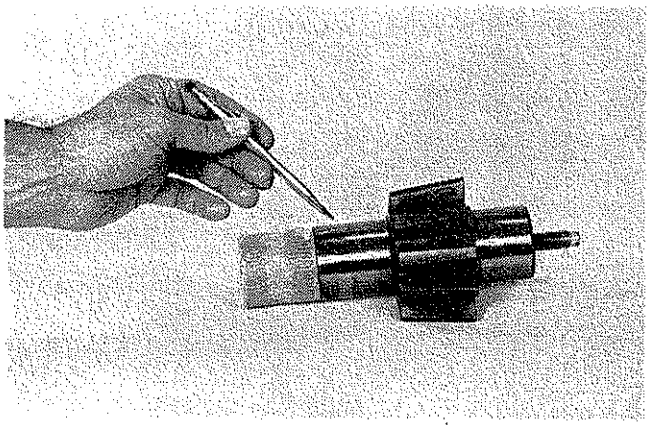


Fig. 77

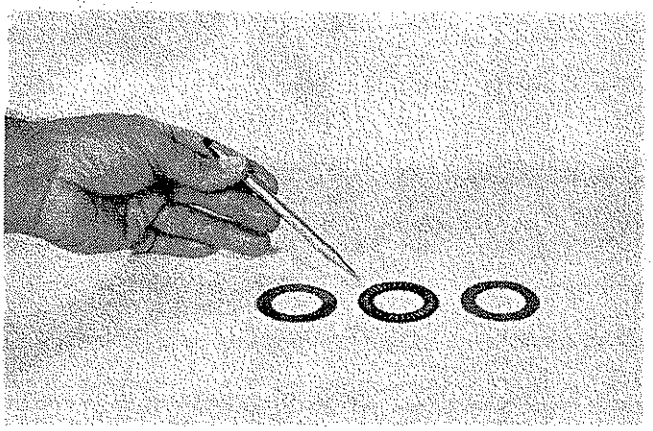


Fig. 78

STEERING GEAR ASSEMBLY (Refer to Fig. 79)

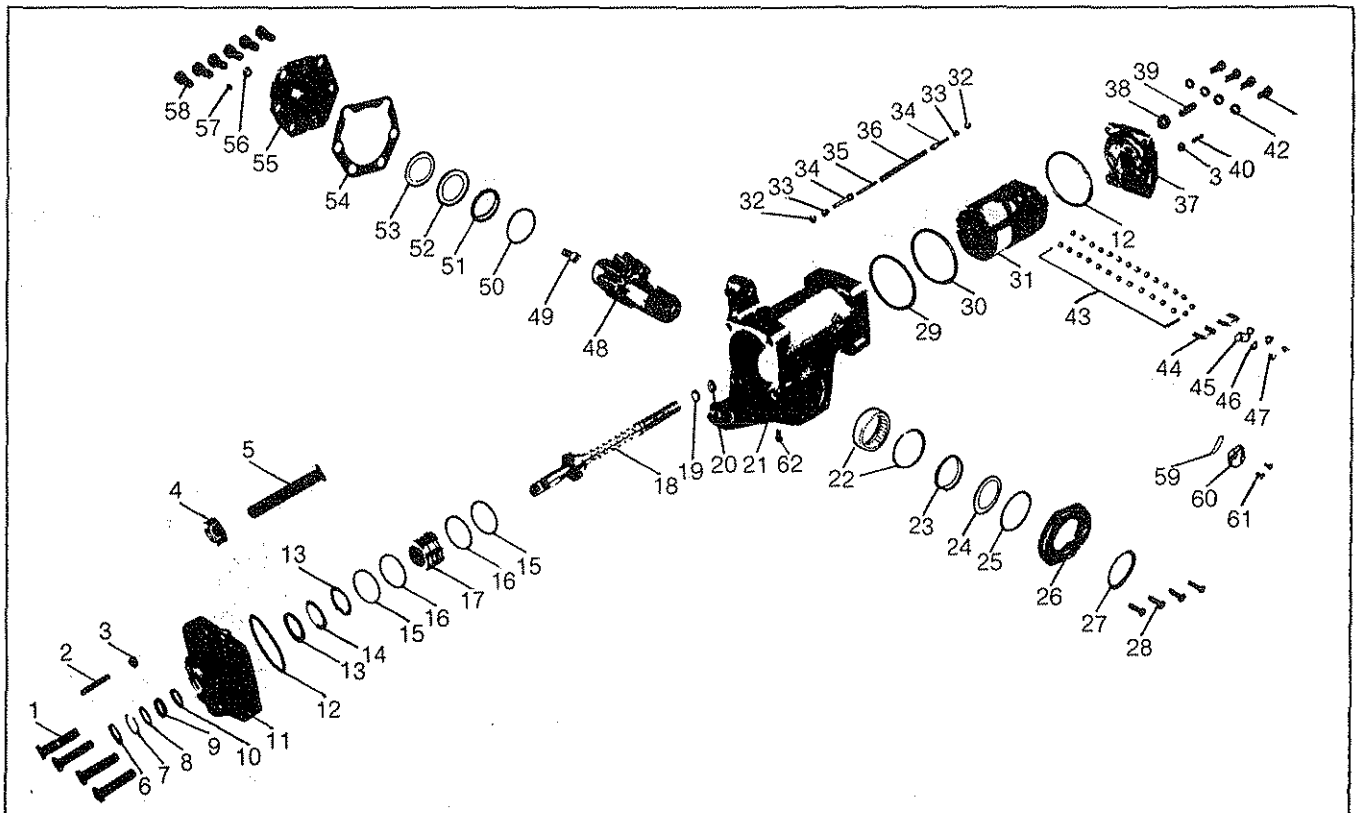
After inspection, clean all parts again in clean petroleum-based solvent, and blow them dry with air.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation or injury. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

All seals, seal rings, and gaskets, must be replaced with new ones each time the gear is disassembled. Individual seals, seal rings, and gaskets, as well as complete seal kits are available from Freightliner part distributors.

1. Using Kent-Moore seal installation tool J26650-01, assemble the new worm shaft backup O-ring (Fig.

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



1. Valve Housing Bolt
2. Poppet Adjusting Screw
3. Poppet Adjusting Screw Jam Nut
4. Internal-Allen-Head Poppet Adjusting Screw Jam Nut
5. Internal-Allen-Head Poppet Adjusting Screw
6. Dirt-and-Water Seal
7. Retaining Ring
8. Steel Backup Washer
9. Input Shaft Seal
10. Input Shaft O-Ring
11. Valve Housing
12. O-Ring
13. Thrustwasher
14. Thrust Bearing
15. Teflon® Seal Ring
16. Backup O-Ring
17. Valve Sleeve
18. Worm Shaft/Input Shaft Assembly
19. Worm Shaft Backup O-Ring
20. Teflon® Worm Shaft Seal Ring
21. Gear Housing
22. Housing Bearing and Retaining Ring
23. Two-Piece Sector Shaft Seal
24. Teflon® Backup Washer
25. Trunnion Cover O-Ring
26. Trunnion Cover
27. Dirt-and-Water Seal
28. Trunnion Cover Bolts
29. Teflon® Rack Piston Seal
30. Rack Piston Backup O-Ring
31. Rack Piston
32. Poppet Retaining Ring
33. Poppet Seat
34. Poppet
35. Nylon Spacer Rod
36. Poppet Spring
37. End Cover
38. Worm Shaft Adjusting Screw Jam Nut
39. Worm Shaft Adjusting Screw
40. Poppet Adjusting Screw
41. End Cover Bolts
42. Washers
43. Steel Balls
44. Ball Return Guide
45. Ball Return Guide Clip
46. Locking Tabs
47. Hexhead Bolts
48. Sector Shaft
49. Sector Shaft Adjusting Screw
50. Side Cover Retaining Ring
51. Two-Piece Side Cover Seal
52. Teflon® Backup Washer
53. Steel Backup Washer
54. Side Cover Gasket
55. Side Cover and Bearing Assembly
56. Sector Shaft Adjusting Screw Jam Nut
57. Rubber Plug
58. Special Bolts
59. Ball Return Guide Cap Seal
60. Ball Return Guide Cap
61. Allen-Head or Torx-Head Bolts
62. Manual Bleed Screw*

*On Some Models

Fig. 79, Ross HFB64 Steering Gear

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

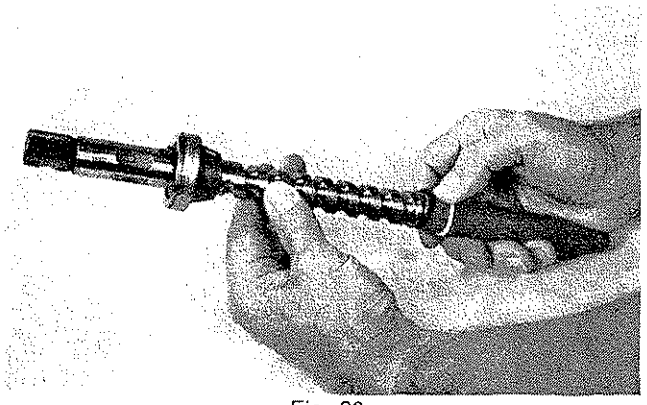


Fig. 80

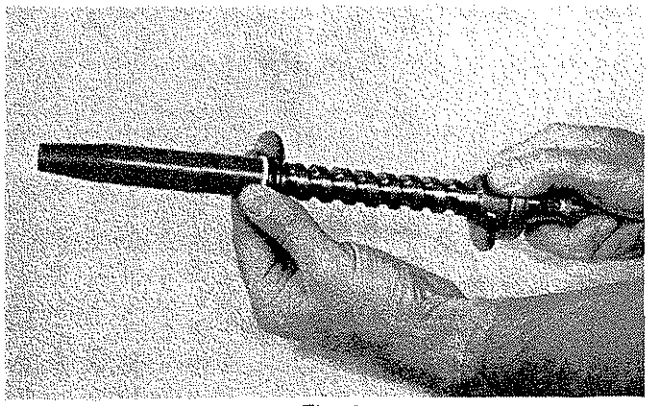


Fig. 81

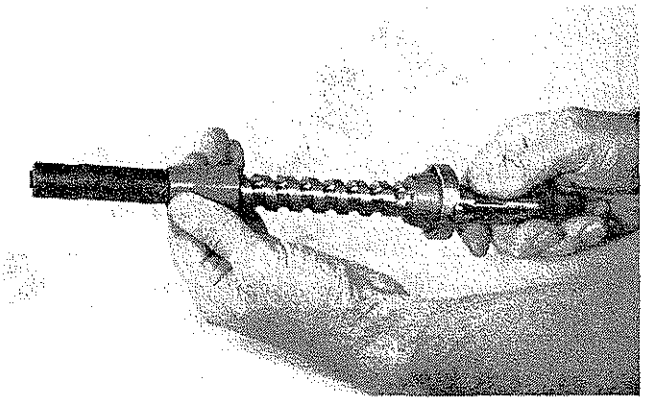


Fig. 82

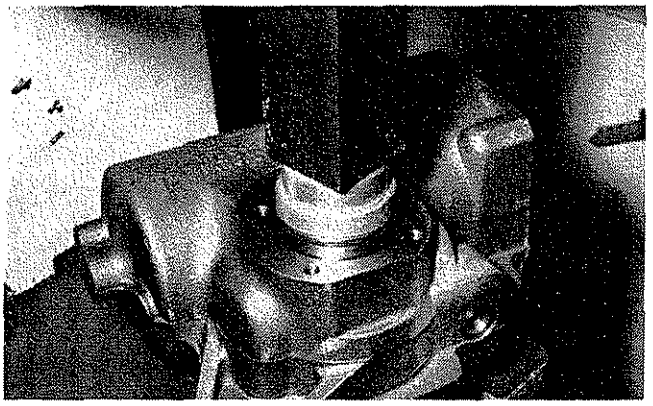


Fig. 83

80), and then the new Teflon® worm shaft seal ring (Fig. 81). Compress the seal ring with Kent-Moore compression tool J26649 (see Fig. 82) and set the worm shaft aside for 10 minutes.

CAUTION: Allow 10 minutes to ensure that the ring and seal are properly seated before installing the worm shaft into the rack piston. If this time is not allowed, the seal may tear or be cut when placing the worm into the rack.

2. If a new housing bearing is being installed, install the retaining ring into the groove on the bearing's outside diameter. Then, press the bearing into the housing from the trunnion side, using Kent-Moore bearing mandrel J26738 against the lettered end of the bearing shell, so the retaining-ring end is away from the housing bore. See Fig. 83. Be sure the bearing mandrel is clean. Take care during this procedure that the housing is square with the press base and that the bearing is not cocked.

   Whether or not a new bearing race was installed, apply a generous amount of clean grease to the bearing race to retain the bearing rolls. Then, place the bearing rolls into the bearing race. Be sure that the rolls have been counted correctly, and the quantity matches the quantity required for the housing bearing part number.

NOTE: If bearing BR-866-1, or a bearing with no part number is being installed, install 44 rolls. If bearing F83508 is being installed, install 43 rolls. If bearing MR-1688-1 is being installed, the rolls are caged (retained) in the bearing race.

WARNING: The bearing rolls must be in place to ensure proper installation of the bearing. If the rolls are improperly installed, the bearing race may collapse and fail. The flange may break, causing premature failure of the bearing. Do not mix the housing bearing rolls with the side cover bearing rolls.

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Fig. 84

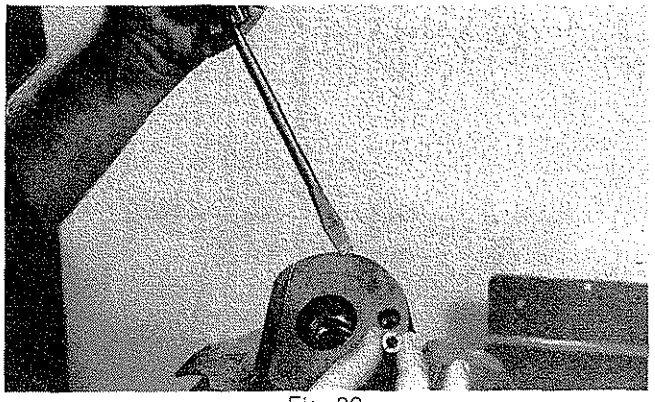

Fig. 86

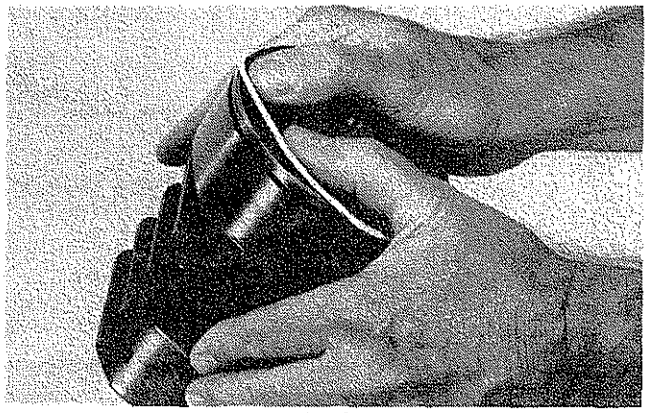

Fig. 85

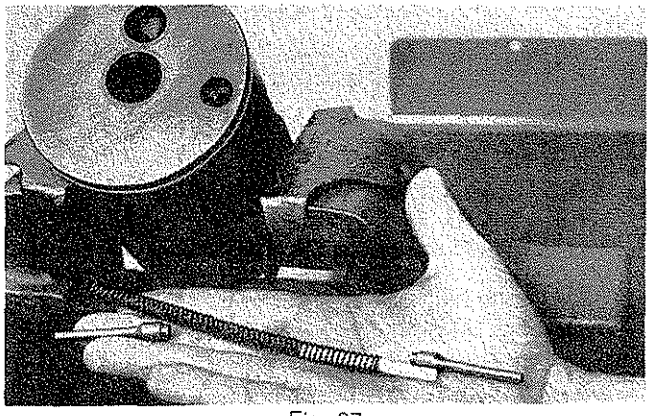

Fig. 87

Interchanging the rolls could result in premature bearing or seal failure, which could cause a loss of steering.

3. Install a new rack piston backup O-ring (see Fig. 84), and a new Teflon® rack piston seal ring (see Fig. 85). Do not stretch these rings when installing them. After they are installed, coat the rings with a liberal amount of grease.

4. Install the components of the poppet assembly in the following order: one poppet seat (Fig. 86); then (from the other end of the poppet hole in the piston) one poppet, the poppet spring, the nylon spacer rod (Fig. 87), the other poppet, and the other poppet seat (Fig. 88).

WARNING: Eye protection must be worn when installing the spring-loaded poppets, which could eject and cause eye injury.

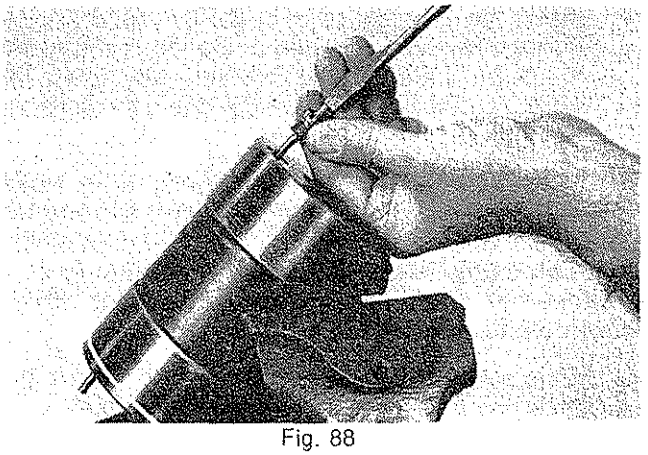

Fig. 88

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

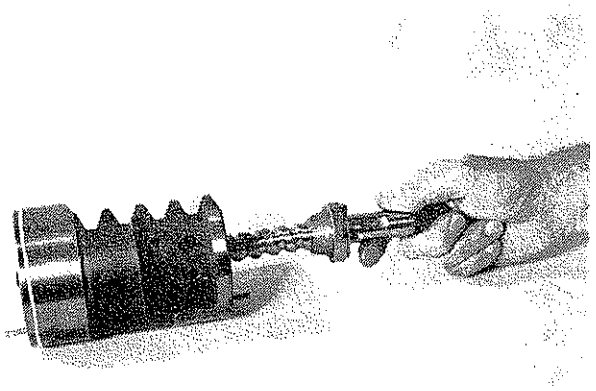

Fig. 89

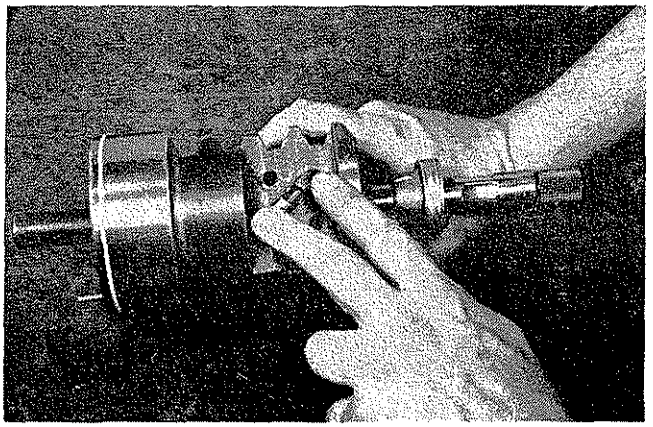

Fig. 90

Tighten the poppet seats 25 to 30 lbf·ft (34 to 41 N·m). Install both retaining rings.

5. If more than 10 minutes have elapsed since installing the worm shaft seal and ring, grease the sealing surface inside the rack piston, and install the worm shaft/input shaft assembly into the rack piston. See Fig. 89.

6. Install the ball return guide halves in the rack piston. See Fig. 90. Make sure they are correctly seated.

WARNING: Do not seat the guides with a hammer. Damage to the guides can result in steering gear lockup or loss of steering.

7. Insert the 27 steel balls in the ball return guide, through the hole provided in the top of the guide. As the balls are dropped into the guide, rotate the worm shaft to pull the balls down into the grooves. See Fig. 91.

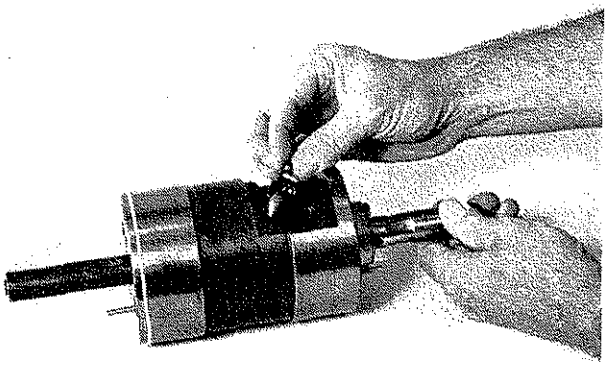

Fig. 91

WARNING: Make sure the ball return guide stays down and in place as the balls are dropped through the hole. Failure to hold the guide down may result in a ball being trapped outside the closed loop. A trapped ball can result in a steering lockup, which could cause an accident.

8. If the steering gear is equipped with a ball return guide clip, install the clip so that both bolt hole faces are in full contact with the rack piston surface. Install the two locktabs and the two hexhead bolts. Tighten the bolts 13 to 17 lbf·ft (18 to 23 N·m). Bend the locking tabs up against the bolt-head flats. See Fig. 92.

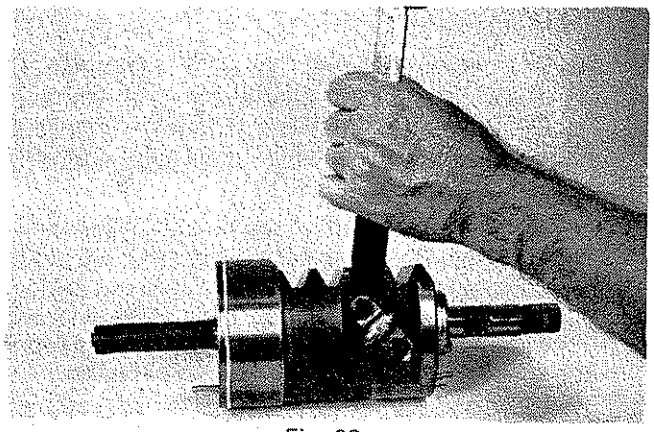

Fig. 92

If the steering gear is equipped with a ball return guide cap, grease the ball return guide cap seal,

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and place it in the seal groove of the cap. Install the cap so that the seal makes full contact with the rack piston surface. Install the two Allen-head or Torx-head bolts and tighten them 13 to 17 lbf·ft (18 to 23 N·m).

WARNING: Rotate the worm shaft from one end of travel to the other end of travel to make certain that the balls have been installed properly. If the worm shaft cannot be rotated, remove the balls and install them again. If the steering gear is installed on a vehicle when the worm shaft is unable to rotate, the steering gear will not function correctly. The steering gear can be damaged, which can result in a loss of steering control.

9. Apply a generous amount of clean grease to the Teflon® rack piston seal and to the housing cylinder bore. Install the rack piston and worm shaft as an assembly into the *long* end of the gear housing, so that the Teflon® rack piston seal goes in last. See Fig. 93.

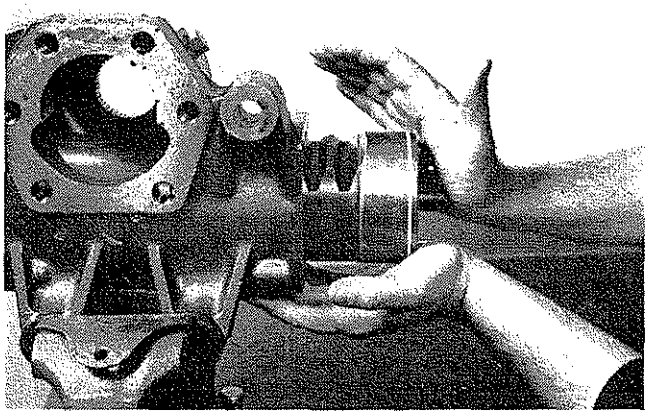

Fig. 93

CAUTION: Be certain that the seal is placed into the long end of the housing last. Otherwise, a large section of the seal will be cut, and the vehicle will have no power steering assist.

NOTE: To ease the later assembly of the sector shaft, rotate the rack piston and worm shaft assembly in the housing so that the rack teeth are exposed in the sector shaft cavity of the housing. See Fig. 94.

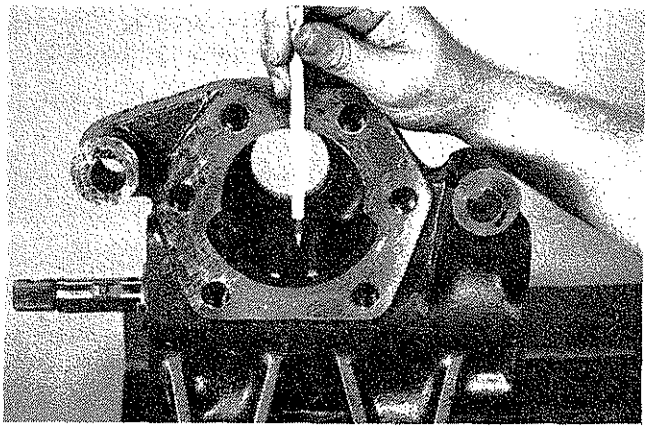

Fig. 94

10. Install the worm shaft adjusting screw jam nut on the nonslotted end of the worm shaft preload adjusting screw, so that the seal on the jam nut faces the end cover of the housing. See Fig. 95. Assemble one poppet valve adjusting screw and jam nut, and the other poppet valve adjusting screw and jam nut in the same manner.

NOTE: The poppet valve adjusting screws (Fig. 79, Ref. 2 and 40), may or may not be the same length. If they are not, install the shorter adjusting screw (Fig. 79, Ref. 40) into the end cover a few turns.

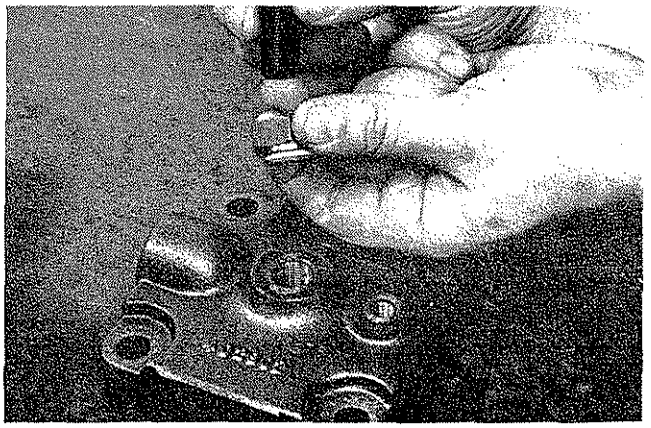

Fig. 95

WARNING: If the screws are unequal in length, the shorter screw must be installed into the end cover. Otherwise, the poppet assembly may break and lock up the steering gear, possibly resulting in an accident.

If the steering gear is equipped with an internal-Allen-hex poppet adjusting screw (see Fig. 79, Ref. 5) in the valve housing, install the sealing jam nut onto the internal-Allen-hex end of the screw after

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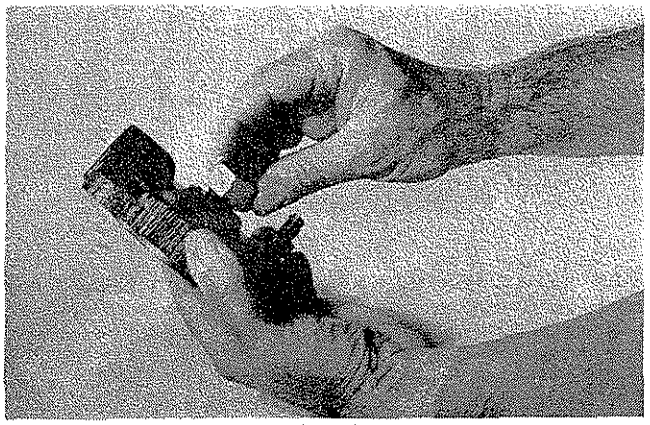

Fig. 96

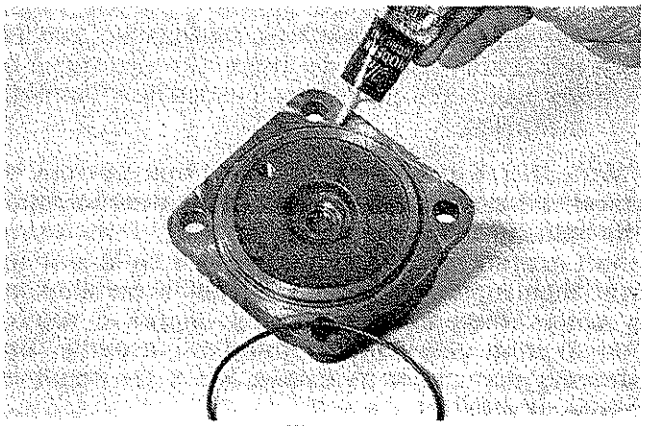

Fig. 97

installing the screw in the valve housing. The seal on the jam nut must face toward the housing.

11. Install the worm shaft preload adjusting screw in the end cover a few turns. See Fig. 96.

NOTE: Final adjustments for steps 10 and 11 above will be made later.

12. Apply clean grease to the O-ring groove in the end cover. See Fig. 97. Install a new end cover O-ring in the groove.

NOTE: When installed, the O-ring will extend slightly above the machined surface of the end cover.

CAUTION: When performing step 13 below, make sure that the rack piston teeth are fully visible in the sector shaft cavity of the gear housing. This will ensure proper location of the poppets and also ensure that the poppet adjusting screw will contact the poppet.

13. Position the end cover so that the poppet adjusting screw is aligned with the end of the poppet. See Fig. 98. Push the end cover in, until it contacts the gear housing.

14. Install the four end-cover bolts and washers, and tighten them 105 to 115 lbf·ft (142 to 156 N·m). See Fig. 99.

15. Grease two new backup O-rings and two new Teflon® seal rings. Install the backup O-rings on the valve sleeve. See Fig. 100. Then use Kent-Moore seal-installation tool J26647 to install the seal rings on the valve sleeve. See Fig. 101.

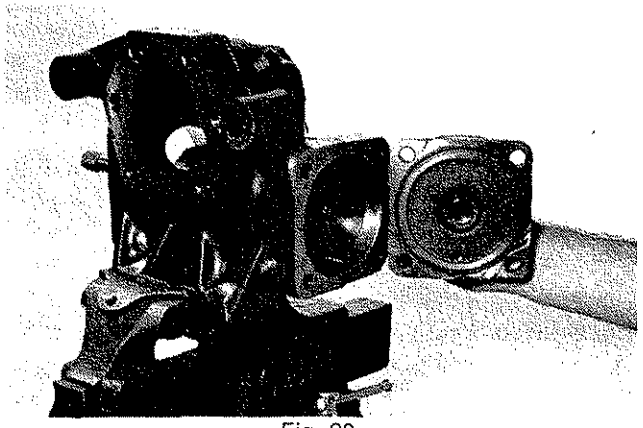

Fig. 98

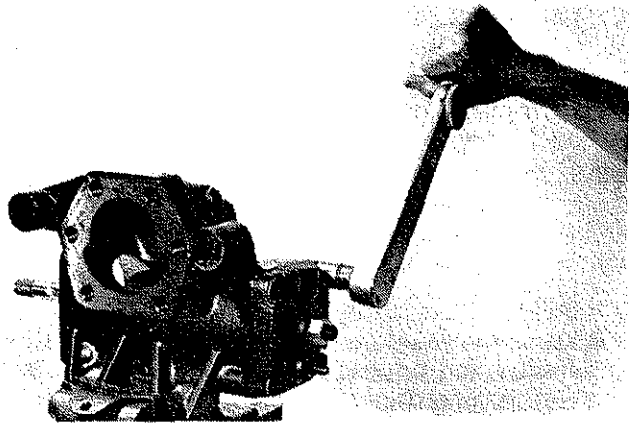

Fig. 99

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

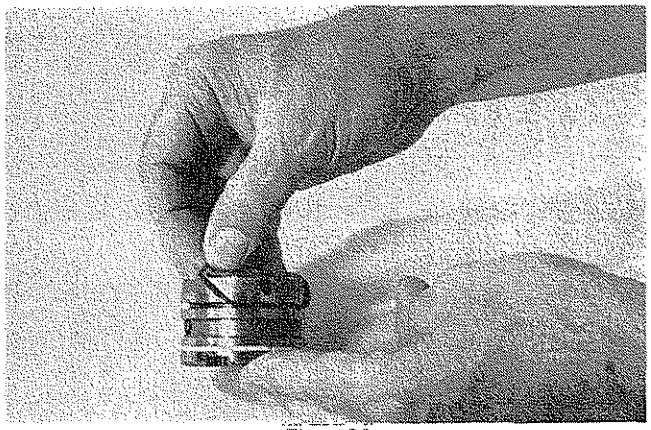

Fig. 100

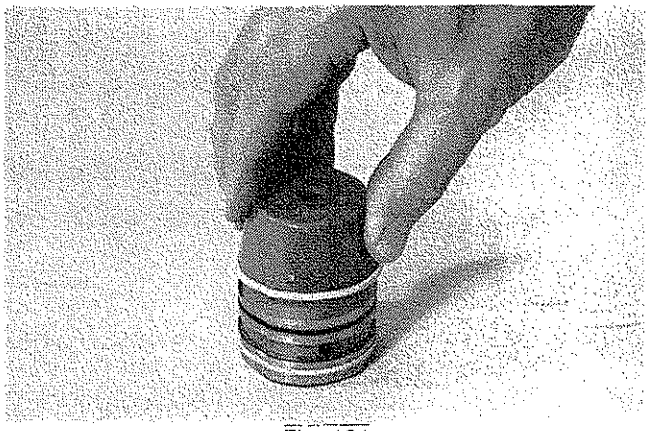

Fig. 101

Fig. 102

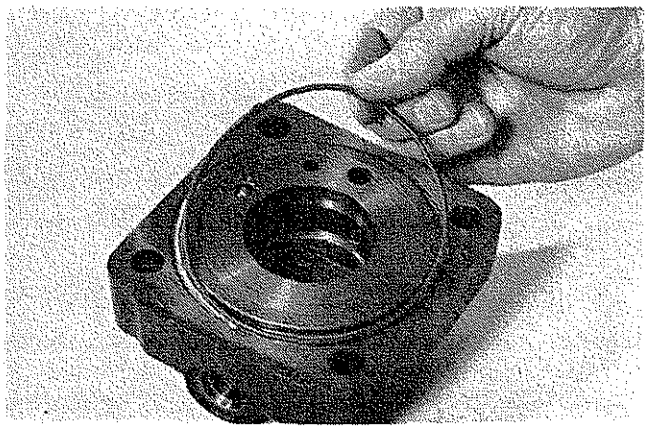

Fig. 103

16. Use Kent-Moore compression tool J26648 to compress the Teflon® seal rings. See Fig. 102. Leave this compression tool on for 10 minutes.

CAUTION: Allow at least 10 minutes to ensure that the seals are properly seated. Otherwise the valve sleeve will be difficult to install in the valve housing, and the seal may be cut during installation.

17. Install the poppet valve adjusting screw in the valve housing a few turns.

NOTE: If the steering gear is equipped with an internal-Allen-hex screw, the screw must be installed from inside the valve housing. The screw should be turned out until just before the flange head of the screw bottoms on the counterbore of the valve housing.

CAUTION: Take special care when turning this screw out. If excessive torque (above 35 lbf·in [396 N·cm]) is applied to the screw after the flange head bottoms in the counterbore, the internal-Allen-hex can break. Then, the screw will have to be replaced, and if it cannot be removed from the valve housing, the entire valve housing assembly will have to be replaced.

18. Apply clean grease to the O-ring groove in the valve housing. Install a new valve housing O-ring in the groove. See Fig. 103.

NOTE: When installed, the valve housing O-ring should extend slightly above the machined surface of the valve housing.

19. Apply a generous amount of clean grease to one thrustwasher. Place the valve housing on a flat surface with the exterior side down, and place the thrustwasher in the valve housing. Be sure the washer is centered. See Fig. 104.

20. Apply a generous amount of clean grease to the thrust bearing. Install the bearing in the valve housing and onto the first thrustwasher. Be sure the bearing is centered. See Fig. 105.

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Fig. 104

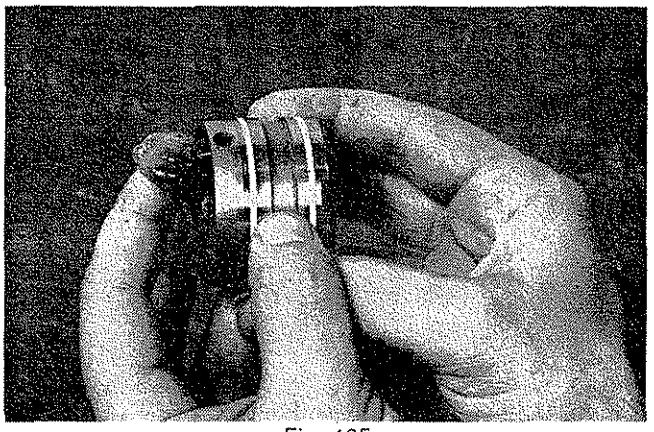

Fig. 105

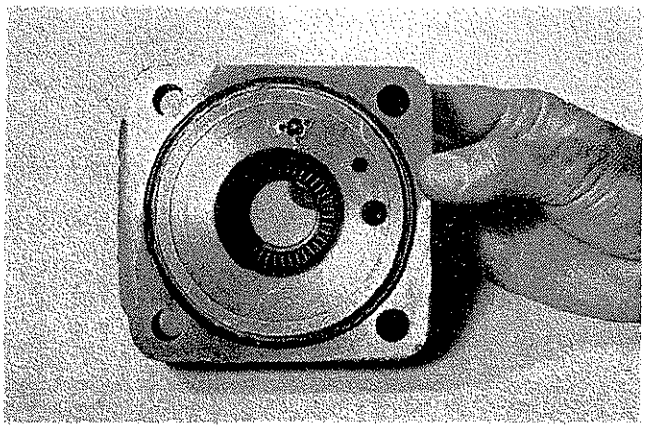

Fig. 106

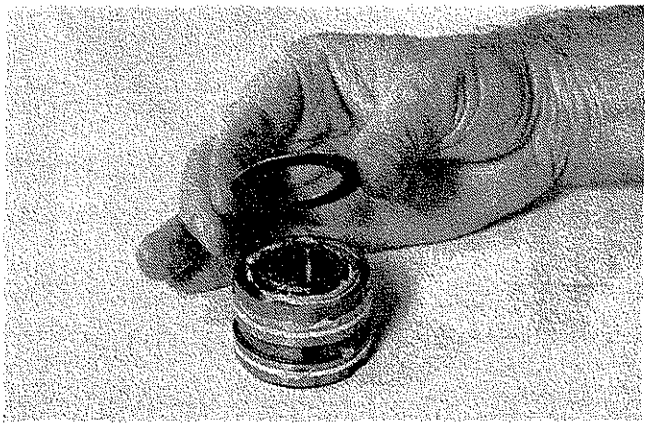

Fig. 107

WARNING: The thrustwasher and thrust bearing must be flat and centered in the counterbore surface of the valve housing. See Fig. 105. Otherwise, the thrustwasher could break when the valve housing is installed on the gear housing. A broken thrustwasher could cause the steering gear to function improperly, resulting in a loss of vehicle control.

21. Remove the compression tool from the valve sleeve. Apply more grease to the valve sleeve seals. Grease the thrustwasher face on the end of the valve sleeve that is without the drive slots. See Fig. 106. Place the second thrustwasher on this face. See Fig. 107.

WARNING: The thrustwasher must fit securely on the valve sleeve. If not, it can break, and this could cause an uncontrollable steering condition, resulting in a loss of vehicle control.

22. Locate the timing mark, a faint punched mark on the chamfered edge of the valve sleeve, or an indented mark on the front face of the sleeve. See Fig. 108. If the edge is marked, make a corresponding mark on the front face with a felt marker (as indicated by the white pencil in Fig. 108).

    Install the valve sleeve, with the second thrustwasher attached in the valve housing, thrustwasher-end first. When the valve sleeve is properly in place, the valve sleeve face should measure approximately 0.400 inch (10.1 mm) below the face of the valve housing. See Fig. 109.

WARNING: Do not force the valve sleeve down into the valve housing. Make sure the valve sleeve seal rings are compressed. Incorrect assembly or measurement may cause the thrustwashers or thrust bearing to break during gear operation. This can cause an uncontrollable steering condition, resulting in a loss of vehicle control.

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

Fig. 108

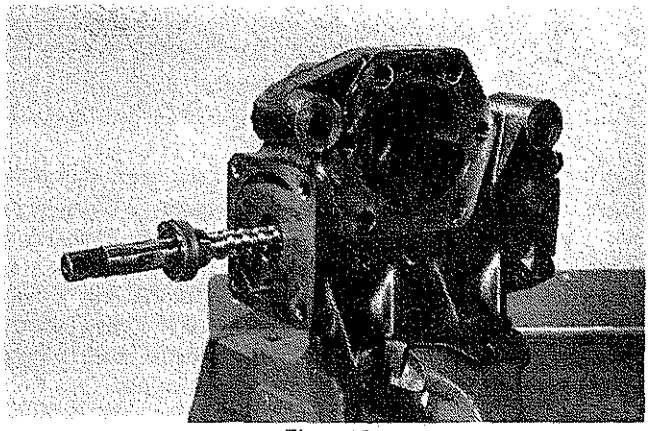

Fig. 110

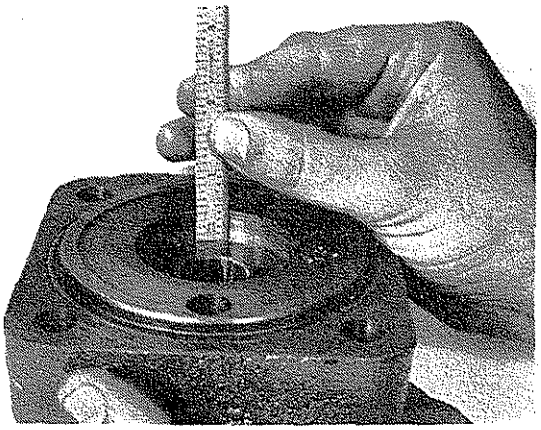

Fig. 109

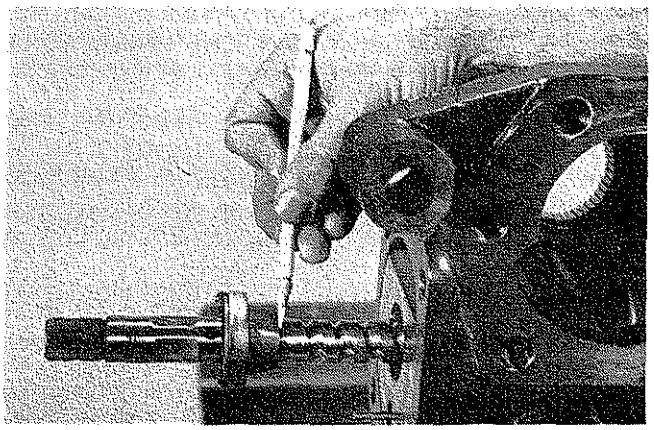

Fig. 111

23. Position the rack piston so that it is flush with the open end of the gear housing. Rotate the worm shaft until it extends out of the rack piston as far as it will go. See Fig. 110.

WARNING: The worm shaft and valve sleeve are assembled and sold as a matched set. Use only matched sets for replacement. Never mate an old valve sleeve with a new worm shaft, or an old worm shaft with a new valve sleeve. This can result in damage to the gear or injury to the driver during operation.

24. Locate the scribed timing mark on the worm shaft. See Fig. 111.

    Grasp the valve housing and valve sleeve as an assembly, with your thumbs on the valve housing and your fingers applying pressure on the valve sleeve to keep it in the valve housing. See Fig. 112.

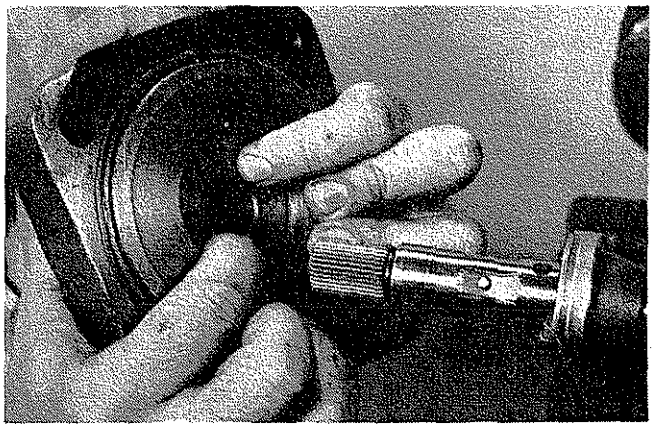

Fig. 112

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Align the previously located timing marks (Figs. 108 and 111). Place the valve housing and valve sleeve as an assembly on the input-shaft end of the worm shaft until the drive lugs are fully engaged. See Fig. 113.

NOTE: Valve sleeves are identified and matched to a right- or left-hand lead of the worm screw. If the screw has a right-hand thread (that is, goes into the rack piston when turned clockwise), the valve sleeve will have the letter "R" stamped between the seal lands. For a left-hand worm lead (which will come out of the rack piston when turned clockwise), the mating valve sleeve has no identifying letter between the seal lands.

WARNING: If an incorrect valve sleeve is placed on a worm, and assembled into the gear, the gear will not function properly. The mechanism will jerk the steering wheel with such force that it could injure the driver or cause a loss of control of the vehicle.

25. Maintain pressure on the valve end of the valve housing to ensure continued engagement of the drive lugs and thrust bearing package. While maintaining this pressure, rotate the valve housing to align the poppet adjusting screw with the poppet in the rack piston. See Fig. 114.

    While continuing pressure, rotate the input shaft to bring the valve housing into contact with the gear housing face.

26. Install the four valve housing bolts in the valve housing, and tighten them 105 to 115 lbf·ft (142 to 156 N·m). See Fig. 115.

27. Apply a generous amount of clean wheel bearing grease (do not substitute another type of grease) to the bearing race inside the side cover.

CAUTION: Use only wheel bearing grease. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Without wheel bearing grease, the bearing could wear prematurely.

28. Assemble the bearing rolls into the side cover bearing race. See Fig. 116. If equipped with an unmarked bearing or bearing BR-866-1, assemble 44 rolls. If equipped with bearing F83508, assemble 43 rolls. If equipped with bearing MR-1688-1, the rolls are caged (retained) in the bearing race.

CAUTION: Apply clean wheel bearing grease to loose rolls to retain them in the bearing race.

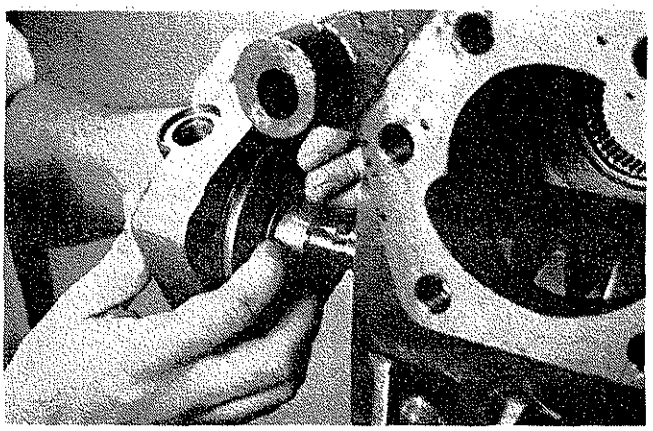


Fig. 113

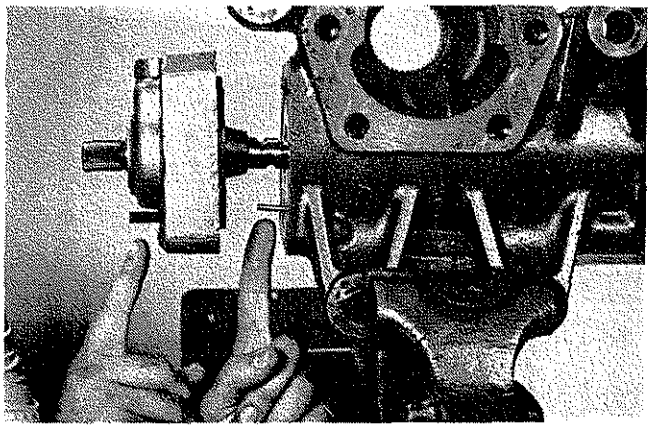


Fig. 114

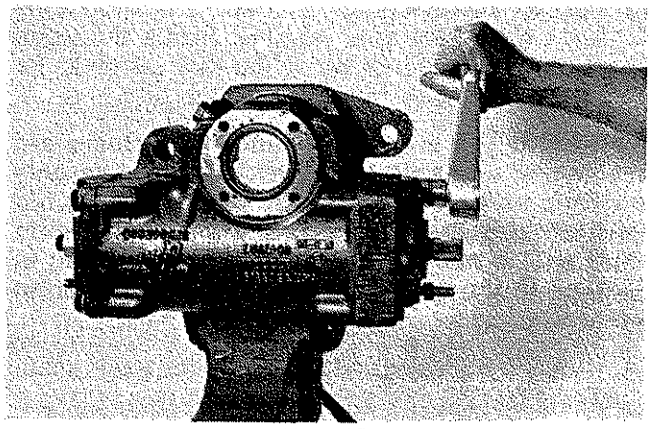


Fig. 115

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

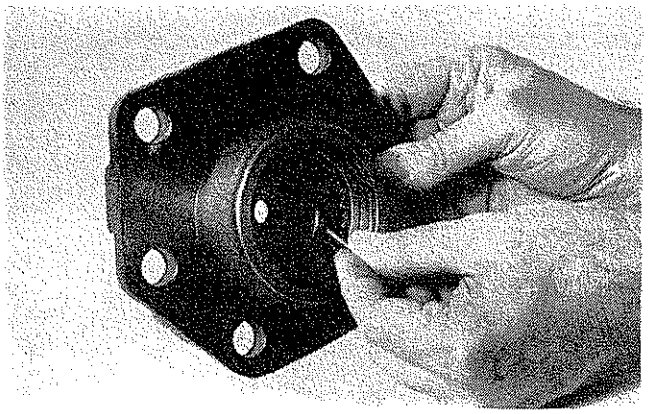


Fig. 116

Fig. 117

29. Install the steel backup washer, a new Teflon® back-up washer, and a new two-piece side cover seal in the side cover. See Fig. 117.

NOTE: In the most recent seal kits and on some units, the Teflon® backup washer is an integral part of the two-piece seal.

Assemble the two-piece seal so that the words "OIL SIDE" are visible after it is installed.

WARNING: The words "OIL SIDE" must be visible once the seal is in place. Otherwise, the seal will not function, which could result in a loss of power steering assist.

30. Install the side cover retaining ring in the ring groove of the side cover. See Fig. 118.

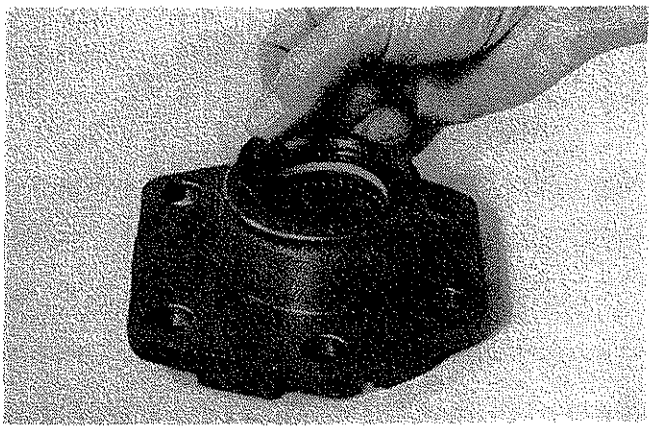


Fig. 118

31. Apply a generous amount of clean grease to the short bearing area of the sector shaft. Insert the sector shaft into the side cover. Screw the sector shaft adjusting screw counterclockwise into the side cover, until the screw seats. See Fig. 119. Then rotate the adjusting screw clockwise one turn, so that the side cover rotates freely on the sector shaft.

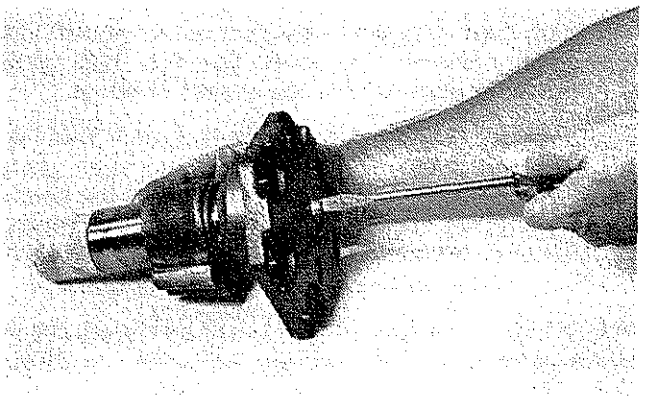


Fig. 119

32. Install the sector shaft adjusting screw jam nut onto the sector shaft adjusting screw a few threads. See Fig. 120. Final adjustment will be made later.

33. Press a new rubber plug into the hole provided in the side cover until the plug is flush. See Fig. 121.

WARNING: Do not weld or plug this hole permanently. This is a safety vent which functions only if the side cover output shaft seal fails. If the seal fails and the plug cannot vent, the steering gear can lock up or otherwise malfunction, resulting in a loss of steering control.

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

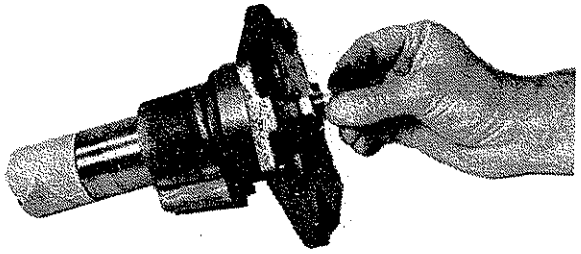


Fig. 120

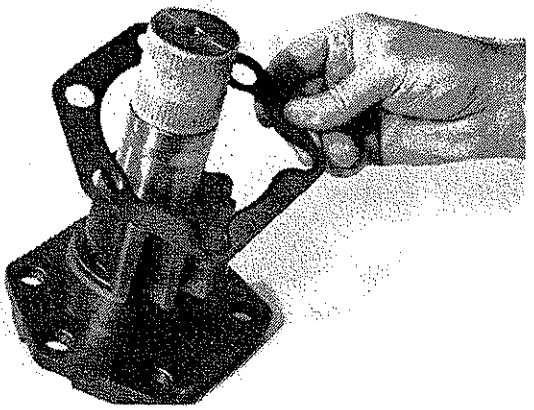


Fig. 122

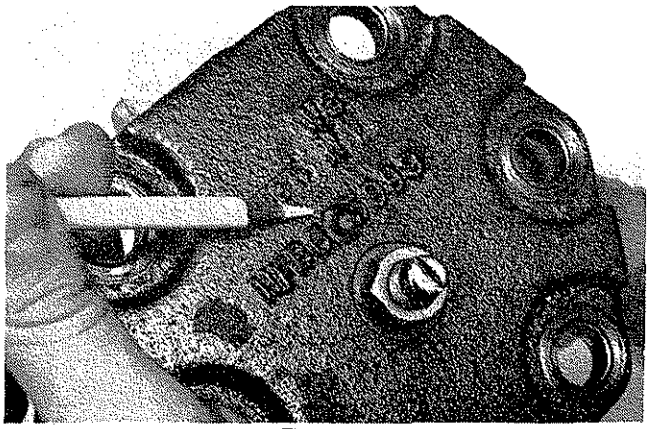


Fig. 121

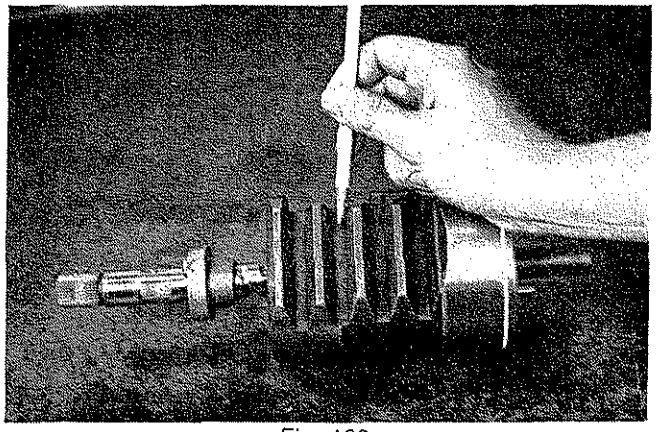


Fig. 123

34. Apply clean grease to a new side cover gasket, and install it on the side cover. See Fig. 122. Apply enough grease to hold the gasket in place.

35. There are four teeth on the rack piston. See Fig. 123. Position the rack piston so that the tooth space identified by the pencil in Fig. 123 (it is the space between the second and the third tooth), is in the center of the sector shaft opening. See Fig. 124. This will center the rack piston in the opening.

WARNING: If the rack piston is not centered, steering gear travel will be severely limited in one direction. This could result in an accident.

36. Remove any tape on the sector shaft serrations. Retape the serrations and bolt groove with *one layer* of masking tape. Install the sector shaft and side cover, as an assembly, into the gear housing. Make sure that the center tooth of the sector shaft en-

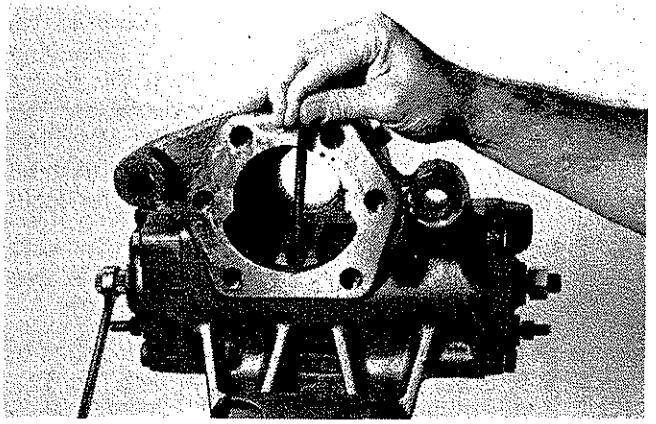


Fig. 124

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

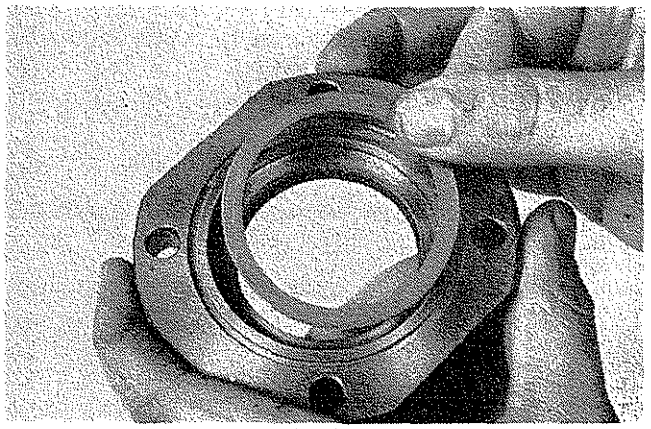


Fig. 125

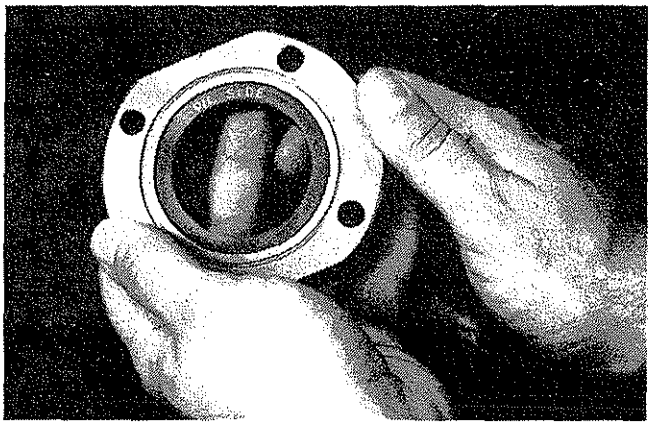


Fig. 126

gages the center space (between the second and third teeth) of the rack piston.

WARNING: When placing the sector shaft through the housing bearing, do not knock any of the bearing rolls out of the bearing race. Do not pinch the side cover gasket. If either is done, the bearing or seal may prematurely fail, and this could result in a loss of power steering assist.

37. Install the six special side-cover bolts into the side cover, and tighten them 220 to 240 lbf·ft (298 to 325 N·m)

38. Place the trunnion cover on a bench with the exterior side down. Install a new Teflon® backup washer. See Fig. 125.

39. Install a new two-piece sector shaft seal so that the words "OIL SIDE" are visible after the seal is in place. See Fig. 126.

WARNING: The words "OIL SIDE" must be visible on the seal after it is in place. See Fig. 126. If not, the seal will not function, and a loss of power steering assist may occur.

40. Grease a new trunnion cover O-ring, and install it in the trunnion cover O-ring groove.

41. Inspect the housing bearing to make sure that all the bearing rolls are properly in place. Then install the trunnion cover. See Fig. 127. Install the four trunnion cover bolts, and tighten them 15 to 22 lbf·ft (20 to 30 N·m). See Fig. 128. Pack the cavity around the seal area of the sector shaft with Mobil Temp® 1

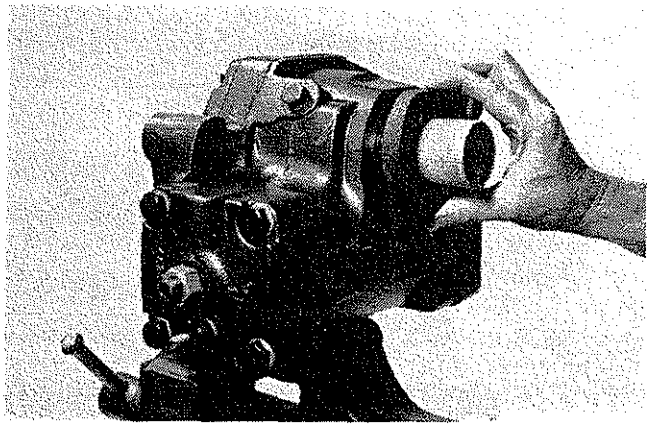


Fig. 127

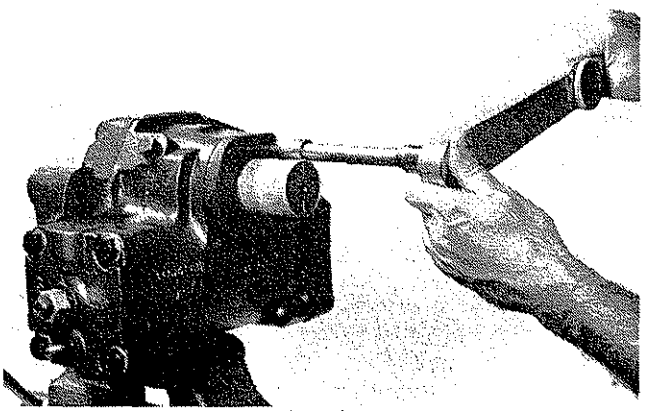


Fig. 128

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

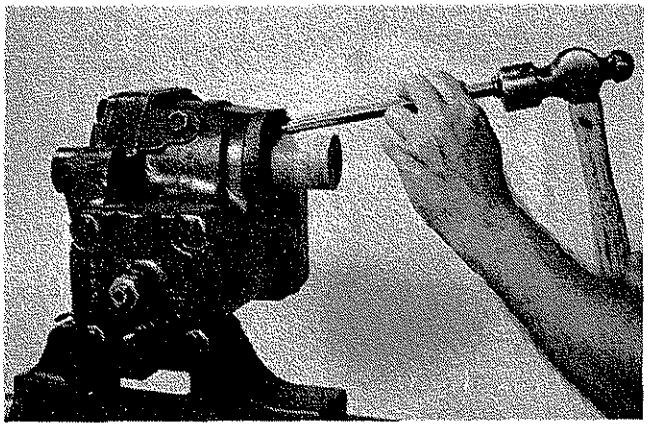


Fig. 129

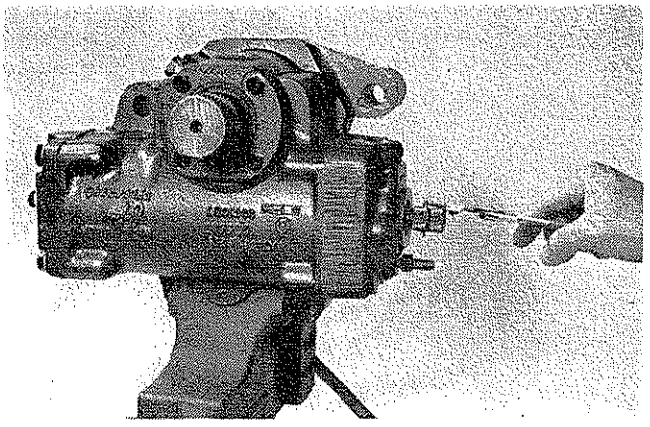


Fig. 131

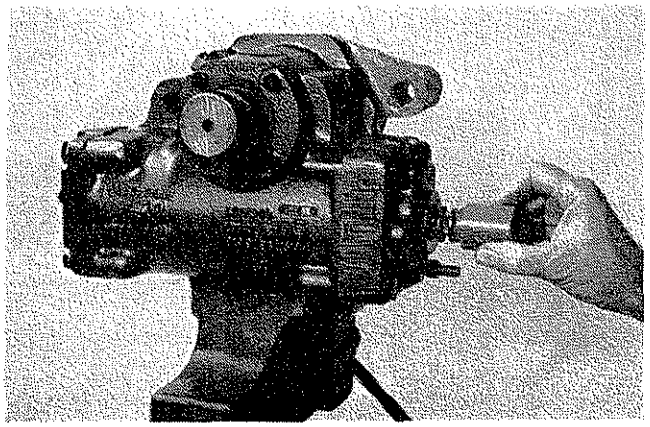


Fig. 130

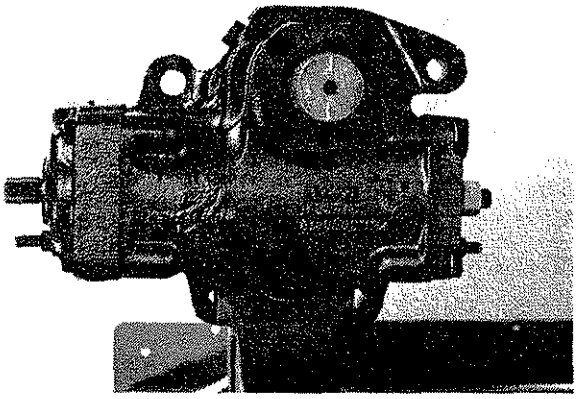


Fig. 132

or 2 grease, or an equivalent. Install a new dirt-and-water seal, using a suitable blunt-ended drift. See Fig. 129.

42. Apply clean grease to the input shaft seal assembly (seal and O-ring) and to the input shaft. Install a new two-piece input shaft seal (with the flat side out), and the steel backup washer, using Kent-Moore seal-driving tool J26653. See Fig. 130. Install the retaining ring. See Fig. 131.
43. Pack the area around the input shaft with clean water-resistant grease and install the dirt-and-water seal, using Kent-Moore seal-driving tool J26654 or a suitable blunt-ended drift.
44. If equipped with a manual bleed screw, install the manual bleed screw and torque it 27 to 33 lbf·in (305 to 373 N·cm).

FINAL ADJUSTMENTS (Refer to Fig. 79)

Before the steering gear can be installed on the vehicle, the final adjustments must be performed as described below.

1. Screw the worm shaft preload adjusting screw finger-tight, until it contacts the worm shaft. Apply 5 to 10 lbf·ft (7 to 14 N·m) of torque. Back the screw out one turn.
2. To center the steering gear, align the sector (output) shaft alignment mark halfway between two trunnion cover bolts. The alignment mark should be perpendicular to the centerline of the cylinder bore (input shaft). See Fig. 132.
3. Adjust the sector shaft adjusting screw while rotating the input shaft 90 degrees each side of center,

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

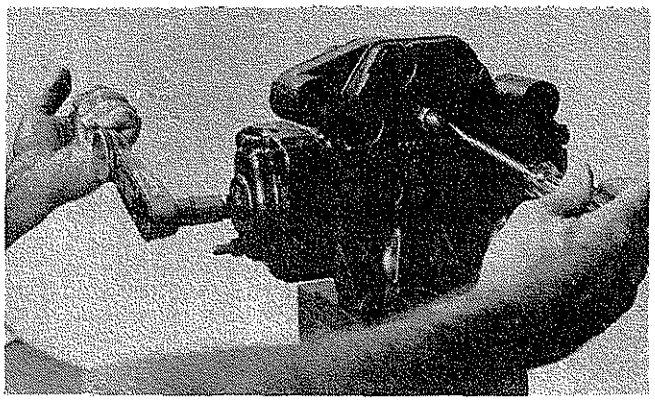


Fig. 133

until the input shaft reaches a torque of 25 to 30 lbf·in (280 to 340 N·cm). See Fig. 133.

NOTE: Use a 12-point socket and an inch-pound torque wrench to rotate the input shaft.

4. Back out the sector shaft adjusting screw one turn. Note the torque now required to rotate the input shaft through 90 degrees each side of center. Then move the adjusting screw in, to increase the noted torque by 2 to 6 lbf·in (23 to 68 N·cm). The increase should be noted at a point within 45 degrees on either side of center.

5. Tighten the sector shaft adjusting screw jam nut 45 to 50 lbf·ft (54 to 61 N·m). The torque now required to rotate the input shaft should not exceed 20 lbf·in (226 N·cm) at any point in the steering gear travel. If it does exceed 20 lbf·in (226 N·cm), repeat step 4 above.

6. While rotating the input shaft back and forth slightly adjust the worm shaft preload adjusting screw to increase the maximum noted input torque by 10 to 15 lbf·in (113 to 169 N·cm). Make sure that the worm shaft adjusting screw jam nut does not contact the end cover while making this adjustment. Tighten the jam nut 70 to 80 lbf·ft (95 to 108 N·m). Be sure that the adjusting screw does not move.

7. The torque now required to rotate the input shaft to traverse the gear through complete travel should not exceed 35 lbf·in (395 N·cm). If it does exceed 35 lbf·in (395 N·cm), repeat step 6, above.

STEERING GEAR INSTALLATION

1. On COEs with 1984 Advancements, install two mounting bolts and washers from the inboard side as shown in Fig. 134. Install a spacer on the lower mounting bolt. (No spacer is required on the upper bolt which is installed through the cab mounting bracket.) Position the steering gear on the steering gear bracket. Install the third mounting bolt, washer and spacer from the outboard side. Install the washers and nuts and tighten the nuts to 600 lbf·ft (814 N·m).

   On other COEs, insert the mounting bolts and washers through the frame rail and mounting bracket from the inboard side. Refer to Fig. 135. Install a spacer on each of the bolts. Position the steering gear on the bracket and frame rail. Install the washers and nuts and tighten the nuts to 600 lbf·ft (814 N·m).

   On Conventionals with 1984 Advancements, install two mounting bolts and washers from the inboard side as shown in Fig. 136. Install a spacer on the two mounting bolts. Position the steering gear on the steering gear bracket. Install the third mounting bolt, washer and spacer from the outboard side. Install the washers and nuts and torque the nuts to 600 lbf·ft (814 N·m).

   On other Conventionals, attach the steering gear to the mounting bracket. Refer to Fig. 137. Tighten the nuts to 600 lbf·ft (814 N·m). Mount the steering gear and bracket on the frame rail and tighten the nuts to the torque values in Table 2.

2. If not previously done, center the steering gear. The sector (output) shaft alignment mark must be perpendicular to the steering gear input shaft centerline. Make sure the steering gear remains centralized as the service operations progress.

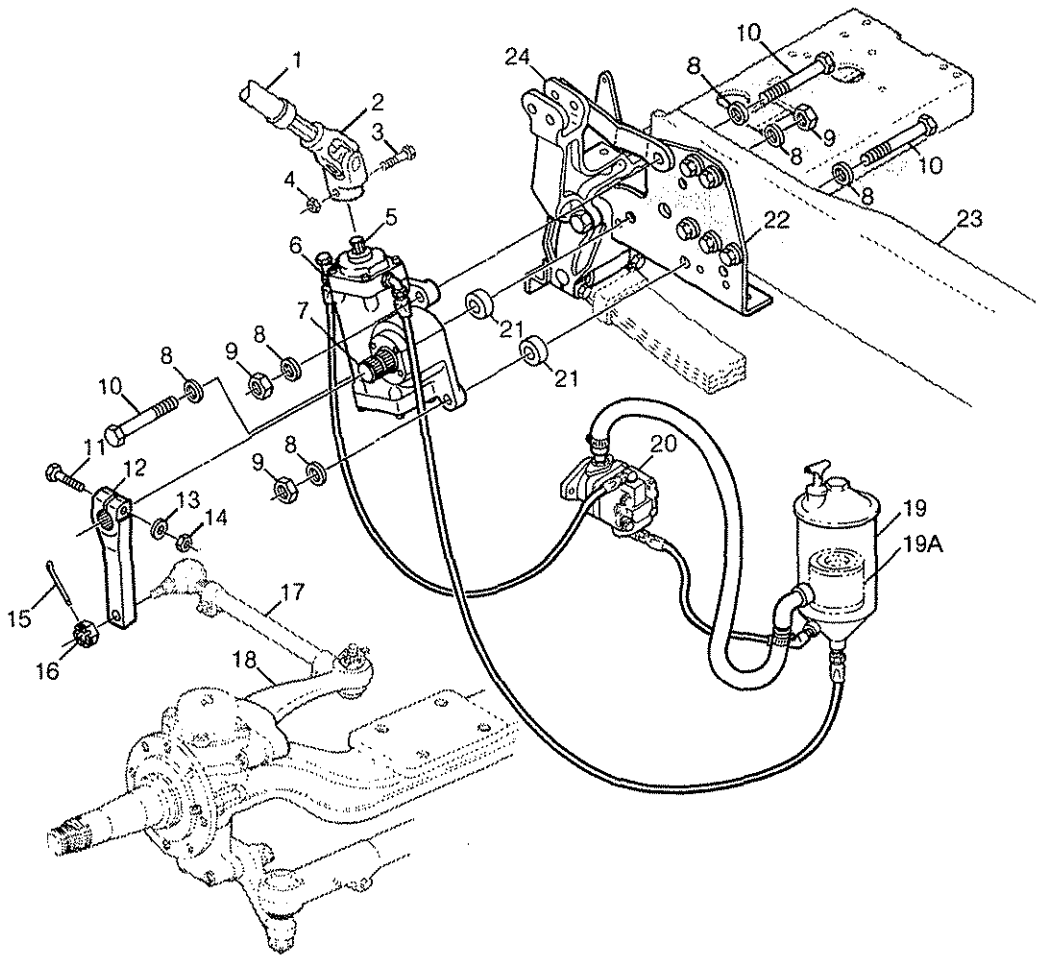
3. If the pitman arm was removed, install the pitman arm on the steering gear, aligning the timing marks.

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. To wedge the slot open, clamp the pitman arm in a vise with the slot at the top. Use a ball peen hammer to drive a chisel into the slot. Hold the chisel in place, remove the pitman arm from the vise, and install the pitman arm on the sector shaft. Remove the chisel from the slot.

WARNING: Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise, the chisel may fly loose, which could cause an injury.

4. Install the pitman arm pinch bolt, washer (if applicable), and a new nut. Tighten the nut to the torque value in Table 2.

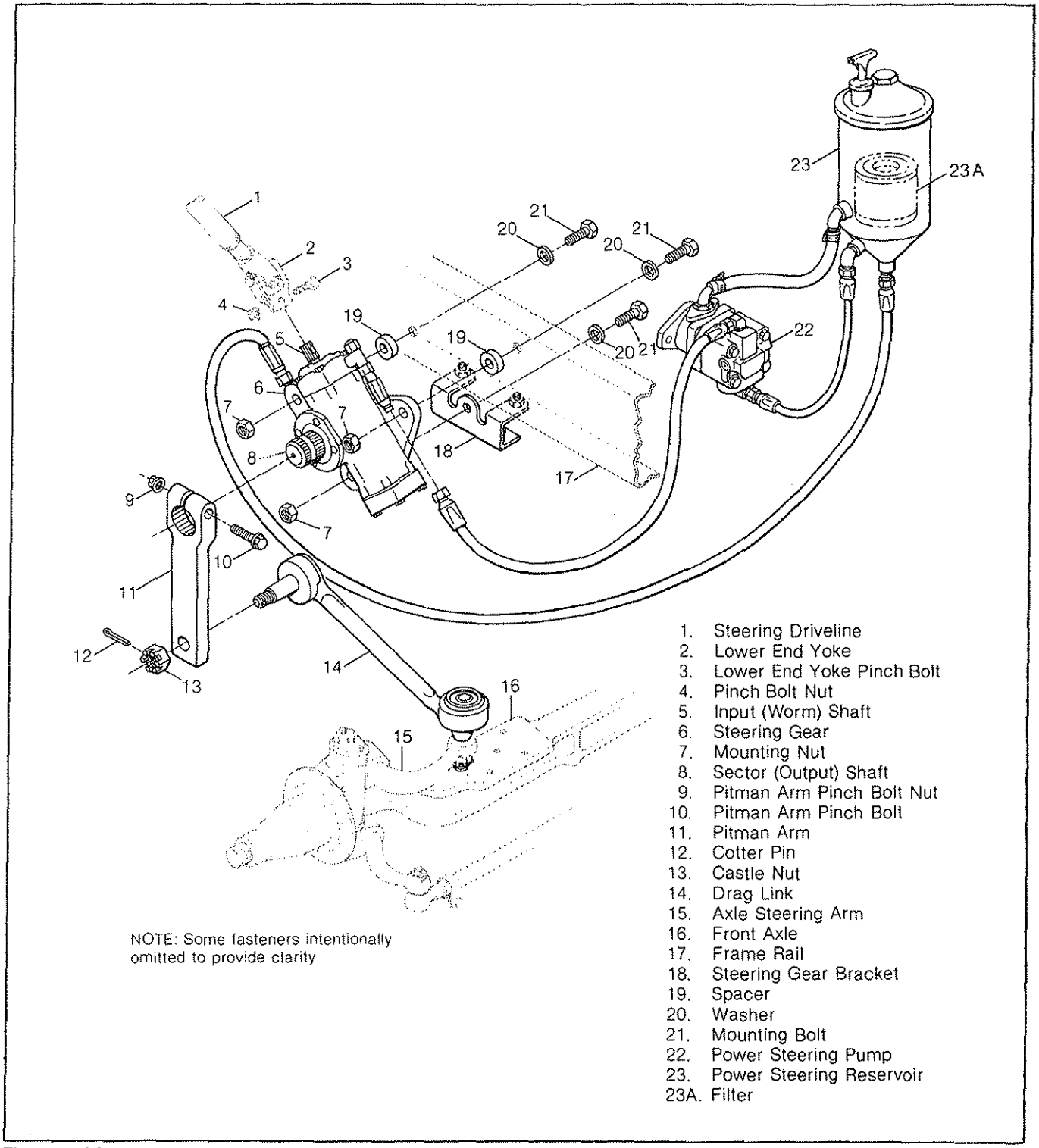
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Sector (Output) Shaft
8. Washer
9. Mounting Nut
10. Mounting Bolt
11. Pitman Arm Pinch Bolt
12. Pitman Arm
13. Washer
14. Pinch Bolt Nut
15. Cotter Pin
16. Castle Nut
17. Drag Link
18. Axle Steering Arm
19. Power Steering Reservoir
19A. Filter
20. Power Steering Pump
21. Spacer
22. Frame Extension
23. Frame
24. Cab Mount

Fig. 134, COE Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



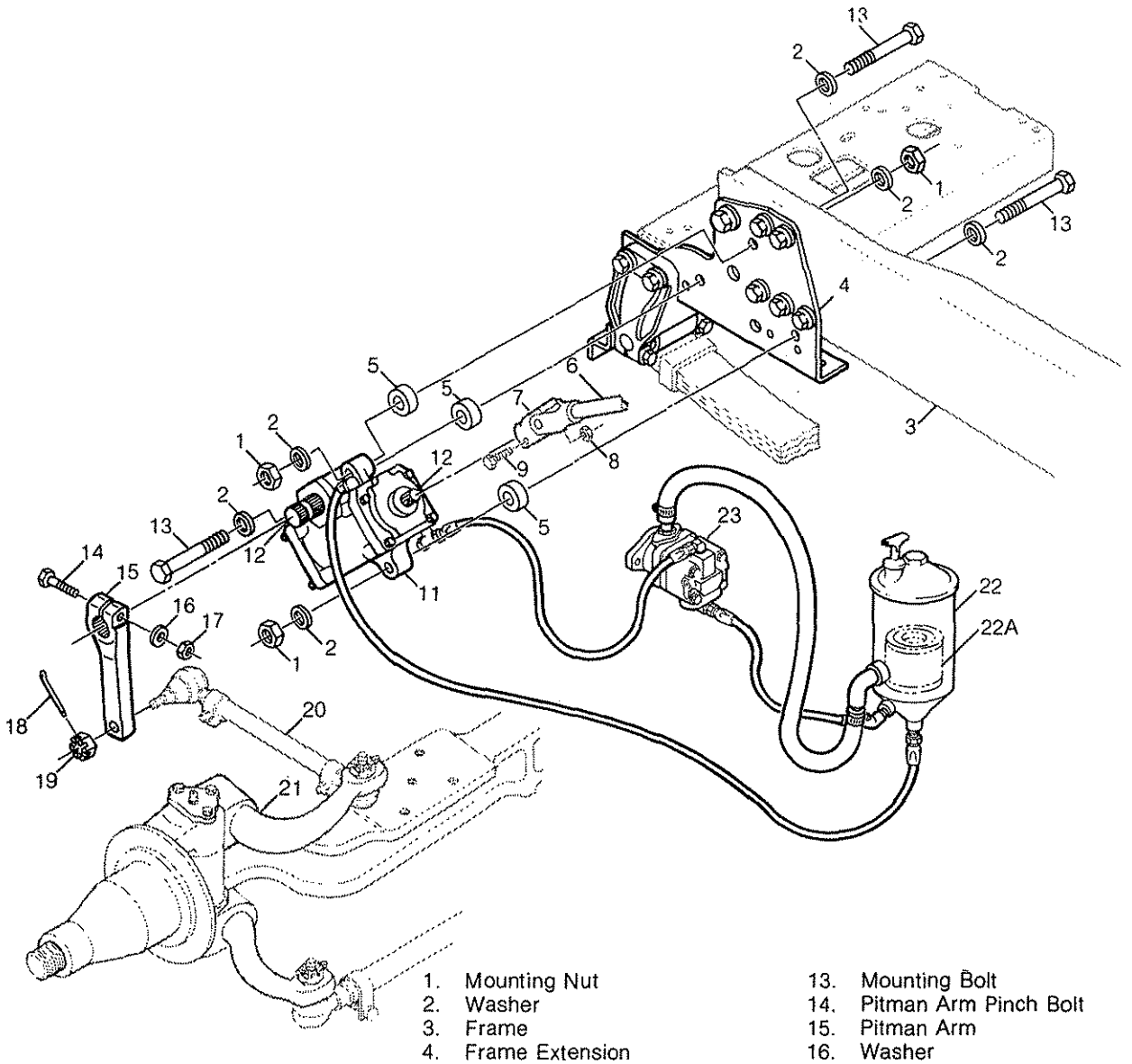
NOTE: Some fasteners intentionally omitted to provide clarity

1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch Bolt
4. Pinch Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Mounting Nut
8. Sector (Output) Shaft
9. Pitman Arm Pinch Bolt Nut
10. Pitman Arm Pinch Bolt
11. Pitman Arm
12. Cotter Pin
13. Castle Nut
14. Drag Link
15. Axle Steering Arm
16. Front Axle
17. Frame Rail
18. Steering Gear Bracket
19. Spacer
20. Washer
21. Mounting Bolt
22. Power Steering Pump
23. Power Steering Reservoir

23A. Filter

Fig. 135, COE Integral Power Steering Installation, Except 1984 Advancements

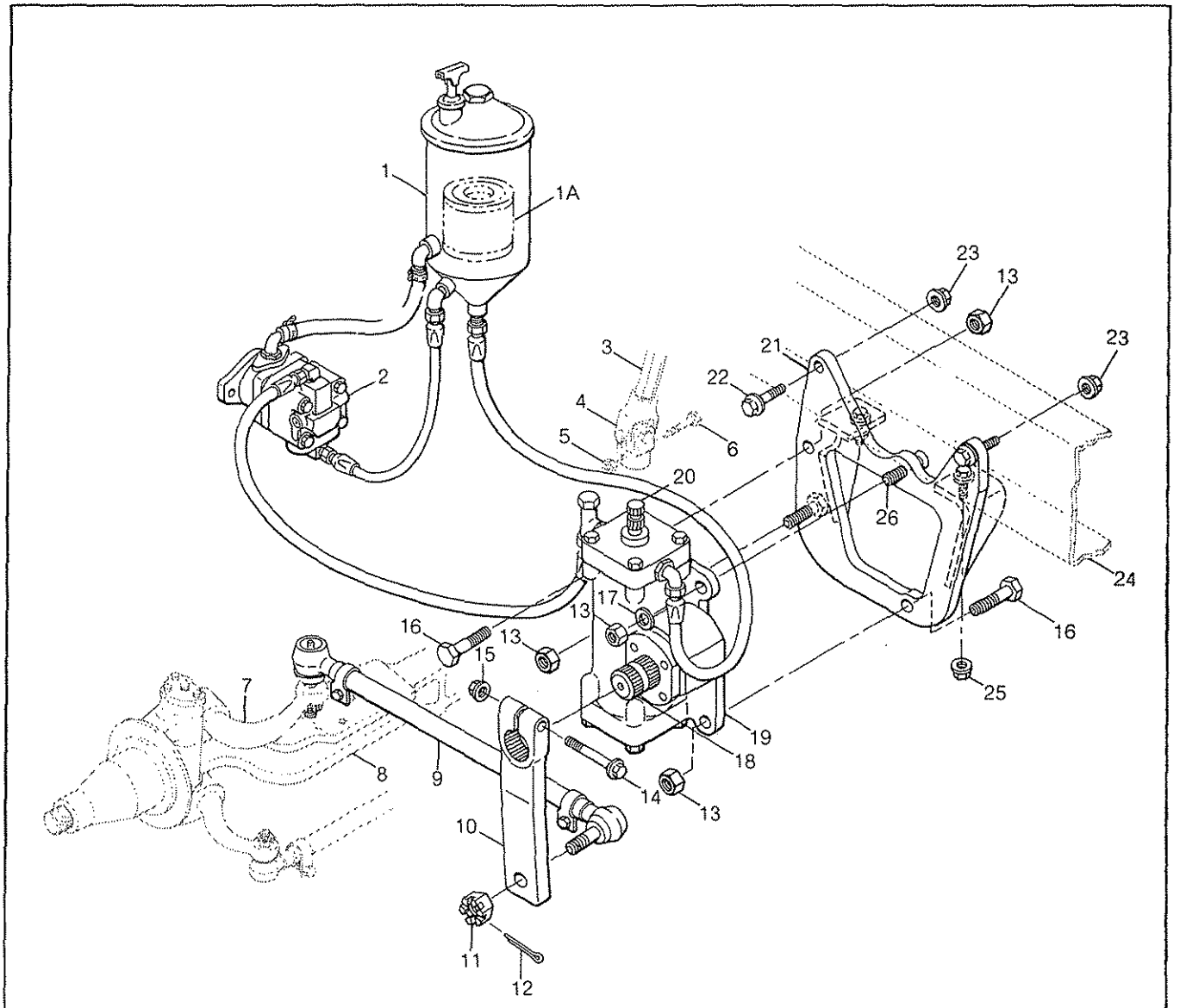
ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



1. Mounting Nut
2. Washer
3. Frame
4. Frame Extension
5. Spacer
6. Steering Driveline
7. Lower End Yoke
8. Pinch Bolt Nut
9. Lower End Yoke Pinch Bolt
10. Input (Worm) Shaft
11. Steering Gear
12. Sector (Output) Shaft
13. Mounting Bolt
14. Pitman Arm Pinch Bolt
15. Pitman Arm
16. Washer
17. Pinch Bolt Nut
18. Cotter Pin
19. Castle Nut
20. Drag Link
21. Axle Steering Arm
22. Power Steering Reservoir
22A. Filter
23. Power Steering Gear

Fig. 136, Conventional Integral Power Steering Installation, 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64



1. Power Steering Reservoir
1A. Filter
2. Power Steering Pump
3. Steering Driveline
4. Lower End Yoke
5. Pinch Bolt Nut
6. Lower End Yoke Pinch Bolt
7. Axle Steering Arm
8. Front Axle
9. Drag Link
10. Pitman Arm
11. Castle Nut
12. Cotter Pin
13. Hex Nut
14. Pitman Arm Pinch Bolt
15. Pitman Arm Pinch Bolt Nut
16. Hex Bolt
17. Washer
18. Sector (Output) Shaft
19. Steering Gear
20. Input (Worm) Shaft
21. Steering Gear Bracket
22. Flanged Bolt
23. Flanged Nut
24. Frame Rail
25. Flanged Nut
26. Countersunk Bolt

Fig. 137, Conventional Integral Power Steering Installation, Except 1984 Advancements

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

5. Position the steering wheel so that the king-spoke (the narrow spoke on some wheels or the spoke with the manufacturer's name imprinted on the underside) points directly toward the front of the vehicle (positioned at 12 o'clock ± 5 degrees). See Fig. 138.
6. Connect the steering driveline to the steering gear input shaft. For instructions, refer to the appropriate section in this group.
7. Attach the drag link to the pitman arm. For instructions, refer to the appropriate section in this group.
8. Attach the hydraulic line elbow fittings to the steering gear. Tighten the elbow fittings 37 lbf·ft (50 N·m).
9. Remove the plugs from the hydraulic lines. Connect the hydraulic lines to the steering gear as previously marked. Tighten the nut on each fitting finger-tight. Then use a wrench to tighten the nut until resistance is felt. Tighten one-sixth turn more.
10. Fill the power steering gear reservoir with fluid. For instructions, refer to "Filling and Air Bleeding the System."
11. Adjust the poppet adjusting screws. For instructions, refer to "Poppet Valve Adjustment."
12. Test drive the vehicle, or take a ride with the driver. Check the steering wheel king-spoke position. If, while driving straight-ahead on a level road, the steering wheel king-spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock ± 5 degrees), reposition the steering wheel so that the king-spoke points directly toward the front of the vehicle. For instructions, refer to the appropriate section in this group.

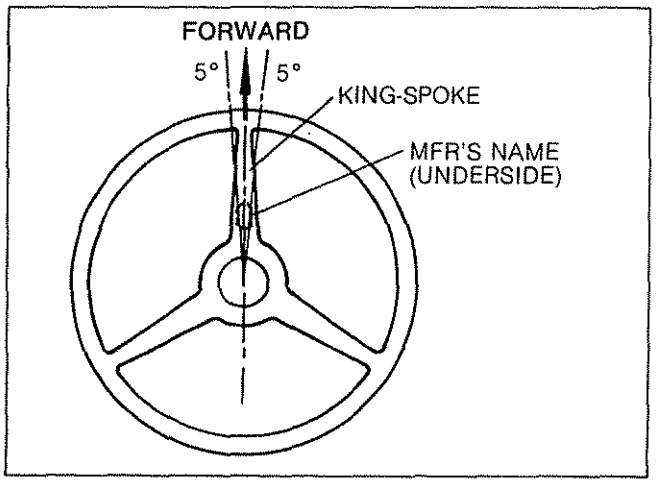


Fig. 138

FILLING AND AIR BLEEDING THE SYSTEM

IMPORTANT: For steps 1 and 2, do not turn the steering wheel. Otherwise, air can enter the system.

If the power steering reservoir was drained, replace the reservoir filter before filling the system. For instructions, refer to the Freightliner *Maintenance and Lube Manual.*

1. Fill the power steering reservoir nearly full. For lubricant recommendations, refer to the Charts and Specifications section of the Freightliner *Maintenance and Lube Manual.* Crank the engine for ten seconds without allowing it to start if possible. If the engine does start, shut it down immediately. Check and refill the reservoir. Do this three times, each time checking and refilling the reservoir.

IMPORTANT: Do not let the reservoir fluid level drop significantly. This would allow air to enter the system.

2. Start the engine and let it idle for two minutes. Shut down the engine and check the reservoir fluid level.
3. Start the engine. Turn the steering wheel full-left and full-right several times. Add fluid to the full line on the dipstick if necessary.

NOTE: Poppets must be adjusted so they relieve pressure at full-left and full-right turns, to remove air from the system. At this time, make sure the poppets are adjusted. Refer to "Poppet Valve Adjustment" for instructions. Then repeat step 3.

4. If the power steering gear has a manual bleed screw, remove air by following steps 1, 2, and 3. Then, with the engine idling, turn the steering wheel full-left and full-right several times. With the steering gear in neutral (no steering action), loosen the manual bleed screw about one turn. Allow air and aerated fluid to escape until only clear fluid is bleeding out. Tighten the bleed screw. Check and refill the reservoir.

IMPORTANT: Do not turn the steering wheel with the bleed screw loosened. This would allow air to enter the system.

WARNING: Do not loosen or remove an automatic bleed screw when the steering gear is mounted on the vehicle. If it is loosened or removed, there could be a loss of power steering assist in one direction

ROSS INTEGRAL POWER STEERING GEAR, MODEL HFB64

of turn. This could cause a loss of vehicle control and possible personal injury. The automatic bleed screw has a 1/2-inch hexhead or E-10 Torx head.

Once again, turn the steering wheel full-right and full-left, three or four times, with the bleed screw closed. Do this until only clear (nonaerated) fluid escapes when the bleed screw is loosened. Add fluid each time as necessary. Tighten the manual bleed screw 27 to 33 lbf·in (300 to 373 N·cm). Check and refill the reservoir, if necessary, to the full line on the dipstick.

TROUBLESHOOTING

For troubleshooting information, refer to the subject covering hydraulic power steering system troubleshooting, and the subjects covering power steering pumps, in this group.

SPECIFICATIONS

KENT-MOORE PART NUMBER	TOOL	APPLICATION
J26647	Seal Installation Tool	Valve Sleeve Seal Ring Installation
J26648	Seal Compression Tool	Valve Sleeve and Teflon® Seal Ring Installation
J26649	Seal Compression Tool	Worm Shaft Seal Installation
J26650-01	Seal Installation Tool	Worm Shaft Seal Installation
J26653	Seal Driving Tool	Input Shaft Seal Installation
J26654	Seal Driving Tool	Input Shaft Dirt-and-Water Seal Installation
J26738	Bearing Mandrel	Housing Bearing Removal and Installation

Table 1, Kent-Moore Tools, Kent-Moore Tool Division, 29784 Little Mack, Roseville, MI 48066

The following special tools are required for some procedures: pressure and flow gauge; inch-pound torque wrench; foot-pound torque wrench.

DESCRIPTION	BOLT OR NUT SIZE	GRADE	TORQUE	
			lbf·ft (N·m)	lbf·in (N·cm)
Valve Housing Bolt	1/2-13	—	105-115 (142-156)	—
Poppet Adjusting Screw Jam Nut	3/8-24	—	12-18 (16-24)	—
	5/16-24	—	8-11 (11-15)	—
	5/8-18	—	20-25 (27-34)	—
Auxiliary Cylinder Fitting	—	—	25-35 (34-47)	—
Trunnion Cover Bolt	5/16-18	—	15-22 (20-30)	—
Poppet Seat	—	—	25-30 (34-41)	—
Worm Shaft Adjusting Screw Jam Nut	—	—	70-80 (95-108)	—
Worm Shaft Preload Adjusting Screw	—	—	—	60-70 (680-780)
End Cover Bolt	1/2-13	—	105-115 (142-156)	—
Ball Return Guide Hexhead Bolt	—	—	13-17 (18-23)	—
Sector Shaft Adjusting Screw Jam Nut	—	—	40-45 (54-61)	—
Side Cover Special Bolts	5/8-18	—	220-240 (298-325)	—
Manual Bleed Screw	—	—	—	27-33 (300-373)
Pitman Arm Pinch Bolt Nut	3/4-16	C	230 (312)	—
Steering Gear Mounting Bolt Nuts*	7/8-14	C	350 (475)	—
Steering Gear Bracket-to-Frame Rail Mounting Bolt Nuts (Flanged Type). Conventional	1/2-13	G	95 (129)	—
	1/2-20	G	110 (149)	—
	5/8-11	G	190 (258)	—
	5/8-18	G	215 (291)	—

Table 2, Steering Gear Torque Values

* Torque values are for nuts that are wax coated and cadmium plated, or for hexbolts that have phosphate- and oil-coated threads. Both are used with hardened washers. For dry threads, refer to the Bolt Torque Specification Chart in the *COE & 120 Conventional Maintenance Manual.*

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

GENERAL DESCRIPTION

The Air-O-Matic power steering system (Fig. 1, 2 or 3) consists of the torque valve, power cylinder, safety valve, and shutoff valve. The torque valve (Fig. 4) is installed in the vehicle's drag link. It has an inlet or feed port, two outlet ports, and two exhaust ports. Each exhaust port has a special fitting designed to keep out foreign matter, but not to restrict the exhausting of air from the power cylinder which the torque valve feeds.

The power cylinder (Fig. 5) furnishes the necessary power for steering. The cylinder has a stroke of twelve inches (305 mm). When the front wheels of the vehicle are in the straight ahead position, the piston within the cylinder is at the halfway point of its travel, which means that it is riding in the center of the cylinder. The power cylinder is either axle-mounted (tie-rod) or frame-mounted.

The purpose of the shutoff valve (Fig. 6) is to provide an easy means for shutting off air to the power steering system in case of a broken air line or when parts of the system are to be repaired or replaced. In the event of air failure for any reason, or damage to the power steering system when the vehicle is in use, the shutoff valve should be shut off. When this is done, steering will revert to manual.

The function of the safety valve (Fig. 7) is to conserve air for brake application and accessories in the event the air pressure in the air reservoir falls below 60-65 psi (413-448 kPa). When this occurs, steering will revert to manual. Then, when the air pressure builds up to approximately 12 psi (83 kPa) above the shutoff setting, the safety valve will open and power assist is restored. The safety valve is not a regulating valve which can be adjusted to give more or less power. Its only purpose is to conserve air for effective brake application in the event of inadequate air pressure or supply.

PRINCIPLES OF OPERATION

When approximately 7 pounds (3 kg) of pressure is applied at the rim of the steering wheel, in either direction, the torque valve begins to open, permitting air flow to the power cylinder. As more pressure is applied to the steering wheel, the torque valve opens wider, permitting more air to flow and greater pressure to develop in the power cylinder. At approximately 10 pounds (5 kg) of pressure on the steering wheel, the torque valve is completely open, permitting unrestricted air flow to the power cylinder and the development of maximum power which is governed by the air pressure. The power developed is always in proportion to the amount of effort applied at the rim of the steering wheel up to approximately 10 pounds (5 kg).

When no effort is being applied at the rim of the steering wheel which is normal for straight ahead driving, no air under pressure is in the power cylinder at either end. In this position, both ends of the power cylinder are full open to the atmosphere, making it impossible for any power to develop within the power cylinder. This gives a good feeling of security, especially when on slippery roads, because no power can develop within the power cylinder to take away the feel of the road.

SERVICE OPERATIONS

STEERING SYSTEM INSPECTION CHECK

The following inspection check should be conducted whenever rapid tire wear, and/or hard or erratic steering indicate a malfunction in the steering system. It is recommended that all other possible sources of steering problems be checked, before servicing the Air-O-Matic power steering system.

1. Check the tire pressure. Make sure the tire pressure is in compliance with the specifications given in the "CHARTS AND SPECIFICATIONS" section of the Freightliner Maintenance and Lubrication Manual, and is equal around entire vehicle.

2. Check all air hoses for damage and leakage. Replace any damaged hoses, and tighten all fittings to stop air leakage.

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

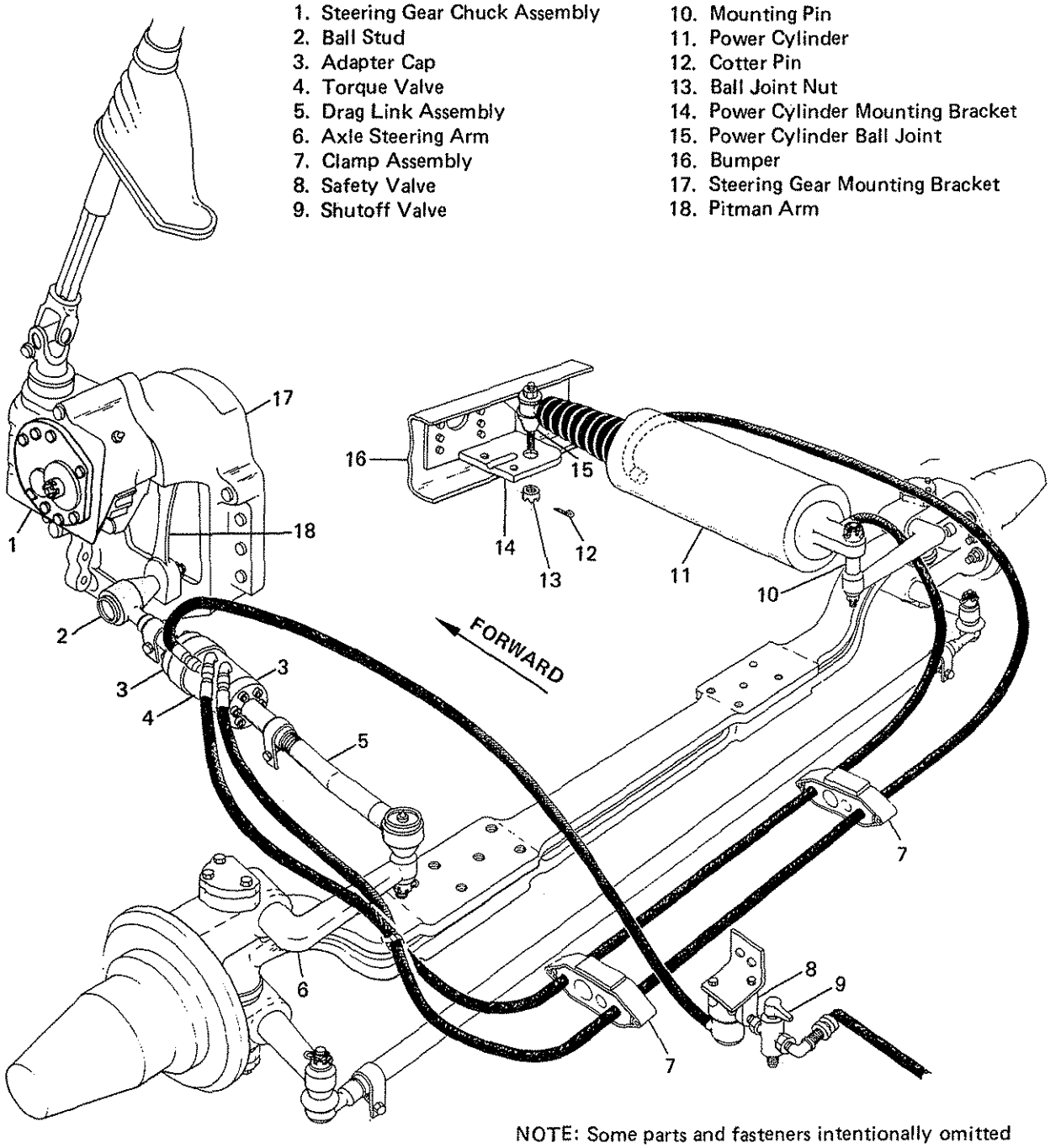


Fig. 1, Air-O-Matic Power Steering Nomenclature (C.O.E. With Frame-Mounted Power Cylinder)

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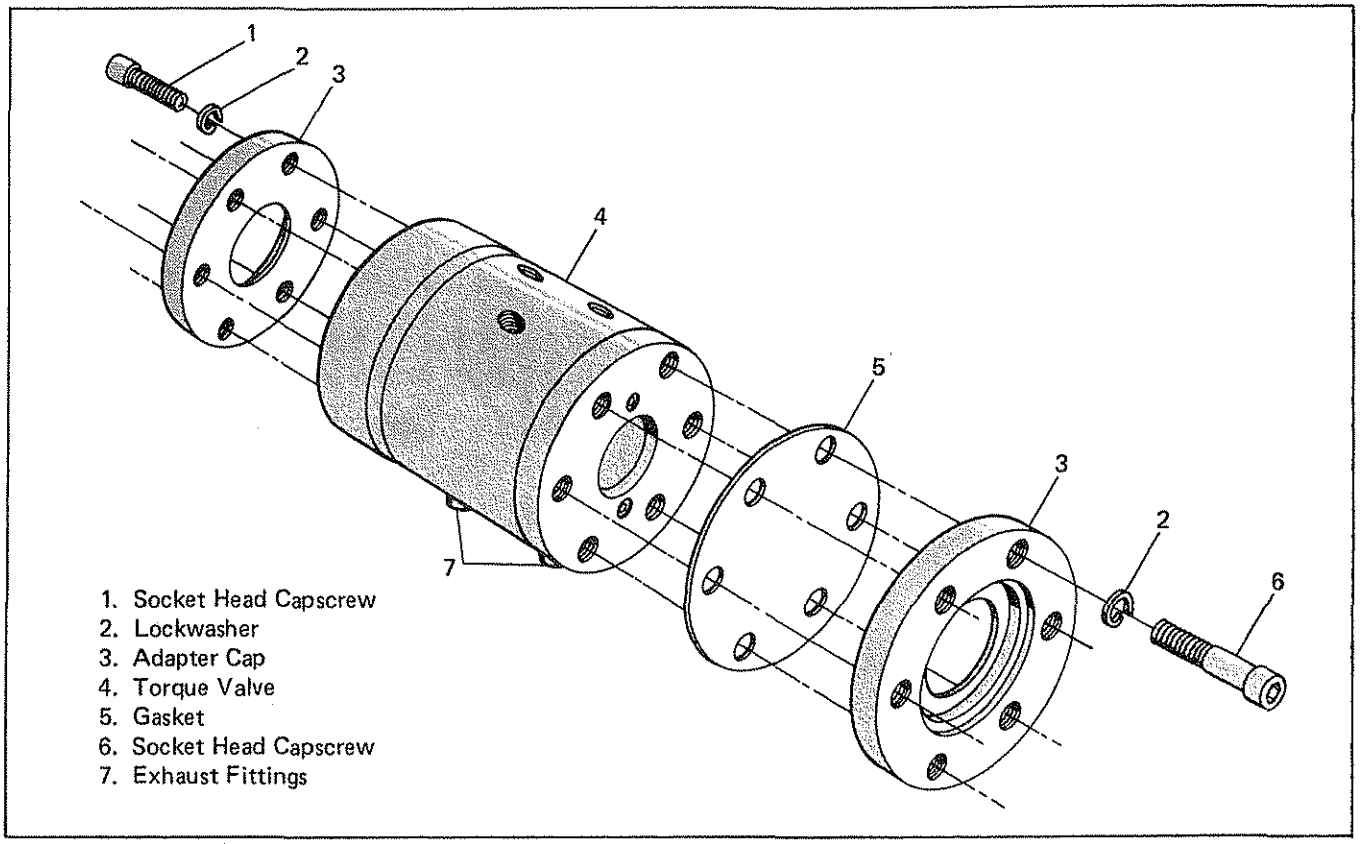

Fig. 4, Torque Valve Assembly

3. Inspect the knuckle pins, knuckle bushings, knuckle bearings, tie rods and tie rod ends for wear or damage following the instructions given in the 10 Group of this manual, or in the applicable front axle manufacturer's maintenance manual.

4. Inspect the drag link, steering driveline, and upper steering column for worn or damaged parts following the instructions given in the 14 Group of this manual.

5. Be sure the wheel bearings are properly adjusted using the instructions given in the 10 Group of the Freightliner Maintenance and Lubrication Manual.

6. Be sure the front axle is in alignment using the instructions given in the 10 Group of this manual.

TORQUE VALVE TESTING

The torque valve feeds air to and exhausts air from the power cylinder. Should air bypass the power cylinder piston it will be exhausted back through the valve giving the impression the valve is "leaking air" and is therefore defective which is not always the case. Therefore, the following procedures for a simple field test are recommended.

Leak Test

1. Remove the torque valve from the drag link in accordance with the procedures given under "TORQUE VALVE REPLACEMENT" in this subject.

2. Connect an air line, having approximately 100 psi (689 kPa) pressure, to the inlet port. With air entering the inlet port it should not escape

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

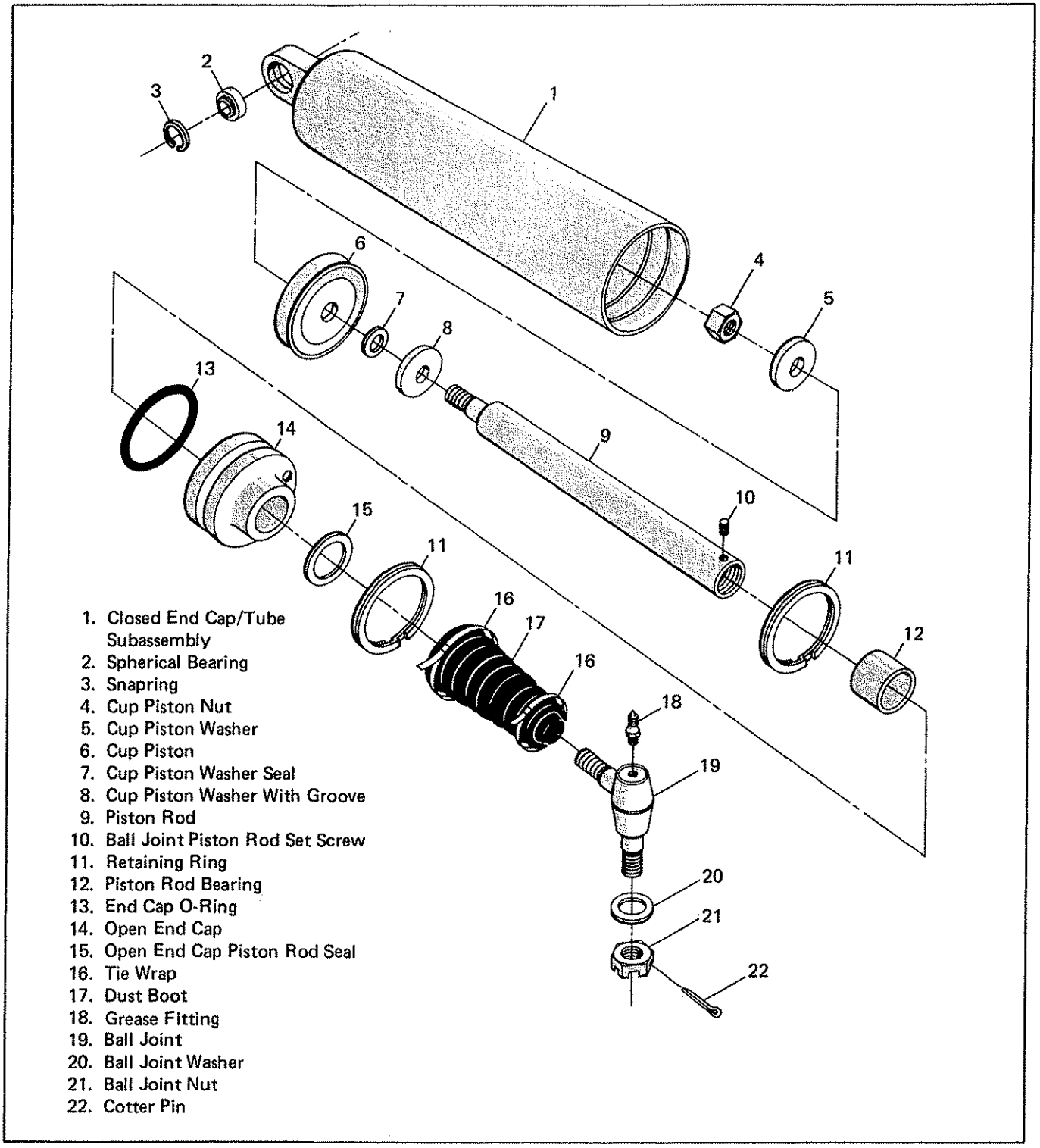

Fig. 5, Power Cylinder Assembly

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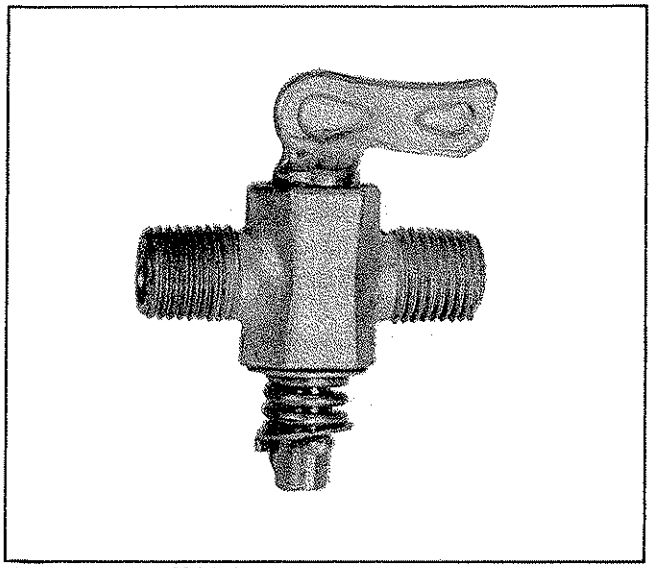

Fig. 6, Shutoff Valve

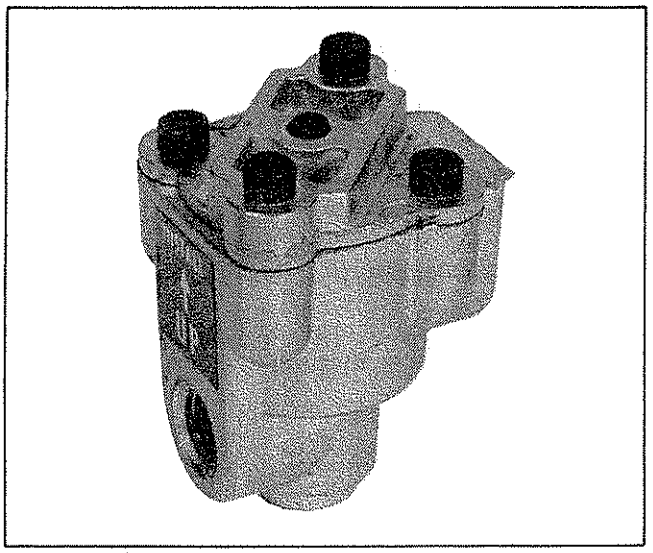

Fig. 7, Safety Valve

from the outlet ports or any other point of the valve. Should air escape at any point, the valve is defective and no further tests are necessary. Replace with a new or a factory rebuilt torque valve.

Compression Test

1. Connect an air pressure gauge to cylinder feed port "A." See Fig. 8.

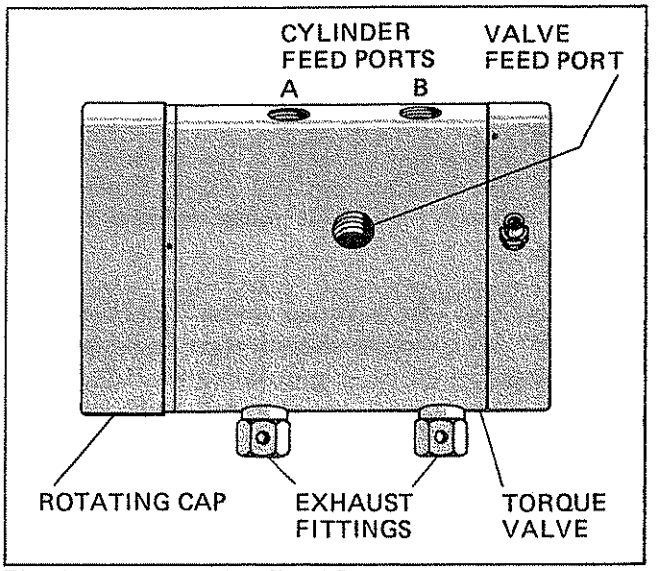

Fig. 8, Torque Valve Feed Ports

2. Now place the valve in a large vise or small arbor press leaving the feed line connected to the inlet port.

3. Compress the valve slowly by tightening the vise. Air pressure should start to register on the pressure gauge at about 1/32 inch (.79 mm) compression with full inlet pressure registering on the pressure gauge when the valve is fully compressed. If the test is satisfactory it can be reasonably assumed air is being properly discharged from outlet port "A."

Tension Test

1. For the tension test leave the air line connected to the inlet port.

2. Remove the air pressure gauge from cylinder feed port "A" and connect to port "B." See Fig. 8.

3. Place two 1/4" x 1 1/4" capscrews or steel dowel pins through the bolt holes in the rotating cap of the valve 180 degrees apart. The capscrews/dowel pins are to extend through the rotating end (without engaging the threads) and touch the body of the valve. On the other

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end of the valve place an ordinary 1/2 inch nut (or similar piece of metal) in the center of the valve on the piston rod cap.

4. Place the valve in a vise or arbor press and bring force against the capscrew heads/dowel pins and the nut. This will place tension on the valve.

5. Repeat the test outlined under "Compression Test." Air pressure should start to register on the pressure gauge at approximately 1/32" (.79 mm) tension and register full inlet pressure upon complete tension travel. If the tension test from port "B" is the same as the results from the compression test from port "A," it can be reasonably assumed the valve is functioning properly.

POWER CYLINDER TESTING

If air exhausts through torque valve when steering wheel is turned in either direction the cause will be found, in most cases, to be a faulty power cylinder permitting air to by-pass the piston and escape by way of the torque valve. To check, proceed as follows:

1. Start the engine and build up the air reservoir pressure to 125-130 psi (861-896 kPa).

2. Turn the engine off; then, disconnect the hose on the end of the power cylinder, opposite to the end air is being fed from the torque valve.

3. Turn steering wheel to actuate valve and admit air to cylinder. If air escapes through cylinder port it is evident air is by-passing the power cylinder cup piston. Correct by rebuilding or replacing with an exchange cylinder.

TORQUE VALVE REPLACEMENT
(Refer to Fig. 1, 2 or 3)

Torque valves are sealed units and are not to be repaired in the field. Interior parts are not available. Factory rebuilt and guaranteed exchange units are available and should be used for replacement. If it is determined that the torque valve is inoperative or damaged, it should be replaced using the following procedures:

1. Position the steering wheel so that the "King-spoke" (the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside) points directly toward the front of the vehicle.

2. On C.O.E. vehicles, remove or secure all loose articles in the cab, then tilt the cab all the way forward following the instructions given in the Freightliner Drivers Manual.

   On Conventional vehicles, release the hood hold-down latches, then tilt the hood all the way forward.

3. Close the power steering shutoff valve, located on the left frame rail near the safety valve, or (if so equipped) turn on the manual override switch mounted on the dashboard.

4. Disconnect the air hoses from the torque valve and mark for later assembly reference. Install plugs in the air hoses. Remove the air fittings from the torque valve.

5. Remove the capscrews and lockwashers from the adapter caps, then remove the torque valve and gasket.

6. Position a new gasket on the stationary end of the new or rebuilt torque valve, so that the capscrew holes in the gasket and torque valve are aligned.

7. Install the torque valve, together with the gasket, between the adapter caps so that the rotating end is nearest to the pitman arm.

8. Position the torque valve so that the feed port and two outlet ports are in the upright position, and so that the capscrew holes in the stationary end of the torque valve and adapter cap are aligned. Then, install new lockwashers and new capscrews. Tighten the capscrews to 18-20 ft-lbs (24-27 N·m). Do not overtighten.

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9. Turn the rotating end of the torque valve so that the capscrew holes in the torque valve and adapter cap are aligned. Then, install new lockwashers and new capscrews. Tighten the capscrews to 18-20 ft-lbs (24-27 N·m). Do not overtighten.

10. Install the air fittings to the torque valve. Tighten the fittings finger-tight; then, with a wrench, tighten one additional turn. If required, continue tightening the fitting until the desired position is attained.

11. Remove the plugs from the air hoses, then connect the hoses to the air fittings as previously marked, or as shown in the plumbing diagram given under "SPECIFICATIONS." Tighten the air hose fitting nuts finger-tight; then, with a wrench, tighten until a solid feeling is encountered. Tighten one-sixth (1/6) turn more.

12. Open the power steering shutoff valve, located on the left frame rail near the safety valve, or (if so equipped) turn off the manual override switch mounted on the dashboard.

13. On C.O.E. vehicles, tilt the cab back to the upright and locked position, following the instructions given in the Freightliner Drivers Manual.

    On Conventional vehicles, tilt the hood back to its operating position, then fasten the hood hold-down latches.

POWER CYLINDER SPHERICAL BEARING REPLACEMENT

1. Position the front wheels in the straight ahead position.

2. Close the power steering shutoff valve, located on the left frame rail near the safety valve, or (if so equipped) turn on the manual override switch mounted on the dashboard.

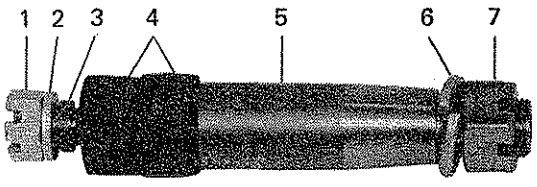
3. Disconnect the air hoses from the power cylinder and mark for later assembly reference. Install plugs in the air hoses.

4. Remove the power cylinder from the vehicle as follows:

   .1 On vehicles equipped with a frame-mounted power cylinder, remove the cotter pin, ball joint nut, and washer from the power cylinder ball joint. Then, at the axle steering arm end of the power cylinder, remove the cotter pin, slotted nut, washer, bearing shield, and spacer from the mounting pin. See Fig. 9. Remove the power cylinder from the vehicle.

   .2 On vehicles equipped with an axle-mounted power cylinder, remove the cotter pin, ball joint nut, and washer from the power cylinder ball joint, then remove the ball joint from the tie-rod bracket.

   At the closed end cap end of the power cylinder, remove the nut, bearing washers, and bolt that attach the power cylinder to the cylinder mounting bracket. Then, remove the closed end cap end of the power cylinder, dust covers, and spacers from the cylinder mounting bracket. Remove the power cylinder from the vehicle.



1. 5/8" Slotted Nut
2. 5/8" Washer
3. Spacer
4. Bearing Shield
5. Mounting Pin
6. 7/8" Lockwasher
7. 7/8" Slotted Nut

Fig. 9, Mounting Pin Assembly

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5. Remove the snapring(s) by using internal snapring pliers.

6. The bearing is a press fit into the closed end of the cylinder. To remove the bearings, the following procedure is to be used:

   1. Extend the pision rod as far as it will go.

   2. Plug the air supply hole in the closed end by using a pipe plug. Do not plug the other end.

   3. Submerge the hub only in a pan of boiling water.

   4. After the hub has heated in the boiling water for 5 minutes, remove the cylinder and tap out the bearing as shown in Fig. 10.

7. The bearing is a press fit requiring that it be started properly, otherwise the bearing will not seat. Use the following procedure:

   .1 Extend piston rod as far as it will go and then plug the air supply hole in the closed (bearing) end of the power cylinder.

   .2 Submerge the hub only in a pan of boiling water.

   .3 Check the outer edge of the new bearing for burrs or ridges. "Dress" the leading edge with a file if necessary.

   .4 After the hub has heated in the boiling water for 5 minutes, remove the cylinder and tap the bearing into place as shown in Fig. 11.

NOTE: The hub has a draft (tapered surface). Align the bearing with the bored hole, not the outer surface of the hub.

CAUTION: After bearing has seated, immediately cool hub with water to prevent the lubricant from leaving the bearing.

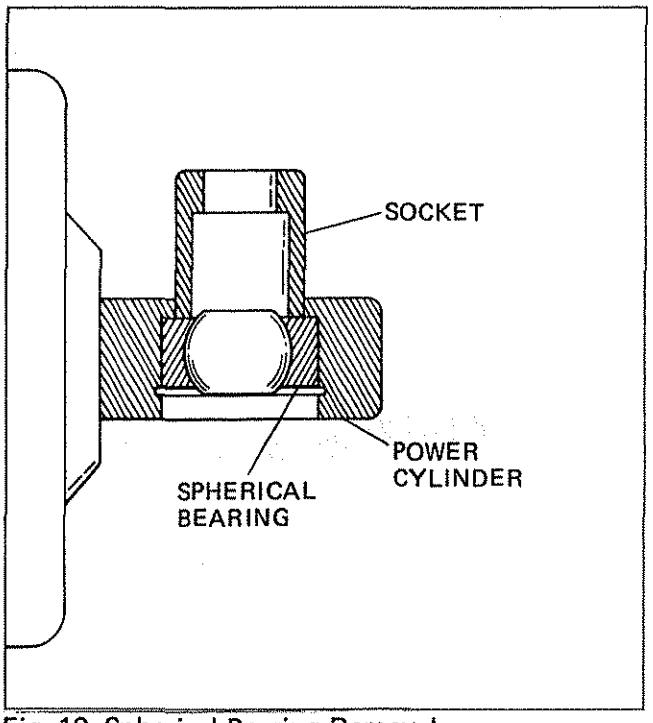

Fig. 10, Spherical Bearing Removal

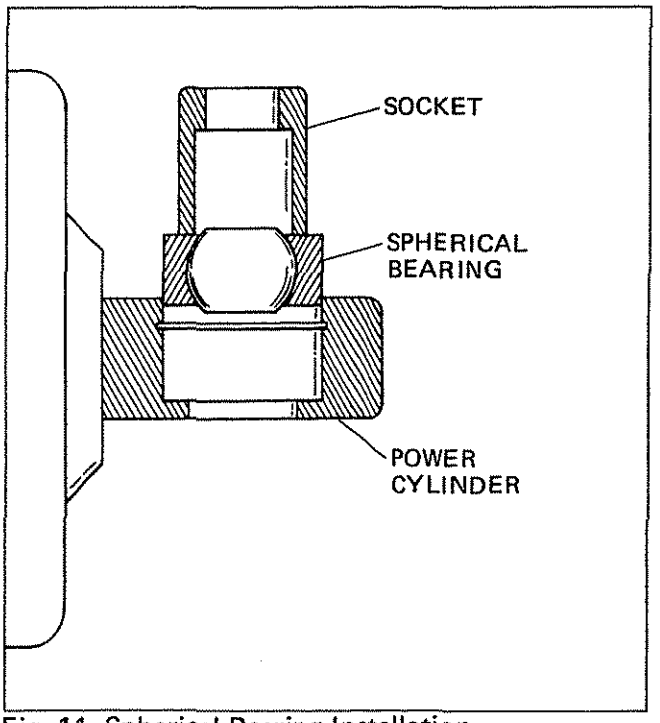

Fig. 11, Spherical Bearing Installation

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8. Insert new snapring(s) by using internal snapring pliers.

9. With the front wheels in the straight ahead position and the power cylinder in the center position, install the power cylinder in the vehicle as follows:

   .1 On vehicles equipped with a frame-mounted power cylinder, install the power cylinder ball joint in the cylinder mounting bracket; then, install the ball joint washer and nut on the ball joint. Tighten the ball joint nut to 110-125 ft-lbs (149-170 N·m).

   Position the closed end cap end of the power cylinder on the mounting pin. Then, install the spacer, bearing shield, washer, and slotted nut. See Fig. 9. Tighten the slotted nut to 50-60 ft-lbs (68-81 N·m).

   If required, continue tightening each nut until a slot on the nut aligns with the hole in the ball joint or mounting pin.

CAUTION: Do not back off the nut when locating the cotter pin hole.

   Install new cotter pins through the ball joint or mounting pin, and nuts, then lock them in place.

WARNING: Failure to install and lock a new cotter pin in the ball joint or mounting pin, and nut could result in a hazardous vehicle operating condition.

   .2 On vehicle equipped with axle-mounted power cylinder, position the closed end of the power cylinder between the cylinder mounting bracket pads; then, position the spacer and dust cover on each side of the closed end cap end of the power cylinder as shown in Fig. 12. Install the bolt, bearing washer, and nut, then tighten the nut to 130 ft-lbs (176 N·m).

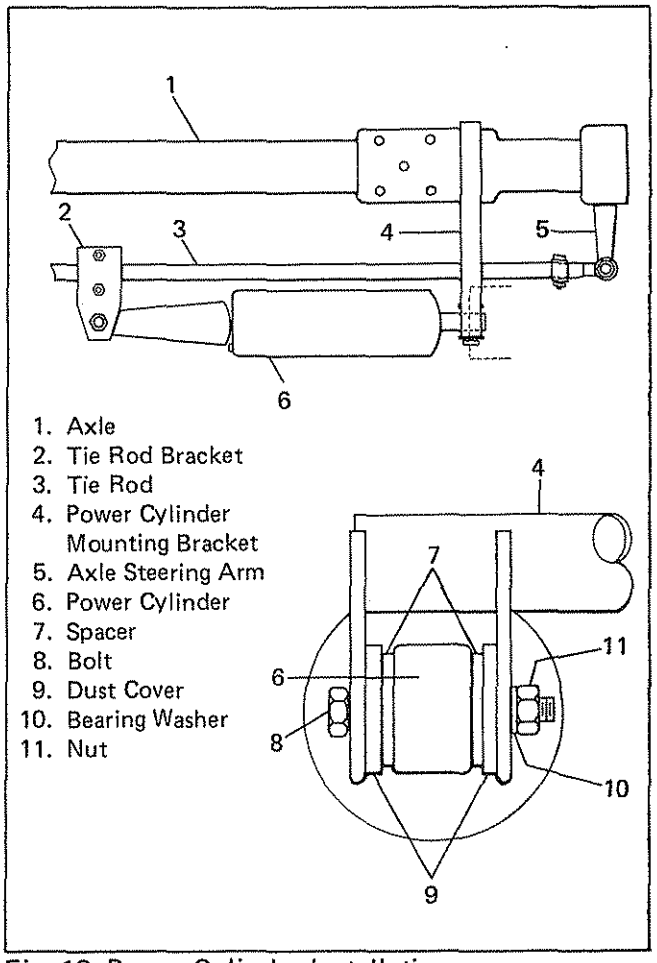

Fig. 12, Power Cylinder Installation

   Position the ball joint in the tie-rod bracket, then install the washer and nut. Tighten the nut to 110-125 ft-lbs (149-170 N·m). If required, continue tightening the nut until a slot on the nut aligns with the hole in the ball joint.

CAUTION: Do not back off the nut when locating the cotter pin hole.

   Install a new cotter pin through the ball joint and nut, then lock it in place.

WARNING: Failure to install and lock a new cotter pin in the ball joint and nut could result in a hazardous vehicle operating condition.

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10. Apply teflon tape or an equivalent to the air fitting threads, then install the air fittings in the power cylinder. Tighten the fittings finger-tight, then with a wrench, tighten one additional turn. If required, continue tightening the fittings until properly positioned.

11. Remove the plugs from the air hoses, then connect the hoses to the air fittings as previously marked, or as shown in the plumbing diagram given under "SPECIFICATIONS." Tighten the air hose fitting nuts finger-tight; then, with a wrench, tighten until a solid feeling is encountered. Tighten one-sixth (1/6) turn more.

12. Open the power steering shutoff valve located on the left frame rail near the safety valve, or (if so equipped) turn off the manual override switch mounted on the dashboard.

POWER CYLINDER DUST BOOT REPLACEMENT (Refer to Fig. 5)

1. Position the front wheels in the straight ahead position.

2. Cut the old dust boot from the piston rod.

3. If equipped with a frame-mounted power cylinder, disconnect the ball joint from the cylinder mounting bracket.

   If equipped with an axle-mounted power cylinder, disconnect the ball joint from the tie-rod bracket.

4. The new dust boot can now be slid over the ball joint and into place.

5. Position the dust boot so the drain holes faces down.

6. Tie wrap the dust boot into the groove on the open end cap. Tie wrap the other end of the dust boot to the end of the rod, near the ball joint.

7. Attach the ball joint to the vehicle, torquing the ball joint nut to 110-125 ft-lbs (149-170 N·m).

POWER CYLINDER INTERNAL PARTS REPLACEMENT (Refer to Fig. 5)

Although internal parts are available, a need to replace one part normally indicates a need to replace all the remaining moving parts. Therefore, it is suggested that a new or rebuilt cylinder be obtained.

SAFETY VALVE ADJUSTMENT (Refer to Fig. 1, 2 or 3)

1. Start the engine and build up air reservoir pressure to 125-130 psi (861-896 kPa), then stop the engine.

2. Remove the two capscrews retaining the valve to its mounting.

3. In the center of the valve cap will be observed an Allen head set screw. This is the adjusting screw.

4. Close the shutoff valve and disconnect the outlet line on the safety valve.

5. Open the shutoff valve and when the reservoir pressure drops to 60 to 65 pounds (413 to 448 kPa) the air should be completely shut off at the safety valve outlet port.

6. Full flow should take place when the pressure is increased approximately 12 psi (83 kPa) above the shut off setting. Turning the adjusting screw counterclockwise will permit the air to flow at lower pressures; turning it clockwise will increase the amount of pressure required to start the air flow.

7. When the adjustment has been completed, remount the valve and connect the outlet line.

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

SAFETY VALVE CLEANING
(Refer to Fig. 1, 2 or 3)

1. On C.O.E. vehicles, remove or secure all loose articles in the cab, then tilt the cab all the way forward following the instructions given in the Freightliner Drivers Manual.

   On Conventional vehicles, release the hood hold-down latches, then tilt the hood all the way forward.

2. Drain all air reservoirs by opening the drain cocks.

3. Disconnect the air hose from the elbow fitting that is connected to the safety valve, then install a plug in the air hose. Remove the elbow fitting from the safety valve.

4. Remove the nuts, washers, and bolts that attach the safety valve support bracket to the frame rail. Then, remove the two capscrews that attach the safety valve to the support bracket.

5. Remove the safety valve and shutoff valve assembly from the close nipple fitting that attaches to the anchor coupling. Then, remove the safety valve from the close nipple fitting that is connected to the shutoff valve.

6. Remove other two capscrews and lift valve cover assembly from valve body.

7. Remove spring cap, spring and piston with O-ring assembled, from valve body.

8. Remove O-ring from piston.

NOTE: Do not remove internal retaining ring and valve seat.

9. Wash all parts in diesel fuel or kerosene and blow dry or wipe parts.

10. Inspect all parts for wear or damage. If any part(s) is worn or damaged, replace the safety valve with a new one, then proceed to step 12.

11. Assemble O-ring to piston and apply a thin coating of a low temperature lubricant (i.e. Lubriplate) to O-ring and reassemble valve.

12. Insure that all pipe fitting threads are free of grease, dirt, and old sealant.

13. Apply teflon tape or an equivalent to the fitting threads, then screw the inlet port of the safety valve onto the close nipple fitting that is connected to the shutoff valve. Tighten the safety valve onto the close nipple fitting finger-tight, then tighten one additional turn. If required, continue tightening the safety valve onto the fitting until properly positioned.

NOTE: The inlet port and outlet port are stamped "IN" and "OUT," respectively.

14. Screw the street elbow fitting that is connected to the shutoff valve onto the close nipple fitting that is connected to the anchor coupling. Tighten the street elbow fitting onto the close nipple fitting finger-tight, then tighten one additional turn. If required, continue tightening the fitting until the shutoff valve and safety valve assembly is properly positioned.

15. Adjust the safety valve, following the instructions given under "SAFETY VALVE ADJUSTMENT" in this subject.

16. Install the elbow fitting in the outlet port of the safety valve. Tighten the fitting finger-tight, then with a wrench, tighten one additional turn. If required, continue tightening the fitting until properly positioned.

17. Connect the air hose to the elbow fitting that is connected to that safety valve. Tighten the air hose fitting nut finger-tight; then, with a wrench, tighten the nut until a solid feeling is encountered. Tighten one-sixth (1/6) turn more.

18. Position the support bracket on the safety valve, then install the two capscrews. Tighten the two capscrews to 9 ft-lbs (12 N·m).

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19. Position the safety valve and support bracket assembly on the frame rail, then install the two bolts, washers, and nuts. Tighten the nuts to 6 ft-lbs (8 N·m).

20. Close the drain cocks on all air reservoirs.

21. On C.O.E. vehicles, tilt the cab back to the upright and locked position, following the instructions given in the Freightliner Drivers Manual.

    On Conventional vehicles, tilt the hood back to its operating position, then fasten the hood hold-down latches.

SHUTOFF VALVE REPLACEMENT
(Refer to Fig. 1, 2, or 3)

1. On C.O.E. vehicles, remove or secure all loose articles in the cab, then tilt the cab all the way forward following the instructions given in the Freightliner Drivers Manual.

   On Conventional vehicles, release the hood hold-down latches, then tilt the hood all the way forward.

2. Drain all air reservoirs by opening the drain cocks.

3. Disconnect the air hose from the elbow fitting that is connected to the safety valve, then install a plug in the air hose.

4. Remove the nuts, washers, and bolts that attach the safety valve support bracket to the frame rail.

5. Remove the safety valve and shutoff valve assembly from the close nipple fitting that attaches to the anchor coupling.

6. Remove the shutoff valve from the close nipple fitting that is connected to the safety valve. Then, remove the street elbow fitting from the shutoff valve.

7. Insure that all pipe fitting threads are free of grease, dirt and old sealant.

8. Apply teflon tape or an equivalent to the fitting threads, then screw the outlet port of the new shutoff valve onto the close nipple fitting that is connected to the safety valve. Tighten the shutoff valve onto the close nipple fitting finger-tight, then tighten one additional turn. If required, continue tightening the shutoff valve onto the fitting until properly positioned.

9. Screw the street elbow fitting into the inlet port of the shutoff valve. Tighten the fitting finger-tight; then, with a wrench, tighten one additional turn. If required, continue tightening the fitting until properly positioned.

10. Screw the street elbow fitting that is connected to the shutoff valve onto the close nipple fitting that is connected to the anchor coupling. Tighten the street elbow fitting onto the close nipple fitting finger-tight, then tighten one additional turn. If required, continue tightening the fitting until the shutoff valve and safety valve assembly is properly positioned.

11. Position the safety valve support bracket on the frame rail, then install the two bolts, washers, and nuts. Tighten the nuts to 6 ft-lbs (8 N·m).

12. Remove the plug from the air hose, then connect the air hose to the safety valve. Tighten the air hose fitting nut finger-tight, then with a wrench, tighten the nut until a solid feeling is encountered. Tighten one-sixth (1/6) turn more.

13. Close the drain cocks on all the air reservoirs.

14. On C.O.E. vehicles, tilt the cab back to the upright and locked position, following the instructions given in the Freightliner Drivers Manual.

    On Conventional vehicles, tilt the hood back to its operating position, then fasten the hood hold-down latches.

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Shimmy	Excessive positive caster.	Align the front axle following the instructions given in the 10 Group of this manual.
	Worn or damaged king pin.	Repair or replace the king pin, using the instructions given in the applicable front axle manufacturer's maintenance manual.
	Weak or broken springs.	Replace the springs, using the instructions given in the 16 Group of this manual.
	Inadequate or uneven tire pressures.	Inflate the tires to the specifications given in the 13 Group of this manual, or the applicable tire manufacturer's specifications.
	Tires out of balance, out of round, etc.	Balance or replace the tires.
	Worn-out shackle pins and bushings.	Replace worn-out shackle pins and bushings using the instructions given in the 16 Group of this manual.
	Shifting of the axle under the springs due to loose U-bolts.	Align the front axle following the instructions given in the 10 Group of this manual.
	Loose or worn tie-rod and drag link ends.	Adjust or replace steering components following the instructions given in the 14 Group of this manual and/or the applicable front axle manufacturer's maintenance manual.
	Improperly adjusted or worn front wheel bearings.	Adjust or replace wheel bearings following the instructions given in the 10 Group of the Freightliner Maintenance and Lubrication Manual.

(Continued on next page)

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Shimmy (Cont.)	Steering gear loose at frame mounting bracket.	Tighten steering gear mounting bracket nuts with respect to their size and grade.
	Steering box not centered, out of adjustment, etc.	Adjust the steering box, following the instructions given in the 14 Group of this manual.
Wander, Darting Or Oversteering	Steering gear improperly adjusted and not centered.	Adjust or repair the steering gear, following the instructions given in the 14 Group of this manual.
	Improper toe-in setting or excessive positive caster.	Align the front axle, following the instructions given in the 10 Group of this manual.
	Dry fifth wheel, or poor finish on fifth wheel or trailer plate.	Lubricate the fifth wheel in accordance with the instructions given in the 22 Group of the Freightliner Maintenance and Lubrication Manual, or the applicable fifth wheel manufacturer's maintenance manual.
	Fifth wheel improperly positioned.	Position the fifth wheel so that the desired load on the axle is no less than 80% of the maximum axle weight rating but in no instances should the axle load exceed the maximum axle weight rating.
	Loose power cylinder bracket bolts.	Tighten power cylinder bracket bolts to the torque value given under "SPECIFICATIONS" in this subject.
	Excessive tie-rod oscillation or roll.	Adjust tie-rod ends, following the instructions given in the applicable front axle manufacturer's maintenance manual.

(Continued on next page)

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Wander, Darting Or Oversteering (Cont.)	Uneven tire pressures.	Inflate tires to the specifications given in the 13 Group of this manual or the applicable tire manufacturer's specifications.
	Weak or broken springs.	Replace the springs, using the instructions given in the 16 Group of this manual.
	Different tire sizes.	Replace with same tire size.
	Bent axle.	Replace the axle, using the instructions given in the applicable front axle manufacturer's maintenance manual.
	Twisted or sprung frame.	Repair or replace the frame rail.
	Universal joints between steering gear and steering wheel too tight, too loose, or worn.	Replace the universal joint, using the instructions given in the 14 Group of this manual.
	Axle steering arm ball socket too tight.	Adjust the axle steering arm ball socket, using the instructions given in the 14 Group of this manual.
	Excessive front wheel brake drag.	Adjust the front wheel brake, following the instructions given in the 10 Group of this manual or the applicable front wheel brake manufacturer's maintenance manual.
	Worn or damaged knuckle pins and bushings.	Replace worn or damaged knuckle pins and bushings, following the applicable front axle manufacturer's maintenance manual.
	Front axle shifted on front springs.	Align the front axle, following the instructions given in the 10 Group of this manual.

(Continued on next page)

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Wander, Darting Or Oversteering (Cont.)	Worn or loose spherical bearing on anchor end of power cylinder.	Replace the spherical bearing, using the procedures given under "POWER CYLINDER SPHERICAL BEARING REPLACEMENT" in this subject.
	Axle stops out of adjustment.	Set axle stops on axle so there is a minimum of .5 to 1.0 inch (12.5 to 25.5 mm) clearance between the tire and the drag link.
	Steering gear loose on frame mounting bracket.	Tighten steering gear mounting bracket nuts to the torque value given under "SPECIFICATIONS" in this subject.
	King pin thrust bearing binding or seized.	Repair or replace the king pin thrust bearing, using the instuctions given in the applicable front axle manufacturer's maintenance manual.
	Insufficient clearance between axle beam and steering knuckle.	Replace the steering knuckle, using the instructions given in the applicable front axle manufacturer's maintenance manual.
	Misalignment of power cylinder causing air leak.	Adjust the power cylinder so it sets parallel to and horizontal with the tie-rod when the wheels are in the straight ahead position.
	Ball sockets worn with flat spots on ball, or ball socket too tight.	Adjust or replace ball sockets, using the instructions given in the 14 Group of this manual.
Hard Steering	Contamination of the air system due to water and other foreign matter.	Drain tanks.
	Restriction of air flow due to water and foreign matter collecting in the safety valve.	Clean and adjust the safety valve, following the instructions given in this subject.

(Continued on next page)

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Hard Steering (Cont.)	Insufficient air supply due to taking air supply from the supply (wet) tank and not the dry tank reservoir.	Reconnect to the secondary dry tank air reservoir.
	Restriction of air to torque valve.	Remove restriction in the line from the air reservoir to the torque valve.
	Insufficient air supply from torque valve to power cylinder.	Remove the restriction in the line from the torque valve to the power cylinder and/or replace the torque valve, following the instructions given in this subject.
	Knuckle pins and bushings worn or too tight.	Repair or replace the knuckle pins and bushings, using the instructions given in the applicable front axle manufacturer's maintenance manual.
	Excessive positive caster.	Align the front axle, following the instructions given in the 10 Group of this manual.
	Steering gear out of adjustment.	Adjust the steering gear, using the instructions given in the 14 Group of this manual.
	Axle shifted.	Align the front axle, following the instructions given in the 10 Group of this manual.
	Bent axle.	Replace the axle, using the instructions given in the applicable front axle manufacturer's maintenance manual.
	Bent frame.	Repair or replace the frame.
	Lack of lubrication.	Lubricate the steering system, using the instructions given in the 14 Group of the Freightliner Maintenance and Lubrication Manual.

(Continued on next page)

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Hard Steering (Cont.)	Steering driveline universal joints worn or seized.	Replace the universal joints, using the instructions given in the 14 Group of this manual.
	Ball joints too tight.	Adjust or replace the ball joints, using the instructions given in the 14 Group of this manual.
	Air leaks.	Check all fitting connections for tightness.
	Knuckle bearings seized or worn.	Repair or replace the knuckle bearings, using the instructions given in the applicable front axle manufacturer's maintenance manual.
	Safety valve out of adjustment or defective, causing air restriction to torque valve.	Adjust or replace the safety valve, following the instructions given in this subject.
No Wheel Return	Caster of front axle.	Align the front axle, following the instructions given in the 10 Group of this manual.
	Steering driveline universal joints too tight.	Replace the universal joints, using the instructions given in the 14 Group of this manual.
	Steering gear too tight.	Adjust the steering gear, using the instructions given in the 14 Group of this manual.
	Steering gear worn or damaged.	Repair or replace the steering gear, using the instructions given in the 14 Group of this manual.
	Ball socket at axle steering arm too tight.	Adjust or replace the ball sockets, using the instructions given in the 14 Group of this manual.

(Continued on next page)

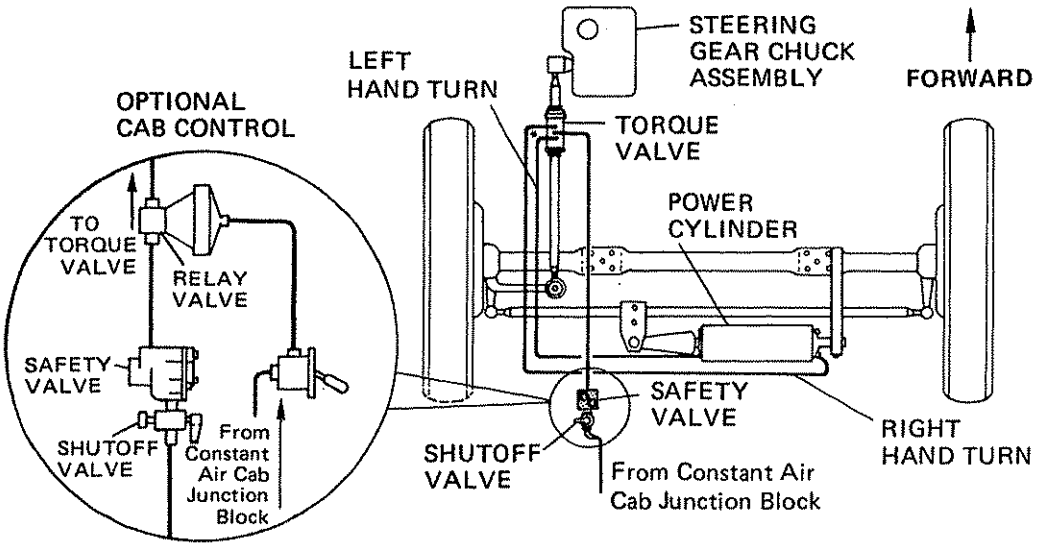
AIR-O-MATIC POWER STEERING SYSTEM SERVICING

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
No Wheel Return (Cont.)	Knuckle pins seized in bushings.	Replace the knuckle pins and bushings, using the instructions given in the applicable front axle manufacturer's maintenance manual.
	Knuckle bearings damaged or seized.	Replace the knuckle bearings, using the instructions given in the applicable front axle manufacturer's maintenance manual.

AIR-O-MATIC POWER STEERING SYSTEM SERVICING

SPECIFICATIONS



*NOTE: Connections are reversed on C.O.E. vehicles equipped with frame-mounted power cylinder, and on Conventional vehicles equipped with an axle-mounted power cylinder. Power steering component location could vary depending on installation.

Fig. 13, Plumbing Diagram (C.O.E. With Axle-Mounted Power Cylinder Shown)

DESCRIPTION	THREAD SIZE	GRADE	TORQUE	
			FT-LBS	N·m
Adapter Cap Capscrews	5/16-18	8	18-20	24-27
Power Cylinder Ball Joint Nut	7/8-14	5	110-125	149-170
Power Cylinder Bracket Bolt Nut (Axle-Mounted)	5/8-18	5	130	176
Mounting Pin Slotted Nut	5/8-18	5	50-60	68-81
Tie-Rod Bracket U-Bolt Nuts	7/16-20	8	60	81
Safety Valve Mounting Capscrews	1/4-20	5	6	8
Safety Valve Support Bracket Mounting Nuts	1/4-20	8	9	12
Steering Gear Mounting Bracket Nuts	5/8-11	8.2	175	237
	5/8-18	5	130	176

Table 1, Torque Specifications

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

SUBJECT CONTENTS

TOPIC **PAGE NUMBER**

General Description

Principles of Operation

Service Operations

Bearing Cap Seal Replacement 4
Steering Gear Removal 4
Steering Gear Disassembly 5
Cleaning and Inspecting 11
Steering Gear Assembly 12
Steering Gear Installation 17
Troubleshooting 19

Specifications

Table 1, Steering Gear Torque Values 19

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

GENERAL DESCRIPTION

Sheppard integral power steering gear models 392S and 492S, Series 3 and 4, provide full-time hydraulic steering. Model 392S is installed on vehicles with a front axle capacity of 12,000 lbs (5443 kg); model 492S is installed on vehicles with a front axle capacity of 18,000 lbs (8165 kg).

Series 3 and 4 gears (the series number indicates a level of design revision) are offered as an option on vehicles built up to February 1984.

The steering gear is mounted on the vehicle frame rail, and connects an actuating (input) shaft to the steering driveline, and an output shaft to the pitman arm. See **Fig. 1** for COE installations or **Fig. 2** for 120 Conventional installations. The steering gear has four moving parts: an actuating shaft, an actuating valve, a piston, and a pinion and output shaft assembly.

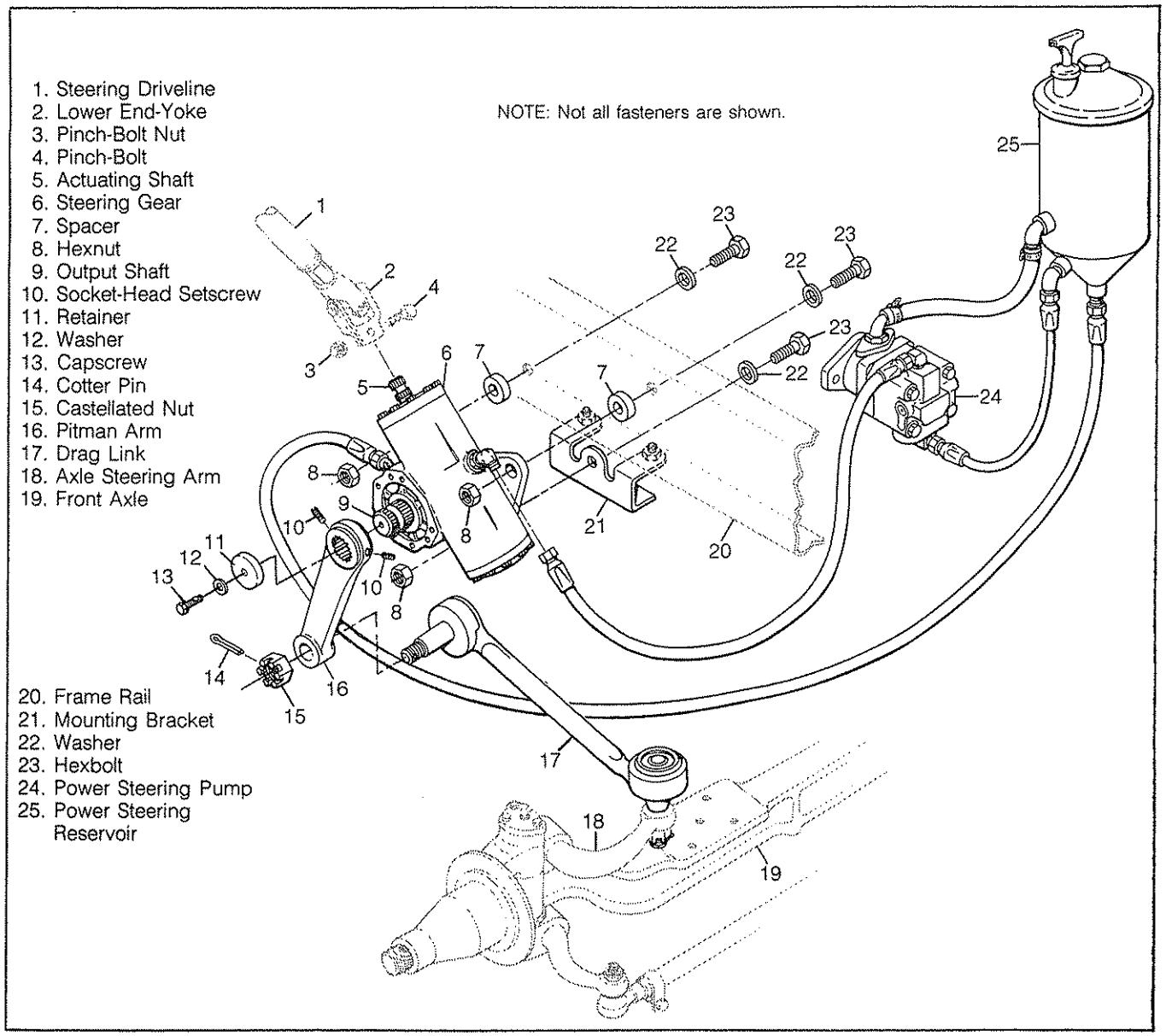


Fig. 1, Integral Power Steering Gear Installation, COE

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

1. Power Steering Reservoir
2. Power Steering Pump
3. Steering Driveline
4. Pinch-Bolt Nut
5. Pinch-Bolt
6. Lower End-Yoke
7. Flanged Hexbolt
8. Frame Rail
9. Flanged Hexnut
10. Hexnut
11. Flathead Bolt
12. Hexbolt
13. Mounting Bracket
14. Actuating Shaft
15. Washer
16. Steering Gear
17. Output Shaft
18. Socket-Head Setscrew
19. Drag Link
20. Front Axle
21. Axle Steering Arm
22. Capscrew
23. Washer
24. Retainer
25. Pitman Arm
26. Castellated Nut
27. Cotter Pin

NOTE: Not all fasteners are shown.

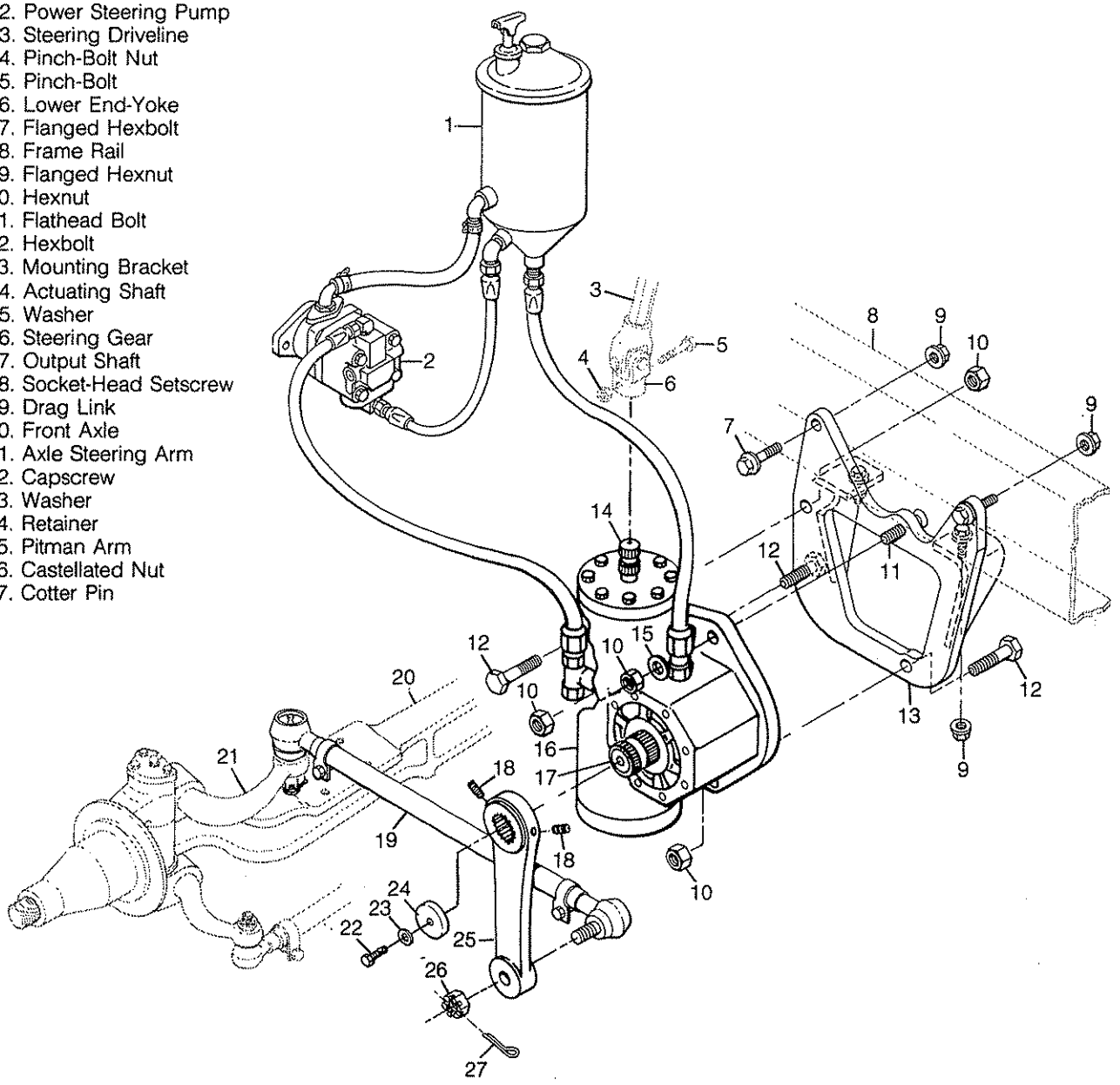


Fig. 2, Integral Power Steering Gear Installation, 120 Conventional

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

PRINCIPLES OF OPERATION

The actuating valve is threaded to accept the actuating (input) shaft, and is centered within the piston by reversing springs. When the valve is centered (in the neutral position), the edges of the two ports on the valve are seated against the mating edges of the three ports on the inside of the piston. See Fig. 3.

When the vehicle steering wheel is turned, the actuating shaft turns within the actuating valve, moving the valve in a linear direction within the piston. This causes oil pressure to build up at one end of the piston, moving the piston in the bore of the steering gear housing.

The output shaft and pinion gear mesh with a rack gear that is machined into one side of the piston. As the piston moves, the pinion gear and output shaft are rotated by the rack, moving the pitman arm, and steering the vehicle.

When rotation or input from the actuating shaft stops, movement of the actuating valve stops, and the reversing springs, at the ends of the valve, center the valve in the piston. This relieves the oil pressure, and stops power-assisted steering of the vehicle.

Relief valve plungers are provided in the bearing cap and the cylinder head. When the plungers are adjusted correctly, they will automatically release hydraulic pressure in the steering system if the wheels are turned too far in either direction.

When the engine is running, a constant low-pressure oil flow is present throughout the steering gear. This constant oil flow allows for quick steering response, and lubricates and cools the hydraulic steering system. It also absorbs road shock, to help eliminate steering wheel kick and to protect the steering gear.

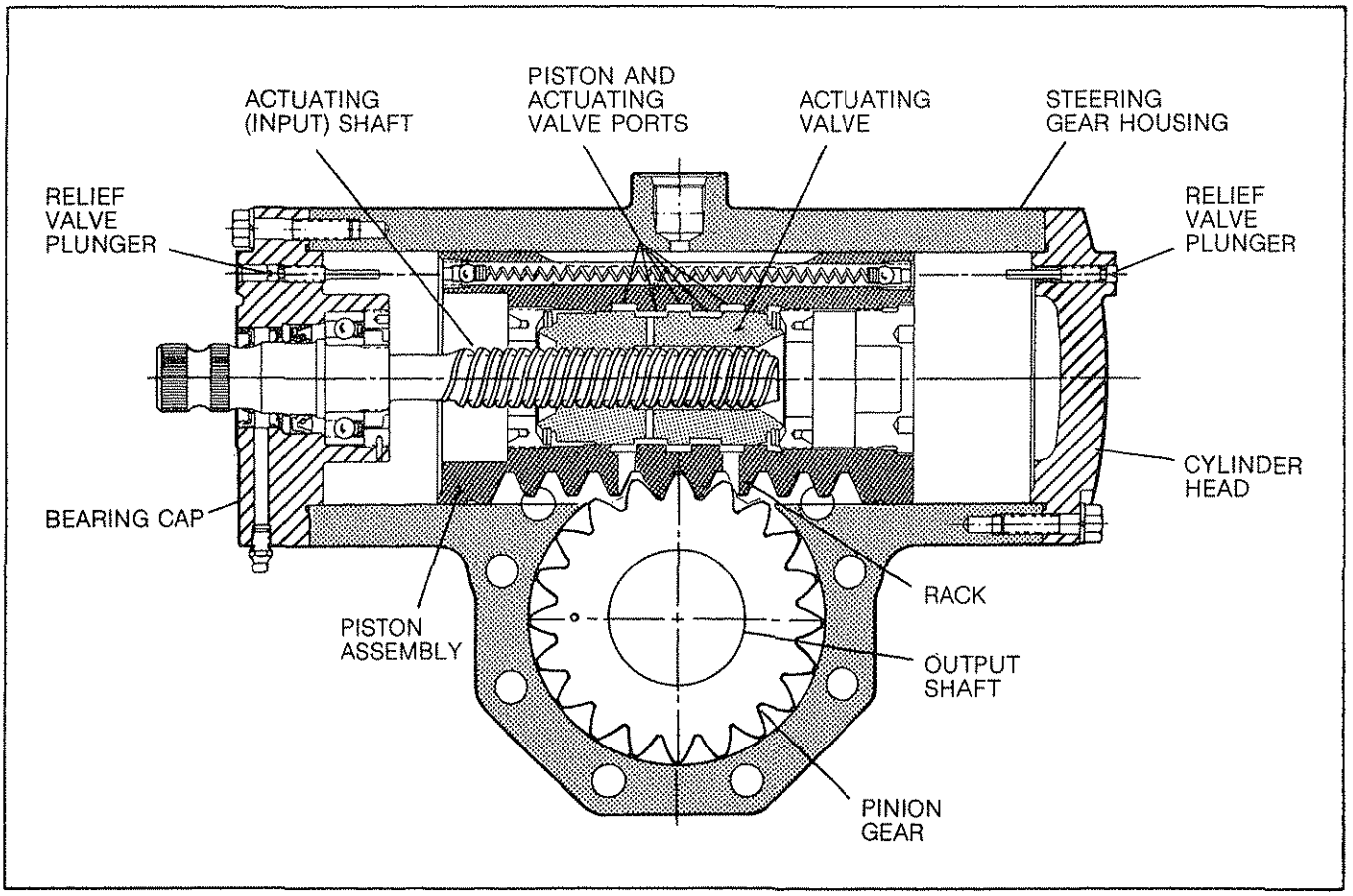


Fig. 3, Sheppard Integral Power Steering Gear, Model 392S or 492S

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

SERVICE OPERATIONS

Before servicing the steering gear or the steering pump, refer to the pre-service checks in the Group 14 subject of this manual that covers hydraulic steering system checking and testing. After doing service work on the power steering system parts, refer to the post-service checks in the same subject.

IMPORTANT: Check the power steering troubleshooting section in Group 14 of this manual before removing the steering gear from the vehicle. Do not remove the steering gear from the vehicle unless you are sure that the problem you are experiencing actually involves the steering gear itself.

BEARING CAP SEAL REPLACEMENT

NOTE: The steering gear does not need to be removed from the vehicle to replace the bearing cap seals.

CAUTION: The Sheppard integral power steering gear is a precision-machined assembly, and care must be taken during repair to keep it free of dirt and foreign material. All internal parts must be handled carefully to avoid damage to machined surfaces. Nicks or burrs can cause damage to mating parts and must be removed with a fine handstone before reassembly. If possible, use a workbench with a surface of soft cardboard or plywood.

1. Place the front tires straight-ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where the work is to be done. Set the parking brakes, and chock the tires.
2. Drain the oil from the power steering reservoir by disconnecting the hose between the reservoir and the steering gear. Use a clean bucket to catch the oil.
3. Disconnect the steering driveline from the steering gear actuating (input) shaft. For instructions, refer to the applicable steering driveline subject in Group 14 of this manual.
4. Follow steps 11 through 16 of "Steering Gear Disassembly."

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

5. Clean machined parts individually, to avoid damage due to bumping together. Use a clean solvent to wash the parts. Dry the parts with compressed air.

CAUTION: Cleanliness is of utmost importance. Dirt and foreign material in the steering system during repair operations can cause damage and steering malfunctions, which could result in an accident causing personal injury and property damage.

6. Follow steps 10 and 11 of "Steering Gear Assembly."
7. Install the relief valve plunger, using a new O-ring. Turn it about six turns.
8. If not previously done, center the steering gear. The output shaft/pitman arm alignment mark must be perpendicular to the actuating (input) shaft centerline.

STEERING GEAR REMOVAL (Refer to Fig. 1 or 2)

NOTE: The steering gear does not need to be removed from the vehicle if replacing only the bearing cap seals. Refer to "Bearing Cap Seal Replacement."

1. Place the front tires straight-ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where the work is to be done. Set the parking brakes, and chock the tires.
2. Disconnect all hydraulic lines from the gear, marking the lines for later assembly. Seal off the lines and the gear ports to prevent fluid from leaking out of the lines and to prevent the entry of dirt.
3. Disconnect the drag link from the pitman arm. For instructions, refer to the drag link subject in Group 14 of this manual.
4. Disconnect the steering driveline from the steering gear actuating (input) shaft. For instructions, refer to the applicable steering driveline subject in Group 14 of this manual.
5. On 120 Conventionals, remove the fasteners attaching the steering gear mounting bracket to the frame rail, then remove the fasteners attaching the mounting bracket to the steering gear. Place the steering gear on a clean surface.

   On COEs, remove the fasteners attaching the steering gear to the frame rail and mounting bracket. Remove the spacers and the steering gear, and place the steering gear on a clean surface.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

STEERING GEAR DISASSEMBLY (Refer to Fig. 4)

1. Remove the steering gear from the vehicle. For instructions, refer to "Steering Gear Removal."

CAUTION: The Sheppard integral power steering gear is a precision-machined assembly, and care must be taken during repair to keep it free of dirt and foreign material. All internal parts must be handled carefully to avoid damage to machined surfaces. Nicks or burrs can cause damage to mating parts, and must be removed with a fine handstone before reassembly. If possible, use a workbench with a surface of soft cardboard or plywood.

2. Remove the two socket-head setscrews that lock the pitman arm to the output shaft of the steering gear. See Fig. 5.

   Note the alignment of the arrow on the pitman arm with the dot or arrow on the output shaft. Refer

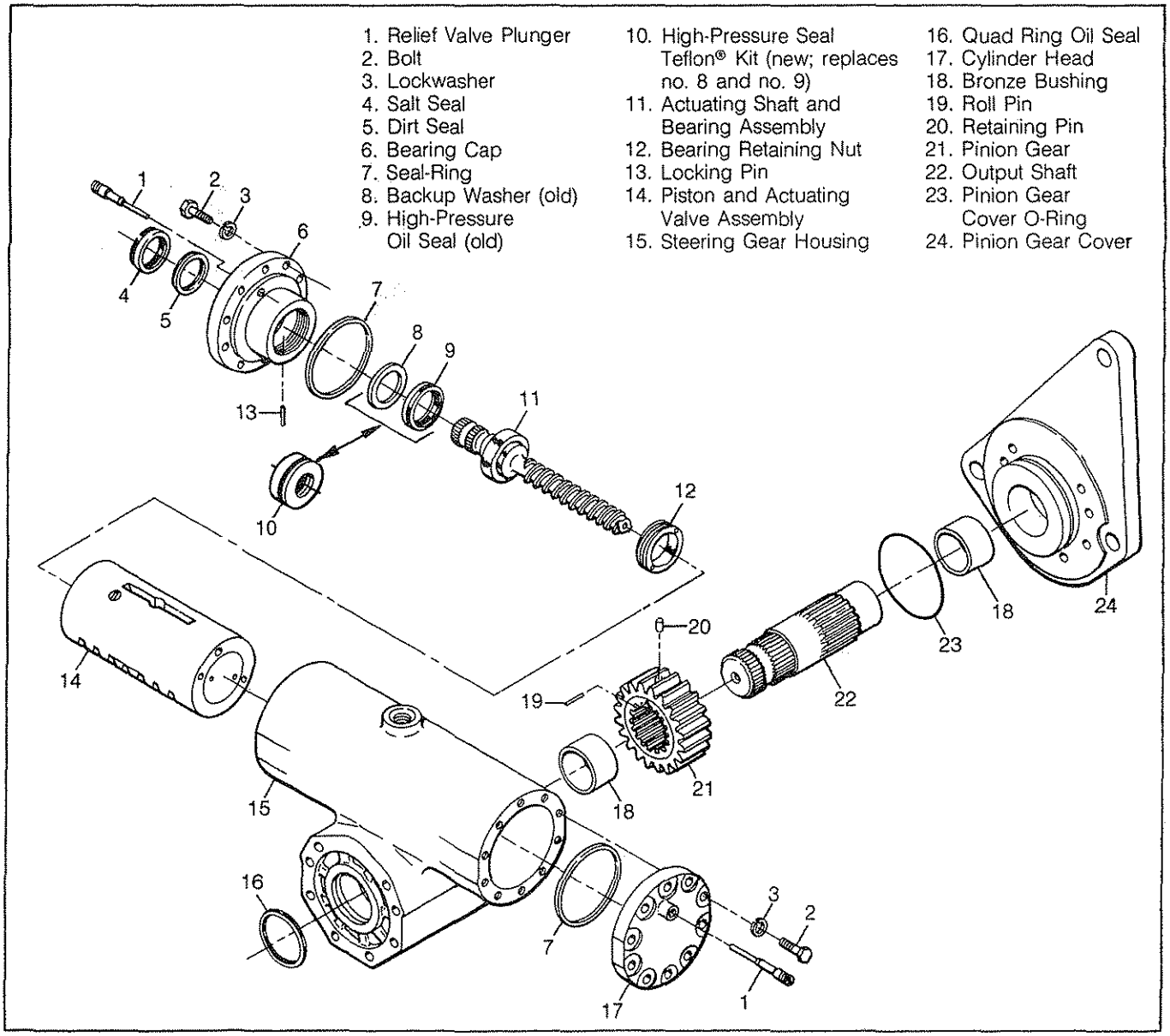


Fig. 4, Steering Gear Parts

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

to Fig. 5. If the arrow and dot (or arrow) are not aligned, using a marking pen or paint, make a mark on the pitman arm, in alignment with the dot or arrow on the output shaft.

If factory alignment marks are not present, center the steering gear by turning the actuating (input) shaft through full travel, counting the number of turns from stop to stop. Then, starting at the end of travel, turn the actuating shaft back half the number of turns. Using a marking pen or paint, mark the pitman arm and output shaft with a line at a right angle to the actuating shaft centerline.

WARNING: Do not pound, weld, or apply heat to the pitman arm or output shaft. Damage to the pitman arm or output shaft could cause a loss of steering control.

3. Using a suitable puller, remove the pitman arm from the output shaft. See Fig. 6.
4. Remove the eight bolts that attach the pinion gear cover to the steering gear housing. See Fig. 7.
5. Clean the exposed portion of the output shaft to prevent damaging the bearing. See Fig. 8. Using a soft hammer, tap on the end of the output shaft to loosen the cover, as shown in Fig. 9.
6. Carefully slide the output shaft and pinion gear through the housing. See Fig. 10. Pull the output

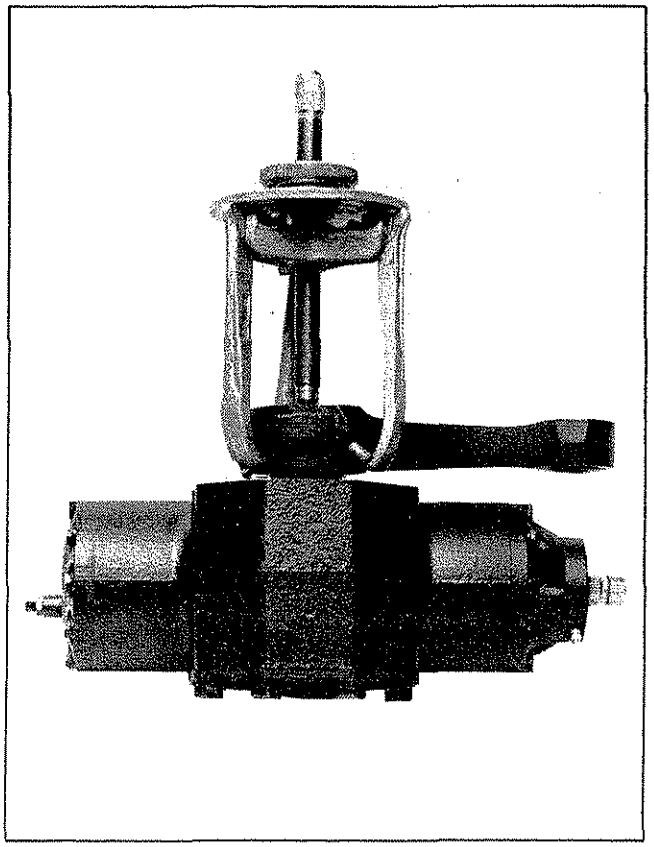


Fig. 6

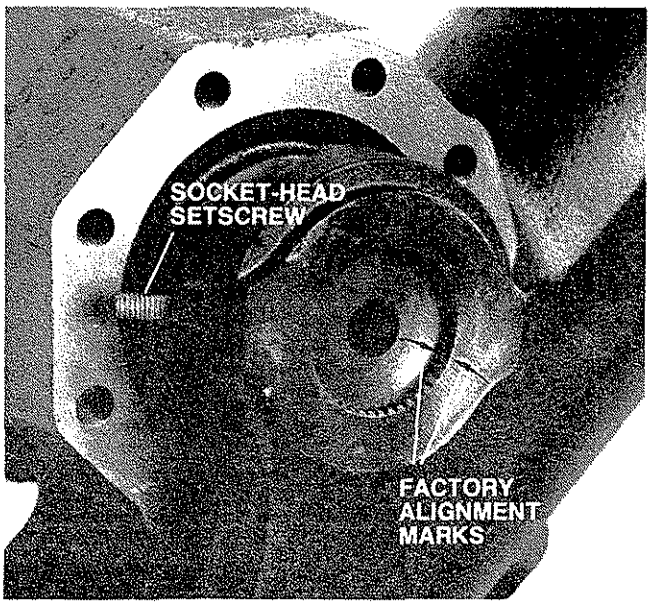


Fig. 5

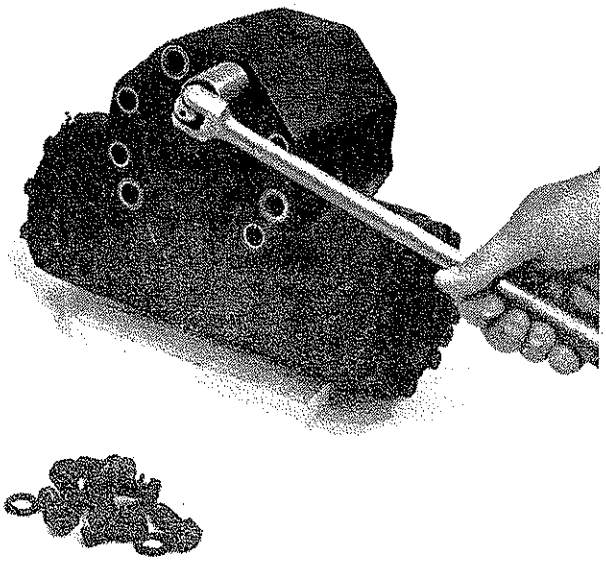


Fig. 7

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

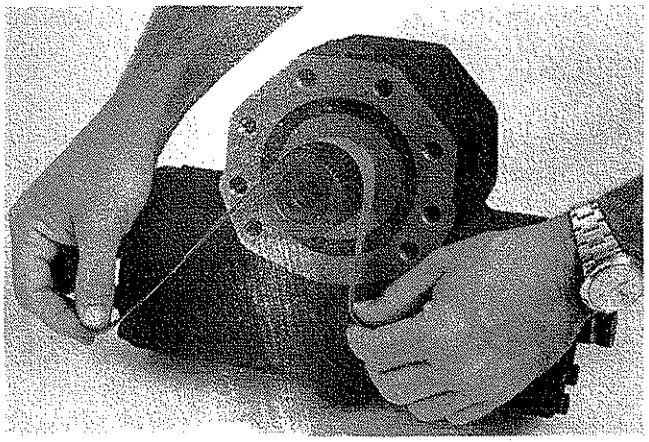


Fig. 8

Fig. 9

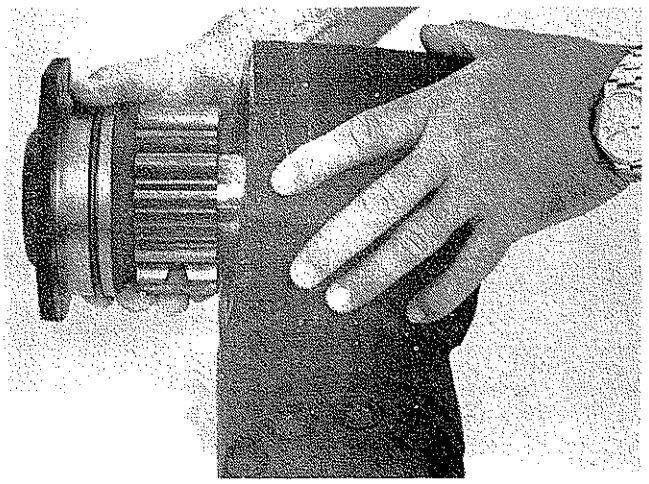


Fig. 10

shaft out of the cover. Remove and discard the cover O-ring.

7. The pinion gear is located and held in place on the output shaft with a retaining pin. See **Fig. 11**. A roll pin through the pinion gear keeps the retaining pin from backing out of place. To remove the pinion gear, punch out the roll pin and drill out the retaining pin; press the pinion gear off of the output shaft.

CAUTION: Use safety precautions when shearing the pin under pressure.

NOTE: If the retaining pin cannot be drilled out, it can be sheared off with approximately 20,000 lbs (9072 kg) of pressure on a press. See **Fig. 12**. Drive half the pin

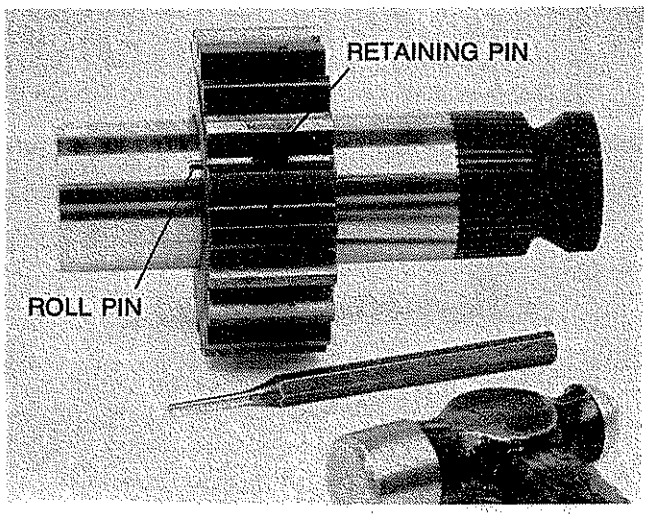


Fig. 11

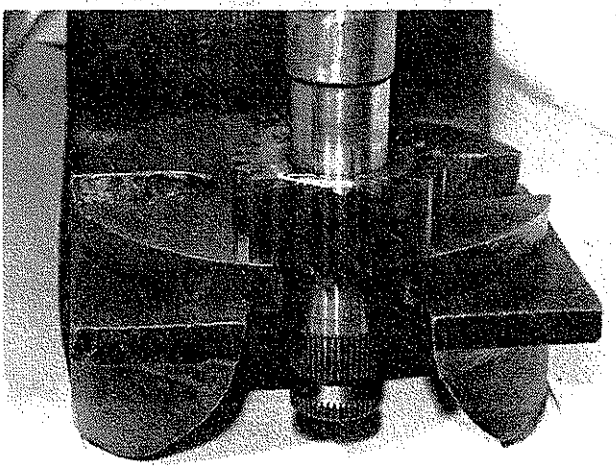


Fig. 12

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

out of the pinion gear, and drill the remaining half out of the shaft.

8. Remove the quad ring oil seal from the gear housing, and discard it. See **Fig. 13**.
9. Use a drift punch to drive the bronze bushing out of the gear housing, as shown in **Fig. 14**. Alternately tap one side of the bushing and then the opposite side, to keep it moving evenly.
10. Withdraw the bronze bushing from the pinion gear cover (**Fig. 15**), using a suitable bushing remover.
11. Remove the relief valve plunger from the bearing cap. See **Fig. 16**. Remove and discard the relief valve plunger O-ring.
12. Make reference marks on the bearing cap and steering gear housing, as shown in **Fig. 17**, so that the steering gear can be reassembled in the same configuration. (The bearing cap and the cylinder head will fit on either end of the steering gear housing, because they are the same diameter. See **Fig. 18**.)

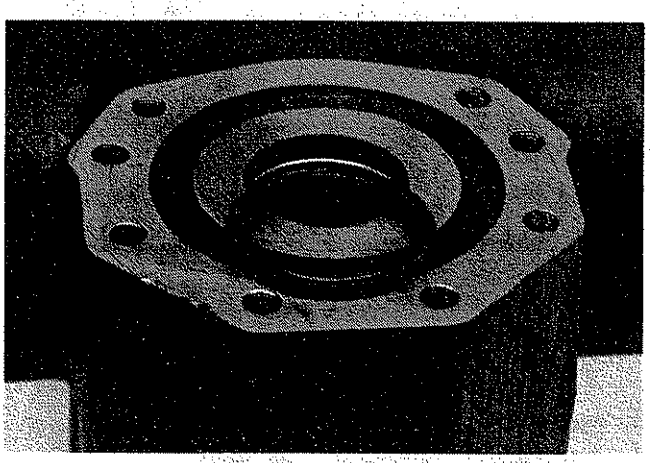


Fig. 13

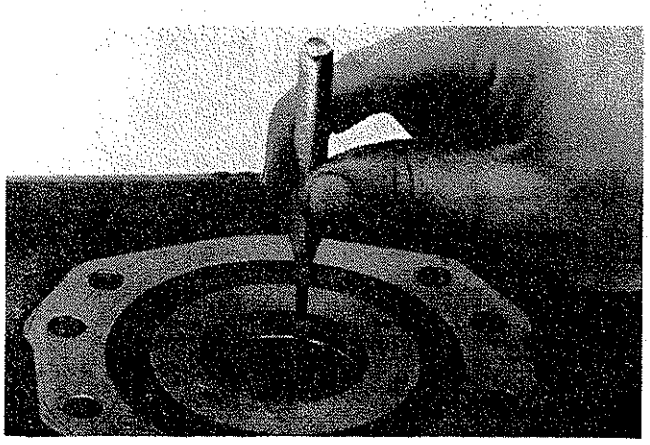


Fig. 14

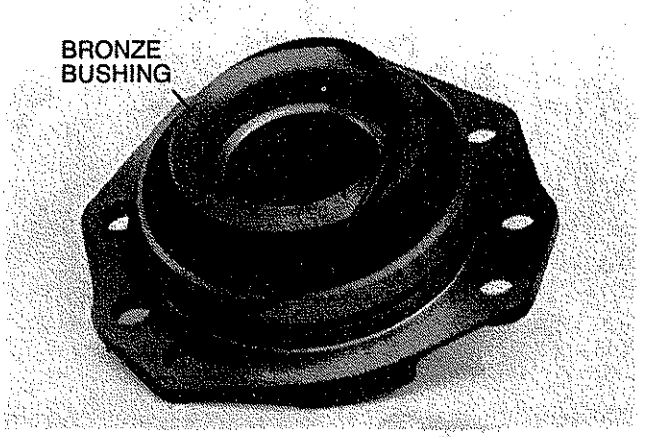


Fig. 15

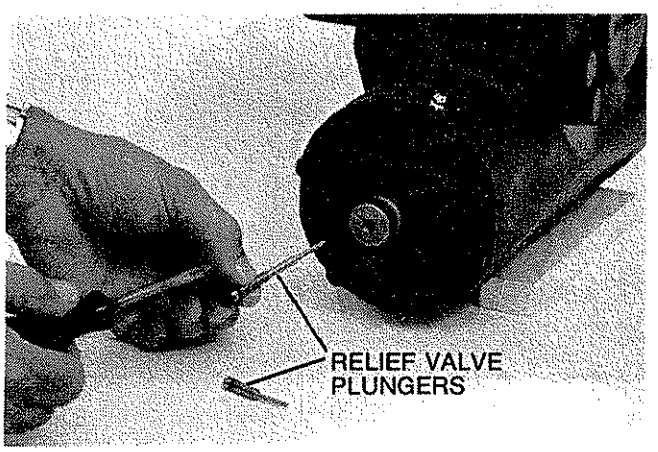


Fig. 16

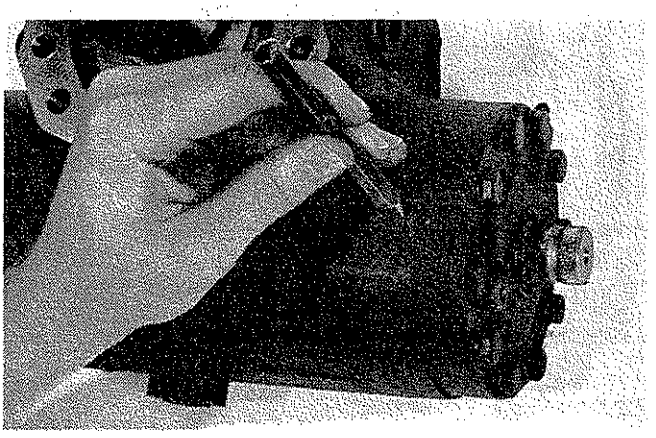


Fig. 17

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

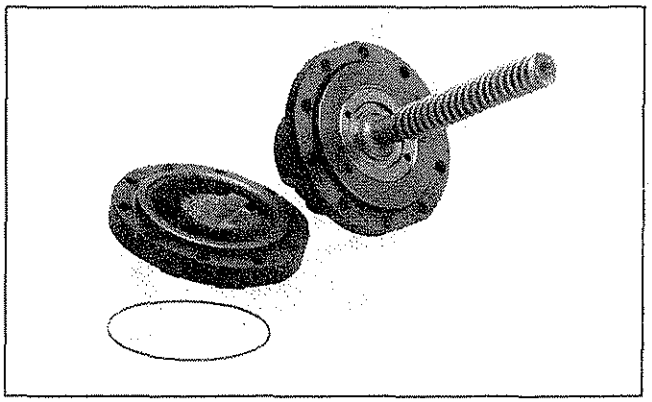


Fig. 18

13. Remove the bolts from the bearing cap, as shown in **Fig. 19.** Turn the actuating shaft to free the bearing cap from the piston and the steering gear housing.
14. Support the bearing cap and turn the actuating shaft until it is free of the piston. See **Fig. 20.** Remove and discard the bearing cap seal-ring.
15. To remove the actuating shaft and bearing assembly from the bearing cap, pull the locking pin from the bearing cap housing. Use a spanner wrench to remove the bearing retaining nut. See **Fig. 21.** Tap or press the actuating shaft and bearing from the bearing cap.

NOTE: The actuating shaft and bearing are serviced only as an assembly. Do not separate them.

16. Remove the three seals of the bearing cap by pressing all three seals toward the inside, with a piece of stock 1.490 inches (37.85 mm) in diameter. See **Fig. 22.**

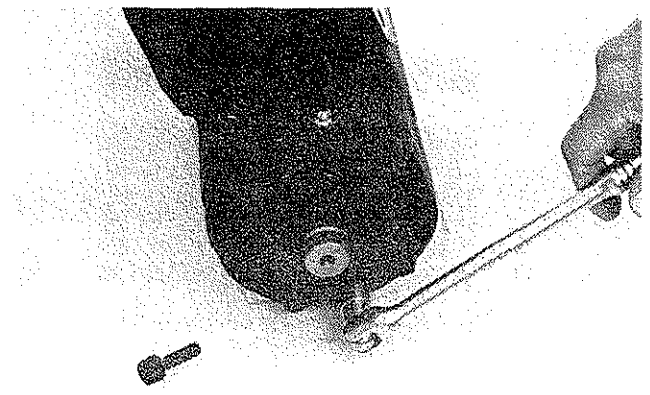


Fig. 19

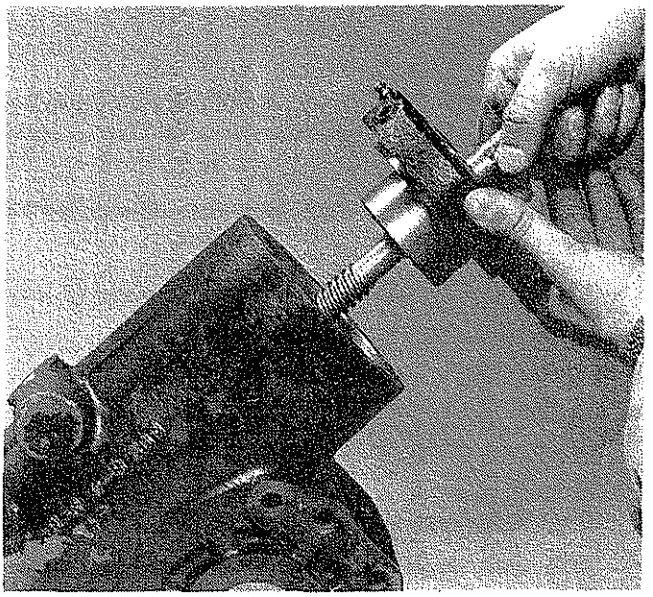


Fig. 20

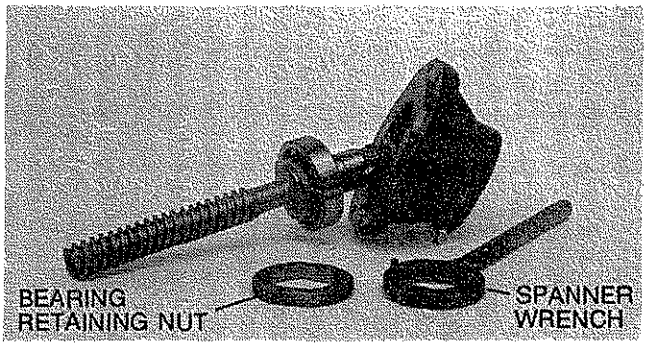


Fig. 21

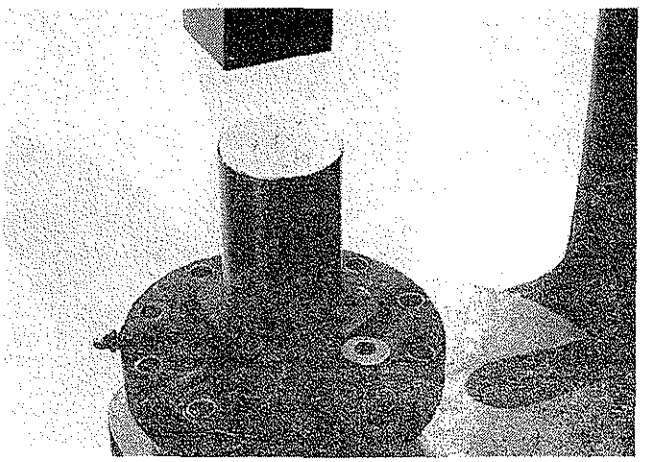


Fig. 22

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

NOTE: Discard all the old bearing cap seals. The seal kit has new seals (**Fig. 23**) that will fit series 3 or 4 gears.

17. Remove the relief valve plunger from the cylinder head. Remove and discard the relief valve plunger O-ring.

18. Remove the cylinder head (**Fig. 24**), and discard the seal-ring.

19. Carefully slide the piston assembly from the bore of the steering gear housing. See **Fig. 25**.

NOTE: The steering gear uses an inverted bearing cap, and the piston is machined to allow the bearing to travel inside the top of the piston. See **Fig. 26**.

20. Use an allen wrench to remove the relief ball seats, relief balls, and spring. See **Fig. 27**.

    The relief balls are under slight spring pressure. Remove them carefully to avoid personal injury or loss of the relief balls.

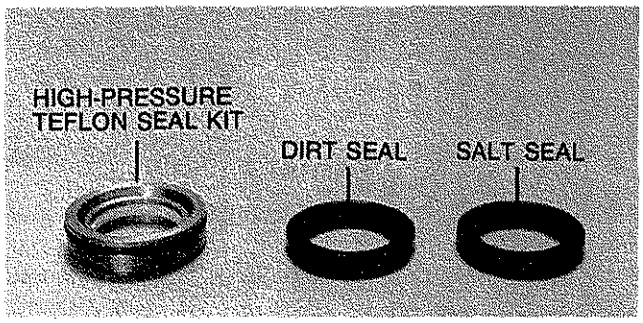


Fig. 23

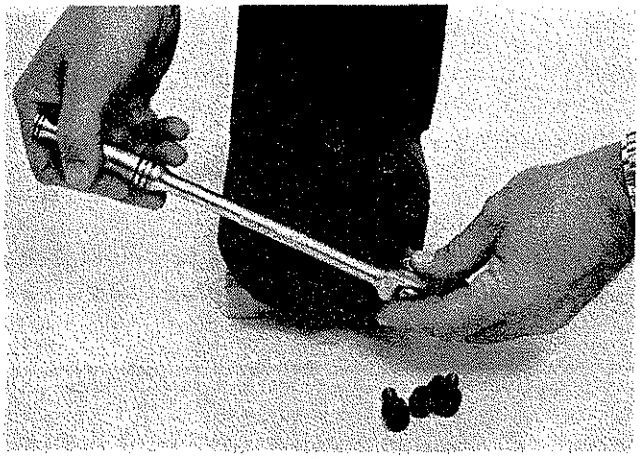


Fig. 24

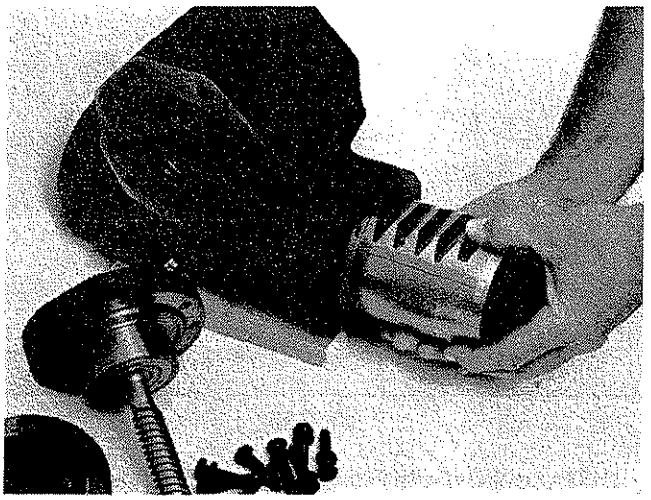


Fig. 25

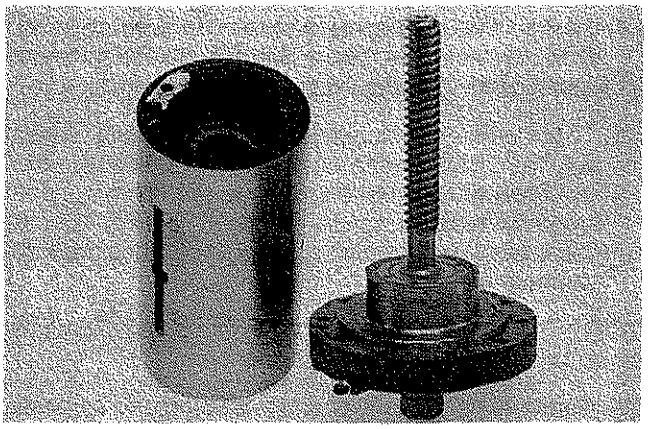


Fig. 26

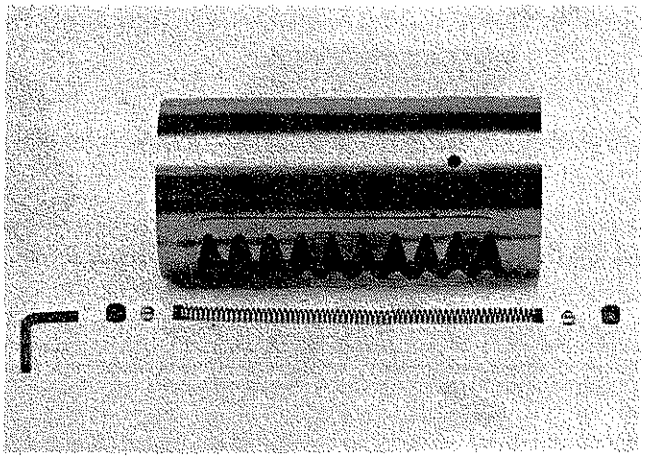


Fig. 27

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CLEANING AND INSPECTING

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

1. Clean machined parts individually, to avoid damage due to bumping together. Use a clean solvent to wash the parts. Dry the parts with compressed air.

CAUTION: Cleanliness is of utmost importance. Dirt and foreign material in the steering system during repair operations can cause damage and steering malfunctions, which could result in an accident causing personal injury and property damage.

2. Replace all O-rings, seals, and gaskets as a part of any repair. See Fig. 28.

NOTE: The seal kit has seals for several steering gear models. Discard any extra seals.

3. Make a careful inspection of all steering gear parts. Replace any worn parts, as well as any parts that show signs of stress or fatigue.

   .1 Check the piston and steering gear housing for scoring. Scoring may be caused by excessive operating temperatures, air in the hydraulic system, or incorrect or contaminated lubricant. Minor scoring should be polished with a fine handstone or crocus cloth to allow free movement of the mating parts. The cylinder bore should *not* be honed or bored out, as this will increase internal leakage.

   NOTE: Minor scoring and scuffing of the piston and steering gear housing should not be cause for alarm.

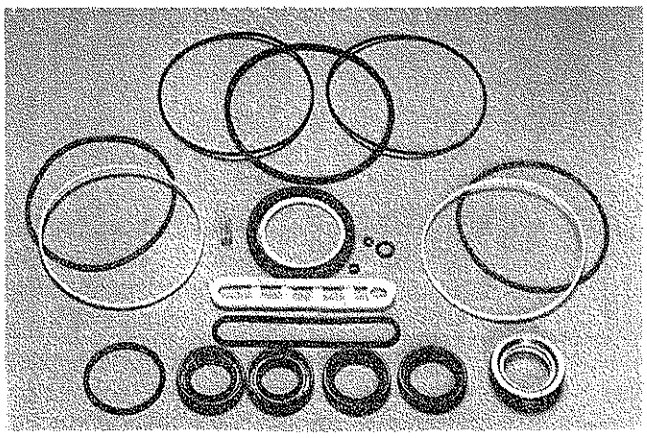

Fig. 28

During operation at relatively high pressures and flow rates, this minor damage will not affect the safety or operation of the steering gear.

If scoring is severe, leakage will affect steering reaction time, and slow, binding, or uneven steering input will be noticeable. In this case, the damaged parts should be replaced.

IMPORTANT: Do not replace the steering gear housing or piston on the basis of observation only. Slow, binding, or uneven steering input can also be caused by problems with the power steering pump. The power steering hydraulic system should be tested before the steering gear components are serviced. Refer to the pre-service checks in the subject covering hydraulic power steering system checking, testing, and troubleshooting, in Group 14 of this manual.

.2 Check the bronze bushings for wear. Wear may be caused by excessive operating temperatures, or incorrect or contaminated lubricant. Replace the bronze bushings if they are worn.

.3 Check the output shaft for bronze deposits, and for wear. Polish the output shaft to remove bronze deposits, or replace it if it is worn.

.4 Check the actuating shaft and actuating valve for wear on the acme threads. Acme thread wear may be caused by high operating temperatures, insufficient oil flow, or insufficient operating pressure. If the acme threads are worn, replace the actuating valve and the actuating shaft and bearing assembly.

NOTE: The actuating shaft acme thread may be a machine-cut thread or a rolled thread. The rolled thread may appear rough and flaky, and seem to have a split. This is normal for a rolled thread.

.5 Check the edges of the ports on the actuating valve and the ports inside the piston for chipping or excessive wear. Replace the actuating valve or piston as necessary.

.6 Examine the sealing surface of the actuating shaft for wear or damage. Replace the actuating shaft and bearing assembly if the sealing surface is worn or damaged.

.7 Check for a stripped actuating shaft bearing retaining nut, and for broken or bent reversing springs. This type of damage may be caused by air in the hydraulic system, or by impact

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damage to the vehicle. Replace the components as necessary.

.8 Examine the piston rack and the output shaft pinion gear for cracked or broken gear teeth. Also, examine the steering gear housing for cracks or breaks. Cracked or broken gear teeth, or a cracked or broken housing, is an indication of impact damage. See step 4.4, below, for recommendations.

4. Steering gear parts inspection may reveal problems in other areas of the steering system. To avoid repeat problems, each clue gained from parts inspection should be followed to its conclusion.

.1 Check the steering gear components for discoloration (blue color), caused by excessive operating temperatures. Excessive operating temperatures are most frequently caused by an inadequate supply of lubricant, an excessive flow rate, or excessive system back-pressure. For further information, refer to the troubleshooting chart in Group 14 subject covering hydraulic power steering system checking, testing, and troubleshooting.

.2 A broken or bent reversing spring, a stripped actuating shaft bearing retaining nut, or scoring of the steering gear housing and piston, can be caused by air in the hydraulic system. Check for an air leak on the suction side of the power steering pump. Eliminate the leak, then bleed the air from the power steering system.

.3 Scoring of the piston or steering gear housing, wear of the bronze bushings, and damage to the ports of the actuating valve or piston, can be caused by incorrect or contaminated lubricant. If the lubricant is contaminated, check for and correct the source of contamination. If incorrect or contaminated lubricant was used, drain, flush, and fill the steering system with clean lubricant of the correct type. Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual* for lubrication specifications.

.4 Distorted pitman arms, a broken steering gear housing, a stripped actuating shaft bearing retaining nut, broken or bent reversing springs, twisted output shafts, and broken or cracked rack and pinion gear teeth, are some signs of impact damage. Broken or damaged mounting brackets should *not* be replaced without further investigation.

Steering gears that have been accident damaged should be considered suspect. Impact loads transmitted through the front axle and steering linkage into the steering gear, can stress parts to a point just short of failure. Further use is unsafe; replace the steering gear assembly and the pitman arm.

STEERING GEAR ASSEMBLY (Refer to Fig. 4)

NOTE: Before assembling the steering gear components, use a fine handstone to remove any nicks or burrs. Clean motor oil may be used to coat the components, to ease assembly. Use *only* clean motor oil to coat the parts. Do *not* use motor oil on the bronze bushings, and the bushing bores of the gear housing and the pinion gear cover.

1. Install new bronze bushings in the gear housing and pinion gear cover, using a press and a straight-line pushing action. See **Fig. 29**. The bushing must be pushed into the gear housing until the inside face of the bushing is flush with the inside face of the gear housing.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent mmanufacturer.

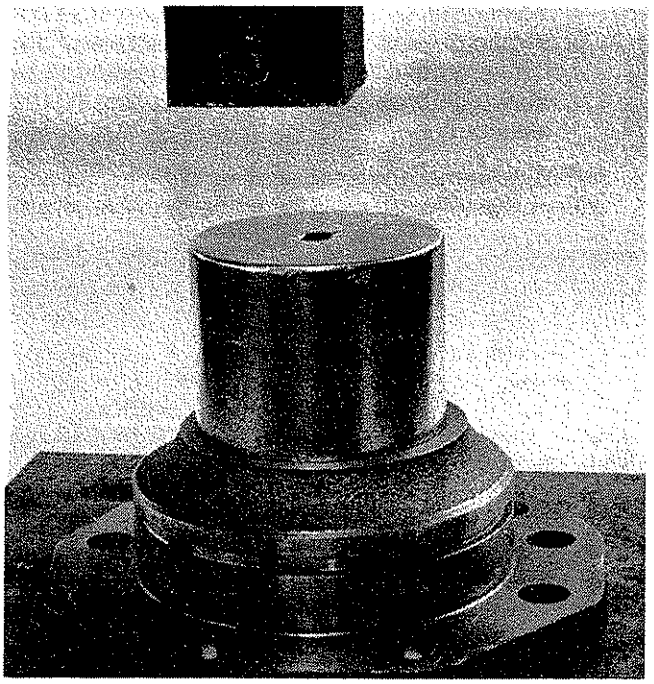

Fig. 29

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When installing a new bronze bushing in the output shaft bore of the housing, if it goes in easily, and heavy press resistance is not encountered, carefully remove the bushing. Clean the bushing of oil and grease, and clean the bore of foreign material by scraping it with a piece of brass sheet. Wash and dry the bushing and bore. Coat the housing bore and the exterior of the bushing with Loctite® high-strength retainer compound. Install the bushing, and allow a minimum of six hours curing time. When the curing time has elapsed, remove any excess Loctite in the quad-ring groove, or elsewhere, by washing with naphtha.

The face of the bushing must be recessed 1/2-inch (12.7 mm) from the cover face. See **Fig. 30**.

NOTE: The bronze bearings are presized, and boring or honing is not required.

3. Install a new quad-ring in the groove in the gear housing. The quad-ring is a "stuff-fit," and at first glance may appear to be too large. See **Fig. 31**.
4. Align the output shaft and pinion gear, for installation of the retaining pin. Press the gear on the shaft. Install the retaining pin through the gear, and seat it in the shaft. Install the roll pin, to hold the retaining pin in place. See **Fig. 32**.
5. Put a light coat of motor oil in the cylinder bore.
6. Note the reference punch mark on the bearing-cap

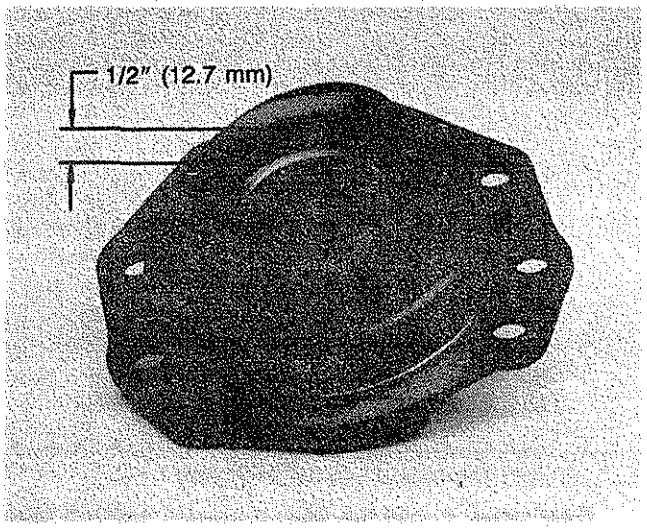

Fig. 30

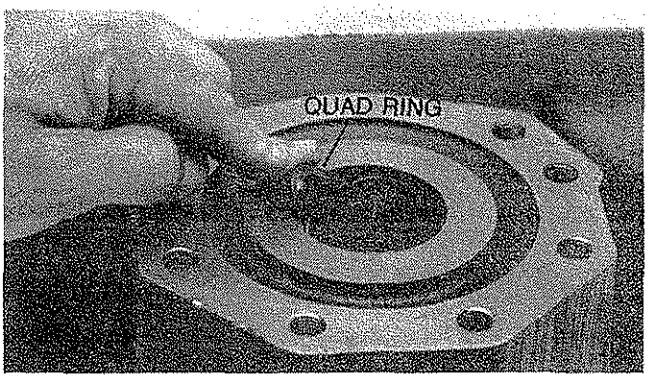

Fig. 31

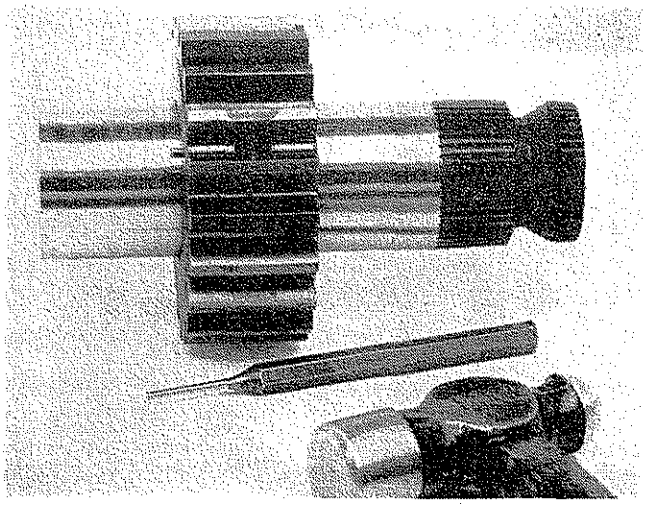

Fig. 32

end of the steering gear housing, then carefully install the piston in the cylinder bore, with the opening for the actuating shaft and bearing towards the bearing-cap end of the housing. See **Fig. 33**.

WARNING: The timing marks must be aligned during assembly of the steering gear. Failure to align the timing marks will decentralize the gear, limiting the vehicle turning angle in one direction.

7. Align the timing mark on the piston rack with the center of the opening in the pinion gear housing. Grease the housing bearing and quad ring, and carefully slide the output shaft through the housing. Align the timing marks on the pinion gear with the timing mark on the rack. See **Fig. 34**.
8. Install the cylinder head, using a new seal, so the relief valve plunger hole in the cylinder head is aligned with the relief valve seat in the piston. Install the bolts.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODELS 392S AND 492S, SERIES 3 AND 4

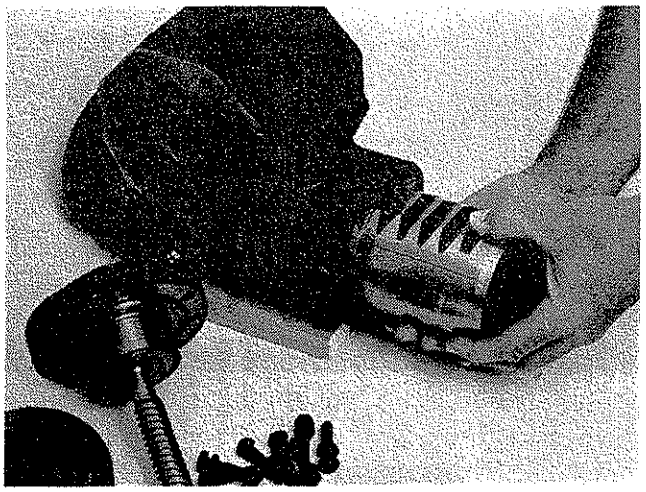

Fig. 33

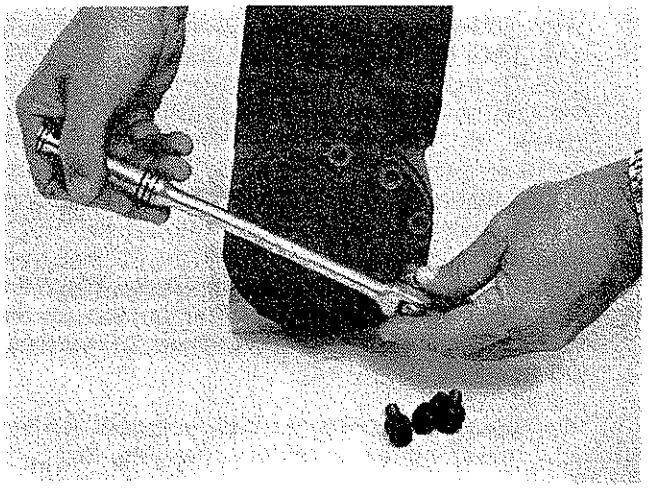

Fig. 35

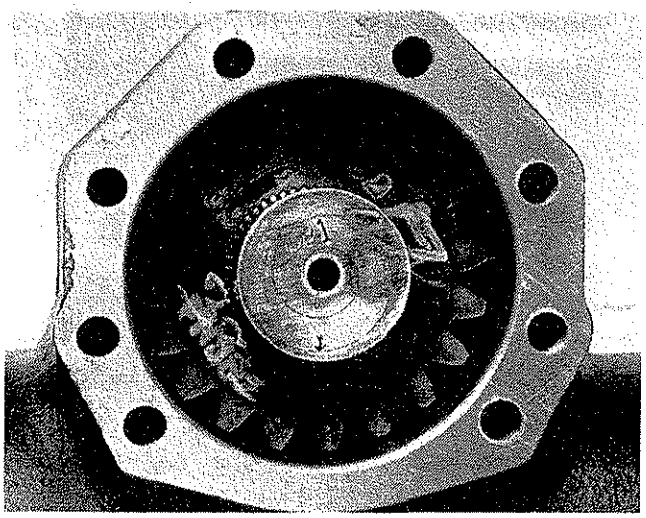

Fig. 34

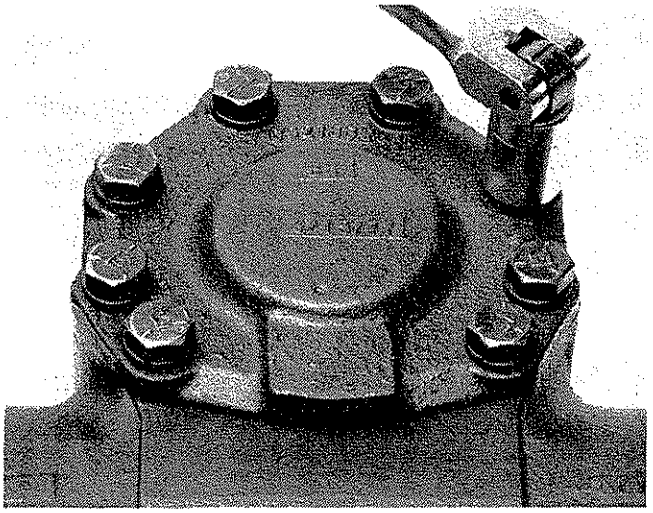

Fig. 36

See **Fig. 35**. If installed on a model 392S steering gear, tighten the bolts 20 lbf·ft (27 N·m); if installed on a model 492S steering gear, tighten the bolts 33 lbf·ft (45 N·m).

9. Position a new O-ring on the pinion gear cover. Install the cover assembly. It may be necessary to use a soft hammer to tap the cover in place. Install the housing cover bolts. See **Fig. 36**. If installed on a model 392S steering gear, tighten the bolts 83 lbf·ft (113 N·m); if installed on a model 492S steering gear, tighten the bolts 122 lbf·ft (165 N·m).

10. Assemble the actuating shaft and bearing cap as follows (refer to **Fig. 37**):

    .1 Using a piece of round stock 2 inches (51 mm) long, turn it to 1.615 inches (41 mm) diameter, and smooth one end. Put the smooth end of the round stock in the bearing end of the bearing cap, against the shoulder area for the high-pressure seal. See **Fig. 38**. Set the bearing cap on a press, and evenly install the dirt seal, lip out, until it rests against the end of the round stock. See **Fig. 39**.

    .2 Evenly install the salt seal, lip out, until it is flush with the top of the bearing cap.

CAUTION: Install the high-pressure Teflon® seal kit correctly, or an oil leak will occur on the first application of pressure.

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.3 Turn the bearing cap over, remove the piece of round stock, and evenly install the high-pressure Teflon seal kit until it rests against the shoulder.

.4 Lubricate all three seals with chassis grease.

NOTE: The bearing cap uses three seals for high-pressure sealing, and actuating shaft protection. The high-pressure Teflon seal is protected by the dirt seal and the salt seal. A grease cavity between the dirt seal and salt seal is filled with chassis lube to block dirt or salt entry. During regular lubrication intervals, this cavity is flushed by forcing chassis grease through the cavity with a low-pressure grease gun. Refer to Group 14 in the *COE and 120 Conventional Maintenance Manual*, for lubrication intervals and procedures.

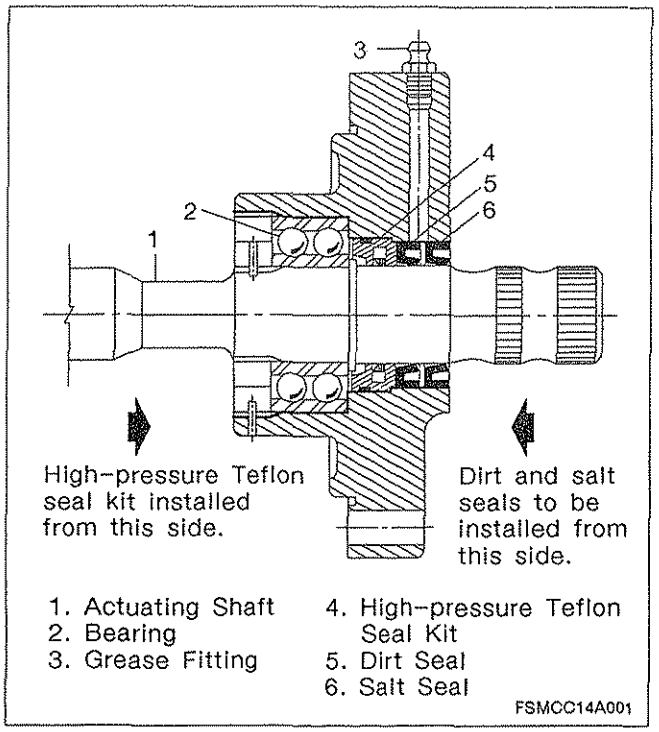

Fig. 37, Bearing Cap Assembly

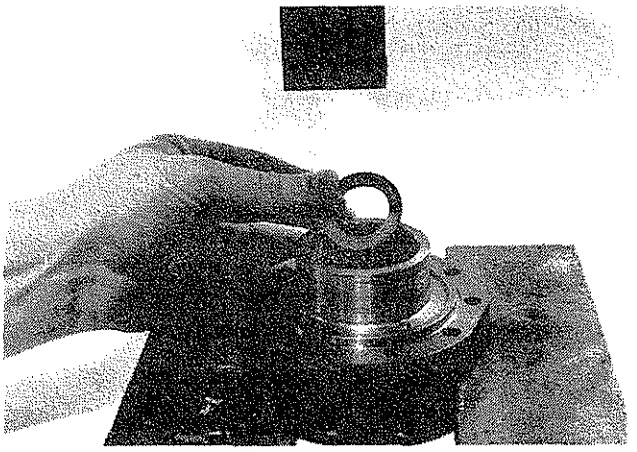

Fig. 39

.5 Press the actuating shaft and bearing assembly into the bearing cap.

.6 Install the bearing retaining nut. Insert the locking pin through the hole in the bearing cap and into the hole in the nut. See Fig. 40. If a new nut is installed, drill a 3/32-inch hole in the nut. The nut must be in place to drill this hole. Drill through

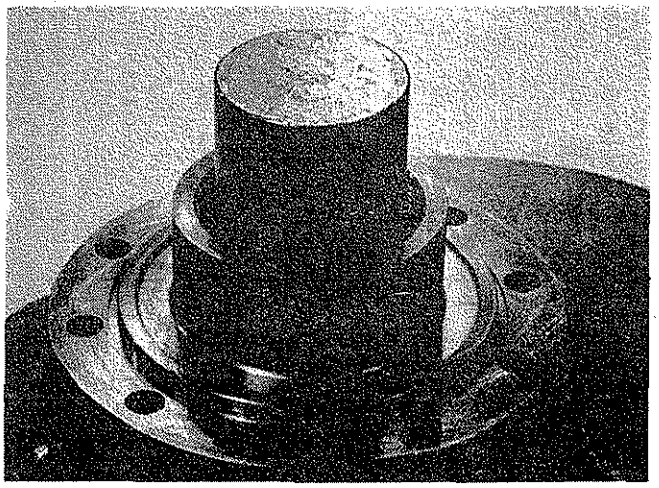

Fig. 38

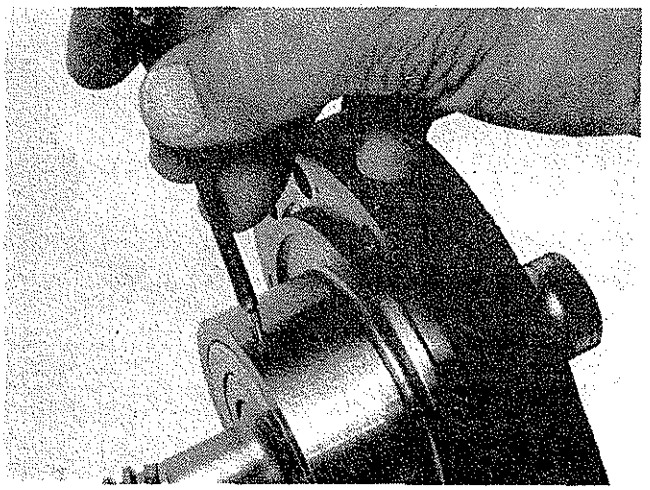

Fig. 40

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the locking pin hole in the bearing cap, to a depth of 3/16-inch (4.8 mm) into the nut.

11. Install a new seal on the bearing cap. Thread the actuating shaft into the actuating valve. See **Fig. 41**. Turn the shaft until the bearing cap comes into place on the end of the housing. Align the relief valve plunger hole with the relief valve seat in the piston. Install the bolts. See **Fig. 42**. If installed on a model 392S steering gear, tighten the bolts 20 lbf·ft (27 N·m); if installed on a model 492S steering gear, tighten the bolts 33 lbf·ft (45 N·m).

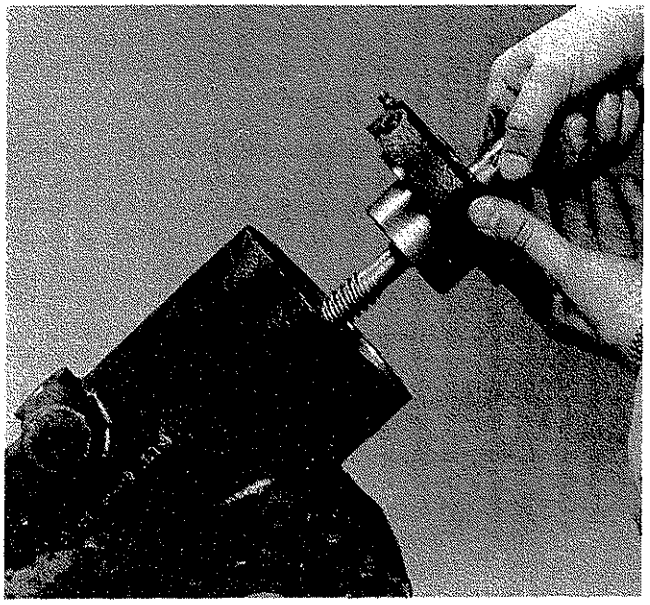

Fig. 41

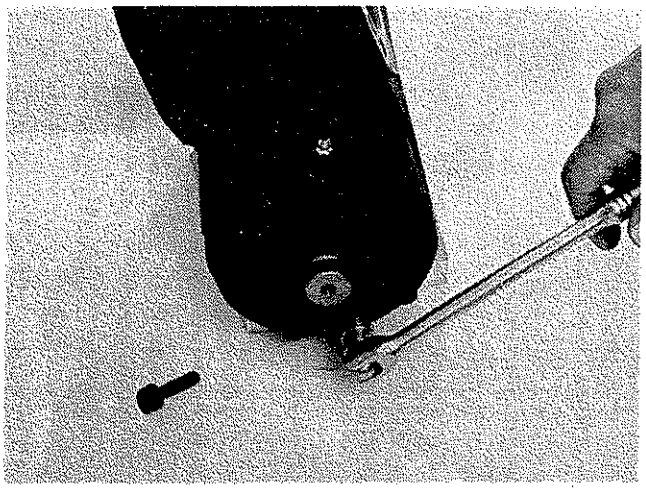

Fig. 42

12. Install the relief valve plungers, using new O-rings. See **Fig. 43**. Turn them approximately six turns. Final adjustment of the plungers is made after the steering gear is installed on the vehicle.

WARNING: Do not pound, weld, or apply heat to the pitman arm or output shaft. Damage to the pitman arm or output shaft could cause a loss of steering control.

13. Install the pitman arm on the output shaft, as follows:

    .1 If the factory alignment marks were visible and were aligned before removal of the pitman arm, or if a new steering gear or pitman arm is being installed, align the arrow on the pitman arm with the dot or arrow on the output shaft.

    If the factory alignment marks were not visible, or were not aligned before removal of the pitman arm, align the marking pen or paint mark on the pitman arm with the mark, dot, or arrow on the output shaft.

    With the marks aligned, push the pitman arm onto the output shaft as far as it will go by hand.

    .2 Apply Lok-Cease® to the retainer E14-10120 and washer 23-09114-003.

    On model 392 steering gears, install the retainer, washer, and installation capscrew 23-9441-225. See **Fig. 44**. Tighten the installation capscrew 85 lbf·ft (115 N·m).

    On model 492 steering gears, install the retainer, washer, and installation capscrew 23-09443-225.

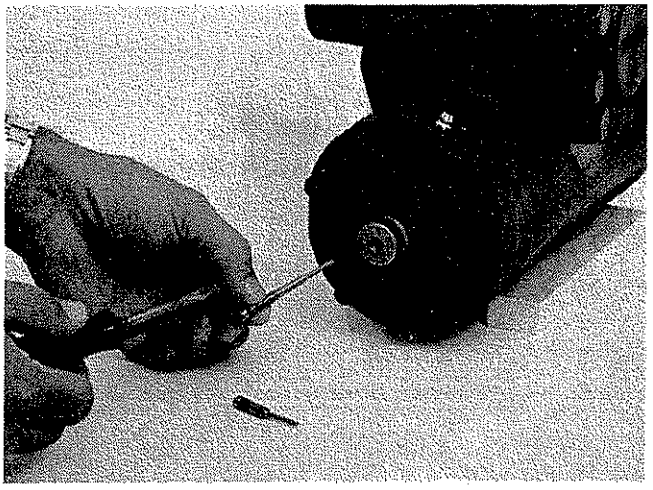

Fig. 43

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See **Fig. 44**. Tighten the installation capscrew 160 lbf·ft (217 N·m).

.3 Remove the installation capscrew, washer, and retainer. Check the clearance between the face of the output shaft and the pitman arm. See **Fig. 45**. The pitman arm must be within 3/64 of an inch (1.2 mm) above or below the face of the output shaft.

If it isn't, remove the pitman arm and check it for worn splines. Replace the pitman arm if necessary.

.4 Wipe the Lok-Cease from the face of the retainer.

On model 392 steering gears, put Lok-Cease on the threads of a new special capscrew 23-11649-225, and install the retainer, washer, and capscrew onto the pitman arm. Tighten the capscrew 85 lbf·ft (115 N·m).

On model 492 steering gears, put Lok-Cease on the threads of a new special capscrew 23-11650-225, and install the retainer, washer, and capscrew onto the pitman arm. Tighten the capscrew 160 lbf·ft (217 N·m).

IMPORTANT: Special capscrews 23-11649-225 and 23-11650-225 are for one-time use only. When they are removed, replace them with new ones.

.5 Lubricate the socket-head setscrews with Lok-Cease, Never Seez®, or an equivalent. Install the socket-head setscrews in the pitman arm, as shown in **Fig. 45**. Tighten the setscrews 10 to 12 lbf·ft (14 to 16 N·m). Remove the bolt and washers (or flatwasher and socket) from the output shaft.

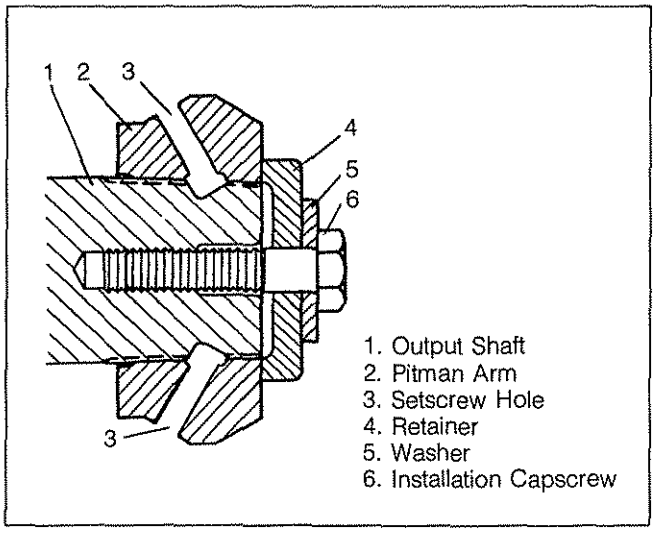

Fig. 44

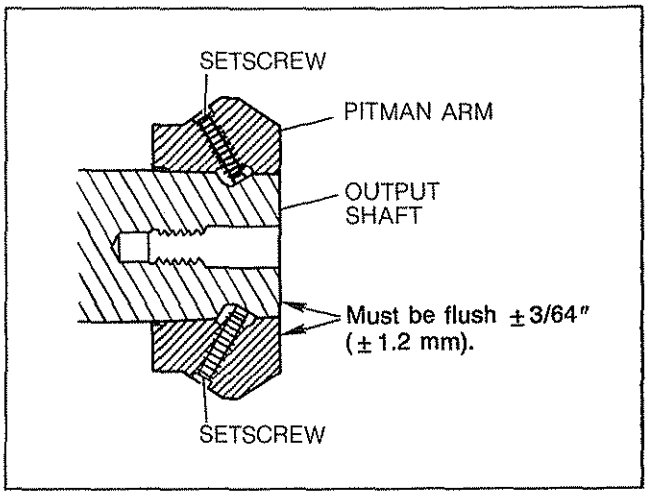

Fig. 45

14. Install the gear on the vehicle. For instructions, refer to "Steering Gear Installation."

STEERING GEAR INSTALLATION
(Refer to **Figs. 1** or **2**)

1. On COEs, from the inboard side, insert the mounting bolts and washers through the frame rail and mounting bracket. Install a spacer on each of the frame rail bolts, then place the steering gear on the mounting bracket and frame rail. Install the washers and nuts, and tighten the nuts to the torque values in **Table 1**, under "Specifications."

   On 120 Conventionals, attach the steering gear to the mounting bracket, and tighten the nuts to the torque values in **Table 1**, under "Specifications." Attach the steering gear and mounting bracket to the frame rail, and tighten the nuts to the torque values in **Table 1**.

2. If not previously done, center the steering gear. The output shaft/pitman arm alignment mark must be at a right angle to the actuating (input) shaft centerline. Make sure the steering gear remains centralized as the service operations progress.

3. Connect the drag link to the pitman arm. For instructions, refer to the appropriate drag link subject in Group 14 of this manual.

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4. Connect the steering driveline to the steering gear actuating shaft. For instructions, refer to Group 14 of this manual.

5. Position the steering wheel so that the king-spoke—the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside—points directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees). Refer to **Fig. 46**.

6. Connect the hydraulic lines to the gear, as marked earlier, or as shown in **Fig. 47**, under "Specifications." Tighten the nut on each fitting finger-tight, then, with a wrench, tighten the nut until resistance is felt. Tighten the nut one-sixth turn more.

7. Fill and air-bleed the system as follows:

CAUTION: When bleeding air from the hydraulic system, and anytime during operation of the system, failure to keep the power steering reservoir fluid level maintained above the "add" mark on the dipstick could result in damage to the power steering pump and improper operation of the power steering system.

.1 Fill the power steering reservoir with hydraulic fluid. Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual* for lubrication specifications.

.2 Start the engine and operate it at fast idle, adding fluid to the reservoir as needed.

.3 Turn the steering wheel through a full left and right turn. Check the hoses and fittings for leaks. Replace leaking hoses, and tighten loose fittings,

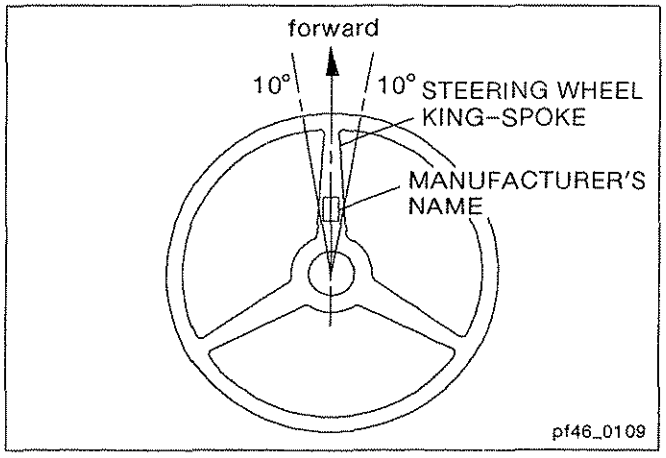

Fig. 46

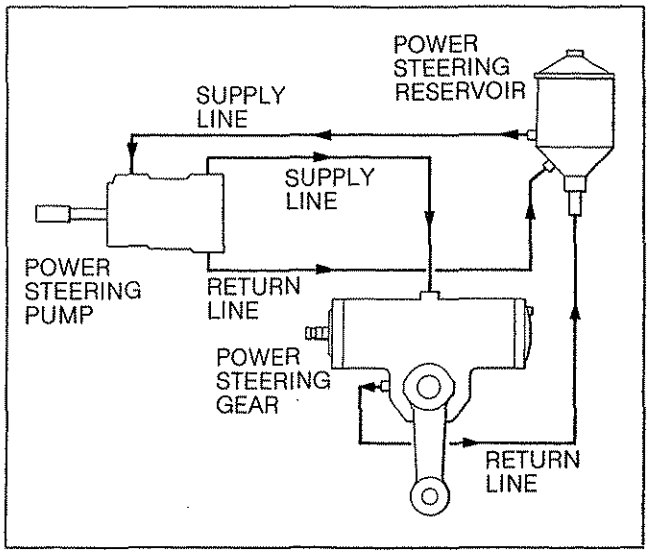

Fig. 47, Plumbing Diagram

as necessary. Turn the steering wheel through three more full left and right turns, or until all air is removed from the hydraulic system (no air bubbles appear in the reservoir, and the fluid in the reservoir is maintained at the "full" mark on the dipstick).

8. Adjust the relief valve plungers, as follows:

.1 Check the settings of the axle stops (and adjust them if necessary), using the instructions in the front axle wheel alignment subject in Group 10 of this manual.

.2 Install a flow meter kit in the supply line from the pump to the steering gear. Make sure that the flow meter can be pressurized. Warm the power steering fluid to operating temperature. For instructions, refer to the subject covering hydraulic power steering system checking, testing, and troubleshooting, in Group 14 of this manual.

CAUTION: As soon as pump relief pressure is reached, release the steering wheel from the full-lock position. At no time should pump relief pressure be maintained for longer than 5 seconds, or damage to the system may result because of excessive heat generation. At no time allow the oil temperature to exceed 180°F (82°C).

.3 With the engine at idle, have someone turn the steering wheel to the right-turn full-lock position. Check the pressure gauge.

.3 With the engine at idle, have someone turn the steering wheel to the right-turn full-lock position. Check the pressure gauge.

If the pressure gauge reading is less than 1575 psi (10 852 kPa), back out the relief valve plunger (at the top of a COE-mounted gear, or at the bottom of a 120 Conventional-mounted gear) until the pressure reading is between the minimum 1575 psi (10 852 kPa) and the maximum 1925 psi (13 262 kPa) pump relief pressures.

If system pressure exceeds the maximum pump relief pressure, repair the power steering pump. Refer to the appropriate power steering pump subject in Group 14 of this manual for repair instructions.

.4 Release the steering from the right-turn full-lock position, enough to allow insertion of a 1/16- to 1/8-inch (1.6 to 3.2 mm) thick flatwasher between the axle beam and the right-side axle stop pin.

.5 Bring the steering back to the right-turn full-lock position, against the flatwasher. Immediately tighten the relief valve plunger (at the top of a COE-mounted gear, or at the bottom of a 120 Conventional-mounted gear) until the pressure gauge reading drops to about 600 psi (4137 kPa).

.6 With the engine at idle, have someone turn the steering wheel to the left-turn full-lock position. Adjust the relief valve plunger (at the bottom of a COE-mounted gear, or at the top of a 120 Conventional-mounted gear), using the procedures in steps 8.3 through 8.5, above (but for the left-turn full-lock position).

9. Drive the vehicle, or take a test ride with the driver. Check the steering wheel king-spoke position. If, during straight-ahead driving on a level road, the steering wheel king-spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock), remove the steering wheel; then, position it so the king-spoke points directly toward the front of the vehicle, following the instructions in Group 14 of this manual.

TROUBLESHOOTING

For troubleshooting information, refer to the subject covering hydraulic power steering system troubleshooting, and the subjects covering power steering pumps, in Group 14 of this manual.

SPECIFICATIONS

DESCRIPTION		BOLT OR NUT SIZE	GRADE	TORQUE lbf·ft (N·m)
Model 392S	Bearing Cap Bolts	5/16-24	—	20 (27)
	Cylinder Head Bolts	5/16-24	—	20 (27)
	Pinion Gear Cover Bolts	1/2-20	—	83 (113)
	Pitman Arm-to-Output Shaft Installation Bolt	1/2-20	5	85 (115)
Model 492S	Bearing Cap Bolts	3/8-24	—	33 (45)
	Cylinder Head Bolts	3/8-24	—	33 (45)
	Pinion Gear Cover Bolts	9/16-18	—	122 (165)
	Pitman Arm-to-Output Shaft Installation Bolt	9/16-18	5	160 (217)
Pitman Arm-to-Output Shaft Socket-Head Setscrews		—	—	12 (16)
Steering Gear-to-Frame Rail Fasteners, COE		7/8-14	8	350 (475)*
Steering Gear-to-Bracket Fasteners, Conventional		7/8-14	8	350 (475)*
Steering Gear Bracket-to-Frame Rail Fasteners, Conventional		1/2-20 5/8-18	8 8	75 (100)* 135 (185)*
Relief Valve Ball Seats		—	—	See the text.
Actuating Valve Positioning Pin		—	—	See the text.

Table 1, Steering Gear Torque Values

* For hexnuts that are wax coated and cadmium plated, or for hexbolts that have phosphate- and oil-coated threads. For dry threads, refer to the Bolt Torque Specification Chart in the *COE and 120 Conventional Maintenance Manual*.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

SUBJECT CONTENTS

TOPIC **PAGE NUMBER**

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Principles of Operation

Service Operations

Bearing Cap Seal Replacement 4
Steering Gear Removal 8
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SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

GENERAL DESCRIPTION

The Sheppard integral power steering gear model 392S Series 6 provides full-time hydraulic power steering. This gear is available as an option on COEs and 120 Conventionals built after February 1984.

The steering gear is mounted on the left-hand frame rail, and connects the steering driveline to an actuating (input) shaft, which in turn is connected to an output shaft and the pitman arm. See **Fig. 1** (COEs) or **Fig. 2** (120 Conventionals).

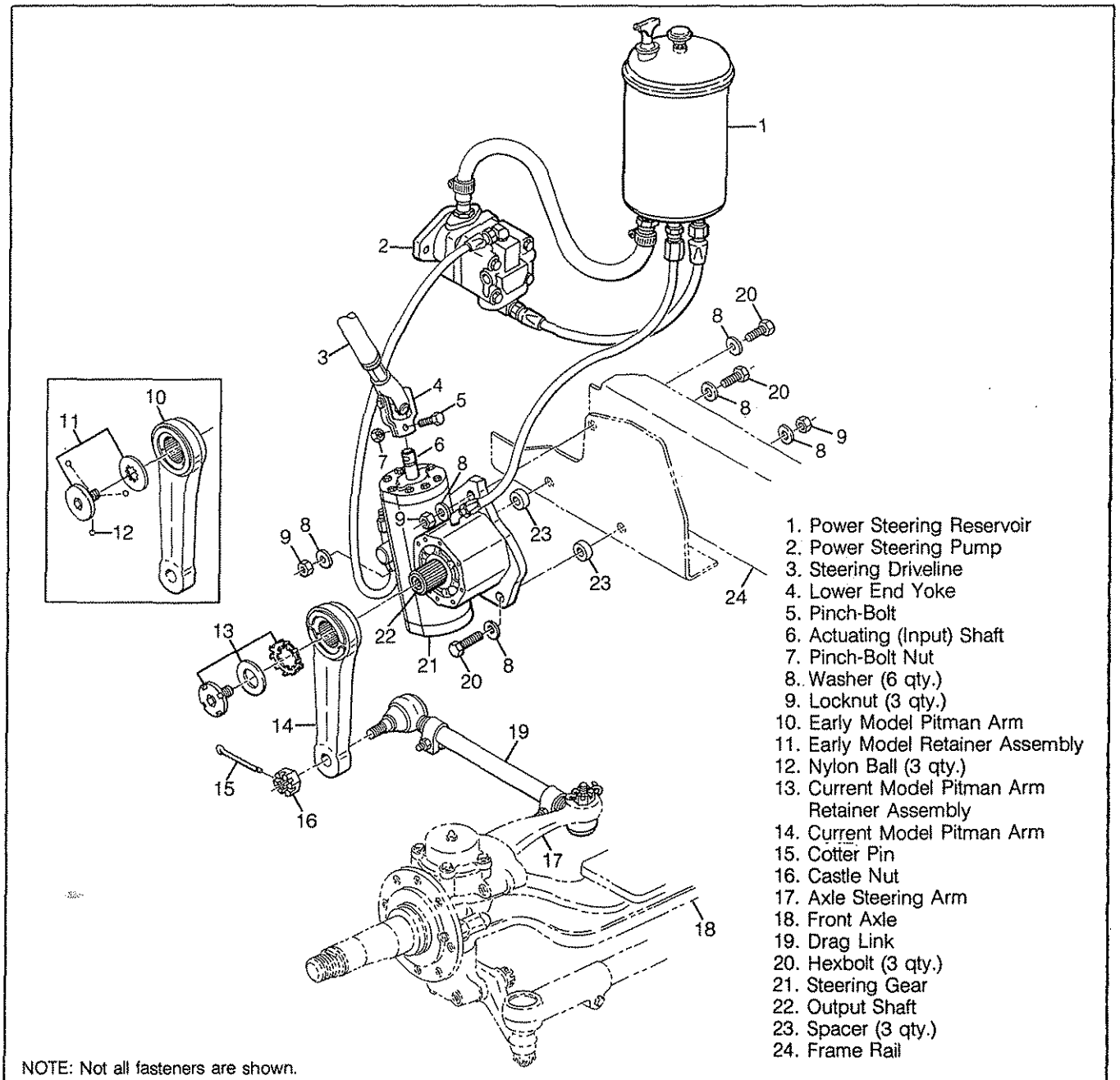


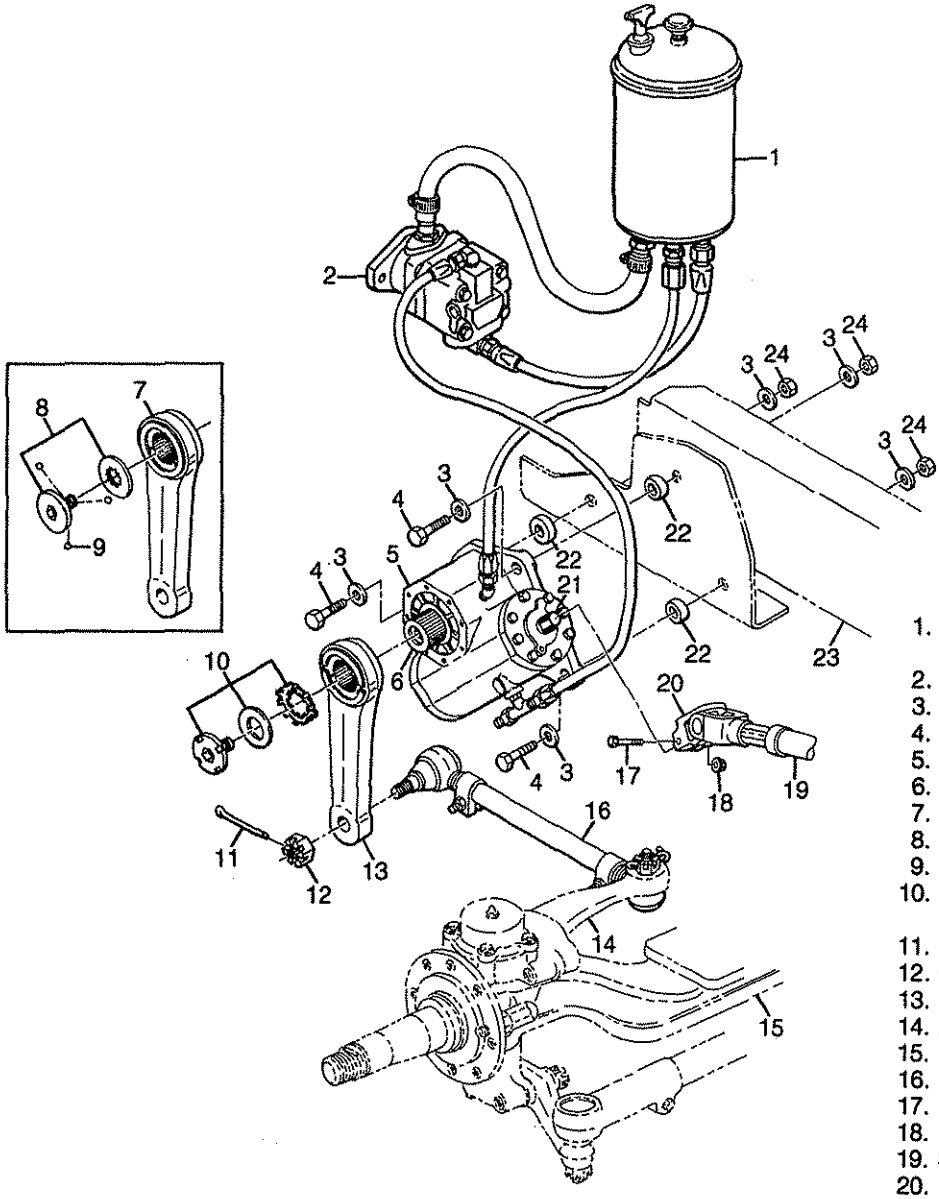
Fig. 1, Sheppard Integral Power Steering Gear Installation, COE

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

The steering gear has four primary moving parts: an actuating (input) shaft, an actuating valve, a piston, and an output shaft and pinion gear assembly.

PRINCIPLES OF OPERATION

The actuating valve is centered inside the piston by the reversing springs. See Fig. 3. The valve is threaded to



1. Power Steering Reservoir
2. Power Steering Pump
3. Washer (6 qty.)
4. Hexbolt (3 qty.)
5. Steering Gear
6. Output Shaft
7. Early Model Pitman Arm
8. Early Model Retainer Assembly
9. Nylon Ball (3 qty.)
10. Current Model Retainer Assembly
11. Cotter Pin
12. Castle Nut
13. Current Model Pitman Arm
14. Axle Steering Arm
15. Front Axle
16. Drag Link
17. Pinch-Bolt
18. Pinch-Bolt Nut
19. Steering Driveline
20. Lower End Yoke
21. Actuating (Input) Shaft
22. Spacer (3 qty.)
23. Frame Rail
24. Locknut (3 qty.)

NOTE: Not all fasteners are shown.

Fig. 2, Sheppard Integral Power Steering Gear Installation, 120 Conventional

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

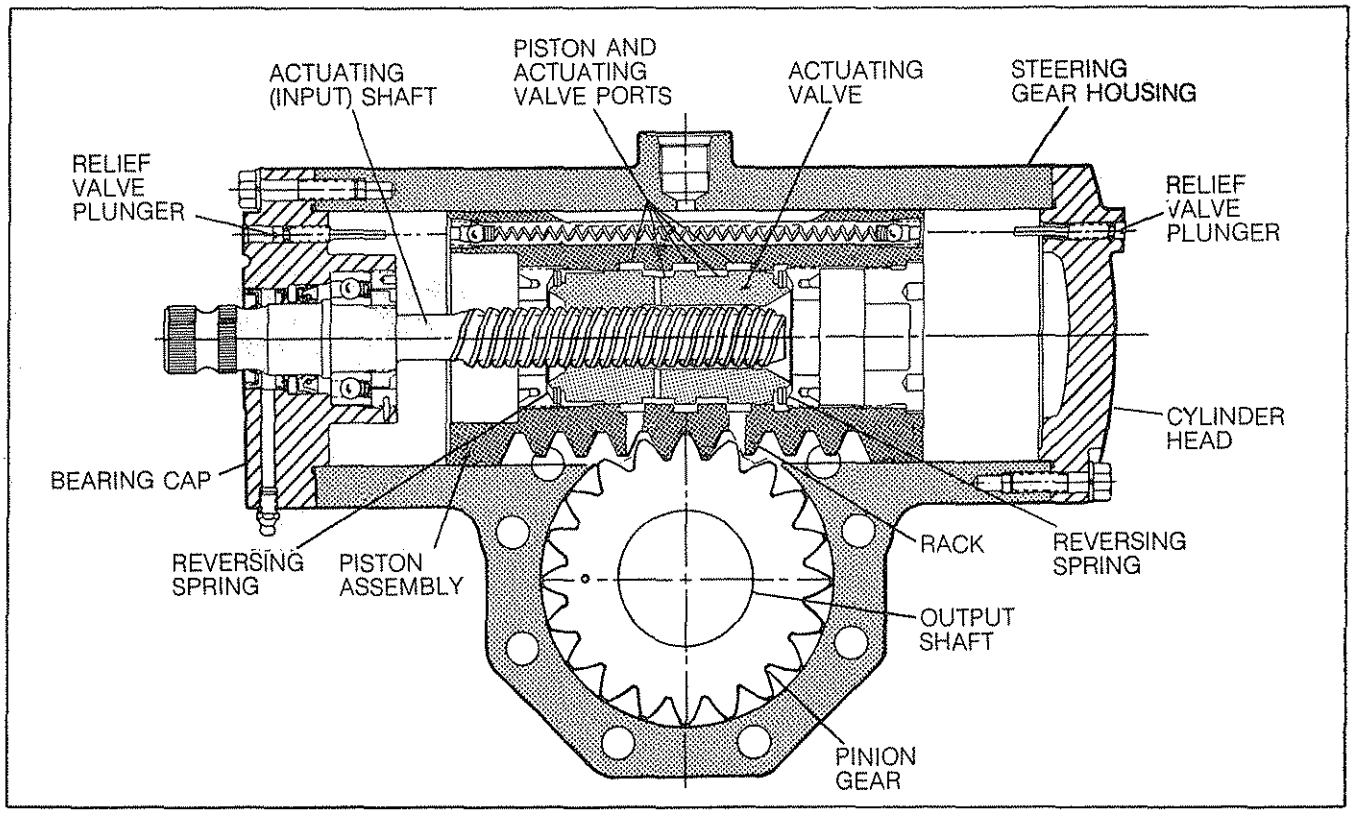


Fig. 3, Sheppard Integral Power Steering Gear, Model 392S Series 6

accommodate the input shaft. When the steering wheel is turned, the actuating shaft turns within the actuating valve, moving the valve inside the piston. This causes fluid pressure to build up at one end of the piston, moving the piston in the bore of the steering gear housing. A rack gear is machined into one surface of the piston, and this rack gear is engaged with a pinion gear that is attached to the output shaft. When the piston moves, the pinion gear and output shaft are rotated by the rack, moving the pitman arm, and steering the vehicle.

When rotation (or input) from the actuating shaft stops, the actuating valve stops moving. The reversing springs, at each end of the valve, then center the valve inside the piston. This reduces the fluid pressure, and stops power-assisted steering of the vehicle.

Relief valve plungers are located in the bearing cap and the cylinder head. When the plungers are adjusted correctly, they actuate the relief valve, which automatically releases pressure in the steering system if the wheels are turned to either extreme direction.

When the engine is running, a constant low-pressure oil flow is present throughout the steering gear. This constant oil flow provides for a quick steering response, and lubrication and cooling of the hydraulic steering system. It also absorbs road shock to help stop steering wheel kick, and to protect the steering gear.

SERVICE OPERATIONS

Before servicing the steering gear or power steering pump, refer to the pre-service checks in the hydraulic power steering system checking and testing subject in Group 14 of this manual. After doing any service operations on the power steering system components, refer to the post-service checks in the same subject.

IMPORTANT: Check the power steering troubleshooting section in Group 14 of this manual before removing the steering gear from the vehicle. Do not remove the steering gear from the vehicle unless you are sure that the problem you are experiencing actually involves the steering gear itself.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

BEARING CAP SEAL REPLACEMENT

Keep the steering gear free of dirt and foreign matter, and handle all internal parts carefully to avoid damage to machined surfaces. Nicks and burrs can cause damage to mating parts; remove them with a fine hand-stone before reassembly. If possible, use a work bench with a soft cardboard or plywood surface.

It isn't necessary to remove the steering gear from the vehicle to replace the bearing cap seals.

1. Place the tires straight-ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where the work is to be done. Apply the parking brakes, and chock the tires.
2. Drain the oil from power steering reservoir and pump.
3. Disconnect the steering driveline from the steering gear actuating shaft as follows (See **Fig. 1** for COEs or **Fig. 2** for 120 Conventionals):
   - .1 Remove the pinch bolt nut and the pinch bolt from the lower end of the steering driveline yoke.
   - .2 Remove the steering driveline yoke from the steering gear actuating shaft. If you cannot remove the yoke with a light application of pressure, then it is secured with adhesive. The adhesive bond can be weakened by applying 300°F (150°C) heat to the base of the yoke.
4. Remove the relief valve plunger from the bearing cap. See **Fig. 4**. Remove and discard the relief plunger O-ring.

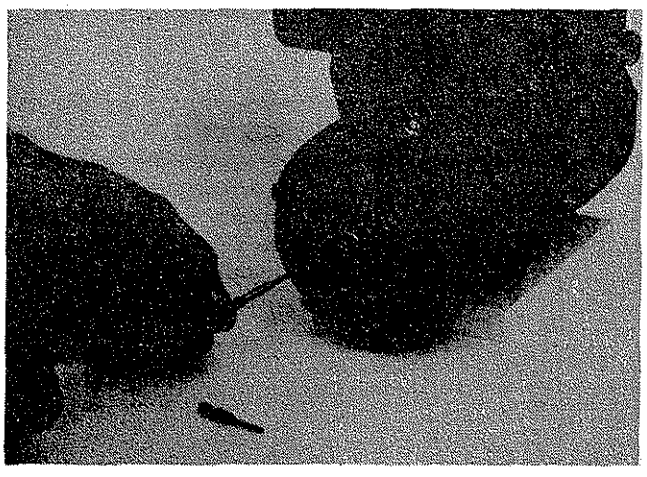


Fig. 4

5. Remove the bolts from the bearing cap. See **Fig. 5**. Turn the actuating shaft to free the bearing cap from the piston and the steering gear housing.
6. Hold the bearing cap and turn the actuating shaft until it is free of the piston. See **Fig. 6**. Remove and discard the bearing cap O-ring seal.

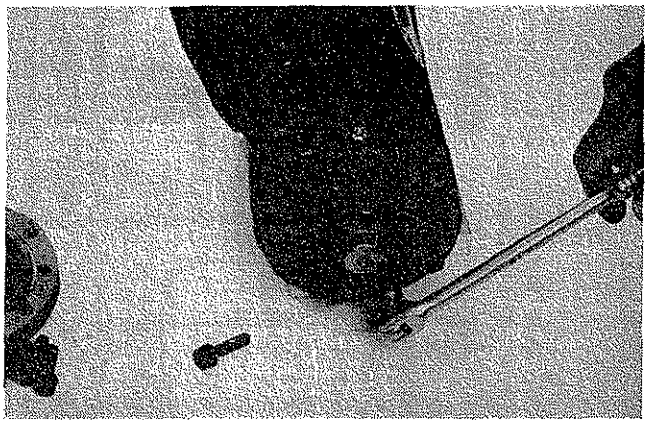


Fig. 5, Gear Removed from Vehicle

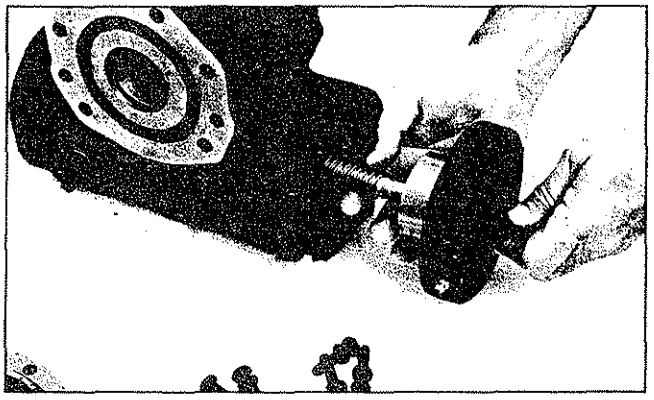


Fig. 6, Gear Removed from Vehicle

7. Remove the actuating shaft and bearing assembly from the bearing cap as follows:
   - .1 Drill out the retainer pin with a 5/64-inch drill bit. See **Fig. 7**.
   - .2 Using a spanner wrench, remove the bearing retainer nut. See **Fig. 8**.
   - .3 Tap or press the actuating shaft/bearing assembly from the bearing cap. The actuating shaft and bearing are one unit; don't try to separate them.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

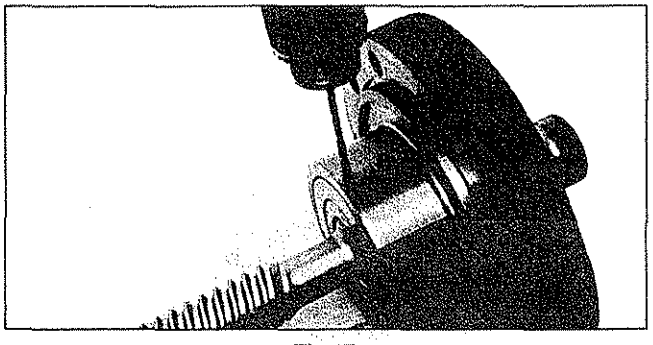


Fig. 7

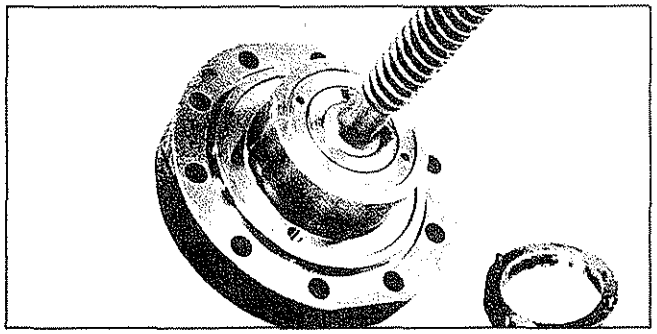


Fig. 8

8. Remove the seals from the bearing cap as follows:

   .1 Put the bearing cap under a press.

   .2 From the outer surface of the bearing cap, insert a piece of stock 1.49 inches (37.85 mm) in diameter into the hole in the bearing cap. See **Fig. 9**.

   .3 Put a cage or other suitable barrier around the bearing cap.

   .4 Press out the high-pressure Telfon® seal kit, the dirt seal, and the salt seal. See **Figs. 9** and **10**.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

Cleanliness is of the utmost importance. Dirt and foreign matter in the steering system can cause damage and steering malfunctions, which could result in an accident that could cause personal injury and property damage.

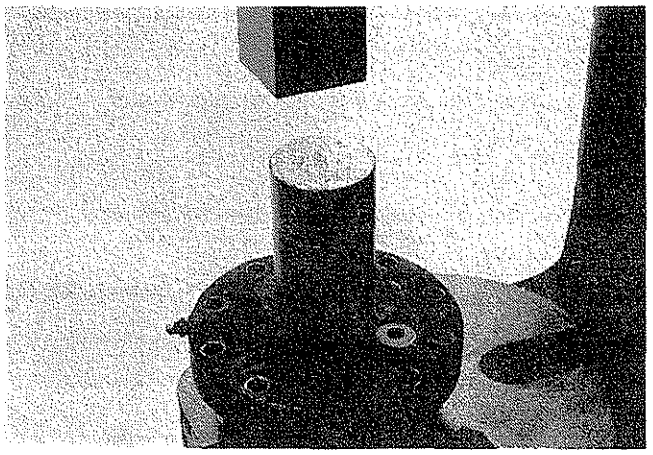


Fig. 9

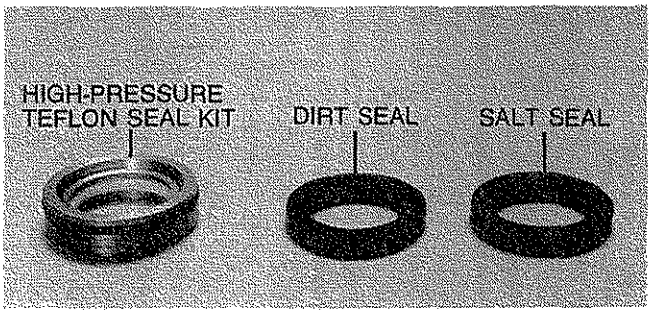


Fig. 10

9. Clean the machined parts, using a solvent, and dry them with compressed air.

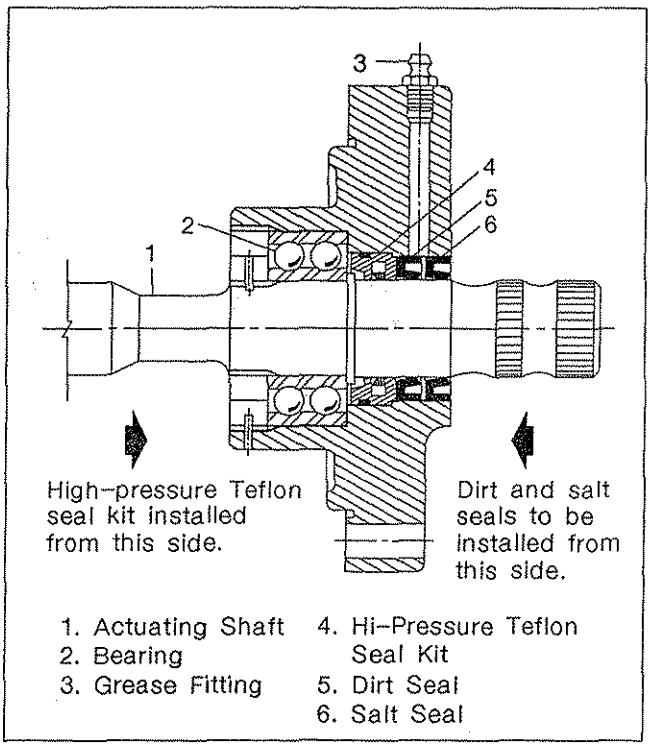
10. Assemble the actuating shaft and bearing cap as follows (refer to **Fig. 11**):

    .1 Using a piece of round stock 2 inches (51 mm) long, turn it to a 1.615-inch (41 mm) diameter, and smooth one end. Put the smooth end of the round stock in the bearing end of the bearing cap, against the shoulder area for the high-pressure seal. See **Fig. 12**. Set the bearing cap on a press, and evenly install the dirt seal, lip out, until it rests against the end of the round stock. See **Fig. 13**.

    .2 Evenly install the salt seal, lip out, until it is flush with the top of the bearing cap.

CAUTION: Install the Teflon high-pressure seal kit properly, or an oil leak will occur on the first application of pressure.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6



1. Actuating Shaft
2. Bearing
3. Grease Fitting
4. Hi-Pressure Teflon Seal Kit
5. Dirt Seal
6. Salt Seal

Fig. 11

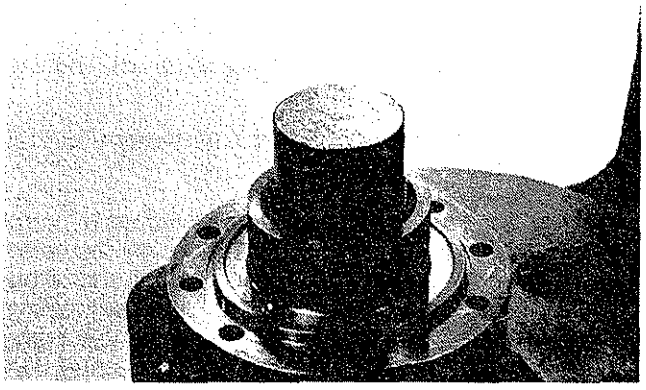


Fig. 12

.3 Turn the bearing cap over, remove the piece of round stock, and evenly install the high-pressure Teflon seal kit until it rests against the shoulder.

.4 Coat all the seals with chassis grease.

NOTE: The bearing cap uses three seals for high-pressure sealing, and actuating shaft protection. The high-pressure

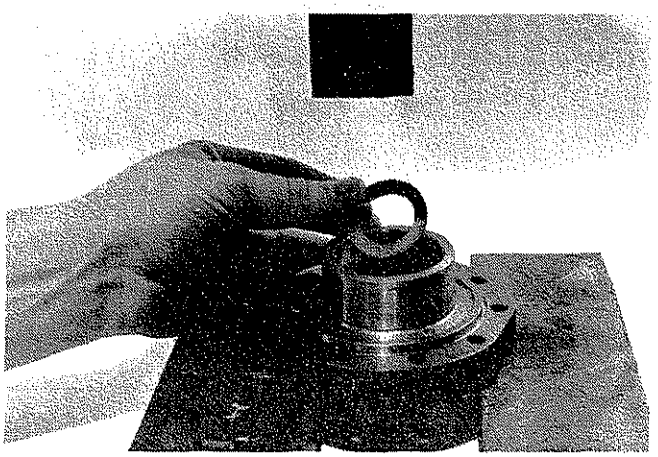


Fig. 13

Teflon seal kit is protected by the dirt seal and the salt seal. A grease cavity between the dirt seal and salt seal is filled with chassis lube to block dirt or salt entry. During regular lubrication intervals, this cavity is flushed by forcing chassis grease through the cavity with a low-pressure grease gun. Refer to Group 14 of the Freightliner *COE and 120 Conventional Maintenance Manual*, for lubrication intervals and procedures.

.5 Press the actuating shaft and bearing assembly into the bearing cap.

.6 Install the bearing retaining nut. Insert the locking pin through the hole in the bearing cap and into the hole in the nut. See **Fig. 14**. If a new nut is installed, drill a 3/32-inch hole in the nut. The nut must be in place to drill this hole. Drill through

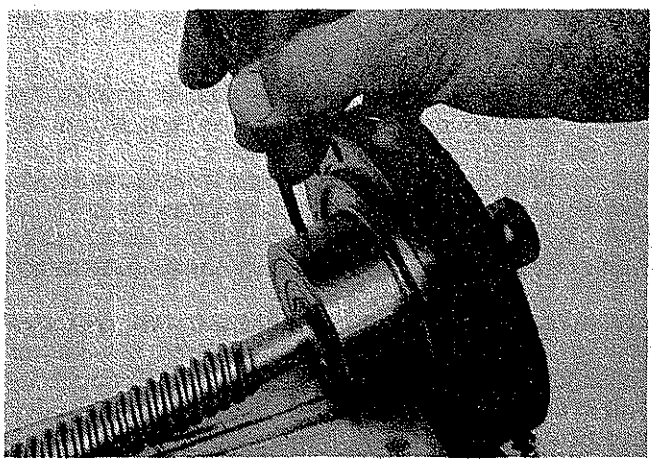


Fig. 14

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

the locking pin hole in the bearing cap, to a depth of 3/16 inch (4.8 mm) into the nut.

11. Install a new seal on the bearing cap. Thread the actuating shaft into the actuating valve. See **Fig. 15**. Turn the shaft until the bearing cap comes into place on the end of the housing. Align the relief valve plunger hole with the relief valve seat in the piston. Install the bearing cap bolts and lockwashers, and tighten the bolts 20 lbf·ft. (27 N·m).

12. Install the relief valve plunger, using a new O-ring. Turn the plunger in about six turns.

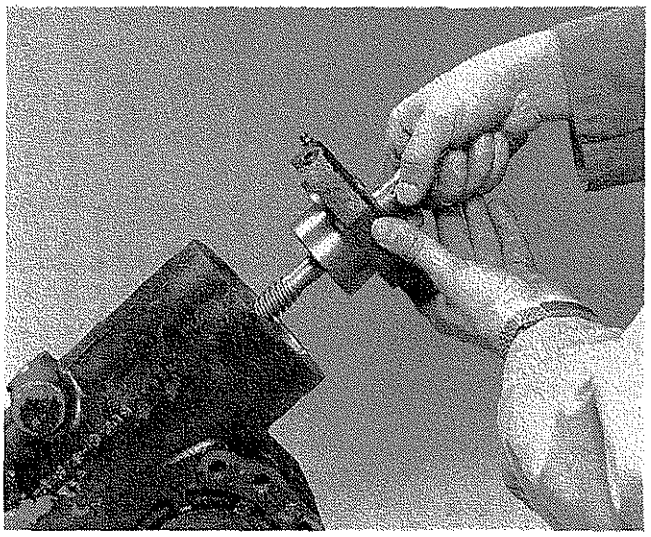


Fig. 15

13. Position the steering wheel so that the king-spoke—the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside—points directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees). Refer to **Fig. 16**.

14. Connect the steering driveline to the steering gear actuating shaft as follows:

    .1 Clean the steering gear actuating shaft and the inside of the steering driveline yoke.

    .2 Apply Locquic® General Purpose Primer T to the steering gear actuating shaft. Let dry for five minutes.

    .3 Apply a bead of Loctite® No. 680 adhesive to the inside surface of the steering driveline yoke.

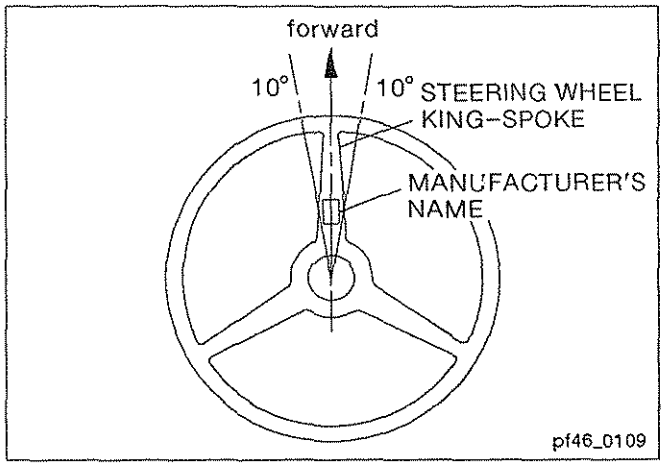


Fig. 16

    .4 Slide the yoke onto the actuating shaft, and install the yoke pinch bolt and a new pinch bolt nut. Tighten the pinch bolt nut 60 lbf·ft (80 N·m).

    .5 Apply white Torque Seal F-900 to the exposed pinch bolt threads and the locknut tips.

CAUTION: When bleeding air from the hydraulic system, and any time during operation of the system, failure to keep the power steering reservoir fluid level maintained above the "add" mark on the dipstick could result in damage to the power steering pump and improper operation of the power steering system.

15. Fill and bleed the system as follows:

    .1 Fill the power steering reservoir with hydraulic fluid. Refer to the "Charts and Specifications" section of the Freightliner *COE and 120 Conventional Maintenance Manual* for lubrication specifications.

    .2 Start the engine and operate it at fast idle, adding fluid to the reservoir as needed.

    .3 Turn the steering wheel through a full left and right turn. Check the hoses and fittings for leaks. Replace leaking hoses, and tighten loose fittings, as necessary. Turn the steering wheel through three more full left and right turns, or until all air is removed from the hydraulic system (no air bubbles appear in the reservoir) and the fluid in the reservoir is maintained at the "full" mark on the dipstick.

16. Adjust the relief valve plungers, as follows:

    .1 Check the settings of the axle stops (and adjust them if necessary), using the instructions in the

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

front axle wheel alignment subject in Group 10 of this manual.

.2 Install a flow meter kit in the supply line from the pump to the steering gear. Make sure that the flow meter can be pressurized. Warm the power steering fluid to operating temperature. For instructions refer to the subject covering hydraulic power steering system checking, testing, and troubleshooting, in Group 14 of this manual.

.3 With the engine at idle, have someone turn the steering wheel to the right-turn full-lock position. Check the pressure gauge.

CAUTION: As soon as pump relief pressure is reached (as described below), release the steering wheel from the full-lock position. Do not maintain pump relief pressure for longer than 5 seconds, or damage to the system may result because of high heat. Never let the oil temperature exceed 180°F (82°C).

If the pressure gauge reading is less than 1575 psi (10 852 kPa), back out the relief valve plunger (at the top of a COE-mounted gear, or at the bottom of a 120 Conventional-mounted gear) until the pressure reading is between 1575 psi (10 852 kPa) and 1925 psi (13 262 kPa) pump relief pressures.

If system pressure is more than the maximum pump relief pressure, repair the power steering pump. Refer to the power steering pump subject in Group 14 of this manual for repair instructions.

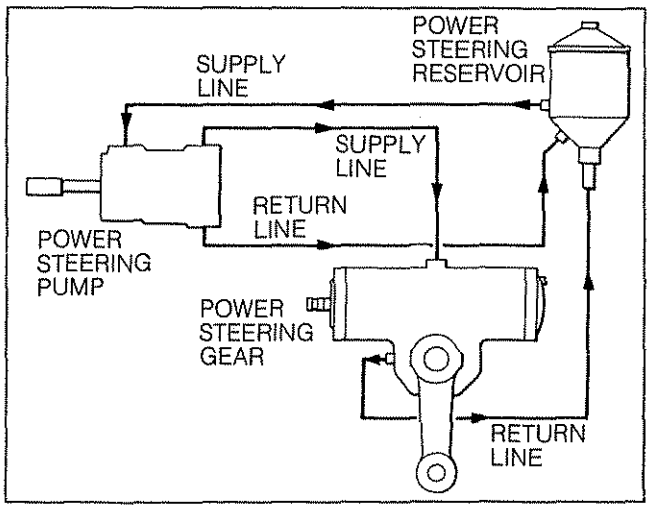


Fig. 17, Plumbing Diagram

.4 Release the steering from the right-turn full-lock position, enough to allow insertion of a 1/16- to 1/8-inch (1.6 to 3.2 mm) thick flatwasher between the axle beam and the right-side axle stop pin.

.5 Bring the steering back to the right-turn full-lock position, against the flatwasher. Immediately tighten the relief valve plunger (at the top of a COE-mounted gear, or at the bottom of a 120 Conventional-mounted gear) until the pressure gauge reading drops to about 600 psi (4137 kPa).

.6 With the engine at idle, have someone turn the steering wheel to the left-turn full-lock position. Adjust the relief valve plunger at the bottom of a COE-mounted gear, or at the top of a 120 Conventional-mounted gear, using the procedures in steps 16.3 through 16.5, above (but for the left-turn full-lock position).

17. Drive the vehicle, or take a test ride with the driver. Check the steering wheel king-spoke position. If, during straight-ahead driving on a level road, the steering wheel king-spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock), remove the steering wheel; then, position it so the king-spoke points directly toward the front of the vehicle, following the instructions in Group 14 of this manual.

STEERING GEAR REMOVAL

The bearing cap seals can be replaced without removing the steering gear from the vehicle. Refer to "Bearing Cap Seal Replacement."

IMPORTANT: Before doing any of the following steps, refer to the "Troubleshooting" section in Group 14 of this manual. Many steering system problems can be resolved without removing the steering gear from the vehicle.

Don't replace the steering gear housing or the piston on the basis of observation only. Slow, binding, or uneven steering input can also be caused by problems with the power steering pump. Test the power steering hydraulic system before servicing the steering gear components. Refer to the pre-service checks in the subject covering hydraulic power steering system checking, testing, and troubleshooting, in Group 14 of this manual.

1. Place the front tires straight ahead.
2. Disconnect all hydraulic lines from the gear, and mark the lines for later connection. Seal the lines to keep dirt out and fluid in.

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3. Disconnect the drag link from the pitman arm as follows (See **Fig. 1** for COEs or **Fig. 2** for 120 Conventionals):
   - .1 Loosen the pinch bolt nut on the drag link.
   - .2 At the pitman arm end of the drag link, remove the cotter pin and the castle nut from the ball stud of the pitman arm.
   - .3 Using a ball stud removal tool, disconnect the drag link assembly from the pitman arm.
4. Disconnect the steering driveline from the steering gear actuating shaft as follows (See **Fig. 1** for COEs or **Fig. 2** for 120 Conventionals):
   - .1 Remove the pinch bolt nut and the pinch bolt from the lower end of the steering driveline yoke.
   - .2 Remove the steering driveline yoke from the steering gear input shaft. If you cannot remove the yoke with a light application of pressure, then it is secured with adhesive. The adhesive bond can be weakened by applying 300°F (150°C) heat to the base of the yoke.
5. Remove the pitman arm from the steering gear as follows:
   - .1 If the retainer has a tab washer (see **Fig. 18**), bend the two locktabs so that the retainer can be removed.
   - .2 Remove the retainer, using a socket wrench with a 5/8-inch hexhead drive.
   - .3 Note the alignment of the timing dot (number 1 or number 2) on the pitman arm with the arrow on the output shaft. See **Fig. 19.**

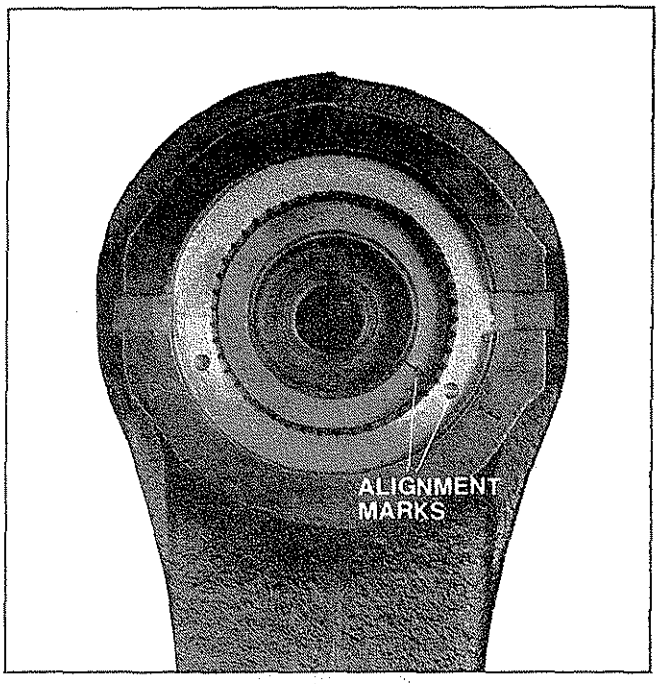

Fig. 19

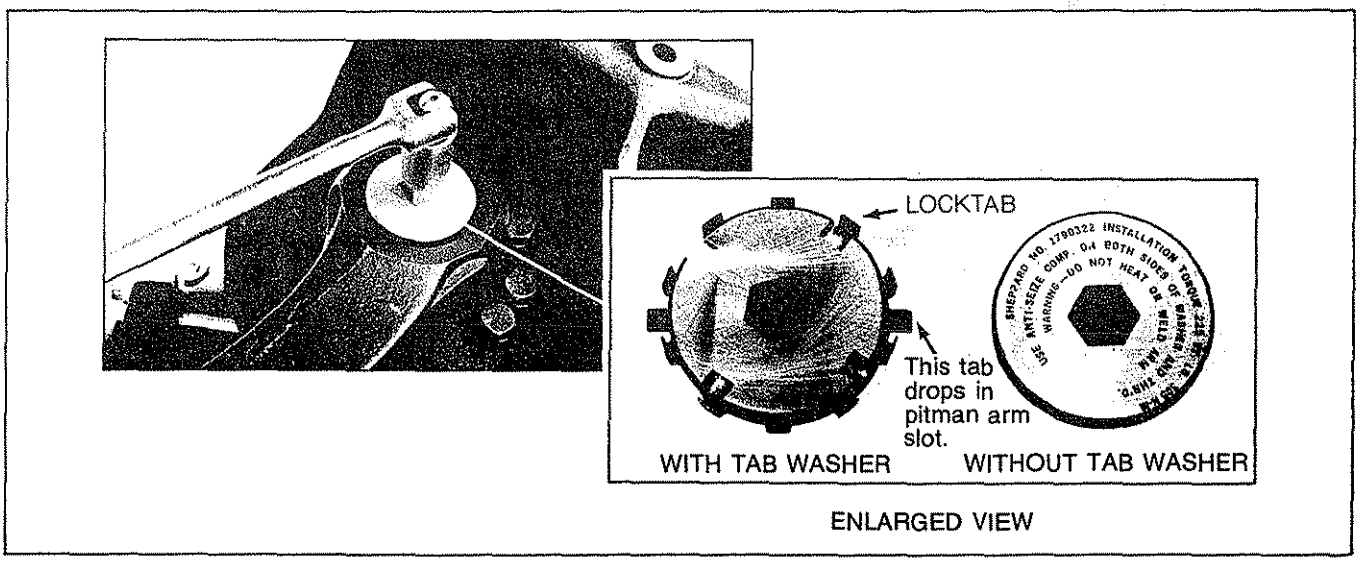

Fig. 18, Pitman Arm Retainer

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If there are no alignment marks on the output shaft, center the steering gear by turning the actuating (input) shaft through full travel. Count the number of turns from stop to stop, and then, starting at the end of travel, turn the actuating shaft back half the number of total turns. Using a marking pen or paint, mark the pitman arm and output shaft with a line that is at a right angle to the actuating shaft axis.

WARNING: Do not pound, weld, or apply heat to the pitman arm or output shaft. Damage to the pitman arm or output shaft could cause a loss of steering control, resulting in possible personal injury or property damage.

.4 Using a suitable puller, remove the pitman arm from the output shaft. See **Fig. 20**.

5. Remove the nuts and washers from the three mounting bolts that attach the steering gear to the frame rail (COEs) or to the frame rail extension (120 Conventionals), and remove the steering gear from the vehicle.

6. Place the steering gear on a clean surface.

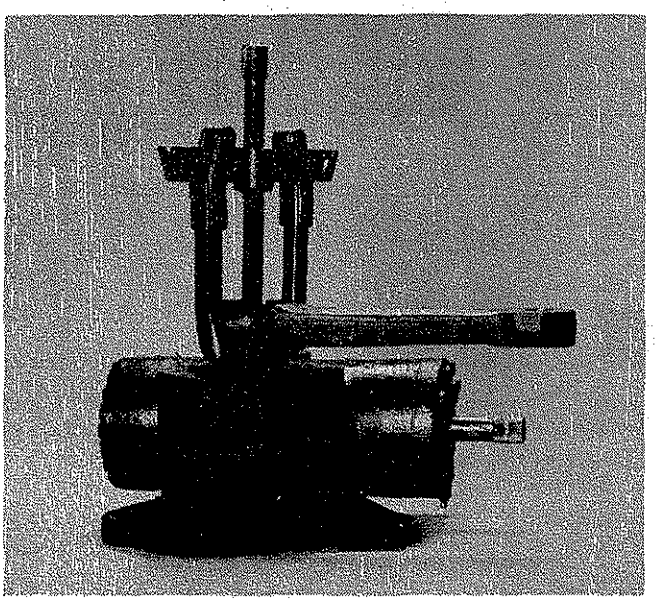

Fig. 20, Gear Removed from Vehicle

STEERING GEAR DISASSEMBLY (Refer to **Fig. 21**)

CAUTION: Use care during repair jobs to keep the steering gear free of dirt and foreign matter. Handle all internal parts carefully to avoid damage to machined surfaces. Nicks and burrs can cause damage to mating parts; remove them with a fine handstone before reassembly. If possible, use a work bench with a surface of soft cardboard or plywood.

1. Remove the eight bolts that attach the pinion gear cover to the steering gear housing. See **Fig. 22**.

2. Clean the exposed portion of the output shaft to prevent damage to the bearing. See **Fig. 23**. Using a soft hammer, tap on the end of the output shaft to loosen the pinion gear cover. See **Fig. 24**.

3. Carefully slide the ouput shaft pinion gear and pinion gear cover out of the housing. See **Fig. 25**.

4. Pull the output shaft out of the pinion cover, and remove and discard the O-ring seal in the pinion cover.

5. If it is necessary to disassemble the two-piece pinion gear and output shaft on early Series 6 gears (see **Fig. 26**), do the following:

IMPORTANT: Current model Series 6 steering gears have a one-piece sector shaft assembly. See **Fig. 21**. Don't disassemble this type of output shaft.

.1 Punch out the roll pin that keeps the retaining pin in place.

.2 Drill out the retaining pin.

.3 Press the pinion gear off of the output shaft.

If you cannot drill out the retaining pin, shear if off using a press. See **Fig. 27**. Use about 20,000 lbs (9000 kg) of pressure. Be sure to put a cage or other suitable barrier around the output shaft before using the press. After shearing off the pin, drive out the half in the pinion gear, then drill out the other half from the output shaft.

6. Remove the quad-ring oil seal from the housing. See **Fig. 28**.

7. Check the roller bearing in the housing. See **Fig. 29**. If the bearing is worn, drive it out of the housing using a drift punch; otherwise, leave it in place.

8. Check the roller bearing in the pinion gear cover. See **Fig. 30**. If the bearing is worn, remove it using a bushing puller; otherwise, leave it in place.

9. Remove the relief valve plunger from the bearing cap. See **Fig. 31**. Remove and discard the relief plunger O-ring.

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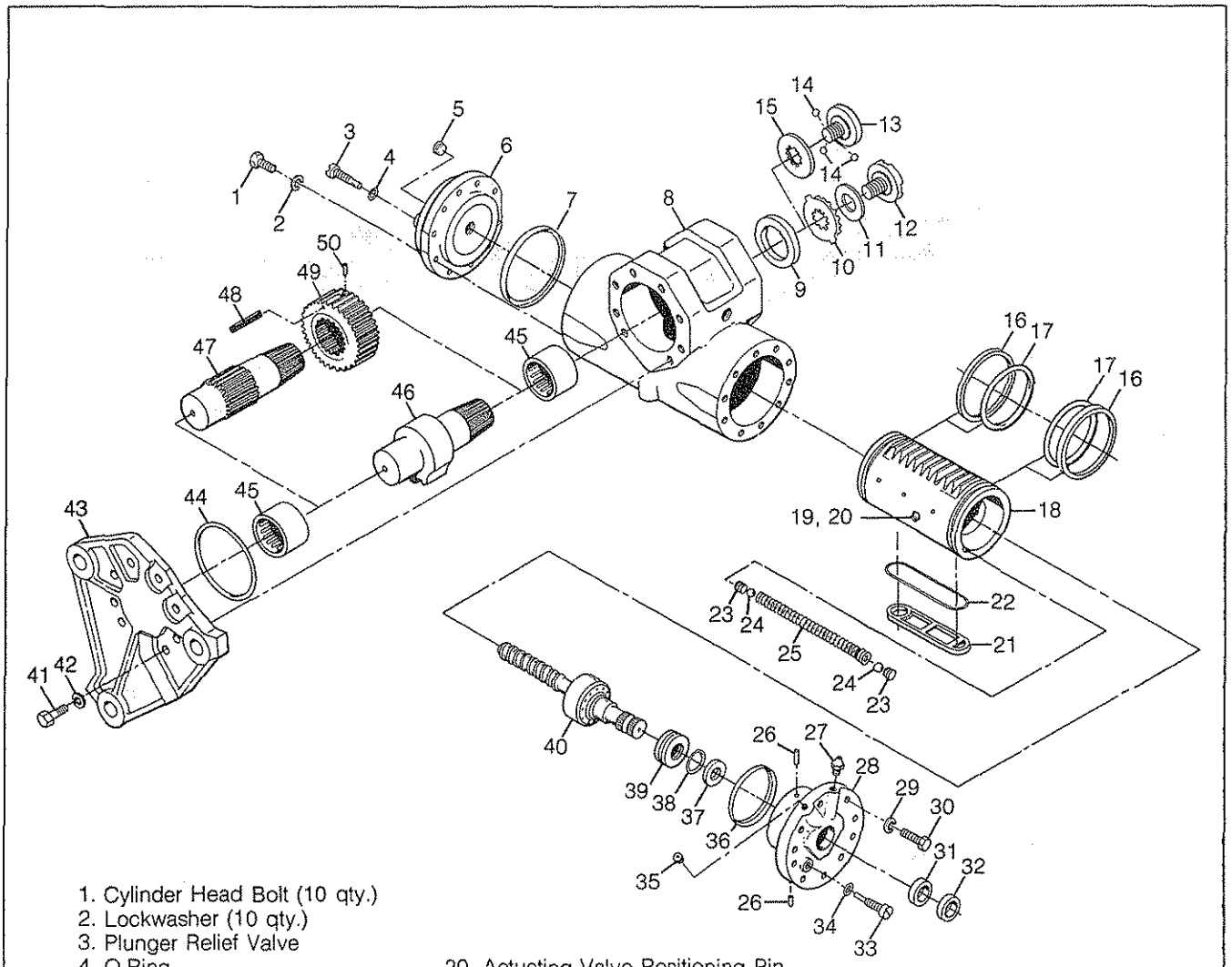

1. Cylinder Head Bolt (10 qty.)
2. Lockwasher (10 qty.)
3. Plunger Relief Valve
4. O-Ring
5. Cylinder Head Plug
6. Cylinder Head
7. O-Ring Seal
8. Steering Gear Housing
9. Quad Ring Oil Seal
10. Tab Washer
11. Friction Washer
12. Retainer, Current Models
13. Retainer, Early Models
14. Nylon Ball (3 qty.)
15. Washer 2261861
16. Teflon Piston Ring (2 qty.)
17. Piston O-Ring (2 qty.)
18. Piston Assemby
19. O-Ring (not visible)
20. Actuating Valve Positioning Pin
21. Slipper Seal
22. Back-up O-Ring
23. Relief Valve Ball Seat (2 qty.)
24. Relief Valve Ball (2 qty.)
25. Relief Valve Spring
26. Locking Pin (2 qty.)
27. Grease Fitting
28. Bearing Cap
29. Lockwasher (10 qty.)
30. Bearing Cap Bolt (10 qty.)
31. Dirt Seal
32. Salt Seal
33. Relief Valve Plunger
34. O-Ring
35. Bearing Cap Plug
36. O-Ring Seal
37. Teflon High-Pressure Seal
38. O-Ring
39. High-Pressure Seal Retainer
40. Actuating Shaft
41. Pinion Cover Bolt (8 qty.)
42. Lockwasher (8 qty.)
43. Pinion Gear Cover
44. O-Ring Seal
45. Roller Bearing (2 qty.)
46. Sector Shaft, Current Models
47. Output Shaft, Early Models
48. Roll Pin
49. Pinion Gear, Early Models
50. Retaining Pin

Fig. 21, Steering Gear Parts

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

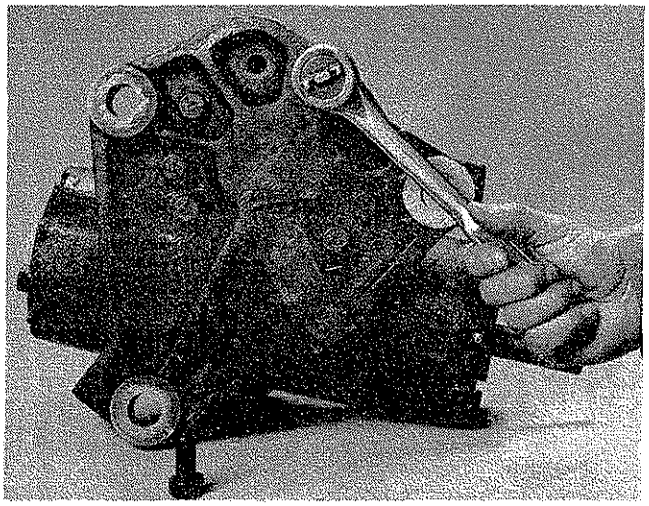

Fig. 22

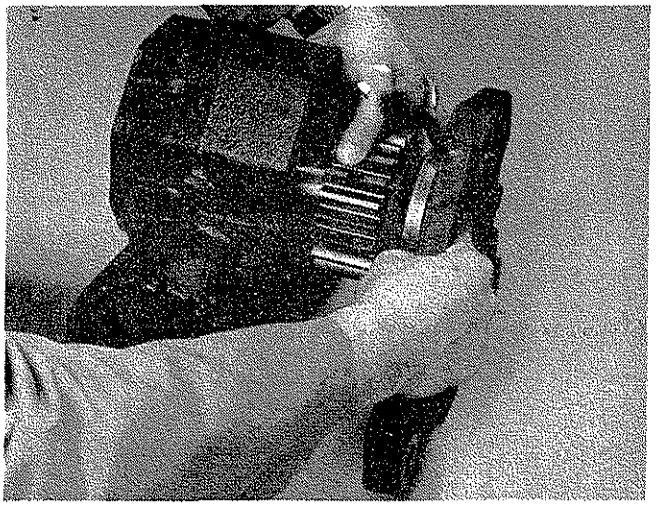

Fig. 25

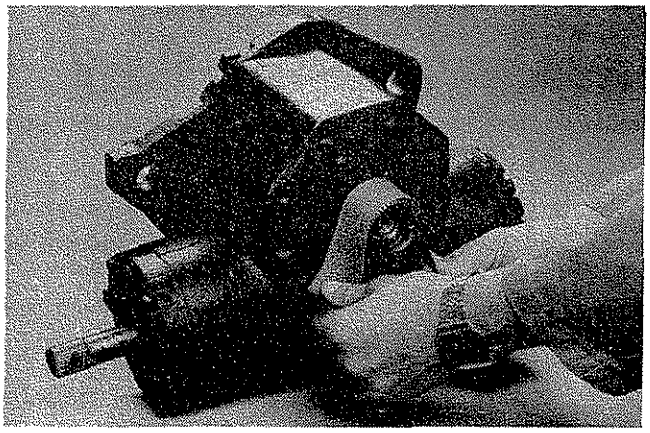

Fig. 23

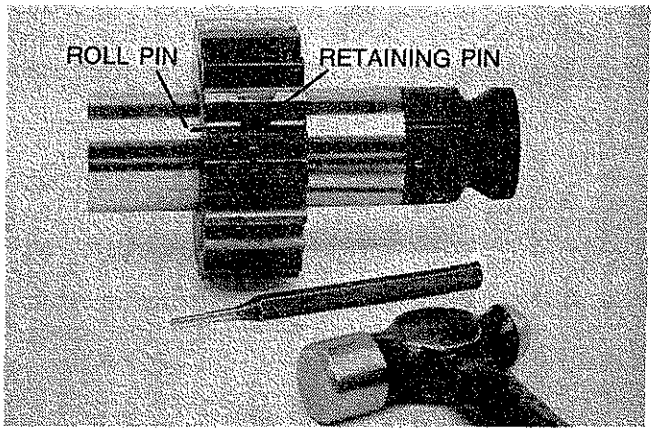

Fig. 26

Fig. 24

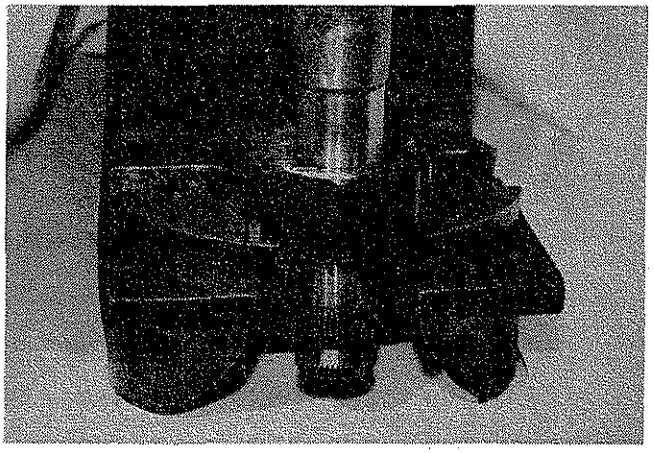

Fig. 27

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

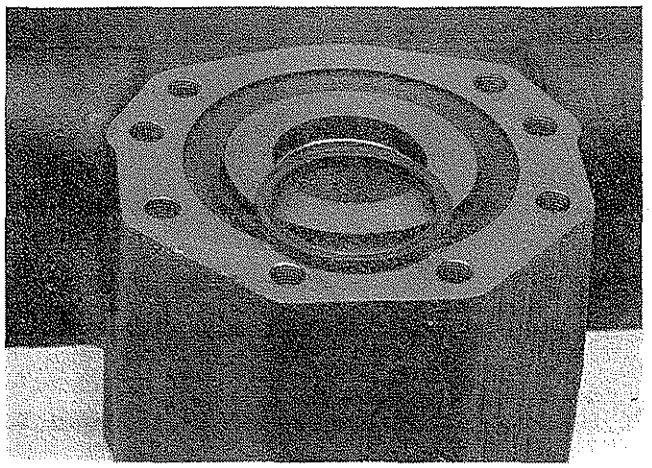

Fig. 28

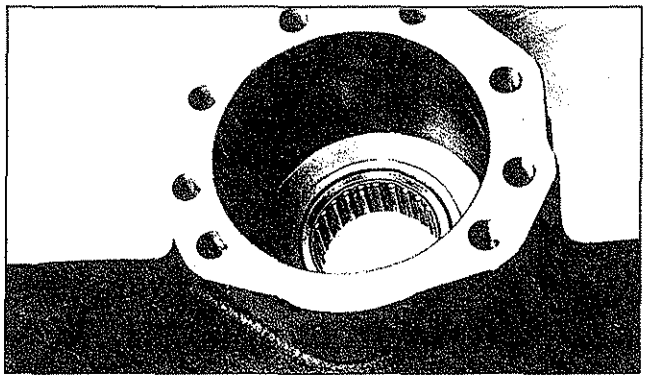

Fig. 29

Fig. 30

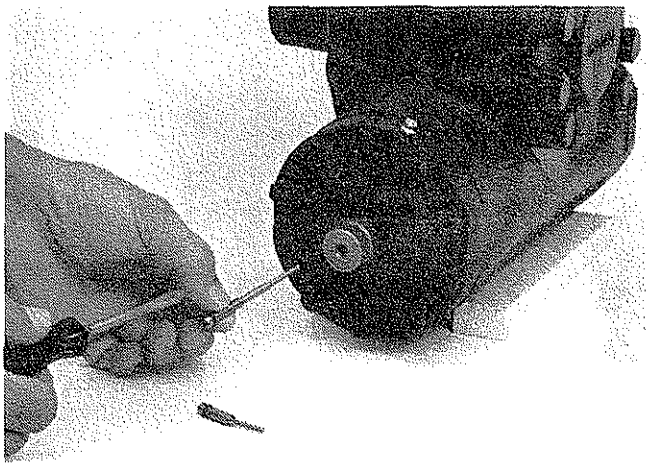

Fig. 31

10. Mark the bearing cap and the steering gear housing so that you can reassemble the steering gear correctly. See **Fig. 32**. (The bearing cap and cylinder head will fit on either end of the gear housing.)
11. Remove the bolts from the bearing cap. See **Fig. 33**. Turn the actuating shaft to free the bearing cap from the piston and the steering gear housing.
12. Hold the bearing cap and turn the actuating shaft until it is free of the piston. See **Fig. 34**. Remove and discard the bearing cap O-ring seal.
13. Remove the actuating shaft and bearing assembly from the bearing cap as follows:
    .1 Drill out the retainer pin with a 5/64-inch drill bit. See **Fig. 35**.

Fig. 32

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

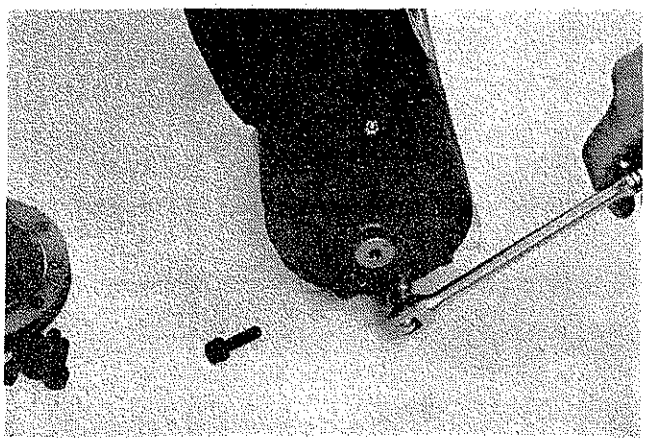

Fig. 33

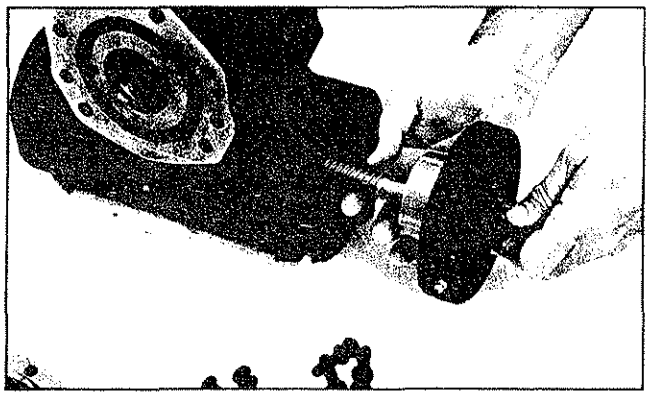

Fig. 34

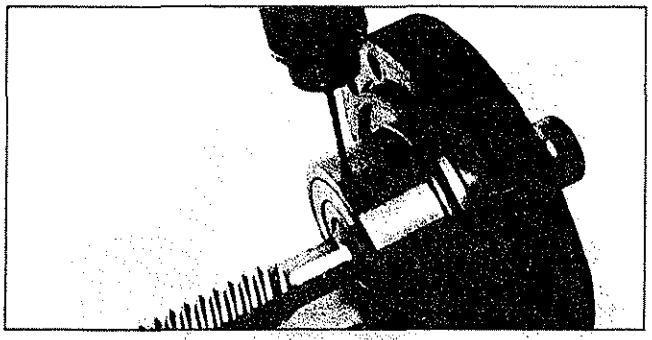

Fig. 35

.2 Using a spanner wrench, remove the bearing retainer nut. See **Fig. 36**.

.3 Tap or press the actuating shaft/bearing assembly from the bearing cap. The actuating shaft and bearing are one unit; don't try to separate them.

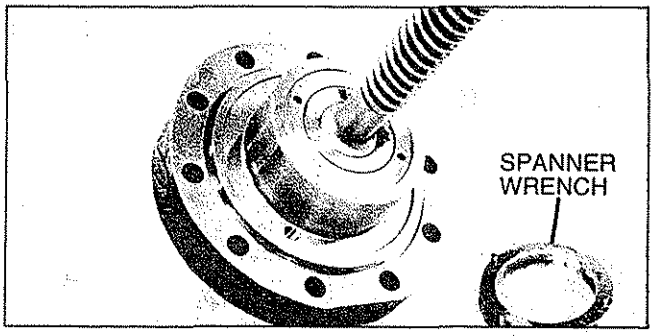

Fig. 36

14. Remove the seals from the bearing cap as follows:

.1 Put the bearing cap under a press.

.2 From the outer surface of the bearing cap, insert a piece of stock 1.49 inches (37.85 mm) in diameter into the hole in the bearing cap. See **Fig. 37**.

.3 Put a cage or other suitable barrier around the bearing cap.

.4 Press out the high-pressure Telfon seal kit, the dirt seal, and the salt seal. See **Figs. 37** and **38**.

15. Remove the relief valve plunger from the cylinder head. Remove and discard the relief-valve plunger O-ring.

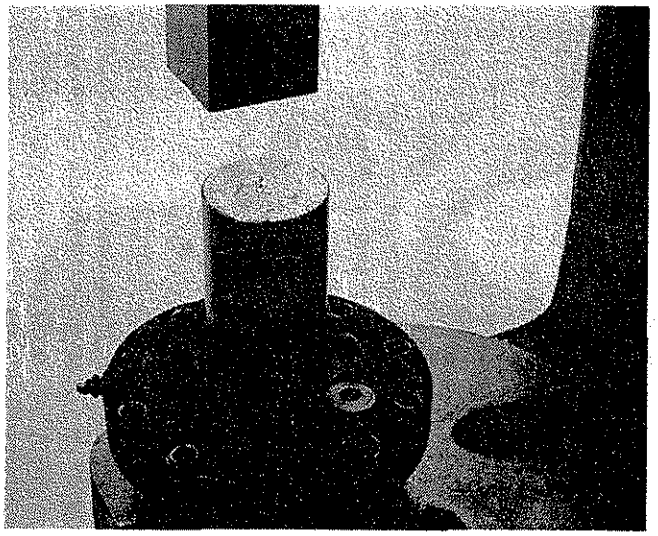

Fig. 37

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

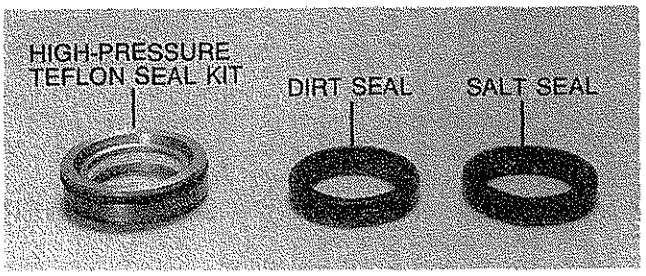

Fig. 38

16. Remove the cylinder head (Fig. 39), and discard the O-ring seal.

17. Carefully slide the piston assembly from the bore of the steering gear housing. See Fig. 40. Notice that the top of the piston is machined to allow the bearing to travel inside of it. See Fig. 41.

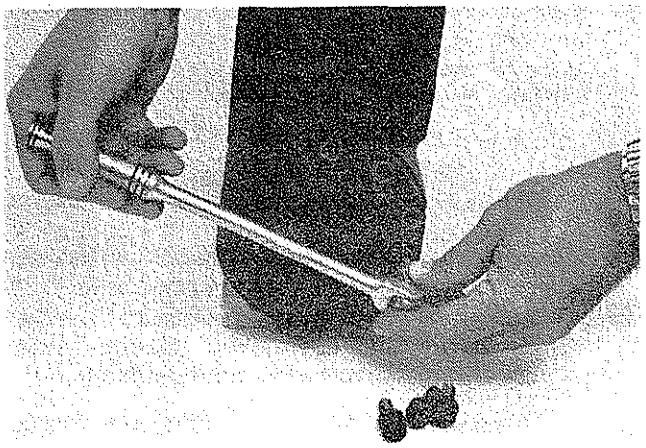

Fig. 39

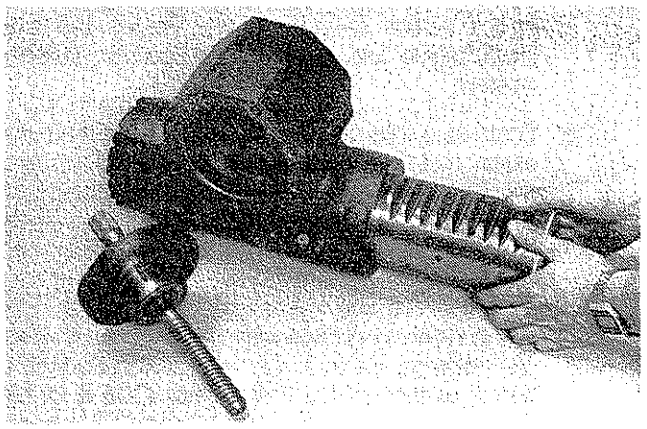

Fig. 40

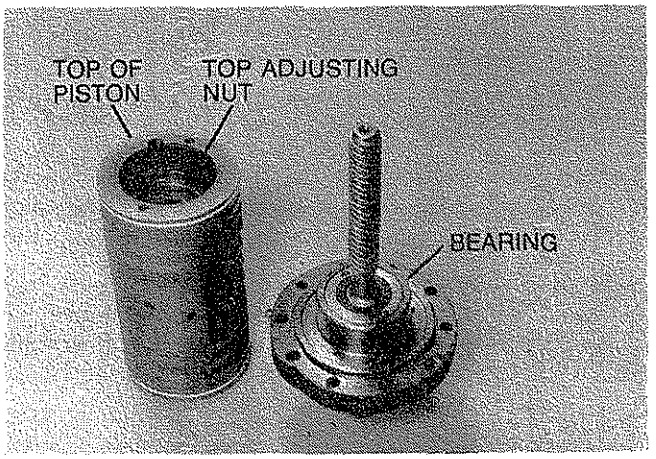

Fig. 41

18. Using an allen wrench, remove the relief ball seats, relief balls, and spring. See Fig. 42. The relief balls are under slight spring pressure. Remove them carefully to avoid personal injury or loss of the relief balls.

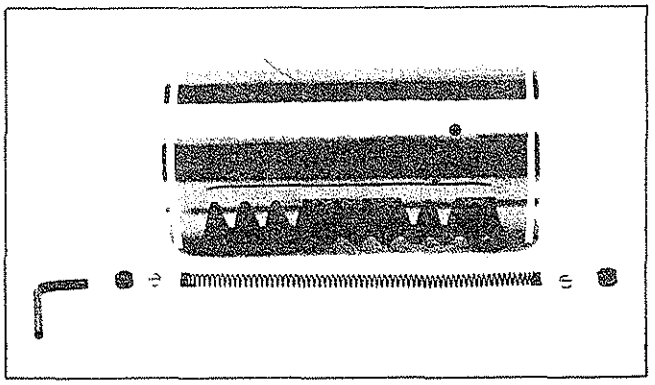

Fig. 42

CLEANING AND INSPECTING

WARNING: Cleanliness is of the utmost importance. Dirt and foreign material in the steering system can cause damage and steering problems resulting in possible personal injury or property damage.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

1. Clean the machined parts one at a time, to avoid damage by bumping them together. Use a clean

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solvent to wash the parts, and dry them with compressed air.

2. Replace all the O-rings and seals whenever doing any kind of repair. See **Fig. 43.**

3. Carefully check all the steering gear parts. Replace worn parts, as well as any parts that show signs of stress or fatigue. Pay particular attention to the following:

   .1 Check the piston and steering gear housing for scoring. Scoring may be caused by high operating temperatures, air in the hydraulic system, or incorrect or contaminated lubricant.

   CAUTION: Do not hone or bore out the cylinder bore. This will increase internal leakage.

   If parts have minor scoring, polish them with a fine handstone or crocus cloth to allow free movement of the mating parts.

   Don't be alarmed over minor scoring or scuffing of the piston or the steering gear housing. This will not affect the safety or operation of the steering gear.

   If scoring is severe, leakage will affect steering reacting time, and slow, binding, or uneven steering input will be noticeable. In this case, replace the damaged parts.

   .2 Check the actuating shaft and actuating valve for wear on the acme threads. Thread wear may be caused by high operating temperatures, too little oil flow, or too little operating pressure. If the acme threads are worn, replace the actuating valve and the actuating shaft and bearing assembly.

   The actuating-shaft acme thread may be a machine-cut thread or a rolled thread. The rolled thread may appear rough and flaky, and seem to have a split in it. This is a normal appearance for a rolled thread.

   .3 Look for wear or damage along the sealing surface of the actuating shaft. Replace the actuating shaft and bearing assembly if the sealing surface is worn or damaged.

   .4 Check the piston rack and the output shaft pinion gear for cracked or broken gear teeth. Also, check the steering gear housing for cracks or breaks. Such conditions are signs of impact damage. Refer to step 4.4 for recommendations.

4. Inspection of the steering gear parts may reveal problems in other areas of the steering system. To avoid repeat problems, follow each clue to its conclusion.

   .1 Check the steering gear components for discoloration (blue color), caused by high operating temperatures. High operating temperatures are most frequently caused by too little lubricant, too high a flow rate, or too much system backpressure. For further information, refer to the troubleshooting chart in the Group 14 subject covering hydraulic power steering system checking, testing, and troubleshooting.

   .2 A stripped actuating-shaft bearing retaining nut, or scoring of the steering gear housing and piston, can be caused by air in the hydraulic system. Check for an air leak on the suction side of the power steering pump. Repair the leak, then bleed the air from the power steering system.

   .3 Scoring of the piston or steering gear housing, wear on the roller bearings, or on the ports of the actuating valve or piston can be caused by an incorrect or contaminated lubricant. If the lubricant is contaminated, check for and correct the source of contamination. If incorrect or contaminated lubricant was used, drain, flush, and fill the steering system with clean lubricant of the correct type. Refer to the "Chart and Specifications" section of the Freightliner *COE and 120 Conventional Maintenance Manual* for lubrication specifications.

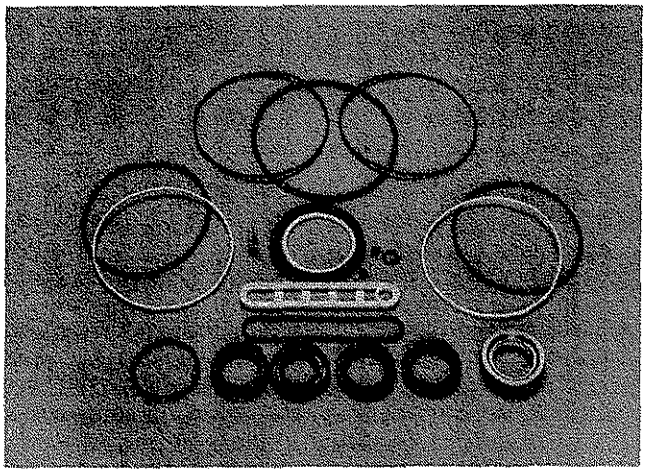

Fig. 43

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.4 A distorted pitman arm, a broken steering gear housing, a stripped actuating-shaft bearing retaining nut, twisted output shaft, and broken or cracked rack and pinion gear teeth are some signs of impact damage. Don't replace broken or damaged mounting brackets without finding the cause of the damage.

Consider any steering gear that has impact damage as suspect. Impact loads transmitted through the front axle and steering linkage into the steering gear, can stress parts to a point just short of failure. Further use is unsafe; replace the steering gear assembly and the pitman arm.

STEERING GEAR ASSEMBLY (Refer to Fig. 21)

Before assembling the steering gear components, use a fine handstone to remove any nicks or burrs. Use clean motor oil to coat the components, to ease assembly.

1. Install new back-up O-rings on the ends of the piston, and on the slipper seal. See Fig. 44.
2. Carefully install the Teflon piston rings and the slipper seal on the piston. See Figs. 44 and 45.
3. Set the piston aside to allow the rings to shrink down.
4. Install a new quad-ring in the groove in the gear housing. The quad-ring is a "stuff-fit," and at first glance may appear to be too large. See Fig. 46.
5. If the roller bearings in the gear housing and pinion cover were removed, press new ones into place. See Figs. 47 and 48. The bearings should bottom out against a shoulder so that they are flush with the inside surface of the housing and pinion gear cover.

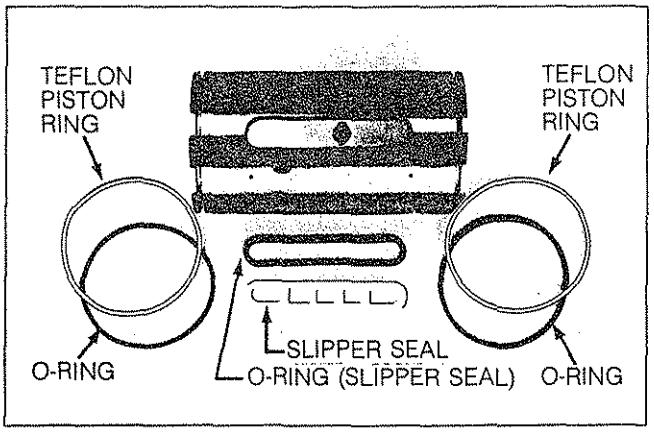


Fig. 44

6. On early Series 6 gears, if the pinion gear was removed from the output shaft, align the output shaft and pinion gear for installation of the retaining pin. Press the gear on the shaft. Install the retaining pin

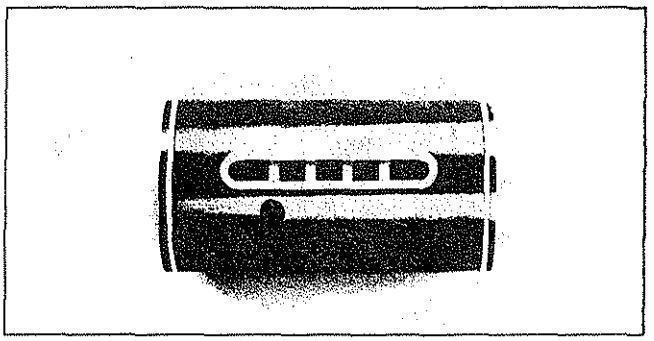


Fig. 45

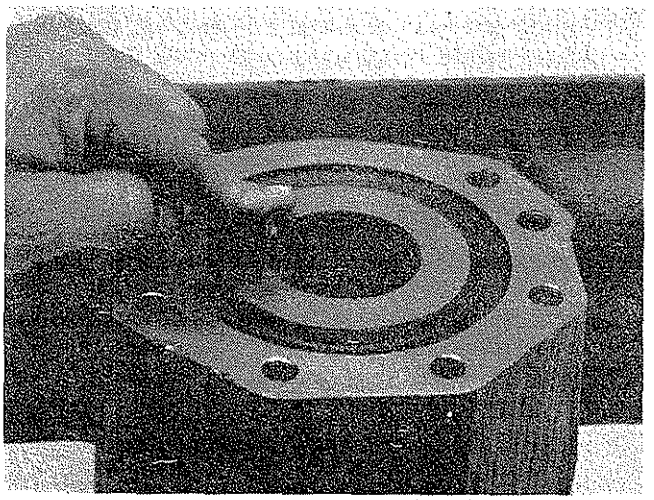


Fig. 46

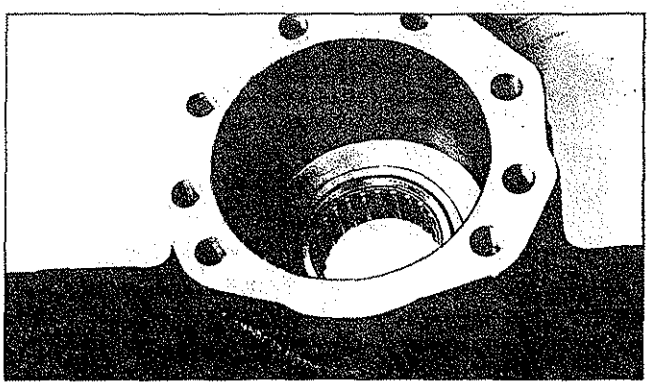


Fig. 47

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

Fig. 48

through the gear, and seat it in the shaft. Install the roll pin, to hold the retaining pin in place. See Fig. 49.

7. Put a light coat of motor oil in the cylinder bore.
8. Using a ring compresser, compress the piston rings. See Fig. 50.
9. Note the reference punch mark on the bearing-cap end of the steering gear housing, then carefully install the piston in the cylinder bore. Install the piston with the opening for the actuating shaft and bearing towards the bearing-cap end of the housing. See Fig. 51.

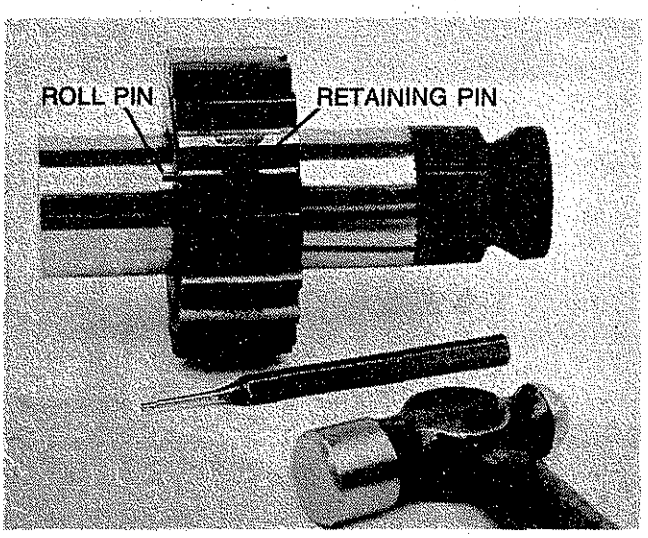


Fig. 49

Fig. 50

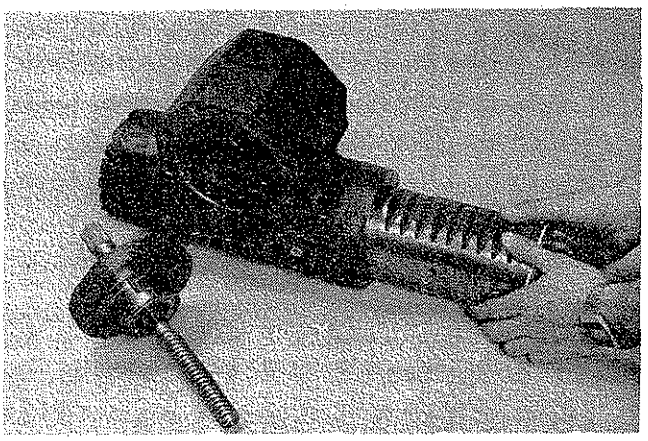


Fig. 51

Carefully work the piston ring past the pinion gear opening in the cylinder bore, to avoid damaging the ring. See Fig. 52. Use the blunt end of a wooden stick to depress the piston ring as you slide the piston into the bore.

WARNING: The timing marks must be aligned during assembly of the steering gear. If the timing marks are not aligned, the steering gear will not be centered. This will limit the vehicle turning angle in one direction, which could cause an accident involving personal injury or property damge.

If the one-piece sector shaft assembly (on current Series 6 gears) is not properly aligned with the piston rack, the gears could become disengaged during operation, resulting in loss of steering control. This could cause personal injury or property damage.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

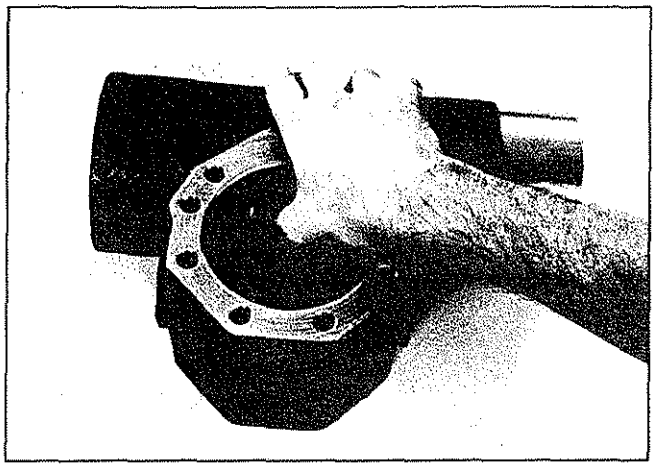


Fig. 52

10. Align the timing mark on the piston rack with the center of the opening in the pinion gear housing. Grease the housing bearing and quad-ring, and carefully slide the output shaft through the housing. Align the timing marks on the pinion gear with the timing mark on the rack. See **Fig. 53**.

11. Position a new O-ring on the pinion gear cover. Install the cover assembly. It may be necessary to use a soft hammer to tap the cover in place. Install the pinion gear cover bolts. Tighten the bolts 90 lbf·ft (122 N·m).

12. Note the reference mark that was made at the end of the gear housing where the bearing cap was removed. Install the cylinder head on the opposite end of the gear housing (it will fit on either end). Use a new seal. Make sure that the relief valve plunger hole in the cylinder head is aligned with the relief valve seat in the piston. Install the cylinder head bolts. Tighten the bolts 20 lbf·ft (27 N·m).

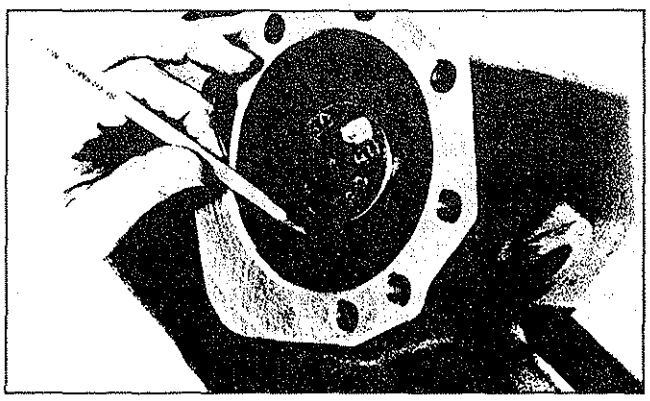


Fig. 53

13. Assemble the actuating shaft and bearing cap as follows (refer to **Fig. 54**):

    .1 Using a piece of round stock 2 inches (51 mm) long, turn it to 1.615 inches (41 mm) diameter, and smooth one end. Put the smooth end of the round stock in the bearing end of the bearing cap, against the shoulder area for the high-pressure seal. See **Fig. 55**. Set the bearing cap on a press, and evenly install the dirt seal, lip out, until it rests against the end of the round stock. See **Fig. 56**.

    .2 Evenly install the salt seal, lip out, until it is flush with the top of the bearing cap.

    CAUTION: Install the Teflon high-pressure seal kit properly, or an oil leak will occur on the first application of pressure.

    .3 Turn the bearing cap over, remove the piece of round stock, and evenly install the high-pressure Teflon seal kit until it rests against the shoulder.

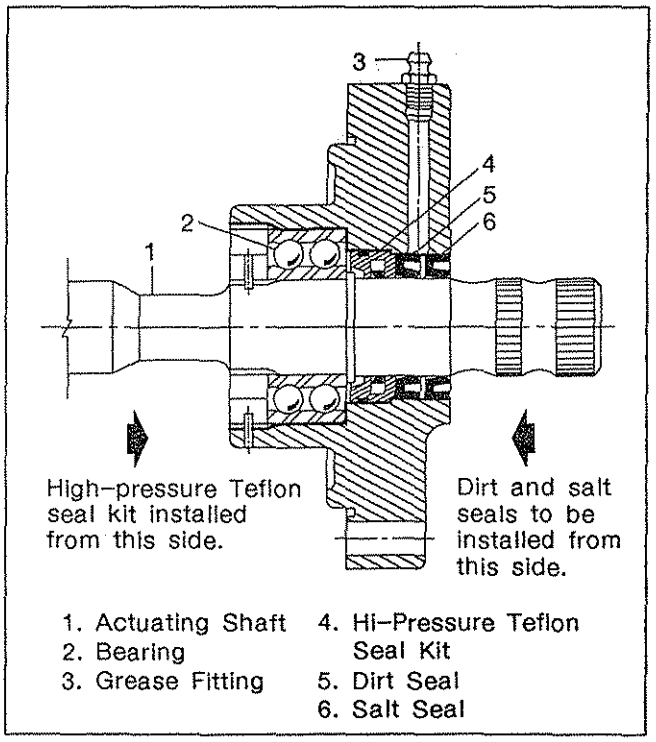


Fig. 54

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

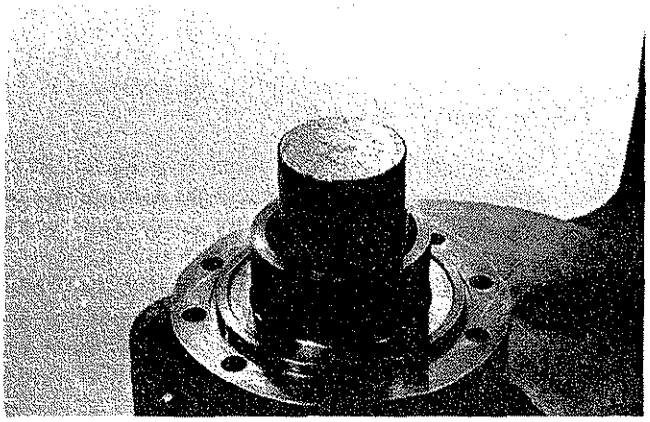


Fig. 55

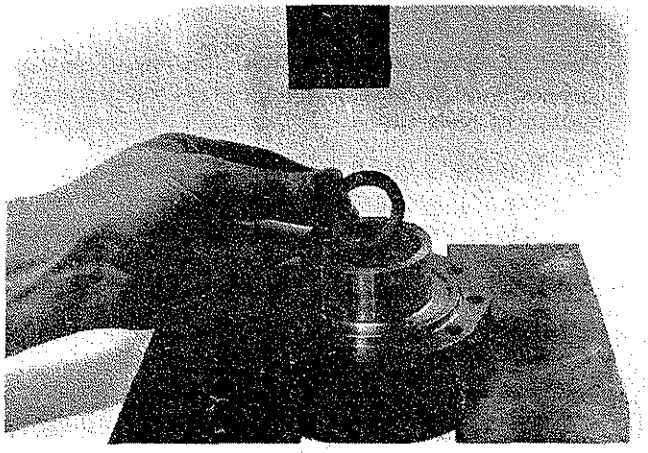


Fig. 56

.4 Coat all the seals with chassis grease.

NOTE: The bearing cap uses three seals for high-pressure sealing, and actuating shaft protection. The high-pressure Teflon seal kit is protected by the dirt seal and the salt seal. A grease cavity between the dirt seal and salt seal is filled with chassis lube to block dirt or salt entry. During regular lubrication intervals, this cavity is flushed by forcing chassis grease through the cavity with a low-pressure grease gun. Refer to Group 14 of the Freightliner *COE and 120 Conventional Maintenance Manual*, for lubrication intervals and procedures.

.5 Press the actuating shaft and bearing assembly into the bearing cap.

.6 Install the bearing retaining nut. Insert the locking pin through the hole in the bearing cap and into the hole in the nut. See **Fig. 57**. If a new nut is installed, drill a 3/32-inch hole in the nut. The nut must be in place to drill this hole. Drill through the locking pin hole in the bearing cap, to a depth of 3/16 inch (4.8 mm) into the nut.

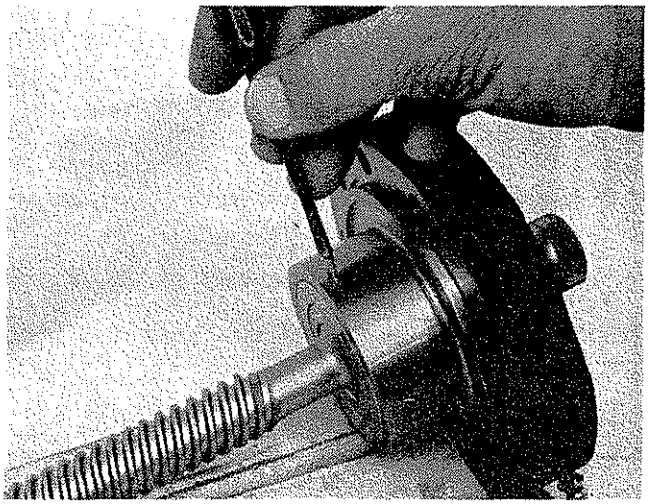


Fig. 57

14. Install a new seal on the bearing cap. Thread the actuating shaft into the actuating valve. See **Fig. 58**. Turn the shaft until the bearing cap comes into place on the end of the housing. Align the relief valve plunger hole with the relief valve seat in the piston. Install the bolts. Tighten the bearing cap bolts 20 lbf·ft (27 N·m).

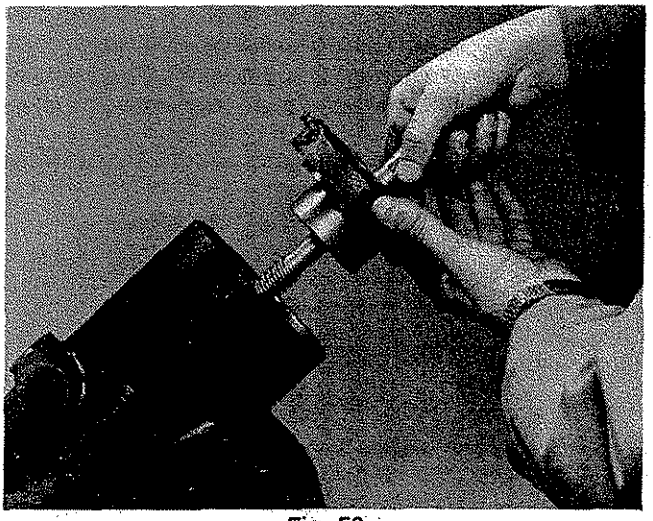


Fig. 58

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

15. Install the relief valve plungers, using new O-rings. See **Fig. 59**. Turn them about six turns. Make the final adjustment of the plungers after the steering gear is installed on the vehicle.

16. Install the steering gear on the vehicle. For instructions, refer to "Steering Gear Installation."

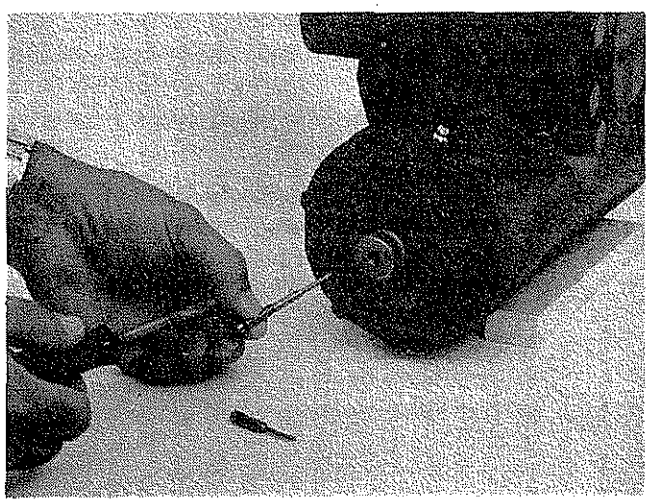


Fig. 59

STEERING GEAR INSTALLATION
(Refer to **Fig. 1** or **Fig. 2**)

1. On COEs, from the inboard side, insert two hexbolts and washers (**Fig. 1**, Refs. 20 and 8) through the and mounting bracket. Install a spacer on each hexbolt, then place the steering gear on the frame rail. Install the third hexbolt (Ref. 20) from the outboard side of the frame rail. Install the washers and nuts, and tighten the nuts to the torque values in **Table 1**, under "Specifications."

   On 120 Conventionals, align the holes in the steering gear pinion gear cover with the holes in the forward frame extension. Place a washer over each hexbolt, and install the three hexbolts from the outboard side of the frame rail. Install a washer and nut on the end of each hexbolt, and tighten the nuts to the torque values in **Table 1**, under "Specifications."

WARNING: Don't pound, weld, or apply heat to the pitman arm or output shaft. Damage to the pitman arm or output shaft could cause a loss of steering control, resulting in possible personal injury or property damage.

2. Install the pitman arm on the output shaft, as follows (See **Fig. 60**):

   .1 On COEs, align the number 2 timing dot on the pitman arm with the arrow on the output shaft.

   On 120 Conventionals with a forward axle, align the number 1 timing dot on the pitman arm with the arrow on the output shaft.

   On 120 Conventionals with a setback axle, align the number 1 timing dot on the pitman arm with

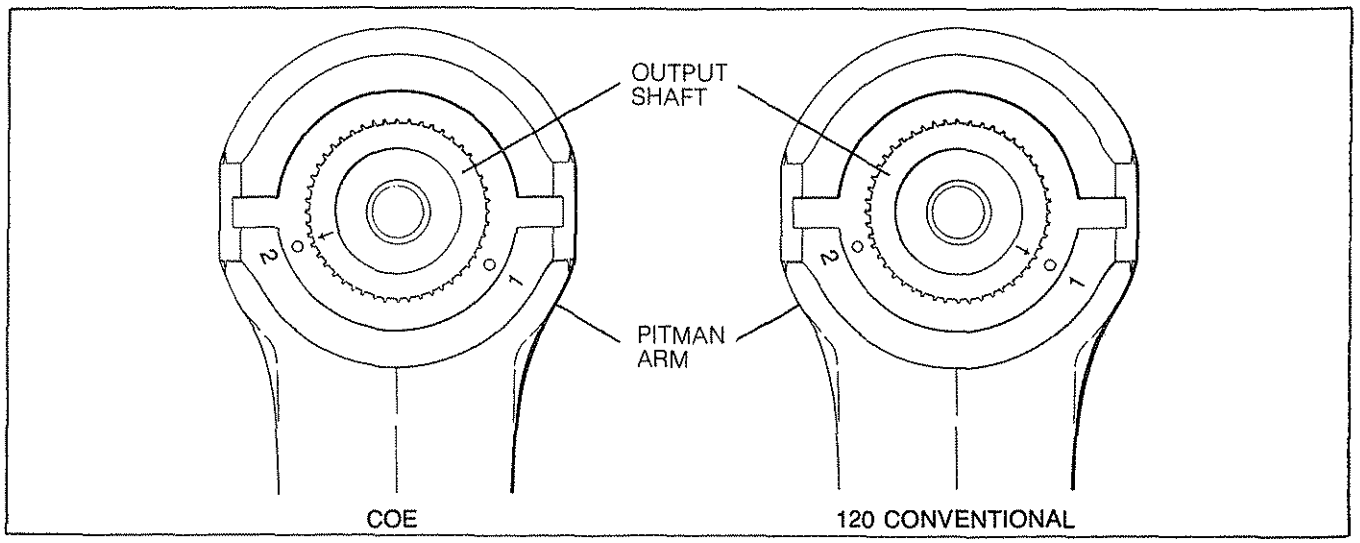


Fig. 60, Aligning the Pitman Arm and Output Shaft

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

the arrow on the output shaft, then rotate the pitman arm one spline tooth counterclockwise.

If the alignment marks are not visible or were not aligned before removal of the pitman arm, align the marking pen or paint mark on the pitman arm with the mark on the output shaft.

.2 With the marks aligned, push the pitman arm on the output shaft as far as it will go by hand. Make sure the pitman arm is in the correct position in relation to the steering gear. See **Fig. 61**.

.3 On early Series 6 gears, use retainer 1790322K and washer 2261861.

Apply Lok-Cease®, Never Seez®, or white lead to the threads of the output shaft and the retainer, and on both sides of the washer. Install the washer and the retainer. Using a torque wrench (not an impact wrench) with a 5/8-inch hex drive, tighten the retainer 225 lbf·ft (305 N·m) to press the pitman arm in place.

On current Series 6 gears, use retainer 1790422K, friction washer 2262021, and tab washer 2262121. Apply Lok-Cease, Never Seez, or white lead to the threads of the output shaft and the retainer, and on both sides of the friction washer and tab washer. Using a torque wrench (not an impact wrench) with a 5/8-inch hex drive, tighten the retainer 225 lbf·ft (305 N·m).

3. After tightening the retainer, remove it from the pitman arm and check the distance between the end of the output shaft and the end of the splined surface of the pitman arm. See Ref. A, **Figs. 62** and **63**. This distance must be between 3/32 and 5/32 inch (2 to 4 mm). If it is not, remove the pitman arm, and check the splines on it for wear. Replace the pitman arm if necessary.
4. Install the pitman arm if it was removed; refer to steps 2.1 thru 2.3.
5. Following step 2.3, install and tighten the retainer. If the tab washer was installed, bend the tabs on it to lock the retainer in place. See **Fig. 62** (Ref. 3).
6. Connect the drag link to the pitman arm as follows:
   .1 Connect the pitman arm end of the drag link to the pitman arm, and install the castle nut on the ball stud at the pitman arm end. Check the drag link for the correct length. Refer to the applicable drag link subject in Group 14 of this manual.
   .2 Tighten the castle nut 100 lbf·ft (136 N·m). If necessary, continue tightening the castle nut until a slot on the nut aligns with a hole in the ball stud.

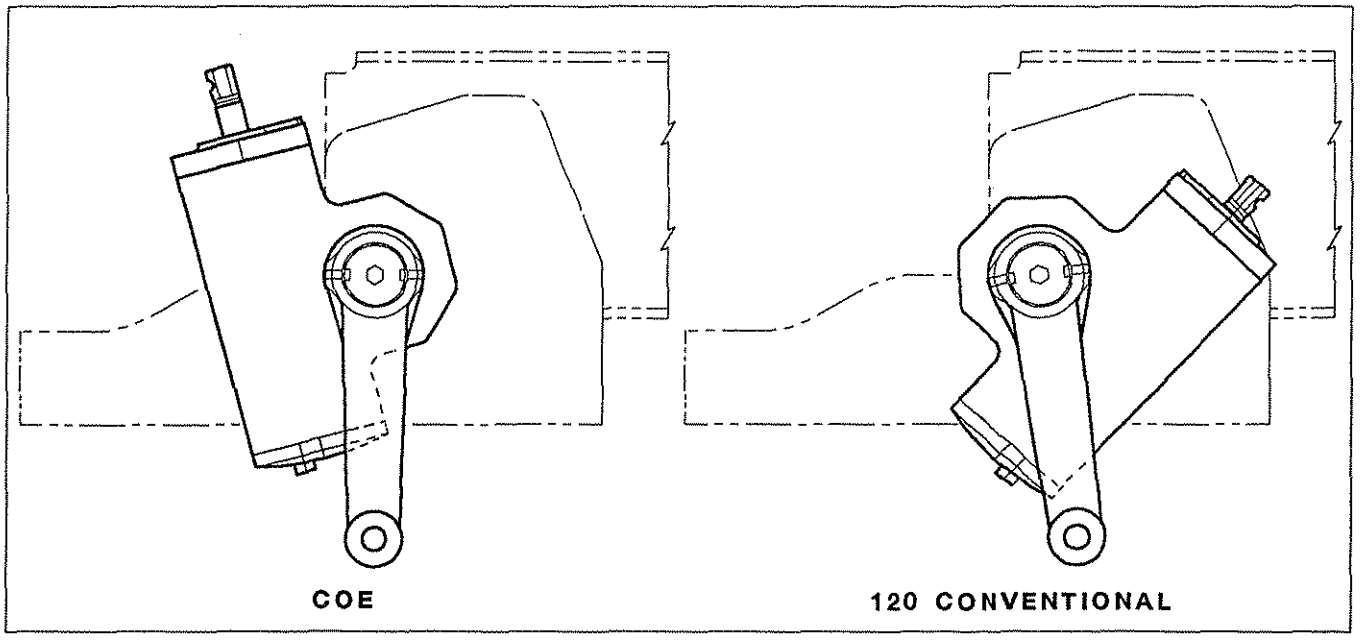
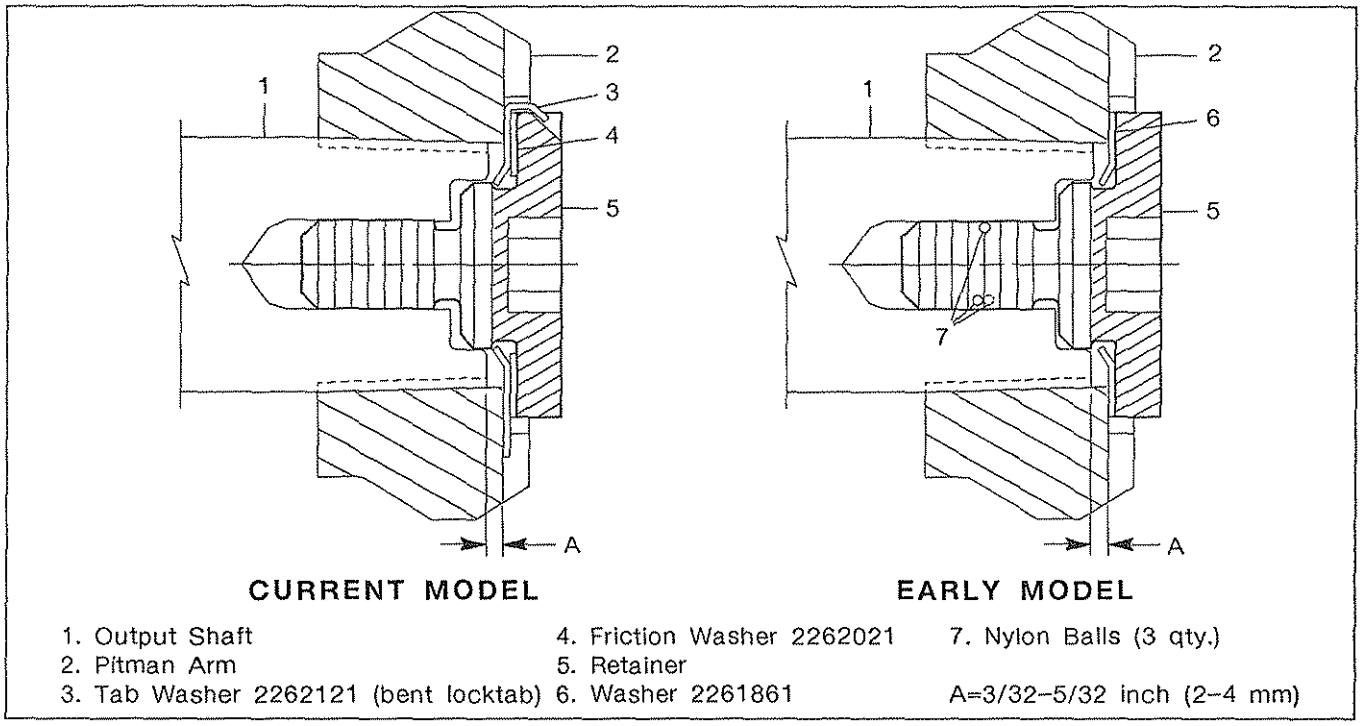


Fig. 61, Steering Gear and Pitman Arm Installations

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6



1. Output Shaft
2. Pitman Arm
3. Tab Washer 2262121 (bent locktab)
4. Friction Washer 2262021
5. Retainer
6. Washer 2261861
7. Nylon Balls (3 qty.)

A=3/32–5/32 inch (2–4 mm)

Fig. 62, Pitman Arm Installation, Cross Section

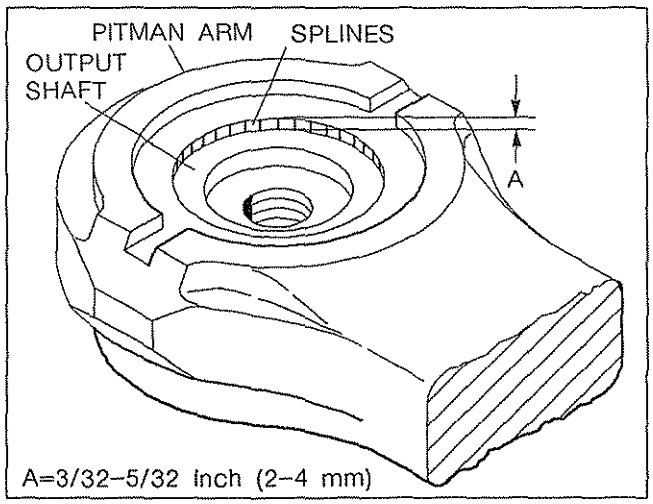


Fig. 63

.3 Install a new cotter pin through the ball stud and castle nut, and lock the cotter pin in place.

.4 Wipe the grease fittings clean at the ball stud, and fill the ball stud with chassis grease, using a pressure gun.

.5 Tighten the pinch bolt nut on the drag link 55 lbf·ft (75 N·m).

7. Connect the steering driveline to the steering gear input shaft as follows:

.1 Clean the steering gear input shaft and the inside of the steering driveline yoke.

.2 Apply Locquic General Purpose Primer T to the steering gear input shaft. Let dry for five minutes.

.3 Apply a bead of Loctite No. 680 adhesive to the inside surface of the steering driveline yoke.

.4 Slide the yoke onto the input shaft, and install the yoke pinch bolt and a new pinch bolt nut. Tighten the pinch bolt nut to 60 lbf·ft (80 N·m).

.5 Apply white Torque Seal F-900 to the exposed pinch bolt threads and the locknut tips.

8. Connect the hydraulic lines to the gear, as marked earlier, or as shown in **Fig. 65**, under "Specifications." Tighten the nut on each fitting finger-tight, then, with a wrench, tighten the nut until there is firm resistance. Tighten the nut one-sixth turn more.

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

9. Position the steering wheel so that the king-spoke—the narrow spoke on some wheels, or the spoke with the manufacturer's name imprinted on the underside—points directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees). Refer to **Fig. 64**.

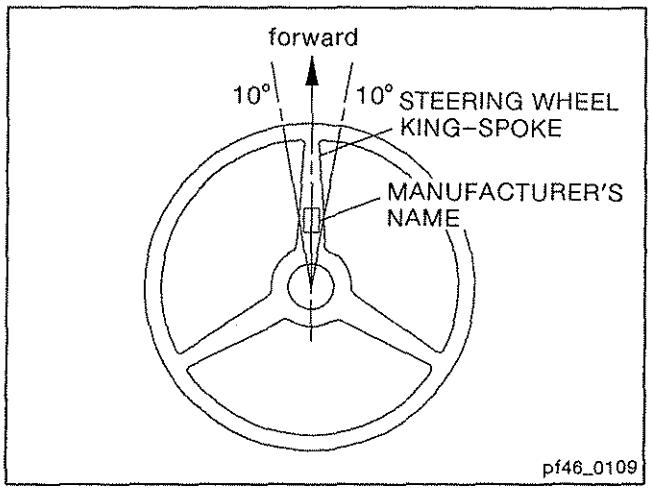


Fig. 64

CAUTION: When bleeding air from the hydraulic system, and any time during operation of the system, failure to keep the power steering reservoir fluid level maintained above the "add" mark on the dipstick could result in damage to the power steering pump and improper operation of the power steering system.

10. Fill and bleed the system as follows:

    .1 Fill the power steering reservoir with lubricant. Refer to the "Charts and Specifications" section of the Freightliner *COE and 120 Conventional Maintenance Manual* for lubrication specifications.

    .2 Start the engine and operate it at fast idle, adding fluid to the reservoir as needed.

    .3 Turn the steering wheel through a full left and right turn. Check the hoses and fittings for leaks. Replace leaking hoses, and tighten loose fittings, as necessary. Turn the steering wheel through three more full left and right turns, or until all air is removed from the hydraulic system (no air bubbles appear in the reservoir) and the fluid in the reservoir is maintained at the "full" mark on the dipstick.

11. Adjust the relief valve plungers, as follows:

    .1 Check the settings of the axle stops (and adjust them if necessary), using the instructions in the front axle wheel alignment subject in Group 10 of this manual.

    .2 Install a flow meter kit in the supply line from the pump to the steering gear. Make sure that the flow meter can be pressurized. Warm the power steering fluid to operating temperature. For instructions refer to the subject covering hydraulic power steering system checking, testing, and troubleshooting, in Group 14 of this manual.

    .3 With the engine at idle, have someone turn the steering wheel to the right-turn full-lock position. Check the pressure gauge.

CAUTION: As soon as pump relief pressure is reached (as described below), release the steering wheel from the full-lock position. Do not maintain pump relief pressure for longer than 5 seconds, or damage to the system may result because of high heat. Never let the oil temperature exceed 180°F (82°C).

    If the pressure gauge reading is less than 1575 psi (10 852 kPa), back out the relief valve plunger (at the top of a COE-mounted gear, or at the bottom of a 120 Conventional-mounted gear) until the pressure reading is between 1575 psi (10 852 kPa) and 1925 psi (13 262 kPa) pump relief pressures.

    If system pressure is more than the maximum pump relief pressure, repair the power steering pump. Refer to the power steering pump subject in Group 14 of this manual for repair instructions.

    .4 Release the steering from the right-turn full-lock position, enough to allow insertion of a 1/16- to 1/8-inch (1.6 to 3.2 mm) thick flatwasher between the axle beam and the right-side axle stop pin.

    .5 Bring the steering back to the right-turn full-lock position, against the flatwasher. Immediately tighten the relief valve plunger (at the top of a COE-mounted gear, or at the bottom of a 120 Conventional-mounted gear) until the pressure gauge reading drops to about 600 psi (4137 kPa).

    .6 With the engine at idle, have someone turn the steering wheel to the left-turn full-lock position. Adjust the relief valve plunger at the bottom of a COE-mounted gear, or at the top of a 120

SHEPPARD INTEGRAL POWER STEERING GEAR, MODEL 392S SERIES 6

Conventional-mounted gear, using the procedures in steps 11.3 through 11.5, above (but for the left-turn full-lock position).

12. Drive the vehicle, or take a test ride with the driver. Check the steering wheel king-spoke position. If, during straight-ahead driving on a level road, the steering wheel king-spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock ± 10 degrees), remove the steering wheel; then, position it so the king-spoke points directly toward the front of the vehicle, following the instructions in Group 14 of this manual.

SPECIFICATIONS

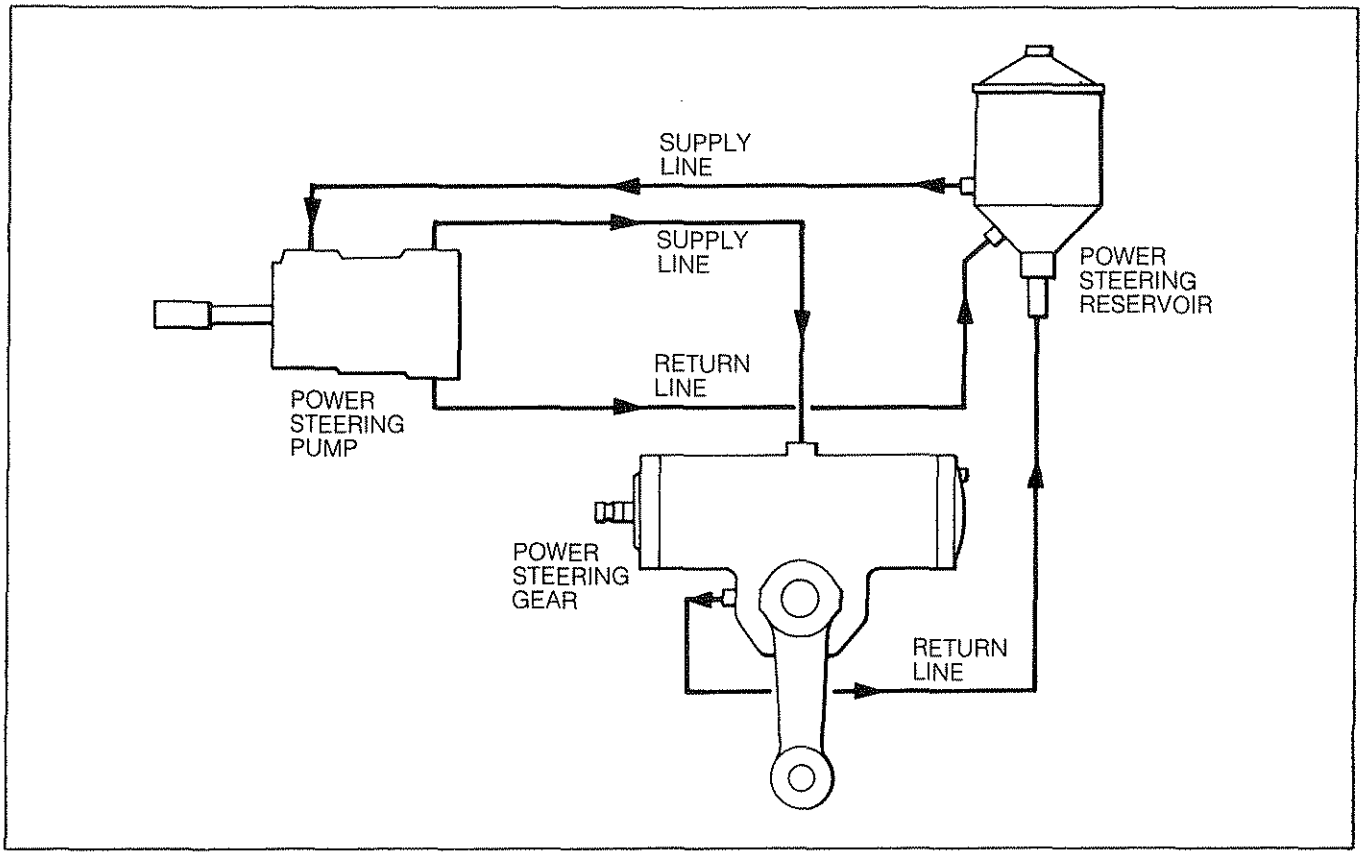


Fig. 65, Plumbing Diagram

DESCRIPTION		BOLT OR NUT SIZE	GRADE	TORQUE lbf·ft (N·m)
Model 392S Series 6	Bearing Cap Bolts	5/16–24	—	20 (27)
	Cylinder Head Bolts	5/16–24	—	20 (27)
	Pinion Gear Cover Bolts	1/2–20	—	90 (122)
Pitman Arm Retainer		—	—	225 (305)
Steering Gear Mounting-Bolt Nuts		7/8–14	8	350 (475)*
Relief Valve Ball Seats		—	—	See the text.

Table 1, Steering Gear Torque Values

* For nuts that are wax coated and cadmium plated, or for hexbolts that have phosphate- and oil-coated threads. For dry theads, refer to the Bolt Torque Specification Chart in the Freightliner *COE and 120 Conventional Maintenance Manual*.

SHEPPARD M-100 STEERING GEAR

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Service Operations

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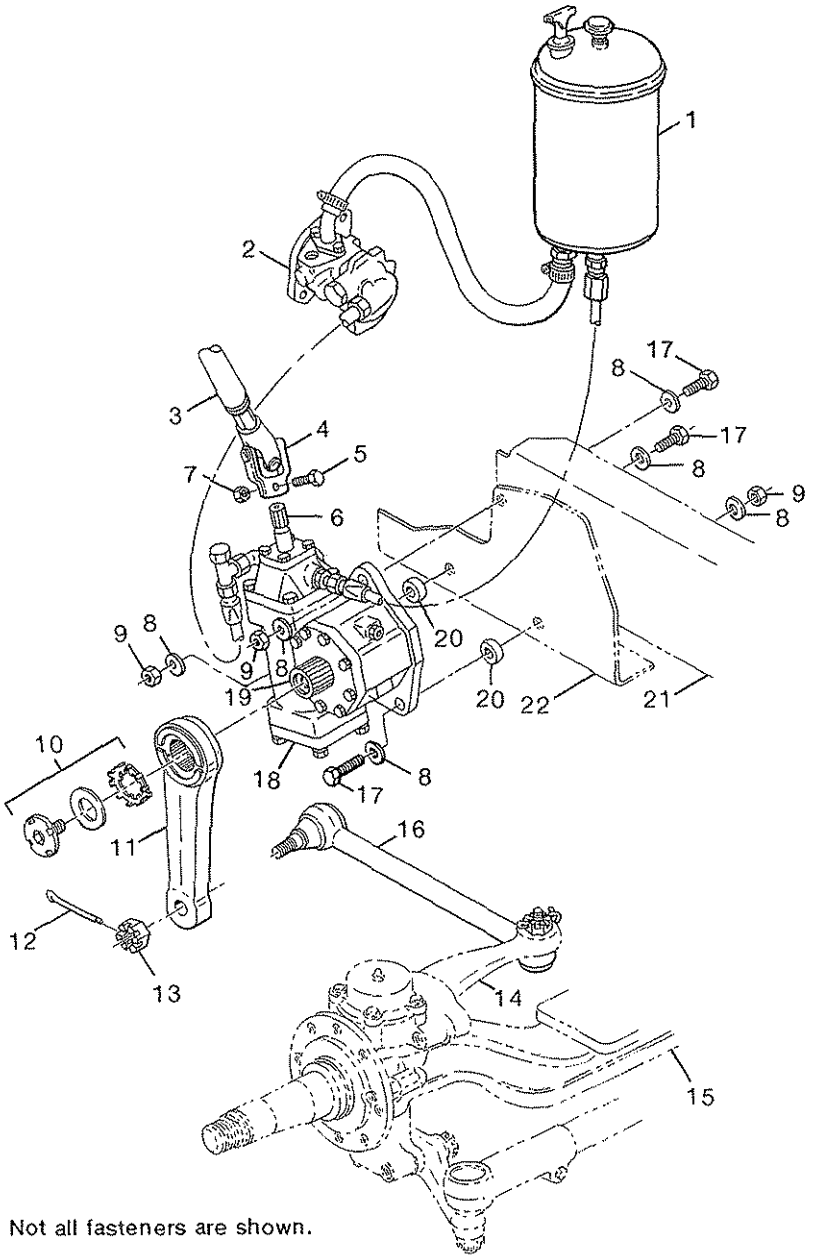
SHEPPARD M–100 STEERING GEAR

GENERAL DESCRIPTION

The Sheppard M–100 integral power steering gear provides full-time hydraulic steering. This gear is installed as an option on COEs and 120 Conventionals with a front axle capacity of up to 14,000 lbs (6350 kg).

The steering gear is mounted on the left frame rail. It connects the steering driveline to an input (actuating) shaft that is connected to an output (sector) shaft and the pitman arm. See **Fig. 1** (COEs) or **Fig. 2** (120 Conventionals).



1. Power Steering Reservoir
2. Power Steering Pump
3. Steering Driveline
4. Lower End Yoke
5. Pinch-Bolt
6. Actuating (Input) Shaft
7. Pinch-Bolt Nut
8. Washer (6 qty.)
9. Hexnut (3 qty.)
10. Pitman Arm Retainer Assembly
11. Pitman Arm
12. Cotter Pin
13. Castle Nut
14. Axle Steering Arm
15. Front Axle
16. Drag Link
17. Hexbolt (3 qty.)
18. Steering Gear
19. Sector (Output) Shaft
20. Spacer (3 qty.)
21. Frame Rail
22. Frame Extension

NOTE: Not all fasteners are shown.

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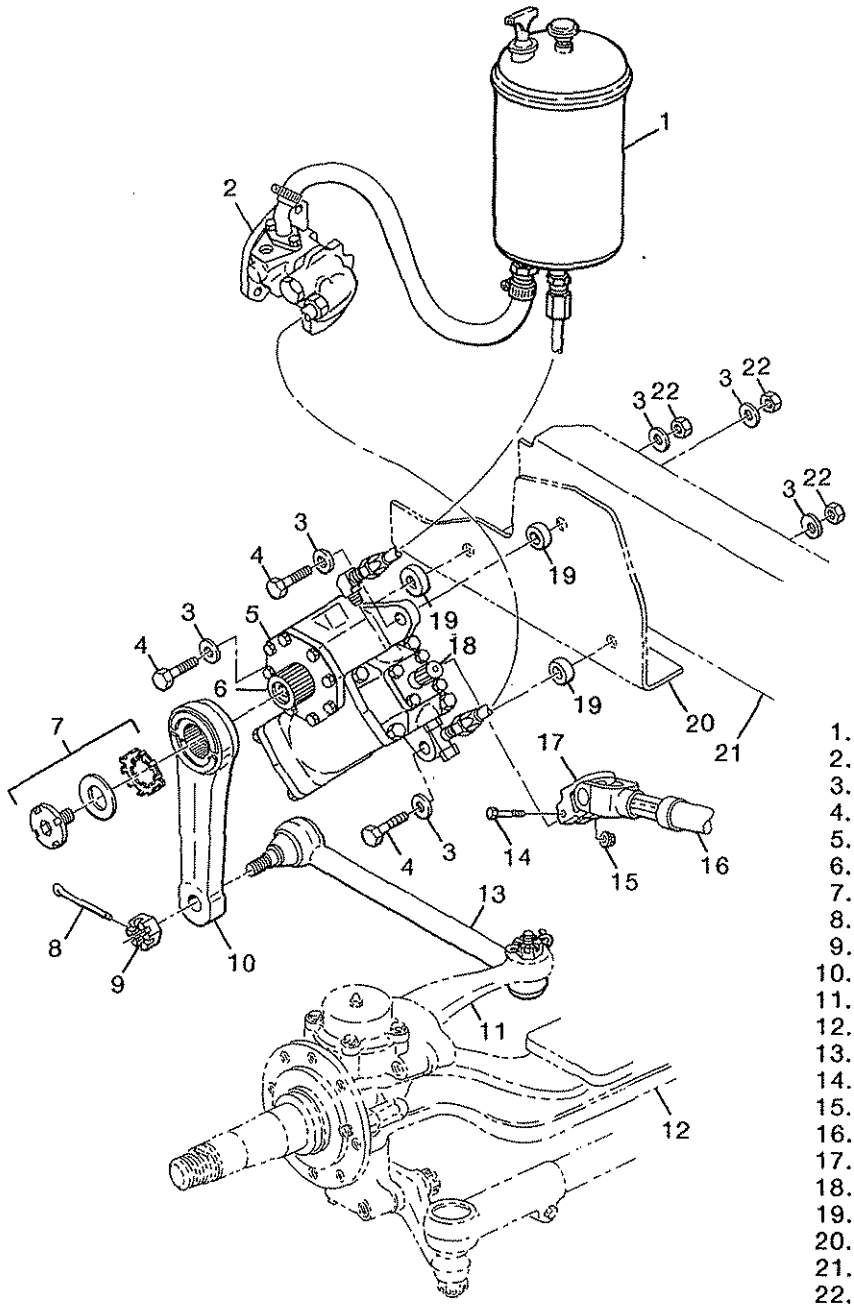
Fig. 1, Sheppard Integral Power Steering Gear Installation, COE

SHEPPARD M-100 STEERING GEAR



1. Power Steering Reservoir
2. Power Steering Pump
3. Washer (6 qty.)
4. Hexbolt (3 qty.)
5. Steering Gear
6. Sector (Output) Shaft
7. Pitman Arm Retainer Assembly
8. Cotter Pin
9. Castle Nut
10. Pitman Arm
11. Axle Steering Arm
12. Front Axle
13. Drag Link
14. Pinch-Bolt
15. Pinch-Bolt Nut
16. Steering Driveline
17. Lower End Yoke
18. Actuating (Input) Shaft
19. Spacer (3 qty.)
20. Frame Extension
21. Frame Rail
22. Hexnut (3 qty.)

NOTE: Not all fasteners are shown.

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Fig. 2, Sheppard Integral Power Steering Gear Installation, 120 Conventional

SHEPPARD M–100 STEERING GEAR

PRINCIPLES OF OPERATION (See Fig. 3)

When the steering wheel is turned, the force is transmitted to the steering gear actuating shaft (Ref. 1) via the steering driveline. The input shaft is connected to the rotary valve (Ref. 3) and a torsion bar (Ref. 2). When the input shaft turns, the twisting force on the torsion bar turns the rotary valve, which causes the fluid pressure to build up at one end of the piston (Ref. 6). The rotary valve shaft (Ref. 4) fits into one end of the piston, and the fluid pressure build up, together with the recirculating ball mechanism, forces the piston to move in one direction inside the bore of the gear housing. The rack teeth (Ref. 8) on the piston mesh with the teeth on the sector shaft (Ref. 9), so the sector shaft rotates when the piston moves. When the sector shaft turns, it moves the pitman arm (which is connected to the sector shaft). The pitman arm, in turn, connects to the vehicle's steering linkage, which turns the wheels.

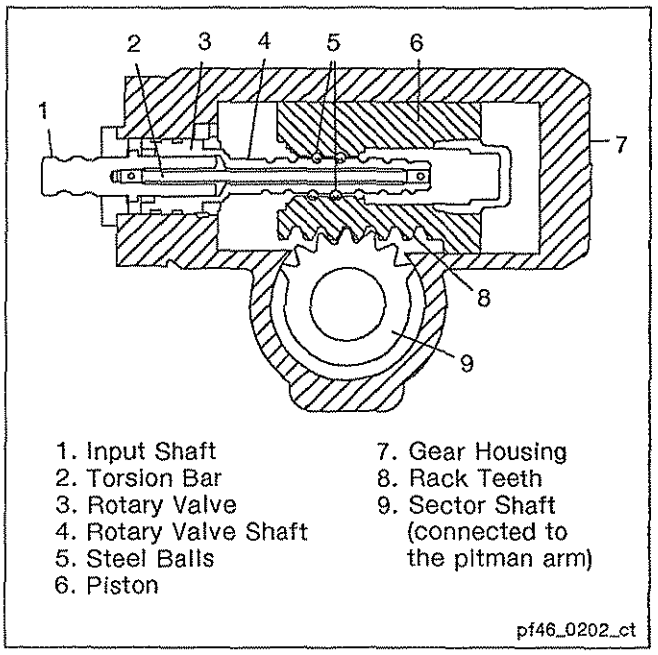


Fig. 3, Steering Gear, Sectional View

SERVICE OPERATIONS

STEERING GEAR REMOVAL (Refer to **Fig. 4** or **5**)

IMPORTANT: Before removing the steering gear, refer to "Troubleshooting" to identify the problem.

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where the work is to be done. Apply the vehicle parking brakes and chock the tires.

2. Clean all outside dirt from around the fittings and hose connections.

3. Drain the power steering system. Disconnect all hydraulic lines from the gear, marking the lines for later assembly reference. Seal the lines and the fittings to keep dirt out.

4. Disconnect the drag link from the pitman arm as follows:

   .1 At the pitman arm end of the drag link, remove the cotter pin and the castle nut from the ball stud of the pitman arm.

   .2 Using a ball stud removal tool, disconnect the drag link assembly from the pitman arm.

5. Disconnect the steering driveline from the steering gear input shaft as follows:

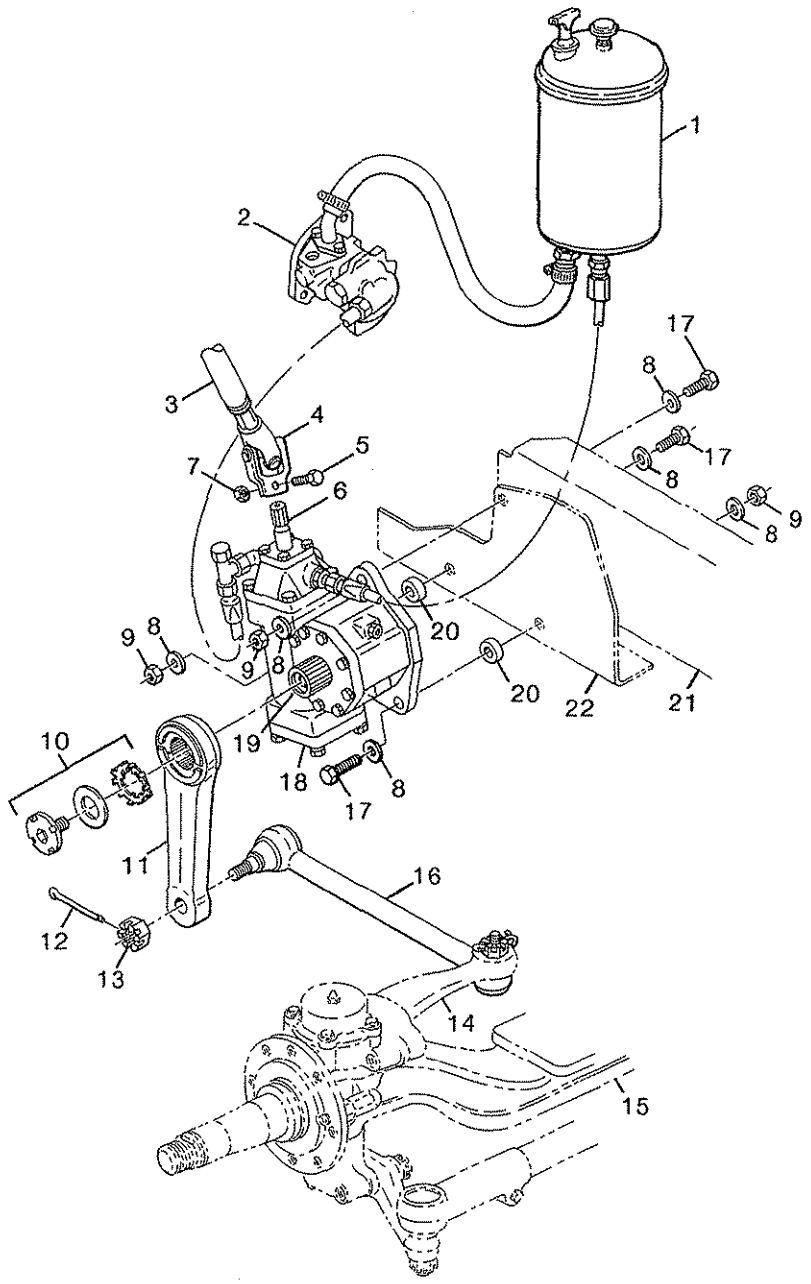
   .1 Remove the pinch-bolt nut and the pinch bolt from the lower end of the steering driveline yoke.

   CAUTION: Do not pound the U-joint or input shaft coupling on or off the input shaft. Internal damage to the steering gear can result.

   .2 Remove the steering driveline yoke from the steering gear input shaft. If you cannot remove the yoke with a light application of pressure, then it is secured with adhesive. Weaken the adhesive bond by applying 300°F (150°C) heat to the base of the yoke.

6. If factory alignment marks on the steering gear output shaft and the pitman arm are not present, center the steering gear by

SHEPPARD M–100 STEERING GEAR



1. Power Steering Reservoir
2. Power Steering Pump
3. Steering Driveline
4. Lower End Yoke
5. Pinch-Bolt
6. Actuating (Input) Shaft
7. Pinch-Bolt Nut
8. Washer (6 qty.)
9. Hexnut (3 qty.)
10. Pitman Arm Retainer Assembly
11. Pitman Arm
12. Cotter Pin
13. Castle Nut
14. Axle Steering Arm
15. Front Axle
16. Drag Link
17. Hexbolt (3 qty.)
18. Steering Gear
19. Sector (Output) Shaft
20. Spacer (3 qty.)
21. Frame Rail
22. Frame Extension

NOTE: Not all fasteners are shown.

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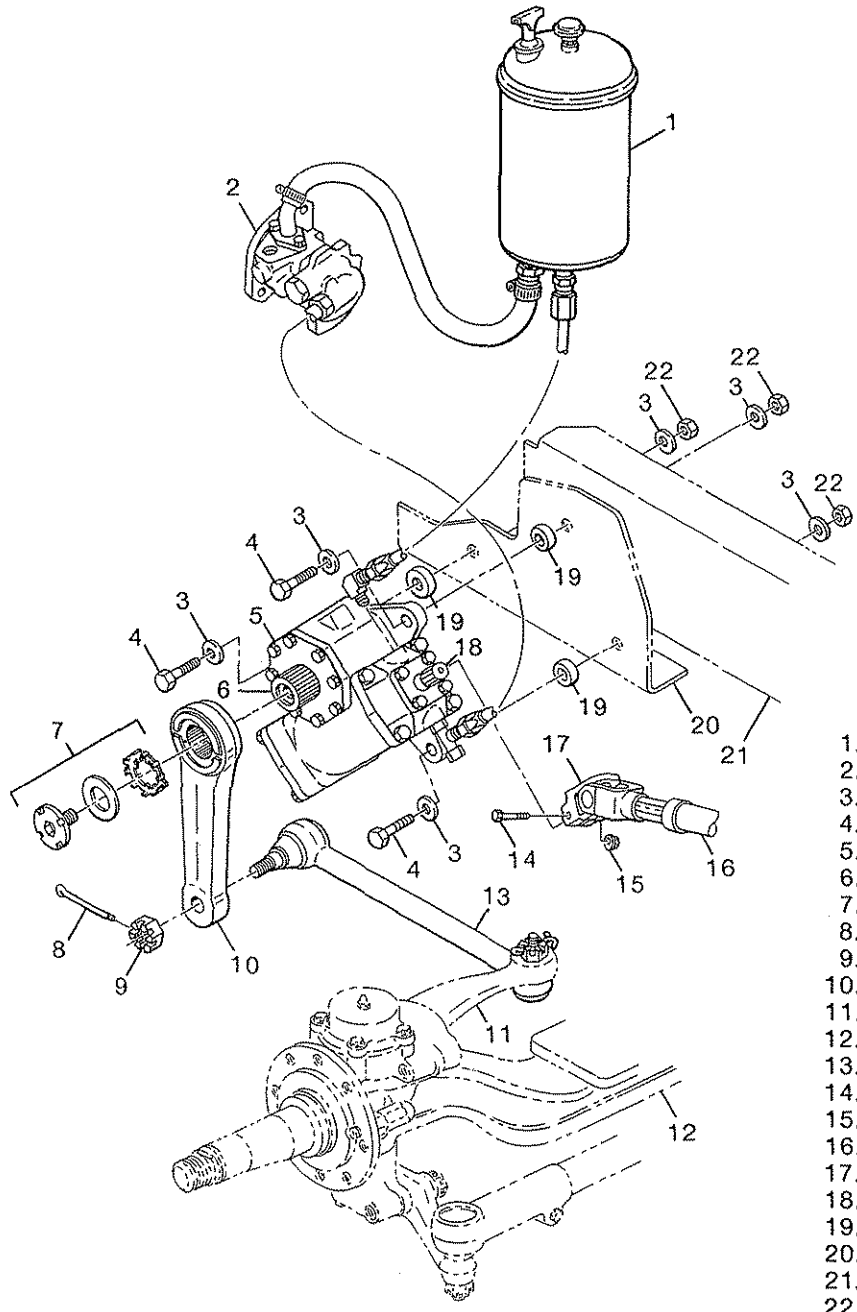
Fig. 4, Sheppard Integral Power Steering Gear Installation, COE

SHEPPARD M-100 STEERING GEAR



1. Power Steering Reservoir
2. Power Steering Pump
3. Washer (6 qty.)
4. Hexbolt (3 qty.)
5. Steering Gear
6. Sector (Output) Shaft
7. Pitman Arm Retainer Assembly
8. Cotter Pin
9. Castle Nut
10. Pitman Arm
11. Axle Steering Arm
12. Front Axle
13. Drag Link
14. Pinch-Bolt
15. Pinch-Bolt Nut
16. Steering Driveline
17. Lower End Yoke
18. Actuating (Input) Shaft
19. Spacer (3 qty.)
20. Frame Extension
21. Frame Rail
22. Hexnut (3 qty.)

NOTE: Not all fasteners are shown.

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Fig. 5, Sheppard Integral Power Steering Gear Installation, 120 Conventional

SHEPPARD M–100 STEERING GEAR

turning the input shaft through full travel. Count the number of turns from stop to stop. Then, starting at the end of travel, turn the input shaft back half the number of turns. Using a marking pen or paint, mark the pitman arm and sector shaft with a line at a right angle to the input shaft centerline.

7. Clean the entire assembly before removing the gear.

WARNING: The steering gear weighs about 80 lbs (36 kg) dry. Use caution when removing, lifting, or carrying the steering gear.

8. Remove the fasteners attaching the steering gear to the frame rail and frame rail extension. Remove the spacers and the steering gear, and place the steering gear on a clean surface.

STEERING GEAR INSTALLATION
(Refer to **Fig. 4** or **5**)

1. On COEs, from the inboard side, insert two hexbolts and washers (**Fig. 4**, Refs. 17 and 8) through the frame rail. Install a spacer on each hexbolt, then place the steering gear on the frame rail. Install the third hexbolt (Ref. 17) from the outboard side of the frame rail. Install the washers and nuts, and tighten the nuts 388 lbf·ft (526 N·m).

   On 120 Conventionals, align the holes in the steering gear housing with the holes in the forward frame extension. Place a washer over each hexbolt, and install the three hexbolts from the outboard side of the frame rail. Install a spacer (**Fig. 5**, Ref. 19) on each hexbolt, between the steering gear and the frame extension. Install a washer and nut on the end of each hexbolt, and tighten the nuts 388 lbf·ft (526 N·m).

2. Connect the steering driveline to the steering gear input shaft as follows:

   .1 Clean the steering gear actuating shaft and the inside of the steering driveline yoke.

   .2 Slide the yoke onto the input shaft, and install the yoke pinch bolt and a new pinch-bolt nut. Tighten the pinch-bolt nut 55 lbf·ft (75 N·m).

   .3 Apply white Torque Seal® F–900 to the exposed pinch-bolt threads and the locknut tips.

3. Connect the hydraulic lines to the gear, as marked earlier, or as shown in **Fig. 85**, under "Specifications." Tighten the nut on each fitting finger-tight, then, with a wrench, tighten the nut until there is firm resistance. Tighten the nut one-sixth turn more.

4. Position the steering wheel so that the spokes point within ±10 degrees of the 4 o'clock and 8 o'clock positions. See **Fig. 6**.

5. Bleed the steering system as follows:

WARNING: For steps 5.1 and 5.2, do not turn the steering wheel. Doing so can cause air to enter the system. This could result in an unexpected loss of power steering assist, which could cause personal injury or property damage.

   .1 Fill the power steering reservoir nearly full with hydraulic fluid. For lubricant specifications, refer to Group 14 of the *COE and 120 Conventional Maintenance Manual.*

   .2 Crank the engine for 10 seconds, without allowing it to start; if the engine does start, shut it down immediately. Check and fill the reservoir as needed.

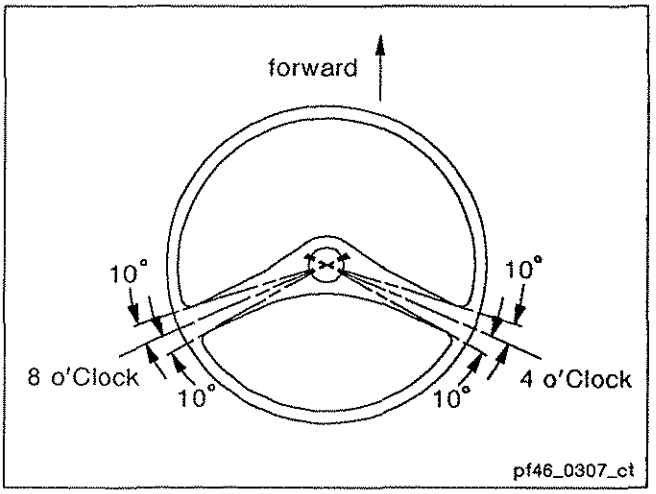


Fig. 6

SHEPPARD M–100 STEERING GEAR

Repeat this procedure three times, each time checking and filling the reservoir.

WARNING: Do not allow the fluid to drop significantly or run out of the reservoir. Doing so can cause air to enter the system. This could result in an unexpected loss of power steering assist, which could cause personal injury or property damage.

.3 Start the engine and run it at fast idle speed.

.4 With the engine running, turn the steering wheel from full left to full right, and back again. Do this three times, then put the wheels straight ahead.

.5 Loosen the manual bleed screw (see **Fig. 7**) at the pinion bore on the steering gear housing. Loosen the screw just enough to let the lubricant flow out.

.6 Check the lubricant for bubbles.

If the lubricant is bubble-free, tighten the manual bleed screw. Go to step 6.

If there are bubbles in the lubricant, tighten the manual bleed screw, then repeat steps 5.4 through 5.6, until the lubricant flow is bubble-free.

.7 Shut off the engine.

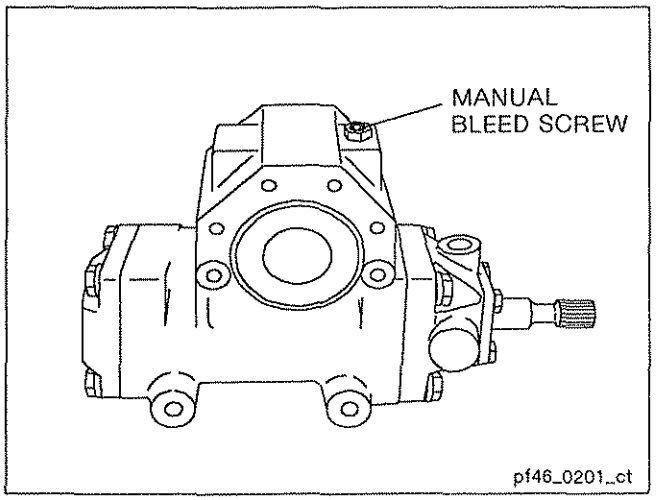


Fig. 7

6. Connect the drag link to the pitman arm as follows:

.1 Connect the pitman arm end of the drag link to the pitman arm, and install the castle nut on the ball stud at the pitman arm end.

.2 Tighten the castle nut 230 lbf·ft (312 N·m). If necessary, continue tightening the castle nut until a slot on the nut aligns with a hole in the ball stud.

.3 Install a new cotter pin through the ball stud and castle nut, and lock the cotter pin in place.

.4 Wipe the grease fittings clean at the ball stud, and fill the ball stud with chassis grease, using a pressure gun.

7. Adjust the relief valve plungers as follows:

.1 Check that there is at least 1/2-inch (13-mm) clearance between the tires and the suspension, frame, and brake parts, when both axle stops are contacted.

.2 Start the engine and warm the hydraulic system fluid to the normal operating temperature of 125° to 135°F (51° to 57°C).

WARNING: If the axle and axle stop make contact, release the steering wheel. Damage to steering components could occur and cause loss of steering control, resulting in possible personal injury or property damage.

.3 When the normal operating temperature is reached, and with the full weight of the vehicle on all wheels, have someone turn the steering wheel all the way to the left.

.4 Using a 1/8-inch (3.2-mm) piece of steel flat stock, check the clearance between the axle and the axle stop.

If the clearance isn't 1/8 inch (3.2 mm), return the front tires to the straight-ahead position and adjust the relief

SHEPPARD M–100 STEERING GEAR

valve plunger at the bottom (COEs) or the top (Conventionals) of the gear.

NOTE: Turning the plunger in will increase the clearance, and backing the plunger out will decrease the clearance.

IMPORTANT: Don't back out the plunger too far; it should never be above the surface of the plunger boss, or the steering gear will leak.

.5 Repeat steps 7.3 and 7.4 for a full right turn. Adjust the relief valve plunger at the other end of the gear.

8. Go to "Post-Service Checks," and do the checks as instructed.

STEERING GEAR DISASSEMBLY (Refer to **Fig. 8**)

1. Remove the pitman arm from the gear as follows:

   .1 Find the two retainer lock tabs that are bent into the pitman arm retainer. See **Fig. 9.**

   .2 Bend the lock tabs out. Then, using a 5/8-inch hex socket wrench and a piece of 5/8-inch hexagon steel stock, remove the pitman arm retainer. Remove the friction washer and the tab washer.

   .3 Using a puller, remove the pitman arm from the sector shaft.

2. Remove the bolts that attach the mounting bracket (if equipped) to the steering gear. See **Fig. 10.** Then remove the mounting bracket from the gear.

3. Using an allen wrench, remove the dirt shield from the end of the sector shaft. See **Fig. 11.**

4. Remove the bolts that attach the sector shaft cover to the gear housing. See **Fig. 12.**

5. Using a soft hammer and drift, tap the end of the sector shaft to loosen the sector shaft cover (**Fig. 13**), then carefully slide the sector shaft and sector shaft cover out of the gear housing. Refer to **Fig. 14.** Pull the sector shaft out of the cover.

6. Remove and discard the O-ring and the three-piece seal assembly from the sector shaft cover. See **Fig. 15.**

7. Remove the relief valve plungers from the cylinder head and the bearing cap. See **Fig. 16.**

8. Using a chisel, nail punch, or screwdriver, make corresponding marks on the gear housing and the bearing cap for later assembly reference. See **Fig. 17.**

9. Remove the cylinder head from the gear housing. See **Fig. 18.** Discard the O-ring and the tetra seal (**Fig. 8,** Refs. 24 and 15).

10. Remove the M14 x 2 bolts that attach the bearing cap to the gear housing (see **Fig. 19**), then turn the actuating shaft so that the bearing cap is free from the gear housing.

CAUTION: Don't let the actuating shaft bind once the bearing cap is free of the gear housing, or you may damage the shaft. Refer to **Fig. 20.**

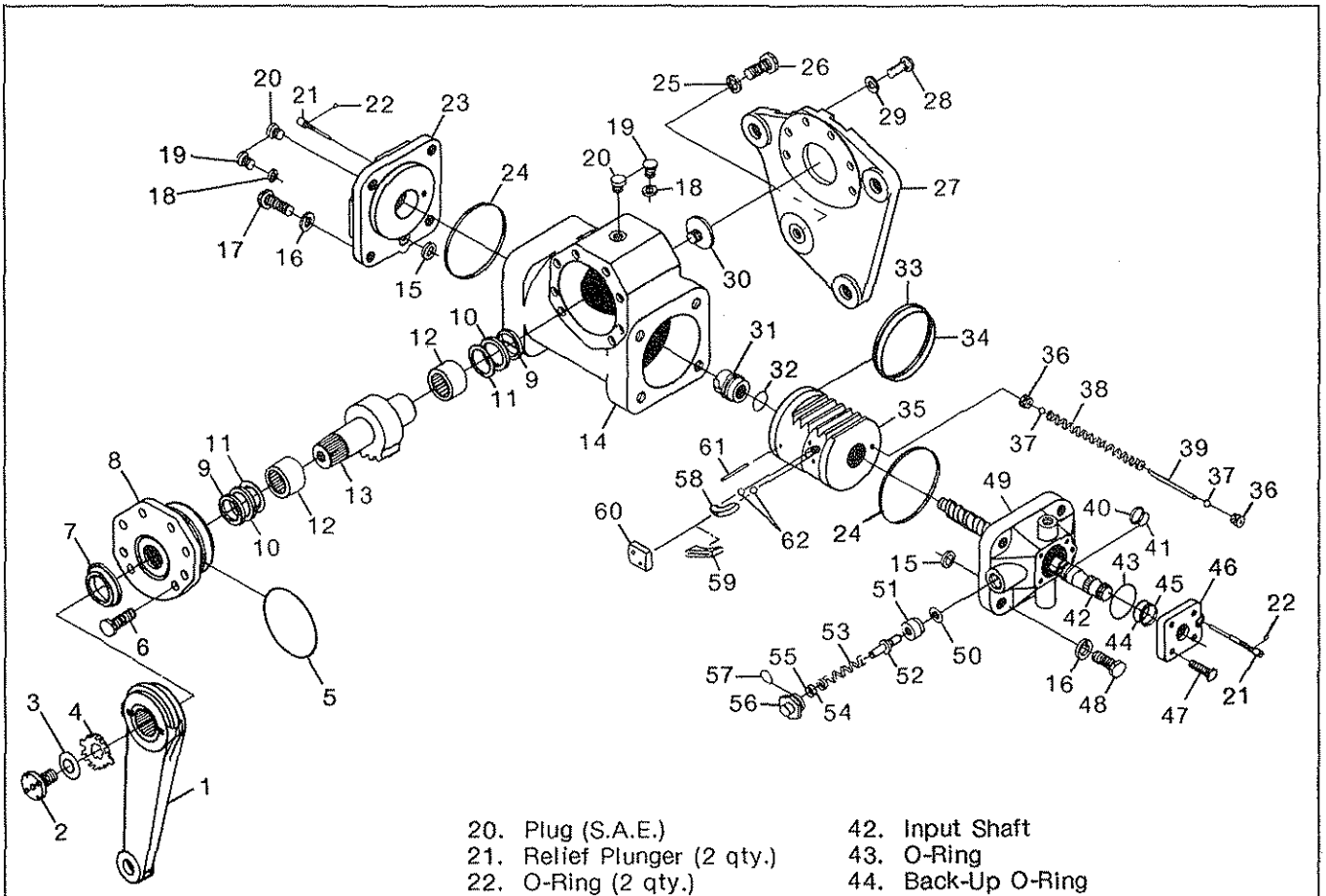
11. Slide the piston and bearing cap assembly out of the gear housing until you can see the ball guide retainer. See **Fig. 21.**

IMPORTANT: If the gear has a non-bolted ball guide retainer, be sure to hold the retainer in place while removing the piston assembly from the gear housing, or the ball return guides will fall out, which could result in the loss of the steel balls.

12. Support the piston and bearing cap assembly with one hand, and hold the ball guide retainer in place with the other hand, as shown in **Fig. 22.** Then slide the piston and bearing cap assembly out of the gear housing.

13. Remove the ball guide retainer (**Fig. 23** or **24**) by either pulling it out, or removing the bolts from it, depending on how the gear is equipped.

SHEPPARD M–100 STEERING GEAR



1. Pitman Arm
2. Retainer
3. Friction Washer
4. Tab Washer
5. O-Ring
6. Hexbolt, M12 x 1.75 (8 qty.)
7. Rubber Boot
8. Sector Shaft Cover
9. Sector Shaft Seal (2 qty.)
10. O-Ring (2 qty.)
11. Spacer (2 qty.)
12. Roller Bearing (2 qty.)
13. Sector Shaft
14. Gear Housing
15. Tetra Seal (2 qty.)
16. Washer
17. Hexbolt, M14 x 2 (4 qty.)
18. Washer
19. Plug (metric)
20. Plug (S.A.E.)
21. Relief Plunger (2 qty.)
22. O-Ring (2 qty.)
23. Cylinder Head
24. O-Ring (2 qty.)
25. Washer
26. Hexbolt
27. Mounting Bracket (COEs only)
28. Hexbolt (6 qty.)
29. Washer
30. Dirt Shield
31. Piston Plug
32. O-Ring
33. Piston Ring
34. O-Ring
35. Piston
36. Relief Valve Seat (2 qty.)
37. Relief Valve Ball (2 qty.)
38. Spring
39. Plastic Rod
40. Seal Ring
41. Back-Up O-Ring
42. Input Shaft
43. O-Ring
44. Back-Up O-Ring
45. Dirt Seal Ring
46. Bearing Cap Cover
47. Hexbolt, M10 x 1.5 (4 qty.)
48. Hexbolt, M14 x 2 (4 qty.)
49. Bearing Cap
50. Strainer
51. Pressure Relief Seat
52. Pressure Relief Valve
53. Pressure Relief Spring
54. Spacer
55. Spacer
56. Pressure Relief Nut
57. O-Ring
58. Ball Return Guide (2 pieces)
59. Ball Guide Retainer
60. Ball Guide Retainer (bolted type)
61. Locking Pin
62. Steel Balls (24 qty.)

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Fig. 8, Steering Gear Parts

SHEPPARD M–100 STEERING GEAR

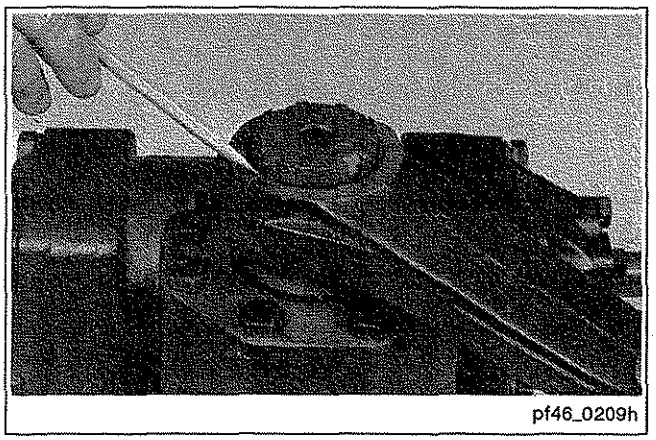

Fig. 9

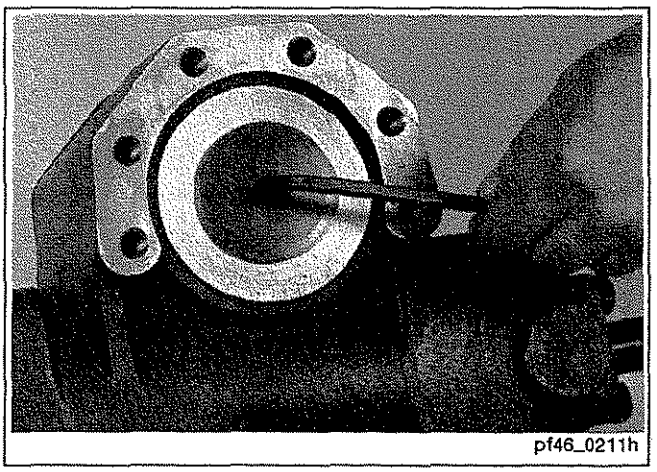

Fig. 11

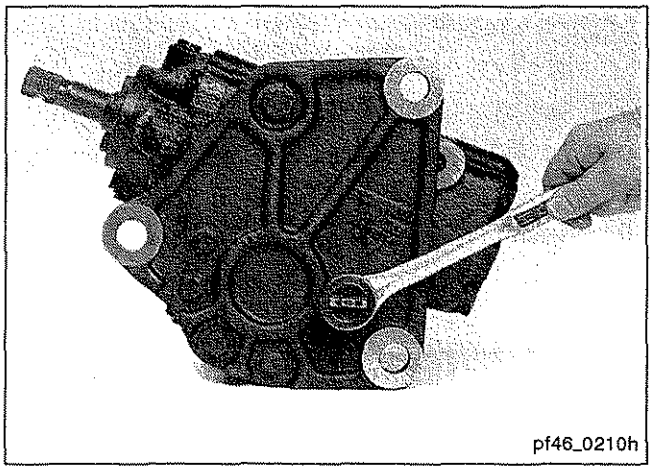

Fig. 10

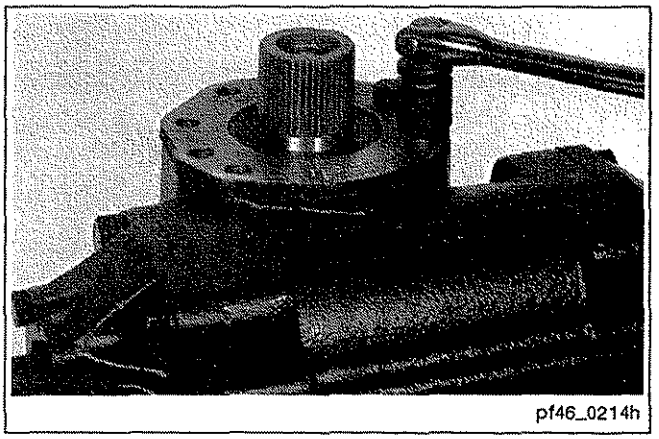

Fig. 12

14. Remove the ball return guide halves from the piston. See **Fig. 25.**

15. Remove the 24 steel balls from inside the piston by turning the piston over, and rotating the actuating shaft in and out of the piston. See **Fig. 26.** Be careful not to lose any of the steel balls; also make sure all 24 are removed.

16. Remove the input shaft and bearing cap assembly from the piston. See **Fig. 27.** Then remove the O-ring and tetra seal from the bearing cap. See **Fig. 28.**

17. Remove the four bolts that attach the bearing-cap cover to the bearing cap, then remove the bearing-cap cover. See **Fig. 29.**

18. Remove and discard the O-ring from inside the bearing-cap cover. See **Fig. 30.**

19. Remove and discard the dirt seal assembly from the bearing-cap cover by first removing the Teflon® seal ring, and then the back-up O-ring. See **Fig. 31.**

20. Remove the input shaft seals by first removing the outer Teflon seal ring, and then the back-up O-ring. See **Fig. 32.**

SHEPPARD M–100 STEERING GEAR

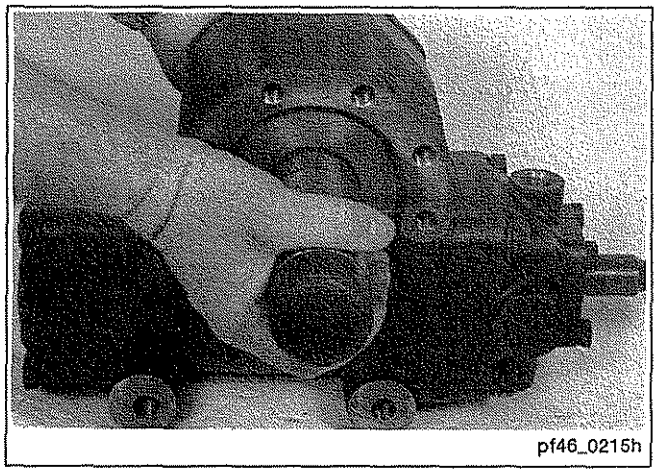

Fig. 13

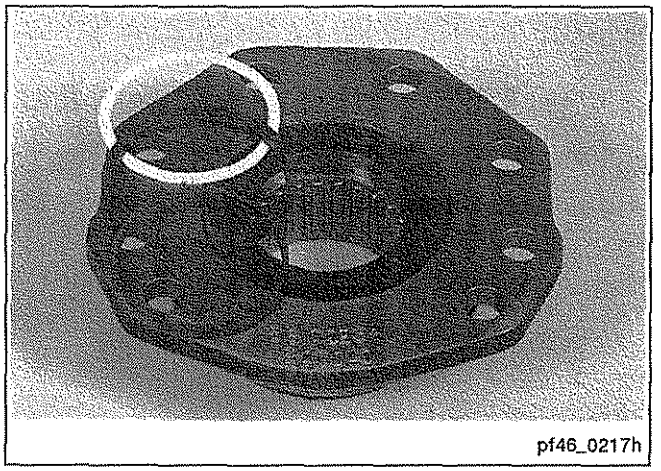

Fig. 15

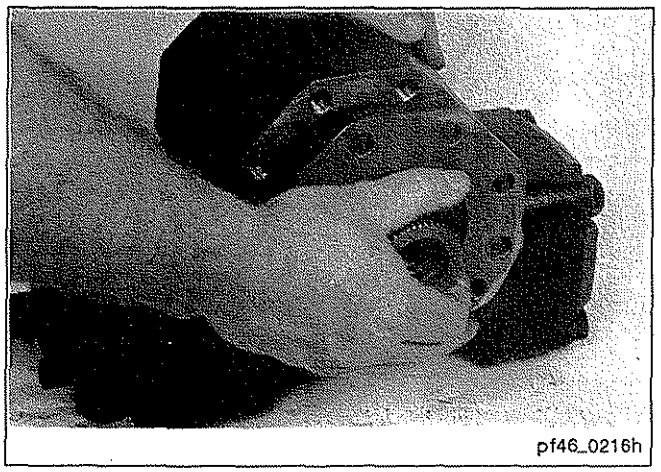

Fig. 14

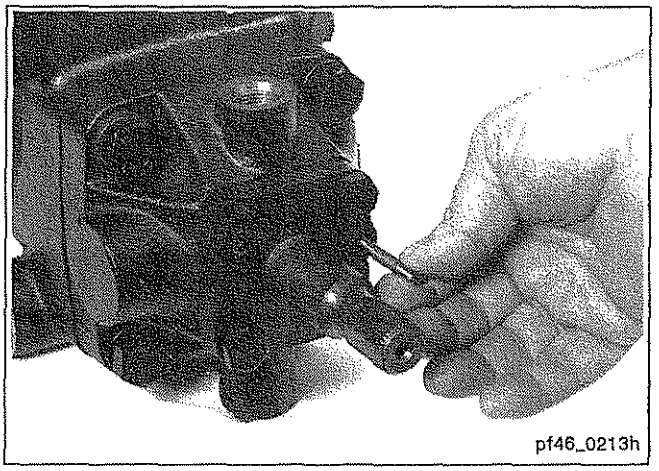

Fig. 16

CAUTION: The relief ball valves inside the piston are held in place by spring tension. Be careful when removing the relief valve seats from the piston to avoid personal injury or loss of the balls.

21. Using a 3/16-inch allen wrench, remove the relief valve seat from one end of the piston, then the steel ball, spring, and plastic rod. See **Fig. 33**.

22. Remove the relief valve seat from the other end of the piston.

23. Remove the Teflon seal ring and the back-up O-ring from the piston. See **Fig. 34.**

24. If needed, remove the end plug (**Fig. 35**) from the piston, by first drilling out the locking pin (**Fig. 8**, Ref. 61). Remove and discard the O-ring from the end plug.

25. Remove the roller bearing from the gear housing (**Fig. 36**), if needed, by pressing it out of the housing.

26. Using a puller, remove the roller bearing (if needed) from the sector shaft cover. See **Fig. 37**.

SHEPPARD M–100 STEERING GEAR

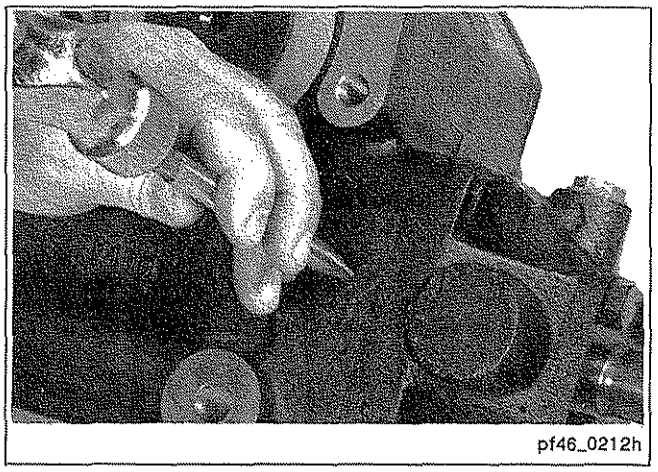

Fig. 17

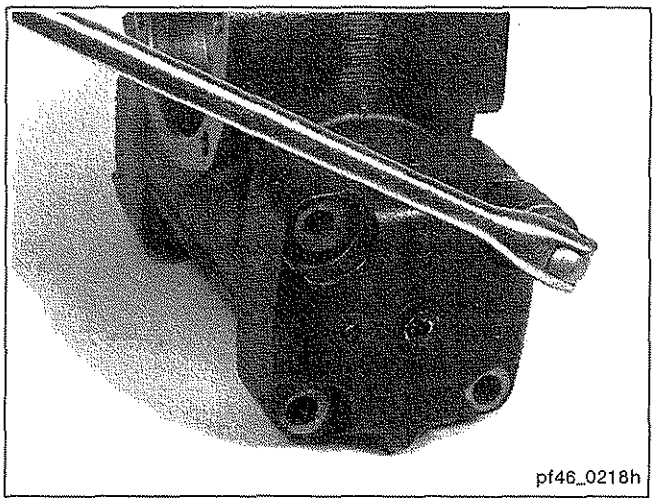

Fig. 18

STEERING GEAR INSPECTION

WARNING: Cleanliness is of the utmost importance. Dirt and foreign material in the steering system can cause damage and steering problems resulting in possible personal injury or property damage.

Also, commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

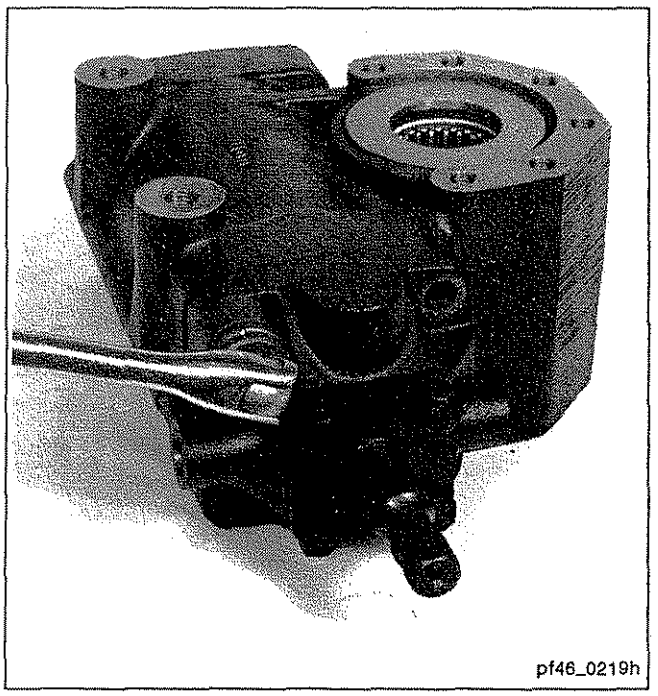

Fig. 19

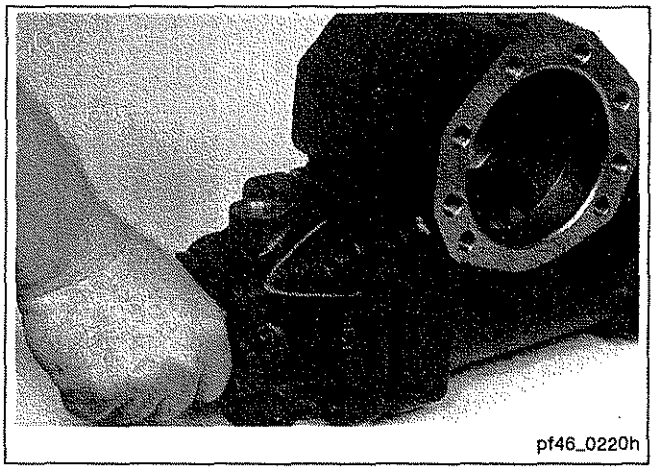

Fig. 20

1. Clean the machined parts one at a time, to avoid damage from bumping them together. Use a clean solvent to wash the parts, and dry them with compressed air.

SHEPPARD M–100 STEERING GEAR

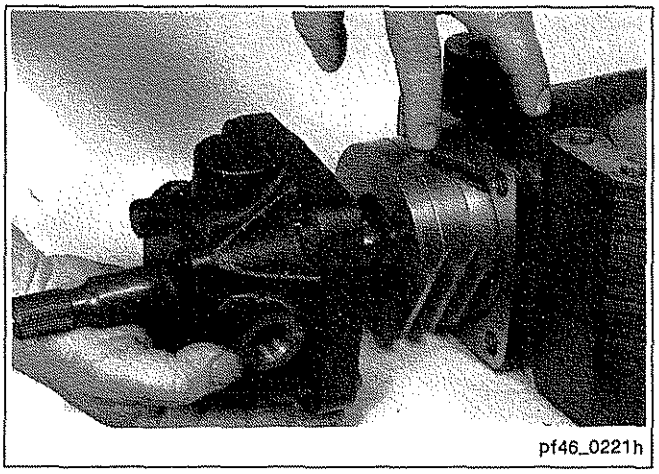

Fig. 21

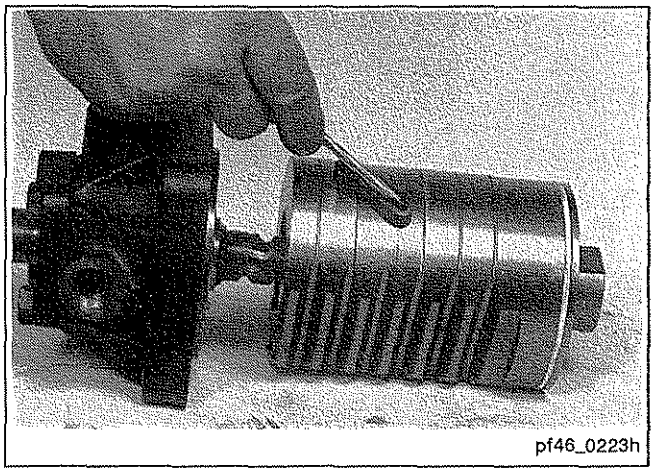

Fig. 23

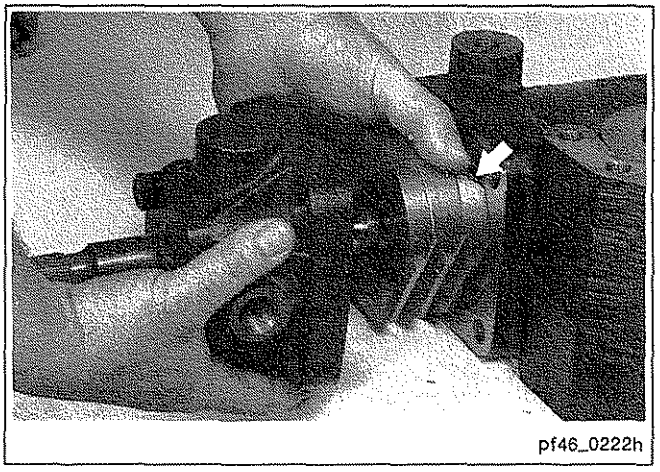

Fig. 22

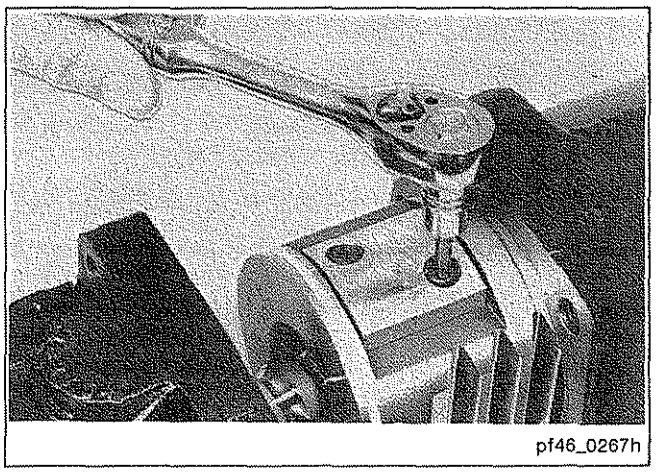

Fig. 24

2. Replace all the O-rings and seals whenever doing any kind of repair.

3. Carefully check all the steering gear parts. Replace worn parts, as well as any parts that show signs of stress or fatigue. Pay particular attention to the following:

   .1 Check the piston and steering gear housing for scoring. Scoring may be caused by high operating temperatures, air in the hydraulic system, or incorrect or contaminated lubricant.

CAUTION: Do not hone or bore out the cylinder bore. This will increase internal leakage.

If parts have minor scoring, polish them with a fine handstone or crocus cloth to allow free movement of the mating parts.

Don't be alarmed over minor scoring or scuffing of the piston or the steering gear housing. This will not affect the safety or operation of the steering gear.

SHEPPARD M–100 STEERING GEAR

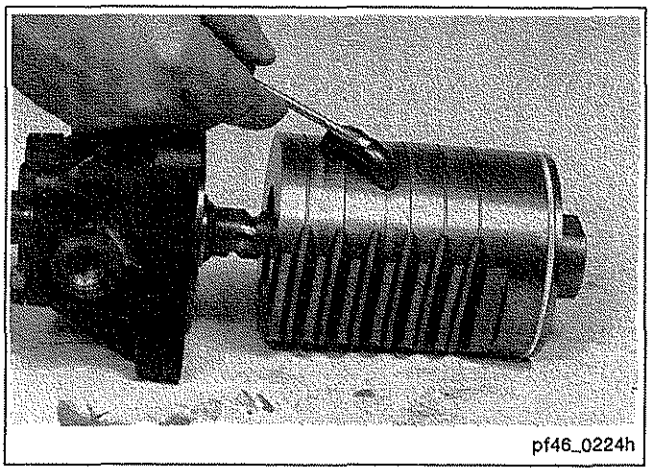
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Fig. 25

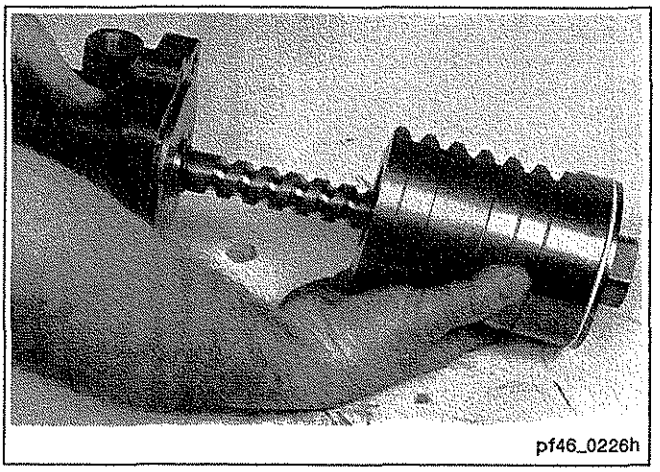
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Fig. 27

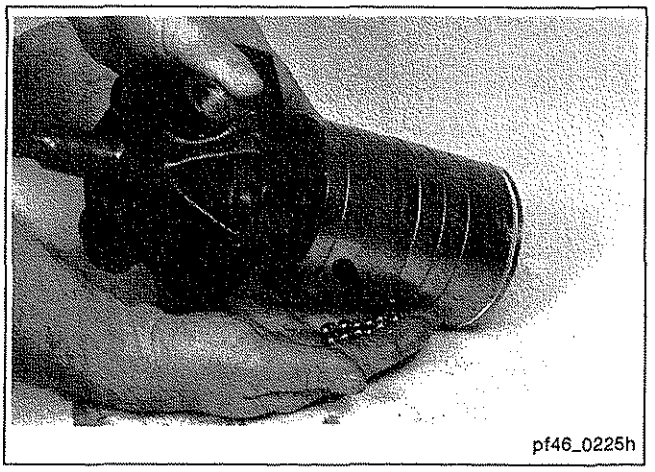
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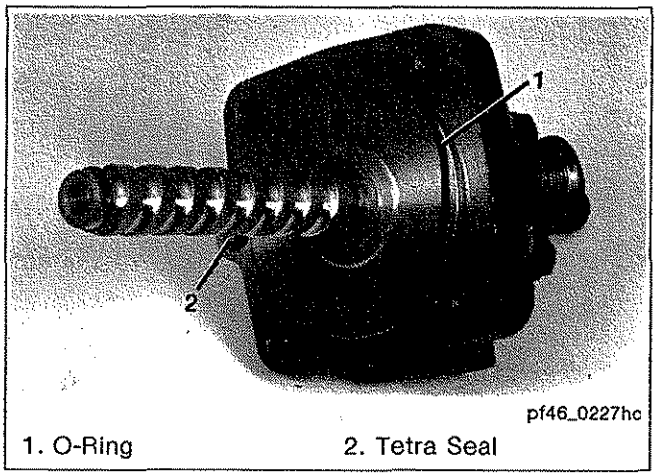
Fig. 26



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1. O-Ring 2. Tetra Seal

Fig. 28

If scoring is severe, leakage will affect steering reacting time; slow, binding, or uneven steering input will be noticeable. In this case, replace the damaged parts.

.2 Check the ball threads on the rotary valve shaft for wear. Thread wear can be caused by the following:

- Incorrect lubricant
- Overloading the steering gear
- Too low operating pressure
- Too low oil pressure
- Constant high temperature

.3 Look for wear or damage along the sealing surface of the actuating shaft. Replace the actuating shaft and the bearing cup assembly if the sealing surface is worn or damaged.

.4 Check the piston rack and the sector shaft pinion gear for cracked or broken gear teeth. Also, check the steering gear housing for cracks or breaks. Such conditions are signs of impact damage. Refer to step 4.4 for recommendations.

SHEPPARD M-100 STEERING GEAR

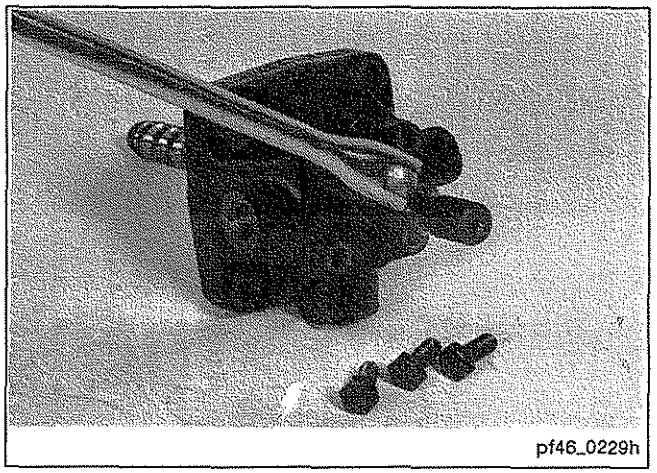

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Fig. 29

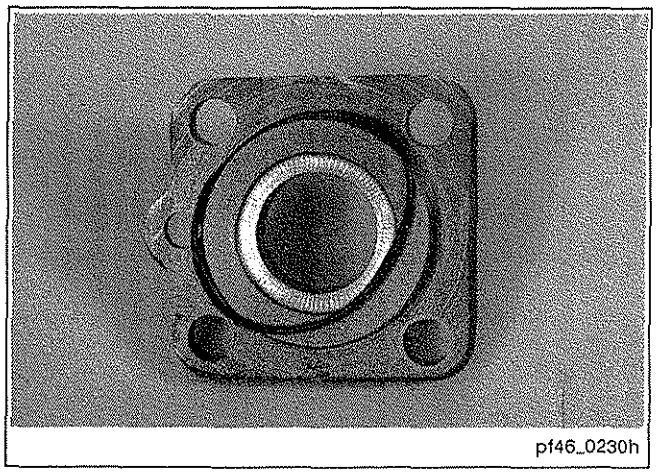

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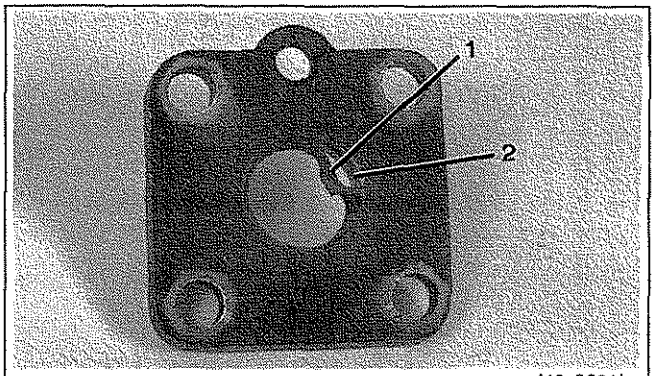
Fig. 30



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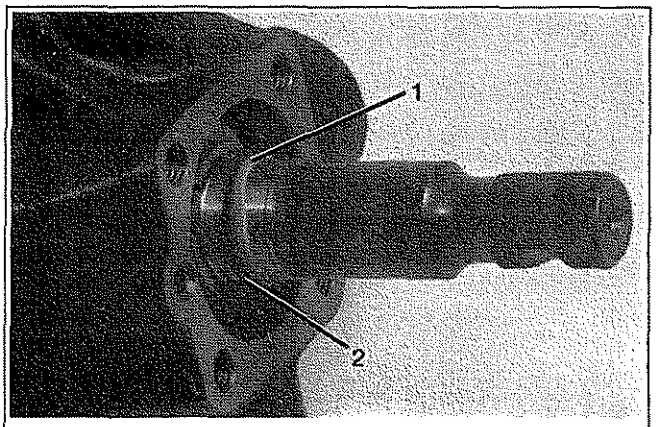
1. Outer Teflon Seal Ring
2. Back-Up O-Ring

Fig. 31



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1. Teflon Seal Ring
2. Back-Up O-Ring

Fig. 32

4. Inspection of the steering gear parts may reveal problems in other areas of the steering system. To avoid repeat problems, follow each clue to its conclusion.

   .1 Check the steering gear components for discoloration (blue color), caused by high operating temperatures. High operating temperatures are most frequently caused by too little lubricant, too high a flow rate, or too much system back-pressure. For further information, refer to the troubleshooting chart in "Troubleshooting."

   .2 Scoring of the steering gear housing and piston can be caused by air in the hydraulic system. Check for an air leak on the suction side of the power steering pump. Repair the leak, then bleed the air from the power steering system.

   .3 Scoring of the piston or steering gear housing, wear on the roller bearings, or on the supply and return ports can be caused by an incorrect or contaminated lubricant. If the lubricant is contaminated, check for and correct the source of contamination. If incorrect

SHEPPARD M–100 STEERING GEAR

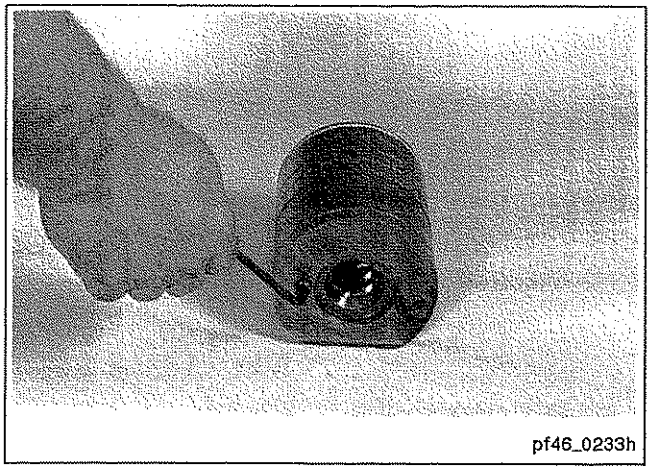
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Fig. 33

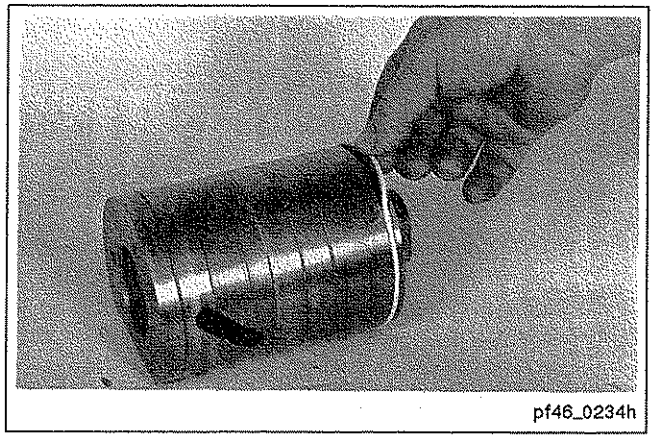
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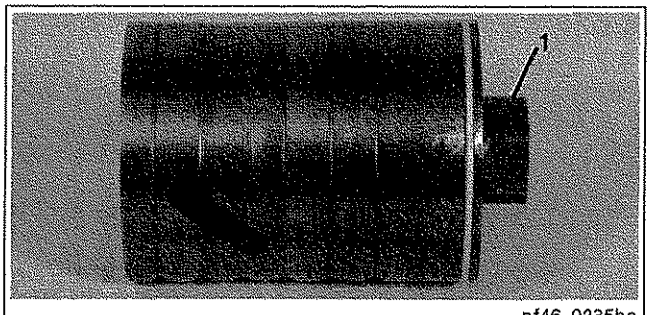
Fig. 34



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1. End Plug

Fig. 35

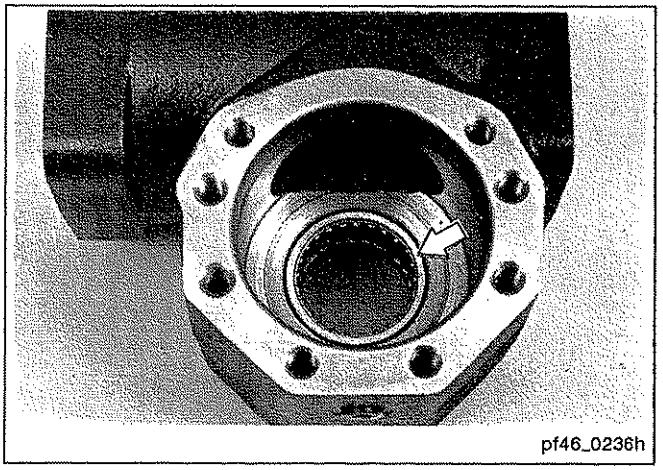
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Fig. 36

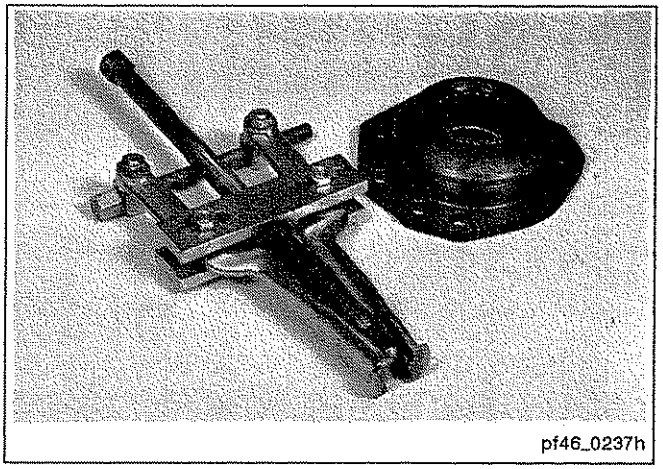
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Fig. 37

or contaminated lubricant was used, drain and flush the system. Change the filter then fill the steering system with clean lubricant of the correct type. Refer to the *COE and 120 Conventional Maintenance Manual* for lubrication specifications.

.4 A distorted pitman arm, a broken steering gear housing, a twisted sector shaft, and broken or cracked rack and sector shaft teeth are some signs of impact damage. Don't replace broken or damaged mounting brackets without finding the cause of the damage.

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Consider any steering gear that has impact damage as unsafe. Impact loads transmitted through the front axle and steering linkage into the steering gear, can stress parts to a point just short of failure. Further use is unsafe; replace the steering gear assembly and the pitman arm.

STEERING GEAR ASSEMBLY

1. Assemble the piston as follows:

   .1 If the piston end plug (**Fig. 38**) was removed, coat its threads lightly with pipe sealer; then install it, along with a new O-ring, on the end of the piston. Using the locking pin (**Fig. 8**, Ref. 61), pin the end plug.

   .2 Using a 3/16-inch allen wrench, install a relief valve seat in one end of the piston. See **Fig. 39.**

   .3 At the opposite end of the piston, install a relief valve ball. Then put the plastic tube inside the spiral spring, and install both in the same passage as the relief valve ball. See **Fig. 39.**

   .4 Install the remaining relief valve ball, then the other relief valve seat. Push in the relief valve seat while engaging its threads. Tighten both relief valve seats firmly.

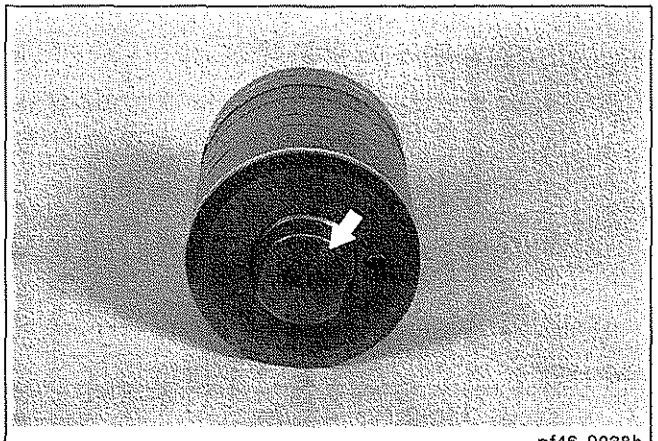

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Fig. 38

   .5 Install the back-up ring in the piston groove, then install the Teflon seal on top of the back-up ring. See **Fig. 40.**

IMPORTANT: When installing square-cut Teflon seal rings, make sure they remain flat. Don't twist them.

   .6 Set the piston assembly aside to let the Teflon seal ring contract. If you are short of time, use a ring compressor, as shown in **Fig. 41.**

2. Install the input shaft seals as follows (see **Fig. 42**):

   .1 Install the back-up O-ring in the groove on the input shaft.

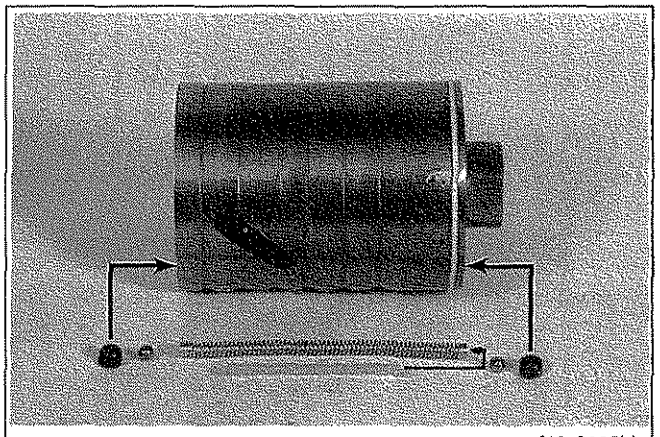

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Fig. 39

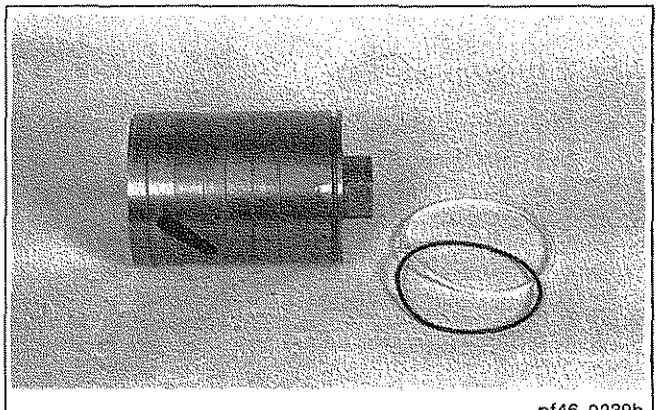

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Fig. 40

SHEPPARD M–100 STEERING GEAR

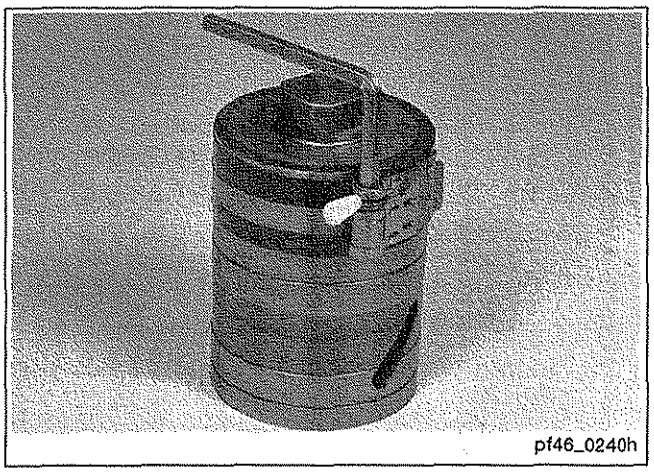

Fig. 41

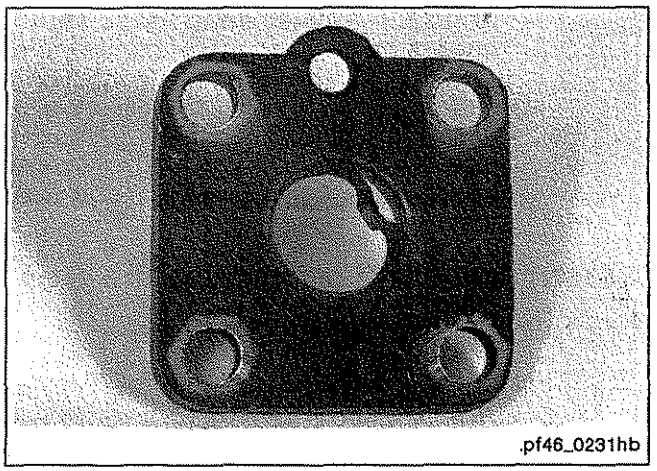

Fig. 43

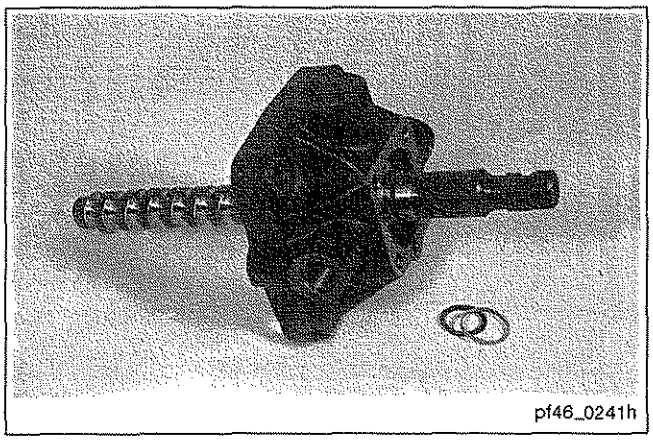

Fig. 42

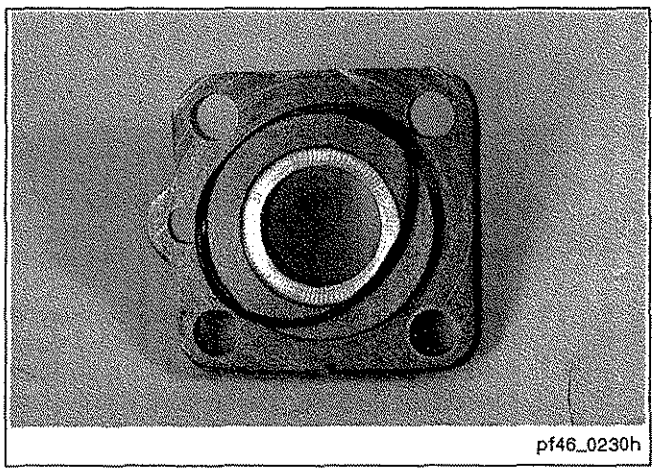

Fig. 44

.2 Install the Teflon seal ring over the back-up ring.

3. Check that the grooves for the dirt seal assembly in the bearing-cap cover (**Fig. 43**) are clean and free of burrs. Then install the new dirt seal assembly as follows:

   .1 Install the back-up O-ring in the bore of the bearing-cap cover.

   .2 Install the Teflon seal ring on top of the back-up O-ring.

4. Install the O-ring in the bearing-cap cover. See **Fig. 44.**

5. Align the plunger hole on the bearing-cap cover with the plunger hole on the bearing cap, as shown in **Fig. 45.** Then install the bearing-cap cover on the bearing cap. Be careful not to pinch the input shaft seals or the dirt seal assembly. Tighten the bolts to the torque values in "Specifications."

6. If the roller bearing was removed from the sector shaft cover, install a new one into the sector shaft cover (see **Fig. 46**), using a press. Press the bearing until it is flush with the face of the bearing bore.

SHEPPARD M–100 STEERING GEAR

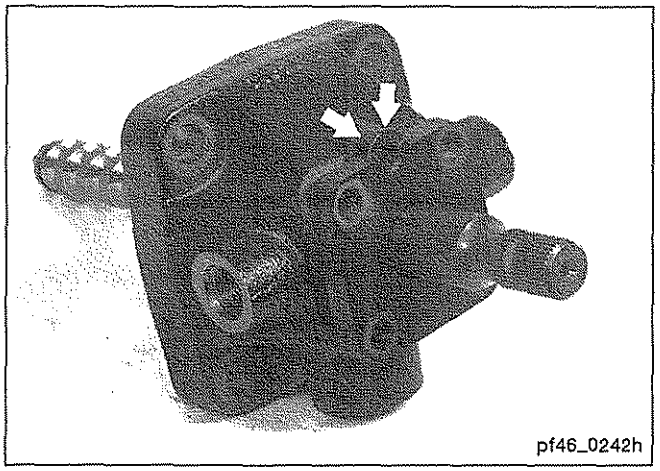

Fig. 45

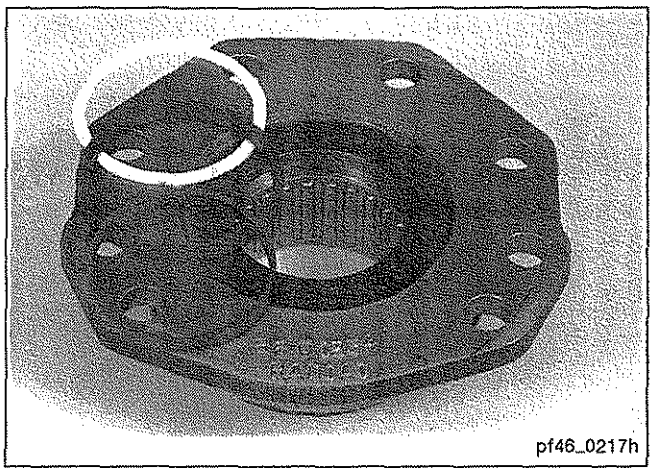

Fig. 47

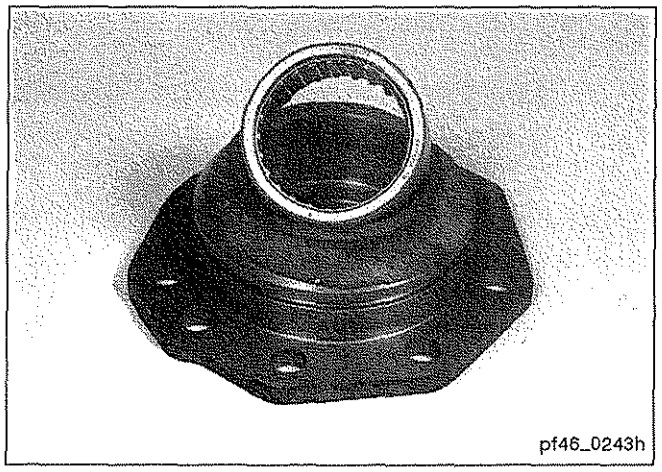

Fig. 46

9. Install the other three-piece high-pressure seal in the gear housing, following step 7.

10. If the roller bearing was removed from the gear housing, install a new one, using a press. Install the new roller bearing so that it bottoms out on the shoulder of the sector shaft bore. See **Fig. 48.**

11. Coat the piston and the gear housing bore lightly with clean engine oil. Find the chamfer at one end of the piston bore in the gear housing, then install the piston in that end of the bore, as shown in **Fig. 49.** If necessary, tap the end of the piston lightly with a soft hammer in order to get it moving into the piston bore. Make sure the ball return guide cavity is exposed.

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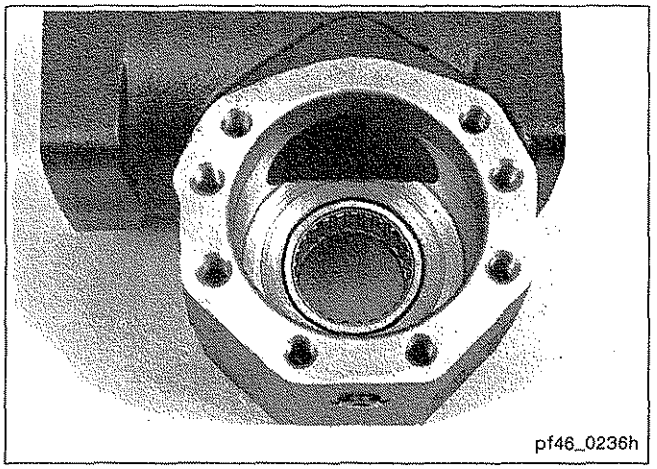

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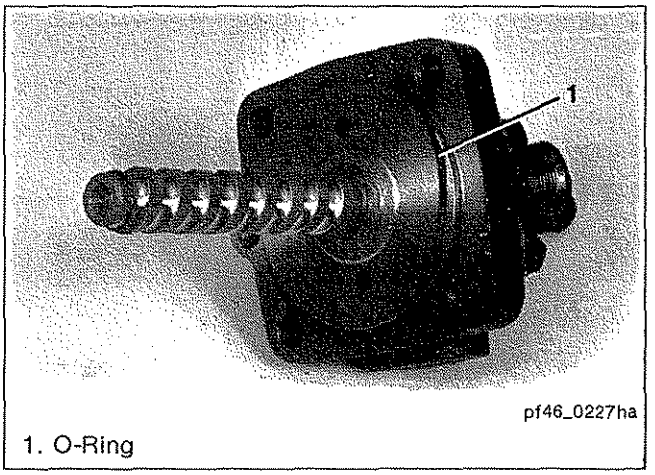
Fig. 48



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1. O-Ring

Fig. 50

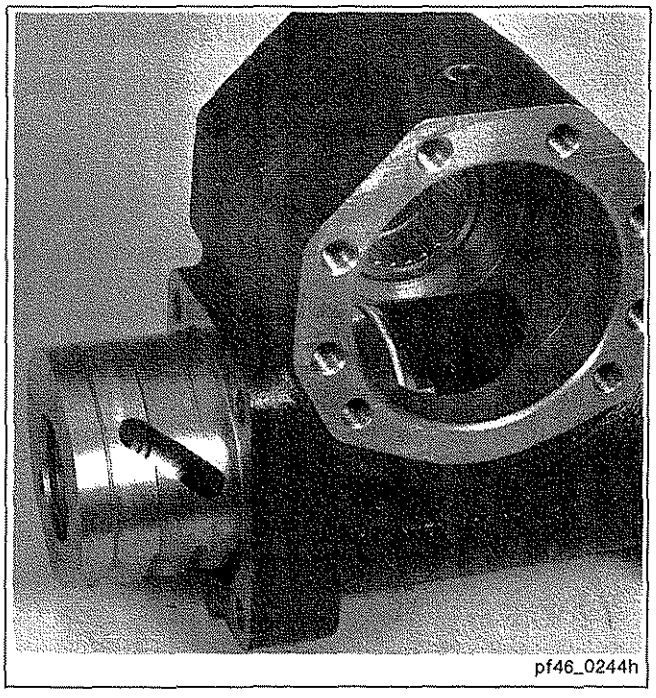

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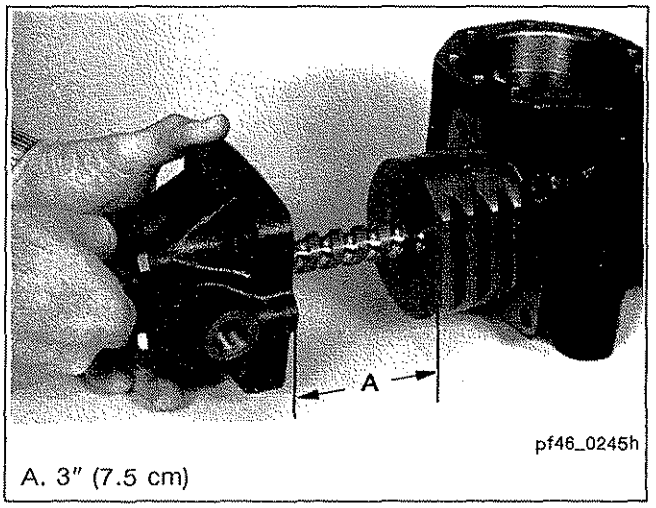
Fig. 49

into the ball guide cavity; otherwise, they could be pushed out when the steel balls are installed, resulting in loss of the steel balls.

14. Install both ball guide halves all the way into the ball guide cavity of the piston. See **Fig. 52.**



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A. 3" (7.5 cm)

Fig. 51

15. Support the bearing cap assembly with one hand, and with the other, load the 24 steel balls into the ball guide. See **Fig. 53.**

    Turn the bearing cap and input shaft assembly slowly inward while installing the steel balls.

CAUTION: Do not back out the input shaft from the piston while loading the steel balls. To do so will cause the shaft to bind, resulting in possible damage to it.

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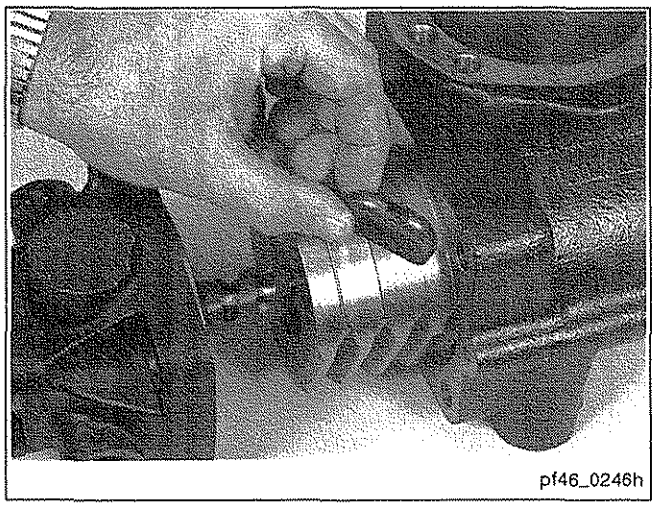

Fig. 52

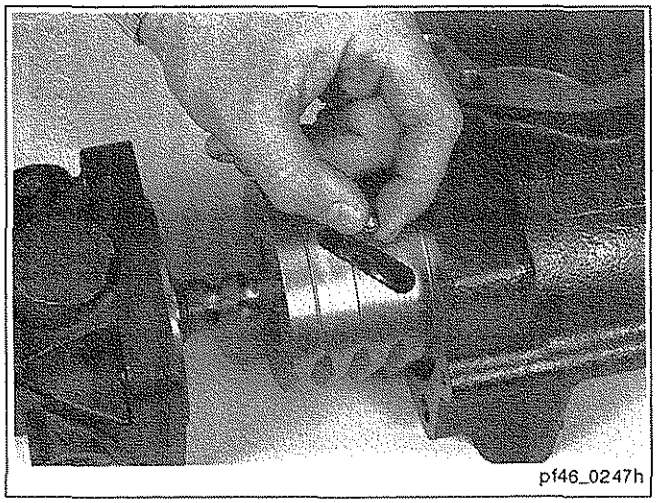

Fig. 53

16. After all 24 balls have been installed, install the ball return guide retainer in the ball guide cavity. See **Fig. 54** or **Fig. 55**.

    If the retainer is the type that slips in (**Fig. 54**), make sure it's installed flush with the surface of the piston.

    If the retainer is the bolted-on type (**Fig. 55**), be sure to replace the seal ring inside the retainer. Tighten the bolts 12 lbf·ft (16 N·m). See **Fig. 56**.

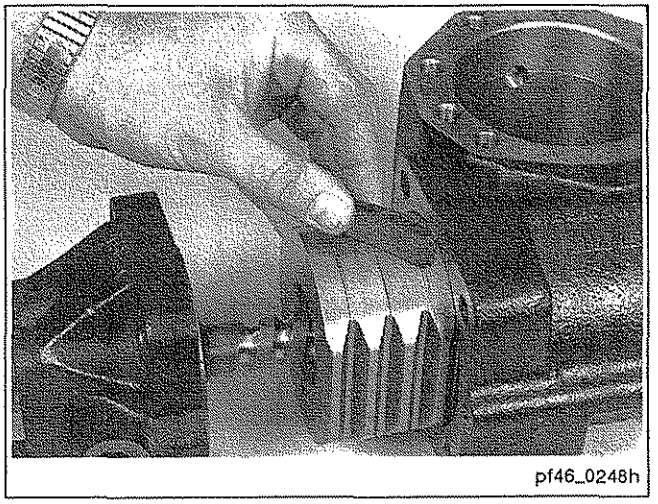

Fig. 54

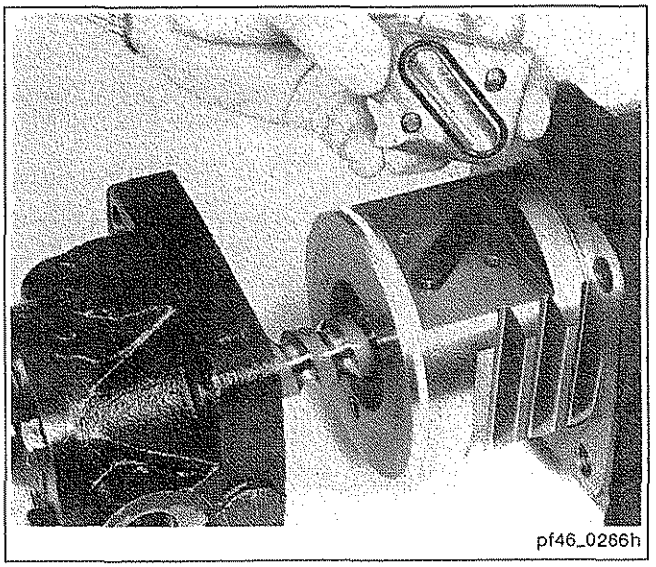

Fig. 55

IMPORTANT: When you install the piston all the way into the housing bore, be careful not to pinch the piston seal.

17. Slide the piston all the way into the housing bore, making sure the piston rack aligns with the bore for the sector shaft as shown in **Fig. 57**. Guide the piston, as shown in **Fig. 58**, so the piston seal ring isn't pinched.

SHEPPARD M–100 STEERING GEAR

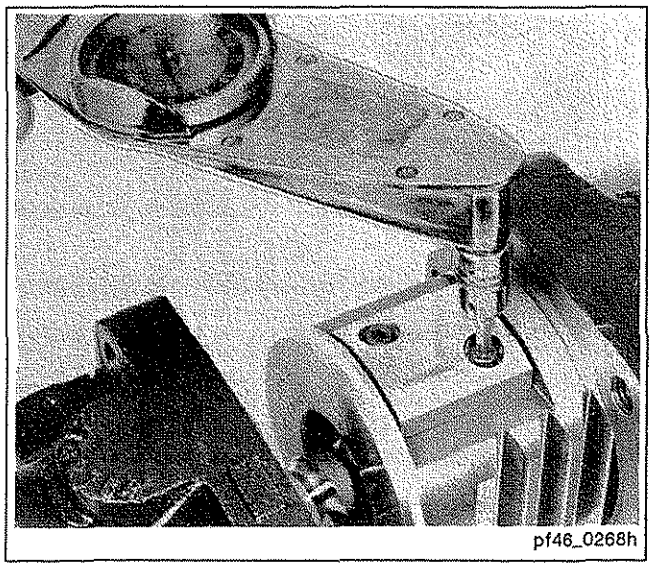
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Fig. 56

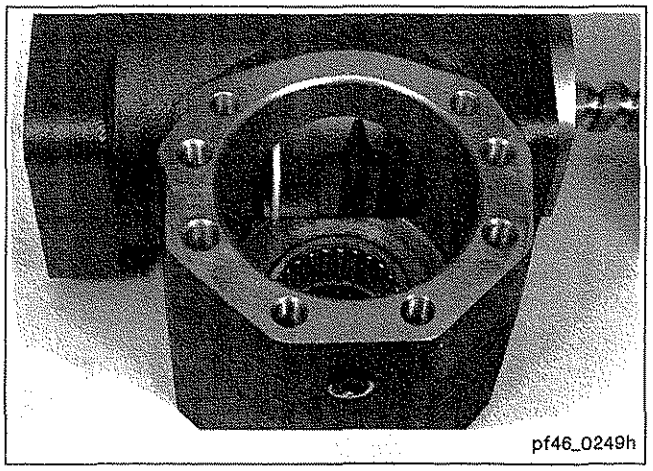
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Fig. 57

18. Install the new tetra seal on the bearing cap assembly (see **Fig. 59**), then put the bearing cap assembly on the gear housing.

NOTE: If the bearing cap assembly doesn't sit flush on the housing, check that the bearing-cap O-ring and the tetra seal are in place.

19. Using the four mounting bolts, install the bearing cap assembly on the gear housing. Tighten the bolts to the torque values in "Specifications." See **Fig. 60**.

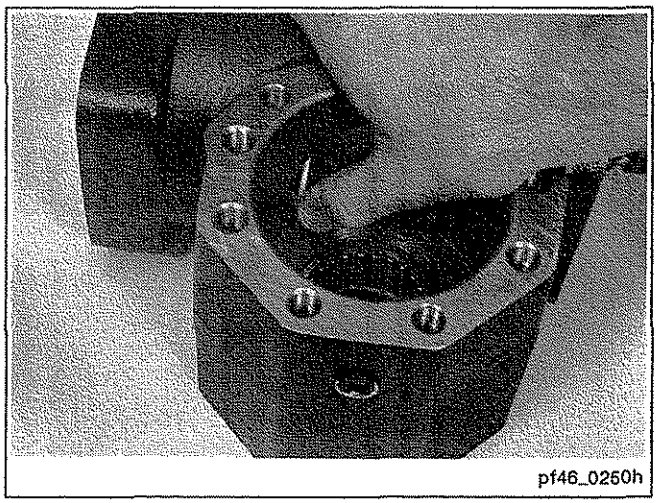
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Fig. 58

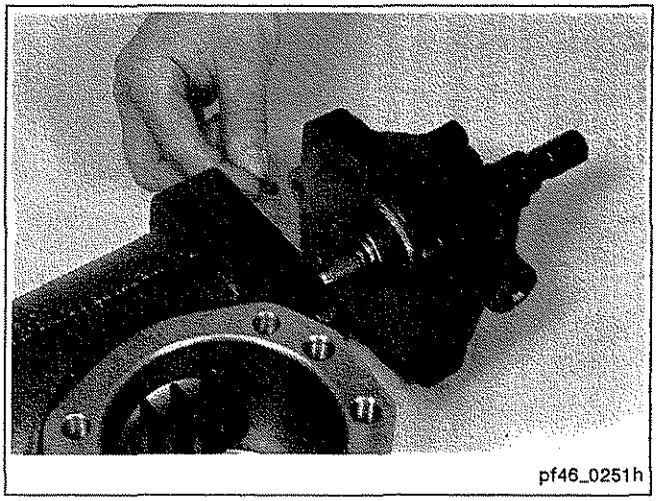
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Fig. 59

20. Find the timing mark on the piston rack; then, by turning the input shaft, center the timing mark in the pinion bore of the housing. See **Fig. 61**.

21. Line up the timing marks on the piston rack and the sector shaft, then install the sector shaft in the pinion bore. See **Fig. 62**.

22. Make sure the sector shaft teeth mesh with the piston rack, then tap the end of the sector shaft with a soft hammer. See **Fig. 63**.

SHEPPARD M–100 STEERING GEAR

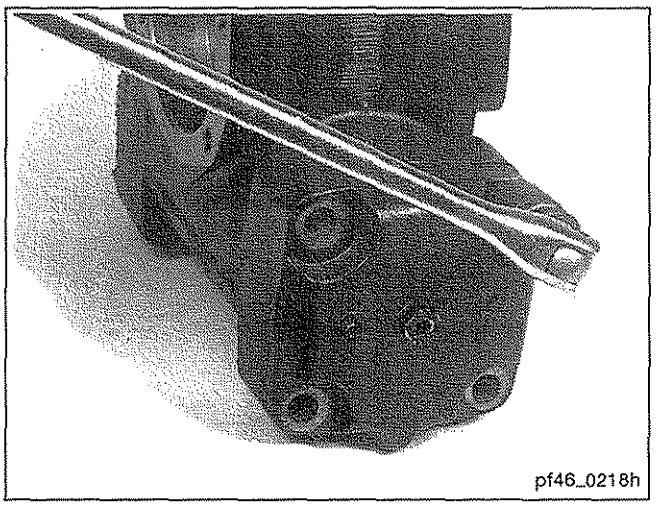


Fig. 60

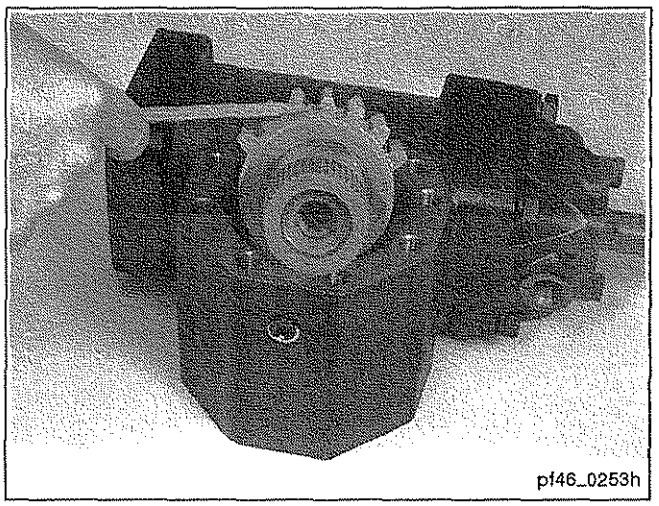


Fig. 62

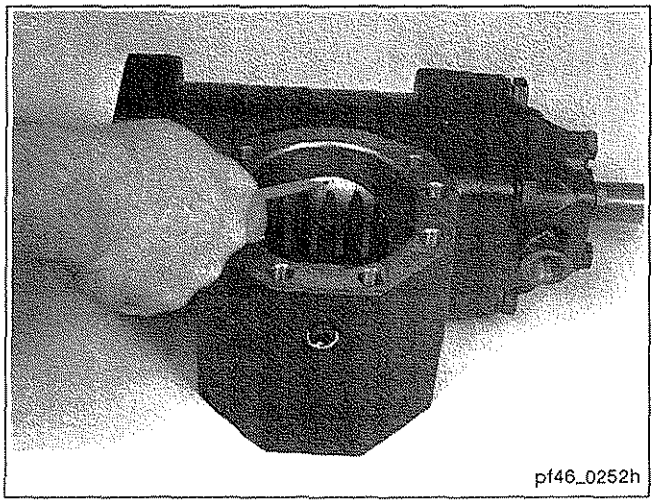


Fig. 61

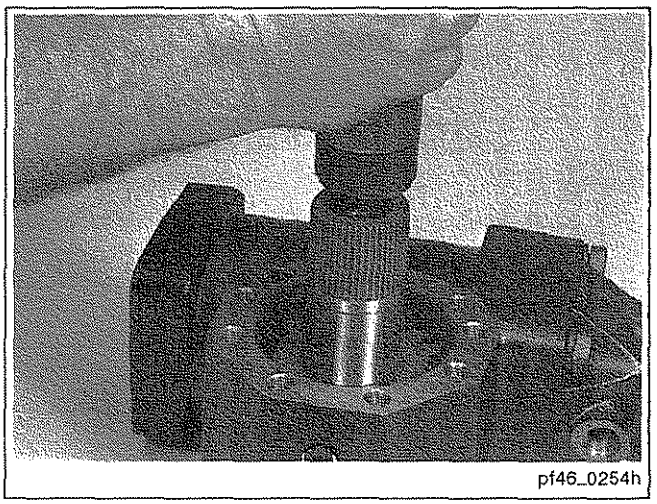


Fig. 63

23. Put a light coat of oil on the seal ring on the sector shaft cover, then, using the eight mounting bolts, install the sector shaft cover. See **Fig. 64**. Tighten the bolts to the torque values in "Specifications."

24. Install a new O-ring and tetra seal on the cylinder head (**Fig. 65**), then put a light coat of grease on the ring and seal.

25. Using four mounting bolts, install the cylinder head on the gear housing. See **Fig. 66**. Tighten the bolts to the torque values in "Specifications."

26. Install the relief plungers in the cylinder head and the bearing cap. Tighten the plungers until they are flush with the end caps, as shown in **Fig. 67**.

27. Install the dust cover on the end of the sector shaft, and tighten it firmly. See **Fig. 68**.

28. If the steering gear is equipped with a mounting bracket (COEs), install the bracket on the gear housing, and tighten the bolts 72 to 81 lbf·ft (98 to 110 N·m).

SHEPPARD M–100 STEERING GEAR

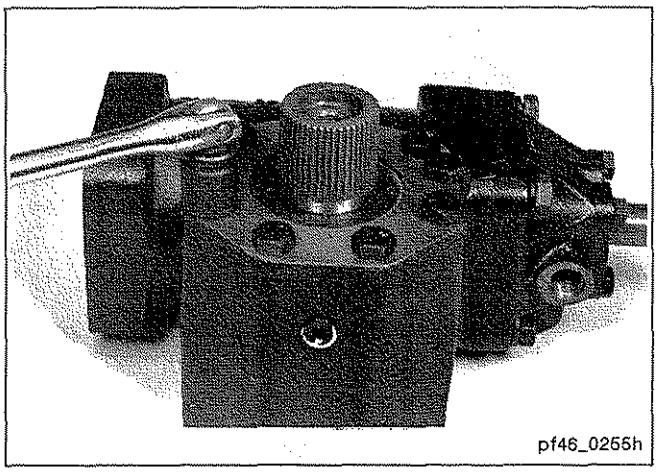
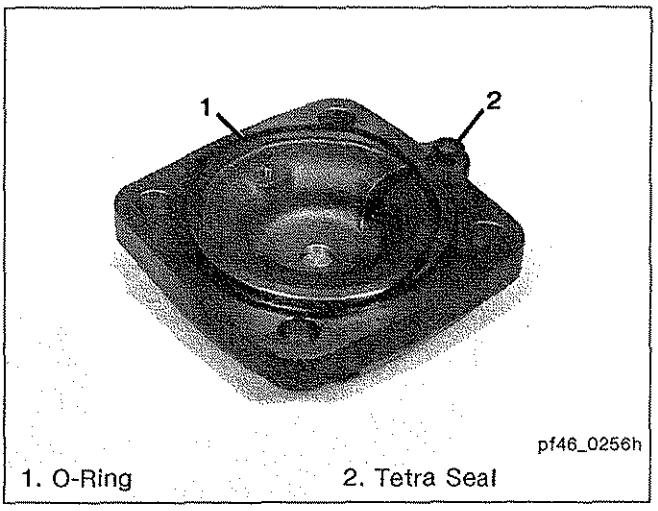


Fig. 64



1. O-Ring 2. Tetra Seal

Fig. 65

Tighten the larger bolt (see **Fig. 69**) 175 to 185 lbf·ft (237 to 251 N·m).

29. Install the rubber boot over the input shaft, as shown in **Fig. 70.**

30. Install the pitman arm as follows:

WARNING: Don't pound, weld, or apply heat to the pitman arm or the sector shaft. Damage to the pitman arm or sector shaft could cause loss of steering control, resulting in possible personal injury or property damage.

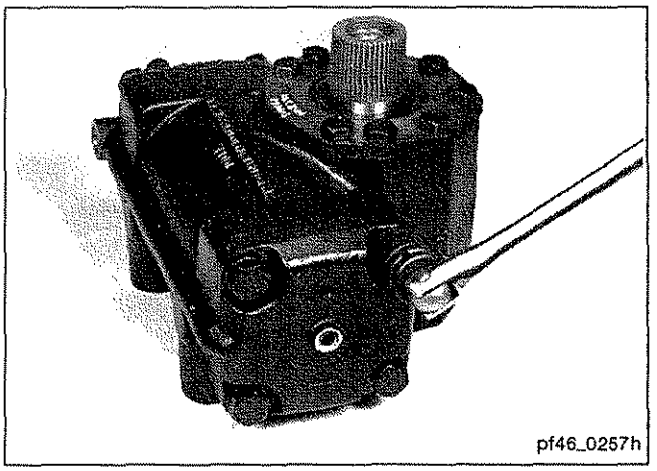


Fig. 66

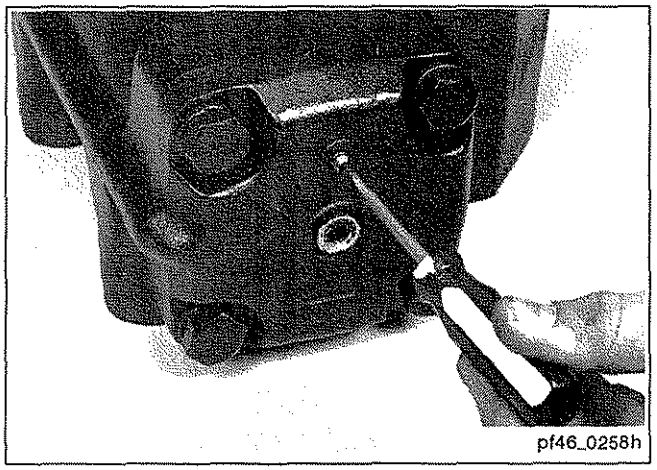


Fig. 67

.1 Line up the timing mark on the pitman arm with the mark on the sector shaft, as shown in **Fig. 71.**

.2 Push the pitman arm on the sector shaft as far as it will go. Do not pound on the pitman arm.

.3 Put Lok-Cease, Never Seez, or white lead on the threads of the retainer, and both sides of the tab washer and friction washer. Then, screw the retainer into the output shaft by hand. Make sure that the tabs of the retainer are aligned with the notches in the pitman arm.

SHEPPARD M–100 STEERING GEAR

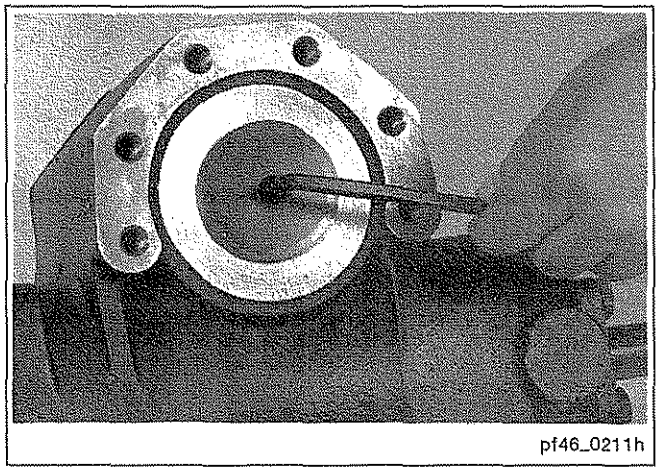


Fig. 68

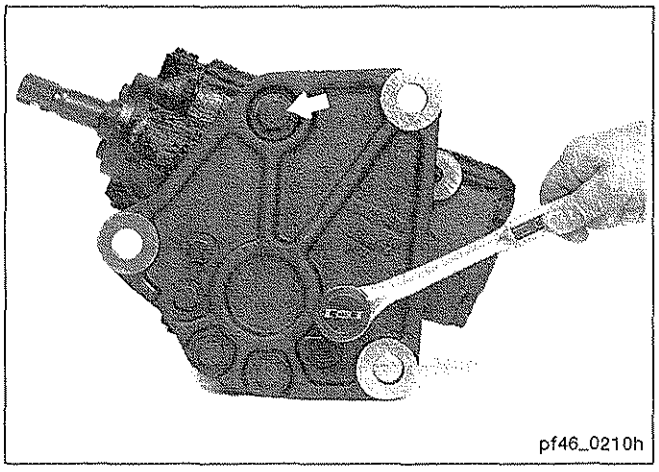


Fig. 69

.4 Using a torque wrench (not an impact wrench), tighten the retainer to the value stamped on the face of the retainer. Refer to **Fig. 72.** The retainers are stamped with one of three different torque values:

- 225 lbf·ft (305 N·m);
- 350 lbf·ft (475 N·m);
- 450 lbf·ft (610 N·m).

.5 After tightening the retainer, remove it from the pitman arm and measure the distance between the end of the sector

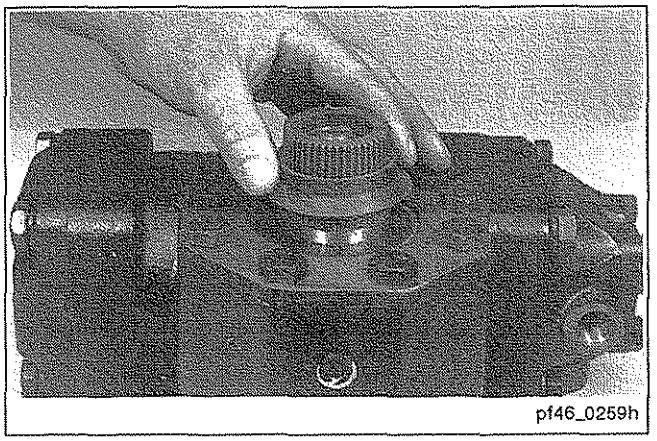


Fig. 70

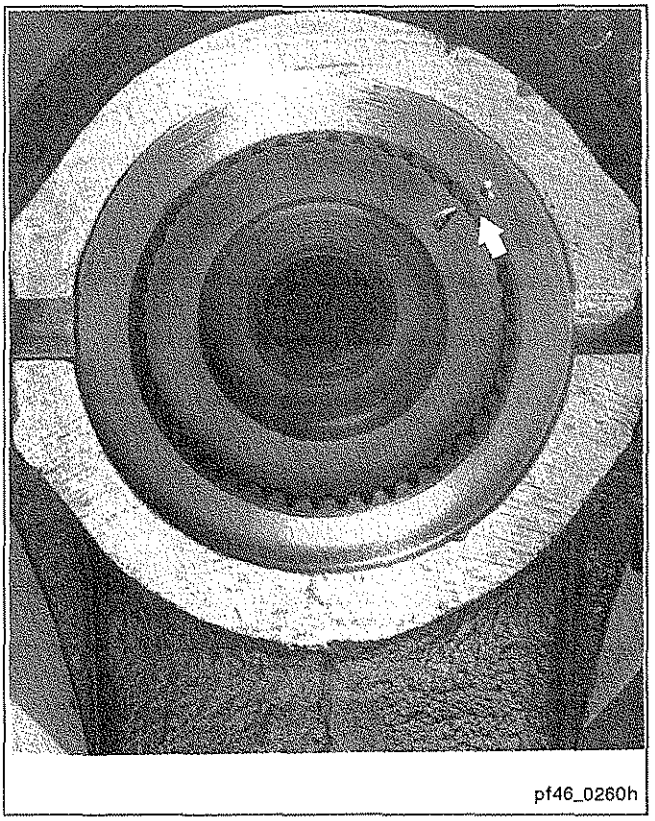


Fig. 71

shaft and the end of the splined surface of the pitman arm. See **Fig. 73,** Ref. *A.*

SHEPPARD M–100 STEERING GEAR

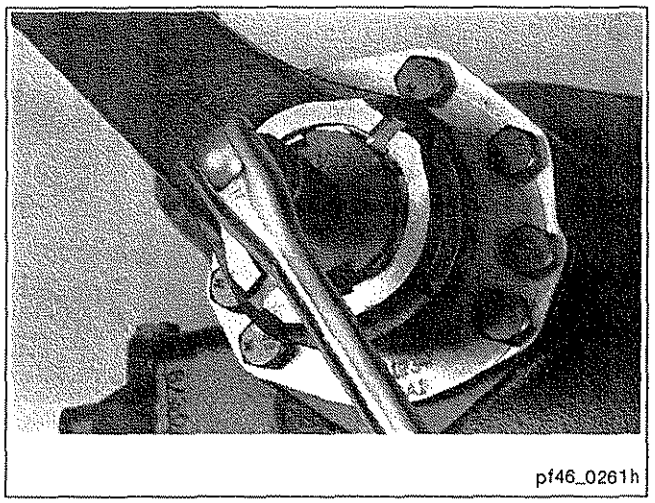


Fig. 72

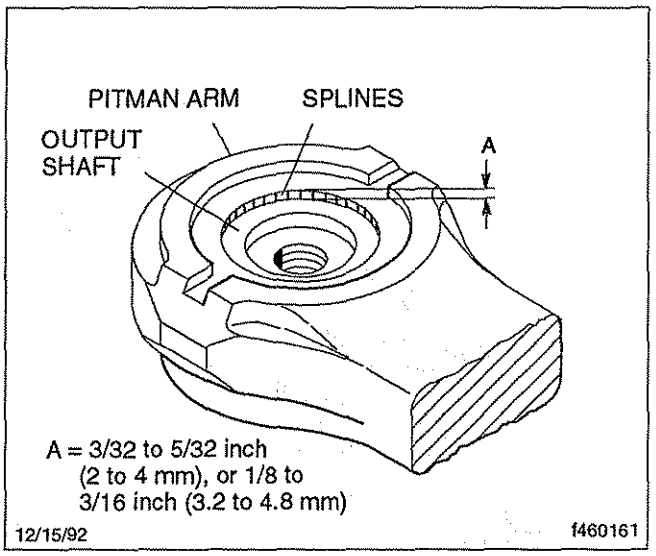


Fig. 73

Depending on which torque value is stamped on the face of the retainer, the distance must be between:

- 3/32 to 5/32 inch (2 to 4 mm) for retainers stamped with the 225 lbf·ft (305 N·m) and 350 lbf·ft (475 N·m) torque values;
- 1/8 to 3/16 inch (3.2 to 4.8 mm) for retainers stamped with the 450 lbf·ft (610 N·m) torque value.

If the measurement is not correct, replace the pitman arm and the sector shaft.

.6 If the measurement is correct, install the retainer and tighten it to the torque value stamped on the face of the retainer. Bend the two tabs on the tab washer up into the slots on the retainer.

IMPORTANT: After the specified torque value is reached, it may be necessary to continue tightening the retainer until two of the tabs on the tab washer are aligned with the notches in the retainer. Do not back off the retainer to align the tabs.

POST-SERVICE CHECKS

After power steering components have been worked on, and before the vehicle is placed into service, the following items must be checked.

WARNING: Failure to check the following items could result in damage to the power steering system. This could cause a loss of hydraulic assist, which could cause personal injury or property damage.

1. Place a thermometer in the power steering reservoir, then warm the hydraulic system to normal operating temperature of 125° to 135°F (51° to 57°C), by starting the engine and operating it at low idle, while turning the steering wheel through several full left and right turns. With the engine running and the power steering system at operating temperature, turn the steering wheel slowly from stop to stop, while checking the power steering reservoir for frothing or a change in the oil level (a sign that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as necessary. Bleed the air from the system.
2. With the engine turned off and warm, check the power steering reservoir fluid level, using the instructions in Group 14 of the *COE and 120 Conventional Maintenance Manual.*
3. At full-left and full-right wheel cuts, be sure the axle stops (on the rear-side of the spindle) are set so there is at least 1/2-inch (13 mm) clearance between the tires and any

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fixed components that are attached to the vehicle. Clearance between moving components should be 3/4 inch (19 mm). If clearance is less than the above, reset the axle stops.

4. Check that the relief valve plungers are set correctly. If needed, adjust them. For instructions refer to "Steering Gear Installation."
5. If there are still problems with the power steering system, go to "Troubleshooting," and perform the steering system hydraulic tests as instructed; otherwise, go to step 6.
6. Test drive the vehicle, or take a ride with the driver. Check the steering wheel spoke position. If, during straight-ahead driving on a level road, the steering wheel spokes do not point within 10 degrees of the 4 o'clock and 8 o'clock positions, remove the steering wheel and reposition it.

TROUBLESHOOTING AND DIAGNOSTIC CHECKS

TROUBLESHOOTING

If there is a complaint about the steering system, do the checks below before servicing the steering gear or pump. This procedure is intended as a general guideline for the mechanic or technician to follow when diagnosing steering complaints.

The first step is always to talk to the driver. Get a detailed explanation of what the problem is and when it happens. Ask about any repairs, modifications, or prior adjustments. Then, if the truck is roadworthy, test drive it or ride with the driver and try to duplicate the problem.

After identifying the complaint, refer to the appropriate box in **Table 1** that best fits the

DIAGNOSTIC CHECKS

(The numbers and checks below correspond to the numbered steps on the next page.)

COMPLAINT	1 Tire Press./ Vehicle Load	2 Fifth Wheel Lube	3 Vehicle Alignment	4 Loose/ Binding Components	5 Noise	6 System Operating Temp.	7 System Leaks or Restrictions	8 Pump Performance	9 Gear Poppet Adjustment	10 Gear Internal Leakage
Hard or Heavy Steering	•	•		•		•	•	•	•	•
Low Assist										
Binding	•	•		•		•	•	•	•	•
Locking										
Occasional Loss of Assist										
Reduced Wheel Cut									•	
Vehicle Pulls to One Side	•		•					•		
Darting/ Oversteer	•	•	•	•						
Vehicle Wanders										
Noisy Steering					•		•	•		
Steering Gear External Seal Leaks						•	•	•		
Excessive Heat										

Table 1, Steering Complaint and Appropriate Checks

SHEPPARD M–100 STEERING GEAR

complaint. Form SD–94, "Checklist for Troubleshooting Hydraulic Power Steering System Performance," should also be used to record test information. Form SD–94 (**Figs. 83** and **84**) is available and can be ordered through your dealer. Dealers can order by using Publishing Request Form FG–138. The table will refer you to a series of checks or tests to do for each type of complaint. The easiest and least costly checks are listed first. By doing the checks in order, starting with the lowest number, you can avoid unnecessary labor and expense. Read the following instructions for doing the checks. Each numbered step in the instructions corresponds with the diagnostic checks in **Table 1.**

DIAGNOSTIC CHECKS

1. Check tire pressure and load.

   .1 Check the tire pressure. Low pressure causes increased steering effort due to extra friction with the road surface. Check the tires for damage or erratic wear. Make sure the tires on each side of the front and rear axles are inflated to the correct pressure. Unequal tire pressure causes unequal friction between the tire and the road. This can cause pulling to one side. Correct the pressures if needed. See **Fig. 74.**

   .2 Check whether duplex or oversized tires have been installed, and that the tire sizes are correctly matched. Extra tire width causes increased steering effort due to extra friction with the road surface. Also, the relief valve plungers will need to be adjusted if the axle stops were turned out to reduce wheel cut due to the change in tires. Refer to "Steering Gear Installation" for instructions.

   .3 Determine whether the vehicle is operated at or over the rated load. Increased load causes greater steering effort. It may be necessary to modify the power steering, wheels, tires, or springs.

2. Check the fifth wheel.

   See if the fifth wheel is adequately lubricated. A dry fifth wheel plate makes it difficult to change direction. See **Fig. 75.** Check the plate surface for burrs, gouges, or irregularities.

3. Check the wheel bearing adjustment and axle alignment.

   .1 Check wheel bearing adjustment. Refer to the front axle and rear axle groups in this manual for instructions.

   .2 Check the front and rear axles for correct alignment. Adjust them back to specifications if necessary. Refer to the front axle and rear axle groups in this manual for instructions.

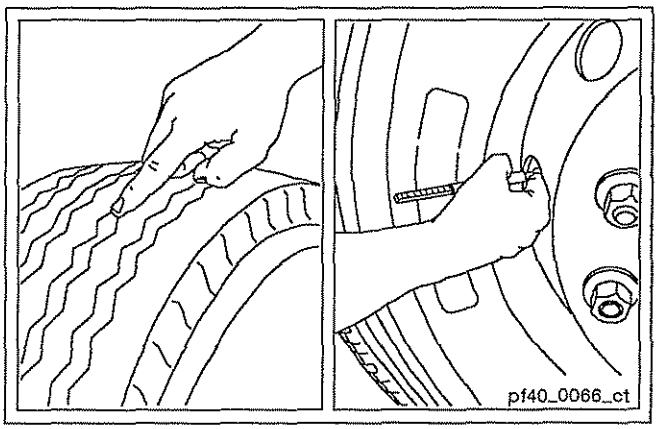

Fig. 74

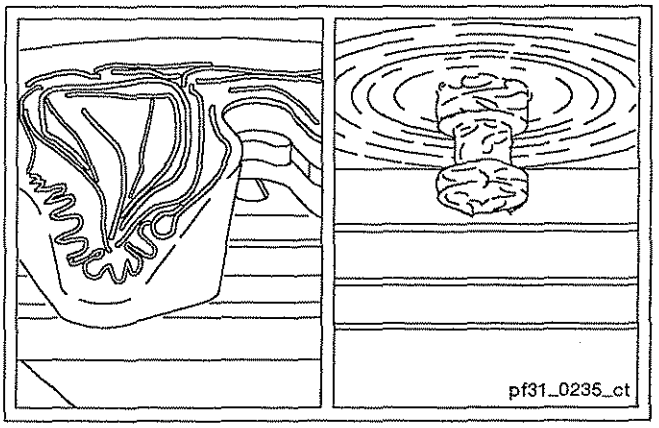

Fig. 75

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4. Check for loose or binding components.

   Check whether any steering components are loose or binding, need maintenance, or need adjustment as follows:

   .1 Lubricate the drag link, tie rods, and knuckle pins. For instructions, refer to the vehicle maintenance manual.

   .2 Chock the rearmost tires and raise the front tires off the ground. With the engine shut down, turn the steering wheel and check for looseness or binding. Make sure all components are free to move but are not excessively loose.

   .3 Check the steering driveline U-joints for looseness or binding. Lubricate them if needed. For instructions, refer to the vehicle maintenance manual.

   .4 Check for correct steering driveline phasing. See **Fig. 76**. Reset the phasing if needed.

   WARNING: Failure to connect the input yoke and the pitman arm, and to tighten all fasteners to the prescribed torque value can cause loss of steering and vehicle control.

   .5 With the engine off, chock the rearmost tires and place the front tires on radius plates (turntables). Disconnect the drag link from the steering arm. See **Fig. 77**.

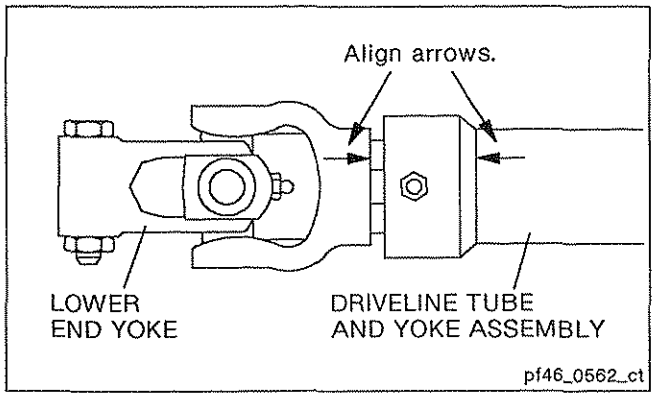

Fig. 76

By hand, pull the tire to one axle stop and release. The tire should self-return to almost straight ahead. See **Fig. 78**. Repeat in opposite direction. If the tire does not return to near straight ahead, check for a binding or lack of lubrication problem in the steering axle kingpin bushings or tie rod linkage. Connect the drag link and tighten the castle nut

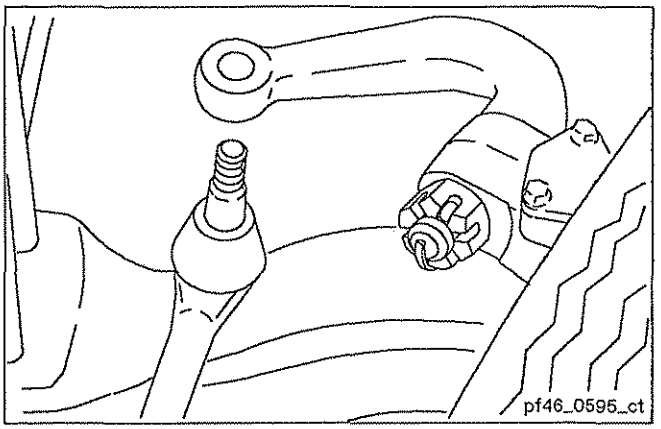

Fig. 77

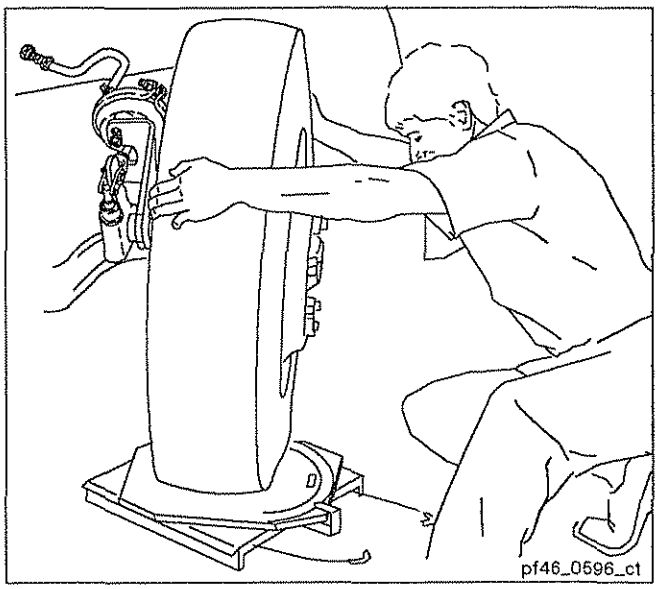

Fig. 78

SHEPPARD M–100 STEERING GEAR

and install a new cotter pin. Refer to the drag link section in this manual.

WARNING: Failure to connect the drag link and the steering arm, and to tighten all fasteners to the prescribed torque value can cause loss of steering and vehicle control.

.6 Visually inspect all suspension fasteners and components for wear or looseness.

5. Check for noise.

NOTE: Noises from the power steering system do not necessarily mean there is a problem. Some noises are normal and are the result of proper operation. See **Table 2.**

6. Test the system operating temperature.

.1 Park the vehicle outside.

Symptom – Growling or Other Abnormal Steering Noise

Action to Take
Check the fluid level. Check for air (bubbles or foam). Check for hose and fitting leaks. Add fluid if needed. If the fluid has air, check for inlet tube/hose leaks. Correct all leaks.

Symptom – A Change from the Usual Pump Sound

Check the power steering fluid reservoir. Check for air in the fluid (bubbles or foam). If the fluid has air, check for inlet tube/hose leaks. Correct all leaks.

Symptom – Clicking Noise During a Turn

Check for loose steering components. Check the front suspension for insufficient spring pin shims. Tighten any loose steering components. Add front spring pin shims if needed.

Symptom – Hissing When the Steering Wheel Is at or Near Full Turn

Fluid flowing past a poppet valve makes a hissing noise. This is normal. No action is needed.

Symptom – Hissing at Less Than Full Turn

Do check (step) no. 9 (Relief Valve Plunger Test).

Table 2, Power Steering System Noises

.2 Check for correct fluid level; if required, add fluid.

.3 Place a thermometer in the fluid reservoir to monitor fluid temperature.

.4 Run the vehicle at governed rpm for 40 minutes to bring the fluid to an elevated temperature. Check and record fluid temperature on the checklist (form SD–94) at the start of the 40 minute test, and at 10, 20, 30, and 40 minutes.

Do not allow the temperature to exceed 150°F (66°C) above the outside temperature (ambient), or 250°F (111°C). If this temperature is exceeded, stop the 40 minute test and record the last noted temperature on the checklist.

.5 If the temperature does not exceed 150°F (66°C) above the outside temperature (ambient), or 250°F (111°C) during the 40 minute test, excessive system heat is probably not the cause of the complaint. Go on to the next test for the complaint. See **Table 1.**

.6 If at any time the temperature exceeded 150°F (66°C) above the outside temperature (ambient), or 250°F (111°C), the system is operating at excessive temperature levels, and steering system performance and life may be affected. Damage to hoses, seals, and other components may result if the vehicle is operated at excessive steering system temperatures.

.7 Excessive system restrictions or excessive pump flow may be the cause of the complaint. Go on to the next test for the complaint. See **Table 1.**

7. Check for leaks, restrictions, and test system back pressure.

.1 Check for correct fluid level, if required, add fluid.

.2 The inspection and test must be done with the power steering fluid at operating temperature 150° to 160°F (66° to 71°C). With the engine at idle, monitor the fluid temperature with a thermome-

SHEPPARD M–100 STEERING GEAR

ter in the fluid reservoir. If the fluid is too cold, raise the temperature by turning the steering wheel from stop to stop until the desired temperature is reached.

.3 With the engine at idle, visually inspect all hoses and fittings for signs of kinked or collapsed hoses, or leaking fittings. Visually inspect all external seals. Repair all leaking fittings, and replace parts as required. Replace any leaking seals. Inspect the seal bores and sealing surfaces for scrapes or burrs. Be sure the seals are installed correctly using the recommended tools. If the steering gear input shaft seal is excessively hard, do check (step) no. 6 (Test System Operating Temperature), if not already done.

.4 Install a low pressure gauge 200 to 300 psi (1378 to 2069 kPa) maximum between the pressure line and the pump (location P2). See **Fig. 79.**

CAUTION: Don't move the steering wheel or allow the system pressure to exceed the rating of the gauge during the following procedure or damage to the gauge may result.

.5 Run the engine at idle and check for correct fluid level; if required, add fluid. If bubbles or foam appear in the reservoir, check the hose fittings for looseness or leaks.

.6 With the engine at idle, read the total system back pressure on the pressure gauge. Record the reading on the checklist (form SD–94).

.7 If the total system back pressure (P2) is greater than 140 psi (965 kPa) (vehicles with hydraulic brakes) or 100 psi (689 kPa) (vehicles with air brakes), go to step 7.8. If the pressure at P2 is less than these values, restriction is not a problem, go to the next test for the complaint. See **Table 1.**

.8 System back pressure has been determined to be excessive and the component at fault can be pinpointed by checking pressures at key locations in the steering system. With the engine at idle, use the low pressure gauge and hose connection adapters necessary to measure pressures at all locations identified in **Fig. 79.** Each time the gauge is moved, ensure that the fluid level is correct, and air is removed from the system by repeating step 7.5.

.9 Determine the individual component restrictions by subtracting the values shown in **Table 3.** Record the values on form SD–94.

.10 Refer to the column on the right in **Table 3** for action to take if any component exceeds the maximum allowable restriction as listed for each component.

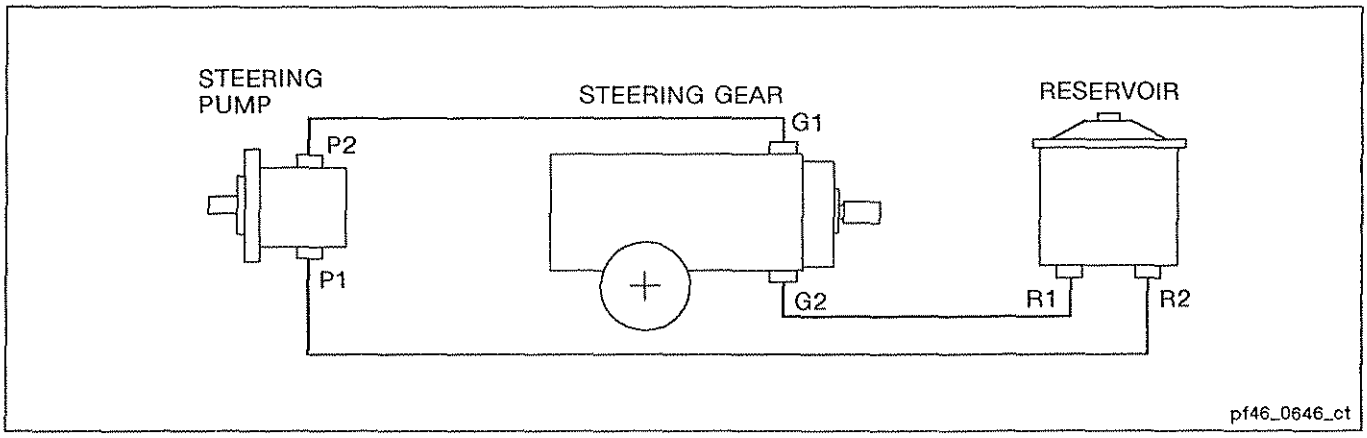

Fig. 79

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Total System and Component Restrictions	Maximum Allowable	Action to Take
P2 = Total System	100 psi (689 kPa)	Check pressures at the key locations.
P2–G1 = Hose: Pump-to-Gear	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
G1–G2 = Steering Gear	55 psi (379 kPa)	The gear rotary valve is damaged. Replace the gear. See instructions in this manual.
G2–R1 = Hose: Gear-to-Reservoir	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
R1–R2 = Reservoir	2 qt: 4 psi (28 kPa) 9 qt: 8 psi (55 kPa)	Replace the filter. Check for internal blockage.
R2–P1 = Hose: Pump Supply	12 psi (83 kPa)	Check for a kinked, collapsed, or plugged hose. Replace the hose if necessary.

Table 3

8. Test pump performance.

   .1 Do the checks under "System Set-Up for Hydraulic Checks."

   .2 Make sure the fluid temperature is 150° to 160°F (66° to 71°C) and the vehicle is stationary with the front wheels pointing forward and the rear-most tires chocked.

   .3 Run the engine at idle. Refer to **Table 4** for the correct engine idle speed.

   .4 Adjust idle speed, if necessary. Refer to the engine manufacturer's instructions.

   .5 Slowly close the load valve. When the valve is completely closed, read the pressure gauge. Refer to **Fig. 80.**

   CAUTION: Don't leave the valve closed for longer than 5 seconds since this could damage the power steering system.

   .6 If the pressure rises rapidly, appears to be uncontrolled, or rises above the maximum pressure of 2275 psi (15 650 kPa), open the load valve immediately. Indicate on form SD–94 whether the pump response was erratic or not. If the response was erratic, replace the pressure relief valve in the pump. For instructions, refer to the pump section in this group. If the pressure was constant, go to step 8.7. With the fluid temperature at 150° to 160°F (66° to 71°C) repeat steps 8.5 and 8.6.

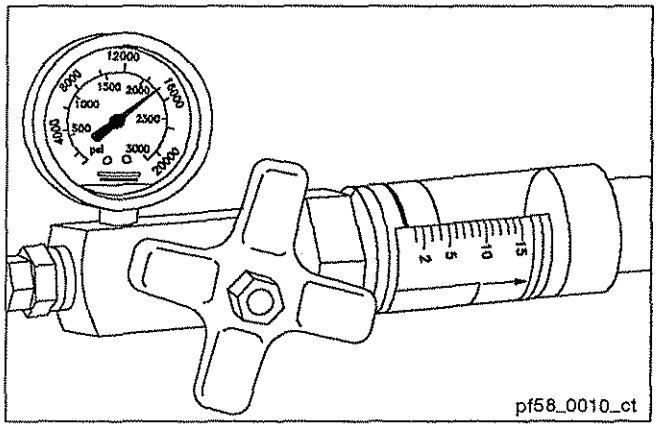

Fig. 80

   .7 If the pump pressure measures 1900 to 2275 psi (13 100 to 15 650 kPa), it is acceptable. Go to step 8.9. If the pressure is not within this range, replace the pressure relief valve if not done previously in this test. With the fluid temperature at 150° to 160°F (66° to 71°C) repeat steps 8.5 to 8.7. If the pressure relief valve has been replaced, go to step 8.8.

   .8 If the pressure was not within the above applicable range, and the relief valve has been previously replaced, replace the pump. For instructions, refer to the pump section in this group. If the pump was replaced, evaluate its performance by repeating check 8.

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.9 Record the relief pressure on form SD–94.

.10 With the engine at idle, test the pump relief valve reaction. Note the flow rate with the load valve open.

.11 Close the load valve until the pump relief pressure is reached (previously determined). The flow rate should drop to zero.

.12 Immediately open the load valve and note the flow rate. It should return to the value noted in step 8.10.

.13 If the flow rate returns immediately, the relief valve is acceptable. Go to step 8.14.

If the flow rate does not return immediately, the pump relief valve is not working correctly. Replace the relief valve if not previously done, following the instructions in the pump section in this group.

.14 Repeat steps 8.10 through 8.13 with the engine at 1500 rpm.

.15 Record on form SD–94 whether the relief valve operated "OK" or "Not OK" at idle and 1500 rpm. Near the bottom of the form, list any pump repairs that were made.

.16 With the engine at idle, test the pump flow. Slowly close the load valve until the pressure gauge reads 1000 psi (6895 kPa).

.17 Read the flow gauge and record the flow rate on form SD–94.

.18 Open the load valve.

.19 Run the engine at 1500 rpm. Leave the load valve open, do *not* close the load valve. Read the flow gauge and record the flow rate on form SD–94.

.20 At idle the minimum flow rate is 3.1 gal/min (11.7 L/min). The maximum flow rate at either engine speed is 6.0 gal/min (22.8 L/min). If the flow rate is below the minimum, repair or replace the pump. For instructions, refer to the pump section in this group. If the flow rate is above the maximum, replace the flow control and relief valve in the pump. For instructions, refer to the pump section in this group.

9. Check the relief valve plungers and the axle stop adjustment.

NOTE: Relief valve plungers limit the steering assist when the front wheels approach the axle stops. Improper adjustment can apply excessive force to the steering linkage or loss of assist as the steering wheel approaches either full left or full right turns.

.1 If the turning angle is inadequate, make sure the axle stops are set to the maximum possible turn angle. Make sure the axle stop settings limit the steering travel so there is 13-mm (1/2-inch) clearance from all stationary components, and 19-mm (3/4-inch) clearance from all moving components.

.2 Make sure the pitman arm is oriented on the steering gear sector shaft correctly. Refer to "Steering Gear Removal and Installation."

.3 Do the checks under "System Set-Up for Hydraulic Checks."

.4 Make sure the fluid temperature is 150° to 160°F (66° to 71°C) and the vehicle is stationary with the front wheels pointing forward.

.5 Run the engine at idle with the load valve open. Refer to **Table 4** for the correct engine idle speed.

.6 Turn the steering wheel to either full-lock position.

CAUTION: If power steering pump relief pressure is reached while the steering wheel is at full-lock, release the steering wheel from this position. Don't allow the pump relief pressure to be maintained for longer than five seconds, or damage to the pump may result.

SHEPPARD M–100 STEERING GEAR

.7 Note the pressure gauge reading.

.8 Repeat steps 9.5 through 9.7 for the opposite turn direction, and note the pressure gauge reading.

.9 The pressure readings at the axle stops should not exceed 1200 psi (8200 kPa). If the pressures are acceptable, record on form SD–94 and go on to the next test for the complaint. If the pressure is too high at either axle stop position, the relief valve plungers must be adjusted. For instructions, refer to "Steering Gear Installation."

10. Test for steering gear internal leakage.

.1 Do the checks under "System Set-Up for Hydraulic Checks."

.2 Make sure the fluid temperature is 150° to 160°F (66° to 71°C) and the vehicle is stationary with the front wheels pointing forward.

.3 Run the engine at idle with the load valve open. Refer to **Table 4** for the correct engine idle speed.

.4 Place an unhardened steel spacer, 1-inch (2.5-cm) thick between the axle and the axle stop at one side of the axle. See **Fig. 81**. The spacer should have an extension or handle long enough to keep your fingers clear of the axle stop area. A brazing rod or welding rod works well for this purpose.

WARNING: Keep your fingers clear of the axle stops and spacer block during this test. Make sure that the spacer block contacts the axle stop squarely. Contact that is not square could break the axle stop, or dangerously eject the spacer block, causing injury.

While running this test, do not hold the steering wheel in the full turn position for longer than 5 seconds at a time to avoid damaging the pump.

.5 Have someone turn the steering wheel until the axle stop contacts the spacer block. Apply 20 lb (9 kg) to the rim of the steering wheel. See **Fig. 82**.

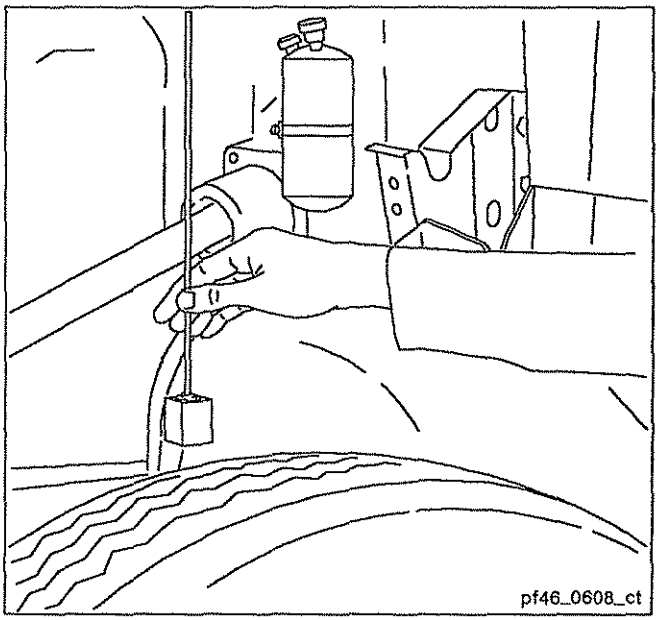

Fig. 81

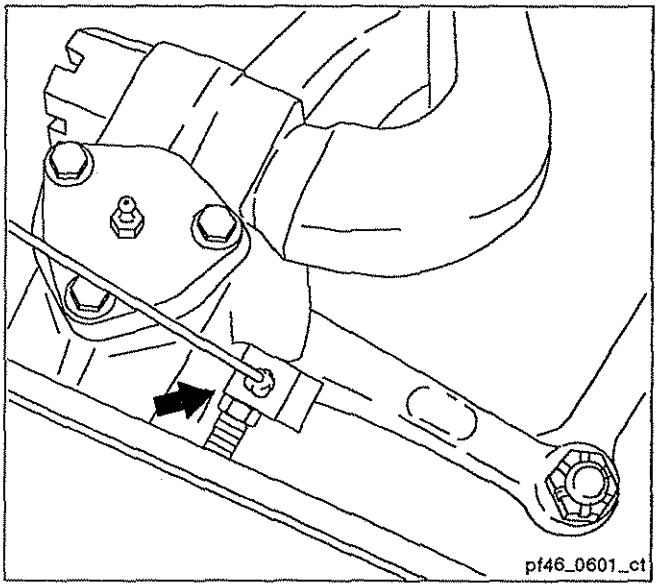

Fig. 82

.6 Read the internal leakage rate on the flow meter.

.7 Record the reading on form SD–94.

SHEPPARD M–100 STEERING GEAR

.8 Repeat steps 10.4 through 10.7 for the opposite turn direction.

.9 The maximum permissible internal leakage is 1.0 gal/min (3.8 L/min). If leakage is greater in either turning direction, replace the steering gear components as needed.

SHEPPARD M–100 STEERING GEAR

FREIGHTLINER
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Checklist for Troubleshooting Hydraulic Power Steering System Performance

Date _____ Work Order No. _____

Evaluation Performed By _____ ☐ Dealership ☐ Fleet ☐ Independent

Vehicle Identification

Vehicle Model _____ Chassis No. _____ Date in Service _____
Mileage _____ Mileage when steering complaint first occurred _____
Vehicle application _____ Normal steering axle load _____

Steering System Description

Steering Pump Manufacturer _____ Model No. _____
Steering Gear Manufacturer _____ Model No. _____ Date Code _____
Reservoir Capacity: ☐ 2 quart ☐ 4 quart ☐ 9 quart
Type of Fluid: ☐ ATF ☐ 10W ☐ 10W–30 ☐ 10W–40 ☐ Other _____

Steering Complaint and Appropriate Checks

				CHECKS									
				1	2	3	4	5	6	7	8	9	10
LH	RH	Both	COMPLAINT	Tire Press./ Vehicle Load	Fifth Wheel Lube	Vehicle Align-ment	Loose/ Binding Compo-nents	Noise	System Operat-ing Temp.	System Leaks or Restric-tions	Pump Perform-ance	Gear Poppet Adjust-ment	Gear Internal Leakage
			Hard or Heavy Steering	•	•		•		•	•	•	•	•
			Low Assist										
			Binding	•	•		•		•	•	•	•	•
			Locking										
			Occasional Loss of Assist										
			Reduced Wheel Cut									•	
			Vehicle Pulls to One Side	•		•					•		
			Darting/ Oversteer	•	•	•	•						
			Vehicle Wanders										
			Noisy Steering					•		•	•		
			Steering Gear External Seal Leaks						•	•	•		
			Excessive Heat										
			Other (describe as completely as possible) _____										

Vehicle Checks

No. 1—Tire Pressure/Load:
Oversized front tires? ☐ Yes ☐ No
Heavy load operation? ☐ Yes ☐ No ☐ psi ☐ kPa
Rear tire pressure even? ☐ Yes ☐ No

Front Tire Pressure: Left _____ Right _____

No. 2—Fifth Wheel Lube and Condition: ☐ OK ☐ Not OK

No. 3—Vehicle Alignment and Wheel Bearing Adjustment:
Rear axle _____ Front axle: Caster Left _____ Right _____
Wheel bearings: ☐ OK ☐ Not OK Camber Left _____ Right _____

No. 4—Binding Components:
Lubrication of drag link, tie rod, and knuckle pins? ☐ Yes ☐ No
COE steering column bearing binds? ☐ Yes ☐ No

SD-94 (9/91P)

Fig. 83, Front Side, "Checklist for Troubleshooting Hydraulic Power Steering System Performance"

SHEPPARD M–100 STEERING GEAR

No. 4—Binding Components: (Continued)

Steering driveline U-joints bind?	☐ Yes	☐ No
Steering driveline phasing OK?	☐ Yes	☐ No
Sector shaft adjustment OK?	☐ Yes	☐ No
Front tire self-return OK?	☐ Yes	☐ No

No. 5—Noise:

Fluid level: ☐ OK ☐ Too low ☐ Too high

Fluid condition: ☐ OK ☐ Discolored ☐ Odorous ☐ Foamy ☐ Other _____

Inlet tube or fittings leaking?	☐ Yes	☐ No
Front spring pin shims required?	☐ Yes	☐ No
Loose steering components?	☐ Yes	☐ No
Normal "hissing" at full turn?	☐ Yes	☐ No
"Hissing" at less than full turn?	☐ Yes	☐ No
Hoses kinked or collapsed?	☐ Yes	☐ No

No. 6—System Operating Temperature: ☐ °F ☐ °C

Outside (ambient) temperature _____°, Test start _____°

10 min. _____°, 20 min. _____°, 30 min. _____°, 40 min. _____°

No. 7—System Leaks or Restrictions:

Hoses kinked or collapsed?	☐ Yes	☐ No
Leaking fittings?	☐ Yes	☐ No
Leaking seals?	☐ Yes	☐ No

Total System and Component Back Pressure: ☐ psi ☐ kPa

Total system _____, Hose: Pump-to-gear _____, Steering gear _____,

Hose: Gear-to-booster _____, Hose: Gear-to-reservoir _____, Booster _____,

Hose: Booster-to-reservoir _____, Reservoir _____, Hose: Pump supply _____

Hydraulic Checks

Power steering fluid temperature: (to be 150° to 160°F [66° to 71°C]; see "System Set-Up for Hydraulic Checks" in applicable service manual) _____°F (_____°C)

Idle RPM: (see "System Set-Up for Hydraulic Checks" in applicable service manual for correct idle rpm) _____rpm

			Idle	Highway
No. 8—Pump Performance:				
Erratic response:	☐ Yes	☐ No		
Pump relief pressure:	☐ psi	☐ kPa	_____	
Pump relief valve operation:		OK ☐		☐
		Not OK ☐		☐
Pump flow:	☐ gpm	☐ Lpm	_____	_____
No. 9—Steering Gear Poppet Adjustment:			Left Turn	Right Turn
Poppet valve trip pressure:	☐ psi	☐ kPa	_____	_____
No. 10—Steering Gear Internal Leakage:				
Ross (TRW):	☐ gpm	☐ Lpm	_____	_____
Sheppard:	☐ psi	☐ kPa	_____	_____

Attempted Corrections and Results

Pump repairs: _____

Steering gear repairs: _____

_____

Other components repairs: _____

SD-94 (9/91P)

Fig. 84, Back Side, "Checklist for Troubleshooting Hydraulic Power Steering System Performance"

SHEPPARD M–100 STEERING GEAR

SYSTEM SET-UP FOR HYDRAULIC CHECKS

NOTE: Use a 1 to 10 gpm (3.8 to 38 L/min) flow meter, a pressure gauge 0 to 2500 psi (0 to 17 225 kPa minimum), and a load valve, preferably in one test unit.

1. Install the test unit between the pump high-pressure line and the steering gear.
2. Fill and bleed the steering system. Refer to "Steering Gear Installation" for instructions.
3. Checks must be done with the power steering fluid at operating temperature 150° to 160°F (66° to 71°C). Monitor the fluid temperature with a thermometer in the fluid reservoir. If the fluid is too cold, raise the temperature as follows:

   Run the engine at idle.

   Partially close the load valve on the test unit until the pressure gauge reads 1000 psi (6895 kPa).

CAUTION: Do not leave the load valve fully closed since this could damage the power steering system.

   Open the valve when the fluid temperature reaches 150° to 160°F (66° to 71°C).

CAUTION: Do not allow the fluid temperature to exceed 250°F (121°C) since this could damage the power steering system.

NOTE: When doing checks (steps) nos. 8, 9, and 10, use **Table 4** below for engine idle speed. Adjust idle speed if necessary. Refer to the engine manufacturer's instructions.

Record all data from the hydraulic checks on form SD-94, "Checklist for Troubleshooting Hydraulic Power Steering System Performance."

Engine Type	Idle Speed (rpm)
Detroit Diesel 6V	500
Detroit Diesel Series 60	600
Cummins NTC	600
Cummins L10	700
Caterpillar 3406 and 3176	700
Caterpillar 3306	750

Table 4

SPECIFICATIONS

Pump	Engine	Minimum Flow Rate gpm (Lpm)
Eaton (all models)	Cummins L10	2.7 (10.2)
	DDE Series 60	
	Caterpillar 3406B, 3306, and 3176	
	Cummins NTC	1.8 (6.8)
Vickers	Caterpillar 3306	2.8 (10.6)

Table 5, Minimum Flow Rates (at engine idle) Needed to Operate the Steering Gear

Description	Size	Grade	Torque lbf·ft (N·m)
Bearing Cap Cover Bolts	M10 x 1.5	8.8	41–51 (56–69)
	M10 x 1.5	10.9	53–63 (72–85)
Bearing Cap Bolts and Cylinder Head Bolts	M14 x 2	8.8	114–124 (155–168)
	M12 x 1.75	8.8	72–81 (98–110)
	M10 x 1.5	8.8	41–51 (56–69)
Sector Shaft Cover Bolts	M12 x 1.75	8.8	72–81 (98–110)
Mounting Bracket Bolts	M12 x 1.75	8.8	72–81 (98–110)
Pitman Arm Retainer	—	—	225 (305)
Steering Gear Mounting Bolt Nuts	7/8–9	8	388 (526)

Table 6, Steering Gear Torque Values

SHEPPARD M–100 STEERING GEAR

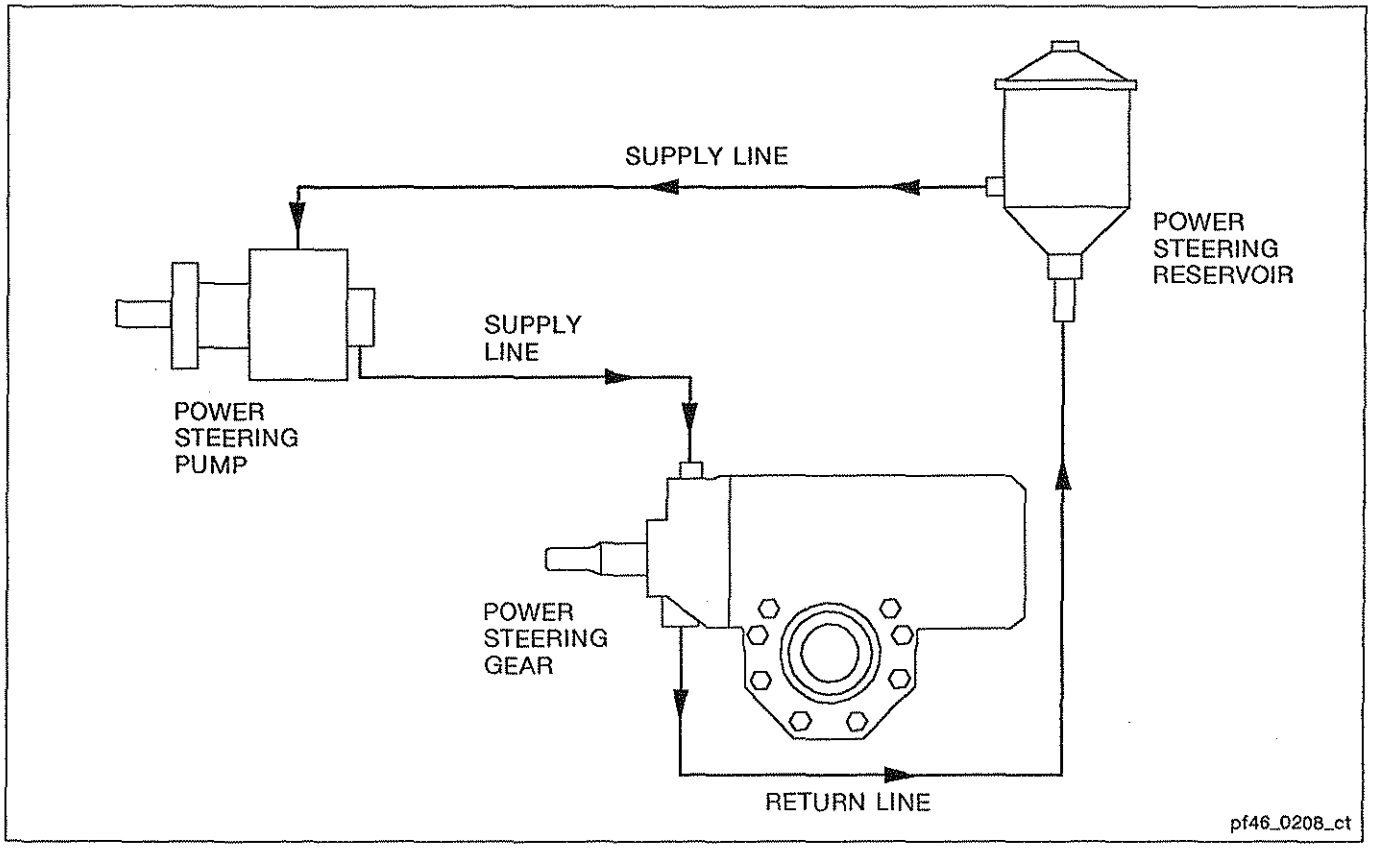

Fig. 85, Plumbing Diagram

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

SUBJECT CONTENTS

Topic **Page Number**

General Description

Principles of Operation

Service Operations

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Sector (Output) Shaft 5
Manual Adjustments of the Poppet Valves 5
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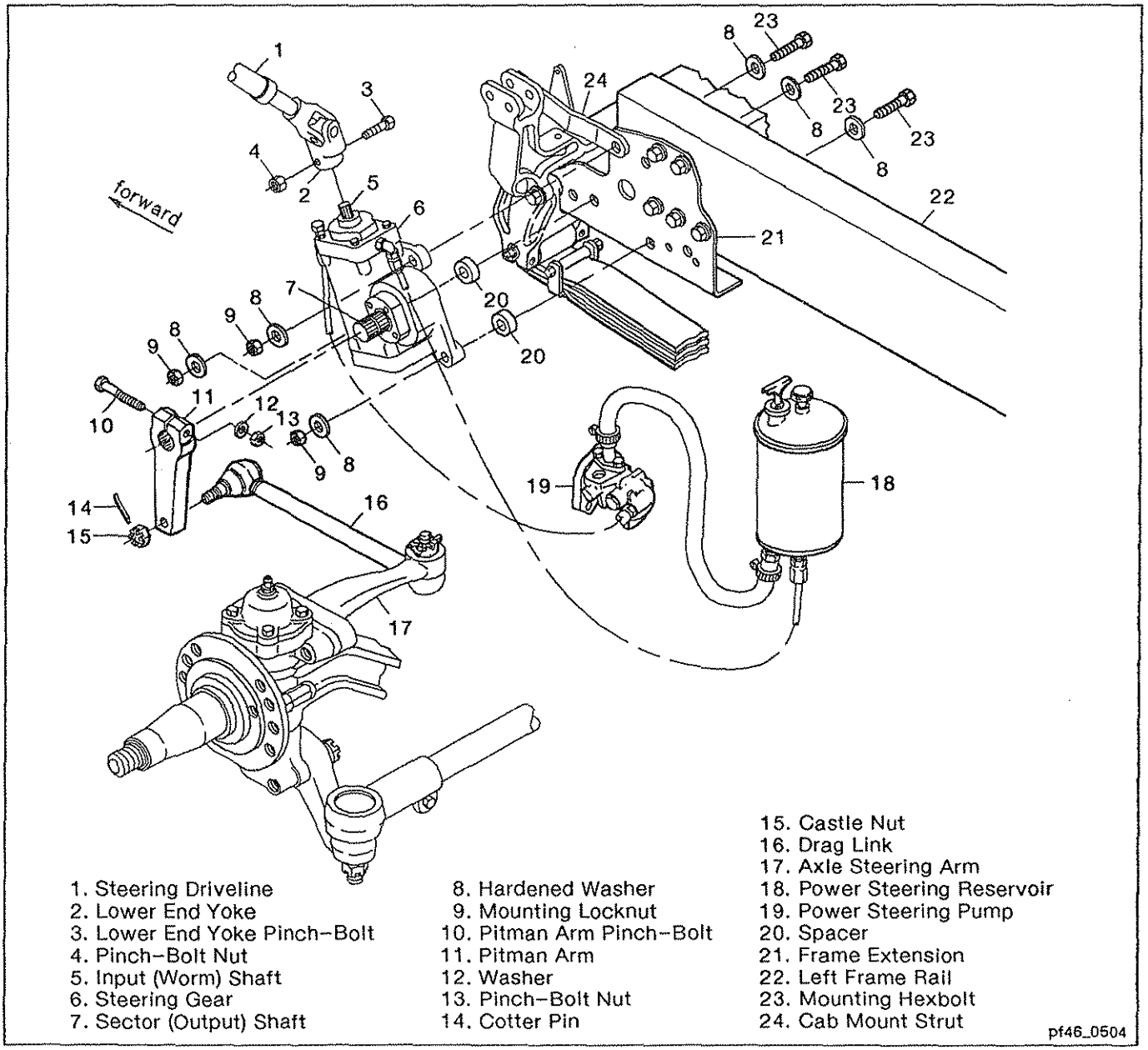
ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

GENERAL DESCRIPTION

The Ross TAS65 integral power steering gear can be installed on vehicles with front axle capacities up to 14,000 lbs (6350 kg). The steering gear is mounted on the vehicle frame rail. See **Fig. 1** (COEs), or **Fig. 2** (120 Conventionals).

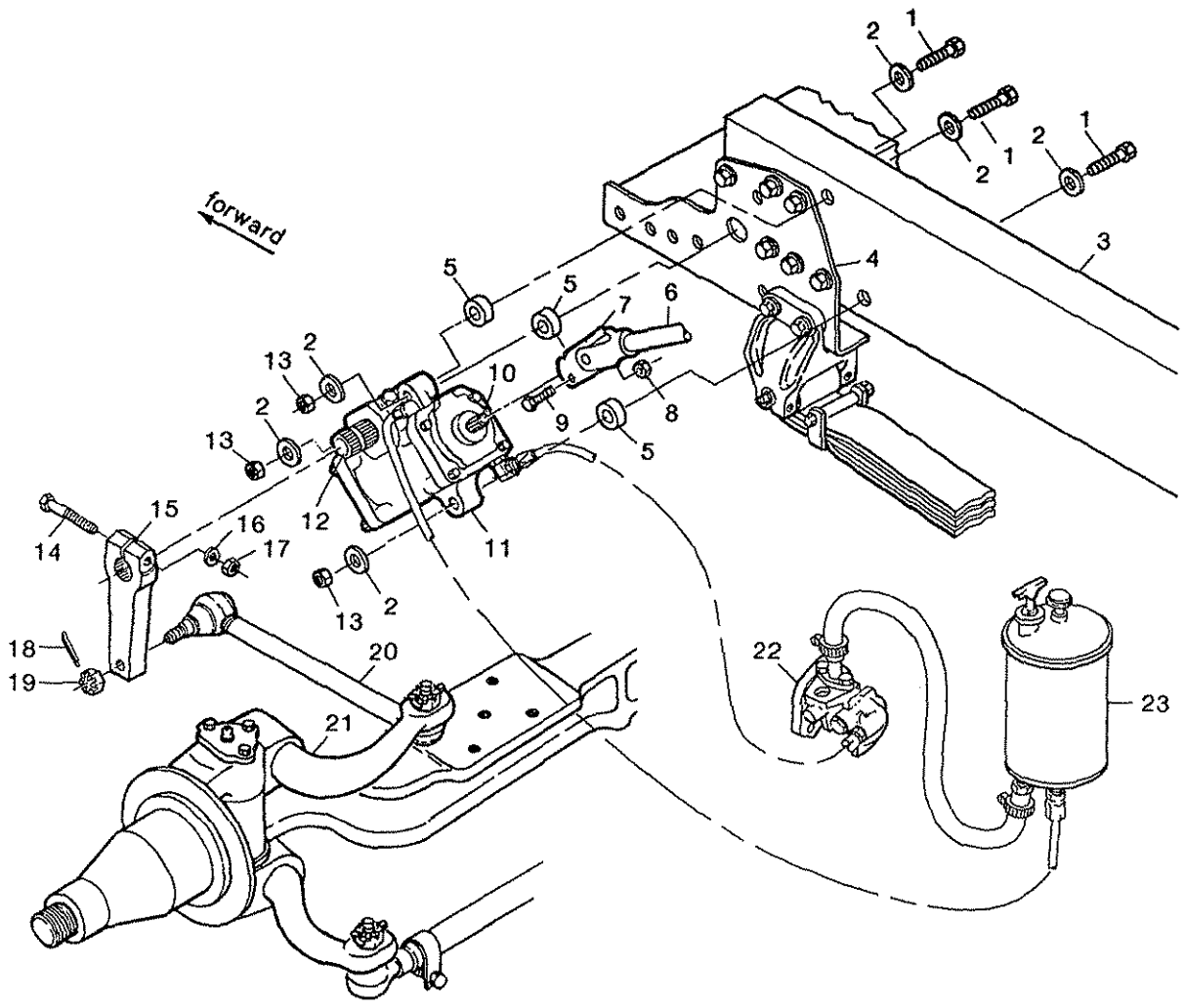
The steering gear incorporates a manual steering mechanism, hydraulic control valve, and a hydraulic power cylinder. The control valve is a rotary design, which directs oil flow from the power steering pump to the upper or lower cylinder cavity.



1. Steering Driveline
2. Lower End Yoke
3. Lower End Yoke Pinch–Bolt
4. Pinch–Bolt Nut
5. Input (Worm) Shaft
6. Steering Gear
7. Sector (Output) Shaft
8. Hardened Washer
9. Mounting Locknut
10. Pitman Arm Pinch–Bolt
11. Pitman Arm
12. Washer
13. Pinch–Bolt Nut
14. Cotter Pin
15. Castle Nut
16. Drag Link
17. Axle Steering Arm
18. Power Steering Reservoir
19. Power Steering Pump
20. Spacer
21. Frame Extension
22. Left Frame Rail
23. Mounting Hexbolt
24. Cab Mount Strut

Fig. 1, Ross TAS65 Integral Power Steering Installation, COE

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65



1. Mounting Bolt
2. Hardened Washer
3. Left Frame Rail
4. Frame Extension
5. Spacer
6. Steering Driveline
7. Lower End Yoke
8. Pinch–Bolt Nut
9. Lower End Yoke Pinch–Bolt
10. Input (Worm) Shaft
11. Steering Gear
12. Sector (Output) Shaft
13. Mounting Locknut
14. Pitman Arm Pinch–Bolt
15. Pitman Arm
16. Washer
17. Pinch–Bolt Nut
18. Cotter Pin
19. Castle Nut
20. Drag Link
21. Axle Steering Arm
22. Power Steering Pump
23. Power Steering Reservoir

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Fig. 2, Ross TAS65 Integral Power Steering Installation, 120 Conventional

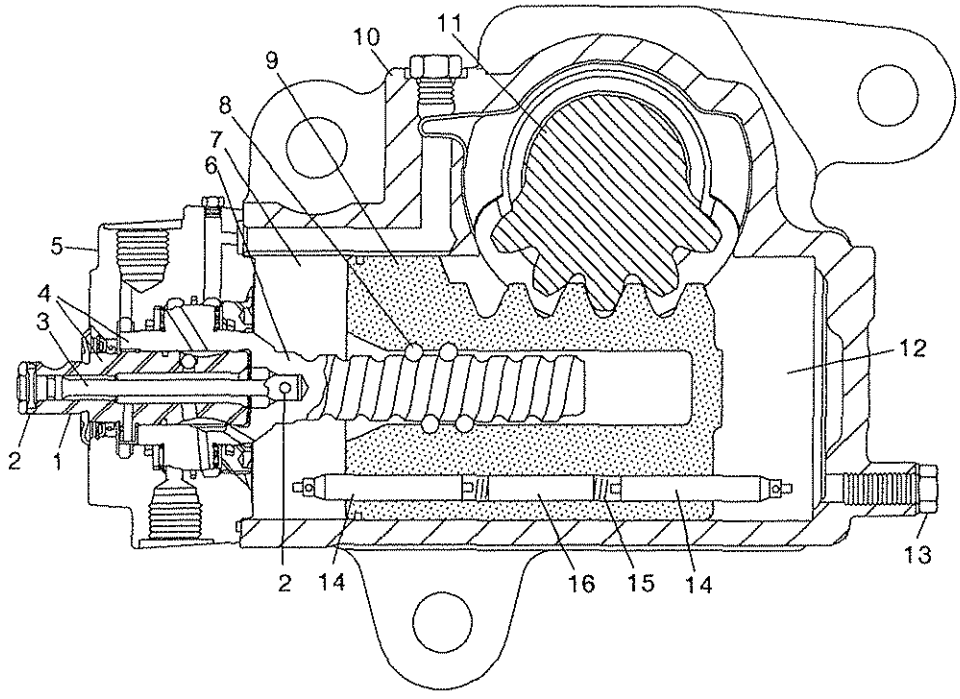
ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

PRINCIPLES OF OPERATION
(Refer to **Fig. 3**)

When the steering wheel is turned, force is transmitted from the steering wheel to the steering gear input shaft. A torsion bar, pinned at one end to the input shaft, and at the other to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston up or down (as applicable) in the gear housing cylinder bore.

The rack piston's movement is resisted by its engagement to the sector shaft, which is linked to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve to the upper or lower cylinder cavity (depending on the direction of turn), assists in moving the rack piston up or down (as applicable) in the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal construction of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents kickback at the steering wheel.



1. Input Shaft
2. Pin
3. Torsion Bar
4. Control Valve
5. Valve Housing
6. Worm Shaft
7. Upper Cylinder Cavity
8. Ball (recirculating)
9. Rack Piston
10. Gear Housing
11. Sector Shaft
12. Lower Cylinder Cavity
13. Poppet Fixed Stopscrew
14. Poppet Assembly
15. Poppet Spring
16. Push Tube

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Fig. 3

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

On each end of the rack piston is a poppet (unloading valve). The appropriate poppet will trip as the steered wheels approach the axle stop for that direction of turn. The tripped poppet reduces pressure in the gear, heat generated by the pump, and outside forces acting on the steering linkage.

SERVICE OPERATIONS

PRE-SERVICE CHECKS

This subject is intended to help in locating the causes of problems that affect the power steering system. Before servicing the power steering system, do the following pre-service checks. After servicing the power steering system, do the checks under "Post-Service Checks."

When steering problems exist, first inspect the vehicle for roadworthiness. Then, if necessary, verify the steering problem by test driving the vehicle, or taking a ride with the driver. If the problem occurs only when the vehicle is loaded, the testdrive should also be made with the vehicle loaded.

1. If the steering problem occurs only when the vehicle is loaded, make sure the fifth wheel is lubricated.
2. Make sure the power steering reservoir is filled to the correct level, and the filter is not clogged. For fluid level checking instructions, and filter changing instructions, refer to Group 14 of the *COE and 120 Conventional Maintenance Manual.*
3. Check the front tires for correct inflation, irregular wear, or mismatched tires. Check the front wheels for loose wheel nuts, damage, an out-of-round condition, and lateral runout.
4. Check the steering gear mounting bolts for tightness. Refer to "Specifications" for steering gear mounting bolt torque.
5. Check the steering linkage, ball joints, and kingpins for loose, damaged, or worn parts. The wheels must turn smoothly from stop to stop.

   Make sure the steering linkage and steering driveline U-joints are lubricated. The steering linkage includes the tie rod, tie-rod ends, knuckle bearings, knuckle bushings, and other components that carry movement of the pitman arm to the steering knuckles. Refer to Group 14 of the *COE and 120 Conventional Maintenance Manual* for instructions.
6. Inspect the steering driveline, and steering column for worn or damaged parts. For service instructions, refer elsewhere in this group.
7. Inspect the front axle suspension for worn or damaged parts.
8. Make sure all hoses that may have been replaced are not misrouted, restricted, or too small in inside diameter. Replace any hoses that are worn or that do not have the same inside diameter as original equipment. Reroute any hose that is kinked or sharply bent. Refer to **Table 1** for the minimum bend radius of each hose.

Hose Size	Minimum Bend Radius inches (mm)
No. 8	4-5/8 (117)
No. 10	2-1/4 (57)
No. 12 Pump Supply	5 (127)
No. 16 Pump Supply	6 (152)

Table 1

9. Check the front axle wheel alignment, including wheel bearing adjustment, caster and camber angles, and toe-in. Also check for the correct clearance between the wheels and tires and other vehicle components. See "Adjustments."
10. Check the rear axle alignment. Rear axle misalignment can cause hard or erratic steering.
11. Place a thermometer in the power steering reservoir, then warm the hydraulic system to normal operating temperature of 125° to 135°F (51° to 57°C), by starting the engine and operating it at low idle, while turning the steering wheel through several full left and right turns. With the engine running

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

and the power steering system at operating temperature, turn the steering wheel slowly from stop to stop, while checking the power steering reservoir for frothing or a change in the fluid level (an indication that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as necessary.

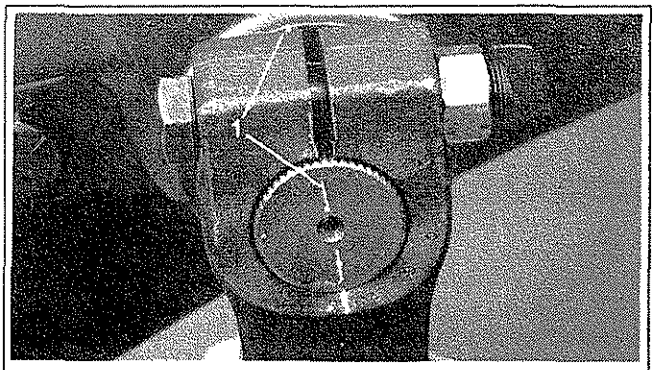
SECTOR (OUTPUT) SHAFT

1. Position the sector shaft at its center of travel by turning the steering wheel until the alignment mark on the sector shaft is at a right angle to the input shaft centerline, and in line with the timing mark on the end of the housing trunnion. See **Fig. 4**.
2. Disconnect the drag link from the pitman arm.

CAUTION: The input-shaft/valve/worm assembly must not be turned more than 1-1/2 turns in either direction from its center of travel while the drag link is disconnected from the pitman arm. Turning the input shaft more than 1-1/2 turns from center will cause misadjustment of the automatic poppets.

3. With the sector shaft in the center position, grasp the pitman arm and gently try to move it back and forth in the direction of travel. Finger-tip force is adequate to detect lash (free-play) of a loose sector shaft. See **Fig. 5**. There may be *no movement* of the input shaft or sector shaft. If no lash is detected, no adjustment is needed.

   If lash is detected, find the sector shaft adjusting screw, in the center of the sector shaft cover, on the inboard side of the gear housing. Loosen the adjusting screw jam nut, and move the adjusting screw clockwise until the sector shaft and rack piston are in contact. Use no more than 10 lbf·ft (14 N·m) of torque. Then, turn the adjusting screw counterclockwise one turn. At this point, there should be lash at the pitman arm.
4. To adjust, slowly turn the adjusting screw clockwise until no lash is felt at the pitman arm, then turn it clockwise an additional one-eighth turn. Hold the adjusting screw in place and tighten the jam nut 40 to 45 lbf·ft (54 to 61 N·m).
5. Check the pitman arm for lash. Turn the steering wheel one-quarter turn each side of center. No lash should be felt. If lash exists, repeat steps 2 through 5.
6. Connect the drag link to the pitman arm. For instructions, refer elsewhere in this group.



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1. Timing Marks

Fig. 4

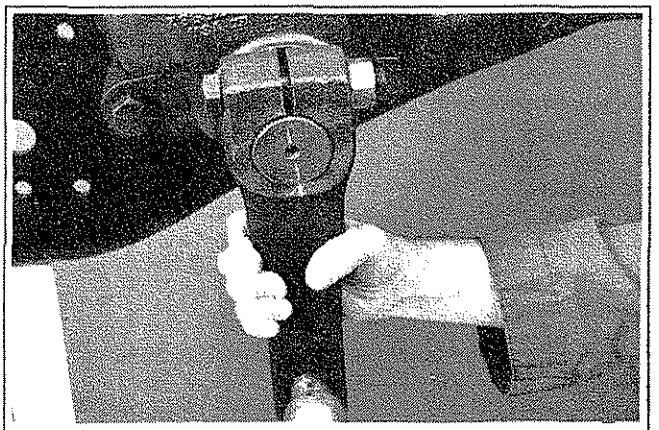

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Fig. 5

MANUAL ADJUSTMENT OF THE POPPET VALVES

The TAS65 steering gear has automatic poppet valves that reset themselves if the axle stops are reset for increased steering travel.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

However, if the axle stops are reset for *decreased* steering travel, the poppet valves must be adjusted manually, as described below, unless they were reset while the steering gear was disassembled.

1. Set the axle stops as follows:

IMPORTANT: The axle stops must be set so that there are at least 1-3/4 steering wheel turns from a straight-ahead position to both a full-left and a full-right turn; otherwise the poppet valves will not work.

.1 Make sure the steering gear is in the center of travel when the wheels are in a straight-ahead position. Center the gear, using the instructions under "Sector (Output) Shaft." Bottoming of the steering gear must not occur when making an extreme right or left turn.

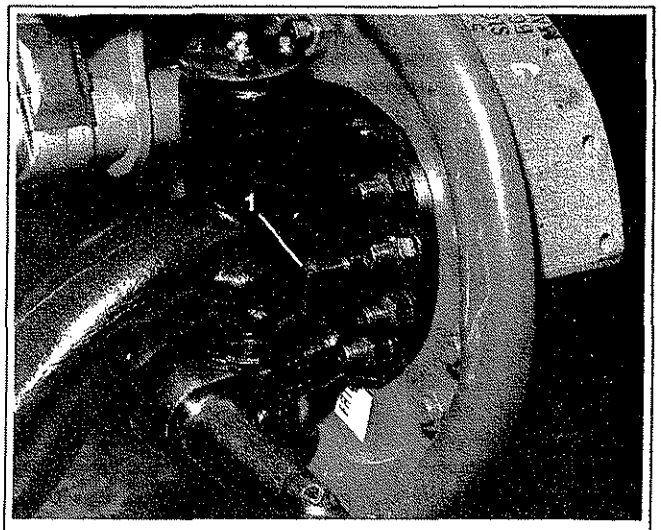
.2 If using stationary turning radius gauges, drive the vehicle on the plates; the tires must be exactly straight ahead. Set the parking brakes.

If using portable gauges, set the parking brakes, chock the rear tires, and raise the front of the vehicle. Place a turning radius gauge under each front tire. With the tires exactly straight ahead, lower the vehicle so that the tires rest on the center of the gauges.

.3 Remove the lock pins from the gauges, and adjust the dials so that the pointers on both gauges read zero.

.4 With the brakes fully applied, turn the steering wheel clockwise to the end of travel. Check both sides of the vehicle for interference at the tires and wheels. There must be at least 1/2-inch (13-mm) clearance in all directions from any fixed components that are attached to the vehicle. Clearance to moving components must be at least 3/4 inch (19 mm).

If necessary, loosen the stopscrew locknut (see **Fig. 6**); adjust the stopscrew to contact the axle when the maximum turning angle of the wheels is determined.



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1. Stopscrew and Locknut

Fig. 6, Axle Stop

Tighten the locknut or stopscrew 50 to 60 lbf·ft (68 to 81 N·m).

.5 Repeat step 1.4 with the steering wheel turned counterclockwise. Adjust the axle stop, as needed, and keep the turning angle within 1 degree of the right-hand turn angle.

.6 Drive the vehicle off the turning radius gauges, or remove them from under the tires.

2. Screw the special poppet adjusting screw (from Ross kit number 021407–X1) into the non-sealing end of the sealing jam nut, until the drive end of the screw is flush with the nut. See **Fig. 7**.

3. With the vehicle unloaded, the engine off, and the front wheels in the straight-ahead position, remove and discard the poppet fixed stopscrew and washer from the lower end of the steering gear housing. See **Fig. 8**.

NOTE: With the wheels in the straight-ahead position, and the timing marks on the sector shaft and gear housing aligned (as shown in **Fig. 4**), the steering gear is centered.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

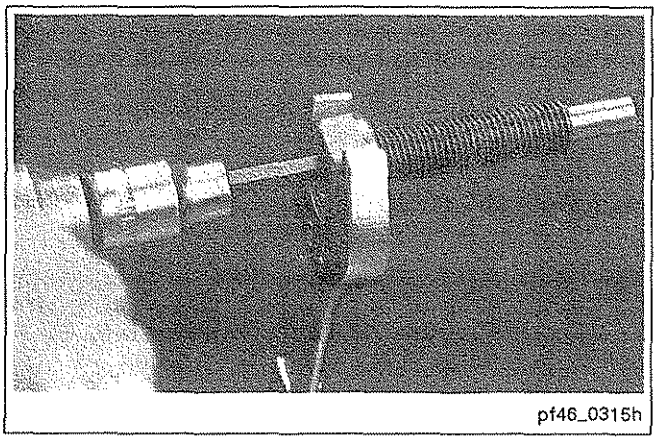


Fig. 7

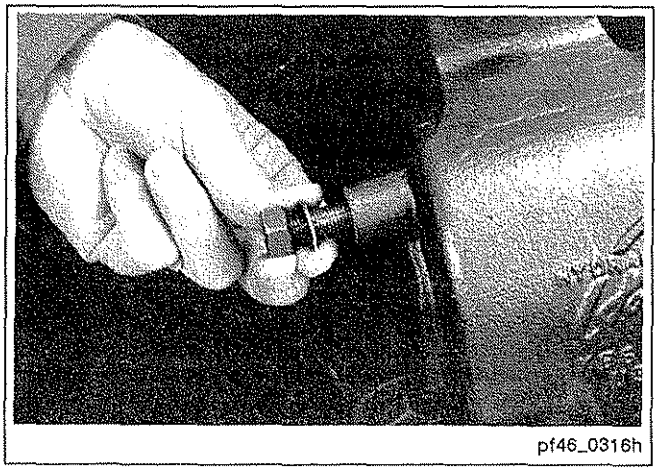


Fig. 8

4. Turn the adjusting screw and nut—together—into the steering gear housing (see **Fig. 9**) until the nut is firmly against the housing.

5. Using a 3/4-inch open end wrench, a 3/4-inch socket on a torque wrench, and a 7/32-inch allen wrench, tighten the sealing nut 38 to 42 lbf·ft (52 to 57 N·m).

6. Fill the power steering reservoir; refer to **Table 4**, under "Specifications" for approved hydraulic fluids.

NOTE: In steps 7 and 9, if you meet resistance of more than 48 lbs (21.8 kg) to steering wheel rim pull before contacting the axle stops, let the vehicle roll slowly forward while turning the steering wheel. If there's still a problem turning the steering wheel, jack up the front axle.

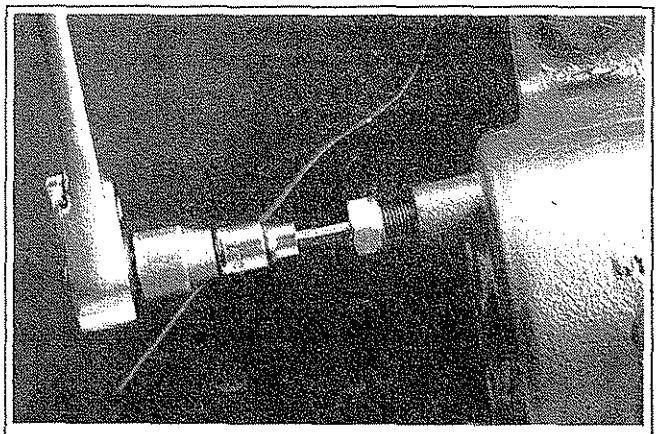


Fig. 9

7. With the engine at idle, position the rack piston by rotating the steering wheel to the full-right-turn position for COEs, or the full-left-turn position for 120 Conventionals. See **Fig. 10**. Turn the steering wheel until the axle stop is contacted.

8. Loosen the sealing nut on the gear housing, and back out the adjusting screw until it is 1 to 1-1/16 inches (25 to 27 mm) beyond the sealing nut. See **Fig. 11**. While holding the screw, tighten the sealing nut 33 to 37 lbf·ft (45 to 50 N·m).

IMPORTANT: Make sure the adjusting screw does not protrude more than 1-1/16 inches (27 mm) beyond the sealing nut.

9. With the engine at idle, turn the steering wheel all the way in the opposite direction it was turned in step 7, until the axle stop is contacted. This positions the upper poppet valve in relation to the axle stop.

CAUTION: At no time should pump relief pressure be maintained for longer than five seconds, or damage to the power steering pump may result.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

10. Have someone turn the steering wheel all the way in the direction it was turned in step 7. The steering system is now at pump relief pressure.

IMPORTANT: In step 11, do not tighten the adjusting screw more than 20 lbf·in (220 N·cm) over its initial positioning in step 8, or the upper poppet valve could be forced out of position. If this happens, the entire adjustment procedure will have to be repeated.

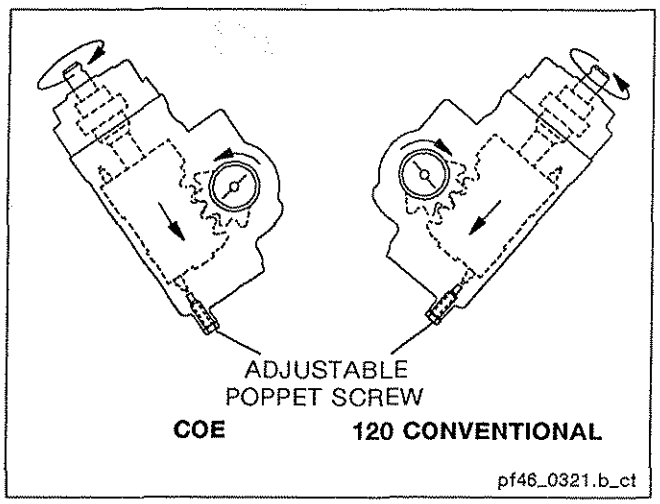


Fig. 10

11. With the steering wheel held in the full-travel position, loosen the sealing nut one turn, and while holding the sealing nut, turn the adjusting screw in until you have tightened it an additional 10 to 20 lbf·in (120 to 220 N·cm). Then back out the adjusting screw 4 turns. Have the steering wheel released at this time.

12. While holding the adjusting screw in place, tighten the sealing nut firmly against the gear housing. See **Fig. 12**. Tighten it 33 to 37 lbf·ft (45 to 50 N·m).

    Check the adjusting screw. If it extends more than 1-1/16 inches (27 mm) from the sealing nut, loosen the sealing nut, and turn the adjusting screw in as needed. Tighten the sealing nut 33 to 37 lbf·ft (45 to 50 N·m). See **Figs. 11** and **12**.

WARNING: If the adjusting screw protrudes more than 1-1/16 inches (27 mm) from the sealing nut, the screw could fall out of the steering gear, resulting in loss of power steering. This could cause an accident resulting in serious personal injury or property damage.

IMPORTANT: Once the poppet adjusting screw and sealing nut are in place and the poppet valves have been manually adjusted, the adjustment procedure must be repeated if steering travel is either increased or decreased in the future.

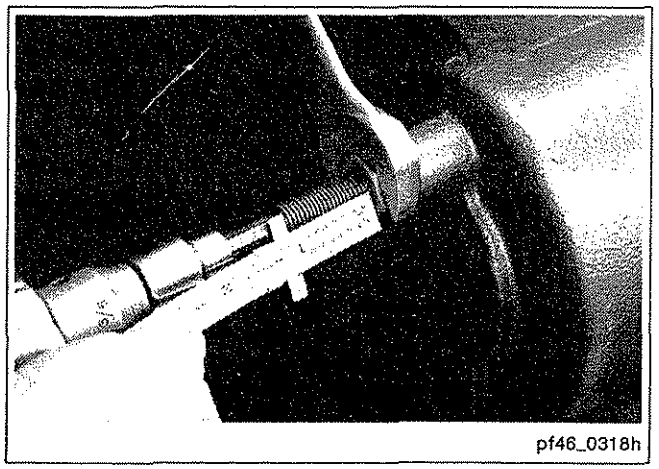


Fig. 11

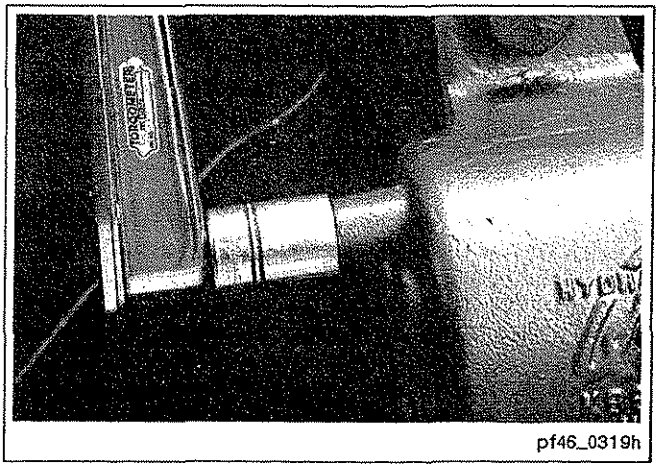


Fig. 12

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

STEERING GEAR REMOVAL AND INSTALLATION

REMOVAL (Refer to **Fig. 1** or **Fig. 2**)

1. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where the work is to be done. Set the parking brakes and chock the tires.
2. Clean all outside dirt from around the fittings and hose connections.
3. Drain the power steering system. Disconnect all hydraulic lines from the gear, marking the lines for later assembly reference. Seal the lines and the fittings to keep out dirt.
4. Disconnect the drag link from the pitman arm as follows:
   .1 At the pitman arm end of the drag link, remove the cotter pin and the castle nut from the ball stud in the pitman arm.
   .2 Using a ball stud removal tool, disconnect the drag link assembly from the pitman arm.
5. Disconnect the steering driveline from the steering gear input shaft as follows:
   .1 Remove the pinch-bolt nut and pinch-bolt from the steering driveline lower end yoke.

   CAUTION: Do not pound the U-joint or lower end yoke on or off the input shaft. Internal damage to the steering gear can result.

   .2 Remove the lower end yoke from the input shaft. If you cannot remove the yoke with a light application of pressure, then it is secured with adhesive. Weaken the adhesive bond by applying 300°F (150°C) heat to the base of the yoke.
6. Clean the entire assembly before removing the gear.

WARNING: The steering gear weighs about 80 lbs (36 kg) dry. Use caution when removing, lifting, and carrying the steering gear, to avoid injury.

7. Remove the fasteners that attach the steering gear to the frame rail and frame rail extension. Remove the spacers and the steering gear.
8. If removing the pitman arm, mark its alignment with the sector shaft for later reference.

INSTALLATION (Refer to **Fig. 1** or **Fig. 2**)

WARNING: The steering gear weighs about 80 lbs (36 kg) dry. Use caution when lifting, carrying, and installing the steering gear, to avoid injury.

1. Install the steering gear, spacers, and fasteners as shown in **Figs. 1** and **2**.

   Tighten the fasteners to the torque values in **Table 3**, under "Specifications."
2. If not previously done, center the steering gear. The sector (output) shaft alignment mark must be at a right angle to the steering gear input shaft centerline. Make sure the steering gear remains centralized as the service work continues.
3. If the pitman arm was removed, install the pitman arm on the steering gear, aligning the timing marks as marked at the time of removal.

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. To wedge the slot open, clamp the pitman arm in a vise with the slot at the top. Use a ball peen hammer to drive a chisel into the slot. Hold the chisel in place, remove the pitman arm from the vise, and install the pitman arm on the sector shaft. Remove the chisel from the slot.

WARNING: Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise, the chisel may fly loose, which could cause an injury.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

4. Install the pitman arm pinch-bolt, washer (if applicable), and a new nut. Tighten the nut 230 lbf·ft (312 N·m).

5. Connect the steering driveline to the steering gear input shaft as follows:

   .1 Clean the input shaft and the inside of the driveline yoke.

   .2 Apply Locquic General Purpose Primer T® to the input shaft. Let dry for five minutes.

   .3 Apply a bead of Loctite® No. 680 adhesive to the inside of the driveline yoke.

   .4 Position the steering wheel so that the king spoke (the narrow spoke on some wheels or the spoke with the manufacturer's name imprinted on the underside) points directly toward the front of the vehicle (positioned at 12 o'clock ±10 degrees). See **Fig. 13.**

   .5 Slide the yoke onto the input shaft, and install the yoke pinch bolt and a new pinch-bolt locknut. Tighten the pinch-bolt nut 60 lbf·ft (81 N·m).

   .6 Apply white Torque Seal® F–900 to the exposed pinch-bolt threads and the locknut tips.

6. Attach the drag link to the pitman arm. For instructions, refer to the applicable section in this group.

7. If they were removed, attach the hydraulic line elbow fittings to the steering gear. Tighten the fittings 37 lbf·ft (51 N·m). Tighten the pressure-line fitting jam nut 495 lbf·in (5600 N·cm), maximum.

8. Remove the plugs from the hydraulic lines. Connect the hydraulic lines to the steering gear as previously marked. Tighten the nut on each fitting finger-tight. Then use a wrench to tighten the nut until there is firm resistance. Tighten one-sixth turn more.

9. Fill and bleed the steering system as follows:

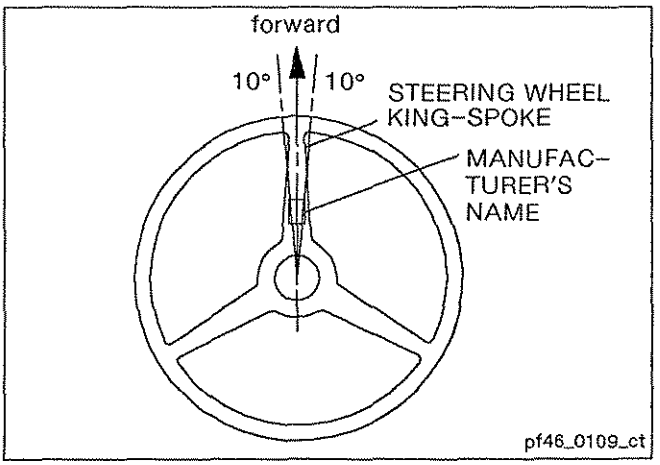


Fig. 13

IMPORTANT: For steps 9.1 and 9.2 below, do not turn the steering wheel. Doing so can cause air to enter the system, which can make it more difficult and time-consuming to bleed air from the system.

.1 Fill the power steering reservoir nearly full; refer to **Table 4** under "Specifications" for approved hydraulic fluids.

Crank the engine for 10 seconds without allowing it to start; if the engine does start, shut it down immediately. Check and fill the reservoir as needed.

Repeat this procedure three times, each time checking and filling the reservoir.

.2 Start the engine and let it idle for two minutes. Shut down the engine, and check the fluid level in the reservoir.

.3 Start the engine again. Steer the vehicle from full-left to full-right, several times. As necessary, add fluid to the full line on the reservoir dipstick.

IMPORTANT: If the poppet adjuster seat and sleeve assemblies were not set for automatic adjustment during the assembly of the steering gear, AND if the axle stops have been adjusted for *decreased* steering travel or the steering gear is installed on a different vehicle, the poppets must be set manually, following the procedure under "Adjustments."

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

10. Go to "Post-Service Checks," and do the checks as instructed.

11. Test drive the vehicle, or take a ride with the driver. Check the steering wheel spoke position. If, during straight-ahead driving on a level road, the steering wheel king spoke doesn't point directly toward the front of the vehicle (positioned at 12 o'clock ±10 degrees), remove the steering wheel and reposition it.

STEERING GEAR DISASSEMBLY, INSPECTION, ASSEMBLY, AND FINAL ADJUSTMENTS

DISASSEMBLY (Refer to **Fig. 14**)

WARNING: All steering mechanisms are safety items. Because of this, follow the instructions in this subject exactly. Failure to do so may result in loss of steering, which could cause an accident resulting in personal injury or property damage.

Be sure that required tools are available before beginning the service procedures described here. See **Table 2** under "Specifications." The special tools required for disassembly and assembly of the steering gear components are available from the Kent-Moore Tool Division, or an affiliated dealer.

IMPORTANT: When the sector shaft is disconnected from the vehicle steering linkage, don't allow the input shaft to move more than 1-1/2 turns from the straight-ahead position, unless you are going to reset the automatic poppet valves while assembling the steering gear. If the input shaft moves more than 1-1/2 turns, the initial setting of the poppet valves will be changed.

Make sure that the steering gear is placed on a clean surface. Clean and dry the gear before disassembly. As the gear is disassembled, clean all parts in a clean, petroleum-based solvent, and blow them dry only.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

Never steam clean or high-pressure wash the hydraulic steering components. Do not force or abuse closely fitted parts. Doing so could cause damage to steering system parts.

Keep each part separate to avoid nicks and burrs. Discard all seals, O-rings, and gaskets, and replace them with new parts.

1. Place the steering gear in a vise so that the output shaft is horizontal. Clamp the gear at the mounting flange.

2. Put a basin under the hydraulic ports, and remove both hydraulic port plugs from the gear.

3. Using a 3/4-inch or 11/16-inch socket wrench, turn the input shaft so that the timing mark on the end of the sector shaft is lined up with the timing mark on the end of the housing trunnion. See **Fig. 15.**

4. Using a small screwdriver, remove and discard the water seal from the housing trunnion. See **Fig. 16.** Remove any dirt, paint, or corrosion from the sector shaft with a piece of fine emery cloth. See **Fig. 17.**

5. Tape the splines and the bolt groove of the sector shaft, using one layer of masking tape. See **Fig. 18.**

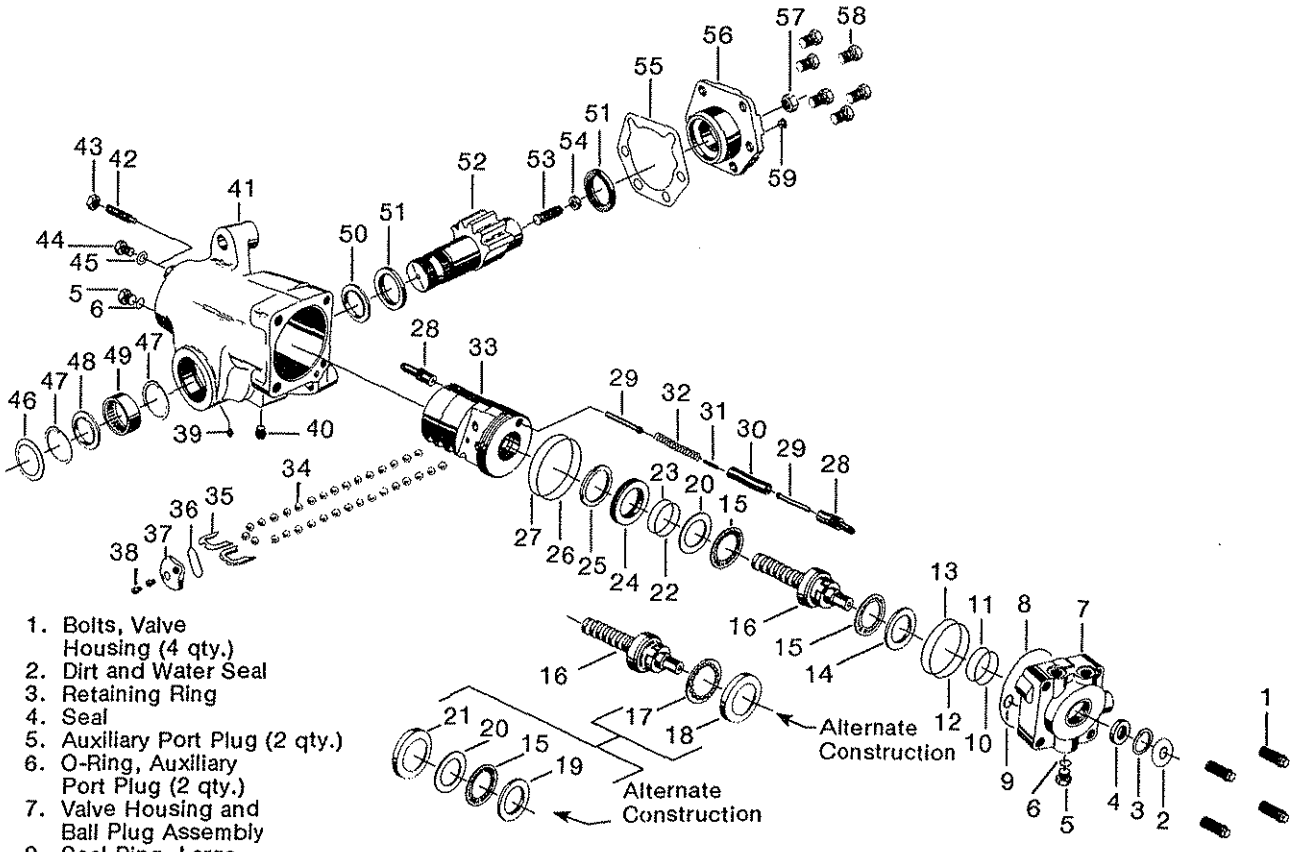
6. Using a 3/4-inch socket, remove the jam nut from the sector shaft adjusting screw. See **Fig. 19.**

7. Put a container under the side cover to catch any drainage, then remove the six special bolts from the side cover. See **Fig. 20.**

IMPORTANT: These special bolts are equipped with either an integral ring or washer on the underside of the head. See **Fig. 21.** If replacing one or more bolts, use bolts of the *same special type and length as those that were removed.* Do not use a substitute. Don't mix different types of bolts.

8. Remove the side cover and the sector shaft assembly, as a unit, from the steering gear housing. See **Fig. 22.** If necessary, start the removal by tapping the end of the sector shaft with a rubber or wooden mallet.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65



1. Bolts, Valve Housing (4 qty.)
2. Dirt and Water Seal
3. Retaining Ring
4. Seal
5. Auxiliary Port Plug (2 qty.)
6. O-Ring, Auxiliary Port Plug (2 qty.)
7. Valve Housing and Ball Plug Assembly
8. Seal Ring, Large
9. Seal Ring, Small
10. O-Ring
11. Seal Ring
12. O-Ring, Valve Housing
13. Seal Ring
14. Thrustwasher, Thick
15. Roller Thrust Bearing (1 or 2 qty.)
16. Input-Shaft/Valve/ Worm Assembly
17. Ball Bearing Assembly (Valve/Worm)
18. Ball Bearing Race
19. Thrustwasher, Thick
20. Thrustwasher, Thin
21. Spacer Sleeve
22. Seal Ring
23. O-Ring
24. Bearing Adjuster
25. Adjuster Locknut
26. Seal Ring, Rack Piston
27. O-Ring (Backup)
28. Poppet Adjuster Seat and Sleeve Assembly (2 qty.)
29. Poppet (2 qty.)
30. Push Tube
31. Spacer Rod
32. Poppet Spring
33. Rack Piston
34. Steel Ball (32 qty.)
35. Ball Return Guide Halves (2 qty.)
36. Seal, Ball Return Guide Cap
37. Ball Return Guide Cap
38. Torx Screws (2 qty.)
39. Grease Fitting
40. Plug, Auto-Bleed
41. Gear Housing
42. Service Poppet Adjusting Screw
43. Service Sealing Jam Nut
44. Fixed Stopscrew, Poppet
45. Washer, Stopscrew
46. Dirt and Water Seal (Trunnion)
47. Retaining Ring (2 qty.)
48. Dirt Seal
49. Roller Bearing
50. Washer (Spacer)
51. Seal, Output (2 qty.)
52. Sector Shaft
53. Adjusting Screw, Shaft
54. Retainer, Adjusting Screw
55. Gasket, Side Cover
56. Side Cover and Bushing Assembly
57. Jam Nut
58. Special Bolts, Side Cover (6 qty.)
59. Vent Plug, Side Cover

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Fig. 14

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

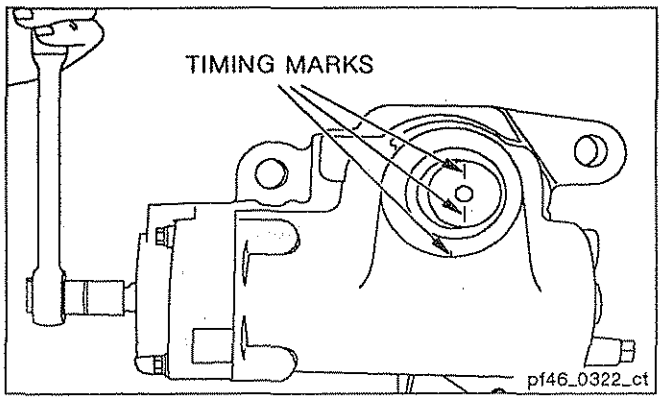


Fig. 15

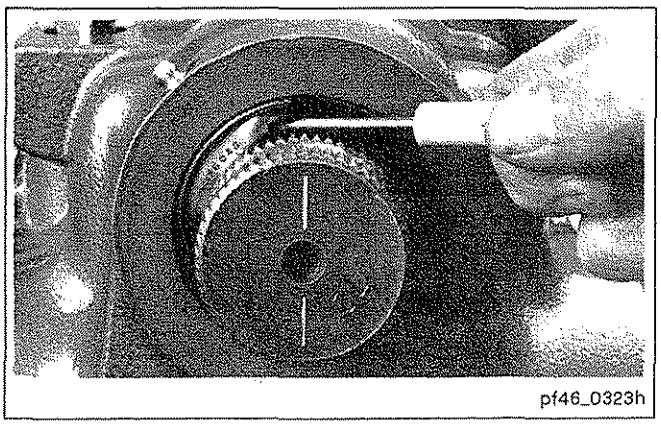


Fig. 16

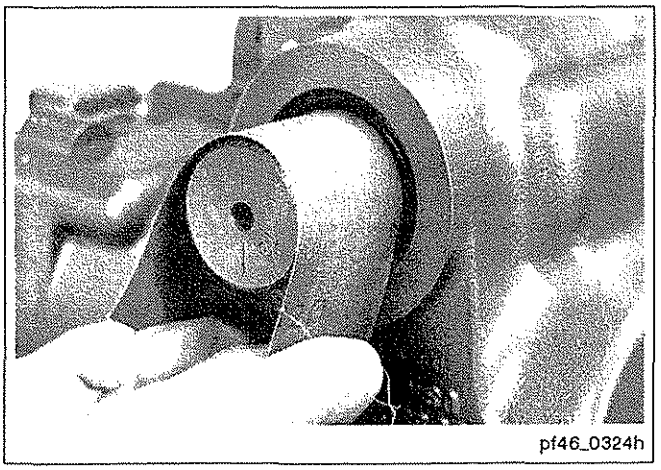


Fig. 17

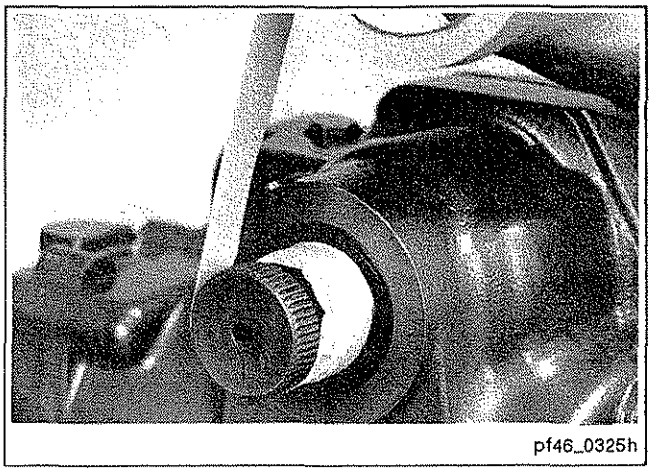


Fig. 18

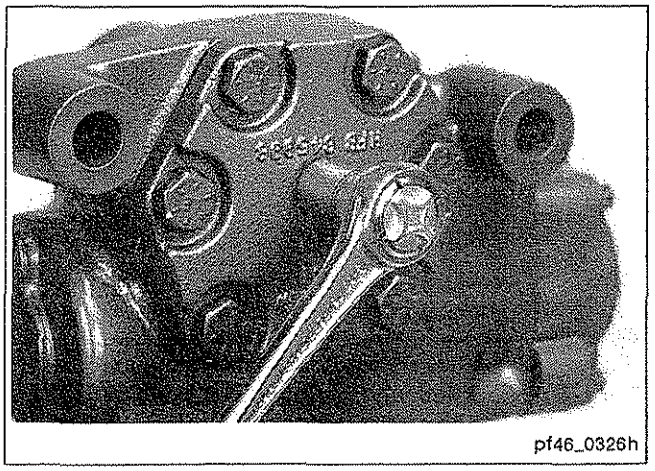


Fig. 19

Remove and discard the side cover gasket.

9. Using a screwdriver, back out and remove the sector shaft adjusting screw from the side cover. See **Fig. 23**.
10. Remove the sector shaft from the side cover.
11. Remove the side-cover seal as follows:

IMPORTANT: Be careful when you are removing the side-cover seal, or you may damage the side-cover bore or the *"DU"* bushing.

.1 Screw a 3-inch, 1/2–20 bolt into the hole in the side cover where the sector shaft adjusting screw was.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

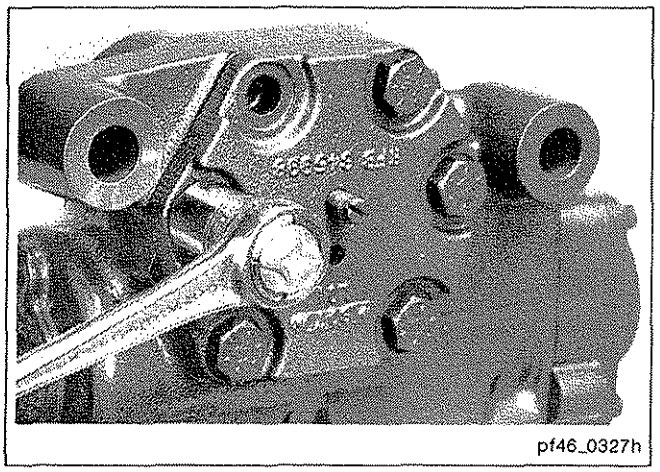


Fig. 20

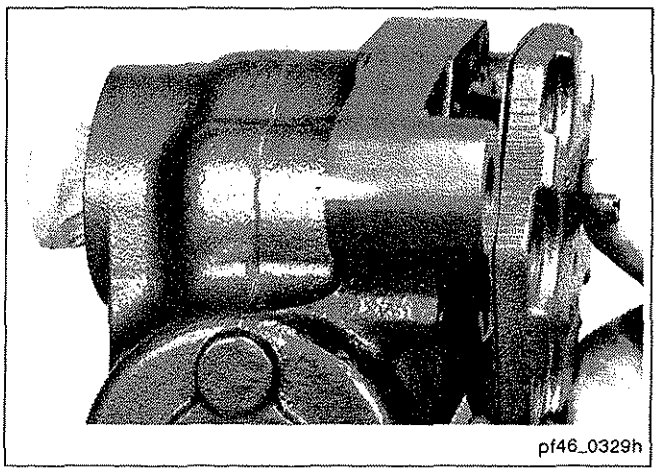
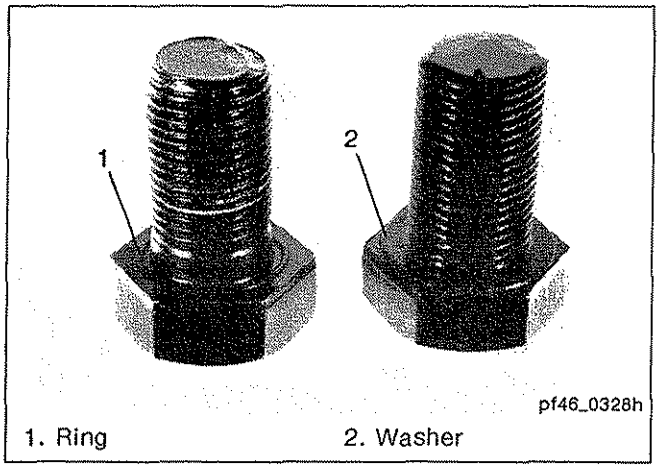


Fig. 22



1. Ring 2. Washer

Fig. 21

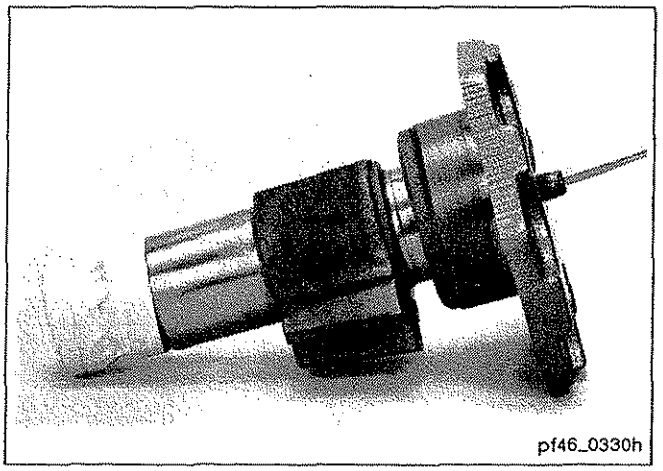


Fig. 23

Make sure the bolt is in far enough so that it will support a rolling head (lady-foot) type pry bar. See **Fig. 24.**

.2 With the pry bar supported by the bolt end, pry up the side-cover seal, and remove it. Discard the side-cover seal, and remove the 3-inch bolt from the side cover.

12. Remove and discard the vent plug from the side cover.

13. Put the sector shaft in a padded vise, and using a chisel, unstake the adjusting-screw retainer. See **Fig. 25.** Unscrew the retainer, remove it from the sector shaft, then remove the adjusting screw. Discard the retainer.

14. Remove and discard the dirt and water seal from the input shaft. Clean the exposed part of the input shaft, using a fine grade emery cloth. See **Fig. 26.**

15. Using an E–16 Torx® socket wrench, remove the four valve housing bolts. See **Fig. 27.**

16. Remove the valve housing from the main gear housing, together with the worm shaft

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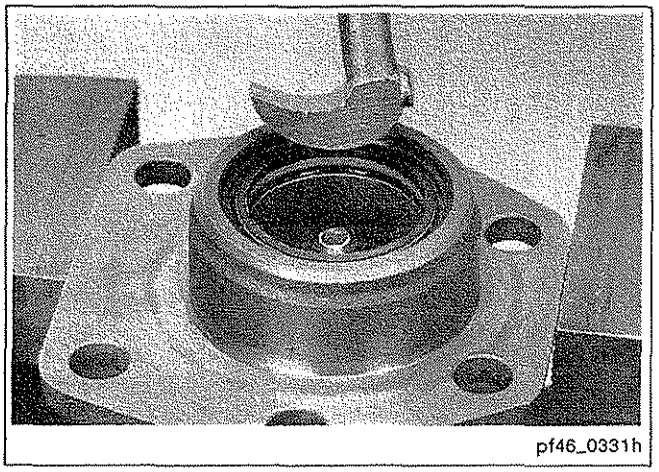


Fig. 24

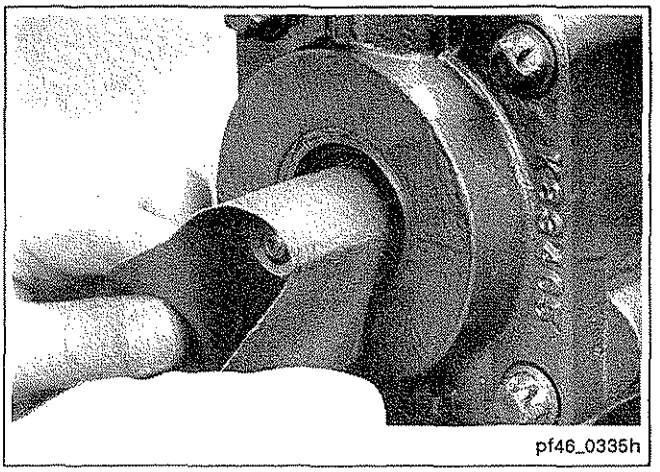


Fig. 26

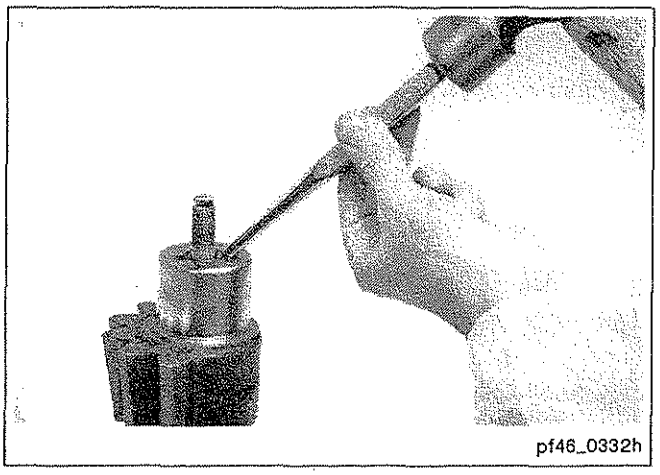


Fig. 25

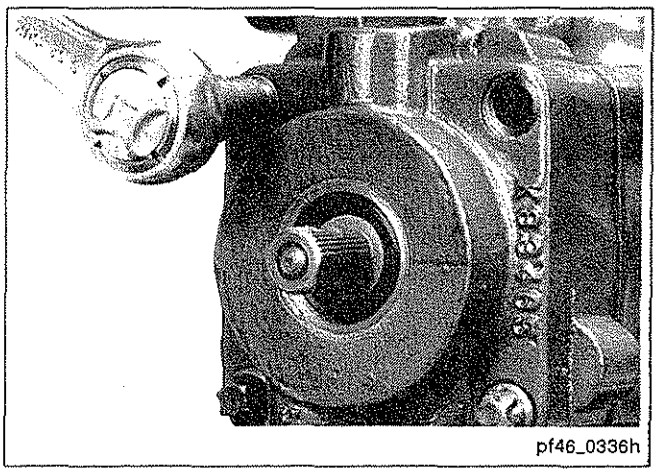


Fig. 27

and rack piston assembly. See **Fig. 28.** Set the assembly on a clean bench.

NOTE: It may be easier to remove the rack piston from the gear housing if the Teflon® ring on the rack piston is cut first. See **Fig. 29.**

17. Remove and discard the seal rings from the valve housing.

IMPORTANT: If you are not going to remove, reset, or replace the poppet valves on the steering gear, make sure that the setting for them isn't accidentally changed. Mark the gear, identifying the vehicle from which it was removed, and note that the poppet valve adjustments are for that particular vehicle.

18. Using a 5/32-inch allen wrench (or a T–30 Torx wrench), remove the two sealing screws holding the ball return guide cap to the rack piston. See **Fig. 30.** Remove the cap and its seal. See **Fig. 31.** Discard the two screws and the seal.

19. Remove the ball return guide halves from the rack piston by carefully prying up on them with a screwdriver. See **Fig. 32.**

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

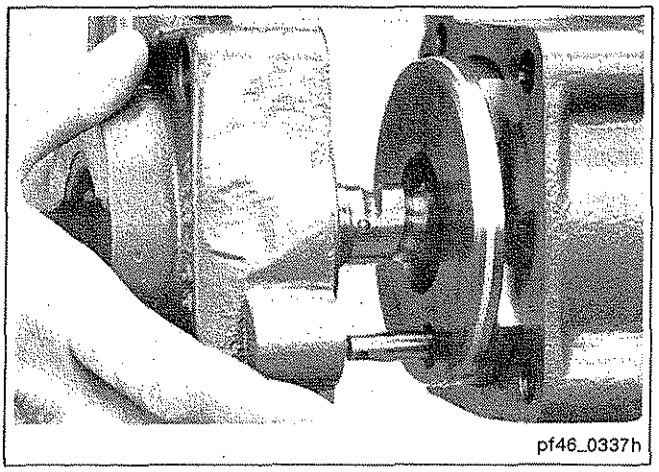


Fig. 28

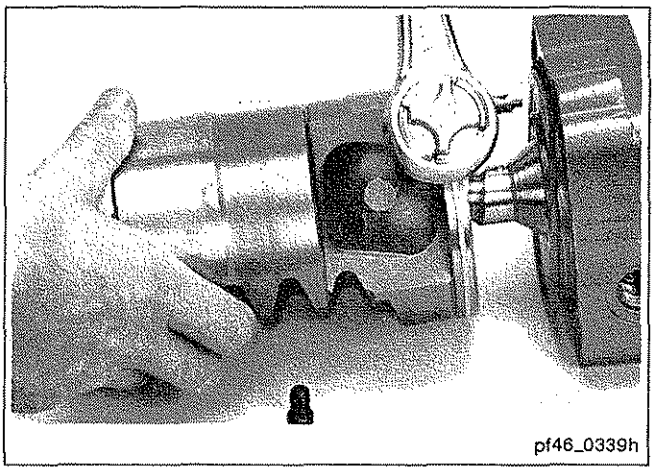


Fig. 30

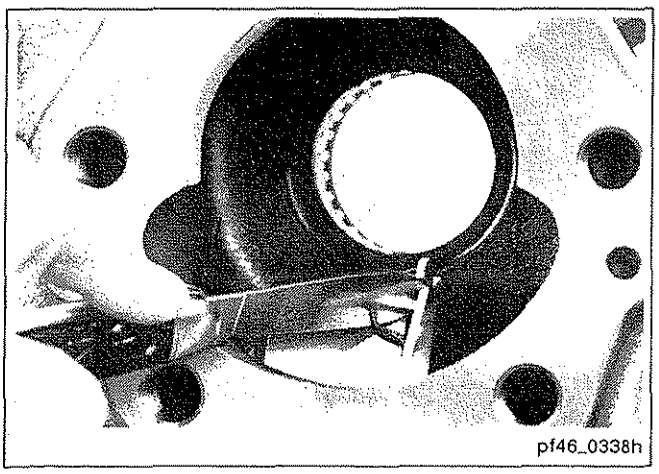


Fig. 29

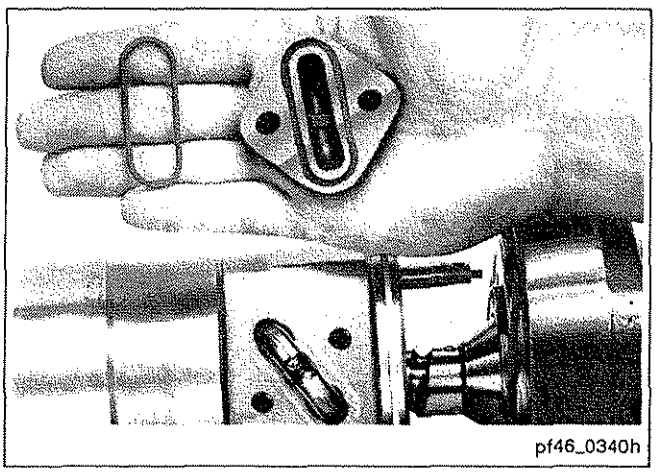


Fig. 31

20. Remove the 32 steel balls from the rack piston by turning the worm shaft until all of them are out. See **Fig. 33.** *Do not lose any of these balls, or you will have to replace the entire set.*

WARNING: Never mix different sets of steel balls. To do so may cause a loss of steering control, which could cause an accident resulting in serious injury or property damage.

21. Remove the worm shaft and valve housing assembly from the rack piston. See **Fig. 34.**

22. If not already done, cut and remove the Teflon seal ring and the O-ring from the rack piston. See **Fig. 35.**

23. Remove the poppet valve assemblies as follows:

CAUTION: The poppet valve assemblies are installed with Loctite®. Be careful when removing them, and use only special tool J36452 or J38713. Failure to do so may damage the rack piston, which would require replacing the rack piston, steel ball kit, and the poppet valve assemblies.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

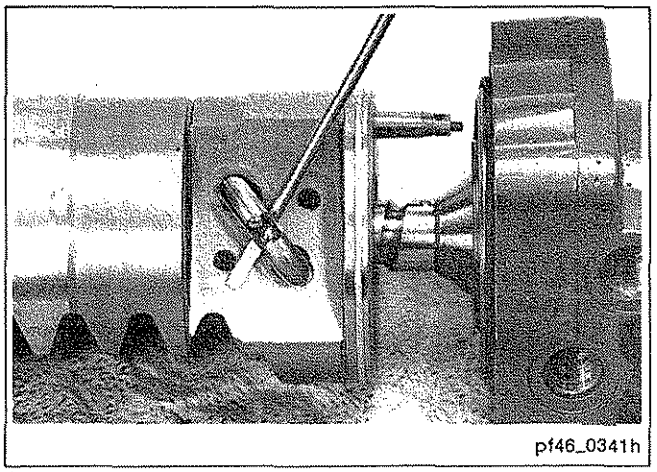


Fig. 32

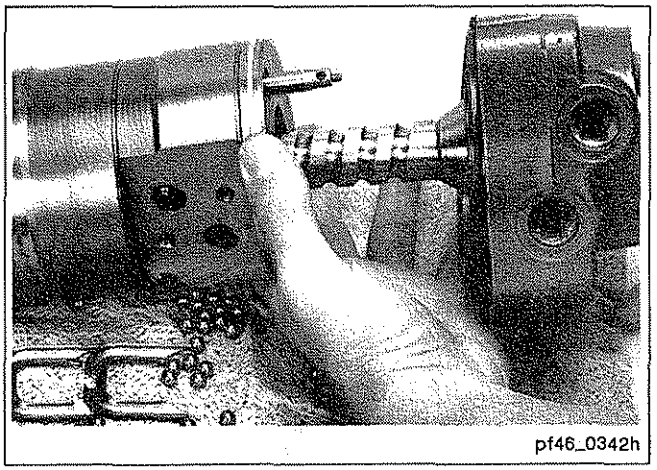


Fig. 33

IMPORTANT: Don't use special tool J38713 on a rack piston that doesn't have a counterbore in the hole for the seat and sleeve assembly.

.1 Put the rack piston in a padded vise.

.2 Slide the special tool J36452 or J38713 over the poppet adjuster seat (see **Fig. 36**), then turn the tool so that its prongs fit into the slot on the threaded adjustment sleeve. Hit the end of the tool firmly four or five times with a 16 oz. hammer to loosen the Loctite. See **Fig. 37**.

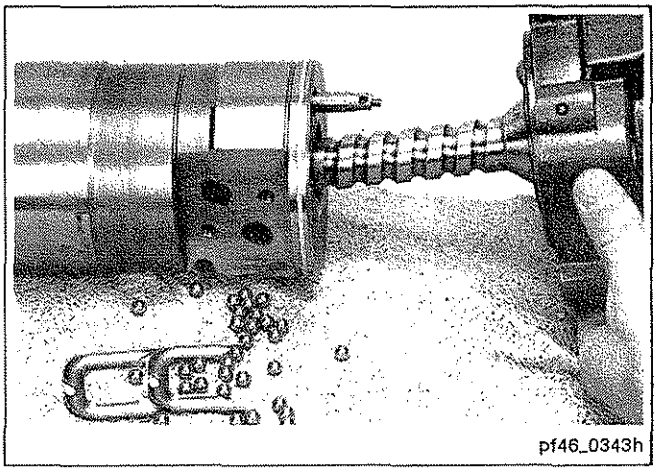


Fig. 34

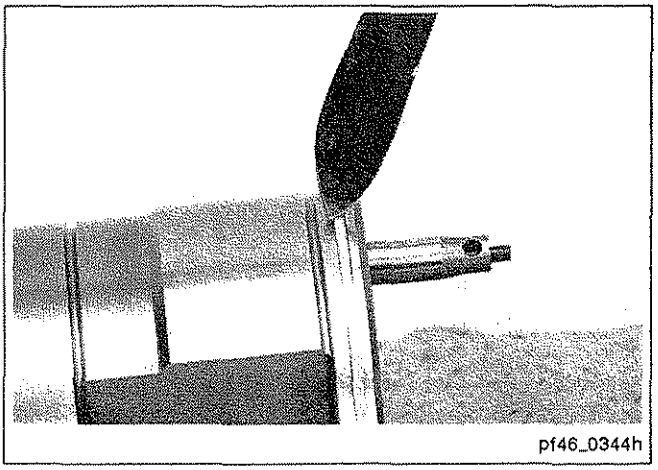


Fig. 35

.3 Using a breaker bar, unscrew the adjuster seat and sleeve assemblies from the rack piston.

.4 Remove both poppets, and the spring, spacer rod, and push tube. See **Fig. 38**.

.5 Repeat steps 23.2 through 23.3 for the other poppet adjuster seat and sleeve assembly.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

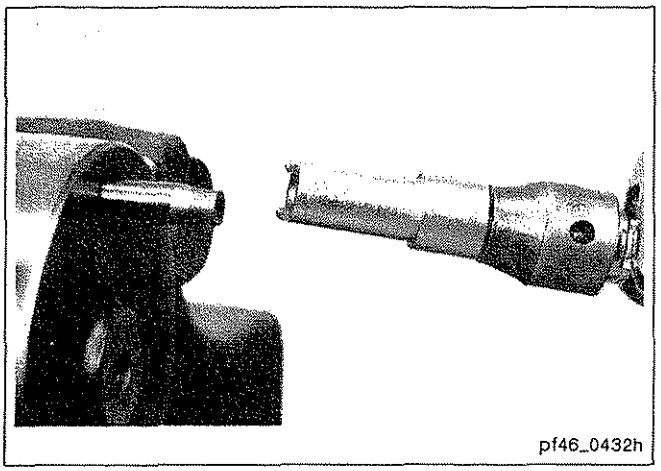


Fig. 36

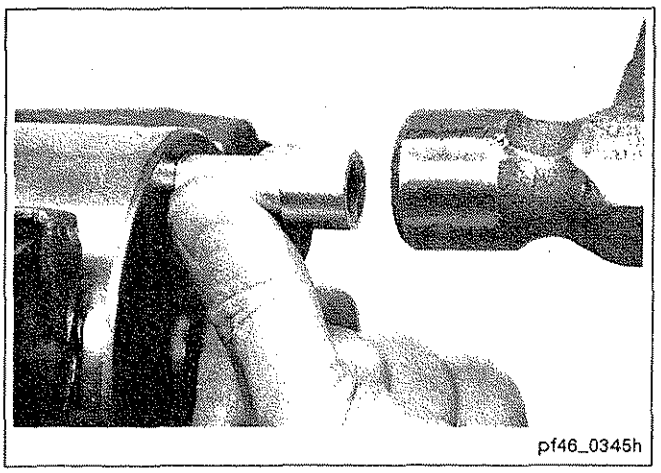


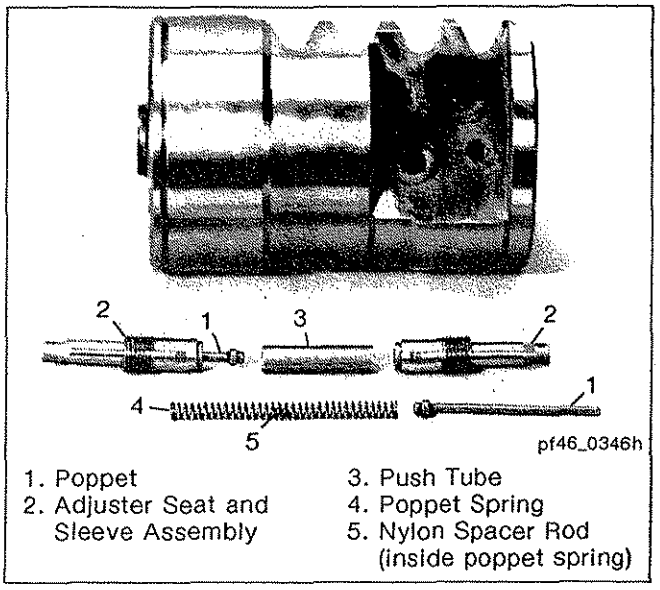
Fig. 37

24. If it's necessary to disassemble the valve housing, do the following:

IMPORTANT: Don't disassemble the valve housing unless you find signs of extreme heat, internal leakage, bearing damage or roughness, or if worm shaft preload adjustment is necessary.

.1 Put the worm shaft and valve housing assembly into a padded vise, with the worm shaft in a vertical position, as shown in **Fig. 39.**

.2 Unstake the adjuster locknut, using a punch. See **Fig. 39.**



1. Poppet
2. Adjuster Seat and Sleeve Assembly
3. Push Tube
4. Poppet Spring
5. Nylon Spacer Rod (inside poppet spring)

Fig. 38

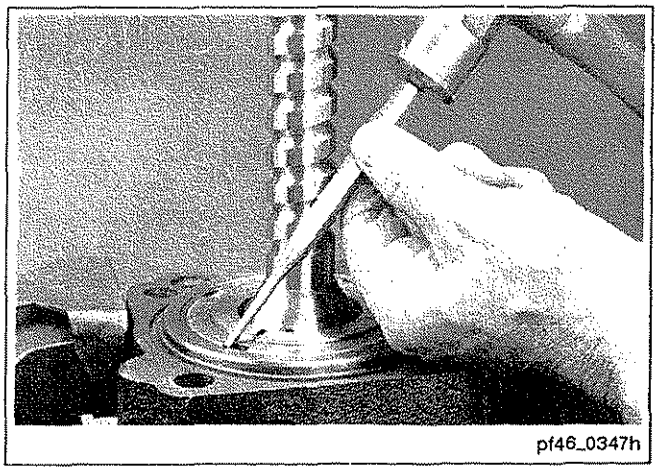


Fig. 39

.3 Using special tools J37464 and J37070, unscrew the adjuster locknut, then the bearing adjuster from the valve housing. See **Fig. 40.**

NOTE: The bearing adjuster has either two slots (new-style), or two drill points (old-style) on its face. Special tool J37070 can be used for removing and installing either style of bearing adjuster. See **Fig. 40.**

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

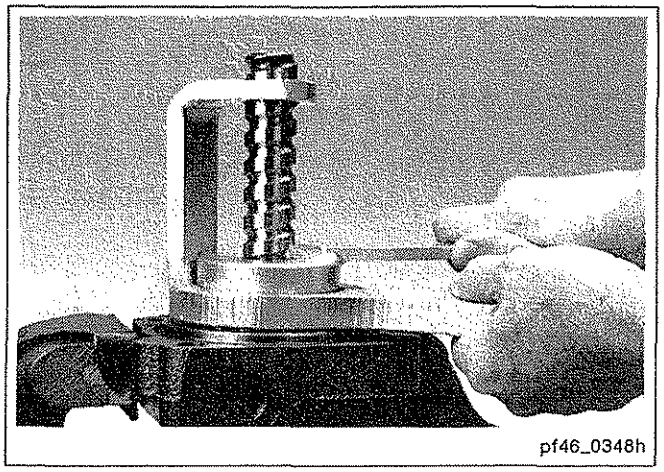


Fig. 40

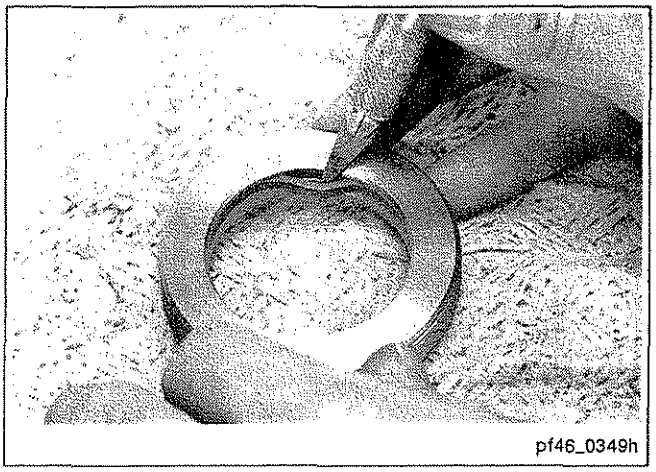


Fig. 41

25. Remove and discard the seal ring and the O-ring from the bearing adjuster. See **Fig. 41.**

26. Remove the thin washer, thrust bearing, input shaft, rotary valve, and worm shaft assembly from the valve housing. See **Fig. 42.**

IMPORTANT: Don't disassemble the input shaft or worm shaft assembly any further. These aren't serviceable.

27. Depending on how the gear is equipped, do one of the following (a, b, or c):

    a. Remove the roller thrust bearing assembly and the thick thrustwasher from the valve housing. See **Fig. 43.**

    b. Remove the spacer sleeve, thin thrustwasher, roller thrust bearing assembly, and the thick thrustwasher from the valve housing. See **Fig. 44.**

    c. Remove the ball bearing assembly and ball race from the valve housing. See **Fig. 45.**

WARNING: If a ball bearing assembly is present, do not continue servicing the steering gear. Contact a Freightliner district service manager for instructions on returning the steering gear to the manufacturer. Under no circumstances is this steering gear to be serviced further, or installed on a vehicle. To do so could cause an accident resulting in property damage or serious personal injury.

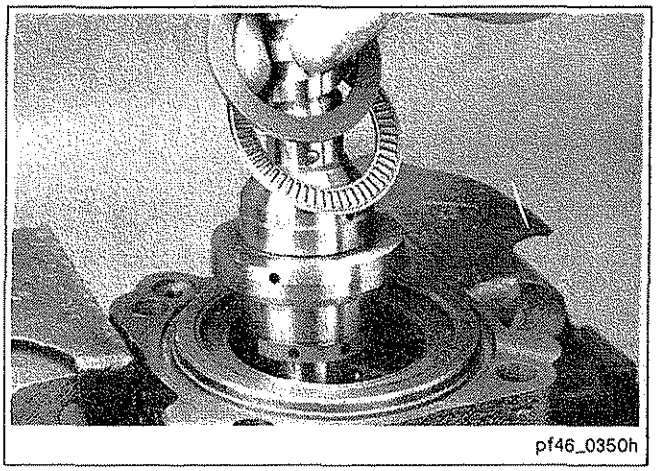


Fig. 42

28. Using a small knife, a probe, or a pick, remove and discard the seal rings and O-rings from the valve housing. See **Fig. 46.**

CAUTION: In step 29, be careful when removing the retaining ring and seal from the valve housing, or you may damage the seal bore. If this

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

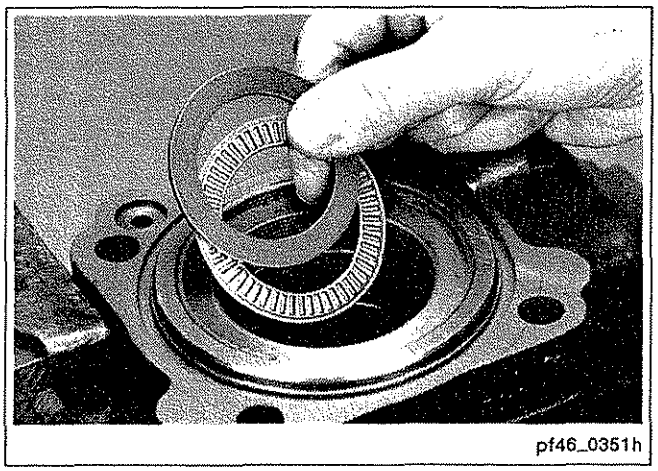

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Fig. 43

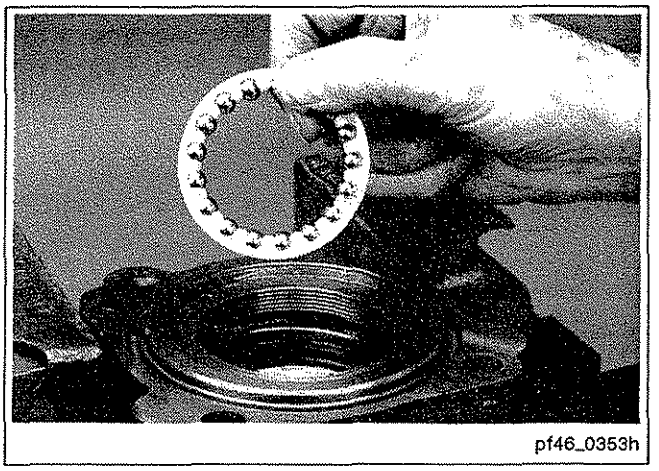
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Fig. 45

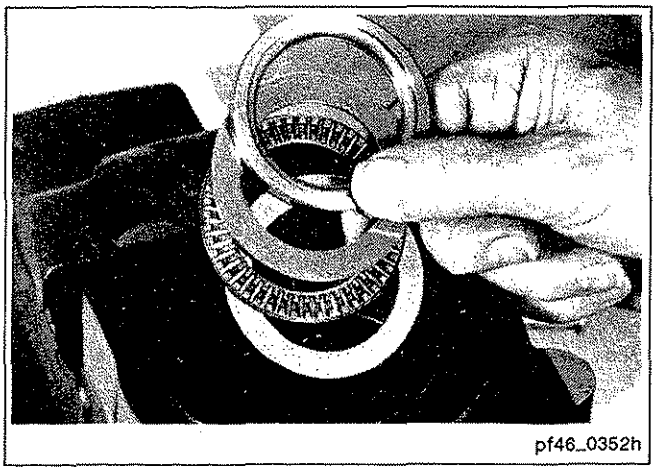
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Fig. 44

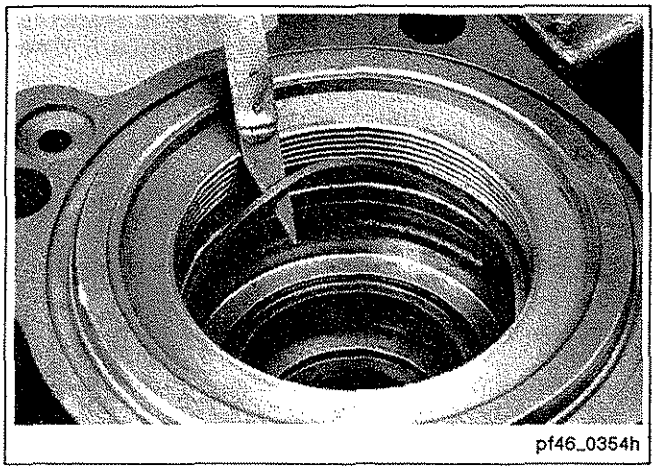
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Fig. 46

happens, you will have to replace the gear housing.

29. Turn the valve housing over, and remove the retaining ring. See **Fig. 47.** Using a 1-1/8 inch socket, tap out the seal from the valve housing. See **Fig. 48.** Discard the seal.

30. If replacing either of the auxiliary port plugs, remove them. Be sure to remove and discard the O-rings.

31. The steering gear is equipped with either a poppet fixed stopscrew, or an adjusting screw and sealing nut (see **Fig. 49**).

    If the poppet fixed stopscrew needs replacement, remove it, using a 5/8-inch socket wrench, or an E–14 Torx wrench.

    If the adjusting screw and sealing nut need replacement, remove them, using a 7/32-inch allen wrench and a 3/4-inch socket wrench.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

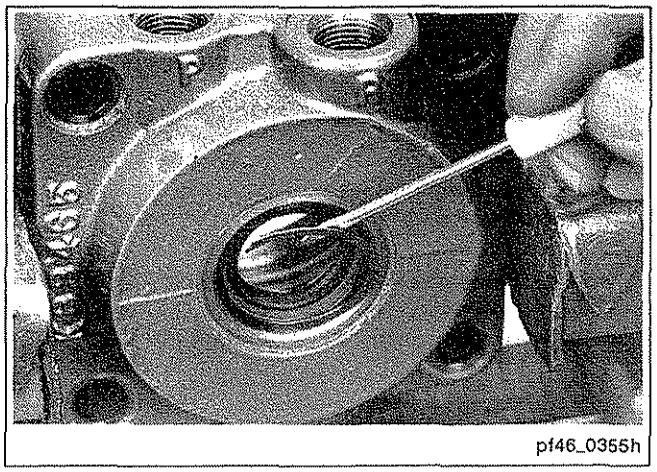

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Fig. 47

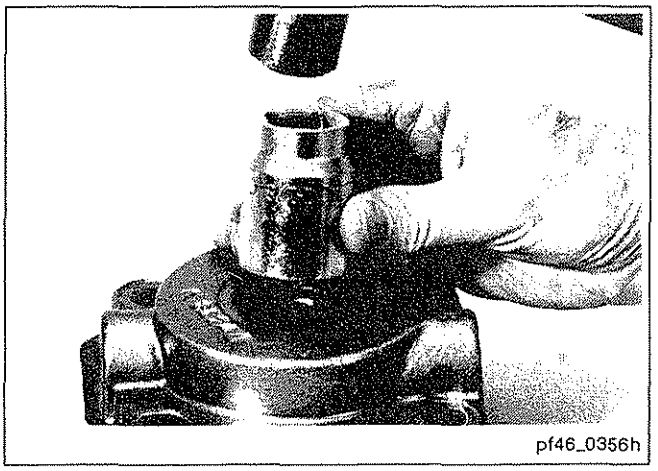

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Fig. 48

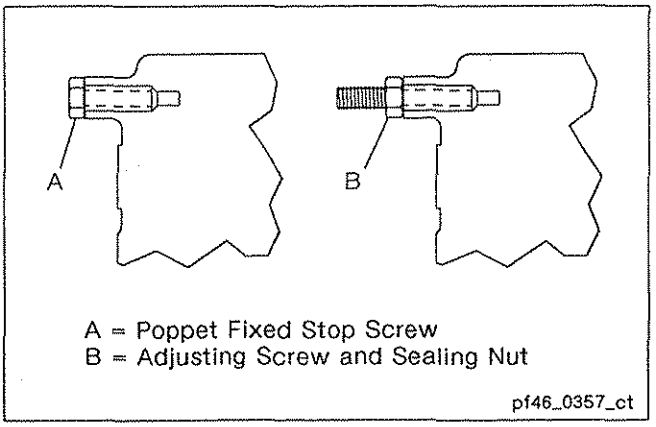

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Fig. 49

32. Remove the retaining ring from the output end of the housing trunnion. See **Fig. 50**.
33. Remove and discard the dirt seal. See **Fig. 51**.
34. Insert a screwdriver into the gear housing, and carefully push the seal and the spacer washer out of the other end of the bearing bore. See **Fig. 52**. Be careful not to damage the sealing area of the bore. Discard the seal.
35. If replacing the roller bearing in the housing, remove it, using special tool J37071. Press the roller bearing out of the trunnion

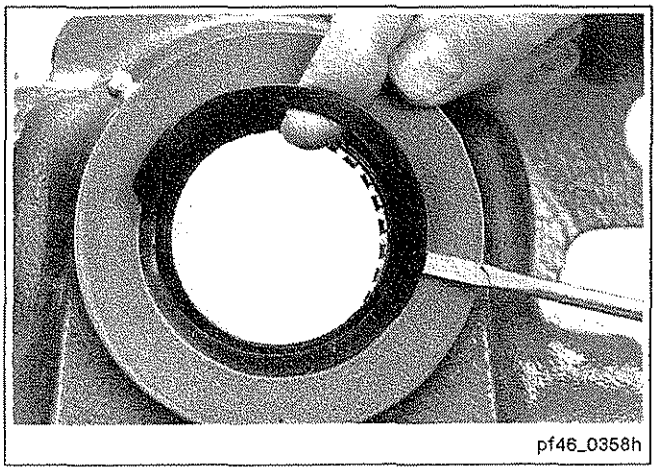

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Fig. 50

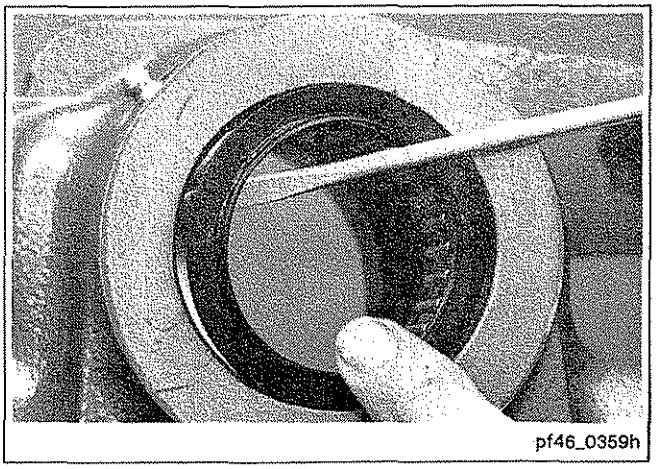

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Fig. 51

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

end of the housing, from the side of the bore where the side cover was attached. See **Fig. 53.**

36. If replacing the retaining ring, remove it through the trunnion end, opposite the end where the side cover was attached. See **Fig. 54.** Be careful not to damage the pressure seal bore area.

INSPECTION

All sealing surfaces and seal cavities must be free of nicks and corrosion. If any part is nicked or corroded where sealing occurs, the part must be replaced to ensure proper sealing.

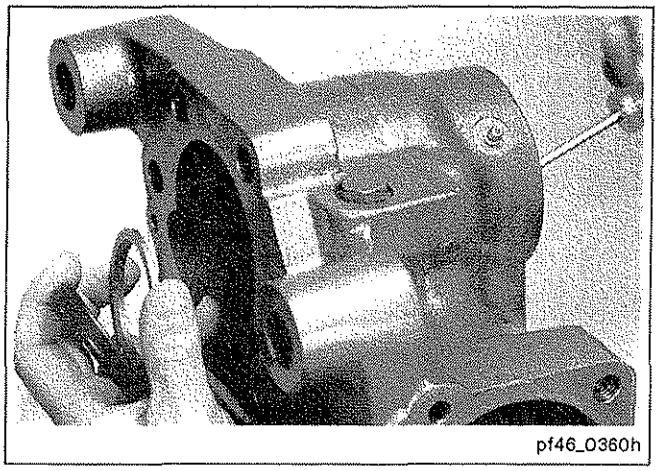

Fig. 52

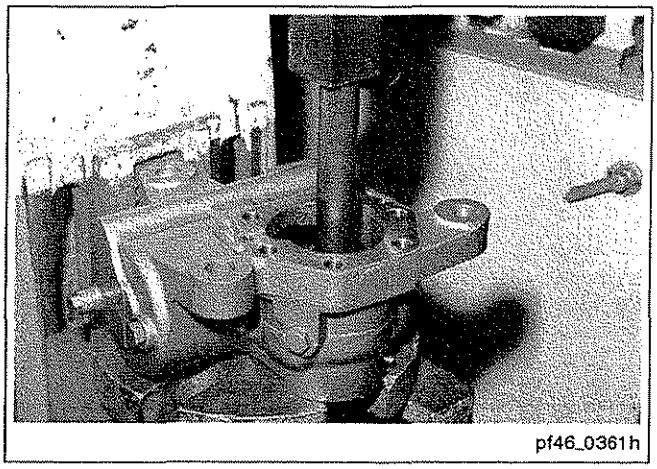

Fig. 53

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

Wash all parts in a clean petroleum-based solvent. Blow them dry with air.

1. Inspect the rack piston teeth for cracks and wear. See **Fig. 55.** If a step can be detected by running your fingernail horizontally across the teeth surfaces, the rack piston, the sector shaft, and the set of 32 steel balls must be replaced.

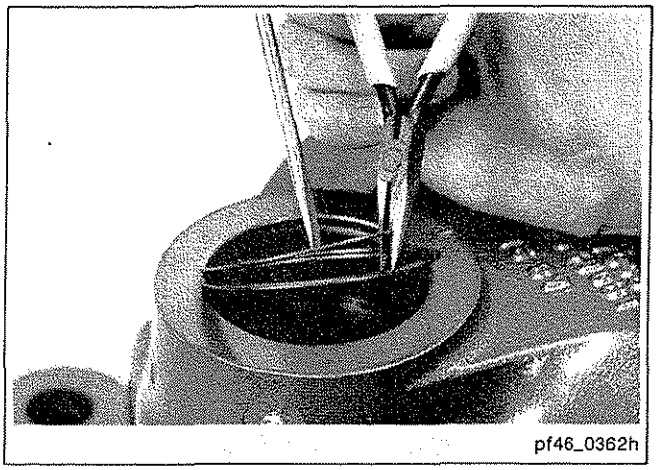

Fig. 54

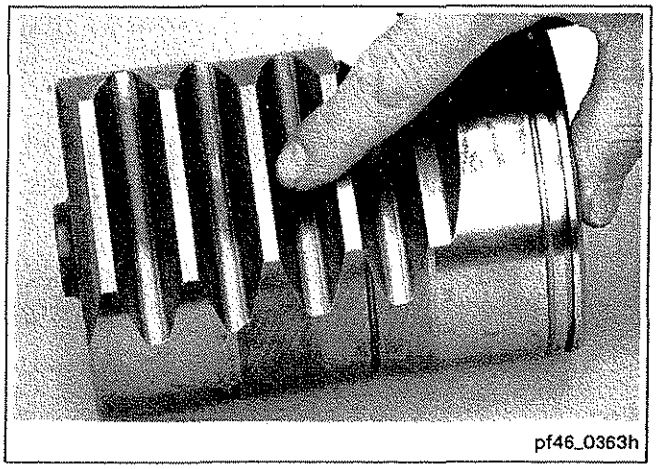

Fig. 55

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

2. Inspect the rack piston internal ball-track grooves for brinelling (dents) or spalling (flaking). See **Fig. 56**. If either condition exists, replace the following parts: the rack piston; the valve/worm shaft assembly, and the set of 32 steel balls.

3. Inspect the worm shaft ball-track grooves for brinelling or spalling. See **Fig. 57**. If either condition exists, replace the following parts: the worm/input shaft assembly; the rack piston; and the set of 32 steel balls. Inspect the upper shaft-seal area, near the input shaft serrations, for nicks. Run your fingernail across the sealing surface to detect steps. See **Fig. 58**.

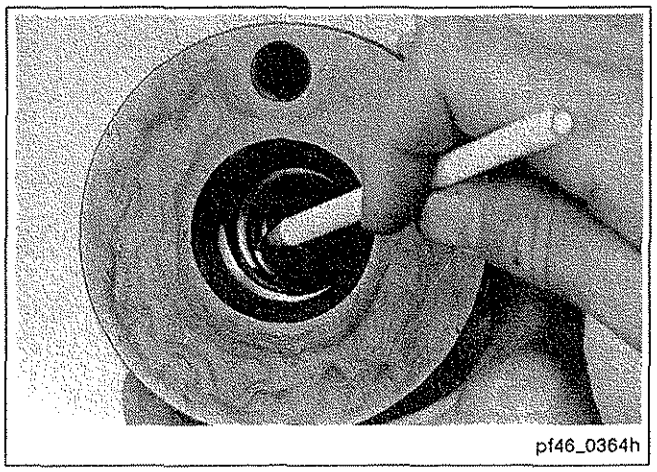

Fig. 56

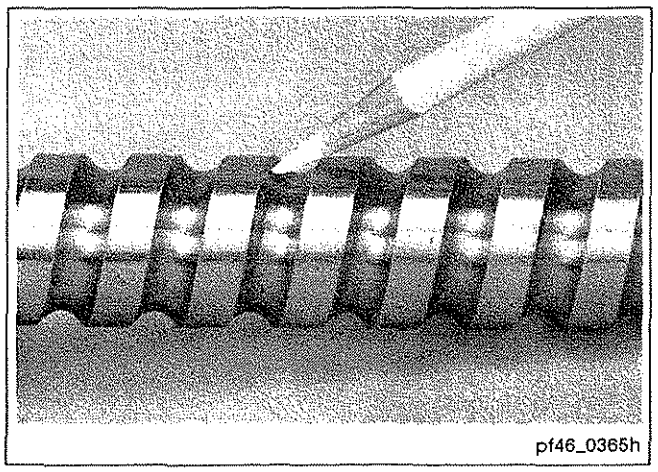

Fig. 57

4. Inspect the housing cylinder bore. See **Fig. 59**. Minor scoring marks running lengthwise through the bore are normal, and should not be compared to the scoring that might be found in the cylinder bores of an internal combustion engine. Replace the housing only if it has been tested for internal leakage, and it is determined that the scoring is the cause of internal leakage greater than 1 gpm (3.8 Lpm). For test procedures, refer to "Troubleshooting."

NOTE: In evaluating this test, make sure that internal leakage of more than 1 gpm (3.8 Lpm) can be attributed only to the housing, and not

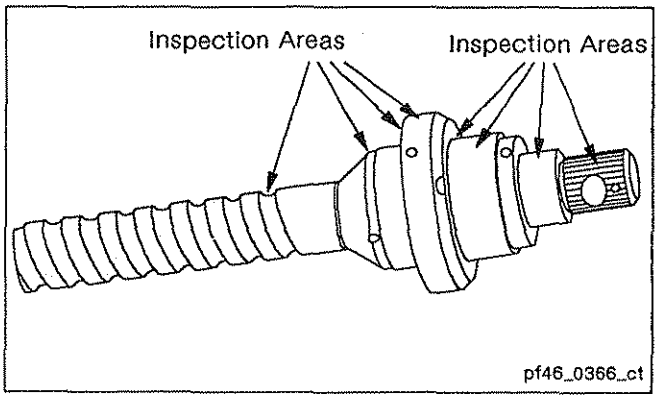

Fig. 58

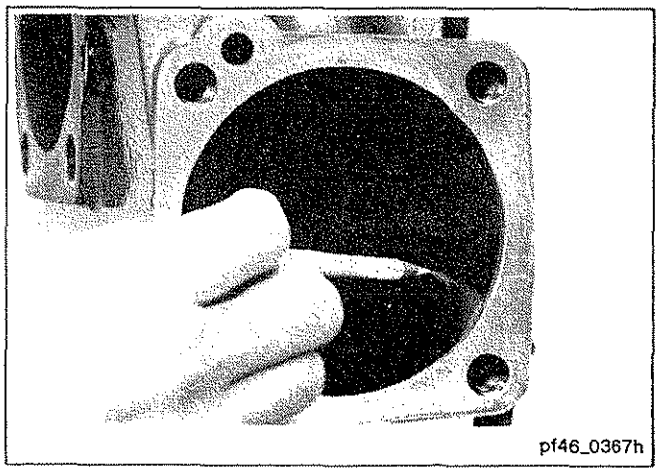

Fig. 59

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

to the seals in the worm shaft, rack piston, and valve assembly.

5. Inspect the housing faces for nicks that would prevent proper sealing. See **Fig. 60.** Replace the gear housing if these nicks cannot be easily removed with a fine-toothed flat file, without changing the dimensional characteristics.
6. Inspect the housing roller bearing (**Fig. 61**) for brinelling or spalling. If either condition exists, replace the housing bearing. For instructions, refer to step 35 under "Disassembly;" then step 1 under "Assembly."

   Inspect the side cover bushing. If the clearance between the bushing and the sector shaft is more than 0.008 inch (0.20 mm), replace the side cover and bushing assembly. See **Fig. 62.**
7. Inspect the sector shaft bearing sealing areas for brinelling or spalling. See **Fig. 63.** Run your fingernail across these areas to detect steps. Also, inspect for cracks. If any of these conditions exist, replace the sector shaft.
8. Check the sector shaft assembly (**Fig. 14,** Ref. 52) for damaged adjusting screw

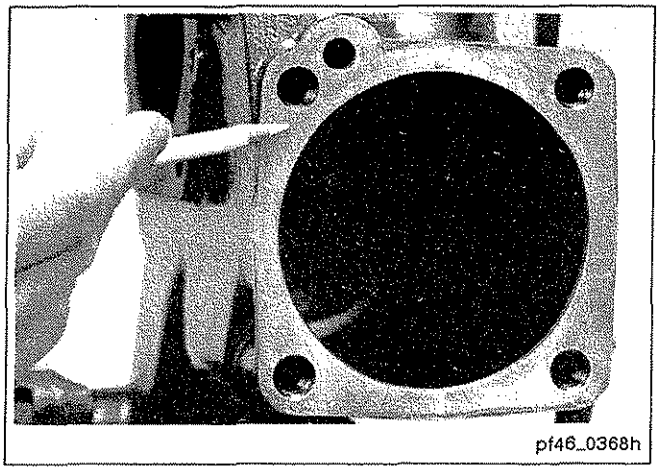

Fig. 60

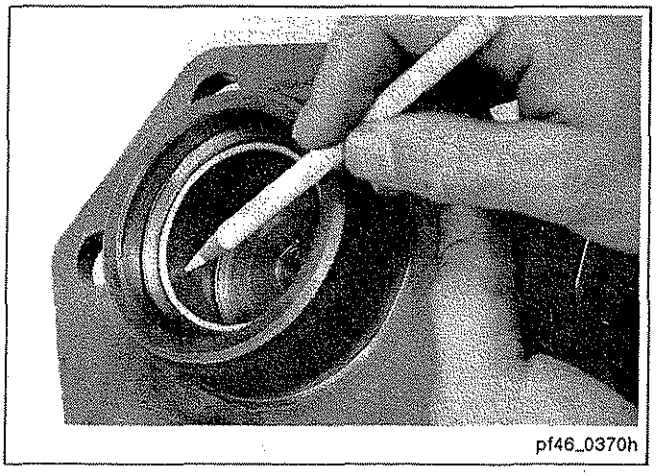

Fig. 62

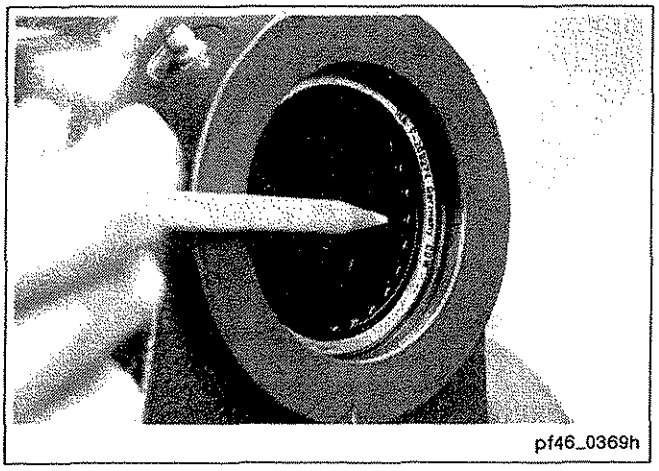

Fig. 61

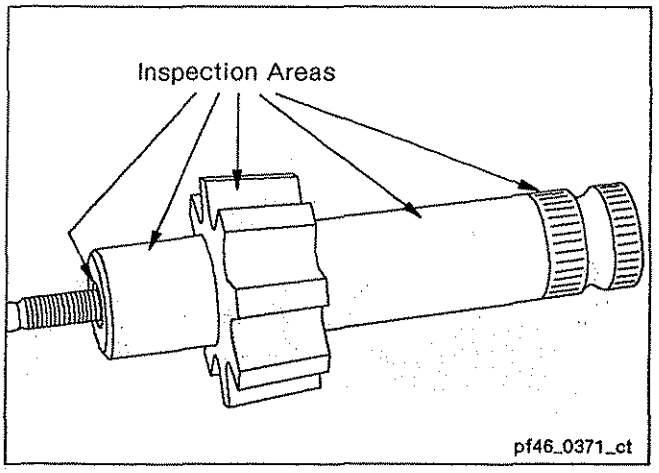

Fig. 63

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

threads. Make sure the staked retainer (Ref. 54) is locked in place and has no cracks. The adjusting screw must turn by hand with no end play (lash). If the adjusting screw is damaged, replace it and its retainer.

9. Inspect the thrust bearing rollers for any deterioration. Inspect the thrustwashers for brinelling, spalling, or cracks. See **Fig. 64** or **65**. Replace any part if these conditions are detected.

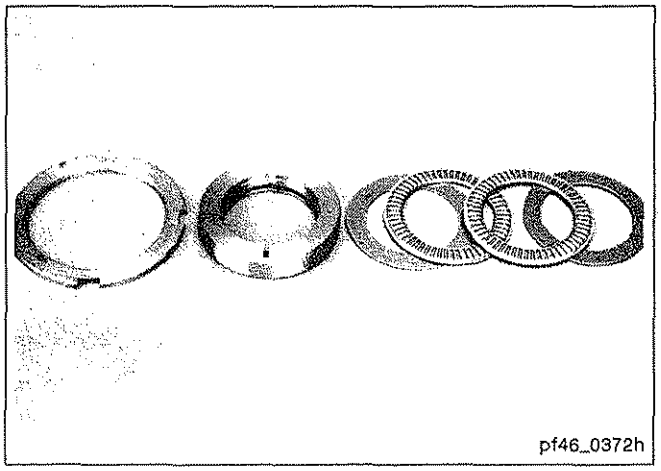

Fig. 64

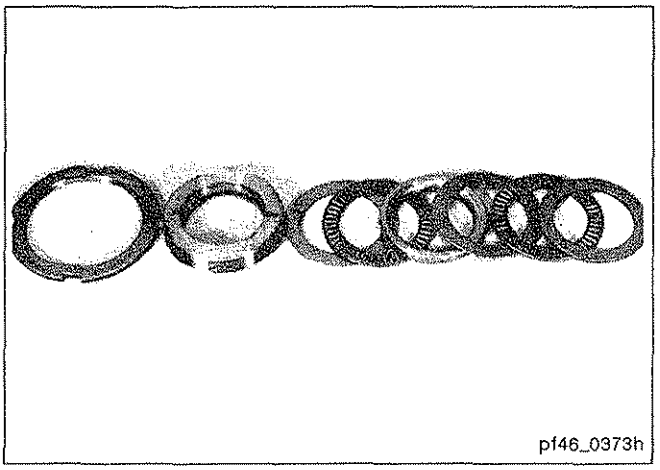

Fig. 65

ASSEMBLY (Refer to **Fig. 14**)

IMPORTANT: Be sure that required tools are available before beginning the service procedures described here. See **Table 2** under "Specifications." The special tools required for disassembly and assembly of the steering gear components are available from the Kent-Moore Tool Division, or an affiliated dealer.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

After inspection, clean all parts again in clean petroleum-based solvent, and blow them dry with air.

All seals, seal rings, and gaskets, must be replaced with new ones each time the gear is disassembled. Individual seals, seal rings, and gaskets, as well as complete seal kits are available from Freightliner parts distributors.

1. If installing a new roller bearing into the gear housing, do the following (otherwise, go to step 2):

   .1 Put the gear housing on its side, with the trunnion end of the bore facing up, as shown in **Fig. 66**.

   .2 Install the retaining ring in the groove closest to the side-cover end of the bore. See **Fig. 66**. Then lubricate the bore.

   .3 Place the new roller bearing on the housing bore, with the lettered side of the bearing shell facing up.

   CAUTION: When using special tool J37071 to install the roller bearing, be sure to use the *installation* side of the tool, or you may damage the new roller bearing.

   .4 Using the installation end of special tool J37071, press the roller bearing into the housing, until it seats against the retaining ring. See **Fig. 67**.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

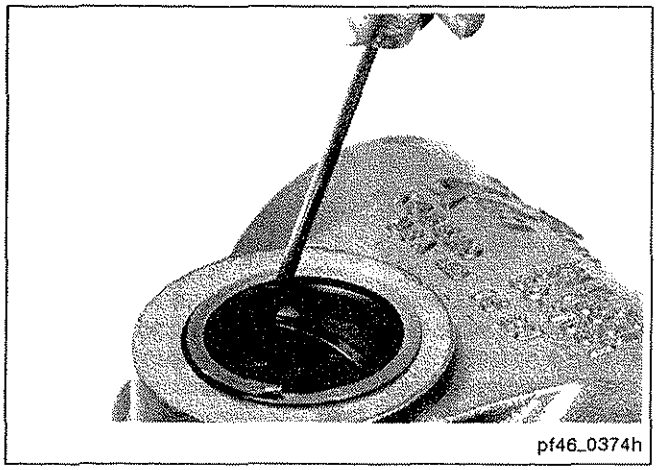

Fig. 66

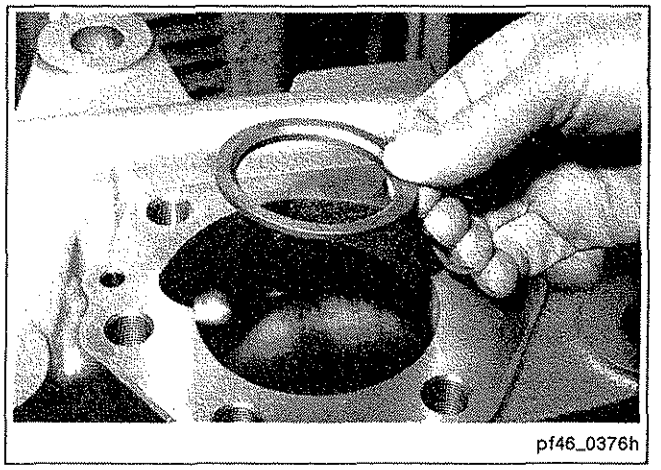

Fig. 68

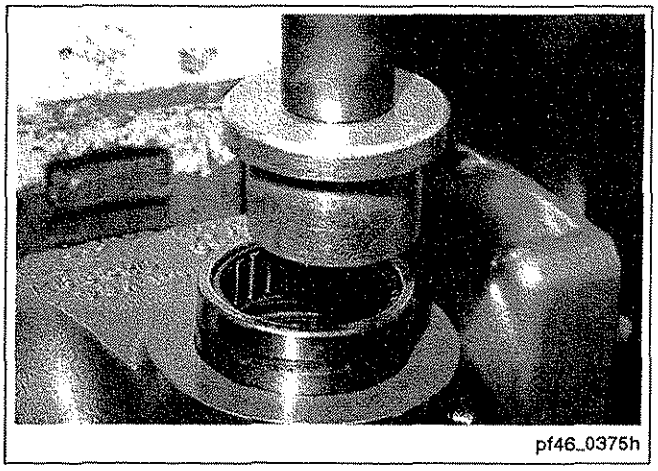

Fig. 67

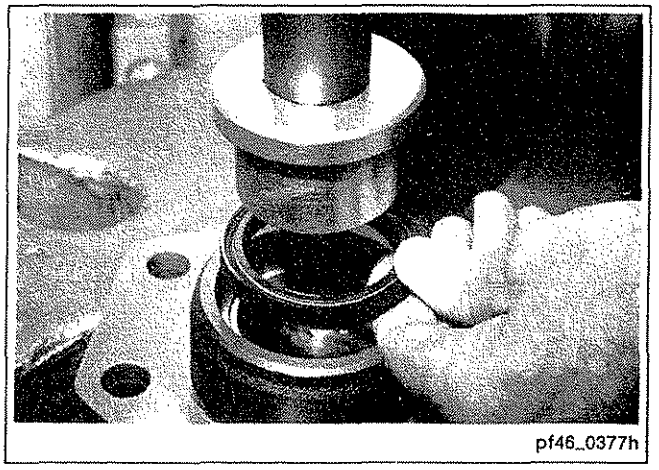

Fig. 69

2. Put the gear housing on its side, with the side-cover end of the bore facing up, as shown in **Fig. 68.**

3. Install the washer in the bore, with the small diameter end of it facing the roller bearing retaining ring. See **Fig. 68.**

4. Put the new seal on special tool J37071 so that the lip of the seal with the garter spring is toward the shoulder of the tool. See **Fig. 69.**

5. From the side-cover end of the bore, press the new seal onto the washer (and the roller bearing below it) with a force of 100 to 800 lbs (45 to 363 kg).

6. Turn the gear housing over so that the trunnion end of the bore is up, and install the new dirt seal against the roller bearing, with the lip facing up. See **Fig. 70.**

7. Install the second retaining ring, seating it firmly into the groove in the bore. See **Fig. 71.**

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

8. Pack the area between the dirt seal and the pressure seal (including the roller bearing) with Mobil Temp® 1 grease, or equivalent. See **Fig. 72.**

CAUTION: In step 9, when putting the valve housing in a vise, be careful not to clamp against the threaded port hole or the relief-valve hole sealing faces. To do so may damage these surfaces, which would require the replacement of the valve housing.

9. Put the valve housing in a vise so the input/worm shaft can be installed with the worm shaft up.

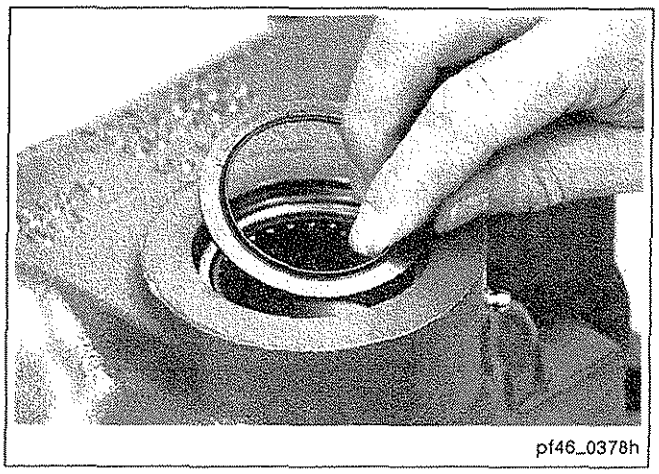
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Fig. 70

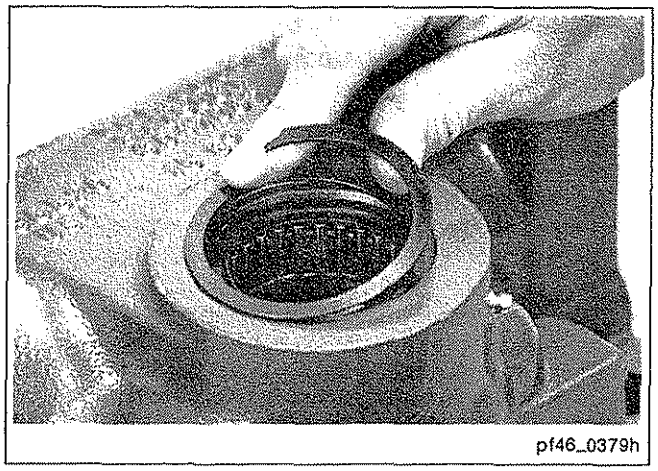
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Fig. 71

10. Lubricate and install a new O-ring in the valve housing. See **Fig. 73.**

11. Lubricate a new large diameter O-ring and a new seal ring, then install them in the valve housing. See **Fig. 74.**

12. Depending on how the steering gear is equipped (refer to **Fig. 14**), do one of the following (a or b):

    a. Install the roller thrust bearing and the thick thrustwasher on the input shaft thrust face. See **Fig. 75.** Then install a new seal ring (**Fig. 14**, Ref. 11) onto the

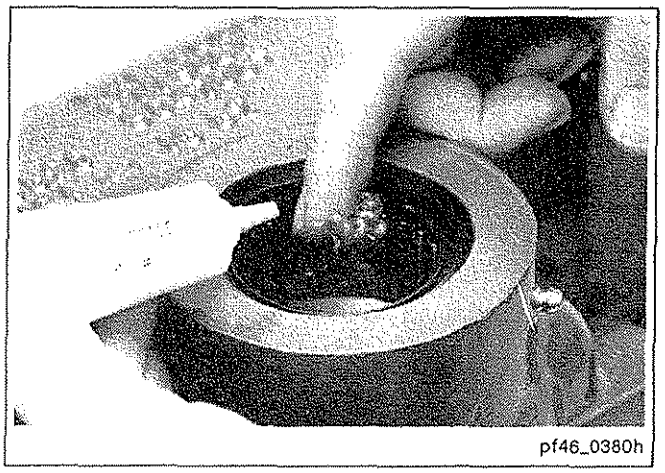
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Fig. 72

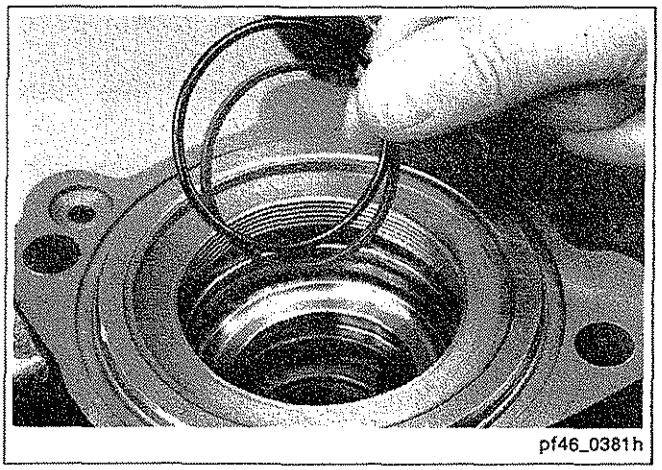
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Fig. 73

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

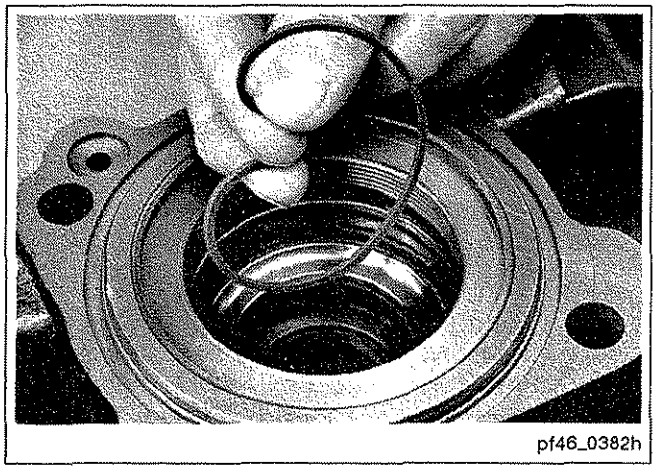

Fig. 74

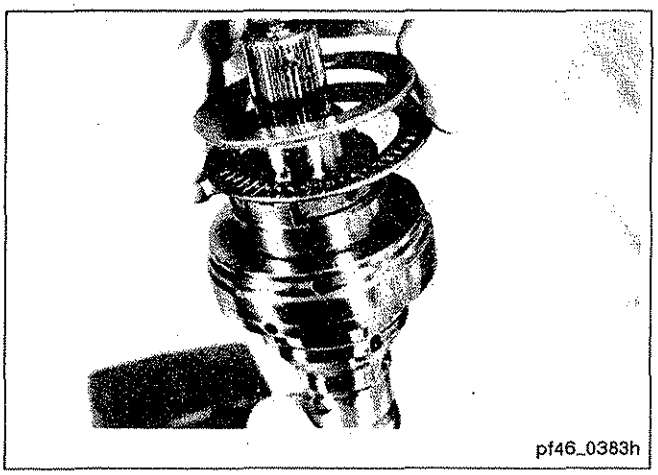

Fig. 75

input shaft, and against the thick thrustwasher.

b. Install the spacer sleeve (the side with the curved edge down), thin thrustwasher, roller thrust bearing, and thick thrustwasher (See **Fig. 14**, Refs. 21, 20, 15, and 19) on the input shaft thrust face. See **Fig. 76**. Then install a new seal ring (**Fig. 14**, Ref. 11) onto the input shaft, and against the thick thrustwasher.

IMPORTANT: If you have replaced the input-shaft/valve/worm assembly with a new assembly, don't install the existing spacer sleeve or the thin washer. They are not needed with a new input-shaft/valve/worm assembly.

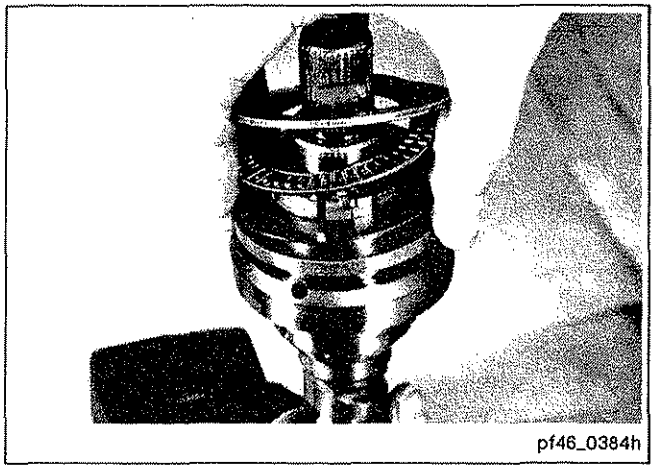

Fig. 76

13. Lubricate, then install the input-shaft/valve/worm assembly in the valve housing, seating it firmly. See **Fig. 77**.

14. Lubricate, then install a second thrust bearing and thin washer over the worm shaft. See **Fig. 78**.

15. Lubricate the new O-ring and seal ring (**Fig. 14**, Refs. 23 and 22). Install the O-ring, then the seal ring in the groove of the bearing adjuster. See **Fig. 79**.

16. Making sure the bearing adjuster threads are clean and free of any stake burrs, lubricate, then install the bearing adjuster over the worm shaft, and into the valve housing.

    Using a torque wrench and bearing adjuster tool J37070, tighten the valve adjuster 11 to 15 lbf·ft (15 to 20 N·m), then back it off 1/4 to 1/2 turn. See **Fig. 80**.

17. Turn the valve housing over in the vise so that the worm shaft is facing down.

18. Using an inch-pound torque wrench, check the torque needed to turn the input shaft

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

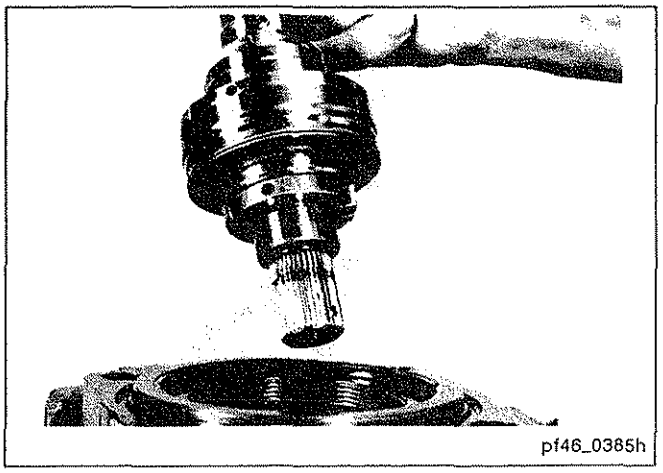

Fig. 77

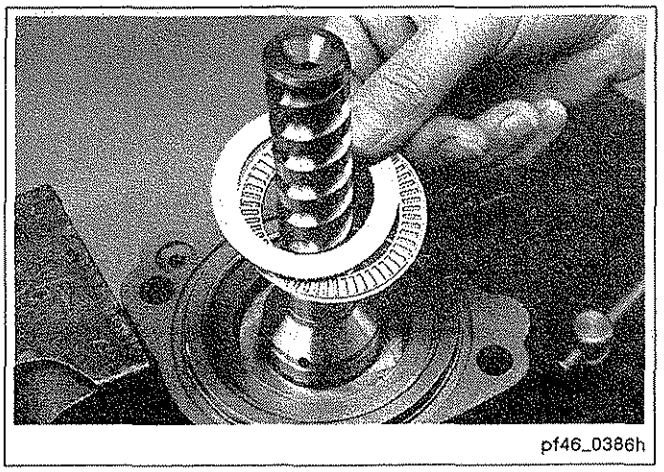

Fig. 78

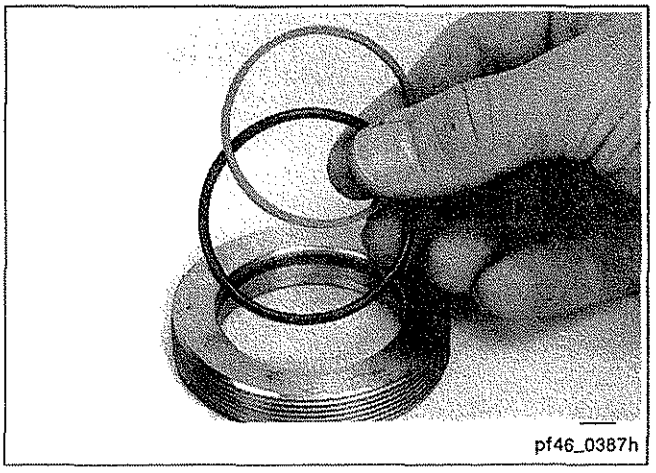

Fig. 79

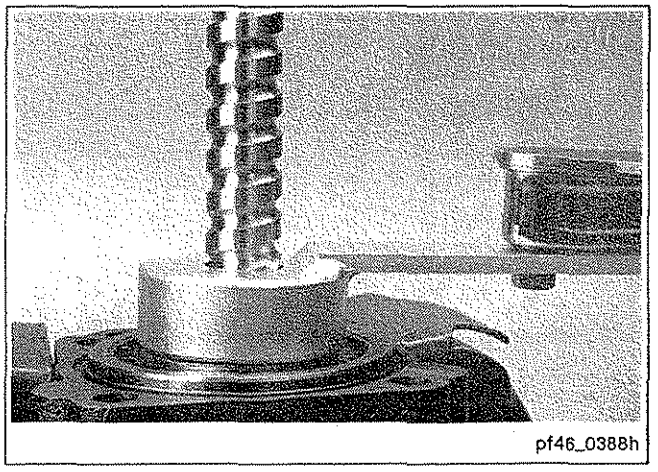

Fig. 80

360 degrees clockwise and counterclockwise. Tighten the bearing adjuster so that the torque needed to turn the input shaft is increased by 5 to 10 lbf·in (60 to 120 N·cm). See **Fig. 81**.

19. Turn the valve housing over in the vise again, so that the worm shaft is facing up.

20. Oil and install the locknut on the bearing adjuster, and using special tools J37070 and J37464, tighten the locknut 101 to 122 lbf·ft (137 to 165 N·m), while holding the bearing adjuster. See **Fig. 82**.

21. Check the torque needed to turn the input shaft again. If the torque isn't the same as it was at the end of step 18, remove the locknut from the bearing adjuster, and repeat steps 17 through 21.

22. Using a punch, stake the locknut to the valve housing at two opposite slots in the locknut. Stake each slot in the most clockwise corner, as shown in **Fig. 83**.

23. Stake the locknut to the bearing adjuster at two places 180 degrees apart. See **Fig. 83**. Don't use a spot that was staked before.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

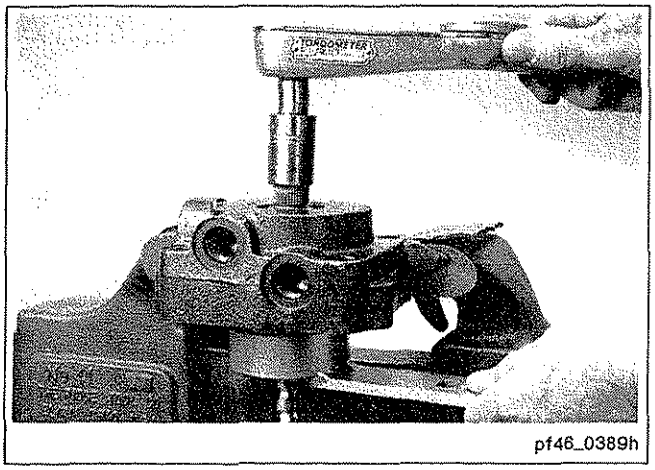
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Fig. 81

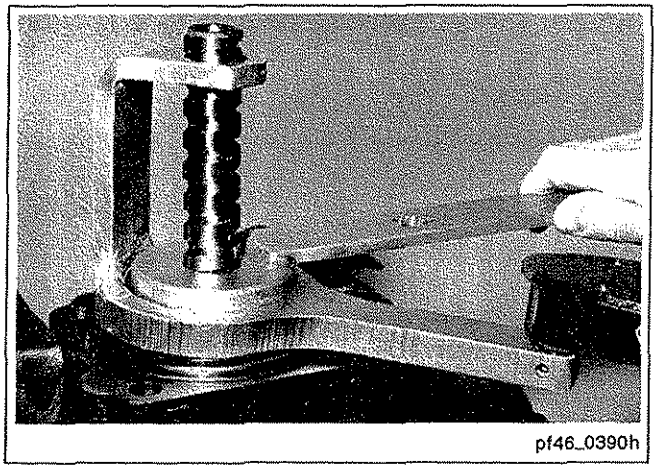
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Fig. 82

24. Check the torque needed to turn the input shaft. If the torque isn't the same as it was at the end of step 18, unstake the locknut and the bearing adjuster, and repeat steps 17 through 24.

NOTE: The torque needed to turn the input shaft must not be more than 22 lbf·in (240 N·cm).

25. Oil the new grease seal rings, and install them in the valve housing. See **Fig. 84.**

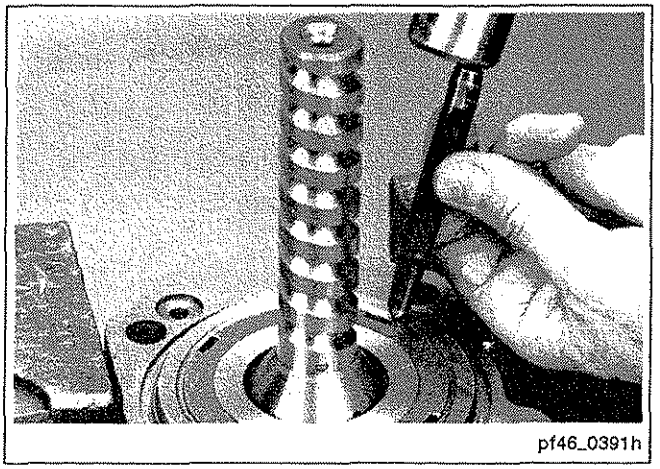
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Fig. 83

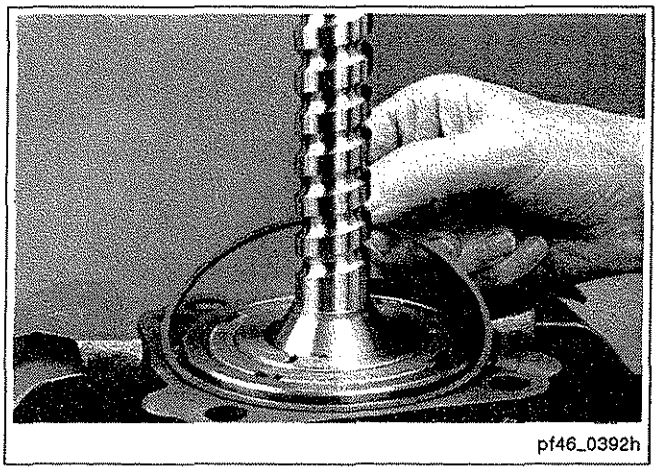
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Fig. 84

26. If you are installing the removed automatic poppet adjuster seats and sleeve assemblies, reset them as follows:

IMPORTANT: Make sure the poppet adjuster seat and sleeve assemblies and the threaded holes in the rack piston are free of Loctite.

.1 Turn the poppet adjuster seat and sleeve assembly so that it is in the *opposite* direction in which it was installed, and loosely screw it into the threaded hole in the rack piston. See **Fig. 85.**

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.2 Press the adjuster seat into the adjuster sleeve with a force of 500 to 2500 lbs (227 to 1134 kg), until the shoulder on the seat bottoms on the sleeve. See **Figs. 86** and **87**.

.3 Remove the adjuster seat and sleeve assembly from the rack piston.

.4 Repeat steps 26.1 through 26.3 for the other poppet adjuster seat and sleeve assembly.

27. Install a new backup O-ring and new Teflon seal ring on the rack piston. See **Fig. 88**. Do not stretch them any more than necessary when installing them.

CAUTION: When doing step 28, be careful not to get any Loctite or Locquic on the adjuster seat itself. If this happens, the automatic poppets will not adjust correctly.

NOTE: If you are installing new poppet adjuster seat and sleeve assemblies, they may already have Dri-Loc® 200 on them; if so, more Loctite isn't needed.

28. Apply Locquic primer "T" to the threaded poppet holes in the rack piston, and to the threads on the poppet adjuster seat and sleeve assemblies. Let dry for ten minutes, then apply Loctite RC680 to the same threads. See **Fig. 89**.

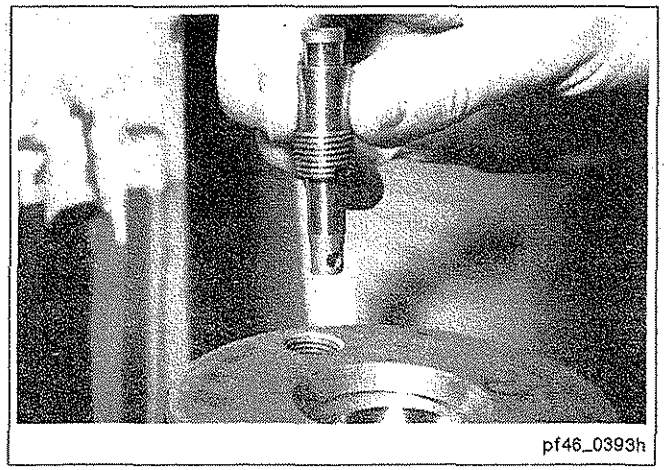

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Fig. 85

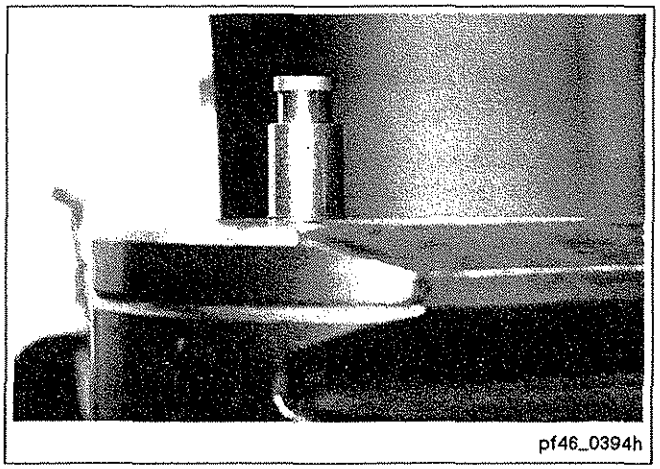

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Fig. 86

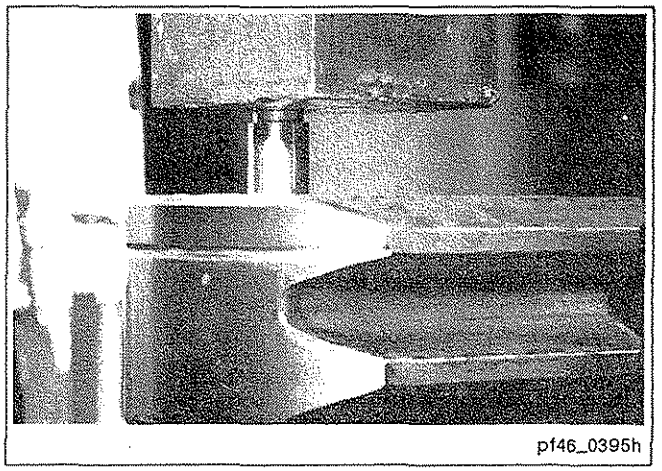

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Fig. 87

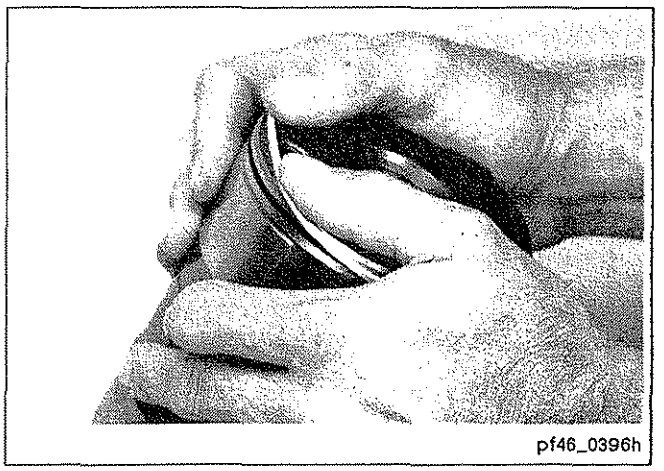

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Fig. 88

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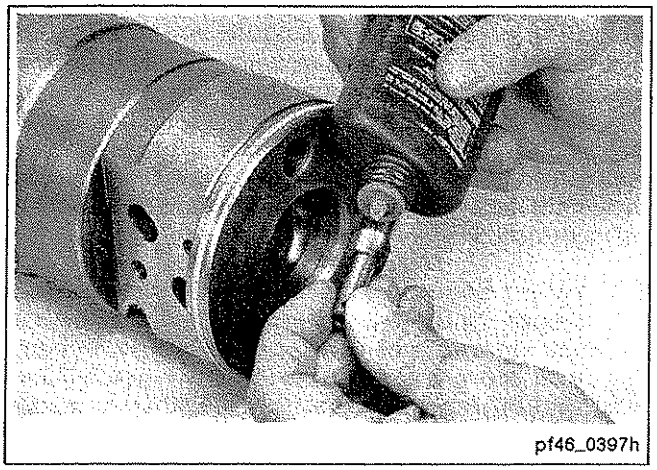

Fig. 89

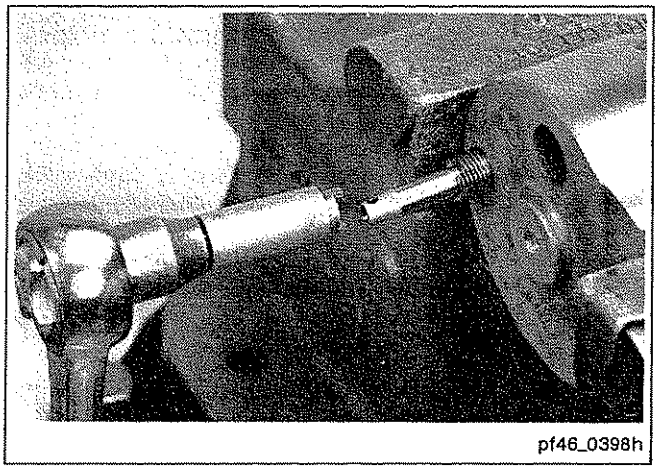

Fig. 90

29. Place the rack piston in a padded vise, and install a poppet adjuster seat and sleeve assembly, slotted end out, into the threaded hole at one end of the rack piston. See **Fig. 90.**

WARNING: Wear eye protection while assembling the poppets. The poppets are spring-loaded, and could be ejected, which could result in serious eye injury.

30. In the other end of the hole, install the poppet assembly parts in the following order (see **Fig. 91**): one poppet, the poppet spring, the nylon spacer rod, the push tube, the other poppet, and the other poppet adjuster seat and sleeve assembly.

31. Using special tool J36452 or J38713, tighten both poppet adjuster seat and sleeve assemblies 96 to 144 lbf·in (1080 to 1620 N·cm). See **Fig. 92.**

32. Put the rack piston on a clean, cloth-covered bench, with the worm end of the piston near the edge of the bench, and the ball guide holes facing up.

NOTE: When made to the correct dimensions to raise and support the piston, a wooden V-block will make the following steps easier.

33. Insert the worm shaft and input shaft assembly into the worm end of the rack piston, close to the maximum depth, without

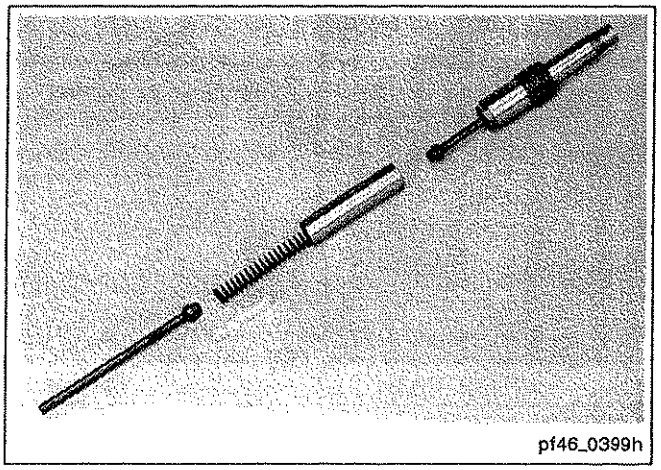

Fig. 91

the valve housing contacting the upper poppet. See **Fig. 93.**

34. Line up the grooves in the worm shaft with the ball guide holes in the rack piston.

    Make sure the valve housing extends over the edge of the bench (as shown in **Fig. 93**), or the rack piston is put on a V-block, so that the valve housing and worm shaft can turn freely.

WARNING: In step 35, do not seat the ball return guides with a hammer. This could damage them and cause steering gear lockup or

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loss of steering, resulting in an accident causing personal injury or property damage.

35. Install *new* ball return guide halves in the rack piston. See **Fig. 94**. Make sure they are correctly seated.

NOTE: Left-side ball return guide halves are copper-plated, and right-side ones are not. Make sure the correct new ball return guide halves are installed, by comparing them with the old ones; then discard the old ones.

CAUTION: If you are installing a new rack piston, or a new input-shaft/valve/worm assembly, don't install the existing steel balls. Use a new set of steel balls, or damage to the steering gear may result.

36. Insert the 32 steel balls in the ball return guide hole, as shown in **Fig. 95**. As the balls are dropped into the guide, turn the worm shaft so that the balls are pulled down into its grooves.

WARNING: Make sure the ball return guide halves stay down and in place while you are inserting the steel balls or turning the input shaft. Failure to hold the ball guide halves

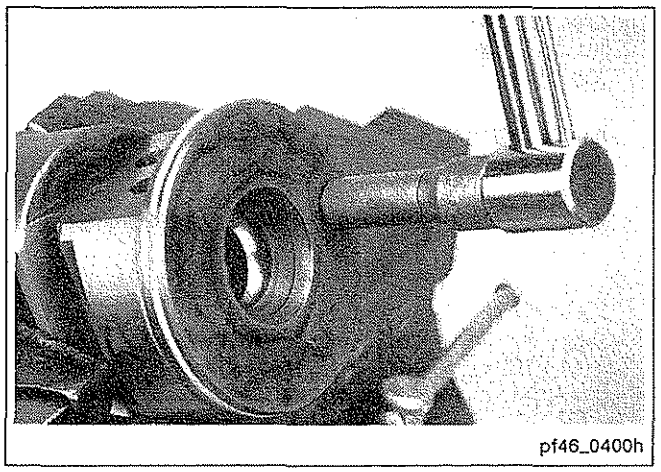

Fig. 92

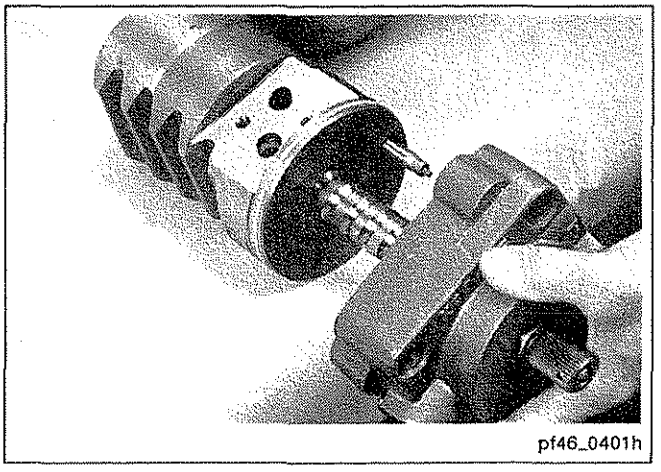

Fig. 93

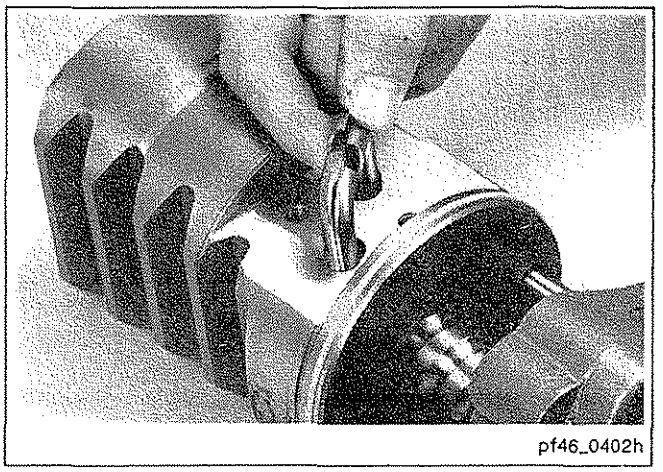

Fig. 94

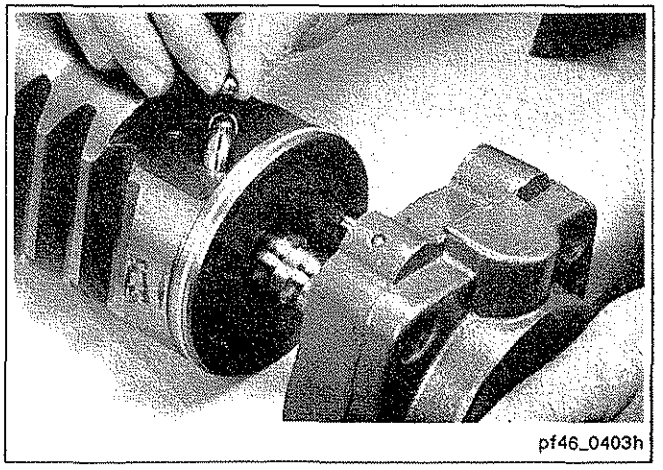

Fig. 95

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down may result in a ball being trapped outside the closed ball-track loop. A trapped ball could cause a steering lockup, which could result in an accident and personal injury or property damage.

If the ball guide halves raise up at any time during or after the installation of the steel balls, remove all of the balls, and the input-shaft/valve/worm assembly from the rack piston. Repeat steps 32 through 36.

IMPORTANT: Don't let the valve housing pilot face touch the poppet adjuster, or move more than 2.7 inches (69 mm) from the upper end of the rack piston. See **Fig. 96**. If this happens, the poppet adjuster could be incorrectly preset or the worm could be backed out beyond the closed ball loop.

37. Lubricate the new seal for the ball return guide cap, and install it in the groove in the cap. See **Fig. 97**.

38. Using a 5/32-inch allen socket and two new 5/32-inch allen screws (or a T–30 Torx socket and two new Torx head screws), install the ball return guide cap on the rack piston. Make sure the seal makes full contact with the rack piston surface. Tighten the fasteners alternately once or twice, to a final torque of 14 to 22 lbf·ft (19 to 30 N·m).

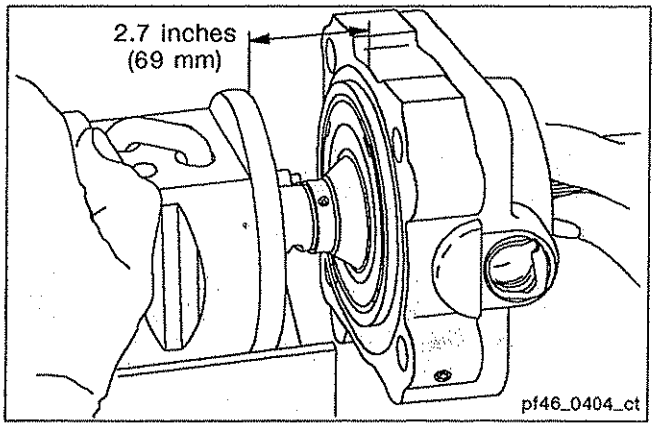

Fig. 96

39. To ensure that the steel balls have been correctly installed, turn the worm shaft from one end of travel to the other, without allowing the valve housing to contact the poppet adjuster, and without moving the valve housing pilot face more than 2.7 inches (69 mm) from the input end (upper end) of the rack piston. See **Fig. 96**.

    If the worm shaft doesn't turn, remove all 32 of the steel balls, and install them again, following the instructions in steps 32 through 39.

40. If the poppet stopscrew is being replaced, install the new one and its washer in the gear housing. See **Fig. 98**. Tighten it 38 to 42 lbf·ft (52 to 57 N·m).

    If the service poppet adjusting screw (**Fig. 14**, Ref. 42) and the service sealing jam nut (Ref. 43) are being used for automatic poppet adjustment, turn the adjusting screw into the jam nut until 1.03 to 1.09 inches (26 to 28 mm) protrudes from the bottom of the jam nut. See **Fig. 99**. Install the assembly into the gear housing. Tighten the jam nut 33 to 37 lbf·ft (45 to 50 N·m).

41. Put clean oil on the rack piston Teflon seal ring and into the bore of the gear housing. Position the rack piston on the worm gear

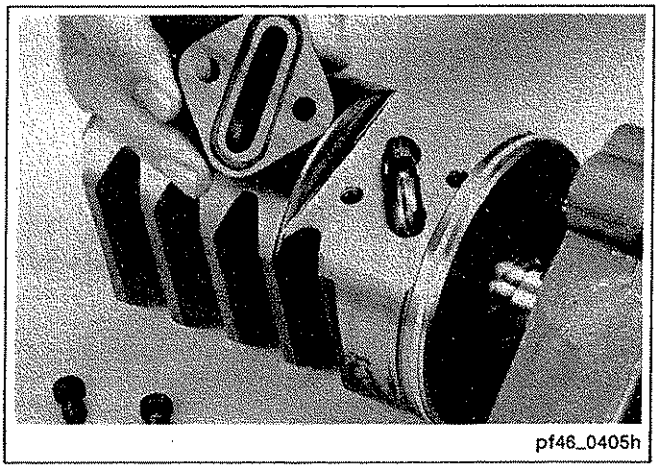

Fig. 97

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with a gap of 3/8 to 1/2 inch (10 to 13 mm) between the valve housing and the upper poppet adjuster seat and sleeve assembly.

IMPORTANT: This gap is to ensure that the poppets don't make contact with anything while the steering gear is being assembled.

CAUTION: When installing the rack piston in the steering gear housing, be careful not to damage the seal ring on the rack piston, as this could seriously affect the operation of the steering gear.

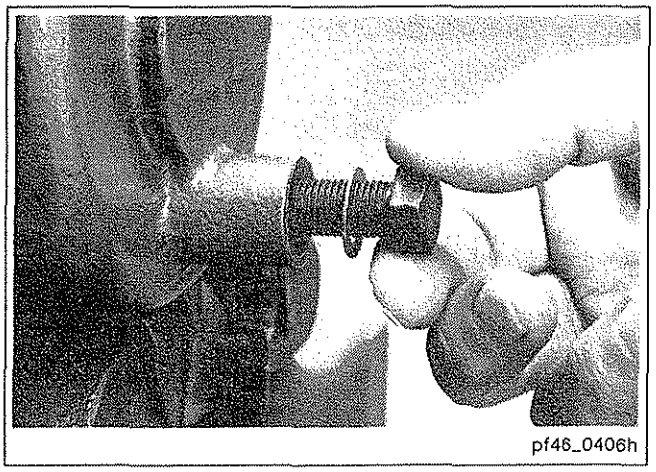
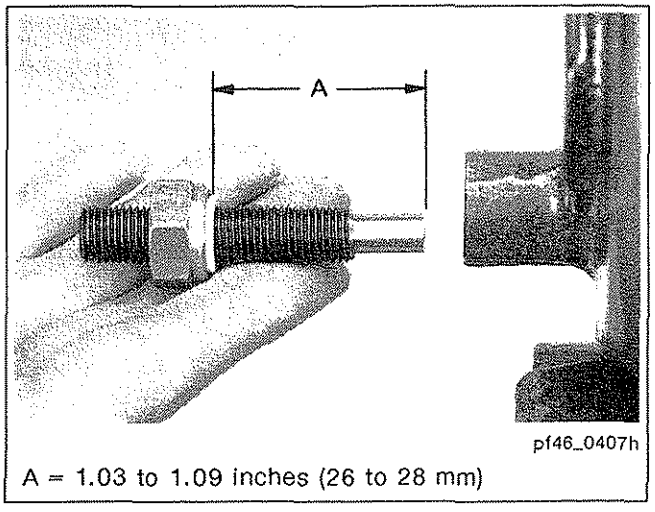


Fig. 98



A = 1.03 to 1.09 inches (26 to 28 mm)

Fig. 99

Do not let the poppet adjuster seat and sleeve assemblies on the rack piston bottom out when installing the rack piston in the gear housing.

42. Install the rack piston and worm shaft assembly in the gear housing, being careful not to damage the seal ring on the rack piston. Don't let the poppet adjuster sleeve assemblies bottom out inside the gear housing. Install the piston with the rack teeth toward the sector shaft hole in the housing. See **Fig. 100.** Be sure the valve housing cylinder feed hole lines up with the gear housing feed hole.

43. Using an E–16 Torx socket wrench, install and tighten the four valve housing bolts. See **Fig. 101.** Tighten dry bolts 105 to 115 lbf·ft (142 to 156 N·m), or lubricated bolts 75 to 85 lbf·ft (102 to 115 N·m).

44. If the sector shaft adjusting screw is being replaced, do the following:

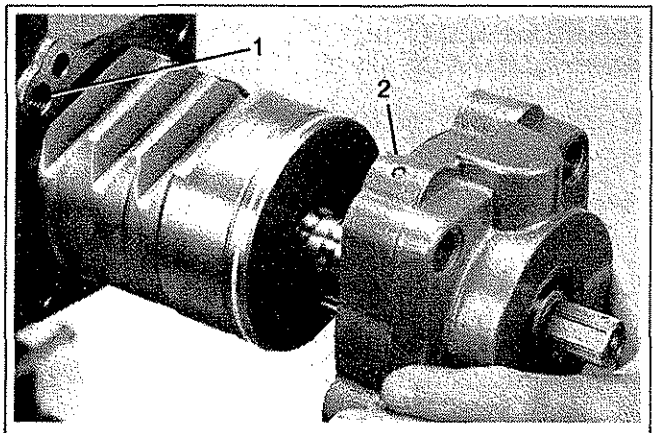
    .1 Coat the end of the new adjusting screw with wheel bearing grease, and with the sector shaft in a padded vise, insert the new adjusting screw into the recess in the sector shaft end.

    .2 Install a new sector-shaft screw retainer in the sector shaft. Adjust the retainer so that the sector shaft adjusting screw can be turned freely by hand. It should have a maximum end play of 0.002 inch (0.05 mm).

    WARNING: Be careful when staking the sector-shaft screw retainer. If the retainer is broken or cracked, the sector shaft could come loose, resulting in loss of manual and power steering control. This could cause an accident resulting in personal injury or property damage. Replace a broken or cracked sector-shaft screw retainer.

    .3 Stake the sector-shaft screw retainer to the slots in the sector shaft. See **Fig. 102.** Check the adjusting screw again for free movement and end play.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65



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1. Gear Housing Feed Hole
2. Valve Housing Cylinder Feed-Hole Boss

Fig. 100

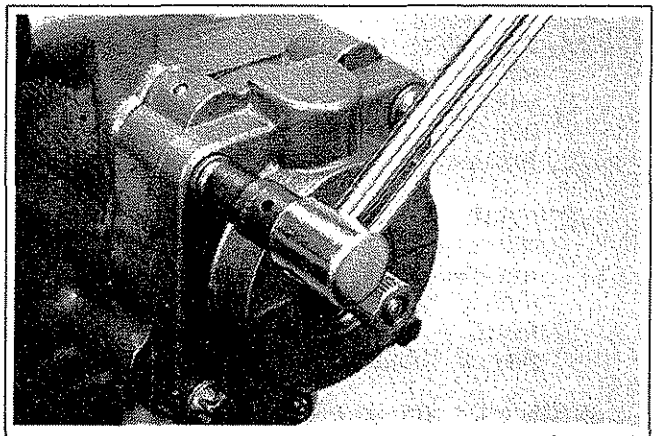

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Fig. 101

45. Lightly oil the side-cover "DU" bushing. Do not grease it. See **Fig. 103.**

46. Put a new seal on special tool J37071 so that the garter spring is against the shoulder of the tool. See **Fig. 104.** Press the new seal into the side cover with a force of 100 to 800 lbs (45 to 363 kg). Make sure the seal is seated against the bottom of the counterbore.

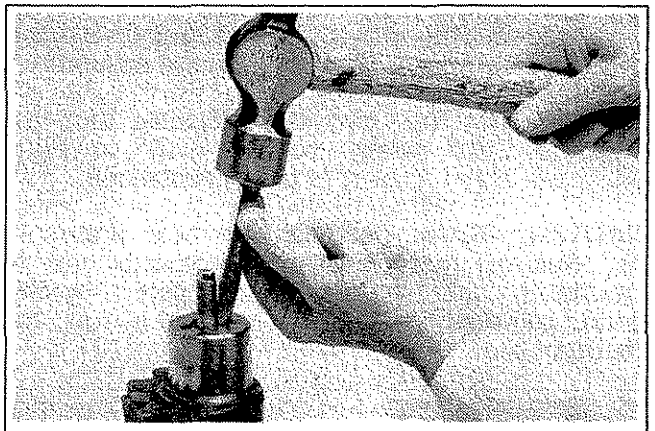

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Fig. 102

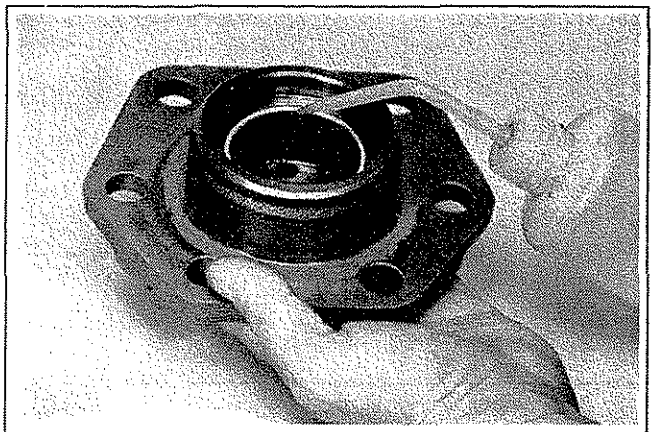

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Fig. 103

47. Lightly oil the short bearing area of the sector shaft. Insert the sector shaft into the side cover. Screw the sector shaft adjusting screw counterclockwise into the side cover, until the screw seats. See **Fig. 105.** Then rotate the adjusting screw clockwise one turn, so that the side cover rotates freely on the sector shaft.

48. Install the sector-shaft adjusting screw jam nut onto the sector-shaft adjusting screw a few threads. See **Fig. 106.** Final adjustment will be made later.

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49. Press a new rubber plug into the hole provided in the side cover, until the plug is flush. See **Fig. 107**.

WARNING: Do not weld or plug this hole permanently. This is a safety vent which functions only if the side cover output shaft seal doesn't work. If the seal doesn't work and the plug cannot vent, the steering gear can lock up or otherwise malfunction. This could result in a loss of steering control, which could cause personal injury or property damage.

50. Apply clean grease to a new side cover gasket, and install it on the side cover. See **Fig. 108**. Apply enough grease to hold the gasket in place.

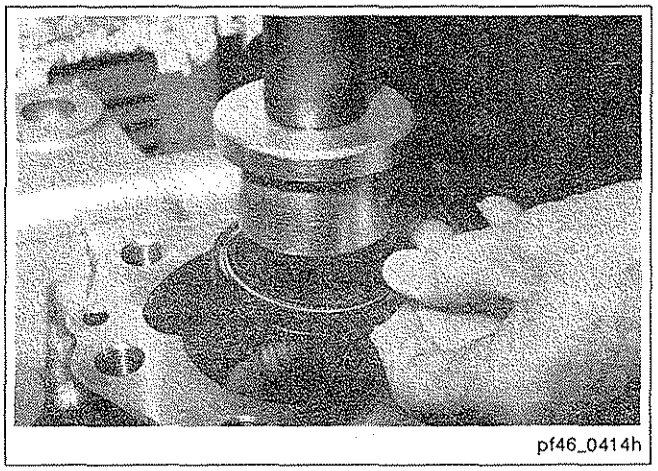

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Fig. 104

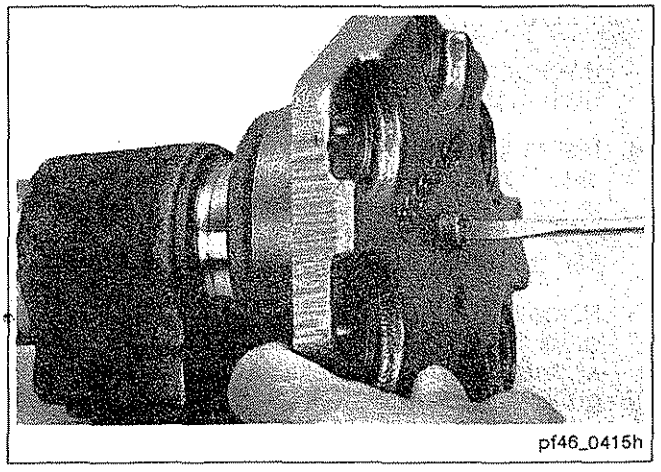

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Fig. 105

51. There are four teeth on the rack piston. Turn the input shaft as needed to position the rack piston so that the tooth space identified by the pencil in **Fig. 109** (it is the space between the second and the third tooth), is in the center of the sector shaft opening. See **Fig. 110**. This will center the rack piston in the opening.

WARNING: If the rack piston is not centered, steering gear travel will be severely limited in one direction. This could cause an accident, resulting in personal injury or property damage.

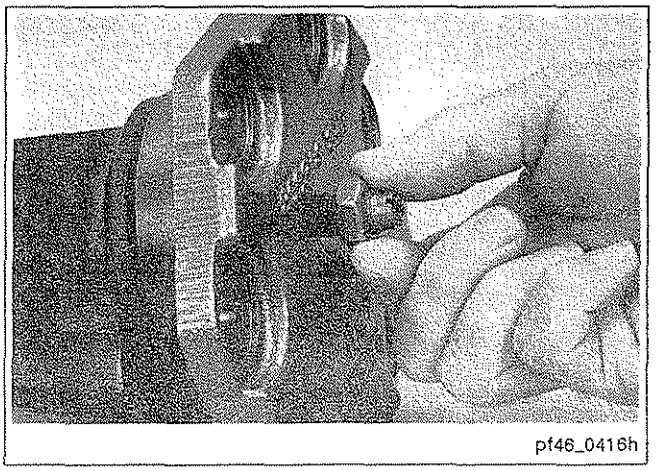

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Fig. 106

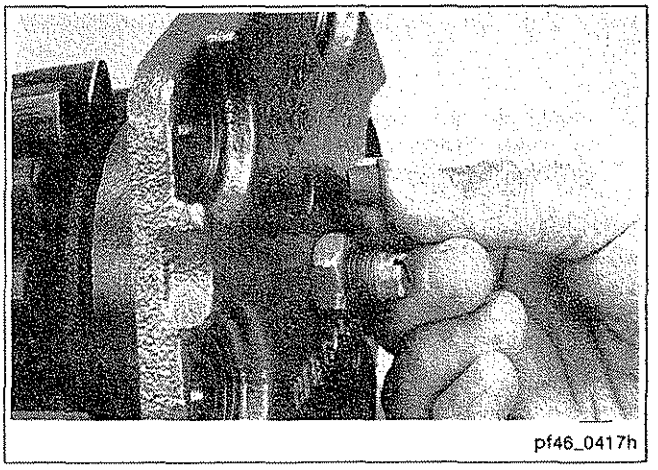

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Fig. 107

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

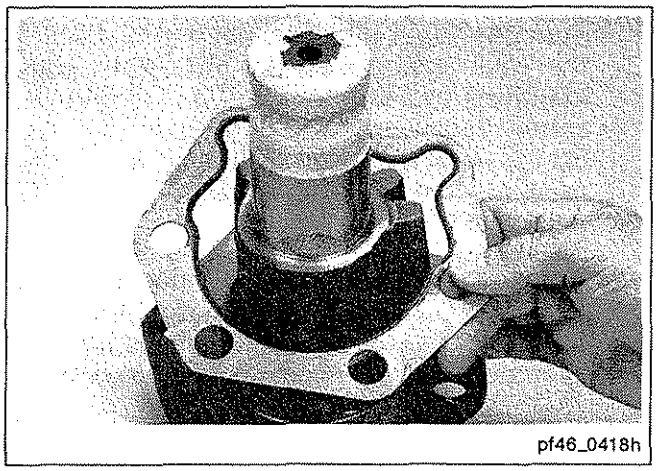

Fig. 108

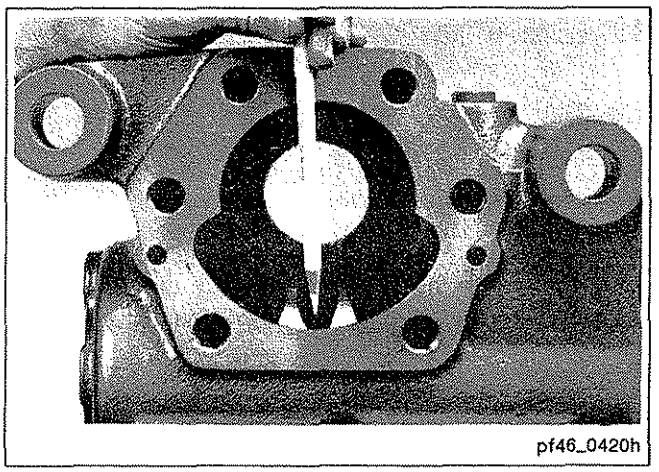

Fig. 110

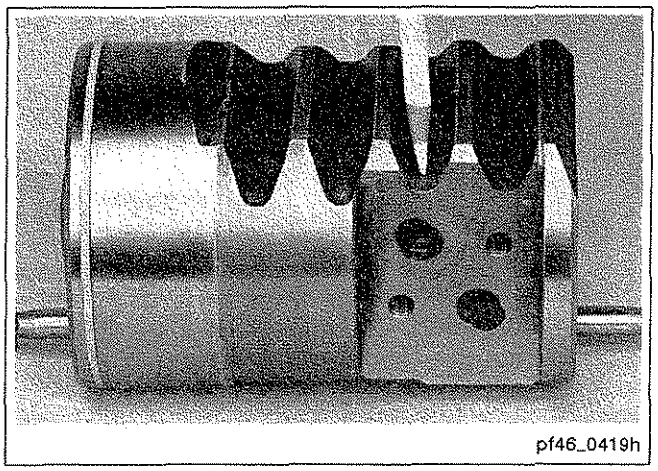

Fig. 109

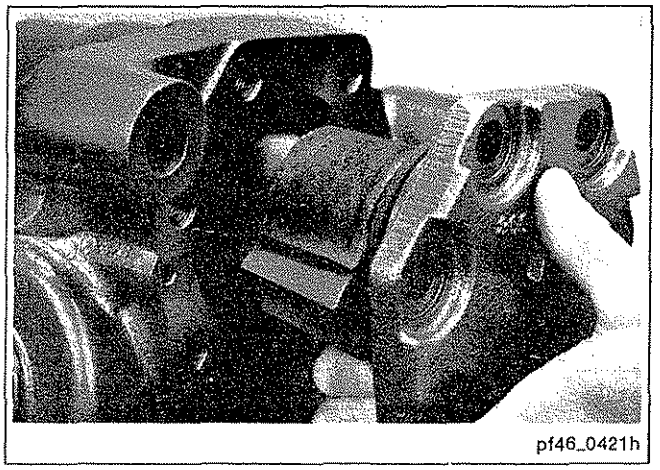

Fig. 111

52. Remove all tape from the sector shaft splines. Retape the splines and the bolt groove with *one layer* of masking tape.

CAUTION: If the splines on the sector shaft are not taped correctly, the splines will damage the housing seal during assembly, causing the seal to leak.

53. Install the sector shaft and side cover, as an assembly, in the gear housing. See **Fig. 111**. Make sure the center tooth of the sector shaft engages the center space (between the second and third teeth) of the rack piston.

54. Install the six special side cover bolts in the side cover. Using the torque pattern shown in **Fig. 112**, tighten dry bolts 220 to 240 lbf·ft (298 to 325 N·m), or lubricated bolts 160 to 180 lbf·ft (217 to 244 N·m). See **Fig. 113**.

55. Remove the tape from the sector shaft, and pack the end of the housing trunnion area at the sector shaft with Mobil Temp 1 or 2 grease, or equivalent. Put grease on the

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

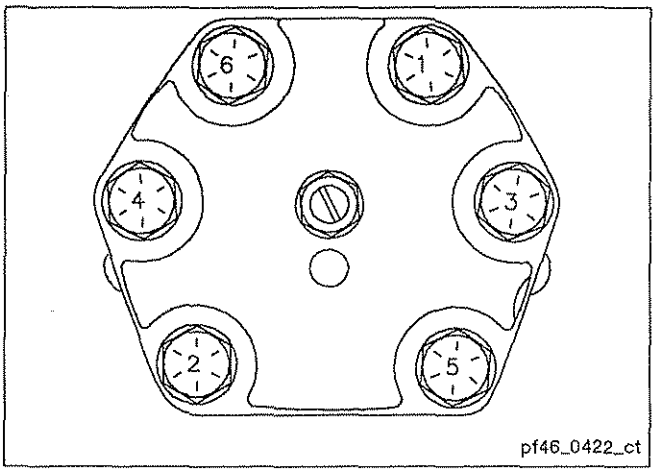

Fig. 112

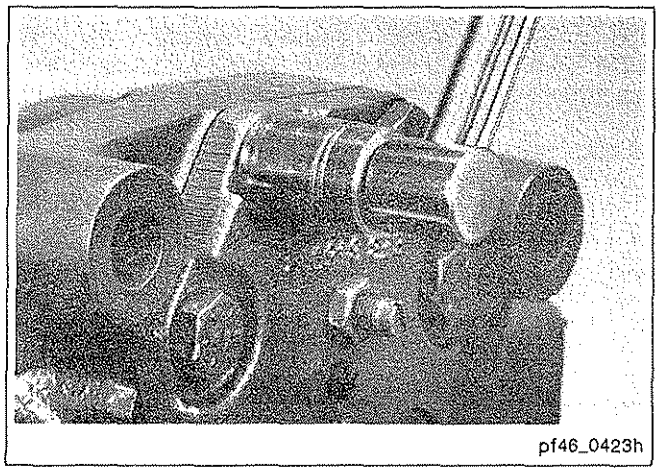

Fig. 113

new trunnion dirt seal, and install it over the sector shaft and into the trunnion bore. See **Fig. 114**.

IMPORTANT: Make sure the input shaft seal is installed squarely in the seal bore.

56. Apply clean grease to the new input shaft seal; then place it, garter spring side first, over the input shaft. Using special tool J37073 and a mallet, tap the seal into the valve housing seal bore until it clears the retaining ring groove. See **Fig. 115**. Remove any seal material that may have sheared off in the retaining ring groove.

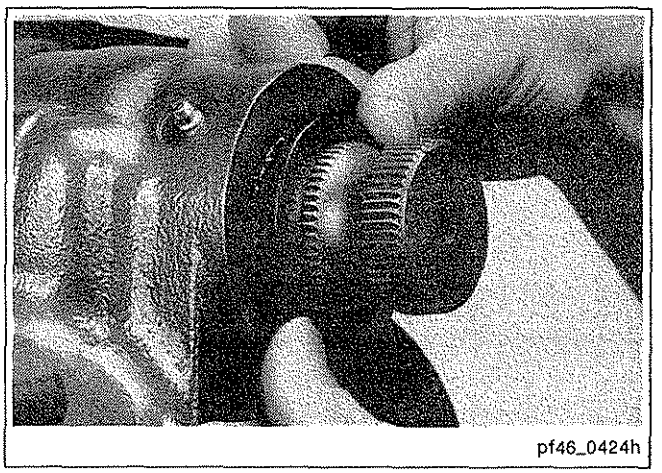

Fig. 114

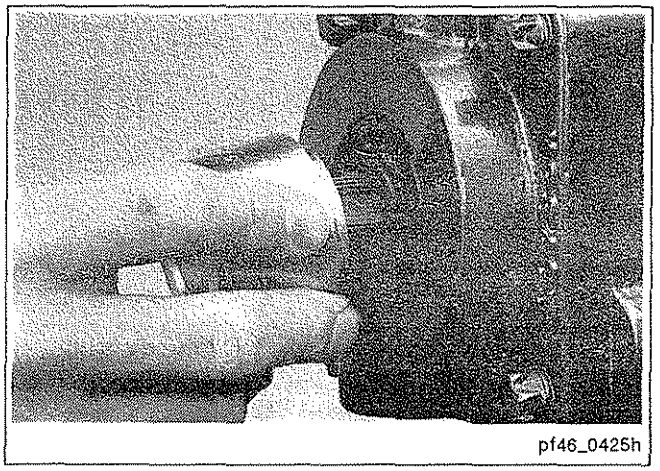

Fig. 115

57. Install a new retaining ring into its groove in the valve housing. See **Fig. 116**.

58. Pack the end of the valve housing bore (around the input shaft) with Mobil Temp 1 or 2 grease, or equivalent. Apply grease to the new dirt and water seal, and install it over the input shaft. Seat the dirt and water seal in the groove behind the serrations of the input shaft, and against the valve housing. See **Fig. 117**.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

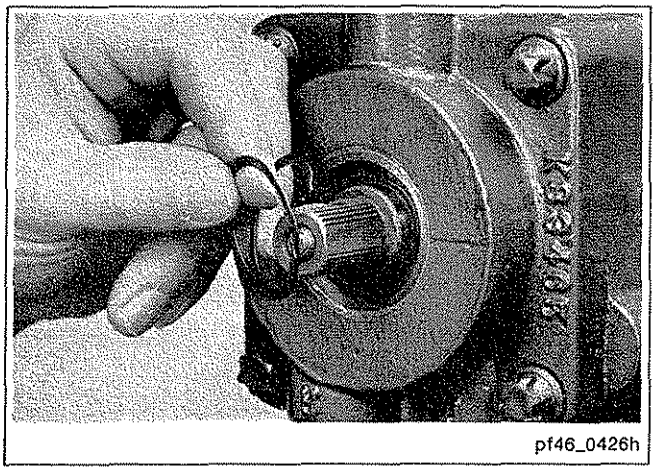
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Fig. 116

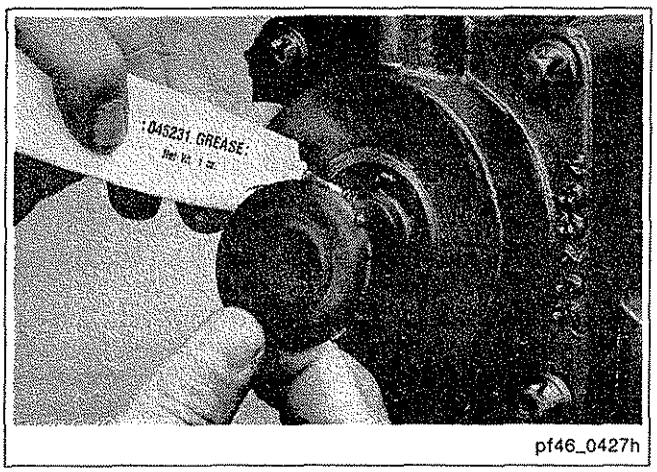

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Fig. 117

59. If the grease fitting is being replaced, install a new one in the gear housing, using a piece of metal tubing over the head of the new fitting, as shown in **Fig. 118**. Tap the new grease fitting in place.

60. If the auxiliary port plugs were removed, install new O-rings on them, and install the plugs in the gear housing. Tighten them 25 to 35 lbf·ft (34 to 47 N·m).

FINAL ADJUSTMENTS

Before installing the steering gear on the vehicle, make these adjustments:

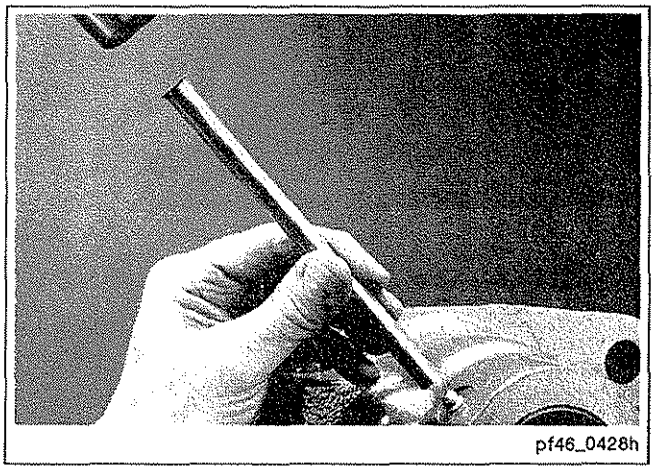
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Fig. 118

NOTE: Worm shaft preload adjustment was done when the input shaft was installed in the valve housing during the assembly procedure.

CAUTION: When the steering gear is not connected to the steering system, don't turn the input shaft more than 1-1/2 turns from the center position, or the automatic poppets could become inoperative when the steering gear is installed on the vehicle. This would require either disassembling the gear to position the poppet seat and sleeve assemblies for automatic adjustment, or using the special poppet adjusting screw kit 021407–X1 for manual poppet adjustment.

1. Center the steering gear by turning the input shaft until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing trunnion. See **Fig. 119**. Use a 12-point, 11/16- or 3/4-inch socket wrench to turn the input shaft.

   If the input shaft is turned more than 1-1/2 turns from the center position, you will have to either disassemble the gear to adjust the poppets again, or install the special poppet adjusting screw kit 021407–X1.

NOTE: If new or reset poppets are in the gear, they will be moved when the input shaft is turned less than one rotation in either direction

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from the center position. This will not affect the function of the poppets.

2. Adjust the sector shaft adjusting screw while turning the input shaft 180 degrees each side of center, until the input shaft reaches a torque of 30 to 35 lbf·in (340 to 400 N·cm). See **Fig. 120.** Use a 12-point socket and an inch-pound torque wrench to turn the input shaft.

3. Back out the sector shaft adjusting screw one turn. Note the torque needed to turn the input shaft through 180 degrees each side of center.

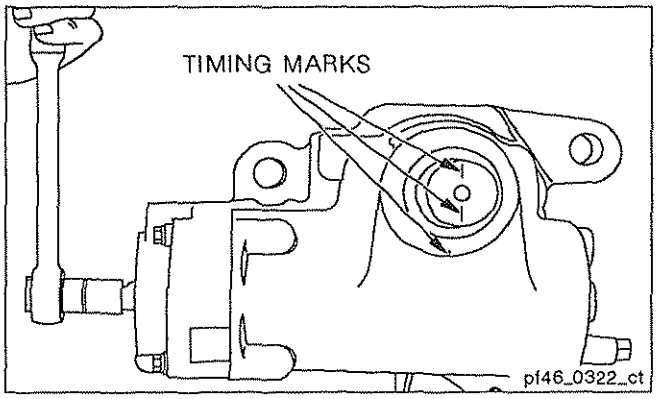

Fig. 119

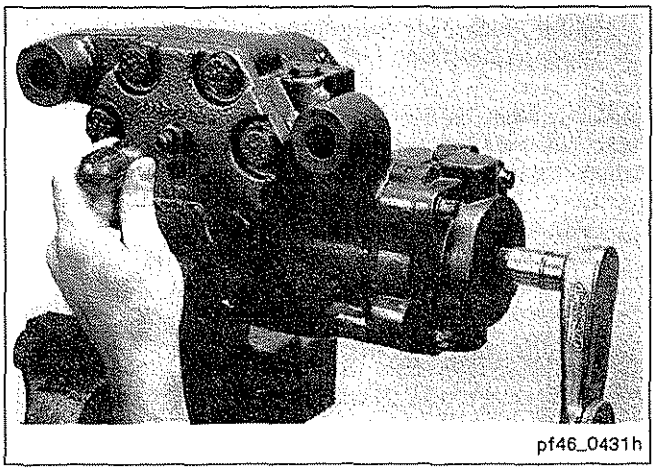

Fig. 120

4. Tighten the sector shaft adjusting screw so that the torque noted in step 3 is increased by 2 to 4 lbf·in (20 to 40 N·cm). Then, while holding the adjusting screw in place, tighten the sector shaft adjusting screw jam nut 40 to 45 lbf·ft (54 to 61 N·m).

5. Check the torque needed to turn the input shaft. If it is more than 35 lbf·in (400 N·cm), repeat steps 3 and 4 to adjust the input shaft again.

POST-SERVICE CHECKS

After power steering components have been worked on, and before the vehicle is placed into service, the following items must be checked.

WARNING: Failure to check the following items could result in damage to the power steering system. This could cause a loss of hydraulic assist, which could cause personal injury or property damage.

1. Place a thermometer in the power steering reservoir, then warm the hydraulic system to normal operating temperature of 125° to 135°F (51° to 57°C), by operating the engine at low idle, while turning the steering wheel through several full left and right turns. With the engine running and the power steering system at operating temperature, turn the steering wheel slowly from stop to stop, while checking the power steering reservoir for frothing or a change in the fluid level (a sign that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as necessary. Bleed the air from the system.

2. With the engine turned off and warm, check the power steering reservoir fluid level, using the instructions in Group 14 of the *COE and 120 Conventional Maintenance Manual.*

3. At full-left and full-right wheel cuts, be sure the axle stops (on the rear-side of the spindle) are set so there is at least 1/2-inch (13 mm) clearance between the tires and any fixed components that are attached to the vehicle. Clearance between moving

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components should be 3/4 inch (19 mm). If clearance is less than the above, reset the axle stops.

4. Check that the poppet plungers are set correctly. If needed, adjust them. For instructions refer to "Adjustments."

5. If there are still problems with the power steering system, go to "Troubleshooting," and perform the steering system hydraulic tests as instructed; otherwise, go to step 6.

6. Test drive the vehicle, or take a ride with the driver. Check the steering wheel spoke position. If, during straight-ahead driving on a level road, the steering wheel king spoke does not point directly toward the front of the vehicle (positioned at 12 o'clock ± 5 degrees) remove the steering wheel and reposition it.

TROUBLESHOOTING

STEERING SYSTEM HYDRAULIC TESTS

When troubleshooting, do the following tests *before* servicing the steering gear or power steering pump. Do the following tests *after* all other possible sources of steering problems have been checked, and any problems corrected. Refer to "Pre-Service Checks."

After completing any service operations on the steering gear or power steering pump, check the items listed under "Post-Service Checks," then do the following tests.

1. Apply the parking brakes, and chock the rear tires.

2. Install a flow meter kit (with the load valve, pressure gauge, and flow meter in one unit) in the applicable fluid line, as indicated by the instructions that come with the flow meter. Place a thermometer in the power steering reservoir. See **Fig. 121.**

IMPORTANT: To accurately test the hydraulic system, a flow meter must be used, and a thermometer is recommended.

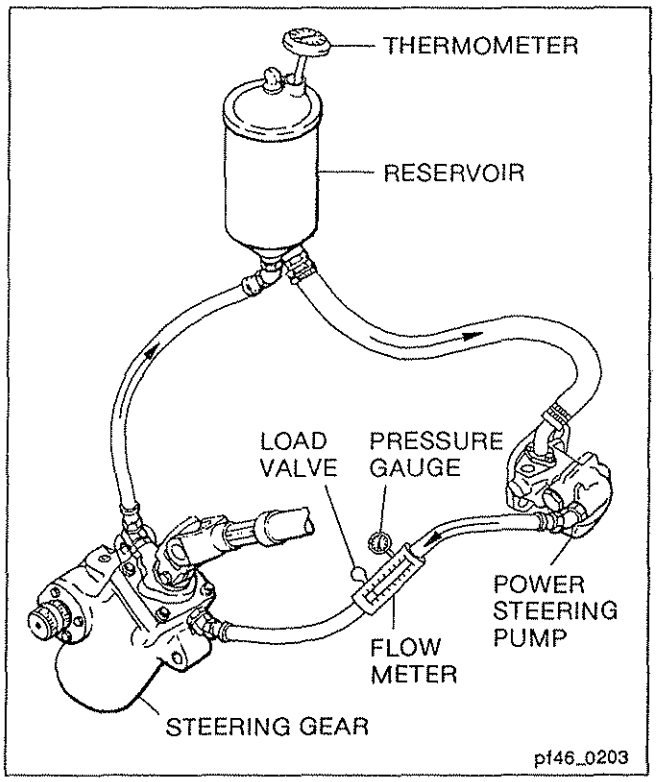

Fig. 121

3. Warm the hydraulic system to normal operating temperature of 125° to 135°F (51° to 57°C), by operating the engine at low idle, while turning the steering wheel through several full left and right turns.

NOTE: The normal operating temperature is most accurate when checked after two hours of normal operation.

An alternate method of warming the steering system is to operate the engine at low idle, while *partially* closing the load valve on the flow meter until the pressure gauge reads 1000 psi (6890 kPa). Open the load valve when the fluid temperature, as indicated on the thermometer, reaches 125° to 135°F (51° to 57°C).

CAUTION: Do not close the load valve completely. Completely closing the load valve causes the power steering pump to operate at relief pressure, and the fluid temperature to

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increase rapidly. Doing so could damage the steering pump. At no time allow the fluid temperature to exceed 180°F (82°C). Run all of the tests at 125° to 135°F (51° to 57°C).

4. The pressure at which the power steering pump's pressure relief valve should open is 2000 to 2200 psi (13 800 to 15 200 kPa). With the engine idling, slowly close the load valve, and read the pressure gauge on the flow meter; then immediately open the load valve.

CAUTION: To avoid damaging the pump, do not keep the load valve closed for longer than five seconds.

If the pressure rises rapidly, appears to be uncontrolled, or rises above the maximum pressure relief valve setting of 2200 psi (15 200 kPa), immediately open the load valve.

CAUTION: Keep watching the pressure gauge while closing the load valve, and while it is closed. An inoperative pressure relief valve may allow too much pressure to build, resulting in severe pump damage or ruptured hoses.

If the pressure relief valve fails to open within the above specifications, install a new pump pressure relief valve, using the instructions elsewhere in this group. Check the operation of the new valve, as instructed.

5. Check the flow rate of the power steering pump, as follows:

   .1 With the engine idling, the vehicle stationary, and with the full weight of the vehicle on the floor, close the load valve until the pressure on the gauge reaches 1000 psi (6890 kPa). Then open the load valve while observing the flow meter. Read and record the flow rate shown by the flow meter. Compare this value with the minimum flow rate of 2.7 gpm (10.2 Lpm).

   WARNING: The minimum flow rate must not be less than 2.7 gpm (10.2 Lpm). Inadequate flow will cause binding, and uneven or difficult steering. This could cause an accident resulting in personal injury or property damage.

   If the flow rate is inadequate, repair or replace the power steering pump. For instructions, refer elsewhere in this group.

   .2 With the engine idling, fully close the load valve until the pressure gauge indicates that the power steering pump pressure relief valve is open—2000 to 2200 psi (13 800 to 15 200 kPa). When the pump relief pressure is reached, the flow rate must be zero gpm. *Immediately open the load valve.* The flow rate must instantly return to the original reading.

   If the original flow rate does not return immediately, the pump is malfunctioning. Repair or replace the pump.

   .3 Increase the engine speed to governed rpm, and, without turning the steering wheel, read and record the flow rate. Compare this value with the maximum flow rate of 6.0 gpm (22.7 Lpm).

   WARNING: The maximum flow rate must not exceed 6.0 gpm (22.7 Lpm). Excessive flow can cause high operating temperatures and oversteering which could cause an accident resulting in personal injury or property damage.

   If the flow rate is excessive, replace the power steering pump's flow control and relief valve. For instructions, refer elsewhere in this group.

   .4 With the engine speed at governed rpm, fully close the load valve until the pressure gauge indicates that the power steering pump pressure relief valve is open. When the pump relief pressure is reached, the flow rate must be zero gpm. *Immediately open the load valve.* The flow rate must instantly return to the original reading.

   If the original flow rate does not return immediately, the pump is malfunctioning. Repair or replace the pump.

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.5 Conduct the pump flow test twice more at governed rpm, as instructed in step 5.4 above.

6. Remove the flow meter kit, then install a pressure gauge on the T-adapter, where the pressure line is connected to the gear.

7. With the steering wheel stationary, the front wheels positioned straight ahead, and the engine idling, check the hydraulic system back-pressure. Normal system back-pressure should never be more than 100 psi (689 kPa).

   If the back-pressure reading is normal, go to step 8.

   If the back-pressure reading is over 100 psi (689 kPa), and the power steering pump is not at fault (the maximum pump flow rate is within specifications at step 5, above), check the power steering system for fluid flow restrictions. Repair or replace parts, as necessary. Then, go to step 8.

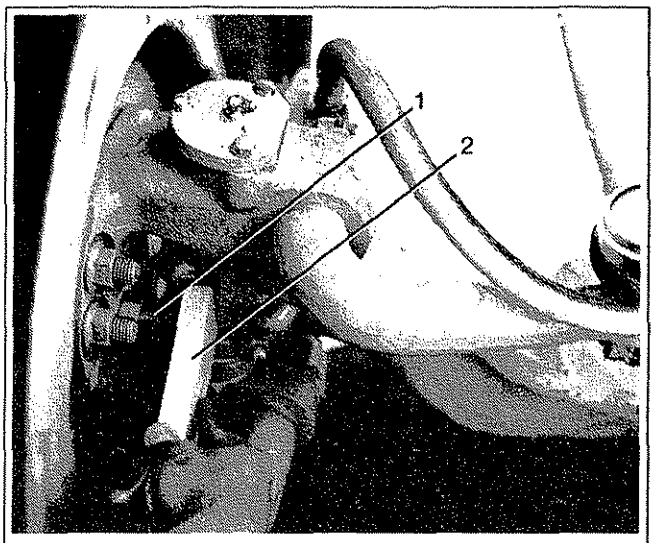
8. Connect the flow meter kit, as instructed in step 2, then test the steering gear for internal leakage, as follows:

NOTE: To test the steering gear for internal leakage, you must first prevent the operation of the gear's internal poppet valves. This will allow full pump relief pressure to develop.

.1 To prevent operation of the poppet valves, place a steel spacer block between the axle and stop, at one wheel. See **Fig. 122**. The spacer block should be about 1-inch (25-mm) thick, and must be long enough in length to keep your fingers clear.

WARNING: Keep your fingers clear of the axle stops and spacer blocks during this test. Make sure that the spacer block contacts the axle stop squarely. Contact that is not square could break the axle stop, or dangerously eject the spacer block, causing injury.

While running this test, do not hold the steering wheel in the full-turn position for longer than 5 seconds at a time, to avoid damaging the pump.



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1. Axle Stop 2. Spacer Block

Fig. 122

.2 With a normal load on the front axle, turn the steering wheel until the axle stop bottoms on the spacer block. Apply 20 pounds (89 N) of force to the rim of the steering wheel (to be sure the steering gear control valve is fully closed).

.3 Check the steering gear internal leakage on the flow meter.

.4 Repeat steps 8.1 through 8.3 for the opposite direction of turn.

   If the amount of internal leakage is more than 1.0 gpm (3.8 Lpm) in either direction of turn, replace the steering gear components, as necessary.

.5 Remove the spacer block.

9. Check the operation of the steering gear poppet valves, as follows:

CAUTION: If power steering pump relief pressure is reached while the steering wheel is at full-lock, release the steering wheel from this position. Do not allow the pump relief pressure

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to be maintained for longer than five seconds, or damage to the pump may result.

.1 Turn the steering wheel clockwise to the full-lock position (to fully trip the poppet valve at one end of the steering gear), and note the reading on the pressure gauge. At the full-lock position, the pressure gauge reading should not exceed 1200 psi (8300 kPa).

.2 Turn the steering wheel counterclockwise to the full-lock position, and note the reading on the pressure gauge. Again, the pressure gauge reading should not exceed 1200 psi (8300 kPa).

If the pressure reading exceeds the above specification at either of the full-lock positions, adjust the poppet valve.

10. Remove the flow meter kit and the thermometer. Remove the chocks from the tires.

TROUBLESHOOTING CHART

A checklist for troubleshooting hydraulic power steering systems, Form SD–94, is available and can be ordered through your dealer. Dealers can order by using Publishing Request Form FG–138. An example of the checklist is shown in **Figs. 123** and **124.**

Problem — No Power Steering on Cold Start

Possible Cause	Remedy
The vanes of the power steering pump are not extending (Vickers pump only).	Increase the engine speed momentarily, to extend the vanes and start the pump action. This is usually a temporary and infrequent occurrence, and is not a cause for pump repair or replacement.

Problem — Steering Input Not Smooth (Seizing, Binding)

U-joints are worn.	Check and replace the U-joints as required.
U-joints are not properly phased.	Check the phasing of the U-joints, and adjust as necessary.
Fluid flow is insufficient.	Refer to the problem "No Power Steering on Cold Start." Check the fluid flow; minimum fluid flow must be 2.7 gpm (10.2 Lpm). Inspect the pump, and repair or replace it as necessary.
Internal leakage in the steering gear.	Check for internal leakage, and replace components as necessary.

Problem — Wheel Cuts Restricted

The relief valve plungers are incorrectly adjusted.	Let the vehicle roll forward while pulling on the steering wheel rim.
The pitman arm is positioned incorrectly.	Center the steering gear, and relocate the pitman arm.
The axle stops are incorrectly adjusted.	Adjust the axle stops.

Problem — No Recovery When Leaving a Turn

Fluid flow is insufficient.	Check the fluid flow; minimum fluid flow must be 2.7 gpm (10.2 Lpm). Inspect the pump, and repair or replace it as necessary.
The tires are underinflated.	Inflate the tires to the correct values.
The fifth wheel is dry, or there is a poor finish on the fifth wheel or trailer plate.	Lubricate the fifth wheel, using the instructions in Group 22 of the *COE and 120 Conventional Maintenance Manual,* or the fifth wheel manufacturer's service information.

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Problem – No Recovery When Leaving a Turn (Continued)

Possible Cause	Remedy
The front axle alignment is not correct.	Align the front axle.
The front axle components are binding.	Adjust or replace the front axle components.
The steering column is binding.	Adjust the steering column.

Problem – High Steering Effort in One Direction

Internal leakage in the steering gear is excessive.	Check for excessive internal leakage, and replace components as necessary.
There is low flow or low pressure from the pump.	Check the power steering pump flow and pressure. Repair or replace the pump.

Problem – High Steering Effort in Both Directions

The hydraulic fluid volume is low.	Fill the reservoir as required. For fluid specifications, see **Table 4**, under "Specifications."
There is a restriction in the return line, or the return line is too small.	Remove the restriction from the line, or replace it with a larger line, as necessary.
The front axle alignment is not correct.	Align the front axle.
The front axle components are worn or damaged.	Repair or replace kingpins and tie rods. Refer to the applicable front axle manufacturer's service manual.
Components of the steering system are binding.	Adjust or replace the steering system components.
There is air in the hydraulic system.	Check for and repair an air leak on the suction side of the power steering pump.
The tires are underinflated.	Inflate the tires to the correct values.

Problem – Steering Shimmy or Chatter

There is air in the hydraulic system.	Check for and repair an air leak on the suction side of the power steering pump.
The wheel bearings are incorrectly adjusted or worn.	Inspect and adjust the wheel bearings, following the instructions in Group 10 of this manual. Replace the bearings if necessary.
The wheels are out of balance.	Balance the wheels, drums, and tires.
A tire or wheel is incorrectly mounted.	Check and correct the mounting of the wheels and tires.
One or more tires are badly or unevenly worn.	Replace badly worn and unevenly worn tires.
The front axle is misaligned.	Align the front axle.
Components in the steering linkage are loose or worn.	Tighten or replace steering linkage components, such as ball sockets on the drag link or tie rod.

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Problem — Excessive Free-Play (Lash) at the Steering Wheel

Possible Cause	Remedy
Components in the steering linkage are loose or worn.	Tighten or replace steering linkage components, such as ball sockets on the drag link or tie rod.
The steering gear is loose on the frame rail or mounting bracket, or the mounting bracket is loose on the frame rail.	Remove and clean the steering gear and the mounting bracket. Check the bracket for wear; replace the bracket if necessary. Install the bracket and steering gear, tightening the bolts to their correct torque value.
The output shaft bearings are worn or damaged.	Replace the bearings and polish the sector shaft to remove deposits.
The pitman arm is loose on the sector shaft, or the sector shaft splines are damaged.	Inspect the sector shaft and pitman arm for damage. Replace parts as necessary. Tighten the pitman arm pinch-bolt nut to its correct torque value.
The pinion gear on the sector shaft is damaged.	Replace the pinion gear and the rack piston.
The rack on the piston is damaged.	Replace the rack piston and the pinion gear.
The connection is loose between the steering gear input shaft and the lower driveline.	Tighten the connection.
The steering wheel is loose on the upper column shaft.	Tighten the steering wheel shaft nut to the correct torque value.

Problem — Darting, Wandering (Oversteering)

The fifth wheel is dry, or there is a poor finish on the fifth wheel or the trailer plate.	Lubricate the fifth wheel.
The vehicle is overloaded.	Reduce the load to the gross axle weight rating.
One or more of the tires is damaged, overinflated or underinflated..	Check the tires for out-of-line tread, and replace them if necessary. Inflate the tires to the correct values.
The wheel bearings are worn or incorrectly adjusted.	Adjust or replace the wheel bearings, following the instructions in Group 10 of this manual.
The rear axle component fasteners may not be tight.	Check the rear axle components for tightness.
The front axle alignment is not correct.	Align the front axle.
Components in the front end or the steering linkage are loose, worn, or binding.	Check the steering gear mounting for damage, distortion, or looseness. Adjust or replace front end steering components, as needed.
The steering column is binding.	Adjust the steering column.
Fluid flow is excessive.	Check the fluid flow; maximum fluid flow must be 6.0 gpm (22.7 Lpm). Inspect the pump, and repair or replace it as necessary.
There is air in the hydraulic system.	Check for and repair an air leak on the suction side of the power steering pump.
Components in the steering gear are damaged or worn.	Inspect the steering gear components, and repair or replace them as necessary.

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Problem – Erratic Steering or No Steering at All

Possible Cause	Remedy
The power steering pump flow control and relief valve is not functioning correctly.	Inspect the power steering pump, and repair it as necessary.

Problem – Abnormal or Excessive Noise

Hydraulic hose lines are in direct contact with the vehicle frame or sheet metal.	Insulate or position lines away from the frame with grommets, clamps, and brackets.
A noise heard when beginning a steering maneuver or when changing directions may indicate that some component is loose and is shifting under load.	Check all components for tightness. Tighten all component fasteners to their correct torque values.
A change in the normal noise from the power steering pump may indicate that air is in the system, or that the fluid level is low.	Check for and repair an air leak on the suction side of the power steering pump. Fill the power steering reservoir as required. For fluid specifications, see **Table 4**, under "Specifications."
Excessive noise from the power steering pump may indicate the entry of foreign material, or that the power steering pump is worn.	Clean and repair the power steering pump, or replace it. Check the power steering reservoir filter, and replace it if necessary.

Problem – High Operating Temperatures

The vehicle is overloaded.	Reduce the load to the gross vehicle weight rating.
An undersized replacement hose, line, or fitting was installed.	Replace any incorrect hoses, lines, or fittings.
A hose or line is kinked or severely bent.	Remove the kink or severe bend by rerouting the hose. Replace the hose if necessary.
Fluid flow is excessive.	Check the fluid flow; maximum fluid flow must be 6.0 gpm (22.7 Lpm). Inspect the pump, and repair or replace it as necessary.
The poppet valves are incorrectly adjusted.	Manually adjust the poppet valves.

Problem – Excessive Power Steering Pump Pressure With Steering Gear in Neutral Position

The fluid return line is pinched, creating high back-pressure.	Relocate the fluid return line.
The input shaft bearing is damaged.	Inspect the steering gear components, and replace damaged parts as required.

Problem – Fluid Leaking at the Sector Shaft

The filter in the power steering reservoir is clogged (creating high system back-pressure).	Replace the filter, and decrease the interval between filter changes.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

Problem — Fluid Leaking at the Sector Shaft (Continued)

Possible Cause	Remedy
The fluid return line is pinched, creating high back-pressure.	Relocate the fluid return line.
The sector shaft seal is damaged.	Replace the sector shaft seal.
The sector shaft roller bearings are damaged.	Replace the roller bearings. Replace the sector shaft, or polish it to remove pitting and grooving.

Problem — Fluid Leaking at the Input Shaft

The input shaft oil seal is damaged.	Replace the input shaft seal.
The seal surface of the input shaft is damaged.	Replace the damaged parts.

Problem — Fluid Leaking at Hoses or Fittings

The hoses are damaged or the fittings are loose or damaged.	Tighten loose fittings, and replace damaged hoses and fittings.

Problem — Fluid Is Forced Out of Power Steering Reservoir

Operating temperatures are too high.	Refer to the problem "High Operating Temperatures."
The filter in the power steering reservoir is clogged (creating high system back-pressure).	Replace the filter, and decrease the interval between filter changes.
The poppet valves are incorrectly adjusted, causing overheated fluid.	Manually adjust the poppet valves.
There is air in the hydraulic system.	Check for and repair an air leak on the suction side of the power steering pump.
The power steering pump is damaged (causing cavitation).	Check for, and correct, a restriction in the power steering fluid supply hose. Repair the power steering pump.

Problem — Fluid Is Foaming in Power Steering Reservoir

Operating temperatures are too high.	Refer to the problem "High Operating Temperatures."
An unapproved fluid was added.	Drain, flush, and refill the system, using the correct fluid. See **Table 4**, under "Specifications."
There is air in the hydraulic system.	Check for and repair an air leak on the suction side of the power steering pump.
The power steering pump is damaged (causing cavitation).	Check for, and correct, a restriction in the power steering fluid supply line. Repair the power steering pump.

Problem — Fluid Is Milky or White in Appearance

Water has entered the reservoir through the reservoir venting system.	Clean the reservoir venting system, or replace the reservoir cap assembly. Drain, flush, and fill the system with the correct fluid. See **Table 4**, under "Specifications" for fluid specifications.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

Problem – Fluid Is Discolored or Smells Burned

Possible Cause	Remedy
Operating temperatures are too high.	Refer to the problem "High Operating Temperatures."
The interval between fluid changes is too long.	Decrease the fluid change interval.
An unapproved fluid was added.	Drain, flush, and refill the system, using the correct fluid. See **Table 4**, under "Specifications" for fluid specifications.

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

Service

FREIGHTLINER Freightliner Corporation®

CHECKLIST FOR TROUBLESHOOTING HYDRAULIC POWER STEERING SYSTEMS

Date _____ Work Order No. _____

Evaluation Performed By _____ ☐ Dealership ☐ Fleet ☐ Independent

Vehicle Identification

Vehicle Model _____ Chassis No. _____

Date in Service _____ Mileage _____

Mileage when steering problem first occurred _____

Vehicle application _____

Normal steering axle load _____

Steering System Description

Steering Pump Manufacturer _____ Model No. _____

Steering Gear Manufacturer _____ Model No. _____

Steering Assist Cylinder (Where Applicable) Manufacturer _____ Model No. _____

Reservoir Type _____ ☐ Integral with pump ☐ Remote

Reservoir Capacity _____

Type of Fluid: ☐ ATF ☐ 10W ☐ 10W-30 ☐ 10W-40 ☐ Other _____

Description of Steering Complaint

☐ Freeplay (lash) at the steering wheel
☐ High steering effort in both directions
☐ High steering effort in left turn only
☐ High steering effort in right turn only
☐ Excessive heat. 150°F (66°C) over ambient
☐ Pulls to left
☐ Pulls to right
☐ Other (Describe as completely as possible)

☐ Road wander
☐ No recovery
☐ External leak
☐ Shimmy
☐ Darting

_____

_____

_____

Preliminary Checks

Dry fifth-wheel _____ ☐ Yes ☐ No

Binding condition at roadwheel with wheels raised off ground _____ ☐ Yes ☐ No

RESERVOIR/FLUID

Fluid Level: ☐ OK ☐ Too low ☐ Too high

Fluid Condition: ☐ OK ☐ Discolored ☐ Odorous ☐ Foamy ☐ Other _____

Filter Condition: ☐ OK ☐ Dirty: Contaminants _____

SD-94 (12/85T)

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Fig. 123, Front Side, "Checklist for Troubleshooting Hydraulic Power Steering Systems"

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

Preliminary Checks (Continued)

FRONT TIRES

Matched Set: ☐ Yes ☐ No Inflation Pressure: Left ____ psi (____ kPa)

Unusual Wear: ☐ Yes ☐ No Right ____ psi (____ kPa)

LASH OR LOOSENESS

Draglink: Adjustment threads and ball studs _____ ☐ Yes ☐ No

Tie rod ends: Adjustment threads and ball studs _____ ☐ Yes ☐ No

Kingpins _____ ☐ Yes ☐ No

Steering column driveline _____ ☐ Yes ☐ No

Steering gear worm shaft _____ ☐ Yes ☐ No

Steering gear sector shaft _____ ☐ Yes ☐ No

Pitman arm _____ ☐ Yes ☐ No

Suspension spring bushings _____ ☐ Yes ☐ No

TOTAL TRUCK ALIGNMENT

Toe-in/out _____ Rear axle alignment _____

Caster: Left ____ Right ____ Alignment testing equipment used _____

Camber: Left ____ Right ____

Hydraulic Checks

Stablized power steering fluid temperature _____ ____°F (____°C)

Pump flow at engine idle _____ ____gpm (____Lpm)

Pump flow at above 1500 rpm _____ ____gpm (____Lpm)

Pump relief pressure at idle _____ ____psi (____kPa)

System back-pressure at idle _____ ____psi (____kPa)

Steering gear internal leakage: Left turn ____gpm (____Lpm)

Right turn ____gpm (____Lpm)

Assist cylinder internal leakage (where applicable): Left turn ____gpm (____Lpm)

Right turn ____gpm (____Lpm)

Steering gear poppet valve trip pressure (Ross): Left turn ____psi (____kPa)

Right turn ____psi (____kPa)

Steering gear relief valve plunger trip pressure (Sheppard): Left turn ____psi (____kPa)

Right turn ____psi (____kPa)

Attempted Corrections and Results

_____

_____

_____

_____

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Fig. 124, Back Side, "Checklist for Troubleshooting Hydraulic Power Steering Systems"

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

SPECIFICATIONS

Kent-Moore Part Number	Tool
J37070	Adjuster Tool
J37464	Adjuster Locknut Tool
J37071	Bearing and Seal Tool
J37073	Input Seal Installer
J36452	Poppet Adjuster Seat Tool
J37130	Relief Valve Plug
J38713	Poppet Adjuster Seat Tool, Heavy Duty
J8092	Tool Handle

Table 2, Kent–Moore Tools, Kent–Moore Tool Division, 29784 Little Mack, Roseville, MI 48066

Description	Bolt or Nut Size	Grade	Torque lbf·ft (N·m)
Valve Housing Bolt	1/2–13	—	105–115 (142–156)
Poppet Fixed Stopscrew	—	—	38–42 (52–57)
Auxiliary Cylinder Fitting	—	—	25–35 (34–47)
Poppet Adjuster Sleeve and Seat Assembly	—	—	8–12 (11–16)
Ball Return Guide Bolt	—	—	13–17 (18–23)
Sector Shaft Adjusting Screw Jam Nut	—	—	40–45 (54–61)
Side Cover Special Bolt	5/8–18	—	220–240 (298–325)
Steering Driveline Lower End Yoke Pinch-Bolt Locknut	7/16–20	C	60 (81)
Pitman Arm Pinch-Bolt Nut	3/4–16	C	230 (312)
Steering Gear Mounting Hexbolt Nut*	7/8–9	C	405 (549)
	7/8–14	C	445 (603)
Steering Gear Bracket-to-Frame Rail Mounting Bolt Nut	1/2–13	C	73 (99)
	5/8–11	C	145 (197)

* Torque values are for nuts that are wax coated and cadmium plated, or for hexbolts that have phosphate- and oil-coated threads. Both are used with hardened washers. For dry threads, refer to "Charts and Specifications" in the *COE and 120 Conventional Maintenance Manual.*

Table 3, Steering Gear Torque Values

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

WARNING: Fill only with approved clean fluid. Do not mix automatic transmission fluid with engine oil; use one or the other. If you are changing from one fluid type to the other, completely flush the steering system with the fluid type being added. Any mixture or any unapproved fluid could lead to seal deterioration and leaks. Any fluid leak could eventually cause loss of power steering assist.

Fluid Type		Recommended Fluid
Automatic Transmission Fluid*		Type "F"; or Dexron II.
Heavy-Duty Engine Oil*	0 to 210°F† (–18 to 99°C)†	Shell Rotella T SAE 30; API service classification SE; CD, or CC; Mobil SAE 10W-30; or Ashland, Union, Texaco, or Mobil SAE 10W-40, API service classification SE, SC, or SD; Heavy-duty engine oil, SAE 10W-40, API service classification SD, SE, or SF; Union Guardol 15W-40 or SAE 30; Imperial Essolube 15W-40; Shell SAE 10W-30 or SAE 10W-40; Chevron 10W-40.

* Do not mix automatic transmission fluid with engine oil. See the warning statement above.

† Operating temperature range: minimum (ambient start-up) to maximum.

Table 4, Power Steering Fluid

ROSS INTEGRAL POWER STEERING GEAR, MODEL TAS65

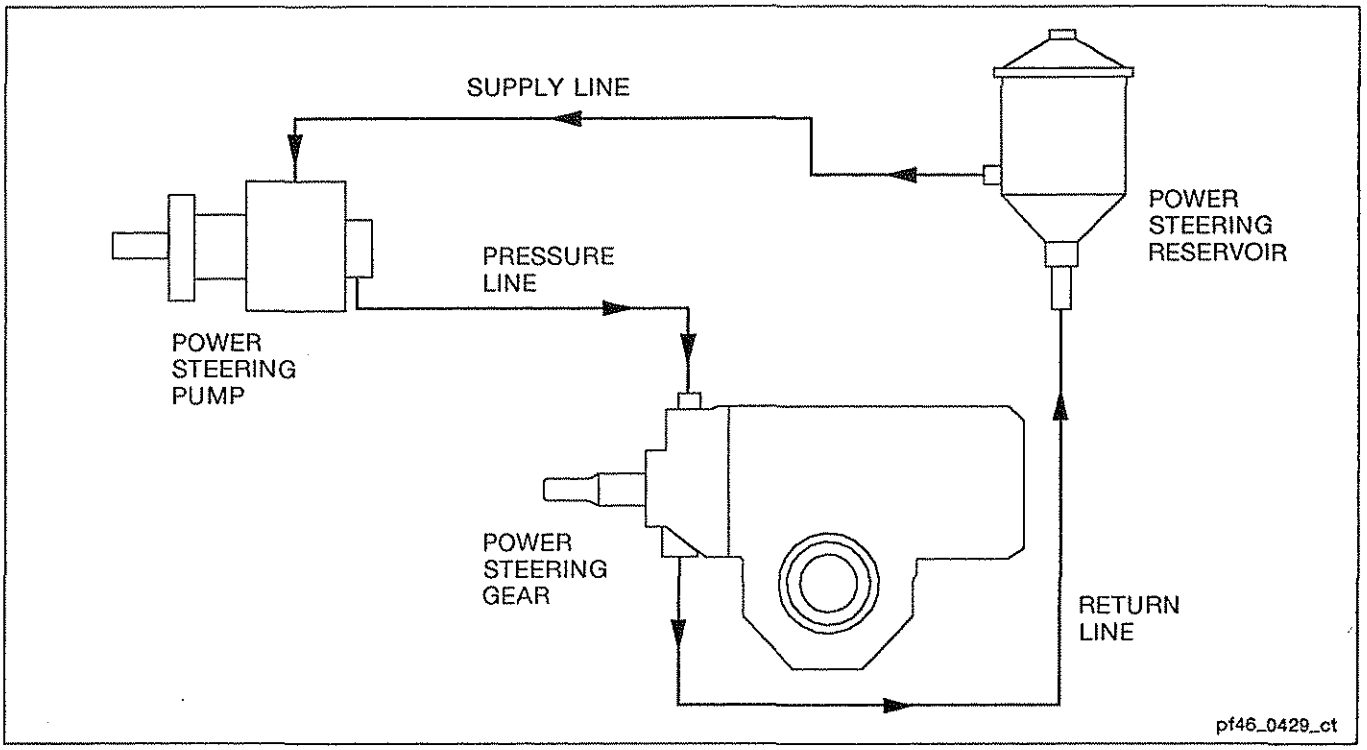

Fig. 125, Plumbing Diagram

EATON POWER STEERING PUMP

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EATON POWER STEERING PUMP

GENERAL DESCRIPTION

The Eaton model "BB" pump is a high-pressure, gear-driven, roller vane pump, that pressurizes fluid from a remote-mounted reservoir for the operation of a power steering gear. Major parts of the pump are the pump body, pumping element components, end plate, pump shaft, and pump cover. See **Fig. 1**.

The pump body contains the cavity for the end plate and pumping element components (which include a locating pin, drive pin, carrier, ten rollers, cam ring with elliptical inner surface, and port plate). To seal in steering fluid and seal out engine oil, a pump shaft oil seal is pressed into the front of the body. As an integral part of the body, a non-replaceable bushing supports the pump shaft near one end.

A second non-replaceable pump shaft bushing is an integral part of the pump cover. The cover's outlet passage contains a flow control orifice that limits the flow of pressurized fluid to the steering gear. Joined to that passage is another that contains a spring and combination valve, for flow-control and pressure-relief.

PRINCIPLES OF OPERATION

Low-pressure fluid from the power steering reservoir comes through the inlet tube assembly, and into the pump inlet chamber. Once inside, the fluid enters the pumping chambers by passing through the large inlet notches in the end plate, port plate, and front and back of the cam ring. See **Fig. 2**.

Fluid entering the inlet chamber pushes against the larger surface at the back of the end plate to counterbalance the pressurized fluid pushing against the smaller surfaces of the end plate cavities. This balance of pressure maintains the correct running clearances between the pumping element components. The seals in the end plate cavities are held against the port plate to separate pressurized fluid from low-pressure fluid. See **Fig. 3**.

A locating pin fits into a hole in the pump body, and passes through notches in the end plate, port plate, and cam ring, to align them and prevent them from turning with the pump shaft. A drive pin locks the carrier to the pump shaft, and snap rings keep the shaft from moving back and forth in the carrier. As the carrier is driven by the shaft, the carrier drives the rollers. Centrifugal force causes the rollers to move outward, and to follow the elliptical surface inside the cam ring. Fluid pressure under any roller equals the fluid pressure above that same roller, to ensure that the rollers are held against the cam ring.

Ten pumping chambers are formed between the carrier and the cam ring (and end plate and cover); one pumping chamber between each adjacent pair of rollers. At the smallest distance from the carrier to the cam ring, which is just before the inlet area, the volume of the pumping chamber is very small. See **Fig. 4**, *A*. As the moving rollers pass the inlet area, the distance increases a small amount, but this greatly increases the volume. This creates a partial vacuum at the inlet area, so that fluid from the reservoir fills the space. See **Fig. 4**, *B*. As soon as the rollers are past the inlet area, the fluid is trapped, and carried to the outlet area. See **Fig. 4**, *C*. As the rollers pass the outlet area, the distance decreases, squeezing the large volume of trapped fluid into the outlet passage in the cover. See **Fig. 4**, *D*.

The pumping element's two inlet areas are directly across the pump shaft from each other, as are the two outlet areas. Thus, whatever the hydraulic force is on one side of the pump shaft, it is balanced by an equal force on the opposite side. Each pumping chamber is filled and pressurized twice during a full rotation of the carrier. For each full rotation, the volume of fluid pumped is always the same. The faster the carrier rotates, the greater the pump's output (gallons per minute of "total flow").

If the flow rate to the steering gear was not controlled by some means, changes in engine speed (causing changes in total flow) would cause changes in steering gear response. The flow control orifice at the pump outlet, and the combination valve in the pump cover, limit the maximum pressure in the system, and the maximum flow to the steering gear (the "controlled flow").

EATON POWER STEERING PUMP

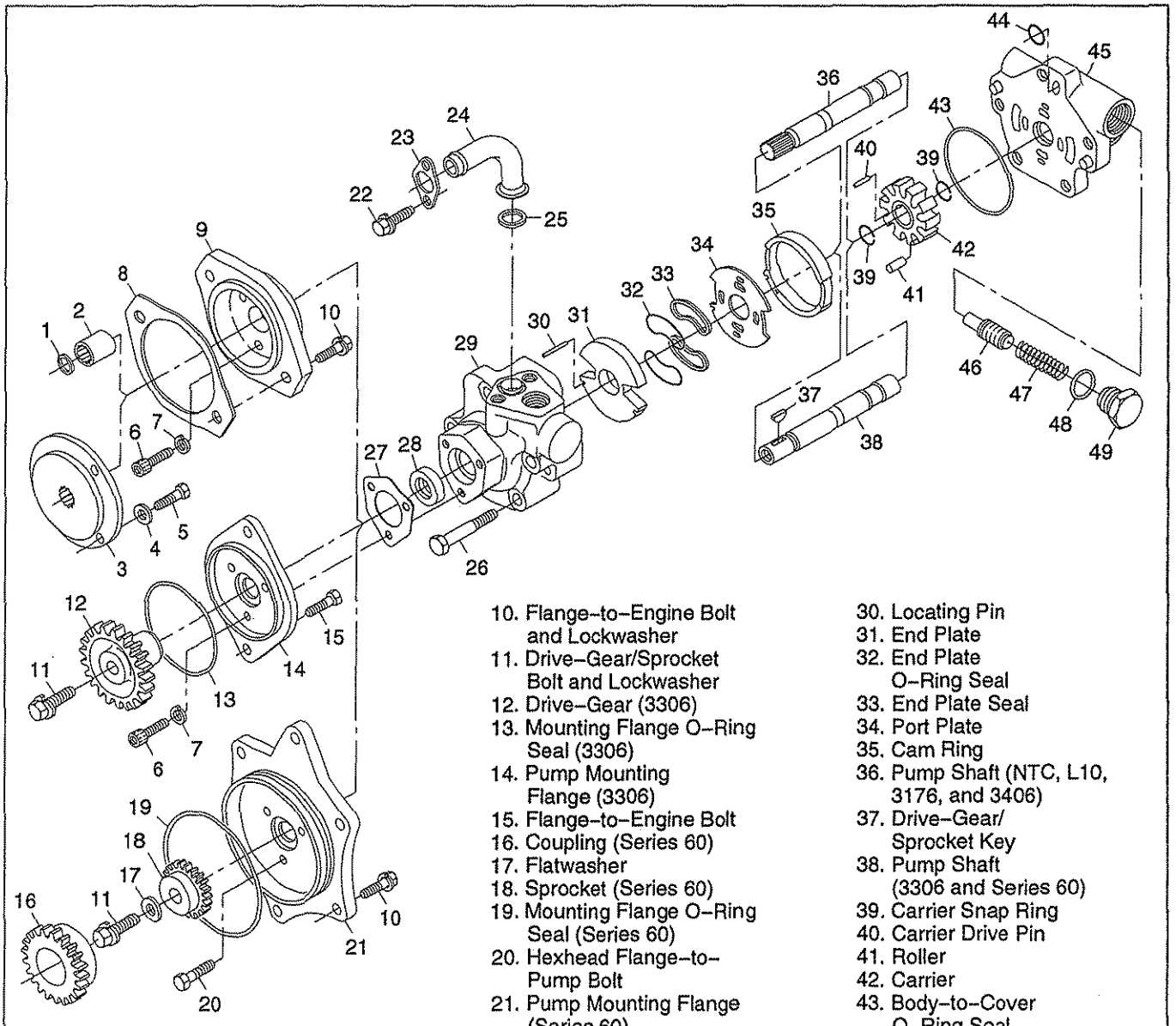

Fig. 1, Power Steering Pump and Pump Mounting Components

EATON POWER STEERING PUMP

1. Pump Shaft Oil Seal
2. Pump Shaft
3. Pump Body
4. Pump Shaft Bushing
5. End Plate
6. Port Plate
7. Cam Ring
8. Roller
9. Pump Cover Dowel Pin
10. Pump Cover
11. Flow Control Orifice
12. Outlet Passage
13. Pump Shaft Bushing
14. Body–to–Cover O–Ring Seal
15. Carrier
16. Inlet Chamber

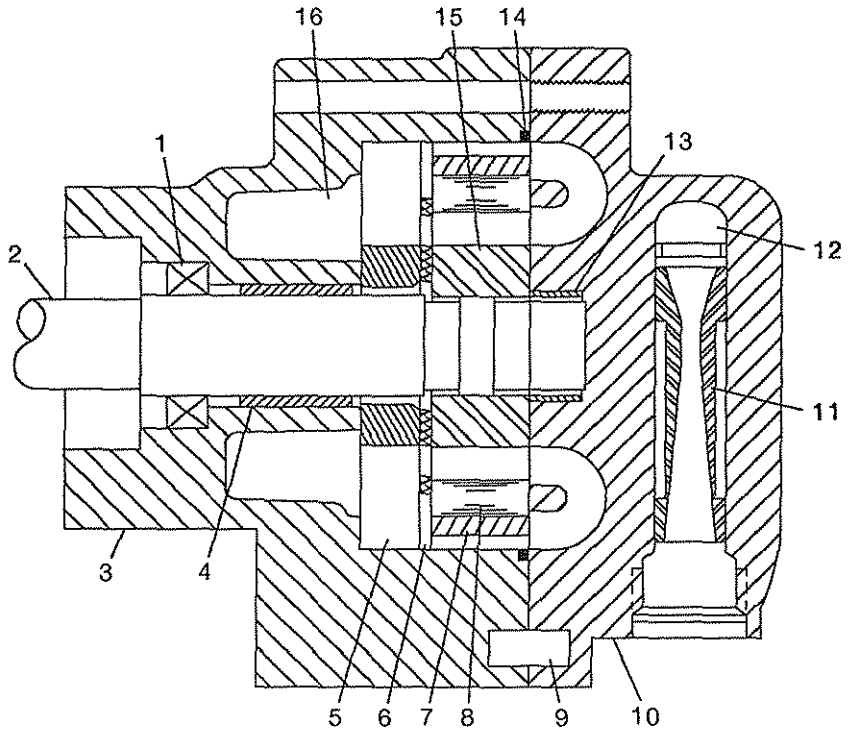

Fig. 2, Pump Assembly (cross–sectional top view)

When the pump operates at low speed, most of its output passes through the flow control orifice, circulates through the steering gear, and returns to the reservoir. The small amount of excess output (total flow minus controlled flow) builds fluid pressure behind the flow control orifice. Because the pressure against the flow-control end of the combination valve will be slightly greater than the combined force of the spring and fluid pressures at the relief-valve end, the combination valve will be forced open a small amount. The excess output goes past the flow-control end of the valve, into the by-pass passage to the pump inlet, where it is recirculated through the pump. See **Fig. 5.**

When the pump operates at high speed, the amount of excess output is much greater. Controlled flow increases, but total flow increases an even greater amount. The increased pressure behind the flow control orifice forces the combination valve to open even further. See **Fig. 6.**

Any time the pump is operating and the steering gear's actuating (control) valve is in the neutral position, a constant flow of low-pressure fluid (the controlled flow) is circulated throughout the gear and returned to the reservoir. If some fluid wasn't returned to the reservoir, the fluid and system would soon overheat.

When the gear's actuating (control) valve is moved from the neutral position (when the steering wheel is turned), the fluid flow is directed by it to the correct end of the steering gear piston. The pump will build enough pressure ("load pressure") against the piston to overcome whatever forces are acting against the vehicle wheels. Load pressure is low when the vehicle makes a high-speed turn, and is high when the vehicle is maneuvered at very low speed. High load pressure results in back-pressure at the outlet end of the flow control

EATON POWER STEERING PUMP

1. Pump Shaft Oil Seal
2. Pump Shaft
3. Pump Body
4. Pump Shaft Bushing
5. End Plate
6. End Plate O-Ring Seal
7. End Plate Seal
8. Port Plate
9. Cam Ring
10. Roller
11. Pump Cover
12. Outlet Passage
13. Flow Control Orifice
14. Combination Valve Cap
15. Combination Valve (Flow Control and Pressure Relief)
16. Body-to-Cover O-Ring Seal
17. Flow Bypass O-Ring Seal
18. Carrier Drive Pin
19. Carrier
20. Bypass Passage
21. Pump Inlet
22. Inlet Chamber

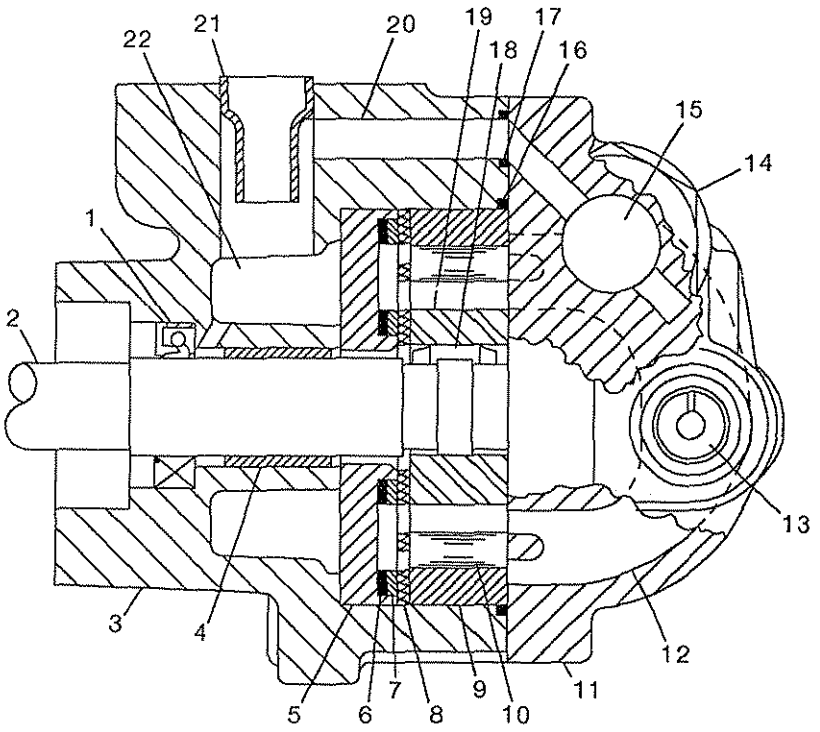

Fig. 3, Pump Assembly (cross–sectional side view)

orifice, slightly decreasing the amount of controlled flow. This prevents load pressure from building too rapidly.

During normal steering conditions, fluid pressure behind the flow control orifice remains greater than load pressure in the steering gear. Thus, pressure against the flow-control end of the combination valve is always greater than pressure against the relief-valve end, ensuring that pressure cannot build in any part of the system to the point of causing damage. See **Fig. 6.**

When *abnormal* steering conditions occur, the combination valve acts as a pressure relief valve. If, for example, the vehicle wheels are against a curb that prevents them from turning, and force is applied to turn the steering wheel, load pressure will build until it is equal to pressure behind the flow control orifice. Fluid pressure against the ends of the combination valve will be balanced, causing the flow-control spring to close the valve. Pressure will build rapidly until it is high enough to overcome the force of the relief-ball spring. When the relief ball opens up the spring chamber to the bypass passage, there is an immediate drop in pressure at the relief-valve end of the combination valve. Pressure cannot build back up in the passage because the relief-valve orifice restricts the amount of fluid flow to no more than what the relief ball can relieve. The drop in pressure at that end allows the combination valve to open all the way, preventing pressure from building to the point of causing damage. See **Fig. 7.** Because all of the pump's output is being recirculated to the pump inlet, and no cooling takes

EATON POWER STEERING PUMP

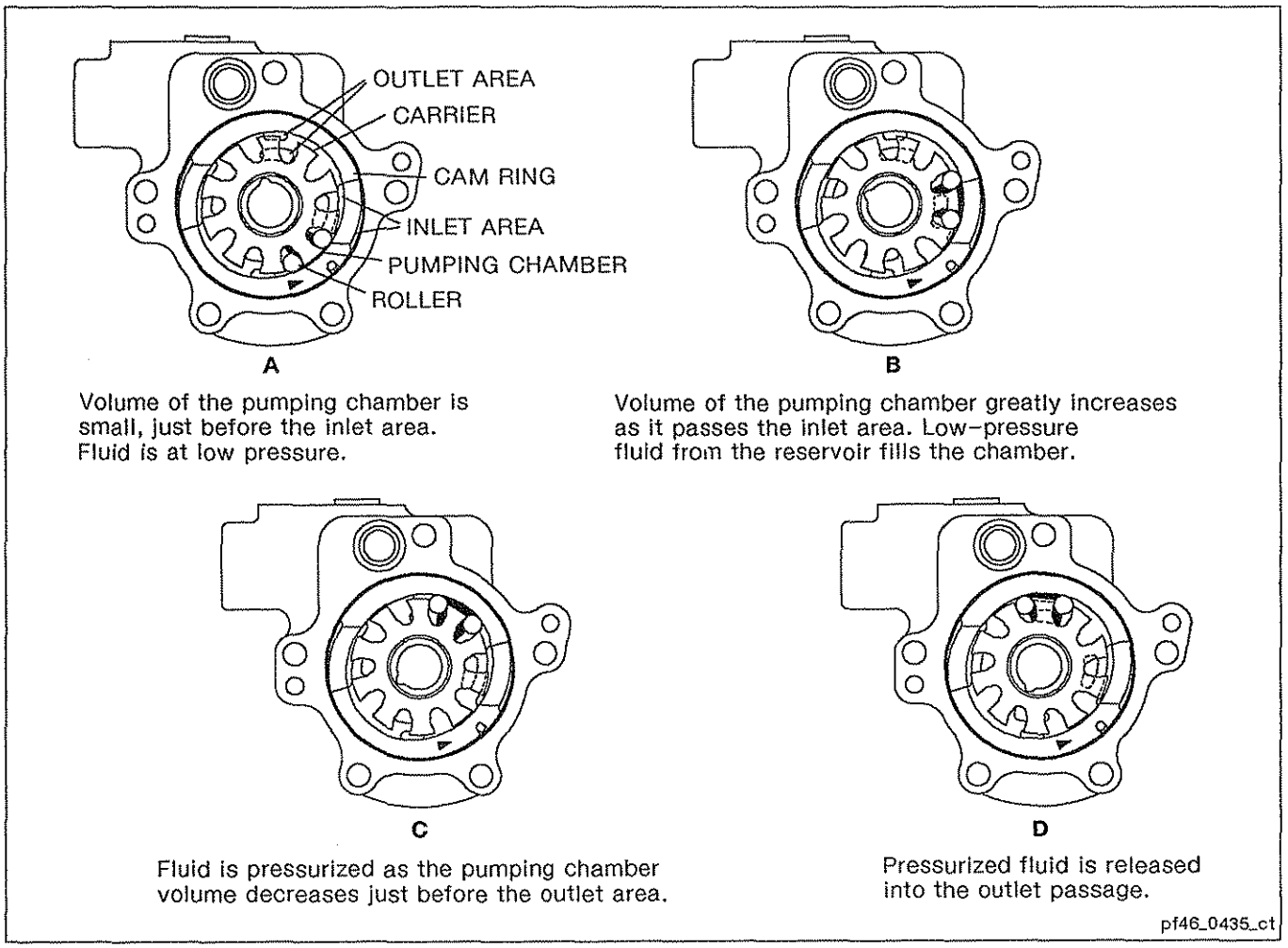

Fig. 4

place, operating the pump at relief valve pressure for more than a few seconds will cause the fluid and pump to overheat.

Whenever the vehicle wheels are turned against either axle stop, an unloading (poppet/relief) valve in one end or the other of the steering gear will automatically reduce load pressure by allowing fluid to return to the reservoir. If not for the unloading valves, the pump would operate at relief valve pressure, and overheating would occur.

SERVICE OPERATIONS

PRE-SERVICE CHECKS

This subject is intended to help locate causes of problems that affect the power steering system, but may or may not originate in it. Before servicing the power steering system, do the following pre-service checks. After servicing the power steering system, do the checks under "Post-Service Checks."

When steering problems exist, first inspect the vehicle for roadworthiness. Then, if necessary, verify the steering problem by test driving the

EATON POWER STEERING PUMP

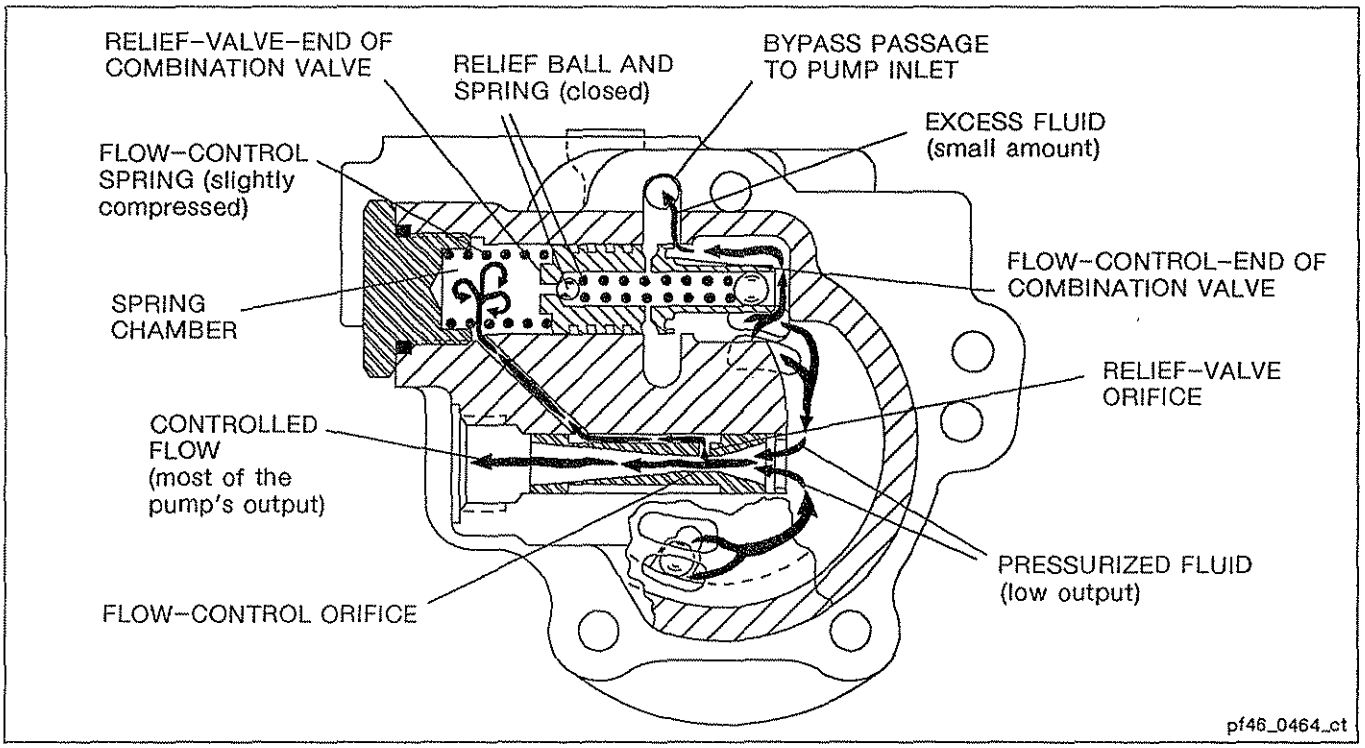

Fig. 5, Conditions During Low-Speed Pump Operation

vehicle, or taking a ride with the driver. If the problem occurs only when the vehicle is loaded, make the test drive with the vehicle loaded.

Once the problem is verified, check the simple possibilities before moving on to the more complicated ones. The following checks should be made whenever steering problems occur.

1. If the steering problem occurs only when the vehicle is loaded, make sure the fifth wheel plate is lubricated. For instructions, refer to the vehicle driver's manual.

2. Make sure the power steering reservoir is filled to the correct level, and the filter isn't clogged. For fluid level checking and filter changing instructions, refer to the steering section in the vehicle maintenance manual.

3. Check the front tires for proper inflation, irregular wear, or mismatched tires. Check the front wheels for loose wheel nuts, damage, an out-of-round condition, and lateral runout. For instructions, refer elsewhere in this manual.

4. Check the steering gear mounting bolts for tightness. For torque values, refer to the steering section in the vehicle maintenance manual.

5. Make sure the steering linkage and steering driveline U-joints are lubricated. The steering linkage includes the tie rod, tie-rod ends, knuckle bearings, knuckle bushings, drag link, and other components that carry movement of the pitman arm to the steering knuckles. For lubrication instructions, refer to the steering section in the vehicle maintenance manual.

   Check the steering linkage, ball joints, and kingpins for loose, damaged, or worn parts. The wheels must turn smoothly from stop to stop. For inspection and service procedures, refer elsewhere in this group and to the front axle manufacturer's service manual.

EATON POWER STEERING PUMP

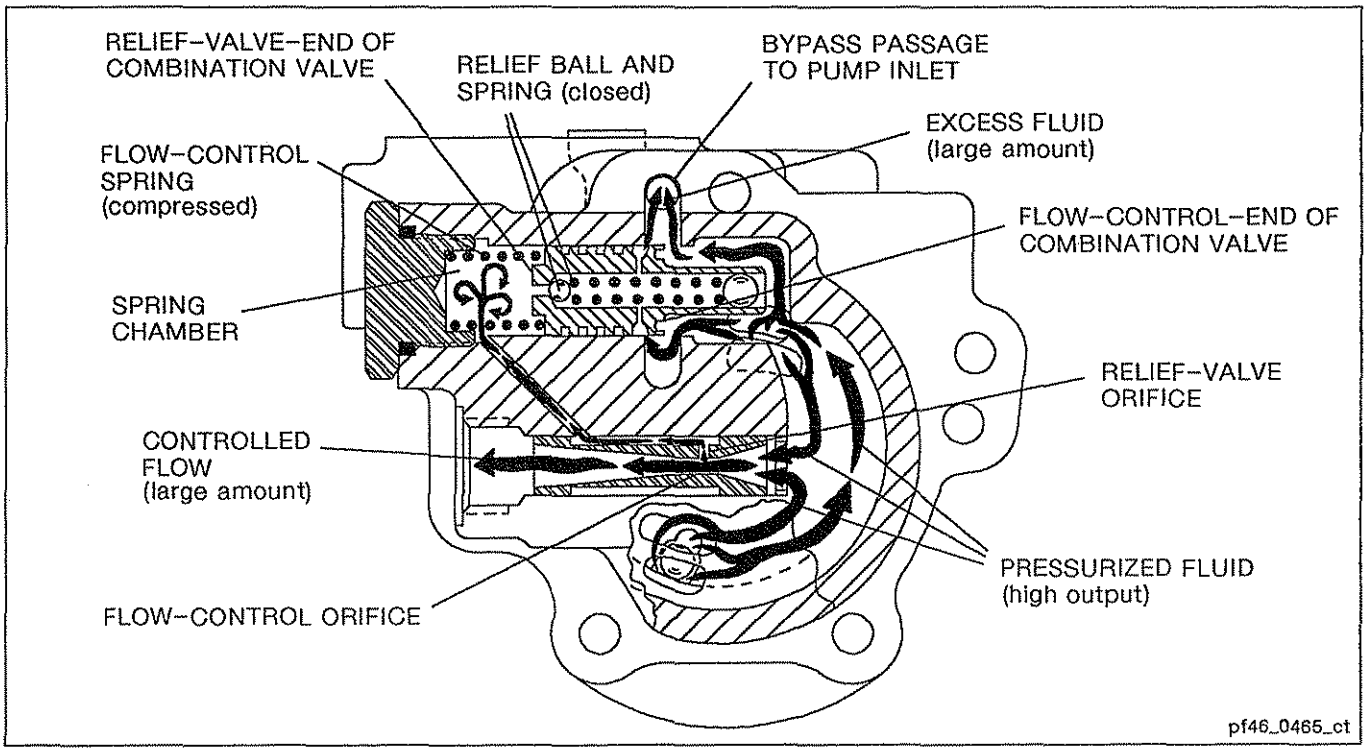

Fig. 6, Conditions During High–Speed Pump Operation

Inspect the steering driveline and steering column for worn or damaged parts. For service instructions, refer elsewhere in this group.

6. Inspect the front axle suspension for worn or damaged parts, using instructions in the suspension section in this manual.

7. Make sure all steering system hoses that may have been replaced are not misrouted, restricted, or too small in inside diameter. Replace any hoses that are worn or that don't have the same inside diameter as original equipment. Reroute any hose that is kinked or sharply bent. Refer to "Specifications, 400" for the minimum bend radius of each hose.

8. Place a thermometer in the steering reservoir. Warm the fluid in the steering system to the normal operating temperature of 125° to 135°F (51° to 57°C), by operating the engine at low idle, while turning the steering wheel through several full left and right turns.

   With the engine running and the steering system at operating temperature, turn the steering wheel slowly from stop to stop, while checking the reservoir for frothing or a change in fluid level (an indication that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace hoses or tighten loose fittings as needed.

9. Check front axle wheel alignment, including turning angles, wheel bearing adjustment, caster and camber angles, and toe-in, using instructions in the front axle section in this manual.

10. Check rear axle alignment, using instructions in the rear axle section in this manual. Rear axle misalignment can cause hard or erratic steering.

EATON POWER STEERING PUMP

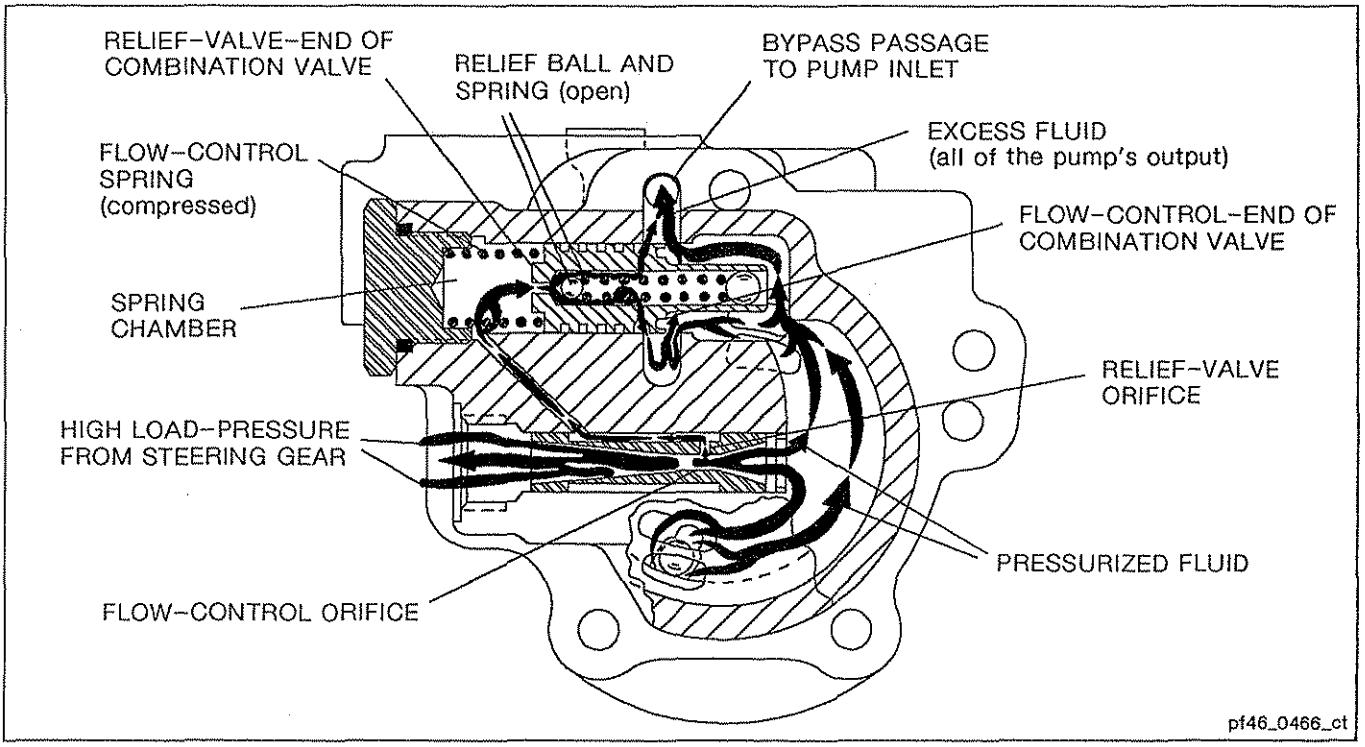

Fig. 7, Conditions When Load–Pressure Builds to Relief–Valve Pressure

After completing all the above steps, if there are still problems with the power steering system, perform the tests under "Steering System Hydraulic Tests."

NOTE: For further information regarding diagnosis of possible causes of power steering problems, refer to "Troubleshooting" in this section and in the power steering gear section elsewhere in this group.

PUMP REMOVAL AND INSTALLATION

Removal (Refer to **Fig. 8**)

1. Remove all dirt from fittings and hose connections at the steering gear, steering pump, and reservoir.
2. From the elbow fitting on the pump, disconnect the fluid pressure line between the gear and the pump. Plug the line and cap the fitting.
3. At the reservoir, disconnect the pump supply hose. Drain the steering fluid from the reservoir and supply hose. After draining, connect the hose to the reservoir, and tighten the hose clamp.
4. Disconnect the supply hose at the pump inlet tube. Plug or cap the hose.
5. Remove the fasteners that attach the pump flange to the engine, and remove the pump.
6. Remove and discard the flange-to-engine gasket, if so equipped. If needed, scrape the gasket and sealant from the sealing surface on the engine; use care not to damage the sealing surface.
7. Tip the pump to drain the fluid from the inlet tube, while turning the pump shaft to remove fluid from internal cavities.

EATON POWER STEERING PUMP

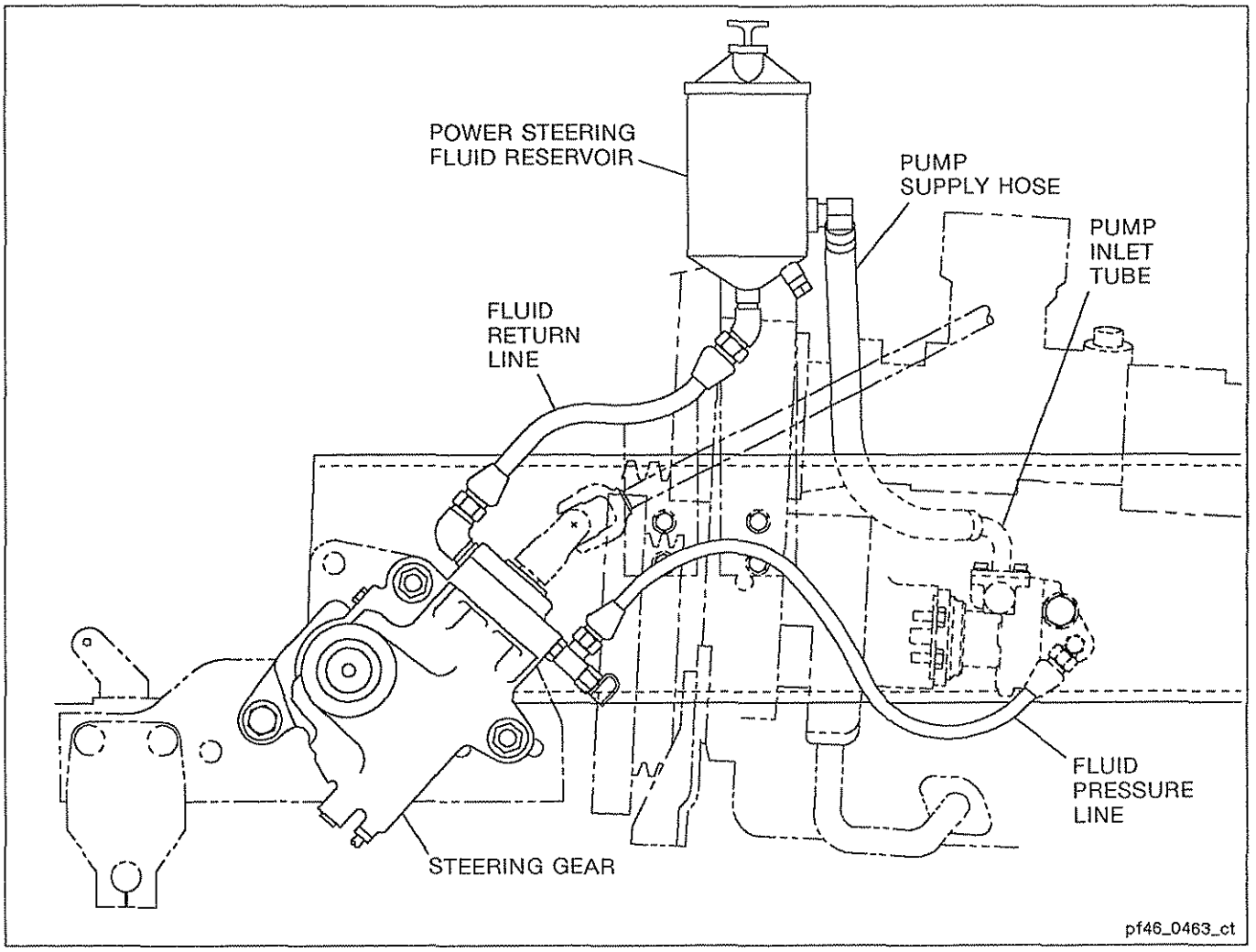

Fig. 8, Power Steering System (NTC/120 Conventional installation shown)

8. *If* the pump will be replaced or disassembled, do the following:

   .1 Clamp the edges of the pump mounting flange in a soft-jawed vise (don't clamp on the sealing surface or pilot of the flange, and don't clamp on the pump body or pump cover).

   .2 Remove the elbow from the pressure line port, and plug the port. From the elbow, remove and discard the O-ring. Save the elbow for later installation.

Installation

Caterpillar 3176 (Refer to **Fig. 9**)

1. If needed, loosen the bolts that attach the inlet tube assembly to the pump, and turn the tube until it points in the direction shown in **Fig. 10**. Tighten the bolts 100 lbf·in (1120 N·cm).

2. At the back of the timing gear plate, inspect the internal splines in the steering pump drive gear sleeve. Replace the sleeve if any splines are worn or damaged. Check

EATON POWER STEERING PUMP

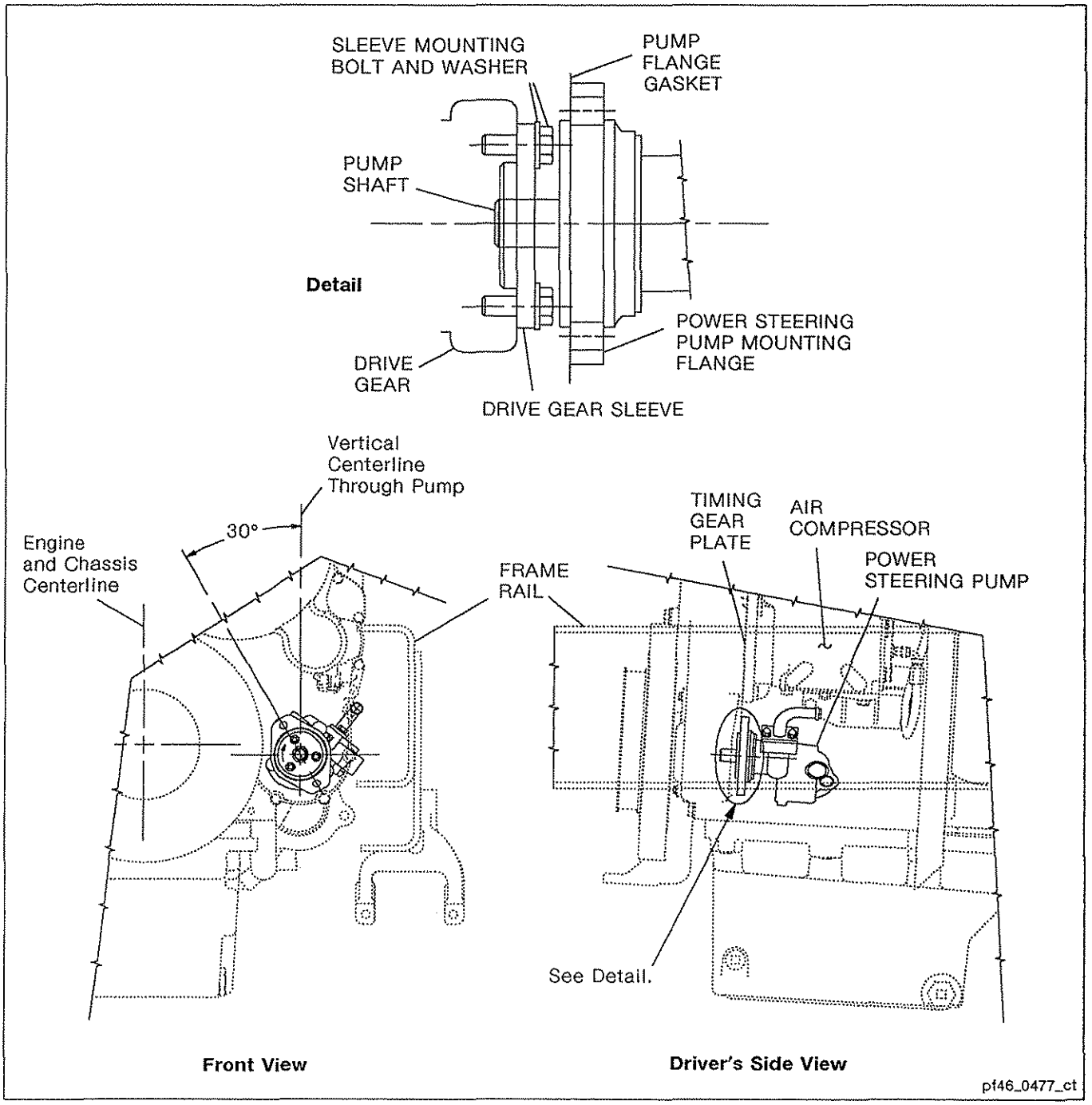

Fig. 9, Caterpillar 3176 Steering Pump Installation

EATON POWER STEERING PUMP

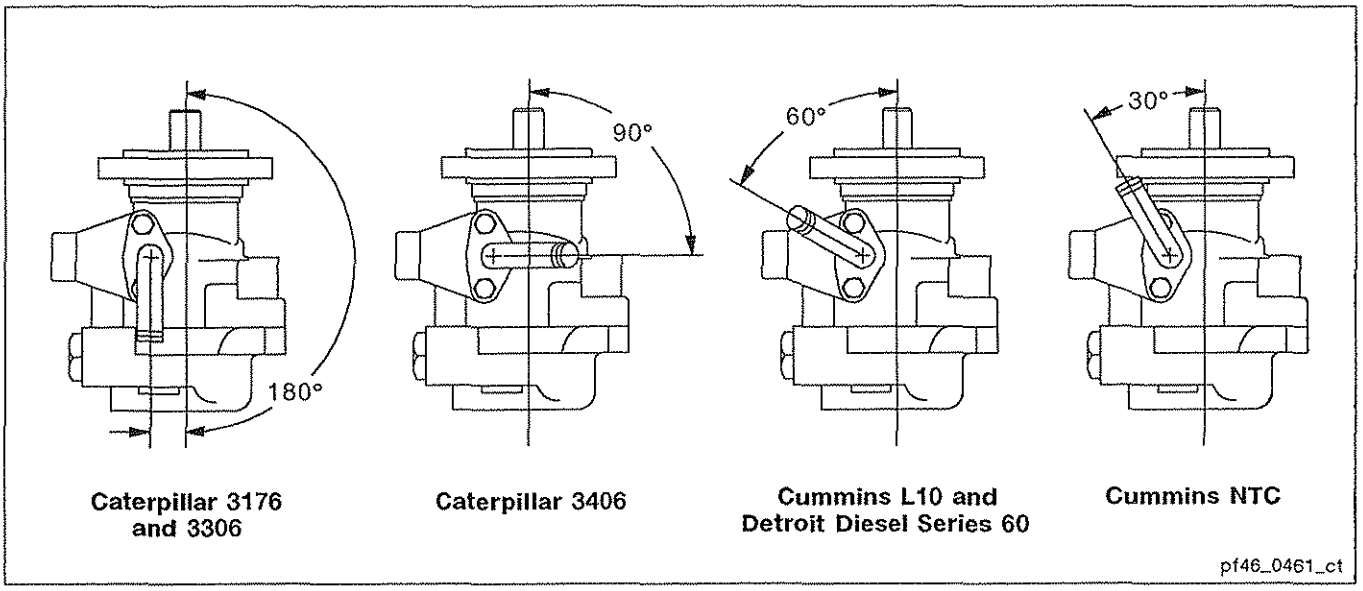

Fig. 10, Pump Inlet Tube Orientation

the sleeve mounting bolts for tightness, and tighten them if needed.

3. Using clean engine oil, *lightly* lubricate the pump shaft and flange pilot for ease of installation.
4. Install a new gasket on the pump mounting flange, then install the pump on the timing gear plate, as shown in **Fig. 9**. Turn the pump shaft as needed to mesh it with the drive gear sleeve. Seat the pilot of the pump flange in the timing gear plate without applying unnecessary force.
5. Install and tighten the pump mounting fasteners.
6. Go to "Filling and Bleeding the Power Steering System."

Caterpillar 3306 (Refer to **Fig. 11**)

1. If needed, loosen the bolts that attach the inlet tube assembly to the pump, and turn the tube until it points in the direction shown in **Fig. 10**. Tighten the bolts 100 lbf·in (1120 N·cm).
2. Install a new O-ring seal on the pump mounting flange pilot. Using clean engine oil, *lightly* lubricate the pump drive gear, flange pilot O-ring seal, and flange pilot for ease of installation.
3. Install the pump on the timing gear plate, as shown in **Fig. 11**. Turn the pump or drive gear as needed to mesh the drive gear teeth with the camshaft gear teeth. Seat the pilot of the pump flange in the timing gear plate, being careful not to pinch the flange pilot O-ring seal.
4. Install the 5/8–11 hexhead mounting bolts, and tighten them 160 lbf·ft (215 N·m).
5. Go to "Filling and Bleeding the Power Steering System."

Caterpillar 3406 (Refer to **Fig. 12**)

1. If needed, loosen the bolts that attach the inlet tube assembly to the pump, and turn the tube until it points in the direction shown in **Fig. 10**. Tighten the bolts 100 lbf·in (1120 N·cm).

EATON POWER STEERING PUMP

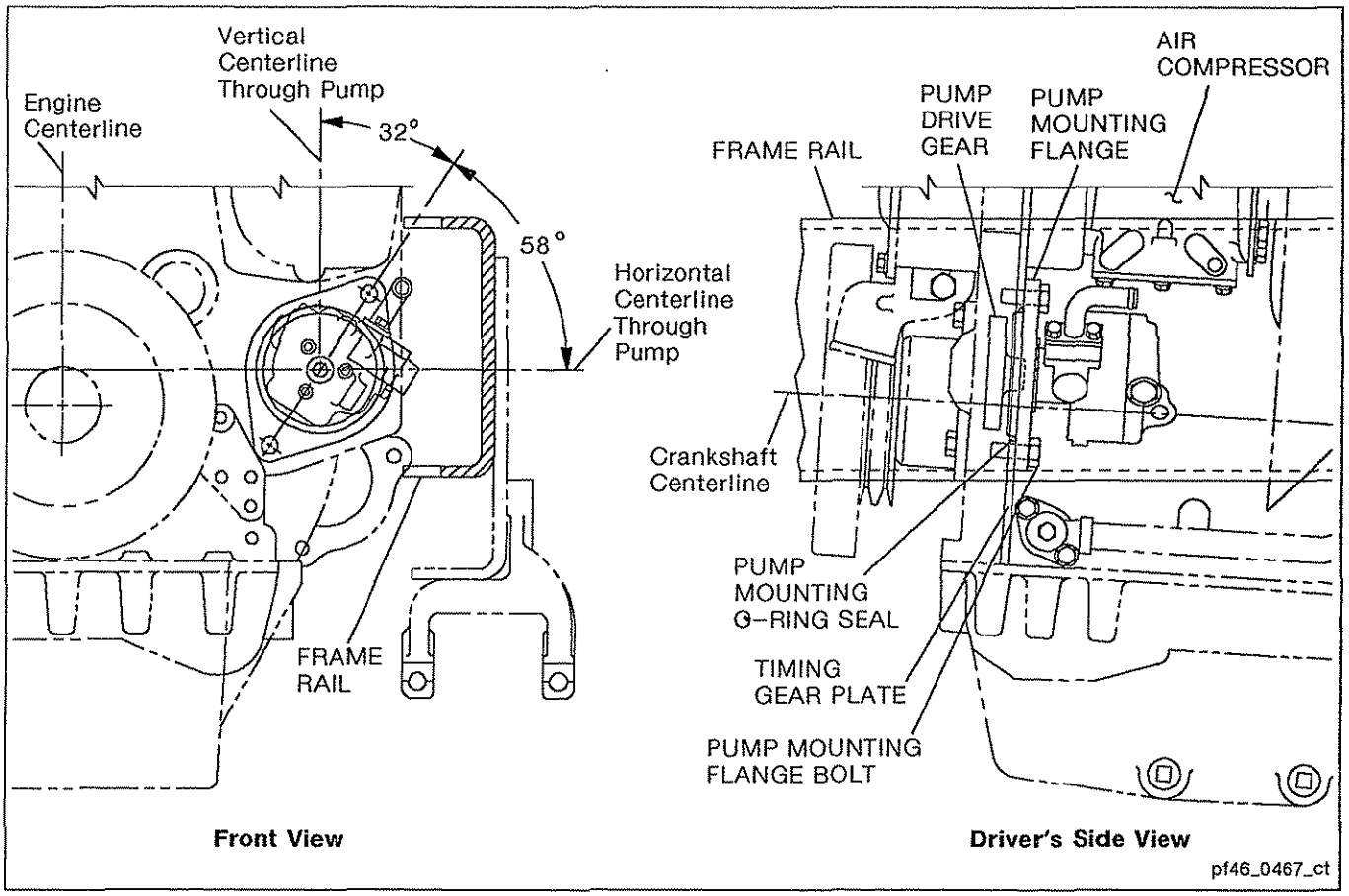

Fig. 11, Caterpillar 3306 Steering Pump Installation

2. At the front of the engine timing gear cover, inspect the internal splines in the steering pump drive gear sleeve. Replace the sleeve if the splines are worn or damaged. Check the sleeve mounting bolts for tightness, and tighten them if needed.

3. Using clean engine oil, *lightly* lubricate the pump shaft and flange pilot for ease of installation.

4. Install a new gasket on the pump mounting flange, then install the pump on the engine timing gear cover, as shown in **Fig. 12.** Turn the pump shaft as needed to mesh it with the drive gear sleeve. Seat the pilot of the pump flange in the timing gear cover without applying unnecessary force.

5. Apply Loctite® 242 to the steering pump mounting studs. Install the 3/8–16 mounting nuts, and tighten them 35 lbf·ft (50 N·m).

6. Go to "Filling and Bleeding the Power Steering System."

Cummins L10 (Refer to **Fig. 13**)

1. If needed, loosen the bolts that attach the inlet tube assembly to the pump, and turn the tube until it points in the direction shown in **Fig. 10.** Tighten the bolts 100 lbf·in (1120 N·cm).

2. Using clean engine oil, *lightly* lubricate the pump shaft and flange pilot for ease of installation.

EATON POWER STEERING PUMP

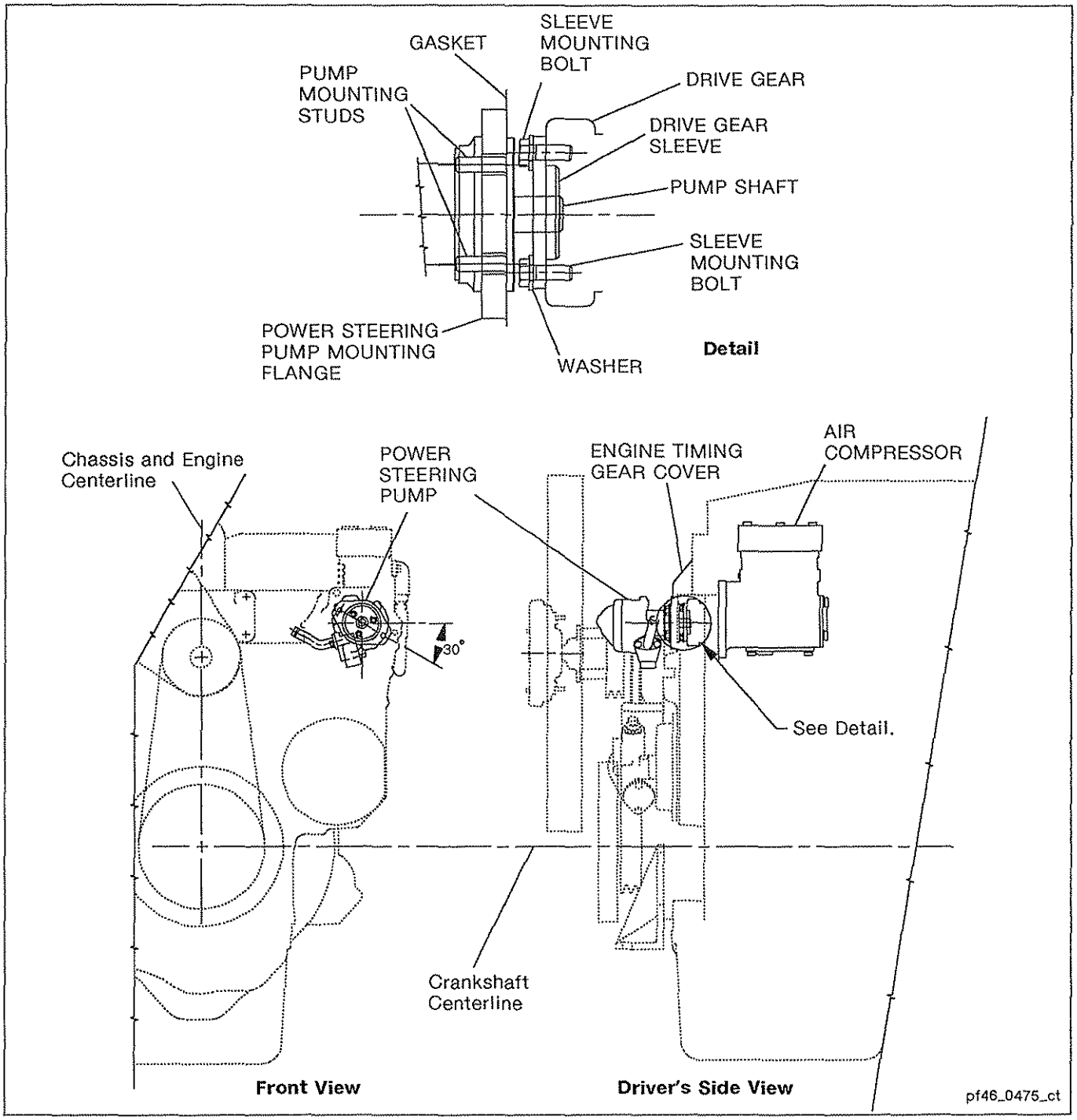

Fig. 12, Caterpillar 3406 Steering Pump Installation

EATON POWER STEERING PUMP

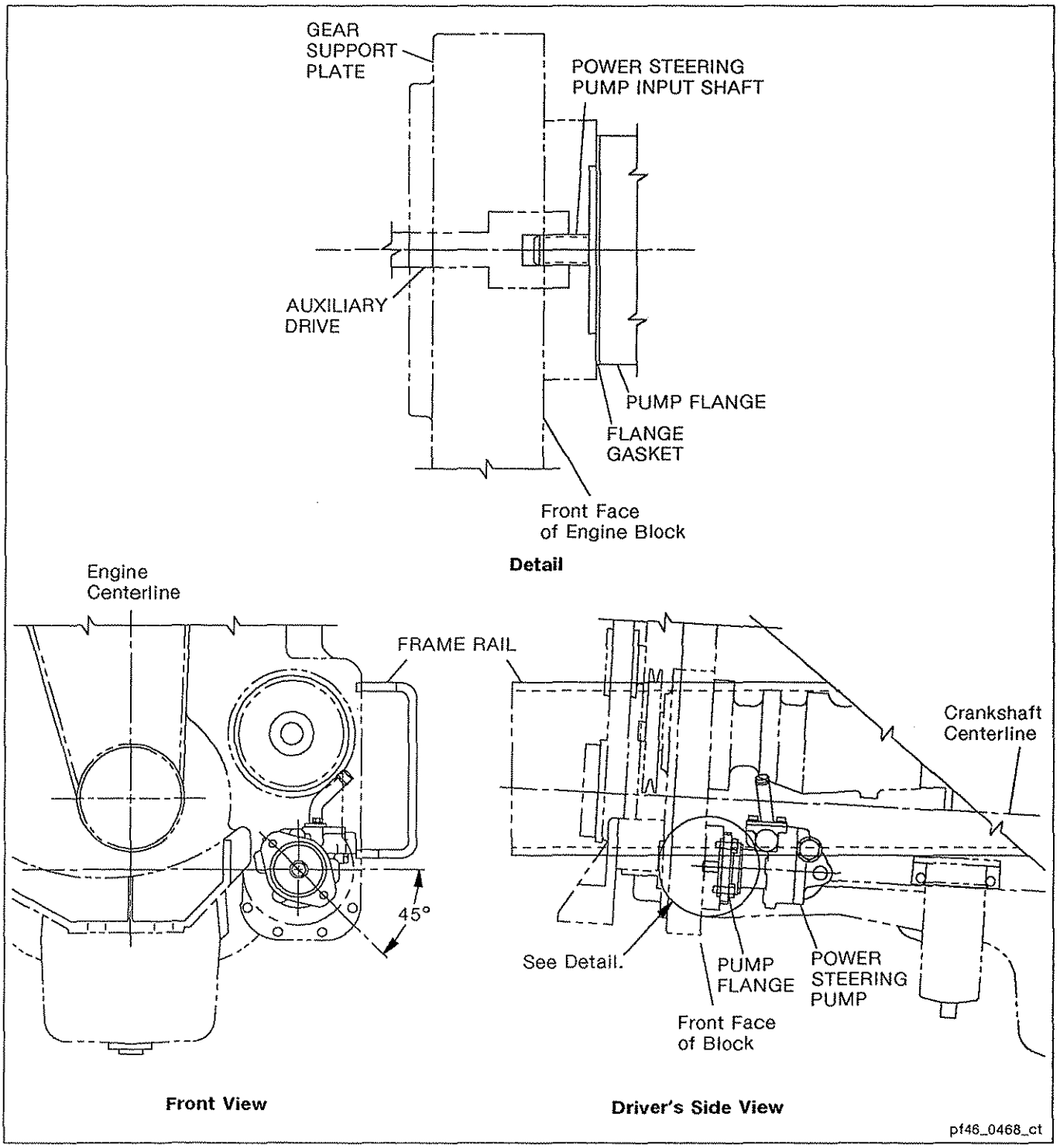

Fig. 13, Cummins L10 Steering Pump Installation

EATON POWER STEERING PUMP

3. Install a new gasket on the pump mounting flange, then install the pump on the engine accessory drive cover, as shown in **Fig. 13.** Turn the pump or shaft as needed to mesh the shaft splines with the splines in the auxiliary drive. Seat the pilot of the pump flange in the accessory drive cover without applying unnecessary force.

4. Install the M10 mounting bolts, and tighten them 35 lbf·ft (50 N·m).

5. Go to "Filling and Bleeding the Power Steering System."

Cummins NTC (Refer to **Fig. 14**)

1. If needed, loosen the bolts that attach the inlet tube assembly to the pump, and turn the tube until it points in the direction shown in **Fig. 10.** Tighten the bolts 100 lbf·in (1120 N·cm).

2. Remove the shaft coupling from the engine's lubricating oil pump shaft. Inspect its internal splines, and replace it if its splines are worn or damaged.

   Inspect the coupling clip for damage and for correct seating in the groove inside the center of the coupling. Seat it if needed, or replace it if damaged.

   Install the coupling on the lubricating oil pump shaft.

3. Using clean engine oil, *lightly* lubricate the pump shaft and flange pilot for ease of installation.

4. Install a new gasket on the pump mounting flange, then install the pump on the lubricating oil pump cover, as shown in **Fig. 14.** Turn the pump or shaft as needed to mesh the shaft splines with the shaft coupling. Seat the pilot of the pump flange in the lubricating oil pump cover without applying unnecessary force.

5. Install the 3/8–16 mounting bolts, and tighten them 35 lbf·ft (50 N·m).

6. Go to "Filling and Bleeding the Power Steering System."

Detroit Diesel Series 60 (Refer to **Fig. 15**)

1. If needed, loosen the bolts that attach the inlet tube assembly to the pump, and turn the tube until it points in the direction shown in **Fig. 10.** Tighten the bolts 100 lbf·in (1120 N·cm).

2. Remove the pump coupling from the engine's power steering drive gear. Inspect its internal and external splines, and replace it if its splines are worn or damaged. Install the coupling in the drive gear.

3. Install a new O-ring seal in the groove of the pump mounting flange pilot.

4. Using clean engine oil, *lightly* lubricate the sprocket and the flange pilot O-ring seal and pilot for ease of installation.

5. Install the pump on the timing gear cover, as shown in **Fig. 15.** Turn the pump or sprocket as needed to mesh the sprocket splines with the pump coupling splines. Seat the pilot of the pump flange in the timing gear cover, being careful not to pinch the flange pilot O-ring seal.

6. Install the six M8 x 20 hexhead bolts and the lockwashers; tighten the bolts 22 lbf·ft (30 N·m), using the torque pattern shown in **Fig. 16.**

7. Go to "Filling and Bleeding the Power Steering System."

FILLING AND BLEEDING THE POWER STEERING SYSTEM (Refer to **Fig. 17**)

IMPORTANT: For steps 1 through 8, don't turn the steering wheel. Doing so can cause air to enter the power steering system, which can make it more difficult and time-consuming to bleed air from the system.

1. Attach the supply hose to the pump inlet tube; tighten the hose clamp.

2. *If* the pump was disassembled and assembled, OR, if a *new* pump is installed, install a new O-ring on the pressure-line port elbow, and install the elbow in the pressure line port. Tighten the elbow 30 lbf·ft (40 N·m), then furthur tighten it to the position that allows easiest installation of the fluid pressure line.

EATON POWER STEERING PUMP

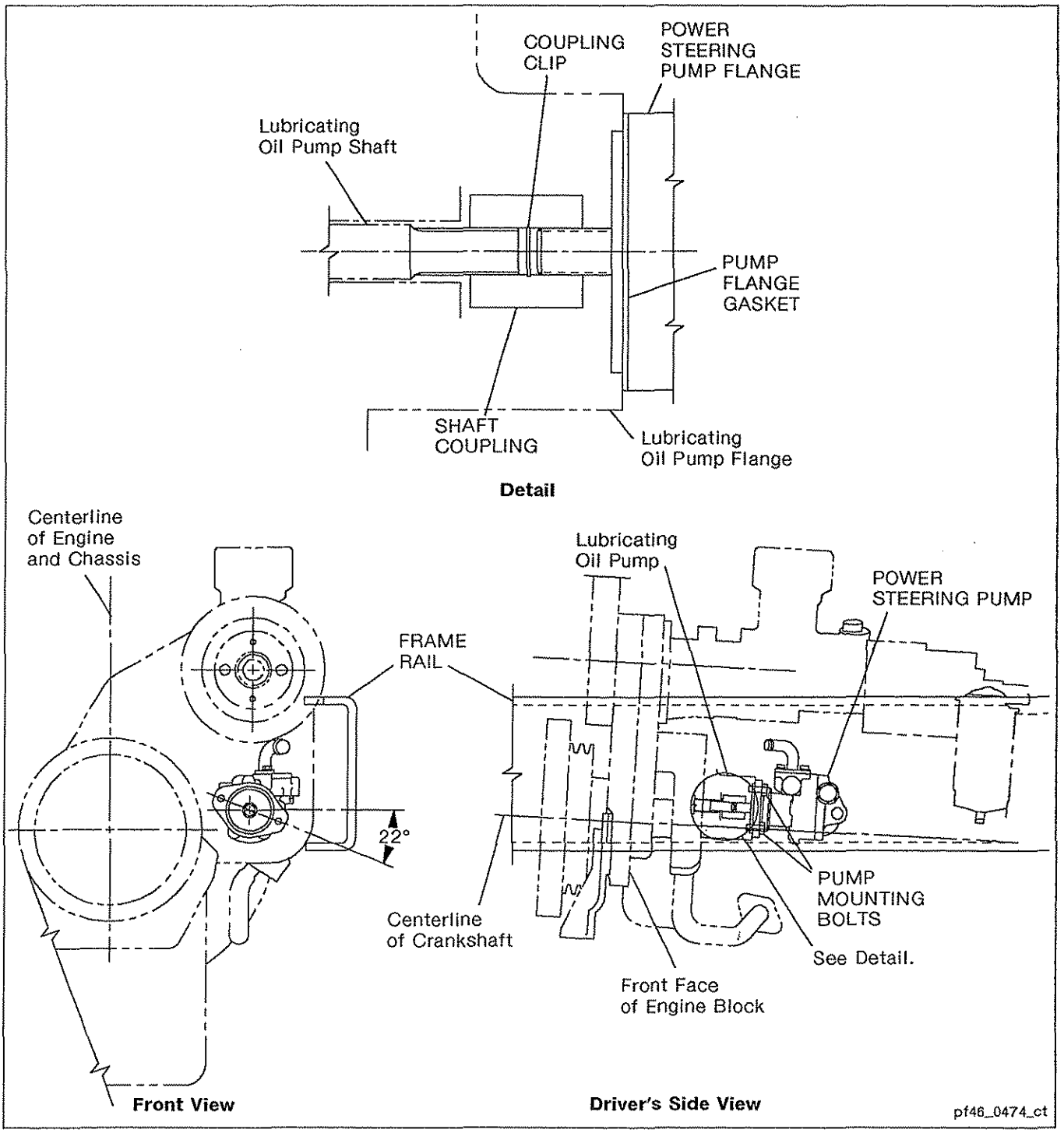

Fig. 14, Cummins NTC Steering Pump Installation

EATON POWER STEERING PUMP

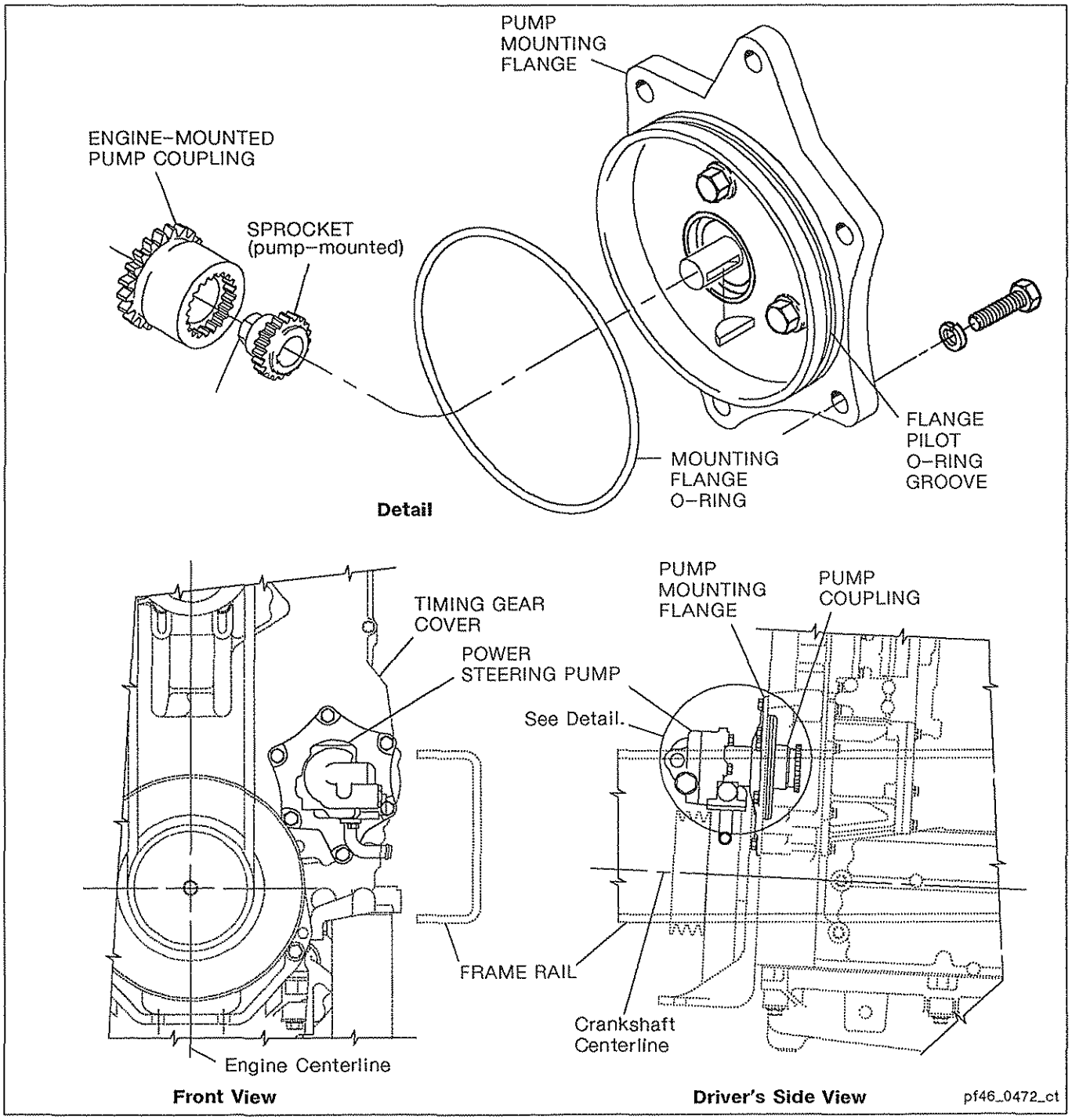

Fig. 15, Detroit Diesel Series 60 Steering Pump Installation

EATON POWER STEERING PUMP

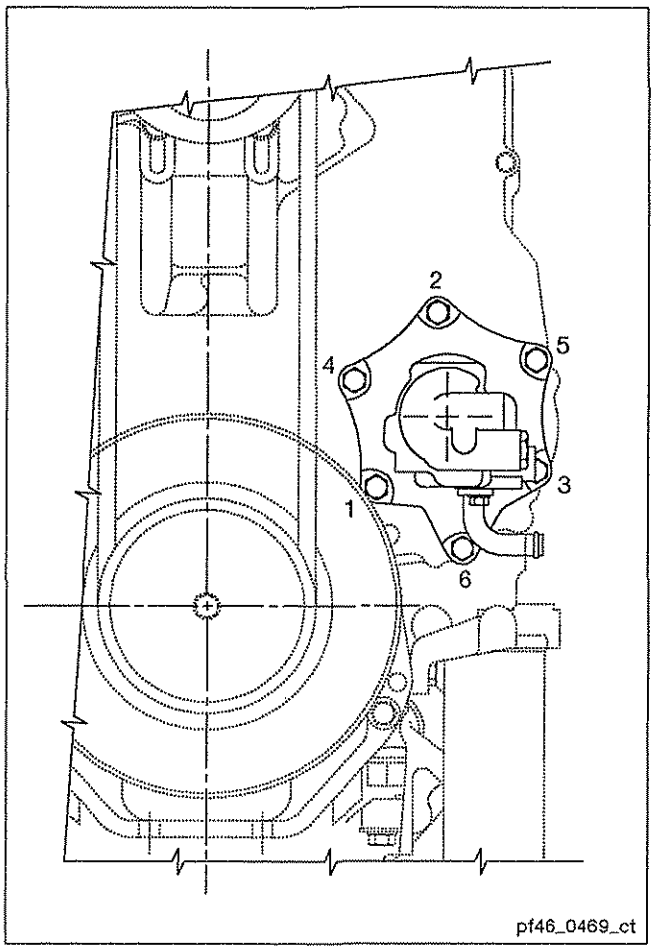

Fig. 16, Detroit Diesel Series 60 Pump Mounting Bolt Torque Pattern

3. Connect the pressure line to the pump pressure-line port elbow. Tighten the fitting nut finger-tight. Use a wrench to tighten it until resistance is felt, then tighten it one-sixth turn more.

4. Install a new filter in the power steering reservoir. Fill the reservoir nearly full; for specified fluids, refer to the steering section in the vehicle maintenance manual.

5. Disconnect the fluid pressure line from the power steering gear, and place the end of it in a container of at least 2 quart (2 L) capacity. Cap the steering gear fitting.

6. Crank the engine for ten seconds without allowing it to start; if it does start, shut it down immediately. Check the reservoir, and fill it as needed; don't allow the reservoir fluid level to drop more than 2 inches (5 cm) below the full mark, or air can enter the system.

   Repeat this step until a stream of fluid is forced from the pressure line, indicating that the pump has primed.

7. Connect the pressure line to the steering gear; tighten the fitting nut as in step 3, above.

8. Start the engine and let it idle for two minutes, without turning the steering wheel. Shut the engine off, and check the reservoir fluid level. Fill the reservoir as needed.

9. Start the engine again. Turn the steering wheel from full-left to full-right several times. Fill the reservoir as needed.

CAUTION: Don't hold the wheel in the full-left or full-right position more than five seconds; overheating of the fluid and pump may occur.

10. Check the system for leaks. As needed, replace leaking hoses and tighten loose fittings, then repeat steps 5 through 9.

DISASSEMBLY, INSPECTION, AND ASSEMBLY

Disassembly (Refer to **Fig. 1**)

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

1. Using a suitable solvent, remove all dirt and oil from the outside of the pump.

2. Clamp the edges of the pump mounting flange in a soft-jawed vise; don't clamp on the sealing surface of the flange, and don't clamp on the pump body or pump cover. See **Fig. 18**. Clamp the pump in a position that will allow loosening of all pump fasteners and the combination-valve cap.

EATON POWER STEERING PUMP

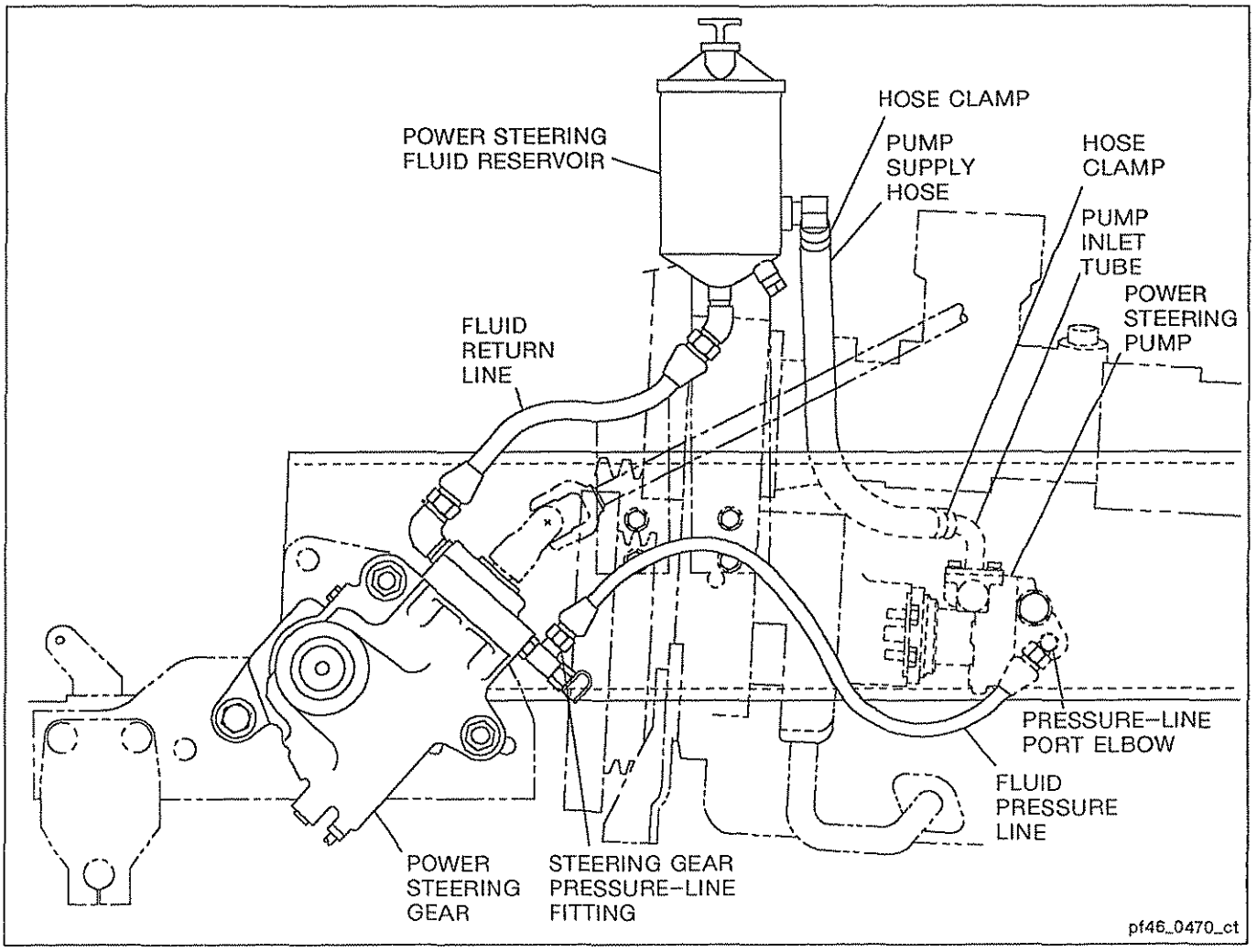

Fig. 17, Power Steering Components and Lines (NTC/120 Conventional installation shown)

3. For a pump used on a Caterpillar 3306 (**Fig. 19**), hold the drive gear to prevent it from turning, and remove the bolt and lockwasher that attach the drive gear to the pump shaft. Remove the drive gear and shaft key. From the pump flange pilot, remove and discard the O-ring seal.

   For a pump used on a Detroit Diesel Series 60 (**Fig. 20**), hold the sprocket to prevent it from turning, and remove the bolt, lockwasher, and large flatwasher that attach the sprocket to the pump shaft. Remove the sprocket and shaft key. From the pump flange pilot, remove and discard the O-ring seal.

   For *all* pumps, loosen but don't remove the mounting-flange-to-body bolts, inlet-tube-clamp-to-body bolts, and body-to-cover bolts. Carefully loosen but don't remove the combination-valve cap; it is pushed outward by spring force.

4. Remove the pump from the vise. Remove the three allen-head bolts and lockwashers, or hexhead bolts, that attach the mounting flange to the pump body. Remove the

EATON POWER STEERING PUMP

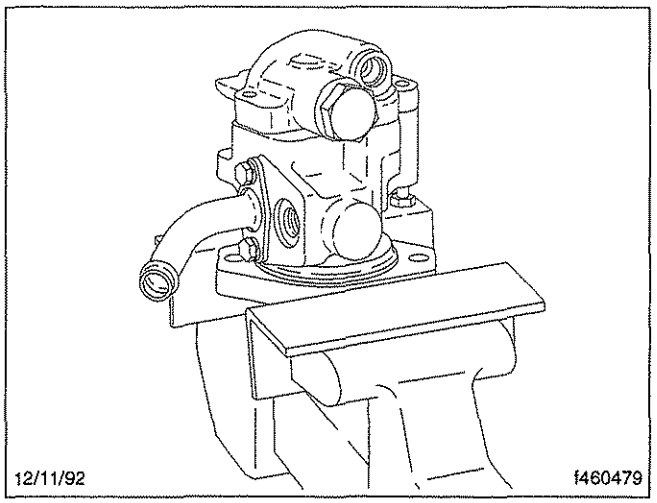

Fig. 18

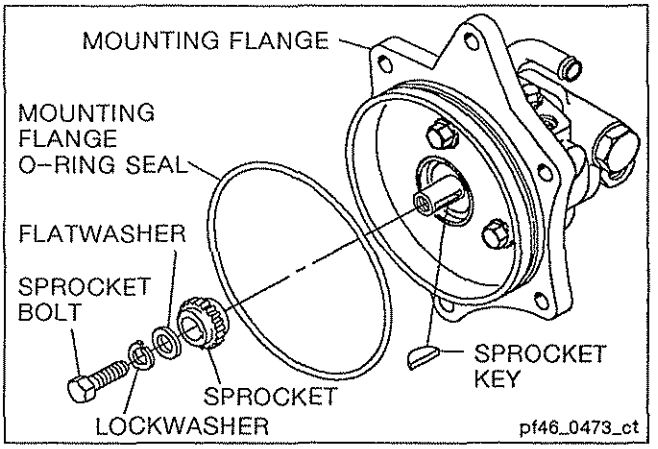

Fig. 20

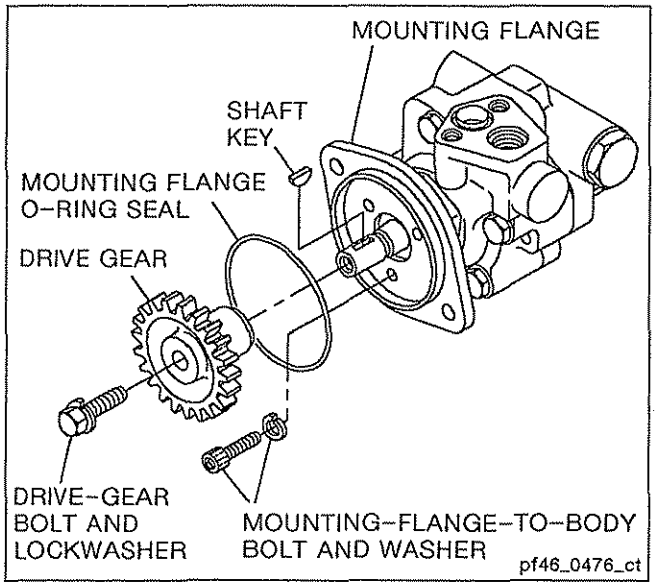

Fig. 19

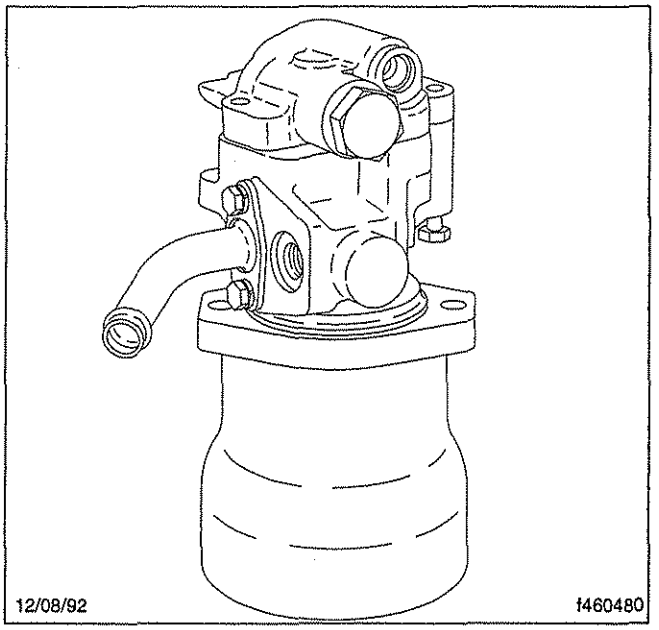

Fig. 21

flange, and remove and discard the flange gasket. If needed, scrape the gasket sealing surfaces on the flange and the pump; use care not to damage the sealing surfaces.

5. Use a suitable block, either with or without the previously removed flange loosely piloted onto the pump shaft, to steady the pump for continued disassembly. See **Fig. 21**.
6. Remove the bolts and washers that attach the inlet tube clamp to the pump body. Remove the inlet tube and tube clamp as an assembly, then remove the inlet tube gasket. See **Fig. 22**.
7. From the pump cover, carefully remove the combination-valve cap; it is pushed outward by spring force. See **Fig. 23**. From the cap, remove and discard the O-ring seal.

EATON POWER STEERING PUMP

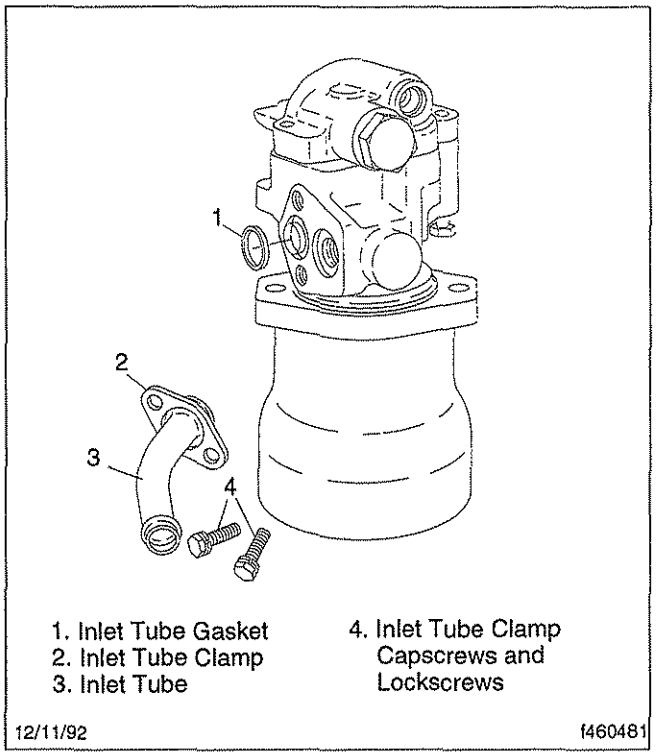

Fig. 22

Remove the valve spring and combination valve by shaking the pump or by gently tapping the pump against a wooden or padded surface. See **Fig. 24**. Don't use metal tools or similar instruments; they could damage the valve or the valve bore.

8. Remove the five bolts that attach the pump cover to the pump body. Carefully remove the cover by pulling it up, while gently tapping it away from the body, using a plastic or rubber mallet. See **Fig. 25**. To disengage the dowel pins and pump shaft, the cover must be lifted straight up from the body. Don't allow any of the internal components to be removed with the cover.

9. For assembly reference, record, or mark on the pump body, the position of the locating pin, and the direction of the cam ring "rotation" arrow. See **Fig. 26**. Use dye or some other semipermanent marker when marking the pump body.

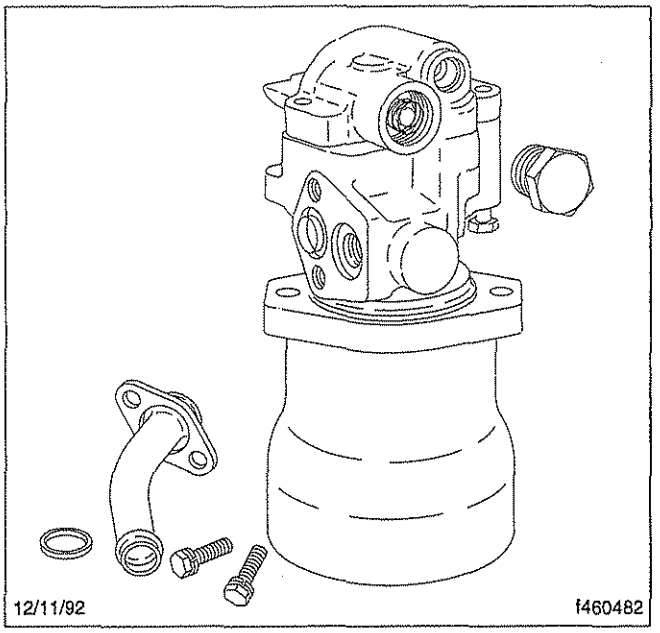

Fig. 23

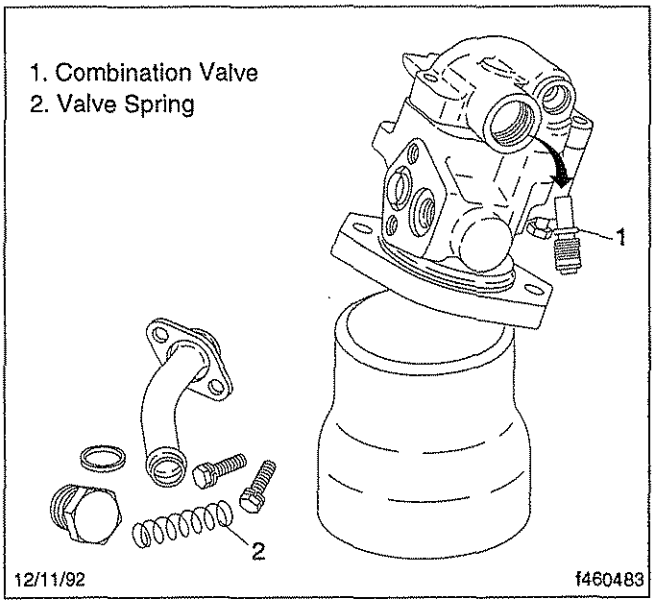

Fig. 24

10. Remove and discard both body-to-cover O-ring seals. See **Fig. 27**.

EATON POWER STEERING PUMP

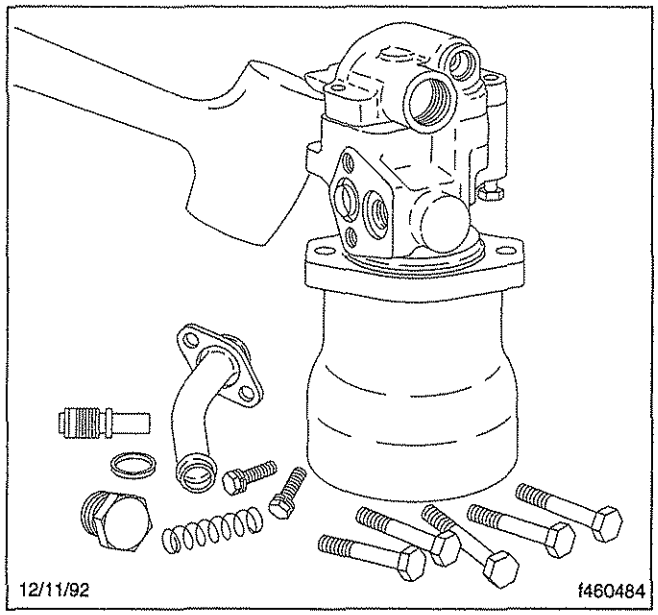

Fig. 25

11. Using a clean magnet, pull the ten rollers out of the carrier. See **Fig. 28.** Don't use pliers or similar tools; they could raise a burr.
12. Lift out the carrier and shaft assembly. See **Fig. 29.** The carrier is held in place on the shaft by snap rings.
13. Remove the cam ring, port plate, end plate, and locating pin. See **Fig. 30.**
14. Remove the end plate seals and O-ring seals from the end plate; *don't* discard them. See **Fig. 31.**
15. Using care not to damage the shaft bushing, use a small-diameter punch from inside the pumping element cavity to drive the pump shaft oil seal out of its bore. See **Fig. 32.** Discard the oil seal.

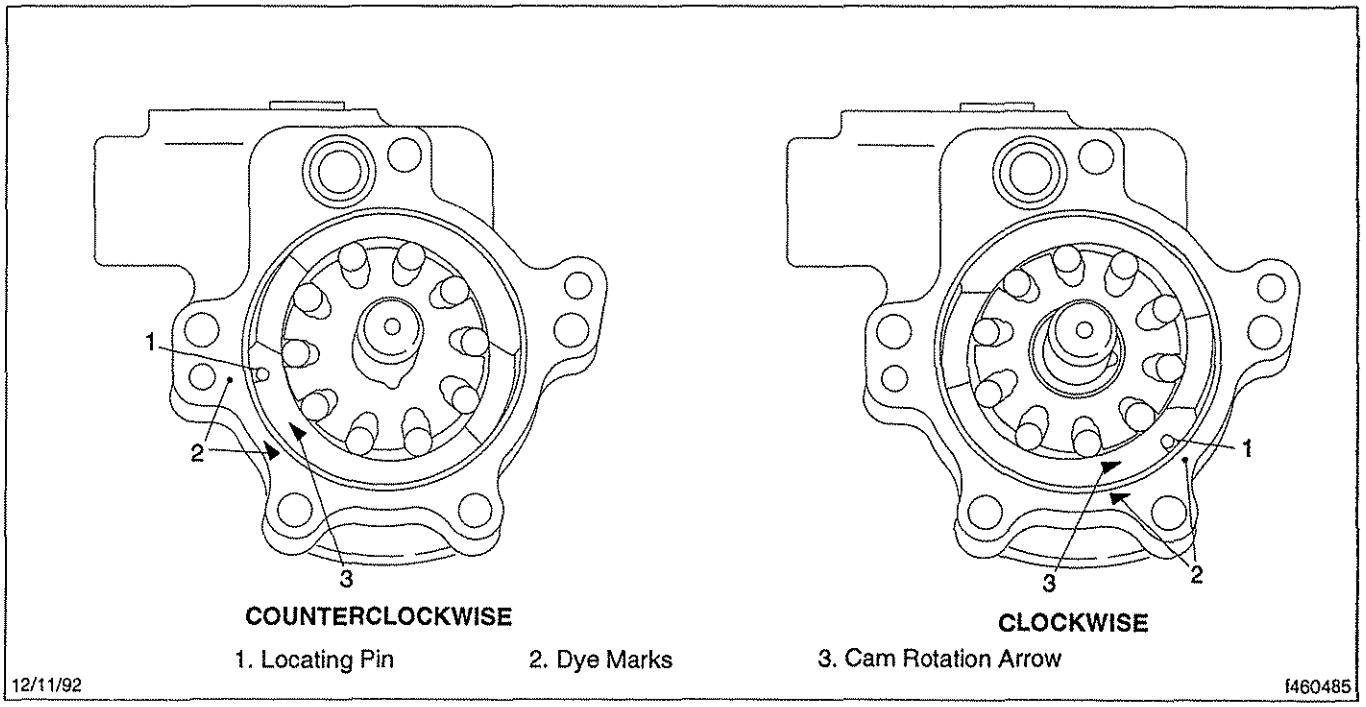

Fig. 26

EATON POWER STEERING PUMP

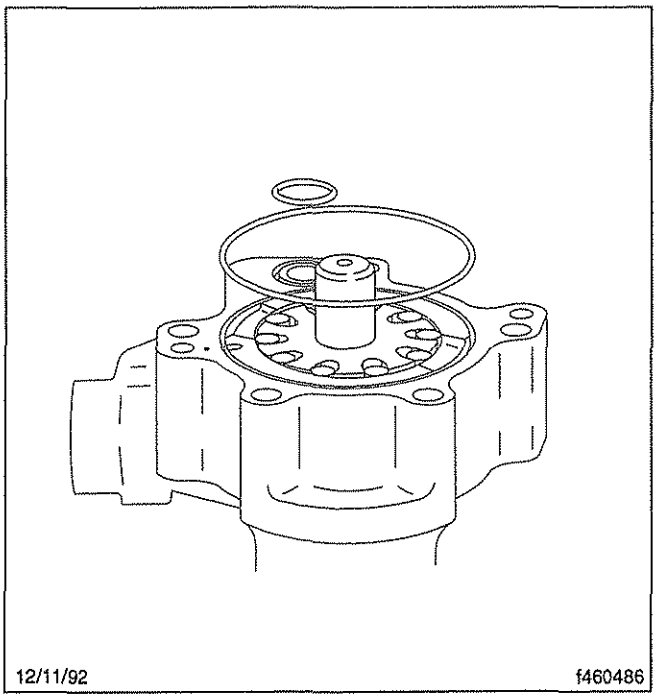

Fig. 27

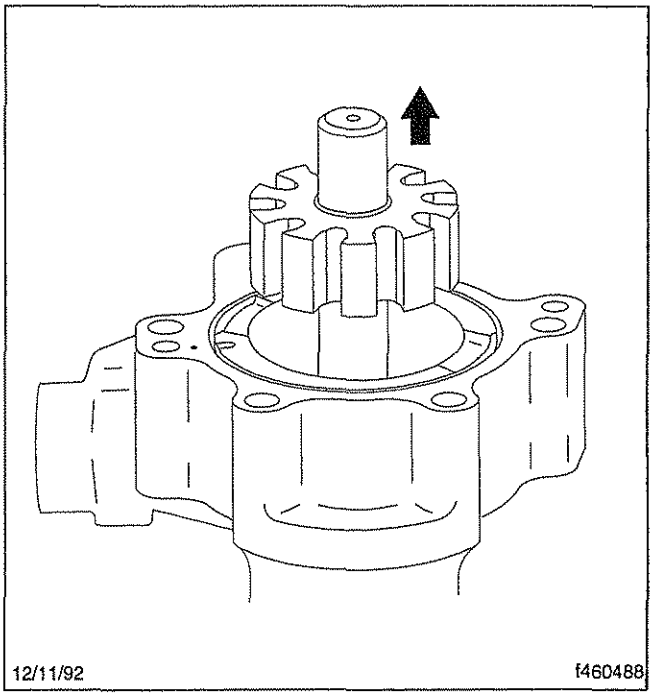

Fig. 29

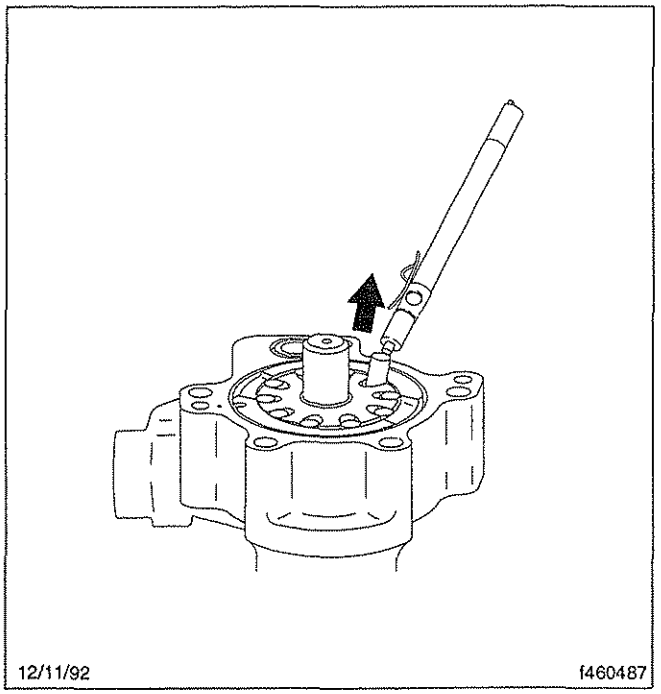

Fig. 28

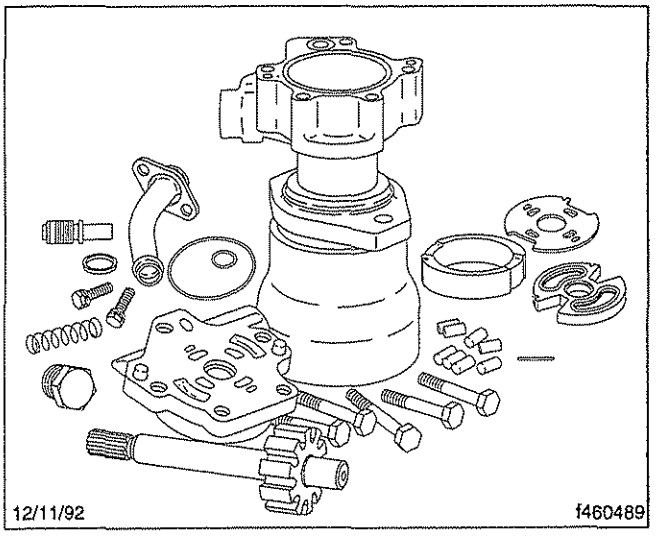

Fig. 30

EATON POWER STEERING PUMP

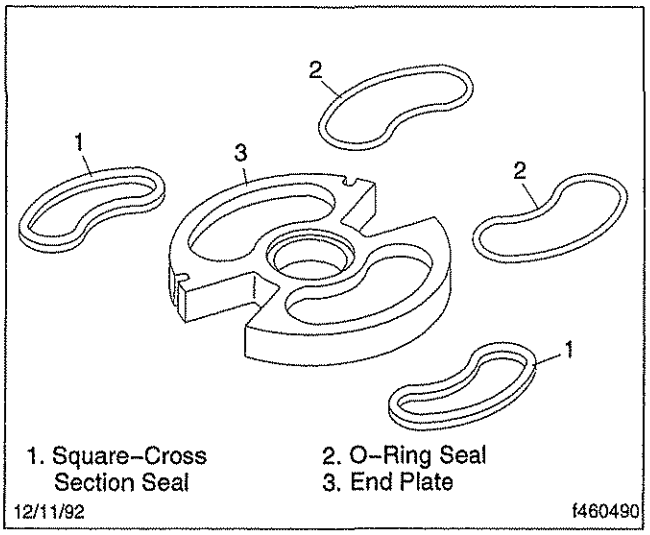

Fig. 31

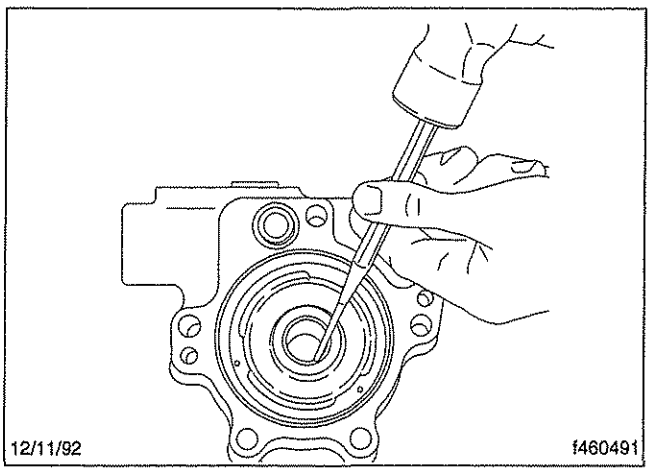

Fig. 32

Inspection

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

1. Wash all components (except seals) in a suitable solvent, then allow them to air-dry.
2. Inspect the pump-body shaft bushing for burning, scoring, and wear. The bushing is not serviceable as a separate part; if the bushing is damaged or worn, replace the pump body.

IMPORTANT: If the pump body is being replaced, and during disassembly it was marked with the position of the locating pin and the direction of the cam ring "rotation" arrow, keep the old pump body for assembly reference, or mark the new body with the same marks in the same locations. See **Fig. 26.**

3. Inspect the pump-cover shaft bushing for burning, scoring, and wear. The bushing is not serviceable as a separate part; if the bushing is damaged or worn, replace the pump cover.

   Inspect the port face of the pump cover for scoring and pitting. Lapping or polishing of the face to remove up to 0.002 inch (0.05 mm) is acceptable, taking care to maintain a flat, polished surface. Clean the ports after refacing. Replace the pump cover if damage is more severe.

4. Inspect the shaft for wear, burning, and scoring in the areas of the bushings, oil seal, and spline drive. If any wear, burning, or scoring is found, replace the shaft during step 9 of "Assembly." Also, replace the pump shaft if either the body bushing or cover bushing is worn to the point that the pump body or pump cover requires replacement.

5. Inspect the carrier on the ends and on the roller drive faces for excessive wear and scoring. If the ends are worn or scored, or if the wear pattern on any roller drive face is greater than 0.06 inch (1.5 mm) in width, replace the carrier during step 9 of "Assembly."

NOTE: The carrier is serviced only as part of a pumping element kit that also includes the rollers, cam ring, and port plate.

If either of the carrier snap rings is bent or broken, replace both of them during step 9 of "Assembly."

EATON POWER STEERING PUMP

6. Inspect the internal surface of the cam ring for wear and scoring. Polish in some areas is normal. If wear is severe enough to raise a noticeable burr on either inside corner of the cam ring face, replace the cam ring. The cam ring is serviced only as part of the pumping element kit.

7. Inspect the ten rollers for pitting, scoring, and wear. If any roller is damaged or worn, replace all the rollers. The rollers are serviced only as part of the pumping element kit.

8. Inspect the port plate for excessive scoring and galling. Because the port plate is flexible, polishing and *minor* scratching of the surface is normal. If scoring or galling is minor, the port plate can be hand-polished; maximum allowable removal of material is 0.0001 inch (0.0025 mm). If wear is more severe, replace the port plate. The port plate is serviced only as part of the pumping element kit.

9. Inspect the end plate for cracks in the areas of the seal cavities. Replace the end plate if cracks are found.

   Inspect the end plate O-ring seals and end plate seals for cracks and excessive swelling. Replace all four seals if any damage is found; install the seals during step 3 of "Assembly."

10. Be sure both the combination valve and the pump-cover valve bore are dry. Insert the valve (long, small-diameter end first) in the cover, and check for free movement in and out of the bore. See **Fig. 33.** The valve must move smoothly in the bore. Use a crocus cloth to remove any burrs from the valve. Minor polishing of the valve outside diameter is acceptable up to 0.0001 inch (0.0025 mm) material removal.

    It is difficult to visually determine if valve components are damaged or worn. If the problem with the pump was "low pressure" or "hard steering," and the pumping element shows no signs of excessive wear, replace the combination valve and valve spring.

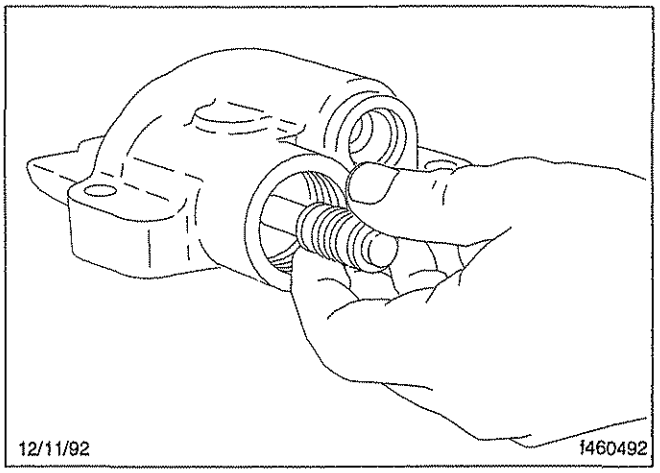

Fig. 33

    If it is necessary to replace the combination valve because of excessive wear, inspect the condition of the pump-cover valve bore; replace the cover if the bore is worn.

11. Inspect the pump inlet tube for cracks and chafing. If the tube is cracked or badly chafed, replace the inlet-tube-and-adapter assembly.

12. For a pump used on a Caterpillar 3306, inspect the external teeth on the drive gear. See **Fig. 19.** Replace the gear if the teeth are damaged or badly worn.

    For a pump used on a Detroit Diesel Series 60, inspect the external teeth on the sprocket. See **Fig. 20.** Replace the sprocket if the teeth are damaged or badly worn.

Assembly (Refer to **Fig. 1**)

1. With the steel cage facing out (**Fig. 34**), install a new pump shaft oil seal in the pump body, using a special seal installation tool, or a length of steel tubing of about the same outer diameter as the seal. See **Fig. 35.** Use caution to avoid caving the oil seal case due to excessive installation pressure; however, the seal must bottom in the bore.

EATON POWER STEERING PUMP

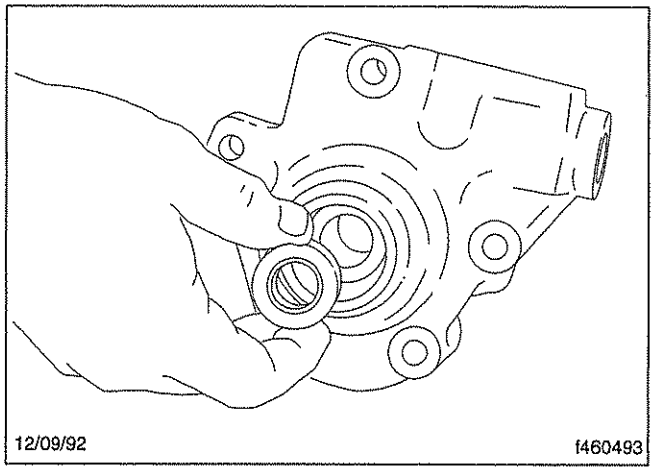

Fig. 34

2. Lubricate the oil seal and pump body bushing with a generous amount of lithium-base grease. See **Fig. 36.**

3. Install an end plate O-ring seal into the bottom of each seal cavity in the end plate, then install an end plate seal over the top of each O-ring seal. See **Fig. 37.** All four seals must fit snug all the way around in the seal cavities; if they don't, replace them.

4. Install the locating pin in the same position that was recorded or marked during disassembly, or refer to **Figs. 38** and **39,** and install the pin as shown. Be sure it is well seated in the hole inside the pump body.

5. Install the end plate in the pump body, with the seals exposed and the plain face down. With one of the locating pin notches of the end plate fitted over the locating pin, the other locating pin notch must be within a few degrees of aligning with the other locating pin hole inside the pump body. See **Fig. 38.**

6. Install the port plate so the locating pin notch aligns with the locating pin, *and* the two large notches align with the large notches in the end plate. See **Fig. 39.** If the large notches don't align, flip the port plate over so the opposite face is exposed.

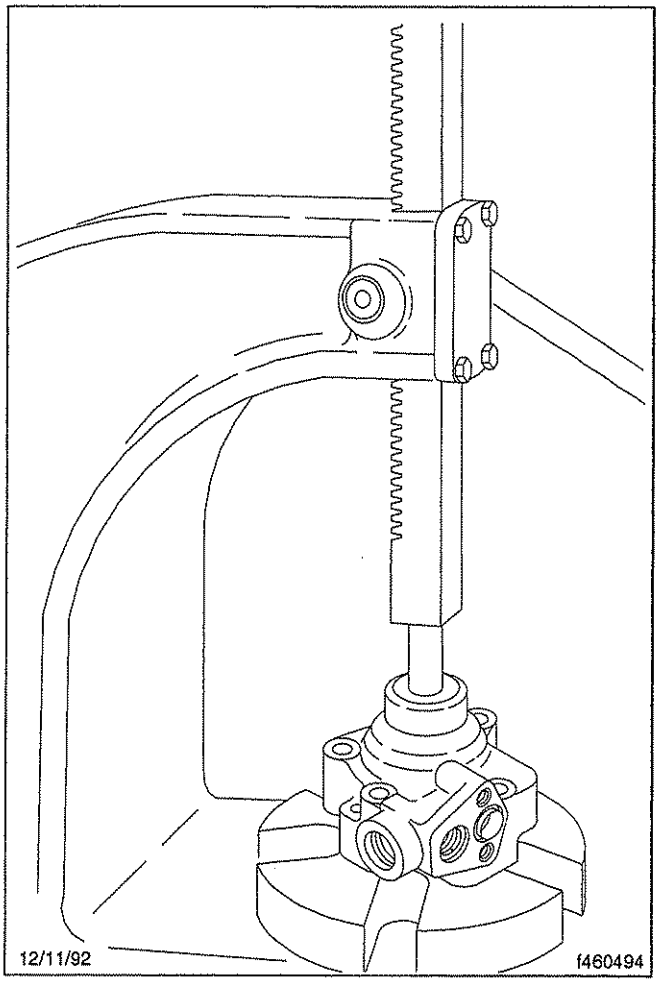

Fig. 35

7. Install the cam ring so the "rotation" arrow is pointing in the same direction as noted or marked during disassembly. With the cam ring locating pin notch aligned with the locating pin, the recesses in the cam ring outer circumference must align with the large notches in the port plate and end plate. See **Fig. 40.**

8. Using a small amount of clean steering system fluid, lubricate the face of the port plate and the internal surface of the cam ring. Don't cover the end of the cam ring with fluid.

EATON POWER STEERING PUMP

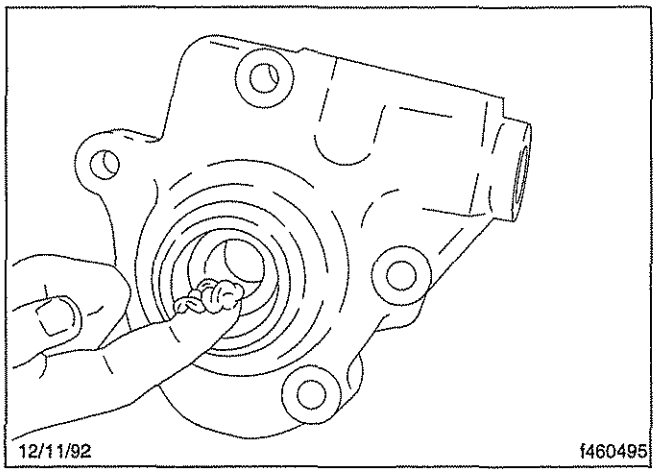

Fig. 36

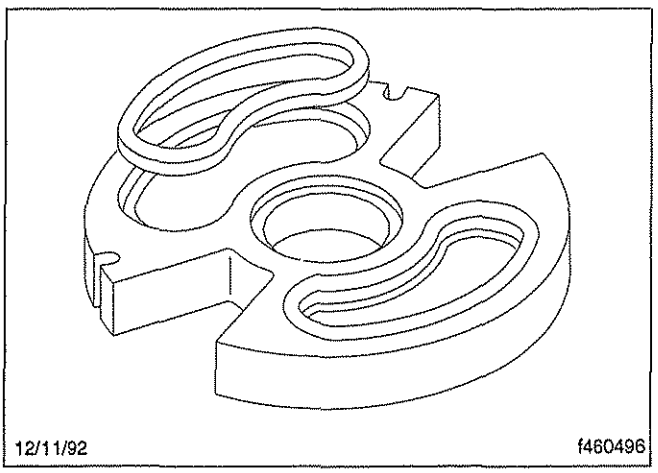

Fig. 37

9. If *none* of the parts of the carrier/shaft assembly need to be replaced, go to step 10.

   If *both the carrier and the shaft* need to be replaced, use the old carrier/shaft assembly as a guide for assembling the new parts. Being careful not to scratch the new shaft, install a new snap ring in the groove that's close to its center. See **Fig. 41.** Install a new drive pin in the keyway, then install the carrier over the drive pin. See **Fig. 42.** Install the carrier with its identification groove facing the same end of the shaft as the identification groove on the old carrier/shaft assembly. See **Fig. 43.** Install a new snap ring in the groove that's near the end of the shaft. See **Fig. 44.**

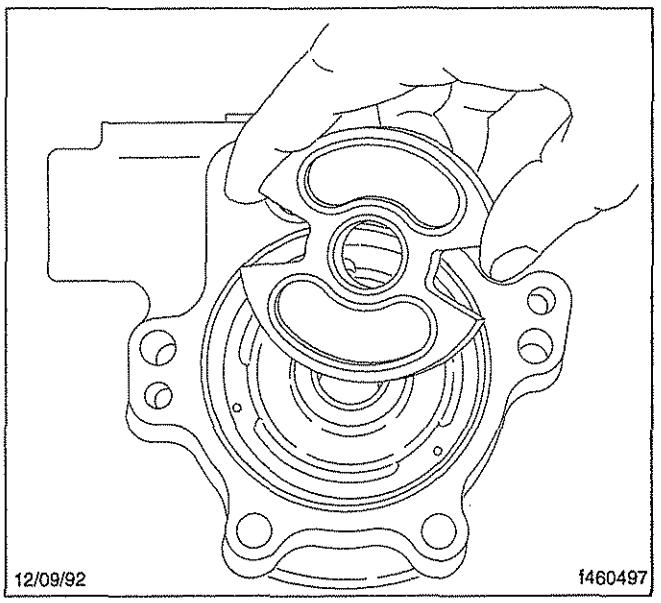

Fig. 38

If *only the carrier* needs to be replaced, note the end of the shaft that the carrier identification groove is facing. See **Fig. 43.** Carefully, without scratching the shaft, remove the snap ring that's near the end of it. Remove the old carrier and drive pin. Install the new carrier onto the shaft, over a new drive pin. See **Fig. 42.** Install the carrier with its identification groove facing the same end of the shaft that the old carrier's groove had been facing. Install the snap ring. See **Fig. 44.**

If *only the shaft* needs to be replaced, note the end of the shaft that the carrier identification groove is facing. See **Fig. 43.** Remove the snap ring that's near the end of the shaft. Remove the carrier, drive pin, and the other snap ring. Being careful not to scratch the new shaft, install a snap ring in the groove that's close to its center. See **Fig. 41.** Install the drive pin in the keyway, then install the carrier over the drive pin. See **Fig. 42.** Install the carrier with its identification groove facing the same end of the new shaft that it had been facing on

EATON POWER STEERING PUMP

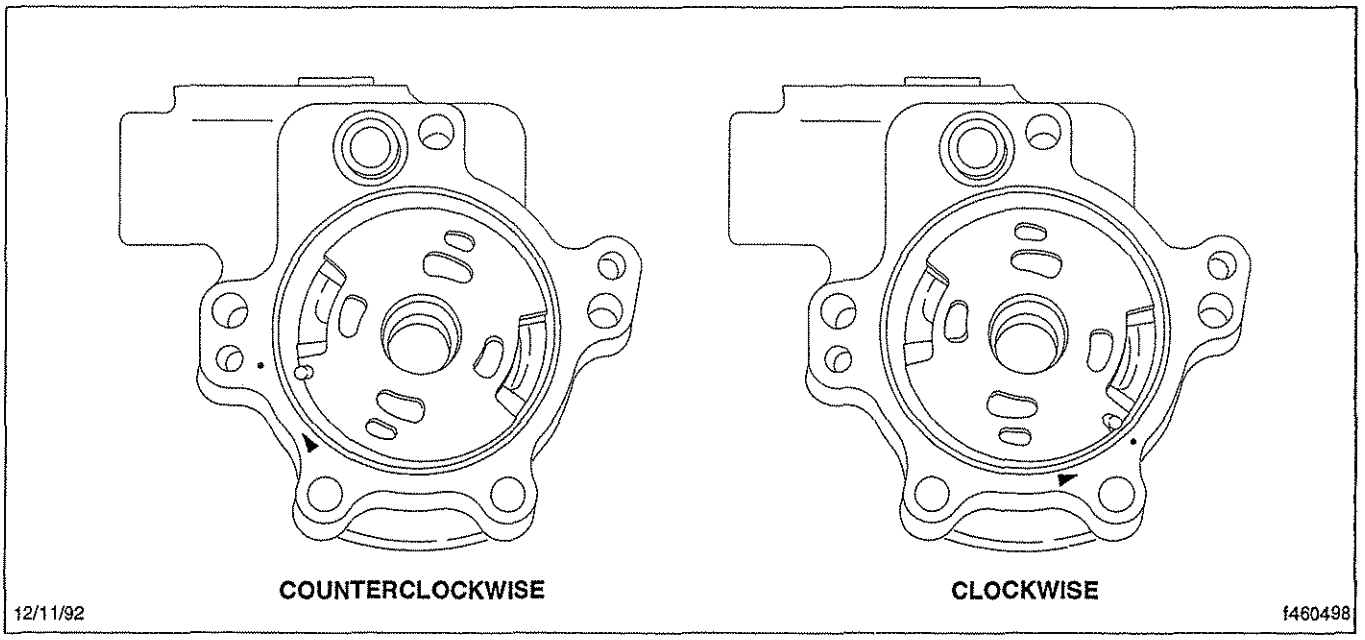

Fig. 39

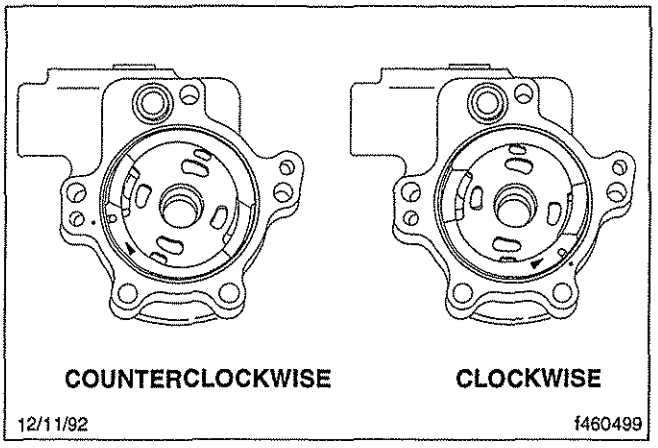

Fig. 40

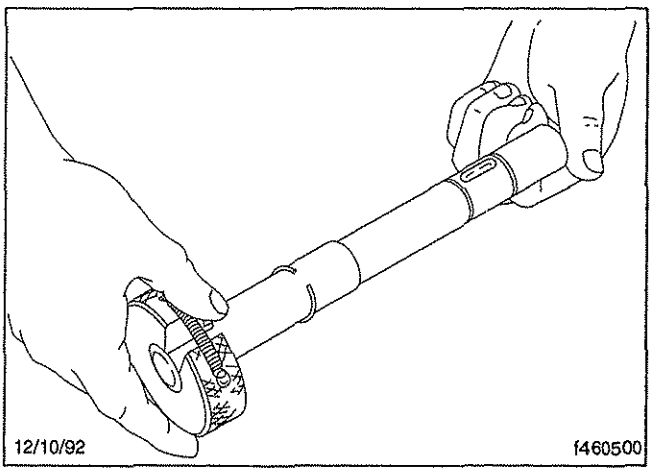

Fig. 41

the old shaft. Install the other snap ring. See **Fig. 44.**

If *only the snap rings* need to be replaced, remove the old ones and install the new ones, one at a time, without removing the carrier and drive pin. Be careful not to scratch the shaft.

10. Install the carrier/shaft assembly in the pump body, being careful not to damage the lip on the shaft oil seal.
11. Install the ten rollers in the carrier. Lubricate the shaft and the face of the carrier with a small amount of clean steering system fluid. Don't cover the end of the cam ring with fluid.

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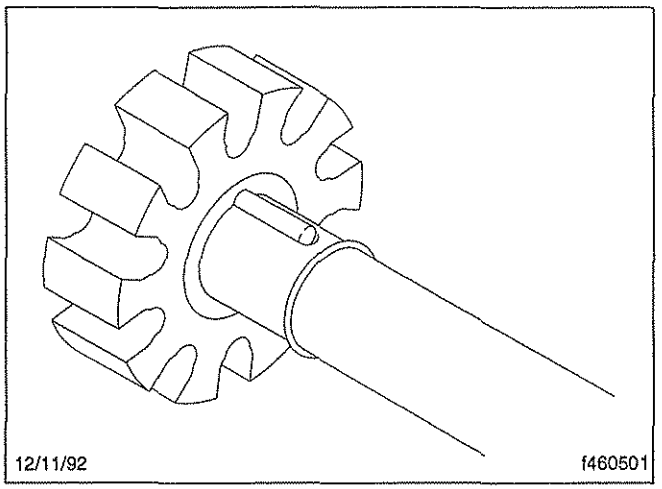

Fig. 42

12. Install new O-ring seals in the flow bypass hole in the pump body, and in the groove between the pump body and the cam ring. See **Fig. 27.**

13. Using clean steering system fluid, lubricate the pump cover bushing and the face of the pump cover. Install the pump cover, aligning the cover dowel pins with the dowel pin holes in the pump body. Install the five body-to-cover bolts finger-tight.

14. Using a small amount of steering system fluid, lubricate the pump-cover valve bore. Insert the combination valve in the pump-cover bore, with the long, small-diameter end in first. See **Fig. 45.** The valve must slide smoothly in the bore.

    Lubricate a new O-ring seal, and install it on the valve cap. Install the valve spring in the pump-cover bore, then install the valve cap finger-tight. See **Fig. 23.**

15. Install a new inlet-tube gasket on the pump body. Install the inlet tube and tube clamp, as an assembly. See **Fig. 22.** Install the tube clamp bolts and washers finger-tight.

16. Install a mounting flange gasket on the pump body. Position the mounting flange on the pump body, as shown in **Fig. 46.** Install, finger-tight, the three allen-head bolts and lockwashers, or the three hexhead bolts.

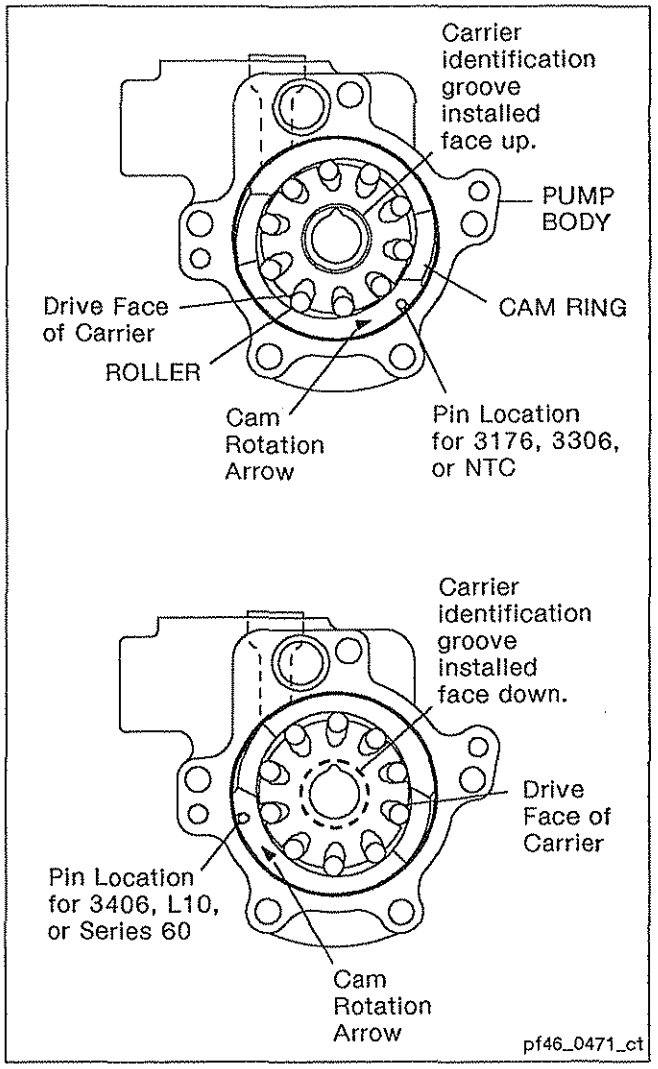

Fig. 43

17. Clamp the edges of the pump mounting flange in a soft-jawed vise; don't clamp on the sealing surface of the mounting flange, and don't clamp on the pump body or pump cover. See **Fig. 18.** Clamp the pump in a position that will allow tightening of all pump fasteners and the combination-valve cap.

18. Tighten the five body-to-cover bolts 35 lbf·ft (50 N·m).

EATON POWER STEERING PUMP

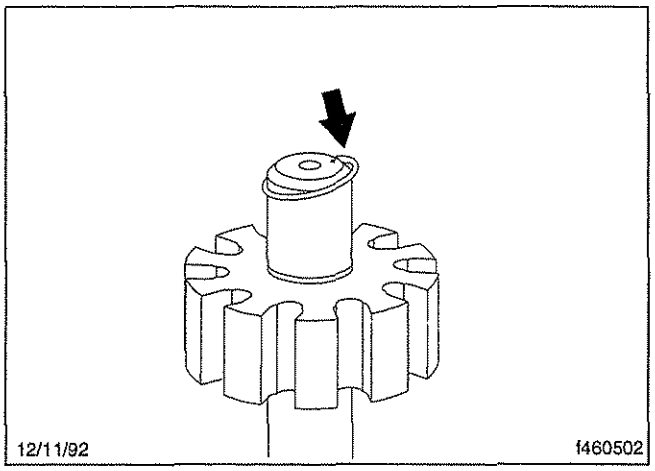

Fig. 44

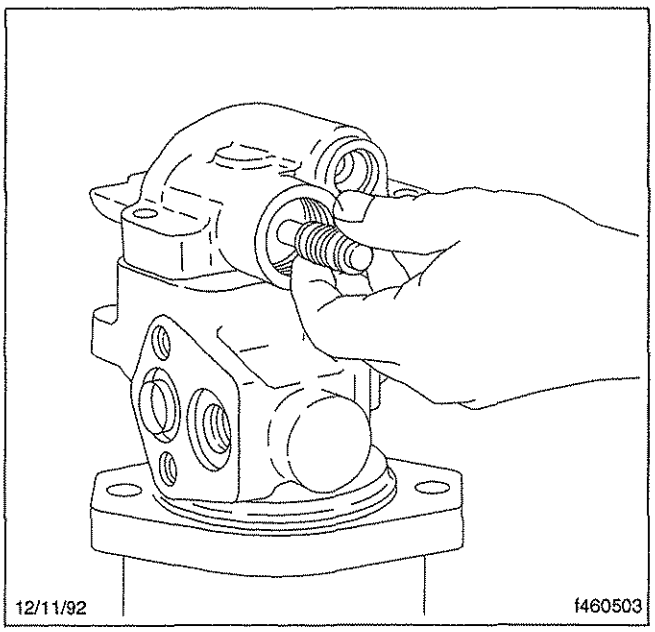

Fig. 45

19. Tighten the three mounting-flange-to-body bolts 35 lbf·ft (50 N·m).

20. Tighten the combination-valve cap 48 lbf·ft (65 N·m).

21. Turn the pump shaft to check for free, smooth rotation; maximum turning torque is 10 lbf·in (120 N·cm). If torque is more than that, disassemble the pump, and check it for burrs, pinched seals, and contamination. Fix the problem; then, clean, lubricate, and reassemble the pump.

22. Remove the pump from the vise.

    For a pump used on a Caterpillar 3306, position the shaft key in the pump shaft, then install the drive gear over the key. See **Fig. 19**. Hold the drive gear to prevent it from turning, while installing the bolt and lockwasher, and tightening the bolt 33 lbf·ft (45 N·m).

    For a pump used on a Detroit Diesel Series 60, position the shaft key in the pump shaft, then install the sprocket over the key. See **Fig. 20**. Hold the sprocket to prevent it from turning, while installing the large flatwasher, lockwasher, and bolt, and tightening the bolt 33 lbf·ft (45 N·m).

COMBINATION VALVE REPLACEMENT

1. Remove the pump, using the instructions under "Pump Removal and Installation."

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

2. Using a suitable solvent, remove all dirt and oil from the outside of the pump.

3. Clamp the edges of the pump mounting flange in a soft-jawed vise; don't clamp on the sealing surface of the flange, and don't clamp on the pump body or pump cover. See **Fig. 18**.

4. Carefully loosen but don't remove the combination-valve cap. Remove the pump from the vise. Carefully remove the combination-valve cap; it is pushed outward by spring force. See **Fig. 23**. From the cap, remove and discard the O-ring seal.

5. Remove the valve spring and the combination valve by shaking the pump or by gently

EATON POWER STEERING PUMP

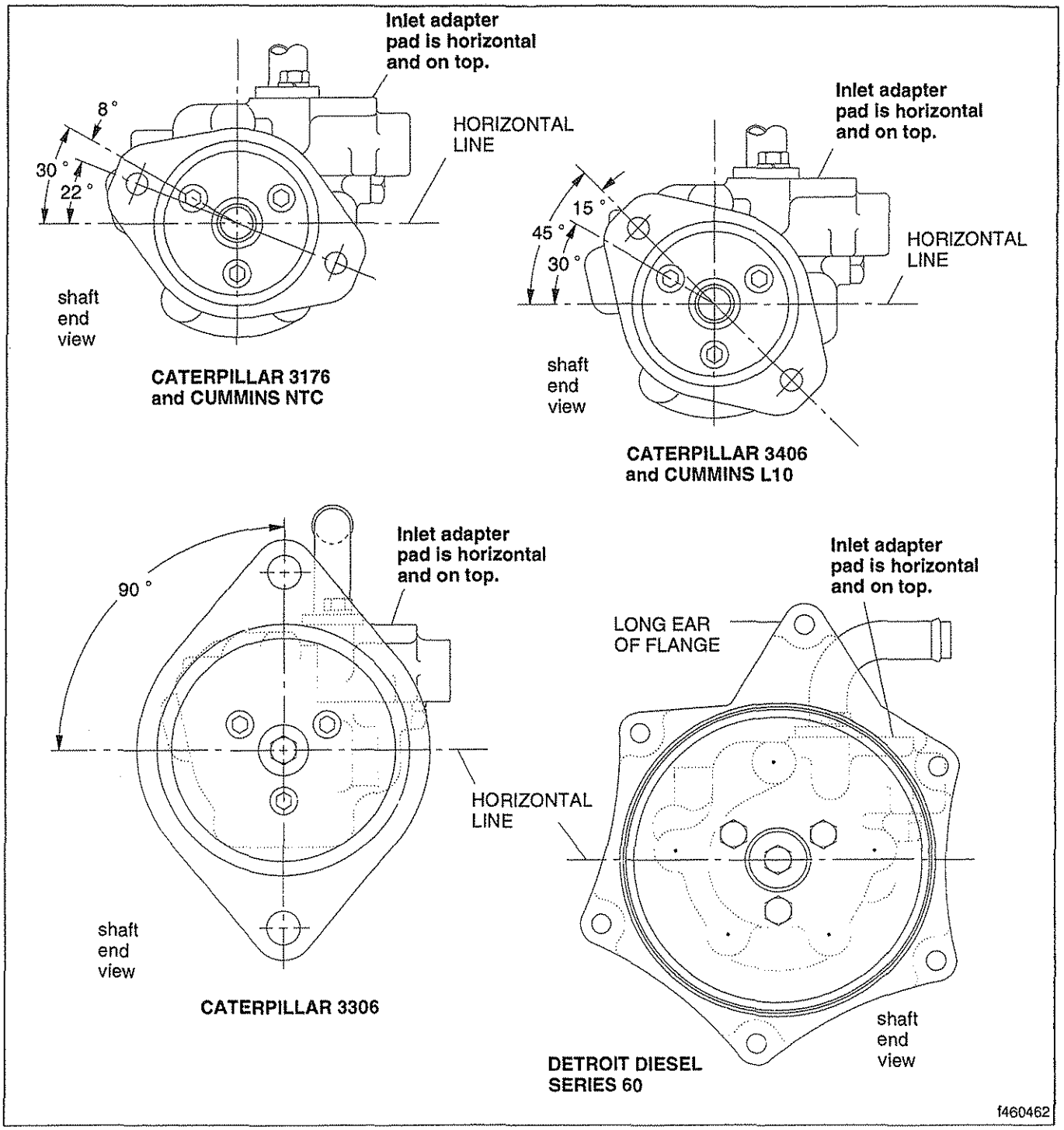

Fig. 46, Pump Mounting Flange Installation (shaft end view)

EATON POWER STEERING PUMP

tapping the pump against a wooden or padded surface. See **Fig. 24**. Don't use metal tools or similar instruments; they could damage the valve bore.

6. Using a clean, dry, lint-free cloth, remove any oil from the pump-cover valve bore. Insert the new (dry) combination valve (long, small-diameter end first) in the cover, and check for free movement in and out of the bore. See **Fig. 45**. The valve must move smoothly in the bore. Remove the valve, and inspect the condition of the bore; replace the pump cover if the valve bore is worn.

7. Using a small amount of clean steering system fluid, lubricate the pump-cover valve bore. Insert the new combination valve in the pump-cover bore, with the long, small-diameter end in first.

8. Lubricate a new O-ring seal, and install it on the valve cap. Install a new valve spring in the pump-cover bore, then install the valve cap finger-tight. See **Fig. 23**.

9. Clamp the edges of the pump mounting flange in a soft-jawed vise; don't clamp on the sealing surface of the flange, and don't clamp on the pump body or pump cover.

10. Tighten the combination-valve cap 48 lbf·ft (65 N·m).

11. Install the pump, using the instructions under "Pump Removal and Installation."

POST-SERVICE CHECKS

After power steering components have been worked on, and before the vehicle is placed into service, do the following checks.

WARNING: Failure to do the following checks could result in damage to the power steering system. This could cause a loss of hydraulic assist, which could result in personal injury or property damage.

1. Place a thermometer in the power steering reservoir. Warm the fluid in the steering system to the normal operating temperature of 125° to 135°F (51° to 57°C), by operating the engine at low idle, while turning the steering wheel through several full left and right turns.

   With the engine running and the steering system at operating temperature, turn the steering wheel slowly from stop to stop, while checking the steering reservoir for frothing or a change in fluid level (an indication that air is trapped in the system). If air is present, check the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as needed. Bleed any air from the system.

2. With the engine turned off and warm, check the steering reservoir fluid level, using the instructions in the steering section in the vehicle maintenance manual.

3. At full-left and full-right wheel cuts, be sure the axle stops (on the rear-side of the spindle) are set so there is at least 1/2-inch (13 mm) clearance between the tires and any fixed components that are attached to the vehicle. Clearance to moving components must be at least 1 inch (25 mm).

   If clearance is less, reset the axle stops using the front axle wheel alignment instructions in the steering section in this manual.

IMPORTANT: If the axle stops are reset, the steering gear's unloading valves (poppet/relief valves) must also be reset; refer to the applicable power steering gear section elsewhere in this group.

If there are still problems with the power steering system, do the tests under "Steering System Hydraulic Tests."

NOTE: For further information regarding diagnosis of possible causes of power steering system problems, refer to "Troubleshooting" in this section and in the applicable power steering gear section elsewhere in this group.

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TROUBLESHOOTING

STEERING SYSTEM HYDRAULIC TESTS

When troubleshooting, do the following tests *before* servicing the steering gear or power steering pump, *after* all other possible sources of steering problems have been checked and any problems corrected. Refer to "Pre-Service Checks."

After completing any service operations on the steering gear or steering pump, check the items listed under "Post-Service Checks," then, if needed, do the following tests.

1. Apply the parking brakes, and chock the rear tires.

2. Install a flow meter kit (with the load valve, pressure gauge, and flow meter in one unit) in the appropriate fluid line, as indicated by the instructions that come with the flow meter. Place a thermometer in the steering reservoir. See **Fig. 47.**

IMPORTANT: To accurately test the hydraulic system, a flow meter must be used, and a thermometer is recommended.

3. Warm the fluid in the steering system to the normal operating temperature of 125° to 135°F (51° to 57°C), by operating the engine at low idle, while turning the steering wheel through several full left and right turns.

NOTE: The normal operating temperature is most accurate when checked after two hours of normal operation.

   An alternate method of warming the fluid in the steering system is to operate the engine at low idle, while *partially* closing the load valve on the flow meter.

CAUTION: Do not close the load valve completely. Completely closing the load valve causes the steering pump to operate at relief pressure, which causes the fluid temperature to increase rapidly. Doing so for longer than five seconds could damage the pump. At no time allow the fluid temperature to exceed 180°F (82°C). Run all tests at 125° to 135°F (51° to 57°C).

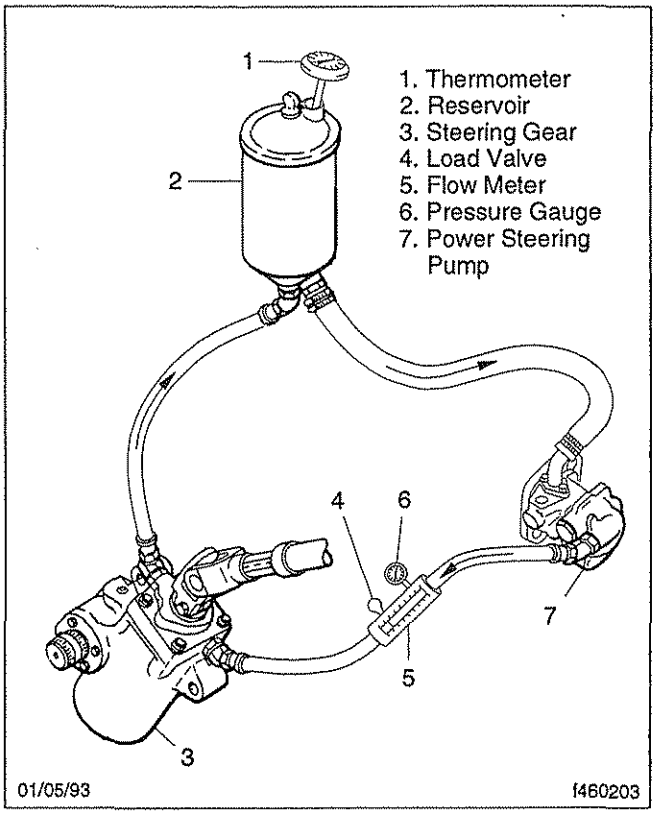

Fig. 47

   Adjust the load valve until the pressure gauge reads 1000 psi (6890 kPa). Open the load valve when the fluid temperature, as indicated on the thermometer, reaches 125° to 135°F (51° to 57°C).

4. Check the steering pump pressure relief valve. With the engine idling, slowly close the load valve, and read the pressure gauge on the flow meter; then immediately open the load valve.

IMPORTANT: Constantly observe the pressure gauge while closing the load valve, and while it is closed. If the pressure rises rapidly, appears to be uncontrolled, or rises above the maximum pressure setting of 2200 psi (15 200 kPa), immediately open the load valve. A malfunctioning pressure relief valve may allow excessive pressure to build, resulting in severe pump damage or ruptured hoses.

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The pressure at which the pump pressure relief valve should open is 2100 to 2200 psi (14 500 to 15 200 kPa). If the pressure relief valve fails to open within those specifications, install a new pressure relief valve (combination valve), using the instructions under "Combination Valve Replacement." Check the operation of the new valve, as instructed above.

5. Check the flow rate of the steering pump, as follows:

   .1 With the engine idling, slowly close the load valve until the pressure gauge reads 1750 psi (12 100 kPa). Read and record the flow rate shown by the flow meter. Compare this value to the specified minimum flow rate of 2.7 gpm (10.2 Lpm).

   WARNING: The minimum flow rate must not be less than 2.7 gpm (10.2 Lpm). Inadequate flow will cause binding, and uneven or difficult steering. This could result in personal injury or property damage.

   If the flow rate is less than specified, repair or replace the pump.

   .2 With the engine idling, fully close the load valve until the pressure gauge indicates that the pump pressure relief valve is open—2100 to 2200 psi (14 500 to 15 200 kPa). When the pump relief pressure is reached, the flow rate must be zero gpm. Immediately open the load valve. The flow rate must instantly return to at least the value recorded in step 5.1.

   If the minimum or a higher flow rate does not return immediately, the pump is malfunctioning. Repair or replace the pump.

   .3 Increase the engine speed to governed rpm, and, without turning the steering wheel, read and record the flow rate. Compare this value with the maximum flow rate of 6.0 gpm (22.7 Lpm).

   WARNING: The maximum flow rate must not exceed 6.0 gpm (22.7 Lpm). Excessive flow can cause high operating temperatures and oversteering, which could result in personal injury or property damage.

   If the flow rate is excessive, replace the pump flow control valve (combination valve), using the instructions under "Combination Valve Replacement." Check the operation of the new valve, as instructed above.

   .4 With the engine speed at governed rpm, fully close the load valve until the pressure gauge indicates that the pump pressure relief valve is open. When the pump relief pressure is reached, the flow rate must be zero gpm. *Immediately open the load valve.* The flow rate must instantly return to the value recorded in step 5.3.

   If the original flow rate does not return immediately, the pump is malfunctioning; repair or replace the pump.

   .5 Conduct the pump flow test twice more at governed rpm, as instructed in step 5.4.

6. With the steering wheel stationary, the front wheels positioned straight-ahead, the engine idling, and the load valve open, check the hydraulic system back-pressure. Normal system back-pressure is 70 psi (482 kPa), and should never be over 100 psi (689 kPa).

   If the back-pressure reading is normal, proceed with step 7.

   If the back-pressure reading is over 100 psi (689 kPa), and the steering pump is *not* at fault (the maximum pump flow rate is within specifications at step 5), check the power steering system for fluid flow restrictions. Repair or replace parts as needed, then go to step 8.

7. Test the steering gear for internal leakage, as follows:

NOTE: To test the steering gear for internal leakage, you must first prevent the operation of the gear's unloading valves (poppet/relief

EATON POWER STEERING PUMP

valves). This will allow the pump to develop full relief pressure.

.1 To prevent operation of the unloading valves, place a steel spacer block between the axle and the axle stop, at one wheel. See **Fig. 48.** The spacer block should be about 1/2-inch (13-mm) thick, and must be long enough in length to allow you to keep your fingers clear.

WARNING: Keep your fingers clear of the axle stop and spacer block during this test. Make sure that the spacer block contacts the axle stop squarely. Contact that is not square could break the axle stop, or dangerously eject the spacer block, causing injury.

While running this test, do not hold the steering wheel in the full-turn position for longer than 5 seconds at a time, to avoid damaging the steering pump.

.2 With a normal load on the front axle, turn the steering wheel until the axle stop bottoms on the spacer block. Apply 20 lbs (88 N) of force to the steering wheel rim, to be sure the steering gear's actuating/control valve is fully closed.

.3 As soon as the pressure gauge indicates that pump relief pressure has been reached, note the steering gear internal leakage reading on the flow meter. Compare this value to the allowable internal leakage in "Specifications, **Table 4.**"

.4 Repeat steps 7.1 through 7.3 for the opposite direction of turn.

If the amount of internal leakage is excessive (in either direction of turn), replace the steering gear or its internal components, as needed. Refer to the applicable power steering gear section elsewhere in this group.

.5 Remove the spacer block, then proceed with step 8.

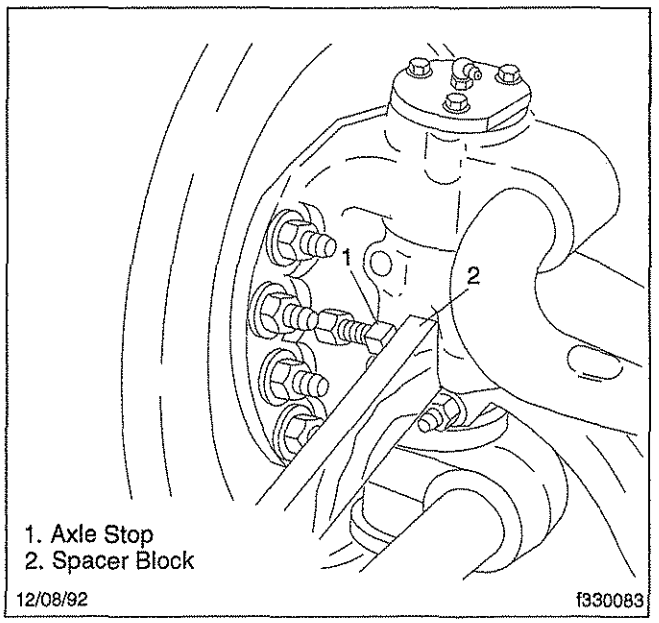

Fig. 48

8. Check the operation of the steering gear's unloading valves (poppet/relief valves), as follows:

CAUTION: If pump relief pressure is reached while the steering wheel is at full-lock, release the wheel from this position. Do not allow the pump relief pressure to be maintained for longer than five seconds, or damage to the pump may result.

.1 Turn the steering wheel clockwise to the full-lock position (to fully trip the unloading valve at one end of the steering gear), and note the reading on the pressure gauge. At the full-lock position, the pressure gauge reading should be less than pump relief pressure by at least 200 psi (1379 kPa). See "Specifications, **Table 3.**"

.2 Turn the steering wheel counterclockwise to the full-lock position, and note the reading on the pressure gauge. Again, the pressure gauge should read at least 200 psi (1379 kPa) less than pump relief pressure.

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Adjust the steering gear unloading valves if the pressure reading is higher than the above specification at either full-lock position. For instructions, refer to the applicable power steering gear section elsewhere in this group.

9. Remove the flow meter kit, thermometer, and wheel chocks.

TROUBLESHOOTING CHART

A checklist for troubleshooting power steering systems, Form SD–94, is available, and can be ordered through your Freightliner dealership. (Dealers, see the publications price list in the Freightliner *Service Bulletins* binder.)

The troubleshooting chart below covers the power steering pump, fluid reservoir, and fluid lines. For further troubleshooting information, refer to the power steering gear sections in this group.

NOTE: Unless otherwise noted, detailed procedures for the remedies listed in this troubleshooting chart can be found in the steering section in this manual or the vehicle maintenance manual.

Problem – Steering Pump Leaks

Possible Cause	Remedy
The power steering hoses are damaged or the fittings are loose or damaged.	Tighten loose fittings. Replace damaged hoses and fittings.
The seals between the pump cover and the pump body are leaking.	Tighten the body-to-cover bolts, or replace both O-ring seals, as needed.
The pump shaft oil seal is leaking.	Replace the pump shaft oil seal or the pump body, as needed.

Problem – Fluid Is Forced Out of Steering Reservoir

Steering system operating temperatures are too high.	Refer to "Problem – High Operating Temperatures."
The filter in the reservoir is clogged (creating system back-pressure).	Replace the filter and decrease the interval between filter changes.
There is air in the power steering system.	Check for and eliminate any air leaks. Bleed the air from the system. Fill the reservoir as needed.
The steering pump is damaged (causing cavitation).	Check for and correct a restriction in the supply hose. Repair the pump. If pump damage resulted in system contamination, clean and flush the system, change the filter, then fill and bleed the system.

Problem – Fluid Is Foaming in Steering Reservoir

Steering system operating temperatures are too high.	Refer to "Problem – High Operating Temperatures."
An unapproved fluid was added to the reservoir.	Drain and flush the system, change the filter, then fill the system with an approved fluid.
There is air in the power steering system.	Check for and eliminate any air leaks. Bleed the air from the system. Fill the reservoir as needed.
The steering pump is damaged (causing cavitation).	Check for and correct a restriction in the supply hose. Repair the pump. If pump damage resulted in system contamination, clean and flush the system, change the filter, then fill and bleed the system.

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Problem – Steering System Fluid Is Milky or White in Appearance

Possible Cause	Remedy
Water has entered the fluid reservoir through the reservoir venting system.	Clean the reservoir venting system, or replace the reservoir cap assembly. Drain and flush the system, change the filter, then fill the system with an approved fluid.

Problem – Steering System Fluid Is Discolored or Smells Burned

Steering system operating temperatures are too high.	Refer to "Problem – High Operating Temperatures."
The interval between fluid changes is too long.	Drain and flush the system, change the filter, then fill the system with an approved fluid. Decrease the fluid change interval.
An unapproved fluid was added to the reservoir.	Drain and flush the system, change the filter, then fill the system with an approved fluid.

Problem – High Operating Temperatures[1]—150°F (66°C) Over Ambient

The vehicle is overloaded.	Reduce the load to the gross vehicle weight rating.
An undersized replacement hose, line, or fitting was installed.	Replace any incorrect hose, line, or fitting, with the correct size.
A hose or line is kinked, severely bent, or internally blocked.	Remove the kink or severe bend by rerouting the hose. Replace the hose if it is internally blocked, or if replacement is otherwise necessary.
The steering pump flow rate is too high.	Check the pump flow rate. If more than the maximum allowable flow, repair or replace the pump.
The poppet valves (Ross gears) or relief valve plungers (Sheppard gears) are incorrectly adjusted.	Adjust the poppet valves or relief valve plungers. Refer to the steering gear section elsewhere in this group.

Problem – No Power Steering on Cold Start

The rollers of the steering pump are not following the inside of the cam ring.	Increase the engine speed momentarily to dislodge the rollers and start pump action. If the pump doesn't start pumping, replace the pump or the pumping element components.

Problem – Too Much System Pressure With Steering Gear in Neutral Position

The fluid return line is pinched, creating high back-pressure.	Relocate the fluid return line.
The actuating shaft bearing is damaged (Sheppard gears only).	Inspect the steering gear parts, and replace damaged parts as needed. Refer to the Sheppard steering gear section elsewhere in this group.

Problem – Low Fluid Flow from Pump or Pump Not Delivering Fluid

The pump is being driven in the wrong direction of rotation.	The wrong pump was installed, or the pumping element components were incorrectly assembled. Repair or replace the pump.

[1] **WARNING: If steering system fluid overheats, it can cause the seals in the steering gear and pump to shrink, harden, or crack, and to lose their sealing ability. Any fluid leak could eventually cause loss of power steering assist, which could result in personal injury or property damage.**

EATON POWER STEERING PUMP

Problem — Low Fluid Flow from Pump or Pump Not Delivering Fluid (Continued)

Possible Cause	Remedy
The pump shaft, drive gear, or coupling is sheared or disengaged.	Remove the pump, and check the drive gear or coupling and the end of the pump shaft. If needed, disassemble the pump and check the shaft and carrier. Replace damaged parts.
The filter in the steering reservoir is clogged.	Replace the filter, and decrease the interval between filter changes.
The power steering system is low on fluid.	Fill the reservoir with clean fluid. If needed, prime the pump, bleed the system, and refill the reservoir.
The pumping element rollers are stuck in the carrier slots.	Replace the pump; *or* disassemble it, check it for contamination, clean it, inspect it for damage, install a new pumping element kit if needed, then assemble it. Replace the reservoir filter, flush the steering system, and refill it with clean fluid.
The steering pump relief valve is stuck open.	Replace the combination valve or the pump cover.
Steering pump parts are worn, causing internal leakage.	Repair or replace the pump. If pump damage resulted in system contamination, clean and flush the system, change the filter, then fill and bleed the system.

Problem — Abnormal or Too Much Noise

The power steering fluid lines are contacting other vehicle parts.	Insulate or position the lines away from other vehicle parts by using grommets, clamps, or brackets.
A noise when turning or when changing directions may mean that some part is loose and is shifting under load.	Check all parts for tightness. Tighten any loose fasteners to their correct torque values.
A change in the normal noise from the steering pump may mean that air has entered the system, or that the fluid level is low.	Check for and eliminate any air leaks, then bleed the air from the system. Fill the reservoir as needed.
Too much noise from the steering pump may indicate entry of foreign material, or that the pump is worn or damaged.	Clean and repair, or replace the pump, as needed. Flush the system, replace the steering reservoir filter, and refill the system with clean fluid.

Problem — Erratic Steering or No Steering at All

The steering pump flow-control-and-relief valve assembly is not functioning correctly.	Replace the combination valve or the pump cover.

Problem — No Recovering When Leaving a Turn[1]

There is low fluid flow from the steering pump.	Check the pump flow rate. If less than the minimum allowable flow, repair or replace the pump.

[1] Additional causes and remedies for this problem may be found in the troubleshooting chart in the power steering gear section in this group.

EATON POWER STEERING PUMP

Problem – High Steering Effort in One Direction[1]

Possible Cause	Remedy
There is low fluid flow from the steering pump.	Check the pump flow rate. If less than the minimum allowable flow, repair or replace the pump.

Problem – High Steering Effort in Both Directions[1]

There is low fluid flow from the steering pump.	Check the pump flow rate. If less than the minimum allowable flow, repair or replace the pump.
The power steering system is low on fluid.	Fill the reservoir with clean fluid.
There is a restriction in the fluid return line, or the line is too small.	Remove any restriction from the line, or replace it with a larger line, as needed.
There is air in the power steering system.	Check for and eliminate any air leaks. Bleed the air from the system. Fill the reservoir as needed.

Problem – Darting or Wandering[1]

The steering pump flow rate is too high.	Check the pump flow rate. If more than the maximum allowable flow, repair or replace the pump.
There is air in the power steering system.	Check for and eliminate any air leaks. Bleed the air from the system. Fill the reservoir as needed.

Problem – Steering Shimmy or Chatter[1]

There is air in the power steering system.	Check for and eliminate any air leaks. Bleed the air from the system. Fill the reservoir as needed.

[1] Additional causes and remedies for this problem may be found in the troubleshooting chart in the power steering gear section in this group.

EATON POWER STEERING PUMP

SPECIFICATIONS

Description	Size	Torque lbf·ft (N·m)
Inlet Tube Clamp Bolts	5/16–18	100 lbf·in (1120 N·cm)
Pressure-Line Port Elbow	—	30 (40)
Pump Body-to-Cover Bolts	3/8–16	35 (50)
Mounting Flange-to-Pump-Body Bolts	3/8–16	35 (50)
Combination-Valve Cap	—	48 (65)
DDE Series 60 Sprocket Bolt	5/16–18	33 (45)
Caterpillar 3306 Pump Drive Gear Bolt	5/16–18	33 (45)
Caterpillar 3306 Pump Mounting Bolts	5/8–11	160 (215)
Caterpillar 3406 Pump Mounting Stud Nuts	3/8–16	35 (50)
Cummins L10 Pump Mounting Bolts	M10 x 35	35 (50)
Cummins NTC Pump Mounting Bolts	3/8–16	35 (50)
DDE Series 60 Pump Mounting Bolts	M8 x 20	22 (30)

Table 1, Power Steering Pump Torque Values

Application	Hose Size	Minimum Bend Radius inches (mm)
Suction (Supply) Hose (Reservoir-to-Pump)	No. 12	5 (127)
Pressure Hose (Pump-to-Gear)	No. 8	4-5/8 (117)
Return Hose (Gear-to-Reservoir)	No. 10	2-1/4 (57)

Table 2, Power Steering Hose Sizes and Minimum Bend Radii

EATON POWER STEERING PUMP

SPECIFICATIONS (Continued)

Engine	Pump Size (cu. in. per revolution)	Pump Rotation Direction[1]	Pump (Engine) Rotation Speed		Relief Valve Opening Pressure psi (kPa) x 100		Flow Rate gpm (Lpm)		System Back-Pressure[6] psi (kPa)	
			RPM at Engine Idle	RPM at No-Load Maximum	Minimum[2]	Maximum[3]	Minimum[4]	Maximum[5]	Normal	Maximum
L10	1.35	LH (CCW)	700 (700)	2460 (2460)	21 (145)	22 (152)	2.7 (10.2)	6.0 (22.7)	70 (482)	100 (689)
NTC	1.00	RH (CW)	900 (600)	3584 (2390)	21 (145)	22 (152)	2.7 (10.2)	6.0 (22.7)	70 (482)	100 (689)
Cat 3176	1.35	RH (CW)	700 (700)	2310 (2310)	21 (145)	22 (152)	2.7 (10.2)	6.0 (22.7)	70 (482)	100 (689)
Cat 3306	1.35	RH (CW)	750 (750)	2485 (2485)	21 (145)	22 (152)	2.7 (10.2)	6.0 (22.7)	70 (482)	100 (689)
Cat 3406B	1.35	LH (CCW)	700 (700)	2310 (2310)	21 (145)	22 (152)	2.7 (10.2)	6.0 (22.7)	70 (482)	100 (689)
DDE Series 60	1.35	LH (CCW)	714 (600)	2648 (2225)	21 (145)	22 (152)	2.7 (10.2)	6.0 (22.7)	70 (482)	100 (689)

[1] The direction of pump rotation is given as it is viewed from the driven end of the pump.
[2] The relief valve ball must be seated (closed) at the minimum pressure.
[3] The relief valve ball must be fully open at the maximum pressure.
[4] Minimum flow rates are measured at engine idle rpm and at 1750 psi (12 100 kPa) of system pressure.
[5] Maximum flow rates are measured at engine no-load maximum rpm and with the steering wheel stationary.
[6] System back-pressure is measured at engine idle rpm and with the steering wheel stationary.

Table 3, Power Steering System Specifications (by engine installation)

Steering Gear	Maximum Internal Leakage gpm (Lpm)	Poppet/Relief Valve Maximum Opening Pressure psi (kPa)
Ross TAS65	1.5 (5.7)	1900 (13 000)
Sheppard M-100	1.0 (3.8)	1900 (13 000)

Table 4, Power Steering Gear Hydraulic Specifications

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WHEEL AND TIRE SERVICING	**32-13100**
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WHEEL AND TIRE SERVICING

SUBJECT CONTENTS

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Installation 2

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WHEEL AND TIRE SERVICING

GENERAL DESCRIPTION

The tires support the weight of the loaded vehicle, and are integral parts of the transmission and braking systems. The wheels serve as load carrying members between the tires and the axle.

There are two types of wheels: spoke and disc.

Spoke wheels consist of a wheel and brake drum assembly installed on the axle (**Fig. 1**), and a tire and rim assembly that mounts on the wheel. Rim clamps and rim nuts hold the tire and rim assembly in place.

Disc wheels consist of a rim and disc. The rim, the portion of the wheel on which the tire is mounted and supported, is welded to the disc (**Fig. 2**). After the tire is mounted on the wheel, the assembly is held in place on the hub with wheel studs and nuts.

Standard ten-hole dual disc wheels are held in place on the hub by self-centering inner and outer wheel nuts. Eight-hole and optional ten-hole (single and dual) disc wheels are centered by pilot pads and are held in place on the hub with cone locknuts.

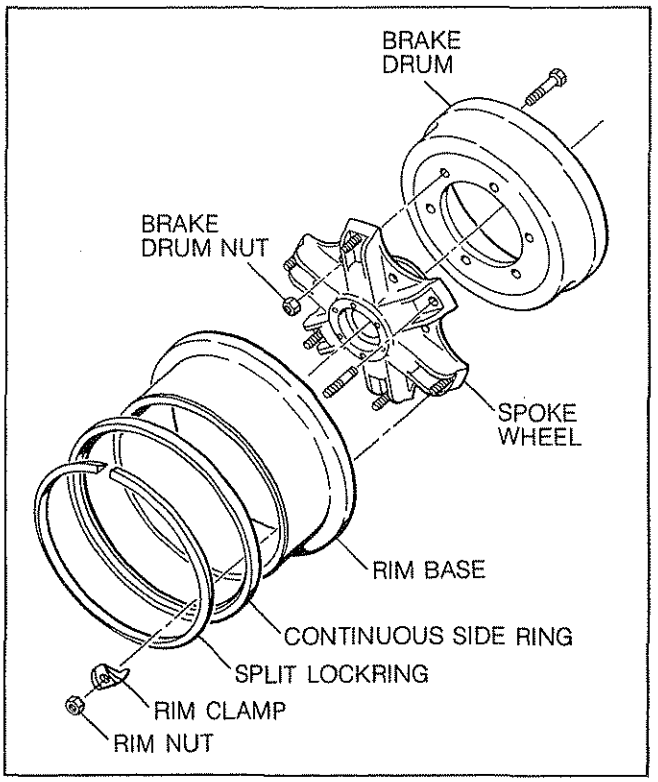


Fig. 1, Spoke Wheel and Brake Drum Assembly (Shown With Three-Piece Rim, for Tube-Type Tires)

Tires are constructed of either radial or bias plies:

Radial tires have ply cords that run from bead to bead, and at a right angle to the belt plies and tire tread (**Fig. 3**). The belt plies constrict the radial ply cords and give rigidity to the tread.

Bias ply tires have body ply cords that run diagonally from bead to bead (**Fig. 4**). The tires may also have narrow plies under the tread, called breakers, with cords that lie in about the same direction as the body ply cords.

Tire body plies, breakers, and belts are made of polyester, rayon, nylon, fiberglass, steel, or aramids (fibrous reinforcements). In radial ply tires, these materials are used in various combinations, including steel body/steel belt, polyester body/fiberglass belt, or nylon body/steel belt.

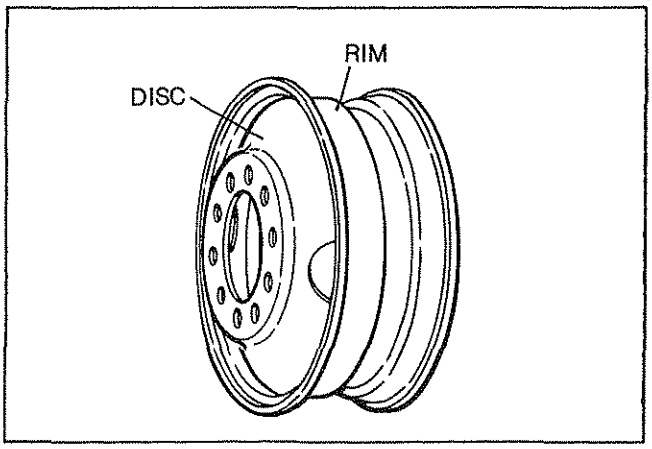


Fig. 2, Disc Wheel

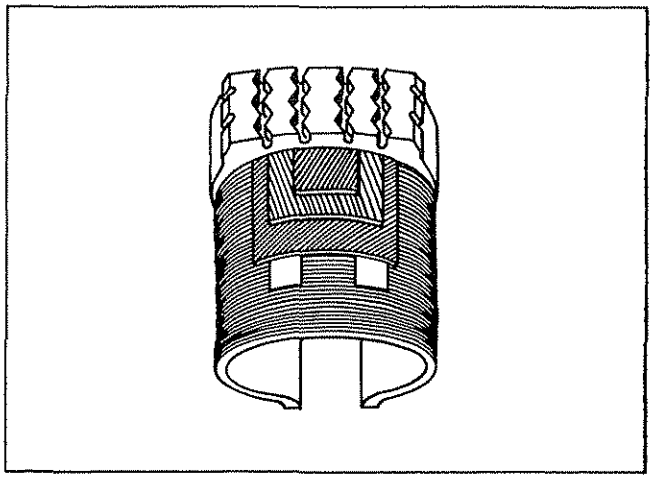


Fig. 3, Radial Ply Tire Construction

WHEEL AND TIRE SERVICING

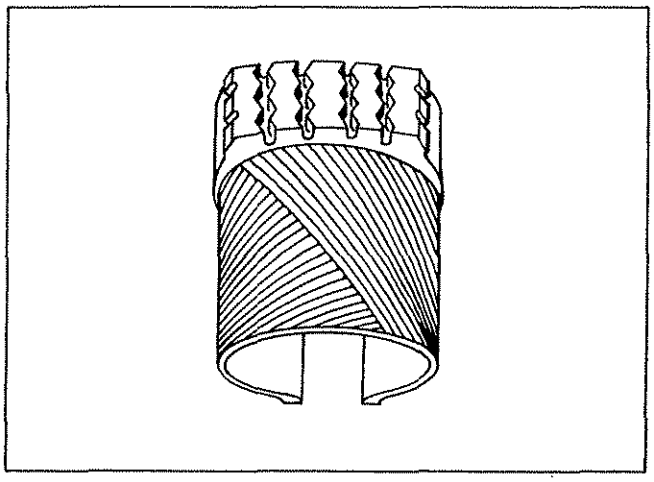


Fig. 4, Bias Ply Tire Construction

Wheels and tires operate either with or without tubes. Tube-type tires require a tube and flap for correct assembly on a two- or three-piece rim (**Fig. 1**). Tubeless tires require only the tire, and a one-piece drop-center wheel or rim. See **Fig. 2.**

SERVICE OPERATIONS

8-HOLE DISC WHEEL WITH CONE LOCKNUTS; REMOVAL AND INSTALLATION

Removal

1. Chock all tires that will not be serviced, to prevent vehicle movement.
2. If removing the wheels and tires from the front axle:
   - .1 Set the parking brake.
   - .2 Raise the front of the vehicle until the tires clear the floor. Place safety stands under the front axle.
   - .3 If the tire or wheel is damaged (or if there is suspected damage), deflate the tire being serviced by removing the valve core.
   - .4 Place a jack or wheel-and-tire dolly under the front wheel assembly being serviced. Turn the wheel until one hub-pilot pad is in the top-center position.
   - .5 Leaving the top nut until last, remove all eight cone locknuts.

   IMPORTANT: On both sides of the vehicle, the cone locknuts have right-hand threads.

   CAUTION: The wheel center hole and hub pilot have close tolerances. If the wheel is not kept square to the hub, it could bind during removal and damage the stud threads. Keep the wheel square to the hub during removal.

   - .6 Remove the wheel. Don't let it drop on or drag across the stud threads.
3. If removing wheels and tires from a rear axle:
   - .1 Raise the rear of the vehicle until the tires clear the floor. Place safety stands under the axle being serviced.
   - .2 If the tire or wheel is damaged (or if there is suspected damage), deflate both tires of the dual assembly being serviced by removing the valve cores.
   - .3 Place a jack or wheel-and-tire dolly under the dual wheel assembly being serviced. Turn the wheel until one hub pilot pad is in the top-center position.
   - .4 Leaving the top nut until last, remove all eight cone locknuts.

   IMPORTANT: On both sides of the vehicle, the cone locknuts have right-hand threads.

   CAUTION: The wheel center hole and hub pilot have close tolerances. If the wheel is not kept square to the hub, it could bind during removal and damage the stud threads. Keep the wheel square to the hub during removal.

   - .5 Remove the wheel. Don't let it drop on or drag across the stud threads.

Installation

NOTE: Before installing a wheel and tire assembly, inspect it using the instructions under "Wheel and Components Inspection." Also, follow the requirements under "Tire Matching and Mixing."

1. Clean the hub and wheel mounting surfaces, and between the rims of dual wheels. Make sure the tire is correctly inflated. For instructions, refer to "Tire Inflation."
2. Apply a few drops of light engine oil to the wheel studs and the area between the body and the flange of each cone locknut. See **Fig. 5.** Wipe off any excess oil.

WHEEL AND TIRE SERVICING

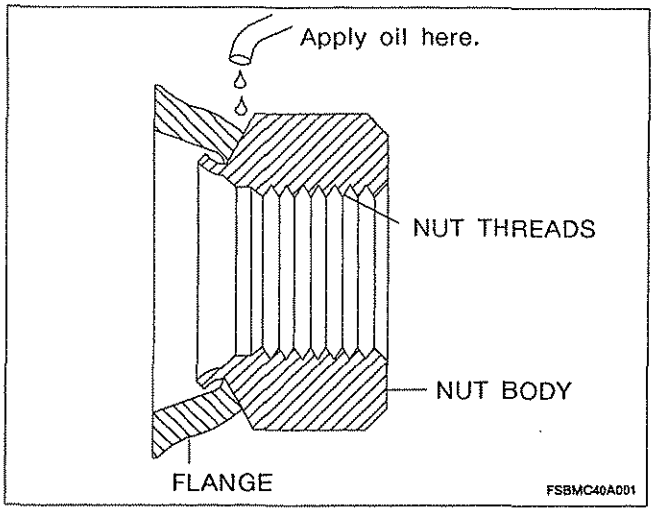


Fig. 5

IMPORTANT: Before installing the wheels, make sure the drum is positioned on the raised step of the pilot pad. One of the hub's pilot pads must be at the top location. To help keep the drum in place, it may be necessary to adjust the brakes before installing the wheels.

CAUTION: The wheel center hole and hub pilot have close tolerances. If the wheel is not kept square to the hub, it could bind during installation and damage the stud threads. Keep the wheel square to the hub during installation.

3. If installing a front wheel assembly:

   .1 Locate one hub-pilot pad in the top-center position. Using a jack or wheel-and-tire dolly, position the wheel assembly on the hub. Make sure the wheel is square to the hub and that the threads are not damaged by contact with the wheel during installation.

   .2 Make sure the hub-pilot pad is still centered at the top.

   IMPORTANT: Install the wheel assembly so that the balance weight(s) on the wheels are 180 degrees opposite the balance weight(s) on the brake drum.

4. If installing a rear wheel assembly:

   .1 Locate one hub-pilot pad in the top-center position. Using a jack or wheel-and-tire dolly, position the inner wheel assembly on the hub. Make sure the wheel is square to the hub and that the threads are not damaged by contact with the wheel during installation.

   .2 Using the same procedure, mount the outer wheel against the inner wheel. Make sure the hub-pilot pad is still centered at the top.

   IMPORTANT: Install the wheel assembly so that the balance weight(s) on the wheels are 180 degrees opposite the balance weight(s) on the brake drum. If this causes the valve stems to be in the same wheel hole, mount the outer wheel so that the outer wheel balance weight(s) are on the same side as the brake drum balance weight(s).

5. Install and hand-tighten a cone locknut on the top and bottom studs.

CAUTION: The cone locknuts have right-hand metric threads. Do not try to install a similar size SAE nut on a stud, or the stud and nut will be damaged.

6. Install and hand-tighten the remaining cone locknuts. Then, tighten the cone locknuts 50 to 100 lbf·ft (68 to 135 N·m) following the sequence in **Fig. 6**.

7. Check that the wheel is correctly seated against the hub and on the hub-pilot pads.

8. Following the sequence in **Fig. 6**, tighten the cone locknuts 450 to 550 lbf·ft (610 to 745 N·m).

WARNING: If the wheel nuts cannot be tightened to minimum torque values, the studs could be turning in the hub flange, having lost their locking ability. In this situation, the wheel hub assembly is damaged and must be replaced with a new assembly.

Failure to reach minimum torque values could also be caused by stripped threads on the wheel studs

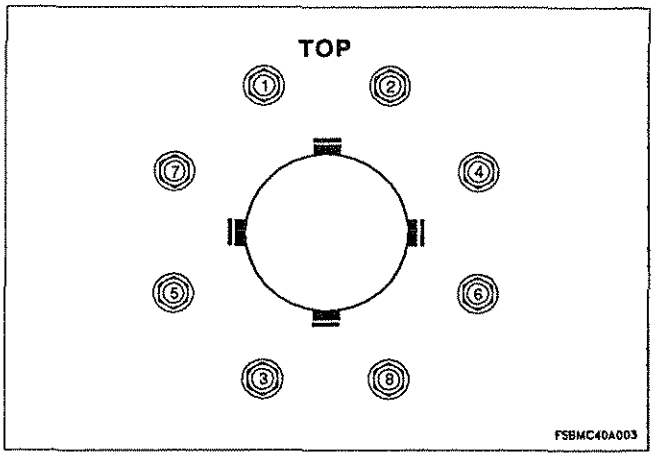


Fig. 6, 8–Stud Disc Wheel Tightening Sequence

WHEEL AND TIRE SERVICING

or wheel nuts. Again, damaged parts must be replaced with new parts. Failure to replace damaged parts could result in the loss of a wheel or loss of vehicle control, causing property damage or personal injury.

NOTE: Replace damaged parts following the instructions in Group 10, "Front Axle," or Group 11, "Rear Axle."

9. Remove the safety stands, lower the vehicle, and remove the chocks.
10. After operating the vehicle for 50 to 100 miles (80 to 160 km), retighten the wheel nuts 450 to 550 lbf·ft (610 to 745 N·m). Follow the sequence in **Fig. 6**.

IMPORTANT: Tighten the cone locknuts to the specified torque 50 to 100 miles (80 to 160 km) after service work, and check the torque every 50,000 miles (80 000 km) thereafter.

CAUTION: The cone locknuts seat during vehicle operation. It is necessary to periodically tighten the wheel nuts to the specified torque. Not enough wheel nut torque can cause wheel shimmy, wheel damage, stud breakage, and extreme tire tread wear. Too much wheel nut torque can break studs, damage threads, and crack discs in the stud hole area. Use the specified torque values, and follow the tightening sequence in Fig. 6.

10-HOLE DISC WHEEL WITH TWO-PIECE FLANGE NUTS; REMOVAL AND INSTALLATION

Removal

1. Chock all tires that will not be serviced, to prevent vehicle movement.
2. Set the parking brake.
3. If working on the front axle wheels, raise the front of the vehicle until the tires clear the floor. Place safety stands under the front axle.

   If working on the rear axle wheels, raise the rear of the vehicle until the tires clear the floor. Place safety stands under the axle being serviced.
4. If the tire or wheel is damaged or if there is suspected damage, deflate the tire (or tires, on a dual assembly) being serviced by removing the valve core.
5. Turn the wheel until one hub-pilot pad is in the top-center position.
6. Leaving the top and bottom nuts until last, remove the other eight two-piece flange nuts.
7. Place a jack or wheel-and-tire dolly under the wheel assembly being serviced. Remove the top and bottom nuts.

IMPORTANT: On both sides of the vehicle, the two-piece flange nuts have right-hand metric threads.

CAUTION: The wheel center hole and hub pilot have close tolerances. If the wheel is not kept square to the hub, it could bind during removal and damage the stud threads. Keep the wheel square to the hub during removal.

8. Remove the wheel. Don't let it drop on or drag across the stud threads.

Installation

NOTE: Before installing a wheel and tire assembly, inspect it using the instructions under "Wheels and Components Inspection." Also, follow the requirements under "Tire Matching and Mixing."

1. Clean the hub and wheel mounting surfaces, and all disc faces of dual wheels. Make sure the tire is correctly inflated. For instructions, refer to "Tire Inflation."
2. Apply a few drops of light engine oil to the wheel studs and the area between the body and the flange of each two-piece flange nut. See **Fig. 7**. Wipe off any excess oil.

IMPORTANT: Before installing the wheels, make sure the drum is positioned on the raised step of the pilot pad. One of the hub's pilot pads must be at the top location. To help keep the drum in place, it may be necessary to adjust the brakes before installing the wheels.

CAUTION: The wheel center hole and hub pilot have close tolerances. If the wheel is not kept square to the hub, it could bind during installation and damage the stud threads. Keep the wheel square to the hub during installation.

3. If installing a front wheel assembly:

   .1 Locate one hub-pilot pad in the top-center position. Using a jack or wheel-and-tire dolly, position the wheel assembly on the hub. Make sure the wheel is square to the hub so that the stud threads are not damaged by contact with the wheel during installation.

   .2 Make sure the hub-pilot pad is still centered at the top.

WHEEL AND TIRE SERVICING

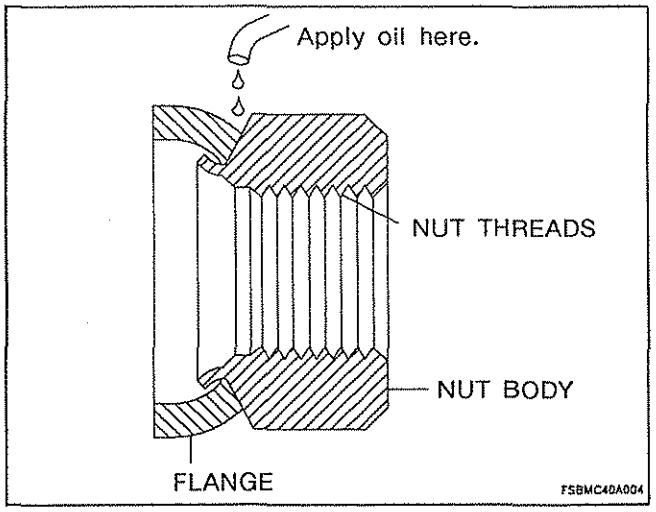


Fig. 7

IMPORTANT: Install the wheel assembly so that the balance weight(s) on the wheels are 180 degrees opposite the balance weight(s) on the brake drum.

4. If installing a rear wheel assembly:

   .1 Locate one hub-pilot pad in the top-center position. Using a jack or wheel-and-tire dolly, position the inner wheel assembly on the hub. Make sure the wheel is square to the hub so that the stud threads are not damaged by contact with the wheel during installation.

   .2 Using the same procedure, mount the outer wheel against the inner wheel. Make sure the hub-pilot pad is still centered at the top.

IMPORTANT: Install the wheel assembly so that the balance weight(s) on the wheels are 180 degrees opposite the balance weight(s) on the brake drum. If this causes the valve stems to be in the same wheel hole on rear wheel assemblies, mount the outer wheel so that the outer wheel balance weight(s) is on the same side as the brake drum balance weight(s).

5. Install and hand-tighten a two-piece flange nut on the top and bottom studs.

CAUTION: The two-piece flange nuts have right-hand metric threads. Do not try to install a similar size SAE nut on a stud, or the stud and nut will be damaged.

6. Install and hand-tighten the remaining two-piece flange nuts. Then, tighten the nuts 50 lbf·ft (68 N·m) following the sequence in Fig. 8.

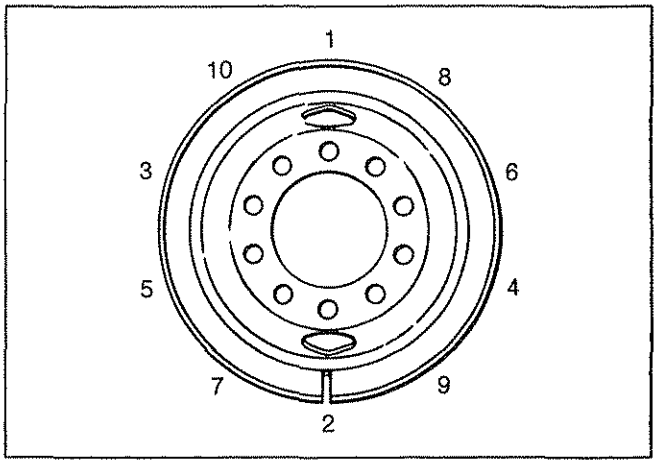


Fig. 8, 10-Stud Disc Wheel Tightening Sequence

7. Check that the wheel is correctly seated against the hub and on the hub-pilot pads.

8. Following the sequence in Fig. 8, tighten the two-piece flange nuts 390 to 440 lbf·ft (529 to 597 N·m).

WARNING: If the wheel nuts cannot be tightened to minimum torque values, the studs could be turning in the hub flange, having lost their locking ability. In this situation, the wheel hub assembly is damaged and must be replaced with a new assembly.

Failure to reach minimum torque values could also be caused by stripped threads on the wheel studs or wheel nuts. Again, damaged parts must be replaced with new parts. Failure to replace damaged parts could result in the loss of a wheel or loss of vehicle control, causing property damage or personal injury.

IMPORTANT: Replace damaged parts following instructions in Group 10, "Front Axle," or Group 11, "Rear Axle."

9. Remove the safety stands, lower the vehicle, and remove the chocks.

10. After operating the vehicle for 50 to 100 miles (80 to 160 km), retighten the wheel nuts 390 to 440 lbf·ft (529 to 597 N·m). Follow the sequence in Fig. 8.

IMPORTANT: Tighten the two-piece flange nuts to the specified torque 50 to 100 miles (80 to 160 km) after service work, and check the torque every 10,000 miles (16 000 km) thereafter.

WHEEL AND TIRE SERVICING

CAUTION: The two-piece flange nuts seat during vehicle operation. It is necessary to periodically tighten the wheel nuts to the specified torque. Not enough wheel nut torque can cause wheel shimmy, wheel damage, stud breakage, and extreme tire tread wear. Too much wheel nut torque can break studs, damage threads, and crack discs in the stud hole area. Use the specified torque values, and follow the tightening sequence in Fig. 8.

10-HOLE DISC WHEEL WITH INNER AND OUTER NUTS; REMOVAL AND INSTALLATION

Removal

1. Chock all tires that will not be serviced, to prevent vehicle movement.
2. If removing wheels and tires from the front axle:
   .1 Set the parking brake.
   .2 Raise the front of the vehicle until the tires clear the floor. Place safety stands under the front axle.
   .3 Deflate the tire being serviced by removing the valve core.
   .4 Place a jack or wheel-and-tire dolly under the front wheel assembly being serviced. Remove the wheel nuts, then raise and remove the wheel assembly. Be careful not to damage the threads of the wheel studs as the wheel is pulled away.
3. If removing wheels and tires from a rear axle:
   .1 Raise the rear of the vehicle until the tires clear the floor. Place safety stands under the axle being serviced.
   .2 Deflate both tires of the dual assembly being serviced by removing the valve cores.
   .3 Place a jack or wheel-and-tire dolly under the outer wheel assembly. Remove the outer wheel nuts, then raise and remove the outer wheel. Be careful not to damage the threads of the inner wheel nuts as the outer wheel is pulled away.
   .4 Place a jack or wheel-and-tire dolly under the inner wheel assembly. Remove the inner wheel nuts, then raise and remove the inner wheel. Be careful not to damage the threads of the wheel studs as the inner wheel is pulled away.

Installation

NOTE: Before installing a wheel and tire assembly, inspect it using the instructions under "Wheel and Components Inspection." Also, follow the requirements under "Tire Matching and Mixing."

1. Clean the hub and wheel mounting surfaces, and between the rims of dual wheels. Make sure the tire is inflated using the procedures under "Tire Inflation."
2. If installing a front wheel assembly:
   .1 Use a jack or wheel-and-tire dolly to mount the wheel assembly on the wheel studs. Be careful not to damage the threads of the wheel studs when installing the wheel assembly.
   .2 Install a wheel nut on each wheel stud, and run them up until each nut is flush with the face or the chamfer of the wheel. Rotate the wheel a half turn to seat the parts.
   .3 Tighten the wheel nuts 50 lbf·ft (68 N·m), following the sequence in Fig. 9.
   .4 Using the same sequence, tighten the wheel nuts again, to the torque in Table 1, under Specifications.

WARNING: If the wheel nuts cannot be tightened to minimum torque values, the studs could be turning in the hub flange, having lost their locking ability. In this situation, the wheel hub assembly is damaged and must be replaced with a new assembly.

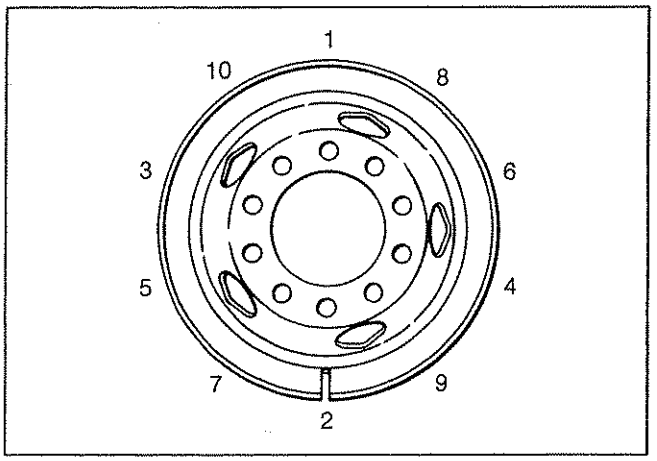


Fig. 9, 10-Stud Disc Wheel Tightening Sequence

WHEEL AND TIRE SERVICING

Failure to reach minimum torque values could also be caused by stripped threads on the wheel studs or wheel nuts. Again, damaged parts must be replaced with new parts, as described in Group 10, "Front Axle," or Group 11, "Rear Axle" of this manual. Failure to replace damaged parts could result in the loss of a wheel and loss of vehicle control, causing property damage or personal injury.

3. If installing a rear wheel assembly:

   .1 Use a jack or wheel-and-tire dolly to mount the inner wheel assembly on the wheel studs. Be careful not to damage the threads of the wheel studs when installing the wheel assembly.

   IMPORTANT: Mount the wheel assembly so that the balance weight(s) on the wheels are 180 degrees opposite the balance weight(s) on the brake drum (Fig. 10).

   If, on two-handhole wheels, this causes the valve stems to be in the same wheel hole, mount the outer wheel so that the outer wheel balance weight(s) are on the same side of the assembly as the brake drum balance weight(s). See Fig. 11.

   If, on five-handhole or aluminum wheels, the valve stems are in the same handhole, separate the valve stems by one hole. Install the wheel weights evenly and as close to 180 degrees opposite the brake drum balance weight(s) as possible. See Fig. 12.

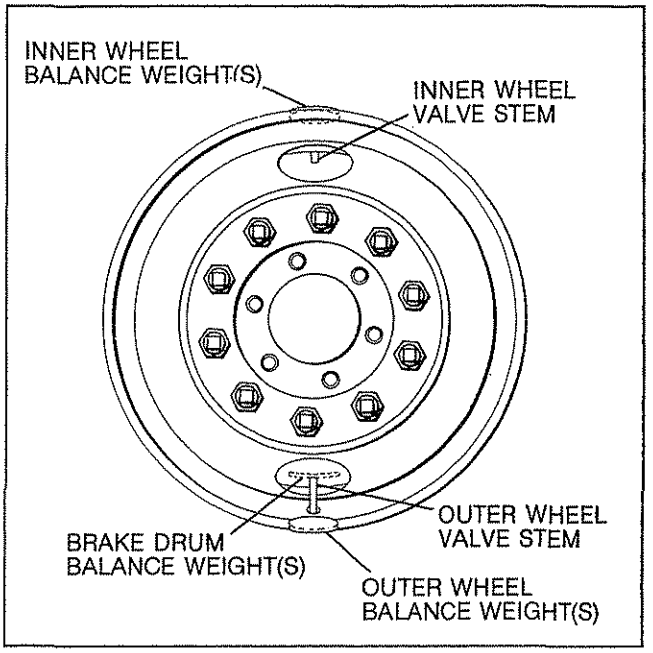


Fig. 11, Alternate Location of Wheel and Brake Drum Balance Weights, Two-Handhole Wheels

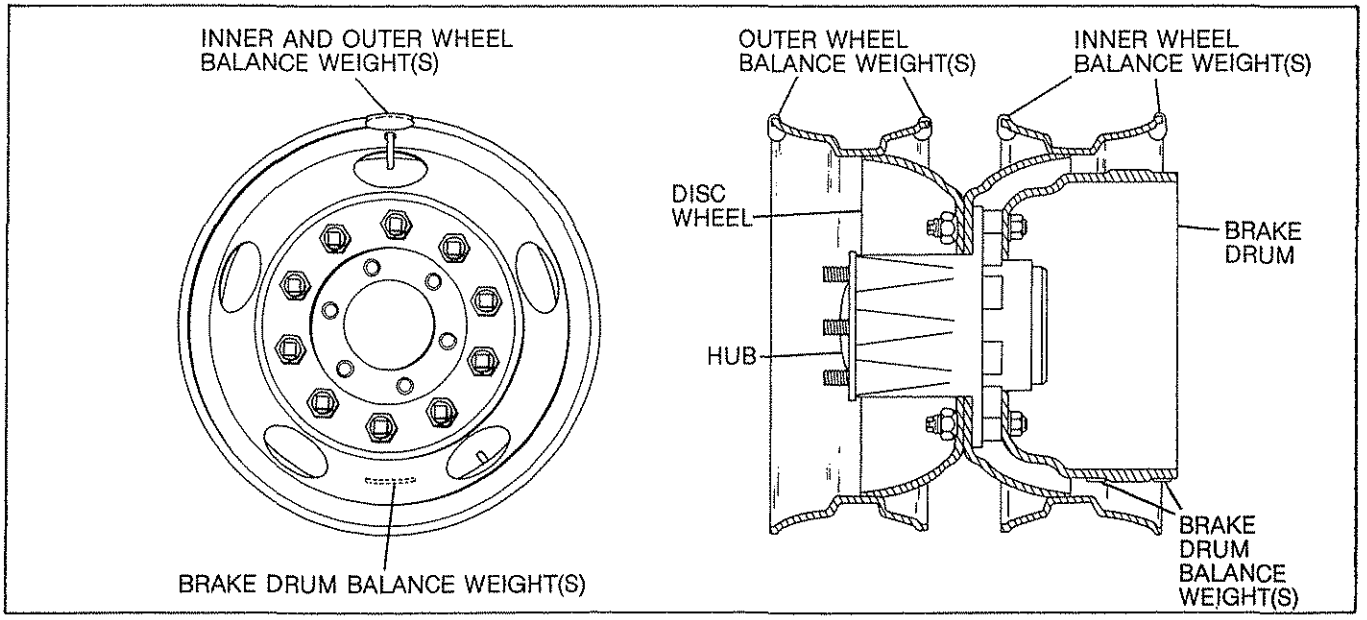


Fig. 10, Recommended Location of Wheel and Brake Drum Balance Weights

WHEEL AND TIRE SERVICING

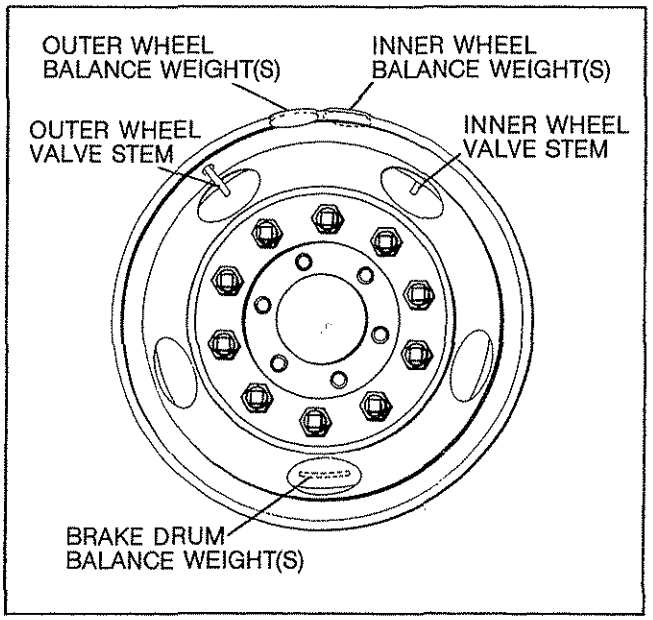


Fig. 12, Alternate Location of Wheel and Brake Drum Balance Weights, Five-Handhole or Aluminum Wheels

.2 Install the inner wheel nuts on each wheel stud, and run them up until each nut is flush with the face or the chamfer of the wheel. Rotate the wheel a half turn to seat the parts.

.3 Tighten the inner wheel nuts 50 lbf·ft (68 N·m), following the sequence in Fig. 9.

.4 Using the same sequence, tighten the inner wheel nuts again, to the torque in Table 1, under Specifications.

WARNING: If the wheel nuts cannot be tightened to minimum torque values, the studs could be turning in the hub flange, having lost their locking ability. In this situation, the wheel hub assembly is damaged and must be replaced with a new assembly.

Failure to reach minimum torque values could also be caused by stripped threads on the wheel studs or wheel nuts. Again, damaged parts must be replaced with new parts, as described in Group 10, "Front Axle," or Group 11, "Rear Axle" of this manual. Failure to replace damaged parts could result in the loss of a wheel and loss of vehicle control, causing property damage or personal injury.

.5 Use a jack or wheel-and-tire dolly to mount the outer dual wheel on the inner wheel nuts. Be careful not to damage the threads of the inner wheel nuts when installing the wheel assembly.

.6 Install the outer wheel nuts following the procedures above.

4. Remove the safety stands, lower the vehicle, and remove the chocks.

5. After operating the vehicle for 50 to 100 miles (80 to 160 km), retighten the wheel nuts to the torque in Table 1, under Specifications. Follow the sequence in Fig. 9.

NOTE: When retightening the inner wheel nuts, loosen the outer wheel nuts several turns, retighten the inner wheel nuts, then the outer wheel nuts.

CAUTION: Locknuts seat during vehicle operation. It is necessary to periodically tighten the wheel nuts to the specified torque. Not enough wheel nut torque can cause wheel shimmy, wheel damage, stud breakage, and extreme tire tread wear. Too much wheel nut torque can break studs, damage threads, and crack discs in the stud hole area. Use the specified torque values, and follow the tightening sequence in Fig. 9.

SPOKE WHEEL, TIRE AND RIM ASSEMBLY; REMOVAL AND INSTALLATION

Removal

1. Chock all tires that will not be serviced, to prevent vehicle movement.

2. If removing tire and rim assemblies from the front axle:

   .1 Set the parking brake.

   .2 Raise the front of the vehicle until the tires clear the floor. Place safety stands under the front axle.

   .3 Deflate the tire being serviced by removing the valve core.

   .4 Place a jack or wheel-and-tire dolly under the front tire and rim assembly being serviced. Remove the rim nuts and rim clamps, then slide the tire and rim assembly off the wheel.

3. If removing tire and rim assemblies from a rear axle:

   .1 Raise the rear of the vehicle until the tires clear the floor. Place safety stands under the axle being serviced.

WHEEL AND TIRE SERVICING

.2 Deflate the tire(s) being serviced by removing the valve core(s).

.3 Place a jack or wheel-and-tire dolly under the outer tire and rim assembly being serviced. Remove the rim nuts and clamps; then slide the outer tire and rim off.

.4 Remove the rim spacer. Place a jack or wheel-and-tire dolly under the inner tire and rim assembly, and slide it off.

Installation

NOTE: Before installing a wheel and tire assembly, inspect it using the instructions under "Wheel and Components Inspection." Also, follow the requirements under "Tire Matching and Mixing."

1. Clean the wheel, rim spacer, and rim mounting surfaces. The mounting surface of the wheel is the 28-degree taper on the inboard side of each spoke. See **Fig. 13.**
2. Make sure the tire and rim assembly is inflated using the procedures under "Tire Inflation."
3. If installing a front tire and rim assembly:

   .1 Slide the assembly over the wheel and push it into place against the tapered mounting surface. It should fit snugly against all the tapers. Be sure that the valve stem faces out and is centered between two spokes.

   .2 Install the rim clamps and nuts. Run the nuts up until the end of each wheel stud is flush with the face of its nut. Rotate the wheel a half turn to seat the parts.

   .3 Tighten the rim nuts a quarter turn at a time, following the star pattern shown in **Fig. 14.** Continue until all the rim nuts are tightened to the torque in **Table 2,** under Specifications.

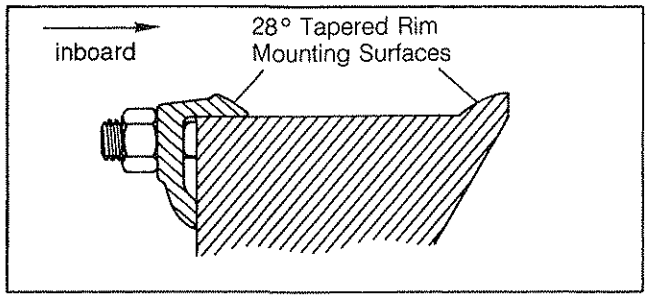


Fig. 13, Spoke Wheel Tapered Mounting Surface

CAUTION: Failure to tighten the nuts in the sequence shown, and to the correct torque, could cause misalignment of the tire and chording of the rim (Fig. 15). This would result in excessive vehicle vibration and permanent damage to the rim and wheel.

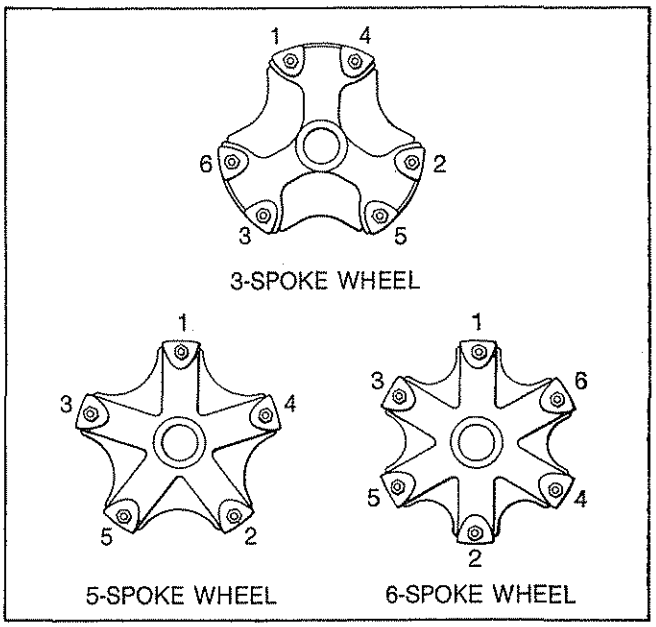


Fig. 14, Spoke Wheel Tightening Sequence

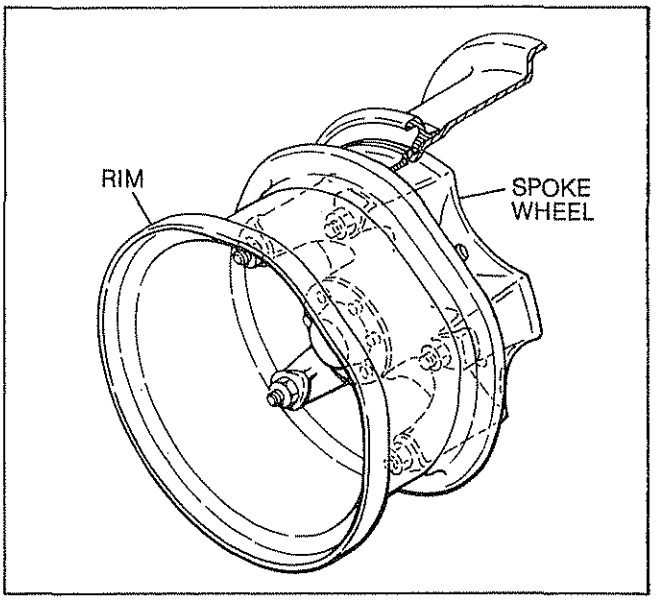


Fig. 15, Out-of-Round Rim (Rim Chording)

WHEEL AND TIRE SERVICING

WARNING: If the wheel nuts cannot be tightened to minimum torque values, the studs could be turning in the hub flange, having lost their locking ability. In this situation, the wheel hub assembly is damaged and must be replaced with a new assembly.

Failure to reach minimum torque values could also be caused by stripped threads on the wheel studs or wheel nuts. Again, damaged parts must be replaced with new parts, as described in Group 10, "Front Axle," or Group 11, "Rear Axle" of this manual. Failure to replace damaged parts could result in the loss of a wheel and loss of vehicle control, causing property damage or personal injury.

NOTE: When replacing a spoke wheel, contact the wheel manufacturer for the correct torque value for the brake drum nuts attaching the spoke wheel to the brake drum.

4. If installing a rear tire and rim assembly:

   .1 Slide the inner tire and rim over the wheel hub. Push it into position against the tapered mounting surface. Make sure the valve stem faces out and is centered between two spokes.

   .2 Slide the rim spacer over the wheel hub.

   .3 Slide the outer tire and rim over the wheel hub. Make sure the valve stem faces inward, and is in the same position as the inner valve stem.

   .4 Push the whole assembly in place, so that the inner rim fits snugly against the tapers all around, the spacer is seated against the inner rim, and the outer rim is seated against the spacer.

   .5 Install the rim clamps and nuts. Run the nuts up until the end of each stud is flush with the face of its nut. Rotate the wheel a half turn to allow the parts to seat.

   .6 Tighten the rim nuts a quarter turn at a time, following the star pattern shown in **Fig 14**. Continue until all the rim nuts are tightened to the torque in **Table 2**, under Specifications.

   .7 The clamps must not bottom out until at least 80 percent of the recommended torque is reached. If the clamps do bottom out, make sure the correct clamps and rim spacers are being used. Make sure the rim edges contact the spacer edges.

   CAUTION: Failure to tighten the nuts in the sequence shown, and to the correct torque, could cause misalignment of the tire and chording of the rim (Fig. 15). This would result in excessive vehicle vibration and permanent damage to the rim and wheel.

   WARNING: If the wheel nuts cannot be tightened to minimum torque values, the studs could be turning in the hub flange, having lost their locking ability. In this situation, the wheel hub assembly is damaged and must be replaced with a new assembly.

   Failure to reach minimum torque values could also be caused by stripped threads on the wheel studs or wheel nuts. Again, damaged parts must be replaced with new parts, as described in Group 10, "Front Axle," or Group 11, "Rear Axle" of this manual. Failure to replace damaged parts could result in the loss of a wheel and loss of vehicle control, causing property damage or personal injury.

NOTE: When replacing a spoke wheel, contact the wheel manufacturer for the correct torque value for the brake drum nuts attaching the spoke wheel to the brake drum.

5. Check the wheel alignment by placing a block of wood or any other point of reference on the floor next to the tire. Rotate the tire and note any variations in the space between the tire and the block. If the variation exceeds 1/16-inch (1.5 mm) for front rims, or 1/8-inch (3 mm) for rear duals, the rim is not correctly mounted.

   To correct any misalignment, loosen the rim nuts where the largest gap occurs, and tighten the nuts on the opposite side. Recheck and correct until the variation is corrected. Make sure the rim nuts are tightened to the correct torque in **Table 2**, under Specifications.

6. Remove the safety stands, lower the vehicle, and remove the chocks.

7. After driving the vehicle for 50 to 100 miles (80 to 160 km), retighten the rim nuts to the torque specified in **Table 2**, under Specifications. Follow the sequence shown in **Fig. 14**.

WHEEL AND TIRE SERVICING

TIRE MATCHING AND MIXING

IMPORTANT: Review and follow these requirements for matching and mixing tires, before installing any tire and wheel or rim assembly on a vehicle.

Before changing wheels and tires, consider the effect that the change may have on the Gross Vehicle Weight Rating (GVWR) of the vehicle. At the time of vehicle certification, the GVWR is calculated by adding the vehicle's Gross Axle Weight Ratings (GAWR). The GVWR and each of the GAWRs are shown on a certification label (U.S.-purchased tractors) or "Statement of Compliance" label (Canadian-purchased tractors) attached to the left rear door post. See **Fig. 16**.

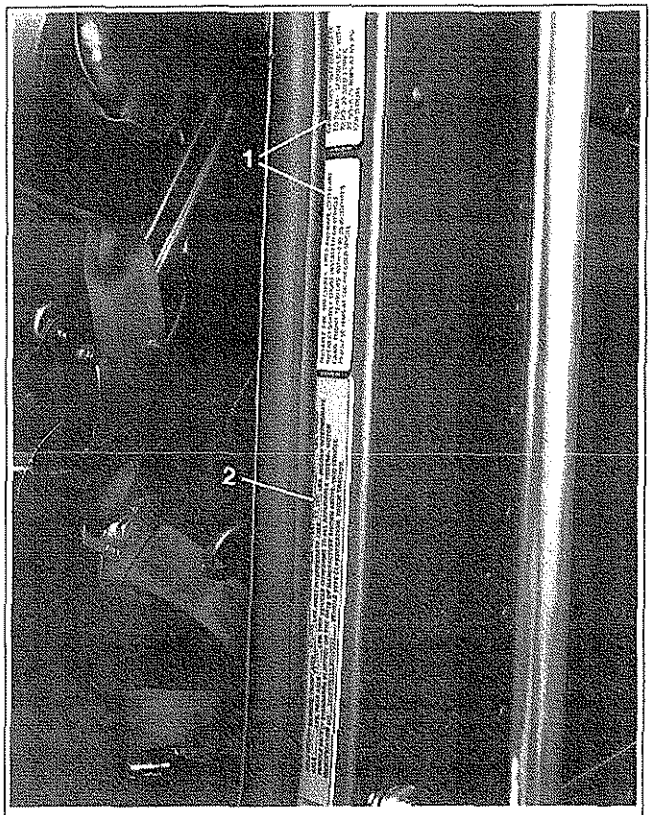
Tire and rim labels (**Figs. 16** and 17) certify the minimum tire and rim combinations that can be installed on the vehicle for the given GAWRs. Each GAWR is determined by considering each component of the axle system, including suspension, axle, wheels, and tires. The lowest component's capacity is the value used for the system. Therefore, the tires and rims installed on the vehicle at the time of vehicle manufacture may have a higher load capacity than that certified by the tire and rim label. Tires and rims of the minimum capacity can be installed without changing the load limitations. If tires and rims are installed that have a lower load capacity than that shown on the tire and rim label, then the tires and rims determine the load limitations (the GAWRs and GVWR will be lower).

When pairing tires in a dual assembly, the tire diameters must not differ by more than 1/4-inch (6.4 mm), or the tire circumference by more than 3/4-inch (19 mm). The total tire circumference of one driving rear axle must match, as nearly as possible, the total tire circumference of the other driving rear axle.

CAUTION: Mismatching dual tires overloads the larger diameter tire, causing it to overdeflect and overheat. The smaller diameter tire, lacking proper road contact, wears faster and unevenly. Tread or ply separation, tire body breaks, and blowouts can occur from mismatched duals.

With an endless pi tape (**Fig. 18**) or square (**Fig. 19**), measure the diameter of the tires 24 hours after inflation. A matching stick (**Fig. 20**), string gauge (**Fig. 21**), or tire straight edge (**Fig. 22**) can also be used to determine the difference in tire radius, which is then doubled to calculate the diameter difference.

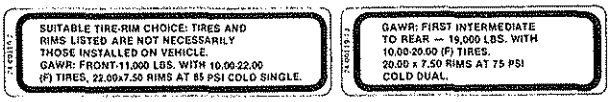
When pairing tires of unequal diameters (but within the above limits), mount the larger tire on the outside.



1. Tire and Rim Labels
2. Certification Label

pf60_0061h

Fig. 16



NOTE: Labels shown are examples only. Actual specifications may vary from vehicle to vehicle.

Fig. 17

CAUTION: Driving a vehicle on one tire of a dual assembly dangerously exceeds the carrying capacity of the single tire and wheel. Operating in this manner can cause damage to the wheel and tire.

Inflate, to within 5 psi (35 kPa) of one another, all tires on an axle, or on both axles of a tandem unit. For tire inflation specifications, refer to the Charts and Specifications section of the *COE and 120 Conventional Maintenance Manual.*

WHEEL AND TIRE SERVICING

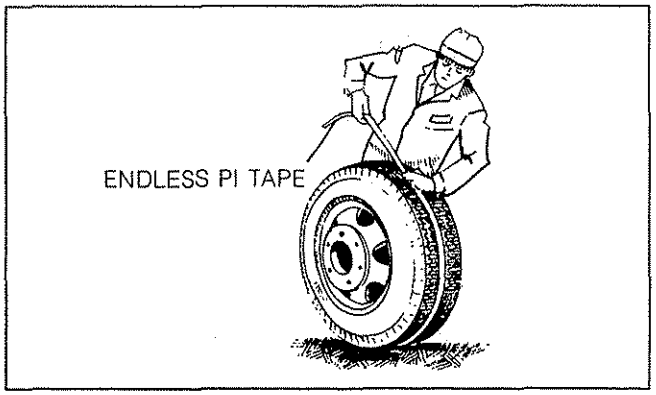


Fig. 18, Endless Pi Tape

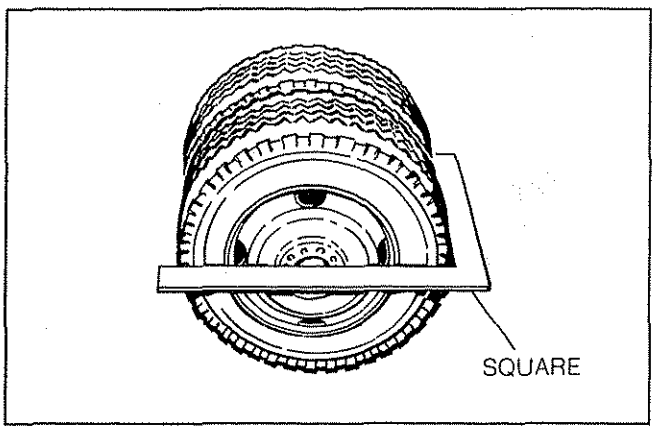


Fig. 19, Square

There must be sufficient space between dual tires for air to flow and cool the tires, and to prevent the tires from rubbing against one another. Rims and wheels of the same size, but of different makes and types, can have different offsets, which would affect dual spacing. If there is sidewall contact between tires, or between the inside tire and the chassis, refer to the tire manufacturer's catalog to determine the minimum dual spacing. Refer to the rim or wheel manufacturer's catalog to determine the correct offset.

Federal Motor Carrier Safety regulations require the removal of all tires with less than 4/32-inch (3 mm) remaining groove depth on a front axle, and tires with less than 2/32-inch (1.5 mm) remaining groove depth on a rear axle. However, tires with the word "Regroovable" on the sidewall, may be regrooved.

Better tire and vehicle performance is usually obtained by using tires of the same size and construction. Using tires of different construction is permitted if the following rules are observed:

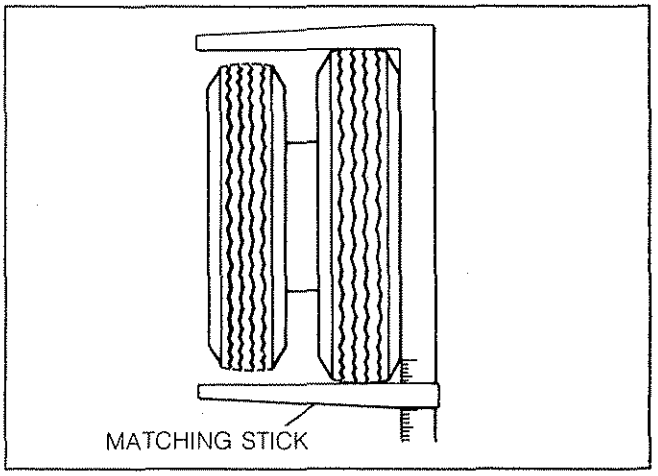


Fig. 20, Matching Stick

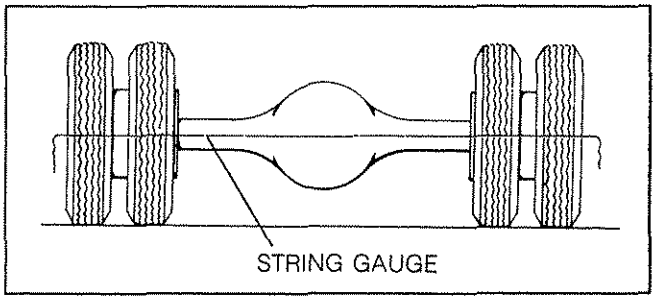


Fig. 21, String Gauge

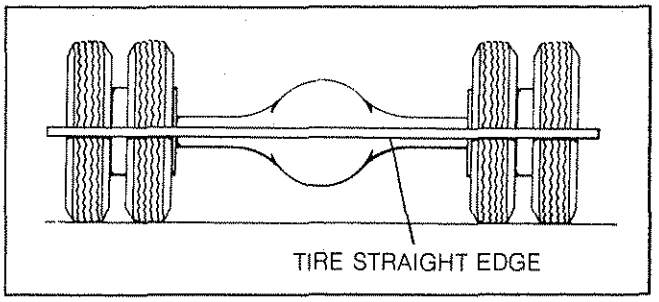


Fig. 22, Tire Straight Edge

- Do not mix radial and bias ply tires on the same axle.
- If both radial and bias ply tires are used, better handling is usually obtained by using the bias ply tires on the front axle.
- Use either all radial or all bias ply tires on the non-driving rear axles of a vehicle. However, all radial or all bias ply tires must be used on vehicles with tandem drive-axles.

CAUTION: Mixing radial and bias ply tires should be done as an emergency measure only. Some loss of steering

WHEEL AND TIRE SERVICING

control and premature tire wear could occur when driving under such conditions.

If installing radial tires on a vehicle formerly equipped with bias ply tires, refer to the vehicle maintenance manual concerning the inflation needs and load limits of the bias ply tires being removed, and of the radial ply tires being installed. Radial ply tires permit greater loads per tire, but also require higher inflation. They can also cause higher stresses on rims and wheels than bias ply tires. Contact the rim or wheel manufacturer about the compatibility of the rim or wheel with radial ply tires. Also, refer to the vehicle maintenance manual for information on the possible differences in toe-in setting between radial and bias ply tires.

TIRE DEMOUNTING AND MOUNTING

Service Precautions

IMPORTANT: Don't mount or demount tires without proper training as required in Occupational Safety and Health Administration (OSHA) Rules and Regulations 1910.177, *Servicing Multi-Piece and Single Piece Rim Wheels*. Service information containing mounting and demounting instructions are available through your rim supplier. Charts detailing service procedures are available through OSHA area offices. The address and telephone number of the nearest OSHA area office can be obtained by looking in the local telephone directory under U.S. Government, Labor Department of Occupational Safety and Health Administration.

Use the information from the above sources with the following precautions before and during the demounting and mounting of tires:

- Examine all wheel and tire parts as explained under the headings "Wheel and Components Inspection" and "Tire and Components Inspection." Replace damaged, rusted, or worn parts.
- Since wheels and rims are under stress, and are dangerous if improperly assembled, be sure all parts of an assembly match in size, manufacturer, and classification within a manufacturer's line. Before assembling the wheel or rim, check the catalog issued by the wheel or rim manufacturer for the correct part numbers and sizes of approved parts. Never use a part that does not bear clear, legible, and correct numbers and manufacturer's identification, even if that part appears to fit.
- Make sure that tires are stored indoors, or outdoors under cover, to prevent water collecting inside the tire.
- Use special tools, as recommended by tire suppliers, for mounting and demounting tires. These tools must be smooth, and used with care, to avoid gouging the rim.
- Loosening tire beads may be difficult, since considerable force may be needed. The use of a machine designed for loosening tire beads is recommended.
- Handle the wheels and rims on a wooden floor or rubber mat to prevent nicking or gouging the wheel or rim.
- Do not use a duck-bill hammer, or any steel hammer on wheel or rim parts. Use rubber, leather-faced, or plastic mallets to tap parts together, if necessary.
- Lubricate the tire with an approved tire-mounting lubricant. Never use antifreeze, silicones, petroleum-based lubricants, or any flammable material (ether/starting aid).
- When lubricating a tire prior to mounting, make sure excess lubricant does not run into the tire.
- Michelin Tire Corporation recommends applying lubricant to the valley of the tire, formed by the tire and rim, before using tools to break the bead.
- Michelin also recommends applying a sufficient but sparing amount of lubricant to the entire rim face when mounting a tire on a rim, to ensure correct bead seating and ease of mounting.
- Balance the tire and wheel or rim assembly before installing the assembly on a vehicle.
- Don't reinflate a tire that has been run flat or has been run at 80 percent or less of its recommended operating pressure. Use your spare. Before removing the low tire from the vehicle, make sure it is completely deflated. Later, have the assembly taken apart and all the parts checked for damage, including the side or lockrings.
- The air pressure contained in a tire is dangerous. When servicing a tire, stay out of any potential path or route that a rim wheel component may travel during an explosive separation.

Tubeless Tires on One-Piece Drop Center Wheels or Rims

5 Degree Full Drop Center

WARNING: Read the information under "Tire Demounting and Mounting: Service Precautions." Failure to follow the precautions, before and during tire demounting and mounting, could cause tire or rim damage while servicing or in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

WHEEL AND TIRE SERVICING

To demount or mount tubeless tires on 5 degree full drop center rims, regular or safety type, follow the same procedures used to demount or mount tubeless automobile tires.

15 Degree Tapered Drop Center

WARNING: Read the information under "Tire Demounting and Mounting: Service Precautions." Failure to follow the precautions, before and during tire demounting and mounting, could cause tire or rim damage while servicing or in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

To demount the tire from the wheel or rim, proceed as follows:

1. Deflate the tire being serviced by removing the valve core. Check the valve stem by running a piece of wire through the stem to make sure it is not plugged.
2. Loosen both beads from the rim by driving the flat end of the tire tool between the tire bead and the rim flange. Holding the tool upright, hammer on the neck to free the tire bead from the rim (Fig. 23). Repeat at 8-inch (20 cm) intervals around the flanges, until both beads are free from the rim.
3. Place the wide side of the rim down. Lubricate the tire bead and the rim. Insert the curved end of two tire tools between the bead and the rim, and just to one side of the tire valve. Step on the side of the tire, opposite from the valve, to force the first bead into the rim well (Fig. 24). Hold one of the tools in place with your foot and pry with the second tool, forcing the bead over the rim flange. Continue to work the first bead off of the rim.
4. When the first bead is off the rim, and the second bead is in the rim well, stand the assembly upright with the valve stem near the top. Lubricate the second bead and rim. Insert the straight end of the tool between the tire bead and the back rim flange, hooking the tool over the second flange. Lean the tire assembly toward the tool and use a rocking or bouncing action to pry the rim out of the tire. See Fig. 25.
5. Clean and inspect all parts. Refer to "Wheel and Components Inspection" and "Tire and Components Inspection" for procedures.

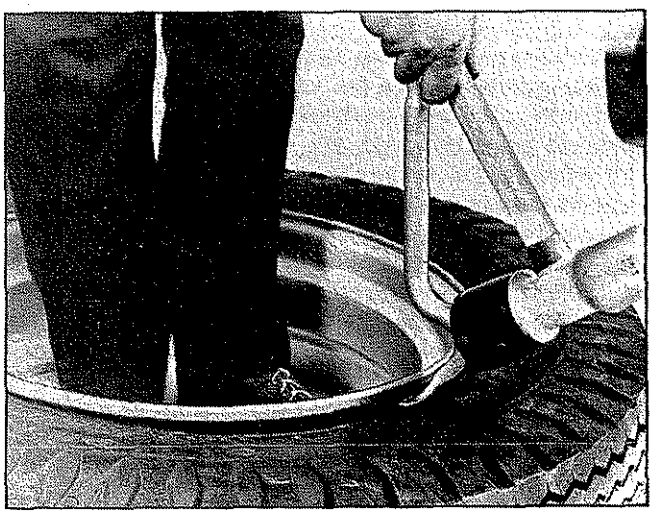


Fig. 23

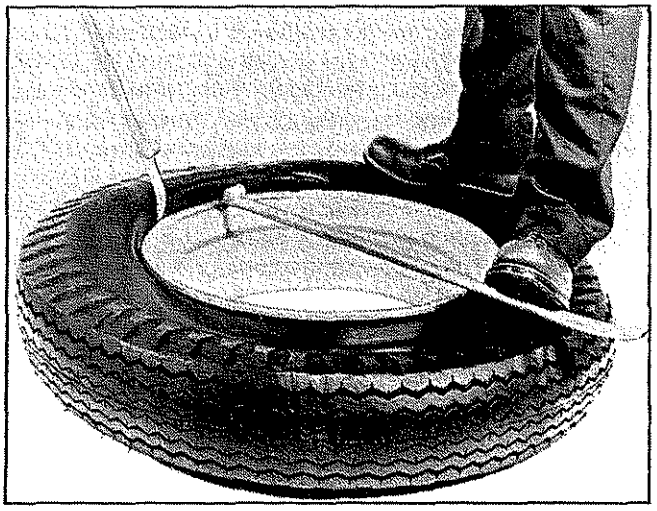


Fig. 24

To mount the tire onto the wheel or rim, proceed as follows:

1. Place the valve stem, with a rubber washer, through the valve hole from the tire side of the rim. Screw on the valve nut from the opposite side. Make sure the rubber bushing and metal collar or nut are centered and fit snugly in the valve hole (Fig. 26). Tighten the nut securely.
2. Place the rim on the floor with the wide side down. Using a brush or swab, lubricate both bead seats (flanges) of the rim, and both tire beads, with an approved lubricant. Apply enough lubricant to enable

WHEEL AND TIRE SERVICING

Fig. 25

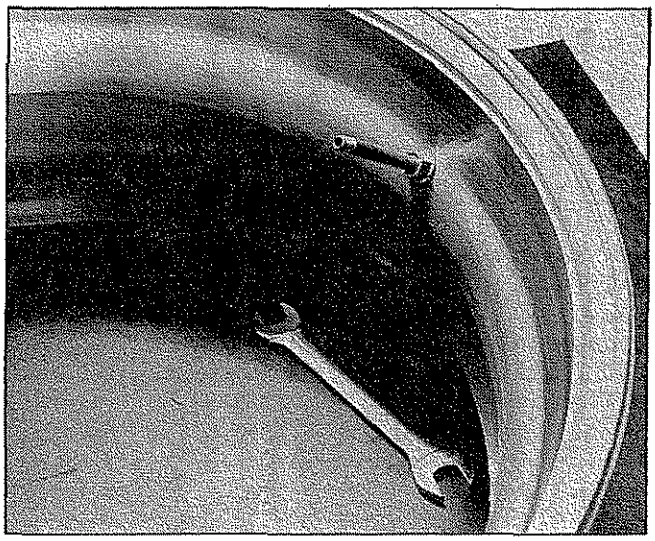


Fig. 26

correct bead seating, and to make mounting easier. Don't let excess lubricant run inside the tire.

3. Lay the tire on the rim. If there is a balance mark on the tire, line up this mark with the valve stem. Push the lower bead over the flange and into the rim well. Using the straight end of the tire tool (with the stop resting on the rim flange), take small bites to work the remaining section of the bead into the rim. See Fig. 27.

4. Start the upper bead over the rim flange and into the rim well by standing on the tire. If necessary, push a section of the bead into the rim well, and anchor it by attaching Vise-Grip® pliers to the rim flange (snub side toward the tire). Using the spoon end of the tire iron, with the stop toward the rim, work around the bead (Fig. 28). Use small bites until the bead slips over the flange and into the rim well. If necessary, insert a second tire iron and relubricate the last 8 inches (20 cm) of bead.

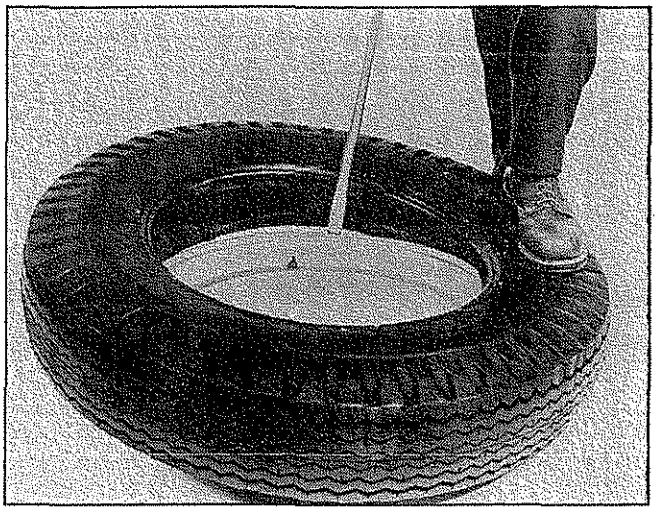


Fig. 27

5. Inflate the tire. Refer to "Tire Inflation" for procedures.

Tube-Type Tires on Two-Piece Flat Base Wheels or Rims

Continuous Base, Split Side Ring

WARNING: Read the information under "Tire Demounting and Mounting: Service Precautions." Failure to follow the precautions, before and during tire demounting and mounting, could cause tire or rim damage while servicing or in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

To demount the tire from the wheel or rim, proceed as follows:

1. Deflate the tire being serviced by removing the valve core. Check the valve stem by running a piece of wire through the stem to make sure it is not plugged.

2. Place the assembly on the floor, side ring up. Insert the hooked ends of the tire tools between the side ring and the sidewall of the tire. Pry the bead loose from the side ring using downward pressure on the

WHEEL AND TIRE SERVICING

Fig. 28

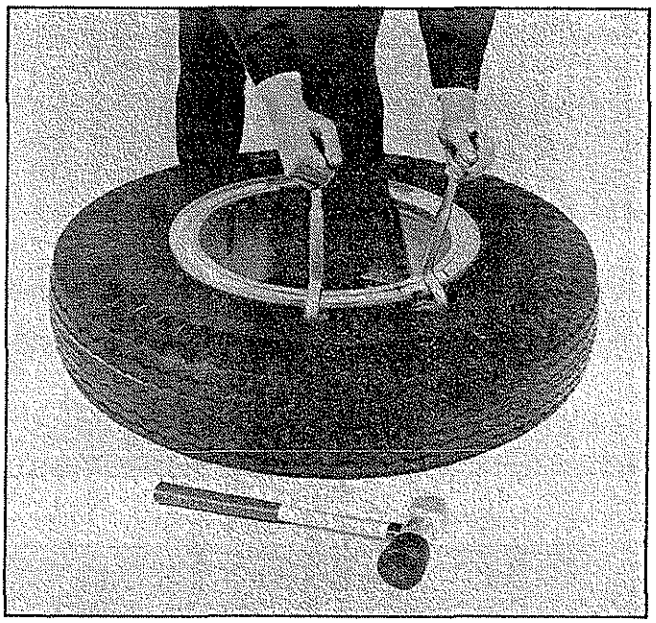


Fig. 29

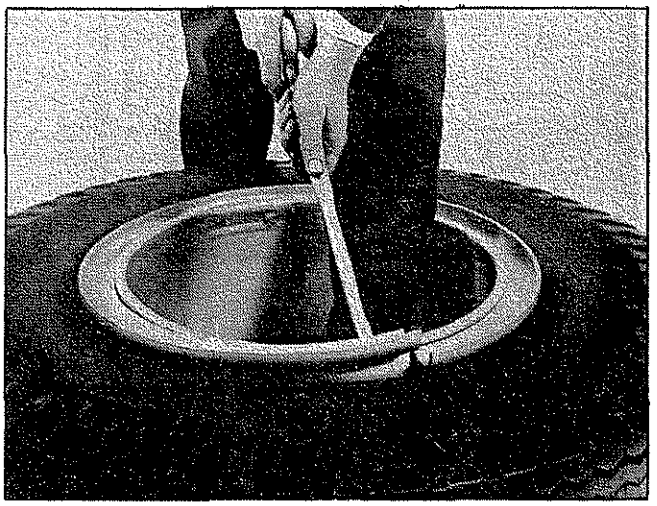


Fig. 30

tools (**Fig. 29**). Continue prying around the rim until the bead is loose.

3. Insert the tapered end of the tool into the prying notch on the side ring (**Fig. 30**). Pry the side ring from its groove in the rim by prying around the tire until the ring is free.
4. Turn the assembly over, and unseat the second tire bead from the rim. Lift the rim from the tire, and remove the tube and flap from the tire.
5. Clean and inspect all parts. Refer to "Wheel and Components Inspection" and "Tire and Components Inspection" for procedures.

To mount the tire onto the wheel or rim, proceed as follows:

1. Place the tube in the tire, then partially inflate it to round it out. Apply an approved tire lubricant to the inside and outside surfaces of both beads and to the portion of the tube that appears between the beads. Insert the flap, and lubricate the portion of the flap that faces the rim. Apply enough lubricant to enable correct bead seating, and to make mounting easier. Don't let excess lubricant run inside the tire.
2. Lay the rim flat on the floor with the valve slot up. Align the valve with the rim valve-slot. Place the tire on the rim, and insert the valve through the valve slot.
3. Place the side ring on the rim base so that the ring split is opposite the valve stem. Snap the leading end

WHEEL AND TIRE SERVICING

of the side ring into the rim groove (Fig. 31). Progressively "walk" the side ring into place. Check that the side ring is seated in the groove.

4. Inflate the tire. Refer to "Tire Inflation" for procedures.

Split Base, Continuous Side Ring

WARNING: Read the information under "Tire Demounting and Mounting: Service Precautions." Failure to follow the precautions, before and during tire demounting and mounting, could cause tire or rim damage while servicing or in use. An incorrectly mounted tire can burst causing equipment damage and personal injurv.

To demount the tire from the wheel or rim, proceed as follows:

1. Deflate the tire being serviced by removing the valve core. Check the valve stem by running a piece of wire through the stem to make sure it is not plugged.
2. Place the assembly on the floor, side ring up. Insert the hooked ends of the tools between the side ring and the sidewall of the tire. Pry the bead loose from the side ring using downward pressure on the tools (Fig. 29). Continue prying around the tire until the bead is loose.
3. Insert the tapered end of the tool into the breaking notch near the rim split, and push downward, partially offsetting the rim ends.
4. Insert the tapered end of the tool in the second rim notch, and push downward, prying the continuous side ring from the rim. See Fig. 32.
5. Turn the assembly over, and unseat the second tire bead from the rim. Lift the rim from the tire, and remove the tube and flap from the tire.
6. Clean and inspect all parts. Refer to "Wheel and Components Inspection" and "Tire and Components Inspection" for procedures.

To mount the tire onto the wheel or rim, proceed as follows:

1. Place the tube in the tire, then partially inflate it to round it out. Apply an approved tire lubricant to the inside and outside surfaces of both beads and to the portion of the tube that appears between the beads. Insert the flap, and lubricate the portion of the flap that faces the rim. Apply enough lubricant to enable correct bead seating, and to make mounting easier. Don't let excess lubricant run inside the tire.

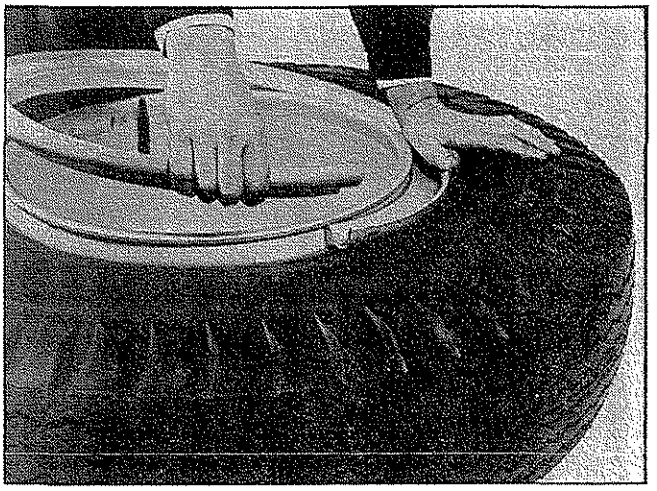


Fig. 31

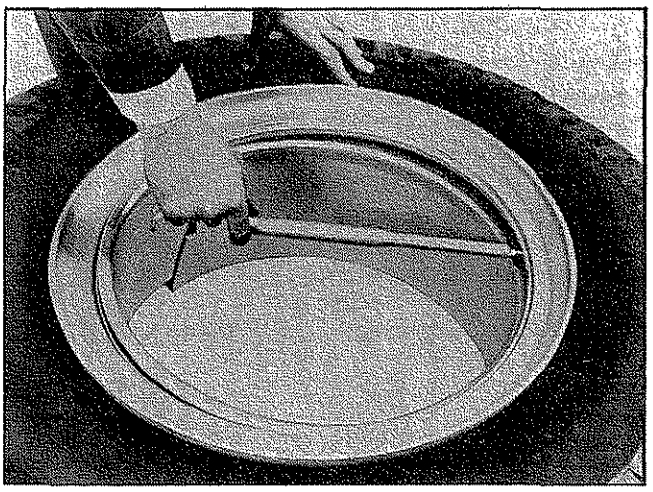


Fig. 32

2. Spread the rim base by placing a wooden block under the left side of the rim split (as shown in Fig. 33). Place the tire, tube, and flap, over the rim base. Lay the rim flat on the floor with the valve slot up. Align the valve with the rim's valve slot. Place the tire on the rim, and insert the valve through the valve slot.
3. Install the side ring by starting at the left side of the split and "walking" the ring into place.
4. Turn the assembly over. With the fixed flange side up, place a wooden block under the right side of the split. Tap the rim base, as shown in Fig. 34, until the split is correctly aligned.
5. Inflate the tire. Refer to "Tire Inflation" for procedures.

WHEEL AND TIRE SERVICING

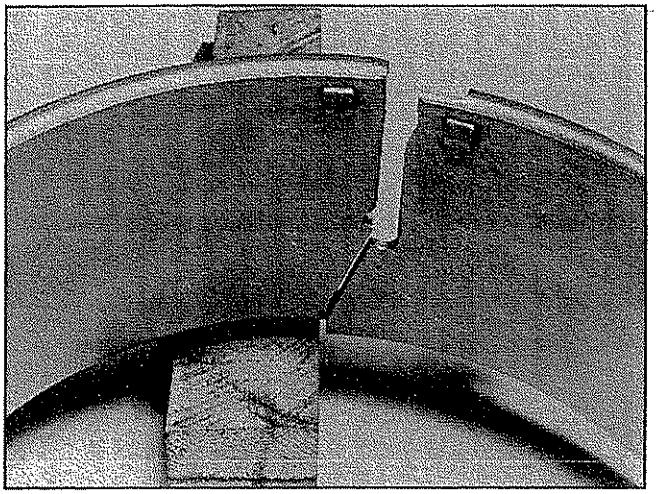


Fig. 33

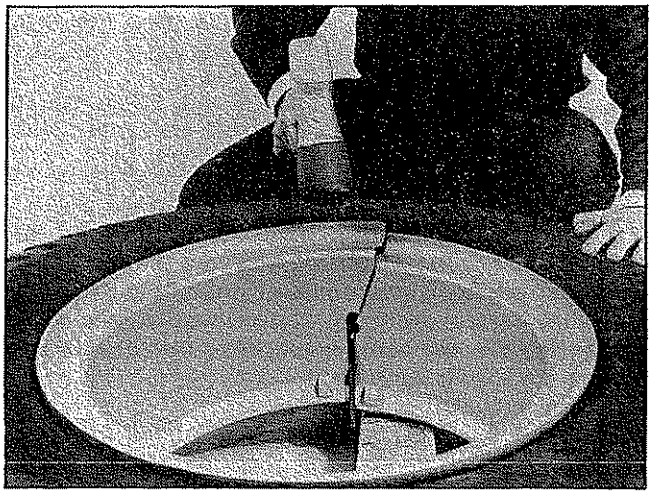


Fig. 34

Continuous Base, Continuous Side Ring

WARNING: Read the information under "Tire Demounting and Mounting: Service Precautions." Failure to follow the precautions, before and during tire demounting and mounting, could cause tire or rim damage while servicing or in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

To demount the tire from the wheel or rim, proceed as follows:

1. Deflate the tire being serviced by removing the valve core. Check the valve stem by running a piece of wire through the stem to make sure it is not plugged.
2. Loosen the tire bead from the side ring by driving the curved end of a rim tool between the side ring and the bead (**Fig. 35**). Pry the bead loose from the side ring, using downward pressure on the tool. Continue prying around the tire until the bead is loose.
3. Insert the straight end of a rim tool into the notch (located between embossings) in the side ring, as shown in **Fig. 36**. Push the ring downward at the point opposite the notch. At the same time, force the tool handle downward to disengage the ring from the rim gutter. Continue prying the side ring away from the rim gutter until it is loose.
4. Turn the assembly over, and unseat the second tire bead the same way the first bead was loosened from the side ring in step 2. Stand the tire up, then remove the rim base. Remove the tube and flap from the tire.

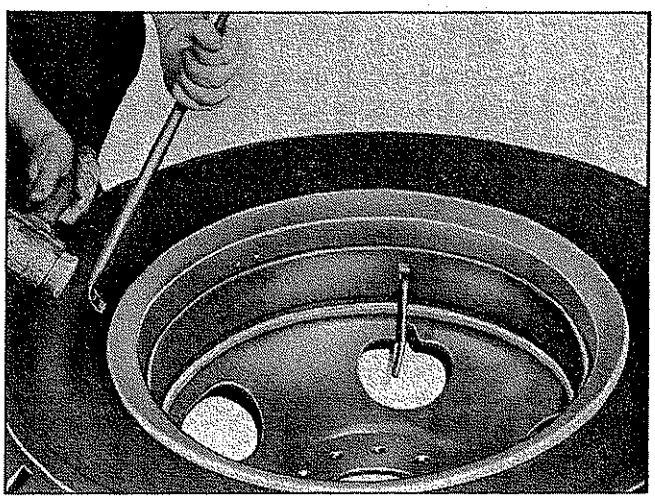


Fig. 35

5. Clean and inspect all parts. Refer to "Wheels and Components Inspection" and "Tire and Components Inspection" for procedures.

To mount the tire onto the wheel or rim, proceed as follows:

1. Place the tube in the tire, then partially inflate it to round it out. Apply an approved tire lubricant to the inside and outside surfaces of both beads and to the portion of the tube that appears between the beads. Insert the flap, and lubricate the portion of the flap that faces the rim. Apply enough lubricant to enable correct bead seating, and to make mounting easier. Don't let excess lubricant run inside the tire.

WHEEL AND TIRE SERVICING

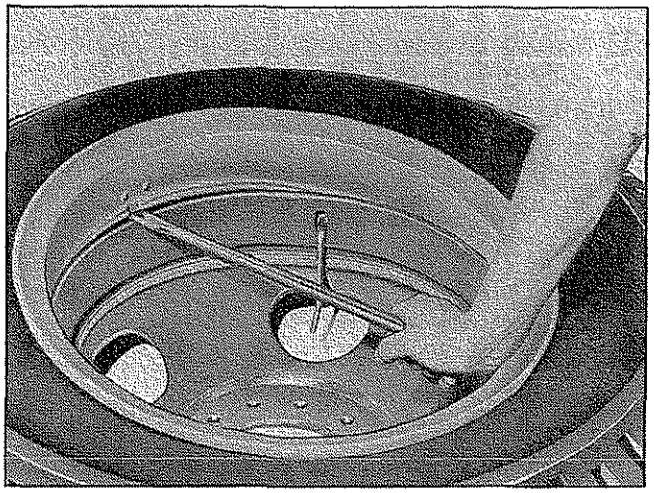


Fig. 36

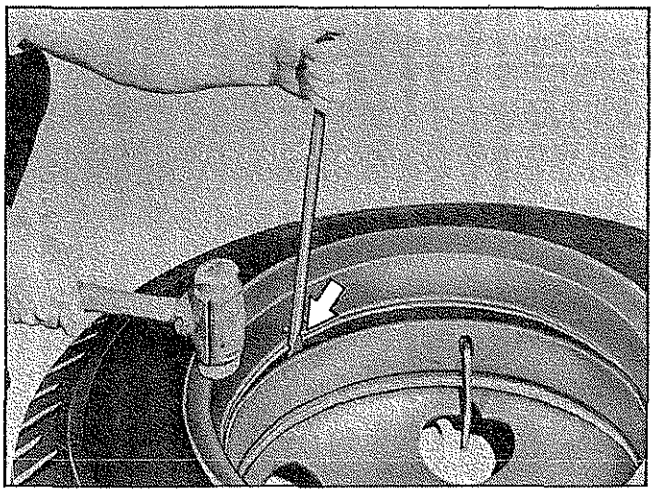


Fig. 37

2. Place the disc portion of the wheel on the floor, with the rim gutter up. Position the tire, with the valve pointing in the desired direction, then insert the valve through the valve slot. Position the side ring by locating the operating notch between the two embossings, about 3 inches (8 cm) from the valve.
3. The two cutaway portions opposite each other in the inner diameter of the ring are placed so as to span the rim gutter. Opposite the valve, work half of the side ring into the gutter, as far as possible, using a mallet.
4. Insert the straight end of the rim tool into the notch, then pull in the direction indicated by the arrow in **Fig. 37**. Maintaining pressure with the tool, strike the side ring downward with a mallet at the point between the tool slot and the cutaway portion, forcing the side ring over the rim gutter. Remove the tool, then strike additional blows, moving toward the other cutaway portion, until the entire toe of the side ring passes over the rim gutter. Be sure the side ring has cleared the gutter of the rim base and that the side ring can be depressed by hand.
5. Inflate the tire. Refer to "Tire Inflation" for procedures.

Tube-Type Tires on Three-Piece Flat Base Wheels or Rims

Continuous Side Ring, Split Lockring

To demount the tire from the wheel or rim, proceed as follows:

WARNING: Read the information under "Tire Demounting and Mounting: Service Precautions." Failure to follow the precautions, before and during tire demounting and mounting, could cause tire or rim damage while servicing or in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

1. Deflate the tire being serviced by removing the valve core. Check the valve stem by running a piece of wire through the stem to make sure it is not plugged.
2. Place the tire on the floor, side ring up. Insert the hooked ends of the tire tools between the side ring and the sidewall of the tire. Pry the bead loose from the side ring, using downward pressure on the tools (**Fig. 29**). Continue prying around the tire until the bead is loose.
3. With the side ring and tire bead pushed down, insert the tapered end of the tool into the notch near the split in the lockring. Push downward to pry the lockring from the gutter groove of the rim base. See **Fig. 38**.
4. Using the hooked end of the tool, complete the removal of the lockring by working around the tire (**Fig. 39**). Lift off the side ring. Turn the assembly over and unseat the second tire bead from the rim. Lift the rim from the tire and remove the tube and flap from the tire.
5. Clean and inspect all parts. Refer to "Wheel and Components Inspection" and "Tire and Components Inspection" for procedures.

WHEEL AND TIRE SERVICING

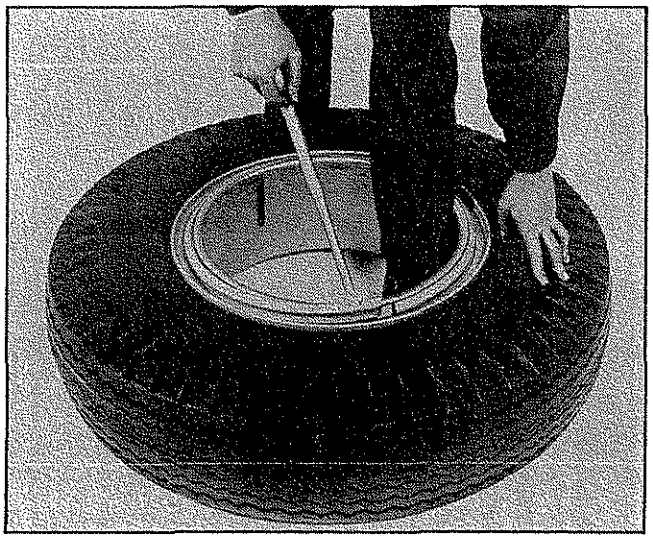


Fig. 38

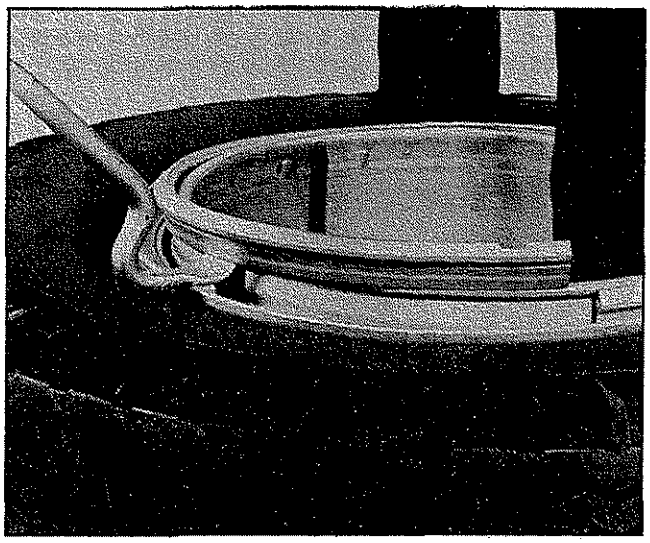


Fig. 39

To mount the tire onto the wheel or rim, proceed as follows:

1. Place the tube in the tire, then partially inflate it to round it out. Apply an approved tire lubricant to the inside and outside surfaces of both beads, and to the portion of the tube that appears between the beads. Insert the flap, and lubricate the portion of the flap that faces the rim. Apply enough lubricant to enable correct bead seating, and to make mounting easier. Don't let excess lubricant run inside the tire.
2. Lay the rim flat on the floor, with the valve slot up. Align the valve with the rim valve slot. Place the tire on the rim and insert the valve through the slot.
3. Place the side ring on the rim base and stand on the ring to position it below the gutter grooves in the rim base.
4. Snap the leading end of the lockring into the gutter groove of the rim base, and "walk" the lockring into place (**Fig. 40**). Check that the lockring is seated in the gutter groove.
5. Inflate the tire. Refer to "Tire Inflation" for procedures.

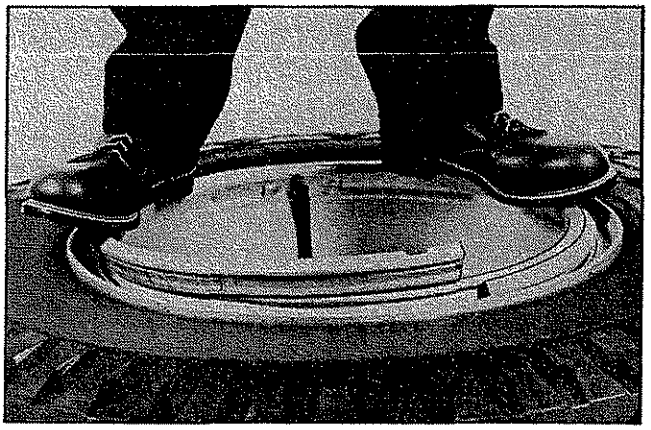


Fig. 40

Tube-Type Tires on Semi-Drop Center Wheels or Rims

Continuous Base, Split Side Ring

Refer to "Tube-Type Tires on Two-Piece Flat Base Wheels or Rims: Continuous Base, Split Side Ring," for tire demounting and mounting on a rim with a continuous base and a split side ring.

Continuous Base, Continuous Side Ring

To demount the tire from the wheel or rim, proceed as follows:

WARNING: Read the information under "Tire Demounting and Mounting: Service Precautions." Failure to follow the precautions, before and during tire demounting and mounting, could cause tire or rim damage while servicing or in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

WHEEL AND TIRE SERVICING

1. Deflate the tire being serviced by removing the valve core. Check the valve stem by running a piece of wire through the stem to make sure it is not plugged.
2. Place the tire and wheel on the floor with the side ring up. Loosen the first bead by driving the hooked end of the rim tool between the tire and rim flange, then press downward on the bead. Do this around the rim, using two tools, as shown in Fig. 41.

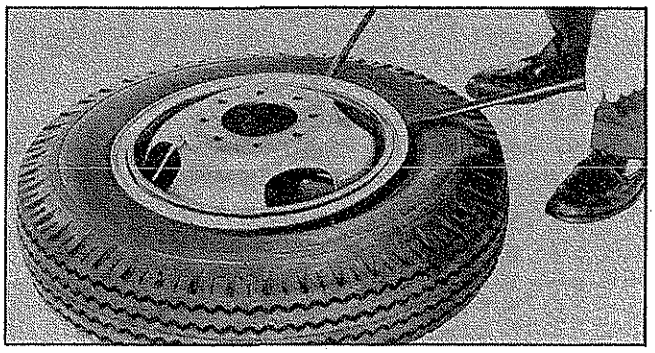


Fig. 41

3. Insert the tool into the notch; then using foot pressure, force the side ring opposite the notch into the gutter (Fig. 42). Then, prying up and out on the side ring, carefully pry off the side ring. Don't bend the side ring.
4. Force the upper tire bead into the well opposite the valve slot. With the tire tool, pry the opposite portion of the bead over the edge of the rim.
5. Turn the tire over. Using the tools, loosen the bead on the opposite bead seat. This can be done using foot pressure. Make sure one portion of the second bead is still in the rim well, then pry the opposite portion of the bead over the edge of the rim. This will free the tire from the rim (Fig. 43). Remove the tube and flap from the tire.
6. Clean and inspect all parts. Refer to "Wheel and Components Inspection" and "Tire and Components Inspection" for procedures.

To mount the tire onto the wheel or rim, proceed as follows:

1. Place the tube in the tire and partially inflate it to round it out. Apply an approved tire lubricant to the inside and outside surfaces of both beads and to the portion of the tube that appears between the beads. Insert the flap, and lubricate the portion of the flap that faces the rim. Apply enough lubricant to enable correct bead seating, and to make mounting easier. Don't let excess lubricant run inside the tire.

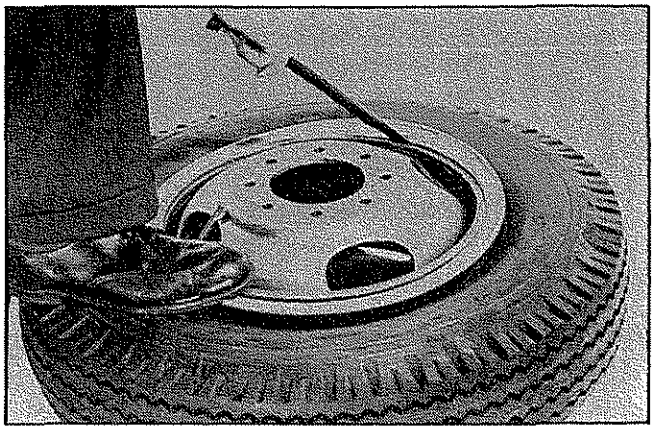


Fig. 42

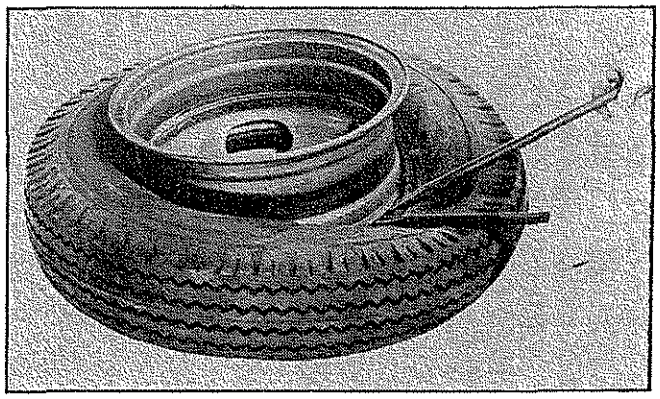


Fig. 43

2. Place the tire on the rim so that the valve lines up with the valve hole. Insert the valve through the valve hole. Using foot pressure, work the first bead into the rim well just to the side of the valve. Pry the first bead over the rim gutter with the rim tool, moving from each side of your foot, alternately, to a point just opposite your foot (Fig. 44). Then pry the last section over the rim gutter.
3. To mount the second bead, start at a point opposite the valve, and using foot pressure, press the bead toe over the rim gutter and into the rim well. Mount the remainder of the bead over the rim gutter, using a thin tire tool, and following the procedure in step 2. Be careful not to pinch the tube.

WHEEL AND TIRE SERVICING

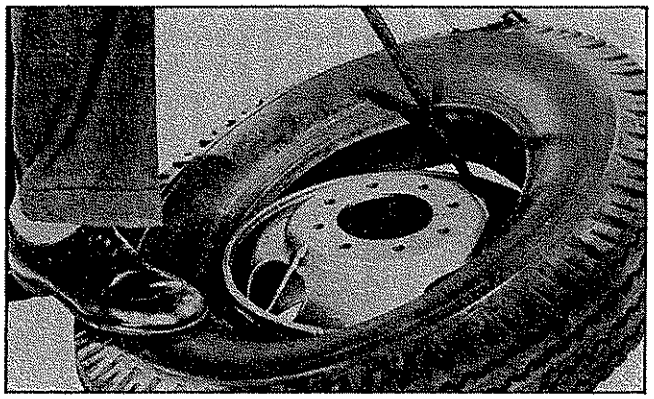


Fig. 44

4. Place half of the side ring in the rim gutter with the cutaway portions in place, as shown in **Fig. 45**. Insert the thin end of a rim tool or heavy screwdriver, then pull the side ring outward toward the centered position. Work the side ring into the gutter by striking it with a mallet.
5. Inflate the tire. Refer to "Tire Inflation" for procedures.

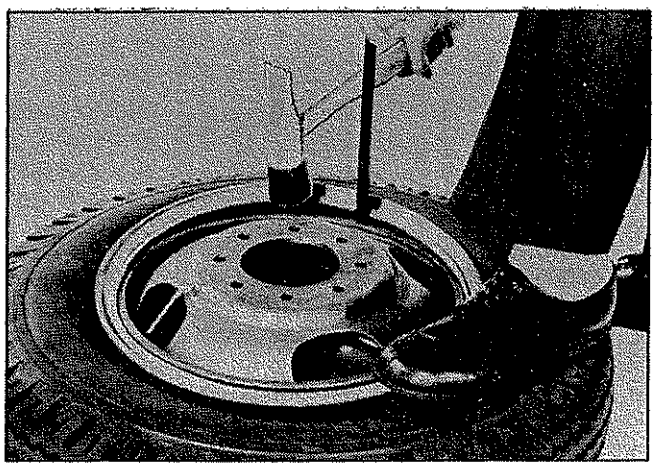


Fig. 45

WHEEL AND COMPONENTS INSPECTION

WARNING: Failure to inspect the tires and wheels and correct any problems, could cause tire or rim damage while servicing or while in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

Examine the wheel or rim, and all parts. Remove any grease, dirt, or rust. Using a wire brush, remove any rubber from the bead seat. Use special care when cleaning the rim gutter. Rust or other foreign matter can prevent the correct fitting of side rings. Replace corroded parts. Paint the rim to prevent corrosion.

NOTE: Don't paint Alcoa aluminum disc wheels. If the wheels are corroded, contact the manufacturer for instructions.

Sprung or broken rings (**Fig. 46**), a cracked rim, wheel (**Fig. 47**), or brake drum, damaged inner or outer wheel nuts (**Fig. 48**), or an out-of-round wheel or rim, requires the replacement of the damaged part. Replace the wheel if it has out-of-round stud holes.

NOTE: Refer to Groups 10 and 11 for inspection and service procedures for the hub, wheel studs, wheel, and brake drum assemblies. When replacing the spoke wheel or the brake drum, contact the wheel manufacturer for the correct torque value for the brake drum nut that attaches the spoke wheel to the brake drum.

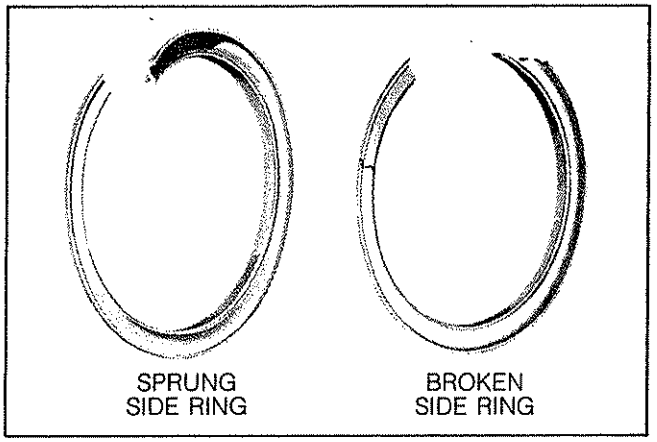


Fig. 46, Sprung and Broken Side Rings

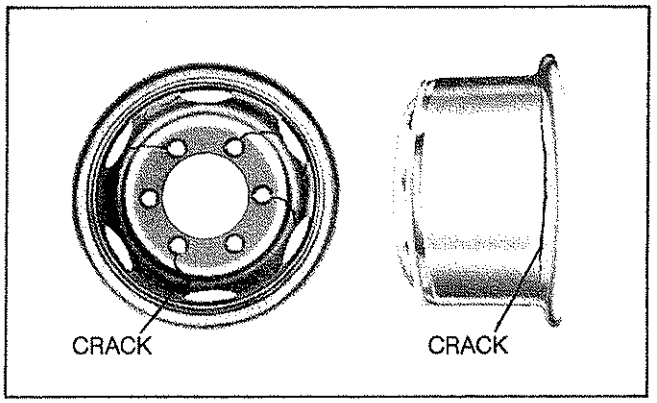


Fig. 47, Cracked Wheel and Rim

WHEEL AND TIRE SERVICING

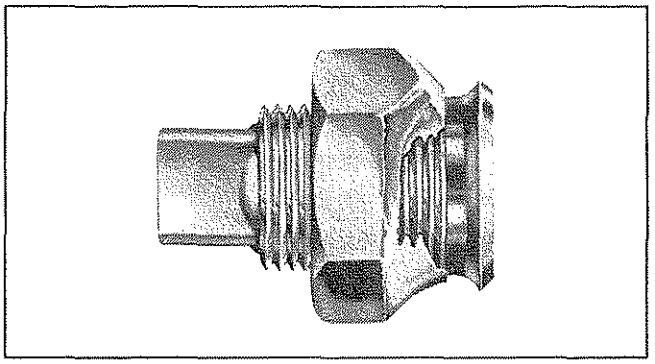


Fig. 48, Damaged Outer Wheel Nut

Inspect valve cores for cracks, bends, and air retention. Replace damaged or leaky cores.

The most critical area of a spoke wheel is the 28-degree tapered rim mounting surface (Fig. 49). Clean the surface and examine it for damage or excessive wear. Replace the wheel if the mounting surface is damaged or worn below the 28-degree taper.

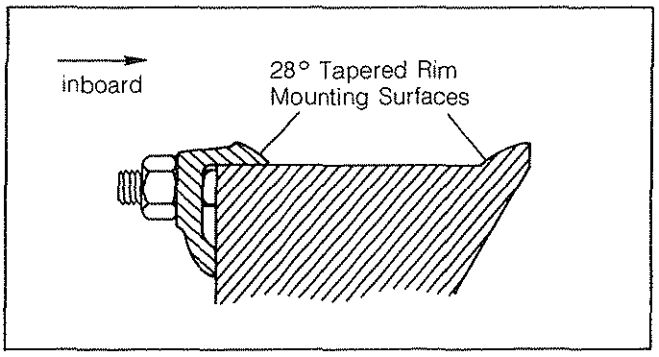


Fig. 49, Spoke Wheel Tapered Mounting Surface

Check the clamps, rim spacer, rim studs, and spoke-wheel nuts for damage or wear. The clamps must not be excessively worn. The end of the wedge portion must be at least 1/16-inch thick (1.5 mm) (Fig. 50). The rim spacer must not be bent, distorted, or crushed. Replace all damaged or broken parts.

Do not attempt to rework, weld, heat, or braze any rim or wheel parts that are cracked, broken, or damaged. Use new parts or parts that are not cracked, broken, or otherwise damaged, and that are of the same size and type.

Remove all foreign matter, such as grease and dirt, from the wheel mounting surface. Smooth any projections on the mounting surface to ensure even pressure when tightening the wheel nuts.

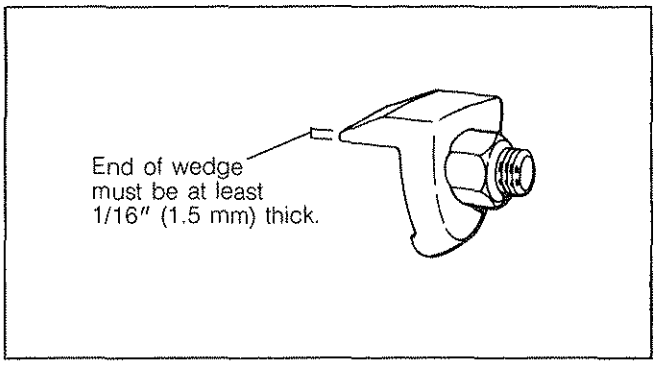


Fig. 50, Rim Clamp

TIRE AND COMPONENTS INSPECTION

WARNING: Failure to inspect the tires and wheels and correct any problems, could cause tire or rim damage while servicing or while in use. An incorrectly mounted tire can burst causing equipment damage and personal injury.

Inspect the inside and outside of the tire for out-of-roundness, loose cords, cuts, foreign objects, and other damage. Repair as needed. Contact the tire manufacturer for repair procedures.

Do not repair tires with the following problems:

- Cuts in the tread that are wire or breaker fiber deep.
- Tread worn to the wire or breaker fibers.
- Tread that is scalloped or otherwise worn unevenly.
- Visible, broken, deformed, or otherwise damaged bead wires.
- Deteriorated rubber.
- Rubber cracked to the wire or cord.
- Separations in the casing.
- Exposed cord (for example, due to weather checking or sidewall scuffing).

Inspect the tread for abnormal or excessive wear. Refer to "Troubleshooting" for possible causes of abnormal wear. If the tires are wearing irregularly, they should be rotated. If the front axle tires become irregularly worn, they should be moved to the drive axle(s) or trailer axles. The front-end alignment should be checked. In a dual assembly, if one tire wears faster than its mate, the position of the two tires should be reversed. Refer to the *COE and 120 Conventional Maintenance Manual* for tire rotation procedures.

WHEEL AND TIRE SERVICING

Government regulations require the removal of any tire with less than 2/32-inch (1.5 mm) tread remaining. Retread the tire (if possible), regroove it (only if marked "Regroovable" on the sidewall), or discard it.

Clean and inspect the tube and flap of tube-type tires. Discard tubes or flaps that are buckled or creased. Do not use an old tube in a new tire, and always mount a used flap in the same size tire and on the same size rim as the one from which it was removed. Michelin Tire Corporation recommends using only new tubes, flaps, valve cores, caps, and O-rings in a new mounting.

TIRE INFLATION

1. Check all parts to make sure they are correctly seated prior to inflation.

NOTE: Inflate tires in a safety cage (**Fig. 51**) or an approved portable restraining device. Always use a clip-on chuck with an inline valve and gauge. Make sure the inflation hose is long enough to permit standing to the side of the tire during inflation. Never sit on or stand in front of an assembly that is being inflated.

WARNING: During initial tire inflation, there is the possibility of an explosion of the assembly. Observe the following safety rules to reduce the possibility of serious physical injury in the event of an explosion.

IMPORTANT: Inflate tires immediately after mounting, before the tire lubricant dries. Once the lubricant dries, bead positioning is not possible, even with increased inflation pressure.

Water in the tire can cause ply separation. During tire inflation, air tank reservoirs and lines must be dry. Use well-maintained air line moisture traps, and service them regularly.

2. After placing the tire in a safety cage, or an approved portable restraining device, inflate the tire to 10 psi (69 kPa). Check the parts for correct seating. If the seating is not correct, completely deflate the tire and correct the problem. Never attempt to seat rings or other parts by hammering on an inflated or partially inflated tire.
3. If there are no problems with the assembly at 10 psi (69 kPa), continue to inflate the tire to the recommended pressure. Refer to the vehicle maintenance manual for correct cold inflation pressures. Michelin Tire Corporation recommends an initial inflation pressure of 90 to 100 psi (620 to 690 kPa) to correctly seat the tire beads.

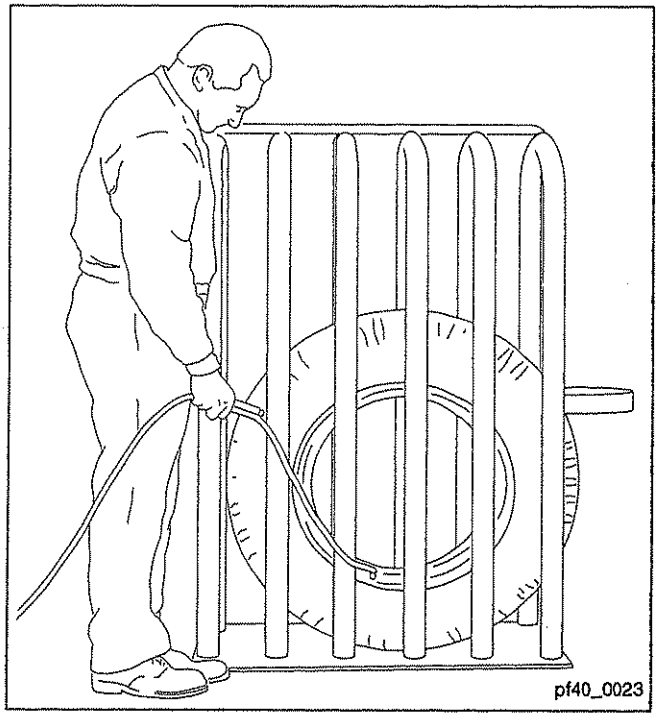


Fig. 51, Safety Cage

NOTE: The position of the beads, flap, and tube with 4 to 5 psi (28 to 35 kPa) pressure is shown in **Fig 52**. The tube is fully rounded-out within the tire, but there isn't enough pressure to move the beads on wide-base rims. Depending on the tire size and rim condition, from 20 to 40 psi (140 to 275 kPa) pressure is needed to push the beads onto the bead seat. See **Fig. 53**.

IMPORTANT: Due to the different flex characteristics of radial sidewalls, it may be necessary to use an inflation aid to help seat tubeless tire beads:

- .1 Metal rings, which use a blast of compressed air to seat the beads.
- .2 Rubber rings, which seal between the tire bead and rim, allowing the bead to move out and seat correctly. A well-lubricated, heavy-duty bicycle tube can be used to help seal between the tire bead and rim.

4. After the initial inflation, completely deflate the tire by removing the valve core. This ensures correct bead seating, and prevents buckling or overstretching the tube in tube-type tires. Then inflate the tire to the recommended cold inflation pressure listed in the vehicle maintenance manual. Install valve caps and tighten them finger-tight.

WHEEL AND TIRE SERVICING

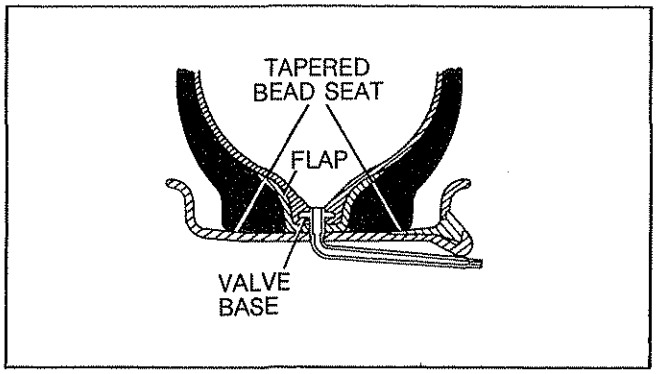


Fig. 52

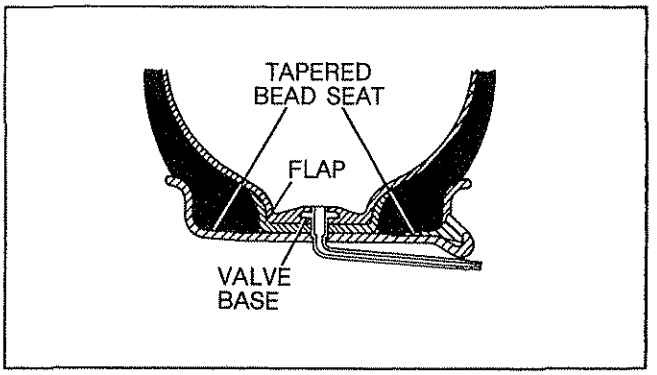


Fig. 53

CAUTION: Improperly inflating tube-type tires can crack or tear the edge or inside of the valve base. Once seated, the tube can stretch only in the rim area. Because resistance to stretch is greatest at the valve base, there is often enough tension to break the tube at the edge of the valve base or in the valve base.

NOTE: Inflate the tires to the recommended pressure. Driving on overinflated tires will weaken the cords by reducing their ability to absorb road shocks, and will increase the danger of cuts, snags, and punctures. Overinflation will overstress and damage the rims. Driving on underinflated tires will generate excessive heat. This weakens the tire body, and reduces tire strength.

WARNING: Tire underinflation or overinflation will damage wheels and tires, and could result in a blowout causing possible property damage and personal injury.

Use tires of the same size, type, and capacity to carry the load at the recommended cold pressure. Attempting to increase the load capacity of a tire by overinflation will damage the tire assembly.

5. Check the inflation pressure 24 hours after mounting new tires.

NOTE: When testing a vehicle on a dynamometer, severe tire damage can occur. Because the manufacturers differ in their recommendations for preventing tire damage, refer to the manufacturer's instructions for testing a vehicle on a dynamometer.

WHEEL AND TIRE SERVICING

TROUBLESHOOTING

Problem – Abnormal Tire Wear

Possible Cause	Remedy
Tires are not inflated to the correct pressure.	Operate the tires at the recommended inflation pressure and use the proper size tires, wheels, and rims for the load to be carried. Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual* for specifications.
Inflation pressures in a dual assembly are unequal.	Inflate all tires to a uniform pressure (within 5 psi [35 kPa]). Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual* for the proper cold inflation pressures.
Dual tires are mismatched.	Examine all tires and match them according to the specifications in this subject.
Vehicle is vibrating severely.	Follow the recommendations given under "Vehicle Vibration" in this chart.
Brakes are grabbing.	Examine and adjust the brakes according to the instructions in Groups 10 and 11.
Axles are improperly aligned.	Align the axles. Refer to Groups 10 and 11 for instructions.
Wheel bearings are loose or damaged, or bushings are excessively worn.	Examine, and repair or replace according to the instructions in Groups 10 and 11.
Wear is uneven amoung tire sets.	Rotate the tires according to the instructions in Group 13 of the *COE and 120 Conventional Maintenance Manual.*
Driver is abusing equipment.	Caution the driver.

Problem – Vehicle Vibration

Possible Cause	Remedy
Axles are improperly aligned.	Align the axles. Refer to Groups 10 and 11 for instructions.
Wheels, rims, or tires are out-of-round, bent, or distorted.	Replace damaged components.
Tires, wheels, rims, or brake drums are out-of-balance.	Determine the out-of-balance component and balance.
Tire beads are not properly seated.	Demount and mount the tire. Make certain adequate lubrication is used and, if necessary, use an inflation aid to help seat tubeless tire beads.
Tire and rim assembly is improperly installed on a spoke wheel.	Remove the tire and rim assembly and inspect it for out-of-round or rim chording. Replace the rim if it is damaged. Follow closely the tightening sequence and torque values listed.
Rim spacers are worn or distorted.	Replace the rim spacers.
Driveline, suspension, or steering components are loose or worn.	Determine the location of the vibration, then repair or replace the loose or worn components.

(Continued on next page)

WHEEL AND TIRE SERVICING

TROUBLESHOOTING (Continued)

Problem - Excessive On-the-Road Tire Failures

Possible Cause	Remedy
Tires are not inflated to the correct pressure.	Operate the tires at the recommended inflation pressure and use the proper size tires, wheels, and rims for the load to be carried. Refer to the "Charts and Specifications" section of the *COE and 120 Conventional Maintenance Manual* for specifications.
Dual tires are mismatched.	Examine all tires and match them according to the specifications in this subject.
Water or foreign material is inside the casing.	Clean and dry the tires and tubes prior to mounting. Make sure excess lubricant does not flow down into the tire. Store unmounted tires indoors, or under cover, to prevent moisture from collecting inside.
Tires are contaminated by oil.	Clean the tires and inspect the engine seals, transmission seals, axle-end and drive axle seals, oil filters, and oil lines for leakage. Make sure the lubricant used in mounting does not contain a petroleum derivative.
Vehicle is vibrating severely.	Follow the recommendations given under "Vehicle Vibration" in this chart.
Wheel or rim components are mismatched.	Check the catalog issued by the applicable wheel or rim manufacturer for the proper part numbers and sizes of approved components. Make sure that all parts of an assembly match in size, manufacturer, and classifications within a manufacturer's line. Never use a component which does not bear clear, legible, and proper numbers and manufacturer's identification, even if it appears to fit.
Parts are corroded, worn, or otherwise damaged.	Clean or replace parts as necessary.

WHEEL AND TIRE SERVICING

SPECIFICATIONS

DESCRIPTION	NUT SIZE	WHEEL MANUFACTURER	TORQUE (dry threads) lbf·ft (N·m)
8-HOLE DISC WHEEL WITH CONE LOCKNUTS			
Front and Rear Wheel Nut	—	All	450–550 (610–745)*
10-HOLE DISC WHEEL WITH TWO-PIECE FLANGE NUTS			
Front and Rear Wheel Nut	1-5/16	Budd	390–440 (529–597)*
10-HOLE DISC WHEEL WITH INNER AND OUTER NUTS			
Front Wheel Nut	1-1/8–16	Alcoa Budd Firestone and Motor Wheel	400–500 (540–680)† 450–500 (610–680)‡ 450–500 (610–680)
Rear Wheel Inner Nut	3/4–16	Alcoa Budd, Firestone, and Motor Wheel	400–500 (540–680)† 450–500 (610–680)
Rear Wheel Outer Nut	1-1/8–16	Alcoa Budd, Firestone, and Motor Wheel	400–500 (540–680)† 450–500 (610–680)
Wheel Stud Retainer Nut	3/4–16	All	175–200 (235–270)

Table 1, Disc-Type Wheel Fastener Torques

* Torque values are given for lubricated threads.

† Lubricated threads should be tightened 300 to 375 lbf·ft (405 to 510 N·m). Lubricate threads with a mixture of 25 percent colloidal graphite in cup grease or equivalent. Do not apply thread lubricant to ball seats of the capnuts and wheels. Wipe it off if it is applied accidentally.

‡ On 1-1/8–16 size wheel studs with a head (**Fig. 54**), tighten the wheel nuts 650 to 750 lbf·ft (880 to 1020 N·m).

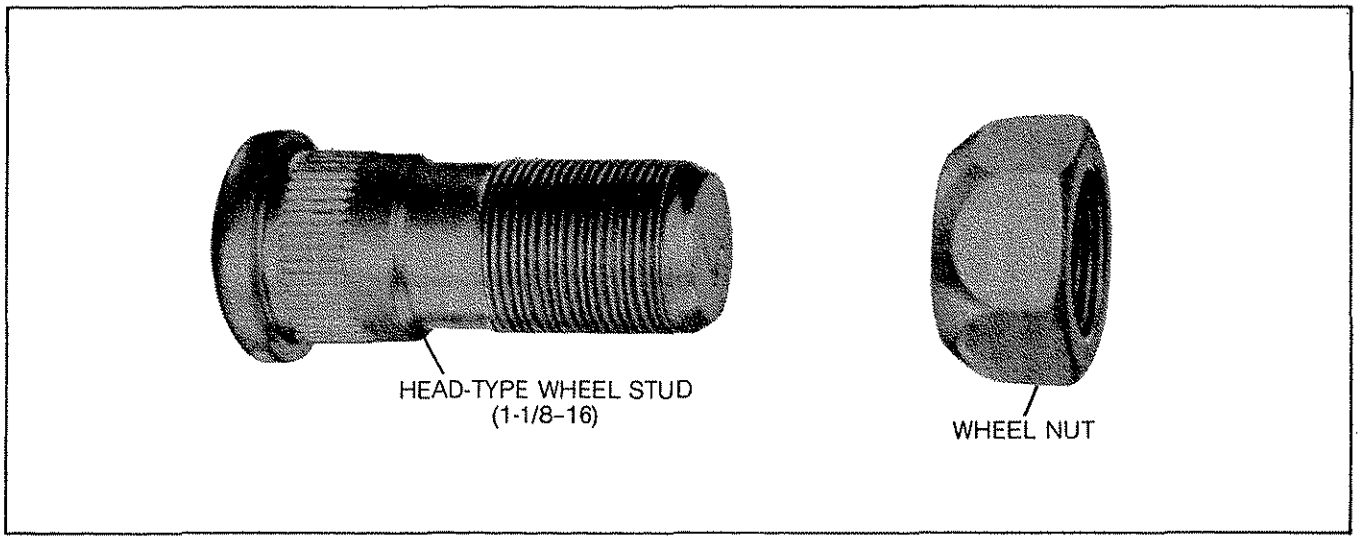


Fig. 54, Head-Type Wheel Stud

WHEEL AND TIRE SERVICING

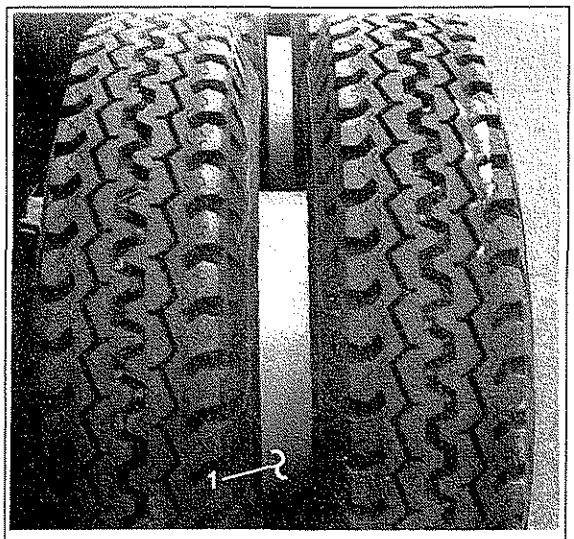
SPECIFICATIONS (Continued)

DESCRIPTION	NUT SIZE	MANUFACTURER	DRY THREADS lbf·ft (N·m)
Front Wheel Nut, 3 Spoke	5/8–11	Dayton Webb	160–175 (215-235) 150–175 (205–235)
	3/4–10	Dayton Webb	240–260 (325–355) 200–250 (270–340)
Rear Wheel Nut, 3 Spoke	5/8–11	Dayton Webb	160–175 (215–235) 150–175 (205–235)
	3/4–10	Dayton Webb	190–210 (260–285)* 200–250 (270–340)
Front Wheel Nut, 5 and 6 Spoke	5/8–11	Dayton and Gunite Webb	160–175 (215–235) 150–175 (205–235)
	3/4–10	Dayton Gunite Webb	240–260 (325–355) 200–225 (270–305)† 200–250 (270–340)
Rear Wheel Nut, 5 and 6 Spoke	5/8–11	Dayton and Gunite Webb	160–175 (215–235) 150–175 (205–235)
	3/4–10	Dayton Gunite Webb	190–210 (260–285)* 200–225 (270–305) 200–250 (270–340)

Table 2, Spoke-Type Wheel Mounting Torque

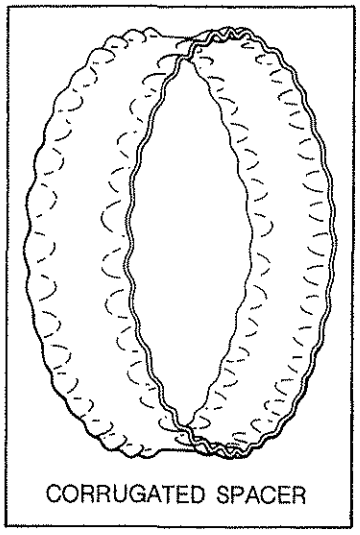
* 190 to 210 lbf·ft (260 to 285 N·m) recommended when using channel spacers (Fig. 55). 240 to 260 lbf·ft (325 to 355 N·m) permitted when using corrugated (Fig. 56) or corrugated-channel (Fig. 57) spacers.

† On front axles with over 12,000 lb (5448 kg) capacity, tighten nuts 240 to 265 lbf·ft (325 to 360 N·m). Gunite part number W-854 nut, with a phosphate and oil coating, must be used.



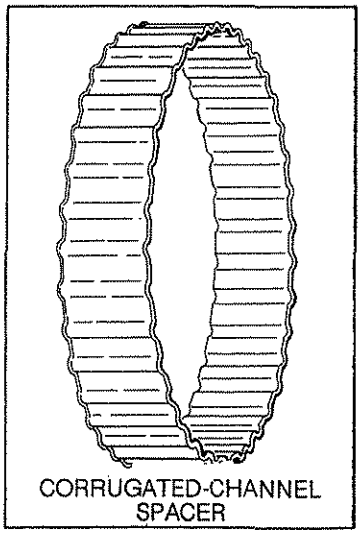
1. Channel Spacer pf40_0033h

Fig. 55



CORRUGATED SPACER

Fig. 56



CORRUGATED-CHANNEL SPACER

Fig. 57

FRAME ASSEMBLY

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FRAME ASSEMBLY

GENERAL DESCRIPTION

The main body of the vehicle's frame assembly is comprised of two frame rails aligned with each other and secured together by frame crossmembers. The frame assembly is supported on the front and rear axles of the vehicle, and supports the rest of the chassis and body.

Frame rails are made of steel or aluminum. Both frame rails of a frame assembly have identical specifications. The frame rail is comprised of the upper flange, the lower flange, and the web (the surface area between the flanges). The inside area of the frame rail is referred to as the channel. See Fig. 1.

In addition to securing the frame rails at the proper distance from each other, the crossmembers control axial rotation and longitudinal motion of the rails, and reduce torsional stress transmitted from one rail to the other. Crossmembers are also used for mounting of vehicle components, and they provide protection for wires and tubing that are routed from one side of the vehicle to the other.

FRAME STATIONS (Refer to Fig. 2)

A frame station is a reference point on the frame rail from which the location of all frame rail components is measured. There are two frame stations on Freightliner frame rails: station zero (usually written as 0.00"); and station 100. There is no identifying mark for station zero.

On vehicles with 1984 Advancements, station zero is located 0.25 inch (6.4 mm) aft of the centerline of the front suspension's forward spring pin.

On previous vehicles, station zero is located 1.25 inches (32 mm) aft of the (cab or hood) pivot hole in the lower frame bracket.

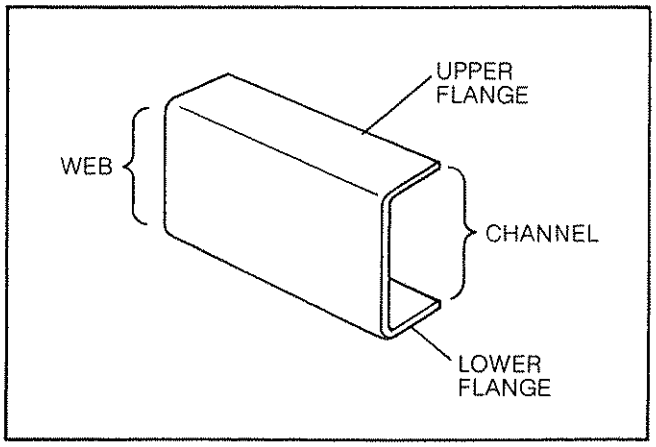


Fig. 1, Frame Rail Identification

Station 100 is located 100 inches (2540 mm) aft of station zero. Station 100 is used when station zero is not accessible because of vehicle assembly. On vehicles equipped with steel frame rails, station 100 is identified by a 1/2-inch (13 mm) high "zero" stamped near the top part of the frame rail web. On vehicles equipped with aluminum frame rails, station 100 is identified by a 1/16-inch (2 mm) deep drill point impression near the top of the frame rail web.

The vehicle's frame drilling chart lists the location of each frame rail component. For example: if a component is given a location of 120.00, then that component is installed on the frame rail 120 inches (3048 mm) aft of station zero, or 20 inches (508 mm) aft of station 100.

SERVICE OPERATIONS

The following information includes guidelines and requirements that must be followed whenever the frame assembly requires service. For information on installation of equipment on the frame assembly, refer to the applicable subject in the 15 Group of this manual.

GENERAL HANDLING

Whenever the frame rails are lifted or moved, take care to avoid anything that may scratch, cut, or damage the exposed frame assembly. Cushion all chain hoists or cable slings with a section of heavy hose. If the frame rail is raised with a jack, place a block of wood between the jack and the frame rail.

Never heat the frame rails for straightening purposes. Such work should be done cold as the frame rails have been heat-treated.

CAUTION: Heating the frame rail for straightening purposes will reduce the strength of the rail temper in localized areas, which can result in structural failure of the frame rail.

On steel and aluminum frame rails, use pencil lines or soapstone marking for any work that requires marking of the frame rail. High visibility can be obtained by first chalking the surface of the frame rail, then making the pencil marks.

CAUTION: Do not use scribe lines for marking or layout work on aluminum frame rails. Scribe lines can cause stress-raising scratches which can develop into starting points for structural damage to the frame.

REPAIR OF CRACKS

IMPORTANT: Freightliner Corporation recommends that cracked or damaged frame rails be replaced.

FRAME ASSEMBLY

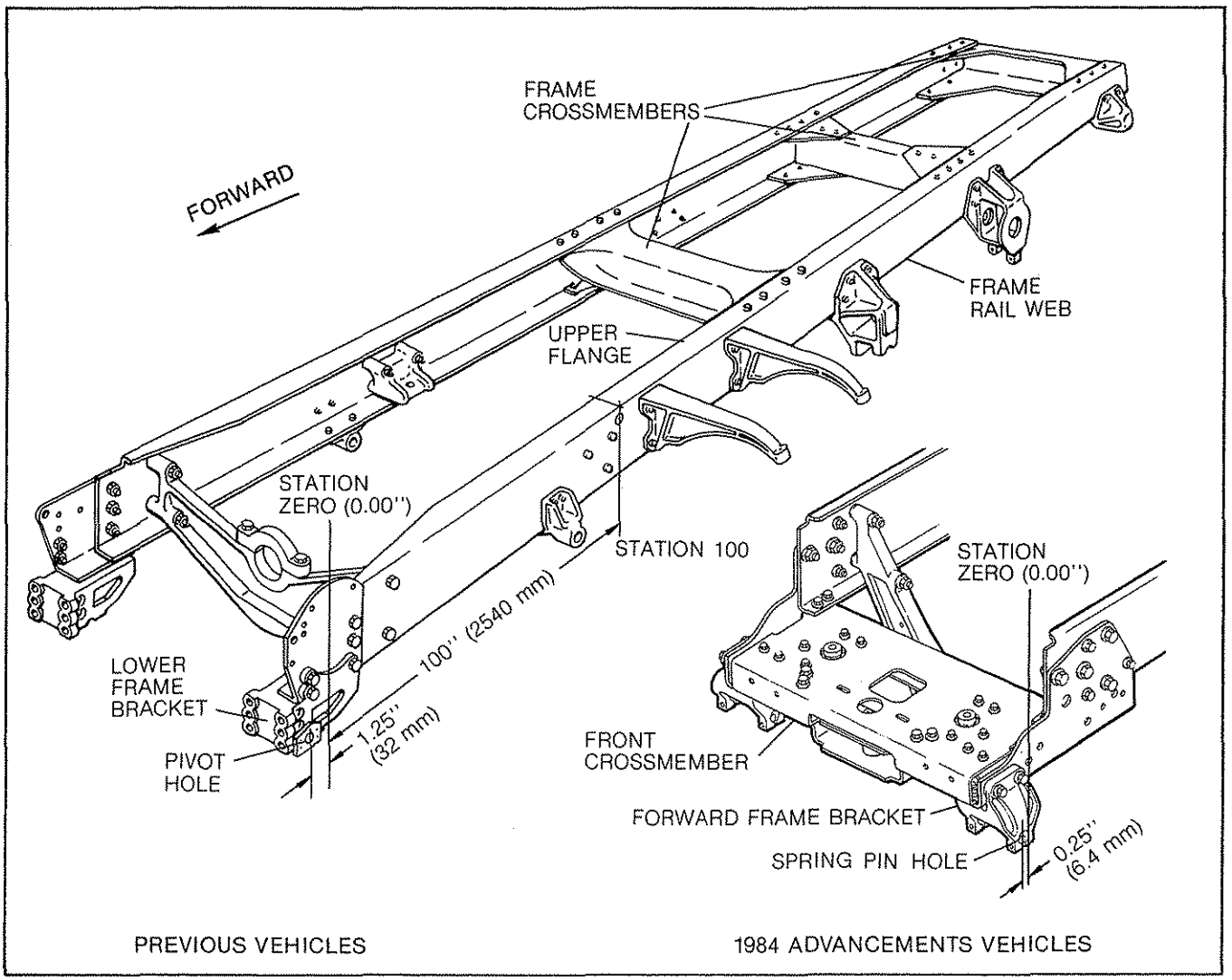


Fig. 2, Frame Station Location

1. Drill a 1/8-inch (3.2 mm) diameter hole at each end of the crack to prevent further spreading of the crack. See Fig. 3.
2. Vee out the crack for two thirds of the stock thickness. Clamp a copper or aluminum bar on the opposite side of the groove. The bar will act as a "chill" strip, pulling away the heat to keep heat dissipation minimal. See Fig. 4.

NOTE: If it will not be possible to grind both sides of the frame rail, then grind the vee groove on one side to the full depth.

WARNING: Protective eye and facial gear must be worn when grinding the frame rails. Failure to wear

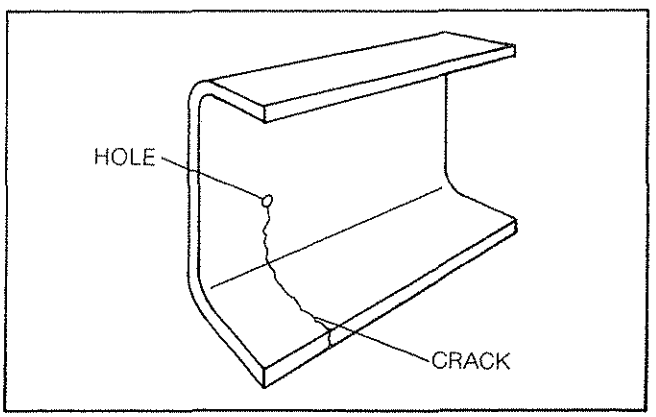


Fig. 3

FRAME ASSEMBLY

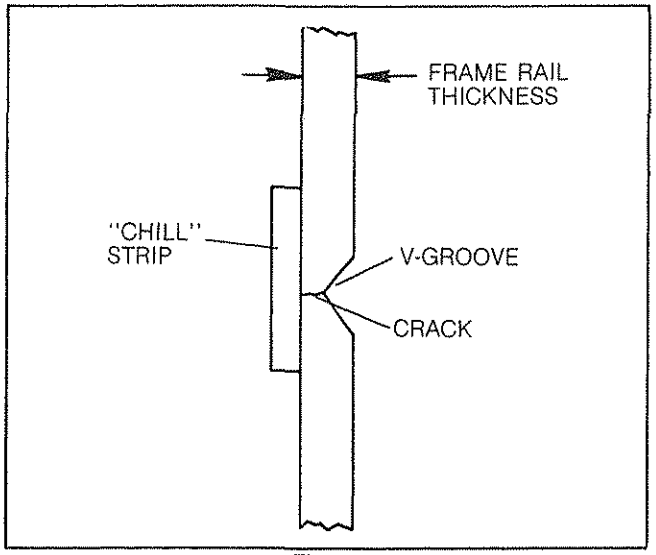


Fig. 4

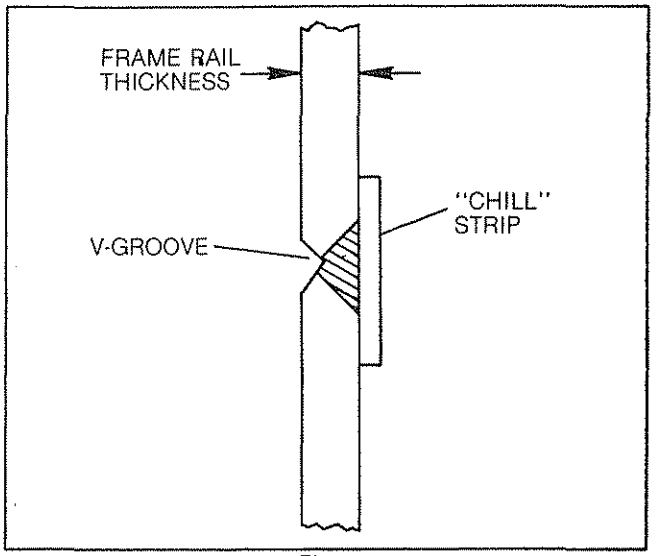


Fig. 6

this gear can result in personal injury due to the flying metal debris from the grinding process.

3. Deposit the weld material using the applicable welding method described in this subject. Then, grind the weld flush with the frame rail. See Fig. 5.
4. Cut a vee groove on the opposite side of the frame rail, deep enough until the weld metal is reached. Clamp the "chill" strip on the opposite side of the groove. See Fig. 6. Weld the vee groove, as instructed in step 3, above. Make full penetration of the weld, then grind the weld flush with the frame rail. See Fig. 7.

FILLING OF UNUSED HOLES

All unused holes in the frame assembly must be filled with either the applicable nut and bolt combination or by welding. In addition, approval must be obtained from the Freightliner Corporate Engineering department before filling any holes.

CAUTION: Weld only when instructed in this subject. Failure to fill the unused holes properly and as instructed, can severely weaken the area and result in starting points for frame rail fractures.

1. If an unused group or pattern of holes is located outside the central one-third of the web, or located

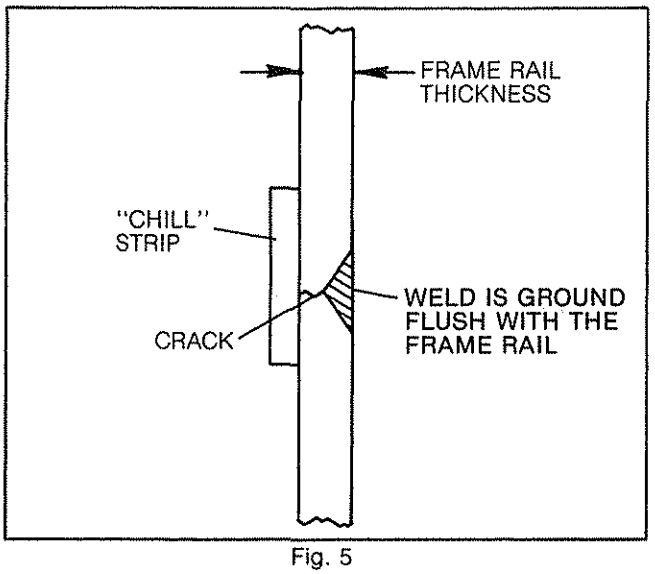


Fig. 5

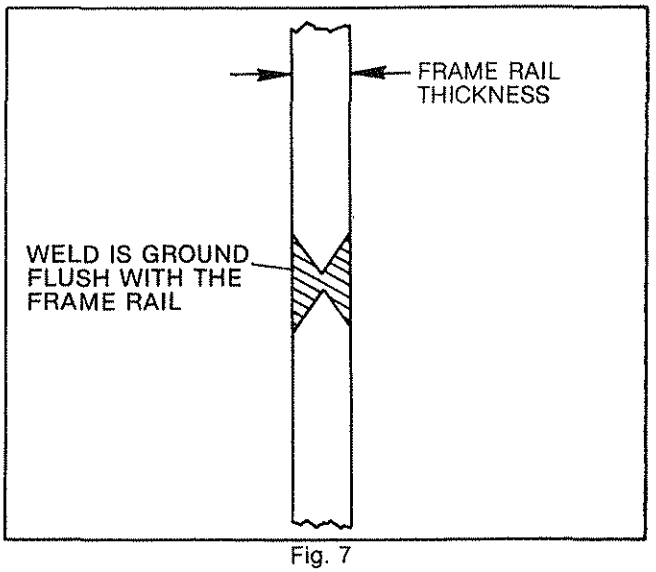


Fig. 7

FRAME ASSEMBLY

within 6 inches (157 mm) of a critical area, contact the Freightliner Corporate Engineering department for instructions. Critical areas include the attachment points for engine mounts, suspension brackets, cab mounts, crossmembers, steering gear, and fuel tank brackets.

2. If a random hole, group, or pattern of holes is located within the central one-third of the web, and is at least 6 inches (157 mm) from a critical area, and the holes are 1/2-inch (13 mm) or more in diameter, then the holes are to be welded closed using one of the following instructions:

   A. On steel frame rails, partially fill the hole with a mild steel slug, with the edges of the steel slug chamfered 45°. Then, weld using one of the methods given under "Welding Methods for Steel Frame Rails."

   B. On aluminum frame rails, partially fill the hole with an aluminum slug, with the edges of the aluminum slug chamfered 45°. Then, weld using the method given under "Welding Method for Aluminum Frame Rails."

3. If the centerline of a random hole falls outside the central one-third of the web, or if the hole is located within 6 inches (157 mm) of a critical area, or if a random hole is located within the central one-third of the web and is 1/2-inch (13 mm) diameter or less, then the hole must be filled with the applicable nut and bolt combination. For proper frame fastening instructions, refer to the 15 Group of this manual.

NOTE: If the diameter of the hole is less than 0.375 inch (9.53 mm), then the hole must be drilled out to 0.375 inch (9.53 mm). Fill with the applicable nut and bolt combination.

FRAME SHAPING

IMPORTANT: Approval must be obtained from the Freightliner Corporate Engineering department before any cutting or frame shaping is done.

If the flange of a frame rail is cut (for relief cuts or notches), the edges of the flange must be shaped to form a smooth ground radius of 0.06 to 0.12 inch (1.52 to 3.05 mm) over the entire length of the cut. Fig. 8 shows this dimension of the edge radius of the frame rail flanges.

NOTE: For information on relief cuts or notches, refer to the 15 Group of this manual.

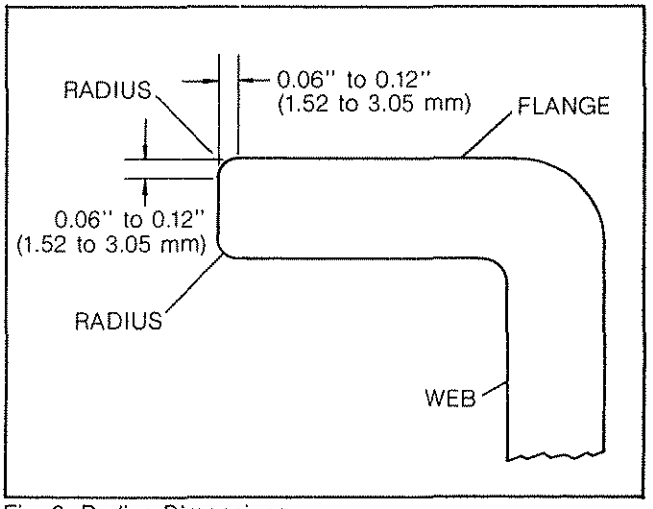


Fig. 8, Radius Dimensions

Using a clean, sharp, rotary drum grinder, or a flapper wheel grinder, apply light pressure and grind the cut edges in the direction of the length of the frame rail to form the radius. Do not grind across the edges. See Fig. 9.

CAUTION: Apply light pressure only. Heavy pressure can result in excessive overheating and a loss of surface temper. Grind only in the direction of the cut. See Fig. 9. Grinding across the direction of the cut can reduce the structural strength of the frame rail.

WARNING: Protective eye and facial gear must be worn when grinding. Failure to wear this gear can

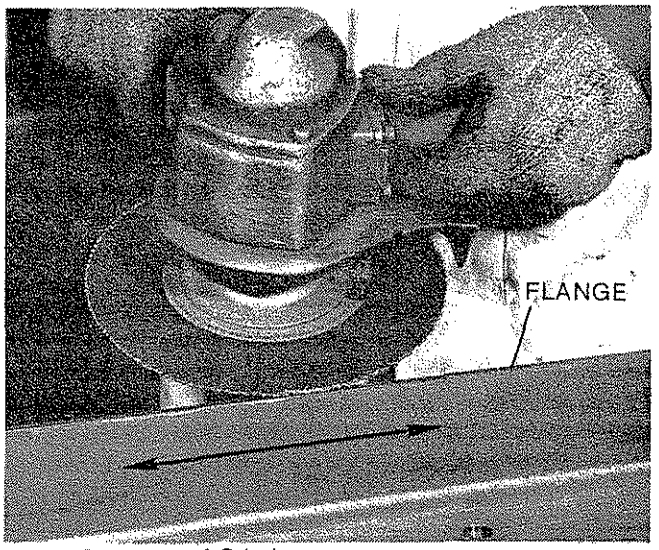


Fig. 9, Direction of Grind

FRAME ASSEMBLY

result in personal injury due to the flying metal debris from the grinding process.

HOLE DRILLING

During vehicle manufacture, holes are drilled or perforated on the frame rail only as specified on the vehicle frame drilling chart. If any additional holes need to be drilled, the Freightliner Corporate Engineering department must be contacted for approval.

NOTE: For additional information on hole drilling, refer to the 15 Group of this manual.

A single exception to this rule is that holes may be drilled for tubing clips and the like through the web portion of the channel only. On aluminum frame rails, the *edge* (not the center) of the hole must be no closer than 1.50 inches (38.1 mm) from the outer face of the flange. On steel frame rails, the *edge* (not the center) of the hole must be no closer than 1.00 inch (25.4 mm) from the outer face of the flange. Fig. 10 shows the minimum distance to the flanges that holes can be placed on the web.

On aluminum frame rails, chamfer both sides of all holes 0.02 inch (0.50 mm) x 45°.

FRAME RAIL WELDING

Welding Precautions

IMPORTANT: There are very few cases in which welding a heat-treated frame rail is tolerable. Direct welding of the frame rail web should be avoided. Before any welding is done, the Freightliner Corporate Engineering department must be contacted for approval.

CAUTION: Weld only when instructed in this subject. When welding, all welding precautions and the applicable welding method information must be strictly followed. Failure to do so can reduce the structural strength in the welded area of the frame rail.

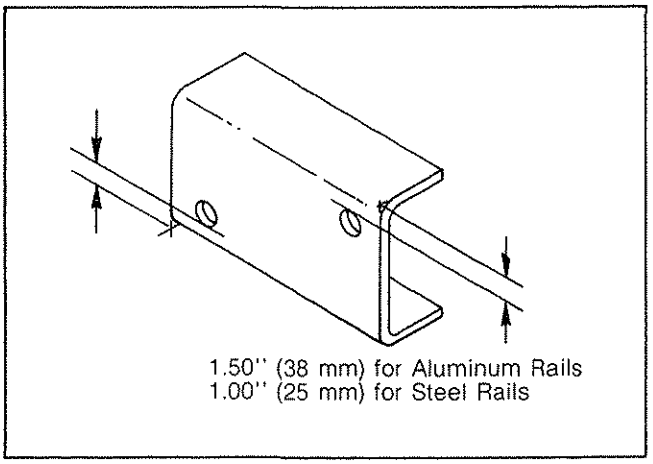


Fig. 10

WARNING: Protective welding masks and gloves must be worn when welding. Failure to do so could result in personal injury, due to the intensity of heat, sparks, and flying debris, from the welding process.

1. Do not weld attachments to the frame rail. For guidelines on the attachment of equipment on the frame rails, refer to the 15 Group of this manual.
2. Use only the applicable welding method given under "Welding Method for Aluminum Frame Rails," or "Welding Methods for Steel Frame Rails."
3. Before welding, always clean the surfaces of oil, grease, paint, scale, and other contaminants. Wipe dry with a clean dry cloth.
4. Do not weld in an area that allows drafts from any source such as windows, engines, or fans, as it will affect the soft flow of gas from the welding gun.
5. Do not weld into the radius of the frame rail flanges or along the edge of the flange.
6. Do not weld square with the frame side rail. Make all reinforcing welds at least 30° from square. This will distribute the welding stresses over a larger area.
7. Do not notch, undercut, or leave craters during the welding process.
8. Keep as close to the weld centerline as possible.

Welding Methods for Steel Frame Rails

Gas-metal arc welding is the recommended method. If gas-metal arc welding is not available, coated-electrode arc welding can be used. Direct current reverse polarity is recommended, however, alternating current can be used. Use either a short arc beading technique or a narrow weave technique.

1. Review the information given under "Welding Precautions." Then, if using the gas-metal arc weld method, proceed to step 2, below. If using the coated-electrode arc weld method, proceed to step 3, below.

WARNING: Disregarding the precautions could result in damage to the frame rail or serious personal injury.

FRAME ASSEMBLY

2. For the gas-metal arc welding method, use the following requirements and specifications:
   .1 Use weld wire that meets American Welding Society (AWS) specification A 5.28, Class E110S.
   .2 Use Linde M-5 gas or an equivalent Argon-Oxygen mixture of 5% Oxygen.
   .3 For applicable machine settings, refer to Table 1, under "SPECIFICATIONS."
3. For the coated-electrode arc welding method, use 1/8-inch-thick AWS-E-11018 type weld rod. For amperage and voltage settings of each weld position, refer to Table 2, under "SPECIFICATIONS."

NOTE: On 1/4-inch-thick frame rails only, AWS-E-9018 type weld rod can be used, however, AWS-E-11018 type weld rod is recommended.

IMPORTANT: Always keep the weld rod free of moisture. The welding rod used should come directly from a hermetically sealed container, or be dried at least one hour in a 700° to 800°F (371° to 427°C) oven. Immediately after removal from a sealed container or after drying, the welding rod must be stored in an oven at 250°F (121°C). A welding rod which has been exposed to the atmosphere for more than one-half hour must be dried before use.

Welding Method for Aluminum Frame Rails

The following is for welding on *truck vehicles* with frame rails of aluminum alloy 6061-T6. Use gas-metal arc welding only.

CAUTION: Do not weld on tractor vehicles with aluminum frame rails. Tractor service imposes high stress in the rear frame area. Welding will result in excessive stress in this area.

NOTE: Refer to spec line numbers 552 and 554 in the 15 Group of the Vehicle Spec Sheet. If the frame rail part number is 15-09331, the frame rail is aluminum alloy 6061-T6. If the part number is 15-09388, the frame rail is aluminum alloy 2014-T6.

CAUTION: Do not weld frame rails of aluminum alloy 2014-T6. Welding on this alloy can result in hot cracking and create a heat affected zone susceptible to stress-corrosion cracking.

1. Review the information given under "Welding Precautions."

WARNING: Disregarding the precautions could result in damage to the frame rail or serious personal injury.

2. Use Linde welding wire 4043 HG, or equivalent, with a 1/16-inch (1.58 mm) diameter.
3. Use Linde T Argon gas, or an equivalent plain argon gas for the inert envelope of the welding arc.
4. Because of various conditions, the machine setting must be determined in consultation with the welding equipment manufacturer.

LENGTHENING THE STEEL FRAME RAIL

Steel frame rails can be lengthened by welding a frame rail extension onto the rear of the frame rail. The frame rail end and the extension piece are cut so that they overlap each other. In addition, approval must be obtained from the Freightliner Corporate Engineering department before any welding and lengthening of the frame rail is done.

NOTE: Figures 16 and 17, located under "SPECIFICATIONS," illustrate the cutting dimensions for the frame rail and extension. Figure 16 applies to truck vehicles. Figure 17 applies to tractor vehicles. Refer only to the illustration which relates to the particular vehicle being modified.

WARNING: Protective eye and facial gear must be worn when cutting and grinding the frame rails. Failure to wear this gear can result in personal injury due to the flying metal debris from the cutting and grinding process.

1. Cut the frame rail end and extension to the applicable dimensions given in Fig. 16 or 17.

NOTE: If the length of the extension is to be 6 inches (152 mm) or less, then the frame rail end and extension are to be straight cut.

2. Grind the cut ends of the frame rail and extension to the dimensions given in Fig. 11.
3. Place the cut ends of the extension piece with the cut ends of the frame rail so that there is a 1/16- to 1/8-inch (1.58 to 3.18 mm) gap between them. See Fig. 11. Using a torch, heat the cut ends to 70°F (21°C) before welding.

NOTE: A 1/16-inch (1.58 mm) gap is recommended. The ends must not contact each other. The joint spacing can be maintained by placing a short piece of clean, 1/16-inch (1.58 mm) diameter bare steel wire between the extension and frame rail. The wire sections must be short enough to be completely fused by the welding process.

FRAME ASSEMBLY

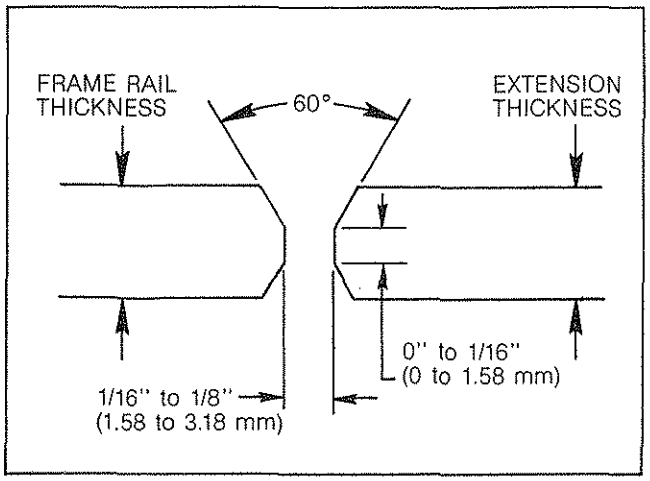


Fig. 11

4. Using one of the methods given under "Welding Methods for Steel Frame Rails," weld the extension to the frame rail, making full penetration as shown in Fig. 12. Remove any slag between passes, and back-gouge the root of the first vee before welding the other side.

IMPORTANT: Weld the web area first, then the flange, working from the inside of the channel. When welding the web area, make sure that the flanges do not contact each other.

CAUTION: Increased stresses will set upon the weld if the web area is not welded first, or if the flanges contact each other when welding the web.

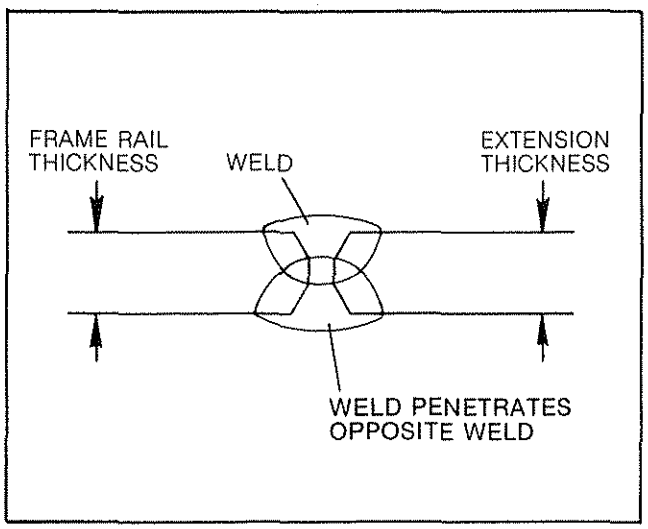


Fig. 12, Correct Weld Penetration

5. When the welding is complete, the joint can be sanded for appearance. Hold the sander so that the grind runs parallel with the length of the frame rail.

CAUTION: Do not "hollow grind" the weld. Small depressions from improper grinding of the weld will reduce the structural strength of the frame rail.

LENGTHENING THE ALUMINUM FRAME RAIL

Only *truck vehicles* equipped with aluminum frame rails made of aluminum alloy 6061-T6 can be lengthened by welding an extension onto the rear of the frame rail. In addition, approval must be obtained from the Freightliner Corporate Engineering department before any welding and lengthening of the frame rail is done.

NOTE: Refer to spec line numbers 552 and 554 in the 15 Group of the Vehicle Spec Sheet. If the frame rail part number is 15-09331, the frame rail is aluminum alloy 6061-T6. If the part number is 15-09388, the frame rail is aluminum alloy 2014-T6.

CAUTION: Do *not* weld extensions on *tractor vehicles* equipped with aluminum frame rails, or on *any* vehicles equipped with frame rails made of aluminum alloy 2014-T6. Tractor service imposes high stress in the rear frame area. Welding in this area could result in excessive frame rail stress. Welding on aluminum alloy 2014-T6 can result in hot cracking and create a heat-affected zone susceptible to stress-corrosion cracking.

WARNING: Protective eye and facial gear must be worn when cutting and grinding the frame rails. Failure to wear this gear can result in personal injury due to the flying metal debris from the cutting and grinding process.

1. Cut the frame rail end and extension to the applicable dimensions given in Fig. 18, located under "SPECIFICATIONS."
2. Grind the cut ends of the frame rail and extension over the full length of the cut to the dimensions given in Fig. 13.
3. Clean all surfaces to be joined with vapor degreasing equipment, or by swabbing with clean, oil-free solvents, or by stainless steel wire brushing.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

FRAME ASSEMBLY

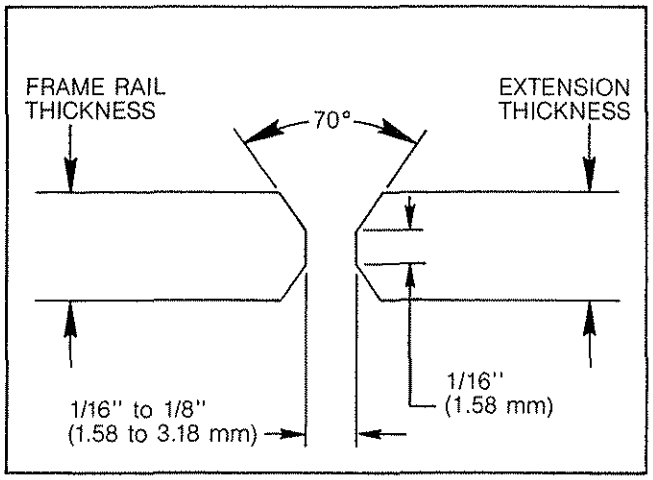


Fig. 13

4. Place the cut ends of the extension piece with the cut ends of the frame rail so that there is a 1/16- to 1/8-inch (1.58 to 3.18 mm) gap between them. See Fig. 13.

NOTE: A 1/16-inch (1.58 mm) gap is recommended. The ends must not contact each other. The joint spacing can be maintained by placing a short piece of clean, 1/16-inch (1.58 mm) diameter aluminum welding wire (E4043) between the extension and frame rail. The wire sections must be short enough to be completely fused by the welding process.

5. Using the method given under "Welding Method for Aluminum Frame Rails," weld the extension to the frame rail, making full penetration as shown in Fig. 14. Remove any slag between passes, and back-gouge the root of the first vee before welding the other side.

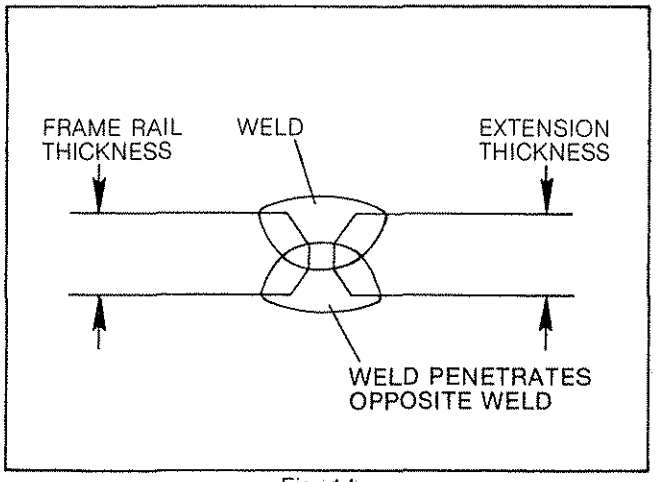


Fig. 14

IMPORTANT: Weld the web area first, then the flanges, working from the inside of the channel. When welding the web, make sure that the flanges do not contact each other. Lay the filler metal at a relatively high temperature in a single rapid pass at the bottom of the vee. This will keep total heat input to the joint at a minimum.

CAUTION: Failure to weld the web area first, or allowing the flanges to contact each other when welding the web, will result in increased stresses set upon the weld.

6. Without weaving motion of the electrode, make the final fill over the same path, first on the inside of the channel, then the outside.

7. When the welding is complete, the joint can be sanded for appearance. Hold the sander so that the grind runs parallel with the length of the frame rail.

CAUTION: Do not "hollow grind" the weld. Small depressions from improper grinding of the weld will reduce the structural strength of the frame rail.

FRAME CROSSMEMBER INSTALLATION

During vehicle manufacture, proper placement of the frame crossmembers is obtained from the vehicle frame drilling chart. If any crossmembers have been removed and are being replaced, or if new crossmembers are being installed, the Freightliner Corporate Engineering department must be contacted for instructions and approval. When the crossmembers are installed on the frame rails, the following fastener tightening sequence is used to keep various tolerances minimal in the final frame structure.

1. Using a minimum amount of fasteners, install the crossmembers on the frame rails.

2. Check to be sure that all the parts are installed properly, then install the remaining fasteners. Do not tighten at this time.

3. Align the frame rails. For instructions, refer to "FRAME RAIL ALIGNMENT."

4. Tighten a few fasteners at each end of the crossmember to a snug condition, to prevent movement of parts.

5. Tighten the remaining fasteners to a snug condition. Scatter the tightening process as widely as possible.

FRAME ASSEMBLY

6. Check again for alignment. For instructions, refer to "FRAME RAIL ALIGNMENT." If not aligned, loosen all fasteners and repeat this procedure beginning with step 3, above. If aligned, tighten all fasteners to their applicable torque values. For torque values, refer to the "CHARTS AND SPECIFICATIONS" section in the Freightliner Maintenance and Lube Manual.

FRAME RAIL ALIGNMENT

IMPORTANT: To align the frame rails on 1984 Advancements vehicles, the frame assembly must be assembled with the crossmembers in place, but the attachment fasteners *not* tightened. The forward frame subassembly fasteners must be tightened to their proper torque values, but the fasteners that attach the subassembly to the frame rails must *not* be tight.

On previous vehicles, the frame assembly must be assembled with the crossmembers and front bumper in place, but the fasteners *not* tightened.

Frame rail alignment is checked by measuring the distances from two sets of points or bolt holes located on the upper flanges of the frame rails. See Fig. 15. The rear set of points or bolt holes should be as far back as possible from the forward set of points or bolt holes. There must be no interference, along or between the frame rails, that would prevent measuring from the forward point on either frame rail to the rear point on the opposite frame rail. The points or bolt holes must be in identical locations on each frame rail.

1. Use a machinists square to determine the exact center of the upper flange at frame station 100 on each of the frame rails. Using a pencil or soapstone, mark the centers.

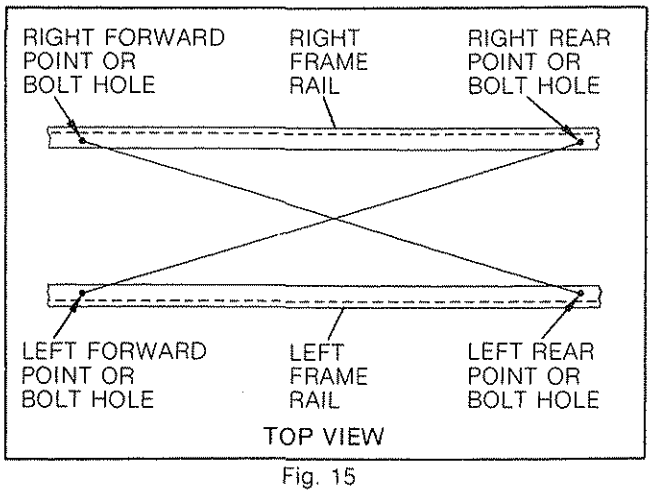


Fig. 15

If frame station 100 cannot be used (because of interference), measurements may be taken from the exact centers of a set of bolt holes that are located as far forward as possible. Use the machinists square to be sure the exact center of each of the two bolt holes is the same distance from the outside face of its respective frame rail.

2. From the forward marks or holes, measure back an equal distance (within 1/32 inch [0.79 mm]) along the upper flange of each frame rail. The rear set of points or bolt holes should be 72 inches (1829 mm) or more from frame station 100, or from the centers of the forward bolt holes. If, because of interference, the distance must be less than 72 inches (1829 mm), the distance should be the maximum that is possible.

   If the rear points will be marked in pencil or soapstone, use the machinists square to make each mark 2 inches (51 mm) inboard from the outside face of its respective frame rail.

   If the rear points will be a set of bolt holes, use the machinists square to be sure the exact center of each of the two bolt holes is the same distance from the outside face of its respective frame rail.

3. Measure the distance from the forward point or centerline of the bolt hole on one frame rail to the rear point or centerline of the bolt hole on the opposite frame rail. See Fig. 15. Then, measure the distance from the other forward point or centerline of the bolt hole to the rear point or centerline of the bolt hole on its opposite frame rail.

4. Compare the two measurements. If the values differ by more than 1/8 inch (3 mm), place a wood block against the end of one frame rail, then using a large hammer, tap the rail until the measurements are within 1/8 inch (3 mm) of each other.

5. Tighten a few fasteners to their applicable torque values. For torque values, refer to the "CHARTS AND SPECIFICATIONS" section in the Freightliner Maintenance and Lube Manual. Check for frame rail alignment.

6. When the measurements are within 1/8 inch (3 mm) of each other, tighten all the crossmember fasteners. For instructions, refer to "FRAME CROSSMEMBER INSTALLATION."

7. Check for axle alignment. For instructions, refer to the 11 Group of this manual.

FRAME ASSEMBLY

SPECIFICATIONS

WIRE DIAMETER inches (mm)	CURRENT (amperes)		WIRE EXTENSION	
	Minimum	Maximum	OPTIMUM inches (mm)	MAXIMUM inches (mm)
0.045 (1.143)	160	320	1/2 (12.7)	3/4 (19.05)
1/16 (1.587)	300	600	3/4 (19.05)	1-1/8 (28.57)
5/64 (1.984)	480	960	1 (25.4)	1-1/2 (38.1)

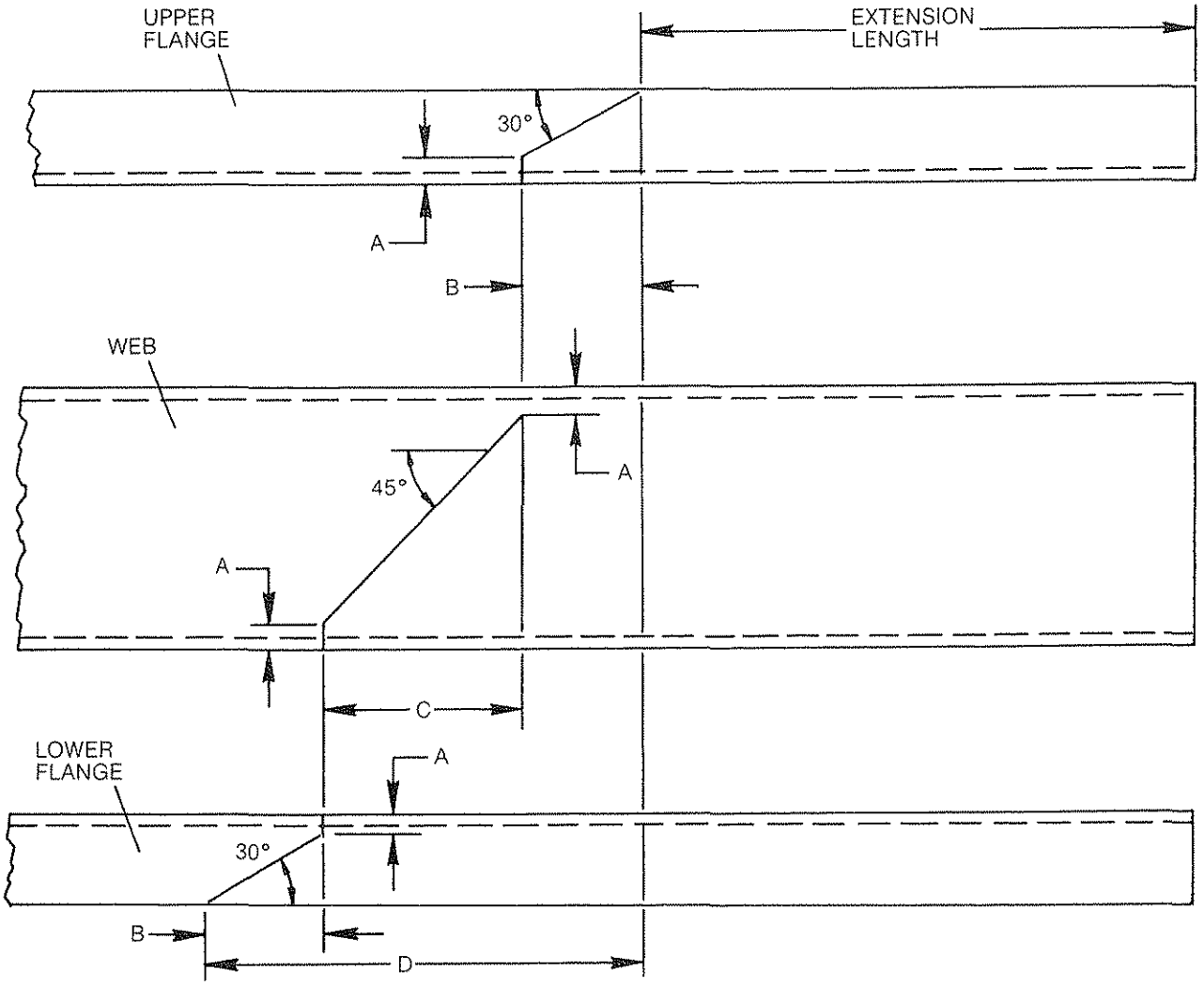
Table 1, Machine Settings for Gas-Metal Arc Weld Method

WELD POSITION	AMPERES	VOLTAGE
Downhand	130/140	21/23
Overhead	130/140	21/23
Vertical Up	110/120	22/24

Table 2, Amperage and Voltage Settings for Coated-Electrode Arc Welding Method

FRAME ASSEMBLY

SPECIFICATIONS (Continued)



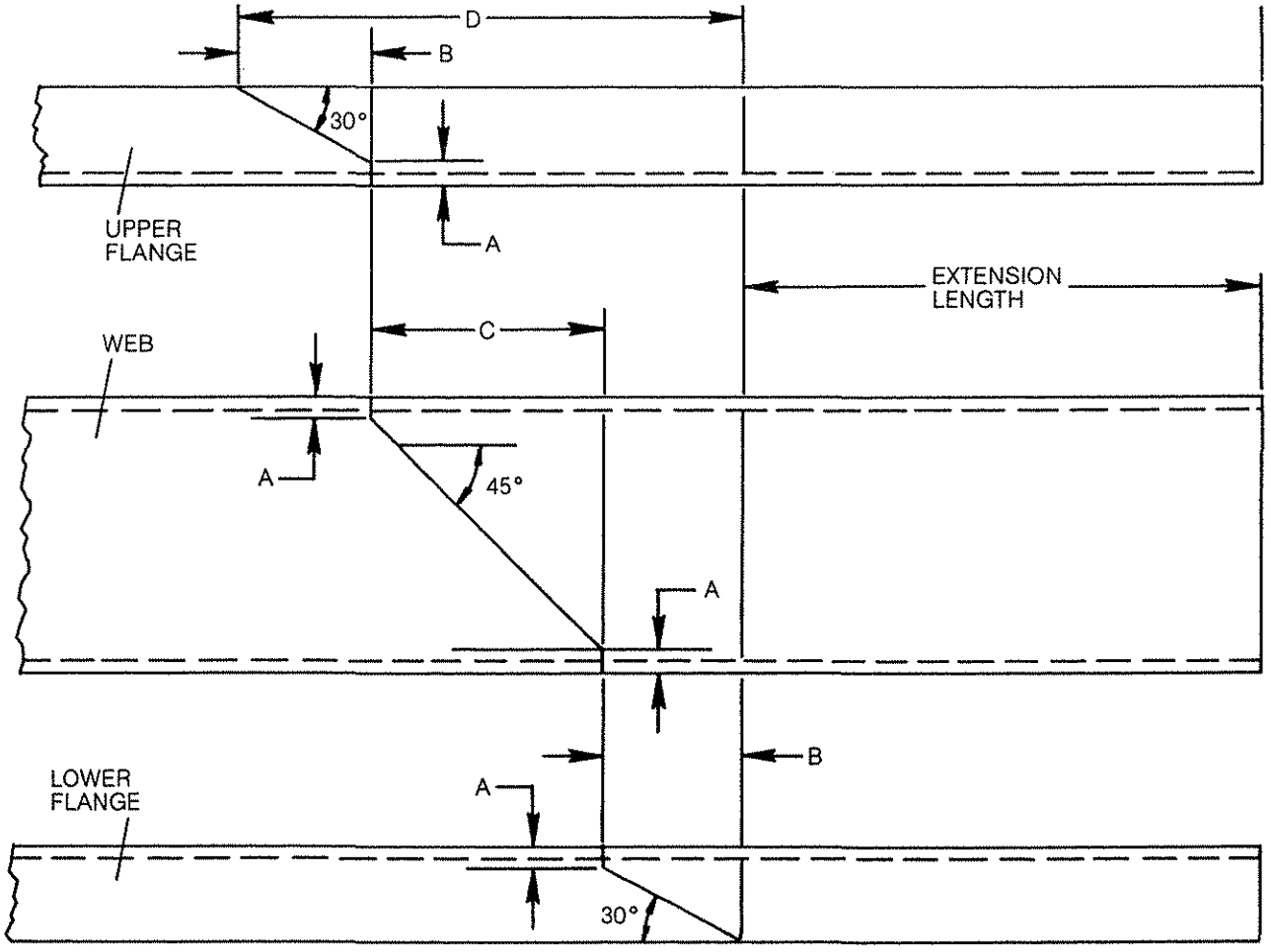
NOTE: Left rail shown, right rail will be opposite dimensions.

FRAME RAIL SIZE inches	DIMENSION			
	A inches (mm)	B inches (mm)	C inches (mm)	D inches (mm)
9.12	0.62 (15.7)	5 (127)	7.75 (196.9)	17.75 (450.9)
10.12	0.69 (17.5)	5 (127)	8.75 (222.2)	18.75 (476.2)

Fig. 16, Steel Frame Rail and Extension Cutting Dimensions for Truck Vehicles

FRAME ASSEMBLY

SPECIFICATIONS (Continued)



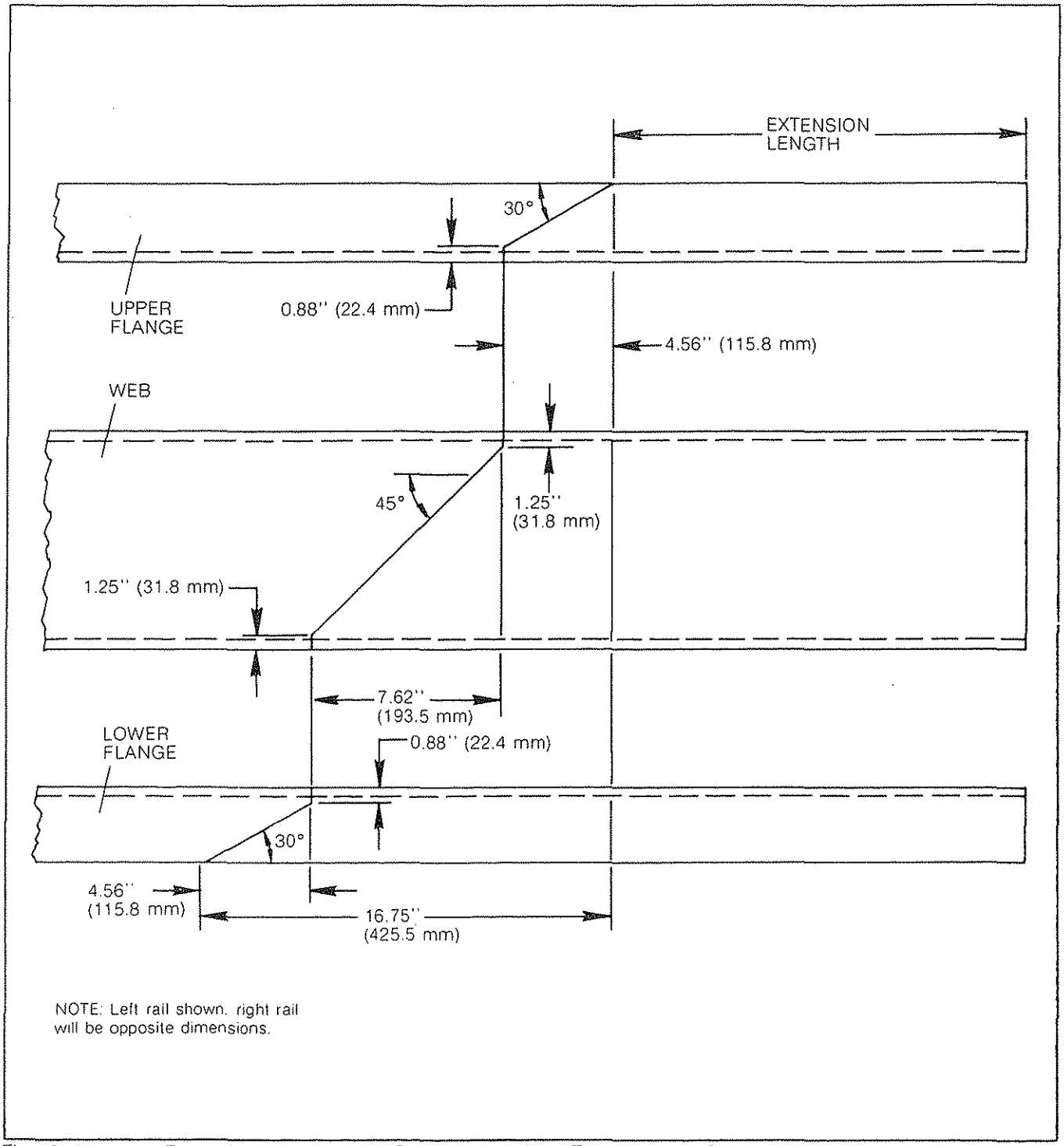
NOTE: Left rail shown, right rail will be opposite dimensions.

FRAME RAIL SIZE inches	DIMENSION			
	A inches (mm)	B inches (mm)	C inches (mm)	D inches (mm)
9.12	0.62 (15.7)	5 (127)	7.75 (196.9)	17.75 (450.9)
10.12	0.69 (17.5)	5 (127)	8.75 (222.2)	18.75 (476.2)

Fig. 17, Steel Frame Rail and Extension Cutting Dimensions for Tractor Vehicles

FRAME ASSEMBLY

SPECIFICATIONS (Continued)



NOTE: Left rail shown, right rail will be opposite dimensions.

Fig. 18. Aluminum Frame Rail and Extension Cutting Dimensions, Truck Vehicles Only

CONSIDERATIONS AND GUIDELINES FOR AFTER MARKET INSTALLED EQUIPMENT ON THE CHASSIS FRAME

GENERAL INFORMATION

Specialized equipment, such as hoists, lifts, winches, and derricks, is often added to a vehicle by distributers and/or installers other than the vehicle manufacturer. Usually, the vehicle manufacturer has not made special provisions for the additional equipment; unless otherwise requested at assembly, the vehicle is equipped with a standard chassis frame.

The organization or individual who installs the specialized equipment, commonly known as the "final stage manufacturer," is often not adequately instructed on the safe and proper installation of the equipment; the equipment manufacturers are not always obligated to provide adequate installation instructions with their products.

The "final stage manufacturer" must be aware of possible implications with Federal requirements for certification, noise, emissions, brakes, lighting systems, fuel systems, and others. The frame is not directly involved; however, components of the regulated systems may be mounted at or near the area where the specialized equipment must be located.

It is important to note that each specialized equipment installer is liable for the safety and durability of their product. It is also the responsibility of each installer to make certain that the specialized equipment complies with all applicable OSHA regulations and Department of Transportation vehicle certification requirements.

Of concern to the "final stage manufacturer" is the Truck Body and Equipment Association, Inc. (TBEA). The TBEA has a continuing program to assist its members in solving the problems discussed above, and to keep them informed on current and pending regulations.

The following information offers general guidelines for the proper installation of equipment to the chassis frame. Included are considerations that go into chassis frame design, and problems that can be encountered by the "final stage manufacturer." Also included, as a supplement to the detailed service information given in the 15 Group of this manual, are general guidelines for the bolting and clamping of specialized equipment to the chassis frame, and also a statement about the application of welds to the chassis frame. Finally, guidelines are given for the attachment of reinforcements to the vehicle frame.

CHASSIS FRAME DESIGN CONSIDERATIONS

Listed below are two of several factors considered during chassis frame design and testing. Whenever specialized equipment is installed on a standard chassis, the added weight, along with the presence of additional bolt holes, brackets, or welds, will increase frame side-rail stress, and influence these factors.

1. Frame deflection is the amount the frame side-rails bend from end to end as a result of their own weight and also the weight of any chassis components mounted on them. When the vehicle is stationary, the deflection is static. When the vehicle is moving, the side-rails are temporarily deflecting at higher degrees, especially as the vehicle travels over rough terrain.

   When a rigid piece of equipment, such as a winch, is attached to the chassis frame, side-rail deflection is locally restricted during vehicle travel. As a result, unwanted stress concentrations occur in the side-rails.

   Other installations, such as aerial ladders and lifts, also cause stress concentrations in the side-rails. But in addition to the stress, they affect vehicle stability, and can accelerate wear on tires and suspension parts.

2. Fatigue is the gradual weakening of material resulting from repeated flexing. Side-rail flexing does not in itself result in significant weakening of the metal, unless the flexing exceeds the endurance limit (even momentarily) of the metal; damage can then be sudden or cumulative. However, fatigue and stress are greatly increased with the presense of bolt

CONSIDERATIONS AND GUIDELINES FOR AFTER MARKET INSTALLED EQUIPMENT ON THE CHASSIS FRAME

holes, brackets, welds, and other stress concentrators, some of which are on all chassis frames. Any effect these stress agents have on the life of the structure will depend on their location and severity.

SERVICE OPERATIONS

GUIDELINES FOR THE ATTACHMENT OF SPECIALIZED EQUIPMENT TO THE CHASSIS FRAME

Any attachment of specialized equipment to the chassis frame will produce stress concentrations. The addition of holes, welds, clamps, reinforcements, or splices will cause a local increase in stress. Fig. 1 illustrates a number of typical stress concentrations in frame side-rails. The location on the chassis frame, the severity and frequency of the applied load, and the type of concentrator will all serve to determine the effect, if any, the stress concentrations have on the life of the structure.

It is important to note that notches placed at any location along the side-rail are critical. Fig. 2 illustrates a clearance notch on the side-rail flange, typical of the kind added by "final stage manufacturers." As shown, the side-rail cracked at the notch (after a few months of vehicle use). The probable causes of the crack were the installer's failure: to use care in grinding; to insure that there was a smooth blend over a distance with no nicks or rough edges; and, to check first with the vehicle manufacturer to determine the magnitude of stress in this area.

IMPORTANT: The practice of adding clearance notches to the frame side-rails may adversely affect the frame warranty, and the installer may be responsible for any consequences resulting from the notches.

Below, three common methods of attaching specialized equipment to the frame chassis are discussed. Under each method, the general advantages and disadvantages of using that method are given – they can help the installer decide which method of attachment is best in a given situation. Also included are guidelines that should be followed by the "final stage manufacturer" when using a particular method of attachment.

Bolt Attachment

Bolt attachments include clips, brackets, and fishplates.

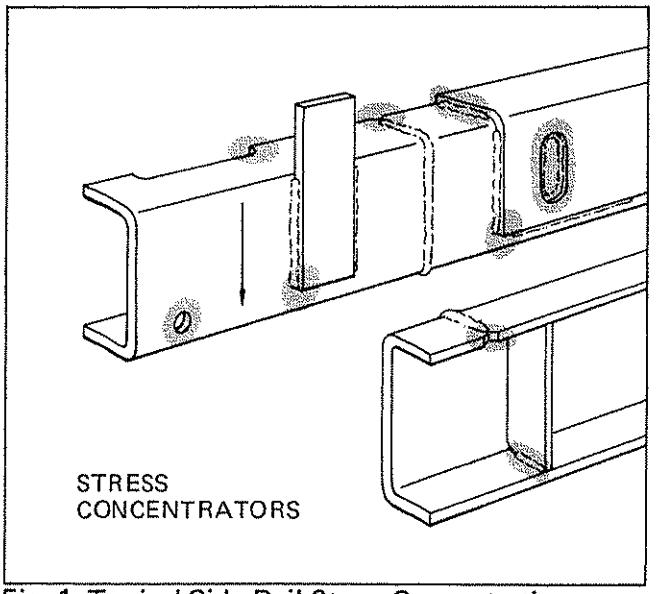


Fig. 1, Typical Side-Rail Stress Concentrations

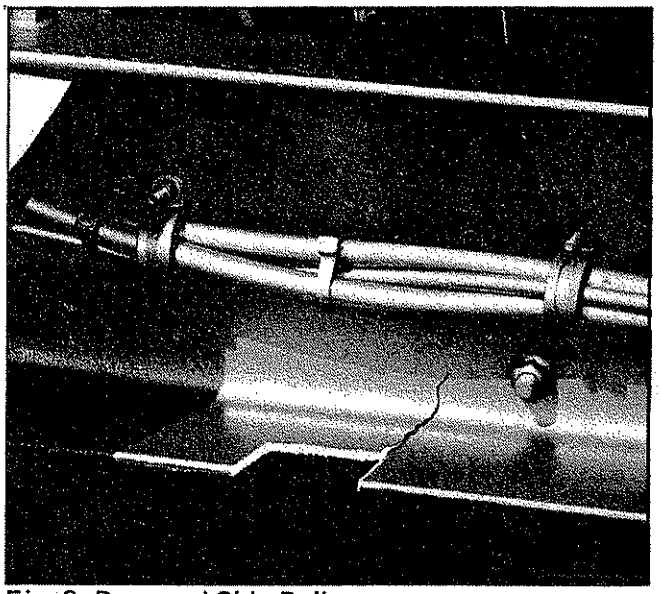


Fig. 2, Damaged Side-Rail

CONSIDERATIONS AND GUIDELINES FOR AFTER MARKET INSTALLED EQUIPMENT ON THE CHASSIS FRAME

Advantage

When the holes used for bolting are in the least critical areas possible, bolting is preferred for its versatility and strength.

Disadvantages

1. Providing access for drilling holes in the frame may require disassembly of chassis components.

2. Drilling holes in heat-treated frames involves higher pressures and requires special drilling equipment, preferably a positive feed machine.

Guidelines

The following is intended to emphasize the importance of hole locations in the side-rails, and help "final stage manufacturers" to avoid some pitfalls which could lead to premature failures:

Fig. 3 depicts a channel section frame side-rail loaded as a beam. This type of loading stretches the lower half of the section (produces "tension") and compresses the upper half of the section (produces "compression"), as indicated by the arrows. If the side-rail section was without holes, the highest concentrations of stress (tension and compression) would be in the lower and upper flanges of the rail.

However, Fig. 3 shows two holes in the lower half of the rail. The uppermost hole is located about one-third of the web depth up from the lower flange. Stress (tension) at the bottom of this hole would be approximately equal to the stress in the lower flange. Any hole located less than this distance (for example, the hole located nearer to the lower flange in Fig. 3) will have significantly higher stress (tension) than will the flange. The reason for the difference in stress among the holes is that the upper hole is located closer to the neutral axis of the rail, or the area where the forces of tension and compression do not exist.

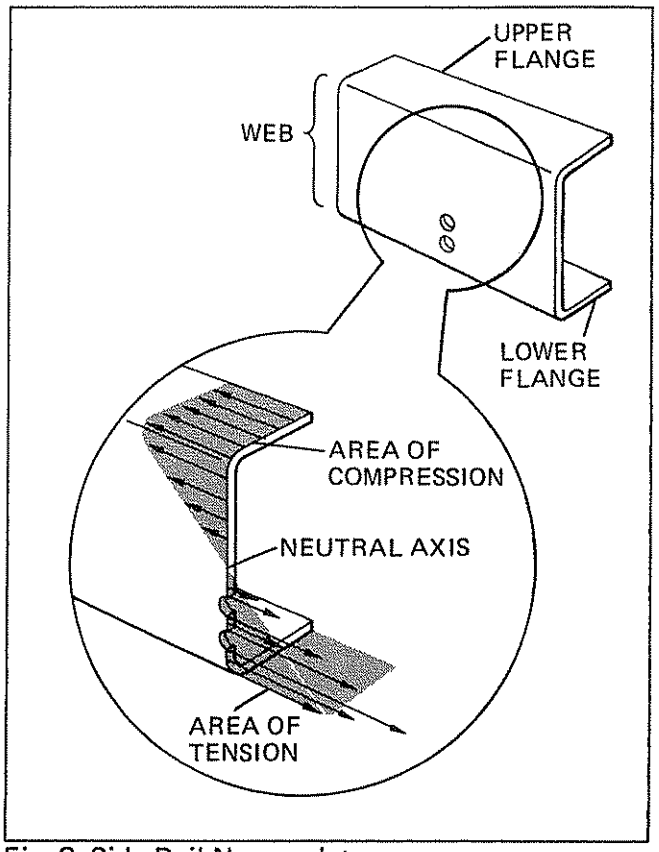


Fig. 3, Side-Rail Nomenclature

Based on these conditions, the recommendations below should be followed whenever specialized equipment is to be bolted to the chassis frame:

1. Use existing holes where possible. When holes must be drilled, they should be located no closer to the top and bottom side-rail flanges than the existing holes placed by the factory.

2. Avoid drilling holes in any area of the side-rail web except the central one-third area (the web is the surface area between the flanges). Depending on loading, the top or the bottom of the side-rail can be the tension side. It is recommended that before side-rail hole drilling is performed, the vehicle manufacturer be consulted.

3. In all cases, avoid drilling holes in the side-rail flanges.

CONSIDERATIONS AND GUIDELINES FOR AFTER MARKET INSTALLED EQUIPMENT ON THE CHASSIS FRAME

U-Bolt And Clamp Attachment

Advantages

1. Generally, clamping devices, such as that shown in Fig. 4, are the least time-consuming and least expensive methods of attachment.

2. U-bolts avoid frame drilling, which is especially helpful when the vehicle is equipped with a heat-treated frame.

Disadvantages

1. Since the U-bolts or clamps are not always attached (locked) to the frame, there is the possibility of heavy equipment moving or being jarred out of place, especially if grease or oil is present on the frame rail.

2. The nuts of the U-bolts or clamps require more periodic retorquing than do those of bolted attachments to the frame.

3. U-bolts and clamps cannot hold high torque loads.

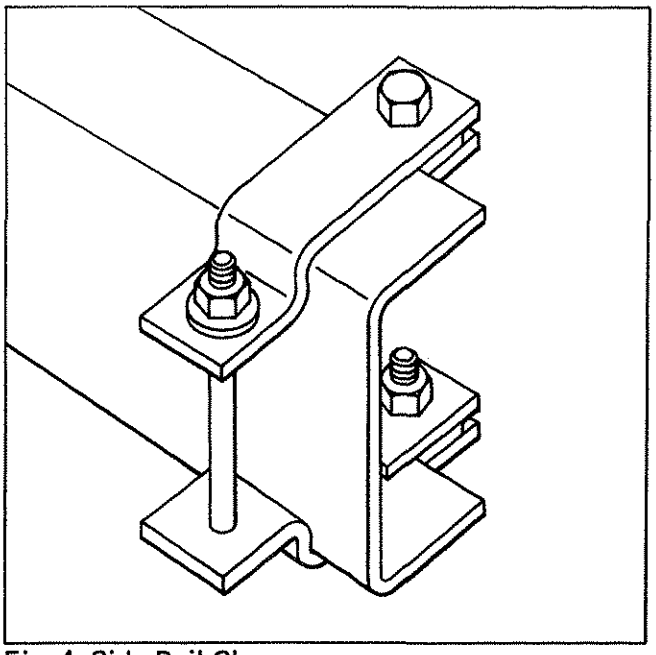


Fig. 4, Side-Rail Clamp

4. U-bolts and clamps cause local stress concentrations.

Guidelines

1. Care should be used to block (with spacers) the side-rail channel to prevent collapse of the flanges when the U-bolts are tightened. Metal blocks are preferred, because wood may shrink and drop out.

2. The blocks utilized to prevent collapse of the side-rail flanges should not interfere with plumbing or wiring routed along the frame rails. In addition, the blocks should not be welded to the side-rail flanges.

3. Since U-bolts and clamping devices depend on friction and a maintained clamping force for attachment, some bolts should directly connect the attachment to the frame side-rail web to prevent the attachment from slipping.

4. Do not notch frame side-rail flanges in order to "force" a U-bolt fit, as shown in Fig. 5. If the side-rail flanges are too wide, obtain a larger U-bolt or use another method of attachment.

CAUTION: Notching a side-rail flange severely weakens the structure and could ultimately result in side-rail fracture. With complete side-rail fracture, other chassis parts could be damaged with consequent substantial increase in repairs.

Weld Attachment

There are very few cases in which welding on a heat treated side-rail is tolerable. Direct welding of the side-rail flanges and web should be avoided. To avoid direct welding, equipment bracketry should be welded on a separate reinforcement, and the reinforcement should be bolted to the side-rail. It is recommended that before any direct welding to the side-rails is performed, the Freightliner Corporate Engineering Department be consulted.

CONSIDERATIONS AND GUIDELINES FOR AFTER MARKET INSTALLED EQUIPMENT ON THE CHASSIS FRAME

Advantage

When the holes used for bolting are in the least critical areas possible, bolting is preferred for its versatility and strength.

Disadvantages

1. Providing access for drilling holes in the frame may require disassembly of chassis components.

2. Drilling holes in heat-treated frames involves higher pressures and requires special drilling equipment, preferably a positive feed machine.

Guidelines

The following is intended to emphasize the importance of hole locations in the side-rails, and help "final stage manufacturers" to avoid some pitfalls which could lead to premature failures:

Fig. 3 depicts a channel section frame side-rail loaded as a beam. This type of loading stretches the lower half of the section (produces "tension") and compresses the upper half of the section (produces "compression"), as indicated by the arrows. If the side-rail section was without holes, the highest concentrations of stress (tension and compression) would be in the lower and upper flanges of the rail.

However, Fig. 3 shows two holes in the lower half of the rail. The uppermost hole is located about one-third of the web depth up from the lower flange. Stress (tension) at the bottom of this hole would be approximately equal to the stress in the lower flange. Any hole located less than this distance (for example, the hole located nearer to the lower flange in Fig. 3) will have significantly higher stress (tension) than will the flange. The reason for the difference in stress among the holes is that the upper hole is located closer to the neutral axis of the rail, or the area where the forces of tension and compression do not exist.

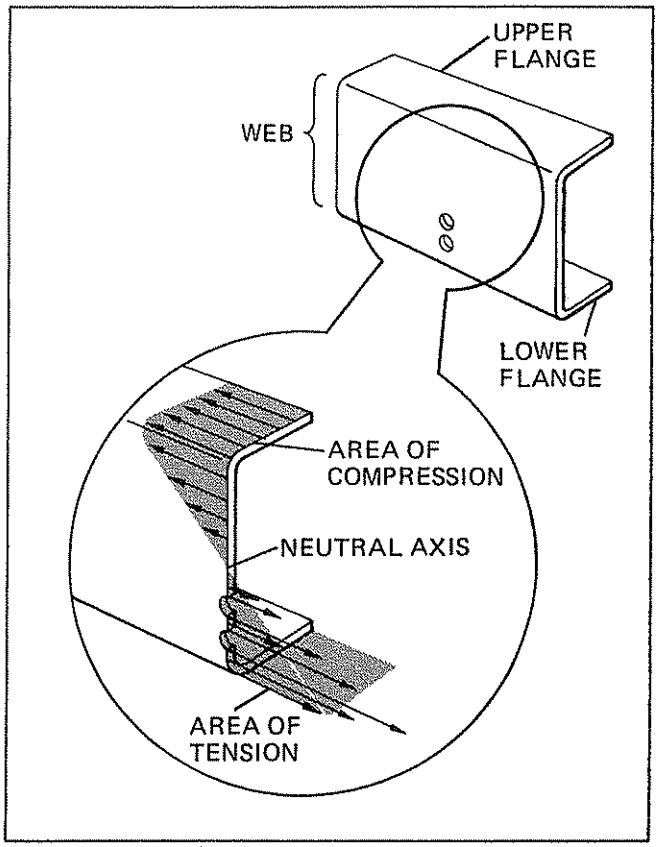


Fig. 3, Side-Rail Nomenclature

Based on these conditions, the recommendations below should be followed whenever specialized equipment is to be bolted to the chassis frame:

1. Use existing holes where possible. When holes must be drilled, they should be located no closer to the top and bottom side-rail flanges than the existing holes placed by the factory.

2. Avoid drilling holes in any area of the side-rail web except the central one-third area (the web is the surface area between the flanges). Depending on loading, the top or the bottom of the side-rail can be the tension side. It is recommended that before side-rail hole drilling is performed, the vehicle manufacturer be consulted.

3. In all cases, avoid drilling holes in the side-rail flanges.

CONSIDERATIONS AND GUIDELINES FOR AFTER MARKET INSTALLED EQUIPMENT ON THE CHASSIS FRAME

U-Bolt And Clamp Attachment

Advantages

1. Generally, clamping devices, such as that shown in Fig. 4, are the least time-consuming and least expensive methods of attachment.

2. U-bolts avoid frame drilling, which is especially helpful when the vehicle is equipped with a heat-treated frame.

Disadvantages

1. Since the U-bolts or clamps are not always attached (locked) to the frame, there is the possibility of heavy equipment moving or being jarred out of place, especially if grease or oil is present on the frame rail.

2. The nuts of the U-bolts or clamps require more periodic retorquing than do those of bolted attachments to the frame.

3. U-bolts and clamps cannot hold high torque loads.

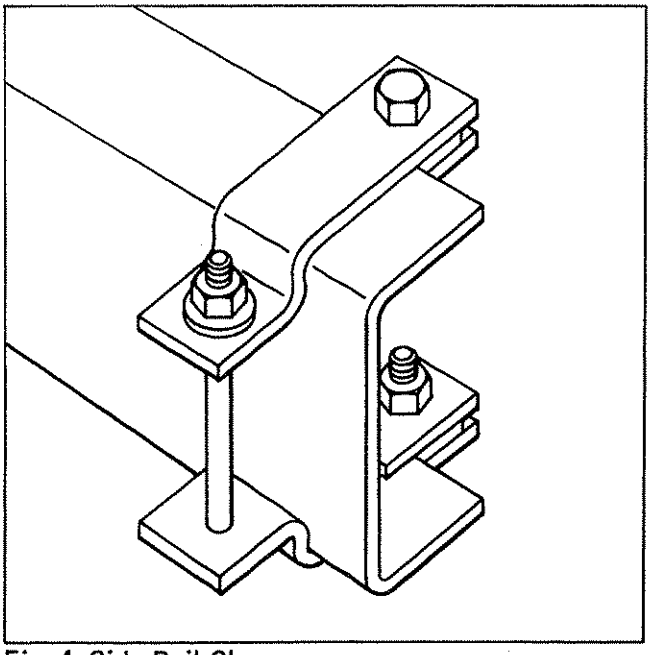


Fig. 4, Side-Rail Clamp

4. U-bolts and clamps cause local stress concentrations.

Guidelines

1. Care should be used to block (with spacers) the side-rail channel to prevent collapse of the flanges when the U-bolts are tightened. Metal blocks are preferred, because wood may shrink and drop out.

2. The blocks utilized to prevent collapse of the side-rail flanges should not interfere with plumbing or wiring routed along the frame rails. In addition, the blocks should not be welded to the side-rail flanges.

3. Since U-bolts and clamping devices depend on friction and a maintained clamping force for attachment, some bolts should directly connect the attachment to the frame side-rail web to prevent the attachment from slipping.

4. Do not notch frame side-rail flanges in order to "force" a U-bolt fit, as shown in Fig. 5. If the side-rail flanges are too wide, obtain a larger U-bolt or use another method of attachment.

CAUTION: Notching a side-rail flange severely weakens the structure and could ultimately result in side-rail fracture. With complete side-rail fracture, other chassis parts could be damaged with consequent substantial increase in repairs.

Weld Attachment

There are very few cases in which welding on a heat treated side-rail is tolerable. Direct welding of the side-rail flanges and web should be avoided. To avoid direct welding, equipment bracketry should be welded on a separate reinforcement, and the reinforcement should be bolted to the side-rail. It is recommended that before any direct welding to the side-rails is performed, the Freightliner Corporate Engineering Department be consulted.

CONSIDERATIONS AND GUIDELINES FOR AFTER MARKET INSTALLED EQUIPMENT ON THE CHASSIS FRAME

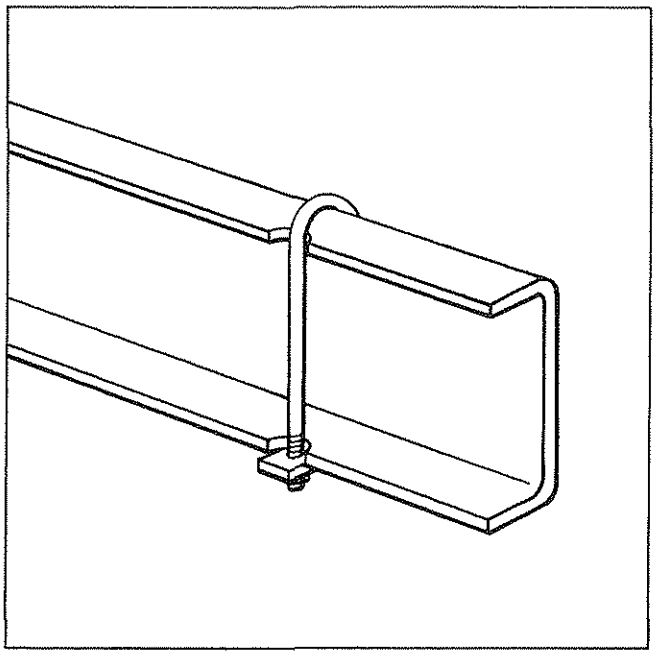


Fig. 5, U-Bolt On Notched Side-Rail

Frame Reinforcement Guidelines

Reinforcements are often added to the vehicle frame because of wheelbase change (extension), improper purchase specification by the customer, or change of intended use. If a reinforcement is necessary, bolting is the preferred method of attachment. Use existing holes, adding bolts only where required.

For a full length reinforcement, the front should extend past the front spring rear hanger and at least past the equalizer bracket. Both ends of the reinforcements (short or long) should be tapered for a smoother transition.

IMPORTANT: The frame requirements for stress and deflection with various axle ratings and wheelbases change rapidly as axle loading varies. If an axle rating is changed for any reason, the frame must be evaluated for adequacy.

FRAME FASTENERS

GENERAL DESCRIPTION

On some vehicles, grade 8.2 flanged hexhead bolts and grade G prevailing torque flanged hexhead locknuts are used for all frame attachments. See **Fig. 1**. On other vehicles, grade 8 hexhead bolts and grade C prevailing torque locknuts are used. See **Fig. 2**. Both types of locknuts have distorted sections of threads to provide torque retention.

When nonflanged hexhead bolts and locknuts are used on an aluminum frame member or an attached part, a hardened flatwasher is required to prevent the bolt head or nut from embedding in the frame or part. In general, hardened washers are used to distribute the load, and to prevent localized overstressing of the frame rails, brackets, and other parts. They are placed directly against the part, under the nut or bolt head. These special hardened washers are used on aluminum or steel frame rails, and for the engine rear supports, rear suspension brackets, and fifth wheel mountings. They are cadmium- or zinc-plated, and have a hardness rating of 38 to 45 HRC.

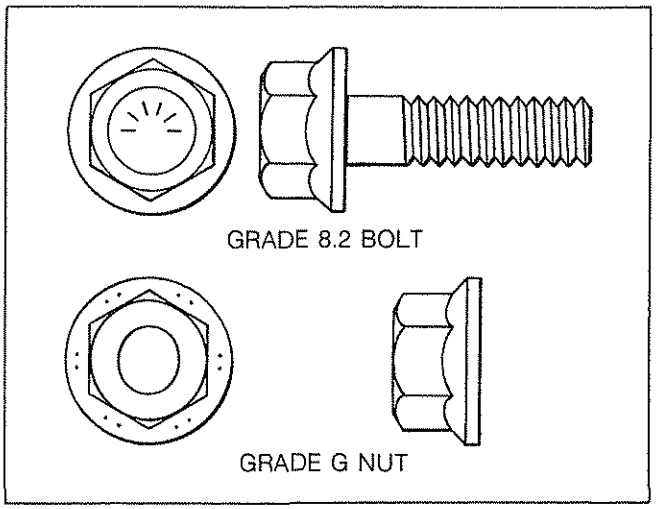


Fig. 1, Flanged Hexhead Fasteners

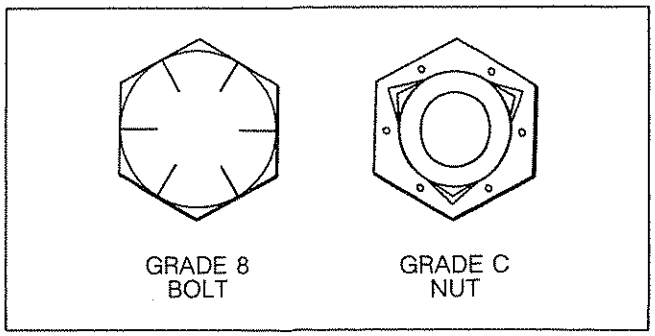


Fig. 2, Hexhead Fasteners

Flanged hexhead bolts and locknuts have integral flanges which eliminate the need for washers on steel and aluminum surfaces. The fasteners are placed directly against the frame where the part is attached.

CAUTION: Failure to apply Alumilastic® compound, or an equivalent, to areas where aluminum and steel parts contact each other, could lead to corrosion of the metals, resulting in damage to the frame or parts.

IMPORTANT: Alumilastic compound, or an equivalent, must be applied to all bolts, nuts, and washers that contact aluminum frame rails or aluminum components.

FRAME FASTENER REPLACING AND TORQUING

CAUTION: Continued vehicle operation with loose fasteners could result in component, bracket, and frame damage.

Replace fasteners with identical bolts and locknuts. Refer to the Freightliner *Parts Book* for fastener specifications.

Tighten frame fasteners periodically to offset the effects of "bedding in" (seating). Refer to the Maintenance Schedule and Group 15 of the *COE and 120 Conventional Maintenance Manual* for intervals.

Never hammer or screw bolts into place. Align the holes of the frame and the part being attached to it, so that the nut and bolt surfaces are flush against the frame and the part. For bolts 4 inches (102 mm) or less in length, make sure that at least 1-1/2 threads and no more than 5/8-inch (16 mm) bolt length extend through the self-locking nut after it has been tightened. For bolts longer than four inches (102 mm), allow a minimum of 3 threads and a maximum of 3/4-inch (19 mm) bolt length.

When tightening the fasteners, tighten the nut, not the bolt head. This will give a true torque reading by eliminating bolt body friction. For torque specifications, refer to the "Charts and Specifications" section of the *COE & 120 Conventional Maintenance Manual.*

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ROUGH RIDE DIAGNOSIS

GENERAL DESCRIPTION

There are two terms used to describe rough ride conditions: harmonic and harsh. Harmonic ride problems are those in which the once-per-revolution energy input from such things as bent or imbalanced wheels match the natural frequency of the frame flexing. This produces a fore-and-aft motion in the cab, which continues as long as the critical road speed is maintained. Harmonic ride problems occur on smooth roads.

Harsh ride problems are those in which the suspension transfers – rather than absorbs – the momentary energy inputs produced when the tires hit bumps or holes in the road. Wavy asphalt, or a series of bumps, may cause repetition of the harsh, jarring motion in the cab, but the motion stops after the tires pass over the bumps. Harsh ride problems occur on rough roads.

This section is designed for use as an aid in locating and correcting rough ride problems. It is not intended for use as a replacement for the detailed service information located in the applicable subjects in this manual, or in the component manufacturers' service manuals.

SERVICE OPERATIONS

HARMONIC AND HARSH RIDE CHECKS

Harmonic Ride Checks

1. Visually check the vehicle for signs of damaged or missing suspension components. Repair or replace the components using the instructions in the 10 or 11 Group of this manual.

2. Test drive the vehicle.

NOTE: When test driving the vehicle, duplicate as closely as possible the conditions under which the problem occurs. Note the area of the vehicle where the problem seems to be coming from. Pay special attention to this area during the service operations.

3. Raise the vehicle until the tires are off the ground, and all of the weight is removed from the leaf springs. Block the axle and frame with safety stands. Perform the corrections given under "TROUBLESHOOTING: Harmonic Ride, Tires Off the Ground."

WARNING: Safety stands must be securely supporting all of the wheel and frame weight during suspension repairs. Unsecured components may drop when the fasteners are loosened or removed, causing component damage and serious personal injury.

4. Remove the safety stands from under the frame and axle, then lower the vehicle. Perform the corrections given under "TROUBLESHOOTING: Harmonic Ride, Tires On the Ground."

Harsh Ride Checks

1. Visually check the vehicle for signs of damaged or missing suspension components. Repair or replace the components using the instructions in the 10 or 11 Group of this manual.

2. Test drive the vehicle.

NOTE: When test driving the vehicle, duplicate as closely as possible the conditions under which the problem occurs. Note the area of the vehicle where the problem seems to be coming from. Pay special attention to this area during the service operations.

3. Raise the vehicle until the tires are off the ground, and all of the weight is removed from the leaf springs. Block the axle and frame with safety stands. Perform the corrections given under "TROUBLESHOOTING: Harsh Ride, Tires Off the Ground."

WARNING: Safety stands must be securely supporting all of the wheel and frame weight during suspension repairs. Unsecured components may drop when the fasteners are loosened or removed, causing component damage and serious personal injury.

Service

Service

FREIGHTLINER

ROUGH RIDE DIAGNOSIS

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Harmonic Ride, Tires On the Ground	On Conventionals, worn or loose cab mounts allow the cab to bounce.	With a long bar, lever the cab legs up and down. If there is looseness, replace or tighten the mounts, as necessary.
	On COEs, the rear cab latches are out of adjustment.	Adjust the latches using the instructions in the 18 Group of this manual.
	Forces from the trailer suspension are pushing on the tractor fifth wheel.	Review the ride problems in this subject that apply to the trailer suspension. Perform the corrections, as necessary.
Harsh Ride, Tires Off the Ground	Seized front spring shackle pins are not allowing the springs to flex.	Replace seized shackle pins. For instructions, refer to the 16 Group of this manual.
Harsh Ride, Tires On the Ground	The tires are improperly inflated.	Adjust the tire pressure using the instructions in the 13 Group of the Freightliner Maintenance and Lube Manual.
	The frame is bottoming out against the suspension.	Check the suspension for weak or damaged springs or components. Inspect the springs for "gull-winging" when the vehicle is loaded. Replace the spring assembly, as necessary, using the instructions in the 10 or 11 Group of this manual.
		Reduce the overall loaded weight on each axle to conform with the maximum spring load capacities given on the vehicle specification sheet. Do not exceed the maximum spring load capacities.
		Adjust the air spring height using the instructions in the 16 Group of this manual.

(Continued on next page)

ROUGH RIDE DIAGNOSIS

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Harsh Ride, Tires On the Ground (Cont.)	The vehicle normal loaded weight is markedly below the spring load capacity.	Contact the Freightliner Service Operations Regional Office for the correct application of a lower rated spring. Replace the spring assemblies using the instructions in the 10 or 11 Group of this manual.
	When the vehicle is loaded, the front axle spring shackle angle is not within the rearward 3 to 18 degree angle.	Contact the Freightliner Service Operations Regional Office for shackle angle corrective measures. Refer to the 16 Group of this manual for service instructions.
	The weight on the tractor fifth wheel is causing overloading on the front axle springs.	If possible, move the fifth wheel towards the rear of the vehicle; otherwise, change the loading pattern on the trailer.
	There is a loaded weight differential between the rear axles greater than 800 pounds (363 kg).	Contact the Freightliner Service Operations Regional Office for corrective measures.
	Forces from the trailer suspension are pushing on the tractor fifth wheel causing a rough ride condition.	Review the ride problems in this subject that apply to the trailer suspension. Perform the corrections, as necessary.

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL, 1984 ADVANCEMENTS

GENERAL DESCRIPTION

The standard Freightliner front suspension (Fig. 1) uses tapered leaf spring assemblies. Flat leaf spring assemblies are optional.

The spring assemblies are mounted to the axle with U-bolts, hardened washers, and high nuts. The forward end of each spring mounts to a stationary frame bracket. The rear of each spring mounts to a pair of spring shackles which are suspended from a frame-mounted bracket. The spring shackles allow for variations in spring length during spring flexing.

The leaf spring assembly serves to absorb and store energy, and then to release it. The individual leaves are held together by a center bolt, with the center bolt head used as a locating dowel during installation on the vehicle. On the front end of the leaf spring assembly is an alignment clip. Alignment clips are used to limit sidewise spread and vertical separation of the individual leaves.

SERVICE OPERATIONS

LEAF SPRING AND COMPONENTS REMOVAL

1. Apply the parking brakes and chock the rear tires. Raise the front of the vehicle until all weight is relieved from the spring to be removed. Support the frame and axle with safety stands.

WARNING: Safety stands must securely support all of the wheel and frame weight during suspension repairs. Unsecured components may drop when the fasteners are loosened or removed, causing component damage and serious personal injury.

2. If the frame bracket flanged pinch bolts are mounted in such a way that the front bumper will interfere with their removal, remove the fog lights from the bumper. Secure the lights out of the way so that they are not dangling from their wires; then remove the front bumper from the vehicle.
3. If a COE, tilt the cab following the instructions in the Freightliner Driver's Manual. This will allow access to the spring shackle.
4. Remove the U-bolts and the stop assembly from the spring.
5. Swing the lower shock absorber bracket assembly away from under the axle and compress the shock absorber fully. This prevents the shock absorber and its lower bracket from interfering with further work.
6. Remove the flanged pinch bolts and flanged nuts from the frame bracket.
7. Using a suitable drift, drive the spring pin inboard to remove it.
8. Remove all the spacers from both sides of the spring end and keep them with the pin for later installation.
9. Remove the flanged pinch bolts and flanged nuts securing the shackle spring pin.
10. With a suitable drift, drive the pin outboard and remove it.
11. Remove all the spacers and wear plates and keep them with the pin for later installation.
12. Lift the spring assembly slightly and remove it toward the front of the truck. Note the taper direction of the caster shim so that it will not inadvertently be reversed during re-installation.

    If the shackle pin or shackle bracket bushings are to be checked for condition or replaced, the pin should be removed at this time.
13. Remove the flanged pinch bolts and flanged nuts.
14. Pull the shackle, wear plate and spacers from each end of the pin.
15. With a suitable drift, drive the pin outboard to remove it.

    If inspection shows the shackle bracket bushing needs to be replaced (see "CLEANING AND INSPECTION," steps 6 and 7), or if the shackle bracket is to be inspected thoroughly, the shackle bracket should be removed.
16. Remove the fasteners which secure the shackle bracket to the frame.

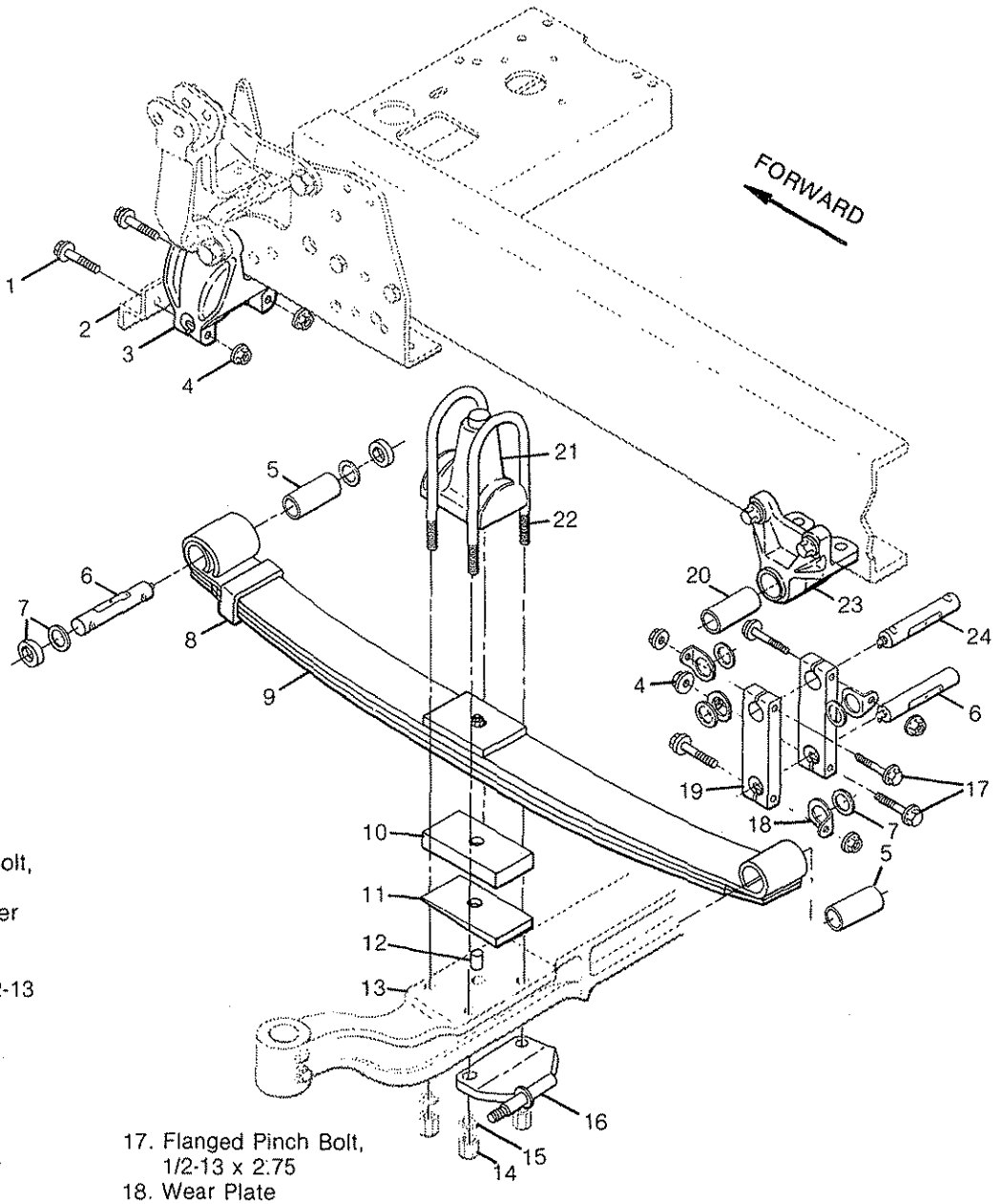
CLEANING AND INSPECTION

1. Using a wire brush and solvent or steam cleaning equipment, wash all parts to remove dirt, grease and scale.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents always comply with the solvent manufacturer's recommended safety precautions.

2. Inspect the shackle bracket and the spring shackles for cracks, wear, and other damage. Replace any damaged components.

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL, 1984 ADVANCEMENTS



1. Flanged Pinch Bolt, 1/2-13 x 3.25
2. Z-Bracket Bumper Mount
3. Frame Bracket
4. Flanged Nut, 1/2-13
5. Spring Bushing
6. Spring Pin
7. Spacing Washer
8. Spring Leaf Alignment Clip
9. Tapered Leaf Spring Assembly
10. Spacer Block
11. Caster Shim
12. Dowel
13. Front Axle
14. U-Bolt High Nut
15. Hardened Washer
16. Lower Shock Absorber Bracket Assembly
17. Flanged Pinch Bolt, 1/2-13 x 2.75
18. Wear Plate
19. Shackle
20. Shackle Bracket Bushing
21. Stop Assembly
22. U-Bolt
23. Shackle Bracket
24. Shackle Pin

Fig. 1

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL, 1984 ADVANCEMENTS

3. Inspect the spring for cracks and corrosion. If any cracked or broken leaves are discovered, the entire spring must be replaced as a unit.

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. On front spring assemblies, if cracks or breaks exist in the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

4. If the protective coating is gone from some areas of the spring, the cleaned areas can be painted with a rust-inhibiting paint. If rusting or corrosion is severe, the spring should be replaced.

5. Using a micrometer, check the spring pins and the shackle pin for wear. Replace a pin if the diameter at any point on the pin is less than 1.242 inches (31.55 mm).

6. Inspect the spring and bracket bushings. Replace the bushings if gouged, cracked, or otherwise damaged. For instructions, refer to the applicable subheading under "BUSHING REPLACEMENT."

7. If the bushings are not damaged, inspect them for wear. Using a micrometer, check the inside diameter of each bushing. The inside diameter of any bushing should not exceed the diameter of its pin by more than 0.020 inch (0.51 mm). Replace any bushing which exceeds this limit.

BUSHING REPLACEMENT

Shackle Bracket Bushing Replacement

1. With the shackle bracket removed from the vehicle, press out the worn or damaged bushing using a press.

2. With an inside micrometer, check for an out-of-round condition in the bracket bore. Replace the bracket if the bushing bore is out-of-round.

3. Before installing the new bushing, check the shackle pin for ease of fit in the bushing. There should be an easy slip fit without wobble between the pin and the bushing.

4. Using a press, press the new bushing into the bracket until the bushing is centered in the bracket.

5. Check the shackle pin for ease of fit in the bushing. There still should be an easy slip fit without wobble between the pin and the bushing. If binding occurs, the bushing may have been distorted during installation. Replace the bushing and check again for proper fit.

Spring Bushing Replacement

1. Replace spring bushings as follows:

   .1 Using a press, press out the worn or damaged bushing.

   .2 Using a press, press the new bushing into the spring eye until bushing and spring edges are flush.

   .3 Ream the newly installed bushing 1.252 to 1.254 inches I.D. (31.80 to 31.85 mm).

LEAF SPRING AND COMPONENTS INSTALLATION (Refer to **Fig. 1**)

WARNING: For normal highway driving do not install two different spring designs or load capacities on the front axle. In order to maintain a balanced front suspension system, and to prevent difficult handling after the vehicle is placed in service, install identical spring assemblies.

1. If the shackle bracket was removed from the vehicle, proceed as follows:

   .1 Apply Alumilastic® or similar compound to all areas of the front spring bracket that contact metal other than aluminum. This includes all capscrews, washers, and locknuts that contact aluminum parts. *Do not apply the compound to the inner (bearing) surface of the bushing or on fastener threads.*

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL, 1984 ADVANCEMENTS

CAUTION: Failure to apply Alumilastic® or similar compound will result in electrolytic corrosion of dissimilar metal components thereby causing damage to the suspension system.

.2 Install the shackle bracket. Torque the 1/2 inch locknuts to 80 lbf·ft (108 N·m) and the 5/8 inch locknuts to 160 lbf·ft (217 N·m).

NOTE: All suspension bracket (frame) fasteners require periodic retorquing. Refer to the 15 and 16 Groups of the Freightliner Maintenance and Lube Manual for recommended intervals.

2. Using multipurpose chassis grease, lubricate both spring pins, the shackle pin, and the inside surfaces of the bushings.

3. If the shackle was disconnected from the shackle bracket, attach it to the bracket as follows:

.1 Remount the shackles with the appropriate wear plates and spacing washers between bracket ends and shackles. Be sure the wear plates are in direct contact with the shackle bars. Insert the pin with its grease fitting end toward the outboard side. Align the grooves of the pin with the flanged pinch bolt bores.

.2 Install the flanged pinch bolts and flanged nuts to secure the shackle pin and wear plates in place. Torque the nuts to 50 lbf·ft (68 N·m).

CAUTION: Do not over-tighten the shackle pinch bolt nuts. Over-tightening these nuts could cause distortion and weakening of the aluminum shackles.

4. Install the dowel, caster shim, and spacer block on the front axle. First apply Alumilastic® or similar compound to all aluminum surfaces which will contact metal other than aluminum. Be sure the caster shim is installed with the taper pointing in the same direction as originally.

CAUTION: Failure to apply Alumilastic® or similar compound will result in electrolytic corrosion of dissimilar metal components, thereby causing damage to the suspension system.

5. Mount the spring assembly on the spacer block, being sure the spring bolt head fits into the bore in the spacer block.

6. Place the axle stop assembly on top of the spring assembly.

7. Install the U-bolts over the axle stop and spring assembly and through the holes in the axle. It may be necessary to compress the sides of the U-bolts slightly in order to get the U-bolt ends to align with the axle holes. A C-clamp attached above the U-bolt threads can be used for this purpose.

8. Attach the hardened washers and the high nuts finger tight.

9. Attach the spring assembly to the frame bracket as follows:

.1 Hold half the total number of spacers between the outboard end of the bracket and the spring, and insert the grease fitting end of the pin far enough into the bushing to hold the spacers in place. Hold the remaining spacers in place and push the spring pin the rest of the way until the grooves in the pin align with the frame bracket flanged pinch bolt bores.

.2 Check for play between the spring and the bracket ends. If needed, install additional 1/32 inch (0.8 mm) spacing washers (1-1/4 inch [32 mm] I.D., 1-7/8 [48 mm] O.D.) so that there is less than one washer thickness of end play. It is preferable to have an equal number of washers on each side of the spring. However, if the amount of play requires an uneven number of washers, the difference between the two sides should be no more than one spacing washer.

.3 Hold the Z-bracket bumper mount in place and install the flanged pinch bolts and flanged nuts. Torque the nuts to 80 lbf·ft (108 N·m).

10. Attach the spring assembly to the shackle bracket as follows:

.1 Hold half the total number of spacers between the outboard shackle and the spring, and with the grease fitting

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL, 1984 ADVANCEMENTS

pointed to the outboard side, insert the spring pin far enough into the bushing to hold the spacers in place. Hold the remaining spacers in place and push the pin the rest of the way until the grooves in the pin align with the shackle pinch bolt bores.

.2 Check for play between the spring and the shackle ends. If needed, install additional 1/32 inch (0.8 mm) spacing washers (1-1/4 inch [32 mm] I.D., 1-7/8 inch [48 mm] O.D.) so that there is less than one washer thickness of end play. It is preferable to have an equal number of washers on each side of the spring. However, if the amount of play requires an uneven number of washers, the difference between the two sides should be no more than one spacing washer.

.3 Install the flanged pinch bolts and flanged nuts. Torque the nuts to maximum 50 lbf·ft (68 N·m).

CAUTION: Do not over-tighten the shackle pinch bolt nuts. Overtightening of these nuts could lead to distortion and weakening of the aluminum shackles.

11. Remove the appropriate pair of high nuts and hardened washers and align the lower shock absorber bracket assembly so the U-bolt ends pass through the holes in the plate.

12. Attach the hardened washers and high nuts to the U-bolts and torque all four nuts to 350 lbf·ft (475 N·m).

CAUTION: The U-bolt high nuts require periodic retorquing. Failure to retorque the fasteners could result in spring breakage and abnormal tire wear. Refer to the 16 group of the Freightliner Maintenance and Lube Manual for recommended intervals.

13. Wipe all dirt from the grease fittings on the spring pins and the shackle pin. Apply multipurpose chassis grease with a pressure gun until grease appears at the opposite end of the pin.

14. If a COE, and if the cab was tilted for this operation, clear the necessary area of tools, etc., and lower the cab to its operating position.

15. Remove the jack stands from the chassis and lower the truck.

16. Install the bumper and the fog lights if these were removed.

17. Remove the chocks from the tires.

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TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Leans to One Side	One or more spring leaves is broken.	Replace the spring assembly.
	The spring assembly is weak or fatigued.	Replace the spring assembly.
	Unmatched spring design/load capacity spring assemblies are installed.	Install the correct spring assemblies as originally specified for the vehicle.
	A frame rail is bent or twisted.	Check the frame rails for bends and twists. Correct as needed.
Vehicle Wanders	One or more spring leaves is broken.	Replace the spring assembly.
	The wheels are out of alignment.	Adjust the wheel alignment using the instructions in the 10 Group of this manual.
	Caster incorrect.	Install correct caster shims. (Refer to the 10 Group of this manual for specifications.)
	Steering gear not centered.	Adjust steering using the instructions in the 14 Group of this manual.
	Drive axles out of alignment.	Align the drive axles using the instructions in the 11 Group of this manual.
Vehicle Bottoms Out	Excessive weight on the vehicle is causing an overload.	Reduce the loaded vehicle weight to the maximum spring capacities.
	One or more spring leaves is broken.	Replace the spring assembly.
	The spring assembly is weak or fatigued.	Replace the spring assembly.
Frequent Spring Breakage	The vehicle is overloaded or operated under severe conditions.	Reduce the loaded vehicle weight to the maximum spring capacities. Caution the driver on improper vehicle handling.
	There is insufficient torque on the U-bolt high nuts.	Torque the U-bolt high nuts to the value listed in Table 1 under "SPECIFICATIONS."
	A loose center bolt is allowing the spring leaves to slip.	Check the spring leaves for damage. If damaged, replace the spring assembly. If not, tighten the center bolt nut to the value listed in Table 1 under "SPECIFICATIONS.'

(Continued on next page)

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL, 1984 ADVANCEMENTS

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Frequent Spring Breakage (continued)	Worn or damaged spring pin bushings are allowing spring end-play.	Replace the spring pin and bushing.
Noisy Spring	A loose U-bolt nut or center bolt is allowing spring leaf slippage.	Inspect the components for damage. Replace damaged components as necessary. Torque all fasteners to the values listed in Table 1, under "SPECIFICATIONS."
	A loose, bent, or broken spring shackle or front spring bracket is impairing the spring flex.	Inspect the shackle and bracket for damage. Replace damaged components as necessary. Torque the fasteners to the values listed in Table 1, under "SPECIFICATIONS."
	Worn or damaged spring pins are allowing spring end-play.	Replace any worn or damaged spring pins.
Rough Ride	Refer to the applicable subject in the 16 Group of this manual.	

SPECIFICATIONS

DESCRIPTION	SIZE	TORQUE lbf·ft (N·m)
Front Spring Shackle Bracket-to-Frame Bolt Locknuts	1/2-13	80 (108)[1]
	5/8-11	160 (217)[1]
Spring Shackle Pinch Bolt Flanged Nuts	1/2-13	50 (68)
Frame Bracket Pinch Bolt Flanged Nuts	1/2-13	80 (108)[1]
U-Bolt High Nuts	7/8-14	350 (475)[1]

Table 1, Front Suspension Fastener Torque Values

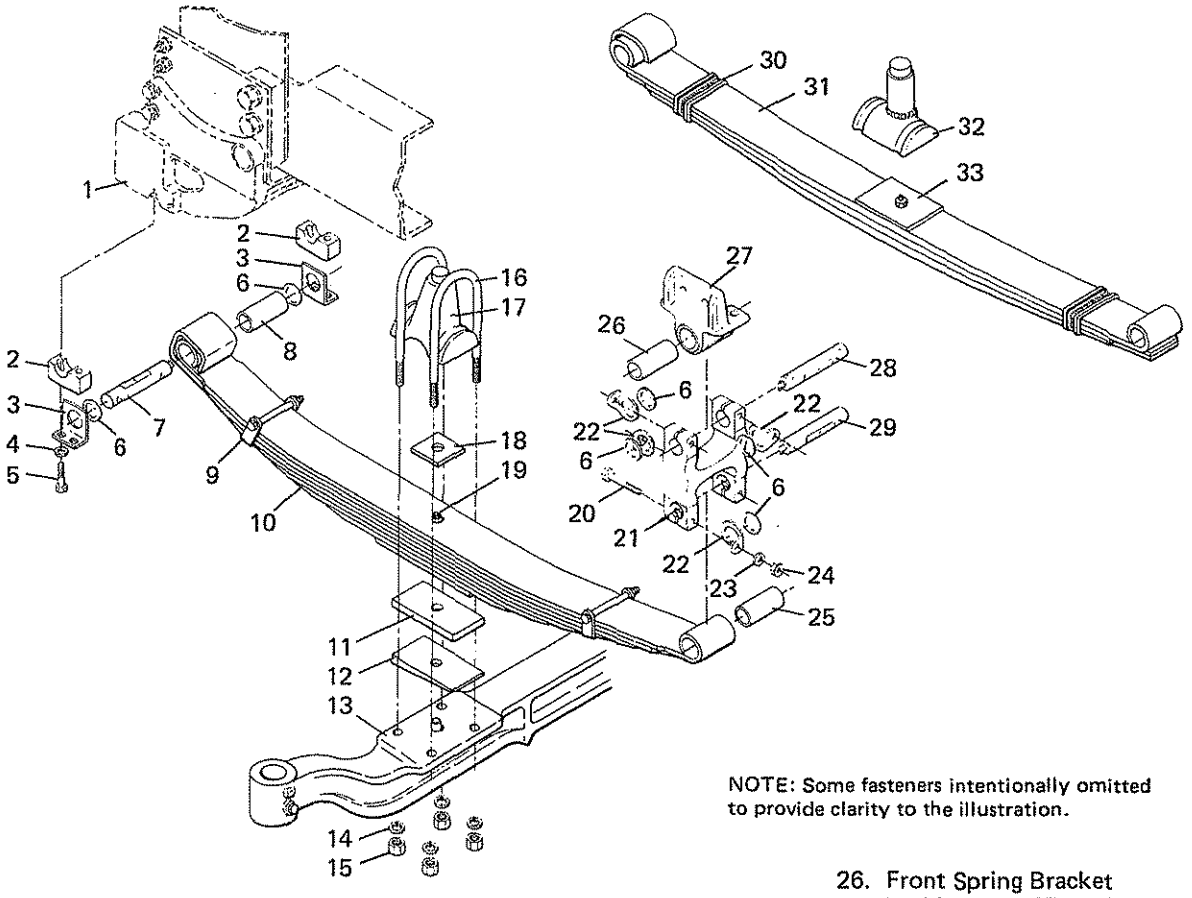
[1] These torque values are for fasteners with lubricated or plated threads. For dry threads, see the General Torque Table in the Freightliner Maintenance and Lubrication Manual.

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL

GENERAL DESCRIPTION

The standard Freightliner front suspension (Figs. 1 and 2) on COE and Conventional vehicles uses semielliptic leaf spring assemblies. Some vehicles are equipped with optional tapered leaf spring assemblies. Refer to Fig. 1.

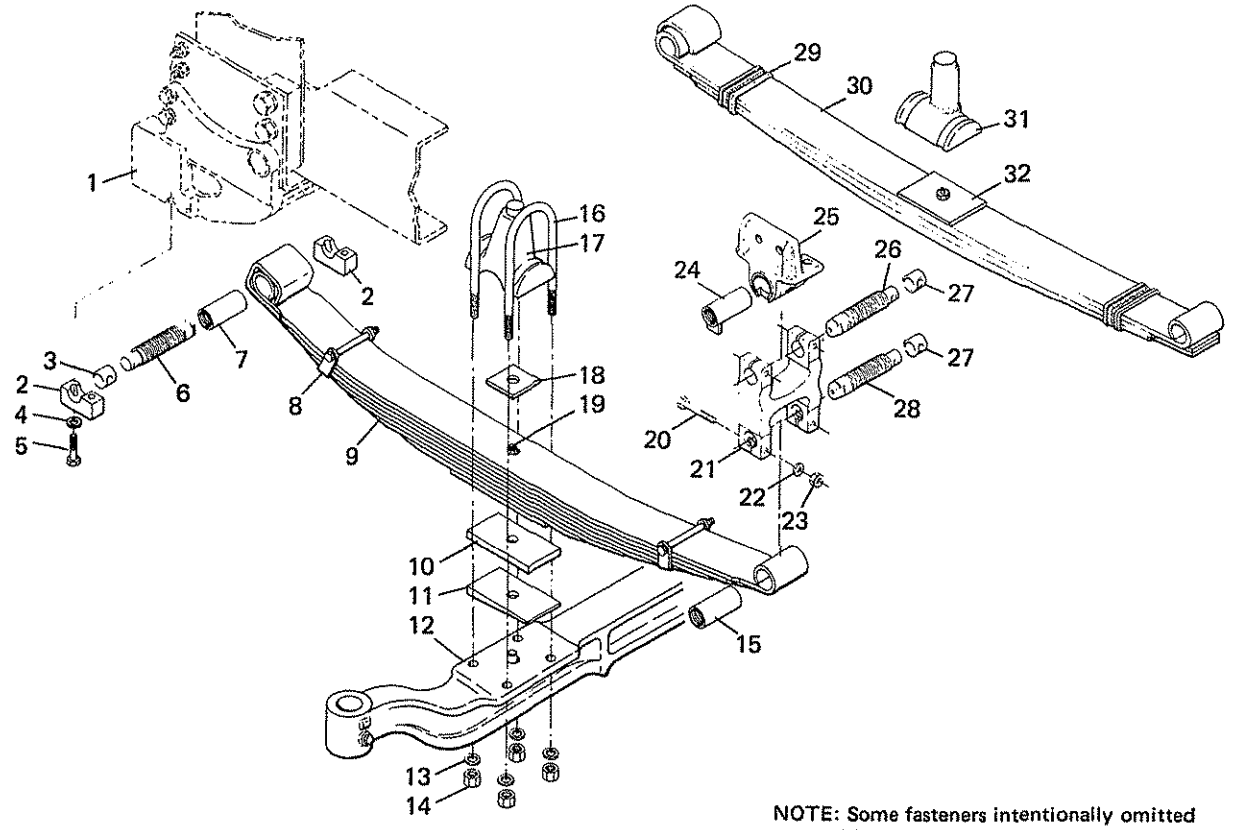
The leaf springs are mounted to the axle with U-bolts, hardened washers, and high nuts. The forward end of each spring mounts to a stationary frame bracket. The rear of each spring mounts to a spring shackle which swings from a frame-mounted bracket. The spring shackle allows for variations in spring length during spring flexing.



1. Frame Bracket
2. Bracket Cap
3. Wear Plate
4. Washer
5. Capscrew
6. Spacing Washer
7. Frame Bracket Pin, Non-Threaded
8. Spring Bushing, Non-Threaded
9. Bolt Alignment Clip Assembly
10. Spring Assembly, Semielliptic Leaf
11. Axle Spacer
12. Front Spring Shim
13. Front Axle
14. Washers
15. U-Bolt High Nuts
16. U-Bolts
17. Stop Assembly
18. Retainer Plate
19. Center Bolt Nut
20. Shackle Bolt
21. Spring Shackle
22. Wear Plate
23. Washer
24. Shackle Bolt Nut
25. Spring Bushing, Non-Threaded
26. Front Spring Bracket Bushing, Non-Threaded
27. Front Spring Bracket
28. Shackle Pin, Non-Threaded
29. Spring Shackle Pin, Non-Threaded
30. Strap Alignment Clip Assembly
31. Spring Assembly, Tapered Leaf
32. Stop Assembly
33. Spacer

Fig. 1, Freightliner Front Suspension, Non-Threaded Bushings

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL



NOTE: Some fasteners intentionally omitted to provide clarity to the illustration.

1. Frame Bracket
2. Bracket Cap
3. Split-Ring
4. Washer
5. Capscrew
6. Frame Bracket Pin, Threaded
7. Spring Bushing, Threaded
8. Bolt Alignment Clip Assembly
9. Spring Assembly, Semielliptic Leaf
10. Axle Spacer
11. Front Spring Shim
12. Front Axle
13. Washers
14. U-Bolt High Nuts
15. Spring Bushing, Threaded
16. U-Bolts
17. Stop Assembly
18. Retainer Plate
19. Center Bolt Nut
20. Shackle Bolt
21. Spring Shackle
22. Washer
23. Shackle Bolt Nut
24. Front Spring Bracket Bushing, Threaded, and Front Spring Bracket Bushing Lock Assembly
25. Front Spring Bracket
26. Shackle Pin, Threaded
27. Split-Ring
28. Spring Shackle Pin, Threaded
29. Strap Alignment Clip Assembly
30. Spring Assembly, Tapered Leaf
31. Stop Assembly
32. Spacer

Fig. 2, Freightliner Front Suspension, Threaded Bushings

The leaf spring assembly serves to absorb and store energy, and then to release it. The individual leaves are held together by a center bolt, with the center bolt head used as a locating dowel during installation on the vehicle. On each end of the leaf spring assembly is an alignment clip. Alignment clips are used to limit sidewise spread and vertical separation of the individual leaves.

The spring, spring shackle, front spring, and frame bracket bushings and pins on standard Freightliner front suspensions are non-threaded. Refer to Fig. 1. Optional threaded bushings and pins are installed on some vehicles. Refer to Fig. 2.

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL

SERVICE OPERATIONS

Depending on the type of bushings installed, refer to either Fig. 1 (non-threaded bushings) or Fig. 2 (threaded bushings).

LEAF SPRING AND COMPONENTS REMOVAL

1. Apply the parking brakes, and chock the rear tires. Raise the front of the vehicle until all weight is relieved from the spring to be removed. Block the frame and axle with safety stands.

WARNING: Safety stands must be securely supporting all of the wheel and frame weight during suspension repairs. Unsecured components may drop when the fasteners are loosened or removed, causing component damage and serious personal injury.

2. If so equipped, remove the shock absorbers.

3. Remove the capscrews and washers that attach the two bracket caps (Ref. 2) to the frame bracket. Remove the caps.

4. Remove the shackle nuts, washers, and bolts that lock the spring shackle pin in place. If equipped with a non-threaded bushing, remove the pin by gently tapping on the end; drive the pin out from the inboard side if clearance is restricted. Discard the wear plates.

   If equipped with a threaded bushing, unscrew the pin from the bushing.

   If the spring shackle is to be replaced or if the front spring bracket and bushing is to be inspected and replaced, repeat the applicable procedure in this step to remove the shackle pin. If the suspension is equipped with threaded bushings, remove the split-rings (Fig. 2, Ref. 27) from the spring shackle.

5. Remove the U-bolt high nuts and washers. Remove the U-bolts, the stop assembly, and the retainer plate.

6. Remove the leaf spring assembly.

7. Remove the frame bracket pin from the spring. If equipped with a non-threaded bushing, discard the wear plates. If the bushing is threaded, remove the split-ring.

8. If necessary, remove the front spring bracket from the frame by removing the fasteners attaching it to the frame rail.

NOTE: The front spring bracket should be removed from the vehicle during inspection for damage to the bracket, and also for bushing replacement.

LEAF SPRING DISASSEMBLY

1. Clamp the leaf spring assembly near the center in a vise or C-clamp.

2. On semielliptic leaf spring assemblies, remove the bolt alignment clips. On tapered leaf spring assemblies, remove the strap alignment clips.

3. Remove the center bolt nut, and release the vise or C-clamp. Remove the spring assembly, and separate the leaves. Discard the center bolt.

CLEANING AND INSPECTION

1. Using a wire brush and solvent or steam cleaning equipment, wash all parts to remove dirt, grease, and scale.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

2. Inspect the front spring bracket and the spring shackle for cracks, wear, and other damage. Replace any damaged components.

3. Inspect each leaf of the spring assembly for cracks, gouges, wear, corrosion, and abnormal

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arches. Discard the entire leaf spring assembly if damage is present in one or more leaves.

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. On front spring assemblies, if cracks or breaks exist in the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

4. On non-threaded spring shackle, shackle, and frame bracket pins, use a micrometer to measure the pins for wear. Replace a pin when the diameter in any spot on the pin is less than 1.242 inches (31.55 mm).

   On threaded spring shackle, shackle, and frame bracket pins, inspect the thread surfaces. Replace the pins if blemishes, galling, and other noticeable signs of wear are present.

5. Inspect the spring and bracket bushings. Replace the bushings if gouged, cracked, or otherwise damaged. For instructions, refer to the applicable subheading under "BUSHING REPLACEMENT."

   If the bushings are not damaged, inspect them for wear:

   .1 On non-threaded bushings, use a micrometer to measure the inside diameter of each bushing. The inside diameter should be no more than 0.015- to 0.020-inch (0.38 to 0.51 mm) greater than the diameter of each pin. Replace any bushing that exceeds these limits.

   .2 On threaded bushings, inspect the thread surfaces. Replace the bushings if blemishes, galling, and other noticeable signs of wear are present.

   Install the pins in the bushings. No end play should be detectable after the pin and the bushing are nested. If end play exists, replace the bushings and pins.

BUSHING REPLACEMENT

Front Spring Bracket Bushing Replacement

1. With the front spring bracket removed from the vehicle, press out the worn or damaged bushing using a shop press. If the bushing is threaded, it must be pressed out from the inboard side of the bracket: the bushing lock will prevent removal of the bushing from the outboard side of the bracket. Refer to **Fig. 3.**

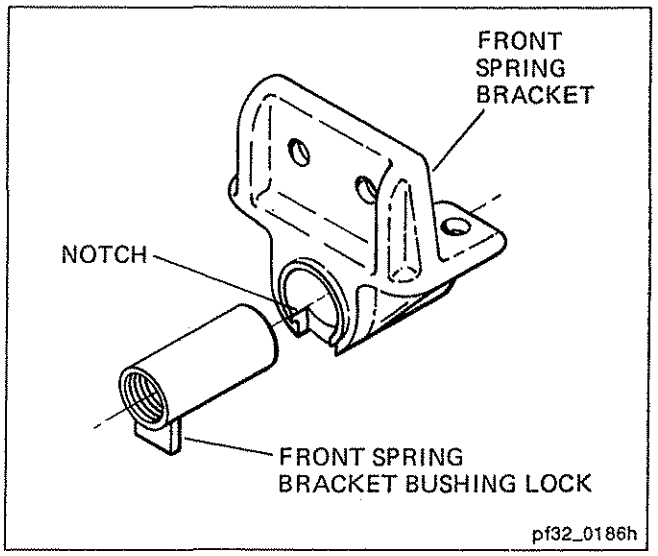

Fig. 3

2. Before installing the new bushing, check the shackle pin for ease of fit in the bushing: there should be no binding when the pin is inserted in the bushing. Using an inside micrometer, check for an out-of-round condition in the bracket bore. Replace the bracket if the bushing bore is out-of-round.

IMPORTANT: The Kaiser bushing assembly has double internal seals on one end, and a single internal seal on the other. If equipped with Kaiser bushings, the double seal end of the bushing must face outboard on all bushing installations. Refer to **Fig. 4.** In addition, the outside diameter of the single seal end of the bushing is reduced, and should be used for starting the bushing into the spring eyes or front spring bracket.

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3. Using a shop press, press the new bushing into the bracket until it is flush with the edge. If the bushing is threaded make sure the front spring bracket bushing lock full seats in the notch provided in the bracket. Refer to **Fig. 3.**

4. Check the shackle pin for ease of fit in the bushing. If equipped with a non-threaded bushing, the pin should slide in by hand. If the bushing is threaded, there should be no binding when the pin is screwed in by hand.

   If binding occurs, the bushing may have been distorted during installation, especially if it was not pressed in, as recommended. Replace the bushing.

Spring Bushing Replacement

1. Replace non-threaded bushings as follows:

   .1 Press out the worn or damaged bushing using a shop press.

   .2 Before installing the new bushing, check the pin for ease of fit in the bushing: there should be no binding when the pin is inserted in the bushing. Using an inside micrometer, check for an out-of-round condition in the spring eye. Replace the spring leaf if an out-of-round condition exists.

   IMPORTANT: The Kaiser bushing assembly has double internal seals on one end, and a single internal seal on the other. If equipped with Kaiser bushings, the double seal end of the bushing must face outboard on all bushing installations. Refer to **Fig. 4.** In addition, the outside diameter of the single seal end of the bushing is reduced, and should be used for starting the bushing into the spring eyes or front spring bracket.

   .3 Using a shop press, press the new bushing into the spring eye until it is flush with the edge.

   .4 Check the pin for ease of fit in the bushing. The pin should slide in by hand. If binding occurs, the bushing may have been distorted during installation, especially if it was not pressed in, as recommended. Replace the bushing.

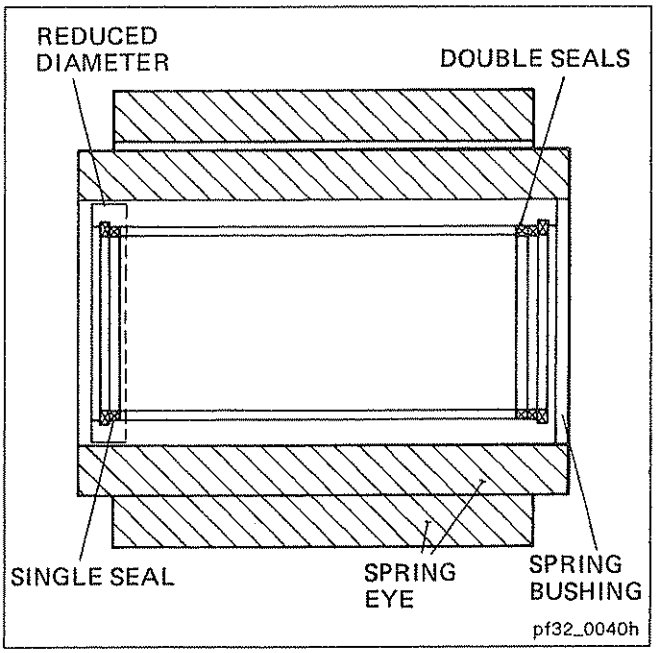

Fig. 4, Kaiser Bushing Installation

2. Replace threaded bushings as follows:

   .1 Grind off the tack welds on both ends of the bushing. Press out the worn or damaged bushing using a shop press.

   WARNING: Approved eye protection must be worn when the tack welds are being removed. Metal particles may become lodged in your eyes, causing severe eye injury.

   .2 Before installing the new bushing, check the pin for ease of fit in the bushing: there should be no binding when the pin is screwed into the bushing. Using an inside micrometer, check for an out-of-round condition in the spring eye. Replace the spring leaf if an out-of-round condition exists.

   IMPORTANT: The Kaiser bushing assembly has double internal seals on one end, and a single internal seal on the other. If equipped with Kaiser bushings, the double seal end of the bushing must face outboard on all bushing installation. Refer to **Fig. 4.** In

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addition, the outside diameter of the single seal end of the bushing is reduced, and should be used for starting the bushing into the spring eyes or front spring bracket.

.3 Using a shop press, press the new bushing into the spring eye until it is flush with the edge.

.4 Check the pin for ease of fit. There should be no binding when the pin is screwed in by hand. If binding occurs, the bushing may have been distorted during installation, especially if it was not pressed in, as recommended. Replace the bushing.

.5 Using a moisture-free, low-hydrogen welding rod (AWS 7016/7018), tack weld both ends of the bushing to the spring. Typical welds should not exceed the dimensions give in **Fig. 8**, under "SPECIFICATIONS." In addition, the welds must be located in the areas shown in **Fig. 8**.

CAUTION: The recommended weld areas are areas of least stress. Welds placed in other spots along the radii will cause local stresses, which could eventually result in spring failure after the vehicle is placed in service.

.6 If necessary, grind the welds down so that the maximum overall width of the spring/weld does not exceed 3.56 inches (90.4 mm). Refer to **Fig. 8**, Section A-A, under "SPECIFICATIONS."

WARNING: Approved eye protection must be worn when using a grinder on the spring/weld. Metal particles may become lodged in your eyes, causing severe eye injury.

LEAF SPRING ASSEMBLY

1. Stack the spring leaves in the correct order, aligning the center bolt holes with a drift pin. On tapered leaf springs, install the Delrin® liners between each leaf and between the top leaf and the spacer. See **Fig. 5**. Remove the drift, and install a new center bolt and nut. Tighten the nut finger-tight.

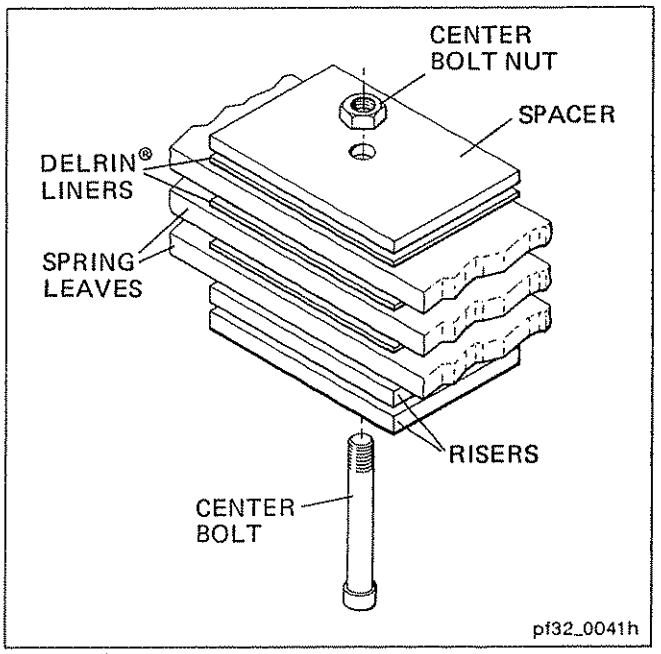

Fig. 5, Tapered Leaf Spring

NOTE: Insert the center bolt through the shortest (or bottom) leaf first. The center bolt head is used as the locating dowel when placed in the axle spacer bore during later installation on the vehicle.

2. Compress the spring assembly in a vise (or, use a C-clamp), clamping the assembly near the center.

3. Align the ends of the spring leaves by tapping with a hammer. On semielliptic leaf spring assemblies, install the bolt alignment clips. Tighten the nuts sufficiently to hold the spring leaves in alignment. On tapered leaf spring assemblies, install the strap alignment clips. Refer to **Fig. 6**.

4. Tighten the center bolt nut to 65 lbf·ft (88 N·m).

5. Remove the spring assembly from the vise (or, remove the C-clamp).

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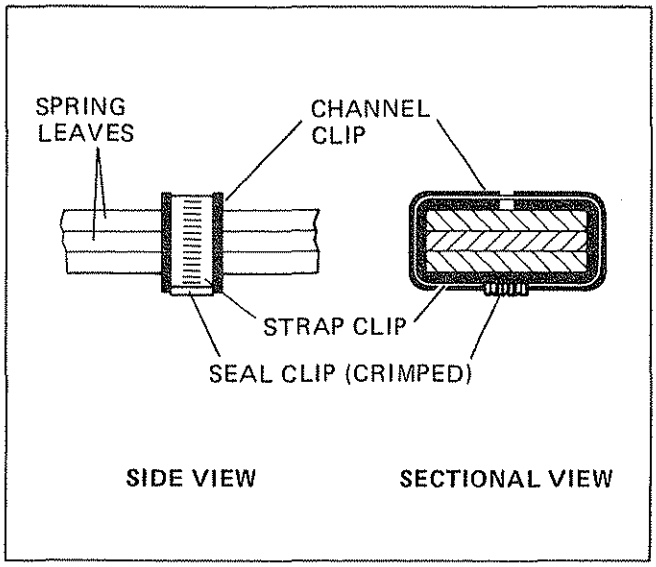

Fig. 6, Strap Alignment Clip Assembly

LEAF SPRING AND COMPONENTS INSTALLATION (Refer to Fig. 1 or 2)

WARNING: Do not install two different spring designs or load capacities on the front axle. In order to maintain a balanced front suspension system, and to prevent difficult handling after the vehicle is placed in service, install identical spring assemblies.

1. If the front spring bracket was removed from the vehicle, proceed as follows:

   .1 Apply Alumilastic compound, or an equivalent, to all areas of the front spring bracket that contact metal other than aluminum. This includes all capscrews, washers, and locknuts that contact aluminum parts. *Do not apply Alumilastic compound to the inside diameter surface of the bushing.*

   CAUTION: Failure to apply Alumilastic compound, or an equivalent, will result in electrolytic corrosion of dissimilar metal components, and cause suspension system damage.

   .2 Install the washers (if so equipped), capscrews, and locknuts that attach the front spring bracket to the frame rail. Tighten the locknuts to 90 lbf·ft (122 N·m).

   IMPORTANT: All suspension brackets that are in contact with the vehicle frame must be attached with SAE Grade 8 flanged bolts and Grade G flanged locknuts. An acceptable alternative is to use hardened flatwashers under SAE Grade 8 bolts and Grade C locknuts.

   NOTE: All suspension bracket (frame) fasteners require periodic retorquing. Refer to the 15 and 16 Groups of the Freightliner Maintenance and Lube Manual for recommended intervals.

2. Using multipurpose chassis grease, lubricate the spring shackle pin, the shackle pin, the frame bracket pin, the inside diameters of the bushings, and, if so equipped, the split-rings.

3. If the spring shackle was disconnected from the front spring bracket, attach it to the bracket as follows:

   .1 If equipped with non-threaded bushings, hold the shackle in place with the new wear plates and spacing washers inserted between the shackle and the front spring bracket. Insert the shackle pin to hold the components in place; locate the grease fitting end of the pin on the outboard side of the spring assembly. Align the notches of the pin with the shackle bolt bore.

   If equipped with Kaiser non-threaded bushings, hold the shackle in place with the new wear plates and spacing washers correctly inserted. Refer to Fig. 1. To hold the components in place, insert the short line-up pin through the inboard side of the bracket until it is flush with the bracket. Insert the long line-up pin through the outboard side of the bracket until it is flush with the bracket. This will force out the

short line-up pin. Place the new shackle pin behind the long line-up pin so that the grease fitting hole is facing outboard, and the arrow is aligned with the shackle bolt bore. Insert the pin until it is centered in the front spring bracket. This will force out the long line-up pin.

If equipped with threaded bushings, hold the spring shackle in place, then screw in the pin until it is centered in the bushing; locate the grease fitting end of the pin on the outboard side of the spring assembly. Align the notches of the pin with the bores in the shackle. Install the shackle split-ring.

.2 Install the shackle bolts, washers, and nuts to lock the shackle pin (and wear plates on non-threaded bushings) in place. Tighten the nuts to 27 lbf·ft (37 N·m).

4. In the frame bracket end of the spring assembly, install the frame bracket pin and, on non-threaded bushings, the new wear plates and spacing washers. Locate the grease fitting end of the pin on the inboard side of the spring assembly. If equipped with Kaiser bushings, locate the grease fitting end of the pin on the outboard side of the spring assembly. On threaded bushings, after centering the pin in the bushing, install the split-ring on the smaller end of the pin, making sure the notches are aligned with the bracket cap bores.

5. Place the spring assembly on the axle spacer with the center bolt head used as the locating dowel.

IMPORTANT: If changing the front axle spacer to correct a leaning situation, do not decrease the axle spacer thickness on the driver's side of the vehicle. By keeping the total thickness of these spacers the same or more than those installed at the factory, the clearance that was built in at the factory will be maintained.

IMPORTANT: On some older vehicles equipped with a block-mounted full-flow oil filter, the filter protrudes out near the spring. When installing new spring assemblies on these vehicles, remove the forward bolt alignment clip, if so equipped (the clip closest to the frame bracket), and rotate the filter drain cock to a position that will provide adequate spring clearance.

WARNING: Failure to perform the precautions above could result in damage to the filter after the vehicle is placed in service. A damaged filter could cause extensive engine damage due to loss of lubricant. In addition, oil spilled on the road could create hazardous driving conditions.

6. Place the retainer plate and the stop assembly in position on the leaf spring assembly. Coat the threaded ends of the U-bolts with chassis lube or an anti-sieze compound, such as Loctite® 242 or equivalent. Install the U-bolts, washers, and U-bolt high nuts. Tighten the nuts finger-tight.

7. Attach the spring assembly to the frame bracket. With the bracket caps in place, install the washers and capscrews. Tighten the capscrews to 82 lbf·ft (111 N·m).

8. Attach the spring assembly to the spring shackle as follows:

   .1 If equipped with non-threaded bushings, insert the spring shackle pin through the spring shackle bores, the new wear plates, spacing washers, and the spring bushing; locate the grease fitting end of the pin on the outboard side of the spring assembly. Align the notches of the pin with the shackle bolt bore.

   If equipped with Kaiser non-threaded bushings, hold the shackle in place with the new wear plates and spacing washers correctly inserted. Refer to Fig. 1. To hold the components in place, insert the short line-up pin through the inboard side of the bracket until it is flush with the bracket. Insert the long line-up pin through the outboard side of the bracket until it is flush

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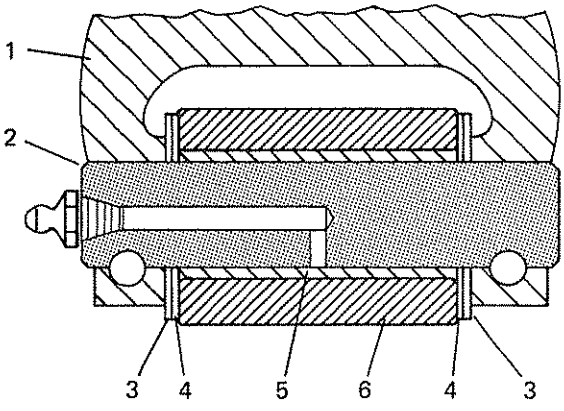
If equipped with threaded bushings, insert the spring shackle pin through the spring shackle bore; locate the grease fitting end of the pin on the outboard side of the spring assembly. Screw the pin in until it is centered in the bushing and extends out the opposite side of the shackle bore. Align the notches of the pin with the shackle bolt bore. Install the shackle split-ring.

.2 Install the shackle bolts, washers, and nuts to lock the spring shackle pin and, on non-threaded bushings, the wear plates in place.

.3 If the assembly is equipped with non-threaded bushings, check for play between the spring and the wear plates. If needed, install additional 1/32-inch spacing washers (1-1/4 inch I.D., 1-7/8 inch O.D.) so that there is less than one washer thickness of play. It is preferable to have an equal number of washers on each side of the spring. See Fig. 7. However, if the amount of play does not allow this, the difference between one side and the other should not exceed one spacing washer.



1. Spring Shackle
2. Spring Shackle Pin
3. Wear Plate
4. Spacing Washer
5. Spring Bushing
6. Spring Leaf

Fig. 7

.4 Tighten the spring shackle nuts to 27 lbf·ft (37 N·m).

9. Tighten the U-bolt high nuts to the torque values given in Table 1, under "SPECIFICATIONS."

CAUTION: The U-bolt high nuts require periodic retorquing. Failure to retorque the fasteners could result in spring breakage and abnormal tire wear. Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for recommended intervals.

10. Wipe all dirt from the grease fittings at the frame bracket, the spring shackle, and the shackle pins. Apply multipurpose chassis grease with a pressure gun until grease appears at the opposite end of the pin.

IMPORTANT: If equipped with Kaiser bushings, and if large amounts of grease appear at the grease fitting end of the pin and little or none at the opposite end, check the installation by removing the pin and observing the position of the internal double seals. The double seal end of the bushing assembly must be at the same end as the grease fitting. If this is not the case, remove the bushing and install it with the opposite end facing outboard. For instructions refer to the applicable subheading under "BUSHING REPLACEMENT."

11. Remove the safety stands, and lower the vehicle to the ground. Remove the chocks from the tires.

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Leans to One Side	One or more spring leaves is broken.	Replace the spring assembly.
	The spring assembly is weak or fatigued.	Replace the spring assembly.
	Unmatched spring design/ load capacity spring assemblies are installed.	Install the correct spring assemblies as originally specified for the vehicle.
	A frame rail is bent or twisted.	Check the frame rails for bends and twists. Correct as needed.
Vehicle Wanders	One or more spring leaves is broken.	Replace the spring assembly.
	The wheels are out of alignment.	Adjust the wheel alignment using the instructions in the 10 Group of this manual.
Vehicle Bottoms Out	Excessive weight on the vehicle is causing an overload.	Reduce the loaded vehicle weight to the maximum spring capacities.
	One or more spring leaves is broken.	Replace the spring assembly.
	The spring assembly is weak or fatigued.	Replace the spring assembly.
Frequent Spring Breakage	The vehicle is overloaded or used under severe operations.	Reduce the loaded vehicle weight to the maximum spring capacities. Caution the driver on improper vehicle handling.
	There is insufficient torque on the U-bolt high nuts.	Torque the U-bolt high nuts to the value listed in Table 1 under "SPECIFICATIONS."
	A loose center bolt is allowing the spring leaves to slip.	Check the spring leaves for damage. If damaged, replace the spring assembly. If not, tighten the center bolt nut to the value listed in Table 1 under "SPECIFICATIONS."

(Continued on next page)

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Frequent Spring Breakage (Cont.)	Worn or damaged spring pin bushings are allowing spring end-play.	Replace the spring pin and bushing.
Noisy Spring	A loose U-bolt high nut or center bolt is allowing spring leaf slippage.	Inspect the components for damage. Replace damaged components as necessary. Torque all fasteners to the values listed in Table 1 under "SPECIFICATIONS."
	A loose, bent, or broken spring shackle or front spring bracket is impairing the spring flex.	Inspect the shackle and bracket for damage. Replace damaged components as necessary. Torque the fasteners to the values listed in Table 1, under "SPECIFICATIONS."
	Worn or damaged spring pins are allowing spring end-play.	Replace any worn or damaged spring pins.
Rough Ride	Refer to the applicable subject in the 16 Group of this manual.	Refer to the applicable subject in the 16 Group of this manual.

SPECIFICATIONS

DESCRIPTION	SIZE	TORQUE lbf·ft (N·m)
Leaf Spring Center Bolt Nut	1/2-20	65 (88)
Front Spring Bracket-to-Frame Bolt Locknuts	1/2-20	90 (122)
Spring Shackle Capscrew Nuts	3/8-24	27 (37)
Frame Bracket Cap Capscrews	1/2-13	82 (111)
U-Bolt High Nuts	3/4-16 7/8-14	250 (339) 400 (542)

Table 1, Front Suspension Fastener Torque Values

FREIGHTLINER FRONT SUSPENSION, COE AND CONVENTIONAL

SPECIFICATIONS (Continued)

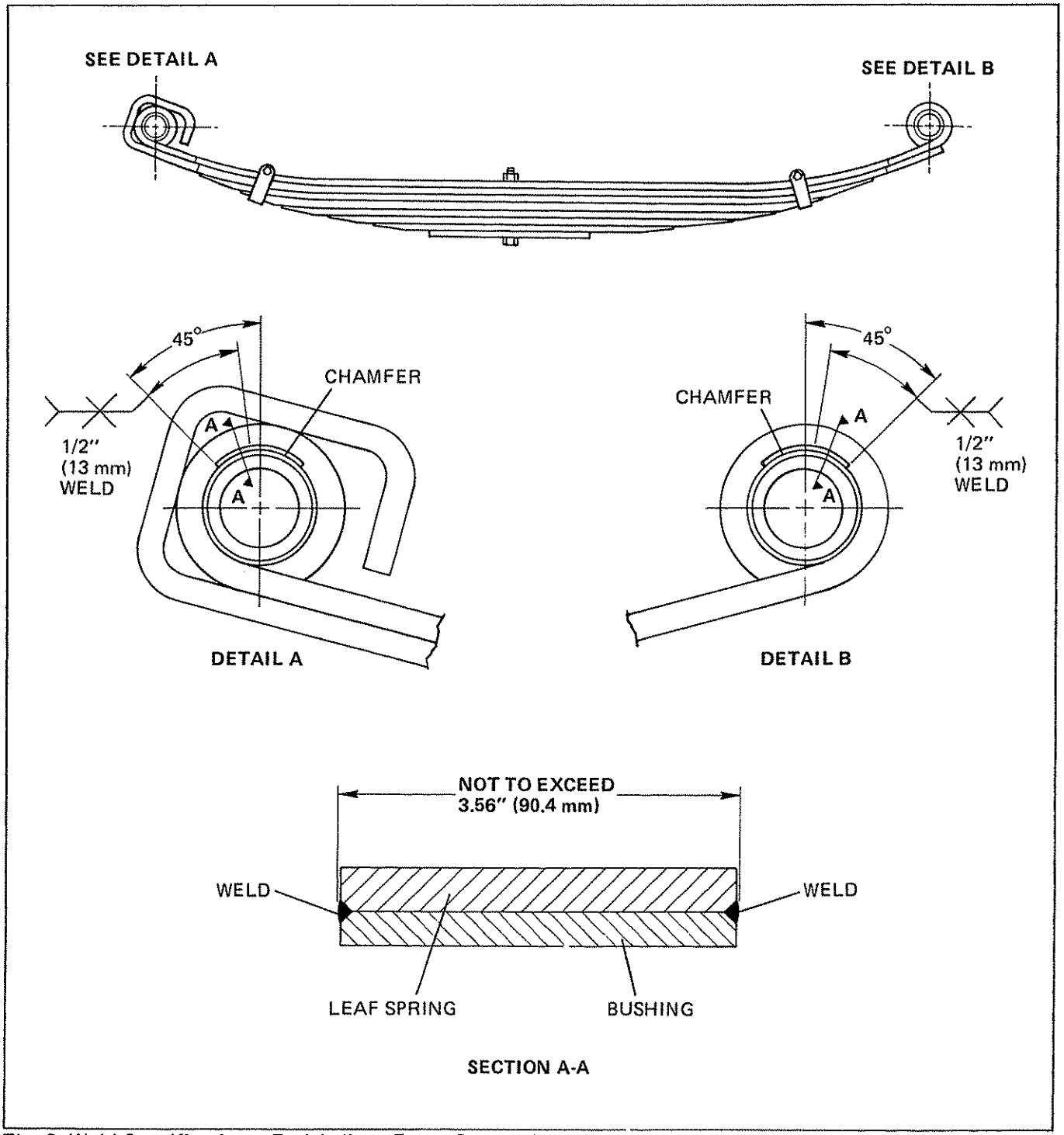


Fig. 8, Weld Specifications, Freightliner Front Suspension With Threaded Bushings

FREIGHTLINER FRONT SUSPENSION, POWERLINER

GENERAL DESCRIPTION

The Powerliner front suspension (Fig. 1) uses semielliptic taper leaf spring assemblies. The leaf springs are mounted to the axle with U-bolts, hardened washers, and high nuts. The forward end of each spring mounts to a stationary frame bracket. The rear of each spring mounts to a shackle which swings from a frame-mounted bracket. The shackle allows for variations in spring length during spring flexing.

The leaf spring assembly serves to absorb and store energy and then to release it. The individual leaves are held together by a center bolt, with the center bolt head used as a locating dowel during installation on the vehicle. On each end of the leaf spring assembly is an alignment clip. Alignment clips are used to limit sidewise spread and vertical separation of the individual leaves in the spring. Strap alignment clip assemblies are used on taper leaf spring assemblies. Refer to Fig. 2.

SERVICE OPERATIONS

LEAF SPRING AND COMPONENTS REMOVAL (Refer to Fig. 1)

1. Activate the parking brakes, and chock the front and rear tires. Raise the vehicle until the weight is relieved from the spring to be removed. Safety block the frame with jack stands.

2. Remove the shock absorbers.

3. Remove the spring pin cap capscrews and washers (Ref. 30). Loosen the forward frame bracket capscrews (Ref. 31).

4. Tap the forward spring pin out of the spring "eye." Discard the spacing washers (Ref. 27), as they cannot be reused.

5. Remove the shackle nuts, washers, and bolts that lock the lower shackle spring pin in place. Gently tap the end of the lower shackle spring pin out of the spring bushing and the shackle. Remove and discard the wear plates and the spacing washers, as they cannot be reused.

   If the shackle is to be replaced, or if the shackle bracket and bushing assembly is to be inspected/replaced, repeat the procedure in this step to remove the upper shackle pin.

6. Remove the U-bolt high nuts and washers. Remove the U-bolts and the stop assembly.

7. Remove the leaf spring assembly.

8. If necessary, remove the shackle bracket from the frame by removing the fasteners attaching it to the frame rail. The shackle bracket should be removed from the vehicle for bushing replacement or inspection for damage.

LEAF SPRING DISASSEMBLY (Refer to Fig. 1)

1. Position the leaf spring assembly in a vise so that the assembly will be clamped near the center.

2. Remove the strap alignment clip assemblies.

3. Remove the center bolt nut from the center bolt.

4. Release the vise, then remove the spring assembly. Separate the leaves, spacer, and delrin liners, marking each for later assembly reference. Discard the center bolt.

CLEANING AND INSPECTION

1. Using a wire brush and solvent (or steam-cleaning equipment), wash all parts to remove dirt, grease, and scale.

WARNING: Commercial cleaning solvents may be flammable, toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

SUSPENSION 16
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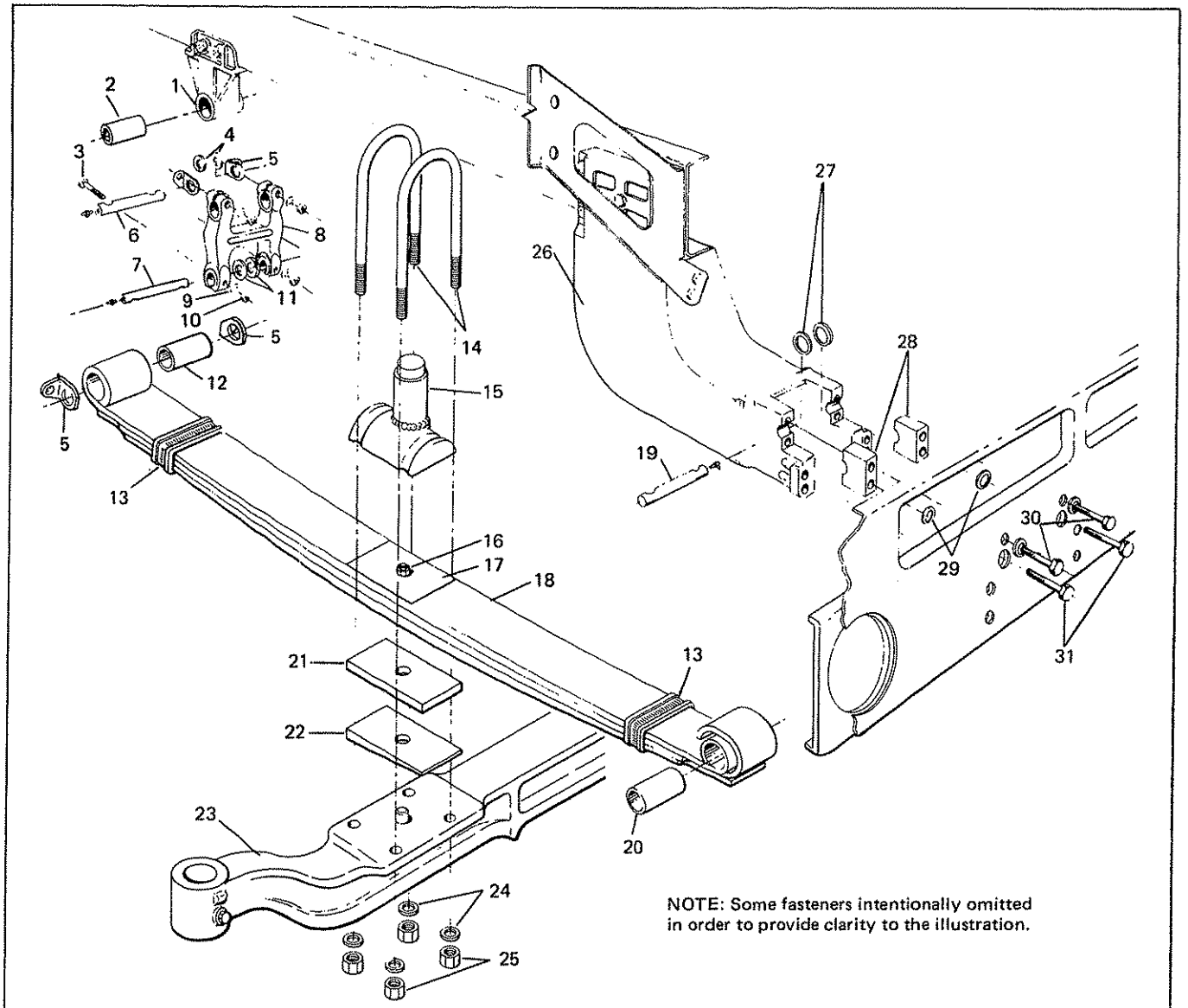
FREIGHTLINER FRONT SUSPENSION, POWERLINER



1. Shackle Bracket
2. Shackle Bracket Bushing
3. Shackle Bolt
4. Spacing Washers
5. Wear Plate
6. Upper Shackle Pin
7. Lower Shackle Spring Pin
8. Shackle
9. Washer
10. Shackle Bolt Nut
11. Spacing Washers
12. Spring Bushing
13. Strap Alignment Clip Assembly
14. U-Bolts
15. Stop Assembly
16. Center Bolt Nut
17. Spacer
18. Spring Assembly, Taper Leaf
19. Forward Spring Pin
20. Spring Bushing
21. Axle Spacer
22. Front Spring Shim
23. Front Axle
24. Washers
25. U-Bolt High Nuts
26. Forward Frame Bracket
27. Spacing Washers
28. Spring Pin Caps
29. Washers
30. Spring Pin Cap Capscrews and Washers
31. Forward Frame Bracket Capscrews and Washers

Fig. 1, Freightliner Front Suspension, Powerliner

FREIGHTLINER FRONT SUSPENSION, POWERLINER

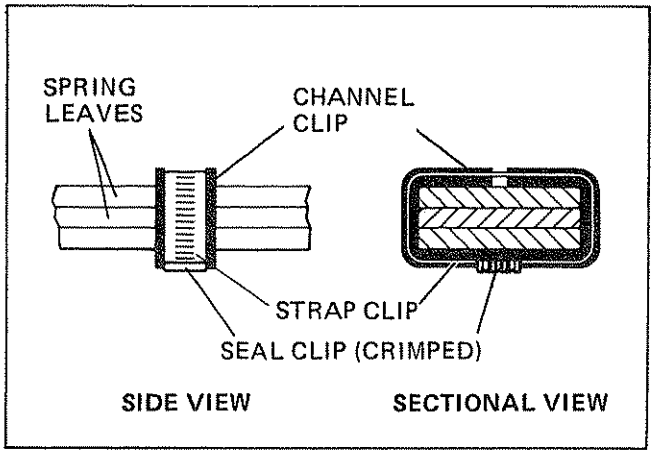


Fig. 2, Strap Alignment Clip Assembly

2. Inspect the shackle bracket for cracks, wear, and other damage. Also, inspect the shackle for damage. Replace the component(s) if damaged.

3. Inspect each leaf for cracks, gouges, wear or corrosion, and abnormal arches. Discard the entire leaf spring assembly if damage is present in one or more leaves.

4. Using a micrometer, measure the shackle pins and the forward spring pin for wear. Replace a forward spring pin or a lower shackle spring pin when the diameter(s) *in a worn spot* is less than .993 inch (25.22 mm). Replace an upper shackle pin when the diameter *in a worn spot* is less than 1.243 inches (31.57 mm).

5. Inspect the spring bushings. Also inspect the shackle bracket bushing. Replace the bushing(s) if gouged, cracked, or otherwise damaged.

   If the bushings are not damaged, inspect them for wear. Using a micrometer, measure the inside diameter of each bushing. The inside diameter should be no more than .030 inch (.76 mm) greater than the diameter of each pin. Replace any bushing that exceeds these limits.

   If a bushing requires replacement, refer to the applicable service heading in this subject.

BUSHING REPLACEMENT

1. With the spring assembly or the shackle bracket removed from the vehicle, press out the worn or damaged bushing using a shop press.

2. Before installing the new bushing, check the pin for ease of fit in the bushing: there should be no binding when the pin is inserted in the bushing. Also, using an inside micrometer, check for an out-of-round condition in the bushing bore of the spring leaf or the shackle bracket. If an out-of-round condition exists, replace the component.

3. Press the new bushing into the component until it is flush with the edge.

4. Check the pin for ease of fit in the bushing. The pin should slide in by hand. If binding occurs, the bushing may have been distorted during installation, especially if it was not pressed in, as recommended. Replace the bushing.

LEAF SPRING ASSEMBLY (Refer to Fig. 1)

1. Stack the spring leaves, delrin liners, and the spacer in the correct order, as referenced earlier or as shown in Fig. 3, aligning the center bolt holes with a drift. Remove the drift, and install the new center bolt and nut. Tighten the nut finger-tight.

NOTE: Insert the center bolt through the bottom leaf first. The center bolt head is used as the locating dowel when placed in the axle spacer bore during later installation on the vehicle.

2. Compress the spring assembly in a vise (or, use a C-clamp), clamping the assembly near the center.

3. Align the spring leaves at the ends by tapping with a hammer. Install the strap alignment clip assemblies (Fig. 2).

FREIGHTLINER FRONT SUSPENSION, POWERLINER

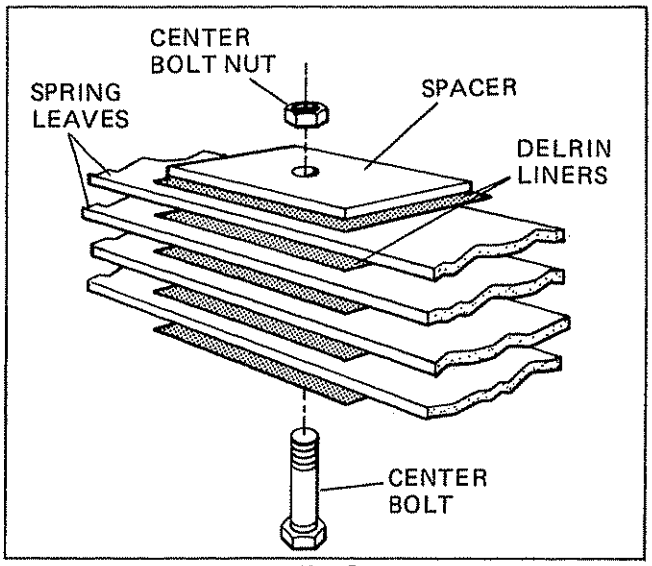


Fig. 3

4. Tighten the center bolt nut to 65 ft-lbs (88 N·m).

5. Remove the spring assembly from the vise (or, remove the C-clamp).

LEAF SPRING AND COMPONENTS INSTALLATION (Refer to Fig. 1)

WARNING: Do not install two different spring designs or load capacities on the front axle. In order to maintain a balanced front suspension system, and to prevent difficult handling after the vehicle is placed in service, install identical spring assemblies. Refer to the Freightliner Parts Book for correct part numbers.

1. If the shackle bracket was removed from the vehicle, proceed as follows:

   .1 Apply Alumilastic compound, or an equivalent, to all areas of the shackle bracket that contact metal other than aluminum. This includes all capscrews, washers, and locknuts that contact aluminum parts. *Do not apply Alumilastic compound to the inside diameter surface of the bushing.*

   CAUTION: Failure to apply Alumilastic compound, or an equivalent, as instructed, will result in electrolytic corrosion of dissimilar metal components, resulting in suspension system damage.

   .2 Install the washers (if so equipped), capscrews, and locknuts that attach the shackle bracket to the frame rail. Tighten the locknuts to 90 ft-lbs (122 N·m).

   IMPORTANT: All suspension brackets that are in contact with the vehicle frame must be attached with SAE Grade 8 flanged capscrews (bolts) and Grade G flanged locknuts. An acceptable alternative is to use hardened flatwashers under SAE Grade 8 capscrews (bolts) and Grade C locknuts.

   All suspension bracket (frame) fasteners require periodic retorquing. Refer to the 15 and 16 Groups of the Freightliner Maintenance and Lube Manual for recommended intervals.

2. Using multipurpose chassis grease, lubricate the shackle pins and the forward spring pin, the shackle, and the inside diameters of the bushings.

3. If the shackle was disconnected from the shackle bracket, attach it to the bracket as follows:

   .1 Hold the shackle in place with the new wear plates inserted between the shackle and the shackle bracket. Insert the upper shackle pin to hold the components in place; locate the grease fitting end of the pin on the outboard side of the spring assembly. Align the notches of the pin with the bores in the shackle.

   .2 Check for play between the shackle bracket and the wear plates. If needed, install 1/32-inch steel spacing washers (1-1/4-inch I.D., 1-7/8-inch O.D.) so that there is less than one washer thickness of play. It is preferable to have an equal number of

FREIGHTLINER FRONT SUSPENSION, POWERLINER

washers on each side of the bracket. See Fig. 4. However, if the amount of play does not allow this, the difference between one side and the other should not exceed one spacing washer.

.3 Install the shackle bolts, washers, and nuts to lock the upper shackle pin and wear plates in place. Tighten the nuts to 27 lbf·ft (37 N·m).

4. Place the spring assembly on the axle spacer with the center bolt head used as the locating dowel.

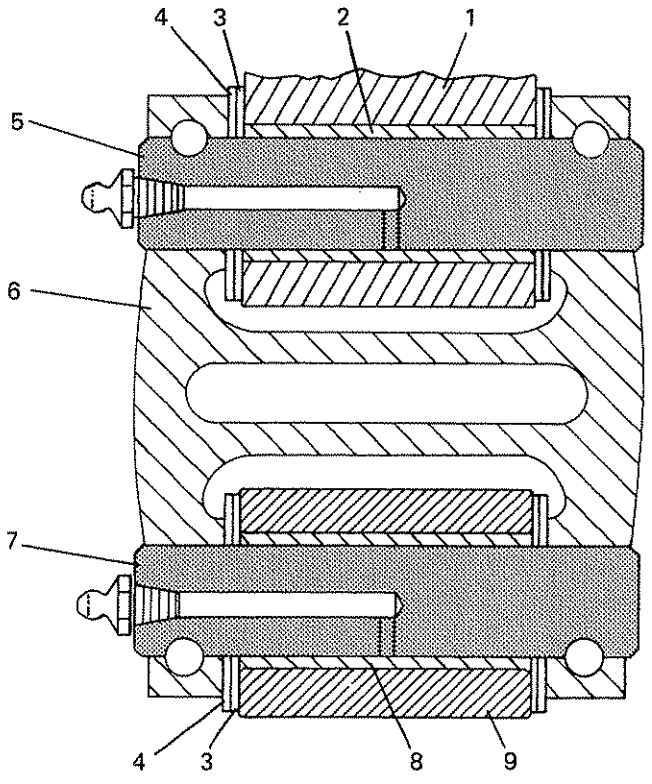
IMPORTANT: If changing the front axle spacer to correct a leaning situation, do not decrease the axle spacer thickness on the driver's side of the vehicle. By keeping the total thickness of these spacers the same or more than those installed at the factory, the clearance that was built in at the factory will be maintained.

Place the stop assembly in position on the leaf spring assembly. Install the U-bolts, washers, and U-bolt high nuts. Tighten the nuts finger-tight.

5. Align the forward spring eye with the spring pin bore surfaces of the forward frame bracket. Install the spring pin caps, washers, and cap-screws (Ref. 30), but do not tighten the cap-screws down.

6. With the grease fitting located on the inboard side of the spring assembly, insert the pin through the spring bushing; the pin notches should face upward, aligned with the bores in the spring pin caps and the forward frame bracket.

Check for play between the spring and the forward frame bracket. If needed, install 1/32-inch steel spacing washers (1-inch I.D., 1-1/2 inch O.D.) so that there is less than one



1. Shackle Bracket
2. Shackle Bracket Bushing
3. Spacing Washer
4. Wear Plate
5. Upper Shackle Pin
6. Shackle
7. Lower Shackle Spring Pin
8. Spring Bushing
9. Spring Leaf

Fig. 4

FREIGHTLINER FRONT SUSPENSION, POWERLINER

washer thickness of play. It is preferable to have an equal number of washers on each side of the spring. However, if the amount of play does not allow this, the difference between one side and the other should not exceed one spacing washer.

7. Tighten the spring pin cap capscrews (Ref. 30), and the forward frame bracket capscrews (Ref. 31) to 82 lbf·ft (111 N·m).

8. Attach the spring to the shackle as follows:

   .1 Insert the lower shackle spring pin through the shackle bores, the new wear plates, and the spring bushing; locate the grease fitting end of the pin on the outboard side of the spring assembly. Align the notches of the pin with the bores in the shackle.

   .2 Install the shackle bolts, washers, and nuts to lock the lower shackle spring pin and the wear plates in place.

   .3 Check for play between the spring and the wear plates. If needed, install 1/32-inch steel spacing washers (1-inch I.D., 1-1/2 inch O.D.) so that there is less than one washer thickness of play. It is preferable to have an equal number of washers on each side of the spring. See Fig. 4. However, if the amount of play does not allow this, the difference between one side and the other should not exceed one spacing washer.

   .4 Tighten the shackle bolt nuts to 27 lbf·ft (37 N·m).

9. Tighten the U-bolt high nuts to 250 lbf·ft (339 N·m).

NOTE: The U-bolt high nuts require periodic retorquing. Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for recommended intervals.

CAUTION: Failure to retorque the fasteners could result in spring breakage and abnormal tire wear.

10. Wipe all dirt from the grease fittings at the forward spring pin and the shackle pins. Then, apply multipurpose chassis grease with a pressure gun until grease is forced out.

FREIGHTLINER FRONT SUSPENSION, POWERLINER

TROUBLESHOOTING

The following troubleshooting information should be used to diagnose front suspension system problems. For additional troubleshooting information, refer to the front axle wheel alignment subject located in the 10 Group of this manual.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Leans To One Side	Broken spring leaf.	Replace the spring assembly.
	Weak or fatigued spring.	Replace the spring assembly.
	Wrong spring design or load capacity installed.	Install identical spring assemblies, as originally specified for the vehicle.
	Bent or twisted frame rail.	Check the frame rails for bends and twists. Correct as needed.
Vehicle Wanders	Incorrect wheel alignment.	Check the wheel alignment as instructed in the 10 Group of this manual. Correct as needed.
	Broken spring leaf.	Replace the spring assembly.
Vehicle Bottoms Out	Overloading.	Reduce the vehicle load.
	Broken spring leaf.	Replace the spring assembly.
	Weak or fatigued spring.	Replace the spring assembly.
Frequent Spring Breakage	Overloading or severe operation.	Reduce the vehicle load; caution the driver.
	Loose U-bolts.	Tighten the U-bolt high nuts to the values given in this subject.
	Loose center bolt.	Check the spring leaves for damage. If damaged, replace the assembly. If not damaged, tighten the center bolt nut to 65 ft-lbs (88 N·m).
	Worn or damaged bushings.	Replace the bushings.

(Continued on next page)

FREIGHTLINER FRONT SUSPENSION, POWERLINER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noisy Spring	Loose U-bolt high nuts or center bolt.	Inspect the components for damage, and replace if needed. Tighten all fasteners to the values given in Table 1, located under "SPECIFICATIONS."
	Loose, bent, or broken shackle bracket or shackle.	Inspect the shackle bracket and the shackle for damage. Replace the component(s) as needed. Tighten the fasteners to the values given in Table 1, located under "SPECIFICATIONS."
	Worn spring pins.	Replace the spring pins.

SPECIFICATIONS

DESCRIPTION	SIZE	TORQUE	
		FT-LBS	N·m
Leaf Spring Center Bolt Nut	1/2-20	65	88
Shackle Bracket-To-Frame Bolt Locknuts	1/2-20	90	122
Shackle Bolt Nuts	3/8-24	27	37
Spring Pin Cap Capscrews	1/2-13	82	111
Forward Frame Bracket Capscrews	1/2-13	82	111
U-Bolt High Nuts	3/4-16	250	339

Table 1, Front Suspension Fastener Torque Values

FREIGHTLINER SINGLE DRIVE SUSPENSION

GENERAL DESCRIPTION

The Freightliner single drive suspension (Fig. 1) uses a full-floating spring design. Two interchangeable, semielliptical springs are mounted to the axles with two U-bolts per spring. The spring ends ride in aluminum brackets with steel bearing surfaces cast into each bracket. The axle is held in alignment by a pair of interchangeable radius rods that extend forward from the axle to the frame-mounted spring bracket. The cushioned axle stops are frame mounted.

SERVICE OPERATIONS

For information and instructions regarding inspection intervals, inspection procedures, lubrication intervals, and lubrication procedures, refer to the applicable reference numbers in the 16 Group of the Freightliner Maintenance and Lube Manual.

RADIUS ROD ASSEMBLY REMOVAL, DISASSEMBLY, INSPECTION, ASSEMBLY, AND INSTALLATION

Removal (Refer to Fig. 1)

1. Remove the radius rod pin cap capscrews, caps, and radius rod pin dowel.

2. Remove the bolts, hardened washers, and locknuts (or flanged bolts and flanged locknuts) that attach the radius rod assembly to the radius rod bracket.

3. Remove the radius rod assembly, and, if so equipped, remove the axle alignment shims (or axle alignment washers).

Disassembly

1. Remove the snaprings from the axle end radius rod pin; then remove the radius rod pin washers from both the forward end and the axle end radius rod pins.

2. Press both radius rod pins out of the radius rod. If necessary, drive out the radius rod pins with a hammer.

IMPORTANT: The forward end and axle end radius rod eyes have a smaller shoulder on one side of the eye than on the other side. Also, the small-shouldered side has a rounded edge around the inside of the eye. See Fig. 2. To avoid damage to the radius rod, the radius rod bushings must be pressed in and out of the side of the radius rod with the smaller shoulder.

NOTE: Removal and installation of radius rod bushings requires the use of a special tool kit, which may be purchased from a Freightliner dealer. The special tool kit may also be fabricated by using the dimensions given in Fig. 6, located under **"SPECIFICATIONS."**

3. Use the bushing plunger from the special tool kit on a hydraulic press to push the bushing plunger into the large-shouldered side of the radius rod eye; then, press the bushing out of the small-shouldered side of the radius rod. Remove both radius rod bushings.

Inspection

1. Clean all dirt, grease, and other foreign matter from the radius rod components.

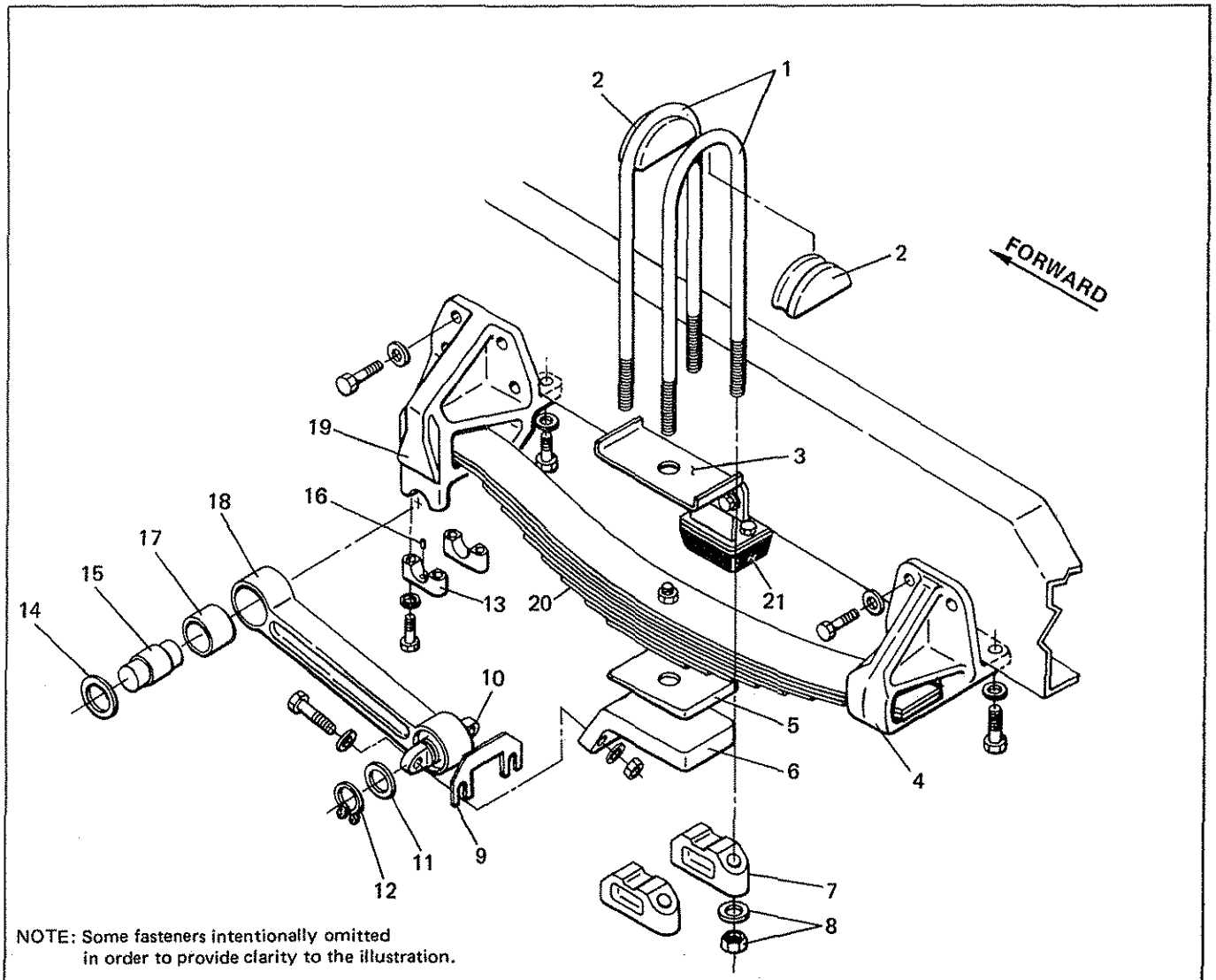
2. Inspect the radius rod components for wear, cracks, and other damage. Replace any components that are worn, cracked, or otherwise damaged.

Assembly

1. Coat the radius rod bushings with a non-mineral lubricant, such as rubber lubricant or waterless hand cleaner.

2. Position a bushing into the larger end of the insertion sleeve from the tool kit; then fit the beveled (smaller) end of the sleeve into the small-shouldered side of the radius rod eye.

FREIGHTLINER SINGLE DRIVE SUSPENSION



NOTE: Some fasteners intentionally omitted in order to provide clarity to the illustration.

1. U-Bolts
2. U-Bolt Pad
3. U-Bolt Pad Retainer
4. Rear Spring Bracket
5. Axle Planning Shim
6. Radius Rod Bracket
7. Axle Clamp
8. U-Bolt Nut & Hardened Washer
9. Axle Alignment Shim
10. Axle End Radius Rod Pin
11. Axle End Radius Rod Pin Washer
12. Snapring
13. Radius Rod Pin Cap
14. Forward End Radius Rod Pin Washer
15. Forward End Radius Rod Pin
16. Radius Rod Pin Dowel
17. Radius Rod Bushing
18. Radius Rod
19. Forward Spring Bracket
20. Spring Assembly
21. Axle Stop Assembly

Fig. 1, Freightliner Single Drive Suspension

FREIGHTLINER SINGLE DRIVE SUSPENSION

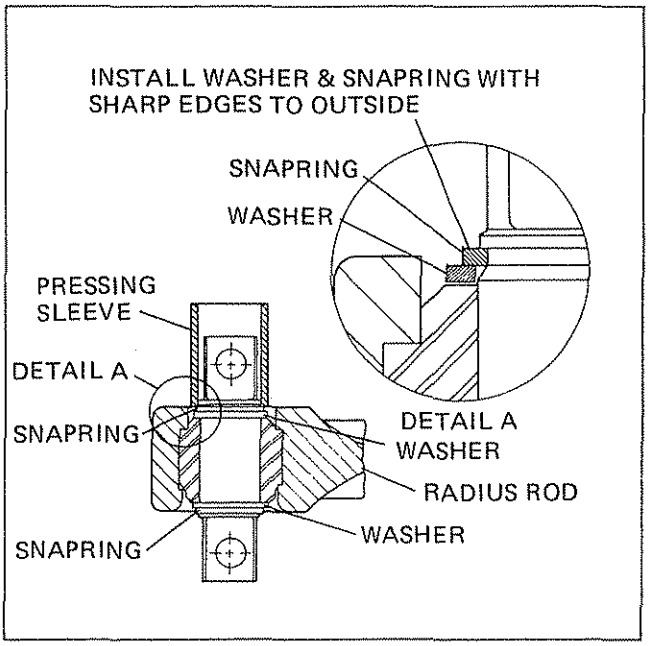


Fig. 2, Snapring And Washer Installation Diagram

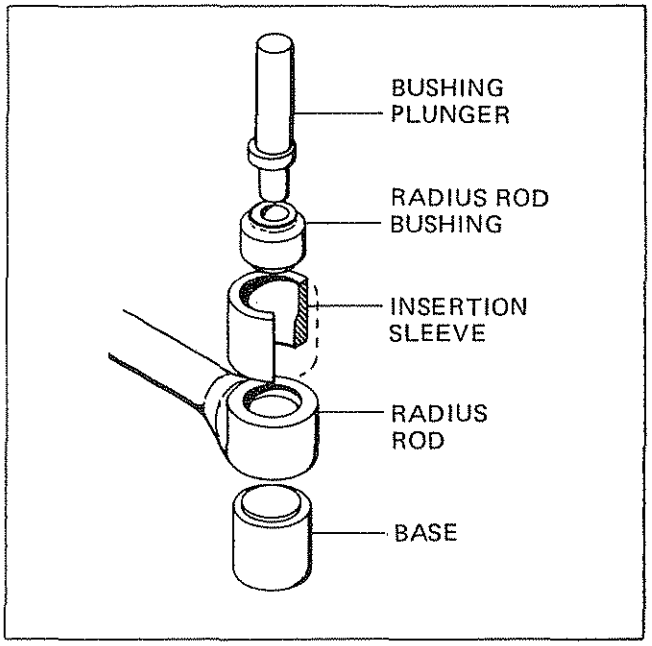


Fig. 3, Radius Rod Bushing Installation

3. Center the radius rod eye on the base tool, and insert the plunger tool into the bushing. See Fig. 3. Use a hydraulic press to force the bushing into the radius rod eye. Install both radius rod bushings.

4. Press the forward end radius rod pin into either of the radius rod eyes.

5. Install a snapring on one end of the axle end radius rod pin; then install a radius rod pin washer over the other end, and slide it down until it is tight against the snapring.

NOTE: Install the snaprings and radius rod pin washers with the sharp edges facing toward the outside. See Fig. 2, Detail A.

6. Press the radius rod pin into the radius rod bushing from the same side as the bushing was pressed into the radius rod eye. Do not lubricate the radius rod pin.

7. Turn the radius rod over and install a flatwasher, with the sharp edge facing away from the bushing; then install the other snapring onto the outer shoulder of the pin, with the sharp edge facing outward.

8. Place a pressing sleeve over the end of the radius rod pin, then press the snapring into its seat. See Fig. 2.

9. After assembly, press the radius rod pin slightly to center it in the radius rod eye. There should be no slack on either side of the bushing, and the bushing should be compressed by approximately half the thickness of the snapring. If there is slack on either side of the bushing, install a second washer under one of the snaprings to compress the bushing.

Installation

1. Install the forward end radius rod pin washers on the forward end radius rod pin; then position the radius rod pin dowel in the forward end radius rod pin. Locate the radius rod pin so the dowel will engage properly with the radius rod pin cap.

FREIGHTLINER SINGLE DRIVE SUSPENSION

2. Hold the forward end of the radius rod in place against the forward spring bracket; then, install the radius rod pin caps, using Grade 8 capscrews and hardened washers. Tighten the capscrews to 82 ft·lbs (111 N·m).

NOTE: Any axle alignment shims that were removed during the radius rod removal procedure may be replaced with an equal thickness of axle alignment washers. An equal thickness of washers should be installed on both ends of the axle end radius rod pin.

3. Hold the axle alignment shims (or washers) in place between the axle end radius rod pin and the radius rod bracket, while installing flanged bolts through the radius rod pin and radius rod bracket. Then install the flanged locknuts.

IMPORTANT: The axle end of the radius rods should be attached to the radius rod brackets with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts, and SAE Grade C prevailing torque locknuts.

4. Tighten the radius rod flanged locknuts to 185 ft·lbs (251 N·m). Then check the axle alignment, using the procedure given in the 11 Group of this manual.

SPRING ASSEMBLY REMOVAL
AND INSTALLATION

Removal

1. Block the front tires with chock blocks; then raise the vehicle frame until the weight is just off the spring assembly. Safety block the frame with jack stands.

2. Remove the U-bolt nuts and hardened washers, axle clamps, U-bolts, U-bolt pads, and U-bolt pad retainer. Note the position of the tapered axle planing shim(s), if so equipped, for later assembly reference.

3. Using a hoist to help lift the spring assembly, slide the spring assembly into the forward or rear spring bracket; then raise the opposite end of the spring above the other bracket. Slide the spring assembly out of the spring bracket, then remove it from the chassis.

4. Inspect the spring assembly for cracked, broken, or abnormally bent leaves. Replace the spring assembly if any of the leaves are cracked, broken, or abnormally bent.

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

Installation

1. Clean the spring seat, then position the axle planing shim(s) on the radius rod bracket. Make sure the tapered planing shim(s) is placed in the same position it was in prior to removal

2. Using a hoist, slide one end of the spring assembly into the appropriate spring bracket; then, lower the spring assembly, and position the opposite end in the other spring bracket. Make sure the head of the spring center bolt is seated in the shim center hole and the radius rod bracket hole.

3. Position the U-bolt pad retainer and U-bolt pads on top of the spring. Apply anti-seize compound to the U-bolt threads, then position the U-bolts over the U-bolt pads.

4. Install the axle clamps, U-bolt hardened washers, and U-bolt nuts. Tighten the U-bolt nuts to 250 ft·lbs (339 N·m) for 3/4–16 U-bolts and 400 ft·lbs (542 N·m) for 7/8–14 U-bolts.

IMPORTANT: The U-bolt nuts should be retorqued after the first 500–1000 miles (800–1600 km) of operation, and thereafter every three months.

FREIGHTLINER SINGLE DRIVE SUSPENSION

Torque the U-bolt nuts with the vehicle loaded. Under severe operating conditions, the U-bolt nuts should be retorqued weekly.

CAUTION: Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

5. Remove the jack stands, then lower the vehicle chassis. Remove the chock blocks from the front tires.

6. Check the axle alignment, using the procedure given in the 11 Group of this manual.

FORWARD SPRING BRACKET AND REAR SPRING BRACKET REPLACEMENT
(Refer to Fig. 1)

WARNING: Failure to replace the forward spring brackets or rear spring brackets if they are worn, cracked, or otherwise damaged could result in progressive damage to, and eventual breakage of the bracket, which could create a loss of vehicle control.

1. Block the front tires with chock blocks. Then, raise the vehicle frame until the weight is just off the spring brackets. Safety block the frame with jack stands.

2. To remove the forward spring bracket, remove the radius rod pin cap capscrews, caps, and radius rod pin dowel.

3. Remove the bolts, hardened washers, and locknuts (or flanged bolts and flanged locknuts) that attach the forward or rear spring bracket to the frame rail; then remove the bracket.

NOTE: On 1/4 inch steel rails, remove the backing plate from the inside of the frame rail.

4. Apply Alumilastic compound, or an equivalent, to all areas of the new forward or rear spring bracket that contact metal other than aluminum. This includes all bolts, washers, and nuts that contact aluminum parts.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metal components contact each other, will result in electrolytic corrosion, which could cause suspension system damage.

5. Position the new forward or rear spring bracket on the frame rail; then attach it with flanged bolts and flanged locknuts. Tighten the locknuts to 90 ft-lbs (122 N·m).

NOTE: On 1/4 inch steel rails, include installation of the backing plate on the inside of the frame rail.

IMPORTANT: Forward spring brackets and rear spring brackets should be attached to the frame rails with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts and SAE Grade C prevailing torque locknuts.

CAUTION: The fasteners that attach the forward and rear spring brackets to the frame rails should be retorqued every three months, until the brackets become seated and the fasteners retain their torque setting. Continued use with insufficiently tightened fasteners could result in bracket and frame damage.

6. To install the forward spring bracket, install the radius rod pin dowel in the forward end radius rod pin; then locate the radius rod pin so the dowel will engage properly with the radius rod pin cap. Hold the radius rod in place; then install the radius rod pin caps with Grade 8 capscrews and hardened washers. Tighten the capscrews to 82 ft-lbs (111 N·m).

7. Remove the jack stands, then lower the vehicle chassis. Remove the chock blocks from the front tires.

8. Check the axle alignment, using the procedure given in the 11 Group of this manual.

FREIGHTLINER SINGLE DRIVE SUSPENSION

REAR AXLE ALIGNMENT

Rear axle alignment should always be checked during vehicle in-servicing. It should also be checked whenever excessive rear tire wear occurs, when hard or erratic steering is experienced, and when rear axle or suspension components are replaced. Refer to the 11 Group of this manual for the axle alignment checking procedure.

If checking of the axle alignment indicates a need for adjustment, proceed as follows:

1. With the axle alignment fixture in position (Fig. 4), determine the exact difference between the measurements at each end of the fixture. Measure on both sides of the vehicle to confirm the measurements. This difference in measurements is the approximate amount that the leading end of the axle will have to be moved rearward to make it perpendicular to the frame. Alignment adjustment must be made on the leading end of the axle. See Fig. 5.

2. Loosen the axle U-bolts enough to allow the springs to shift on the axle pads.

3. On the side of the vehicle which has the leading axle end, remove the bolts, locknuts, and hardened washers (or flanged bolts and flanged locknuts) that attach the radius rod assembly to the radius rod bracket. Remove the axle alignment shims (or washers), if so equipped.

4. Block the front tires with chock blocks, then raise the vehicle frame just enough to relieve the weight from the springs. Safety block the vehicle frame with jack stands.

5. Move the leading end of the axle rearward by rolling the wheels (on that end) away from the cab. Roll them rearward just enough to provide space to allow installation of axle alignment washers between the radius rod pin and the radius rod bracket.

6. On one end of the radius rod pin, insert the correct thickness of axle alignment washers that are needed to bring the leading axle end into alignment.

IMPORTANT: Any axle alignment shims that were removed when the radius rod assembly was de-

Fig. 4, Axle Alignment Fixture In Position

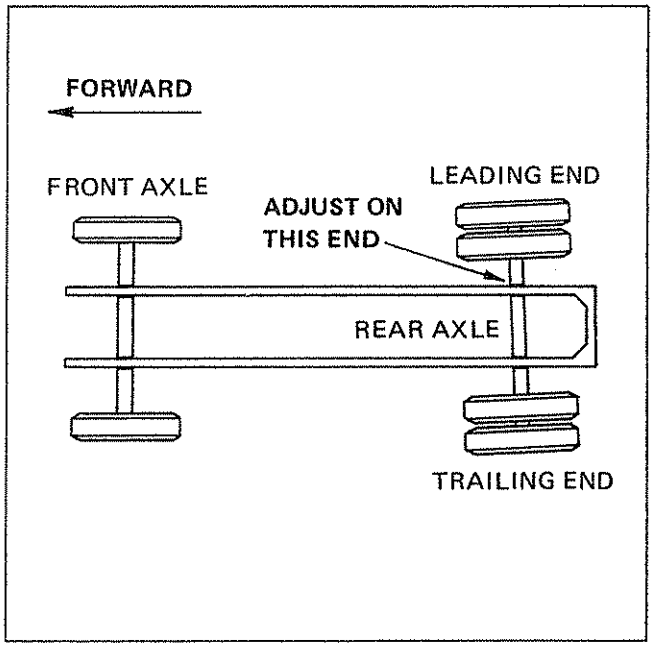


Fig. 5, Single Drive Axle, Out Of Alignment

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FREIGHTLINER SINGLE DRIVE SUSPENSION

tached from the radius rod bracket should be replaced with an equal thickness of axle alignment washers. To this thickness of washers, add an additional thickness of washers equal to the measured difference at the ends of the axle alignment fixture.

As an example: if the leading end of the axle was equipped with a 3/16" (4.5 mm) thickness of shims, and the difference in measurements at the ends of the alignment fixture was 1/4" (6 mm), discard the shims and add 3/16" (4.5 mm) of washers, plus an additional 1/4" (6 mm) of washers to correct the axle alignment.

Install a flanged bolt through the radius rod pin and radius rod bracket; then install a flanged locknut. Position an equal thickness of axle alignment washers on the other end of the radius rod pin; then install the flanged bolt and flanged locknut at that end.

IMPORTANT: The radius rods should be attached to the radius rod brackets with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts and SAE Grade C prevailing torque locknuts.

7. Tighten the locknuts to 185 ft-lbs (251 N·m).

8. Remove the jack stands, then lower the vehicle frame. Remove the chock blocks from the front tires, then check the axle alignment with the axle alignment fixture. If the alignment is within the specifications, tighten the axle U-bolt nuts to 250 ft-lbs (339 N·m) for 3/4-16 U-bolts, or 400 ft-lbs (542 N·m) for 7/8-14 U-bolts.

   If not in alignment, repeat the alignment procedure above, until the axle is aligned in accordance with the specifications.

IMPORTANT: U-bolt nuts should be retorqued after the first 500-1000 miles (800-1600 km) of operation, and thereafter, every three months. Torque the U-bolt nuts with the vehicle loaded. Under severe operating conditions, the U-bolt nuts should be retorqued weekly.

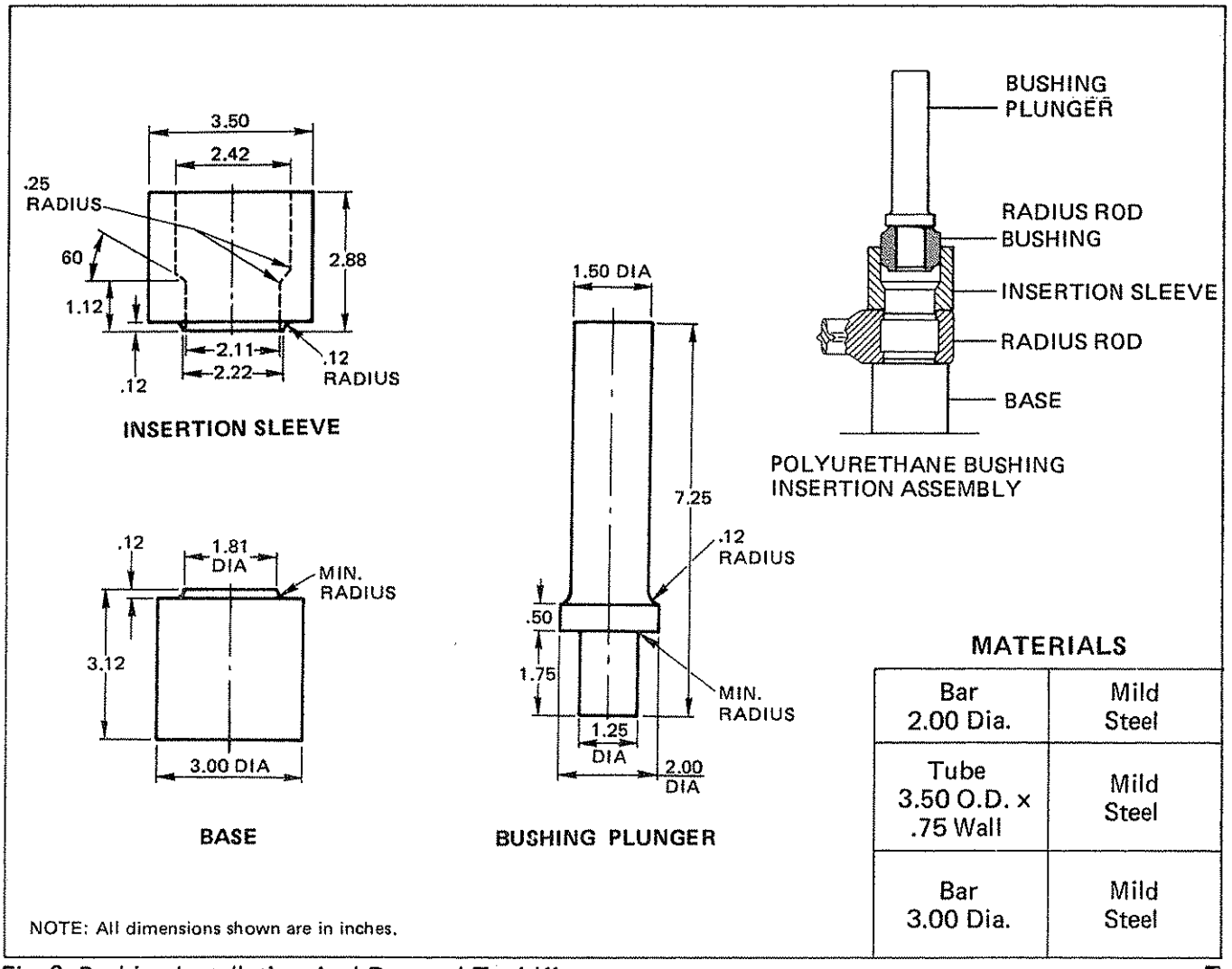
CAUTION: Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

FREIGHTLINER SINGLE DRIVE SUSPENSION

SPECIFICATIONS

DESCRIPTION	SIZE	GRADE	TORQUE	
			FT-LBS	N·m
Radius Rod Pin Cap Capscrews	1/2-20	8	82	111
Radius Rod Pin-to-Radius Rod Bracket Locknuts	5/8-18	G	185	251
U-bolt Nuts	3/4-16 7/8-14	SPECIAL PART	250 400	339 542
Spring Bracket-to-Frame Locknuts	1/2-20	G	90	122

Table 1, Torque Specifications



NOTE: All dimensions shown are in inches.

MATERIALS

Bar 2.00 Dia.	Mild Steel
Tube 3.50 O.D. x .75 Wall	Mild Steel
Bar 3.00 Dia.	Mild Steel

Fig. 6, Bushing Installation And Removal Tool Kit

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FREIGHTLINER SINGLE-DRIVE SUSPENSION, TYPE A

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FREIGHTLINER SINGLE-DRIVE SUSPENSION, TYPE A

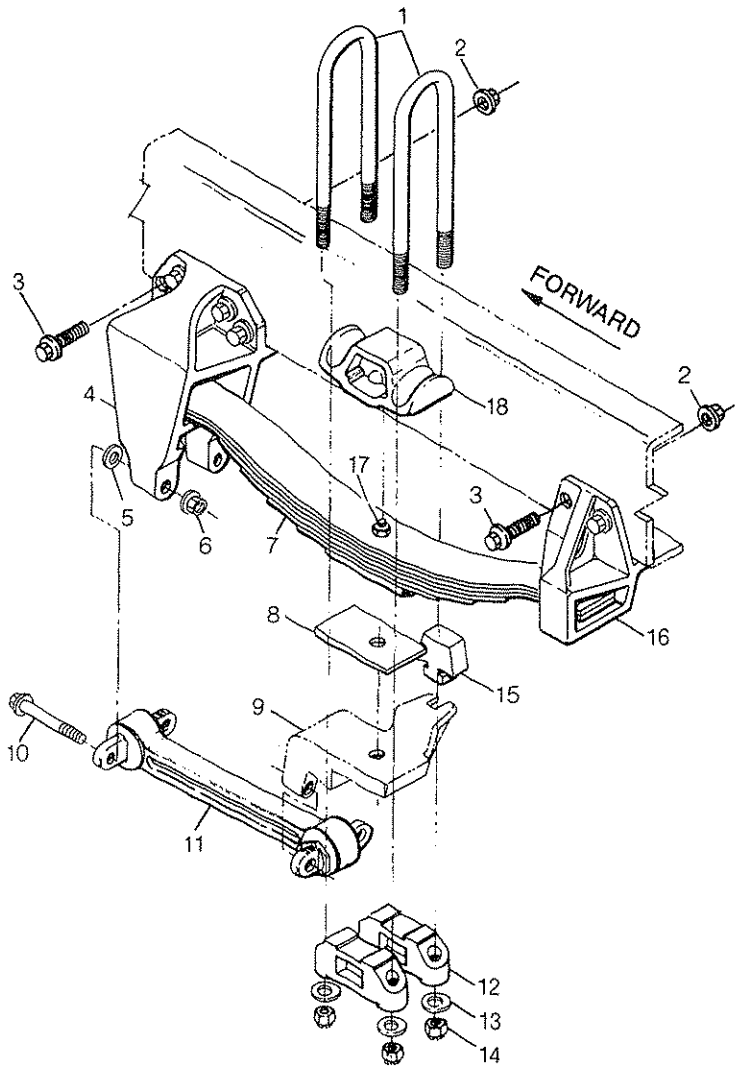
GENERAL DESCRIPTION

The Freightliner Type A single-drive suspension (Fig. 1) uses a full-floating spring design. Semielliptical spring assemblies are attached to the axles with U-bolt assemblies. The spring ends ride in frame rail mounted aluminum brackets, with steel bearing surfaces cast into each bracket. Radius rods attached to the axle and the forward spring brackets hold the axle in alignment. Cushioned axle stops are mounted on the radius rod brackets.

SERVICE OPERATIONS

GENERAL GUIDELINES AND PRECAUTIONS

1. Spring brackets and radius rod assemblies should be attached with SAE Grade 8 flanged bolts and Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts and Grade C prevailing torque locknuts.
2. All suspension fasteners require periodic torquing. For suspension component inspecting, lubricating,



1. U-Bolt
2. Flanged Locknut
3. Flanged Bolt
4. Forward Spring Bracket
5. Axle Alignment Washer
6. Flanged Locknut
7. Spring Assembly
8. Shim
9. Radius Rod Bracket
10. Flanged Bolt
11. Radius Rod Assembly
12. Axle Pads
13. Hardened Washers
14. U-Bolt Nuts
15. Axle Stop
16. Rear Spring Bracket
17. Spring Center-Bolt and Nut
18. U-Bolt Retainer

NOTE: Some fasteners have been omitted for clarity.

Fig. 1, Freightliner Single-Drive Suspension, Type A

FREIGHTLINER SINGLE-DRIVE SUSPENSION, TYPE A

and fastener torque checking intervals and instructions, refer to the maintenance schedule and the 16 Group of the Freightliner Maintenance and Lube Manual.

CAUTION: Failure to periodically torque the suspension fasteners, can result in abnormal tire wear and damage to the springs, spring brackets, and frame rail.

3. At all points where aluminum parts are fastened to steel parts, use Alumilastic® compound, or equivalent on the mating surfaces. This includes nuts, bolts, and washers.

CAUTION: Failure to apply Alumilastic® compound, or equivalent, to areas where aluminum and steel components contact each other, could cause decomposition of the metals, resulting in suspension system and frame damage.

RADIUS ROD ASSEMBLY REMOVAL, DISASSEMBLY, CLEANING AND INSPECTION, ASSEMBLY, AND INSTALLATION

Removal (Refer to Fig. 1)

1. Apply the parking brakes, and chock the tires.
2. Note the number of axle alignment washers (Ref. 5) or shims, if equipped, at the forward end of each radius rod.
3. Remove the fasteners that attach the radius rod assembly to the forward spring bracket, and radius rod bracket.
4. Remove the radius rod assembly and, if equipped, the axle alignment washers and compression nut locks. Discard the compression nut locks.

NOTE: If the left side of the radius rod is not marked with the notation "10°" cast in at the forward end (Fig. 2, Ref. A), using pen or paint, mark the left side of the radius rod forward (spring bracket) end for later reference.

Disassembly (Refer to Fig. 2)

NOTE: At the forward end of the radius rod, if equipped with a compression nut of the style shown in Fig. 3, Ref. A, the nut and radius rod pin surfaces may not be aligned, due to an interference fit between the radius rod and the forward spring bracket. Before disassembly, note the position of the compression nut on the radius rod pin for later reference.

1. Place the radius rod assembly in a vise, clamping it firmly in the center, so that the bushings and radius rod pins can be removed from it.
2. Remove the compression nuts and compression washers from the pins. If the compression nut is secured with adhesive, place a long-handled box wrench over the nut. Using a butane torch, heat the

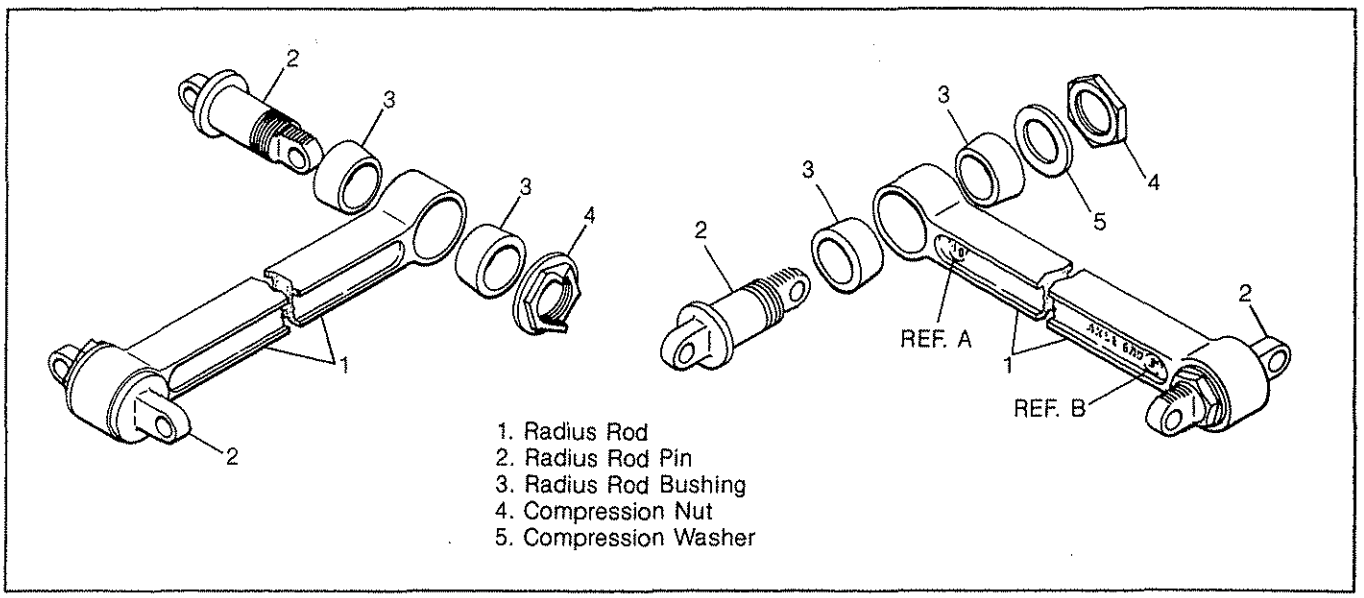


Fig. 2, Radius Rod Assembly

FREIGHTLINER SINGLE-DRIVE SUSPENSION, TYPE A

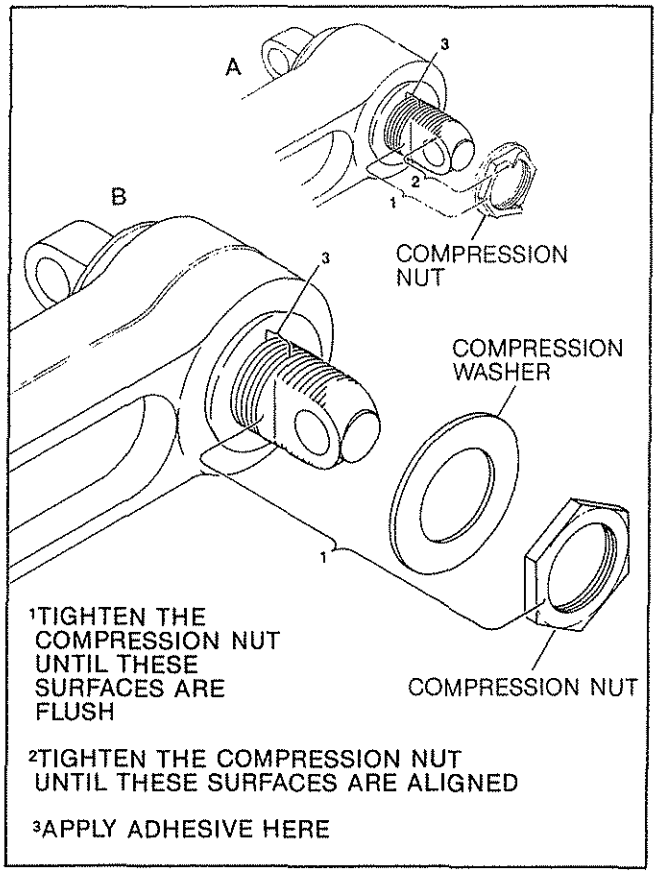


Fig. 3, Tightening of Compression Nuts

adhesive while applying removal pressure to the wrench. Concentrate the heat on the bond line, all the way around the threads of the compressed nut. Do not overheat the components. Once the nut begins to turn, discontinue the application of heat.

WARNING: To avoid personal injury from burns, do not touch any heated metal parts, nor make any contact with dissolved material from the urethane bushings.

3. Press out the pins from the radius rod eyes. If necessary, drive out the pins with a hammer.
4. Remove and discard the radius rod bushings.

Cleaning and Inspection

1. Clean all of the radius rod components with clean solvent, and allow them to air-dry for ten minutes.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

2. Using a stiff bristled brush, clean the threads of the compression nuts and radius rod pins. Replace any parts that have damaged threads.
3. Inspect the radius rod components for wear, cracks, galling, corrosion, or other damage. If any of these conditions are present, replace the component(s).

Assembly (Refer to Fig. 2)

1. Place the unthreaded end of the radius rod pin in a vise, clamping it firmly in a vertical position.
2. Place a new bushing, with the large end down, on the pin. Place the forward eye of the radius rod (the end with "10°" cast into the left side of the rod [Ref. A], or as previously marked) on the pin, with the left (marked) side of the rod facing down.
3. Place the other new bushing, with the small end down, on the pin. Manually force the bushings into the radius rod eye.
4. Rotate the radius rod 10° counterclockwise. See Fig. 4, Detail A.

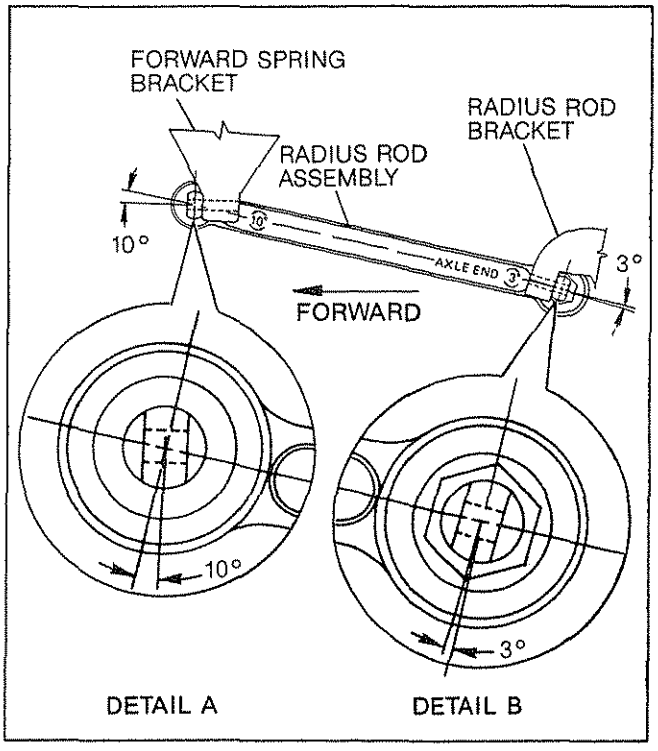


Fig. 4, Radius Rod Pin Positioning

FREIGHTLINER SINGLE-DRIVE SUSPENSION, TYPE A

5. Dispense a small amount of Loctite® 277, or an equivalent adhesive, in a small dish or paper cup.

   Using a non-metallic brush, apply adhesive to the three or four pin threads that will be covered by the compression nut after it is tightened. See Fig. 3. Do not apply adhesive to the end of the pin. Apply enough adhesive to fill the compression nut threads, with a slight excess.

CAUTION: Do not use a metallic brush to apply the adhesive, as it will contaminate the adhesive.

6. Install the washer, if equipped, and start the compression nut on the pin. Without disturbing the angle of the pin, tighten the nut until the flat outside surface of the nut is flush with the flat shoulder of the pin. See Fig. 3.

   On compression nuts of the style shown in Fig. 3, Ref. A, the two locking ears must be parallel to the flat surfaces of the pin end; if not, back off the nut until they are parallel. If the pin and nut are not aligned due to an interference fit between the radius rod and forward spring bracket, install the nut as previously noted.

IMPORTANT: After the compression nut has been tightened, the adhesive will cure in less than two minutes. Adjustment of the nut position is not possible after the adhesive has cured.

7. Remove the forward end of the radius rod from the vise. Place the unthreaded end of the other pin in the vise, clamping it firmly in a vertical position.

8. Place a new bushing, with the large end down, on the pin. Place the other eye of the radius rod on the pin, with the left (marked) side of the rod facing up. The threaded ends of the pins should be on opposite sides of the other radius rod.

9. Place the other new bushing, with the small end down, on the pin. Manually force the bushings into the radius rod eye.

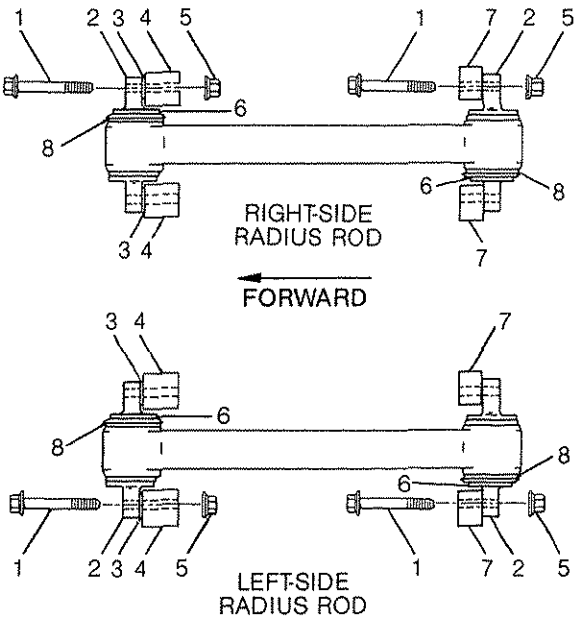
10. Rotate the radius rod 3° clockwise. See Fig. 4, Detail B. Then, repeat steps 5 and 6 to install the compression nut.

11. Remove the radius rod from the vise.

Installation

1. Place the radius rod pins on the front side of the forward spring bracket, and on the rear side of the radius rod bracket. See Fig. 4.

IMPORTANT: Be sure the pins are rotated to the dimensions in Fig. 4. The forward compression nut should be on the right side of the radius rod forward eye, and the axle end compression nut on the left side of the radius rod rear eye. See Fig. 5.



1. Flanged Bolt
2. Radius Rod Pin
3. Axle Alignment Washer
4. Forward Spring Bracket
5. Flanged Locknut
6. Compression Nut
7. Radius Rod Bracket
8. Compression Washer

NOTE: Some fasteners have been omitted for clarity.

Fig. 5, Radius Rod and Compression Nut Positions

2. Install the bolts and locknuts in the radius rod bracket and pins.

3. Install any previously removed axle alignment washers between the forward radius rod pins and forward spring brackets. See Fig. 5. Install the bolts and locknuts in the forward radius rod pins and spring brackets.

IMPORTANT: Any axle alignment shims that were removed during radius rod removal should be replaced with an equal thickness of axle alignment washers. An equal thickness of washers should be installed on both ends of the forward radius rod pins.

FREIGHTLINER SINGLE-DRIVE SUSPENSION, TYPE A

4. Tighten the radius rod locknuts to the applicable torque value in **Table 1**, under "SPECIFICATIONS."

5. Check the axle alignment. For instructions refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

SPRING ASSEMBLY REPLACEMENT
(Refer to **Fig. 1**)

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

1. Chock the front tires.

2. Raise the vehicle, and block the axle with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then block the frame with safety stands. Make sure the stands will securely support the weight of the axle and frame. Remove the wheel assembly, to gain easy access to the suspension system.

3. Remove the U-bolt nuts, hardened washers, axle pads, U-bolts, and U-bolt retainer. Note the position of the tapered axle planing shim(s) (Ref. 8), for later reference.

4. Using an overhead hoist, or other lifting device, lift the spring assembly, and slide the spring into the forward spring bracket. Raise the other end of the spring above the rear spring bracket. Slide the spring assembly out of the forward spring bracket, and remove the spring from the vehicle.

5. Place the axle planing shim(s) on the radius rod bracket, as previously noted.

6. Place the forward end of the spring in the forward spring bracket. Lower the spring assembly, and place the other end of the spring in the rear spring bracket. Make sure the spring center bolt head seats in the shim center hole and the radius rod bracket hole.

7. Place the U-bolt retainer on the spring assembly.

8. Place the U-bolts over the spring assembly and the U-bolt retainer.

9. Install the axle pads, hardened washers, and U-bolt nuts on the U-bolts.

10. Tighten the U-bolt nuts to the applicable torque value in **Table 1**, under "SPECIFICATIONS."

11. Install the wheel assembly. Remove the safety stands from under the vehicle frame and axle, and lower the vehicle.

12. Check the axle alignment. For instructions, refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

13. Remove the chocks from the tires.

SPRING BRACKET REPLACEMENT
(Refer to **Fig. 1**)

WARNING: Failure to replace worn, cracked, or damaged spring brackets could result in breakage of the bracket, which could cause a loss of vehicle control.

1. Chock the front tires.

2. Raise the vehicle, and block the axle with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then block the frame with safety stands. Make sure the stands will securely support the weight of the axle and frame. Remove the wheel assembly, if necessary, to gain easy access to the brackets.

3. If removing the forward spring bracket, note the number of any axle alignment washers (Ref. 5) or shims, then remove the fasteners that attach the radius rod assembly to the forward spring bracket. Remove any axle alignment washers.

FREIGHTLINER SINGLE–DRIVE SUSPENSION, TYPE A

4. Remove the fasteners that attach the spring bracket to the frame rail. Remove the spring bracket, and if equipped, the backing plate on the inside of the frame rail.

5. Place the new spring bracket on the frame rail, and if equipped, the backing plate on the inside of the frame rail. Align the mounting holes, and install the spring bracket bolts and locknuts. Tighten the locknuts to the applicable torque value in **Table 1**, under "SPECIFICATIONS."

6. If replacing the forward spring bracket, install any previously removed axle alignment washers between the radius rod forward pin and the forward spring bracket. See **Fig. 5**. Install the bolts and locknuts in the forward radius rod pins and spring brackets.

IMPORTANT: Any axle alignment shims that were removed during removal of the forward spring bracket should be replaced with an equal thickness of axle alignment washers. An equal thickness of washers should be installed on both ends of the forward radius rod pins.

7. Tighten the locknuts to the applicable torque value in **Table 1**.

8. Install the wheel assembly, if previously removed. Remove the safety stands from under the vehicle frame and axle, and lower the vehicle.

9. Check the axle alignment. For instructions, refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

REAR AXLE ALIGNMENT AND ADJUSTMENT

1. With the axle alignment fixture (**Fig. 6**) in position, determine the exact difference between the measurements at each end of the fixture, on both sides of the vehicle. This difference in measurements is the approximate amount that the trailing end of the axle will have to be brought forward to make it perpendicular to the frame. Alignment adjustment must be made on the trailing end of the axle (**Fig. 7**).

2. Loosen the axle U-bolts enough to allow the springs to shift on the axle pads.

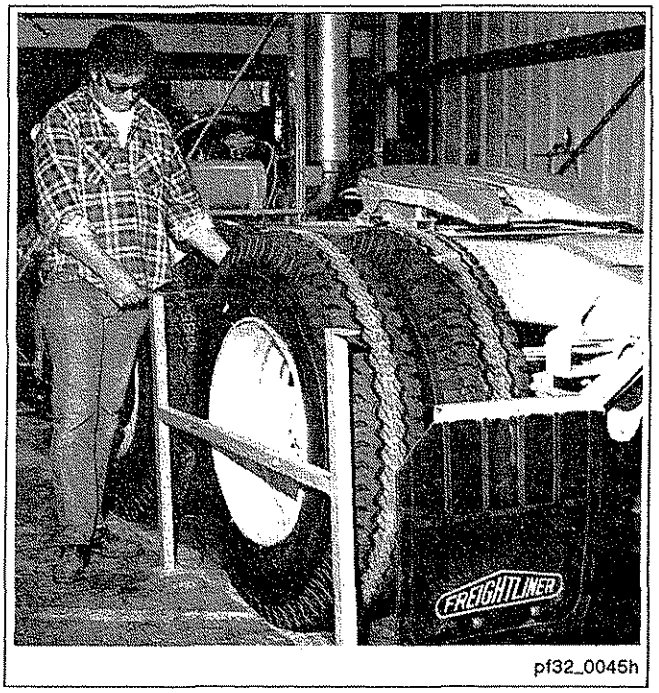


Fig. 6, Axle Alignment Fixture

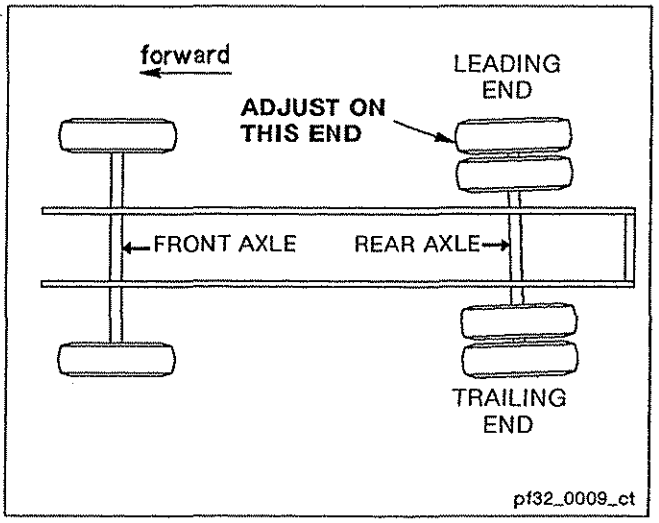


Fig. 7, Single Axle, Out of Alignment

3. On the side of the vehicle which has the trailing axle end, remove the fasteners that attach the radius rod assembly to the forward spring bracket. Remove any axle alignment washers.

FREIGHTLINER SINGLE–DRIVE SUSPENSION, TYPE A

4. Raise the vehicle frame just enough to relieve the weight from the springs. Place safety stands under the vehicle frame. Make sure the stands will support the weight of the vehicle frame.
5. Move the trailing end of the axle forward by rolling the wheels (on that end) toward the cab. Roll them forward just enough to provide space to allow installation of axle alignment washers between the forward spring bracket and the radius rod pin (**Fig. 5**).
6. Between the radius rod pin and the forward spring bracket, insert the correct thickness of axle alignment washers that are needed to bring the trailing axle end into alignment.

IMPORTANT: Any axle alignment shims that were removed when the radius rod assembly was detached from the forward spring bracket should be replaced with an equal thickness of axle alignment washers. To this thickness of washers, add an additional thickness of washers equal to the measured difference at the ends of the axle alignment fixture.

For example, if the trailing end of the axle was equipped with a 3/16-inch (4.5 mm) thickness of shims, and the difference in measurements at the end of the alignment fixture is 1/4 inch (6 mm), discard the shims and add 3/16 inch (4.5 mm) of washers, plus an additional 1/4 inch (6 mm) of washers to correct the axle alignment.

7. Install the bolt and locknut in the radius rod pin and forward spring bracket. Place an equal thickness of axle alignment washers on the other end of the radius rod pin, and install the bolt and locknut.
8. Tighten the locknuts to the torque value in **Table 1**, under "Specifications."
9. Remove the safety stands, and lower the vehicle. Remove the chocks from the front tires.
10. Check the axle alignment with the axle alignment fixture. If alignment is within the specifications, tighten the axle U-bolt nuts to the torque value in **Table 1**.

    If not in alignment, repeat the procedure above.

SPECIFICATIONS

DESCRIPTION	SIZE	IFI GRADE*	TORQUE lbf·ft (N·m)
Spring Bracket-to-Frame Rail Flange Prevailing Torque Locknut	1/2–13†	C	68 (92)
	1/2–13	G	95 (130)
	1/2–20†	C	77 (104)
	1/2–20	C	100 (135)
Spring Bracket-to-Frame Rail Web Prevailing Torque Locknut	5/8–11†	C	136 (184)
	5/8–11	G	190 (260)
	5/8–18†	C	154 (209)
	5/8–18	C	195 (265)
	1/2–13†	C	68 (92)
	1/2–13	G	95 (130)
	1/2–20†	C	77 (104)
	1/2–20	C	100 (135)
U-Bolt Nut	3/4–16	SPECIAL PART	250 (339)
	7/8–14		400 (542)
Radius Rod Prevailing Torque Locknut	5/8–11	G	190 (260)
	5/8–18	C	195 (265)

Table 1, Torque Values

* Hardened flatwashers must be used under both grade 8 bolts and grade C prevailing torque locknuts.
† Grade 8 bolts with phosphate- and oil-coated threads, and cadmium-plated, wax-coated grade C locknuts; both used with hardened washers.

FREIGHTLINER TANDEM SUSPENSION

GENERAL DESCRIPTION

The Freightliner tandem suspension (Fig. 1) uses a six point true-equalizing leaf spring design. Four interchangeable, semielliptical springs are mounted to the axles with eight U-bolts. At the fore and aft terminals, the spring ends ride in aluminum brackets with steel bearing surfaces cast into each bracket. At the center, the springs ride on a steel equalizer which pivots on a steel cross shaft. The cross shaft is attached to each side of the frame with aluminum brackets. Equalizer stops, attached to the frame, prevent overtravel of the equalizer. Each axle is held in alignment by a pair of interchangeable radius rods that extend forward from the axles to the frame mounted spring brackets. The cushioned axle stops are frame mounted.

SERVICE OPERATIONS

For information regarding inspection intervals and procedures, and lubrication intervals and procedures, refer to the Freightliner Maintenance and Lube Manual.

RADIUS ROD ASSEMBLY REMOVAL, DISASSEMBLY, INSPECTION, ASSEMBLY, AND INSTALLATION

Removal (Refer to Fig. 1)

1. Remove the radius rod pin cap capscrews, caps, and radius rod pin dowel.

2. Remove the bolts, hardened washers, and locknuts (or flanged bolts and flanged locknuts) that attach the radius rod assembly to the radius rod bracket.

3. Remove the radius rod assembly, and, if so equipped, remove the axle alignment shim(s) (or axle alignment washers).

Disassembly

1. Remove the snaprings from the axle end radius rod pin; then remove the radius rod pin washers from both the forward end and the axle end radius rod pins.

2. Press both radius rod pins out of the radius rod. If necessary, drive out the radius rod pins with a hammer.

IMPORTANT: The forward end and axle end radius rod eyes have a smaller shoulder on one side of the eye than on the other side. Also, the small-shouldered side has a rounded edge around the inside of the eye. See Fig. 2. To avoid damage to the radius rod, the radius rod bushings must be pressed in and out of the side of the radius rod with the smaller shoulder.

NOTE: Removal and installation of radius rod bushings require the use of a special tool kit, which may be purchased from Freightliner. The special tool kit may also be fabricated by using the dimensions given in Fig. 11, located under **"SPECIFICATIONS."**

3. Use the bushing plunger from the special tool kit on a hydraulic press to push the bushing plunger into the large-shouldered side of the radius rod eye; then, press the bushing out of the small-shouldered side of the radius rod. Remove both radius rod bushings.

Inspection

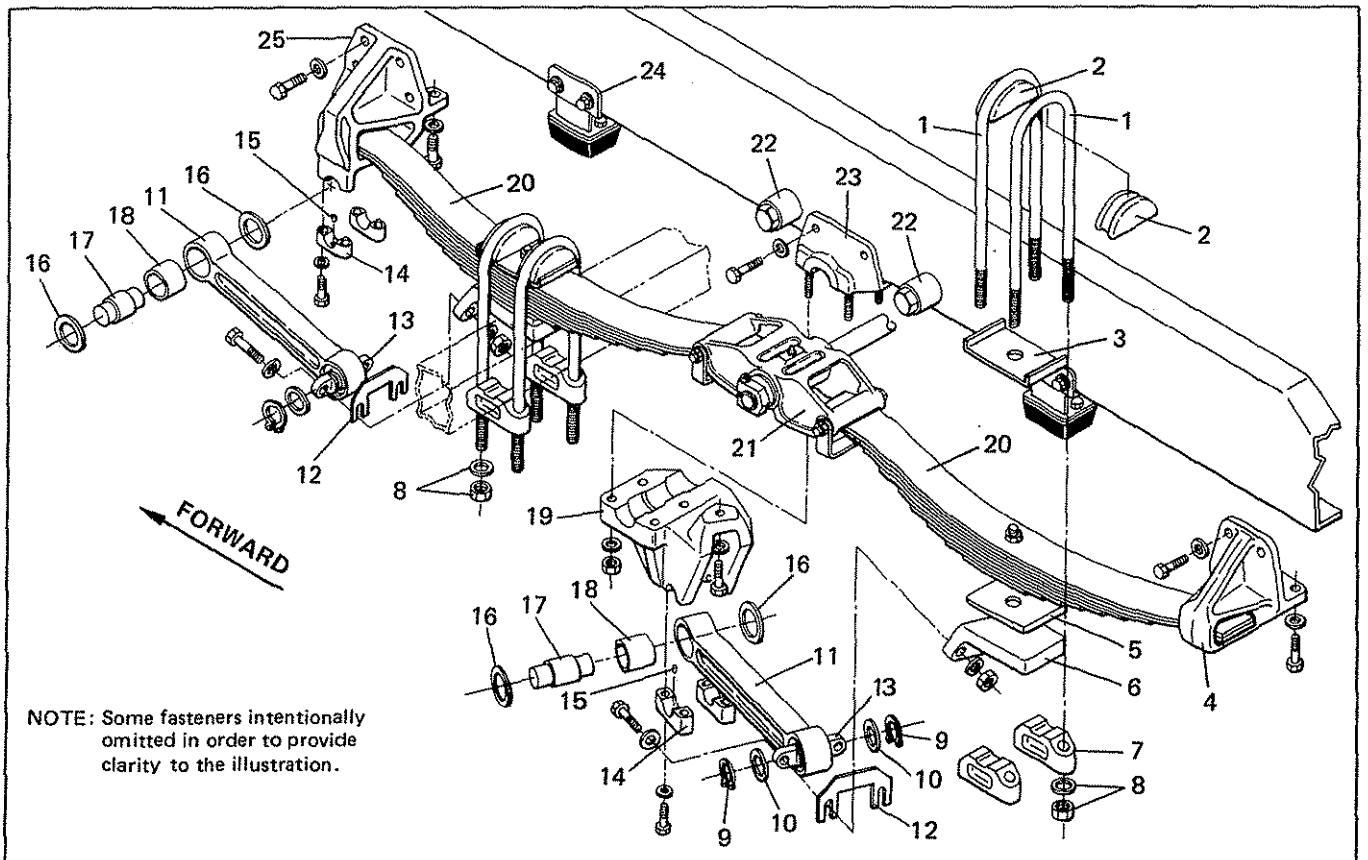
1. Clean all dirt, grease, and other foreign matter from the radius rod components.

2. Inspect the radius rod components for wear, cracks, and other damage. Replace any components that are worn, cracked, or otherwise damaged.

Assembly

1. Coat the radius rod bushings with a non-mineral lubricant, such as rubber lubricant or waterless hand cleaner.

FREIGHTLINER TANDEM SUSPENSION



1. U-Bolt
2. U-Bolt Pad
3. U-Bolt Pad Retainer
4. Rear Spring Bracket
5. Axle Planing Shim
6. Radius Rod Bracket
7. Axle Clamp
8. U-Bolt Nut And Hardened Washer
9. Snapring
10. Radius Rod Pin Washers (Axle End)
11. Radius Rod
12. Axle Alignment Shim
13. Radius Rod Pin (Axle End)
14. Radius Rod Pin Cap
15. Radius Rod Pin Dowel
16. Radius Rod Pin Washer (Forward End)
17. Radius Rod Pin (Forward End)
18. Radius Rod Bushing
19. Lower Equalizer Bracket
20. Spring Assembly
21. Equalizer Assembly
22. Equalizer Stop
23. Upper Equalizer Bracket
24. Axle Stop Assembly
25. Forward Spring Bracket

Fig. 1, Freightliner Tandem Suspension

2. Position a bushing into the larger end of the insertion sleeve from the tool kit; then fit the beveled (smaller) end of the sleeve into the small-shouldered side of the radius rod eye.

3. Center the radius rod eye on the base tool, and insert the plunger tool into the bushing. See Fig. 3. Use a hydraulic press to force the bushing into the radius rod eye. Install both radius rod bushings.

4. Press the forward end radius rod pin into either of the radius rod eyes.

5. Install a snapring on one end of the axle end radius rod pin; then install a radius rod pin washer over the other end, and slide it over the pin until it is tight against the snapring.

NOTE: Install the snapring and radius rod pin washers with the sharp edges facing toward the outside. See Fig. 2, Detail A.

FREIGHTLINER TANDEM SUSPENSION

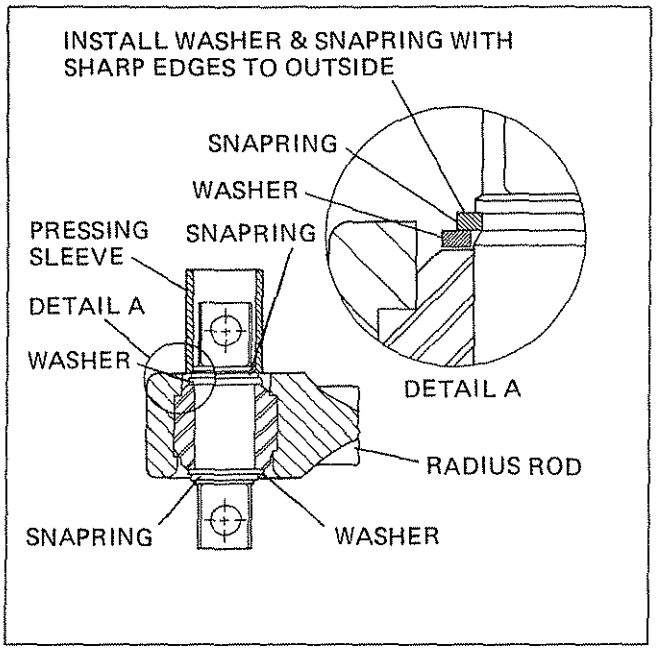


Fig. 2, Snapring And Washer Installation

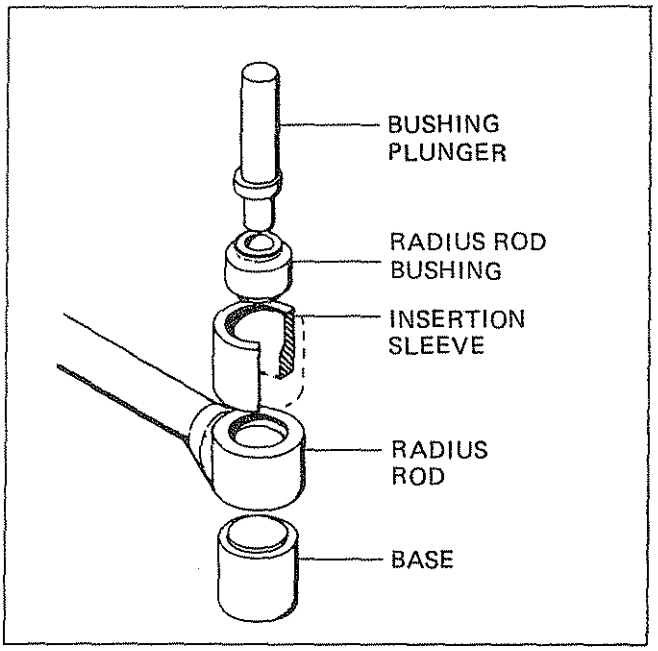


Fig. 3, Radius Rod Bushing Installation

6. Press the radius rod pin into the radius rod bushing from the same side as the bushing was pressed into the radius rod eye. Do not lubricate the radius rod pin.

7. Turn the radius rod over and install a flat washer, with the sharp edge facing away from the bushing; then install the other snapring onto the outer shoulder of the pin, with the sharp edge facing outward.

8. Place a pressing sleeve over the end of the radius rod pin, then press the snapring into its seat, as shown in Fig. 2.

9. After assembly, press the radius rod pin slightly to center it in the radius rod eye. There should be no slack on either side of the bushing, and the bushing should be compressed by approximately half the thickness of the snapring. If there is slack on either side of the bushing, install a second washer under one of the snaprings to compress the bushing.

Installation

1. Install the forward end radius rod pin washers on the forward end radius rod pin; then position the radius rod pin dowel in the forward end radius rod pin. Locate the radius rod pin so the dowel will engage properly with the radius rod pin cap.

2. Hold the forward end of the radius rod in place against the forward spring bracket or lower equalizer bracket; then, install the radius rod pin caps, using Grade 8 capscrews and hardened washers. Tighten the capscrews to 82 ft-lbs (111 N·m).

NOTE: Any axle alignment shims that were removed during the radius rod removal procedure may be replaced with an equal thickness of axle alignment washers. An equal thickness of washers should be used on both ends of the axle end radius rod pin.

FREIGHTLINER TANDEM SUSPENSION

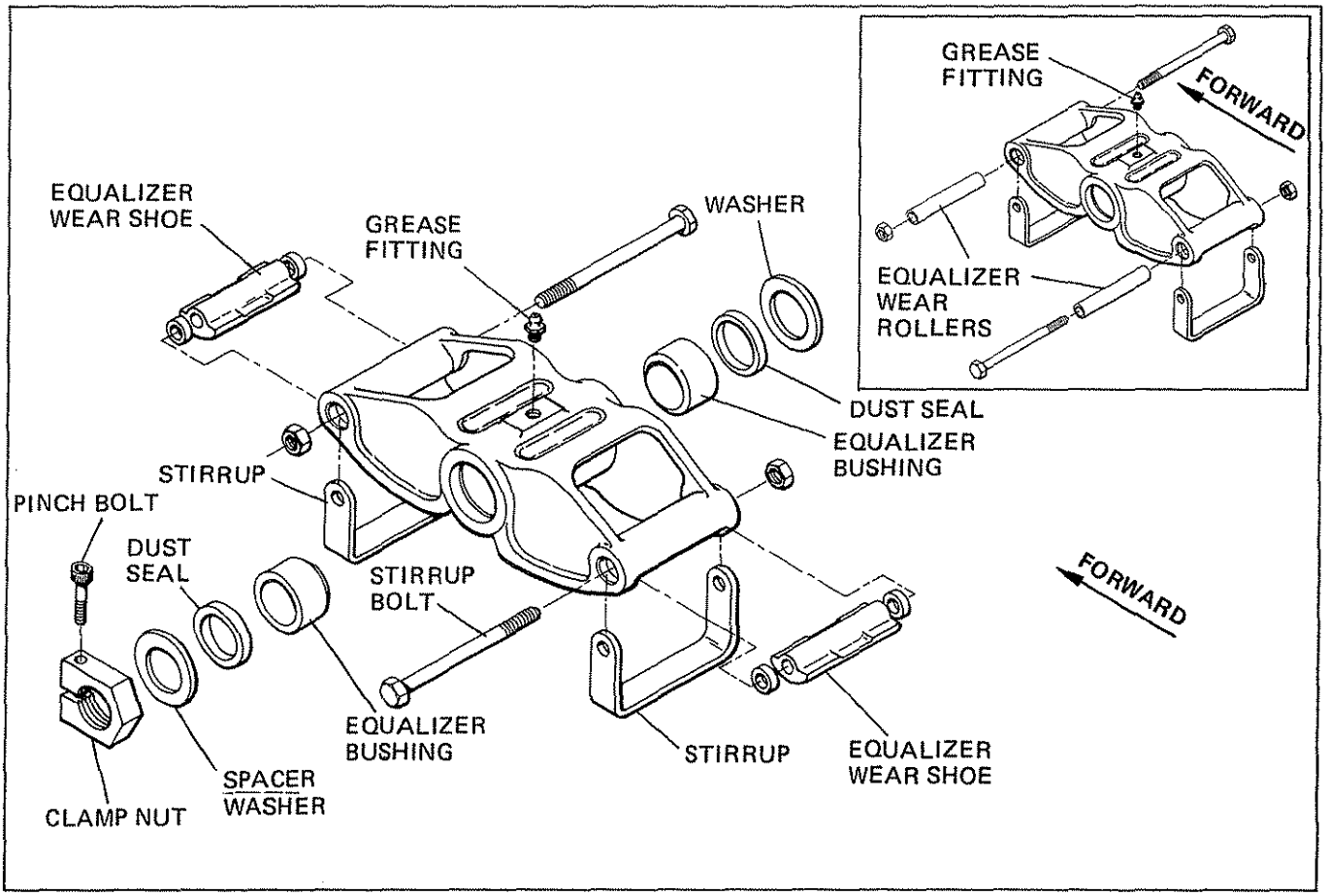


Fig. 4, Equalizer Assembly

3. Hold the axle alignment shims (or washers) in place between the axle end radius rod pin and the radius rod bracket, while installing flanged bolts through the radius rod pin and radius rod bracket. Then install the flanged locknuts.

IMPORTANT: The axle end of the radius rods should be attached to the radius rod brackets with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts, and SAE Grade C prevailing torque locknuts.

4. Tighten the radius rod flanged locknuts to 185 ft-lbs (251 N·m). Then check the axle alignment, using the procedure given in the 11 Group of this manual.

EQUALIZER ASSEMBLY REMOVAL, DISASSEMBLY, INSPECTION, ASSEMBLY, AND INSTALLATION

Removal (Refer to Fig. 4)

1. Block the front tires with chock blocks; then raise the vehicle frame until the weight is just off the equalizer. Safety block the frame with jack stands.

2. Using a cutting torch, cut the tack welds that attach the thin nuts to the wear shoe bolts and the stirrups; then cut the welds that attach the wear shoe bolts to the stirrups. Remove the nuts, wear shoe bolts, stirrups, and equalizer wear shoes or equalizer wear rollers. Discard the wear shoe bolts and thin nuts.

FREIGHTLINER TANDEM SUSPENSION

3. Remove the pinch bolt, clamp nut, and outside spacer washer from the equalizer cross shaft. If so equipped, remove the frame mounting bolts and nuts, and the equalizer outboard support. Then slide the equalizer off the equalizer cross shaft, and remove any inside spacer washers that are present.

Disassembly (Refer to Fig. 4)

1. Remove the dust seals.

2. Press out, or tap out the two equalizer bushings.

Inspection

1. Thoroughly clean the equalizer with steam or a hot soap solution, then inspect it for cracks or other damage. Replace the equalizer if either of these conditions are present.

CAUTION: Failure to replace the equalizer if it is cracked or otherwise damaged could result in progressive damage, and eventual breakage of the equalizer.

2. Inspect the equalizer bushings for wear, cracks, or other damage. Replace the equalizer bushings if worn by more than 1/8" (3 mm), or if they are cracked or otherwise damaged.

Assembly

1. Using an installation tool of the same outside diameter as the equalizer bushings, press or tap the equalizer bushings into the equalizer (with the beveled edges of the bushings to the inside of the equalizer, and the square edges to the outside), until the square edge of the bushing is flush with the bevel inside the cross shaft bore of the equalizer.

NOTE: There must be a slight gap between the two equalizer bushings.

2. Install two new dust seals in the equalizer, with the lip of the dust seals extending outward.

Installation

1. Be sure the equalizer cross shaft is clean, then position the inside spacer washers, if so equipped, on the cross shaft.

2. Lightly lubricate the cross shaft with multi-purpose chassis grease. Then, position a sleeve over the shoulder of the cross shaft to avoid damaging the equalizer dust seals.

3. Position the equalizer assembly on the cross shaft; then remove the sleeve.

4. Install the outside spacer washer on the cross shaft. Then, if so equipped, install the equalizer outboard support and attaching bolts and nuts (use SAE Grade 8 low-profile flanged bolts in the lower mounting bolt holes, to ensure adequate equalizer clearance). Torque the flanged locknuts to 90 ft-lbs (122 N·m).

5. Install the clamp nut, and tighten it until a push or pull force of 40 lbs (18 Kg) is required to tilt the ends of the equalizer. Install and tighten the clamp nut pinch bolt to 27 ft-lbs (37 N·m).

NOTE: Refer to the Freightliner Maintenance and Lube Manual for schedules and procedures regarding equalizer adjustment.

6. Lubricate the spring ends with multi-purpose chassis grease if equalizer wear shoes are being installed in the equalizer; do not apply lubricant if equalizer wear rollers are being installed. (If wear shoes or wear rollers require replacement, use sintered metallic, oil-impregnated wear shoes, with spacers, for greater service life.)

7. With the spring ends in place, install the equalizer stirrups, wear rollers or wear shoes and spacers, and stirrup bolts.

FREIGHTLINER TANDEM SUSPENSION

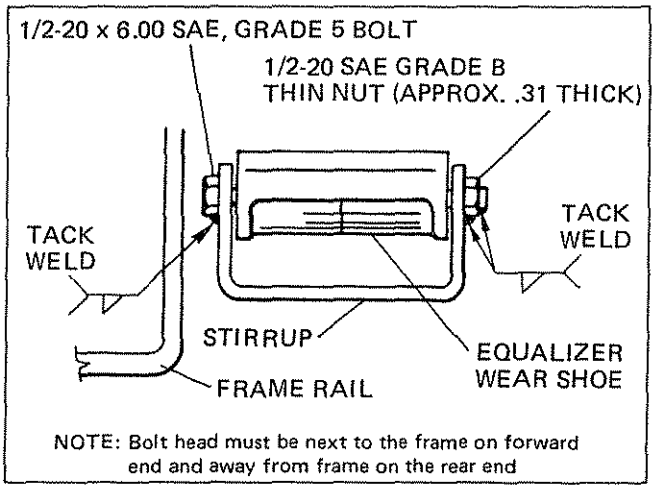


Fig. 5, Welding Of Stirrup Bolt And Nut

IMPORTANT: Install a new forward stirrup bolt with the bolt head next to the frame rail, and a new rear stirrup bolt with the bolt head away from the frame rail. Then install and tighten new stirrup bolt thin nuts, so the stirrups will still swing freely on the stirrup bolts. Tack weld the thin nut to the stirrup bolt; then tack weld the stirrup bolt head and thin nut to the stirrup. See Fig. 5.

8. Lubricate the equalizer assembly and contact surfaces of the equalizer wear shoes, using multi-purpose chassis grease. Do not lubricate wear rollers.

NOTE: Refer to the Freightliner Maintenance and Lube Manual for schedules and procedures regarding equalizer and wear shoe lubrication.

SPRING ASSEMBLY REMOVAL AND INSTALLATION

Removal

1. Block the front tires with chock blocks; then raise the vehicle frame until the weight is just off the spring assembly. Safety block the frame with jack stands.

2. Using a cutting torch, cut the tack welds that attach the thin nut to the wear shoe bolt and the stirrup; then cut the weld that attaches the wear shoe bolt to the stirrup. Remove the nut, wear shoe bolt, stirrup, and equalizer wear shoe or equalizer wear roller. Discard the wear shoe bolt and thin nut.

3. Remove the U-bolt nuts and hardened washers, axle clamps, U-bolts, U-bolt pads, and U-bolt pad retainer. Note the position of the tapered axle planing shim(s), if so equipped, for later assembly reference.

4. Using a hoist to help lift the spring assembly, slide the spring assembly into the applicable spring bracket; then raise the opposite end of the spring above the equalizer. Slide the spring assembly out of the spring bracket, then remove it from the chassis.

Installation

1. Clean the spring seat, then position the axle planing shim(s) on the radius rod bracket. Make sure the tapered planing shim(s) is placed in the same position it was in prior to removal.

2. Using a hoist, slide one end of the spring assembly (the end without a wear plate) into the appropriate spring bracket; then, lower the spring assembly, and position the opposite end in the equalizer bracket. Make sure the head of the spring center bolt is seated in the shim center hole and the radius rod bracket hole.

3. Position the U-bolt pad retainer and U-bolt pads on top of the spring. Apply anti-seize compound to the U-bolt threads, then position the U-bolts over the U-bolt pads.

4. Install the axle clamps, U-bolt hardened washers, and U-bolt nuts. Tighten the U-bolt nuts to 250 ft-lbs (339 N·m) for 3/4-16 U-bolts, and 400 ft-lbs (542 N·m) for 7/8-14 U-bolts.

IMPORTANT: The U-bolt nuts should be re-torqued after the first 500 to 1000 miles (800 to 1600 km) of operation, and thereafter every three

FREIGHTLINER TANDEM SUSPENSION

months. Torque the U-bolt nuts with the vehicle loaded. Under severe operating conditions, the U-bolt nuts should be retorqued weekly.

CAUTION: Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

5. With the spring ends in place, install the equalizer stirrup, wear roller, or wear shoe and spacers, and stirrup bolt.

IMPORTANT: Install a new forward stirrup bolt with the bolt head next to the frame rail, and a new rear stirrup bolt with the bolt head away from the frame rail. Then install and tighten new stirrup bolt thin nuts, so the stirrups will swing freely on the stirrup bolts. Tack weld the thin nut to the stirrup bolt; then tack weld the stirrup bolt head and thin nut to the stirrup. See **Fig. 5**.

6. Lubricate the contact surface of the equalizer wear shoe, using multi-purpose chassis grease. Do not lubricate wear rollers.

7. Remove the jack stands, then lower the vehicle chassis. Remove the chock blocks from the front tires.

MAIN LEAF WEAR PLATE REPLACEMENT

1. Remove the spring assembly, following the procedure given in "SPRING ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

2. Inspect the spring assembly for cracked, broken, or abnormally bent leaves. Replace the spring assembly if any of the leaves are cracked, broken or abnormally bent.

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

3. Using a cutting torch, remove the weld from the main leaf wear plate. Drive a thin chisel between the main leaf and the wear plate to help separate the wear plate from the main leaf while cutting the weld with the torch. Use care not to damage the spring leaf when cutting off the old wear plate. Be sure only the weld is removed.

4. Grind the residual weld off the main leaf; then remove all dirt, grease, and paint from the area to be welded.

WARNING: When grinding the weld off the main leaf, use a shield (such as safety glasses) to protect the eyes from flying debris. Failure to wear such protection could result in personal injury.

5. Position a new wear plate on the main leaf, as shown in **Fig. 6**. Clamp the wear plate to the main leaf with a 'C' clamp, at the area of equalizer wear shoe or wear roller contact.

6. Preheat the wear plate and the leaf area to be welded, to 400–450°F (205–232°C). Use a welding heat crayon in the 400–450°F range to indicate when the proper heat range is reached.

7. Weld the plate to the leaf, using a low hydrogen rod with ultimate strength of 70,000 to 80,000 psi (4,921 to 5,625 kg/cm^2), and a

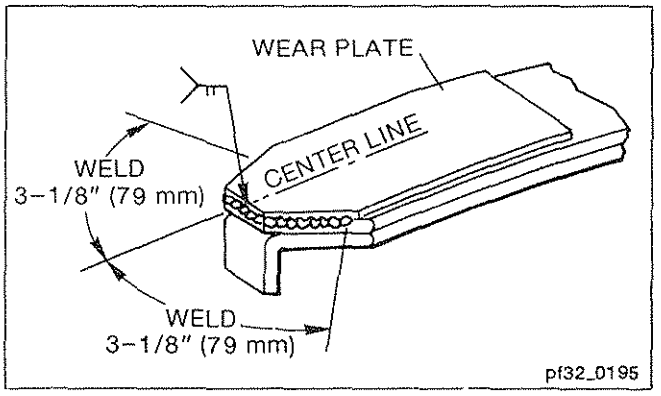


Fig. 6, Welding of Main Leaf Wear Plate

yield strength of 60,000 to 70,000 psi (4,218 to 4,921 kg/cm^2). Weld the outer edges of the plates 3-1/8" (70 mm) on each side (Fig. 6).

8. Allow the weld to air cool (do not oil or water quench the weld). Remove the slag, then paint the areas where the paint was removed. Remove the 'C' clamp.

9. Install the spring assembly, following the procedure given in "SPRING ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

UPPER AND LOWER EQUALIZER BRACKET REPLACEMENT

WARNING: Failure to replace the upper or lower equalizer brackets if they are worn, cracked, or otherwise damaged could result in progressive damage to, and eventual breakage of the bracket, which could create a loss of vehicle control.

1. Block the front tires with chock blocks. Then, raise the vehicle frame until the weight is just off the spring brackets. Safety block the frame with jack stands.

2. Remove the radius rod pin cap capscrews, caps, and radius rod pin dowel.

3. Remove the nut, washers, and bolt securing the lower equalizer bracket to the frame rail. Then remove the nuts and lockwashers (or capscrews and washers) that attach the lower equalizer bracket to the upper equalizer bracket.

4. Remove the equalizer assembly, following the procedure given under 'Removal' in "EQUALIZER ASSEMBLY REMOVAL, DISASSEMBLY, INSPECTION, ASSEMBLY, AND INSTALLATION," in this subject.

NOTE: If the upper and lower equalizer brackets are being replaced on both sides of the vehicle, it is not necessary to remove the equalizer assemblies. However, if the suspension is equipped with equalizer outboard supports, they must be removed to facilitate removal of the upper equalizer brackets. Remove the frame mounting bolts and nuts, and the equalizer outboard supports.

5. Remove the nuts, washers, and bolts that attach the upper equalizer bracket to the frame rail. Raise the frame rail and remove the upper equalizer bracket.

IMPORTANT: Whenever an upper or lower equalizer bracket employing 1/2" capscrews or 1/2" studs needs to be replaced, replace both brackets. For greater service life, install upper and lower equalizer brackets which employ 5/8" studs, lockwashers, and 5/8" plain hex nuts.

6. Apply Alumilastic® compound, or an equivalent, to all areas of the upper equalizer bracket that come in contact with metals other than aluminum. This includes all bolts, washers, and nuts that contact aluminum parts.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metal components contact each other, will result in electrolytic corrosion, which could cause suspension system damage.

7. Attach the upper equalizer bracket to the frame rail using flanged bolts and flanged locknuts. If the suspension is equipped with equalizer outboard supports, do not install the two upper-most upper equalizer bracket attaching bolts and nuts until Step 8. Tighten the flanged locknuts to 90 ft·lbs (122 N·m).

IMPORTANT: The upper equalizer bracket (and equalizer outboard support) should be attached to the frame rail with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts and SAE Grade C prevailing torque locknuts.

CAUTION: The fasteners that attach the upper equalizer bracket to the frame should be retorqued every three months, until the bracket becomes seated and the fasteners retain their torque setting. Continued use with insufficiently tightened fasteners could result in bracket and frame damage.

FREIGHTLINER TANDEM SUSPENSION

8. Install the equalizer assembly, if removed, following the procedure given under 'Installation' in "EQUALIZER ASSEMBLY REMOVAL, DISASSEMBLY, INSPECTION, ASSEMBLY, AND INSTALLATION," in this subject.

NOTE: If the suspension is equipped with equalizer outboard supports, install the equalizer outboard supports using SAE Grade 8 low-profile flanged bolts in the lower mounting bolt holes, to ensure adequate equalizer clearance. Install SAE Grade G prevailing torque flanged locknuts, then tighten the locknuts to 90 ft-lbs (122 N·m).

9. Apply Alumilastic compound, or an equivalent, to all surfaces of the lower equalizer brackets that come in contact with metals other than aluminum. This includes all bolts, washers, and nuts that contact aluminum parts.

10. Position the lower equalizer bracket in place over the 5/8" studs and the equalizer cross shaft, then install the internal tooth lockwashers and Grade C 5/8" plain hex nuts on the studs (Fig. 7, positions 1, 2, 3 & 4).

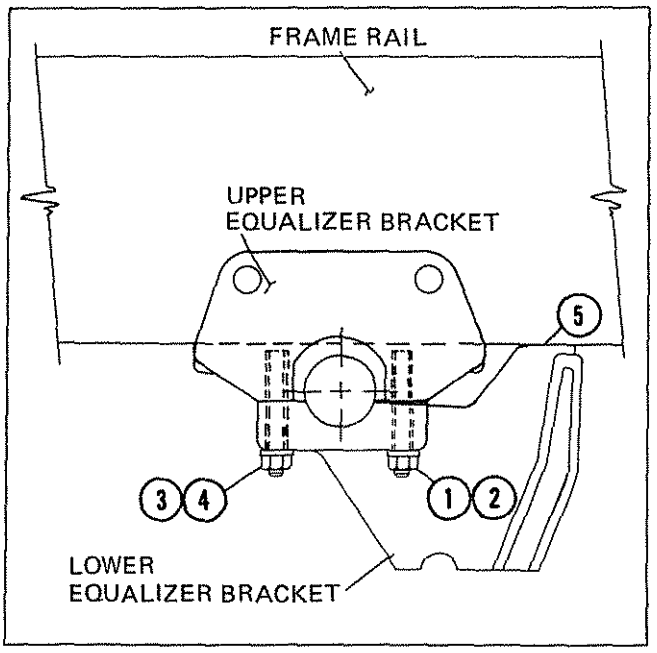


Fig. 7, Nut Tightening Sequence

11. Install an SAE Grade 8 bolt, hardened washer, and SAE Grade C prevailing torque locknut to attach the lower equalizer bracket to the frame rail (Fig. 7, position 5).

12. Tighten the plain hex nuts and the prevailing torque locknut to 40-50 ft-lbs (54-68 N·m) using the tightening sequence shown in Fig. 7. Then, using the same sequence, tighten the plain hex nuts to 185 ft-lbs (251 N·m), and the prevailing torque locknut to 90 ft-lbs (122 N·m).

CAUTION: The nuts attaching the lower equalizer bracket to the upper equalizer bracket and the frame rail should be retorqued after 500 to 1000 miles (800 to 1600 km) of operation, and thereafter every three months, until the parts become seated and the nuts retain their torque setting. Continued use with insufficiently tightened fasteners could result in bracket and frame damage.

13. Install the radius rod pin dowel in the forward end radius rod pin; then locate the radius rod pin so the dowel will engage properly with the radius rod pin cap. Hold the radius rod in place; then install the radius rod pin caps with Grade 8 capscrews and hardened washers. Tighten the capscrews to 82 ft-lbs (111 N·m).

14. Remove the jack stands, then lower the vehicle chassis. Remove the chock blocks from the front tires.

FORWARD SPRING BRACKET AND REAR SPRING BRACKET REPLACEMENT
(Refer to Fig. 1)

WARNING: Failure to replace the forward spring brackets or rear spring brackets if they are worn, cracked, or otherwise damaged could result in progressive damage to, and eventual breakage of the bracket, which could create a loss of vehicle control.

1. Block the front tires with chock blocks. Then, raise the vehicle frame until the weight is just off the spring brackets. Safety block the frame with jack stands.

FREIGHTLINER TANDEM SUSPENSION

2. To remove the forward spring bracket, remove the radius rod pin cap capscrews, caps, and radius rod pin dowel.

3. Remove the bolts, hardened washers, and locknuts (or flanged bolts and flanged locknuts) that attach the forward or rear spring bracket to the frame rail; then remove the bracket.

NOTE: On 1/4 inch steel rails, remove the backing plate from the inside of the frame rail.

4. Apply Alumilastic compound, or an equivalent, to all areas of the new forward or rear spring bracket that contact metal other than aluminum. This includes all bolts, washers, and nuts that contact aluminum parts.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metal components contact each other, will result in electrolytic corrosion, which could cause suspension system damage.

5. Position the new forward or rear spring bracket on the frame rail; then attach it with flanged bolts and flanged locknuts. Tighten the locknuts to 90 ft-lbs (122 N·m).

NOTE: On 1/4 inch steel rails, include installation of the backing plate on the inside of the frame rail.

IMPORTANT: Forward spring brackets and rear spring brackets should be attached to the frame rails with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts and SAE Grade C prevailing torque locknuts.

CAUTION: The fasteners that attach the forward and rear spring brackets to the frame rails should be retorqued every three months, until the parts become seated and the fasteners retain their torque setting. Continued use with insufficiently tightened fasteners could result in bracket and frame damage.

6. To install the forward spring bracket, install the radius rod pin dowel in the forward end radius rod pin; then locate the radius rod pin so the dowel will engage properly with the radius rod pin cap. Hold the radius rod in place; then install the radius rod pin caps with Grade 8 capscrews and hardened washers. Tighten the capscrews to 82 ft-lbs (111 N·m).

7. Remove the jack stands, then lower the vehicle chassis. Remove the chock blocks from the front tires.

8. Check the axle alignment, using the procedure given in the 11 Group of this manual.

REAR AXLE ALIGNMENT

Rear axle alignment should always be checked during vehicle in-servicing. It should also be checked whenever excessive rear tire wear occurs, when hard or erratic steering is experienced, and when rear axle or suspension components are replaced. Refer to the 11 Group of this manual for the axle alignment checking procedure.

Forward Rear Axle

If checking of the rear axle alignment indicates a need for adjustment of the forward rear axle, proceed as follows:

1. With the axle alignment fixture in position (Fig. 8), determine the exact difference between the measurements at each end of the fixture. Measure on both sides of the vehicle to confirm the measurements. This difference in measurements is the approximate amount that the leading end of the axle will have to be moved rearward to make it perpendicular to the frame. Alignment adjustment must be made on the leading end of the axle. See Fig. 9.

2. On the forward axle, loosen the axle U-bolts enough to allow the springs to shift on the axle pads.

FREIGHTLINER TANDEM SUSPENSION

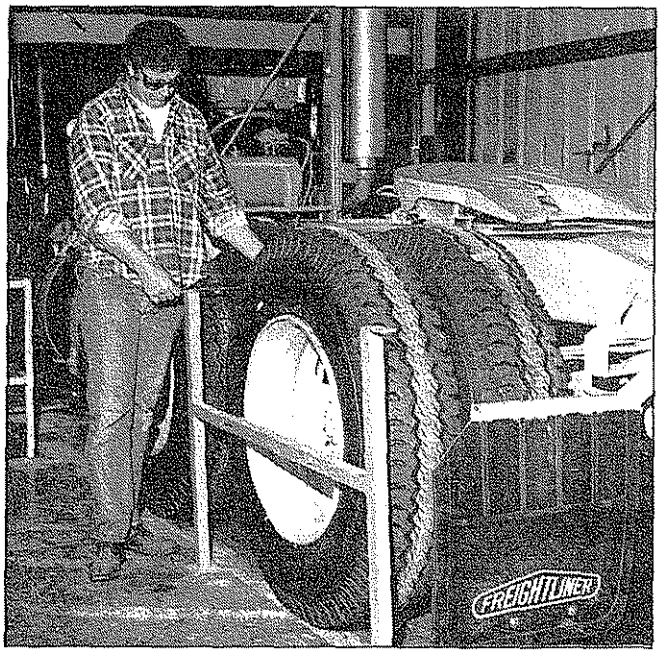


Fig. 8, Axle Alignment Fixture In Position

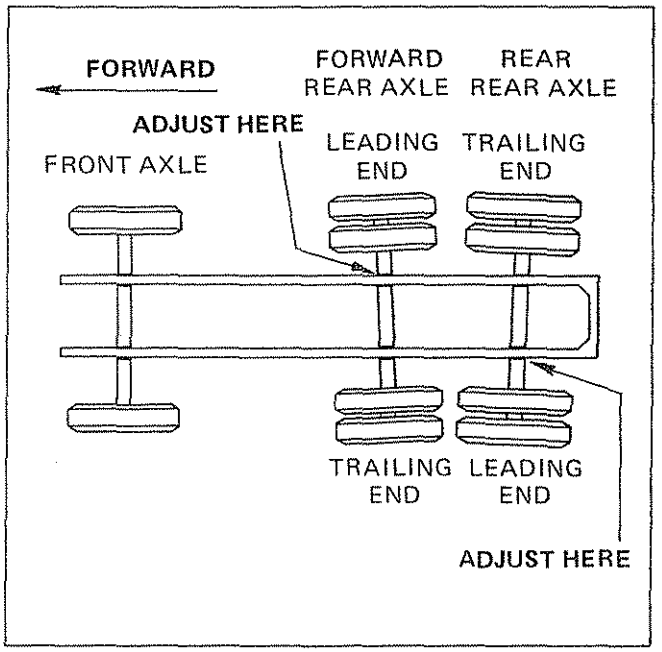


Fig. 9, Tandem Axles, Out Of Alignment

3. On the side of the vehicle which has the leading axle end, remove the bolts, locknuts, and hardened washers (or flanged bolts and flanged locknuts) that attach the radius rod assembly to the forward radius rod bracket. Remove the axle alignment shims (or washers), if so equipped.

4. Block the front tires with chock blocks, then raise the vehicle frame just enough to relieve the weight from the springs. Safety block the vehicle frame with jack stands.

5. Move the leading end of the axle rearward by rolling the wheels (on that end) away from the cab. Roll them rearward just enough to provide space to allow insertion of axle alignment washers between the radius rod pin and the radius rod bracket.

6. On one end of the radius rod pin, insert the correct thickness of axle alignment washers that are needed to bring the leading axle end into alignment.

IMPORTANT: Any axle alignment shims that were removed when the forward radius rod assembly was detached from the radius rod bracket should be replaced with an equal thickness of axle alignment washers. To this thickness of washers, add an additional thickness of washers equal to the measured difference at the ends of the axle alignment fixture.

As an example: if the leading end of the forward rear axle was equipped with a 3/16" (4.5 mm) thickness of shims, and the difference in measurements at the ends of the alignment fixture was 1/4" (6 mm), discard the shims and add 3/16" (4.5 mm) of washers, plus an additional 1/4" (6 mm) of washers to correct the axle alignment.

Install a flanged bolt through the radius rod pin and radius rod bracket; then install a flanged locknut. Position an equal thickness of axle alignment washers on the other end of the radius rod pin; then install the flanged bolt and flanged locknut at that end.

FREIGHTLINER TANDEM SUSPENSION

IMPORTANT: The radius rods should be attached to the radius rod brackets with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts and SAE Grade C prevailing torque locknuts.

7. Tighten the locknuts to 185 ft-lbs (251 N·m).

8. Remove the jack stands, then lower the vehicle frame. Remove the chock blocks from the front tires, then check the axle alignment with the axle alignment fixture. If the alignment is within the specifications, tighten the axle U-bolt nuts to 250 ft-lbs (339 N·m) for 3/4-16 U-bolts, or 400 ft-lbs (542 N·m) for 7/8-14 U-bolts.

   If not in alignment, repeat the alignment procedure above, until the axle is aligned in accordance with the specifications.

IMPORTANT: U-bolt nuts should be retorqued after the first 500 to 1000 miles (800 to 1600 km) of operation, and thereafter, every three months. Torque the U-bolt nuts with the vehicle loaded. Under severe operating conditions, the U-bolt nuts should be retorqued weekly.

CAUTION: Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

Rear Rear Axle

If checking of the axle alignment indicates a need for adjustment of the rear rear axle (the forward rear axle must be in correct alignment before checking the rear rear axle), proceed as follows:

1. Using the center point bar (Fig. 10), determine the exact difference between the axles' center-to-center measurements on each side of the vehicle. This difference in measurements is the approximate amount that the leading end of the rear rear axle will have to be adjusted rearward to make it perpendicular to the frame, and parallel to the forward rear axle. Alignment adjustment must be made on the leading end of the axle.

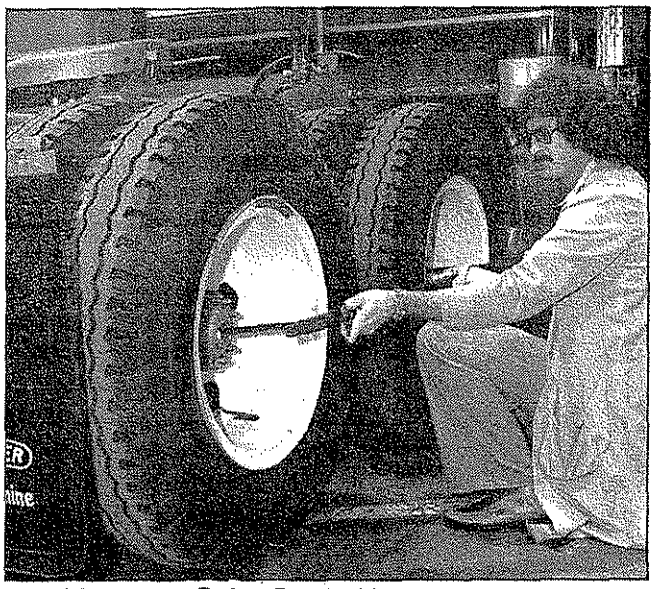


Fig. 10, Center Point Bar In Use

2. On the rear rear axle, loosen the axle U-bolts enough to allow the springs to shift on the axle pads.

3. On the side of the vehicle which has the leading axle end, remove the bolts, locknuts, and hardened washers (or flanged bolts and flanged locknuts) that attach the rear radius rod assembly to the radius rod bracket. Remove the axle alignment shims (or washers), if so equipped.

4. Block the front tires with chock blocks, then raise the vehicle frame just enough to relieve the weight from the springs. Safety block the frame with jack stands.

5. Move the leading end of the axle rearward by rolling the wheels (on that end) away from the cab. Roll them rearward just enough to provide space to allow installation of axle alignment washers between the radius rod pin and the radius rod bracket.

FREIGHTLINER TANDEM SUSPENSION

6. On one end of the radius rod pin, insert the correct thickness of axle alignment washers that are needed to bring the leading axle end into alignment.

IMPORTANT: Any axle alignment shims that were removed when the rear radius rod assembly was detached from the radius rod bracket should be replaced with an equal thickness of axle alignment washers. To this thickness of washers, add an additional thickness of washers needed to equal the difference in center point bar measurements.

As an example: If the leading end of the rear rear axle was equipped with a 3/16" (4.5 mm) thickness of shims, and the difference in center point bar measurements is 1/4" (6 mm), discard the shims and add 3/16" (4.5 mm) of washers, plus an additional 1/4" (6 mm) of washers to correct the axle alignment.

Install a flanged bolt through the radius rod pin and radius rod bracket; then install a flanged locknut.

Position an equal thickness of axle alignment washers on the other end of the radius rod pin; then install the flanged bolt and flanged locknut at that end.

IMPORTANT: The radius rods should be attached to the radius rod brackets with SAE Grade 8 flanged bolts and SAE Grade G prevailing torque flanged locknuts. An acceptable alternative is to use hardened flatwashers under both SAE Grade 8 bolts and SAE Grade C prevailing torque locknuts.

7. Tighten the locknuts to 185 ft-lbs (251 N·m).

8. Remove the jack stands, then lower the vehicle frame. Remove the chock blocks from the front tires, then check the axle alignment using the center point bar. If the axle alignment is within the specifications, tighten the axle U-bolt nuts to 250 ft-lbs (339 N·m) for 3/4-16 U-bolts, or 400 ft-lbs (542 N·m) for 7/8-14 U-bolts.

If not in alignment, repeat the alignment procedure above, until the axle is aligned in accordance with the specifications.

IMPORTANT: U-bolt nuts should be retorqued after the first 500-1000 miles (800-1600 km) of operation, and thereafter, every three months. Torque the U-bolt nuts with the vehicle loaded. Under severe operating conditions, the U-bolt nuts should be retorqued weekly.

CAUTION: Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

FREIGHTLINER TANDEM SUSPENSION

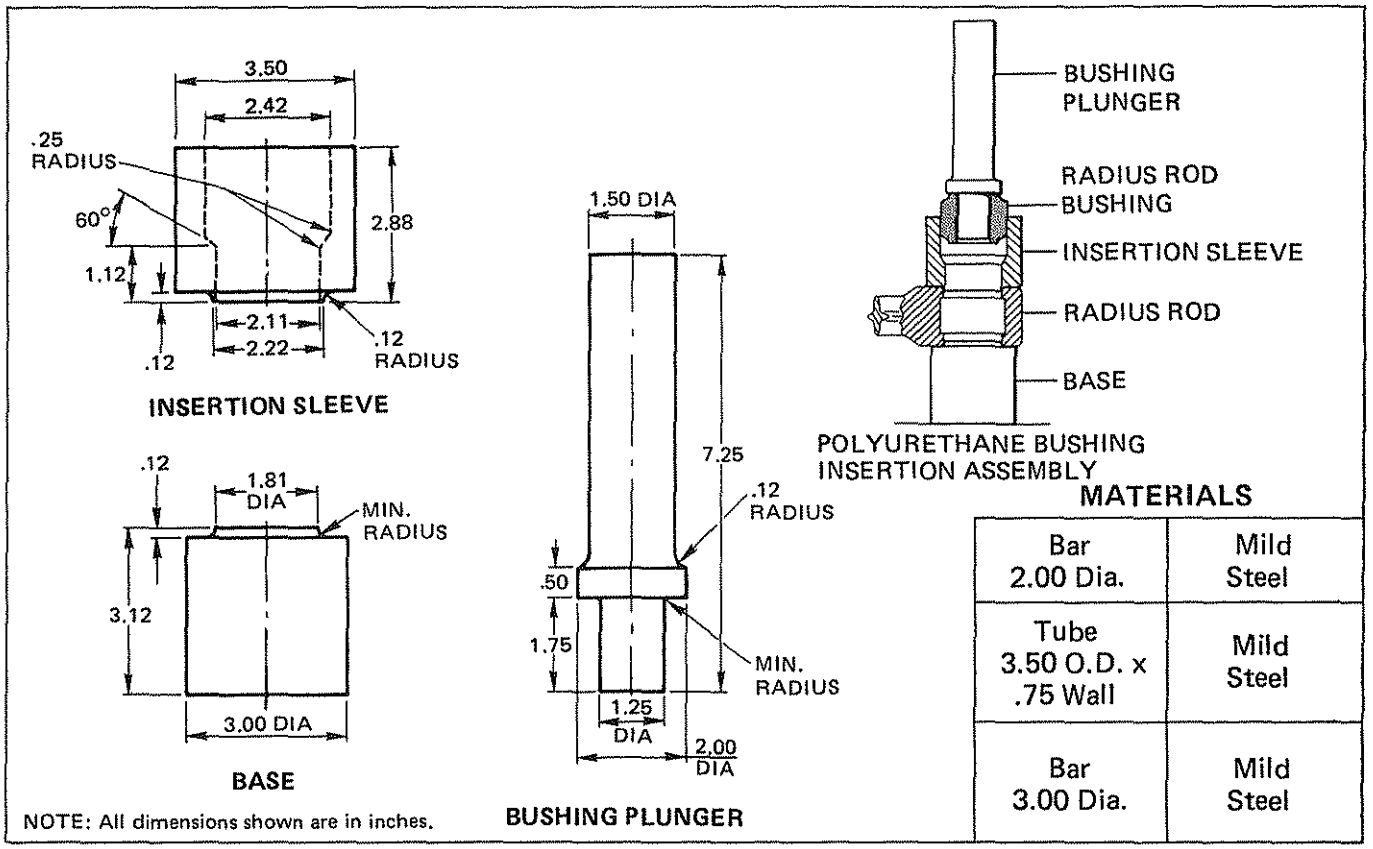
SPECIFICATIONS

DESCRIPTION	SIZE	GRADE	TORQUE	
			FT-LBS	N·m
Radius Rod Pin Cap Capscrews	1/2-13	8	82	111
Radius Rod Pin-to-Radius Rod Bracket Locknuts	5/8-18	C	185	251
Upper Equalizer Bracket-to-Frame Locknuts	1/2-20	C	90	122
Equalizer Outboard Support To Frame Locknuts	1/2-20	C	90	122
Equalizer Clampnut Pinch Bolt	3/8-14	5	27	37
U-bolt Nuts	3/4-16 7/8-14	SPECIAL PART	250 400	339 542
Lower Equalizer Bracket-to-Upper Equalizer Bracket Step 1 Final	5/8-18	C	 40-50 185	 54-68 251
Lower Equalizer Bracket-to-Frame Rail Locknut Step 1 Final	1/2-20	C	 40-50 90	 54-68 122
Spring Bracket-to-Frame Locknuts	1/2-20	C	90	122

Table 1, Torque Specifications

FREIGHTLINER TANDEM SUSPENSION

SPECIFICATIONS (Continued)



MATERIALS

Bar 2.00 Dia.	Mild Steel
Tube 3.50 O.D. x .75 Wall	Mild Steel
Bar 3.00 Dia.	Mild Steel

Fig. 11, Bushing Installation And Removal Tool Kit

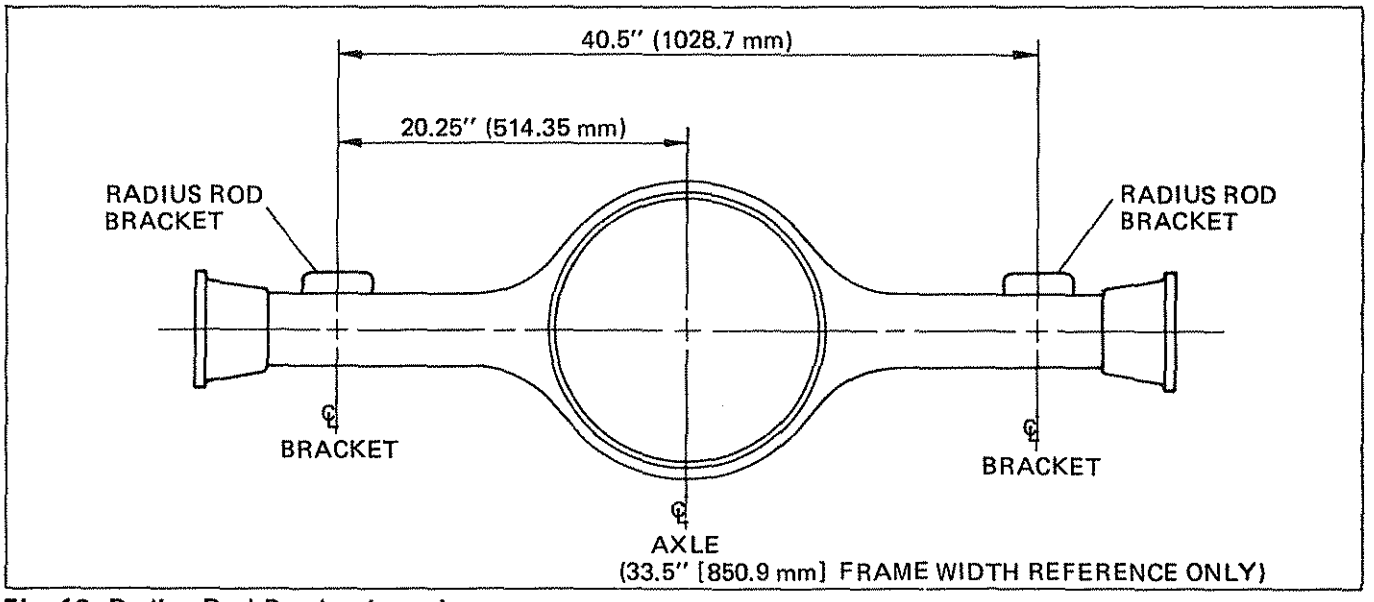
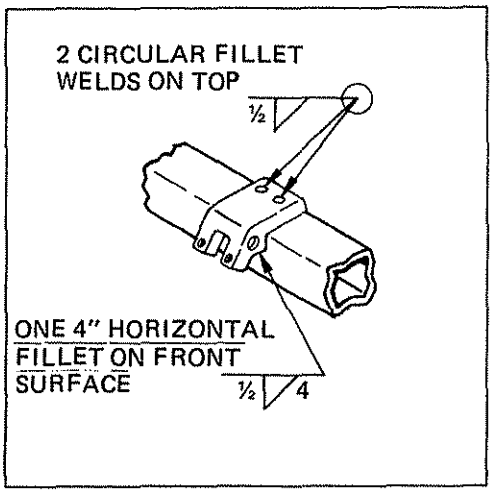


Fig. 12, Radius Rod Bracket Location

FREIGHTLINER TANDEM SUSPENSION

SPECIFICATIONS (Continued)



FORWARD REAR AND REAR REAR
AXLE RECTANGULAR AXLE HOUSING

NOTE: Make all weldments with low hydrogen electrodes meeting A.W.S. (American Welding Society) Specification E-7016, or E-7018. All welds to be full width of brackets longitudinally.

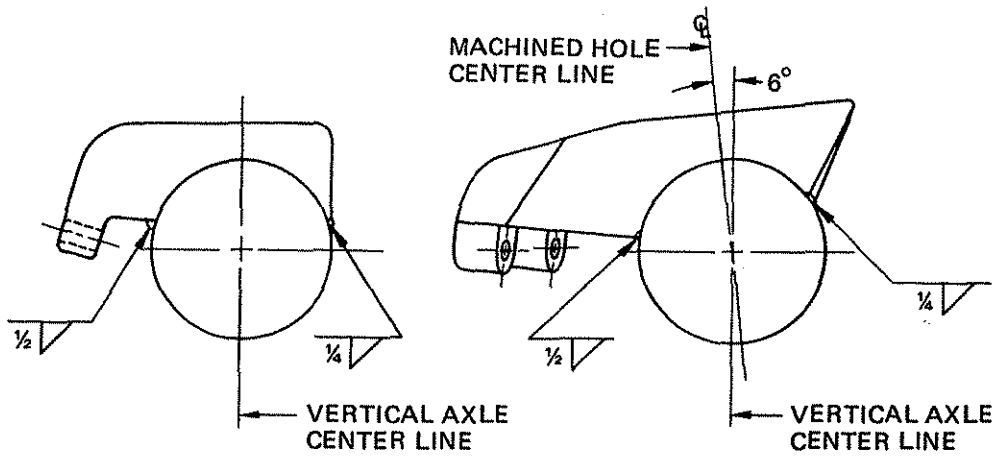
CAUTION:

Do not weld cross-wise (fore and aft) of the axle housing.

Do not ring the housing with a circumferential weld, nor make any straight weld in a vertical direction.

Do not weld on or near the corners of square (or rectangular) housings.

Any of the above practices could result in axle housing damage.



ROUND AXLE HOUSING

Fig. 13, Radius Rod Bracket Welding

FREIGHTLINER TANDEM SUSPENSION, TYPE A

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FREIGHTLINER TANDEM SUSPENSION, TYPE A

GENERAL DESCRIPTION

The Freightliner Type A tandem suspension (Fig. 1) uses a six-point true-equalizing leaf spring design. Four semi-elliptical springs are attached to the axles with U-bolt assemblies. The spring ends ride in aluminum brackets with steel bearing surfaces cast into each bracket. At the center, the springs ride on an equalizer which pivots on a steel pin in the equalizer bracket. Equalizer overtravel stop occurs when the top of the equalizer and the equalizer bracket make contact. Each axle is held in alignment by a pair of radius rods that extend forward from the axles to the frame-mounted forward spring bracket and equalizer bracket. Cushioned axle stops are mounted on the radius rod brackets.

SERVICE OPERATIONS

GENERAL GUIDELINES AND PRECAUTIONS

1. Attach spring brackets and radius rod assemblies to the frame using SAE grade 8 bolts with phosphate and oil coated threads, and grade C prevailing torque locknuts that are cadmium-plated and wax-coated. Install flatwashers with a hardness rating of 38 to 45 HRC under both the bolt and the nut. An acceptable alternative is to use SAE grade 8.2 flanged hexbolts and grade G prevailing torque flanged locknuts.

CAUTION: Failure to periodically tighten the suspension fasteners can result in abnormal tire wear and damage to the springs, spring brackets, and the frame rail.

2. All suspension fasteners require periodic torquing. For suspension component inspecting, lubricating, and fastener torque checking intervals and instructions, refer to the maintenance schedule and Group 16 of the *COE & 120 Conventional Maintenance Manual.*

CAUTION: Failure to apply Alumilastic® compound, or equivalent, to areas where aluminum and steel parts contact each other, could lead to corrosion of the metals, resulting in damage to the suspension and frame.

3. At all points where aluminum parts are fastened to steel parts, use Alumilastic compound, or equivalent on the mating surfaces. This includes nuts, bolts, and washers.

RADIUS ROD ASSEMBLY REMOVAL, DISASSEMBLY, CLEANING AND INSPECTION, ASSEMBLY, AND INSTALLATION

Removal (Refer to Fig. 1)

1. Apply the parking brakes, and chock the tires.
2. Note the number of axle alignment washers (Ref. 8) or shims, if equipped, at the forward end of each radius rod.
3. Remove the fasteners that attach the radius rod assembly to the forward spring bracket or equalizer bracket, and to the radius rod bracket.
4. Remove the radius rod assembly and any axle alignment washers. If equipped with compression nut locks, remove and discard the compression nut locks.

NOTE: If the left side of the radius rod is not marked with the notation "10°" cast in at the forward end (Fig. 2, Ref. A), using pen or paint, mark the left side of the forward end of the radius rod for later reference.

Disassembly (Refer to Fig. 2)

NOTE: At the forward end of the radius rod, if equipped with a compression nut of the style shown in Fig. 3, Ref. A, the nut and radius rod pin surfaces may not be aligned, due to an interference fit between the radius rod and the forward spring bracket or equalizer bracket. Before disassembly, note the position of the compression nut on the radius rod pin for later reference.

1. Place the radius rod assembly in a vise, clamping it firmly in the center, so that the bushings and radius rod pins can be removed from it.

WARNING: To avoid personal injury from burns, do not touch any heated metal parts, nor make any contact with dissolved material from the urethane bushings.

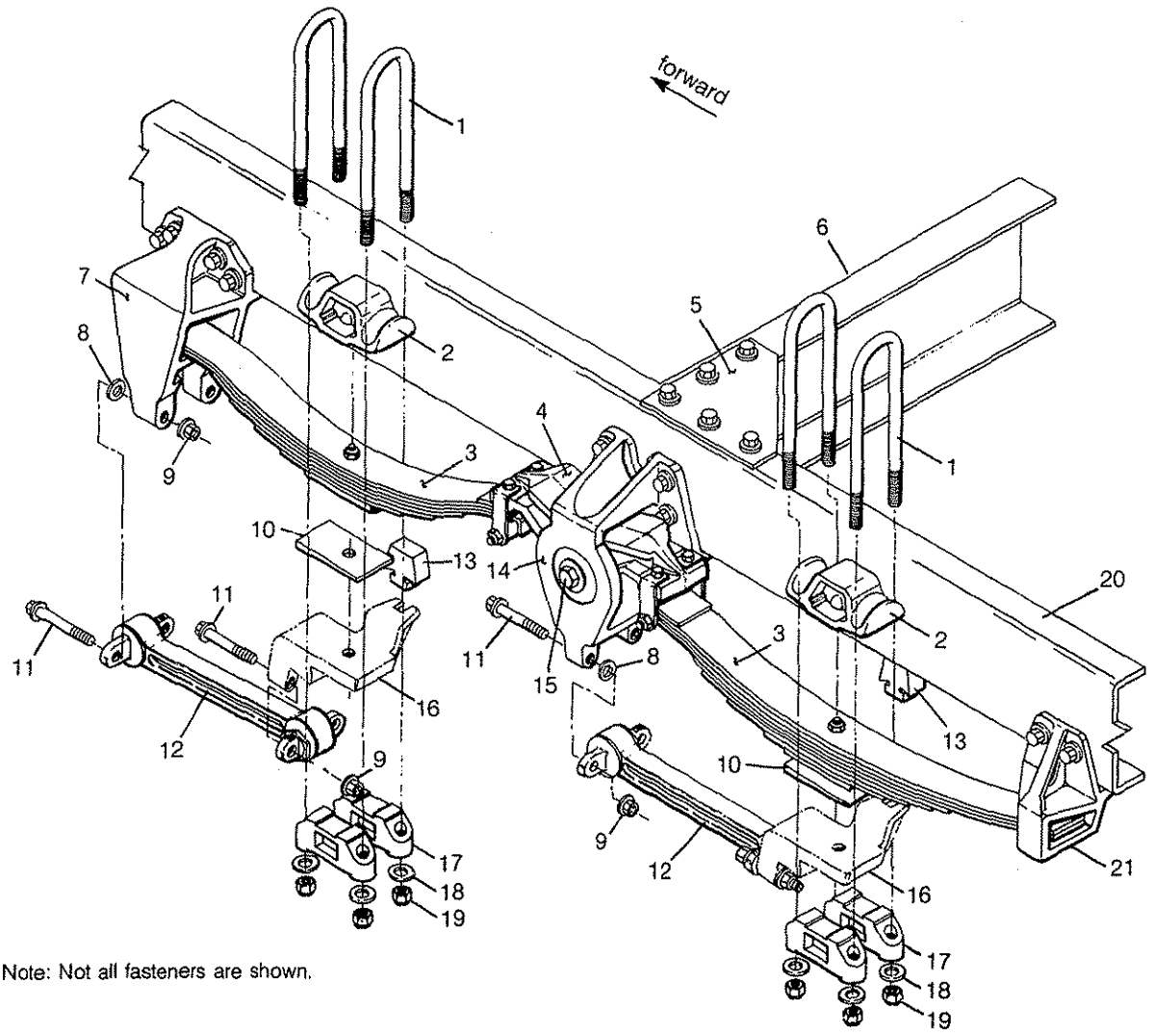
2. Remove the compression nuts and compression washers from the pins. If the compression nut is secured with adhesive, place a long-handled box wrench over the nut. Using a butane torch, heat the adhesive while turning the wrench. Concentrate the heat on the bond line, all the way around the threads of the compression nut. Do not overheat the components. Once the nut begins to turn, stop applying heat.
3. Press out the pins from the radius rod eyes. If necessary, drive out the pins with a hammer.
4. Remove and discard the radius rod bushings.

Cleaning and Inspection

1. Clean all of the radius rod components with clean solvent, and allow them to air-dry for ten minutes.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire

FREIGHTLINER TANDEM SUSPENSION, TYPE A

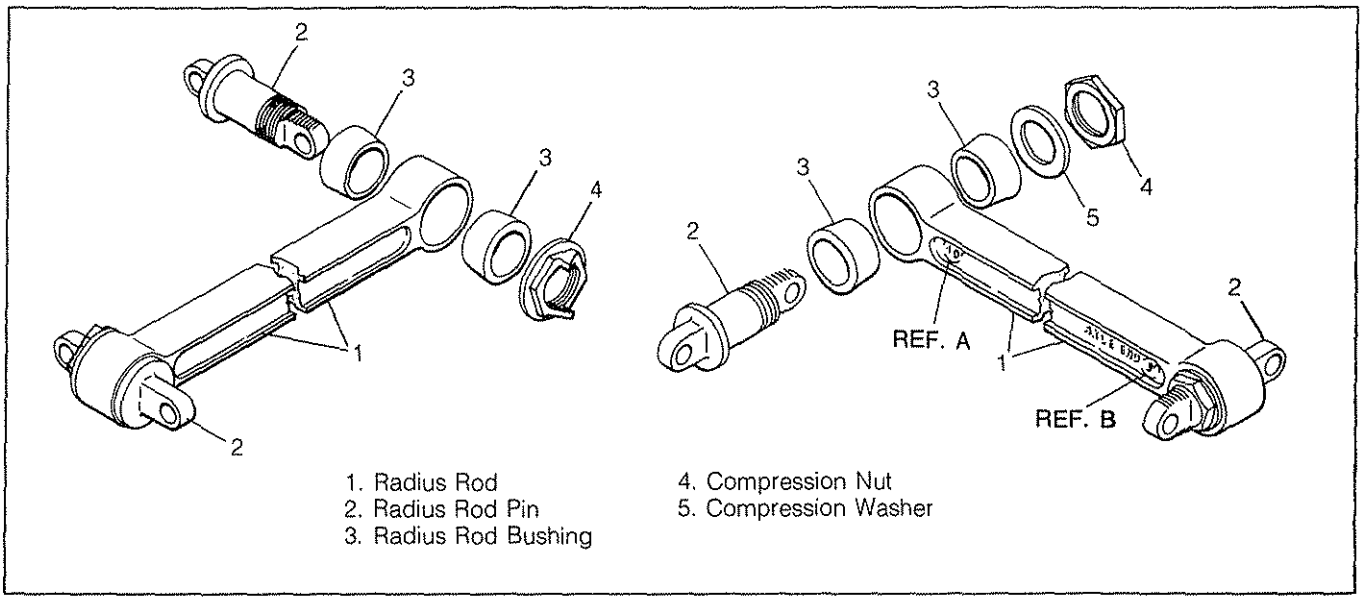


Note: Not all fasteners are shown.

1. U-Bolts
2. U-Bolt Retainer
3. Spring Assembly
4. Equalizer
5. Upper Gusset
6. Crossmember
7. Forward Spring Bracket
8. Axle Alignment Washer
9. Radius Rod Flanged Nut
10. Planing Shim
11. Radius Rod Flanged Bolt
12. Radius Rod Assembly
13. Axle Stop
14. Equalizer Bracket
15. Equalizer Cap and Tube Assembly
16. Radius Rod Bracket
17. Axle Pads
18. Hardened Washers
19. U-Bolt Nuts
20. Frame Rail
21. Rear Spring Bracket

Fig. 1, Freightliner Tandem Suspension, Type A

FREIGHTLINER TANDEM SUSPENSION, TYPE A



1. Radius Rod
2. Radius Rod Pin
3. Radius Rod Bushing
4. Compression Nut
5. Compression Washer

Fig. 2, Radius Rod Assembly

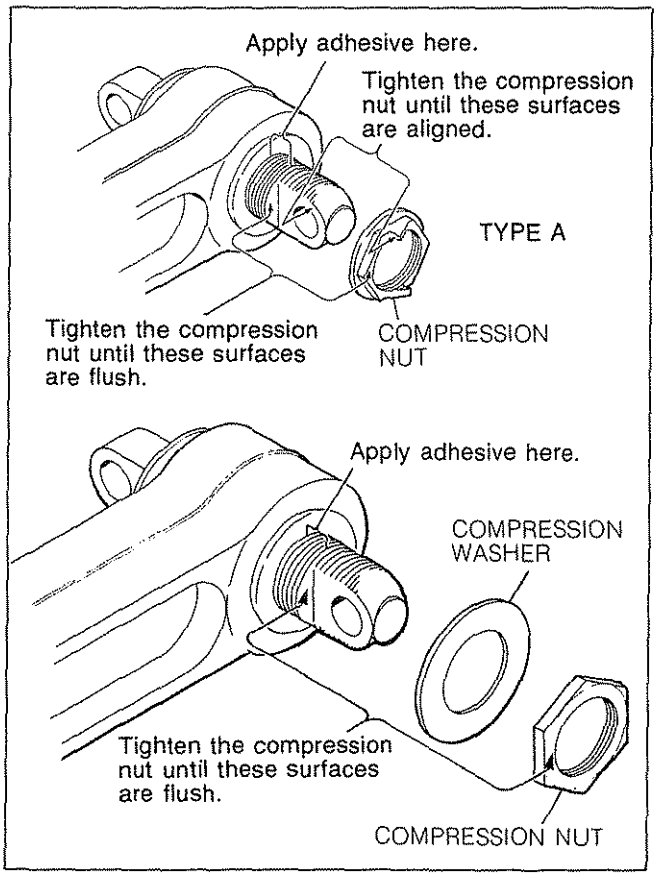


Fig. 3, Tightening of the Compression Nuts

hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

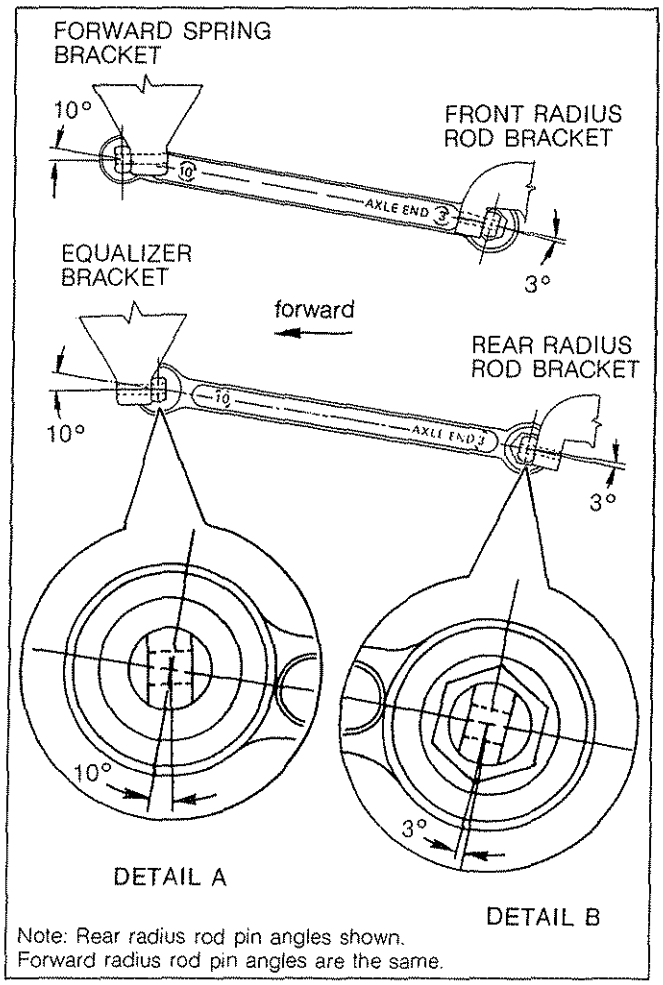
2. Using a stiff bristled brush, clean the threads of the compression nuts and radius rod pins. Replace any parts that have damaged threads.
3. Inspect the radius rod components for wear, cracks, galling, corrosion, or other damage. If any of these conditions are present, replace the component(s).

Assembly (Refer to Fig. 2)

1. Place the unthreaded end of the radius rod pin in a vise, clamping it firmly in a vertical position.
2. Place a new bushing, with the large end down, on the pin. Place the forward eye of the radius rod (the end with "10°" cast into the left side of the rod [Ref. A]), or as previously marked) on the pin, with the left (marked) side of the rod facing down.
3. Place the other new bushing, with the small end down, on the pin. Manually force the bushings into the radius rod eye.
4. Rotate the radius rod 10 degrees counterclockwise. See Fig. 4, Detail A.
5. Place a small amount of Loctite® 277, or an equivalent adhesive, in a small dish or paper cup.

   Using a nonmetallic brush, apply adhesive to the three or four pin threads that will be covered by

FREIGHTLINER TANDEM SUSPENSION, TYPE A



Note: Rear radius rod pin angles shown. Forward radius rod pin angles are the same.

Fig. 4, Radius Rod Pin Positioning

the compression nut after it is tightened. See **Fig. 3**. Do not apply adhesive to the end of the pin. Apply enough adhesive to fill the compression nut threads, with a slight excess.

IMPORTANT: Do not use a metallic brush to apply the adhesive, as it will contaminate the adhesive.

6. Install the washer, if equipped, and start the compression nut on the pin. Without disturbing the angle of the pin, tighten the nut until its flat outside surface is flush with the flat shoulder of the pin. See **Fig. 3**.

   If the compression nut is type A, as shown in **Fig. 3**, the two locking ears must be parallel to the flat surfaces of the pin end; if not, back off the nut until they are parallel. If the pin and nut are not aligned due to an interference fit between the radius rod and forward sping bracket or equalizer bracket, install the nut as previously noted.

IMPORTANT: After the compression nut has been tightened, the adhesive will cure in less than two minutes. It is not possible to adjust the nut position after the adhesive has cured.

7. Remove the forward end of the radius rod from the vise. Place the unthreaded end of the other pin in the vise, clamping it firmly in a vertical position.

8. Place a new bushing, with the large end down, on the pin. Place the other eye of the radius rod on the pin, with the left (marked) side of the rod facing up. The threaded ends of the pins should be on opposite sides of the radius rod.

9. Place the other new bushing, with the small end down, on the pin. Manually force the bushings into the radius rod eye.

10. Rotate the radius rod 3 degrees clockwise. See **Fig. 4**, Detail B. Then, repeat steps 5 and 6 to install the compression nut.

11. Remove the radius rod from the vise.

Installation

Forward Radius Rods

1. Place the radius rod pins on the front side of the forward spring bracket, and on the rear side of the front radius rod bracket. See **Fig. 4**.

IMPORTANT: Be sure the pins are rotated to the dimensions in **Fig. 4**. The forward compression nut should be on the right side of the radius rod forward eye, and the axle end compression nut on the left side of the radius rod rear eye. See **Fig. 5**.

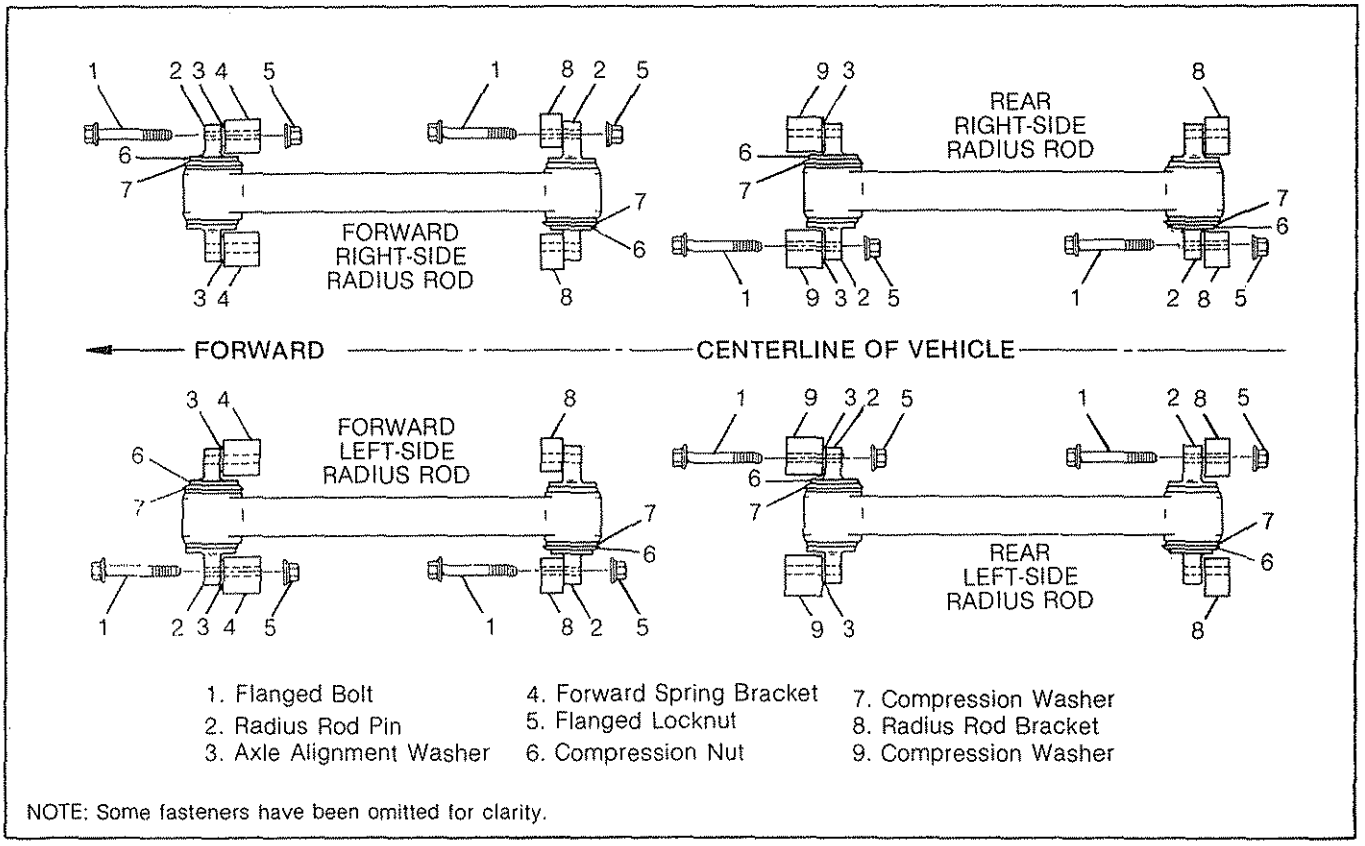
2. Install the bolts and locknuts in the radius rod bracket and pins.

3. Install any previously removed axle alignment washers between the forward radius rod pins and forward spring brackets. See **Fig. 5**. Install the bolts and locknuts in the forward radius rod pins and spring brackets.

IMPORTANT: When removing the radius rod, make sure to replace any axle shims with an equal thickness of axle alignment washers. Install an equal thickness of these washers on both ends of the forward radius rod pins.

4. Tighten the radius rod locknuts to the torque value in **Table 1**, under "Specifications."

FREIGHTLINER TANDEM SUSPENSION, TYPE A



NOTE: Some fasteners have been omitted for clarity.

Fig. 5, Radius Rod and Compression Nut Positions

5. Install the rear radius rod assemblies, following the instructions below. If only the front radius rods were serviced, check the axle alignment. For instructions, refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

Rear Radius Rods

1. Place the radius rod pins on the rear side of the equalizer bracket, and on the front side of the rear radius rod brackets. See Fig. 4.

IMPORTANT: Be sure the pins are rotated to the dimensions in Fig. 4. The forward compression nut should be on the right side of the radius rod forward eye, and the axle end compression nut on the left side of the radius rod rear eye. See Fig. 5.

2. Install the bolts and locknuts in the radius rod bracket and pins.

3. Install any previously removed axle alignment washers between the forward radius rod pins and equalizer brackets. See Fig. 5. Install the bolts and locknuts in the forward radius rod pins and equalizer brackets.

IMPORTANT: Any axle alignment shims that were removed during radius rod removal should be replaced with an equal thickness of axle alignment washers. An equal thickness of washers should be installed on both ends of the forward radius rod pins.

4. Tighten the radius rod locknuts to the applicable torque value in Table 1, under "SPECIFICATIONS."

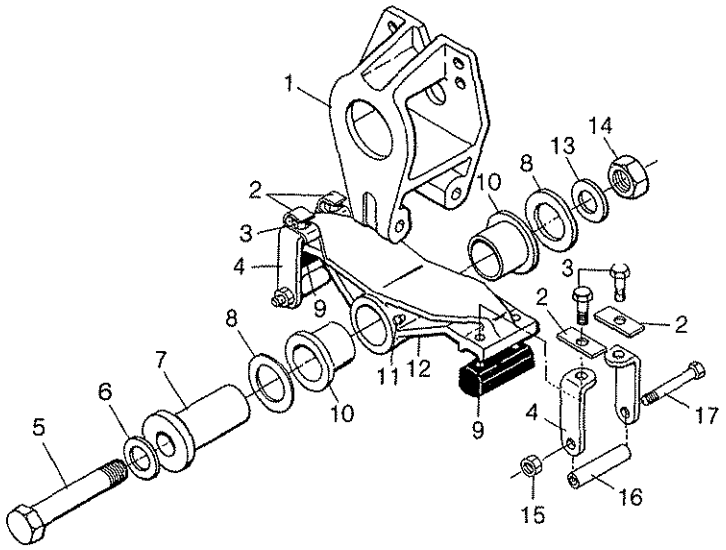
5. Check the axle alignment. For instructions refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

EQUALIZER REMOVAL, INSPECTION, AND INSTALLATION

Removal (Refer to Fig. 6)

1. Chock the front tires.

FREIGHTLINER TANDEM SUSPENSION, TYPE A



1. Equalizer Bracket
2. Locktab
3. Equalizer Wear Shoe Capscrews
4. Spring Side Restraints
5. Cap and Tube Assembly Bolt
6. Outboard Flatwasher
7. Cap and Tube Assembly
8. Bushing Washer
9. Equalizer Wear Shoe
10. Equalizer Bushing
11. Grease Fitting
12. Equalizer
13. Inboard Hardened Washer
14. Cap and Tube Assembly Locknut
15. Spacer Tube Self-Locking Nut
16. Spacer Tube
17. Spacer Tube Bolt

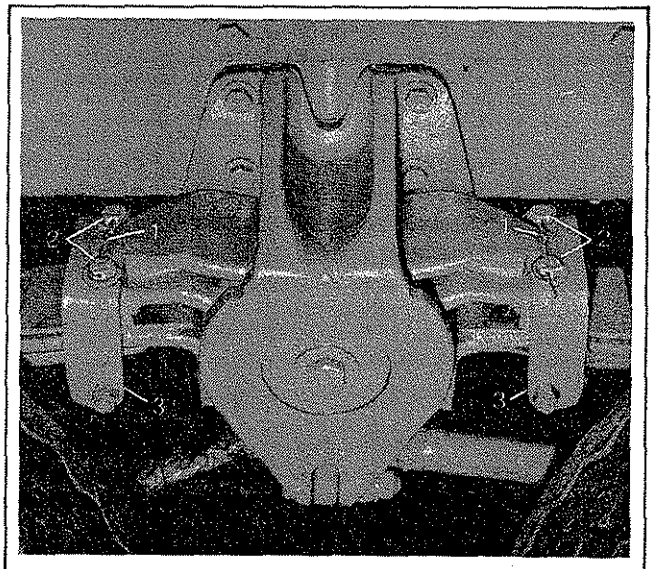
Fig. 6, Equalizer Assembly

2. Raise the vehicle, and block the axles with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then block the frame with safety stands. Make sure the stands will securely support the weight of the axles and frame. Remove the wheel assembly, if necessary, to gain access to the equalizer.
3. On each end of the equalizer, remove the self-locking nuts from the spacer tube bolts. Remove the spacer tube bolts and spacer tubes.
4. Bend down the equalizer wear shoe capscrew locktabs, and remove the capscrews, locktabs, equalizer wear shoes, and spring side restraints.

NOTE: On some installations, remove the lockwire (used between the equalizer wear shoe capscrews to lock them in place), equalizer wear shoe capscrews, washers, and the one-piece side restraint. See Fig. 7.

5. Remove the equalizer cap and tube assembly locknut, inboard hardened washer, bolt, and outboard flatwasher.

NOTE: If equipped with a castellated nut and cotter pin on the equalizer cap and tube assembly bolt, remove the cotter pin and nut.



1. Lockwire
2. Capscrew and Washer
3. One-Piece Spring Side-Restraint

Fig. 7, Equalizer with Lockwired Wear Shoe Capscrews

FREIGHTLINER TANDEM SUSPENSION, TYPE A

If equipped with a high nut and locktab on the equalizer cap and tube assembly bolt, remove the locktab and high nut.

6. Insert a bar between the bottom of the equalizer and the equalizer bracket. Gently lever the weight of the equalizer off the equalizer cap and tube assembly. Insert a piece of barstock through the inboard equalizer cap and tube assembly bolt hole, and lightly tap the equalizer cap and tube assembly out of the equalizer.
7. Remove the equalizer from the equalizer bracket. Remove the bushing washers and equalizer bushings from the equalizer.

Inspection

1. Thoroughly clean the equalizer with steam or a hot soap solution. Inspect it for wear, cracks, or other damage. Replace the equalizer if any of these conditions are present.

CAUTION: Failure to replace the equalizer if it is cracked or otherwise damaged could result in progressive damage to, and eventual breakage of the equalizer.

2. Inspect the equalizer bushings for wear, cracks, or other damage. Replace the bushings if any of these conditions exist.

Installation (Refer to Fig. 6)

1. Apply multipurpose chassis grease to the inside of the equalizer bushings, then install the bushings in the equalizer.
2. Install the equalizer in the equalizer bracket.
3. Apply multipurpose chassis grease on the equalizer cap and tube assembly. Place the bushing washer on the equalizer cap and tube assembly, and start the equalizer cap and tube assembly (with the bushing washer) in the equalizer, through the equalizer bracket.
4. Push the equalizer cap and tube assembly part way through the equalizer, then place the inboard bushing washer on the equalizer cap and tube assembly. Push the cap and tube assembly the rest of the way in the equalizer bracket.
5. Place the outboard flatwasher on the equalizer cap and tube assembly bolt, and install the bolt in the equalizer cap and tube assembly.
6. Install the inboard hardened washer and locknut on the equalizer cap and tube assembly bolt. Tighten the locknut to the torque value in Table 1, under "SPECIFICATIONS."

NOTE: If equipped with a castellated nut and cotter pin, install the castellated nut and tighten it 220 to 250 lbf·ft (298 to 339 N·m). Install a new cotter pin and lock it.

If equipped with a high nut and locktab, replace the high nut and locktab with a Grade C prevailing torque locknut and hardened washer. Tighten the locknut to the torque value in Table 1.

7. Install the spring side-restraints, equalizer wear shoe capscrew locktabs, capscrews, and equalizer wear shoes on the equalizer. Tighten the equalizer wear shoe capscrews to the torque value in Table 1. Lock the locktabs against the equalizer wear shoe capscrews and spring side restraints.

NOTE: If equipped with a lockwire and capscrew washers, replace the lockwire and washers with the locktabs.

8. Install the spacer tubes and spacer tube bolts in the spring side-restraints. Install the spacer tube self-locking nuts, and tighten the nuts to the torque value in Table 1.
9. Install the wheel assembly. Remove the safety stands from under the vehicle frame and axle, and lower the vehicle.
10. Check the axle alignment. For instructions, refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.
11. Remove the chocks from the tires.

SPRING ASSEMBLY REMOVAL AND INSTALLATION

Removal (Refer to Fig. 1)

1. Chock the front tires.
2. Raise the vehicle, and block the axles with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then block the frame with safety stands. Make sure the stands will securely support the weight of the axles and frame. Remove the wheel assembly, to gain easy access to the suspension system.
3. Remove the self-locking nuts from the spacer tube bolt on the end of the equalizer from which the spring is being removed. Remove the bolt and the spacer tube from the spring side-restraints. See Fig. 6.

FREIGHTLINER TANDEM SUSPENSION, TYPE A

4. Remove the U-bolt nuts, hardened washers, axle pads, U-bolts, and U-bolt retainer. Note the position of the tapered axle planing shim(s) (Ref. 10), for later reference.

5. Using an overhead hoist, or other lifting device, lift the spring assembly, and slide the spring assembly into the spring bracket. Raise the other end of the spring above the equalizer. Slide the spring assembly out of the spring bracket, and remove it from the vehicle.

6. Inspect the spring assembly for cracked, broken, or abnormally bent leaves. Replace the spring assembly if any of the leaves are damaged.

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

Installation (Refer to **Fig. 1**)

NOTE: The main leaf rebound lip (**Fig. 8**) is notched to clear the radius rod during extreme suspension operation. Do not install a leaf spring assembly that does not have this main leaf design.

1. Place the axle planing shim(s) on the radius rod bracket, as previously noted.

2. Place the end of the spring assembly (the end without a wear plate) in the spring bracket. Lower the spring assembly, and place the other end (the end with a rebound lip) in the equalizer bracket. Make sure the spring center bolt head seats in the shim center hole and the radius rod bracket hole.

3. Place the U-bolt retainer on the spring

4. Place the U-bolts over the spring assembly and the U-bolt retainer.

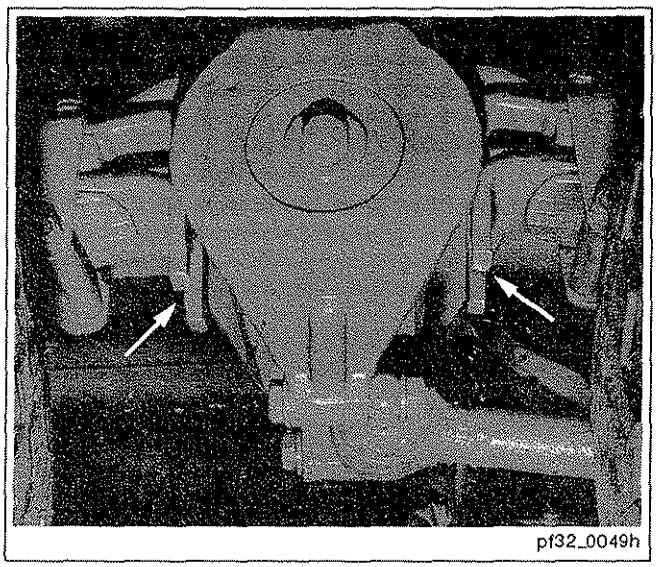


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Fig. 8, Notched Main Leaf Rebound Lip

5. Install the axle pads, U-bolt hardened washers, and the U-bolt nuts. Tighten the U-bolt nuts to the applicable torque value in **Table 1**, under "SPECIFICATIONS."

6. Install the spacer tube bolt and spacer tube in the spring side-restraints. Install the self-locking nut and tighten it to the torque value in **Table 1.**

7. Install the wheel assembly. Remove the safety stands from under the vehicle frame and axle, and lower the vehicle.

8. Check the axle alignment. For instructions, refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

9. Remove the chocks from the tires.

SPRING LEAF WEAR PLATE REPLACEMENT

1. Remove the spring assembly. For instructions, refer to "SPRING ASSEMBLY REMOVAL AND INSTALLATION: Removal."

2. Using a cutting torch, remove the weld from the main leaf wear plate. Drive a thin chisel between the main leaf and the wear plate to help separate the wear plate from the main leaf while cutting the weld with the

FREIGHTLINER TANDEM SUSPENSION, TYPE A

torch. Use care not to damage the spring leaf when cutting off the old wear plate. Be sure only the weld is removed.

3. Grind the residual weld off the main leaf. Remove all dirt, grease, and paint from the area to be welded.

WARNING: When grinding the weld off the main leaf, wear safety glasses to protect you eyes from flying debris. Failure to wear such protection could result in personal injury.

4. Place a new wear plate on the main leaf, as shown in **Fig. 9**. Clamp the wear plate to the main leaf with a C-clamp, at the area of equalizer wear shoe contact.

5. Preheat the wear plate and the leaf area to be welded, to 400° to 450°F (205° to 232°C). Use a welding heat crayon in the 400° to 450°F range to indicate when the proper heat range is reached.

6. Weld the plate to the leaf, using E7016 or E7018 low-hydrogen rod. Weld the outer edges of the plate 2-1/2 inches (64 mm) on each side (**Fig. 9**).

7. Allow the weld to air cool (do not oil- or water-quench the weld). Remove the slag, then paint the areas where the paint was removed.

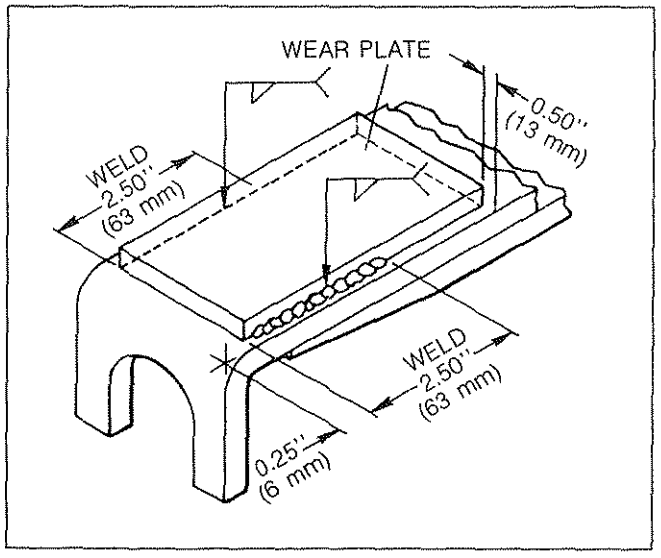


Fig. 9, Wear Plate Replacement

8. Install the spring assembly. For instructions, refer to "SPRING ASSEMBLY REMOVAL AND INSTALLATION: Installation."

SPRING BRACKET AND EQUALIZER BRACKET REPLACEMENT (Refer to **Fig. 1**)

WARNING: Failure to replace worn, cracked, or damaged spring brackets or equalizer brackets could result in breakage of the bracket, which could cause a loss of vehicle control.

1. Chock the front tires.

2. Raise the vehicle, and block the axles with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then block the frame with safety stands. Make sure the stands will securely support the weight of the axles and frame. Remove the wheel assembly, if necessary, to gain easy access to the brackets.

3. If removing the forward spring bracket, or the equalizer bracket, note the number of any axle alignment washers (Ref. 8) or shims, then remove the fasteners that attach the radius rod assembly to the forward spring bracket or equalizer bracket. Remove any axle alignment washers.

4. Remove the fasteners that attach the forward or rear spring bracket, or equalizer bracket, to the frame rail. Remove the bracket, and if equipped, the backing plate from the inside of the frame rail.

IMPORTANT: If the equalizer bracket is being removed, remove the equalizer components from the bracket, and install them in the new bracket. For instructions, refer to "EQUALIZER COMPONENT REMOVAL, INSPECTION, AND INSTALLATION."

5. Place the bracket on the frame rail, and if equipped, the backing plate on the inside of the frame rail. Align the mounting holes, and install the bracket bolts and locknuts. Tighten the locknuts to the applicable torque value in **Table 1**, under "SPECIFICATIONS."

6. If replacing the forward spring bracket, or equalizer bracket, install any previously removed axle alignment washers between the

FREIGHTLINER TANDEM SUSPENSION, TYPE A

forward radius rod pin and the forward spring bracket or equalizer bracket. See **Fig. 5**. Install the bolts and locknuts in the radius rod pins and forward spring brackets or equalizer brackets.

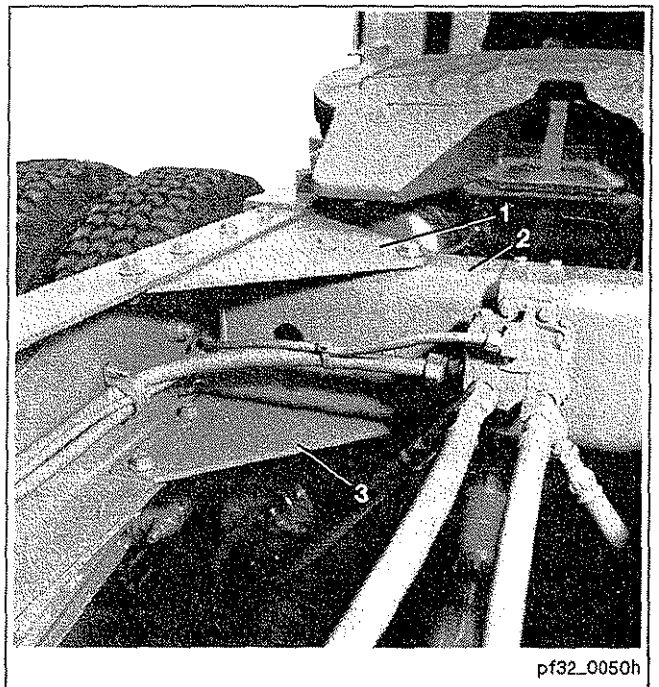
IMPORTANT: Any axle alignment shims that were removed during removal of the forward spring bracket or equalizer bracket, should be replaced with an equal thickness of axle alignment washers. An equal thickness of washers should be used on both ends of the radius rod pins.

7. Tighten the locknuts to the applicable torque value in **Table 1**.
8. Install the wheel assembly, if previously removed. Remove the safety stands from under the vehicle frame and axle, and lower the vehicle.
9. Check the axle alignment. For instructions, refer to Group 11 of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

SUSPENSION CROSSMEMBER AND GUSSET REPLACEMENT

CAUTION: Failure to replace cracked, worn, or otherwise damaged suspension crossmembers or gussets, could result in damage to the vehicle chassis.

1. Apply the parking brakes, and chock the tires. Remove any components that are attached to the crossmember (**Fig. 10**).
2. Remove the fasteners that attach the upper gussets (**Fig. 10**) to the crossmember and the frame rails. Remove both upper gussets.
3. Remove the fasteners that attach the crossmember to the lower gussets (**Fig. 10**), and remove the crossmember. Remove the fasteners that attach the lower gussets to the frame rails, then remove both lower gussets.
4. Install the bolts and locknuts that attach the upper and lower gussets to the crossmember. Place the gussets and crossmember in the frame rails, and attach them with the bolts and locknuts. Tighten the locknuts to the applicable torque value in **Table 1**, under "Specifications."



1. Upper Gusset
2. Crossmember
3. Lower Gusset

Fig. 10, Crossmember and Gussets

5. Install any previously removed components.
6. Check the axle alignment. For instructions, refer to Group 11 of this manual. If necessary, adjust the rear axle alignment using the instructions in this subject.

REAR AXLE ALIGNMENT ADJUSTMENT

Forward Rear Axle

1. With the axle alignment fixture (**Fig. 11**) in position, determine the difference between the measurements at each end of the fixture, on both sides of the vehicle. This difference in measurements is the approximate amount that the trailing end of the axle will have to be brought forward to make it perpendicular to the frame. Alignment adjustment must be made on the trailing end of the axle (**Fig. 12**).
2. On the forward rear axle, loosen the axle U-bolts enough to allow the springs to shift on the axle pads.

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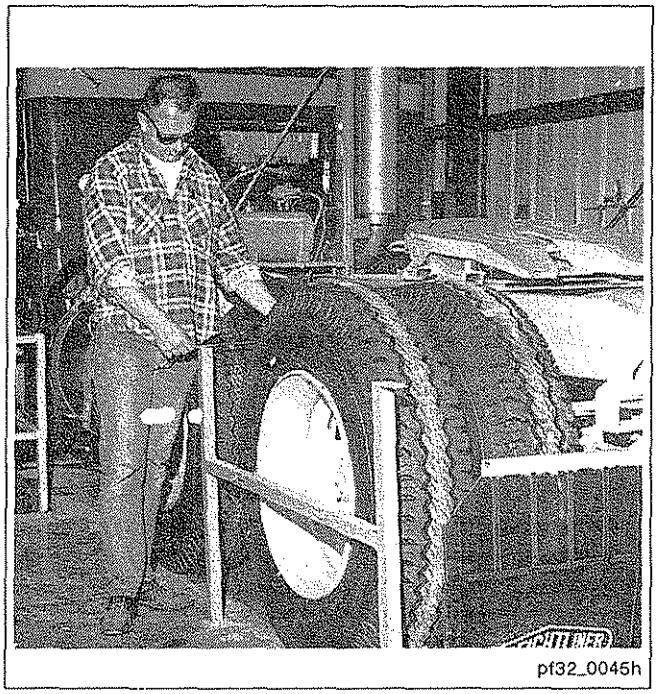

Fig. 11, Axle Alignment Fixture

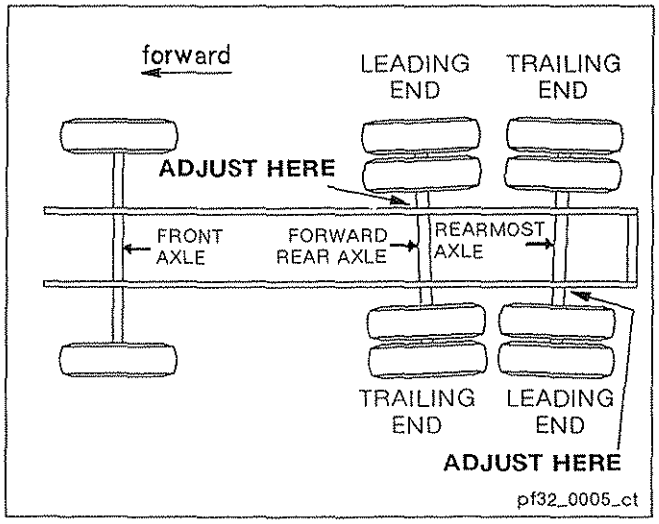

Fig. 12, Tandem Axles, Out of Alignment

3. On the side of the vehicle which has the trailing axle end, remove the fasteners that attach the radius rod assembly to the forward spring bracket. Remove any axle alignment washers.
4. Raise the vehicle frame just enough to relieve the weight from the springs. Place safety stands under the vehicle frame. Make sure the stands will securely support the weight of the frame.
5. Move the trailing end of the axle forward by rolling the wheels (on that end) toward the cab. Roll them forward just enough to provide space to allow installation of axle alignment washers between the forward spring bracket and the radius rod pins (**Fig. 5**).
6. Between the radius rod pin and the forward spring bracket, insert the correct thickness of axle alignment washers that are needed to bring the trailing axle end into alignment.

IMPORTANT: Any axle alignment shims that were removed when the forward radius rod assembly was detached from the forward spring bracket, should be replaced with an equal thickness of axle alignment washers. To this thickness of washers, add an additional thickness of washers equal to the measured difference at the ends of the axle alignment fixture.

For example, if the trailing end of the forward rear axle was equipped with a 3/16-inch (4.5 mm) thickness of shims, and the difference in measurements at the end of the alignment fixture is 1/4 inch (6 mm), discard the shims and add 3/16 inch (4.5 mm) of washers, plus an additional 1/4 inch (6 mm) of washers to correct the axle alignment.

7. Install a bolt and locknut in the radius rod pin and forward spring bracket. Place an equal thickness of axle alignment washers on the other end of the radius rod pin, and install the bolt and locknut at that end.
8. Tighten the radius rod locknuts to the applicable torque value in **Table 1**, under "Specifications."
9. Remove the safety stands, and lower the vehicle. Remove the chocks from the front tires.
10. Check the axle alignment with the axle alignment fixture. If alignment is within the specifications, tighten the axle U-bolt nuts to the applicable torque value in **Table 1**.

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If not in alignment, repeat the alignment procedure above.

Rear Rear Axle

1. Using the center point bar (**Fig. 13**), determine the difference between the axles' center-to-center measurements on each side of the vehicle. This difference in measurements is the approximate amount that the leading end of the rear axle will have to be adjusted rearward to make it perpendicular to the frame and parallel to the forward rear axle. Alignment adjustment must be made in the leading end of the axle (**Fig. 12**).

2. On the rear rear axle, loosen the axle U-bolts enough to allow the springs to shift on the axle pads.

3. On the side of the vehicle which has the leading axle end, remove the fasteners that attach the rear radius rod assembly to the equalizer bracket. Remove any axle alignment washers.

4. Raise the vehicle frame just enough to relieve the weight from the springs. Place safety stands under the vehicle frame. Make sure the stands will securely support the weight of the frame.

5. Move the leading end of the axle rearward by rolling the wheels (on that end) away from the cab. Roll them rearward just enough to provide space to allow installation of axle alignment washers between the equalizer bracket and the radius rod pin (**Fig. 5**).

6. Between the radius rod pin and the equalizer bracket, insert the correct thickness of axle alignment washers that are needed to bring the leading axle end into alignment.

IMPORTANT: To correct the axle alignment, add the thickness of washers needed to equal the difference in center point bar measurements.

For example, if the leading end of the axle was equipped with a 3/16-inch (4.5 mm) thickness of washers, and the difference in the center point bar measurements is 1/4 inch (6 mm), add an additional 1/4 inch (6 mm) of washers to the 3/16 inch (4.5 mm) of original washers, to correct the axle alignment.

7. Install the bolt and locknut in the equalizer bracket and the radius rod pin. Place an equal thickness of axle alignment washers on the other end of the radius rod pin, and install the bolt and locknut at that end.

8. Tighten the radius rod locknuts to the applicable torque value in **Table 1**, under "Specifications."

9. Remove the safety stands, and lower the vehicle. Remove the chocks from the front tires.

10. Check the axle alignment using the center point bar. If axle alignment is within the specifications, tighten the axle U-bolt nuts to the applicable torque value in **Table 1**.

    If not in alignment, repeat the procedure above.

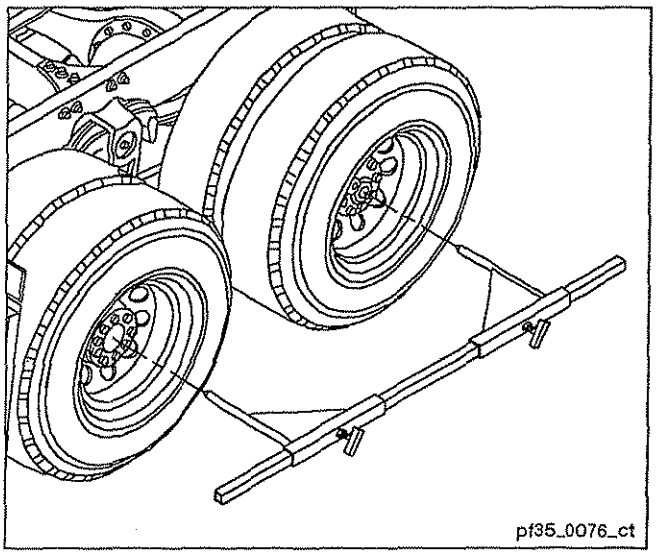

Fig. 13, Center Point Bar

FREIGHTLINER TANDEM SUSPENSION, TYPE A

SPECIFICATIONS

DESCRIPTION	SIZE	IFI GRADE*	TORQUE lbf·ft (N·m)
Spring Bracket-to-Frame Rail Flange Prevailing Torque Locknut	1/2–13†	C	70 (95)
	1/2–13	G	95 (130)
	1/2–20†	C	75 (100)
	1/2–20	C	100 (135)
Spring Bracket-to-Frame Rail Web Prevailing Torque Locknut	5/8–11†	C	125 (170)
	5/8–11	G	190 (260)
	5/8–18†	C	135 (185)
	5/8–18	C	195 (265)
	1/2–13†	C	70 (95)
	1/2–13	G	95 (130)
	1/2–20†	C	75 (100)
	1/2–20	C	100 (135)
Equalizer Bracket-to-Frame Rail Flange Prevailing Torque Locknut	1/2–13†	C	70 (95)
	1/2–13	G	95 (130)
	1/2-20	C	100 (135)
Equalizer Bracket-to-Frame Rail Web Prevailing Torque Locknut	5/8–11†	C	125 (170)
	5/8–11	G	190 (260)
	5/8–18†	C	135 (185)
	5/8–18	C	195 (265)
Crossmember and Gusset Prevailing Torque Locknut	1/2–13†	C	70 (95)
	1/2–13	G	95 (130)
	1/2–20†	C	75 (100)
	1/2–20	C	100 (135)
U-Bolt Nut	3/4–16	SPECIAL PART	250 (339)
	7/8–14		400 (542)
Radius Rod Prevailing Torque Locknut	5/8–11	G	190 (260)
	5/8–18	C	195 (265)
Equalizer Cap and Tube Assembly Prevailing Torque Locknut	3/4–16	C	340 (465)
Equalizer Wear Shoe Capscrew	1/2–20	8	100 (135)
Spacer Tube Nut	1/2–20	C	100 (135)

Table 1, Torque Values

* Hardened flatwashers must be used under both grade 8 bolts and grade C prevailing torque locknuts. Failure to use hardened washers will result in insufficient clamp load.

† Grade 8 bolts with phosphate- and oil-coated threads, and cadmium-plated, wax-coated grade C locknuts; both used with hardened washers.

FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

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FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

GENERAL INFORMATION

Freightliner Airliner® suspension systems are of the trailing arm type, journaled at the forward end to allow a controlled amount of cross-articulation. The trailing arm consists of either a 4- or 7-leaf spring assembly, secured to the axle housing by U-bolts. The springs, axle housing, and crosstube function together as an anti-sway bar. Air springs mounted near the end of each leaf spring assembly are used to adjust the vehicle height, compensating for variations in the road and vehicle loading conditions.

Two types of leveling valve installations are found on Freightliner vehicles: dual valve or single valve systems. Both systems use changes in the clearance spacing between the vehicle frame and the rear axle housing to activate the leveling valve(s). The dual valve system uses independent leveling valves (Fig. 1) to regulate the pressure in the air springs mounted on each side of the vehicle. The single valve system uses one leveling valve to regulate the pressure in all of the air springs. See Fig. 2.

An in-line automatic pressure holding valve (Fig. 3) is located prior to the leveling valve. The pressure holding valve is pre-set to maintain a minimum pressure of 65 psi (448 kPa) in the vehicle auxiliary air system, should a leak occur in the suspension system.

If a leak occurs in the air suspension system, the internal solid rubber bumpers of the air springs will support the vehicle and its load until a repair can be made. Before a vehicle with a leak in the suspension system is moved, disconnect the leveling valve linkage(s), and rotate the overtravel lever(s) to the vertical-down (exhaust) position. See Fig. 3, Ref. 3. This will bleed the air suspension until the weight of the vehicle is being carried evenly by the air spring bumpers.

CAUTION: Under no circumstances should a vehicle equipped with air suspension be driven in excess of 30 mph (48 km/h) with the air springs deflated. The vehicle should be driven only as far as the nearest repair facility. Excessive speed or mileage could damage the vehicle or its load.

PRINCIPLES OF OPERATION

The leveling valve is the controlling unit to the air suspension system. All of the air pressure contained in the system must either be admitted through, or exhausted from, this valve. The Airliner® suspension is equipped with either Neway (Fig. 5) or Delco (Fig. 6) leveling valves, which both operate in the same manner.

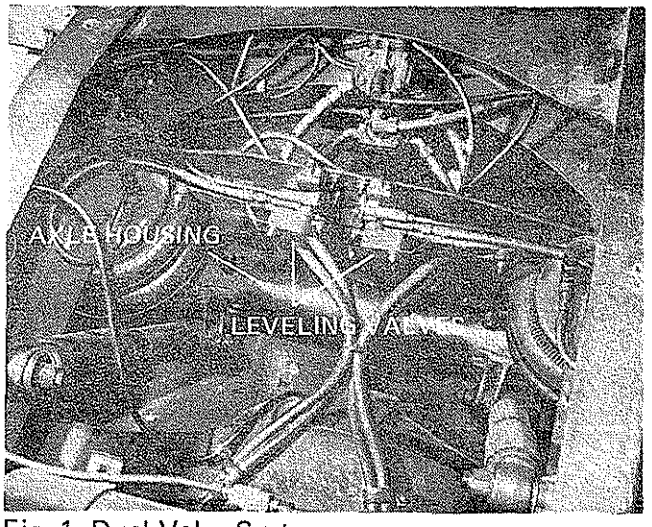

Fig. 1, Dual Valve System

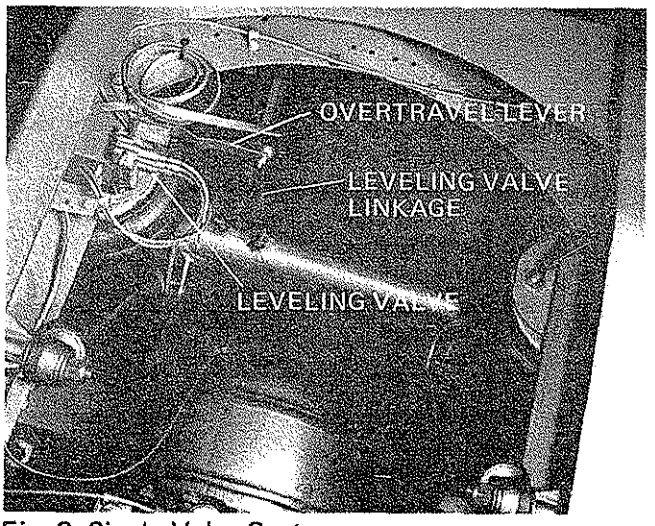

Fig. 2, Single Valve System

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FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

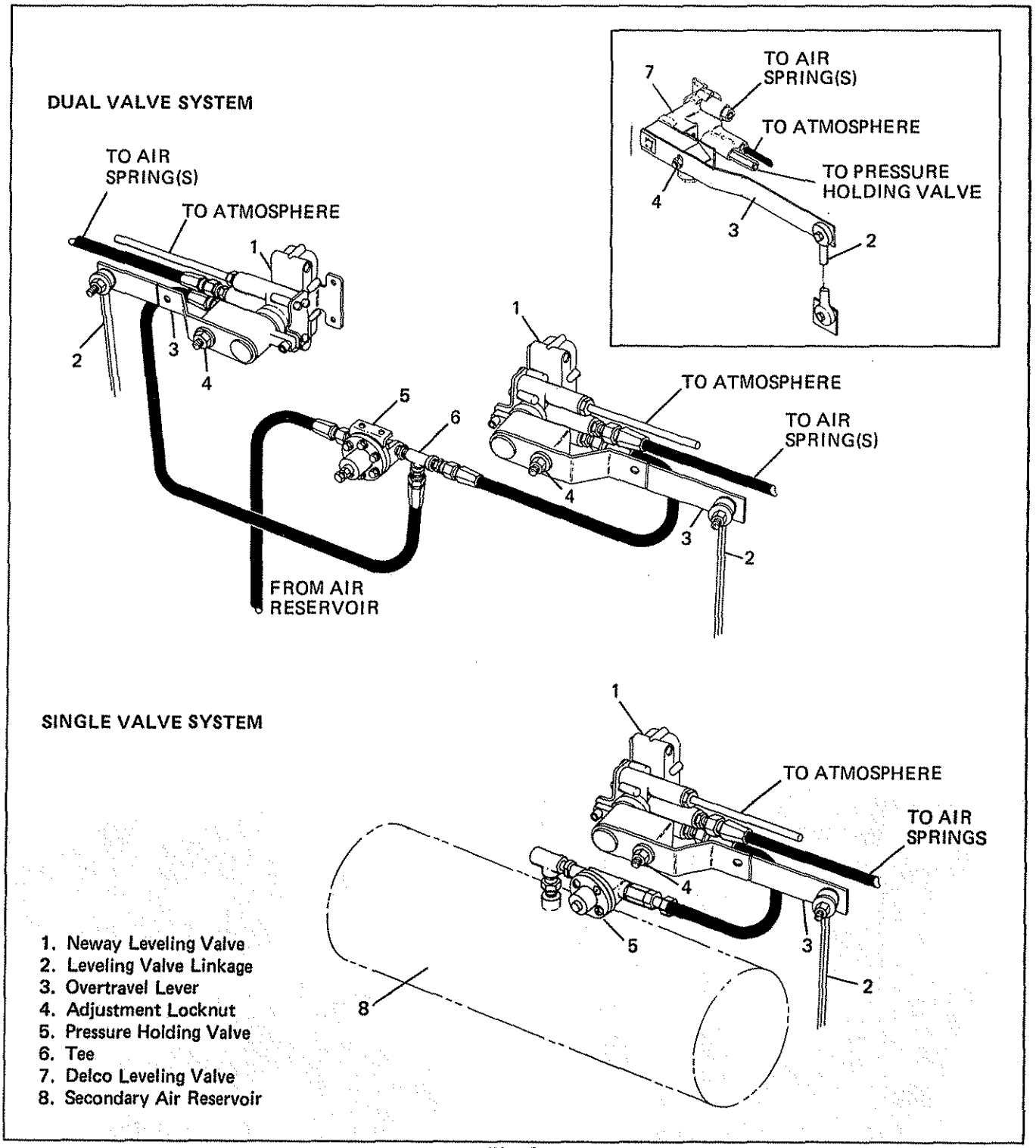

Fig. 3

FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

The leveling valve is mounted either on a frame crossmember (dual valve systems) or on the inside web of the frame rail (single valve systems). An overtravel lever extends horizontally from the end of the leveling valve control shaft to the end of a vertical linkage arm connected to the rear axle housing. Refer to **Fig. 1** or **2**. When the load changes, the overtravel lever turns the leveling valve control shaft, activating either the intake or exhaust valve core inside the leveling valve. This adjusts the air pressure in the air springs, until the frame returns to the normal ride height, and the overtravel lever returns to the horizontal (neutral) position.

With the vehicle in motion, and the overtravel lever in the neutral position, small movements of the overtravel lever may occur, without activating the leveling valve. This is due to a free-travel range, or a gap between the leveling valve control shaft and the internal valve cores of the leveling valve. In addition, each leveling valve is filled with a silicone-type fluid which delays from one to six seconds, the closing of one valve core to the opening of the other. This prevents activation of the leveling valve during abrupt movements of the vehicle axle.

SERVICE OPERATIONS

CAUTION: Failure to take precautions against the entry of moisture, oil, or other foreign material into the suspension air system could eventually lead to sludge formations occurring throughout the air system. Sludge formations could adversely affect the operation of the air suspension system as well as other air system components.

Because air suspension systems are controlled by contaminant-sensitive air valves, the air system must be kept free of any oil, moisture, or foreign material. Air tanks should be drained daily, filters cleaned weekly, and the air compressor maintained in good operating condition. Refer to the applicable group of the *COE & 120 Conventional Maintenance Manual* for maintenance operations.

CAUTION: Failure to apply Alumilastic® compound, or an equivalent, to areas where aluminum and steel parts contact each other, could lead to corrosion of the metals, resulting in damage to the frame or parts.

Attach all suspension brackets that are in contact with the frame by using SAE grade 8 bolts with phosphate- and oil-coated threads, and grade C prevailing torque locknuts that are cadmium plated and wax coated. Install flatwashers with a hardness rating of 38 to 45 HRC under both the bolt and the nut. An acceptable alternative is to use SAE grade 8.2 flanged hexbolts and grade G prevailing torque flanged locknuts.

LEVELING VALVE ADJUSTMENT

Adjustment of the leveling valve(s) should be performed with the vehicle on a level surface, under an evenly distributed load. If the vehicle has two valves, adjust the valves one at a time.

1. Park the vehicle on a level surface, then chock the tires. Run the engine to build up and maintain a vehicle air pressure of 80 psi (551 kPa).

2. Disconnect the leveling valve linkage from the overtravel lever. Disconnect both linkages if a dual valve system is being adjusted. Refer to **Fig. 3**.

3. Exhaust the air from all air springs by moving one or both overtravel levers to the vertical-down position.

4. Loosen the adjustment locknut, and move the overtravel lever until the stud in the nylon block (overtravel control body) is centered in the overtravel lever adjustment slot. Refer to **Fig. 5** or **6**. Then, tighten the adjustment locknut 60 lbf·in (700 N·cm).

NOTE: If the vehicle is equipped with Neway leveling valves, temporarily insert a 3/16-inch diameter locating pin (or a 3/16-inch drill bit) in the hole at the back of the nylon block and through the hole in the mounting bracket. Refer to **Fig. 5**.

FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

This will aid in centering the nylon block stud in the overtravel lever adjustment slot. After tightening the adjustment locknut, remove the locating pin (drill bit).

5. Connect one of the overtravel levers to its respective linkage, and allow the air springs controlled by the valve to fill until the valve shuts off.

6. If equipped with an air bag support (Fig. 10, Ref. 34), measure the distance from the top of the inflated air springs to the bottom of the air springs. See Fig. 4. This dimension should be 6-1/2 inches (165 mm).

   If equipped with an air spring upper mounting bracket (Fig. 10, Ref. 36), measure the distance from the bottom of the frame rail to the bottom of the air springs. This dimension should be 6-3/4 inches (171 mm).

   Adjust the leveling valve by loosening the valve mounting capscrew nuts, and rotating the entire valve slightly until the height dimension is attained.

IMPORTANT: Because of a built-in time delay in the leveling valve, two to six seconds will be required after making adjustments before a change will occur in the height dimension.

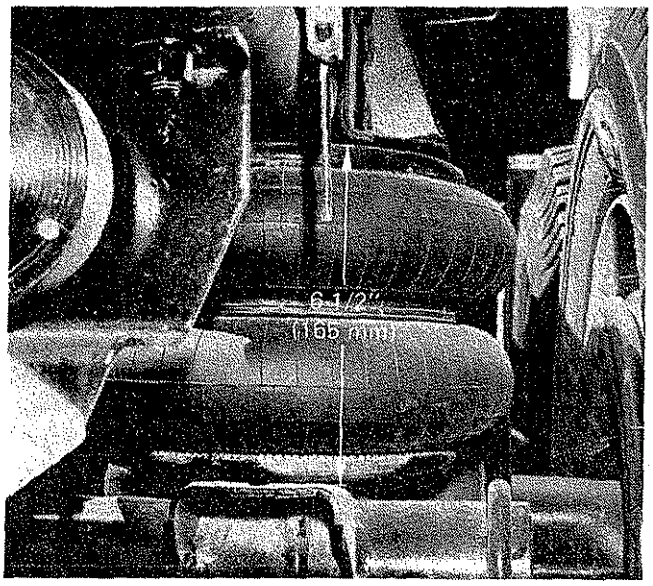

Fig. 4, Air Spring Height Measurement

7. Tighten the valve mounting capscrew nuts 9 to 11 lbf·ft (12 to 15 N·m).

8. Disconnect the leveling valve linkage and allow the air springs to deflate approximately halfway. Then, connect the linkage to inflate the air springs, and check the height dimension again. Repeat steps 6 through 8 above, until the correct height is maintained.

NOTE: When the height dimension is within 1/8-inch (3 mm) of the applicable dimension, the final adjustment can be made by loosening the adjustment locknut and slightly moving the overtravel lever relative to the nylon block (overtravel control body). Then, tighten the adjustment locknut 5 lbf·ft (7 N·m).

If the system has two leveling valves, and only one of the valves is in adjustment, proceed to step 9. If the system is a single leveling system, proceed to step 11.

9. After the first leveling valve is adjusted, disconnect the overtravel lever from the leveling valve linkage, and rotate it to the vertical-down position to fully deflate the air springs.

10. Adjust the leveling valve on the other side of the vehicle by performing steps 4 through 8 under this heading. Then, proceed to step 11.

11. Connect the leveling valve linkage(s) to the overtravel lever(s). All of the air spring dimensions should be equal. If adjusting a two valve system, both valves must be synchronized. If not, repeat the adjustment procedure until height equalization and valve synchronization are achieved.

CAUTION: Failure to adjust the leveling valve(s) could adversely affect driveline angles. In addition, if the air springs are set too high, the driver may have difficulty (or be prevented from) maneuvering the vehicle under the trailer.

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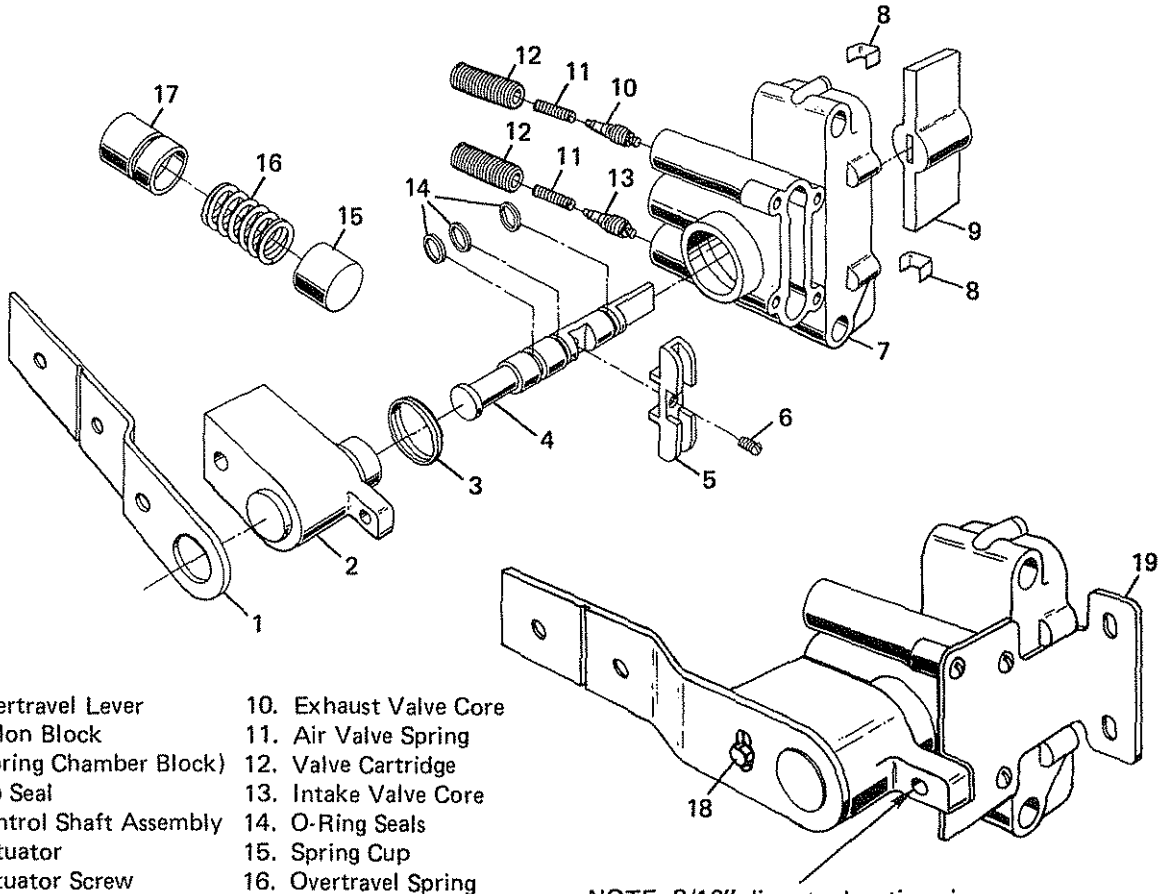

Fig. 5, Neway Leveling Valve

12. Remove the chocks from the tires.

LEVELING VALVE CHECKS

The leveling valve is the brain of any air suspension system and is basically sensitive to height; when properly adjusted at installation it will provide and maintain suspension ride height.

Often a valve is unnecessarily replaced. There are basic checks that can be performed to determine if the valve is defective, or if proper adjustment had not been performed. To determine the status of a valve, perform the following functions:

1. Disconnect the valve linkage. Refer to Fig. 3.
2. Rotate the overtravel lever to the up position approximately 45° for 6 to 8 seconds. If air passes through the valve, this segment of the valve is okay. See Fig. 7, Ref. A.
3. Return the valve to center neutral position. Air should stop flowing and if so, this segment of the valve is okay. See Fig. 7, Ref. B.
4. Rotate the overtravel lever to the down position approximately 45° for 6 to 8 seconds. If air

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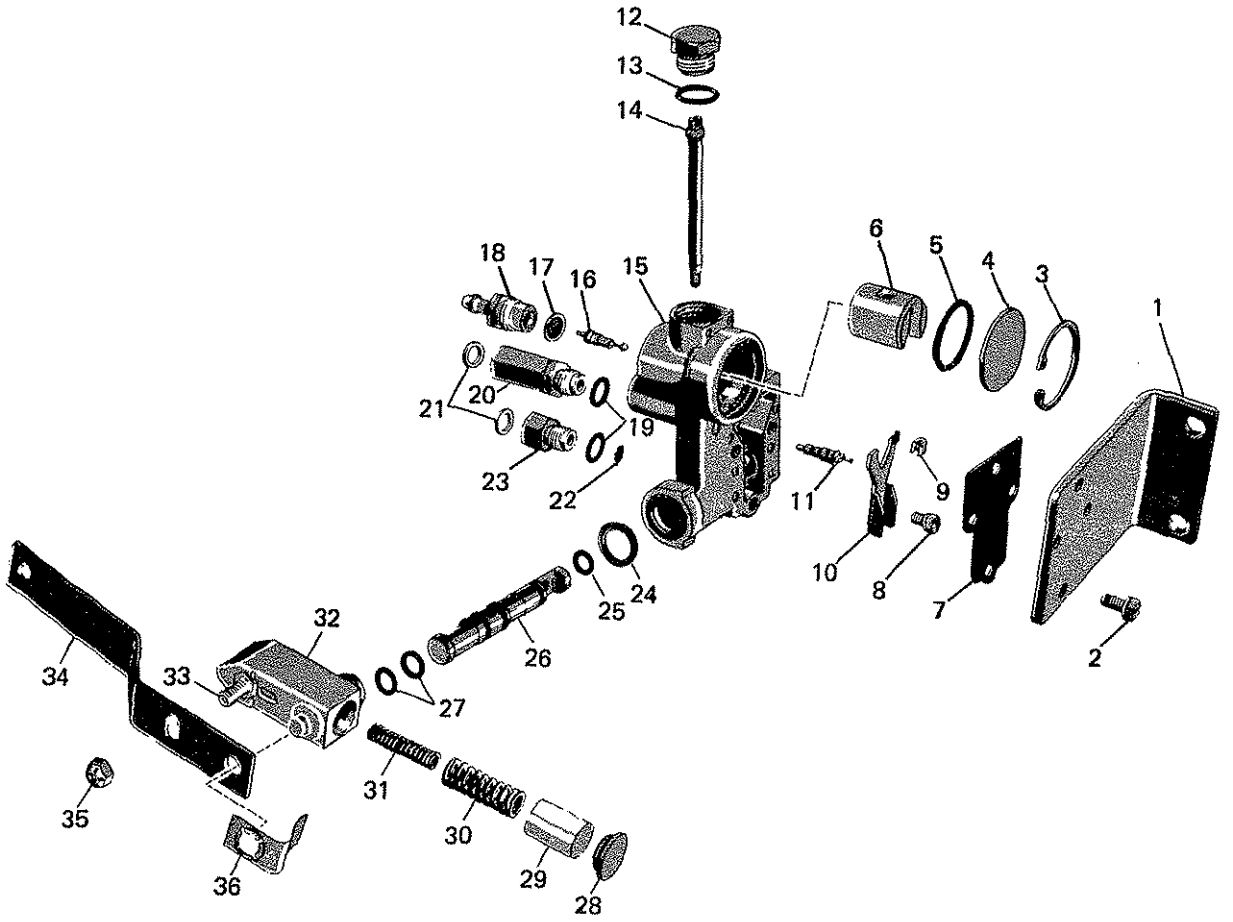

1. Cover/Bracket
2. Cover Screw and Lockwasher
3. Delay Cover Retainer
4. Delay Cover
5. Delay Cover O-Ring
6. Delay Piston
7. Cover Gasket
8. Valve Lever Screw
9. Valve Stem Lock Clip
10. Intake and Exhaust Valve Lever
11. Intake Valve Core
12. Delay Plug
13. Delay Plug O-Ring
14. Piston Pin
15. Valve Body
16. Exhaust Valve Core
17. Exhaust Screen
18. Exhaust Fitting
19. Adapter O-Rings
20. Inlet Adapter and Check Valve Assembly
21. Air Line Fitting Gaskets
22. Air Spring Port Adapter Screen
23. Air Spring Adapter Port
24. Overtravel Control Body Seal
25. Shaft O-Ring (Medium)
26. Overtravel Control Shaft
27. Shaft O-Rings (Large)
28. Overtravel Body Plug
29. Overtravel Piston
30. Overtravel Spring (Large)
31. Overtravel Spring (Small)
32. Overtravel Control Body
33. Overtravel Lever Stud
34. Overtravel Lever
35. Adjustment Locknut
36. Plug Retainer

Fig. 6, Delco Leveling Valve

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exhausts from the valve, this segment of the valve is okay also. See Fig. 7, Ref. C.

5. Return the valve to the neutral position, and if air stops, the valve is okay in the neutral position again. See Fig. 7, Ref. B.

6. If all of the above steps have been performed and qualify in the manner they are stated, the valve is in operational condition and will not be honored for warranty.

   If readjustment or disassembly of the height control valve is necessary, refer to the applicable heading in this subject for service instructions.

LEVELING VALVE REMOVAL AND INSTALLATION

Removal

1. Chock the vehicle tires.

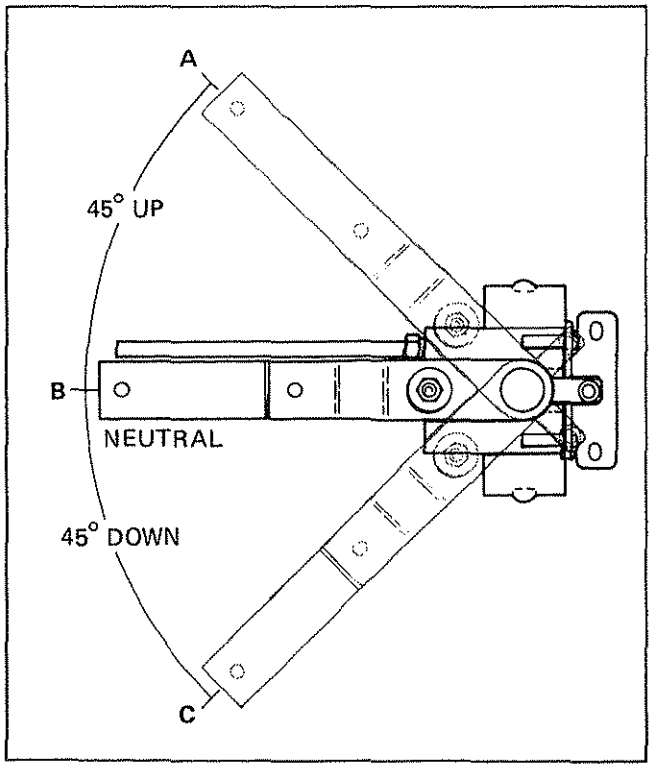

Fig. 7

2. Drain the air system. For instructions, refer to the 12 Group of the Freightliner Maintenance and Lube Manual.

3. Disconnect the overtravel lever from the leveling valve linkage. Refer to Fig. 3. Exhaust all air from the air springs by pushing down on the overtravel lever.

4. Disconnect the air lines at the leveling valve, and mark the lines for later assembly reference (do not disconnect the exhaust tube). Using tape, cover the open ends of the air lines and fittings to prevent dirt or foreign material from entering.

5. Remove the leveling valve mounting capscrews and nuts, then remove the leveling valve from the vehicle frame.

Installation

NOTE: For Delco leveling valves only, inspect the air line fittings before installing the leveling valve. If the air line fitting gaskets are worn or damaged, replace the gaskets (Fig. 6, Ref. 21) in the adapters. Keep the adapters free of any dirt or foreign matter to prevent damage to the valves.

1. Attach the leveling valve to the vehicle frame rail or frame crossmember. Tighten the valve mounting capscrew nuts to 11 lbf·ft (15 N·m).

2. Remove the tape from the air lines and fittings, then connect the air lines to the leveling valve, as referenced earlier or as shown in Figs. 14 or 15 under "SPECIFICATIONS." Tighten the lines to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

3. Connect the leveling valve linkage to the end of the overtravel lever. Tighten the nut to 12-17 lbf·ft (16-23 N·m).

4. Close the drain cocks on all air reservoirs.

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5. Build up normal operating pressure in the vehicle air system. Then, check all air lines and connections for leaks. Eliminate all leaks.

6. Adjust the leveling valve, following the procedure given under "LEVELING VALVE ADJUSTMENT."

7. Remove the chocks from the tires.

SHOCK ABSORBER REPLACEMENT

1. Chock the vehicle tires.

2. Remove the locknuts and washers from the shock absorber upper and lower mounting pins. See Fig. 8.

3. Pull the shock absorber off the mounting pins to remove it from the vehicle. If the inner metal sleeve has fastened to the the mounting pin, use a small, sharp chisel to force the sleeve from the pin.

4. Install the replacement shock absorber on the mounting pins, then secure it with the locknuts and washers. Tighten the locknut 150 lbf·ft (203 N·m).

5. Remove the chocks from the tires.

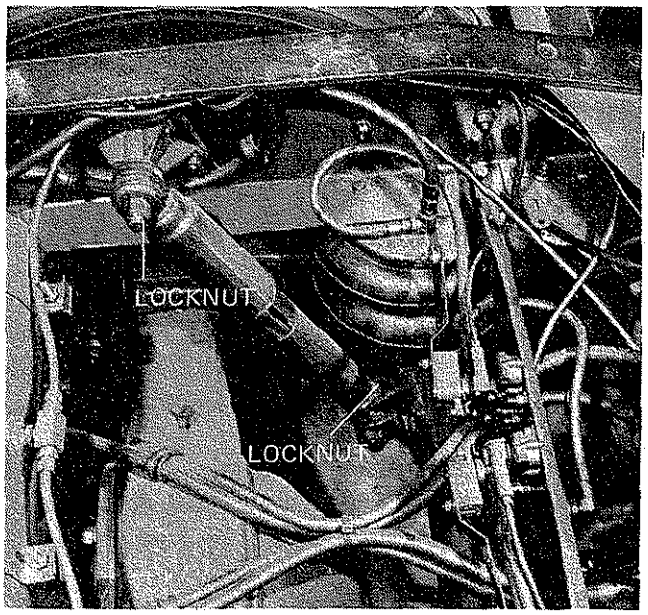

Fig. 8, Shock Absorber Removal and Installation

SPRING HANGER BUSHING REPLACEMENT

Depending on the leaf spring assembly model, refer to either Fig. 9 or Fig. 10, when referenced below.

1. Chock the vehicle tires.

2. Remove the locknut (Ref. 10) and flatwasher from the rubber bushing capscrew (Ref. 6).

3. Using an impact wrench on the bushing capscrew head, maintain a counterclockwise action on the capscrew. At the same time, apply firm pressure against the threaded end of the capscrew and extract it from the spring hanger.

4. Remove the spring hanger rubber bushings and spacer (Ref. 8) or two-piece urethane bushings out of the spring hanger and the adjustment block. Discard the bushings and spacer.

5. Slide the new two-piece urethane bushings into the spring hanger.

6. Place the flatwasher (Ref. 7) over the bushing capscrew, then insert the capscrew through the bushing from the inboard side of the spring hanger.

7. Install the flatwasher and locknut on the bushing capscrew. Tighten the locknut until the spring hanger has compressed to a width of 4-1/6 inches ± 1/32 inch (103 ± 0.8 mm). See Cross Section D.

8. Remove the chocks from the tires.

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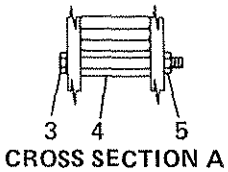
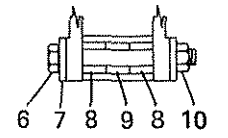


CROSS SECTION A



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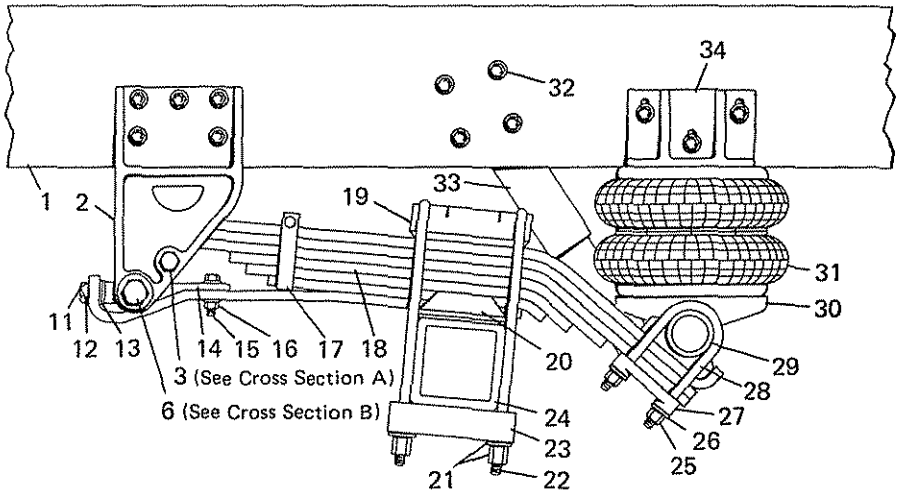
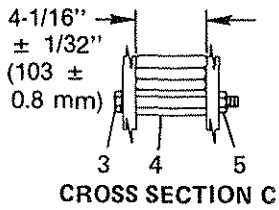


1. Frame Rail
2. Spring Hanger
3. Capscrew
4. Neoprene Sleeve
5. Locknut
6. Bushing Capscrew
7. Flatwasher
8. Spring Hanger Rubber Bushing
9. Spacer
10. Locknut
11. Capscrew
12. Locking Tab Shim
13. Axle Alignment Shims
14. Adjusting Block
15. Capscrew
16. Locknut
17. Bolt Type Clip
18. Leaf Spring Assembly
19. U-Bolt Pad
20. Spring Seat
21. Flatwasher and High Nut
22. Axle U-Bolt
23. Axle Clamp
24. Axle (Sectional View)
25. High Nut
26. Flatwasher
27. Pressure Plate
28. Crossmember U-Bolt
29. Crossmember Assembly (Sectional View)
30. Lower Bag Support
31. Air Spring
32. Rail Bracket Spacer/Shock Absorber Bracket Capscrew
33. Shock Absorber
34. Air Bag Support Bracket
35. Urethane Bushing
36. Air Spring Upper Mounting Bracket



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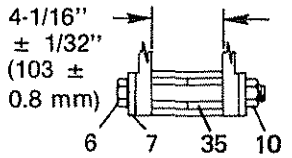

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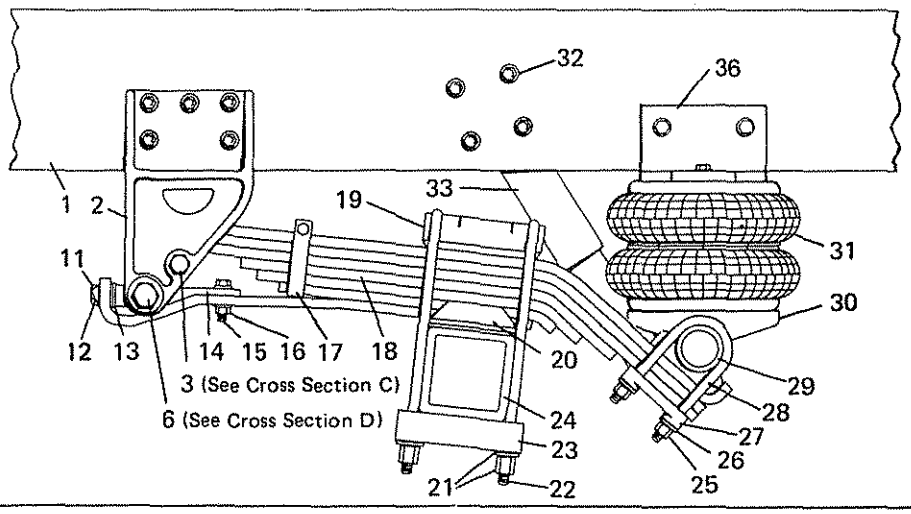

Fig. 9, 7-Leaf Spring Airliner® Suspension System

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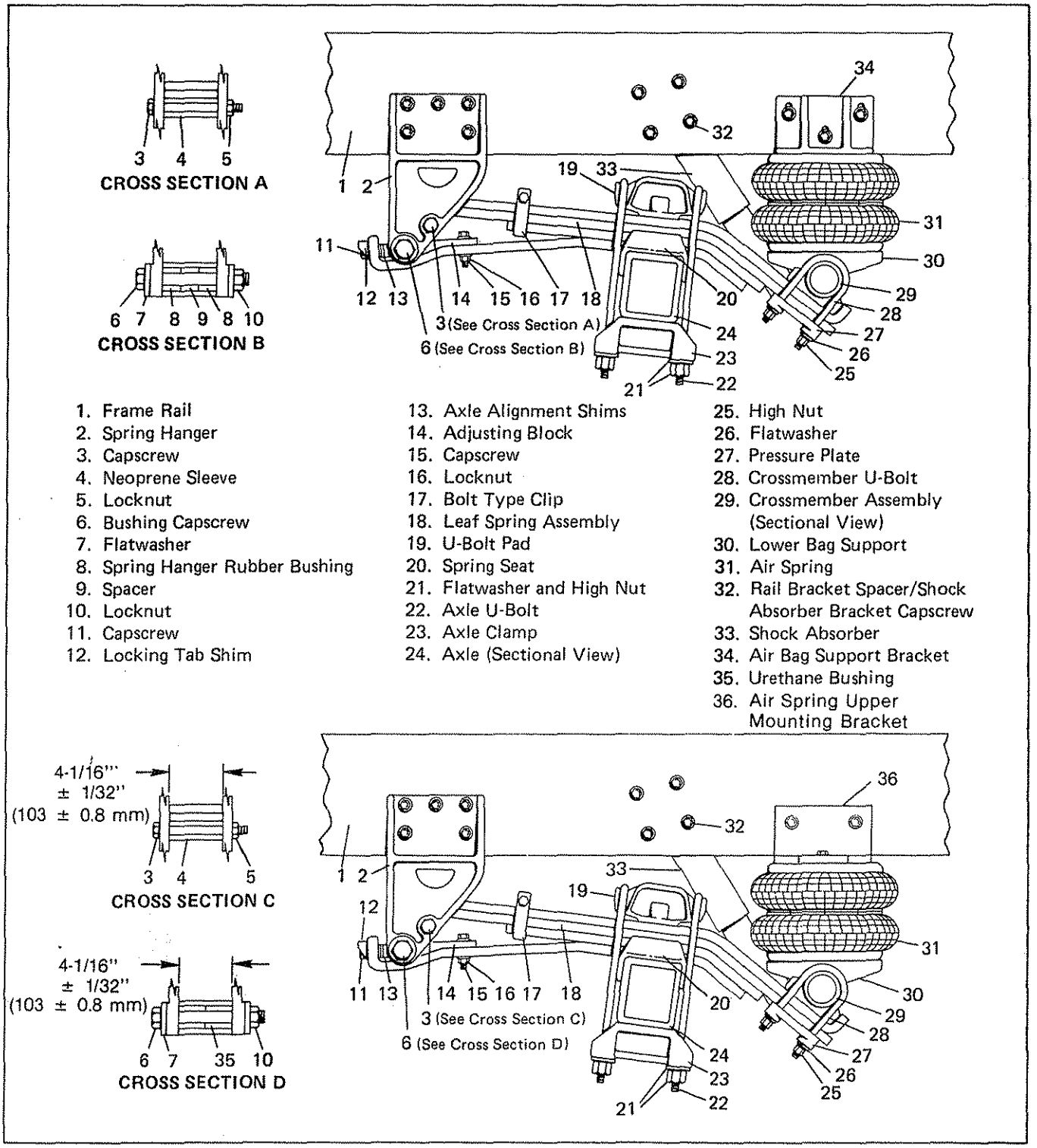

1. Frame Rail
2. Spring Hanger
3. Capscrew
4. Neoprene Sleeve
5. Locknut
6. Bushing Capscrew
7. Flatwasher
8. Spring Hanger Rubber Bushing
9. Spacer
10. Locknut
11. Capscrew
12. Locking Tab Shim
13. Axle Alignment Shims
14. Adjusting Block
15. Capscrew
16. Locknut
17. Bolt Type Clip
18. Leaf Spring Assembly
19. U-Bolt Pad
20. Spring Seat
21. Flatwasher and High Nut
22. Axle U-Bolt
23. Axle Clamp
24. Axle (Sectional View)
25. High Nut
26. Flatwasher
27. Pressure Plate
28. Crossmember U-Bolt
29. Crossmember Assembly (Sectional View)
30. Lower Bag Support
31. Air Spring
32. Rail Bracket Spacer/Shock Absorber Bracket Capscrew
33. Shock Absorber
34. Air Bag Support Bracket
35. Urethane Bushing
36. Air Spring Upper Mounting Bracket

Fig. 10, 4-Leaf Spring Airliner® Suspension System

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AIR SPRING REPLACEMENT

Two slightly different types of air springs and air spring upper mounting brackets are used on Freightliner vehicles. See Fig. 11.

1. Chock the vehicle tires. Raise and block the vehicle frame with safety stands to remove all weight from the air springs. The leveling valve(s) automatically releases air from the air springs when all weight is removed from the suspension.
2. Disconnect the air supply line from the air spring. Use care to prevent foreign material from entering the line or fitting. Using tape, cover the ends of the air supply line and the fitting to prevent dirt or foreign material from entering.
3. Remove the capscrews and lockwashers or nuts and lockwashers, that connect the air spring upper mounting plate to the vehicle. See Fig. 11.
4. Remove the capscrews and lockwashers that connect the air spring lower mounting plate to the lower bag support. See Fig. 12. Remove the air spring.
5. Position the new air spring on the lower bag support, and install the capscrews securing the air spring lower mounting plate in place. See Fig. 12. Tighten the capscrews to 34 lbf·ft (46 N·m).
6. Attach the capscrews and lockwashers, or nuts and lockwashers, connecting the air spring upper mounting plate to the vehicle. Refer to Fig. 11. Depending on which type of air spring upper mounting plate is on the vehicle, tighten the capscrews to 34 lbf·ft (46 N·m) or the nuts to 45 lbf·ft (61 N·m) and 20 lbf·ft (27 N·m). Review the information given in Table 1, under "SPECIFICATIONS."
7. Remove the tape from the end of the air supply line and the fitting. Connect the air supply line to the air spring. Tighten the line to the values given in the 12 Group of the Freightliner Maintenance and Lube Manual.

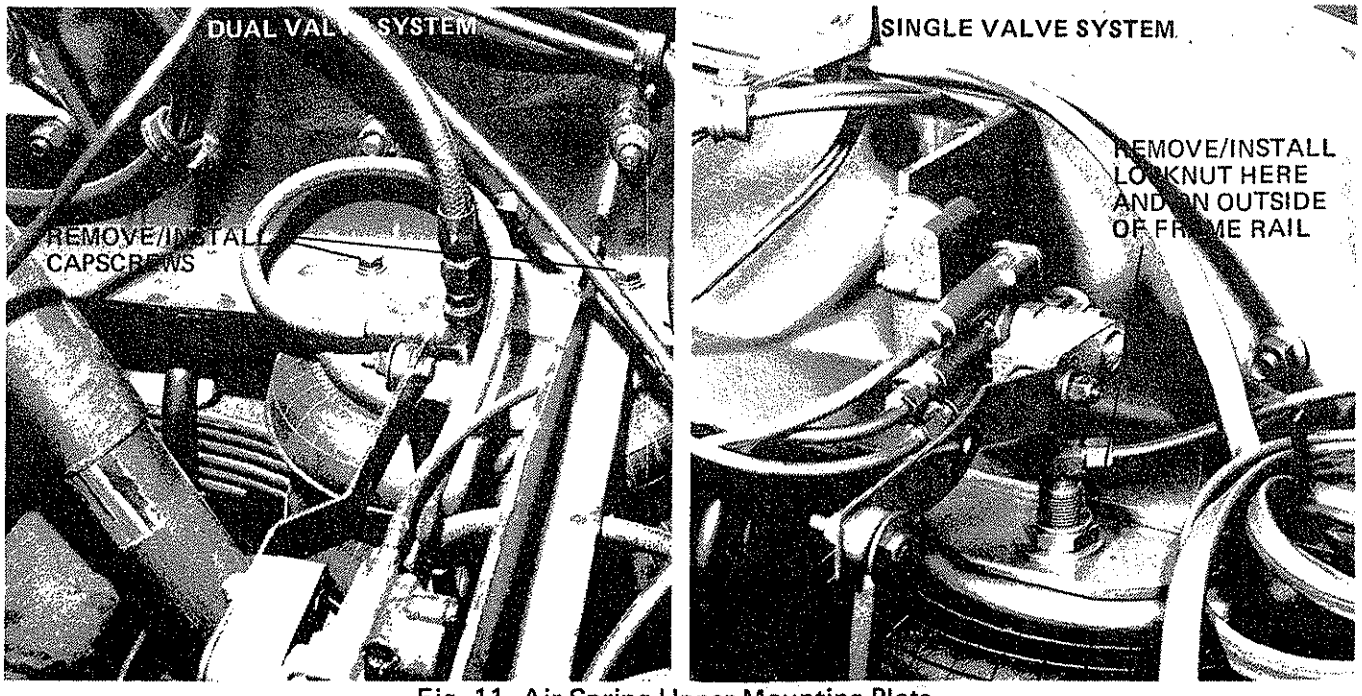

Fig. 11, Air Spring Upper Mounting Plate

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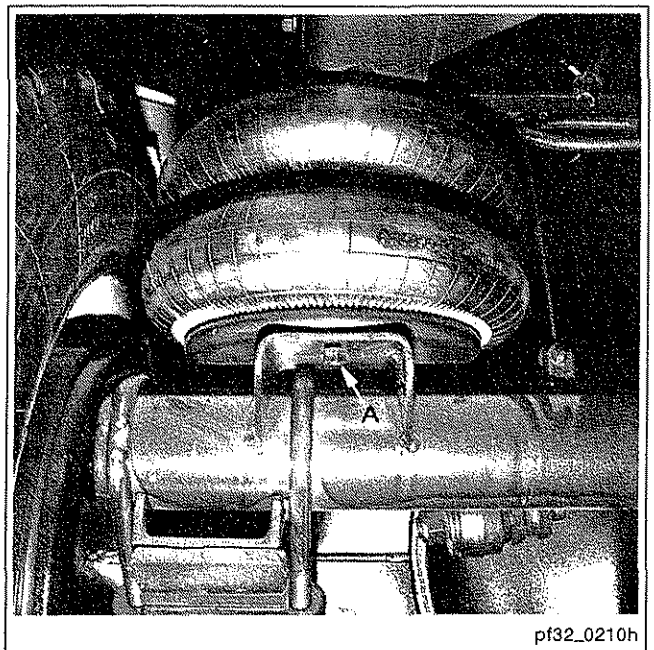
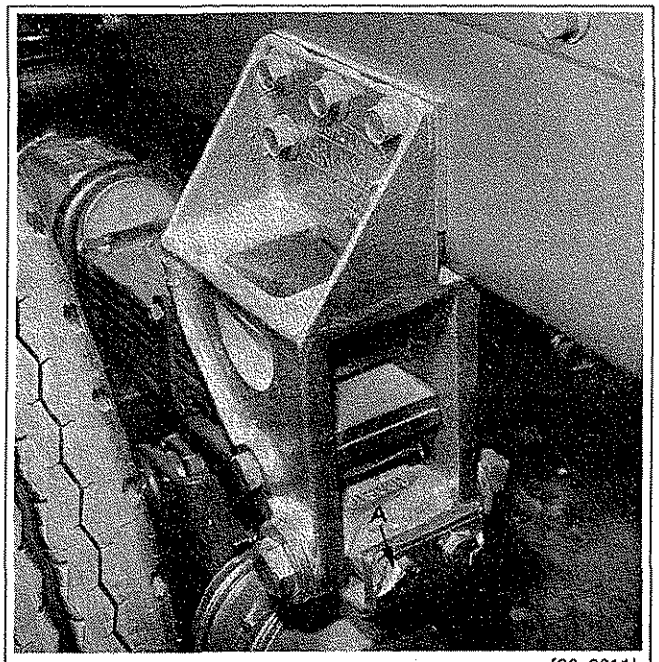


A. Remove/Install capscrew here and on opposite end.

Fig. 12, Air Spring Lower Mounting Plate



A. Bend locking tab shims as shown.

Fig. 13, Axle Alignment Locking Tab Shim

8. Remove the safety stands from the vehicle frame, then lower the vehicle. Remove the chocks from the tires.

LEAF SPRING REPLACEMENT

Depending on the leaf spring assembly model, refer to either **Fig. 9** or **Fig. 10**, when referenced below.

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

1. Chock the vehicle tires.
2. Remove the locknut (Ref. 5), flatwashers, capscrews, and neoprene sleeve.
3. Raise the vehicle, and block the axle with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then block the vehicle frame with safety stands. Remove the wheel assembly, in order to gain easy access to the suspension system.

WARNING: Safety stands must be securely supporting all of the wheel and frame weight during suspension repairs. Unsecured components may drop when the fasteners are loosened or removed, cuasing component damage and serious personal injury.

4. Straighten the corners of the locking tab shim (Ref. 12), then remove the capscrews (Ref. 11). Note the position of the axle alignment shims so they can be returned to their original positions during later assembly. Remove the capscrew (Ref. 15) at the tail of the adjusting block.
5. Remove the high nuts (Ref. 25) and flatwashers from the crossmember U-bolts. Remove the pressure plate (Ref. 27) and the U-bolts.

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6. Remove the high nuts and flatwashers (Ref. 21) from the axle U-bolts. Remove the axle clamp (Ref. 23), then remove the axle U-bolts and the U-bolt pad (Ref 19).

7. Slide the leaf spring assembly off the spring seat. Discard the leaf spring assembly.

8. Maneuver the new leaf spring assembly in place. Set the U-bolt pad in position on top of the leaf spring assembly, then slide the axle U-bolts in place. Install the axle clamp, and hold it in place with the flatwashers and high nuts. Tighten the nuts finger-tight.

9. Install the crossmember U-bolts and the pressure plate, securing the leaf spring assembly to the crossmember. Install the flatwashers and high nuts on the crossmember U-bolts. Tighten the high nuts (Ref. 25) 85 to 100 lbf·ft (115 to 136 N·m).

10. Install the axle alignment shims, as noted earlier. Install the capscrews (Ref. 11), with the locking tab shim outside of the spring.

IMPORTANT: Original factory installation will use up to five 1/16-inch axle alignment shims with a 1/16-inch locking tab shim and a 1-3/4 inch long capscrew. The maximum thickness of all the shims (including the locking tab shim) is 3/8-inch. If more than five shims are used, a longer capscrew must be installed to maintain a thread engagement in the adjusting block of no less than 3/4-inch (19 mm) and no more than 1-1/8 inches (28 mm).

11. Tighten the capscrews (Ref. 11) 170 to 185 lbf·ft (230 to 251 N·m), then bend the corners of the locking tab shim over the heads of the capscrews (see Fig. 13). Install the capscrew locknut (Ref. 16) at the tail of the adjusting block and tighten 90 to 100 lbf·ft (122 to 136 N·m). Tighten the high nuts on the axle U-bolts (Ref. 21) 400 lbf·ft (542 N·m).

12. Install the wheel assembly. Remove the safety stands from under the vehicle frame and axle, then lower the vehicle.

13. Install the spring hanger neoprene sleeve (Ref. 4). Then install the capscrew, flatwashers, and locknut (Ref. 5). Tighten the locknut until the spring hanger has compressed to a width of 4-1/16 inches ± 1/32 inch (103 ± 0.8 mm). See Cross Section C.

NOTE: If the spring hanger bushing capscrew and locknut (Ref. 10) are removed or loosened, the locknut should be tightened until the spring hanger has compressed to a width of 4-1/16 inches ± 1/32 inch (103 ± 0.8 mm). See Cross Section D.

14. Check the rear axle alignment. For instructions, refer to the 11 Group of this manual. If necessary, adjust the rear axle alignment using the instructions given in this subject.

15. Remove the chocks from the tires.

CAUTION: All suspension fasteners require periodic torquing. Failure to periodically torque the fasteners could result in spring breakage and abnormal tire wear. Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for recommended intervals.

REAR AXLE ALIGNMENT ADJUSTMENT

Depending on the leaf spring assembly model, refer to either Fig. 9 or Fig. 10, when referenced below.

Alignment of the rear axle(s) can be adjusted by adding or removing the axle alignment shims between the spring end and the adjusting block, on one side of the vehicle. Alignment may be adjusted on either side of the vehicle. To adjust either single or tandem drive axles, proceed as follows:

1. Straighten the corners of the locking tab shim (Ref 12), then remove the capscrews (Ref. 11). Loosen the capscrew locknut (Ref. 16) at the tail of the adjusting block.

2. Move the axle forward or backward until it is aligned within the tolerances given in the 11 Group of this manual.

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3. After the axle is in alignment, install the axle alignment shims to take up the slack between the end of the spring and the adjusting block. Install the capscrews (Ref. 11), with the locking tab shim outside of the spring.

IMPORTANT: Original factory installations will use up to five 1/16-inch axle alignment shims with a 1/16-inch locking tab shim and a 1-3/4 inch long capscrew. The maximum thickness of all shims (including the locking tab shim) is 3/8-inch. If more than five shims are used, a longer capscrew must be installed to maintain a thread engagement in the adjusting block of no less than 3/4-inch (19 mm) and no more than 1-1/8 inches (28 mm).

4. Tighten the capscrews (Ref. 11) to 170-185 lbf·ft (230-251 N·m). Then, check the axle alignment using the instructions given in the 11 Group of this manual. Repeat the alignment adjustment procedure until the alignment is within tolerances.

5. After the axle is in alignment, and the capscrews (Ref. 11) are tightened to 170-185 lbf·ft (230-251 N·m), bend the corners of the locking tab shim over the heads of the capscrews, as shown in Fig. 13. Tighten the capscrew locknut (Ref. 16) at the tail of the adjusting block to 100 lbf·ft (136 N·m).

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TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
All Air Springs Flat	The air pressure in the vehicle air system is insufficient.	Check the air pressure gauge on the instrument panel. If air pressure is low, run the engine until a minimum pressure of 80 psi (551 kPa) is indicated on the gauge.
	Air is leaking from the suspension air system.	Listen for leakage due to loose fittings or damaged air lines, air springs, or leveling valve(s). Tighten loose fittings and clamps to stop air leakage; replace worn or damaged parts with new ones.
	The leveling valve(s) is out of adjustment.	Adjust the leveling valve(s) using the instructions given in this subject.
Air Spring(s) Flat on One Side of the Vehicle Only	The air spring(s) is punctured or leaking.	Visually inspect the air springs for leaks resulting from damage, wear, or deterioration. If an air spring is leaking, install a new one.
	Air is leaking between the pressure holding valve and the air spring(s).	Listen for leakage due to loose fittings or damaged air lines. Tighten loose fittings to stop leakage; replace damaged air lines with new ones.
	The leveling valve linkage is bent, broken, or disconnected.	Visually inspect the linkage for loose or damaged parts. Tighten loose linkage parts; replace unserviceable parts with new ones.
	The leveling valve is out of adjustment.	Check the adjustment of the leveling valve. Adjust the valve, if necessary.
	The leveling valve is inoperative.	If movement of the overtravel lever (on a properly adjusted valve) fails to inflate the air spring(s), the leveling valve should be replaced with a new one.

(Continued on next page)

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TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Leans Due to Unequal Inflation of the Air Springs	The leveling valve is out of adjustment.	Check the adjustment of the leveling valve using the instructions given in this subject. Adjust the valve, if necessary.
	The leveling valve mounting capscrews or adjustment locknut is loose or missing.	Visually inspect for loose or missing leveling valve mounting capscrews or adjustment locknut. Tighten loose fasteners; replace missing components. Then, adjust the leveling valves. Tighten all connections to the values given under "SPECIFICATIONS."
	The leveling valve linkage is damaged.	Visually inspect for damage to the leveling valve linkage and overtravel lever. Repair or replace damaged linkage parts.
Air Springs Deflate Rapidly When the Vehicle is Parked	Air is leaking from the suspension air system.	Listen for leakage due to loose fittings or damaged air lines, punctured air springs, or damaged leveling valve(s). Tighten loose fittings to stop leakage; replace damaged components with new ones.
Vehicle Rides Too High or Too Low	The leveling valve(s) is out of adjustment.	Check the adjustment of the leveling valve(s). Adjust the valves, if necessary.
Air Spring Collapsed	An air spring is punctured.	Locate leaks by listening for escaping air, or by applying a soap and water solution to the air spring and watching for bubbles. Repair punctures and cuts of less than 1/8-inch (3 mm). Replace the air spring if damage is more extensive.

(Continued on next page)

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TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Air Spring Collapsed (Continued)	After-market-installed vehicle equipment is rubbing against the air spring.	Visually inspect the area around the damaged air spring. Check for air spring contact with such things as frame-mounted accessories, new tires and rims, tire chains, and other components. Correct the problem areas as needed.
	The air spring is continually or repeatedly over-extended.	Check the height of the air spring. Make sure the correct air spring height is maintained. Adjust if needed. Check for a broken shock absorber. Replace, if broken.
Air Springs Do Not Fully Deflate When All Weight is Removed From the Suspension	The leveling valve(s) is out of adjustment.	Adjust the leveling valve(s).
	The air line between the leveling valve and the air spring is restricted.	Disconnect the leveling valve linkage, and rotate the overtravel lever to the vertical-down position. If the air spring remains inflated, check for a pinched or blocked line. Clean out plugged lines; replace damaged lines. Repeat this procedure on the other side of the vehicle, if necessary.

FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

SPECIFICATIONS

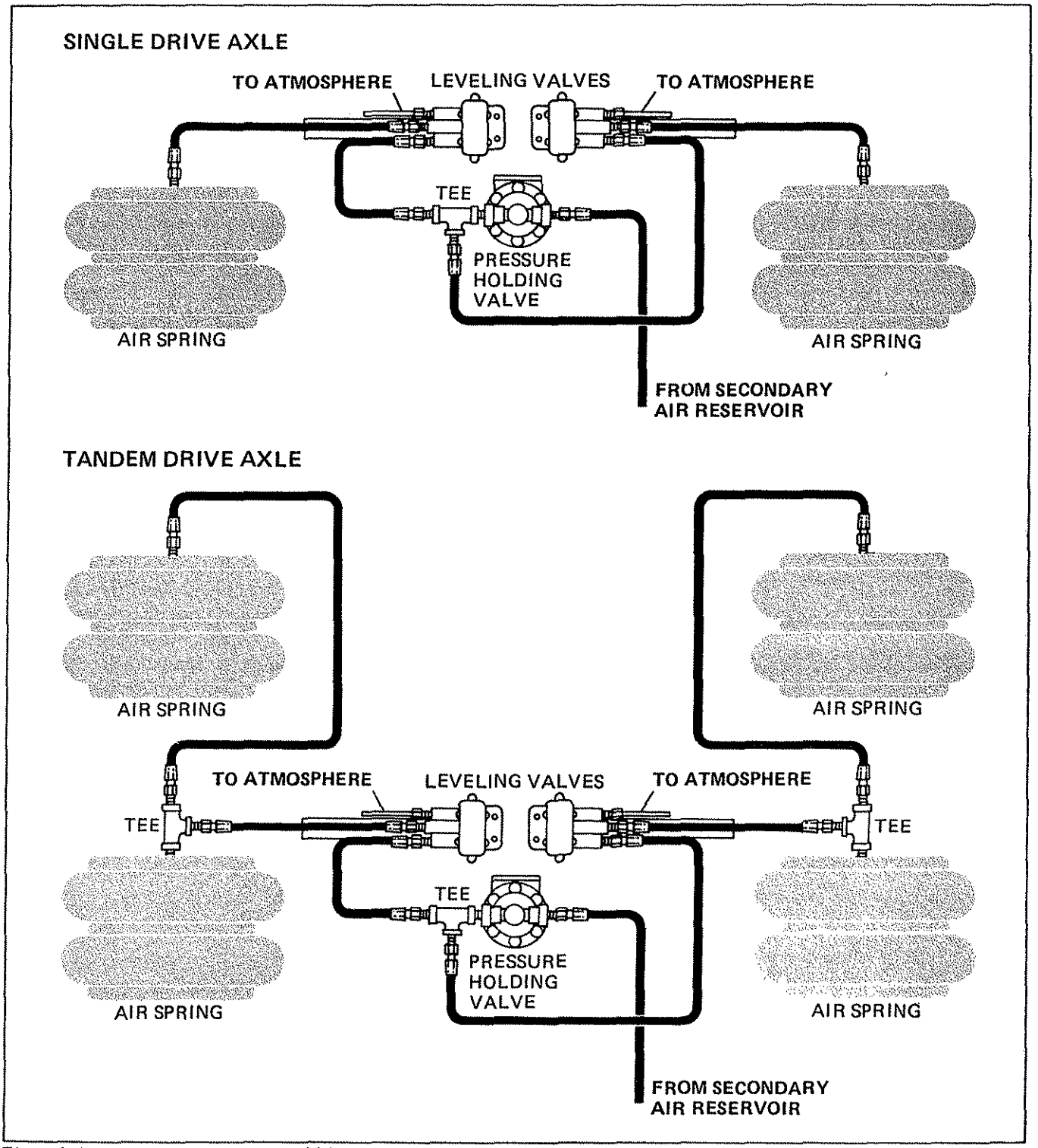

Fig. 14, Plumbing Diagram, Dual Valve System

FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

SPECIFICATIONS

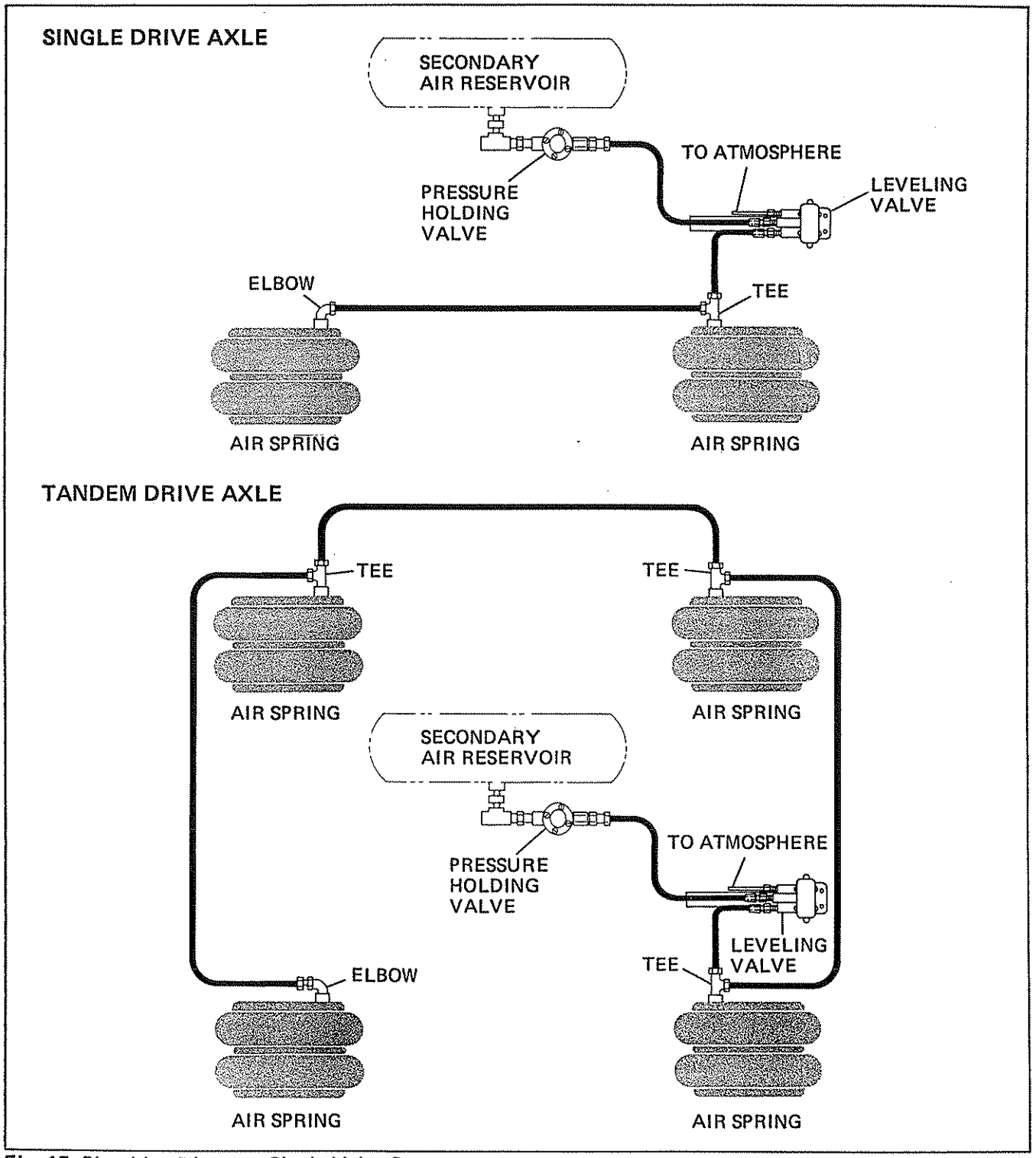

Fig. 15, Plumbing Diagram, Single Valve System

FREIGHTLINER AIRLINER® MULTILEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

SPECIFICATIONS (Continued)

DESCRIPTION	SIZE	TORQUE lbf·ft (N·m)
Adjustment Locknut	1/4–20	5 (7)
Leveling Valve Mounting Capscrew Nuts	1/4–28	10 (14)
Leveling Valve Linkage-to-Overtravel Lever Nut	1/4–20	6 (8)
Shock Absorber Mounting Locknuts	3/4–16	150 (203)
Spring Hanger Bushing Locknut	1–14	*
Air Spring Lower Mounting Plate Capscrews	3/8–16	34 (46)
Air Spring Upper Mounting Plate Capscrews	3/8–16	34 (46)
Air Spring Upper Mounting Plate Nuts	3/4–16	45 (61)
Air Spring Upper Mounting Plate Nuts	1/2–13	20 (27)
Crossmember U-Bolt High Nuts	5/8–18	90 (120)
Spring-to-Adjusting Block Capscrews	5/8–11	175 (240)
Spring Adjusting Block Rear Locknut	1/2–20	130 (175)
Axle U-Bolt High Nuts	7/8–14	400 (542)
Spring Hanger (Neoprene Sleeve) Capscrew Locknut	3/4–16	*
Spring Hanger Mounting Locknuts	5/8–11†	136 (184)
	5/8–11	200 (271)
Shock Absorber Upper Bracket Locknuts	1/2–13†	68 (92)
	1/2–13	82 (111)
Air Bag Support Bracket	1/2–13†	68 (92)
	1/2–13	82 (111)

Table 1, Torque Specifications

* Refer to text.
† Grade 8 bolts with phosphate- and oil-coated threads, and cadmium-plated, wax-coated grade C locknuts; both used with hardened washers.

FREIGHTLINER AIRLINER® TAPERED LEAF SUSPENSION, MODELS FAS 20 AND FAS 38

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FREIGHTLINER AIRLINER® TAPERED LEAF SUSPENSION, MODELS FAS 20 AND FAS 38

GENERAL DESCRIPTION

The Freightliner Airliner® suspension (FAS) is equipped with a tapered leaf spring assembly, secured to the axle housing by U-bolts. The rear end of the spring attaches to a suspension crossmember, and the forward end to a spring hanger. Air springs mounted between the frame rail and suspension crossmember are used to adjust vehicle height, compensating for changes in road conditions and vehicle load. The air springs also absorb road shock.

A leveling valve regulates the flow of air into or out of the air springs. See **Fig. 1**. Changes in the clearance between the vehicle frame and the suspension crossmember activate the leveling valve.

A pressure holding valve (**Fig. 2**, Ref. 2) located in the air line to the leveling valve, is preset to maintain a minimum pressure of about 65 psi (448 kPa) in the vehicle secondary air system, should a leak occur in the air suspension system. If a leak occurs in the air suspension system, solid rubber bumpers in the air springs will support the vehicle load until a repair can be made.

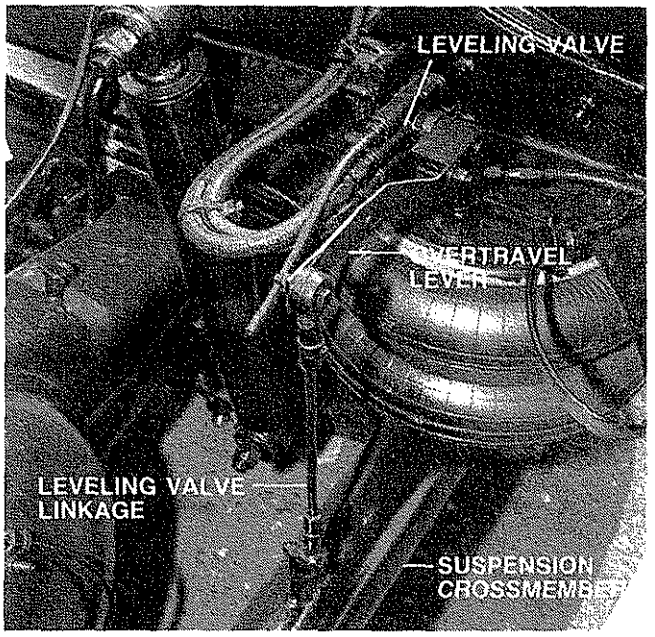


Fig. 1, Leveling Valve System

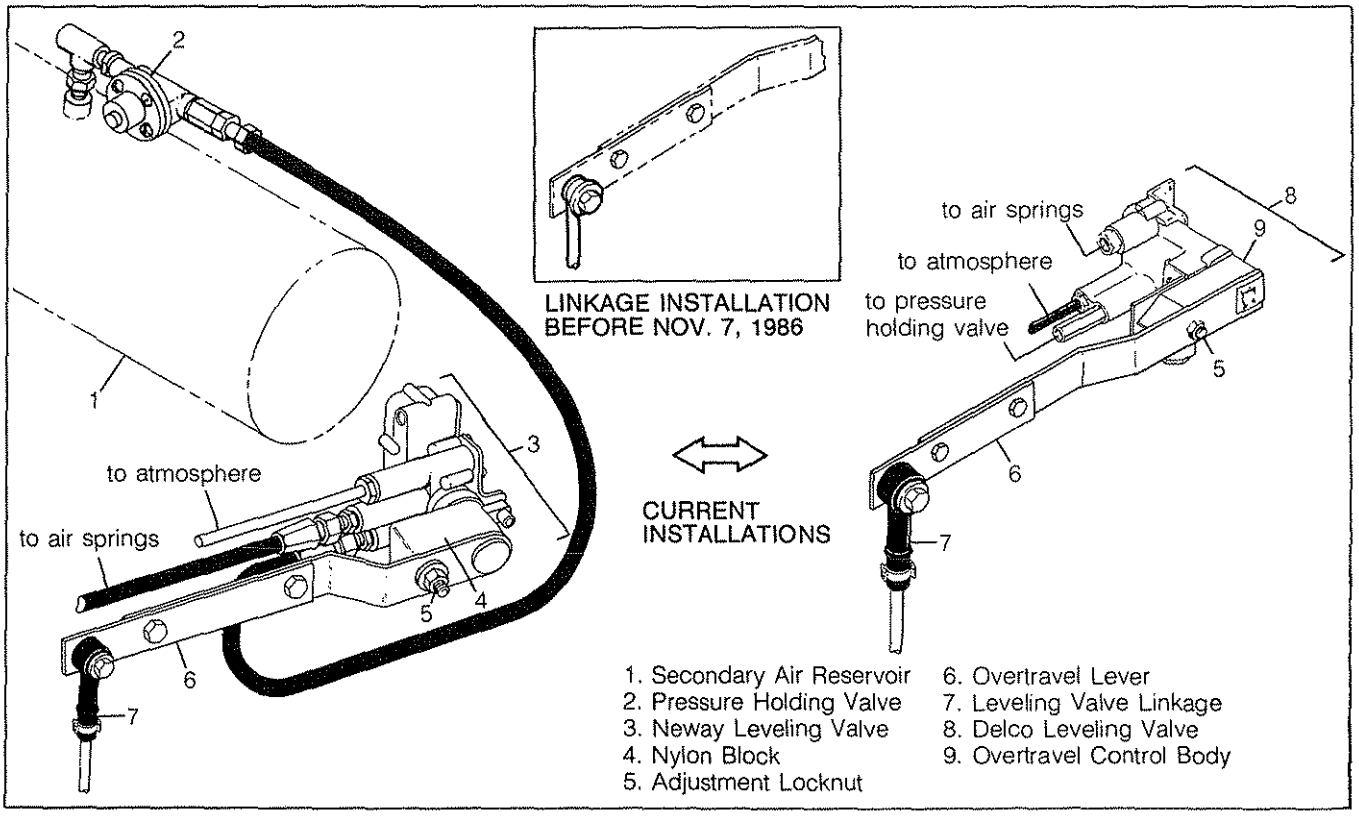


Fig. 2, Leveling Valve Linkage Installation

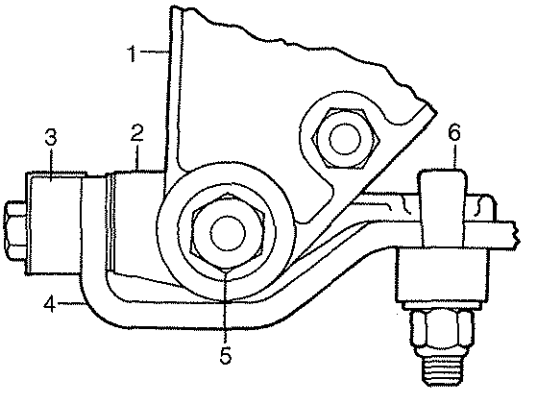
FREIGHTLINER AIRLINER® TAPERED LEAF SUSPENSION, MODELS FAS 20 AND FAS 38

The forward end of the tapered leaf spring may have either an adjustment block design as shown in **Figs. 3** and **4**, or a leaf spring that bolts to the spring hanger through mounting eyes as shown in **Fig. 5**.

PRINCIPLES OF OPERATION

The leveling valve controls the air suspension system. All of the air in the system is admitted through or exhausted from this valve.

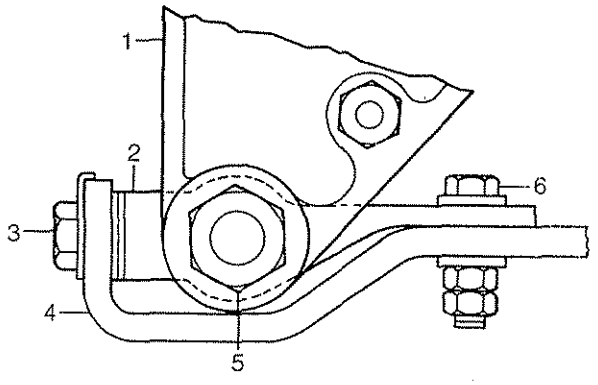
The leveling valve is mounted on the inside web of the frame rail. An overtravel lever extends horizontally from the end of the leveling valve control shaft to a linkage arm that connects to the suspension crossmember. See **Fig. 1**. When the load changes, the overtravel lever turns the leveling valve control shaft, activating either the intake or exhaust valve core inside the leveling valve. This adjusts the air pressure in the air springs, until the frame returns to the normal ride height, and the overtravel lever returns to the neutral (horizontal) position.

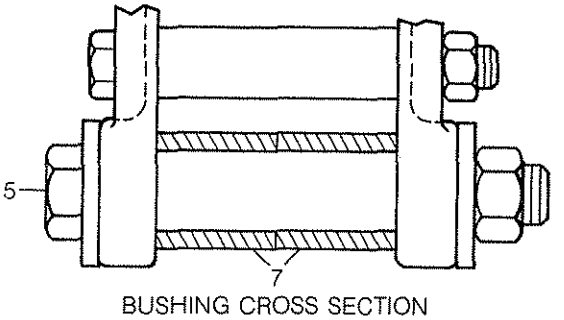


1. Spring Hanger
2. Adjustment Block With Integral Bushing
3. Spacer
4. Spring
5. Bushing Bolt
6. Adjustment Block-to-Spring U-Bolt

Fig. 4

With the vehicle in motion, and the overtravel lever in the neutral position, small movements of the overtravel lever occur without activating the leveling valve. This is due to a free-travel range: a gap between the leveling valve control shaft and the internal valve cores of the leveling valve. In addition, the leveling valve is filled with



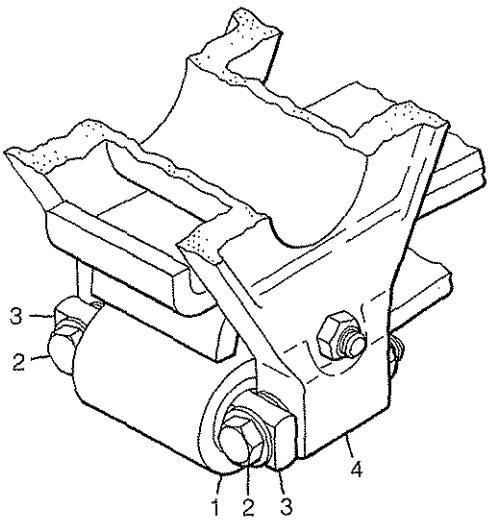


BUSHING CROSS SECTION

1. Spring Hanger
2. Adjustment Block
3. Spring-to-Adjustment Block Capscrew
4. Spring
5. Bushing Bolt
6. Adjustment Block-to-Spring Bolt
7. Two-Piece Urethane Bushing

Fig. 3

FREIGHTLINER AIRLINER® TAPERED LEAF SUSPENSION, MODELS FAS 20 AND FAS 38



1. Spring
2. Spring Mounting-Eye Bolt
3. Mounting-Eye Pin and Bushing Assembly
4. Spring Hanger

Fig. 5

a silicone fluid, which delays (from two to six seconds) the closing of one valve core after the opening of the other. This prevents activation of the leveling valve during abrupt movements of the axle.

SERVICE OPERATIONS

GENERAL GUIDELINES AND PRECAUTIONS

1. Because air suspension systems are controlled by contaminant-sensitive air valves, the air system must be kept free of any oil, moisture, or foreign material. Air system components should be inspected and maintained regularly. Refer to the applicable group of the *COE & 120 Conventional Maintenance Manual* for maintenance operations.

CAUTION: Failure to prevent the entry of moisture, oil, or other foreign material into the air suspension system could eventually lead to sludge forming in the air system. Sludge could adversely affect the operation of the air suspension system as well as other air system components.

2. Attach spring hangers and brackets to the frame using SAE grade 8 bolts with phosphate- and oil-coated threads, and grade C prevailing torque locknuts that are cadmium plated and wax coated. Install flatwashers with a hardness rating of 38 to 45 HRC under both the bolt and the nut. An acceptable alternative is to use SAE grade 8.2 flanged hexbolts and grade G prevailing torque flanged locknuts.

3. All suspension fasteners require periodic retorquing. For suspension component inspecting, lubricating, and fastener torque checking intervals and instructions, refer to the maintenance schedule and Group 16 of the *COE & 120 Conventional Maintenance Manual.*

CAUTION: Failure to periodically torque suspension fasteners can result in abnormal tire wear and damage to springs, spring hangers, brackets, and frame rails.

4. At all points where aluminum parts are fastened to steel parts, use Alumilastic® compound, or equivalent, on the mating surfaces. This includes nuts, bolts, and washers.

CAUTION: Failure to apply Alumilastic compound, or equivalent, to areas where aluminum and steel parts contact each other, could lead to corrosion of the metals, resulting in suspension system and frame damage.

LEVELING VALVE ADJUSTMENT

Adjust the leveling valve with the vehicle on a level surface.

CAUTION: Failure to adjust the leveling valve could adversely affect driveline angles. Also, if the air springs are set too high, the driver may have difficulty (or be prevented from) backing the vehicle under a trailer. If the air springs are set too low, too much wear of suspension parts will result.

1. Chock the tires. Run the engine to build up and maintain a vehicle air pressure of 70 psi (482 kPa).
2. Disconnect the leveling valve linkage from the overtravel lever. Refer to **Fig. 2**. Exhaust all air from the air springs by moving the overtravel lever down.
3. Loosen the adjustment locknut (**Fig. 2**, Ref. 5), and move the overtravel lever until the stud in the nylon block or overtravel control body is centered in the overtravel lever adjustment slot. Then, tighten the leveling valve adjustment locknut 60 lbf·in (680 N·cm).

NOTE: If the vehicle is equipped with a Neway leveling valve, insert a 3/16-inch diameter locating pin (or a 3/16-inch drill bit) in the hole at the back of the nylon block

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and through the hole in the mounting bracket. Refer to **Fig. 6**. This will aid in centering the nylon block stud in the overtravel lever adjustment slot. After tightening the adjustment locknut, remove the locating pin (drill bit).

4. Connect the overtravel lever to its linkage, and allow the air springs to fill until the valve shuts off.
5. Measure the distance from the bottom of the frame rail flange to the bottom of the air springs. See **Fig. 7**. This distance should be 6-3/4 inches (170 mm).

NOTE: Perform this measurement on the forward axle of tandem axle installations.

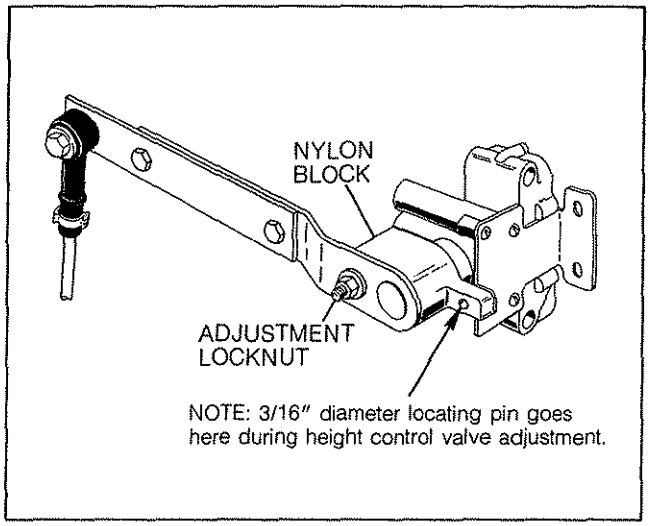

Fig. 6, Neway Leveling Valve

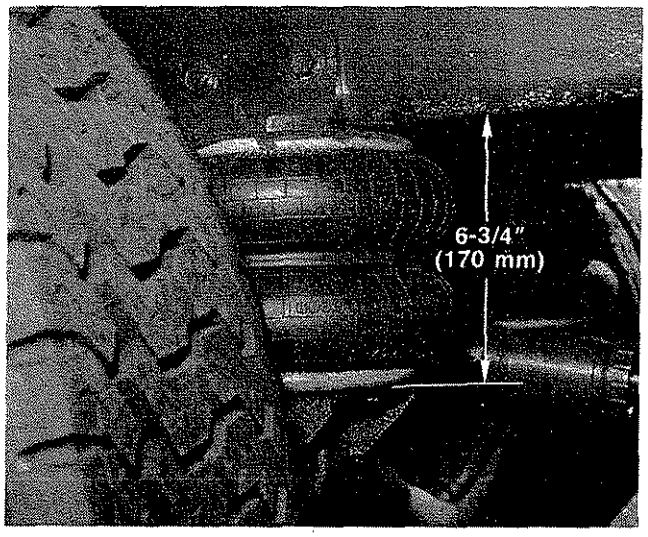

Fig. 7, Air Spring Height Measurement

If the distance is not 6-3/4 inches (170 mm), loosen the leveling valve mounting bolt nuts, and rotate the entire valve slightly until the height is correct. Tighten the leveling valve mounting bolt nuts 14 lbf·ft (19 N·m).

IMPORTANT: Because of a built-in delay in the leveling valve, two to six seconds are required after making adjustments before the spring height changes.

6. Disconnect the leveling valve linkage, and allow the air springs to deflate about halfway.

   Connect the linkage to inflate the air springs, and check the air spring height again. Repeat steps 5 and 6 above, until the height measures 6-3/4 inches (170 mm).

   When the height is within 1/8-inch (3 mm) of the required 6-3/4 inches (170 mm), final adjustment is made by loosening the adjustment locknut and slightly moving the overtravel lever relative to the nylon block or overtravel control body. Tighten the leveling valve adjustment locknut 60 lbf·in (680 N·cm).
7. Connect the leveling valve linkage to the overtravel lever. Tighten the lever nut 12 lbf·ft (16 N·m).
8. Remove the chocks from the tires.

LEVELING VALVE CHECKS

The leveling valve is the control center of any air suspension system and is sensitive to changes in height; when correctly adjusted, it maintains the correct suspension ride height.

Carefully check the valve before replacing it. Do the following steps to see if a valve is damaged or out of adjustment.

1. Disconnect the valve linkage from the overtravel lever. Refer to **Fig. 2**.
2. Pull the overtravel lever up about 45 degrees for 6 to 8 seconds. See **Fig. 8**, Ref. A. If air passes through the valve, that section of the valve is okay.
3. Return the valve to the neutral position. See **Fig. 8**, Ref. B. Air should stop flowing. If so, that section of the valve is okay.
4. Push the overtravel lever down about 45 degrees for 6 to 8 seconds. See **Fig. 8**, Ref. C. If air exhausts from the valve, that section of the valve is okay.
5. Return the valve to the neutral position. If the air stops again in the neutral position, the valve is working correctly.

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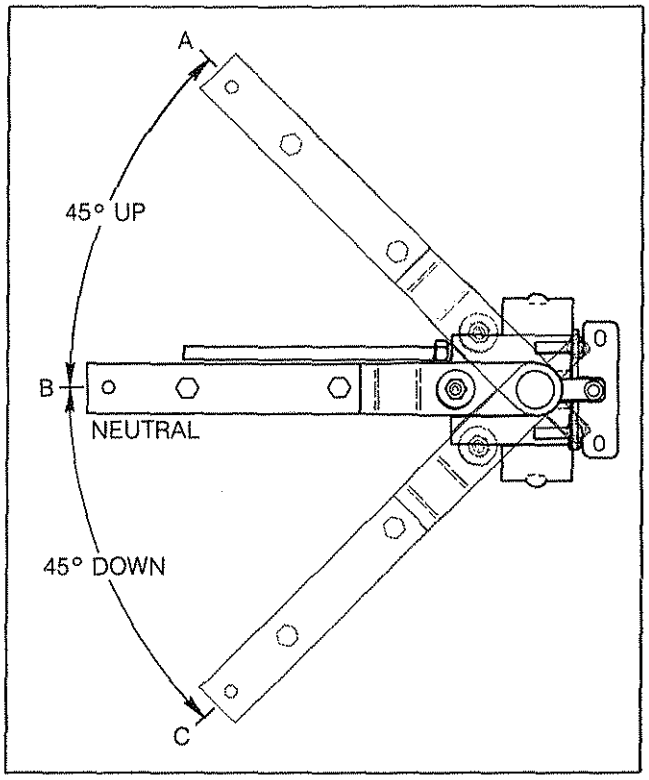

Fig. 8

6. If you do all of the above steps and the valve works as stated, the valve is operative.

   If adjustment of the leveling valve is needed, refer to "Leveling Valve Adjustment."

LEVELING VALVE REMOVAL AND INSTALLATION

Removal

1. Chock the tires.
2. Drain the air system. For instructions, refer to Group 12 of the Freightliner *Maintenance and Lube Manual.*
3. Disconnect the linkage from the overtravel lever. Refer to **Fig. 2.** Exhaust all air from the air springs by moving the overtravel lever down.
4. Disconnect the air lines at the leveling valve, and mark the lines for later assembly reference (do not disconnect the exhaust tube). Using tape, cover the open ends of the air lines and fittings to prevent dirt or foreign material from entering.
5. Remove the leveling valve mounting bolts and nuts, and remove the leveling valve from the frame rail.

Installation

NOTE: For Delco leveling valves (**Fig. 2**, Ref. 8), inspect the air line adapter fittings before installing the leveling valve. If the gaskets in the adapter fitting ports are worn or damaged, replace the gaskets. Keep the adapters free of any dirt or foreign material to prevent damage to the valves.

1. Attach the leveling valve to the frame rail. Tighten the valve mounting bolt nuts 14 lbf·ft (19 N·m).
2. Remove the tape from the air lines and fittings, and connect the air lines to the leveling valve, as referenced earlier or as shown in **Fig. 17** under Specifications. Tighten the lines to the values in Group 12 of the Freightliner *Maintenance and Lube Manual.*
3. Connect the leveling valve linkage to the overtravel lever. Tighten the lever nut 12 lbf·ft (16 N·m).
4. Close the drain cocks on all reservoirs.
5. Build up normal operating pressure in the air system. Check all air lines and connections for leaks. Eliminate all leaks.
6. Adjust the leveling valve. For instructions, refer to "Leveling Valve Adjustment."

SHOCK ABSORBER REPLACEMENT

1. Chock the tires.
2. Remove the locknuts and washers from the shock absorber upper and lower mounting pins. See **Fig. 9.**
3. Pull the shock absorber off the mounting pins to remove it from the vehicle. If the inner metal sleeve has fastened to the mounting pin, use a small, sharp chisel to force the sleeve from the pin.
4. Install the replacement shock absorber on the mounting pins, and secure it with the locknuts and washers. Tighten the shock absorber mounting locknuts 150 lbf·ft (203 N·m).
5. Remove the chocks from the tires.

ADJUSTMENT BLOCK WITH INTEGRAL BUSHING REPLACEMENT (Refer to **Fig. 10**)

NOTE: If equipped with a two-piece urethane bushing, refer to "Spring Hanger Urethane Bushing Replacement" for instructions.

1. Chock the front tires.

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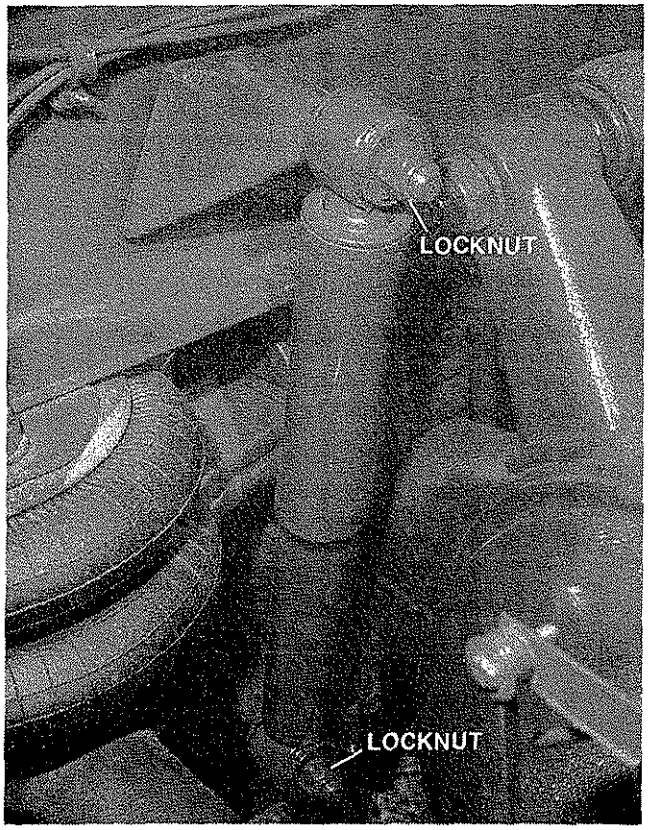

Fig. 9, Shock Absorber Fasteners

2. Raise the rear of the vehicle, and support the rear axle(s) with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then support the frame with safety stands. Make sure the stands will securely support the weight of the vehicle frame. Remove the wheel assembly, to gain access to the adjustment block.
3. Disconnect the leveling valve linkage from the overtravel lever. Refer to **Fig. 2**.
4. Remove the locknut, bearing washers, and bolt from the spring hanger and adjustment block bushing.
5. Remove the locknut, flatwasher (if equipped), bolt, and neoprene sleeve from the spring hanger.
6. Remove the adjustment block U-bolt nuts, bearing washers, U-bolt, and U-bolt pad.
7. Note the number of axle alignment shims for later reference. Straighten the corners of the locking tab shim, and remove the spring-to-adjustment block capscrews, spacer, and shims.

NOTE: If replacing the adjustment block on the other end of the axle, repeat steps 4 through 7 for that end before going to step 8.

8. Lower the axle until the spring clears the spring hanger. Pull the adjustment block forward and out of the spring. If needed, use a pry bar to push downward on the spring torque leaf.
9. Place the new adjustment block in the spring. Raise the axle until the bushing hole is aligned with the spring hanger bushing holes.
10. Place the adjustment block U-bolt over the rear of the adjustment block. Install the U-bolt pad, bearing washers, and U-bolt nuts. Bring the nuts up snug, but do not tighten. The adjustment block must be able to slide under the U-bolt.
11. Install the axle alignment shims, as previously noted. Place the locking tab shim and spacer against the spring torque leaf, and align the mounting holes. Attach with the spring-to-adjustment block capscrews. Bring the capscrews up snug, but do not tighten.
12. Install the neoprene sleeve, bolt, flatwasher (if equipped), and locknut in the spring hanger.
13. Place a bearing washer over the bushing bolt. Install the bolt and washer from the inboard side of the spring hanger. Install the bearing washer and locknut on the bolt. Tighten the nut 450 lbf·ft (610 N·m).
14. Tighten the neoprene sleeve locknut 30 lbf·ft (41 N·m).
15. Tighten the spring-to-adjustment block capscrews 190 lbf·ft (258 N·m). Bend a corner of the locking tab shim over the head of each spring-to-adjustment block capscrew. See **Fig. 11**.
16. Tighten the U-bolt locknuts 340 lbf·ft (461 N·m).
17. Connect the leveling valve linkage to the overtravel lever. Tighten the lever nut 12 lbf·ft (16 N·m).
18. Install the wheel assembly. For instructions, refer to Group 13. Remove the safety stands, and lower the vehicle. Remove the chocks from the tires.

TWO-PIECE URETHANE BUSHING REPLACEMENT (Refer to **Fig. 12**)

If equipped with a two-piece urethane bushing (**Fig. 12**), proceed as follows:

1. Chock the tires.

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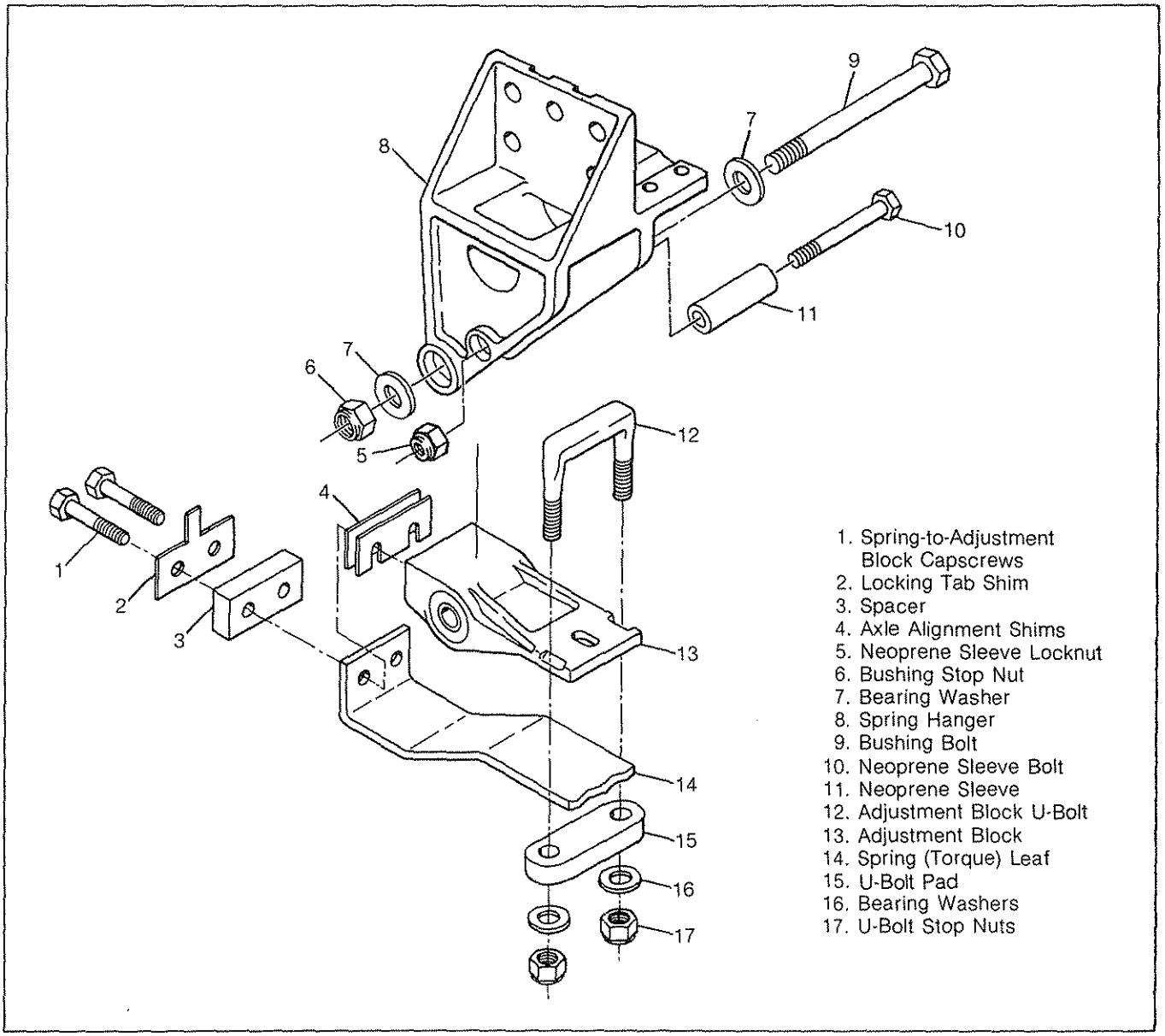

Fig. 10, Adjustment Block With Integral Bushing

2. Remove the locknut and flatwasher from the urethane bushing bolt.

3. Using an impact wrench on the bushing bolt head, turn the bolt counterclockwise. At the same time, apply firm pressure against the threaded end of the bolt and extract it from the spring hanger.

4. Remove the two-piece urethane bushings from the spring hanger and the adjustment block.

5. Slide the new two-piece urethane bushings into the spring hanger and adjustment block.

6. Place the flatwasher over the bushing bolt. Install the bolt and washer from the inboard side of the spring hanger.

7. Install the flatwasher and locknut on the bushing bolt.

   Insert a measuring rule in the space between the forward end of the leaf spring and the lower ends

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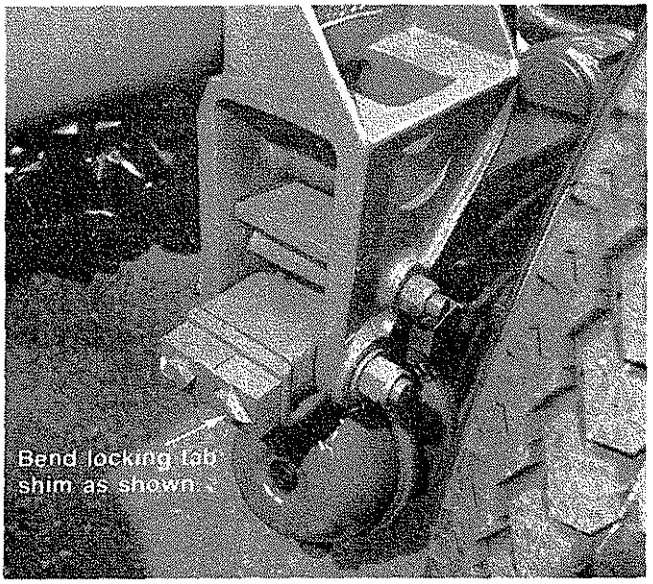


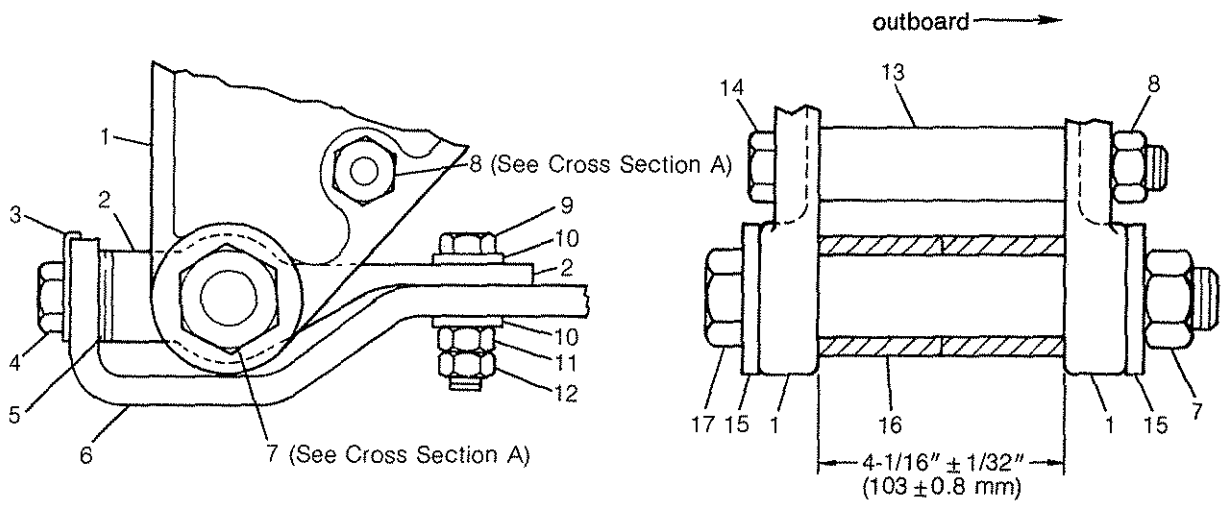
Fig. 11

of the spring hanger. See Fig. 13. Measure the distance between the inside edges of the spring hanger ears. This distance must be 4-1/16 inches ± 1/32 inch (103 ± 0.8 mm). See Fig. 12, Cross Section A. Tighten or loosen the bushing bolt locknut until this measurement is obtained. Using a center punch, stake the exposed thread of the bushing bolt to the locknut in one place, to maintain the position of the locknut.

8. Remove the chocks from the tires.

AIR SPRING REPLACEMENT

1. Chock the front tires. Raise and support the vehicle frame with safety stands to remove all weight from the air springs. The leveling valve automatically releases air from the air springs when all weight is removed from the suspension.
2. Disconnect the air supply line from the air spring. Using tape, cover the ends of the air supply line and the fitting to prevent dirt or foreign material from entering.



CROSS SECTION A

1. Spring Hanger
2. Adjustment Block
3. Locking Tab Shim
4. Spring-to-Adjustment Block Capscrew
5. Axle Alignment Shims
6. Spring (Torque) Leaf
7. Bushing Locknut
8. Neoprene Sleeve Locknut
9. Adjustment Block-to-Spring Bolt
10. Bearing Washer
11. Hex Nut
12. Self-Locking Jam Nut
13. Neoprene Sleeve
14. Neoprene Sleeve Bolt
15. Flatwasher
16. Two-Piece Urethane Bushing
17. Urethane Bushing Bolt

Fig. 12, Adjustment Block With Two-Piece Urethane Bushing

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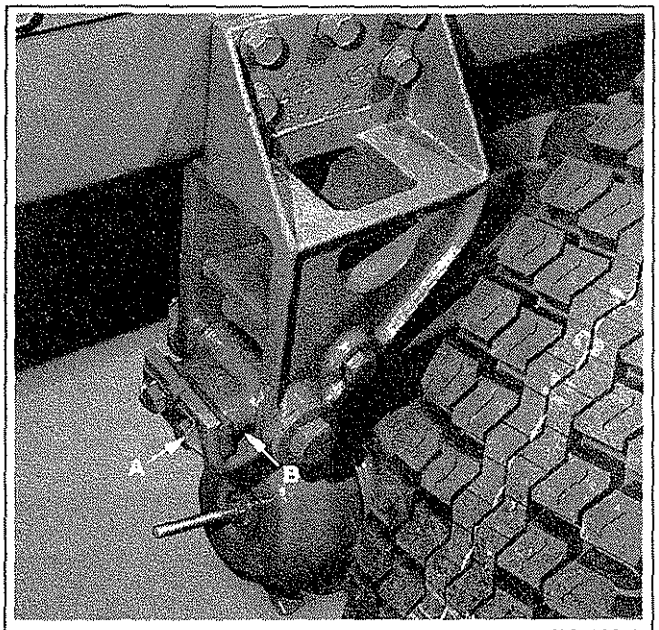

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A. Bend locking tab shim as shown.
B. Insert measuring rule through here.

Fig. 13

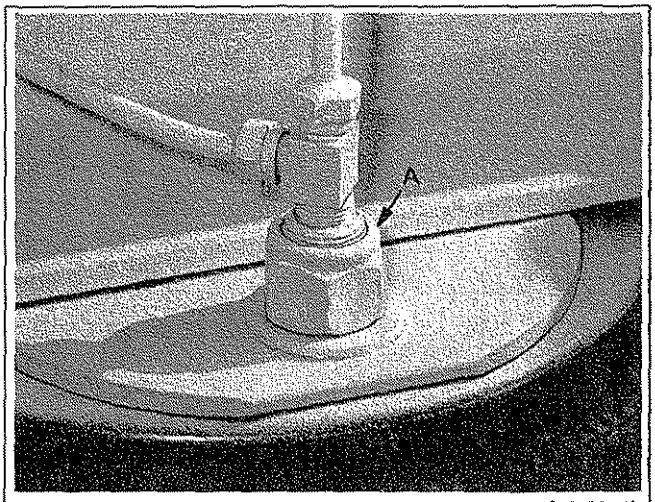
3. Remove the locknuts and washers that connect the air spring to the upper mounting bracket. See **Fig. 14.**

4. Remove the serrated-flange capscrews that connect the air spring to the lower bag support. See **Fig. 15.** Remove the air spring.

5. Place the new air spring on the lower bag support, and install the capscrews securing the air spring in place. See **Fig. 15.** Use only serrated-flange 3/8–16 by 3/4-inch cadmium-plated capscrews. Tighten the capscrews 34 lbf·ft (46 N·m).

6. Attach the washers and locknuts connecting the air spring to the upper mounting bracket. See **Fig. 14.** Tighten air spring upper mounting 3/4–16 locknuts 45 lbf·ft (61 N·m); tighten 1/2–13 locknuts 20 lbf·ft (27 N·m).

7. Remove the tape from the end of the air supply line and the fitting. Connect the air supply line to the air spring. Tighten the line to the value in Group 12 of the *Freightliner Maintenance and Lube Manual.*



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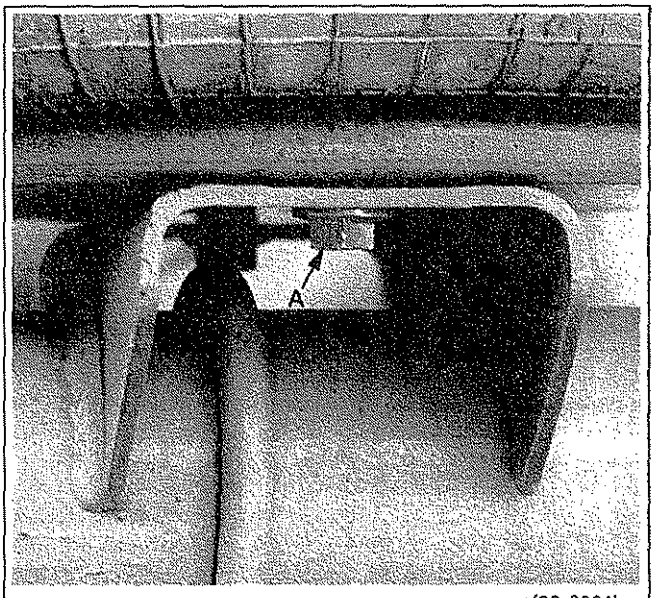
A. Remove/install locknut here and on outside of frame rail.

Fig. 14, Air Spring Upper Mounting Bracket



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A. Remove/install capscrew here and on opposite end.

Fig. 15, Air Spring Lower Mounting

8. Remove the safety stands, and lower the vehicle. Remove the chocks from the tires.

FREIGHTLINER AIRLINER® TAPERED LEAF SUSPENSIONS, MODELS FAS 20 AND FAS 38

LEAF SPRING REMOVAL AND INSTALLATION (Refer to **Fig. 16**)

Removal

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

1. Chock the front tires.
2. Raise the rear of the vehicle, and support the rear axle(s) with safety stands. Raise the vehicle frame so that all weight is removed from the leaf springs, then securely support the frame with safety stands. Remove the wheel assembly, to gain easy access to the suspension.
3. Remove the locknut, flatwasher (if equipped), bolt, and neoprene sleeve from the spring hanger. See **Fig. 10.**
4. Disconnect the spring torque leaf from the spring hanger as follows:

   .a On springs with mounting eyes, note the number and position of washers on the eye-to-hanger bolts. Remove the locknuts, bolts, and washers.

   .b On springs with adjustment blocks, straighten the corners of the locking tab shim. Note the number of axle alignment shims for later reference. Remove the spring-to-adjustment block capscrews, locking tab shim, spacer (if equipped), and shims.

5. Remove the adjustment block U-bolt nuts, bearing washers, U-bolt pad, and U-bolt (if equipped).

   On earlier installations, remove the nuts (Refs. 40 and 41), bearing washers (Ref. 35) (if equipped), and the adjustment block-to-spring bolt (Ref. 42).

6. Remove the high nuts and flatwashers from the crossmember U-bolts. Remove the pressure plate and the U-bolts.
7. Remove the high nuts and flatwashers from the axle U-bolts. Remove the axle clamp, then remove the axle U-bolts and the U-bolt pad.
8. Slide the leaf spring off the spring seat. Discard the leaf spring assembly.

Installation

1. Install the new leaf spring assembly. Set the axle U-bolt pad in place on top of the leaf spring assembly, then slide the axle U-bolts into place. Apply antisieze compound to the U-bolt threads. Install the axle clamp, and hold it in place with the flatwashers and high nuts. Tighten the nuts finger-tight.
2. Install the suspension crossmember U-bolts and the pressure plate, securing the leaf spring assembly to the crossmember. Install the flatwashers and high nuts on the crossmember U-bolts. Tighten the high nuts 65 lbf·ft (88 N·m).
3. On springs with mounting eyes, install the washers, bolts, and locknuts as noted earlier. Tighten the locknuts 190 lbf·ft (258 N·m).
4. On springs with adjustment blocks, attach the spring to the spring hanger as follows:

   .1 Install the axle alignment shims, as previously noted.

   IMPORTANT: The maximum thickness of all the shims, including the locking tab shim, is 3/8 inch. If more shims are used, a capscrew longer than 2-3/4 inches (1-3/4 inches on installations without the spacer) must be installed to maintain a thread engagement in the adjustment block of no less than 3/4 inch (19 mm) and no more than 1-1/8 inches (28 mm).

   .2 For one-piece adjustment blocks, install the adjustment block, U-bolt, U-bolt pad, bearing washers, and U-bolt nuts. Bring the nuts up snug, but don't tighten them.

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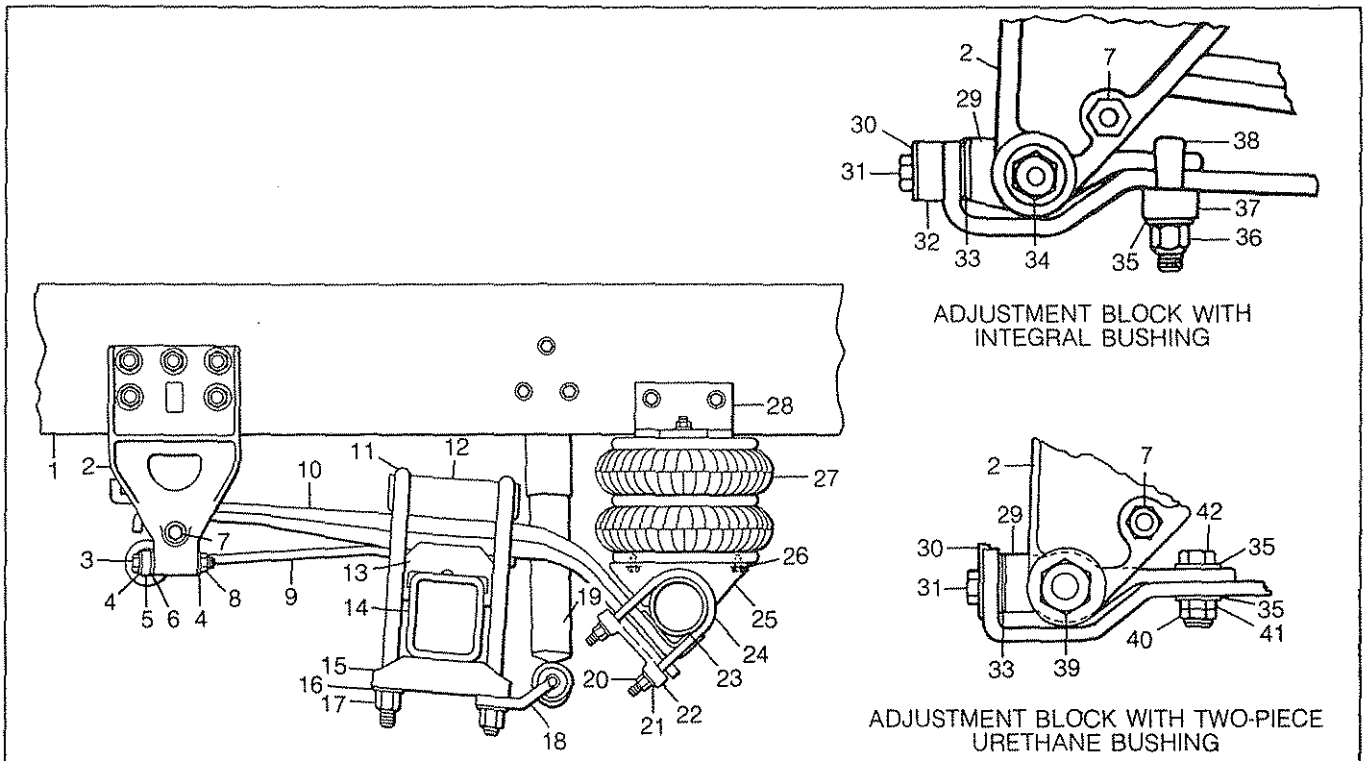

1. Frame Rail
2. Spring Hanger
3. Spring Mounting Eye Bolt
4. Bearing Washer
5. Spring Mounting Eye
6. Alignment Washer
7. Neoprene Sleeve Locknut
8. Locknut
9. Spring Torque Leaf
10. Tapered Leaf Spring Assembly
11. Axle U-Bolt
12. Axle U-Bolt Pad
13. Spring Seat
14. Axle (Sectional View)
15. Axle Clamp
16. Flatwasher
17. High Nut
18. Shock Absorber Mounting Bracket
19. Shock Absorber
20. High Nut
21. Flatwasher
22. Pressure Plate
23. Suspension Crossmember
24. Suspension Crossmember U-Bolt
25. Lower Air Spring Support
26. Serrated-Flange Capscrew
27. Air Spring
28. Air Spring Upper Mounting Bracket
29. Adjustment Block Assembly
30. Locking Tab Shim
31. Spring-to-Adjustment Block Capscrew
32. Spacer
33. Axle Alignment Shims
34. Adjustment Block Bushing Locknut
35. Bearing Washer
36. U-Bolt Locknut
37. Adjustment Block U-Bolt Pad
38. Adjustment Block U-Bolt
39. Urethane Bushing Locknut
40. Self-Locking Jam Nut
41. Hex Nut
42. Adjustment Block-to-Spring Bolt

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Fig. 16

On earlier installations (**Fig. 12**), install the bearing washer on the hex bolt, then install the bolt in the adjustment block and spring. Install the bearing washer, hex nut, and self-locking jam nut on the bolt. See **Fig. 12.** Do not tighten the nuts.

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If equipped with flanged fasteners, install the flanged bolt in the adjustment block and spring. Install the flanged nut on the bolt, but do not tighten the nut.

.3 Place the locking tab shim and spacer (if equipped) on the spring-to-adjustment block capscrews, then install the capscrews in the spring and adjustment block. Tighten the capscrews 190 lbf·ft (258 N·m). Bend a corner of the locking tab shim over the head of each capscrew. See **Fig. 11.**

.4 Tighten one-piece adjustment block U-bolt nuts 340 lbf·ft (461 N·m).

On earlier installations (**Fig. 12**), align the wrench flats on the hex nut with the flats on the self-locking nut, with a small space between the two nuts; the nuts must not be touching each other. Slip a 3/4-inch deep-well socket over both nuts, while maintaining the space between them. Tighten the hex nut 100 lbf·ft (136 N·m). Then, position the socket on the self-locking nut only, and tighten it the same amount.

If equipped with flanged fasteners, tighten the nut 100 lbf·ft (136 N·m).

5. Tighten the axle U-bolt high nuts 400 lbf·ft (542 N·m).

6. Install the neoprene sleeve in the spring hanger, then install the bolt from the inboard side of the spring hanger. Install the flatwasher (if equipped) and locknut on the bolt. Tighten the locknut 30 lbf·ft (41 N·m).

   On springs with urethane bushings, tighten the neoprene sleeve locknut until the distance between the inside edges of the spring hanger measures 4-1/16 inches ± 1/32 inch (103 ± 0.8 mm). See **Fig. 12**, Cross Section A, and **Fig. 13.**

7. Install the wheel assembly. For instructions, refer to Group 13. Remove the safety stands, and lower the vehicle.

8. Check the rear axle alignment. For instructions, refer to Group 11. If necessary, adjust the rear axle alignment using the instructions under "Rear Axle Alignment Adjustment."

REAR AXLE ALIGNMENT ADJUSTMENT
(Refer to **Fig. 16**)

1. Disconnect the forward end of the spring torque leaf from the spring hanger as follows:

   .1 On springs with mounting eyes, remove the spring eye-to-hanger bolts, nuts, and washers.

   .2 On springs with adjustment blocks, straighten the corners of the locking tab shim, then remove the spring-to-adjustment block capscrews and, if equipped, the spacer. Loosen the adjustment block U-bolt stop nuts or the adjustment block-to-spring bolt locknuts.

2. Move the axle forward or backward until it is aligned within the tolerances in the rear axle alignment checking subject in Group 11.

3. When the axle is in alignment:

   .a On springs with mounting eyes, install axle alignment washers as needed between the mounting eyes and the spring hanger. Install the bearing washers, bolts, and locknuts. Refer to **Fig. 16.** Tighten the locknuts 190 lbf·ft (258 N·m).

   .b On springs with adjustment blocks, install the axle alignment shims to take up the slack between the end of the spring and the adjustment block. Place the locking tab shim and spacer (if equipped) against the leaf spring, and align the mounting holes. Install the spring-to-adjustment block capscrews. Tighten the capscrews 190 lbf·ft (258 N·m).

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IMPORTANT: Up to five 1/16-inch axle alignment shims can be used with a 1/16-inch locking tab shim and 2-3/4 inch long capscrews (1-3/4 inches without a spacer). The maximum thickness of all the shims, including the locking tab shim, is 3/8 inch. If more than five shims are used, install a longer capscrew to maintain a thread engagement in the adjustment block of no less than 3/4 inch (19 mm) and no more than 1-1/8 inches (28 mm).

4. Check the axle alignment again. Repeat the above procedure until alignment is within tolerances.

5. After the axle is in alignment and the capscrews are tightened, bend the corners of the locking tab shim (if equipped) over the capscrew heads. See **Fig. 11.** Tighten one-piece adjustment block U-bolt locknuts 340 lbf·ft (461 N·m).

   On installations with urethane bushings, align the wrench flats on the hex nut with the flats on the self-locking nut, with a small space between the two nuts; the nuts must not be touching each other. Slip a 3/4-inch deep-well socket over both nuts, while maintaining the space between them. Tighten the hex nut 100 lbf·ft (136 N·m). Then, position the socket on the self-locking nut only, and tighten it the same amount.

   If equipped with a flanged locknut, tighten the nut 100 lbf·ft (136 N·m).

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TROUBLESHOOTING

Problem – All Air Springs Are Flat

Possible Cause	Remedy
Low air pressure in the secondary air system.	Check the air pressure gauge on the instrument panel. If secondary air pressure is low, run the engine until at least 70 psi (482 kPa) is indicated.
Air is leaking from the air suspension system.	Check for leakage from fittings, air lines, air springs, and the leveling valve. Tighten loose fittings and clamps to stop leakage; replace worn or damaged parts.
The leveling valve is out of adjustment.	Adjust the leveling valve.
The leveling valve is inoperative.	If upward movement of the overtravel lever on a properly adjusted valve fails to inflate the air springs, replace the leveling valve.
The leveling valve linkage is damaged.	Check for damage to the leveling valve linkage and overtravel lever. Repair or replace damaged linkage parts.

Problem – Air Springs Deflate Rapidly When the Vehicle is Parked

Air is leaking from the air suspension system.	Check for leakage from fittings, air lines, air springs, and the leveling valve. Tighten loose fittings and clamps to stop leakage; replace worn or damaged parts.

Problem – Vehicle Rides Too High or Too Low

The leveling valve is out of adjustment.	Adjust the leveling valve.

Problem – Collapsed Air Spring

An air spring is punctured.	Locate leaks by listening for escaping air, or by applying a soap and water solution to the air spring and watching for bubbles. Repair punctures and cuts that are less than 1/8 inch (3 mm). Replace the air spring if damage is greater.
	Check the area around the damaged air spring for air spring contact with such things as frame-mounted accessories, new tires and rims, tire chains, and other components. Correct the problem areas as needed.
The air spring is continually or repeatedly over-extended.	Check the height of the air spring. Make sure the 6-3/4 inch (171 mm) air spring height is maintained. Adjust, if needed. Check for a broken shock absorber. Replace, if broken.

Problem – Air Springs Do Not Fully Deflate When All Weight is Removed from the Suspension

The leveling valve is out of adjustment.	Adjust the leveling valve.
The air line between the leveling valve and the air spring is restricted.	Disconnect the leveling valve linkage, and move the overtravel lever down. If the air spring remains inflated, check for a pinched or blocked line. Clean out plugged lines; replace damaged lines.
The leveling valve is inoperative.	If downward movement of the overtravel lever on a properly adjusted valve fails to deflate the air springs, replace the leveling valve.

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SPECIFICATIONS

Description	Size	Torque
Leveling Valve Adjustment Locknut	1/4–20	60 lbf·in (680 N·cm)
Leveling Valve Mounting Bolt Nuts	1/4–28	14 lbf·ft (19 N·m)
Leveling Valve Linkage-to-Overtravel Lever Nut	1/4–20	12 lbf·ft (16 N·m)
Shock Absorber Locknuts	3/4–16	150 lbf·ft (203 N·m)
Adjustment Block Bushing Locknut	7/8–14	450 lbf·ft (610 N·m)
	1–14	*
Air Spring Lower Mounting Capscrews†	3/8–16	34 lbf·ft (46 N·m)
Air Spring Upper Mounting Locknuts	3/4–16	45 lbf·ft (61 N·m)
	1/2–13	20 lbf·ft (27 N·m)
Crossmember U-Bolt High Nuts	1/2–20	65 lbf·ft (88 N·m)
	5/8–18	100 lbf·ft (136 N·m)
Spring Mounting Eye Bolt Nuts	5/8–11	190 lbf·ft (258 N·m)
Spring-to-Adjustment Block Capscrews	5/8–11	190 lbf·ft (258 N·m)
Adjustment Block U-Bolt Stop Nuts	3/4–16	340 lbf·ft (461 N·m)
Adjustment Block-to-Spring Hex Nut and Self-Locking Nut	1/2–20	100 lbf·ft (136 N·m)
Axle U-Bolt High Nuts	7/8–14	400 lbf·ft (542 N·m)
Neoprene Sleeve Locknut*	3/4–16	30 lbf·ft (41 N·m)
Spring Hanger Mounting Locknuts	5/8–11‡	136 lbf·ft (184 N·m)
	5/8–11	210 lbf·ft (285 N·m)
	3/4–10‡	210 lbf·ft (327 N·m)
	3/4–10	340 lbf·ft (461 N·m)
Shock Absorber Upper Bracket Locknuts	1/2–13‡	68 lbf·ft (92 N·m)
	1/2–13	105 lbf·ft (142 N·m)
Air Spring Upper Mounting Bracket Nuts	1/2–13‡	68 lbf·ft (92 N·m)
	1/2–13	105 lbf·ft (142 N·m)
	5/8–13	190 lbf·ft (258 N·m)

Table 1, Torque Values

* For urethane bushing installations, refer to text.

† Use only serrated-flange 3/8–16 by 3/4-inch cadmium-plated capscrews.

‡ Grade 8 bolts with phosphate- and oil-coated threads, and cadmium-plated, wax-coated grade C locknuts; both used with hardened washers.

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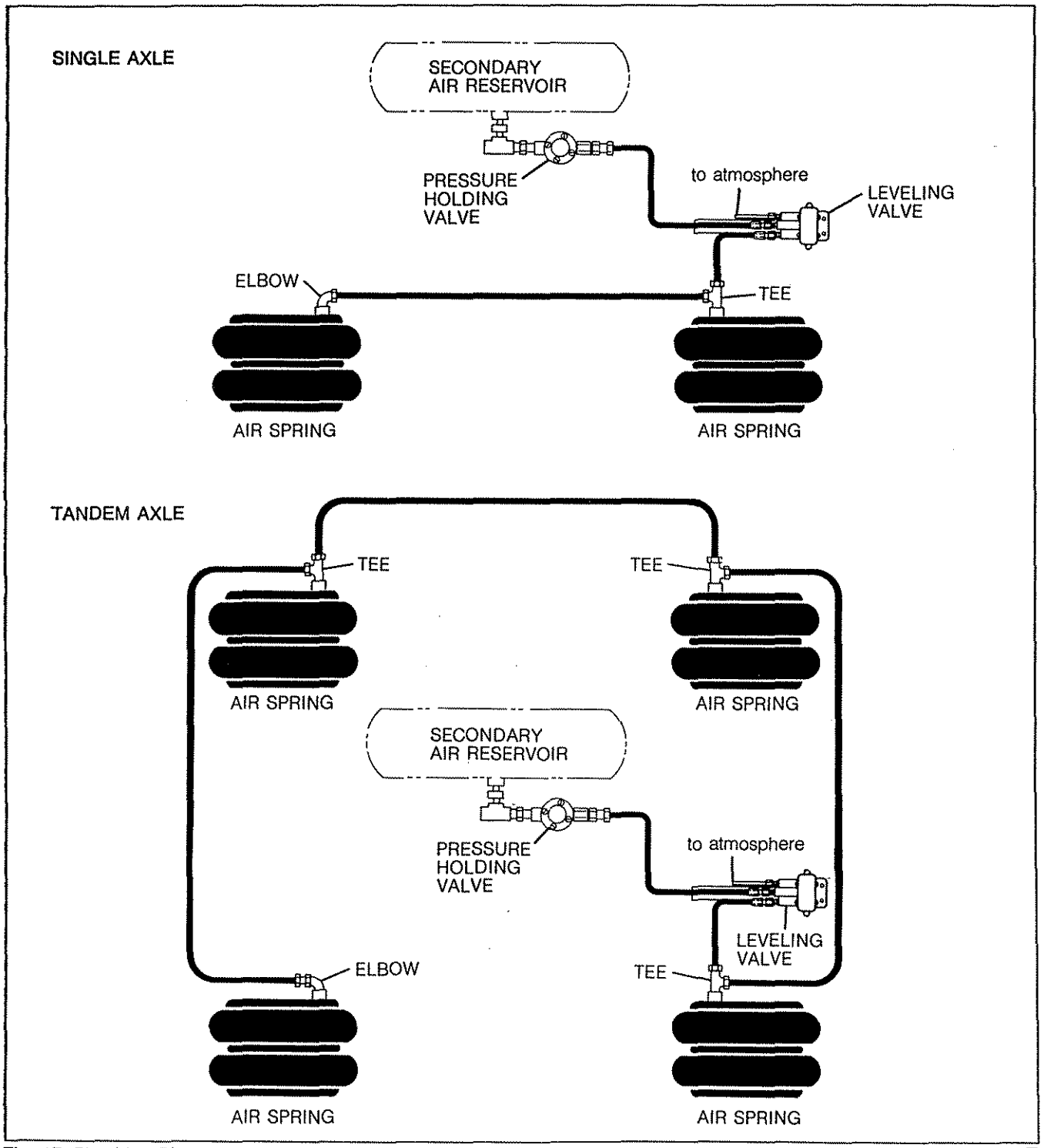

Fig. 17, Plumbing Diagram

HENDRICKSON TANDEM SUSPENSION "U" AND "UE" SERIES, MODEL 340 SUBJECT CONTENTS

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HENDRICKSON TANDEM SUSPENSION "U" & "UE" SERIES, MODEL 340

GENERAL DESCRIPTION

The Hendrickson "U" series suspension (Fig. 1) uses semi-elliptical, steel leaf springs to carry and cushion the load. The springs are mounted on a saddle assembly, on each side of the vehicle, and are pivoted at the forward end, on spring pins in the spring hangers. The rear ends of the springs have no rigid attachment to the rear spring hangers, and are free to move forward and backward to compensate for spring deflection.

The "UE" series suspension (Fig. 2) is basically the same as the "U" series, with the addition of a third, rear spring hanger, and a redesigned spring, with the four top spring leaves extended and the top spring leaf in contact with the rear spring hanger. When the vehicle is operating in an unloaded condition, a gap exists between the top spring leaf and the No. 2 spring hanger, while the sprung weight of the vehicle is carried through the No. 3 spring hanger and most of the spring deflection is through the top extended leaves. See Fig. 3. When the vehicle is operating in the loaded condition, the top extended leaf contacts the No. 2 spring hanger, and the spring weight is carried through the No. 1 and 2 spring hangers. See Fig. 4.

The leaf spring and saddle assemblies attach to the equalizing beams, by clamping of the saddle caps to the equalizing beam center bushings. The axles are attached to beam hangers at the ends of the equalizing beams. This allows an articulating action between the axles to absorb road shock. Torque rods are mounted longitudinally from the axles to the frame crossmember, to control axle torque resulting from accelerating or braking. In addition, some models are equipped with lateral track bar torque rods, to control side-to-side movement.

SERVICE OPERATIONS

For information regarding inspection intervals and procedures, and lubrication intervals and procedures, refer to the 16 Group of the Freightliner Maintenance and Lube Manual.

Most repairs to the Hendrickson suspension system consist of replacing damaged or worn parts. Items most frequently requiring service are the equalizing beam bushings. Special tools (see Table 1, under "SPECIFICATIONS") for replacement of the bushings are available from the Owatonna Tool Company, Owatonna, Minnesota, or an affiliated dealer. Although the use of these special tools is recommended, shop-made adapters may be used if a vertical hydraulic press with a 50-ton capacity is available. Dimensions for the shop-made adapters are given in Table 2, under "SPECIFICATIONS."

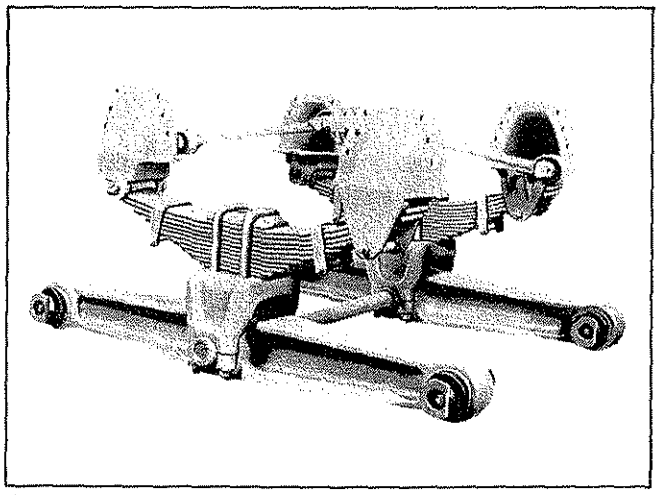


Fig. 1, Hendrickson "U" Series Suspension

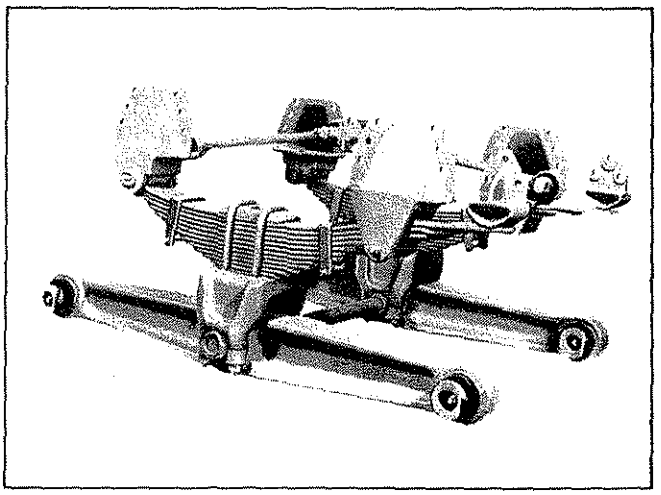


Fig. 2, Hendrickson "UE" Series Suspension

HENDRICKSON TANDEM SUSPENSION
"U" & "UE" SERIES, MODEL 340

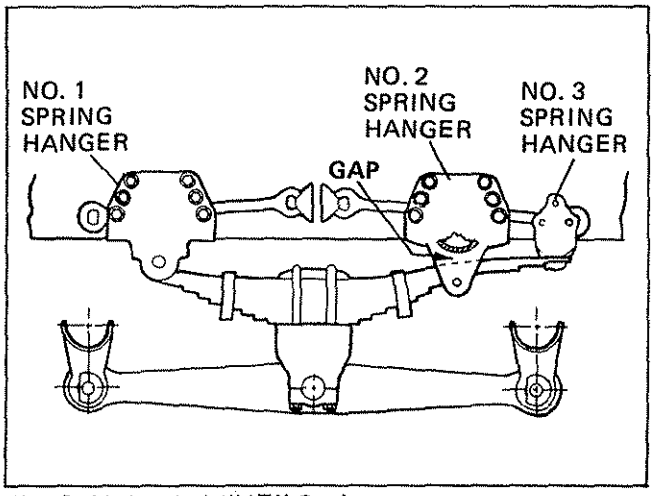


Fig. 3, Unloaded "UE" Spring

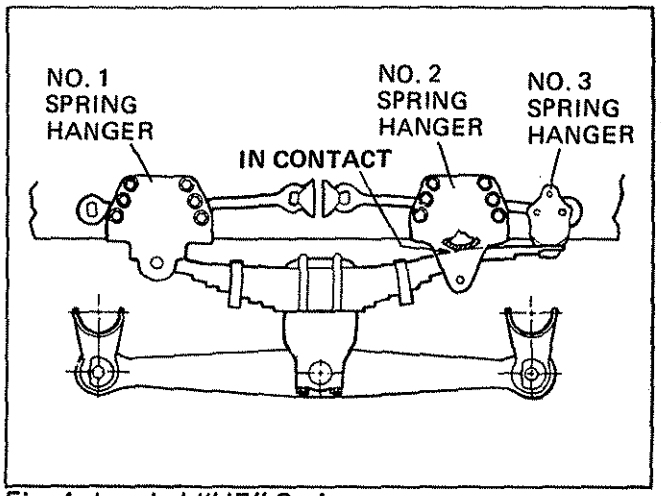


Fig. 4, Loaded "UE" Spring

When wear on any of the major components reaches the point where replacement is necessary, it is recommended that the entire suspension be removed from the vehicle and overhauled. In cases where individual suspension system components require service, follow only the applicable instructions relating to the components to be serviced.

Before the rear suspension is serviced, chock the front tires to prevent vehicle movement. Always use safety stands under the frame when the vehicle is raised or the suspension removed.

Apply Alumilastic compound, or an equivalent, to all areas where aluminum and steel parts contact each other.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metal components contact each other will result in electrolytic corrosion, which could cause suspension damage.

SUSPENSION SYSTEM REMOVAL AND INSTALLATION

Removal

If the suspension system is being overhauled, remove the suspension using the following procedure:

1. Chock the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles, marking the lines for later assembly reference. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.

2. Disconnect the driveline rear universal joint from the forward-rear axle. For instructions, refer to the 09 Group of this manual.

3. Manually release the parking brake chambers. For instructions, refer to the 12 Group of this manual.

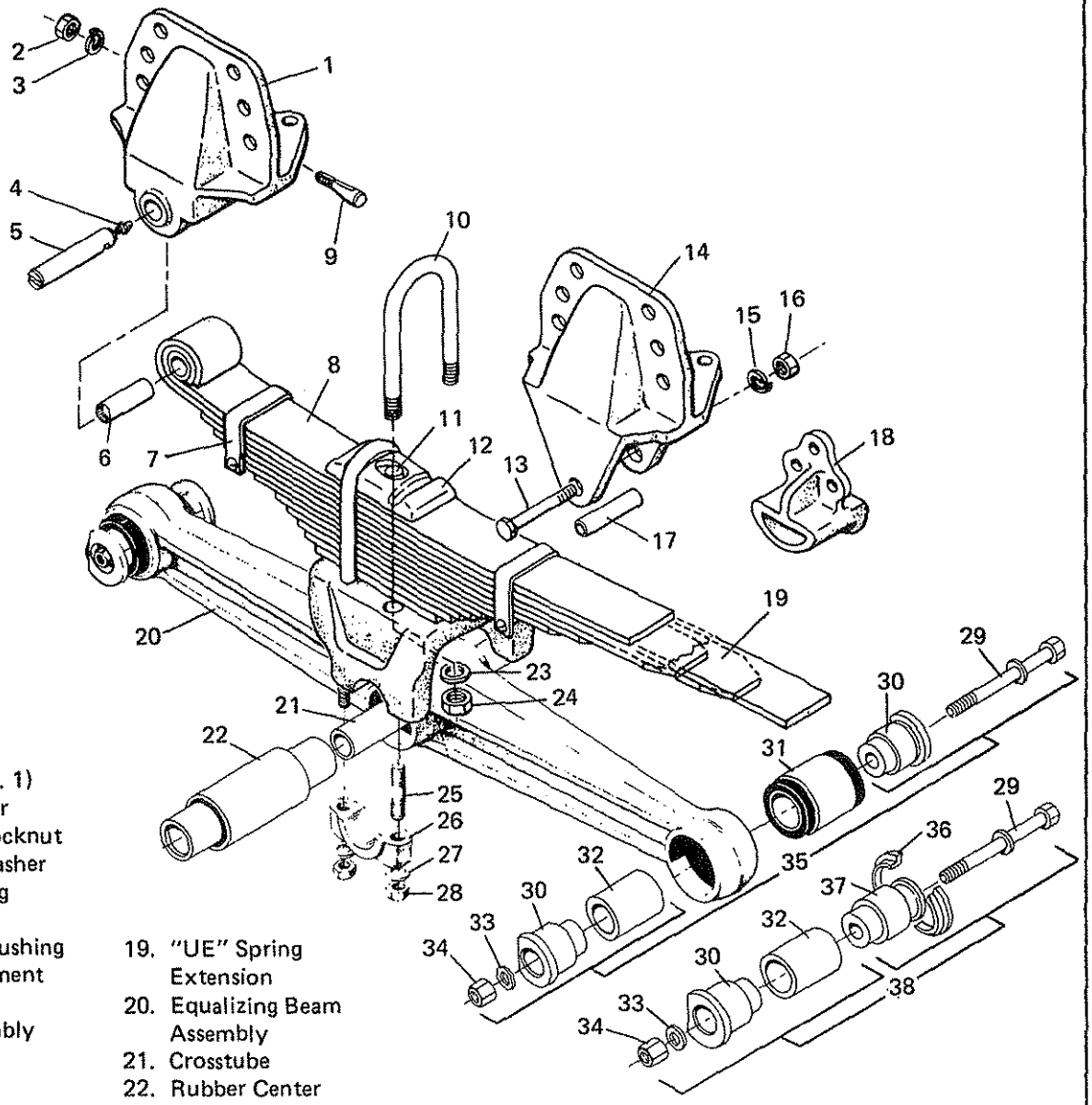
4. Using an overhead hoist, raise the rear of the vehicle enough to relieve the weight from the suspension.

NOTE: Do not raise the vehicle to the point where the weight of the suspension and axles "hang" from the vehicle.

5. Remove the saddle cap nuts and washers from each side of the vehicle. Then remove the saddle caps that secure the equalizing beam center bushing to the saddles. See Fig. 5.

6. Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

HENDRICKSON TANDEM SUSPENSION
"U" & "UE" SERIES, MODEL 340



1. Forward (No. 1) Spring Hanger
2. Draw Key Locknut
3. Draw Key Washer
4. Grease Fitting
5. Spring Pin
6. Spring Eye Bushing
7. Spring Alignment Clips
8. Spring Assembly
9. Draw Key
10. U-Bolt
11. Spring Center Bolt and Nut
12. Top Pad
13. Rebound Spacer Bolt
14. Rear (No. 2) Spring Hanger
15. Spacer Bolt Washer
16. Spacer Bolt Locknut
17. Rebound Spacer
18. "UE" Rear (No. 3) Spring Hanger
19. "UE" Spring Extension
20. Equalizing Beam Assembly
21. Crosstube
22. Rubber Center Bushing
23. U-Bolt Washer
24. U-Bolt Nut
25. Saddle Cap Stud
26. Saddle Cap
27. Saddle Cap Washer
28. Saddle Cap Nut
29. Adapter Bolt and Washer
30. Adapter
31. End Bushing
32. Intermediate Tube
33. Adapter Bolt Washer
34. Adapter Bolt Nut
35. Adapter-Type End Support Assembly
36. Splitring
37. Adapter Plug
38. Splitring Adapter Assembly

NOTE: Some fasteners intentionally omitted in order to provide clarity to the illustration.

Fig. 5, "U" Series, Exploded View

HENDRICKSON TANDEM SUSPENSION "U" & "UE" SERIES, MODEL 340

If also equipped with the lateral track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles may become free to pivot on the equalizing beam end bushings. Keep clear of the beam hangers and beam ends to avoid possible injury.

7. Raise the rear of the vehicle frame until there is sufficient clearance to roll the axles and suspension from beneath the saddles. Install safety stands under the vehicle frame, then roll the axles and equalizing beams from under the frame.

Installation

1. Roll the axles (with the equalizing beams and crosstube attached), under the vehicle frame. Align the ends of the beam center bushings with the saddle legs.

2. Using an overhead hoist, lift the vehicle off the safety stands, then remove the stands from under the frame. Lower the vehicle, so that the saddles seat on the beam center bushings.

3. Position the saddle caps on the saddle cap studs, then install the washers and the new saddle cap nuts. Do not tighten the nuts at this time.

4. Install the torque rods on the axles following the instructions given under the heading, "TORQUE ROD INSTALLATION," in this subject.

5. Tighten the saddle cap nuts to 125-145 ft-lbs (170-197 N·m).

6. Tighten the end support adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 5, Ref. 30.

WARNING: The adapter-type end support fasteners must be tightened to the torque value given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in a possible separation of suspension components, and a loss of vehicle control.

7. Lower the vehicle, then remove the overhead hoist. Manually reset the parking brake chambers. For instructions, refer to the 12 Group of this manual.

8. Connect the driveline rear universal joint to the forward-rear axle. For instructions, refer to the 09 Group of this manual.

9. Taking care to prevent dirt and other foreign material from entering the lines or fittings, connect the air brake lines leading to the axles. Close the air system drain valve.

10. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual. Adjust the angle if it is not according to specifications.

SPRING AND SADDLE ASSEMBLY REMOVAL AND INSTALLATION (Refer to Fig. 5)

Removal

If the spring and saddle assembly needs to be removed for replacement or for service to its components, remove the spring and saddle assembly using the following procedure:

1. If the suspension has been removed from the vehicle, support the spring and saddle assembly on a floor jack, then proceed to step 2. If the suspension is installed on the vehicle, use the following procedure for removal:

   .1 Chock the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.

HENDRICKSON TANDEM SUSPENSION "U" & "UE" SERIES, MODEL 340

.2 Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

If also equipped with the lateral track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles may become free to pivot on the equalizing beam end bushing. Keep clear of the beam hangers and beam ends to avoid possible injury.

.3 Using an overhead hoist, raise the rear of the vehicle enough to remove the weight from the leaf springs, then block the vehicle frame with safety stands. Remove the wheel assembly, if necessary, to gain easy access to the suspension system. For instructions, refer to the 11 Group of this manual.

NOTE: Do not raise the vehicle to the point where the weight of the suspension and axles "hang" from the vehicle.

.4 Securely block up the axle with safety stands to prevent it from dropping away from the vehicle when the spring is loosened and removed.

WARNING: Failure to remove all weight from the wheels and failure to securely block the axles with safety stands, could result in the axles suddenly dropping from the vehicle.

2. Loosen the spring pin draw key locknut on the forward (No. 1) spring hanger. Back off the nut until it is flush with the end of the spring pin draw key, then strike the locknut with a soft hammer to loosen the draw key. Remove the spring pin draw key, locknut, and lockwasher from the spring hanger assembly.

3. Using a slightly smaller drift than the 1-3/8 inch diameter spring pin, drive the spring pin through the forward (No. 1) spring hanger and out the inboard side of the spring hanger. See Fig. 6.

4. Remove the locknut and lockwasher from the rebound spacer bolt in the rear (No. 2) spring hanger. Remove the rebound spacer bolt and rebound spacer from the rear (No. 2) spring hanger. If the suspension has been removed from the vehicle, lower the spring and saddle off of the jacks and on to the ground.

5. Remove the U-bolt nuts and washers from the U-bolts, then remove the U-bolts from the spring and saddle assembly.

6. Remove the top pad from the spring leaves, then remove the spring assembly from the saddle.

NOTE: If the suspension is installed on the vehicle, it may be necessary to raise the vehicle so that the spring assembly clears the spring hangers. Install safety stands under the vehicle frame.

7. If the suspension is installed on the vehicle, remove the saddle cap nuts, washers, and saddle caps that secure the equalizing beam center bushings to the saddles. Remove the saddles from the suspension.

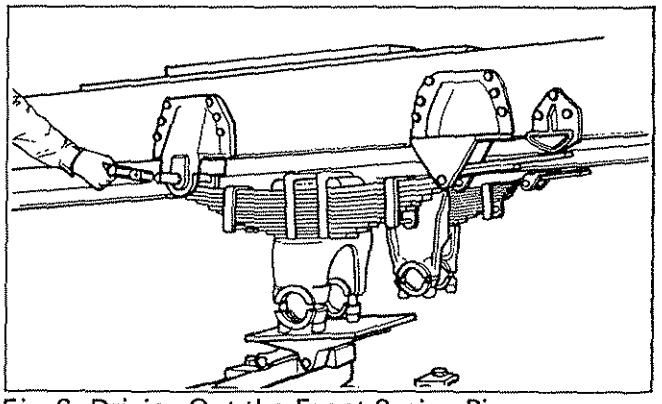


Fig. 6, Driving Out the Front Spring Pin

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8. If the saddle cap studs are damaged or worn, install new saddle cap studs with the shorter threaded end of the studs in the saddle. Lubricate the threads with SAE-20 oil. Tighten the studs to 55-65 ft-lbs (75-88 N·m).

Installation

1. If the suspension has been removed from the vehicle, proceed to step 2. If the suspension is installed on the vehicle, position the saddle on the center bushing and equalizing beam. Position the saddle caps on the saddle cap studs, then install the washers and new saddle cap nuts. Do not tighten the nuts at this time.

2. Seat the leaf spring assembly in the saddle, using the spring center bolt head as a locating dowel in the saddle. Make sure the spring assembly is aligned with the equalizing beam and is at an angle of 90° with the saddle center bushing bore.

3. Position the top pad over the center bolt nut and on the spring assembly.

4. Lubricate the threads on the new U-bolts with SAE-20 oil. Then install the U-bolts over the top pad and through the saddle. Install new nuts and washers on the U-bolts, then tighten the nuts to 237-302 ft-lbs (321-410 N·m). Using a hammer, rap the U-bolts, then tighten the nuts again to 237-302 ft-lbs (321-410 N·m).

5. If the suspension is installed on the vehicle, lower the vehicle rear frame so the spring assembly is in position in the forward and rear (Nos. 1 and 2) spring hangers.

   If the suspension has been removed from the vehicle, using a roller jack, position the spring and saddle assembly into the forward and rear (Nos. 1 and 2) spring hangers.

6. Align the spring eye bushing with the spring pin eye in the forward spring hanger. Coat the spring pin and the inside diameter of the spring eye bushing with multipurpose chassis grease, then insert the spring pin through the outside spring hanger leg hole and spring eye bushing. Tap the spring pin lightly with a soft hammer, while moving the spring to ease entry into the hole of the inside spring hanger leg.

7. Insert the new draw key with the flat side up, into the spring hangers, using a screwdriver to rotate the spring pin at the slotted end to align the keyway into the draw key hole at the bottom of the inside spring hanger leg. See Fig. 7. When the draw key is engaged in the slot, drive the draw key into place with a hammer. Lubricate the draw key threads with SAE-20 oil, then install the lockwasher and locknut on the draw key. Tighten the locknuts to 75-100 ft-lbs (101-136 N·m).

CAUTION: Do not allow the spring pin draw key to engage the slot in the spring pin at an angle, as it will wedge and gall. If locked in this position, it will work loose in a short time, allowing the spring pin to turn and wear the spring hanger, elongating the spring pin eye. If not corrected, this condition could result in structural failure of the spring pin, the spring hanger, or the spring eye.

8. Position the rebound spacer in the rear (No. 2) spring hanger legs, then install the rebound spacer bolts, lockwashers, and locknuts. Tighten the locknuts to 70-80 ft-lbs (95-109 N·m).

9. Install the grease fittings in both spring eye pins. Apply multipurpose chassis grease to the grease fitting until clean grease appears on both sides of the spring eye bushings.

NOTE: Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for spring eye pin bushing maintenance and lubrication procedures.

10. If the suspension is installed on the vehicle, complete the spring and saddle assembly installation using the following procedure:

    .1 Install the wheel assembly. For instructions, refer to the 11 Group of this manual.

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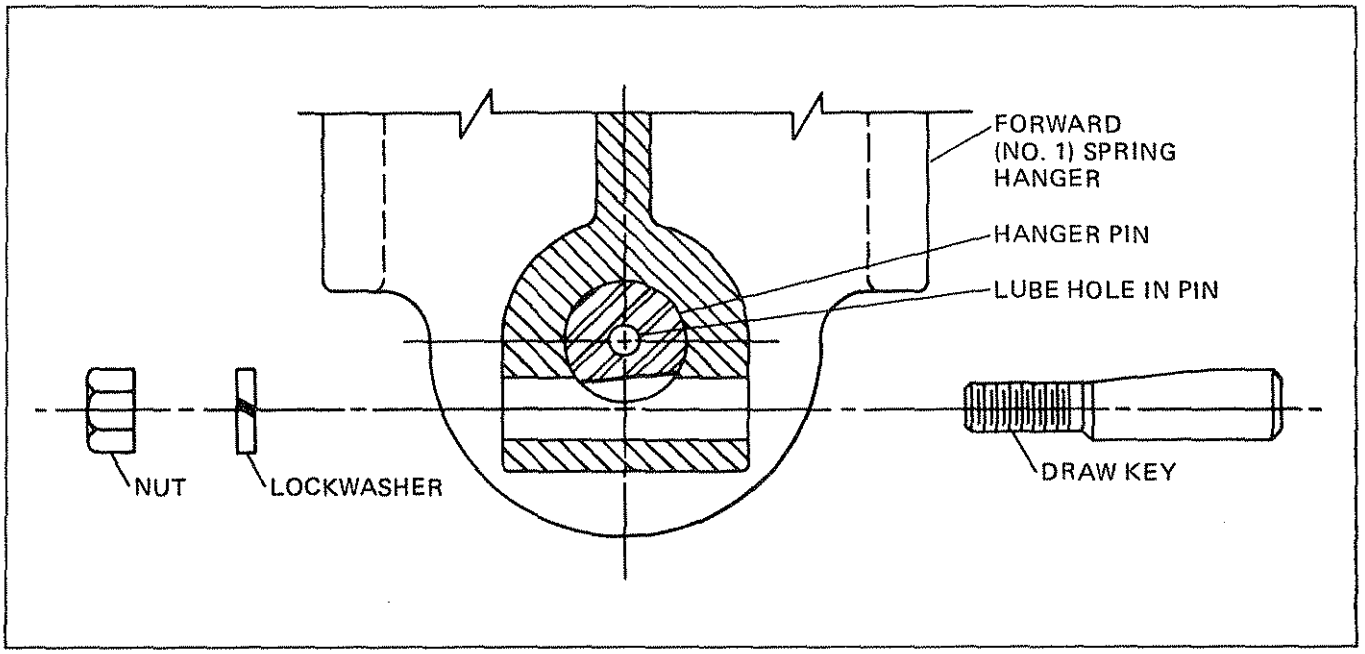

Fig. 7

.2 Install the torque rods on the axles. For instructions, refer to "TORQUE ROD INSTALLATION," in this subject.

.3 Tighten the new saddle cap nuts to 125-145 ft-lbs (167-197 N·m).

.4 Lower the vehicle, then remove the overhead hoist. Taking care to prevent dirt and other foreign material from entering the lines or fittings, connect the air brake lines leading to the axles. Close the air system drain valve.

SPRING LEAF INSPECTION AND REPLACEMENT

1. Remove the spring assembly from the vehicle. For instructions, refer to "SPRING AND SADDLE ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

2. Use a "C" clamp to hold the spring leaves together, then remove the center bolt and nut, and the spring alignment clips, from the spring leaves. Remove the "C" clamp and separate the leaves.

3. Using a wire brush and solvent, clean all grease, dirt, and rust from the spring leaves.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

Visually inspect for cracks, gouges, wear, or abnormal bends. If any of these conditions are present, install a new leaf in place of the damaged one. The No. 1 Main and No. 2 Wrapper spring leaves (the top two spring leaves) may be individually replaced. If equipped with the "UE" series suspension, the Nos. 1, 2, and 3 spring leaves (the top three spring leaves) may be individually replaced. If a spring leaf is damaged below these numbers in a pack, then it is recommended that the spring assembly be replaced. In addition, both spring assemblies should be replaced to insure even spring deflection.

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4. Inspect the spring eye bushing and spring pin for wear or damage. For instructions, refer to "SPRING PIN AND SPRING EYE BUSHING REPLACEMENT," in this subject.

NOTE: If the spring assemblies are to be reused, new spring eye bushings should be installed.

5. Position the spring leaves in sequence, then use a drift punch through the center bolt hole to align the leaves. Compress the leaves together with a "C" clamp, then install the spring alignment clips around the spring leaves. Attach with the spring alignment clip nuts and bolts. Tighten the nuts to 15 ft-lbs (20 N·m).

6. Remove the drift punch, then insert the center bolt through the spring from the bottom side. Attach the center bolt nut on the center bolt, then tighten the nut to 65-75 ft-lbs (88-102 N·m).

NOTE: Always use new center bolts and nuts whenever the spring assembly is overhauled or replaced.

7. Install the spring assembly on the vehicle. For instructions, refer to "SPRING AND SADDLE ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

SPRING PIN AND SPRING EYE BUSHING REPLACEMENT

NOTE: It is recommended that the spring pins and spring eye bushing be replaced with new spring pins and new spring eye bushings whenever the suspension is overhauled.

1. Inspect the spring pins for wear. If the spring pin diameter measures less than 1.367 inches (34.7 mm), then replace the spring pins with new pins.

2. Inspect the spring eye bushing for wear. If the inside diameter of the bushing measures larger than 1.395 inches (35.4 mm), then replace the bushings and pins with new ones.

3. Press the bushing out of the main spring leaf. If needed, use a vertical hydraulic press. Insert the new bushing with the split of the bushing to the top of the spring eye (unloaded side) ± 30° as shown in Fig. 8.

EQUALIZING BEAM REMOVAL AND INSTALLATION, ADAPTER-TYPE END SUPPORTS (Refer to Fig. 5)

Adapter-type end supports connect the equalizing beam to the axle beam hangers using three-piece "adapters" installed into each of the axle beam hangers. See Fig. 9. The inner sleeve of the beam end bushing is locked to the beam hanger by pressure of the adapter bolt, pulling the adapters against the outer surface.

Removal

IMPORTANT: If using the special Owatonna tools (OTC set No. Y-865-D) to remove the equalizing beam from the axle beam hangers, the suspension system must be installed on the vehicle. If not using the special Owatonna tools, the equalizing beam can be removed from the axle beam hangers, either with the suspension installed on the vehicle, or with the suspension removed from the vehicle.

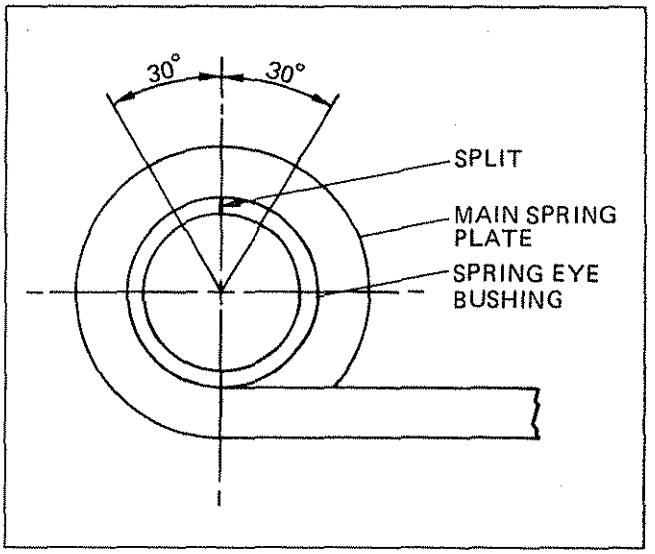

Fig. 8

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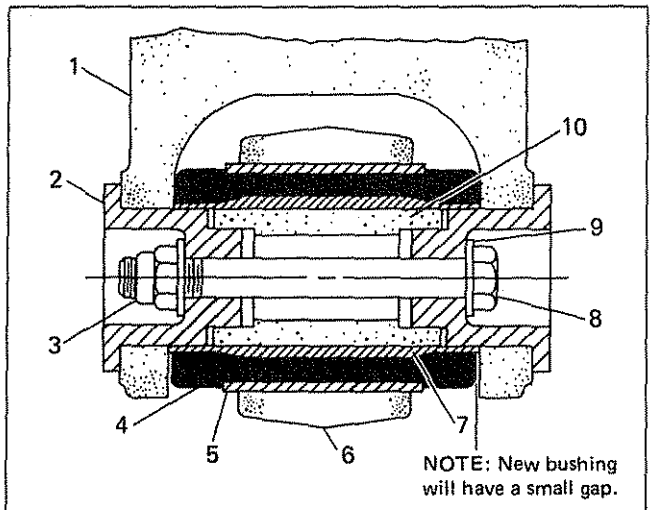

1. Beam Hanger
2. Adapter
3. Adapter Bolt Nut
4. Rubber End Bushing
5. Bushing Outer Sleeve
6. Equalizing Beam
7. Bushing Inner Sleeve
8. Adapter Bolt
9. Washer (both ends)
10. Intermediate Tube

Fig. 9, Equalizing Beam Adapter-Type End Support

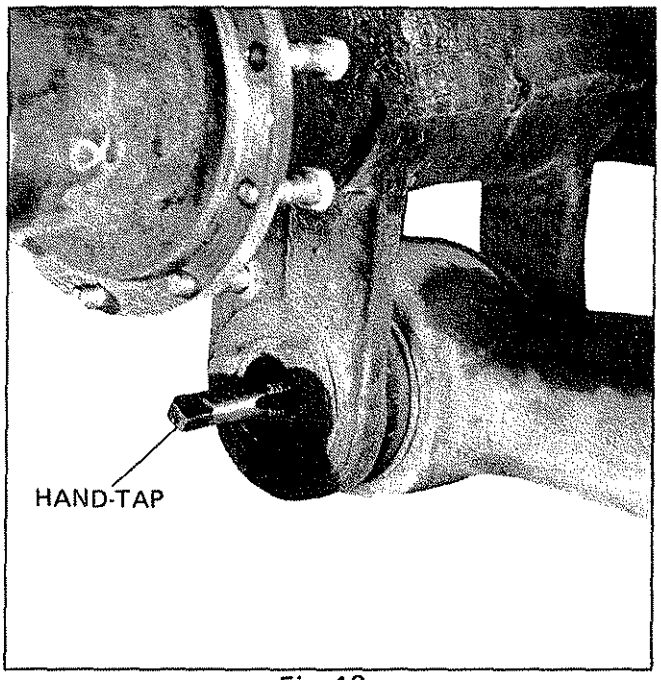

Fig. 10

1. Remove the saddle cap nuts and washers, then remove the saddle caps that secure the equalizing beam center bushings to the saddles. See Fig. 5.

2. Support the equalizing beams with safety stands. Remove the nut, washers, and adapter bolt from the beam end adapters.

3. If not using the special Owatonna tools, proceed to step 4. If using the special Owatonna tools, remove the adapter plug using the following procedure:

   .1 Remove the wheels, hubs, and brake drums from the rear axles. For instructions, refer to the 11 Group of this manual.

   .2 Select a hand-tap (7/8" for 3/4"-cored-hole, or 1" for 7/8"-cored-hole), and tap the hole from which the adapter bolt was removed, as shown in Fig. 10. Then, position the pulling plate (OTC part No. 28445) over the hand-tap and against the beam hanger. Attach the forcing screw (OTC part No. 28446 for 7/8"-hand-tap, or OTC part No. 28447 for 1"-hand-tap) to the hand-tap, and secure with the nut (OTC part No. 10220) against the pulling plate. While holding the nut with a wrench, tighten the forcing screw to pull the adapter plug from the beam hanger. See Fig. 11. Proceed to step 5.

4. If not using the special Owatonna tools, a relief is provided on each side of the adapter for chisel entry. Insert a chisel into the relief on the inboard adapter, and drive the chisel in, to wedge the adapter out of the beam hanger. Repeat this step for the outboard adapter.

NOTE: In some installations, a splitring type adapter assembly (see Fig. 5, Ref 38) is used instead of the standard adapter. To remove, drive the chisel between the two halves of the splitring, forcing them to snap out of the adapter plug. Then drive the adapter plug into the equalizing beam end bushing until it clears the beam hanger. After the equalizing beam has been removed from the beam hanger, drive the plug out of the bushing.

5. After the ends of both equalizing beams have been separated from the axle beam hangers, lower the equalizing beams, together with the

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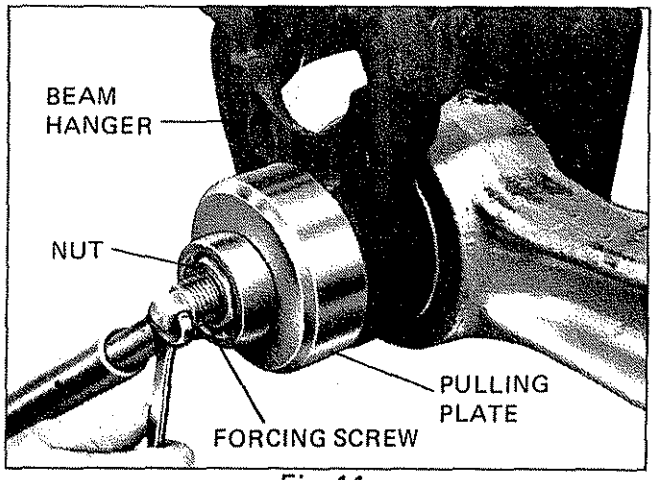

Fig. 11

crosstube, to the ground. Separate the beams from the crosstube by pulling apart by hand.

Installation

1. Apply Texaco "Compound L," or an equivalent rust preventive lubricant, to the axle beam hanger eyes, beam end bushing inner sleeve, end support adapters, outside surface of the bushing intermediate tubes, and the ends of the crosstube.

2. Install the crosstube into both equalizing beam center bushings.

   If new rubber center bushings equipped with end plugs as separate parts are installed, arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and debris, from the welding process.

NOTE: Because of the distance from the point of welding, there is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve.

3. Position the equalizing beam assembly under the axles, then raise the assembly and place the forward ends of each beam in the forward-rear axle beam hangers. Align the beam end bushings with the beam hangers.

4. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

5. Place the rear ends of each beam in the rear-rear axle beam hangers. Align the beam end bushings with the beam hangers.

6. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

NOTE: If the suspension and saddle assembly has been removed from the vehicle, installation of the equalizing beam will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

7. Position the saddle caps on the saddle cap studs, then install the washers and new saddle cap nuts. Tighten the nuts to 125-145 ft-lbs (170-197 N·m).

8. Tighten the adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 5, Ref. 30.

WARNING: The adapter bolt nuts must be tightened to the torque value given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in separation of suspension components and a loss of vehicle control.

EQUALIZING BEAM END BUSHING REPLACEMENT (Refer to Fig. 5)

IMPORTANT: If one or more of the end bushings requires replacement, it is recommended that all four end bushings be replaced.

1. Remove the equalizing beam from the vehicle. For instructions, refer to "EQUALIZING BEAM REMOVAL AND INSTALLATION,

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ADAPTER-TYPE END SUPPORTS," in this subject.

2. On one side only of each beam end bushing, cut back the protruding rubber portion flush with the equalizing beam, as shown in Fig. 12, to allow the adapter to squarely contact the bushing outer sleeve.

3. If using the special Owatonna tools, remove the beam end bushings using the following procedure (refer to Fig. 13):

   .1 Center the end bushing removing adapter on the trimmed side of the beam end bushing.

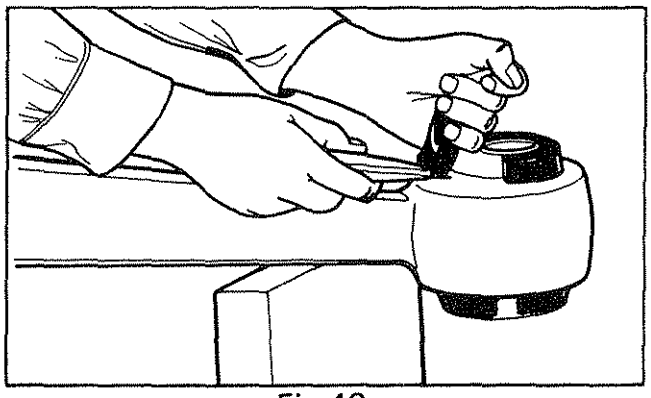

Fig. 12

   .2 Position the receiving tube on the untrimmed side of the beam end bushing. Assemble the hydraulic ram and speed nut on the pulling screw, then position the assembly through the receiving tube, bushing, and removing adapter, as shown in Fig. 13. Secure with the hex nut.

IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube as it is pulled through the beam. The removing adapters should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean pull through the beam.

   .3 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

   .4 If the pressure gauge on the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas. If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure,

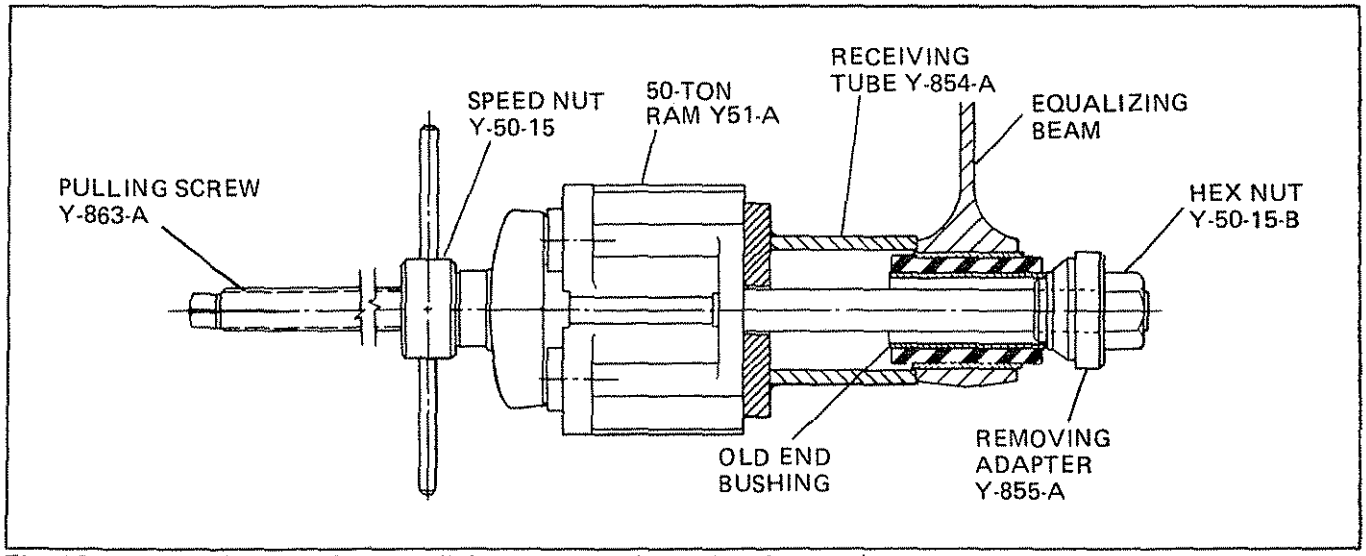

Fig. 13, OTC Tool Set-up for Equalizing Beam End Bushing Removal

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strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa) pressure; if the bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard, and the pressure gauge reading drops.

.5 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the end bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, remove the beam end bushing with shop-made adapters using the following procedure:

   .1 Position the equalizing beam on a 50-ton vertical hydraulic press.

   .2 Center the shop-made adapter (tool No. 1 from Table 2, located under "SPECIFICATIONS") on the trimmed end of the equalizing beam bushing. Then, press the end bushing from the beam eye.

5. Using emery cloth, remove all scale, rust, or corrosion from the equalizing beam eyes. Replace the equalizing beam if cracks, gouges, or other damage is evident in the beam eyes.

6. Clean the outer sleeves of the new equalizing beam end bushings with emery cloth to remove excess phosphate protective coating, then apply a thin coating of White Lead, or an equivalent lubricant, to the surface of the new bushing outer sleeves. Position the bushing on the equalizing beam eye.

7. If using the special Owatonna tools, use the following procedure for installation of the beam end bushing (refer to Fig. 14):

   .1 Fit the adapter clamp over the exposed rubber on the new bushing, then tighten the clamp nuts until the contact surface on the clamp rests fully against the bushing outer sleeve.

   .2 Position the pilot adapter into the beam eye, as shown in Fig. 14.

   .3 Install the speed nut, hydraulic ram, and receiving tube on the pulling screw, then position the assembly through the pilot

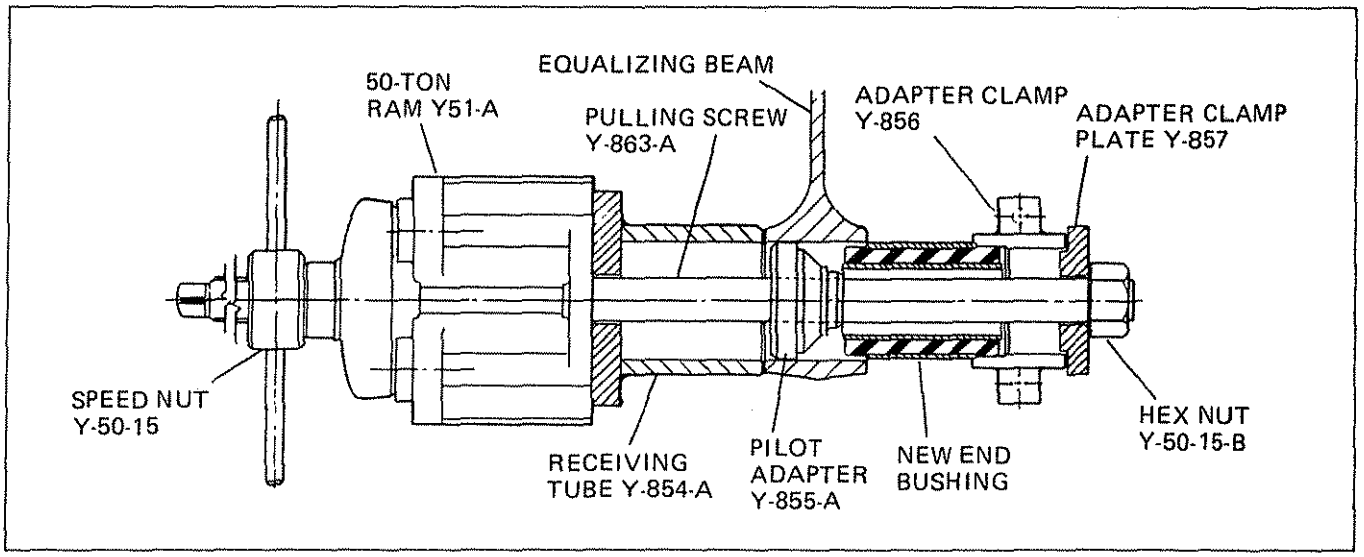

Fig. 14, OTC Tool Set-up for Equalizing Beam End Bushing Installation

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adapter in the beam eye, bushing, and adapter clamp. Attach the adapter clamp plate to the pulling screw and adapter clamp. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 The pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new end bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure, and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam, and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), the new bushing has been installed. Make a visual inspection.

8. If not using the special Owatonna tools, install the new bushing with shop-made adapters using the following instructions (refer to Fig. 15):

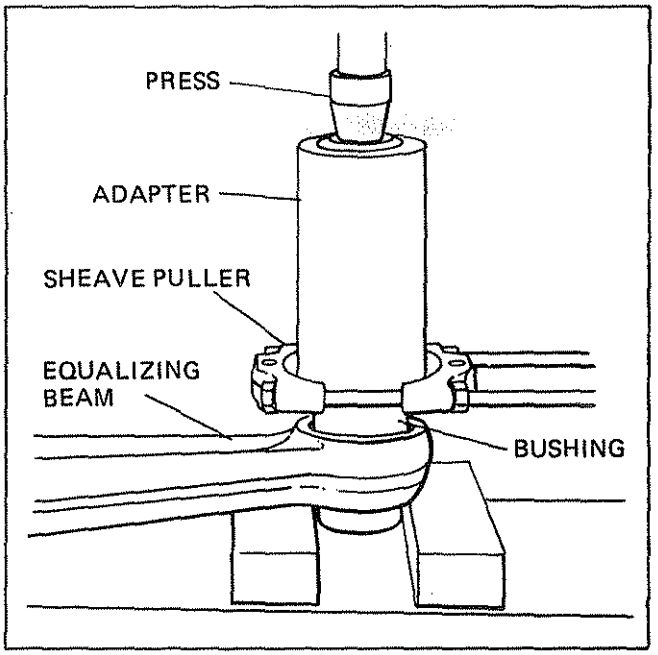

Fig. 15, Equalizing Beam End Bushing Installation Using Adapter and Sheave Puller

.1 Using a sheave puller, compress the exposed rubber of the new bushing until the puller jaws seat against the end of the new bushing outer sleeve.

.2 Position the shop-made adapter (tool No. 2 from Table 2, located under "SPECIFICATIONS") against the jaws of the sheave puller. Then, press the new bushing into the beam eye.

9. Replace the center bushings, if needed. For instructions, refer to "EQUALIZING BEAM RUBBER CENTER BUSHING REPLACEMENT," in this subject.

10. Install the equalizing beam on the axle beam hangers. For instructions, refer to "EQUALIZING BEAM REMOVAL AND INSTALLATION, ADAPTER-TYPE END SUPPORTS," in this subject.

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EQUALIZING BEAM RUBBER CENTER BUSHING REPLACEMENT (Refer to Fig. 5)

IMPORTANT: If a beam rubber center bushing is worn or damaged, and needs to be replaced, the rubber center bushings must be replaced on both equalizing beams.

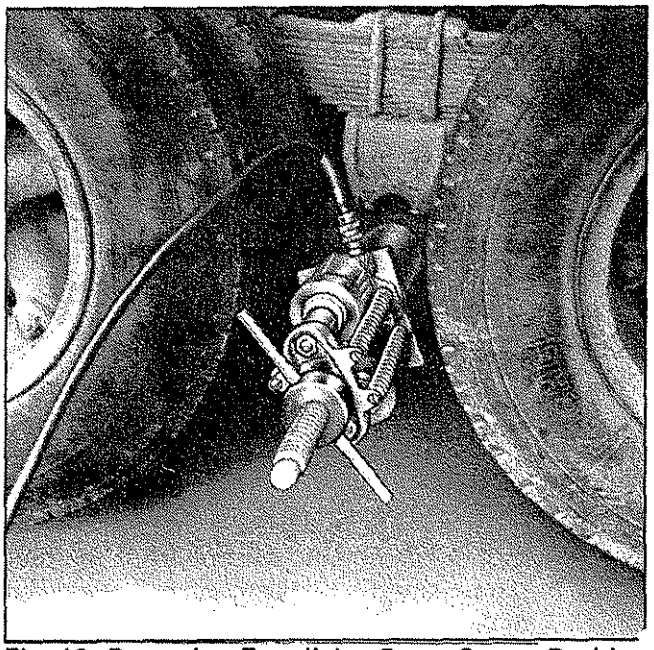

Fig. 16, Removing Equalizing Beam Center Bushing Installed on Vehicle, Using OTC Tools

NOTE: If using the special Owatonna tools, the beam center bushing can be replaced either with the equalizing beam installed on the vehicle (see Fig. 16), or with the beam removed from the vehicle.

If not using the special Owatonna tools, remove the equalizing beam from the vehicle. For instructions, refer to "EQUALIZING BEAM REMOVAL AND INSTALLATION, ADAPTER-TYPE END SUPPORTS," in this subject.

1. Check the inboard exposed edge of the equalizing beam center bushing outer sleeve. If the outer sleeve is worn and has flared over the face of the equalizing beam, then chisel or grind the flared portion off, so it will not impede removal of the bushing.

WARNING: Protective eye goggles must be worn when grinding. Failure to do so could result in injury to the eye, due to the metal debris from the grinding process.

2. If using the special Owatonna tools, remove the beam center bushing using the following procedure (refer to Fig. 17):

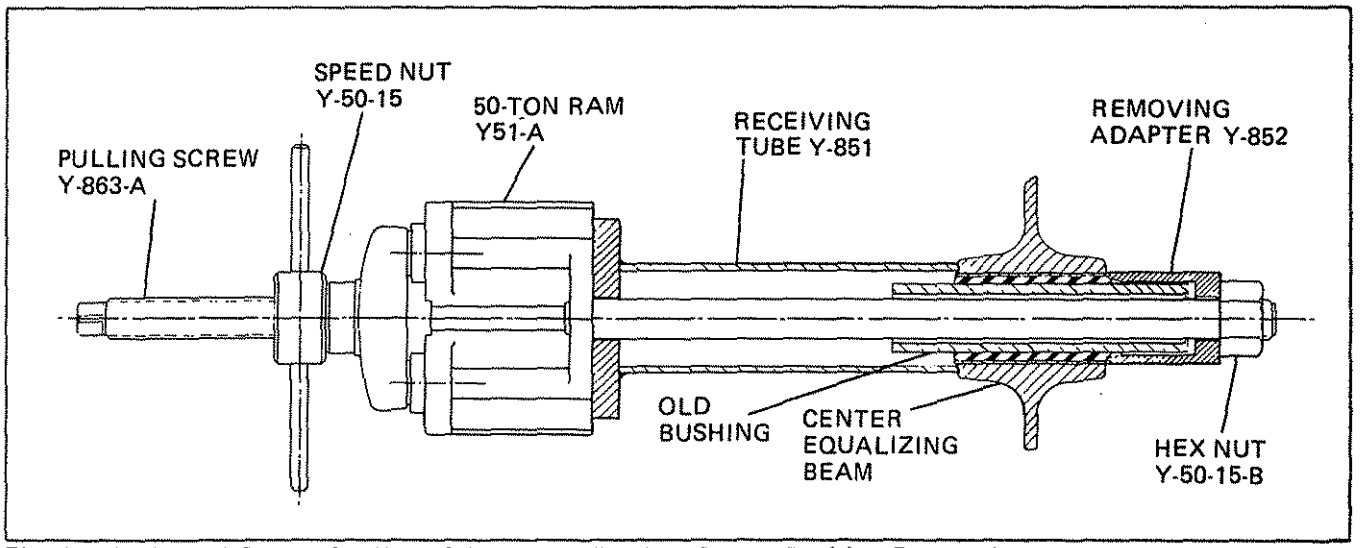

Fig. 17, OTC Tool Set-up for Equalizing Beam Rubber Center Bushing Removal

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.1 Before the Owatonna tools can be used, the welded end plug in the outside end of the inner sleeve must be removed. Use a 2-inch diameter hole saw to cut out the end plugs from the bushing.

CAUTION: Do not use a cutting torch to burn out the end plugs from the beam center bushings. The equalizing beam has been heat-treated, and the use of heat could adversely affect the strength of the beam.

If the equalizing beam is installed on the vehicle, the crosstube must be removed.

.2 Position the removing adapter on the bushing end prepared in step 1, above.

.3 Position the receiving tube on the opposite side of the beam center bushing. Then, assemble the hydraulic ram, speed nut, and pulling screw, as shown in Fig. 17. Secure with the hex nut.

IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube as it is pulled through the beam. The removing adapter should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 If the pressure gauge of the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa) pressure, if the bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard, and the pressure gauge reading drops.

.6 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the center bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

3. If not using the special Owatonna tools, remove the old center bushing with shop-made adapters using the following procedure:

   .1 Position the shop-made adapter (tool No. 3 from Table 2, located under "SPECIFICATIONS") on the bushing end prepared in step 1, above.

   .2 Position the beam on a 50-ton vertical hydraulic press, then apply pressure to press the center bushing from the bushing eye.

4. Using a cylinder hone or emery cloth, remove all scale, rust, or corrosion from the equalizing beam eye. Replace the equalizing beam if cracks, gouges, or damage exists in the beam eyes.

5. Clean the outer sleeves of the new equalizing beam center bushing with emery cloth, then apply a thin coating of White Lead, or an equivalent lubricant, to the surface of the new bushing outer sleeve and the beam center eye. Position the bushing against the equalizing beam eye.

6. If using the special Owatonna tools, use the following procedure for installation of the beam center bushing (refer to Fig. 18):

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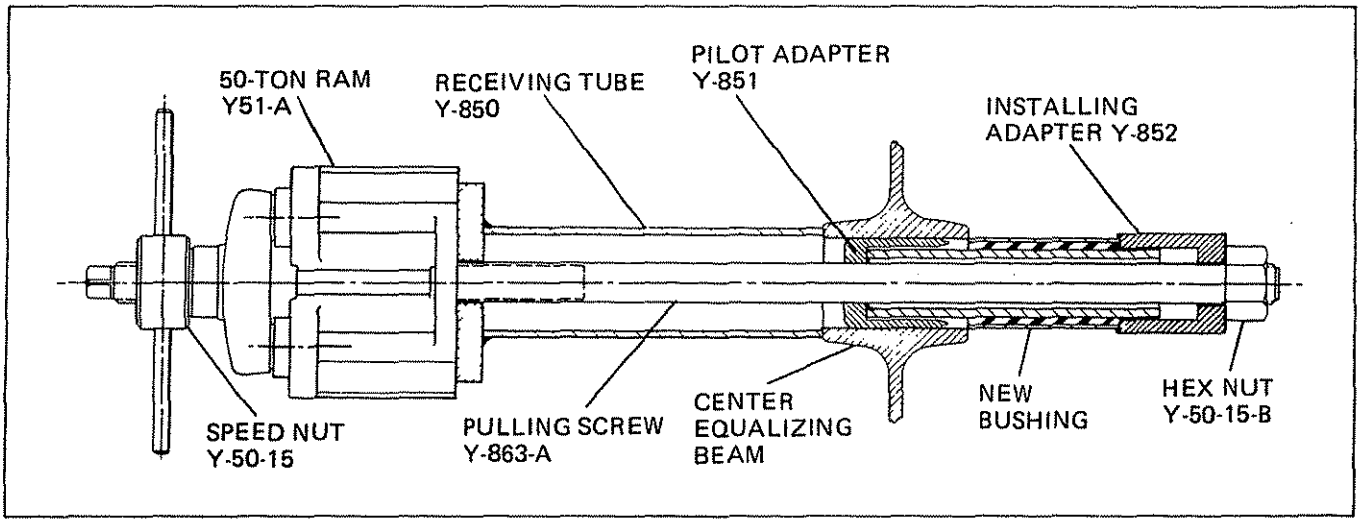

Fig. 18, OTC Tool Set-up for Equalizing Beam Rubber Center Bushing Installation

NOTE: New rubber center bushings with the end plugs as separate parts must be used.

.1 Fit the installing adapter over the bushing inner sleeve and against the outer sleeve end.

.2 Position the pilot adapter in the beam center eye.

.3 Install the speed nut, hydraulic ram, and receiving tube on the pulling screw, then position the assembly through the pilot adapter in the beam eye, bushing, and removing adapter. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 The pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new center bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam, and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), the new bushing has been installed. Make a visual inspection.

.8 If the new center bushings were installed with the equalizing beams installed on the vehicle, position the crosstube in the center

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bushings. Arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and flying debris, from the welding process.

NOTE: Because of the distance from the point of welding, there is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve.

7. If not using the special Owatonna tools, install the new center bushing with shop-made adapters using the following procedure:

NOTE: Use the standard center bushings with the end plugs welded in place.

.1 Position the shop-made adapter (tool No. 3 from Table 2, located under "SPECIFICATIONS") over the bushing inner sleeve, so that it bottoms against the bushing outer sleeve.

.2 Position the beam, bushing, and adapter on a 50-ton vertical hydraulic press, then apply pressure to press the bushing into the beam eye.

8. Replace the end bushings, if needed. For instructions, refer to "EQUALIZING BEAM END BUSHING REPLACEMENT," in this subject.

9. Install the equalizing beam on the axle beam hangers. For instructions, refer to "EQUALIZING BEAM REMOVAL AND INSTALLATION, ADAPTER-TYPE END SUPPORTS," in this subject.

TORQUE ROD REMOVAL AND INSTALLATION (Refer to Fig. 19)

Removal

If the suspension has been removed from the vehicle, proceed to step 3.

1. If not previously done, disconnect the torque rods from the torque rod axle brackets by removing the attaching flanged nuts and flanged bolts.

2. If also equipped with the lateral track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles may become free to pivot on the equalizing beam end bushings. Keep clear of the beam hangers and beam ends to avoid the possibility of injury.

3. Remove the flanged locknuts and flanged bolts that attach the torque rod straddle mount assembly to the frame crossmember. Remove the torque rods, crossmember brackets, and shim(s) from the vehicle. Keep track of the torque rod crossmember spacer in the suspension crossmember.

4. If also equipped with lateral track bar torque rods, remove the flanged locknuts and flanged bolts that attach the torque rod assembly to the frame rail. Remove the torque rods, frame bracket, and backing plate from the vehicle.

5. Visually inspect the torque rod for bends or cracks. Work the torque rod pins to check for looseness in the bushing. If the torque rod is bent, cracked, or otherwise damaged, replace it with a new one. If either of the bushings is loose, both of the bushings must be replaced with new ones. For instructions, refer to "TORQUE ROD BUSHING REPLACEMENT," in this subject.

Installation

NOTE: Torque rods are to be installed when the axle and suspension assemblies are installed on the vehicle.

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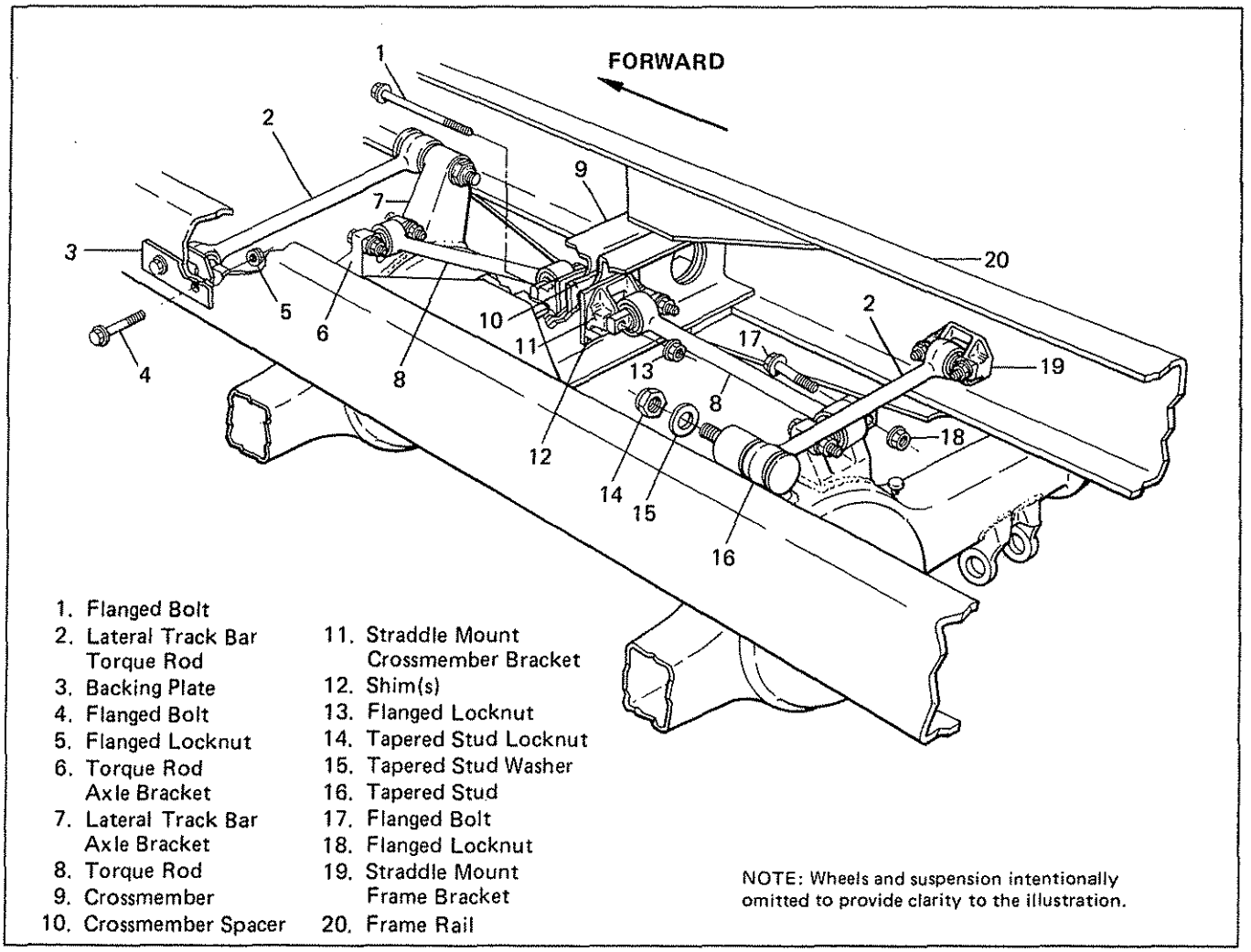

1. Flanged Bolt
2. Lateral Track Bar Torque Rod
3. Backing Plate
4. Flanged Bolt
5. Flanged Locknut
6. Torque Rod Axle Bracket
7. Lateral Track Bar Axle Bracket
8. Torque Rod
9. Crossmember
10. Crossmember Spacer
11. Straddle Mount Crossmember Bracket
12. Shim(s)
13. Flanged Locknut
14. Tapered Stud Locknut
15. Tapered Stud Washer
16. Tapered Stud
17. Flanged Bolt
18. Flanged Locknut
19. Straddle Mount Frame Bracket
20. Frame Rail

NOTE: Wheels and suspension intentionally omitted to provide clarity to the illustration.

Fig. 19, Torque Rod and Lateral Track Bar Torque Rod Assembly

1. Before installation, make certain that all contact surfaces are free of dirt or other foreign material. Lubricate all bolt threads with SAE-20 oil.
2. Position the torque rod straddle mount pins against the forward-rear axle torque rod bracket. Then, install the flanged bolts through the torque rod axle bracket and the torque rod pin.
3. Install the flanged nuts on the torque rod mounting bolts, then tighten the nuts to 150-175 ft-lbs (203-237 N·m).
4. Install the rear-rear axle torque rod in the same manner.
5. Position the torque rod crossmember spacer in the crossmember. Position the shim(s) (not to exceed 1/2-inch [13 mm] thick), and crossmember straddle mount bracket on the front side of the crossmember, then position the torque rod with the torque rod pins aligned with the bracket.
6. Install the flanged bolts through the torque rod pins, bracket, and the front side of the crossmember.

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7. On the back side of the crossmember, position the shim(s) (not to exceed 1/2-[13 mm] thick), and crossmember bracket through the ends of the flanged bolts and against the crossmember; then position the torque rod so that the torque rod pins are aligned through the ends of the flanged bolts and against the bracket. Install the flanged nuts on the bolts and tighten to 150-175 ft-lbs (203-237 N·m).

8. If also equipped with the lateral track bar torque rods, use the following procedure for installation:

   .1 Make certain that the tapered stud and tapered stud bracket hole are free of dirt or other foreign material. Lubricate the tapered stud ends of the torque rod with SAE-20 oil.

   .2 Install the tapered stud into the lateral track bar axle bracket. Install the locknut on the stud and tighten to 175-225 ft-lbs (237-303 N·m). Then, rap the axle bracket with a hammer to seat the tapered stud. Tighten the locknut again to 175-225 ft-lbs (237-303 N·m).

   .3 Position the straddle mount frame bracket, shim(s), and backing plate to the inside of the frame rail. Then position the torque rod pins against the frame bracket.

   .4 Install the flanged bolts through the frame rail, bracket assembly, and torque rod pins. Install the flanged locknuts on the flanged bolts, then tighten the locknuts to 150-175 ft-lbs (203-237 N·m).

9. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual.

TORQUE ROD BUSHING REPLACEMENT

IMPORTANT: To replace the torque rod polyurethane bushings, it is necessary to have the special installation tool kit (Freightliner part No. P-097-009), or a tool kit can be made, using the dimensions given in Fig. 27 under "SPECIFICATIONS." If equipped with the lateral track bar torque rods, the bushings must be replaced using the special Owatonna tool set No. Y-820, as shown in Fig. 20 (see Table 3, under "SPECIFICATIONS").

1. Remove the torque rods. For instructions, refer to "TORQUE ROD REMOVAL AND INSTALLATION," in this subject.

2. Remove the snapring and bearing washer from each side of the torque rod bushing to be removed. See Fig. 21. Note that the torque rod eye has a smaller shoulder on one side than on the other, and it also has a rounded edge around the inside of the smaller shoulder side

1. Press Plate Y-825
2. Clamp Assembly Y-824
3. Remover Y-826
4. Remover Y-822
5. Remover/Replacer Y-823
6. Cap Y-821

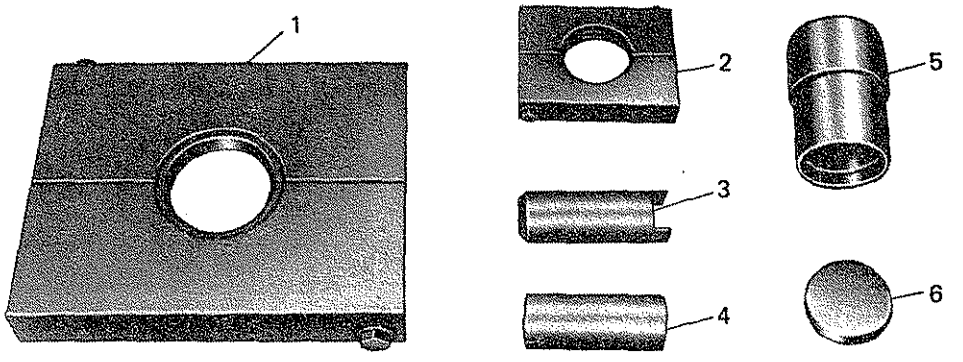

Fig. 20, OTC Tool Set No. Y-820

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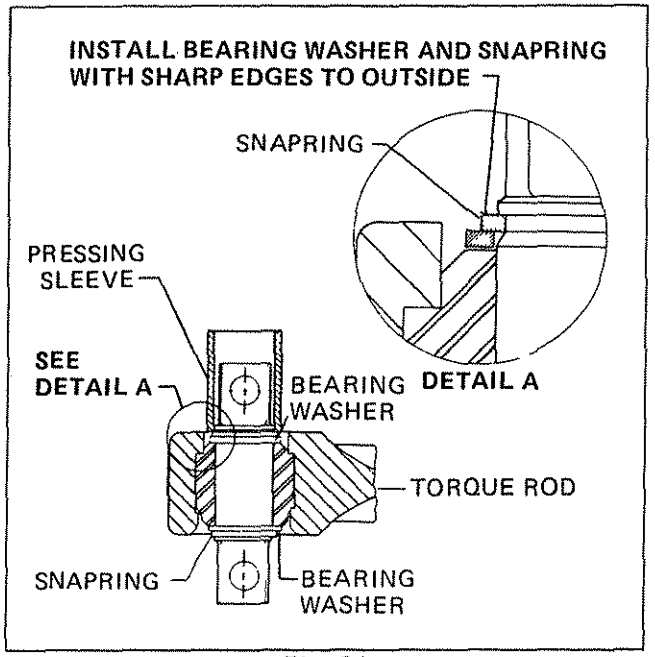

Fig. 21

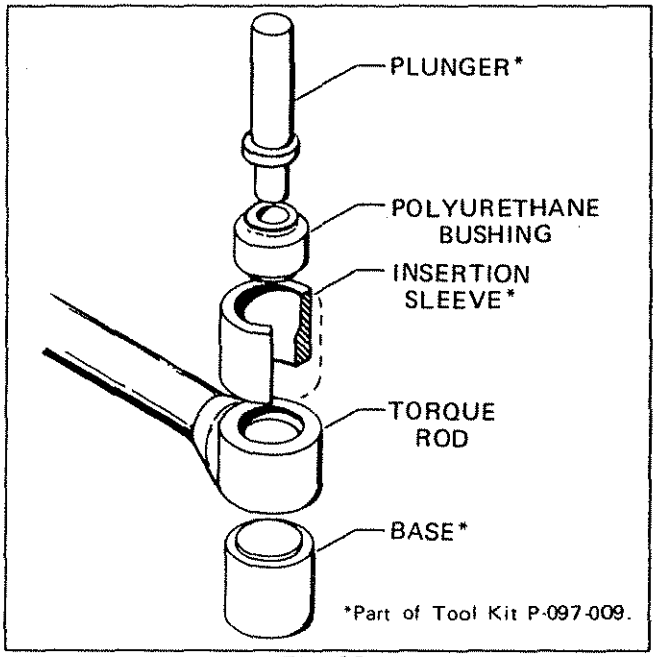

Fig. 22

of the eye. The bushing must be pressed in and out using this side of the torque rod.

3. Position the plunger and torque rod on a vertical hydraulic press, then press the old bushing assembly out of the torque rod eye.

4. Clean all dirt, grease, or other foreign material from the torque rod eye. Coat the new bushing and torque rod eye with a non-mineral lubricant or waterless hand cleaner.

5. Position the bushing in the larger end of the insertion sleeve from the tool kit, then fit the beveled (smaller) end of the sleeve into the larger side of the torque rod eye.

6. Center the torque rod eye on the base tool, and insert the plunger tool into the bushing. See Fig. 22. Use a vertical hydraulic press to press the bushing into the torque rod eye.

7. Install the snapring and bearing washer on one end of the torque rod pins, with the sharp edges of the washer and snapring facing the outward end of the pin. See Fig. 21, Detail A.

8. Press the torque rod pin into the torque rod bushing from the same side as the bushing was pressed into the torque rod eye. Do not lubricate the torque rod pin.

   Turn the torque rod over, and install a bearing washer, with the sharp edge facing away from the bushing, then install the other snapring onto the outer shoulder of the pin, with the sharp edge facing outward.

   Place a pressing sleeve over the end of the torque rod pin, then press the snapring into its seat. See Fig. 21.

9. After assembly, lightly press the torque rod pin or tapered stud, to center it in the torque rod eye. There should be no slack on either side of the bushing, and the bushing should be compressed by approximately half the thickness of the snapring. If necessary, install a second washer under one of the snaprings to compress the bushing.

10. If equipped with the lateral track bar torque rods, remove the old bushing from the torque

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rod eye with the special Owatonna tools using the following procedure:

.1 Position the press plate on the bed of a vertical hydraulic press, with the small counterbore of the press plate hole facing up.

.2 Install the straddle mount ends of the lateral track bar torque rod, in the hole of the press plate. Secure by tightening the press plate capscrews.

.3 Position the straddle mount pin remover on the straddle mount pin. Lubricate the bushing liberally with lubricating oil. Press the straddle mount pin out of the bushing. See Fig. 23.

.4 Position the bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing. Lubricate the bushing liberally with lubricating oil. Press the rubber bushing out of the torque rod eye. See Fig. 24.

.5 Install the tapered stud end (with the stud face up) in the hole of the press plate. Secure by tightening the press plate capscrews.

NOTE: Some tapered stud torque rod bushings have a large non-removeable washer on the back end of the stud and will not fit through the press plate hole. Loosen the press plate capscrews and separate the halves (see Fig. 25) until the washer clears the counterbore of the press plate, and the torque rod sets on the press plate. Tighten the capscrews until the press plate halves are closed completely. If the washer is removeable, remove the washer before installing the torque rod end in the press plate.

Position the tapered stud remover tool (OTC part No. Y-822) with the smaller inside diameter of the remover tool on the torque rod stud. Lubricate the bushing liberally with lubricating oil. Press the stud out of the bushing.

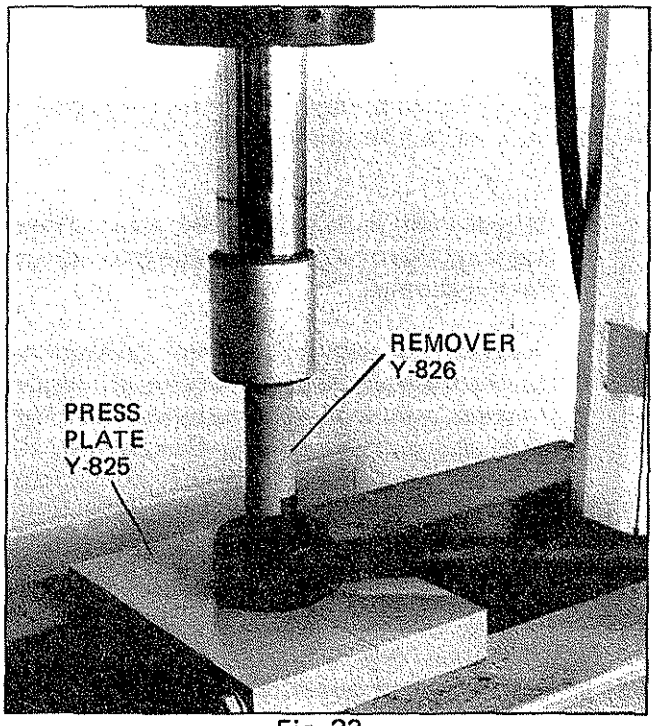

Fig. 23

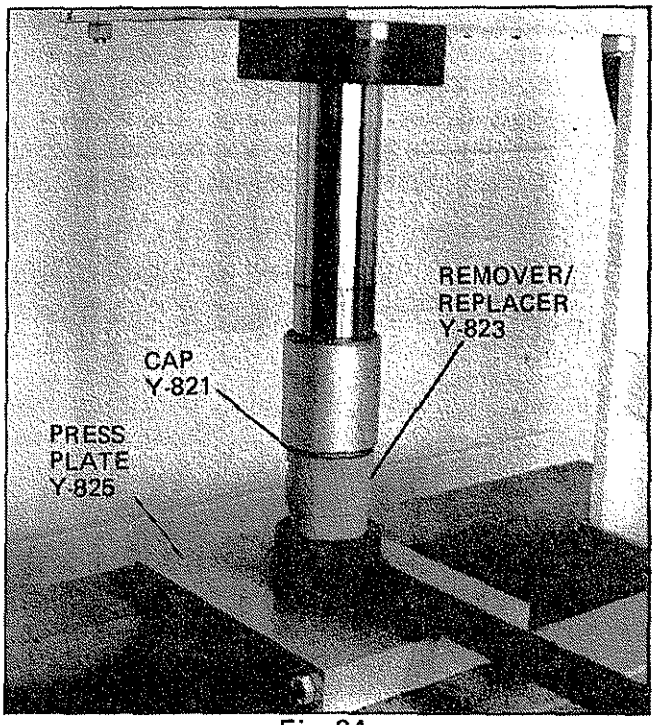

Fig. 24

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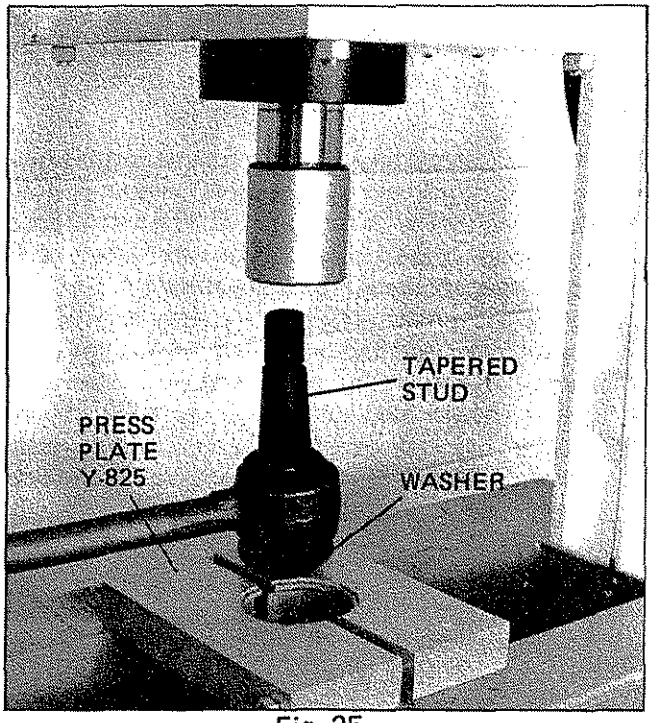

Fig. 25

Position the rubber bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing. Lubricate the bushing liberally with lubricating oil. Press the bushing out of the torque rod eye. See Fig. 24.

.6 Clean all dirt, grease, or other foreign material from the torque rod eye. Proceed to step 6.

6. Install the new lateral track bar torque rod cartridges with the special Owatonna tools using the following procedure:

NOTE: New replacement cartridges with the bushings bonded to the straddle mount pins and tapered studs must be used.

.1 Position the press plate on the bed of a vertical hydraulic press. Position the torque rod eye into the hole of the press plate.

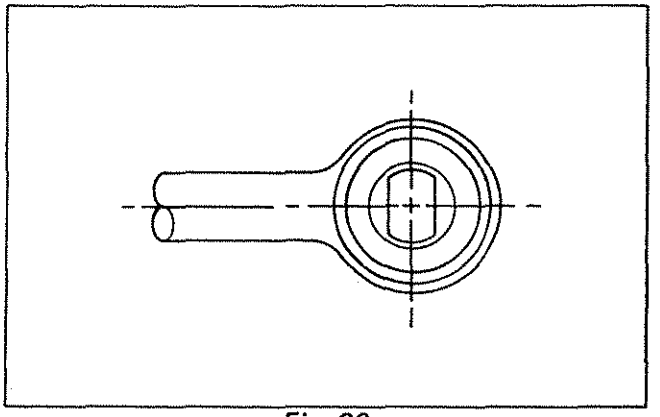

Fig. 26

.2 Position the new straddle mount replacement cartridges on the torque rod eye. Position the remover/replacer tool and cap, with the smaller outside diameter of the remover/replacer tool against the rubber bushing of the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: The center metal section flats of the pin must be perpendicular to the center line of the torque rod shank. See Fig. 26. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

.3 Remove the bolt, lockwasher, and washer-type cap from the new tapered stud replacement cartridge.

Position the new replacement cartridge on the torque rod eye with the stud end down. Position the remover/replacer tool and cap, with the smaller outside diameter of the remover/replacer tool against the rubber bushing of the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: Install the replacement cartridge with the threaded end down. The outer steel sleeve must protrude equally on each side.

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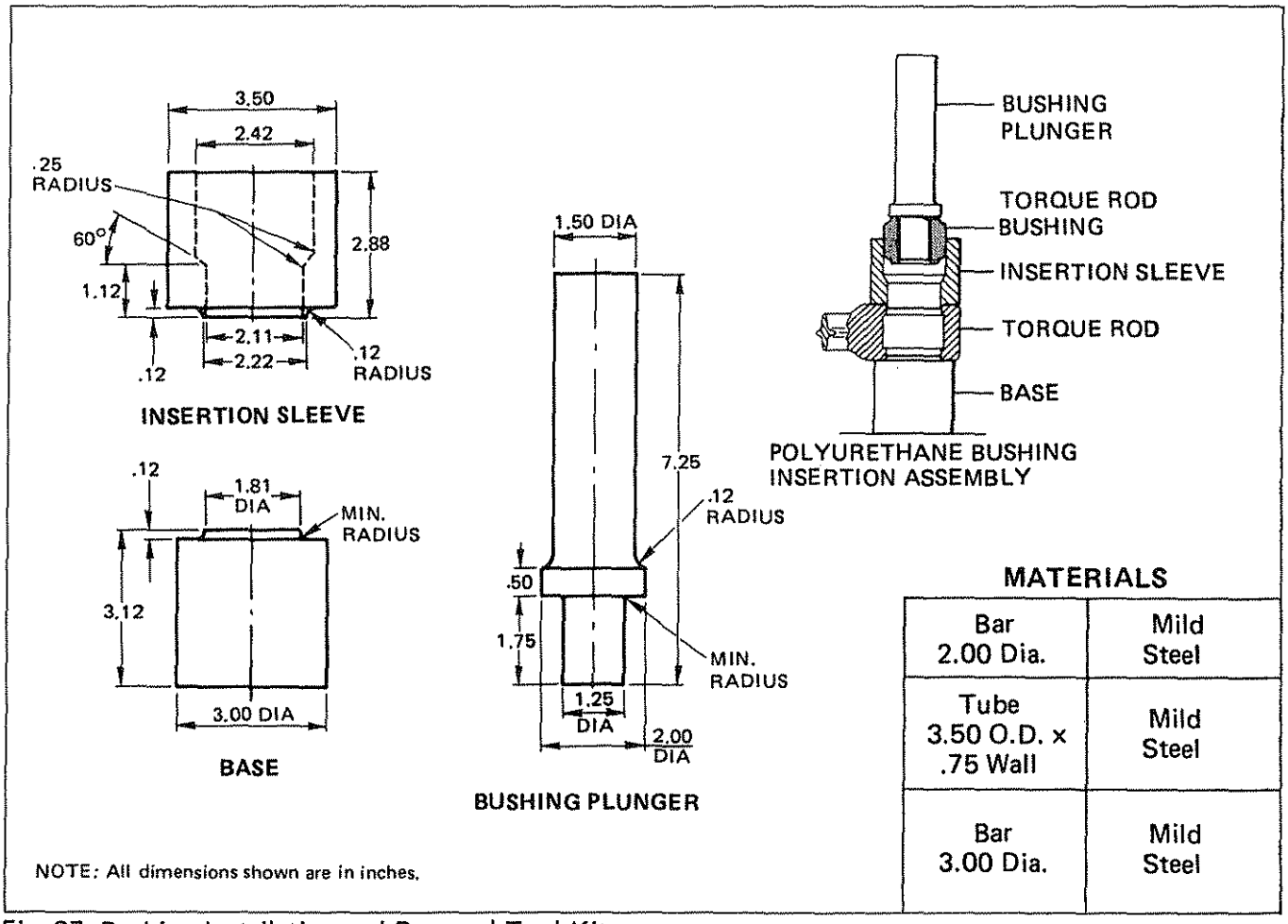
AXLE ALIGNMENT

There are no axle alignment adjustments on the Hendrickson "U" and "UE" Series suspension. At the time of the original installation, the placement of the frame hangers to the frame sets the suspension alignment. Parallel alignment of the axles to each other is automatic, because of the compression centering. In turning, the rubber in the equalizing beam bushings are compressed at all points, and the reflex action to the rubber maintains the parrallelogram form.

SPECIFICATIONS



NOTE: All dimensions shown are in inches.

MATERIALS

Bar 2.00 Dia.	Mild Steel
Tube 3.50 O.D. x .75 Wall	Mild Steel
Bar 3.00 Dia.	Mild Steel

Fig. 27, Bushing Installation and Removal Tool Kit

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SPECIFICATIONS (Continued)

OTC PART NUMBER	TOOL	APPLICATION
Y-851	Receiving Tube	Center Bushing Removal and Installation
Y-852	Removing and Pilot Adapter	Center Bushing Removal and Installation
Y-853	Installing Adapter	Center Bushing Installation
Y-854-A	Receiving Tube	End Bushing Removal and Installation
Y-855-A	Removing and Pilot Adapter	End Bushing Removal and Installation
Y-856	Adapter Clamp	End Bushing Installation
Y-857	Adapter Clamp Plate	End Bushing Installation
Y-858	Receiving Tube	Beam End Tube-Type Hanger Pin Removal
Y-859-A	Removing Adapter	Beam End Tube-Type Hanger Pin Removal
Y-863-A	Pulling Screw	All Operations
Y-864	Sledging Adapter	Seized Part Removal
Y-865-D	Adapter Puller Set	Beam End Adapter-Type Beam Hanger Plug Removal
Y-50-15	Speed Nut	All Operations
Y-50-15-B	Hex Nut	All Operations
*Y51-A	50-Ton Hydraulic Ram	All Operations

*Used in addition to Tool Set Y-850.

Table 1, Owatonna Tool Set No. Y-850 (Owatonna Tool Company, Owatonna, Minnesota)

TOOL NO.	ADAPTER SIZE	APPLICATION
1	4 1/4" O.D. x 4" Length	Beam End Bushing Removal
2	*4 1/2" I.D. x 4 " Length	Beam End Bushing Installation
3	3 1/2" O.D. x 7" Length	Beam Center Bushing Removal and Installation

*Adapter to be used with a sheave puller. See Fig. 15.

Table 2, Shop-Made Adapters for use with a 50-Ton Vertical Hydraulic Press

OTC PART NUMBER	TOOL	APPLICATION
Y-821	Cap	Bushing Removal and Installation
Y-822	Remover	Tapered Stud Removal
Y-823	Remover/Replacer	Bushing Removal and Installation
Y-824	Clamp Assembly	Straddle Mount Bushing Installation
Y-825	Press Plate	Bushing Removal and Installation
Y-826	Remover	Straddle Mount Pin Removal

Table 3, Owatonna Tool Set No. Y-820 (Owatonna Tool Company, Owatonna, Minnesota)

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SPECIFICATIONS (Continued)

DESCRIPTION	SIZE	GRADE	TORQUE	
			FT-LBS	N·m
Spring Center Bolt Nut	1/2-20	B	65-75	88-102
Torque Rod Straddle Mount Attaching Flanged Nut	5/8-11	G	150-175	203-237
Lateral Track Bar Torque Rod Stud Locknut	1 1/8-12	B	175-225	237-303
U-Bolt Nuts	—	—	237-302	321-410
Spring Pin Draw Key Locknut	—	B	75-100	101-136
Spring Rear Hanger Rebound Bolt Locknut	1/2-13	B	70-80	95-109
Saddle Cap Studs	7/8-14	B	55-65	75-88
Saddle Cap Nuts	7/8-14	B	125-145	167-197
Adapter-Type Beam End Nut	3/4-16	C	210-240	285-325

Table 4, Torque Values

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

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HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

GENERAL DESCRIPTION

The Hendrickson "SR" series suspension system (Fig. 1) uses four sets of two-stage rubber shear springs to carry and cushion the load. These rubber shear springs are mounted on an aluminum saddle assembly, two sets of shear springs on each side of the vehicle. Positive mounting between the vehicle frame and the suspension unit is accomplished by four frame hanger assemblies. The vertical drive pin extension of each of the frame hangers extends through the inner sleeve of the rubber shear springs. Lightly loaded, both stages of the rubber shear springs are in shear to provide a relatively high deflection and a low spring rate, for a cushioned ride. At the rated load, the flange on the frame hanger pin compresses and cushions out the first stage of the shear spring. See Fig. 2. This results in an increased spring rate and a decreased deflection rate to accommodate the increased load.

The shear spring and saddle assembly carries the equalizer beam, connected through the equalizer beam center bushing. The axles are attached to beam hangers at the ends of the equalizer beam. This allows an articulating action between the axles to absorb road shock. Torque rods are mounted longitudinally from the axles to the frame crossmember, to control axle torque resulting from acceleration or braking. In addition, some models are equipped with lateral, track bar torque rods, to control side-to-side movement.

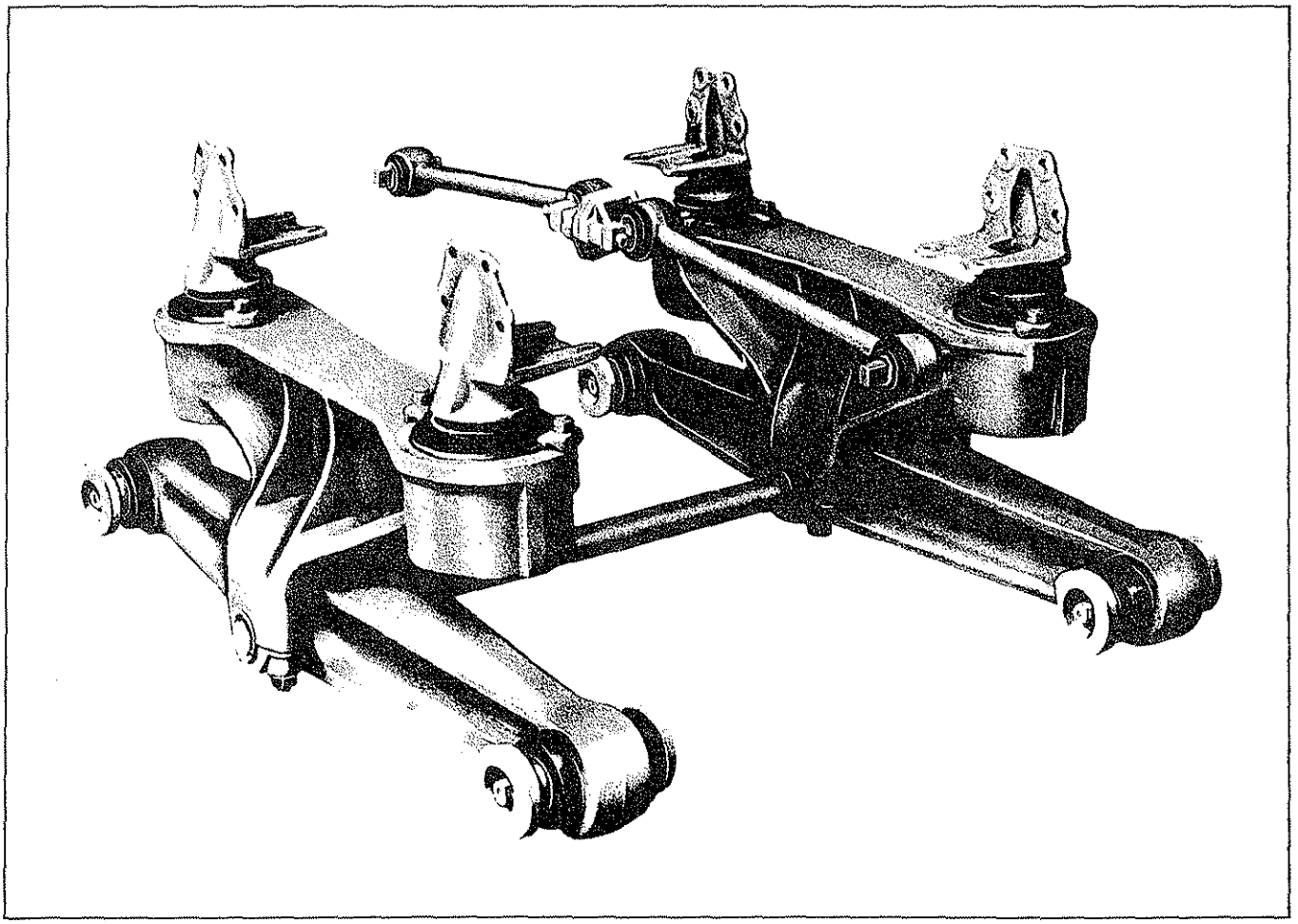

Fig. 1, Hendrickson "SR" Series Suspension

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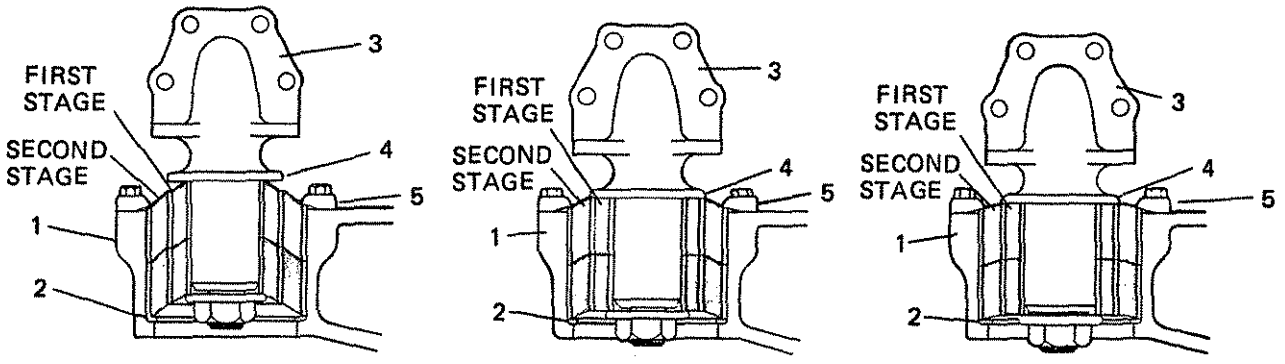

1. Saddle 2. Spacer Ring 3. Spring Hanger 4. Flange 5. Spring Clamp

Fig. 2

SERVICE OPERATIONS

For information regarding inspection intervals and procedures, and lubrication intervals and procedures, refer to the Freightliner Maintenance and Lube Manual.

Most repairs to the Hendrickson suspension system consist of replacing damaged or worn parts. Items most frequently requiring service are the equalizer beam bushings. Special tools (see Table 1, under "SPECIFICATIONS") for replacement of the bushings are available from the Owatonna Tool Company, Owatonna, Minnesota, or an affiliated dealer. Although the use of these special tools is recommended, shop-made adapters may be used if a vertical hydraulic press with a 50-ton capacity is available. Dimensions for the shop-made adapters are given in Table 2, under "SPECIFICATIONS."

When wear on any of the major components reaches the point where replacement is necessary, it is recommended that the entire suspension be removed from the vehicle and overhauled. In cases where individual suspension system components require service, follow only the applicable instructions relating to the components to be serviced.

Whenever the rear suspension is being serviced, block the front wheels to prevent vehicle movement. Always use safety stands under the frame when the vehicle is raised or the suspension removed.

Apply Alumilastic compound, or an equivalent, to all areas where aluminum and steel parts contact each other.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metal components contact each other will result in electrolytic corrosion, which could cause suspension damage.

SUSPENSION SYSTEM REMOVAL AND INSTALLATION

Removal

If the suspension system is being overhauled, remove the suspension using the following procedure:

1. Block the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles, marking the lines for later assembly reference. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.

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2. Disconnect the driveline rear universal joint from the forward-rear axle. For instructions, refer to the applicable subject located in the 09 Group of this manual.

3. Manually release the spring brake chambers. For instructions, refer to the applicable subject located in the 12 Group of this manual.

4. Using an overhead hoist, raise the rear of the vehicle enough to relieve the weight from the suspension.

NOTE: Do not raise the vehicle to the point where the weight of the suspension and axles "hang" from the vehicle.

5. Remove the saddle cap nuts and washers from each side of the vehicle. Then remove the saddle caps that secure the equalizer beam center bushing to the saddles. See Fig. 3.

6. Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

   If also equipped with the lateral, track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushings. Keep clear of the beam hangers and beam end bushings to avoid possible injury.

7. Raise the rear of the vehicle frame until there is sufficient clearance to roll the axles and suspension from beneath the saddles. Install safety stands under the vehicle frame, then roll the axles and equalizer beams from under the frame.

Installation

1. Roll the axles (with the equalizer beams and crosstube attached), under the vehicle frame. Align the ends of the beam center bushings with the saddle legs.

2. Using an overhead hoist, lift the vehicle off the safety stands, then remove the stands from under the frame. Lower the vehicle, so that the saddles seat on the beam center bushings.

3. Position the saddle caps on the saddle cap studs, then install the washers and the new, saddle cap nuts. Do not tighten the nuts at this time.

4. Install the torque rods on the axles, following the instructions given under the heading, "TORQUE ROD INSTALLATION," in this subject.

5. Tighten the new saddle cap nuts to 225-275 ft-lbs (305-373 N·m).

6. If equipped with the adapter-type end supports, tighten the adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 3, Ref. 22.

   If equipped with the tube-type end supports, tighten each end tube nut to 375-425 ft-lbs (441-576 N·m).

WARNING: The adapter-type and tube-type end support fasteners must be tightened to the torque values given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in a possible separation of suspension components, and a loss of vehicle control.

7. Lower the vehicle, then remove the overhead hoist. Manually reset the spring brake chambers. For instructions, refer to the 12 Group of this manual.

8. Connect the driveline rear universal joint to the forward-rear axle. For instructions, refer to the 09 Group of this manual.

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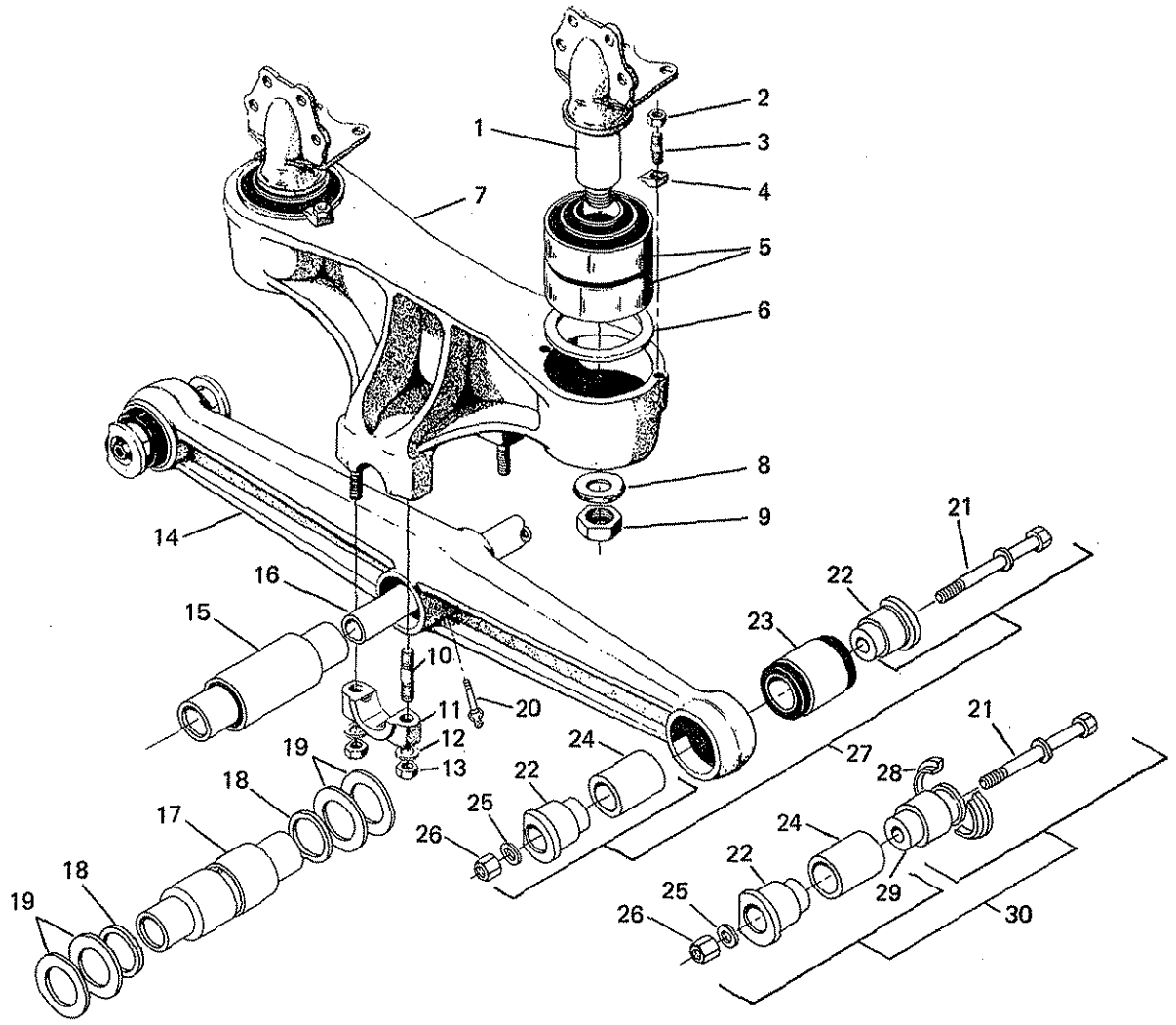

1. Frame Hanger and Vertical Drive Pin Assembly
2. Spring Clamp Nut
3. Spring Clamp Stud
4. Spring Clamp
5. Rubber Shear Spring
6. Spacer Ring
7. Saddle Assembly
8. Vertical Drive Pin Washer
9. Vertical Drive Pin Nut
10. Saddle Cap Stud
11. Saddle Cap
12. Saddle Cap Washer
13 Saddle Cap Nut
14. Equalizer Beam Assembly
15. Rubber Center Bushing
16. Crosstube
17. Bronze Center Bushing
18. Bronze Bushing Seal
19. Thrustwashers
20. Bronze Bushing Grease Fitting
21. Adapter Bolt and Washer
22. Adapter
23. End Bushing
24. Intermediate Tube
25. Washer
26 Adapter Nut
27. Adapter-Type End Support Assembly
28. Splitring
29. Adapter Plug
30. Splitring Adapter Assembly

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Fig. 3, Hendrickson "SR" Series Suspension, Exploded View

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9. Taking care to prevent dirt and other foreign material from entering the lines or fittings, connect the air brake lines leading to the axles. Close the air system drain valve.

10. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual. Adjust the angle if it is not according to specifications.

SADDLE ASSEMBLY REMOVAL AND INSTALLATION (Refer to Fig. 3)

Removal

If the saddle assembly needs to be removed from the vehicle for replacement or overhaul, remove the saddle assembly using the following procedure:

1. Remove the suspension from the vehicle. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

2. Remove the vertical drive pin nuts and washers from the bottoms of the vertical drive pins.

3. Lower the saddle, together with the rubber shear springs, from the frame hanger and frame hanger vertical drive pins.

NOTE: If the steel sleeve in the center of the rubber shear spring is seized to the vertical drive pin, use a Porta-Power, or an equivalent hydraulic tool, between the vehicle frame and the saddle, to break the sleeve loose.

Installation

1. Coat the vertical drive pins and the rubber shear spring inner sleeves with Texaco "Compound L," or an equivalent rust preventive lubricant. Lubricate the threads of the vertical drive pins with SAE-20 oil.

2. Raise the saddle assembly, with the rubber shear springs installed, so that the vertical drive pins center through the rubber shear springs. The threads of the vertical drive pins will extend out of the bottom of the rubber shear springs.

3. Install the vertical drive pin washers and nuts on the vertical drive pins. Tighten the nuts to 175-225 ft-lbs (237-303 N·m).

RUBBER SHEAR SPRING REPLACEMENT (Refer to Fig. 3)

If a rubber shear spring is damaged, cut, or worn, it is recomended that all the rubber shear springs be replaced.

1. Visually inspect the rubber shear spring for cuts, damage, or if the flange on the frame hanger(s) is riding on the second stage (partial load) in an unloaded condition, as shown in Fig. 2. If any of these conditions exist, replace the rubber shear springs.

2. If the suspension and saddle assembly has been removed from the vehicle, proceed to step 3. If the suspension system is installed on the vehicle, remove the rubber shear springs, using the following procedure:

   .1 Block the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.

   .2 Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

   If also equipped with the lateral, track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles

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become free to pivot on the equalizer beam end bushing. Keep clear of the beam hangers and beam end bushings to avoid possible injury.

.3 Remove the spring clamp nuts from the spring clamps and spring clamp studs, then remove the spring clamps from the saddle and rubber shear spring assembly. If the spring clamp studs are damaged or worn, install new spring clamp studs. Lubricate the threads with SAE-20 oil. Tighten the studs to 55-65 ft-lbs (75-88 N·m).

.4 Using an overhead hoist, raise the rear of the vehicle enough to pull out the four rubber shear springs from the saddles and expose the vertical drive pin nuts. Install safety stands under the vehicle frame.

NOTE: If a rubber shear spring is tight in a saddle cavity, use a Porta-Power, or jack, between the saddle and frame to start the tight rubber shear spring out of the saddle.

CAUTION: Do not use a cutting torch to heat the aluminum saddle, and do not pound on it with a hammer. The saddle has been heat treated, and the use of heat could adversely affect the strength of the saddle.

.5 Remove the vertical drive pin nuts and washers.

.6 Remove the rubber shear springs from the vertical drive pins. Proceed to step 4.

3. If the suspension and saddle assembly has been removed from the vehicle, remove the rubber shear springs using the following procedure:

.1 Remove the spring clamp stud locknuts from the spring clamps and spring clamp studs, then remove the spring clamps from the saddle and rubber shear spring assembly. If the spring clamp studs are damaged or worn, install new spring clamp studs. Lubricate the threads with SAE-20 oil. Tighten the studs to 55-65 ft-lbs (75-88 N·m).

.2 Press the rubber shear springs out of the saddle cavities from the bottom side. If the outer sleeve is frozen to the saddle cavity wall, press the two inner sleeves and rubber out of the shear springs, and work the outer sleeve out of the saddle.

CAUTION: Do not use a cutting torch to heat the aluminum saddle, and do not pound on it with a hammer. The saddle has been heat treated, and the use of heat could adversely affect the strength of the saddle.

4. Remove the steel spacer rings from the bottom of the rubber shear spring cavities of the saddles.

5. Remove any small nicks or scratches from the vertical drive pins and the saddle shear spring cavities using emery cloth. Clean the saddle shear spring cavities with solvent.

WARNING: Commercial cleaning solvents may be flammable, toxic, or cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

6. Install the steel spacer rings in the bottom of the saddle shear spring cavities.

7. If the suspension and saddle assembly has been removed from the vehicle, proceed to step 8. If the suspension system is installed on the vehicle, install the new rubber shear springs using the following procedure:

.1 Coat the inner sleeve of the rubber shear springs and vertical drive pins with Texaco "Compound L," or an equivalent rust preventive lubricant, then slide the rubber shear springs on the vertical drive pins.

.2 Install new washers and new vertical drive pin nuts on the vertical drive pins. Tighten the nuts to 175-225 ft-lbs (237-303 N·m).

.3 Coat the outer shell of the new rubber shear springs and the saddle cavities with

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Texaco "Compound L," or an equivalent rust preventive lubricant.

.4 Remove the safety stands from under the vehicle frame, then lower the vehicle frame until the rubber shear springs start to enter the saddle cavities. If the saddle is tilted, it will be necessary to level and position the saddle so that the rubber shear springs can enter the saddle cavities. Lower the vehicle frame until all the rubber shear springs are fully seated in the saddle cavities.

.5 Install the spring clamps and spring clamp locknuts on the spring clamp studs. Tighten the locknuts to 100-125 ft-lbs (136-167 N·m).

.6 Connect the torque rods to the axles. For instructions, refer to "TORQUE ROD INSTALLATION," in this subject.

.7 Taking care to prevent dirt and other foreign material from entering the air lines or fittings, connect the air lines leading to the axles. Close the air system drain valve.

8. If the suspension and saddle assembly is removed from the vehicle, install the new rubber shear springs using the following procedure:

.1 Coat the outer shell of the new rubber shear springs and the saddle cavities with Texaco "Compound L," or an equivalent rust preventive lubricant.

.2 Hand press the new rubber shear springs into the saddle cavities.

NOTE: The rubber shear springs are not a press fit into the saddle cavities. There will be at least a .002 inch (.051 mm) clearance to allow the rubber shear springs to be hand pressed into the cavities.

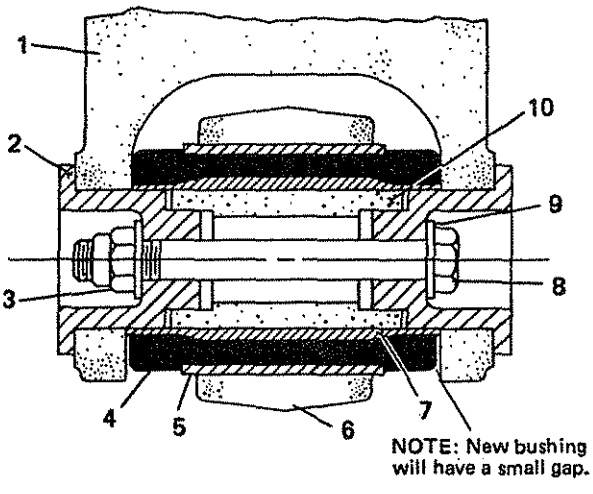
.3 Install the spring clamps and spring clamp nuts on the spring clamp studs. Tighten the nuts to 100-125 ft-lbs (136-167 N·m).

EQUALIZER BEAM REMOVAL AND INSTALLATION, ADAPTER-TYPE END SUPPORTS (Refer to Fig. 3)

Adapter-type end supports connect the equalizer beam to the axle beam hangers using three-piece "adapters" installed into each of the axle beam hangers. See Fig. 4. The inner sleeve of the beam end bushing is locked to the beam hanger by pressure of the adapter bolt, pulling the adapters against the outer surface.

Removal

IMPORTANT: If using the special Owatonna tools (OTC set No. Y-865-D) to remove the equalizer beam from the axle beam hangers, the suspension system must be installed on the vehicle. If not using the special Owatonna tools, the equalizer beam can be removed from the axle beam hangers, either with the suspension installed on the vehicle, or with the suspension removed from the vehicle.



1. Beam Hanger
2. Adapter
3. Adapter Bolt Nut
4. Rubber End Bushing
5. Bushing Outer Sleeve
6. Equalizer Beam
7. Bushing Inner Sleeve
8. Adapter Bolt
9. Washer (both ends)
10. Intermediate Tube

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Fig. 4, Equalizer Beam Adapter-Type End Support

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1. Remove the saddle cap nuts and washers, then remove the saddle caps that secure the equalizer beam center bushings to the saddles. See Fig. 3.

2. Support the equalizer beams with safety stands. Remove the nut, washers, and adapter bolt from the beam end adapters.

3. If not using the special Owatonna tools, proceed to step 4. If using the special Owatonna tools, remove the adapter plug using the following procedure:

   .1 Remove the wheels, hubs, and brake drums from the rear axles. For instructions, refer to the 11 Group of this manual.

   .2 Select a hand-tap (7/8" for 3/4"-cored-hole, or 1" for 7/8"-cored-hole), and tap the hole from which the adapter bolt was removed, as shown in Fig. 5. Then, position the pulling plate (OTC part No. 28445) over the hand-tap and against the beam hanger. Attach the forcing screw (OTC part No. 28446 for 7/8"-hand-tap, or OTC part No. 28447 for 1"-hand-tap) to the hand-tap, and secure with the nut (OTC part No. 10220) against the pulling plate. While holding the nut with a wrench, tighten the forcing screw to pull the adapter plug from the beam hanger. See Fig. 6. Proceed to step 5.

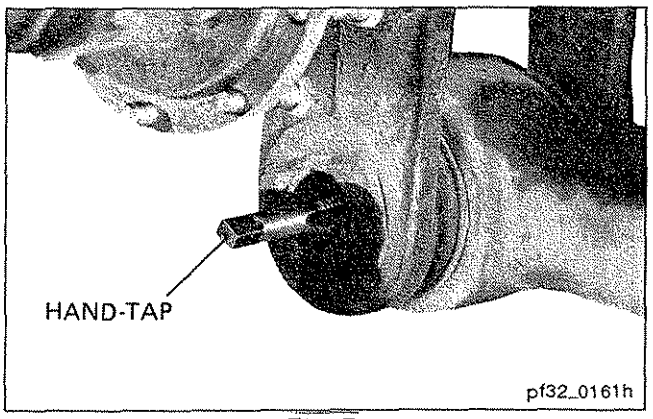

Fig. 5

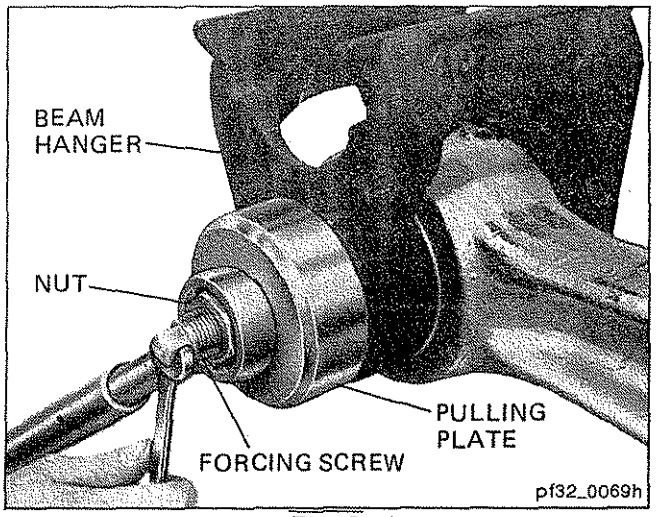

Fig. 6

4. If not using the special Owatonna tools, a relief is provided on each side of the adapter for chisel entry. Insert a chisel into the relief on the inboard adapter, and drive the chisel in, to wedge the adapter out of the beam hanger. Repeat this step for the outboard adapter.

NOTE: In some installations, a splitring type adapter assembly (see Fig. 3, Ref. 30) is used instead of the standard adapter. To remove, drive the chisel between the two halves of the splitring, forcing them to snap out of the adapter plug. Then drive the adapter plug into the equalizer beam end bushing until it clears the beam hanger. After the equalizer beam has been removed from the beam hanger, drive the plug out of the bushing.

5. After the ends of both equalizer beams have been separated from the axle beam hangers, lower the equalizer beams, together with the crosstube, to the ground. Remove the thrustwashers, if applicable, then separate the beams from the crosstube by pulling apart by hand.

Installation

1. Apply Texaco "Compound L," or an equivalent rust preventive lubricant, to the axle beam hanger eyes, beam end bushing inner sleeve,

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end support adapters, outside surface of the bushing intermediate tubes, and the ends of the crosstube.

2. Install the crosstube in both equalizer beam center bushings. If equipped with bronze center bushings, install the thrustwashers.

   If new rubber center bushings that have the end plugs as a separate part are installed, then, arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: **Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and debris, from the welding process.**

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

3. Position the equalizer beam assembly under the axles, then raise the assembly and place the forward ends of each beam in the forward-rear axle beam hangers. Align the beam end bushings with the beam hangers.

4. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

5. Place the rear ends of each beam in the rear-rear axle beam hangers. Align the beam end bushings with the beam hangers.

6. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

NOTE: If the suspension and saddle assembly has been removed from the vehicle, installation of the equalizer beam will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

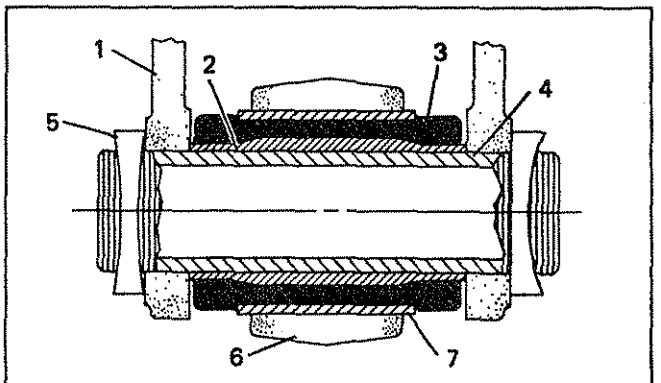
7. Position the saddle caps on the saddle cap studs, then install the washers and new, saddle cap nuts. Tighten the nuts to 225-275 ft-lbs (305-373 N·m).

8. Tighten the adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 3, Ref. 22.

WARNING: **The adapter bolt nuts must be tightened to the torque value given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in separation of suspension components, and a loss of vehicle control.**

EQUALIZER BEAM REMOVAL AND INSTALLATION, TUBE-TYPE END SUPPORTS

On tube-type end supports, the inner sleeve of the beam end bushing is locked to the axle beam hanger legs by pressure on the beam hanger legs from the beam end tube nuts, on a 2 1/2 inch (64 mm) diameter end tube. See Fig. 7.



1. Beam Hanger
2. Bushing Inner Sleeve
3. Rubber End Bushing
4. Beam End Tube
5. End Tube Nut
6. Equalizer Beam
7. Bushing Outer Sleeve

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Fig. 7, Equalizer Beam Tube-Type End Support

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Removal

IMPORTANT: If using the special Owatonna tools to remove the equalizer beam from the axle beam hangers, the suspension system must be installed on the vehicle.

1. Remove the saddle cap nuts and washers, then remove the saddle caps that secure the equalizer beam center bushings to the saddles. See Fig. 3.

2. Support the equalizer beam ends with safety stands. Remove the beam end tube nuts from both sides of the beam end tubes.

3. If not using the special Owatonna tools, proceed to step 4. If using the special Owatonna tools, remove the tube-type end supports using the following procedure:

   .1 Remove the wheels, hubs, and brake drums from the rear axles. For instructions, refer to the 11 Group of this manual.

   .2 Position the receiving tube over the outboard end of the beam end tube. Then assemble the hydraulic ram, pulling screw, speed nut, and the removing adapter, as shown in Fig. 8. Connect a hydraulic pumping unit to the hydraulic ram, then apply hydraulic pressure to remove the beam end tube. Proceed to step 5.

4. If not using the special Owatonna tools, install a spacer bushing between one end tube nut and the beam hanger, tightening the nut to pull the end tube out of the beam end bushing. If this method does not loosen the tube, use a hack saw to saw through the tube along the inside surface of the beam hanger legs.

CAUTION: Do not use a cutting torch to remove the equalizer beams from the beam hangers. The equalizer beam has been heat treated, and the use of heat could adversely affect the strength of the equalizer beams.

5. After the ends of both equalizer beams have been separated from the axles, lower the equalizer beams, together with the crosstube, to the ground. Remove the thrustwashers, if applicable, then separate the beams from the crosstube by pulling apart by hand.

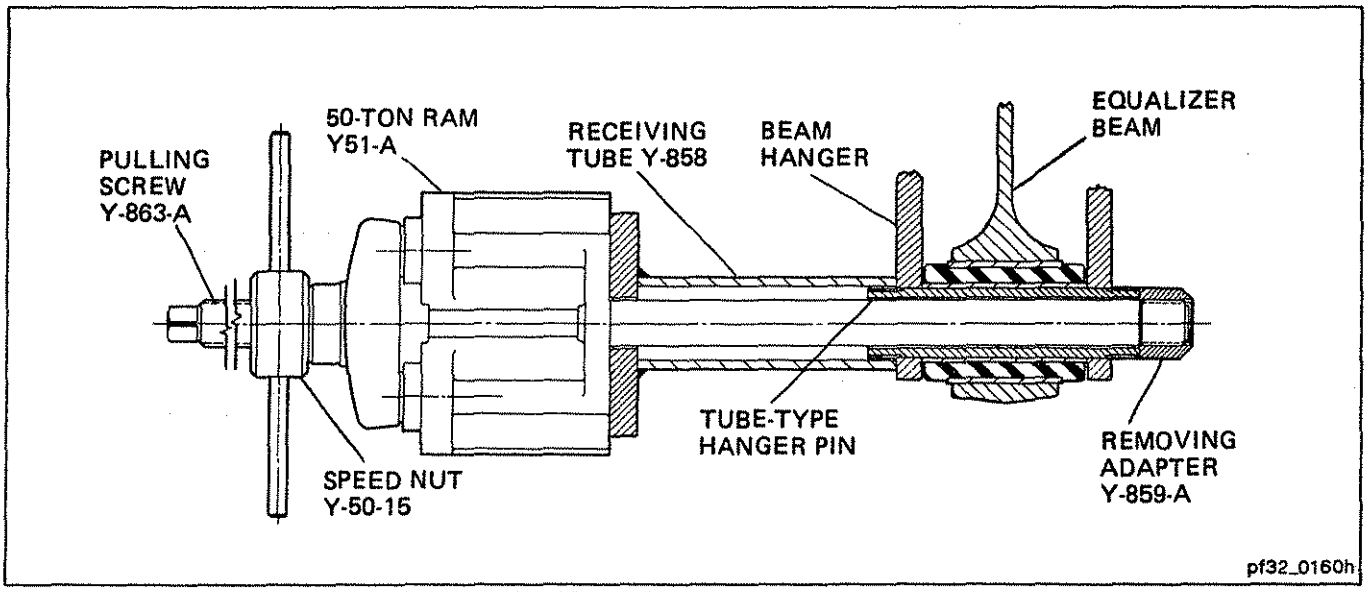

Fig. 8, OTC Tool Set-up For Tube-Type End Tube Removal

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Installation

1. Apply Texaco "Compound L," or an equivalent rust preventive lubricant, to the axle beam hanger eyes, beam end bushing inner sleeve, outer surface of the beam end tubes, beam center bushing inner sleeves, and the ends of the crosstube.

2. Lubricate the threads of the beam end tubes with SAE-20 oil.

3. Install the crosstube in both equalizer beam center bushings. If equipped with bronze center bushings, install the thrustwashers.

   If new rubber center bushings that have the end plugs as a separate part are installed, then, arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and debris, from the welding process.

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

4. Position the equalizer beam assembly under the axles, then raise the assembly and place the forward ends of each beam in the forward-rear axle beam hangers. Align the beam end bushings with the beam hangers.

5. Install the beam end tubes through the beam hangers and the beam end bushings. Hand start both nuts on the beam end tubes. Do not tighten the nuts at this time.

6. Place the rear ends of each beam in the rear-rear axle beam hangers. Align the beam end bushings with the beam hangers.

7. Install the beam end tubes through the beam hangers and the beam end bushings. Hand start both nuts on the beam end tubes. Do not tighten the nuts at this time.

NOTE: If the suspension and saddle assembly is removed from the vehicle, installation of the equalizer beam will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

8. Position the saddle caps on the saddle cap studs, then install the washers and new, saddle cap nuts. Tighten the nuts to 225-275 ft-lbs (305-373 N·m).

9. Tighten the end tube nuts to 375-425 ft-lbs (441-576 N·m).

WARNING: The end tube nuts must be tightened to the torque value given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in separation of suspension components, and a loss of vehicle control.

EQUALIZER BEAM END BUSHING REPLACEMENT (Refer to Fig. 3)

IMPORTANT: If one or more of the end bushings requires replacement, it is recommended that all four end bushings be replaced.

1. Remove the equalizer beam from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. On one side only of each beam end bushing, cut back the protruding rubber portion, flush with the equalizer beam, as shown in Fig. 9, to allow the adapter to squarely contact the bushing outer sleeve.

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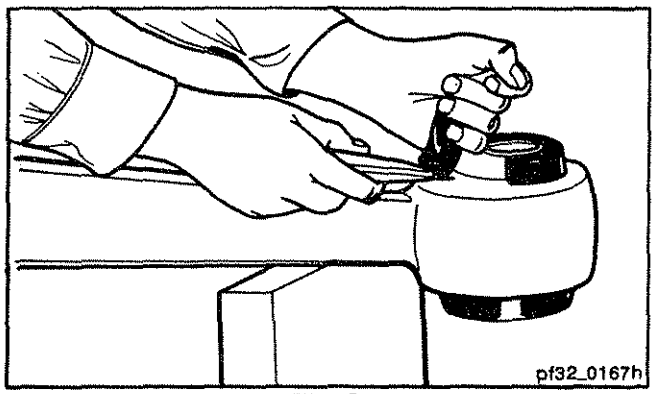

Fig. 9

3. If using the special Owatonna tools, remove the beam end bushings, using the following procedure (refer to Fig. 10):

   .1 Center the end bushing removing adapter on the trimmed side of the beam end bushing.

   .2 Position the receiving tube on the untrimmed side of the beam end bushing. Assemble the hydraulic ram and speed nut on the pulling screw, then position the assembly through the receiving tube, bushing, and removing adapter, as shown in Fig. 10. Secure with the hex nut.

   IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube as it is pulled through the beam. The removing adapters should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean pull through the beam.

   .3 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

   .4 If the pressure gauge on the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

   If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa); if the bushing does not pull out, strike sledging adapter

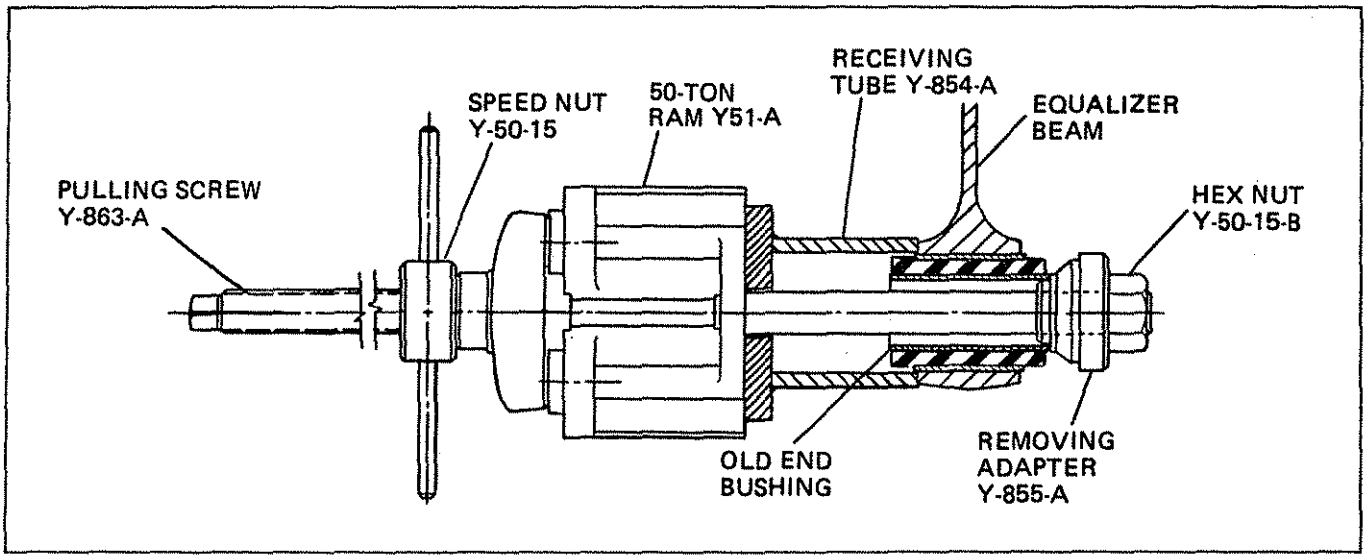

Fig. 10, OTC Tool Set-up For Equalizer Beam End Bushing Removal

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again until another loud "crack" is heard and the pressure gauge reading drops.

.5 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the end bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, remove the beam end bushings with shop-made adapters, using the following procedure:

   .1 Position the equalizer beam on a 50-ton vertical hydraulic press.

   .2 Center the shop-made adapter (tool No. 1 from Table 2, located under "SPECIFICATIONS") on the trimmed end of the equalizer beam bushing. Then, press the end bushing from the beam eye.

5. Using emery cloth, remove all scale, rust, or corrosion from the equalizer beam eyes. Replace the equalizer beam if cracks, gouges, or damage is evident in the beam eyes.

6. Clean the outer sleeves of the new equalizer beam end bushings with emery cloth, then apply a thin coating of white lead, or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeves. Position the bushing on the equalizer beam eye.

7. If using the special Owatonna tools, use the following procedure for installation of the beam end bushing (refer to Fig. 11):

   .1 Fit the adapter clamp over the exposed rubber on the new bushing, then tighten the clamp nuts until the contact surface on the clamp rests fully against the bushing outer sleeve.

   .2 Position the pilot adapter into the beam eye, as shown in Fig. 11.

   .3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the pilot adapter in the beam eye, bushing, and adapter clamp. Attach the adapter clamp plate to the pulling screw and adapter clamp. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment

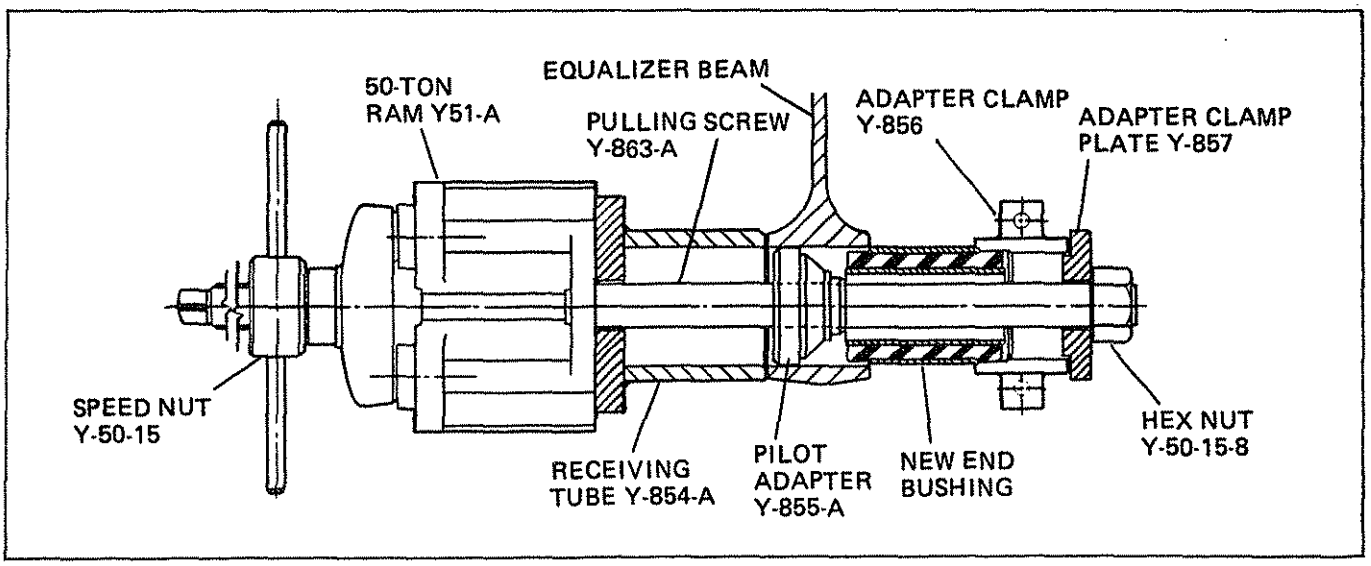

Fig. 11, OTC Tool Set-up For Equalizer Beam End Bushing Installation

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa), when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new end bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), then the new bushing has been installed. Make a visual inspection.

8. If not using the special Owatonna tools, install the new bushing with shop-made adapters, using the following instructions (refer to Fig. 12):

.1 Using a sheave puller, compress the exposed rubber of the new bushing, until the puller jaws seat against the end of the new bushing outer sleeve.

.2 Position the shop-made adapter (tool No. 2 from Table 2, located under "SPECIFICATIONS") against the jaws of the sheave puller. Then, press the new bushing into the beam eye.

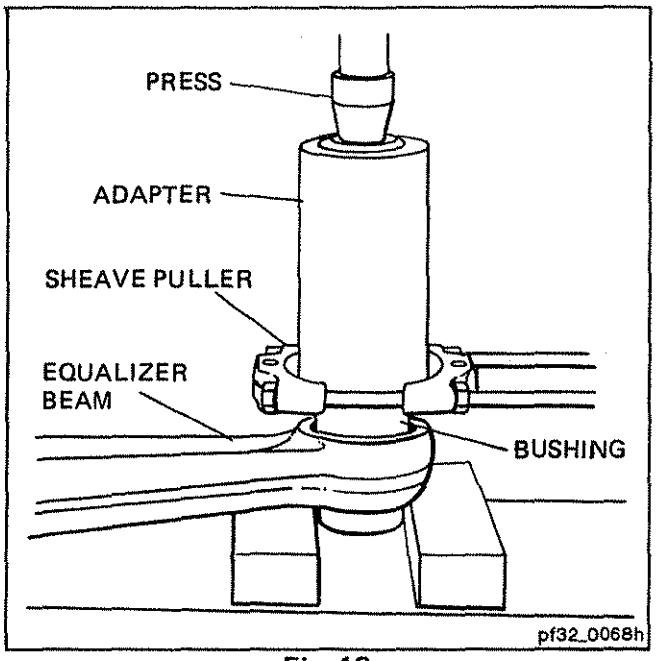

Fig. 12

9. Replace the center bushings, if needed. For instructions, refer to the applicable center bushing replacement heading, in this subject.

10. Install the equalizer beam on the axle beam hangers. For instructions, refer to the applicable equalizer beam installation heading, in this subject.

EQUALIZER BEAM RUBBER CENTER BUSHING REPLACEMENT (Refer to Fig. 3)

IMPORTANT: If a beam rubber center bushing is worn or damaged, and needs to be replaced, then the rubber center bushings must be replaced on both equalizer beams.

NOTE: If using the special Owatonna tools, the beam center bushing can be replaced either with the equalizer beam installed on the vehicle (see Fig. 13), or with the beam removed from the vehicle.

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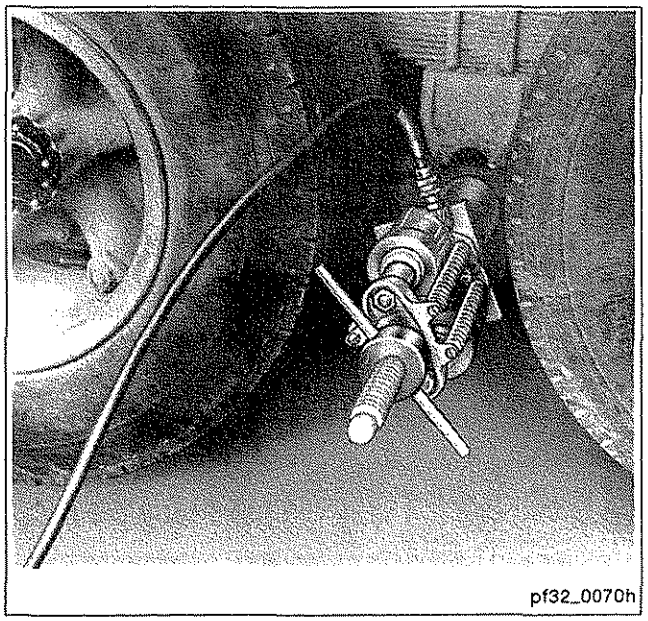

Fig. 13, Removing Equalizer Beam Center Bushing Installed on Vehicle

1. If not using the special Owatonna tools, remove the equalizer beam from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. Check the inboard exposed edge of the equalizer beam center bushing outer sleeve. If the outer sleeve is worn and has flared over the face of the equalizer beam, then chisel or grind the flared portion off, so it will not impede removal of the bushing.

WARNING: Protective eye goggles must be worn when grinding. Failure to do so could result in injury to the eye, due to the metal debris from the grinding process.

3. If using the special Owatonna tools, remove the beam center bushing using the following procedure (refer to Fig. 14):

   .1 Before the Owatonna tools can be used, the welded end plug in the outside end of the inner sleeve must be removed. For the Model 340, use a 2-inch diameter hole saw, for the Model 380, use a 2 1/2-inch diameter hole saw, to cut out the end plugs from the bushing.

CAUTION: Do not use a cutting torch to burn out the end plugs from the beam center bushings. The equalizer beam has been heat-treated, and the use of heat could adversely affect the strength of the beam.

   If the equalizer beam is installed on the vehicle, the crosstube must be removed.

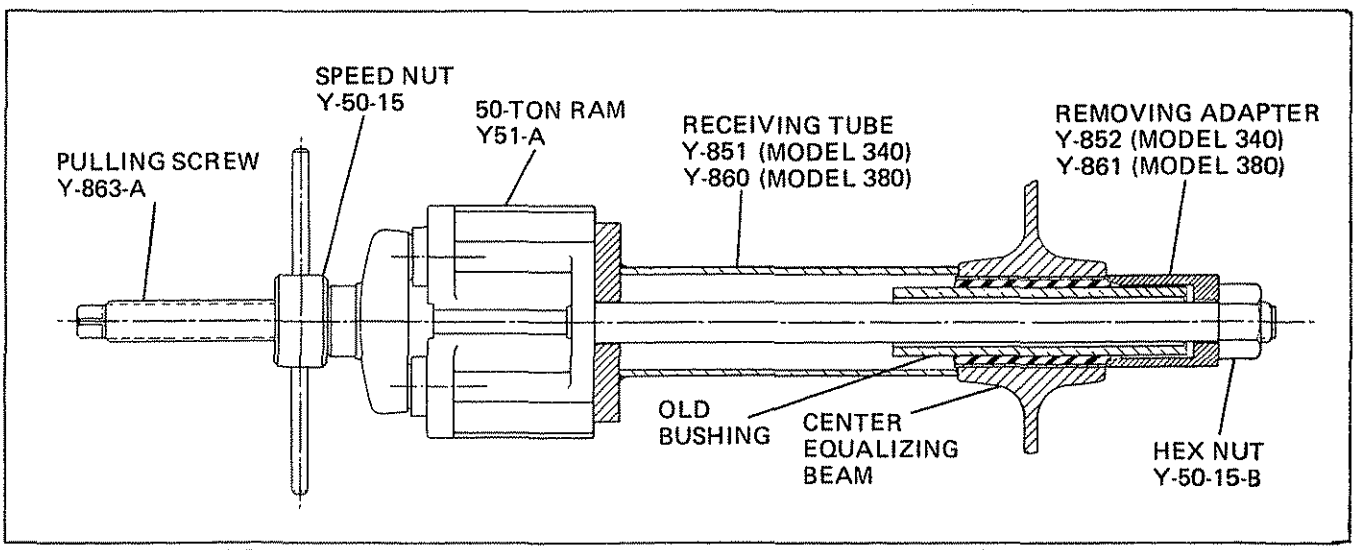

Fig. 14, OTC Tool Set-up for Equalizer Beam Rubber Center Bushing Removal

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.2 Position the removing adapter or on the bushing end prepared in step 2, above.

.3 Position the receiving tube on the opposite side of the beam center bushing. Then, assemble the hydraulic ram, speed nut, and pulling screw, as shown in Fig. 14. Secure with the hex nut.

IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube, as it is pulled through the beam. The removing adapter should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 If the pressure gauge of the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa); if bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

.6 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the center bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, remove the old center bushing with shop-made adapters, using the following procedure:

.1 Position the shop-made adapter (tool No. 3 for Model 340, or tool No. 4 for Model 380, given in Table 2, under "SPECIFICATIONS") on the bushing end prepared in step 2, above.

.2 Position the beam on a 50-ton vertical hydraulic press, then apply pressure to press the center bushing from the bushing eye.

5. If converting from a rubber center bushing to a bronze center bushing, proceed to step 5, located under the heading, "EQUALIZER BEAM BRONZE CENTER BUSHING REPLACEMENT," in this subject. If not converting to bronze center bushings, proceed to step 6, below.

6. Using a cylinder hone or emery cloth, remove all scale, rust, or corrosion from the equalizer beam eye. Replace the equalizer beam if cracks, gouges, or damage exists in the beam eyes.

7. Clean the outer sleeves of the new equalizer beam center bushing with emery cloth, then apply a thin coating of white lead, or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeve and the beam center eye. Position the bushing against the equalizer beam eye.

8. If using the special Owatonna tools, use the following procedure for installation of the beam center bushing (refer to Fig. 15):

NOTE: New rubber center bushings with the end plugs as a separate part must be used.

.1 Fit the installing adapter over the bushing inner sleeve and against the outer sleeve end.

.2 Position the pilot adapter in the beam center eye.

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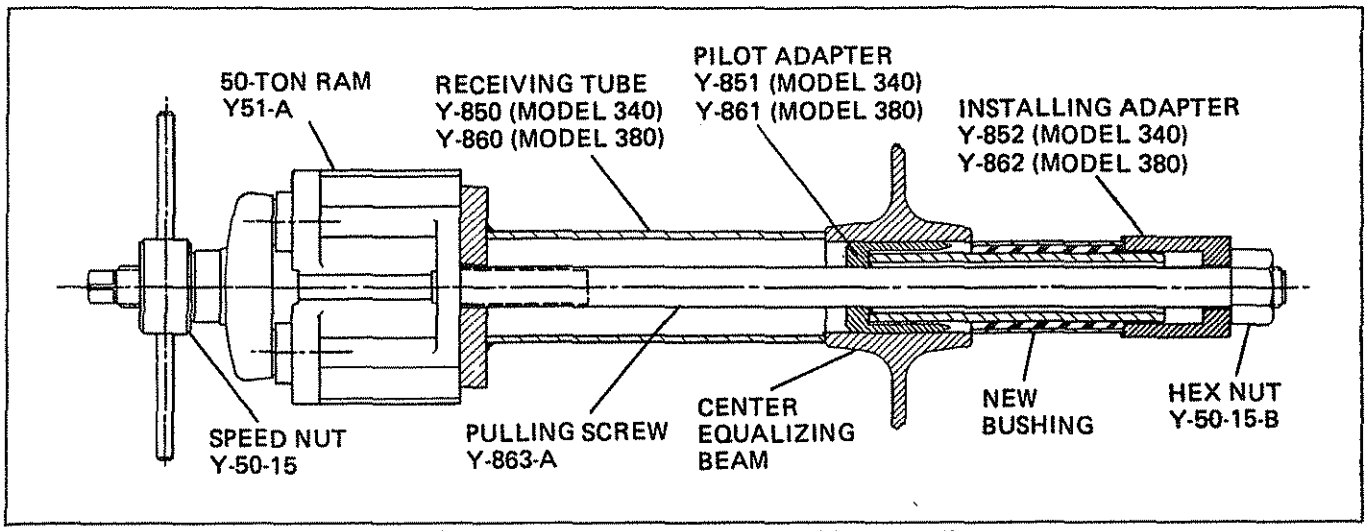

Fig. 15, OTC Tool Set-up for Equalizer Beam Rubber Center Bushing Installation

.3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the pilot adapter in the beam eye, bushing, and installing adapter. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa), when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new center bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), then the new bushing has been installed. Make a visual inspection.

.8 If both of the new center bushings were installed with the equalizer beams installed on the vehicle, position the crosstube in the center bushings. Arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and flying debris, from the welding process.

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to

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the bushing inner sleeve, because of the distance from the point of welding.

9. If not using the special Owatonna tools, install the new center bushing with shop-made adapters, using the following procedure:

NOTE: Use the standard center bushings with the end plugs welded in place.

.1 Position the shop-made adapter (tool No. 3 for Model 340, or tool No. 4 for Model 380, given in Table 2, under "SPECIFICATIONS") over the bushing inner sleeve, so that it bottoms against the bushing outer sleeve.

.2 Position the beam, bushing, and adapter on a 50-ton vertical press, then apply pressure to press the center bushing into the beam eye.

10. Replace the end bushings, if needed. For instructions, refer to "EQUALIZER BEAM END BUSHING REPLACEMENT," in this subject.

11. Install the equalizer beam on the axle beam hangers. For instructions, refer to the applicable equalizer beam installation heading, in this subject.

EQUALIZER BEAM BRONZE CENTER BUSHING REPLACEMENT (Refer to Fig. 3)

IMPORTANT: If a beam bronze center bushing is worn or damaged, and needs to be replaced, then the bronze center bushing must be replaced on both equalizer beams.

NOTE: If using the special Owatonna tools, the bronze center bushing can be replaced either with the equalizer beam installed on the vehicle (see Fig. 13), or with the beam removed from the vehicle.

IMPORTANT: Do not install bronze bushings on aluminium equalizer beams.

1. If not using the special Owatonna tools, remove the equalizer beam from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. Remove the saddle caps. Then slide out the beam center sleeve and thrustwashers from the center bushing, and discard these parts.

3. If using the special Owatonna tools, remove the bronze center bushing using the following procedure:

.1 If the equalizer beam is installed on the vehicle, remove the crosstube.

.2 Position the bronze center bushing adapter in the bushing to be removed, as shown in Fig. 16.

.3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the beam eye, bushing, and adapter, as shown in Fig. 17. Secure with the hex nut.

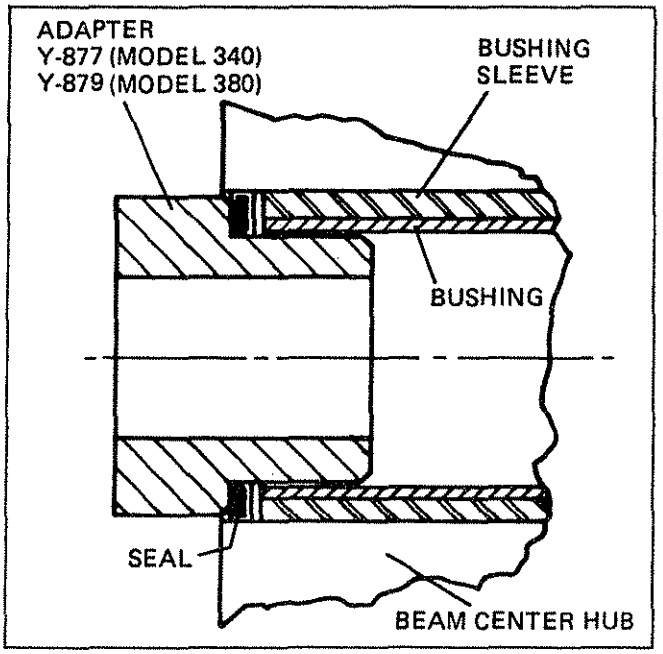

Fig. 16, OTC Adapter Position for Equalizer Beam Bronze Center Bushing Removal

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IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing the bushing to clear the edges of the receiving tube as it is pulled through the beam. The adapter should be aligned so that the force is exerted on the bushing and seals *only* (as shown in Fig. 16), not against the beam, to allow for a clean pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 If the pressure gauge shows a reading of 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

.6 If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa), if bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

.7 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the center bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

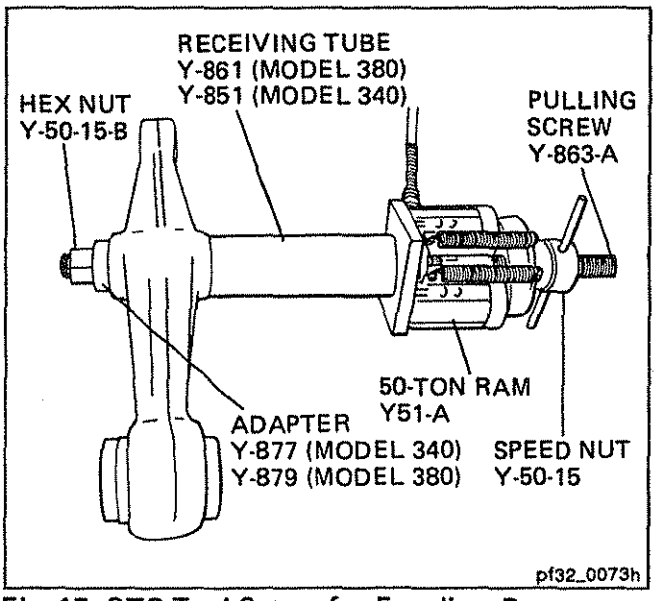

Fig. 17, OTC Tool Set-up for Equalizer Beam Bronze Center Bushing Removal

4. If not using the special Owatonna tools, position the equalizer beam on a 50-ton vertical hydraulic press. Center the adapter on the bushing, then press the bushing from the beam eye.

IMPORTANT: The adapter should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean press through the beam eye.

5. Using a cylinder hone or emery cloth, remove all scale, rust, or corrosion from the equalizer beam eyes. Replace the equalizer beam if cracks, gouges, or damage is evident in the beam eyes. Remove the grease fitting, then run a wire through the hole to make certain that it is not blocked.

NOTE: When converting from rubber bushings to bronze bushings, it is necessary to drill the lube fitting hole in the equalizer beam hub before installing the bushings. Drill the hole according to the dimensions given in Fig. 34, under "SPECIFICATIONS."

6. Apply a thin coating of Texaco "Compound L," or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeve and the inside surface of the beam eye.

7. Position the new bronze bushing on the equalizer beam eye, so that the grooves on the

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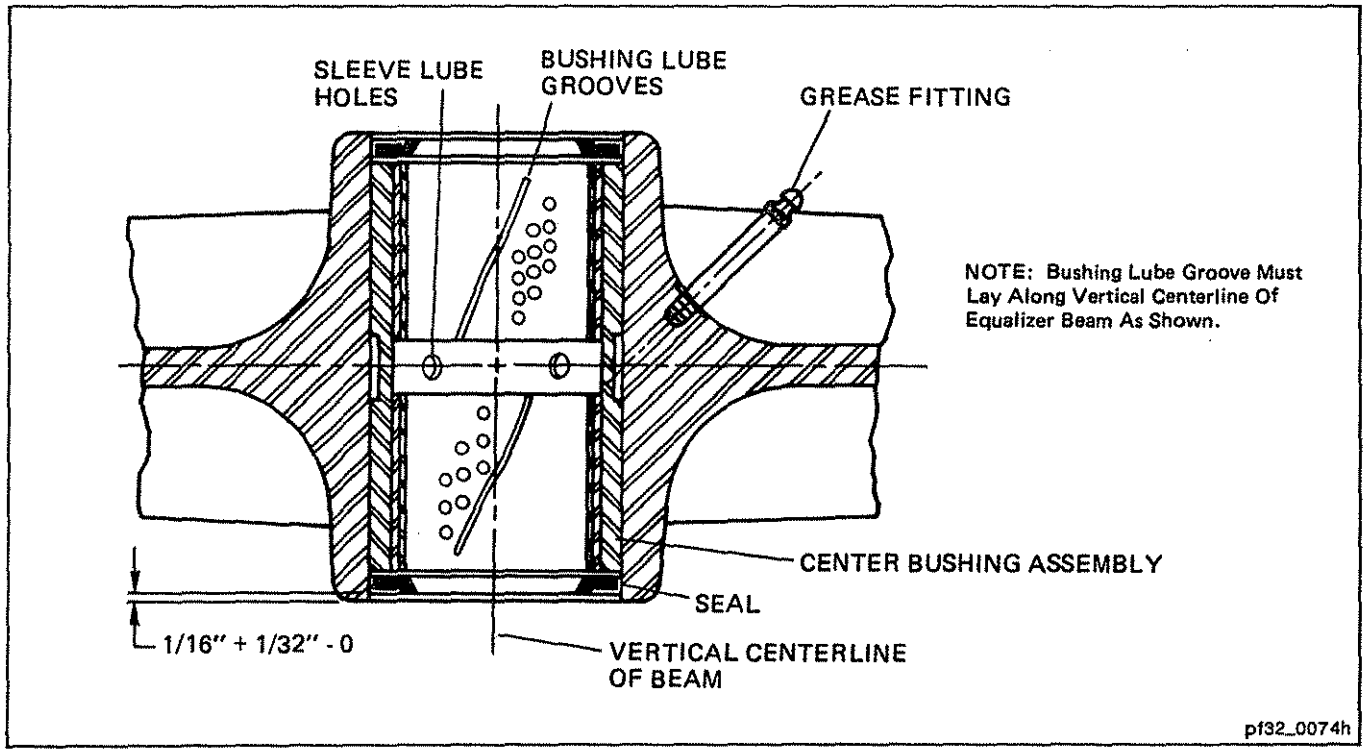

Fig. 18

bushing will lay along the vertical centerline of the equalizer beam, when installed. See Fig. 18.

8. If using the special Owatonna tools, use the following procedure for installation of the beam bronze center bushing (refer to Fig. 19):

   .1 Install the grease seal adapter plate on the adapter, with the smaller shoulder of the adapter plate against the adapter. Then, position the adapter and adapter plate assembly on the bronze center bushing. When installed, the adapter plate will bottom on the beam, as shown in Fig. 20.

   .2 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the beam eye, bushing, adapter plate, and adapter. Secure with the hex nut.

   IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube

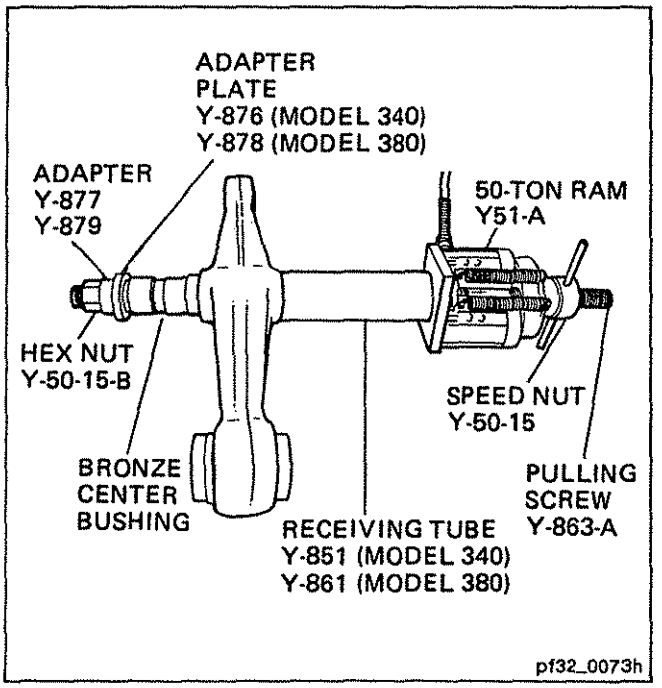

Fig. 19, OTC Tool Set-up for Equalizer Beam Bronze Center Bushing Installation

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exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter and adapter plate should fit on the bushing so that the adapter plate will bottom on the beam when the bushing is installed, as shown in Fig. 20.

.3 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.4 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa), when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.5 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new center bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.6 When the adapter plate bottoms on the beam (see Fig. 20) and the pressure gauge shows a pressure reading increase of up to 10,000 psi (68 900 kPa), then the new bushing is installed. Make a visual inspection.

.7 Install the grease seals (one on each side of the bushing), after the bushings are installed, by inverting the adapter plate so that the smaller shoulder is against the seal, as shown in Fig. 21. Install the new grease seals with the lips of the seals facing outward, as shown in Fig. 18. On the outside of the beam, place the seal and adapters in place, and tap the seal in place with a hammer by striking the adapter

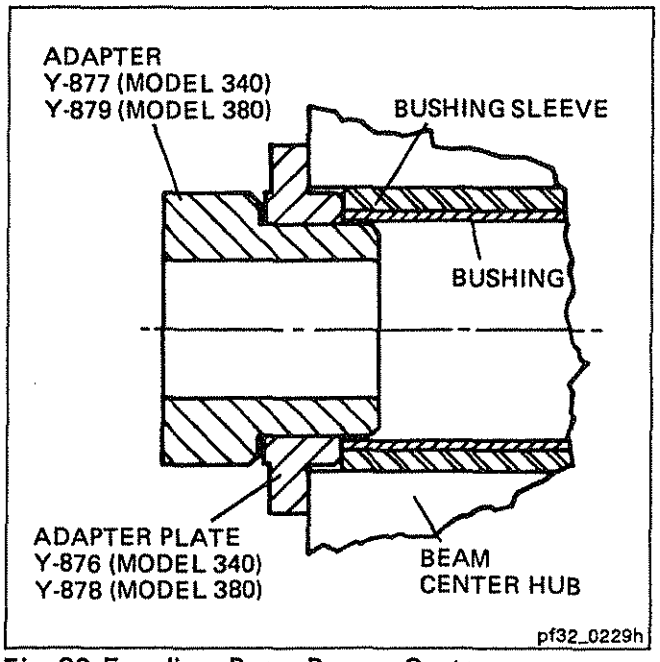

Fig. 20, Equalizer Beam Bronze Center Bushing Installation

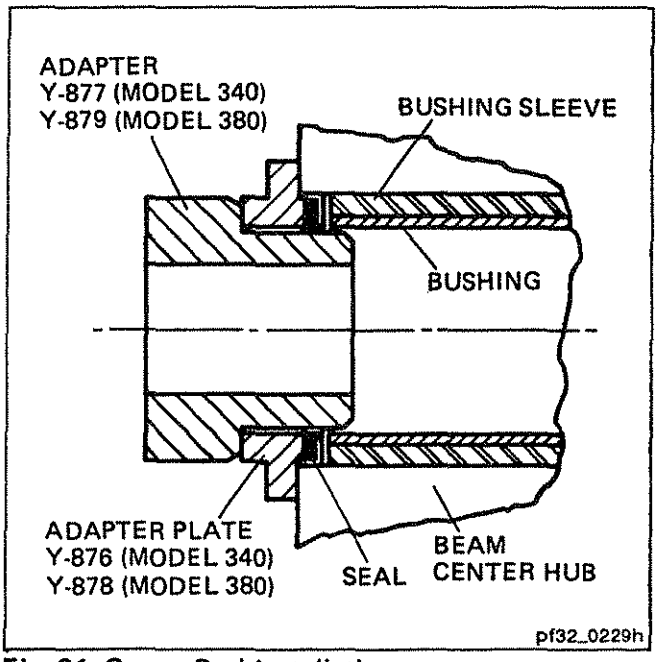

Fig. 21, Grease Seal Installation

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assembly. When adapter plate bottoms against the beam, the seal is installed to its proper depth. Proceed to step 10.

9. If not using the special Owatonna tools, use the following procedure to install the new bronze center bushing:

   .1 Position the beam on a 50-ton vertical hydraulic press, then position the new bushing over the beam eye. Using a standard bushing driver, drive the bushing into the beam eye.

   .2 Center the bushing in the beam eye, so that there is equal spacing between both ends of the bushing and the sides of the beam. See Fig. 18.

   .3 Install the new grease seals into the ends of the equalizer beam eye, with the lips of the seals facing outward. The face of the seals must be inside the beam eye and 1/16" + 1/32"-0, to provide clearance and protection of the seals. See Fig. 18. Do not bend the seal.

10. Apply a thin coating of multipurpose chassis grease to the outer surface of the bushing center sleeve, then slide the sleeve into the bushing. Install the grease fitting into the beam hub. Apply multipurpose chassis grease through the grease fitting, while rotating the center sleeve. Continue until grease appears at both grease seals.

NOTE: Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for lubrication schedules and procedure for bronze bushings.

11. If the beam hub length measures 6 7/8 inches (175 mm), install one thrustwasher on each side of the beam center bushing. If the beam hub length measures 6 3/4 inches (171 mm), install two thrustwashers on each side of the beam center bushing.

TORQUE ROD REMOVAL AND INSTALLATION (Refer to Fig. 22)

Removal

If the suspension has been removed from the vehicle, proceed to step 3.

1. If not previously done, disconnect the torque rods from the torque rod axle brackets by removing the attaching flanged nuts and flanged bolts.

2. If also equipped with the lateral, track bar torque rods, remove the attaching locknuts from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushings. Keep clear of the beam hangers and beam ends to avoid the possibility of injury.

3. Remove the flanged locknuts and flanged bolts that attach the torque rod straddle mount assembly to the frame crossmember. Remove the torque rods, crossmember brackets, and shim(s), from the vehicle. Keep track of the torque rod crossmember spacer in the suspension crossmember.

4. If also equipped with lateral, track bar torque rods, remove the flanged locknuts and flanged bolts that attach the torque rod assembly to the frame rail. Remove the torque rods, frame bracket, and backing plate from the vehicle.

5. Visually inspect the torque rod for bends or cracks. Work the torque rod pins to check for looseness in the polyurethane bushing. If the torque rod is bent, cracked, or otherwise damaged, replace it with a new one. If either of the bushings is loose, both of the bushings must be replaced with new ones. For instructions refer to "TORQUE ROD BUSHING REPLACEMENT," in this subject.

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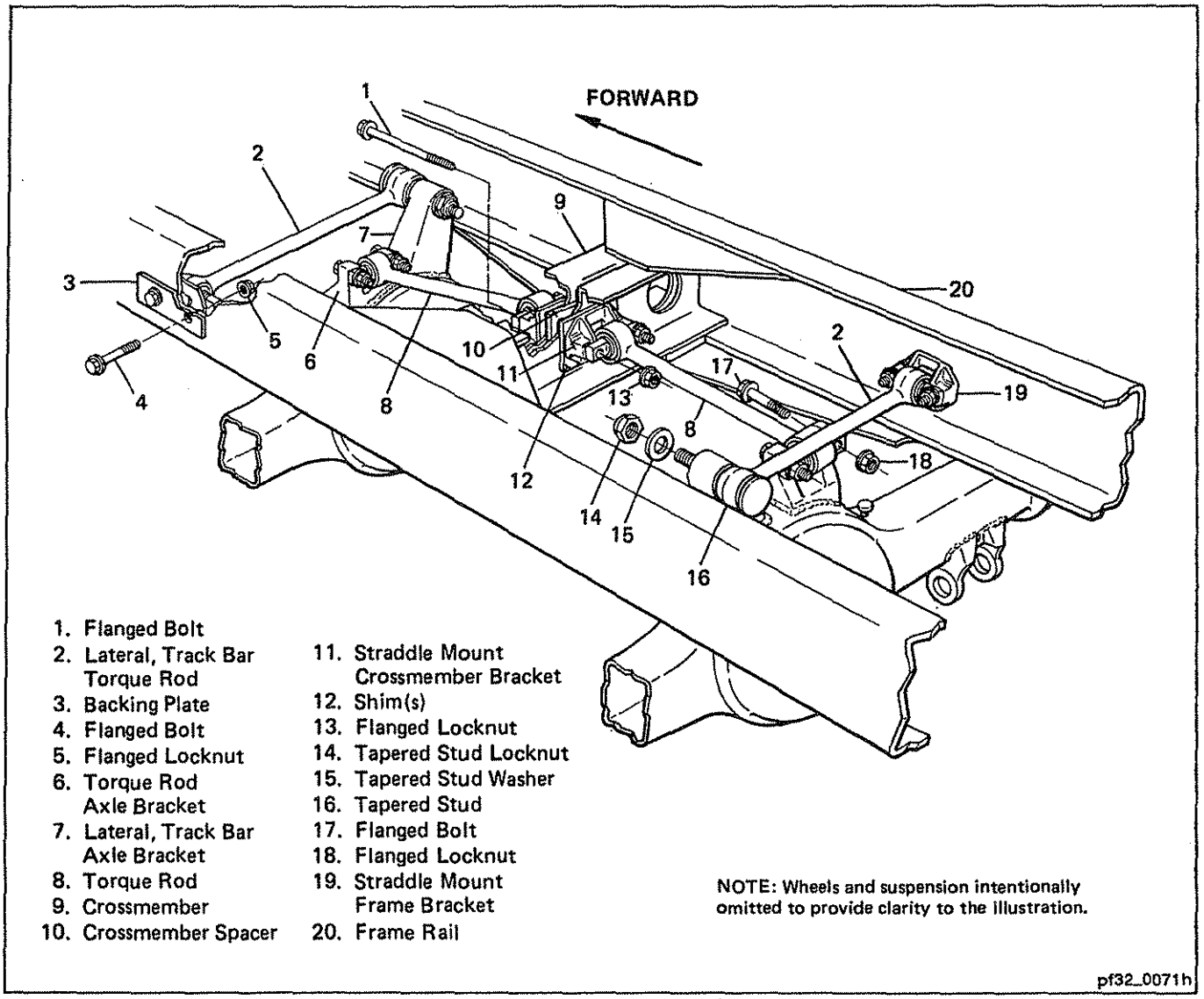

1. Flanged Bolt
2. Lateral, Track Bar Torque Rod
3. Backing Plate
4. Flanged Bolt
5. Flanged Locknut
6. Torque Rod Axle Bracket
7. Lateral, Track Bar Axle Bracket
8. Torque Rod
9. Crossmember
10. Crossmember Spacer
11. Straddle Mount Crossmember Bracket
12. Shim(s)
13. Flanged Locknut
14. Tapered Stud Locknut
15. Tapered Stud Washer
16. Tapered Stud
17. Flanged Bolt
18. Flanged Locknut
19. Straddle Mount Frame Bracket
20. Frame Rail

NOTE: Wheels and suspension intentionally omitted to provide clarity to the illustration.

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Fig. 22, Torque Rod and Lateral, Track Bar Torque Rod Assembly

Installation

NOTE: Torque rods are to be installed when the axle and suspension assemblies are installed on the vehicle.

1. Before installation, make certain that all contact surfaces are free of dirt or other foreign material. Lubricate all bolt threads with SAE-20 oil.
2. Position the torque rod straddle mount pins against the forward-rear axle torque rod bracket. Then, install the flanged bolts through the torque rod axle bracket and the torque rod pin.
3. Install the flanged nuts on the torque rod mounting bolts, then tighten the nuts to 150-175 ft-lbs (203-237 N·m).

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4. Install the rear-rear axle torque rod in the same manner.

5. Position the torque rod crossmember spacer in the crossmember. Position shim(s) (not to exceed 1/2 inch [13 mm] thick), and crossmember straddle mount bracket on the front side of the crossmember, then position the torque rod so the torque rod pins are aligned with the bracket.

6. Install the flanged bolts through the torque rod pins, bracket, and the front side of the crossmember.

NOTE: Do not install the flanged bolt completely through the crossmember until the other side torque rod assembly is installed.

7. On the back side of the crossmember, position the shim(s) (not to exceed 1/2 inch [13 mm] thick), and crossmember bracket; then position the torque rod so the torque rod pins are aligned with the bracket. Attach, by completely installing the flanged bolts from the front side torque rod, through the crossmember and torque rod assembly. Install the flanged nuts on the bolts and tighten to 150-175 ft-lbs (203-237 N·m).

8. If also equipped with the lateral, track bar torque rods, use the following procedure for installation:

   .1 Make certain that the tapered stud and tapered stud bracket hole are free of dirt or other foreign material. Lubricate the tapered stud ends of the torque rod with SAE-20 oil.

   .2 Install the tapered stud into the lateral torque rod axle bracket. Install the locknut on the stud and tighten to 175-225 ft-lbs (237-303 N·m). Then, tap the axle bracket with a hammer. Tighten the locknut again to 175-225 ft-lbs (237-303 N·m).

   .3 Position the lateral, torque rod frame bracket, shim(s), and backing plate on the inside of the frame rail. Then position the torque rod pins against the frame bracket.

   .4 Install the flanged bolts through the frame rail, bracket assembly, and torque rod pins. Install the flanged locknuts on the flanged bolts, then tighten the locknuts to 150-175 ft-lbs (203-237 N·m).

9. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual.

TORQUE ROD BUSHING REPLACEMENT

IMPORTANT: To replace the torque rod polyurethane bushings, it is necessary to have the special installation tool kit (Freightliner part No. P-097-009), or a tool kit can be made, using the dimensions given in Fig. 35 under "SPECIFICATIONS." If equipped with the lateral, track bar torque rods, the bushings must be replaced using the special Owatonna tool set No. Y-820, as shown in Fig. 23 (see Table 3, under "SPECIFICATIONS").

1. Remove the torque rods. For instructions, refer to "TORQUE ROD REMOVAL AND INSTALLATION," in this subject.

2. Remove the snapring and bearing washer from each side of the bushing to be removed. See Fig. 24. Note that the torque rod eye has a smaller shoulder on one side than on the other, and it also has a rounded edge around the inside of the smaller shoulder side of the eye. The bushing must be pressed in and out through this side.

3. Position the plunger and torque rod on a vertical hydraulic press, then press the old bushing assembly out of the torque rod eye.

4. Clean all dirt, grease, or other foreign material from the torque rod eye. Coat the new bushing

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

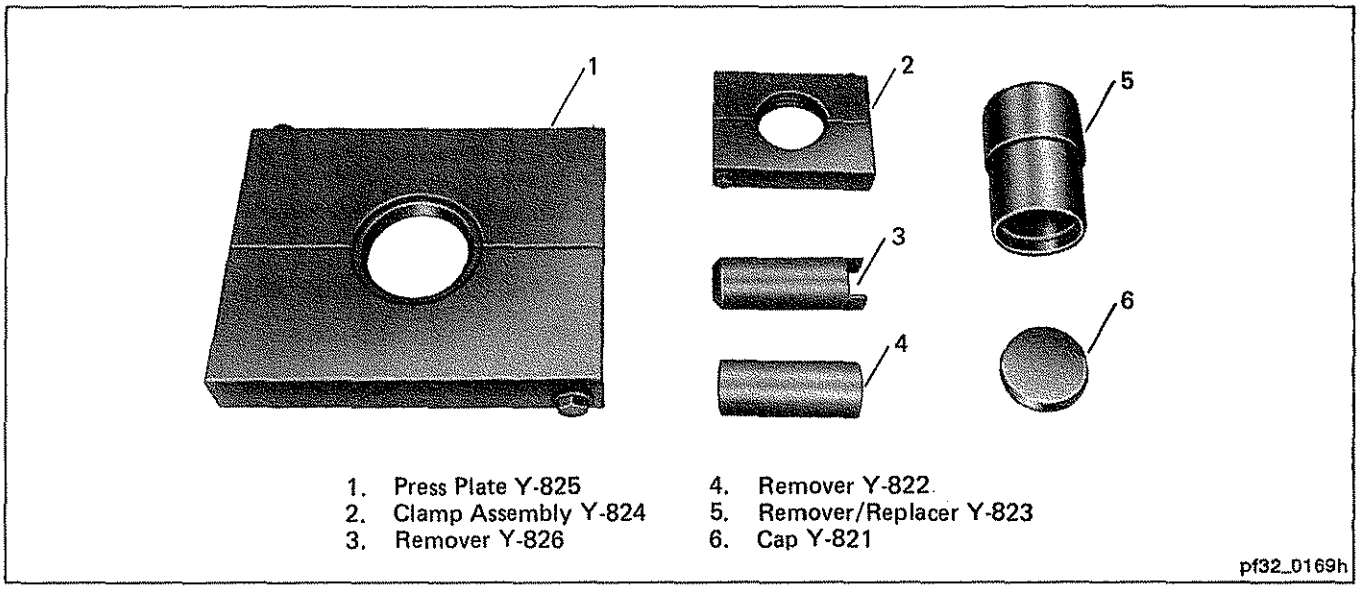


Fig. 23, OTC Tool Set No. Y-820

and torque rod eye with a non-mineral lubricant or waterless hand cleaner.

5. If not equipped with the lateral, track bar torque rods, proceed to step 7. If equipped with the lateral, track bar torque rods, remove the old bushing from the torque rod eye with the special Owatonna tools and using the following procedure:

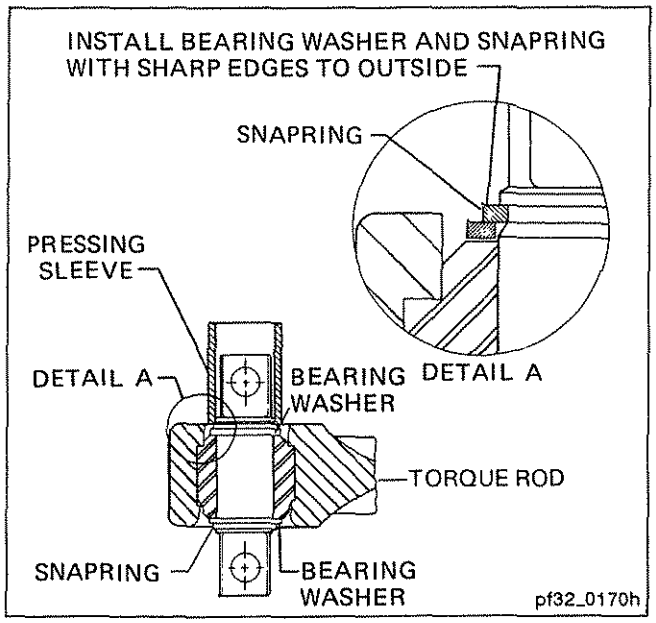


Fig. 24

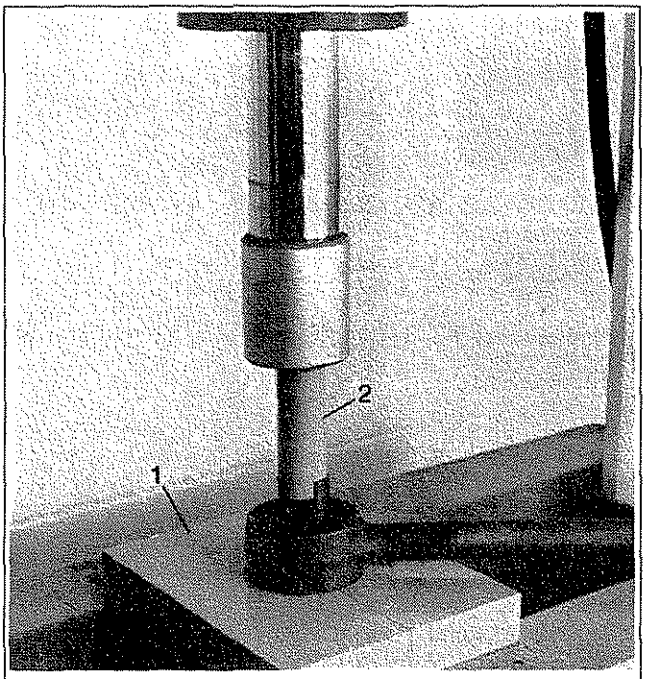
.1 Position the press plate on the bed of a vertical hydraulic press, with the small counterbore of the press plate hole facing up.

.2 Install the straddle mount ends of the lateral, track bar torque rod, in the hole of the press plate. Secure by tightening the press plate capscrews.

.3 Position the straddle mount pin remover on the straddle mount pin. Lubricate the bushing liberally with lubricating oil. Press the straddle mount pin out of the bushing. See Fig. 25.

.4 Position the bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing for Model 340, or with the larger outside diameter of the remover/replacer tool against the bushing for Model 380. Lubricate the bushing liberally with lubricating oil. Press the rubber bushing out of the torque rod eye. See Fig. 26.

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380



1. Press Plate Y-825
2. Remover Y-826

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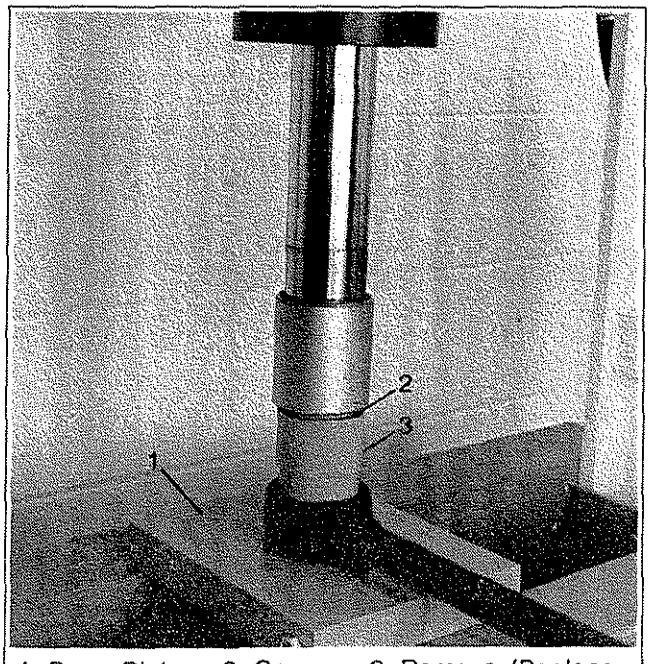
Fig. 25

.5 Install the tapered stud end (with the stud face up) in the hole of the press plate. Secure by tightening the press plate capscrews.

NOTE: Some tapered stud torque rod bushings have a large non-removable washer on the back end of the stud and will not fit through the press plate hole. Loosen the press plate capscrews and separate the halves (see Fig. 27) until the washer clears the counterbore of the press plate, and the torque rod sets on the press plate. Tighten the capscrews until the press plate halves are closed completely. If the washer is removable, then remove the washer before installing the torque rod end in the press plate.

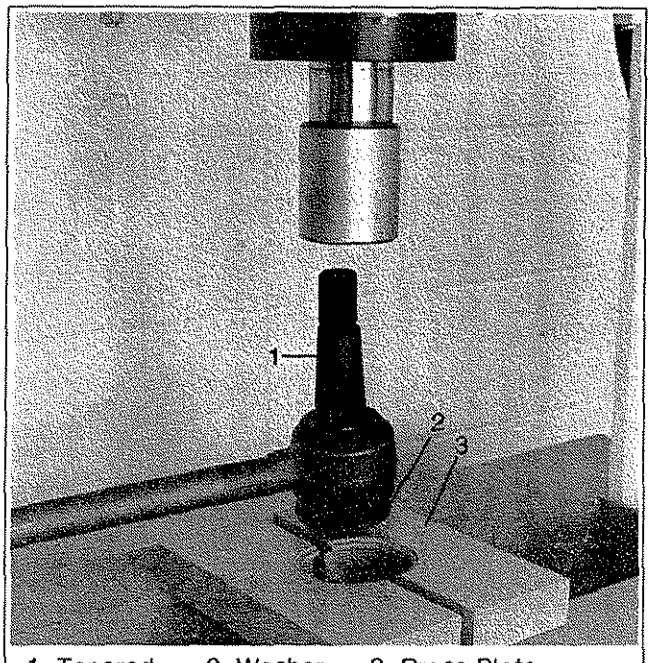
Position the tapered stud remover tool with the smaller inside diameter of the remover tool on the Model 340 torque rod stud, or the larger inside diameter of the remover tool on the Model 380 torque rod stud. Lubricate the bushing liberally with lubricating oil. Press the stud out of the bushing.



1. Press Plate Y-825
2. Cap Y-821
3. Remover/Replacer Y-823

pf32_0075h

Fig. 26



1. Tapered Stud
2. Washer
3. Press Plate Y-825

pf32_0075h

Fig. 27

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

Position the bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing for Model 340, or with the larger outside diameter of the remover/replacer tool against the bushing for Model 380. Lubricate the bushing liberally with lubricating oil. Press the rubber bushing out of the torque rod eye. See Fig. 26.

.6 Clean all dirt, grease, or other foreign material from the torque rod eye. Proceed to step 6.

6. Install the new lateral, track bar torque rod cartridges with the special Owatonna tools, and using the following procedure:

NOTE: New replacement cartridges with the bushings bonded to the straddle mount pins and tapered studs must be used.

.1 Position the press plate on the bed of a vertical hydraulic press. Position the torque rod eye into the hole of the press plate.

.2 For Model 340, position the new straddle mount replacement cartridge on the torque rod eye. Position the remover/replacer tool and cap, with the smaller outside diameter of the remover/replacer tool against the rubber bushing of the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: The center metal section flats of the pin must be perpendicular to the center line of the torque rod shank. See Fig. 28. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

.3 For Model 380, use the clamp assembly to compress the rubber of the new straddle mount cartridge bushing, and act as a pushing plate. See Fig. 29. The clamp must be completely closed to compress the rubber. See Fig. 30.

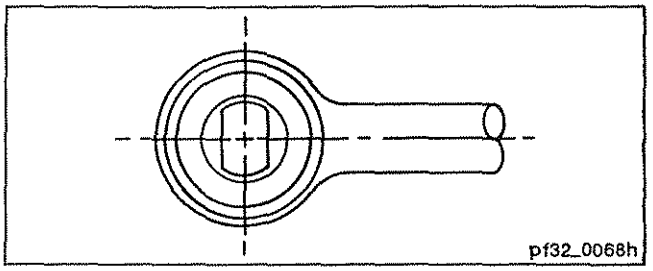


Fig. 28

NOTE: When clamping the clamp assembly around the bushing, line up the metal section flats of the straddle pins, perpendicular to the splits of the clamp assembly. See Fig. 29.

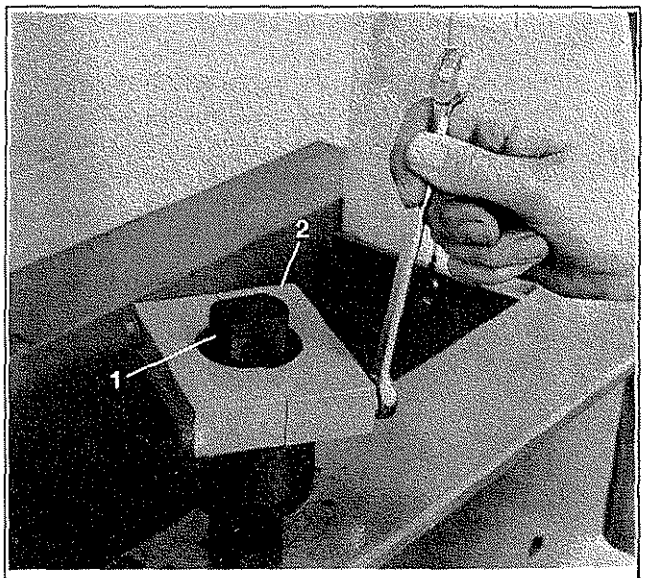


Fig. 29

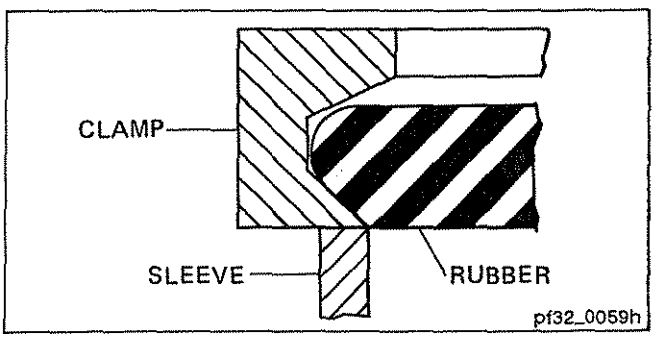


Fig. 30

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

Position the new straddle mount cartridge and clamp over the torque rod eye. Position the remover/replacer tool and cap, on top of the clamp assembly with the larger outside diameter end of the remover/replacer tool against the clamp assembly. Set the assembly so that the split of the clamp assembly lines up with the shank of the torque rod. See Fig. 31. Press the replacement cartridge into the torque rod eye. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

.4 Remove the bolt, lockwasher, and washer-type cap from the new tapered stud replacement cartridge.

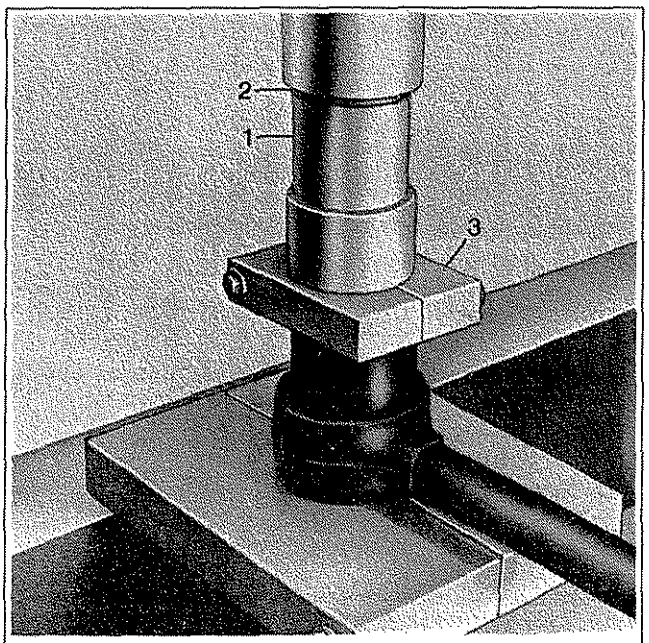
For the Model 340, position the new replacement cartridge on the torque rod eye with the stud end down. Position the remover/replacer tool and cap, with the smaller outside diameter of the remover/replacer tool against the rubber bushing of the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: Install the replacement cartridge with the threaded end down. The outer steel sleeve must protrude equally on each side.

For the Model 380, use the clamp assembly to compress the rubber of the new tapered stud cartridge bushing and act as a pushing plate. See Fig. 32. The clamp must be completely closed to compress the rubber. See Fig. 30.

Position the new replacement cartridge and clamp over the torque rod eye. Position the remover/replacer tool and cap, on top of the clamp assembly with the larger outside diameter end of the remover/replacer tool against the clamp assembly. Set the assembly so that the split of the clamp assembly lines up with the shank of the torque rod. See Fig. 31. Press the replacement cartridge into the torque rod eye. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

7. Position the bushing in the larger end of the insertion sleeve from the tool kit, then fit the



1. Remover/Replacer Y-823
2. Cap Y-821
3. Clamp Assembly Y-824

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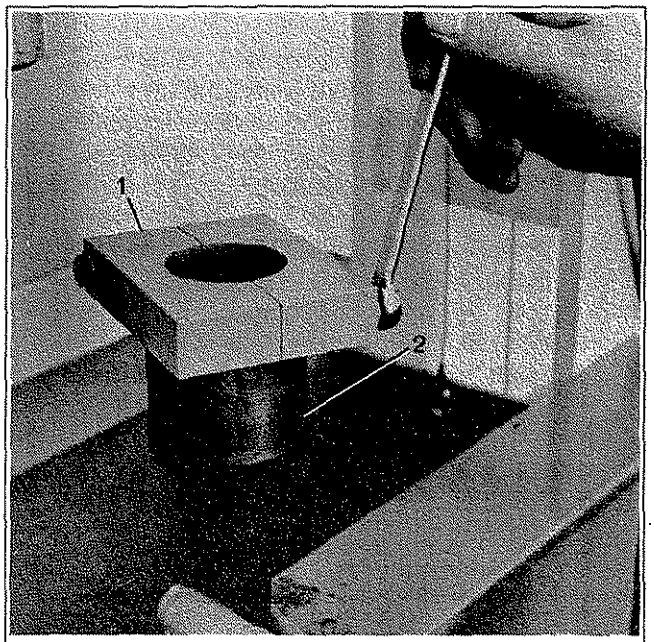
Fig. 31



1. Clamp Assembly Y-824
2. Tapered Stud

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Fig. 32

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

beveled (smaller) end of the sleeve into the larger side of the torque rod eye.

8. Center the torque rod eye on the base tool, and insert the plunger tool into the bushing. See Fig. 33. Use a vertical hydraulic press to press the bushing into the torque rod eye.

9. Install the snapring and bearing washer on one end of the torque rod pins, with the sharp edges of the washer and snapring facing the outward end of the pin. See Fig. 24, Detail A.

10. Press the torque rod pin into the torque rod bushing from the same side as the bushing was pressed into the torque rod eye. Do not lubricate the torque rod pin.

    Turn the torque rod over and install a bearing washer, with the sharp edge facing away from the bushing, then install the other snapring onto the outer shoulder of the pin, with the sharp edge facing outward.

    Place a pressing sleeve over the end of the torque rod pin, then press the snapring into its seat. See Fig. 24.

11. After assembly, lightly press the torque rod pin or tapered stud, to center it in the torque rod eye. There should be no slack on either side of the bushing, and the bushing should be compressed by approximately half the thickness of the snapring. If necessary, install a second washer under one of the snaprings to compress the bushing.

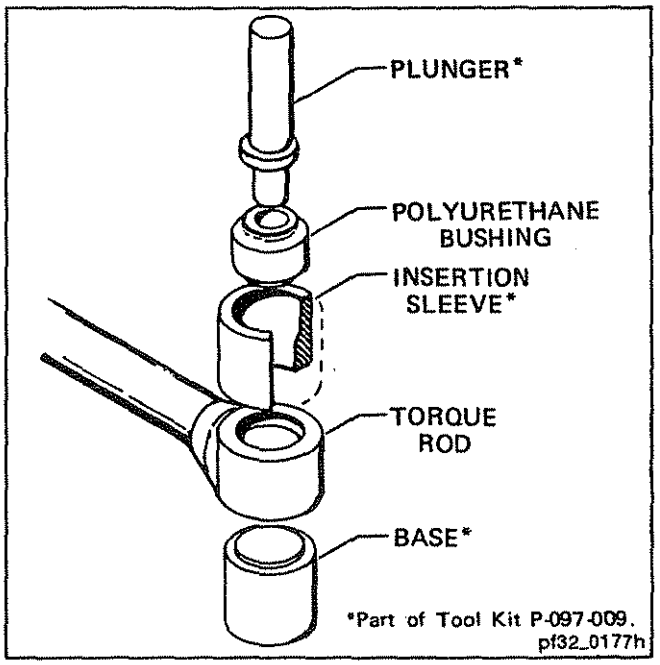


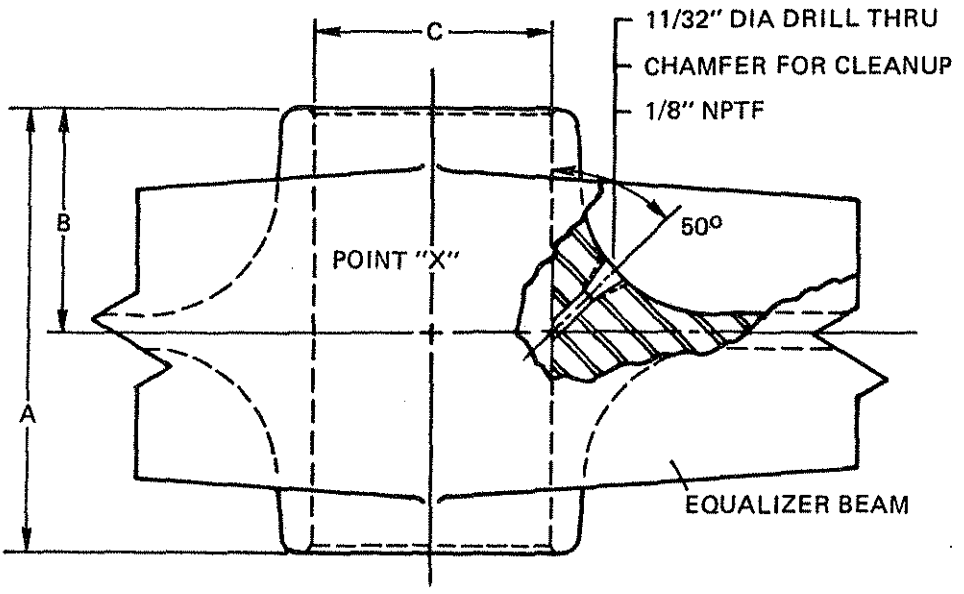
Fig. 33

AXLE ALIGNMENT

There are no axle alignment adjustments on the Hendrickson "SR" series suspension. At the time of the original installation, the placement of the frame hangers to the frame sets the suspension alignment. Parallel alignment of the axles to each other is automatic, because of compression centering. In turning, the rubber in the equalizer beam bushings is compressed at all points, and the reflex action to the rubber maintains the parallelogram form.

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

SPECIFICATIONS



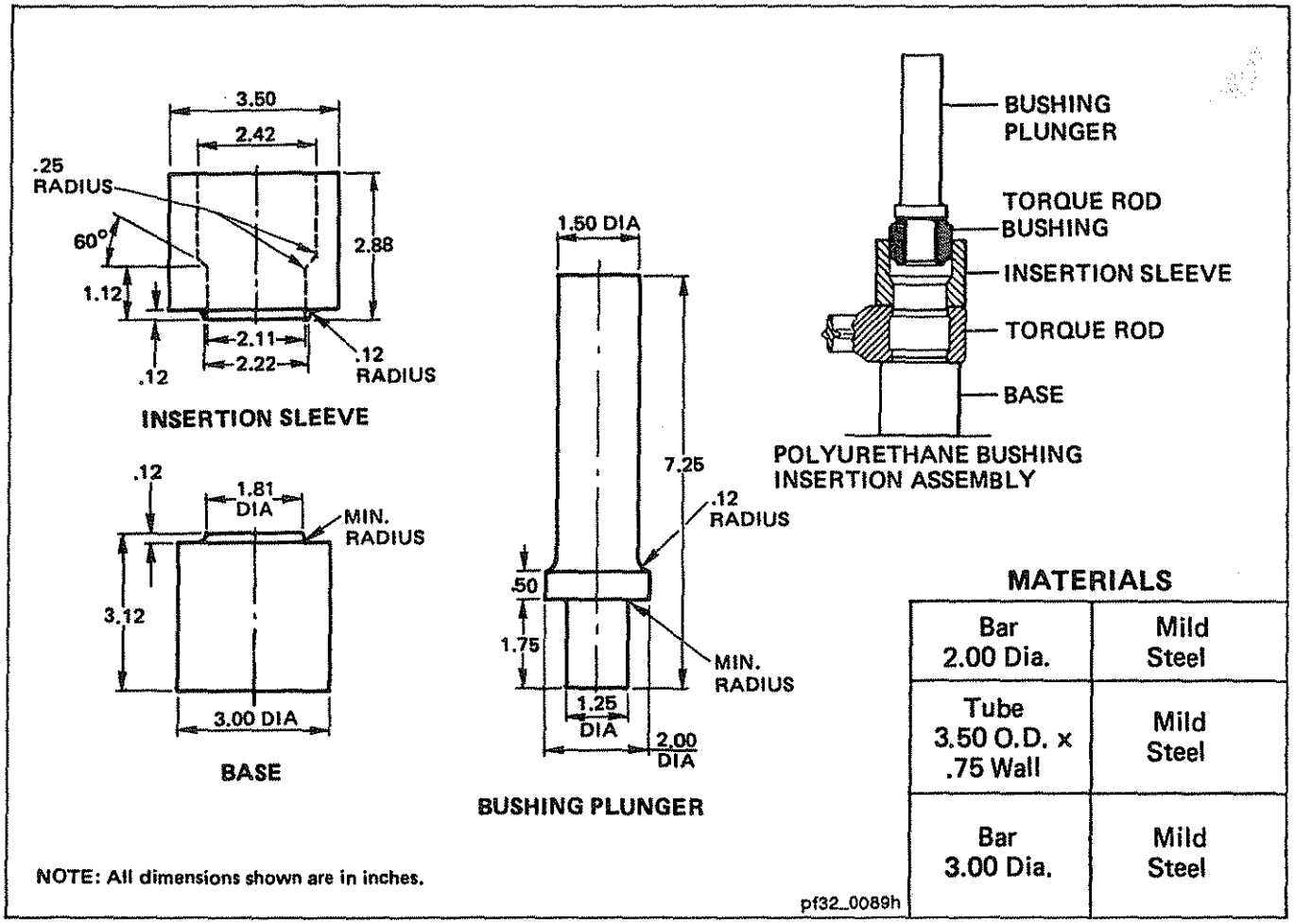
BEAM HUB DIMENSIONS

A - 6.75 inches
B - 3.375 inches
C - 3.613 to 3.617 inches for Model 340
4.738 to 4.742 inches for Model 380
Point "X" - must fall on centerline of beam center hub within ± 1/8"

Fig. 34, Grease Fitting Location On Equalizer Beam Hub, Bronze Center Bushing

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

SPECIFICATIONS (Continued)



MATERIALS

Bar 2.00 Dia.	Mild Steel
Tube 3.50 O.D. x .75 Wall	Mild Steel
Bar 3.00 Dia.	Mild Steel

NOTE: All dimensions shown are in inches.

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Fig. 35, Bushing Installation and Removal Tool Kit

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

SPECIFICATIONS (Continued)

OTC PART NUMBER	TOOL	APPLICATION	"SR" SERIES MODEL NO.
Y-851	Receiving Tube	Center Bushing Removal and Installation	340
Y-852	Removing and Pilot Adapter	Center Bushing Removal and Installation	340
Y-853	Installing Adapter	Center Bushing Installation	340
Y-854-A	Receiving Tube	End Bushing Removal and Installation	All
Y-855-A	Removing and Pilot Adapter	End Bushing Removal and Installation	All
Y-856	Adapter Clamp	End Bushing Installation	All
Y-857	Adapter Clamp Plate	End Bushing Installation	All
Y-858	Receiving Tube	Beam End Tube-Type Hanger Pin Removal	All
Y-859-A	Removing Adapter	Beam End Tube-Type Hanger Pin Removal	All
*Y-860	Receiving Tube	Center Bushing Removal and Installation	380
*Y-861	Removing and Pilot Adapter	Center Bushing Removal and Installation	380
*Y-862	Installing Adapter	Center Bushing Installation	380
Y-863-A	Pulling Screw	All Operations	All
Y-864	Sledging Adapter	Seized Part Removal	All
Y-865-D	Adapter Puller Set	Beam End Adapter-Type Beam Hanger Plug Removal	All
*Y-876	Adapter Plate	Center Bushing (Bronze) and Seal Installation	340
*Y-877	Adapter	Center Bushing (Bronze) Removal and Installation	340
*Y-878	Adapter Plate	Center Bushing (Bronze) and Seal Installation	380
*Y-879	Adapter	Center Bushing (Bronze) Removal and Installation	380
Y-50-15	Speed Nut	All Operations	All
Y-50-15-B	Hex Nut	All Operations	All
*Y-51-A	50-Ton Hydraulic Ram	All Operations	All

*Used in addition to Tool Set Y-850, depending on application.

Table 1, Owatonna Tool Set No. Y-850 (Owatonna Tool Company, Owatonna, Minnesota)

TOOL NO.	ADAPTER SIZE	APPLICATION	"SR" SERIES MODEL NO.
1	4 1/4" O.D. x 4" Length	Beam End Bushing Removal	All
2	*4 1/2" I.D. x 4" Length	Beam End Bushing Installation	All
3	3 1/2" O.D. x 7" Length	Beam Center Bushing Removal and Installation	340
4	4 5/8" O.D. x 7" Length	Beam Center Bushing Removal and Installation	380

*Adapter to be used with a sheave puller. See Fig. 13.

Table 2, Shop-Made Adapters for use with a 50-Ton Vertical Hydraulic Press

HENDRICKSON TANDEM SUSPENSION "SR" SERIES, MODELS 340 AND 380

SPECIFICATIONS (Continued)

OTC PART NUMBER	TOOL	APPLICATION	"SR" SERIES MODEL NO.
Y-821	Cap	Bushing Removal and Installation	All
Y-822	Remover	Tapered Stud Removal	All
Y-823	Remover/Replacer	Bushing Removal and Installation	All
Y-824	Clamp Assembly	Straddle Mount Bushing Installation	380
Y-825	Press Plate	Bushing Removal and Installation	All
Y-826	Remover	Straddle Mount Pin Removal	All

Table 3, Owatonna Tool Set No. Y-820 (Owatonna Tool Company, Owatonna, Minnesota)

DESCRIPTION		SIZE	GRADE	TORQUE	
				FT-LBS	N·m
Vertical Drive Pin Nut		1 1/2-12	B	175-225	237-303
Shear Spring Clamp Studs (Coarse Thread in Saddle)		5/8-11	B	55-65	75-88
Shear Spring Clamp Nut		5/8-18	A	100-125	136-167
Torque Rod Straddle Mount Attaching Flanged Nuts		5/8-11	G	150-175	203-237
Lateral, Track Bar Torque Rod Stud Locknut	Model 340	1 1/8-12	B	175-225	237-303
	Model 380	1 1/4-12	B	175-225	237-303
Saddle Cap Studs		7/8-9	B	55-65	75-88
Saddle Cap Nuts		7/8-14	B	225-275	303-373
Adapter-Type Beam End Nut		3/4-16	C	210-240	285-325
Tube-Type Beam End Nut		—	—	375-425	441-576

Table 4, Torque Values

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440
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HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

GENERAL DESCRIPTION

The Hendrickson "RS" series suspension system uses rubber load cushions to carry and cushion the load. These load cushions are mounted on a saddle assembly, two on each side of the vehicle. See Fig. 1. A third load cushion (heavy duty kit) is equipped on each side of the Model 440 (Optional on Models 340 and 380). See Fig. 2. Positive mounting between the vehicle frame and the suspension unit is accomplished by rubberbushed vertical drive pins, each of which passes through the load cushion. Lightly loaded, the unit rides on the outer edges of the load cushions. As the load is increased, the inner cross bars of the load cushions are progressively brought into contact, to accommodate the increased load. See Fig. 3.

The load cushion and saddle assembly carries the equalizer beam, connected through the equalizer beam center bushing. The axles are attached to beam hangers at the ends of the equalizer beams. This allows an articulating action between the axles to absorb road shock. Torque rods are mounted longitudinally from the axles to the frame crossmember, to control axle torque resulting from accelerating or braking. In addition, some models are equipped with lateral, track bar torque rods, to control side-to-side movement.

SERVICE OPERATIONS

For information regarding inspection intervals and procedures, and lubrication intervals and procedures, refer to the Freightliner Maintenance and Lube Manual.

Most repairs to the Hendrickson suspension system consist of replacing damaged or worn parts. Items most frequently requiring service are the equalizer beam bushings. Special tools (see Table 1, under "SPECIFICATIONS") for replacement of the bushings are available from the Owatonna Tool Company, Owatonna, Minnesota, or an affiliated dealer. Although the use of these special tools is recommended, shop-made adapters may be used if a vertical hydraulic press with a 50-ton capacity is available. Dimensions for the shop-made adapters are given in Table 2, under "SPECIFICATIONS."

When wear on any of the major components reaches the point where replacement is necessary, it is recommended that the entire suspension be removed from the vehicle and overhauled. In cases where individual suspension system components require service, follow only the applicable instructions relating to the components to be serviced.

Whenever the rear suspension is being serviced, block the front tires to prevent vehicle movement.

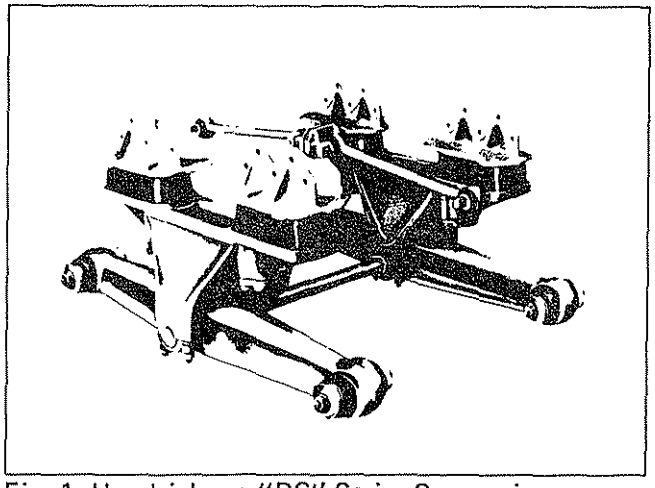


Fig. 1, Hendrickson "RS" Series Suspension

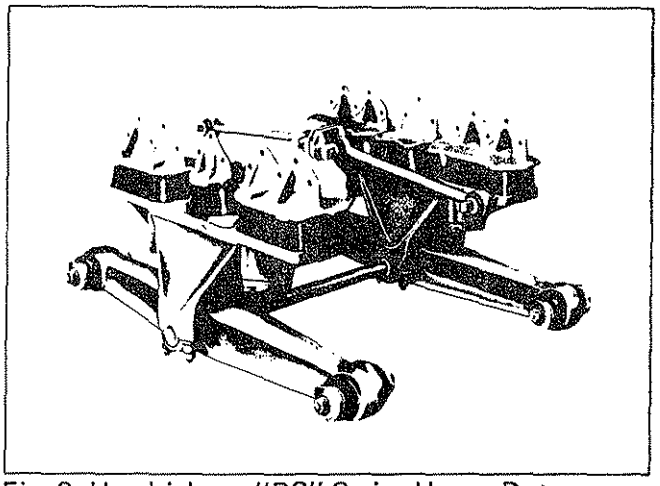


Fig. 2, Hendrickson "RS" Series Heavy Duty Suspension

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

Always use safety stands under the frame when the vehicle is raised or the suspension removed.

Apply Alumilastic compound, or an equivalent, to all areas where aluminum and steel parts contact each other.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metal components contact each other will result in electrolytic corrosion, which could cause suspension damage.

SUSPENSION SYSTEM REMOVAL AND INSTALLATION

Removal

If the suspension system is being overhauled, remove the suspension using the following procedure:

1. Block the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles, marking the lines for later assembly reference. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.
2. Disconnect the driveline rear universal joint from the forward-rear axle. For instructions, refer to the applicable subject located in the 09 Group of this manual.
3. Manually release the spring brake chambers. For instructions, refer to the applicable subject located in the 12 Group of this manual.
4. Using an overhead hoist, raise the rear of the vehicle enough to relieve the weight from the suspension.

NOTE: Do not raise the vehicle to the point where the weight of the suspension and axles "hang" from the vehicle.

5. Remove the saddle cap nuts and washers from each side of the vehicle. Then remove the saddle caps that secure the equalizer beam center bushing to the saddles. See Fig. 4.

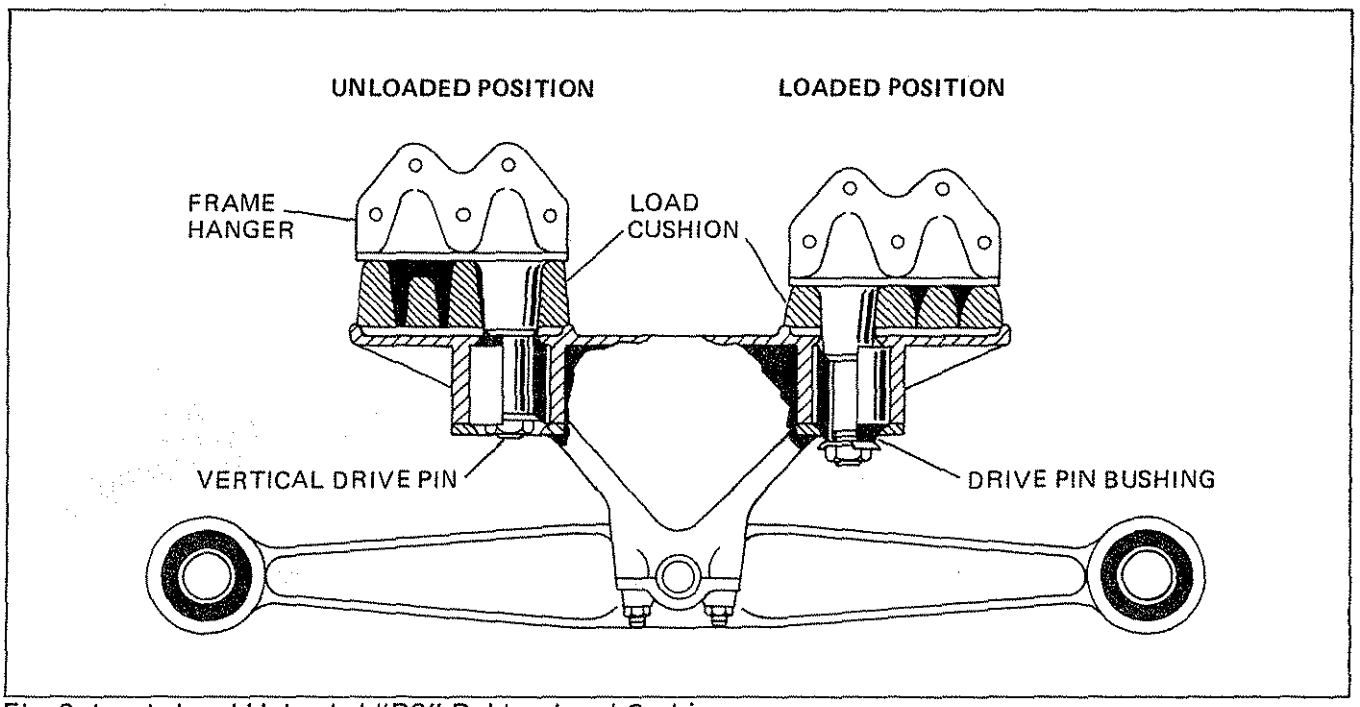
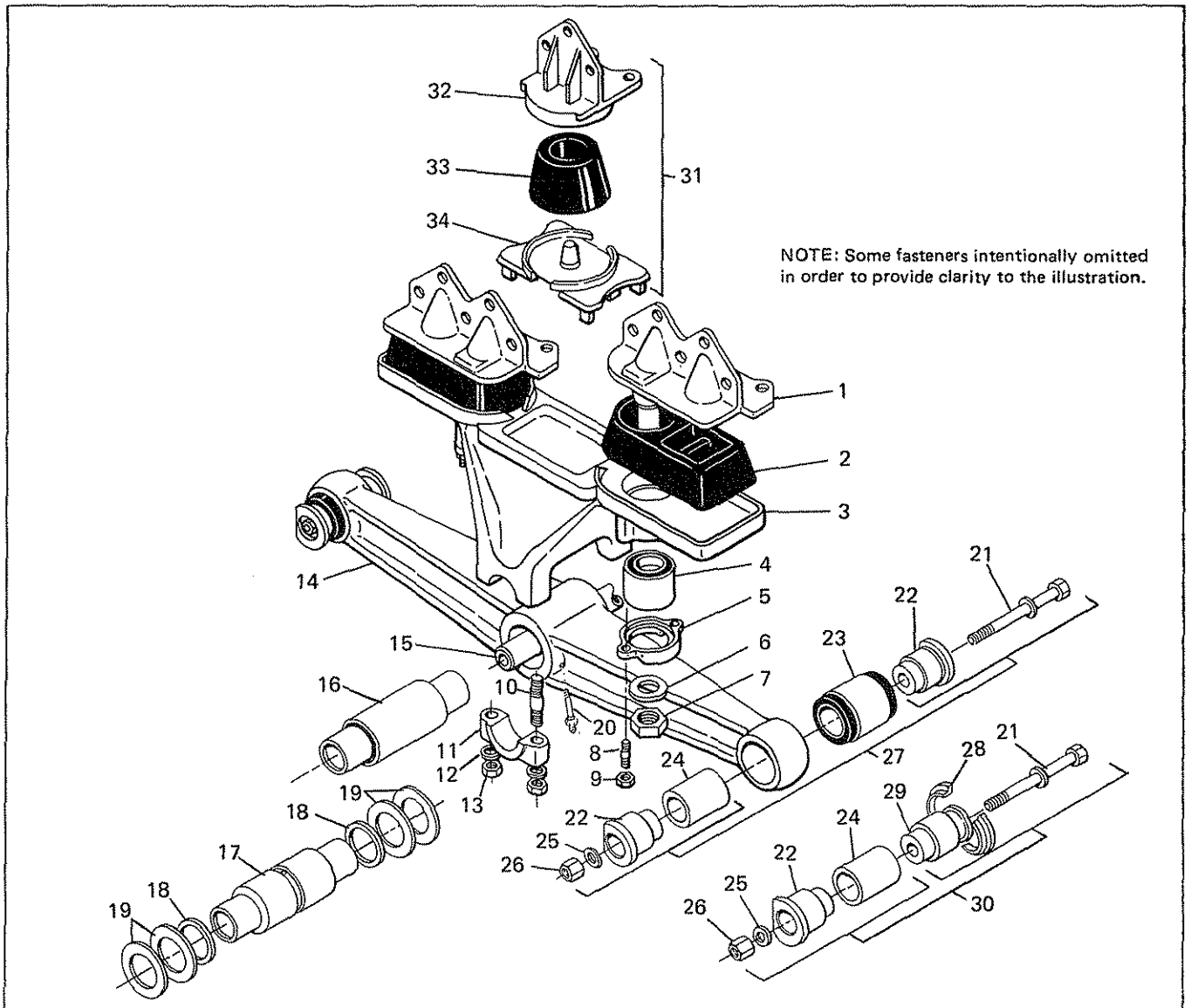


Fig. 3, Loaded and Unloaded "RS" Rubber Load Cushions

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440



1. Frame Hanger and Vertical Drive Pin
2. Rubber Load Cushion
3. Saddle Assembly
4. Vertical Drive Pin Bushing
5. Vertical Bushing Retainer Cap
6. Vertical Drive Pin Washer
7. Vertical Drive Pin Nut
8. Retainer Cap Stud
9. Retainer Cap Nut
10. Saddle Cap Stud
11. Saddle Cap
12. Saddle Cap Washers
13. Saddle Cap Nuts
14. Equalizer Beam
15. Crosstube
16. Rubber Center Bushing
17. Bronze Center Bushing
18. Bronze Bushing Seals
19. Thrustwashers
20. Bronze Bushing Grease Fitting
21. Adapter Bolt and Washer
22. Adapter
23. End Bushing
24. Intermediate Tube
25. Adapter Bolt Washer
26. Adapter Bolt Nut
27. Adapter-Type End Support Assembly
28. Splitring
29. Adapter Plug
30. Splitring Adapter Assembly
31. Heavy Duty Kit
32. Frame Hanger
33. Rubber Load Cushion
34. Saddle Plate

Fig. 4, Hendrickson "RS" Series Suspension, Exploded View

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

6. Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

   If also equipped with the lateral, track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushings. Keep clear of the beam hangers and beam ends to avoid possible injury.

7. Raise the rear of the vehicle frame until there is sufficient clearance to roll the axles and suspension from beneath the saddles. Install safety stands under the vehicle frame, then roll the axles and equalizer beams from under the frame.

Installation

1. Roll the axles (with the equalizer beams and crosstube attached), under the vehicle frame. Align the ends of the beam center bushings with the saddle legs.

2. Using an overhead hoist, lift the vehicle off the safety stands, then remove the stands from under the frame. Lower the vehicle, so that the saddles seat on the beam center bushings.

3. Position the saddle caps on the saddle cap studs, then install the washers and the new, saddle cap nuts. Do not tighten the nuts at this time.

4. Install the torque rods on the axles, following the instructions given under the heading, "TORQUE ROD INSTALLATION," in this subject.

5. Tighten the saddle cap nuts to 225-275 ft-lbs (305-373 N·m).

6. If equipped with the adapter-type end supports, tighten the adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 4, Ref. 22.

   If equipped with the tube-type end supports, tighten each end tube nut to 375-425 ft-lbs (441-576 N·m).

WARNING: The adapter-type and tube-type end support fasteners must be tightened to the torque values given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in a possible separation of suspension components, and a loss of vehicle control.

7. Lower the vehicle, then remove the overhead hoist. Manually reset the spring brake chambers. For instructions, refer to the 12 Group of this manual.

8. Connect the driveline rear universal joint to the forward-rear axle. For instructions, refer to the 09 Group of this manual.

9. Taking care to prevent dirt and other foreign material from entering the lines or fittings, connect the air brake lines leading to the axles. Close the air system drain valve.

10. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual. Adjust the angle if it is not according to specifications.

SADDLE ASSEMBLY REMOVAL AND INSTALLATION (Refer to Fig. 4)

Removal

If the saddle assembly needs to be removed from the vehicle for replacement or overhaul, then use the following procedure:

If the suspension has been removed from the vehicle, proceed to step 6.

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1. Block the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles, marking the lines for later assembly reference. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.

2. Using an overhead hoist, raise the rear of the vehicle enough to relieve the weight from the suspension.

NOTE: Do not raise the vehicle to the point where the weight of the suspension and axles "hang" from the vehicle.

3. Remove the saddle cap nuts and washers from each side of the vehicle. Then remove the saddle caps that secure the equalizer beam center bushing to the saddles. See Fig. 4.

4. Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

   If also equipped with the lateral, track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushings. Keep clear of the beam hangers and beam ends to avoid possible injury.

5. Using an overhead hoist, raise the rear of the vehicle frame until there is sufficient clearance to allow the saddle assembly to be lowered from the frame hanger and vertical drive pins. Install safety stands under the vehicle frame.

6. Remove the vertical drive pin nuts and washers from the bottoms of the vertical drive pins.

7. Lower the saddle assembly (together with the rubber load cushions) from the frame hanger and vertical drive pins.

NOTE: If the steel sleeve in the vertical drive pin bushing is seized to the vertical drive pin, use a Porta-Power, or an equivalent tool, between the frame and the saddle to break loose the sleeve.

Installation

1. Coat the vertical drive pins and drive pin bushing inner sleeve with Texaco "Compound L," or an equivalent rust preventive lubricant. Lubricate the threads of the vertical drive pins with SAE-20 oil.

2. Position the rubber load cushions on the saddles, then raise the saddle assembly so that the vertical drive pins center through the load cushions and drive pin bushings in the saddle.

3. Install the vertical drive pin washers (with the flanged end down) and drive pin locknut on the drive pins. Tighten the locknuts to 175-225 ft-lbs (237-305 N·m).

NOTE: If the suspension has been removed from the vehicle, installation of the saddle assembly will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

4. Using an overhead hoist, lift the vehicle off the safety stands, then remove the stands from under the frame. Lower the vehicle, so that the saddles seat on the beam center bushings.

5. Position the saddle caps on the saddle cap studs, then install the washers and the new, saddle cap nuts. Do not tighten the nuts at this time.

6. Install the torque rods on the axles, following the instructions given under the heading, "TORQUE ROD INSTALLATION," in this subject.

7. Tighten the saddle cap nuts to 225-275 ft-lbs (305-373 N·m).

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8. Lower the vehicle, then remove the overhead hoist.

9. Taking care to prevent dirt and other foreign material from entering the lines or fittings, connect the air brake lines leading to the axles. Close the air system drain valve.

RUBBER LOAD CUSHION AND VERTICAL DRIVE PIN BUSHING REPLACEMENT (Refer to Fig. 4)

If a rubber load cushion or vertical drive pin bushing is damaged, cut, or worn, it is recomended that all the load cushions and vertical drive pin bushings be replaced.

1. Remove the saddle assembly. For instructions, refer to "SADDLE ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

2. Visually inspect all the rubber load cushions for cuts, damage, or wear. The height of a new load cushion is 3 15/16 inches (100 mm). If a permanent set has come about in service, and the load cushion has a free height measuring less than 3 11/16 inches (94 mm), then the load cushion and vertical drive bushing should be replaced.

3. Remove the rubber load cushions from the saddle.

4. Remove the retainer cap nuts from the vertical bushing retainer cap, then remove the retainer cap from the bottom of the saddles. If the retainer cap studs are damaged or worn, install new retainer cap studs. Lubricate the threads with SAE-20 oil. Tighten the studs to 55-65 ft-lbs (75-88 N·m).

5. Using a hydraulic press, press the vertical drive pin bushings out of the saddles from the top side.

WARNING: Do not use a torch to cut the bushing sleeves or to heat the aluminum saddle for removing the vertical drive pin bushings. The saddle is heat-treated, and application of heat could adversely affect the strength of the saddle, which can result in the loss of vehicle control.

6. Using emery cloth, remove any small nicks or scratches from the vertical drive pin and saddle drive pin bushing cavities. Clean the saddle drive pin bushing cavities with solvent.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

7. Lightly coat the saddle bushing cavities, and the outside sleeves of the new vertical drive pin bushings with Texaco "Compound L," or an equivalent rust preventive lubricant.

8. Install the new bushings in the bushing cavities of the saddle, then position the vertical bushing retainer caps over the bottoms of the bushings.

9. Install the bushing retainer cap nuts. Tighten the nuts to 100-125 ft-lbs (136-170 N·m).

10. Install the new rubber load cushions on the saddle. Install the saddle assembly on the vehicle. For instructions, refer to "SADDLE ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

EQUALIZER BEAM REMOVAL AND INSTALLATION, ADAPTER-TYPE END SUPPORTS (Refer to Fig. 4)

Adapter-type end supports connect the equalizer beam to the axle beam hangers using three-piece "adapters" installed into each of the axle beam hangers. See Fig. 5. The inner sleeve of the beam end bushing is locked to the beam hanger by pressure of the adapter bolt, pulling the adapters against the outer surface.

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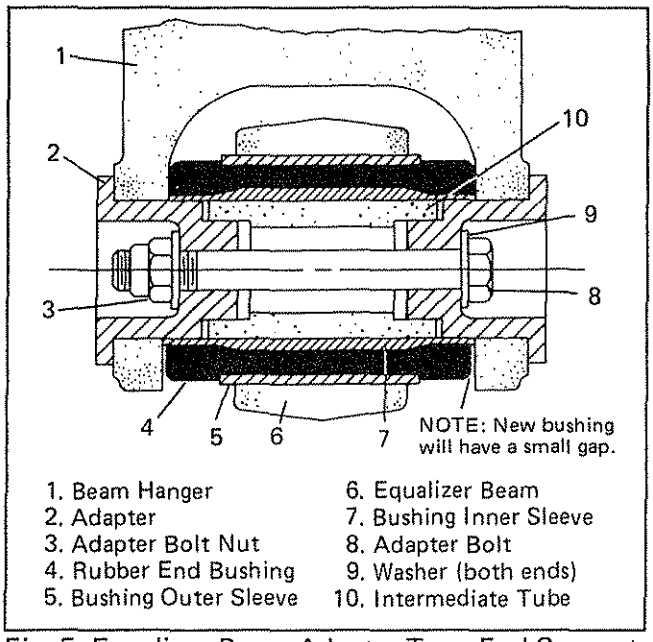

1. Beam Hanger
2. Adapter
3. Adapter Bolt Nut
4. Rubber End Bushing
5. Bushing Outer Sleeve
6. Equalizer Beam
7. Bushing Inner Sleeve
8. Adapter Bolt
9. Washer (both ends)
10. Intermediate Tube

Fig. 5, Equalizer Beam Adapter-Type End Support

Removal

IMPORTANT: If using the special Owatonna tools (OTC set No. Y-865-D) to remove the equalizer beam from the axle beam hangers, the suspension system must be installed on the vehicle. If not using the special Owatonna tools, the equalizer beam can be removed from the axle beam hangers, either with the suspension installed on the vehicle, or with the suspension removed from the vehicle.

1. Remove the saddle cap nuts and washers, then remove the saddle caps that secure the equalizer beam center bushings to the saddles. See Fig. 4.

2. Support the equalizer beams with safety stands. Remove the nut, washers, and adapter bolt from the beam end adapters.

3. If not using the special Owatonna tools, proceed to step 4. If using the special Owatonna tools, remove the adapter plugs using the following procedure:

   .1 Remove the wheels, hubs, and brake drums from the rear axles. For instructions, refer to the 11 Group of this manual.

   .2 Select a hand-tap (7/8" for 3/4"-cored-hole, or 1" for 7/8"-cored-hole), and tap the hole from which the adapter bolt was removed, as shown in Fig. 6. Then, position the pulling plate (OTC part No. 28445) over the hand-tap and against the beam hanger. Attach the forcing screw (OTC part No. 28446 for 7/8"-hand-tap, or OTC part No. 28447 for 1"-hand-tap) to the hand-tap, and secure with the nut (OTC part No. 10220) against the pulling plate. While holding the nut with a wrench, tighten the forcing screw to pull the adapter plug from the beam hanger. See Fig. 7. Proceed to step 5.

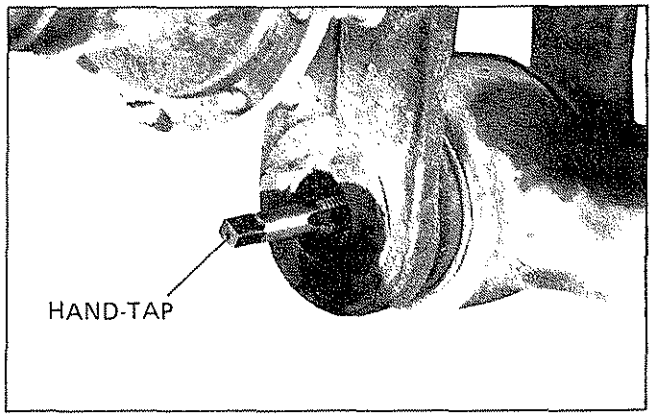

Fig. 6

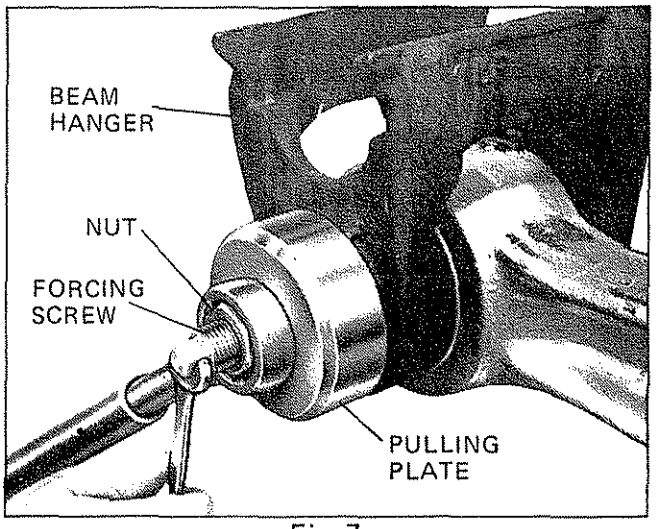

Fig. 7

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4. If not using the special Owatonna tools, a relief is provided on each side of the adapter for chisel entry. Insert a chisel into the relief on the inboard adapter, and drive the chisel in, to wedge the adapter out of the beam hanger. Repeat this step for the outboard adapter.

NOTE: In some installations, a splitring type adapter assembly (see Fig. 4, Ref. 30) is used instead of the standard adapter. To remove, drive the chisel between the two halves of the splitring, forcing them to snap out of the end support plug. Then drive the plug into the equalizer beam end bushing until it clears the beam hanger. After the equalizer beam has been removed from the beam hanger, drive the adapter plug out of the bushing.

5. After the ends of both equalizer beams have been separated from the axle beam hangers, lower the equalizer beams, together with the crosstube, to the ground. Remove the thrustwashers, if applicable, then separate the beams from the crosstube by pulling apart by hand.

Installation

1. Apply Texaco "Compound L," or an equivalent rust preventive lubricant, to the axle beam hanger eyes, beam end bushing inner sleeve, end support adapters, outside surface of the bushing intermediate tubes, and the ends of the crosstube.

2. Install the crosstube in both equalizer beam center bushings. If equipped with bronze center bushings, install the thrustwashers.

   If new rubber center bushings that have the end plugs as a separate part are installed, then, arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and debris, from the welding process.

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

3. Position the equalizer beam assembly under the axles, then raise the assembly and place the forward ends of each beam in the forward-rear axle beam hangers. Align the beam end bushings with the beam hangers.

4. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

5. Place the rear ends of each beam in the rear-rear axle beam hangers. Align the beam end bushings with the beam hangers.

6. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

NOTE: If the suspension and saddle assembly has been removed from the vehicle, installation of the equalizer beam will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

7. Position the saddle caps on the saddle cap studs, then install the washers and new, saddle cap nuts. Tighten the nuts to 225-275 ft-lbs (305-373 N·m).

8. Tighten the adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 4, Ref. 22.

WARNING: The adapter bolt nuts must be tightened to the torque value given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in separation of suspension components, and a loss of vehicle control.

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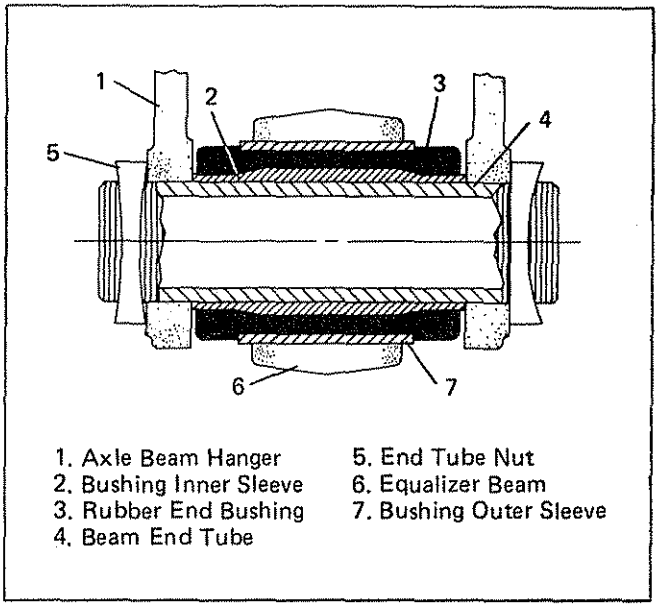
EQUALIZER BEAM REMOVAL AND INSTALLATION, TUBE-TYPE END SUPPORTS

On tube-type end supports, the inner sleeve of the beam end bushing is locked to the axle beam hanger legs by pressure on the beam hanger legs from the end tube nuts, on a 2 1/2 inch (64 mm) diameter end tube. See Fig. 8.



1. Axle Beam Hanger
2. Bushing Inner Sleeve
3. Rubber End Bushing
4. Beam End Tube
5. End Tube Nut
6. Equalizer Beam
7. Bushing Outer Sleeve

Fig. 8, Equalizer Beam Tube-Type End Support

Removal

IMPORTANT: If using the special Owatonna tools to remove the equalizer beam from the axle beam hangers, the suspension system must be installed on the vehicle. If not using the special Owatonna tools, the equalizer beam can be removed from the axle beam hangers, either with the suspension installed on the vehicle, or with the suspension removed from the vehicle.

1. Remove the saddle cap nuts and washers, then remove the saddle caps that secure the equalizer beam center bushings to the saddles. See Fig. 4.

2. Support the equalizer beam ends with safety stands. Remove the beam end tube nuts from both sides of the beam end tubes.

3. If not using the special Owatonna tools, proceed to step 4. If using the special Owatonna tools, remove the tube-type end supports using the following procedure:

   .1 Remove the wheels, hubs, and brake drums from the rear axles. For instructions, refer to the 11 Group of this manual.

   .2 Position the receiving tube over the outboard end of the beam end tube. Then assemble the hydraulic ram, pulling screw, speed nut, and the removing adapter, as shown in Fig. 9. Connect a hydraulic pumping unit to the hydraulic ram, then apply hydraulic pressure to remove the beam end tube. Proceed to step 5.

4. If not using the special Owatonna tools, install a spacer bushing between one end tube nut and the beam hanger, tightening the nut to pull the end tube out of the beam end bushing. If this method does not loosen the tube, use a hack saw to saw through the tube along the inside surface of the axle beam hanger legs.

CAUTION: Do not use a cutting torch to remove the equalizer beams from the beam hangers. The equalizer beam has been heat-treated, and the use of heat could adversely affect the strength of the equalizer beams.

5. After the ends of both equalizer beams have been separated from the axle beam hangers, lower the equalizer beams, together with the crosstube, to the ground. Remove the thrustwashers, if applicable, then separate the beams from the crosstube by pulling apart by hand.

Installation

1. Apply Texaco "Compound L," or an equivalent rust preventive lubricant, to the axle beam hanger eyes, beam end bushing inner sleeve,

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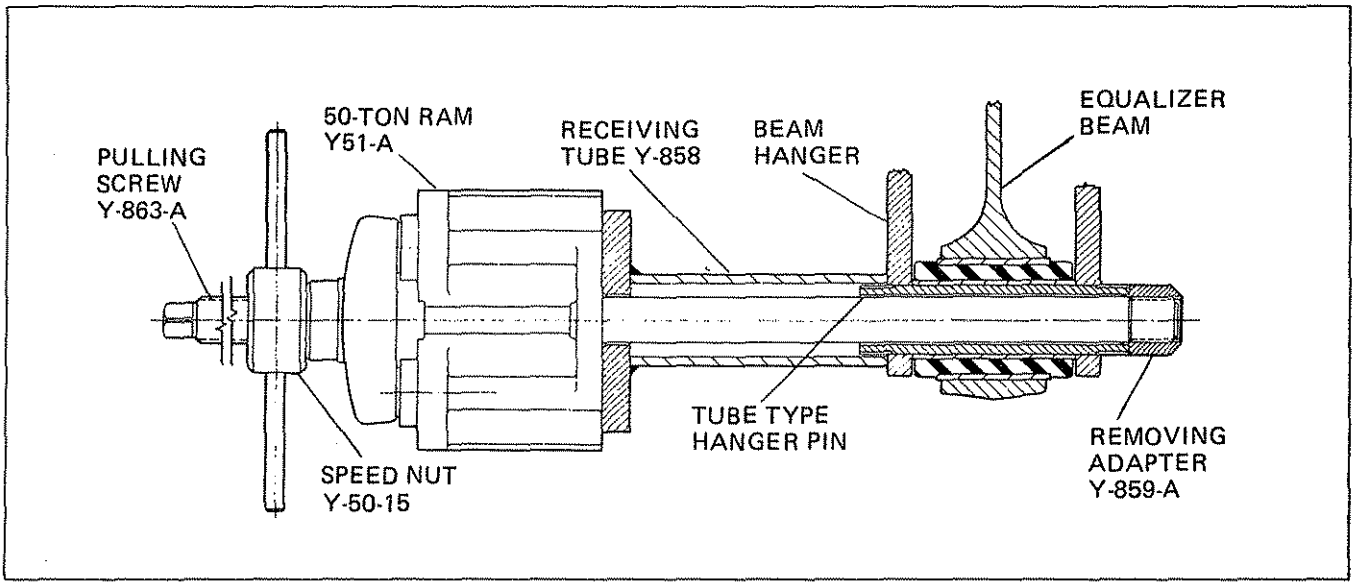

Fig. 9, OTC Tool Set-up for Equalizer Beam End Tube Removal

outer surface of the beam end tubes, beam center bushing inner sleeves, and the ends of the crosstube.

2. Lubricate the threads of the beam end tube with SAE-20 oil.

3. Install the crosstube in both equalizer beam center bushings. If equipped with bronze center bushings, install the thrustwashers.

   If new rubber center bushings that have the end plugs as a separate part are installed, then, arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and flying debris, from the welding process.

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

4. Position the equalizer beam assembly under the axles, then raise the assembly and place the forward ends of each beam in the forward-rear axle beam hangers. Align the beam end bushings with the beam hangers.

5. Install the beam end tubes through the beam hangers and the beam end bushings. Hand start both nuts on the beam end tubes. Do not tighten the nuts at this time.

6. Place the rear ends of each beam in the rear-rear axle beam hangers. Align the beam end bushings with the beam hangers.

7. Install the beam end tubes through the beam hangers and the beam end bushings. Hand start both nuts on the beam end tubes. Do not tighten the nuts at this time.

NOTE: If the suspension and saddle assembly is removed from the vehicle, installation of the equalizer beam will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

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8. Position the saddle caps on the saddle cap studs, then install the washers and new, saddle cap nuts. Tighten the nuts to 225-275 ft-lbs (305-373 N·m.).

9. Tighten the end tube nuts to 375-425 ft-lbs (441-576 N·m.).

WARNING: The end tube nuts must be tightened to the torque value given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in separation of suspension components, and a loss of vehicle control.

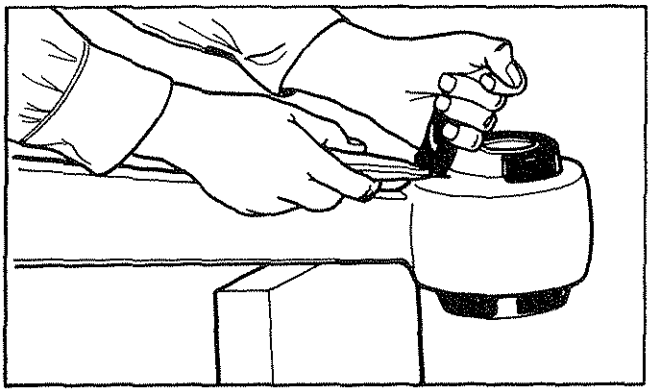

Fig. 10

EQUALIZER BEAM END BUSHING REPLACEMENT (Refer to Fig. 4)

IMPORTANT: If one or more of the end bushings requires replacement, it is recommended that all four end bushings be replaced.

1. Remove the equalizer beams from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. On one side only of each beam end bushing, cut back the protruding rubber portion, flush with the equalizer beam, as shown in Fig. 10, to allow the adapter to squarely contact the bushing outer sleeve.

3. If using the special Owatonna tools, remove the beam end bushings, using the following procedure (refer to Fig. 11):

   .1 Center the end bushing removing adapter on the trimmed side of the beam end bushing.

   .2 Position the receiving tube on the untrimmed side of the beam end bushing. Assemble the hydraulic ram and speed nut on the pulling screw, then position the assembly

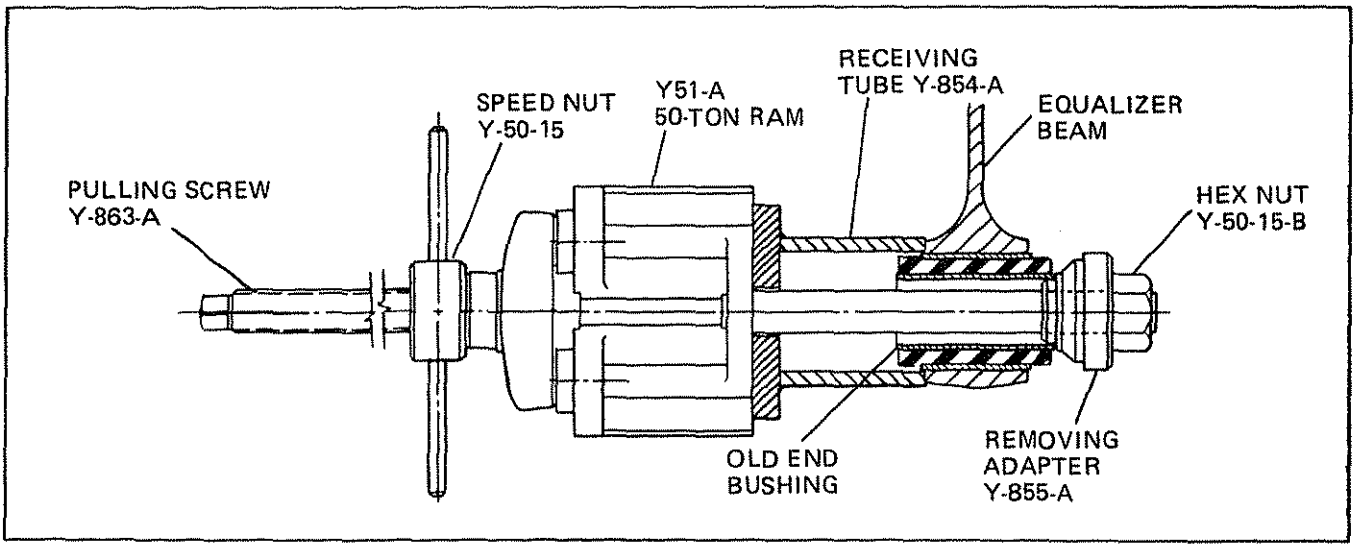

Fig. 11, OTC Tool Set-up For Equalizer Beam End Bushing Removal

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through the receiving tube, bushing, and removing adapter, as shown in Fig. 11. Secure with the hex nut.

IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube as it is pulled through the beam. The removing adapters should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean pull through the beam.

.3 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.4 If the pressure gauge on the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa); if the bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

.5 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the end bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, remove the beam end bushings with shop-made adapters, using the following procedure:

.1 Position the equalizer beam on a 50-ton vertical hydraulic press.

.2 Center the shop-made adapter (tool No. 1 from Table 2, located under "SPECIFICATIONS") on the trimmed end of the equalizer beam bushing. Then, press the end bushing from the beam eye.

5. Using emery cloth, remove all scale, rust, or corrosion from the equalizer beam eyes. Replace the equalizer beam if cracks, gouges, or damage is evident in the beam eyes.

6. Clean the outer sleeves of the new equalizer beam end bushings with emery cloth, then apply a thin coating of white lead, or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeves. Position the bushing on the equalizer beam eye.

7. If using the special Owatonna tools, use the following procedure for installation of the beam end bushing (refer to Fig. 12):

.1 Fit the adapter clamp over the exposed rubber on the new bushing, then tighten the clamp nuts until the contact surface on the clamp rests fully against the bushing outer sleeve.

.2 Position the pilot adapter into the beam eye, as shown in Fig. 12.

.3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the pilot adapter in the beam eye, bushing, and adapter clamp. Attach the adapter clamp plate to the pulling screw and adapter clamp. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight

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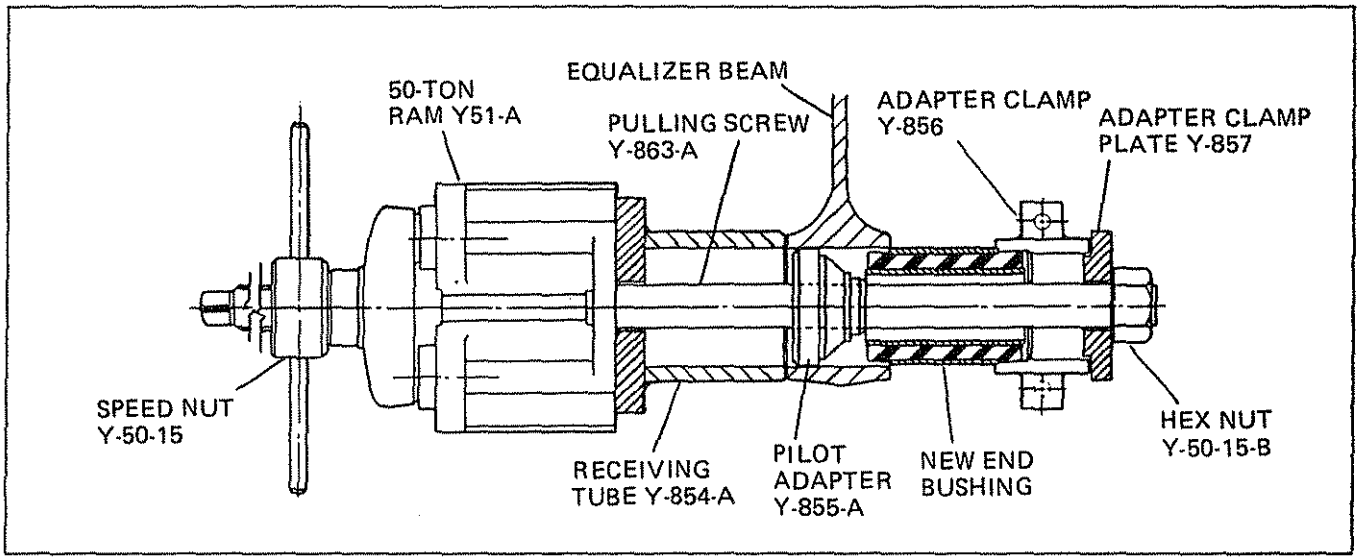

Fig. 12, OTC Tool Set-up For Equalizer Beam End Bushing Installation

into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new end bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), then the new bushing has been installed. Make a visual inspection.

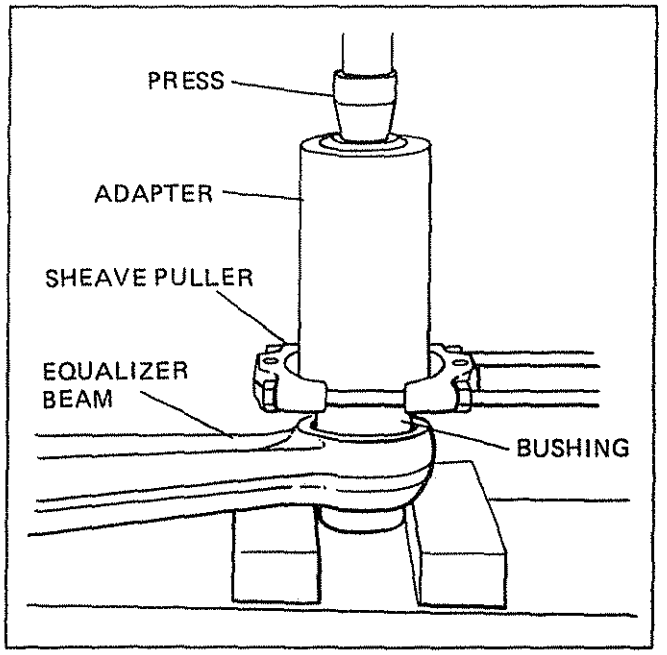

Fig. 13, Equalizer Beam End Bushing Installation Using Adapter and Sheave Puller

8. If not using the special Owatonna tools, install the new bushing with shop-made adapters, using the following instructions (refer to Fig. 13):

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.1 Using a sheave puller, compress the exposed rubber of the new bushing, until the puller jaws seat against the end of the new bushing outer sleeve.

.2 Position the shop-made adapter (tool No. 2 from Table 2, located under "SPECIFICATIONS") against the jaws of the sheave puller. Then, press the new bushing into the beam eye.

9. Replace the center bushings, if needed. For instructions, refer to the applicable center bushing replacement heading, in this subject.

10. Install the equalizer beam on the axle beam hangers. For instructions, refer to the applicable equalizer beam installation heading, in this subject.

EQUALIZER BEAM RUBBER CENTER BUSHING REPLACEMENT (Refer to Fig. 4)

IMPORTANT: If a beam rubber center bushing is worn or damaged, and needs to be replaced, then the rubber center bushings must be replaced on both equalizer beams.

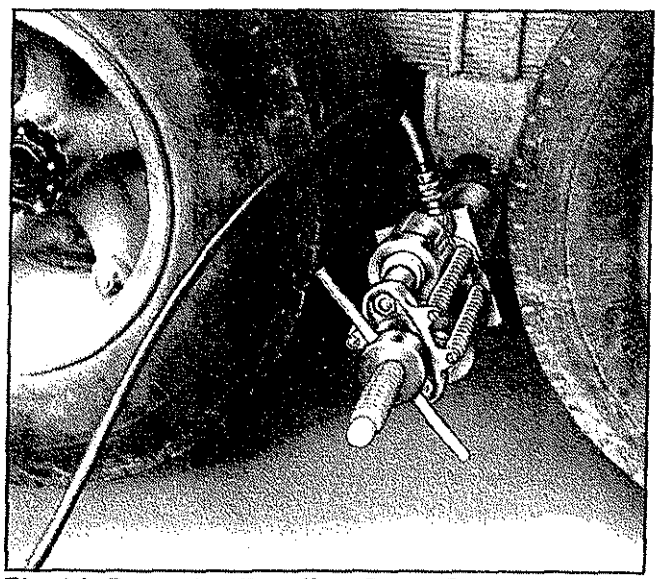

Fig. 14, Removing Equalizer Beam Center Bushing Installed on Vehicle, Using OTC Tools

NOTE: If using the special Owatonna tools, the beam rubber center bushing can be replaced either with the equalizer beam installed on the vehicle (see Fig. 14), or with the beam removed from the vehicle.

1. If not using the special Owatonna tools, remove the equalizer beams from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. Check the inboard exposed edge of the equalizer beam center bushing outer sleeve. If the outer sleeve is worn and has flared over the face of the equalizer beam, then chisel or grind the flared portion off, so it will not impede removal of the bushing.

WARNING: Protective eye goggles must be worn when grinding. Failure to do so could result in injury to the eye, due to the metal debris from the grinding process.

3. If using the special Owatonna tools, then remove the old center bushing using the following procedure (refer to Fig. 15):

.1 Before the Owatonna tools can be used, the welded end plug in the outside end of the inner sleeve must be removed. For the Model 340, use a 2-inch-diameter hole saw, for Models 380 and 440, use a 2 1/2-inch-diameter hole saw, to cut out the end plugs from the bushing.

CAUTION: Do not use a cutting torch to burn out the end plugs from the beam center bushings. The equalizer beam has been heat-treated, and the use of heat could adversly affect the strength of the beam.

If the equalizer beam is installed on the vehicle, remove the crosstube.

.2 Position the removing adapter on the bushing end prepared in step 2, above.

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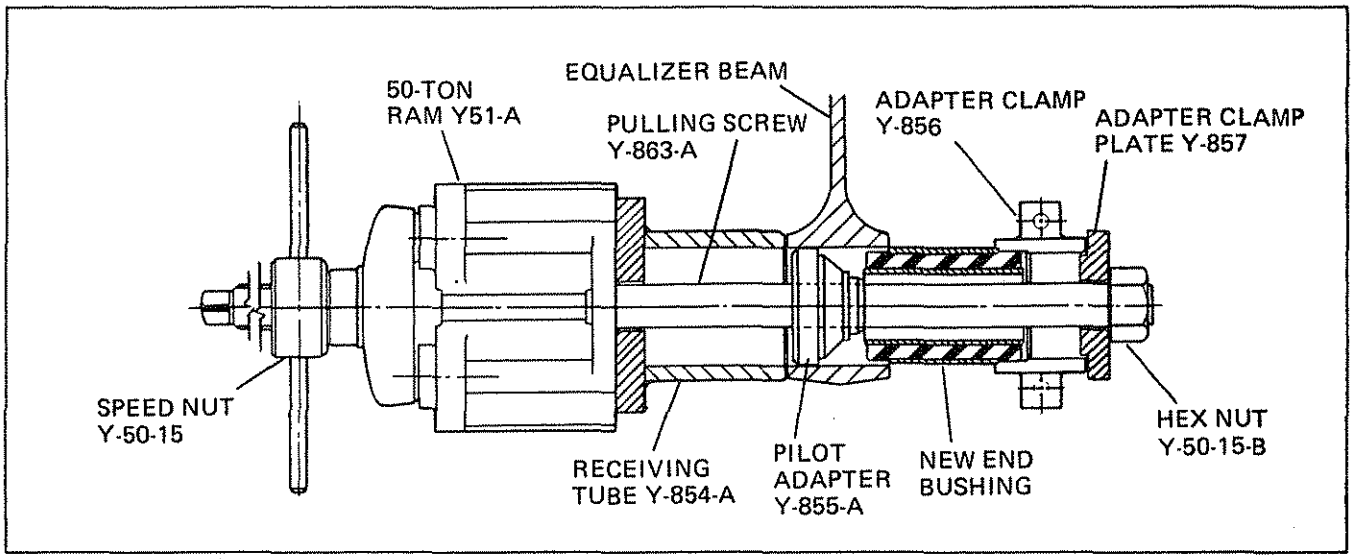

Fig. 12, OTC Tool Set-up For Equalizer Beam End Bushing Installation

into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new end bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), then the new bushing has been installed. Make a visual inspection.

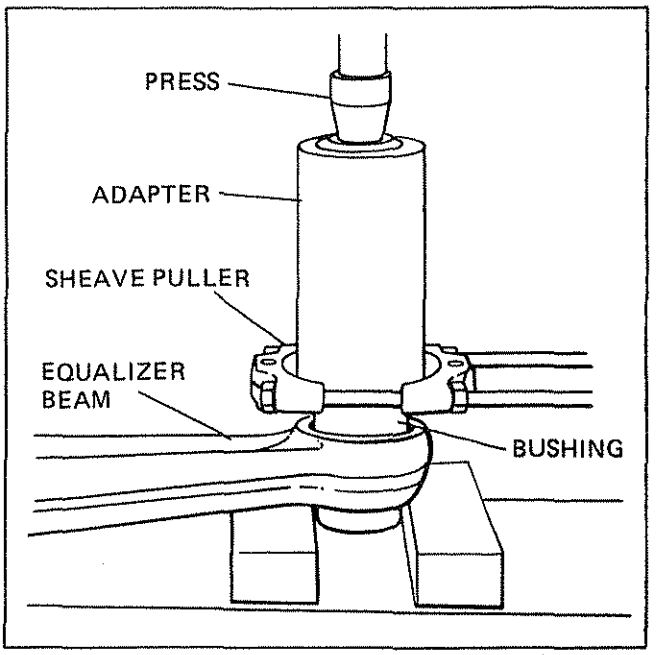

Fig. 13, Equalizer Beam End Bushing Installation Using Adapter and Sheave Puller

8. If not using the special Owatonna tools, install the new bushing with shop-made adapters, using the following instructions (refer to Fig. 13):

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.1 Using a sheave puller, compress the exposed rubber of the new bushing, until the puller jaws seat against the end of the new bushing outer sleeve.

.2 Position the shop-made adapter (tool No. 2 from Table 2, located under "SPECIFICATIONS") against the jaws of the sheave puller. Then, press the new bushing into the beam eye.

9. Replace the center bushings, if needed. For instructions, refer to the applicable center bushing replacement heading, in this subject.

10. Install the equalizer beam on the axle beam hangers. For instructions, refer to the applicable equalizer beam installation heading, in this subject.

EQUALIZER BEAM RUBBER CENTER BUSHING REPLACEMENT (Refer to Fig. 4)

IMPORTANT: If a beam rubber center bushing is worn or damaged, and needs to be replaced, then the rubber center bushings must be replaced on both equalizer beams.

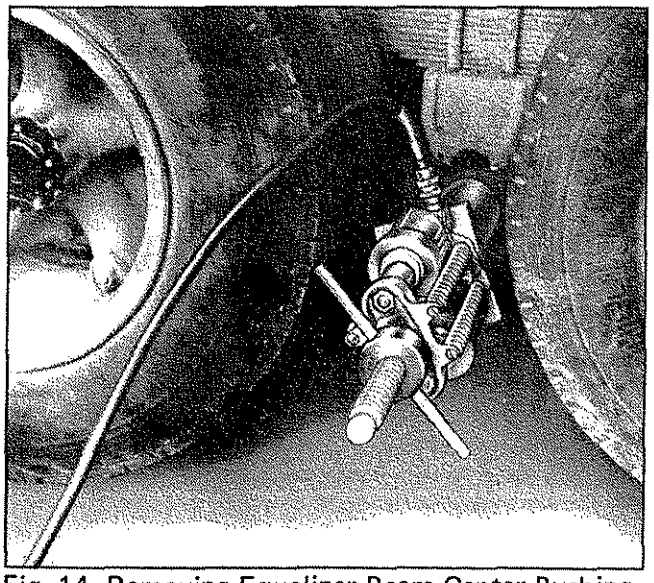

Fig. 14, Removing Equalizer Beam Center Bushing Installed on Vehicle, Using OTC Tools

NOTE: If using the special Owatonna tools, the beam rubber center bushing can be replaced either with the equalizer beam installed on the vehicle (see Fig. 14), or with the beam removed from the vehicle.

1. If not using the special Owatonna tools, remove the equalizer beams from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. Check the inboard exposed edge of the equalizer beam center bushing outer sleeve. If the outer sleeve is worn and has flared over the face of the equalizer beam, then chisel or grind the flared portion off, so it will not impede removal of the bushing.

WARNING: Protective eye goggles must be worn when grinding. Failure to do so could result in injury to the eye, due to the metal debris from the grinding process.

3. If using the special Owatonna tools, then remove the old center bushing using the following procedure (refer to Fig. 15):

.1 Before the Owatonna tools can be used, the welded end plug in the outside end of the inner sleeve must be removed. For the Model 340, use a 2-inch-diameter hole saw, for Models 380 and 440, use a 2 1/2-inch-diameter hole saw, to cut out the end plugs from the bushing.

CAUTION: Do not use a cutting torch to burn out the end plugs from the beam center bushings. The equalizer beam has been heat-treated, and the use of heat could adversly affect the strength of the beam.

If the equalizer beam is installed on the vehicle, remove the crosstube.

.2 Position the removing adapter on the bushing end prepared in step 2, above.

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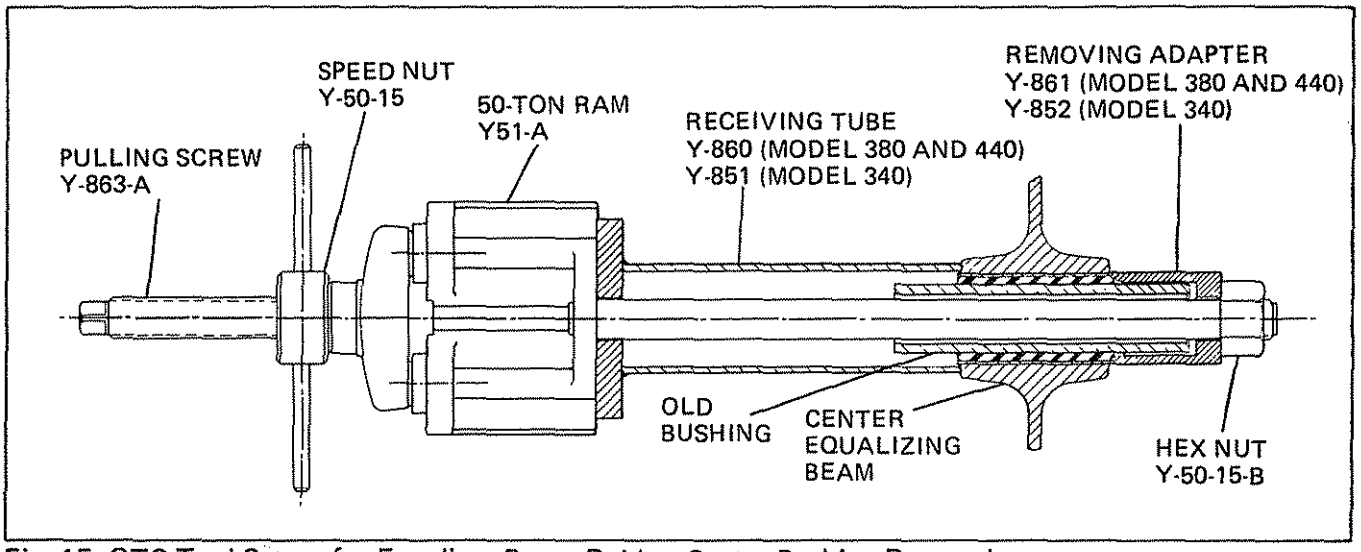

Fig. 15, OTC Tool Set-up for Equalizer Beam Rubber Center Bushing Removal

.3 Position the receiving tube on the opposite side of the beam center bushing. Then, assemble the hydraulic ram, speed nut, and pulling screw, as shown in Fig. 15. Secure with the hex nut.

IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube, as it is pulled through the beam. The removing adapter should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 If the pressure gauge of the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa); if bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

.6 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the center bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, remove the old center bushing with shop-made adapters, using the following procedure:

.1 Position the shop-made adapter (tool No. 3 for Model 340, or tool No. 4 for Models 380 and 440, given in Table 2, under "SPECIFICATIONS") on the bushing end prepared in step 2, above.

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.2 Position the beam on a 50-ton vertical hydraulic press, then apply pressure to press the center bushing from the bushing eye.

5. If converting from a rubber center bushing to a bronze center bushing, proceed to step 5, located under "EQUALIZER BEAM BRONZE CENTER BUSHING REPLACEMENT," in this subject. If not converting to bronze center bushings, proceed to step 6, below.

6. Using a cylinder hone or emery cloth, remove all scale, rust, or corrosion from the equalizer beam eye. Replace the equalizer beam if cracks, gouges, or damage exists in the beam eyes.

7. Clean the outer sleeves of the new equalizer beam center bushing with emery cloth, then apply a thin coating of white lead, or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeve and the beam center eye. Position the bushing against the equalizer beam eye.

8. If using the special Owatonna tools, use the following procedure for installation of the beam center bushing (refer to Fig. 16):

NOTE: New rubber center bushings with the end plugs as a separate part must be used.

.1 Fit the installing adapter over the bushing inner sleeve and against the outer sleeve end.

.2 Position the pilot adapter in the beam center eye.

.3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the pilot adapter in the beam eye, bushing, and removing adapter. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

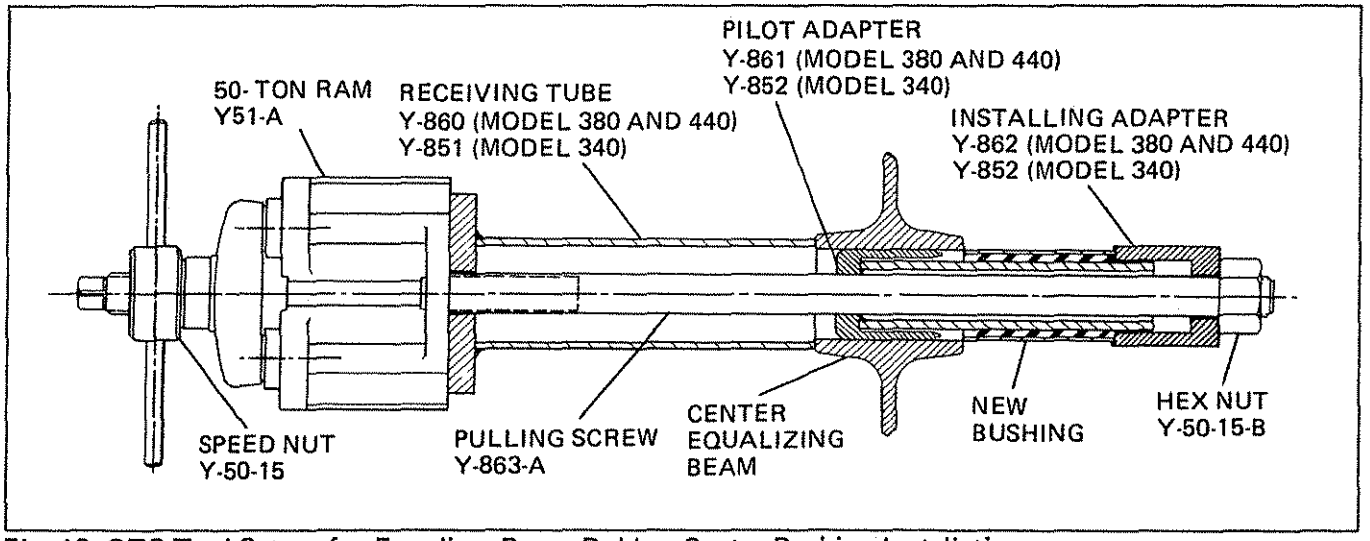

Fig. 16, OTC Tool Set-up for Equalizer Beam Rubber Center Bushing Installation

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.5 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new center bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), then the new bushing has been installed. Make a visual inspection.

.8 If the new center bushings were installed with the equalizer beams installed on the vehicle, position the crosstube in the center bushings. Arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and flying debris, from the welding process.

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

9. If not using the special Owatonna tools, install the new center bushing with shop-made adapters, using the following procedure:

NOTE: Use the standard center bushings with the end plugs welded in place.

.1 Position the shop-made adapter (tool No. 3 for Model 340, or tool No. 4 for Models 380 and 440, given in Table 2, under "SPECIFICATIONS") over the bushing inner sleeve, so that it bottoms against the bushing outer sleeve.

.2 Position the beam, bushing, and adapter on a 50-ton vertical press, then apply pressure to press the center bushing into the beam eye.

10. Replace the end bushings, if needed. For instructions, refer to "EQUALIZER BEAM END BUSHING REPLACEMENT," in this subject.

11. Install the equalizer beam on the axle beam hangers. For instructions, refer to the applicable equalizer beam installation heading, in this subject.

EQUALIZER BEAM BRONZE CENTER BUSHING REPLACEMENT (Refer to Fig. 4)

IMPORTANT: If the beam bronze center bushing is worn or damaged, and needs to be replaced, then the bronze center bushing must be replaced on both equalizer beams.

NOTE: If using the special Owatonna tools, the bronze center bushing can be replaced either with the equalizer beam installed on the vehicle (see Fig. 14), or with the beam removed from the vehicle.

IMPORTANT: Do not install bronze bushings on aluminium equalizer beams.

1. If not using the special Owatonna tools, remove the equalizer beam from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. Remove the beam center sleeve and thrustwashers from the center bushing, and discard these parts.

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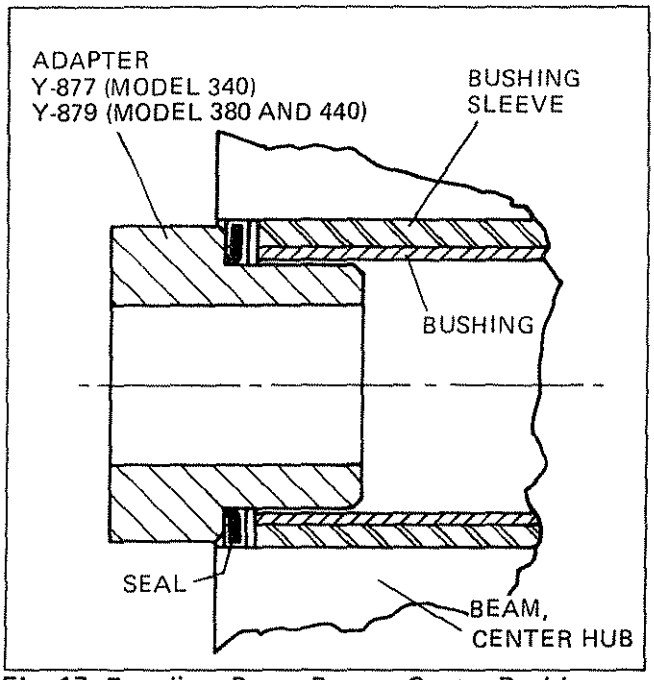

Fig. 17, Equalizer Beam Bronze Center Bushing Removal

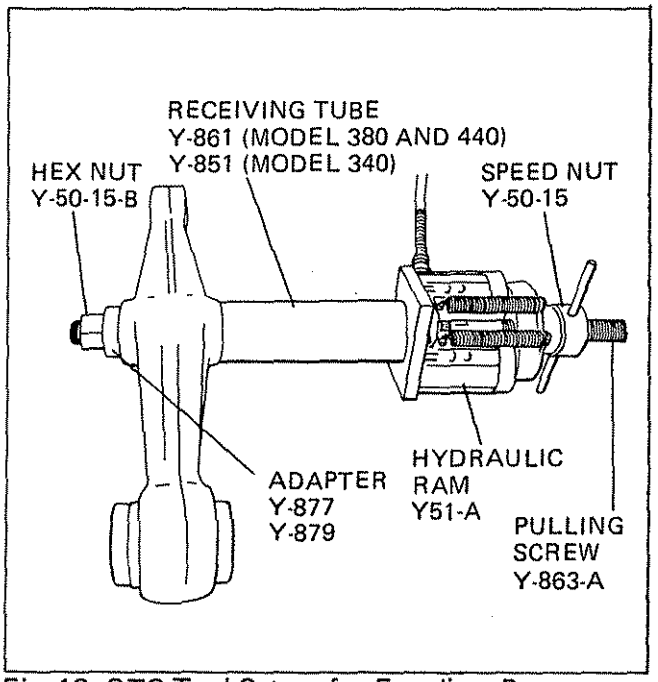

Fig. 18, OTC Tool Set-up for Equalizer Beam Bronze Center Bushing Removal

3. If using the special Owatonna tools, remove the bronze center bushing using the following procedure:

   .1 If the equalizer beam is installed on the vehicle, remove the crosstube.

   .2 Position the bronze center bushing adapter in the bushing to be removed, as shown in Fig. 17.

   .3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the beam eye, bushing, and adapter, as shown in Fig. 18. Secure with the hex nut.

   IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing the bushing to clear the edges of the receiving tube as it is pulled through the beam. The adapter should be aligned so that the force is exerted on the bushing and seals *only* (as shown in Fig. 17), not against the beam, to allow for a clean pull through the beam.

   .4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

   .5 If the pressure gauge shows a reading of 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

   .6 If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa), if bushing does

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not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

.7 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the center bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, position the equalizer beam on a 50-ton vertical hydraulic press. Center the adapter on the bushing, then press the bushing from the beam eye.

IMPORTANT: The adapter should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean press through the beam eye.

5. Using a cylinder hone or emery cloth, remove all scale, rust, or corrosion from the equalizer beam eyes. Replace the equalizer beam if cracks, gouges, or damage exists in the beam eyes. Remove the grease fitting, then run a wire through the hole to make certain that it is not blocked.

NOTE: When converting from rubber bushings to bronze bushings, it is necessary to drill the lube fitting hole in the equalizer beam hub before installing the bushings. Drill the hole according to the dimensions given in Fig. 35, under "SPECIFICATIONS."

6. Apply a thin coating of Texaco "Compound L," or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeve and the inside surface of the beam eye.

7. Position the new bronze bushing on the equalizer beam eye, so that the grooves on the bushing will lay along the vertical centerline of the equalizer beam, when installed. See Fig. 19.

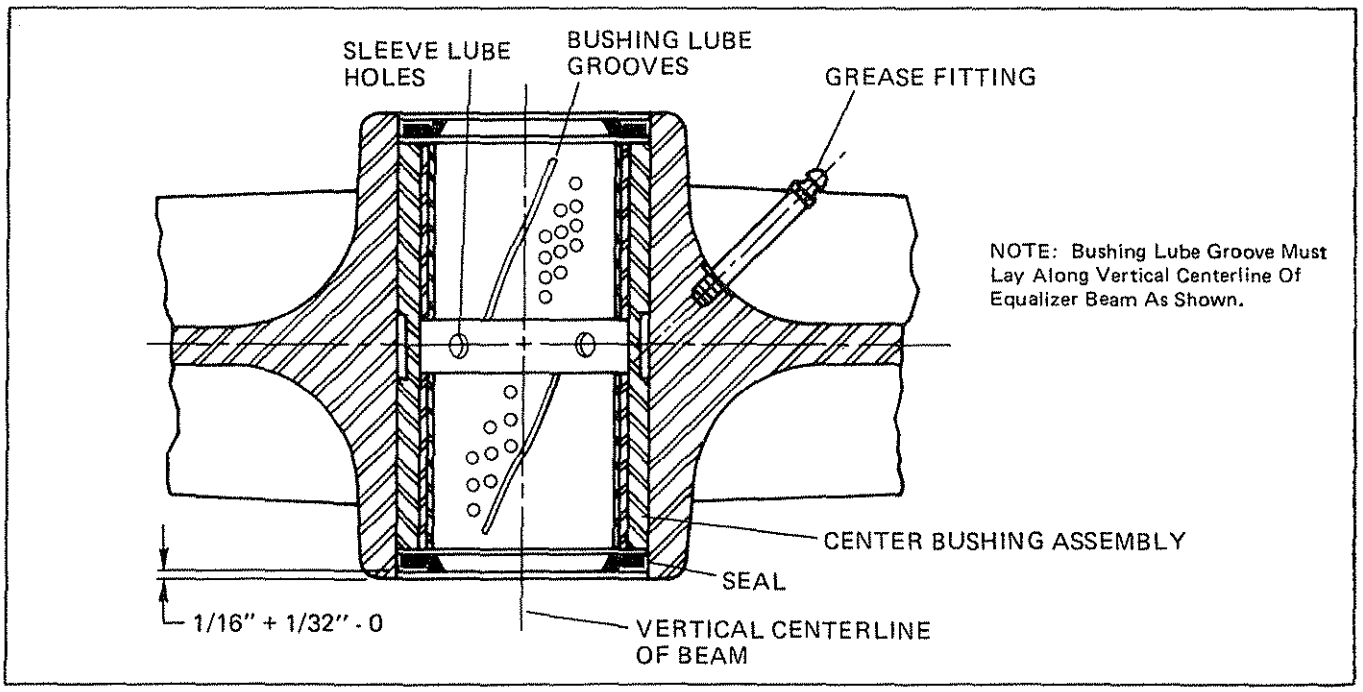

Fig. 19

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8. If using the special Owatonna tools, use the following procedure for installation of the beam bronze center bushing (refer to Fig. 20):

   .1 Install the grease seal adapter plate on the adapter, with the smaller shoulder of the adapter plate against the adapter. Then, position the adapter and adapter plate assembly on the bronze center bushing. When installed, the adapter plate will bottom on the beam, as shown in Fig. 21.

   .2 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the beam eye, bushing, adapter plate, and adapter. Secure with the hex nut.

   IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter and adapter plate should fit on the bushing so that the adapter plate will bottom on the beam when the bushing is installed, as shown in Fig. 21.

   .3 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

   .4 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

   .5 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new center bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

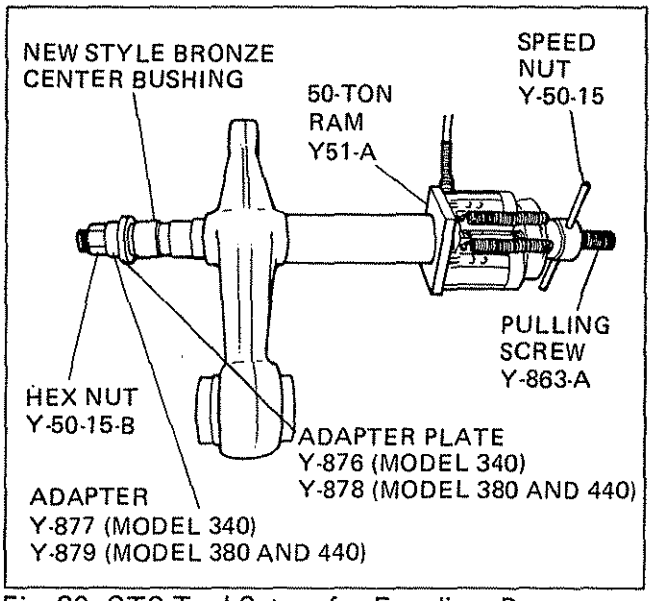

Fig. 20, OTC Tool Set-up for Equalizer Beam Bronze Center Bushing Removal

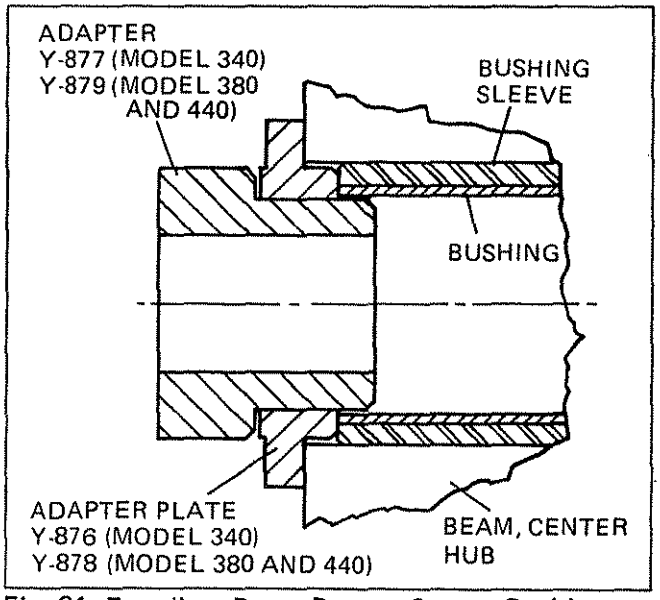

Fig. 21, Equalizer Beam Bronze Center Bushing Installation

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.6 When the adapter plate bottoms on the beam (see Fig. 21) and the pressure gauge shows a pressure reading increase of up to 10,000 psi (68 900 kPa), then the new bushing is installed. Make a visual inspection.

.7 Install the grease seals (one on each side of the bushing), after the bushings are installed, by inverting the adapter plate so that the smaller shoulder is against the seal, as shown in Fig. 22. Install the new grease seals with the lips of the seals facing outward, as shown in Fig. 19. On the outside of the beam, place the seal and adapters in place, and tap the seal in place with a hammer by striking the adapter assembly. When the adapter plate bottoms against the beam, the seal is installed to its proper depth. Proceed to step 10.

9. If not using the special Owatonna tools, use the following procedure to install the new bronze center bushing:

.1 Position the beam on a 50-ton vertical hydraulic press, then position the new bushing over the beam eye. Using a standard bushing driver, drive the bushing into the beam eye.

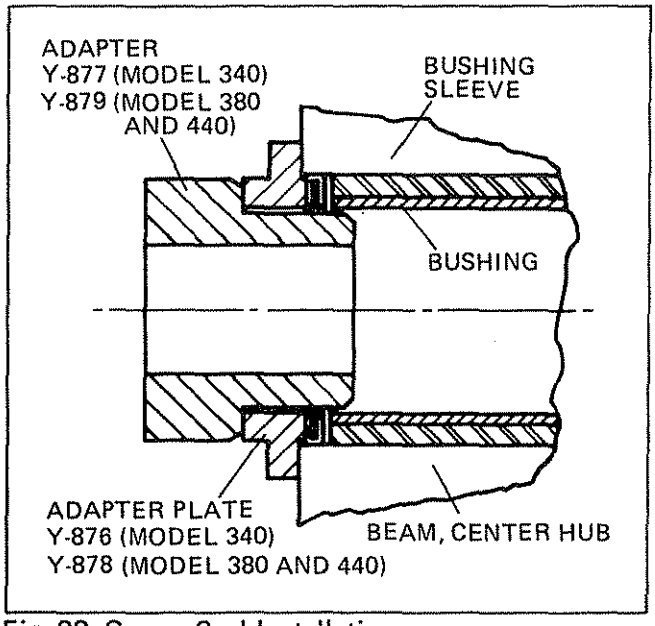

Fig. 22, Grease Seal Installation

.2 Center the bushing in the beam eye, so that there is equal spacing between both ends of the bushing and the sides of the beam. See Fig. 19.

.3 Install the new grease seals into the ends of the equalizer beam eye, with the lips of the seals facing outward. The face of the seals must be inside the beam eye and 1/16" + 1/32"-0, to provide clearance and protection of the seals. See Fig. 19. Do not bend the seal.

10. Apply a thin coating of multipurpose chassis grease to the outer surface of the bushing center sleeve, then slide the sleeve into the bushing. Install the grease fitting into the beam hub. Apply multipurpose chassis grease through the grease fitting, while rotating the center sleeve. Continue until grease appears at both grease seals.

NOTE: Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for lubrication schedules and procedure for bronze bushings.

11. If the beam hub length measures 6 7/8 inches (175 mm), install one thrustwasher on each side of the beam center bushing. If the beam hub length measures 6 3/4 inches (171 mm), install two thrustwashers on each side of the beam center bushing.

TORQUE ROD REMOVAL AND INSTALLATION (Refer to Fig. 23)

Removal

If the suspension system has been removed from the vehicle, proceed to step 3.

1. If not previously done, disconnect the torque rods from the torque rod axle brackets by removing the attaching flanged nuts and flanged bolts.

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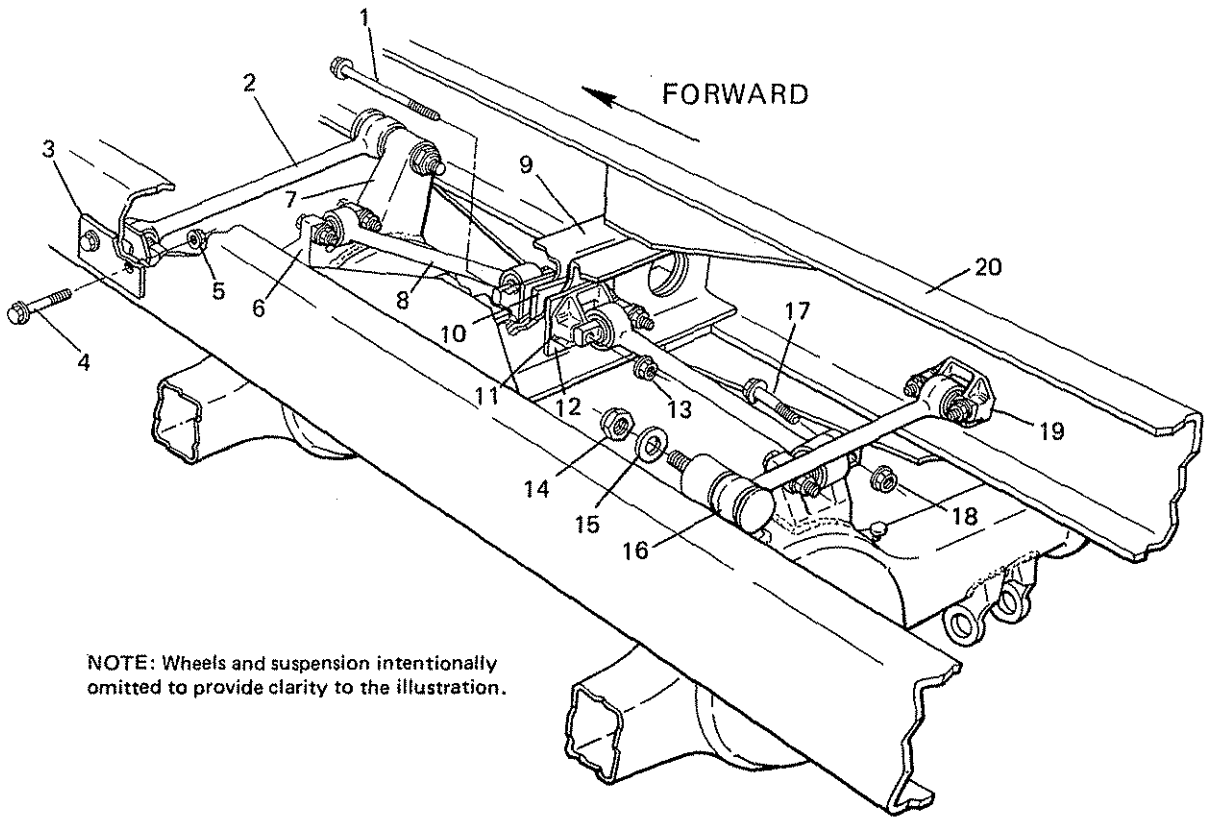

1. Flanged Bolt
2. Lateral, Track Bar Torque Rod
3. Backing Plate
4. Flanged Bolt
5. Flanged Locknut
6. Torque Rod Axle Bracket
7. Lateral, Track Bar Torque Rod
8. Torque Rod
9. Crossmember
10. Crossmember Spacer
11. Straddle Mount Crossmember Bracket
12. Shim(s)
13. Flanged Locknut
14. Tapered Stud Locknut
15. Tapered Stud Washer
16. Tapered Stud
17. Flanged Bolt
18. Flanged Locknut
19. Straddle Mount Frame Bracket
20. Frame Rail

Fig. 23, Torque Rod and Lateral, Track Bar Torque Rod Assembly

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2. If also equipped with the lateral, track bar torque rods, remove the attaching locknuts from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushings. Keep clear of the beam hangers and beam ends to avoid the possibility of injury.

3. Remove the flanged locknuts and flanged bolts that attach the torque rod straddle mount assembly to the frame crossmember. Remove the torque rods, crossmember brackets, and shim(s) from the vehicle. Keep track of the torque rod crossmember spacer in the suspension crossmember.

4. If also equipped with lateral, track bar torque rods, remove the flanged locknuts and flanged bolts that attach the torque rod assembly to the frame rail. Remove the torque rods, frame bracket, and backing plate from the vehicle.

5. Visually inspect the torque rod for bends or cracks. Work the torque rod pins to check for looseness in the polyurethane bushing. If the torque rod is bent, cracked, or otherwise damaged, replace it with a new one. If either of the bushings is loose, both of the bushings must be replaced with new ones. For instructions, refer to "TORQUE ROD BUSHING REPLACEMENT," in this subject.

Installation

NOTE: Torque rods are to be installed when the axle and suspension assemblies are installed on the vehicle.

1. Before installation, make certain that all contact surfaces are free of dirt or other foreign material. Lubricate all bolt threads with SAE-20 oil.

2. Position the torque rod straddle mount pins against the forward-rear axle torque rod bracket. Then, install the flanged bolts through the torque rod axle bracket and the torque rod pin.

3. Install the flanged nuts on the torque rod mounting bolts, then tighten the nuts to 150-175 ft-lbs (203-237 N·m).

4. Install the rear-rear axle torque rod in the same manner.

5. Position the torque rod crossmember spacer in the crossmember. Position shim(s) (not to exceed 1/2 inch [13 mm] thick), and crossmember straddle mount bracket on the front side of the crossmember, then position the torque rod so the torque rod pins are aligned with the bracket.

6. Install the flanged bolts through the torque rod pins, bracket, and the front side of the crossmember.

NOTE: Do not install the flanged bolt completely through the crossmember until the other side torque rod assembly is installed.

7. On the back side of the crossmember, position the shim(s) (not to exceed 1/2 inch [13 mm] thick), and crossmember bracket; then position the torque rod so the torque rod pins are aligned with the bracket. Attach, by completely installing the flanged bolts from the front side torque rod, through the crossmember and torque rod assembly. Install the flanged nuts on the bolts and tighten to 150-175 ft-lbs (203-237 N·m).

8. If also equipped with the lateral, track bar torque rods, use the following procedure for installation:

   .1 Make certain that the tapered stud and tapered stud bracket hole are free of dirt or other foreign material. Lubricate the

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tapered stud ends of the torque rod with SAE-20 oil.

.2 Install the tapered stud into the lateral torque rod axle bracket. Install the locknut on the stud and tighten to 175-225 ft-lbs (237-303 N·m). Then, tap the axle bracket with a hammer. Tighten the locknut again to 175-225 ft-lbs (237-303 N·m).

.3 Position the lateral torque rod frame bracket, shim(s), and backing plate on the inside of the frame rail. Then position the torque rod pins against the frame bracket.

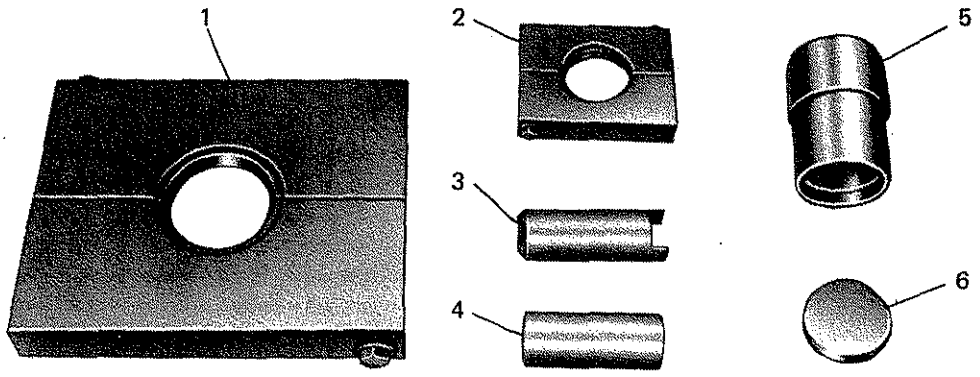
.4 Install the flanged bolts through the frame rail, bracket assembly, and torque rod pins. Install the flanged locknuts on the flanged bolts, then tighten the locknuts to 150-175 ft-lbs (203-237 N·m).

8. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual.

TORQUE ROD BUSHING REPLACEMENT

IMPORTANT: To replace the torque rod polyurethane bushings, it is necessary to have the special installation tool kit (Freightliner part No. P-097-009), or a tool kit can be made, using the dimensions given in Fig. 36 under "SPECIFICATIONS." If equipped with the lateral, track bar torque rods, the bushings must be replaced using the special Owatonna tool set No. Y-820, as shown in Fig. 24 (See Table 3, under "SPECIFICATIONS").

1. Remove the torque rods. For instructions, refer to "TORQUE ROD REMOVAL AND INSTALLATION," in this subject.
2. Remove the snapring and bearing washer from each side of the torque rod bushing to be removed. See Fig. 25. Note that the torque rod eye has a smaller shoulder on one side than on the other, and it also has a rounded edge around the inside of the smaller shoulder side of the eye. The bushing must be pressed in and out through this side.



1. Press Plate Y-825
2. Clamp Assembly Y-824
3. Remover Y-826
4. Remover Y-822
5. Remover/Replacer Y-823
6. Cap Y-821

Fig. 24, OTC Tool Set No. Y-820

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

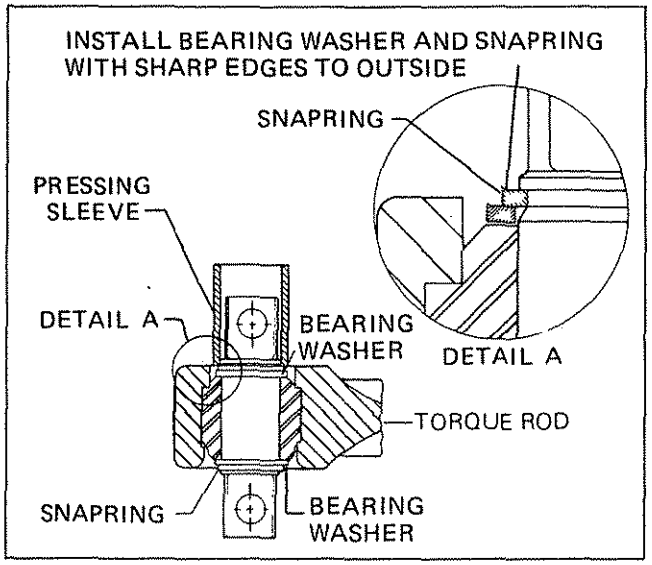


Fig. 25

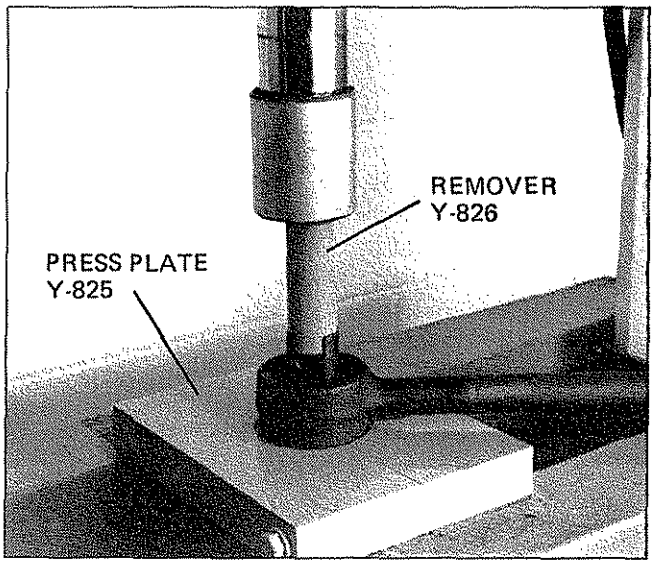


Fig. 26

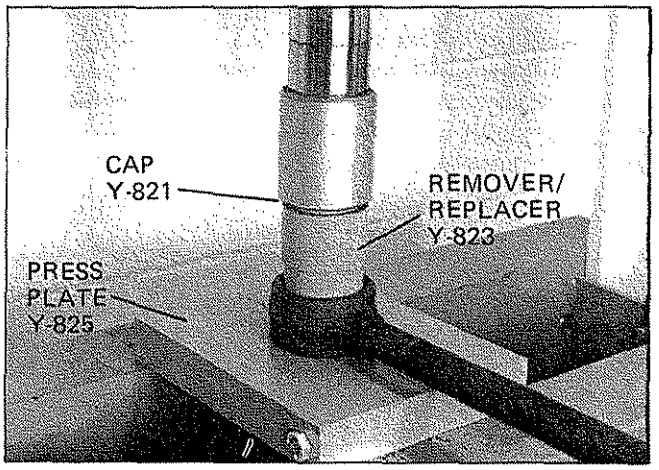


Fig. 27

3. Position the plunger and torque rod on a vertical hydraulic press, then press the old bushing assembly out of the torque rod eye.

4. Clean all dirt, grease, or other foreign material from the torque rod eye. Coat the new bushing and torque rod eye with a non-mineral lubricant or waterless hand cleaner.

5. If not equipped with the lateral, track bar torque rods, proceed to step 7. If equipped with the lateral, track bar torque rods, remove the old bushing from the torque rod eye with the special Owatonna tools and using the following procedure:

   .1 Position the press plate on the bed of a vertical hydraulic press, with the small counterbore of the press plate hole facing up.

   .2 Install the straddle mount ends of the lateral, track bar torque rod, in the hole of the press plate. Secure by tightening the press plate capscrews.

   .3 Position the straddle mount pin remover on the straddle mount pin. Lubricate the bushing liberally with lubricating oil. Press the straddle mount pin out of the bushing. See Fig. 26.

   .4 Position the rubber bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing for Model 340, or with the larger outside diameter of the remover/replacer tool against the bushing for Models 380 and 440. Lubricate the bushing liberally with lubricating oil. Press the rubber bushing out of the torque rod eye. See Fig. 27.

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.5 Install the tapered stud end (with the stud face up) in the hole of the press plate. Secure by tightening the press plate capscrews.

NOTE: Some tapered stud torque rod bushings have a large non-removable washer on the back end of the stud and will not fit through the press plate hole. Loosen the press plate capscrews and separate the halves (see Fig. 28) until the washer clears the counterbore of the press plate, and the torque rod sets on the press plate. Tighten the capscrews until the press plate halves are closed completely. If the washer is removable, then remove the washer before installing the torque rod end in the press plate.

Position the tapered stud remover tool (OTC part No. Y-822) with the smaller inside diameter of the remover tool on the Model 340 torque rod stud, or the larger inside diameter of the remover tool on the Model 380 and 440 torque rod stud. Lubricate the bushing liberally with lubricating oil. Press the stud out of the bushing.

Position the rubber bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing for Model 340, or with the larger outside diameter of the remover/replacer tool against the bushing for Models 380 and 440. Lubricate the bushing liberally with lubricating oil. Press the rubber bushing out of the torque rod eye. See Fig. 27.

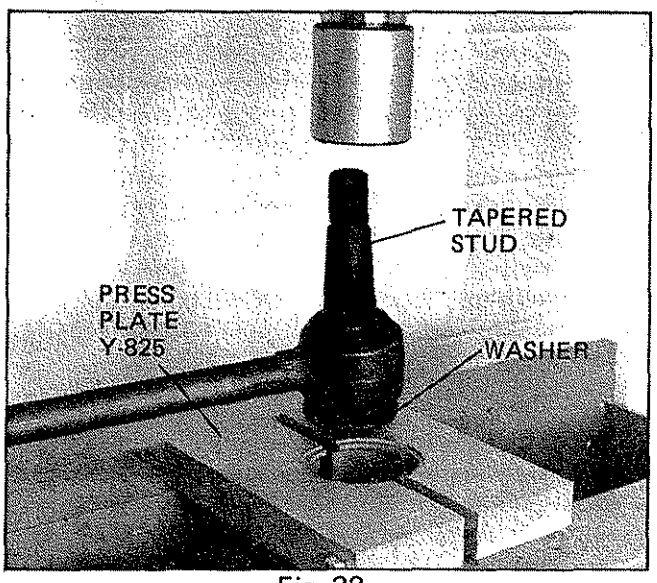

Fig. 28

.6 Clean all dirt, grease, or other foreign material from the torque rod eye. Proceed to step 6.

6. Install the new lateral, track bar torque rod cartridges with the special Owatonna tools, and using the following procedure:

NOTE: New replacement cartridges with the bushings bonded to the straddle mount pins and tapered studs must be used.

.1 Position the press plate on the bed of a vertical hydraulic press. Position the torque rod eye into the hole of the press plate.

.2 For Model 340, position the new straddle mount replacement cartridge on the torque rod eye. Position the remover/replacer tool and cap, with the smaller outside diameter of the remover/replacer tool against the rubber bushing of the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: The center metal section flats of the pin must be perpendicular to the center line of the torque rod shank. See Fig. 29. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

.3 For Models 380 and 440, use the clamp assembly to compress the rubber of the new straddle mount cartridge bushing, and act as a pushing plate. See Fig. 30. The clamp must be completely closed to compress the rubber. See Fig. 31.

NOTE: When clamping the clamp assembly around the bushing, line up the metal section

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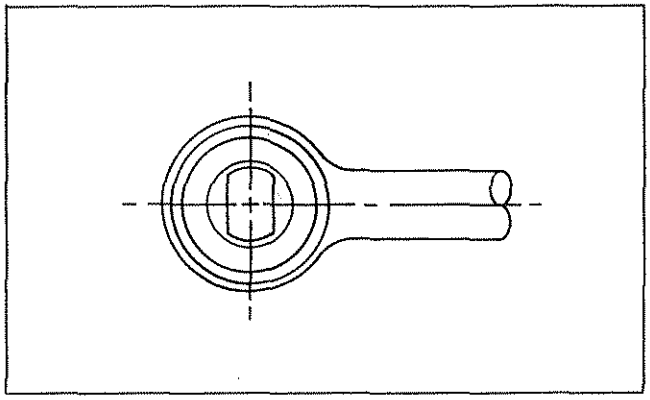

Fig. 29

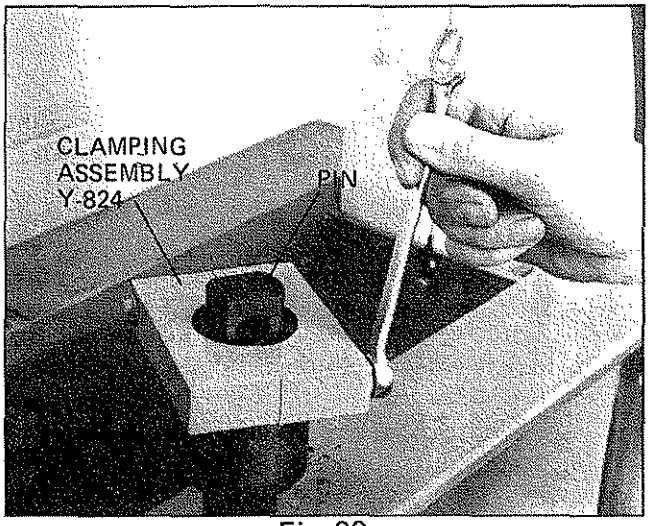

Fig. 30

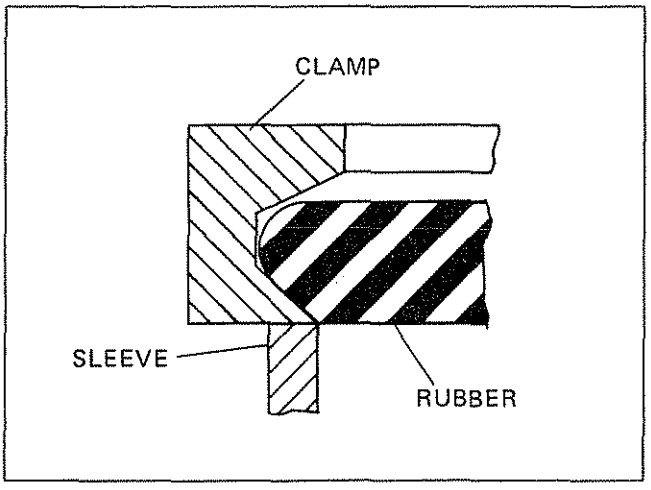

Fig. 31

flats of the straddle pins, perpendicular to the splits of the clamp assembly. See Fig. 30.

Position the new straddle mount cartridge and clamp over the torque rod eye. Position the remover/replacer tool and cap, on top of the clamp assembly with the larger outside diameter end of the remover/replacer tool against the clamp assembly. Set the assembly so that the split of the clamp assembly lines up with the shank of the torque rod. See Fig. 32. Press the replacement cartridge into the torque rod eye. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

.4 Remove the bolt, lockwasher, and washer-type cap from the new tapered stud replacement cartridge.

For the Model 340, position the new replacement cartridge on the torque rod eye with the stud end down. Position the remover/replacer tool and cap, with the smaller outside diameter of the remover/replacer tool against the rubber bushing of the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: Install the replacement cartridge with the threaded end down. The outer steel sleeve must protrude equally on each side.

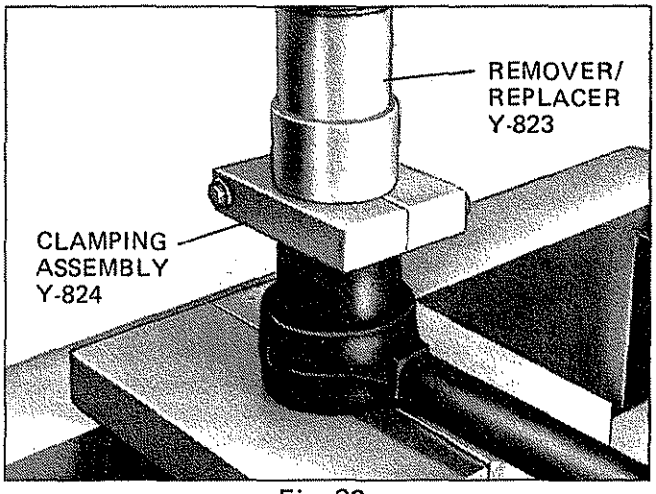

Fig. 32

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

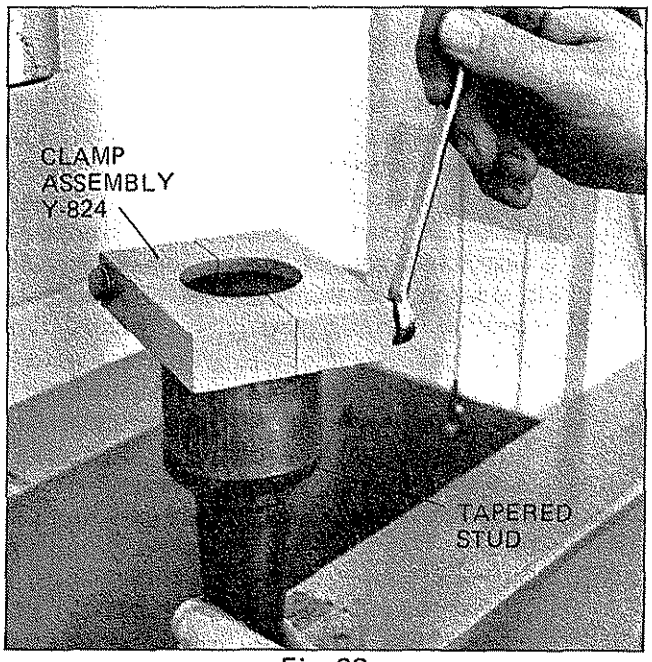

Fig. 33

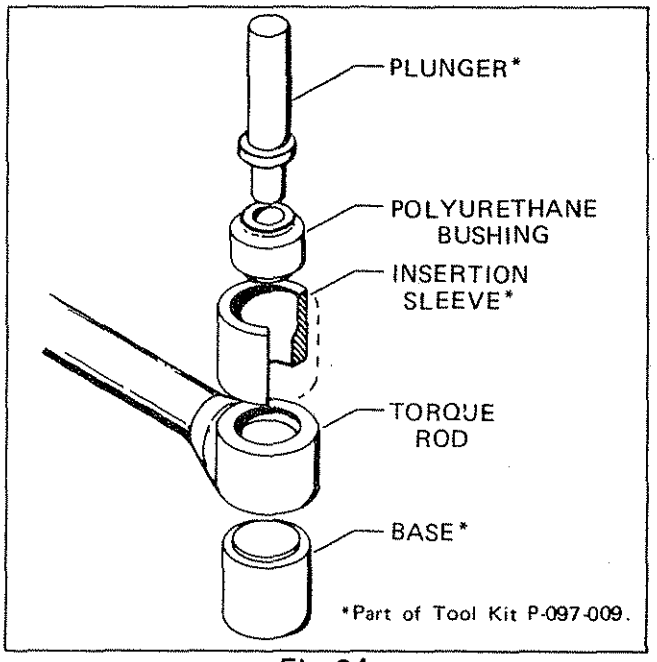

Fig. 34

For Models 380 and 440, use the clamp assembly to compress the rubber of the new tapered stud cartridge bushing, and act as a pushing plate. See Fig. 33. The clamp must be completely closed to compress the rubber. See Fig. 31.

Position the new replacement cartridge and clamp over the torque rod eye. Position the remover/replacer tool and cap, on top of the clamp assembly with the larger outside diameter end of the remover/replacer tool against the clamp assembly. Set the assembly so that the split of the clamp assembly lines up with the shank of the torque rod. See Fig. 32. Press the replacement cartridge into the torque rod eye. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

7. Position the bushing in the larger end of the insertion sleeve from the tool kit, then fit the beveled (smaller) end of the sleeve into the larger side of the torque rod eye.

8. Center the torque rod eye on the base tool, and insert the plunger tool into the bushing. See Fig. 34. Use a vertical hydraulic press to press the bushing into the torque rod eye.

9. Install the snapring and bearing washer on one end of the torque rod pins, with the sharp edges of the washer and snapring facing the outward end of the pin. See Fig. 25, Detail A.

10. Press the torque rod pin into the torque rod bushing from the same side as the bushing was pressed into the torque rod eye. Do not lubricate the torque rod pin.

    Turn the torque rod over and install a bearing washer, with the sharp edge facing away from the bushing, then install the other snapring onto the outer shoulder of the pin, with the sharp edge facing outward.

    Place a pressing sleeve over the end of the torque rod pin, then press the snapring into its seat. See Fig. 25.

11. After assembly, lightly press the torque rod pin or tapered stud, to center it in the torque rod eye. There should be no slack on either side of the bushing, and the bushing should be com-

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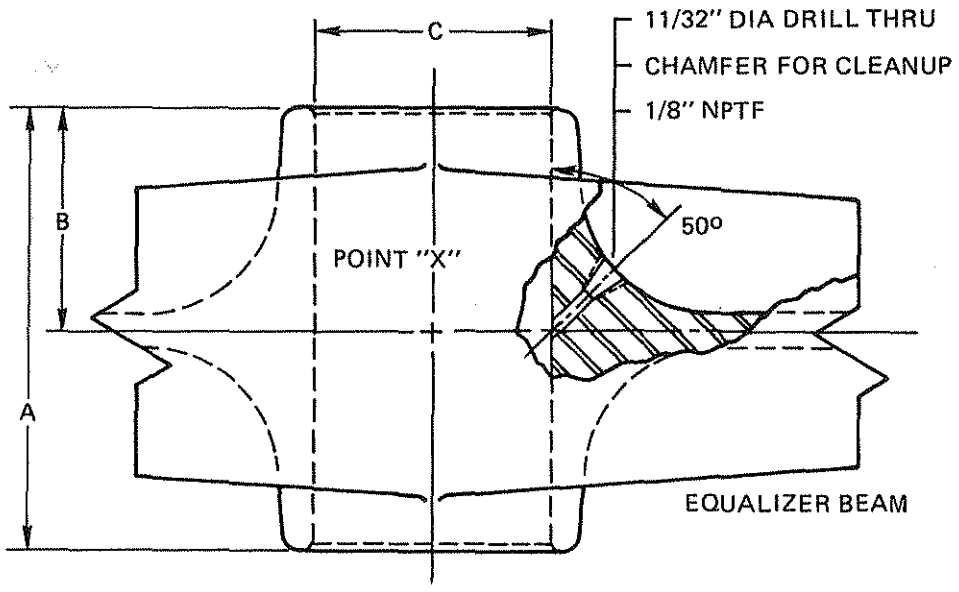
pressed by approximately half the thickness of the snapring. If necessary, install a second washer under one of the snaprings to compress the bushing.

AXLE ALIGNMENT

There are no axle alignment adjustments on the Hendrickson "RS" series suspension. At the time of the original installation, the placement of the frame hangers on the frame sets the suspension alignment. Parallel alignment of the axles to each other is automatic, because of compression centering. In turning, the rubber in the equalizer beam bushings is compressed at all points, and the reflex action to the rubber maintains the parallelogram form.

SPECIFICATIONS



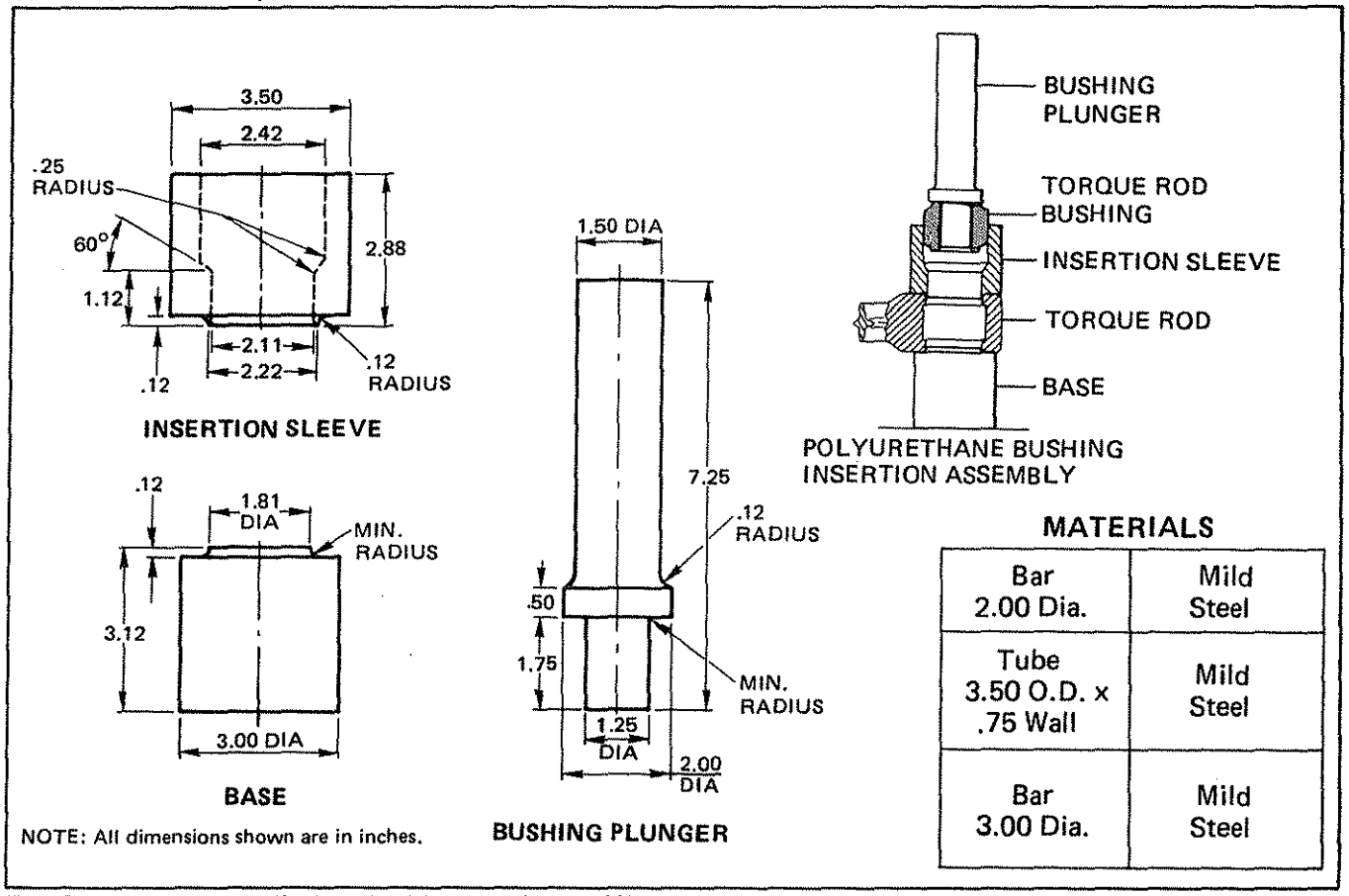
BEAM HUB DIMENSIONS

A - 6.70 inches
B - 3.375 inches
C - 3.613 to 3.617 inches for Model 340
4.738 to 4.742 inches for Models 380 and 440
Point "X" - must fall on centerline of beam center hub within ± 1/8"

Fig. 35, Grease Fitting Location on Equalizer Beam Hub

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

SPECIFICATIONS (Continued)



MATERIALS

Bar 2.00 Dia.	Mild Steel
Tube 3.50 O.D. x .75 Wall	Mild Steel
Bar 3.00 Dia.	Mild Steel

Fig. 36, Bushing Installation And Removal Tool Kit

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

SPECIFICATIONS (Continued)

OTC PART NUMBER	TOOL	APPLICATION	"RS" SERIES MODEL NO.
Y-851	Receiving Tube	Center Bushing Removal and Installation	340
Y-852	Removing and Pilot Adapter	Center Bushing Removal and Installation	340
Y-853	Installing Adapter	Center Bushing Installation	340
Y-854-A	Receiving Tube	End Bushing Removal and Installation	All
Y-855-A	Removing and Pilot Adapter	End Bushing Removal and Installation	All
Y-856	Adapter Clamp	End Bushing Installation	All
Y-857	Adapter Clamp Plate	End Bushing Installation	All
Y-858	Receiving Tube	Beam End Tube-Type Hanger Pin Removal	All
Y-859-A	Removing Adapter	Beam End Tube-Type Hanger Pin Removal	All
*Y-860	Receiving Tube	Center Bushing Removal and Installation	380/440
*Y-861	Removing and Pilot Adapter	Center Bushing Removal and Installation	380/440
*Y-862	Installing Adapter	Center Bushing Installation	380/440
Y-863-A	Pulling Screw	All Operations	All
Y-864	Sledging Adapter	Seized Part Removal	All
Y-865-D	Adapter Puller Set	Beam End Adapter-Type Beam Hanger Plug Removal	All
*Y-876	Adapter Plate	Center Bushing (Bronze) and Seal Installation	340
*Y-877	Adapter	Center Bushing (Bronze) Removal and Installation	340
*Y-878	Adapter Plate	Center Bushing (Bronze) and Seal Installation	380/440
*Y-879	Adapter	Center Bushing (Bronze) Removal and Installation	380/440
Y-50-15	Speed Nut	All Operations	All
Y-50-15-B	Hex Nut	All Operations	All
*Y51-A	50-Ton Hydraulic Ram	All Operations	All

*Used in addition to Tool Set Y-850, depending on application.

Table 1, Owatonna Tool Set No. Y-850 (Owatonna Tool Company, Owatonna, Minnesota)

TOOL NO.	ADAPTER SIZE	APPLICATION	"RS" SERIES MODEL NO.
1	4 1/4" O.D. x 4" Length	Beam End Bushing Removal	All
2	*4 1/2" I.D. x 4" Length	Beam End Bushing Installation	All
3	3 1/2" O.D. x 7" Length	Beam Center Bushing Removal and Installation	340
4	4 5/8" O.D. x 7" Length	Beam Center Bushing Removal and Installation	380/440

*Adapter to be used with a sheave puller. See Fig. 13.

Table 2, Shop-Made Adapters for use with a 50-Ton Vertical Hydraulic Press

HENDRICKSON TANDEM SUSPENSION "RS" SERIES, MODELS 340, 380, AND 440

SPECIFICATIONS (Continued)

OTC PART NUMBER	TOOL	APPLICATION	"RS" SERIES MODEL NO.
Y-821	Cap	Bushing Removal and Installation	All
Y-822	Remover	Tapered Stud Removal	All
Y-823	Remover/Replacer	Bushing Removal and Installation	All
Y-824	Clamp Assembly	Straddle Mount Bushing Installation	380/440
Y-825	Press Plate	Bushing Removal and Installation	All
Y-826	Remover	Straddle Mount Pin Removal	All

Table 3, Owatonna Tool Set No. Y-820 (Owatonna Tool Company, Owatonna, Minnesota)

DESCRIPTION		SIZE	GRADE	TORQUE	
				FT-LBS	N·m
Vertical Drive Pin Bushing Retainer Cap Nuts		5/8-18	C	100-125	136-170
Vertical Drive Pin Bushing Retainer Cap Stud		7/8-9	C	55-65	75-88
Vertical Drive Pin Bushing Nut		1 1/2-12	C	175-225	237-303
Torque Rod Straddle Mount Attaching Flanged Nuts		5/8-11	G	150-175	203-237
Lateral, Track Bar Torque Rod Stud Locknut	Model 340	1 1/8-12	B	175-225	237-303
	Model 380/440	1 1/4-12	B	175-225	237-303
Saddle Cap Studs		7/8-14	B	55-65	75-88
Saddle Cap Nuts		7/8-14	B	225-275	303-373
Adapter-Type Beam End Nut		3/4-16	C	210-240	285-325
Tube-Type Beam End Nut		—	—	375-425	441-576

Table 4, Torque Values

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440
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HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

GENERAL DESCRIPTION

The Hendrickson "RT" series suspension (Fig. 1) uses semi-elliptical, steel leaf springs to carry and cushion the load. The springs are mounted on a saddle assembly, on each side of the vehicle, and are pivoted at the forward end, on spring pins in the spring hangers. The rear ends of the springs have no rigid attachment to the rear spring hangers, and are free to move forward and backward to compensate for spring deflection.

The "RTE" series suspension (Fig. 2) is basically the same as the "RT" series, with the addition of a third, rear spring hanger, and a redesigned spring, with the four top spring leaves extended and the top spring leaf in contact with the rear spring hanger. When the vehicle is operating in an unloaded condition, a gap exists between the top spring leaf and the No. 2 spring hanger, while the sprung weight of the vehicle is carried through the No. 3 spring hanger and most of the spring deflection is through the top extended leaves. See Fig. 3. When the vehicle is operating in the loaded condition, the top extended leaf contacts the No. 2 spring hanger and the spring weight is carried through the No. 1 and 2 spring hangers. See Fig. 4.

The leaf spring and saddle assemblies carry the equalizer beams, connected through the equalizer beam center bushings. The axles are attached to beam hangers at the ends of the equalizer beams.

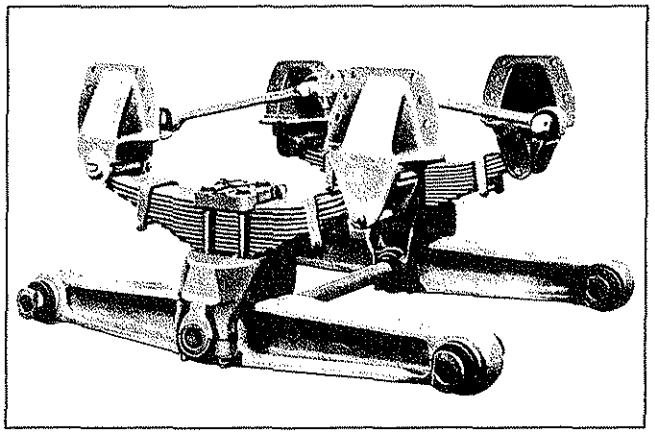


Fig. 1, Hendrickson "RT" Series Suspension

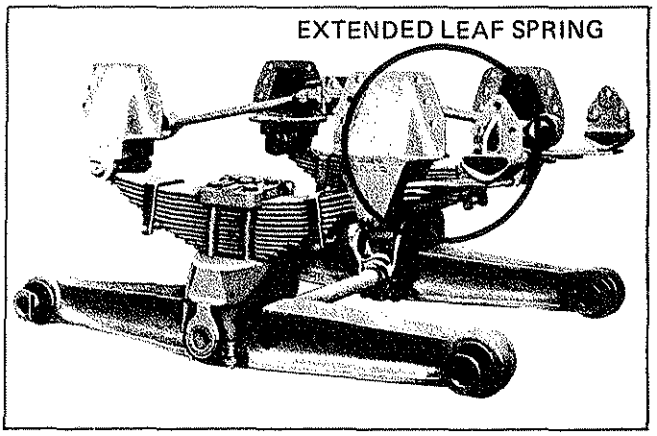


Fig. 2, Hendrickson "RTE" Series Suspension

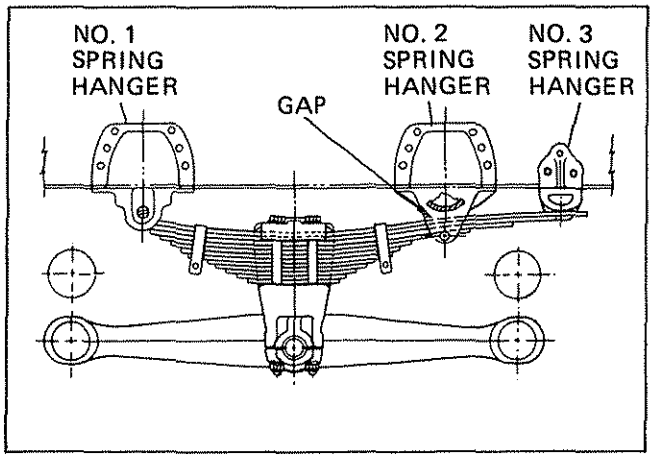


Fig. 3, Unloaded "RTE" Spring

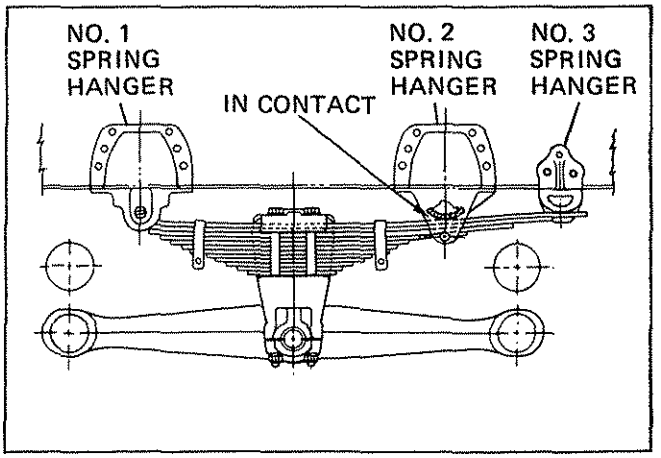


Fig. 4, Loaded "RTE" Spring

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

This allows an articulating action between the axles to absorb road shock. Torque rods are mounted longitudinally from the axles to the frame cross-member, to control axle torque resulting from accelerating or braking. In addition, some models are equipped with lateral, track bar torque rods, to control side-to-side movement.

SERVICE OPERATIONS

For information regarding inspection intervals and procedures, and lubrication intervals and procedures, refer to the Freightliner Maintenance and Lube Manual.

Most repairs to the Hendrickson suspension system consist of replacing damaged or worn parts. Items most frequently requiring service are the equalizer beam bushings. Special tools (see Table 1, under "SPECIFICATIONS") for replacement of the bushings are available from the Owatonna Tool Company, Owatonna, Minnesota, or an affiliated dealer. Although the use of these special tools is recommended, shop-made adapters may be used if a vertical hydraulic press with a 50-ton capacity is available. Dimensions for the shop-made adapters are given in Table 2, under "SPECIFICATIONS."

When wear on any of the major components reaches the point where replacement is necessary, it is recommended that the entire suspension be removed from the vehicle and overhauled. In cases where individual suspension system components require service, follow only the applicable instructions relating to the components to be serviced.

Whenever the rear suspension is being serviced, block the front tires to prevent vehicle movement. Always use safety stands under the frame when the vehicle is raised or the suspension removed.

Apply Alumilastic compound, or an equivalent, to all areas where aluminum and steel parts contact each other.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metal components contact each other will result in electrolytic corrosion, which could cause suspension damage.

SUSPENSION SYSTEM REMOVAL AND INSTALLATION

Removal

If the suspension system is being overhauled, remove the suspension using the following procedure:

1. Block the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles, marking the lines for later assembly reference. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.

2. Disconnect the driveline rear universal joint from the forward-rear axle. For instructions, refer to the applicable subject located in the 09 Group of this manual.

3. Manually release the spring brake chambers. For instructions, refer to the applicable subject located in the 12 Group of this manual.

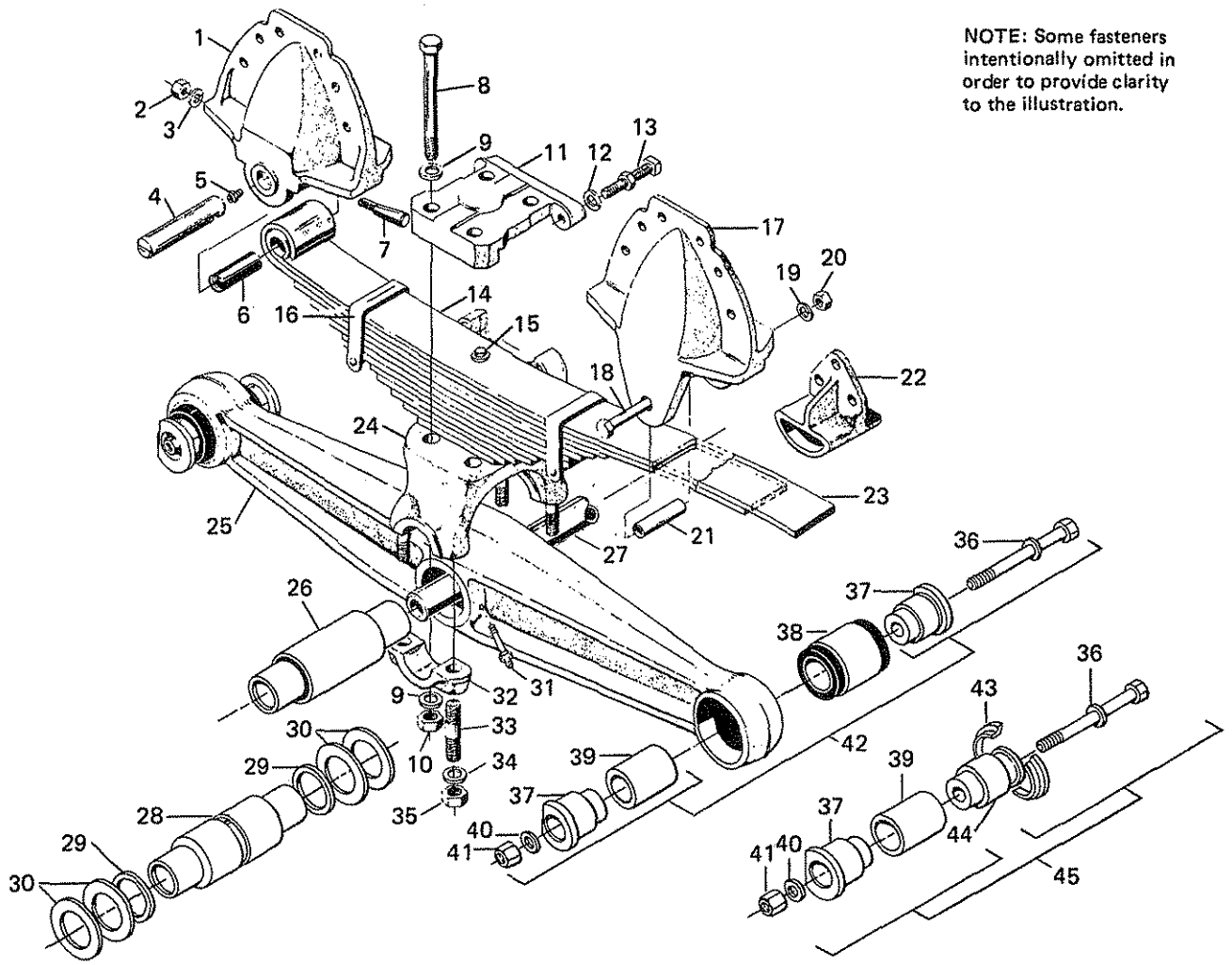
4. Using an overhead hoist, raise the rear of the vehicle enough to relieve the weight from the suspension.

NOTE: Do not raise the vehicle to the point where the weight of the suspension and axles "hang" from the vehicle.

5. Remove the saddle cap nuts and washers from each side of the vehicle. Then remove the saddle caps that secure the equalizer beam center bushing to the saddles. See Fig. 5.

6. Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440



1. Forward (No. 1) Spring Hanger
2. Draw Key Locknut
3. Draw Key Washer
4. Spring Pin
5. Grease Fitting
6. Spring Eye Bushing
7. Draw Key
8. Top Pad Bolt
9. Top Pad Washer
10. Top Pad Locknut
11. Top Pad
12. Set Screw Washer
13. Set Screw and Locknut
14. Spring Assembly
15. Spring Center Bolt and Nut
16. Spring Alignment Clips
17. Rear (No. 2) Spring Hanger
18. Rebound Spacer Bolt
19. Spacer Bolt Washer
20. Spacer Bolt Locknut
21. Rebound Spacer
22. "RTE" Rear (No. 3) Spring Hanger
23. "RTE" Spring Extension
24. Saddle Assembly
25. Equalizer Beam Assembly
26. Rubber Center Bushing
27. Crosstube
28. Bronze Center Bushing
29. Bushing Grease Seal
30. Thrustwashers
31. Grease Fitting (Bronze Bushing)
32. Saddle Cap
33. Saddle Cap Stud
34. Saddle Cap Washer
35. Saddle Cap Nut
36. Adapter Bolt and Washer
37. Adapter
38. End Bushing
39. Intermediate Tube
40. Adapter Bolt Washer
41. Adapter Bolt Nut
42. Adapter-Type End Support Assembly
43. Splitring
44. Adapter Plug
45. Splitring Adapter Assembly

Fig. 5, "RT" Series, Exploded View

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If also equipped with the lateral, track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushings. Keep clear of the beam hangers and beam end bushings to avoid possible injury.

7. Raise the rear of the vehicle frame until there is sufficient clearance to roll the axles and suspension from beneath the saddles. Install safety stands under the vehicle frame, then roll the axles and equalizer beams from under the frame.

Installation

1. Roll the axles (with the equalizer beams and crosstube attached), under the vehicle frame. Align the ends of the beam center bushings with the saddle legs.

2. Using an overhead hoist, lift the vehicle off the safety stands, then remove the stands from under the frame. Lower the vehicle, so that the saddles seat on the beam center bushings.

3. Position the saddle caps on the saddle cap studs, then install the washers and the new, saddle cap nuts. Do not tighten the nuts at this time.

4. Install the torque rods on the axles following the instructions given under the heading, "TORQUE ROD INSTALLATION," in this subject.

5. Tighten the new, saddle cap nuts to 225-275 ft-lbs (305-373 N·m).

6. If equipped with the adapter-type end supports, tighten the adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 5, Ref. 37.

   If equipped with the tube-type end supports, tighten each end tube nut to 375-425 ft-lbs (441-576 N·m).

WARNING: The adapter-type and tube-type end support fasteners must be tightened to the torque values given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in a possible separation of suspension components, and a loss of vehicle control.

7. Lower the vehicle, then remove the overhead hoist. Manually reset the spring brake chambers. For instructions, refer to the 12 Group of this manual.

8. Connect the driveline rear universal joint to the forward-rear axle. For instructions, refer to the 09 Group in this manual.

9. Taking care to prevent dirt and other foreign material from entering the lines or fittings, connect the air brake lines leading to the axles. Close the air system drain valve.

10. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual. Adjust the angle if it is not according to specifications.

SPRING AND SADDLE ASSEMBLY REMOVAL AND INSTALLATION
(Refer to Fig. 5)

Removal

If the spring and saddle assembly needs to be removed for replacement, or for service to its components, remove the spring and saddle assembly using the following procedure:

1. If the suspension has been removed from the vehicle, support the spring and saddle assembly on a floor jack, then proceed to step 2. If the suspension is installed on the vehicle, use the following procedure for removal:

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

.1 Block the front tires to prevent vehicle movement. Drain the vehicle air system. Disconnect all air lines leading to the rear axles. Plug all lines and fittings to prevent dirt or foreign material from entering the lines.

.2 Disconnect the torque rods from the axle torque rod brackets by removing the attaching flanged nuts and flanged bolts.

If also equipped with the lateral, track bar torque rods, remove the attaching locknut from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushing. Keep clear of the beam hangers and beam end bushings to avoid possible injury.

.3 Using an overhead hoist, raise the rear of the vehicle enough to remove the weight from the leaf springs, then block the vehicle frame with safety stands. Remove the wheel assembly, if necessary, to gain easy access to the suspension system. For instructions, refer to the 11 Group of this manual.

NOTE: Do not raise the vehicle to the point where the weight of the suspension and axles "hang" from the vehicle.

.4 Securely block up the axle with safety stands to prevent it from dropping away from the vehicle when the spring is loosened and removed.

WARNING: Failure to remove all weight from the wheels and failure to securely block the axles with safety stands, could result in the axles dropping suddenly from the vehicle.

2. Loosen the spring pin draw key locknut on the forward (No. 1) spring hanger. Back off the nut until it is flush with the end of the spring pin draw key, then strike the locknut with a soft hammer to loosen the draw key. Remove the spring pin draw key, locknut, and lockwasher from the spring hanger assembly.

3. Using a slightly smaller drift than the 1-3/8-inch diameter spring pin, drive the spring pin through the forward (No. 1) spring hanger and out the inboard side of the spring hanger. See Fig. 6.

4. Remove the locknut and lockwasher from the rebound spacer bolt in the rear (No. 2) spring hanger. Remove the rebound spacer bolt and rebound spacer from the rear (No. 2) spring hanger. If the suspension has been removed from the vehicle, lower the spring and saddle off of the jacks and on to the ground.

5. Loosen the spring alignment set screws on the top pad. Then, remove the top pad nuts, washers, and bolts from the top pad and saddle. Remove the top pad from the springs, then remove the springs from the saddle.

NOTE: If the suspension is installed on the vehicle, it may be necessary to raise the vehicle so that the spring assembly clears the spring hangers. Install safety stands under the vehicle frame.

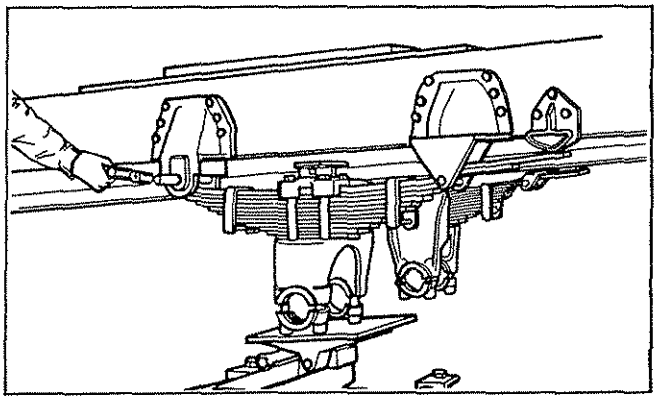

Fig. 6, Driving Out the Front Spring Pin

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

6. If the suspension is installed on the vehicle, remove the saddle cap nuts, washers, and saddle caps that secure the equalizer beam center bushings to the saddles. Remove the saddles from the suspension.

7. If the saddle cap studs are damaged or worn, install new saddle cap studs. Lubricate the threads with SAE-20 oil. Tighten the studs to 55-65 ft-lbs (75-88 N·m).

Installation

1. If the suspension has been removed from the vehicle, proceed to step 2. If the suspension is installed on the vehicle, position the saddle on the center bushing and equalizer beam. Position the saddle caps on the saddle cap studs, then install the washers and new, saddle cap nuts. Do not tighten the nuts at this time.

2. Seat the leaf spring assembly in the saddle, using the spring center bolt head as a locating dowel in the saddle.

3. Center the top pad slide, if so equipped, over the spring center bolt nut on the top leaf spring.

4. Position the top pad on the spring, and top pad slide, if so equipped. Make sure the top pad is properly seated.

5. Lubricate the threads on the top pad bolts with SAE-20 oil, then install the washers and bolts through the top pad and saddle. Install new nuts and washers and run them up snug with the saddle. Do not tighten the nuts at this time.

6. Lubricate the threads on the spring alignment set screws with SAE-20 oil. To properly position the spring in the saddle, run the spring alignment set screws up snug against the leaf springs. Tighten the set screws to 100-150 ft-lbs (136-203 N·m), then tighten the set screw locknuts until the lockwasher is locked.

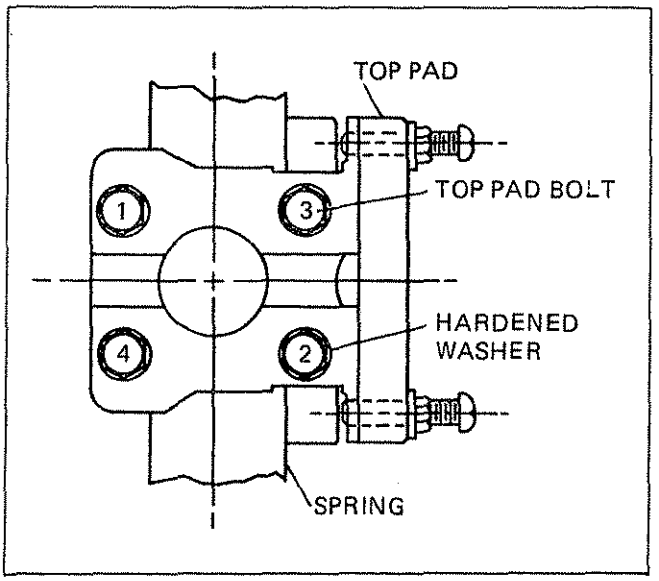

Fig. 7, Top Pad Bolt Tightening Sequence

7. Tighten the top pad nuts to 275-300 ft-lbs (373-407 N·m) in the sequence shown in Fig. 7.

8. If the suspension is installed on the vehicle, lower the vehicle rear frame so the spring assembly is in position in the forward and rear (Nos. 1 and 2) spring hangers.

   If the suspension has been removed from the vehicle, then, using a roller jack, position the spring and saddle assembly into the forward and rear (Nos. 1 and 2) spring hangers.

9. Align the spring eye bushing with the spring pin eye in the forward spring hanger. Coat the spring pin and the inside diameter of the spring eye bushing with multipurpose chassis grease, or an equivalent, then insert the spring pin through the outside spring hanger leg hole and spring eye bushing. Tap the spring pin lightly with a soft hammer, while moving the spring to ease entry into the hole of the inside spring hanger leg.

10. Insert the draw key with the flat side up, into the spring hangers, using a screwdriver to rotate the spring pin at the slotted end to align the

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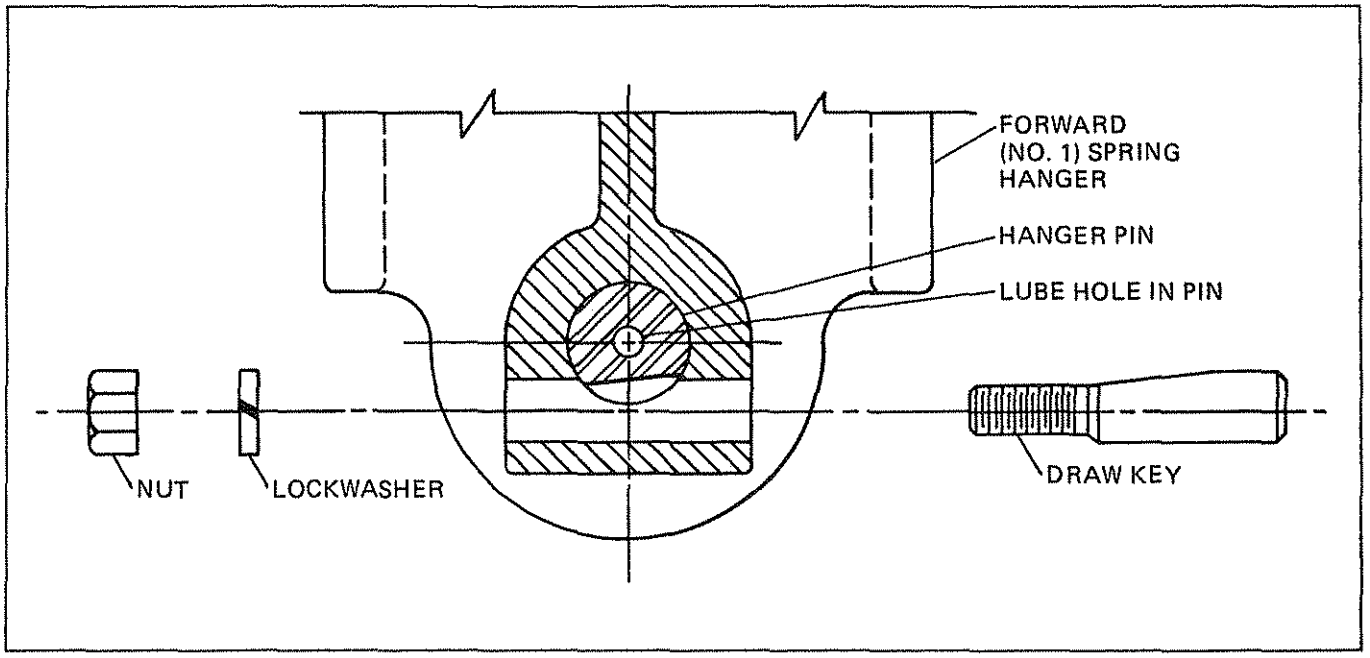

Fig. 8

keyway into the draw key hole at the bottom of the inside spring hanger leg. See Fig. 8. When the draw key is engaged in the slot, drive the draw key into place with a hammer. Lubricate the draw key threads with SAE-20 oil, then install the lockwasher and locknut on the draw key. Tighten the locknuts to 75-100 ft-lbs (101-136 N·m).

CAUTION: Do not allow the spring pin draw key to engage the slot in the spring pin at an angle, as it will wedge and gall. If locked in this position, it will work loose in a short time, allowing the spring pin to turn and wear the spring hanger, elongating the spring pin eye. If not corrected, this condition could result in structural failure of the spring pin, the spring hanger, or the spring eye.

11. Position the rebound spacer in the rear (No. 2) spring hanger legs, then install the rebound spacer bolts, lockwashers, and locknuts. Tighten the locknuts to 70-80 ft-lbs (95-109 N·m).

12. Install the grease fittings in both spring eye pins. Apply multipurpose chassis grease to the grease fitting until grease appears on both sides of the spring eye bushings.

NOTE: Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for spring eye pin bushing maintenance and lubrication procedures.

13. If the suspension is installed on the vehicle, complete the spring and saddle assembly installation, using the following procedure:

    .1 Install the wheel assembly. For instructions, refer to the 11 Group of this manual.

    .2 Install the torque rods on the axles. For instructions, refer to "TORQUE ROD INSTALLATION," in this subject.

    .3 Tighten the new saddle cap nuts to 225-275 ft-lbs (305-373 N·m).

    .4 Lower the vehicle, then remove the overhead hoist. Taking care to prevent dirt and other foreign material from entering the lines or fittings, connect the air brake lines leading to the axles. Close the air system drain valve.

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SPRING LEAF INSPECTION AND REPLACEMENT

1. Remove the spring assembly from the vehicle. For instructions, refer to "SPRING AND SADDLE ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

2. Use a "C" clamp to hold the spring leaves together, then remove the center bolt and nut, and the spring alignment clips, from the spring leaves. Remove the "C" clamp and separate the leaves.

3. Using a wire brush and solvent, clean all grease, dirt, and rust from the spring leaves. Visually inspect for cracks, gouges, wear, or abnormal bends. If any of these conditions are present, install a new leaf in place of the damaged one. The No. 1 Main and No. 2 Wrapper spring leaves (the top two spring leaves) may be individually replaced. If equipped with the "RTE" series suspension, the Nos. 1, 2, and 3 spring leaves (the top three spring leaves) may be individually replaced. If a spring leaf is damaged below these numbers in a pack, then it is recommended that the spring assembly be replaced. In addition, both spring assemblies should be replaced to insure even spring deflection.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

4. Inspect the spring eye bushing and spring pin for wear or damage. For instructions, refer to "SPRING PIN AND SPRING EYE BUSHING REPLACEMENT," in this subject.

NOTE: If the spring assemblies are to be reused, new spring eye bushings should be installed.

5. Position the spring leaves in sequence, then use a drift punch through the center bolt hole to align the leaves. Compress the leaves together with a "C" clamp, then install the spring alignment clips around the spring leaves. Attach with the spring alignment clip nuts and bolts. Tighten the nuts to 15 ft-lbs (20 N·m).

6. Remove the drift punch, then insert the center bolt through the spring from the bottom side. Attach the center bolt nut on the center bolt and tighten to the appropriate torque value given in Table 4 under "SPECIFICATIONS."

NOTE: Always use new center bolts and nuts whenever the spring assembly is overhauled or replaced.

7. Install the spring assembly on the vehicle. For instructions, refer to "SPRING AND SADDLE ASSEMBLY REMOVAL AND INSTALLATION," in this subject.

SPRING PIN AND SPRING EYE BUSHING REPLACEMENT

NOTE: It is recommended that the spring pins and spring eye bushings be replaced with new spring pins and new spring eye bushings whenever the suspension is overhauled.

1. Inspect the spring pins for wear. On all models, except for a Model 340 manufactured before 1975, if the pin diameter measures less than 1.367 inches (34.7 mm), then replace the spring pins with new pins.

   If equipped with a Model 340 manufactured before 1975, and the pin diameter measures less than 1.240 inches (31.5 mm), then replace the spring pins with new pins.

2. Inspect the spring eye bushing for wear. On all models, except for a Model 340 manufactured before 1975, if the inside diameter of the bushing measures larger than 1.395 inches (35.4 mm), then replace the bushings and pins with new ones.

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If equipped with a Model 340 manufactured before 1975, and the inside diameter of the bushing measures larger than 1.270 inches (32.2 mm), then replace the bushings and pins with new ones.

3. Press the bushing out of the main spring leaf. If needed, use a vertical hydraulic press. Insert the new bushing with the split of the bushing to the top of the spring eye (unloaded side) ± 30° as shown in Fig. 9.

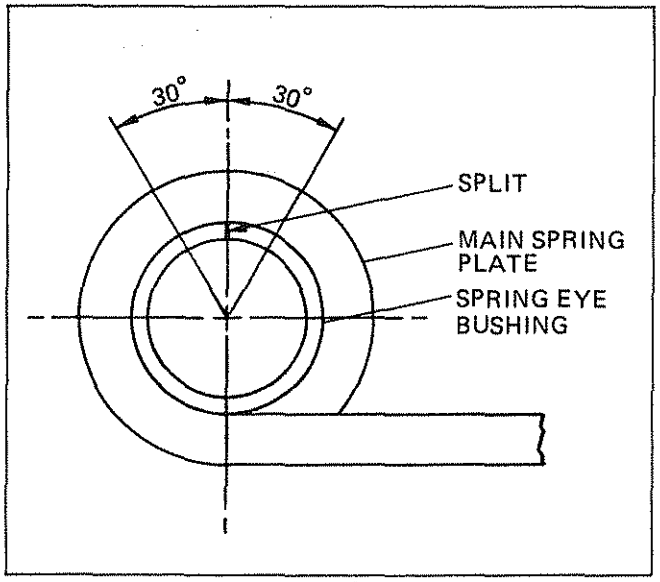


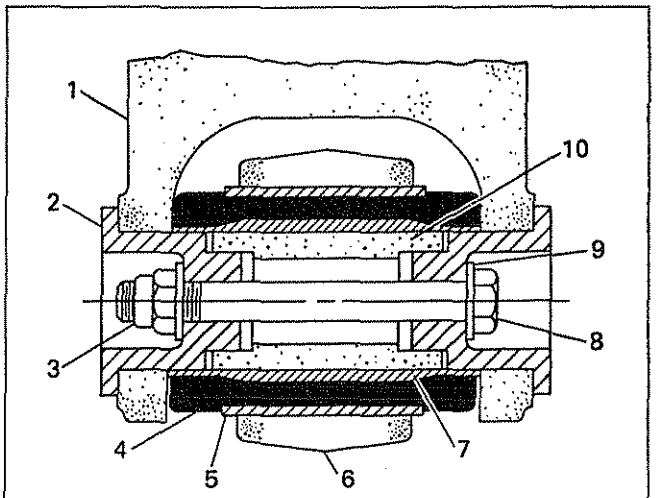
Fig. 9

EQUALIZER BEAM REMOVAL AND INSTALLATION, ADAPTER-TYPE END SUPPORTS (Refer to Fig. 5)

Adapter-type end supports connect the equalizer beam to the axle beam hangers using three-piece "adapters" installed into each of the axle beam hangers. See Fig. 10. The inner sleeve of the beam end bushing is locked to the beam hanger by pressure of the adapter bolt, pulling the adapters against the outer surface.

Removal

IMPORTANT: If using the special Owatonna tools (OTC set No. Y-865-D) to remove the equalizer beam from the axle beam hangers, the suspension system must be installed on the vehicle. If not using the special Owatonna tools, the equalizer beam can be removed from the axle beam hangers, either with the suspension installed on the vehicle, or with the suspension removed from the vehicle.



1. Beam Hanger
2. Adapter
3. Adapter Bolt Nut
4. Rubber End Bushing
5. Bushing Outer Sleeve
6. Equalizer Beam
7. Bushing Inner Sleeve
8. Adapter Bolt
9. Washer (both ends)
10. Intermediate Tube

Fig. 10, Equalizer Beam Adapter-Type End Support

1. Remove the saddle cap nuts and washers, then remove the saddle caps that secure the equalizer beam center bushings to the saddles. See Fig. 5.

2. Support the equalizer beams with safety stands. Remove the nut, washers, and adapter bolt from the beam end adapters.

3. If not using the special Owatonna tools, proceed to step 4. If using the special Owatonna tools, remove the adapter plug using the following procedure:

   .1 Remove the wheels, hubs, and brake drums from the rear axles. For instructions, refer to the 11 Group of this manual.

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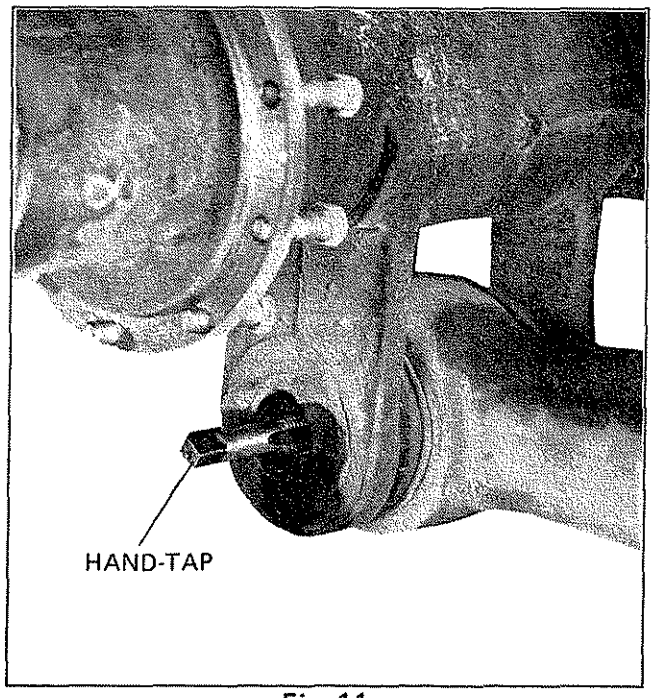

Fig. 11

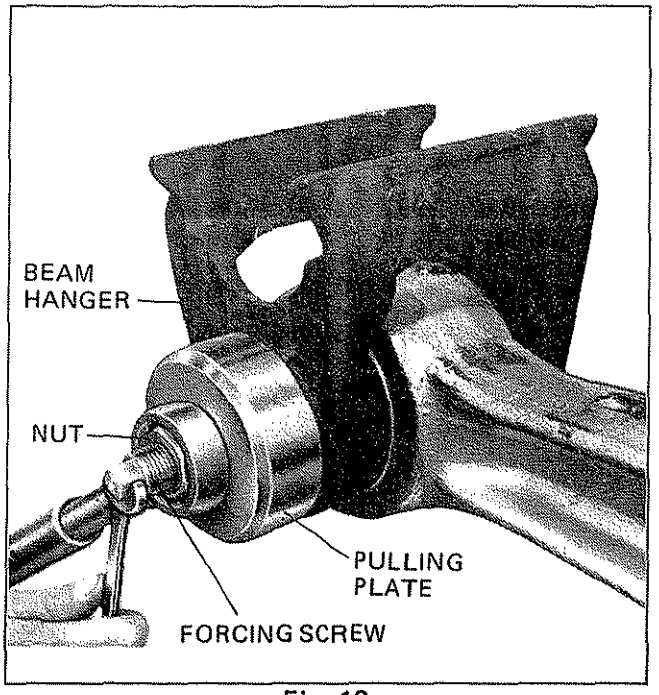

Fig. 12

.2 Select a hand-tap (7/8" for 3/4"-cored-hole, or 1" for 7/8"-cored-hole), and tap the hole from which the adapter bolt was removed, as shown in Fig. 11. Then, position the pulling plate (OTC part No. 28445) over the hand-tap and against the beam hanger. Attach the forcing screw (OTC part No. 28446 for 7/8"-hand-tap, or OTC part No. 28447 for 1"-hand-tap) to the hand-tap, and secure with the nut (OTC part No. 10220) against the pulling plate. While holding the nut with a wrench, tighten the forcing screw to pull the adapter plug from the beam hanger. See Fig. 12. Proceed to step 5.

4. If not using the special Owatonna tools, a relief is provided on each side of the adapter for chisel entry. Insert a chisel into the relief on the inboard adapter, and drive the chisel in, to wedge the adapter out of the beam hanger. Repeat this step for the outboard adapter.

NOTE: In some installations, a splitring type adapter assembly (see Fig. 5, Ref. 45) is used instead of the standard adapter. To remove, drive the chisel between the two halves of the splitring, forcing them to snap out of the adapter plug. Then drive the adapter plug into the equalizer beam end bushing until it clears the beam hanger. After the equalizer beam has been removed from the beam hanger, drive the plug out of the bushing.

5. After the ends of both equalizer beams have been separated from the axle beam hangers, lower the equalizer beams, together with the crosstube, to the ground. Remove the thrust-washers, if applicable, then separate the beams from the crosstube by pulling apart by hand.

Installation

1. Apply Texaco "Compound L," or an equivalent rust preventive lubricant, to the axle beam hanger eyes, beam end bushing inner sleeve, end support adapters, outside surface of the bushing intermediate tubes, and the ends of the crosstube.

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2. Install the crosstube in both equalizer beam center bushings. If equipped with bronze center bushings, install the thrustwashers.

   If new rubber center bushings that have the end plugs as a separate part are installed, then, arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and debris, from the welding process.

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

3. Position the equalizer beam assembly under the axles, then raise the assembly and place the forward ends of each beam in the forward-rear axle beam hangers. Align the beam end bushings with the beam hangers.

4. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

5. Place the rear ends of each beam in the rear-rear axle beam hangers. Align the beam end bushings with the beam hangers.

6. Install the adapters, adapter bolt, washers, and nut in each beam end to hold the beam in the axle beam hangers. Do not tighten the nuts at this time.

NOTE: If the suspension and saddle assembly has been removed from the vehicle, installation of the equalizer beam will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

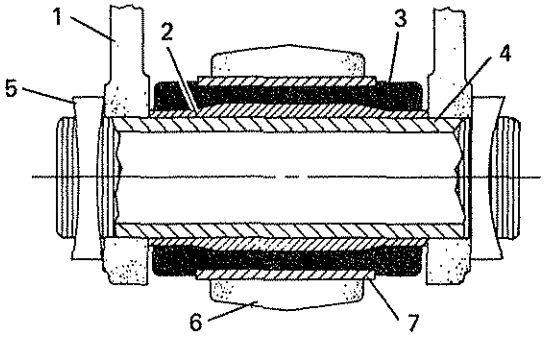
7. Position the saddle caps on the saddle cap studs, then install the washers and new, saddle cap nuts. Tighten the nuts to 225-275 ft-lbs (305-373 N·m).

8. Tighten the adapter bolt nuts to 210-240 ft-lbs (285-325 N·m). Make sure the flat section of the adapter flange is in the vertical position. See Fig. 5, Ref. 37.

WARNING: The adapter bolt nuts must be tightened to the torque values given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in separation of suspension components, and a loss of vehicle control.

EQUALIZER BEAM REMOVAL AND INSTALLATION, TUBE-TYPE END SUPPORTS

On tube-type end supports, the inner sleeve of the beam end bushing is locked to the axle beam hanger legs by pressure on the beam hanger legs from the beam end tube nuts, on a 2½ inch (64 mm) diameter end tube. See Fig. 13.



1. Beam Hanger
2. Bushing Inner Sleeve
3. Rubber End Bushing
4. Beam End Tube
5. End Tube Nut
6. Equalizer Beam
7. Bushing Outer Sleeve

Fig. 13, Equalizer Beam Tube-Type End Support

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Removal

IMPORTANT: If using the special Owatonna tools to remove the equalizer beam from the axle beam hangers, the suspension system must be installed on the vehicle. If not using the special Owatonna tools, the equalizer beam can be removed from the axle beam hangers, either with the suspension installed on the vehicle, or with the suspension removed from the vehicle.

1. Remove the saddle cap nuts and washers, then remove the saddle caps that secure the equalizer beam center bushings to the saddles. See Fig. 5.
2. Support the equalizer beams with safety stands. Remove the beam end tube nuts from both sides of the beam end tubes.
3. If not using the special Owatonna tools, proceed to step 4. If using the special Owatonna tools, remove the tube-type end supports using the following procedure:
   .1. Remove the wheels, hubs, and brake drums from the rear axles. For instructions, refer to the 11 Group of this manual.
   .2 Position the receiving tube over the outboard end of the beam end tube. Then assemble the hydraulic ram, pulling screw, speed nut, and the removing adapter, as shown in Fig. 14. Connect a hydraulic pumping unit to the hydraulic ram, then apply hydraulic pressure to remove the beam end tube. Proceed to step 5.
4. If not using the special Owatonna tools, install a spacer bushing between one end tube nut and the beam hanger, tightening the nut to pull the end tube out of the beam end bushing. If this method does not loosen the tube, use a hack saw to saw through the tube along the inside surface of the beam hanger legs.

CAUTION: Do not use a cutting torch to remove the equalizer beams from the beam hangers. The equalizer beam has been heat-treated, and the use of heat could adversely affect the strength of the equalizer beams.

5. After the ends of both equalizer beams have been separated from the axles, lower the equalizer beams, together with the crosstube, to the ground. Remove the thrustwashers, if applicable, then separate the beams from the crosstube by pulling apart by hand.

Installation

1. Apply Texaco "Compound L," or an equivalent rust preventive lubricant, to the axle beam hanger eyes, beam end bushing inner sleeve, outer surface of the beam end tubes, beam center bushing inner sleeves, and the ends of the crosstube.

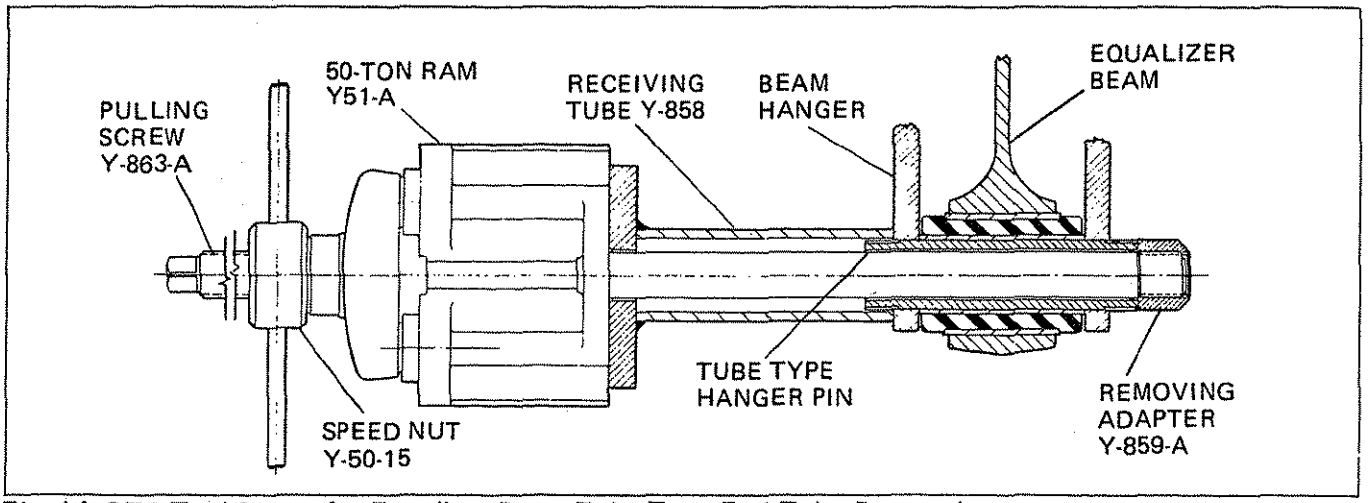

Fig. 14, OTC Tool Set-up for Equalizer Beam Tube-Type End Tube Removal

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2. Lubricate the threads of the beam end tubes with SAE-20 oil.

3. Install the crosstube in both equalizer beam center bushings. If equipped with bronze center bushings, install the thrustwashers.

   If new rubber center bushings that have the end plugs as a separate part are installed, then, arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and debris, from the welding process.

NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

4. Position the equalizer beam assembly under the axles, then raise the assembly and place the forward ends of each beam in the forward-rear axle beam hangers. Align the beam end bushings with the beam hangers.

5. Install the beam end tubes through the beam hangers and the beam end bushings. Hand start both nuts on the beam end tubes. Do not tighten the nuts at this time.

6. Place the rear ends of each beam in the rear-rear axle beam hangers. Align the beam end bushings with the beam hangers.

7. Install the beam end tubes through the beam hangers and the beam end bushings. Hand start both nuts on the beam end tubes. Do not tighten the nuts at this time.

NOTE: If the suspension and saddle assembly is removed from the vehicle, installation of the equalizer beam will be completed during suspension installation. For instructions, refer to "SUSPENSION SYSTEM REMOVAL AND INSTALLATION," in this subject.

8. Position the saddle caps on the saddle cap studs, then install the washers and new saddle cap nuts. Tighten the nuts to 225-275 ft-lbs (305-373 N·m).

9. Tighten the end tube nuts to 375-425 ft-lbs (441-576 N·m).

WARNING: The end tube nuts must be tightened to the torque value given above. If proper tightening of fasteners is not achieved, metal surfaces will work and wear the beam hanger legs, holes, and end bushing inner sleeves, which could result in separation of suspension components, and a loss of vehicle control.

EQUALIZER BEAM END BUSHING REPLACEMENT (Refer to Fig. 5)

IMPORTANT: If one or more of the end bushings requires replacement, it is recommended that all four end bushings be replaced.

1. Remove the equalizer beam from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. On one side only of each beam end bushing, cut back the protruding rubber portion, flush with the equalizer beam, as shown in Fig. 15, to allow the adapter to squarely contact the bushing outer sleeve.

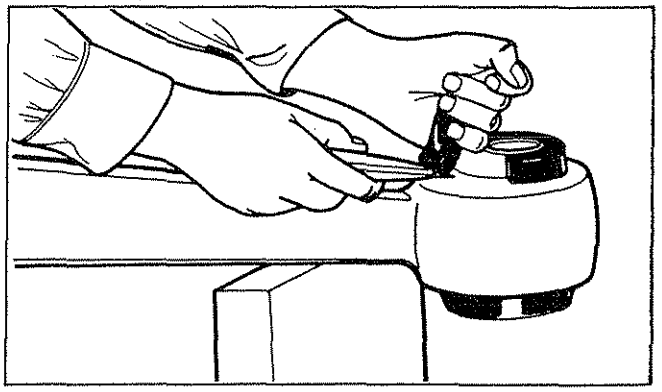

Fig. 15

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

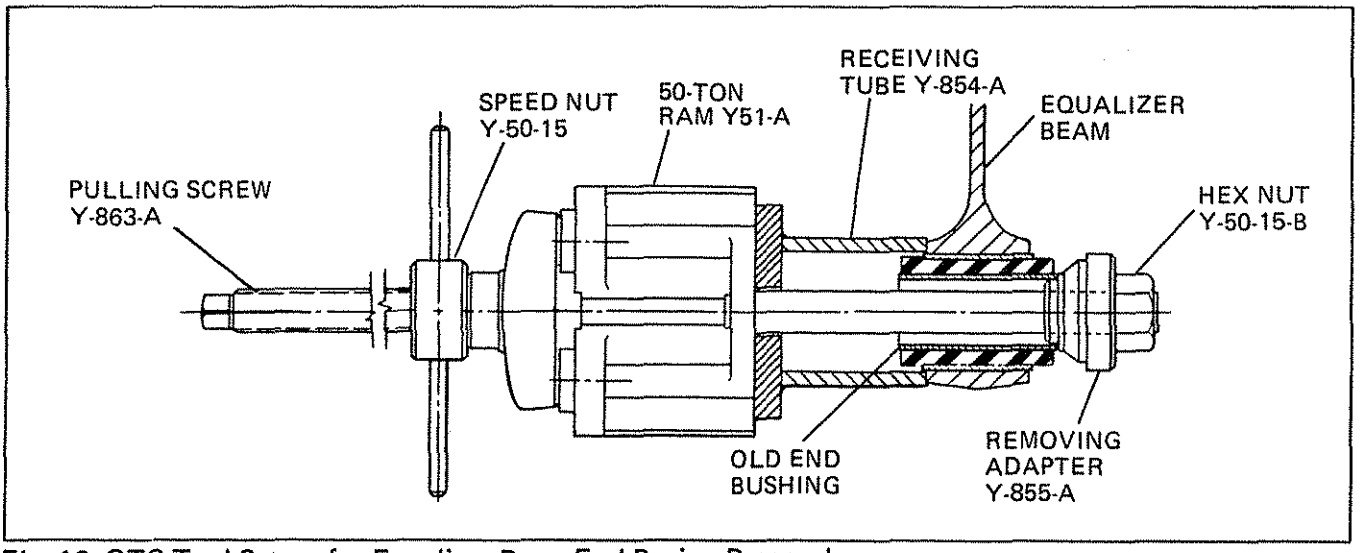

Fig. 16 ,OTC Tool Set-up for Equalizer Beam End Busing Removal

3. If using the special Owatonna tools, remove the beam end bushings, using the following procedure (refer to Fig. 16):

   .1 Center the end bushing removing adapter on the trimmed side of the beam end bushing.

   .2 Position the receiving tube on the untrimmed side of the beam end bushing. Assemble the hydraulic ram and speed nut on the pulling screw, then position the assembly through the receiving tube, bushing, and removing adapter, as shown in Fig. 16. Secure with the hex nut.

   IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube as it is pulled through the beam. The removing adapters should be aligned so that the force is exerted on the bushing *only,* not against the beam, to allow for a clean pull through the beam.

   .3 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

   .4 If the pressure gauge on the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

   If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa); if the bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

   .5 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the end bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

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4. If not using the special Owatonna tools, remove the beam end bushing with shop-made adapters, using the following procedure:

   .1 Position the equalizer beam on a 50-ton vertical hydraulic press.

   .2 Center the shop-made adapter (tool No. 1 from Table 2, located under "SPECIFICATIONS") on the trimmed end of the equalizer beam bushing. Then, press the end bushing from the beam eye.

5. Using emery cloth, remove all scale, rust, or corrosion from the equalizer beam eyes. Replace the equalizer beam if cracks, gouges, or damage is evident in the beam eyes.

6. Clean the outer sleeves of the new equalizer beam end bushings with emery cloth, then apply a thin coating of white lead, or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeves. Position the bushing on the equalizer beam eye.

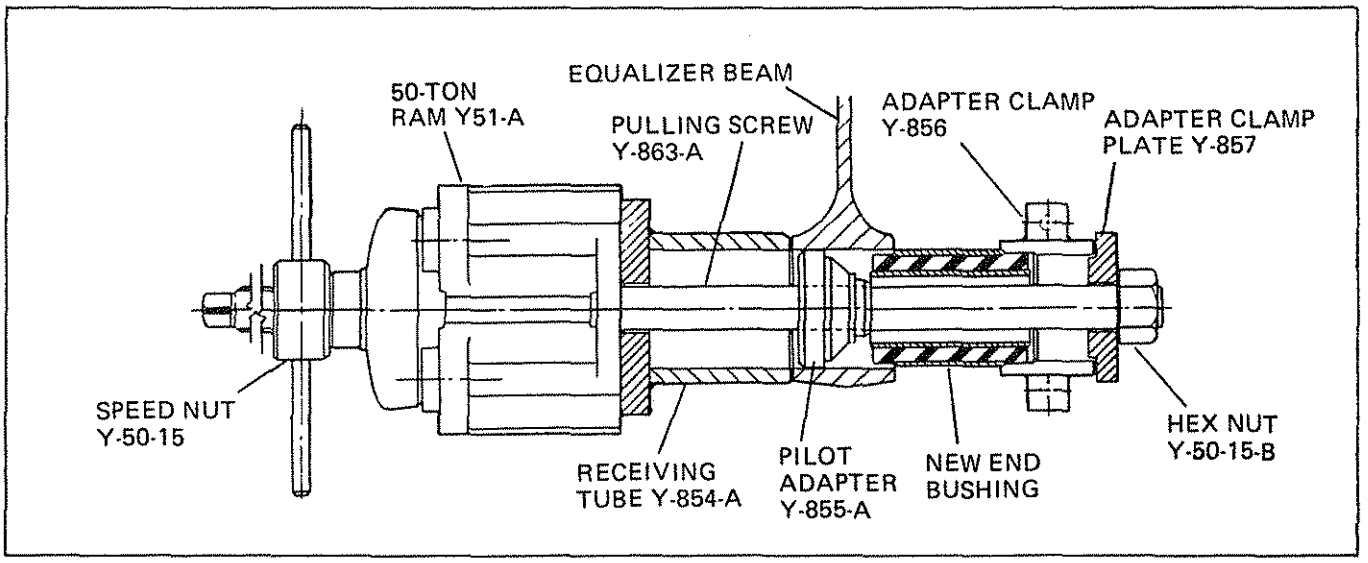
7. If using the special Owatonna tools, use the following procedure for installation of the beam end bushing (refer to Fig. 17):

   .1 Fit the adapter clamp over the exposed rubber on the new bushing, then tighten the clamp nuts until the contact surface on the clamp rests fully against the bushing outer sleeve.

   .2 Position the pilot adapter into the beam eye, as shown in Fig. 17.

   .3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the pilot adapter in the beam eye, bushing, and adapter clamp. Attach the adapter clamp plate to the pulling screw and adapter clamp. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.



OTC Tool Set-up for Equalizer Beam End Bushing Installation

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new end bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), then the new bushing has been installed. Make a visual inspection.

8. If not using the special Owatonna tools, install the new bushing with shop-made adapters, using the following instructions (refer to Fig. 18):

.1 Using a sheave puller, compress the exposed rubber of the new bushing until the puller jaws seat against the end of the new bushing outer sleeve.

.2 Position the shop-made adapter (tool No. 2 from Table 2, located under "SPECIFICATIONS") against the jaws of the sheave puller. Then, press the new bushing into the beam eye.

9. Replace the center bushings, if needed. For instructions, refer to the applicable center bushing replacement heading, in this subject.

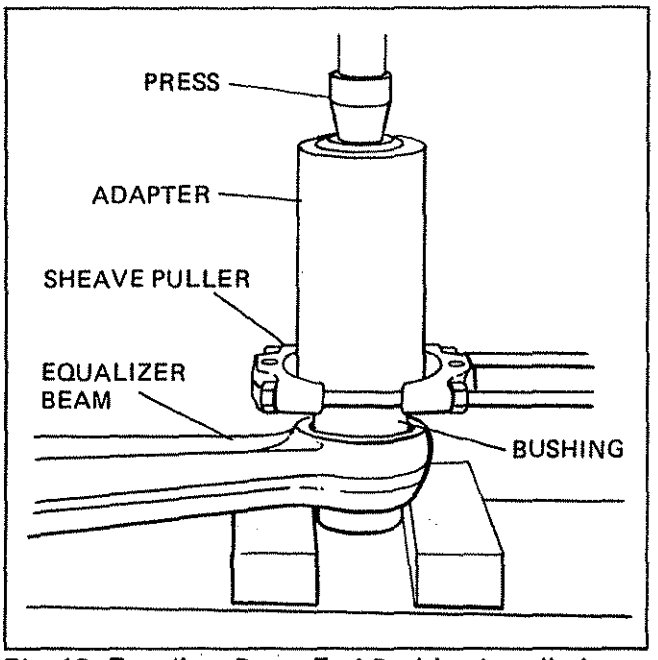


Fig. 18, Equalizer Beam End Bushing Installation Using Adapter and Sheave Puller

10. Install the equalizer beam on the axle beam hangers. For instructions, refer to the applicable equalizer beam installation heading, in this subject.

EQUALIZER BEAM RUBBER CENTER BUSHING REPLACEMENT (Refer to Fig. 5)

IMPORTANT: If a beam rubber center bushing is worn or damaged, and needs to be replaced, then the rubber center bushings must be replaced on both equalizer beams.

NOTE: If using the special Owatonna tools, the beam center bushing can be replaced either with the equalizer beam installed on the vehicle (see Fig. 19), or with the beam removed from the vehicle.

1. If not using the special Owatonna tools, remove the equalizer beam from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

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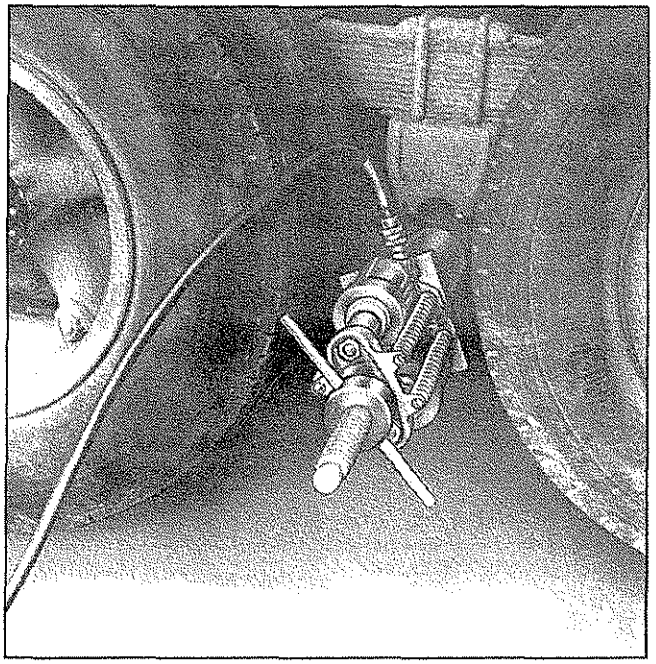

Fig. 19, Removing Equalizer Beam Center Bushing Installed on Vehicle, Using OTC Tools

2. Check the inboard exposed edge of the equalizer beam center bushing outer sleeve. If the outer sleeve is worn and has flared over the face of the equalizer beam, then chisel or grind the flared portion off, so it will not impede removal of the bushing.

WARNING: Protective eye goggles must be worn when grinding. Failure to do so could result in injury to the eye, due to the metal debris from the grinding process.

3. If using the special Owatonna tools, remove the beam center bushing using the following procedure (refer to Fig. 20):

   .1 Before the Owatonna tools can be used, the welded end plug in the outside end of the inner sleeve must be removed. For the Model 340, use a 2-inch-diameter hole saw, for Models 380 and 440, use a 2½-inch-diameter hole saw, to cut out the end plugs from the bushing.

CAUTION: Do not use a cutting torch to burn out the end plugs from the beam center bushings. The equalizer beam has been heat-treated, and the use of heat could adversely affect the strength of the beam.

   If the equalizer beam is installed on the vehicle, the crosstube must be removed.

   .2 Position the removing adapter on the bushing end prepared in step 2, above.

   .3 Position the receiving tube on the opposite side of the beam center bushing. Then, assemble the hydraulic ram, speed nut, and pulling screw, as shown in Fig. 20. Secure with the hex nut.

IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing for the bushing to clear the edges of the receiving tube, as it is pulled through the beam. The removing adapter should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean pull through the beam.

   .4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

   .5 If the pressure gauge of the hydraulic pumping unit reads 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

   If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then, while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa), if bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

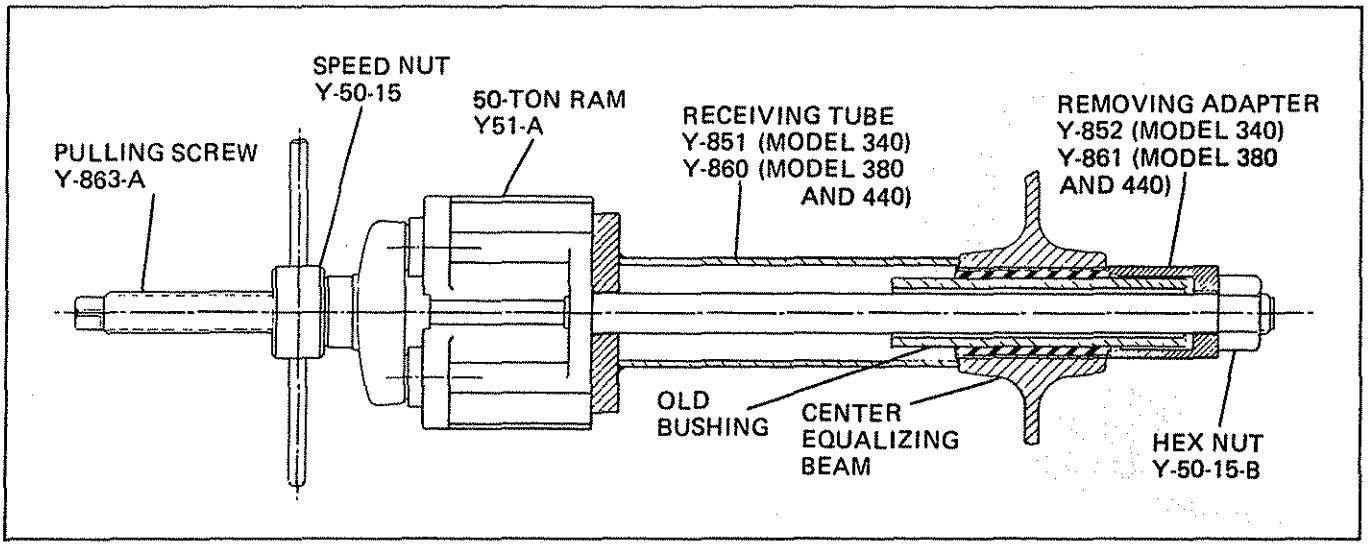

Fig. 20, OTC Tool Set-up for Equalizer Beam Rubber Center Bushing Removal

.6 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the center bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, remove the old center bushing with shop-made adapters, using the following procedure:

   .1 Position the shop-made adapter (tool No. 3 for Model 340, or tool No. 4 for Models 380 and 440, given in Table 2, under "SPECIFICATIONS") on the bushing end prepared in step 2, above.

   .2 Position the beam on a 50-ton vertical hydraulic press, then apply pressure to press the center bushing from the bushing eye.

5. If converting from a rubber center bushing to a bronze center bushing, proceed to step 5, located under "EQUALIZER BEAM BRONZE CENTER BUSHING REPLACEMENT," in this subject. If not converting to bronze center bushings, proceed to step 6, below.

6. Using a cylinder hone or emery cloth, remove all scale, rust, or corrosion from the equalizer beam eye. Replace the equalizer beam if cracks, gouges, or damage exists in the beam eyes.

7. Clean the outer sleeves of the new equalizer beam center bushing with emery cloth, then apply a thin coating of white lead, or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeve and the beam center eye. Position the bushing against the equalizer beam eye.

8. If using the special Owatonna tools, use the following procedure for installation of the beam center bushing (refer to Fig. 21):

NOTE: New rubber center bushings with the end plugs as a separate part must be used.

   .1 Fit the installing adapter over the bushing inner sleeve and against the outer sleeve end.

   .2 Position the pilot adapter in the beam center eye.

   .3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then

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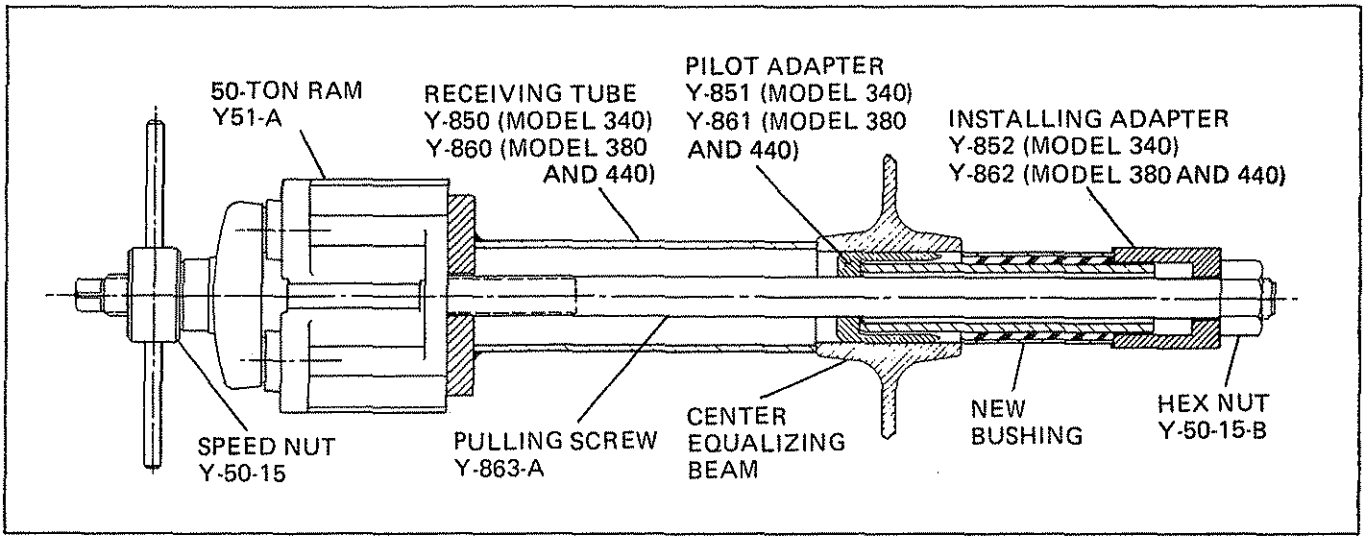

Fig. 21, OTC Tool Set-up for Equalizer Beam Rubber Center Bushing Installation

position the assembly through the pilot adapter in the beam eye, bushing, and removing adapter. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter should fit the outside edge of the new bushing to insure an even and complete pull through the beam.

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.6 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new center bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.7 When the installing adapter bottoms against the beam and the pressure gauge shows a pressure increase up to 10,000 psi (68 900 kPa), then the new bushing has been installed. Make a visual inspection.

.8 If the new center bushings were installed with the equalizer beams installed on the vehicle, position the crosstube in the center bushings. Arc weld the loose end plugs to the "tire side" (outboard side) of each center bushing inner sleeve.

WARNING: Protective welding masks must be worn when welding. Failure to do so could result in eye and facial injury, due to the intensity of heat, sparks, and flying debris, from the welding process.

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NOTE: There is no heat affect to the beam or rubber bushing when welding the end plug to the bushing inner sleeve, because of the distance from the point of welding.

9. If not using the special Owatonna tools, install the new center bushing with shop-made adapters, using the following procedure:

NOTE: Use the standard center bushings with the end plugs welded in place.

.1 Position the shop-made adapter (tool No. 3 for Model 340, or tool No. 4 for Models 380 and 440, given in Table 2, under "SPECIFICATIONS") over the bushing inner sleeve, so that it bottoms against the bushing outer sleeve.

.2 Position the beam, bushing, and adapter on a 50-ton vertical hydraulic press, then apply pressure to press the bushing into the beam eye.

10. Replace the end bushings, if needed. For instructions, refer to "EQUALIZER BEAM END BUSHING REPLACEMENT," in this subject.

11. Install the equalizer beam on the axle beam hangers. For instructions, refer to the applicable equalizer beam installation heading, in this subject.

EQUALIZER BEAM BRONZE CENTER BUSHING REPLACEMENT (Refer to Fig. 5)

IMPORTANT: If a beam bronze center bushing is worn or damaged, and needs to be replaced, then the bronze center bushing must be replaced on both equalizer beams.

NOTE: If using the special Owatonna tools, the bronze center bushing can be replaced with either the equalizer beam installed on the vehicle (see Fig. 19), or with the beam removed from the vehicle.

IMPORTANT: Do not install bronze bushings on aluminium equalizer beams.

1. If not using the special Owatonna tools, remove the equalizer beam from the vehicle. For instructions, refer to the applicable equalizer beam removal heading in this subject.

2. Remove the saddle caps. Then slide out the beam center sleeve and thrustwashers from the center bushing, and discard these parts.

3. If using the special Owatonna tools, remove the beam bronze center bushing using the following procedure:

.1 If the equalizer beam is installed on the vehicle, remove the crosstube.

.2 Position the bronze center bushing adapter in the bushing to be removed, as shown in Fig. 22.

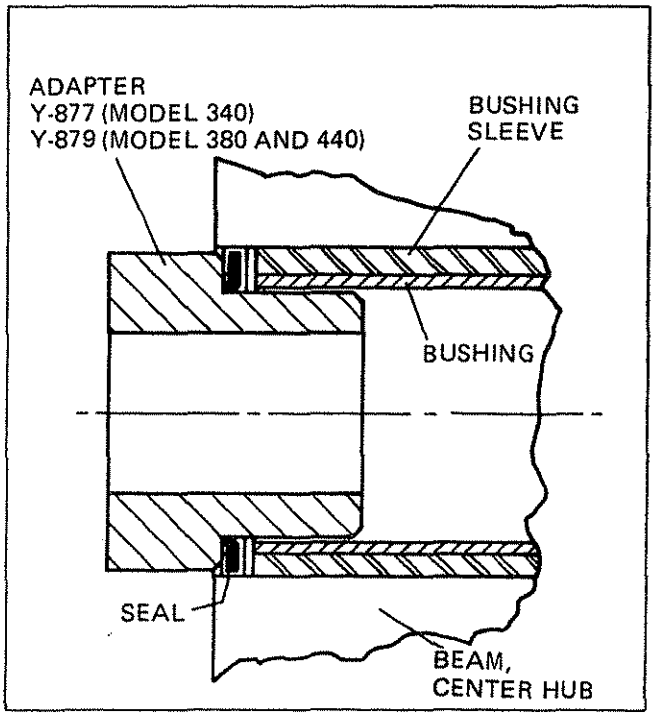

Fig. 22, OTC Adapter Position for Equalizer Beam Bronze Center Bushing Removal

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.3 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the beam eye, bushing, and adapter, as shown in Fig. 23. Secure with the hex nut.

IMPORTANT: The receiving tube should be aligned so that the force is exerted against the beam, allowing the bushing to clear the edges of the receiving tube as it is pulled through the beam. The adapter should be aligned so that the force is exerted on the bushing and seals *only* (as shown in Fig. 22), not against the beam, to allow for a clean pull through the beam.

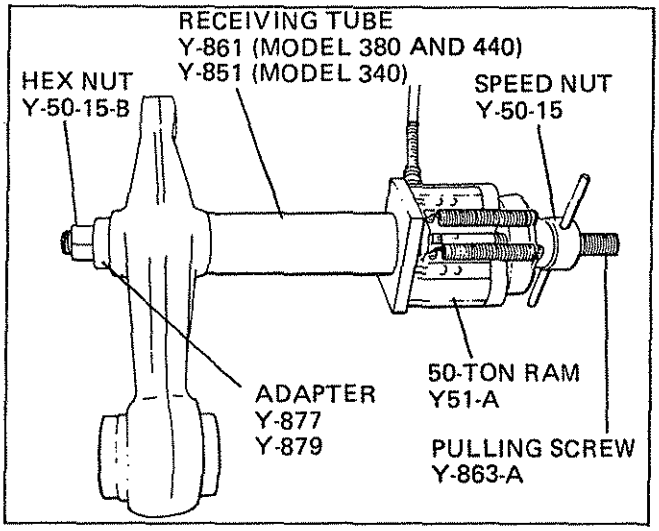

Fig. 23, OTC Tool Set-up for Equalizer Beam Bronze Center Bushing Removal

.4 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.5 If the pressure gauge shows a reading of 10,000 psi (68 900 kPa), and the bushing has not broken loose, then stop the application of pressure, and check the alignment of the tools to be sure force is being applied to the proper areas.

.6 If the tools are properly aligned, attach a sledging adapter (OTC part No. Y-864) on the speed nut end of the pulling screw. Then while maintaining hydraulic pressure, strike the sledging adapter with a heavy hammer. A loud "crack" will be heard and the pressure gauge reading will drop when the bushing has broken loose. Apply full 10,000 psi (68 900 kPa), if bushing does not pull out, strike the sledging adapter again until another loud "crack" is heard and the pressure gauge reading drops.

.7 It may require that the hydraulic equipment, tooling, and adapters be adjusted and activated about three times to completely remove the center bushing. After the hydraulic ram reaches its stroke limit, release the hydraulic pressure and adjust the speed nut to take up all slack. Proceed to step 5.

4. If not using the special Owatonna tools, position the equalizer beam on a 50-ton vertical hydraulic press. Center the adapter on the bushing, then press the bushing from the beam eye.

IMPORTANT: The adapter should be aligned so that the force is exerted on the bushing *only*, not against the beam, to allow for a clean press through the beam eye.

5. Using a cylinder hone or emery cloth, remove all scale, rust, or corrosion from the equalizer beam eyes. Replace the equalizer beam if cracks, gouges, or damage is evident in the beam eyes. Remove the grease fitting, then run a wire through the hole to make certain that it is not blocked.

NOTE: When converting from rubber bushings to bronze bushings, it is necessary to drill the lube fitting hole in the equalizer beam hub before installing the bushings. Drill the hole according to the dimensions given in Fig. 40, under "SPECIFICATIONS."

6. Apply a thin coating of Texaco "Compound L," or an equivalent rust preventive lubricant, to the surface of the new bushing outer sleeve and the inside surface of the beam eye.

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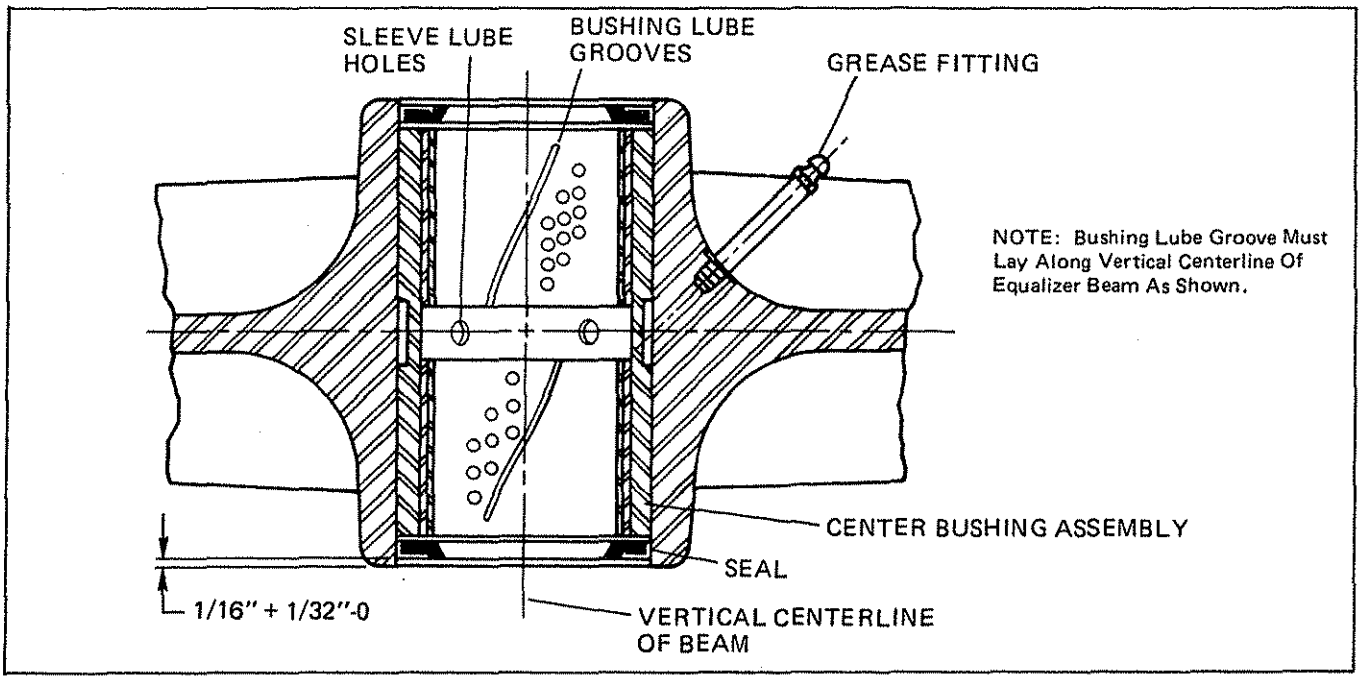

Fig. 24

7. Position the new bronze bushing on the equalizer beam eye, so that the grooves on the bushing will lay along the vertical centerline of the equalizer beam when installed. See Fig. 24.

8. If using the special Owatonna tools, use the following procedure for installation of the beam bronze center bushing (refer to Fig. 25):

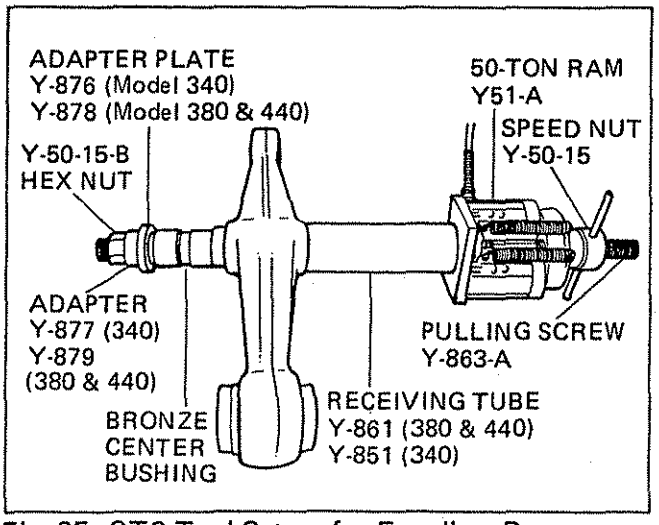

Fig. 25, OTC Tool Set-up for Equalizer Beam Bronze Center Bushing Installation

.1 Install the grease seal adapter plate on the adapter, with the smaller shoulder of the adapter plate against the adapter. Then, position the adapter and adapter plate assembly on the bronze center bushing. When installed, the adapter plate will bottom on the beam, as shown in Fig. 26.

.2 Install the speed nut, hydraulic ram, and receiving tube, on the pulling screw, then position the assembly through the beam eye, bushing, adapter plate, and adapter. Secure with the hex nut.

IMPORTANT: Make certain that the new bushing, tooling, and hydraulic equipment are properly aligned so that the receiving tube exerts force against the beam, allowing the new bushing to clear the receiving tube as it is pulled through the beam. The new bushing should be aligned to insure that it goes straight into the beam. The installing adapter and adapter plate should fit on the bushing so that the adapter plate will bottom on the beam when the bushing is installed, as shown in Fig. 26.

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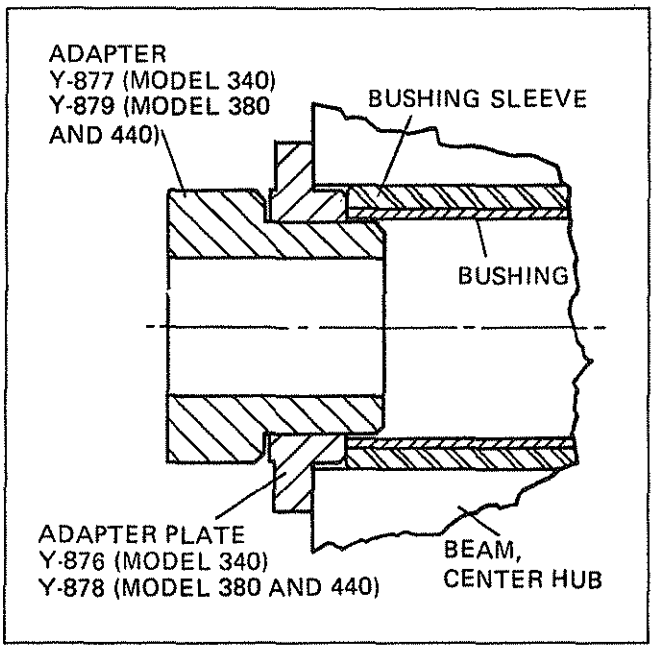

Fig. 26, Beam Bronze Center Bushing Installation

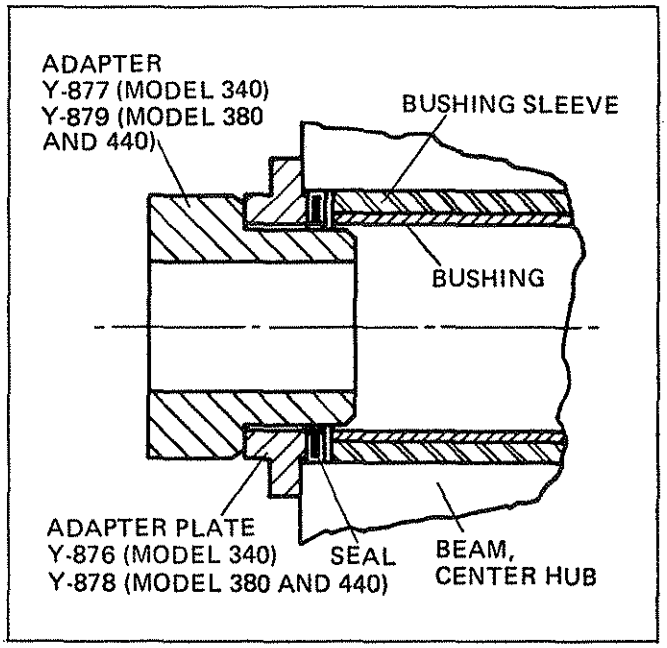

Fig. 27, Grease Seal Installation

.3 Connect a hydraulic pumping unit to the hydraulic ram, and apply hydraulic force.

.4 Pressure gauge on the hydraulic pumping unit should read between 4000-5500 psi (27 560-37 895 kPa) when installing the new bushing. If the gauge reading consistently reaches the operating limit of 10,000 psi (68 900 kPa) and the bushing is not going into the beam, then check the bushing, tooling, and hydraulic equipment alignment.

.5 It may require that the hydraulic equipment be adjusted and activated about three times to complete the installation of the new center bushing. After the hydraulic cylinder reaches its stroke limit, release the pressure and adjust the speed nut so that the tooling and hydraulic equipment are positioned for activating the hydraulic cylinder again.

.6 When the adapter plate bottoms on the beam (see Fig. 26) and the pressure gauge shows a pressure reading increase of up to 10,000 psi (68 900 kPa), then the new bushing is installed. Make a visual inspection.

.7 Install the grease seals (one on each side of the bushing), after the bushings are installed, by inverting the adapter plate so that the smaller shoulder is against the seal, as shown in Fig. 27. Install the new grease seals with the lips of the seals facing outward, as shown in Fig. 24. On the outside of the beam, place the seal and adapters in place, and tap the seal in place with a hammer by striking the adapter assembly. When the adapter plate bottoms against the beam, the seal is installed to its proper depth. Proceed to step 10.

9. If not using the special Owatonna tools, use the following procedure to install the new bronze center bushing:

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.1 Position the beam on a 50-ton vertical hydraulic press, then position the new bushing over the beam eye. Using a standard bushing driver, drive the bushing into the beam eye.

.2 Center the bushing in the beam eye, so that there is equal spacing between both ends of the bushing and the sides of the beam. See Fig. 24.

.3 Install the new grease seals into the ends of the equalizer beam eye, with the lips of the seals facing outward. The face of the seals must be inside the beam eye and 1/16" + 1/32"-0, to provide clearance and protection of the seals. See Fig. 24.

10. Apply a thin coating of multipurpose chassis grease to the outer surface of the bushing center sleeve, then slide the sleeve into the bushing. Install the grease fitting into the beam hub. Apply multipurpose chassis grease through the grease fitting, while rotating the center sleeve. Continue until grease appears at both grease seals.

NOTE: Refer to the 16 Group of the Freightliner Maintenance and Lube Manual for lubrication schedules and procedure for bronze bushings.

11. If the beam hub length measures 6 7/8 inches (175 mm), install one thrustwasher on each side of the beam center bushing. If the beam hub length measures 6 3/4 inches (171 mm), install two thrustwashers on each side of the beam center bushing.

TORQUE ROD REMOVAL AND INSTALLATION (Refer to Fig. 28)

Removal

If the suspension has been removed from the vehicle, proceed to step 3.

1. If not previously done, disconnect the torque rods from the torque rod axle brackets by removing the attaching flanged nuts and flanged bolts.

2. If also equipped with the lateral, track bar torque rods, remove the attaching locknuts from the axle bracket. Then, strike the top of the axle bracket with an impact hammer to disengage the torque rod stud from the bracket.

WARNING: When the torque rods are disconnected from the axle brackets, the axles become free to pivot on the equalizer beam end bushings. Keep clear of the beam hangers and beam ends to avoid the possibility of injury.

3. Remove the flanged locknuts and flanged bolts that attached the torque rod straddle mount assembly to the frame crossmember. Remove the torque rods, crossmember brackets, and shim(s) from the vehicle. Keep track of the torque rod crossmember spacer in the suspension crossmember.

4. If also equipped with lateral, track bar torque rods, remove the flanged locknuts and flanged bolts that attach the torque rod assembly to the frame rail. Remove the torque rods, frame bracket, and backing plate from the vehicle.

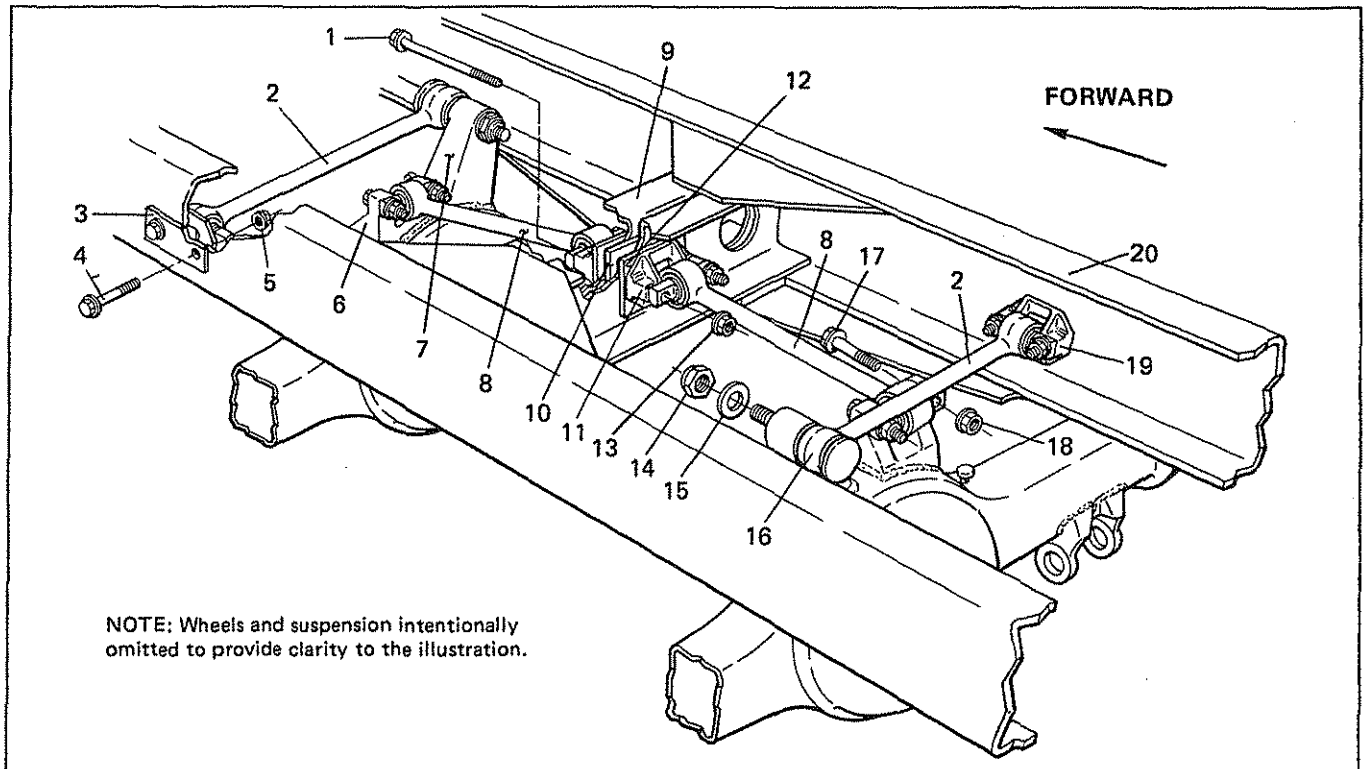
5. Visually inspect the torque rod for bends or cracks. Work the torque rod pins to check for looseness in the polyurethane bushing. If the torque rod is bent, cracked, or otherwise damaged, replace it with a new one. If either of the bushings is loose, both of the bushings must be replaced with new ones. For instructions, refer to "TORQUE ROD BUSHING REPLACEMENT," in this subject.

Installation

NOTE: Torque rods are to be installed when the axle and suspension assemblies are installed on the vehicle.

1. Before installation, make certain that all contact surfaces are free of dirt or other foreign material. Lubricate all bolt threads with SAE-20 oil.

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440



1. Flanged Bolt
2. Lateral, Track Bar Torque Rod
3. Backing Plate
4. Flanged Bolt
5. Flanged Locknut
6. Torque Rod Axle Bracket
7. Lateral, Track Bar Axle Bracket
8. Torque Rod
9. Crossmember
10. Crossmember Spacer
11. Straddle Mount Crossmember Bracket
12. Shim(s)
13. Flanged Locknut
14. Tapered Stud Locknut
15. Tapered Stud Washer
16. Tapered Stud
17. Flanged Bolt
18. Flanged Locknut
19. Straddle Mount Frame Bracket
20. Frame Rail

Fig. 28, Torque Rod and Lateral, Track Bar Torque Rod Assembly

2. Position the torque rod straddle mount pins against the forward-rear axle torque rod bracket. Then, install the flanged bolts through the torque rod axle bracket and the torque rod pin.

3. Install the flanged nuts on the torque rod mounting bolts, then tighten the nuts to 150-175 ft-lbs (203-237 N·m).

4. Install the rear-rear axle torque rod in the same manner.

5. Position the torque rod crossmember spacer in the crossmember. Position the shim(s) (not to exceed ½ inch [13 mm] thick), and crossmember straddle mount bracket on the front side of the crossmember, then position the torque rod with the torque rod pins aligned with the bracket.

6. Install the flanged bolts through the torque rod pins, bracket, and the front side of the crossmember.

NOTE: Do not install the flanged bolt completely through the crossmember until the other side torque rod assembly is installed.

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

7. On the back side of the crossmember, position the shim(s) (not to exceed ½ inch [13 mm] thick), and crossmember bracket; then position the torque rod so the torque rod pins are aligned with the bracket. Attach, by completely installing the flanged bolts from the front side torque rod, through the crossmember and torque rod assembly. Install the flanged nuts on the bolts and tighten to 150-175 ft-lbs (203-237 N·m).

8. If also equipped with the lateral, track bar torque rods, use the following procedure for installation:

   .1 Make certain that the tapered stud and tapered stud bracket hole are free of dirt or other foreign material. Lubricate the tapered stud ends of the torque rod with SAE-20 oil.

   .2 Install the tapered stud into the lateral torque rod axle bracket. Install the locknut on the stud and tighten to 175-225 ft-lbs (237-303 N·m). Then, tap the axle bracket with a hammer. Tighten the locknut again to 175-225 ft-lbs (237-303 N·m).

   .3 Position the lateral torque rod frame bracket, shim(s), and backing plate to the inside of the frame rail. Then position the torque rod pins against the frame bracket.

   .4 Install the flanged bolts through the frame rail, bracket assembly, and torque rod pins. Install the flanged locknuts on the flanged bolts, then tighten the locknuts to 150-175 ft-lbs (203-237 N·m).

9. Check the axle pinion angle. For instructions, refer to the 09 Group of this manual.

TORQUE ROD BUSHING REPLACEMENT

IMPORTANT: To replace the torque rod polyurethane bushings, it is necessary to have the special installation tool kit (Freightliner part No. P-097-009), or a tool kit can be made, using the dimensions given in Fig. 41 under "SPECIFICATIONS." If equipped with the lateral, track bar torque rods, the bushings must be replaced using the special Owatonna tool set No. Y-820, as shown in Fig. 29 (see Table 3, under "SPECIFICATIONS").

1. Remove the torque rods. For instructions, refer to "TORQUE ROD REMOVAL AND INSTALLATION," in this subject.

2. Remove the snapring and bearing washer from each side of the torque rod bushing to be removed. See Fig. 30. Note that the torque rod eye has a smaller shoulder on one side than on the other, and it also has a rounded edge around the inside of the smaller shoulder side of the eye. The bushing must be pressed in and out through this side.

1. Press Plate Y-825
2. Clamp Assembly Y-824
3. Remover Y-826
4. Remover Y-822
5. Remover/Replacer Y-823
6. Cap Y-821

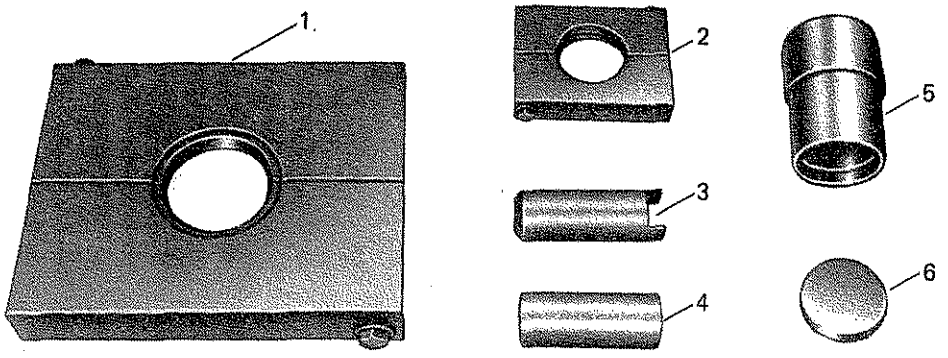


Fig. 29, OTC Tool Set No. Y-820

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

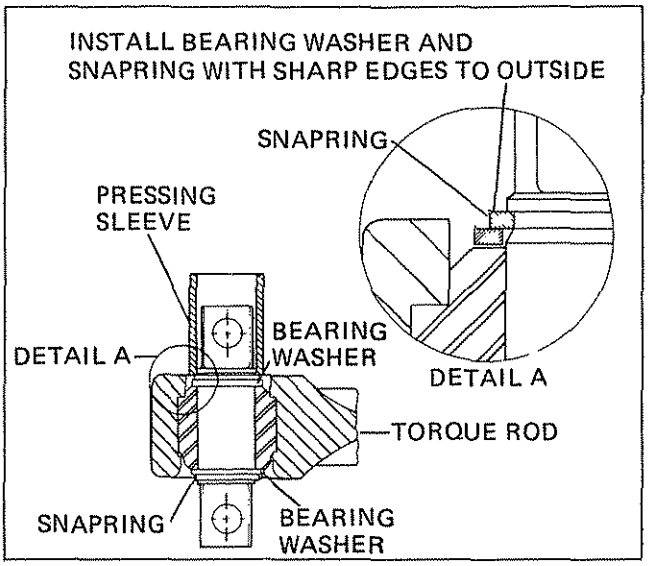


Fig. 30

3. Position the plunger and torque rod on a vertical hydraulic press, then press the old bushing assembly out of the torque rod eye.

4. Clean all dirt, grease, or other foreign material from the torque rod eye. Coat the new bushing and torque rod eye with a non-mineral lubricant or waterless hand cleaner.

5. If not equipped with the lateral, track bar torque rods, proceed to step 7. If equipped with the lateral, track bar torque rods, remove the old bushing from the torque rod eye with the special Owatonna tools and using the following procedure:

   .1 Position the press plate on the bed of a vertical hydraulic press, with the small counterbore of the press plate hole facing up.

   .2 Install the straddle mount ends of the lateral, track bar torque rod, in the hole of the press plate. Secure by tightening the press plate capscrews.

   .3 Position the straddle mount pin remover on the straddle mount pin. Lubricate the bushing liberally with lubricating oil. Press the straddle mount pin out of the bushing. See Fig. 31.

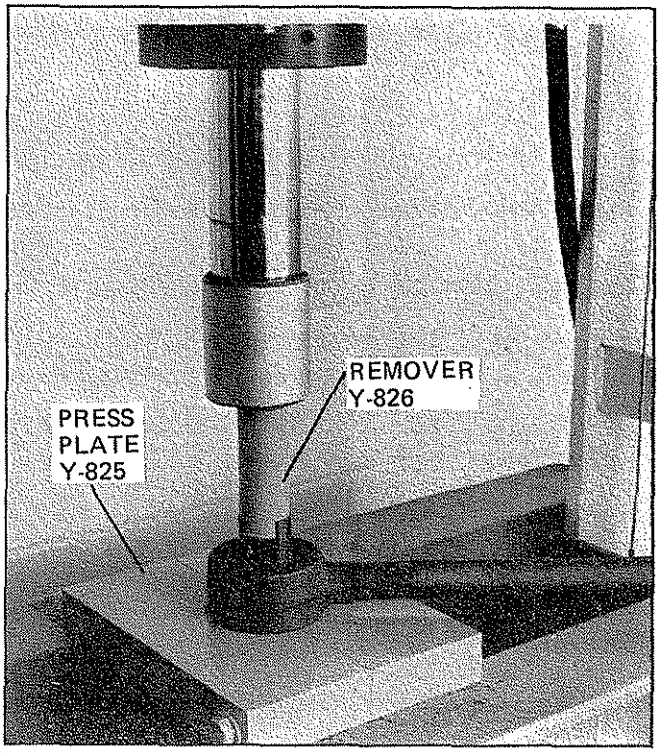


Fig. 31

   .4 Position the bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing for Model 340, or with the larger outside diameter of the remover/replacer tool against the bushing for Models 380 and 440. Lubricate the bushing liberally with lubricating oil. Press the rubber bushing out of the torque rod eye. See Fig. 32.

   .5 Install the tapered stud end (with the stud face up) in the hole of the press plate. Secure by tightening the press plate capscrews.

NOTE: Some tapered stud torque rod bushings have a large non-removeable washer on the back end of the stud and will not fit through the press plate hole. Loosen the press plate capscrews and separate the halves (see

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

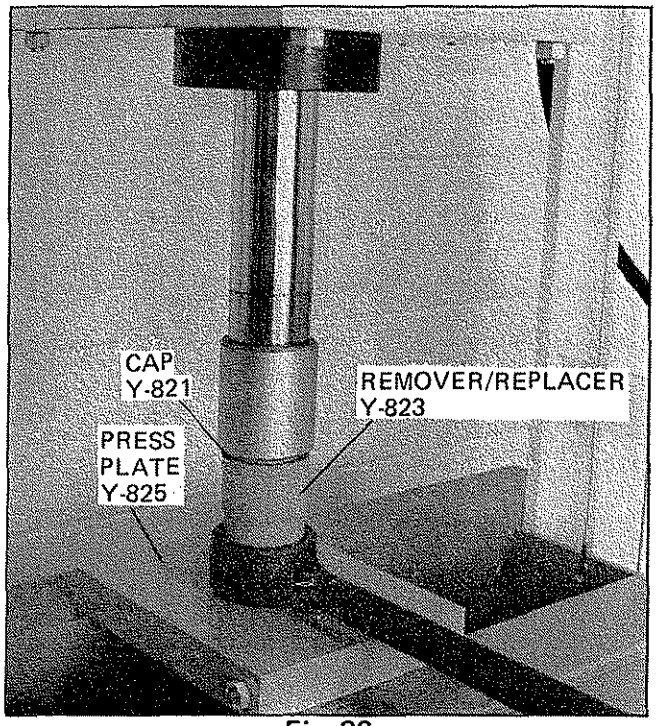


Fig. 32

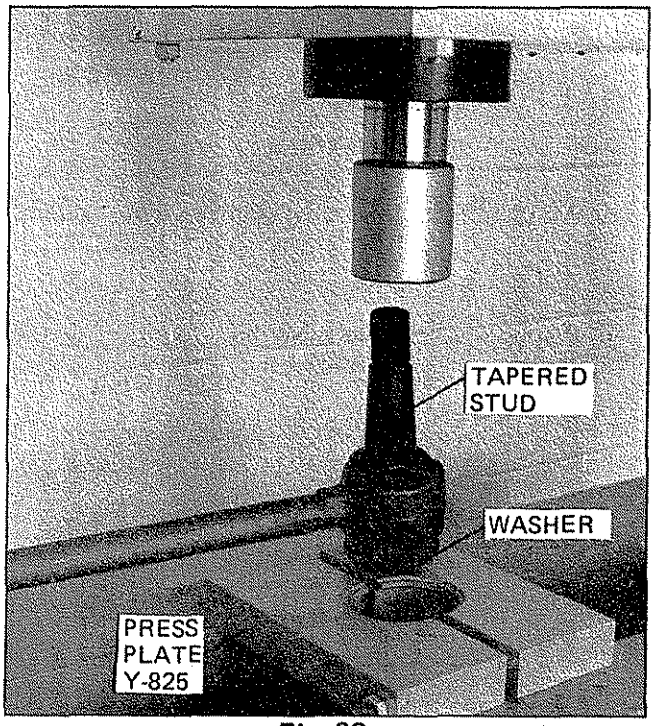


Fig. 33

Fig. 33) until the washer clears the counterbore of the press plate, and the torque rod sets on the press plate. Tighten the capscrews until the press plate halves are closed completely. If the washer is removeable, then remove the washer before installing the torque rod end in the press plate.

Position the tapered stud remover tool (OTC part No. Y-822) with the smaller inside diameter of the remover tool on the Model 340 torque rod stud, or the larger inside diameter of the remover tool on the Model 380 and 440 torque rod stud. Lubricate the bushing liberally with lubricating oil. Press the stud out of the bushing.

Position the rubber bushing remover/replacer tool and cap, with the smaller inside diameter of the remover/replacer tool against the bushing for Model 340, or with the larger outside diameter of the remover/replacer tool against the bushing for Models 380 and 440. Lubricate the bushing liberally with lubricating oil. Press the bushing out of the torque rod eye. See Fig. 32.

.6 Clean all dirt, grease, or other foreign material from the torque rod eye. Proceed to step 6.

6. Install the new lateral, track bar torque rod cartridges with the special Owatonna tools, and using the following procedure:

NOTE: New replacement cartridges with the bushings bonded to the straddle mount pins and tapered studs must be used.

.1 Position the press plate on the bed of a vertical hydraulic press. Position the torque rod eye into the hole of the press plate.

.2 For Model 340, position the new straddle mount replacement cartridge on the torque rod eye. Position the remover/replacer tool and cap, with the smaller outside diameter

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

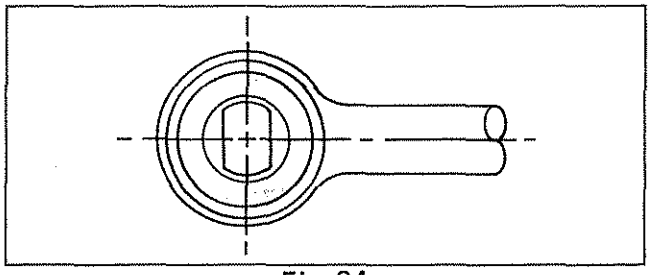


Fig. 34

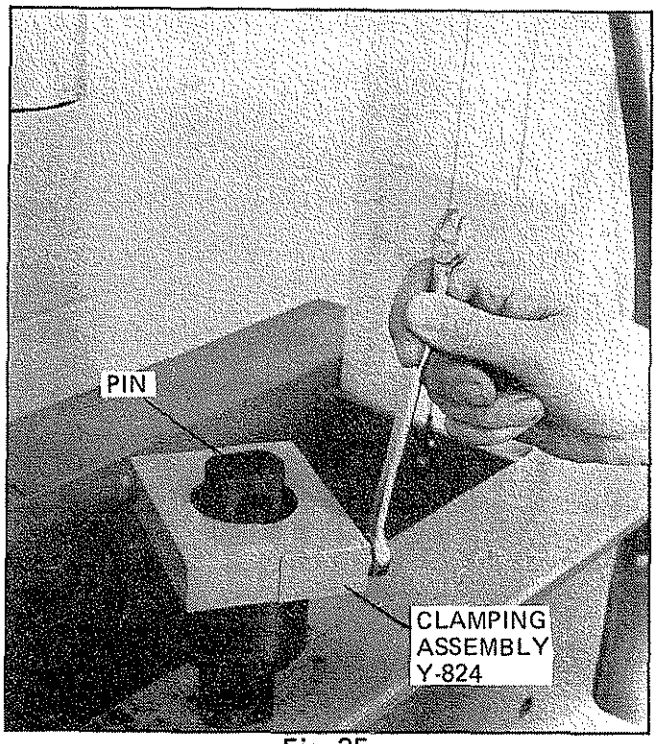


Fig. 35

of the remover/replacer tool against the rubber bushing of the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: The center metal section flats of the pin must be perpendicular to the center line of the torque rod shank. See Fig. 34. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

.3 For Models 380 and 440, use the clamp assembly to compress the rubber of the

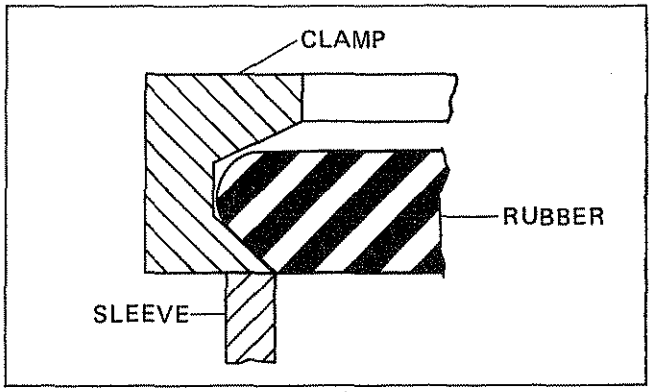


Fig. 36

new straddle mount cartridge bushing, and act as a pushing plate. See Fig. 35. The clamp must be completely closed to compress the rubber. See Fig. 36.

NOTE: When clamping the clamp assembly around the bushing, line up the metal section flats of the straddle pins, perpendicular to the splits of the clamp assembly. See Fig. 35.

Position the new straddle mount cartridge and clamp over the torque rod eye. Position the remover/replacer tool and cap, on top of the clamp assembly with the larger outside diameter end of the remover/replacer tool against the clamp assembly. Set the assembly so that the split of the clamp assembly lines up with the shank of the torque rod. See Fig. 37. Press the replacement cartridge into the torque rod eye. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

.4 Remove the bolt, lockwasher, and washer-type cap from the new tapered stud replacement cartridge.

For the Model 340, position the new replacement cartridge on the torque rod eye with the stud end down. Position the remover/replacer tool and cap, with the smaller outside diameter of the remover/replacer tool against the rubber bushing of

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

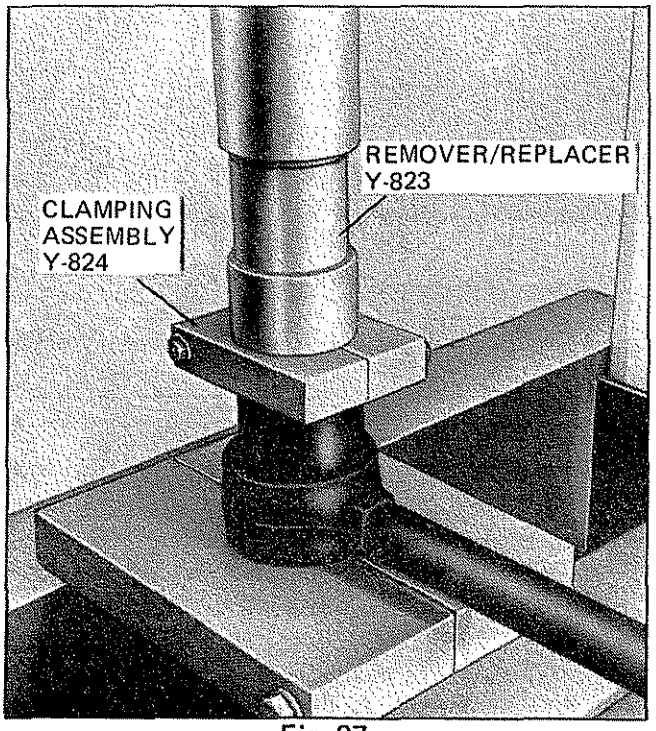


Fig. 37

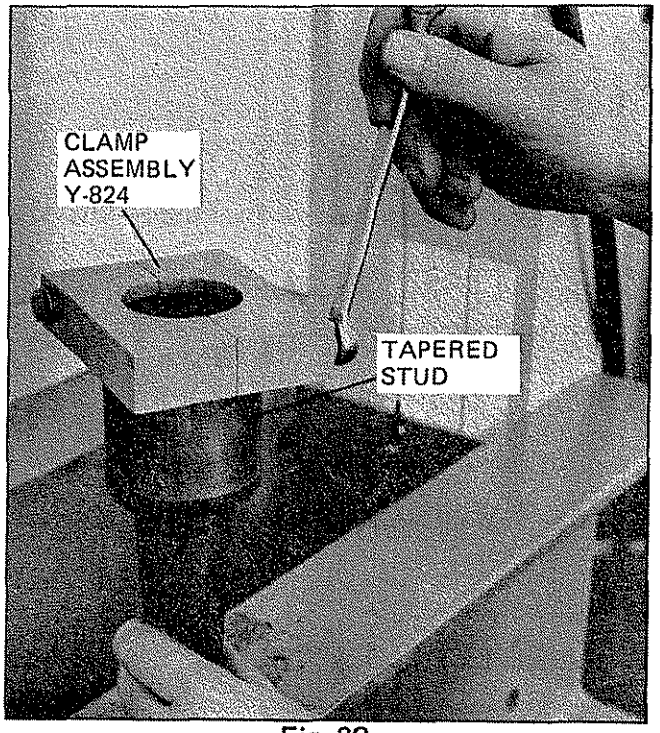


Fig. 38

the replacement cartridge. Press the replacement cartridge into the torque rod eye.

NOTE: Install the replacement cartridge with the threaded end down. The outer steel sleeve must protrude equally on each side.

For Models 380 and 440, use the clamp assembly to compress the rubber of the new tapered stud cartridge bushing, and act as a pushing plate. See Fig. 38. The clamp must be completely closed to compress the rubber. See Fig. 36.

Position the new replacement cartridge and clamp over the torque rod eye. Position the remover/replacer tool and cap, on top of the clamp assembly with the larger outside diameter end of the remover/replacer tool against the clamp assembly. Set the assembly so that the split of the clamp assembly lines up with the shank of the torque rod. See Fig. 37. Press the replacement cartridge into the torque rod eye. The outer sleeve of the bushing must protrude equally on each side of the torque rod eye.

7. Position the bushing in the larger end of the insertion sleeve from the tool kit, then fit the beveled (smaller) end of the sleeve into the larger side of the torque rod eye.

8. Center the torque rod eye on the base tool, and insert the plunger tool into the bushing. See Fig. 39. Use a vertical hydraulic press to press the bushing into the torque rod eye.

9. Install the snapring and bearing washer on one end of the torque rod pins, with the sharp edges of the washer and snapring facing the outward end of the pin. See Fig. 30, Detail A.

10. Press the torque rod pin into the torque rod bushing from the same side as the bushing was pressed into the torque rod eye. Do not lubricate the torque rod pin.

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

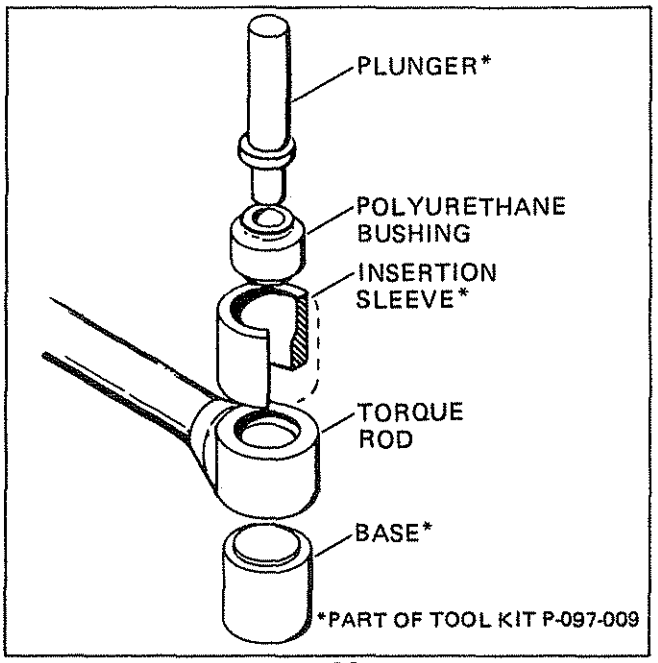


Fig. 39

Turn the torque rod over and install a bearing washer, with the sharp edge facing away from the bushing, then install the other snapring onto the outer shoulder of the pin, with the sharp edge facing outward.

Place a pressing sleeve over the end of the torque rod pin, then press the snapring into its seat. See Fig. 30.

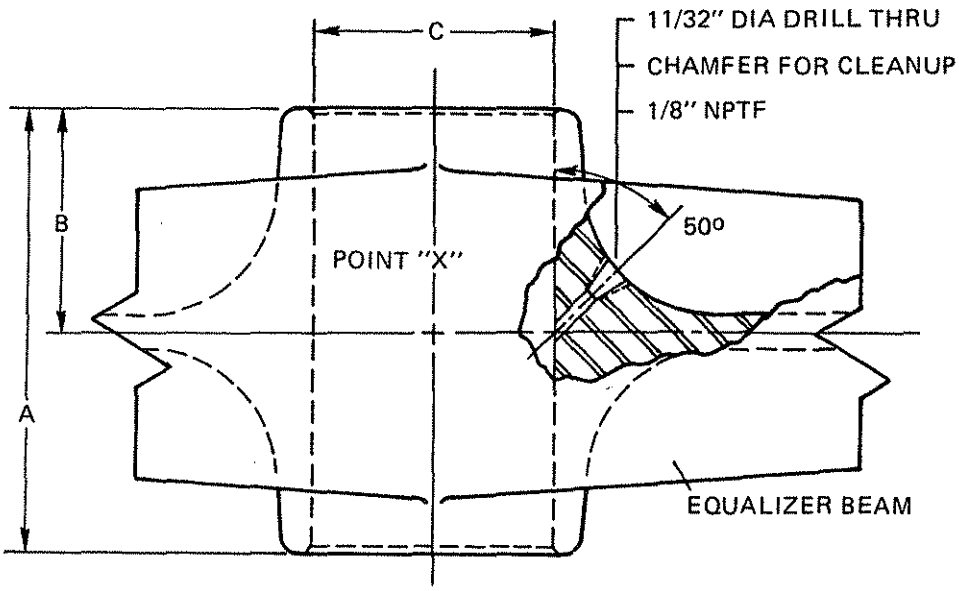
11. After assembly, lightly press the torque rod pin or tapered stud, to center it in the torque rod eye. There should be no slack on either side of the bushing, and the bushing should be compressed by approximately half the thickness of the snapring. If necessary, install a second washer under one of the snaprings to compress the bushing.

AXLE ALIGNMENT

There are no axle alignment adjustments on the Hendrickson "RT and RTE" Series suspension. At the time of the original installation, the placement of the frame hangers to the frame sets the suspension alignment. Parallel alignment of the axles to each other is automatic, because of the compression centering. In turning, the rubber in the equalizer beam bushings are compressed at all points, and the reflex action to the rubber maintains the parallelogram form.

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

SPECIFICATIONS



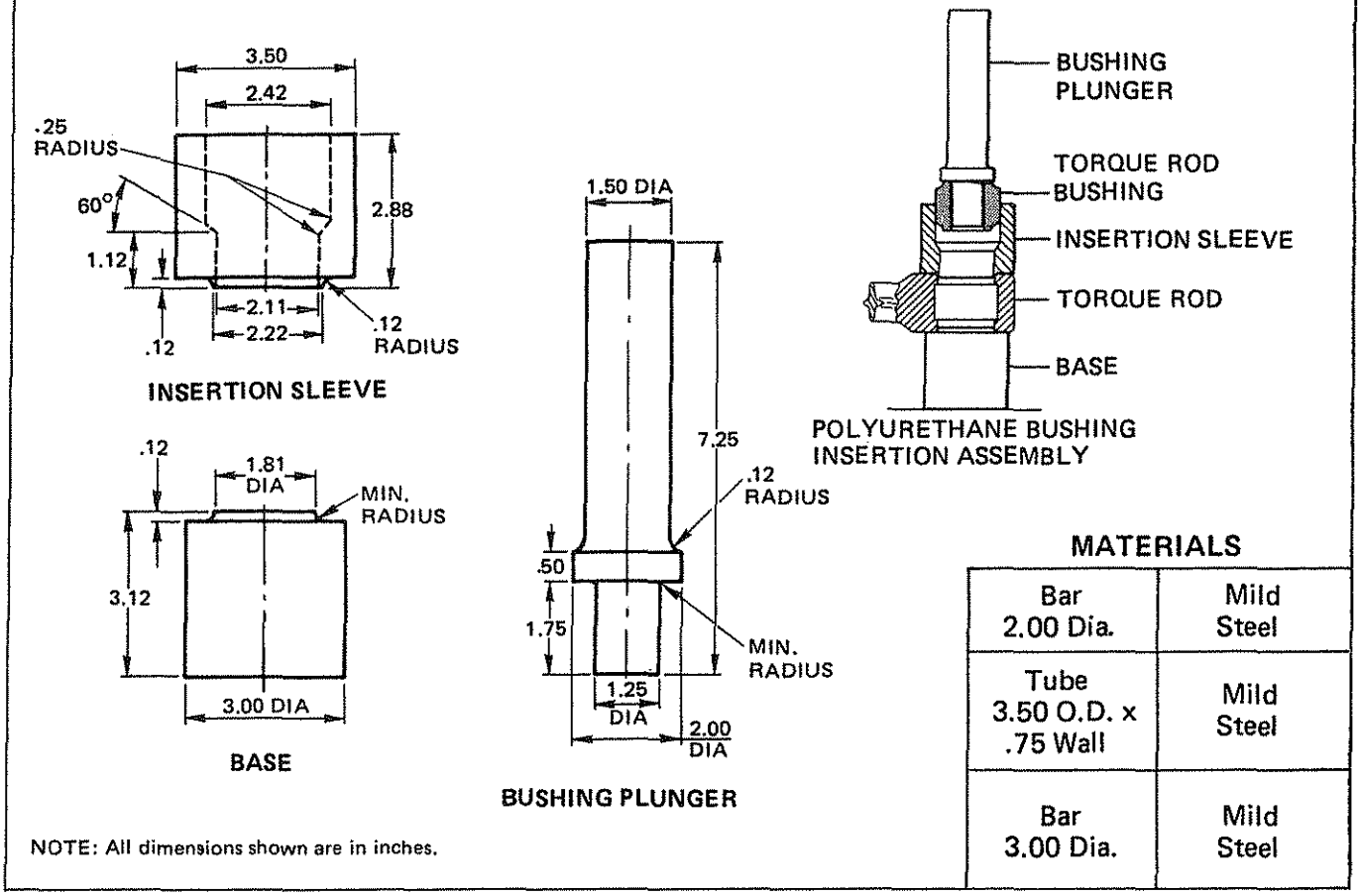
BEAM HUB DIMENSIONS

A - 6.75 inches
B - 3.375 inches
C - 3.613 to 3.617 inches for Model 340
4.738 to 4.742 inches for Model 380 & 440
Point "X" - must fall on centerline of beam center hub within ± 1/8"

Fig. 40, Grease Fitting Location on Equalizer Beam Hub

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

SPECIFICATIONS (Continued)



NOTE: All dimensions shown are in inches.

MATERIALS

Bar 2.00 Dia.	Mild Steel
Tube 3.50 O.D. x .75 Wall	Mild Steel
Bar 3.00 Dia.	Mild Steel

Fig. 41, Bushing Installation and Removal Tool Kit

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

SPECIFICATIONS (Continued)

OTC PART NUMBER	TOOL	APPLICATION	"RT" AND "RTE" SERIES MODEL NO.
Y-851	Receiving Tube	Center Bushing Removal and Installation	340
Y-852	Removing and Pilot Adapter	Center Bushing Removal and Installation	340
Y-853	Installing Adapter	Center Bushing Installation	340
Y-854-A	Receiving Tube	End Bushing Removal and Installation	All
Y-855-A	Removing and Pilot Adapter	End Bushing Removal and Installation	All
Y-856	Adapter Clamp	End Bushing Installation	All
Y-857	Adapter Clamp Plate	End Bushing Installation	All
Y-858	Receiving Tube	Beam End Tube-Type Hanger Pin Removal	All
Y-859-A	Removing Adapter	Beam End Tube-Type Hanger Pin Removal	All
*Y-860	Receiving Tube	Center Bushing Removal and Installation	380/440
*Y-861	Removing and Pilot Adapter	Center Bushing Removal and Installation	380/440
*Y-862	Installing Adapter	Center Bushing Installation	380/440
Y-863-A	Pulling Screw	All Operations	All
Y-864	Sledging Adapter	Seized Part Removal	All
Y-865-D	Adapter Puller Set	Beam End Adapter-Type Beam Hanger Plug Removal	All
*Y-876	Adapter Plate	Center Bushing (Bronze) and Seal Installation	340
*Y-877	Adapter	Center Bushing (Bronze) Removal and Installation	340
*Y-878	Adapter Plate	Center Bushing (Bronze) and Seal Installation	380/440
*Y-879	Adapter	Center Bushing (Bronze) Removal and Installation	380/440
Y-50-15	Speed Nut	All Operations	All
Y-50-15-B	Hex Nut	All Operations	All
*Y51-A	50-Ton Hydraulic Ram	All Operations	All

*Used in addition to Tool Set Y-850, depending on application.

Table 1, Owatonna Tool Set No. Y-850 (Owatonna Tool Company, Owatonna, Minnesota)

TOOL NO.	ADAPTER SIZE	APPLICATION	"RT" AND "RTE" SERIES MODEL NO.
1	4 1/4" O.D. x 4" Length	Beam End Bushing Removal	All
2	*4 1/2" I.D. x 4" Length	Beam End Bushing Installation	All
3	3 1/2" O.D. x 7" Length	Beam Center Bushing Removal and Installation	340
4	4 5/8" O.D. x 7" Length	Beam Center Bushing Removal and Installation	380/440

*Adapter to be used with a sheave puller. See Fig. 18.

Table 2, Shop-Made Adapters for use with a 50-Ton Vertical Hydraulic Press

HENDRICKSON TANDEM SUSPENSION "RT" AND "RTE" SERIES, MODELS 340, 380, AND 440

SPECIFICATIONS (Continued)

OTC PART NUMBER	TOOL	APPLICATION	"RT" AND "RTE" SERIES MODEL NO.
Y-821	Cap	Bushing Removal and Installation	All
Y-822	Remover	Tapered Stud Removal	All
Y-823	Remover/Replacer	Bushing Removal and Installation	All
Y-824	Clamp Assembly	Straddle Mount Bushing Installation	380/440
Y-825	Press Plate	Bushing Removal and Installation	All
Y-826	Remover	Straddle Mount Pin Removal	All

Table 3, Owatonna Tool Set No. Y-820 (Owatonna Tool Company, Owatonna, Minnesota)

DESCRIPTION		SIZE	GRADE	TORQUE	
				FT-LBS	N·m
Spring Center Bolt Nut		7/16-20	B	50-60	68-81
		1/2-20	B	65-75	88-102
Torque Rod Straddle Mount Attaching Flanged Nuts		5/8-11	G	150-175	203-237
Lateral, Track Bar Torque Rod Stud Locknut	Model 340	1 1/8-12	B	175-225	237-303
	Model 380/440	1 1/4-12	B	175-225	237-303
Top Pad to Spring Aligning Set Screw		—	C	100-150	136-203
Top Pad Nut		—	C	275-300	373-407
Spring Pin Draw Key Locknut		—	B	75-100	101-136
Spring Rear Hanger Rebound Bolt Locknut		1/2-13	B	70-80	95-109
Saddle Cap Studs		7/8-14	B	55-65	75-88
Saddle Cap Nuts		7/8-14	B	225-275	303-373
Adapter-Type Beam End Nut		3/4-16	C	210-240	285-325
Tube-Type Beam End Nut		—	—	375-425	441-576
Top Pad Set Screw Nut		Tighten until lockwasher is flat.			

Table 4, Torque Values

GENERAL DESCRIPTION

The RU-340 suspension uses semi-elliptic leaf springs to cushion load and road shocks. The springs are mounted on saddle assemblies above the equalizer beams, and are secured to the saddle by two U-bolts and a spring pad. The spring assembly has each leaf interlocked with cups through the center section at the center bolt. The springs are pivoted at the front end on spring pins, and brackets. Rear ends of the springs have no rigid attachment to the spring brackets, but are free to move forward and backward to compensate for spring deflection. (Fig. 1)

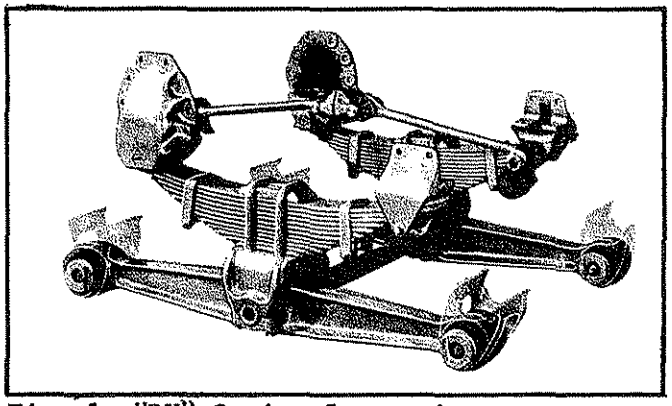


Fig. 1 "RU" Series Suspension

The RUE-340 suspension is basically an RU-340 tandem suspension with the following two differences: The addition of a third pair of rear frame hangers, and the extension of the two top spring leaves. The RUE-340 suspension provides a light spring rate for empty conditions, and picks up the heavier portion of the spring for loaded conditions. To maintain this ride feature, a minimum clearance of .38" is recommended between the bottom of the No. 2 hangers and the top of the extended leaves. (Fig. 1A)

SERVICE OPERATIONS

Most repairs to the suspension system consist of replacing worn or damaged parts. The major item is removal and replacement of the rubber bushings. While bushings have long life and replacement will be limited, they can be replaced if damaged or deteriorated. Special service tools for performing this task on the equalizing beams are available and though recommended are not absolutely necessary. If press equipment is available, standard steel tubing having diameters to match the bushing sleeves (metal bands surrounding rubber bushings) can be used as adapters for removing and installing the bushings. Refer to Table 1 (Adapter Chart) for shop-made adapters. Press pressures required to remove the bushing and sleeve assemblies will generally be between 35 to 50 tons.

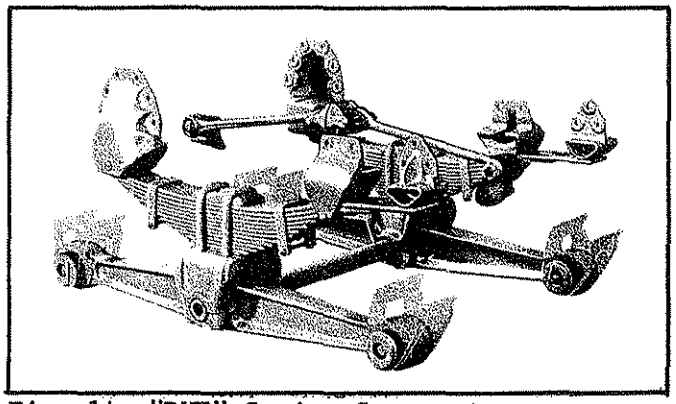


Fig. 1A "RUE" Series Suspension

CLEANING & INSPECTION

Clean the suspension thoroughly, then carefully inspect parts for cracks, bends or other damage. Repair or replace such parts. Inspect rubber bushings for damage or deterioration; replace them if they are damaged, worn or deteriorated. Non-destructive inspections, such as magnaflux, and fluorescent penetration, should be made on metal parts at the repairman's discretion.

WARNING: Failure to repair, or replace worn, damaged or deteriorated parts as described above, could result in an unsafe operating condition.

REMOVAL & DISASSEMBLY

When a major overhaul is required, the complete tandem unit should be removed from the frame. Torque arms, spring assemblies, equalizing beams and other

parts, however, may be removed separately as required. Care should be taken when disconnecting torque rods, since axle assemblies may be free to roll or pivot at the equalizer beam ends. Block the vehicle front wheels securely, before disconnecting any of the suspension parts. Safely position jacks, or attach a hoist to raise the frame from the suspension.

CAUTION: Failure to take the above precautions could result in injury to personnel or damage to the unit.

Axle Removal

1. Block front wheels to prevent a runaway. Failure to do so may contribute to a hazardous working condition.

2. Disconnect the brake lines from axles.

3. Release the spring brakes. Refer to Group 12, Brake Control for the applicable procedure for the spring brake release.

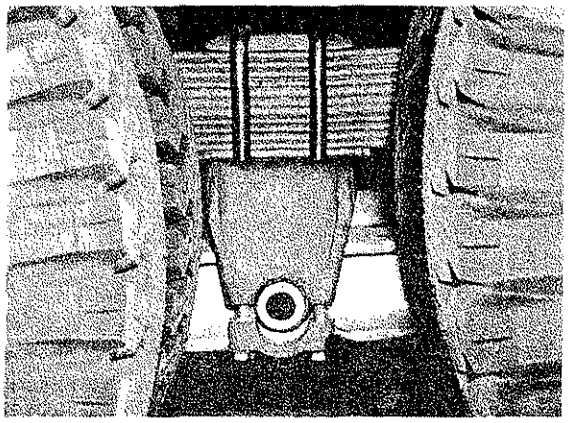


Fig. 2 Removing Saddle Caps

4. Remove the four saddle caps that lock
3. saddles to the beam cross tube.(Fig. 2)

5. Remove both torque rods at axle bracket ends.

6. With "A" frame, or overhead hoist, raise rear of vehicle frame until lower part of saddle assembly clears top of axle; then roll axles from under unit with beams attached. (Fig. 3)

Suspension Disassembly

1. Support the spring and saddle assembly

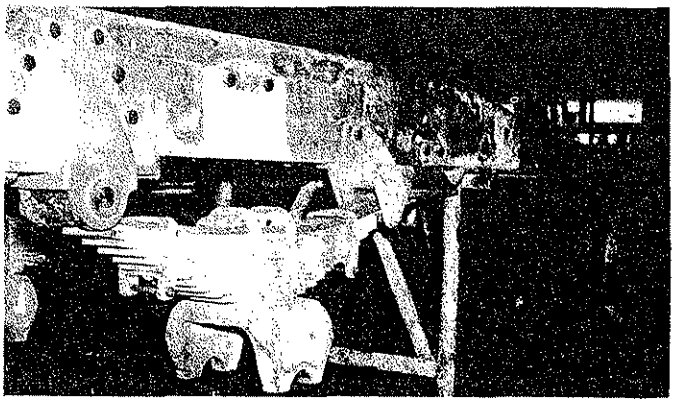


Fig. 3 Removing Axles From Chassis

on a floor jack. Loosen locknut on front spring pin lock bolt (tapered draw key) and back off nut until it is flush with the end of the threads; then strike the nut with a soft hammer to loosen the draw key. Remove draw key and drive the spring pin out of the spring eye and casting. (Fig. 4) Remove the rear spring rebound hanger spacer bolt nut, lockwasher, spacer, and spacer bolt from rear hanger. Lower the spring and saddle assembly from the frame, and remove floor jack.

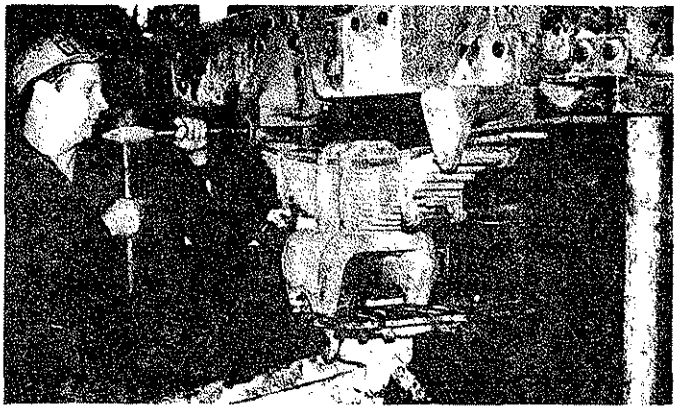


Fig. 4 Driving Out Front Spring Pin

2. Remove spring U-bolt nuts, and hardened flat washers. Remove U-bolts and spring top pad, then remove the spring from the saddle.

Equalizer Beam Removal

Adapter Type End Supports

Disconnect equalizer beam from axle. Support the beam ends before disassembly. Remove adapter draw bolt and adapter. Drive a chisel between the adapter flange and hanger leg to loosen and remove the

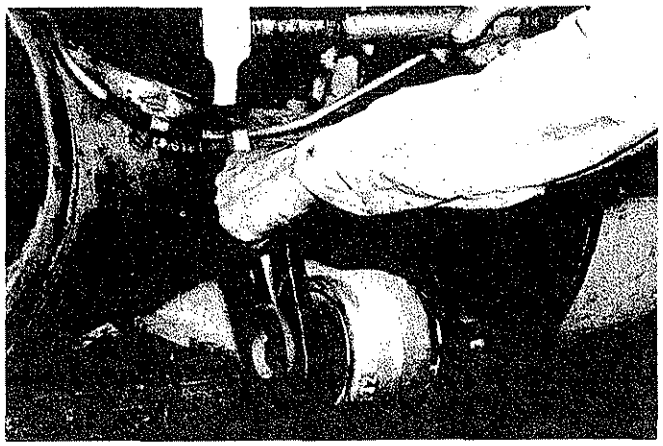


Fig. 5 Removing Beam End Adapter

adapter. (Fig. 5) Drive the opposite adapter out with an impact hammer or heavy bar and hammer.

Tube Type End Supports

1. Support beam ends before disassembly. Remove retaining nuts from beam end tube. Install sleeve (about 1/2" long) over the tube end and use the nut as a puller. Increase sleeve length as tube moves out of beam end. (Fig. 10) If tube is seized to the beam end, cut it off on both sides of the beam. Cut away the extruding rubber on each side of the beam bushing. (Fig. 6) The preferred method of cutting the beam end tube is by using a portable hack saw.

CAUTION: If a torch is used to cut the beam end tube, take special care to protect the end of the beam from torch heat.

Failure to take the above precautions could affect the service life of the beam, and could result in an unsafe operating condition.

2. Separate equalizer beams from cross shaft.

Equalizer Beam End Bushing Replacement

(Using Shop-Made Adapters) See Adapter Chart, Table 1, for proper size and length adapter.

1. Cut the rubber bushing back flush with beam on one side. (Fig. 6) This will allow the adapter to contact the outer bushing sleeve squarely for removal.

2. Apply a rust preventive to outer surface of new bushing sleeve, and inner surface of beam end before assembly.

Fig. 6 Cutting Off Rubber Bushing

3. To install new end bushing, use a sheave puller clamp to compress the extruded rubber of the bushing as shown in Fig. 7. This allows the puller jaw to seat against the outer bushing sleeve. Place No. 2 shop-made adapter over the inner bushing sleeve and against sheave puller. Press on adapter with vertical press to install beam bushing.

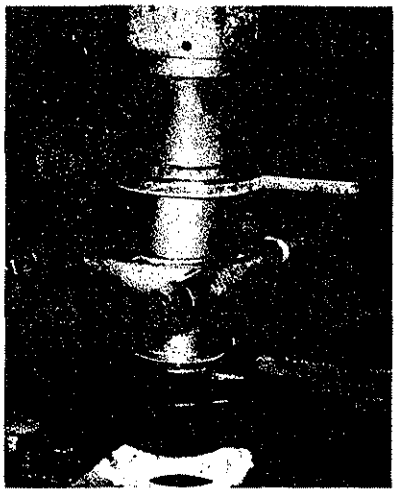


Fig. 7 Pressing In End Bushing

Equalizer Beam Center Bushing Replacement

(Using Shop-Made Adapters & Vertical Press)
Beam removal is covered in the Removal and Disassembly section of this subject.

Bushing Removal (Rubber)

1. Position beam in press.
2. Refer to adapter chart (Table 1) for correct adapter. Use adapter No. 3 for model 340 suspension.
3. Press out bushing, and clean beam center bore surface of rust or any rough surfaces.

Bushing Installation (Bronze Steel Back)

Refer to subject 32-16368, this manual, which covers Equalizer Beam Center Bushing Installation (Bronze Steel Back).

Torque Rod Bushing Replacement

Rubber Bushed

Visual inspection of the rubber bushing in the torque rods will determine replacement. If the bushing shows shredding of the rubber, it will be necessary to re-bush, or replace the torque rod assembly, either with an exchange or a new torque rod.

Fabrylon Bushed

The Fabrylon bushing bearing is cotton, impregnated with a special lubricant and is a self-lubricating bearing. If the ball stud is loose at time of inspection, a new torque rod assembly should be installed. Failure to do so could result in an unsafe operating condition.

Spring Repair

1. Remove spring leaf retainer clamps bolts. Remove spring center bolt.
2. Inspect spring leaves, and replace those that are gouged, or worn. If two or more leaves are broken, replace the complete spring.
3. Inspect main leaf eye and pin for wear. If the pin and bushing combined wear exceeds .025" to .030" over new pin diameter, install new bushing. Ream the new bushing to .005" to .010" larger than new pin. If pin is worn, install new pin.
4. Align spring leaves in assembly order; then clamp them together with a heavy "C" clamp. Install new center bolt and nut. Tighten 1/2" center bolt nut to 65-75 ft-lbs. Remove "C" clamp. Install spring alignment clamp bolts and nuts. Torque clamp bolt nut to 15 ft-lbs.

NOTE: When the spring pin is broken, a new pin and spring eye bushing must be installed. Bell shaped condition of bushing will cause early failure of spring pin.

WARNING: Failure to replace worn or broken parts may result in an unsafe operating condition.

Spring And Saddle Assembly

1. Seat the spring in the saddle with head of spring center bolt positioned in hole provided in the saddle.
2. Position spring top pad on spring.

Apply rust preventive to U-bolt threads. Install U-bolts, hardened flat washers and new nuts. Tighten U-bolts to 237-300 ft-lbs. Rap top center of U-bolt with hammer, then retighten to 237-300 ft-lbs.

Spring And Saddle Installation

1. Using a roller jack or hoist, position spring and saddle assembly into the front and rear spring-hanger frame brackets. Install rebound spacers and bolts in rear casting, tighten nuts to 80-85 ft-lbs.

2. Align spring eye with spring pin bore in front bracket. Coat spring hanger

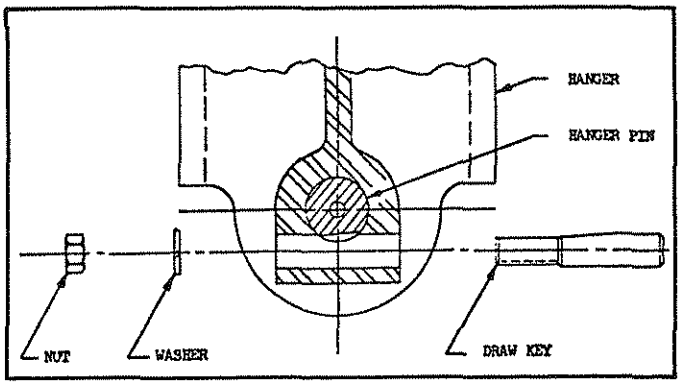


Fig. 8 Hanger Pin Draw Key

Spring And Saddle Installation

pin with chassis lubricant and install pin, aligning draw key flat surface with draw key bore in hanger. Install draw key. As key is inserted, turn pin until draw key taper contacts flat surface of locking slot. This will allow the draw key to contact the high side of the pin and will roll the spring pin into the correct position. Tap end of draw key with hammer to seat in casting and against spring pin. Tighten draw key nut to 75-100 ft-lbs. torque. (Fig. 8)

CAUTION: If the draw key is not correctly installed and locked, the pin will move in the hanger bracket and cause early wear of the bracket holes and pin. This could result in an unsafe operating condition. Review paragraph two under Spring And Saddle Installation for correct Procedures.

Beam And Saddle Installation

1. Install cross tube into both equalizing beams, and position under axles.

2. Raise and place the same end of each beam into axle brackets of one axle.

3. Align the beam end rubber bushings to the axle brackets, and apply rust preventive to axle bracket holes and to the inner sleeve of end bushings.

4. Install adapters, bolt, washers, and nut to each beam end to hold beam in bracket, but do not lock the nut tight. If tubular type beam end hanger pins are used, install in end of beam. Do not tighten nuts until installation is completed.

5. Install opposite ends of beams to other axle, using same procedure as above.

6. With the beams attached to the axles, roll unit under the center of the saddle legs. Lower vehicle frame, centering saddles on beam center bushings. Apply rust preventive to saddle cap bolt threads. Install saddle caps, hardened flat washers and nylock bolts. Tighten nylock bolts to 310-340 ft-lbs.

7. Install torque rods to axle brackets and frame brackets. When tightening nuts, rap bracket with hammer to drive taper of torque rod stud into bracket. Tighten to 175-225 ft-lbs torque.

IMPORTANT: The nuts on the torque rods, saddle cap studs, saddle vertical bushing cap studs, and vertical drive pins are self-locking and must be replaced with new nuts once removed, because removal damages the locking feature.

Adapter Type Ends

Tighten beam end adapter bolt nuts to 210-240 ft-lbs torque. Be sure the flat section on the adapter flange is in a vertical position. (Figs. 5 & 9)

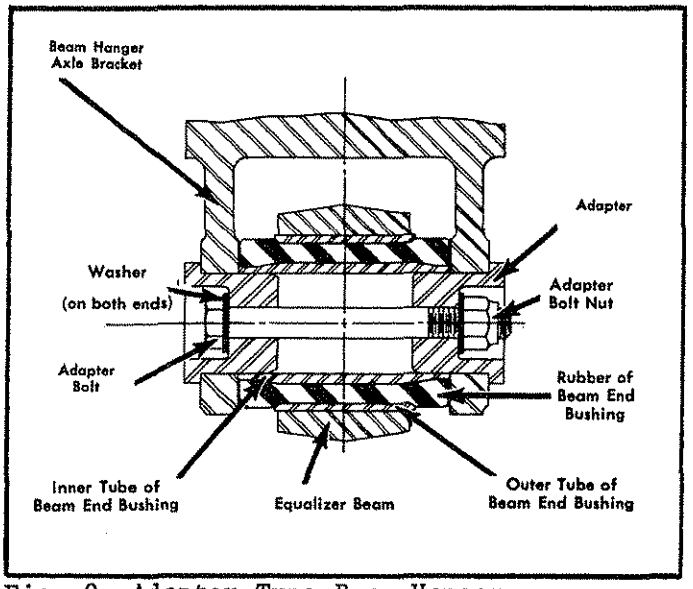


Fig. 9 Adapter Type Beam Hanger

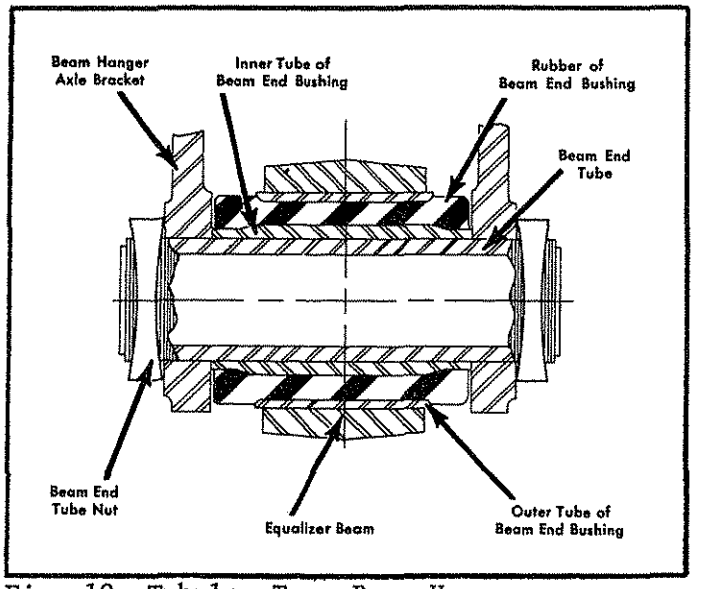


Fig. 10 Tubular Type Beam Hanger

Tubular Type Ends

Tubular type beam end tube nuts should be tightened to 375-425 ft-lbs torque. (Fig. 10)

WARNING: Failure to repair or replace parts of equalizer beams and/or saddles when worn or damaged could result in an unsafe operating conditon.

Tools to remove and install suspension bushings individually, may be obtained from tool supply sources of puller equipment. One such source is:

Owatonna, Minnesota

ALIGNMENT

There are no alignment adjustments. Parallel alignment of the axles to each other and to the frame is automatic, due to compression centering. In turning, the rubber is compressed at all points and the reflex action of the rubber maintains the parallelogram form.

LUBRICATION

1. Lubricate the spring pivot pins and top spring leaves at brackets with multi-purpose chassis lubricant.
2. Lubricate the equalizer beam bronze center bushings weekly, and more frequent under adverse conditions. Use a multi-purpose chassis grease. Lubricate until clean grease appears at both hub seals.

SPECIFICATIONS

WELDING

1. Position the suspension hanger bracket 17.94" from the centerline of the housing to the center of the hanger bracket. The hanger must be aligned with the fore and aft centerline of the housing before being welded.
2. The hanger is to be welded to the housing using a horizontal weld only on top of the hanger flange. The weld is to be a multiple pass 3/8 - 45° fillet. Use low hydrogen rod No. AWS-E7018 or ASW-E6016. Do not leave undercut edges or unfilled craters.
3. On the RU340 suspension, a 1/4" thick spacer is welded on the inside of each hanger as shown is Fig. 11. Check beam end width, and inside hanger dimensions to make sure beam will fit in bracket. If not, use thinner spacers. Refer to Fig. 11 for welding procedures.

WARNING: Failure to follow these welding procedures could result in an unsafe operating condition.

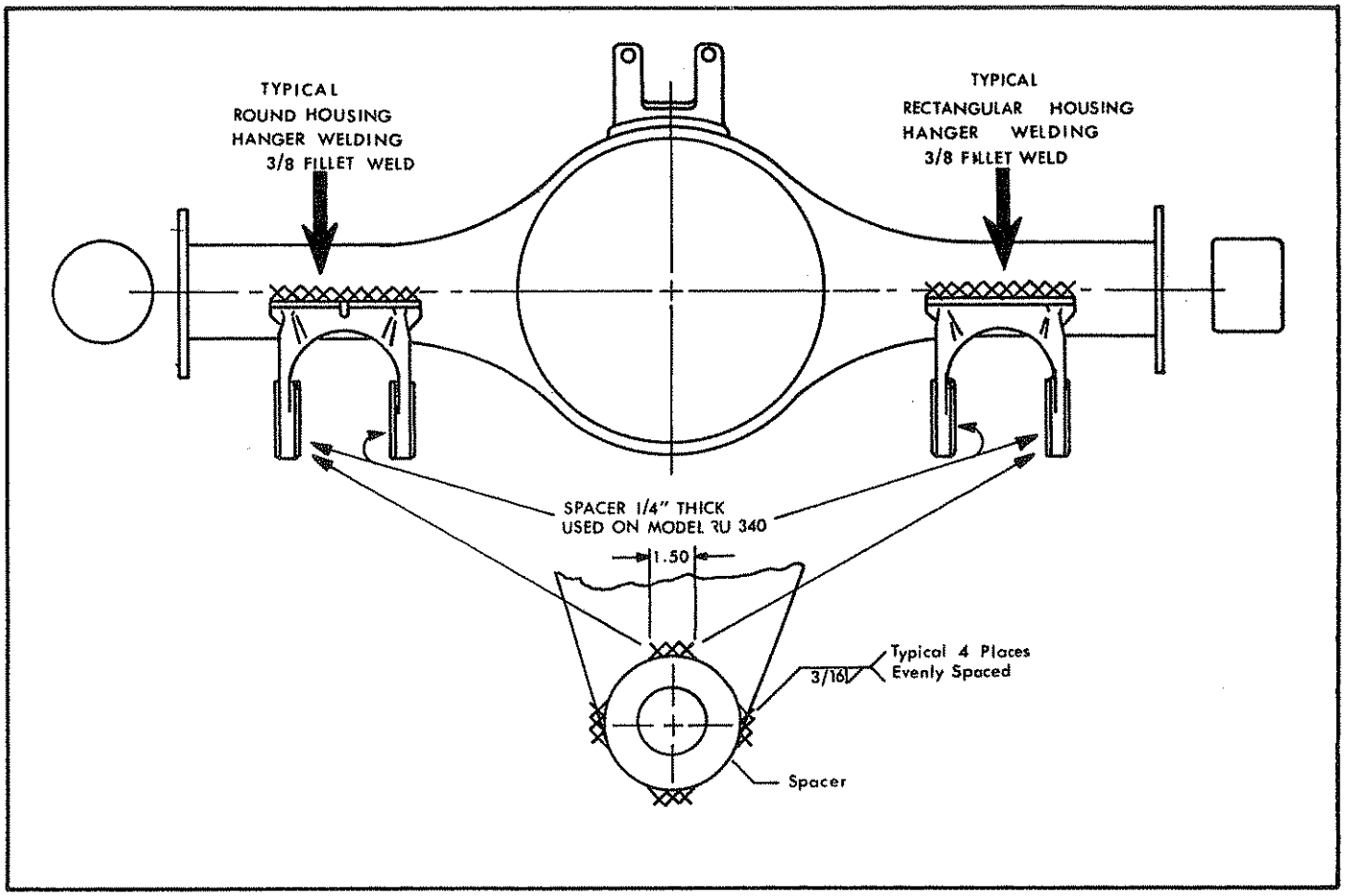


Fig. 11 Hanger Welding Diagram

ADAPTER CHART

The adapters listed in this table are for use in removing and installing rubber bushings. The one with an * is to be used with a sheave puller and can be made locally in the field.

IDENT. NO.	ADAPTER SIZE	APPLICATION
1	4-1/4" O.D. x 4" Long	Equalizer beam end bushing remover
2	*4-1/2" I.D. x 4" Long	Equalizer beam end bushing installer
3	3-1/2" O.D. x 7" Long	Equalizer beam center bushing remover and installer

Table 1 Adapter Chart

LOCATION	THREAD SIZE	RECOMMENDED TORQUE FT-LBS
Spring Center Bolt Nut	1/2"	65-75
Spring Pin Draw Key Nut	-	75-100
U-Bolt (Spring To Saddle Nut)	-	237-300
Spring Rear Hanger Rebound Bolt Nut	1/2" - 13	80-85
Bolt Nylock (Saddle Cap)	-	310-340
Torque Rod Stud Nut	1-1/4" - 12 UNF	175-225
Adapter Bolt Nut	3/4" - 16 NF	210-240
Beam Hanger Tube Nut	-	375-425

Lubricate all threads with S.A.E. 20 oil before assembly to obtain effective torque for maximum service life from suspension system. Mounting bolts, studs, and nuts should be checked quarterly and tightened to specified torque. This check to be made monthly in "off-the-road" or "rough service" operations.

Table 2 Torque Specification Chart

GENERAL DISCUSSION

The R340 & R380 suspensions are available with two types of equalizer beam center bushings - rubber, or bronze with steel back. When changing from rubber to bronze center bushing, the equalizer beam must be drilled and tapped for a grease fitting. Refer to Fig. 1 for dimensions. The information for removal and installation of the beam is covered in this manual under the applicable subject for each respective series.

CENTER BUSHING REMOVAL AND INSTALLATION

CENTER BUSHING REMOVAL (RUBBER)

When changing the equalizer beam center bushings from rubber to bronze steel back, use the following procedures:

1. Refer to Beam Bushing Adapter Chart (Table 1) for correct size adapter.
2. Position beam in press.
3. Press out center bushing then clean hub surface of rust or corrosion, and smooth down any rough surfaces.

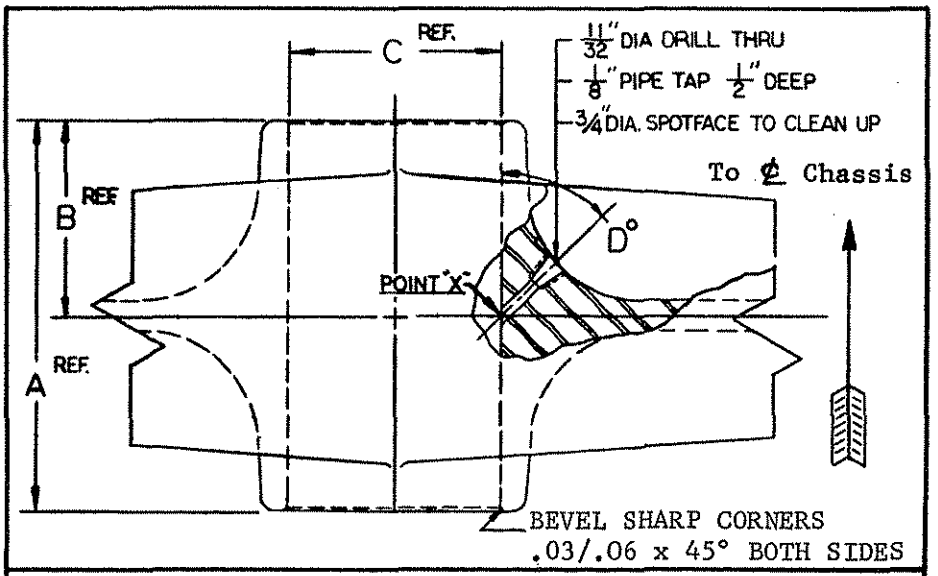
CENTER BUSHING INSTALLATION (BRONZE STEEL BACK)

1. Apply a coating of rust preventive to the inside bore of the beam hub, and the outer surface of the beam center bushing assembly. Be sure the grease grooves in the bushing are positioned as shown in Fig. 2. Press the bushing into the beam hub until it is centered.
2. After the bushing is installed in the beam, it is necessary to hone the bushing to .002" larger than the center sleeve outside diameter for working clearance.
3. Press the new seals into the hub with the lip of the seal facing outward. (Fig. 2) This allows the used grease to be expelled; yet prevents water and contaminants from entering the bearing surface.
4. Install grease fitting in beam hub. Apply a thin coating of chassis grease to the outer surface of the beam center sleeve, and insert sleeve into the beam center bushing. Apply grease through fitting, and rotate the center sleeve to assure complete lubrication of the bushing surface. Continue until the grease appears at both seals.
5. Install an equal number of thrust washers on each side of the beam center sleeve, until the overall dimension of washers plus equalizer beam hub width equals the inside saddle dimension to within less than one washer thickness (Fig. 3).

Ident. No.	Adapter Size	Suspension Model	Application
1	3-1/2" O.D. x 7" Long	340	Equalizer beam center bushing remover and installer
2	4-5/8" O.D. x 7" Long	380	Equalizer beam center bushing remover and installer

Table 1 Beam Bushing Adapter Chart (Adapters can be made locally from standard tubing.)

SPECIFICATIONS



BEAM HUB DIMENSIONS

A	-	6.750"
B	-	3.375"
C	-	3.613" to .617" - R340
C	-	4.738" to .742" - R380
D° & X	-	45° angle as shown

Fig. 1

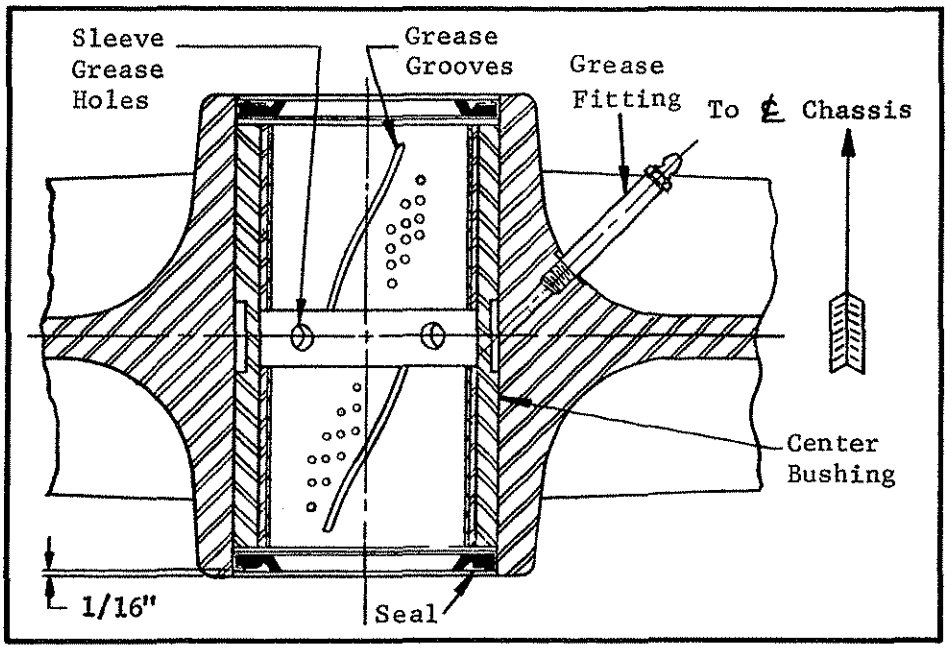


Fig. 2

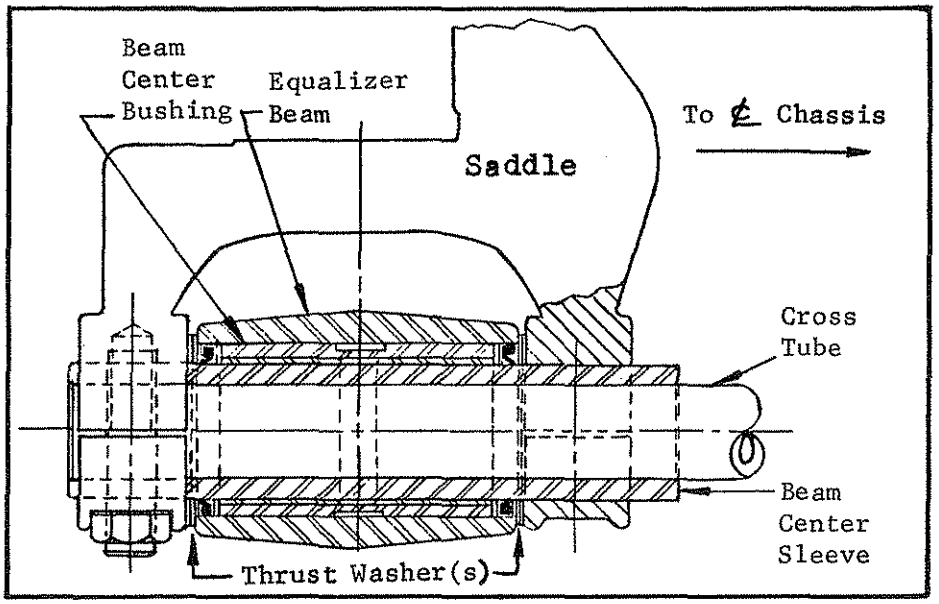

Beam
Center
Bushing
Equalizer
Beam
Saddle
To ℄ Chassis
Cross
Tube
Beam
Center
Sleeve
Thrust Washer(s)

Fig. 3

GENERAL DESCRIPTION

The Neway Air Suspension uses pressurized air, drawn from the turck air system, to form the load-carrying air spring. Automatic control valves regulate the air pressure to the air springs, thereby compensating for varying loads by maintaining a constant vehicle riding height. An automatic brake protection valve is used to maintain a safe air brake pressure of 65 lbs. in the event of an air loss in the suspension system.

PRE-OPERATIONAL CHECK

Before the tractor is placed into service, inspect as follows:

1. With the engine running to maintain air pressure in excess of 65 psi and the vehicle parked on a level surface.
   - 1.1 All air springs should be of equal firmness. If not, check air lines for restrictions and air leakage. Remove air restrictions and/or replace leaking air springs or air lines.
   - 1.2 Dimension from axle horizontal centerline to underside of frame should be 10.00" ± .12". If not, adjust height control valve until above dimension is achieved.
   - 1.3 The air springs must have a clearance of at least 1 3/4" around the rubber air cell. If clearance is less than 1 3/4" clearance, relocate obstructing parts.

2. With the engine shut off, check the suspension air system for air leaks. If leaks are present, correct before operating vehicle. Failure to do so can result in inadequate suspension height.

3. Tighten all nuts and bolts using the values given in Table 1 under SPECIFICATIONS.

OPERATING INSTURCTIONS

The truck air pressure must be built up and maintained in excess of 65 psi to inflate the air springs before operating vehicle. If an air leak occurs in the suspension system, stop truck, and make the necessary repairs. If the repairs cannot be completed, proceed as follows:

Disconnect the height control valve linkage and rotate the valve levers to the vertical down, deflated position. The air spring internal rubber bumpers will support the load, while vehicle is being moved to the nearest repair facility. Since the vehicle will not have the articulation capacity of a standard suspension, the operation should be done at a reduced speed and with extreme care.

CAUTION: The air suspension is controlled by sensitive air valves, the air supply must be kept free of moisture, oil or any foreign matter. Air tanks must be drained daily, fitlers drained regularly, and air compressor maintained in good operating condition. Failure to follow the above recommendations may result in an unsafe operating condition.

INSPECTION CHECK

FIRST 1,000 AND 3,000 MILES (PHYSICAL)

1. Tighten all nuts and bolts to torque, as covered under SPECIFICATIONS, Table 1. Check all suspension air line fittings for tightness; tighten all loose fittings. Check hoses and hose support brackets; reposition all configurations that could contact and result in wear.

2. Check all air springs for equally inflated firmness. If not equally firm, check air lines for restrictions, and air springs and air lines for air leakage. Remove air restrictions and/or replace leaking air springs, or air lines.

3. Check ride height dimension. If not 10.00" ± .12" from axle horizontal centerline to underside of frame, adjust height control valve until above dimension is achieved. Park on level surface for this check.

DAILY (VISUAL)

1. Check air springs for inflation. If under-inflated, resolve in accordance with TROUBLE SHOOTING Table on following pages.

2. Check for worn, loose or broken parts. Tighten all loose parts, and replace any broken or worn parts.

EVERY 30 DAYS (VISUAL)

1. Tighten all nuts, bolts and air connections to specifications given in Table 1.

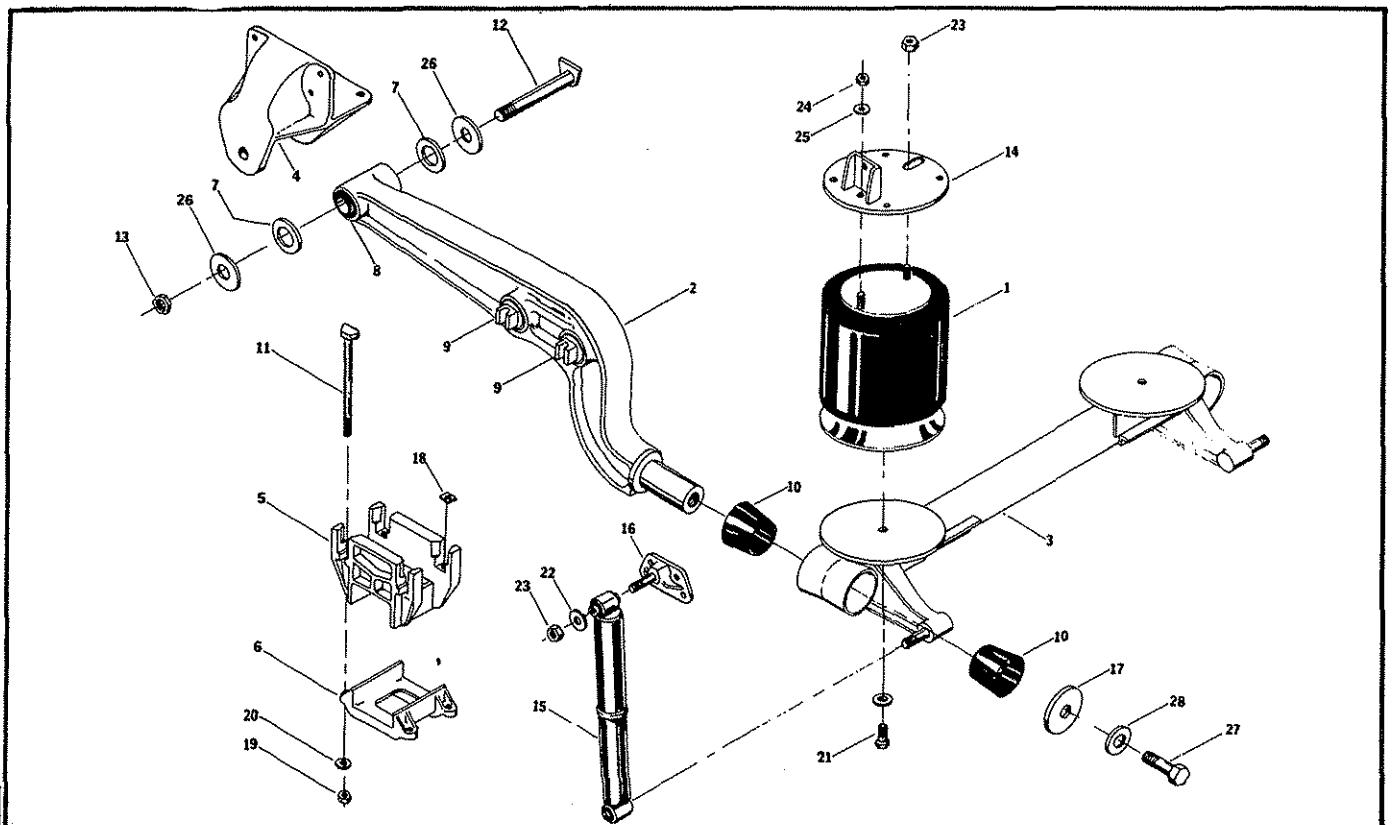
2. Check all air springs for equally inflated firmness. If not equally firm, check air lines for restrictions, air springs and air lines for air leakage. Remove all restrictions and/or replace leaking air springs or air lines.

3. Check for broken and worn parts. Replace any broken and/or worn parts.

4. Check for wear from insufficient clearance around air springs, shock absorbers, air brake chambers and tires. Relocate obstructing parts.

EVERY 90 DAYS (PHYSICAL)

1. Thoroughly check all items listed for 30 day inspection.



1. AIR SPRING
2. EQUALIZING BEAM
3. TRANSVERSE BEAM, W/SHOCK BRACKET
4. FRAME BRACKET
5. UPPER AXLE ADAPTER
6. LOWER AXLE ADAPTER
7. SPACER WASHER
8. BEAM PIVOT BUSHING
9. AXLE CONNECTION BUSHING
10. TRANSVERSE BEAM BUSHING
11. ROD BOLT
12. ROD BOLT
13. LOCK NUT , ROD BOLT
14. AIR SPRING MOUNTING PLATE
15. SHOCK ABSORBER
16. UPPER SHOCK ABSORBER BRACKET
17. SPACER WASHER
18. SHIM , PLANING
19. LOCK NUT , ROD BOLT
20. WASHER
21. CAPSCREW
22. WASHER
23. LOCK NUT
24. HEXAGON NUT
25. LOCK WASHER
26. SPACER WASHER
27. CAPSCREW
28. LOCKWASHER

Fig. 1 SUSPENSION NOMENCLATURE

2. Block front wheels with chock block, then block up rear of tractor until tires clear floor and suspension is fully extended. Use safety blocks under frame.
   - 2.1 Air springs should be completely deflated.
   - 2.2 Inspect air spring for wear at its connection to the pedestal. If wear is present, replace air spring.
   - 2.3 Check shock absorbers for oil leakage and worn rubber bushings. If shock absorber(s) is leaking and/or rubber bushings are worn, replace with new shock absorber and/or rubber bushings.

3. Remove front wheel chocks and frame safety blocks. Let the tractor down. All of the air springs should inflate equally if height control valves function properly and air reservoir pressure is in excess of 65 psi. If inflation is unequal, repeat 90 day check using new height control valve. (Make sure air reservoir pressure is in excess of 65 psi.)

SERVICE OPERATIONS

EQUALIZING BEAM REPLACEMENT

1. Block front wheels with chock block. Remove all the weight from the suspension by jacking and blocking up the tractor frame.

2. If unit is a single rear axle vehicle, disconnect the height control valve linkage from the lower connection. This applies to a tandem unit only if the height control valves are attached to the beam being removed.

3. Remove the capscrews and washers connecting the air spring to the transverse beam. (Fig. 1, Ref. 21)

4. Remove the nuts and washers connecting the shock absorber to the transverse beam. (Fig. 1, Ref. 23)

5. Remove the capscrews and washers connecting the transverse beam to the equalizing beam. (Fig. 1, Ref. 27)

6. Pull the transverse beam back free from the equalizer beams.

NOTE: In some instances the transverse beam bushings will take set making it difficult to remove the transverse beam. In order to remove it, use a porta-power between the axle housing and transverse beam.

7. Remove the locknut, washers and rod bolt connecting the equalizing beam to the frame bracket. (Fig. 1, Ref. 12)

8. IMPORTANT: Before removing the axle connection rod bolts, note the number of shims between the axle connection bushings and adapters. These must be installed exactly as removed, or the pinion angle will be affected. Remove the axle connection nuts, washers and rod bolts, then lift the equalizing beam from the axle adapter.

9. Replace equalizing beam, reversing the preceding steps using caution to install shims and front spacer washers in original position. Remove blocks from front wheels and from frame.

EQUALIZING BEAM BUSHING(S) REPLACEMENT

1. With the equalizing beam removed, press out the bushings with a hydraulic press using approximately 5,000 to 6,000 lbs.

2. Clean out the bushing receptacles.

3. Lubricate the new bushings with a non-oil lubricant such as rubber lubricant

4. Align the (axle connection) bushing with the beam end positioned to accept the beam retaining bolts. Press the bushing slightly pass center, then turn the beam over and press the bushing back to a centered position.

AXLE ADAPTER(S) REPLACEMENT

1. Measure and mark the axle adapters

center position on the axle housing before removing. The axle adapters must be parallel when reinstalled.

2. When burning weld to remove the adapters, use extreme care to avoid cutting into the axle housing. Failure to do so could result in damage to the housing.

3. Use a suitable low-hydrogen welding rod such as 7018 or 718 classification to weld the adapters to the axle housing. Weld full horizontal welds on both upper and lower castings. See welding diagram located under SPECIFICATIONS.

SHOCK ABSORBER REPLACEMENT

1. Remove nuts and washers connecting the shock absorber to the upper and lower mounting pins.

2. If the shock absorber is fully extended, jack up the axle to relieve the tension, then remove the shock absorber.

3. If the inner metal sleeve is rusted to the mounting pin, use a small sharp chisel to force the sleeve from the pin.

4. Install new shock absorber by reversing removal procedure.

AIR SPRING REPLACEMENT

1. Remove all weight from the air springs. All the air pressure in the suspension system will be exhausted through the height control valve.

2. Disconnect the air supply line from the air spring.

3. Remove the nuts and washers connecting the air spring to the upper mounting plate. (Fig. 1, Refs. 23, 24 and 25)

4. Remove the capscrew connecting the air spring to the transverse beam's lower mounting plate. (Fig. 1, Ref. 21)

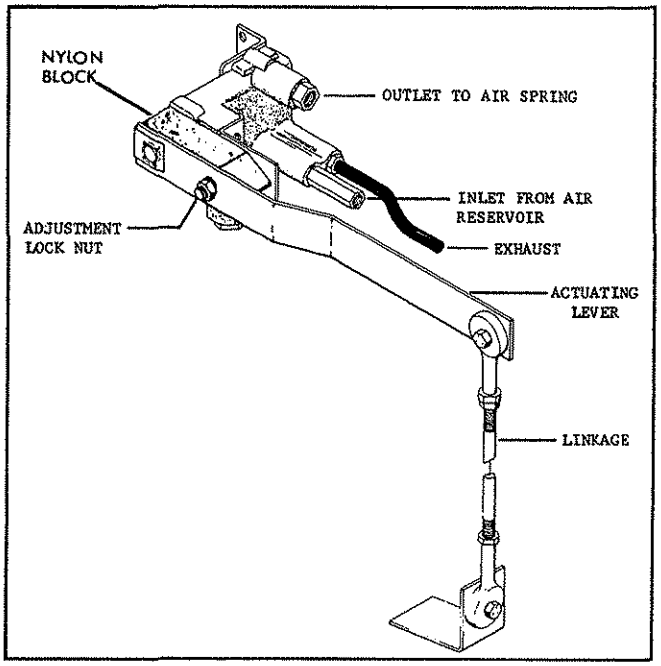


Fig. 2 HEIGHT CONTROL VALVE

5. Install the new air spring using 25 ft-lbs of torque when tightening the upper air spring mounting stud nuts. (Fig. 1, Ref. 23 and 24)

CAUTION: Do not exceed 25 ft-lbs of torque. Failure to install air spring as described, could result in an unsafe operating condition.

HEIGHT CONTROL VALVE ADJUSTMENT

1. Position the vehicle on a level area with the engine running to maintain air pressure in excess of 65 psi re- (Required for adjusting the control valves.)

2. Remove the bolts that attach the height control linkages to the actuating levers. Disconnect both height control valve linkages from the actuating levers.

3. Exhaust air from all the air springs by moving both actuating levers to the vertical down position.

4. Connect one of the actuating levers to its respective linkage. This will allow the air spring controlled by this valve to fill up with air.

5. Measure the distance from the centerline of the axle to the underside of the frame in the same area that the valve and linkage are located. This dimension should be 10.00" ± .12". If it is not, adjust the valve by loosening the adjustment lock nut and carefully moving the nylon block until the correct height dimension is reached. (Fig. 2)

NOTE: Because of a built-in time delay it will require from 2 to 6 seconds after moving the nylon block before a change will occur in the height dimensions. A

6. Tighten the adjustment lock nut, then disconnect the linkage and allow the air spring to deflate about half way. Reconnect the linkage to inflate the air spring , and recheck the height dimension. Repeat steps 5 and 6 until the correct height dimension is achieved.

7. Disconnect this properly set height control valve and move the actuating lever to the vertical down position to deflate the air spring

8. Adjust the other height control valve in accordance with steps 5 and 6

9. Connect both linkage assemblies to the actuating levers. Both height dimensions should now be equal and both valves synchronized. If not, repeat steps 5 thru 9 until height equalization and valve synchronization is achieved.

WARNING: Failure to properly adjust height control valves could result in an unsafe operating condition.

TROUBLE SHOOTING

PROBLEMS	POSSIBLE CAUSE	CORRECTIONS
All Air Springs Flat	Insufficient Air Pressure Supplied to Suspension	Build Up Air Pressure in Excess of 65 PSI
	Leaking or Broken Line(s) in Vehicle or Suspension Air System	Locate and Repair, or Replace Line
Air Springs Flat on One Side Only	Improperly Adjusted Height Control Valves	Readjust Height Control Valves
	Air Springs Blown Out or Leaking Severely	Replace Air Spring
	Defective Height Control Valve	Replace Height Control Valve
	Bent or Broken Valve Linkage	Repair or Replace Linkage
	Leaking or Broken Line in Suspension System	Locate and Repair, or Replace
Tractor Leans	Improperly Adjusted or Malfunctioning Height Control Valves	Readjust or Repair Height Control Valve(s)
	Air Spring Blown Out or Leaking	Repair or Replace Air Spring

continued

TROUBLE SHOOTING

PROBLEMS	POSSIBLE CAUSE	CORRECTIONS
Tractor Leans(cont'd)	Leak(s) in Suspension Air System	Repair Air Leak(s)
Suspension Deflates Rapidly When Parked	Leak(s) in Air Suspension System	Locate and Repair Air Leak(s)
	Leaking Air Spring	Check for Puncture or Wear, Repair or Replace Air Spring
Air Spring Blown Out	Air Spring Punctured or Cut	Repair with Hot Patch Inside and Out if Cut is Less Than 1/8" Long. If More Than 1/8" Long, Replace Air Spring
	Tires or Rims Rubbing Air Spring	Change to Narrower Tires and Rims to Provide More Clearance A
	Air Brake Chamber Rubbing Air Spring	Relocate Brake Chambers on Axle to Provide More Clearance with Factory Approved Parts and Instructions
	Suspension Operated Without Air Pressure in Springs	Refer to Air Springs Flat on One Side Only; Make Corrections as Listed
	Continual or Repeated Overextension of Air Spring	Suspension Riding too High, Adjust Height Control Valves
		Shock Absorber Broken, Replace Shock Absorber
		Upper Shock Mount Bracket Improperly Installed or Broken Off, Reposition Bracket
Tractor Rides Too High or Low	Improperly Adjusted Height Control Valves	Readjust Height Control Valve
	Improper Installation of Height Control Valves	Install Height Control Valves in Accordance With Height Control Valve Adjustment Procedures given on prior pages

SPECIFICATIONS

DESCRIPTION OR BOLT SIZE	RECOMMENDED TORQUE IN FT-LBS (LUBRICATED THREADS)
Air Spring Mounting Bolt Nuts	25
1/4"	20 - 25
5/8"	90
5/8" Axle Connection Rod Bolts Only	175
3/4"	100
1 1/4"	450

Table 1 Suspension Torque Specifications

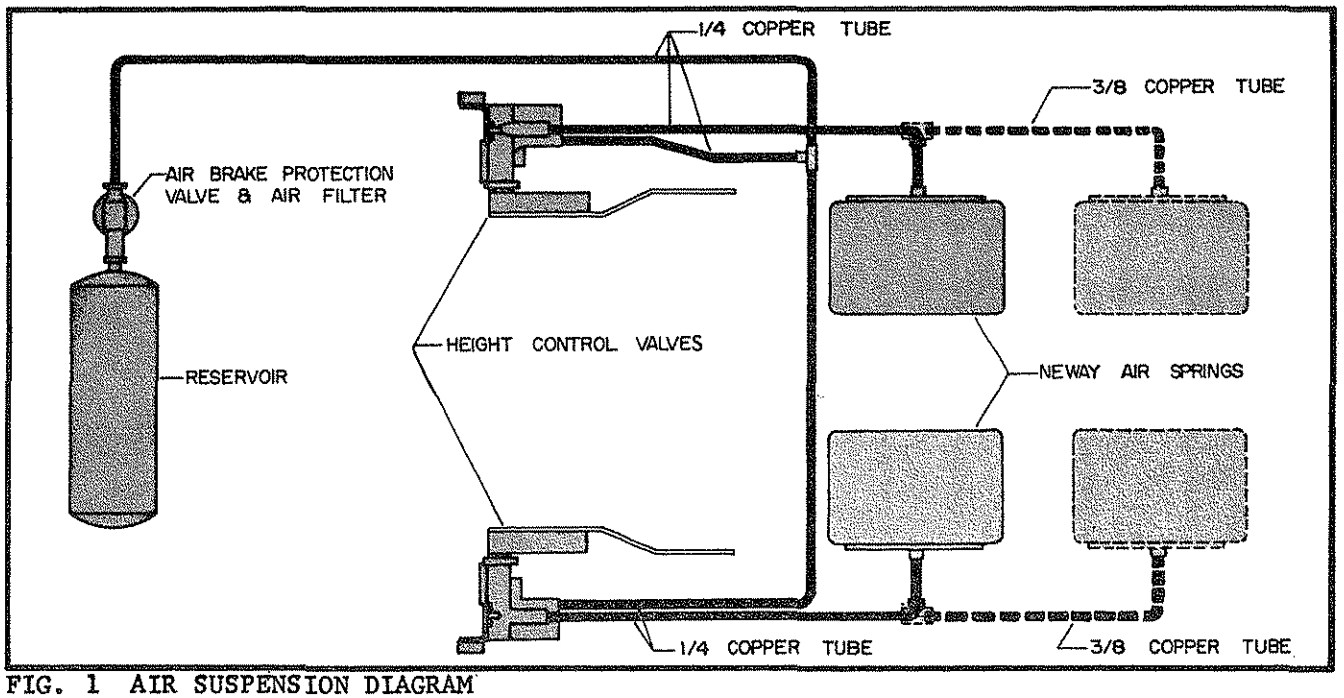


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FIG. 1 AIR SUSPENSION DIAGRAM

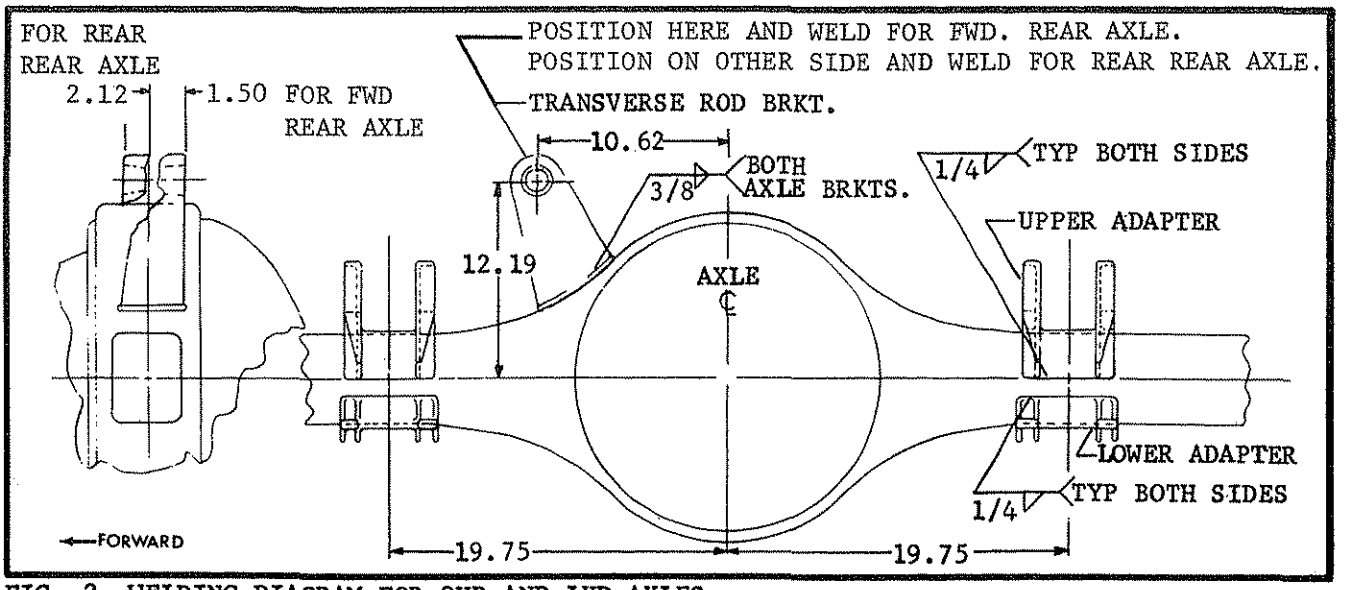


FIG. 2 WELDING DIAGRAM FOR QHD AND LHD AXLES

For Welding Use Low Hydrogen Rod 718 or 7018 A.W.S. Classification

A

SPECIFICATIONS

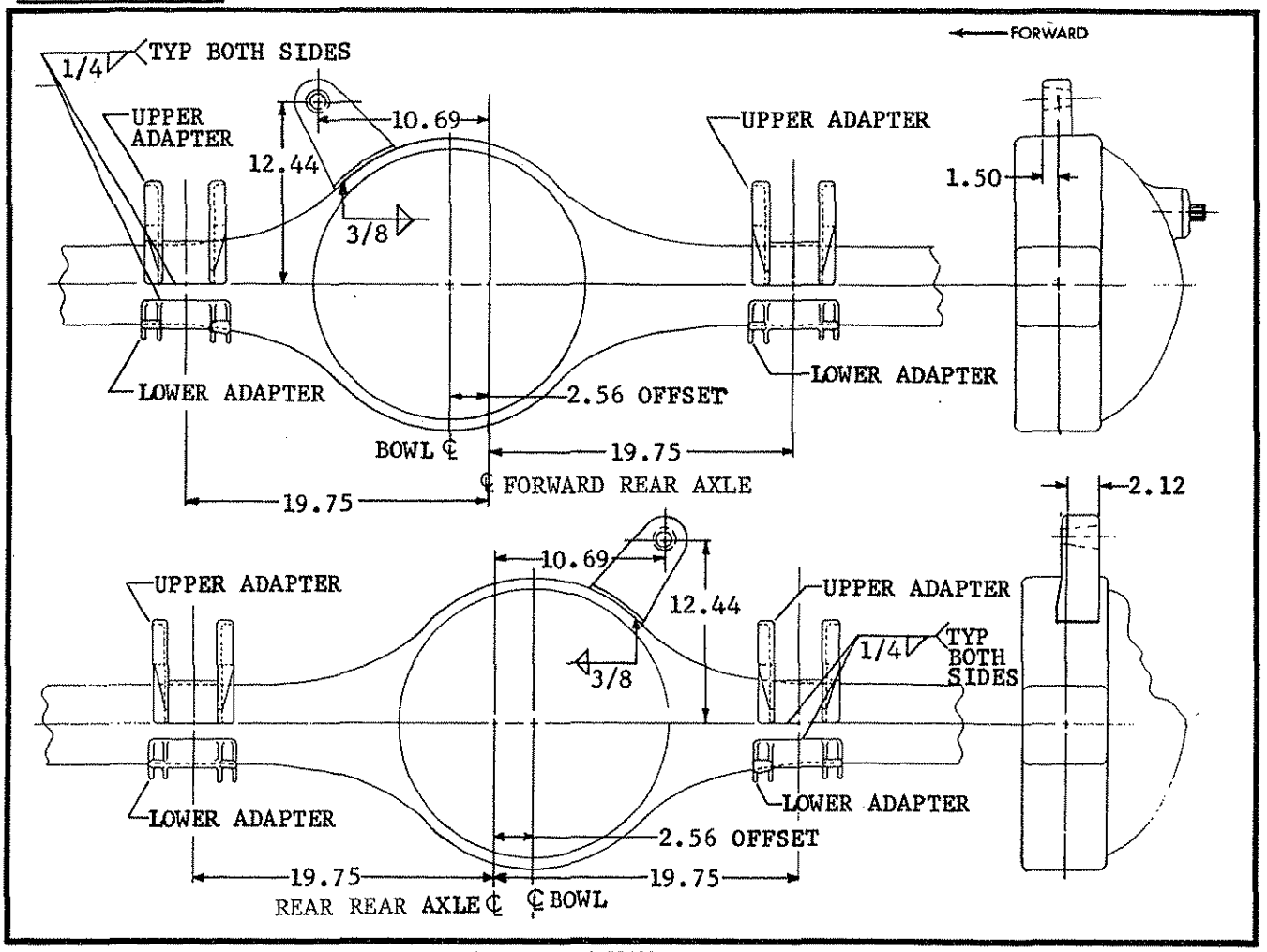


FIG. 3 WELDING DIAGRAM FOR SHD AND RHD AXLES

For Welding, Use Low Hydrogen Rod 718 or 7018 A.W.S. Classification

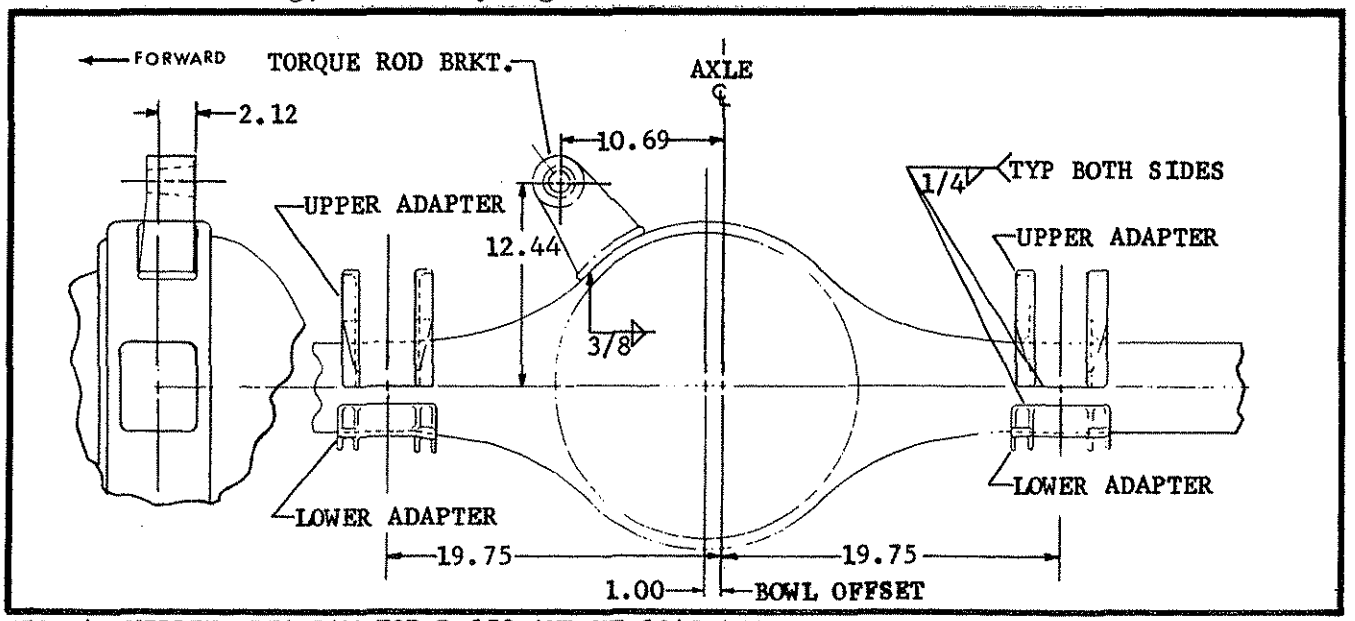


FIG. 4 WELDING DIAGRAM FOR R-170 AND WT-134C AXLES

GENERAL DESCRIPTION

Neway suspension system models ARD 125-8 (Fig. 1) and ARD 244-8 use inflatable air springs to provide a constantly stable and cushioned ride under varying road conditions throughout the vehicle's load range. The air springs use pressurized air, drawn from the vehicle's air brake reservoir (Fig. 3) through automatic height control valves that regulate air pressure within the air springs, to maintain a constant vehicle riding height.

The air springs are mounted on platforms at the outboard ends of two longitudinal equalizing beams. The forward ends of the equalizing beams are journaled to mounting brackets that are rigidly attached to the vehicle frame rails. The axle is mounted above the equalizing beams on hangers that are journaled to the beams. Direct acting shock absorbers are mounted between the axle and the frame rails.

A torque rod mounted longitudinally between a frame crossmember and the axle housing prevents torque-induced rotation of the axle, and maintains the axle plane angle. A similar rod mounted laterally between the frame rail and the axle housing prevents lateral movement of the axle.

The ARD 125-8 suspension system is for single axle installations. Two of the single axle units make up the ARD 244-8 suspension system for tandem installations. Both models allow the axle 8 inches of vertical travel, and thus are suitable for both on and off highway operation. The maximum loading capacity of the ARD 125-8 suspension system is 22,500 lbs; and maximum loading capacity of model ARD 244-8 is 44,000 lbs.

Should a leak occur in the suspension air system, an automatic pressure holding valve will maintain a safe air brake pressure of approximately 65 psi. The air springs are equipped with internal solid rubber bumpers to support the vehicle and its load in the event of a loss of air pressure from the suspension system.

If the vehicle must be moved before repairs can be made, disconnect the height control valve linkages and rotate the actuating levers to the vertical down, deflated position (Fig. 4). Bleed the air springs down until the weight of the vehicle is being carried on the solid rubber bumpers. The

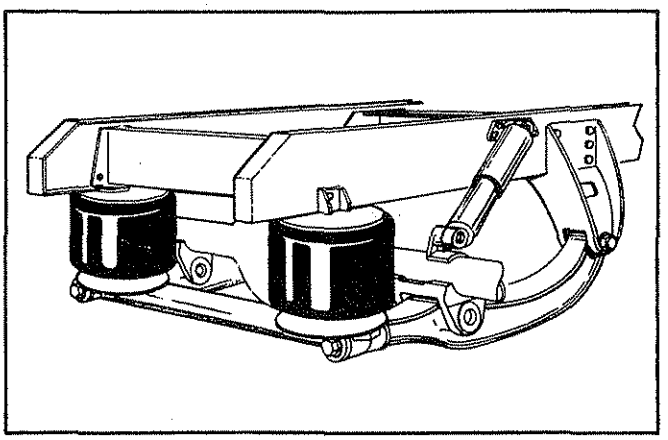


Fig. 1, Neway Air Ride Suspension ARD 125-8

vehicle should not, under any circumstances, be driven in excess of 30 mph with the suspension in this condition; and it should be driven only as far as the nearest repair facility.

Air suspension systems are controlled by sensitive air valves. The air system must be kept free of any oil, moisture or foreign matter. Air tanks should be drained daily, filters drained weekly and the compressor maintained in good operating condition.

WARNING: Failure to take precautions against the entry of moisture, oil or foreign matter into the suspension air system could result in a hazardous vehicle operating condition.

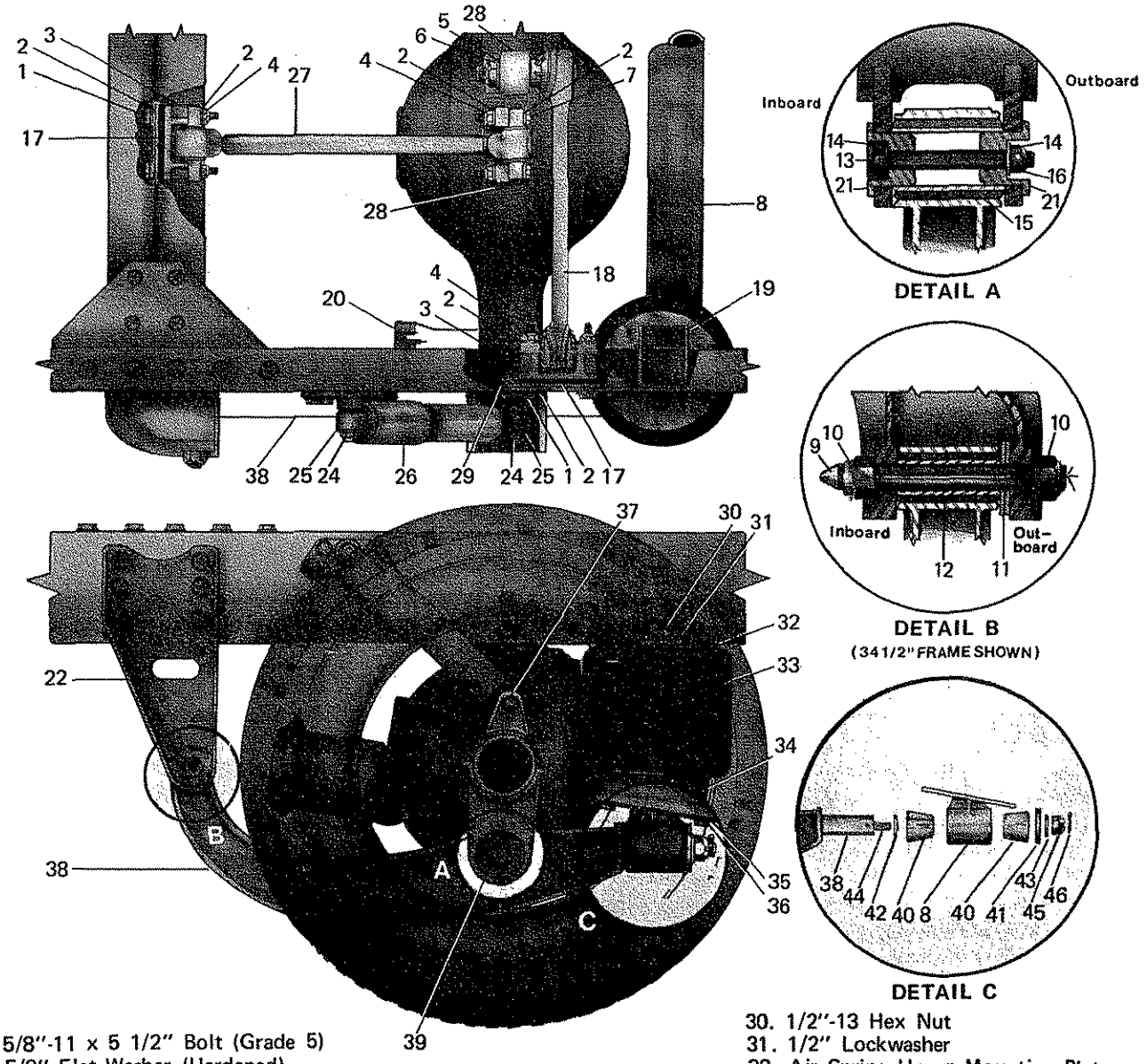
INSPECTION CHECKS

FIRST 1,000 AND 3,000 MILE INSPECTION CHECK

1. Tighten all nuts and capscrews to the torque values listed on Tables 1 and 2 under "SPECIFICATIONS."

2. Determine if there is any air leakage from air lines or fittings in the suspension air system (Fig. 3). Tighten loose fittings to stop air leakage. If tightening fails to stop the air leakage remove the leaking parts and inspect for damage, wear, deterioration and other defects. Replace all defective parts with new ones.

3. Make certain that all hoses and support brackets are positioned away from each other



1. 5/8"-11 x 5 1/2" Bolt (Grade 5)
2. 5/8" Flat Washer (Hardened)
3. Control Rod Mount
4. 5/8"-11 Locknut (Brade B)
5. 1 1/4" Flat Washer (Hardened)
6. 1 1/4"-12 Locknut (Grade B)
7. 5/8"-11 x 4" Bolt (Grade 5)
8. Transverse Beam
9. 1 1/4"-12 Rod Bolt
10. 1 1/4"-12 Locknut (Grade B)
11. Spacer Washer
12. Equalizing Beam Front Bushing
13. 3/4"-16 x 7" Bolt (Grade 5)
14. 3/4" Flat Washer (Hardened)
15. Equalizing Beam Center Bushing
16. 3/4"-16 Locknut (Grade B)
17. Axle Alignment Shim(s)
18. Lateral Rod
19. 3/4"-16 Thin Locknut
20. Height Control Valve
21. Beam Hanger Bracket Adapter
22. Frame Bracket
23. Shock Absorber Upper Bracket
24. 3/4"-16 Shock Absorber Locknut
25. 3/4" Flat Washer (Hardened)
26. Shock Absorber
27. Torque Rod
28. Axle Bracket
29. Backing Plate
30. 1/2"-13 Hex Nut
31. 1/2" Lockwasher
32. Air Spring Upper Mounting Plate
33. Air Spring
34. Air Spring Piston
35. Air Spring Lower Mounting Plate
36. 1/2"-13 x 1" Capscrew
37. Shock Absorber Lower Bracket
38. Equalizing Beam
39. Beam Hanger Bracket
40. Transverse Beam Bushing
41. Retainer Washer
42. 1 1/4" Internal Tooth Lockwasher
43. 1 1/4" Flat Washer (Hardened)
44. 1 1/4"-12 Stud (Grade 5)
45. 1 1/4"-12 Locknut (Hardened)
46. Cotter Pin

Fig. 2, Single Axle Suspension (Model No. ARD 125-8)

and away from all moving parts. Reposition any configurations that could contact and result in friction and wear.

4. Visually check to see that all air springs are inflated. If any air springs are not inflated, refer to the "TROUBLE SHOOTING" section for possible causes of, and corrective measures for failure to inflate.

PRE-TRIP INSPECTION CHECK

1. Park the vehicle on a level surface, and block the wheels. Run the engine to build up and maintain a vehicle air pressure of at least 70 psi throughout the system. Release the parking brake.

2. Visually check to see that all air springs are inflated. If any air springs are not inflated, refer to the "TROUBLE SHOOTING" section for possible causes of, and corrective measures for failure to inflate.

3. With the vehicle engine shut off, listen for leakage from the air springs, fittings, lines and valves. Tighten loose fittings and/or replace defective parts to stop leakage.

4. Visually check for worn, loose or broken parts. Tighten any loose parts to the torque values listed on Tables 1 and 2 under "SPECIFICATIONS," and replace any defective parts with new ones.

30 DAY INSPECTION CHECK

1. Tighten all nuts and capscrews to the torque values listed on Tables 1 and 2 under "SPECIFICATIONS."

2. Visually check to see that all air springs are inflated. If any air springs are not inflated, refer to the "TROUBLE SHOOTING" section for possible causes of, and corrective measures for failure to inflate.

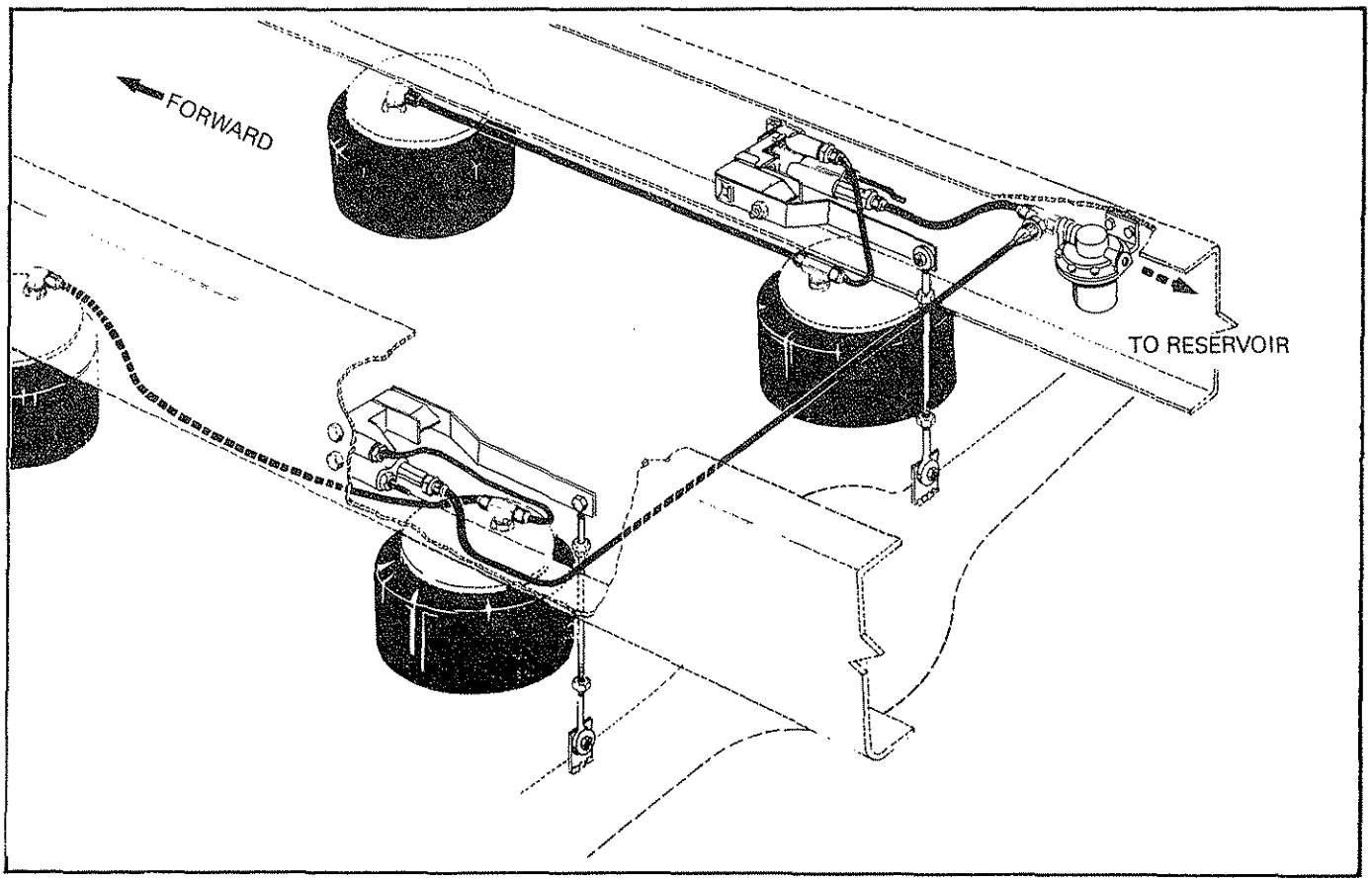


Fig. 3, Air Suspension Diagram

3. Make certain that all hoses and support brackets are positioned away from each other and away from all moving parts. Reposition any configurations that could contact and result in friction and wear.

4. Determine if there is any air leakage from air lines or fittings in the suspension air system (Fig. 3). Tighten loose fittings to stop air leakage. If tightening fails to stop leakage, remove the leaking parts and inspect for wear, damage, deterioration and other defects. Replace all defective parts with new ones.

90 DAY INSPECTION CHECK

1. Follow the instructions given for the 30 day inspection check.

2. Block the front wheels to prevent vehicle movement, then raise the rear of the vehicle frame so the tires just clear the floor and the suspension is fully extended. Place safety stands under the frame.

   .1 Squeeze all air springs to check for complete deflation. If any air springs remain partially or fully inflated, refer to the "TROUBLE SHOOTING" section for possible causes of, and corrective measures for failure of the air springs to fully deflate when all weight is removed from the suspension.

   .2 Visually inspect the air springs for wear at the connections to the pistons. Replace any air springs upon which wear is present.

   .3 Visually check the shock absorbers for oil leakage and worn rubber bushings. Replace shock absorbers and/or rubber bushings if wear, damage or other defects are noted.

3. Remove the safety stands, and lower the vehicle to the floor. Start and run the engine to build up and maintain a vehicle air pressure of at least 70 psi throughout the system. Visually check to see that all air springs are inflated. If any air springs are not inflated, refer to the "TROUBLE SHOOTING" section for possible causes of, and corrective measures for failure of the air springs to inflate.

WARNING: Failure to perform the periodic inspection checks recommended above could result in a hazardous vehicle operating condition.

SERVICE OPERATIONS

IMPORTANT: All suspension brackets that are in contact with the vehicle frame must be attached with Grade 8 bolts, Grade C nuts, and hardened flat washers. The washers are to be installed under both the bolt head and the nut. At all points where aluminum parts are fastened to steel parts, use Alumilastic compound on the mating surfaces, to prevent electrolysis and corrosion.

HEIGHT CONTROL VALVE ADJUSTMENT

Adjustment of the height control valves should be performed with the vehicle on a level surface, under an evenly distributed load equal to that encountered under normal operating conditions. Adjust the height control valves one at a time, as follows:

1. Park the vehicle on a level surface, and block the wheels. Run the engine to build up and maintain a vehicle air pressure of at least 70 psi throughout the system.

2. Remove the bolts that secure the height control valve linkages to the actuating levers (Fig. 4). Disconnect both height control valve linkage assemblies from the actuating levers.

3. Exhaust all air from all air springs by moving both actuating levers to the vertical down position.

4. Connect one of the actuating levers to its respective linkage, and allow the air spring(s) controlled by the valve to fill until the valve shuts off.

5. Measure the distance from the underside of the frame rail to the centerline of the axle (Fig. 2). This dimension should be 10 inches. Adjust the height control valve by loosening the adjustment locknut (Fig. 4) and moving the actuating lever slightly, relative to the nylon block. When the 10 inch height dimension is achieved, retighten the adjustment locknut.

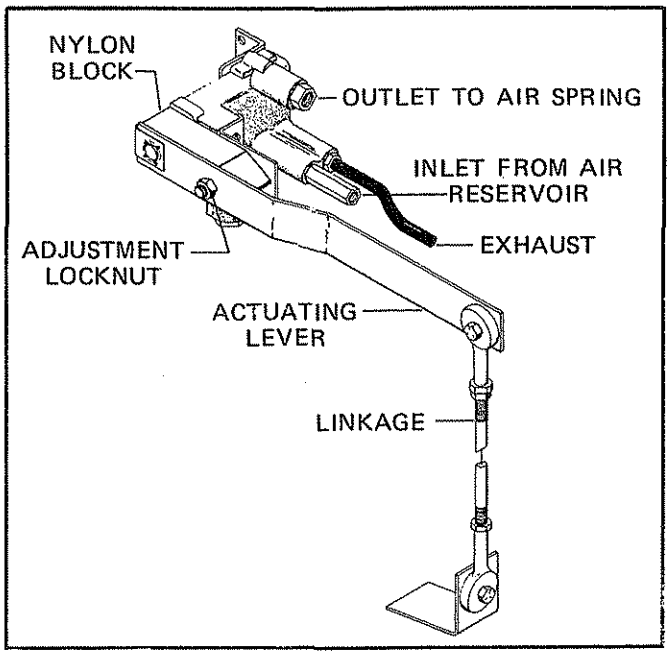


Fig. 4, Height Control Valve

6. Disconnect the actuating lever from the linkage, and rotate it downward to deflate the air spring(s) about half way. Reconnect the linkage to inflate the air spring(s), then check the height dimension. Repeat steps 5 and 6 until the height dimension measures 10 inches.

7. When the height control valve is adjusted disconnect the actuating lever from the height control valve linkage, and rotate it to the vertical down position to fully deflate the air spring.

8. Perform "HEIGHT CONTROL VALVE ADJUSTMENT" steps 4 through 7 on the other height control valve.

9. Connect both linkage assemblies to the actuating levers. All height dimensions should now be equal. If they are not, check for loose mounting bolt nuts on the height control valves. Tighten any loose nuts or capscrews to the torque values given in Tables 1 and 2 under "SPECIFICATIONS." Repeat the adjustment procedure until all height dimensions are 10 inches.

WARNING: Failure to adjust the height control valves as explained above could result in an unsafe vehicle operating condition.

SHOCK ABSORBER REPLACEMENT

1. Remove the locknuts (Fig. 2, Ref. 24) from the shock absorber upper and lower mounting brackets.

2. If the shock absorber if fully extended, block the vehicle wheels, and jack up the axle to relieve the tension, then remove the shock absorber. If the inner metal sleeve is rusted to the mounting pin, use a small, sharp chisel to force the sleeve from the pin.

3. Install the new shock absorber on the mounting pins, and secure it with the locknuts and washers. Tighten the locknuts to 150 ft-lbs torque.

AIR SPRING REPLACEMENT

1. Block the front wheels to prevent vehicle movement. Raise and block the vehicle frame to remove all weight from the air springs. All air pressure will automatically be released from the air springs by the height control valves.

2. Taking care to prevent foreign substances from entering the line or fittings, disconnect the air supply line from the air spring.

3. Remove the 3/4" locknut (Fig. 2, Ref. 19) and the 1/2" nut (Fig. 2, Ref. 30) and lockwasher that secure the air spring to the air spring upper mounting plate (Fig. 2, Ref. 32).

4. Remove the capscrews (Fig. 2, Ref. 36) and lockwashers that connect the air spring to the air spring lower mounting plate (Fig. 2, Ref. 35). Remove the air spring.

5. Position the new air spring on the air spring lower mounting plate, then install the capscrews and lockwashers securing the air spring to the air spring lower mounting plate. Tighten the capscrews to 35 ft-lbs torque.

6. Install the 1/2" nut and lockwasher and the 3/4" locknut connecting the air spring to the air spring upper mounting plate. Tighten the 1/2" nut to 35 ft-lbs torque, and tighten the 3/4" locknut to 150 ft-lbs torque.

7. Taking care to prevent foreign substances from entering the line or fitting, reconnect the air supply line to the air spring.

8. Check the height control valve adjustment as outlined in prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions. If necessary, make adjustments to reach a uniform ride height of 10 inches.

EQUALIZING BEAM REMOVAL

1. Block the front wheels to prevent vehicle movement. Raise and block the frame of the vehicle to remove all weight from the rear suspension.

2. Remove the wheels and tires to provide free access to the suspension being serviced. Block up the axle to prevent it from dropping away from the vehicle when the equalizing beam is removed.

3. With all weight removed from the suspension, the air spring(s) should be fully deflated. If it is not, disconnect the height control valve linkage from the actuating lever (Fig. 4). Rotate the lever to the vertical down position to deflate the air spring(s).

4. Remove the capscrews (Fig. 2, Ref. 36) and lockwashers that secure the air springs to the air spring lower mounting plate (Fig. 2, Ref. 35) on both ends of the transverse beam (Fig. 2, Ref. 8).

5. Remove the cotter pins, locknuts (Fig. 2, Ref. 45), flat washers, and retainer washers (Fig. 2, Ref. 41) from the studs in the ends of the equalizing beams. Tap the transverse beam back, free from the equalizing beams.

NOTE: In some instances, the transverse beam bushings (Fig. 2, Ref. 40) will take set, making it difficult to remove the transverse beam from the equalizing beams. Use a Porta-Power (or equivalent tool) between the axle housing and the transverse beam at a point as near the end of the transverse beam as possible, to remove the beam.

6. Remove the locknut (Fig. 2, Ref. 16) and flat washer from the outboard end of the equalizing beam center bushing bolt (Fig. 2, Ref. 13). Support the equalizing beam on a floor jack, then extract the equalizing beam center bushing bolt from the beam hanger bracket (Fig. 2, Ref. 39).

7. Use a drift to tap the beam hanger bracket adapters (Fig. 2, Ref. 21) from the beam hanger bracket. Lower the equalizing beam to the floor.

8. Remove the locknut (Fig. 2, Ref. 10) from one end of the rod bolt (Fig. 2, Ref. 9). Note the positions of the spacer washers (Fig. 2, Ref. 11) at the side of the equalizing beam, so they can be returned to their original positions upon reassembly. Use a drift to drive the rod bolt out of the frame bracket (Fig. 2, Ref. 22). Remove the equalizing beam from the vehicle.

EQUALIZING BEAM BUSHING REPLACEMENT

1. Remove the equalizing beam from the vehicle following prior "EQUALIZING BEAM REMOVAL" instructions.

2. Use a hydraulic press to remove the equalizing beam front bushing (Fig. 2, Ref. 12) and the equalizing beam center bushing (Fig. 2, Ref. 15). Approximately 2,000 to 3,000 lbs. pressure will be required to press the bushings from the equalizing beam.

WARNING: Do not use a torch to cut the bushing sleeves out of the equalizing beam. To do so could alter the molecular structure of the equalizing beam, seriously weakening the casting, thus resulting in an unsafe operating condition.

3. Using a wire brush and cleaning solvent, clean out the equalizing beam bushing receptacles. Inspect the entire beam for cracks or bends. Replace any damaged equalizing beam with a new one.

4. Lubricate the replacement bushings and the bushing receptacles with a non-mineral lubricant. If standard rubber lubricant is not available, use a soap and water solution or a waterless hand cleaner.

5. Press the replacement bushings into the bushing receptacles with a hydraulic press using

approximately 2,500 lbs. Press the bushings slightly past center, then turn the equalizing beam over and press the bushings back to a centered position.

EQUALIZING BEAM INSTALLATION

1. Position the equalizing beam with the front bushing (Fig. 2, Ref. 12) centered in the frame bracket (Fig. 2, Ref. 22). Push the rod bolt (Fig. 2, Ref. 9) into the frame bracket, and, at the same time, insert the spacer washers (Fig. 2, Ref. 11) into their original positions between the equalizing beam and the frame bracket.

NOTE: The positions of the spacer washers varies according to the width of the vehicle frame. Refer to Fig. 9 under "SPECIFICATIONS" for the proper location of the spacer washers.

2. Lubricate the threads on the rod bolt with SAE-20 oil, then install the locknuts (Fig. 2, Ref. 10). Tighten the locknuts to 700 ft-lbs torque.

3. Raise the equalizing beam so that the center bushing (Fig. 2, Ref. 15) is centered in the beam hanger bracket (Fig. 2, Ref. 39). Insert the beam hanger bracket adapters (Fig. 2, Ref. 21) through the beam hanger bracket, into the equalizing beam center bushing.

4. With a flat washer under the head, insert the center bushing bolt (Fig. 2, Ref. 13) through the beam hanger adapters with the threaded end on the outboard side of the suspension.

5. Lubricate the center bushing bolt threads with SAE-20 oil, then install the flat washer and locknut (Fig. 2, Ref. 16) on the bolt. Tighten the locknut to 200 ft-lbs torque.

6. Lubricate the transverse beam bushings (Fig. 2, Ref. 40) with rubber lubricant (or with a soap and water solution or waterless hand cleaner). Install the internal tooth lockwashers (Fig. 2, Ref. 42), then the inner halves of the bushings on the equalizing beam journals, with the thicker ends toward the front of the vehicle.

7. Install the transverse beam (Fig. 2, Ref. 8) on the equalizing beams, with the air spring lower mounting plates (Fig. 2, Ref. 35) tilted toward the rear of the vehicle. Install the outer halves of the transverse beam bushings on the equalizing beam journals.

8. Apply SAE-20 oil to the threads on the studs (Fig. 2, Ref. 44) at the rear of equalizing beams. Install the retainer washers (Fig. 2, Ref. 41), flat washers, and locknuts (Fig. 2, Ref. 45) on the studs. Tighten the locknuts to 700 ft-lbs torque, then install the cotter pins (Fig. 2, Ref. 46) and lock them in place.

9. Apply SAE-20 oil to the threads of the capscrews (Fig. 2, Ref. 36) that secure the air springs to the air spring lower mounting plates (Fig. 2, Ref. 35), then install the capscrews, with lockwashers, in the air springs. Tighten the capscrews to 35 ft-lbs torque.

10. Install the wheels and tires, then let the vehicle down from its blocks. Check the adjustment of the height control valves, following prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions. If the ride height dimension is not 10 inches, adjust the height control valves to achieve that dimension.

11. After 1,000 miles and again after 3,000 miles following servicing of the suspension, conduct the "FIRST 1,000 AND 3,000 MILE INSPECTION CHECK."

CONTROL ROD SERVICE

Lateral Rod Removal and Inspection

Lateral Rod Removal and Inspection

1. Remove the locknuts (Fig. 5, Ref. 6) and flat washers from the bolts (Fig. 5, Ref. 2) that secure the control rod mount (Fig. 5, Ref. 4) to the vehicle frame rail. Keep track of the axle alignment shim(s) (Fig. 5, Ref. 16) between the control rod mount and the backing plate so they can be returned to their original position upon reassembly.

2. Remove the control rod mount bolts. Swing the lateral rod clear of the control rod mount, and remove the axle alignment shim(s) and the control rod mount.

3. Remove the locknut (Fig. 5, Ref. 9) and flat washer from the ball stud (Fig. 5, Ref. 10) on the inboard end of the lateral rod. Rap the ball stud eye on the lateral rod axle mount (Fig. 5, Ref. 11) with a hammer to loosen the ball stud. If this fails to break it loose, use a tie rod separator tool to remove the ball stud from the lateral rod axle mount. Remove the lateral rod.

4. Remove the seals (Fig. 5, Ref. 7) from both ends of the lateral rod. Clean the seals and rod to remove all dirt and grease.

5. Visually inspect the seals for dryness, cracks or other signs of deterioration and wear. Replace defective seals with new ones. Visually inspect the lateral rod for cracks or bends. Work the ball joint and the lateral rod pin to check for looseness in the fabrylon bushings. If the lateral rod is bent, cracked or otherwise damaged, or if there is any slack in either of the fabrylon bushings, replace the lateral rod with a new one.

Lateral Rod Installation

1. Before installation, make certain that all contact surfaces are free of dirt or other foreign matter. Lubricate all threads with SAE-20 oil.

2. Insert the lateral rod ball stud (Fig. 5, Ref. 10) through the lateral rod axle mount (Fig. 5, Ref. 11), then install the flat washer and locknut (Fig. 5, Ref. 9) on the stud. Tighten the locknut to 225 ft-lbs torque, then rap the lateral rod axle mount with a hammer. Retighten the locknut to 225 ft-lbs torque.

3. Position the control rod mount (Fig. 5, Ref. 4) and the axle alignment shim(s) (Fig. 5, Ref. 16) against the backing plate on the inside of the frame rail, then move the lateral rod into position on the control rod mount.

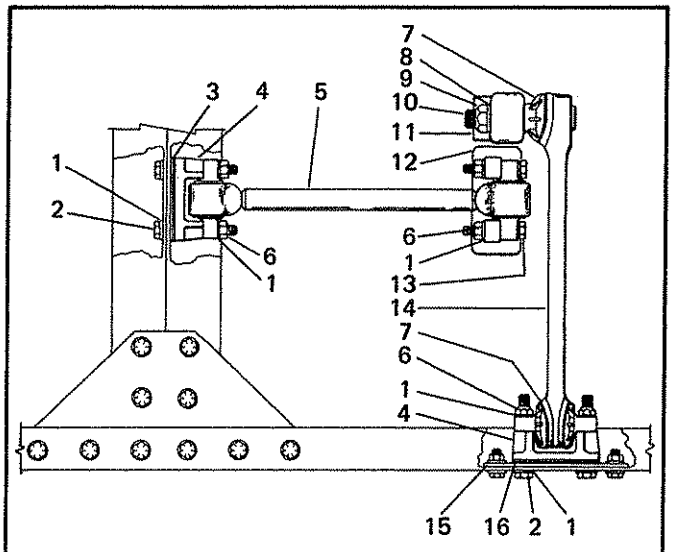
4. Install flat washers on the control rod mount bolts (Fig. 5, Ref. 2), then install the bolts through the frame rail, the backing plate, the shim(s), the control rod mount and the lateral rod pin. Install the flat washers and locknuts (Fig. 5, Ref. 6) on the bolts, then tighten the locknuts to 130 ft-lbs torque.

5. Check the alignment of the axle, following instructions given under "AXLE ALIGNMENT"; and adjust the axle alignment if it is not within the given tolerance.

Torque Rod Removal and Inspection

1. Remove the locknuts (Fig. 5, Ref. 6) and flat washers from the bolts (Fig. 5, Ref. 2) that secure the control rod mount (Fig. 5, Ref. 4) to the vehicle frame crossmember. Keep track of the axle plane shim(s) (Fig. 5, Ref. 3) between the control rod mount and the frame crossmember, so they can be returned to their original position upon reassembly.

2. Remove the control rod mount bolts. Swing the torque rod clear of the control rod mount, and remove the axle plane shim(s) together with the control rod mount.



1. 5/8" Flat Washer
2. 5/8"-18 Control Rod Mount Bolt
3. Axle Plane Shim(s)
4. Control Rod Mount
5. Torque Rod
6. 5/8"-18 Locknut
7. Seal
8. 1 1/4" Flat Washer
9. 1 1/4"-12 Locknut
10. Ball Stud
11. Lateral Rod Axle Mount
12. Torque Rod Axle Mount
13. 5/8" Torque Rod Mount Bolt
14. Lateral Rod
15. Backing Plate
16. Axle Alignment Shim(s)

Fig. 5, Control Rod Installation

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

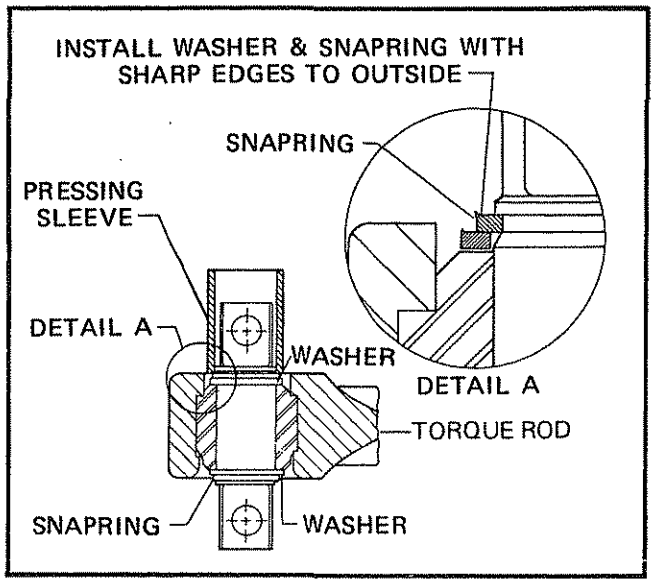


Fig. 6, Snapring And Washer Installation Diagram

3. Remove the locknuts (Fig. 5, Ref. 6) and flat washers from the bolts (Fig. 5, Ref. 13) that secure the torque rod to the torque rod axle mount (Fig. 5, Ref. 12), then remove the bolts. Remove the torque rod from the vehicle.

4. Visually inspect the torque rod for bends or cracks. Work the torque rod pins to check for looseness in the polyurethane bushings. If the torque rod is bent, cracked, or otherwise damaged, replace it with a new one. If either of the polyurethane bushings is loose, the bushing must be replaced with a new one.

Torque Rod Bushing Replacement

IMPORTANT: In order to replace the torque rod polyurethane bushings, it is necessary to have a special installation tool kit (Part No. P-097-009). This tool kit can be purchased from White Freightliner, or it can be machined, using the dimensions given in Fig. 10 under "SPECIFICATIONS."

1. Remove the snapring and washer from each side of the bushing to be removed (Fig. 6). Note that the torque rod eye has a smaller shoulder on one side than on the other, and it also has a rounded edge around the inside of the eye. The polyurethane bushing must be pressed in and out through this side.

2. Using the plunger from the special tool kit on a hydraulic press, press the old bushing out of the torque rod eye. Clean all dirt, grease or other foreign matter from the torque rod.

3. Coat the replacement bushing with a non-mineral lubricant, such as rubber lubricant or waterless hand cleaner. Position the bushing in the larger end of the insertion sleeve from the tool kit, then fit the beveled (smaller) end of the sleeve into the larger side of the torque rod eye.

4. Center the torque rod eye on the base tool, and insert the plunger tool into the polyurethane bushing (Fig. 7). Use a hydraulic or pneumatic press to press the bushing into the torque rod eye.

5. Install the snapring and flat washer on one end of the torque rod pin, with the sharp edges on the washer and snapring facing the outward end of the pin (Fig. 6, Detail A).

6. Press the torque rod pin into the torque rod bushing from the same side as the bushing was pressed into the torque rod eye. Do not lubricate the torque rod pin.

7. Turn the torque rod over and install a flat washer, with the sharp edge facing away from the bushing; then install the other snapring onto the outer shoulder of the pin, with the sharp edge facing outward.

8. Place a pressing sleeve over the end of the torque rod pin, then press the snapring into its seat (Fig. 6).

9. After assembly, press the torque rod pin slightly to center it in the torque rod eye. There should be no slack on either side of the polyurethane bushing, and the bushing should be compressed by approximately half the thickness of the snapring. If necessary, install a second washer under one of the snaprings to compress the bushing.

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

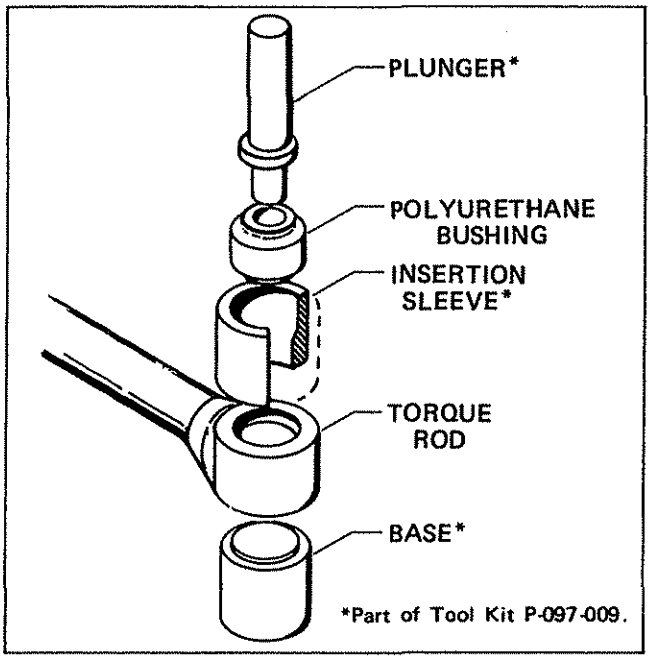


Fig. 7, Torque Rod Bushing Installation

Torque Rod Installation

1. Before installation, make certain that all contact surfaces are free of dirt or other foreign matter. Lubricate all bolt threads with SAE 20 oil.

2. Position the torque rod pin on one end of the torque rod against the torque rod axle mount (Fig. 5, Ref. 12). Slip a flat washer over each of the torque rod mount bolts (Fig. 5, Ref. 13), then insert the bolts through the torque rod axle mount and the torque rod pin.

3. Install the flat washers and locknuts (Fig. 5, Ref. 6) on the torque rod mount bolts, then tighten the locknuts to 130 ft-lbs.

4. Position the control rod mount (Fig. 5, Ref. 4) and the axle plane shim(s) (Fig. 5, Ref. 3) against the frame crossmember, then move the torque rod into position on the control rod mount.

5. Install flat washers on the control rod mount bolts (Fig. 5, Ref. 2), then install the bolts through the frame crossmember, the shim(s), the control rod mount, and the torque rod pin. Install the flat washers and locknuts (Fig. 5, Ref. 6) on the bolts. Tighten the locknuts to 130 ft-lbs.

6. Check the axle plane angle, following instructions in Subject No. 32-11110 in the Freightliner Service Manual; and adjust the angle if it is not within the given tolerance.

AXLE ALIGNMENT

Rear axle alignment should always be checked whenever excessive rear tire wear occurs, hard or erratic steering is experienced, and rear axle or suspension components are replaced.

Aligning of the rear axles requires two distinct checking and adjusting procedures; one for lateral alignment, and the other for parallel alignment.

The lateral alignment procedure consists of checking and adjusting (if needed) the position of the vehicle frame, side-to-side, to center it over the rear axle track. All of the Neway suspensions covered by this subject are adjustable for lateral alignment by the addition or removal of shims at the lateral rod mount. See Fig. 5.

The parallel alignment procedure consists of checking and adjusting (if needed) the position of the axle ends, fore-and-aft, to align the rear wheels parallel with the frame. Only those Neway suspensions equipped with an axle alignment feature (alignment bushings welded to slotted frame brackets) can be adjusted for parallel alignment. See Fig. 9 under "SPECIFICATIONS."

Lateral Alignment

1. Chock the front wheels to prevent vehicle movement. Then raise the rear of the vehicle

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

until the tires clear the ground. Place jack stands under the rear of the vehicle to hold it in this position. Release the parking brakes.

2. Check the wheel bearing adjustment, as specified in the 11 Group of the Freightliner Maintenance and Lube Manual. Adjust or replace the wheel bearings, as needed.

3. Measure the lateral runout of the rear wheels. If runout on any wheel exceeds .18 inch (4.6 mm), replace the wheel before proceeding with the axle alignment check.

4. Remove the jack stands and lower the rear of the vehicle. Relieve any internal stresses in the suspension by jacking the axles up and letting them down; or, remove the wheel chocks, then move the vehicle back and forth (with the interaxle differential lockout disengaged).

5. Park the vehicle on a level surface; then chock the front wheels and release the parking brakes. Position the front axle wheels straight ahead. Place the transmission in neutral.

6. On either rear axle, measure the distance between the left frame rail and the nearest point on the inside wheel rim (Fig. 8, Dimension A).

7. On the same axle, measure the distance between the right frame rail and the nearest point on the inside wheel rim (Fig. 8, Dimension B).

8. Compare Dimension A with Dimension B. If the dimensions are within 1/8" (3.25 mm) of being equal, alignment is not necessary. However, if the dimensions are different by more than 1/8" (3.25 mm), the lateral alignment must be adjusted, as follows:

   .1 Loosen the locknuts on the bolts that secure the lateral rod and control rod mount to the frame rail. See Fig. 5.

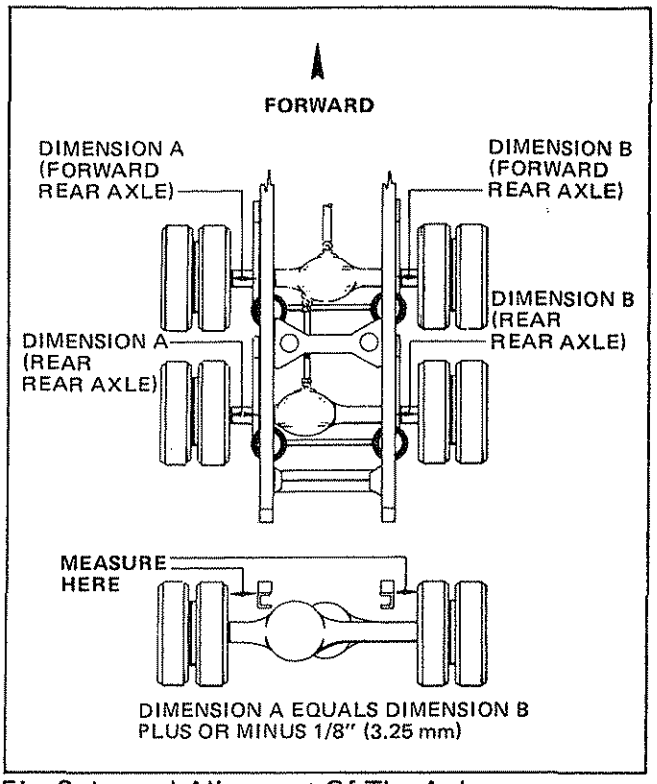


Fig. 8, Lateral Alignment Of The Axles

   .2 Add or remove one axle alignment shim for each 1/8" (3.25 mm) difference between Dimensions A and B. Adding shims will decrease the measurement on the side of the vehicle to which the lateral rod is attached, and removing shims will increase the measurement.

   .3 After installing the shims, lubricate the threads on the control rod mount bolts with engine oil; then tighten the locknuts to 110-150 ft-lbs (149-203 N·m).

9. On tandem axle installations, perform steps 6 through 8.3, above, on the other axle.

10. On suspension installations equipped with an axle alignment feature (alignment bushings welded to slotted frame brackets), proceed to "PARALLEL ALIGNMENT," which follows in this subject.

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

On suspension installations not equipped with an axle alignment feature, no further checking is required. Apply the parking brakes; then, remove the chocks from the front wheels.

Parallel Alignment

1. Check and, if needed, adjust the lateral alignment of the rear axles(s) before checking parallel alignment. Refer to "LATERAL ALIGNMENT," in this subject, for procedures.

2. Check the axle(s) for parallel alignment. Refer to the 11 Group of this manual for the axle alignment checking procedure.

3. If adjustment of the rear axle(s) is necessary, proceed as follows:

   .1 Using jack stands, support the vehicle frame at normal ride height. Disconnect both height control valve linkages from their respective actuating levers (Fig. 4). Then exhaust all air from all air springs by moving both external actuating levers to the vertical down position.

   .2 Remove the equalizer beam pivot connection locknut and bolt, and both spacer washers. See Fig. 9 under "SPECIFICATIONS." Then lower the equalizer beam from the frame bracket.

   .3 Cut the welds off of the alignment bushings on both sides of the frame bracket. Remove the alignment bushings; then grind any remaining weld material off of the frame bracket and the alignment bushings.

   WARNING: Protective goggles must be worn during grinding. Failure to do so could cause personal injury resulting from sparks and metal debris from the grinding process.

   .4 Position the alignment bushings in the frame bracket; then raise the equalizer beam until the front eye is in alignment with the frame bracket. Install the spacer washers and the pivot connection bolt and locknut. Position the spacer washers as shown in Fig. 9, under "SPECIFICATIONS." Suspension installations which have a 1/4" frame rail spacer between the forward frame bracket and the frame rail will require one spacer washer on each side of the equalizer beam. Installations without a frame rail spacer require two spacer washers on the inboard side of the equalizer beam.

   .5 Move the axle forward or backward by rolling the wheels on that side of the vehicle (only on that axle), until the correct axle alignment is obtained.

   .6 With the axle aligned and the vehicle frame supported at normal ride height, torque the pivot connection locknut to 600-700 ft-lbs (814-949 N·m).

   .7 Weld both of the alignment bushings to the frame bracket, using AWS spec E7018 welding rod or Linde 3/32 FC 72 wire weld, or an equivalent. Weld (1/4 inch fillet) each bushing with three, 3/4 inch (19 mm) long welds. See Fig. 9 under "SPECIFICATIONS."

   .8 Connect both height control valve linkages to their respective actuating levers (Fig. 4). Remove the jack stands from the vehicle frame.

4. Apply the parking brakes; then, remove the chocks from the front wheels.

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
All air springs flat.	Insufficient air pressure in the vehicle air brake system.	Check the air pressure gauge on the instrument panel. If air pressure is low, run the engine until a minimum pressure of 70 psi is indicated on the gauge.
	Air leakage from the suspension air system or the air brake system.	Listen for leakage due to loose fittings or damaged air lines, air springs, brake actuators or control valves. Tighten loose fittings to stop leakage and/or replace worn or damaged parts with new ones.
Air spring(s) flat on one side of the vehicle only.	Air leakage between the pressure holding valve and the air spring(s).	Listen for leakage due to loose fittings or damaged air lines. Tighten loose fittings to stop leakage and/or replace damaged air lines with new ones.
	Air spring(s) leaking air.	Visually inspect the air spring(s) for leaks resulting from damage, wear or deterioration. If any air spring is leaking, install a new one.
	Bent, broken or disconnected height control valve linkage.	Visually inspect the linkage for damaged or loose parts. Reconnect loose linkage parts and/or replace defective parts with new ones.
	Height control valve out of adjustment.	Disconnect the height control valve actuating lever from the height control valve linkage. Move the lever upward. If the air spring then inflates, adjust the height control valve.
	Inoperative height control valve.	If movement of the actuating lever in the above step fails to inflate the air spring, the height control valve is defective. Install a new valve.
Tractor leans due to unequal inflation of air springs.	Damaged height control valve linkage.	Visually inspect for damage to the height control valve linkages and actuating levers. Repair or replace damaged linkage parts.
	Loose or missing height control valve bolts or adjustment locknut.	Visually inspect for loose or missing height control valve mounting bolts and/or adjustment locknut. Replace any missing bolts and/or nuts, then adjust the height control valves. Tighten all connections to the values listed in Table 1 under "SPECIFICATIONS."
	Height control valve out of adjustment.	Readjust the height control valves as outlined in prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions.

(Continued on next page)

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Air springs deflate rapidly when vehicle is parked.	Air leakage from the suspension air system.	Listen for leakage due to loose fittings or damaged air lines, air springs or height control valves. Tighten loose fittings to stop leakage and/or replace worn or damaged parts with new ones.
Tractor rides too high or too low.	Height control valve(s) out of adjustment.	Readjust the height control valve(s) as outlined in prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions.
Air spring blown out.	Air spring cut or punctured.	Locate large leaks by listening for escaping air; and locate smaller leaks by applying a soap and water solution to the suspected air spring and watching for bubbles. Repair punctures and cuts of less than 1/8" by applying hot patches on both sides of the hole. If the cut is more than 1/8" long, install a new air spring.
	Tires, rims or chains rubbing the air spring.	Check the clearance between the air spring and the tire. If the tire, rim or chains contact the inflated air spring, change to narrower tires and rims to provide clearance for tires with chains.
	Air brake actuator rubbing against the air spring.	Relocate the brake actuator with factory approved parts to provide adequate clearance.
Air spring failure due to fatigue.	Operation of the vehicle with the air springs deflated for a protracted period of time or at too high a speed.	Should a leak in the air suspension system force operation of the vehicle with the air springs deflated, maintain a speed of less than 30 mph, and drive only as far as the nearest repair facility.
	Continual or repeated over-extension of the air spring.	Visually inspect for broken or loose shock absorber or shock absorber mounting bracket. Reconnect loose parts and replace any defective parts. Check the adjustment of the height control valves as outlined in prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions.
Air spring(s) fail to fully deflate when all weight is removed from the suspension.	Restricted air line(s) between the height control valve(s) and the air spring(s).	Disconnect the height control valve linkage(s) and rotate the actuating lever(s) to the vertical down position. If the air spring(s) remain inflated, check for pinched or blocked line(s). Clean out plugged line(s) and/or replace defective line(s).

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

SPECIFICATIONS

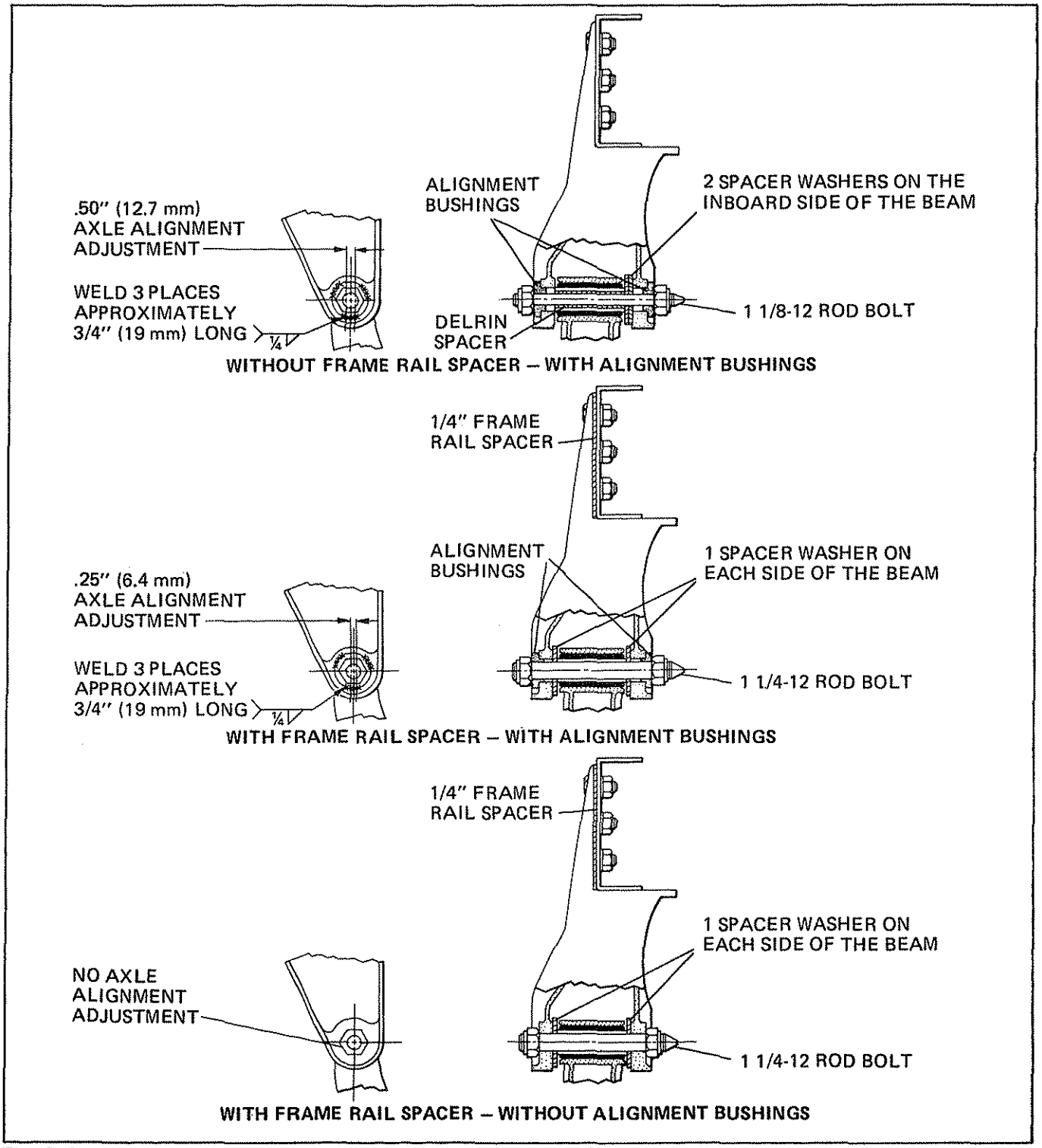
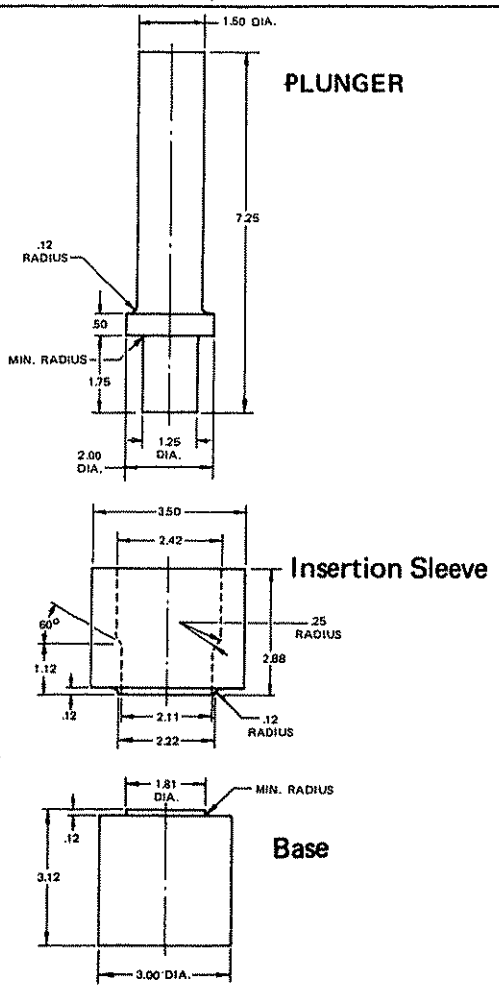
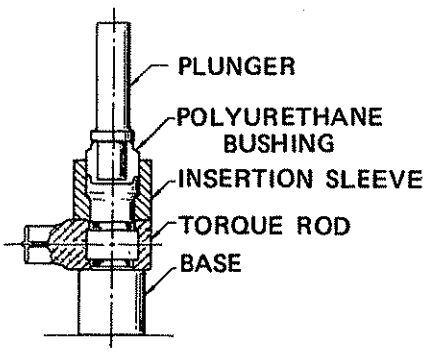


Fig. 9, Spacer Washer Installation And Alignment Bushing Welding

NEWAY AIR RIDE SUSPENSION, MODELS ARD 125-8 AND ARD 244-8

SPECIFICATIONS (Continued)





POLYURETHANE BUSHING INSERTION ASSEMBLY

MATERIALS

Bar 2.00 Dia.	Mild Steel
Tube 3.50 O.D x .75 Wall	Mild Steel
Bar 3.00 Dia.	Mild Steel

Fig. 10, Polyurethane Bushing Installation Tooling

DESCRIPTION	SIZE	TORQUE	
		FT-LBS	N·m
Shock Absorber Mount Locknut	3/4-16	110-150	149-203
Air Spring Upper Mounting Plate Locknut	3/4-16	31-42	42-57
Air Spring Upper Mounting Plate Capscrew	1/2-13	31-42	42-57
Air Spring Lower Mounting Plate Capscrew	1/2-13	31-42	42-57
Transverse Beam Bushing Locknuts	1 1/4-12	600-700	814-949
Equalizing Beam Center Bushing Locknut	3/4-16	150-200	203-271
Equalizing Beam Front Bushing Locknut	1 1/8-12 1 1/4-12	600-700 600-700	814-949 814-949
Lateral Rod Ball Stud Locknut	1 1/8-12	550-650	746-881
Control Rod Mount Locknuts	5/8-18	110-150	149-203

Table 1, Suspension Torque Specifications (Lubricated Threads)

WESTERN UNIT STABILAIRE SUSPENSIONS MODELS 300 AND 400 SERIES

GENERAL DESCRIPTION

Western Unit Stabilaire suspension systems (Fig. 1) are of the trailing arm type, journaled at the forward end to allow a controlled amount of cross-articulation. The trailing arms consist of multiple-leaf springs, and are securely clamped to the axle housing by U-bolts. The springs, axle housing, and crosstube together function as an anti-sway bar.

Air springs at the rear of the trailing arms are used to compensate for variations in road, and/or vehicle loading conditions. This is accomplished by automatic height control valves (Fig. 2) that adjust the flow of compressed air into or out of the air springs.

Two automatic height control valves are used in the vehicle air suspension system; one on each side of the vehicle frame, with a single outlet to supply the air spring or springs on that side. The height control valves are activated by the rear-most axle, with the air springs mounted at the end of each leaf spring assembly at each end of each rear axle.

The height control valves draw air from the vehicle air system. An automatic pressure holding valve (Fig. 2, Ref. 8) maintains a minimum pressure of 65 psi (448 kPa) in the air system in the event of an air loss from the suspension system.

Should a leak occur in the suspension air system, the air springs are equipped with internal solid rubber bumpers to support the vehicle and its load until a repair can be made. If the vehicle must be moved before repairs can be made, disconnect the height control valve linkages (Fig. 2, Ref. 4), and rotate the external actuating levers (Fig. 2, Ref. 3)

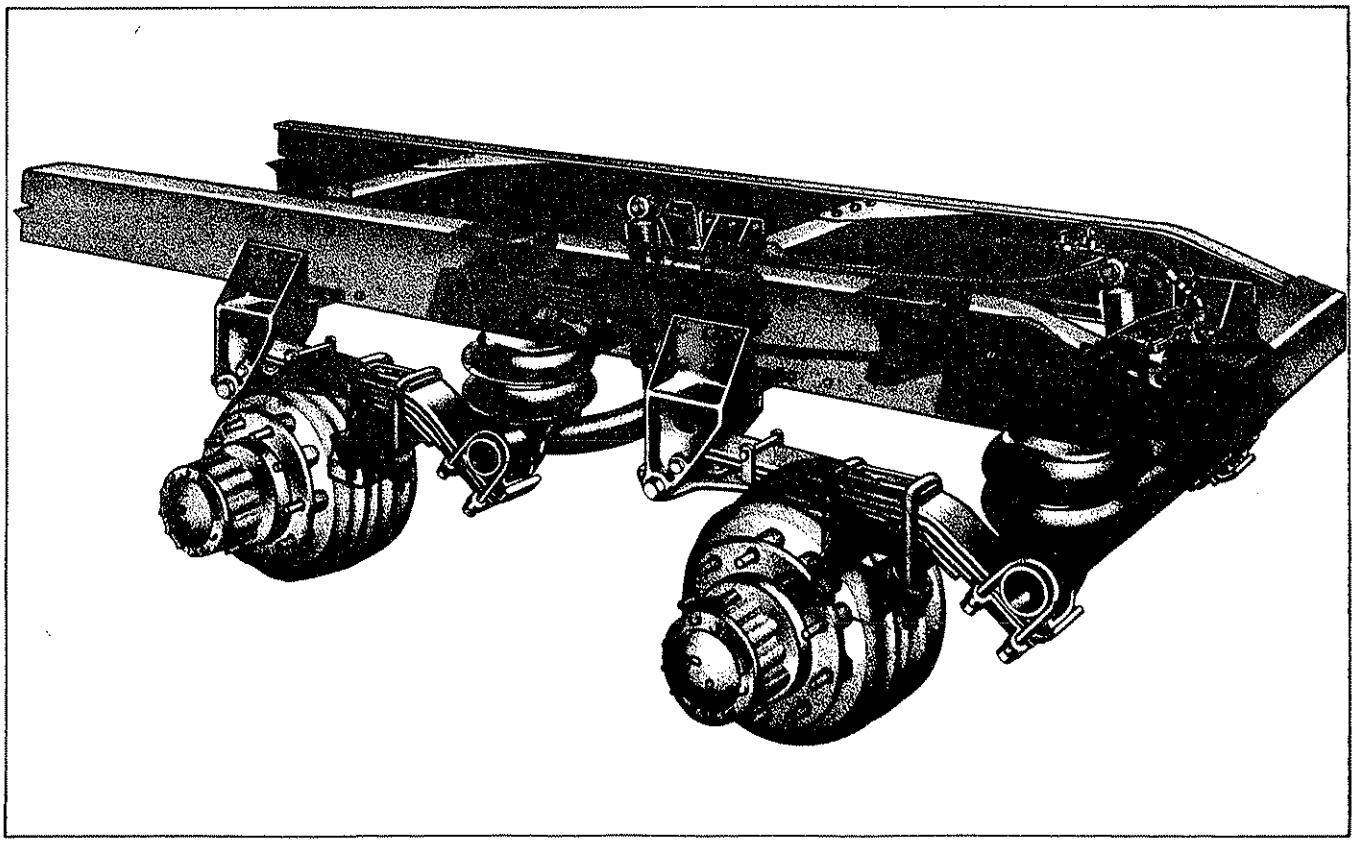


Fig. 1, Western Unit Stabilaire Suspension

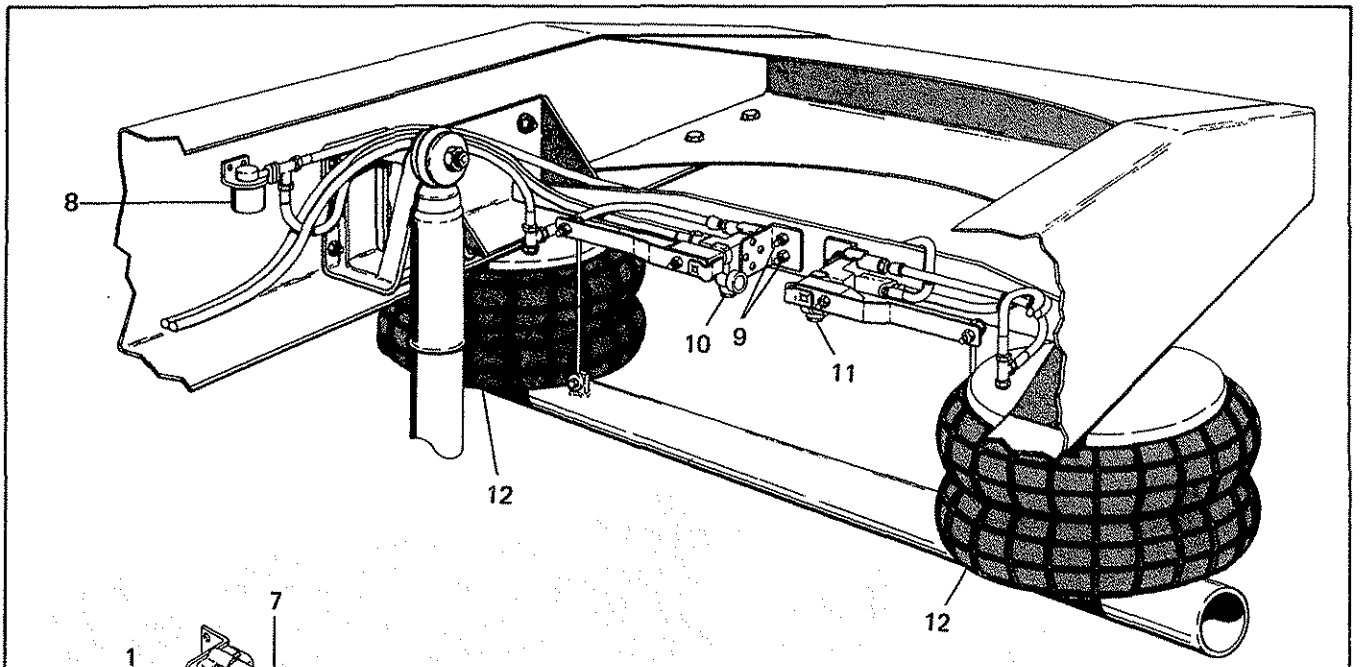
WESTERN UNIT STABILAIRE SUSPENSIONS
MODELS 300 AND 400 SERIES

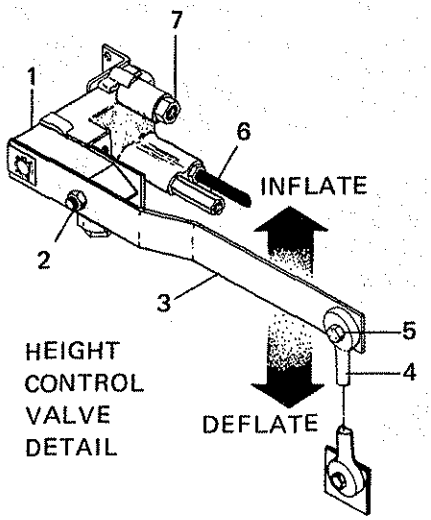
to the vertical down, deflated position. Bleed the air springs down until the weight of the vehicle is being carried on the solid rubber bumpers.

CAUTION: The vehicle should not, under any circumstances, be driven in excess of 30 mph (48 kmph) with the suspension in this condition; and it should be driven only as far as the nearest repair facility. Excessive speed or mileage could cause damage to the vehicle or its load.

PRINCIPLES OF OPERATION (Refer to Fig. 3)

The automatic height control valves independently adjust for loading, neutral position, and unloading. The body of each height control valve contains an intake valve core (Ref. 9), an exhaust valve core (Ref. 14), and a delay piston (Ref. 5). The delay piston, connected through a piston pin (Ref. 11) to the overtravel control shaft (Ref. 23) is contained in a cylinder of silicone-type fluid. The slowing

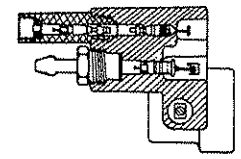




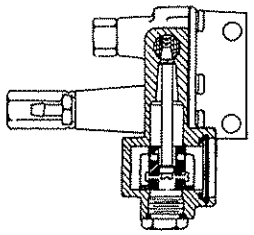
1. Nylon Adjusting Block
2. Vernier Adjustment Nut
3. External Actuating Lever
4. Height Control Valve Linkage
5. Height Control Valve Linkage Bolt
6. Inlet From Pressure Holding Valve
7. Outlet To Air Spring
8. Automatic Pressure Holding Valve
9. Height Control Valve Mounting Bolts
10. Height Control Valve (Right)
11. Height Control Valve (Left)
12. Air Spring

Fig. 2, Height Control Valves

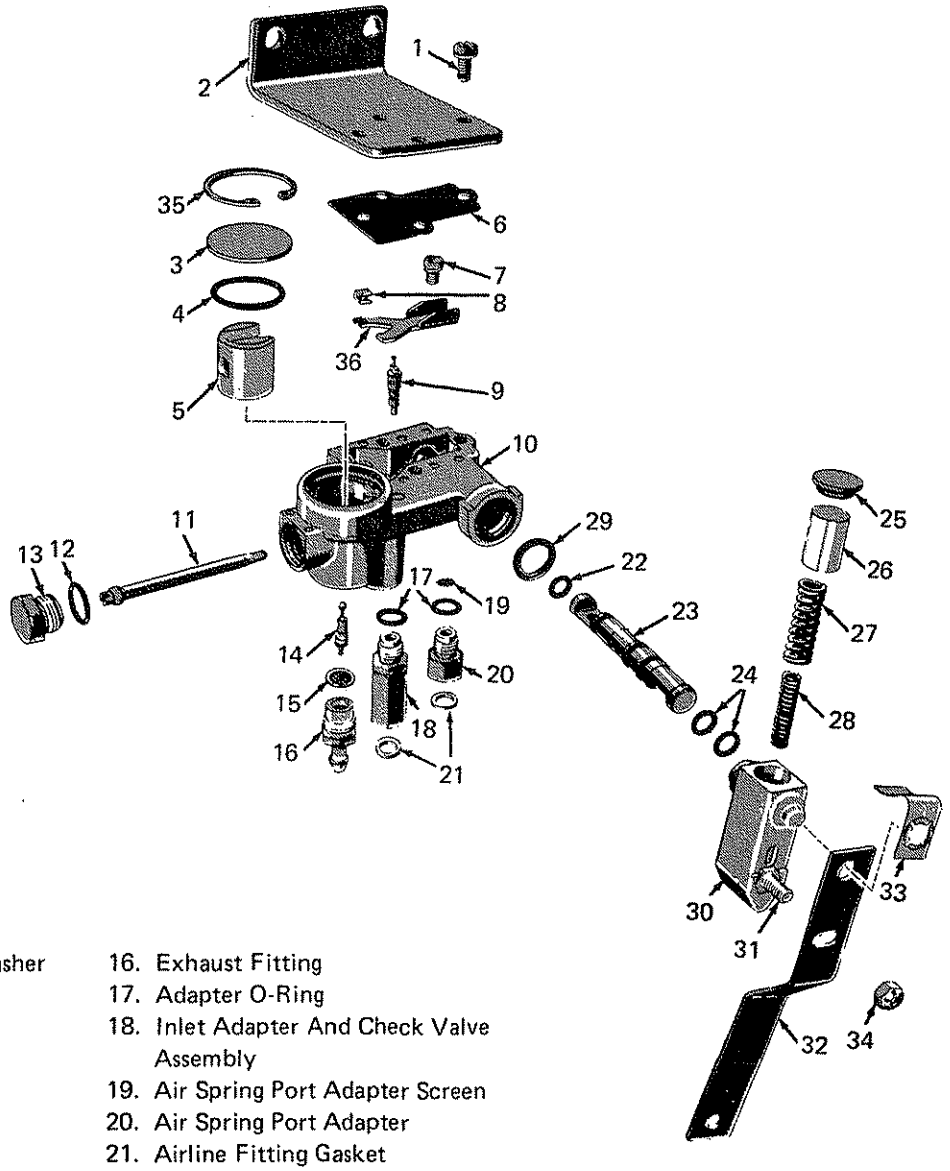
WESTERN UNIT STABILAIRE SUSPENSIONS
MODELS 300 AND 400 SERIES



Section Through Valves



Section Through Delay Piston And Pin



1. Cover Screw And Lock Washer
2. Cover/Bracket
3. Delay Cover
4. Delay Cover O-Ring
5. Delay Piston
6. Cover Gasket
7. Valve Lever Screw
8. Valve Stem Lock Clip
9. Intake Valve Core
10. Valve Body
11. Piston Pin
12. Delay Plug O-Ring
13. Delay Plug
14. Exhaust Valve Core
15. Exhaust Screen
16. Exhaust Fitting
17. Adapter O-Ring
18. Inlet Adapter And Check Valve Assembly
19. Air Spring Port Adapter Screen
20. Air Spring Port Adapter
21. Airline Fitting Gasket
22. Shaft O-Ring (Medium)
23. Overtravel Control Shaft
24. Shaft O-Ring (Large)
25. Overtravel Body Plug
26. Overtravel Piston
27. Overtravel Spring (Large)
28. Overtravel Spring (Small)
29. Overtravel Control Body Seal
30. Overtravel Control Body
31. External Actuating Lever Stud
32. External Actuating Lever
33. Plug Retainer
34. Vernier Adjustment Nut
35. Delay Cover Retainer
36. Intake And Exhaust Valve Lever

Fig. 3, Height Control Valve Components

action of this fluid delays from one to six seconds, the closing of one valve to the opening of the other.

With the vehicle in motion, and the frame at normal ride height, the external actuating lever (Ref. 32) is in the "neutral" position. Small movements of the external actuating lever may occur without activating the intake or exhaust valve cores. The lever must move in excess of 3/16" (5 mm) before either valve is opened. This distance is the free-travel range.

If the frame of the vehicle lowers, as when loaded, the external actuating lever will turn the overtravel control shaft. As the shaft turns, the intake valve lever will press against the pin of the intake valve core, allowing air pressure to flow through the height control valve into the air springs. The increased air pressure will expand the air springs, raising the frame of the vehicle. The external actuating lever will be returned to neutral (horizontal) as the vehicle frame approaches normal ride height.

If the frame of the vehicle raises, as when the load is lightened, the external actuating lever will apply a force that will slowly move the delay piston. The exhaust valve lever, moving with the delay piston, will open the exhaust valve when the external actuating lever moves beyond the free-travel range. The intake valve will remain closed, allowing air from the air springs to exhaust to the atmosphere. As air is exhausted from the air springs, the vehicle frame will lower until the external actuating lever returns to neutral.

The overtravel control body (Ref. 30) contains a spring loaded nylon overtravel piston (Ref. 26). The purpose of the overtravel piston is to prevent the damage of parts inside the control valve if the external actuating lever is moved beyond the normal operating range. The piston also provides a delay in the action of the height control valve so air is not used during momentary bumps, but only during load changes.

SERVICE OPERATIONS

Since air suspension systems are controlled by sensitive air valves, the air system must be kept free of any oil, moisture, or foreign matter. Air tanks should be drained daily, filters drained weekly, and the compressor maintained in good operating condition.

WARNING: Failure to take precautions against the entry of moisture, oil, or foreign matter into the suspension air system could result in a hazardous vehicle operating condition.

IMPORTANT: All suspension brackets that are in contact with the vehicle frame must be attached with SAE Grade 8 flange type bolts, and SAE Grade C flange type nuts. An acceptable alternative is to use hardened flat washers under both SAE Grade 8 bolts, and SAE Grade C nuts. At all points where aluminum parts are fastened to steel parts, use Alumilastic compound, or equivalent, on the mating surfaces.

CAUTION: Failure to apply Alumilastic compound, or equivalent, to areas in which aluminum and steel components contact each other will result in electrolysis which will cause decomposition of the metals, and could in turn cause suspension system damage.

HEIGHT CONTROL VALVE ADJUSTMENT

Adjustment of the height control valves should be performed with the vehicle on a level surface, under an evenly distributed load. Adjust the height control valves one at a time, as follows:

1. Park the vehicle on a level surface, then block the wheels with chock blocks. Run the engine

WESTERN UNIT STABILAIRE SUSPENSIONS
MODELS 300 AND 400 SERIES

to build up and maintain a vehicle air pressure of at least 70 psi (482 kPa) throughout the system.

2. Disconnect both height control valve linkages from their respective actuating levers (Fig. 2).

3. Exhaust all air from all air springs by moving both external actuating levers to the vertical down position.

4. Loosen the vernier adjustment nut (Fig. 2, Ref. 2) and move the actuating lever until the stud in the nylon adjustment block (Fig. 2, Ref. 1) is centered in the actuating lever adjustment slot. Then tighten the vernier adjustment nut to 4 ft-lbs (5 N·m).

5. Connect one of the external actuating levers to its respective linkage, and allow the air spring(s) controlled by the valve to fill until the valve shuts off.

6. Measure the distance from the top of the inflated air spring(s) to the bottom of the air spring(s) (Fig. 4). This dimension should be 6-1/2" (165 mm). Adjust the height control valve by loosening the valve mounting bolts and rotating the entire valve slightly until the height dimension is attained.

IMPORTANT: Because of a built-in time delay in the height control valve, two to six seconds will be required after making adjustments before a change will occur in the height dimension.

7. Tighten the valve mounting bolt nuts to 11 ft-lbs (15 N·m).

8. Disconnect the height control valve linkage and allow the air spring(s) to deflate approximately half way. Then, connect the linkage to inflate the air spring(s), and check the height dimension again. Repeat steps 6 through 8 until the height dimension measures 6-1/2" (165 mm).

NOTE: When the height dimension is within 1/8" (3.2 mm) of the required 6-1/2" (165 mm), the final adjustment can be made by loosening the vernier adjustment nut and moving the actuating lever slightly, relative to the nylon adjustment block. Then tighten the vernier adjustment nut to 4 ft-lbs (5 N·m).

9. When the height control valve is adjusted, disconnect the external actuating lever from the height control valve linkage, and rotate it to the vertical down position to fully deflate the air spring(s).

10. To adjust the other height control valve, perform steps 4 through 9 of the "HEIGHT CONTROL VALVE ADJUSTMENT" procedure on the other side of the vehicle.

11. Connect both linkage assemblies to their respective actuating levers. All height dimensions should now be equal and both valves should be synchronized. If not, repeat the adjustment procedure until height equalization and valve synchronization are achieved.

WARNING: Failure to adjust the height control valves as explained above could result in an unsafe vehicle operating condition.

HEIGHT CONTROL VALVE REMOVAL

1. Block the front wheels with chock blocks to prevent vehicle movement, then raise the rear of the vehicle so the tires just clear the floor and the suspension is fully extended. Place safety stands under the vehicle frame.

2. Open the drain cocks at all primary, secondary, and supply reservoirs to exhaust all air from the air spring and brake systems.

3. Disconnect the external actuating lever (Fig. 2, Ref. 3) from the height control valve linkage

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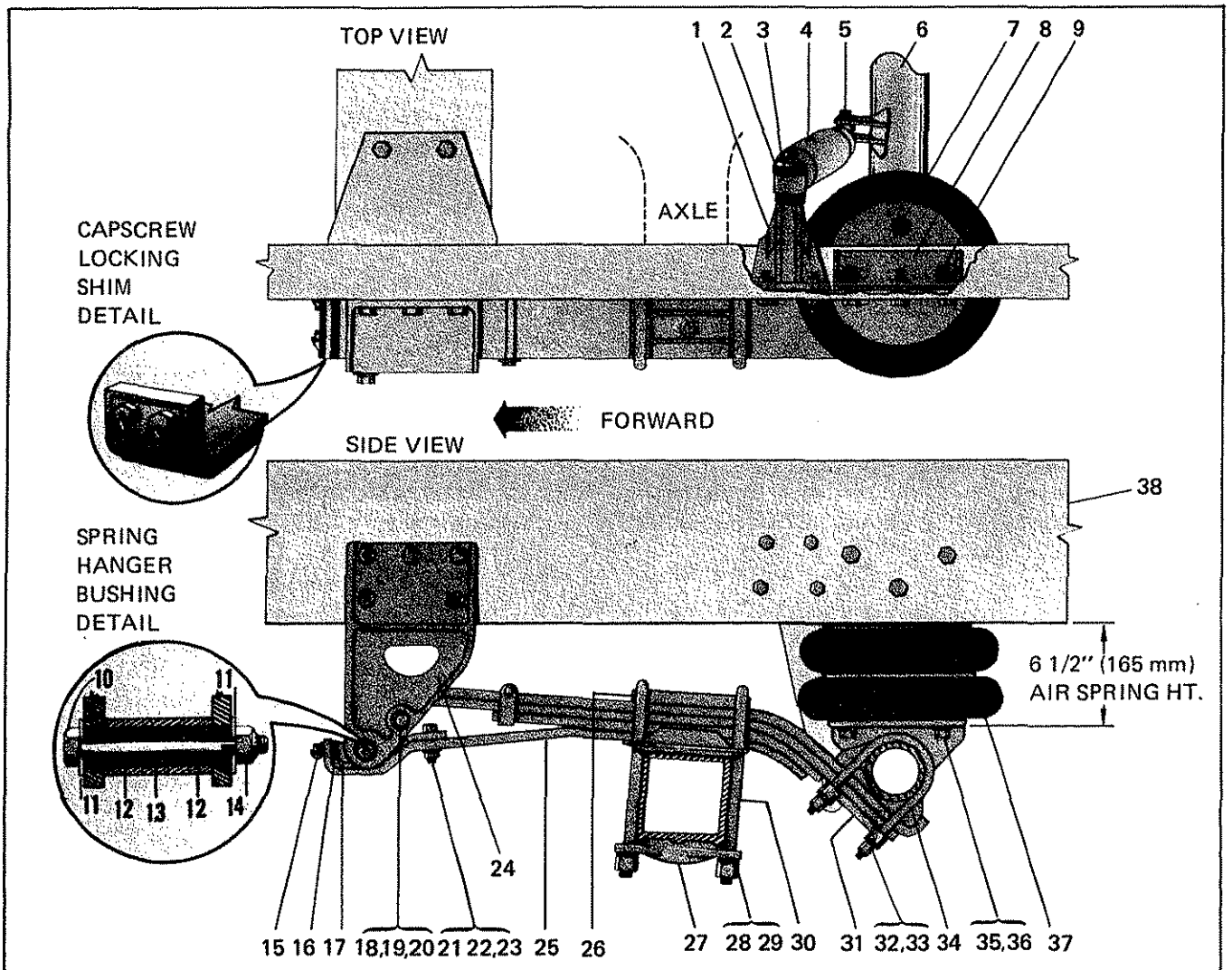

1. Shock Absorber Upper Mount
2. Shock Absorber Bushing
3. 3/4" - 16 Thin Locknut
4. Shock Absorber
5. Shock Absorber Lower Mount
6. Rear Crosstube
7. Air Spring Air Inlet
8. Air Spring Upper Bracket
9. 3/8" - 16 x 1" Capscrew
10. 1" - 14 x 8" Bolt
11. 1" Flat Washer
12. Spring Hanger Bushing
13. Bushing Spacer
14. 1" - 14 Locknut
15. 5/8" - 11 x 1 1/2" Capscrew*
16. Axle Alignment Shims
17. Spring Pin Block
18. Neoprene Sleeve (Hidden)
19. 3/4" - 16 x 7" Bolt
20. 3/4" - 16 Locknut
21. 1/2" - 20 x 1 1/2" Bolt
22. 1/2" - 20 Hex Nut
23. 1/2" Lockwasher
24. Forward Spring Hanger
25. Leaf Spring Assembly
26. Axle U-Bolt Pressure Plate
27. Axle Lower Pressure Plate
28. 7/8"-14 High Nuts**
29. 7/8" Hard Flat Washer**
30. Axle U-Bolt
31. Crosstube U-Bolt Pressure Plate
32. 5/8" - 18 High Nut
33. 5/8" Hard Flat Washer
34. Crosstube U-Bolt
35. 3/8" Lockwasher
36. 3/8" - 16 x 3/4" Capscrew
37. Air Spring
38. Frame Rail

*Length Will Vary With Shim Usage

**Some Vehicles Are Equipped With 3/4"-16 U-Bolts

Fig. 4, Parts Identification

WESTERN UNIT STABILAIRE SUSPENSIONS MODELS 300 AND 400 SERIES

(Fig. 2, Ref. 4). Exhaust all air from the air spring(s) by pulling down on the external actuating lever.

4. Disconnect both air lines at the height control valve (from the pressure holding valve, and to the air spring), (Fig. 2, Refs. 6 & 7). Cover the ends with tape.

5. Remove the mounting bolts, then remove the height control valve from the vehicle frame.

HEIGHT CONTROL VALVE INSTALLATION

Before installing the height control valve, inspect the air line fittings. Replace the air line fitting gaskets (Fig. 3, Ref. 21) in the adapters, if the gaskets are worn or damaged. Keep the adapters free from any dirt or foreign matter to prevent damage to the valves.

1. Attach the height control valve to the vehicle frame with two 1/4-28 SAE Grade 5 mounting bolts. Tighten the mounting bolt nuts to 11 ft-lbs (15 N·m).

2. Connect and tighten the air supply line to the inlet adapter (Fig. 3, Ref. 18), then connect and tighten the air spring air line to the air spring port adapter (Fig. 3, Ref. 20).

3. Connect and tighten the height control valve linkage to the end of the external actuating lever. Tighten the nut to 7 ft-lbs (9 N·m).

4. Close all drain cocks at the primary, secondary, and supply reservoirs. Remove the safety stands from under the vehicle frame and lower the vehicle.

5. Build-up normal operating pressure in the vehicle air system; then, check all line connections for leaks. Eliminate any leaks.

6. Adjust the height control valve following the procedure given under "HEIGHT CONTROL VALVE ADJUSTMENT" in this subject.

SHOCK ABSORBER REPLACEMENT

1. Remove the locknuts (Fig. 4, Ref. 3) from the shock absorber upper and lower mounting pins.

2. If the shock absorber is fully extended, block the vehicle wheels with chock blocks, then jack up the axle to relieve the tension. Pull the shock absorber off the mounting pins to remove it from the vehicle. If the inner metal sleeve is seized to the mounting pin, use a small, sharp chisel to force the sleeve from the pin.

3. Install the replacement shock absorber on the mounting pins, then secure it with the locknuts and washers. Tighten the locknuts to 150 ft-lbs (203 N·m).

FORWARD SPRING HANGER BUSHING REPLACEMENT

1. Block the front wheels with chock blocks to prevent vehicle movement. Then, raise and block the rear of the vehicle with safety stands, so the tires are clear of the floor. Remove the wheels and tires, if necessary, to gain clear access to the forward spring hanger (Fig. 4, Ref. 24).

2. Remove the locknut (Fig. 4, Ref. 14) and flat washer from the spring hanger bushing bolt (Fig. 4, Ref. 10).

3. Using an impact wrench on the bolt head, maintain a counterclockwise action on the bolt. At the same time, apply a firm pressure against the threaded end of the bolt to extract the bolt from the spring hanger.

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4. Pry the rubber spring hanger bushings (Fig. 4, Ref. 12) out of the forward spring hanger and the spring pin block (Fig. 4, Ref. 17).

5. Coat the new bushings and the bolt with rubber lubricant. Slide one bushing into the hanger, then the bushing spacer (Fig. 4, Ref. 13), then the other bushing.

6. Place the flat washer (Fig. 4, Ref. 11) over the spring hanger bushing bolt, then insert the bolt through the bushings from the outboard side of the spring hanger.

7. Install the washer and nut on the inboard side of the spring hanger bushing bolt, then tighten the nut to 150 ft-lbs (203 N·m).

8. Install the wheels and tires, if removed, and let the vehicle down from the safety stands. Remover the chock blocks from the front wheels.

AIR SPRING REPLACEMENT

1. Block the front wheels with chock blocks to prevent vehicle movement. Raise and block the vehicle frame with safety stands to remove all weight from the air springs. All air pressure will automatically be released from the air springs, by the height control valves, when all weight is removed from the suspension.

2. Disconnect the air supply line from the air spring. Take care to prevent foreign substances from entering the line or fittings; cover the end with tape.

3. Remove the capscrews (Fig. 4, Ref. 9) and lockwashers that connect the air spring upper mounting plate to the air spring upper bracket (Fig. 4, Ref. 8).

4. Remove the capscrews (Fig. 4, Ref. 36) and lockwashers that connect the air spring lower mounting plate to the air spring lower bracket. Remove the air spring.

5. Position the new air spring on the lower mounting bracket, then install the capscrews securing the air spring lower mounting plate to the air spring lower bracket. Tighten the capscrews to 34 ft-lbs (46 N·m).

6. Install the capscrews and lock washers connecting the air spring upper mounting plate to the air spring upper bracket. Then, tighten the capscrews to 34 ft-lbs (46 N·m).

7. Connect the air supply line to the air spring, then tighten. Take care to prevent foreign substances from entering the line or fittings.

8. Let the vehicle down from the safety stands, then remove the wheel chock blocks.

LEAF SPRING REPLACEMENT

WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

1. Block the front wheels with chock blocks to prevent vehicle movement, then raise and block the vehicle frame with safety stands so all weight is removed from the springs. Remove the wheels and tires, if necessary, in order to gain easy access to the suspension.

2. Securely block up the axle with safety stands to prevent it from dropping away from the vehicle when the spring is loosened and removed.

WARNING: Failure to remove all weight from the wheels or failure to securely block the axle could result in an unsafe working condition.

WESTERN UNIT STABILAIRE SUSPENSIONS
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3. Remove the spring-to-spring pin block capscrews (Fig. 4, Ref. 15), keeping track of the axle alignment shims (Fig. 4, Ref. 16) between the spring end and the spring pin block, so they can be returned to their original positions upon assembly. Remove the bolt (Fig. 4, Ref. 21) at the tail of the spring pin block.

4. Remove the high nuts (Fig. 4, Ref. 32) and washers from the crosstube U-bolts (Fig. 4, Ref. 34). Remove the crosstube U-bolt pressure plate (Fig. 4, Ref. 31) and the U-bolts.

5. Remove the high nuts (Fig. 5, Ref. 5) and lock washers from the axle U-bolts. On axle clamps of the type "L" group, remove the axle lower pressure plate (Fig. 5, Ref. 7). Remove the axle U-bolts (Fig. 5, Ref. 4) and the axle U-bolt pressure plate (Fig. 5, Ref. 2).

6. Slide the leaf spring off the axle spring seat (Fig. 5, Ref. 1); then maneuver the new spring assembly into position.

7. Position the spring liner (Fig. 5, Ref. 3) and the axle U-bolt pressure plate on top of the leaf spring, then install the axle U-bolts. On axle clamps of the type "L" group, install the axle lower pressure plate. Install the flat washers and high nuts on the U-bolts.

8. Install the crosstube U-bolts and the crosstube U-bolt pressure plate, securing the leaf springs to the rear crosstube. Install the flat washers and high nuts on the crosstube U-bolts; then, tighten the high nuts to 100-125 ft-lbs (136-170 N·m).

9. Install the axle alignment shims in their original positions between the spring end and the spring pin block. Install the spring-to-spring pin block capscrews through the spring end and the axle alignment shims, with one shim on the outside of the spring to lock the capscrew, as shown in Fig. 4.

IMPORTANT: Original factory installations will use four each 1/16 inch (1.5 mm) shims with a 1/16 inch (1.5 mm) locking shim and 1-1/2 inch (38 mm) long capscrew. Any number of the four shims can be on either side of the spring (the location depends on axle alignment), but the total thickness of all the shims (including the locking shim), must total 5/16 inch (8 mm). If four or more additional 1/16 inch (1.5 mm) shims are added (totaling an additional 1/4 inch [6.5 mm] or more), a longer capscrew must be installed to maintain a thread engagement in the spring pin block of no less than 3/4 inch (19 mm) and no more than 31/32 inch (24.5 mm).

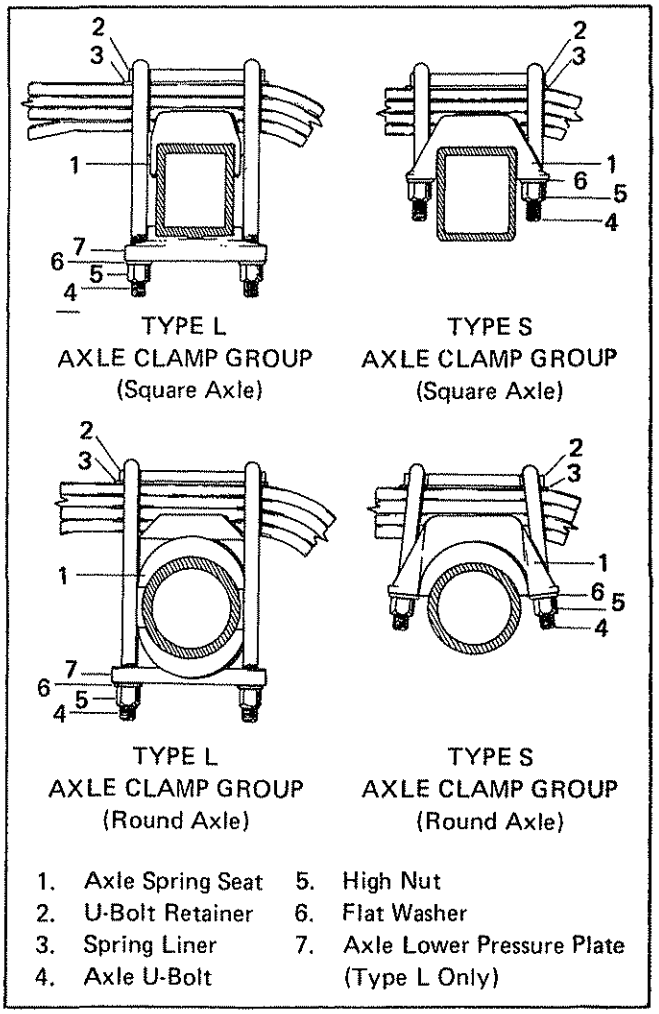

Fig. 5, Axle Clamp

WESTERN UNIT STABILAIRE SUSPENSIONS
MODELS 300 AND 400 SERIES

10. Tighten the spring-to-spring pin block capscrews to 200 ft-lbs (271 N·m), then bend the corners of the locking shim over the heads of the capscrews (Fig. 4). Tighten the nut on the bolt at the tail of the spring pin block to 100 ft-lbs (136 N·m). Tighten the high nuts on the axle U-bolts to 250 ft-lbs (339 N·m) for 3/4-16 U-bolts, and 400 ft-lbs (542 N·m) for 7/8-14 U-bolts.

11. Install the wheels and tires, if removed, then let the vehicle down from the safety stands. Remove the chock blocks.

12. Check the axle alignment, as outlined in "REAR AXLE ALIGNMENT CHECKING" procedures in subject 32-11115 of the Freightliner Service Manual.

REAR AXLE ALIGNMENT

Alignment of the rear axle or axles can be adjusted by adding or removing the alignment shims between the spring end and the spring pin block, on one side of the vehicle. Alignment may be adjusted on either side of the vehicle. To adjust either single or tandem axles, proceed as follows:

1. Remove the spring-to-spring pin block capscrews (Fig. 4, Ref. 15), then loosen the nut on the bolt (Fig. 4, Ref. 21) at the tail of the spring pin block.

2. Move the axle forward or backward until it is aligned within the tolerances given in "REAR AXLE ALIGNMENT CHECKING" instructions in subject 32-11115 of the Freightliner Service Manual.

3. After the axle is in alignment, install axle alignment shims (Fig. 4, Ref. 16) to take up the slack between the end of the spring and the spring pin block. Install the spring-to-spring pin block capscrews, with one alignment shim on the outside of the spring to lock the capscrews, as shown in Fig. 4.

IMPORTANT: Original factory installations will use four each 1/16 inch (1.5 mm) shims and a 1/16 inch (1.5 mm) locking shim with a 1-1/2 inch (38 mm) long capscrew. Any number of the four shims can be on either side of the spring (the location depends on axle alignment), but the total thickness of all the shims (including the locking shim), must total 5/16 inch (8 mm). If four or more additional 1/16 inch (1.5 mm) shims are added (totaling an additional 1/4 inch [6.5 mm] or more), a longer capscrew must be installed to maintain a thread engagement in the spring pin block of no less than 3/4 inch (19 mm) and no more than 31/32 inch (24.5 mm).

4. Tighten the spring-to-spring pin block capscrews to 200 ft-lbs (271 N·m); then, check the axle alignment, and if it is outside the tolerances given in "REAR AXLE ALIGNMENT CHECKING" instructions in subject 32-11115, repeat the alignment procedure until the alignment is within tolerances.

5. After the axle is in alignment, and the spring-to-spring pin block capscrew tightened to 200 ft-lbs (271 N·m), bend the corners of the locking shim over the heads of the capscrews as shown in Fig. 4. Tighten the nut on the bolt at the tail of the spring pin block to 100 ft-lbs (136 N·m).

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TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
All Air Springs Flat	Insufficient air pressure in the vehicle air brake system.	Check the air pressure gauge on the instrument panel. If air pressure is low, run the engine until a minimum pressure of 70 psi (482 kPa) is indicated on the gauge.
	Air leakage from the suspension air system or the air brake system.	Listen for leakage due to loose fittings or damaged air lines, air springs, brake actuators, or control valves. Tighten loose fittings to stop leakage and/or replace worn or damaged parts with new ones.
Air Spring(s) Flat On One Side Of Vehicle Only	Air leakage between the pressure holding valve and the air spring(s).	Listen for leakage due to loose fittings or damaged air lines. Tighten loose fittings to stop leakage and/or replace damaged air lines with new ones.
	Air spring(s) leaking air.	Visually inspect the air spring(s) for leaks resulting from damage, wear, or deterioration. If any air spring is leaking, install a new one, following "AIR SPRING REPLACEMENT" instructions in this subject.
	Bent, broken, or disconnected height control valve linkage.	Visually inspect the linkage for damaged or loose parts. Connect loose linkage parts and/or replace unserviceable parts with new ones.
	Height control valve out of adjustment.	Disconnect the height control valve external actuating lever from the height control valve linkage. Move the lever upward. If the air spring then inflates, adjust the height control valve, following "HEIGHT CONTROL VALVE ADJUSTMENT" instructions in this subject.

(Continued on next page)

WESTERN UNIT STABILAIRE SUSPENSIONS, MODELS 300 AND 400 SERIES

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Air Spring(s) Flat On One Side Of Vehicle Only (Cont.)	Inoperative height control valve.	If movement of the actuating lever in the above step fails to inflate the air spring, the height control valve is inoperative. Install a new valve following "HEIGHT CONTROL VALVE REMOVAL" and "HEIGHT CONTROL VALVE INSTALLATION" instructions in this subject.
Vehicle Leans Due To Unequal Inflation Of Air Springs	Damaged height control valve linkage.	Visually inspect for damage to the height control valve linkages and actuating levers. Repair or replace damaged linkage parts.
	Loose or missing height control valve bolts or vernier adjustment nut.	Visually inspect for loose or missing height control valve mounting bolts and/or vernier adjustment nut. Replace any missing bolts and/or nuts, then adjust the height control valves, following "HEIGHT CONTROL VALVE ADJUSTMENT" instructions in this subject. Tighten all connections to the torque values listed in Table 1 under "SPECIFICATIONS" in this subject.
	Height control valve out of adjustment.	Readjust the height control valves as outlined in prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions in this subject.
Air Spring(s) Deflate Rapidly When Vehicle Is Parked	Air leakage from the suspension air system.	Listen for leakage due to loose fittings or damaged air lines, air springs, or height control valves. Tighten loose fittings to stop leakage and/or replace worn or damaged parts with new ones.

(Continued on next page)

WESTERN UNIT STABILAIRE SUSPENSIONS, MODELS 300 AND 400 SERIES

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Rides Too High Or Too Low	Height control valves out of adjustment.	Readjust the height control valves as outlined in prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions in this subject.
Air Spring Blown Out	Air spring cut or punctured.	Locate leaks by listening for escaping air, or by applying a soap and water solution to the suspected air spring and watching for bubbles. Repair punctures and cuts of less than 1/8" (3 mm) by applying hot patches on both sides of the hole. If the cut is more than 1/8" (3 mm) long, install a new air spring, following "AIR SPRING REPLACEMENT" instructions in this subject.
	Tires, chains, or rims rubbing the air spring.	Check the clearance between the air spring and the tire. If the tire, chain, or rim contacts the inflated air spring, change to narrower tires and rims to provide more clearance.
	Air brake actuator rubbing against the air spring.	Relocate the actuator with factory approved parts to provide adequate clearance.
Air Spring(s) Fail To Fully Deflate When All Weight Is Removed From The Suspension	Restricted air line(s) between the height control valve(s) and the air spring(s).	Disconnect the height control valve linkage(s) and rotate the actuating lever(s) to the vertical down position. If the air spring(s) remain inflated, check for pinched or blocked line(s). Clean out plugged line(s) and/or replace damaged line(s).
	Height control valve(s) out of adjustment.	Readjust the height control valve(s) as outlined in prior "HEIGHT CONTROL VALVE ADJUSTMENT" instructions in this subject.

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SPECIFICATIONS

DESCRIPTION	SIZE	TORQUE	
		FT-LBS	N·m
Spring-To-Spring Pin Block Capscrews	5/8-11	200	271
Spring Hanger Bushing Nut	1-14	150	203
Shock Absorber Mounting Locknuts	3/4-16	150	203
Air Spring Upper Mounting Capscrews	3/8-16	34	46
Forward Spring Stop Locknut	3/4-16	150	203
Spring Pin Block Rear Nut	1/2-20	100	136
Axle U-Bolt High Nuts	3/4-16 7/8-14	250 400	339 542
Crosstube U-Bolt High Nuts	5/8-18	100-125	136-170
Air Spring Lower Mounting Capscrews	3/8-16	34	46
Front Spring Hanger Mounting Nuts	5/8-11	200	271
Shock Absorber Upper Bracket Nuts	1/2-13	82	111
Air Spring Upper Mounting Bracket Nuts	1/2-13	82	111
Height Control Valve Mounting Bolt Nuts	1/4-28	11	15
Vernier Adjustment Nut	1/4-20	4	5

Table 1, Torque Values

CONTENTS

SUBJECT	SUBJECT NUMBER
ALUMINUM OR FIBERGLASS HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT	32-17100
FIBERGLASS HOOD REPAIRS, CONVENTIONAL	32-17200
ALUMINUM HOOD REPAIRS	32-17300
HOOD ATTACHMENTS, REPAIR AND REPLACEMENT	32-17400

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

GENERAL DESCRIPTION

Freightliner Conventionals may be equipped with an aluminum hood assembly (Fig. 1), or a fiberglass hood assembly (Fig. 2). Both hood assemblies use the same grille components, hood pivots, tilt-assist assemblies, rear mounts, and hood latches.

Mounted on two chassis pivot brackets directly behind the front bumper, the hood may be tilted forward for vehicle service. The hood pivots work in conjunction with the tilt-assist springs and stop cables to allow a forward hood tilt of approximately 80 to 90 degrees.

In the operating position, the rear of the hood is supported by one of the following: Adiprene cushions attached to firewall-mounted adjuster blocks, hood-mounted sockets over cowl-mounted alignment pins, or by the top rear edge of the hood resting directly on the top edge of the cowl. To prevent lateral movement of the hood sides, the hood is held in place either by lower hood sockets and alignment pins, or by lateral restraint brackets and tongue assemblies. Spring-loaded latches, one on each side of the hood, prevent any upward hood travel.

Some aluminum and fiberglass hood assemblies include a 1-inch (25 mm) thick, sound-absorbent foam liner on the underside of the hood, depending on the engine type and model. The mylar-covered foam reduces engine noise emissions.

SERVICE OPERATIONS

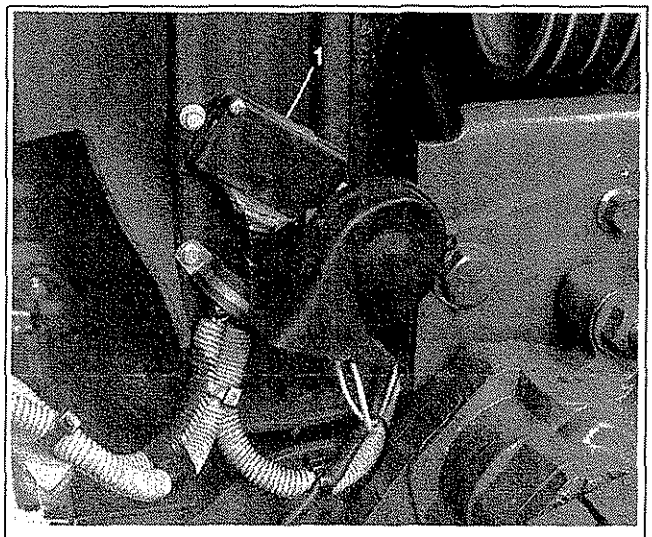
HOOD REMOVAL

1. Apply the parking brakes and chock the tires.
2. Release the hood latches, and tilt the hood to the full-open position.
3. On vehicles with 1984 Advancements, at the left radiator side channel, loosen the electric horn attaching screw, remove the cover from the hood-wiring junction block, and remove the wiring harness retaining clamp. See Fig. 3. Remove the nuts that hold the wiring in place inside the junction block, and mark the wires for later assembly reference. Remove from the posts all the wires that are in the harness that goes to the hood; then install the nuts on the posts to hold in place all the wires that are coming from the firewall.

Fig. 1, Aluminum Hood Assembly

Fig. 2, Fiberglass Hood Assembly, With 1984 Advancements

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT



1. Hood Wiring Junction Box

Fig. 3

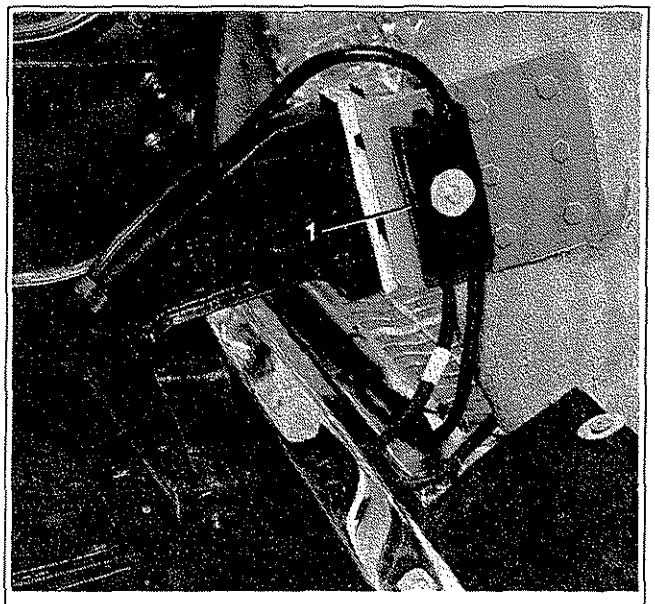
On vehicles without 1984 Advancements, separate the halves of the headlight wiring-harness disconnect plug (Fig. 4), located on the right hood-mounting bracket.

4. Place sawhorses, benches, a roll-around stand, or other supports under the grille of the hood. Use suitable padding (cardboard, carpet, etc.) to prevent scratching the finish on the grille. To avoid having to lift the hood, use supports that are the same height as the face of the grille in the forward-tilt position. The lowest edge of the grille should rest on the supports. The supports should be as wide, or spaced apart to be as wide, as the grille is, and should be as long as the grille is tall (46 inches [1168 mm]). See Fig. 5.

5. Tilt and hold the hood in a position that relieves the tension on the hood tilt-assist springs. Remove the hood-stop shoulder bolts located on each side of the hood. Refer to Fig. 6. The springs and cables may be left attached to the radiator side channels. Lower the front of the hood onto the supports.

6. On vehicles with 1984 Advancements, remove the prevailing torque locknuts from the pivot pins that attach the hood to the forward mounting brackets. See Fig. 7. Drive out the pivot pins.

   On vehicles without 1984 Advancements, remove the nuts and washers that hold the hood-mounting brackets to the pivot arms. Refer to Fig. 6. After the nuts and washers are removed from both sides, the pivot arms should be rotated down, away from the hood-mounting brackets. Leave any shims (if present) in place, and install the washers and nuts to retain them.



1. Headlight Wiring-Harness Disconnect Plug

Fig. 4

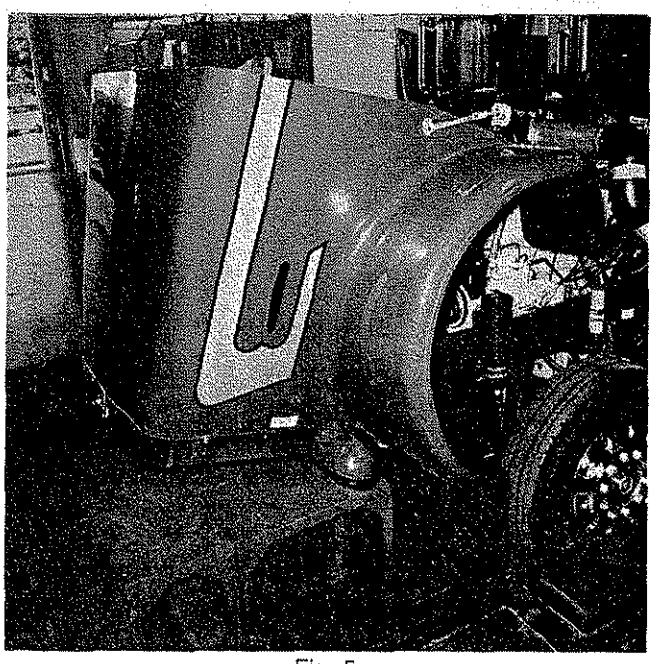
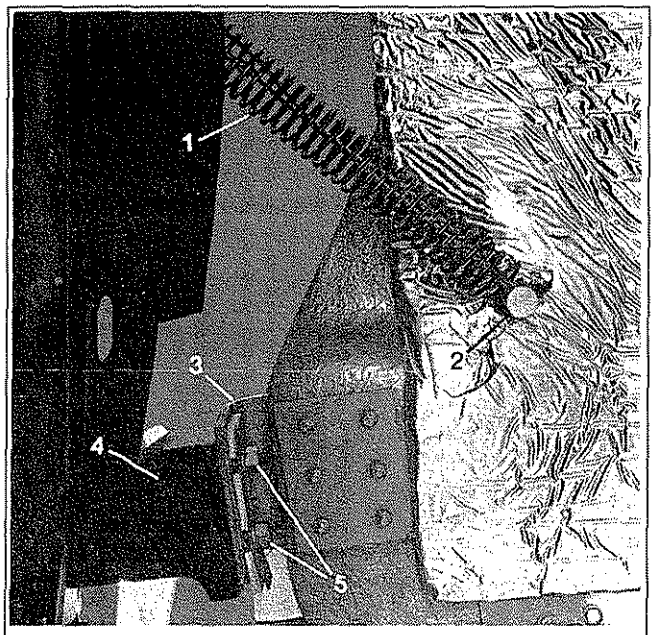


Fig. 5

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT



1. Hood Tilt-Assist Spring and Stop Cable
2. Hood-Stop Shoulder Bolt
3. Hood-Mounting Bracket
4. Pivot Arm
5. Hood-Mounting Bracket Nuts

Fig. 6

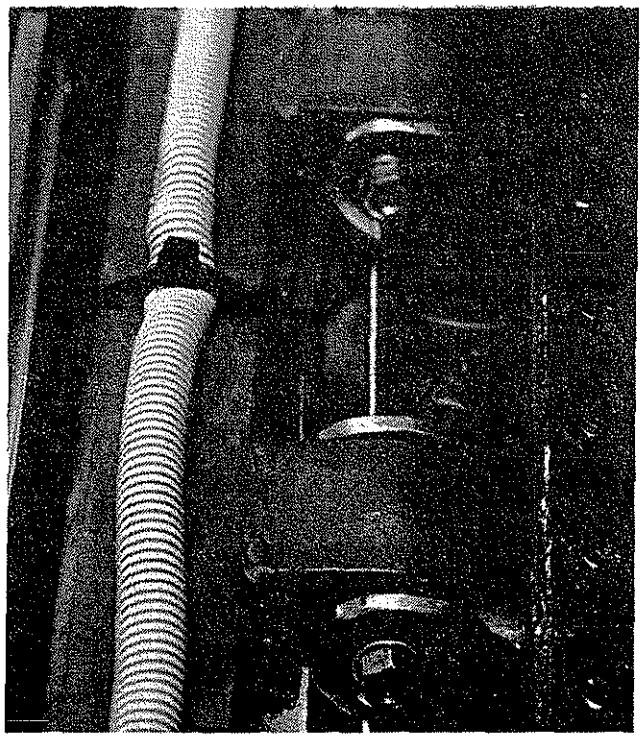


Fig. 7

7. To move the hood, carefully roll or slide the hood supports away from the vehicle; do not attempt to lift the hood.

WARNING: Attempting to lift the hood unassisted, or with the assistance of only one or two other people, could result in personal injury, or damage to the hood assembly and other components.

HOOD INSTALLATION

1. With the hood in the forward-tilt position and resting on the support at approximately the same height as the top of the bumper, move the support and hood into alignment with the front of the vehicle. To move the hood, carefully roll or slide the hood supports; do not attempt to lift the hood.

WARNING: Attempting to lift the hood unassisted, or with the assistance of only one or two other people, could result in personal injury, or damage to the hood assembly and other components.

2. On vehicles with 1984 Advancements, align the pivot pin holes of the aluminum crosstie assembly, with the pivot pin holes of the forward mounting brackets. Push the pivot pins into place; both pins must be installed from right to left. Install the prevailing torque locknuts, and tighten them 23 lbf·ft (17 N·m).

   On vehicles without 1984 Advancements, remove the nuts and washers from the pivot-arm studs, and rotate the pivot arms upward while guiding the hood-mounting bracket over the studs. Install the washers and nuts. See Fig. 6. Tighten the nuts 50 lbf·ft (68 N·m).

3. Place the end of the hood tilt-assist spring and stop cable over the hood-stop shoulder bolt, as shown in Fig. 8. Tilt the top of the hood up far enough to screw the bolt into the spring mounting-assembly bracket. Repeat this procedure for the other hood-stop shoulder bolt. Tighten the bolts 55 to 65 lbf·ft (75 to 88 N·m).

4. Remove the hood supports from the front of the vehicle.

5. On vehicles with 1984 Advancements, remove the nuts from the posts in the hood-wiring junction block, at the left radiator side channel. Install the wires, as previously marked, then install and tighten the nuts. Install the junction block cover and wiring harness retaining clamp, and tighten the electric horn

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

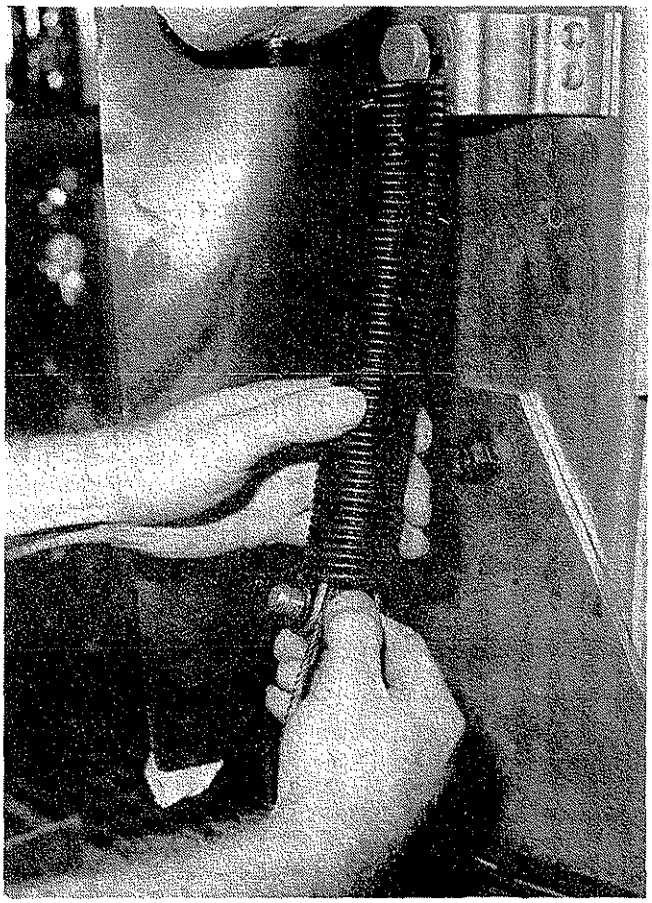


Fig. 8, Stop Cable and Spring on Shoulder Bolt

attaching screw. Using a grease gun, apply petroleum jelly or a light chassis grease, at the junction block grease fitting, until the junction block is full.

On vehicles without 1984 Advancements, connect the headlight wiring-harness disconnect plug. Secure a tie-strap around the plug to prevent the plug halves from separating during service. See Fig. 4.

6. Return the hood to the operating position, and fasten both hood latches.
7. Align the hood, following the procedures in this subject.
8. Remove the chocks from the tires.

HOOD ALIGNMENT ADJUSTMENT

IMPORTANT: All inspections and adjustments must be made with the vehicle parked on a flat, level surface. Drive the vehicle back and forth to settle the frame and suspension.

If any adjustments are made to the position of the hood with respect to the frame rails or cab of the vehicle, check and adjust the headlight aim, following the procedures given in the 06 Group of the Freightliner Maintenance and Lube Manual.

If the hood cannot be adjusted to the specifications described in the following procedures, check for broken fasteners or sagging springs. Replace any damaged parts.

All hood adjustment dimensions allow a minimum and a maximum tolerance. It is important that the adjustments be kept within these tolerances; however, for appearance sake, the alignment of paint stripes (when so equipped) between the hood and the cab should be used to determine the actual adjustment settings within the minimum and maximum tolerances.

Parallelism (Cab-to-Frame and Hood-to-Cowl)

The cab and hood should be parallel to the vehicle frame, and the rear edge of the hood should be parallel to the cowl sides. Check and adjust the hood as follows:

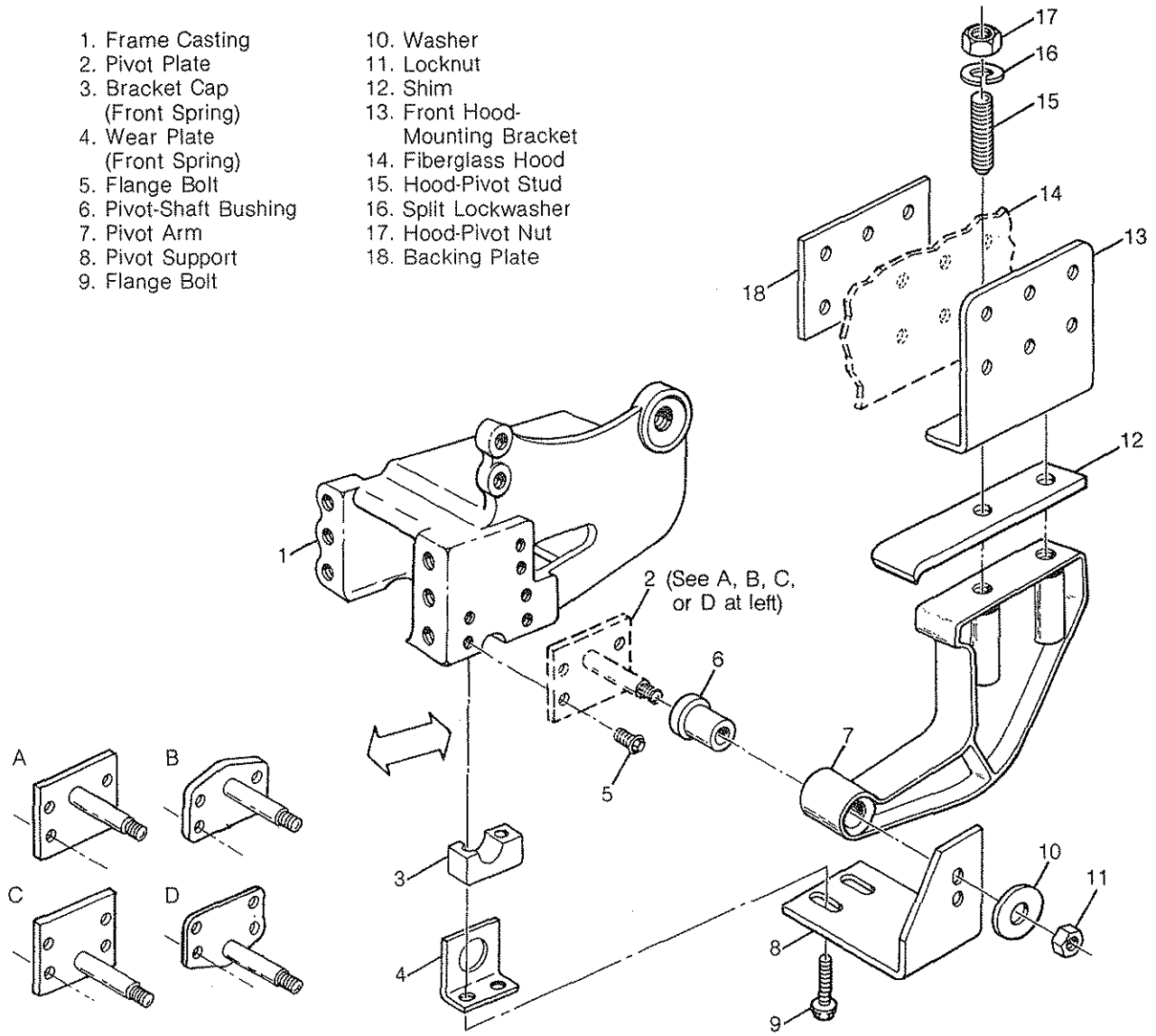
1. Measure the vertical distance from the bottom of the cab deck to the top of the frame rail at the four corners of the cab. This distance should be 8-1/2 ± 1/4 inches (216 ± 6 mm) at all locations. If the vertical distance is not 8-1/2 inches (216 mm), add spacers, as necessary, between the frame rails and front cab rubber mounts, or between the channel support assembly and the rear cab rubber mounts.
2. On vehicles with 1984 Advancements, proceed to step 4.

   On vehicles without 1984 Advancements, check that the pivot plates are correctly positioned on the frame castings. For instructions, refer to Fig. 9, Ref. 2 (A, B, C, or D): note that there is only one *correct* way to position the pivot plate and off-center stud assembly, depending on the size and composition of the frame rails.

   If the pivot plates are installed incorrectly, remove the pivot-plate bolts, and rotate the plates to the correct position. Tighten the pivot-plate bolts 20 to 25 lbf·ft (27-34 N·m), and the pivot-support bolts 55 to 65 lbf·ft (75-88 N·m).
3. The vertical rear edges of the hood must be parallel to the cowl sides (Fig. 10). If they are not parallel, spacers or shims must be added or removed at the forward hood-mounting brackets.

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

1. Frame Casting
2. Pivot Plate
3. Bracket Cap (Front Spring)
4. Wear Plate (Front Spring)
5. Flange Bolt
6. Pivot-Shaft Bushing
7. Pivot Arm
8. Pivot Support
9. Flange Bolt
10. Washer
11. Locknut
12. Shim
13. Front Hood-Mounting Bracket
14. Fiberglass Hood
15. Hood-Pivot Stud
16. Split Lockwasher
17. Hood-Pivot Nut
18. Backing Plate



A or B: Installed position of pivot plate for aluminum or 10-1/8" (317 mm) steel frame rails.

C or D: Installed position of pivot plate for 9-1/8" (235 mm) steel frame rails.

Fig. 9, Hood-Pivot Assembly to Frame Casting (For Hoods Without 1984 Advancements)

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

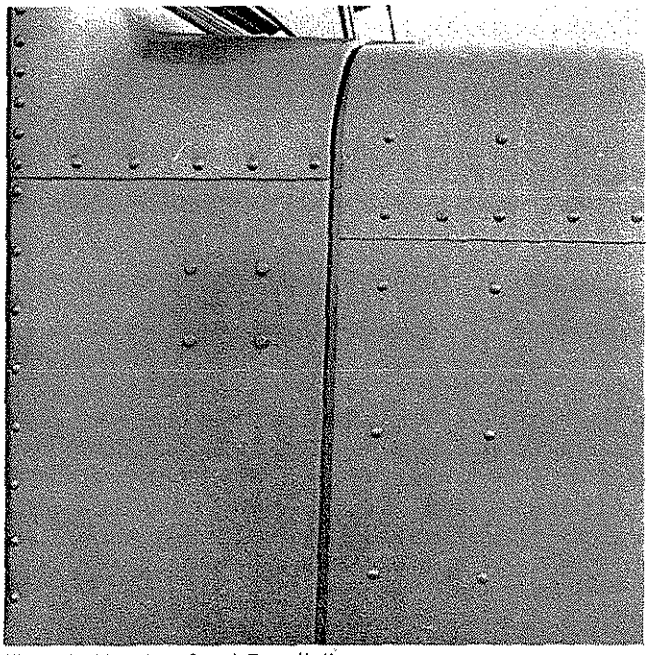


Fig. 10, Hood-to-Cowl Parallelism

On vehicles with 1984 Advancements, proceed to step 4.

On vehicles without 1984 Advancements, add or remove shims as follows:

.1 Release the hood latches, and tilt the hood to a position that relieves the tension on the hood tilt-assist springs.

.2 On the side of the hood where the adjustment is needed, remove the hood-stop shoulder bolt. Refer to Fig. 6. Tilt the hood to the full-open position.

.3 Remove the nuts and washers that hold the hood-mounting bracket to the pivot arm. Refer to Fig. 6.

.4 Push the hood-mounting bracket forward until it clears the studs in the pivot arm. Add or remove 1/4-inch (6.5 mm) shims as needed. Refer to Fig. 11.

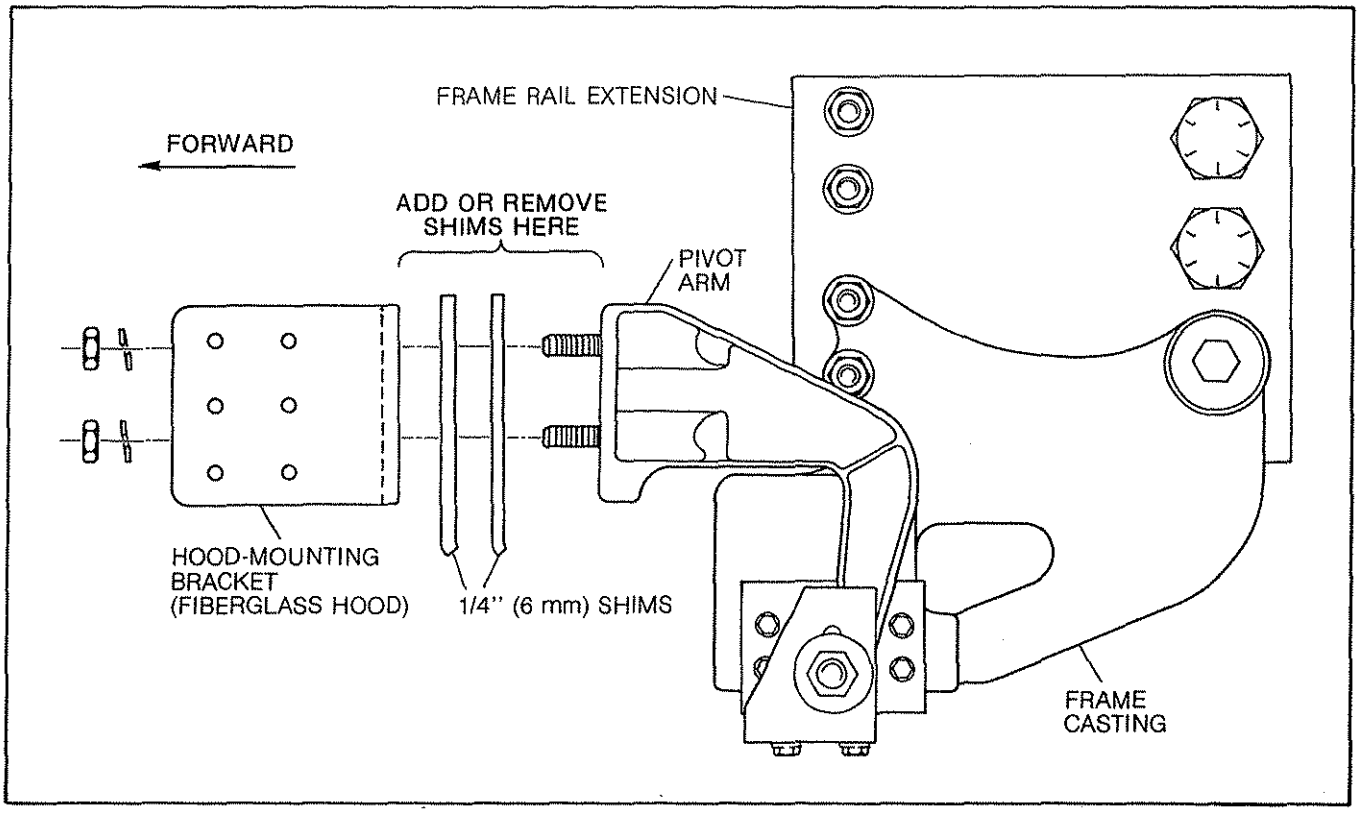


Fig. 11, Installing Shims Between Hood-Mounting Bracket and Pivot Arm (For Hoods Without 1984 Advancements)

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

.5 Guide the hood-mounting bracket over the studs in the pivot arm. Install the washers, and start the nuts on the studs. Tighten the nuts 50 lbf·ft (68 N·m).

.6 Place the end of the hood tilt-assist spring and stop cable over the hood-stop shoulder bolt, as shown in Fig. 8. Tilt the top of the hood up far enough to screw the bolt into the spring mounting-assembly bracket. Tighten the bolt 55 to 65 lbf·ft (75-88 N·m).

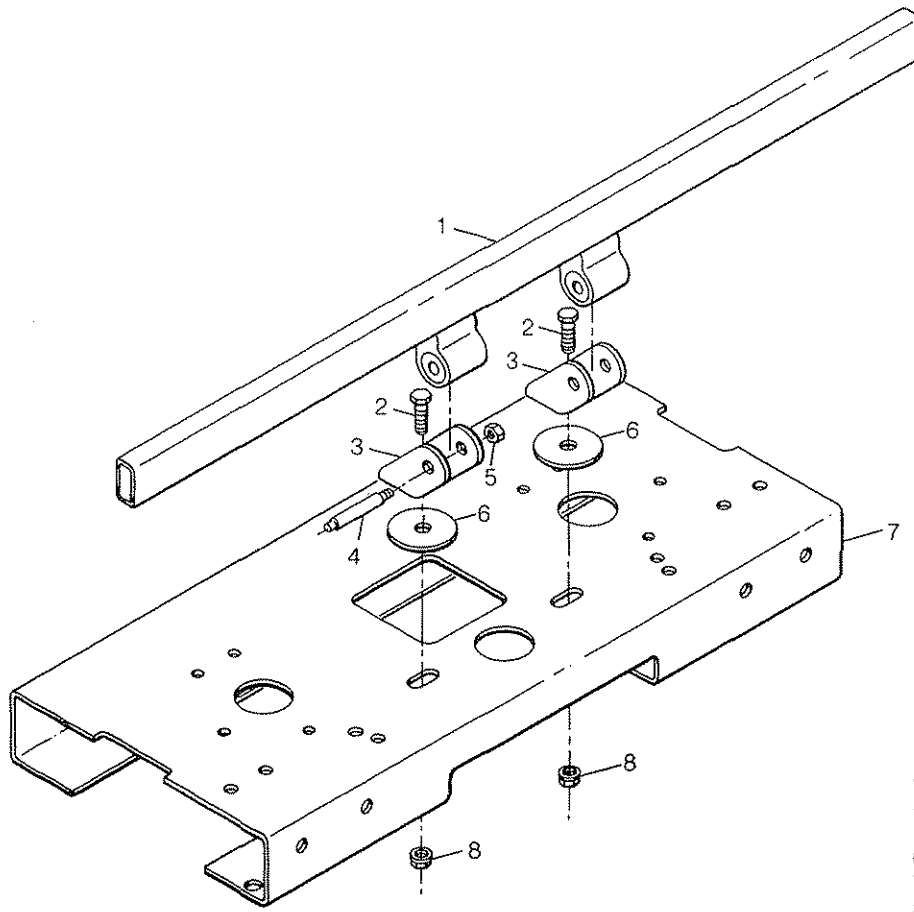
.7 Adjust the other side of the hood, as necessary.

.8 Return the hood to the operating position, and fasten the hood latches.

4. On vehicles with 1984 Advancements, add or remove spacers as follows:

.1 With the hood in the operating position, and the hood latches latched, remove the 1/2-13 flange nuts from the forward hood-mounting bracket bolts. See Fig. 12.

.2 Raise one of the bolts until the lower end of the bolt clears the front crossmember and any spacers. Hold the bolt up, and raise the front of the hood high enough to allow insertion or removal of 1/4-inch (6 mm) spacers. Insert or remove the spacers, as needed, then push the bolt back down.



1. Crosstie Assembly
2. 1/2-13 Flange Bolt
3. Forward Hood-Mounting Bracket
4. Pivot Pin
5. Prevailing Torque Locknut
6. Spacer
7. Front Crossmember
8. 1/2-13 Flange Nut

Fig. 12

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

.3 Raise the other bolt, and insert or remove spacers, as needed, on that side.

IMPORTANT: The same number of 1/4-inch (6 mm) spacers must be used under both hood-mounting brackets; up to a maximum of three on each side.

.4 Lower the hood, and push the bolts down. Install the 1/2-13 flange nuts, and tighten them 80 lbf·ft (108 N·m).

Hood-to-Cowl Clearance

Measure the distance between the outside edge of the cowl and the back edge of the hood at the top and at the sides. Refer to Fig. 13.

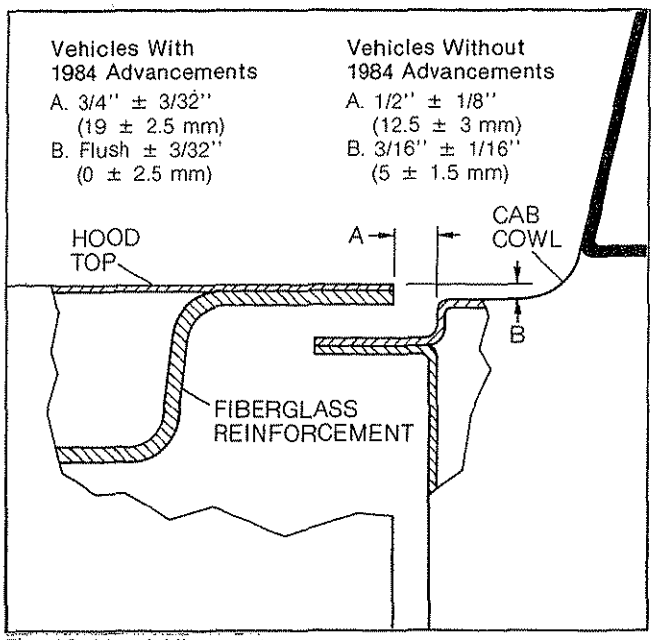


Fig. 13, Hood Alignment

On vehicles with 1984 Advancements, this distance should be 3/4 ± 3/32 inch (19 ± 2.5 mm). On vehicles without 1984 Advancements, the distance should be 1/2 ± 1/8 inch (12.5 ± 3 mm). If the distance is not correct, proceed as follows:

1. On vehicles with 1984 Advancements, with the hood in the operating position, loosen the 1/2-13 flange nuts on the forward hood-mounting bracket bolts. See Fig. 12.

   On vehicles without 1984 Advancements, with the hood in the operating position, loosen the hood-mounting bracket nuts on both pivot arms. See Fig. 6.

2. Push the hood back, or pull it forward, until the spacing is correct.

3. On vehicles with 1984 Advancements, tighten the 1/2-13 flange nuts 80 lbf·ft (108 N·m).

   On vehicles without 1984 Advancements, tighten the nuts 50 lbf·ft (68 N·m).

Rear Hood Supports Adjustment

Rear hood supports must be adjusted to keep the top of the hood properly supported on or above the top of the cowl. The type of support varies, depending on the installation.

If the vehicle is equipped with one of the supports shown in Fig. 14 or 15, refer to the applicable heading below for adjustment procedures.

If the vehicle is not equipped with hood supports, as shown in Figs. 14 and 15, the rear of the hood rests directly on the cowl lacing; proceed to "Lower Hood Lateral Restraint Adjustment."

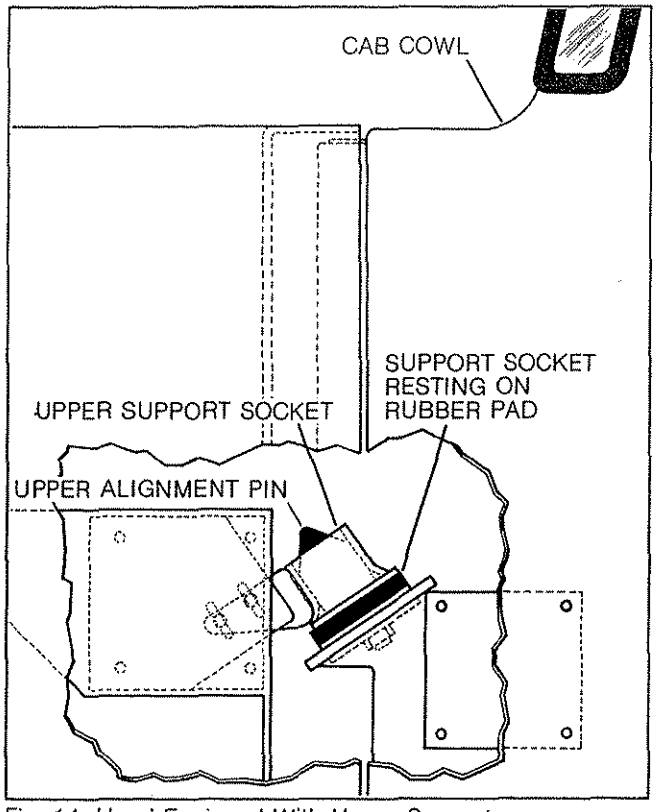
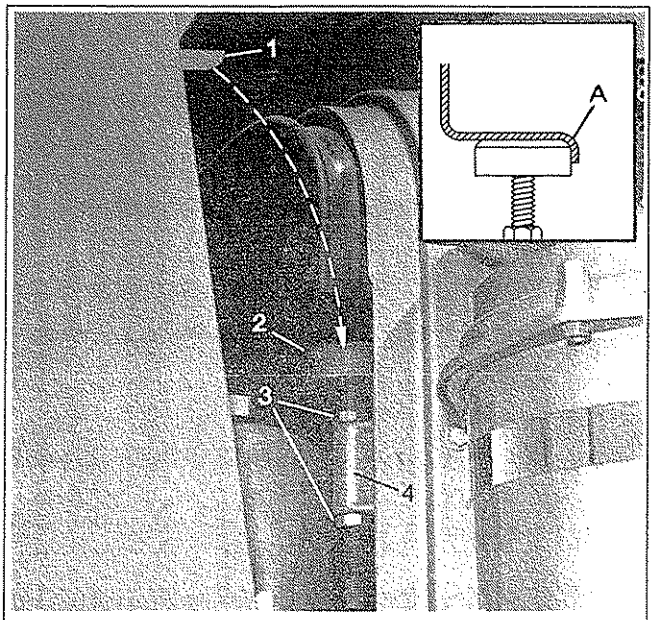


Fig. 14, Hood Equipped With Upper Support Sockets and Alignment Pins

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT



1. Hood Rest
2. Isolator Assembly
3. Jam Nuts
4. Adjuster Block
A. Outboard Edge of Hood Rest

Fig. 15, Hood Equipped With Adjuster Blocks

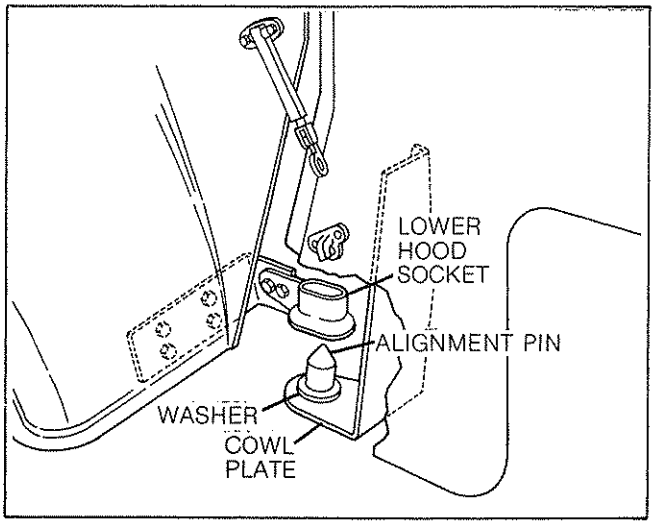


Fig. 16, Lower Hood Socket and Alignment Pin

Adjuster Blocks

1. Release the hood latches, and tilt the hood to the full-open position.
2. If the vehicle is equipped with lower sockets and alignment pins (Fig. 16), proceed as follows:

   If the vehicle is equipped with restraint bracket and tongue assemblies (Fig. 17 or 18), proceed to step 3.

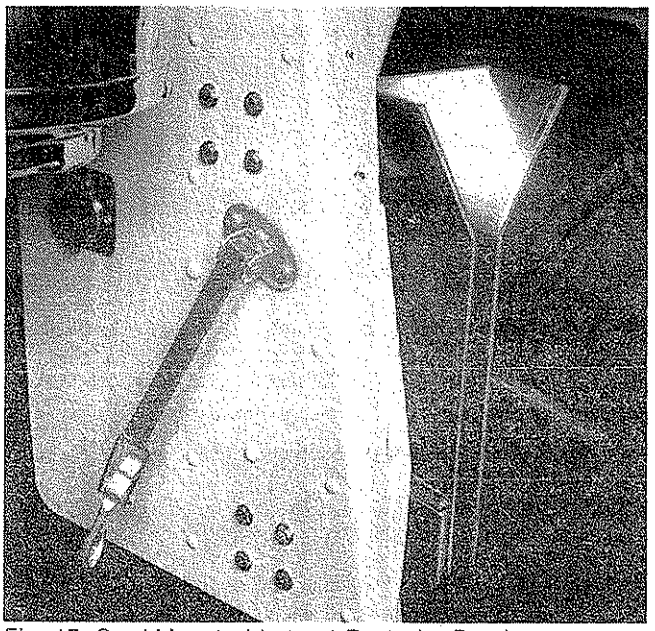
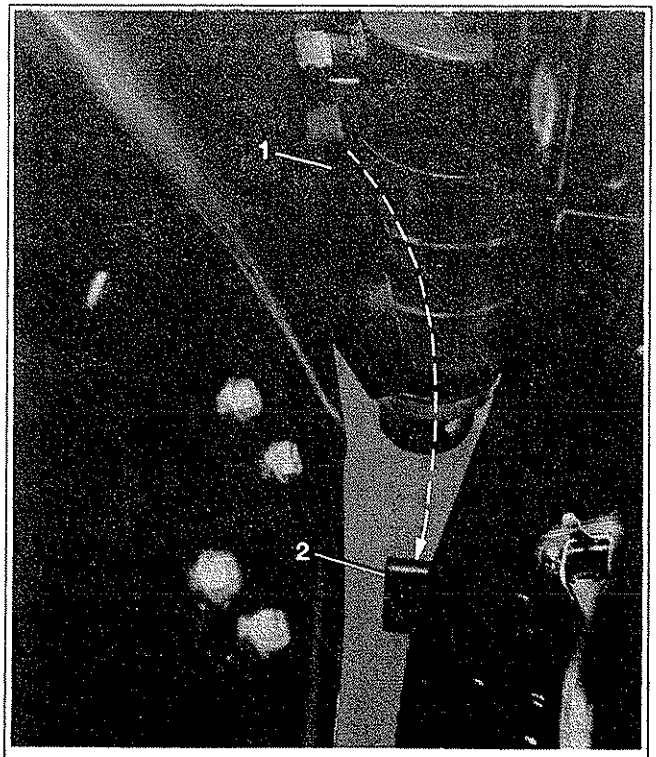


Fig. 17, Cowl-Mounted Lateral Restraint Bracket



1. Lateral Restraint Bracket
2. Tongue Assembly

Fig. 18, Hood-Mounted Lateral Restraint Bracket and Cowl-Mounted Tongue Assembly

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

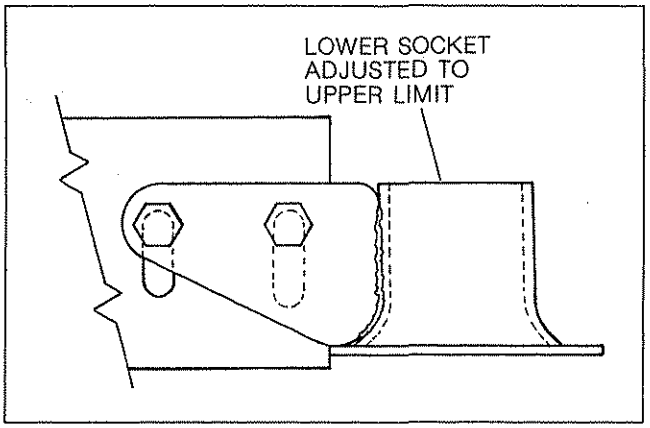


Fig. 19, Lower Hood Socket Adjusted Up

.1 Loosen the nut at the bottom of each lower hood alignment pin (Fig. 16).

.2 Loosen both lower hood sockets, and push them to the upper limit of their adjustment. See Fig. 19. Tighten the nuts to hold them in place.

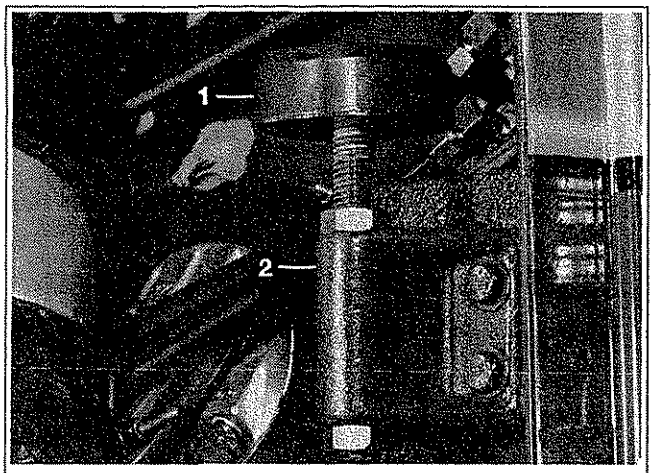
3. Loosen the nuts on the bolts holding the upper hood-adjuster blocks to the firewall. See Fig. 20. Determine the cowl centerline, and position the adjuster blocks so that the center of the threaded isolator-adjusting rod passing through the adjuster block is approximately 29-inches (737 mm) outboard from the cowl centerline. Refer to Fig. 21.

4. Return the hood to the operating position, but do not fasten the hood latches. Determine the point at which the hood rest makes contact with the isolator assembly (Fig. 15). The adiprene portion of the isolator must be positioned so that it fits snugly against the outboard edge of the hood rest, to prevent side-to-side movement of the hood. If necessary, slide the adjuster blocks outboard until a tight fit is achieved. Tighten the adjuster-block nuts 20 to 25 lbf·ft (27 to 34 N·m).

5. With the hood in the operating position and the hood latches unfastened, adjust the hood height in relation to the cowl, as follows:

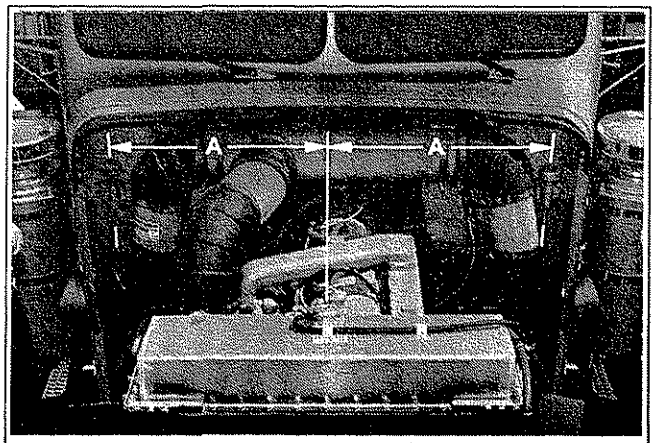
   .1 Measure the vertical gap between the top of the hood and the top of the cowl on each side of the hood as shown in Fig. 13.

   On vehicles with 1984 Advancements, the top of the hood should be flush ± 3/32 inch (0 ± 2.5 mm) with the top of the cowl. On vehicles without 1984 Advancements, the vertical gap should be 3/16 ± 1/16 inch (5 ± 1.5 mm).



1. Isolator Assembly 2. Adjuster Block

Fig. 20



A. 29" (737 mm)

Fig. 21, Cowl-Centerline to Isolator-Rod Measurement

   .2 If the measurement is not within these specifications, determine the adjustment necessary on each side of the hood. Tilt the hood to the full-open position.

   .3 Loosen the jam nuts securing the threaded isolator-adjusting rods to the adjuster blocks. Turn the rods to raise or lower the adiprene isolator assembly until the measurement is within the tolerances given above. Tighten the jam nuts securely.

6. Proceed to "Lower Hood Lateral Restraint Adjustment."

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

Upper Socket and Alignment Pins

1. Release the hood latches, and tilt the hood to the full-open position.
2. Loosen the nut at the bottom of each of the four hood alignment pins. The cowl plates have enlarged bolt holes to allow the hood alignment pins to adjust in all directions. Tighten the nuts approximately 1/8-turn past finger-tight.
3. Loosen both lower hood sockets. Push the sockets to the upper limit of their adjustment. See Fig. 19. Tighten the nuts to hold them in place.
4. Loosen both upper support sockets. Position the sockets at approximately the same angle as the upper alignment pins, but at the lower limit of their adjustment. See Fig. 22. Tighten the nuts approximately 1/8-turn past finger-tight.

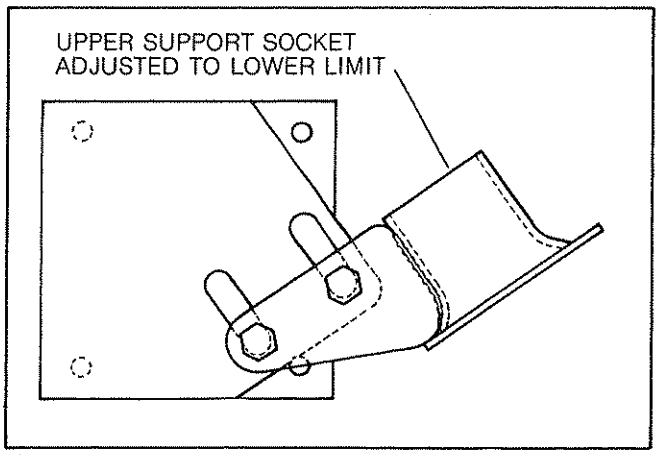


Fig. 22, Upper Hood Support Socket Adjusted Down

5. Return the hood to the operating position, but do not fasten the hood latches. The hood should not be pulled down flush with the cowl, and the hood should not rest on the cowl lacing. The top of the hood and the top of the cowl should be misaligned by 3/16 ± 1/16 inch (5 ± 1.5 mm). See Fig. 13. The hood should be pulled down just enough to obtain this measurement. The upper support socket must rest on the rubber pad of the upper alignment pin when the hood is in the operating position. See Fig. 23.
6. Tilt the hood to the full-open position. Without disturbing the adjustment of the upper support sockets or upper alignment pins, tighten the upper alignment-pin nuts 55 to 65 lbf·ft (75 to 88 N·m), and the upper support socket nuts 25 to 30 lbf·ft (34 to 41 N·m).

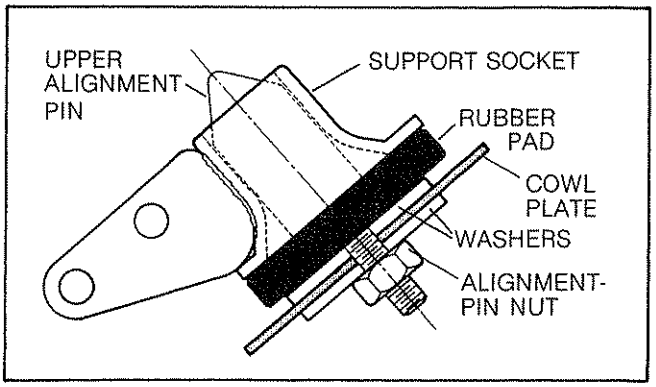


Fig. 23

Apply Lubriplate, or an equivalent lubricant, to the alignment pins.

Lower Hood Lateral Restraint Adjustment

From Figs. 16, 17, and 18, determine which type of lateral restraints are installed on your vehicle, then proceed to the applicable heading below.

Cowl-Mounted or Hood-Mounted Restraint Bracket and Hood-Mounted or Cowl-Mounted Tongue Assembly

1. On one side of the hood, loosen the nuts holding the hood-mounted tongue assembly (Fig. 17), or the hood-mounted lateral restraint bracket (Fig. 18), as applicable. Tighten the nuts approximately 1/8-turn past finger-tight.
2. Return the hood to the operating position, but do not fasten the hood latches. Push on the rear edge of the hood (at the side being adjusted) until the side of the hood is flush with the side of the cowl.
3. Tilt the hood to the full-open position, while maintaining enough pressure on the side of the hood to prevent disturbing the adjustment of the tongue assembly or lateral restraint bracket. Tighten the tongue assembly or restraint-bracket nuts 20 to 25 lbf·ft (27 to 34 N·m).
4. Repeat steps 1 through 3 to adjust the tongue assembly or lateral restraint bracket on the other side of the hood.
5. Return the hood to the operating position and fasten both hood latches.

Lower Socket and Alignment Pins

1. On one side of the hood, loosen the lower hood socket, and position it at the lowest limit of its adjustment. See Fig. 24. Loosen the nut at the bottom

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

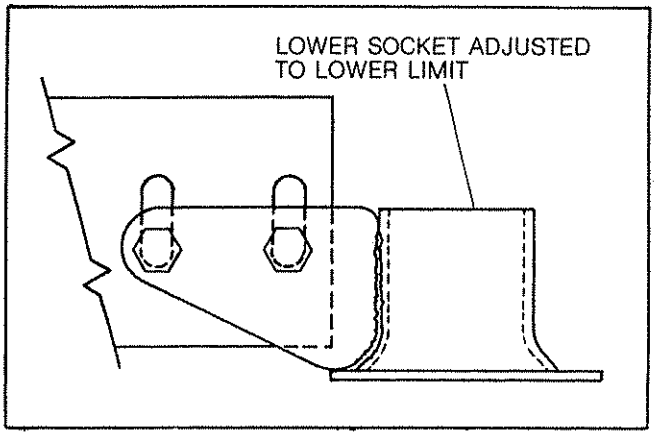


Fig. 24, Lower Hood Socket Adjusted Down

of the alignment pin (Fig. 16). Tighten the nuts approximately 1/8-turn past finger-tight.

2. Using a sturdy material (steel, aluminum, or hard plastic), fabricate a spacer that meets the specifications shown in Fig. 25. Install the spacer over the hood alignment pin on the side of the hood that is being adjusted. See Fig. 16.

NOTE: When the hood is in the operating position, the lower hood sockets must not rest on the cowl plates or on the alignment-pin washers.

3. Return the hood to the operating position, and fasten both hood latches, to center the hood.

4. Release both hood latches. Push on the rear edge of the hood (at the side being adjusted) until the side of the hood is flush with the side of the cowl. Lift the hood until the lower hood socket clears the hood alignment pin, while maintaining just enough pressure on the side of the hood to prevent disturbing the adjustment of the socket or pin.

5. Tilt the hood to the full-open position. Tighten the hood-socket nuts 25 to 30 lbf·ft (34 to 41 N·m), and the alignment-pin nut 55 to 65 lbf·ft (75 to 88 N·m).

6. Remove the spacer from the alignment pin on the adjusted side, and move it to the pin on the other side.

7. Repeat steps 1, 3, 4, and 5, to adjust the lower socket and alignment pin on the other side of the hood, then remove the spacer from the pin. Apply Lubriplate, or an equivalent lubricant, to the alignment pins.

8. Return the hood to the operating position, and fasten both hood latches.

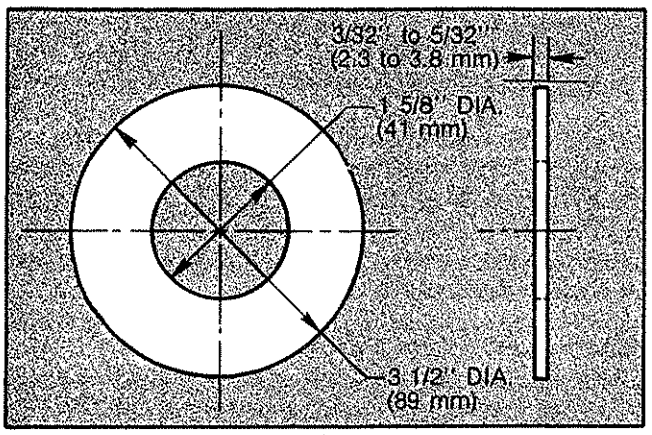


Fig. 25, Lower Hood Socket Adjustment Spacer

HOOD LATCH ADJUSTMENT

After completing the adjustments under "HOOD ALIGNMENT ADJUSTMENTS," check each hood latch for spring tension. The latch must have enough tension to hold the hood firmly in place, without binding the latch. Adjust the latches as follows:

1. Release the latch, and pull the hinged portion of the latch to a horizontal position.

2. Twist the hook-and-ring of the hinged portion in a clockwise direction to increase the spring tension, or in a counterclockwise direction to relax the spring tension, as necessary. See Fig. 26. Repeat this step for the latch on the other side of the hood.

3. Fasten both hood latches.

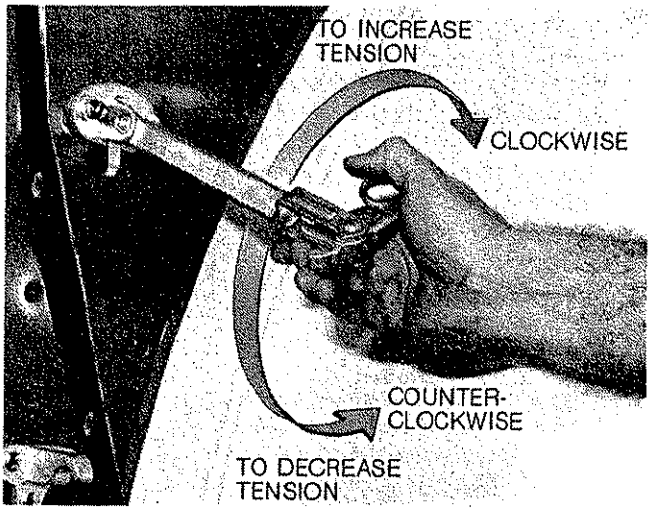


Fig. 26, Hood Latch Adjustment

HOOD REMOVAL, INSTALLATION, AND ADJUSTMENT

SPECIFICATIONS

DESCRIPTION	SIZE	TORQUE[1] lbf·ft (N·m)
Pivot Pin Locknuts	3/8-16	23 (31)
Pivot-Plate to Frame-Casting Bolts	3/8-16	23 (31)
Pivot-Support to Frame-Casting Bolts	1/2-13	55 (75)
Hood-Mounting Bracket to Front Crossmember Nuts	1/2-13	80 (108)
Hood-Mounting Bracket to Pivot-Arm Nuts	1/2-20	50 (68)
Adjuster-Block to Firewall Nuts	3/8-16	23 (31)
Rear Hood Support-Socket Nuts	3/8-24	25 (34)
Rear Hood Alignment-Pin Nuts	1/2-13	55 (75)
Hood-Stop Shoulder Bolts	1/2-13	55 (75)
Tongue-Assembly Nuts	3/8-16	23 (31)
Lateral Restraint-Bracket Nuts	3/8-16	23 (31)

Table 1, Fastener Torque Values

[1] These torque values are for fasteners with lubricated or plated threads. For dry threads, see the General Torque Table in the Freightliner Maintenance and Lube Manual.

FIBERGLASS HOOD REPAIRS, CONVENTIONAL
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FIBERGLASS HOOD REPAIRS, CONVENTIONAL

GENERAL INFORMATION

The materials utilized in fiberglass Conventional hoods are a combination of glass filaments, resin (the binder), catalysts (to initiate the cure), and weather resistance additives. The filaments of pure glass provide strength, dimensional stability, and heat resistance to the structure. The resin is a liquid plastic that hardens when combined with another substance, the catalyst. The resin acts as a binder to hold the filaments together; it supplies only a limited additional amount of strength to the structure.

Of the several methods in which fiberglass can be applied, the "contact molding" technique is used in the manufacture of fiberglass Conventional hoods. As illustrated in Fig. 1, contact molding is done with an open mold, or a female configuration, which controls external shape and finish.

A gel coating is first sprayed onto the mold. The gel coating eventually becomes the smooth outer surface of the hood. It provides impact and abrasion resistance to the laminate underneath. In addition, it readily accepts a coating of paint.

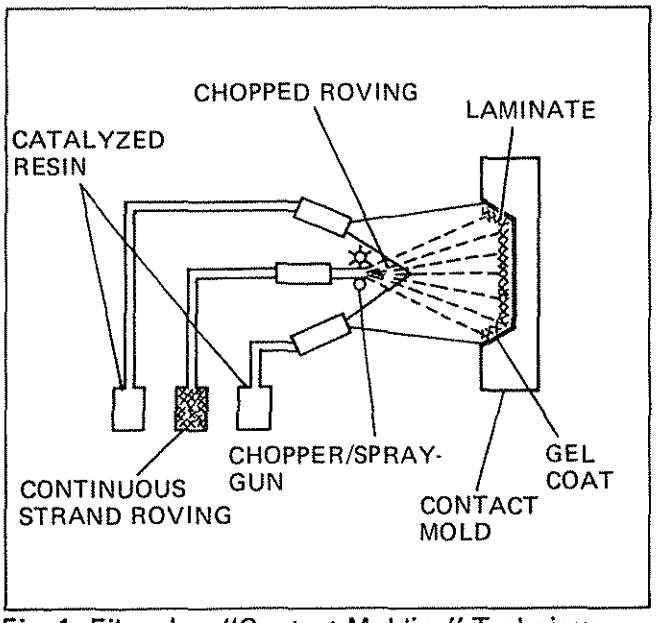

Fig. 1, Fiberglass "Contact Molding" Technique

A laminate of fiberglass reinforcement and resin is then built up by use of a special chopper/spray-gun which directs short glass fibers and catalyzed resin onto the mold (gel) surface. The glass fibers are rapidly "chopped" from a feeder roll of continuous strand roving, which consists of numerous, untwisted fiberglass strands wound into a cylindrical package.

The resin used in this process is air-inhibited; that is, it will not completely cure, or harden, when the laminate is exposed to the air. All portions not directly exposed to the air (including those portions of the laminate contacting the gel), dry instantly. As a result, no matter how many "passes" are made of the roving fiberglass chopper/spray gun in a particular area, the final structure will have only one layer of fiberglass (that is, distinct layers of fiberglass will not be present when using this process).

Upon completion of this phase in the manufacture of a fiberglass hood (termed "spray-up"), major stress areas are reinforced by hand (termed "hand lay-up"). During hand lay-up, fiberglass reinforcement in the form of woven roving (a heavy, drapeable fabric) is manually built-up, with air-inhibited resin added as needed.

SERVICE OPERATIONS

In many cases of structural damage, repair is the economical choice over replacement. When deciding whether or not a damaged hood should be repaired or replaced, two factors should be considered:

1. Can the damaged area be repaired and still maintain the structural integrity of the hood?

2. Is it more economical to repair the damaged area than it is to replace the hood?

After major collision damage, the obvious choice would be to replace the hood assembly. The original structural integrity of the damaged hood could not be duplicated through repair, and the repairs would be more expensive than replacement.

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

In cases where, for example, damage results in the form of a crack extending up the side of the hood, structural integrity could likely be regained through repair.

TOOLS AND MATERIALS

Fiberglass repair kits can be purchased from many sources. Among them are automotive or truck parts outlets, body shops, boat marinas, plastics distributors, and various department stores. In all cases, the mixing instructions on the particular fiberglass repair kit should be followed closely, especially when adding catalyst to the resin.

Because most of the liquids involved in fiberglass repair are flammable, it is recommended that a repair kit large enough to accommodate only one or two jobs be purchased in order to avoid storing any quantity of these materials.

Refer to the "SPECIFICATIONS" section in this subject for a general list of tools and materials needed for repairing damaged fiberglass hoods.

SAFETY PRECAUTIONS

The following precautions should be thoroughly read before performing any fiberglass repairs. Any additional precautions given by the fiberglass repair kit manufacturer should also be observed.

1. All of the raw materials used in repairing fiberglass are injurious to the eyes and could cause blindness. Goggles or other protective eye shields should be worn to minimize the possibility of splash contacting the eyes.

2. Protective gloves should be worn as some individuals may have skin sensitivity to resin. In addition, do not allow the catalyst (hardener) to contact the skin. The catalyst can be a severe skin irritant.

IMPORTANT: In case the catalyst contacts the skin, wash with soap and water. If the catalyst or resin should contact the eyes, rinse with plenty of water (15 minutes), and contact a physician.

3. When working with fiberglass materials, old clothing should be worn, since the resin and catalyst may damage garment material. If splash accidentally contacts clothing, remove the spot(s) immediately with water.

4. Most of the liquids involved in fiberglass repair and cleanup (especially when using acetone as a solvent) are flammable; some are also toxic. Do not perform repairs in areas where exposed (or stored) flammable liquids may contact an open flame or any burning material, such as a cigarette. Do not perform repairs in areas that are not well-ventilated.

WARNING: Failure to insure that fiberglass repair is done in a safe workshop environment could result in severe personal injury due to explosion of flammable liquids or inhalation of toxic fumes.

5. Do not use electric tools when the fumes of flammable solvents are present. The heat and/or sparks generated by the tools could create a fire hazard.

6. When grinding or sanding fiberglass surfaces, the worker should wear goggles or other protective eye shields and also an air purifying respirator, either a throwaway type or one with replaceable particulate filter(s). The grinding dust or particles must not be inhaled, otherwise irritation may occur. In addition, during grinding and sanding operations, a disposable (paper) shop coat should be worn to keep dust and fiber slivers from becoming embedded in the worker's clothing.

7. Because fiberglass dust can shorten the life of electrical units, air-powered tools are preferred (for frequent use).

8. Unless fiberglass repairs are performed on a regular (daily) basis, leftover liquids should not be saved. Under no circumstances should leftover catalysts (hardeners) be stored in metal containers. If liquids must be saved, they should be stored in cool, dark areas, away from direct sunlight.

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

WARNING: Catalysts, if they contact metal over extended periods of time, cause oxidation of the metal. If stored in a sealed metal container, the catalyst may cause the container to explode, which can cause severe personal injury or property damage. If catalysts must be saved, they should be stored in a plastic container. Avoid storing catalysts in glass containers; glass will shatter, if dropped, which could result in the worker being sprayed with catalyst and glass fragments.

GENERAL PREPARATION

Fiberglass repairs should be performed in a workshop that is well-ventilated, absent of flame, burning materials, and sparks, and one that is relatively warm and dry, away from direct sunlight.

With most resins, the air temperature in the workshop should be 60°-80°F (16°-27°C), and the humidity should be 70 percent or lower. At higher temperatures, the curing time is considerably reduced, which can restrict the worker. At cooler temperatures, curing time is prolonged. High humidity may result in moisture being absorbed in the resin, which may inhibit curing and leave the surface tacky.

The practice of over-catalyzing the resin in order to "speed up" the cure if workshop temperatures are below 60°F (16°C) is not recommended. In many cases, if more catalyst than the usual two to three percent ratio is added to the resin, curing will not take place. Always follow the resin manufacturer's specifications when adding the catalyst to the resin. If in doubt, under-catalyze; applying heat later from a heat lamp or heat gun will cause the under-catalyzed resin to "kick," and eventually to harden.

It is important to note that the cure of a thermoset proceeds in two distinct stages. The first stage is the formation of a soft gel. Up to the formation of the gel, the fiberglass/resin mixture is pliant and can be molded to a desired shape. Under typical (warm) conditions (77°F [25°C] air temperature, and a resin mixture of one percent catalyst), the gel-time is about 15 to 20 minutes.

Immediately after gelation, the cure proceeds rapidly with the evolution of heat, up to an exothermic peak. Under the same typical (warm) conditions, the peak exotherm, or the point at which the cure is hottest, will occur after 26 minutes. During this second stage of the thermoset, the repair mixture is not pliant and cannot be shaped or cut with scissors.

SURFACE DAMAGE REPAIR

Surface damage refers to minor scratches or gouges which affect the appearance of the fiberglass, but penetrate through the paint and only slightly into the laminate itself.

For a list of tools and materials needed for repairs, refer to the "SPECIFICATIONS" section in this subject.

1. As precautions, chock block the vehicle tires to prevent accidental rolling, and activate the parking brakes.
2. Push on the area immediately around the damaged area to insure that there is no structural damage. There should be no weakness or "give." If the area can be pushed in or made to look dented, structural damage exists. Proceed to the applicable heading in this subject for repair instructions.
3. Check the shop temperature and humidity, and compare with the recommendations given on the resin/body filler can labels. Generally, 70°F (21°C) and 70% humidity are considered ideal.
4. Gather the required materials.
5. Clean the entire repair area with xylene or an equivalent grease and wax remover.
6. Form (rout) a V-groove for the length of the scratch or gouge using a burr bit or a sanding sleeve on a power drill. See Fig. 2. Do not cut through the laminate.

WARNING: Wear goggles and an air purifying respirator when grinding, cutting, or sanding during

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

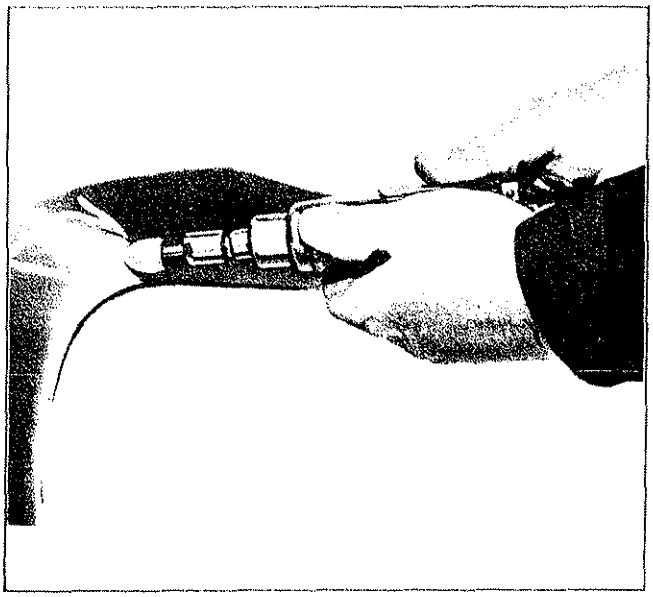

Fig. 2, V-Groove Formation

Fig. 3, Mixing Body Filler

all fiberglass repairs. The ground dust and particles could cause temporary or permanent damage to the eyes and, if inhaled, could cause irritation.

7. Remove the flaky edges, and gently feather the painted surface back about 1/2 inch (13 mm) beyond the damaged area by hand-sanding or power-sanding with 360-grit (or higher) sandpaper. Avoid causing any sudden steps or uneven protrusions in the area.

8. Clean the area using compressed air. Then, wipe with a solvent-dampened cloth. Allow the surface to completely dry.

9. Mask off the undamaged surfaces, leaving a working area of approximately 5 inches (127 mm) surrounding the repair area.

10. Following the resin/body filler manufacturer's instructions, mix enough body filler to re-establish the surface. See Fig. 3.

IMPORTANT: Mix the body filler on a hard, non-porous surface. Do not work on a porous surface, such as cardboard. Porous surfaces absorb the body filler liquids, which can adversely affect the final curing time and bond.

11. Apply and spread the body filler with a rubber or plastic "squeegee" (or similar wooden spreader) making sure to remove all air bubbles. See Fig. 4. The filler should extend above the surface to allow for shrinkage.

IMPORTANT: Make sure that no air is trapped in the repair area. When heat is later applied to shrink the body filler, the trapped air will expand and could cause the repair area to blister.

12. Allow time for the body filler to set until it is firm to the touch. Then, re-establish the original contour or surface by filing off the excess filler. See Fig. 5. The remaining filler level should be slightly lower than that of the original surface.

13. Pre-shrink the body filler, using a heat gun or an infrared heat lamp. See Fig. 6. Generally, a minimum temperature of 120°F (49°C) is required for shrinkage.

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

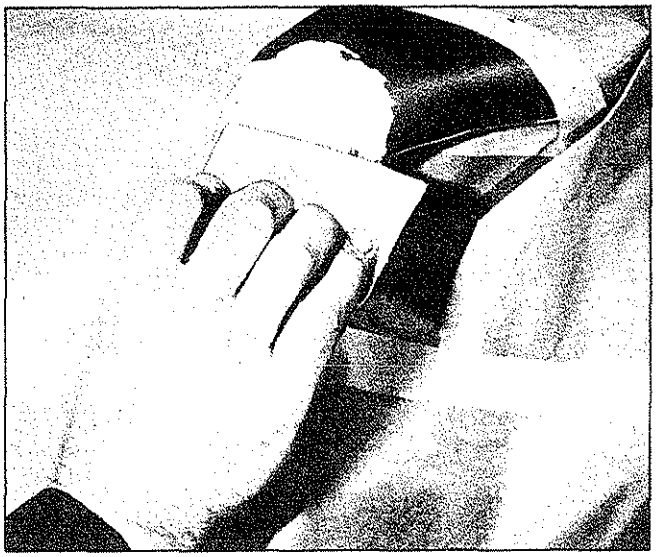

Fig. 4, Applying Body Filler With A Plastic Squeegee

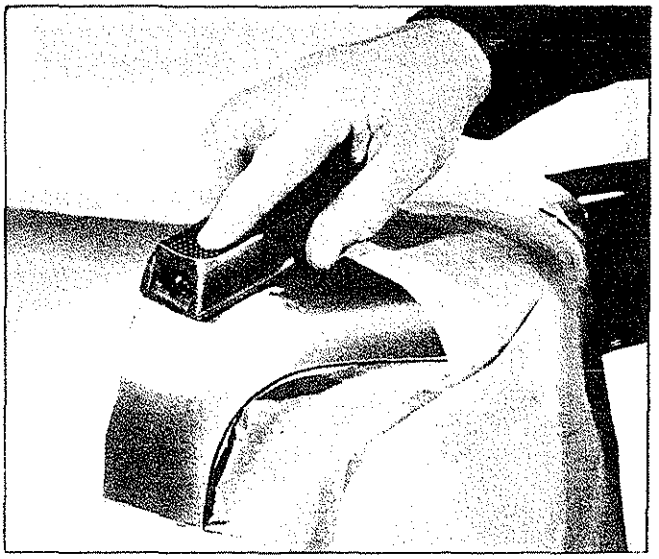

Fig. 5, Filing Off Excess Body Filler

CAUTION: Allow at least 12 inches (305 mm) of clearance between the heat source and the repair surface. Do not exceed the maximum temperature required for shrinkage, as recommended by the body filler manufacturer.

14. Apply a non-shrinking sealer to the body filler. Sherwin Williams Sprayfil D61A23, or an equivalent, is recommended.

15. After the surface has cured, finish by sanding with a sanding block and 360-grit (or higher) sandpaper.

IMPORTANT: Do not use the palm of the hand as a sanding backer (as opposed to using a hard sanding block), which only accentuates dips and hollows instead of removing them.

16. Complete the repair by cleaning the area with compressed air. See Fig. 7. Remask, if necessary, then spot prime and paint the repair area. Refer to the 18 Group of this manual for spot-painting instructions.

17. Remove the chock blocks from the tires.

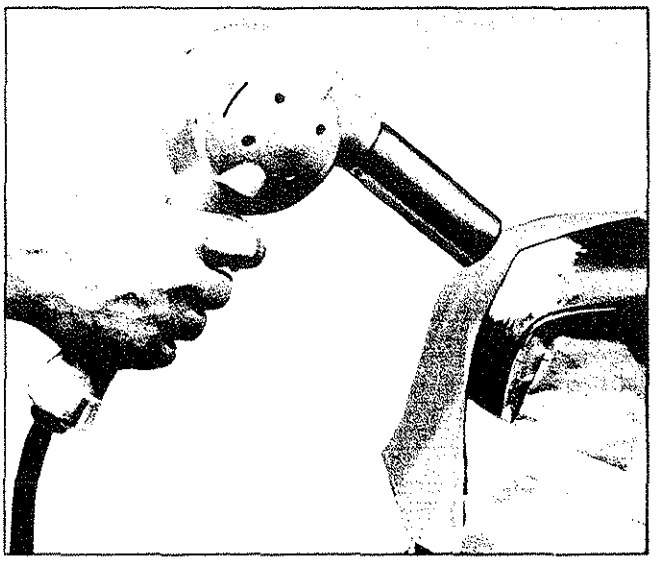

Fig. 6, Pre-Shrinking The Body Filler Using A Heat-Gun

STRUCTURAL DAMAGE REPAIR (INCLUDING CRACKS, PUNCTURES, AND FRACTURES)

Structural Damage—General

Structural damage refers to any type of damage that penetrates through the laminate, thus affecting the structural soundness of the damaged part, from hairline cracks to large fractures or punctures.

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

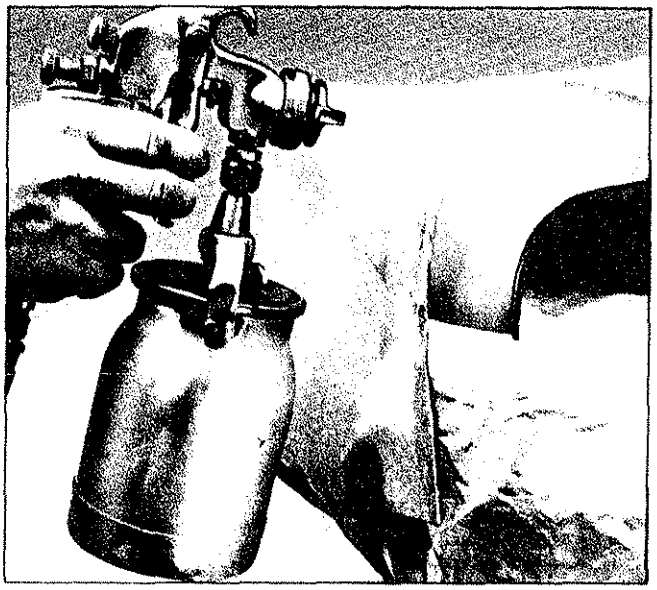

Fig. 7, Cleaning The Repair Area With Compressed Air

NOTE: If damage is severe and requires that the hood be removed from the vehicle, refer to the 17 Group of this manual for instructions. Whenever the hood is removed from the vehicle, it should be placed on a support frame, similar to that shown in Fig. 8.

If repairs are to be made with the hood attached to the vehicle, the vehicle tires should be chock blocked to prevent accidental rolling, and the parking brakes should be activated. The vehicle should be on level ground.

For a list of tools and materials needed for repairs, refer to the "SPECIFICATIONS" section in this subject.

Repair Of Cracks (See Fig. 9)

1. Using a detergent and water solution, remove the surface dirt from around the damaged area. Then, clean the area with xylene or an equivalent grease and wax remover.

2. Check the shop temperature and humidity, and compare with the recommendations given on the resin/body filler can labels. Generally, 70°F (21°C) and 70% humidity are considered ideal.

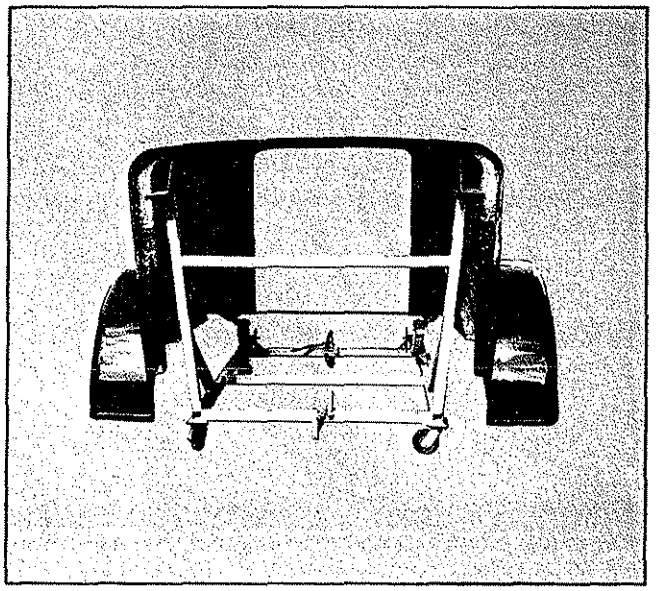

Fig. 8, Fiberglass Hood Placed On A Support Frame

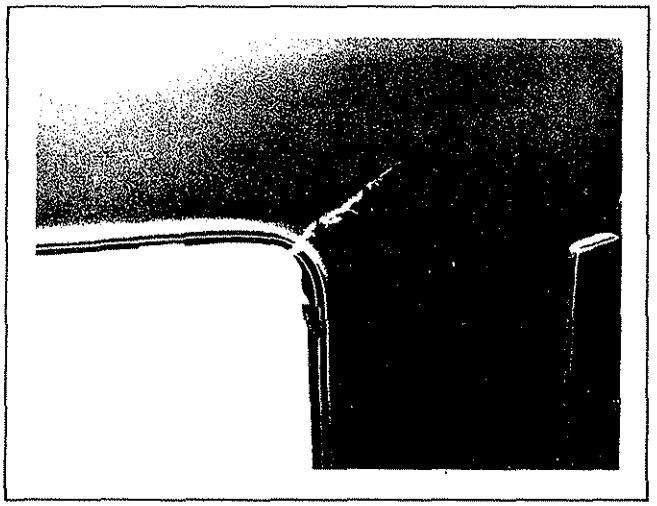

Fig. 9, Cracked Fiberglass Panel

3. If sound-absorbent lining is present on the underside of the damaged area, remove enough lining to provide an adequate working area, or approximately 5 inches (127 mm) on all sides of the damage. Push on the area immediately surrounding and underneath the crack to determine the extent of structural damage (damaged areas often show up better on the underside of the laminate).

4. Gather the required materials.

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

5. Mask off the undamaged surface, leaving a working area on the outer finished surface of approximately 5 inches (127 mm) surrounding the crack.

6. Working on the outer finished surface, and using a grinder with a burr bit or sanding sleeve, taper the edges of the crack at an angle of no more than 45 degrees. See Fig. 10.

WARNING: Wear goggles and an air purifying respirator when grinding, cutting, or sanding during all fiberglass repairs. The ground dust and particles could cause temporary or permanent damage to the eyes and, if inhaled, could cause irritation.

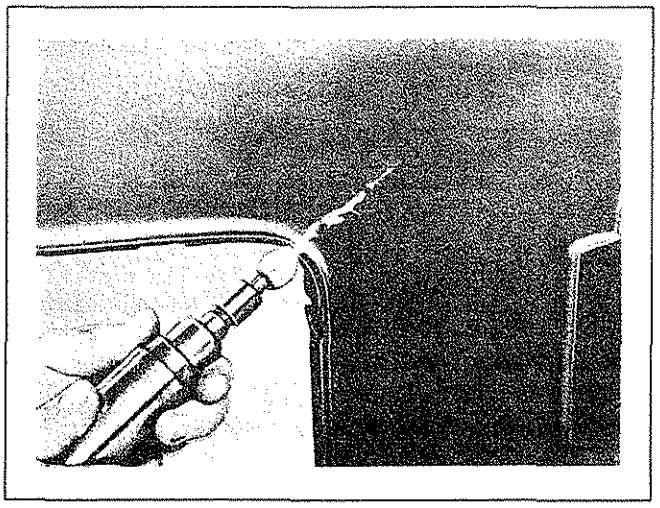

Fig. 10, Tapering The Edges Of The Crack

7. Remove the flaky edges and gently feather the painted surface back about 1/2 inch (13 mm) beyond the damaged area by hand-sanding or power-sanding with 360-grit (or higher) sandpaper. Avoid causing any sudden steps or uneven protrusions in the area.

8. Sand the inside unfinished surface around the repair area with 60-grit (or less) sandpaper to create a rough bonding surface approximately 3 inches (76 mm) from the center of the crack. Be sure to completely sand off any undercoating sprayed on this area.

9. Clean the sanded areas using compressed air. Then, wipe with a solvent-dampened cloth. Allow the surfaces to completely dry.

10. If the panel is out of alignment, realign it using C-clamps or equivalent devices, and a bridge strip of metal, hardwood, or plastic. An example of this alignment method is shown in Fig. 11.

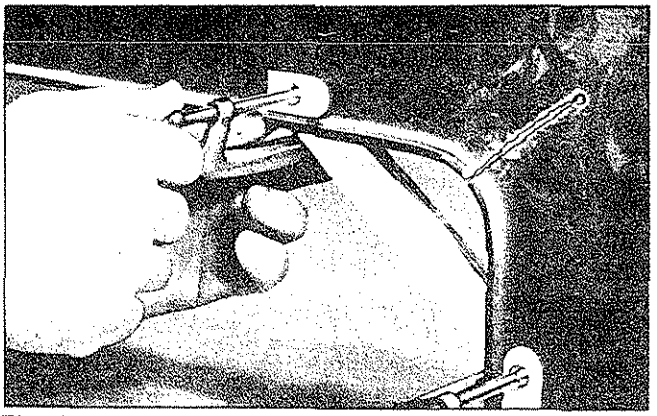

Fig. 11, Alignment Method Using C-Clamps And A Bridge Strip

An alternate method of aligning the parts is to use a nut and bolt and two flatwashers. See Fig. 12. As the nut is tightened, the parts are drawn into alignment.

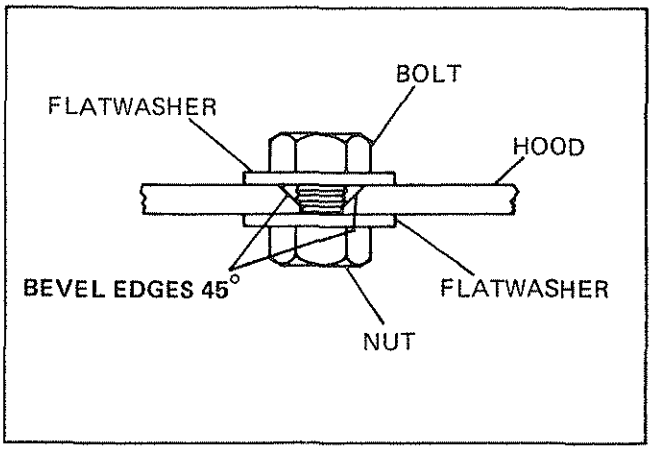

Fig. 12, Alignment Method Using A Nut, Bolt, And Two Flatwashers

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

In order to install the bolt, a hole must be drilled which will allow the bolt to pass through the seam. If more than one bolt is required, they should be spaced approximately every 6 inches (152 mm).

IMPORTANT: When installing the nut and bolt, it is important that the nut be located on the underside of the panel, where it will remain as a part of the repair. Use a bolt that is short enough not to protrude through the nut. Do not tighten the nut(s) more than is necessary to align the sections.

11. Beginning with 1.5 ounce fiberglass mat, cut out a patch (strip) that will extend about 2 inches (51 mm) on all sides of the crack. Then, cut out a patch of 18 ounce fiberglass woven roving that is slightly larger than the first patch.

    Cut out subsequent patches (alternating mat and woven roving layers) so that each is slightly larger than the last. See Fig. 13. The combined thickness of the fiberglass patches should be about 25% to 30% thicker than the original laminate.

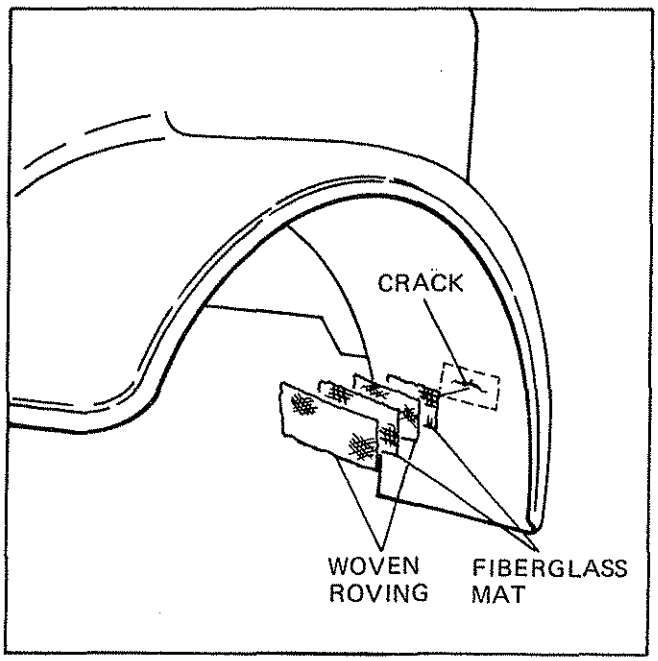

Fig. 13, Fiberglass Patch Sizes

12. Make sure that all tools necessary for fiberglass lay-up are at hand. Then, following the resin manufacturer's instructions, mix enough resin and catalyst to saturate the pieces of fiberglass mat and woven roving.

13. Using a roller or paint brush, apply some resin on the underside of the repair area.

14. Soak the first layer of mat in the catalyzed resin; then, place the mat over the repair area. Using a roller, or dabbing with a stiff bristle brush, work out all air bubbles, which show up as white in the patch. If a nut and bolt and flatwashers were used to align the panels, cut slits in the mat (along the nut) in order to work out all trapped air.

15. Allow the patch to harden slightly, until it has cured to a leather-like condition.

16. Apply the remaining pieces of resin-soaked woven roving and mat. Work steadily on the patches so that lay-up is completed within the resin gel-time, which is usually 20 to 30 minutes.

17. Allow the repair laminate to completely harden (about two hours). Then, remove the C-clamps and bridge strip, or the bolt(s) and flatwasher(s), if either method of alignment was utilized. The latter method of alignment requires that the nut(s) and flatwasher(s) remain as a part of the repair patch.

18. Following the body filler manufacturer's instructions, mix enough body filler to re-establish the surface. See Fig. 3.

IMPORTANT: Mix the body filler on a hard, non-porous surface. Do not work on a porous surface, such as cardboard. Porous surfaces absorb the body filler liquids, which can adversely affect the final curing time and bond.

19. If a nut(s) and flatwasher(s) remain as a part of the repair patch, fill the hole of each nut with body filler.

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

20. Fill the tapered crack with body filler and a non-shrinking coating, then spot prime and paint the surface. For instructions, refer to steps 11 through 16 under the heading, "SURFACE DAMAGE REPAIR," in this subject.

21. If applicable, install the section of sound-absorbent lining previously removed from the underside of the damaged area.

22. Remove the chock blocks from the tires after all repairs are completed.

Repair Of Punctures And Fractures (Over Simple Curves Or Large Flat Areas)

Small or large punctures, and fractures that branch out in several directions, which occur on flat surfaces or in simple curves (such as those where the sides and the top of the hood meet) can be repaired using the procedure below.

1. Using a detergent and water solution, remove the surface dirt from around the damaged area. Then, clean the area with xylene or an equivalent grease and wax remover.

2. Check the shop temperature and humidity, and compare with the recommendations given on the resin/body filler can labels. Generally, 70°F (21°C) and 70% humidity are considered ideal.

3. If sound-absorbent lining is present on the underside of the damaged area, remove enough lining to provide an adequate working area, or approximately 5 inches (127 mm) on all sides of the damage.

4. Inspect the area to determine the extent of the damage (damaged areas often show up better on the underside of the laminate). Push on the surfaces immediately surrounding and underneath the damaged area. All ragged edges and unsound fragments will later be removed. Using a marking pen, circle the area to be removed, if applicable.

5. Mask off the undamaged surface, leaving a working area on the outer finished surface of approximately 5 inches (127 mm) surrounding the damage.

6. Using a saber saw, cut away the ragged edges of the damaged area; cutting is not necessary for damage such as a clean puncture. In some cases, it will be necessary to greatly enlarge the hole in order to cut back to sound material.

WARNING: Wear goggles and an air purifying respirator when grinding, cutting, or sanding during all fiberglass repairs. The ground dust and particles could cause temporary or permanent damage to the eyes and, if inhaled, could cause irritation.

7. Working on the outer finished surface, and using a file or grinder with a burr bit or sanding sleeve, taper the edges of the hole at an angle of no more than 45 degrees. See Fig. 14.

8. Sand the inside unfinished surface around the hole with 60-grit (or less) sandpaper to create a rough bonding surface approximately 2 to 3 inches (51 to 76 mm) from all edges of the hole. Be sure to completely sand off any undercoating sprayed on this area. See Fig. 15.

9. Clean the sanded areas using compressed air. Then, wipe with a solvent-dampened cloth. Allow the surfaces to completely dry.

Fig. 14

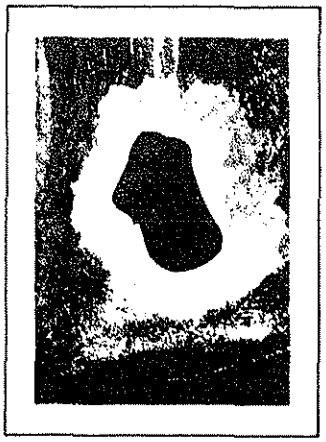

Fig. 15

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

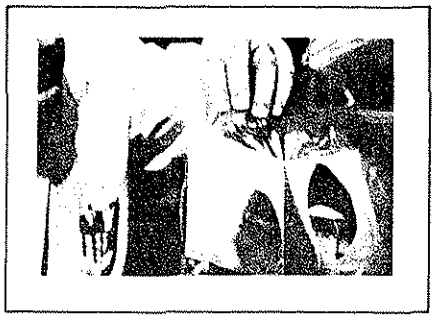

Fig. 16

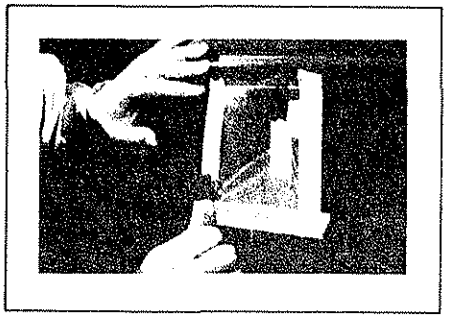

Fig. 17

Fig. 18

NOTE: Steps 10 through 17 describe the attachment of a template or "backing patch" that is temporarily affixed over the hole on the outer finished surface of the hood. The template provides a firm foundation on which the laminate can be built up from the underside of the hood. In addition, it provides a mold on which a surface can be structured to blend in with the surrounding contour or plane.

For small holes and damage to curved surfaces, the template material should be one that is basically stiff, yet flexible enough to conform to gradual curves. Light aluminum flashing is ideal.

For damage to flat surfaces, a stiff sheet of metal, fiberboard, or plywood can serve as template material.

10. Cut a piece of plastic separating film (cellophane wrap) large enough to overlap all sides of one face of the template. Then, position the cellophane covered surface of the template over the hole, and fasten in place with tape or clamps. See Fig. 16 and 17. Make sure there are no folds in the cellophane.

    Test the bond of the template by applying moderate pressure to the cellophane covered surface of the template (from the underside of the hood). There should be no yielding.

11. Following the resin manufacturer's instructions, mix enough resin and catalyst to apply a coat approximately 1/32 inch (about 1 mm) thick on the template surface exposed through the hole. Apply the resin through the hole and around the edges of the cutout. See Fig. 18. Wait for the filler to cure until it is nearly tack-free. The resin coating will prevent transfer of the fiberglass mat pattern on the outside surface of the hood.

12. Cut a series of 1.5 ounce fiberglass mat and alternating 18 ounce fiberglass woven roving patches progressively larger than the hole. Cut the first ply to fit as closely as possible to the shape of the hole. The last ply should be approximately 2 inches (51 mm) larger than the hole. See Fig. 19.

    The combined thickness of the fiberglass patches should be about 25 to 30 percent thicker than the original laminate.

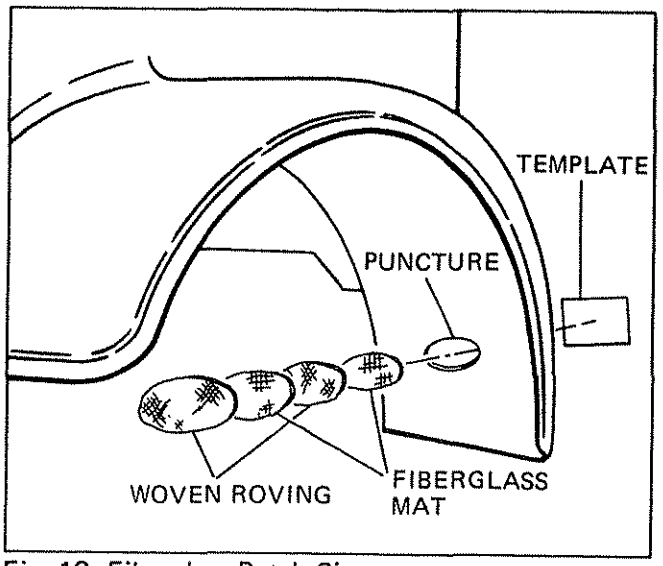

Fig. 19, Fiberglass Patch Sizes

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

13. Make sure that all tools necessary for fiberglass lay-up are at hand. Then, following the resin manufacturer's instructions, mix enough resin and catalyst to saturate the pieces of fiberglass mat and woven roving.

14. Build up a structural patch with alternate layers of resin-soaked mat and woven roving. Apply the resin-soaked mat first so that it forms the outermost ply. See Fig. 20.

15. Using a roller, or dabbing with a stiff bristle brush, work out all air bubbles, which show up as white in the patch. See Fig. 21.

16. Work steadily on the patch so that it is completed within the resin gel-time, which is usually 20 to 30 minutes. If more than 3/16 inch (about 5 mm) thickness of laminate is required, complete the patch in two phases: first, wait until the first layers have cured to a leather-like condition; then, finish the remainder.

17. Allow the repair laminate to completely harden (about two hours). After complete cure, carefully remove the template from the outer surface of the hood.

18. Using 100-200 grit sandpaper, sand the outer surface of the work area until the patch blends in as much as possible with the original surface. Then clean the sanded areas using compressed air, and wipe with a solvent-dampened cloth. Allow the surfaces to completely dry.

Fig. 20

Fig. 21

19. If there are any deep imperfections or pock-marks in the resin surface after sanding, fill them with body filler and a non-shrinking coating. Then, spot prime and paint the repair area. For instructions, refer to steps 10 through 16 under the heading, "SURFACE DAMAGE REPAIR," in this subject.

20. If applicable, install the section of sound-absorbent lining previously removed from the underside of the damaged area.

21. Remove the chock blocks from the tires after all repairs are completed.

SECTION REPLACEMENT (Refer to Fig. 22)

On extremely large damaged areas, for example, structural damage on the side surface of the hood covering a square foot area, it may be more convenient to perform a section replacement rather than make a lay-up patch. A second damaged hood must be available, as scrap, with this section intact.

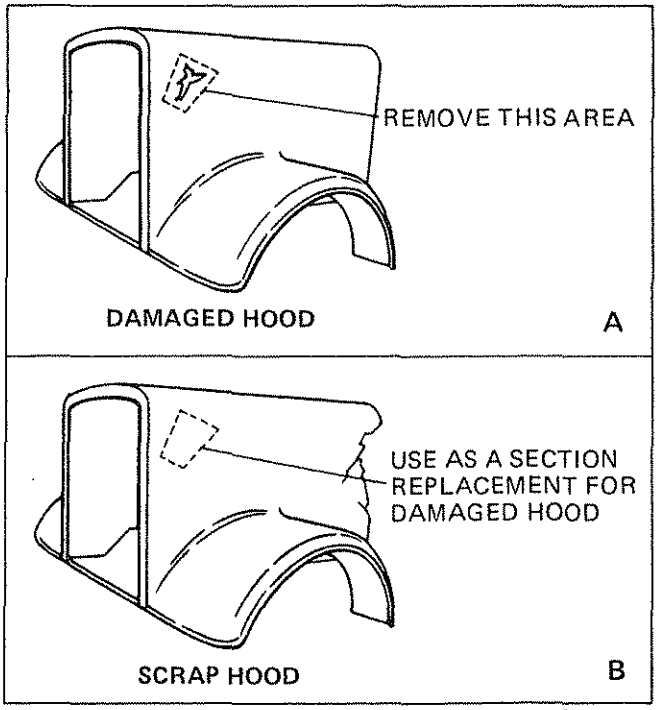

Fig. 22, Section Replacement Of A Damaged Fiberglass Hood

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

1. Push on the area immediately surrounding and underneath the damaged area to determine the extent of damage.
2. Clean the damaged area with xylene or an equivalent grease and wax remover. Inspect the area closely.
3. Mask off an area approximately 5 inches (127 mm) away from the damaged area (on all sides).
4. If sound-absorbent lining is present on the underside of the damaged area, remove enough lining to provide an adequate working area, or approximately 5 inches (127 mm) beyond the area to be removed.
5. Using a saber saw, cut out a large, straight-sided panel containing the damaged area. Refer to the example given in Fig. 22, Ref. A.

CAUTION: Wear goggles and an air purifying respirator when cutting, grinding, or sanding during all fiberglass repairs. The ground dust and particles could cause temporary or permanent damage to the eyes and, if inhaled, could cause irritation.

6. From the scrap hood, cut a patch from the same area, only slightly larger than the original cutout. Refer to the example given in Fig. 22, Ref. B. Then, trim the patch to fit both the size and the contour of the original cutout.
7. After the trimming is completed, sand the edges to allow 1/16 to 1/8 inch (about 1 1/2 to 3 mm) gap all around the cutout.
8. Using a disc sander with 60-grit (or less) sandpaper, create a rough bonding surface on the underside of the patch at least 3 inches (76 mm) from the edges. Also sand the underside of the hood at least 3 inches (76 mm) from all edges of the repair area. Be sure to completely sand off any undercoating sprayed on these areas.
9. On the outer sides of both the hood and the patch, bevel the edges approximately 45 degrees. See Fig. 23.

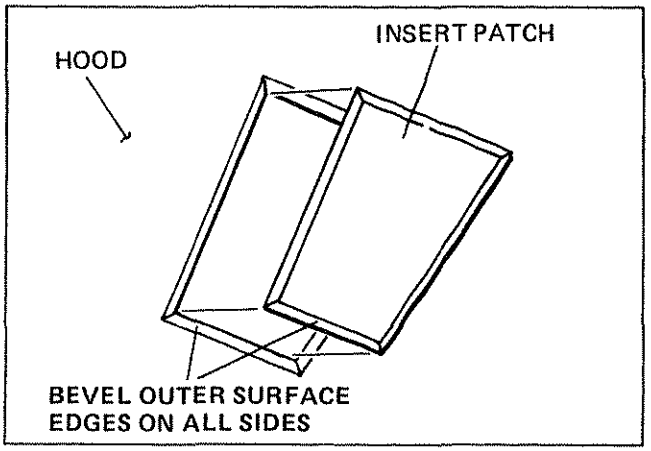

Fig. 23, Areas To Be Beveled

10. Gently feather the painted surfaces back about 1/2 inch (13 mm) beyond the edges of the repair areas (both the hood and the patch) by hand-sanding or power-sanding with 360-grit (or higher) sandpaper. Avoid causing any sudden steps or uneven protrusions in these areas.
11. Clean the sanded areas using compressed air. Then, wipe with a solvent-dampened cloth. Allow the surfaces to completely dry.
12. Check the shop temperature and humidity and compare with the recommendations given on the resin/body filler can labels. Generally, 70°F (21°C) and 70% humidity are considered ideal.
13. In order to secure the patch, while fiberglass lay-up repair is made to permanently secure the insert, the bolt and nut method is used (refer to Fig. 24):

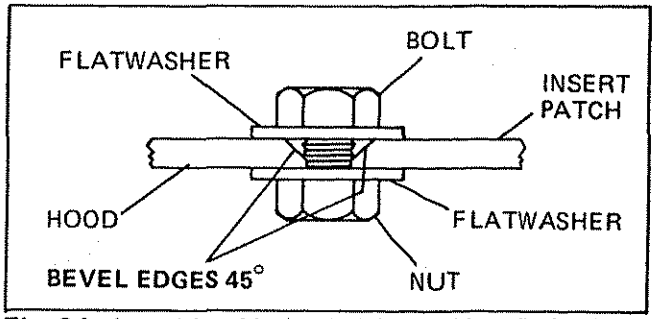

Fig. 24, Attaching Method Using A Nut, Bolt, And Two Flatwashers

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

.1 Fit the insert patch in the hole. Holding it in place, drill holes which will allow the bolts to pass through the seam (the bolts should be spaced approximately every 6 inches [152 mm]).

.2 Using bolts short enough not to protrude through the nuts, fasten large flatwashers on each side of the panel. It is important that the nuts be located on the underside of the panel, where they will remain as a part of the repair.

.3 As the nuts are tightened, the patch will be drawn into alignment with the original surface. Do not tighten more than is necessary to align the parts.

14. Cut out and apply alternating patches of fiberglass mat and woven roving on the underside seams of the repair area. For instructions, refer to steps 11 through 16 under the heading, "REPAIR OF CRACKS," in this subject.

15. Allow the laminate to completely harden (about two hours). Then, remove the bolts and flatwashers utilized to hold the patch in place. The nuts and flatwashers on the underside will remain as parts of the repair.

16. Following the body filler manufacturer's instructions, mix enough body filler to re-establish the outer surface.

IMPORTANT: Mix the body filler on a hard, non-porous surface. Do not work on a porous surface, such as cardboard. Porous surfaces absorb the body filler liquids, which can adversely affect the final curing time and bond.

17. Fill the holes of each nut with body filler.

18. Fill the tapered cracks with body filler, then spot prime and paint the surface. For instructions, refer to steps 11 through 16 under the heading, "SURFACE DAMAGE REPAIR," in this subject.

19. If applicable, install a section of sound-absorbent lining in the same area where it was previously removed.

20. Remove the chock blocks from the tires after all repairs are completed.

SPECIFICATIONS

Refer to the applicable heading below for a general list of tools and materials needed for repairing damaged fiberglass hoods.

SURFACE DAMAGE

NOTE: A fiberglass repair kit is not required for repair of surface damage.

1. Sandpaper and sanding discs (24- to 60-grit and 360- to 600-grit).

2. Air motor or electric drill with sanding attachment and burr bit (or sanding sleeve).

3. Files.

4. Sanding block.

5. Orbital or flat jitterbug sander.

6. Xylene, methylene, acetone or equivalent solvent.

7. Heat gun or infrared heat lamp.

8. Body filler compound. For pinholes, use 3M Acryl Red Putty, Part Number 05966; or, Midland (Division of Dexter Corporation) Cond. Filler 28-C-1; or equivalent. For larger holes, pockmarks, and tapered grooves, use Dupont 212-S Polyester Bondo Filler; or, Swiss Company "Snow White" Polyester Body Filler; or equivalent.

9. Non-shrinking sealer for body filler compound (such as Sherwin Williams Sprayfil [part number D61A23] or an equivalent).

FIBERGLASS HOOD REPAIRS, CONVENTIONAL

10. Rubber or plastic squeegee (or similar wooden spreader).

11. Goggles and an air purifying respirator.

STRUCTURAL DAMAGE

1. Fiberglass repair kit (including: fire-retardant polyester resin [such as Ashland 470-P, or equivalent]; 1.5 ounce mat; and, 18 ounce woven roving).

2. Electric sander and sanding discs (100- to 200-grit).

3. Electric saber saw or hacksaw.

4. C-clamps.

5. Plastic separating film (cellophane or equivalent).

6. All of the tools and materials listed above, under "SURFACE DAMAGE."

ALUMINUM HOOD REPAIRS

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ALUMINUM HOOD REPAIRS

GENERAL INFORMATION

Proper maintenance and repair techniques are very important towards realizing maximum service from the Conventional aluminum hood. The hood skin and framing should be checked occasionally for structural damage and loose or missing fasteners. To prevent deterioration, any damage should be repaired promptly. Skin surfaces should also be checked periodically for adequate paint coverage, to prevent aluminum oxidation.

SERVICE OPERATIONS

HOOD REPAIR GUIDELINES

IMPORTANT: Repairs to aluminum components should be attempted only by experienced, qualified personnel, using proper equipment and tools.

Replacing or Removing and Installing Components

1. When replacing damaged components, use new Freightliner parts.
2. Always apply Alumilastic compound, or an equivalent, between surfaces of aluminum and steel (or other dissimilar metals) whenever they make contact with each other. This includes rivets, bolts, nuts, and washers.

CAUTION: Failure to apply Alumilastic compound, or an equivalent, to surfaces where dissimilar metals contact each other, will result in electrolytic corrosion, which could cause hood damage.

3. Most of the rivets used for skin installation are aluminum, generally of 3/16-inch diameter. Refer to the 18 Group of this manual, for information pertaining to rivet removal.
4. Lockbolts (Huckbolt® fasteners) should be removed by splitting the lockbolt collar with a chisel designed for this purpose. If a collar-removing chisel is not available, the head of the lockbolt can be drilled, using a drill bit that has the same diameter as the lockbolt's shank diameter in the grip area.
5. When making field repairs where heli-arc welding equipment is not available, riveting or bolting is generally permissible. However, care must be taken to use approved riveting and fastening techniques. Refer to the 18 Group of this manual, for information pertaining to rivet installation.
6. Substitution of rivet or bolt fasteners for other rivets or bolts must be approved by Freightliner Service Engineering.

   When 3/16-inch wide-grip-range lockbolts are specified for attaching hood skins to hood framing (for example, attaching hood side skins to the fiberglass reinforcement or the torque tube assembly supports), and lockbolt installation tools are not available, 10-24 round-head carriage bolts, flatwashers, and elastic-stop self-locking nuts may be substituted for lockbolts and lockbolt collars.

   When 1/4-inch wide-grip-range lockbolts are specified for attachment of hood framing, or fender skirts to hood framing, (where fasteners do not show on the outside of the hood), and lockbolt installation tools are not available, 1/4-20 cadmium-plated hex-head bolts, flatwashers, and prevailing torque locknuts may be substituted for lockbolts and lockbolt collars.
7. Before backdrilling holes in repaired or replacement hood skins, install sheet metal screws, or machine screws and nuts, through the hood framing into the pilot holes in the replacement skin. Along edges where pilot holes are not provided, use C-clamps or locking jaw pliers to hold components together. Use enough temporary fasteners to prevent gaps between components, otherwise misalignment or elongation of the holes may cause buckling when permanent fasteners are installed.

   When backdrilling holes, first backdrill holes that do not have temporary fasteners installed in them. Move the temporary fasteners to the holes that have been backdrilled (or, install permanent fasteners in the drilled holes), and backdrill the holes that were previously occupied by the temporary fasteners. Except where indicated in the installation procedures, it is best to backdrill the holes in all edges of the repaired or replacement skin before installing any permanent fasteners.

Repairing Cracks In Aluminum

Cracks in aluminum should be repaired as soon as they are detected. Delaying a repair will result in elongation of the crack and increased damage to the hood. Make a thorough inspection to determine the extent of the cracking. The use of a dye penetrant is recommended. The cause should also be determined and remedied.

IMPORTANT: Reinforcing cracked or broken parts does not insure against transfer of stress to other components. The cause of cracking must be corrected, or cracking or breaking of other parts may result.

Small cracks can be effectively repaired as follows:

1. Clean the surface area around the crack.
2. Drill holes at both ends of the crack. The diameter of the holes must be one to one and one-half times the thickness of the material being repaired.

ALUMINUM HOOD REPAIRS

3. Place a backing plate behind the cracked area; use the same material for the backing plate as that in which the crack occurred. Rivet the backing plate to the cracked component.
4. Repair the crack by welding, and grind off the weld if finishing is necessary.

Welding of Aluminum

NOTE: Welding of aluminum reduces material strength by 30 to 40 per cent.

The welding technique for aluminum is somewhat different from welding methods used on other materials, and requires special training. Recommended welding procedures are discussed in a manual entitled "Welding Aluminum," published by the American Welding Society (AWS). This manual can be obtained from the AWS at a nominal charge.

Good welding procedures require that all foreign material be removed from areas to be welded. This includes dirt, moisture, loose metal particles, paint, oxide coating, grease, oil, etc. If chemicals or degreasing agents are used for cleaning, remember that some solvents require ventilation to aid evaporation, and others require rinsing with water. After the area has been cleaned, drying is important to insure that no moisture is present in the area to be welded. Solvents should never be used where evaporation is hindered, or where residue is entrapped behind the joint to be welded.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

To impede distortion in heli-arc welding, use fast stringer beads. Do not build up heat, or allow excessively large weld puddles to form. For heavier sections, use the MIG welding process.

Forming of Aluminum

Cold forming is recommended for working of aluminum. Reshaping of aluminum parts may be accomplished by means of rubber or wood mallets. Whenever steel hammers or hydraulic jacks are used, they should be used with wood blocks. Avoid local thinning or stretching caused by heavy steel hammers. Final operations consist of planishing with smooth, polished steel tools.

Replace any aluminum parts that show strain cracks after straightening.

Painting

All replacement panels, replacement framing, and repair areas should be painted as soon as possible after repair work is completed. Refer to the 18 group of this manual, for information pertaining to repainting and touch-up painting.

HOOD SKIN REMOVAL AND INSTALLATION

Top Skin Removal

1. Remove the hood assembly, following the procedure in the 17 group of this manual. After removing the hood, place it in the upright (operating) position.
2. Remove the grab handle, all three grille shell splice covers, and both upper pieces of the outer grille shell. Follow the procedures in the 17 group of this manual.
3. Detach the hood lining panels, if so equipped, as follows:

   If hood lining panels are attached to the hood with speed clips and liner mounting angles, proceed to step 4.

   .1 If hood lining panels are attached to hood skins with double-faced adhesive transfer tape only, use a putty knife or similar tool to carefully pry the lining away from the hood panels. Remove all six upper panels.

   .2 Detach and fold down the upper edges of the four lining panels that cover the bottom edges of the two side stiffeners.

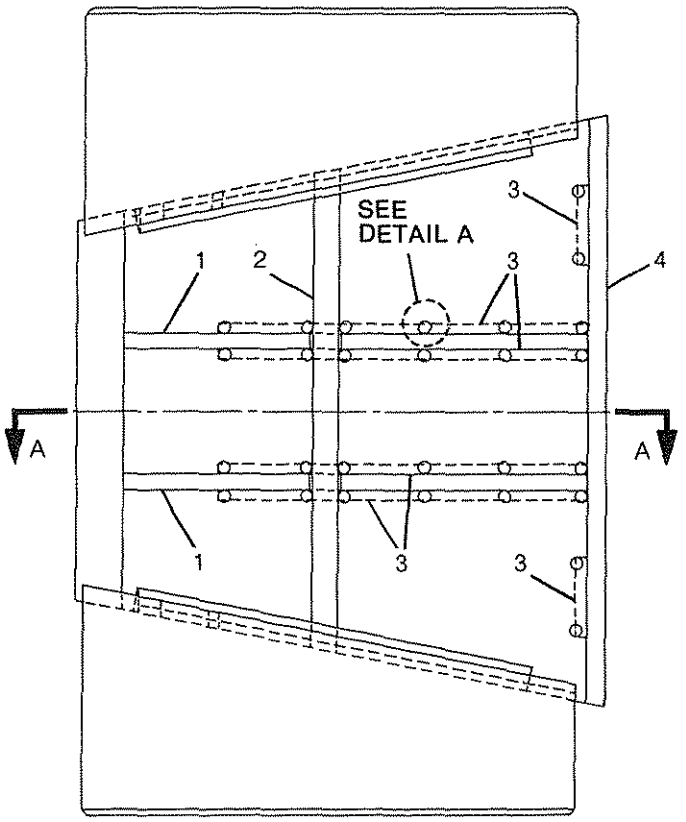
   Proceed to step 5.
4. Detach the hood lining panels, if equipped with speed clips and liner mounting angles, as follows:

   .1 Use the blade of a pocket knife or a small-tipped screwdriver to carefully pry outward on the center tabs of all speed clips located along the bottom edges of the side stiffeners. Pry all of the tabs on each clip. Remove the clips, using care not to break the weld pins. Do not discard the clips.

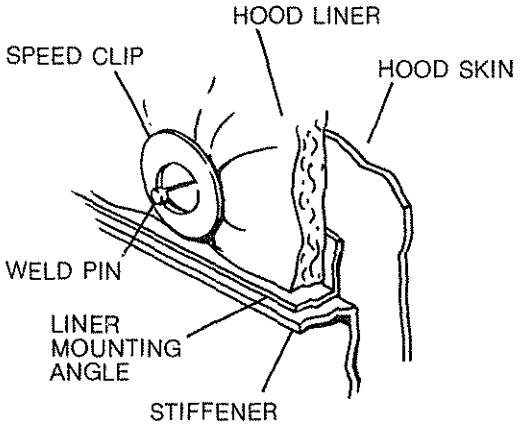
   .2 Carefully pull the top edge of the side panel lining off the weld pins. Fold the lining down, all along the rivet line of the top-skin/side-skin seam.

   .3 Working with one hood lining panel at a time, drill out or chisel the rivets that attach each of the liner mounting angles to the hood top stiffeners, side stiffeners, and rear stiffener assembly. See Fig. 1.

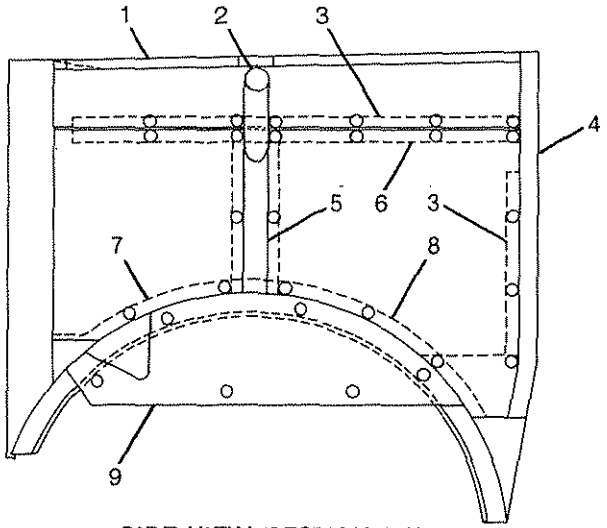
ALUMINUM HOOD REPAIRS



BOTTOM VIEW



DETAIL A



SIDE VIEW (SECTION A-A)

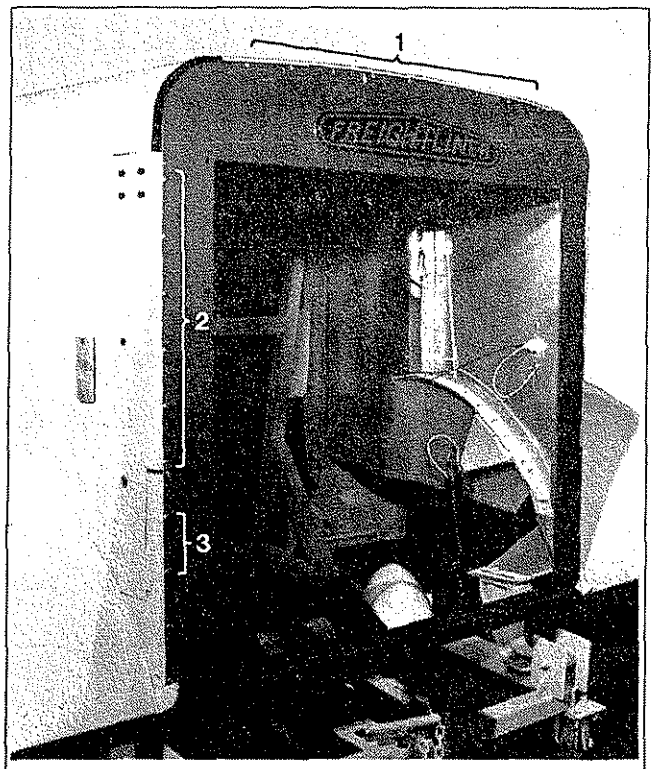
1. Top Stiffener
2. Torque Tube
3. Liner Mounting Angle
4. Rear Stiffener Assembly
5. Torque Tube Bracket
6. Side Stiffener
7. Forward Junction Angle
8. Rear Junction Angle
9. Fender Skirt

Fig. 1, Hood Liner Mounting Angles and Speed Clips

ALUMINUM HOOD REPAIRS

.4 Using a putty knife or similar tool, carefully pry the lining away from the top skin. Remove all six upper lining panels. Do not detach lining panels from liner mounting angles, unless new panels will replace those that are damaged.

5. Using a No. 11 drill bit, remove the rivets that attach the top skin to the inner grille shell. See Fig. 2.



1. Top Skin Attachment Rivets
2. Side Skin Attachment Rivets
3. Forward Hood Bracket Assembly Attachment Rivets

pf88_0055h

Fig. 2, Inner Grille Shell Rivets

6. Detach the top skin from both side skins, as follows:

.1 If the hood is equipped with a torque tube assembly having 90-degree bends (earlier torque tubes have 60-degree bends), remove the lockbolts at the front and rear torque tube assembly supports, where they attach to the side stiffeners. See Fig. 3.

.2 If the hood is equipped with upper hood-support sockets, remove the four capscrews, lockwashers, and nuts that attach each of the support socket brackets to the side stiffeners. See Fig. 4.

.3 Beginning at the rear of the hood, use a No. 11 drill bit to remove all rivets that join the top skin to the side skins.

7. Detach the top skin from the rear stiffener, as follows:

.1 If the hood is equipped with a fiberglass reinforcement, remove the lockbolts that attach the top skin to the front and rear flanges of the rear stiffener. See Fig. 3.

.2 If the hood is equipped with an aluminum rear stiffener assembly, drill out the rivets that attach the top skin to the rear stiffener assembly. See Fig. 5.

8. When all fasteners have been removed, gently work the top skin loose, and lift it off.

Top Skin Installation

NOTE: If either side skin requires repair or replacement, remove and install the side skin before installing the top skin. Refer to "Side Skin Removal" and "Side Skin Installation."

1. If neither side stiffener requires repair or replacement, and both are attached to their respective side skin with one flush rivet near each end, proceed to step 3. If either or both of the side stiffeners is not attached to its respective side skin with a flush rivet near each end, proceed to step 2.

   If either side stiffener requires repair or replacement, remove it from the hood. Using a No. 11 drill bit, drill out any flush rivets that may be securing the side stiffener to the side skin.

   If the hood is equipped with upper hood-support sockets, drill out the rivets that attach the rearmost end of the side stiffener to the aluminum rear stiffener assembly. See Fig. 4.

   Repair the side stiffener if it is not being replaced.

   Proceed to step 2.

2. Clamp each side stiffener in place behind the top edge of its respective side skin, using four clamps for each stiffener. See Fig. 6, Ref. A. If the side stiffener was not replaced, align the holes in the stiffener with the holes in the side skin.

   Approximately 5 inches (127 mm) from each end of the side stiffener, and immediately above the rivet line, drill (using a No. 11 drill bit) and countersink

- ALUMINUM HOOD REPAIRS

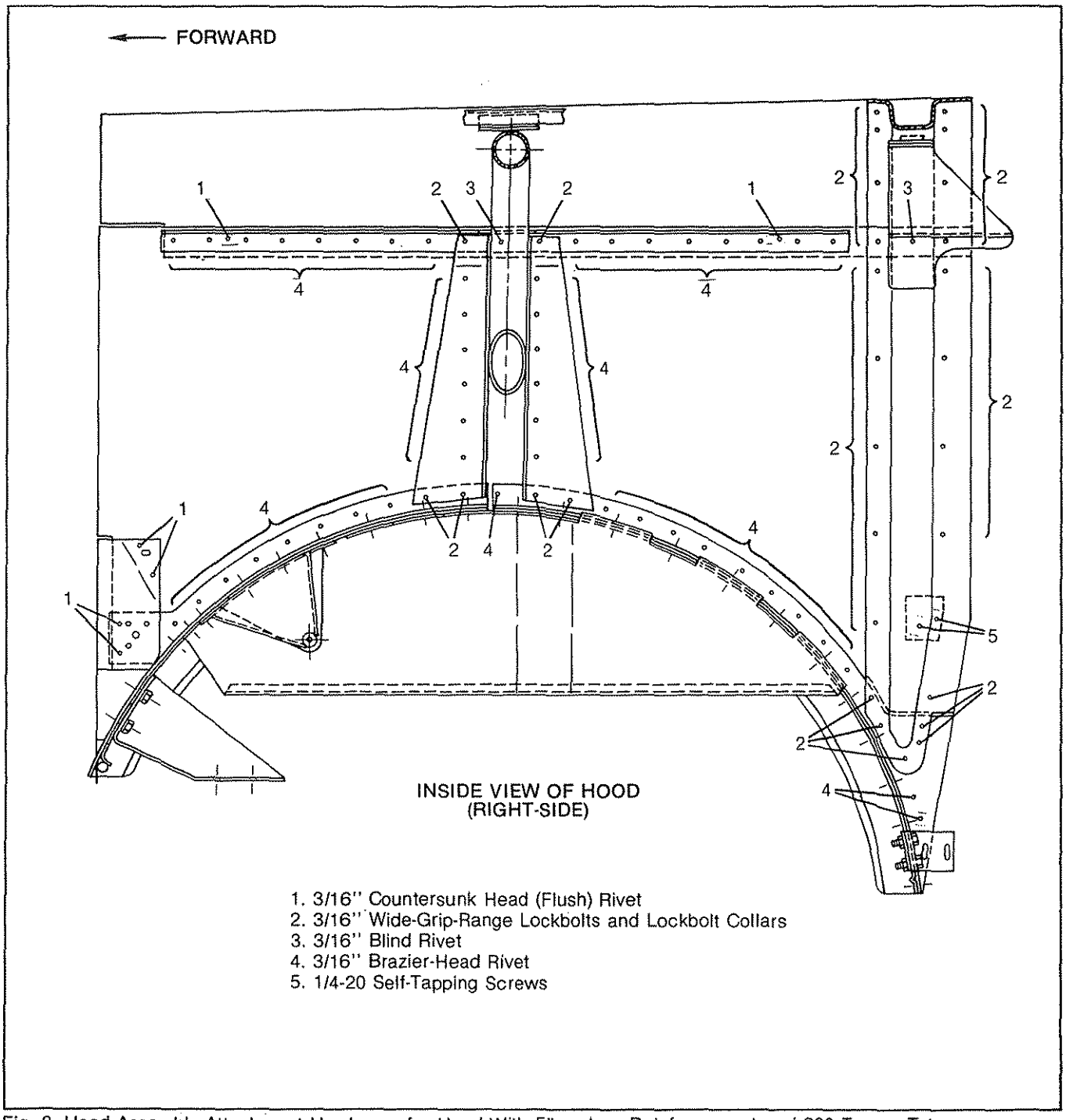
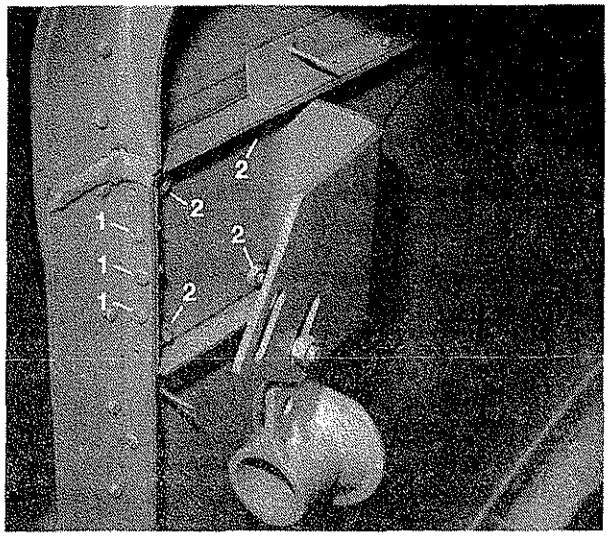


Fig. 3, Hood Assembly Attachment Hardware, for Hood With Fiberglass Reinforcement and 90° Torque Tube.

ALUMINUM HOOD REPAIRS



1. Brazier-Head Rivets
2. 1/4-28 Hex Nuts and Lockwashers

Fig. 4. Upper Hood-Support Socket Bracket and Side Stiffener Attachment

(using a 78-degree countersink) a hole through the side skin into the side stiffener. See Fig. 6, Ref. B. Install a flush rivet in each hole. Remove the clamps.

If the side stiffener was replaced, backdrill all of the top-skin/side-skin seam holes through the side skin into the new side stiffener.

If the hood is equipped with upper hood-support sockets, and either side stiffener was replaced, backdrill, using a No. 11 drill bit, the three holes through the aluminum rear stiffener assembly into the rearmost end of the side stiffener, and install 3/16-inch brazier-head rivets. See Fig. 4.

Proceed to step 3.

3. If either top stiffener assembly requires repair or replacement, remove it. If the hood is equipped with an aluminum rear stiffener, drill out the rivets that attach the top stiffener assembly to the rear stiffener assembly.

   Repair the top stiffener assembly if it is not being replaced.

   Install the new or repaired top stiffener assembly on the torque tube; position the rearmost end in the notch in the fiberglass reinforcement (if so equipped), or backdrill and rivet the top stiffener assembly to the aluminum rear stiffener assembly (if so equipped).

4. Place the new or repaired top skin in position on the hood, making sure the pilot holes in the top skin are aligned with the rivet holes in both side skins.

5. Using sheet metal screws, installed from inside, or machine screws and nuts, temporarily secure the top skin to the side skins and side stiffeners. At both sides of the hood, place a screw in the forwardmost hole of the top-skin/side-skin seam, and thereafter, in every fourth hole along the seam. See Figs. 7 and 8, Ref. A. Do not install screws in holes that align with the rear stiffener.

6. If the hood is equipped with an aluminum rear stiffener assembly, proceed to step 7.

   If the hood is equipped with a fiberglass reinforcement, attach the top skin to the reinforcement, as follows:

   .1 Using at least eight C-clamps or locking jaw pliers, secure the top skin to the reinforcement, aligning the back edge of the reinforcement with the back edge of the top skin as much as possible.

   NOTE: The jaws of the C-clamps and locking jaw pliers should be padded with several layers of masking tape, to prevent damage to hood components.

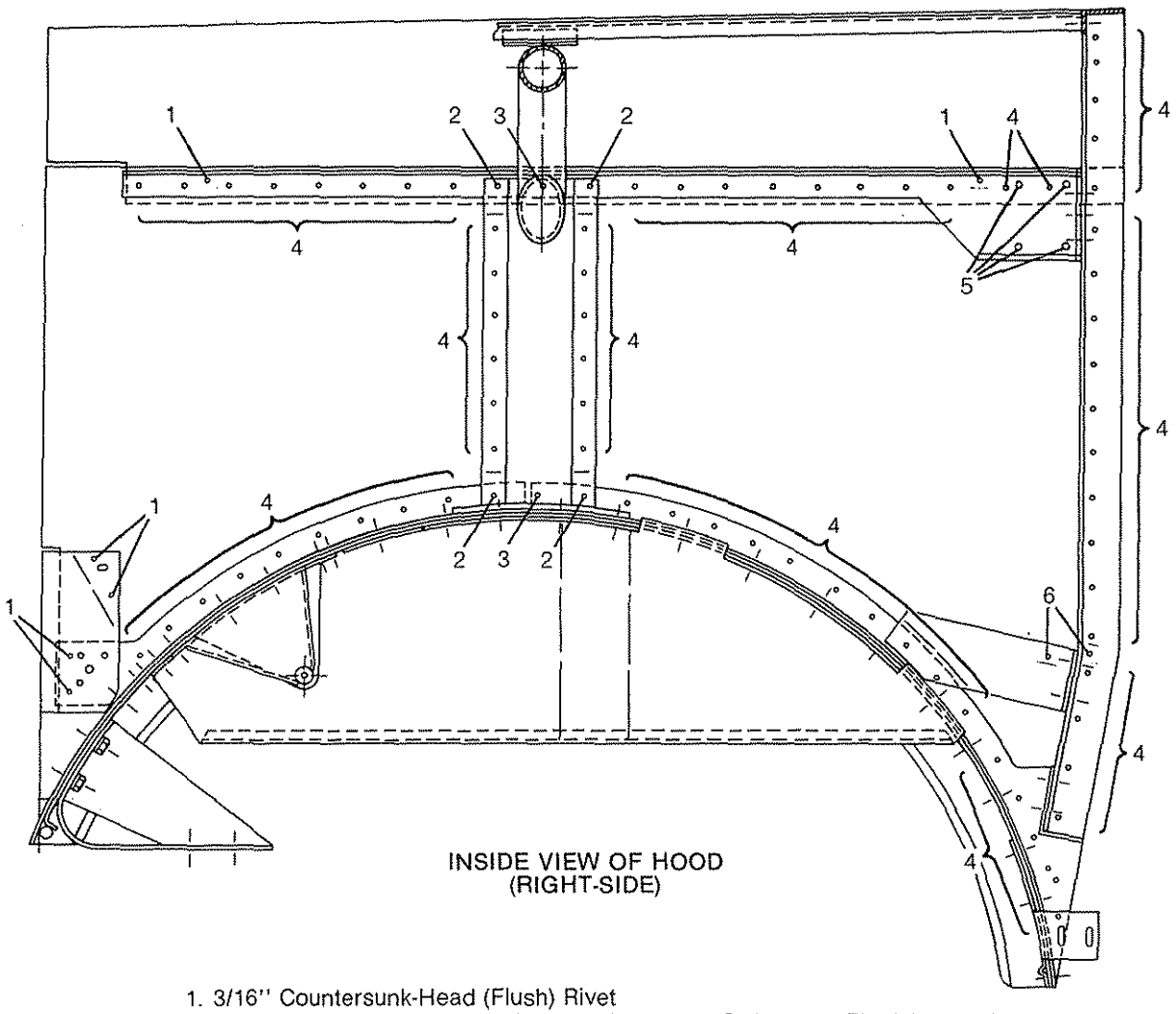
   Beginning at the hood centerline, center the clamps in the spaces between the holes in each flange of the reinforcement. Both flanges should be firmly clamped to the top skin, as shown in Fig. 9, Refs. A and B. There must be no gaps between the top skin and flanges in the area contained within the clamps.

   .2 If the top skin is new, backdrill, using a No. 11 drill bit, through both flanges of the reinforcement into the hood top skin, at all holes between the outermost clamps (Fig. 9, Ref. C). If the top skin is repaired, backdrill through the hood skin into the reinforcement.

   .3 Through the holes in the hood skin, install a screw in the center hole in the forward flange of the reinforcement, and in the rear flange install a screw in each hole on either side of the center hole. See Fig. 9, Ref. D. Tighten the screws sufficiently to prevent gaps between the top skin and reinforcement when the clamps are removed.

   .4 Remove the innermost sets of clamps (Fig. 9, Ref. A), and move them to the spaces between

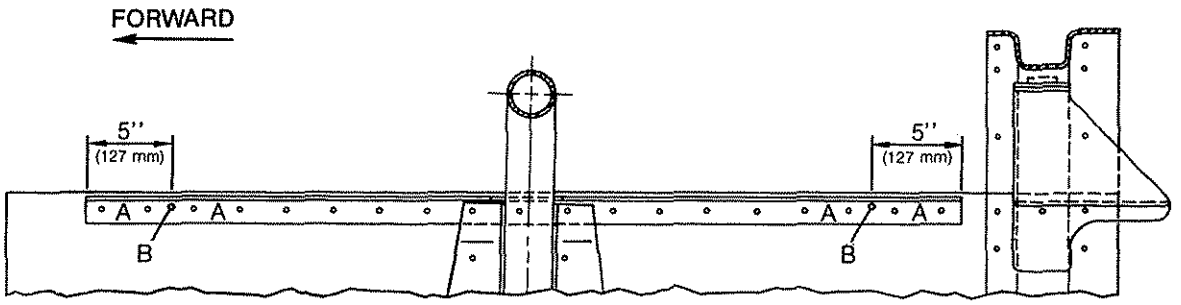
ALUMINUM HOOD REPAIRS



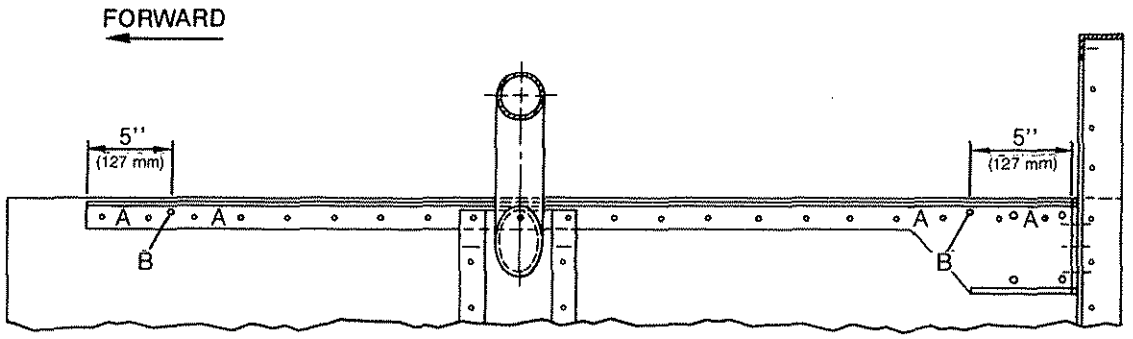
1. 3/16" Countersunk-Head (Flush) Rivet
2. 3/16" Wide-Grip-Range Lockbolts and Lockbolt Collars (for Field Assembly)
3. 3/16" Blind Rivet
4. 3/16" Brazier-Head Rivet
5. 1/4-28 Capscrews, Internal-Tooth Lockwashers, and Hex Nuts
6. 1/4-20 Capscrews, Washers, and Acorn Nuts

Fig. 5, Hood Assembly Attachment Hardware, for Hood With Aluminum Rear Stiffener Assembly and 60° Torque Tube

ALUMINUM HOOD REPAIRS



INSIDE VIEW OF HOOD (RIGHT-SIDE)
WITH FIBERGLASS REINFORCEMENT

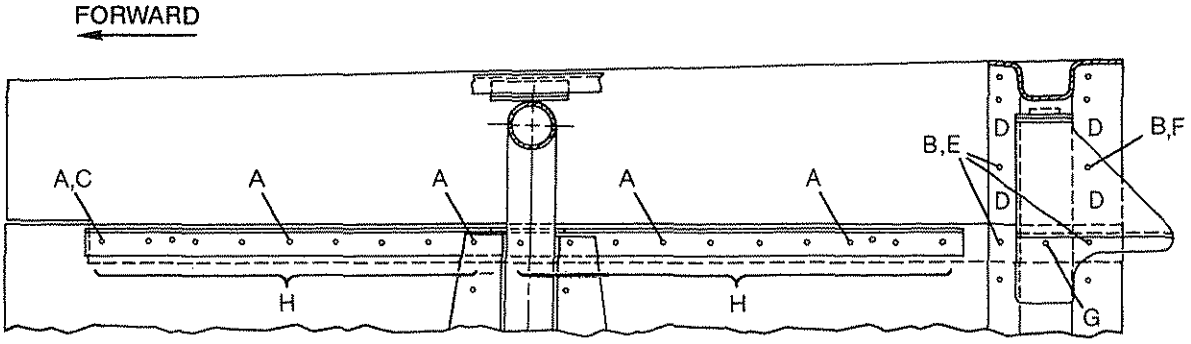


INSIDE VIEW OF HOOD (RIGHT-SIDE)
WITH ALUMINUM REAR STIFFENER ASSEMBLY
AND UPPER HOOD SUPPORT SOCKETS

A. Position clamps at these locations.
B. Drill and countersink, from outside of the hood, a 3/16" hole at each of these locations (using a No. 11 drill bit and a 78° countersink); install a flush rivet in each of the holes—the manufactured heads of the rivets must be flush with the side skin.

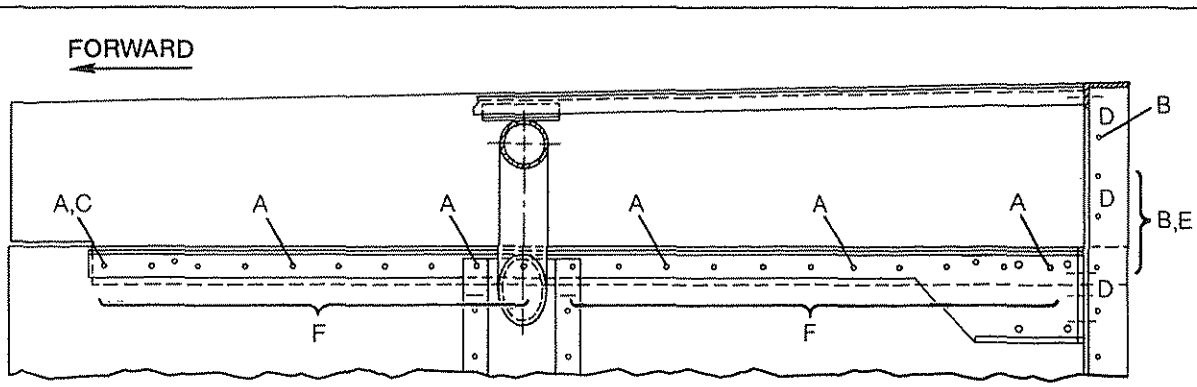
Fig. 6, Attachment of Side Stiffener to Side Skin

ALUMINUM HOOD REPAIRS



NOTE: Inside view of the right-side of the hood is shown; repeat for left-side.

Fig. 7



NOTE: Inside view of the right-side of the hood is shown; repeat for left-side.

Fig. 8

the next outboard sets of holes (Fig. 9, Ref. E). Backdrill the holes between the clamps (Fig. 9, Ref. F), and install screws. The screws should be staggered back and forth between the two flanges of the reinforcement (Fig. 9, Ref. G).

.5 Continue to move the innermost clamps, backdrill the holes, and install the screws, in this manner (Fig. 9, Ref. H), until all but the last eight (four on each side) of the reinforcement/top-skin holes have been backdrilled. See Fig. 9, Ref. J.

.6 When all but the last eight holes (four on each side) have been backdrilled, remove the clamps. From each top-skin/side-skin seam, remove all but the forwardmost screw. See Fig. 7, Ref. C. Position the clamps for backdrilling of the last four holes on each side of the rear of the top skin (Fig. 7, Ref. D), and backdrill the holes. Install screws in *both* flanges of the last sets of holes. See Fig. 7, Refs. E and F.

NOTE: If the top skin is new, and the installed rear hood rests prevent backdrilling of any of the reinforcement holes, use a hole-finder to mark the position of the holes on the outside of the top skin, and drill the holes from outside. See Fig. 7, Ref. F.

.7 Remove all clamps, then check at all locations for gaps between the top skin and both flanges of the reinforcement.

If any gaps exist, remove all screws between the area of the gap and the top-skin/side-skin

ALUMINUM HOOD REPAIRS

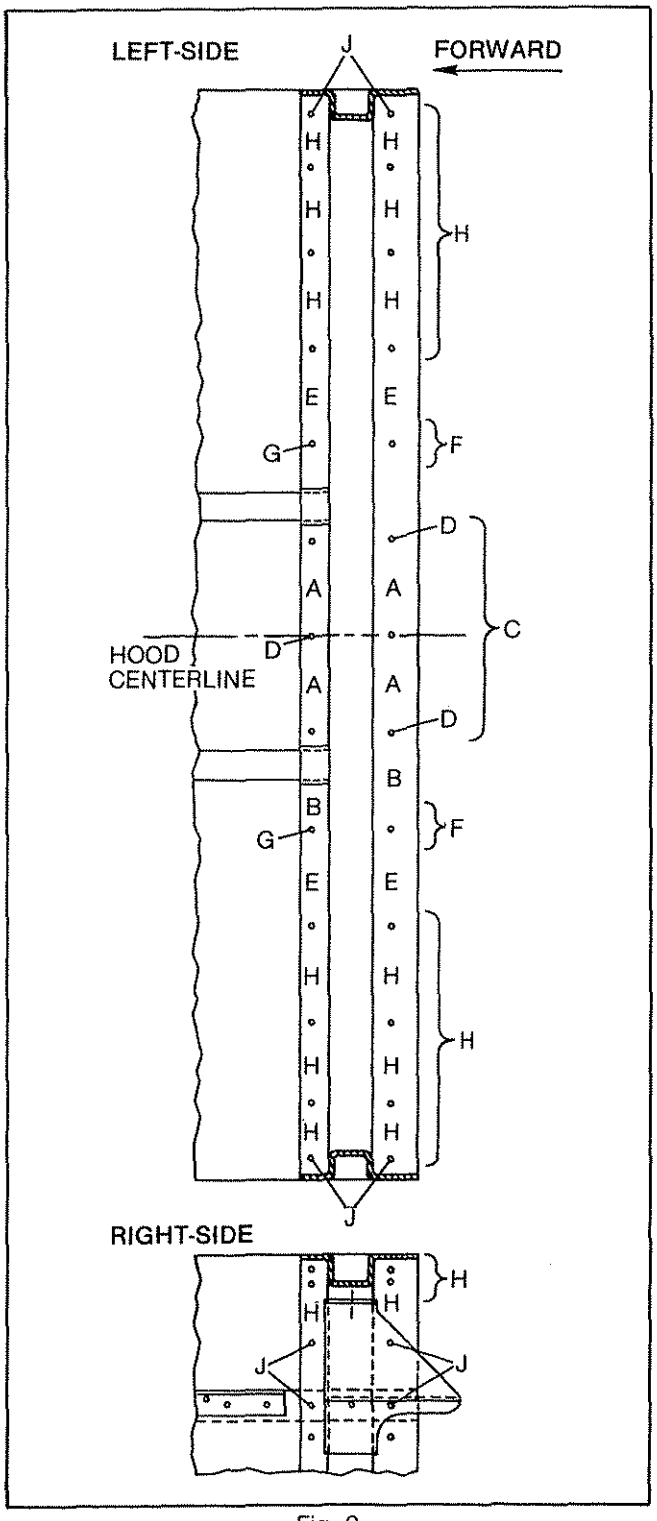


Fig. 9

seam. Clamp the top skin and flanges in the area of the gap, backdrill again, from outside the hood, and install screws in all holes of both flanges. Move the clamps and backdrill the holes, as before, until the top-skin/side-skin seam is reached. Each time a pair of holes is drilled, install screws in both flanges.

NOTE: When backdrilling holes for the second time, do not elongate the holes more than necessary.

.8 When no gaps exist between the top skin and reinforcement, backdrill through the top skin pilot holes into the side-skins and side stiffeners, beginning with the holes nearest the reinforcement. See Fig. 7, Refs. G and H.

NOTE: The top-skin/side-skin seam holes which lie between the reinforcement flanges must also be drilled through the top skin from outside the hood. See Fig. 7, Ref. G. Avoid drilling into the fiberglass reinforcement.

Install screws in the same holes in which they were previously installed (see step 5), as soon as each of those holes is backdrilled. See Fig. 7, Ref. A.

.9 Beginning at the centerline of the rear of the hood, attach the top skin to the reinforcement, using 3/16-inch wide-grip-range lockbolts and lockbolt collars. Install fasteners in both reinforcement flanges, alternating from one side of the hood to the other each time two sets of fasteners are installed. See Fig. 10. Do not remove any temporary fastener until it becomes necessary to install a permanent fastener in the hole it occupies.

Proceed to step 8.

7. If the hood is equipped with an aluminum rear stiffener assembly, attach the top skin to the rear stiffener assembly, as follows:

.1 Using at least six C-clamps or locking jaw pliers, secure the top skin to the rear stiffener assembly.

NOTE: The jaws of the C-clamps and locking jaw pliers should be padded with several layers of masking tape, to prevent damage to hood components.

Beginning with the holes at either side of the hood centerline, center the clamps in every other space between the holes in the rear stiffener assembly (Fig. 11, Refs. A and B). There

ALUMINUM HOOD REPAIRS

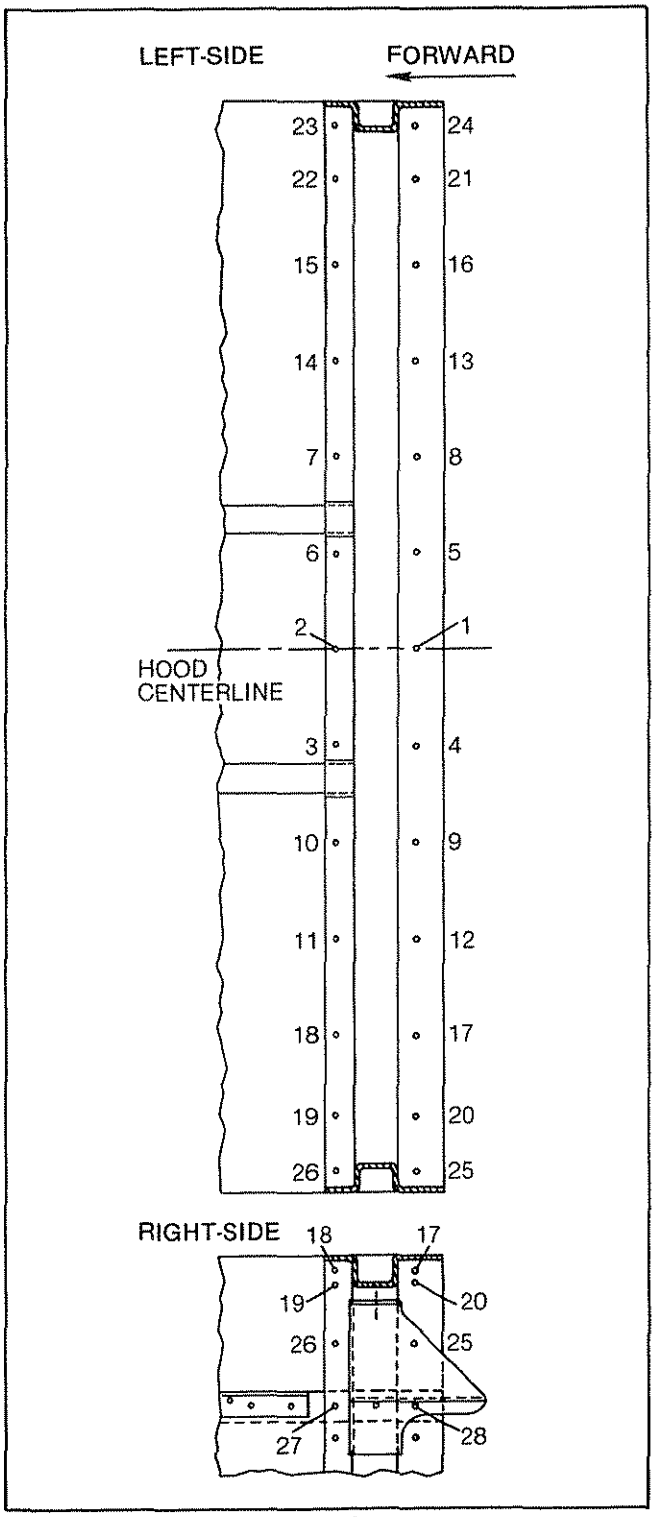


Fig. 10

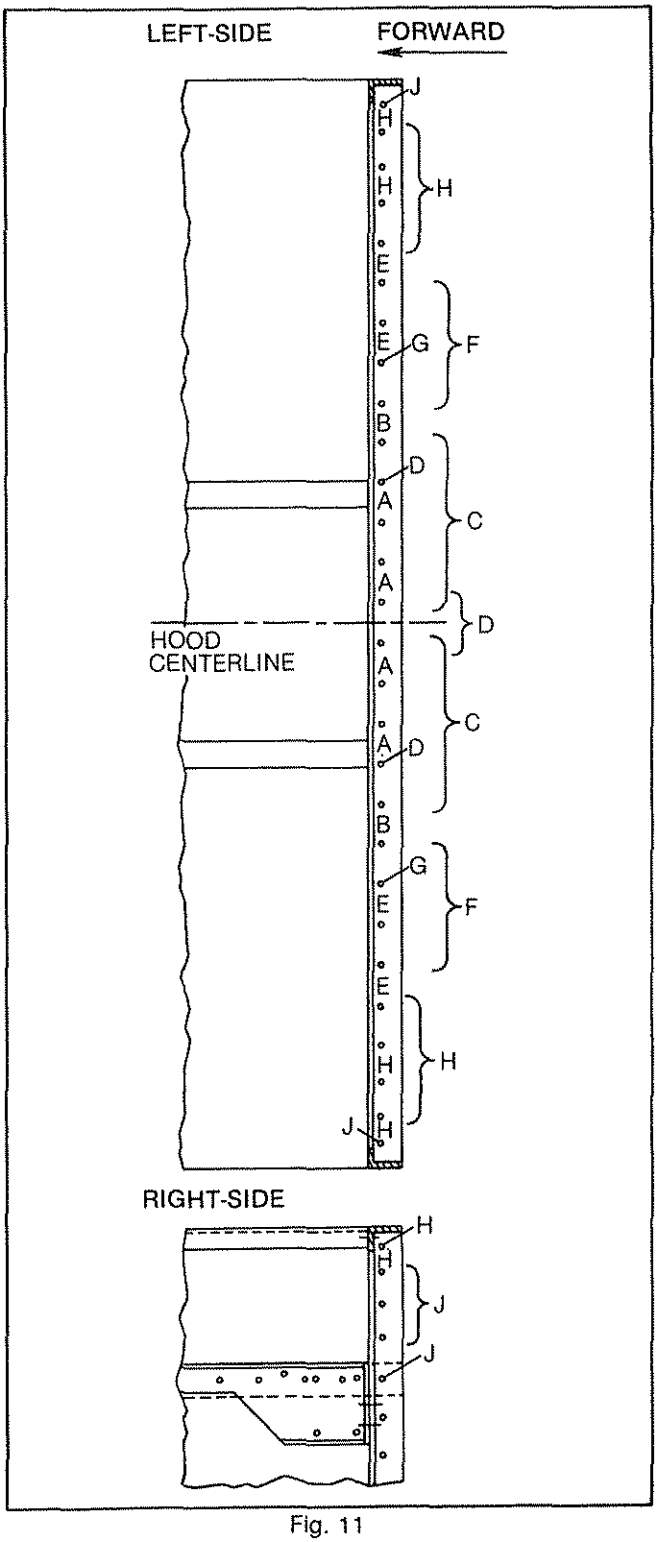


Fig. 11

ALUMINUM HOOD REPAIRS

must be no gaps between the top skin and the rear stiffener assembly in the area between the clamps.

.2 If the top skin is new, backdrill, using a No. 11 drill bit, through the rear stiffener assembly into the hood top skin at all holes between the outermost clamps. See Fig. 11, Ref. C. If the top skin is repaired, backdrill through the hood skin into the rear stiffener assembly.

.3 Through the holes in the top skin, install screws in the two holes nearest the centerline of the hood, and in the third holes to the left and right of these holes. See Fig. 11, Ref. D. Tighten the screws sufficiently to prevent gaps between the top skin and the rear stiffener assembly when the clamps are removed.

.4 Remove the inner clamps (Fig. 11, Ref. A), and install them at the spaces between every other set of holes to the left and right of the holes that have already been backdrilled. See Fig. 11, Ref. E. Backdrill all holes between the outermost and innermost clamps at each side of the hood (Fig. 11, Ref. F). Install screws in the third holes outboard from the last screws installed. See Fig. 11, Ref. G.

.5 Move the inner clamps, backdrill the holes, and install the screws in this manner (Fig. 11, Ref. H), until all but the last eight holes (four on each side of the rear edge of the top skin) have been backdrilled. Refer to Fig. 11, Ref. J.

.6 When all but the last eight holes have been backdrilled (Fig. 8, Ref. B), remove the clamps. From each top-skin/side-skin seam, remove all but the forwardmost screw. See Fig. 8, Ref. C. Position the clamps for backdrilling the last four holes on each side of the rear of the top skin (Fig. 8, Ref. D), and backdrill all eight holes (Fig. 8, Ref. B). Install screws in the last three holes on each side of the top skin. See Fig. 8, Ref. E.

.7 Remove the clamps, then check at all locations for gaps between the top skin and the rear stiffener assembly.

If any gaps exist, remove all screws between the gap and the top-skin/side-skin seam. Clamp the top skin to the rear stiffener assembly at *every* space between the gap and the seam. Backdrill, from outside the hood, all holes between the innermost and outermost clamps. Install 3/16-inch brazier-head rivets in all of those holes. If the seam has not been reached, move the clamps to all remaining spaces, backdrill the holes, and install 3/16-inch brazier-head rivets in all of the holes.

NOTE: When backdrilling holes for the second time, do not elongate the holes more than necessary.

.8 When no gaps exist between the top skin and the rear stiffener assembly, backdrill all pilot holes through the top skin into each side stiffener, beginning with the holes nearest the rear stiffener (Fig. 8, Ref. F). Install 3/16-inch brazier-head rivets in the same holes in which screws were previously installed (see step 5), as soon as each of those holes is backdrilled. See Fig. 8, Ref. A.

.9 Beginning at the center of the rear of the hood, attach the top skin to the rear stiffener assembly, using 3/16-inch brazier-head rivets. Install and buck the rivets, alternating from one side of the hood to the other. See Fig. 12. Do not remove any temporary fastener until it becomes necessary to install a rivet in the hole it occupies.

Proceed to step 8.

8. Attach the top skin to the side skins and side stiffeners, as follows:

.1 If the hood is equipped with a fiberglass reinforcement, install a 3/16-inch blind rivet in the hole which lies between the reinforcement flanges, at each top-skin/side-skin seam. See Fig. 7, Ref. G.

.2 At each side of the hood, install two 3/16-inch wide-grip-range lockbolts and lockbolt collars in the top-skin/side-skin seam holes that were backdrilled through the torque tube assembly supports or torque tube brackets. See Fig. 13, Ref. 2.

.3 If the hood is equipped with upper hood-support sockets, backdrill the support socket bracket holes through the side stiffeners into the top skin, using a 9/32-inch drill bit. See Fig. 14. Install four internal-tooth lockwashers and 1/4-28 capscrews through the top skin, side skin, and side stiffener, at each side of the hood. Position the support socket brackets over the capscrews, and install lockwashers and hex nuts to retain them; tighten the nuts finger-tight. See Fig. 4.

ALUMINUM HOOD REPAIRS

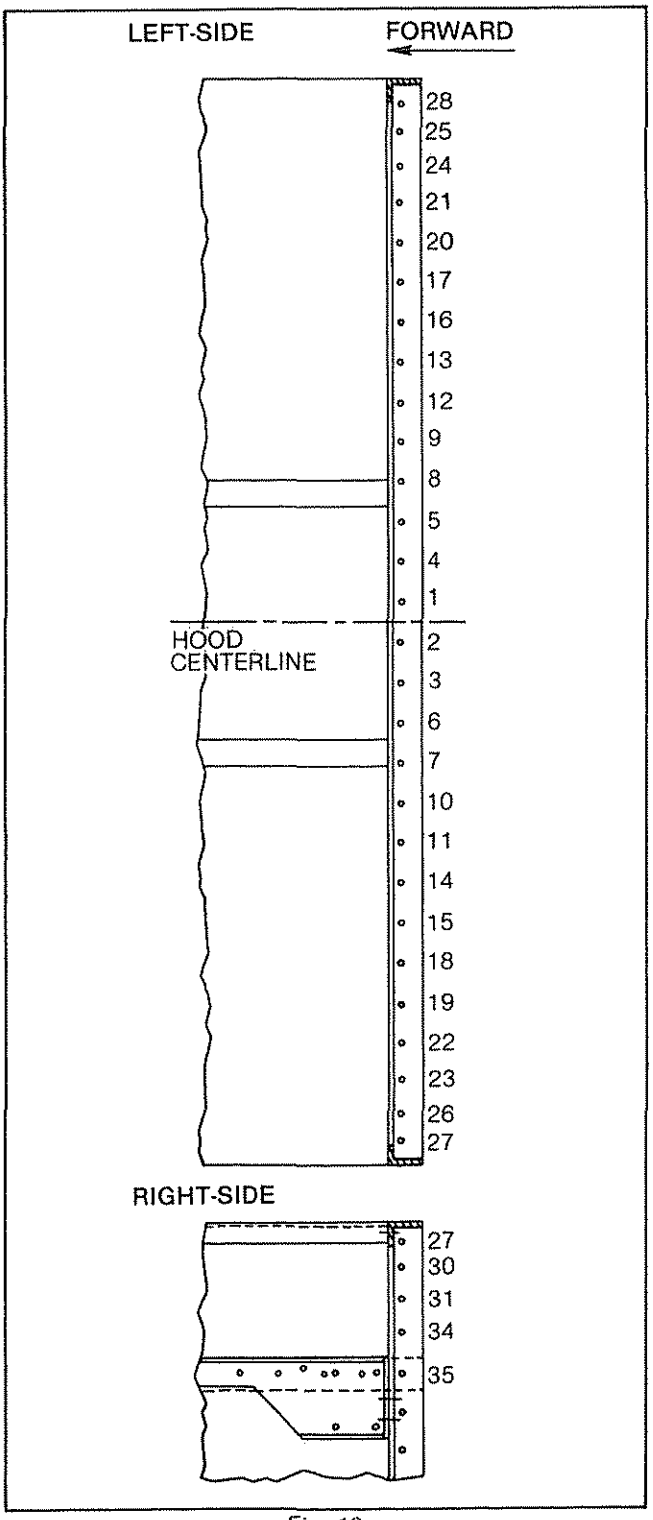


Fig. 12

.4 Beginning at the rear of the hood, install 3/16-inch brazier-head rivets in both hood seams. Install 3/16-inch blind rivets in the holes between the torque tube assembly supports, or between the torque tube bracket flanges. See Fig. 13, Ref. 1.

.5 If the hood is equipped with upper hood-support sockets, tighten the attaching nuts to 8 lbf·ft (11 N·m).

9. Use a No. 11 drill bit to backdrill through the inner grille shell holes into the top skin. Attach the inner grille shell to the top skin, using 3/16-inch aluminum blind rivets. See Fig. 2.

10. Paint the repaired areas of the hood, following the procedure in the 18 Group of this manual.

11. Install the upper pieces of the outer grille shell, all three grille shell splice covers, and the grab handle. Follow the procedures in the 17 Group of this manual.

12. Attach the hood lining panels, if so equipped, by following the repair and replacement instructions in the 17 Group of this manual.

13. Install and adjust the hood assembly, following the procedure in the 17 Group of this manual.

Side Skin Removal

NOTE: If the top skin and side skin both require repair or replacement, remove the top skin before removing the side skin. Refer to "Top Skin Removal."

1. Remove the hood assembly, following the procedure in the 17 Group of this manual. After removing the hood, place it in the upright (operating) position.

2. Remove the grab handle and grille shell top splice cover. From the same side of the hood that the side skin will be removed, remove the headlight assembly, grille shell side splice cover, and upper and lower pieces of the grille shell. Follow the procedures in the 17 Group of this manual.

3. If hood lining panels, when so equipped, are attached to hood skins with double-faced adhesive transfer tape only, proceed to step 4.

   If hood lining panels are attached to the hood with speed clips and liner mounting angles, proceed as follows:

ALUMINUM HOOD REPAIRS

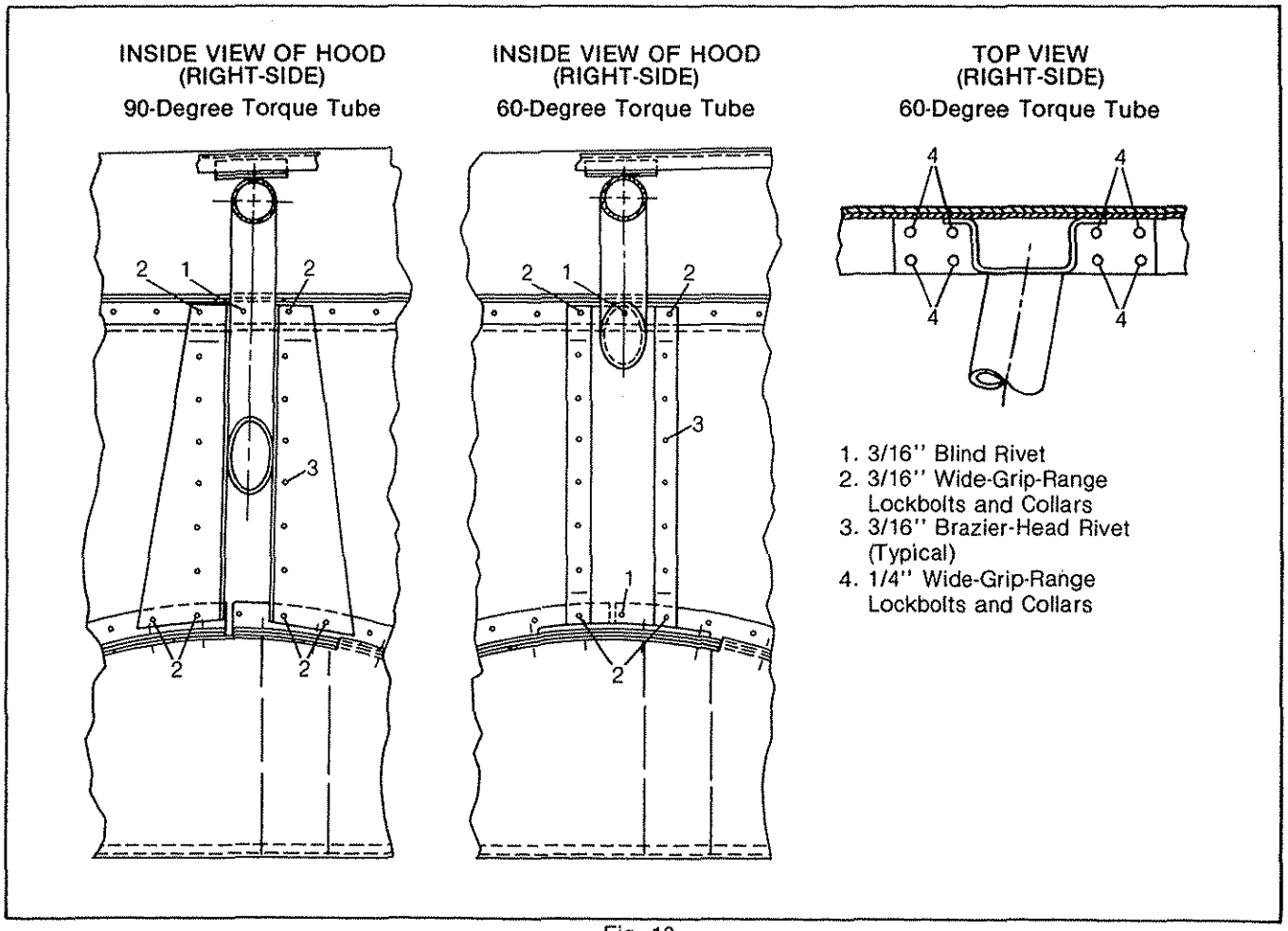


Fig. 13

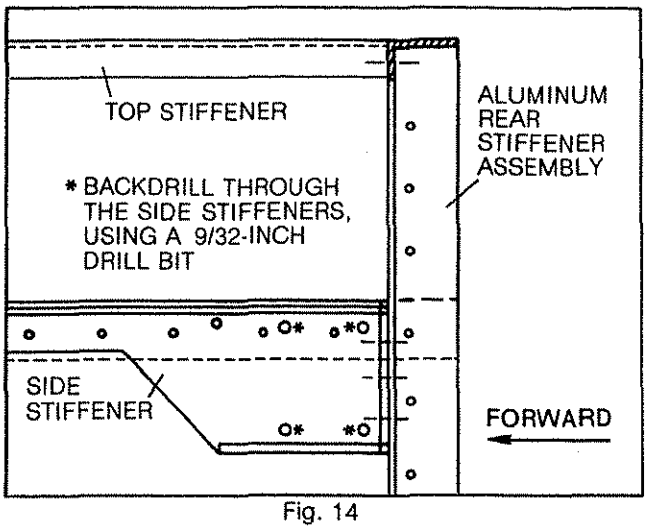


Fig. 14

.1 Use the blade of a pocket knife or a small-tipped screwdriver to carefully pry outward on the center tabs of all speed clips located along the bottom edge of the side stiffener, along the junction angles, and along both sides of the torque tube bracket. See Fig. 1. Pry all tabs on each clip. Remove the clips, using care not to break the weld pins. Do not discard the clips.

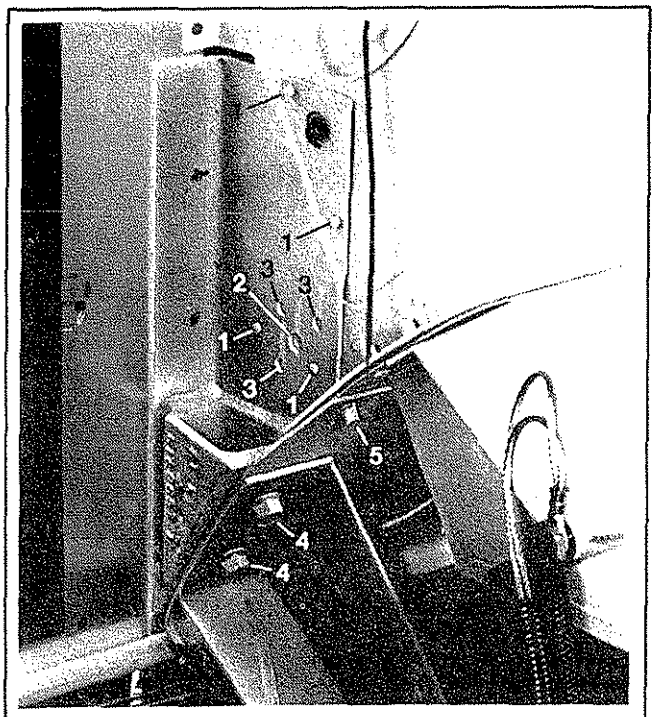
.2 Drill out the rivets that attach the liner mounting angles to the side stiffener and the rear stiffener assembly. See Fig. 1. Do not detach lining panels from liner mounting angles, unless lining panels will be replaced because of damage.

Proceed to step 4.

4. Use a putty knife or similar tool to carefully pry both lower lining panels away from the side skin that is being removed.

ALUMINUM HOOD REPAIRS

5. Remove the side marker light and lens, the upper part of the hood latch, and the nameplate emblem. Using a No. 11 drill bit, remove the four 3/16-inch countersunk rivets that attach the side skin to the forward hood-bracket assembly. See Fig. 15.



1. Use No. 11 Drill Bit To Remove 3/16" Flush Rivets
2. Backdrill (1/2" Drill Bit); Install Grommet
3. Backdrill (11/32" Drill Bit)
4. Use 1/2-13 Flanged Capscrews and Lockwashers
5. Backdrill (F Drill Bit); Use 1/4" Lockbolt

pf88_0055h

Fig. 15

6. Detach the side skin and one-half of the top skin from the hood framing, as follows:

   .1 If the hood is equipped with a torque tube assembly having 90-degree bends (earlier torque tubes have 60-degree bends), remove the six lockbolts at the top and bottom of the torque tube assembly supports, where they attach to the side stiffener and junction angles. See Fig. 3.

   .2 If the hood is equipped with a fiberglass reinforcement, remove the lockbolts that attach the side skin to the front and rear flanges of the reinforcement. On the same side of the hood, for halfway across the rearmost end of the top skin, remove the lockbolts that attach the top skin to the fiberglass reinforcement. See Fig. 3.

   .3 If the hood is equipped with upper hood-support sockets, remove the four capscrews, lockwashers, and nuts that attach the support socket bracket to the side stiffener. See Fig. 4.

   .4 If the hood is equipped with an aluminum rear stiffener assembly, drill out the rivets, using a No. 11 drill bit, that attach the side skin to the forward and rear junction angles, the front and rear flanges of the torque tube bracket, the inner grille shell, the side stiffener, and the rear stiffener assembly. Also, on the same side of the hood, drill out the rivets for halfway across the rearmost end of the top skin, that attach the top skin to the rear stiffener assembly. See Fig. 5.

   .5 If the hood is equipped with a fiberglass reinforcement, drill out the rivets, using a No. 11 drill bit, that attach the side skin to the forward and rear junction angles, the front and rear supports of the torque tube assembly, the inner grille shell, and the side stiffener. Also, drill out the rivet which lies between the reinforcement flanges, along the top-skin/side-skin seam; avoid drilling into the fiberglass reinforcement. See Fig. 3.

   .6 For halfway across the hood, drill out the rivets that attach the top skin to the inner grille shell. See Fig. 2.

7. On the same side of the hood that has the top skin detached from the hood framing, insert a wooden block between the torque tube and top skin, just above the sharpest curvature of the top skin. The block should be tall enough to raise the lower edge of the top skin above the upper edge of the side skin.

8. Using a No. 11 drill bit, remove any flush rivets that may be attaching the side stiffener to the side skin. Remove the side stiffener.

   If the hood is equipped with upper hood-support sockets, drill out the rivets that attach the rearmost end of the side stiffener to the aluminum rear stiffener assembly. See Fig. 4.

   Repair the side stiffener assembly if it is not being replaced.

9. When all fasteners have been removed, lift the side skin a slight amount, and pull outward at the bottom, until the bottom of the side skin clears the top of the fender. Lift off the side skin.

ALUMINUM HOOD REPAIRS

Side Skin Installation

1. Place the upper edge of the new or repaired side skin beneath the overlap of the blocked-up top skin. Lift the side skin upward slightly, and when it is high enough to clear the fender, push inward on the bottom edge. Position the side skin so its pilot holes are aligned with the rivet holes in the forward and rear junction angles.

2. Using sheet metal screws, installed from inside, or machine screws and nuts, temporarily secure the side skin to the forward and rear junction angles. Install a screw in the forwardmost hole, and thereafter in every fourth hole along the junction angles. See Figs. 16 and 17, Ref. A.

   If the hood is equipped with a torque tube assembly having 90-degree bends, the third and fourth screws must also secure the lower ends of the torque tube assembly supports to the forward and rear junction angles. Also, attach the side skin to the torque tube assembly supports by installing screws in the fourth or fifth holes down from the top. See Fig. 16, Ref. B.

3. Position and temporarily secure, using four small C-clamps, the repaired or replacement side stiffener between the upper edge of the side skin and the upper ends of the torque tube assembly supports or bracket flanges, aligning any existing holes. See Fig. 6, Ref. A.

   Drill, using a No. 11 drill bit, and countersink, using a 78-degree countersink, two holes through the side skin and side stiffener; placing the holes approximately 5 inches (127 mm) from each end of the side stiffener. Install flush rivets in the two holes, then remove the clamps. See Fig. 6, Ref. B.

   If the hood is equipped with upper hood-support sockets, attach the side stiffener to the aluminum rear stiffener assembly, using three 3/16-inch brazier-head rivets. See Fig. 4.

4. If the hood is equipped with an aluminum rear stiffener assembly, proceed to step 5.

   If the hood is equipped with a fiberglass reinforcement, attach the side skin and top skin to the hood framing, as follows:

   .1 Using at least six C-clamps or locking jaw pliers, secure the side skin to the fiberglass reinforcement.

   NOTE: The jaws of the C-clamps and locking jaw pliers should be padded with several layers of masking tape, to prevent damage to hood components.

   Beginning at the rear junction angle, align the lockbolt holes in the bottom of the reinforcement with the holes in the rear junction angle, and install a clamp to secure the components in this position. See Fig. 16, Ref. C. Install the remaining clamps at the center of each space between the holes in the reinforcement flanges, alternating between the front flange and rear flange, as shown in Fig. 16, Ref. D.

   .2 Remove the wooden block from between the top skin and torque tube, and pull the top skin down.

   IMPORTANT: If the top skin was removed for repair or replacement, install it at this time; follow steps 3 through 6 under "Top Skin Installation" before continuing the side skin installation procedure.

   Beginning at the hood centerline, use 3/16-inch wide-grip-range lockbolts and lockbolt collars to attach the top skin to the reinforcement. Install fasteners in both flanges of the reinforcement, alternating from one flange to the other each time two sets of fasteners are installed. Do not install fasteners in the top-skin/side-skin seam.

   .3 Beginning at the bottom of the reinforcement, backdrill, using a No. 11 drill bit, through all holes in both flanges, into the side skin.

   When the top-skin/side-skin seam is reached, backdrill through the top skin, into the side-skin and flanges of the reinforcement. Also, backdrill through the top skin into the side skin, but *not* into the reinforcement, at the hole which lies between the reinforcement flanges. See Fig. 16, Ref. E.

   .4 Install sheet metal screws, or machine screws and nuts, in two holes that are common to the reinforcement and rear junction angle. At the uppermost holes below the seam, and at the third holes down from the top, install screws in both flanges of the reinforcement. See Fig. 16, Ref. F. Tighten the screws sufficiently to prevent gaps between the side skin and reinforcement when the clamps are removed. Remove the clamps.

   .5 Install 3/16-inch wide-grip-range lockbolts and lockbolt collars in the two top-skin/side-skin

ALUMINUM HOOD REPAIRS

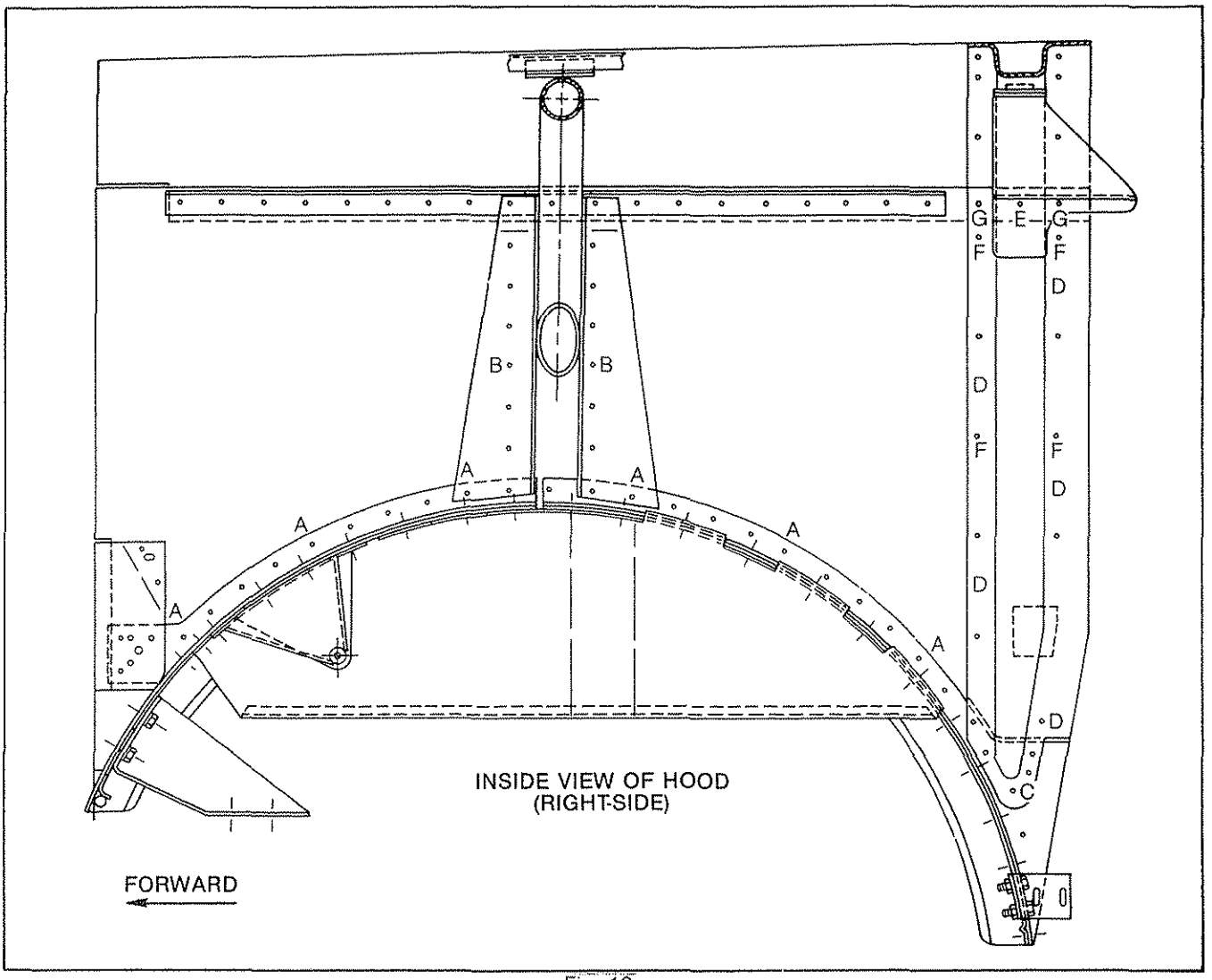


Fig. 16

seam holes at the reinforcement flanges. See Fig. 16, Ref. G. Install a 3/16-inch blind rivet in the hole between the reinforcement flanges. See Fig. 16, Ref. E.

.6 Backdrill, using a No. 11 drill bit, the lockbolt holes at the top of both torque tube assembly supports or both torque tube bracket flanges, through the top skin, into the side stiffener, side skin, and torque tube assembly supports. See Fig. 13. Use care not to elongate existing holes in the side stiffener, torque tube assembly supports or bracket, and top skin.

.7 Install 3/16-inch lockbolts and lockbolt collars in the uppermost holes of the torque tube assembly supports or torque tube bracket flanges. See Fig. 13.

.8 Use a No. 11 drill bit to backdrill all holes through the top skin into the side-skin and side stiffener, beginning with the holes nearest the reinforcement. Install a 3/16-inch brazier-head rivet in each hole as soon as it has been backdrilled. Install a 3/16-inch blind rivet in the hole that lies between the supports or bracket flanges of the torque tube assembly. See Fig. 13.

ALUMINUM HOOD REPAIRS

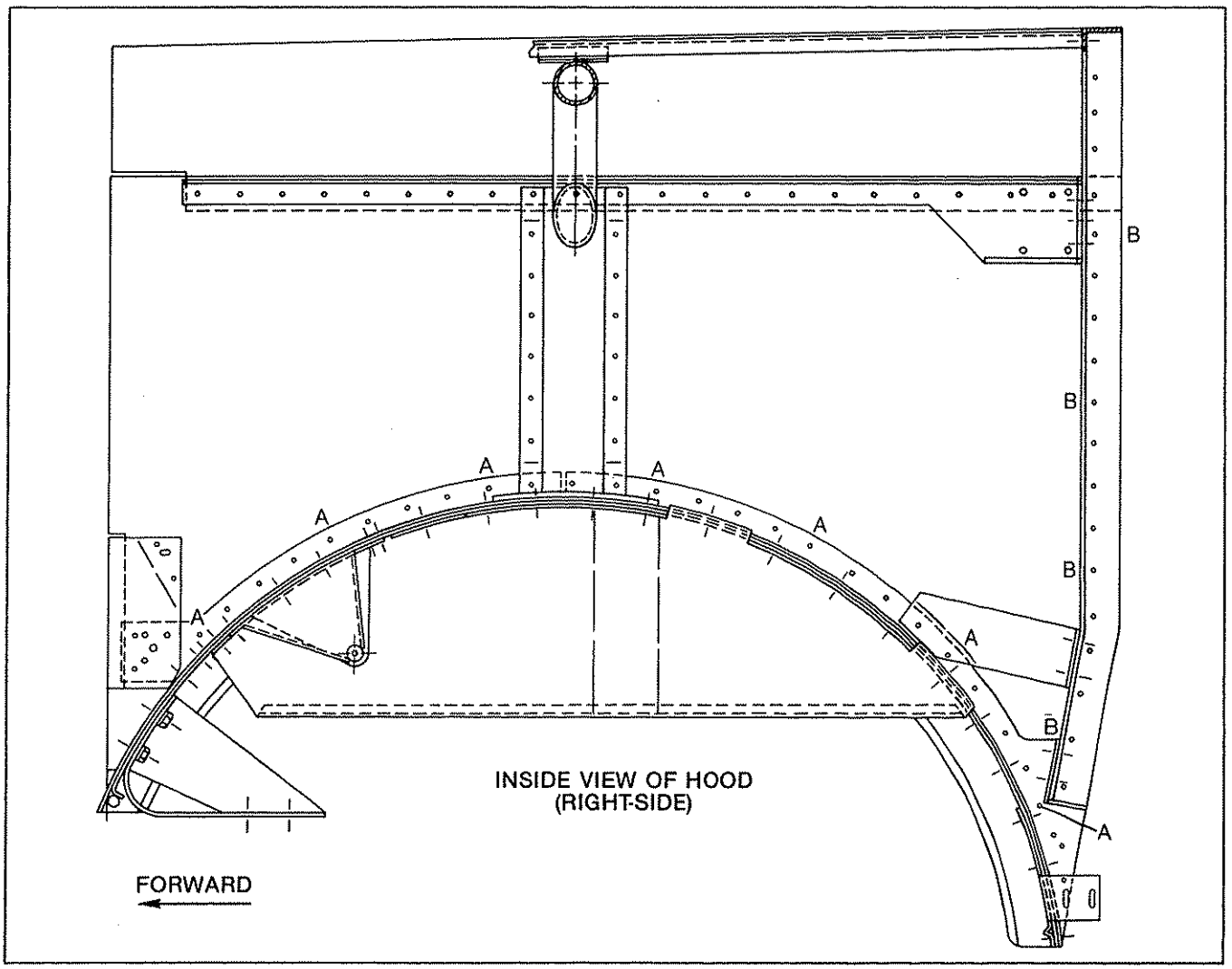


Fig. 17

.9 Backdrill the holes at the bottom of the torque tube assembly supports or torque tube bracket flanges, through the side skin into the forward and rear junction angles. Install 3/16-inch lockbolts and lockbolt collars in all of the holes. See Fig. 13.

.10 Install 3/16-inch lockbolts and lockbolt collars in all of the holes in both flanges of the reinforcement. See Fig. 3.

Proceed to step 6.

5. If the hood is equipped with an aluminum rear stiffener assembly, attach the side skin and top skin to the hood framing, as follows:

.1 Using sheet metal screws, installed from inside, or machine screws and nuts, temporarily secure the side skin to the rear stiffener assembly. Install a screw in the uppermost hole, and thereafter in every fourth hole. See Fig. 17, Ref. B.

.2 Remove the wooden block from between the top skin and torque tube, and pull the top skin down.

IMPORTANT: If the top skin was removed for repair or replacement, install it at this time: follow steps 3 through 7 under "Top Skin Installation" before continuing the side skin installation procedure.

ALUMINUM HOOD REPAIRS

Beginning at the hood centerline, install a 3/16-inch brazier-head rivet in each top-skin/rear-stiffener hole. Do not install rivets in the top-skin/side-skin seam.

.3 Using a No. 11 drill bit, backdrill the holes at the top of both torque tube bracket flanges, through the top skin, side skin, torque tube bracket, and side stiffener. Use care not to elongate existing holes in the torque tube bracket, side stiffener, or top skin. Install 3/16-inch wide-grip-range lockbolts and lockbolt collars in the uppermost holes of the torque tube bracket flanges, to attach the side stiffeners. See Fig. 13.

.4 Backdrill through the hood skin into the side stiffener and rear junction angle, at the holes between the torque tube bracket flanges; install 3/16-inch blind rivets in the holes. See Fig. 5, Ref. 3.

.5 If the hood is equipped with upper hood-support sockets, backdrill, using a 9/32-inch drill bit, through the support socket bracket holes in the side stiffener, into the side skin. See Fig. 14.

Install four internal-tooth lockwashers and 1/4-28 capscrews through the top skin, side skin, and side stiffener. Position the support socket bracket over the capscrews, install lockwashers and hex nuts, and tighten the hex nuts to 8 lbf·ft (11 N·m).

.6 Using a No. 11 drill bit, backdrill through the side skin into all of the holes in the rear stiffener assembly, and backdrill through the top skin into the remaining holes in the side stiffener. Attach the side skin to the stiffeners, with 3/16-inch brazier-head rivets. See Fig. 5.

Proceed to step 6.

6. Using a No. 11 drill bit, backdrill through the side skin into the remaining holes in the forward and rear junction angles, and the remaining holes in the torque tube assembly supports. Or, backdrill through the flanges of the torque tube bracket, if so equipped, into the side skin. Install 3/16-inch brazier-head rivets in all of the holes. See Figs. 3 and 5.

7. Using a No. 11 drill bit, backdrill into the side skin and top skin through the inner grille shell. Attach the inner grille shell to the side skin and top skin, using 3/16-inch aluminum blind rivets. See Fig. 2.

8. Using a 1/2-inch (13 mm) drill bit for the wiring grommet hole, and an 11/32-inch (9 mm) drill bit for the attachment bolt holes, backdrill into the side skin through the forward hood-bracket assembly, for attachment of the headlight bracket. See Fig. 15.

9. If the hood is equipped with an aluminum rear stiffener assembly, backdrill, using a 9/32-inch (7 mm) drill bit, into the side skin through the rear stiffener assembly and lower side stiffener, for attachment of the upper part of the hood latch. See Fig. 18.

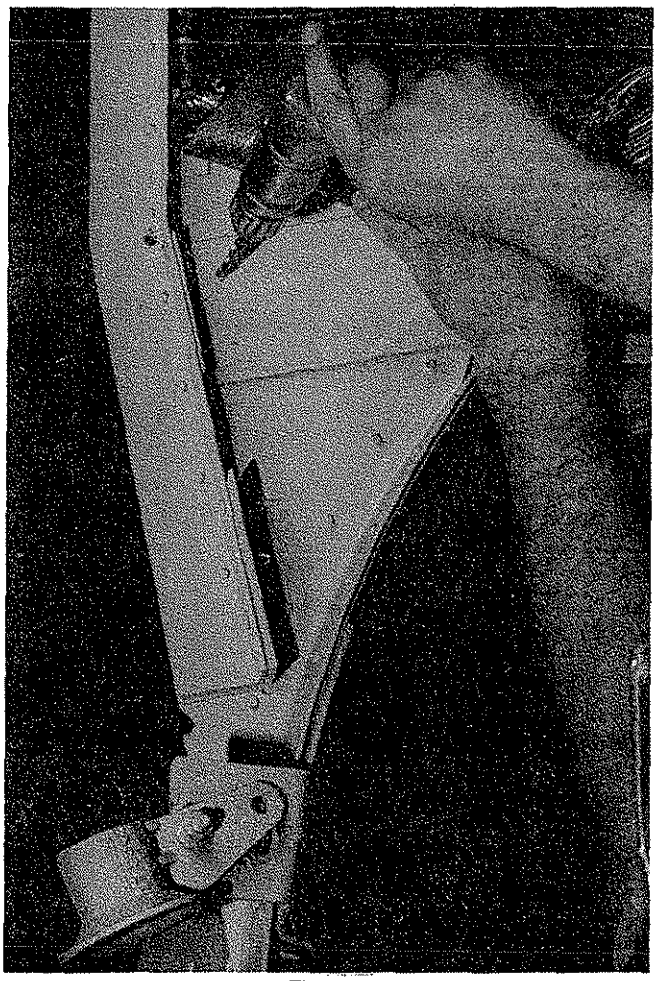


Fig. 18

10. Paint the repaired areas of the hood, following the procedure in the 18 Group of this manual.

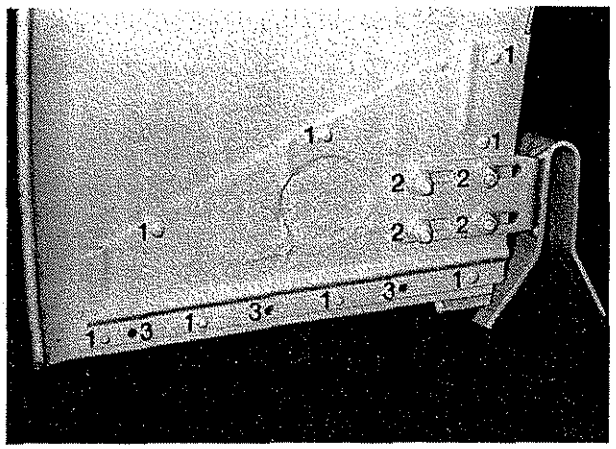
11. Install the upper and lower pieces of the outer grille shell, the grille shell splice covers, the grab handle, and the headlight assembly. Follow the procedures in the 17 Group of this manual.

ALUMINUM HOOD REPAIRS

12. Install the side marker light and lens, and nameplate emblem. Install the upper part of the hood latch, using 1/4-20 capscrews, washers, and acorn nuts if the hood is equipped with an aluminum rear stiffener assembly (Fig. 5, Ref. 6); or, using 1/4-20 self-tapping screws if the hood is equipped with a fiberglass reinforcement (Fig. 3, Ref. 5).
13. Attach the hood lining panels, if so equipped, by following the repair and replacement instructions in the 17 Group of this manual.
14. Install and adjust the hood assembly, following the procedure in the 17 Group of this manual.

Fender Removal

1. Remove the flap attachment strap and mud flap, by removing the locknuts, washers, and bolts that attach them to the rearmost edge of the fender. See Figs. 19 and 20.



1. Backdrill (No. 11 Drill Bit); Use 3/16" Brazier-Head Rivets
2. Backdrill (13/32" Drill Bit); Use 3/8-24 Hex Bolts, Lockwashers, and Nuts
3. Backdrill (5/16" Drill Bit); Use 1/4-20 Bolts, Flatwashers, and Prevailing Torque Locknuts

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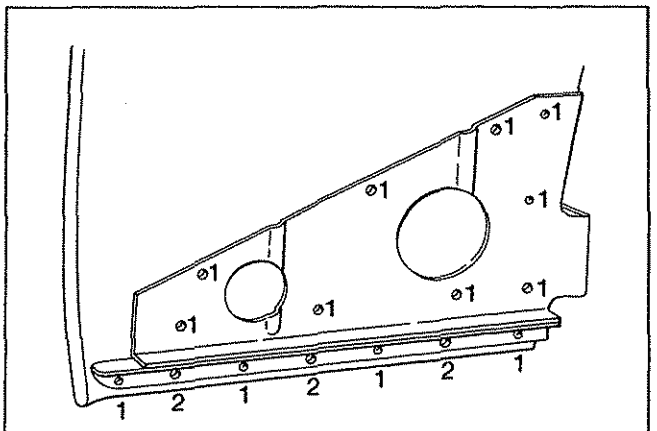
Fig. 19

2. Remove the hood assembly, following the procedure in the 17 Group of this manual.
3. If hood lining panels, when so equipped, are attached to hood skins with double-faced adhesive



1. Backdrill (No. 11 Drill Bit); Install 3/16" Brazier-Head Rivets
2. Backdrill (5/16" Drill Bit); Install 1/4-20 Bolts, Flatwashers, and Prevailing Torque Locknuts

Fig. 20

transfer tape only, use a putty knife or similar tool to carefully pry both lower lining panels away from the side skin, on the side of the hood that the fender is being replaced.

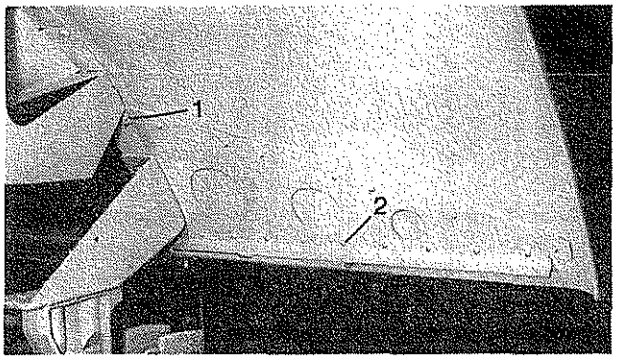
If hood lining panels are attached to the hood with speed clips and liner mounting angles, use the blade of a pocket knife or a small-tipped screwdriver to carefully pry outward on the center tabs of all speed clips located along the forward and rear junction angles. Pry all of the tabs on each clip. Remove the clips, using care not to break the weld pins; do not discard the clips. Fold up the lower edges of the lower lining panels, so they are clear of the junction angels.

4. Remove the lateral restraint bracket, if so equipped, by removing the hex nuts, lockwashers, and bolts that attach it to the rear fender stiffener and fender. See Fig. 19, Ref. 2.
5. Remove the hood mount bracket, by removing the flanged capscrews (and lockwashers) that attach it to the forward hood-bracket assembly. See Fig. 15, Ref. 4.
6. Detach the fender cross-tie assembly, if so equipped, by removing the lockbolt that attaches it to the

ALUMINUM HOOD REPAIRS

junction angle, and by drilling out, using a No. 11 drill bit, the rivets that attach it to the fender. See Fig. 21.

Remove the rear fender stiffener, and the front fender stiffener and lower hood support bracket if so equipped, by drilling out, using a No. 11 drill bit, the rivets that attach them to the fender. See Figs. 19 and 20.



1. Backdrill (F Drill Bit); Use 1/4" Wide-Grip-Range Lockbolt
2. Backdrill (No. 11 Drill Bit); Use 3/16" Brazier-Head Rivet (Typical)

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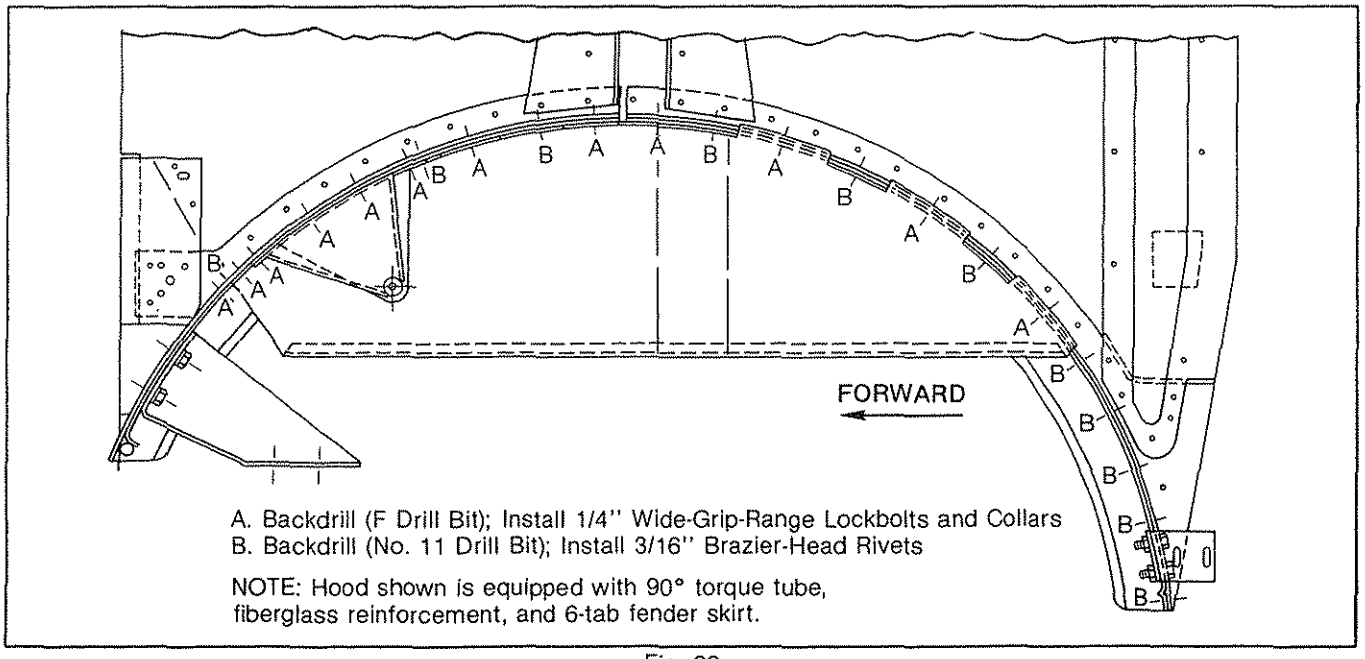
Fig. 21

7. Remove the stop device bracket, by removing the lockbolts that attach it to the forward junction angle. See Figs. 22 and 23.
8. Remove the fender skirt, fender, and fender welting, by removing all lockbolts and rivets that attach the components to the junction angles. See Figs. 22 and 23.

Fender Installation

1. Clamp the new fender into place, with a 7-foot (2134 mm) length of fender welting installed between the top of the fender and the bottom of the junction angles. The inside edge of the fender must be flush with the inside edge of the junction angles. The forwardmost edge of the fender, *not* the notch, must be in alignment with the *top* surface of the tang at the lower end of the outer grille shell. The holes at the front of the fender must be aligned with the holes in the forward hood-bracket assembly. See Fig. 21. Be sure the top surface of the fender is at an angle of 90 degrees to the side of the hood.
2. Place the fender cross-tie assembly or front fender stiffener (as equipped) against the front edge of the fender, and install the hood mount bracket and 1/2-13 flanged capscrews (and lockwashers). Tighten the capscrews finger-tight. Align and clamp the

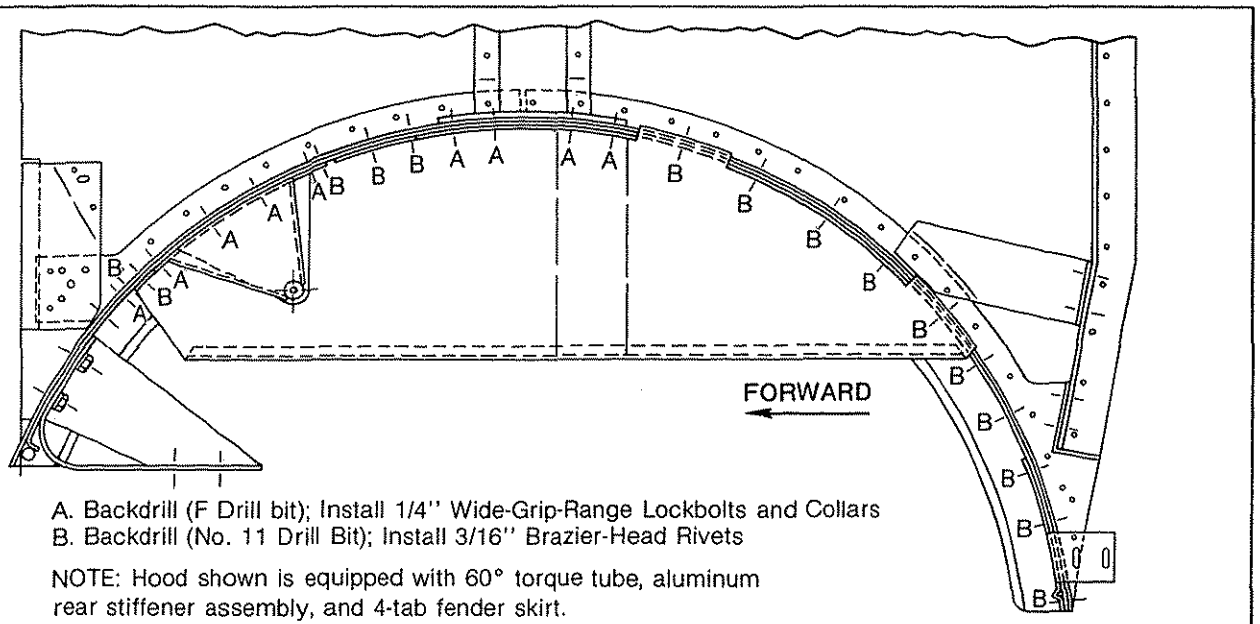


A. Backdrill (F Drill Bit); Install 1/4" Wide-Grip-Range Lockbolts and Collars
B. Backdrill (No. 11 Drill Bit); Install 3/16" Brazier-Head Rivets

NOTE: Hood shown is equipped with 90° torque tube, fiberglass reinforcement, and 6-tab fender skirt.

Fig. 22

ALUMINUM HOOD REPAIRS



A. Backdrill (F Drill bit); Install 1/4" Wide-Grip-Range Lockbolts and Collars
B. Backdrill (No. 11 Drill Bit); Install 3/16" Brazier-Head Rivets

NOTE: Hood shown is equipped with 60° torque tube, aluminum rear stiffener assembly, and 4-tab fender skirt.

Fig. 23

fender cross-tie assembly or front fender stiffener so the bottom edge is parallel to the bottom edge of the fender, and the uppermost lockbolt (or rivet) hole is aligned with the forwardmost hole in the forward junction angle. See Fig. 21.

3. Using a No. 11 drill bit, backdrill into the fender through all *rivet* holes (0.191 inch) in the forward and rear junction angles. See Figs. 22 and 23.

4. Position and clamp the rear fender stiffener (and lower hood-support bracket, if so equipped) in correct alignment with the rear edge of the fender. The rivet holes in the innermost edge of the rear fender stiffener (and lower hood-support bracket) must be in alignment with the rivet holes in the rear junction angle. See Figs. 19 and 20.

5. Install 3/16-inch aluminum brazier-head rivets in all rivet holes in both junction angles.

IMPORTANT: Do not install rivets in the fender skirt mounting holes. Refer to Figs. 22 and 23.

6. Using an F drill bit, backdrill into the fender through all of the 1/4-inch lockbolt holes in the forward and rear junction angles.

7. Using 1/4-inch wide-grip-range lockbolts and lockbolt collars, attach the stop device bracket to the forward junction angle. Install a 1/4-inch lockbolt in the uppermost hole of the fender cross-tie assembly, if so equipped. See Fig. 21.

   If the hood is equipped with a torque tube having 60-degree bends, install 1/4-inch lockbolts through the torque tube bracket baseplate, to attach it to the junction angle. See Fig. 23.

8. If the hood is equipped with fender skirts having six mounting tabs, attach the fender skirt with 1/4-inch lockbolts. See Fig. 22.

   If the hood is equipped with fender skirts having four mounting tabs, attach the fender skirt with 3/16-inch aluminum brazier-head rivets. See Fig. 23.

9. Using a No. 11 drill bit, backdrill into the fender through all rivet holes in the fender cross-tie assembly or front fender stiffener, as equipped, and the rear fender stiffener (and lower hood-support bracket, if so equipped). See Figs. 19, 20, and 21.

   Install 3/16-inch aluminum brazier-head rivets in all of the rivet holes. Remove the clamps.

10. Tighten the hood mount bracket flanged capscrews 80 lbf·ft (108 N·m).

11. Using a 5/16-inch (8 mm) drill bit, backdrill into the fender through the three holes in the rear fender stiffener, for attachment of the mud flap. See Figs. 19 and 20.

ALUMINUM HOOD REPAIRS

If the hood is equipped with lateral restraint brackets, backdrill, using a 13/32-inch drill bit, into the fender through the four holes in the rear fender stiffener. See Fig. 19, Ref. 2.

12. Attach the hood lining panels, if so equipped, by following the repair and replacement instructions in the 17 Group of this manual.
13. Paint the repaired areas of the hood, following the procedure in the 18 Group of this manual.
14. Install the lateral restraint brackets, if so equipped, using four 3/8-24 bolts, internal-tooth lockwashers, and hex nuts. See Fig. 19, Ref. 2.
15. Install and adjust the hood assembly, following the procedure in the 17 Group of this manual.
16. Install the mud flap and flap attachment strap, using 1/4-20 bolts, flatwashers, and prevailing torque locknuts. See Figs. 19 and 20.

HOOD FRAMING REPLACEMENT

Fender Skirt Replacement

1. If hood lining panels, when so equipped, are attached to hood skins with double-faced adhesive transfer tape only, use a putty knife or similar tool to carefully pry both lower lining panels away from the side of the hood that the fender skirt is being replaced. Also, pry the lining off the fender skirt.

   If hood lining panels are attached to the hood with speed clips and liner mounting angles, use the blade of a pocket knife or a small-tipped screwdriver to carefully pry outward on center tabs of all speed clips located along the forward and rear junction angles. Pry all of the tabs on each clip. Remove the clips, using care not to break the weld pins; do not discard the clips. Fold up the lower edges of the lower lining panels, so they are clear of the junction angles. Remove the speed clips that attach the lining panel to the fender skirt, then use a putty knife to pry the lining off the skirt.

2. If the fender skirt has six mounting tabs, remove it by removing the six lockbolts that attach it to the forward and rear junction angles. See Fig. 22.

   If the fender skirt has four mounting tabs, remove it by using an air chisel to remove the T-rivets that attach it to the junction angles. See Fig. 23.

3. Clamp the new fender skirt in place on the junction angles. If the removed fender skirt being replaced has six mounting tabs, use an F drill bit to backdrill through the holes in the junction angles into the fender skirt tabs.

   If the fender skirt being replaced has four mounting tabs, use an F drill bit to enlarge the four 0.191-inch junction angle holes, and to backdrill into four of the six fender skirt tabs. Centerpunch the other two tabs, within ± 1/2 inch (± 13 mm) of their lengthwise centers. Use an F drill bit to drill through the fender skirt tabs, fender, and junction angles. See Fig. 22.

4. Attach the fender skirt to the junction angles, using six 1/4-inch wide-grip-range lockbolts and lockbolt collars. Remove the clamps.
5. Attach the hood lining panels, if so equipped, by following the repair and replacement instructions in the 17 Group of this manual.

Forward Hood-Bracket Assembly Replacement

(Refer to Fig. 19)

1. Remove the hood assembly, following the procedure in the 17 Group of this manual.
2. Remove the hood mount bracket, by removing the two flanged capscrews (and lockwashers) that attach it to the forward hood-bracket assembly.
3. Remove the clamp that attaches the headlight wiring harness to the forward hood-bracket assembly.
4. Remove the headlight assembly, grille shell side splice cover, and lower outer grille shell. Follow the procedures in the 17 Group of this manual.
5. Remove the nut, washer, and carriage bolt that attach the lower grille angle and pivot angle to the forward hood-bracket assembly.
6. Using a No. 11 drill bit, remove the rivets that attach the inner grille shell to the forward hood-bracket assembly.
7. Using a No. 11 drill bit, remove the four 3/16-inch countersunk rivets that attach the side skin to the forward hood-bracket assembly.
8. Lift the forward hood-bracket assembly up and out.
9. Position the new forward hood-bracket assembly so its headlight bracket holes are aligned with the headlight bracket holes in the forward junction

ALUMINUM HOOD REPAIRS

angle and side skin, and its pivot angle carriage bolt hole is aligned with the hole in the inner grille shell.

10. Insert the carriage bolt through the lower grille angle, inner grille shell, forward hood-bracket assembly, and pivot angle. Install the washer and nut; tighten the nut 5 lbf·ft (7 N·m).
11. Install the hood mount bracket on the forward hood-bracket assembly, using two lockwashers and 1/2-13 flanged capscrews; tighten the capscrews 80 lbf·ft (108 N·m).
12. Using a No. 11 drill bit, backdrill through the holes in the inner grille shell, into the forward hood-bracket assembly. Using 3/16-inch aluminum blind rivets, attach the forward hood-bracket assembly to the inner grille shell.
13. Install the lower grille shell, grille shell side splice cover, and headlight assembly. Follow the procedures in the 17 Group of this manual.
14. Attach the clamp and the headlight wiring harness to the forward hood-bracket assembly.
15. Install the hood assembly, following the procedure in the 17 Group of this manual.

Aluminum Rear Stiffener Assembly Parts Replacement (Refer to Fig. 24)

1. Remove the hood assembly, following the procedure in the 17 Group of this manual.
2. If hood lining panels, when so equipped, are attached to hood skins with double-faced adhesive transfer tape only, use a putty knife or similar tool to carefully pry the lining panels away from the hood in areas where the rear stiffener components are being replaced.

   If hood lining panels are attached with speed clips and liner mounting angles, use an air chisel to remove the rivets that attach liner mounting angles to the rear stiffener components that are being replaced.

   Fold the edge of the lining panels away from the rear stiffener.
3. Using a No. 11 drill bit, remove all rivets that attach the hood skins to the rear stiffener assembly in the immediate areas where rear stiffener components that are being removed are welded to other rear stiffener components.

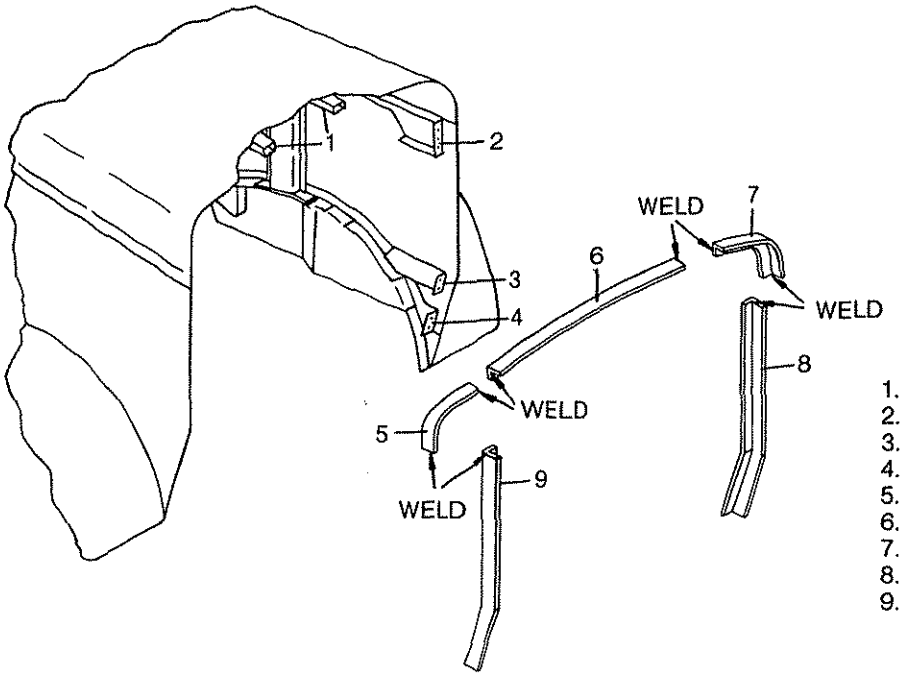


Fig. 24

ALUMINUM HOOD REPAIRS

4. Using a hacksaw to cut the welds, separate components that are being replaced, from other rear stiffener components. Use care to make straight 90-degree cuts. Do not cut into the hood skins.

5. Using a No. 11 drill bit, remove any rivets that attach the top stiffener assembly, or upper or lower side stiffener, or rear junction angle, to rear stiffener components that are being replaced.

   If replacement of either of the lower rear stiffener or lower side stiffener components is required, remove the upper part of the hood latch on that side.

6. Drill out the rivets that attach hood skins to rear stiffener components that are being replaced; remove the components.

7. Where the rear stiffener assembly was cut with a hacksaw, file the ends smooth on components that were not removed. Be careful to not file off too much material.

8. Clamp the new rear stiffener components in place, but do not clamp the stiffener components to the hood skins near the ends that must be welded.

9. Weld the ends of new components to the ends of components that were not removed.

CAUTION: Use care in welding rear stiffener assembly components. The application of great amounts of heat can cause severe weakening of the aluminum, resulting in possible hood damage.

   During the welding operation, an assistant should apply wet cloths to the hood skin outer surface, in the area of the weld, to prevent damage to the paint finish.

10. Using a No. 11 drill bit, backdrill all rivet holes through the hood skins into the replacement components. Also backdrill any holes for attachment of top stiffener assemblies, or upper or lower side stiffeners. Using a 9/32-inch (7 mm) drill bit, backdrill (if necessary) for installation of the upper part of the hood latch.

11. Remove the clamps. Then, using 3/16-inch aluminum brazier-head rivets, attach the rear stiffener components to the hood skins, top stiffener assemblies, or upper and lower side stiffeners, as applicable. Install the upper part of the hood latch, if applicable.

12. Attach the hood lining panels, if so equipped, by applying contact cement to the hood skins and the backside (dull side) of the rearmost edges of the panels. Press the panels into place, and hold them until the contact cement bonds.

    If the hood lining panels are equipped with liner mounting angles, clamp the angles to the rear stiffener assembly. Using a No. 11 drill bit, backdrill the holes through the angle into the rear stiffener assembly, then attach the angles with 3/16-inch aluminum blind T-rivets.

13. At all locations where the rear stiffener assembly was welded, a 4-1/4 inch (108 mm) long reinforcing angle should be attached. Use a 1-inch by 1-inch (25 mm by 25 mm) angle. Clamp the angle into place so the weld is centered under the length of the angle. Using a No. 11 drill bit, drill four evenly spaced holes through the angle and the rear stiffener assembly. Attach the angle, using 3/16-inch aluminum brazier-head rivets. Remove the clamps.

14. Install the hood assembly, following the procedure in the 17 Group of this manual.

HOOD ATTACHMENTS, REPAIR AND REPLACEMENT

GENERAL DESCRIPTION

Attachments to the hood include the grille assembly, headlight assembly, and hood lining. A chrome-plated multisectioned grille shell is attached to the sides and top of the front of the hood. A grab handle is centrally located on the top of the grille shell. On all aluminum hood installations, and fiberglass hood installations except on Conventionals with 1984 Advancements, single or dual, round headlights are mounted on brackets that attach to each side of the grille shell. See Fig. 1. On fiberglass hood installations on all Conventionals with 1984 Advancements, dual, rectangular headlights are mounted horizontally in molded transitions on each front fender. See Fig. 2.

On some vehicles, mylar faced, one-inch (25 mm) thick sound-absorbent foam is attached to the contour of the underside of the hood and the fender skirts. On aluminum hoods, individual foam lining panels are attached by double-backed adhesive transfer tape, or by adhesive contact cement and by speed clips installed over weld pins pushed through the lining panels. See Fig. 3. The weld pins are attached to the hood stiffeners and framing, and to liner mounting angles. On fiberglass hoods, a two-piece liner panel is attached with double-backed adhesive transfer tape.

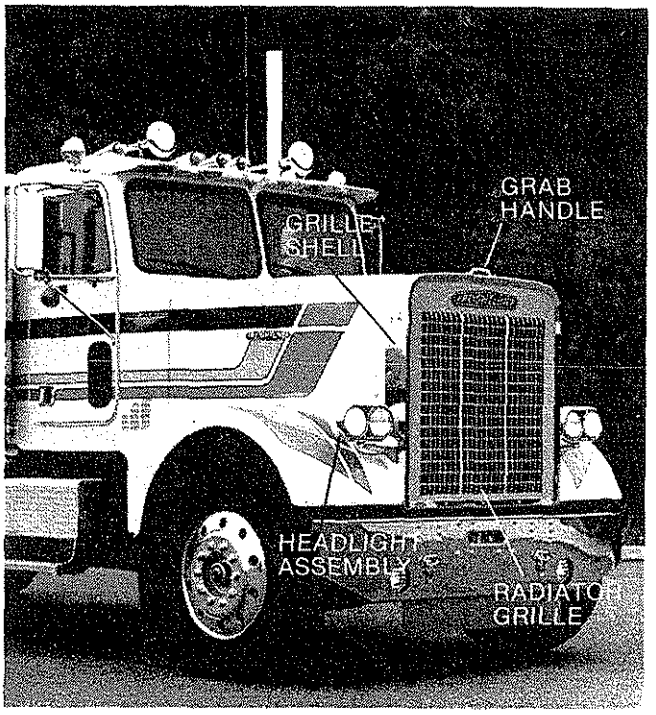


Fig. 1

Fig. 2

SERVICE OPERATIONS

HOOD LINING REPAIR

1. Remove the hood assembly, if required for access to the repair area. For instructions, refer to the 17 Group of this manual.

2. Small tears in the mylar facing or tape-sealed edges of the lining panels may be repaired by covering the torn area with 2-inch (51 mm) wide aluminized polyester sealant tape or duct tape. The surface of the mylar should be thoroughly cleaned to assure satisfactory tape adhesion.

IMPORTANT: If tears in the mylar facing of the lining panels have resulted in water-soaking or oil-soaking of the acoustical foam, the lining panel must be replaced. For instructions, refer to "HOOD LINING REPLACEMENT."

3. If equipped, replace any missing speed clips with new ones on undamaged weld pins.

   If any of the weld pins are damaged, carefully pull the hood lining panel off of the damaged pin, then clip the pin off flush with the liner mounting angle or hood framing. Apply contact cement to the lining

HOOD ATTACHMENTS, REPAIR AND REPLACEMENT

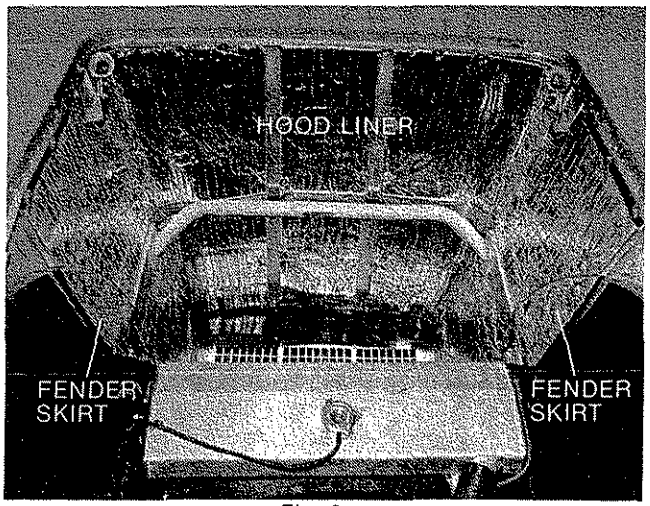


Fig. 3

panel and the hood skin in the area of the broken weld pin. Push the panel into place, and hold until the contact cement bonds.

4. Secure any detached areas of the lining by using contact cement on the lining panel and hood skin. Push the lining into place and hold until the contact cement bonds.

HOOD LINING REPLACEMENT

1. Remove the hood assembly. For instructions, refer to the 17 Group of this manual.
2. On hoods with the lining installed using adhesive transfer tape, proceed to step 3. On aluminum hoods that have the lining installed with speed clips and contact cement, proceed as follows:

   .1 Using a small-tipped screwdriver or the blade of a pocketknife, carefully pry outward on the center tabs of the speed clips securing the lining panel(s) being replaced (Fig. 4). Pry all of the tabs on each speed clip; then remove the clips, using care not to break the weld pins. Save the speed clips, if desired.

Fig. 4, Speed Clip Removal

   .2 Carefully pull the edge of the lining panel off of the weld pins.

   .3 Using a putty knife, or similar tool, pry the lining panel from the hood skin or fender skirt. Proceed to step 4.

3. Carefully pull the lining panel(s) and adhesive transfer tape from the hood.

NOTE: On aluminum hoods, if removing the fender skirt panel(s), first remove the speed clips, using the instructions given in step 2.1, above.

4. Using a wire brush, clean the inside surface of the hood where the lining panel was removed. Then, steam clean the area thoroughly, and allow it to air dry.
5. Apply the adhesive tape around the back perimeter (dull side) of the replacement lining panel. Then, apply strips of tape at 7-inch (178 mm) intervals, running parallel to the radius that the panel will form at installation. See Fig. 5. Do not overlap the tape.

NOTE: If contact cement is used, on aluminum hoods, apply the cement on the inside hood surface and back (dull) side of the lining panels in the shaded areas shown in Fig. 6. On fiberglass hoods, apply the cement to the entire inside hood surface and back side of the lining panels.

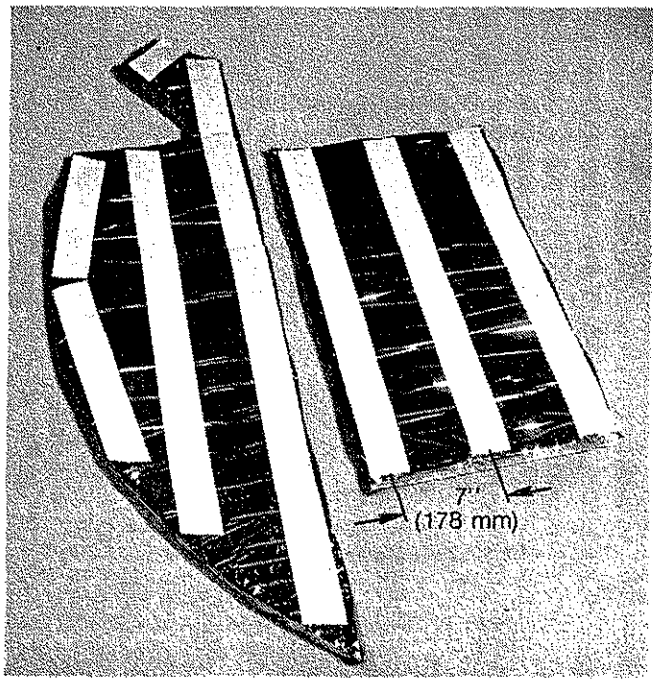


Fig. 5

HOOD ATTACHMENTS, REPAIR AND REPLACEMENT

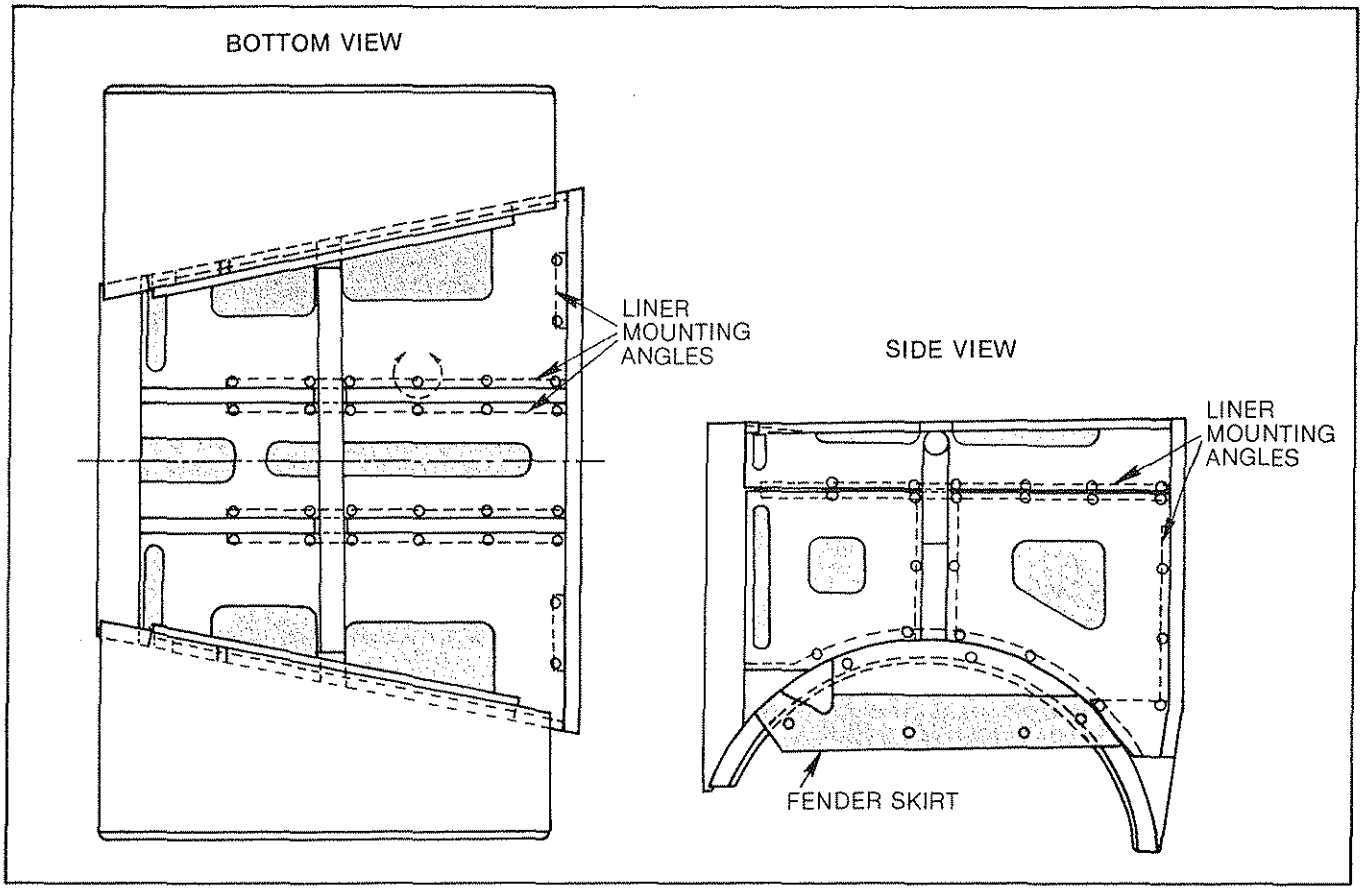


Fig. 6

6. Remove the backing strip from the tape, and lightly press the lining in place on the hood. If equipped with weld pins, push the lining in place over the weld pins.

NOTE: If any of the weld pins are damaged, clip the pin(s) off flush with the liner mounting angle or hood framing. If using contact cement, apply contact cement to the lining panel and hood skin in the area of the broken weld pin, and push the lining into place.

7. Once the liner is correctly in place, use an application roller, and apply heavy pressure over the liner to achieve proper adhesion.

   If equipped with speed clips, push a speed clip over each of the weld pins.

NOTE: If using the old speed clips, lay the speed clips on a flat surface, and use a hammer to gently tap the center tabs down so they will fit over the weld pins.

8. Install the hood on the vehicle. For instructions, refer to the 17 Group of this manual.

HEADLIGHT ASSEMBLY REMOVAL

Fiberglass Hoods on Conventionals With 1984 Advancements

1. Tilt the hood to the full-open position.
2. Pull apart the headlight wiring harness connector, at that side of the hood where the headlight is being removed.
3. Return the hood to the operating position.
4. Remove the screws that attach the trim ring to the housing assembly, and remove the trim ring. See Fig. 7.
5. Remove the screws and nuts that attach the housing assembly to the fender, and remove the headlight assembly.

HOOD ATTACHMENTS, REPAIR AND REPLACEMENT

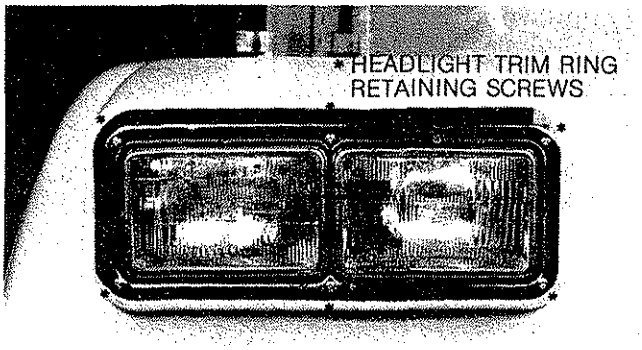


Fig. 7

NOTE: If both headlight assemblies are being removed and will be reinstalled, tag the headlight assemblies as right or left to indicate the side of the vehicle from which they were removed.

All Aluminum Hoods, and Fiberglass Hoods on Conventionals Without 1984 Advancements

1. Tilt the hood to the full-open position.
2. Remove the headlight ground wire from the grille (Fig. 8, Ref. A) or the forward hood bracket.

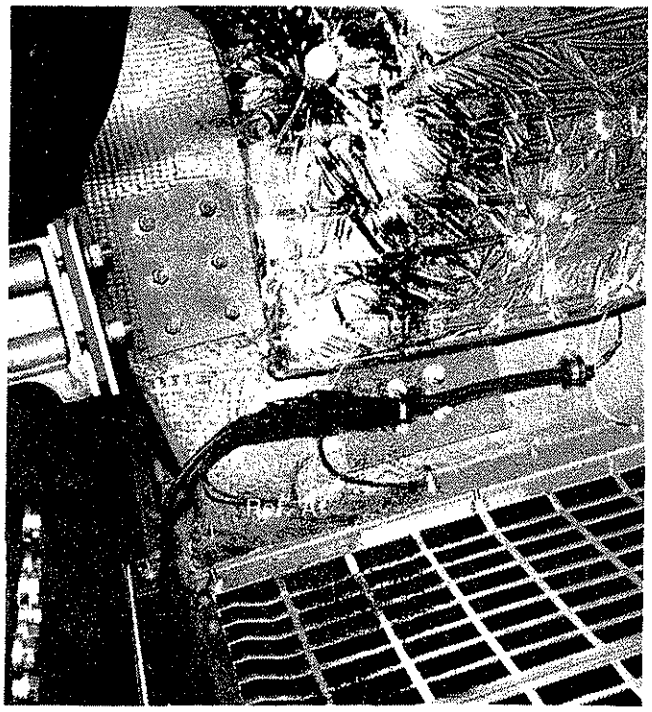


Fig. 8

3. Remove the electrical tape from the two headlight pigtail wires (Fig. 8, Ref. B) that pass through the hole in the grille shell. Cut the wires approximately 1/4 inch (6 mm) from the splices. See Fig. 9.
4. Pull the wires from the headlight housing out through the hole in the grille shell and through the hole in the headlight mounting bracket.
5. To remove the headlight housing and bracket as one assembly, proceed to step 6. To remove the headlight housing from the bracket, proceed as follows:

   .1 Return the hood to the operating position.

   .2 On dual headlights, remove the screws that attach the bezel to the housing, and remove the bezel. See Fig. 10. While holding the housing-to-bracket bolt head in place, remove the attaching nut and washer from the bottom of the bracket. Remove the housing from the bracket.

   NOTE: If both dual headlight housings are being removed and will be reinstalled, tag the headlight housings as right or left to indicate the side of the vehicle from which they were removed.

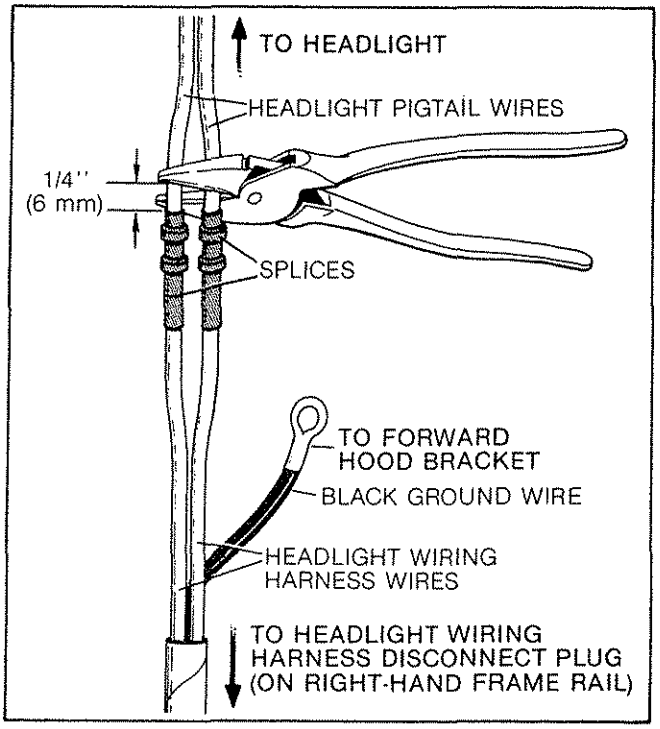


Fig. 9

HOOD ATTACHMENTS, REPAIR AND REPLACEMENT

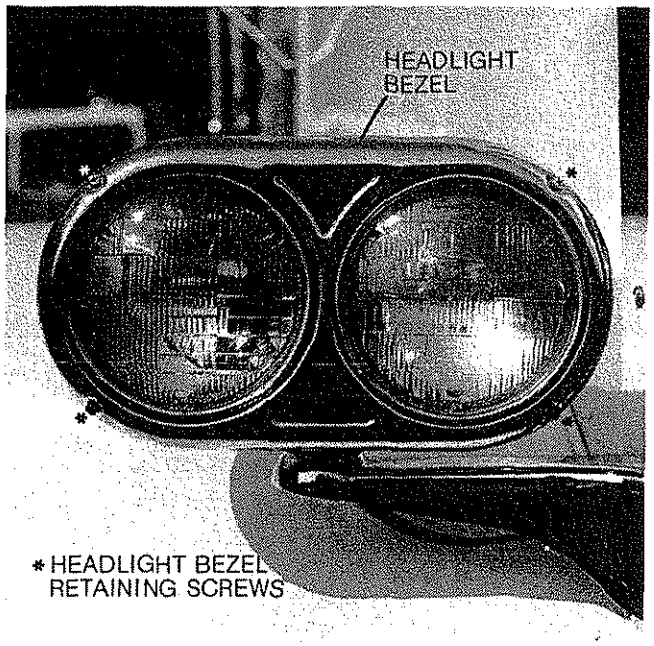


Fig. 10

On single headlights, remove the nut and washer that attaches the headlight housing to the bracket (see Fig. 11), and remove the housing from the bracket.

6. Tilt the hood to the full-open position. Remove the flange bolts, washers, and nuts attaching the headlight bracket to the grille shell, and remove the bracket. On fiberglass hoods, remove the reinforcement plate.

CAUTION: Use care not to scratch the bracket or grille shell when removing the fasteners and bracket.

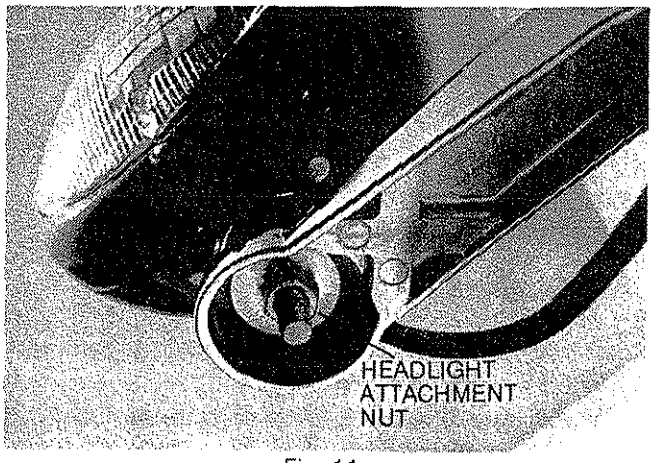


Fig. 11

HEADLIGHT ASSEMBLY INSTALLATION

Fiberglass Hoods on Conventionals With 1984 Advancements

1. With the hood in the operating position, insert the headlight wiring harness and the headlight housing assembly into the front of the opening in the fender.

IMPORTANT: Headlight assemblies must be mounted on the vehicle so that the high beam headlights are nearest the hood.

Install the attaching screws and nuts, and tighten them to the torque value in Table 1, under "SPECIFICATIONS."

2. Install the trim ring, and tighten the attaching screws.
3. Tilt the hood to the full-open position.
4. Push together the halves of the headlight wiring harness connector.
5. Return the hood to the operating position, and fasten the hood latches.
6. Aim the headlights; for instructions, refer to the 06 Group of the Freightliner Maintenance and Lube Manual.

All Aluminum Hoods, and Fiberglass Hoods on Conventionals Without 1984 Advancements

1. Tilt the hood to the full-open position.
2. Place the headlight mounting bracket, and reinforcing plate, if so equipped, against the grille shell, and align the mounting holes.

Install the flanged bolts (with the flanged heads of the bolts on the bracket), and attach with the flanged nuts. Tighten the nuts to the torque value in Table 1, under "SPECIFICATIONS."

3. Return the hood to the operating position. If previously removed, place the housing on the bracket and insert the housing bolt through the housing and top of the bracket. Install the flatwasher and nut on the bolt, and tighten the nut until it makes contact with the bottom of the bracket. Do not tighten further.

IMPORTANT: Single headlight housings are interchangeable from one side of the vehicle to the other. Dual headlight housings, with headlights installed, must be mounted on the vehicle so that the high beam headlights are nearest the hood.

HOOD ATTACHMENTS, REPAIR AND REPLACEMENTS

4. Tilt the hood to the full-open position. Feed the wires from the headlight pigtail through the hole in the headlight mounting bracket and the hole in the grille shell.
5. Replace the old splices, as follows:
   .1 Strip approximately 3/16 inch (5 mm) of insulation from the ends of the headlight pigtail wires. See Fig. 12.
   .2 Cut the headlight wiring harness wires approximately 1/4 inch (6 mm) from the ends of the splices, as shown in Fig. 12. Each splice should have 1/4 inch (6 mm) of clipped insulated wire at each end. Do not discard the splices.
   .3 Strip approximately 3/16 inch (5 mm) of insulation from the ends of the two headlight wiring harness wires. See Fig. 12.

NOTE: Do not strip the black ground wire with the terminal attached to it.

   .4 Insert the ends of the headlight wiring harness wires into two new No. 14-16 AWG butt splices, and crimp them tight.
   .5 Referring to the splices previously removed in substep 5.2 above, determine the correct combination of wire colors to be spliced. Insert the ends of the headlight pigtail wires into the correct splices, and crimp them tight.

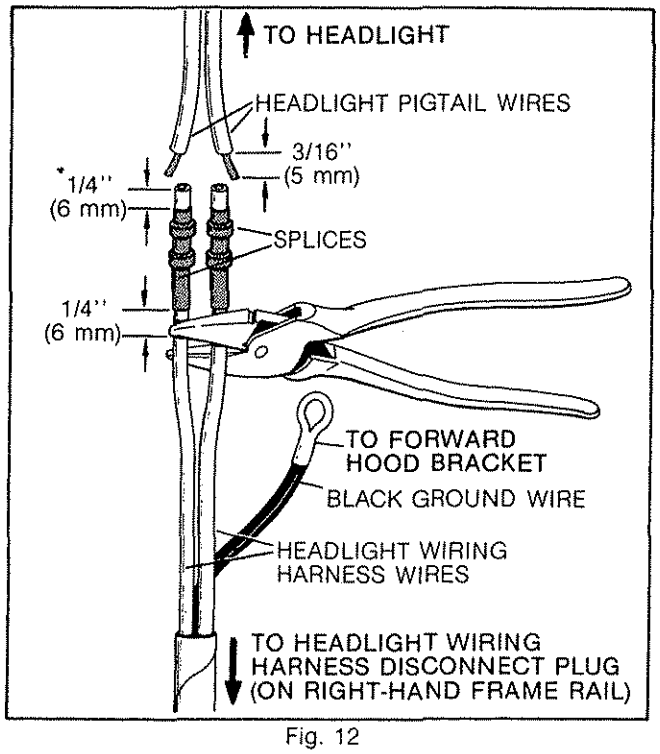


Fig. 12

6. Remove the nut, washer, and bolt from the grille shell or forward hood bracket, and attach the terminal of the ground wire to the bolt. Install the bolt, washer, and nut, then tighten the nut.
7. Wrap the wires and splices with electrical tape.
8. Return the hood to the operating position, and fasten the hood latches.
9. Aim the headlights. For instructions, refer to the 06 Group of the Freightliner Maintenance and Lube Manual.
10. Install the bezel and attaching screws.

GRILLE COMPONENTS REMOVAL AND INSTALLATION (Refer to Fig. 13)

Removal

1. Remove the hood assembly. For instructions, refer to the 17 Group of this manual.

   Set the hood upright, with the front of the hood on a table or bench, and the rear edges of the fenders supported on workstands.
2. Detach all of the underhood wiring and the wiring harness clamps, by removing any attaching bolts or nuts.
3. On all hood installations except on Conventionals with 1984 Advancements, remove the nuts, washers, and bolts that attach the radiator grille to the radiator grille shell. Remove the radiator grille.
4. Remove the upper wind baffle.
5. Remove the nuts, washers, and bolts that attach the grab handle to the top of the grille, and remove the grab handle.
6. Remove the nuts, washers, and bolts that attach the top splice cover to the grille, and remove the splice cover and splice plate.
7. Remove the nuts, washers, and bolts that attach the side splice covers to the grille, and remove the side splice covers and splice plates.
8. Remove the nuts, washers, and bolts that attach the top grille shell sections to the hood, and remove the top grille shell sections.
9. If applicable, remove the headlight assembly from the side grille shell sections. For instructions, refer

HOOD ATTACHMENTS, REPAIR AND REPLACEMENT

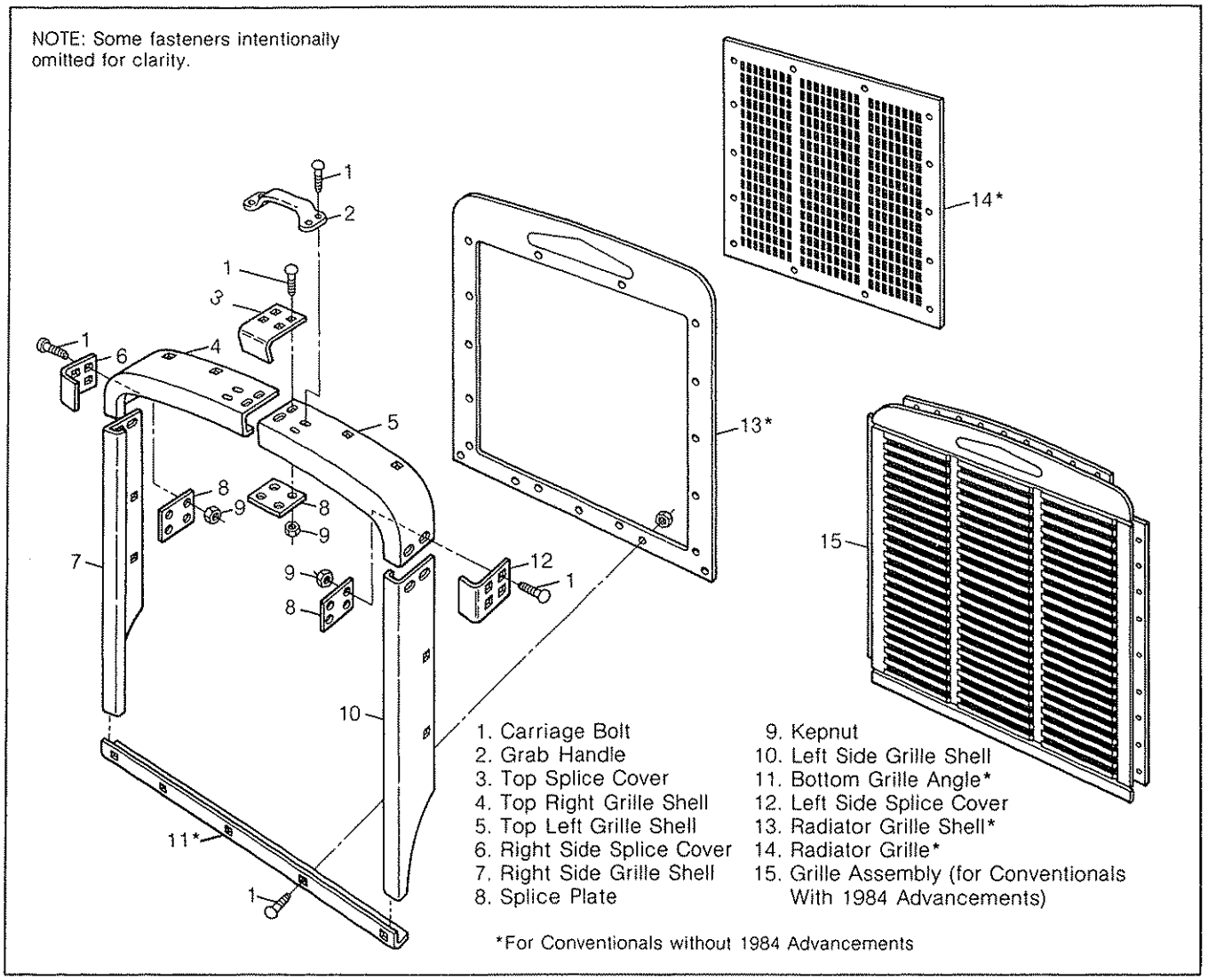


Fig. 13, Grille Assembly

to "HEADLIGHT ASSEMBLY REMOVAL: All Aluminum Hoods, and Fiberglass Hoods on Conventionals Without 1984 Advancements."

10. Remove the nuts, washers, and bolts that attach the side grille shell sections to the hood, and remove the side grille shell sections.

11. On all hood installations except on Conventionals with 1984 Advancements, remove the nuts, washers, and bolts that attach the bottom grille angle to the pivot angle, and remove the bottom grille angle.

NOTE: If the bottom grille angle is the only grille component that requires replacement, it is not necessary to remove any of the other grille components. The side grille shell sections may be pulled forward and held at the bottom with small wedges of soft wood. This will allow removal of the bottom grille angle bolts.

12. On *all* fiberglass hoods, and on aluminum hoods on Conventionals with 1984 Advancements, remove the grille screws and kepnuts that attach the grille assembly or radiator grille shell to the hood, then remove the grille assembly or radiator grille shell.

13. On aluminum hoods on Conventionals without 1984 Advancements, secure the headlight wiring harness in a position below the level of the grille. Using a No. 11 drill bit, remove the rivets that secure the radiator

HOOD ATTACHMENTS, REPAIR AND REPLACEMENT

grille shell to the hood, then remove the radiator grille shell.

14. If replacing the grille assembly or radiator grille shell, remove the nameplate for installation on the new grille.

Installation

1. If replacing the grille with a new one, attach the nameplate to the new grille with the nameplate clips.
2. Align the mounting holes of the grille assembly or radiator grille shell with the mounting holes in the hood, and attach it with 10-24 grille screws and kepnuts.
3. On all hood installations except on Conventionals with 1984 Advancements, align the mounting holes of the bottom grille angle with the mounting holes of the radiator grille shell and pivot angle. Attach the grille angle with 1/4-20 bolts, washers, and kepnuts. Tighten the kepnuts to the torque value in Table 1, under "SPECIFICATIONS."
4. Align the side grille shell sections with the mounting holes of the hood. Attach them with 1/4-20 bolts, large washers, and kepnuts. Tighten the kepnuts to the torque value in Table 1.
5. If applicable, install the headlight assemblies on the sides of the hood. For instructions, refer to "HEADLIGHT ASSEMBLY INSTALLATION: All Aluminum Hoods, and Fiberglass Hoods on Conventionals Without 1984 Advancements."
6. Align the top grille shell sections with the mounting holes of the hood. Install the 1/4-20 bolts through the grille shells and hood, then position the upper wind baffle inside the hood, on the 1/4-20 bolts. On early aluminum hood installations, place the forward end of each top stiffener onto the bolts nearest the center of the hood. Install the washers and kepnuts, and tighten the kepnuts to the torque value in Table 1, under "SPECIFICATIONS."
7. Insert the bolts through the holes of the side splice covers and grille shell. Place the splice plates inside the hood, on the bolts, and attach with the washers and nuts. Tighten the nuts to the torque value in Table 1.
8. Align the top splice cover holes with the holes of the grille shell, and insert the four bolts. Place the splice plate inside the hood, on the bolts, and attach with the washers and nuts. Tighten the nuts to the torque value in Table 1.
9. Align the grab handle holes with the mounting holes of the grille shell, and insert the four bolts. Attach the washers and nuts, and tighten the nuts to the torque value in Table 1.
10. On all hood installations except on Conventionals with 1984 Advancements, align the radiator grille holes with the mounting holes of the radiator grille shell (the radiator grille goes on the inside). Install the upper outside-edge carriage bolts, washers, and nuts. Do not tighten the nuts. One at a time, install the four lower carriage bolts and place the headlight wiring harness clamps over them. Attach with the washers and nuts.

    Install the remaining bolts, washers, and nuts. Tighten all the nuts.
11. Attach all of the underhood wiring and wiring harness clamps.
12. Install the hood on the vehicle. For instructions, refer to the 17 Group of this manual.

SPECIFICATIONS

DESCRIPTION	SIZE	TORQUE	
		lbf·ft (N·m)	lbf·in (N·cm)
Rectangular-Headlight Housing Assembly Attachment Nuts	1/4-20	—	72 (814)[1]
Single or Dual Round-Headlight Mounting Nut	1/2-20	90 (122)[1]	—
Headlight Bracket-to-Grille Shell Nuts	5/16-24 3/8-24	20 (27)[1] 37 (50)[1]	— —
Grille Assembly Attachment Nuts	10-24	—	32 (362)
Radiator Grille Shell Attachment Nuts	10-24	—	32 (362)
Top and Side Grille Shell, Splice Cover, and Grab Handle Carriage Bolt Kepnuts	1/4-20	—	72 (814)[1]

Table 1, Fastener Torque Values

[1] These torque values are for fasteners with lubricated or plated threads. For dry threads, see the General Torque Table in the Freightliner Maintenance and Lube Manual.

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Subject	Subject Number
General Cab Construction	32-18205
Cab Installation	32-18210
Cab Frame Repair, COE (61 Series Cab)	32-18214
Repairing Structural Foam	32-18215
Repairing ABS Plastic	32-18216
Skin Removal and Installation (COE 31, 41, and 61 Series)	32-18220
Windshield and Seal Replacement, Conventional and COE With Separate Center Post Cover	32-18230
Windshield and Seal Replacement, Unitized Windshield Seal	32-18231
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Cab Latch	32-18305
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71 Series COE and Conventional Door Servicing	32-18500
Bulkhead Style Cab Door	32-18510
Baggage Doors and Sleeper Box Access Doors	32-18520
Riveting	32-18605
Tunnel Liner and Noise Baffle, COE and Powerliner	32-18700

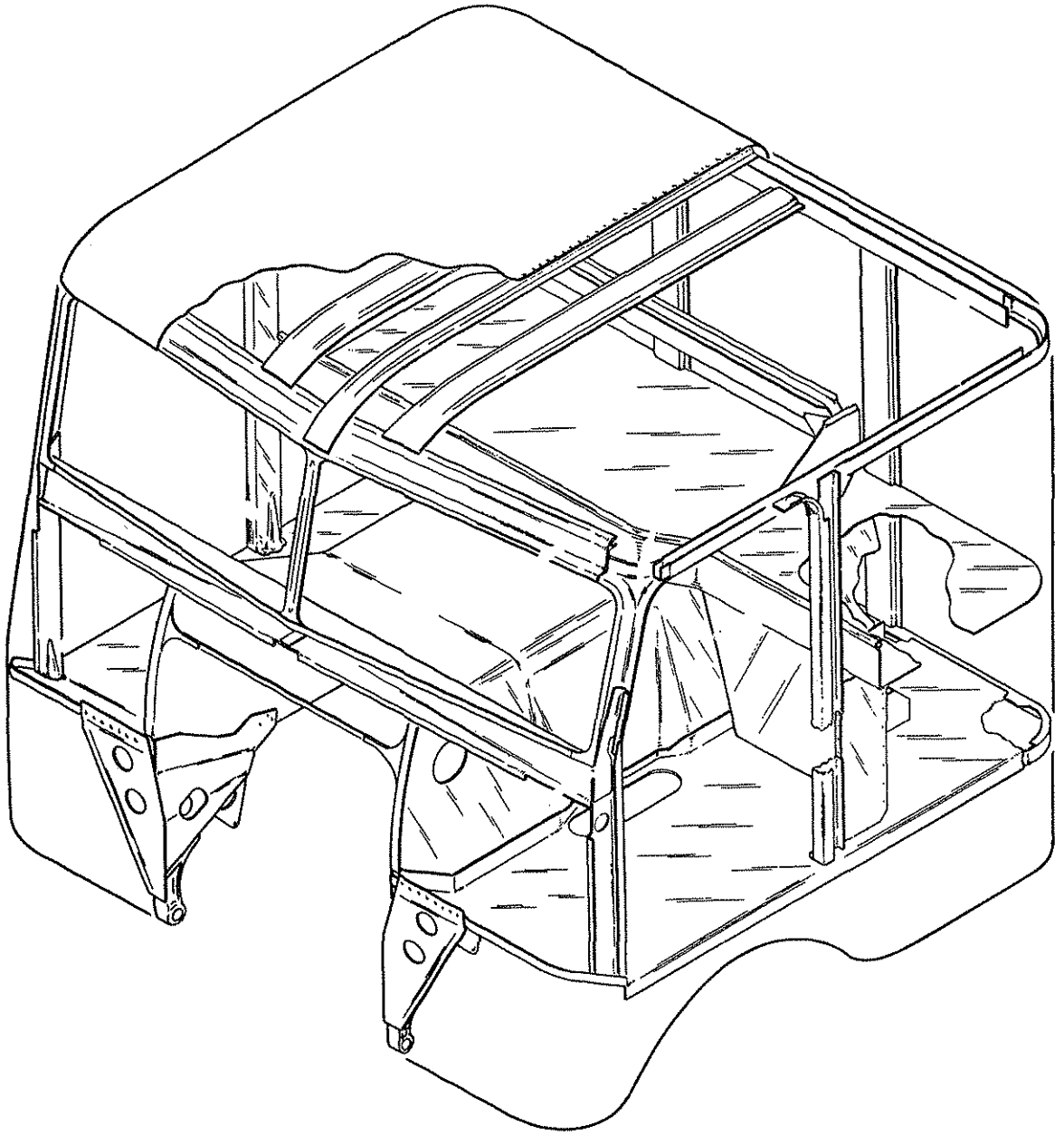
The Freightliner cab is constructed of aluminum alloy and is of a semimonocoque design. That is, the outer skin carries a part of the stress and works in conjunction with the inner cab frame to incorporate a strong light structure.

This design follows aircraft principles to some degree and incorporates riveting and a minimum of welding. The outer skin panels are riveted to the inner frame members. This principle enables easy and economical skin panel replacement.

Likewise, the inner frame members are either formed or extruded, and assembled with rivets, also providing economy of maintenance.

All Freightliner cab models have a basic similarity of construction and many common parts are used throughout.

This results in a line of cabs which answers any need but is easily serviced with a minimum of parts inventory.



CAB INSTALLATION

Protection of Cab While Mounting

Since the cab is mounted on the vehicle in essentially finished condition, it is important to protect paint and brightwork from scratches and scuffing. The following are some areas that need protecting and some suggestions for doing this simply and effectively:

1. Front Skirt: A two foot length of 2" radiator hose, slit full length, can be slipped over the top flange at each outboard end of the bumper while the cab is being maneuvered into place (see Fig. 1). Besides cushioning any bumps, this has the added advantage that a small amount of slippage or rolling of the slit hose can reduce scuffing of the parts.

2. Loose Objects in Cab: Make sure all loose objects, especially the larger ones, are adequately secured, or placed well forward on the floor, before tilting the cab.

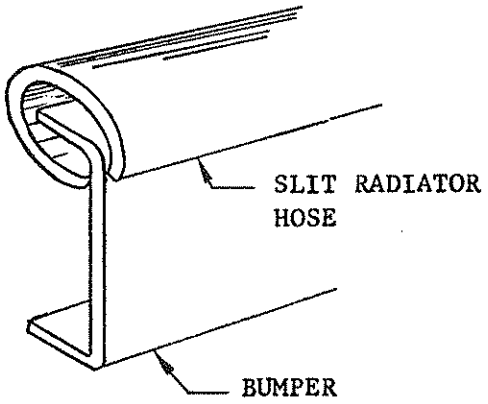


Fig. 1, Cab Installation and Removal

Cab removal from chassis can be accomplished by tilting the cab to the 90° position and supporting it on a resting beam made from a wooden 2 x 6 cut to fit the front of the cab at the nose beams (use suitable padding so as not to scratch the finish) and further support the cab at the base of the cab near the pivot.

Disconnect all plumbing and wiring that attaches to the cab. Wiring may be conveniently cut and then spliced on installation or disconnected at their origin.

Disconnect the tilt cylinder at the forward end, and remove the two pivot pin bolts (care should be taken at this point as the cab might rock slightly on the resting beam).

If an overhead crane is available the cab can be lifted with the aid of lifting beams or a "T" frame with cushioned hooks. Hooks pass under the top grab handle brackets on each side of the cab, and a third hook passes into the radiator opening near the cab center line. Make sure the lifting lines do not scuff the paint as they become straight under load. Also take care that the control box for the hoist is not allowed to mar the finish during these operations.

CAB TILT PIVOT BUSHING INSTALLATION

A shouldered cab pivot bolt has been in use since the 1984 advancements. If a standard (non-shouldered) bolt is used, the joint will bind.

A urethane cab pivot bushing has been in use since October 1966. This bushing replaces and is interchangeable with the metal and rubber bonded bushing used previously. It has a longer life and better ability to withstand road shocks.

To replace the pivot pin and bushing, do the following steps:

1. Park the vehicle, shut down the engine, apply the parking brakes, and chock the tires.
2. Place the cab in the operating position, with all latches locked.
3. Support the pivot bracket with blocks or wedges.
4. Remove the pivot pin.
5. Remove the cab mount plate.

CAB INSTALLATION

6. Remove the bushing from the pivot bracket eye (see Fig. 2).
7. Insert the new bushing. Make sure it is centered in the bracket eye.
8. Install the cab mount plate.

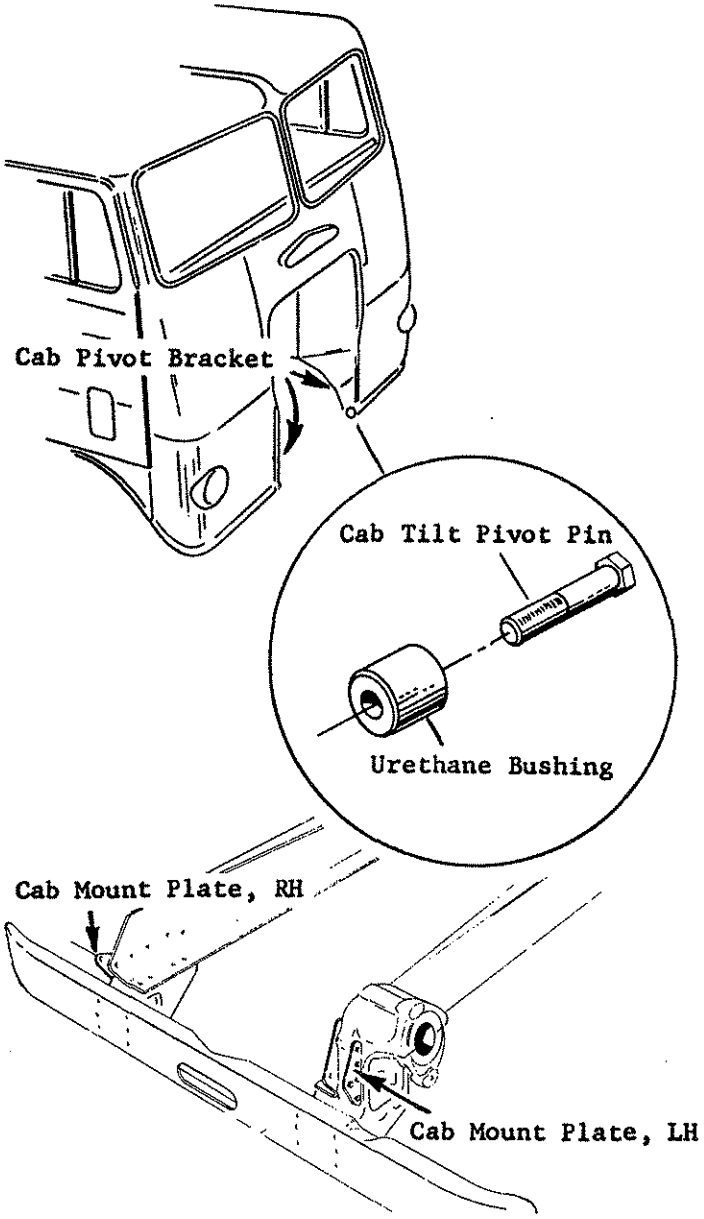


Fig. 2

9. Install the pivot bolt. Consult the Freightliner Parts Book for the correct part number. Tighten the bolt 75-125 lbf·ft (102-170 N·m).

NOTE: Because the pivot bolt is shouldered, there may be a gap of up to 0.030-inch (0.75 mm) between the pivot bolt head and the bracket (see Fig. 3). Do not attempt to close this gap by overtightening the pivot bolt.

10. Remove blocks or wedges from pivot bracket.

NOTE: After tightening, the urethane bushing may bulge from the bracket eye on one side or the other. This is normal and is no cause for concern.

11. Remove the chocks from the tires.

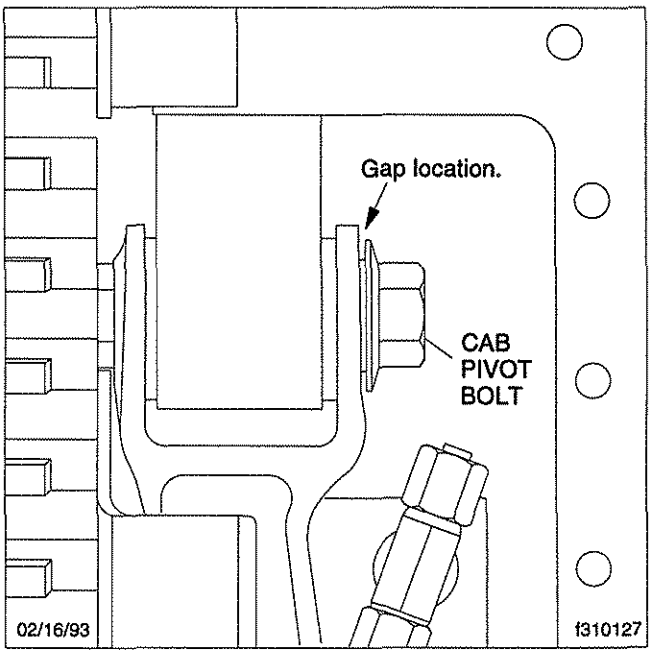


Fig. 3

GENERAL DISCUSSION, COE CAB

The frame of the Freightliner COE cab is made of aluminum. It is an integral part of the monocoque design, that is, it works in conjunction with the skin to establish the required strength and rigidity.

In making field repairs where heli-arc welding is not available, riveting or bolting is generally permissible. Care must be taken however to use approved riveting and fastening techniques. Substitution of rivet or bolt fasteners for other rivets or bolts must be factory approved.

Knowledge of the following will be helpful whenever work is required on your Freightliner aluminum cab.

Aluminum Forming

Reshaping of aluminum parts may be accomplished by means of rubber or wood mallets. Steel hammers and hydraulic jacks should be used with wood blocks. Avoid local thinning from heavy steel hammers. Final operations consist of planishing with smooth polished steel tools.

Cold forming is recommended for working aluminum. Use of heat should be limited to the cab decks. When using heat, preferred practice is to use "Tempilstiks" which mark only when the temperature of the material exceeds the value designated on the crayon. These can be obtained from your local welding material supplier. Maximum heat allowable is 350°.

Crack Repair

Repair cracks as soon as they are observed. Make a thorough visible inspection to determine the extent and cause of cracking. The use of a dye penetrant check is recommended. Delay of repair will result in elongation and increased damage.

Small cracks can be effectively repaired as follows:

1. Clean surface area around crack.
2. Drill holes at both ends of crack. Size of holes to be 1 to 1½ times the thickness of the material being repaired.
3. Place backing plate behind cracked area. Use same material for backing plate as that in which the crack occurred.
4. Rivet backing plate to cracked member.
5. Repair crack with welding, and grind off if finishing is needed.

Welding Aluminum

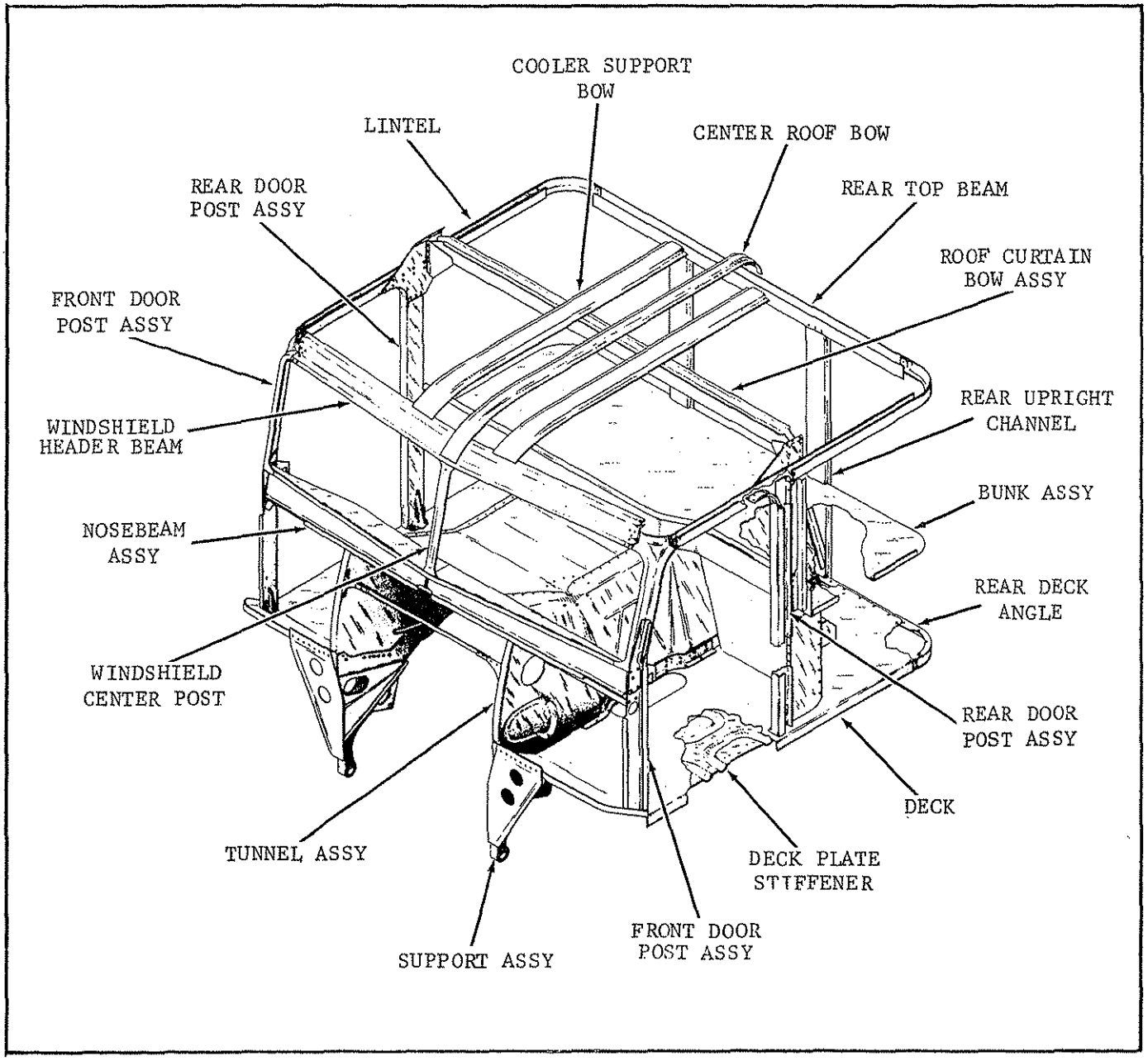
The welding technique for aluminum is somewhat different from methods used on other materials and does require training. Good welding procedures require that all foreign material be removed from the areas to be welded. This includes dirt, loose metal particles, moisture, paint, oxide coating, grease, oil, etc. If chemicals or degreasing agents are used to clean, it should be remembered that some solvents require ventilation and others require rinsing with water. Solvents should never be used where evaporation is hindered, or where residue is entrapped behind the joint to be welded. After the area has been cleaned, drying is important to insure that no moisture is present in the area to be welded.

Welding of aluminum reduces material strength 30-40%. To impede distortion in heli-arc welding, use fast stringer beads. Do not build up heat, or allow excessively large weld puddles to form. For heavier sections, use the MIG welding process. Recommended welding procedures are discussed in a manual entitled "Welding Aluminum" published by the American Welding Society. This manual can be obtained from the AWS at a nominal charge.

Squaring

In working with any part of the cab it is important that the cab be square and that dimensions be closely observed. In preparing your cab therefore, for repair work make certain that the decks are square. If decks are not true, fitting problems will occur throughout all other areas of the cab where parts make contact.

The Freightliner service department solicits the opportunity to advise on the repair of Freightliner cabs.



C.O.E. CAB FRAME NOMENCLATURE FIG. 1

DECK REMOVAL AND REPLACEMENT C.O.E. CABS, 6100 SERIES

Where damage is minor, removal of the deck may not be necessary. When this condition exists, the damaged portion can be cut away and a replacement portion welded into place. If damage is limited to the deck extremeties, the skin section housing the damaged deck can be removed and the deck reshaped while in the cab frame. This method of repair often affords considerable savings in labor cost. When damage is extensive, it may be necessary to remove the decks. This operation is discussed below:

Left Deck

1. Place the cab in the upright (or untilted) position.
2. Block cab securely in tunnel or by overhead support to prevent cab from falling when deck is removed.
3. Disconnect heater hoses, air lines, steering gear shaft, etc., located on the left side.
4. Remove seat assembly.
5. Temporarily support deck pending fastener removal.
6. Remove huck bolts that attach lower skin to deck flange. (Fig. 2).
7. Remove deck from cab frame assembly.
8. Remove deck stiffener from underside of deck. (Point D, Fig. 3).
9. Repair deck as needed. Cold forming is preferred but if necessary, moderate heat can be applied.
10. Check deck for alignment and dimensions. (See subject 32-18290).
11. To re-assemble, reverse removal procedure.

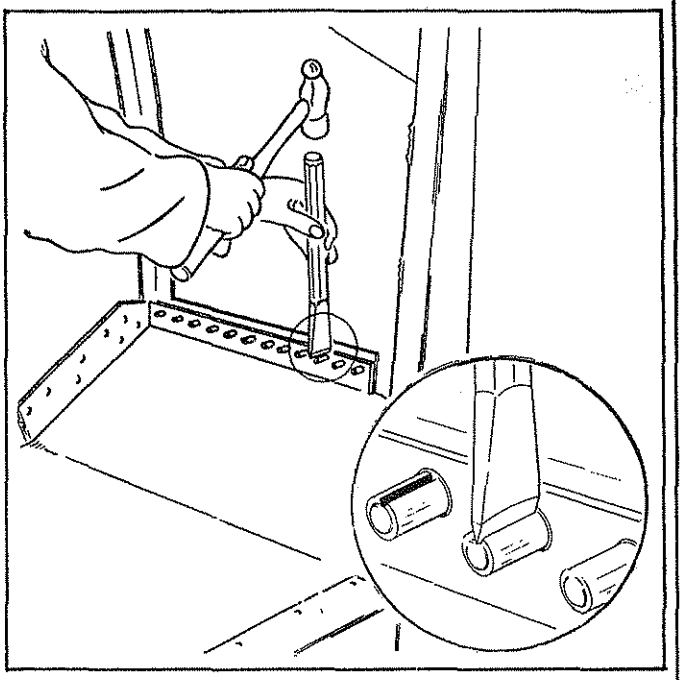


Fig. 2.

Right Deck

Follow same procedure as for left deck with the exception of item three. This item now applies to right deck.

UPRIGHT MEMBER REMOVAL AND REPLACEMENT, C.O.E. CAB, 6100 SERIES

Front Door Posts

To remove the front door posts proceed as follows:

1. Remove the windsheild glass. Refer to Subject number 32-18230.
2. Remove drip moulding, door check arm, door and windshield corner skin. Refer to subject 32-18220, page 10, items 1 through 8.
3. Remove rivets at header plate (Point A, Fig. 3).

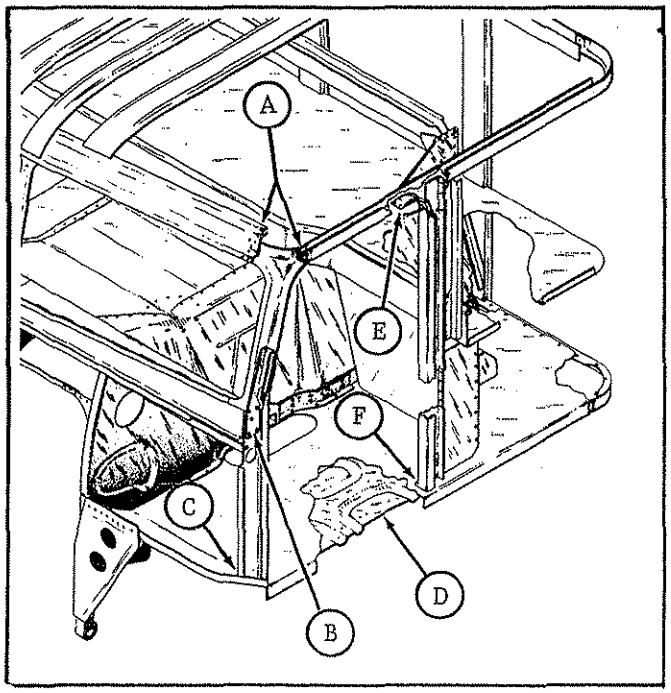


Fig. 3.

4. Remove huck bolts at nose beam (Point B, Fig. 3) and deck (Point C, Fig. 3).

5. Remove door post for repair or replacement.

6. Install new or repaired door post in cab frame structure. Align post to door dimensions shown in subject 32-18290. This alignment can be made with an 18 x 24 carpenter type square, or equivalent.

7. Replace fasteners in door post by reversing steps 3 and 4 above. Bolts may be installed if huck bolts are not available.

8. Replace windshield corner skin as described in subject 32-18220, page 10, items 12 and 13; and 32-18220, page 12.

9. Install poly vinyl chloride tape between door hinge and door post. Install door.

10. Adjust door latch so door will fit and seal properly.

Rear Door Posts

To remove the rear door posts, proceed in the following manner:

1. Remove door striker plate.

2. Remove lining from door post area.

3. Remove rivets from rear door post. (Point E, Fig. 3, and Point A, Fig. 4).

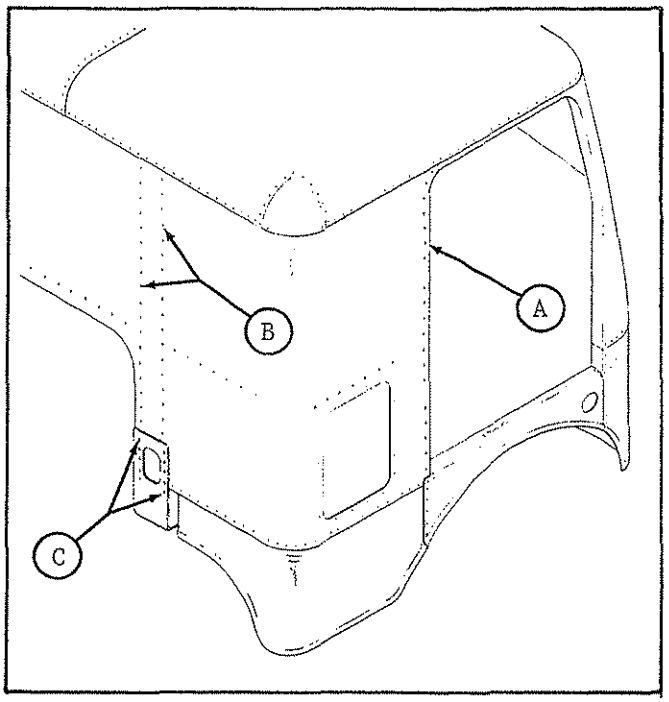


Fig. 4.

4. Remove huck bolts from base of post. (Point F, Fig. 3).

5. Remove post for replacement or repair. On left side of sleeper cabs, bunk duct will be removed with door post as an assembly. Detach bunk duct at work bench.

6. Replace rear door post and check alignment. Refer to door dimensions in subject 32-18290. Alignment can be made with an 18" x 24" carpenters square or equivalent.

7. To install, reverse removal procedure. Re-fasten bunk duct to door post with pull rivets when installing door post to cab.

Rear Upright Channels

To remove rear channels proceed as follows:

1. Remove sleeper bunk where applicable.
2. Remove upholstery and insulation from rear of cab.
3. Remove fasteners from rear skin and cab mounts. (Points B and C, Fig. 4).
4. Remove channel for repair or replacement.
5. Re-install channel by reversing removal procedure.

TUNNEL REMOVAL AND REPLACEMENT C.O.E. CAB, 6100 SERIES

To remove tunnel assembly, proceed as follows:

1. Where applicable, disconnect heater hose from bunk assembly.
2. Remove sleeper bunk assembly. (Sleeper cabs)
3. Where applicable, disconnect heater assembly from right side of tunnel.
4. Remove dash assembly from tunnel top.
5. Remove tunnel cover where applicable
6. Drill out rivets from front and rear flanges of tunnel. (Points A and B, Fig. 5).
7. Remove fasteners from inboard deck flanges. (Point C, Fig. 5).

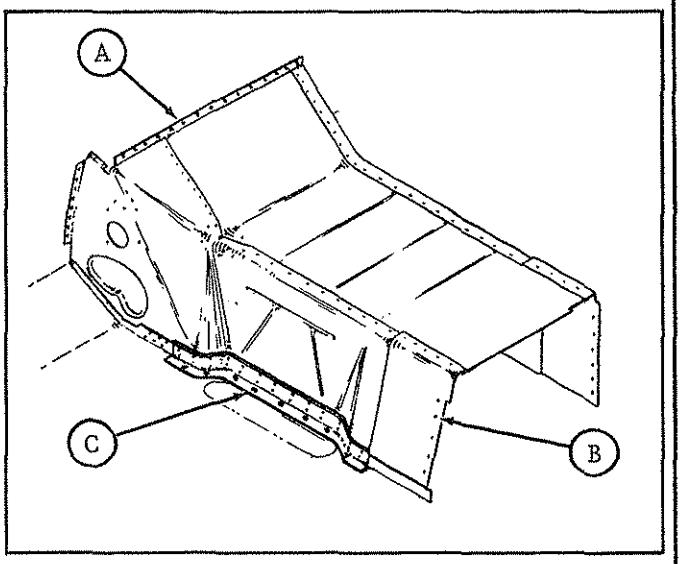


Fig. 5.

8. Remove tunnel for replacement or repair.
9. Replace tunnel by reversing removal procedure. For leak prevention, install 1/16" thick poly vinyl chloride tape sealer at front and rear tunnel flanges (Points A and B, Fig. 5) before fastening. At the deck flanges 1/8" thick poly vinyl chloride tape sealer is installed (Point C, Fig. 5), before installing fasteners. Care must be taken to install flat washers between flange and nut on the deck/tunnel attachment. In the turbo cutout area, fender type large O.D. washers are required.

REMOVAL & REPLACEMENT OF CAB FRAME HORIZONTAL MEMBERS: COE CAB, 6100 SERIES

Nosebeam Removal & Replacement

1. Remove bolts in steering column clamps. Tilt steering wheel and assembly back against seat.
2. Remove screws that attach dash panel to nosebeam.
3. Remove fasteners from horn relay and

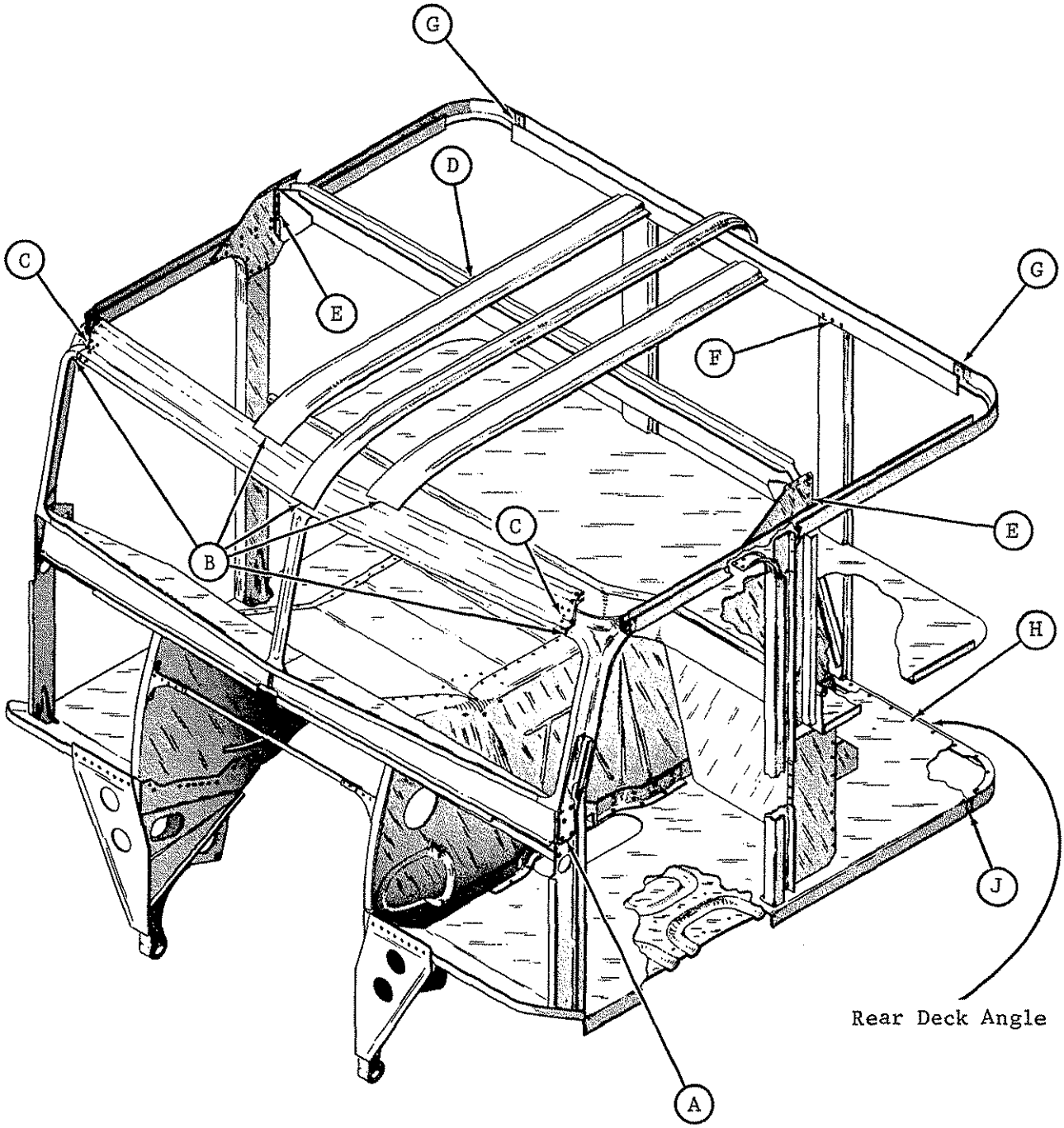


Fig. 6.

circuit breakers. Remove wiring harness attached to nosebeam.

4. Remove bracketing for wing window defrosting duct. Disconnect duct.

5. Disconnect door check arms from doors.

6. Remove huck bolts at ends of nosebeam. (Point A, Fig. 6).

7. Remove rivets that attach tunnel to nosebeam. (Point A, Fig. 5).

8. Drill out rivets shown at Point A, Fig. 7.

9. Remove nosebeam for repair or replacement.

10. To install nosebeam, reverse removal procedure.

11. Attachment points, such as the tunnel to nosebeam area, and the rivets just above the radiator fill opening, may be inaccessible for bucking purposes. (Point C, Fig. 7). These surfaces should be fastened with high shear strength pull rivets. In this application, cherry rivet CR2249 (3/16Dx.63") is recommended. The Townsend Co.'s cherry rivet hand tool G155 is available from tool suppliers for performing this function.

Header Beam Removal & Replacement

1. Remove windshields; see subject 32-18230.

2. Remove cab lining insulation, sun visors, air horn controls, etc. that are attached to the forward roof area.

3. Grind off weld that attaches the front door posts and the roof bows to the header beam. (Point B, Fig. 6).

4. Remove rivets shown in Fig. 7, Point B.

5. Remove rivets that attach header beam to front door posts. (Point C, Fig. 6).

6. Remove header beam for repair or replacement.

7. To install header beam, reverse removal procedure.

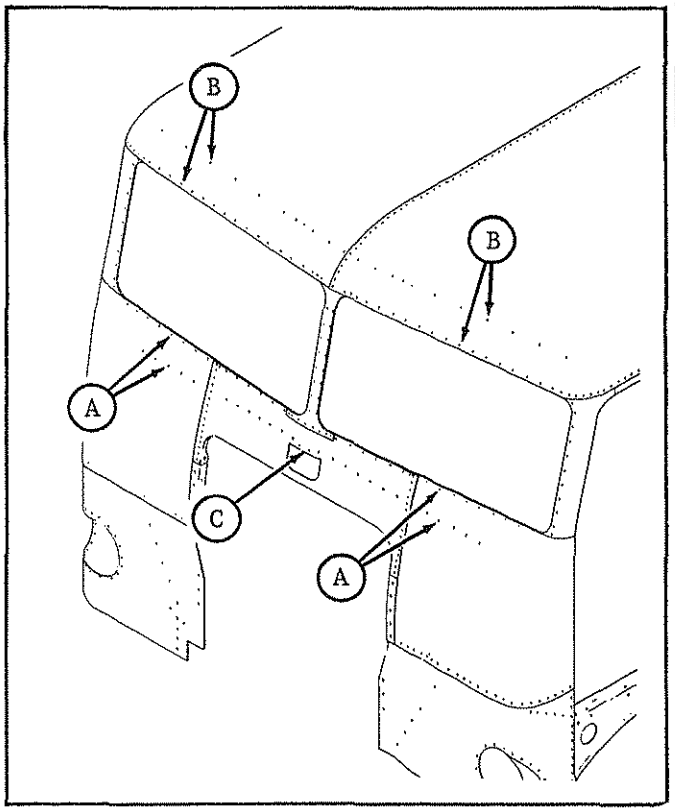


Fig. 7.

Roof Curtain Bow Removal & Replacement

1. Remove air conditioner housing and ducting as required.

2. Remove headliner and insulation.

3. Grind off tack weld that attaches the curtain bow to the roof bows (Point D, Fig. 6).

4. Remove rivets that attach curtain bow to roof bows. (Point D, Fig. 6).

5. Remove rivets that attach the curtain bow support to the door post. (Point E, Fig. 6).

6. Remove curtain bow for repair or replacement.

7. To install curtain bow, reverse removal procedure. Where heli-arc welding is not available, parts may be assembled by riveting or bolting. Care must be taken however, to maintain a distance of 2 to 2 1/2 times the diameter of the rivet or bolt from the edge of the drilled member.

Rear Top Beam Removal & Replacement

1. Remove lining and insulation in rear upper section of cab.

2. Drill out rivets in upper rear skin and top joints (Point A, Fig. 8).

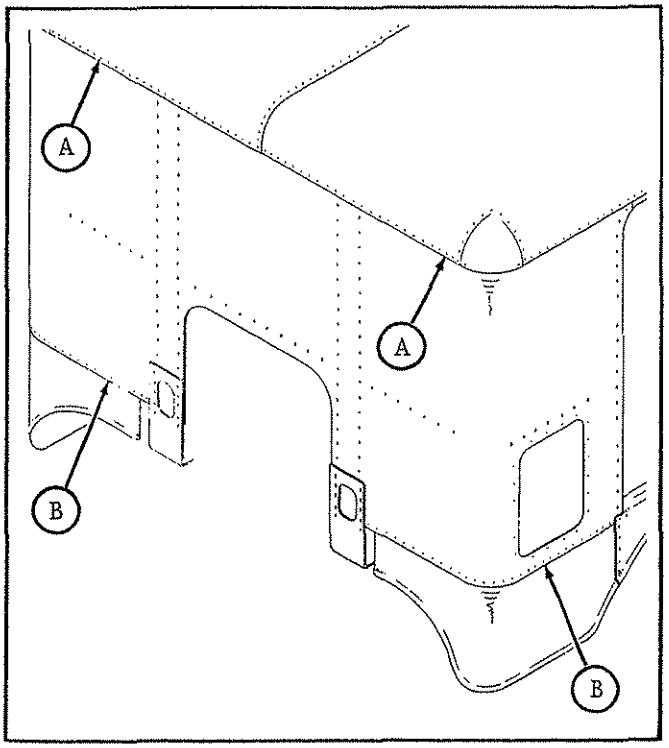


Fig. 8.

3. Remove rivets at corners. (Point G, Fig. 6).

4. Remove rivets that secure the rear cab upright channels to the rear top beam. (Point F, Fig. 6).

5. Remove beam for repair or replacement.

6. To install, reverse removal procedure. If heli-arc welding is not available, sections may be bolted or riveted as required for repairs. Again care must be taken to maintain a distance of 2 to 2 1/2 times the diameter of the rivet from the edge of the drilled member. Install 1/16" thick poly vinyl chloride tape between the top skin and rear face of the top beam prior to riveting.

Rear Lower Horizontal Offset Beam Removal & Replacement

This member (See Fig. 9) is used in cabs that leave the factory with both of the following:

1. Outboard rear windows.
   AND
2. Cab mounts located outboard of the frame rail.

This assembly is the most important structural member in the rear portion of the cab. It is therefore repaired or replaced as a unit. If shaping is required, cold forming must be used; DO NOT USE HEAT IN THE FORMING OF THIS ASSEMBLY. To remove this member from the cab frame assembly proceed as follows:

1. Remove the rear skin (See subject 32-18220, Page 18). It is permissible to remove only that section of the rear skin that is damaged. Partial rear skin replacement pieces are available for this purpose. Removal of the rear skin will require removing of the rear fasteners

on the rear cab support; DO NOT REMOVE THE INBOARD FASTENERS ON THE REAR SUPPORT. By leaving these fasteners intact the cab mount will stay with the cab during this repair. This is the preferred practice.

2. Remove rivets as shown at Point A, Fig. 9.

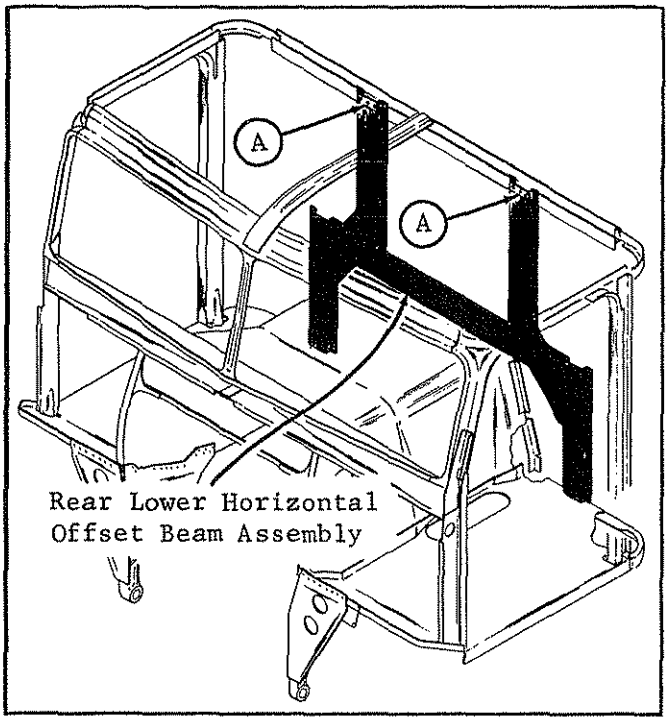


Fig. 9.

3. Remove horizontal offset beam by sliding either right or left, then exiting the beam from the rear. Repair or replace as required.

4. To re-install beam, reposition by installing from the rear and then moving the member to the right or left to seat into rear cab supports. Position so that existing rivet holes can be re-used whenever possible.

5. Rivet channels at Point A, Fig. 9.

6. Install poly vinyl chloride tape between skin and cab frame at (Points A and B, Fig. 8).

7. Install rear skin and secure reinforcing plate. (See 32-18220, Page 18). Complete installation by attaching rear cab supports.

Rear Deck Angle Removal & Replacement
(See Fig. 6 for identification)

1. Remove rear cab lining and insulation as required to provide access to rear deck angle.

2. Remove rivets and huck bolts from the rear cab support, and along bottom edge of back skin (Point B, Fig. 8).

3. Remove fasteners that attach deck to rear deck angle. (Point H, Fig. 6).

4. Grind off weld between rear deck angle and deck flange. (Point J, Fig. 6).

5. Remove rear deck angle for repair or replacement.

6. To install rear deck angle, reverse removal procedure. Insert 1/8" thick poly vinyl chloride cab seal tape between the skirt and the deck angle. Caulking compound is used between the skin and the skirt. Exercise care in this application to assure a leak-proof installation.

Rough Service Kit

Rough service cab kits are recommended for use with units that may experience rougher than normal over-the-road wear. The kit consists of steel members and stiffeners to add strength to the standard aluminum structure. Steel material includes angles for inside deck flanges and a rear cab tunnel plate. Angles are fastened with 1/4" huck bolts using 2 1/2" spacing. Bolt washers are used on the head next to the aluminum. Fasteners in the cab nose stiffener

are 3/16" aluminum rivets. The upper portion of the rear tunnel (Horseshoe) reinforcement plate is fastened with 3/16" aluminum rivets; spacing is 2 1/2". The lower portion of this member between the rear cab support and skin is attached by huck bolts installed through the cab support bracket. Always use a generous supply of alumalastic compound between the mating surfaced whenever steel and aluminum make contact. (See Fig.10).

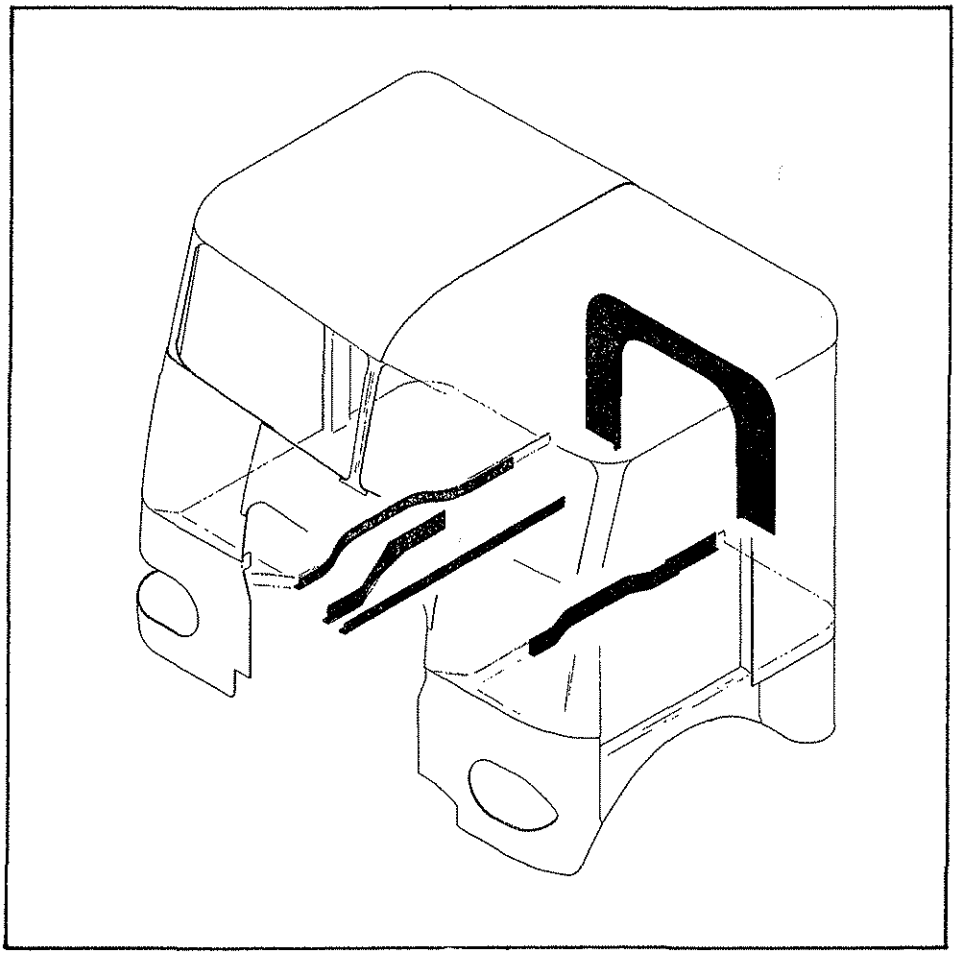


Fig.10.

REPAIRING STRUCTURAL FOAM

GENERAL INFORMATION

The Freightliner Advanced Interior System dashboards and consoles are made of injection-molded ABS structural foam. Use these procedures to repair cracks, tears, splits, and holes that appear in these areas.

SERVICE OPERATIONS

Before servicing or repairing areas made of structural foam, clean the damaged foam surfaces using soapy water or a mild nonabrasive cleaner.

CAUTION: Do not use Armor-All Protectant, STP Son-of-a-Gun, or other equivalent treatments. These cleaners contain vinyl plasticizers, which can cause stress crazing in the ABS material of the structural foam and result in cracking.

In some cases, the structural foam section may need to be removed.

If service is required on dashboard Sections A or B (see **Fig. 1** for COE or **Fig. 2** for Conventional), remove the individual gauge and control panels to gain access to the area to be repaired. Remove the screws attaching the control panel to the dash, then move the panel away from the dash. Finally, remove the fasteners attaching the structural foam section to the cab.

On COE vehicles, to remove Section C (see **Fig. 1**), first remove the accessory panel located on the lower left corner of Section C; then disconnect the spring that secures section C to the cab. See **Fig. 3**. Remove the screws that attach Section C to Section D, then remove the fasteners attaching Section C to the cab.

REPAIR OF SMALL SCRATCHES OR SCRAPES

To refinish minor scratches and scrapes, first remove any burrs with a razor knife, then paint over the prepared area. For instructions refer to "Touch-Up Painting."

REPAIR OF GOUGES, CHIPS, OR DEEP SCRATCHES

Gouges, chips, or deep scratches can be filled with one of the following filler compounds:

- Sherwin-Williams D61-A-21
- Pettit Paint Polyester Mender
- Fiberglass-Evencoat, Brightwhite Formula 27
- Linkoloid Spackling Paste, or an equivalent plastic spackling compound.

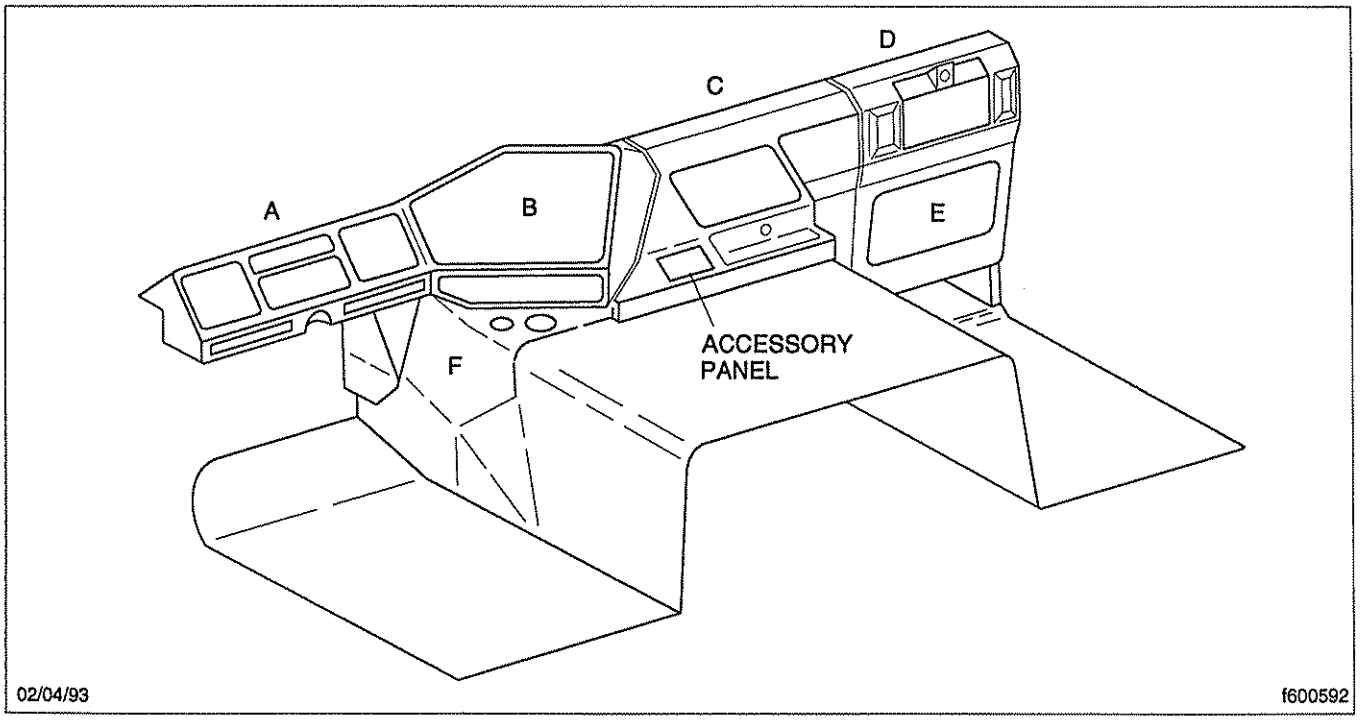


Fig. 1, COE Dash Section Identification

REPAIRING STRUCTURAL FOAM

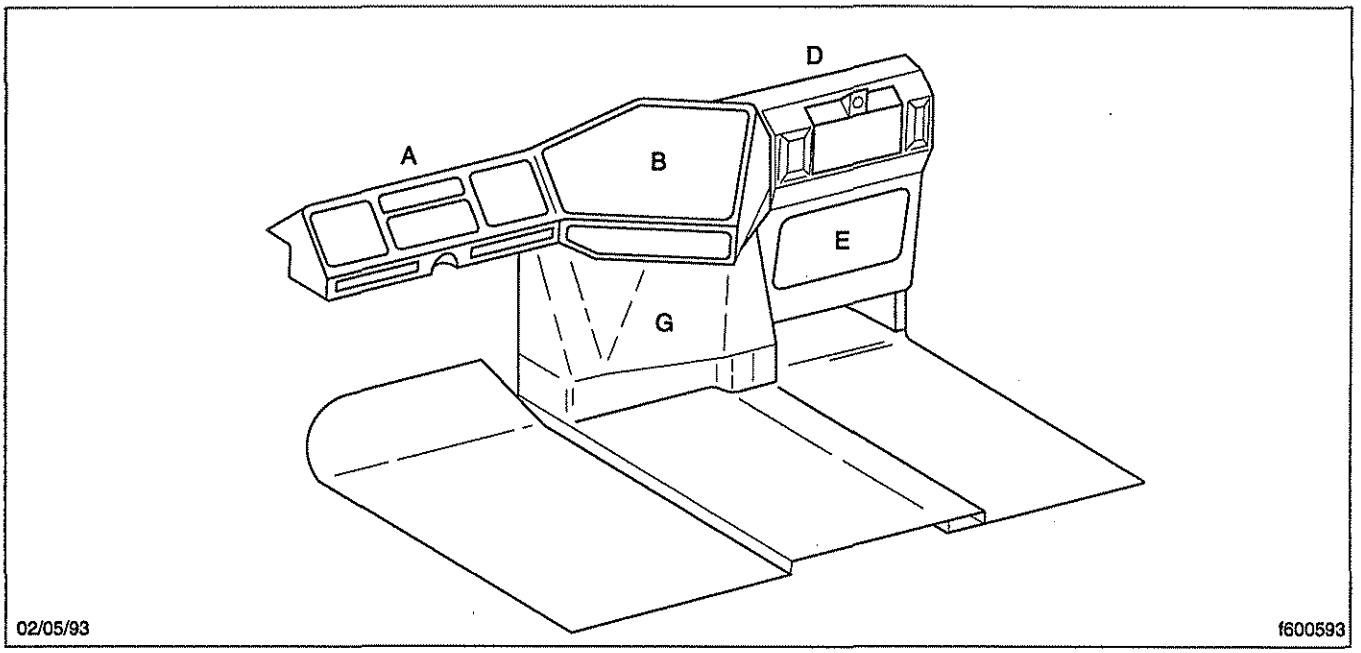


Fig. 2, Conventional Dash Section Identification

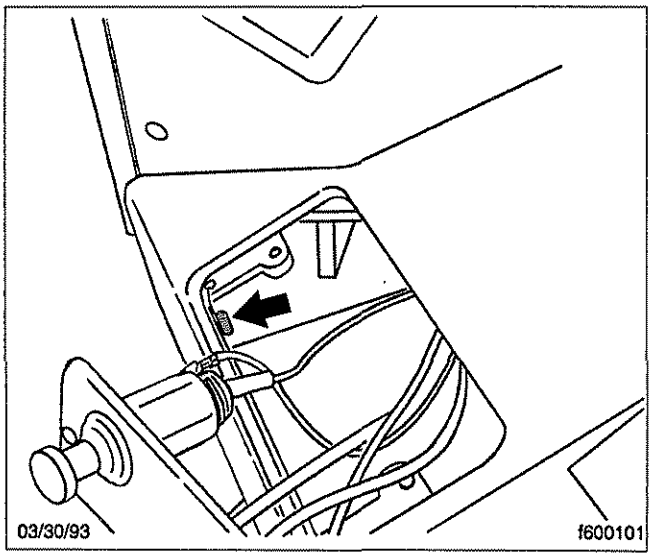


Fig. 3

Use the following instructions to repair gouges, deep scratches, or chipped areas:

1. Use a razor knife to scrape the scratch or gouge clean, taking care not to damage the surrounding paint.
2. Mix the filler compound, if needed, following the manufacturer's instructions.
3. Fill the damaged area with filler compound and smooth the filled area with a flexible, non-scratching tool, such as a plastic spatula. While the compound is still soft, use a clean, damp cloth to wipe off the excess compound from the surrounding area and painted surfaces.

NOTE: If using spackling paste, fill the damaged area slightly higher than the surface, since spackling paste will shrink when drying.

4. After the compound is dry, sand the filled area using 400-grit (or finer) sandpaper.
5. Paint over the area. For instructions, refer to "Touch-Up Painting."
6. Allow to dry for 12 to 24 hours. Then, if necessary, use very fine steel wool to buff in the gloss to match the rest of the area.

REPAIR OF CRACKS, TEARS, OR SPLITS

IMPORTANT: Use these instructions only for bonding structural foam to itself. Do not attempt to join other materials using this method.

REPAIRING STRUCTURAL FOAM

WARNING: The recommended bonding materials are flammable and toxic, and can cause severe skin irritation. When using these materials, follow the cement manufacturer's safety precautions.

1. Apply SC125 acrylic cement, methylene chloride, or methyl ethyl ketone (MEK) to the surfaces to be bonded together.
2. Bring the surfaces together and apply light pressure until initial bond strength is achieved.

NOTE: If bonding a crack, apply light pressure to open up the crack. This helps the cement penetrate all the way to the back of the crack. If needed, additional cement can be applied to the back of the crack.

3. Allow to dry for at least 12 hours before applying any force to the repaired areas.

REPAIR OF A HOLE 1/4-INCH (6-mm) DIAMETER OR LESS

NOTE: To perform this repair, obtain access to the back side of the hole to be filled.

1. Cut a piece of scrap structural foam, enough to make a snug fit in the hole.
2. Apply a flat piece of steel or aluminum against the rear of the hole, if possible. This will draw off some of the heat, preventing distortion in the surrounding plastic. Insert the tip of a soldering iron into the hole until the foam along the edges of the hole begins to melt.

CAUTION: Do not continue heating once the foam along the edges of the hole has melted. Overheating will cause the surrounding area to melt, which could distort the shape of the hole and cause bubbles to form on the surface of the surrounding area.

Quickly insert the previously cut piece of foam into the hole, using the soldering iron to melt and bond the piece into the hole.

3. Remove any excess using a razor knife.

REPAIR OF A HOLE LARGER THAN 1/4-INCH (6-mm) DIAMETER

NOTE: To perform this repair, obtain access to the back side of the hole to be repaired.

1. Apply strips of fiberglass cloth from the back side to fill the hole. Bond the fiberglass with fiberglass resin.
2. Mix the filler compound, if needed, using the manufacturer's instructions. For recommended filler compounds, refer to "Repair of Gouges, Chips, or Deep Scratches." Then apply the compound over the fiberglass and allow it to dry.

NOTE: If using spackling paste, fill the damaged area slightly higher than the surface, since spackling paste will shrink when drying.

3. After the compound is dry, sand the filled area using 400-grit (or finer) sandpaper. Wipe clean with a damp cloth.
4. Paint over the area. For instructions, refer to "Touch-Up Painting."
5. Allow to dry for 12 to 24 hours. Then, if necessary, use very fine steel wool to buff in the gloss to match the rest of the area.

TOUCH-UP PAINTING

1. For saddle colored structural foam sections, use Dupont Lucite H7909L paint or Sherwin Williams Polane T No. Z99NY17 paint. For black colored structural foam sections, use Dupont Lucite H7911L paint or Sherwin Williams Polane T No. Z99BY4 paint.
   1.1. If using Dupont Lucite H7909L saddle colored paint, mix the paint and tint according to the applicable mixing formula (see **Table 1**).
   1.2. If using Dupont Lucite H7911 L black colored paint, mix the paint and tint according to the applicable mixing formula (see **Table 2**).
   1.3. If using Sherwin Williams Polane T Z99NY17 saddle colored paint, or Sherwin Williams Polane T Z99BY4 black colored paint, mix the paint, catalyst and reducer for one minute,

Tint	Ounces Tint/ 1 Ounce Paint	Grams Tint/ 1 mL Paint
453L	0.184	0.175
428L	0.308	0.295
406L	0.352	0.337
402L	0.369	0.353
465L	0.845	0.811
4528S	0.981	0.940

Table 1, Dupont Lucite H7909L Saddle Color Tint and Paint Mixing Formula

REPAIRING STRUCTURAL FOAM

Tint	Ounces Tint/ 1 Ounce Paint	Grams Tint/ 1 mL Paint
406L	0.369	0.354
465L	0.857	0.822
4528S	0.964	0.925

Table 2, Dupont Lucite H7911L Black Color Tint and Paint Mixing Formula

using the following ratio: 6 units paint, 1 unit catalyst, and 4 units reducer.

IMPORTANT: After one minute of mixing, Polane T paint must be used within 5 minutes. If this time limit is exceeded, add 2 units of reducer, and use within one minute.

2. An air brush or a small camel's hair brush can be used to apply the paint to the structural foam. In a very small area, use an even smaller applicator, such as the end of a toothpick.

NOTE: If possible, paint only in the repaired area. The textured surface of the foam is difficult to reproduce.

2.1. If using an air brush, spray the paint lightly over the damaged area until a slight gloss appears. Allow the solvent to flash off. Then, lightly spray a second coat and feather out around the damaged area, keeping within 1-1/2 inches (38 mm) of the damaged area.

2.2. If using a small camel's hair brush, apply paint quickly and directly over the area to be painted. Do not continue brushing. Let stand for at least 30 minutes before applying a second coat. Allow two hours before handling.

NOTE: If too much paint is applied, pat the area with a soft sponge. Excess paint can be scraped off using a razor knife.

3. To texture a large area (for appearance), dab the paint on with a textured material, such as a small piece of sponge or terry cloth.

4. Clean all tools immediately after painting, since these paints are catalyzed and cannot be removed with solvent after they dry.

REPAIRING ABS PLASTIC

GENERAL INFORMATION

Some Freightliner cab dashboards, consoles, and interior cab linings are formed from ABS plastic sheets. Any cracks, tears, splits, or holes that appear in these areas can be bonded back together, using an ABS plastic pipe cement that meets ASTM (American Society for Testing and Materials) specification D-2235.

A backing piece is cut and formed from scrap ABS plastic. ABS plastic cement is applied to the damaged surface and the backing piece. Next, the two surfaces are joined. As the cement hardens, it bonds the surfaces together. The backing piece serves to reinforce the damaged area.

SERVICE OPERATIONS

IMPORTANT: Use the following only to bond ABS plastic to itself. Do not attempt to join different materials to each other by this method.

Gain access to the back (smooth) side of the ABS section in need of repair. Remove the attaching capscrews until the ABS panel can be lifted enough to provide access for bonding the backing piece to the back side. If this approach does not provide access, remove the entire section and perform the repair procedures at a work bench.

Using soapy water, alcohol, or paint thinner, thoroughly clean all ABS surfaces to be cemented. Allow them to dry completely.

CAUTION: Do not use lacquer thinner to clean ABS surfaces. It can create stress lines in ABS plastic.

REPAIR OF CRACKS, TEARS, OR SPLITS

1. Using tin snips or heavy-duty scissors, cut out a backing piece from scrap ABS plastic. The backing piece must be larger on all sides than the cracked area, to provide reinforcement when the crack is bonded together. If available, a piece can be cut from the same area of an identical ABS section that has been scrapped.

NOTE: If an identical piece is not available, form one by placing the backing piece on the edge of a work bench and heating it with a hot air gun until it is soft enough to be formed to the desired contours. If a hot air gun is not available, use a 1200 watt hair dryer.

WARNING: ABS plastic pipe cement is flammable and toxic, and can cause severe skin irritation. When using ABS plastic pipe cement, always comply with the cement manufacturer's recommended safety precautions.

2. Apply a moderate, even coat (avoid excess) of ABS plastic cement to the cracked surfaces, the back side of the cracked area, and to the backing piece. Work fast, as the cement hardens quickly.
3. Bring the cracked surfaces into contact and apply the backing piece to the back side. Apply light pressure for approximately 30 seconds, or until initial bond strength has been achieved.
4. Do not flex the area for at least 30 minutes after bonding. If possible, clamp the bonded area for at least 30 minutes. Then allow it to set for 8 to 12 hours.

REPAIR OF A HOLE 1/4-INCH (6-mm) DIAMETER OR LESS

NOTE: The damaged area must be in a horizontal position in order to prevent dripping of the ABS plastic cement when the hole is filled.

1. Using tin snips or heavy-duty scissors, cut out a backing piece from scrap ABS plastic. The backing piece must be larger in circumference than the hole, to provide reinforcement when the hole is repaired. If available, a piece can be cut from the same area of an identical ABS section that has been scrapped.

NOTE: If an identical piece is not available, form one by placing the backing piece on the edge of a work bench and heating it with a hot air gun until it is soft enough to be formed to the desired contours. If a hot air gun is not available, use a 1200 watt hair dryer.

WARNING: ABS plastic pipe cement is flammable and toxic, and can cause severe skin irritation. When using ABS plastic pipe cement, always comply with the cement manufacturer's recommended safety precautions.

2. Apply a moderate, even coat (avoid excess) of ABS plastic cement to the backing piece and the surrounding back side of the hole to be repaired. Bond the backing piece to the back side of the hole. Apply light pressure until initial bond strength has been achieved.
3. File a piece of scrap ABS plastic to obtain enough shavings to fill the hole.

REPAIRING ABS PLASTIC

4. Mix the shavings with ABS plastic cement, then fill the hole with the mixed shavings and cement. While the cement is still pliable, pat the filled hole using a cloth with a rough surface (such as the back of a piece of scrap carpet) to achieve the desired texture. Allow it to set for 8 to 12 hours.

REPAIR OF A HOLE LARGER
THAN 1/4-INCH (6-mm) DIAMETER

1. Shave the edges of the hole or section with a razor knife to make the edges smooth and even.
2. Using tin snips or heavy-duty scissors, cut a piece of scrap ABS plastic to the size and shape of the hole in order to fill it.

NOTE: To obtain the desired shape, place the piece of scrap ABS plastic on the back side of the hole. Using a pencil, outline the shape of the hole.

3. Cut a backing piece larger in circumference than the hole to be repaired. If available, a piece can be cut from the same area of an identical ABS section that has been scrapped.

NOTE: If an identical piece is not available, form one by placing the backing piece on the edge of a work bench and heating it with a hot air gun until it is soft enough to be formed to the desired contours. If a hot air gun is not available, use a 1200 watt hair dryer.

WARNING: ABS plastic pipe cement is flammable and toxic, and can cause severe skin irritation. When using ABS plastic pipe cement, always comply with the cement manufacturer's recommended safety precautions.

4. Apply a moderate, even coat (avoid excess) of ABS plastic cement to the backing piece, the back side of the fitted piece, and the surrounding back side of the hole to be repaired. Bond the backing piece and the fitted piece together, then attach the assembly to the back side of the hole so that the fitted piece fits into the hole. Work fast, as the cement hardens quickly.
5. Do not flex the area for at least 30 minutes after bonding. If possible, clamp the bonded area for at least 30 minutes. Then allow it to set for 8 to 12 hours.

REPAIR OF STRESS LINES

Stress lines produce a whitened appearance in a localized area. Generally, they appear when a strong force hits or bends the plastic. To restore ABS plastic to its original condition and color, gradually heat the affected area with a hot air gun; then allow it to cool. Upon cooling, the ABS will return to its original state. If a hot air gun is not available, use a 1200 watt hair dryer.

CAUTION: Take care not to overheat ABS plastic. Doing so can cause it to become too soft and lose its original shape. A moist cloth held against the back side of the ABS during the heating process will minimize the softening of the plastic.

LOWER NOSE SKIN (Series 31, 41, & 61 Cabs)

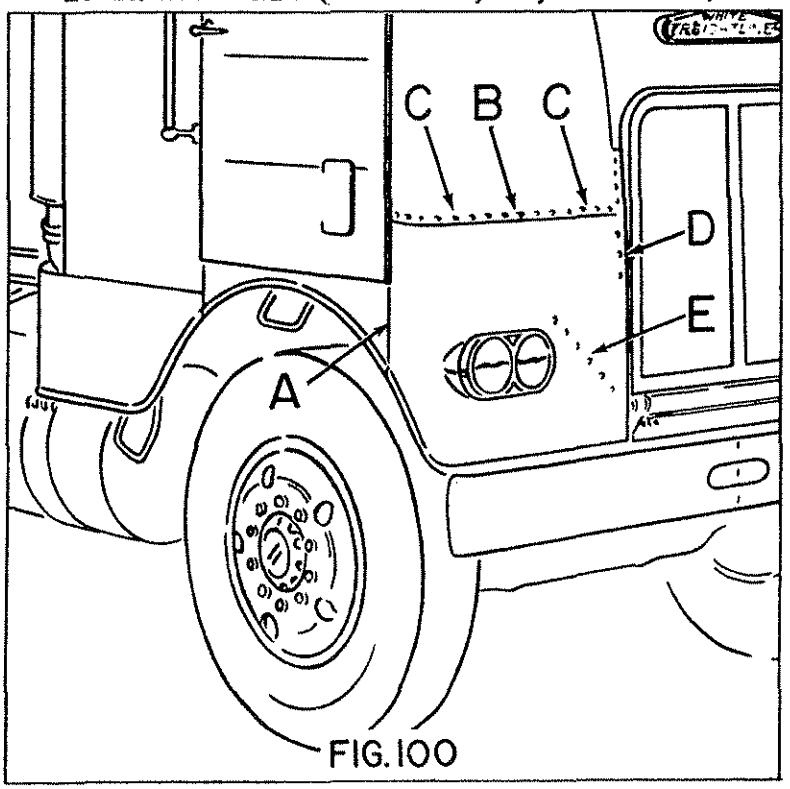


FIG. 100

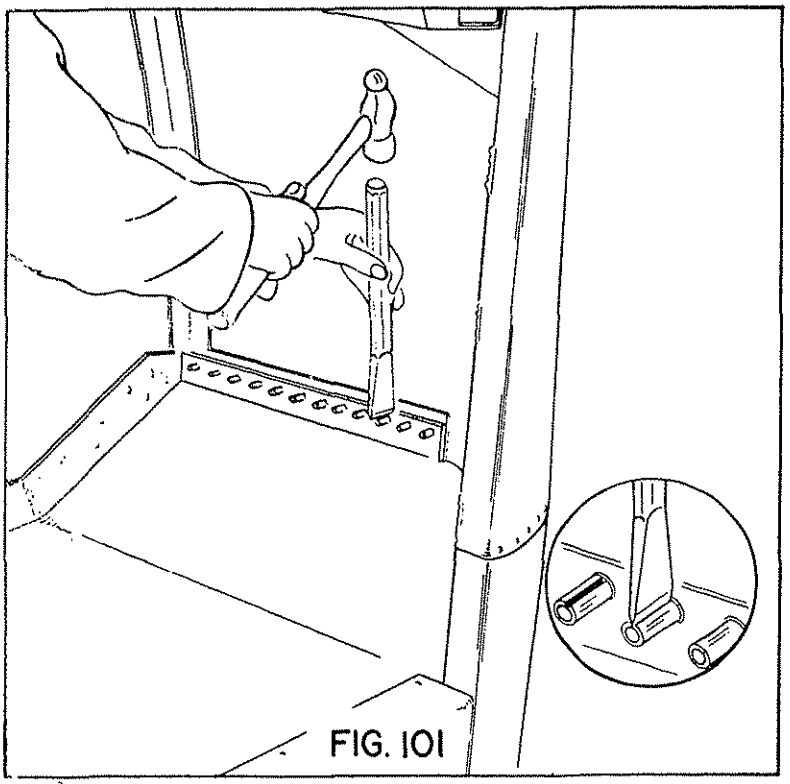


FIG. 101

LOWER NOSE SKIN
(Series 31, 41, &61 Cabs)

1. Remove grille.

2. Disconnect headlight.

3. Remove upholstery above the toe board.

4. Remove all screws that attach the door hinge to the front door post, and remove the door.

5. Remove fasteners (Point A, Fig. 100 from the inside flange of the deck skirt.

6. At the inside flange of the toe board are huck bolts. (Point B, Fig. 100). Split the huck bolt collar with a chisel (Fig. 101) and tap out the bolts. There are also flathead rivets (Point C, Fig. 100) that hold the lower panel in place. Remove these rivets by using a 3/16" drill.

7. Remove flathead rivets that attach the lower nose skin to the front tunnel angle (Point D, Fig. 100). These rivets should be removed by drilling with a 3/16" drill.

8. Remove the diagonal row of fasteners that attach the lower nose skin to the front cab mount. (Point E, Fig. 100).

9. To remove the lower nose panel, slide downward.

10. To replace the panel, slide it in position and where huck bolts had been use 5/16" NF Cadmium Plated Bolts. Where rivets had been used, refasten with 3/16" rivets.

UPPER NOSE SKIN
(Series 31, 41 & 61 Cabs)

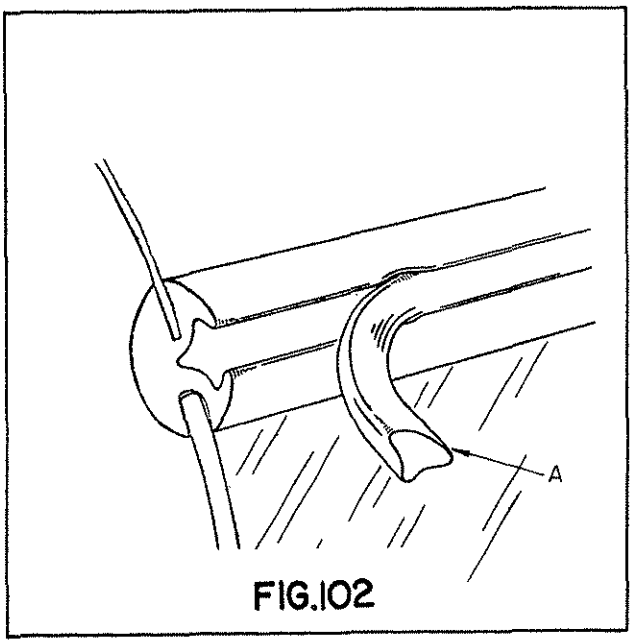


FIG.102

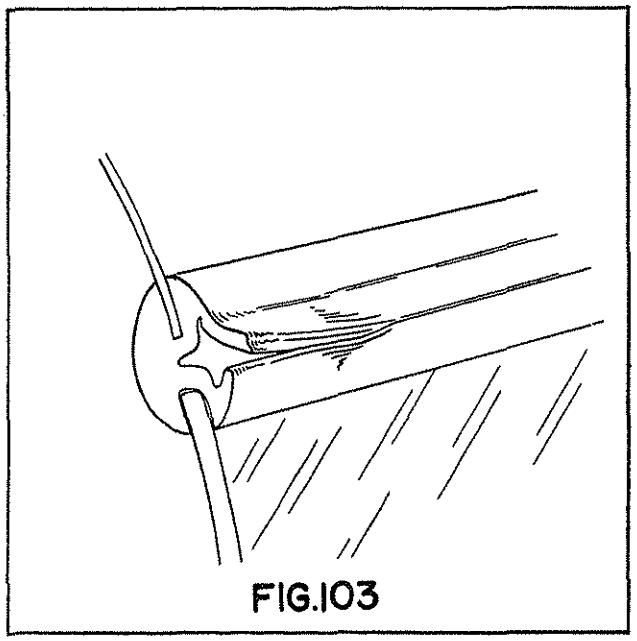


FIG.103

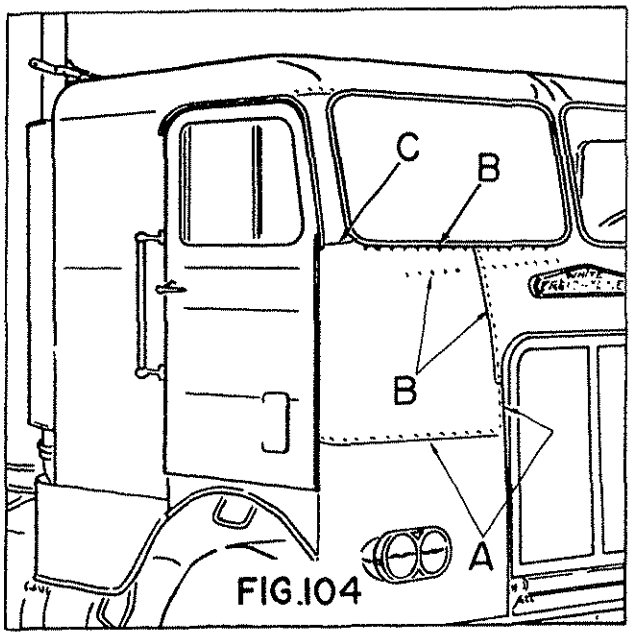


FIG.104

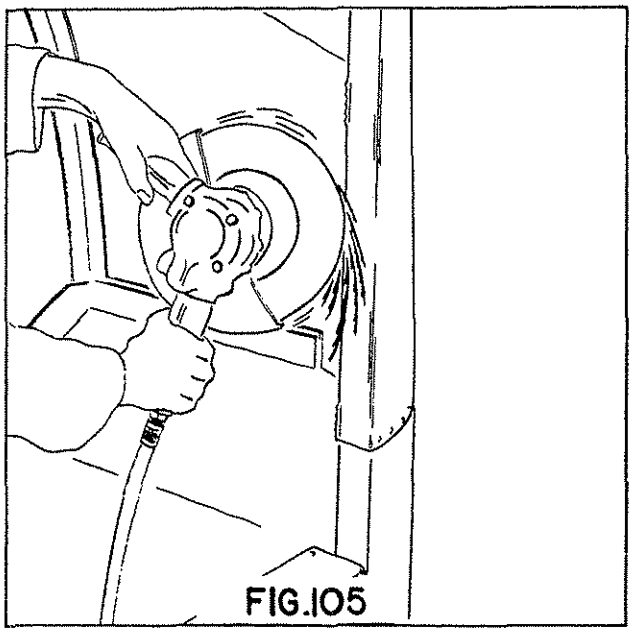


FIG.105

UPPER NOSE SKIN
(Series 31, 41 & 61 Cabs)

1. Remove door check arm.

2. Remove all screws that attach the door hinge to the front door post and remove the door.

3. Remove the wiper arm and blade, and the wiper shaft nut.

4. Pull the inner weatherstrip wedge (Point A, Fig. 102) from the windshield weatherstrip and remove the windshield glass outward. On later models, a single piece windshield weatherstrip was used (Fig.103).

5. Remove the fasteners (Point A, Fig. 104) located at the inside flange of the toe board as well as the ones in the side flange. Refer to Removal and Installation of Lower Nose Skin (Step 4, Fig. 100 & 101).

6. Use a 5/32" drill to remove aluminum rivets (Point B, Fig. 104).

7. Remove the weld that secures the upper nose panel to the door post (Fig. 105). Be careful not to damage frame structure.

8. Fit the new panel temporarily in place over the old one. When making this fitting, align the new panel with the windshield opening. With the new panel in the temporary position, scribe location to cut (Point C, Fig. 104). Then remove the new panel and cut old panel along scribe mark.

9. To remove panel, pull the panel from beneath overlapping center panel.

10. To install new panel, reverse removal procedure. Caution: Pieces to be welded must be perfectly butted for a good weld joint (Point C, Fig. 104).

CENTER NOSE SKIN
(Series 31, 41 & 61 Cabs)

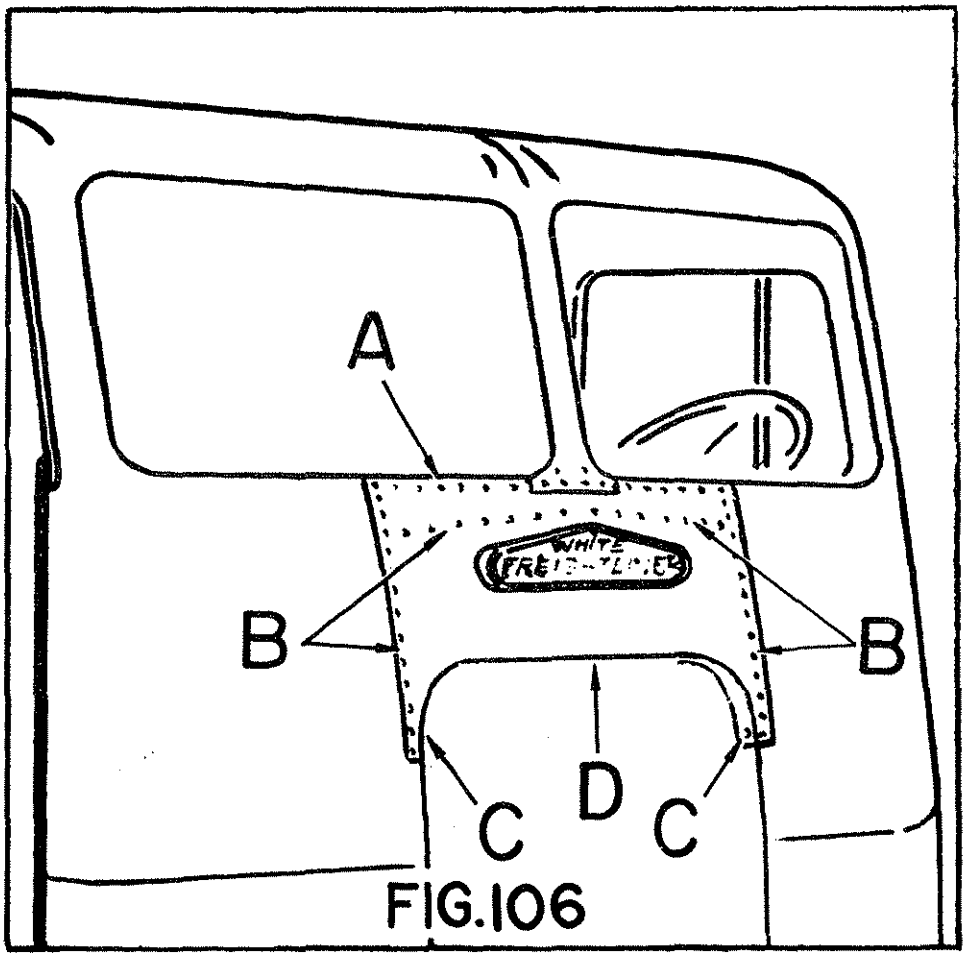


FIG.106

CENTER NOSE SKIN
(Series 31, 41 & 61 Cabs)

1. Remove both windshields.
   (See Section 32-18230, "Removal & Installation of Windshield Glass")
2. Remove grille and nameplate.
3. Remove the flathead rivets along rivet line (Point A, Fig. 106) by drilling with a 5/32" drill. Note: Be sure to center drill.
4. Remove the rivets along rivet lines (Point B, Fig. 106) by drilling with a 5/32" drill.
5. Remove two Huck Bolts (Point C, Fig. 106).
6. Remove five rivets (Point D, Fig. 106) on underside of tunnel flange by drilling with a 5/32" drill.
7. Remove panel.
8. Remove nameplate.
9. To install panel, use 5/16" NF Cadmium Plated Bolts where Huck Bolts were used (Point C, Fig. 106). Where rivets were used replace with rivets the same size as those removed.

WINDSHIELD CENTER SKIN
(Series 31, 41 & 61 Cabs)

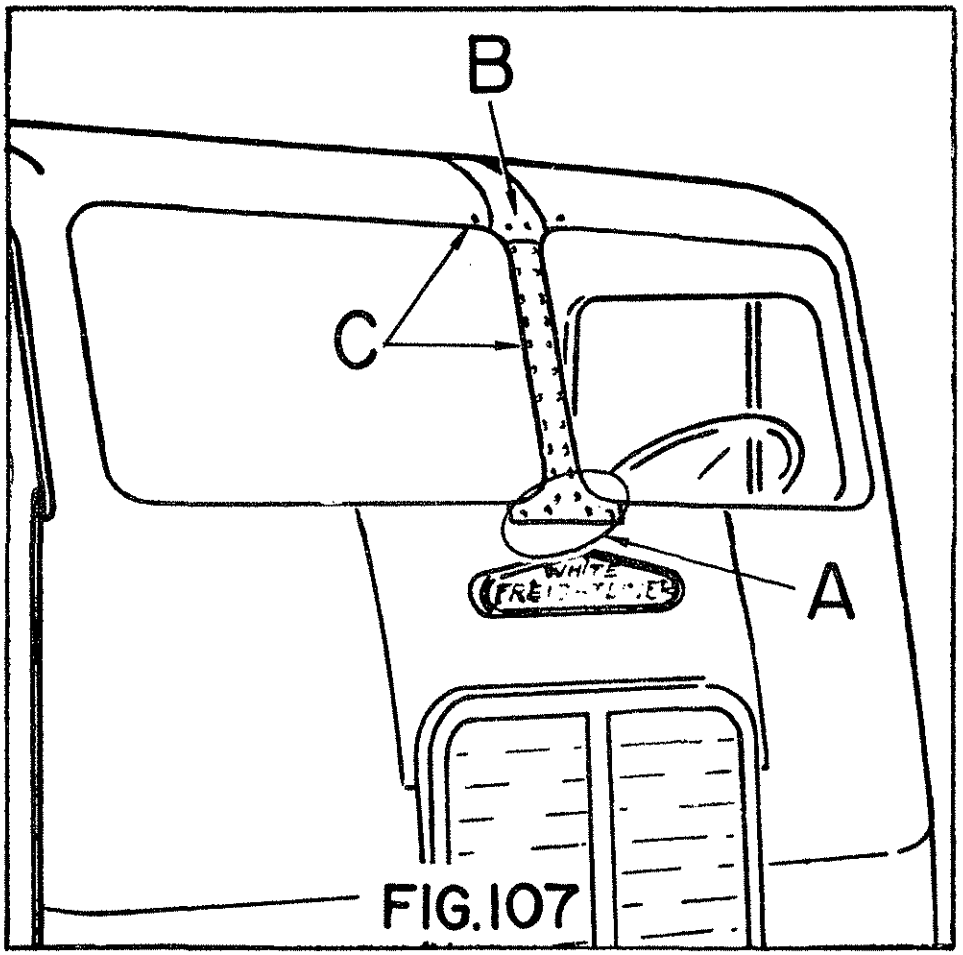


FIG.107

WINDSHIELD CENTER SKIN
(Series 31, 41 & 61 Cabs)

1. Remove wiper arms and blades.

2. Remove windshields.
   (See Section 32-18230, "Removal & Installation of Windshield Glass")

3. Remove brazier-head rivets with 5/32" drill (Point A, Fig. 107).

4. Remove rivets at top of center skin (Point B, Fig. 107).

5. Remove countersunk rivets with 5/32" drill (Point C,Fig. 107).

6. To install center skin reverse removal procedure.

WINDSHIELD CORNER SKIN (Series 31, 41 & 61 Cabs)

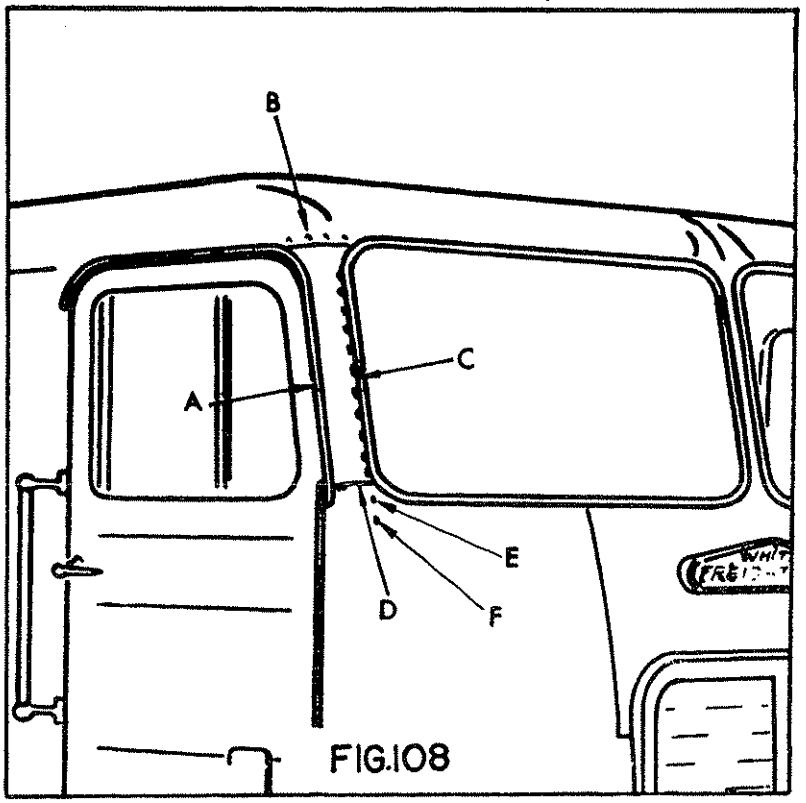


FIG.108

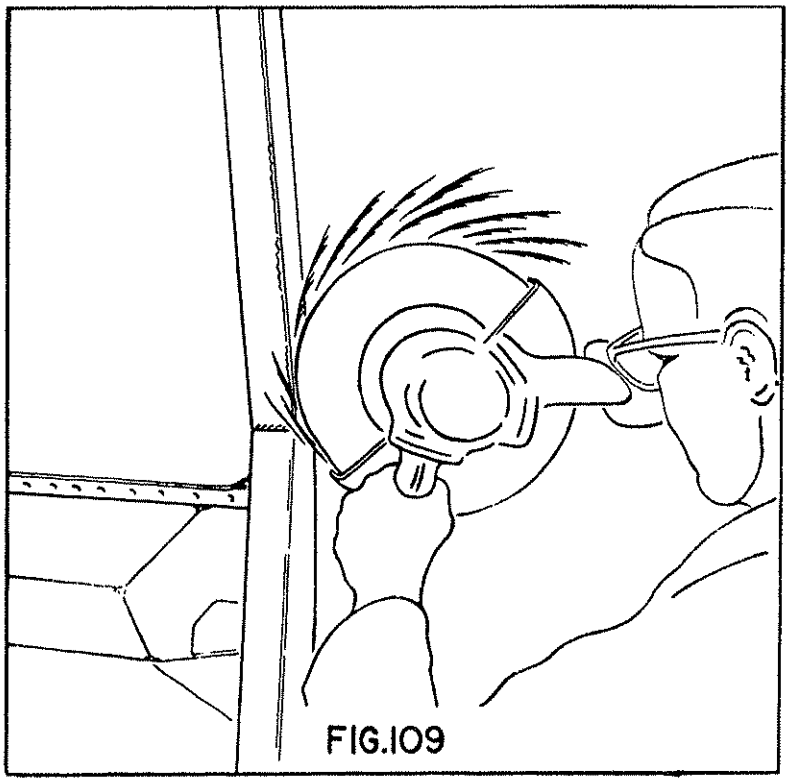


FIG.109

WINDSHIELD CORNER SKIN
(Series 31, 41 & 61 Cabs)

1. Remove wiper arm and blade.

2. Remove windshield.
(See Section 32-18230, "Removal & Installation of Windshield Glass"

3. Remove drip molding.

4. Remove door check arm.

5. Remove door.

6. Remove weld (Point A, Fig. 108 as shown in Fig. 109). Use safety glasses.

7. Remove rivets (Point B, Fig. 108) at top of windshield corner skin with a 5/32" drill.

8. Remove countersunk rivets (Point C, Fig. 108) with a 5/32" drill.

9. Fit new panel over old one and scribe a mark (Point D, Fig. 108) for making cut. Be sure that corner skin is in proper alignment with windshield cutout before making scribe mark.

10. Cut along scribed mark (Point D, Fig. 108). Be careful not to damage door post frame structure.

11. Remove windshield corner skin.

12. To replace windshield corner skin, place corner skin in position and replace rivets (Point C & B, Fig. 108), then weld (Point A & D, Fig. 108). Make sure that oval surface of windshield corner skin (Point D, Fig. 108) is evenly matched with upper nose skin panel. This is mandatory in order to obtain a sound butt weld.

13. When repairing the weld (Point D, Fig. 108) in the field, make sure there is a 5/32" countersunk head rivet approximately 1" below the weld (Point E, Fig. 108). Also install a 5/32" brazier head rivet approximately 2" below the weld (Point F, Fig. 108). Before installing the rivet (Point F, Fig. 108) tap the flange of the door post with a block of wood and hammer until the flange and nose skin come together. We do not recommend using a shim to fill this gap. The first rivet above the weld should be approximately 1". If it is located higher than 1" , then a 5/32" countersunk head rivet should be installed at the 1" location.

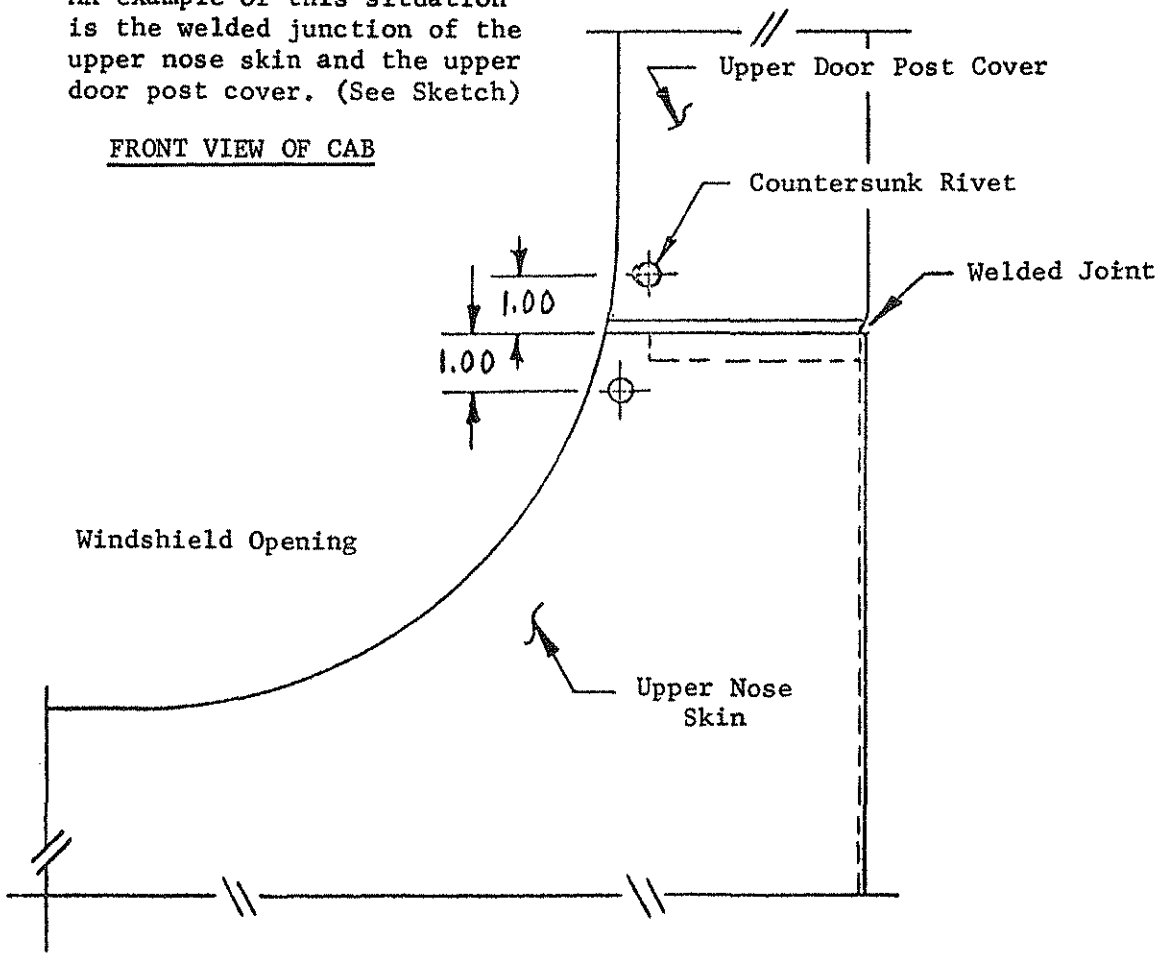
WINDSHIELD CORNER SKIN
CAB DOOR POST REPAIR
(Series 31, 41 & 61 Cabs)

1. Rivets Near Weld

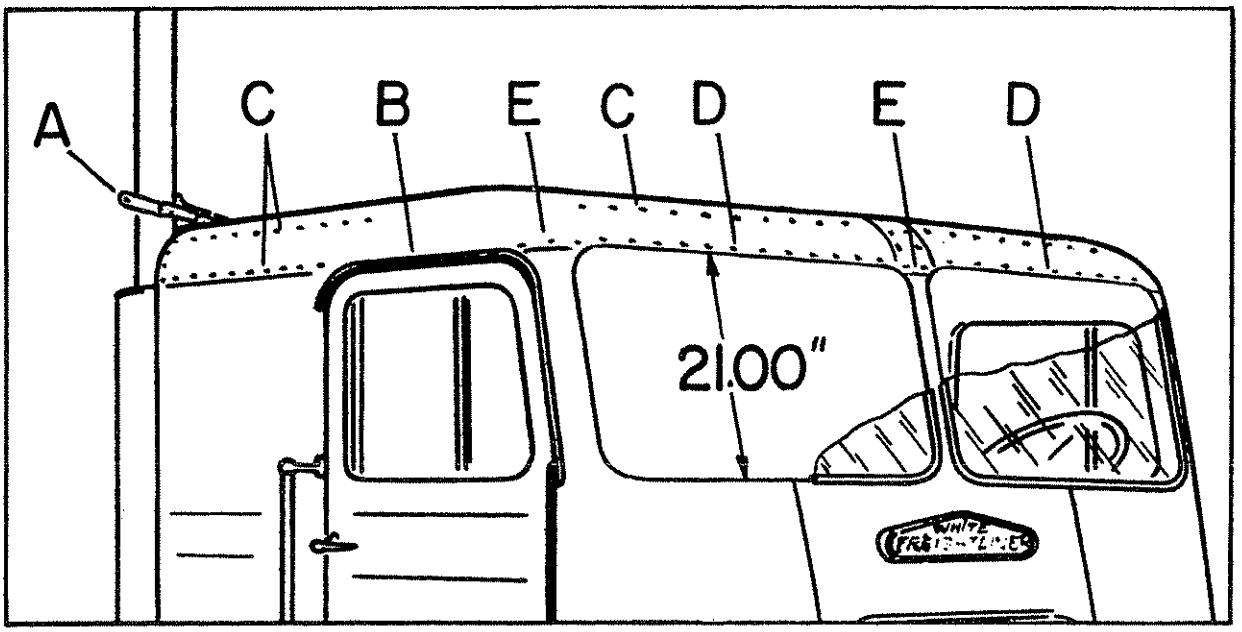
When a metal sheet joined by a weld must be fastened to another member, it is essential for the life of the joint to allow sufficient distance (about an inch) between the rivet, bolt, screw, or the like, and the weld line.

An example of this situation is the welded junction of the upper nose skin and the upper door post cover. (See Sketch)

FRONT VIEW OF CAB



CAB ROOF SKIN (Series 31, 41 & 61 Cabs)



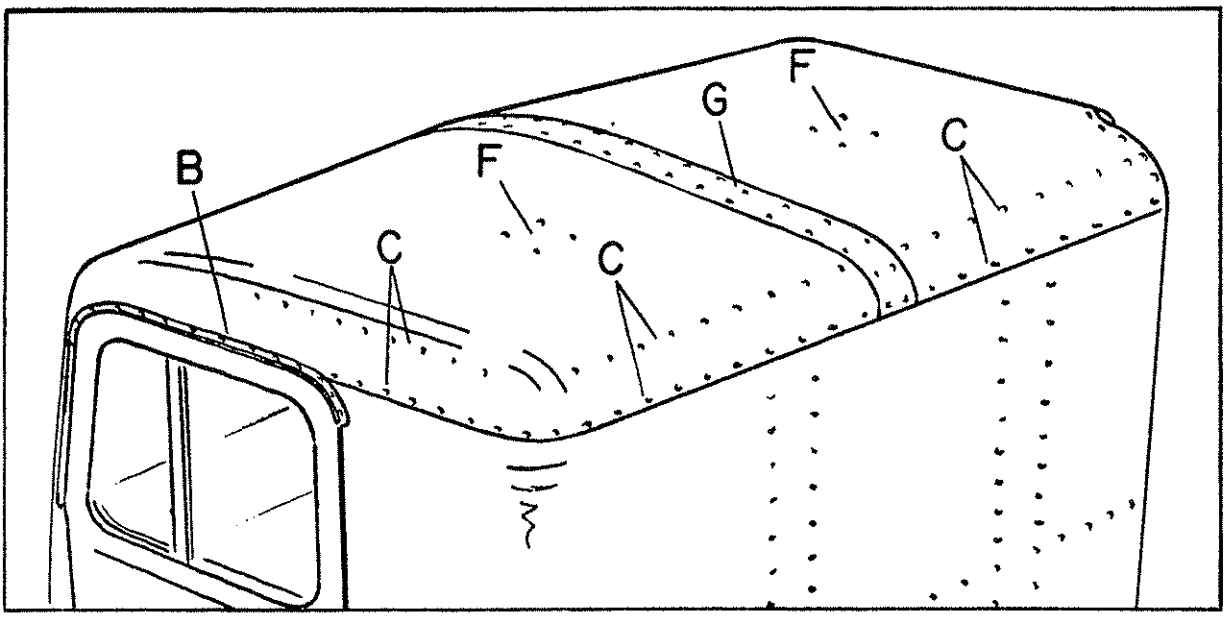


FIG.110

CAB ROOF SKIN
(Series 31, 41 & 61 Cabs)

1. Remove wiper arms and blades.
2. Remove windshield.
   (See Section 32-18230, "Removal & Installation of Windshield Glass")
3. Remove upholstery liner throughout the top and back of cab.
4. Disconnect all accessories, air horn, marker lights, dome lights, air conditioner, etc. that are connected to the roof panel.
5. Disconnect upper exhaust stack bracket (Point A, Fig. 110).
6. Remove drip molding (Point B, Fig. 110).
7. Remove rivets (Point C, Fig. 110) from roof top using 5/32" drill.
8. **Remove countersunk rivets (Point D, Fig. 110).**
9. Remove rivets (Point E, Fig. 110).
10. Remove rivets (Point F, Fig. 110).
11. **On 31 and 41 series cabs, roof can be removed in two separate sections by first removing roof batten rivets (Point G, Fig. 110).**
12. In replacing roof skin, reverse the removal procedure.

REAR SKIRT SKIN
(Series 31 & 41 Cabs)

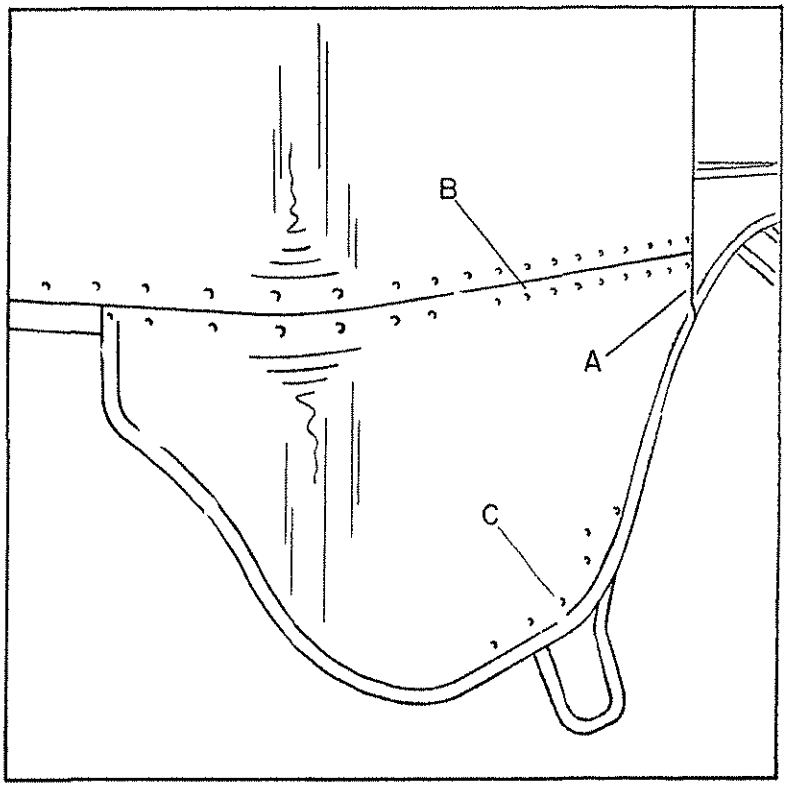


FIG. 111

REAR SKIRT SKIN
(Series 31 & 41 Cabs)

1. Remove two bolts (Point A, Fig. 111).
2. Remove rivets along rivet line using 5/32" drill (Point B, Fig. 111).
3. Remove rivets from step brace (Point C, Fig. 111).
4. Remove rear skirt skin.
5. To replace rear skirt reverse removal procedure using bolts where bolts were used and rivets where rivets where used.

REAR SKIN
(Series 31 & 41 Cabs)

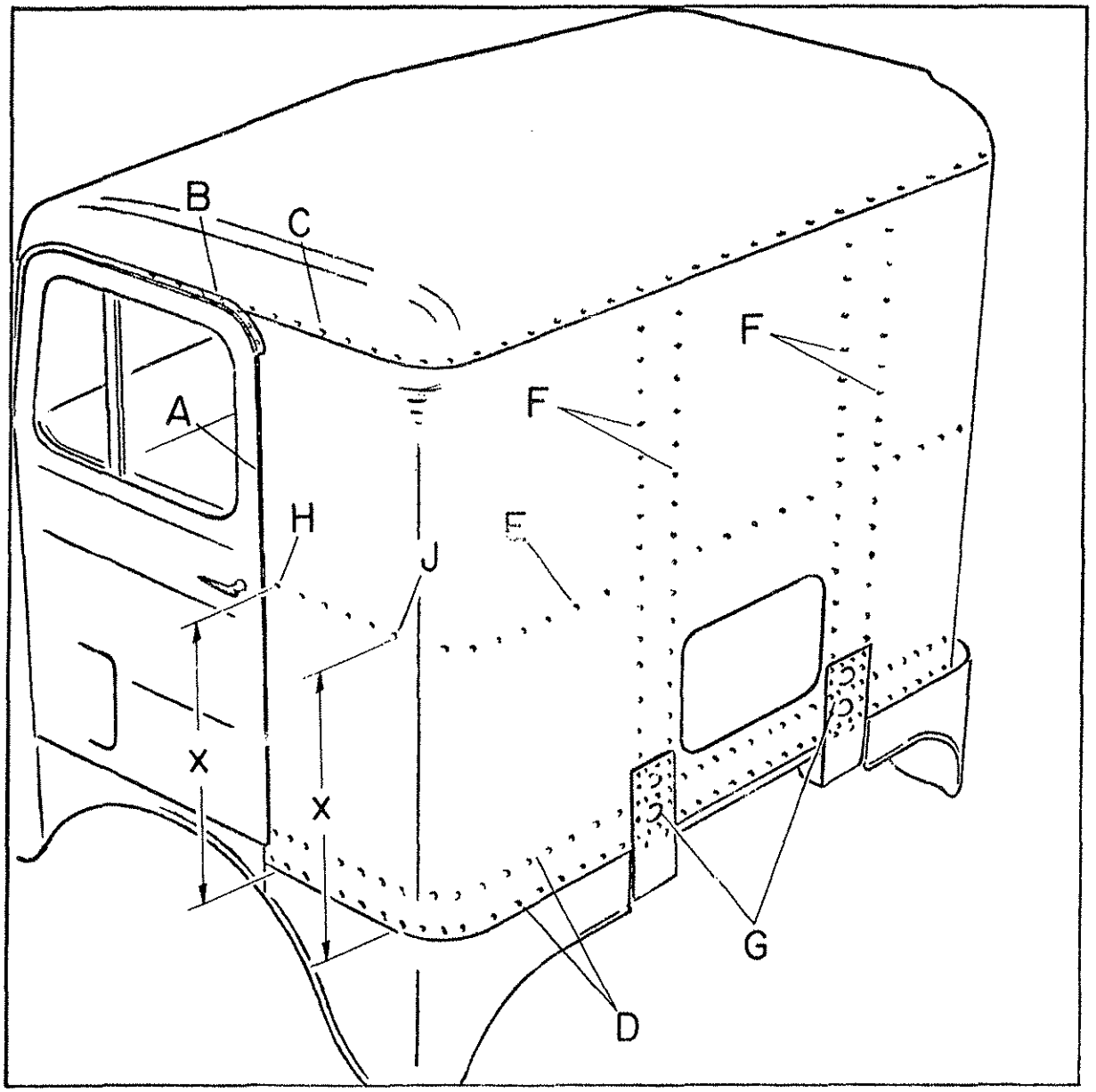


FIG. 112

REAR SKIN
(Series 31 & 41 Cabs)

1. Remove upholstery and insulation from rear of cab.

2. Remove all external accessories, grab handle, exhaust shield, muffler, muffler brackets, cooler piping cover, etc.

3. Remove rivets at inside flange of door post (Point A, Fig. 112)
   In some instances, cherry rivets or drive rivets are used from the door striker to the sill; in any case, these rivets must be removed.

4. Remove screws from rear portion of drip molding (Point B, Fig. 112).

5. Remove rivets from roof rivet line (Point C, Fig. 112).

6. Remove rivets (PointsD, E, & F, Fig. 112)

7. Remove right rear skirt.

8. Remove Huck Bolts and rivets from rear supports with chisel and hammer (Point G, Fig. 112) and slide panel down, then up and out. Note: Do not remove rear support completely, simply loosen the back surface.
   (See section on rear skirt skin (Fig. 111).

9. Three-piece replacement skins are available for repair of vehicles with partial rear cab skin damage. (See parts book for description and details.)

10. To replace the rear skin reverse the removal procedure in Item 8. Slide the new skin downward behind the rear cab supports, then upward under roof skin.

11. Position the skin and use sheet metal screws to hold it in position for drilling.

12. After fitting new panel in place drill new holes in panel from the inside using existing holes in framework as much as possible. CAUTION: When this repair is being made on sleeper cabs, care must be taken to properly align and secure the bunk prior to drilling holes for rivet line (Point E, Fig. 112). This precaution must be taken in order to prevent subsequent wracking of the bunk.

    When aligning the bunk (prior to drilling holes in rivet line Point E, Fig. 112), first drill hole at Point H, Fig. 112 and secure sheet metal screw. Next measure down distance "X", Fig. 112, then seek a point approximately 17" to 23" aft on a level plane and measure up distance "X" to Point J, and then drill hole from the outside and secure sheet metal screw. Repeat this procedure on the opposite side of the cab. When this has been done, the bunk is sufficiently secure to permit completion of drilling holes on rivet line (Point E, Fig. 112) from the inside.

13. When the rivet holes have been drilled, start riveting process first on the vertical center rivet lines (Point F, Fig. 112), then move to the horizontal rivet lines (PointsC, D, & E, Fig. 112). To minimize "metal creep" work the rivets from the center area outboard in all directions.

OUTER DOOR SKIN (Series 31, 41 & 61 Cabs)

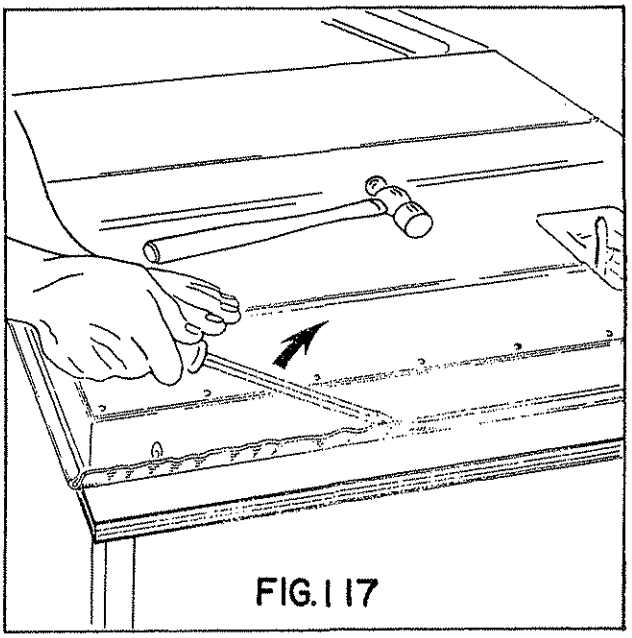


FIG. 117

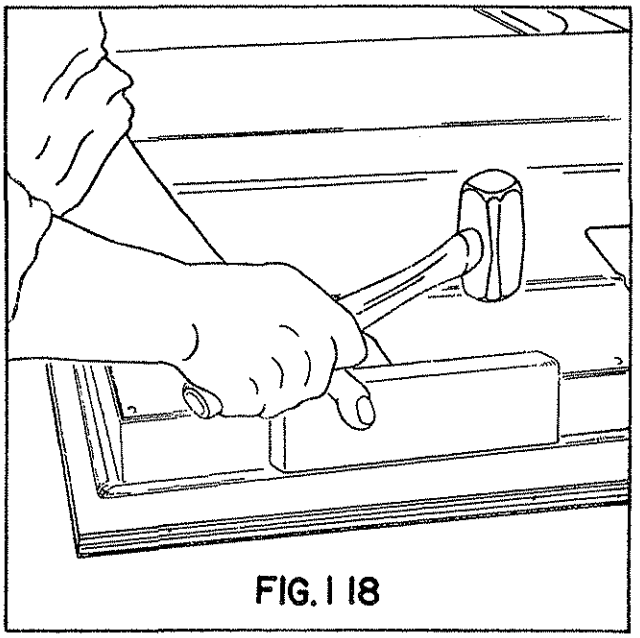


FIG. 118

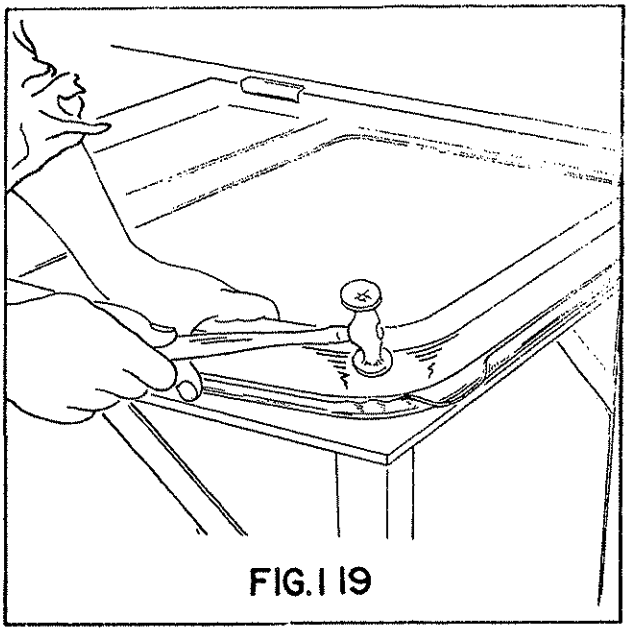


FIG. 119

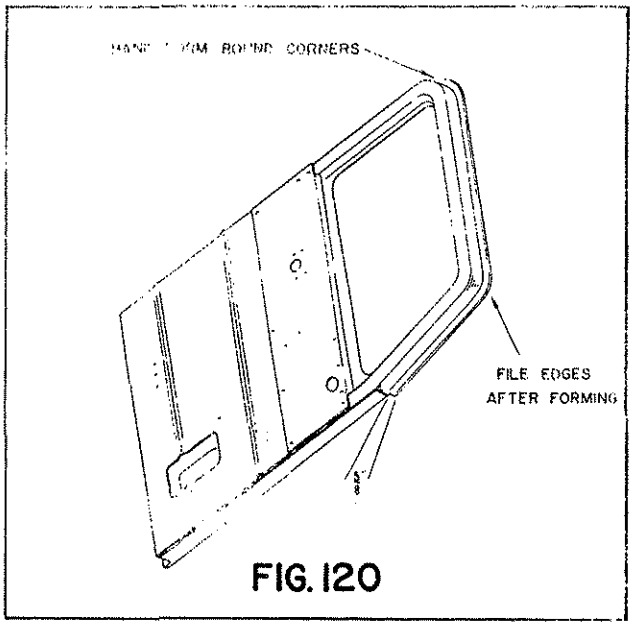


FIG. 120

OUTER DOOR SKIN
(Series 31, 41 & 61 Cabs)

1. Remove door hinge screws that hold door to hinge and remove two door-stop bolts. Remove the door from cab.

2. Remove mirror bracket, door handles, etc.

3. Remove door glass and wing window.
   (See Section 32-18225. "Doors 31, 41, 61 Series Cabs")

4. To prevent scratching the outer surface of the door panel, the door should be laid on a plywood work table. To remove the outer door skin pry up the crimped flange (Fig. 117).

5. When installing the new door panel, crimp the new panel (Fig. 118). Corner areas require special care and should be hand formed as illustrated (Fig. 119); after forming, the corners should be dressed with a file. The leading edge of the door must be hemmed 5/8" as indicated (Fig. 120).

Common Rivets used in manufacture of FL cab.

Description	Material	Size	Alloy	AN Part Number	FL Part Number
Countersunk Head	Alu.	5/32" x 3/8"	6053-T61	AN455-5-6	23-9367-506
Brazier Head	Alu.	5/32" x 3/8"	25F Soft	AN455-5-6	23-9368-506
Brazier Head	Alu.	5/32" x 7/16"	6053-T61	AN455-5-7	23-9367-507
Brazier Head	Alu.	5/32" x 1/2"	6053-T61	AN455-5-8	23-9367-508
Round Head	Alu.	1/4" x 5/8"	6053-T61	AN430-8-10	23-9369-810
Countersunk Head	Alu.	3/16" x 1/2"	6053-T61	AN425-6-8	23-9366-608
Brazier Head	Alu.	3/16" x 3/8"	6053-T61	AN425-6-6	23-9366-606
Brazier Head	Alu.	3/16" x 7/16"	6053-T61	AN425-6-7	23-9366-607
Brazier Head	Alu.	3/16" x 1/2"	6053-T61	AN425-6-8	23-9366-608
Brazier Head	Alu.	3/16" x 5/8"	6053-T61	AN425-6-10	23-9366-610
Brazier Head	Alu.	3/16" x 3/4"	6053-T61	AN425-6-12	23-9366-612

NOTE: Approximately 2 lbs. of each size and length group of rivets used per cab.

WINDSHIELD AND SEAL REPLACEMENT, CONVENTIONALS AND COE WITH SEPARATE CENTER POST COVER

GENERAL INFORMATION

This subject is for service operations on Conventional and COE cabs that use a two-section, flat glass windshield with a separate center post cover piece between the windshield sections (Fig. 1). Two types of windshield seals are used: some models use a windshield seal with a separate lockstrip (Fig. 2), while others use a one-piece seal and lockstrip (Fig. 3).

CAUTION: Follow the procedures described here carefully, to prevent water leakage into the cab or damage to the windshield glass.

SERVICE OPERATIONS

REMOVING THE WINDSHIELD AND SEAL

1. Remove the windshield wiper arm and blade.
2. On models with the two-piece lockstrip and seal, remove the lockstrip. (Fig. 2.) On models with the one-piece seal, disengage the lockstrip from the seal. (Fig. 3.)
3. Run a bead spreader or a screwdriver carefully around the windshield between the glass and seal from both sides of the windshield. This will break the seal between the rubber and the glass. In some instances, where removal is difficult, it may be necessary to fabricate a custom tool similar to the one shown in Fig. 4.

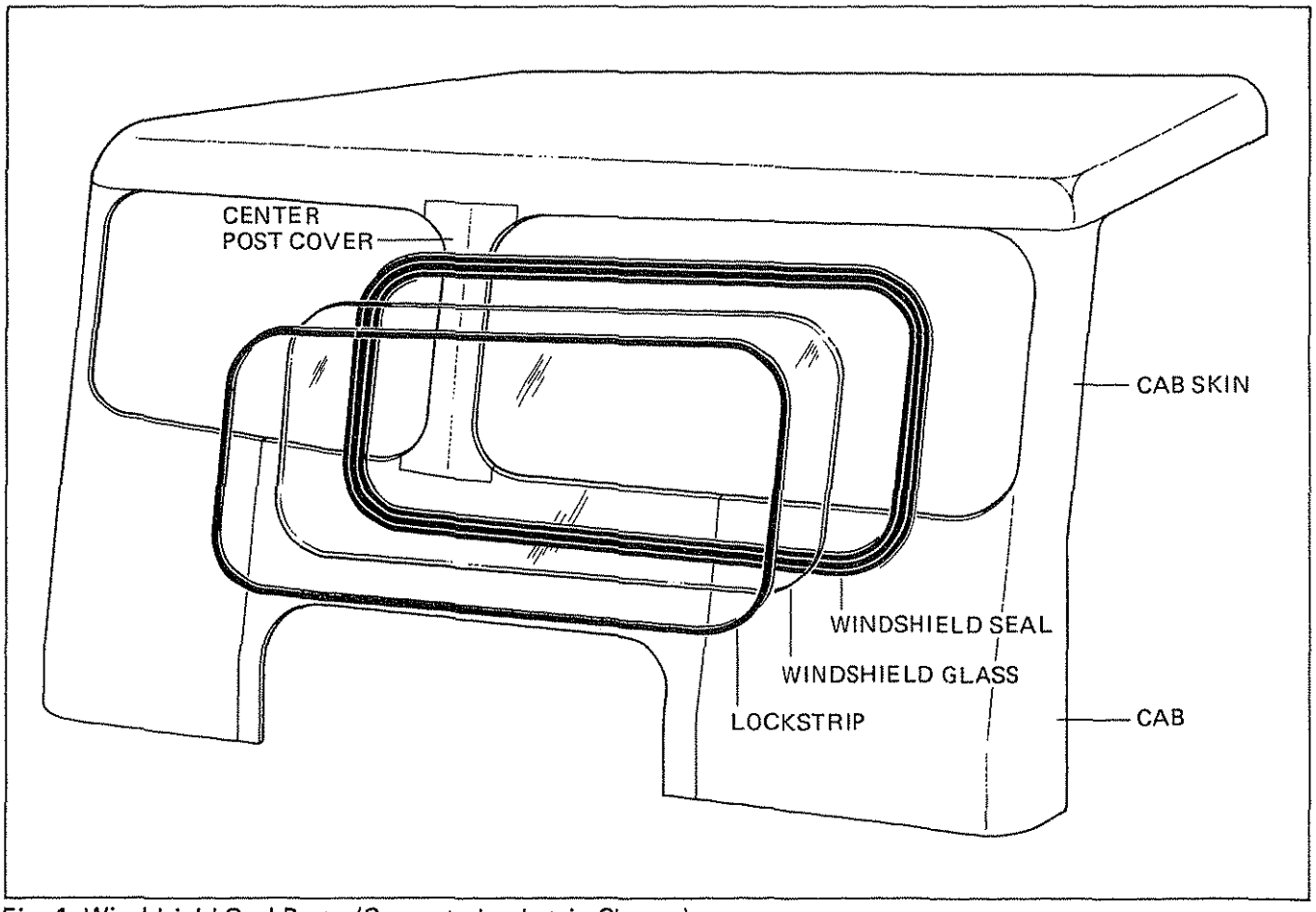


Fig. 1, Windshield Seal Parts (Separate Lockstrip Shown)

WINDSHIELD AND SEAL REPLACEMENT, UNITIZED WINDSHIELD SEAL

3. If both the windshield and the seal are to be re-used, or if the seal is to be re-used, proceed with steps 3 through 5. With an assistant outside the cab, supporting the windshield, remove the windshield following instructions shown in Fig. 3. Start at one corner and carefully work around the windshield.

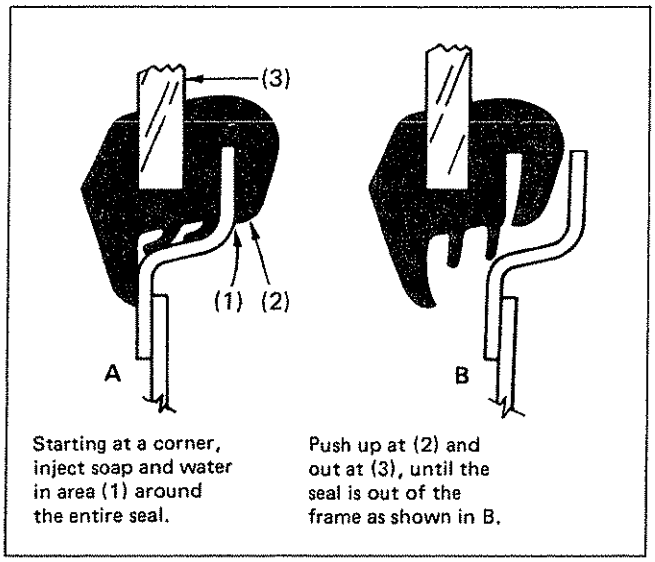


Fig. 3, Windshield And Seal Removal

4. If the glass it to be re-used, remove all rubber seal remnants, dirt and other foreign matter.

5. Inspect the windshield seal. If it is to be re-used, it must be clean, limber and free of cracks or cuts. Clean it carefully to remove all sealing compound, dirt, and other foreign matter.

INSTALLING THE WINDSHIELD AND SEAL

1. Clean the windshield flange thoroughly to remove all traces of old sealing compound, dirt, and other foreign matter.

2. Apply windshield sealant (3M8648 or 3M5537) in a 1/8" bead into areas 1 and 2, as shown in Fig. 4. The sealant must be installed within 10 minutes of glass and seal installation into vehicle.

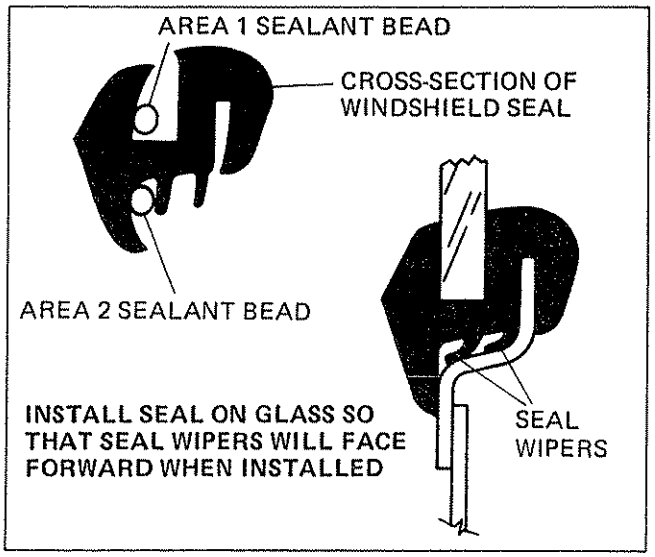


Fig. 4, Installing The Windshield Seal On Windshield Glass

3. Carefully place the molded windshield seal around the edge of the windshield glass, as shown in Fig. 4.

4. Place a chalk line cord in the windshield seal metal flange channel. Work the cord completely into the channel, being careful to keep the cord straight and free of kinks. Refer to Fig. 5. When finished, both ends of the cord should protrude from the seal at the bottom edge of the glass.

Fig. 5, Positioning The Draw Cord In The Windshield Seal

WINDSHIELD AND SEAL REPLACEMENT, CONVENTIONALS AND COE WITH SEPARATE CENTER POST COVER

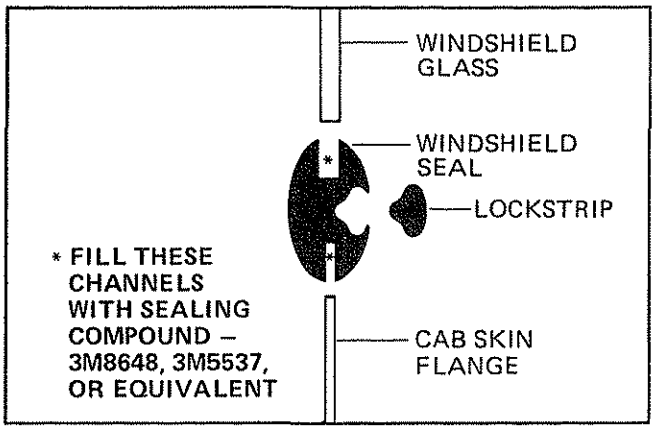


Fig. 5, Windshield Seal Parts, Showing Areas To Fill With Sealing Compound

4. Continue to press the seal around the edge of the opening, pressing the seal in firmly to ensure a snug fit. Cut the seal to overlap the starting point by about 1/8 inch.

5. Refer to Fig. 7. Withdraw the starting and ending edges of the windshield seal. Coat both ends of the windshield seal with 3M8648 or 3M5537 sealing compound and join the ends together. Force the two ends together, back over the edge of the windshield opening. Make certain the full length of the seal is firmly against the windshield opening, completely around the opening.

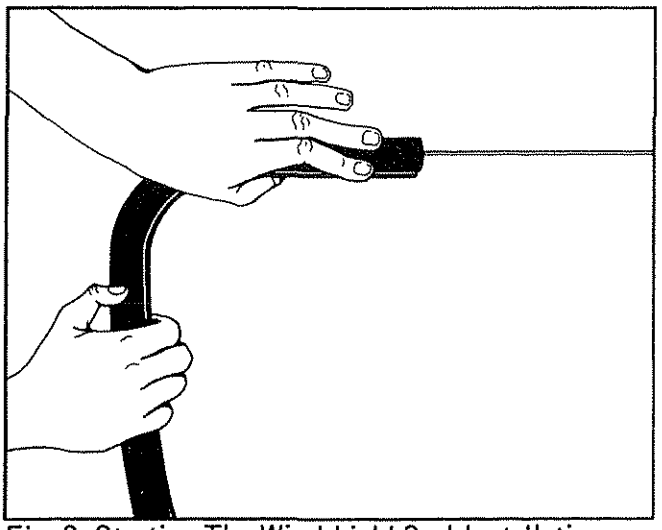


Fig. 6, Starting The Windshield Seal Installation

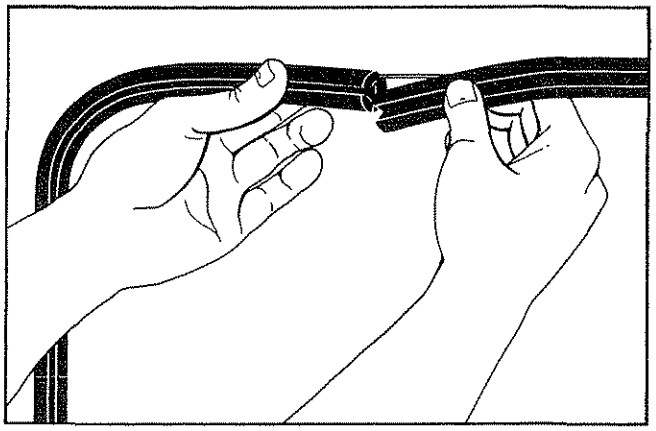


Fig. 7, Completing The Windshield Seal Installation

Installing The Windshield Glass

1. Before installing windshield glass (re-used or new), clean the edge of the glass thoroughly to remove all dirt and foreign matter. Inspect the glass for chips, cracks, or other damage. A small chip is permissible, while a crack, however small, will enlarge and eventually require removal of the glass.

2. Fit the glass into the lower corner channel as far as it will go without forcing it, as shown in Fig. 8.

3. Insert the seal spreading tool, as shown in Fig. 9, into the glass channel of the windshield seal starting near the positioned corner. Move the tool along the edge slowly, raising the lip of the glass channel and carefully pressing the glass into the channel.

4. Continue with the glass fitting operation until the glass is entirely within the windshield seal channel.

5. Press the glass carefully into position until it is in line with the windshield opening plane.

6. Lubricate the lock strip channel with "Glass Slip" Lubricant or equivalent.

7. If the windshield uses a one-piece seal and lockstrip, press the lockstrip into the lockstrip channel. If not, proceed to step 8.

WINDSHIELD AND SEAL REPLACEMENT, CONVENTIONALS AND COE WITH SEPARATE CENTER POST COVER

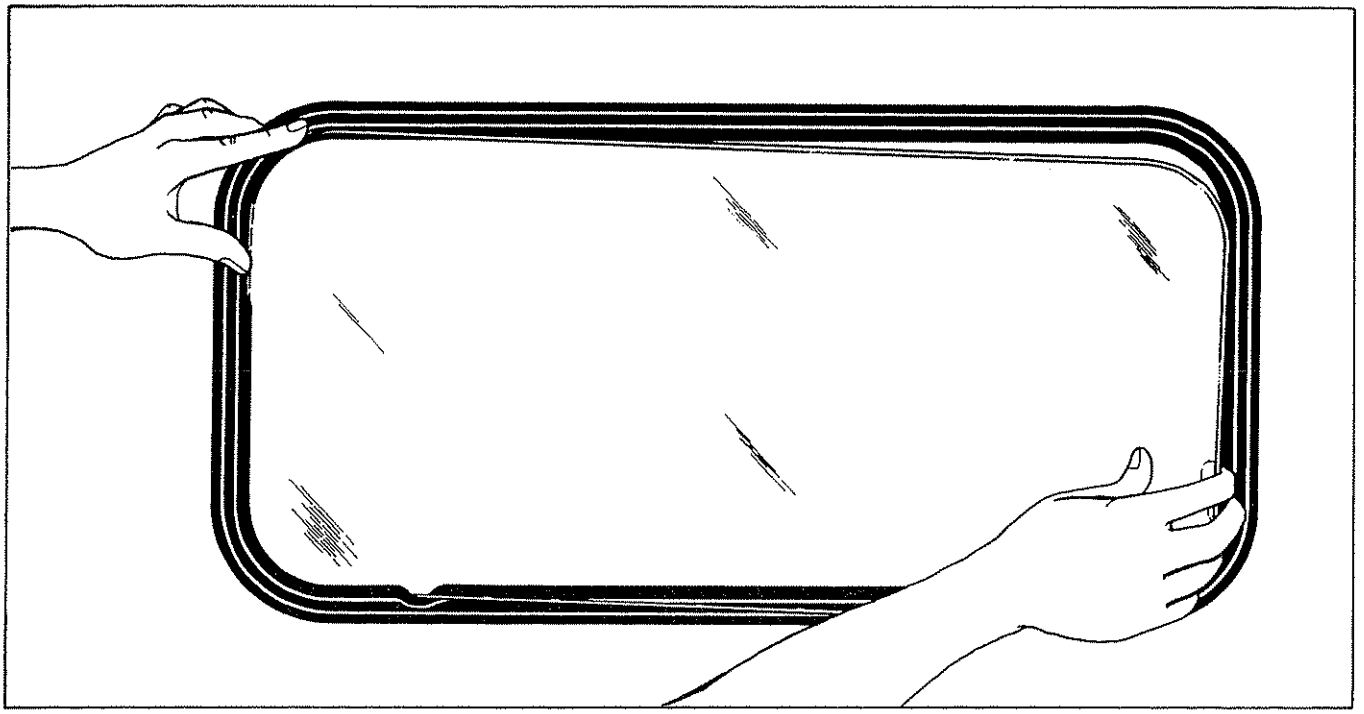


Fig. 8, Inserting The Glass Into Position In The Seal

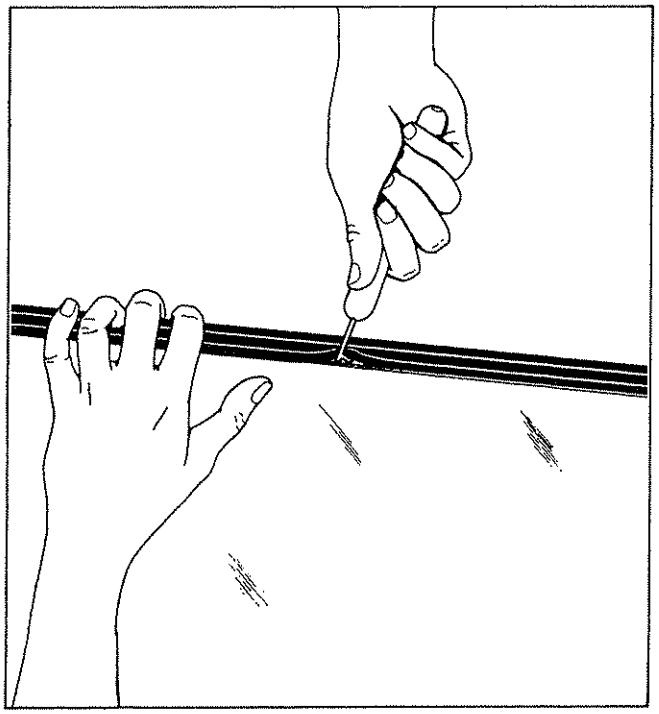


Fig. 9, Placing The Lip Of The Seal Over The Edge Of The Glass

8. Insert the lockstrip into the eye of the seal spreading tool. Insert the lockstrip and tool into the lockstrip channel at any point at the top except that point where the windshield seal is joined.

9. Hold the end of the lockstrip with your thumb while first pulling the tool in the channel. Then move the tool along the channel, feeding the lockstrip into the channel through the tool's eye. Use caution to prevent the lockstrip from twisting. (Refer to Fig. 10.)

10. When the starting point is reached, remove the tool. Cut the lockstrip to overlap the starting point, so that when both ends are forced into the channel, the joint will be under pressure. (Refer to Fig. 11.)

11. On either type of windshield seal, check to make sure the lockstrip is completely installed.

12. Re-install windshield wiper arms and blades.

WINDSHIELD AND SEAL REPLACEMENT, CONVENTIONALS AND COE WITH SEPARATE CENTER POST COVER

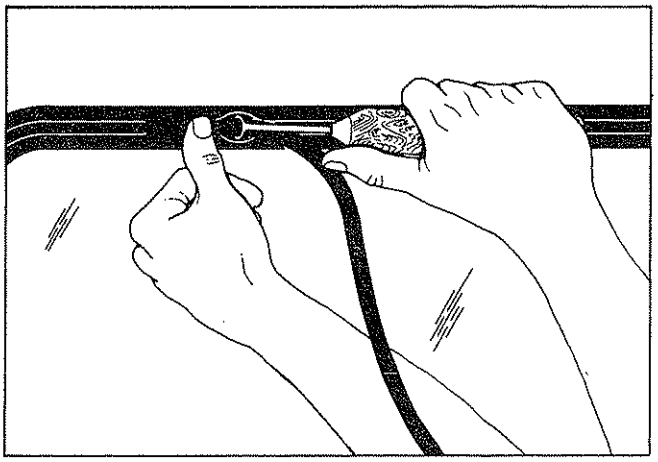


Fig. 10, Inserting The Lockstrip Into The Channel, Using The Seal Spreading Tool

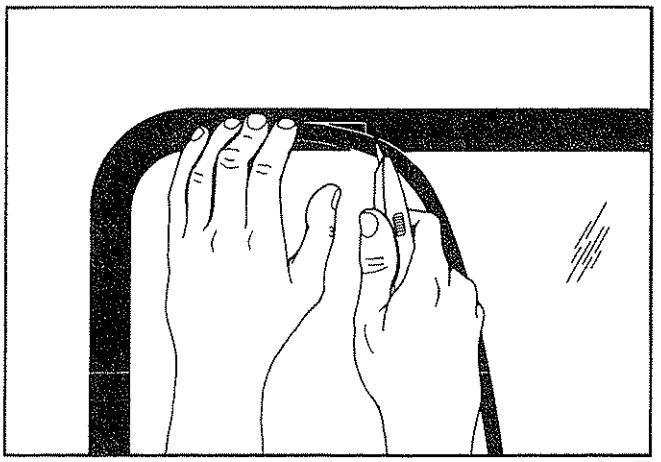


Fig. 11, Completing The Lockstrip Installation

WINDSHIELD AND SEAL REPLACEMENT, UNITIZED WINDSHIELD SEAL

GENERAL INFORMATION

This subject is for service operations on cabs that use a two-section flat glass windshield with a one-piece windshield mask and a one-piece, unitized windshield seal (Fig. 1). Either half of the windshield may be replaced independently, using the instructions in this section.

CAUTION: Follow the instructions in this procedure carefully, to prevent water leakage into the cab or damage to the glass.

SERVICE OPERATIONS

REMOVING THE WINDSHIELD AND SEAL

1. Remove both windshield wiper arms and blades.
2. If the windshield is undamaged and the seal alone is to be replaced, first cut away the portion of the seal that is molded around the flange in the cab. Refer to Fig. 2. Cutting off this portion of the seal will allow easier removal of the glass and reduce the possibility of damaging the glass in the process.

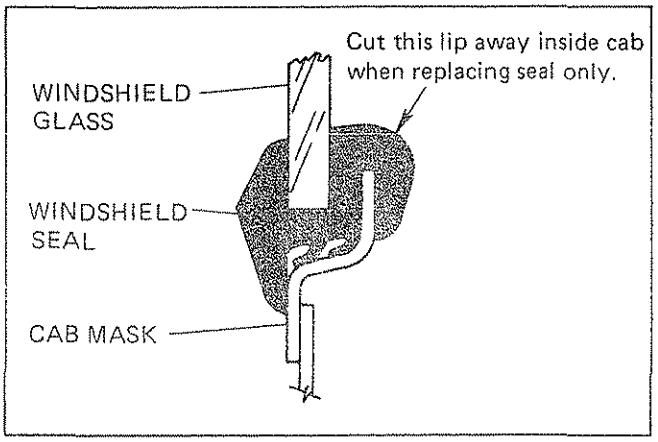


Fig. 2, Windshield Seal Junction

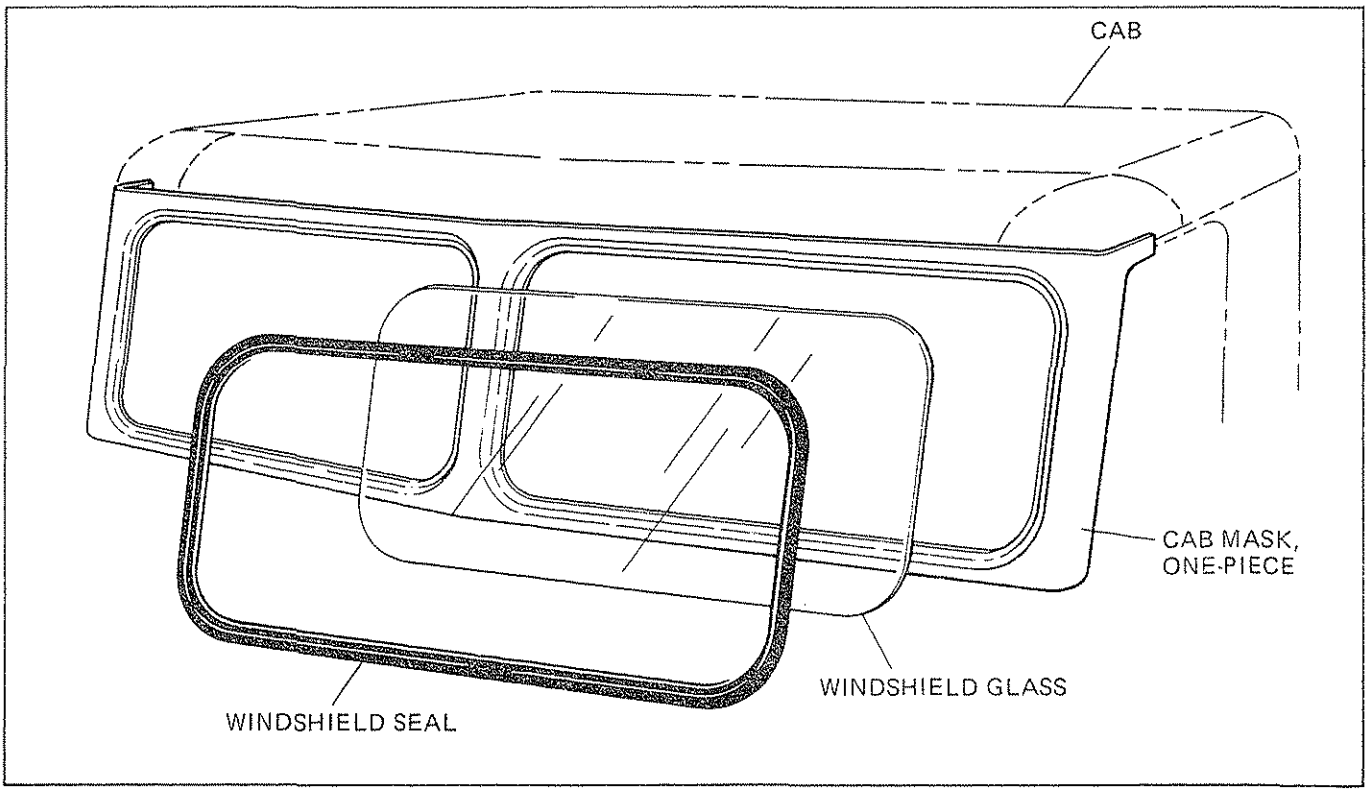


Fig. 1, One-Piece Cab Mask

WINDSHIELD AND SEAL REPLACEMENT, CONVENTIONALS AND COE WITH SEPARATE CENTER POST COVER

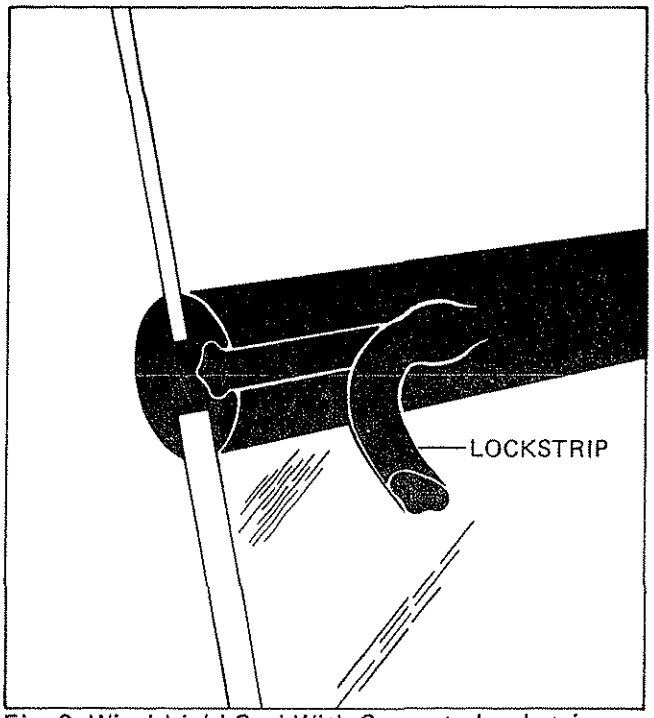


Fig. 2, Windshield Seal With Separate Lockstrip

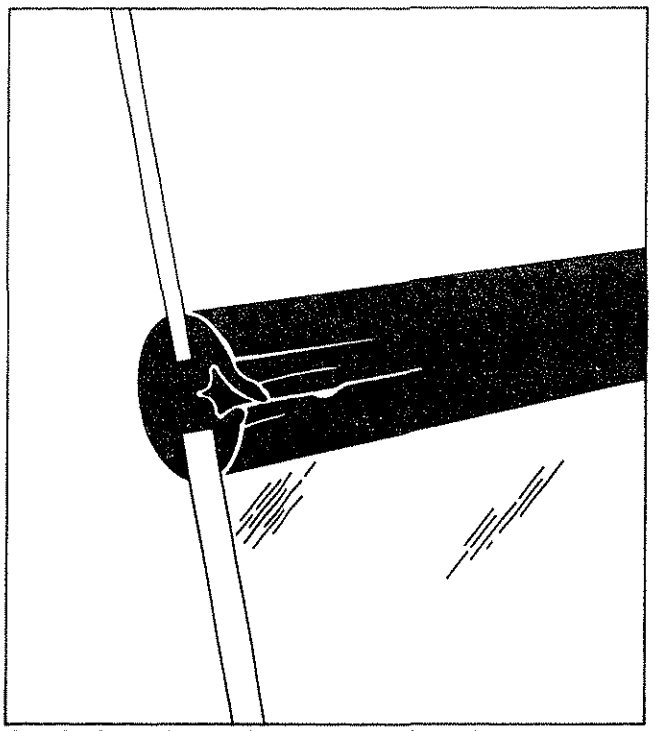


Fig. 3, One-Piece Windshield Seal And Lockstrip

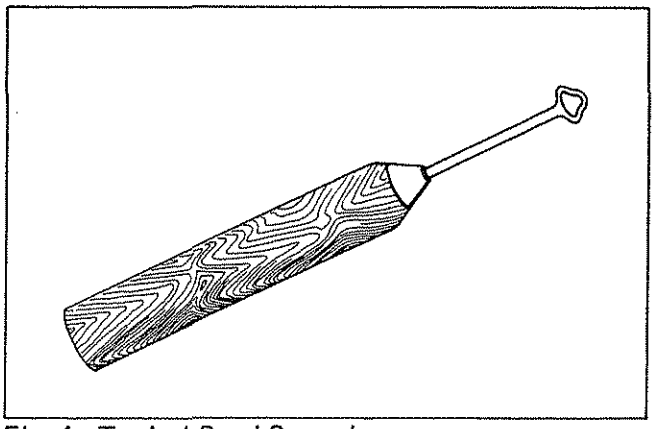


Fig. 4, Typical Bead Spreader

4. With an assistant on the outside to support the glass, carefully remove the windshield by pushing out from the inside of the cab.

5. If it is desired that the removed windshield seal be re-used, carefully inspect it for flexibility and cuts, cracking, or other signs of damage or wear.

   If the seal is rigid, cracked, cut or damaged, discard it and install a new seal.

   If the seal is to be re-used, carefully clean it to remove all remnants of sealing compound, dirt, and other foreign matter.

INSTALLING THE WINDSHIELD AND SEAL

Installing The Seal

1. Carefully clean the windshield opening edge flange to remove all old sealing compound, dirt, and other foreign matter. Remove all traces of old sealing compound, being careful not to mar the painted surface.

2. Using 3M8648 or 3M5537 sealing compound or equivalent, fill the metal channel and the glass channel in the windshield seal with at least a 1/8" bead.

3. Starting at the top of the windshield opening, fit the cab skin channel over the edge of the cab skin, as shown in Fig. 6.

WINDSHIELD AND SEAL REPLACEMENT, UNITIZED WINDSHIELD SEAL

5. With an assistant, carefully place the windshield in position in the cab opening. The cord ends should be inside the cab opening, at the bottom of the glass. Refer to Fig. 6.

Fig. 6, Beginning The Windshield Installation

6. With one person working from inside the cab and the other serving to press the glass inward, grasp either end of the cord, as shown in Fig. 7. During this drawing operation (steps 6 through 8) the person outside the cab must carefully press inward.

Fig. 7, Beginning To Withdraw The Cord

7. Carefully draw the cord from the flange channel in the seal to bring the lip of the channel over the cab flange. Draw one side of the cord out of the seal until the cord has traveled completely around to the top of the glass. (It is not important which side of the seal is first drawn over the cab flange.) Refer to Fig. 8.

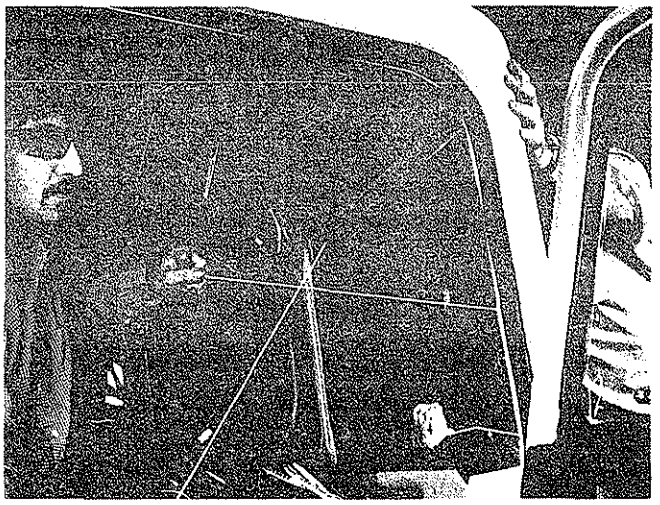


Fig. 8, Withdrawing The Second Part Of The Cord

8. Leave the drawn end of the cord at the top center of the glass. Grasp the opposite end of the cord to complete the drawing operation around the opposite side of the glass, until drawn within approximately 12" of completing the drawing operation. Refer to Fig. 9.

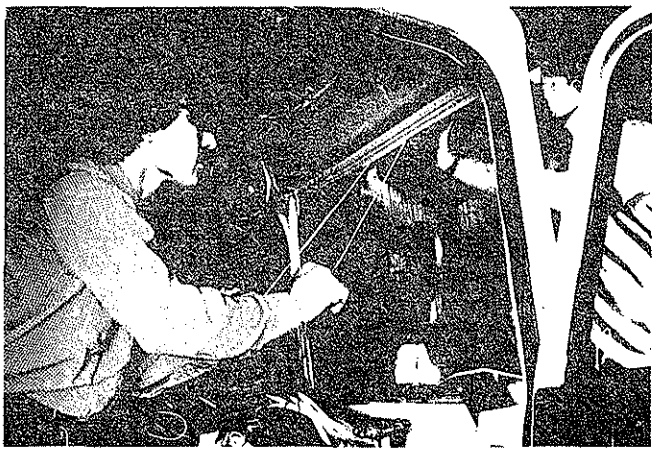


Fig. 9, Completing The Cord Withdrawal

WINDSHIELD AND SEAL REPLACEMENT, UNITIZED WINDSHIELD SEAL

9. Before completing the drawing operation at the top of the windshield seal, hold the cord which was first pulled around the edge of the glass in one hand to prevent its being drawn out of position. Then carefully pull the opposite end of the cord to complete the drawing operation.

10. Upon completion of the drawing operation, press the seal from the outside firmly against the cab flange to bring the seal evenly to its seat in the cab opening. Refer to Fig. 10.

11. Re-install wiper arms and blades.

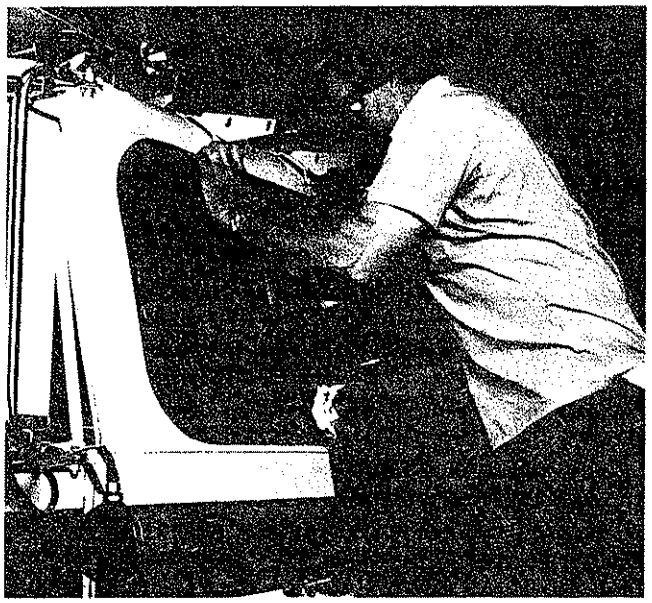


Fig. 10, Final Seating Of Windshield And Seal

COMPLETE PAINTING OR TOUCH-UP PAINTING

GENERAL INFORMATION

Freightliner Corporation currently uses DuPont® high-solids Standard Urethane and Imron 5000 paint on 120 Conventionals. Since February 1, 1989, these paints have been applied to the chassis and bumpers; since April 1989, they have also been used on cabs, hoods, and sleeper boxes. To meet the new federal air quality regulations imposed by the EPA and local jurisdications, both new products contain less solvent than earlier types (916Y, Centari, and Imron), and both can be formulated free of lead and chrome.

The procedures in this section are for use with DuPont products on all COEs and 120 Conventionals. Unless otherwise noted, all products are manufactured by E. I. du Pont de Nemours and Company, Inc. Obtain approval from a Freightliner Regional Office for use of topcoats produced by other manufacturers.

SERVICE OPERATIONS

COLOR-MATCHING

Imron 5000 is the recommended aftermarket paint for color-matching all high-solid Standard Urethane and Imron 5000 colors. Although the new paint formulas are different from the formulas for 916Y, Centari, and Imron, most of the new solid colors will match the old solid colors. Some reds, oranges, and yellows could be different if lead-and-chrome bearing pigments are eliminated from the formula. Imron 5000 metallic colors will not be straight crossovers; the new metallics will appear to be darker than similiar colors in Imron.

To ensure proper gloss, durability, and color-matching of enamel, use only Imron paint on previously painted panels of Imron painted vehicles. The finished appearance of some Imron metallic colors can be improved by using a base coat. A base coat is a solid color that closely matches a particular metallic color. Use of a base coat increases paint coverage by reducing the total number of paint coats needed to achieve ideal results. A properly matched base coat greatly improves the hiding characteristics of metallics listed in **Table 1**, under "Specifications, 400."

916Y acrylic urethane and the high-solids Standard Urethane are sold to original equipment manufacturers only, and are not available for aftermarket sale. To color-match 916Y, use DuPont's Centari acrylic enamel or Imron enamel, or an approved equivalent manufacturer's paint. Centari enamel cannot be used for color-matching Imron. To color-match the Standard Urethane, use only Imron 5000. Imron 5000 can also be used over 916Y, Centari, or Imron for color-matching most solid colors.

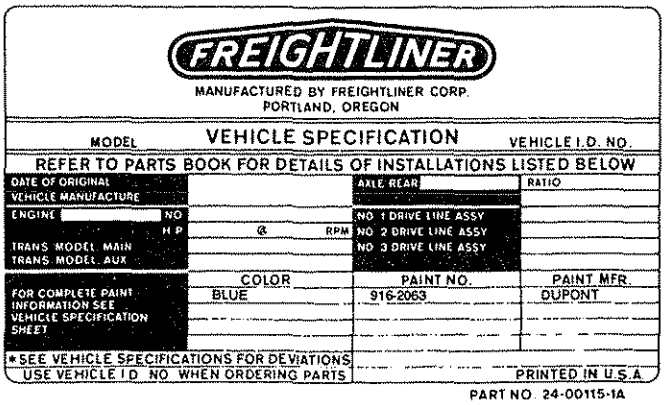
To determine the correct paint number for color-matching of any original finish on a vehicle, refer to the paint specification on the vehicle specification decal (**Fig. 1**). Refer to the vehicle driver's manual for the location of this decal.

To match DuPont 916Y paint in the field, the paint number (916-2063, in the example) must be converted to the DuPont code number. To do this, delete any prefix or suffix (916); the remaining numbers (2063) will be the DuPont code number. Look up this code number in the DuPont cross reference list under "DuPont." See **Fig. 2**. Then, go across to the appropriate column and find the code for the desired paint.

To obtain the correct paint number of a Freightliner-approved paint manufactured by a company other than DuPont, the paint number (916-2063) must still be converted to the DuPont code number (2063). Cross reference this number to the approved paint manufacturer's paint number by using that manufacturer's cross reference chart.

If the paint number is not contained in the other manufacturer's cross reference chart, contact the nearest DuPont dealer. Give the dealer the DuPont code number and have the dealer convert this code to the vehicle application by year, make, vehicle model, and the color by name. Using the application information, refer to the paint manufacturer's automotive refinish colors book to find the paint number corresponding to the DuPont paint.

If unable to find the correct paint number using the method above, contact a Freightliner Regional Office for assistance.



FREIGHTLINER

MANUFACTURED BY FREIGHTLINER CORP.
PORTLAND, OREGON

MODEL	VEHICLE SPECIFICATION	VEHICLE I.D. NO.

REFER TO PARTS BOOK FOR DETAILS OF INSTALLATIONS LISTED BELOW

DATE OF ORIGINAL VEHICLE MANUFACTURE		AXLE REAR	RATIO
ENGINE NO H.P.	@ RPM	NO. 1 DRIVE LINE ASSY NO. 2 DRIVE LINE ASSY	
TRANS. MODEL MAIN TRANS. MODEL AUX		NO. 3 DRIVE LINE ASSY	
	COLOR	PAINT NO.	PAINT MFR.
FOR COMPLETE PAINT INFORMATION SEE VEHICLE SPECIFICATION SHEET	BLUE	916-2063	DUPONT

*SEE VEHICLE SPECIFICATIONS FOR DEVIATIONS
USE VEHICLE I.D. NO. WHEN ORDERING PARTS

PRINTED IN U.S.A.

PART NO. 24-00115-1A

Fig. 1 pdla_0002h

COMPLETE PAINTING OR TOUCH-UP PAINTING

GENERAL GUIDELINES

1. Preparation materials specified for one type of surface should not be used for any other type of surface.
2. Limit intermediate coatings, such as sealers, to the brand and type specified by the finish coat manufacturer.
3. Do not mix additives with the finish coats, unless they are specified by the finish coat manufacturer.

IMPORTANT: Only experienced, qualified persons, using proper equipment, should attempt repainting and touch-up painting.

PREPARATION FOR TOPCOATING

To prepare a vehicle for topcoating with DuPont Centari acrylic enamel, Imron polyurethane enamel, or Imron 5000, proceed as follows:

1. Wash and dry the entire truck.

WARNING: If using an enamel reducer, keep the container closed. Use only with adequate ventilation. Avoid breathing the vapor, or headache, nausea, and impaired reaction time and coordination may result.

2. Using a clean cloth soaked with DuPont Prep-Sol 3919 S, wipe all surfaces to be painted. Remove all traces of wax, polish, grease, and silicones, as follows:
   - .1 Work on small areas at a time, wetting the surface liberally.
   - .2 Wipe off the surface with a clean cloth before the Prep-Sol 3919 S has a chance to dry. Change cloths frequently.
3. Feather-edge all repaired areas, chipped surfaces, and scratches, as follows:
   - .1 Cut down the edges of broken spots with no. 220 sandpaper.
   - .2 Feather the edges by hand, using a sanding block with no. 400 sandpaper.
4. Sand the entire area to be painted. Use a sanding block and no. 400 sandpaper to remove the gloss and to improve adhesion of the primer.
5. Using a clean cloth soaked with DuPont 3939 S laquer and enamel cleaner, remove any sanding dust.

WARNING: Use DuPont 225 S aluminum cleaner and 5717 S metal conditioner with adequate ventilation. Avoid breathing the vapor, or headache, nausea, and impaired reaction time and coordination may result.

6. Treat bare metal and rusted areas. For aluminum, use DuPont 225 S aluminum cleaner; for all other metals, use 5717 S metal conditioner.
   - .1 Mix one part of the cleaner with two parts of water in a plastic bucket.
   - .2 Apply the cleaner with a cloth or sponge. If corrosion is present, work the surface with a stiff brush or Scotch-Brite pad.

MANUFACTURER CODE					916 LINE M/M CODE		
DUPONT	CENTARI	DULUX	IMRON	LUCITE	COMPUTER	GREEN CARD	COLOR
1863	48AH	1863H	1863UH	48LH	1863E	1863	Red
2015	2015A	2015	2015U	—	2015E	2015	Green
2063	2063AH	2063	2063UH	2063L	2063E	2063	Blue
2244	2244A	2244	2244U	—	2244E	2244	Yellow
2304	2304A	2304	2304U	—	2304E	2304	Cream
2305	2305A	2305	2305U	52999LH	2305E	2305	Orange
2619	—	2619	70093U	—	2619E	2619	Green
2850	2850A	2850	—	—	2850E	2850	Green
3295	3295A	3205	3295U	—	3205E	3295	Tan
3421	446A	3421	3421U	448LH	3421E	3421	Yellow
3422	—	3422H	3422UM	—	—	3422	Red
3430	7165A	3430	3430U	7165LH	3430E	7165	Blue

Fig. 2, Sample Portion of DuPont Cross-Reference Chart

COMPLETE PAINTING OR TOUCH-UP PAINTING

.3 While the metal is still wet, wipe off thoroughly with a clean, dry cloth. Allow the surface to dry before applying a conversion coating.

7. Apply a conversion coating to all bare metal. For aluminum, use DuPont 226 S aluminum conversion coating; for steel, use 224 S conversion coating; for zinc casings, or galvanized iron or steel, use 227 S conversion coating.

.1 Pour the conversion coating into a plastic container (do not dilute). Using a Scotch-Brite or similiar abrasive pad, apply the conversion coating to the metal surface. Work only as much area as can be coated and rinsed before the solution dries.

.2 Leave the coating on the surface for two to five minutes. Then, rinse off the solution with cold water, or mop with a damp sponge or cloth rinsed occasionally in clean water.

NOTE: If the metal surface dries before rinsing, reapply the conversion coating, then repeat step 7.2.

.3 Wipe the surface dry with a clean cloth, or air dry.

8. With paper and tape, mask all areas that are not to be painted, then prime immediately.

NOTE: Either DuPont 131 S acrylic lacquer-type primer-surfacer, or DuPont Corlar® epoxy primer, may be used. The procedures for their application are listed below as steps 9 and 10, respectively.

9. Prime all bare metal and feathered areas with DuPont 131 S primer-surfacer, as follows:

WARNING: Primer-surfacer and thinner are flammable; keep them away from heat, sparks, and open flame. Avoid breathing the vapor or spray mist. Keep the container closed. Use only with adequate ventilation. Breathing the vapor may cause headache, nausea, and impaired reaction time and coordination.

.1 Clean all cracks and surfaces with dry compressed air.

.2 Using a tack cloth, wipe all surfaces to be painted.

IMPORTANT: Wear a properly fitted vapor and particulate respirator, approved by NIOSH or MSHA (TC-23C), when mixing or applying primer.

.3 Stir the primer well. Then, add one part of DuPont 3602 S or 3661 S thinner to one part of the primer (viscosity reading 17 to 19 seconds, no. 2 Zahn cup). Stir thoroughly.

.4 Apply medium coats of primer to the bare metal and feathered areas until adequate build (1.0 to 1.5 mils, for use under Centari; 1.8 to 2.4 mils, for use under Imron or Imron 5000) is obtained. Allow each coat to completely flash before applying the next coat.

.5 Allow the final coat to dry for 60 minutes, then sand with no. 360 sandpaper and water, or no. 320 sandpaper dry.

.6 Using a squeegee, fill the remaining imperfections with DuPont Spot-N-Glaze putty. Allow the putty to dry for about one hour, then sand.

10. Prime all bare metal and feathered areas with DuPont Corlar epoxy primer, as follows:

WARNING: Primer is flammable; keep it away from heat, sparks, and open flame. Keep the container closed. Avoid contact with eyes and skin, as it could cause skin or eye irritation. Use only with adequate ventilation. Avoid prolonged or repeated breathing of vapor or spray mist; breathing the vapor may cause irritation.

.1 Clean all cracks and surfaces with dry compressed air.

.2 Using a tack cloth, wipe all surfaces to be painted.

WARNING: Lacquer thinner is flammable; keep it away from heat, sparks, and open flame. Keep the container closed. Use only with adequate ventilation. Avoid breathing the vapor, or headache, nausea, and impairment of reaction time and coordination may result.

IMPORTANT: Wear a positive-pressure, supplied-air, vapor and particulate respirator, approved by NIOSH or MSHA (TC-19C), when mixing or spraying primer, and until the work area has been exhausted of all vapor and spray mist.

.3 Stir Corlar 825 S primer thoroughly; then mix two parts of Corlar primer with one part of DuPont 826 S activator. Reduce three parts of this mixture with one part of DuPont 3602 S Lacquer thinner (viscosity reading 18 to 22 seconds, no. 2 Zahn cup). Stir thoroughly.

.4 Wait one to two hours from time of mixing before using. This provides time for complete chemical induction.

COMPLETE PAINTING OR TOUCH-UP PAINTING

.5 Spray one full wet coat to give a dry film thickness of 0.7 to 1.0 mil. Allow the primer to dry two to four hours before applying the topcoat.

.6 Clean equipment with DuPont 3602 S lacquer thinner.

11. Clean all cracks and surfaces with dry compressed air.

12. Using a tack cloth, wipe all surfaces to be painted.

CENTARI ACRYLIC APPLICATION

IMPORTANT: Wear a positive-pressure, supplied-air, vapor and particulate respirator, approved by NIOSH or MSHA (TC-19C), when spraying Centari mixed with 792 S or 793 S hardener. This mixture contains isocyanates having air contaminant properties equivalent to toulene 2, 4-diisocynate.

Mixing

WARNING: When Centari is mixed with 792 S or 793 S hardener, the vapor is harmful. Breathing the vapor may cause headache, nausea, and impaired reaction time and coordination.

1. Stir Centari enamel thoroughly; then, add one pint (0.5 L) of DuPont 792 S hardener to one gallon (3.8 L) of unreduced Centari acrylic enamel, when color-matching spot repairs. Or, add one pint (0.5 L) of DuPont 793 S hardener to one gallon (3.8 L) of unreduced Centari acrylic enamel, when painting entire vehicle or complete panels.

2. Add one part of reducer to two parts of catalyzed enamel for a viscosity reading of 18 to 22 seconds, no. 2 Zahn cup. Refer to **Table 2** under "Specifications" for the appropriate reducer as determined by temperature range. Stir thoroughly and strain.

NOTE: Pot life of Centari after 792 S hardener has been added is six to eight hours. Pot life of Centari after 793 S hardener has been added is three to four hours.

Color-Matching Spot Repairs

1. Using 30 to 40 psi (207 to 276 kPa) gun pressure, hold the spray gun 8 to 10 inches (20 to 25 cm) from the surface and apply a medium coat. Allow to set for 20 to 30 minutes. This is the sealer coat.

2. Apply three or more medium coats until hiding is achieved, extending each coat beyond the previous one. Allow each coat to flash before applying the next coat.

3. Increase the gun pressure to 65 to 70 psi (448 to 482 kPa), then spray a full wet coat beyond the previous one.

4. Empty the spray cup, then refill it with DuPont 8022 S reducer or a blend of 8022 S and 8093 S.

NOTE: A mist coat of five parts of color to three parts of 8022 S is recommended when applying metallics.

5. Lower the gun pressure to 15 to 20 psi (103 to 138 kPa), then carefully blend the edge of the repair with even coats to melt in the overspray. Spray one or two medium coats of the reducer over the entire area. If a haze appears around the edge after the reducer has dried, lightly rub the edge with DuPont 1500 S one-step polish.

Repainting Entire Vehicle, Painting Complete Panels, and Two-Toning

1. Use 65 psi (448 kPa) pressure at the gun. If using pressure pot equipment, use 20 psi (138 kPa) pot pressure for a fluid flow of 20 to 25 fl oz (591 to 739 mL) per minute, and 70 psi (482 kPa) gun pressure.

2. Apply three full wet coats, allowing each coat to flash before applying the next coat.

3. If color-matching is required, empty the spray cup, then refill it with DuPont 8022 S reducer or a blend of 8022 S and 8093 S.

NOTE: A mist coat of five parts of color to three parts of 8022 S is recommended when applying metallics.

4. Lower the gun pressure to 15 to 20 psi (103 to 138 kPa), then carefully blend the edge of the repair with even coats to melt in the overspray. Spray one or two medium coats of the reducer over the entire area. If a haze appears around the edge after the reducer has dried, lightly rub the edge with DuPont 1500 S one-step polish.

Tape-Time and Curing

1. Under normal drying conditions, two-toning, striping, lettering, and decals may be applied any time after four hours. For top coats cured over 72 hours, scuff-sand with no. 400 sandpaper before recoating, striping, lettering, or applying decals.

NOTE: Wait 60 days before waxing.

2. Remove all masking tape immediately after the final color is applied, to prevent tape marking. Avoid masking paper contact with fresh enamel.

COMPLETE PAINTING OR TOUCH-UP PAINTING

WARNING: Lacquer thinner is flammable; keep it away from heat, sparks, and open flame. Keep the container closed. Use only with adequate ventilation. Avoid breathing the vapor, or headache, nausea, and impaired reaction time and coordination may result.

3. Wearing a properly fitted vapor and particulate respirator approved by NIOSH or MSHA (TC-23C), clean all spray equipment, immediately after use, with DuPont 3602 S lacquer thinner.

IMRON POLYURETHANE APPLICATION

IMPORTANT: Wear a positive-pressure, supplied-air, vapor and particulate respirator approved by NIOSH or MSHA (TC-19C), while spraying Imron, and until the work area has been exhausted of all vapor and spray mist.

Mixing

WARNING: Imron enamel is flammable; keep it away from heat, sparks, and open flame. Breathing the vapor may cause breathing difficulty, coughing, and chest pains. Imron colors may contain lead. Dried film of this paint may be harmful or fatal if eaten or chewed. When Imron enamel is mixed with 192 S activator, the mixture will have the hazards of both components. Observe all label precautions.

1. Stir Imron enamel thoroughly. Then, mix three parts of Imron enamel with one part of DuPont 192 S activator.
2. If faster curing time is desired, add DuPont 189 S accelerator at the rate of 4 fl oz (120 mL) to 1 gal (3.8 L) of mixed material.

NOTE: Mix no more material than can be used in an eight hour period.

WARNING: Retarder is flammable; keep it away from heat, sparks, and open flame. Close the container after each use. Breathing the vapor may cause headache, nausea, and impaired reaction time and coordination. Use with adequate ventilation.

3. Spray viscosity should be 18 to 22 seconds, no. 2 Zahn cup. Check viscosity every four hours. No further reduction is necessary for application. If desired, material may be further reduced with DuPont Y-8485 S reducer.
4. Mix thoroughly and strain.

Spraying Solid Colors

1. Hold the spray gun approximately 8 inches (20 cm) from the surface. Use 50 psi (345 kPa) gun pressure, and spray a minimum first coat.
2. Allow the first coat to get tacky, then follow with a second full coat.

Spraying Metallics

NOTE: To apply the metallic colors listed in Table 2 under "Specifications," first apply the applicable base coat, following the procedure above for "Spraying Solid Colors." Then, follow the instructions under "Tape-Time and Curing," before applying the metallic top coat.

1. Hold the spray gun about 8 inches (20 cm) from the surface. use 65 psi (448 kPa) gun pressure, and spray a light to medium coat.
2. Wait 20 minutes, then apply a second light to medium coat.
3. Reduce the paint mixture 15 percent with DuPont Y-8485 S reducer (17 to 18 seconds, no. 2 Zahn cup), then apply the third light coat, followed, if desired, by a fourth light coat.

Tape-Time and Curing

1. Two-toning striping, lettering, and decals may be applied in 2 to 4 hours if DuPont 189 S accelerator was added to the Imron. Wait 6 to 10 hours if no accelerator was used.
2. For topcoats cured over 72 hours, scuff-sand with no. 400 sandpaper before recoating, striping, lettering, or applying decals.

WARNING: Lacquer thinner is flammable; keep it away from heat, sparks, and open flame. Keep the container closed. Use only with adequate ventilation. Avoid breathing the vapor, or headache, nausea, and impaired reaction time and coordination may result.

3. Wearing a properly fitted vapor and particulate respirator, approved by NIOSH or MSHA (TC-23C), clean all spray equipment immediately after use with lacquer thinner or retarder. Do not leave mixed material in equipment.

COMPLETE PAINTING OR TOUCH-UP PAINTING

Spot Repair Touch-Up

IMPORTANT: DuPont recommends that Imron be panel-repaired to achieve the best results. However, small areas are often spot-repaired. Successful spot repair depends on operator skill and should not be attempted in high visibility areas such as door panels or hoods.

1. Sand or grind all dents and scratches.
2. Sand the area being repaired with a 400 or finer wet grit sandpaper or 600 dry grit sandpaper.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

3. Clean the area with DuPont 3812 S solvent; then, wipe with a tack cloth.
4. Apply a wash primer (**Fig. 3**, Ref. 1) 0.5 to 0.7 mil thick. For recommended primer, see **Table 3** under "Specifications." Dry according to the manufacturer's instructions.
5. Apply a sealer primer (**Fig. 3**, Ref. 2) 0.9 to 1.1 mils thick. For recommended primer, see **Table 3** under "Specifications." Dry according to the manufacturer's instructions.

IMPORTANT: Use wash primer and sealer primer from the same manufacturer. Primers from different manufacturers may not be compatible. Use DuPont Imron as the topcoat with both DuPont and PPG primers.

6. Scuff-sand the primer with 320 to 400 dry grit sandpaper.

WARNING: Imron enamel is flammable; keep it away from heat, sparks, and open flame. Breathing the vapor may cause breathing difficulty, coughing, and chest pains. Imron colors may contain lead. Dried film of this paint may be harmful or fatal if eaten or chewed. When Imron enamel is mixed with 192 S activator, the mixture will have the hazards of both components. Observe all label precautions.

7. Stir the Imron enamel thoroughly. Then, mix three parts of Imron enamel with one part of DuPont 192 S activator.
8. Thin the activated Imron color with 8485 S solvent to a viscosity of 20 seconds as measured with a no. 2 Zahn cup. Use no more than 25 percent thinner by volume.

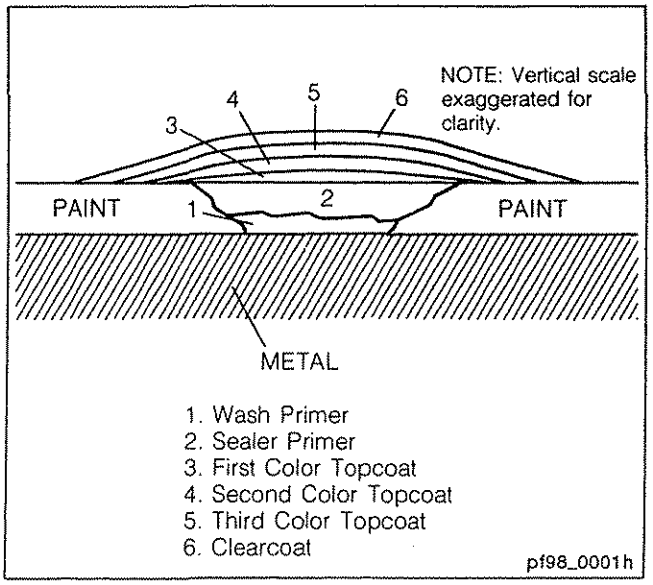


Fig. 3, Application of Primer and Topcoats

9. Use 50 to 60 psi (345 to 414 kPa) air pressure at the paint gun.

IMPORTANT: Wear a positive-pressure, supplied-air, vapor and particulate respirator approved by NIOSH or MSHA (TC-19C). Wear the respirator while spraying, and until the work area has been exhausted of all vapor and spray mist.

10. Apply at least three topcoats of Imron color. Each color topcoat should extend beyond the preceding topcoat to provide the proper taper and to avoid a visible ring. See **Fig. 3**, Refs. 3 through 5.
11. Coat the outer edge of each color topcoat with a *mist* of solvent while the color topcoat is still wet.
    a. When the ambient temperature is below 80°F (27°C), use 8485 S solvent.
    b. When the ambient temperature is 80°F (27°C), or higher, use a mixture of 8485 S and 8100 S.

IMPORTANT: Coat only the edge of each color coat with solvent mist. Excess solvent in the center of the color coats could cause the paint to sag.

12. Apply a final clearcoat (**Fig. 3**, Ref. 6) of activated 500 S urethane, thinned with 200 percent 8585 S or 8575 S solvent.

COMPLETE PAINTING OR TOUCH-UP PAINTING

Imron 5000 Urethane Application

IMPORTANT: Wear a positive-pressure, supplied-air, vapor and particulate respirator approved by NIOSH or MSHA (TC-19C), while spraying Imron 5000, and until the work area has been exhausted of all vapor and spray mist.

MIXING

WARNING: Imron 5000 enamel is flammable; keep it away from heat, sparks, and open flame. Breathing the vapor or spray mist may cause a variety of health problems, including lung irritation and allergic respiratory reaction. Do not get Imron 5000 or its spray mist in your eyes or on your skin; it could cause skin or eye irritation. Imron colors may contain lead. Always keep containers closed when not in use. Do not transfer the materials to bottles or other unmarked containers. When Imron 5000 enamel is mixed with 193 S activator, the mixture will have the hazards of both components. Observe all label precautions.

1. Stir Imron 5000 enamel thoroughly. Then, mix three parts of Imron 5000 enamel with one part of 193 S activator.

NOTE: The pot life is about two to four hours at 70°F (21°C).

2. If faster curing time or an extended pot life is desired, add Imron 5000 fast-dry accelerator 389 S. Add up to two fluid ounces (60 mL) to one gallon (3.8 L) of mixed material.

3. Mix thoroughly and strain.

NOTE: The viscosity of the mixture is about 9 to 20 seconds in a Zahn no. 3 cup, depending on the color. No further reduction is required. Adding reducer could affect the color match on some metallics.

SPRAYING SOLID COLORS AND METALLICS

1. For gravity feed systems, set the air pressure to 60 to 70 psi (414 to 483 kPa) at the gun.

   For pressure feed systems, set the air pressure to 60 to 70 psi (414 to 483 kPa) at the gun, and set the fluid delivery at 10 to 12 ounces (300 to 350 mL) per minute.

2. Hold the spray gun about 8 inches (20 cm) from the surface. Use a cross-coat technique. Spray a tack coat first, using a top to bottom motion. Wait five minutes, then spray a medium-wet second coat using a side-to-side motion. For metallic colors, wait another five minutes and apply a mist coat if desired.

3. To air dry, allow 2 to 4 hours with accelerator 389 S, and 6 to 8 hours without accelerator.

   To force dry, wait 15 minutes following the application of the final coat, then dry for 30 minutes at 180°F (82°C).

4. Two-toning, striping, and lettering may be applied in 4 to 6 hours if accelerator 389 S is used. Wait 10 to 12 hours if no accelerator was used.

   Decals may be applied in 12 to 16 hours if accelerator 389 is used. Wait 24 hours if no accelerator is used.

WARNING: Lacquer thinner and reducer are flammable; keep them away from heat, sparks, and open flame. Keep the container closed. Use only with adequate ventilation. Avoid breathing the vapor, or headache, nausea, impaired reaction time, and impaired coordination may result.

5. Wearing a positive-pressure, supplied air, vapor and particulate respirator, approved by NIOSH or MSHA (TC-23C), clean all spray equipment immediately after use with Acrylic Lacquer Thinner 3602 S or Imron 5000 Reducer 8685 S. Do not leave mixed paint in the equipment.

SPOT REPAIR TOUCH-UP

IMPORTANT: DuPont recommends that Imron 5000 be panel-repaired to achieve best results. However, small areas are often spot-repaired. Successful spot repair depends on operator skill and should not be attempted in high visibility areas such as door panels or hoods.

1. Sand or grind all dents and scratches.

2. Sand the area being repaired with a 320 or finer wet grit sandpaper, or a Scotch-Brite pad.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

3. Clean the area with DuPont 3812 S solvent; then, wipe with a tack cloth.

COMPLETE PAINTING OR TOUCH-UP PAINTING

4. Apply a wash primer 0.5 to 0.7 mil thick. See **Table 3** under "Specifications" for recommended primer. Dry according to the manufacturer's instructions.
5. Apply a sealer primer 0.9 to 1.1 mil thick. See **Table 3** under "Specifications" for recommended primer. Dry according to the manufacturer's instructions.

IMPORTANT: Use wash primer and sealer primer from the same manufacturer. Primers from different manufacturers may not be compatible. Use DuPont Imron 5000 as the topcoat with both DuPont and PPG primers.

WARNING: Imron 5000 is flammable; keep it away from heat, sparks, and open flame. Breathing the vapor may cause breathing difficulty, coughing, and chest pains. When Imron 5000 enamel is mixed with 193 S activator, the mixture will have the hazards of both components. Observe all label precautions.

6. Stir the Imron 5000 enamel thoroughly. Then, mix three parts of Imron 5000 enamel with one part of DuPont 193 S activator.
7. To speed the drying time of activated Imron 5000 color, add up to two fluid ounces (60 mL) of fast-dry accelerator 389 S to one gallon (3.8 L) of mixed material.
8. Mix eight parts of 500 S urethane with one part 193 S activator.
9. Reduce the activated 500 S urethane 50 percent with 8685 S reducer.
10. Use 50 to 60 psi (345 to 414 kPa) air pressure at the paint gun.

IMPORTANT: Wear a positive-pressure, supplied-air, vapor and particulate respirator approved by NIOSH or MSHA (TC-19C), while spraying Imron 5000, and until the work area has been exhausted of all vapor and spray mist.

11. Apply a medium-wet coat of 500 S urethane over the entire repair area, and well beyond where the color will be applied. Allow two to three minutes for the application to flash before applying Imron 5000.
12. Apply at least two topcoats of Imron 5000 color. Allow five to ten minutes drying time between each topcoat. Each color topcoat should extend beyond the preceding topcoat to provide the proper taper and to avoid a visible ring.
13. After the Imron 5000 color has dried, apply a coat of 500 S urethane clear to melt in the overspray edges.

IMPORTANT: Coat only the edge of each color coat with 500 S urethane. Excess in the center of the color coats could cause the paint to sag.

14. For a uniform flake appearance, immediately apply a mist of Imron 5000 color over the 500 S urethane clear.
15. Apply a final clearcoat using 9300 S, or activated 500 S urethane, thinned 100 percent with 8685 S reducer.

SPECIFICATIONS

IMRON		
Metallic Paint Number	Metallic Color	Base Coat Paint Number
44419UH	Dark Frost Green	55337UH
44420U	Medium Olive	43943U
44445UH	Light Brown	7202U
44446U	Dark Saddle	29607U
44453U	Sand	96939U
44455U	Light Maroon	5321

Table 1, Metallic Paint Number and Base Coat Paint Number Cross Reference

Ambient Air Temperature	DuPont Reducer
80°F (26°C) or Above	8093 S, or a blend of 8093 S and 8022 S
70°F (21°C) to 80°F (26°C)	8022
Under 70°F (21°C)	8034 S, or a blend of 8034 S and 8022 S

Table 2, DuPont Reducer Selection Per Ambient Air Temperature, for Mixing Centari

Product	PPG Brand Name	DuPont Brand Name
Cleaning Solvent	—	3812 S/3832 S/3939 S
Wash Primer	DX 1791	Variprime 615 S or 616 S
Sealer Primer	DP-40	Corlar 824 S
Topcoat	—	Imron
Topcoat Solvent	—	8485 S 8685 (for Imron 5000)
Clearcoat	—	500 S
Accelerator	—	389 S

Table 3, Materials Needed for Spot Repair Touch-Up With Imron

CAB LATCH

GENERAL DESCRIPTION

The cab latch assembly consists of two locking devices which allow a controlled amount of looseness before stopping the upward motion of the back of the cab. The looseness serves as a means of relieving possible stresses in the cab due to the normal motions of the frame during vehicle operation. The cab latch prevents the possibility of the cab tilting during vehicle operation, and the unwanted separation of the engine air intake duct where applicable.

Two styles of cab support mounts are used on the Freightliner COE vehicles. Figure 1 shows the frame-top mounted inboard mount used on the longer length and sleeper cab models. Where the mounting of other assemblies interfere with the mounting of the inboard mount, or when the short cab models are used, the outboard cab support mount (Fig. 2) which bolts to the side of the frame, is used. All adjustments or measurements shown in Figure 3 apply to both types of cab support mounts.

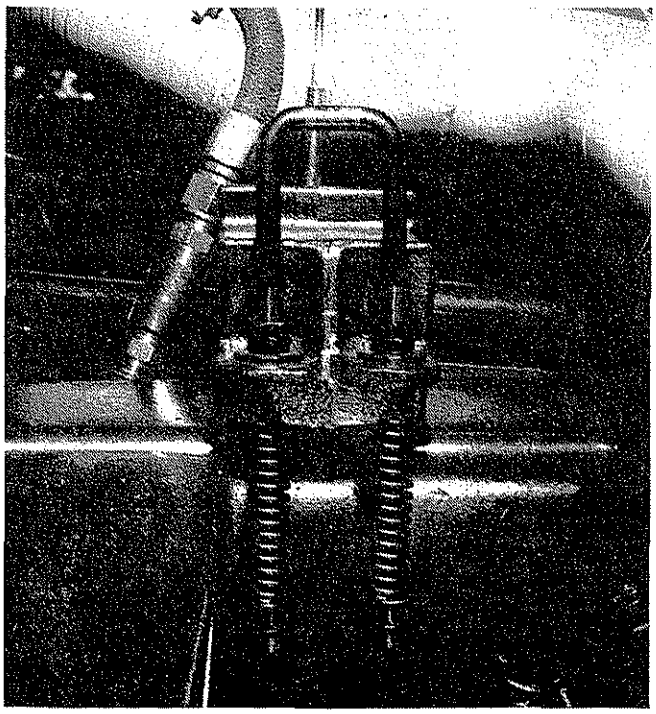


Fig. 1, Inboard Mount

SERVICE OPERATIONS

LATCH ADJUSTMENT (Refer to Fig. 3)

1. Unlock and tilt the cab until all pressure is released from the U-bolt assembly. The spacing between the bottom edge of the U-bolt arch and the U-bolt retainer should be 4-1/4 inches (108 mm).
2. Slowly lower the cab. Adjust the cab latch handle linkage (Ref. 1) so that as the cab is lowered, the cab latch hook lip (Ref. 2) nudges the U-bolt arch.
3. Lock the cab latch handle with the cab in the upright (operating) position. As the cab latch hook (Ref. 2) rotates, be sure it lifts the U-bolt to the over-center position causing a locking action. With the cab in this locked position:

   .1 Eliminate the cab-to-frame looseness by attempting to raise the cab, until the U-bolt springs are fully compressed. See Fig. 3 locked position.

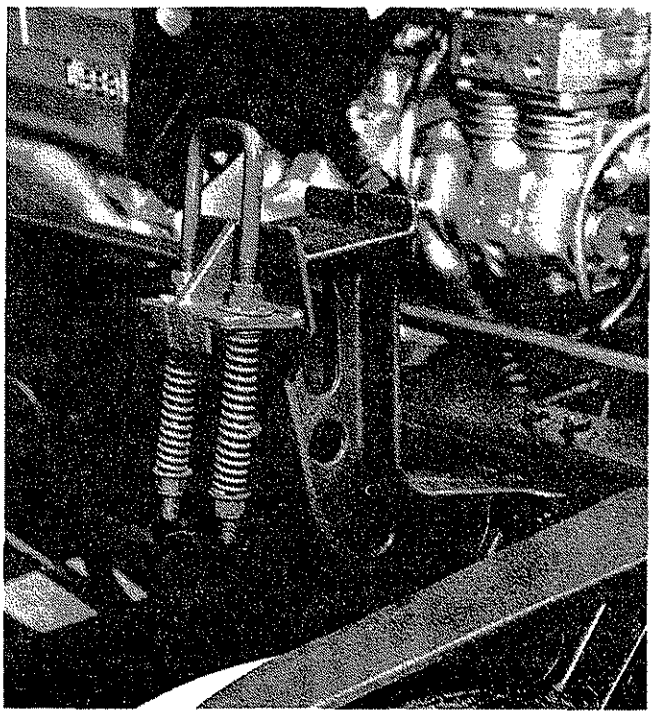
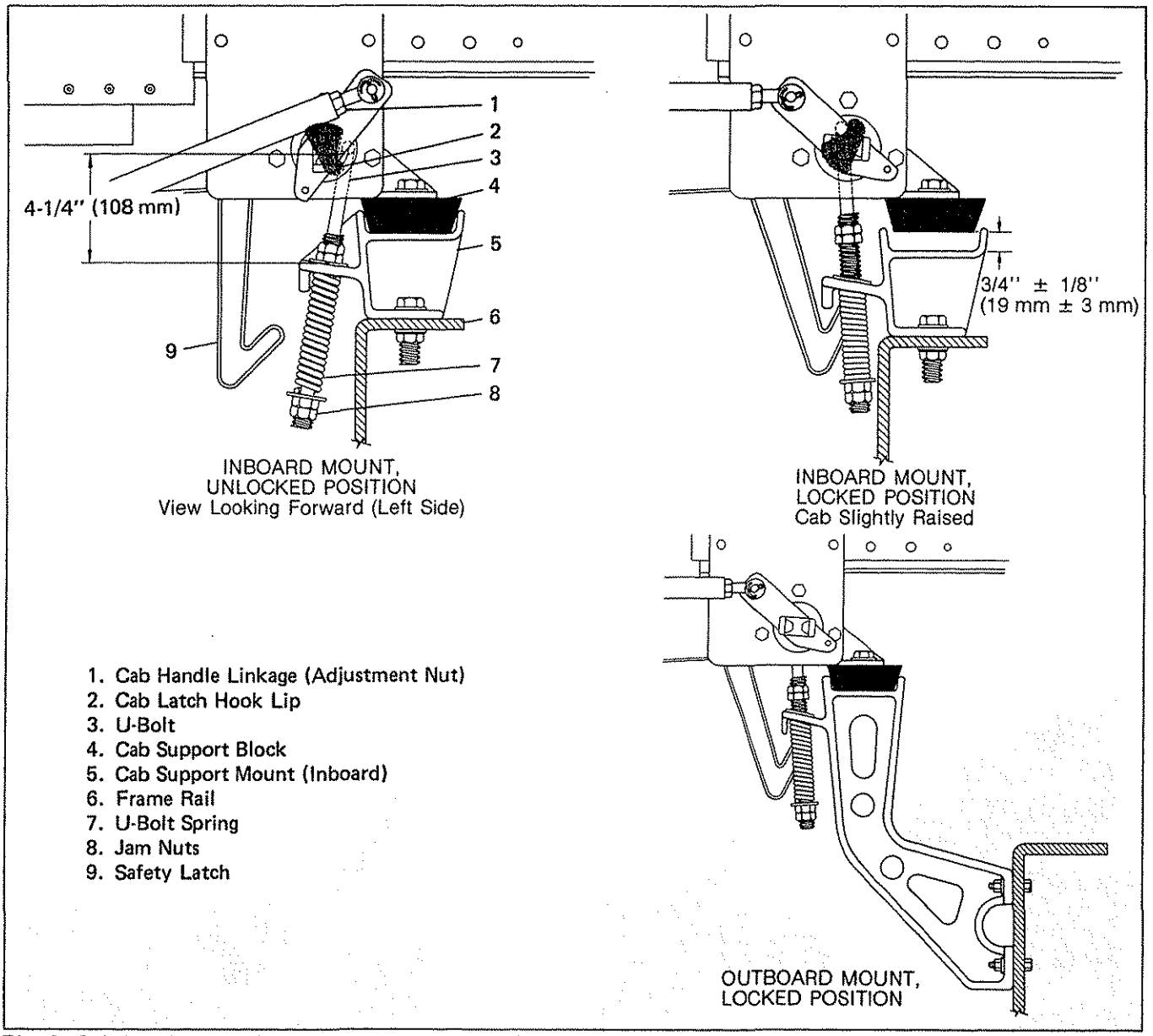


Fig. 2, Outboard Mount

CAB LATCH



1. Cab Handle Linkage (Adjustment Nut)
2. Cab Latch Hook Lip
3. U-Bolt
4. Cab Support Block
5. Cab Support Mount (Inboard)
6. Frame Rail
7. U-Bolt Spring
8. Jam Nuts
9. Safety Latch

Fig. 3, Cab Latch Assembly

.2 Measure the spacing between the cab support block and the cab mount plate. This measurement should be 3/4-inch ± 1/8-inch (19 mm ± 3 mm). Tighten or loosen the jam nuts (Ref. 8) to maintain this measurement.

4. Unlock the cab latch. Slowly raise the cab and observe that the safety-catch securely stops the upward motion of the cab.

WARNING: Do not operate the vehicle with either one or both of the cab latch handles unlocked, or with an inoperative cab latch. Failure to secure the cab could allow the cab to tilt during a brake application. This would result in a loss of vehicle control by the driver and pose a danger to the driver and persons in the area.

FREIGHTLINER CAB-TILT SYSTEM

GENERAL INFORMATION

The Freightliner cab-tilt system, used to raise and lower the cab, consists of three major parts:

1. A hydraulic pump, which is a multipiece assembly consisting of a pump body, reservoir, and needle valve;
2. Cab tilt cylinders (two);
3. A cyclomatic valve, which is mounted on the hydraulic pump and controls the directional flow of hydraulic fluid to the cab tilt cylinders.

PRINCIPLES OF OPERATION

The cab is tilted by releasing the cab latches, moving the cyclomatic valve plunger to the tilt position, closing the needle valve, operating the hydraulic pump, and pulling the safety hook release handle until the safety hook clears the safety catch. The tilt cylinders lift the cab to about 45 degrees, and from a full-tilt position back to 45 degress (**Fig. 1**). At about 45 degrees, the cab weight going overcenter cycles the cyclomatic valve and allows a controlled lowering of the cab to full tilt or to the operating position. The rate of descent beyond overcenter (in either direction) is controlled by opening or closing the needle valve. Refer to the Freightliner *Driver's Manual* for detailed cab-tilt instructions.

Refer to the following headings for additional operating principles of the Freightliner cab-tilt system:

FLUID FLOW THROUGH THE TILT PUMP (See Fig. 2)

With the needle valve closed, an outward stroke of the piston draws hydraulic fluid through the ball check valve assembly and into the piston chamber. As the outward stroke of the piston is completed, the ball check valve seats, trapping fluid in the piston chamber. On the inward stroke of the piston, the trapped fluid is forced through the piston, through the cyclomatic valve, and into the tilt cylinders. As the inward stroke of the piston is completed, the fluid coming out of the piston valve fills the piston chamber between the head of the piston and the packing nut. On the next outward stroke, the fluid between the head of the piston and the packing nut is forced through the cyclomatic valve. Also, during this stroke, fluid is again drawn from the reservoir and through the ball check valve assembly to refill the piston chamber.

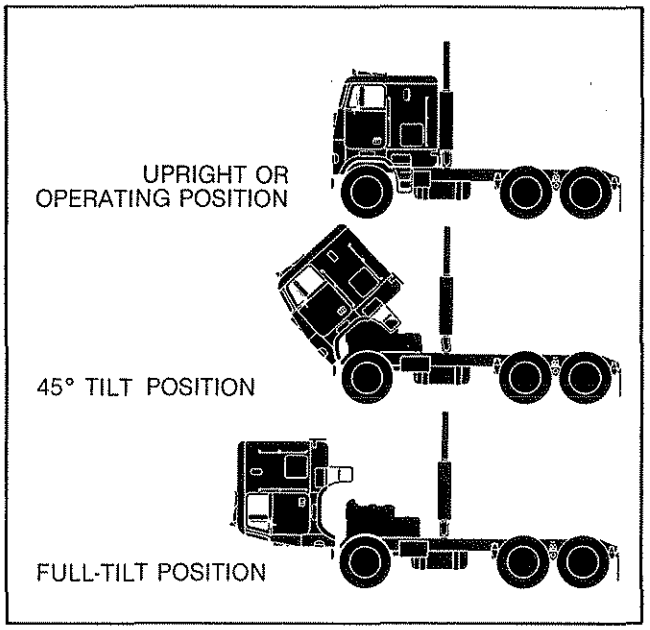


Fig. 1

RAISING THE CAB FROM THE OPERATING POSITION TO A 45-DEGREE TILT POSITION (See **Fig. 2** and **Fig. 3**, Ref. 1)

With the cyclomatic valve plunger in the tilt position, pumping action forces fluid to flow through the cyclomatic valve, out of fitting A (**Fig. 3**), and into the lower ends of the tilt cylinders and, if equipped, to the shift tube latch mechanism.

An unusual amount of resistance during the first six inches (150 mm) of lift, or release of the needle valve, indicates that the shift tube latch mechanism or the hydraulic cab latches are not operating properly.

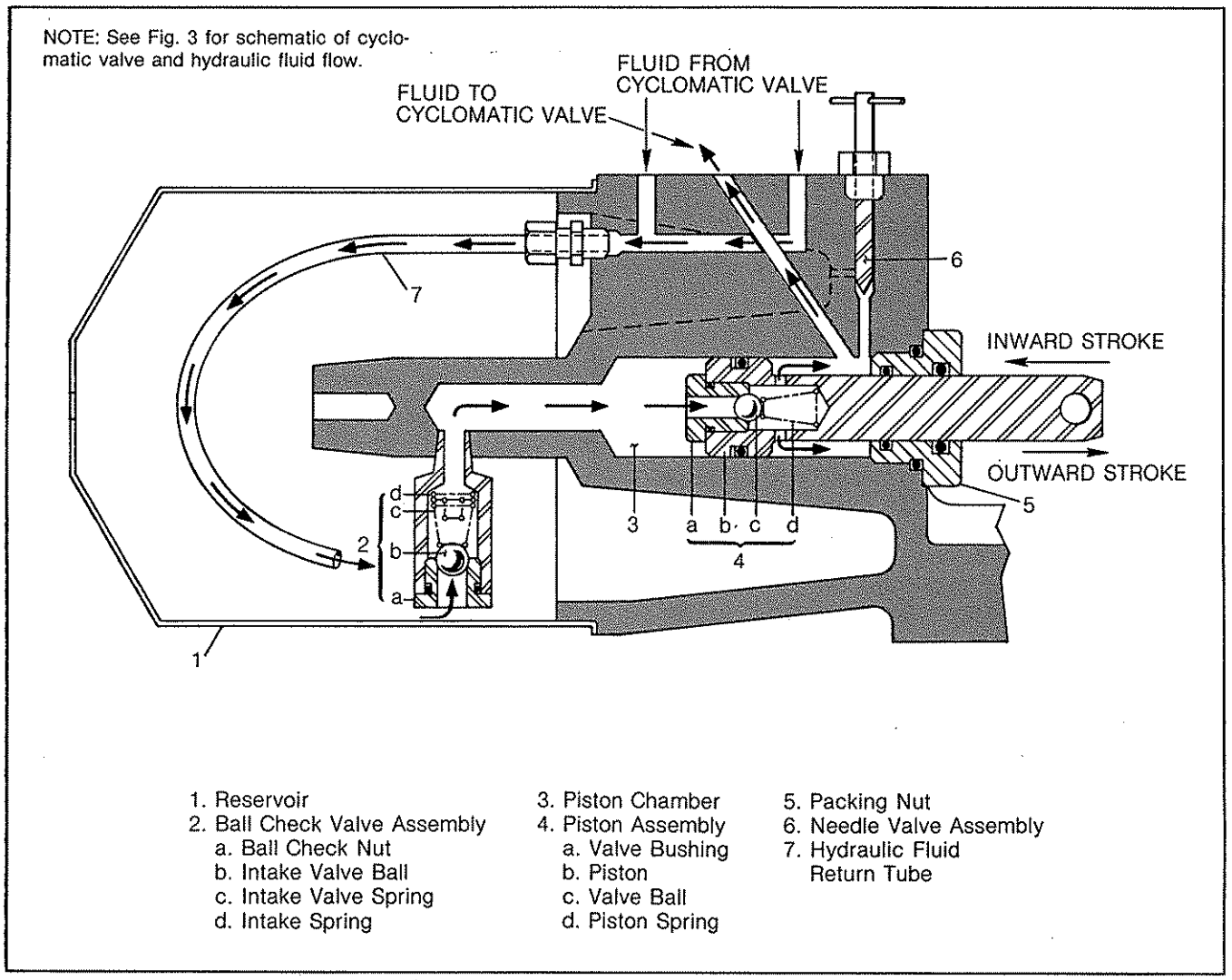
CAUTION: Do not continue to tilt the cab. It could damage the shift tubes and the remote shift dome.

As fluid on the opposite side of the pistons is forced out of the upper ends of the tilt cylinders, into fitting B (**Fig. 3**), and through the cyclomatic valve. Fluid is then forced into the channel which leads to the hydraulic fluid return tube and back into the reservoir.

LOWERING THE CAB FROM A 45 DEGREE TILT POSITION TO A FULL-TILT POSITION (See Fig. 2 and Fig. 3, Ref. 2)

As the cab reaches a 45 degree position, the cab weight going overcenter increases the fluid pressure on the fitting B (Fig. 3) side of the cyclomatic valve

FREIGHTLINER CAB-TILT SYSTEM



1. Reservoir
2. Ball Check Valve Assembly
   a. Ball Check Nut
   b. Intake Valve Ball
   c. Intake Valve Spring
   d. Intake Spring
3. Piston Chamber
4. Piston Assembly
   a. Valve Bushing
   b. Piston
   c. Valve Ball
   d. Piston Spring
5. Packing Nut
6. Needle Valve Assembly
7. Hydraulic Fluid Return Tube

Fig. 2, Tilt Pump Schematic

piston and reduces the pressure on the fitting A side. This causes the piston to move to the opposite side of the valve. Fluid coming into the valve from the tilt cylinders is then routed back to the piston chamber, where it becomes trapped.

The cab stops its free-fall a few degrees past the 45 degree tilt position. Opening the needle valve (**Fig. 2**, Ref. 6) allows the trapped fluid to escape from the piston chamber back into the reservoir. The cab descends to a full-tilt position at a rate controlled by varying the amount the needle valve is opened. As the weight of the cab forces fluid through the cyclomatic valve and into the piston chamber, fluid is simultaneously being drawn from the reservoir into the hydraulic fluid return tube, through the cyclomatic valve, and into the lower ends of the tilt cylinders.

RAISING THE CAB FROM A FULL-TILT POSITION TO A 45 DEGREE TILT POSITION (See **Fig. 2** and **Fig. 3**, Ref. 3)

With the cyclomatic valve plunger in the raise position, and the needle valve (**Fig. 2**, Ref. 6) closed, pumping action forces fluid to flow through the cyclomatic valve, into the upper ends of the tilt cylinders. As the fluid forces the tilt cylinder pistons downward, fluid on the opposite side of the pistons is forced out of the lower end of the tilt cylinders, through the cyclomatic valve, and into the channel which leads to the hydraulic fluid return tube and back into the reservoir.

FREIGHTLINER CAB-TILT SYSTEM

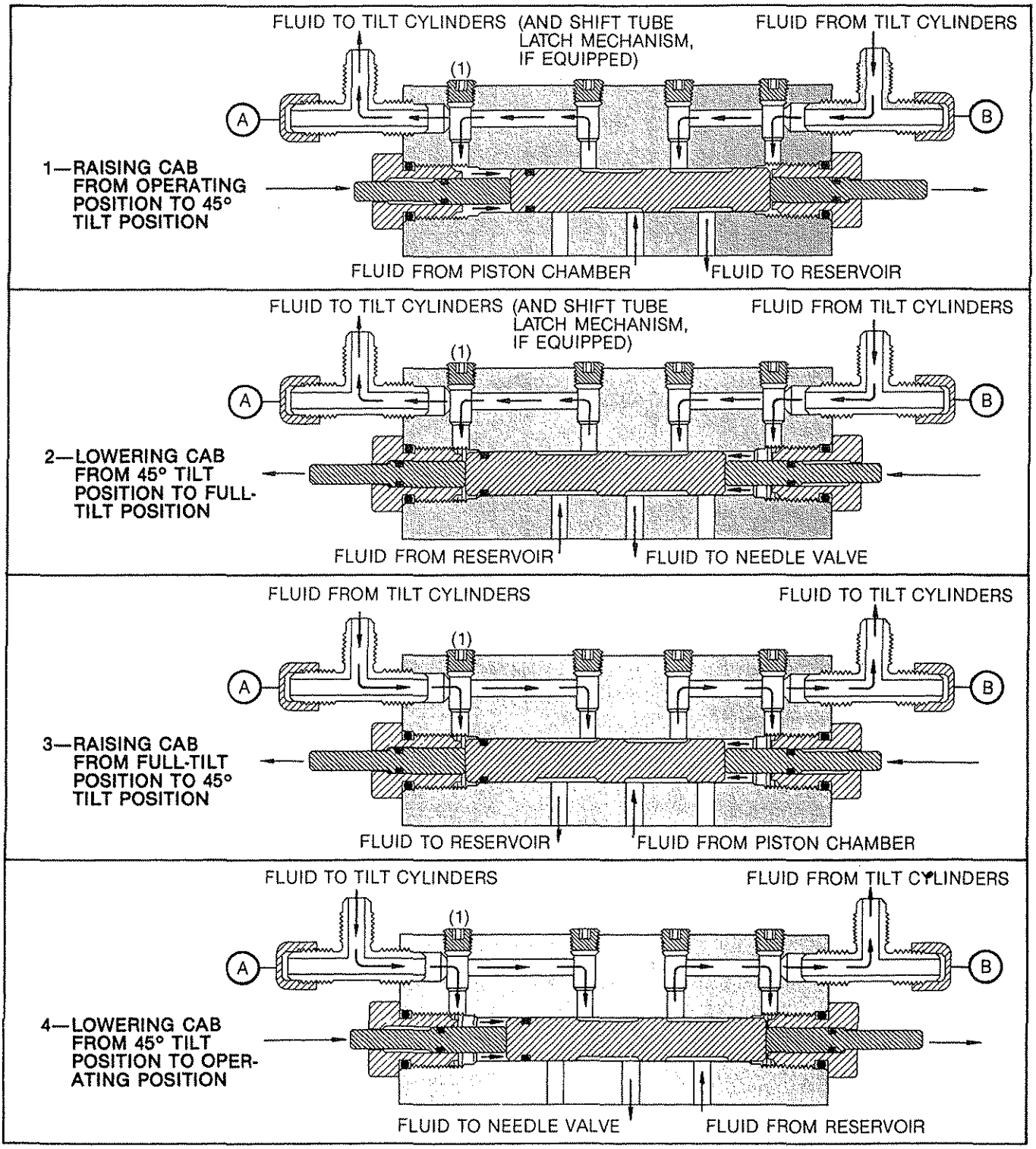


Fig. 3, Schematic of Cyclomatic Valve Assembly

[1] Some cyclomatic valve assemblies are equipped with press-in plugs instead of Allen head pipe plugs as shown.

FREIGHTLINER CAB-TILT SYSTEM

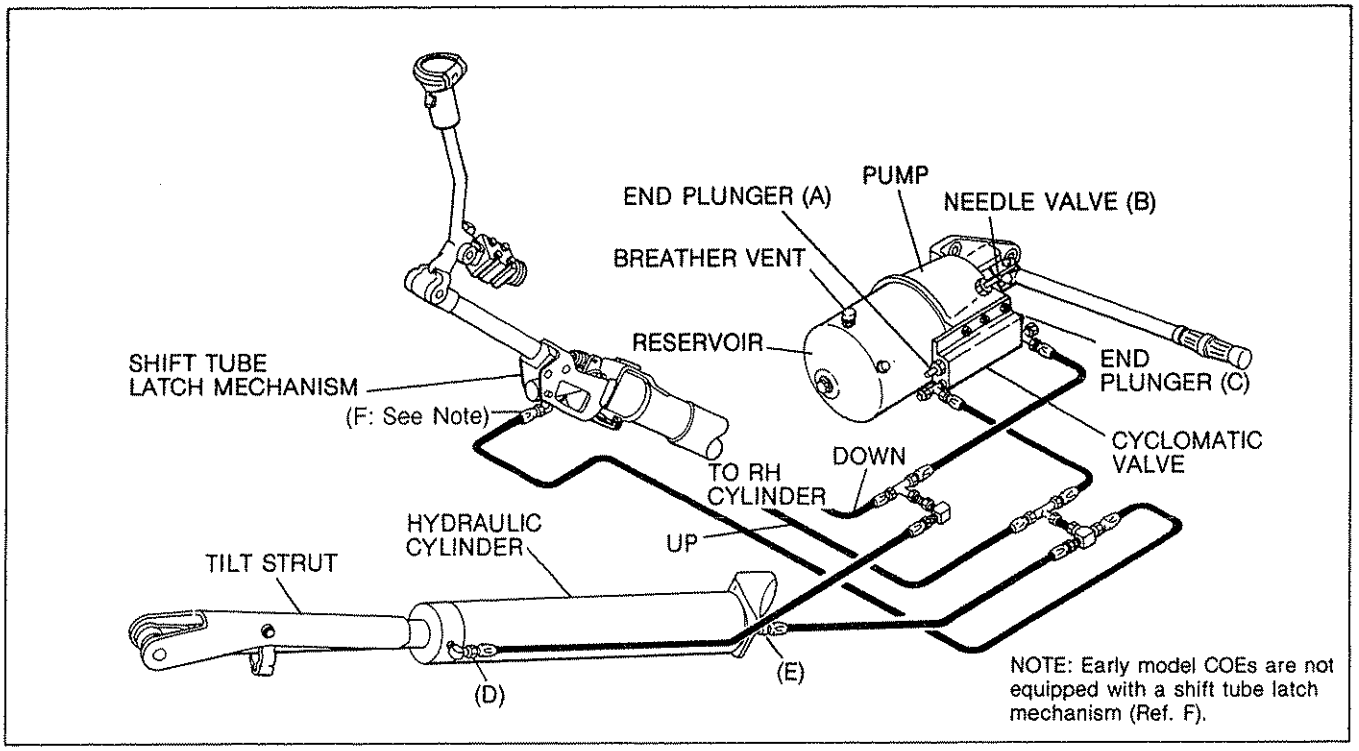


Fig. 4, Cab-Tilt Installation

LOWERING THE CAB FROM A 45 DEGREE TILT POSITION TO THE OPERATING POSITION
(See **Fig. 2** and **Fig. 3**, Ref. 4)

As the cab reaches the 45 degree position, the cab weight going overcenter increases the fluid pressure on the fitting A (**Fig. 3**) side of the cyclomatic valve piston and reduces the pressure on the fitting B side. This causes the piston to move to the opposite side of the valve. Fluid coming into the valve from the tilt cylinders is then routed back to the piston chamber where it becomes trapped. The cab stops its free-fall a few degrees past the 45 degree tilt position. Opening the needle valve (**Fig. 4**, Ref. B) allows the trapped fluid to escape from the piston chamber back into the reservoir. The cab descends to the operating position at a rate controlled by varying the amount the needle valve is opened. As the weight of the cab forces fluid through the cyclomatic valve and into the piston chamber, fluid is simultaneously being drawn from the reservoir into the hydraulic fluid return tube, through the cyclomatic valve, and into the upper end of the tilt cylinders.

SERVICE OPERATIONS

NOTE: Refer to the Freightliner *Driver's Manual* for cab tilt instructions.

INITIAL FILL AND BLEED INSTRUCTIONS

Use the following procedure to bleed air from the tilt system after initial filling, or whenever air is present in the system, before tilting the cab.

1. Fill the reservoir with a low pour-point, multipurpose automotive hydraulic fluid. The reservoir is full when the fluid level reaches the fill hole.

NOTE: For temperatures 10°F (-12°C) and below, fill the reservoir with aircraft hydraulic oil or its equivalent.

2. Unlock the cab latches and place drain pans under the cylinder fittings.
3. Push in the cyclomatic valve end plunger (**Fig. 4**, Ref. C).

FREIGHTLINER CAB-TILT SYSTEM

4. Insert the pump handle, and make sure the needle valve (**Fig. 4**, Ref. B) is closed by turning it clockwise.
5. Operate the pump slowly until pressure builds up in the system, and the cab just starts to push down against the cab mount. To release the pressure, open the needle valve by turning it counter-clockwise.
6. Close the needle valve, then loosen the hydraulic line fittings (**Fig. 4**, Ref. D) at the upper end of the tilt cylinders. Operate the pump slowly until only clear (nonaerated) fluid escapes from the fittings.
7. Check the reservoir fluid level. If the level is low, add fluid until the reservoir is full (when the level reaches the fill hole).
8. Push in the cyclomatic valve end plunger (**Fig. 4**, Ref. A).
9. Loosen the hydraulic line fittings at the lower end of the tilt cylinders and, if equipped, the shift tube latch mechanism. See **Fig. 4**, Refs. E and F.
10. Operate the pump slowly until only clear (nonaerated) fluid escapes from the fittings (Ref. E); tighten the fittings finger-tight, then, using a wrench, tighten them until resistance is felt. Tighten one-sixth turn more. Perform the same procedure on the shift tube latch mechanism fitting (Ref. F), if equipped.
11. Operate the pump slowly until the piston moving upward in the cylinder forces all of the air out of the loosened fittings (**Fig. 4**, Ref. D). Tighten the fittings finger-tight, then, using a wrench, tighten them until resistance is felt. Tighten one-sixth turn more.
12. Check the reservoir fluid level. If the level is low, add fluid until the reservoir is full (when the level reaches the fill hole).
13. When all of the air has been bled from the system, open the needle valve, then lock the cab latches.

TILT CYLINDER REMOVAL, DISASSEMBLY, ASSEMBLY, AND ADJUSTMENT AND INSTALLATION

Removal (See Fig. 5)

1. With a drain pan under the cylinder, disconnect the two hydraulic hoses from the fittings located on each end of the tilt cylinder.

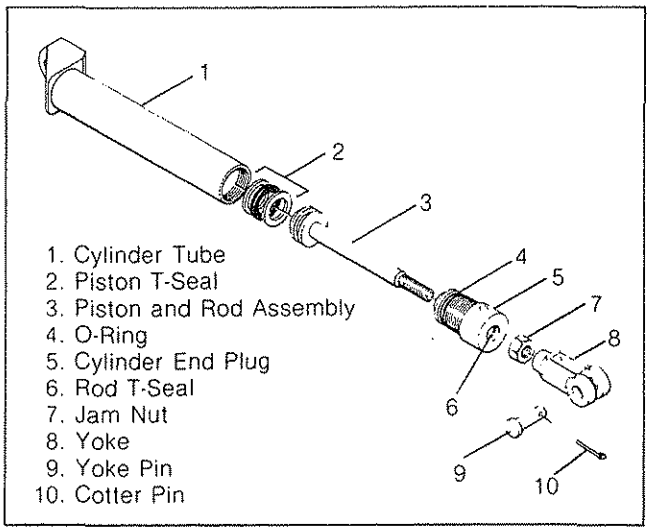


Fig. 5, Tilt Cylinder

2. Remove the cotter pin from the piston rod yoke pin, then remove the yoke pin from the yoke.
3. Remove the tilt cylinder mounting bolt, steel washer (if equipped), mounting spacer, and nut which attach the tilt cylinder to the frame. Remove the tilt cylinder and rubber washer.

Disassembly (See Fig. 5)

1. Loosen the jam nut, then remove the yoke and the jam nut.
2. Using a spanner wrench, remove the cylinder end plug.
3. Pull the piston and rod assembly out of the cylinder tube.
4. Remove the piston T-seal from the piston.
5. Remove the rod T-seal and O-ring from the cylinder end plug.
6. Inspect all parts for wear or damage, and replace as needed.
7. Measure the length of the piston and rod assembly. The length of the assembly must be 25-3/8 to 25-1/2 inches (645 to 648 mm) for COEs, and 26-13/16 to 26-15/16 inches (681 to 684 mm) for Powerliners (**Fig. 6**). Replace the piston and rod assembly if its length does not fall within these dimensions.

FREIGHTLINER CAB-TILT SYSTEM

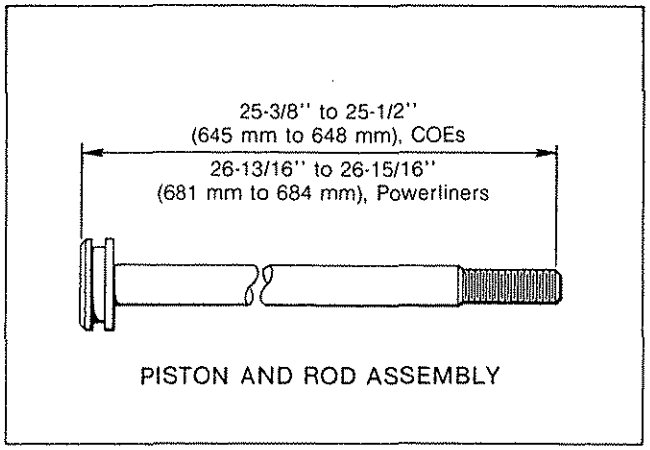


Fig. 6

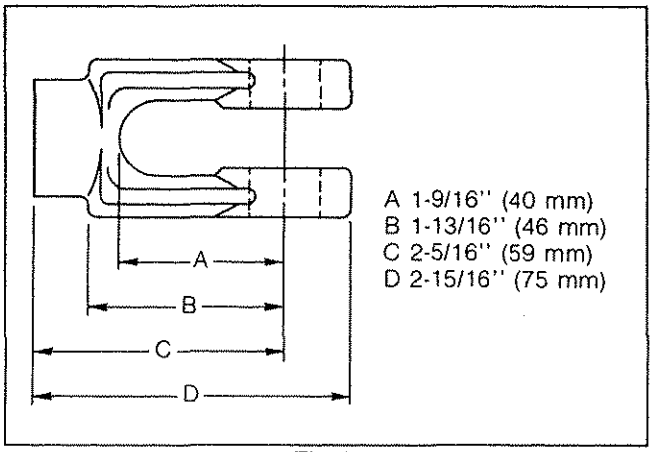


Fig. 7

8. Check the dimensions of the yoke (Fig. 7). If there are any differences between the dimensions in Fig. 7 and the actual yoke dimensions, replace the yoke and yoke pin.

Assembly (See Fig. 5)

1. Position the piston T-seal on the piston.
2. Lubricate the inside of the cylinder tube and the piston with a low pour-point, multipurpose automotive hydraulic fluid. Position the piston and rod assembly in the cylinder tube.

CAUTION: Make sure the piston T-seal and the cylinder tube are free of dirt before the piston is inserted in the tube. Also, the piston T-seal must not contact the cylinder tube threads when the piston is inserted in the tube. Dirt or sharp threads on the piston could damage the piston T-seal.

3. Place the O-ring in the groove on the outside of the cylinder end plug.
4. Place the rod T-seal inside the cylinder end plug.
5. Install the cylinder end plug. Using a spanner wrench, tighten it 100 lbf·ft (136 N·m).
6. Install the jam nut and yoke on the piston and rod assembly.

Adjustment and Installation

1. Check the location of the cylinder end cap fitting. The fitting must be located within the area specified in Fig. 8. If the fitting is not in the allowed area, remove the hole plug from the opposite side of the cylinder end cap and move the fitting to the opposite hole. Install the hole plug in the hole from which the fitting was removed. Securely tighten the fitting and the hole plug. If moving the fitting on the left tilt-cylinder does not correct the fitting location, then use the left tilt-cylinder on the right side and use the right tilt-cylinder on the left side, with the fittings correctly positioned.

WARNING: The fitting must be located within the area shown in Fig. 6 to avoid interference with the tilt strut or radiator support strut. Interference with the tilt strut or radiator support could cause the fitting to be sheared off when raising or lowering the cab, resulting in a sudden loss of hydraulic system pressure and an uncontrolled fall of the cab. This could cause serious personal injury or damage to the vehicle. Make sure all persons are clear of the vehicle whenever tilting the cab.

2. Compress the piston and rod assembly completely into the cylinder tube.
3. With the piston and rod assembly still compressed in the cylinder tube, position the yoke on the threaded end of the rod so that the distance from the yoke eye centerline to the cylinder mounting hole centerline falls within a range of 28-7/8 ± 1/8 inches (733 ± 3 mm) for COEs, and 30-13/32 to 30-15/32 inches (772 to 774 mm) for Powerliners. See Fig. 9.
4. Lock the yoke in place by tightening the jam nut 230 lbf·ft (312 N·m).

FREIGHTLINER CAB-TILT SYSTEM

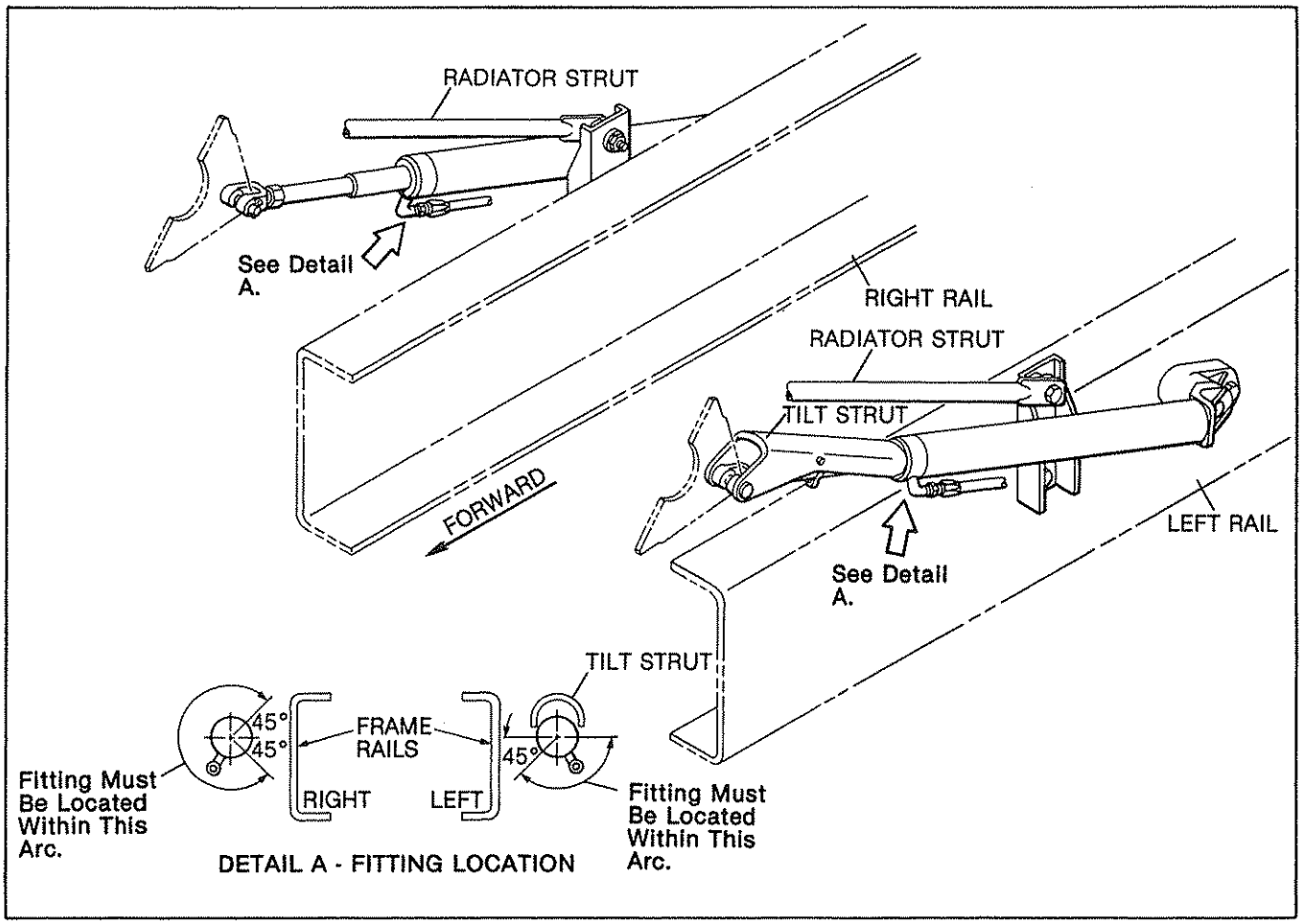


Fig. 8, Tilt Cylinder End Cap Fitting Location

5. Measure the distance from the yoke eye centerline to the exposed end of the piston and rod assembly (Fig. 9). The distance must be 1 to 1-9/16 inches (25 to 39 mm).

   .1 If the distance from the yoke eye center to the exposed end of the piston and rod assembly falls within the above specifications, proceed to step 7.

   .2 If the distance from the yoke eye center to the exposed end of the piston and rod assembly is not within the above specifications, and the tilt cylinder assembly is new, replace the assembly with another new one. Repeat steps 1 through 4, then proceed to step 7.

   CAUTION: The yoke must be correctly positioned on the piston and rod assembly before the tilt cylinder is installed on the vehicle. If the

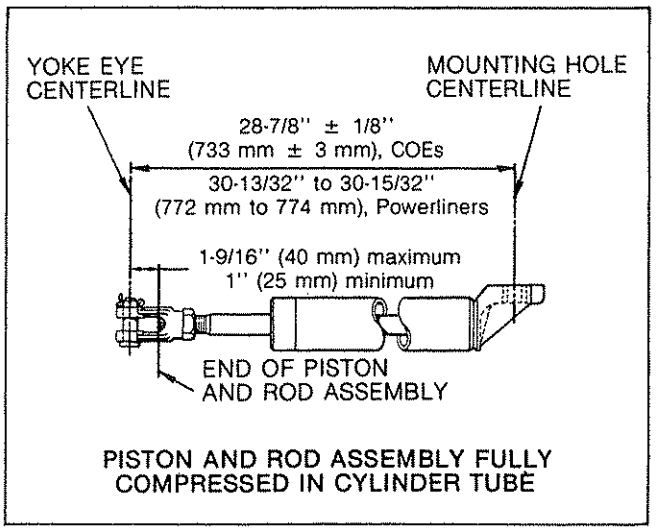


Fig. 9

FREIGHTLINER CAB-TILT SYSTEM

assembly is allowed to bottom out in the cylinder tube, the controlled amount of looseness at the back of the cab permitted by the cab latches will be reduced or lost. When the vehicle is operated in this position, above-average stresses in the cab due to normal motions of the vehicle frame will be transmitted to the front cab support assembly (under normal conditions, above-average stresses in the cab due to normal motions of the vehicle frame are relieved at the cab latches). Continued operation of the vehicle with the piston and rod assembly bottomed out in the cylinder tube could result in damage to the front cab support assembly, and premature wear of the front cab support bushing.

.3 If the distance from the yoke eye centerline to the exposed end of the piston and rod assembly is not within the above specifications, and the tilt cylinder assembly has just been serviced, proceed to step 6.

6. If a serviced tilt cylinder assembly is adjusted as described in steps 2 through 4, and the distance from the yoke eye centerline to the exposed end of the piston and rod assembly is not within the specifications detailed in step 5, proceed as follows:

.1 Loosen the jam nut, then remove the yoke and the jam nut.

.2 Using a spanner wrench, remove the cylinder end plug.

.3 Remove the piston and rod assembly from the cylinder tube.

.4 Measure the length of the piston and rod assembly. The length of the assembly must be 25-3/8 to 25-1/2 inches (645 to 648 mm) for COEs, and 26-13/16 to 26-15/16 inches (681 to 684 mm) for Powerliners (Fig. 6). Replace the piston and rod assembly if its length does not fall within these dimensions.

.5 Check the dimensions of the yoke (Fig. 7). If there are any differences between the dimensions in (Fig. 7) and the actual yoke dimensions, replace the yoke and yoke pin.

.6 Place the piston and rod assembly in the cylinder tube.

CAUTION: Make sure the piston T-seal and the cylinder tube are free of dirt before the piston is inserted in the tube. Also, the piston T-seal must not contact the cylinder tube threads when the piston is inserted in the tube. Dirt or sharp threads on the piston could damage the piston T-seal.

.7 Install the cylinder end plug and, using a spanner wrench, tighten it 100 lbf·ft (136 N·m).

.8 Install the jam nut and the yoke on the piston and rod assembly.

.9 Compress the piston and rod assembly completely into the cylinder tube.

.10 With the piston and rod assembly still compressed in the cylinder tube, turn at the threaded end of the rod so that the distance from the yoke eye centerline to the cylinder mounting hole centerline falls within the range shown in Fig. 9.

.11 Lock the yoke in place by tightening the jam nut 230 lbf·ft (312 N·m).

CAUTION: The yoke must be correctly positioned on the piston and rod assembly before the tilt cylinder is installed on the vehicle. If the assembly is allowed to bottom out in the cylinder tube, the controlled amount of looseness at the back of the cab permitted by the cab latches will be reduced or lost. When the vehicle is operated in this position, above-average stresses in the cab due to normal motions of the vehicle frame will be transmitted to the front cab support assembly (under normal conditions, above-average stresses in the cab due to normal motions of the vehicle frame are relieved at the cab latch mechanism). Continued operation of the vehicle with the piston and rod assembly bottomed out in the cylinder tube could result in damage to the front cab support assembly, and premature wear of the front cab support bushing.

7. Position the tilt cylinder and the rubber washer on the frame and again check the position of the tilt cylinder end cap fitting. Install the tilt cylinder mounting bolt, steel washer (if equipped), mounting spacer, and nut. If the tilt cylinder mounting bolt has coarse threads (11 threads per inch), tighten the bolt 165 lbf·ft (224 N·m). If the tilt cylinder mounting bolt has fine threads (18 threads per inch), tighten the bolt 185 lbf·ft (251 N·m).

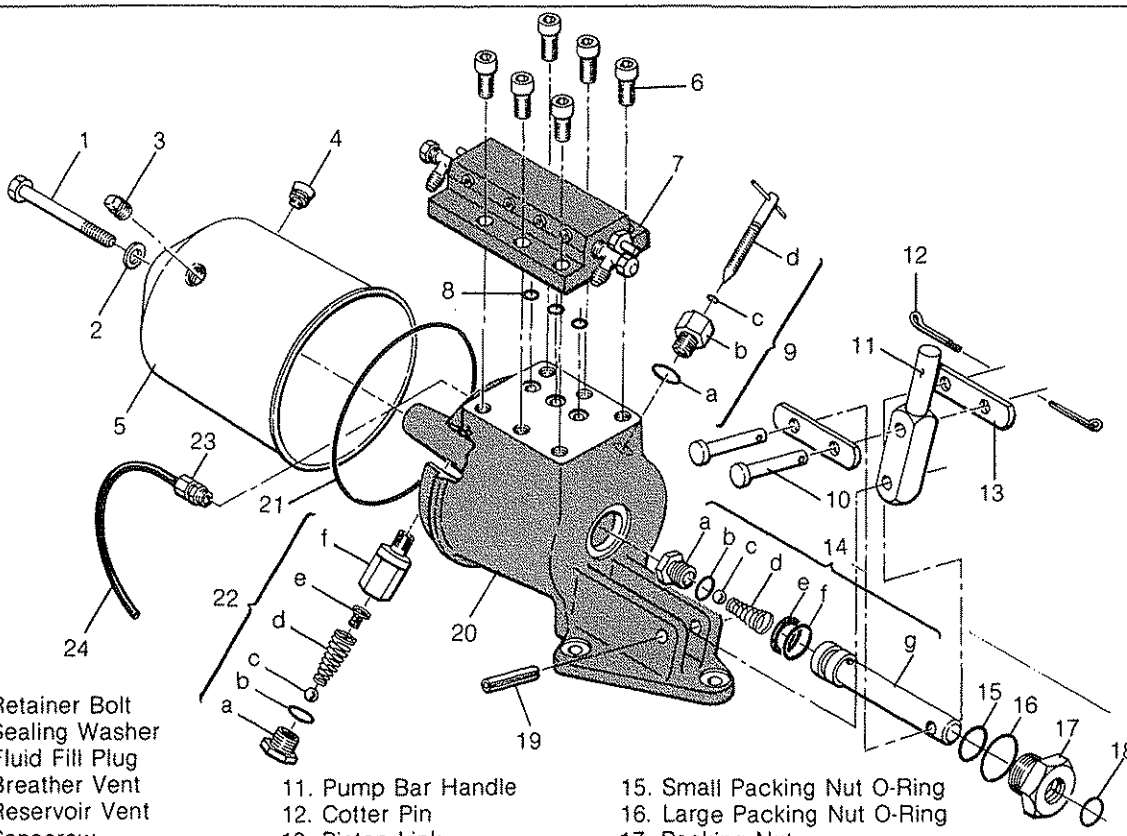
FREIGHTLINER CAB-TILT SYSTEM

8. Install the piston rod yoke pin in the yoke. Insert the cotter pin through the hole in the yoke pin, then lock it in place.
9. Connect the hydraulic lines to the cylinder fittings.
10. Bleed the system, using the instructions in this subject.

CYCLOMATIC VALVE REMOVAL, DISASSEMBLY, ASSEMBLY, AND INSTALLATION

Removal (See Fig. 10)

1. With the cab in the operating position, disconnect the hydraulic lines from the cyclomatic valve.



1. Retainer Bolt
2. Sealing Washer
3. Fluid Fill Plug
4. Breather Vent
5. Reservoir Vent
6. Capscrew
7. Cyclomatic Valve
8. O-Ring Seals
9. Needle Valve Assembly
   a. Valve Bushing O-Ring
   b. Valve Bushing
   c. Needle Valve O-Ring
   d. Needle Valve
10. Clevis Pin
11. Pump Bar Handle
12. Cotter Pin
13. Piston Link
14. Piston Assembly
    a. Valve Bushing
    b. Valve Bushing O-Ring
    c. Valve Ball
    d. Piston Spring
    e. Backup Piston Ring
    f. Piston O-Ring
    g. Piston
15. Small Packing Nut O-Ring
16. Large Packing Nut O-Ring
17. Packing Nut
18. GT-Ring
19. Roll Pin
20. Pump Body
21. Seal O-Ring
22. Ball Check Valve Assembly
    a. Ball Check Nut
    b. Ball Check Nut O-Ring
    c. Intake Valve Ball
    d. Intake Valve Spring
    e. Intake Spring
    f. Adapter
23. Tubing Nut
24. Hydraulic Fluid Return Tube

Fig. 10, Tilt Pump Assembly

FREIGHTLINER CAB-TILT SYSTEM

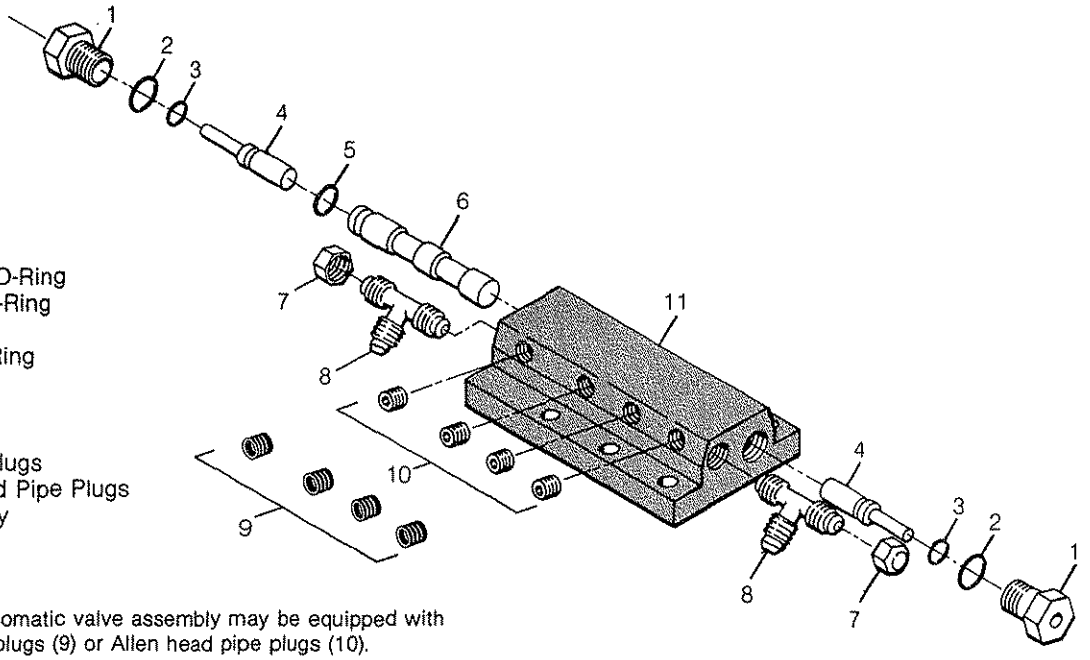


Fig. 11, Cyclomatic Valve Assembly

2. Remove the six Allen capscrews attaching the valve to the pump body.
3. Remove the valve and the three O-ring seals from the tilt pump body.
4. Inspect the O-ring seals for wear or damage, and replace as needed.

Disassembly (See Fig. 11)

1. Remove the two end plugs and plungers from the valve body, them remove their respective O-rings.
2. Remove the piston and O-ring from the valve body.
3. Inspect all parts for wear or damage, and replace as needed.

NOTE: The piston and valve body are a matched set. If either needs to be replaced, replace both the piston and the valve body.

Assembly (See Fig. 11)

WARNING: The cyclomatic valve must be free of dirt and other contaminants before assembly. The fit between the piston and valve body is so precise that any dirt in the system could cause the piston to jam. If the cyclomatic valve fails to cycle when the cab goes over the 45 degree tilt position in either direction, the cab will free-fall to a full tilt or to the operating position. This, in turn, could result in serious personal injury or damage to the vehicle. Make certain that all persons are clear of the vehicle whenever tilting the cab.

1. Lubricate the inside of the valve body and the piston with a low pour-point, multipurpose automotive hydraulic fluid.
2. Install the piston O-ring on the piston. Place the piston in the valve body.
3. Install a plunger O-ring on each plunger. Place the plungers in the valve body.
4. Install an end plug O-ring on each end plug. Install the plugs in the valve body.
5. Check the cyclomatic valve piston movement in the valve body by alternately pushing in the end plungers. If the piston does not move back and forth freely, check that the valve is assembled correctly. If the valve is correctly assembled and the piston does not move back and forth freely, replace the valve assembly.

FREIGHTLINER CAB-TILT SYSTEM

Installation (See Fig. 10)

1. Place the three O-ring seals in the machined surface of the pump body.
2. Place the cyclomatic valve on the pump body with the offset part of the valve over the reservoir tank, then install the six Allen capscrews. Tighten the capscrews 18 lbf·ft (24 N·m).
3. Connect the hydraulic lines to the cyclomatic valve.
4. Bleed the system, using the instructions in this subject.

TILT PUMP REMOVAL, DISASSEMBLY, ASSEMBLY, AND INSTALLATION

Removal

1. With the cab in the operating position, disconnect the hydraulic lines from the cyclomatic valve.
2. Remove the tilt pump mounting bolts, washers (if equipped), and nuts from the tilt pump assembly. Remove the tilt pump.

Disassembly (See Fig. 10)

1. Remove the fluid fill plug from the reservoir tank. Drain the hydraulic fluid by tilting the pump assembly.
2. Remove the six Allen capscrews that attach the cyclomatic valve to the tilt pump. Remove the cyclomatic valve. Remove the three O-ring seals from the pump body.
3. Remove the retainer bolt and the sealing washer from the reservoir tank.
4. Remove the reservoir tank by tapping a light plastic or rubber hammer on the reservoir while applying pressure at the end.
5. Remove the hydraulic fluid return tube from the pump.
6. Remove the ball check valve assembly from the pump, then disassemble as follows:
   .1 Remove the ball check nut and the O-ring from the adapter. Remove the O-ring from the ball check nut.
   .2 Turn the adapter so the female end is facing down, then collect the intake valve ball, intake valve spring, and the intake spring as they fall out of the adapter.
7. Remove the cotter pins, clevis pins, and piston links at the pump bar handle.
8. Remove the roll pin and the pump bar handle.
9. Remove the packing nut and the piston assembly from the tilt pump, then disassemble as follows:
   .1 Remove the packing nut from the piston. Remove the large packing nut O-ring, small packing nut O-ring, and the GT-ring from the packing nut.
   .2 Remove the valve bushing from the piston. Remove the valve bushing O-ring from the valve bushing.
   .3 Turn the piston so the wide end is facing down, then collect the piston valve ball and the piston spring as they fall out of the piston.
   .4 Remove the piston O-ring and the backup piston ring from the piston.
10. Remove the needle valve from the valve bushing, then remove the valve bushing from the pump body. Remove the needle valve and valve bushing O-rings.
11. Inspect all parts for wear or damage, and replace as needed.

Assembly (See Fig. 10)

If new valve balls and seats are used, they must be seated before installation. This is done by positioning the ball in the seat and tapping it lightly but firmly with a plastic hammer until the seat is slightly displaced. The ball check seat must be free of burrs and other surface irregularities. Lubricate all parts of the pump during assembly with a low pour-point, multipurpose automotive hydraulic fluid.

1. Assemble the ball check valve assembly using the following procedure:
   .1 Blow out the adapter with compressed air to remove any dirt particles.
   .2 Place the intake spring, wide end down, into the female end of the adapter.
   .3 Place the intake valve spring, wide end down, on top of the intake spring.
   .4 Place the O-ring on the ball check nut using a large thimble to slip the the O-ring over the threads.

FREIGHTLINER CAB-TILT SYSTEM

.5 Screw the ball check nut with the intake valve ball into the adapter, then tighten 38 lbf·ft (52 N·m).

2. Screw the ball check valve assembly in the pump body and tighten 14 lbf·ft (19 N·m).
3. Install the hydraulic fluid return tube, with the outlet positioned toward the bottom of the reservoir. Tighten the tubing nut finger-tight; using a wrench, tighten a minimum of two turns or until no threads show on the fitting body.
4. Assemble the piston assembly using the following procedure:

   .1 Blow out the piston with compressed air to remove any dirt particles.

   .2 Stretch the backup piston ring, concave side down, over the top (wide) end of the piston.

   .3 Push the piston O-ring on from the bottom of the piston, holding the backup piston ring next to the top of the piston in place.

   .4 Insert the piston spring, wide end down, into the piston.

   .5 Place the O-ring onto the piston-valve bushing using a large thimble to slip the O-ring over the threads.

   .6 Screw the piston valve bushing with the piston valve ball into the piston, then tighten 45 lbf·ft (61 N·m).

5. Roll the large packing nut O-ring over the packing nut. Push the small packing nut O-ring into the lower groove of the packing nut. Push the GT-ring into the upper groove of the packing nut.
6. Slip the packing nut over the piston with a slight twisting motion. Install the piston assembly and packing nut in the pump body and tighten 60 lbf·ft (81 N·m).
7. Place the pump bar handle in position. Install the roll pin.
8. Position the piston links. Install the clevis pins and cotter pins.
9. Lubricate the reservoir seal O-ring with a low pour-point, multipurpose automotive hydraulic fluid. Install the O-ring on the pump body.
10. Place the reservoir on the pump so that the breather vent is located at the top when the pump is mounted on the vehicle.
11. Place the sealing washer on the retainer bolt, then install the bolt. Tighten the retainer bolt 8 lbf·ft (11 N·m).
12. Place the three cyclomatic valve O-ring seals in the machined surface of the pump body.
13. Place the cyclomatic valve assembly on the pump body with the offset part of the valve over the reservoir tank. Install the six capscrews and tighten 18 lbf·ft (24 N·m).
14. Roll the needle valve O-ring onto the top thread (the thread near the center) of the needle valve, then roll the valve bushing O-ring onto the valve bushing.
15. Insert the needle valve bushing into the pump body and tighten 25 lbf·ft (34 N·m). Turn the needle valve into the bushing so that its O-ring is just hidden.

Installation

1. Place the pump assembly on the frame or mounting bracket. Install the pump assembly mounting bolts, washers (if equipped), and nuts. Tighten the mounting nuts 35 lbf·ft (47 N·m).
2. Connect the hydraulic lines to the cyclomatic valve.
3. Bleed the pump and system, using the instructions in this subject.

ENERPAC®[1] CAB-TILT SYSTEM

GENERAL INFORMATION

The ENERPAC cab-tilt system has four major parts (See Fig. 1):

- A hydraulic pump consisting of a pump body, a reservoir, and a pump control lever.
- Two hydraulic tilt cylinders that raise and lower the cab.
- A shift-disconnect cylinder that allows the shift tube to extend during cab tilting.
- A tilt strut on the right-side tilt cylinder, which must be used when working under a cab that has not been fully tilted.

The tilt cylinders are connected to the pump by flexible high-pressure lines. Velocity fuses are built into the tilt cylinder ports. They act as check valves to prevent the cab from free falling in case of hydraulic system damage, such as a ruptured line.

PRINCIPLES OF OPERATION

There are two hydraulic circuits in the ENERPAC system: the *push* circuit raises the cab from the lowered position to the desired tilt position, and the *pull* circuit brings the cab from a fully tilted position up and over top-dead-center. See Figs. 1 and 2.

Placing the control lever in the "Raise" position opens the *push* circuit in the hydraulic system. When the cab hold-down latches are released and the pump lever is operated, hydraulic pressure builds up in the tilt cylinders and the shift-disconnect cylinder. As pressure increases, the shift-disconnect cylinder releases to allow the shift tube to telescope out. Then the tilt cylinder piston rods extend, raising the cab. When the cab goes over top-dead-center, it falls at a controlled rate to the full-tilt position, automatically relieving hydraulic system pressure.

When the control lever is placed in the "Lower" position, the *pull* circuit in the hydraulic system opens. When the pump is operated, hydraulic pressure forces the cab

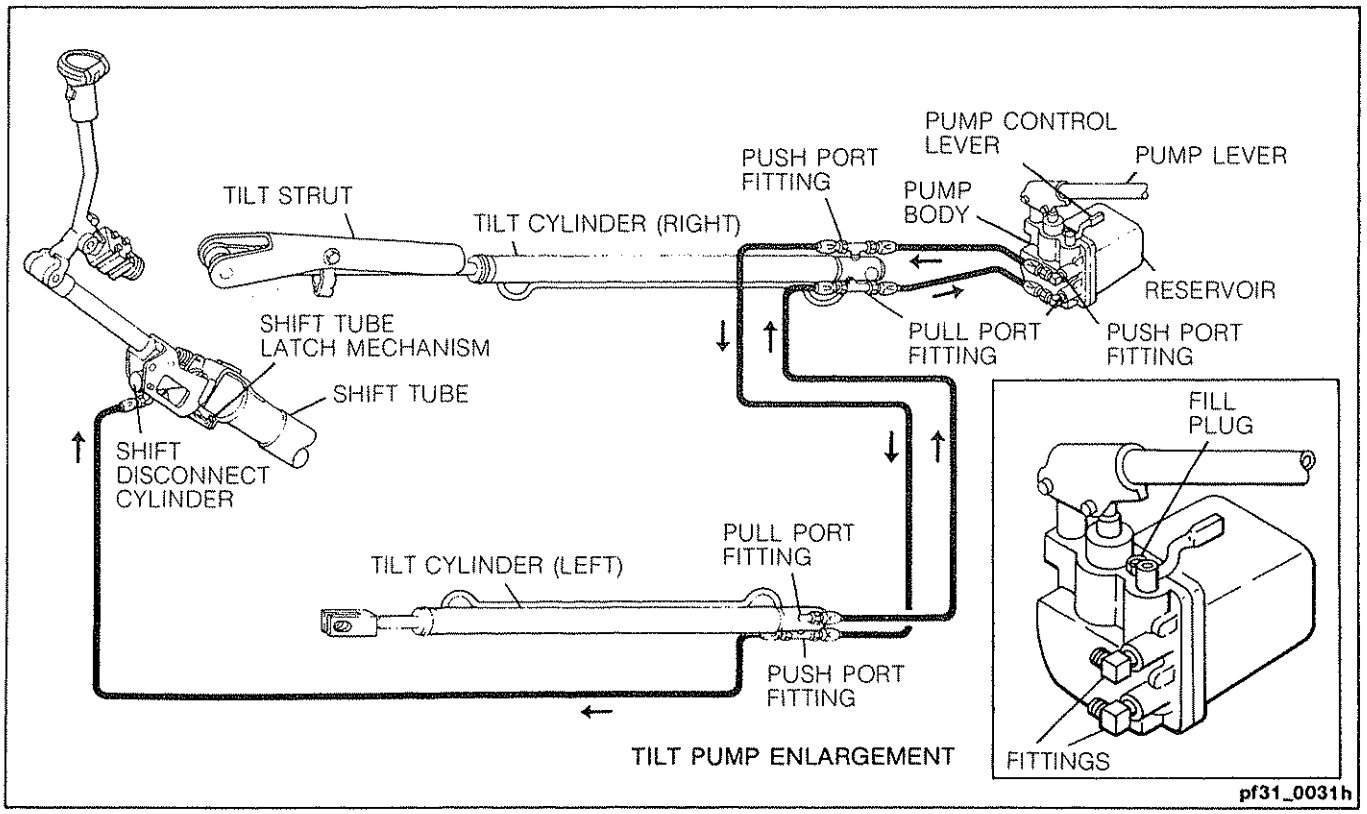


Fig. 1

[1] Formerly called Power-Packer®

ENERPAC® CAB-TILT SYSTEM

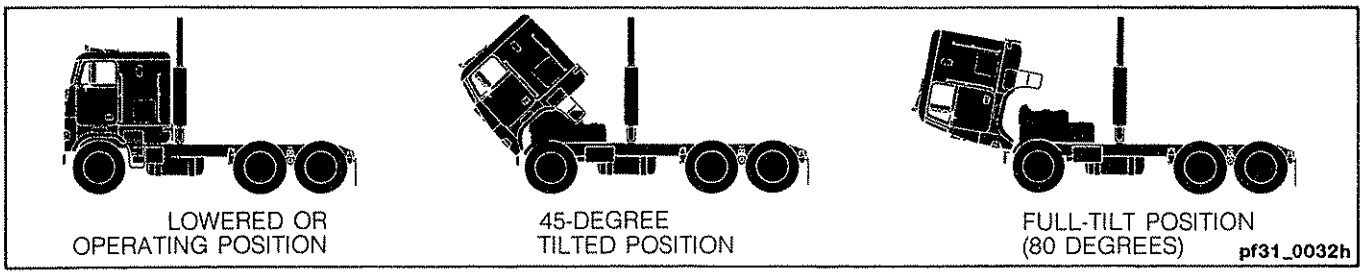


Fig. 2

back up and over top-dead-center. The cab then falls at a controlled rate until it settles onto the rear mounts.

NOTE: Whenever raising or lowering the cab, stop working the pump once the cab goes over center. The cab falls at a controlled rate and continued pumping could lock up the tilt cylinders.

HYDRAULIC LOCK-UP

Hydraulic lock-up can occur for the following reasons:

- Very cold weather
- Use of the wrong hydraulic fluid
- Air in the system
- Sudden cab movement
- A ruptured hydraulic line
- Continued pumping after cab goes over center

Any of the above situations will cause the velocity fuses to function as check valves, and lock up the tilt cylinders. To unlock the cylinders, the cab must be moved in the opposite direction of travel (back toward the 45 degree position).

For example, if the cab is moving toward the full-tilt position when the lock-up occurs, move the control lever to "Lower," and work the pump a few strokes. This will unlock the cylinders. Move the control lever to "Raise," and allow the cab to descend to a full-tilt position.

If the cab is moving toward the lowered (operating) position when the lock-up occurs, move the control lever to "Raise," and work the pump a few strokes. This will unlock the cylinders. Move the control lever to "Lower," and allow the cab to descend to the operating position.

SERVICE OPERATIONS

NOTE: Refer to the Freightliner *COE Driver's Manual* for detailed cab tilt instructions.

BLEEDING THE SYSTEM

A "spongy" feeling (cylinders do not move when the pump handle is operated) indicates air in the cab-tilt sytem. Use the following procedures to remove the air from the cab-tilt system:

IMPORTANT: With the exception of bleeding the *pull* port fittings on the tilt cylinders, never bleed any part of the system while the cab is tilted.

Bleeding the Tilt Cylinders:

1. With the cab completely lowered and the tilt cylinders retracted, loosen the *push* port fitting on each tilt cylinder. See **Fig. 1**. Do not disconnect the hose from the fitting. Place the control lever in the "Raise" position, and operate the tilt pump until a bubble-free stream of hydraulic fluid flows from the *push* ports on the tilt cylinders.
2. Tighten the *push* port fitting on each tilt cylinder.
3. Tilt the cab to the full-tilt position.
4. Loosen the *pull* port fitting on each tilt cylinder. See **Fig. 1**. Place the control lever in the "Lower" position, and operate the tilt pump until a bubble-free stream of hydraulic fluid flows from the *pull* port fitting on each cylinder.
5. Tighten the *pull* port fitting on each tilt cylinder.
6. Lower the cab to the operating position.
7. Make sure all the fittings are tight on both tilt cylinders. Fill the tilt pump reservoir until hydraulic fluid appears in the fill port. Install and tighten the fill plug. Refer to the Charts and Specifications section of the *COE and 120 Conventional Maintenance Manual* for the specified hydraulic fluid. Do not use engine oil, brake fluid, or automatic transmission fluid.
8. Tilt the cab fully and return it to the lowered position. Fill the tilt pump reservoir until hydraulic fluid appears in the fill port. Use only specified hydraulic fluid. Install and tighten the fill plug.

ENERPAC® CAB-TILT SYSTEM

Bleeding the Shift-Disconnect Cylinder:

Since this cylinder is mounted at the highest point in the system (on the shifter mechanism under the tunnel), air going to the top of it will not discharge to the reservoir.

1. With the shift-disconnect cylinder fully collapsed, and the cab in the lowered (operating) position, loosen the fitting on the cylinder. See **Fig. 1**. Place the control lever in the "Raise" position, and operate the tilt pump until a bubble-free stream of hydraulic fluid flows from the fitting. Pump until about 2 oz (60 mL) of hydraulic fluid flows from the fitting to ensure that the entire line is free of air.

2. Tighten the fitting and refill the tilt pump until hydraulic fluid appears in the fill port. Refer to the Charts and Specifications section of the *COE and 120 Conventional Maintenance Manual* for the specified hydraulic fluid. Do not use engine oil, brake fluid, or automatic transmission fluid. Install and tighten the fill plug.

TILT CYLINDER REMOVAL, DISASSEMBLY, ASSEMBLY, AND INSTALLATION

Removal

NOTE: Remove the tilt cylinder assemblies from the vehicle only when the cab is in the lowered (operating) position.

1. Release the hydraulic pressure by alternately moving the control lever on the tilt pump to the "Raise" and "Lower" positions. Hold the control lever in each position for a few seconds. Allow enough time for the shift-disconnect cylinder to empty. Return the control lever to the "Lower" position before proceeding.

2. Disconnect the hydraulic lines from both tilt cylinders. Cover the ends of the lines to prevent dirt from entering the system.

3. Disconnect the right tilt cylinder at the clevis end by removing the cotter pin (**Fig. 3**, Ref. 5), and the clevis pin (Ref. 6). Remove the tilt strut by removing the locknut (Ref. 3) and the machine screw (Ref. 1), then the tilt strut spring (Ref. 4).

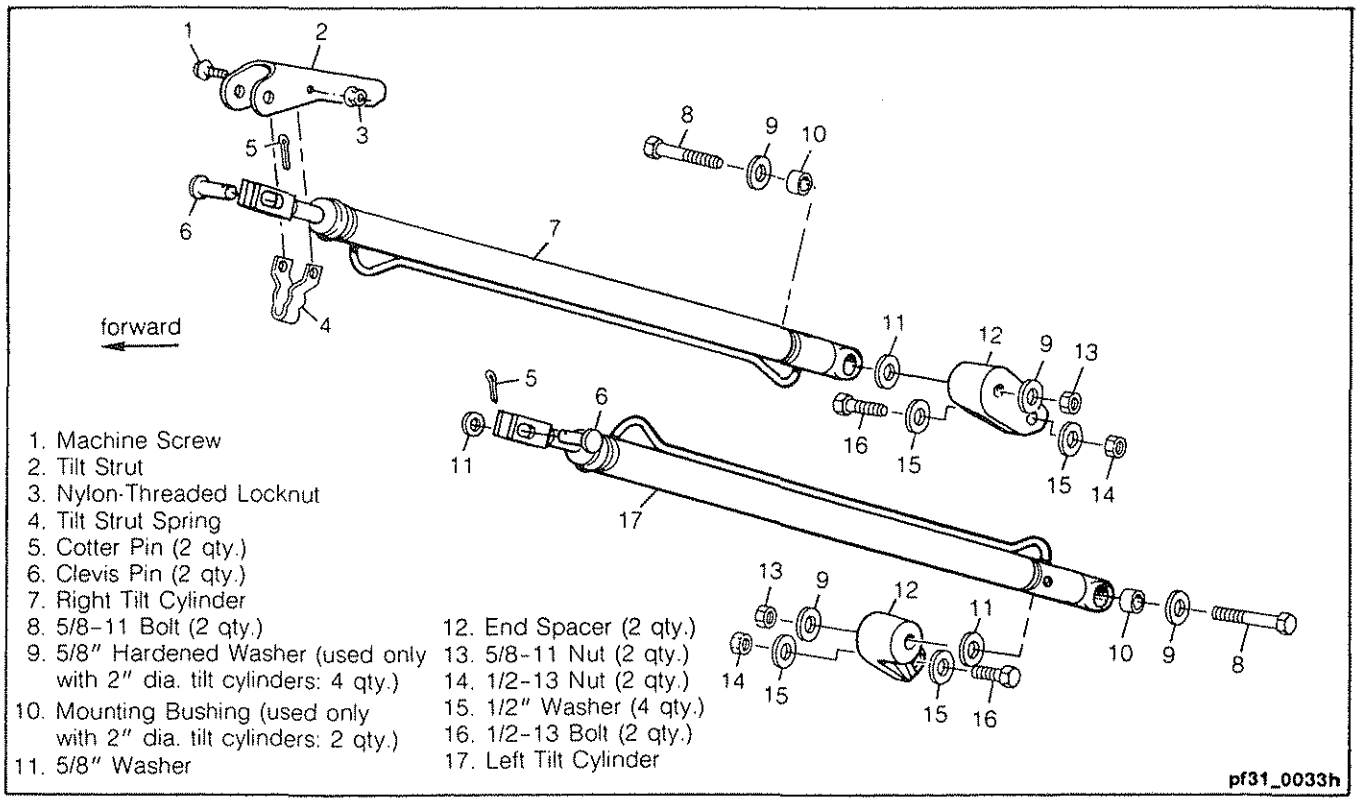


Fig. 3

ENERPAC® CAB-TILT SYSTEM

4. Loosen and remove the 5/8–11 bolt (Ref. 8) that holds the lower end of the tilt cylinder to the end spacer (Ref. 12) on the right-side frame rail.
5. Remove the right tilt cylinder from the vehicle.
6. Repeat steps 3 through 5 for the left tilt cylinder.

NOTE: There is no tilt strut on the left tilt cylinder.

Disassembly

IMPORTANT: The smallest amount of dirt in a hydraulic system can impair its function; therefore always work under the cleanest possible conditions.

1. Clean both tilt cylinder assemblies with solvent before disassembling them. Clean them with the piston rods retracted.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

2. Remove the piston rod assembly from the cylinder as follows (see **Fig. 4**):
   .1 Remove the retaining ring (Ref. 3). Use the 1/8-inch hole at the upper end of the cylinder tube as an aid.
   .2 Gently pull the piston rod assembly from the cylinder tube.
3. Unscrew the piston from the piston rod assembly. If the piston was staked to the rod, inspect the internal threads for damage and replace the piston if necessary.
4. If the piston is to be used again, remove and discard the O-ring and seal (Refs. 11 and 10) from the piston.
5. Remove and discard the small O-ring (Ref. 2) from the threaded portion of the piston rod.
6. Remove the gland (Ref.7) from the piston rod.

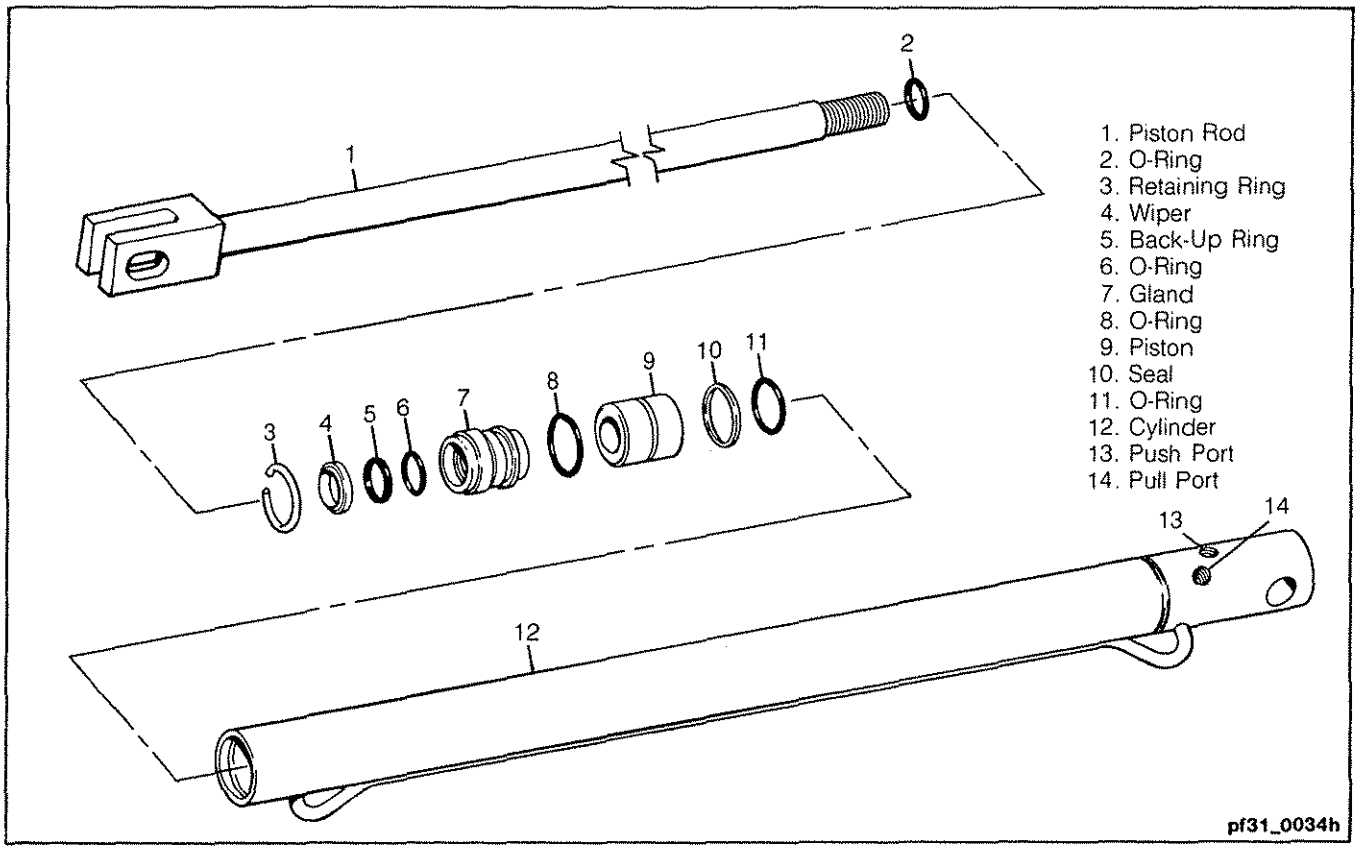


Fig. 4, Tilt Cylinder Components

ENERPAC® CAB-TILT SYSTEM

7. Remove the wiper, back-up ring, and the O-ring (Refs. 4, 5, and 6) from inside the gland.

8. Check the piston rod, gland, piston, and the cylinder tube for wear and damage. Clean them.

9. Repeat steps 2 through 8 for the left-side tilt cylinder.

NOTE: Do not re-use or try to straighten a bent piston rod. Replace the rod even if the bend is slight.

Assembly

NOTE: Use the Cylinder Seal Kit. Refer to the *COE and 120 Conventional Parts Book* for the correct part number.

1. Install the new wiper, back-up ring, and O-ring inside the gland of one of the tilt cylinders.

2. Lubricate the inside of the gland with hydraulic fluid, and put it back on the piston rod. See **Fig. 4**.

3. Wipe a thin coat of hydraulic fluid on the piston rod.

4. Install the new small O-ring on the threaded portion of the piston rod. See **Fig. 4**.

5. Screw the piston onto the piston rod, using Loctite® sealant on the threads. Stake the piston threads in two places, 180 degrees apart.

6. Install the new seal (Ref. 10) and O-ring (Ref. 11) on the piston.

7. Make sure the cylinder bore is clean, and pour a small amount of hydraulic fluid into it. Rotate the cylinder tube to spread the fluid evenly throughout the bore.

8. Install the piston rod assembly in the cylinder. Lightly tap the gland to position it, and install the retaining ring (Ref. 3).

9. Repeat steps 1 through 8 for the other tilt cylinder.

10. Check both pistons for smooth action in the cylinders. Make sure that they don't bind.

11. Push the piston rod assemblies into the cylinders as far as possible. Fill both cylinders at the *pull* ports with the specified hydraulic fluid. Refer to the Charts and Specifications section of the *COE and 120 Conventional Maintenance Manual* for the specified hydraulic fluid.

Installation

1. Install the right tilt cylinder assembly on the vehicle as follows (see **Fig. 3**):
   - .1 Place the tilt strut (Ref. 2) over the clevis of the tilt cylinder, making sure the holes in both parts are aligned.
   - .2 Place the tilt cylinder clevis and tilt strut on the mounting flange of the cab, and insert the clevis pin through the aligned holes of all three parts.
   - .3 Place the washer over the end of the clevis pin, and install the cotter pin into the clevis pin hole. Lock the cotter pin.
   - .4 Place the tilt strut spring (**Fig. 3**, Ref. 4) over the piston rod, then install it onto the tilt strut, using the machine screw and nylon locknut (Refs. 1 and 3). Refer to **Fig. 1** for the correct installation of the tilt strut spring.
   - .5 Line up the mounting hole at the bottom end of the tilt cylinder with that on the right-side end spacer. See **Fig. 3**.
   - .6 Install the 5/8–11 bolt and nut, and mounting bushing (Ref. 10) as shown in **Fig. 3**.
   - .7 Tighten the 5/8–11 bolt 190 lbf·ft (258 N·m).
   - .8 Check the end spacer mounting bolt (Ref. 16) for tightness, and tighten it 95 lbf·ft (129 N·m) if necessary.
2. Repeat steps 1.2, 1.3, and 1.5 through 1.8 for the left tilt cylinder. Note that there is no tilt strut on the left tilt cylinder.
3. Connect the hydraulic lines to the cylinder port fittings, but do not tighten them.
4. Bleed the hydraulic system as described under "Bleeding the System."

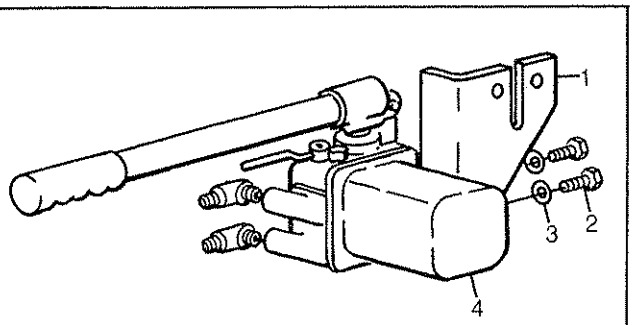
TILT PUMP REMOVAL, DISASSEMBLY, ASSEMBLY, AND INSTALLATION

Removal

1. Release the hydraulic pressure in the lines, tilt cylinders, and the shift-disconnect cylinder. Refer to step 1 under "Tilt Cylinder Removal."
2. Mark the hydraulic lines and disconnect them at the *push* and *pull* ports on the tilt pump assembly. Place a container under the ends of the disconnected lines to catch any fluid remaining in them.
3. Cover the ends of the hydraulic lines to prevent the entry of dirt into the system.

ENERPAC® CAB-TILT SYSTEM

4. Remove the two capscrews that hold the tilt pump assembly to the bracket on the frame. See **Fig. 5**.
5. Remove the tilt pump assembly from the vehicle.



1. Tilt Pump Bracket
2. 3/8″ Capscrew (2 qty.)
3. 3/8″ Washer (2 qty.)
4. Tilt Pump Assembly

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Fig. 5

Disassembly

1. Clean the exterior of the pump before disassembly.
2. Place the tilt pump assembly over a container and remove the four capscrews that attach the reservoir to the tilt pump body.
3. Remove the reservoir from the tilt pump body, allowing the hydraulic fluid to drain into the container.
4. Remove and discard the O-ring from the groove in the edge of the tilt pump reservoir. See **Fig. 6**, Ref. 26.
5. Remove the right angle fittings from the *push* and *pull* ports on the tilt pump body. See **Fig. 1**, "Tilt Pump Enlargement."
6. Check the screens (**Fig. 6**, Ref. 38) in each port for dirt particles and damage. Clean the screens with a pointed tool; if they are very clogged or damaged, remove them by releasing the retaining rings (Ref. 39).
7. Remove the plunger (Ref. 7) as follows:

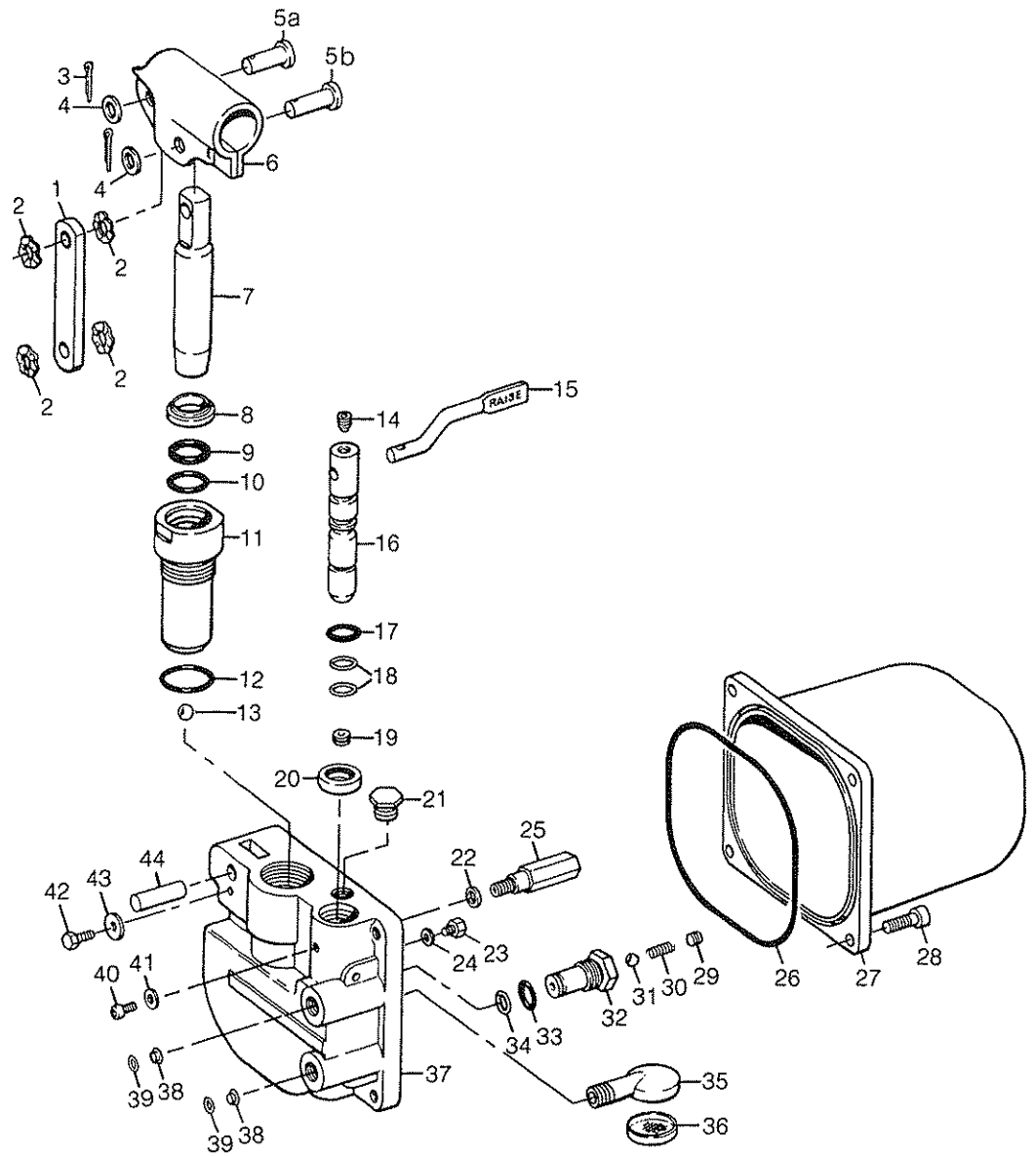
   .1 Remove the cotter pin, washers, and wave washers (Refs. 3, 4, and 2) from the upper beam link pin (Ref. 5a).

   .2 Remove the upper beam link pin, and disconnect the beam link from the beam (Ref. 6).

   .3 Pull straight up on the beam to remove the plunger from the cylinder (Ref. 11).

8. Using a small screwdriver, carefully pry the wiper (Ref. 8), the back-up ring (Ref. 9), and the O-ring (Ref. 10) from the inside of the cylinder.
9. Remove the cylinder by unscrewing it from the tilt pump body.
10. Remove and discard the O-ring (Ref. 12) from the cylinder.
11. Remove the capscrew (Ref. 40) from the tilt pump body.
12. Pull up on the control lever (Ref. 15) and the spool (Ref. 16), and remove the spool from the tilt pump body.
13. Remove and discard the black O-ring (Ref. 17) and the two clear O-rings (Ref. 18) from the spool.
14. Remove the orifice screw (Ref. 19) from the bottom of the spool, and make sure that it is free of dirt particles.
15. Loosen the setscrew (Ref. 14) at the top of the spool, and remove the control lever from the spool.
16. Pry the wiper (Ref. 20) from the hole in the tilt pump body, and discard it.
17. Remove the plug (Ref. 23) from the tilt pump body. Turn the tilt pump body upside down and remove the 1/4-inch ball (Ref. 13) from the bottom of the bore where the cylinder (Ref. 11) was installed.
18. Remove the outlet seat (Ref. 32) from the tilt pump body, and remove the two O-rings (Refs. 33 and 34) from the outlet seat.
19. Remove the plug (Ref. 29) from the top of the outlet seat, and remove the spring and the 3/16-inch ball (Refs. 30 and 31).
20. Remove the inlet adapter (Ref. 35) from the body of the tilt pump.

ENERPAC® CAB-TILT SYSTEM



1. Beam Link
2. Wave Washer (4 qty.)
3. Cotter Pin (2 qty.)
4. Washer (2 qty.)
5. Beam Link Pin
   a. upper
   b. lower
6. Beam
7. Plunger
8. Wiper
9. Back-up Ring
10. O-Ring
11. Cylinder
12. O-Ring
13. 1/4" Ball
14. Setscrew
15. Control Lever
16. Spool
17. Black O-Ring
18. Clear O-Ring (2 qty.)
19. Orifice Screw
20. Wiper
21. Fill Plug
22. Gasket
23. Plug
24. Gasket
25. Relief Valve
26. Reservoir O-Ring
27. Reservoir
28. Capscrew (4 qty)
29. Plug
30. Spring
31. 3/16" Ball
32. Outlet Seat
33. O-Ring
34. O-Ring
35. Inlet Adapter
36. Screen
37. Tilt Pump Body
38. Screen (2 qty.)
39. Retaining Ring (2 qty.)
40. Capscrew
41. Gasket
42. Screw
43. Washer
44. Pin

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Fig. 6, Tilt Pump Assembly

ENERPAC® CAB-TILT SYSTEM

21. Inspect and clean the screen (Ref. 36) from the bottom of the inlet adapter. Remove and discard the screen if it is damaged or completely clogged.

Assembly (Refer to **Fig. 6**)

Before beginning, make sure that all of the tilt pump components are as clean as possible. Any particles of dirt or foreign matter in the system will affect its efficiency. Always work in as clean an environment as possible.

Use the Tilt Pump Seal Kit for the new O-rings, wipers, 1/4-inch ball, and 3/16-inch ball, and copper seals. Refer to the *COE and 120 Conventional Parts Book* for the correct part number.

CAUTION: Do not use any type of Teflon® tape on the threaded components (such as bolts, plugs, and valves) that are to be installed on the tilt pump. Small particles of tape may eventually work their way into the hydraulic system, impairing its efficiency.

1. Insert the 1/4-inch ball (Ref. 13) into the cylinder bore.
2. Install and tighten the plug (Ref. 23) and, if necessary, the new gasket (Ref. 24).
3. Install the O-ring (Ref. 12) on the cylinder (Ref. 11), and install the cylinder into the tilt pump body. Tighten the cylinder 80 lbf·ft (108 N·m).
4. Lightly coat the back-up ring (Ref. 9), the O-ring (Ref. 10), and the wiper (Ref. 8) with hydraulic fluid, and install them into the cylinder.
5. Carefully insert the plunger into the cylinder and push it down as far as it will go. Do not damage the wiper or O-ring.
6. Line up the holes in the beam (Ref. 6) and the beam link (Ref. 1), and install the wave washers (Ref. 2), the upper beam link pin (Ref. 5a), washer (Ref. 4), and the cotter pin (Ref. 3).
7. Install the two small, clear O-rings (Ref. 18) and the black O-ring (Ref. 17) on the spool (Ref. 16).
8. Install and tighten the orifice screw (Ref. 19) on the bottom of the spool.
9. Apply a light coat of hydraulic fluid on the spool. Find the wide groove on the spool just below the black O-ring. See **Fig. 7**. The capscrew (**Fig. 7**) seats in this groove when the spool is properly installed in the tilt pump body.

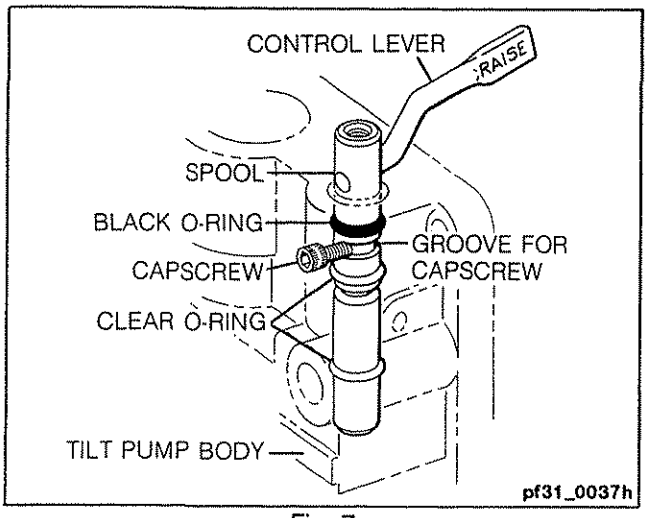

Fig. 7

10. Install the spool into the bore on the tilt pump body.

IMPORTANT: Install the spool in the bore far enough for the wide groove to align with the capscrew hole. See **Fig. 7**.

11. If replacing the gasket (Ref. 41), insert a new gasket into the tilt pump body.
12. Install the capscrew (Ref. 40) into the hole in the tilt pump body. Make sure it seats in the spool groove, as shown in **Fig. 7**. If the capscrew does not seat firmly on its gasket, then it is not in the groove on the spool.
13. Slide the new wiper (Ref. 20) over the top of the spool. Place a 1/2-inch (13 mm) socket (1/2-inch drive) over the spool, and drive the wiper into position.
14. Install the control lever (Ref. 15) in the spool. Make sure that it is correctly lined up.
15. Install the setscrew (Ref. 14) on top of the spool, and tighten it firmly.
16. If the relief valve (Ref. 25) was removed, install it, along with a new gasket (Ref. 22). Tighten the relief valve 60 lbf·in (680 N·cm).
17. Install the clear O-ring (Ref. 34) and the black O-ring (Ref. 33) on the outlet seat (Ref. 32).

ENERPAC® CAB-TILT SYSTEM

18. Install the outlet seat into the tilt pump body. Tighten the outlet seat 19 to 21 lbf·ft (26 to 28 N·m).
19. Install the 3/16-inch ball (Ref. 31), the spring, (Ref. 30), and the plug (Ref. 29) into the outlet seat. Tighten the plug firmly.
20. If the screen (Ref. 36) was removed, insert it into the inlet adapter (Ref. 35), and install the inlet adapter into the tilt pump body.
21. If the screens (Ref. 38) in the *push* and *pull* ports were removed, insert new screens, and install the retaining rings (Ref. 39).
22. Apply a small amount of white grease to the reservoir O-ring (Ref. 26), and insert it into the groove in the reservoir (Ref. 27).
23. Install the reservoir on the tilt pump body.
24. Install and tighten the four capscrews (Ref. 28) 96 lbf·in (1080 N·cm).
25. Install the fittings on the *push* and *pull* ports. Tighten them 96 lbf·in (1080 N·cm).

Installation

1. Using the two mounting capscrews and washers, install the assembled tilt pump onto the bracket attached to the vehicle. See **Fig. 5**, Refs. 2 and 3. Tighten the capscrews 23 lbf·ft (31 N·m).
2. Connect the hydraulic lines to the *push* and *pull* ports on the tilt pump assembly. Do not tighten the lines on the fittings until the system has been bled.
3. Fill the reservoir with the specified hydraulic fluid, and install and tighten the fill plug. Refer to the Charts and Specifications section of the *COE and 120 Conventional Maintenance Manual* for the specified hydraulic fluid. Do not use engine oil, brake fluid, or automatic transmission fluid.
4. Bleed the entire system. Refer to "Bleeding the System." Tighten the hydraulic lines firmly.

TROUBLESHOOTING

Problem – Cab Fails to Tilt or Fails to Return from Tilt

Possible Cause	Remedy
Cab latch binding, or failing to unlatch.	Check the cab latch release handles.
Plugged orifice at bottom of spool in the tilt pump.	Replace or rebuild the tilt pump.
Control lever in the wrong position.	Put the control lever in the correct position.
Worn piston seal in the tilt pump.	Replace or rebuild the tilt pump.
Hoses blocked.	Replace the hoses.
Shift tube latch assembly not disconnecting.	Manually disconnect the shift tube latch mechanism.
Push and *pull* lines crossed.	Check for correct installation.

Problem – Cab Stops Moving When in Controlled Fall

Velocity fuses locked up.	Reverse the pump direction with the control lever, and operate the pump to unlock.
Plugged orifice.	Inspect, and clean or replace.

Problem – Cylinder Velocity Fuses Lock Up

Controlled fall rate too fast.	Inspect orifice in bottom of spool valve; replace or rebuild the tilt pump, if needed.
Air in the system.	Bleed the system.
Ruptured hydraulic line.	Replace the hydraulic line.

ENERPAC® CAB-TILT SYSTEM

Problem – Oil Leaking at Hand Pump Plunger or Around Spool Valve

Possible Cause	Remedy
Worn seals and O-rings.	Replace or rebuild the tilt pump.

Problem – Oil Leak at the Tilt-Cylinder Gland

Worn seal on the gland.	Replace or rebuild the tilt cylinder.

Problem – Tilt Pump Leaks Between the Pump Base and the Reservoir

Worn O-ring on the reservoir.	Replace the O-ring on the reservoir.
O-ring on reservoir pinched.	Replace the O-ring, making sure it is properly positioned.

Problem – Cab Drifts When in the Half-Raised Position

Worn spool valve seals.	Replace the spool valve seals or rebuild the tilt pump.
Worn piston seals inside the tilt cylinders.	Replace the piston seals or rebuild the tilt cylinders.
Control lever not all the way in the proper position.	Place the control lever in the proper position.

SPECIFICATIONS

DESCRIPTION	SIZE	GRADE	TORQUE lbf·ft (N·m)
Tilt Cylinder Mounting Bolts	5/8–11	8	190 (258)
End Spacer Mounting Bolts	1/2–13	8	95 (129)
Tilt Pump Mounting Capscrews	3/8–16	5	23 (31)

Table 1

71 SERIES C.O.E. AND CONVENTIONAL DOOR SERVICING
SUBJECT CONTENTS

TOPIC	PAGE NUMBER
GENERAL INFORMATION	
SERVICE OPERATIONS	
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DOOR PANEL REMOVAL AND INSTALLATION	10-13
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WING WINDOW ASSEMBLY REMOVAL AND INSTALLATION	15
WING WINDOW GLASS REPLACEMENT	15-17
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71 SERIES C.O.E. AND CONVENTIONAL DOOR SERVICING

GENERAL DESCRIPTION

The Freightliner cab door (Refer to Fig. 1) features a frame with a double, horizontal brace, welded on midway up the door. The frame is sandwiched between an outside door panel (skin) and an upper and lower inside door panel.

The position of the door relative to the door posts is adjustable, owing to a hinge which is both vertically and horizontally slotted to allow for upright and lateral adjustment. The door is supported by a door check arm which is bolted to the door on one end, and mounted under the dashboard on the other.

The door may come equipped with a one or two-way air vent assembly, which is riveted to the skin near the lower front corner of the driver's door. A stationary visibility window may be mounted in lieu of the vent in the same location on the passenger's door.

The Atwood door latch is flush-mounted by two screws. Its basic components are a latch (with jaws), a striker pin, handles, and three rods. The rods run from the inside handle paddle to the outside handle paddle, from the outside handle paddle to the latch, and from the inside lock to the tumbler. The tumbler is mounted on the outside door handle mechanism. Refer to Fig. 2.

The striker pin is mounted on the rear door post, and may be adjusted either vertically or horizontally to correctly engage the latch jaws, which are mounted on the rear of the door frame. Through the use of shims, the forward and aft position of the striker pin is also adjustable.

The door handles may be adjusted in their oversized holes to allow for proper fit of the rods.

The wing window assembly (Refer to Fig. 3) is held in place by a single mounting bracket at the bottom, and by a mounting screw at the top. The glass sub-frame assembly houses a rubber weatherstrip, the glass frame, glass packing, and the window glass. The forward glass channel assembly mounts to the wing window assembly by means of a single screw. The lower rear bar assembly, actually an extension of the forward glass channel, protrudes below the glass channel and pivots forward to help facilitate the installation and removal of the window glass. Once in place, the lower rear bar pivots back and is secured by a pan head screw which is installed in the lower inside door panel.

The window is operated by a vertically-mounted, chain-driven regulator. Mounted on the chain is a bracket with a peg, which fits into a slot in the window lift assembly. Refer to Fig. 4.

The window glass is fitted in a rubber packing and inserted into a groove in the window lift assembly. The system is activated by a crank, which is mounted through the upper inside door panel to the top regulator sprocket. When the crank is turned by the handle, the window is guided up or down between the grooves of the glass channels. The trailing glass channel assembly (Fig. 1, Ref. 4) fits into a groove in the door frame and is secured to the frame by a single screw located above the window.

On doors equipped with Aristo-Aire air-powered windows, the vehicle air accessory system supplies air to the window via a hose which runs through a grommetted hole in the lower inside door panel to a regulator, or "air tube." The tube is vertically mounted behind the inside door panels. The air activates a piston, one end of which fits into a vertical slot which runs up the center of the tube. The other end of the piston arm attaches to, and raises when activated, a horizontal window lift assembly, into which the window fits. Refer to Figs. 5 and 6.

Other options that may require wiring through the door panels are CB radios (to the antenna), outside mirror heaters, and turn signals. The Aristo-Aire hose and the accessory wires, coming from the dashboard controls, traverse the lower inside door panel. The CB antenna cable traverses the upper inside door panel.

The circumference of the door (with the exception of the hinge area) is sealed with a single piece of preformed rubber. The hinge is sealed with three

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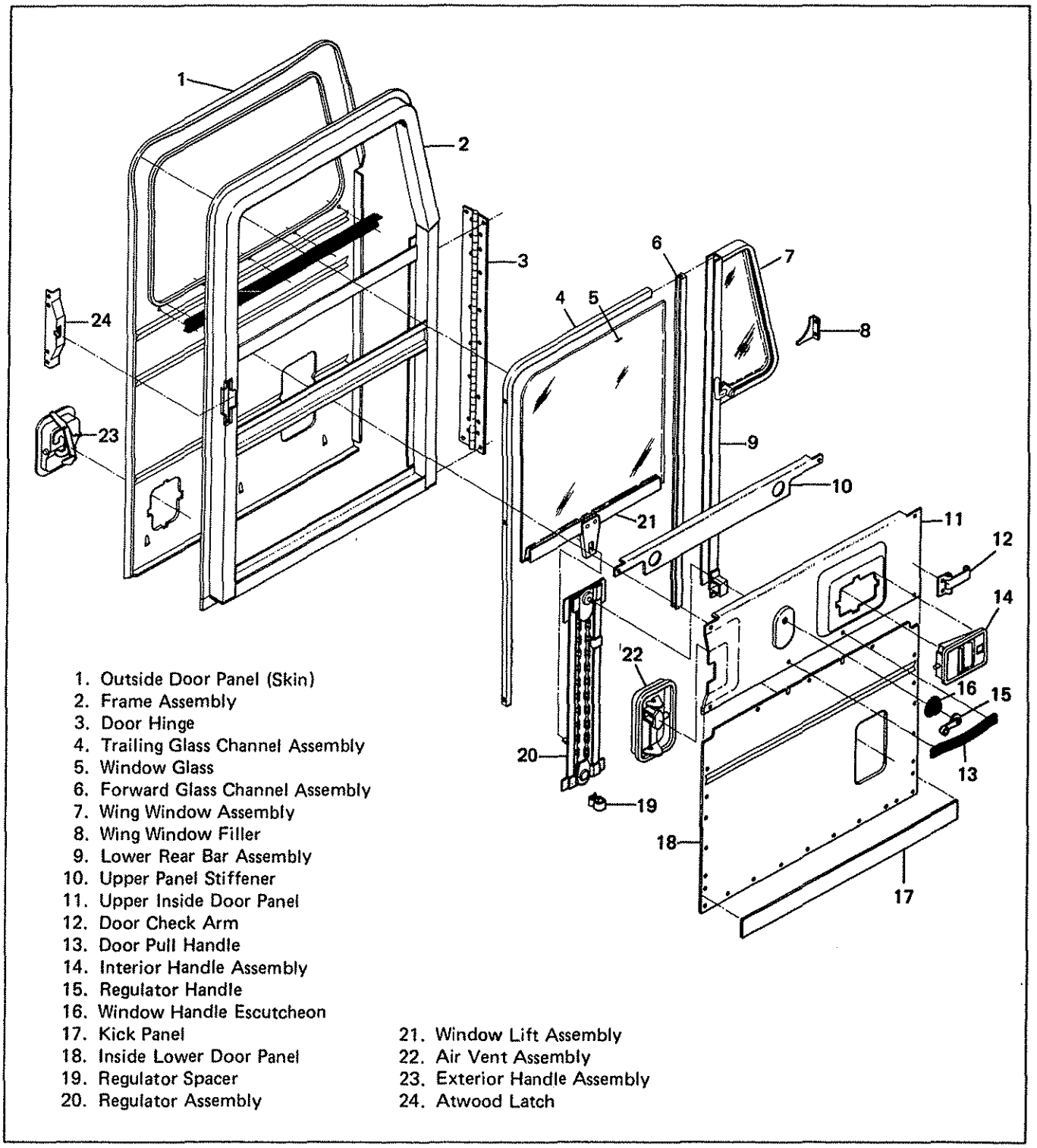

1. Outside Door Panel (Skin)
2. Frame Assembly
3. Door Hinge
4. Trailing Glass Channel Assembly
5. Window Glass
6. Forward Glass Channel Assembly
7. Wing Window Assembly
8. Wing Window Filler
9. Lower Rear Bar Assembly
10. Upper Panel Stiffener
11. Upper Inside Door Panel
12. Door Check Arm
13. Door Pull Handle
14. Interior Handle Assembly
15. Regulator Handle
16. Window Handle Escutcheon
17. Kick Panel
18. Inside Lower Door Panel
19. Regulator Spacer
20. Regulator Assembly
21. Window Lift Assembly
22. Air Vent Assembly
23. Exterior Handle Assembly
24. Atwood Latch

Fig. 1, Cab Door Assembly, Left Side

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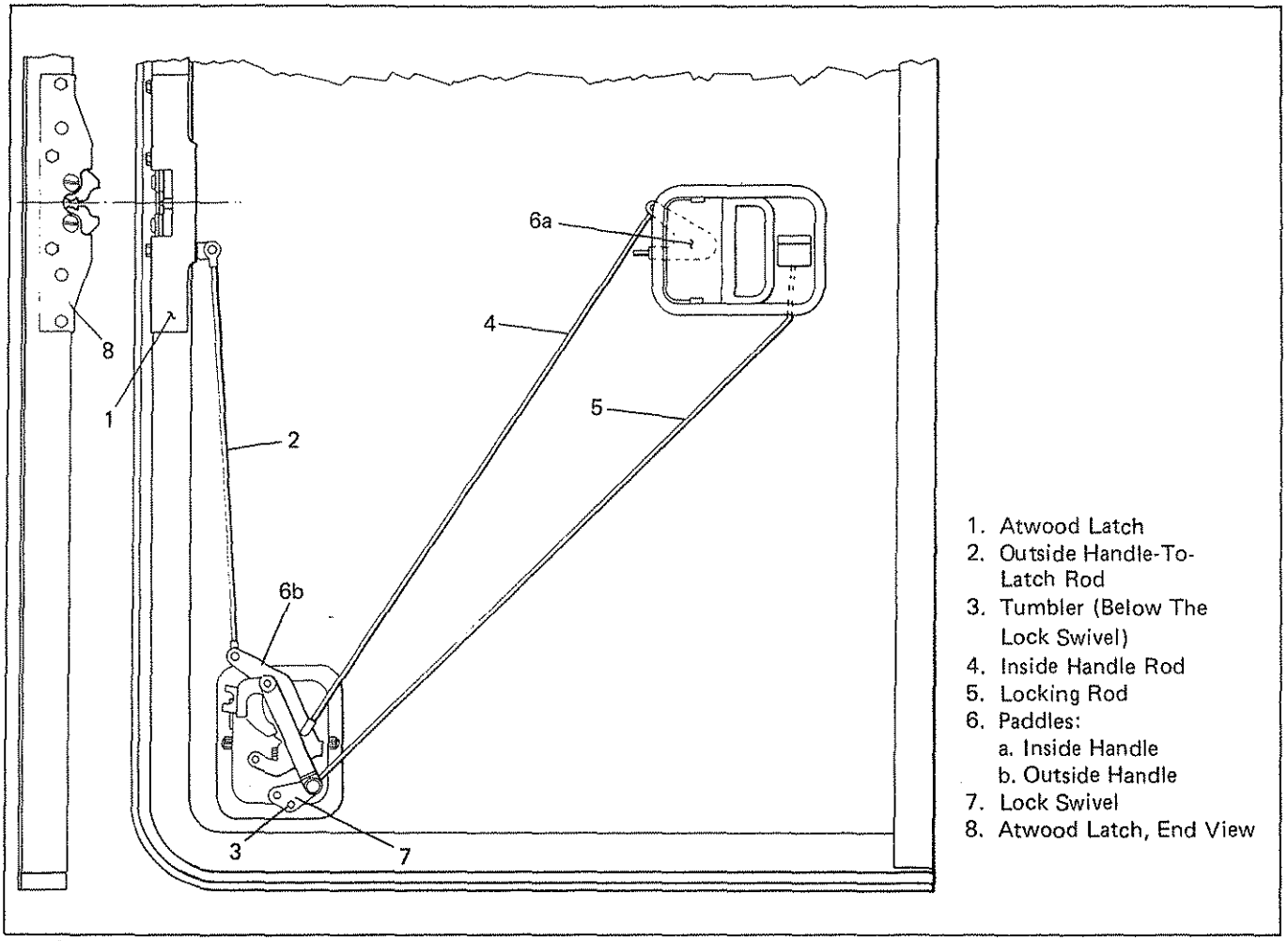

Fig. 2, Cutaway Showing Handles And Rods

pieces of self-adhesive sponge tape. A fourth piece of sponge is installed along the bottom of the front door post. Vehicles having doors with square rear corners have a fifth piece of sponge seal along the bottom of the rear door post.

On the bottom edge of the door, there are two small holes for drainage of any water which seeps through the window cavity into the frame area.

SERVICE OPERATIONS

Most of the service operations below may be performed with the door remaining on the cab. However, the mechanic may find it easier to work with the door removed from the cab. In such case, refer to the "DOOR REMOVAL, INSTALLATION, AND ADJUSTMENT" section of this subject before proceeding to the applicable service section.

DOOR REMOVAL, INSTALLATION, AND ADJUSTMENT

Removal (Refer to Fig. 1)

1. Disconnect the butt splices which join the linkage wires from the accessories (outside

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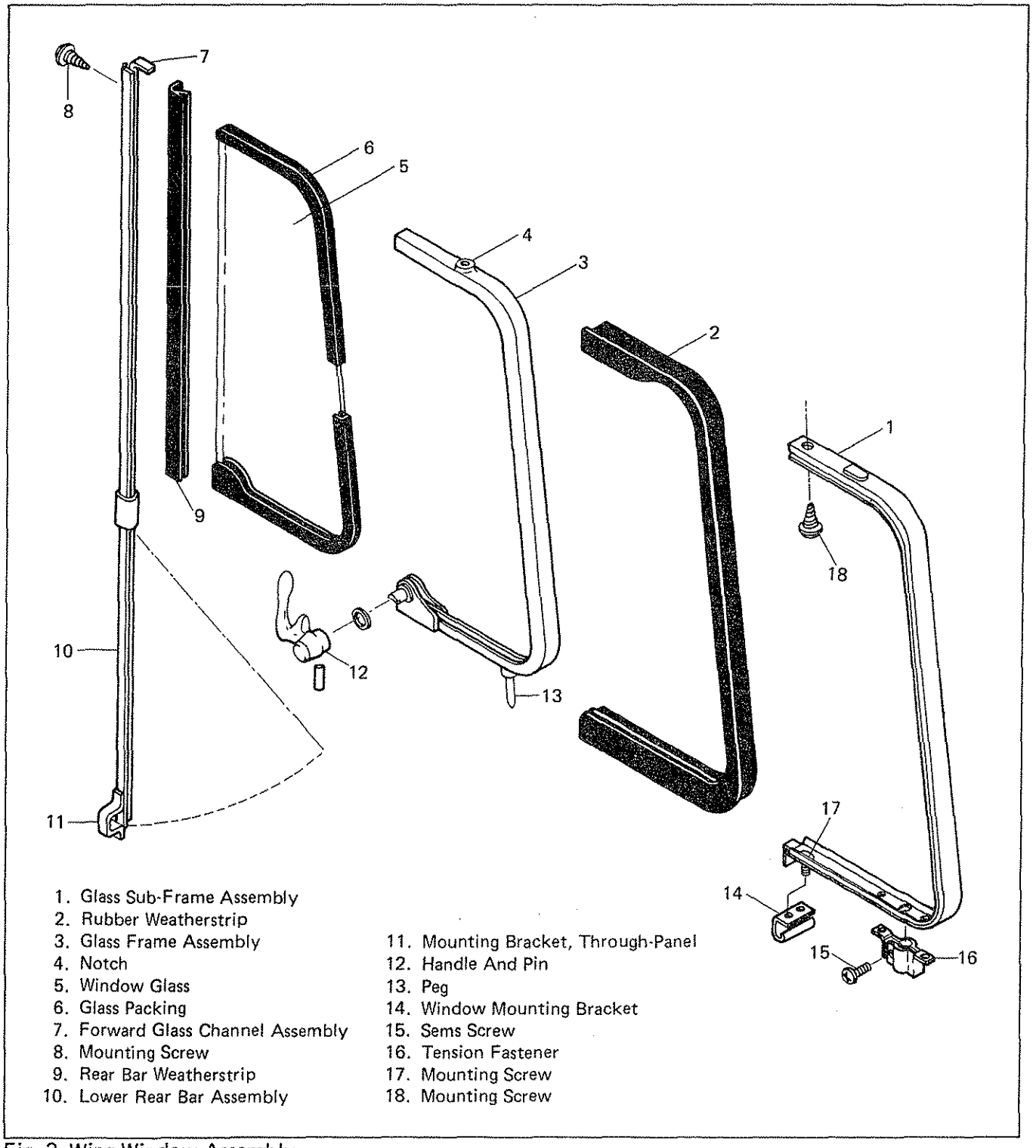

1. Glass Sub-Frame Assembly
2. Rubber Weatherstrip
3. Glass Frame Assembly
4. Notch
5. Window Glass
6. Glass Packing
7. Forward Glass Channel Assembly
8. Mounting Screw
9. Rear Bar Weatherstrip
10. Lower Rear Bar Assembly
11. Mounting Bracket, Through-Panel
12. Handle And Pin
13. Peg
14. Window Mounting Bracket
15. Sems Screw
16. Tension Fastener
17. Mounting Screw
18. Mounting Screw

Fig. 3, Wing Window Assembly

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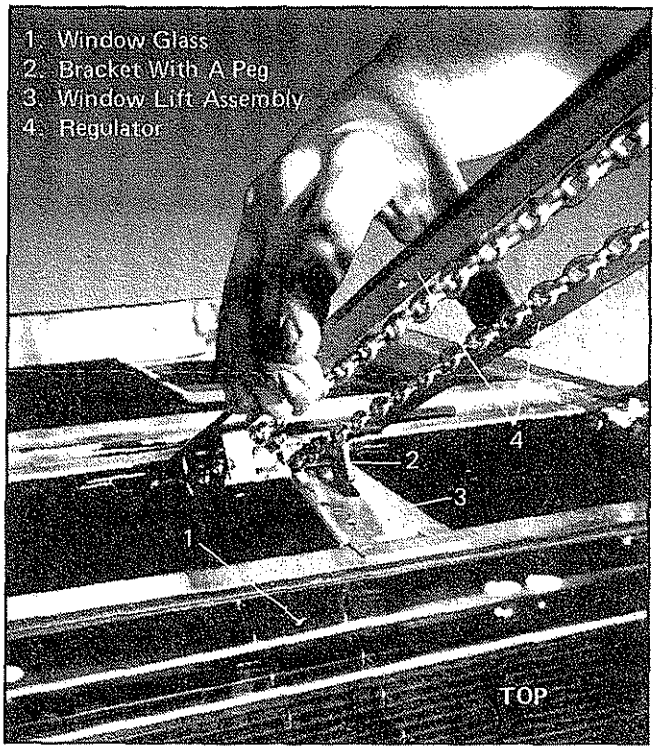

Fig. 4, Attaching The Regulator To The Window Lift Assembly

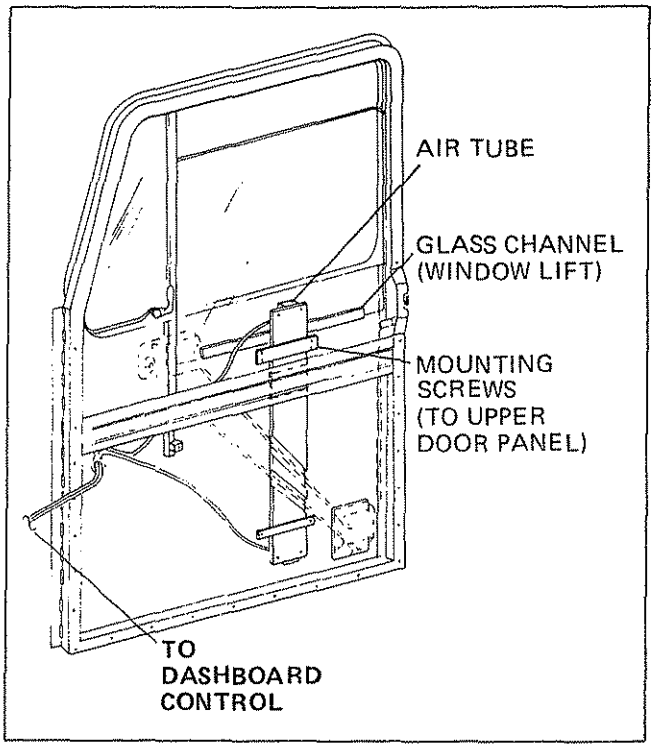

Fig. 5, Aristo-Aire Window Installation

mirror heater, turn signal) with the lead wires from the accessory controls.

NOTE: The butt splices and the Aristo-Aire hose joint are located under the dashboard one-to-two inches (25-51 mm) toward the accessory source from the dash bracket (to which the door check arm is mounted). On some vehicles it may be necessary to remove upholstery screws to facilitate reaching under the dash.

2. If equipped with an Aristo-Aire window, lower the window, and then disconnect the air tube hose linkage from the operating valve assembly linkage hose.

3. If the vehicle is equipped with a CB radio, disconnect the cable from the antenna outside the cab and run the cable through the door.

4. Remove the two capscrews that attach the door check arm to the door.

5. Remove the screws attaching the door hinge to the cab frame, then remove the door from the cab.

CAUTION: Support the bottom of the door during removal to prevent it from falling.

6. If the sponge seal on the front door post is found defective or weathered, peel or scrape it off.

Installation

1. If new sponge seal is to be installed, thoroughly clean and dry the surface where the new seal is to be applied. Use solvent to remove any rust, grease, or bits of old seal.

2. Apply the adhering side of the new sponge seal to the door post as in Fig. 7.

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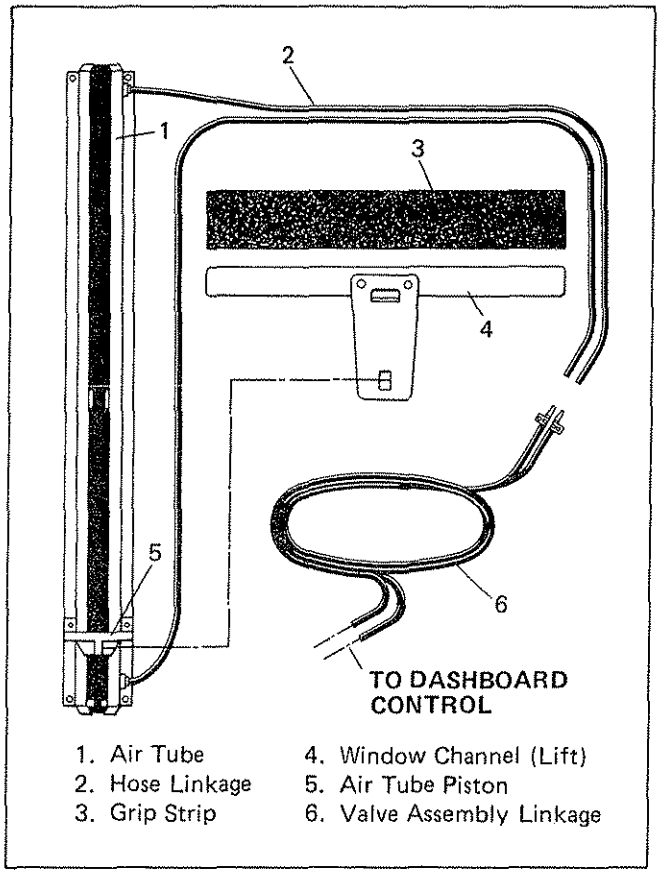

Fig. 6, Aristo-Aire System Components

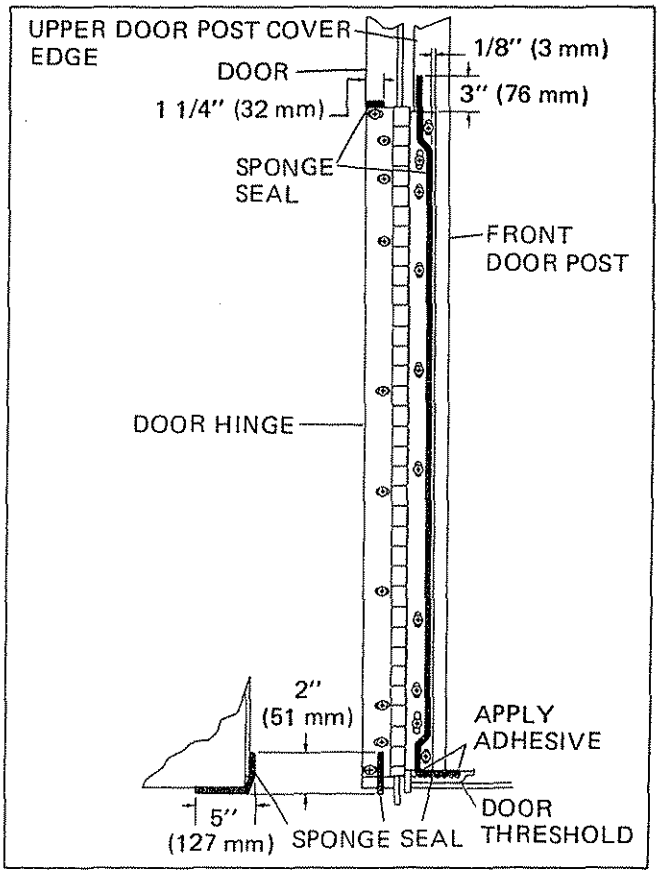

Fig. 7, Sponge Seal Installation, Left Hand Door (Right Hand Door Opposite)

3. Position the door to the front door post. Secure the hinge with the mounting screws, leaving the screws loose for later adjustment.

CAUTION: Support the bottom of the door during installation to prevent it from falling.

4. Adjust the position of the door within the cab frame and, if necessary, the location of the striker pin. Refer to the "DOOR ADJUSTMENT" section of this subject, which follows.

5. Install the door check arm.

6. If the vehicle is equipped with a CB radio, disconnect the cable from the antenna outside the cab and run the cable through the door.

7. Connect the butt splices which join the linkage wires from the accessories (outside mirror heater, turn signal) with the lead wires from the accessory controls.

8. If so equipped, join the Aristo-Aire air tube hose linkage with the operating valve assembly linkage hose.

Door Adjustment

A misaligned cab door can cause wind noise, poor temperature control in the cab due to drafts, and water damage to the upholstery or carpets.

The cab door hinge is slotted both vertically and horizontally, allowing the cab door to be adjusted relative to the cab frame.

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Up And Down Adjustment

Indications of improper up and down door adjustment include wind or water leaks at the top or bottom of a door, premature wear of the door seal at the top or bottom of a door, or sticking on the top or bottom of a door. Use the following procedure for door adjustment if any of these conditions exist:

1. Slightly loosen the pan head tapping screws that secure the hinge to the front door post.
2. Raise or lower the door until there is 13/32 inch (10.5 mm) clearance at the top and bottom of the door. The top measurement is taken between the top of the door and the door frame.
3. With the door positioned, tighten the pan head tapping screws to 7 ft-lbs (9 N·m).
4. Center the striker pin, if necessary, between the latch jaws of the door latch assembly. Refer to the heading "STRIKER PIN ADJUSTMENT" in this subject.

In Or Out Adjustment (Refer to Fig. 8)

Indications of improper in and out door adjustment include hard closing of the door, wind and water leaks on the perimeter of the door, or permature wear of the door seal on the perimeter. Use the following procedure for door adjustment if any of these conditions exist:

1. Slightly loosen the pan head tapping screws that secure the hinge to the cab door.
2. Move the door in or out of the door opening until it is adjusted as shown in Fig. 8.
3. With the door positioned, tighten the pan head tapping screws to 7 ft-lbs (9 N·m).
4. Adjust the striker pin horizontally, if necessary. Refer to the heading "STRIKER PIN ADJUSTMENT" in this subject.

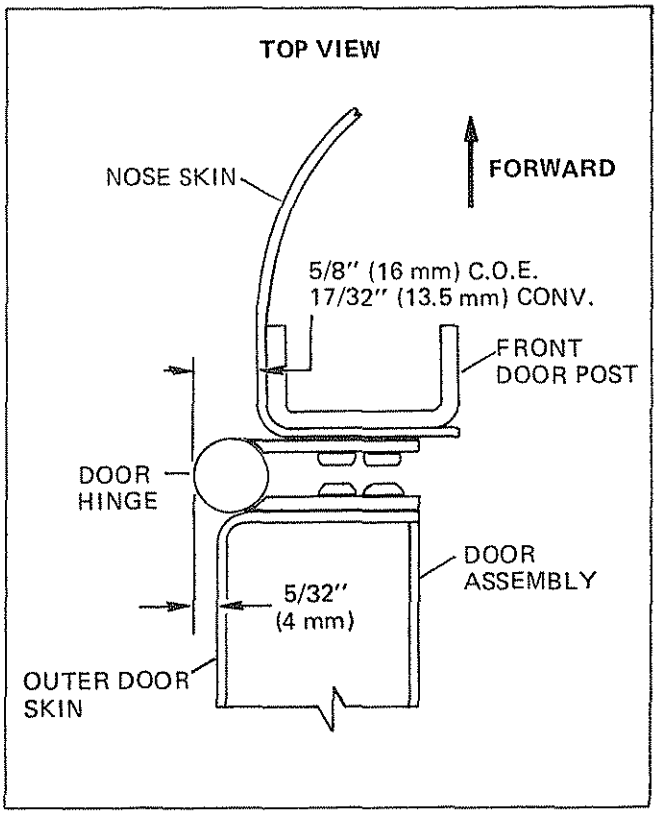

Fig. 8, Door Location In Or Out Adjustment, Left Hand Door (Right Hand Door Opposite)

Striker Pin Adjustment (Refer to Fig. 9)

The striker pin assembly consists of a striker pin, shim(s), and a tapping plate. The tapping plate is loosely riveted to the door post. The rivet holes are oversized to allow for vertical and horizontal adjustment of the striker pin. Use the following procedure to adjust the striker pin position:

1. From the inside of the cab, visually check to see if the latch jaws surround the striker pin at a point between the door post and the striker pin head, as shown in Fig. 10.
2. Use a number 50 Torx recess driver (Refer to Fig. 11) to remove the striker pin. Adjust the striker pin fore and aft position (as necessary) by inserting, or removing, shim(s) between the striker pin and the door post. Refer to Fig. 10.

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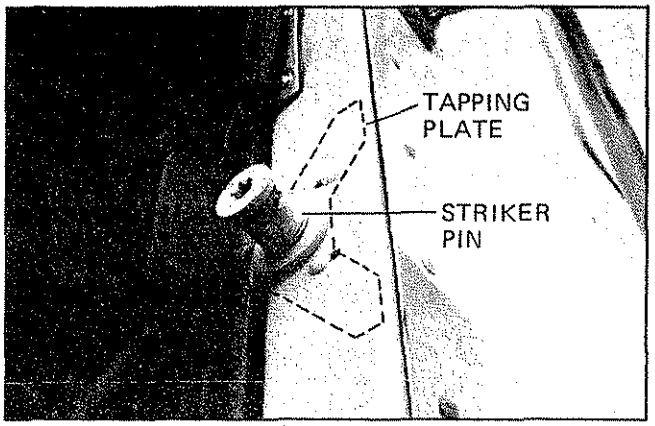

Fig. 9, Position Of Striker Pin In Door Post

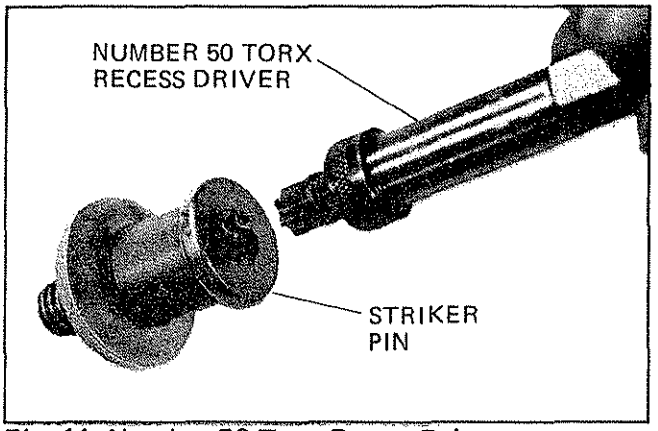

Fig. 11, Number 50 Torx Recess Driver

3. Adjust the striker pin horizontally until its center is 1 1/4 inches (32 mm) inboard of the cab skin. Refer to Fig. 12.

4. Adjust the striker pin vertically so that the latch jaws engage it cleanly.

5. When all adjustments of the striker pin are made, tighten the striker pin to 50 ft-lbs (68 N·m).

DOOR SKIN REPLACEMENT

1. Remove the door from the cab, following the instructions given under the heading "DOOR REMOVAL, INSTALLATION, AND ADJUSTMENT" in this subject.

2. Remove all installations and assemblies from the door, so that only the frame and the skin remain. Refer to the applicable "REMOVAL" section of this subject.

3. Use a prying device, such as a crowbar or a screwdriver, to pry the skin bead at least 90° away from the door frame. Continue to pry around the perimeter of the frame, and around the circumference of the window opening, until the frame is free of the skin. Refer to Fig. 13.

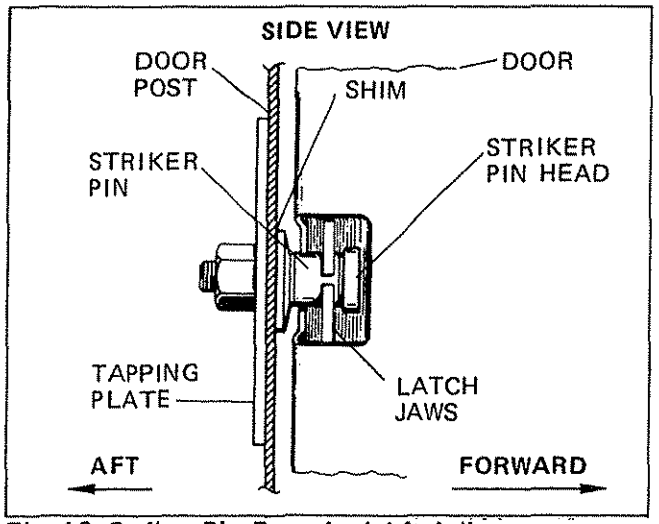

Fig. 10, Striker Pin Fore And Aft Adjustment

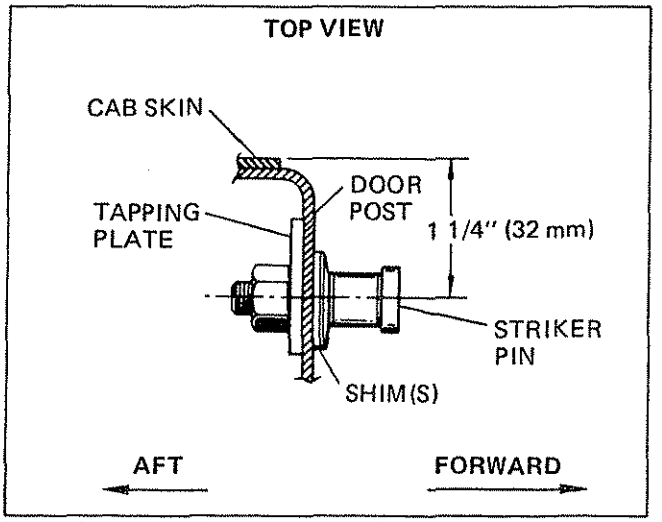

Fig. 12, Striker Pin Horizontal Adjustment

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4. Lift out the frame.

5. Using a carpenter's square, or a similar tool, check the frame for squareness. If it is not true, use body hammer to pound the out-of-square areas into alignment.

6. Place the skin and frame on a skinning table. If a skinning table is not available, use a strong, stable table (preferrably a steel bench) that is clean and flat.

NOTE: Firmly hold the frame in place. The recommended device is that which is shown in Fig. 14. If this is not available, two acceptable alternatives are: 1) bench vises or; 2) to have a second person sit on the skin.

7. Position the frame into the new skin. A flange on the new skin is preformed at a 90° angle. Refer to Fig. 15.

8. By using a rubber mallet around the perimeter of the frame, and around the window opening, bend the flange of the skin to form a bead. Refer to Fig. 16.

9. Position an aluminum wedge, or similar device, over the bead. Tap on the wedge continuously with a body hammer while sliding the wedge around the perimeter of the frame and the window opening to complete the formation of the bead. Refer to Fig. 17.

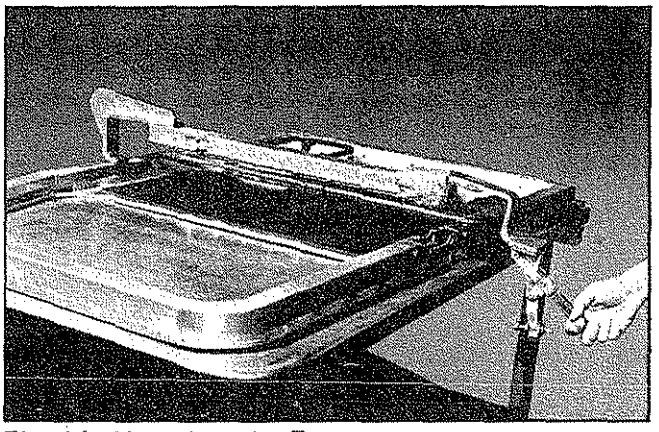

Fig. 14, Clamping The Frame

10. Paint the skin, referring to the 18 Group of this manual for instructions.

11. Install all installations and assemblies that were removed from the door. Refer to the applicable "REMOVAL" and "INSTALLATION" section of this subject.

12. Install the door to the cab door opening. Refer to the "DOOR REMOVAL, INSTALLATION AND ADJUSTMENT" section of this subject.

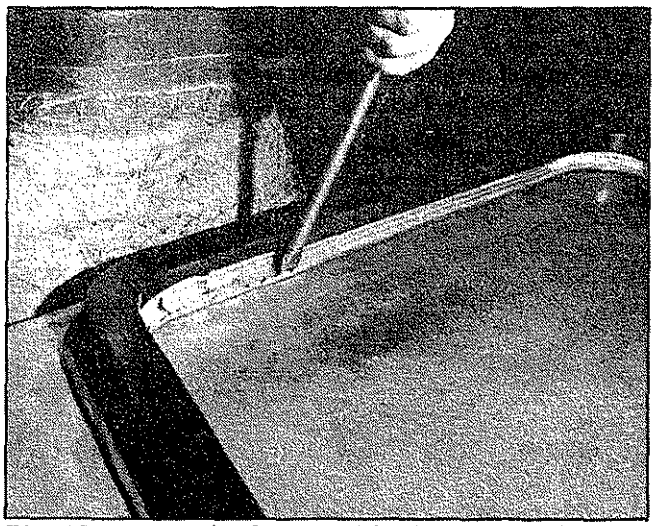

Fig. 13, Removal Of Door Skin From Door Frame

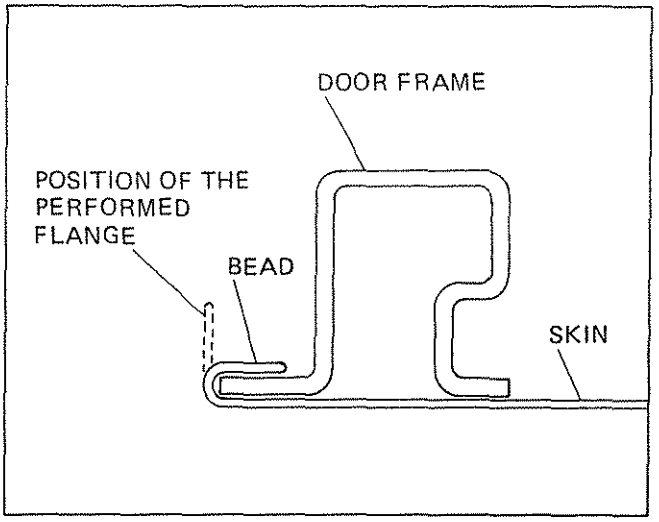

Fig. 15, Position Of Door Skin And Door Frame Edge

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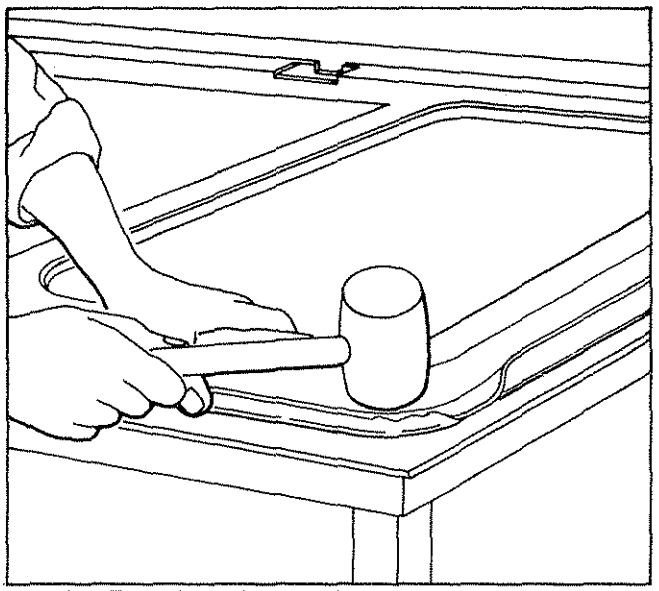

Fig. 16, Forming The Bead

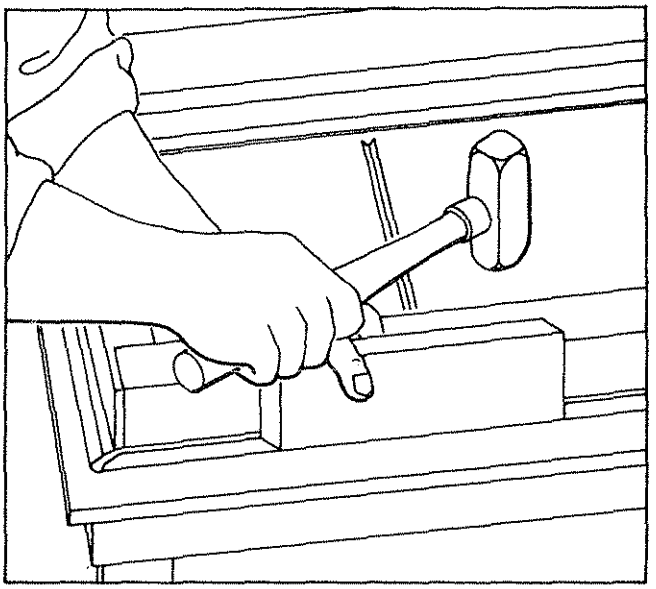

Fig. 17, Completing The Bead

DOOR PANEL REMOVAL AND INSTALLATION (Refer to Fig. 18)

Removal

1. Remove the door check arm from the upper inside door panel.

2. Remove the kick panel from the bottom of the door.

3. If so equipped, remove the vinyl edging around the inside air vent and visibility window openings.

4. Remove the upholstery, exposing the lower inside door panel.

5. Crank the window down into the frame. Remove the screw that attaches the window handle and the handle escutcheon to the regulator crank.

6. Remove the lower inside door panel mounting screws, the pan head screw which holds the lower rear bar in place behind the panel, and the lower regulator mounting screws. Lift the lower inside door panel out of the way. If there are no accessory wires (or hose) traversing the lower panel, remove the panel from the door.

7. Unlatch the keepers which secure the inside handle rod and the locking rod to the outside handle assembly (Refer to Fig. 19). Then, lift the rods out of their guides as they cross the regulator.

8. Remove the vinyl inserts from the door pull handle, then remove the screws and handle.

NOTE: If the vehicle is equipped with a CB radio, it is necessary to create slack in the cable to facilitate removal of the inside upper door panel, which must be pulled upward to remove the attached rods from behind the door frame brace.

9. Disconnect the CB antenna cable from its mounting bracket on the antenna above the left outside mirror, then slide it back through the inside upper door panel.

10. Remove the screws attaching the inside upper door panel to the frame, and the through-panel screws which mount the regulator or the air tube in its place behind the upper panel. Slide the panel out the top of the door to remove it. Refer to Fig. 20.

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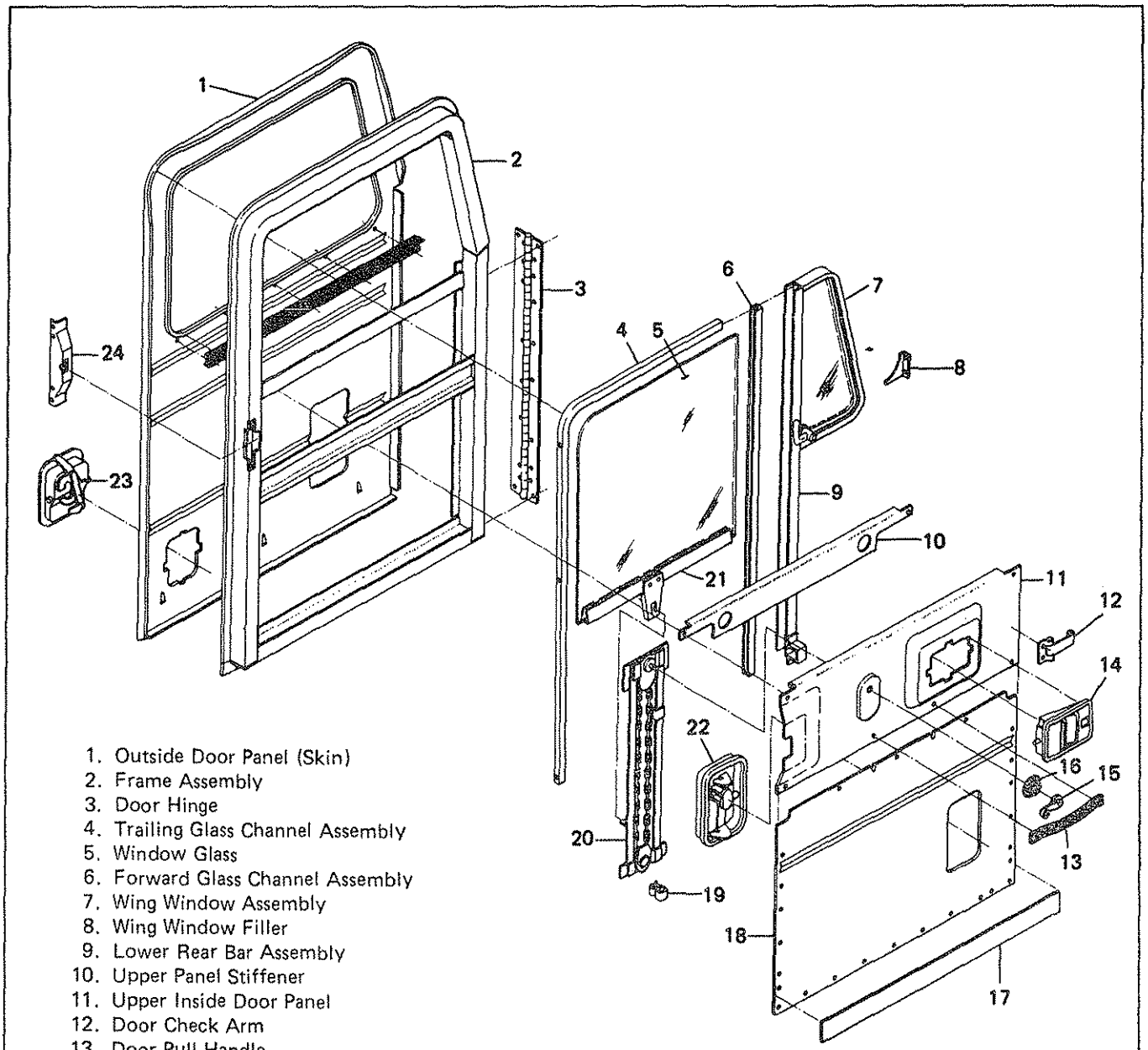

1. Outside Door Panel (Skin)
2. Frame Assembly
3. Door Hinge
4. Trailing Glass Channel Assembly
5. Window Glass
6. Forward Glass Channel Assembly
7. Wing Window Assembly
8. Wing Window Filler
9. Lower Rear Bar Assembly
10. Upper Panel Stiffener
11. Upper Inside Door Panel
12. Door Check Arm
13. Door Pull Handle
14. Interior Handle Assembly
15. Regulator Handle
16. Window Handle Escutcheon
17. Kick Panel
18. Inside Lower Door Panel
19. Regulator Spacer
20. Regulator Assembly
21. Window Lift Assembly
22. Air Vent Assembly
23. Exterior Handle Assembly
24. Atwood Latch

Fig. 18, Cab Door Assembly, Left Side

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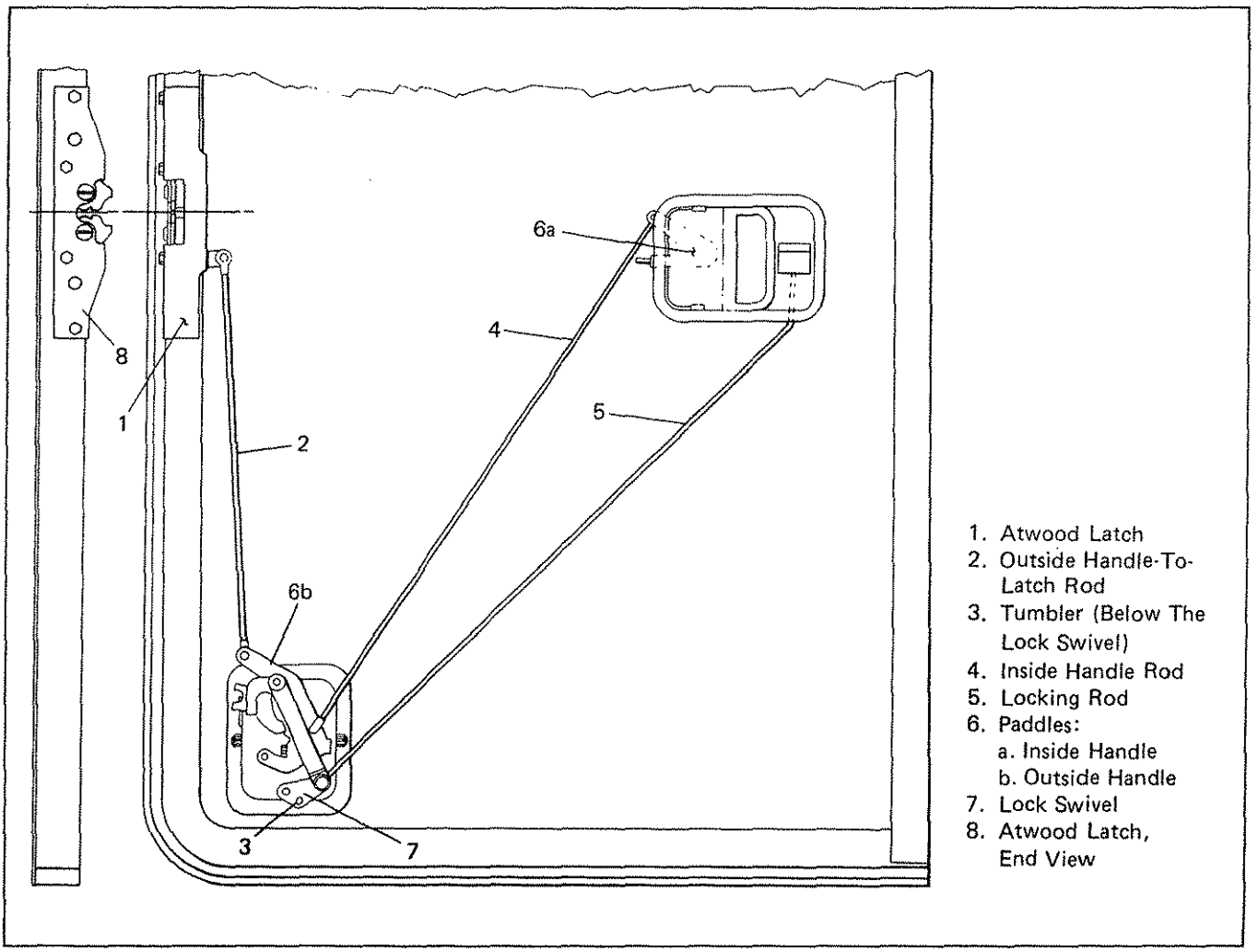

Fig. 19, Cutaway Showing Handles And Rods

Installation (Refer to Fig. 18)

1. Insert the outside handle-to-latch rod into the keepers on the latch and on the outside handle paddle. Lock the keepers.

NOTE: The outside handle-to-latch rod is the shortest of the three rods. All rods must fit into the keepers without pulling or pushing. If they don't, adjust the handles by tapping them with a ball peen hammer until the adjustment is obtained.

2. Insert the inside handle rod into the keeper on the handle paddle and lock the keeper.

NOTE: The inside handle rod is the shorter of the two remaining rods.

3. Attach the bent end of the locking rod to the back side of the inside lock, and fasten the keeper.

4. If the cab is equipped with a CB unit, route the CB antenna cable through the grommetted hole at the front of the upper door panel and through the hole in the outer panel.

5. Position the upper door panel, with the rods attached, near the cab frame. Guide the rods

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into position behind the brace until the upper panel seats in place on the door frame. Refer to Fig. 20.

6. Insert the four mounting screws into the upper regulator assembly, leaving them loose to allow for later adjustment (if necessary). Install the screws that hold the inside upper door panel in place, leaving the screws loose to allow for possible later adjustment.

7. Install the lock swivel on the tumbler, and fasten with a lock swivel retainer clip.

8. Position the lock rod (the bottom rod) into the back of the lock swivel, and lock the keeper.

9. Fasten the inside handle rod to the paddle on the outside handle, and lock the keeper.

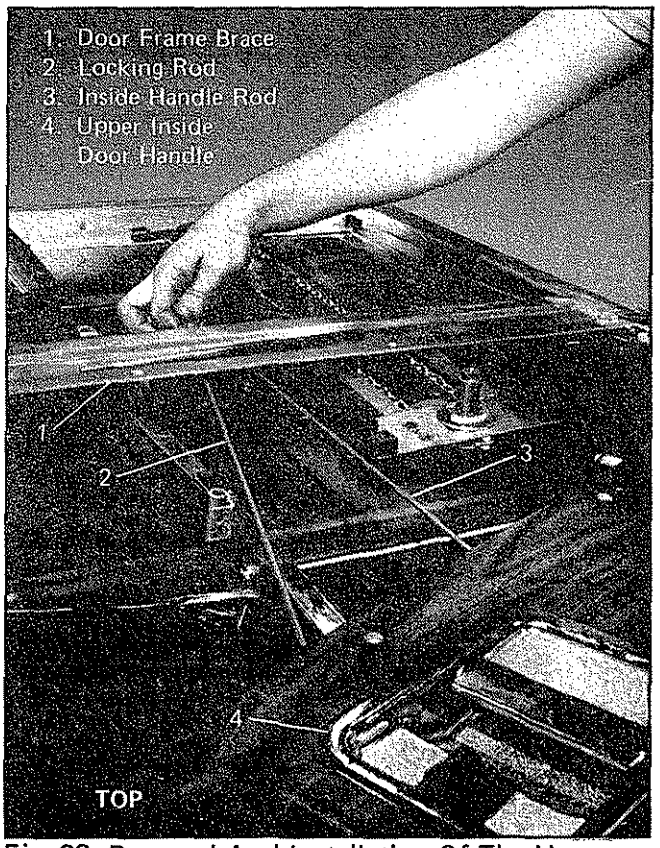

Fig. 20, Removal And Installation Of The Upper Inside Door Panel

10. If equipped with an Aristo-Aire window, insert the air hose linkage and any other wires that have been disconnected, through the grommetted hole in the upper front corner of the lower inside door panel.

11. Install the lower inside door panel, the lower regulator mounting screws, and the screw holding the lower rear bar in position. Leave the screws loose, allowing for later adjustment of the channel and wing window position, if necessary.

12. Install the handle and handle escutcheon to the window crank, and test to see if the window moves freely within its channel. Refer to the "WINDOW GLASS REMOVAL, INSTALLATION, AND ADJUSTMENT" section of this subject.

13. Install the upholstery, kick panel, and door check arm which were previously removed.

14. Connect the CB cable to the antenna.

WINDOW GLASS REMOVAL, INSTALLATION, AND ADJUSTMENT

Removal

1. Remove the door panels. Refer to the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.

2. If so equipped, engage the operating valve to lower the Aristo-Aire window lift assembly to the bottom of the door.

3. Disengage the regulator, or air tube, from the window lift assembly (Refer to Fig. 21). Slide the regulator out the door bottom.

4. Pivot the rear bar assembly away from the window glass. With a screwdriver, or similar tool, pry the glass out of the forward glass channel assembly. Refer to Fig. 22.

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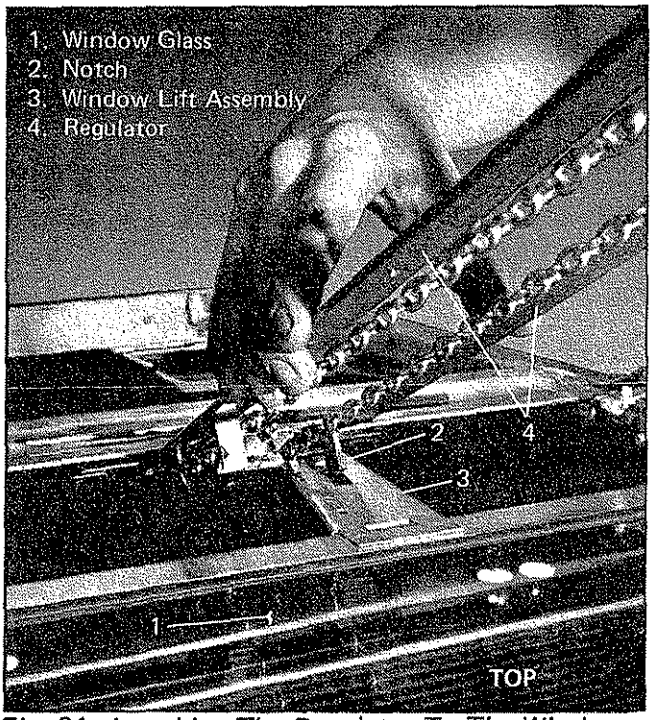

Fig. 21, Attaching The Regulator To The Window Lift Assembly

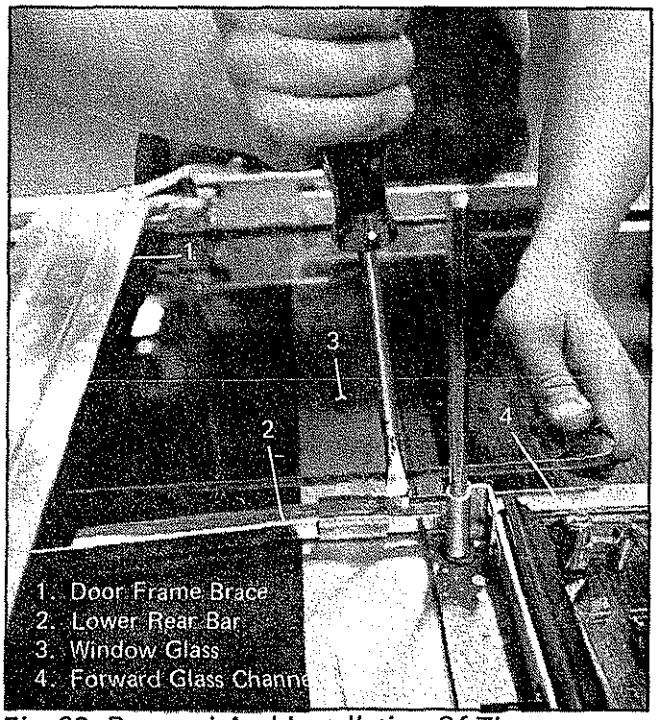

Fig. 22, Removal And Installation Of The Window Glass

5. Lift the window out of the trailing glass channel groove, then slide it under the door frame brace and out the top of the door. If equipped with an Aristo-Aire window, slide the window under the door frame brace and out the top.

Installation

1. Place the window lift assembly (which includes the glass) into the door frame, positioning the glass into the groove of the trailing glass channel.

2. Pivot the lower rear bar away from the glass.

3. Using a screwdriver, or similar tool, pry the window glass into the forward glass channel. (Refer to Fig. 22) Then, return the lower rear bar to its operating position.

4. Check to make sure the regulator is well lubricated; then install the regulator by fitting the notch (Refer to Fig. 21) into the slot in the window lift assembly. Slide the regulator, with the window lift attached to the bottom of the door to position the regulator.

NOTE: On Aristo-Aire windows, engage the operating valve to raise the air tube piston, if necessary. Position the piston in the window lift assembly slot, then slide the air tube and lift assembly to the bottom of the door to position the air tube.

5. Install the inside door panels. The regulator is held in place on the inside of the panels by four screws in both the upper and lower panels, as well as by the window handle that attaches to the top sprocket (via the crank).

Adjustment

Crank Windows

Before tightening the screws which mount the regulator to the upper door panel, and the screws

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which mount the panel to the door frame, install the regulator handle and handle escutcheon. Crank the window up and down to check for binding. If the glass does not move freely in the door, realign the position of the wing window and check the position of the glass channel. When the glass moves freely, tighten all regulator and door panel mounting screws.

Air Windows

Before tightening all air tube mounting screws, attach the hose linkage to the operating valve assembly and test the window for alignment. The lift assembly should ride freely on the air tube piston arm. The air tube should not bind against the loosely attached panels. If binding occurs, inspect the alignment of the air tube under the panel.

If the glass will not move freely within the glass channels, check the alignment of the glass within the lift assembly, and check the alignment of the lift assembly. When the alignment is such that the window moves up and down without binding, tighten all air tube mounting screws and inside door panel screws.

WING WINDOW ASSEMBLY REMOVAL AND INSTALLATION (Refer to Fig. 23)

Removal

1. Remove the wing window filler. Refer to Fig. 18, Ref. 8.
2. Remove the door panels from the door frame. Refer to the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.
3. Open the wing window.
4. Peel back the weatherstripping above and below the glass frame assembly, then remove each underlying screw. Refer to Fig. 24.
5. Remove the screw securing the wing window mounting bracket to the door frame.
6. Pivot the lower rear bar assembly away from the window glass. Using a screwdriver, with the glass channel for a brace, disjoin the wing window assembly and the window glass (Refer to Fig. 22).

NOTE: The forward glass channel assembly will still be affixed to the wing window assembly.

7. Remove the wing window assembly from the door frame.

Installation

1. Slide the lower rear bar assembly of the wing window assembly under the door frame brace, bringing the wing window assembly into position within the door frame.
2. Pivot the lower rear bar toward the front of the door. Using a screwdriver, pry the window glass into the forward glass channel assembly. Then return the lower rear bar to its operating position.
3. Peel back the weatherstripping above and below the glass frame assembly. Install the screw in the top and in the bottom. Then reposition the weatherstripping. Refer to Fig. 24.
4. Install the screw which secures the wing window mounting bracket to the frame. Refer to Fig. 23, Ref. 14.
5. Install the door panels. Refer to the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.
6. Attach the wing window filler by installing its mounting screw. Refer to Fig. 18, Ref. 8.

WING WINDOW GLASS REPLACEMENT (Refer to Fig. 23)

1. Perform steps 1, 2, and 3 under the "REMOVAL" heading of the "WING WINDOW ASSEMBLY REMOVAL AND INSTALLATION" section of this subject.

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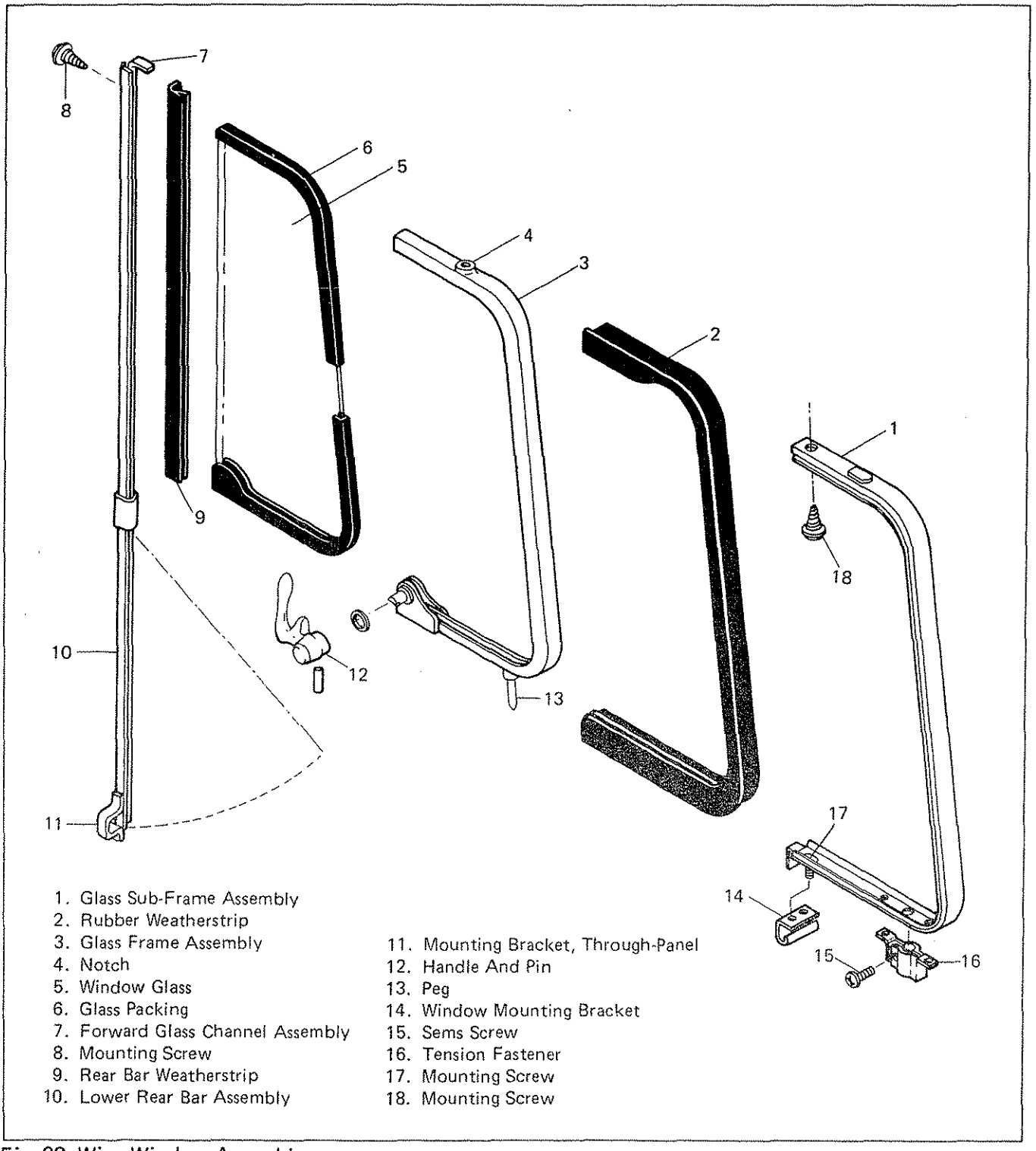

1. Glass Sub-Frame Assembly
2. Rubber Weatherstrip
3. Glass Frame Assembly
4. Notch
5. Window Glass
6. Glass Packing
7. Forward Glass Channel Assembly
8. Mounting Screw
9. Rear Bar Weatherstrip
10. Lower Rear Bar Assembly
11. Mounting Bracket, Through-Panel
12. Handle And Pin
13. Peg
14. Window Mounting Bracket
15. Sems Screw
16. Tension Fastener
17. Mounting Screw
18. Mounting Screw

Fig. 23, Wing Window Assembly

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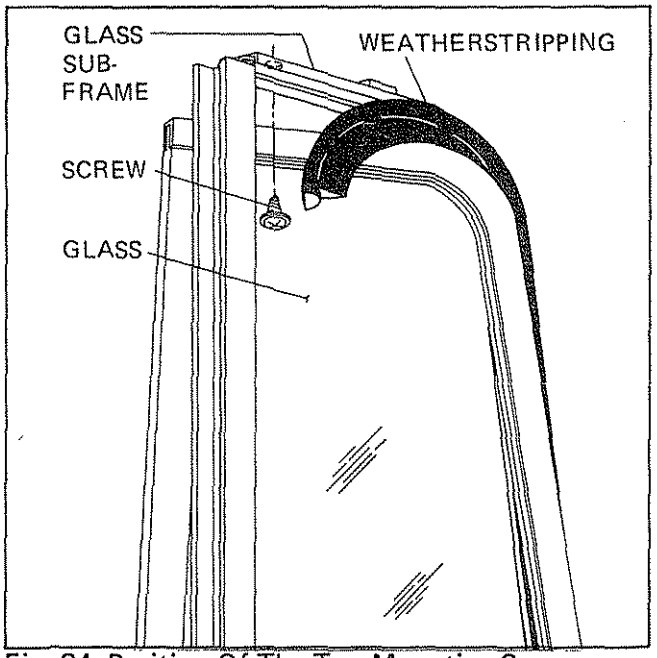

Fig. 24, Position Of The Top Mounting Screw In The Glass Sub-Frame

Fig. 25, Wing Window Glass Frame Removal

2. Loosen the pan head screw on the tension fastener.

3. Place a screwdriver tip near the notch (Ref. 4) and, using the glass subframe as a brace, gently pry the glass frame assembly out of the glass subframe assembly. Refer to Fig. 25.

4. The wing window now swivels only on the tension fastener. Loosen the screw (Fig. 23, Ref. 15) and lift the peg (Fig. 23, Ref. 13) out of the tension fastener, removing the glass subframe assembly.

5. Insert the wing window glass frame assembly peg into the tension fastener.

6. Place a screwdriver tip near the notch on the subframe assembly to pry the glass frame into the notch, just as it was removed in step 3, above.

7. Tighten the pan head screw on the tension fastener.

8. Install the door panels. Refer to the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.

9. Attach the wing window filler by installing its mounting screw. Refer to Fig. 18, Ref. 8.

VISIBILITY WINDOW REMOVAL AND INSTALLATION

Removal (Refer to Fig. 26)

Work from the outside of the door to remove the visibility window:

1. At the joint of the visibility window channel (weatherstripping) slide a screwdriver or similar tool under the lockbead ("filler strip") to break the bond between the lockbead and window channel. Pull out the lockbead.

2. Run the tip of the screwdriver between the visibility window and its channel to break the window seal. Repeat this procedure on the inside of the channel.

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3. With another person holding the outside of the visibility glass to guard against dropping it, push carefully, from the inside, around the edges of the glass pane to unseat it.

WARNING: Since stress is greater at the center of the glass, a broken pane and possible abrasions could result from attempts to push out the glass from the middle.

Installation

1. Glaze the grooves of the glass channel with an adhesive (Adco WD-300 or an equivalent).

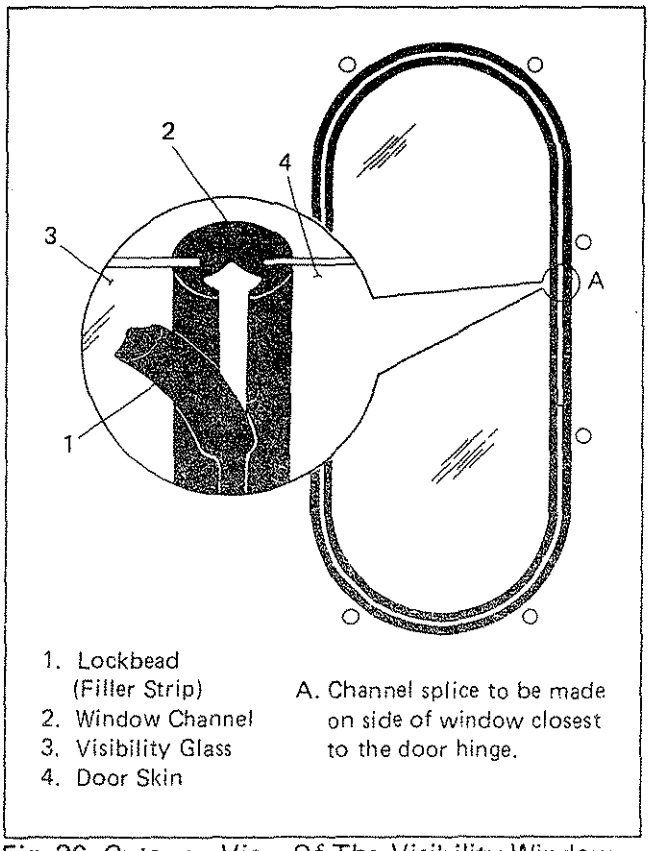
2. Starting at Fig. 26, Ref. A, position the glass channel around the circircumference of the visibility window cavity in the passenger's door skin.

3. Insert the bottom of the visibility window pane into the bottom of the glass channel, as shown in Fig. 27.

4. While gently pressing on the window pane, run a screwdriver or similar device between the channel and the pane. Continue around the circumference of the channel to seat the pane. Refer to Fig. 28.

WARNING: Since stress is greater at the center of the glass, a broken pane and possible abrasions may result from any attempt to seat the glass by pressing it in the middle.

5. Starting near the splice of the glass channel, press the lockbead into the remaining channel groove. It should press in easily with the thumb.



1. Lockbead (Filler Strip)
2. Window Channel
3. Visibility Glass
4. Door Skin

A. Channel splice to be made on side of window closest to the door hinge.

Fig. 26, Cutaway View Of The Visibility Window

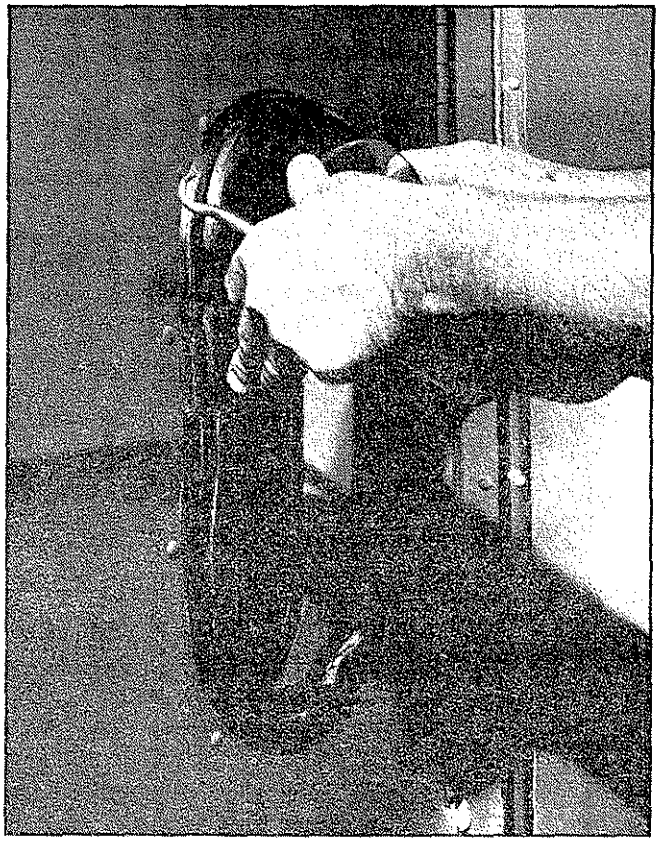


Fig. 27, Inserting The Visibility Window Pane Into The Visibility Glass Channel

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AIR VENT REMOVAL AND INSTALLATION (Refer to Fig. 29)

Removal

1. Remove the lower door panel. Refer to the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.

2. Working from the outside, use a No. 21 (or 5/32 inch) drill bit to drill out the 12 Brazier head rivets which mount the air vent assembly to the outer door panel.

CAUTION: The aluminum door skin rips easily, and may be damaged by attempts to remove the rivets by any other means.

3. Lift out the air vent assembly.

4. If the sponge seal or sponge tape is found defective or weathered, peel or scrape it off.

Installation

1. If new sponge seal or sponge tape is to be installed, thoroughly clean and dry the surface where the new seal is to be applied. Use solvent to remove any rust, grease or bits of old vent seal.

2. Apply the adhering side of the new sponge tape around the air vent opening on the inside of the outer door panel.

3. Apply the adhering side of the new sponge seal to the lip of the air vent assembly which faces the inside of the cab.

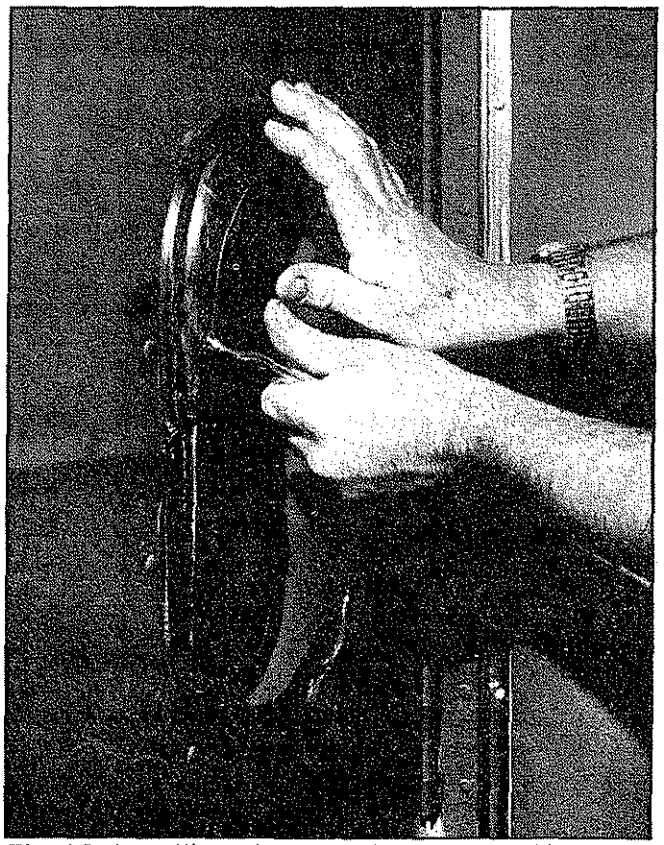

Fig. 28, Installing The Visibility Window Glass

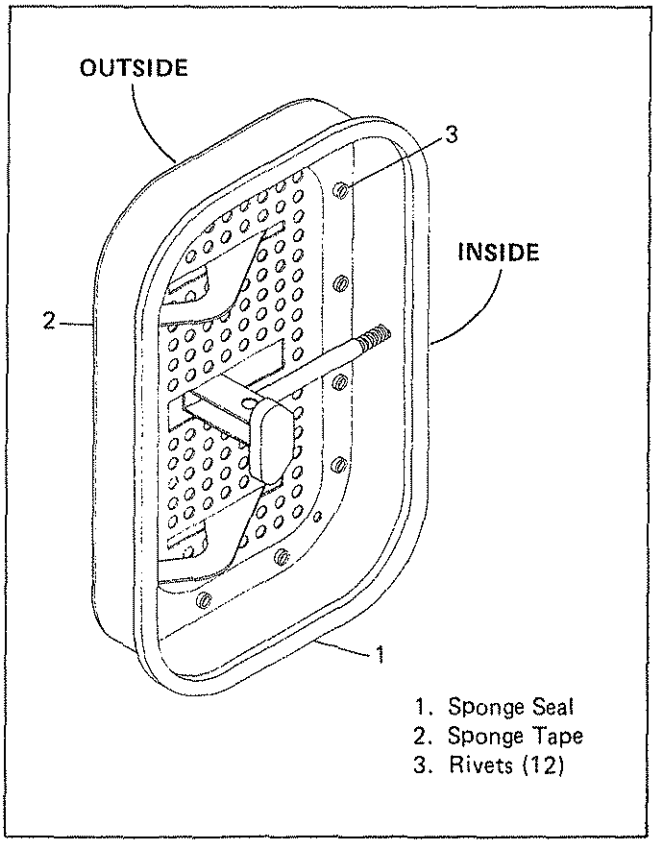

Fig. 29, Air Vent Assembly

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4. Use a 5/32 inch rivet set to install the 12 Brazier head rivets.

DOOR HANDLE REMOVAL, INSTALLATION, AND ADJUSTMENT

Inside Handle Removal

1. Remove the door panels. Refer to the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.

2. Unlatch the keepers which attach the inside handle rod to the paddle and the lock rod to the lock button.

3. Remove the nut securing the horseshoe fastening clip to the handle assembly, then remove the horseshoe fastening clip. Refer to Fig. 30.

4. Lift out the handle assembly.

Outside Handle Removal (Refer to Fig. 31)

1. Remove the lower door panel. Refer to steps two through seven of the "REMOVAL" subheading of the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.

2. Unlatch the keepers which secure the inside handle rod to the outside handle paddle, and the lock rod to the lock swivel.

3. Unlatch the keeper which attaches the latch rod to the outside handle paddle.

4. Remove the nut securing the horseshoe fastening clip to the handle assembly, and remove the horseshoe fastening clip. Refer to Fig. 30.

NOTE: It may be necessary to tap at the prongs of the horseshoe clip with a mallet to nudge it out of position.

5. Lift out the handle assembly.

Tumbler Removal (Refer to Fig. 31)

1. Detach the lock swivel from the tumbler, by using a lightweight ball peen hammer to tap the

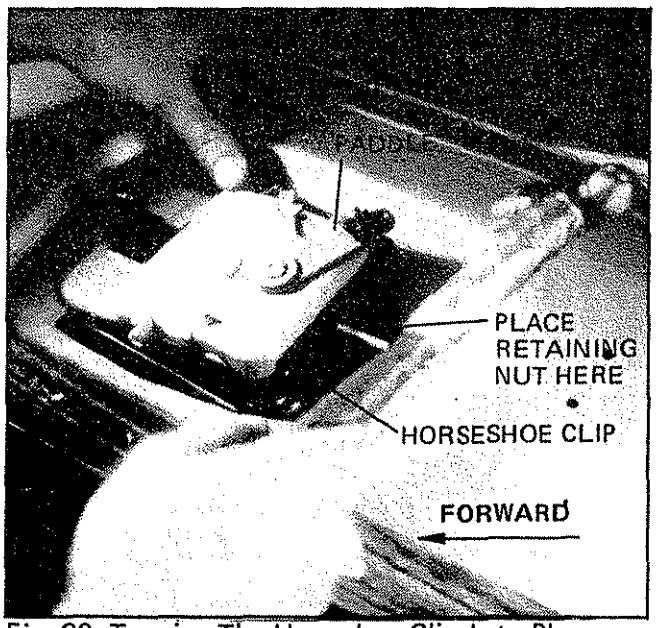

Fig. 30, Tapping The Horseshoe Clip Into Place (Inside Handle Shown)

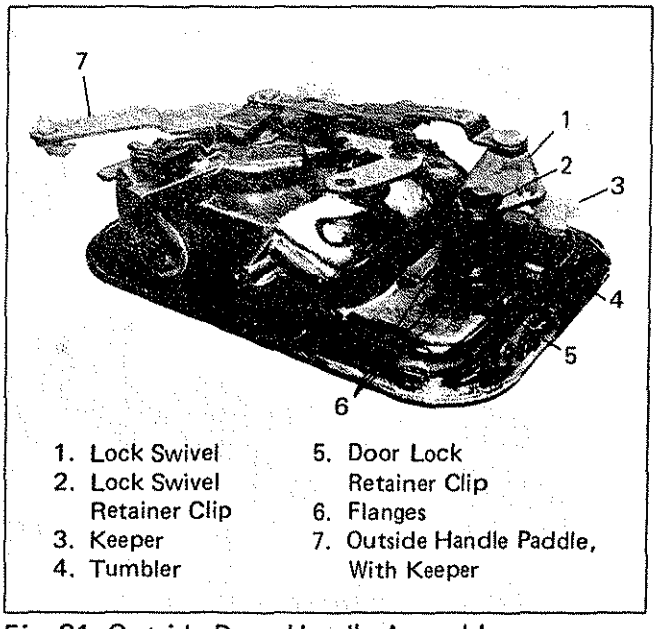

Fig. 31, Outside Door Handle Assembly

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lock swivel retainer ring out of position, so that it may then be removed. Refer to Ref. 2.

2. Using a lightweight ball peen hammer, unseat the door lock retainer clip from its position around the tumbler. Refer to Ref. 5.

3. Remove the tumbler from the outside handle assembly.

Tumbler Installation (Refer to Fig. 31)

1. Place the tumbler into the outside handle assembly from the outside. Use a ball peen hammer to gently tap the door lock retainer clip into position around the tumbler.

NOTE: The tumbler has three flanges. The retainer clip must be pushed on from the side without a flange. Refer to Ref. 5.

2. Position the lock swivel above the tumbler. Install the lock swivel retaining ring, using the ball peen hammer to tap it into position.

Inside And Outside Handle Installation

1. From the front side of the upper panel (for the inside handle), or the outside of the door skin (for the outside handle), insert the handle assembly into the oversized hole provided for it.

2. Install the horseshoe fastening clip around the backside of the handle assembly so that the flat sides of the clip prongs are flush against the backside of the upper door panel (for the inside handle) or the inside of the skin (for the outside handle).

3. Tap the horseshoe clip into position with a lightweight ball peen hammer, then install the retaining nut. Refer to Fig. 30.

4. Insert the outside handle-to-latch rod into the keeper on the outside handle paddle and lock the keeper.

5. Install the inside door panel(s). Refer to the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject. If only the lower door panel is to be installed, refer to steps 8 through 13 of the "INSTALLATION" sub-heading of the "DOOR PANEL REMOVAL AND INSTALLATION" section of this subject.

Testing The Latch And Lock Adjustment

WARNING: Failure to test the latch system after installation could result in a potentially dangerous operating condition, allowing the door to open inadvertently and possibly throw the operator from the vehicle.

Failure to test the lock system after installation could result in the operator being locked out of the vehicle.

To test the latch, close one jaw of the latch and open it with the inside handle. If the jaw does not open, tap the outside handle into position by using a lightweight hammer and a woodblock. The oversized handle mounting holes allow for this.

To test the lock, close one jaw of the latch and lock it with the inside lock tab. Try to open the locked jaw with the outside handle. If the jaw opens, tap the outside handle into position to where the jaw will not open when the outside handle is activated.

DOOR SEAL AND SPONGE SEAL REPLACEMENT

Door Seal Replacement (Refer to Fig. 32)

Leaks (wind and water) around the perimeter of a cab door, hard closing of the cab door, or premature wear of the door seal are all indications of improper in and out adjustment of the cab door. To adjust the door opening, refer to the "DOOR REMOVAL, INSTALLATION, AND ADJUST

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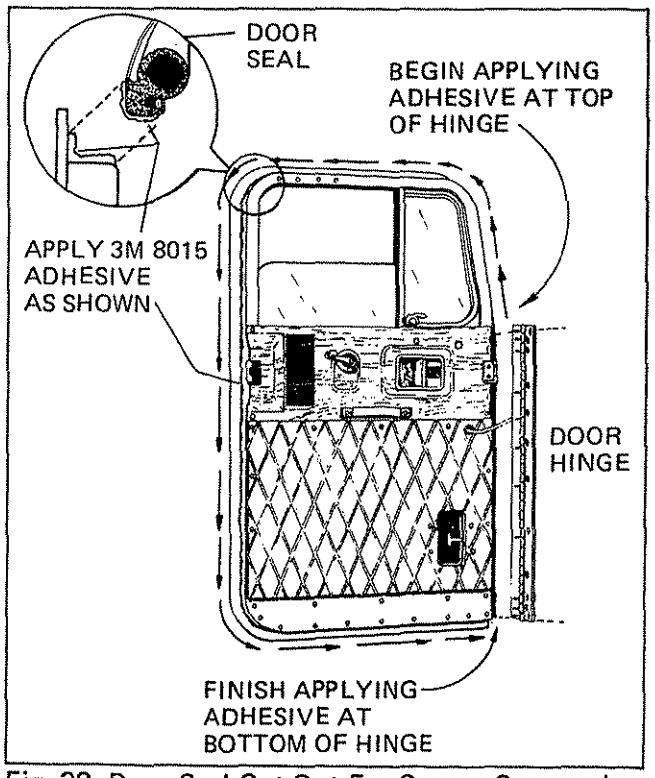

Fig. 32, Door Seal Cut Out For Square Cornered Door, Left Hand Door (Right Hand Door Opposite)

MENT" section of this subject. To replace the door seal, use the following procedure:

1. Pull an open end of the old door seal away from the door enough to allow a razor cutter blade to slide between the seal and the door. As the blade cuts through the door seal adhesive, slowly pull the seal away from the door. Continue this procedure until all of the door seal has been removed from the door.

2. Thoroughly clean and dry the surfaces to which the new door seal is to be applied. Use solvent to remove rust, grease, old cement, and any bits of the old door seal.

3. Apply Fuller SC-1112 adhesive or an equivalent to the area of the door where the door seal is to be installed and allow to air dry for ten minutes.

4. Apply Fuller SC-1112 adhesive or an equivalent to the flat edges of the door seal and allow to air dry for ten minutes.

5. Starting at the top of the door hinge, apply the door seal to the door assembly.

CAUTION: The door seal must be installed as shown in Fig. 32 in order to seal properly. Also, the door seal must not be stretched during installation. Improper installation of door seals, or stretching of door seals during installation, could result in water damage to upholstery or carpets.

6. Continue the door seal up the front surface of the door frame, along the top, and down the back side to the bottom corner on the back of the door.

   If the bottom corner on the back of the door is rounded, continue the door seal around the corner and along the bottom of the door. Apply the door seal until it nears the door hinge, then cut the door seal so that its edge will be flush with the bottom of the hinge.

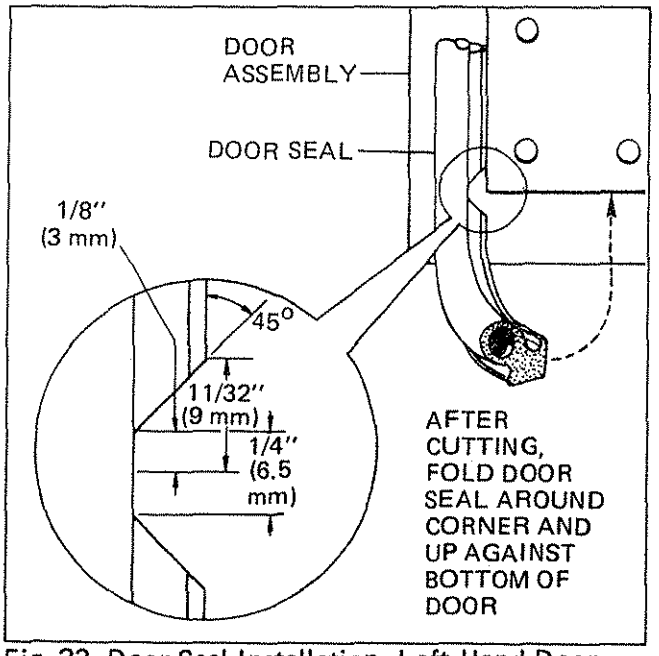

Fig. 33, Door Seal Installation, Left Hand Door (Right Hand Door Opposite)

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If the bottom corner on the back of the door is square, the section of the door seal that fits around the corner must be cut as shown in Fig. 33. The centerline of the cut should be at the door corner. Continue the door seal around the corner and along the bottom of the door. Apply the door seal until it nears the door hinge, then cut the door seal so that its edge will be flush with the bottom of the hinge.

Sponge Seal Replacement (Refer to Fig. 34)

1. Peel the three pieces of sponge seal from the door hinge, then peel the piece of sponge seal from the front door post. If the vehicle is equipped with a square rear cornered door, peel the piece of sponge seal from the rear door post.

2. Thoroughly clean and dry the surfaces to which the new sponge seal is to be applied. Use solvent to remove rust, grease, and any bits of the old sponge seal.

3. Apply the adhering side of the new sponge seal to the door hinge in the three places shown in Fig. 34.

4. Apply the adhering side of the new sponge seal to the front door post as shown in Fig. 34, then bond the sponge seal to the door threshold with Fuller SC-1112 adhesive or an equivalent.

5. If the vehicle is equipped with a square rear cornered door, apply a piece of sponge seal to the rear door post following the procedure used in step 4, above.

6. Apply Fuller SC-1112 adhesive or an equivalent between the hinge seal and the threshold seal as shown in Fig. 34.

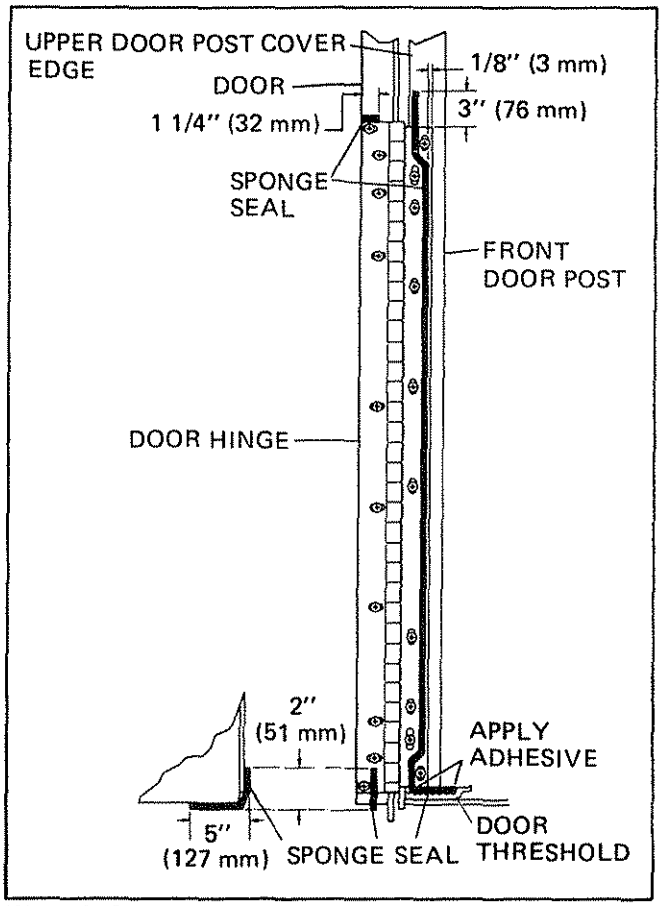

Fig. 34, Sponge Seal Installation, Left Hand Door (Right Hand Door Opposite)

BULKHEAD-STYLE CAB DOOR

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BULKHEAD-STYLE CAB DOOR

GENERAL DESCRIPTION

The bulkhead-style cab door (Fig. 1) features two one-piece aluminum extrusions with welded ends: one for the door frame, and the other for the door opening frame. As of January 10, 1986, the cab seal is mounted on the door instead of the door opening frame.

The "bulkhead" description refers to the manner in which the door, when closed, seats inside the door opening frame; the outer panel surface of the door is then flush with the outermost edge of the drip molding.

The bulkhead-style cab door differs from previous door designs in that the position of the exterior door handle has been "rotated" 90 degrees to a horizontal position. Refer to Fig. 1. Also, all four corners of the door are rounded instead of squared.

The door opening frame has an integral drip molding, which is riveted to the cab skin, deck plate, windshield mask, and roof. Both the door opening frame and the drip molding are painted the predominant color of the exterior cab.

The door frame is the foundation of the door assembly (Fig. 2), serving as:

- the mount for the outer panel of the door
- the window sill mount
- the channel support for the window glass
- the hinge support
- the ventilator window mount
- the door latch mount

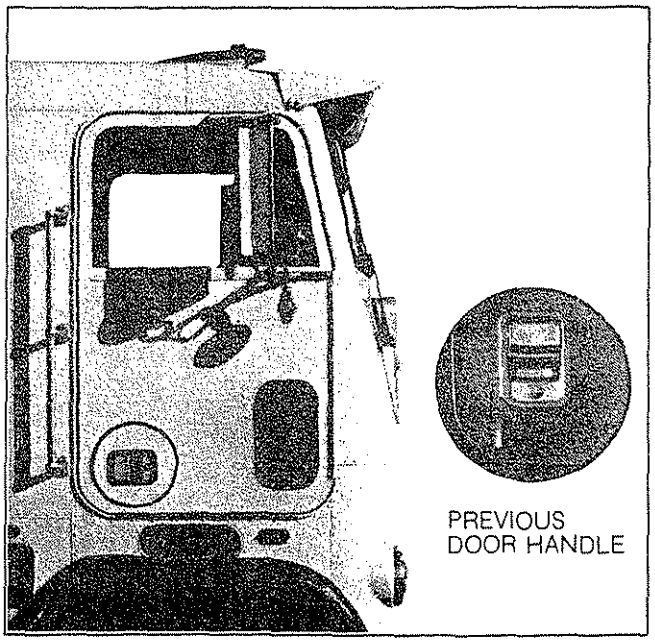


Fig. 1, Bulkhead-Style Cab Door

A sector gear-and-arm window crank (the window crank regulator assembly; see Fig. 2, Ref. 15), provides for up-and-down movement of the door window on standard door assemblies. Optional pneumatic window lifts use compressed air from the vehicle's air system.

The wiring harness for the turn signals, heated mirrors, and CB/radio antenna is routed along the inner portion of the hinge and is not visible with the door closed.

Most components of the door are replaceable, with the exception of the outer panel (the exterior door skin). The outer panel is crimped to and bonded with structural adhesive to the door frame flange. If damaged, the outer panel and door frame assembly must be replaced as one assembly.

SERVICE OPERATIONS

Unless otherwise noted, all service operations can be performed with the door attached to the vehicle. To reduce work time, don't remove the door unless told to do so.

NOTE: Some parts of the door, such as the hinge and the window crank regulator assembly, require periodic lubrication. Refer to Group 18 in the *COE and 120 Conventional Maintenance Manual*.

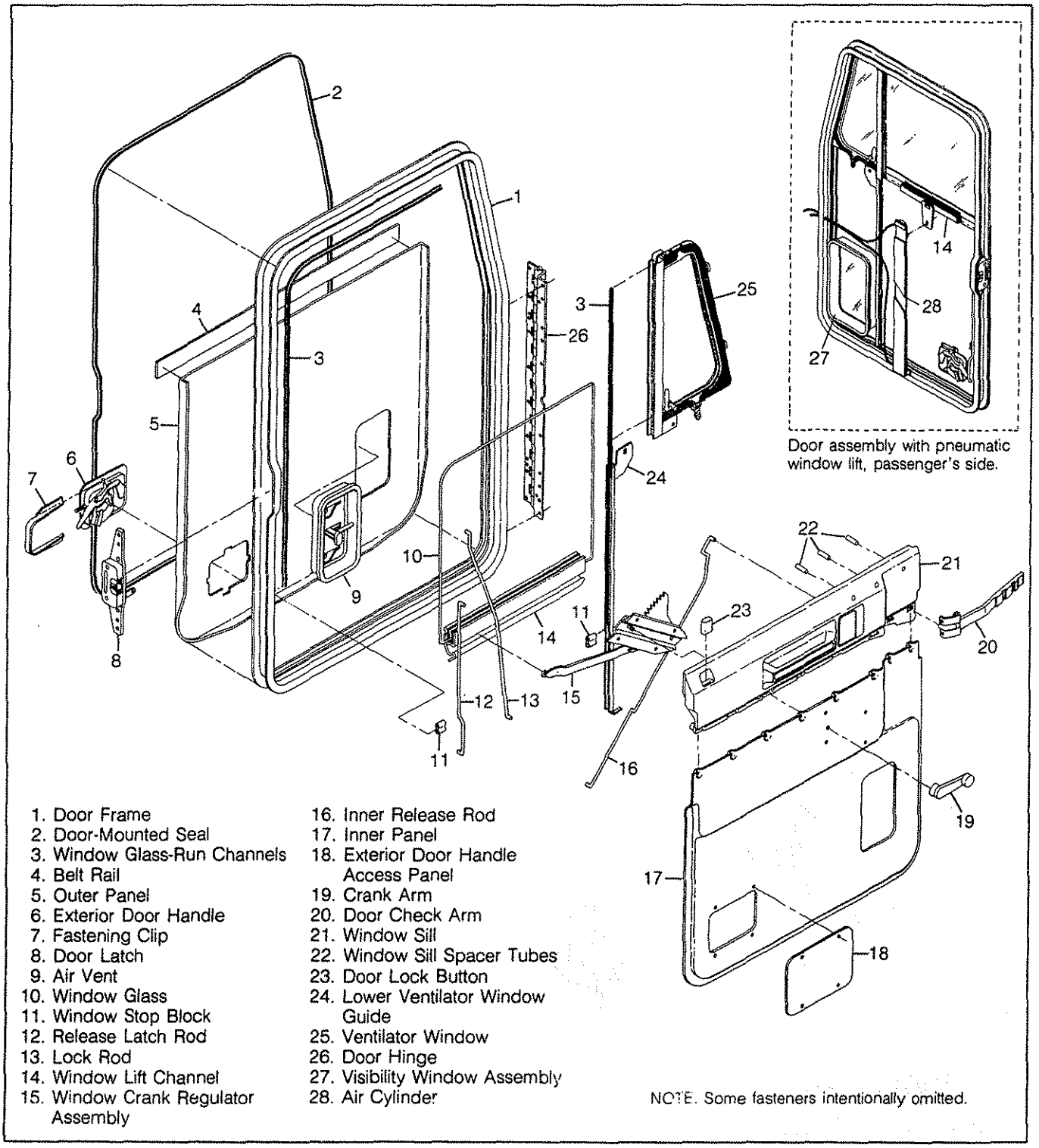
DOOR REMOVAL, INSTALLATION, AND ADJUSTMENT

Door Removal

1. Set the parking brakes and chock the tires.
2. Lower the window. When the door is equipped with pneumatic window lifts, it is not necessary to drain the air system reservoirs if the air hoses are disconnected at the intermediate fittings, as described in step 4.
3. Turn off the ignition switch. Disconnect all electrical wiring to the door, including wiring to the mirror heater and to the turn signal: first mark the wires for later assembly reference, and then disconnect them at the butt splices located just inside the cab and near the door frame. See Fig. 3.

NOTE: The butt splices are behind the panel near the floor of the cab and the door opening frame. To access

BULKHEAD-STYLE CAB DOOR



Door assembly with pneumatic window lift, passenger's side.

1. Door Frame
2. Door-Mounted Seal
3. Window Glass-Run Channels
4. Belt Rail
5. Outer Panel
6. Exterior Door Handle
7. Fastening Clip
8. Door Latch
9. Air Vent
10. Window Glass
11. Window Stop Block
12. Release Latch Rod
13. Lock Rod
14. Window Lift Channel
15. Window Crank Regulator Assembly
16. Inner Release Rod
17. Inner Panel
18. Exterior Door Handle Access Panel
19. Crank Arm
20. Door Check Arm
21. Window Sill
22. Window Sill Spacer Tubes
23. Door Lock Button
24. Lower Ventilator Window Guide
25. Ventilator Window
26. Door Hinge
27. Visibility Window Assembly
28. Air Cylinder

NOTE. Some fasteners intentionally omitted.

Fig. 2, Cab Door Assembly, Exploded View (Driver's Side)

BULKHEAD-STYLE CAB DOOR

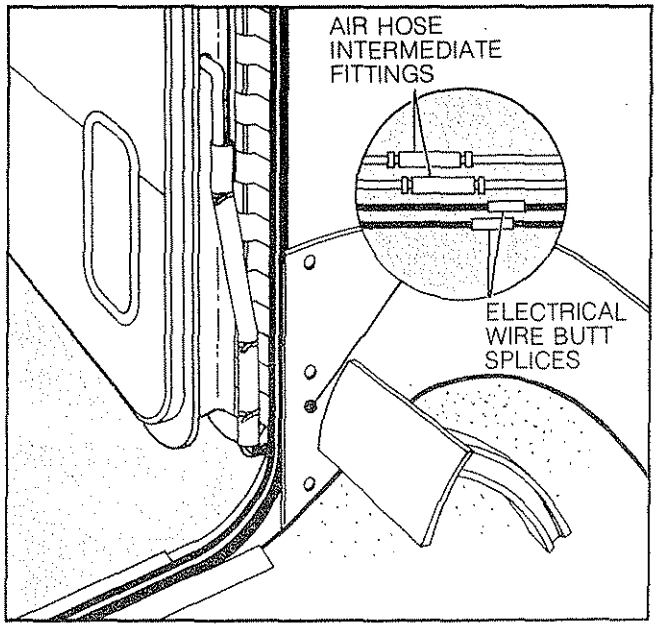


Fig. 3, Cab Door Electrical Wire/Air Hose Disconnect Locations

the splices, first remove the upholstery screws that attach the panel to these areas.

4. If the vehicle is equipped with pneumatic window lifts, disconnect the air hoses at the intermediate fittings, located near the butt splices described in step 3. The hoses are disconnected by pushing in the white rings at the fittings, then pulling the hoses free.

5. Disconnect the CB/radio antenna cable at the base of the antenna, if so equipped. Unwind the cable from around the outside mirror bracket.

6. Remove the two hexhead capscrews that attach the door check arm to the door frame. Refer to Fig. 2. Unseat the door check arm from between the window sill and the door frame. Use care not to let the door freely swing open as the service operations progress. (Normally, the door check arm would prevent this.)

7. Snip off all of the plastic spot ties that bundle the electrical wires, the antenna cable, and, if applicable, the air hoses along the inner door hinge area. See Fig. 4. Unhook the wires and air hoses.

8. Pull the disconnected end of the antenna cable through the grommetted hole in the top portion of the door frame assembly. If the cable is clamped to the door frame, loosen or remove the two panhead screws (and lockwashers) that partially attach the ventilator window assembly to the side of the door frame (the panhead screws also fasten the clamps to the frame). See Fig. 4. Remove the cable from the clamps. Lay the cable on the cab floor where it will not be stepped on or tripped over.

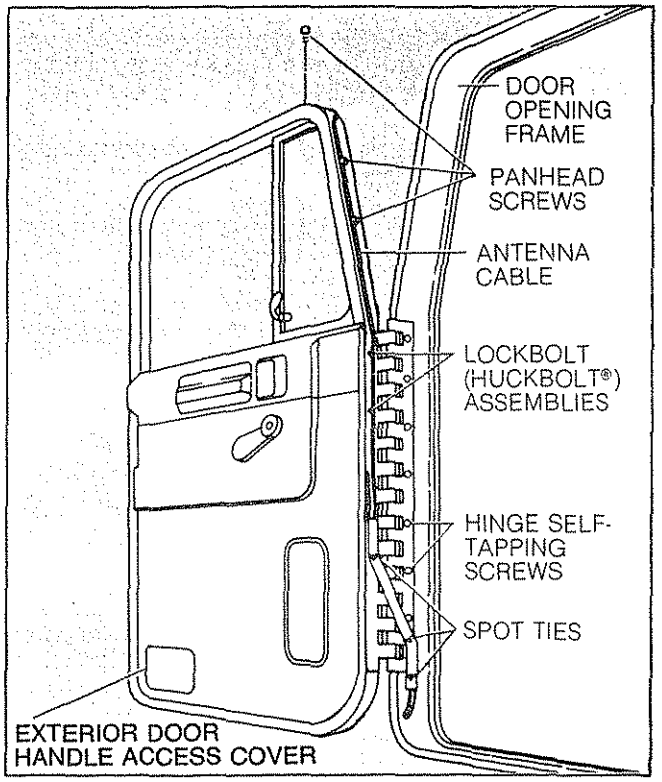


Fig. 4

9. Carefully pull the disconnected electrical wires and, if so equipped, the air hoses through the grommetted holes in the bottom portion of the door opening frame.

IMPORTANT: As a safety precaution, bundle the loose wires or air hoses, then temporarily tape them to the door. Dangling wires or air hoses could be tripped over as the door is removed, resulting in personal injury or property damage.

10. With the door open, loosen all of the self-tapping screws that attach the hinge to the cab door opening frame.

CAUTION: Support the door frame from its bottom to prevent it from falling or tipping during removal.

11. Remove the self-tapping screws. Then, remove the door from the door opening frame.

BULKHEAD-STYLE CAB DOOR

Door Installation

1. If the door seal has been damaged or is weathered, replace it. For instructions, refer to "Door Seal Replacement."
2. Place the door in the opening frame so that the hinge can be fastened down.

CAUTION: Support the door from its bottom to prevent it from falling or tipping during installation.

3. Install the hinge adjusting screws. Refer to **Fig. 5**. Tighten the screws finger-tight. Then, adjust the door in the door opening frame using the instructions under "Door Adjustment."
4. Unfasten the previously tied and bundled wires and, if applicable, air hoses. Thread the electrical wires and air hoses through the grommetted holes in the bottom portion of the door opening frame and into the cab.

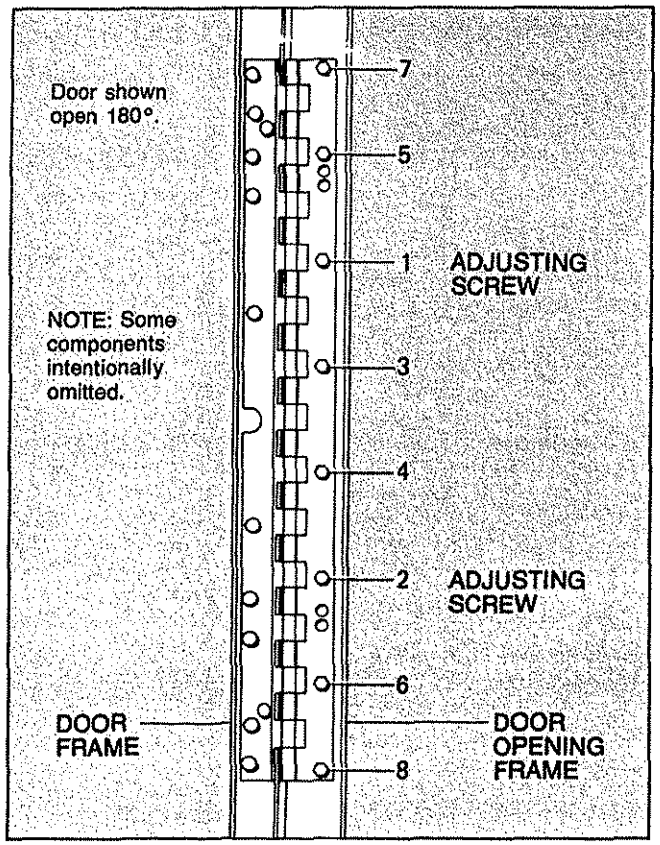


Fig. 5, Hinge Self-Tapping Screws Tightening Sequence

5. If applicable, connect the pneumatic window air hoses at the intermediate fittings, located just inside the cab and near the door opening frame. See **Fig. 3**. The hoses automatically lock in place when they're inserted and seated in the fittings.
6. As marked earlier, connect all electrical wiring to the door, including wiring to the mirror heater and to the turn signal. The wires should be connected at the butt splices located just inside the cab, near the door opening frame.
7. Install the previously removed upholstery screws that attach the panel to the cab-floor/door-opening frame area.
8. Install new plastic spot ties to hold the wiring harness and hoses in place. Refer to **Fig. 4**.
9. If applicable, clamp the antenna cable to the inner portion of the door frame, and tighten the previously loosened or removed panhead screws (and lockwashers) that partially attach the ventilator window assembly to the door frame.
10. Seat the door check arm between the window sill and the door frame. Then, install the two hexhead capscrews that attach the door check arm to the door frame. If equipped with 1/4–20, SAE grade 5 capscrews, tighten them 60 to 84 lbf·in (680 to 940 N·cm); if equipped with 1/4–28, SAE grade 8 capscrews, tighten them 120 lbf·in (1360 N·cm).
11. If applicable, thread the antenna cable through the grommetted hole in the top portion of the door frame assembly. Wind the cable around the outside mirror bracket until most of the slack is eliminated.

    Attach the CB/radio antenna cable to the base of the antenna.
12. Make sure the door electrical components and the air window are operating correctly.

Door Adjustment

Don't begin door adjustment until you review and understand all of the information under this heading.

When a door assembly is newly installed on a vehicle, it must be adjusted for correct up-and-down, and in-and-out positioning, relative to the door opening frame. The

BULKHEAD-STYLE CAB DOOR

door assembly should also be adjusted whenever one or more of the following conditions exist (providing the door seal is correctly installed and is in good condition; for more information, refer to "Door Seal Replacement"):

- wind or water leaks at the door opening frame
- premature wear of the door seal
- hard closing or opening of the door

The hinge is horizontally slotted, and when the self-tapping screws (Fig. 5) are loosened, the door can be moved in or out of the door opening frame. The vertically slotted holes along the hinge area of the door opening frame allow for up-and-down adjustment of the door.

The self-tapping screws of the hinge, when installed in the order shown in Fig. 5, tap onto a loosely riveted metal plate. The metal plate is riveted—using countersunk rivets and pushnuts—to the internal side of the door opening frame. The plate is therefore out of view.

Design considerations of the door assembly and the door opening frame require that all but two of the self-tapping screws along the hinge be loose during door adjustment. The only screws that should be tightened during door adjustment are the third one up from the bottom and the third one down from the top. See Fig. 5 ("Adjusting Screws"). After the door is adjusted to specifications, the remaining screws must be tightened in the order shown in Fig. 5.

IMPORTANT: Don't try to adjust the door using any of the self-tapping screws except the third one up from the bottom and the third one down from the top. These screws are closest to the rivet/pushnut fasteners that attach the tapping plate to the internal portion of the door opening frame. Because of their closeness to the fasteners, the screws are certain to latch onto the tapping plate and hold the door in the desired position. If any of the other screws are used during door adjustment, it may not be possible to tighten them after the door has been positioned.

Up-and-Down, In-and-Out Adjustment

1. With the door installed in the door opening frame, remove or loosen all but two of the self-tapping screws. The third screw up from the bottom of the hinge and the third screw down from the top of the hinge should be used to hold the door in the desired position. Refer to Fig. 5.
2. Adjust the door in the door opening frame to an estimated correct position as follows:
   - .1 Carefully close the door. See if the top and bottom edges of the door are evenly gapped from the drip molding. Adjust if necessary.
   - .2 Open the door about 90 degrees. Place a source of light in back of the door, if sunlight is not available.
   - .3 Look at the hinge and the visible edges of the drip molding in back of the hinge (from the vantage point of the striker pin). A broken, hairline thread of light should extend down the hinge. See Fig. 6. The "thread" should not widen at either end. Adjust if necessary.
3. From inside the cab, with the door closed or nearly closed, measure for specific up-and-down positioning of the door, and adjust as necessary. The distance between the inner flange of the door frame and the door opening frame, measured vertically at the top and bottom edges of the door, must be equal, within 3/32-inch (2.4 mm), at the top and bottom edges of the door. See Fig. 7.
4. Close the door to the fully latched position (second click). From outside the cab, check the in-and-out positioning of the door, and adjust as necessary. Refer to Fig. 8.

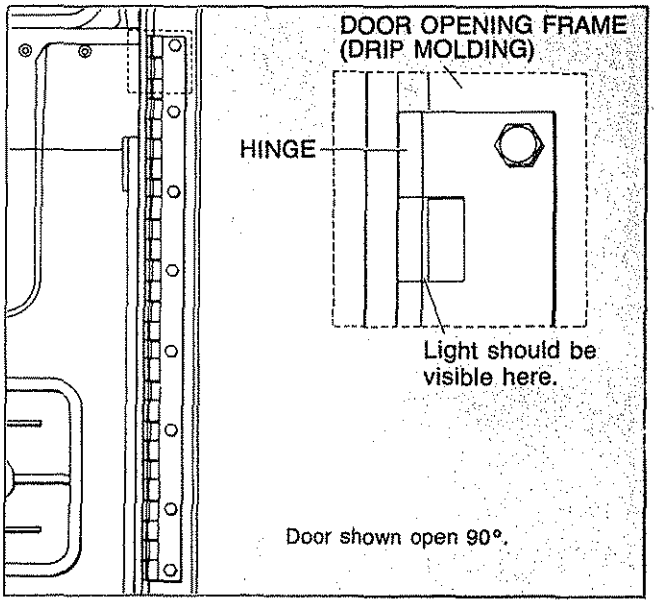


Fig. 6

BULKHEAD-STYLE CAB DOOR

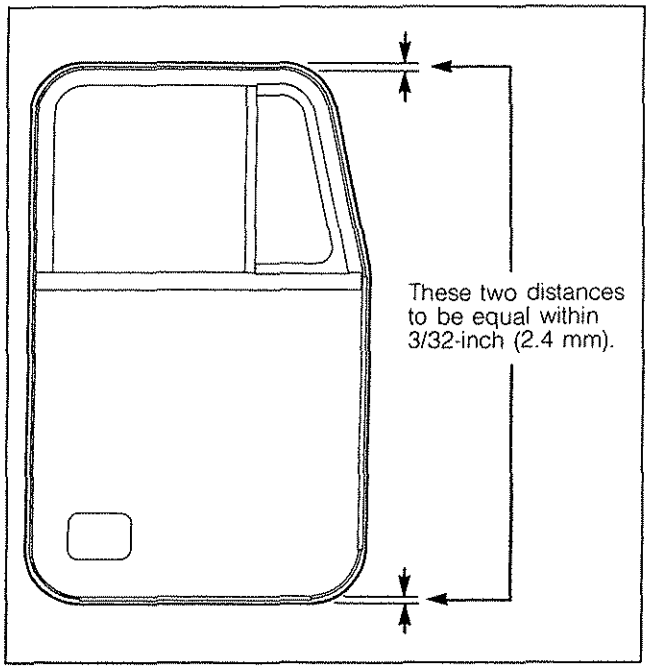


Fig. 7, Up-and-Down Positioning of the Door

The door should protrude 0.05 inch (1.27 mm) at the top, but may protrude as much as 0.112 inch (2.80 mm). It may be recessed as much as 0.075 inch (1.91 mm). The gap along the top of the door must be parallel to the door opening frame within 0.062 inch (1.58 mm).

At the door latch, the door should be flush, but may protrude as much as 0.125 inch (3.18 mm). It must not be recessed. The gap along the back of the door must be parallel to the door opening frame within 0.062 inch (1.58 mm).

The door should be flush at the bottom, but may protrude as much as 0.125 inch (3.18 mm). It may be recessed as much as 0.062 inch (1.58 mm). The gap along the bottom of the door must be parallel to the door opening frame within 0.062 inch (1.58 mm).

5. Tighten the adjusting screws to a final torque of 120 lbf·in (1360 N·cm). Tighten the remaining self-tapping screws to the same torque; they should be tightened in the order shown in **Fig. 5**.
6. Test the striker pin adjustment, as described in this subject.

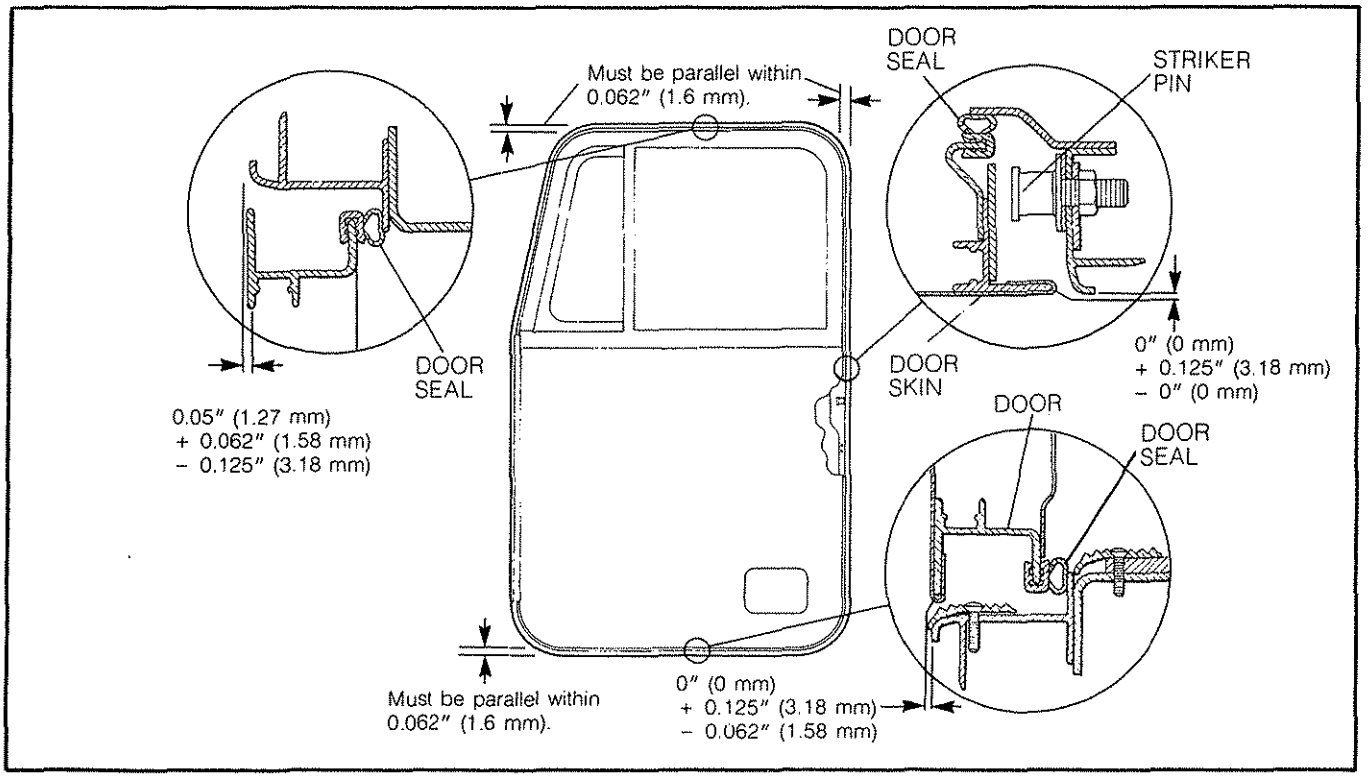


Fig. 8, In-and-Out Positioning of the Door

BULKHEAD-STYLE CAB DOOR

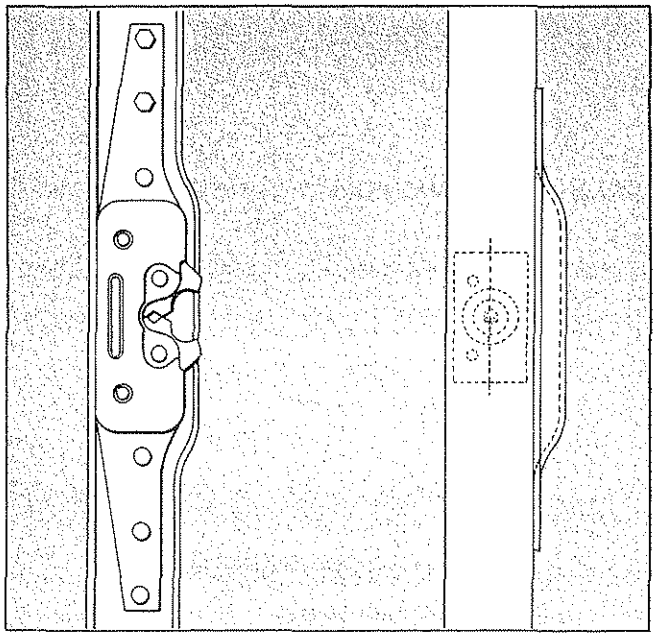


Fig. 9

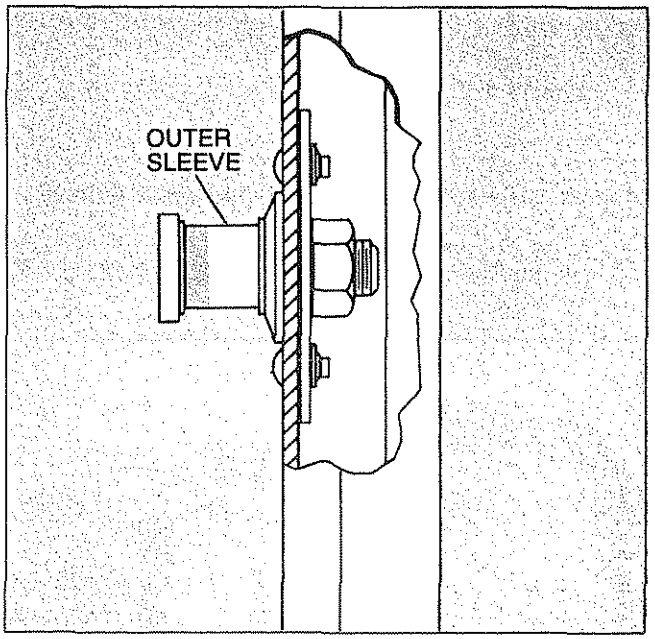


Fig. 10, Striker Pin Assembly

Striker Pin Adjustment

CAUTION: The striker pin cannot be substituted for one used with previous door models; it is a different size from earlier models and can be replaced only with an identical part.

Refer to the *COE and 120 Conventional Parts Book* for correct part numbers.

1. From outside the cab, partially close the door until the latch jaws are about 1 to 2 inches (2.5 to 5.0 cm) from the striker pin. See Fig. 9.

2. See if the latch jaws will be centered around the striker pin's outer sleeve (shown in Fig. 10) when the door is closed. If necessary, reposition the striker pin after loosening it with a no. 50 Torx® recess driver, shown in Fig. 11. If needed, add shims between the coned washer and the door opening frame.

   Add only enough shims to allow proper engagement of the latch jaws around the striker pin's outer sleeve; too many shims will cause interference between the striker pin and the backing plate of the latch assembly.

3. Repeat steps 1 and 2. If the striker pin appears to be correctly positioned, tighten it 50 lbf·ft (68 N·m).

4. Carefully close the door to the fully latched position (second click). From outside the cab, check the in-and-out positioning of the door. See "Up-and-Down, In-and-Out Adjustment" and Fig. 12.

5. If one or both of the door's rear corners twist away from the drip molding, thus exceeding the specifications shown in Fig. 12, do the following:

   .1 Loosen the screws that attach the inner panel to the window sill. On custom interiors, first remove the naugahyde and carpet inserts, and then (if equipped) the black lower door cover, both of which are attached with panhead screws.

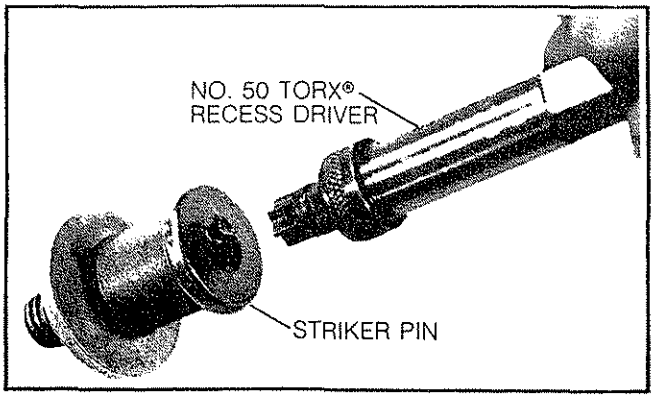


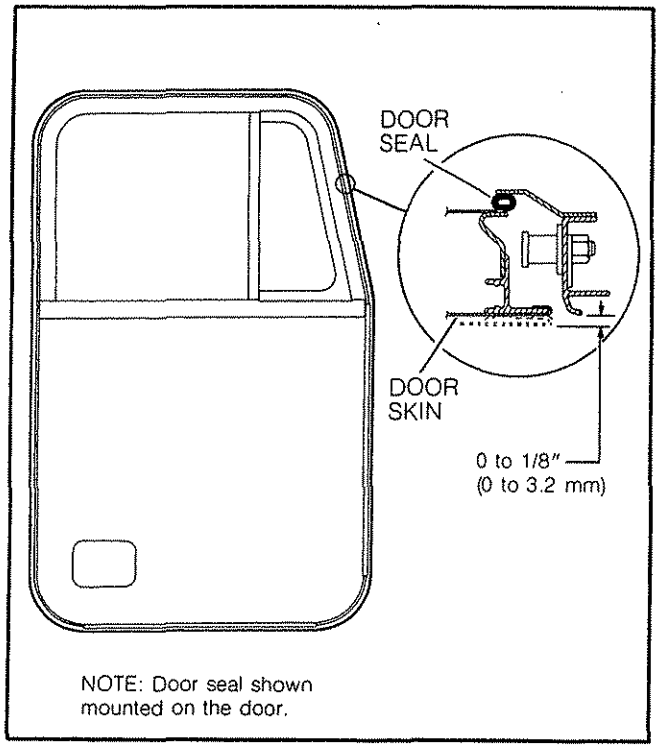
Fig. 11, Striker Pin Tool

BULKHEAD-STYLE CAB DOOR

.2 Carefully close the door, and check the alignment of the rear corners of the door. For specifications, refer to **Fig. 12.**

If a twist is found, force the door to a twist in the opposite direction, then tighten the screws while holding the door in place. Recheck the alignment, and repeat this procedure if not correct.

.3 If equipped with a custom interior, first install the naugahyde and carpet inserts, and then the black lower door cover.

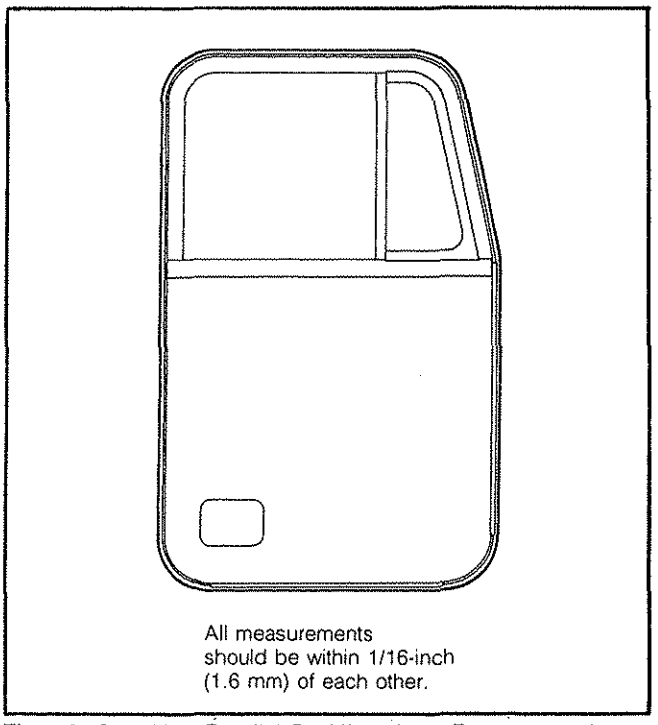


NOTE: Door seal shown mounted on the door.

Fig. 12, In-and-Out Positioning of the Door

Checking Parallel Positioning

The entire door should be as parallel as possible to the side of the cab. Therefore, all in-and-out measurements should be within 1/16 inch (1.6 mm) of each other. See **Fig. 13.**



All measurements should be within 1/16-inch (1.6 mm) of each other.

Fig. 13, Checking Parallel Position of the Door

DOOR SEAL REPLACEMENT

Seal Replacement With Seal Located on Door

As of January 10, 1986, the cab door seal mounts on the door, instead of the door opening frame. To replace the seal on vehicles built after January 10, 1986, use the following instructions:

1. Pull the entire length of the seal from the inner door flange.
2. Install the new door seal by pushing it firmly onto the inner door flange, with the ends of the seal meeting at the lower forward edge of the door. See **Fig. 14.** Trim to length as needed. Make sure the seal is pushed completely onto the flange all around the door. There should be no creases or buckles on the sealing surface.

CAUTION: Do not stretch the door seal during installation. To do so may reduce its sealing ability, which could result in water leaks.

3. Check the door adjustments using the instructions under "Up-and-Down, In-and-Out Adjustments."

Seal Replacement With Seal Located on Cab

The neoprene sponge door seal is available for replacement on the door opening frame on vehicles built before January 10, 1986.

NOTE: The door-mounted seal can be installed in place of the door opening frame seal on any vehicle with bulkhead-style cab doors. Refer to "Converting the Cab-Mounted Door Seal to the Door-Mounted Seal."

BULKHEAD-STYLE CAB DOOR

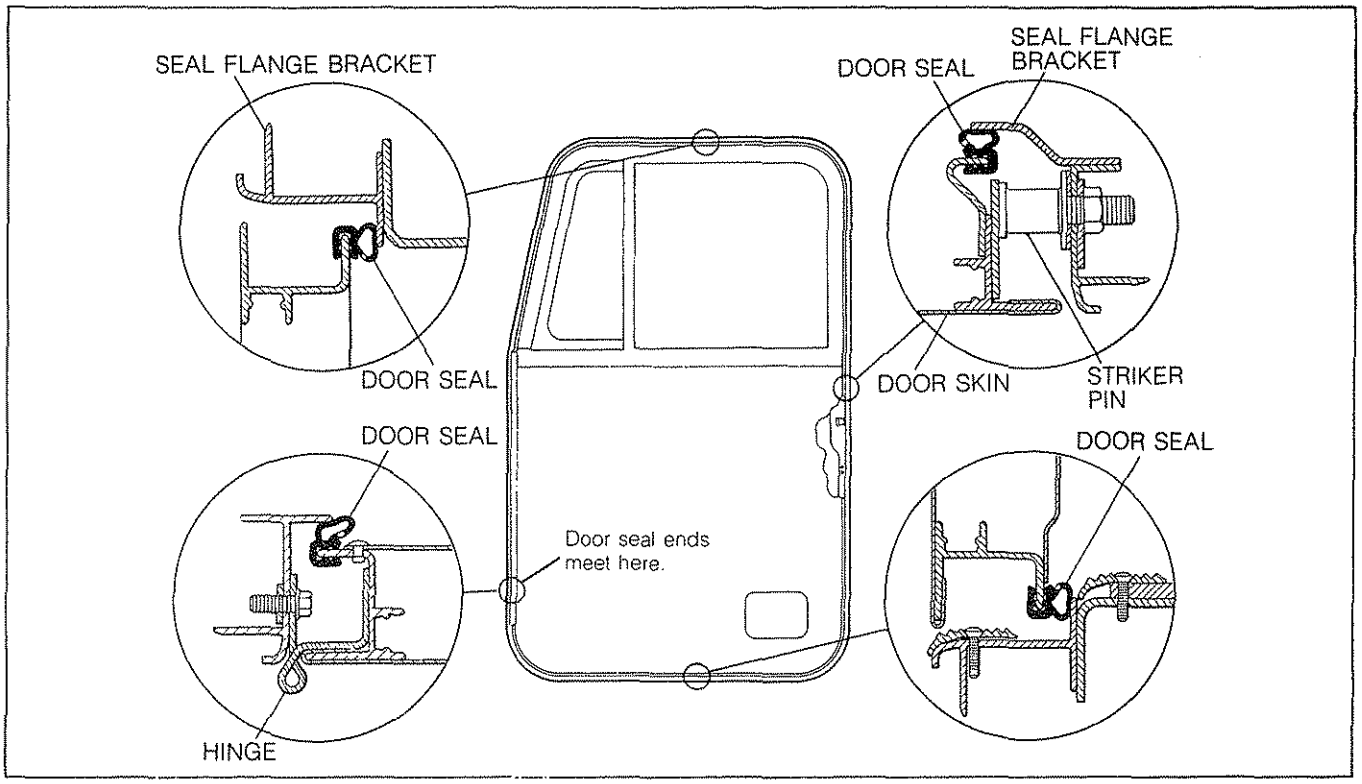


Fig. 14, Door Seal Installation (Door-Mounted Seal)

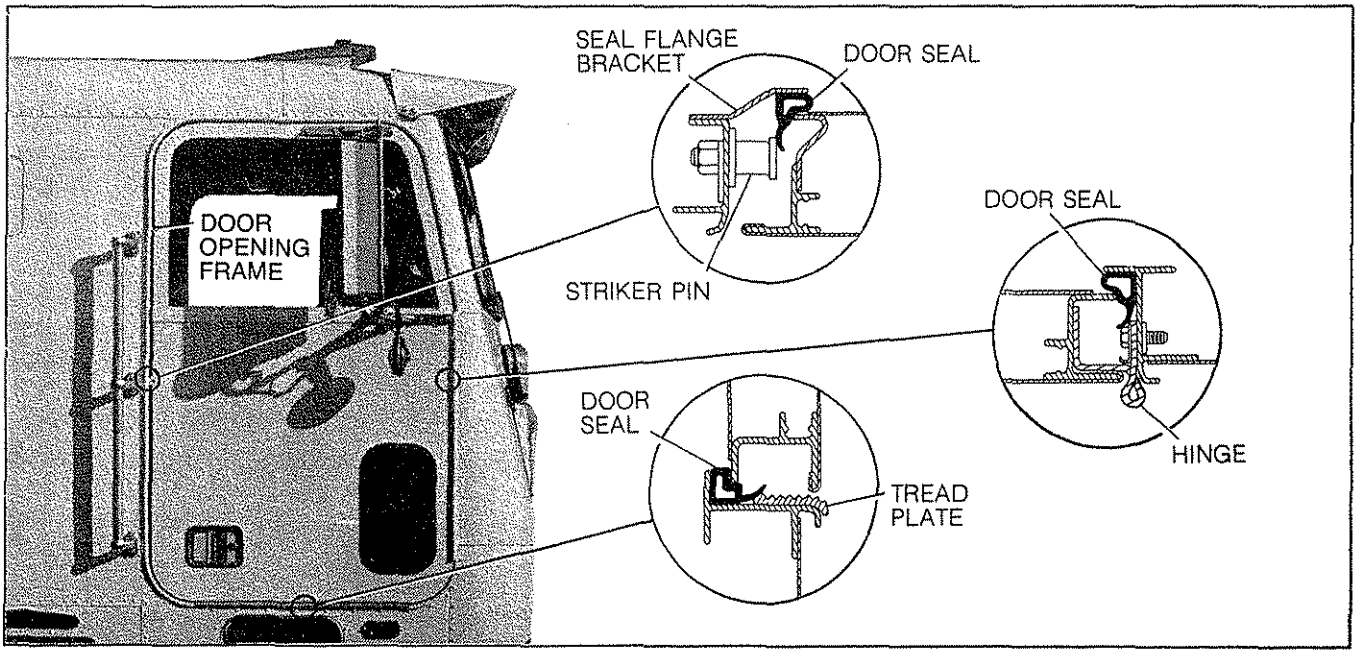


Fig. 15, Door Seal Installation (Door-Opening Mounted Seal)

BULKHEAD-STYLE CAB DOOR

The neoprene sponge door seal is a flap-and-bulb design, single length strip that extends around the inner edge of the door opening frame. See Fig. 15. When the door compresses the bulb, it causes the flap to tip up and grip the edge of the door. If incorrectly installed, the seal will peel off the door opening frame when the door is closed.

When removing the door seal from the frame, begin at the seam at the bottom of the frame.

1. Using a putty knife, separate one end of the door seal from the door opening frame. Then, gripping that end of the seal, pull the entire length of the seal off the frame.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

2. Using a solvent (such as chlorothane or methylene-chloride), clean and dry the area of the door opening frame where the seal will be installed. Remove all rust, grease, dirt, and old adhesive from the surfaces.

3. If not already done, cut a length of new door seal 166 inches (4220 mm) or longer, to go around the door frame opening.

4. Apply HBF/SC-1112 Contact Cement (manufactured by the H.B. Fuller® Company), or an equivalent adhesive, to the door seal, as specified in Fig. 16, Ref. A. Do not apply adhesive to the flap of the door seal.

5. Apply adhesive to the inner door frame flange. Apply only as much as is needed to contact the door seal application area. See Fig. 16, Ref. A.

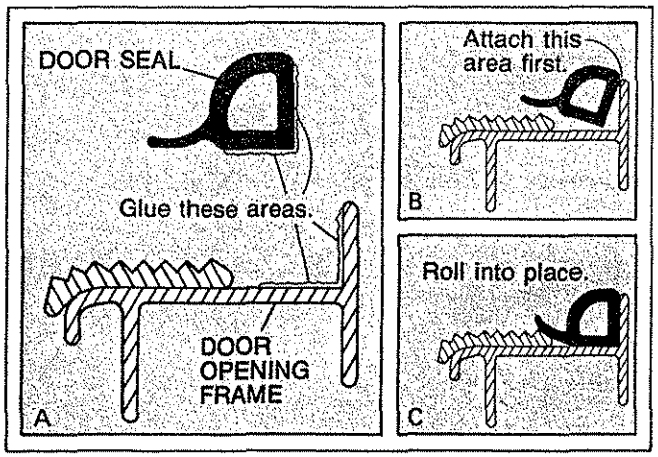


Fig. 16, Door Seal Installation Procedures

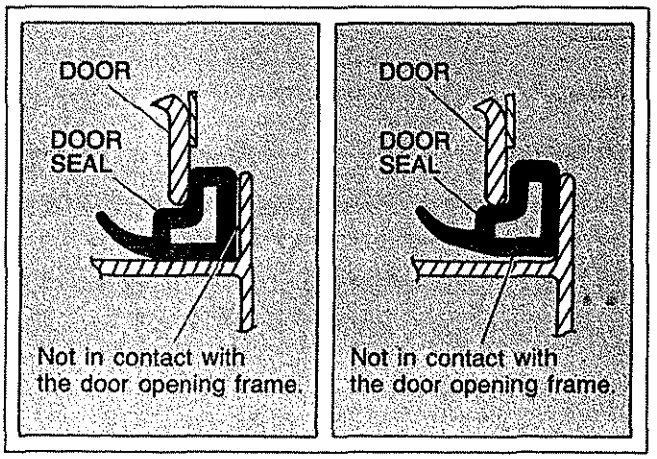


Fig. 17, Incorrect Door Seal Installations

6. Allow the adhesive to dry, as specified by the manufacturer.

7. Referring to Fig. 16, Refs. B and C, install the door seal. Begin at the center of the tread plate area. As the door seal is installed, attach the uppermost tip first, and then roll the remaining portion of the seal into place. (If you attach the lower flap portion first, you increase the chances of the flap incorrectly sticking up.)

CAUTION: Do not stretch the door seal during installation. To do so may reduce its sealing ability, which could result in water leaks.

Guard against the seal installation conditions shown in Fig. 17. The square corner of the seal must be nested into the square corner of the door opening frame.

When forming the seal into the top curves of the seal flange bracket, the door seal profile must not go beyond (forward) the seal flange bracket profile by more than 1/8 inch (3.2 mm). Profiles in excess of 1/8 inch (3.2 mm) could result in the seal being pinched by the window sill when the door is closed.

8. Just before you completely seat the door seal, cut off (square) the excess strip so that a hairline seam (butt joint) will connect the two ends of the seal. Apply HBF/SC-1112 Contact Cement, or add an equivalent adhesive to both ends of the door strip. Allow the adhesive to dry, as specified by the manufacturer, then complete the door seal installation.

BULKHEAD-STYLE CAB DOOR

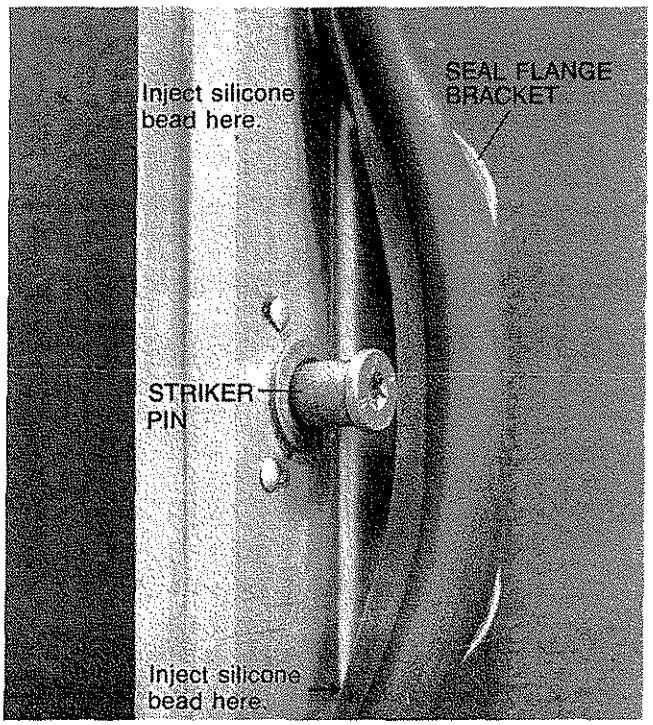


Fig. 18, Silicone Application Areas

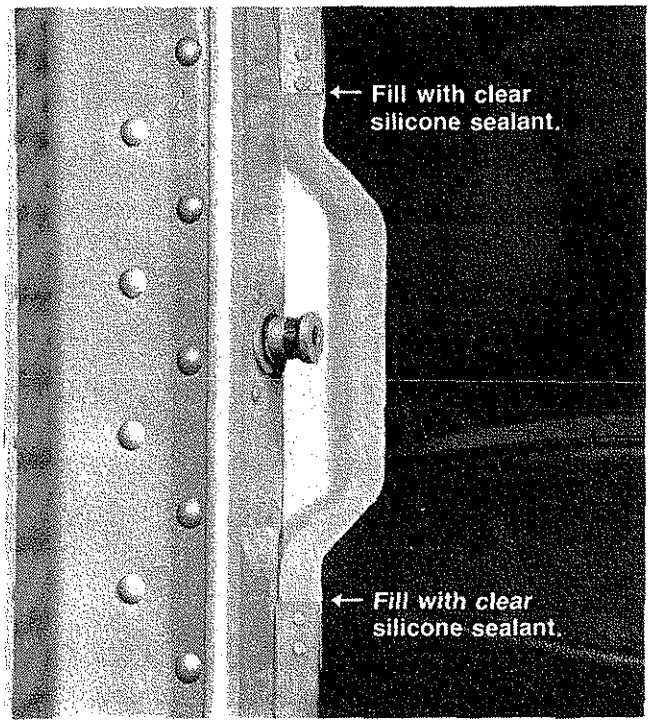


Fig. 19

9. In the area of the stop block along the hinge, trim away the door seal flap that contacts the stop block. Then press down the entire length of the seal to ensure proper bonding to the door frame. Allow enough time for the bond to set, as recommended by the adhesive manufacturer.

10. Test the door for ease of opening and closing. Interference from the door seal will occur if the door seal flap is sticking up away from the door opening frame, when the door is open. In this case, install a new door seal.

11. Inject a 1/8-inch (3.2 mm) bead of silicone rubber Loctite® no. 593, or an equivalent, behind the door seal in the area of the seal flange bracket, as shown in Fig. 18. Allow it to dry.

Converting the Cab-Mounted Seal to the Door-Mounted Seal

The door-mounted seal can replace the cab-mounted seal on any vehicle with bulkhead-style cab doors.

To convert the cab-mounted seal to the door-mounted seal, on vehicles built before January 10, 1986, use the following instructions:

1. Remove the old seal from the door opening frame. Using a suitable cleaner, remove the old adhesive from the frame.

2. Using clear silicone sealant, fill the areas on the door opening frame, as shown in Fig. 19. This gives the new door seal a flat surface to seal against.

3. On COEs, replace the check-strap stop block and capscrew with stop block 18-23434-000 and capscrew 23-10800-150. This provides clearance for the new seal. Tighten the capscrew 108 lbf·in (1220 N·cm).

4. Install the new door seal by pushing it firmly onto the inner door flange, with the ends of the seal meeting at the lower forward edge of the door. See Fig. 14. Trim to length as needed. Make sure the seal is pushed completely onto the flange all around the door. There should be no creases or buckles on the sealing surface.

BULKHEAD-STYLE CAB DOOR

5. Make sure the sealant (applied in step 2) on the door opening frame is dry. Slowly close the door and check that the seal clears the striker pin by 1/8 to 3/16 inch (3.2 to 4.8 mm). See **Fig. 20**, Ref. A.

   Check the front-to-rear position of the striker pin. If possible, remove shims from behind the striker pin, leaving only enough to allow the pin to engage the latch correctly. Again check the clearance between the seal and the striker pin. If there is enough clearance, go to step 6. If there isn't enough clearance, trim the inner door flange as follows:

   .1 Pull the seal off the latch side of the door, then mark the flange, as shown in **Fig. 21**. After trimming, the striker pin-to-seal clearance should be 1/8 to 3/16 inch (3.2 to 4.8 mm). For example:

   1/16 inch (1.6 mm) Clearance before trimming
   + 1/16 inch (1.6 mm) Trimmed from door flange
   1/8 inch (3.2 mm) Clearance after trimming

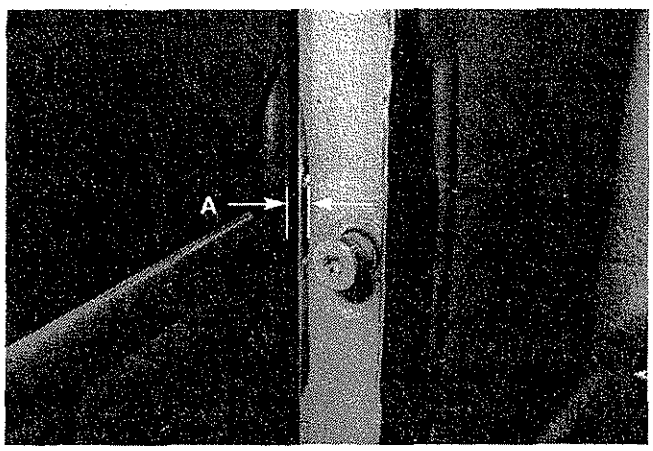


Fig. 20

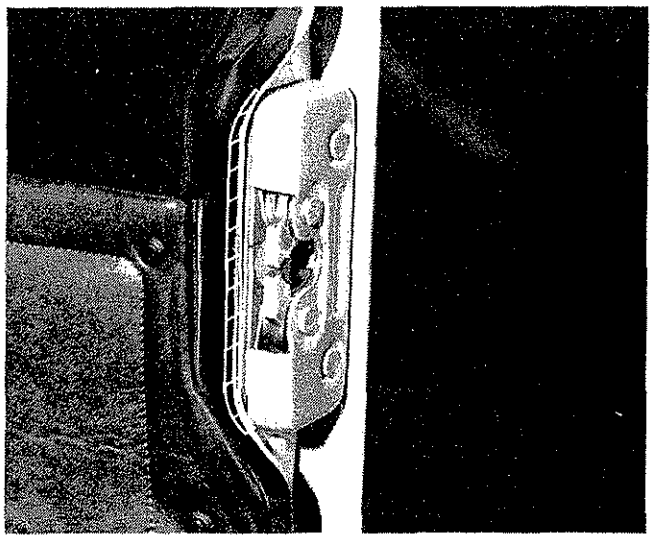


Fig. 21

   .2 To protect the area from filings and grinder damage, place duct or masking tape over the latch and nearby upholstery, as shown in **Fig. 22**.

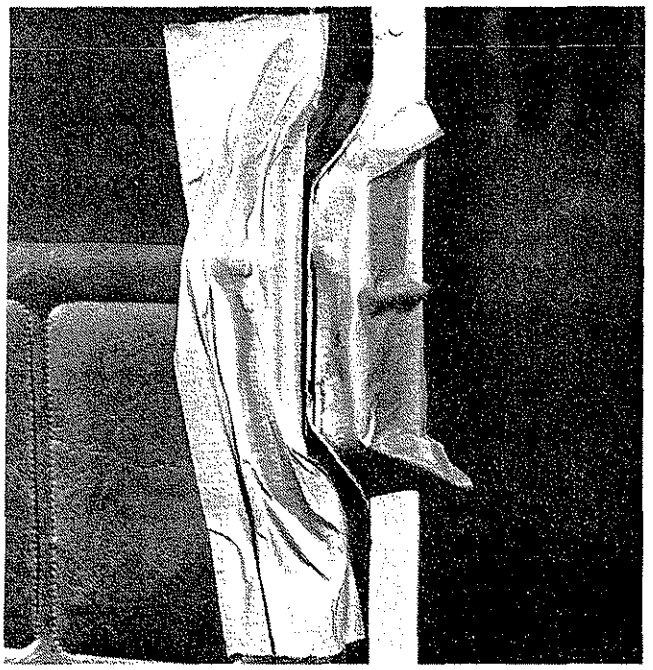


Fig. 22

   .3 Using a rotary file, carefully trim metal from the door flange as marked. See **Figs. 21** and **23**. Use care not to grind too far: the door is aluminum, which is much softer than steel.

   .4 Remove the tape from the latch and upholstery. Clean all filings from the area.

   .5 Install the seal as instructed in step 4.

6. Check the door adjustments using the instructions under "Up-and-Down, In-and-Out Adjustments."

BULKHEAD-STYLE CAB DOOR

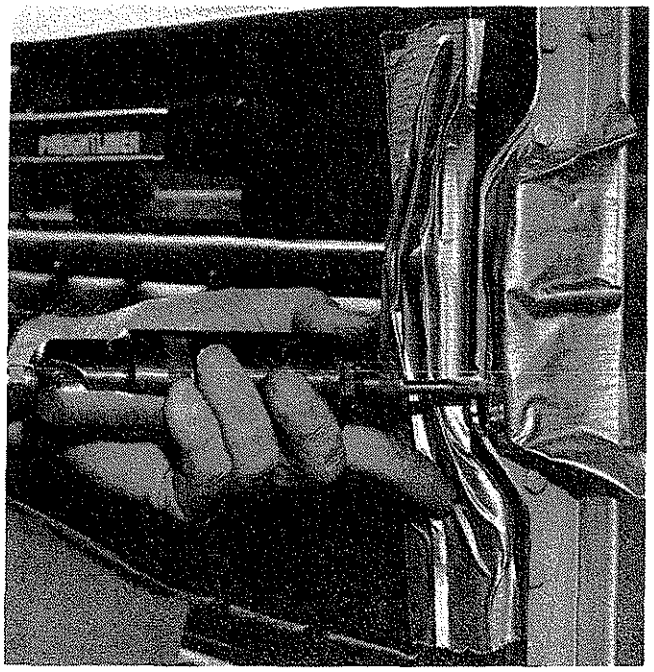


Fig. 23

WINDOW GLASS REMOVAL AND INSTALLATION

Window Glass Removal

WARNING: Use care when working around or handling glass. Wear protective gloves to eliminate the possibility of personal injury resulting from accidentally breaking or splintering the glass.

1. Set the parking brakes. Then, lower the window glass.
2. Mark the three socket-head capscrews that partially attach the outside mirror mounting bracket to the door, for later assembly reference. Using an allen wrench, remove the capscrews, nuts, and washers. See **Fig. 24**. If the three window sill spacer tubes and washers can be easily pushed out, they, too, should be referenced and removed.
3. For manually operated windows, remove the crank arm from the regulator assembly mounting spindle.
4. Remove the screws that attach the inner panel to the window sill. See **Fig. 25**. On custom interiors first remove the naugahyde and carpet inserts, and then (if equipped) the black lower door cover, both of which are attached with panhead screws. Refer to **Fig. 26**.

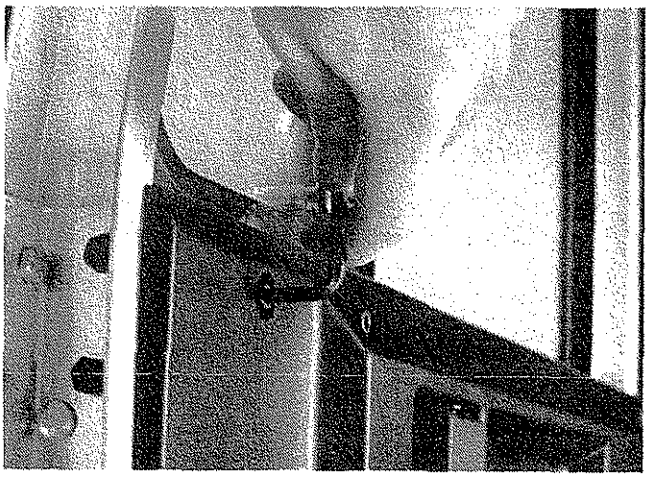


Fig. 24, Window Sill Capscrew Removal/Installation

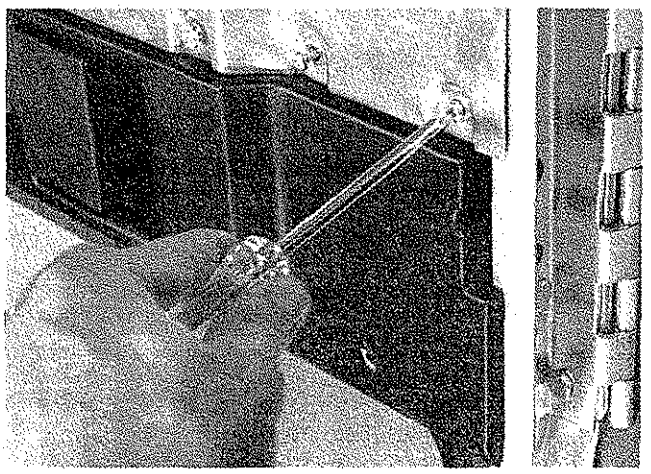


Fig. 25, Inner Panel Screw Removal/Installation

5. If the door is equipped with a pneumatic window lift, also remove the two screws that attach the air cylinder to the window sill. Refer to **Fig. 27**.
6. Remove the upper four hexhead capscrews located on the hinge side of the door. See **Fig. 28**. Two of the capscrews attach the door check arm to the door frame. Unseat the door check arm from between the window sill and the door frame. Use care not to let the door freely swing open as the service operations progress. (Normally, the door check arm would prevent this.)
7. Remove the two hexhead capscrews located on the opposite side of the door (above the door latch assembly). See **Fig. 29**.

BULKHEAD-STYLE CAB DOOR

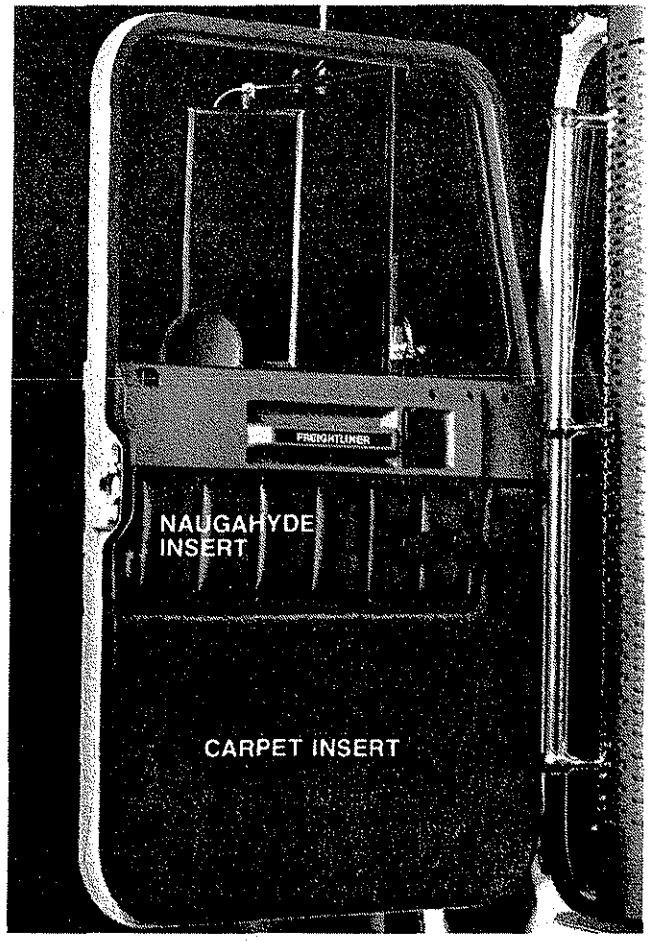


Fig. 26, Custom Interior Door

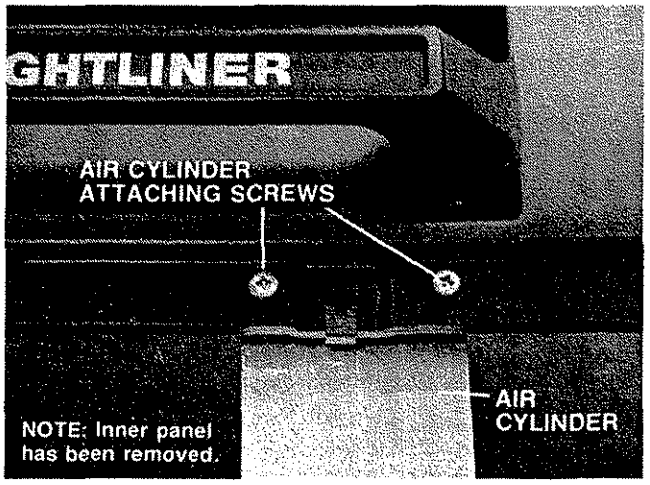


Fig. 27

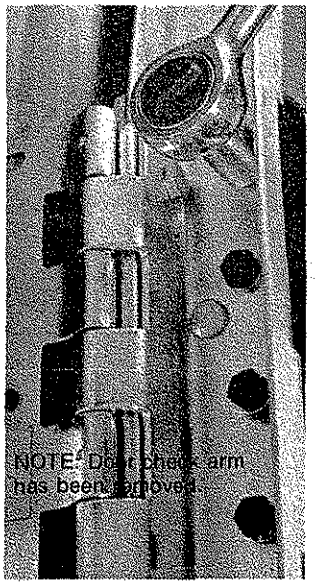


Fig. 28

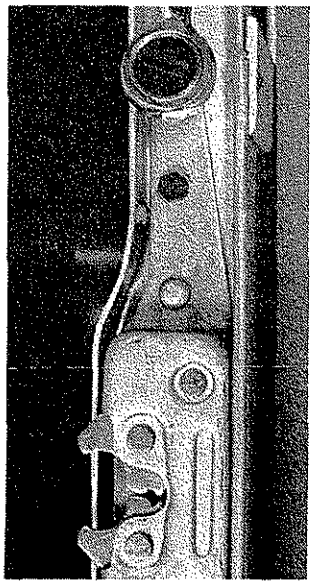


Fig. 29

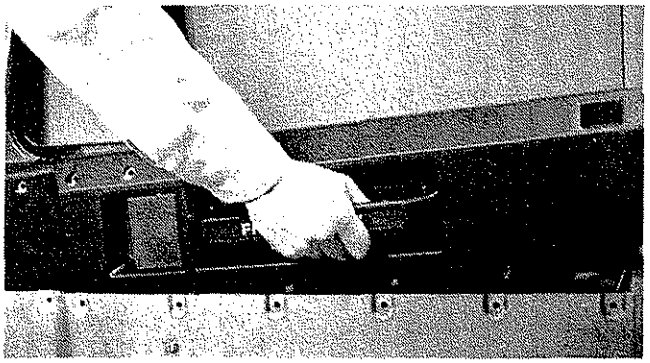


Fig. 30, Unseating the Window Sill

8. Carefully remove the window sill as follows:

IMPORTANT: The window sill is not completely unfastened from the door at this point. The rod that connects to the window sill release handle inside the door must first be disconnected.

.1 Gripping the window sill door handle, lean the top of the window sill away from the door so that it clears the ventilator window seal. With steady, upward movement, pull the window sill until the entire bottom portion unseats from the edge of the inner panel. See **Fig. 30**. The window sill will resist this movement, but will seem unsprung after it is unseated.

BULKHEAD-STYLE CAB DOOR

IMPORTANT: Do not attempt to completely separate the window sill from the door.

.2 Lean the top of the window sill away from the door after pushing the door lock button free. See **Fig. 31**. Then disconnect the release handle rod plastic keeper from the rod. See **Fig. 32**. Remove the window sill.

NOTE: As the window sill is pulled away, if not previously removed, be careful not to let the three window sill spacer tubes (see **Fig. 33**) and the washers drop into the door. During removal, keep the window sill tilted as shown in **Fig. 31**.

.3 If applicable, reference the window sill spacer tubes and remove them (and the washers) from the window sill. See **Fig. 33**.

9. If the door is equipped with pneumatic window lifts, go to step 11.

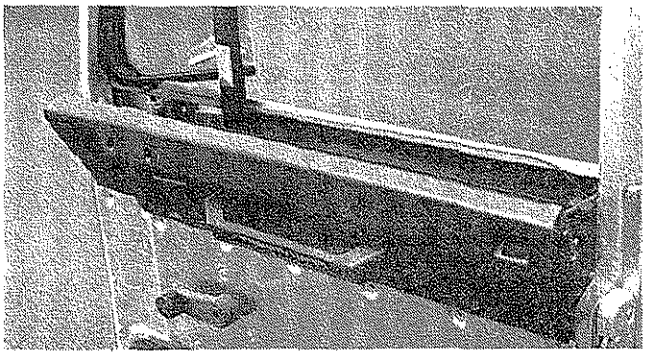


Fig. 31

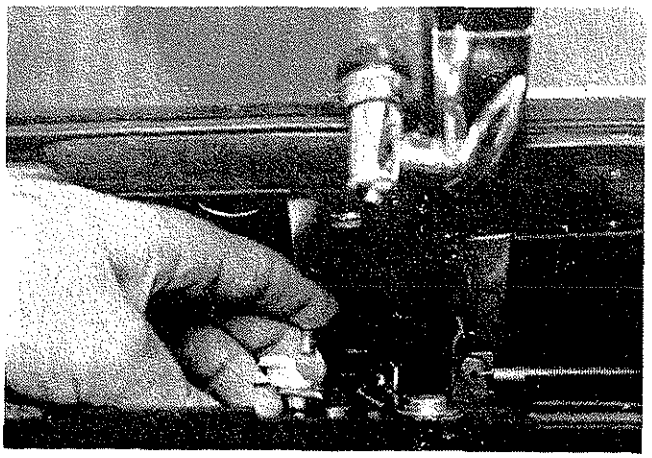


Fig. 32, Disconnecting/Connecting the Release Handle Rod from the Window Sill

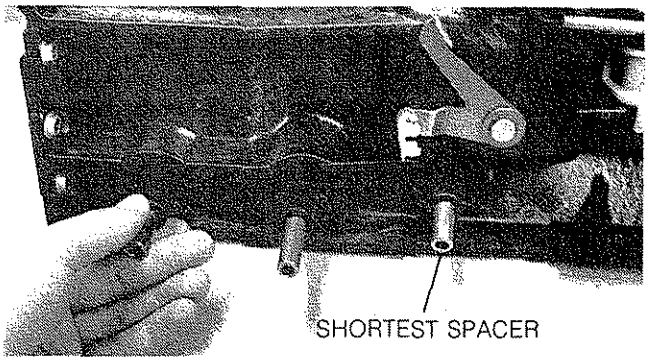


Fig. 33, Window Sill Spacers (Unseated)

For manually operated windows, remove the fasteners and lockwashers that attach the window crank regulator assembly to the inner panel.

10. Pull the inner panel away from the door so that the crank arm mounting spindle (of the regulator assembly) clears the inner panel. See **Fig. 34**. Disengage the regulator arm roller from the window lift channel by rolling it out of one end of the window lift channel.

    Remove the window crank regulator assembly from the door. Go to step 12.

Fig. 34, Regulator Assembly Removal/Installation

11. Disengage the window glass assembly from the air cylinder using the following procedure:

    .1 Remove the exterior door handle access cover from the inner panel. Refer to **Fig. 35**.

    .2 Because the window is in the lowered position, the pin that connects the window lift channel to the air cylinder (refer to **Fig. 36**) can be removed by reaching in through the access hole of the exterior door handle. If the pin cannot be reached,

BULKHEAD-STYLE CAB DOOR

the work space can be increased by removing the exterior door handle, following the instructions under "Exterior Door Handle Replacement."

.3 After removing the pin, unseat the window lift channel from the air cylinder.

12. Tilt the lower ventilator window guide toward the hinge. See **Fig. 37**.

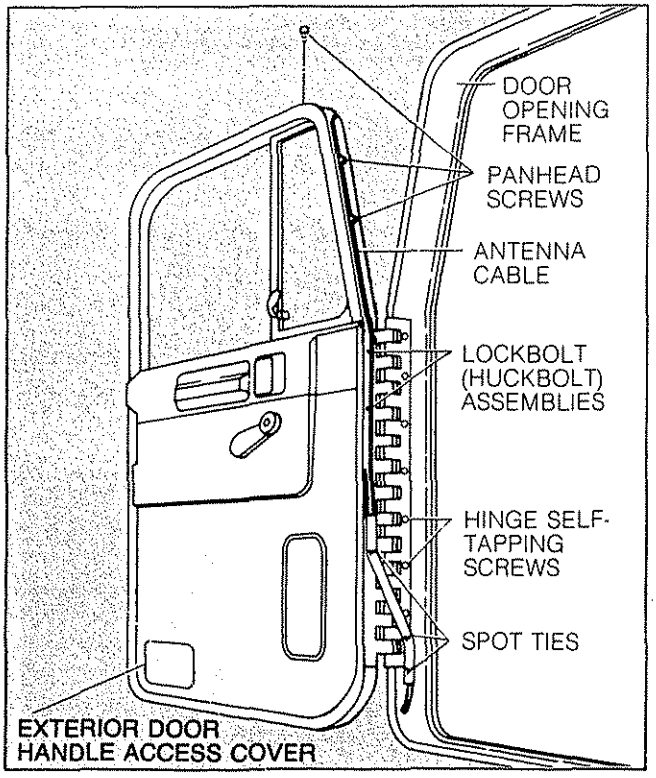


Fig. 35, Cab Door

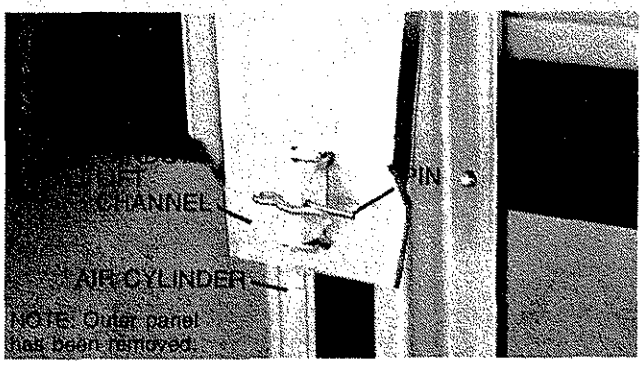


Fig. 36, Air Cylinder/Window Lift Channel

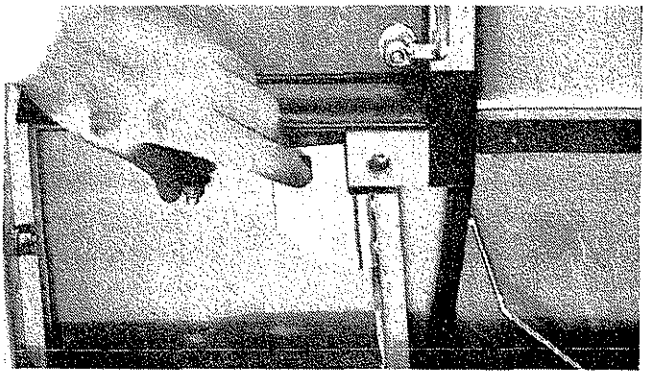


Fig. 37, Tilting the Lower Ventilator Window Guide

13. If the window glass has been shattered, go to step 14.

IMPORTANT: Wear rubber gripper gloves during the removal of the window glass to ensure a secure grip on the glass.

If the window glass is not shattered, carefully unseat the bottom portion (on the latch side of the door) off of the window stop block and out of the glass-run channel. See **Fig. 38**. This can be done by slowly lifting up on the top (hinge side) corner of the window glass. Then, unseat the opposite (hinge side) corner of the window glass off the stop block.

Lean the window glass so that it is outside the window channel of the ventilator window mounting bracket, then carefully lift out the window glass assembly. Go to step 15.

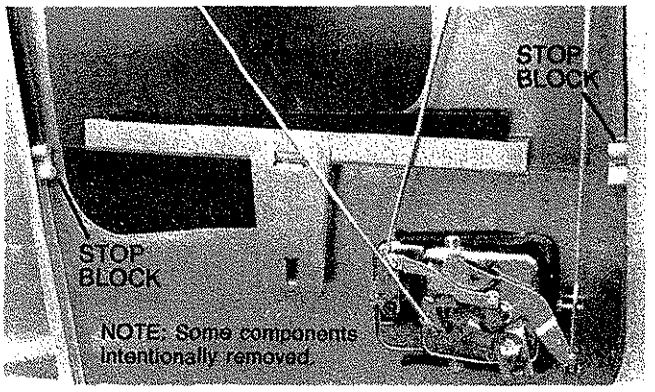


Fig. 38, Unseating/Partially-Seating the Window Glass Assembly

BULKHEAD-STYLE CAB DOOR

14. Wearing protective gloves, remove all accessible shattered glass. Then, if applicable, remove the window lift channel.

    Remove the exterior door handle. For instructions, refer to "Exterior Door Handle Replacement." Using a narrow extension accessory, vacuum out small glass fragments that may have fallen to the bottom of the door frame through the space behind the exterior door handle access cover attached to the inner panel. Refer to **Fig. 35**. Failure to remove the glass fragments could cause them to plug the drain holes at the bottom of the door frame.

15. If necessary, remove the window glass-run channels. Refer to **Fig. 39**. If the window glass was shattered,

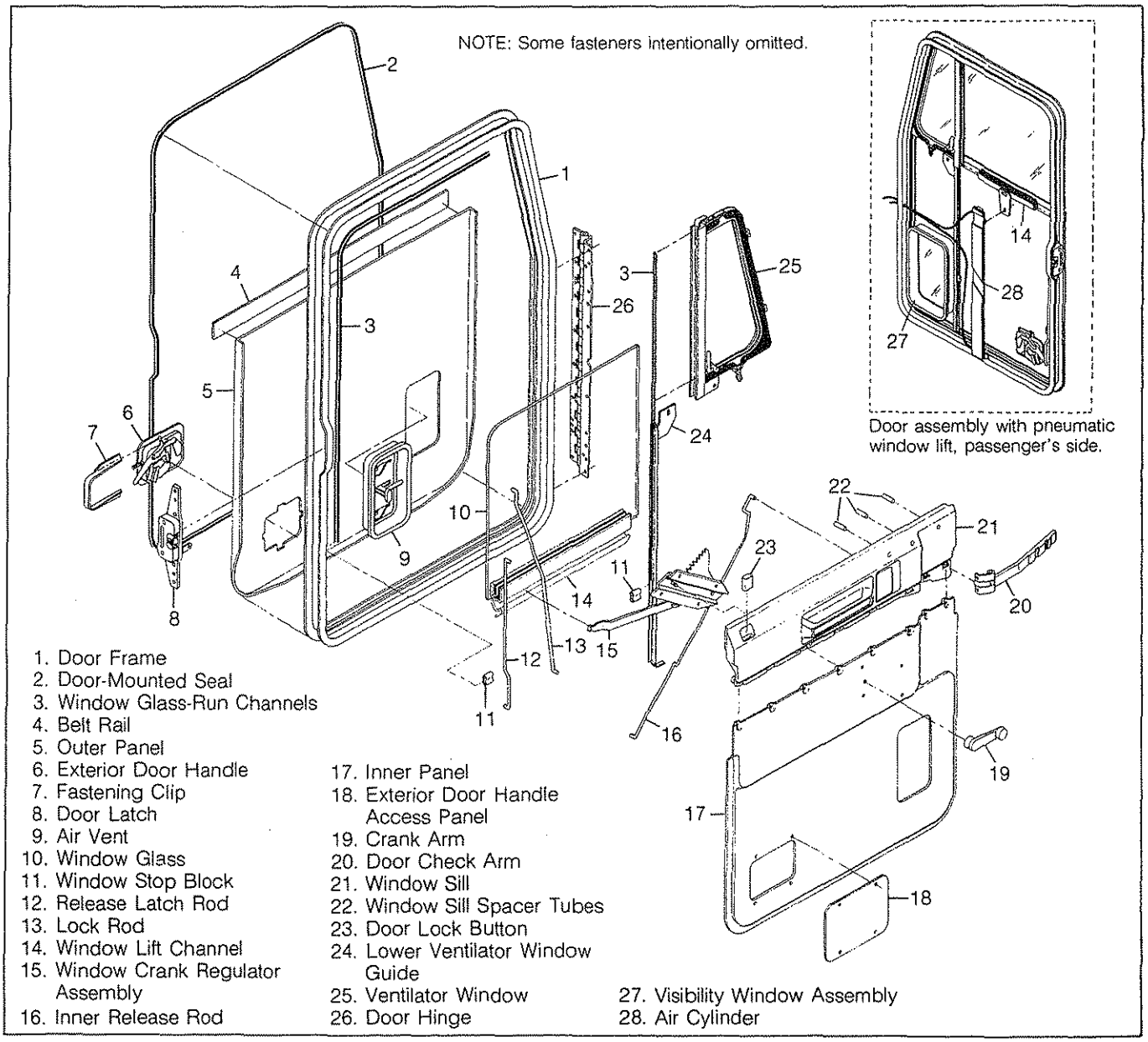


Fig. 39, Cab Door Assembly, Exploded View (Driver's Side)

BULKHEAD-STYLE CAB DOOR

inspect the glass-run channels for cuts. Replace the glass-run channels, if damaged.

16. If the ventilator window assembly must be replaced, remove the three panhead screws and lockwashers that attach the window assembly to the door frame. Refer to Fig. 35. Remove the window glass-run channel from the ventilator window.

    Remove the ventilator assembly.

Window Glass Installation

IMPORTANT: If the ventilator window assembly has been removed, follow steps 1 and 2 carefully. Proper installation of the ventilator window seal will prevent problems arising during window sill installation. Also, proper installation of the ventilator window seal will prevent water leaks from occurring when the vehicle is later placed in service.

If the ventilator window assembly has not been removed, go to step 3.

1. Seat the ventilator window assembly in the door frame. Tilt the lower ventilator window guide toward the hinge. Make sure that the bottom seal flap on the outside of the door *overlaps* the belt rail (Fig. 40). The flap does not go under the belt rail.

2. Make sure that the flaps of the ventilator window side seal overlap onto the outside and inside surfaces of the door frame. If the seal flaps come between the door frame and the ventilator window mounting bracket, the holes for the panhead screws will not line up.

   Install the lockwashers and panhead screws. Check the position (squareness) of the ventilator window in the door frame. The window channels should be parallel to one another, or binding of the window glass will occur as the window is raised. If necessary, adjust the position of the ventilator window. Tighten the panhead screws securely.

3. If the window glass-run channels have been removed, install them. Make sure the glass-run channels are fully seated in the window channels.

IMPORTANT: Wear rubber gripper gloves when installing the window glass. Usually, service operations performed on the door will be done while the door is in a vertical position (that is, attached to the vehicle). Because of this, you will need a secure grip when handling the glass.

CAUTION: Failure to wear rubber gripper gloves while installing the window glass in the door could result in the glass slipping out of the your hands and breaking.

4. Carefully place the window glass assembly inside the door. If applicable, make sure the window lift channel will be facing toward the inner panel.

5. Make sure that the lower ventilator window guide is tilted toward the hinge. Install the window glass assembly in the window channel as follows:

   .1 Position the bottom (hinge side) corner of the window glass on the window stop block. See Fig. 38.

   .2 Position the top (hinge side) area of the window glass so that it is inside the window channel of the ventilator window mounting bracket. See Fig. 41.

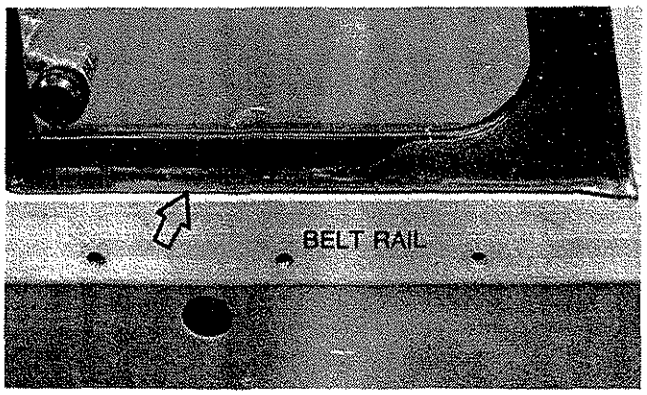


Fig. 40, Bottom Seal of the Ventilator Window Assembly

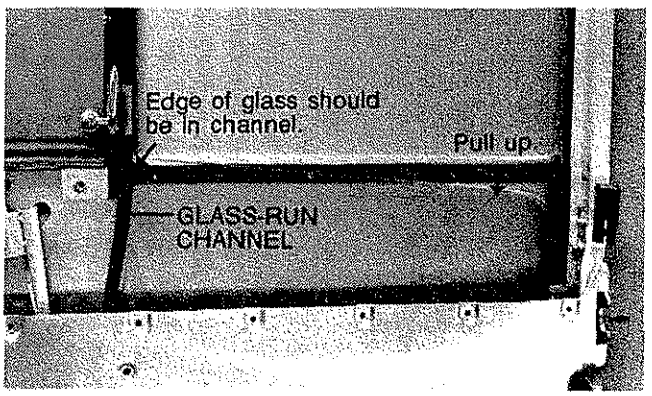


Fig. 41, Window Glass Installation

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.3 Pull up on the top (latch side) corner of the window glass. Refer to **Fig. 41**. As the window is pulled up into a horizontal position, the bottom (latch side) corner of the window will clear the window stop block and seat in the channel, as shown in **Fig. 42**.

.4 Tilt the lower ventilator window guide back to the vertical position. *Make sure that the guide remains in the vertical position.*

6. If the door is equipped with pneumatic window lifts, go to step 10.

   For manually operated windows, engage the regulator arm roller of the window crank regulator assembly to the window lift channel. If necessary, pull the window glass up in order to ease installing the regulator arm roller in one end of the window lift channel.

IMPORTANT: (If not already done, install the exterior door handle, using the instructions under "Exterior Door Handle Replacement.") Before concluding the installation of the window crank regulator assembly, make sure the release handle rod (the "loose" rod that tends to interfere with service operations) leans on *top* of the regulator assembly and not below it. Also, make sure that it is not placed on the roller side of the regulator.

7. Install the regulator assembly so that the crank arm mounting spindle protrudes through the inner panel. This requires that the inner panel be pulled away from the door until a gap exists that is wide enough to allow the installation of the regulator assembly. See **Fig. 34**.

8. Install the lockwashers and fasteners that attach the window glass, as needed to align the inner panel holes with the regulator assembly holes. (A second person may be needed to assist during this procedure.) Tighten the fasteners 96 lbf·in (1080 N·cm).

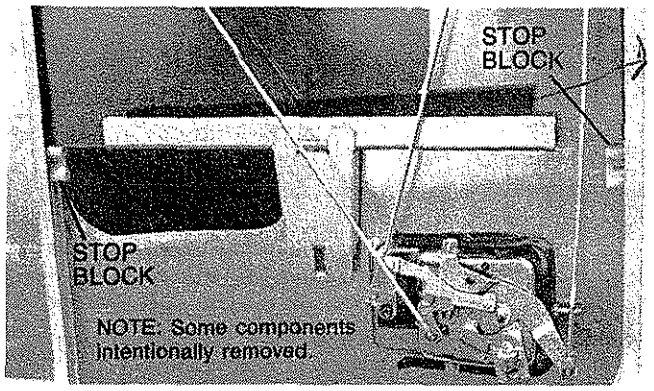

Fig. 42, Correctly Seated Window Glass Assembly

9. Attach the crank arm to the regulator assembly mounting spindle. Then, install the allen-head capscrew. Test the window for up-and-down movement. Hard rolling usually means the window glass-run channels are not seated properly. Inspect the glass-run channels for seating. Go to step 11.

10. Attach the window lift channel to the air cylinder as follows:

    .1 Seat the window lift channel in the air cylinder mounting bracket; access the components through the exterior door handle access hole on the inner panel. See **Fig. 35**.

    .2 Install the pin that prevents the window lift channel from slipping out of the air cylinder mounting bracket. See **Fig. 36**. Then, if the exterior door handle was removed from the door, install it, using the instructions under "Exterior Door Handle Replacement."

    .3 Attach the exterior door handle access cover to the inner panel. Then proceed to step 11.

11. Install the window sill as follows:

    .1 Place the window sill in its approximate installation position, with the bottom edge tucked under the inner panel. Use care not to dislodge the Tinnerman clip from the mounting angle of the window sill. Insert the door lock button through the hole in the window sill.

    .2 Connect the release handle rod in the plastic keeper attached to the window sill. See **Fig. 32**. Make sure the rod is locked in place.

    .3 Push the window sill approximately in place; allow about a 1/2-inch (13 mm) or less gap to exist directly under the ventilator window assembly. Open the ventilator window. Then, using a flat, blunt instrument, work out the ventilator window seal flap (in the bottom corner nearest the hinge) so that the flap *overlaps* the window sill. The flap does not go under the window sill. After this has been done, the remaining portion of the ventilator window seal flap can be manually worked out without the use of a tool. See **Figs. 43** and **44**.

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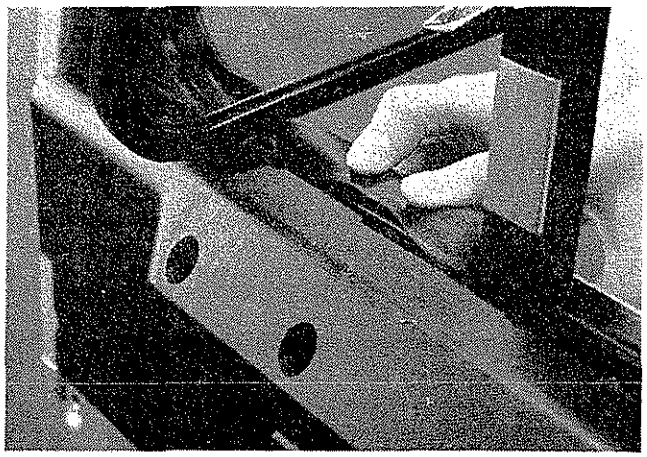

Fig. 43

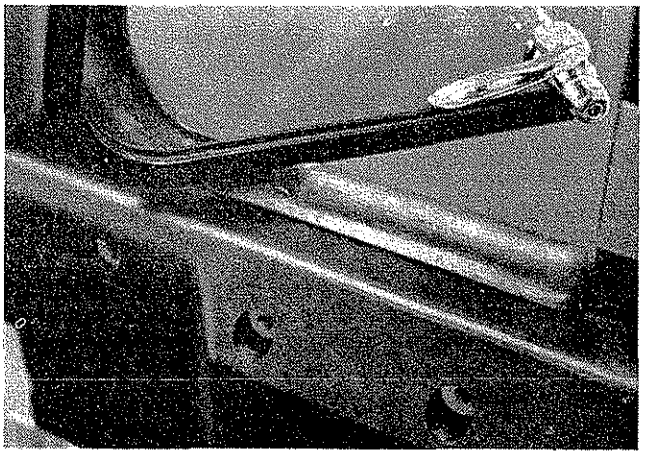

Fig. 44, Correctly Installed Ventilator Window Seal

.4 Push the window sill in place, snug against the door frame. Install the two longest window sill spacer tubes (as referenced earlier) and washers in the window sill.

12. Install the last window sill spacer tube through the window sill hole. The spacer should be completely seated. If it does not seat, remove it, then see if the lower ventilator window guide is tilted out of place. See **Fig. 45**. Using the tip of a small screwdriver through the spacer hole from outside the door, lever the window guide back to a vertical position. At the same time, push the spacer in place. Then install the washer.

13. Install the door check arm between the window sill and door frame. Install the four hexhead capscrews on the hinge side of the door frame. See **Fig. 28**. If equipped with 1/4–20 SAE grade 5 capscrews, tighten them 60 to 84 lbf·in (680 to 940 N·cm); if equipped with 1/4–28 SAE grade 8 capscrews, tighten them 120 lbf·in (1360 N·cm).

CAUTION: Don't force a capscrew in place. If the capscrew seems to be going in crooked, the holes in the spline unit (which is pressed into the window sill) and the door frame are not properly aligned. The spline nut could be pushed out of the window sill if undue force is applied to the capscrew.

If the holes are misaligned, the probable cause is an improperly installed ventilator window seal (weatherstrip). Refer to steps 1 and 11.3 under this heading for information on the proper installation of the ventilator window seal.

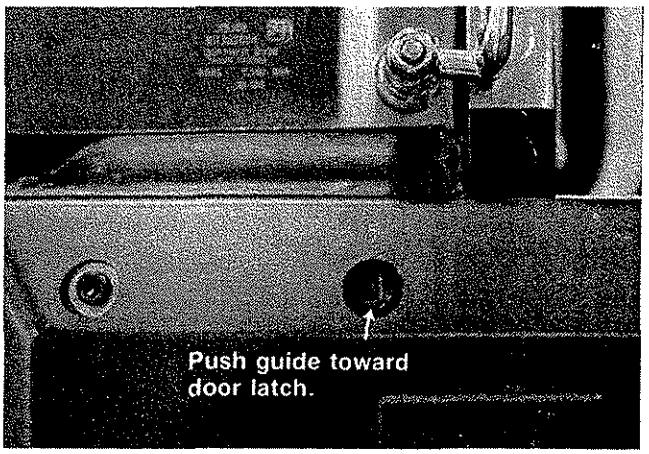

Fig. 45, Lower Ventilator Window Guide Tilted Out of Place

14. Install the two hexhead capscrews on the opposite side of the door frame (above the door latch assembly), as shown in **Fig. 29**. Note the "Caution" in step 13. If equipped with 1/4–20 SAE grade 5 capscrews, tighten them 60 to 84 lbf·in (680 to 940 N·cm); if equipped with 1/4–28, SAE grade 8 capscrews, tighten them 120 lbf·in (1360 N·cm).

15. Install the screws that attach the inner panel to the window sill (the longest screw is installed at the door latch end of the panel). See **Fig. 25**. Also, if applicable, install the two screws that attach the air cylinder to the window sill. See **Fig. 27**.

16. On custom interiors, install the black lower door cover, and the naugahyde and carpet inserts. See

BULKHEAD-STYLE CAB DOOR

Fig. 26. This requires that the previously installed window crank arm, if so equipped, be removed again. Reinstall the crank arm after the door panel and inserts have been attached.

17. As referenced earlier, install the three capscrews (using an allen wrench), nuts, and washers, that partially attach the outside mirror mounting bracket to the door. See Fig. 24. Tighten the capscrews 120 lbf·in (1360 N·cm).

VENTILATOR WINDOW ASSEMBLY REMOVAL AND INSTALLATION

Removal

NOTE: The ventilator window glass can be "pulled" out of the mounting bracket assembly without having to disassemble the components. A special tool, usually available through automotive glass shops, is required.

1. Lower the window.
2. Pull out the window glass-run channel that is seated in the side of the ventilator window mounting bracket.
3. Remove the allen-head capscrew and the outside nuts and washer above the release handle on the window sill. See Fig. 46. Using an allen wrench, push out the spacer and washer from the outside hole in the door.
4. Loosen, but don't remove, the other two window sill allen-head capscrews and nuts that partially fasten the outside mirror to the door. Refer to Fig. 46.
5. Remove the three panhead screws and lockwashers that attach the ventilator window assembly to the door frame. Refer to Fig. 35.

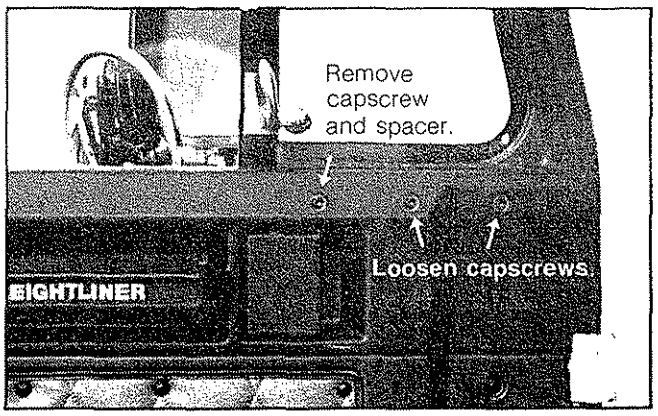

Fig. 46

6. Tilt the top of the ventilator window assembly toward the door latch. Remove the ventilator window assembly.

Installation

1. Seat the ventilator window assembly in the door. All portions (the inside and outside "flaps") of the seal must *overlap* the door, frame, the exterior door belt rail (Fig. 40), and the window sill (Fig. 44).

CAUTION: Failure to ensure correct installation of the seal could eventually result in cab water leaks.

2. Install the three panhead screws and lockwashers that attach the ventilator window assembly to the door frame. Refer to Fig. 35. Check the position (squareness) of the ventilator window in the door frame. The window channels should be parallel to each other, or binding of the window glass will occur as the window is raised. Adjust the position of the ventilator window, if necessary. Tighten the panhead screws securely.
3. Using an allen wrench, tighten the two previously loosened window sill capscrews and nuts 120 lbf·in (1360 N·cm).
4. Install the previously removed window sill spacer through the window sill hole. The spacer should be completely seated. If it doesn't seat, the lower ventilator window guide is tilted out of place. See Fig. 45. Using the tip of a small screwdriver through the spacer hole from outside the door, lever the window guide back to a vertical position. At the same time, push the spacer in place. Install the washer.
5. Install the allen-head capscrew, nuts, and washers that partially attach the outside mirror bracket to the door. Tighten the capscrew 120 lbf·in (1360 N·cm).
6. Seat the window glass-run channel along the side of the ventilator window.
7. Test the window for up-and-down movement. Hard rolling means that the previously removed window glass-run channel was not seated correctly. Seat the glass-run channel completely.

EXTERIOR DOOR HANDLE REPLACEMENT

1. On custom interiors equipped with manually operated windows, remove the crank arm from the window crank regulator assembly. On all custom door interiors, first remove the naugahyde and carpet inserts,

BULKHEAD-STYLE CAB DOOR

and then (if equipped) the black lower door cover from the inner panel of the door. Refer to **Fig. 26**. The panels are attached with a panhead screw.

NOTE: On some installations, access to the exterior door handle access cover is gained by removing the carpet insert only.

2. Remove the exterior door handle access cover from the inner panel. Refer to **Fig. 35**.
3. Reference the three rods (inner release rod, release latch rod, and lock rod; see **Fig. 47**) attached to the door handle assembly. Release the rods from the plastic keepers, as shown in **Fig. 47**.

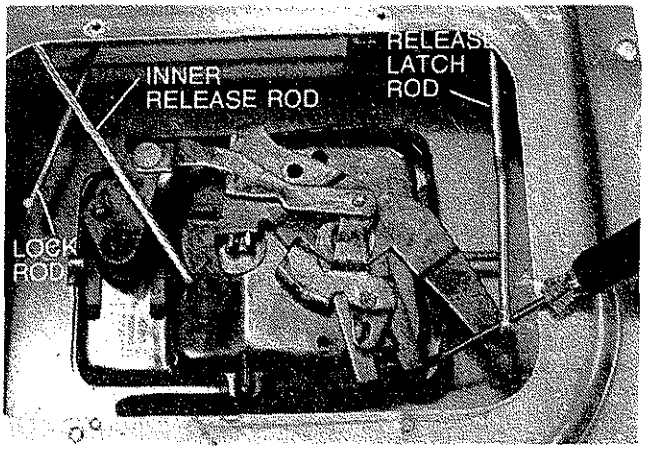

Fig. 47, Releasing the Rods from the Exterior Door Handle

4. Remove the retaining nut that secures the fastening clip to the door handle assembly. Refer to **Fig. 48**.
5. Using a pry, such as a screwdriver, push the fastening clip to the side until it clears the door handle bolt. See **Fig. 48**. Be careful not to let the door handle assembly drop as the fastening clip is pushed out of place.
6. Position the new door handle assembly in the door, then slide the fastening clip in place (reverse the procedure used to remove it).

   Remove the door handle assembly.
7. Install the retaining nut that secures the fastening clip to the door handle assembly. Refer to **Fig. 48**. Tighten the nut securely.
8. As referenced earlier, attach the three rods to the door handle assembly. Make sure the plastic keepers are locked in place.

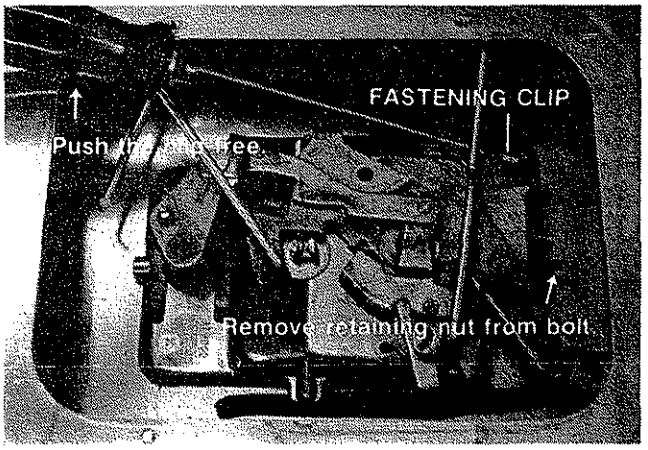

Fig. 48, Removing the Exterior Door Handle Fastening Clip

9. Make sure that the three rods have been correctly installed by doing the following tests:

   Close the jaws of the latch until they lock in place. Depress the lock button on the interior side of the door.

   Attempt to open the locked jaws using the exterior door handle. The jaws should not open. Attempt to open the locked jaws using the interior door handle. The jaws should open and the lock button should release.
10. Attach the exterior door handle access cover to the inner panel of the door.
11. If applicable, attach the black lower door cover, and the naugahyde and carpet inserts, to the inner panel of the door (or, if applicable, attach the carpet inserts to the door). Attach the crank arm to the window crank regulator assembly. Install and tighten the allen-head capscrew.

OUTER PANEL REPLACEMENT

The outer panel is not replaceable. If the outer panel is structurally damaged, replace the door-frame/outer-panel assembly.

CAUTION: Do not attempt to replace the outer panel if it is structually damaged. The entire portion of the panel that is crimped around the door frame is also bonded with a high-strength structural adhesive. In order to weaken this adhesive, a temperature of 400°F

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(204°C) is needed. If the aluminum door frame is heated to temperatures approaching 400°F (204°C), the door frame can crack or warp; accelerated aging of the metal may also occur.

VISIBILITY WINDOW GLASS REPLACEMENT

Special tools are not needed to remove and install the visibility window glass. A regular screwdriver (a small one) and a thin, flat tool, such as a putty knife, can be used if a special corkscrew instrument (utilized in major body shops for window glass replacement) is not available.

WARNING: Use care when working around or handling glass. Wear protective gloves to eliminate the possibility of personal injury resulting from accidentally breaking or splintering the glass.

1. From the outside of the door locate the seam of the visibility window glass rubber extrusion ends. Then, carefully using a tool such as a small screwdriver, unseat the rubber extrusion lockstrip. Refer to **Fig. 49**.
2. Using the screwdriver, carefully unseat the entire length of the lockstrip. See **Fig. 49**. If desired, the lockstrip can be worked out without the aid of the screwdriver; this will lessen the chances of blemishing the rubber extrusion.
3. After the lockstrip is completely unseated, push out the visibility glass from inside the door.

NOTE: If the lockstrip is completely unseated, little pressure is needed to push out the glass.

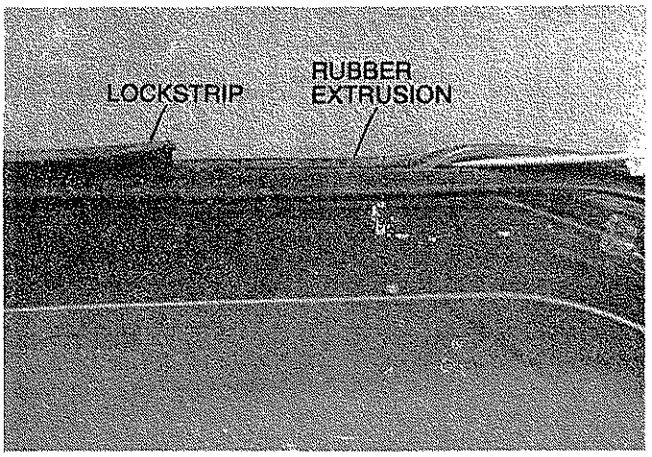

Fig. 49, Unseating the Lockstrip of the Visibility Window Rubber Extrusion

When pushing out the glass, wear heavy protective gloves if the glass is blemished with fine, hairline scratches or if it is cracked.

NOTE: Steps 4 through 7 can be performed simultaneously by alternating steps as needed. It is not necessary to completely seat the window glass in order to begin step 5.

4. Replace the rubber extrusion, if necessary.

   Seat as much of the new window glass (without using tools) as possible. Be sure the glass is seated properly with the rubber extrusion flaps overlapping the inner and outer surfaces of the glass.
5. If possible, begin at the rubber extrusion seam and tuck the lockstrip end in place. By lifting up the rubber extrusion using a putty knife, the lockstrip can be worked in using your fingers, as shown in **Fig. 50**.
6. Seat about 80 percent of the lockstrip around the border of the rubber extrusion. As you work, frequently and gently push down on the glass in order to seat it in the door. Except for the rounded portions of the work area, most of the seating of the lockstrip can be done without using the putty knife.

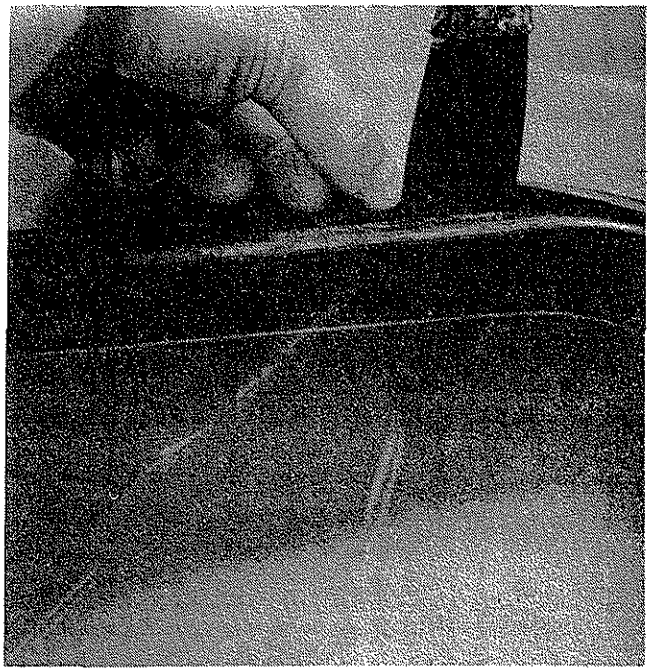

Fig. 50, Seating the Lockstrip of the Visibility Window Rubber Extrusion

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7. After about 80 percent of the lockstrip length has been seated, and if steps 4 and 5 are being performed simultaneously, gently use the putty knife to work out the flap of the rubber extrusion, so that the glass is completely seated. See Fig. 51.

WARNING: Use care when sliding the putty knife blade along the edge of the glass. Small splinters of glass will break off if the work is done carelessly.

Push down on the glass until it is level with the outer panel of the door; only slight pressure is needed to seat the glass. Then, again using the putty knife, seat the remaining portion of the lockstrip.

IMPORTANT: To prevent cab water leaks, the rubber extrusion should lay flat against the outer panel and should not crease at any point, especially around the corners of the visibility window. Reinstall the visibility window if the rubber extrusion creases; make sure that the glass is completely seated in the door.

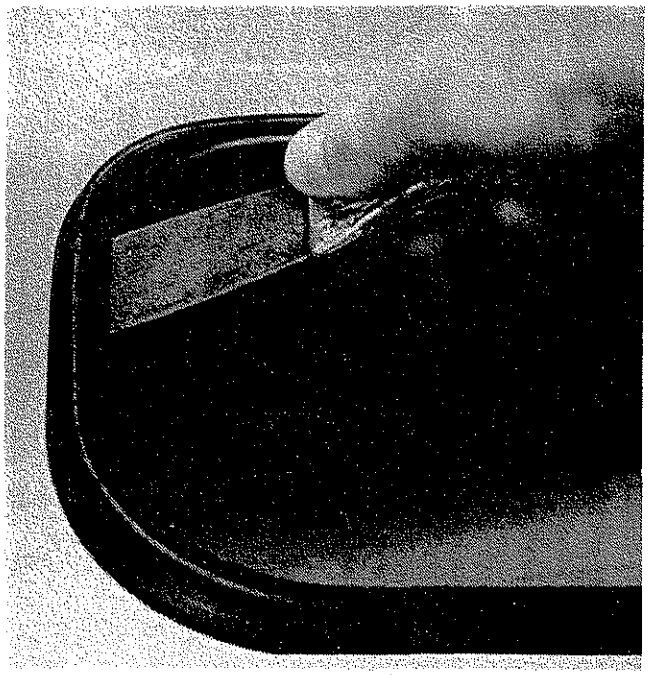

Fig. 51, Seating the Visibility Window Glass

DOOR HINGE REMOVAL AND INSTALLATION

Removal

1. Remove the door from the vehicle. For instructions, refer to "Door Removal."
2. Remove the window sill from the door. For instructions, refer to steps 1 through 8 under "Window Glass Removal."
3. If applicable, remove the capscrew, nuts, and washer that partially attach the outside mirror mounting bracket to the door frame/hinge assembly.
4. Remove the panhead screws that attach the inner panel to the hinge side of the door frame.
5. Centerpunch the rivets that attach the inner panel to the door frame. Using a no. 11 (0.191-inch) drill bit, drill out the rivets. Do not enlarge the original hole.

IMPORTANT: On doors equipped with visibility windows, it is possible to replace the hinge without removing the rivets from the inner panel/door frame assembly. After removing the visibility window trim ring (see Fig. 52), the applicable service operations below can be performed utilizing the temporary access space.

6. Remove the inner panel assembly from the door frame. For doors equipped with crank-style windows, disengage the regulator arm roller from the window lift channel as the inner panel is pulled away.
7. Centerpunch the lockbolt (Huckbolt®) assemblies that attach the hinge to the door frame. Refer to Fig. 35. Carefully drill out the fasteners using a 1/4-inch drill bit. Do not enlarge the original holes.

   Remove all debris that falls inside the door.
8. Remove the hinge.

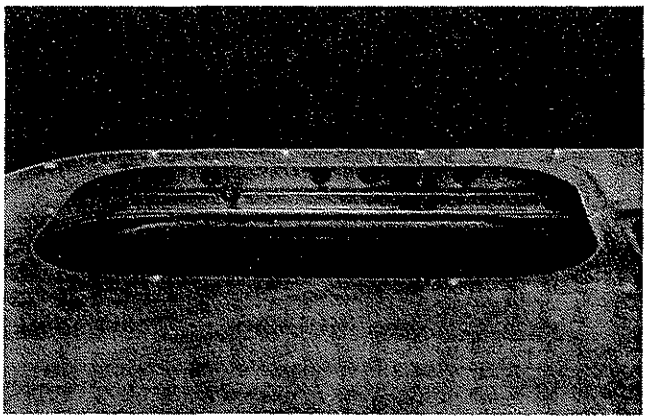

Fig. 52, Access Space to the Lockbolt Assemblies (visibility window trim ring removed)

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Installation

1. If necessary, replace the rubber sealant tape found on the inner side edges of the inner panel (does not include the window sill edge).
2. Depending on the availability of tools, attach the new hinge to the door frame using one of the following methods:
   a. 1/4-inch, mild steel, pin and collar lockbolt assemblies A23-09988-005.
   b. 1/4–20, grade 5, 1-inch bolts used in combination with *either* pre-assembled nut and lockwasher assemblies (kep nuts), 23-10340-125, *or*, standard hexnuts and lockwashers.
3. Position the inner panel assembly on the door frame. For doors equipped with crank-style windows, engage the regulator arm roller of the window crank regulator assembly in the window lift channel as the inner panel is installed.
4. Using 3/16-inch rivets, attach the inner panel to the door frame. Do not attempt to rivet the portion in the hinge area.
5. Install the panhead screws that attach the inner panel to the remaining portion of the door frame.
6. If applicable, install the visibility window trim ring and countersunk screws.
7. If applicable, install the capscrews, nuts, and washers that partially attach the outside mirror mounting bracket to the door frame/hinge assembly. Tighten the capscrews 120 lbf·in (1360 N·cm).
8. Install the window sill on the door. For instructions, refer to steps 11 through 17 under "Window Glass Installation."
9. Install and adjust the door on the vehicle. For instructions, refer to "Door Installation."
10. Spray a light coating of silicone lubricant, such as WD-40® or an equivalent, along the entire length of the hinge.

DOOR LATCH ASSEMBLY REMOVAL AND INSTALLATION

Removal

1. Do steps 1 through 5 under "Door Hinge Removal and Installation: Removal."
2. Unfasten the latch release rod from the plastic keeper on the latch assembly.
3. Centerpunch the lockbolt (Huckbolt) assemblies that attach the door latch assembly to the door frame. Carefully drill out the fasteners using a 1/4-inch drill bit. Do not enlarge the original holes.

   Remove all the debris that falls inside the door.
4. Remove the door latch assembly.

Installation

1. To ease installation of the window sill, ream the top two (window sill) capscrew holes of the door latch 5/16 inch (7.9 mm).
2. Depending on the availability of tools, attach the new door latch assembly to the door frame using one of the following methods:
   a. 1/4-inch, mild steel, pin and collar lockbolt assemblies A23-09988-005.
   b. 1/4–20, grade 5, 1-inch bolts used in combination with *either* pre-assembled nut and lockwasher assemblies (kep nuts), 23-10340-125, *or*, standard hexnuts and lockwashers.

   Tighten the nuts 60 to 84 lbf·in (680 to 940 N·cm).
3. Attach the latch release rod to the plastic keeper on the latch assembly.
4. Do steps 3 through 8 under "Door Hinge Removal and Installation: Installation."
5. Test the latch for correct operation:

   Close one jaw of the latch until it locks in place. Release the jaw (repeatedly) using the interior door handle and the exterior door handle. There should be a crisp release.

   Repeat the test using the opposite jaw.

   Replace the latch assembly if binding occurs.

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6. Install and adjust the door on the vehicle. For instructions, refer to "Door Installation."

AIR VENT ASSEMBLY REMOVAL AND INSTALLATION

Removal (Refer to Fig. 53)

1. Do steps 1 through 5 under the heading, "Door Hinge Removal and Installation: Removal."
2. Centerpunch the rivets that attach the air vent assembly to the outer panel of the door. Using a no. 11 (0.191-inch) drill bit, drill out the rivets. Do not enlarge the original holes.

   Remove all debris that falls inside the door.
3. Remove the air vent assembly.

Installation (Refer to Fig. 53)

1. The replacement air vent assembly should be lined with sealant tape as follows:

   .1 On the entire inboard lip of the air vent assembly (the portion facing the inner panel), attach vinyl foam tape 48-00016-805.

   .2 On the outboard face of the air vent assembly (the portion touching the outer panel), attach vinyl foam tape 48-00050-206.
2. Using 3/16-inch rivets (5/16-inch long), attach the air vent assembly to the outer panel.
3. Do steps 3 through 9 under "Door Hinge Removal and Installation: Installation."

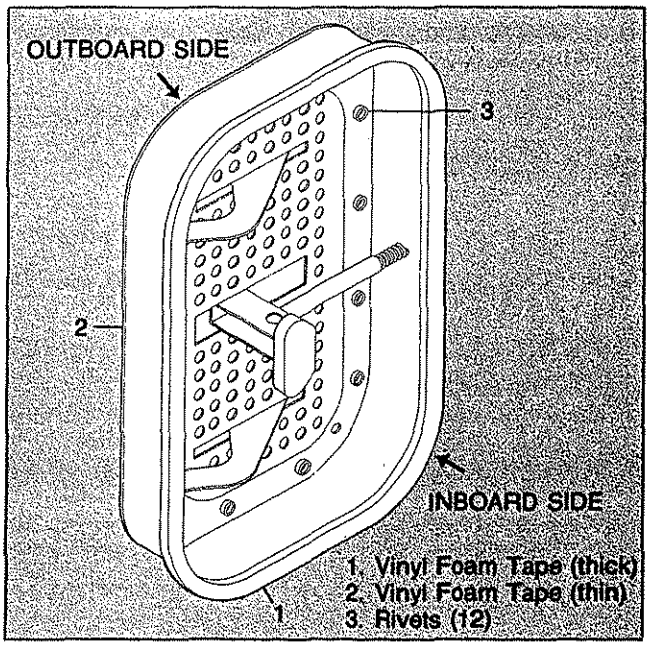


Fig. 53, Air Vent Assembly

SPECIFICATIONS

Description	Grade	Size	Torque
Hinge Self-Tapping Screws	8	1/4–20	120 lbf·in (1360 N·cm)
Door-Latch/Window-Sill Hexhead Capscrews	5	1/4–20	60–84 lbf·in (680–940 N·cm)
	8	1/4–28	120 lbf·in (1360 N·cm)
Hinge/Door-Frame/Window-Sill Hexhead Capscrews	5	1/4–20	60–84 lbf·in (680–940 N·cm)
	8	1/4–28	120 lbf·in (1360 N·cm)
Window Sill Capscrews (Allen-Head)	—	1/4–20	60 lbf·in (680 N·cm)
Striker Pin	8	7/16–14	50 lbf·ft (68 N·m)
Inner Panel to Window Sill Screws: Sheet Metal Screws	—	Type A, #10	30 lbf·in (340 N·cm)
Machine Screws	—	10–24	60 lbf·in (680 N·cm)

Table 1, Torque Values

BAGGAGE DOORS AND SLEEPER BOX ACCESS DOORS

GENERAL INFORMATION

On COE sleeper cabs and Conventionals with sleeper boxes, baggage doors are located on either side of the vehicle, to allow access to the storage compartments beneath the sleeper bunk. COEs have varying sizes of baggage doors, and may have single doors at each side, or dual doors at each side, depending on the cab size and the installation of various options. See Fig. 1. Conventionals with 1984 Advancements have a 22-inch-wide by 18-inch-high door on each side of the sleeper box. See Fig. 2.

The baggage doors on COE sleeper cabs and 1984 Advancements Conventional sleeper boxes have rounded corners, single-panel construction, a piano-style hinge, and a one-piece extruded aluminum door-opening frame. The baggage door panel is slightly recessed in the door-opening frame, and the door-opening frame features a full-circumference integral drip molding. A neoprene sponge bulb seal is glued to the inner perimeter of the door panel. A door stop chain limits opening the door beyond approximately 105 degrees. Refer to Fig. 1 or 2.

Each of the COE single baggage doors or forward baggage doors (of dual doors) is held closed by a lanyard-pull latch that is opened by a remote-cable in the driver's compartment. Rear door latches (of dual doors) are opened by remote cables in the forward baggage compartments.

Each of the Conventional baggage doors is held closed by a rotary latch that is opened by a keyed lock cylinder.

Access to the COE sleeper compartment is provided by the opening from the driver's compartment, with no access from outside the cab.

Access to 1984 Advancements Conventional sleeper boxes is provided by a 22-inch-wide by 37-inch-high access door, in addition to the walk-through opening at the back of the cab. The access door is on the curbside of the sleeper on all sizes of sleeper boxes, with an additional street-side 22-inch by 37-inch door available as an option on 40-inch sleeper boxes.

The sleeper box access door(s) is a rounded-corner bulkhead-style door, similar to the bulkhead-style cab doors on COEs and Conventionals. The door opening frame has a full-circumference integral drip molding, and the surface of the access door is flush with the outermost edge of the drip molding. A push-on neoprene sponge bulb seal fits over the inner flange of the door opening frame. A door check strap prevents the door from opening too far. Refer to Fig. 2.

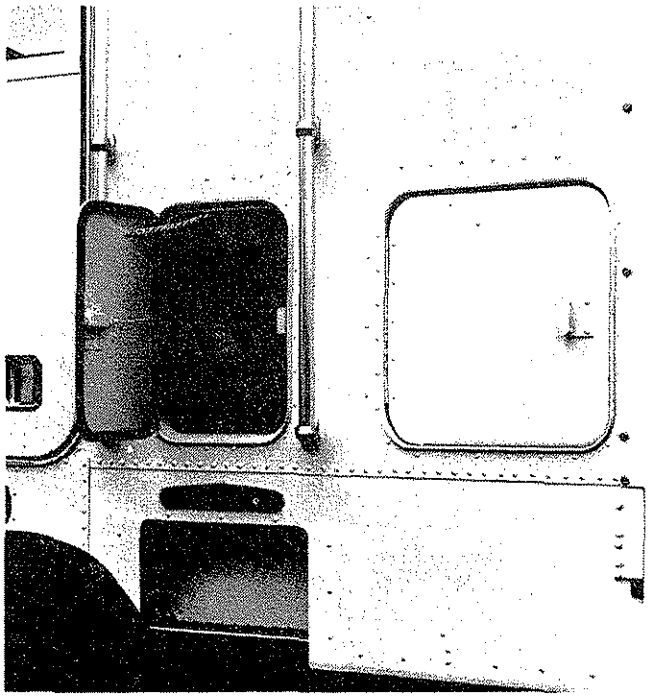


Fig. 1

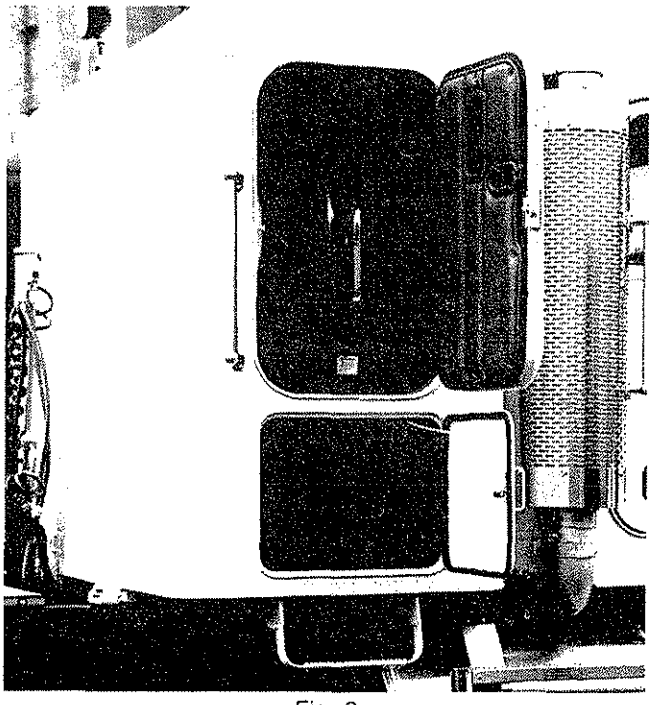


Fig. 2

BAGGAGE DOORS AND SLEEPER BOX ACCESS DOORS

A lever handle releases the access door from inside the sleeper box. A keyed lock cylinder actuates the rotary latch from the outside.

On 1984 Advancements Conventionals, the same key used for the cab doors and ignition is used for the baggage doors and access door(s).

SERVICE OPERATIONS

NOTE: Some components of the baggage doors and sleeper box access doors (such as hinges, latches, and weather stripping) require periodic lubrication. Refer to the 18 Group of the Freightliner Maintenance and Lube Manual for instructions and recommended intervals.

BAGGAGE DOOR SEAL REPLACEMENT

1. Using a putty knife, separate one end of the baggage door seal, at the seal seam located at the center of the bottom of the door panel. Refer to Fig. 3 or 4. Gripping that end of the seal, pull the entire length of the seal off of the door panel.
2. Using a solvent (such as chlorothane or methylene-chloride), thoroughly clean and dry the seal application area of the door panel. Remove any rust, grease, dirt, or old adhesive from the surface.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commerical cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

3. If not already done, cut a length of new door seal that is just longer than the total perimeter of the baggage door.
4. Apply HBF/SC-1112 contact cement (manufactured by the H.B. Fuller Company), or an equivalent adhesive, to the door seal at the areas identified in Fig. 5. Apply the adhesive to the inside edges of the door panel at the areas identified in Fig. 5. Apply extra adhesive to the seal area of the hinge-leaf-to-panel overlap, as shown in Fig. 3.

   Allow the adhesive to dry, as specified by the manufacturer.
5. Beginning with one (squared off) end of the seal at the center of the bottom inside edge of the door

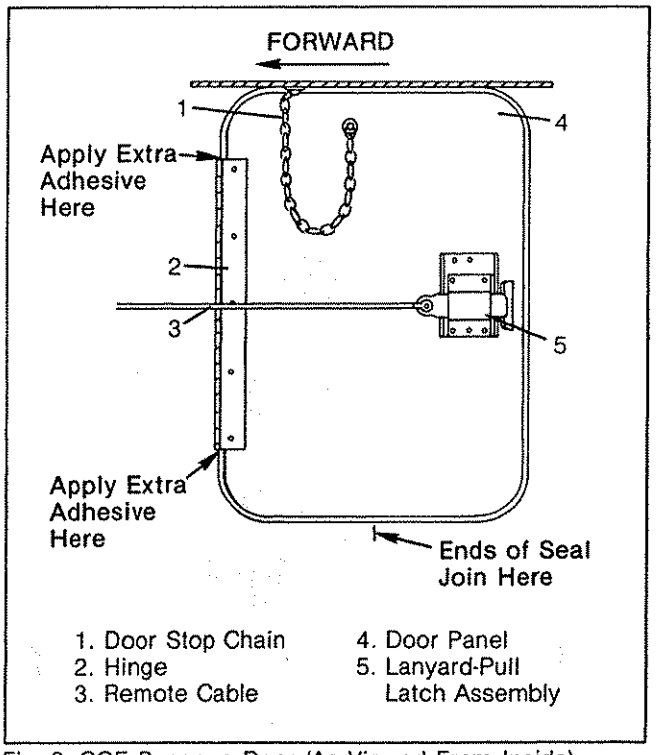


Fig. 3, COE Baggage Door (As Viewed From Inside)

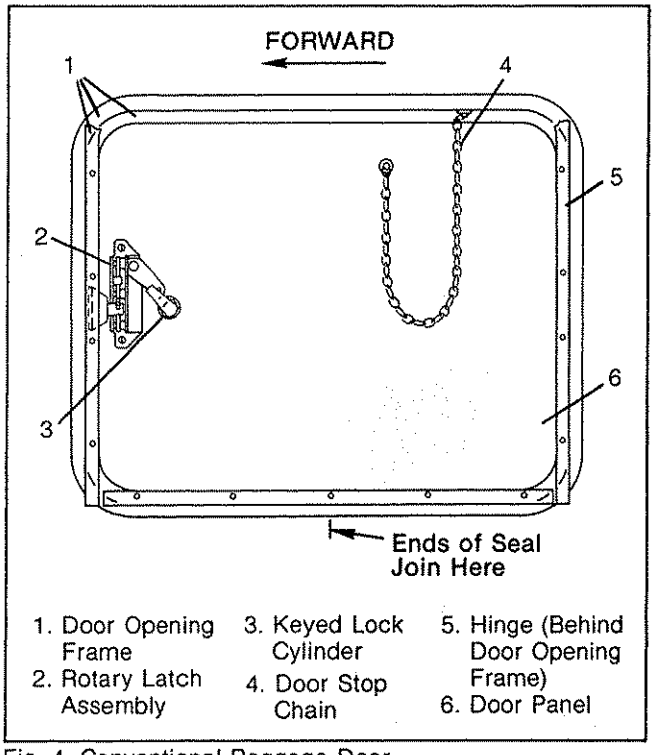


Fig. 4, Conventional Baggage Door (As Viewed From Inside)

BAGGAGE DOORS AND SLEEPER BOX ACCESS DOORS

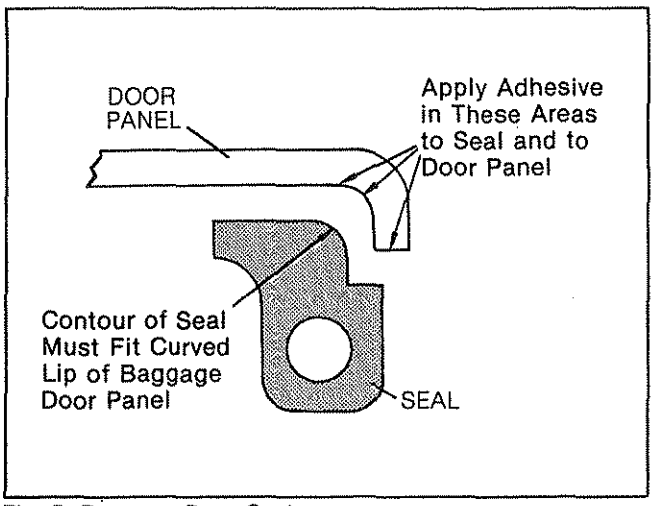


Fig. 5, Baggage Door Seal

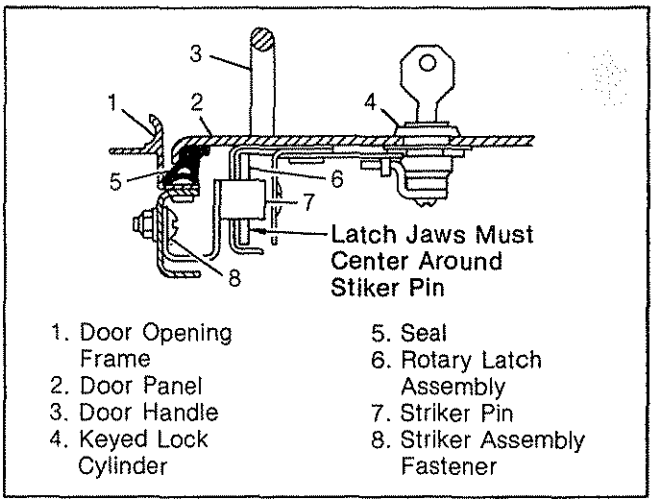


Fig. 6, Conventional Baggage Door Latch

panel, install the door seal, making sure that the contour of the seal is fitted to the curved lip of the door panel all the way around its perimeter, except at the hinge. See Fig. 5. To avoid pulling the seal away from the corners of the panel, do not stretch the seal.

6. Just prior to complete seating of the door seal, cut off (square) the excess length of the seal so that the two ends will form a hairline seam (butt joint) at the center of the bottom of the door panel. Apply HBF/SC-1112 contact cement, or an equivalent adhesive, to both ends of the seal. Allow the adhesive to dry, as specified by the manufacturer, then complete the door seal installation, and press the seal ends together.
7. Test the door for ease of opening and closing, and adjust the latch mechanism if necessary.

BAGGAGE DOOR LATCH ADJUSTMENT

Whenever the baggage door is difficult to open or close, or whenever there are wind or water leaks at the door opening frame (when the door seal is correctly installed and is in good condition), adjust the baggage door latch, using the appropriate procedure below.

Conventional (Refer to Fig. 6)

NOTE: The mounting holes in the striker assembly are horizontally slotted to allow in and out movement. The matching holes in the baggage door latch reinforcement are vertically slotted to allow up and down movement of the striker assembly.

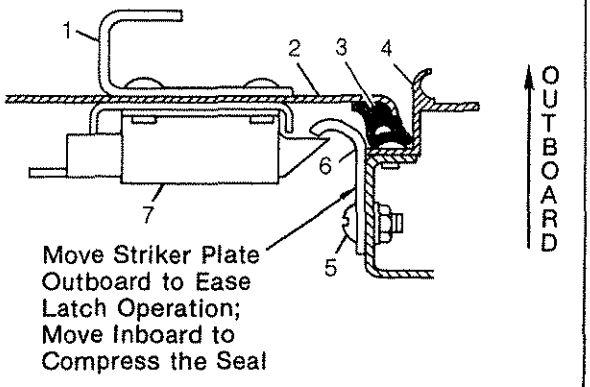
1. Loosen the fasteners that hold the striker assembly in position, but do not loosen them any further than what is needed to allow movement of the striker assembly.
2. Partially close the baggage door to approximately 1 inch (50 mm) of the latched position, and visually check to see if the latch jaws will be centered around the striker pin when the door is closed. Move the striker assembly up or down as necessary.
3. Adjust the in and out position of the striker assembly as needed. If the baggage door was difficult to open or close, move the striker assembly outboard a slight amount; if wind or water leaks were a problem, move the striker assembly inboard.
4. Tighten the fasteners, then check the adjustment of the latch by opening and closing the door several times. Readjust if necessary.

COE (Refer to Fig. 7)

NOTE: The mounting holes in the striker plate are horizontally slotted to allow in and out adjustment. Because of the design of the COE baggage door latch, up and down adjustment is not required.

1. Loosen the fasteners that hold the striker plate in position, but do not loosen them any further than what is needed to allow movement of the striker plate.
2. Move the striker plate outboard if the baggage door was difficult to open or close, or move it inboard if wind or water leaks were a problem.

BAGGAGE DOORS AND SLEEPER BOX ACCESS DOORS



1. Door Handle
2. Door Panel
3. Seal
4. Door Opening Frame
5. Striker Plate Fastener
6. Striker Plate
7. Lanyard-Pull Latch Assembly

Fig. 7, COE Baggage Door Latch

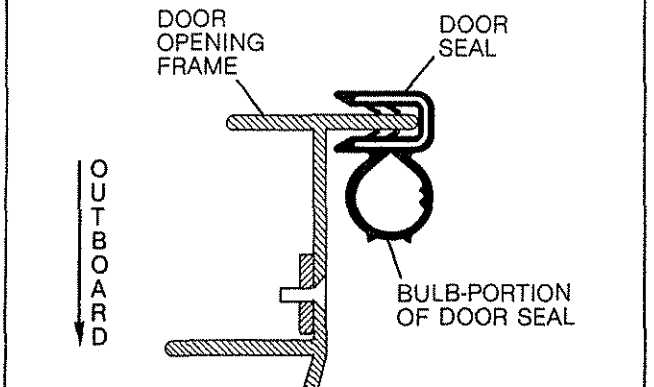


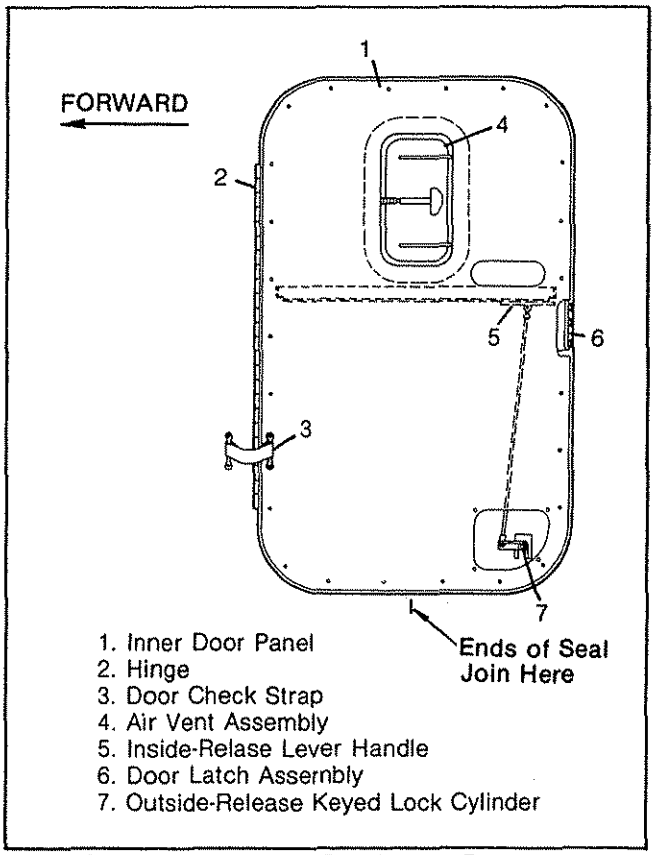
Fig. 8, Sleeper Box Access Door Seal

SLEEPER BOX ACCESS DOOR SEAL REPLACEMENT

1. Using a putty knife, separate one end of the access door seal, at the seal seam. Gripping that end of the seal, pull the entire length of the seal off of the door opening frame, by pulling toward the center of the opening.
2. Using a solvent (such as chlorothane or methylene-chloride), thoroughly clean and dry the seal application area of the door opening frame. Remove any rust, grease, or dirt from the surface.

WARNING: Commercial cleaning solvents may be flammable and toxic, and can cause severe skin irritation. When using commercial cleaning solvents, always comply with the solvent manufacturer's recommended safety precautions.

3. Install the new seal on the door opening frame and seal flange bracket, so the bulb-portion of the seal will be facing the door when it is closed. See Fig. 8. The ends of the seal should be located at the bottom of the door. See Fig. 9.
4. Just prior to complete seating of the door seal, cut off (square) any excess length of the seal so that the two ends will form a hairline seam (butt joint).
5. Test the door for ease of opening and closing, and adjust the latch mechanism or door hinge if necessary.



1. Inner Door Panel
2. Hinge
3. Door Check Strap
4. Air Vent Assembly
5. Inside-Release Lever Handle
6. Door Latch Assembly
7. Outside-Release Keyed Lock Cylinder

Fig. 9, Conventional Sleeper Box Access Door (As Viewed From Inside)

BAGGAGE DOORS AND SLEEPER BOX ACCESS DOORS

SLEEPER BOX ACCESS DOOR ADJUSTMENT

Whenever the sleeper box access door is difficult to open or close, or the door seal is wearing prematurely, or whenever there are wind or water leaks at the door opening frame (when the door seal is correctly installed and is in good condition) check and adjust the access door.

1. With the access door closed and latched, check the vertical space between the access door and the closest point on the door opening frame, at the top center and bottom center of the door.

   If the space is not the same, adjust the height of the door in the door opening frame, as follows:

   .1 Open the door to the 90-degree position.

   .2 Loosen all of the hinge-attachment bolts (Fig. 10), but do not loosen them any further than what is needed to allow movement of the access door.

   .3 Move the door straight up or down until the spaces at the top and bottom are equal. Hold the door in position, and tighten the hinge-attachment bolts.

2. Partially close the access door to approximately 1 inch (50 mm) of the latched position, and visually check to see if the latch jaws will be centered around the outer sleeve of the striker pin (See Fig. 11) when the door is closed.

   If not, adjust the striker pin, as follows:

   .1 Open the access door. Using a No. 50 Torx® recess driver, loosen the striker pin. Refer to Fig. 12.

   .2 If the latch jaws are not closing around the outer sleeve, but are hitting the head of the striker pin, or the inner sleeve or coned washer, remove the striker pin, then add or remove shims (as needed) between the coned washer and the door opening frame. See Fig. 11. Reinstall the striker pin.

   NOTE: Add only enough shims to allow proper engagement of the latch jaws around the striker pin's outer sleeve; too many shims will cause interference between the striker pin and the backing plate of the latch assembly.

   .3 Move the striker pin up or down as needed, to align it with the latch jaws.

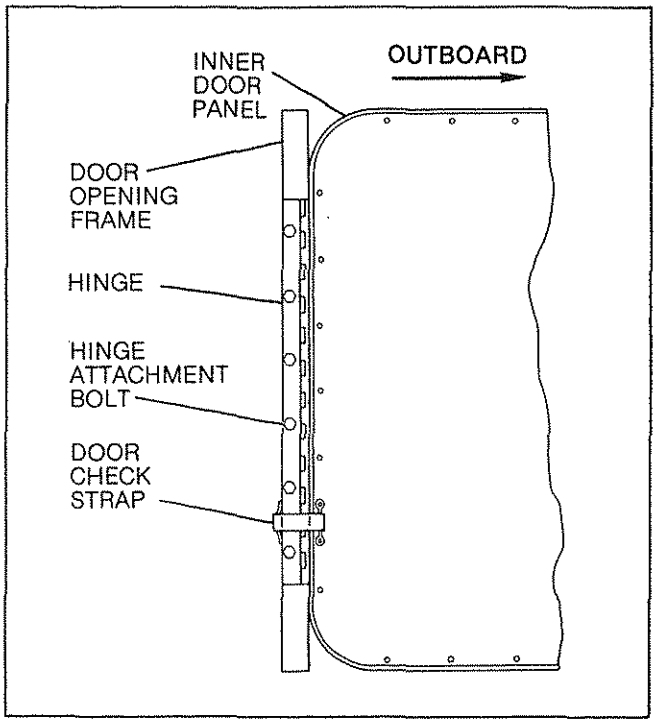


Fig. 10

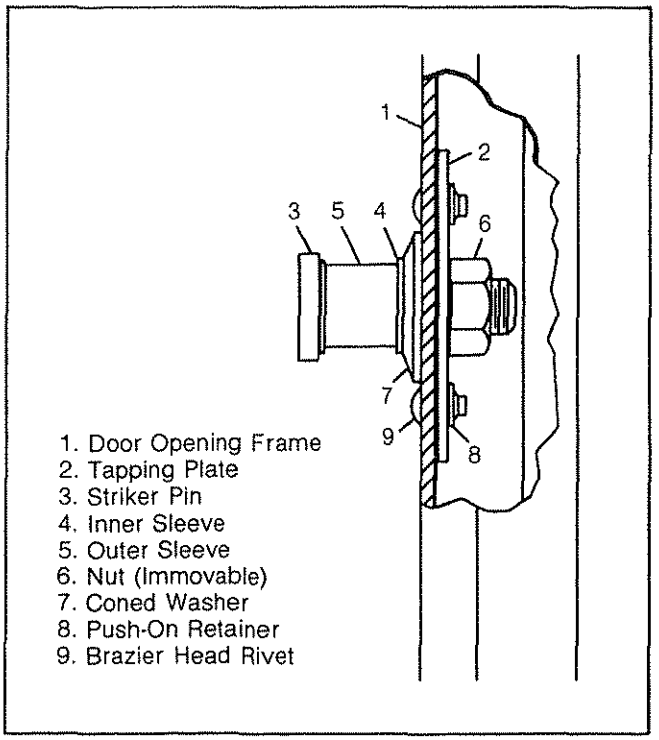


Fig. 11, Striker Pin Assembly

BAGGAGE DOORS AND SLEEPER BOX ACCESS DOORS

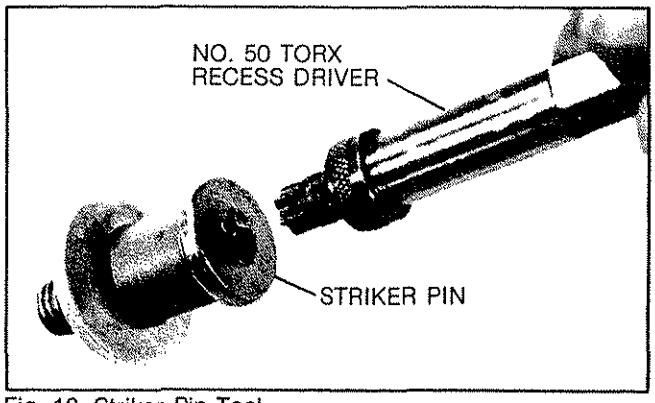


Fig. 12, Striker Pin Tool

.4 Using the Torx® driver, tighten the striker pin enough to prevent its movement.

.5 Close the door, and check the adjustment. Readjust if necessary.

3. Close and latch the access door. Check for flushness between the outer surface of the access door and the door opening frame's integral drip molding, at the hinged edge of the access door (the hinge will not be flush).

   If the door surface is not flush with the molding, adjust the hinged edge inward or outward, as follows:

   .1 Open the door to the 90-degree position.

   .2 Loosen, but do not remove, all but the uppermost and lowermost hinge-attachment bolts. See Fig. 10.

   .3 Adjust the in and out position of the top of the door by loosening the upper bolt, moving the top of the door as needed, then tightening the upper bolt enough to resist movement.

   .4 Adjust the bottom of the door by loosening the lower bolt, moving the bottom of the door as needed, then tightening the lower bolt enough to resist movement.

   Close and latch the access door. Check for flushness between the outer surface of the access door and the door opening frame's integral drip molding, at the latched edge of the access door.

   If the door surface is not flush with the molding, adjust it inward or outward at the latch, as follows:

   .1 Open the access door. Using a No. 50 Torx® recess driver, loosen the striker pin. Refer to Fig. 12.

   .2 Without moving the striker pin vertically, move the striker pin in or out of the opening, as needed.

   .3 Using the Torx® driver, tighten the striker pin enough to prevent its movement, then close the door, and check its adjustment. Readjust if necessary.

5. Make a final check of all of the above adjustments, including checking to be sure the door opens and closes properly. Readjust if needed.

6. Open the door, and tighten all of the hinge-attachment bolts 32 lbf·in (362 N·cm). See Fig. 10.

   Using the No. 50 Torx® recess driver, tighten the striker pin 50 lbf·ft (68 N·m). See Fig. 12.

RIVETING

GENERAL INFORMATION

The overlapping skin panels on the Freightliner cab are fastened together with aluminum alloy rivets. The rivets share the load of the stressed skin panels.

A rivet is a fastening device and as such, it must have two ends (or heads) to hold the material together. One of these heads is preformed by the manufacturer, and is referred to as the "manufactured head." The other end of the rivet is formed after the rivet has been driven through the material that is to be fastened together. This head is referred to as the "bucked head" and is formed (or shaped) when driven against a bucking bar. See Fig. 1.

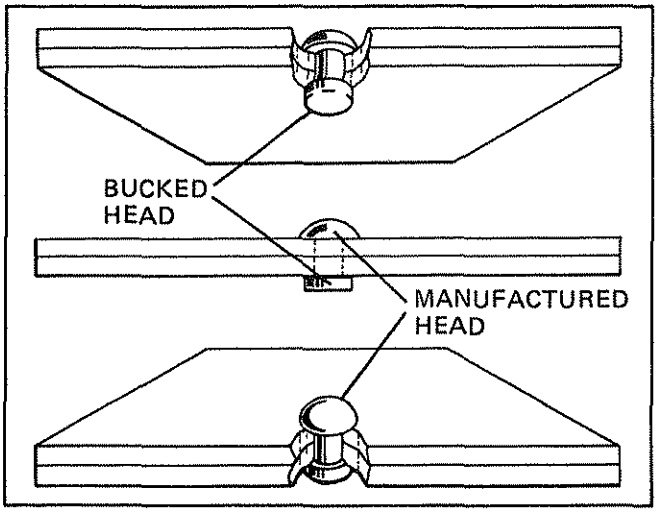


Fig. 1

A rivet set connects to an air-driven rivet gun, and when the proper size rivet set is positioned on the rivet, the rivet gun delivers hammer-like blows which upsets the rivet shank and forms the bucked head when it is backed up against a bucking bar. See Fig. 2.

The following information provides general guidelines for the proper methods and procedures for riveting the skin panels of the Freightliner cab. Included are types of rivets used, proper rivet sets, rivet gun operation, bucking bars, removal of rivets, and a troubleshooting section on improperly installed rivets.

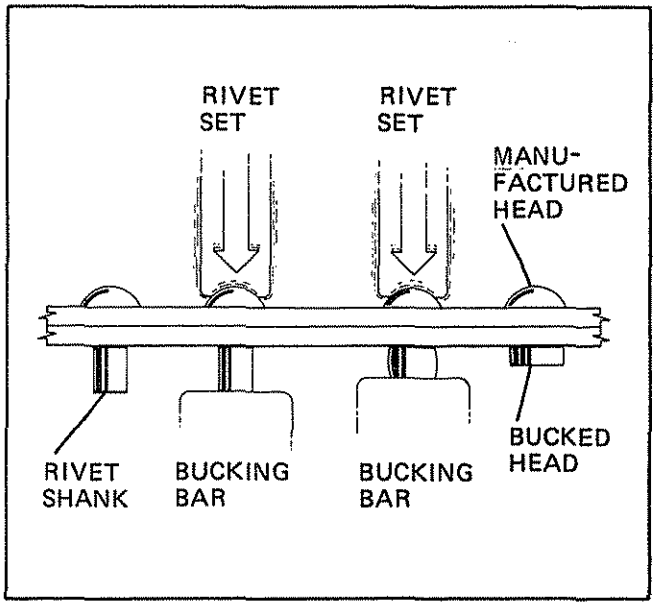


Fig. 2, Riveting Operation

TYPES OF RIVETS

Freightliner uses two types of aluminum alloy rivets. One type is the brazier head rivet. See Fig. 3. The rivet set used to drive the brazier head rivet is cupped to fit the round head of the rivet.

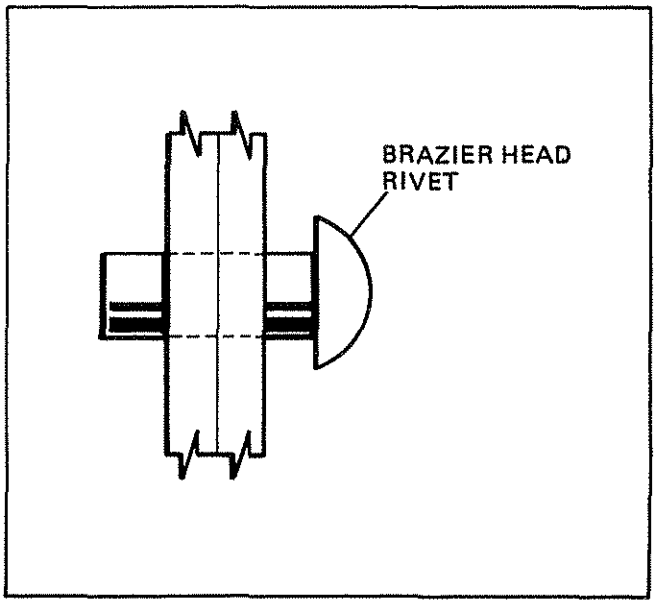


Fig. 3, Brazier Head Rivet

RIVETING

The other type of rivet used is the flush type, or 78 degree countersunk rivet. See Fig. 4. Its name is derived from the angle between the shoulders of the rivet. This rivet requires the use of a "mushroom" flush type rivet set.

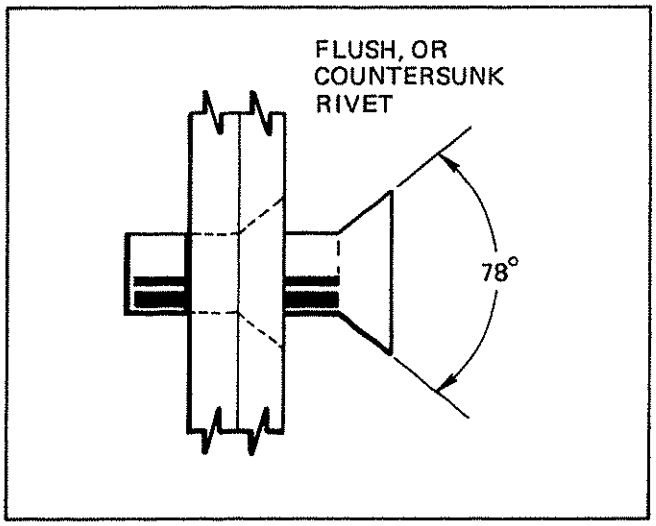


Fig. 4, Flush Type, or 78-degree Countersunk Rivet

RIVET SETS

The rivet set is the link that transmits the power of the blow from the rivet gun to the rivet head. The following describes a few of the common types of rivet sets.

1. Two types of rivet sets are the straight rivet set (Fig. 5), and the offset rivet set (Fig. 6). The offset rivet set is used when the operation cannot be properly performed with a straight rivet set because of the location of the rivet.

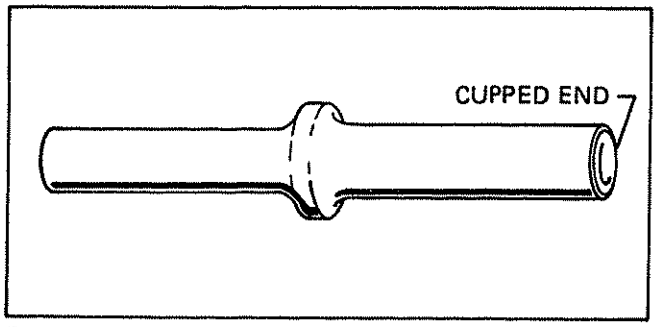


Fig. 5, Straight Rivet Set, Cupped End

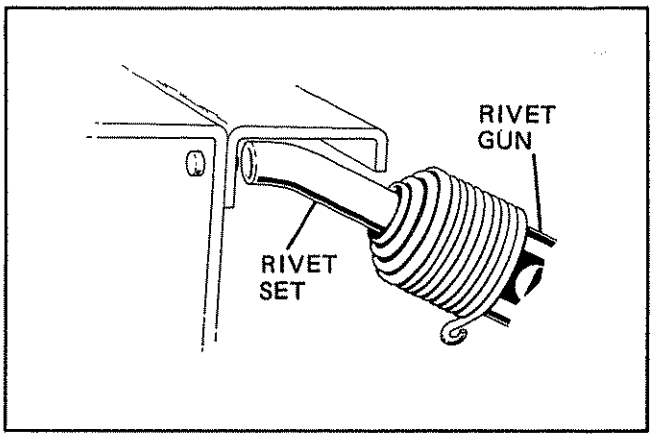


Fig. 6, Offset Rivet Set, Cupped End

2. A straight or offset rivet set with a cupped end (Fig. 5) is used on the brazier head rivets.

3. A straight or offset rivet set with a flat end is used on the flush, or 78 degree countersunk rivet. This flat ended rivet set is referred to as the "mushroom" type (see Fig. 7), and must be positioned flush against the work in order to drive the rivet correctly.

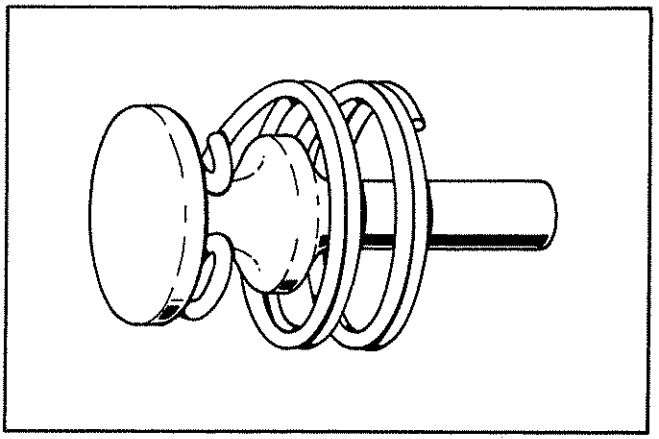


Fig. 7, Mushroom Type Rivet Set End

NOTE: The rivet set end must fit the manufactured head of the rivet at all times. See Fig. 8. If the size of the rivet and the rivet set are not identical to each other, damage to the rivet or the material being fastened can result. The rivet set has the size of the rivet that it is to be used for stamped on the rivet set, as shown in Fig. 9.

RIVETING

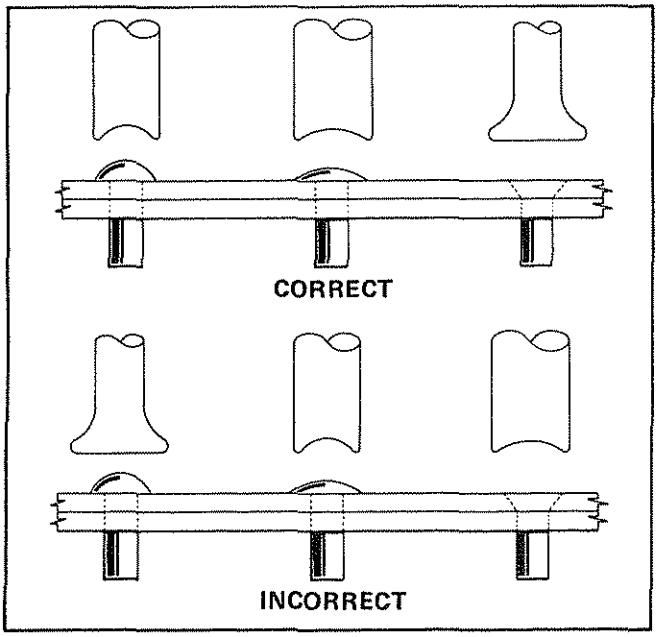


Fig. 8, Rivet Set and Rivet Head Sizing

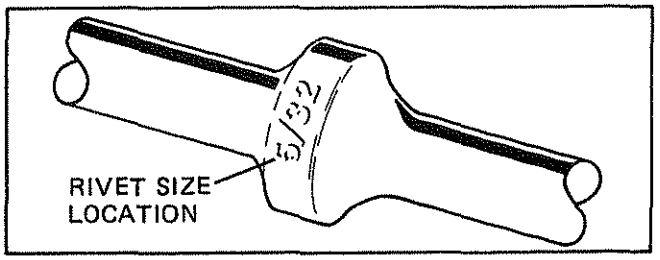


Fig. 9, Rivet Size Identification

RIVET GUN (Refer to Fig. 10)

The air-driven rivet gun provides the force needed for riveting. Rivet guns are made in varying sizes. Each rivet gun size has a definite range of rivet sizes that it can drive. The gun sizes are identified as follows: 2X, 3X, 4X, 5X, 9X, and so on. The larger the number, the larger the size rivet it will handle. In general, rivets 3/16-inch (4.8 mm) diameter or less can be driven with any one of the following gun sizes: 2X, 3X, or 4X.

The air connector attaches the air line to the rivet gun. The air regulator adjusts the volume of air pressure to the desired hitting power of the rivet gun.

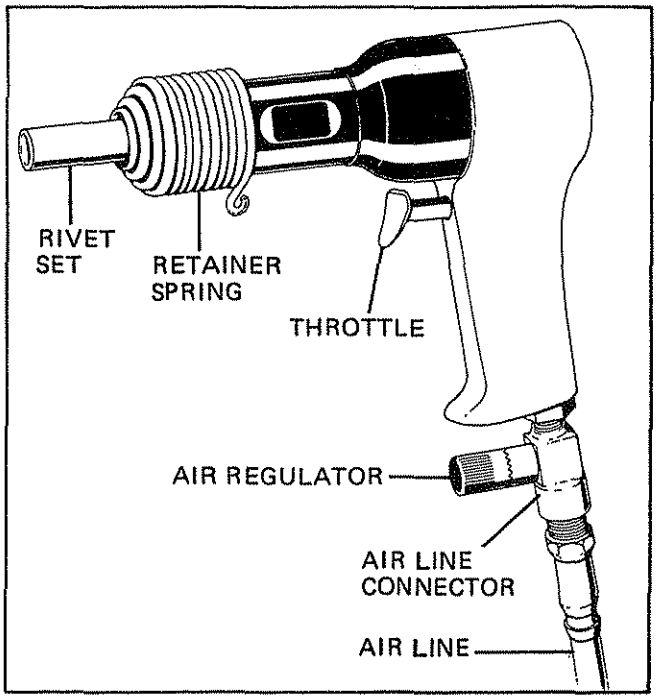


Fig. 10, Typical Rivet Gun (Rivet Set Installed)

The retainer spring on the rivet gun is a safety feature that prevents the rivet set from flying out of the gun during operation.

BUCKING BARS

Bucking bars are made of steel, and vary in size and shape. See Fig. 11. Various shapes are required for "hard to get" rivets.

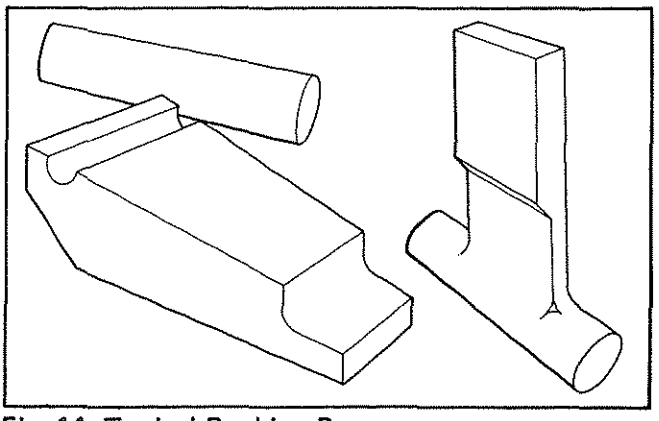


Fig. 11, Typical Bucking Bars

RIVETING

The proper weight of a bucking bar depends on the size, strength, and position of the rivet being used. Bucking bars vary in weight from approximately 1 to 15 lbs. (0.45 to 6.75 kg).

The polished surface (or end) of the bucking bar is called the "face." See Fig. 12. The "face" of the bucking bar is positioned against the rivet shank and parallel to the panels being fastened when the rivet is being "shot." This forms the bucked head of the rivet.

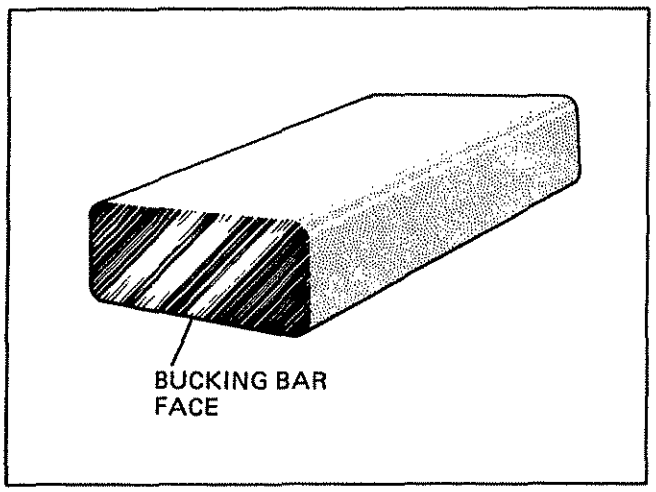


Fig. 12, Bucking Bar

SERVICE OPERATIONS

NOTE: If the rivet holes need to be drilled, refer to Table 1, located under "SPECIFICATIONS," for the proper drill size to use for each rivet size.

GUIDELINES FOR PROPER RIVETING

CAUTION: All rivets must be driven and bucked properly. Failure to do so can result in damage to the cab skin panels or rivet(s). Failure of one rivet in a row of rivets will place additional clamping loads on the remaining rivets, reducing rivet strength and causing possible rivet failure.

1. Remove the retainer spring from the rivet gun by turning the spring in a counterclockwise direction. See Fig. 13.

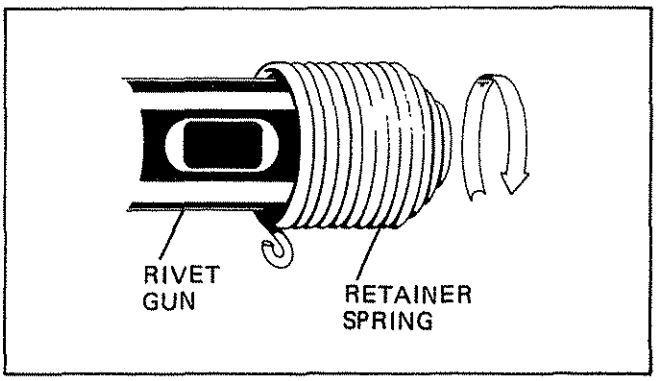


Fig. 13, Retainer Spring Removal

2. Place the desired size and type rivet set in the rivet gun. See Fig. 14.

CAUTION: The size of the rivet set must be the same size as the rivet. See Fig. 8. An incorrect size will damage either the rivet or the skin panels. Too large a rivet set will flatten the rivet head and mar the skin panels.

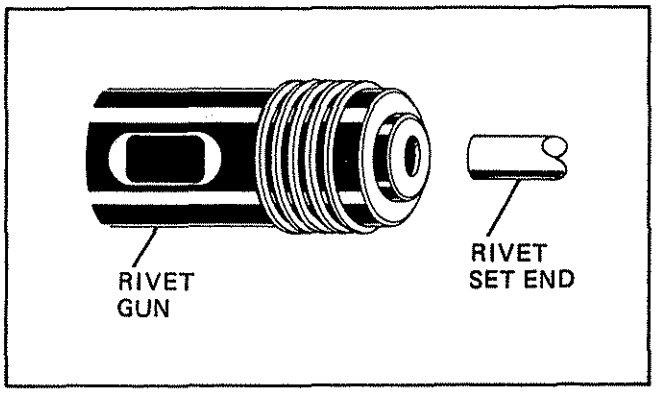


Fig. 14, Rivet Set Installation into Rivet Gun

3. Install the retainer spring over the rivet set and on the rivet gun. Secure the rivet set by turning the retainer spring in a clockwise direction. See Fig. 15.

4. Connect the air line to the rivet gun. Adjust the air regulator to obtain the desired hitting power. Turn the regulator clockwise (see Fig. 16) to reduce the hitting power of the rivet gun. Turn the air regulator counterclockwise to increase the hitting power of the rivet gun.

RIVETING

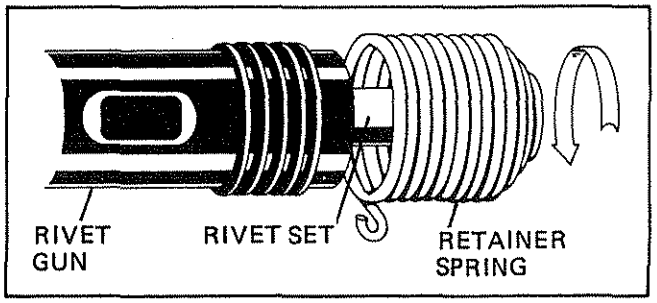


Fig. 15, Retainer Spring Installation

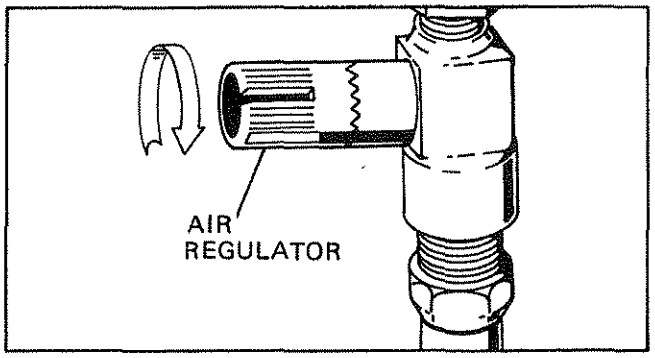


Fig. 16

5. Check the hitting power by pressing the rivet set against a block of wood and opening the throttle of the gun. Adjust to the desired hitting power.

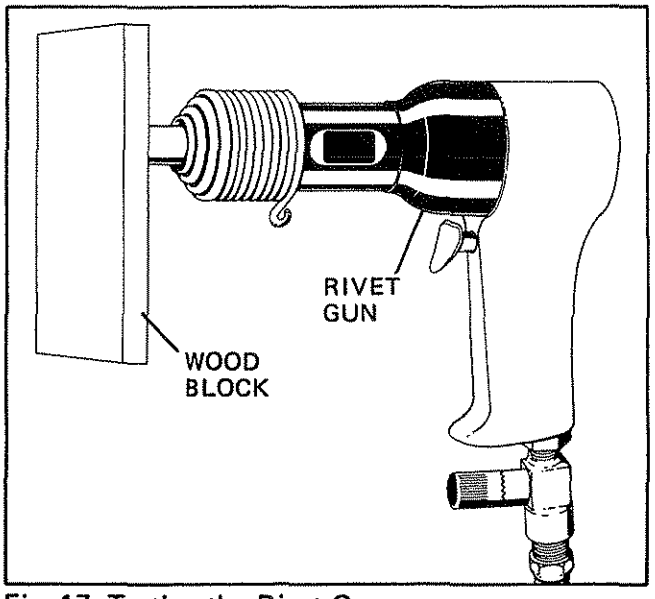


Fig. 17, Testing the Rivet Gun

6. Place the rivet in the rivet holes of the panels to be fastened. As a general rule, the projection of the rivet shank, before driving, should be approximately 1-1/2 times the diameter of the rivet shank. See Fig. 18.

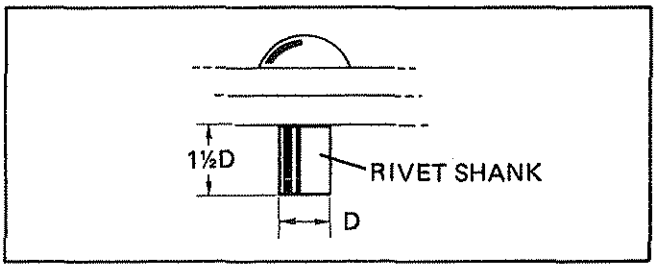


Fig. 18, Correct Rivet Shank Length

7. Align the rivet set and rivet gun, rivet, and bucking bar as shown in Fig. 2. Be sure to keep the line of pressure in a straight line with the manufactured rivet head. Be sure that the "face" of the bucking bar is kept parallel to the skin panels when the rivet is being "shot," as this will form the bucked head of the rivet properly.

CAUTION: If the "face" of the bucking bar is not parallel to the skin panels, damage to the skin panels and an improperly formed bucked head can result. See Fig. 19.

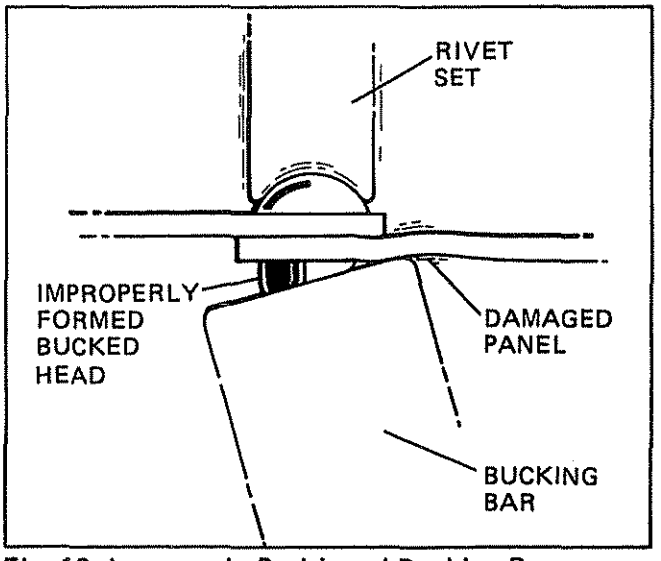


Fig. 19, Improperly Positioned Bucking Bar

RIVETING

8. Drive the rivet through by opening the throttle of the rivet gun.

IMPORTANT: The manufactured heads of the rivets must be driven carefully to avoid dimpling of the skin panels and "eye-browing" of the heads. These conditions will reduce the overall appearance of the vehicle, as they are highly visible after painting.

9. Inspect the rivet. The bucked head of the rivet should be 1-1/2 "D" wide, and 1/2 "D" thick, with "D" being the original diameter of the rivet shank. See Fig. 20. If there are any imperfections, refer to "TROUBLESHOOTING RIVET IMPERFECTIONS," in this subject, for possible causes and corrections.

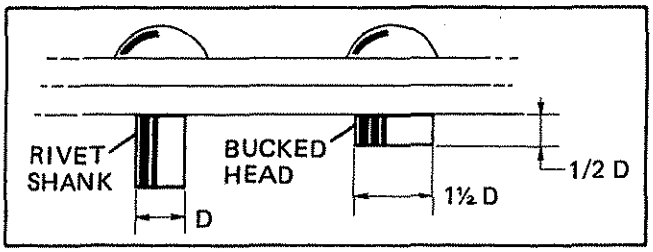


Fig. 20, Correct Bucked Head Size

REMOVING RIVETS

If a drill is not available, a chisel can be used to cut off the manufactured head of the rivet. See Fig. 21. Extreme care must be taken not to damage the surrounding material.

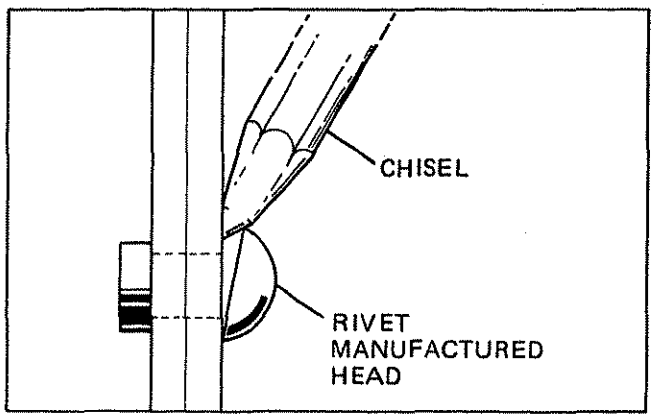


Fig. 21

1. Using a drill bit that has the same diameter as the rivet shank to be removed (see Fig. 22), drill into the exact center of the manufactured head (see Fig. 23) to the depth shown in Fig. 24.

NOTE: A smaller size drill bit can be used.

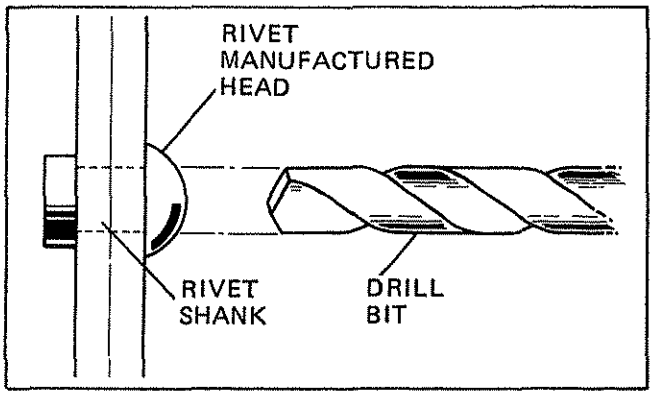


Fig. 22

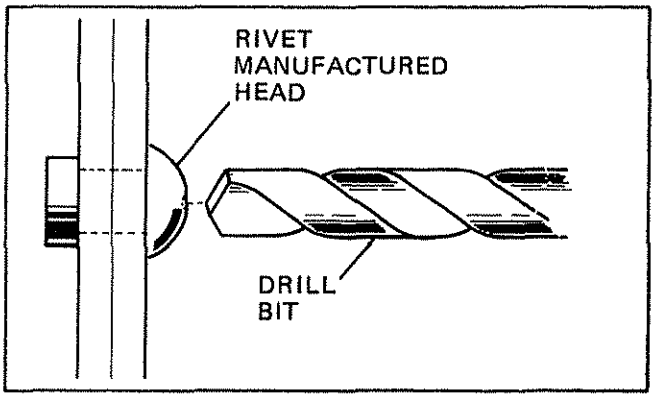


Fig. 23

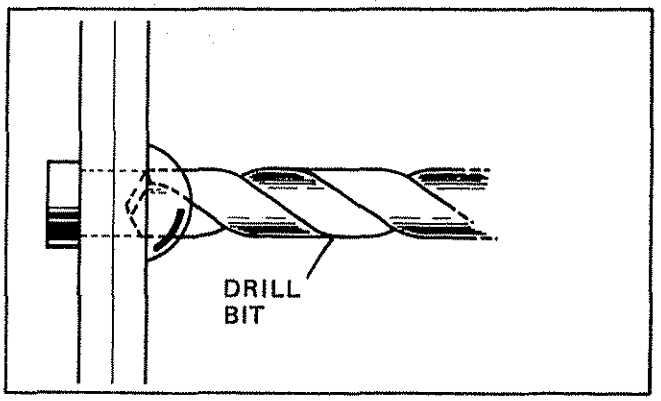


Fig. 24

RIVETING

2. Using a drill punch, pry off the rivet head. See Fig. 25.

3. Drive out the shank with the drill punch. See Fig. 26.

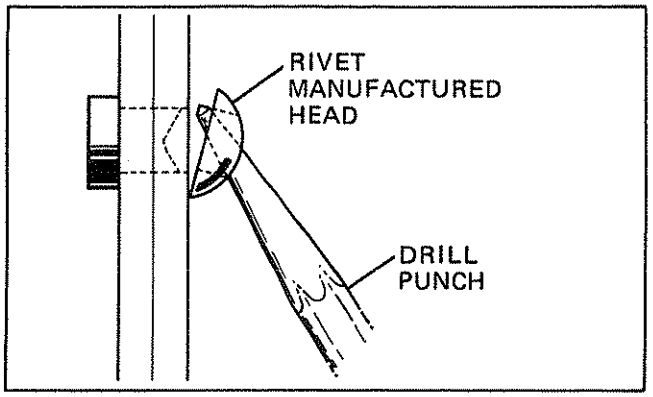


Fig. 25

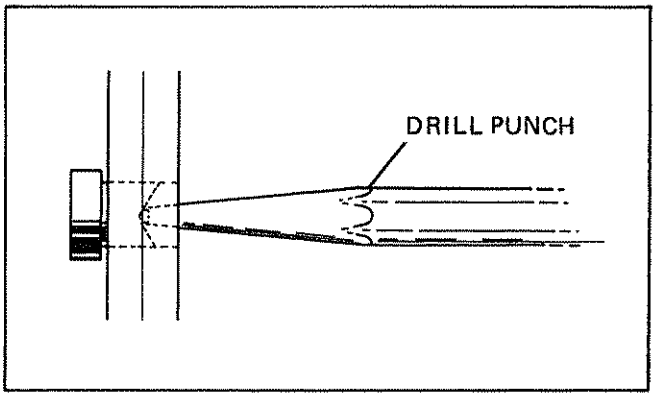
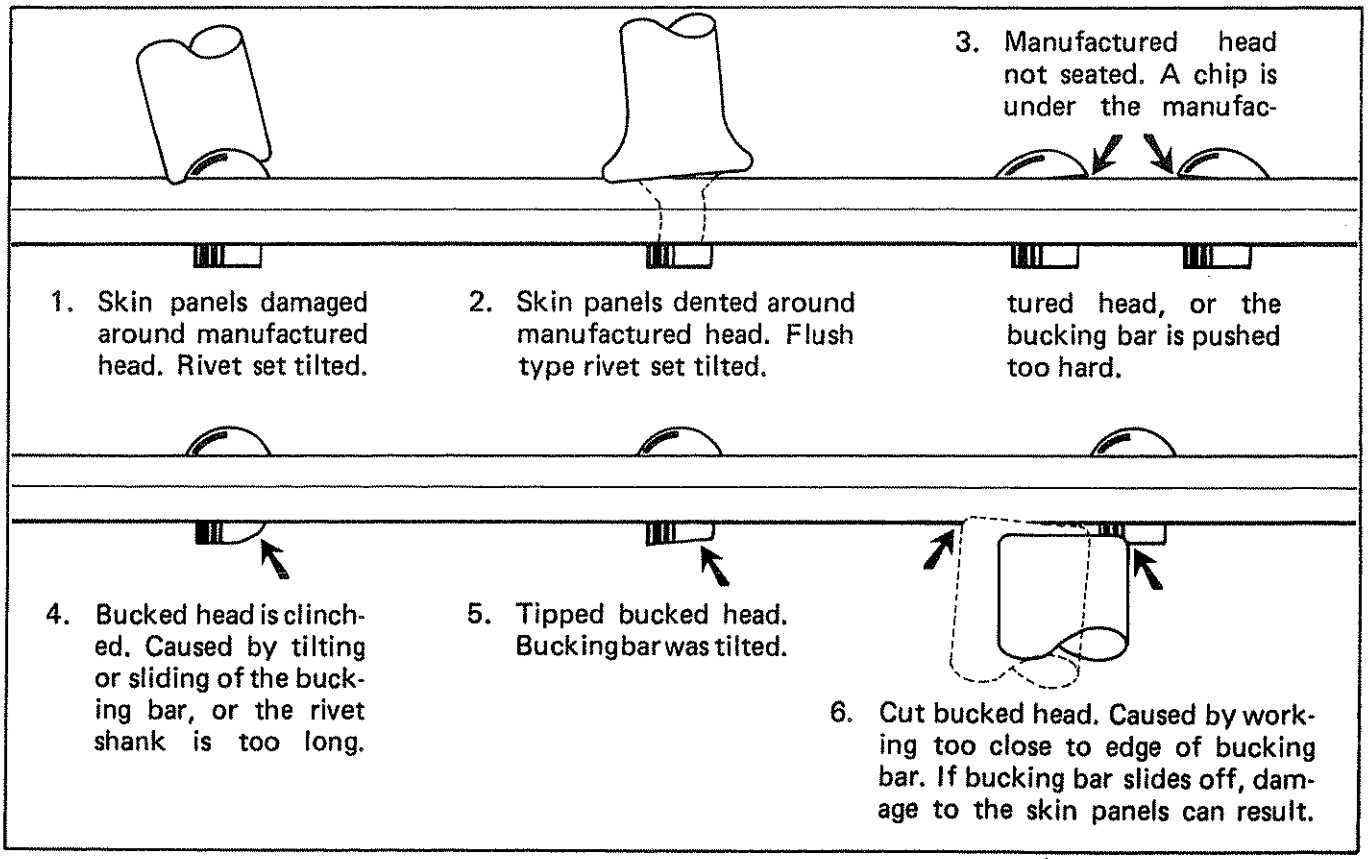


Fig. 26

TROUBLESHOOTING

TROUBLESHOOTING RIVET IMPERFECTIONS

The following troubleshooting information should be used as an aid in correcting rivet imperfections that can result from improper riveting operations.



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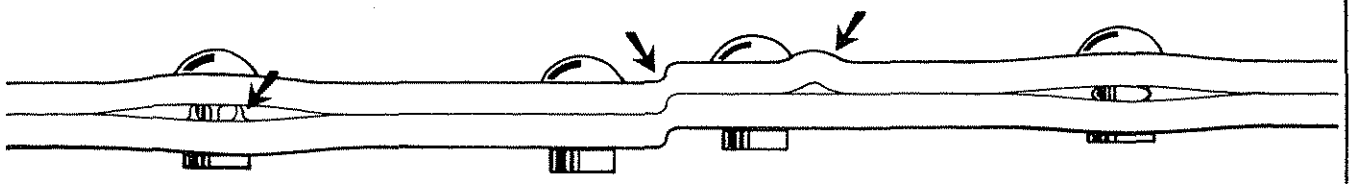
RIVETING

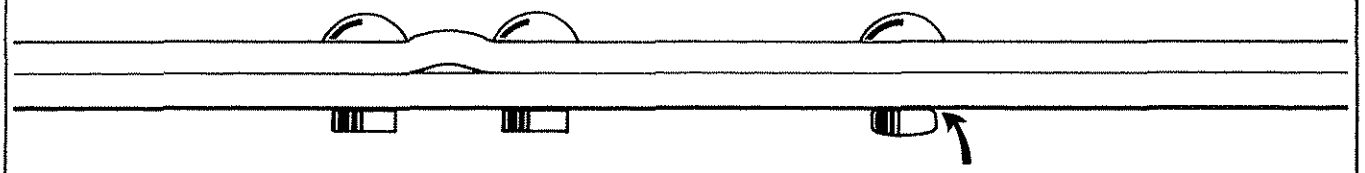
TROUBLESHOOTING (Continued)



7. Gaps between skin panels. Drill chips caught between panels. Remove all foreign material before riveting.

8. Skin panels are pulled in, or to one side of the manufactured head, or wrinkled between rivets. Panels were loose or the rivet holes were misaligned during riveting.

9. Swelling of rivets between skin panels. Panels were not held tightly together.



10. Panel skin buckles or holes not aligned. Panel skin is not held together tightly.

11. Bucked head is bell shaped and does not fill the hole. Bucking bar is too light.

SPECIFICATIONS

RIVET SHANK DIAMETER	DRILL SIZE	DRILL SIZE DECIMAL EQUIVALENT
1/8-inch	No. 30	.128 inch
5/32-inch	No. 21	.159 inch
3/16-inch	No. 11	.191 inch
1/4-inch	F	.259 inch

Table 1, Drill Size for Rivet Holes

TUNNEL LINER AND NOISE BAFFLE, C.O.E. AND POWERLINER

GENERAL DESCRIPTION

To absorb noise emitted from the engine, and to comply with Federal Law, Part 205, Transportation Equipment Noise Emission Controls, one inch (25 mm) thick acoustical foam with aluminized mylar facing lines the contour of the cab tunnel of all Freightliner C.O.E.'s and Powerliners manufactured after January 1, 1978. The acoustical foam is also attached to the cab deck skirts on some cab-engine combinations.

Two tunnel liner panels, taped together, line the cab tunnel, (Fig. 1) and, if so equipped, one noise baffle panel is attached to each of two cab deck skirts (Fig. 2). The noise baffle panels are attached by speed clips installed over weld pins that are pushed through the backs of the noise baffle panels and are attached to the cab deck skirts. The tunnel liner panels are attached in the center of the tunnel by speed clips and weld pins, and to the fore and aft edges of the tunnel by retainer strips held in place by blind rivets.

SERVICE OPERATIONS

If the tunnel liner and/or noise baffle panels are damaged, use the following procedures for repair.

Fig. 1, Tunnel Liner

If the tunnel liner and/or noise baffle panels are damaged beyond repair, replace the panel(s), following the instructions given under "TUNNEL LINER PANEL REPLACEMENT" and/or "NOISE BAFFLE PANEL REPLACEMENT" in this subject.

TUNNEL LINER AND/OR NOISE BAFFLE REPAIR

1. Tilt the cab to the full-open position, using the procedure given in the 18 Group of this manual.

2. Replace any missing speed clips with new ones. Check the weld pins for damage.

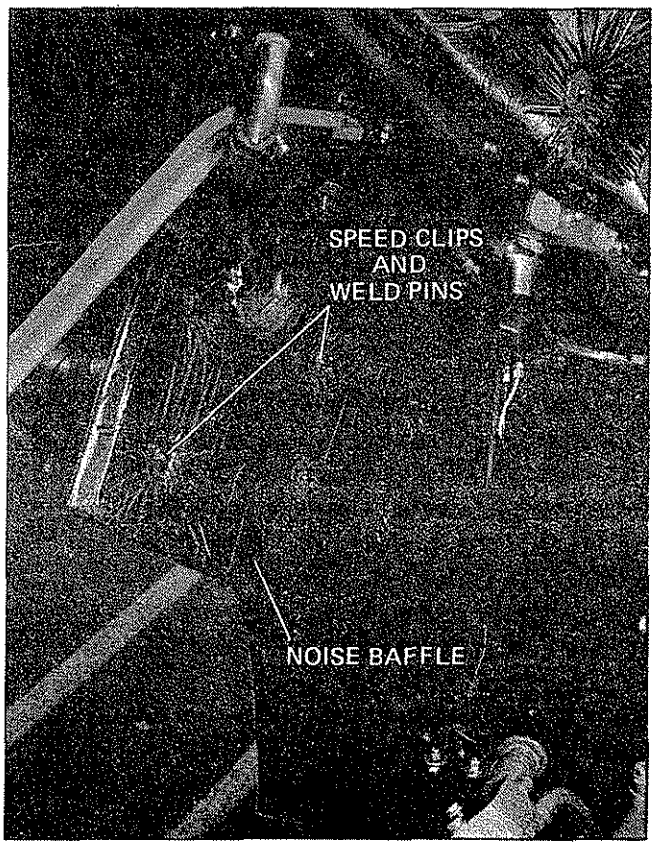


Fig. 2, Noise Baffle

TUNNEL LINER AND NOISE BAFFLE, C.O.E. AND POWERLINER

3. If any of the weld pins are damaged, proceed as follows:

   1. Carefully pull the tunnel liner or noise baffle panel off of the damaged pin, then clip the pin off flush with the cab tunnel or cab deck skirt.

   NOTE: To gain access to a damaged weld pin, it may be necessary to remove the nearby speed clips and retaining strip(s) so the tunnel liner or noise baffle panel can be moved out of the way. Use a small-tipped screwdriver to carefully pry outward on each of the center tabs of the speed clips. (Fig. 3) Do not discard the speed clips.

   .2 Using a No. 8 drill bit, drill a .199" hole through the acoustical foam panel and the tunnel (or deck skirt), in the location of the removed weld pin.

   .3 Insert a 3/16" blind rivet in the hole.

   In deck skirts, insert the rivet from inside the tunnel; then, from the outside, place a 1 1/4" diameter washer, having a 1/4" bolt hole, over the end of each rivet. (Fig. 4)

   Set the rivet just enough to secure it in the tunnel (or deck skirt), but not enough to break off the rivet mandrel. (Fig. 5)

   .4 Secure the tunnel liner or noise baffle panel by pushing a speed clip over the end of the weld pin or rivet mandrel. Then, clip the pin off flush with the speed clip.

   NOTE: Used speed clips should be laid on a flat surface, and the center tabs should be lightly tapped with a hammer so the clips will fit tightly over the weld pins. (Fig. 6)

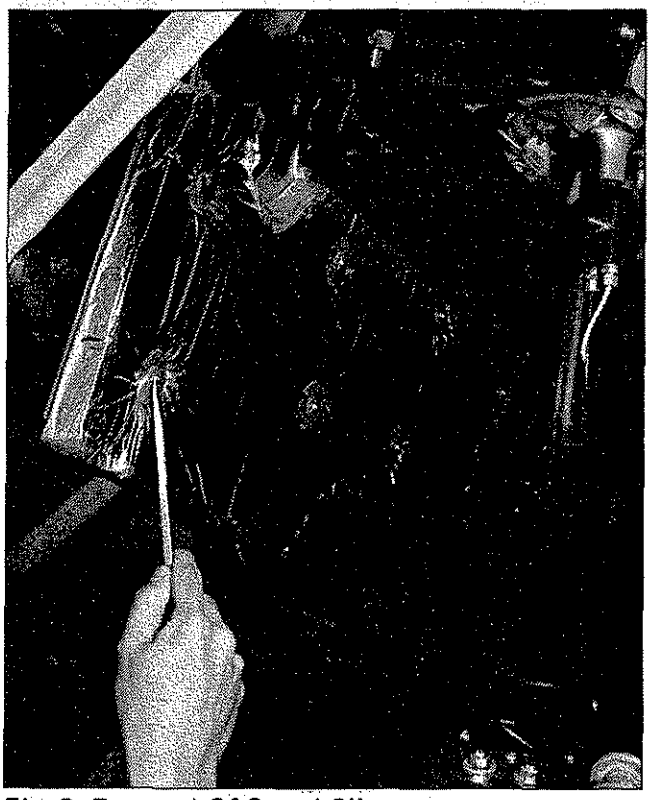


Fig. 3, Removal Of Speed Clips

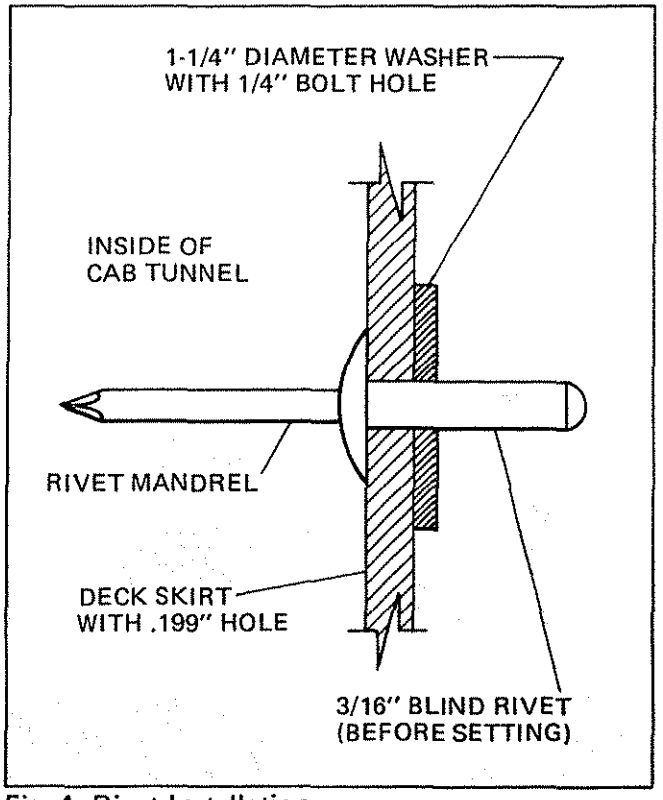


Fig. 4, Rivet Installation

TUNNEL LINER AND NOISE BAFFLE, C.O.E. AND POWERLINER

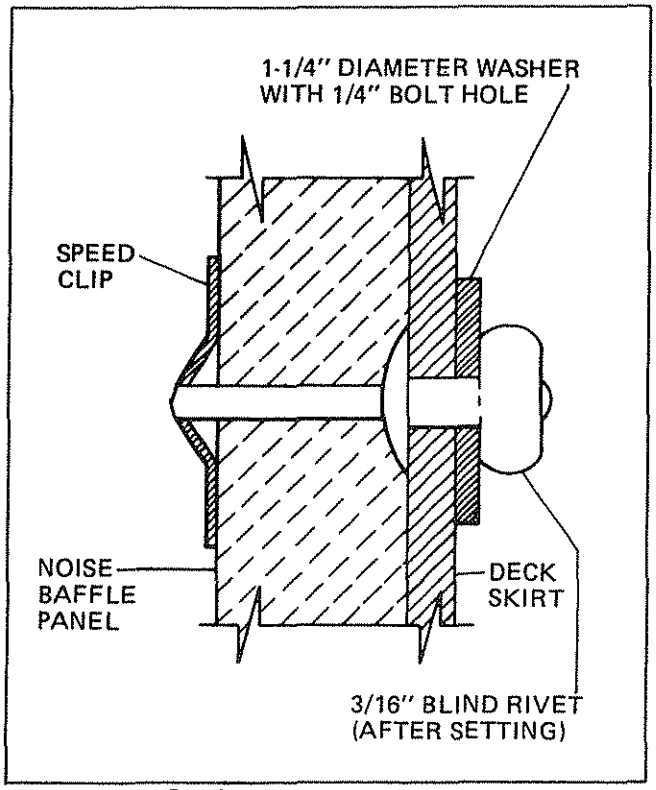


Fig. 5, Rivet Setting

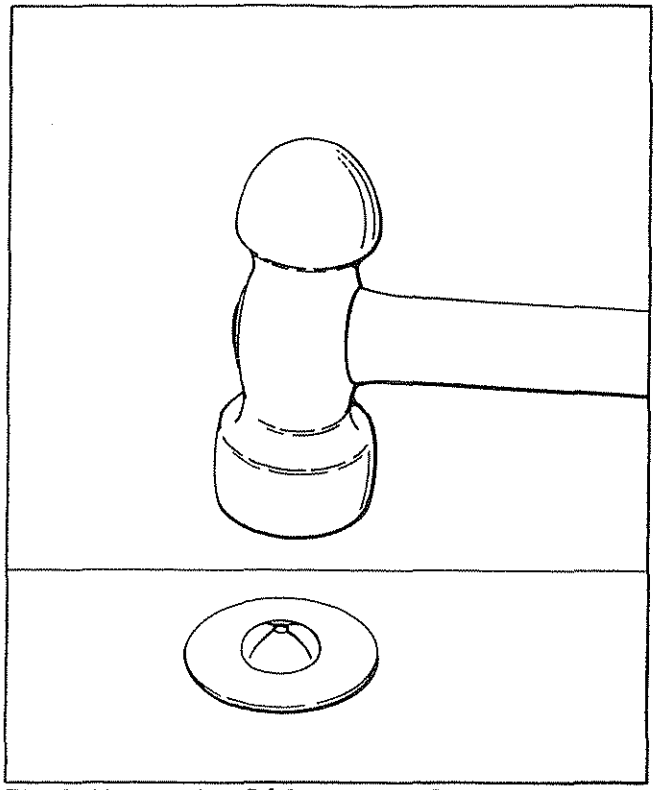


Fig. 6, Hammering Of Speed Clip Center Tabs

.5 If the retaining strip(s) were removed, place them in their original position, then secure them with blind rivets.

4. Small tears in the mylar facing of the tunnel liner or noise baffle panels may be repaired by covering the torn area with 2" (55 mm) wide aluminized polyester sealant tape, or duct tape. The surface of the mylar should be thoroughly cleaned to assure satisfactory tape adhesion.

NOTE: Check the acoustical foam of the tunnel liner or noise baffle panel wherever tears in the mylar, or separation of the taped edges has occurred. If the acoustical foam has become oil or water-soaked, the entire panel must be replaced.

5. Tilt the cab back to the operating position, then lock the cab latch handles, using the procedure given in the 18 Group of this manual.

TUNNEL LINER PANEL REPLACEMENT

1. Tilt the cab to the full-open position, using the procedure given in the 18 Group of this manual.

2. Remove the speed clips from the weld pins that hold the tunnel liner panel(s) in place. Use a small-tipped screwdriver to carefully pry outward on each of the center tabs of the speed clips. (Fig. 3) Do not discard the speed clips.

3. Drill out the blind rivets that attach the front and rear retainer strips. Remove the retainer strips (if both panels are being replaced); then, remove the tunnel liner panels from the tunnel.

NOTE: If only one tunnel liner panel is being replaced, pull the retainer strips out of the way; then, carefully remove the aluminized polyester sealant tape to separate the two tunnel liner panels.

TUNNEL LINER AND NOISE BAFFLE, C.O.E. AND POWERLINER

4. After removing the tunnel liner panel(s), clip any broken weld pins flush with the tunnel surface.

5. Using a No. 8 drill bit, drill a .199" hole in the tunnel surface at each location where a weld pin was removed. Insert a 3/16" blind rivet in the drilled hole. Set the rivet just enough to secure it in the tunnel, but not enough to break off the rivet mandrel.

6. Steam clean the tunnel surface, then air dry.

7. Install the tunnel liner to the contour of the tunnel by pushing the liner panel(s) over the weld pins and rivet mandrels. Secure the liner panel(s) by pushing a speed clip over the end of each weld pin and rivet mandrel. Then, clip the pin off flush with the speed clip.

NOTE: Used speed clips should be laid on a flat surface, and the center tabs should be lightly tapped with a hammer so the clips will fit tightly over the weld pins. (Fig. 6)

8. Center a strip of 2" (55 mm) wide aluminized polyester sealant tape, or duct tape, over the seam between the two tunnel liner panels. The mylar surfaces should be thoroughly cleaned to assure satisfactory tape adhesion.

9. Place the retainer strips in their original position, then secure them with blind rivets.

10. Tilt the cab to the operating position, then lock the cab latch handles, using the procedure given in the 18 Group of this manual.

NOISE BAFFLE PANEL REPLACEMENT

1. Tilt the cab to the full-open position, using the procedure given in the 18 Group of this manual.

2. Remove the speed clips from the weld pins that hold the noise baffle panel in place. Use a small-tipped screwdriver to carefully pry outward on the center tabs of the speed clips. (Fig. 3) Do not discard the speed clips. Remove the noise baffle panel from the deck skirt.

NOTE: If the noise baffle panel is attached by rivets and washers (from a previous field repair), drill the rivets out from the backside of the deck skirt, then remove the panel.

3. After removing the noise baffle panel, clip any broken weld pins flush with the deck skirt.

4. Using a No. 8 drill bit, drill a .199" hole in the deck skirt at each location where a weld pin was removed. Insert a 3/16" blind rivet in each hole, from inside the tunnel. From the outside, place a 1-1/4" diameter washer, having a 1/4" bolt hole, over the end of each rivet. (Fig. 4) Set the rivet(s) just enough to secure it in the deck skirt, but not enough to break off the rivet mandrel. (Fig. 5)

5. Steam clean the deck skirt surface, then air dry.

6. Install the noise baffle panel on the deck skirt by pushing the noise baffle panel over the weld pins and rivet mandrels. Secure the panel by pushing a speed clip over the end of each weld pin and rivet mandrel. Then, clip the pin off flush with the speed clip.

NOTE: Used speed clips should be laid on a flat surface, and the center tabs should be lightly tapped with a hammer so the clips will fit tightly over the weld pins. (Fig. 6)

7. Tilt the cab to the operating position, then lock the cab latch handles, using the procedure given in the 18 Group of this manual.

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SUBJECT	SUBJECT NUMBER
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Red Dot Auxiliary Heater, Models R-254-1 and R-255-1, COE	32-22050
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Heater Installation, Weather King 30, 35, 40 and 45	32-22101
Freightliner Conventional Cab Heater/Heater-Air Conditioner	32-22102
Air Conditioner, Frigiking TC-660	32-22106
Freightliner Air Conditioner Model 320D	32-22107
Conventional Cab Sleeper Box Heater-Air Conditioner	32-22108
Freightliner Conventional Cab Under Dash (Red Dot) Heater/Heater-Air Conditioner	32-22109
Freightliner Heater-Air Conditioner, Advanced Interior System	32-22110
Seats	
National Cush-N-Aire® Seats, Models 95 and 195	32-22140
Seat, Bostrom "Westcoaster"	32-22141
Seat, Bostrom Levelair	32-22142
Seat, Unison Action	32-22145
Seat, Bostrom Viking T-Bar	32-22146
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Freightliner (Motorola®) Electronic Tachometer	32-22220
Freightliner (Motorola®) Electronic Speedometer System on Vehicles Utilizing a 45-Pulse Slotted Disc	32-22225
Freightliner (Motorola®) Electronic Speedometer System With Transmission-Mounted Magnetic Pick-Up	32-22230
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SUBJECT	SUBJECT NUMBER
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Windshield Wiper, Sprague M531	32-22250
Windshield Washer, Sprague Air-Push® MW-10	32-22255
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Holland Models 3500 and 3600 Series Fifth Wheels	32-22274
Holland Sliding Fifth Wheel Models 2500, 2535, and 2536	32-22276
Fontaine, 900 Series, No-Slack Fifth Wheel	32-22280
Fruehauf Fifth Wheel	32-22285
Simplex, Slack-Free, Fifth Wheel	32-22290
ASF Model 400C Series Fifth Wheel	32-22300
Engine Protection System	
Kysor Engine Warning and Shutdown Systems	32-22400
Fuel Monitoring	
FloScan Fuel-Tach™	32-22500

RED DOT AUXILIARY HEATER, MODELS R-254-1 AND R-255-1, COE

GENERAL DESCRIPTION

The Freightliner COE auxiliary heater is a compact unit designed to supplement an existing heater installation. See Fig. 1. The heater is located behind the driver's or the passenger's seat, or both seats if more than one auxiliary heater is installed. Each unit is equipped with a heater core, a blower motor, a fan, and a heater housing. Some units are equipped with dual blower motors and fans. See Fig. 2.

Each auxiliary heater is controlled by a toggle switch located near the heater-air conditioner control panel. See Fig. 3. Engine coolant flow to the heater core is controlled by a water shut-off valve, located on the floor of the cab behind the seat. See Fig. 4.

Refer to the Freightliner COE Drivers Manual for auxiliary heater operating instructions.

PRINCIPLES OF OPERATION

When the water shut-off valve is opened and the engine is operating, engine coolant flows through the heater core. Heat dissipated by the heater core fins is propelled into the cab by the blowers.

The intensity of heat emitted from the auxiliary heater is determined by the amount of coolant flowing into the heater core. The coolant is regulated by opening and closing the water shut-off valve.

NOTE: The water shut-off valve is connected to the inlet side of the heater core.

The coolant within the heater core is then returned to the engine block, where it absorbs the heat from the engine.

SERVICE OPERATIONS

CONTROL PANEL TOGGLE SWITCH REPLACEMENT

CAUTION: Make sure the ignition switch is off, to prevent damage to the electrical system during service operations.

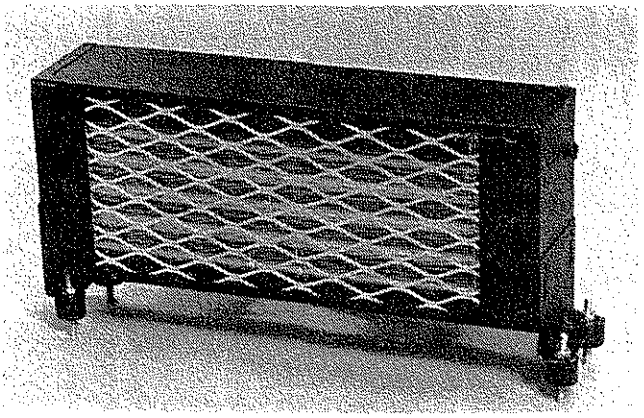


Fig. 1

1. Remove (pull off) the knobs from the heater-air conditioner lever slide controls.
2. Remove the screws attaching the control panel to the dash. Move the control panel away from the dash to a serviceable position.
3. For later assembly reference, mark the wires connected to the toggle switch that is to be replaced; then disconnect the wires.
4. Replace the toggle switch.
5. Connect the wires, as previously marked.
6. Install the control panel and attaching screws in the dash; then install the knobs on the lever slide controls.
7. Test the new toggle switch for operation.

HEATER ASSEMBLY REMOVAL AND INSTALLATION (Refer to Fig. 2)

Removal

1. Turn the ignition switch off.

WARNING: Failure to turn the ignition switch off could cause accidental blower motor operation during the service procedure. This could result in personal injury or electrical shock.

RED DOT AUXILIARY HEATER, MODELS R-254-1 AND R-255-1, COE

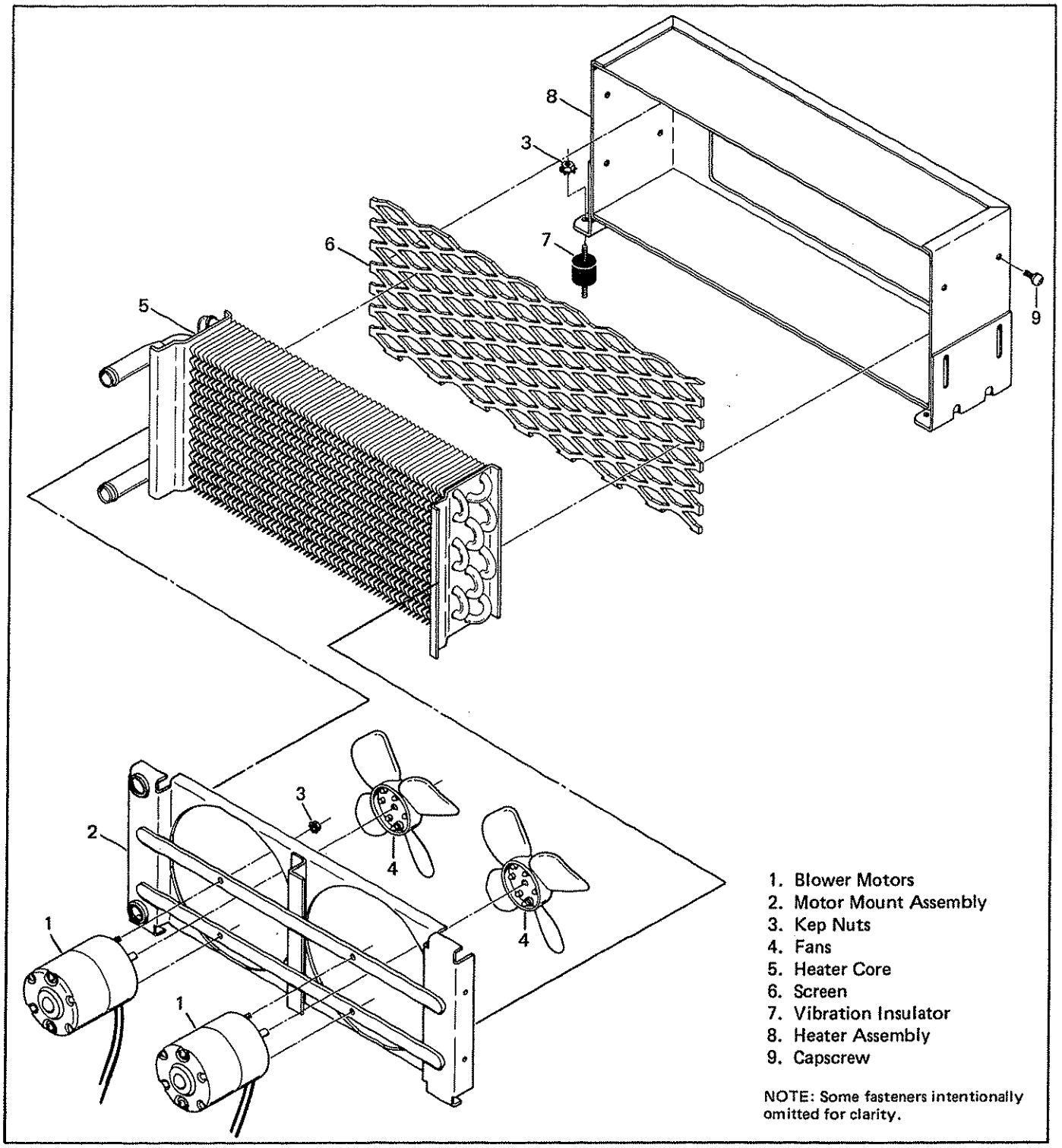


Fig. 2, Auxiliary Heater with Dual Blower Assembly, COE

RED DOT AUXILIARY HEATER, MODELS R-254-1 AND R-255-1, COE

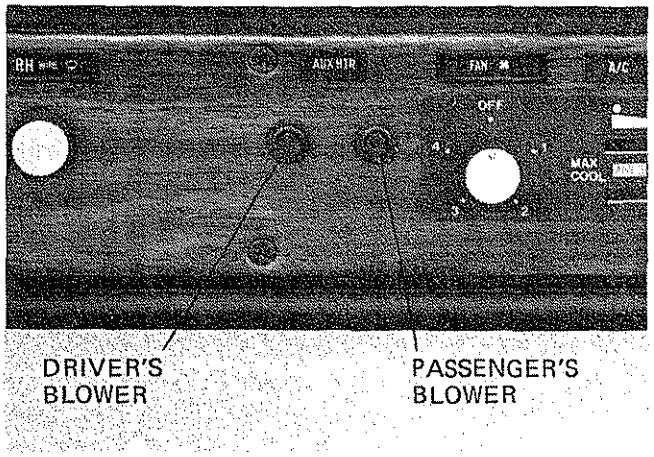


Fig. 3, Auxiliary Heater Toggle Switch

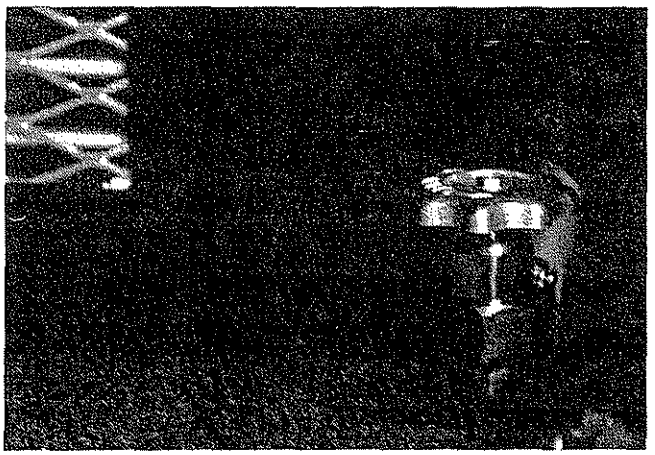


Fig. 4, Water Shut-Off Valve

2. Drain the heater core and the cooling system (into a clean container) at the radiator drain cock. Save the coolant for later use.

WARNING: Do not drain the heater core and hoses while the engine and coolant are hot. To avoid personal injury from scalding, wait until the engine has cooled before draining the system.

3. Using a screwdriver, loosen the hose clamps attaching the heater hoses to the heater core ports. Disconnect the hoses from the heater core ports.

4. For later assembly reference, mark the wires connected to each blower motor; then disconnect the wires.

5. Remove the Kep nuts that attach the heater assembly to the vibration insulators; then remove the heater assembly from the vehicle.

Installation

1. Position the heater assembly in the cab. Install the four Kep nuts that attach the heater to the vibration insulators. Tighten the nuts to 72 lbf·in (814 N·cm).

2. Connect the electrical wires to each blower motor, as previously marked.

3. Connect the heater hoses to the heater core ports. Install and tighten the hose clamps.

4. Close the drain cock on the bottom of the radiator.

5. Fill the cooling system with the saved or new coolant. Add enough coolant to bring the level to within one inch (25 mm) of the radiator filler neck.

CAUTION: Failure to keep the engine coolant filled to within one inch (25 mm) of the bottom of the radiator filler neck could result in engine overheating and damage.

6. Start the engine. When the engine thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again, and fill, if needed, as specified in step 5.

HEATER CORE REPLACEMENT
(Refer to Fig. 2)

1. Remove the heater assembly from the vehicle. For instructions, refer to "HEATER ASSEMBLY REMOVAL AND INSTALLATION."

2. Remove the four capscrews that attach the motor mount assembly to the heater housing, then remove the motor mount assembly.

RED DOT AUXILIARY HEATER, MODELS R-254-1 AND R-255-1, COE

3. Wearing protective gloves, slide the heater core out and remove it from the heater housing.

4. Position the new heater core in the heater housing.

WARNING: Failure to wear protective gloves could result in serious skin lacerations caused by the sharp edges of the heater core fins.

5. Position the motor mount assembly inside the heater housing. Install and tighten the capscrews to 84 lbf·in (940 N·cm).

6. Install the heater assembly in the vehicle. For instructions, refer to "HEATER ASSEMBLY REMOVAL AND INSTALLATION."

BLOWER MOTOR REPLACEMENT
(Refer to Fig. 2)

1. Remove the heater assembly from the vehicle. For instructions, refer to "HEATER ASSEMBLY REMOVAL AND INSTALLATION."

2. For later assembly reference, mark the wires connected to each blower motor; then disconnect the wires.

3. Remove the capscrews that attach the motor mount assembly to the heater housing. Remove the motor mount assembly.

4. Pull the fan off of the motor shaft.

5. Remove the Kep nuts attaching the blower motor to the motor mount assembly. Remove the blower motor.

6. Position the new blower motor on the motor mount. Install the Kep nuts that attach the blower motor to the motor mount, then tighten the nuts to 60 lbf·in (670 N·cm).

7. Push the fan on to the motor shaft.

8. Position the motor mount assembly inside the heater housing. Install and tighten the capscrews to 84 lbf·in (940 N·cm).

9. Install the heater assembly in the vehicle. For instructions, refer to "HEATER ASSEMBLY REMOVAL AND INSTALLATION."

GENERAL DESCRIPTION

The Weatherking III heater installation consists of a fresh air defroster mounted on the right side of the tunnel, a recirculating heater mounted behind the driver's seat and a recirculating fan mounted under the passenger's seat with an air duct leading to the sleeper bunk.

OPERATING INSTRUCTIONS

The heating and defrosting system are controlled by four levers and three toggle switches. Three of the levers and two of the switches are located in a panel on the dash. The other lever and switch are located in a panel mounted on the tunnel near the bunk. Illustrations of heater control panels are shown in Fig. 1 Standard Console, Fig. 2 Custom Console and Fig. 3 Bunk Control Panel.

1. The "AIR" lever controls the air door located in the defroster air inlet. Push the lever to "on" for outside air; push the lever to "off" to shut-off the outside air. The "AIR" lever must be in the "on" position for maximum heat.

2. The "HOT" and "COLD" lever controls the water valve that regulates the flow of water from the engine to the heater. Push the lever up to the "hot" position for warm air; push the lever proportionally down for cooler air operation.

3. The "L. H. HEAT" and "DEFROST" lever controls an air door located in the defroster ducting. Push the lever up for defrosting; push the lever down for partial delivery of warm air out the air duct located by the throttle pedal.

4. The first toggle switch located to the left of the defroster lever controls the defroster blower located on the right side of the tunnel. Push the switch up for "HI" speed; push the switch down for "LOW" speed.

5. The second toggle switch located to the left of the defroster lever controls the L. H. heater blower located behind the driver's seat. Push the switch up for "HI" speed; push the switch down for "LOW" speed. A

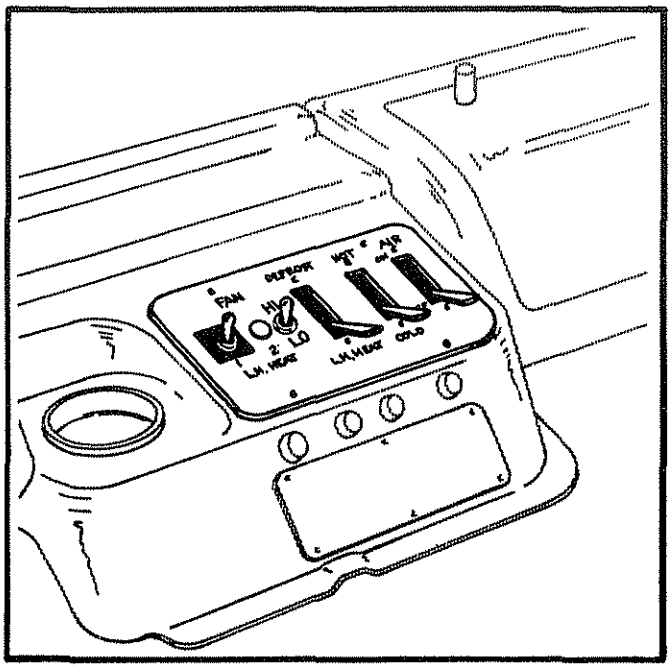


Fig. 1 HEATER CONT. PANEL, STD. CONSOLE

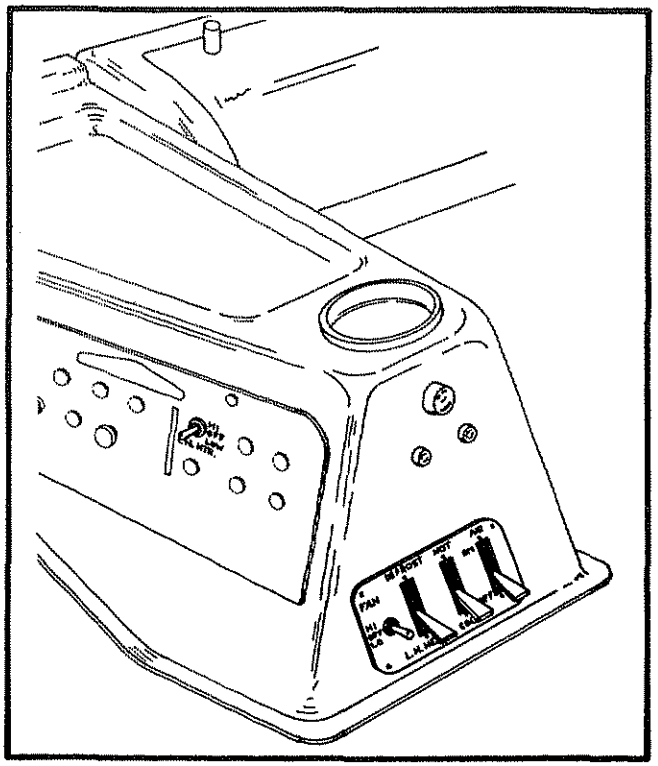


Fig. 2 HEATER CONT. PANEL, CUST. CONSOLE

6. The "BUNK" lever controls an air door located in the recirculating blower housing. Push the lever down for air distribution to the bunk; push the lever up for air distrubution to the right side.

7. The toggle switch located in the bunk panel controls the recirculating blower located under the passenger seat. Push the switch to the left for "HI" speed; push the switch to the right for "LOW" speed.

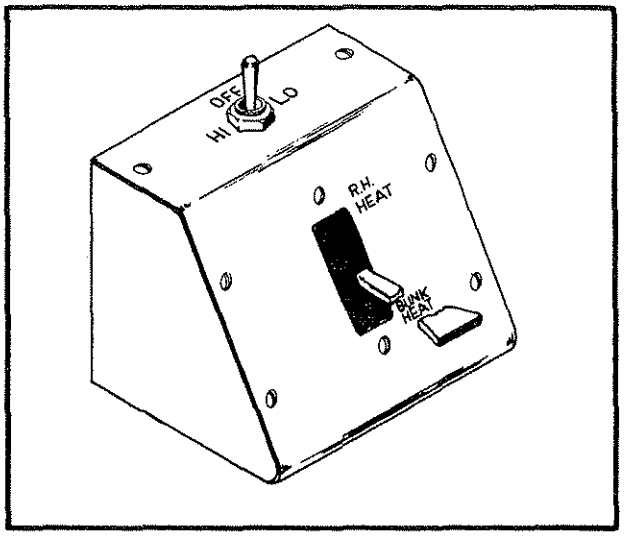


Fig. 3 BUNK CONTROL PANEL

SERVICE OPERATIONS

DEFROSTER CORE REMOVAL AND INSTALLATION
See Fig. 4.

Removal

1. Remove the passenger seat if needed to provide room to remove the heater.

2. Remove the screws attaching the heater cover to the deck and tunnel, then remove the cover.

3. Drain the cooling system and disconnect the heater hoses from the pipe nipples located in each end of the heater core.

4. Loosen the hose clamps attaching the flex tubing to the front and bottom of the defroster housing, then separate the tubing from the housing.

5. Disconnect the electrical wires from the blower motor.

6. Disconnect and remove the air door control cable.

7. Remove the four nuts, on the engine side of the tunnel, attaching the defroster housing to the tunnel, then remove the defroster assy from the cab.

8. Remove the inlet elbow from the end of the heater core.

9. Remove the two seal clips that hold the core in the housing, then slide the core out of the housing.

Installation

1. Position the heater core in the housing and install the seal clips that hold the core in the housing.

2. Using sealant compound on the pipe threads, install the inlet elbow in the heater core.

3. Place the defroster assembly in the cab, then install the fresh air flex hose on the defroster neck and tighten the hose clamp.

4. Position the defroster assembly on the tunnel and install the four washers and four nuts attaching the defroster to the tunnel.

5. Connect the air door control cable to air door and install the cable hold down clamp.

6. Connect the electrical wires to the blower motor.

7. Connect the bunk duct flex hose to the bottom defroster neck and tighten the hose clamp.

8. Connect the heater hoses to the pipe nipples located in each end of the heater core.

9. Fill the cooling system, then bleed the air from the system using the procedure given under "Bleeding Air" this section.

10. Check the heater core and heater hose connections for leaks.

11. Position the defroster cover over the defroster assy and install the screws attaching the cover to the tunnel and deck.

12. Install the passenger seat if removed.

DEFROSTER BLOWER MOTOR REMOVAL AND INSTALLATION See Fig. 4.

Removal

1. Disconnect the electrical wires from the blower motor.

2. Remove the screws attaching the blower motor mount to the housing.

3. Remove the blower motor, mount and blower wheel as a unit.

4. Remove the allen head screw attaching the blower wheel to the blower motor shaft, then separate the wheel from the shaft.

5. Remove the nuts attaching the blower mount to the blower motor, then separate the mount from the motor.

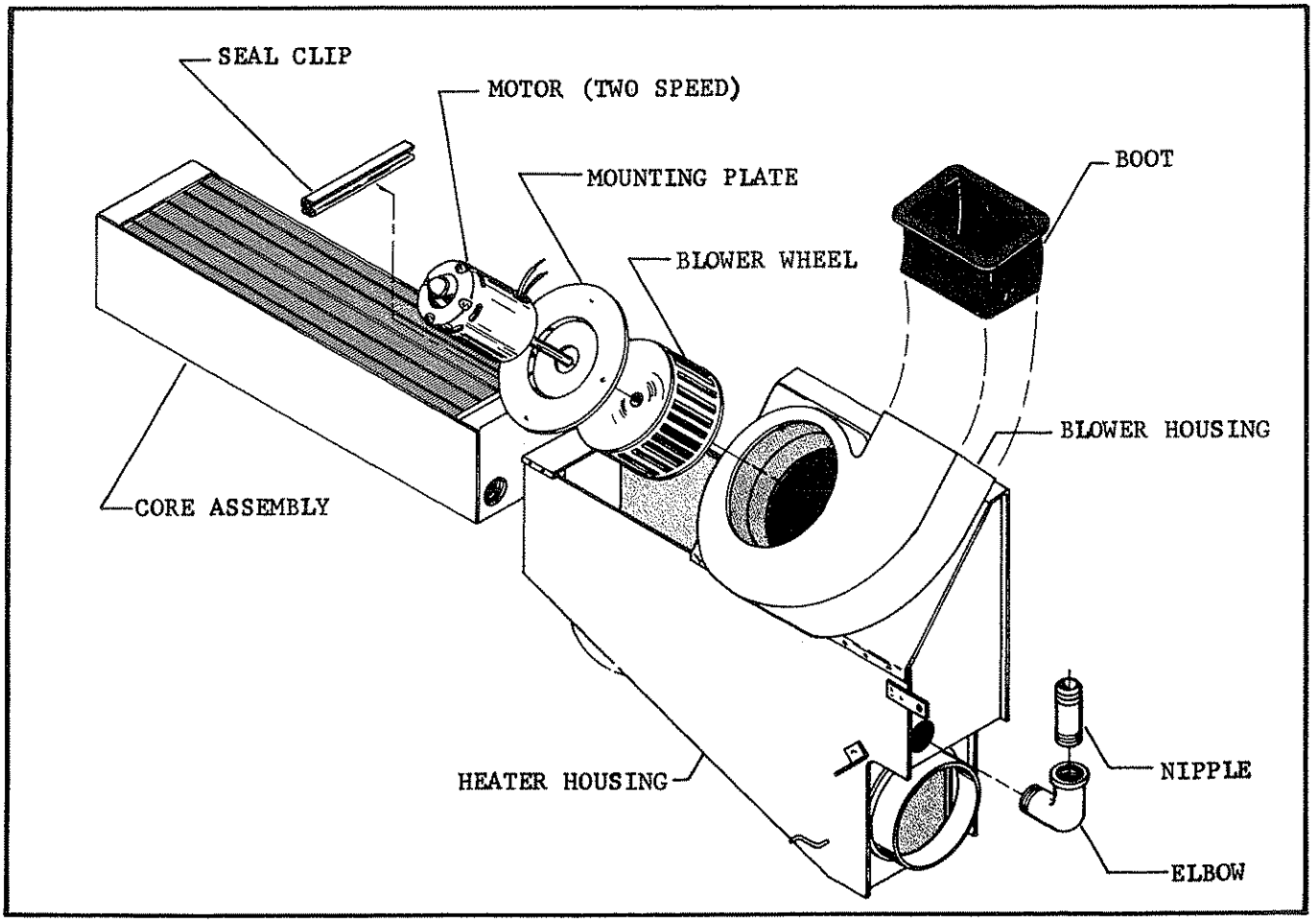


Fig. 4 FRESH AIR DEFROSTER NOMENCLATURE

Installation

1. Position the mount on the blower motor and install the nuts attaching the motor to the mount.

2. Position the blower wheel on the motor shaft and tighten the allen head set screw.

3. Position the blower motor, mount and wheel assembly in the blower housing and install the screws attaching the mount to the blower housing.

4. Connect the electrical wires to the blower motor.

RECIRCULATING AIR BLOWER MOTOR REMOVAL AND INSTALLATION See Fig. 5.

Removal

1. Disconnect the electrical wires from the blower motor.

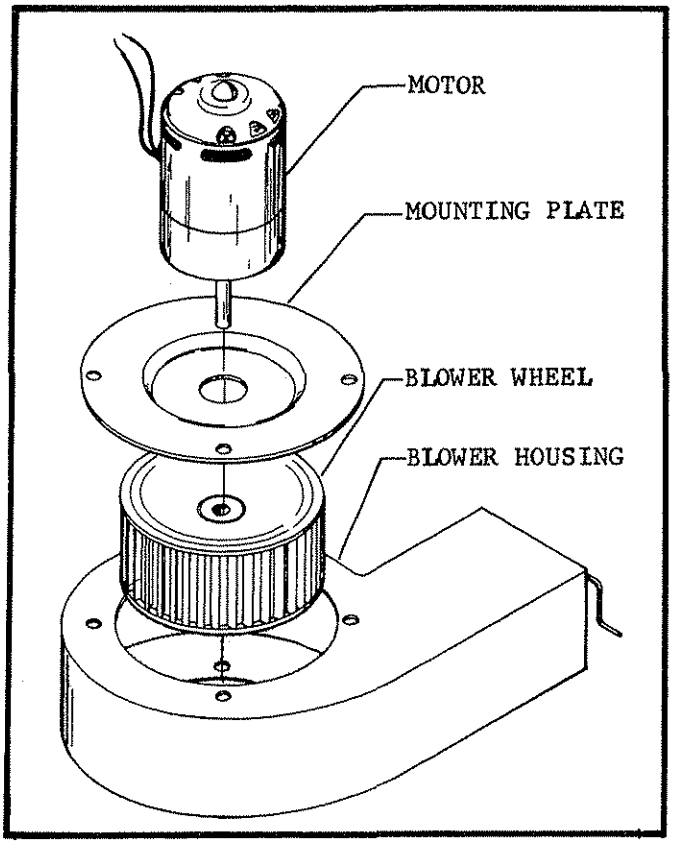


Fig. 5 RECIRC. AIR BLOWER NOMENCLATURE

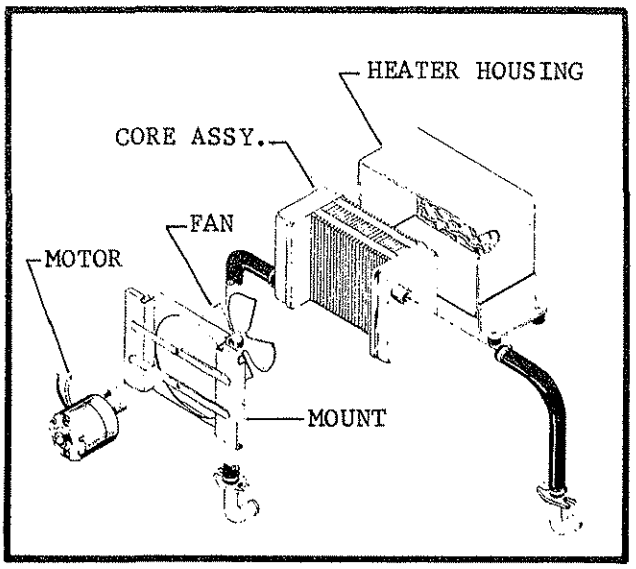


Fig. 6 L. S. AUXILIARY HEATER NOMENCLATURE

2. Remove the bolts attaching the motor mount to the housing.

3. Remove the blower motor, mount and blower wheel as a unit.

4. Remove the allen head set screw attaching the blower wheel to the blower motor shaft.

5. Remove the nuts attaching the blower mount to the blower motor, then separate the mount from the motor.

Installation

1. Position the mount on the blower and install the nuts attaching the mount to the motor.

2. Position the blower wheel on the motor shaft and tighten the allen head set screw.

3. Position the blower motor, mount and wheel assembly in the housing and install the screws attaching the mount to the blower housing.

4. Connect the electrical wires to the blower motor.

L. S. AUXILIARY HEATER CORE REMOVAL AND INSTALLATION See Fig. 6.

Removal

1. On sleeper cabs, remove the metal cover installed to protect the heater assy.
2. Drain the cooling system and disconnect the heater hoses from each end of the heater core.
3. Disconnect the electrical wires from the blower motor.
4. If there isn't room to remove the screws attaching the motor mount assembly to the housing, remove the four nuts attaching the heater assembly to the vibration insulators, then remove the heater.
5. Remove the screws attaching the motor mount assembly to the housing and separate it from the housing.
6. Remove the heater core from the heater housing.

Installation

1. Position the heater core in the heater housing.
2. Position the motor mount in the housing and install the screws attaching the mount to the housing.
3. If the heater was removed, position the heater in the cab and install the nuts attaching the heater to the vibration insulators.
4. Connect the electrical wires to the blower motor.
5. Connect the heater hoses to the heater core.
6. Fill the cooling system and bleed the air from the system using the procedure given under "Bleeding Air" this section.
7. Check the heater core and heater hose connections for leaks.
8. On sleeper cabs, install the metal protection cover.

L. S. AUXILIARY HEATER BLOWER MOTOR REMOVAL AND INSTALLATION See Fig. 6.

Removal

1. On sleeper cabs, remove the heater metal protection cover.
2. Disconnect the electrical wires from the blower motor.
3. Loosen the allen head screw holding the fan on the blower motor shaft.
4. Remove the nuts attaching the blower motor to the motor mount, then remove the blower motor from the mount.

Installation

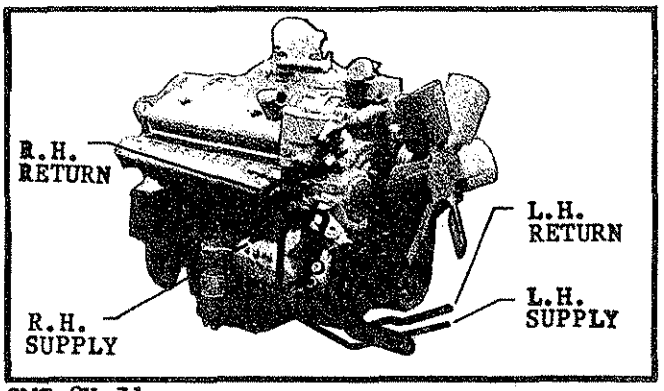
1. Position the blower motor in the mount and install the nuts attaching the motor to the mount.
2. Position the blower fan on the blower shaft and tighten the allen head set screw.
3. Connect the electrical wires to the blower motor.
4. On sleeper cabs, install the heater metal protection plate.

BLEEDING AIR FROM HEATER CORES

Remove the outlet hose from the heater core outlet connection. Allow all of the trapped air to flow out. When a continuous flow of coolant is obtained, reconnect the outlet hose to the heater core outlet connection.

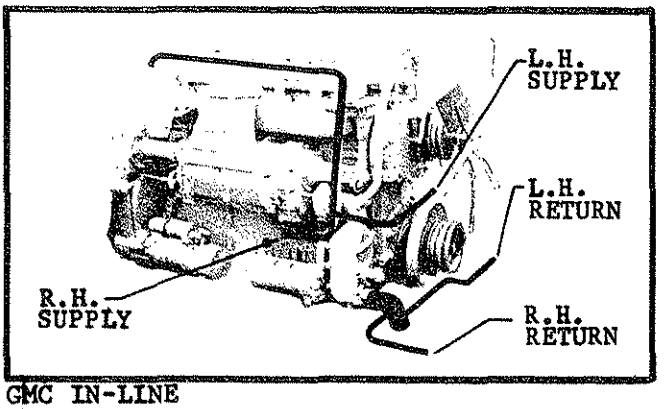
SPECIFICATIONS

A

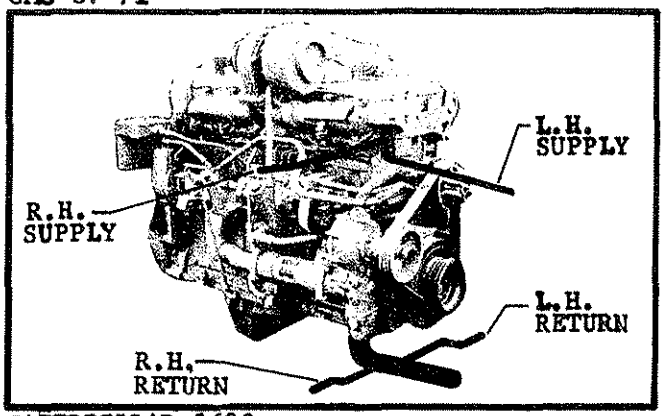


A

GMC 8V-71



GMC IN-LINE



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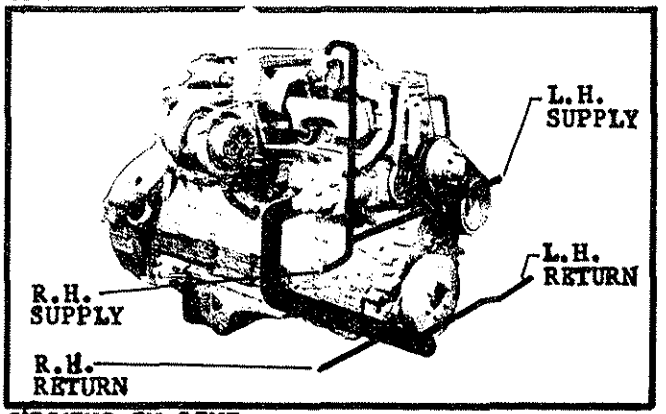
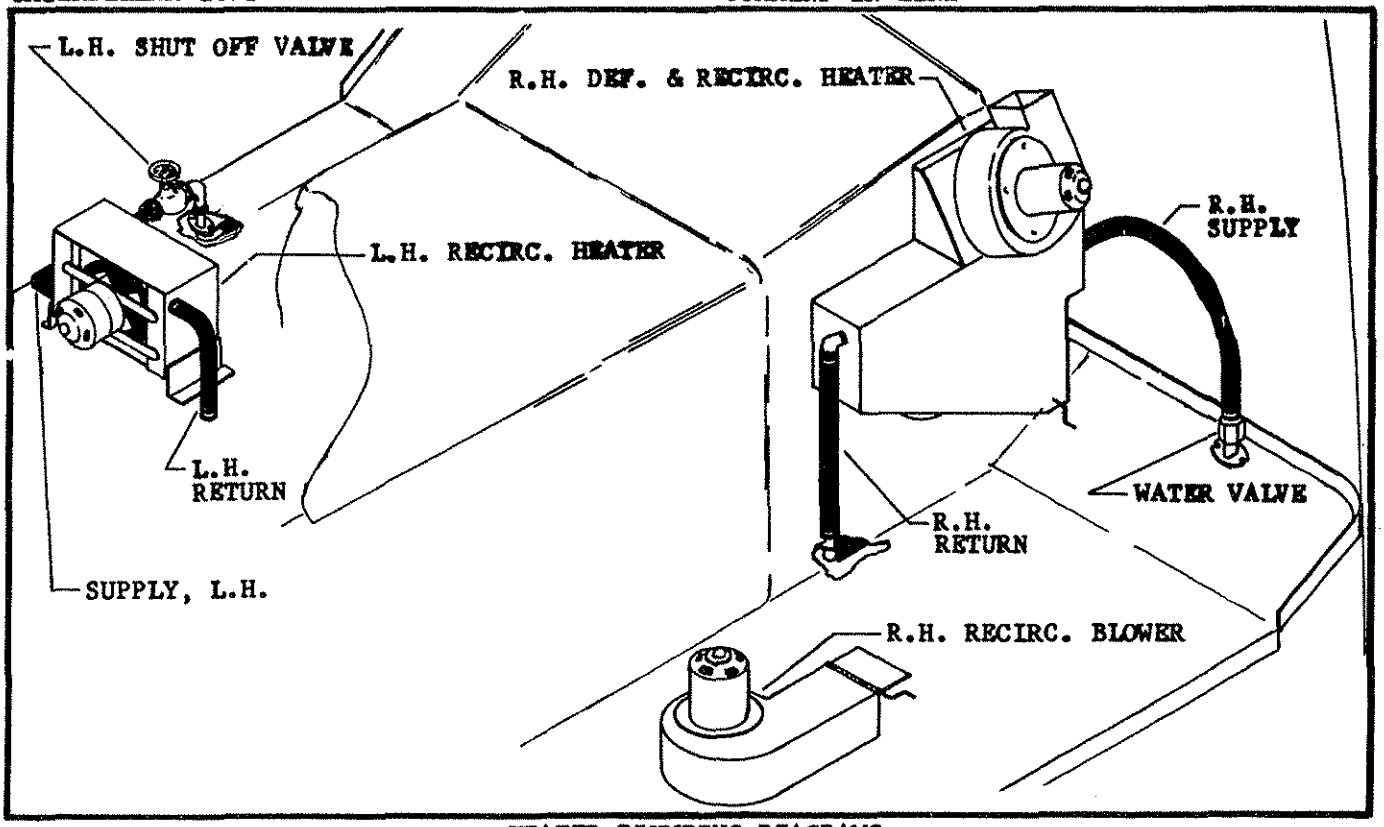
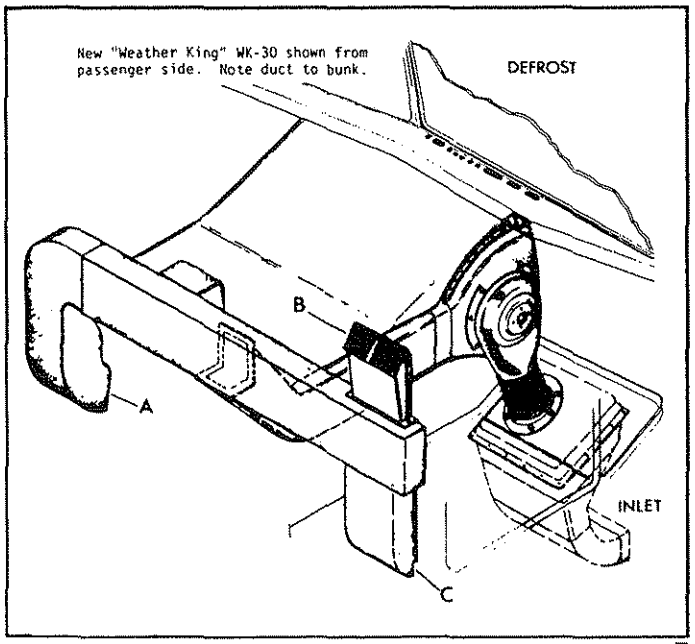


CUMMINS IN-LINE



HEATER PLUMBING DIAGRAMS



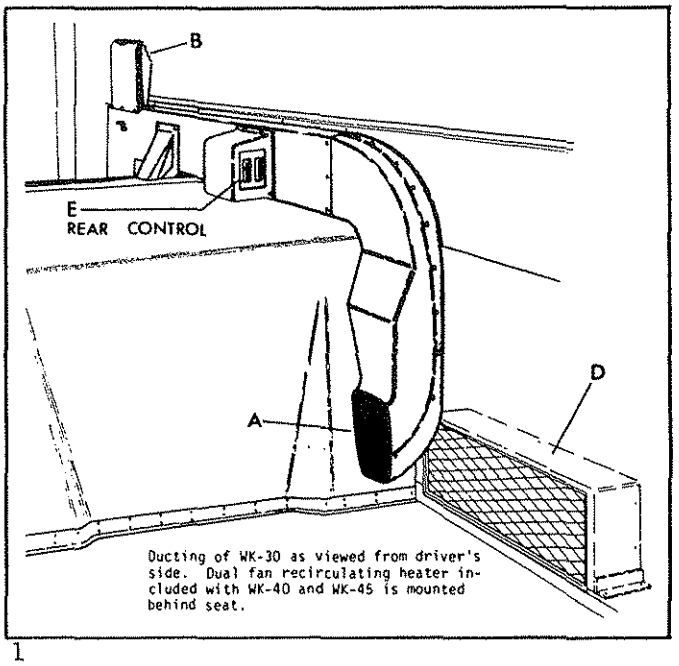


Fig. 1

GENERAL DESCRIPTION

A The "Weather King" 30, 35, 40 and 45 heater installation is a fresh air heater/defroster system designed exclusively for Freightliner trucks and tractors. This fresh air heater/defroster system uses outside air ducted in from the lower right front side of the cab. The fresh air then passes through the heater core located beneath the right side deck. The heated fresh air flows from the heater core to the different air ducting outlets. These outlets, which include the "R.H.", "L.H.", "BUNK" and "DEFROSTER" can be selected individually or in different combinations. The "Weather King" 40 and 45 models incorporate in addition a dual fan recirculating heater located behind the driver.

Early production installations of the "Weather King" 30, 35, 40, and 45 heater have a manually operated water shutoff

A valve while later production installations have an air operated water shutoff valve. This valve controls the flow of hot water to the heater core in the cab, and is part of the heater plumbing installation. The valve opens when the hot water flow switch on the heater control panel is placed in the "on" position. The valve closes when the hot water flow switch on the heater control panel is switched to "off". The valve air actuating cylinder draws its source of air from the main air reservoir with built in safeguards to prevent loss of air through any valve system failure.

The four models of the "Weather King" heater are as follows: See Fig. 1

WK-30 Includes duct to driver area (A), duct to passenger area (C) and duct to bunk (B).

WK-35 Includes duct to driver area (A) and duct to passenger area (C).

WK-40 Includes duct to driver area (A), duct to passenger area (C), duct to bunk (B) and dual fan recirculating heater behind driver (D).

WK-45 Includes duct to driver area (A), duct to passenger area (C) and dual fan recirculating heater behind driver (D).

OPERATING INSTRUCTIONS

The fresh air heater/defroster system is controlled by four levers, two toggle

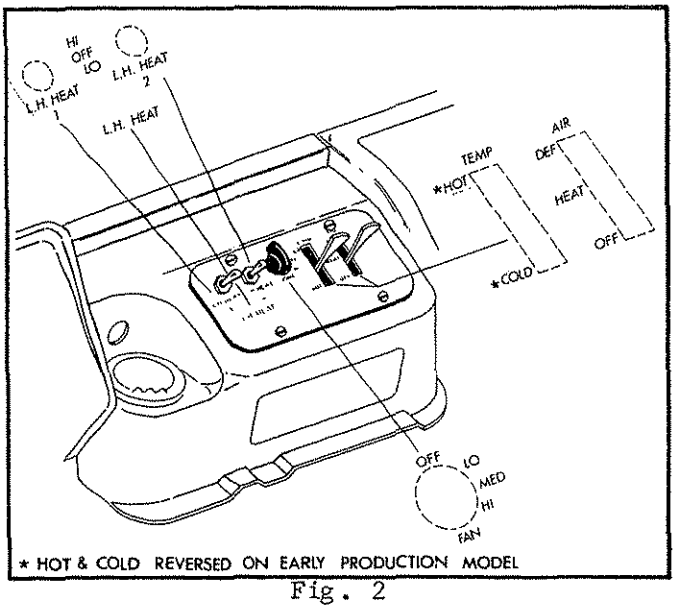


Fig. 2

switches, (WK-40 & 45 only) and a heater switch. Two of the levers, two toggle switches and the heater switch are located in a panel on the dash. The other two levers are located in a panel mounted on the tunnel crossover duct. Illustrations of the heater control panels are shown in Fig. 2 Standard Console, Fig. 3 Heater Control Panel, Fig. 4 Custom Console, and Fig. 5 Bunk Control Panel.

For later production installations of the "Weather King" 30, 35, 40 and 45 heaters the air operated water shutoff valve is controlled by the hot water flow switch on the heater control panel. To obtain a flow of hot water to the heater core, place the hot water flow switch to "on". To shut off the flow of hot water to the heater core, place the hot water flow switch to "off". The air operated water shutoff valve controls only the flow of water from the engine to the heater core; cab air temperature is controlled by the operation of the air temperature lever also located on the heater control panel.

1. The "AIR" lever controls the air door located in the fan housing and riser assembly. See Fig. 6. Push the lever to "HEAT" for maximum air distribution to the tunnel crossover duct; a small volume of air will be directed through the defrosters. Push the lever to "DEF" for air distribution to the tunnel crossover duct and maximum air to the defroster ducting. Push the "AIR" lever to the "OFF" position to prevent air from entering the cab.

2. The "TEMP" lever controls the air mix door located in the lower heater core housing. See Fig. 7. The air mix door regulates the air temperature by splitting the fresh air around and/or through the heater core proportionally to the selected door position. Push the lever to "HOT" for maximum heat. Push the lever to "COLD" for no heat or summer operation.

3. The toggle switches located to the left of the "TEMP" lever control the two blower motors of the dual fan recirculating heater. Push the toggle switches up for "HIGH" speed; push the toggle switches down for "LOW" speed.

4. The four position dial switch controls the fresh air heater blower motor speed. Turn the dial to "LOW", "MED" or "HIGH" depending on the performance desired.

5. The "L.H." bunk lever controls the air door located in the left side of the tunnel crossover duct. See Fig. 8. Push the lever to "ON" for air distribution to the L.H. outlet; push the lever to "OFF" for no air delivery to the L.H. outlet.

6. The "R.H." bunk lever controls the air door located in the right side of the crossover duct. See Fig. 8. On sleeper models, push the lever to "RH" for air distribution to the right hand outlet, "BUNK" for air distribution to bunk, or a position in between for air distribution to bunk and to right hand outlet. On non-sleeper models, push the lever to "ON" for air distribution to R.H. outlet, push the lever to "OFF" for no air delivery to the R.H. outlet.

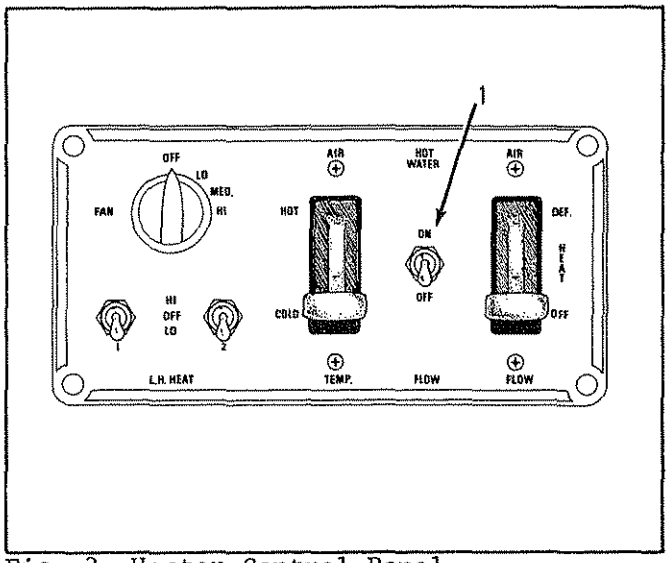


Fig. 3 Heater Control Panel

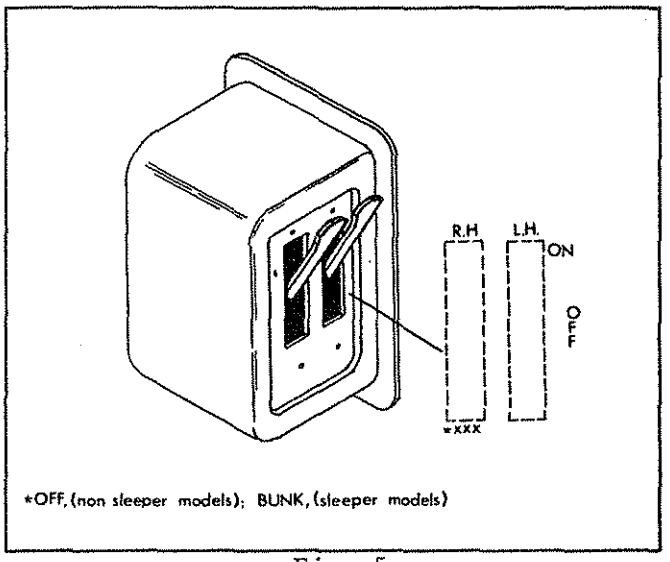


Fig. 5

SERVICE OPERATIONS

HEATER CORE REMOVAL AND INSTALLATION
SEE FIGS. 6 & 7, ALSO FIG. 9 OR 10

Removal

CAUTION: Place heater fan switch to "OFF" to prevent accidental heater fan operation during servicing.

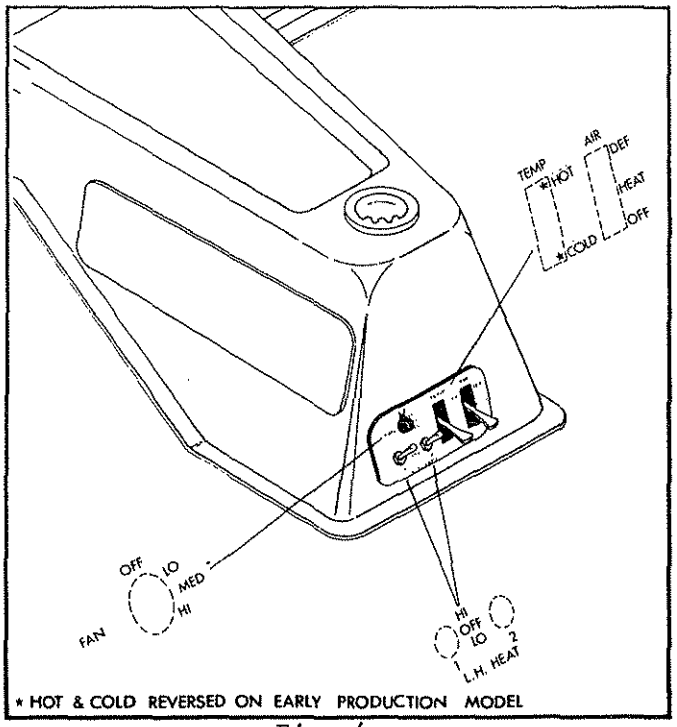


Fig. 4

1. Remove all loose articles from the cab, then tilt the cab.

2. Drain the cooling system and the heater core. Disconnect the heater hoses from the heater core.

3. Remove the bolts and screws attaching the air inlet duct assembly to the front skin and the lower heater core housing. Remove the air inlet duct assembly.

4. On early production, external linkage-type air-mix doors, remove the cable housing clamps and disconnect the cable from the door.

5. Lower the cab, remove the passenger seat if necessary and the floor mat. Remove the screws attaching the impact resistant plastic heater cover to the tunnel and deck. Remove the heater cover.

6. On current production, internal linkage-type air-mix doors, remove the cable housing saddle clamps, and disaway from the air intake boot. Remove the locknut and swivel from the temperature control lever.

7. Loosen the air intake boot clamps, and remove the air intake boot.

8. Remove the four hex-head and three round head capscrews attaching the heater core housing and air intake adapter to the deck.

CAUTION: Handle the heater core assembly gently so that it will not be damaged.

9. Remove the heater core assembly from the underside of the deck.

10. Remove the nuts and bolts that attach the upper core housing to the lower core housing assembly. Separate the housings and remove the heater core.

Installation

1. Install a strip of 1/16" x 1" x 8 1/2" Weatherban sealant tape on each of the four tank end radii as shown in Fig. 11.

CAUTION: Handle the heater core assembly gently so that damage will not occur to the heater core tubes, or fins.

2. Position the heater core in the lower heater core housing. Install a new heater core housing gasket if damaged.

3. Position the upper core housing on the lower core housing assembly. On internal-linkage type air-mix doors, be sure the temperature control arm protrudes through the nylon bushing. Install the nuts and bolts attaching the upper housing to the lower housing.

4. On current production, internal linkage-type installations (Fig. 10), install a new core housing cable gasket with the large opening toward the core. Install heater to deck gasket, if damaged. Use H.B. Fuller #900 cement or equivalent.

5. Position the heater core assembly on the underside of the deck. On internal-linkage type air-mix doors, be sure the temperature control lever sticks up through the hole in the deck.

6. Install a new gasket on the air inlet adapter if damaged, then position the air inlet adapter in place.

7. Install the four hex-head and three round-head capscrews attaching the heater core assembly and the air intake adapter to the deck.

8. On internal-linkage type air-mix doors, install the swivel and locknut, but leave it loose for later cable adjustment.

9. Position the air intake boot over the air intake adapter and blower fan housing. Tighten the air intake boot clamps.

10. On internal-linkage type air-mix doors, position the temperature control cable in the cable mounting bracket with the end of the cable housing extended 7/8" below the bottom edge of the bracket. See Fig. 6. When this dimension is obtained, tighten the saddle clamps. Set the temperature control lever located in the heater control panel in the "cold" position (Fig. 4). Set the air-mix door in the "cold" position (Fig. 7). Turn the swivel until it will engage the control cable loop. Hold the swivel in place and tighten the locknut. Install the rod clip and cable loop on the swivel. Check the control system to make sure the air-mix door opens and shuts freely upon activation of the temperature control lever in the cab.

11. On external-linkage type air-mix doors, set the temperature control lever, located in the heater control panel, in the "cold" position (Fig. 4). Set the air-mix door in the "cold" (forward) position (Fig. 7). Install the rod clip and cable loop on the door lever. With the air-mix door and the control lever in the "cold" position, tighten the cable housing saddle clamps. Check the control system to make sure the air-mix door opens and shuts freely upon activation of the temperature control lever in the cab.

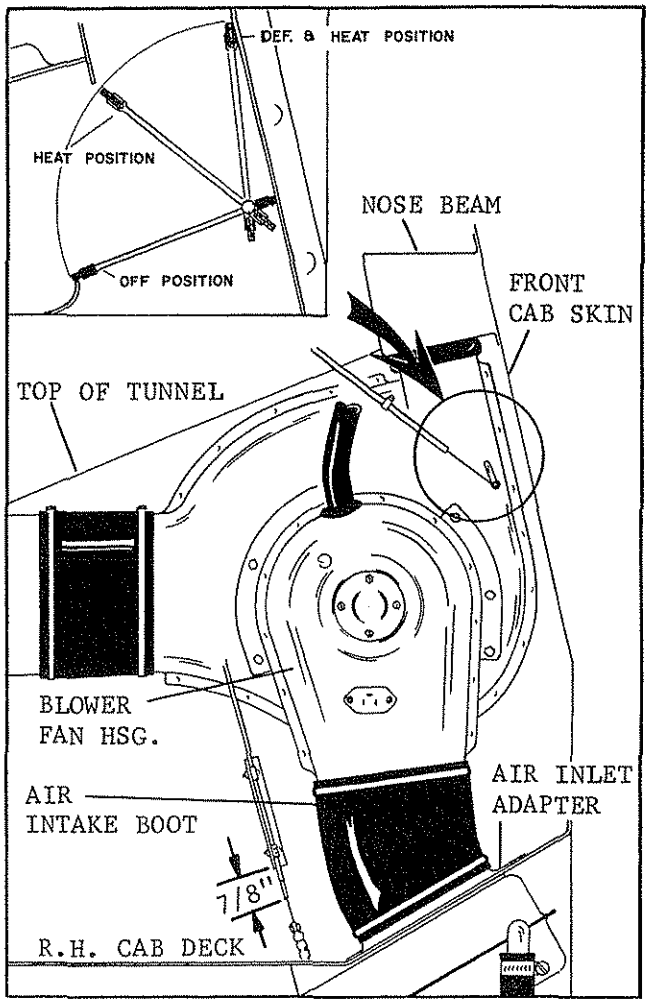


Fig. 6

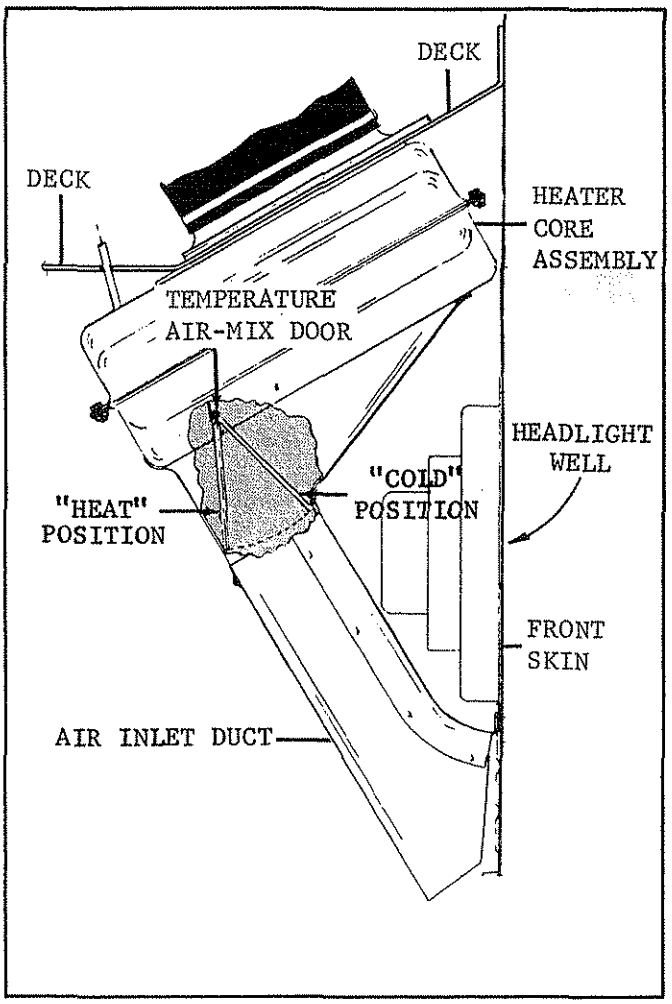


Fig. 7

12. Position the heater cover in place and install the screws that attach the heater cover to the tunnel and deck. Install the passenger seat and floor mat if removed.

13. Position the air inlet duct assembly in place and install the bolts and screws attaching the air inlet duct to the front skin and lower heater core housing (Fig. 7).

14. Connect the heater hoses to the heater core.

15. Fill the cooling system with coolant and check the system for leaks. Make sure all leaks have been eliminated prior to releasing the vehicle for road trips.

CAUTION: Coolant fluid should be to within one inch of the bottom of the radiator fill neck. Less than this could result in overheating which in turn could cause engine damage.

HEATER BLOWER MOTOR REMOVAL AND INSTALLATION SEE FIG. 12

Removal

CAUTION: Place heater fan switch to "off" to prevent accidental heater fan operation during servicing.

1. Remove the passenger seat and floor mat if needed. Remove the screws attaching the heater cover to the tunnel and deck. Remove the plastic heater cover.

2. Mark the wires connected to the resistor for later assembly. Disconnect the wires from the resistor block.

3. Loosen the air intake boot clamps and remove the air intake boot (Fig. 6).

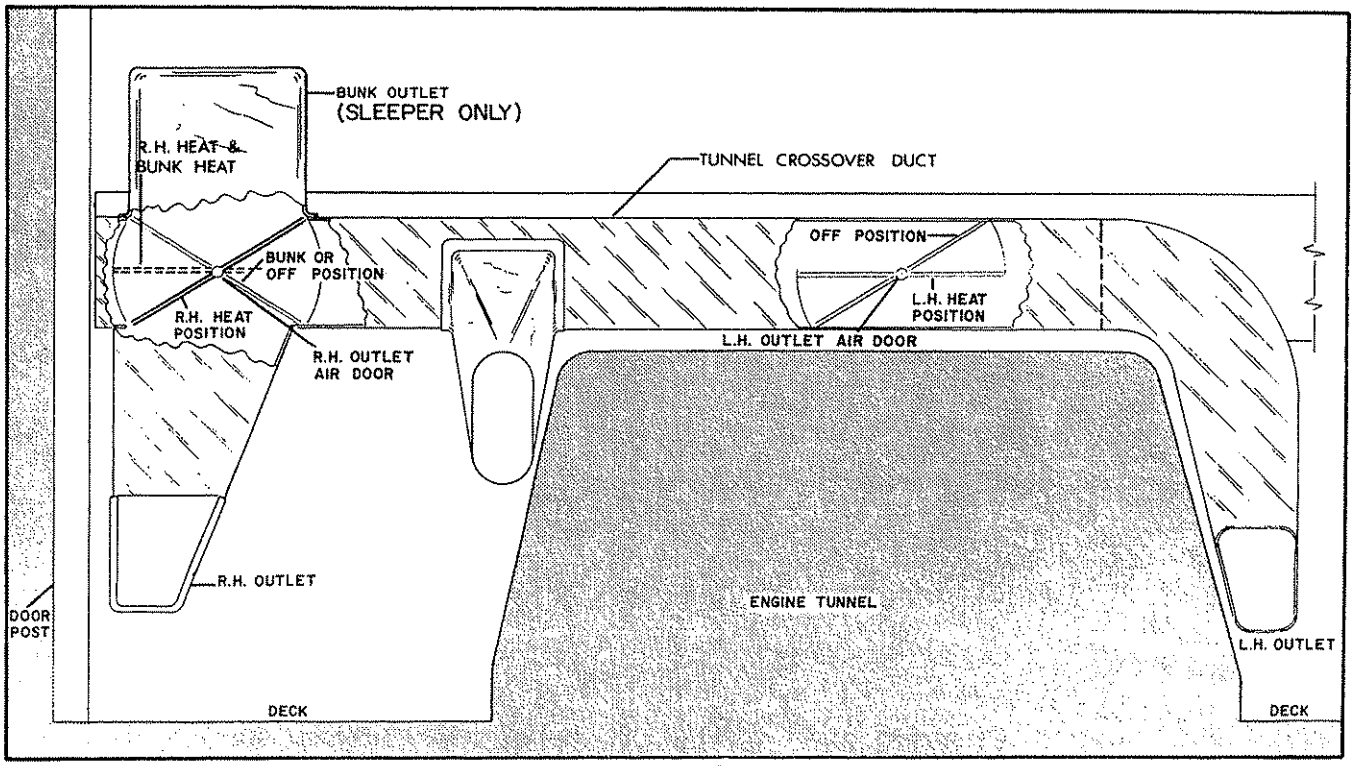


Fig. 8

4. Remove the bolts attaching the heater riser assembly to the heater fan housing assembly. Remove the riser assembly.

5. Remove the blower wheel and loosen the motor support hose clamp. Remove the bolt attaching the motor support bracket to the riser housing.

6. Pull the air hose off the blower motor vent.

7. Remove the nuts and washers attaching the blower motor to the riser housing. Remove the blower motor.

Installation

1. Position the blower motor in the riser housing. Position the two washers on the slotted holes.

2. Install and evenly tighten the four locknuts (Fig. 12, Ref. 11).

3. Position the motor support bracket in place, and install the capscrew (Fig. 12, Ref. 9) that attaches the motor support bracket to the riser housing.

4. Tighten the motor support clamp.

5. Push the air hose onto the blower motor vent.

6. Install the blower wheel.

7. Using a new gasket if present one is damaged (Fig. 12, Ref. 12), position the heater riser assembly on the heater fan housing. Install the capscrews that attach the heater riser assembly to the heater fan assembly.

8. Install the air intake boot (Fig. 6) and tighten the air intake boot clamps.

9. Connect the electrical wires to the resistor block. Replace frayed, cut, or exposed electrical wires with new wires.

10. Check the blower motor for proper operation.

10.1 Operate the blower motor switch, and check for three speed operation by switching the fan switch through "LO", "MED", and "HI" positions.

10.2 If the blower motor does not operate at all, use a voltmeter, or A test light, and test for voltage at the blower motor, the resistor block, the fan switch, and the "C" circuit breaker. (See Fig. 18 Heater Wiring Diagram.)

10.3 When either the blower motor, resistor block, fan switch, or circuit breaker are trouble isolated; remove the faulty component, and replace with a new blower motor, resistor block, fan switch, or circuit breaker. Repeat step 10.1.

10.4 If the blower motor operates at the wrong speeds according to the fan switch positions "LO", "MED", and "HI"; then the connections from the fan A switch to the resistor block have been made in the wrong sequence. Remove the wires from the resistor block terminals on the incorrect switch positions, and replace the wires on the correct resistor block terminals. (See Fig. 18 Heater Wiring Diagram.) Repeat step 10.1.

10.5 If the blower motor operates only on one, or two of the three available speed selections on the fan switch, use an ohmeter, or test light to check the resistor block and fan switch. Remove the faulty resistor block or fan switch, and replace with a new resistor block or A fan switch. (See Fig. 18 Heater Wiring Diagram.) Repeat step 10.1.

11. Position the heater cover in place and install the screws attaching the heater cover to the tunnel and deck.

HEATER CONTROL CABLE ADJUSTMENTS

The control cable of each air door must be adjusted properly to insure correct air door operation.

Air Flow Control Cable See Fig. 6

CAUTION: Place heater fan switch to "off" to prevent accidental heater fan operation during servicing.

1. Remove the screws attaching the heater cover to the tunnel and deck, then re-

2. With the control cable disconnected from the air door, push the "AIR FLOW" lever, located in the control panel, toward "OFF" until the lever is 1/8" to 1/4" from the "OFF" position.

3. Check the air door operation. Be sure the air door works freely, has full movement and seals securely when in the "OFF" position.

4. Put the air door in the "OFF" (down) position.

5. Move the cable assembly in the clamp until the cable loop will engage the air door handle. Tighten the cable clamps.

6. Install the rod clip and cable loop on the air door handle.

7. Using the "AIR FLOW" lever, located in the control panel, recheck the air door operation; review step 3 above.

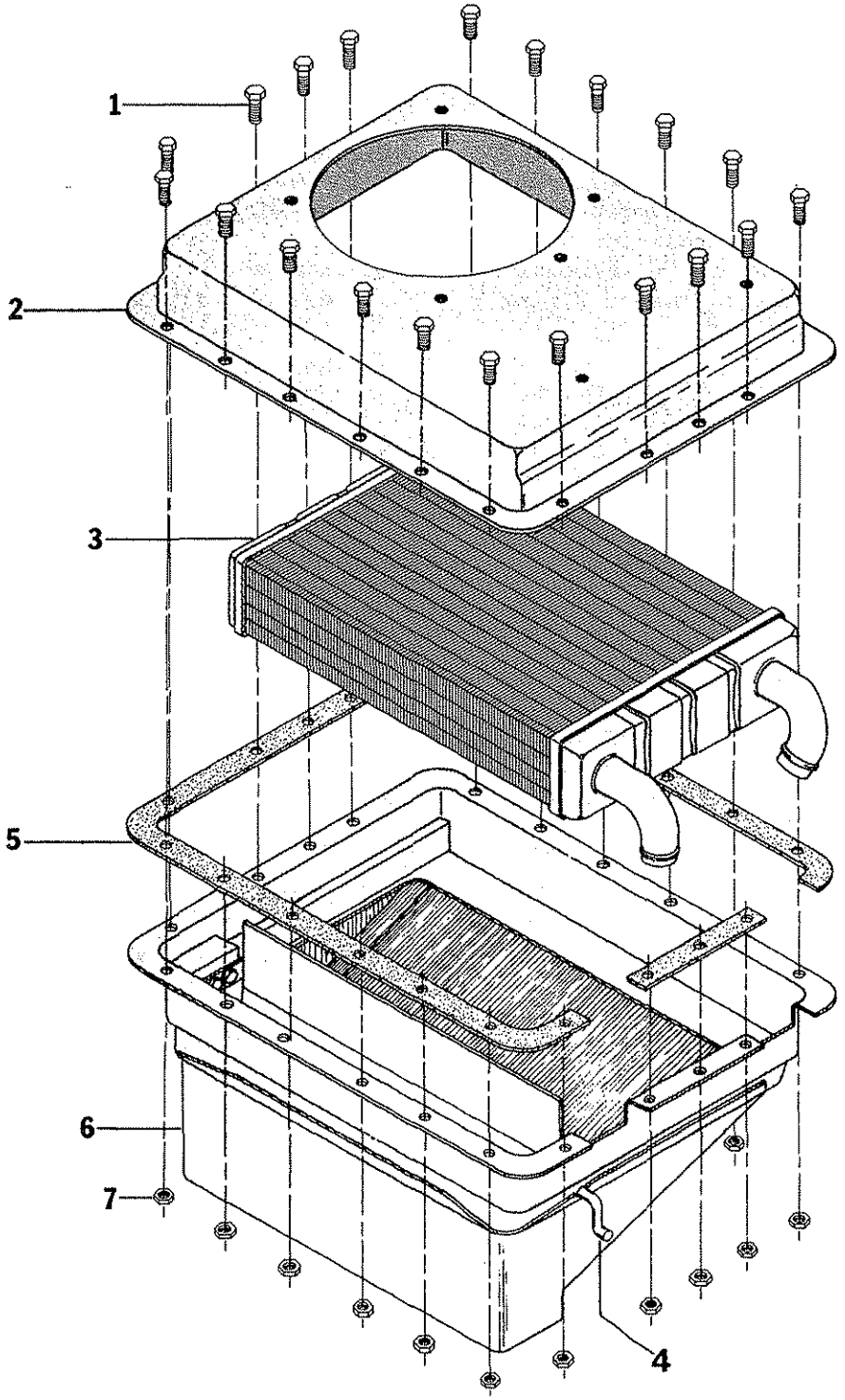
8. Position the heater cover in place and install the screws that attach the heater cover to the tunnel and deck.

Temperature Control Cable See Fig. 7

External-Linkage Type

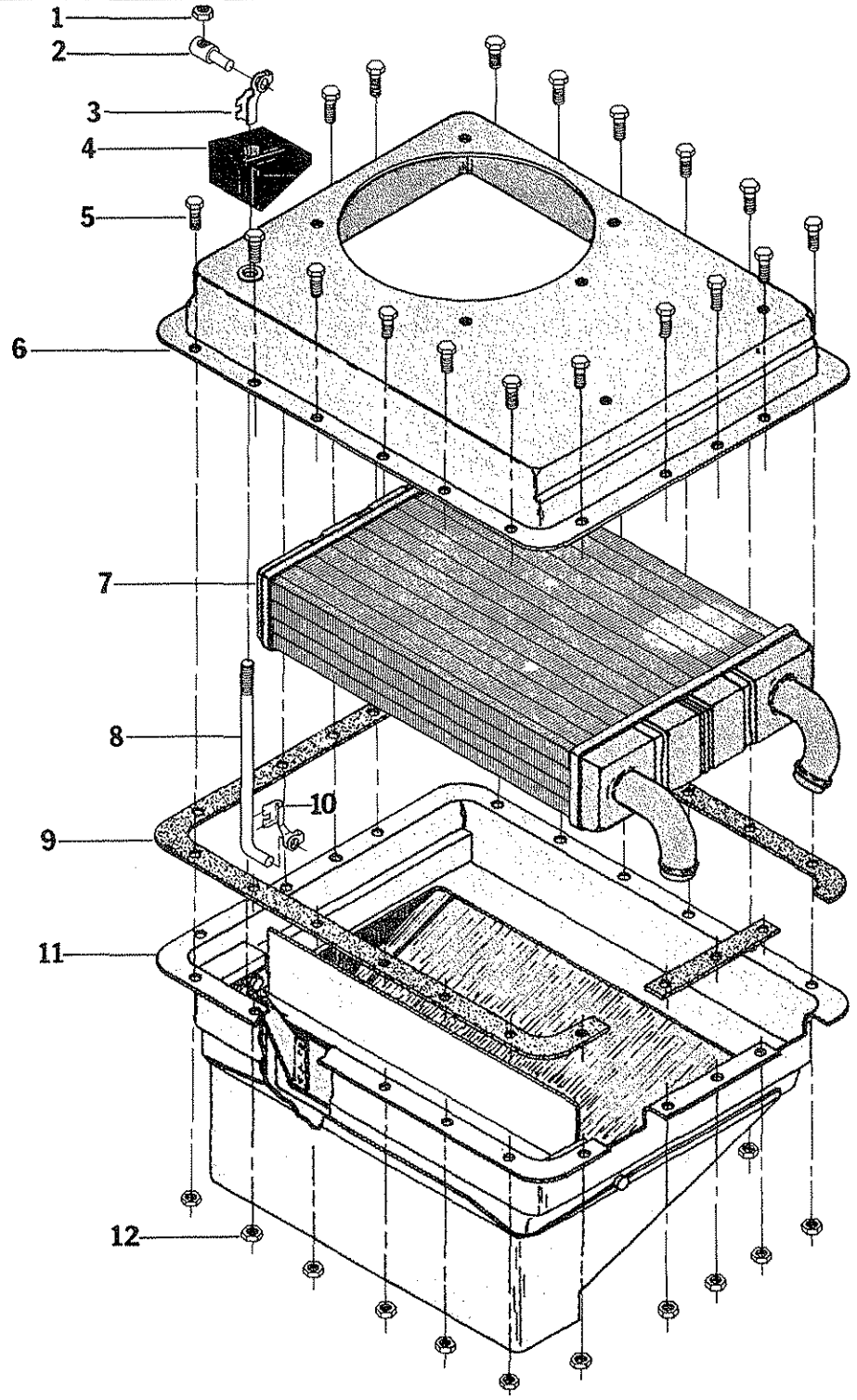
1. With the control cable disconnected from the air-mix door, push the "TEMP" lever, located in the control panel, to the "COLD" position.

2. Check the air-mix door operation. Be sure the door works freely and has full movement.



1. Screw
2. Upper Core Housing Assembly
3. Heater Core Housing
4. Temperature Control Lever
5. Heater Core Housing Gasket
6. Lower Core Housing Assembly
7. Lock Nut

Fig. 9 Early Production Core Housing



1. Lock Nut
2. Swivel
3. Rod Clip
4. Cable Core Housing Gasket
5. Screw
6. Upper Core Housing Assembly
7. Heater Core Assembly
8. Temperature Control Lever
9. Heater Core Housing Gasket
10. Rod Clip
11. Lower Core Housing Assembly
12. Locknut

Fig. 10 Current Production Core Housing

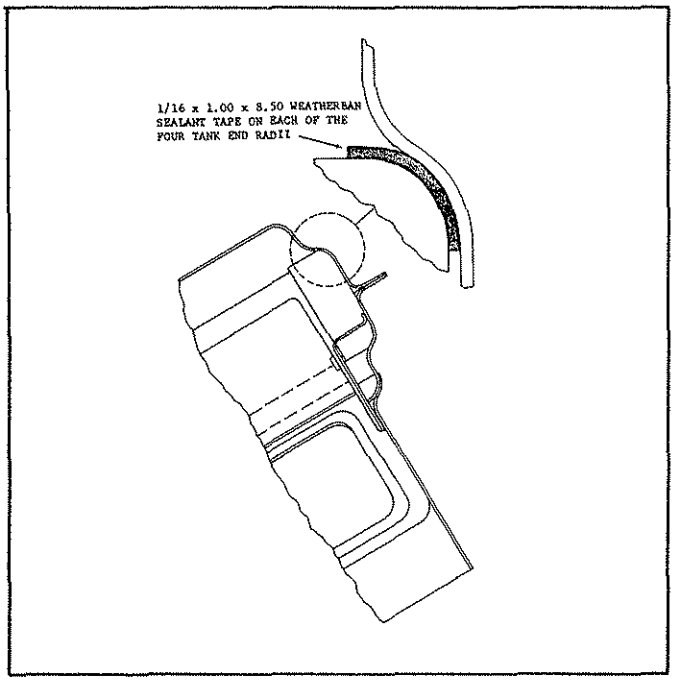


Fig. 11

3. Put the air door in the "COLD" (forward) position.

4. Move the cable assembly in the clamp until the cable loop will engage the air door handle. Tighten the cable housing clamps.

6. Using the "TEMP" lever, located in the control panel, recheck the air door operation. Review step 2 under Temperature Control Cable, External-Linkage Type.

Internal-Linkage Type

CAUTION: Place heater fan switch to "off" to prevent accidental heater fan operation during servicing.

1. Remove the screws attaching the heater cover to the tunnel and deck, then remove the cover.

2. With the control cable disconnected from the air-mix door, push the "TEMP" lever, located in the control panel to the "COLD" position.

3. Check the air-mix door operation. Be sure the door works freely and has full movement.

4. Position the temperature control cable in the cable mounting bracket with the end of the cable housing extended 7/8" below the bottom edge of the bracket. See Fig. 6. Tighten the saddle clamps.

5. Put the air-mix door in the "COLD" position (Fig. 7).

6. Loosen the swivel locknut and turn the swivel until it will engage the control cable loop. Hold the swivel in place and tighten the locknut. Install the rod clip and cable loop on the swivel.

7. Using the "TEMP" lever, located in the control panel, recheck the air-mix door operation. Review step 3 under Temperature Control Cable, Internal Linkage Type.

8. Position the heater cover in place and install the screws attaching the heater cover to the tunnel and deck.

R.H. Bunk Outlet Control Cable
See Fig. 8

On sleeper models, this outlet control is "R.H." or "BUNK"; on non-sleeper models this outlet control is "R.H." or "OFF" (Fig. 5).

1. With the control cable disconnected from the air door, push the "R.H." - "BUNK" or "OFF" lever located in the bunk control panel to the "BUNK" or "OFF" position.

2. Check the air door operation. Be sure the air door works freely and has full movement.

3. Put the air door in the "BUNK" or "OFF" position.

4. Move the cable assembly until the cable loop will engage the air door handle. Tighten the cable clamps.

5. Install the rod clip or push-on locks, and cable loop on the air door handle.

6. Using the "R.H." marked lever located in the bunk control panel, recheck the air door operation. The air door should travel freely, and without binding throughout its arc; and should

seal securely when in either of its extreme positions. Adjust the cable until this operating specification is achieved.

L.H. Outlet Control Cable See Fig. 8

The "L.H." - "OFF" control cable located in the bunk control panel is a fixed length, non-adjustable cable.

A L.H. RECIRCULATING HEATER CORE REMOVAL AND INSTALLATION (WK-40 AND WK-45 ONLY) SEE FIG. 13

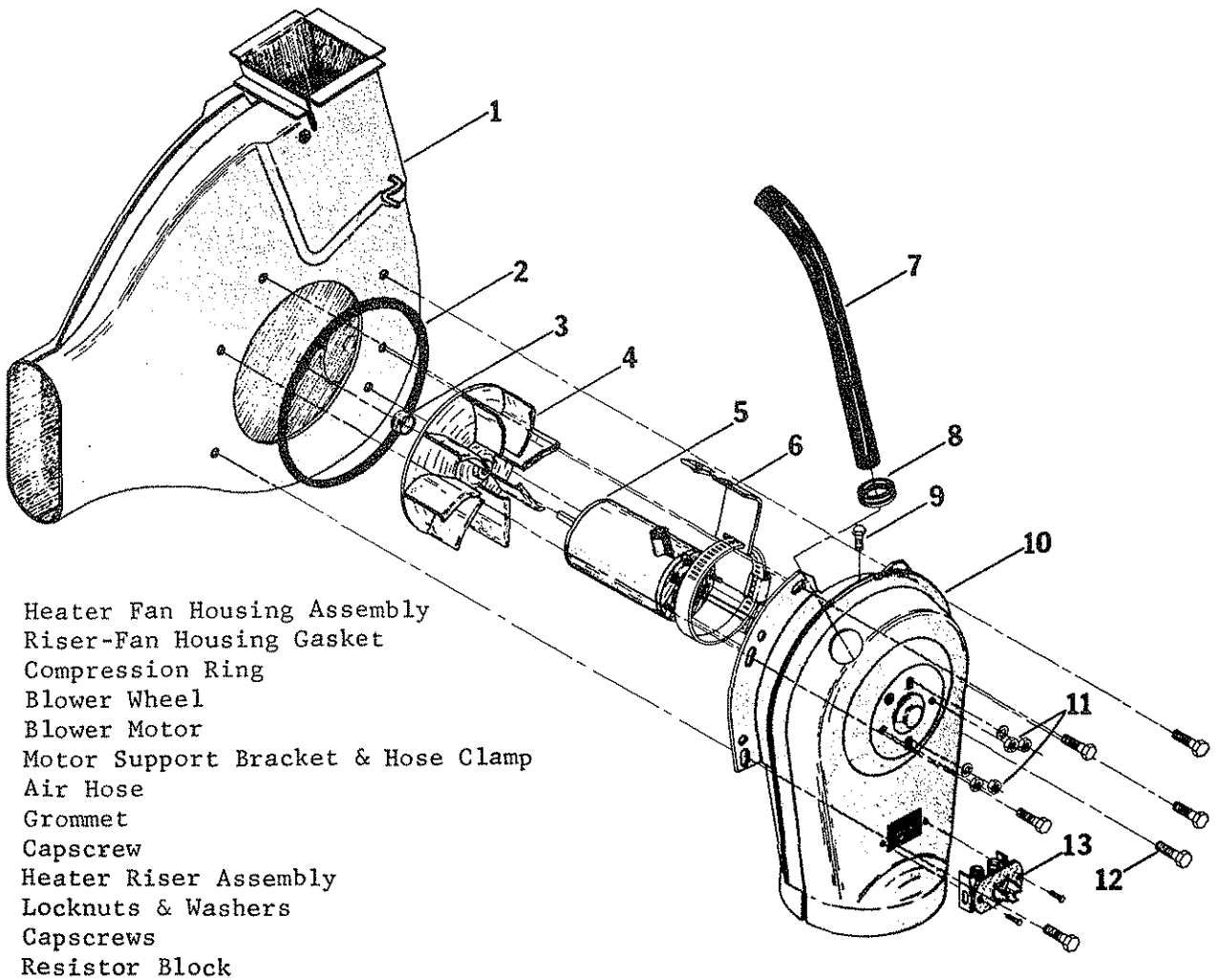
Removal

CAUTION: Place heater fan switch to "off" to prevent accidental heater fan operation during servicing.

1. Drain the cooling system and disconnect the heater hoses from the heater core.
2. On sleeper models, remove the heater's metal protection cover.
3. Mark the wires for later assembly, then disconnect the electrical wires from the blower motors.
4. Remove the four nuts and washers attaching the heater assembly to the vibration insulators, then remove the heater.
5. Remove the screws that attach the motor mount assembly to the housing, then separate it from the housing.

CAUTION: Handle the heater core assembly gently so that the heater core will not be damaged.

A



A
1. Heater Fan Housing Assembly
2. Riser-Fan Housing Gasket
3. Compression Ring
4. Blower Wheel
5. Blower Motor
6. Motor Support Bracket & Hose Clamp
7. Air Hose
8. Grommet
9. Capscrew
10. Heater Riser Assembly
11. Locknuts & Washers
12. Capscrews
13. Resistor Block

Fig. 12 Blower Nomenclature

6. Remove the heater core from the heater housing.

Installation

CAUTION: Handle the heater core assembly gently so that the heater core will not be damaged.

1. Position the heater core in the heater housing.
2. Position the motor mount in the housing and install the screws attaching the motor mount to the housing.
3. Position the heater in the cab and install the washers and nuts attaching the heater to the vibration insulators.
4. Refer to the identifying marks made earlier, and connect the electrical wires to the blower motors accordingly. Replace frayed, cut, or exposed electrical wires with new wires.
5. On sleeper models, install the metal protective cover.
6. Connect the heater hoses to the heater core.
7. Fill the cooling system with coolant and check the system for leaks. Make sure all leaks have been eliminated prior to releasing the vehicle for road trips.

CAUTION: Coolant fluid should be to within one inch of the bottom of the radiator fill neck. Less than this could result in overheating which in turn could cause engine damage.

L.H. RECIRCULATING HEATER BLOWER MOTOR(S) REMOVAL AND INSTALLATION (WK-40 AND WK-45 ONLY) SEE FIG. 13

Removal

CAUTION: Place heater fan switch to "off" to prevent accidental heater fan operation during servicing.

1. On sleeper models, remove the heater metal protection cover.
2. Mark the wires for later assembly, then disconnect the electrical wires from the blower motor(s).
3. Loosen the allen head set screw(s) holding the fan(s) on the blower motor shaft(s).
4. Remove the nuts attaching the blower motor(s) to the motor mount, then remove the blower(s) from the mount.

Installation

1. Position the blower motor(s) in the motor mount and install the nuts attaching the blower motor(s) to the motor mount.
2. Position the blower fan(s) on the blower shaft(s), and tighten the allen head set-screws to 10-15 in-lbs torque.
3. Refer to identifying marks made earlier, and connect the electrical wires to the blower motor(s) accordingly. Replace frayed, cut, or exposed electrical wires with new wires.
4. On sleeper models, install the heater metal protection cover.

BLEEDING AIR FROM HEATER CORES

It is necessary to bleed air from the heater core as trapped air will prevent heated water circulation through the formation of air locks in the heater core.

Remove the outlet hose from the heater core outlet connection. Allow all of the air to flow out of the hose. When a continuous flow of coolant is obtained, reconnect the outlet hose to the heater core outlet connection.

CAUTION: Coolant fluid should be to within one inch of the bottom of the radiator fill neck. Less than this could result in overheating which in turn could cause engine damage.

AIR OPERATED WATER SHUTOFF VALVE REMOVAL, DISASSEMBLY, ASSEMBLY, AND INSTALLATION

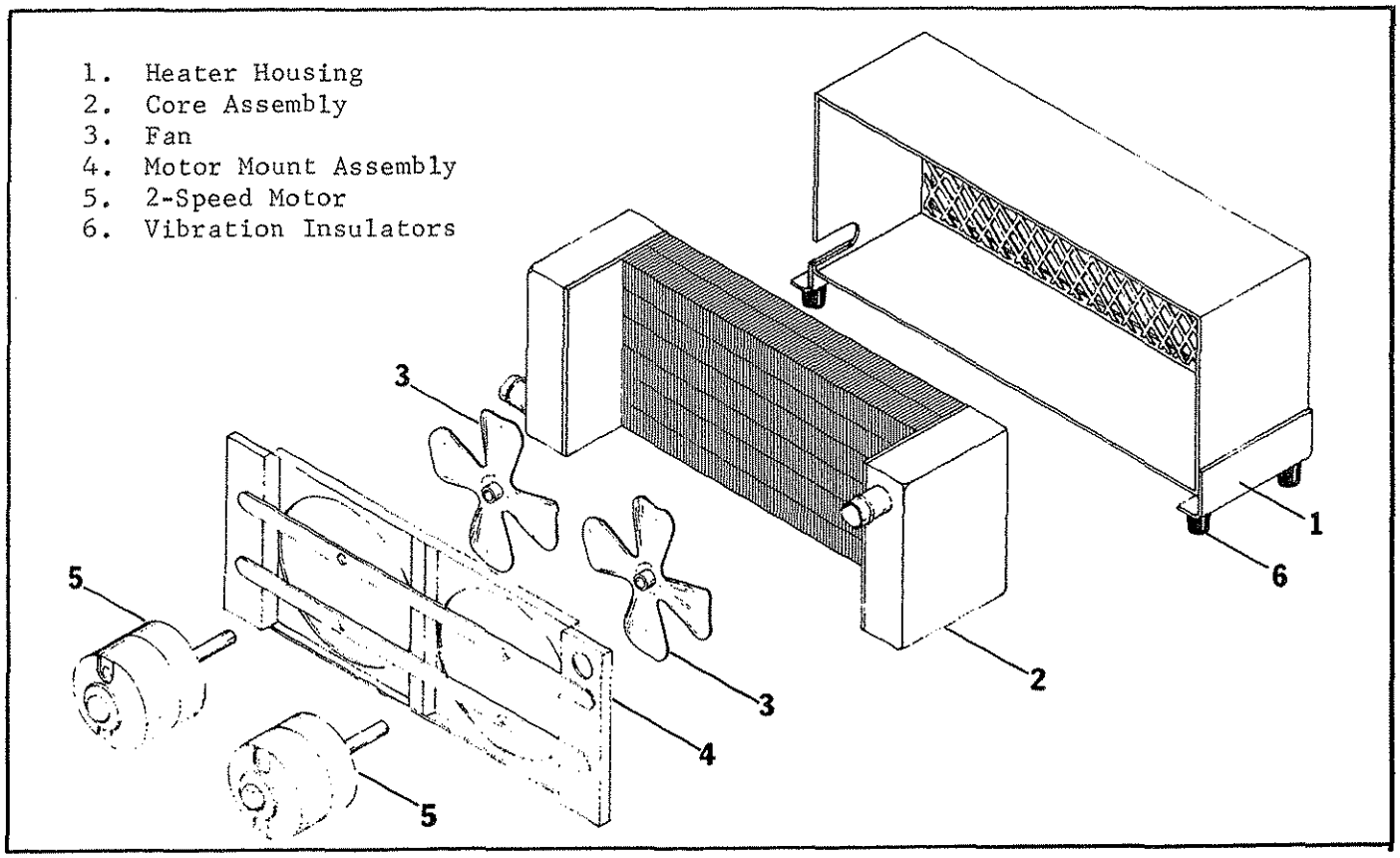
Removal

1. Place the control switch inside the cab to the "on" position (Fig. 3, Ref. 1).
2. Remove the air control line (Fig. 14, Ref. 1) from the valve (Fig. 14, Ref. 3).
3. Drain the cooling system and save the coolant fluid for re-use at end of the servicing operations.
4. Remove the heater water supply hose (Fig. 14, Ref. 2) from the valve (Fig. 14, Ref. 3).
5. Remove the air operated water shutoff valve assembly (Fig. 14, Ref. 3).

Disassembly

1. Place the gate housing (Fig. 15, Ref. 9) in a vise.
2. Unscrew the stem and air cylinder assembly (Fig. 16, Ref. 1) from the gate housing.
3. Place the female adapter portion of the stem and air cylinder assembly (Fig. 15, Ref. 3) in a vise. Do not disassemble this portion of the valve at this point.
4. Apply 30 to 100 lbs of compressed air to the air cylinder (Fig. 15, Ref. 1) to extend the air cylinder rod (Fig. 17, Ref. 1).
5. Tap out the roll pin (Fig. 15, Ref. 7) and remove the gate (Fig. 15, Ref. 8) from the air cylinder rod (Fig. 17, Ref. 1).
6. Cease application of compressed air to the air cylinder (Fig. 15, Ref. 1) to release the air cylinder rod (Fig. 17, Ref. 1).
7. Remove the stem (Fig. 15, Ref. 5) from the female adapter and air cylinder assembly (Fig. 16, Ref. 1).

NOTE: Leave the locknut (Fig. 15, Ref. 2)



S.A. Fig. 13 Recirculating Heater Nomenclature

snugged to the female adapter (Fig. 15, Ref. 3) to maintain the valve seating adjustment of the assembled valve. The male air cylinder fitting (Fig. 17, Ref. 3), locknut (Fig. 15, Ref. 2), and female adapter (Fig. 15, Ref. 3) may be removed as an assembly.

8. Remove the inside threaded male air cylinder fitting (Fig. 17, Ref. 3) from the air cylinder body (Fig. 17, Ref. 4).

9. Slide the male air cylinder fitting (Fig. 17, Ref. 3) and the female adapter (Fig. 15, Ref. 3) with the snugged locknut (Fig. 15, Ref. 2) as an assembly off the air cylinder rod (Fig. 17, Ref. 1).

10. Remove the male air cylinder fitting from the cylinder body by turning it counterclockwise, then lift out the air cylinder rod (Fig. 17, Ref. 1).

11. Remove the piston return spring (Fig. 17, Ref. 5) from the air cylinder rod (Fig. 17, Ref. 1).

12. Check the U-cup piston seal (Fig. 17, Ref. 6) for wear. Install new U-cup piston seal if present seal is cut, torn, solidified or otherwise damaged.

13. Inspect the rod seal (Fig. 15, Refs. 4 & 10) without removing it from the female adapter to see if it is allowing water to leak into the atmosphere. Replace the rod seal with a new one if it is allowing water to leak, or if it is cut, torn, solidified or otherwise damaged.

14. Remove the slotted retainer plug (Fig. 15, Ref. 6) from the stem (Fig. 15, Ref. 5).

NOTE: All the disassembled parts should be washed in soap and water, rinsed, and air dryed. Any foreign material allowed to remain on the parts may cause valve malfunction upon reassembly.

Assembly

1. Install the slotted retainer plug (Fig. 15, Ref. 6) into the stem (Fig. 15, Ref. 5).

2. Place a thin film of light oil on the inside surface of the air cylinder body (Fig. 17, Ref. 4).

3. Check the air cylinder exhaust port in the air cylinder body for obstructions. Remove any lodged material before further assembly.

4. Install the piston return spring (Fig. 17, Ref. 5) onto the air cylinder rod (Fig. 17, Ref. 1).

5. Install the air cylinder rod and the piston return spring assembly into the air cylinder body (Fig. 17, Ref. 4).

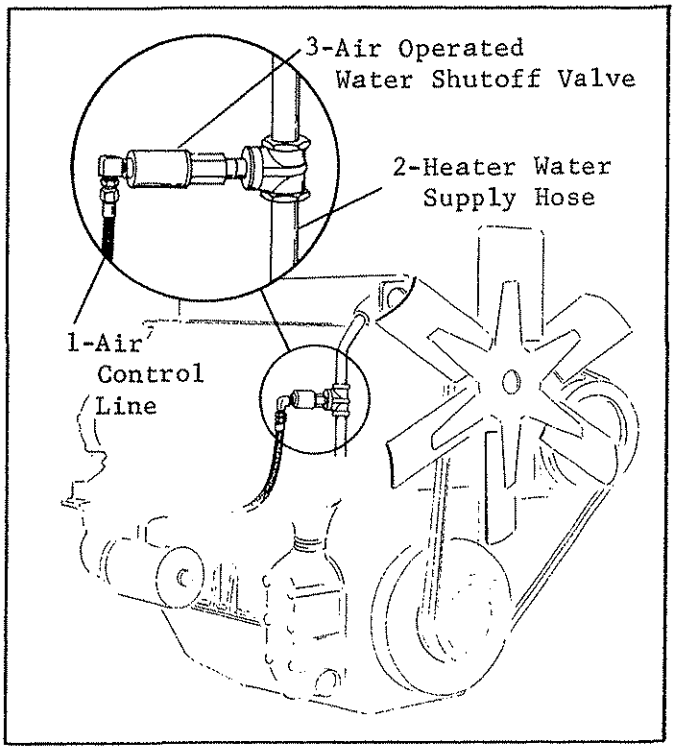


Fig. 14 Typical Air Operated Water Shutoff Valve Installation

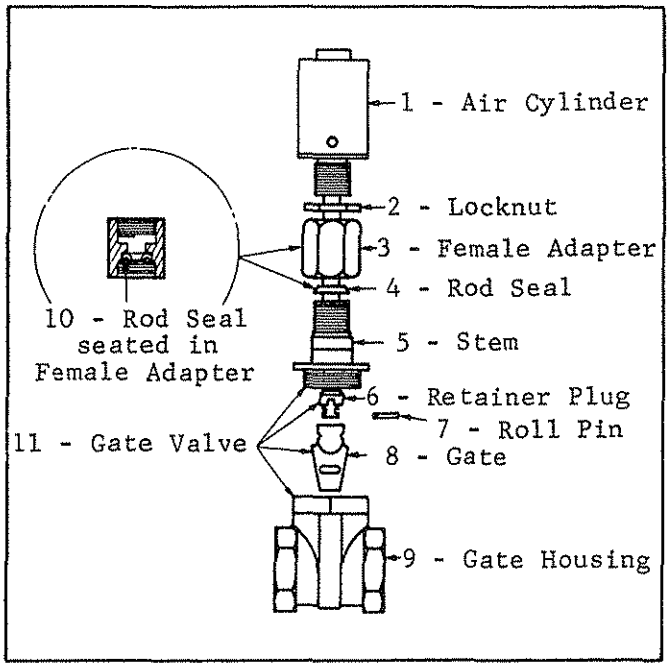


Fig. 15 Air Operated Water Shutoff Valve, Exploded View

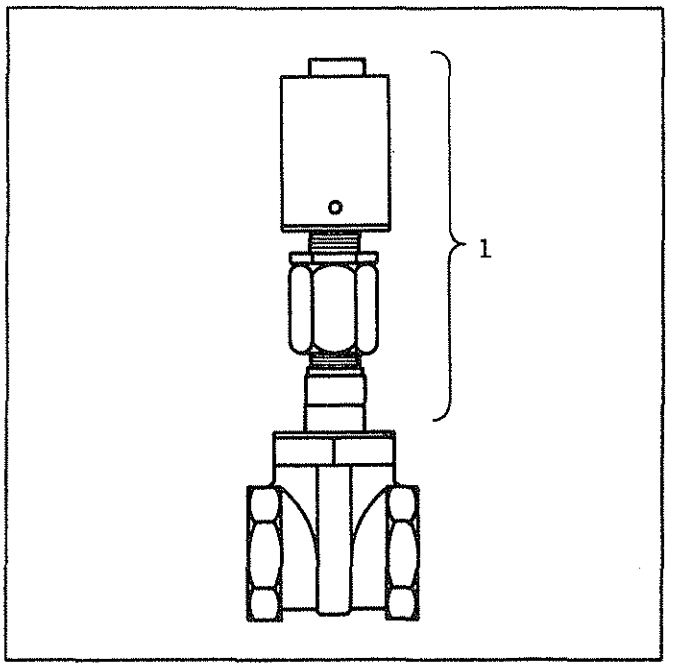


Fig. 16 Air Operated Water Shutoff Valve, Assembled View

6. Slide the male air cylinder fitting (Fig. 17, Ref. 3) and the female adapter (Fig. 15, Ref. 3) with the snugged locknut (Fig. 15, Ref. 2) as an assembly onto the air cylinder rod (Fig. 17, Ref. 1).

7. Install the inside threaded male air cylinder fitting (Fig. 17, Ref. 3) into the air cylinder body (Fig. 17, Ref. 4).

8. Install the stem (Fig. 15, Ref. 5) into the female adapter and air cylinder assembly (Fig. 16, Ref. 1).

9. Place the female adapter (Fig. 15, Ref. 3) in a vise.

10. Apply 30 to 100 lbs of compressed air to the air cylinder (Fig. 15, Ref. 1) to extend the air cylinder rod (Fig. 17, Ref. 1).

11. Place the gate (Fig. 15, Ref. 8) onto the air cylinder rod (Fig. 17, Ref. 1) and tap in the roll pin (Fig. 15, Ref. 7).

12. Cease application of compressed air to the air cylinder. This will result in the release of the air cylinder rod (Fig. 17, Ref. 1).

13. Place the gate housing (Fig. 15, Ref. 9) in a vise.

14. Install the stem and air cylinder assembly (Fig. 16, Ref. 1) into the gate housing (Fig. 15, Ref. 9).

15. Apply and remove 30 to 100 lbs of compressed air to the air cylinder (Fig. 15, Ref. 1) to visually observe the cycling of the valve gate (Fig. 15, Ref. 8) into the gate housing; do this from 5 to 10 times. The gate should seat without jamming. If it does jam, loosen the locknut (Fig. 15, Ref. 2) and move the female connector (Fig. 15, Ref. 3) in or out to produce a jam-free gate operation. Secure the locknut (Fig. 15, Ref. 2), then check the operation again; readjust until gate seats 5 to 10 times consecutively without jamming.

16. Remove the compressed air hose from the assembled valve.

17. Remove the assembled valve from the vise.

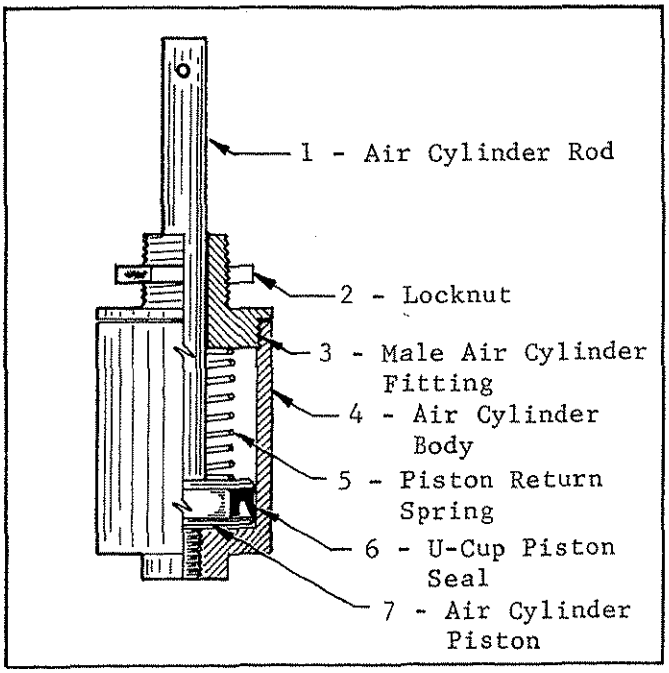


Fig. 17 Air Operated Water Shutoff Valve Air Cylinder, Cutaway View

Installation

1. Install the air operated water shutoff valve assembly (Fig. 14, Ref. 3).

2. Connect the heater water supply hose to the valve (Fig. 14, Ref. 2).

3. Install (saved) coolant fluid in the cooling system.

CAUTION: Coolant fluid should be to within one inch of the bottom of the radiator fill neck. Less than this could result in overheating which in turn could cause engine damage.

4. Connect the air control line (Fig. 14, Ref. 1) to the valve (Fig. 14, Ref. 3).

5. Start vehicle engine with cab tilted so observation can be made of air operated water shutoff valve. With water circulating, observe valve for water leaks. If leakage is present, repeat "Removal" steps 1 through 5; re-test valve prior to use; and perform "Installation" steps 1 through 6. Place the control switch inside cab to the "off" position (Fig. 3, Ref. 1). Cover the valve air line connection with a soap-water solution to detect air leaks. Leakage generating a one inch bubble in three seconds is acceptable. Leakage greater than this is unacceptable. If no bubble appears, inspect closely via sound and feel to make certain that air is not escaping at a rate too fast to develop bubbles. Such leaks are unacceptable.

6. If no water or air leaks are present, installation is complete. If there are water or air leaks, repeat "Removal" steps 1 through 5; re-test the valve; and repeat "Installation" steps 1 through 6 until all leakage is eliminated or is within the acceptable limits given in step 5 under "Installation".

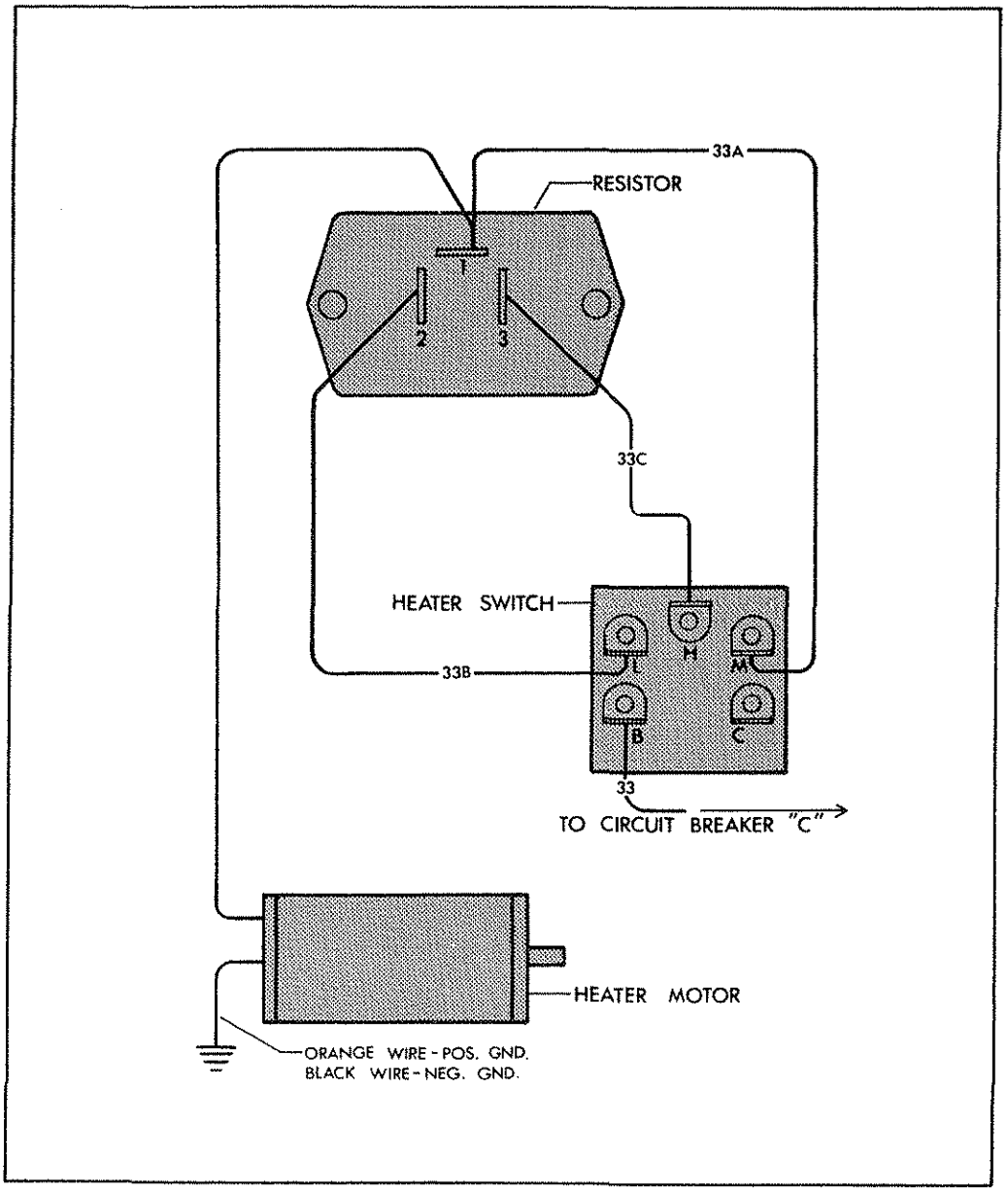


Fig. 18 Heater Wiring Diagram

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER
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FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

GENERAL DESCRIPTION

The Freightliner heater/heater-air conditioner unit is a unique system, in that it can be made available as a heater only or as a combined heater and air conditioning unit. This unit is built into one case utilizing the same motors, blowers, and ducting. The heater/heater-air conditioner is located in the cab between the driver and passenger seats. The system uses outside air that is ducted in from the lower left side of the cab, and cab air that recirculates through the recirculating vents of the heater/heater-air conditioner.

OPERATING INSTRUCTIONS

Fig. 1 heater-air conditioner control panels consist of a fan speed rocker switch, a heater/heater-air conditioner rocker switch, a pneumatic heater toggle switch, and an air conditioner thermostat dial. All of the controls except for the thermostat dial are located in a panel mounted on the plenum cover assembly of the heater/heater-air conditioner. The air conditioner thermostat dial is mounted directly on the plenum cover assembly.

Fig. 2 heater-air conditioner control panels consist of a cab blower dial switch, a defrost blower dial switch, a heater-air conditioner toggle switch, a pneumatic heater toggle switch and an air conditioner thermostat dial. These controls are located in a panel mounted on the plenum cover assembly of the heater/heater-air conditioner.

1. On Fig. 1 control panels, the fan speed rocker switch controls the fresh and recirculating air blower speed. It directs the air through the tunnel ducts to the defrosters and through the console. Depending on the performance desired, the switch can be pushed to "LOW," "MEDIUM," or "HIGH".

   On Fig. 2 control panels, the cab blower dial switch directs fresh air and recirculated air

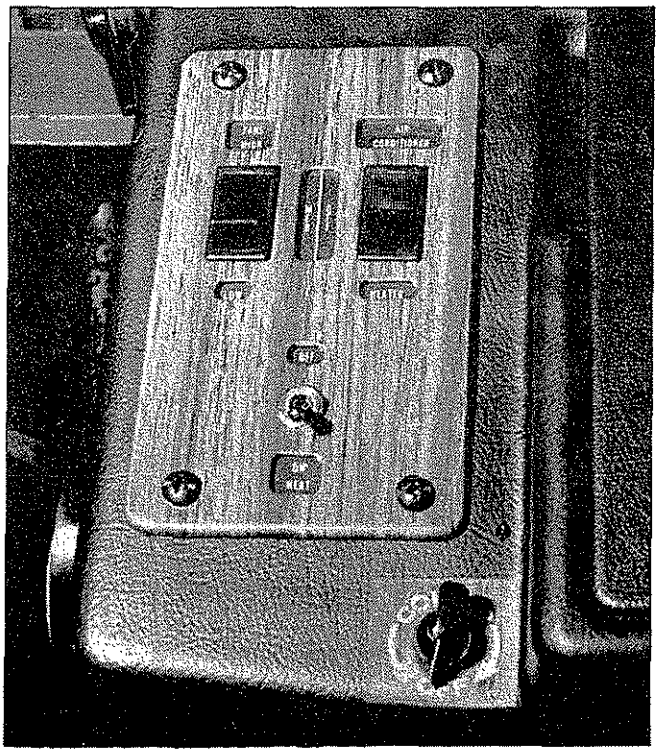


Fig. 1, Heater-Air Conditioner Control Panel With Rocker Switches

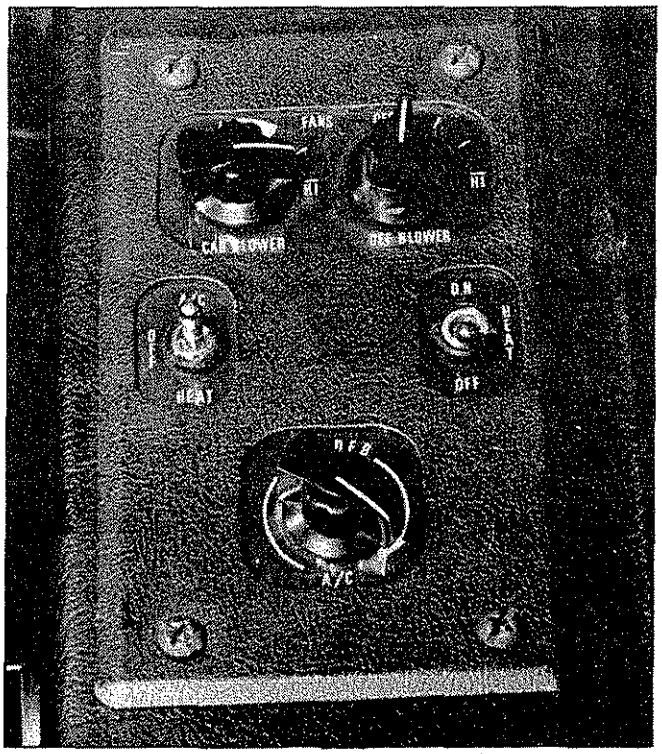


Fig. 2, Heater-Air Conditioner Control Panel With Dial Switches

through the tunnel ducts and into the cab. On heater-air conditioner control panels, this dial can be turned from low (two positions) to medium to high; when the heater-air conditioner toggle switch is in the "OFF" position, the cab blower unit is deactivated. On heater only control panels, the cab blower has an off position (marked "LO" on the control panel), with fan speeds of low, medium, and high.

The defrost blower dial switch, found on Fig. 2 control panels, directs air through the tunnel ducts to the defrosters. Depending on the performance desired, the dial can be turned from low to medium to high, or the defrost blower unit can be turned off completely.

2. On Fig. 1 control panels, the "HEATER-AIR CONDITIONER" rocker switch is used to select either the heater or the air conditioner system and to activate the blower fans. On heater only installations, there are two positions: "ON" and "OFF". On heater-air conditioner units, there are three positions: "HEATER," "AIR CONDITIONER," and "OFF".

   On Fig. 2 control panels, the "A/C—OFF—HEAT" toggle switch is used to select either the heater or the air conditioner system and to activate the cab blower unit. On heater only installations, air and heat flow is controlled by the cab blower dial switch and the defrost blower dial switch (see reference 1 above), and the pneumatic heater toggle switch (see reference 3 below).

3. The pneumatic heater toggle switch controls the air door which is located behind the recirculating vents inside the heater/heater-air conditioner housing. It also controls the air operated water (coolant) shutoff valve. In the "ON" position, the toggle switch opens the air door and activates the water shutoff valve, which controls the flow of engine coolant to the heater core. In the "OFF" position, the toggle switch closes the air door and shuts off the flow of coolant to the heater core.

4. The air conditioner's air temperature is controlled by an adjustable thermostatic dial. When the dial is turned clockwise, cooler conditions are obtained. A rise in temperature closes the switch, thus activating the magnetic clutch and putting the refrigerant compressor into operation. A lowering in temperature opens the switch and deactivates the clutch, thus stopping the refrigerant compressor.

SERVICE OPERATIONS

HEATER/HEATER-AIR CONDITIONER CONTROL PANEL LIGHT(S) REPLACEMENT

CAUTION: Turn the ignition switch to the "off" position to prevent damage to the electrical system during service operations.

1. Remove the screws attaching the heater/heater-air conditioner control panel to the plenum cover, then lift the control panel assembly to a serviceable level.

2. Mark the light socket connected to the light panel cup for later assembly reference. Disconnect the light socket from the light panel cup by pulling them apart.

3. Remove the light bulb from the light socket and install a new one.

4. Assemble the light socket to the light panel cup by firmly pushing them together.

5. Position the control panel on the plenum cover, then install and tighten the screws.

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

FAN/BLOWER SWITCH REPLACEMENT

CAUTION: Turn the ignition switch to the "off" position to prevent damage to the electrical system during service operations.

1. Remove the screws attaching the heater/heater-air conditioner control panel to the plenum cover, then lift the control panel assembly to a serviceable level.

2. Mark the wires connected to the fan/blower switch for later assembly reference. Disconnect the wires from the switch.

3. On Fig. 1 control panels, remove the rocker switch by pushing it outward from the back side of the control panel. Install a new switch, then proceed to step 6.

   On Fig. 2 control panels, loosen the Allen head screw that fastens the blower dial knob to the control panel. Remove the knob. Then, remove the nut located directly under the knob and attached to the control panel.

4. Remove the blower dial switch assembly, then install a new replacement.

5. Install the nut, then install the blower dial knob and tighten the Allen head screw.

6. Connect the electrical wires to the fan/blower switch as previously marked or as shown in Fig. 15 located under **"SPECIFICATIONS".**

7. Position the control panel assembly on the plenum cover, then install and tighten the screws.

HEATER/HEATER-AIR CONDITIONER ROCKER/TOGGLE SWITCH REPLACEMENT

CAUTION: Turn the ignition switch to the "off" position to prevent damage to the electrical system during service operations.

1. Remove the screws attaching the heater/heater-air conditioner control panel to the plenum cover, then lift the control panel assembly to a serviceable level.

2. Mark the wires connected to the heater/heater-air conditioner switch for later assembly reference. Disconnect the wires from the switch.

3. On Fig. 1 control panels, remove the rocker switch by pushing it outward from the back side of the control panel. Install a new switch, then proceed to step 5.

   On Fig. 2 control panels, remove the toggle switch nut from the front of the control panel, then remove the toggle switch.

4. Install a new toggle switch, then install the toggle switch nut.

5. Connect the electrical wires to the heater-air conditioner switch as previously marked or as shown in Fig. 15 located under **"SPECIFICATIONS".**

6. Position the control panel assembly on the plenum cover, then install and tighten the screws.

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

HEATER PNEUMATIC TOGGLE SWITCH REPLACEMENT

1. Remove the screws attaching the heater/heater-air conditioner control panel to the plenum cover, then lift the control panel assembly to a serviceable level.
2. Drain the vehicle air system, then disconnect the air hoses from the heater toggle switch (Fig. 3).
3. Remove the air hose fittings from the heater toggle switch. Then, remove the toggle switch nut from the front of the control panel. Replace the toggle switch with a new one, then fasten the new switch to the control panel, and tighten the toggle switch nut.
4. Apply pipe sealant to the threads on the fittings, then install the air hose fittings on the heater toggle switch.
5. Connect the air hoses to the toggle switch air hose fittings; make sure the tubing is bottomed in the body of the fittings. Tighten the connections according to the instructions given in Table 1 located under **"SPECIFICATIONS".**
6. Position the control panel assembly on the plenum cover, then install and tighten the screws.

THERMOSTAT DIAL AND THERMOSTAT SENSING TUBE REPLACEMENT (Refer to Fig. 4)

CAUTION: Turn the ignition switch to the "off" position to prevent damage to the electrical system during service operations.

1. Remove the plenum cover assembly following the procedure given under "PLENUM COVER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

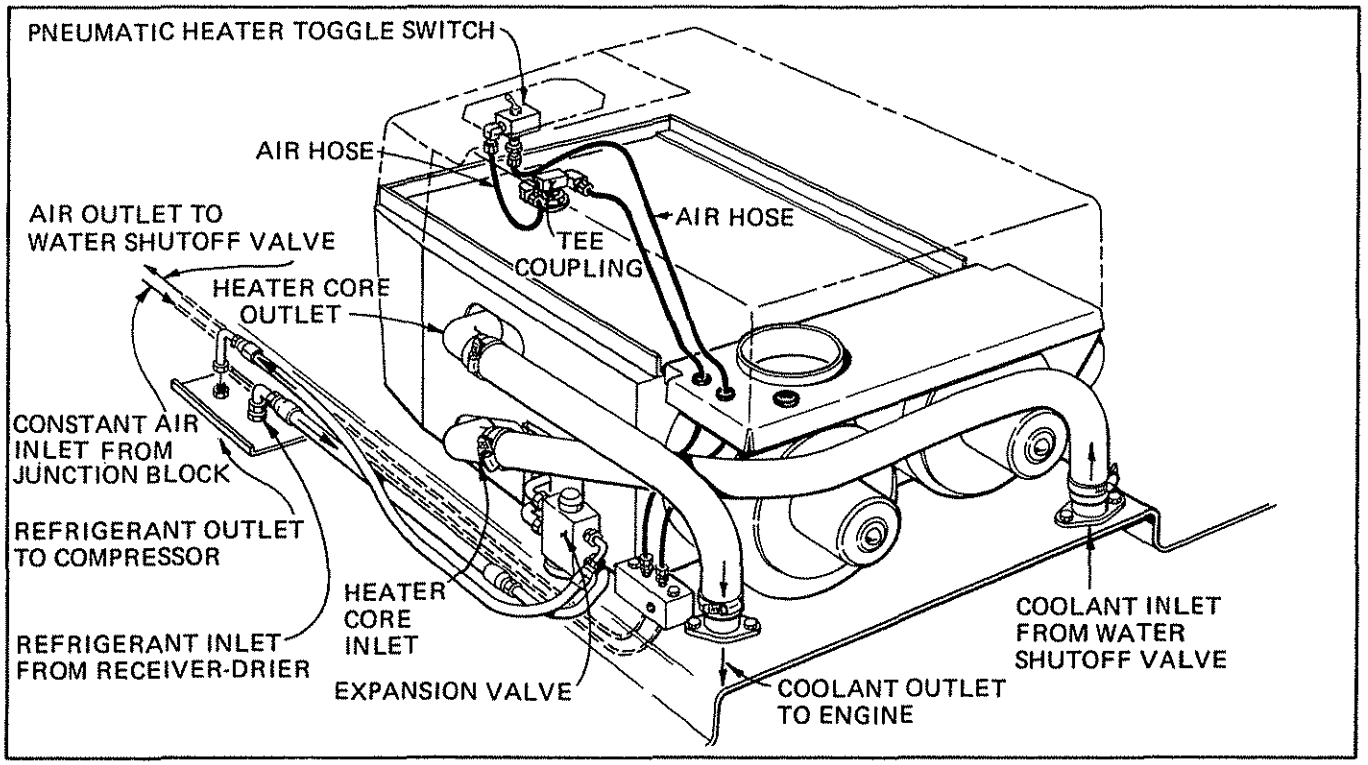
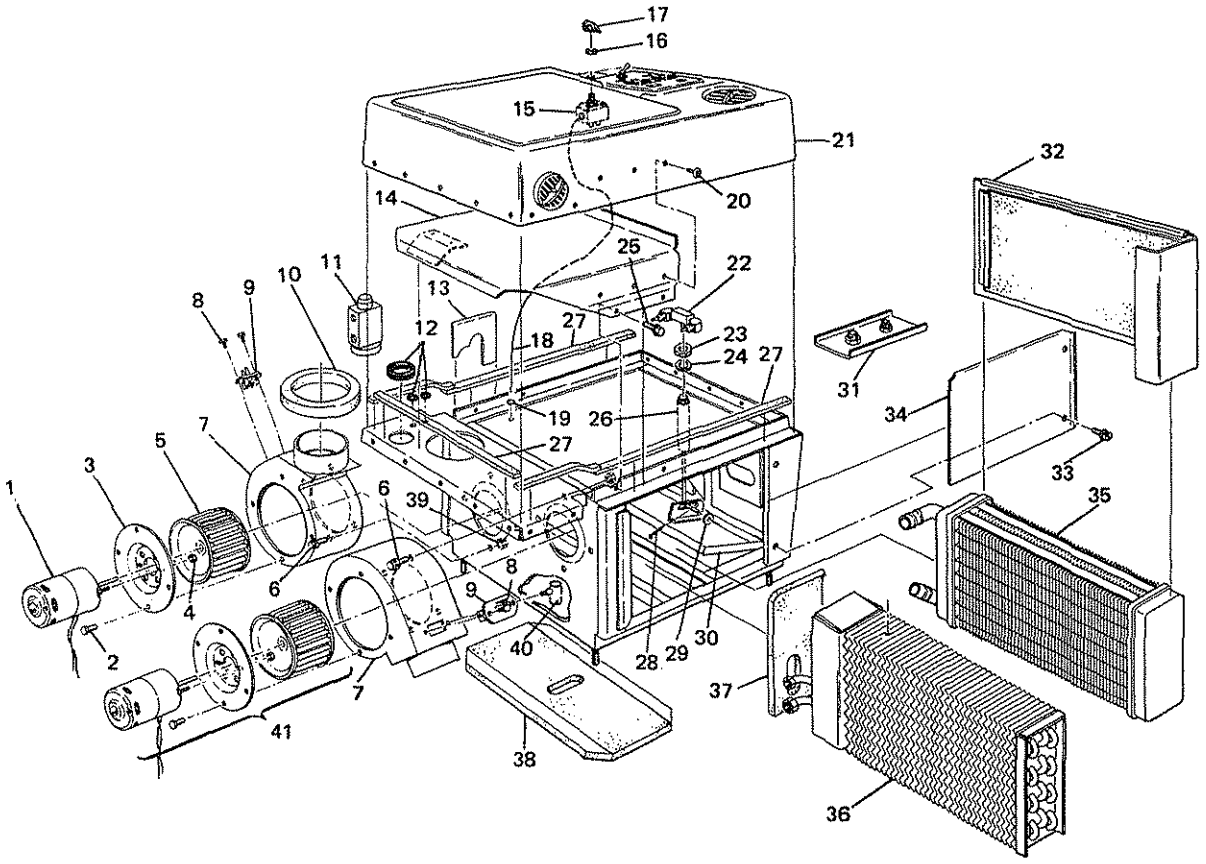


Fig. 3, Heater-Air Conditioner Plumbing

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER



1. Blower Motor
2. Capscrew
3. Motor Mount
4. Nut
5. Blower Wheel
6. Bolt
7. Blower Plenum Assembly
8. Capscrew
9. Resistor Block
10. Heater to Bottom Seal
11. Expansion Valve
12. Grommet
13. Evaporator Seal Panel
14. Stiffener Assembly
15. Thermostat Switch
16. Nut (And Washer)
17. Thermostat Knob
18. Thermostat Sensing Tube
19. Grommet
20. Capscrew
21. Plenum Cover Assembly
22. Air Door Tee Coupling
23. Bulkhead Nut
24. Washer
25. Capscrew
26. Air Actuator
27. Sealant Tape
28. Retainer Clip
29. Washer
30. Air Door
31. Deck Plate
32. Air Filter Assembly
33. Capscrew
34. Door Cover
35. Heater Core
36. Evaporator Coil
37. Insulating Pad
38. Insulating Pad
39. Nut
40. Drain Tube
41. Blower Motor Assembly

NOTE: Some fasteners intentionally omitted in order to provide clarity to the illustration.

Fig. 4, Heater-Air Conditioner Nomenclature

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

2. Remove the capscrews attaching the stiffener to the heater-air conditioner housing, then remove the stiffener.

3. Mark the wires connected to the thermostat for later assembly reference, then disconnect the wires.

4. Remove the thermostat sensing tube from the evaporator coil by straightening it so that it is perpendicular to the top of the housing. Pull straight up until it is completely out.

5. Position the new thermostat dial and thermostat sensing tube through the grommet on top of the housing, then through the evaporator coil fins until the bottom of the evaporator coil is reached. Pull the sensing tube back up 1 1/2 inches (38 mm) and bend it 90° at the grommet to prevent the sensing tube from slipping back into the drain pan. See Fig. 5.

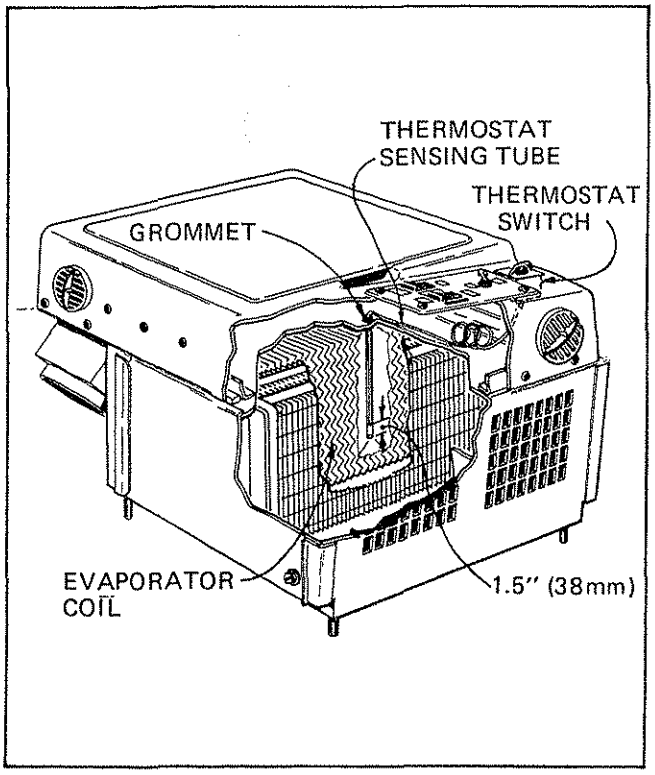


Fig. 5, Thermostat Sensing Tube Installation

6. Connect the electrical wires to the thermostat dial as previously marked or as shown in Fig. 15 located under **"SPECIFICATIONS".**

7. Position the stiffener to the housing, then install and tighten the capscrews.

8. Install the plenum cover assembly using the procedure given under "PLENUM COVER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

PLENUM COVER ASSEMBLY REMOVAL AND INSTALLATION

Removal (Refer to Fig. 4)

CAUTION: Turn the ignition switch to the "off" position to prevent damage to the electrical system during service operations.

1. Remove the nut (and washer) from the heater toggle switch that is attached to the heater/heater-air conditioner control panel.

2. On Fig. 2 control panels only, remove the air conditioner knob that is attached to the thermostat assembly dial. Use an Allen wrench to loosen the knob screw, then remove the knob. Next, remove the nut that fastens the thermostat assembly to the control panel.

3. Remove the screws attaching the control panel assembly to the plenum cover, then lift the control panel assembly to a serviceable level. Remove the heater toggle switch from the control panel, but do not disconnect the air hoses.

4. Mark all the electrical wires for later assembly reference, then disconnect the wires. Set the control panel aside.

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5. On Fig. 1 control panels only, remove the air conditioner thermostat knob that is attached to the thermostat assembly dial. Remove the knob by pulling it upward. Then, remove the nut and washer that fasten the thermostat assembly to the plenum cover.

6. Remove the screws attaching the plenum cover to the heater/heater-air conditioner housing.

7. Remove the plenum cover from the heater/heater-air conditioner.

8. Remove, then discard the old sealant tape found along the bottom edge of the plenum cover assembly.

Installation (Refer to Fig. 4)

1. Install new sealant tape, as shown in Fig. 6.

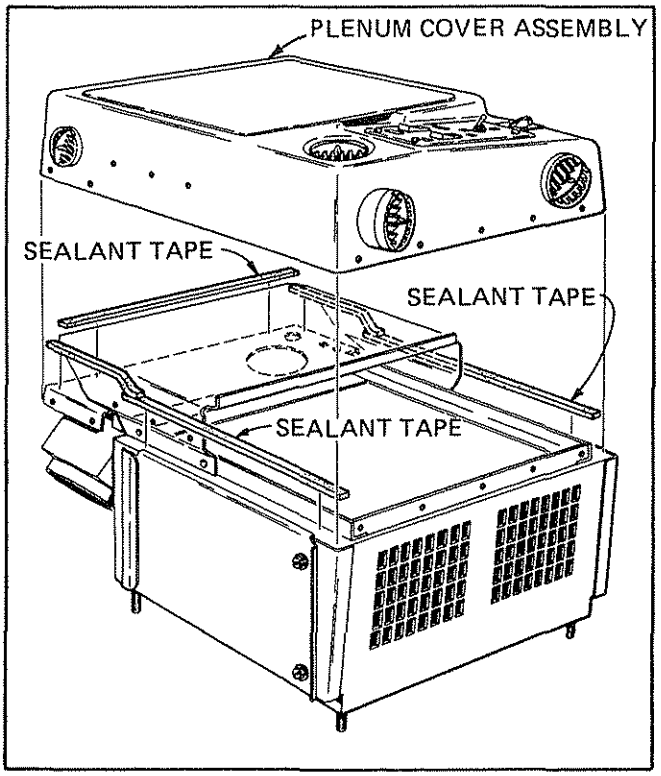

Fig. 6, Sealant Tape Installation

NOTE: Apply sealant tape to clean, dry, and greasefree surfaces only.

2. Position the plenum cover on the heater/heater-air conditioner housing. On Fig. 1 control panel plenum covers, make sure the thermostat assembly shaft is through the proper installation hole. Then, install and tighten the screws attaching the plenum cover to the housing.

3. On Fig. 1 control panel plenum covers, install and tighten the washer and nut attaching the thermostat assembly to the plenum cover. Then, install the thermostat knob by pushing it downward until it seats on the thermostat assembly shaft.

4. Position the heater toggle switch in the control panel, then install and tighten the nut (and washer).

5. Connect the electrical wires as previously marked or as shown in Fig. 15 located under **"SPECIFICATIONS".**

6. On Fig. 2 control panels, install the thermostat assembly shaft in the proper control panel installation hole. Then, attach and tighten the nut that fastens the thermostat assembly to the control panel. Install the thermostat knob and tighten the screw with an Allen wrench.

7. Position the control panel assembly on the plenum cover, then install and tighten the attaching screws.

DEFROST AND/OR CONSOLE BLOWER MOTOR(S) REMOVAL AND INSTALLATION

Removal (Refer to Fig. 4)

1. Remove the heater/heater-air conditioner assembly using the procedure given under

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"HEATER/HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

CAUTION: Turn the ignition switch off and place the heater/heater-air conditioner switch in the "OFF" position to prevent accidental fan operation during service operations.

2. Mark the wires connected to the blower motor for later assembly reference, then disconnect the wires.

3. Remove the capscrews attaching the blower motor assembly to the blower plenum housing.

4. Remove the blower motor assembly from the blower plenum housing.

5. Remove the Allen head set screw attaching the blower wheel to the motor shaft.

6. Remove the blower wheel.

7. Remove the nuts and washers attaching the motor mount to the blower motor.

8. Remove the motor mount.

Installation (Refer to Fig. 4)

1. Position the motor mount on the blower motor, then install and tighten the nuts and washers.

2. Position the blower wheel over the motor shaft making sure the Allen head set screw is over the flat part of the shaft.

3. Install and tighten the Allen head set screw with an Allen wrench.

4. Position the blower motor assembly inside the blower plenum housing, then install and tighten the capscrews.

5. Connect the electrical wires to the blower motor as previously marked or as shown in Fig. 15 located under **"SPECIFICATIONS".**

6. Install the heater/heater-air conditioner unit using the procedure given under "HEATER/HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

HEATER CORE REMOVAL AND INSTALLATION

Removal (Refer to Fig. 4)

1. Remove the passenger seat. Place the pneumatic heater toggle switch inside the cab in the "OFF" position.

2. Drain the heater core by disconnecting the heater hose clamps from the elbows that protrude through the cab floor outside the vehicle. Save the coolant for later use. After the fluid is drained, disconnect the heater hoses from the heater core. See Fig. 3.

3. Remove the door cover screws, then remove the door cover by pulling the forward side outward and sliding the door cover forward.

CAUTION: Remove the door cover carefully so that other components will not be damaged.

4. Remove the air filter assembly, if so equipped, and the heater core from the housing by sliding them outward.

WARNING: Because of the sharp edges on the heater core grille blades, protective gloves should be worn when servicing the heater core.

Installation (Refer to Fig. 4)

1. Wearing protective gloves, position the heater core in the housing.

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2. Install the air filter assembly, if so equipped, alongside the heater core.

3. Position the door cover to the housing, then install and tighten the attaching screws.

CAUTION: Install the door cover carefully so that other components will not be damaged.

4. Connect the heater hoses to the heater core, as shown in Fig. 3, then securely tighten all clamps.

5. Fill the cooling system with coolant, then follow the instructions given under "BLEEDING AIR FROM THE HEATER CORE," in this subject.

6. Install the passenger seat.

BLEEDING AIR FROM THE HEATER CORE

With the engine running, place the cab pneumatic heater toggle switch in the "ON" position. Fluid will flow through the heater core and force any entrapped air through the heater outlet hose and out the radiator. If there is a drop in the coolant fluid level after the air is exhausted, fill the radiator to within one inch (25.4 mm) of the bottom of the filler neck.

CAUTION: Coolant fluid should be filled to within one inch (25.4 mm) of the bottom of the radiator filler neck. Less than this could result in overheating which could cause engine damage.

AIR FILTER ASSEMBLY REMOVAL, CLEANING, AND INSTALLATION

NOTE: The air filter assembly is a customer requested option.

Removal (Refer to Fig. 4)

1. Remove the passenger seat.

2. Remove the door cover screws, then remove the door by pulling the forward side out and sliding the door cover forward.

CAUTION: Remove the door cover carefully so that other components will not be damaged.

3. Remove the air filter assembly from the housing by sliding it outward.

Cleaning

1. Clean the air filter with soap and water.

2. Air dry the filter before installing.

Installation

1. Install the air filter and air filter bracket alongside the heater core.

2. Position the door cover on the housing, then install and tighten the attaching screws.

CAUTION: Install the door carefully so that other components will not be damaged.

3. Install the passenger seat.

AIR ACTUATOR ASSEMBLY REPLACEMENT (Refer to Fig. 4)

1. Remove the passenger seat.

2. Remove the plenum cover assembly using the procedure given under "PLENUM COVER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

3. Remove the door cover screws, then remove the door cover by pulling the forward side out and sliding it forward.

CAUTION: Remove the door cover carefully so that other components will not be damaged.

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4. Drain the vehicle air system, then mark the air hoses connected to the tee coupling for later assembly reference. Disconnect the air hoses. See Fig. 3.

5. Remove the tee coupling from the bulkhead nut.

6. Remove the bulkhead nut and washers from the air actuator assembly.

7. Remove the retainer clip that attaches the air actuator assembly to the air door, then remove the air actuator.

8. Position the new air actuator through the heater/heater-air conditioner housing, then install the washer and bulkhead nut. Tighten the bulkhead nut finger-tight. Then, with a wrench, tighten 2 1/2 additional turns.

9. Position the air actuator on the air door handle and install the retainer clip attaching the air actuator to the door handle.

10. Check the air door operation. Be sure the door works freely, has full movement, and seals securely.

11. Apply pipe sealant to all fitting threads, and assemble the tee coupling to the bulkhead nut. Tighten the tee coupling finger-tight. Then, with a wrench, tighten 2 1/2 additional turns.

12. Connect the air hoses to the tee coupling; make sure the tubing is bottomed in the fitting. Tighten the connection using the instructions given in Table 1 located under **"SPECIFICATIONS."** Use two wrenches when tightening the fittings to prevent twisting of the tubing.

13. Position the door cover on the heater/heater-air conditioner housing, then install the door cover screws.

CAUTION: Install the door cover carefully so that other components will not be damaged.

14. Install the plenum cover assembly using the procedure given under "PLENUM COVER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

15. Install the passenger seat.

AIR OPERATED WATER SHUTOFF VALVE REPLACEMENT (Refer to Fig. 7)

1. Place the heater toggle switch inside the cab to the "ON" position. When in this position, air pressure to the water shutoff valve is stopped.

2. Drain the cooling system by opening the drain cock located on the bottom tank of the radiator. Save the coolant fluid for later use.

3. Disconnect the air control line from the water shutoff valve.

4. Disconnect the heater hoses from the water shutoff valve.

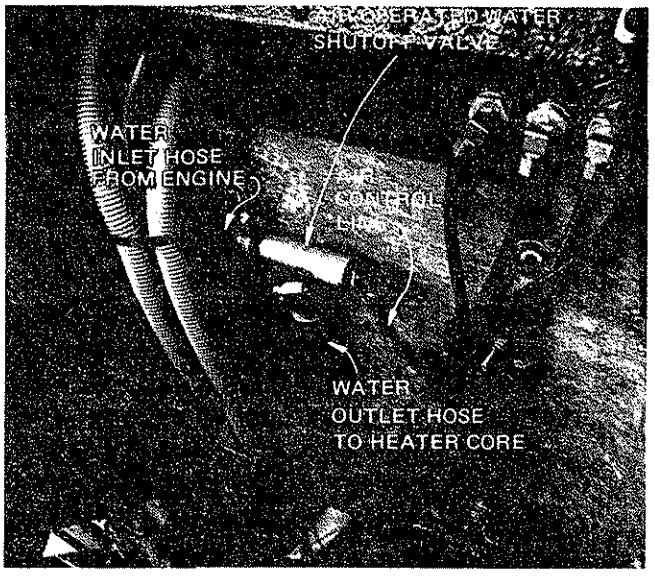

Fig. 7, Air Operated Water Shutoff Valve

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5. Remove the water shutoff valve assembly and install a new one.

6. Connect the heater hoses to the water shutoff valve.

7. Close the drain cock on the bottom tank of the radiator.

8. Install the (saved) coolant fluid in the cooling system.

CAUTION: Coolant fluid should be filled to within one inch (25.4 mm) of the bottom of the radiator filler neck. Less than this could result in overheating which could cause engine damage.

9. Apply pipe sealant to the threads on the fitting, then connect the air control line to the water shutoff valve. See Fig. 7. Tighten the connections to the specifications given in Table 1 located under **"SPECIFICATIONS."**

10. Start the vehicle engine with the hood tilted so that observation can be made of the water shutoff valve. With the coolant circulating, observe the valve for coolant leaks. If leakage is present, turn off the engine, then repeat steps 2 through 10.

11. With the engine running, and the cab pneumatic heater toggle switch in the "OFF" position, cover the water shutoff valve air control line connection with a soapwater solution to detect air leaks. Leakage generating a one inch (25.4 mm) bubble or less in three seconds is acceptable. Leakage greater than this is unacceptable. If no bubble appears, inspect closely via sound, and feel to make certain that air is not escaping at a rate too fast to develop bubbles. Such leaks are unacceptable.

    If there are unacceptable air leaks, turn off the engine, then repeat steps 1, 3, 9, and 11.

EVAPORATOR COIL REMOVAL AND INSTALLATION

Removal (Refer to Fig. 4)

1. Remove the driver and passenger seats.

2. When any air conditioner components containing refrigerant are replaced, the system must be discharged and purged. Discharge and then purge the air conditioner system following the procedures under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, and/or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas which, if inhaled, causes severe respiratory irritation.

3. After the system is completely discharged and purged, remove the expansion valve using the following procedure:

    .1 Remove the evaporator seal panel, then remove the refrigeration insulating tape that covers the refrigerant lines.

    .2 Disconnect the refrigerant lines from the expansion valve. See Fig. 3. Use two wrenches to avoid twisting the tubing. Install plugs in the refrigerant lines and the ports of the expansion valve.

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CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Water will freeze inside the expansion valve and combine with the refrigerant to create acid. The ice in the expansion valve stops the cooling and the acid will gradually corrode the entire system. Dirt will plug the expansion valve and stop the cooling. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

4. Remove the plenum cover assembly using the procedure given under "PLENUM COVER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

5. Remove the stiffener capscrews, then remove the stiffener assembly.

6. Remove the thermostat sensing tube from the evaporator coil by straightening it so that it is perpendicular to the top of the heater-air conditioner housing. Pull straight up until it is completely out.

7. Remove the heater core (and air filter assembly) using the procedure given under "HEATER CORE REMOVAL AND INSTALLATION" in this subject.

8. Remove the evaporator coil from the housing by sliding it outward.

WARNING: Because of the sharp edges on the evaporator coil grille blades, protective gloves should be worn when servicing the evaporator coil.

Installation (Refer to Fig. 4)

1. Place the refrigeration insulating pad over the evaporator coil tubing. Then, wearing protective gloves, install the evaporator coil in the heater-air conditioner housing.

2. Install the heater core (and air filter assembly) using the procedure given under "HEATER CORE REMOVAL AND INSTALLATION" in this subject.

3. Position the door cover to the housing, then install and tighten the screws.

CAUTION: Install the door cover carefully so that other components will not be damaged.

4. Install the thermostat sensing tube through the grommet on top of the housing, then through the evaporator coil fins until the bottom of the evaporator coil is reached. Pull the sensing tube back up 1 1/2 inches (38 mm) and bend it 90° at the grommet to prevent the sensing tube from slipping back into the drain pan. See Fig. 5.

5. Install the expansion valve using the following procedure:

   .1 Remove the plugs from the refrigerant lines and expansion valve. Apply refrigerant oil to the threads and connect the refrigerant lines to the expansion valve. Tighten the connection to the torque value given in Table 2 located under **"SPECIFICATIONS."** Use two wrenches when tightening fittings to prevent twisting of tubing.

   .2 Evacuate, charge, and leak test the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

   .3 Clean the refrigerant lines and insulate them with refrigeration insulating tape.

6. Position the stiffener on the housing, then install and tighten the capscrews.

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7. Install the plenum cover assembly using the procedure given under "PLENUM COVER ASSEMBLY REMOVAL AND INSTALLATION" in this subject.

8. Install the driver and passenger seats.

THERMOSTATIC EXPANSION VALVE REPLACEMENT

1. Remove the driver's seat.

2. When any air conditioner components containing refrigerant are replaced, the system must be discharged and purged. Discharge, and then purge the air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, and/or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas which, if inhaled, causes severe respiratory irritation.

3. After the system is completely discharged and purged, remove the evaporator seal panel (Fig. 4, Ref. 13). Then, remove the refrigeration insulating tape that covers the refrigerant lines.

4. Disconnect the refrigerant lines from the expansion valve. See Fig. 3. Use two wrenches to avoid twisting the tubing. Install plugs in the refrigerant lines and install a new expansion valve.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Water will freeze inside the expansion valve and combine with the refrigerant to create acid. The ice in the expansion valve stops the cooling and the acid will gradually corrode the entire system. Dirt will plug the expansion valve and stop the cooling. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

5. Remove the plugs from the refrigerant lines and expansion valve. Apply refrigerant oil to the threads and O-rings and connect the refrigerant lines to the expansion valve. Tighten the connection to the torque value given in Table 2 located under **"SPECIFICATIONS."** Use two wrenches when tightening fittings to prevent twisting of tubing.

6. Evacuate, charge, and leak test the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

7. Wipe the refrigerant lines clean with a rag, then insulate with refrigeration insulating tape.

8. Install the evaporator seal panel.

9. Install the driver's seat.

RECEIVER-DRIER REPLACEMENT

1. When any air conditioner components containing refrigerant are replaced, the system must be discharged and purged. Discharge, and then purge the air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric

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pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, and/or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas which, if inhaled, causes severe respiratory irritation.

2. After the system is completely discharged and purged, disconnect the refrigerant lines from the receiver-drier. Use two wrenches to avoid twisting the tubing. Install plugs in the refrigerant lines.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

3. Remove the U-bolt nuts, washers, and U-bolt that attach the receiver-drier to the mounting bracket, then remove the receiver-drier.

4. Position the new receiver-drier (Fig. 8) in the mounting bracket and install the U-bolts, washers and nuts. Tighten the U-bolt nuts to 13 ft-lbs (18 N·m).

5. Remove the plugs from the refrigerant lines. Apply refrigeration oil to the seal surface and threads, then connect the lines to the receiver-drier. Tighten the connections to the torque values given in Table 2 located under **"SPECIFICATIONS"** (use two wrenches to avoid twisting the tubing).

6. Evacuate, charge, and leak test the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

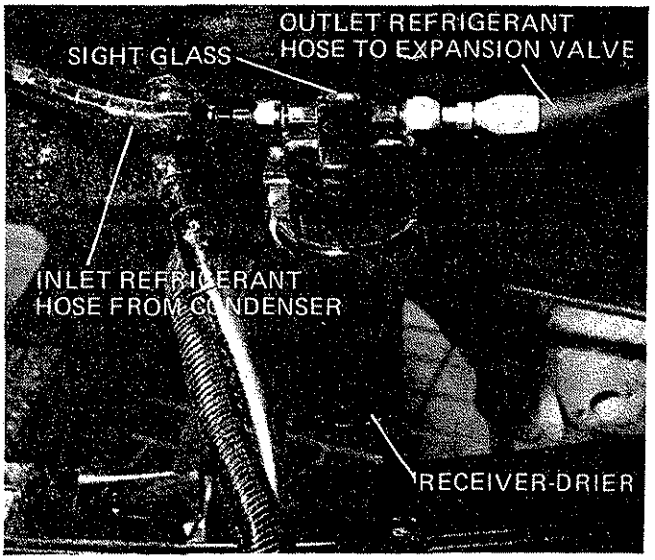

Fig. 8, Typical Receiver-Drier

CONDENSER REMOVAL AND INSTALLATION

Removal

1. When any air conditioner components containing refrigerant are replaced, the system must be discharged and purged. Discharge, and then purge the air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, and/or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas which, if inhaled, causes severe respiratory irritation.

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2. After the system is completely discharged and purged, disconnect the refrigerant lines from the condenser. See Fig. 9. Use two wrenches to avoid twisting the line while loosening the fittings. Install plugs in the refrigerant lines and condenser inlet-outlet tubes.

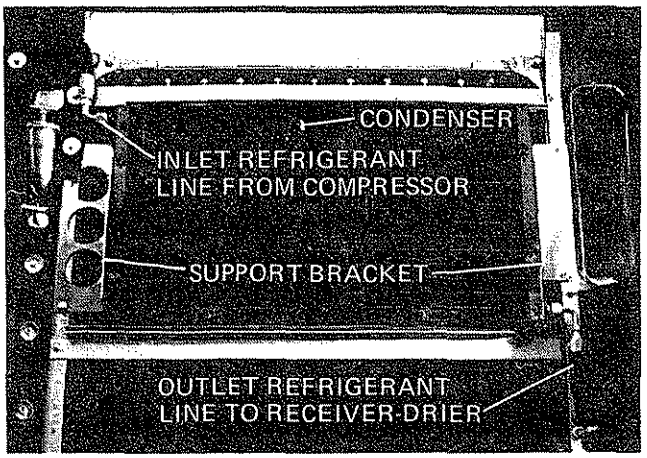

Fig. 9, Condenser

3. Remove the capscrews attaching the support bracket of the condenser to the radiator, then remove the condenser.

Installation

1. Position the condenser and support brackets on the radiator, then install and tighten the capscrews to 9 ft-lbs (12 N·m).

2. Remove the plugs from the refrigerant lines and condenser inlet-outlet tubes. Apply refrigerant oil to seal surfaces, O-rings, and threads. Connect the refrigerant lines to the condenser. Tighten the connections to the torque value given in Table 2 located under **"SPECIFICATIONS."** Use two wrenches to avoid twisting the tubing.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

3. Discharge, purge, evacuate, charge, and then leak test the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING

Whenever repairs have to be made on any of the air conditioner system components containing refrigerant, the system must be discharged, purged, evacuated, charged, and leak tested.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, and/or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas which, if inhaled, causes severe respiratory irritation.

The following checks should be made whenever the system is not cooling properly and the causes are unknown, or whenever routine maintenance of the air conditioning system occurs. These checks should be made prior to discharging the air conditioning system.

1. Adjust the refrigerant compressor belt tension. Refer to the 01 Group in this manual for instructions.

2. Check the refrigerant compressor clutch coil wire connection for tightness. Tighten if loose. Repair if broken or damaged.

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3. Check for broken or cut hoses and for loose fittings on all components. Remove broken or cut hoses, and replace them with new ones. Tighten loose fittings to the torque values given in Table 2 under **"SPECIFICATIONS."**

4. Check for foreign material blockage of condenser external fins. Using air pressure and whisk broom, clean the condenser if foreign material is present.

5. With the blower motor on "HI" and the "AIR CONDITIONER" switch turned on, make sure there is no air leakage at any of the air duct connections. If leakage is present, repair the connection.

6. When the checks above are completed, proceed to **"Discharging Using A Manifold Gauge Set"** in this subject.

Discharging Using A Manifold Gauge Set

Discharging the air conditioner system removes most of the refrigerant present in the system. After discharging, the system should be purged. For purging instructions, refer to **"Purging Using Dry Nitrogen"** in this subject.

1. Connect the service gauges to the service valves on top of the refrigerant compressor, (as shown in Fig. 12) but do not connect the manifold center service hose to the vacuum pump.

2. Position the open end of the center service hose in a jar to catch the refrigeration oil, then place in the shop exhaust system.

3. With both manifold valves off, open both service valves (on the compressor), then open the suction side manifold valve and bleed so that a minimum of oil is escaping into the jar. As the pressure drops, slowly open the discharge manifold valve again being careful to minimize oil escaping with the refrigerant. Do not discharge rapidly or the oil will be carried out with the refrigerant. If the oil does escape, any oil carried out will collect in the jar, and the compressor will have to be refilled with the same quantity of new refrigerant oil. Refer to the 01 Group of this manual for refrigerant compressor servicing information.

4. Position the refrigerant compressor suction service valve and discharge service valve halfway in.

5. After the refrigerant has been discharged from the system, disconnect the center service hose from the shop exhaust outlet, then disconnect the service gauges from the refrigerant compressor service valves. Proceed to **"Purging Using Dry Nitrogen"** in this subject.

Purging Using Dry Nitrogen

Purging the air conditioning system completely flushes out any moisture laden air, residual refrigerant and dirt from the plumbing. If left in the system, these contaminants would adversely affect the life and operation of the air conditioning system.

The entire plumbing circuit may be contaminated, or just a portion of it. If contamination is suspected, the extent of the problem can be determined by disconnecting and inspecting individual components (including the sleeper box air conditioner, if so equipped) for dirt, sludge, metallic grit, or other foreign materials. In any event, the system should be purged in segments to minimize the chance of blowing these deposits against one of the internal screens or orifices where it remains to become a problem again.

Figure 10 is an outline of the basic plumbing circuit with potential problem areas and recommended purge points.

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

NOTE: Dry nitrogen gas is recommended for purging, but any safe, inert, dry gas may be substituted.

To purge that segment of the system containing the refrigerant compressor, proceed as follows (refer to Fig. 11):

1. Hook the nitrogen pressure hose onto the uncapped end of the suction service valve of the refrigerant compressor.
2. Disconnect the refrigerant hose from the discharge service valve of the refrigerant compressor.
3. Back seat (turn counterclockwise all the way out) the refrigerant compressor discharge service valve.
4. Front seat (turn clockwise all the way in) the suction service valve on the refrigerant compressor.

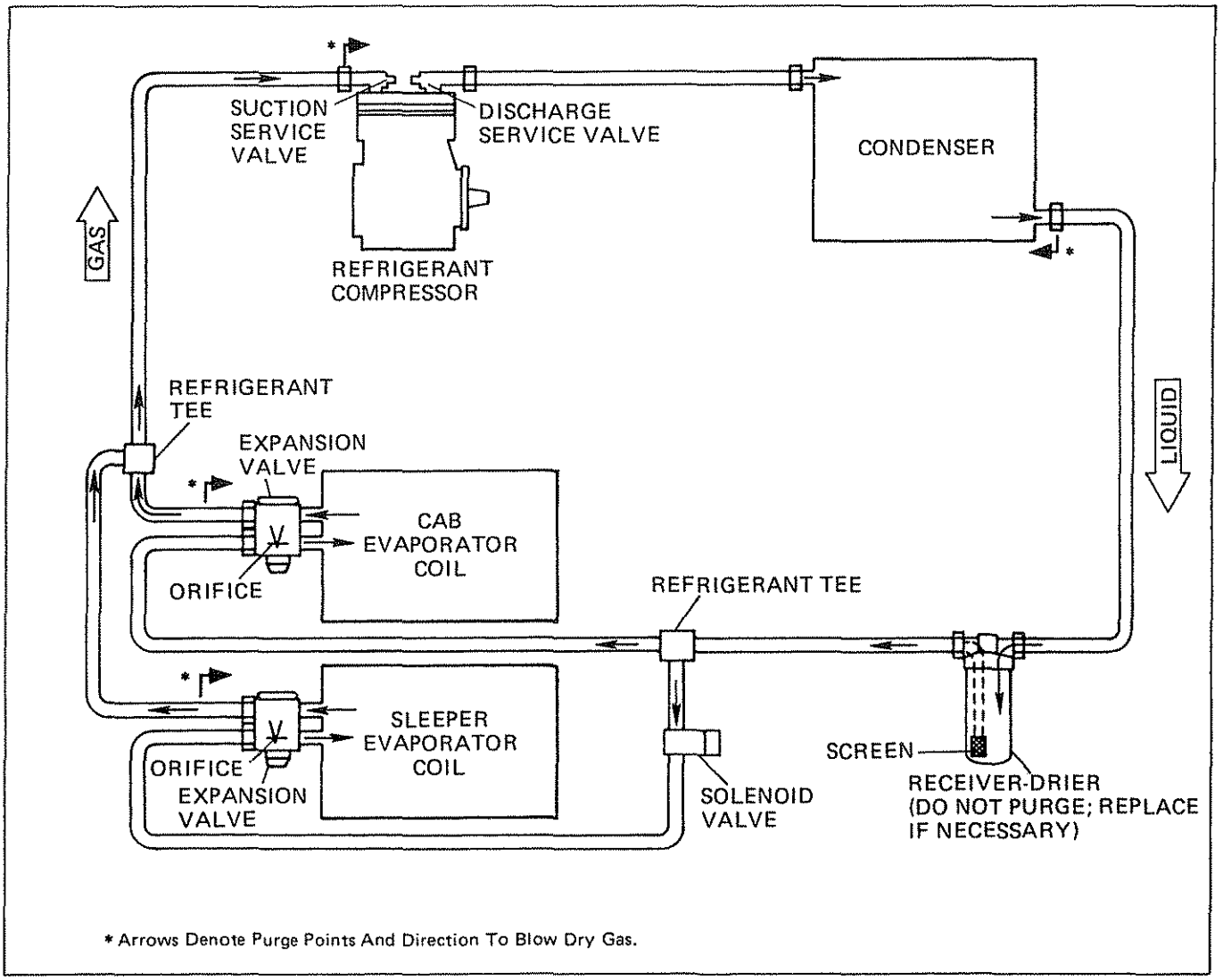

Fig. 10, Purge Points In Air Conditioner System (Including Sleeper Box Air Conditioner)

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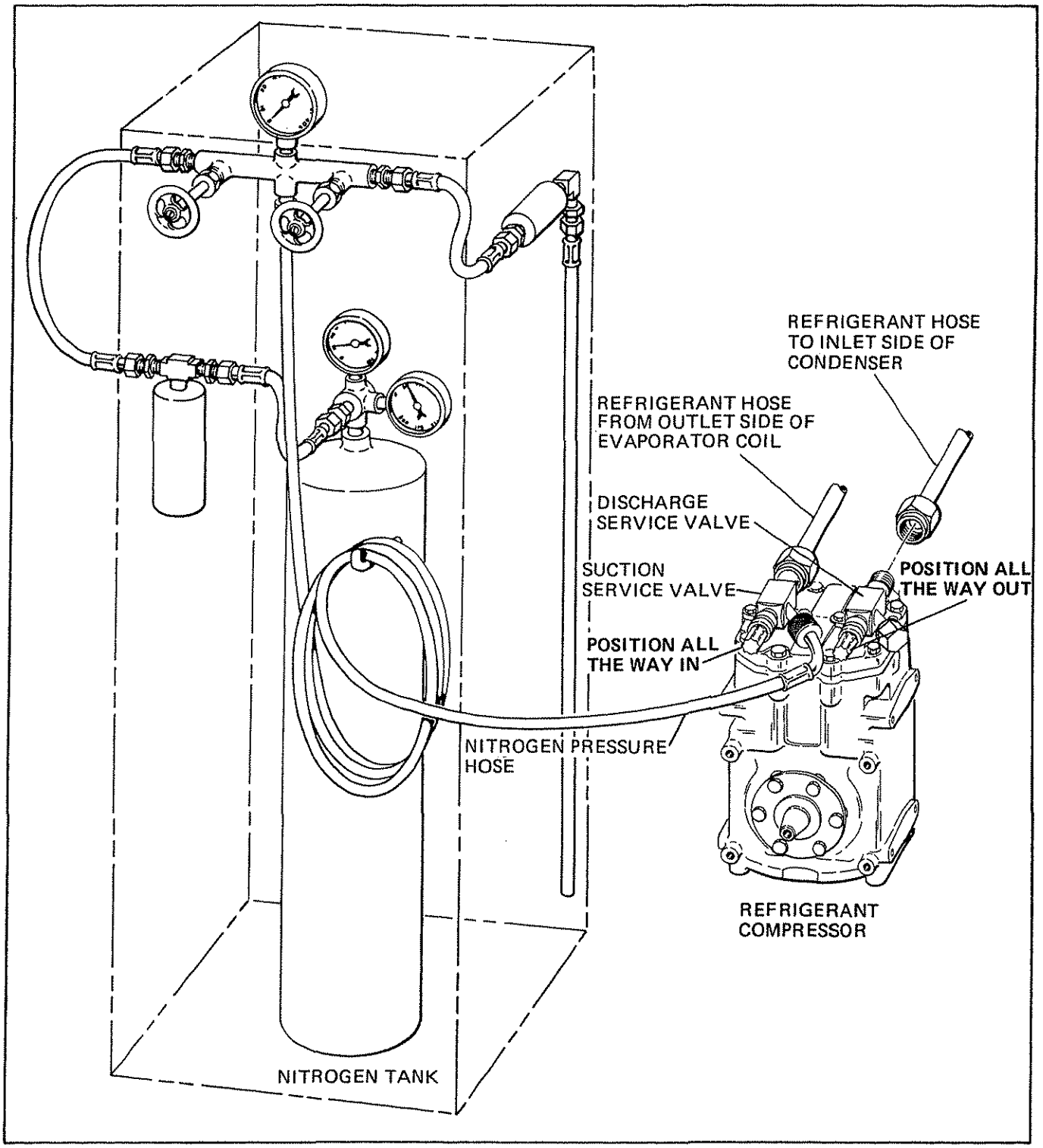

Fig. 11, Purging The Refrigerant Compressor Using Dry Nitrogen

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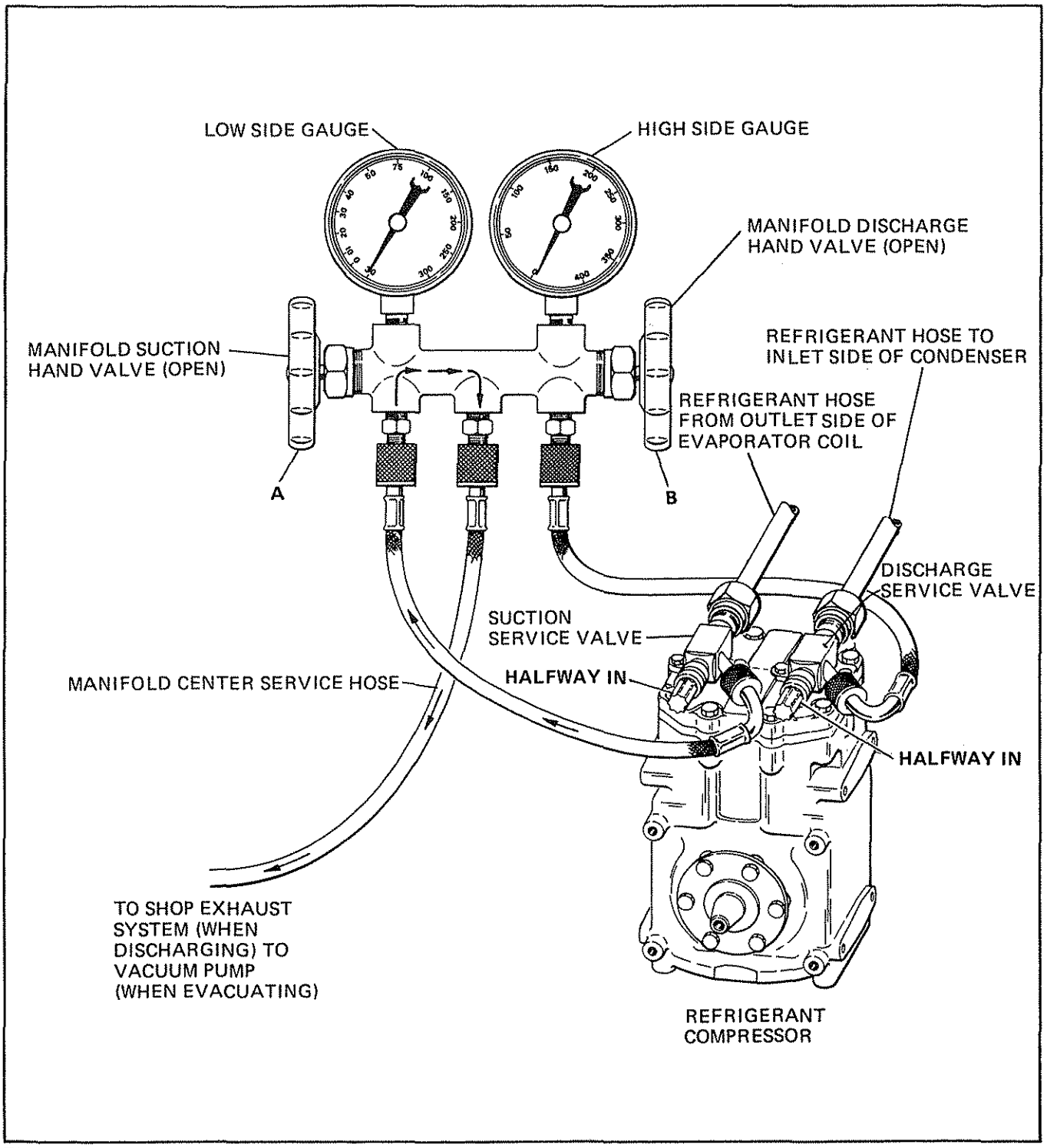

Fig. 12, Evacuating The System With A Vacuum Pump

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5. Turn on the nitrogen tank; nitrogen will flow through the suction service valve, through the refrigerant compressor, and out the discharge service valve.

6. Feel the outlet from the discharge service valve to see if there is a definite flow of nitrogen coming out.

7. Purge the system for about 25-30 seconds at 200 psi (1378 kPa). Reduce the pressure to 3-4 psi (14-21 kPa) and continue purging for one to two minutes. Then, turn off the nitrogen flow at the tank.

8. Reconnect the refrigerant hose to the discharge service valve of the compressor.

9. Remove the nitrogen pressure hose from the suction service valve of the refrigerant compressor.

10. If no other segments need purging, position the refrigerant compressor discharge and suction service valves halfway in. Then, proceed to **"Evacuating"** in this subject.

To purge other areas of the system, disconnect the segment in question, connect the nitrogen hose to the downstream end (to flow the dry gas opposite to the direction of refrigerant flow), and perform those portions of steps 5, 6, and 7, as applicable. Then, reconnect the segment to provide a tightly sealed system.

Evacuating

Evacuating the air conditioning system creates a vacuum within the system in order to remove all traces of air and moisture, and to determine if refrigerant leaks are occuring. A vacuum must be held throughout the system in order to be able to charge the system with refrigerant.

1. With the system completely discharged and purged, connect the service gauges to the service valves on top of the refrigerant compressor, as shown in Fig. 12, then connect the manifold center service hose to the vacuum pump.

2. Start the vacuum pump, then open the manifold suction hand valve and the manifold discharge hand valve (Fig. 12, Ref. A & B).

3. When the low side gauge reads 27-29 inHg (91-98 kPa) of vacuum and will go no lower, and the high side gauge reads slightly below the zero index of the gauge, let the pump operate another 10 minutes, then close (turn clockwise all the way in) the manifold suction hand valve and the manifold discharge hand valve, and shut off the vacuum pump.

4. If the low side gauge rises after 15 minutes and continues to rise, the system has a leak. A partial charge must be installed and the system must be leak checked. Refer to **"Leak Testing"** in this subject.

   If the low side gauge does not rise, there is no leak present; open (turn counterclockwise all the way out) the manifold suction and discharge hand valves, turn on the vacuum pump and let it run for at least one hour. After one hour or more of evacuation on the vacuum pump, close the manifold suction hand valve and the discharge hand valve, then shut off the vacuum pump. Negative pressure must be held in the system.

Charging

Charging the air conditioning system places a charge of refrigerant in the system.

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With the System Evacuated and Using Liquid Refrigerant

CAUTION: Never charge liquid refrigerant into the system while the refrigerant compressor or engine is running. To do so could result in damage to the compressor.

1. With the system completely evacuated and no leaks present, connect the manifold center service hose to the refrigerant can. Position the refrigerant can as shown in Fig. 13.

2. Loosen the manifold center service hose connection at the manifold (Fig. 13, Ref. C) approximately 2 turns.

3. Open the valve on the refrigerant can and allow gas to escape at the loosened connection for about 5 seconds, then tighten the manifold center service hose connection.

NOTE: The amount of refrigerant required to charge a completely evacuated system is 42 fl. oz. (1260 ml) for vehicles without a sleeper box air conditioner unit. For installations equipped with a sleeper box air conditioner, the refrigerant capacity is 52 fl. oz. (1560 ml).

4. Open the manifold discharge hand valve (Fig. 13, Ref. B). Be sure the manifold suction hand valve remains closed (Fig. 13, Ref. A).

5. Insure that the refrigerant compressor suction service valve is in the halfway in position (Fig. 13, Ref. E).

6. Insure that the refrigerant compressor discharge service valve is in the halfway in position (Fig. 13, Ref. D). If negative pressure has been contained in the system, the refrigerant will be pulled into the system.

7. After the refrigerant is pulled into the system, close the manifold discharge hand valve.

NOTE: To determine when the refrigerant can is empty, turn it right side up, then tap it on the bottom. A hollow ring should be heard when empty.

Open the refrigerant compressor suction and discharge service valves all the way (counterclockwise). Start the engine and run at fast idle with the air conditioner and cab blower on their highest settings. Also, if applicable, activate the sleeper box air conditioner.

.1 Check the sight glass on the receiver-drier (see Fig. 8). If there are no bubbles or foam visible in the sight glass, the system is completely charged. Disconnect the manifold suction and discharge service hoses from the refrigerant compressor valve ports; then install sealing caps.

.2 If there are bubbles or foam present in the sight glass, finish charging the system following the procedure under **"Charging,** With the System Partially Filled and Using Refrigerant in a Gaseous State" in this subject.

With the System Partially Filled and Using Refrigerant in a Gaseous State

1. Connect the manifold suction and discharge service lines to the compressor service ports as shown in Fig. 14.

2. Position the refrigerant can as shown in Fig. 14, then connect the manifold center service hose to the refrigerant can.

3. Open the manifold suction hand valve (Fig. 14, Ref. A). Be sure the manifold discharge hand valve (Fig. 14, Ref. B) is closed.

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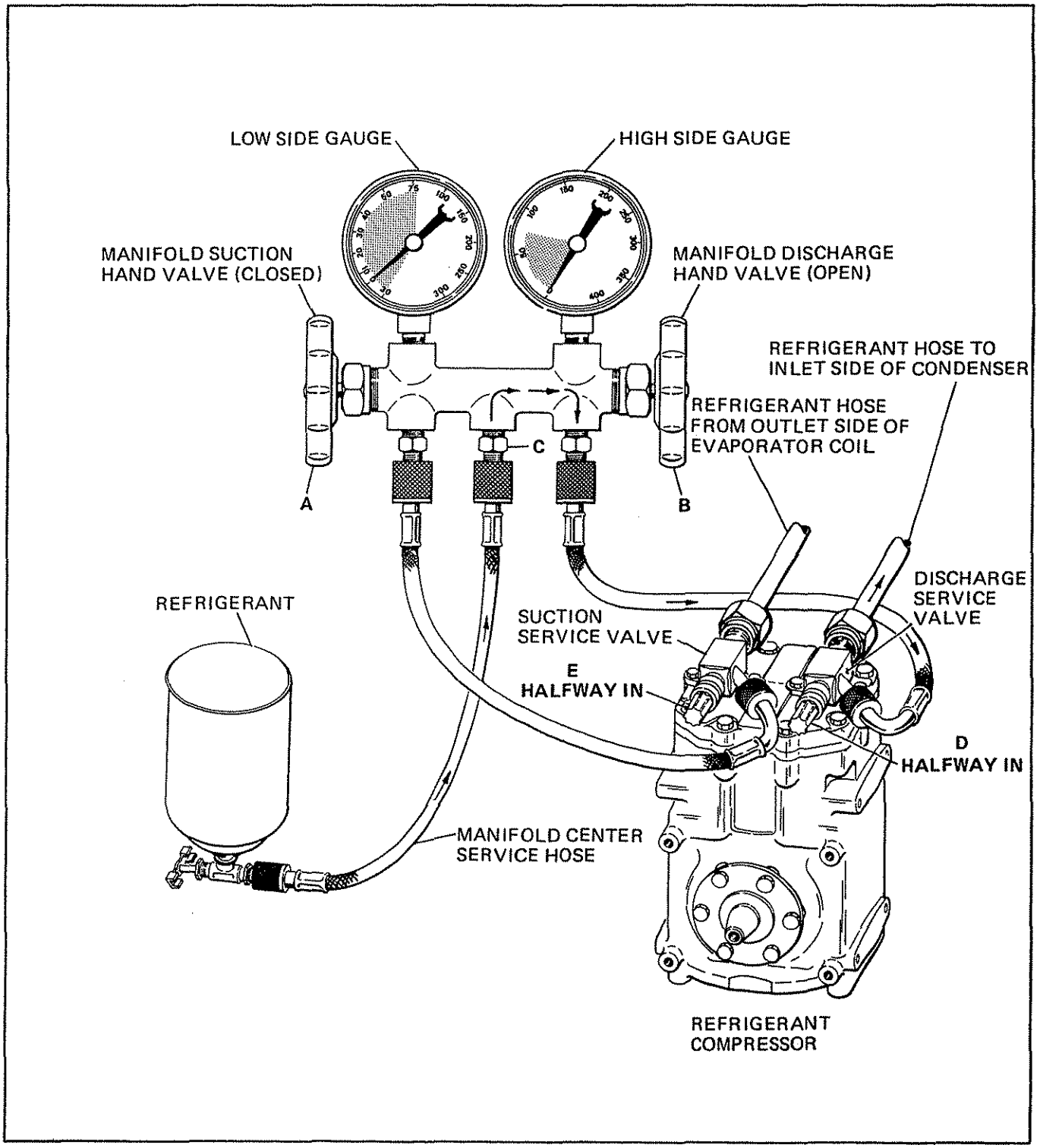

Fig. 13, Charging The System With Liquid Refrigerant

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

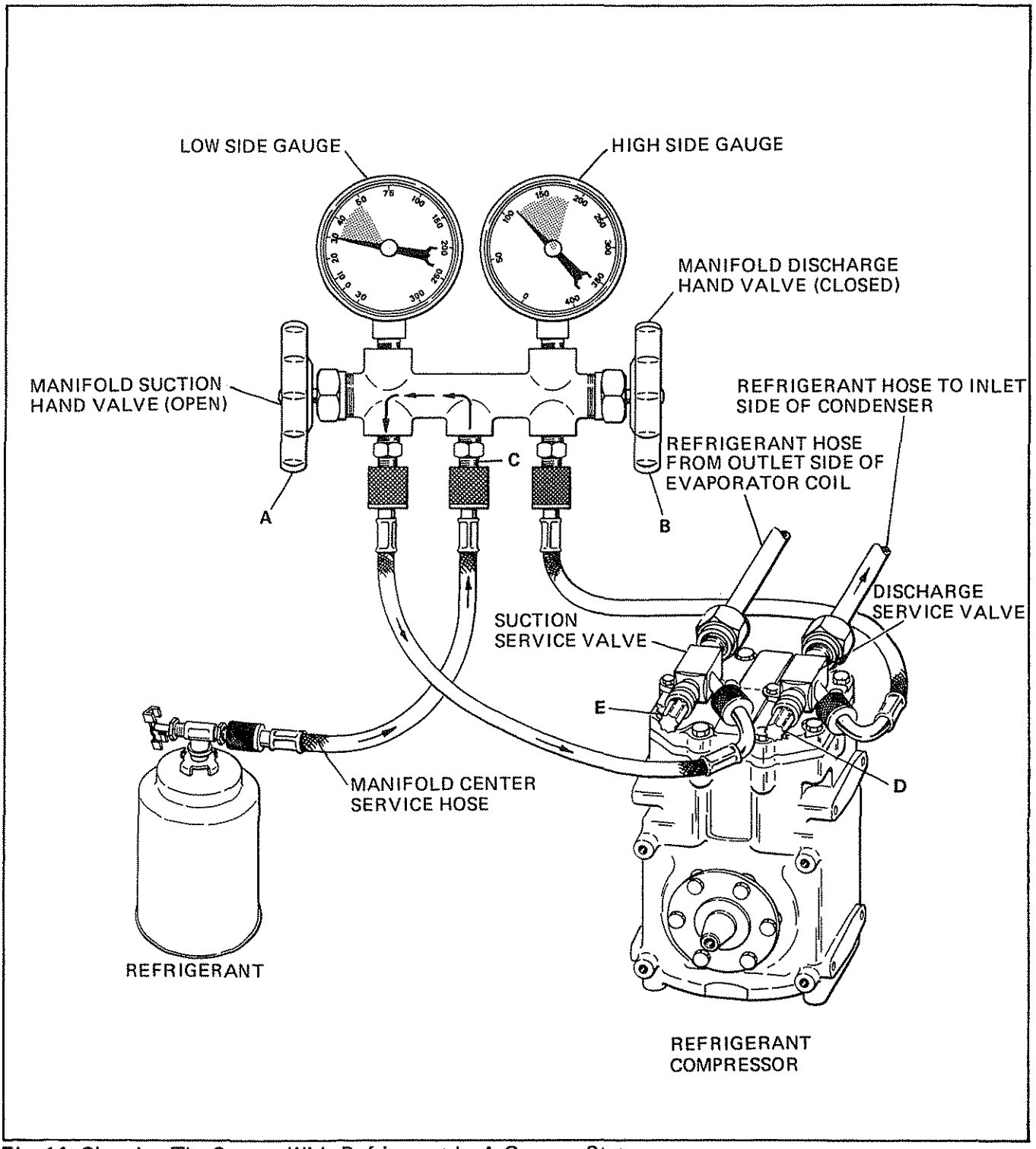

Fig. 14, Charging The System With Refrigerant In A Gaseous State

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

4. Position the compressor suction service valve (Fig. 14, Ref. E) halfway in. Be sure the compressor discharge service valve (Fig. 14, Ref. D) is all the way out.

CAUTION: Be sure the refrigerant can is held upright at all times to prevent liquid refrigerant from entering the refrigerant compressor when the engine is running. Refrigerant in the compressor could result in damage to the unit.

5. Start the engine and run at fast idle with the air conditioner and blower at their highest settings. Also, if applicable, activate the sleeper box air conditioner. When the sight glass on the receiver-drier becomes completely free of bubbles or foam, close the valve on the refrigerant can, then close the manifold suction hand valve (Fig. 14, Ref. A).

6. Disconnect the manifold center service hose from the refrigerant can. Open the refrigerant compressor discharge and suction service valves (one turn clockwise from the all the way out position). Refer to Fig. 14, Refs. D & E. With the air conditioner(s) and blower(s) at their highest settings and the system completely charged, be sure the operating pressures are within the values given in Table 3 under **"SPECIFICATIONS"** in this subject. If the operating pressures are unacceptable, refer to the **"TROUBLESHOOTING"** section in this subject.

7. Turn the refrigerant compressor suction and discharge service valves (Fig. 14, Refs. D & E) all the way out (counterclockwise), then disconnect the manifold service valve hoses. Install sealing caps on the refrigerant compressor service valve ports.

Leak Testing

WARNING: If a halide (open flame) leak detector is to be used, the work area must have total ventilation. Combusted refrigerant gas creates poisonous phosgene gas which, if inhaled, causes severe respiratory irritation. Do not smoke or have any burning material in the area where leak detection is performed.

Use the following procedure for the detection of leaks:

NOTE: A pressure reading of 50 psi (345 kPa) on the low side gauge is necessary to detect leaks. If pressure is 50 psi (345 kPa) or greater, proceed to step 7. If pressure is lower than 50 psi (345 kPa), proceed as follows:

1. Connect the charging manifold suction service hose to the refrigerant compressor suction service valve, and the manifold discharge service hose to the refrigerant compressor discharge service valve. Be sure the manifold suction and discharge hand valves are closed.

2. Connect the manifold center service hose to the refrigerant can; the can should be in the upright position. Loosen the manifold center service hose connection at the manifold, then open the valve on the refrigerant can momentarily to force out any air that might be in the charging hose. After the air is removed, tighten the connection at the manifold and close the valve on the refrigerant can.

3. Open the refrigerant compressor service valves halfway.

4. Open the manifold suction and discharge hand valves.

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

5. Open the refrigerant can valve; the can should be in the upside down position. When approximately 1/2 to 1 lb. (.23 to .43 kg) of refrigerant has entered the system, close the refrigerant can valve.

6. Close the refrigerant compressor service valves and the manifold suction and discharge hand valves, then disconnect the manifold service hoses.

7. Leak test the system using an electronic leak detector, or equivalent, using the procedures specified by the detection equipment manufacturer.

8. If a leak is detected at a connection, tighten the fitting(s) and/or replace worn or damaged seal(s). If a leak is detected in a component of the system, replace the damaged part, then retest for leaks. Continue checking for leaks until they have all been eliminated.

9. After the leak is detected and repaired, the system must again be completely discharged and purged of refrigerant and then evacuated. Follow the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

HEATER/HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION

Removal

1. Remove the driver and passenger seats. Place the pneumatic heater toggle switch inside the cab in the "ON" position.

2. Drain the heater core and the cooling system at the radiator drain cock. Save the coolant for later use. After the fluid is drained, disconnect the heater core outlet and inlet hoses (Fig. 3).

3. Drain the vehicle air system.

4. Discharge, and then purge the heater-air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

5. Disconnect the refrigerant lines from the heater-air conditioner and plug all lines.

6. Remove the heater flex hose clamp attaching the heater flex hose to the defroster blower plenum assembly and heater adapter. Remove the flex hose.

7. Mark all the wires and hoses connected to the heater/heater-air conditioner for later assembly reference. Disconnect the wires and the hoses.

8. Remove the nuts (from underneath the cab) attaching the heater/heater-air conditioner assembly to the cab floor. Remove any obstruction which may prevent the removal of the nuts.

9. Remove the heater/heater-air conditioner assembly.

CAUTION: When removing the heater-air conditioner assembly, use care not to damage the unit's drain tube (Fig. 4, Ref. 40), which protrudes through the cab floor.

Installation

1. Position the heater/heater-air conditioner in the cab floor making sure the drain tube, if so equipped, protrudes through the cab floor.

2. Install and tighten the nuts attaching the heater/heater-air conditioner to the cab floor.

3. Install any parts that were obstructing the removal of the nuts.

4. Position the heater flex hose on the defroster blower plenum assembly and heater adapter. Then install and tighten the heater flex hose clamps.

5. Connect the electrical wires as previously marked or as shown in Fig. 15 located under **"SPECIFICATIONS".**

6. Connect the heater hoses to the heater core (refer to Fig. 3), and close the radiator drain cock.

7. Remove the plugs and connect the refrigerant lines to the heater-air conditioner. Tighten the connection to the torque values given in Table 2 located under **"SPECIFICATIONS".** Use two wrenches when tightening fittings to prevent twisting of tubing.

8. Fill the cooling system with coolant. Make sure all leaks have been eliminated prior to driving the vehicle. Follow the instructions given under "BLEEDING AIR FROM THE HEATER CORE" in this subject.

9. Evacuate, charge and leak test the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

10. Install the driver and passenger seats.

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Little Or No Air Flow	Blower not operating.	Check for open circuit breaker. An open circuit breaker indicates a short in the electrical system which must be located and repaired.
		Insure that the fan speed switch is operative; replace, if needed. Refer to "FAN/BLOWER SWITCH REPLACEMENT" for instructions.
		Check blower motor. If inoperative, replace. Refer to "DEFROST AND/OR CONSOLE BLOWER MOTOR(S) REMOVAL AND INSTALLATION" for instructions.
		Check resistor block (Fig. 4, Ref. 9). If inoperative, replace.
		Check wiring on blower motor. Refer to wiring diagram (Fig. 15) located under **"SPECIFICATIONS."** Make sure wiring conforms with diagram.
	Blower wheel installed backwards.	Install blower wheel as shown in Fig. 4.
	Restricted or leaking air ducts.	Examine all air ducts and remove any blockages. Repair leak(s) or replace any portion where the leak(s) cannot be repaired.
	Ice blocking evaporator.	Adjust the thermostat to the "OFF" or lowest position for 2 or 3 minutes, then resume cooling at a higher fan speed than before frosting occured.

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FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
PROBLEMS INVOLVING INADEQUATE COOLING		
Foaming In Sight Glass	System low in refrigerant.	Add refrigerant. Refer to **"Charging."**
	Leaks in system; receiver-drier inoperative.	Follow leak testing procedure. If no leaks are found, replace the receiver-drier. Refer to "RECEIVER-DRIER REPLACEMENT" for instructions.
	Restrictions in line between condenser and sight glass.	Remove restriction from line.
Low Evaporator Coil Outlet Pressure	Inoperative thermostatic expansion valve.	Replace thermostatic expansion valve. Refer to "THERMOSTATIC EXPANSION VALVE REPLACEMENT" for instructions.
	Restriction(s) in liquid line to thermostatic expansion valve.	Remove line restriction(s).
High Compressor Discharge Pressure	Shutter not opening.	Adjust or repair shutters. Refer to wiring diagram (Fig. 15) located under **"SPECIFICATIONS."** Replace shutter solenoid valve.
	Condenser air flow restricted.	Remove restriction of air flow through condenser.
	Refrigerant restriction in condenser. Return tube bends should be the same temperature as each other.	Replace condenser. Refer to "CONDENSER REMOVAL AND INSTALLATION" for instructions.
	Air in system.	Repair leaks in system. Refer to **"Leak Testing."**
Evaporator Outlet Air Temperature Drops As Compressor Discharge Pressure Drops	Leaks in system.	Repair leaks. Refer to **"Leak Testing."**

(Continued on next page)

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
PROBLEMS INVOLVING INADEQUATE COOLING (Continued)		
Evaporator Outlet Air Temperature Increases As Compressor Discharge Pressure Drops	Thermostatic expansion valve setting is low.	Replace thermostatic expansion valve. Refer to "THERMOSTATIC EXPANSION VALVE REPLACEMENT" for instructions.
	Excessive oil in system. An indication of this is clutch slippage or belt slippage at governed engine speed.	Set controls at high blower and maximum cold, operate engine at idle for 10 minutes. Discharge and purge the system and drain excess oil from refrigerant compressor. Evacuate, charge and leak test system.
	Excessive oil in thermostatic expansion valve.	Remove thermostatic expansion valve. Refer to "THERMOSTATIC EXPANSION VALVE REPLACEMENT" for instructions. Drain oil from the thermostatic expansion valve and flush the remaining components with R-11 Flushing Fluid or equivalent (in accordance with the procedures specified by the flushing fluid manufacturer), to remove any remaining oil. Refill refrigerant compressor with new oil. Refer to the 01 Group of this manual for instructions. Evacuate, charge and leak test system.
Temperature In Cab Too High With Normal Evaporator And Discharge Pressure	Heater water shutoff valve open.	Close heater water shutoff valve.
	Air door to heater not closed.	Close air door. Make sure the door works freely and has full movement.
	Air door not sealing.	Reseal air door.
	Evaporator to cover seal leakage.	Reseal cover to evaporator.

(Continued on next page)

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
PROBLEMS INVOLVING INADEQUATE COOLING (Continued)		
Temperature In Cab Too High With Normal Evaporator And Discharge Pressure (Cont.)	Air filter (if used) is dirt-clogged.	Clean the air filter.
PROBLEM	**POSSIBLE CAUSE**	**CORRECTION**
PROBLEMS INVOLVING INADEQUATE HEATING		
Temperature In Cab Too Low Or No Heat	Heater water shutoff valve not opened.	Open heater water shutoff valve.
	Inoperative heater water shutoff valve.	Replace water shutoff valve. Refer to "AIR OPERATED WATER SHUTOFF VALVE REPLACEMENT" for instructions.
	Heater hose pinched or twisted.	Open air door. Make sure the door works freely and has full movement.
	Water leakage in the system.	Repair or replace heater hose.
	Air door to heater not opened.	Repair the leak(s) or replace any portion where the leak(s) cannot be repaired.
	Heater core plugged with lint or dust.	Remove heater core to clean. Refer to "HEATER CORE REMOVAL AND INSTALLATION" for instructions.

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

SPECIFICATIONS

Tighten Nut Finger-Tight; Then With Wrench, Tighten Further As Follows:				
FITTING SIZE	TUBE O.D.	TURNS REQUIRED TO SEAL FROM HAND TIGHT		
		COMPRESSION	THREADED SLEEVE	SAE 45° FLARE
2	1/8"	1 1/4	1 1/2	1/6 DO NOT OVERTORQUE
3	3/16"			
4	1/4"			
5	5/16"	1 3/4		
6	3/8"	2 1/4		
8	1/2"			
10	5/8"			
12	3/4"			
16	1"			
20	1 1/4"			

Table 1, Air Tubing Fitting Torque Specifications

OUTSIDE DIAMETER OF METAL TUBE IN INCHES	*TORQUE FOR STEEL TUBES		*TORQUE FOR ALUMINUM OR COPPER TUBES	
	FT-LBS	N·m	FT-LBS	N·m
1/4"	10-15	14-20	5-7	7-9
3/8"	30-35	41-47	11-13	15-18
1/2"	30-35	41-47	15-20	20-27
5/8"	30-35	41-47	21-27	28-37
3/4"	30-35	41-47	28-33	38-45
*When tightening fittings always use the torque reading for the softer metal when unlike metals are used.				

Table 2, Refrigerant Line Torque Specifications

TEMPERATURE	SYSTEM PRESSURE			
	LOW SIDE		HIGH SIDE	
	PSI	kPa	PSI	kPa
Cool Day 70°F (21°C) to 80°F (27°C)	20-25	138-172	160-180	1102-1240
Warm Day 80°F (27°C) to 90°F (32°C)	25-30	172-207	180-200	1240-1378
Hot Day 90°F (32°C) +	30-35	207-241	200-220	1378-1516

Table 3, Temperature/Pressure Specifications

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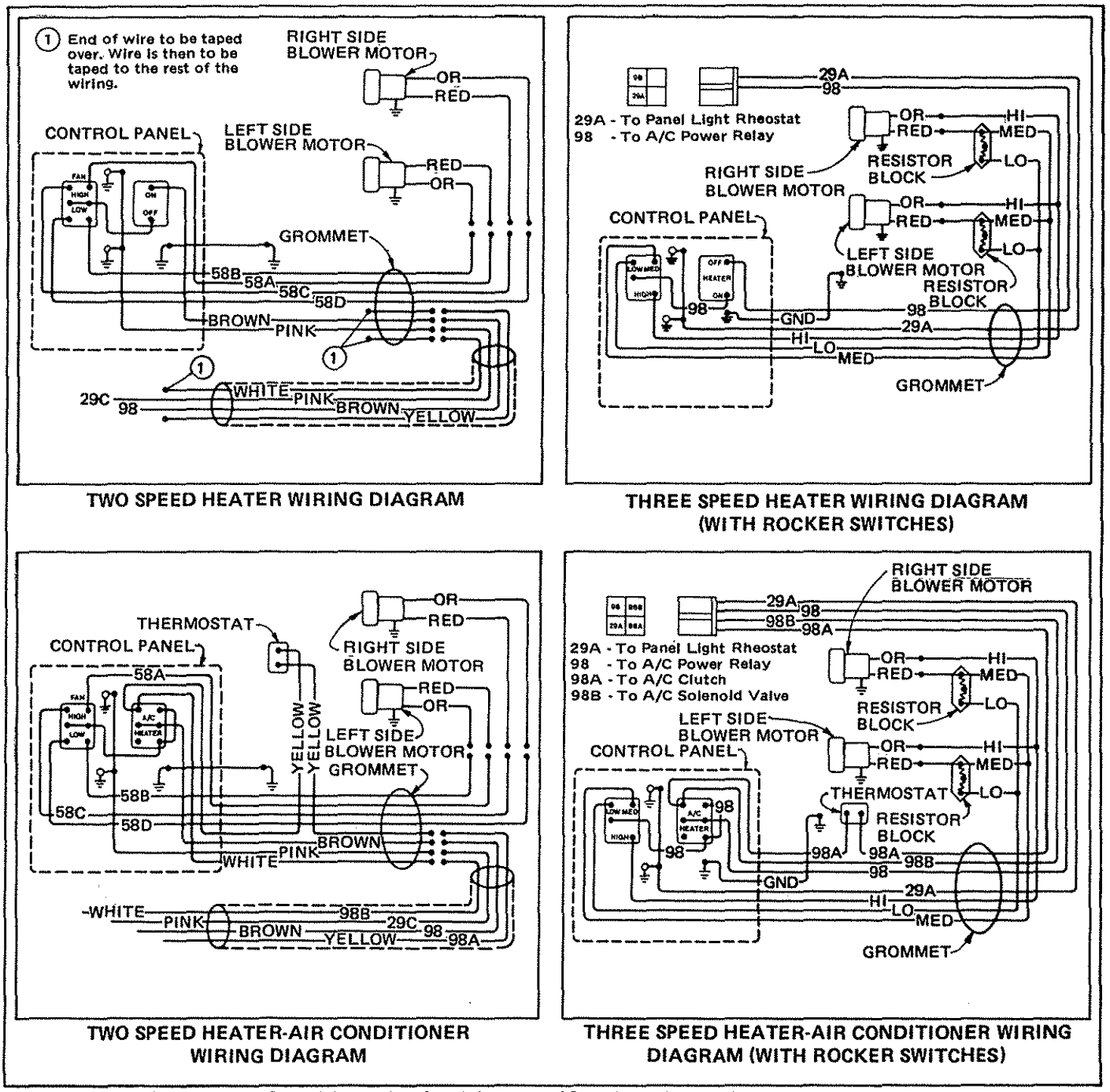
FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

SPECIFICATIONS (Continued)



TWO SPEED HEATER WIRING DIAGRAM

THREE SPEED HEATER WIRING DIAGRAM (WITH ROCKER SWITCHES)

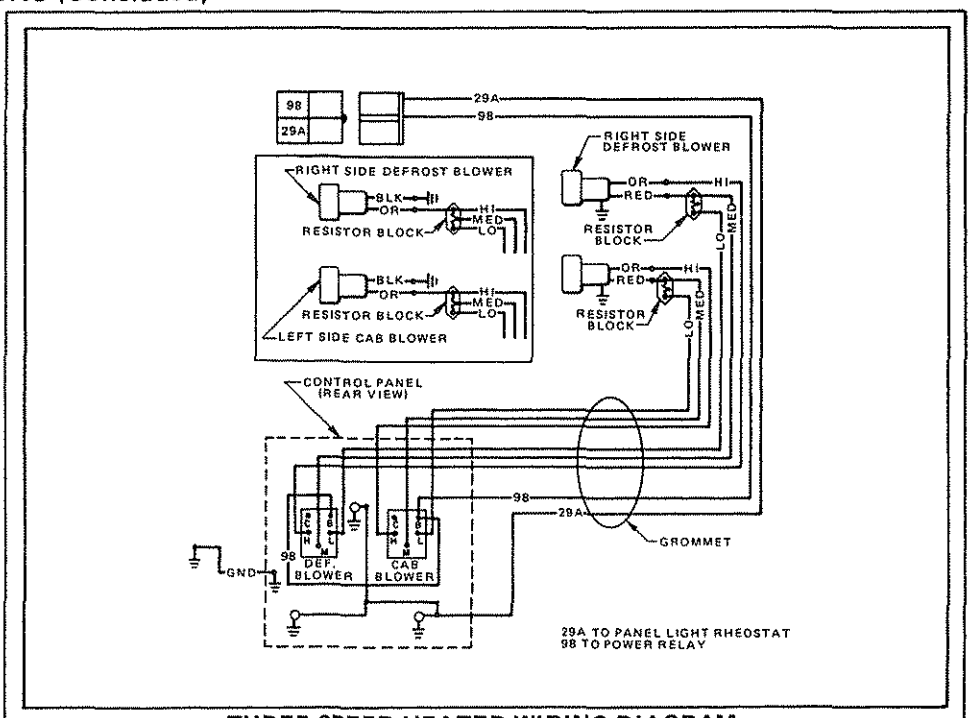
TWO SPEED HEATER-AIR CONDITIONER WIRING DIAGRAM

THREE SPEED HEATER-AIR CONDITIONER WIRING DIAGRAM (WITH ROCKER SWITCHES)

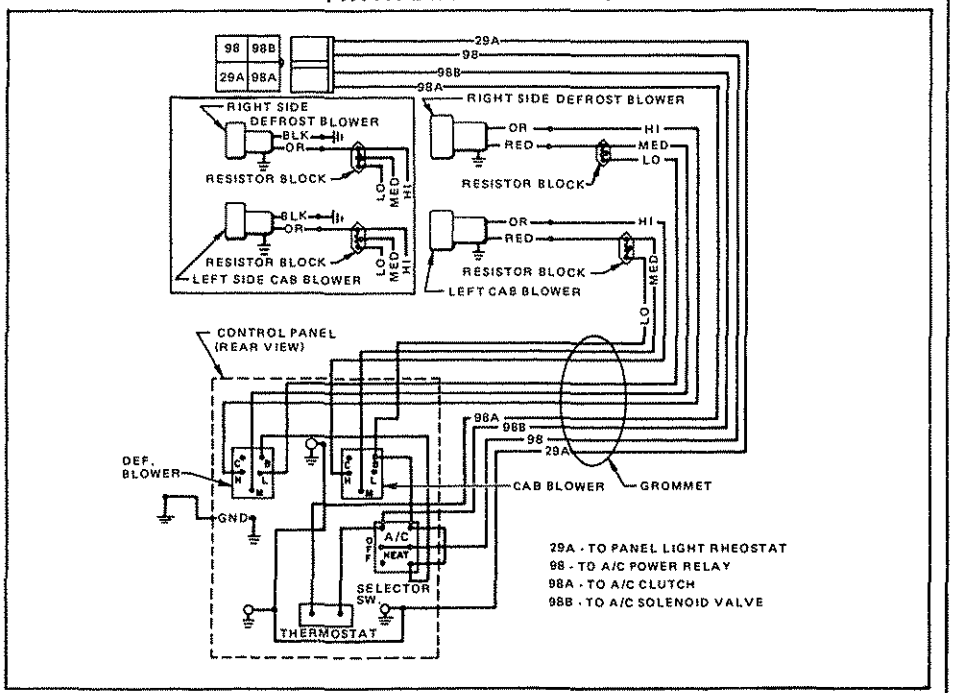
Fig. 15, Heater/Heater-Air Conditioner Wiring Diagrams (Continued Next Page)

FREIGHTLINER CONVENTIONAL CAB HEATER/HEATER-AIR CONDITIONER

SPECIFICATIONS (Concluded)



THREE SPEED HEATER WIRING DIAGRAM
(WITH DIAL SWITCHES)



THREE SPEED HEATER-AIR CONDITIONER WIRING DIAGRAM
(WITH DIAL SWITCHES)

Fig. 15, Heater/Heater -Air Conditioner Wiring Diagrams (Continued)

NOTES

GENERAL DESCRIPTION

The Frigiking Air Conditioner installation consists of a roof mounted (top) condenser-evaporator and control panel assembly, and an engine mounted and driven compressor connected together by refrigerant hoses and wiring.

The roof unit consists of the condenser and condenser fan assembly; the evaporator and evaporator blower assembly; the receiver drier; and the air handling chamber and control panel assembly. The air handling chamber and control panel assembly protrudes into the cab area about 4" and has adjustable louvers.

The engine mounted and driven compressor is a two cylinder reciprocating type and features non-corrosive case and positive lubrication. A thermostatically controlled clutch is mounted on the compressor shaft and controls compressor operation.

OPERATING INSTRUCTIONS

The air conditioner system is controlled by two switches located on the air conditioner instrument panel. The temperature control is an adjustable thermostatic switch that will automatically maintain the incoming air at a selected temperature. A rise in temperature closes the switch energizing the magnetic clutch and puts the compressor into operation. As the temperature reaches the low point, the thermostatic switch opens and the compressor stops. The unit switch has four positions; off and lo, med and hi fan speed positions.

1. With engine running, set temperature control to coldest position.

2. Set fan speed on high until the cab is cooled, then reduce fan speed and thermostat to maintain desired temperature.

NOTE: To prevent evaporator frosting and icing, avoid the combination of low fan speed and the coldest thermostat settings, especially on humid days. Should frosting or icing occur, turn the fan to high speed and the thermostat to off for 2 or 3 minutes, then resume cooling at a higher (warmer) thermostat setting and a higher fan speed than before frosting occured.

3. To cool a hot cab fast, close outside air vents, turn on air conditioner (set temperature on cold and fan on high), then open window. This will blow the hot air out. Then close the window and the cab will cool to a comfortable level quickly.

4. To remove excessive smoke, slightly open a window or vent to admit fresh air.

5. If cab windows fog up, turn the air conditioner on and direct the air louvers toward the windows until the fogging ceases, then turn off air conditioner.

PREVENTIVE MAINTENANCE

WEEKLY

1. Check belts, refrigerant hoses and wiring for chafing and wear.

2. When operating in extremely dusty or dirty conditions, check the clutch for foreign accumulations and clean if needed. It may be necessary to disassemble the clutch and blow out with compressed air.

MONTHLY

1. Check drive belts for proper tension, 100-125 lbs. for new belts, 80-100 lbs. for used belts.

2. Check refrigerant hoses, connections, and electrical wiring for chafing, wear and proper clamping.

3. Check to see if the drain hoses are open and in good condition.

4. Remove the top of the roof unit and inspect the condenser coil for obstructions by sighting through coil. Remove dirt and obstructions as needed.

5. Start vehicle and observe sight glass for continuous presence of bubbles or foam. Have unit serviced by qualified personnel if this condition exists.

ANNUALLY

(To be performed only by qualified service personnel.)

1. Clean condenser with compressed air.

2. Check condenser fan motor mounting bolts and tighten as needed.

3. Remove evaporator housing cover and inspect seals and gaskets.

4. Check drain pan and drain hoses for free flow of condensate.

5. Remove dust and lint accumulation from evaporator with vacuum cleaner.

6. Make sure that the thermostat element is well embedded between the fins of the evaporator coil and will not work loose during operation.

7. Make sure evaporator blower mounting bolts are secure.

8. Check blower wheels for looseness, wobble and end play.

9. Turn on ignition and check fan speed control and compressor clutch operation in response to thermostat switch position.

10. Thoroughly inspect hoses and wiring for chafing and wear. Tighten or replace clamps as needed.

11. Check unit operation for proper cooling, inspect sight glass for low refrigerant charge. If unit shows low refrigerant charge, locate leak, repair and recharge.

12. If unit has lost refrigerant charge completely, check compressor oil level before evacuating, leak testing and charging.

13. Install air evaporator housing cover securely.

14. Install unit cover.

SERVICE OPERATIONS

ROOF UNIT REMOVAL AND INSTALLATION

Removal

1. Discharge the system into the shop exhaust system if possible. (Care should be taken to avoid the refrigerant contacting the skin or eyes. Goggles should be worn while charging or discharging the cooler system.)

2. Disconnect the cooler refrigerant hoses from the cooler and seal the fittings with caps to avoid moisture entering hoses.

3. Disconnect the cooler drain hose.

4. Remove the cab headliner as needed to reach cooler mounting bolts.

5. Disconnect the electrical molded connector.

6. Remove the four cooler mounting stud nuts.

7. Raise the cooler and block it up.

8. Cut the sealer joint loose from the top cab skin.

9. Remove the seal ring from cooler unit and clean the surface for replacement of seal ring.

Installation

Roof Mounted Unit

1. Use location diagram #D22-11841 for

drilling and cutout of top of cab to install cooler.

2. If headliner is not cutout for cooler, temporarily position headliner, mark and cutout for air chamber.

3. The contact area of the seal on the cab and cooler must be bare metal. Using a mild solvent, throughly clean the sealing bare metal surface.

4. Apply a non-hardening sealer (Permatex #2 or equivalent) to threads of mounting stud before screwing into the weld nut holes on the bottom of cooler case.

5. Apply a coating of non-hardening sealer to the top face of the top spacer and to the bottom of the bottom spacer disc before installing the discs over the studs.

6. Apply a coating of the adhesive supplied with the unit to the cleaned area on the bottom of the unit and around the top of the seal ring. Let adhesive become tacky, then place seal ring around air handling chamber and press firmly to the bottom of the unit case.

7. Cut eight pieces of cardboard roughly 4" x 6" from the unit shipping carton. Fold each piece to form a "V" roughly 4" x 3". Insert four of the pieces - one on each side of the air chamber unit - with the bottom of the "V" resting firmly against the bottom of the unit case between the seal ring and the side of the air handling chamber.

8. Allow adhesive to dry at least one half hour, then remove the cardboard spacers. Use of these cardboard spacers is recommended in order to obtain a water tight installation.

9. Apply a coating of the adhesive to the bottom of the seal ring and to the prepared surface around the air handling chamber on top of the cab.

10. Let adhesive become tacky, then mount unit in place. Make sure the rear air discharge damper is closed to prevent damage when air handling chamber is lowered through the opening.

11. Apply non-hardening sealant around the threads of the mounting studs at the stud holes.

12. Place the flat washers, internal lock washers and the 5/16" - 18 hexagon nut onto the mounting studs and tighten evenly in rotation until the seal compresses to a thickness of 1 1/2" to 1 5/8". Any compression more than this will make the seal ring bulge and be ineffective.

13. Cut off the ends of mounting stud if they extend below headliner.

14. Remove the two louvered grills by depressing one end of retainer clip and pulling louver to one side.

15. Loosen the 1/4" hexagon head bolts located on the air chamber divider and pull the air chamber down as far as possible.

16. Connect the electrical molded connector.

17. Install headliner.

18. Position trim molding over air chamber against headliner.

19. Raise air chamber to position the trim near the lower radius of air chamber. Tighten the two 1/4" bolts securing chamber to cooler web. Install the screws attaching the trim to air chamber housing.

20. Install the chamber louvers.

21. Remove seal plug from end of hoses, then connect cooler refrigerant hoses to cooler.

22. Connect the cooler drain hose.

23. Evacuate and charge the system using the procedure given under EVACUATING, CHARGING AND LEAK TESTING.

EVAPORATOR BLOWER MOTOR REMOVAL AND INSTALLATION **See Fig. 1 Part A for exploded view.**

Removal

1. Remove the case assembly top.
2. Remove the evaporator plenum cover.
3. Remove the four motor mount support clamp nuts and the top half of the motor mount. Cut supply wire near connector.
4. Remove the three screws securing the forward edge of each blower wheel housing. Leave the bottom mounting plate screws intact.
5. To remove the blower wheel cover housings, carefully raise the forward flange of the blower housings enough to clear the bottom mounting plate lip. Move the housing forward until it is released from the rear housing flange. Lift the fan motor and housings upward to remove from unit, then separate the housings and blower motors and wheels.
6. Remove blower wheel retainer clips and slide wheels off shaft, making note of position on the shaft.
7. Repair or replace fan motor if required.

Installation

1. Position the L.H. and R.H. blower wheel on the motorshaft with the longer hub toward the motor and the outer blade curvature in the direction of rotation. Position the blower 9/16" from end of shaft to hub. (Fig. 1, Part A.)
2. Install the blower wheel retaining clips.
3. Position the blower wheel housings over the blower wheels, then position the blower motor, wheels and housings in the motor mount and housing mounting plate. Position the rear lip of the housing in under the mounting plate and slide the housing back until the forward flange of the housing will snap down into place.
4. Position the top half of the blower motor mount over the blower motor and mounting studs.
5. Position the ground wire on one of the mounting studs, then install the four motor support clamp nuts on the mounting studs.
6. Install the three screws in each forward edge of the blower wheel housings attaching the housings to the bottom mounting plate.
7. Using a new connector, connect the supply wire to the blower motor wire.
8. Install the evaporator plenum cover.
9. Install the case assembly top.

EVAPORATOR COIL REMOVAL AND INSTALLATION **See Fig. 1 Part A for exploded view.**

Removal

1. Discharge the system into the shop exhaust system if possible. (Care should be taken to avoid the refrigerant contacting the skin or eyes. Goggles should be worn while charging or discharging the cooler system.)
2. Remove the air conditioner top cover plate.
3. Carefully disconnect the capillary tube clamped on the suction line and the small line connected to the expansion valve. Plug fitting when tube is removed to avoid dirt or moisture entering system.
4. Remove the evaporator plenum cover.
5. Remove the four screws securing evaporator coil to end support

brackets. Remove the expansion valve tube grommet retainer plate.

6. Remove the evaporator coil assembly with expansion valve attached.

7. Remove the expansion valve assembly. (Use two wrenches to avoid twisting or kinking the three small tubes attached to the coil.)

Installation

1. Connect the expansion valve to the coil assembly. (Use two wrenches to avoid twisting or kinking the three small tubes attached to the coil.)

2. Inspect the evaporator drain pan condition and hoses for free draining.

3. Position the evaporator coil in the housing.

4. Install rubber grommet over the expansion valve tube and install retainer plate, then install the evaporator coil four mounting screws.

5. Connect refrigerant lines to coil and expansion valve fittings. (Use two wrenches while tightening fittings to avoid twisting tubing.) Check the hose fittings for removal of sealing cap.

6. Clamp capillary tube from expansion valve to compressor suction line.

7. Evacuate, charge and leak test the system using the procedure under EVACUATING, CHARGING AND LEAK TESTING.

8. Install adhesive coated sponge rubber insulation on expansion valve outlet tubing, and suction tubing from evaporator.

9. Install air conditioner top cover plate.

CONDENSER FAN MOTOR REMOVAL AND INSTALLATION **See Fig. 1 Part A for exploded view.**

Removal

1. Remove the air conditioner top cover plate.

2. Loosen the condenser fan allen head setscrew, then remove the fan.

3. Disconnect the fan motor electrical supply wire.

4. Remove the two nuts attaching the fan motor clamp to the mounting studs.

5. Remove the fan motor clamp and fan motor.

Installation

1. Position the fan motor in the fan motor clamp.

2. Position the fan motor clamp on the mounting bolts, then position the ground wire on one of the studs and install the two nuts attaching the fan motor clamp to the mounting studs.

3. Connect the fan motor electrical supply wire.

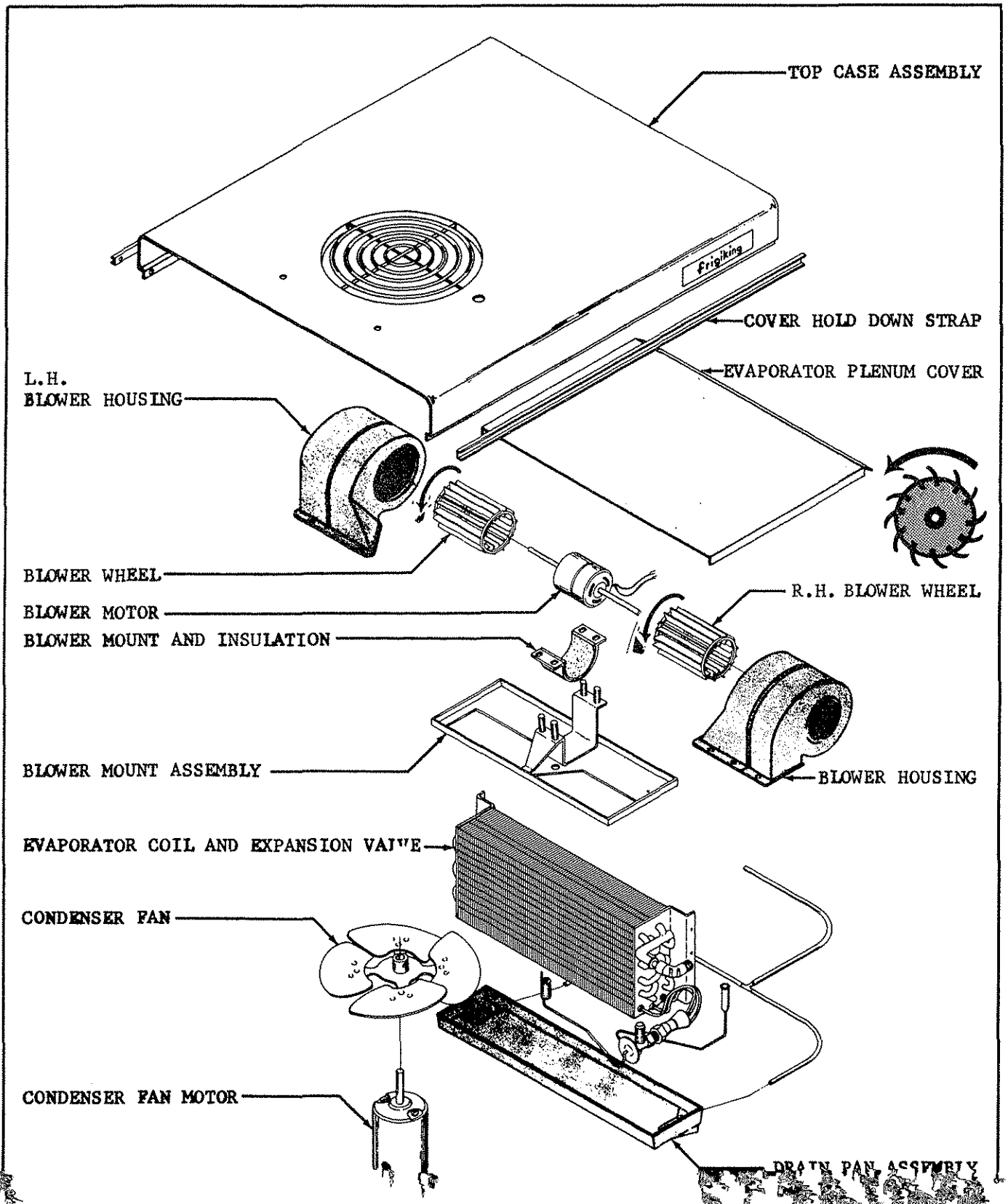
4. Position the fan on the motor shaft and tighten the allen head setscrew.

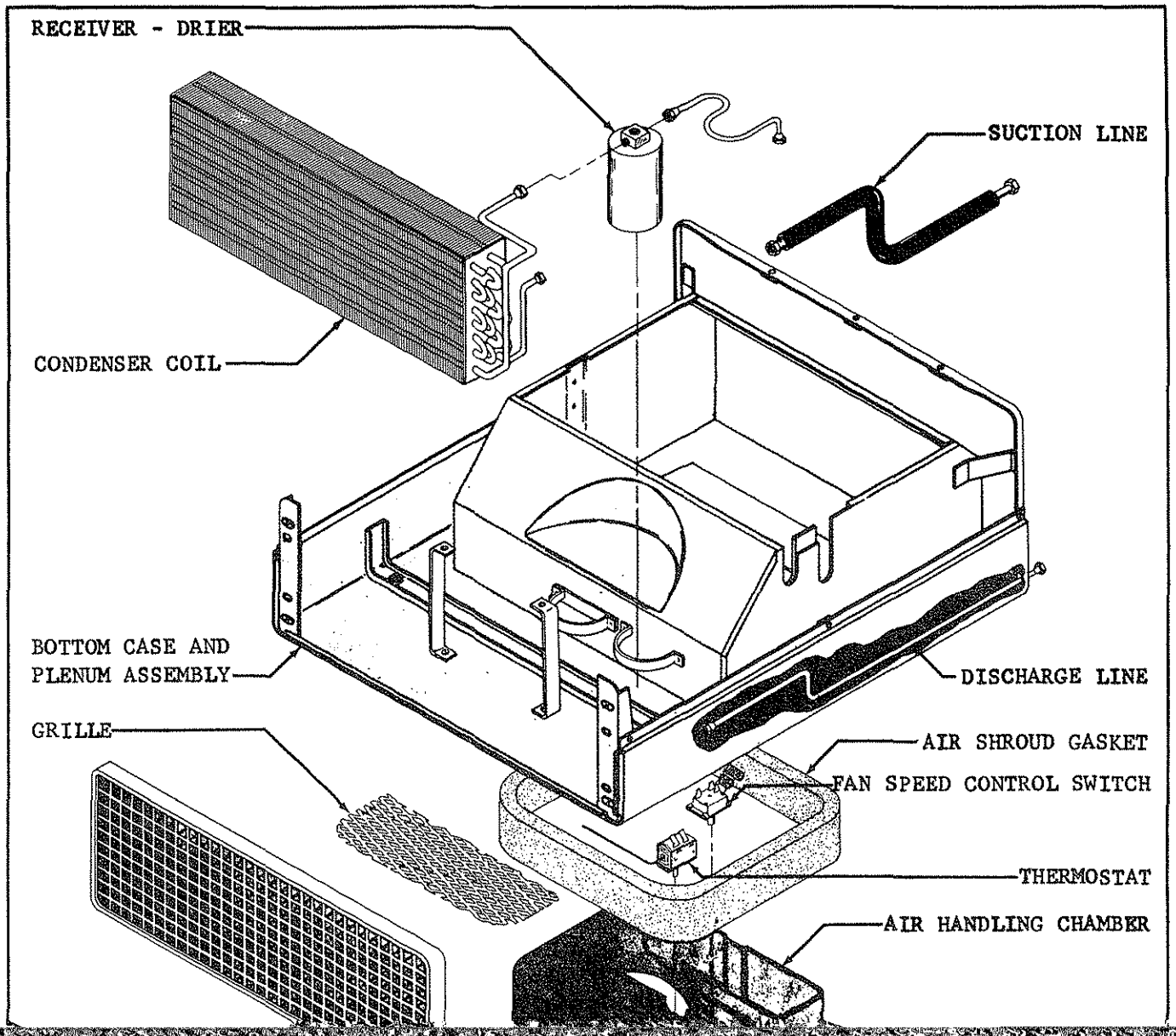
5. Install the air conditioner top cover plate.

CONDENSER COIL REMOVAL AND INSTALLATION **See Fig. 1 Part B for exploded view.**

Removal

1. Discharge the system into the shop exhaust system if possible. (Care should be taken to avoid the refrigerant contacting the skin or eyes. Goggles should be worn while charging or discharging the cooler system.)


TOP CASE ASSEMBLY
Frigiking
COVER HOLD DOWN STRAP
EVAPORATOR PLENUM COVER
L.H.
BLOWER HOUSING
BLOWER WHEEL
BLOWER MOTOR
BLOWER MOUNT AND INSULATION
R.H. BLOWER WHEEL
BLOWER MOUNT ASSEMBLY
BLOWER HOUSING
EVAPORATOR COIL AND EXPANSION VALVE
CONDENSER FAN
CONDENSER FAN MOTOR
DRAIN PAN ASSEMBLY


RECEIVER - DRIER
SUCTION LINE
CONDENSER COIL
BOTTOM CASE AND
PLENUM ASSEMBLY
DISCHARGE LINE
GRILLE
AIR SHROUD GASKET
FAN SPEED CONTROL SWITCH
THERMOSTAT
AIR HANDLING CHAMBER

2. Remove the air conditioner top cover and grille.

3. Disconnect the condenser line from the drier and compressor main line. (Use two wrenches to avoid twisting line while loosening nuts.)

4. Remove the four screws securing condenser to end support brackets.

5. Carefully remove condenser coil.

6. Plug drier and refrigerant line fittings to avoid the entrance of dirt or moisture into system.

7. Repair or replace the condenser coil.

Installation

1. Position the condenser coil and install the four mounting screws.

2. Connect condenser line to drier and compressor line to condenser. (Be sure cap plugs are removed from fittings.) Use two wrenches to avoid twisting tubing when tightening fittings.

3. Evacuate, charge and leak test the system using the procedure under EVACUATING, CHARGING AND LEAK TESTING.

DRIER UNIT REMOVAL AND INSTALLATION
See Fig. 1 Part B for exploded view.
Removal

1. Discharge the system into the shop exhaust system if possible. (Care should be taken to avoid the refrigerant contacting the skin or eyes. Goggles should be worn while charging the cooler system.)

2. Remove the air conditioner top cover plate.

3. Disconnect the refrigerant lines from the drier and plug line fittings to avoid dirt or moisture entering system.

4. Remove the nuts from clamp mounting bolts and remove receiver drier.

Installation

1. Position the receiver drier in the housing, then install the mounting clamp and nuts.

2. Connect the refrigerant lines to the receiver drier. (Be sure cap plugs are removed from fittings.) Use two wrenches to avoid twisting lines when tightening fittings.

3. Evacuate, charge and leak test the system using the procedure under EVACUATING, CHARGING AND LEAK TESTING.

4. Replace the air conditioner top cover plate.

EVACUATING, CHARGING AND LEAK TESTING

Before the air conditioner can be operated, it must be evacuated of air and moisture, leak tested and charged with the correct amount of refrigerant.

NOTE: **Care should be taken to avoid the refrigerant contacting the skin or eyes. Wear goggles and gloves while evacuating, charging or leak testing the refrigerant**

Evacuating

Prior to evacuating the system, be certain that it does not contain any Freon. Connect the Service gauges to the Service valves in top of the compressor as shown in Fig. 2 , but do not connect Service hose to the vacuum pump. Close both valves on the gauge manifold. Using a wrench, open both valves on the compressor by screwing the stem of each valve in two or three turns. Position the manifold center Service hose in a shop exhaust system, then slowly discharge the Freon into the shop exhaust system by opening one or both of the valves on the gauge manifold.

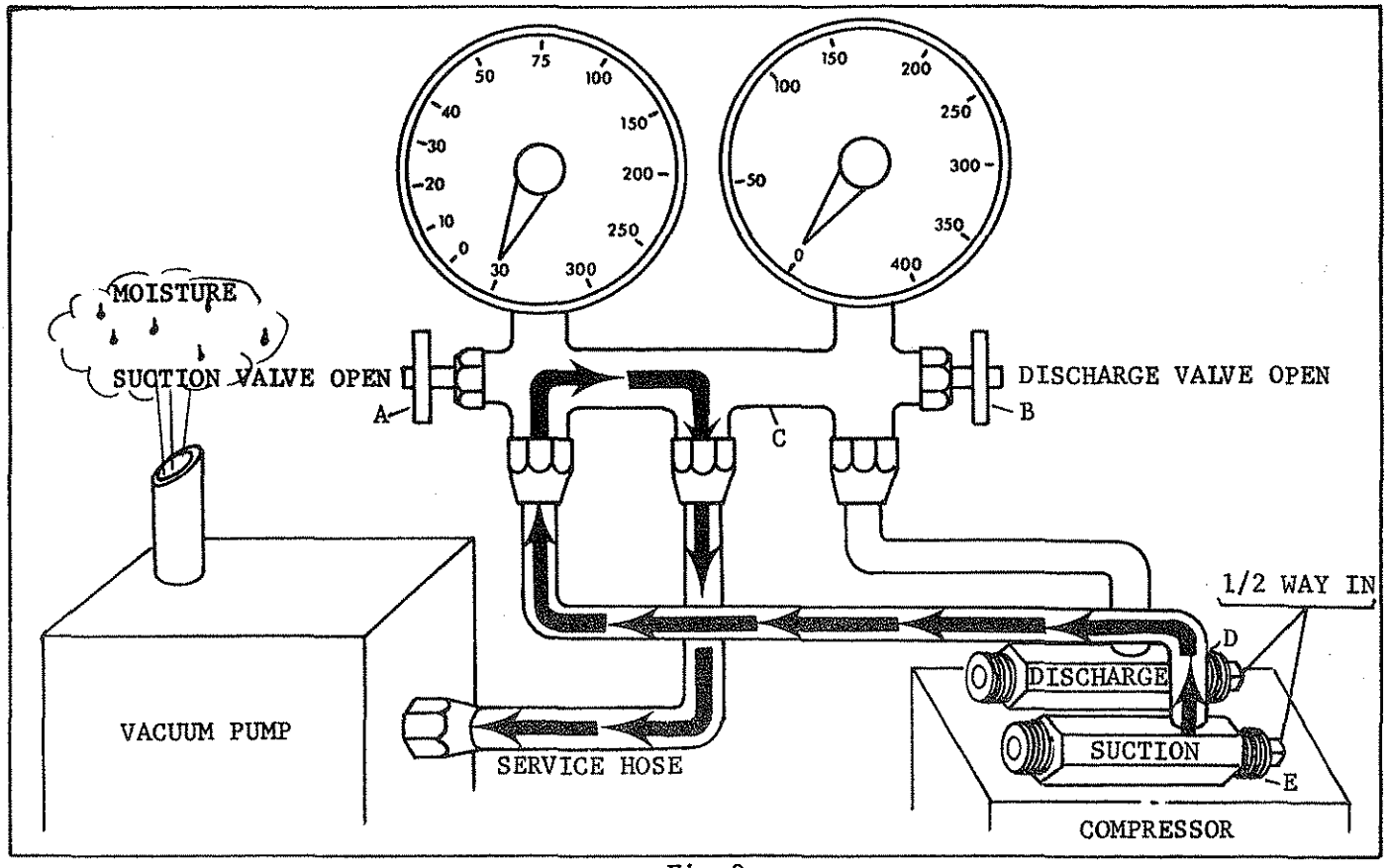


Fig. 2

NOTE: Do not discharge too fast because the Freon must be given time to separate from the oil in the system or the oil will be carried out along with it and the compressor will have to be refilled again.

1. With the system empty, connect the center hose to the vacuum pump. (Fig. 2, C)
2. Turn the compressor Service valves in two or three turns. (Fig. 2, D and E)
3. Open both manifold valves and start the vacuum pump. (Fig. 2, A and B)
4. When the low side gauge reads 27 to 29 inches of mercury and will go no lower, let the pump operate another 10 minutes then close both manifold valves and shut off the vacuum pump.
5. If the low side rises after 15 minutes and continues to rise, the system has a leak that must be repaired before the system can be evacuated. If there is no leak present, re-open the valves on the Service gauge manifold and turn the vacuum pump on and let it run for at least one hour.

Charging

1. With the system completely evacuated, connect the center hose of the charging manifold to the refrigerant can.
2. Loosen the center hose at the connection on the manifold approximately two turns. (Fig. 3, C)
3. Open valve on the refrigerant can and allow gas to escape at the loosened connection on the charging manifold to force out any air that might be in the charging hose, then tighten the loosened connection after about 5 seconds.
4. Open the charging manifold suction gauge valve. (Fig. 3, A) Be sure the manifold discharge gauge valve is closed. (Fig. 3, B)

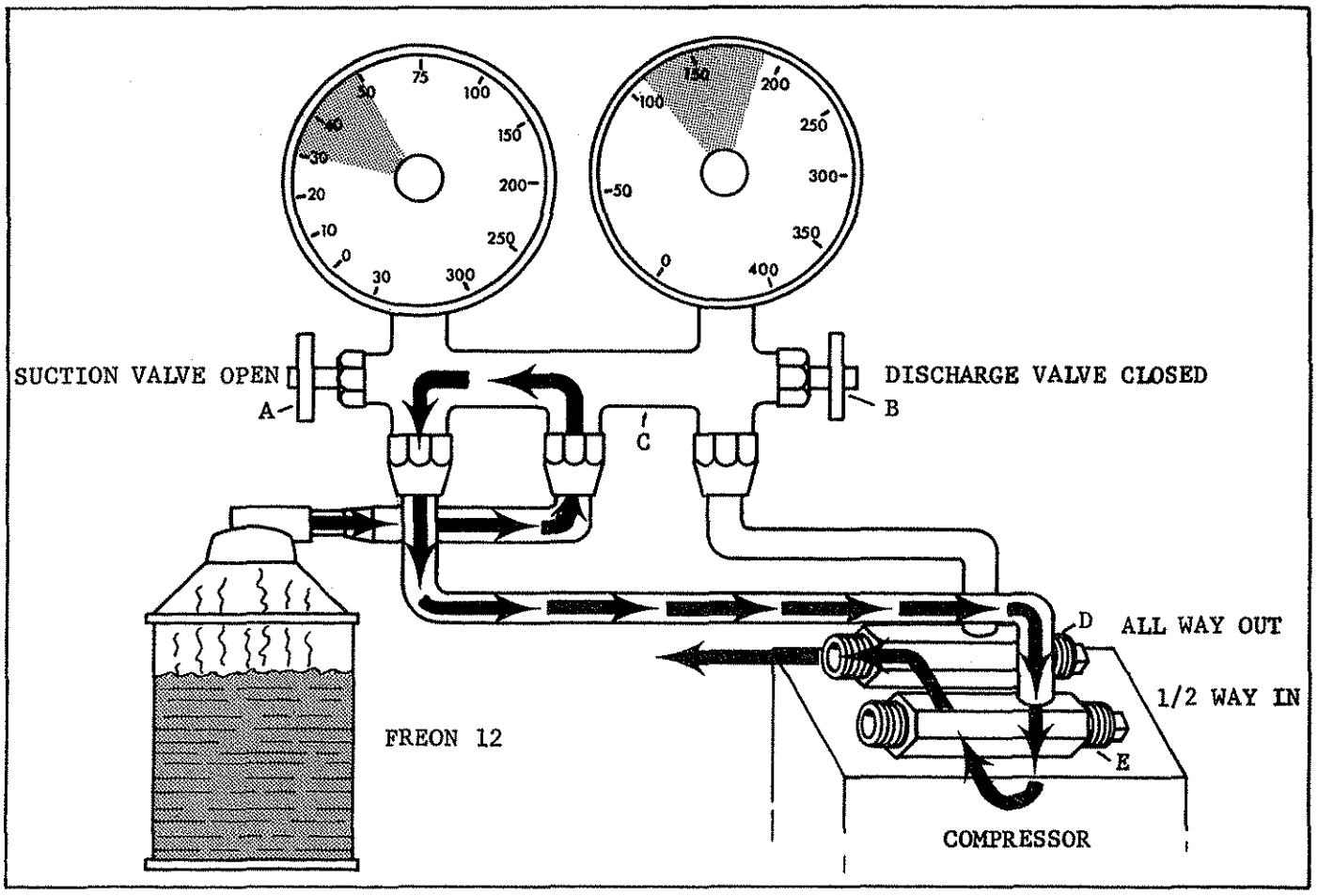


Fig. 3

5. Open compressor suction Service valve half-way. (Fig. 3, E)

6. Open compressor discharge Service valve all the way, (Fig. 3, D) then turn the valve clockwise one turn. If a good vacuum has been applied during evacuation of the system, the refrigerant will now be pulled into the system.

7. Start engine and turn air conditioner on full and leave doors of cab open. Check sight glass for shortage of refrigerant.

8. After the sight glass becomes completely clear (no bubbles or foam), close the valve on the charging can. The amount of refrigerant in a fully charged system will vary according to hose length and atmospheric conditions.

9. Open both the suction and discharge valves all the way.

10. Remove the manifold suction and discharge hoses from the Service valve gauge ports.

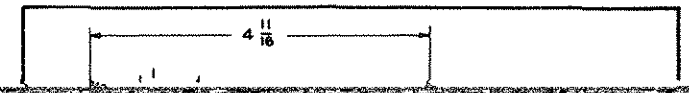
Leak Testing

If a leak in the system is discovered during the evacuation process, use the following procedure for leak testing.

1. Connect the charging manifold gauges to the suction and discharge Service valve gauge ports. Be sure both gauge valves are closed.

2. Open both Service valves to the half-way position.

3. Connect the center hose of the charging manifold to a refrigerant can.



TROUBLE SHOOTING

INSPECTION SEQUENCE

1. Inspect compressor for leaks evident by the refrigerant oil around shaft seal, valve plate assembly and service valves.

2. Inspect compressor for loose bolts and spacers and any cracks in the case.

3. Check compressor drive belt alignment with straight edge or true rod positioned in the pulley grooves. Check belts for the proper tension of 80 to 100 lbs. with belt tension gauge or 1/2" depression of belt over the longest span.

4. Check refrigerant hoses and fittings for any evidence of refrigerant leaks. Clamp hoses to avoid any chafing or exposure to excessive heat from exhaust.

5. Check clutch electrical wires for visual evidence of breaks, shorts and insulation wear.

6. Remove roof-top unit cover and plastic evaporator compartment cover. Inspect evaporator for air flow restrictions such as lint, dirt or any foreign matter and blow out with air hose.

7. Make sure evaporator drain pan and hoses are clean and open for proper drainage.

8. Inspect evaporator compartment gasket, seals, and insulation for conditions and proper sealing against air and water leaks.

9. Start engine, turn unit on and check compressor, compressor mount and clutch for bearing noise and vibration.

10. Check unit switch for proper operation. Compressor clutch should engage and disengage in response to the thermostat adjustment.

11. Check the sight glass. If bubbles are continually present, system may be low on refrigerant charge.

12. Connect manifold and gauge set, then check the system pressures. If the pressures do not fall within the limits listed under Specifications, use the following trouble analysis chart to determine possible cause and remedy.

13. Inspect the condenser for air flow restrictions such as lint, dirt and foreign matter. Blow out with air hose.

TROUBLE ANALYSIS CHART

SYMPTOM	CAUSE	REMEDY
Compressor "High Side" pressure too high.	Air in system.	Install pressure gauge in discharge service valve. Turn valve clockwise at least one complete turn opening refrigeration system and release excess air through manifold gauge.
	Too much refrigerant in system.	Bleed off refrigerant until pressure returns to normal.
	Discharge valve partially closed.	Turn discharge valve on compressor counter clockwise to full open position.
	Clogged condenser coil fins.	Clean condenser with high pressure water hose or blow out with air.
	Wrong condenser motor rotation.	Reverse motor leads (positive ground application.)
Compressor "High Side" pressure too low.	Not enough refrigerant in system.	Add refrigerant to system until sight glass appears completely clear-no foam or bubbles.
	Compressor head gasket leaking.	Replace head gasket.
	Suction valve leaking.	Change valve plate in compressor.
	Worn piston.	Change compressor.
Compressor "Low Side" pressure too low.	Defective or blocked expansion valve.	Replace.
	Leaky compressor suction valves.	Replace.
	Plugged drier.	Replace.
	Suction service valve partially closed.	Open valve completely.
	Leak in system.	Use leak tester to find leak and repair or replace faulty part.
	Shortage of refrigerant.	Add refrigerant to system until sight glass appears completely clear - no foam or bubbles.

TROUBLE ANALYSIS CHART (continued)

Compressor "Low Side" pressure too high.	Too much refrigerant in system.	Bleed off refrigerant through pressure gauge until pressure returns to normal.
	Loose expansion valve feeler bulb.	Tighten feeler bulb clamp.
	Expansion valve not feeding properly.	Replace expansion valve.
Evaporator not cooling.	Defective or improperly set expansion valve.	Replace.
	Expansion valve frozen (moisture in system). Ice will appear on outside of expansion valve.	Remove refrigerant from system and replace receiving drier. Recharge system.
	Blocked expansion valve (dirt or foreign matter).	Remove refrigerant from system and replace receiver drier. Recharge system.
	Not enough refrigerant in system.	Add refrigerant to system until sight glass appears completely clear - no foam or bubbles.
	Faulty clutch.	Check clutch wire for loose or broken connection and repair or replace.
	Compressor drive belt slipping.	Adjust belt tension by tightening idler pulley eccentric. Replace belt if it shows excessive wear.
	Ice on evaporator coil.	Defrost coil.
	Hot air entering cab.	Close all vents and heater openings. Check heater switches for off position.
	Partially plugged filter or screen in drier.	Replace receiver drier.
	Capillary tube and expansion valve broken.	Replace expansion valve.
	High head pressure.	Check chart.

TROUBLE ANALYSIS CHART (continued)

	High suction pressure.	Check chart.
Overheating of engine when unit is operating.	Not enough air pulled through radiator for proper cooling.	Check for foreign material plugging core fins. Install heavy duty (six blade) cooling fan.
	Engine out of tune.	Have engine tune-up, valves and injectors reset.
Compressor drive belts too loose.	Belts too large.	Remove belt and install proper size.
	Belts too loose, (belt stretches after initial installation).	Tighten belt, using idler pulley eccentric.
Frozen Evaporator coil.	Not enough air passing over evaporator coil.	Increase air volume by turning switch to high setting.
	Faulty thermostat.	Replace.
	Thermostat not turned to proper setting.	Set thermostat to driving condition.

SPECIFICATIONS

GENERAL

1. Weight 56 lbs. net - nominal
2. Size - 25 7/8" x 27" x 8 1/8" high plus protrusion through cab roof 10 1/8" x 10 1/8" x 6 3/4".

MECHANICAL

1. Condenser fan 4 blade 9" dia. cadium plated hub.
2. Evaporator blower 3 3/16" dia. balanced blower wheels.
3. Compressor - 2 cyl. 10.35 cu. in. positive lubrication.
4. Clutch - electro-magnetic 12 volt D.C. fixed field 4 amp.

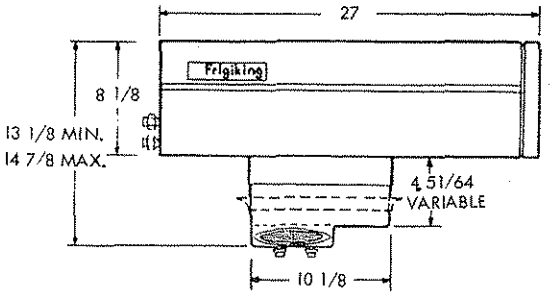
REFRIGERATION

1. Refrigerant type R12 in all models.
2. Refrigerant charge. Exact charge will vary with length of hoses. Nominal charge 3 1/2 to 4 lbs.
3. Thermostatic expansion valve pressure limiting type.

ELECTRICAL

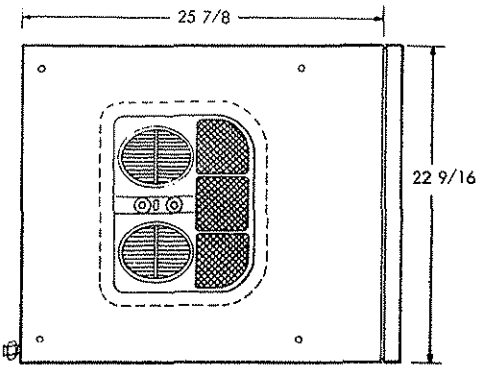
1. Evaporator motor 12 volt D. C. double shaft 3800 RPM 10 amp.
2. Condenser motor 12 volt D. C. single shaft 2800 RPM 8 amp.
3. Total current drain - 22 amp intermittent.

4. Protective Devices
   A. Circuit Breaker 30 amp.
   B. High pressure limit switch - Thermopressure sensing type in series with compressor clutch field opens at 200° F ± 5° F closes at 180° F ± 5° F.



COMPRESSOR POSITION	OIL HEIGHT		FACTORY TOTAL CHARGE
	MIN.	MAX.	
Vertical	7/8"	1 3/8"	11 fl. oz.
Horizontal	7/8"	1 5/8"	11 fl. oz.

Table 1 OIL LEVEL CHART



5/16-18 MOUNTING BOLTS (4 PLACES)

TEMPERATURE	PRESSURE	
	LOW SIDE	HIGH SIDE

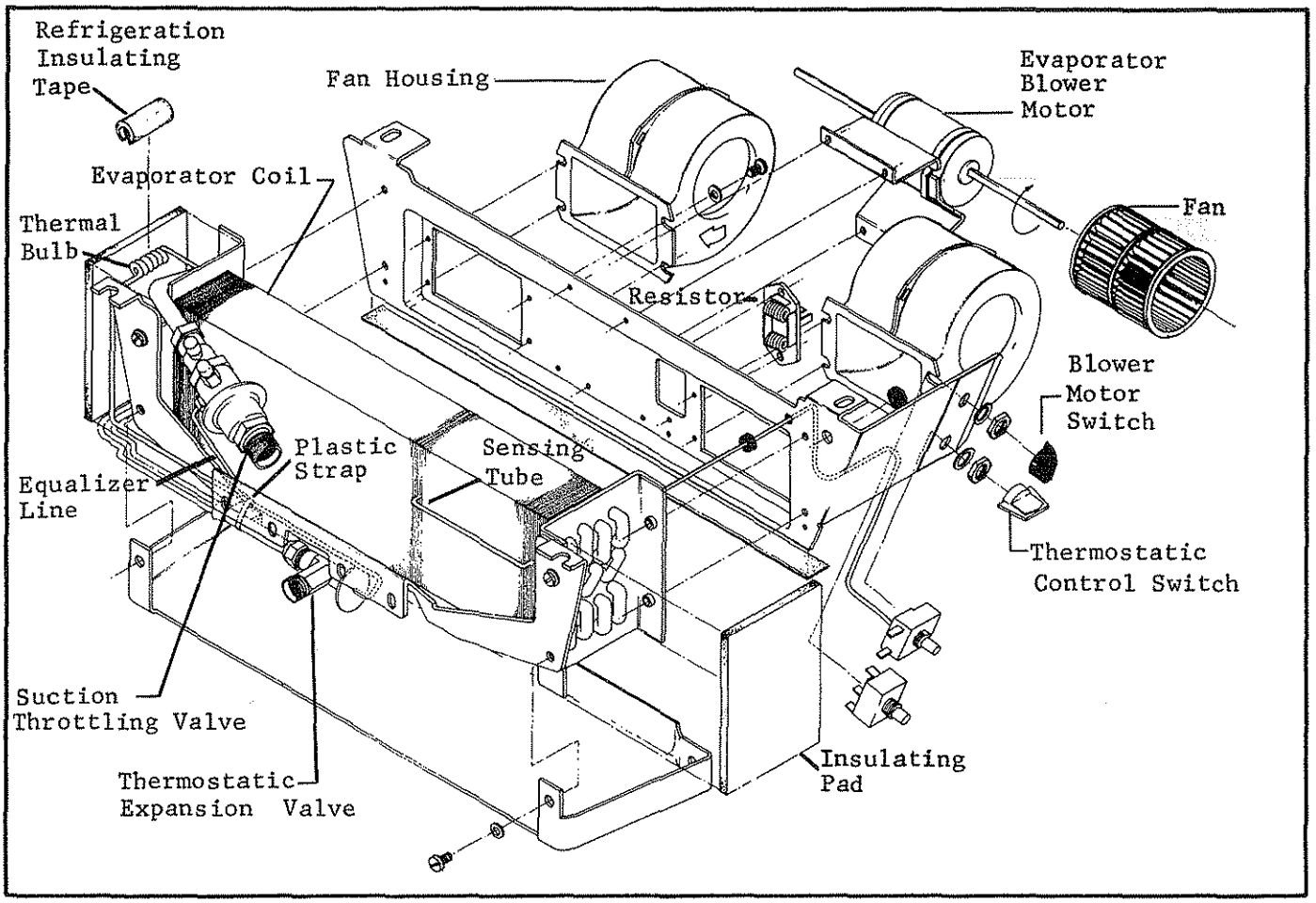


Fig. 1 Exploded View Of Air Conditioner

GENERAL DISCUSSION

The early versions of the Freightliner Model 320D air conditioner had SAE fittings with a metal to metal sealing surface and the drain hose attached to the drain pan assembly. Later models have O-ring seals and metal to metal shoulder surface contact. The drain hose of the later models attaches to the cover assembly instead of the drain pan assembly.

The Freightliner air conditioner Model 320D uses a suction throttling valve located in the evaporator coil outlet line. The function of the suction throttling valve is to control the evaporator pressure. This is accomplished by throttling

The suction throttling valve controls its inlet pressure by establishing a chamber of constant pressure above the piston. Opening or closing of the pilot valve changes the pressure on the compressor side of the piston in relation to the pressure on the evaporator side. This causes the piston to move, opening or closing the main port of the valve to maintain the predetermined evaporator pressure.

The inlet end of the valve has a test port containing a valve core. The service test gauge is connected to this fitting to determine the evaporator pressure. The other two fittings on the suction throttling valve are the oil bleed line (not used)

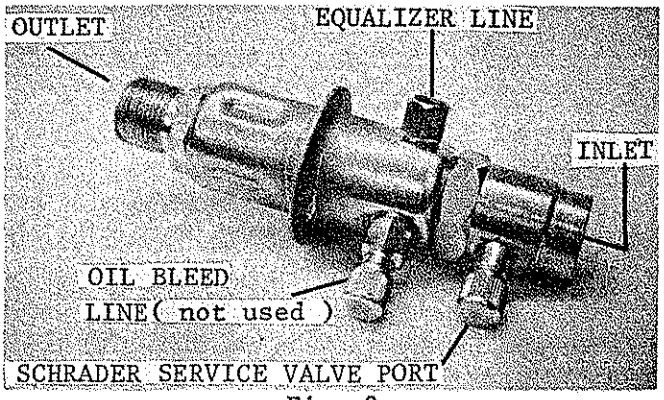


Fig. 2

that it is malfunctioning. Refer to procedures given under SUCTION THROTTLING VALVE TESTING, REMOVAL AND INSTALLATION.

OPERATING INSTRUCTIONS

The air conditioner system is controlled by two switches located on the air conditioner instrument panel. The temperature control is an adjustable thermostatic switch that will automatically maintain the incoming air at a selected temperature. A rise in temperature closes the switch. This in turn energizes the magnetic clutch, putting the Freon compressor into operation. As the temperature reaches the low point, the switch opens, deenergizing the clutch stopping the compressor. The blower motor switch has four positions: "OFF", "LOW", "MED" and "HI".

1. With engine running, set temperature control to coldest position.

2. Set fan speed on "HI" until the cab is cooled, then reduce fan speed, and lower thermostat setting to maintain desired temperature.

NOTE: To prevent evaporator frosting and icing, avoid the combination of low fan speed, and the coldest thermostat setting, especially on humid days. Should frosting or icing occur, turn the fan switch to "HI", and the thermostat to "OFF" for 2 or 3 minutes, then resume cooling at a higher fan speed than before frosting occured.

3. To quickly cool a hot cab, close outside air vents, turn on air conditioner, set temperature on "COLD" and fan switch on "HI", then open a window. These steps will result in the hot air being blown out of the cab. After three minutes, close the window, and the cab will cool to a comfortable level quickly.

4. To remove smoke, slightly open a window or vent to admit fresh air.

5. If cab windows fog up, turn the air conditioner on and direct the air louvers toward the windows until the fogging ceases, then set fan switch and thermostat to the desired position.

SERVICE OPERATIONS

Refer to Freightliner Maintenance Manual for air conditioner preventive maintenance schedules and operations.

EVAPORATOR ASSEMBLY REMOVAL AND INSTALLATION

Removal Refer to Fig. 1

1. Disconnect water drain hose; be sure water has drained from pan before disconnecting hose.

2. Remove evaporator cover.

3. Connect service gauges to the service valves on top of the compressor, as shown in Fig. 4, but do not connect the center service hose to the vacuum pump. Position the center service hose in the shop exhaust system outlet. Open the manifold gauge discharge valve all the way, then open the compressor discharge valve just enough to slowly discharge the refrigerant into the shop exhaust system. Do not discharge rapidly or the oil will be carried out with the Freon. If the oil does get carried out with the Freon, the compressor will have to be refilled with oil.

WARNING: Care should be taken to avoid refrigerant from contacting the skin or eyes because liquid refrigerant-12, at

normal atmospheric pressure and temperature, evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while charging or discharging the system.

4. Mark wires for later hook-up, then disconnect the wires.

5. Remove the four unit-to-roof mounting capscrews, then lower unit onto tunnel. Use protective covering on tunnel.

6. Remove the duct-to-bunk, on sleeper cabs, if required.

7. Disconnect cooler refrigerant hoses from suction throttling valve and thermostatic expansion valve. Use two wrenches to avoid twisting the tubing. Seal the hoses with caps to prevent moisture from entering the system.

8. Carefully inspect the hose fitting sealing surfaces for any grooves or nicks. Replace parts if worn, grooved, nicked, or otherwise damaged.

NOTE: On the earlier model 320D, the fittings are SAE 45° flared type. The fittings on the later model 320D are O-ring seal type. Carefully inspect O-ring seal surface of suction throttling valve, and thermostatic expansion valve. If nicked, grooved or in any way damaged, replace valve(s).

9. Remove evaporator assembly components in accordance with procedures described in this subject.

Installation Refer to Fig. 1

1. Apply refrigeration oil to O-rings, and threads at the fittings.

2. Remove plugs from hoses. Connect refrigerant hoses to thermostatic expansion valve, and suction throttling valve. Carefully align fittings to avoid cutting the O-rings. Use two wrenches when tightening fittings to prevent twisting of tubing. Tighten the connections to the torque value given in Table 1 located under SPECIFICATIONS.

3. Securely clamp the suction throttling valve hose and the thermostatic expansion valve outlet line to the evaporator frame.

4. If removed earlier, install duct-to-bunk.

5. Position the evaporator assembly unit on the cab roof mounting brackets. Install the four mounting capscrews using a lockwasher, and flatwasher under the bolt head. Before tightening the capscrews, push the evaporator assembly forward until the defroster fan bracket contacts air plenum. Tighten the capscrews to 6 ft-lbs.

6. Connect the electrical wires using the identifications previously made; or the wiring diagram located under SPECIFICATIONS.

7. On late models, connect drain hose to cover assembly. On early models, connect drain hose to drain pan. The drain hose must slope downward in an even arc. Be sure the end under the deck is open and cut off at a 45° angle with the longer portion toward the front for scavenging effect.

8. Be sure the foam rubber seal, shown in Fig. 3 is positioned across the inside of the cover 2" from the front edge, and is securely glued in place.

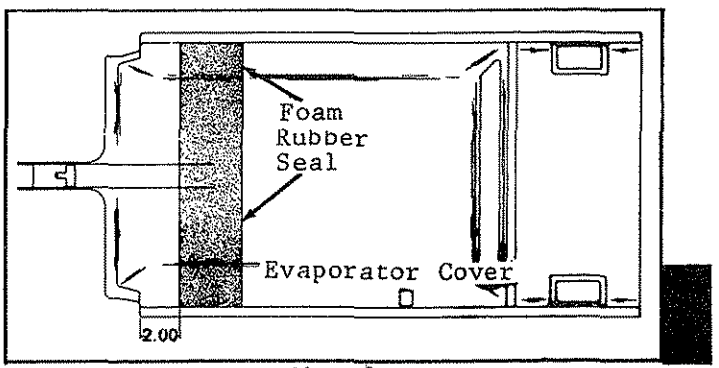


Fig. 3

9. Evacuate, charge, and leak test the system using the procedures given under EVACUATING, CHARGING, AND LEAK TESTING.

10. After the system has been evacuated, charged, and leak tested, install the evaporator cover.

EVAPORATOR COIL REMOVAL AND INSTALLATION

Removal Refer to Fig. 1

1. Remove the evaporator assembly using the procedures given under EVAPORATOR ASSEMBLY REMOVAL AND INSTALLATION.

2. Remove the thermostat switch from the frame, then carefully remove the sensing tube from the coil.

3. Remove the refrigerant insulating tape, then cut the plastic retainer strap that holds the evaporator inlet line to the evaporator frame.

4. Disconnect the suction throttling valve from the evaporator coil outlet tube and the thermostatic expansion valve from the evaporator coil inlet tube. Disconnect the equalizer line from the suction throttling valve. Remove the thermostatic expansion valve and the suction throttling valve.

5. Remove the screws that attach the evaporator coil to the evaporator frame assembly, then remove the evaporator coil.

Installation Refer to Fig. 1

1. Position evaporator coil in frame and attach to frame with machine screws.

2. Apply refrigerant oil to O-ring(s) and fitting threads, then connect suction throttling valve to evaporator coil outlet line and thermostatic expansion valve to evaporator coil inlet line. Connect equalizer line to suction throttling valve. Use two wrenches when tightening connections to avoid twisting of tubing. Tighten the connections to the torque values given in Table 1 located under SPECIFICATIONS.

3. Clamp thermal bulb to evaporator core outlet tube with a plastic or copper retainer strap, then cover thermal bulb with refrigeration insulating tape.

4. Position the thermostat switch sensing tube through the frame grommet, then through the evaporator core fins near the end. Use a thin screwdriver or an awl to carefully spread fins for tubing insertion, then insert tubing below top row of tubes and exit below the second row of tubes on the opposite side. Embed end of sensing tube back into fins approximately 6" inboard and 1" deep.

5. Position the thermostat switch in the frame, then install the nut attaching the switch to the frame.

6. Install refrigeration tape and insulating pads over the evaporator coil tubing on each end.

7. Install the evaporator assembly using the procedures given under EVAPORATOR ASSEMBLY, REMOVAL AND INSTALLATION.

RESISTOR AND/OR BLOWER MOTOR SWITCH REMOVAL AND INSTALLATION

Removal Refer to Fig. 1

1. Remove the evaporator cover attaching screws, and lower the cover onto the tunnel.

2. Identify and mark wires for later connection, then disconnect the wires from the resistor and/or blower motor switch.

3. Remove the resistor and/or blower motor switch from the evaporator frame.

Installation Refer to Fig. 1

1. Install resistor and/or blower motor switch in the evaporator frame.

2. Connect the wires using the previously marked identification or the wiring diagram located under SPECIFICATIONS.

3. Position the evaporator cover in place, and install the attaching screws.

EVAPORATOR BLOWER MOTOR REMOVAL AND INSTALLATION

Removal Refer to Fig. 1

1. Remove the evaporator cover attaching screws, and lower the cover onto the tunnel.

2. Identify and mark wires for later connection, then disconnect the wires from the blower motor.

3. Remove the fan housings;

   3.1 On metal type housings, remove the outer inlet flanges. Loosen the Allen head set screw in the fan hub, then remove the fan. Remove the screws that attach the blower housings to the evaporator frame.

   3.2 On plastic molded type housings, remove the screws that attach the housings to the evaporator frame. Unsnap the center flange fasteners, then loosen the Allen head set screw in the fan hub. Remove fan and fan housing.

4. Remove the blower motor retaining clamps, then remove the blower motor.

Installation Refer to Fig. 1

1. Center blower motor on mounting bracket with the wire leads to the right side as viewed from the back. Rotation is counterclockwise viewed from the wire end.

2. Install the two blower motor retaining clamps and tighten.

3. Install the fan housings;

   3.1 On metal type housings, position the housing over the shaft, then install fan on shaft. (Outer edge of bottom blades should point toward evaporator). Refer to Fig. 1. Install the screws attaching the fan housing to the evaporator frame, then center the fan in the housing, and tighten the fan shaft Allen head set screw. Attach the outer inlet flange (not shown) to the fan housing.

   3.2 On molded type housings, position the fan housing over the blower motor shaft, then install the screws attaching the fan housing to the evaporator frame. Position the fan on the blower motor shaft and tighten the Allen head set screw. (Outer edge of bottom blades should point toward evaporator.) Refer to Fig. 1.

4. Connect the blower motor wires using the previously made identification, or the wiring diagram located under SPECIFICATIONS.

5. Install the evaporator cover, and connect drain hose. Be sure drain hose is routed downward without kinks or sharp bends so that condensate drainage will be unhampered.

THERMOSTATIC EXPANSION VALVE REMOVAL AND INSTALLATION

Removal Refer to Fig. 1

1. Remove the evaporator assembly using the procedures given under EVAPORATOR ASSEMBLY REMOVAL AND INSTALLATION.

2. Remove the insulating tape that covers the thermal bulb, then remove the plastic strap holding the thermal bulb to the evaporator coil line.

3. Disconnect the equalizer line from the suction throttling valve. Install a plug in the equalizer line.

4. Disconnect the evaporator coil line

from the expansion valve, then remove the expansion valve. Install a plug in the evaporator coil line.

Installation Refer to Fig. 1

1. Remove plug from evaporator coil line, then position expansion valve in place; apply refrigerant oil to O-rings and threads. Connect evaporator coil line to expansion valve, and tighten the connection to the torque value given in Table 1 located under SPECIFICATIONS.
2. Connect the equalizer line to the suction throttling valve. Tighten the connection to the torque value given in Table 1 located under SPECIFICATIONS.
3. Clean the evaporator coil line at the thermal bulb contact area to assure a good metal to metal contact, then clamp the thermal bulb to the evaporator coil line with a plastic or copper retainer strap. Insulate thermal bulb with refrigeration insulating tape.
4. Install the evaporator assembly using the procedures given under EVAPORATOR ASSEMBLY REMOVAL AND INSTALLATION.

SUCTION THROTTLING VALVE TESTING, REMOVAL AND INSTALLATION

The suction throttling valve is an evaporator pressure regulator used to control the pressure and temperature of the evaporator. This valve is sealed and is not repairable. If proved to be defective by the following test, it must be replaced with a new valve.

Testing

1. The system must be fully charged before testing suction throttling valve for correct operation. Check sight glass for bubbles or foam. If bubbles or foam are present charge system using the procedures given under EVACUATING, CHARGING AND LEAK TESTING.
2. Connect a pressure gauge (gauge line must have a Schrader type connecter) to the Schrader type service valve port of the suction throttling valve.
3. Start the engine and run at 1000-1200 rpm.
4. Set the air conditioning controls for maximum cooling, and operate for 10-15 minutes.
5. Read pressure on pressure gauge connected to suction throttling valve. Pressure should be 27.5 - 29.5 psig at sea level. For each 1,000' of elevation, add .5 psig for correct reading. If pressure is not correct, replace suction throttling valve using the procedures given under Removal and Installation.

Removal Refer to Fig. 1

1. Remove the evaporator assembly using the procedures given under EVAPORATOR ASSEMBLY REMOVAL AND INSTALLATION.
2. Disconnect the equalizer line from the suction throttling valve. Install a plug in the equalizer line.
3. Disconnect the evaporator coil line from the suction throttling valve, then remove the suction throttling valve. Install a plug in the evaporator coil line.

Installation Refer to Fig. 1

1. Remove the plug from the evaporator coil line. Position the suction throttling valve in place and connect the evaporator coil line to the suction throttling valve. Tighten the connection to the torque value given in Table 1 located under SPECIFICATIONS.
2. Remove plug from equalizer line. Connect the equalizer line to the suction throttling valve. Tighten the connection to the torque value given in Table 1 located under SPECIFICATIONS.

3. Install the evaporator assembly using the procedures given under EVAPORATOR ASSEMBLY REMOVAL AND INSTALLATION.

CONDENSER COIL REMOVAL AND INSTALLATION

1. Connect service gauges to the service valves on top of the compressor, as shown in Fig. 4, but do not connect the manifold center service hose to the vacuum pump. Position the center service hose in the shop exhaust system outlet. Open the manifold gauge discharge valve all the way, then open the compressor discharge valve just enough to slowly discharge the refrigerant into the shop exhaust system. Do not discharge rapidly or the oil will be carried out with the refrigerant. If the oil does get carried out, the compressor will have to be refilled with oil. Refer to the 01 section of this manual for freon compressor information.

WARNING: Care should be taken to avoid refrigerant from contacting the skin or eyes because liquid refrigerant-12, at normal atmospheric pressure and temperature, evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while charging or discharging the system.

2. After the system is completely discharged, disconnect the Freon compressor line from the condenser coil. Use two wrenches to avoid twisting the line while loosening the fitting. Install a plug in the compressor line.

3. Disconnect the receiver-drier line from the condenser coil. Use two wrenches to avoid twisting the line while loosening the fitting. Install a plug in the receiver-drier line.

4. Remove the capscrews that attach the condenser to the end support brackets, then remove the condenser.

Installation

1. Position the condenser on the end support brackets, and install the capscrews attaching the condenser to the end support brackets.

2. Remove the plug from the receiver-drier line, apply refrigerant oil to seal surfaces, O-rings and threads. Connect receiver-drier line to condenser coil. Tighten the connection to the torque value given in Table 1 located under SPECIFICATIONS.

3. Remove the plug from the compressor line, apply refrigerant oil to seal surfaces, O-rings and threads. Connect the compressor line to the condenser coil. Tighten the connection to the torque value given in Table 1 located under SPECIFICATIONS.

4. Evacuate, charge, and leak test the system using the procedures given under EVACUATING, CHARGING AND LEAK TESTING.

RECEIVER-DRIER REMOVAL AND INSTALLATION

Removal

1. Connect service gauges to the service valves on top of the compressor, as shown in Fig. 4, but do not connect the manifold center service hose to the vacumm pump. Position the center service hose in the shop exhaust system outlet. Open the manifold gauge discharge valve all the way, then open the compressor discharge valve just enough to slowly discharge the refrigerant into the shop exhaust system. Do not discharge rapidly or the oil will be carried out with the Freon. If the oil does get carried out, the compressor will have to be refilled with refrigeration oil.

WARNING: Care should be taken to avoid refrigerant from contacting the skin or eyes because liquid refrigerant-12, at normal atmospheric pressure and temperature, evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while charging or discharging the system.

2. After the system is completely discharged, disconnect the evaporator line and the condenser line from the receiver-drier. Use two wrenches to avoid twisting the tubing. Install a

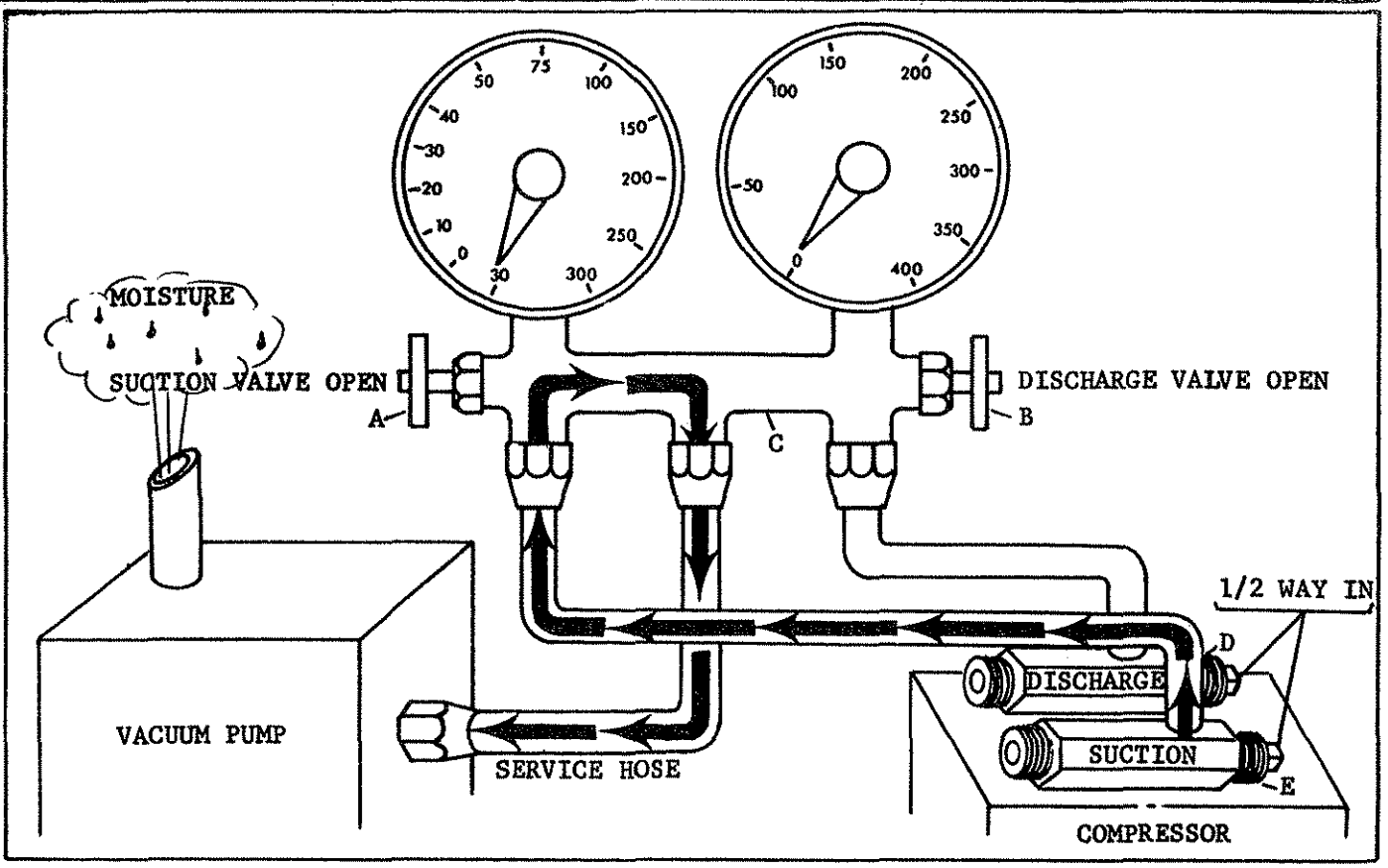


Fig. 4 Evacuating System With Vacuum Pump

plug in the evaporator line and the condenser line.

3. Remove the U-bolt nuts, washers, and U-bolts that attach the receiver-drier to the mounting bracket, then remove the receiver-drier

Installation

1. Position the receiver-drier in the mounting bracket, and install the U-bolts, washers, and nuts attaching the receiver-drier to the mounting bracket. Tighten the U-bolt nuts to 13 ft-lbs.

2. Remove the plugs from the evaporator line and condenser line. Apply refrigeration oil to seal surface and threads, then connect the lines to the receiver-drier. Using two wrenches to avoid twisting of the tubing, tighten the connections to the torque value given in Table 1 located under SPECIFICATIONS.

3. Evacuate, charge, and leak test the system using the procedures given under EVACUATING, CHARGING AND LEAK TESTING.

EVACUATING, CHARGING AND LEAK TESTING

Whenever repairs have been made on any of the air conditioner system components containing refrigerant, the system must be evacuated, charged and leak tested.

Make the following checks before evacuating, charging, or leak testing system:

1. Check for proper Freon compressor belt tension. Refer to subject 32-01040. Adjust belt tension if not in compliance.

2. Check Freon compressor clutch coil wire connection for tightness. Tighten if loose. Repair if broken or damaged.

3. Check for broken or cut hoses, and for loose fittings on all components. Remove broken or cut hoses, and replace

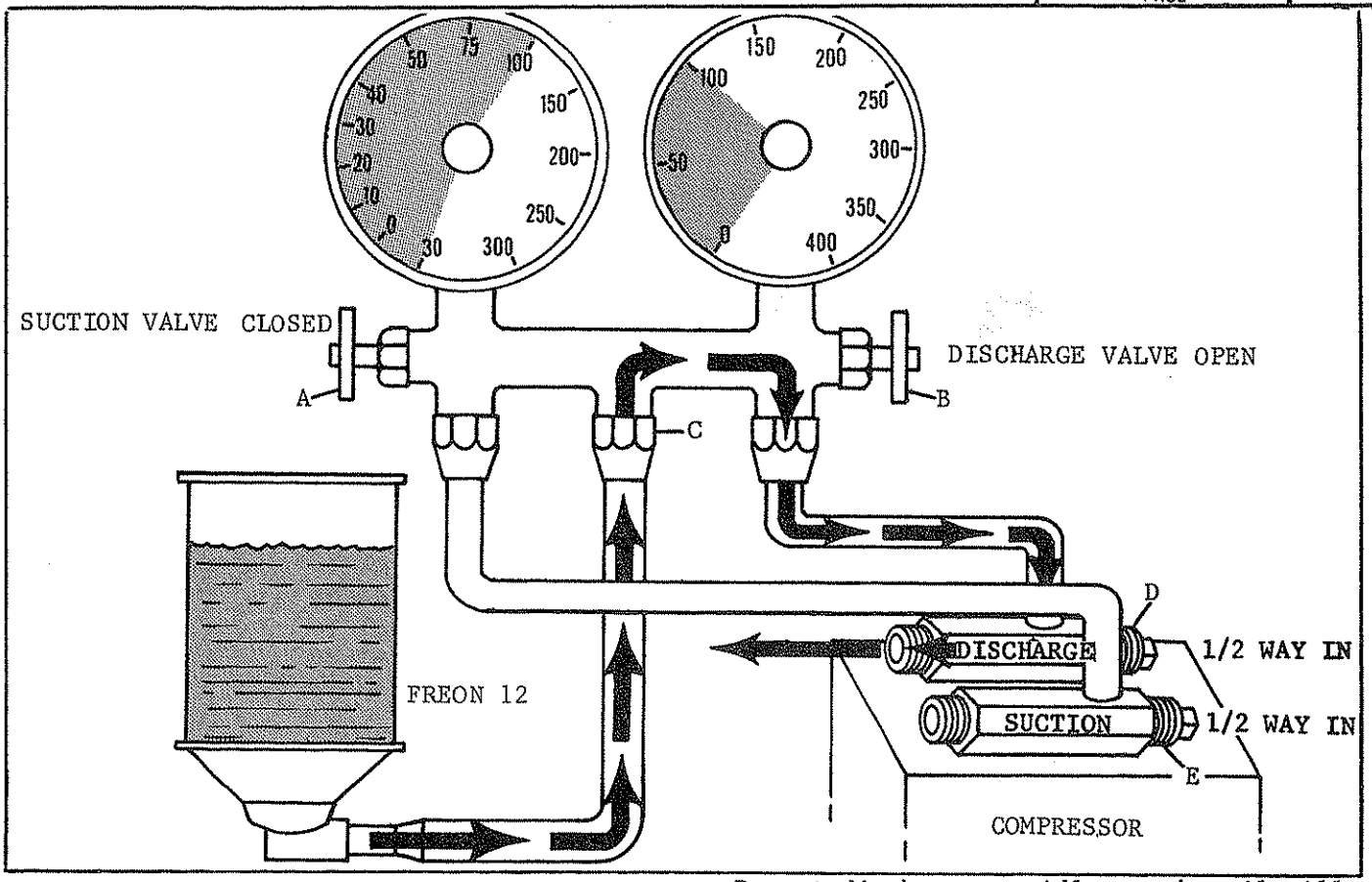


Fig. 5 Charging System With Liquid Freon

them with new ones. Tighten loose fittings in accordance with the torque values given in Table 1 located under SPECIFICATIONS.

4. Check for condenser air blockage of external fins due to foreign material. Using air pressure and a whisk broom, clean the condenser coil, if foreign material is present.
5. With the blower motor on "HI", make sure there is no air leakage at any of the air duct connections. If leakage is present, repair the connection.

Prior to evacuating the system be certain that it does not contain any refrigerant. Connect service gauges to the service valves on top of the compressor, as shown in Fig. 4, but do not connect the manifold center service hose to the vacuum pump. Position the center service hose in the shop exhaust system outlet. Open the manifold discharge valve all the way, then open the compressor discharge valve just enough to slowly discharge the refrigerant into the shop exhaust system. Do not discharge rapidly or the oil will be carried out with the refrigerant. If the oil does get carried out with the refrigerant, (any oil carried out will be visibly present in the discharge hose and shop exhaust system) the compressor will have to be refilled with oil. Refer to the 01 section of this manual for freon compressor information.

WARNING: Care should be taken to avoid refrigerant from contacting the skin or eyes because liquid refrigerant-12, at normal atmospheric pressure and temperature, evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while evacuating, charging, discharging and/or leak testing. the system.

Evacuating Refer to Fig. 4

1. With the system completely discharged, connect the manifold center service hose to the vacuum pump. (Fig. 4, Ref. C)
2. Open the manifold valves completely, and start the vacuum pump. (Fig. 4, Ref. A & B)

3. When the low side gauge reads 27 to 29 inches of vacuum and will go no lower, let the pump operate another 10 minutes, then close both manifold valves and shut off the vacuum pump.

4. If the low side gauge rises after 15 minutes and continues to rise, the system has a leak that must be repaired before the system can be evacuated. Refer to Leak Testing. If the low side gauge does not rise, there is no leak present, re-open the manifold valves, turn on the vacuum pump and let it run for at least one hour.

Charging

WARNING: Care should be taken to avoid refrigerant from contacting the skin or eyes because liquid refrigerant-12, at normal atmospheric pressure and temperature, evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while charging the system.

With System Evacuated And Using Liquid Freon Refer to Fig. 5

WARNING: Never charge liquid Freon into the system while the Freon compressor or engine is running. To do so could result in damage to the Freon compressor.

1. With the system completely evacuated and no leaks present, connect the manifold center hose to the refrigerant can. Position refrigerant can as shown in Fig. 5.

2. Loosen the manifold center hose connection at the manifold approximately 2 turns.

3. Open the valve on the refrigerant can and allow gas to escape at the loosened connection to force out any air that might be in the hose. Tighten the loosened connection after about 5 seconds.

NOTE: The amount of refrigerant required to charge the system when completely evacuated is 3 lbs.

4. Open the manifold discharge valve (Fig. 5, Ref. B) Be sure the manifold suction valve is closed. (Fig. 5, Ref. A)

5. Open compressor suction service valve half-way. (Fig. 5, Ref. E)

6. Open compressor discharge service valve half-way. (Fig. 5, Ref. D) If a good vacuum has been applied during evacuation of the system the 3 lbs. of Freon will now be pulled into the system.

7. After the 3 lbs. of Freon is pulled into the system, close the manifold discharge valve. Open the compressor suction, and discharge valves all the way out (counterclockwise). Start the engine and run at fast idle with the air conditioner on full.

   7.1 Check the sight glass for bubbles or foam. If there are no bubbles or foam visible in the sight glass, the system is completely charged. Disconnect the manifold suction, and discharge service hoses from the compressor valve ports, and install sealing caps.

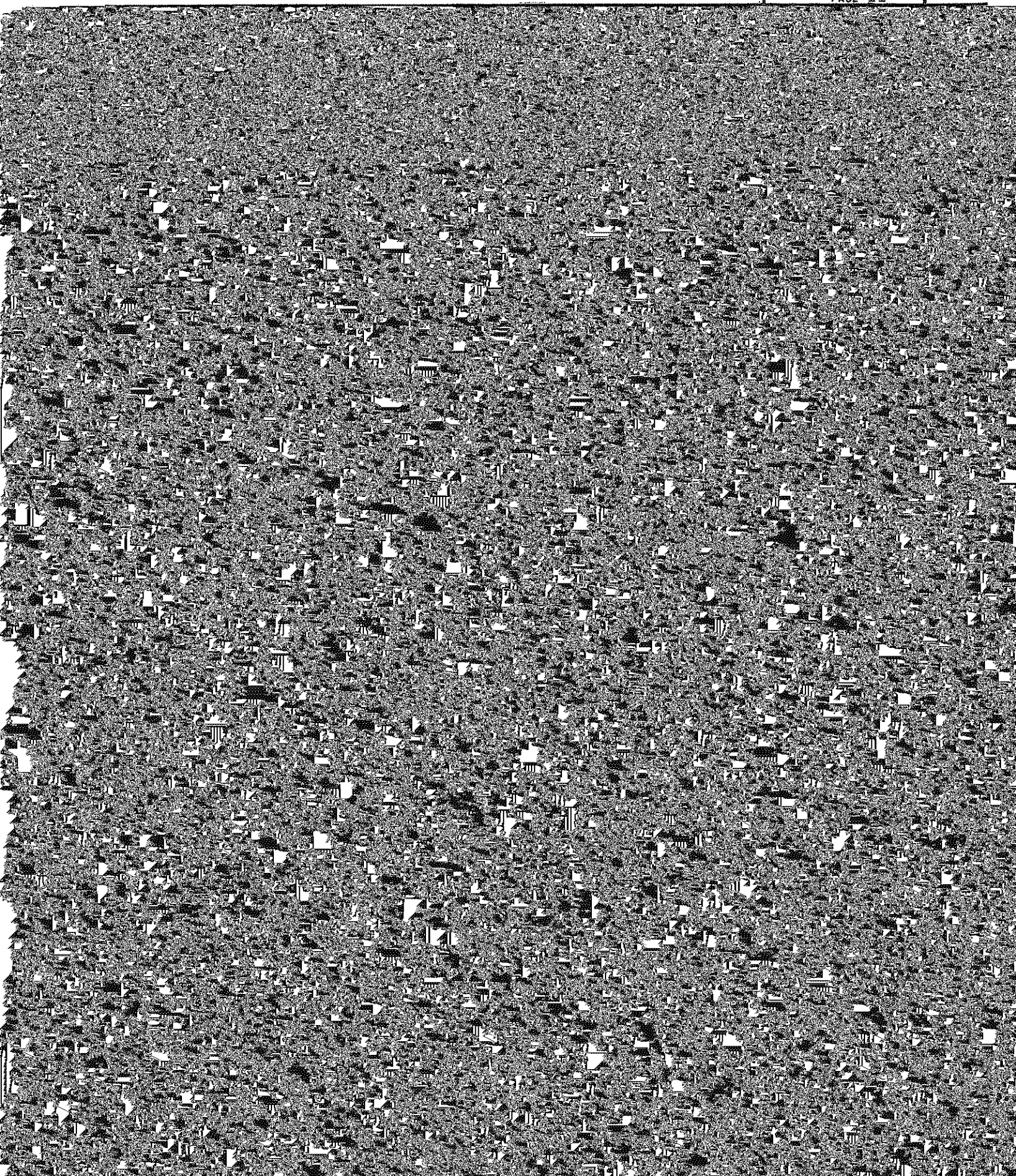
   7.2 If there are bubbles or foam present in the sight glass, finish charging the system using the procedures given under Charging, With System Partially Filled And Using Freon In A Gaseous State

With System Partially Filled And Using Freon In A Gaseous State Refer to Fig. 6

1. Connect the manifold suction and discharge service lines to the compressor service ports as shown in Fig. 6.

2. Position the Freon can as shown in Fig. 6, then connect manifold center service line to Freon can.

3. Open manifold suction valve (Fig. 6, Ref. A). Be sure manifold discharge valve (Fig. 6, Ref. B) is closed.



refrigerant from contacting the skin or eyes because liquid refrigerant-12, at normal atmospheric pressure and temperature, evaporates and will tend to freeze anything it contacts. Goggles and gloves should be worn while charging, discharging or leak testing the system.

Use the following procedure to leak test the system:

1. Connect the charging manifold suction service hose to the compressor suction service valve and the manifold discharge service hose to the compressor discharge service valve. Be sure the manifold suction and discharge valves are closed.
2. Connect the manifold center service hose to the refrigerant can. Loosen the manifold center service hose connection at the manifold, then open the valve on the refrigerant can momentarily to force out any air that might be in the charging hose. After the air is removed, tighten the connection.
3. Open the compressor service valves half-way.
4. Open the manifold suction and discharge valves.
5. Open the refrigerant can valve, when approximately 1/2 to 1 lb. of refrigerant has entered the system, close the refrigerant can valve and disconnect the hose.
6. Close the compressor service valves and the manifold valves, then disconnect the manifold service hoses.
7. Leak test the system using an electrontic leak detector or equivalent in accordance with procedures specified by detection manufacturer.
8. If a leak is detected at a connection, tighten the fitting(s) and/or replace worn or damaged seal(s). If a leak is dectected in a component of the system, replace the defective part, then retest for leaks. Continue checking for leaks until they have all been eliminated.

TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Low or No Evaporator Air Flow	Blower not operating	Circuit Breaker Open. Locate Short in Circuit and Repair Defective Blower Motor Switch; Replace Switch Loose Wire Connector or Broken Wire in Air Conditioner Circuit; Repair Blower Motor Turning Backwards. Refer to Fig. 1 for Correct Rotation. Defective blower motor or resistor; replace.
	Blower wheel installed backwards.	Correct blower wheel installation. Refer to Fig. 1
	Restricted Air Duct	Remove restriction.
	Ice Blocking Evaporator Low Evaporator Pressure	Defective Suction Throttling Valve; replace valve.
cont'd.	Moisture in System Receiver Drier Defective	Replace drier.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Low Or No Evaporator Air Flow Cont'd.	Leaks in system	Locate and repair leaks. See section entitled "Leak Testing".
HIGH EVAPORATOR DISCHARGE AIR TEMPERATURE (All problems listed from here, in this column can cause HIGH EVAPORATOR TEMPERATURES.)	———	———
Foaming in Sight Glass	System low on refrigerant	Add refrigerant.
	Leaks in system.	Repair leaks. See "Leak Testing"
	Restrictions in line between condenser and sight glass	Remove restriction in line.
No Foaming, but High Evaporator Discharge Temperature	System may be empty. Low pressure compressor line not cold. High pressure line on compressor not warm.	Evacuate, charge, and leak test the system. See section titled "Evacuating, Charging, and Leak Testing".
Low Evaporator Coil Outlet Pressure	Suction Throttling Valve inlet line warm, restrictions in line showing frost spots	Remove restrictions or replace line.
	Plugged inlet screen in Thermostatic Expansion Valve.	Clean screen in Thermostatic Expansion Valve
	Defective Thermostatic Expansion Valve.	Replace Thermostatic Expansion Valve.
	Restriction(s) in liquid line to Thermostatic Expansion Valve.	Remove line restriction(s).
	Ice Blocked Evaporator	Allow system to warm up with compressor stopped.
	Defective Suction Throttling Valve.	Replace Suction Throttling Valve.
	Equalizer Line to Thermostatic Expansion Valve kinked	Replace Thermostatic Expansion Valve and Equalizer line assembly if kinked or flattened.

PROBLEM	POSSIBLE CAUSE	CORRECTION
High Compressor Discharge Pressure	Shutter not opening	Adjust or repair shutters. Refer to wiring diagram, Fig. 7. Replace shutter solenoid valve.
	Condenser air flow restricted	Remove restriction of air flow thru condenser.
	Refrigerant restriction in condenser. Return tube bends should be same temperature.	Replace condenser.
	Air in system	Repair leaks in system. See "Leak Testing"
High Evaporator Discharge Pressure	Thermal bulb not secure to evaporator line or contact area not clean	Clean tube and secure bulb to tube.
Equalizer Line Frosty or Cold	Suction Throttling Valve not operating due to moisture freezing piston.	Allow system to warm up. Restart engine, check evaporator outlet pressure. If still low, replace Suction Throttling Valve.
Equalizer Line Warm	Clutch or Belt Slipping	Clean clutch facing. Adjust belt. Refer to subject 32-01040.
	Suction Line Restricted	Remove restriction (s).
	Compressor in need of repair.	Repair or replace compressor.
Evaporator Outlet Air Temperature Drops As Compressor Discharge Pressure Drops	Leaks in System.	Repair leaks. See section titled "Leak Testing".
Evaporator Outlet Air Temperature Increases As Compressor Discharge Pressure Drops	Thermostatic Expansion Valve setting is low.	Replace Thermostatic Expansion Valve.

Cont'd next page

PROBLEM	POSSIBLE CAUSE	CORRECTIONS
Temperature in Cab too high with normal Evaporator and Discharge Pressure.	Heater water shutoff valve not closed	Close heater water valve
	Air door to heater not closed (temperature door).	Close heater air door and make sure cable linkage is free from binding and is engaging full travel.
	Evaporator to cover seal leakage.	Reseal cover to evaporator.
	Heater shutoff door not sealing.	Reseal heater door.
Evaporator Outlet Air Temperature Increases as Compressor Discharge Pressure Drops	Excessive oil in system. An indication of this is clutch slippage or belt slippage at governed engine speed.	Set controls at high blower and maximum cold, operate engine at idle for 10 minutes. Discharge system and drain excess oil from compressor. Evacuate, charge and leak test system.
	Excessive oil in Thermostatic Expansion Valve and Suction Throttling Valve.	Remove Thermostatic Expansion Valve and Suction Throttling Valve. Drain oil from valves and flush the remaining components with R-11 flushing fluid or equivalent to remove any remaining oil. Refill compressor with new oil. Refer to 01 section. Evacuate, charge and leak test system. Refer to section titled Evacuate, Charge and Leak Test for procedures.

SPECIFICATIONS

OUTSIDE DIAMETER OF METAL TUBE IN INCHES	* TORQUE FOR STEEL TUBES IN FT-LBS	* TORQUE FOR ALUMINUM OR COPPER TUBES IN FT-LBS
1/4"	10 - 15	5 - 7
3/8"	30 - 35	11 - 13
1/2"	30 - 35	15 - 20
5/8"	30 - 35	21 - 27
3/4"	30 - 35	28 - 33

* When tightening fittings always use the torque reading for the softer metal when unlike metals are used.

Table 1 Refrigerant Line Torque Specifications

TEMPERATURE	SYSTEM PRESSURE, PSI	
	LOW SIDE	HIGH SIDE
Cool Day 70° - 80°	20 - 25 psi	160 - 180 psi
Warm Day 80° - 90°	25 - 30 psi	180 - 200 psi
Hot Day 90° +	30 - 35 psi	200 - 220 psi

Table 2 Temperature/Pressure Specifications

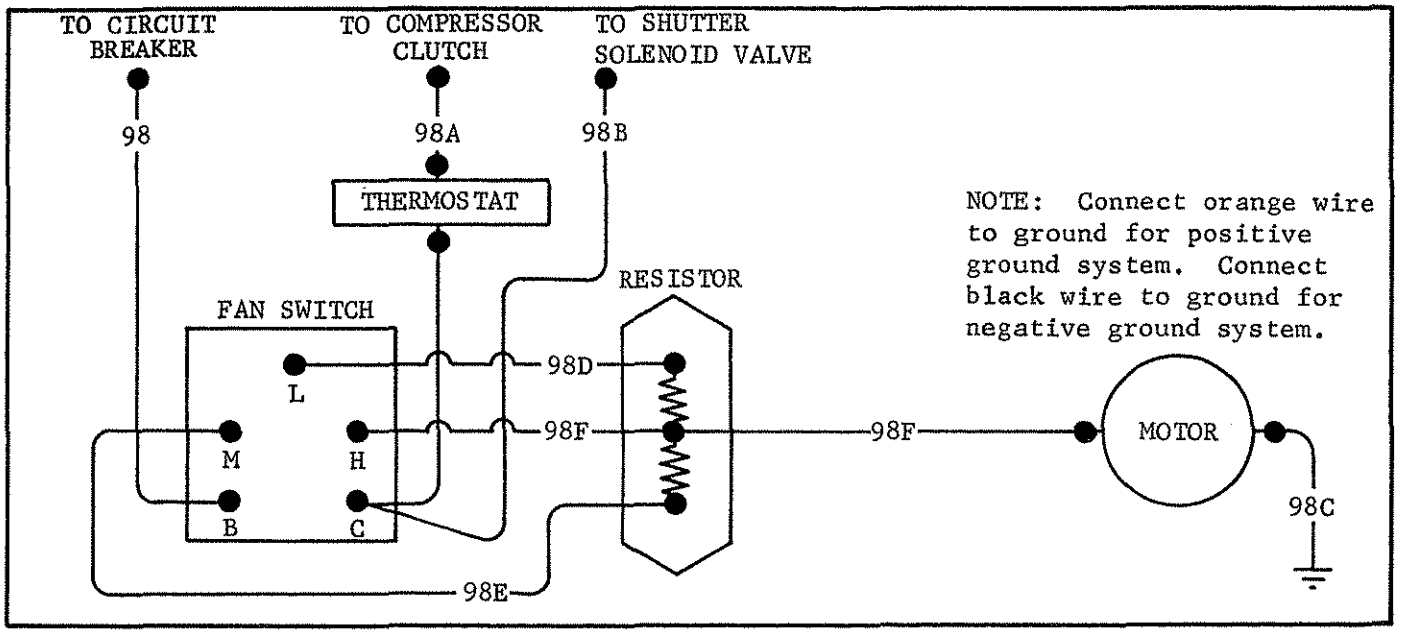


Fig. 7 Air Conditioner Wiring Diagram

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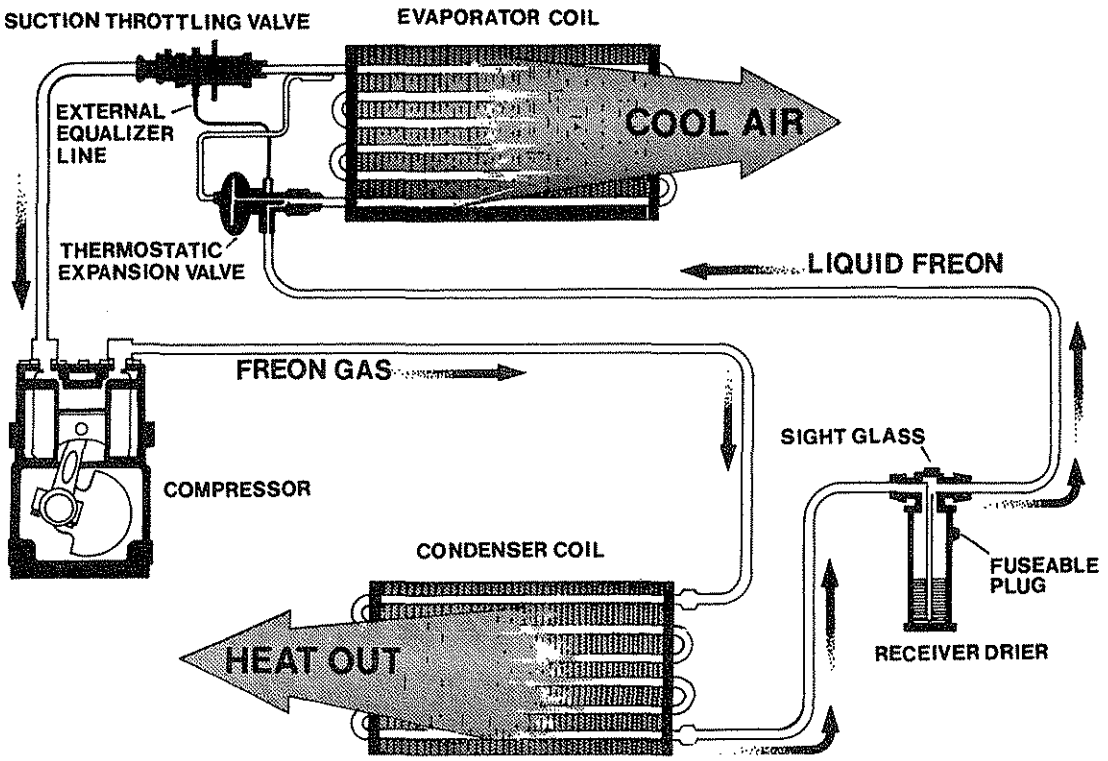

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Fig. 8 Air Conditioner Refrigerant Flow Diagram

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

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CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

GENERAL INFORMATION

The Freightliner sleeper box heater-air conditioner (Fig. 1) is combined into one unit and integrates all components, including the heater core and evaporator coil, blower, and control valves. The unit is mounted in the baggage compartment, and air is ducted into the sleeper compartment through a flex hose. Some units are equipped with a heater-only.

The sleeper box air conditioning system is dependent on the cab's air conditioning system, utilizing the same refrigerant and compressor.

The sleeper box heating system is independent of the cab's heating system. Each is equipped with a separate plumbing system to the engine.

There are two variations of sleeper box heater-air conditioner control panels, depending on the size of the sleeper box. The controls in 60-inch sleeper boxes are located in a panel mounted on the storage shelf partition next to the mattress. Refer to Fig. 2. On all other sleeper boxes, the control panel is mounted on the rearmost sleeper box wall, opposite the blower air duct. Refer to Fig. 3. The individual controls shown in Figs. 2 and 3 are identical, but are arranged differently in the panels.

Refer to the Freightliner Drivers Manual for operating instructions of the sleeper box heater-air conditioner.

PRINCIPLES OF OPERATION

CONTROL PANEL

In the control panel, the mode relay component (Fig. 4) is the interconnecting point of all electrical wires to the heater-air conditioner. The mode relay component is identified on the control panel face by an attaching screw. Refer to Fig. 2 or 3, Ref. 4.

The mode relay is energized whenever the function toggle switch (Fig. 2 or 3, Ref. 2) and the thermostat dial (Fig. 2 or 3, Ref. 3) are adjusted to activate either the heater or the air conditioner. When these adjustments are made, power flow to the electrical components of the heater-air conditioner is controlled by the mode relay.

On heater-air conditioner units, power enters the system at the function toggle switch. On heater-only units, power enters the system at the thermostat dial.

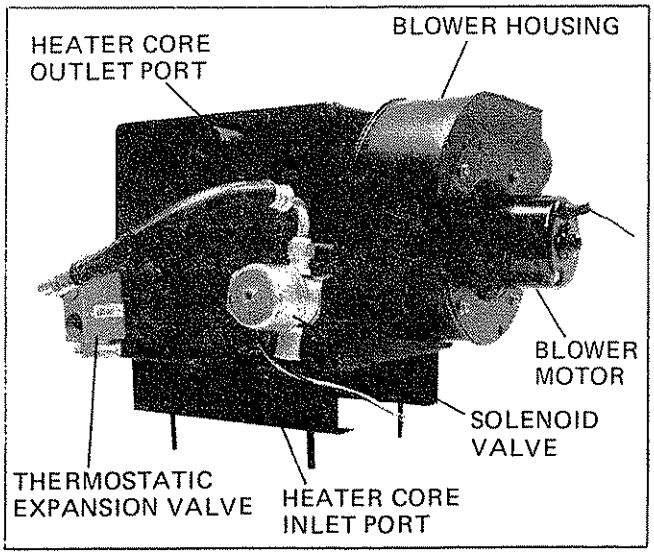


Fig. 1, Sleeper Box Heater-Air Conditioner

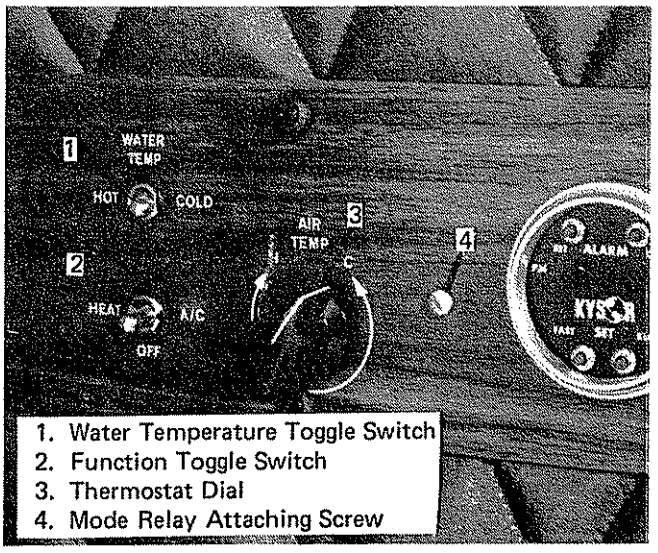
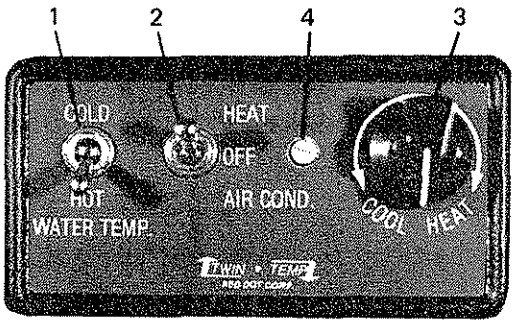


Fig. 2, Control Panel, 60-Inch Sleeper Box

CONVENTIONAL CAB SLEEPER BOX
HEATER-AIR CONDITIONER



1. Water Temperature Toggle Switch
2. Function Toggle Switch
3. Thermostat Dial
4. Mode Relay Attaching Screw

Fig. 3, Control Panel, All Sleeper Boxes Except 60-Inch

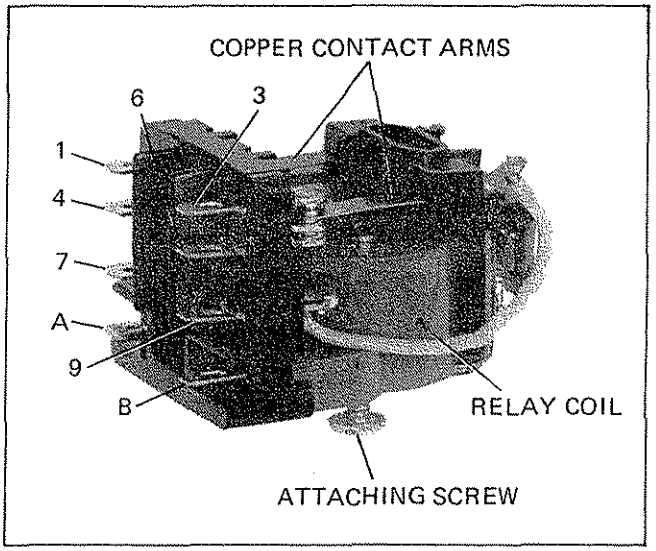


Fig. 4, Mode Relay Component

AIR CONDITIONER (Refer to Fig. 5)

When both the cab and the sleeper box air conditioners are turned on, the refrigerant compressor is activated. Refrigerant vapor is drawn through the suction line into the compressor cylinder. The downstroke of the piston pulls a cylinder of vapor through the suction valve and compresses it on the upstroke, raising its temperature, and compressing the vapor to about 135 psi (930 kPa). The pressure that is produced causes the vapor, now superheated, to flow to the condenser. The compressor discharge valve prevents re-entry of compressed vapor into the cylinder and forms a boundary between the high and low pressure sides of the system.

In the condenser, the condensing medium (that is, air passing over the condenser coil fins) absorbs heat to condense the hot refrigerant vapor. The combination of cooling and high pressure causes the vapor to liquify. The liquid refrigerant then moves to the receiver-drier, which removes all traces of moisture and acids. The receiver-drier stores the refrigerant until needed by the system.

From the receiver-drier, liquid refrigerant moves to the solenoid valve which, when opened, allows passage of the refrigerant to the expansion valve. The expansion valve regulates the flow of liquid into the evaporator coil and acts as a boundary between the high and low pressure sides of the system. The metered release by the expansion valve expands the refrigerant and partially vaporizes it, dropping its pressure to about 10 psi (69 kPa). The pressure reduction rapidly cools the refrigerant.

The cold refrigerant liquid and vapor move through the evaporator coil and absorb heat from the blower-circulated air that passes over the evaporator coil fins. As the refrigerant liquid absorbs heat, it boils and evaporates. The resulting "cooled" blower-circulated air is then propelled into the sleeper compartment. At the same time, the heat-saturated refrigerant vapor is drawn back into the refrigerant compressor, where the cycle is repeated.

HEATER

When the heater water temperature toggle switch (Fig. 2 or 3, Ref. 1) is set at "HOT," the air-operated water shutoff valve (Fig. 6) opens, allowing engine coolant to flow to the heater core. Heat dissipated by the heater core fins is propelled through the duct and into the sleeper compartment by the blower.

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

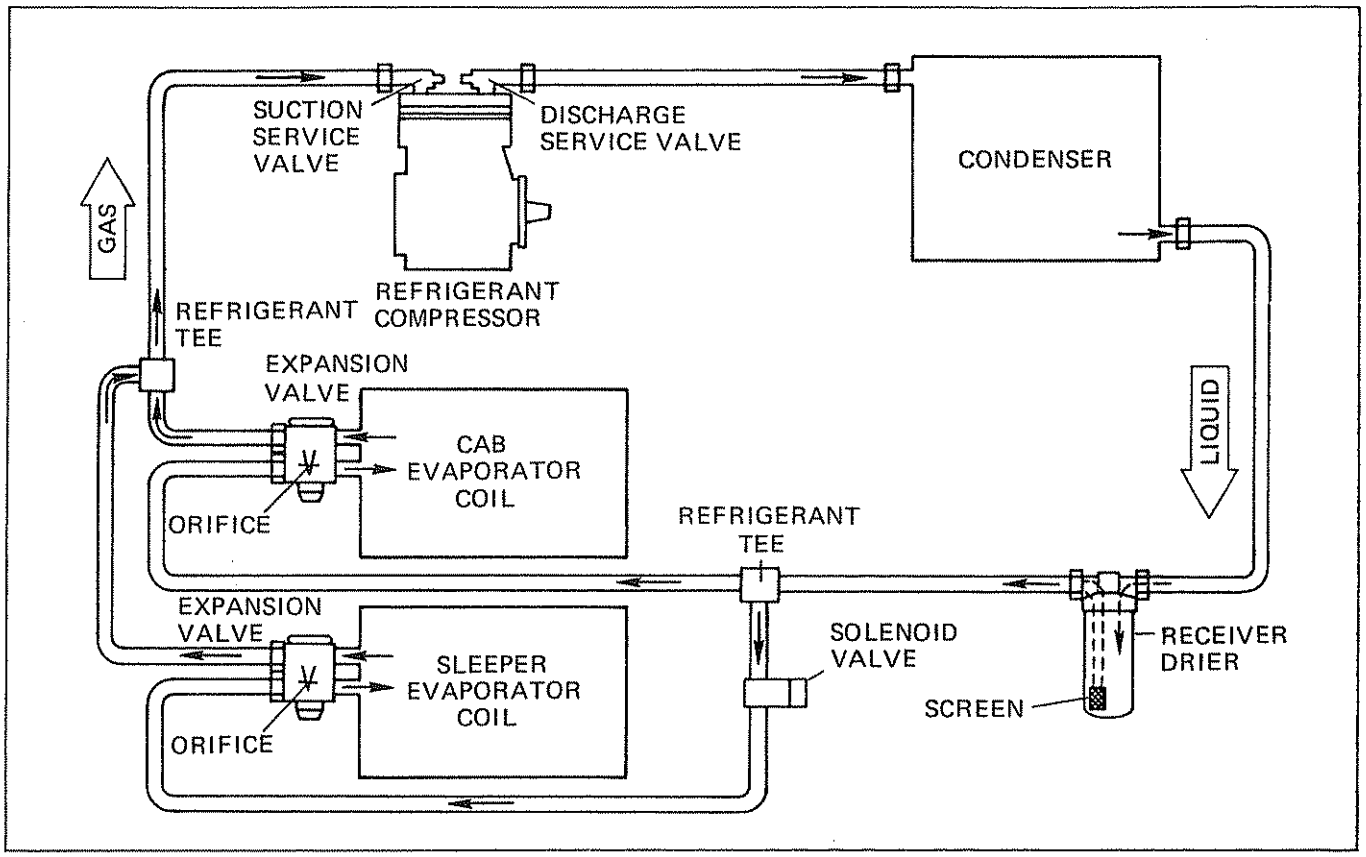


Fig. 5, Refrigerant Flow in Air Conditioner System

SERVICE OPERATIONS

The service operations that follow apply to heater-only units as well as heater-air conditioner units. In some cases, the operations are intended for air conditioner components. In all other cases, operations specifying "heater-air conditioner" also apply to heater-only units, as long as instructions relating to refrigerant system items, such as the drain tube and the refrigerant lines, are disregarded.

Whenever refrigerant lines are disconnected, always check the condition of the O-ring seals. See Fig. 7. Missing, dry, brittle, or cracked O-rings should be replaced. O-rings and threads should be lubricated with refrigerant oil before connecting.

Do not disconnect or connect refrigerant fittings using only one wrench. Always hold one fitting stationary using a wrench, and turn the other fitting using a second wrench.

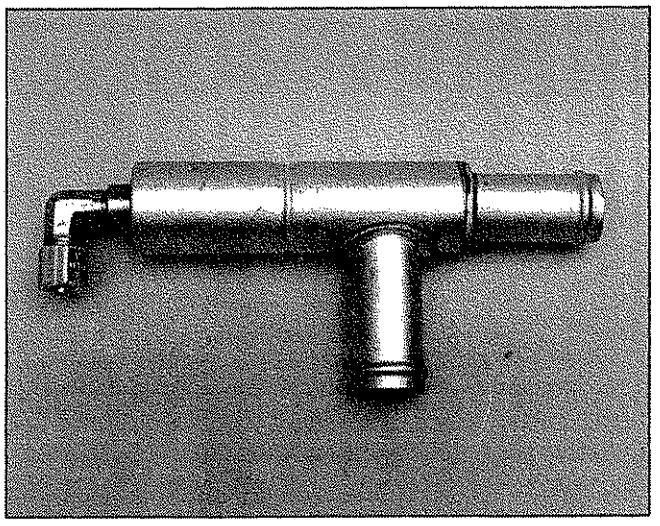


Fig. 6, Water Shutoff Valve

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

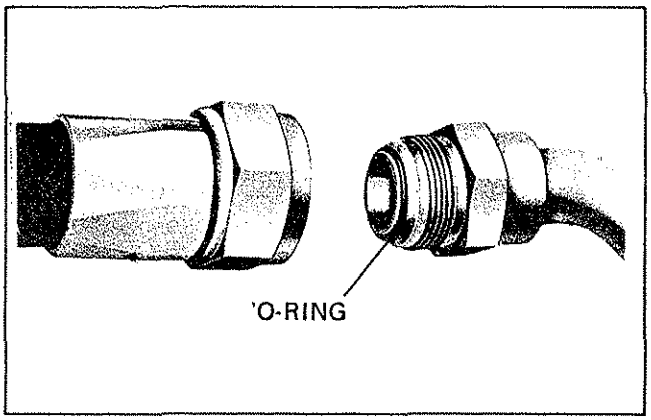


Fig. 7

SAFETY PRECAUTIONS (AIR CONDITIONING SYSTEM)

Whenever repairs are made to any of the air conditioner system components containing refrigerant, the system must be discharged, purged, evacuated, charged, and leak tested.

Refrigerant 12 is classified as safe when used under properly controlled conditions. Always use safety goggles and gloves while discharging, purging, evacuating, charging, or leak testing the system.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, when exposed to normal atmospheric pressure and temperature, rapidly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result from contact with liquid refrigerant.

Refrigerant splash in the eyes should be initially treated with a few drops of sterile mineral oil in the eyes, followed by a rinse with a weak boric acid solution. *Do not rub the eyes.* Immediately contact a physician.

Refrigerant splash on the skin should be treated the same as for frostbite: Gently pour lukewarm *(not hot)* water on the affected area, but *do not rub the skin.* Keep the skin warm with layers of soft, clean cloth. Immediately contact a physician.

Even though refrigerant is not combustible, in the presence of extreme heat or flame, poisonous gas is created. This gas is also generated when an open flame leak detector is used. Refrigerant gas tarnishes polished metal surfaces.

WARNING: Do not work in an area where exposed refrigerant may contact an open flame or any burning material, such as a cigarette. When in contact with extreme heat, refrigerant decomposes to a poisonous phosgene gas which, if inhaled, causes severe respiratory irritation. Do not inhale the fumes from an open flame leak detector. Phosgene fumes are detected by their acrid odor.

To prevent any possible risks, it is safest to discharge the air conditioning system out-of-doors or into the shop exhaust system. Adequate ventilation must be available when the system is discharged or leak tested using an open flame leak detector.

TOGGLE SWITCH REPLACEMENT

1. Turn the ignition switch off. Drain the air system if the heater water temperature toggle switch is to be replaced.

2. Remove the screws attaching the control panel to the wall or partition.

3. Mark the wires/tubes connected to the toggle switch for later assembly reference. Disconnect the wires/tubes from the switch. Install plugs in the air tubing to keep out dirt and debris.

4. Replace the toggle switch.

5. For function toggle switches, connect the wires as previously marked, or as shown in Fig. 14 under "SPECIFICATIONS."

   For heater water temperature toggle switches, remove the plugs from the tubing. Connect the tubing, as previously marked, to the toggle switch as follows:

   .1 Remove the tube fittings from the toggle switch. Insure that the threads on the fit-

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

tings are free of grease, dirt, and old sealant. Apply pipe sealant to the threads. Install the fittings on the toggle switch. If new tubing is installed, replace the plastic sleeves inside the fittings.

.2 Tighten the nuts on the fittings finger-tight. Then, using a wrench, tighten two additional turns, or as near to two turns as possible.

6. Position the control panel on the wall or partition. Install the screws to secure it in place.

THERMOSTAT ASSEMBLY/MODE RELAY COMPONENT REPLACEMENT

1. Turn the ignition switch off.

2. Remove the screws attaching the control panel to the wall or partition.

3. Remove the thermostat assembly by loosening the setscrew that fastens the thermostat knob to the control shaft. Remove the nut located directly beneath the knob and attached to the control panel assembly. Remove the thermostat assembly.

   Remove the mode relay component by backing off the attaching screw located on the control panel face. Refer to Fig. 2 or 3.

4. For later assembly reference, mark the wires connected to the thermostat assembly/ mode relay terminals. Disconnect the wires.

5. As previously marked, or as shown in Fig. 14 under "SPECIFICATIONS," connect the wires to the replacement thermostat assembly/mode relay component.

6. Position the thermostat assembly in the control panel. Install the nut to secure it in place. Install the thermostat knob on the control shaft, then tighten the setscrew.

   Position the mode relay component in the control panel. Install and tighten the attaching screw.

7. Position the control panel on the wall or partition. Install the screws to secure it in place.

HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION

Removal

1. Turn the ignition switch off. Set the parking brakes to prevent vehicle movement.

2. Set the heater water temperature toggle switch at "COLD"/"C" (off).

3. Remove the sleeper box mattress and wooden bunk panel to gain access to the heater-air conditioner unit.

4. For later assembly reference, mark the coolant hoses under the sleeper box outside the vehicle. Drain the heater core (into a clean container) by disconnecting the heater hose clamps attached to the deck elbows, which protrude from the bottom of the sleeper box. Save the coolant for later use.

WARNING: Do not drain the heater core and hoses while the engine and coolant are hot. To avoid personal injury from scalding, wait until the engine has cooled before draining the system.

5. Discharge and purge the refrigerant from the system. For instructions, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

6. Remove the locking nuts and flatwashers securing the heater-air conditioner to the sleeper box deck. The nuts are located on the bottom of the sleeper box outside the vehicle.

7. Loosen the fasteners of the air flex hose clamps at the blower housing and the air duct coming

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from the sleeper box. Gain access to the latter clamp through the baggage compartment on the passenger's side of the vehicle. See Fig. 8. Remove the air flex hose.

8. Remove the washer-head screws attaching the heater guard to both the sleeper box deck and the housing body. Remove the heater guard.

9. Mark all wires for later assembly reference. Disconnect the wires from the heater-air conditioner.

10. Mark all hoses for later assembly reference. Disconnect the coolant hoses from the heater core ports (refer to Fig. 1).

    Disconnect the refrigerant hoses at the air conditioner unit; use two wrenches to avoid twisting the tubing. Install caps on the refrigerant hoses, and plug the ports of the disconnected components.

CAUTION: Contaminants, such as water and dirt, can damage the refrigerant system (refer to the troubleshooting section of this subject for additional information). Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

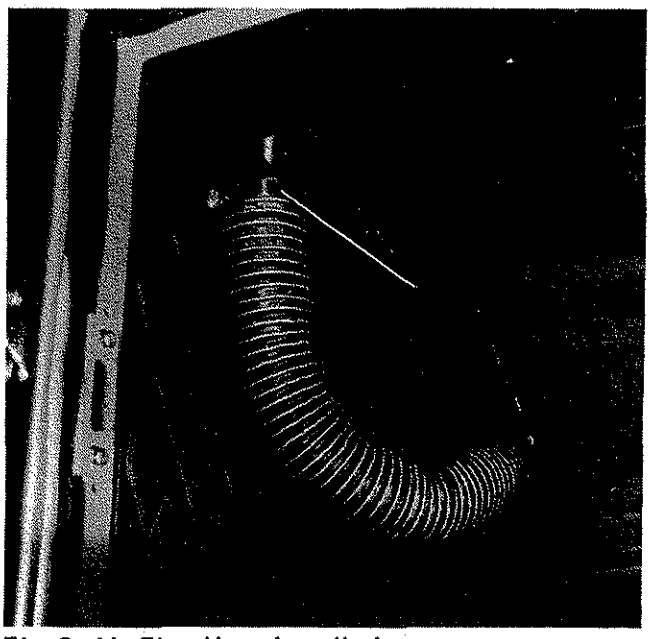

Fig. 8, Air Flex Hose Installation

11. Lift the heater-air conditioner from the deck so that the unit's water drain tube, if so equipped, does not get damaged. Remove the unit from the sleeper box.

Installation

1. Position the heater-air conditioner on the deck, making sure the water drain tube, if so equipped, protrudes through the floor.

2. Attach the air flex hose to both the blower housing and the air duct coming from the sleeper box. Install the clamps to secure the hose in place.

3. Attach the inlet and outlet coolant hoses and clamps to the heater core ports, as previously marked. (The upper heater core port returns coolant to the engine; the lower port receives coolant from the engine.) Tighten the clamps securely.

4. Remove the plugs from the refrigerant components. Apply refrigerant oil to all threads and also the rubber O-rings on the fittings. Refer to Fig. 7. If the O-rings are brittle or otherwise damaged, replace them with new ones.

   Install the refrigerant hoses, as previously marked. Tighten the hexhead couplers finger-tight. Using two wrenches, further tighten the couplers one-eighth of a turn. Or, if a torque wrench is used, refer to Table 1 under "SPECIFICATIONS" for torque values.

5. Connect the wires to the heater-air conditioner as previously marked or as shown in Fig. 14 under "SPECIFICATIONS."

6. Attach the protective heater guard to both the housing body and the sleeper box deck. Install the washer-head screws.

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7. Install the flatwashers and locking nuts that attach the heater-air conditioner to the sleeper box deck. Tighten the nuts to 13 ft-lbs (18 N·m).

8. Connect the coolant hoses and clamps to the deck elbows, as previously marked. Tighten the clamps securely.

9. Evacuate, charge, and leak test the system. For instructions, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

10. Fill the cooling system with the saved or new coolant. Add enough coolant to bring the level to within one inch (25 mm) of the radiator filler neck.

CAUTION: Failure to keep the engine coolant level filled to within one inch (25 mm) of the bottom of the radiator filler neck could result in engine overheating and damage.

11. Set the heater water temperature toggle switch at "HOT"/"H." Start the engine. When the radiator thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again, and fill, if needed, as specified in step 10.

12. Install the wooden bunk panel and the mattress in the sleeper box.

BLOWER MOTOR ASSEMBLY REPLACEMENT (Refer to Fig. 9)

1. Turn the ignition switch off.

2. Remove the sleeper box mattress and wooden bunk panel to gain access to the heater-air conditioner unit.

3. Mark the wires connected to the blower motor for later assembly reference. Disconnect the wires.

4. Remove the capscrews attaching the blower motor assembly to the blower housing. Remove the blower motor assembly.

5. Loosen the setscrew attaching the blower wheel to the motor shaft. Remove the blower wheel.

6. Remove the nuts and lockwashers attaching the motor mount to the motor. Remove the motor mount.

7. Remove the capscrews attaching the blower housing to the housing body. Remove both the blower housing and the housing disk.

8. Position both the housing disk and the blower housing on the housing body. Install the capscrews and tighten to 5 ft-lbs (7 N·m).

9. Position the motor mount on the motor. Install the lockwashers and nuts. Tighten the nuts to 5 ft-lbs (7 N·m).

10. Position the blower wheel on the motor shaft. Lower the wheel until it contacts the nuts that attach the motor mount to the motor. Then, back off the blower wheel just enough to gain clearance of the nuts. Do not back off the wheel any further.

    Tighten the setscrew to lock the blower wheel in place. Manually spin the wheel. If the wheel is making contact with the nuts, it is not properly installed; repeat this step.

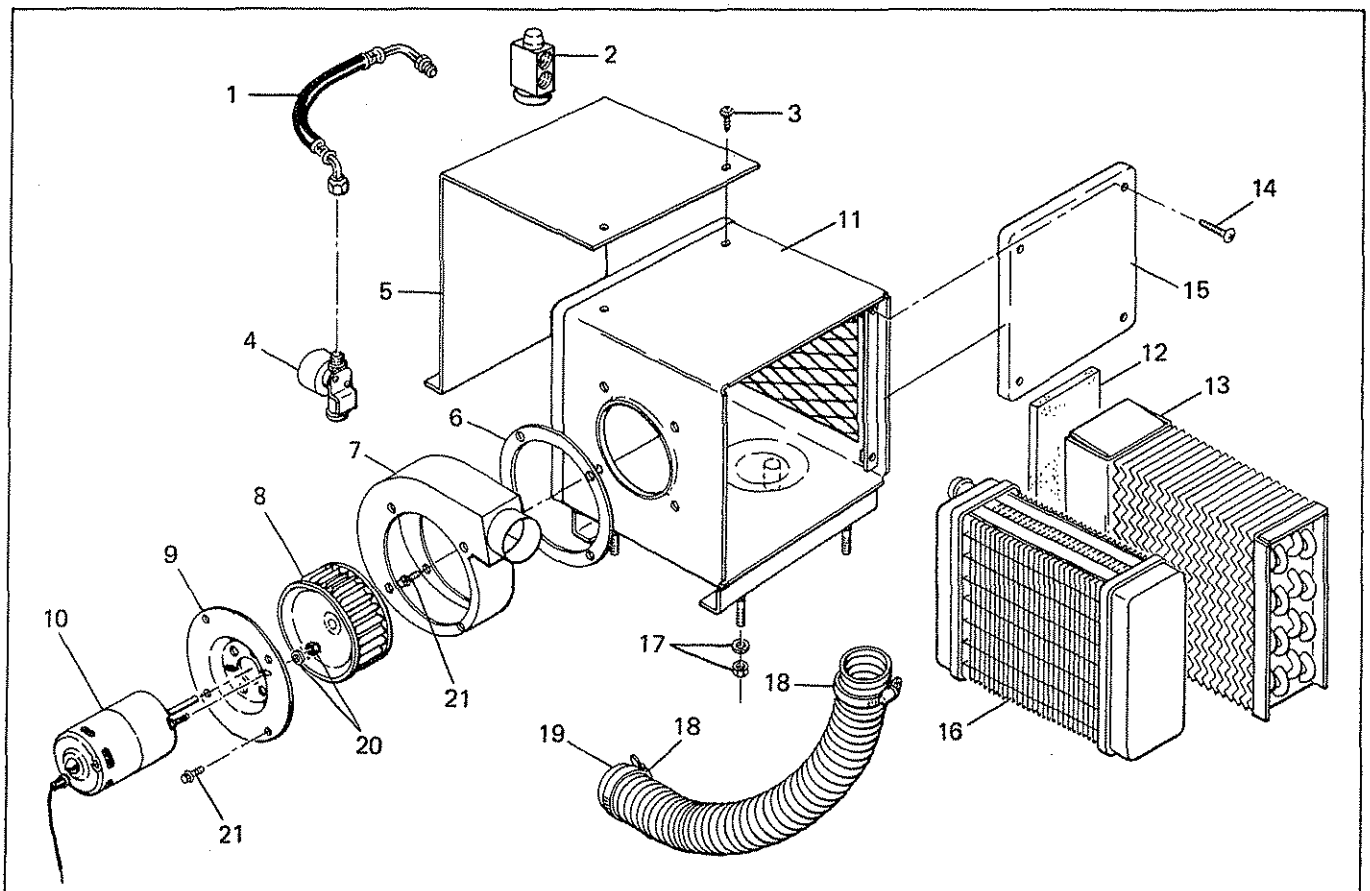
CAUTION: If the blower wheel does not spin freely at installation, blower motor drag will result and can lead to permanent damage to the motor.

11. Position the blower motor assembly on the blower housing, then install the capscrews. Tighten the capscrews to 5 ft-lbs (7 N·m).

12. Connect the wires to the blower motor as previously marked or as shown in Fig. 14 under "SPECIFICATIONS."

13. Install the wooden bunk panel and the mattress in the sleeper box.

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER



1. Expansion/Solenoid Valve Hose Assembly
2. Expansion Valve
3. Washer Head Screws
4. Solenoid Valve Assembly
5. Heater Guard
6. Housing Disk
8. Blower Wheel
9. Motor Mount
10. Blower Motor
11. Housing Body
12. Rubber Cushion
13. Evaporator Coil
14. Phillip Head Screws
15. Housing Cover
16. Heater Core
17. Locking Nut And Flatwasher
18. Flex Hose Clamps
19. Air Flex Hose
20. Lockwashers And Nuts
21. Capscrews

Fig. 9, Sleeper Box Heater-Air Conditioner

WATER SHUTOFF VALVE REPLACEMENT
(See Fig. 6)

NOTE: The water shutoff valve is located under the sleeper box outside the vehicle.

1. Set the heater water temperature toggle switch at "HOT"/"H." When in this position, air pressure to the water shutoff valve is stopped.
2. Drain the cooling system (into a clean container) by opening the drain cock located on the bottom tank of the radiator. Save the coolant for later use.

WARNING: Do not drain the system while the engine and coolant are hot. To avoid personal injury from scalding, wait until the engine has cooled before draining the system.

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3. Disconnect the air control line from the water shutoff valve. Install a plug in the air control line to keep out dirt and debris.

4. Disconnect the coolant hoses from the water shutoff valve.

5. Remove the water shutoff valve, and install a new one.

6. Connect the coolant hoses to the water shutoff valve.

7. Close the drain cock on the bottom tank of the radiator.

8. Fill the cooling system with the saved or new coolant. Add enough coolant to bring the level to within one inch (25 mm) of the radiator filler neck.

CAUTION: Failure to keep the engine coolant level filled to within one inch (25 mm) of the bottom of the radiator filler neck could result in engine overheating and damage.

9. Remove the plug from the air control line. On the threads of the air control line and the valve, clean off all grease, dirt, and old sealant. Apply pipe sealant to the threads on the fitting, then connect the air control line to the water shutoff valve. Tighten the connections finger-tight, then, using two wrenches, tighten a minimum of two turns or until no threads show on the fitting body.

10. Start the vehicle engine. As the coolant circulates, observe the valve for coolant leaks. If leakage is present, turn off the engine, then repeat steps 2 through 10, above. Check the coolant level again, and fill, if needed, as specified in step 8.

11. With the engine running, set the heater water temperature toggle switch at "COLD"/"C." Cover the water shutoff valve air control line connection with a soap-water solution to detect air leaks. Leakage generating a one-inch (25 mm) or less bubble in three seconds is acceptable. Leakage greater than this is unacceptable. If no bubble appears, listen for air leaks, and feel to make certain that air is not escaping at a rate too fast to develop bubbles. Such leaks are unacceptable.

    If there are unacceptable air leaks, turn off the engine, then repeat steps 1, 3, 9, and 11.

THERMOSTATIC EXPANSION VALVE AND SOLENOID VALVE REMOVAL AND INSTALLATION

Removal (Refer to Fig. 9)

NOTE: The thermostatic expansion valve and solenoid valve can be replaced without removing the heater-air conditioner from the sleeper box deck.

1. Turn the ignition switch off.

2. Remove the sleeper box mattress and the wooden bunk panel to gain access to the heater-air conditioner.

3. Discharge and purge the refrigerant from the system. For instructions, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

4. Remove the washer-head screws attaching the heater guard to both the sleeper box deck and the housing body. Remove the heater guard.

5. Mark the solenoid valve wires for later assembly reference. Disconnect the wires.

6. Mark all the refrigerant hoses at the air conditioner for later assembly reference. Disconnect the hoses using two wrenches. Cap the disconnected components.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system (refer to the

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

troubleshooting section of this subject for additional information). Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant components. Shop air is wet (humid).

7. Slide the solenoid valve assembly from the bracket.

8. Remove and discard all mastic insulating tape from around the inlet and outlet ports of the evaporator coil.

9. Using two wrenches, disconnect the evaporator coil hexhead couplers from the expansion valve. Cap all disconnected components.

Installation (Refer to Fig. 9)

1. Insure that the rubber O-rings are attached to the evaporator coil inlet and outlet ports. If the O-rings are brittle or otherwise damaged, replace them with new ones.

2. Remove the caps from the evaporator coil ports and the respective ports of the expansion valve. Coat all threads and the rubber O-rings with refrigerant oil.

3. Connect the expansion valve to the evaporator coil ports; tighten the hexhead couplers finger-tight. Using two wrenches, further tighten the couplers one-eighth of a turn. Or, if a torque wrench is used, refer to Table 1 under "SPECIFICATIONS" for torque values.

4. Wrap new mastic insulating tape around the evaporator coil ports. A seal should be formed protecting the exposed surfaces of the ports from the air.

5. Install the solenoid valve assembly in the housing body bracket.

6. Connect the refrigerant hoses as previously marked, removing the protective air caps as required. All threads and rubber O-rings should be coated with refrigerant oil; brittle or otherwise damaged O-rings should be replaced with new ones.

   Tighten the hexhead couplers finger-tight. Using two wrenches, further tighten the couplers one-eighth of a turn. Or, if a torque wrench is used, refer to Table 1 under "SPECIFICATIONS" for torque values.

7. Connect the wires as previously marked or as shown in Fig. 14 under "SPECIFICATIONS."

8. Attach the protective heater guard to both the housing body and the sleeper box deck. Install the washer-head screws.

9. Evacuate, charge, and leak test the system. For instructions, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

10. Install the wooden bunk panel and the mattress in the sleeper box.

HEATER CORE REPLACEMENT (Fig. 9)

1. Perform steps 1 through 4, then 6 through 8, under the heading "HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION" ("Removal").

2. Mark the coolant inlet and outlet hoses for later assembly reference. Disconnect the clamps attaching the hoses to the heater core ports.

3. Raise the heater-air conditioner unit until the mounting studs and, if so equipped, the water drain tube are clear of the deck. Be careful not to damage or disconnect the refrigerant hoses or the wiring. Turn the unit until the housing cover is in a serviceable position.

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

4. Remove the Phillip-head screws that attach the housing cover to the housing body. Remove the housing cover.

5. On units with an air conditioner, remove the sealant along the inner bottom portion of the housing cover and the housing body. Do not remove the protective rubber pad, which is permanently glued to the housing cover. See Fig. 10.

6. Wearing protective gloves, slide the heater core out, and remove it from the housing body.

WARNING: Failure to wear protective gloves could result in serious skin lacerations due to the sharp edges of the heater core fins.

   Wearing protective gloves, carefully slide the replacement heater core into the housing body until the end of the core is aligned with the edge of the housing body.

7. On heater-air conditioner units, apply new sealant along the length of the inner bottom portion of the housing cover; extend the sealant one inch (25 mm) vertically up each side of the application area. See Fig. 10.

NOTE: "Green" Presstite No. 579.6 sealant, or an equivalent, should be used.

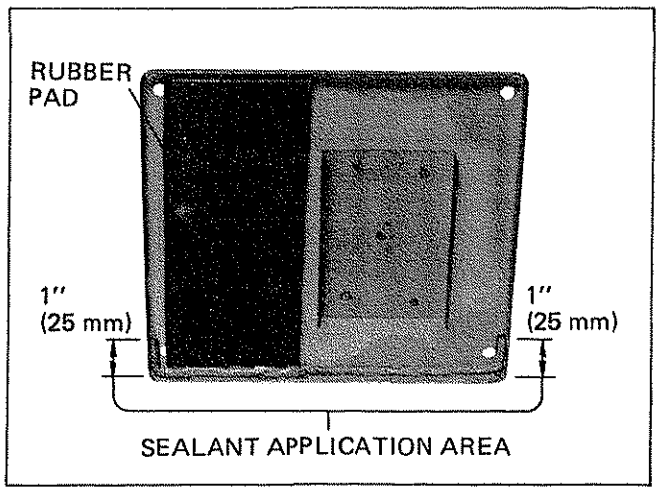

Fig. 10

8. Position the housing cover on the housing body, then install the Phillip-head screws.

9. Perform all steps except 4, 5, and 9 under the heading, "HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION" ("Installation").

EVAPORATOR COIL REMOVAL AND INSTALLATION

Removal (Refer to Fig. 9)

1. Perform steps 1 through 3, then 5 through 8 under the heading, "HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION" ("Removal").

2. Remove and discard all accessible mastic insulating tape from around the inlet and outlet ports of the evaporator coil.

3. Using two wrenches, disconnect the evaporator coil hexhead couplers from the expansion valve. Remove the expansion valve. Cap all disconnected components.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system (refer to the troubleshooting section of this subject for additional information). Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant components. Shop air is wet (humid).

4. Raise the heater-air conditioner unit until the mounting studs and water drain tube are clear of the deck. Be careful not to damage or disconnect the coolant hoses or the wiring. Turn the unit until the housing cover is in a serviceable position.

5. Remove the Phillip-head screws that attach the housing cover to the housing body. Remove the housing cover.

6. Remove the sealant from along the inner bottom portion of the housing cover and the

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

housing body. Do not remove the protective rubber pad, which is permanently glued to the housing cover. See Fig. 10.

7. Wearing heavy protective gloves, carefully slide the evaporator coil out, and remove it from the housing body.

WARNING: Failure to wear heavy protective gloves could result in serious skin lacerations due to the sharp edges of the evaporator coil fins.

8. Remove and discard the remaining mastic insulating tape from around the inlet and outlet ports of the evaporator coil. Remove the protective rubber pad from the copper coils.

Installation (Refer to Fig. 9)

1. Position the protective rubber pad against the copper coils of the evaporator coil. Wrap the inner half of the inlet and outlet port appendages with new mastic insulating tape. See Fig. 11.

2. Wearing heavy protective gloves, carefully slide the evaporator coil into the housing body until the end of the coil is aligned with the edge of the housing body.

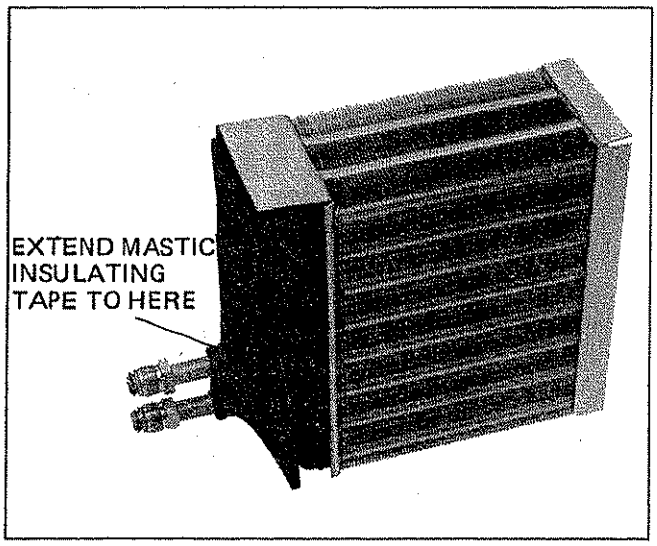

Fig. 11

3. Apply new sealant along the length of the inner bottom portion of the housing cover; extend the sealant one inch (25 mm) vertically up each side of the application area. See Fig. 10.

NOTE: "Green" Presstite No. 579.6 sealant, or an equivalent, should be used.

4. Attach the housing cover to the housing body. Install the Phillip-head screws.

5. Position the heater-air conditioner on the deck, making sure that the water drain tube protrudes through the floor.

6. Remove the plugs from the refrigerant components. Apply refrigerant oil to all threads and also the rubber O-rings on the evaporator coil ports; if the O-rings are brittle or otherwise damaged, replace them with new ones.

7. Connect the expansion valve to the evaporator coil ports; tighten the hexhead couplers finger-tight. Using two wrenches, further tighten the couplers one-eighth of a turn. Or, if a torque wrench is used, refer to Table 1 under "SPECIFICATIONS" for torque values.

8. Wrap new mastic insulating tape around the inlet and outlet ports of the evaporator coil. A seal should be formed protecting the exposed surfaces of the ports from the air.

9. Attach the protective heater guard to both the housing body and the sleeper box deck. Tighten the washer-head screws.

10. Install the flatwashers and locking nuts that attach the heater-air conditioner to the sleeper box deck. Tighten the nuts to 13 ft-lbs (18 N·m).

11. Evacuate, charge, and leak test the system. For instructions, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

12. Install the wooden bunk panel and the mattress in the sleeper box.

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

REFRIGERANT TEES REPLACEMENT

The refrigerant tees, mounted on the driver's side frame rail underneath the sleeper compartment, are the interconnecting points of refrigerant distribution to and from both the cab and the sleeper box air conditioners. The liquid refrigerant from the receiver-drier enters one tee and is directed to one or both air conditioners, as needed. See Fig. 5.

The other tee receives the warmed refrigerant gas from one or both air conditioners, and then routes the gas through a single hose line directly to the refrigerant compressor.

1. Turn the ignition switch off. Set the parking brakes to prevent vehicle movement.

2. Discharge and purge the refrigerant from the system. For instructions, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

3. Mark all hoses for later assembly reference, then disconnect the hoses from the tees. Install caps on the refrigerant hoses, and plug the ports of the disconnected tees.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system (refer to the troubleshooting section of this subject for additional information). Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant components. Shop air is wet (humid).

4. Remove the nuts that attach the tee mounting bracket to the frame rail. Remove the bolts and washers.

5. Remove the setscrews that attach the tees to the bracket.

6. Attach the replacement tees to the mounting bracket. Tighten the setscrews securely.

7. Position the mounting bracket assembly on the frame rail, then insert the bolt through the frame rail and washer. Install the nut, and tighten to 6 ft-lbs (8 N·m).

8. As previously marked, connect the refrigerant hoses, removing the protective air caps and plugs, as required. All threads and rubber O-rings should be coated with refrigerant oil; brittle or otherwise damaged O-rings should be replaced with new ones.

   Tighten the hexhead couplers finger-tight. Then, using two wrenches, further tighten the couplers one-eighth of a turn. Or, if a torque wrench is used, refer to Table 1 under "SPECIFICATIONS" for torque values.

9. Evacuate, charge, and leak test the air conditioner system. For instructions, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

RECEIVER-DRIER, CONDENSER, AND COMPRESSOR REPLACEMENT

For instructions covering replacement of the receiver-drier and the condenser, refer to the cab heater-air conditioner subject located in the 22 Group of this manual.

For service instructions covering the refrigerant compressor, refer to the 01 Group of this manual.

TROUBLESHOOTING

CONTROL PANEL ELECTRICAL TESTS USING A VOLTMETER

The following is a control panel troubleshooting elimination process (for negative ground vehicles) requiring the use of a DC voltmeter. If the vehicle under test is positive ground, reverse the voltmeter probe connections specified below; that is, use the positive or red probe as the chassis ground.

The tests below should be conducted whenever one of the electrical components of the heater or air

CONVENTIONAL CAB SLEEPER BOX
HEATER-AIR CONDITIONER

conditioner fails to perform, and the cause (either the component or the control panel) has not been determined.

NOTE: In all cases, refer to the applicable heading in this subject for service instructions.

1. Insure that the voltmeter is operable and that the vehicle batteries are neither overcharged nor undercharged. Remove the screws attaching the control panel to the compartment wall or partition.

2. Turn the ignition switch on. For heater-only installations, proceed to step 4.

3. Set both the thermostat dial and the function (electric) toggle switch at "HEAT"/"H." Touch the red probe of the voltmeter to the bottom terminal on the back of the function toggle switch (see the "heat connection" terminal shown in Fig. 12 or 13); the black probe should be connected to a convenient chassis ground. Correct battery voltage (10 to 14 volts) should register; if it does, proceed to step 4.

NOTE: Be sure the correct terminal on the function toggle switch is tested. The actual heater-air conditioner electrical connections on the back of the toggle switch are opposite the labels appearing on the control panel face.

   If the voltage is not 10 to 14 volts, touch the red probe to the center terminal ("power terminal," Fig. 12 or 13) on the toggle switch. If battery voltage registers, the toggle switch is inoperative and must be replaced. If battery voltage does not register, fault lies in the wiring between the toggle switch and the battery. Trace the wiring to the battery, and repair or replace the faulty lead. Proceed to step 9.

4. For heater-air conditioner installations, leave the function toggle switch and the thermostat dial at "HEAT"/"H." For heater-only installations, turn the thermostat dial to "HEAT." Check the voltage of the thermostat by touching

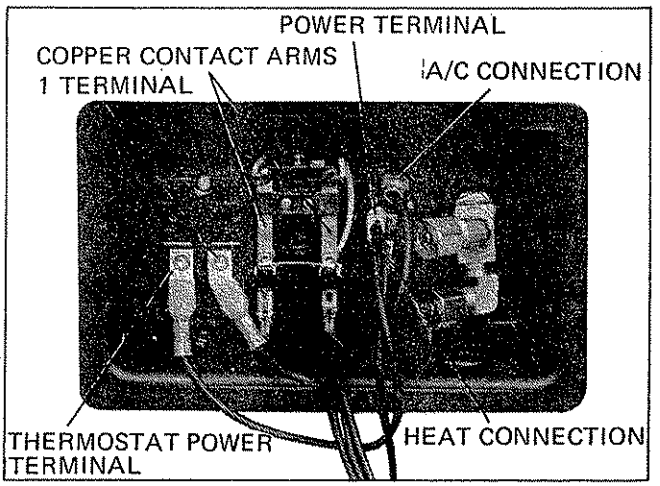

Fig. 12, Control Panel, All Sleeper Boxes Except 60-Inch

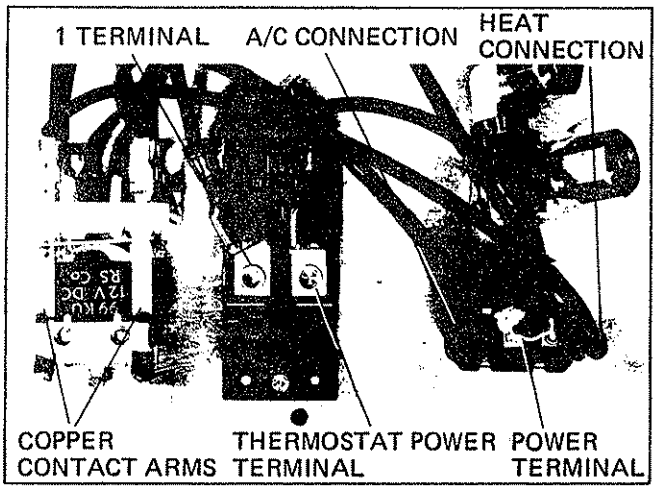

Fig. 13, Control Panel, 60-Inch Sleeper Box

   the red voltmeter probe to the "1 terminal," shown in Fig. 12 or 13 (the black voltmeter probe should remain grounded to the chassis).

   On heater-air conditioner installations, if battery voltage registers, proceed to step 5. If battery voltage does not register, the thermostat is inoperative. Replace the thermostat assembly.

   On heater-only installations, if battery voltage registers (and the blower motor is not operating), check the wiring to and from the blower motor. Repair or replace loose or damaged

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

wires. If the wiring is not at fault, the blower motor is inoperative. Proceed to step 9, then replace the motor.

On heater-only installations, if battery voltage does not register, touch the red voltmeter probe to the "thermostat power terminal" (Fig. 12 or 13) on the thermostat assembly (the black voltmeter proble should remain grounded to the chassis). Lack of voltage to this terminal indicates fault in the wiring to the battery. Trace the wiring to the trouble spot, and correct, as required. Proceed to step 9. If battery voltage registers, the thermostat is inoperative; replace the thermostat assembly.

5. Visually inspect the two "copper contact arms" (see Fig. 12 or 13) on the mode relay component. When the heater is selected, the contact arms should be making electrical contact with terminals 4 and 6 (refer to Fig. 4). If they are contacting terminals 1 and 3, check the relay ground lead. If the ground wire is loose or damaged, repair or replace, as necessary. If the ground is not at fault, the coil in the relay is inoperative.

6. Set the function toggle switch at "AIR COND."/"A/C," then turn the termostat dial counterclockwise to "COOL"/"C"; make sure the cab air conditioner is operating. Touch the red probe of the voltmeter to the "A/C connection" terminal (Fig. 12 or 13) on the back of the function toggle switch (the black voltmeter probe should remain grounded to the chassis). Proceed to step 7 if battery voltage registers.

   If battery voltage does not register, replace the function toggle switch.

7. Visually inspect the two copper contact arms on the mode relay component. When the air conditioner is selected and set at the coolest setting, both the blower motor and the solenoid valve are activated; the copper contact arms should be making electrical contact with terminals 1 and 3. There should be no power flowing to terminal A; if there is, replace the thermostat assembly.

   When the air conditioner is selected, but the components are temporarily deactivated due to thermostatic control (turn the thermostat dial to the warmest setting), the copper contact arms of the mode relay should be contacting terminals 4 and 6, and battery voltage should be flowing to terminal A. If battery voltage is not flowing to terminal A (the air conditioner operates at any thermostat setting resulting in excessive cooling), replace the thermostat assembly.

8. If, after reaching this step without locating the trouble spot, component failure persists, fault lies either in the wiring to and from the component or in the component itself.

   Make sure that the wiring (both the power and the ground leads) is neither damaged nor loosely connected. Repair or replace any wire(s) at fault.

9. Turn the ignition switch off, position the control panel on the sleeper box wall or partition, then install the screws to secure it in place.

   Proceed to "COMPONENT PERFORMANCE TESTS" if the cause of problems in the air conditioning system has not been determined.

COMPONENT PERFORMANCE TESTS

The guidelines below should be used to isolate trouble spots in the air conditioning system. When applicable, test results are reliable only after the air conditioner and refrigerant compressor have been operating for at least five minutes.

Line Restrictions

Line restrictions can be isolated by touch (temperature). From the discharge side of the refrigerant compressor to the condenser inlet, the lines are normally hot to the touch. The lines from the condenser outlet to the receiver-drier are normally warm to cool. The expansion valve and the evaporator coil will be very cold. And, from the evaporator

CONVENTIONAL CAB SLEEPER BOX
HEATER-AIR CONDITIONER

coil to the refrigerant compressor, the line should be moderately cool.

Deviations from the conditions above indicate a restriction in the line or component. Generally, areas of ice or frost build-up also indicate a restriction. Components that regularly freeze up are likely to be corroded or inoperative and should be replaced. Components that periodically freeze up (such as the expansion valve) may do so because of ice crystals (moisture) in the system. When moisture is in the system, the refrigerant charge must be replaced with an uncontaminated charge.

Receiver-Drier Operation Check

The receiver-drier is normally at ambient temperature. To the touch, the entire length of the receiver-drier should be the same temperature. If noticeable cool spots are present, the receiver-drier should be replaced.

Condenser Operation

The condenser is basically trouble-free when road debris, such as leaves or dirt build-up, and other restrictions to air flow are eliminated. If debris is allowed to accumulate, the passage of air over the condenser fins will be hampered. Consequently, air cannot absorb the heat to condense the hot refrigerant vapor. High refrigerant compressor discharge pressures will result.

High discharge pressures will also result when the condenser tubing is abnormally bent, restricting the flow of refrigerant. Internal blockages (foreign matter or metallic grit build-up) will also restrict the flow of refrigerant. In each case, the condenser should be replaced.

Expansion Valve Troubleshooting

Problems originating in the expansion valve are identified as follows: When stuck closed, the evaporator coil and the expansion valve will be at ambient temperatures; when stuck open, both components will be extremely cold with frost or ice build-up.

Because the expansion valve is very sensitive to contamination, blockages in the refrigerant system tend to originate here. A typical contaminant in the system is moisture; less than a drop of water is needed to render the expansion valve inoperative. When moisture reaches the expansion valve, the extreme cold crystalizes it, forming a "block" of ice in the valve. When the ice melts as the refrigerant warms up, the expansion valve will resume operation, only to freeze up when the moisture accumulates again.

Sporatic operation of the expansion valve may indicate that the receiver-drier is not effectively removing moisture and acids from the system. If visual inspection of the expansion valve reveals no internal corrosion, replace the receiver-drier.

Evaporator Coil Operation

The evaporator coil, like the condenser, is basically trouble-free when air flow over the fins is not restricted. Externally- or internally-caused blockages will cause low refrigerant compressor suction pressure as well as a lack of cooling. Replace the evaporator coil in each case.

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Little or No Air Flow	The blower is not operating.	Check for an open circuit breaker. An open circuit breaker indicates a short in the electrical system which must be repaired. Check for broken or loose electrical connections, especially the blower motor ground and power leads. Repair the connections, if necessary. Check for a locked or dragging blower motor. If either condition exists, replace the blower motor.
	The air duct is disconnected or restricted.	Examine the air duct in the sleeper compartment; remove any blockages. Check the air flex hose; if restricted or disconnected, repair as necessary.
	The function toggle switch is inoperative.	Troubleshoot the control panel electrical circuitry. Replace the switch if necessary.
	Air flow is blocked at the heater-air conditioner unit (the blower suction is obstructed).	Remove all blockages from in front of the housing body air screen. Check the evaporator coil fins for dirt buildup. If buildup is present, remove the evaporator coil from the unit; tightly cap the inlet and outlet ports of the coil (waterproof them), then flush the dirt from the coil using clean water.

(Continued on next page)

CONVENTIONAL CAB SLEEPER BOX
HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Little or No Air Flow (Cont.)	Air flow is blocked at the heater-air conditioner unit (the blower suction is obstructed). (Cont.)	Check the evaporator coil for ice buildup. If ice is present, set both the thermostat dial and the function toggle switch at "HEAT"/"H," and allow the blower to operate for five minutes or until the ice melts. If ice buildup persists, the expansion valve or solenoid valve may be at fault. Proceed to the causes given under "Inadequate Cooling" in this chart.
	When the heater is used, the temperature setting is too low.	Turn the thermostat dial clockwise to the end of travel (in the maximum heat position). Blower operation will be continuous in this position.
	If the air conditioner is in use, the blower will shut off when the sleeper compartment air temperature falls below the thermostatic setting.	The fan will operate when the air temperature exceeds the thermostatic setting, or when the thermostat dial is turned to a cooler setting.
	The water shutoff valve was left open (the water temperature toggle switch is set at "HOT").	Close the water shutoff valve by setting the toggle switch at "COLD."
Inadequate Cooling	The water shutoff valve is inoperative.	Insure that the water temperature toggle switch is set at "COLD," then check the air control line to the water shutoff valve for leaks or breakage. Repair or replace the line as necessary. If no leaks are present, and the coolant hoses between the heater and the valve are warm to the touch, replace the water shutoff valve.

(Continued on next page)

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Inadequate Cooling (Cont.)	The expansion valve stays open and floods the evaporator coil with refrigerant (the suction line from the coil to the compressor feels cold or is frosted; ice buildup may be present on the evaporator coil).	The expansion valve could be damaged due to internal ice or dirt buildup caused by inadequate purging of the system or by an inoperative receiver-drier. Replace the component(s), as necessary.
	The expansion valve stays closed and prevents refrigerant flow to the evaporator coil.	The expansion valve could be damaged due to internal ice or dirt buildup caused by inadequate purging of the system or by an inoperative receiver-drier. Replace the component(s), as necessary.
	There is a low charge of refrigerant in the system.	Check the receiver-drier sight glass. If foaming is present, air is in the system. If no foaming is present, the system may be empty. Check for hissing at the expansion valve or evaporator coil. If any of these conditions exist, leaks are occurring and must be corrected. Leak test the system (including the cab air conditioner) as instructed in the cab heater-air conditioner subject located in the 22 Group of this manual.
	The control panel thermostat is sticking or inoperative (sporatic cooling or no cooling).	Troubleshoot the control panel.

(Continued on next page)

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Excessive Cooling	If the thermostat setting is low, the thermostat may be sticking or is inoperative.	Adjust the thermostat clockwise towards "HEAT"/"H." If cooling persists, troubleshoot the control panel.
Inadequate Heating	The water shutoff valve is not opened.	Open the water shutoff valve by setting the water temperature toggle switch at "HOT."
	The water shutoff valve is inoperative.	Replace the water shutoff valve.
	The engine has not had time to warm up.	Allow sufficient time for the engine to warm up and for the radiator thermostat to open.
	The radiator thermostat is inoperative.	Test the thermostat using the instructions given in the 05 Group of this manual.
	The coolant hose is pinched or twisted.	Inspect the coolant outlet and inlet heater hoses from the heater to the engine. Repair or replace the hoses, as necessary.
	The heater core fins are dirt-clogged.	Remove the heater core from the housing body, and flush the exterior with clean water. Install the heater core.

CONVENTIONAL CAB SLEEPER BOX HEATER-AIR CONDITIONER

SPECIFICATIONS

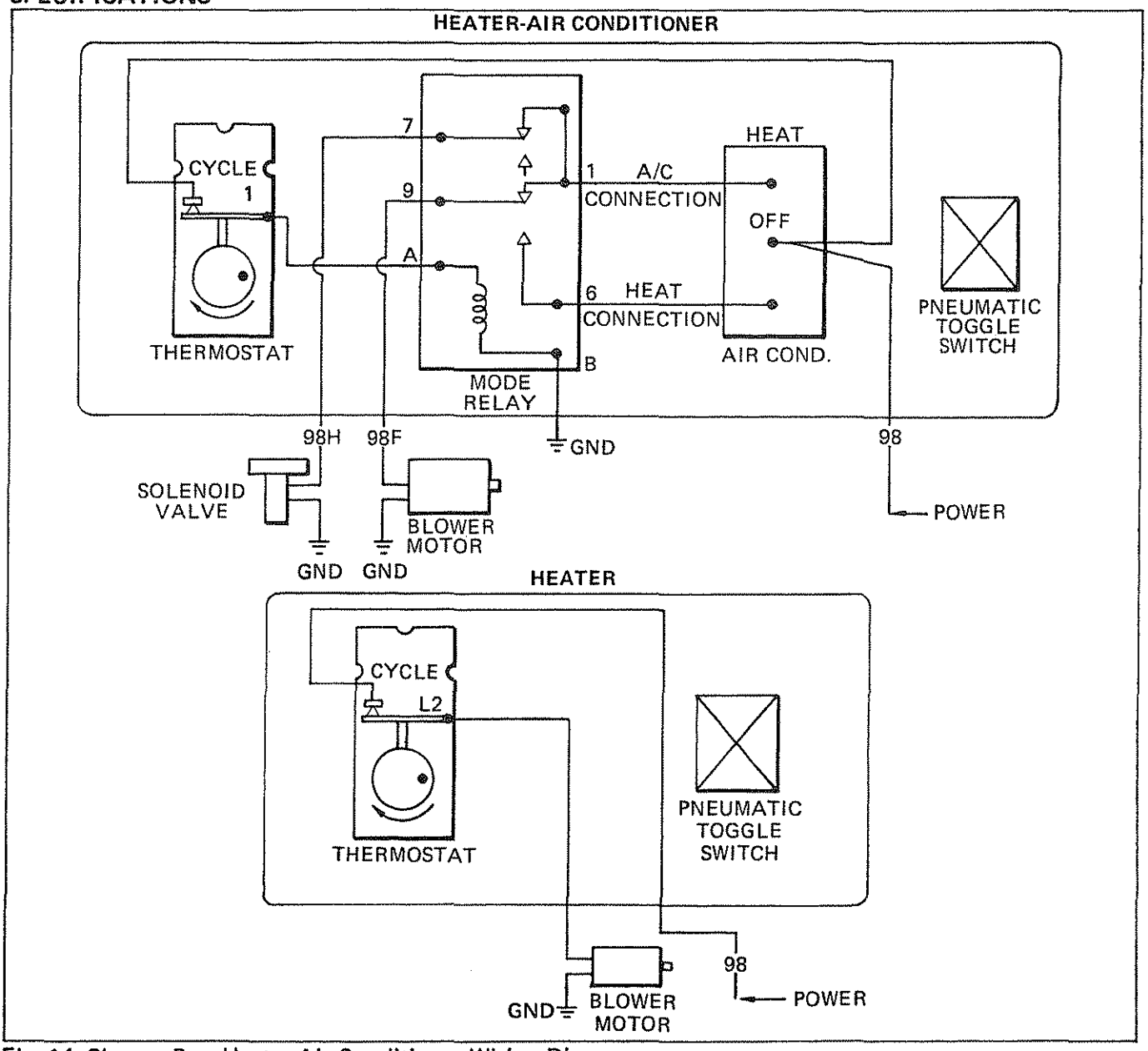

Fig. 14, Sleeper Box Heater-Air Conditioner Wiring Diagrams

FITTING SIZE	TUBE O.D.	TORQUE	
		Ft-Lbs.	N·m
6	3/8"	11-13	15-18
8	1/2"	15-20	20-27
10	5/8"	21-27	28-37

Table 1, Refrigerant Line Torque Specifications

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER SUBJECT CONTENTS

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FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

GENERAL DESCRIPTION

The Freightliner Conventional cab underdash heater/heater-air conditioner unit is available as a heater only or as a combined heater and air conditioner unit. The heater/heater-air conditioner unit is located under the right-hand side of the cab dash. This unit is built into one housing utilizing the same blower motors and ducting. The system uses outside air that is ducted in either from an air scoop located on the top center of the cowl or from the lower right-hand side of the cowl, and cab air that recirculates through the air door of the heater/ heater-air conditioner unit.

When air (outside or recirculated) is ducted into the system, it passes through an evaporator coil and heater core which are located in the housing. The conditioned air then flows through the blower housings to the cab outlets and defroster outlets. See Fig. 1.

The heater-only control panel (Fig. 2) and heater-air conditioner control panel (Fig. 3) consist of a defrost blower dial switch, a cab blower dial switch, a pneumatic recirculating-fresh air toggle switch, and a cold-hot (temperature) lever. In addition, the heater-air conditioner control panel includes a heater-air conditioner toggle switch, and an air conditioner thermostat dial.

Refer to the Freightliner Conventional Drivers Manual for operating instructions for the underdash heater/heater-air conditioner unit.

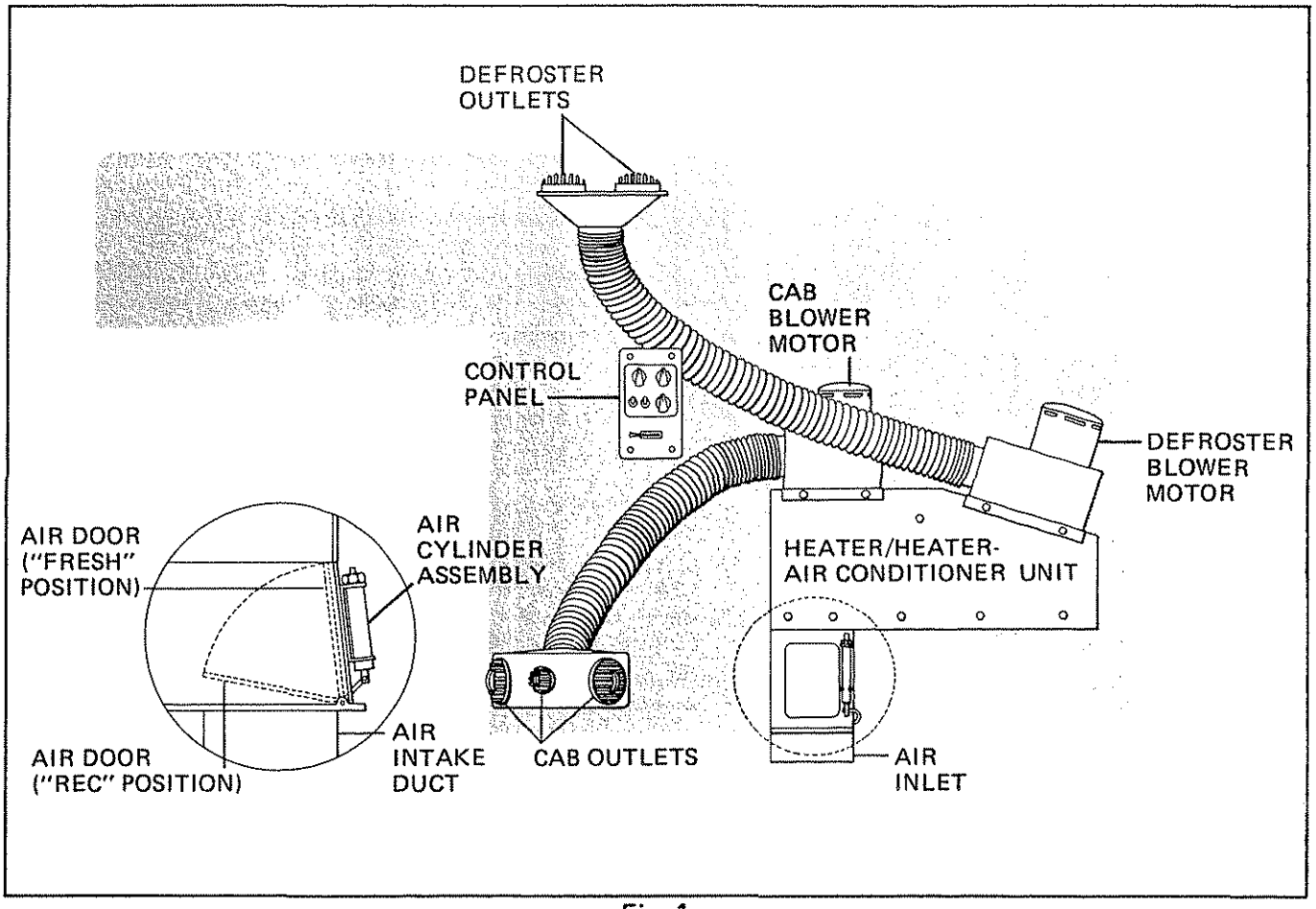

Fig. 1

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

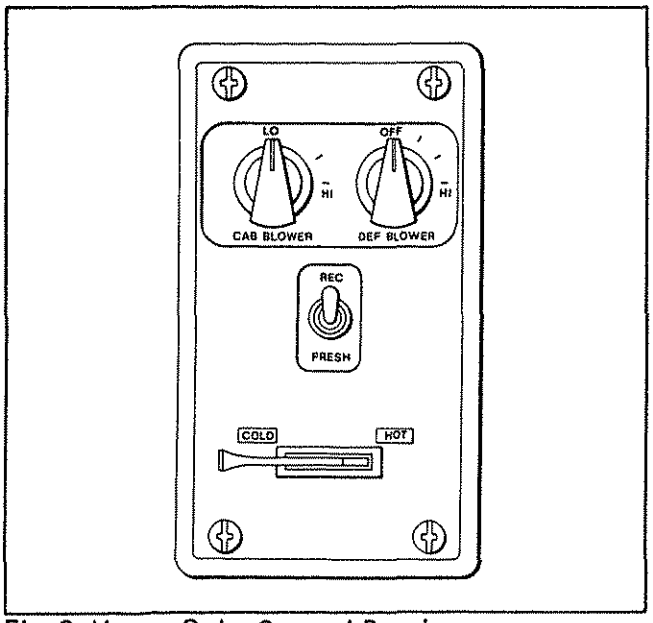

Fig. 2, Heater-Only Control Panel

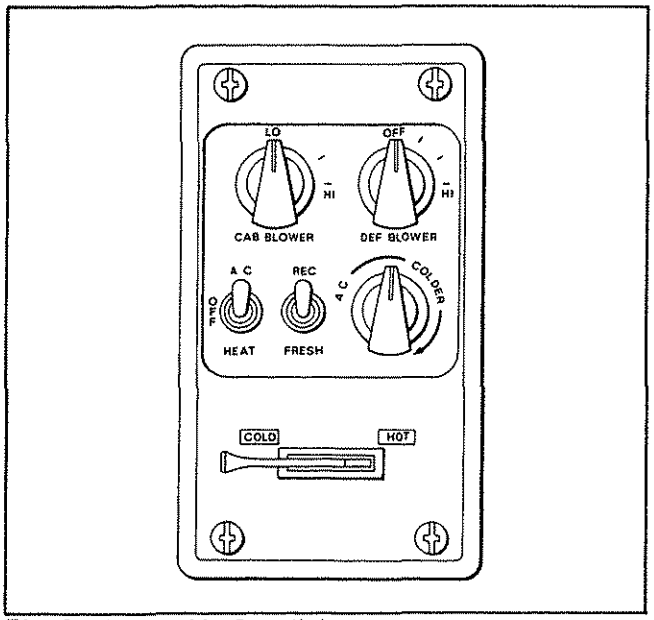

Fig. 3, Heater-Air Conditioner Control Panel

PRINCIPLES OF OPERATION

1. Activation of the air conditioner thermostat dial allows the passage of liquid refrigerant to the expansion valve. As the liquid refrigerant enters the expansion valve, the refrigerant is already pressurized at about 135 psi (930 kPa). The expansion valve expands the refrigerant, dropping its pressure to about 10 psi (69 kPa). This rapid drop in pressure significantly cools the refrigerant as it enters the evaporator coil. The passage of blower-forced air over the evaporator coil is then conducted to the cab and defroster outlets. See Fig. 1.

   As the refrigerant warms in the evaporator coil, it boils and becomes a gas. This gas is pumped out of the coil and into the compressor, where it is compressed to about 135 psi (930 kPa). The warmed refrigerant gas is then pumped to the condenser, which is mounted either in front of the radiator or on top of the roof. The passage of air over the condenser coils cools the refrigerant gas, causing it to condense into a liquid.

   The liquid refrigerant is then stored until needed in the receiver-drier, where small amounts of water and acids are removed.

2. Pushing the "COLD-HOT" (temperature) lever towards the "HOT" position activates the cable operated water shutoff valve, which regulates the flow of engine coolant to the heater core. When the valve opens, heated coolant from the vehicle radiator flows to the heater core. With the passage of blower-forced air over the heater core grille, heat is conducted to the cab and defroster outlets. See Fig. 1.

   In a continuing process, the coolant fluid within the heater core is then returned to the engine block, where it is once again heated.

SERVICE OPERATIONS

HEATER/HEATER-AIR CONDITIONER CONTROL PANEL LIGHT(S) OR SWITCH(ES) REPLACEMENT

CAUTION: Make sure the ignition switch is in the OFF position to prevent damage to the electrical system during service operations.

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

1. Remove the screws attaching the heater/heater-air conditioner control panel to the lower control panel. Lift the heater/heater-air conditioner control panel to a serviceable level.

2. Mark the wires and air hoses connected to the switches or lights to be replaced for later assembly reference. Disconnect the wires, air hoses, and light sockets.

3. Replace the lights and switches as needed.

4. Connect the wires, air hoses, or light sockets, as previously marked.

5. Position the heater/heater-air conditioner control panel against the lower control panel, then install and tighten the screws.

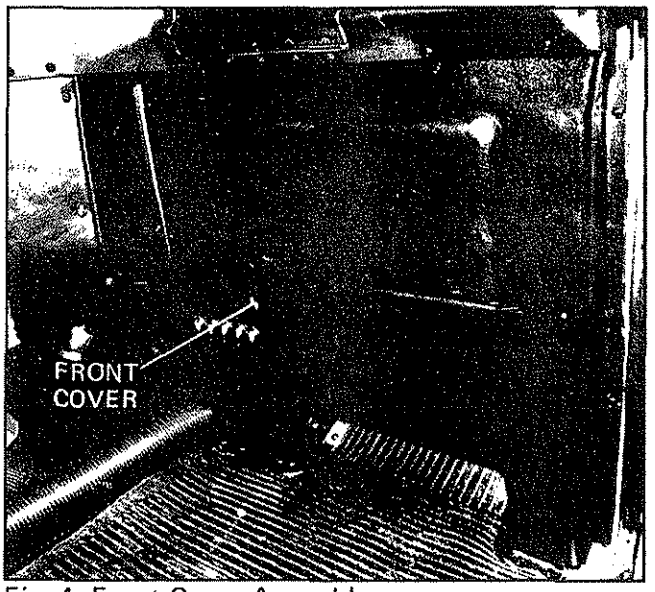

Fig. 4, Front Cover Assembly

AIR CONDITIONER THERMOSTAT DIAL SWITCH AND SENSING TUBE REPLACEMENT

CAUTION: Make sure the ignition switch is in the OFF position to prevent damage to the electrical system during service operations.

1. Remove the screws attaching the heater-air conditioner control panel to the lower control panel. Lift the heater-air conditioner control panel to a serviceable level.

2. Mark the wires connected to the thermostat dial switch for later assembly reference. Disconnect the wires from the switch.

3. Loosen the Allen-head screw that fastens the thermostat dial knob to the switch. Remove the knob, then remove the nut located directly under the knob.

4. Remove the thermostat dial switch assembly from the control panel.

5. Remove the screws attaching the heater-air conditioner front cover assembly (Fig. 4.) to the cab dash. Remove the cover assembly.

6. Remove the front access panel capscrews from the housing, then remove the front access panel.

7. Remove the thermostat sensing tube (Fig. 5) from the evaporator coil by pulling it straight out through the grommet and front panel until it is completely out of the housing.

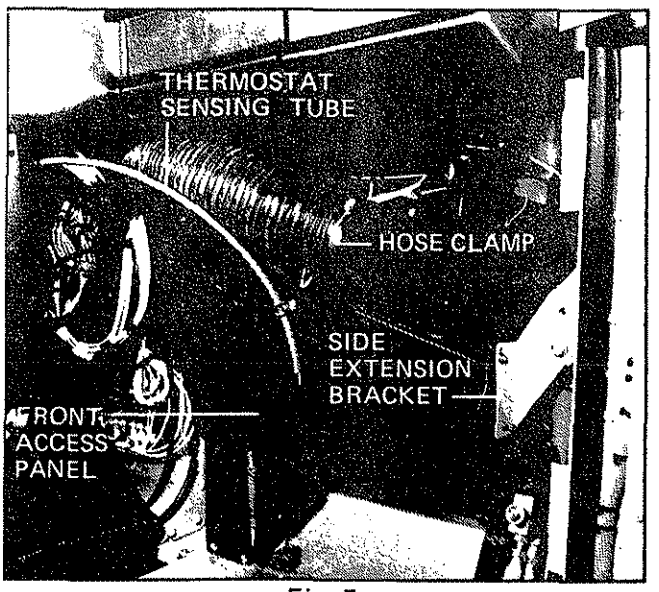

Fig. 5

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

8. Position the new thermostat sensing dial and thermostat sensing tube (Fig. 5) through the grommet on the front panel, then guide the sensing tube through the evaporator coil fins until the sensing tube reaches the bottom of the evaporator coil.

9. Position the front access panel against the housing, then install and tighten the front acess panel capscrews. Pull the sensing tube back out approximately 1 1/2 inches (38 mm) and bend it 90° at the grommet to prevent the sensing tube from slipping back into the evaporator coil.

10. Install the thermostat dial switch through the control panel, then install and tighten the nut. Install the thermostat dial knob on the switch, then tighten the Allen-head screw.

11. Connect the electrical wires to the thermostat dial switch as previously marked, or as shown in Fig. 16, located under "SPECIFICATIONS."

12. Position the heater-air conditioner control panel against the lower control panel, then install and tighten the screws.

13. Position the heater/heater-air conditioner front cover assembly (Fig. 4) against the cab dash. Install and tighten the attaching screws.

DEFROST OR CAB BLOWER MOTOR REPLACEMENT (Refer to Fig. 6)

CAUTION: Turn the ignition switch off. This prevents accidental fan operation during service operations.

1. Remove the screws attaching the heater/heater-air conditioner front cover assembly (Fig. 4) to the cab dash. Remove the front cover assembly.

2. Using a screwdriver, loosen the hose clamp attaching the air ducting hose (Fig. 5) to the blower mount housing. Disconnect the hose from the blower mount housing.

3. Mark the wires connected to the blower motor for later assembly reference, then disconnect the wires.

4. Remove the capscrews attaching the blower mount housing assembly to the heater/heater-air conditioner unit. Remove the blower mount housing assembly from the unit.

5. Remove the capscrews attaching the blower motor assembly to the blower mount housing, then remove the blower motor assembly.

6. Remove the Allen-head setscrew attaching the blower wheel to the motor shaft, then remove the blower wheel.

7. Remove the nuts and washers attaching the motor mount to the blower motor, then remove the motor mount.

8. Position the motor mount on the new blower motor, then install and tighten the nuts and washers.

9. Position the blower wheel over the motor shaft, making sure the Allen-head setscrew is over the flat part of the shaft. Install and tighten the Allen-head setscrew using an Allen wrench.

10. Position the blower motor assembly inside the blower mount housing, then install and tighten the capscrews.

11. Install the blower motor and blower mount housing assembly to the heater/heater-air conditioner unit. Install the attaching capscrews and tighten.

12. Connect the electrical wires to the blower motor as previously marked or as shown in Fig. 16 located under "SPECIFICATIONS."

13. Connect the air ducting hose (Fig. 5) to the blower mount housing, then install and tighten the hose clamp.

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

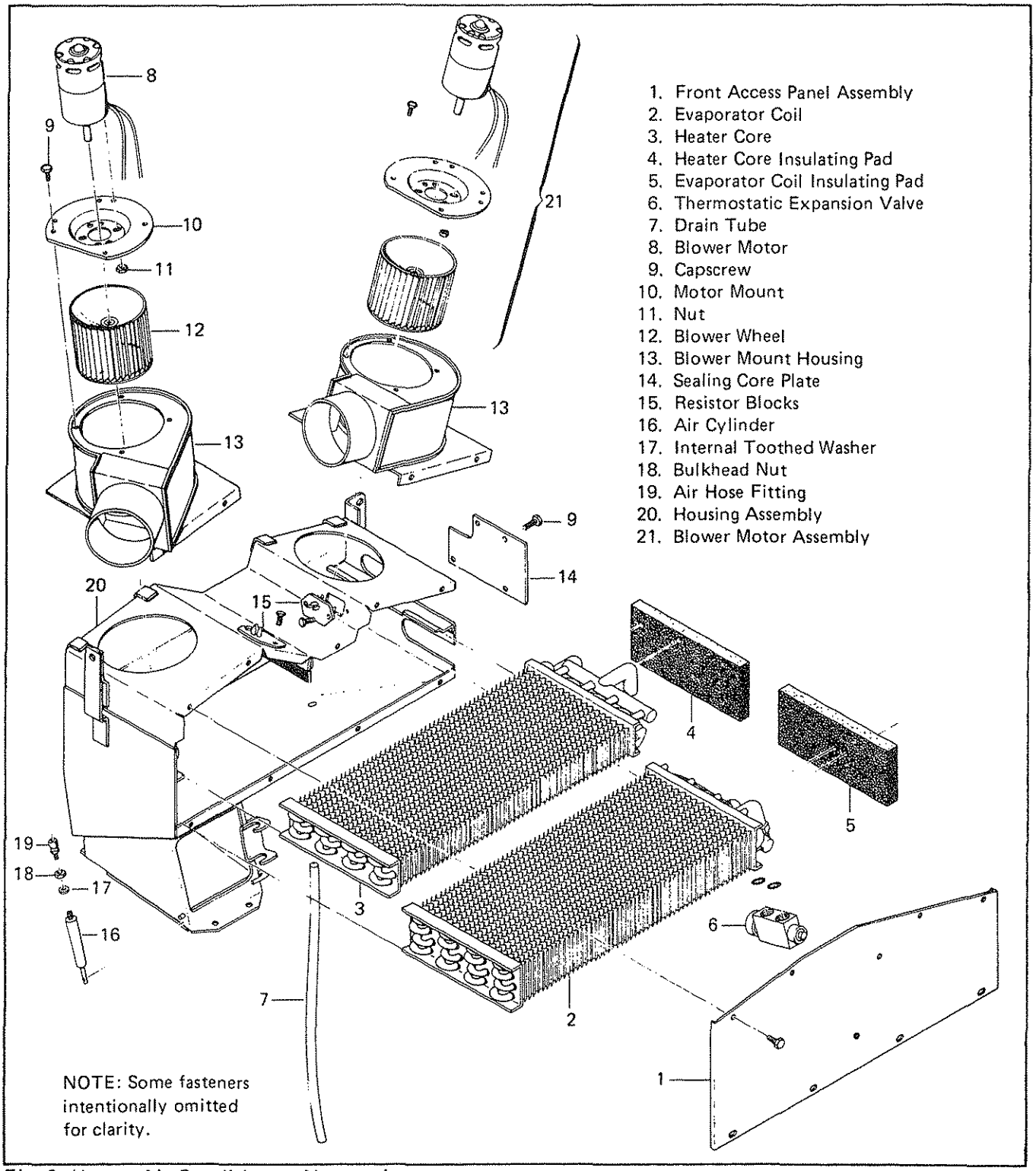

Fig. 6, Heater-Air Conditioner, Nomenclature

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

14. Position the heater/heater-air conditioner front cover assembly (Fig. 4) against the cab panel. Install and tighten the attaching screws.

HEATER CORE REPLACEMENT
(Refer to Fig. 6)

1. Shut off the heater's water supply by placing the cold-hot (temperature) lever to the "COLD" position.

2. Drain the heater core by disconnecting the heater hoses from the connector and shutoff valve either mounted on the firewall or located right below the firewall outside the cab. Drain the coolant into a clean container, if desired, for later use.

3. Remove the front cover assembly (Fig. 4) by removing the capscrews attaching the cover to the cab panel.

4. Remove the front access panel capscrews from the housing, then remove the front access panel.

5. Remove the thermostat sensing tube (Fig. 5), if so equipped, by pulling it straight out through the grommet and front panel of the heater-air conditioner housing. Move the tube away from the front panel.

6. Disconnect the side bracket extension (Fig. 5) from the mounting bracket by removing the hex nuts, washers and bolts. Remove the capscrews attaching the side bracket extension to the sealing core plate.

7. Disconnect the heater hoses from the heater core.

8. Remove the remaining two sealing core plate capscrews from the sealing core plate, then remove the sealing core plate from the housing.

9. Remove the heater core and insulating pad from the housing by sliding it outward.

WARNING: Because of the sharp edges of the heater core grille blades, protective gloves should be worn when servicing the heater core.

10. Wearing protective gloves, position the new heater core and insulating pad in the housing.

11. Connect the heater hoses to the heater core, then securely tighten the heater hose clamps.

12. Position the sealing core plate against the housing, then install and tighten the two rear capscrews.

13. Position the side bracket extension against the sealing core plate and housing, then install the remaining two capscrews. Attach the side bracket extension to the cab mounted bracket with the hex nuts, washers and bolts, then tighten the nuts.

14. Install the thermostat sensing tube straight in through the grommet in the front panel, then through the evaporator coil fins until the sensing tube reaches the end of the evaporator coil.

15. Position the front access panel against the housing, then install and tighten the front access panel capscrews. Pull the sensing tube back out approximately 1 1/2 inches (38 mm) and bend the tube 90° at the grommet to prevent the tube from sliding back into the evaporator coil.

16. Install the front cover assembly (Fig. 4) to the cab dash with the attaching capscrews.

17. Connect the previously removed heater hoses to the shutoff valve and connector. Fasten by tightening the heater hose clamps.

18. Fill the cooling system with coolant, then follow the instructions given under the heading, "BLEEDING AIR FROM THE HEATER CORE" in this subject.

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

BLEEDING AIR FROM THE HEATER CORE

With the engine running, place the heater-air conditioner toggle switch to the "HEAT" position. Move the cold-hot (temperature) lever to the "HOT" position. Coolant will flow through the heater core and force any entrapped air through the heater outlet hose and out the radiator. If there is a drop in the coolant fluid level after the air is exhausted, fill the radiator to within one inch (25 mm) of the bottom of the filler neck.

CAUTION: Coolant fluid should be filled to within one inch (25 mm) of the bottom of the radiator filler neck. Less than this could result in overheating which could cause engine damage.

AIR DOOR AIR CYLINDER ASSEMBLY REPLACEMENT

1. Remove the screws attaching the heater/heater-air conditioner front cover assembly (Fig. 4) to the cab dash. Remove the cover assembly.

2. Drain the vehicle air system. Disconnect the air hose from the air actuator. See Fig. 7.

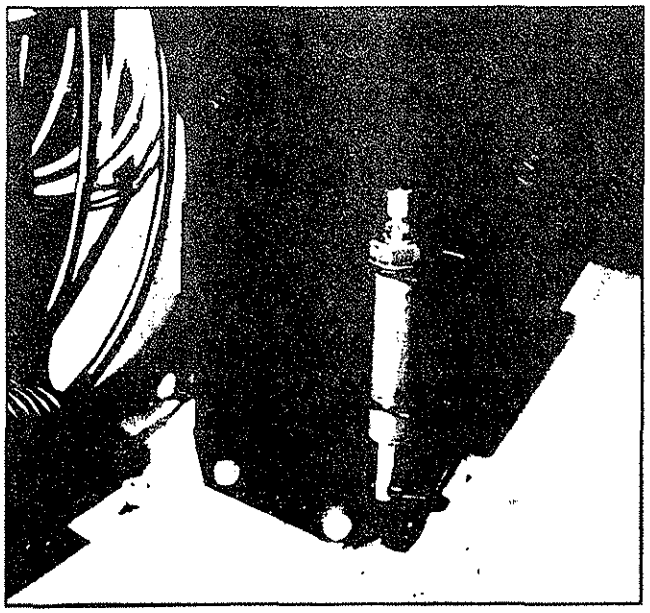

Fig. 7, Air Door Air Cylinder Assembly

3. Remove the bulkhead nut and internal-toothed lockwasher. Then, remove the air cylinder from the mounting bracket and air door handle.

4. Position the new air cylinder on the mounting bracket and air door handle. Install the internal-toothed lockwasher and bulkhead nut. Tighten the nut finger-tight, then with a wrench, tighten 2 1/2 additional turns.

5. Check the air door operation. Be sure the door works freely, has full movement, and seals securely.

6. Apply pipe sealant to the external threads of the air hose fittings. Connect the air hose to the air fitting, making sure the tubing is bottomed in the fitting. Tighten the connection using the instructions given in Table 1, located under "SPECIFICATIONS." Use two wrenches when tightening the fittings to prevent twisting of the tubing.

7. Position the heater/heater-air conditioner front cover assembly (Fig. 4) to the cab, then install and tighten the capscrews.

WATER SHUTOFF VALVE REPLACEMENT (Refer to Fig. 8)

1. Place the cold-hot (temperature) lever to the "HOT" position, which opens the shutoff valve completely.

2. Drain the cooling system by disconnecting the heater hoses from the water shutoff valve. Save the coolant, if desired, in a clean container. Then, remove the water shutoff valve.

3. Disconnect the water shutoff valve operating cable from the shutoff valve by first uncoiling the cable core from the shutoff valve stem. Then loosen the cable housing clamp and remove the operating cable assembly. Remove and discard the water shutoff valve.

4. Connect the operating cable core to the new water shutoff valve by wrapping the cable core

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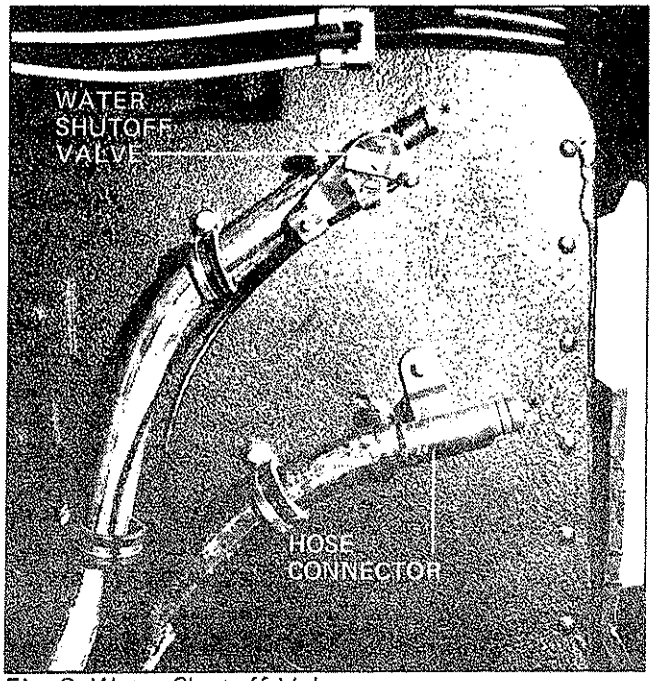

Fig. 8, Water Shutoff Valve

two complete loops around the shutoff valve stem. If previously removed, install a new push-on retainer on the valve stem to secure the cable. Place the shutoff valve stem to the full "ON" position on the valve. Connect the cable housing to the cable housing clamp, then tighten the clamp.

5. Attach the heater hoses to the water shutoff valve and fasten with the heater hose clamps.

6. Install (new or saved) coolant fluid in the cooling system.

CAUTION: Coolant fluid should be filled to within one inch (25 mm) of the bottom of the radiator filler neck. Less than this could result in overheating which could cause engine damage.

7. Start the vehicle engine with the hood tilted so that observation can be made of the water shutoff valve. Make sure there are no coolant leaks in the hose connections. If leakage is present in the water shutoff valve, turn off the engine, then repeat steps 2 through 7.

EVAPORATOR COIL REMOVAL AND INSTALLATION

Removal (Refer to Fig. 6)

1. Remove the front cover assembly (Fig. 4) by removing the capscrews attaching the cover to the cab dash.

2. When any air conditioner components containing refrigerant are replaced or to be serviced, the system must be discharged. Discharge the air conditioner system following the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas, which, if inhaled, causes severe respiratory irritation.

3. Disconnect the refrigerant lines from the expansion valve. Use two wrenches to avoid twisting the tubing. Install plugs in the refrigerant lines and the ports of the expansion valve.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Water will freeze inside the expansion valve and combine with the refrigerant to create acid. The ice in the expansion valve stops the cooling and the acid will gradually corrode the entire system. Dirt will plug the expansion valve and stop the cooling. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

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4. Remove the heater-air conditioner front access panel capscrews from the housing, then remove the front panel.

5. Remove the thermostat sensing tube, by pulling it straight out through the grommet and front panel of the heater-air conditioner housing. Move the tube away from the front panel.

6. Remove the evaporator coil and insulating pad from the housing by sliding it outward.

WARNING: Because of the sharp edges on the evaporator coil grille blades, protective gloves should be worn when servicing the evaporator coil.

Installation (Refer to Fig. 6)

1. Wearing protective gloves, install the evaporator coil and insulating pad in the heater-air conditioner housing.

2. Install the thermostat sensing tube straight in through the grommet in the front panel, then through the evaporator coil fins until the tube reaches the end of the evaporator coil.

3. Position the front access panel against the housing, then install and tighten the front panel capscrews. Pull the sensing tube back out approximately 1 1/2 inches (38 mm) and bend the tube 90° at the grommet to prevent the tube from sliding back into the evaporator coil.

4. Remove the plugs from the refrigerant lines and expansion valve. Apply refrigerant oil to the threads, and connect the refrigerant lines to the expansion valve. Tighten the connection to the torque value given in Table 2 located under "SPECIFICATIONS." Use two wrenches when tightening fittings to prevent twisting of tubing.

5. Purge the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

6. Replace the receiver-drier following steps 2 through 6 given under the heading "RECEIVER-DRIER REPLACEMENT."

7. Attach the front cover assembly (Fig. 4) to the cab dash with the attaching capscrews.

THERMOSTATIC EXPANSION VALVE REPLACEMENT

1. Remove the front cover assembly (Fig. 4) by removing the capscrews attaching the cover to the cab dash.

2. When any air conditioner components containing refrigerant are replaced or serviced, the system must be discharged. Discharge the air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas, which, if inhaled, causes severe respiratory irritation.

3. After the system is completely discharged, remove the refrigeration insulating tape that covers the connection from the evaporator coil to the expansion valve.

4. Disconnect the refrigerant lines from the expansion valve using two wrenches to avoid

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

twisting the tubing. Install plugs in the refrigerant lines and evaporator coil. Then, remove the expansion valve from the evaporator coil.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

5. Attach the new expansion valve to the evaporator coil, then remove the plugs from the refrigerant lines. Apply refrigerant oil to the threads and connect the refrigerant lines to the expansion valve. Tighten the connection to the torque value given in Table 2 located under "SPECIFICATIONS." Use two wrenches when tightening fittings to prevent twisting of tubing.

6. Purge the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

7. Replace the receiver-drier following steps 2 through 6 given under the heading "RECEIVER-DRIER REPLACEMENT."

8. Wipe the refrigerant lines clean with a rag. Insulate the evaporator coil and expansion valve connection with refrigeration insulating tape.

9. Install the front cover assembly (Fig. 4) with the attaching capscrews.

RECEIVER-DRIER REPLACEMENT

1. When the receiver-drier is to be replaced, the system must be discharged and purged. Discharge, and then purge the air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas, which, if inhaled, causes severe respiratory irritation.

2. After the system is completely discharged and purged, disconnect the refrigerant lines from the receiver-drier. Use two wrenches to avoid twisting the tubing. Install plugs in the refrigerant lines.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

3. Remove the U-bolt nuts, washers, and U-bolt that attach the receiver-drier to the mounting bracket, then remove the receiver-drier.

4. Position the new receiver-drier (Fig. 9) in the mounting bracket, then install the U-bolt, washers, and nuts. Tighten the U-bolt nuts to 13 ft-lbs (18 N·m).

5. Remove the plugs from the refrigerant lines and the receiver-drier. Apply refrigeration oil to the seal surface and threads, then connect the lines to the receiver-drier. Tighten the connections to the torque values given in Table 2 located under "SPECIFICATIONS." Use two wrenches to avoid twisting the tubing.

6. Evacuate, charge, and leak test the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

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CONDENSER REPLACEMENT

1. When any air conditioner components containing refrigerant are replaced or serviced, the system must be discharged. Discharge the air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas, which, if inhaled, causes severe respiratory irritation.

2. After the system is completely discharged, disconnect the refrigerant lines from the condenser. See Fig. 10. Use two wrenches to avoid twisting the lines while loosening the fittings. Install plugs in the refrigerant lines and condenser inlet-outlet tubes.

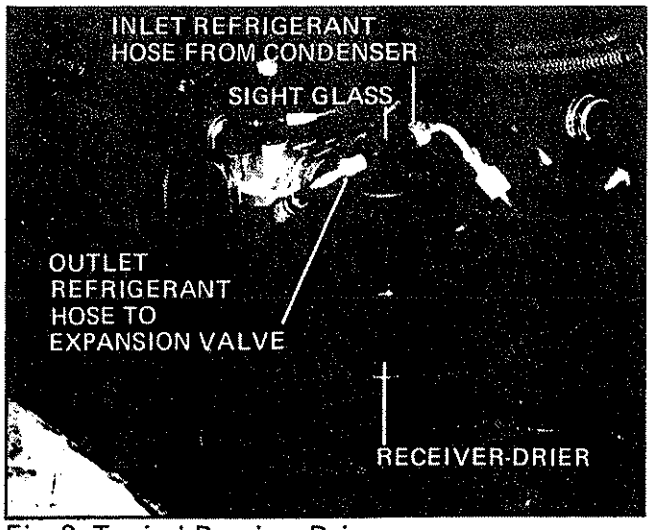

Fig. 9, Typical Receiver-Drier

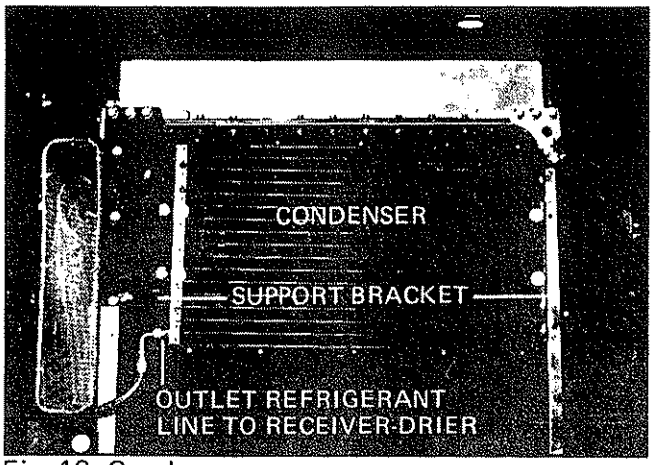

Fig. 10, Condenser

3. Remove the capscrews attaching the support bracket of the condenser to the radiator, then remove the condenser.

4. Position the condenser and support brackets on the radiator, then install and tighten the capscrews to 9 ft-lbs (12 N·m).

5. Remove the plugs from the refrigerant lines and condenser inlet-outlet tubes. Apply refrigerant oil to seal surfaces, O-rings, and threads. Connect the refrigerant lines to the condenser. Tighten the connections to the torque value given in Table 2 located under "SPECIFICATIONS." Use two wrenches to avoid twisting the tubing.

CAUTION: Contaminants such as water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses. Shop air is wet (humid) air.

6. Purge the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

7. Replace the receiver-drier following steps 2 through 6 given under the heading "RECEIVER-DRIER REPLACEMENT."

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DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING

Whenever repairs have to be made on any of the air conditioner system components containing refrigerant, the system must be discharged, purged, evacuated, charged, and leak tested.

WARNING: Care should be taken to prevent the refrigerant from contacting the skin or eyes because liquid refrigerant, at normal atmospheric pressure and temperature, rapidly evaporates and will tend to freeze anything that it contacts. Goggles and gloves should be worn while discharging, purging, evacuating, charging, or leak testing the system.

Do not work in an area where exposed gas or liquid refrigerant may contact an open flame or any burning material, such as a cigarette. Combusted refrigerant creates poisonous phosgene gas, which, if inhaled, causes severe respiratory irritation.

The following checks should be made whenever the system is not cooling properly and the causes are unknown, or whenever routine maintenance of the air conditioning system occurs. Refer to the "MAINTENANCE SCHEDULE" section in the Freightliner Maintenance and Lube Manual for air conditioner maintenance intervals. These checks should be made prior to discharging the air conditioning system.

1. Adjust the refrigerant compressor belt tension. Refer to the 01 Group in this manual for instructions.

2. Check the refrigerant compressor clutch coil wire connection for tightness. Tighten if loose. Repair if broken or damaged.

3. Check for broken or cut hoses and for loose fittings on all components. Remove broken or cut hoses, and replace them with new ones. Tighten loose fittings to the torque values given in Table 2 under "SPECIFICATIONS."

4. Check for foreign material blockage of condenser external fins. Using air pressure and whisk broom, clean the condenser if foreign material is present.

5. With the blower motors on "HI" and the heater-air conditioner toggle switch in the "A/C" position, make sure there is no air leakage at any of the air duct connections. If leakage is present, repair the connection.

6. When the checks above are completed, proceed to "DISCHARGING USING A MANIFOLD GAUGE SET" in this subject.

Discharging Using A Manifold Gauge Set

Discharging the air conditioner system removes most of the refrigerant present in the system. After discharging, the system should be purged. For purging instructions, refer to "PURGING USING DRY NITROGEN" in this subject.

1. Connect the service gauges to the service valves on top of the refrigerant compressor, as shown in Fig. 11, but do not connect the manifold center service hose to the vacuum pump.

2. Position the open end of the center service hose in a jar to catch the refrigerant oil, then place the hose in the shop exhaust system.

3. With both manifold valves off, open both service valves (on the compressor), then open the suction side manifold valve and bleed so that a minimum of oil is escaping into the jar. As the pressure drops, slowly open the discharge manifold valve again being careful to minimize oil escaping with the refrigerant. Do not discharge rapidly or the oil will be carried out with the refrigerant. If the oil does escape, any oil carried out will collect in the jar, and the compressor will have to be refilled with the same quantity of new refrigerant oil. Refer to the 01 Group of this manual or to the applicable manufacturers instructions for refrigerant compressor servicing information.

4. Position the refrigerant compressor suction service valve and discharge service valve halfway in.

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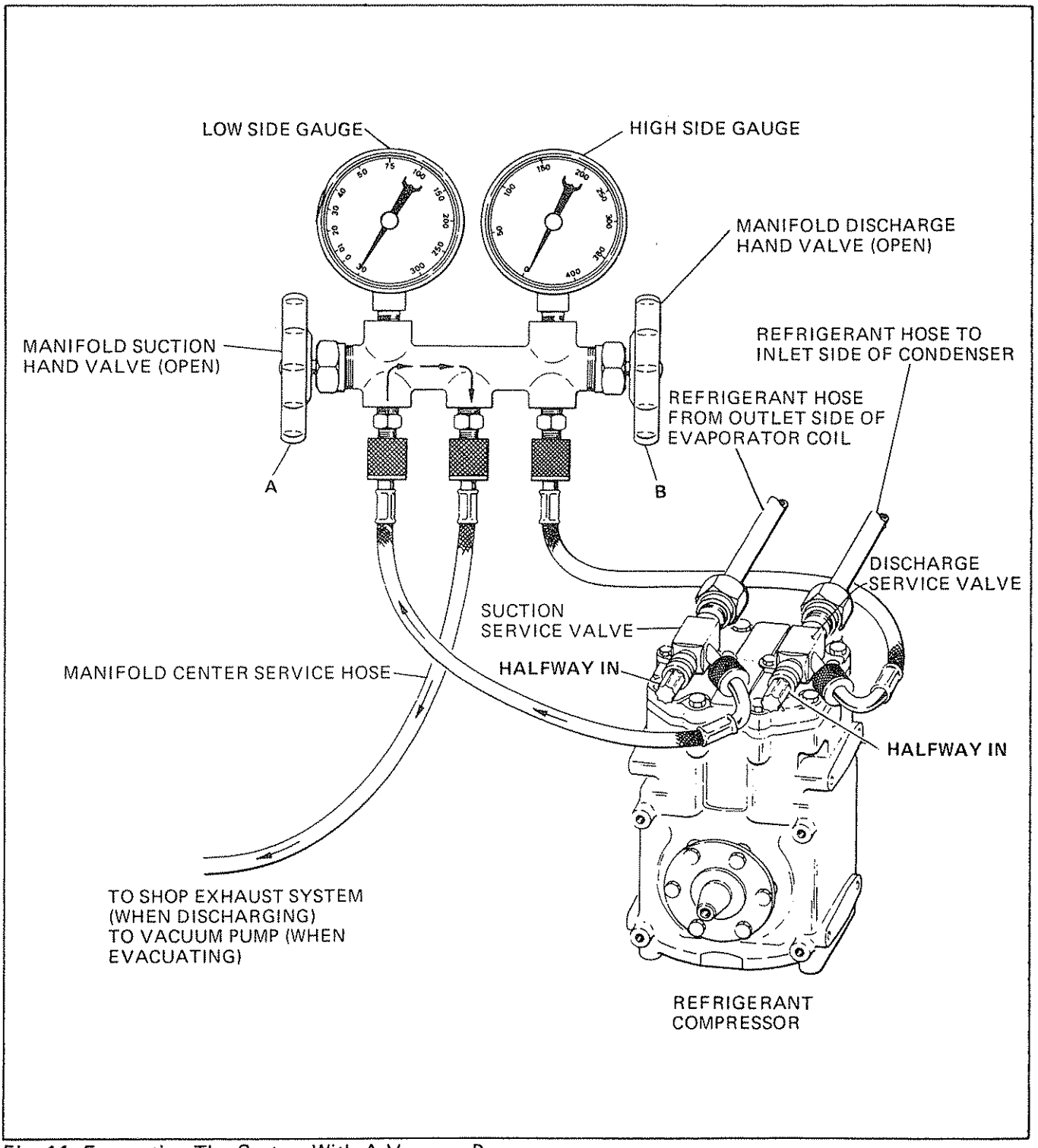

Fig. 11, Evacuating The System With A Vacuum Pump

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5. After the refrigerant has been discharged from the system, disconnect the center service hose from the shop exhaust outlet, then disconnect the service gauges from the refrigerant compressor service valves. Proceed to "PURGING USING DRY NITROGEN" in this subject.

Purging Using Dry Nitrogen

Purging the air conditioning system completely flushes out any moisture laden air, residual refrigerant, and dirt from the plumbing. If left in the system, these contaminants would adversely affect the life and operation of the air conditioning system.

The entire plumbing circuit may be contaminated, or just a portion of it. If contamination is suspected, the extent of the problem can be determined by disconnecting and inspecting individual components (including the sleeper box air conditioner, if so equipped) for dirt, sludge, metallic grit, or other foreign materials. In any event, the system should be purged in segments to minimize the chance of blowing these deposits against one of the internal screens or orifices where it remains to become a problem again.

Figure 12 is an outline of the basic plumbing circuit with potential problem areas and recommended purge points.

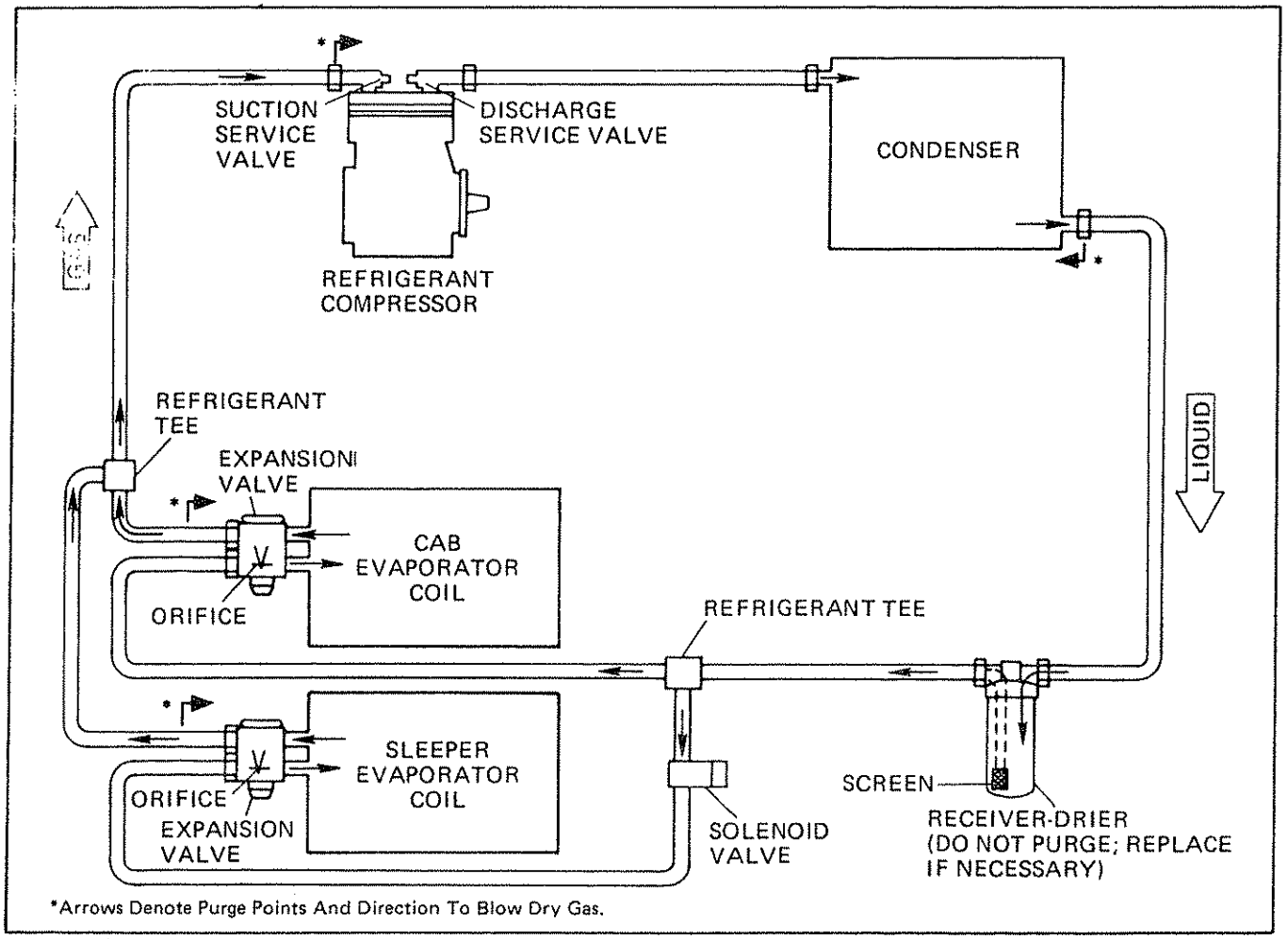

Fig. 12, Purge Points In Air Conditioner System (Including Sleeper Box Air Conditioner)

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NOTE: Dry nitrogen gas is recommended for purging, but any safe, inert, dry gas may be substituted.

To purge that segment of the system containing the refrigerant compressor, proceed as follows (refer to Fig. 13):

1. Hook the nitrogen pressure hose onto the uncapped end of the suction service valve of the refrigerant compressor.

2. Disconnect the refrigerant hose from the discharge service valve of the refrigerant compressor.

3. Back-seat (turn counterclockwise all the way out) the refrigerant compressor discharge service valve.

4. Front-seat (turn clockwise all the way in) the suction service valve on the refrigerant compressor.

5. Turn on the nitrogen tank; nitrogen will flow through the suction service valve, through the refrigerant compressor, and out the discharge service valve.

6. Check the outlet from the discharge service valve for pressure to see if there is a definite flow of nitrogen coming out.

7. Purge the system for about 25-30 seconds at 200 psi (1378 kPa). Reduce the pressure to 3-4 psi (14-21 kPa) and continue purging for one to two minutes. Then, turn off the nitrogen flow at the tank.

8. Connect the refrigerant hose to the discharge service valve of the compressor.

9. Remove the nitrogen pressure hose from the suction service valve of the refrigerant compressor.

10. If no other segments need purging, position the refrigerant compressor discharge and suction service valves halfway in. Then, proceed to "EVACUATING" in this subject.

To purge other areas of the system, disconnect the segment in question, connect the nitrogen hose to the downstream end (to flow the dry gas opposite to the direction of refrigerant flow), and perform those portions of steps 5, 6, and 7, as applicable. Then, connect the segment to provide a tightly sealed system.

Evacuating

Evacuating the air conditioning system creates a vacuum within the system in order to remove all traces of air and moisture, and to determine if refrigerant leaks are occurring. A vacuum must be held throughout the system in order to be able to charge the system with refrigerant.

1. With the system completely discharged and purged, connect the service gauges to the service valves on top of the refrigerant compressor, as shown in Fig. 11, then connect the manifold center service hose to the vacuum pump.

2. Start the vacuum pump, then open the manifold suction hand valve and the manifold discharge hand valve. See Fig. 11, Ref. A & B.

3. When the low side gauge reads 27-29 inHg (91-98 kPa) of vacuum and will go no lower, and the high side gauge reads slightly below the zero index of the gauge, let the pump operate another 10 minutes, then close (turn clockwise all the way in) the manifold suction hand valve and the manifold discharge hand valve, and shut off the vacuum pump.

4. If the low side gauge rises after 15 minutes and continues to rise, the system has a leak. A partial charge must be installed and the system must be leak checked. Refer to "LEAK TESTING" in this subject.

   If the low side gauge does not rise, there is no leak present; open (turn counterclockwise all

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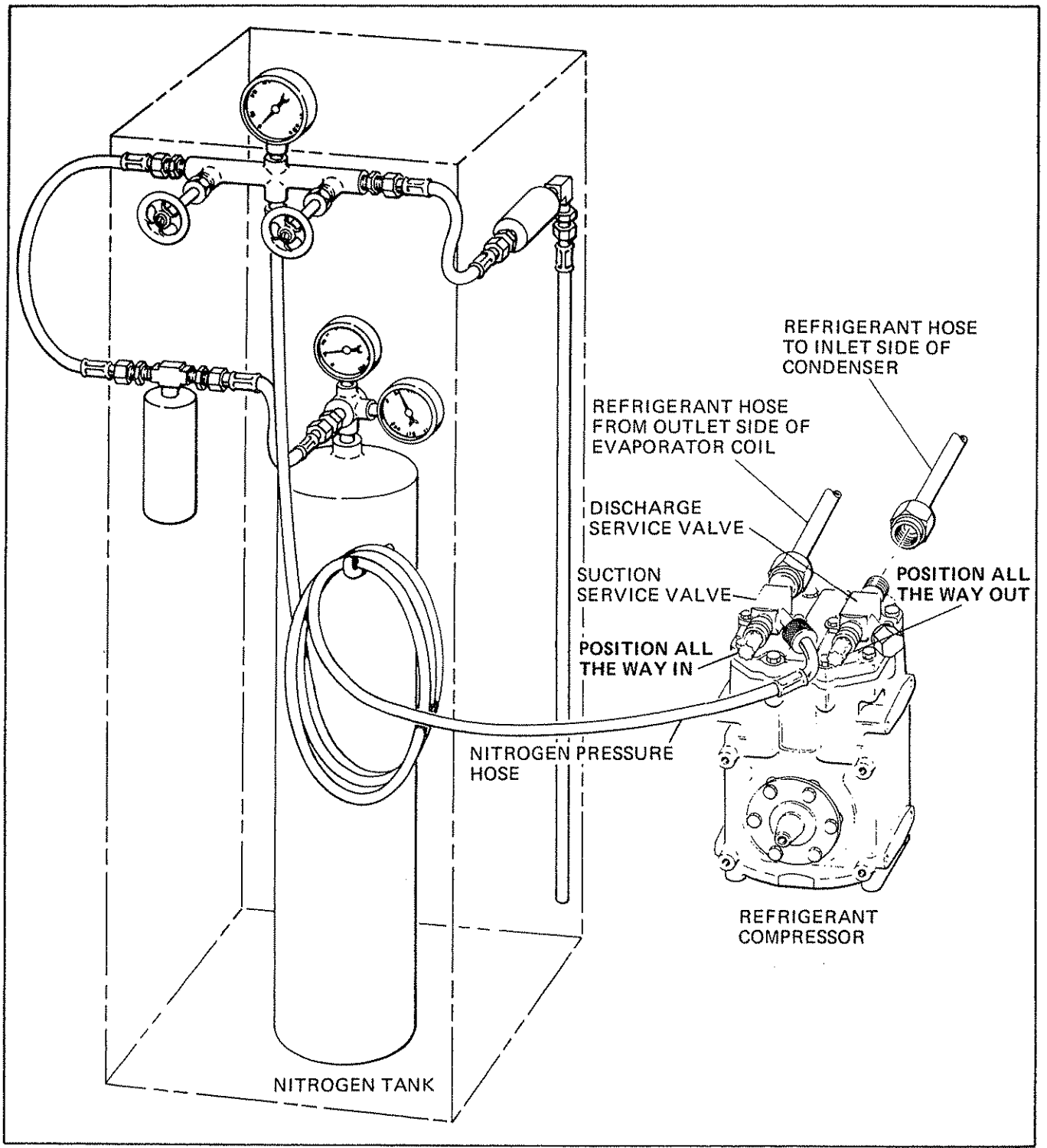


Fig. 13, Purging The Refrigerant Compressor Using Dry Nitrogen

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

the way out) the manifold suction and discharge hand valves, turn on the vacuum pump and let it run for at least one hour. After one hour or more of evacuation on the vacuum pump, close the manifold suction hand valve and the discharge hand valve, then shut off the vacuum pump. Negative pressure (vacuum) must be held in the system.

Charging

Charging the air conditioning system places a charge of refrigerant in the system.

With The System Evacuated And Using Liquid Refrigerant

CAUTION: Never charge liquid refrigerant into the system while the refrigerant compressor or engine is running. To do so could result in damage to the compressor.

1. With the system completely evacuated and no leaks present, connect the manifold center service hose to the refrigerant can. Position the refrigerant can as shown in Fig. 14.

2. Loosen the manifold center service hose connection at the manifold (Fig. 14, Ref. C) approximately 2 turns.

3. Open the valve on the refrigerant can and allow gas to escape at the loosened connection for about 5 seconds, then tighten the manifold center service hose connection.

NOTE: The amount of refrigerant required to charge a completely evacuated system is 42 fl. oz. (1242 ml) for vehicles without a sleeper box air conditioner unit. Vehicles equipped with a sleeper box air conditioner, the refrigerant capacity is 52 fl. oz. (1539 ml).

4. Open the manifold discharge hand valve (Fig. 14, Ref. B). Be sure the manifold suction hand valve (Fig. 14, Ref. A) remains closed.

5. Insure that the refrigerant compressor suction service valve is in the halfway in position. See Fig. 14, Ref. E.

6. Insure that the refrigerant compressor discharge service valve is in the halfway in position. See Fig. 14, Ref. D. If negative pressure has been contained in the system, the refrigerant will be pulled into the system.

7. After the refrigerant is pulled into the system, close the manifold discharge hand valve.

NOTE: To determine when the refrigerant can is empty, turn it right side up, then tap it on the bottom. A hollow ringing should be heard when empty.

Open the refrigerant compressor suction and discharge service valves all the way (counterclockwise). Start the engine and run at fast idle with the air conditioner and cab blower on their highest settings. Also, if applicable, activate the sleeper box air conditioner.

.1 Check the sight glass on the receiver-drier, as shown in Fig. 10. If there are no bubbles or foam visible in the sight glass, the system is completely charged. Disconnect the manifold suction and discharge service hoses from the refrigerant compressor valve ports; then install sealing caps.

.2 If there are bubbles or foam present in the sight glass, finish charging the system following the procedure under "(CHARGING) WITH THE SYSTEM PARTIALLY FILLED AND USING REFRIGERANT IN A GASEOUS STATE" in this subject.

With The System Partially Filled And Using Refrigerant In A Gaseous State

1. Connect the manifold suction and discharge service lines to the compressor service ports as shown in Fig. 15.

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

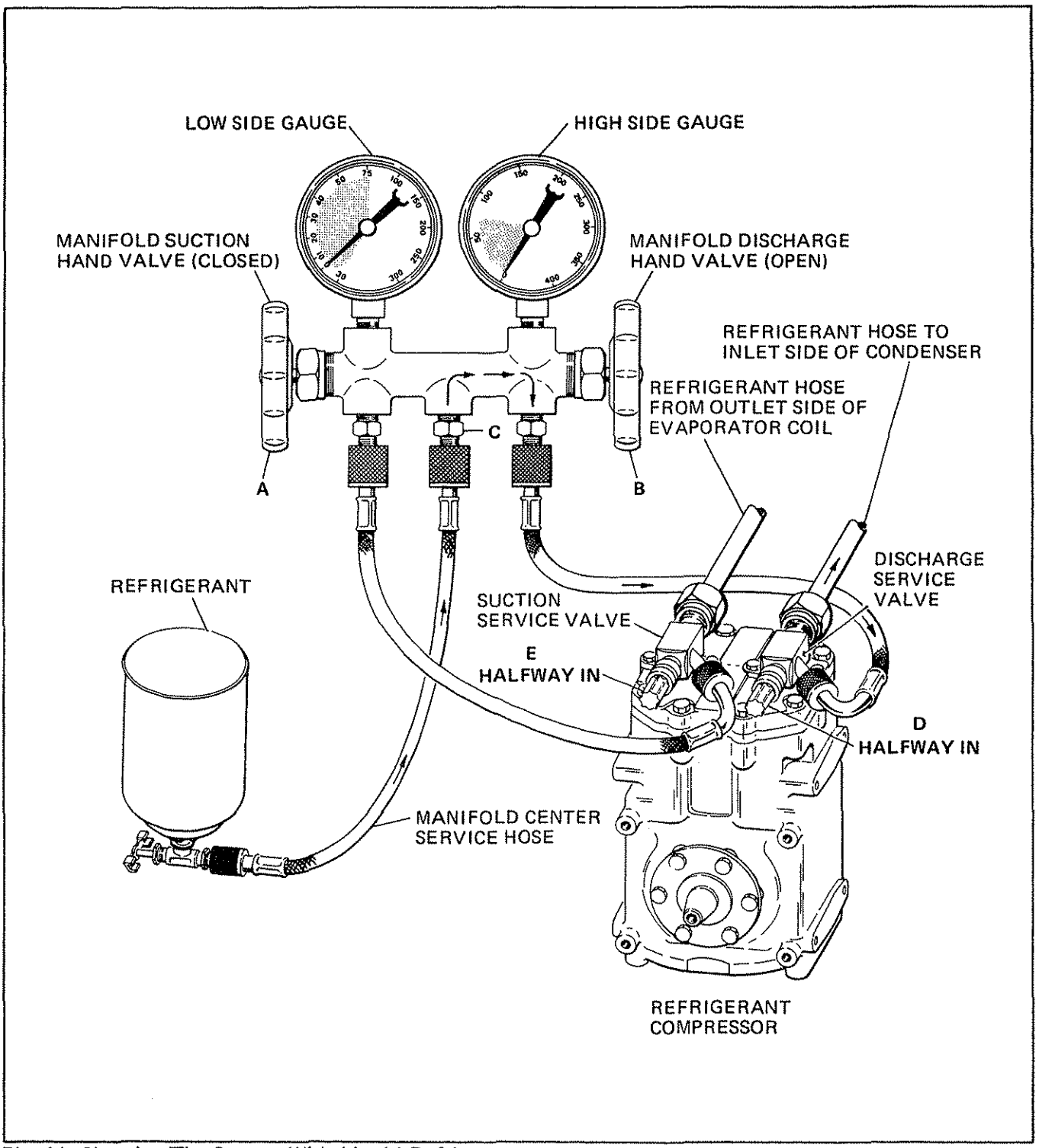


Fig. 14, Charging The System With Liquid Refrigerant

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

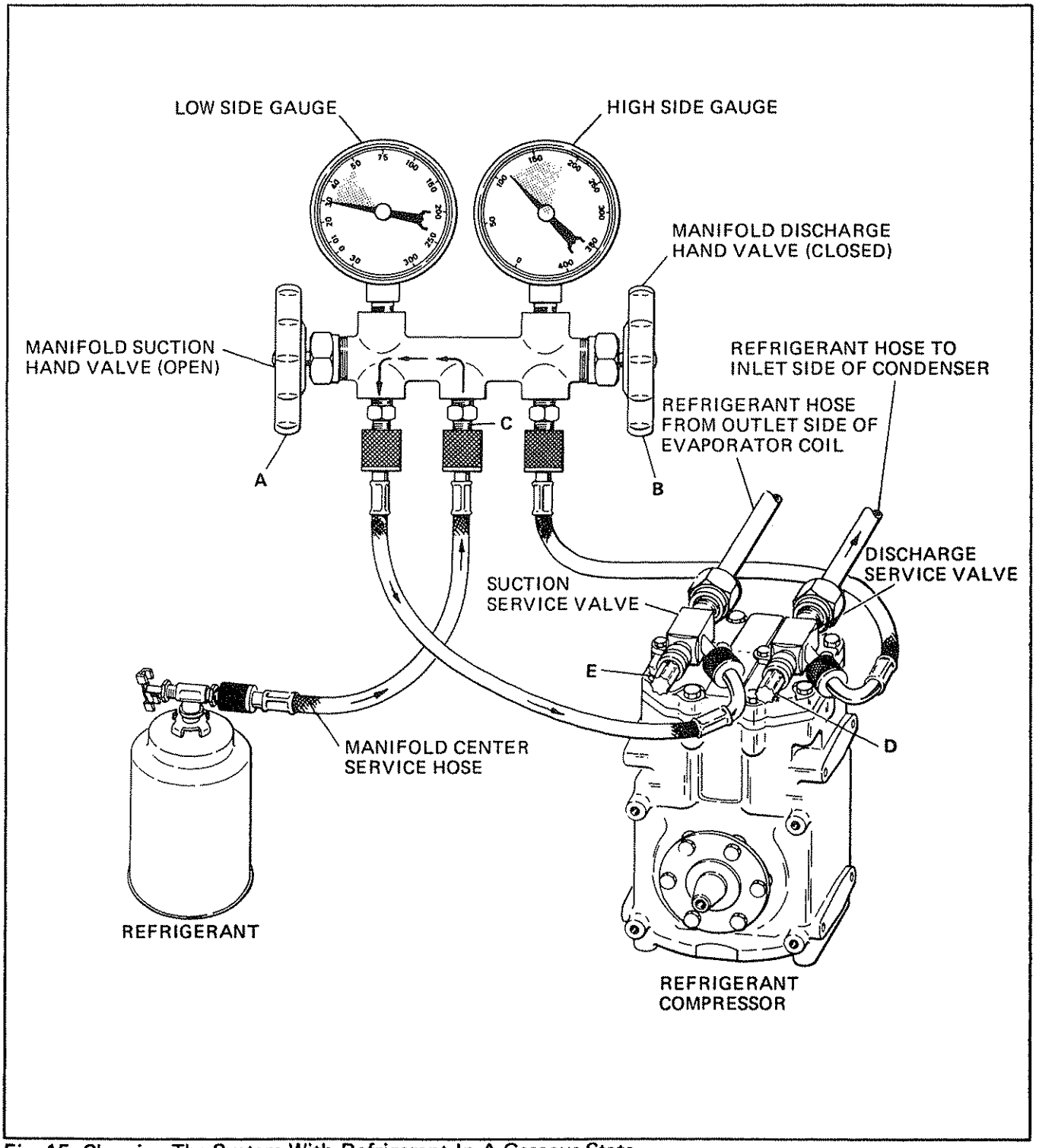


Fig. 15, Charging The System With Refrigerant In A Gaseous State

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

2. Position the refrigerant can as shown in Fig. 15, then connect the manifold center service hose to the refrigerant can.

3. Open the manifold suction hand valve (Fig. 15, Ref. A). Be sure the manifold discharge hand valve (Fig. 15, Ref. B) is closed.

4. Position the compressor suction service valve (Fig. 15, Ref. E) halfway in. Be sure the compressor discharge service valve (Fig. 15, Ref. D) is all the way out.

CAUTION: Be sure the refrigerant can is held upright at all times to prevent liquid refrigerant from entering the refrigerant compressor when the engine is running. Refrigerant in the compressor could result in damage to the unit.

5. Start the engine and run at fast idle with the air conditioner and blower at their highest settings. Also, if applicable, activate the sleeper box air conditioner. When the sight glass on the receiver-drier becomes completely free of bubbles or foam, close the valve on the refrigerant can, then close the manifold suction hand valve (Fig. 14, Ref. A).

6. Disconnect the manifold center service hose from the refrigerant can. Open the refrigerant compressor discharge and suction service valves (one turn clockwise from the all the way out position). See Fig. 15, Refs. D & E. With the air conditioner(s) and blower(s) at their highest settings and the system completely charged, be sure the operating pressures are within the values given in Table 3 located under "SPECIFICATIONS" in this subject. If the operating pressures are unacceptable, refer to the "TROUBLESHOOTING" section in this subject.

7. Turn the refrigerant compressor suction and discharge service valves (Fig. 15, Refs. D & E) all the way out (counterclockwise), then disconnect the manifold service valve hoses. Install sealing caps on the refrigerant compressor service valve ports.

Leak Testing

WARNING: If a halide (open flame) leak detector is to be used, the work area must have total ventilation. Combusted refrigerant gas creates poisonous phosgene gas which, if inhaled, causes severe respiratory irritation. Do not smoke or have any burning material in the area where leak detection is performed.

NOTE: A pressure reading of 50 psi (345 kPa) on the low-side gauge is necessary to detect leaks. If pressure is 50 psi (345 kPa) or greater, proceed to step 7. If pressure is lower than 50 psi (345 kPa), proceed as follows:

1. Connect the charging manifold suction service hose to the refrigerant compressor suction service valve, and the manifold discharge service hose to the refrigerant compressor discharge service valve. Be sure the manifold suction and discharge hand valves are closed.

2. Connect the manifold center service hose to the refrigerant can; the can should be in the upright position. Loosen the manifold center service hose connection at the manifold approximately 2 turns, then open the valve on the refrigerant can momentarily to force out any air that might be in the charging hose. After the air is removed, tighten the connection at the manifold and close the valve on the refrigerant can.

3. Open the refrigerant compressor service valves halfway.

4. Open the manifold suction and discharge hand valves.

5. Open the refrigerant can valve; the can should be in the upside down position. When approximately 8 to 16 fl. oz. (237-474 ml) of refrigerant has entered the system, close the refrigerant can valve.

6. Close the refrigerant compressor service valves and the manifold suction and discharge hand

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

valves, then disconnect the manifold service hoses.

7. Leak test the system using an electronic leak detector, or equivalent, using the procedures specified by the detection equipment manufacturer.

8. If a leak is detected at a connection, tighten the fitting(s) or replace worn or damaged seal(s). If a leak is detected in a component of the system, replace the damaged part, then test for leaks. Continue checking for leaks until they have all been eliminated.

9. After the leak is detected and eliminated, the system must again be completely discharged and purged of refrigerant and then evacuated. Follow the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

HEATER/HEATER-AIR CONDITIONER ASSEMBLY REMOVAL AND INSTALLATION

Removal

If the heater/heater-air conditioner assembly is to be removed for servicing or replacement, use the following procedure.

1. Remove the front cover assembly (Fig. 4) by removing the capscrews attaching the cover to the cab dash.

2. Drain the vehicle air system. Disconnect the air hose from the air actuator.

3. Disconnect the side bracket extension (Fig. 5) from the mounting bracket by removing the hex nuts, washers, and bolts. Remove the capscrews that attach the side bracket extension to the housing. Remove the side bracket extension.

4. Drain the heater core and the cooling system at the radiator drain cock. Save the coolant, if desired, for later use. After the coolant is drained, disconnect the heater core outlet and inlet hoses.

5. Discharge the air conditioner system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.

6. Disconnect the refrigerant hoses from the expansion valve and plug all hoses and expansion valve connections.

7. In order to reach some of the mounting brackets, the cab and defrost blower mount housing assemblies need to be removed. Use the following procedure:

   .1 Loosen the clamp attaching the air ducting hose to the blower housing, then disconnect the hose from the blower housing.

   .2 Mark the wires connected to the blower motor assembly for later assembly reference, then disconnect the wires.

   .3 Remove the blower mount housing assemblies from the heater/heater-air conditioner by removing the attaching capscrews.

8. Remove the front access panel from the housing by removing the front access panel capscrews.

9. Remove the thermostat sensing tube from the evaporator coil by pulling it straight out from the grommet and front access panel. Move the sensing tube out of the way.

10. Mark all wires connected to the heater/heater-air conditioner for later assembly reference. Disconnect the wires and hoses.

11. Support the heater/heater-air conditioner unit to prevent it from sliding while removing from

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

the mounting brackets. Disconnect the housing from the mounting brackets, then remove the heater/heater-air conditioner assembly.

CAUTION: When removing the heater-air conditioner assembly, use care not to damage the unit's drain tube (Fig. 6, Ref. 7), which protrudes through the cab floor.

Installation

1. Position the heater/heater-air conditioner to the cab floor and firewall, making sure the drain tube, if so equipped, protrudes through the cab floor.
2. Install the bolts, nuts, and washers that attach the heater/heater-air conditioner to the cab floor and mounting brackets, then tighten the nuts.
3. Install the thermostat sensing tube through the grommet on the front access panel, then through the evaporator coil fins until the sensing tube reaches the bottom of the evaporator coil.
4. Position the front access panel to the housing, then install and tighten the front access panel capscrews. Pull the sensing tube back out approximately 1 1/2 inches (38 mm) and bend it 90° at the grommet to prevent the sensing tube from slipping back into the evaporator coil.
5. Using the following procedure, install the cab and defrost blower mount housing assemblies to the heater/heater-air conditioner.
   .1 Position the blower mount housing assemblies to the heater/heater-air conditioner. Install and tighten the attaching capscrews.
   .2 Connect the wires as previously marked or as shown in Fig. 16 located under "SPECIFICATIONS."
   .3 Connect the flex hose to the blower motor mount, then attach by tightening the flex hose clamp.
6. Connect the heater hoses to the heater core, and close the radiator drain cock.
7. Remove the plugs, apply refrigerant oil to the hose connections, then connect the refrigerant hoses to the expansion valve. Tighten the connection to the torque values given in Table 2 located under "SPECIFICATIONS" in this subject. Use two wrenches when tightening fittings, to prevent twisting of the tubing.
8. Fill the cooling system with coolant. Make sure all leaks have been eliminated prior to driving the vehicle. Then, follow the instructions given under "BLEEDING AIR FROM THE HEATER CORE" in this subject.
9. Purge, evacuate, charge, and leak test the system using the procedures given under "DISCHARGING, PURGING, EVACUATING, CHARGING, AND LEAK TESTING" in this subject.
10. Attach the side bracket extension (Fig. 5) to the mounting bracket and the heater/heater-air conditioner housing, with the bolts, washers, and nuts. Tighten the nuts.
11. Position the front cover assembly (Fig. 4) against the cab dash, then install and tighten the capscrews.

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Little Or No Air Flow	Blower not operating.	Check for open circuit breaker. An open circuit breaker indicates a short in the electrical system which must be located and repaired.
		Insure that the fan speed switch is operative; replace, if needed. Refer to "HEATER/HEATER-AIR CONDITIONER CONTROL PANEL LIGHT(S) OR SWITCH(ES) REPLACEMENT" for instructions.
		Check blower motor. If inoperative, replace. Refer to "DEFROST OR CAB BLOWER MOTOR REPLACEMENT" for instructions.
		Check resistor blocks (Fig. 6). If inoperative, replace.
		Check wiring on blower motor. Refer to wiring diagram (Fig. 16) located under "SPECIFICATIONS." Make sure wiring conforms with diagram.
	Blower wheel installed backwards.	Install blower wheel as shown in Fig. 6.
	Restricted or leaking air ducts.	Examine all air ducts and remove any blockages. Repair leak(s) or replace any portion where the leak(s) cannot be repaired.
	Ice blocking evaporator coil.	Adjust the thermostat to the OFF or lowest position for 2 or 3 minutes, then resume cooling at a higher fan speed than before frosting occurred.

(Continued on next page)

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
PROBLEMS INVOLVING INADEQUATE COOLING		
Foaming In Sight Glass	System low in refrigerant.	Add refrigerant. Refer to "CHARGING."
	Leaks in system; receiver-drier inoperative.	Follow leak testing procedure. If no leaks are found, replace the receiver-drier. Refer to "RECEIVER-DRIER REPLACEMENT" for instructions.
	Restrictions in line between condenser and sight glass.	Remove restriction for line.
Low Evaporator Coil Outlet Pressure	Inoperative thermostatic expansion valve.	Replace thermostatic expansion valve. Refer to "THERMOSTATIC EXPANSION VALVE REPLACEMENT" for instructions.
	Restriction(s) in liquid line to thermostatic expansion valve.	Remove line restriction(s).
High Compressor Discharge Pressure	Shutter not opening.	Replace shutter solenoid valve.
	Condenser air flow restricted.	Remove restriction of air flow through condenser.
	Refrigerant restriction in condenser. Return tube bends should be the same temperature as each other.	Replace condenser. Refer to "CONDENSER REPLACEMENT" for instructions.
	Air in system.	Repair leaks in system. Refer to "LEAK TESTING."
Evaporator Outlet Air Temperature Drops As Compressor Discharge Pressure Drops	Leaks in system.	Repair leaks. Refer to "LEAK TESTING."

(Continued on next page)

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
PROBLEMS INVOLVING INADEQUATE COOLING (Continued)		
Evaporator Outlet Air Temperature Increases As Compressor Discharge Pressure Drops	Thermostatic expansion valve setting is low.	Replace thermostatic expansion valve. Refer to "THERMOSTATIC EXPANSION VALVE REPLACEMENT" for instructions.
	Excessive oil in system. An indication of this is clutch slippage or belt slippage at governed engine speed.	Set controls at high blower and maximum cold, operate engine at idle for 10 minutes. Discharge and purge the system and drain excess oil from refrigerant compressor. Evacuate, charge, and leak test system.
	Excessive oil in thermostatic expansion valve.	Remove thermostatic expansion valve. Refer to "THERMOSTATIC EXPANSION VALVE REPLACEMENT" for instructions. Drain oil from the thermostatic expansion valve and flush the remaining components with R-11 Flushing Fluid or equivalent (in accordance with the procedures specified by the flushing fluid manufacturer), to remove any remaining oil. Fill refrigerant compressor with new oil. Refer to the 01 Group of this manual for instructions. Evacuate, charge, and leak test system.
Temperature In Cab Too High With Normal Evaporator And Discharge Pressure	Heater water shutoff valve open.	Close heater water shutoff valve.
	Air door not in "REC" position. See Fig. 1.	Make sure the door works freely and has full movement.

(Continued on next page)

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
PROBLEMS INVOLVING INADEQUATE HEATING		
Temperature In Cab Too Low Or No Heat	Heater water shutoff valve not opened.	Open heater water shutoff valve.
	Inoperative heater water shut-off valve.	Replace water shutoff valve. Refer to "WATER SHUTOFF VALVE REPLACEMENT" for instructions.
	Air door not in "FRESH" position. See Fig. 1.	Close air door. Make sure the door works freely and has full movement.
	Heater hose pinched or twisted.	Repair or replace heater hose.
	Water leakage in the system.	Repair the leak(s) or replace any portion where the leak(s) cannot be repaired.
	Heater core plugged with lint or dust.	Remove heater core to clean. Refer to "HEATER CORE RE-PLACEMENT" for instructions.

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

SPECIFICATIONS

Tighten Nut Finger-Tight; Then With Wrench, Tighten Further As Follows:				
FITTING SIZE	TUBE O.D.	TURNS REQUIRED TO SEAL FROM FINGER-TIGHT		
		COMPRESSION	THREADED SLEEVE	SAE 45° FLARE
2	1/8"	1 1/4	1 1/2	1/6 DO NOT OVERTORQUE
3	3/16"			
4	1/4"			
5	5/16"	1 3/4		
6	3/8"	2 1/4		
8	1/2"			
10	5/8"			
12	3/4"			
16	1"			
20	1 1/4"			

Table 1, Air Tubing Fitting Torque Specifications

OUTSIDE DIAMETER OF METAL TUBE IN INCHES	*TORQUE FOR STEEL TUBES		*TORQUE FOR ALUMINUM OR COPPER TUBES	
	FT-LBS	N·m	FT-LBS	N·m
1/4"	10-15	14-20	5-7	7-9
3/8"	30-35	41-47	11-13	15-18
1/2"	30-35	41-47	15-20	20-27
5/8"	30-35	41-47	21-27	28-37
3/4"	30-35	41-47	28-33	38-45
*When tightening fittings always use the torque reading for the softer metal when unlike metals are used.				

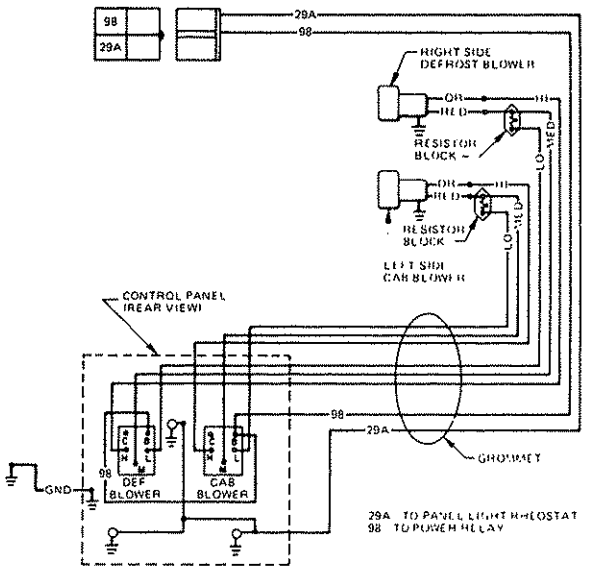
Table 2, Refrigerant Line Torque Specifications

TEMPERATURE	SYSTEM PRESSURE			
	LOW SIDE		HIGH SIDE	
	PSI	kPa	PSI	kPa
Cool Day 70°F (21°C) to 80°F (27°C)	20-25	138-172	160-180	1102-1240
Warm Day 80°F (27°C) to 90°F (32°C)	25-30	172-207	180-200	1240-1378
Hot Day 90°F (32°C) +	30-35	207-241	200-220	1378-1516

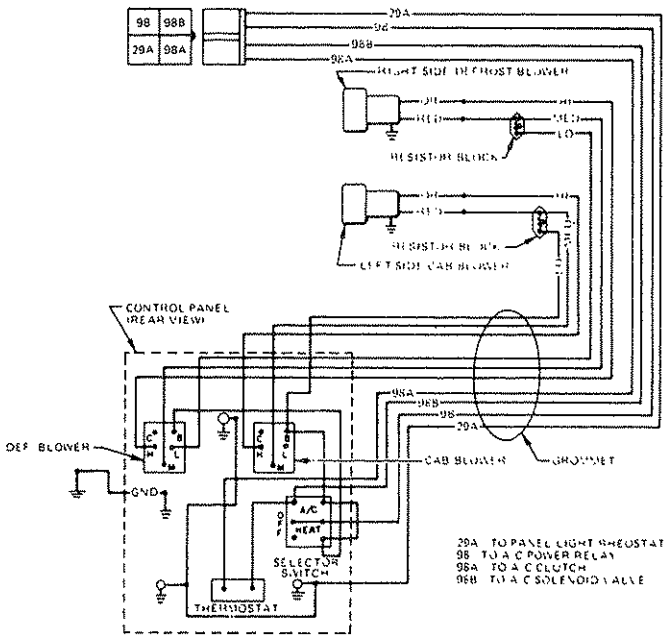
Table 3, Temperature/Pressure Specifications

FREIGHTLINER CONVENTIONAL CAB UNDERDASH (RED DOT) HEATER/HEATER-AIR CONDITIONER

SPECIFICATIONS (Continued)



HEATER-ONLY WIRING DIAGRAM



HEATER-AIR CONDITIONER WIRING DIAGRAM

Fig. 16, Heater/Heater-Air Conditioner Wiring Diagrams

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

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FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

GENERAL INFORMATION

The Freightliner heater-air conditioner is combined into one unit and includes the heater core and evaporator coil, blowers, control valves, and fresh air/recirculated air inlets. The unit is mounted under the glove compartment. Refer to Fig. 1.

By modulating the coolant flow through the heater core, and by controlling the airflow through the heater core and evaporator coil, an even cab temperature is maintained. Air conditioning temperature is moderated by opening a water regulating valve and heating the air. Fresh or recirculated air is selected at the recirc/fresh air toggle switch, or if not equipped with a toggle switch, at the lever slide controls. Refer to the Freightliner *Driver's Manual* for heater-air conditioner operating instructions.

The front ducting system allows for single lever control over all of the air outlets. In COEs, it also allows for blending between heat and defrost outlets, and heat and air conditioning outlets. The front ducting system in COEs consists of the front duct assembly, several outlet transition ducts, a tunnel top and crossover duct, and two down ducts. The down ducts are in the lower rear inboard area of each seat assembly. Refer to Fig. 2, which shows the ducting system in COEs, and the outlets it serves.

Conventionals are equipped with a ducting system similar to that in COEs. The system differs from the COE in that the front duct model is narrower. Also, the outboard blower feeds only the sleeper and the deck ducts. (Both blowers feed the cab, the bunk, and the down ducts in COEs.) Airflow to the sleeper and deck ducts

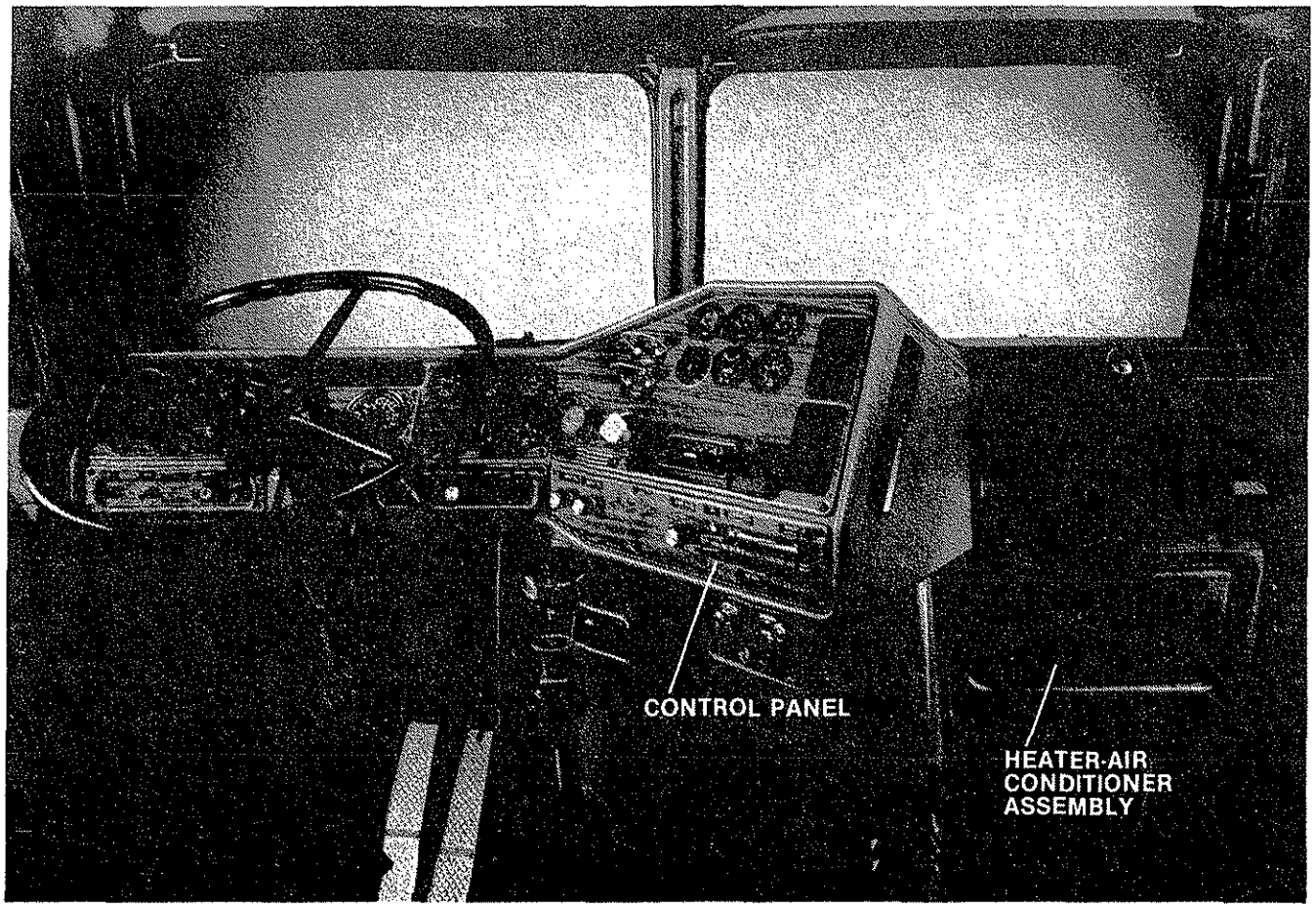

Fig. 1

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

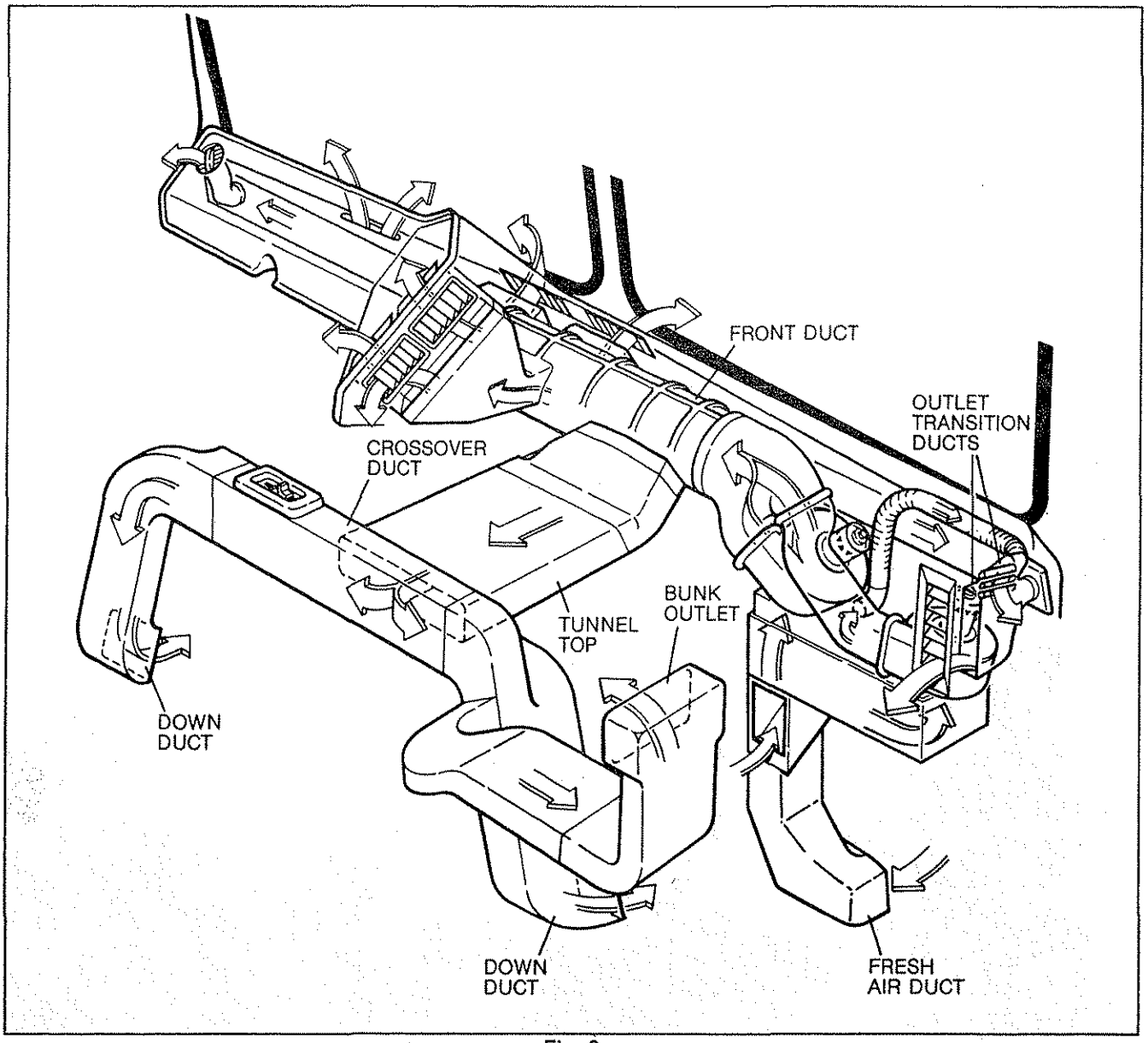

Fig. 2

is fed through a tunnel along the cab deck. Fig. 3 shows the ducting system in a Conventional equipped with a sleeper.

The COE bunk air outlet has a set of adjustable louvers on the right-hand wall. Controls for the bunk/down ducts (Fig. 4) are in the crossover duct on the tunnel top. The Conventional sleeper's standard control panel is next to the louvers near the right-hand wall. See Fig. 5.

HEATER-AIR CONDITIONER MAJOR COMPONENTS

Refrigerant (R-12)

Refrigerant is a substance that absorbs heat from the air in the cab and releases it to the air outside the cab. In the air conditioner system, ARI designation refrigerant-12 (R-12) is used. R-12 is an odorless, colorless, chemically altered by-product of carbon tetrachloride, which is used in fire extinguishers and as

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

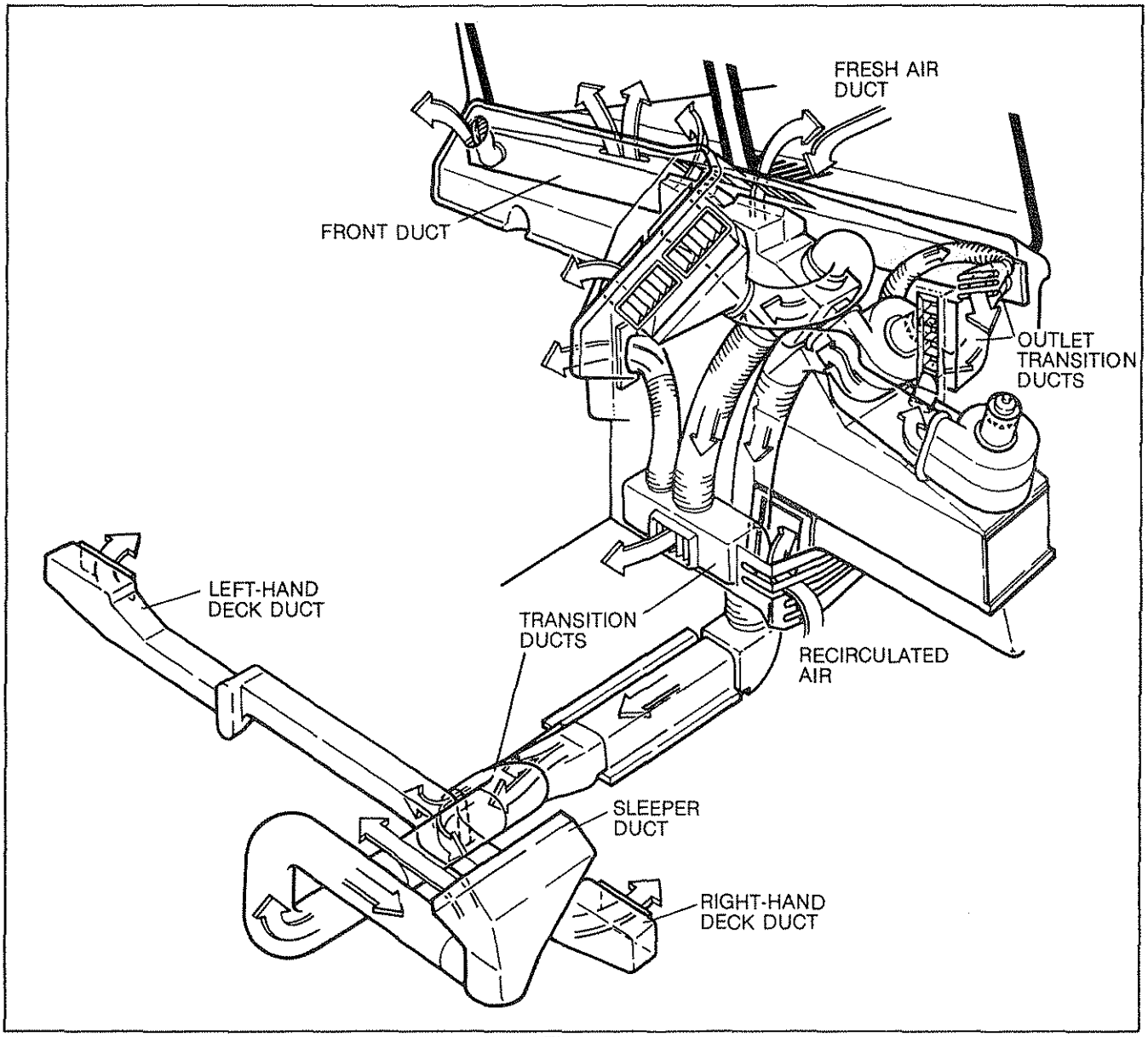

Fig. 3

a dry-cleaning agent. The chemical name of R-12 is dichlorodifluoromethane; brand names include Freon® 12, Genetron® 12, and Isotron® 12.

In an open container, R-12 boils at minus 21.6°F (minus 30°C); sealing and pressurizing R-12 in the air conditioning system raises its boiling-point temperature.

During compressor operation, R-12 constantly changes from a gas to a liquid, depending on whether it is absorbing heat (boiling) in the low-pressure evaporator coils, or releasing absorbed heat in the high-pressure condenser.

Refrigerant Compressor

"Heat" in the low-pressure gas of the evaporator coils is not heat that can be noticed by touch, because liquid R-12 boils at a temperature much lower than the temperature at which water turns to ice. By touch, the "heated" gas in the coils is very cold. As a result, there

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

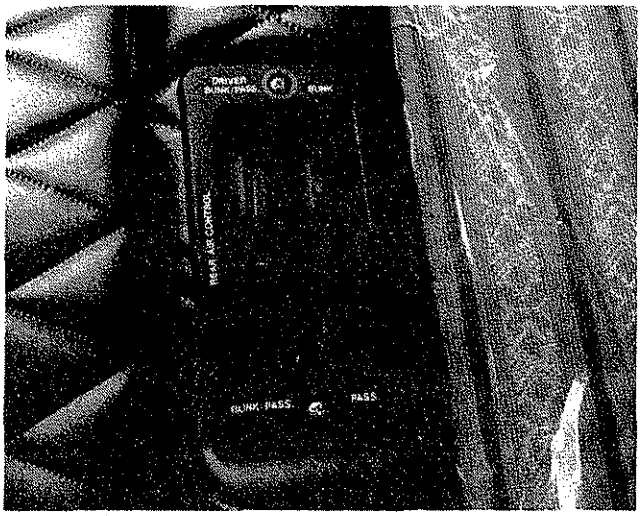

Fig. 4, COE Bunk/Down Duct Controls

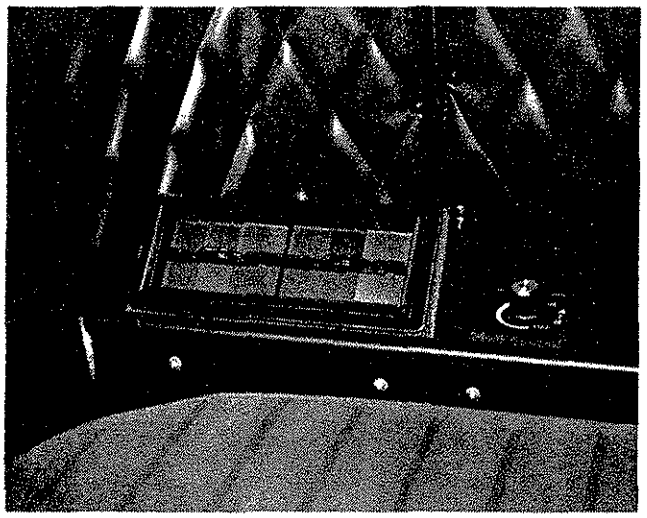

Fig. 5, Conventional Sleeper Louvers and Control Panel

is the problem of how to remove heat from subfreezing gas using outside air that may be higher than 100°F (38°C).

With a refrigerant compressor (Fig. 6), low-pressure gas from the evaporator can be squeezed into a much smaller space. When the gas is compressed, the heat it contains becomes concentrated. In this way, the gas is made hotter than the outside air, without adding heat.

A secondary purpose of the compressor is to move R-12 through the system.

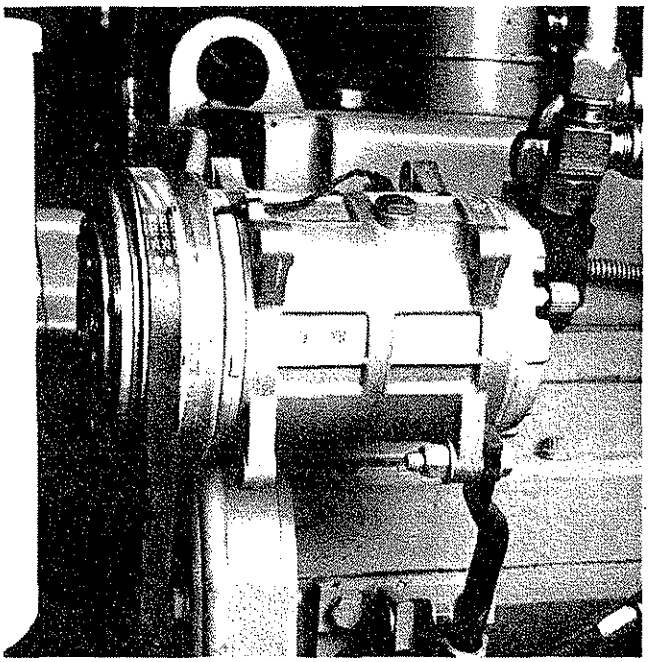

Fig. 6

Thermostatic Switch

A thermostatic switch engages and disengages the R-12 compressor. Refer to Fig. 7, Ref. 9. From the themostatic switch, a sensing tube extends to the evaporator coil where it monitors the temperature by the coil tubes. As air passes through the evaporator coil, water vapor can condense and freeze on the coil, blocking airflow. If this happens, the thermostatic switch disengages the refrigerant compressor clutch until all ice has melted.

Condenser

A condenser (Fig. 8) turns hot R-12 gas, coming from the compressor, into liquid. Mounted in front of the radiator, it is made up of a coiled tube and a series of fins. Because of its location, the condenser transfers heat to air that is drawn in by the engine fan and by air that is forced into the engine compartment as the vehicle moves forward (ram air).

Receiver-Drier

Used as a reservoir and filter for liquid R-12 from the condenser, a receiver-drier (Fig. 9) also removes water and acids from the R-12. The water-absorbing material (desiccant) in the unit helps stop blockages from forming in the expansion valves and in other parts of the

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

1. Slotted Screw
2. Main Access Cover
3. Access Cover Gasket
4. Evaporator Coil
5. Heater Core
6. Drain Tube
7. Air Actuator Assembly (see note)
8. Sensing Tube
9. Thermostatic Switch
10. Blower Wheel
11. Nuts
12. Machine Screw and Washer
13. Blower Housing
14. Motor Mount
15. Blower Motor
16. Blower Motor Assembly
17. Top Main Housing
18. Bottom Main Housing
19. Heater Hose and Clamps
20. Water Regulating Valve
21. Thermostatic Expansion Valve
22. Resistors

NOTE: Some fasteners intentionally omitted for clarity. The air actuator assembly (Ref. 7) on your vehicle may be different from the one shown here.

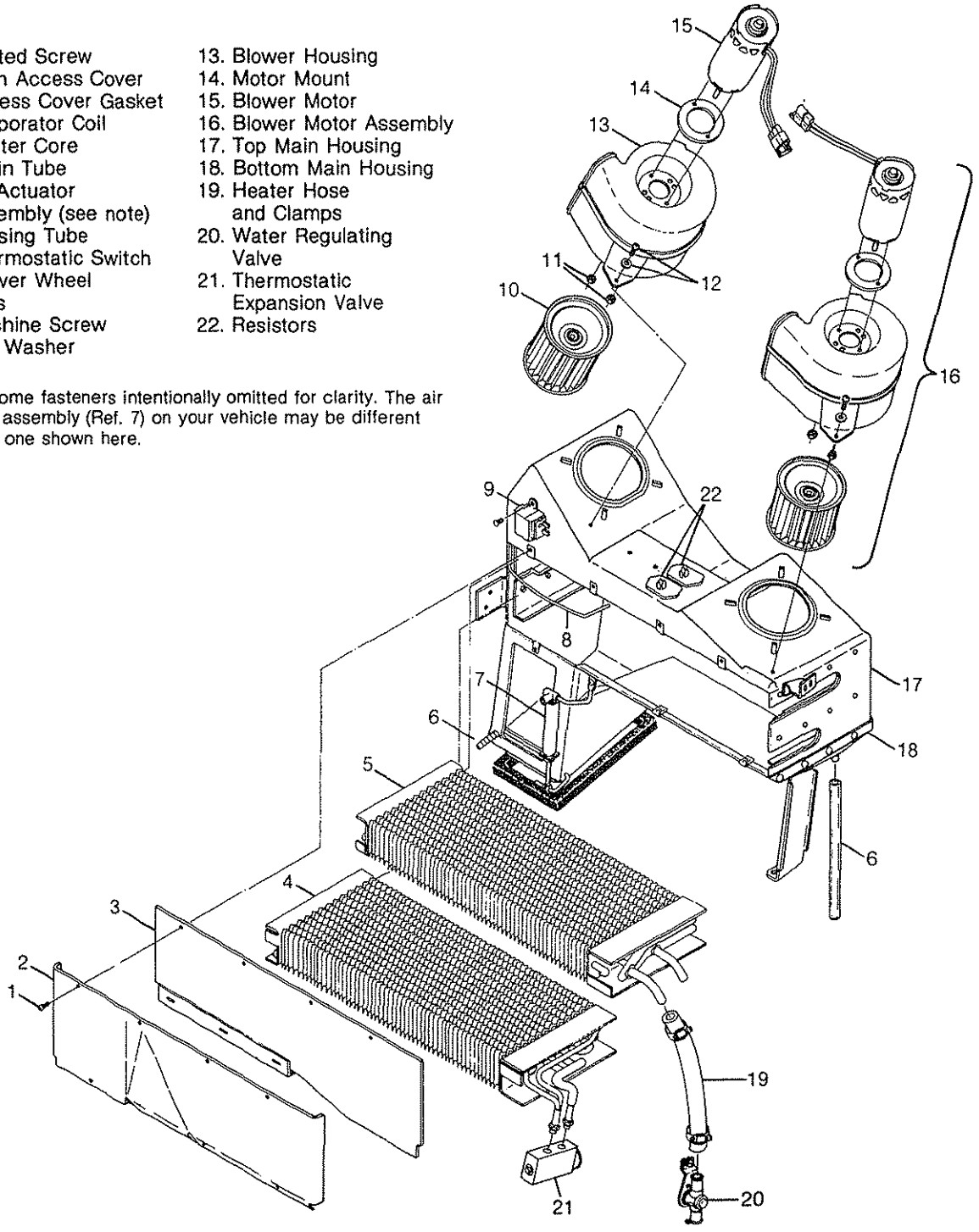

Fig. 7

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

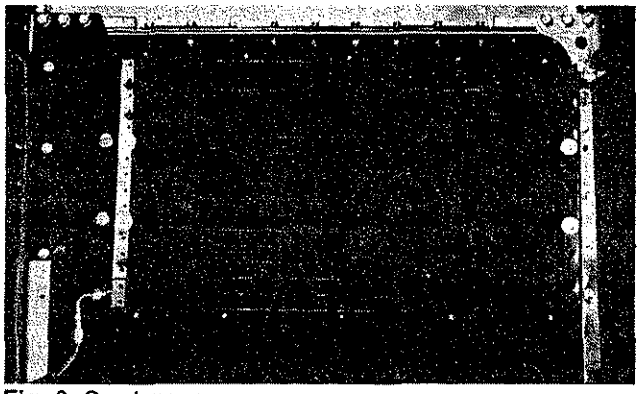

Fig. 8, Condenser

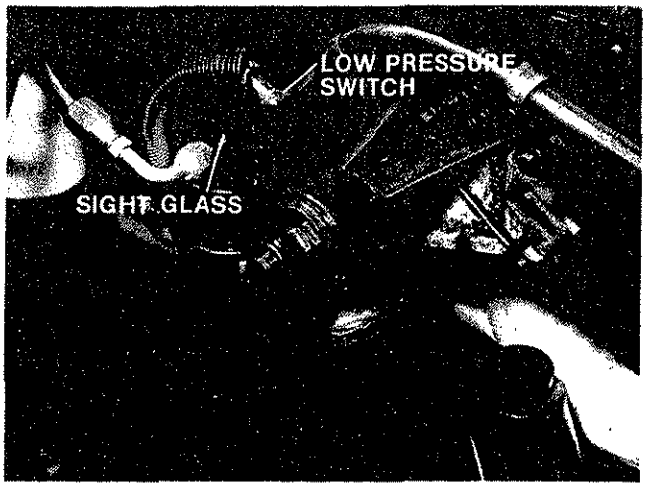

Fig. 9, Receiver-Drier/Sight Glass

system. A sight glass is installed in the receiver-drier line through which the R-12 flows. The sight glass is used to see if the system is fully charged.

Moisture Indicator

Some receiver-driers are equipped with a moisture indicator. A moisture indicator shows the degree of water in the R-12 system. A sight glass (aperture) on the unit contains a specially treated element (litmus paper) that changes color, depending on the water content of the R-12. The indicator changes from a deep cobalt blue (dry) to light greyish blue (wet) to lilac, lavender, and finally pink or white (very wet). Any color other than cobalt blue is considered wet. After a contaminated charge is removed and the system is evacuated (dehydrated), the element in the moisture indicator changes back to cobalt blue. The moisture indicator should always be checked while the system is at operating temperature.

Low-Pressure Switch

A low-pressure switch disengages the compressor when falling pressure goes below 28 ± 3 psig (193 ± 21 kPa); normal compressor operation resumes when rising pressure goes above about 40 psig (276 kPa). Low pressure in the system occurs when there is a loss of R-12 or when the ambient temperature is too low to cause enough evaporation of R-12 in the evaporator coil.

A low-pressure switch attaches directly to the receiver-drier (Fig. 9) and is installed only on vehicles that have a viscous radiator fan clutch.

Trinary Switch

A trinary switch disengages the refrigerant compressor to protect it from harmful operating conditions; it is installed only on vehicles that have an on-off radiator fan clutch, and performs three functions:

1. If R-12 is lost or the outside temperature is too low, the trinary switch will keep the compressor from operating. The switch disengages the compressor when falling pressure goes below 15 to 30 psig (103 to 207 kPa); normal compressor operation resumes when rising pressure reaches a maximum 40 psig (276 kPa).
2. If the compressor cylinder head pressure increases to unsafe levels, above 300 psig (2067 kPa), the trinary switch shuts off the compressor. Too much pressure may be caused by blocked air flow through the condenser, a plugged expansion valve or receiver-drier, or too much R-12 in the system. When pressure falls back 80 to 120 psig (551 to 827 kPa) from shut-off pressure, the compressor resumes operation.
3. If the compressor cylinder head pressure goes above about 200 psig (1378 kPa), the trinary switch turns on the radiator fan to draw in air across the condenser. This might occur when the air conditioner is turned on before the engine has warmed up. When pressure falls back 35 to 60 psig (241 to 413 kPa), normal fan operation resumes.

Refer to Group 05 for detailed trinary switch service information and wiring diagrams.

Expansion Valve

An expansion valve is a dividing point between the high- and low-pressure parts of the refrigerant system. High-pressure liquid R-12 from the receiver-drier passes through the expansion valve and moves into the low-pressure area of the evaporator coil.

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An expansion valve controls the flow rate of R-12 in proportion to the rate of evaporation in the evaporator. If the amount of liquid in the evaporator drops off, the temperature of the gas going to the compressor rises. This causes a diaphragm in the expansion valve to react to opposing pressures on both of its sides, which causes an orifice in the valve to open or close. Refer to Fig. 10. Through the orifice, liquid R-12 is metered into the evaporator, as needed.

Evaporator Coil

Because the evaporator coil (Fig. 7, Ref. 4) is an area of low pressure in the system, the boiling point of R-12 lowers, which causes it to absorb heat from the tubing walls and fins of the coils. As it absorbs heat, liquid R-12 quickly boils and turns into a gas.

As heat is absorbed from the outside surfaces of the evaporator coil, air passing over the unit loses its heat to these cooler surfaces. Moisture in the air condenses on the outside of the coil and drains off as water (the air becomes dehumidified).

Water Regulating Valve

When opened, the water regulating valve (Fig. 7, Ref. 20) allows engine-heated coolant to flow through the heater core.

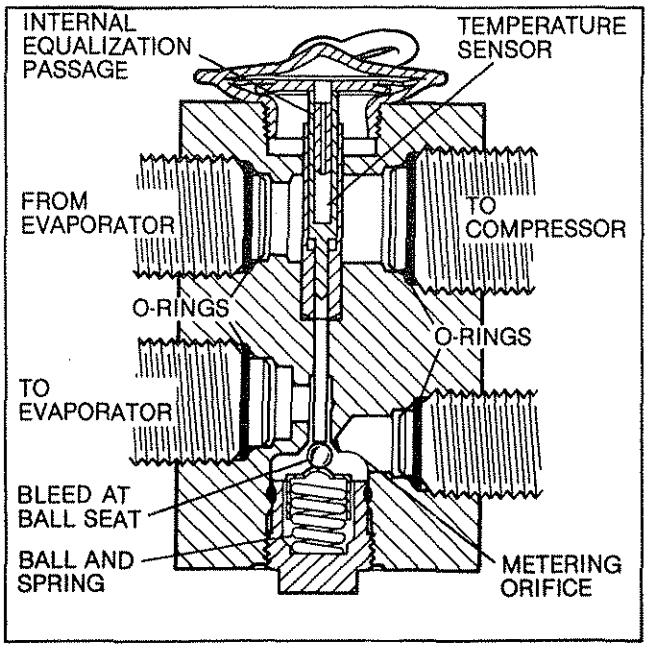

Fig. 10

Heater Core

The heater core (Fig. 7, Ref. 5) is a series of fins through which tubing is routed. When the heating system is on, engine-heated coolant flows through the heater core tubes; both the tubes and the fins are heated. The heat is absorbed by air that is drawn through the heater core by the blowers.

Air Blowers

Two air blowers (Fig. 7, Ref. 16) circulate air over the heater core and the evaporator coil, and propel the heat absorbed/reduced air into the cab.

Resistor Blocks

The air conditioner system has two blower motor resistors, each regulating the speed of one blower motor. Both resistors are mounted on the air conditioner's top main housing between the motors. Refer to Fig. 7, Ref. 22.

The current resistor model (Fig. 11) is equipped with a thermal cutout. If the resistor's temperature were to rise above 257°F (125°C), the blower motor circuit would open and remain open until the resistor is replaced.

The previous resistor model (Fig. 11), which was not equipped with a thermal cutout, is not available for parts replacement: vehicles needing replacement parts must be retrofitted with a thermal cutout resistor. Refer to service operations for instructions.

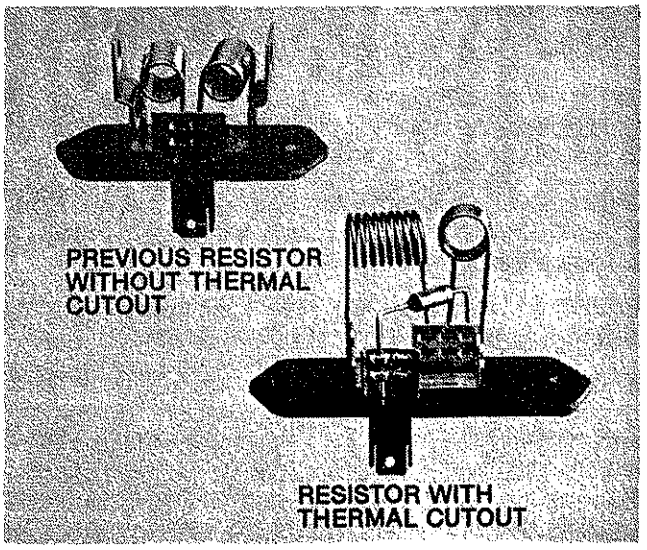

Fig. 11

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

Definition of Terms

Air Conditioner A device used to control the temperature, humidity, cleanness, and movement of air.

Air Cylinder An air-operated device used to open or close a vent through which fresh air is drawn into the cab by the blower.

Air Pressure The pressure exerted in every direction at any given point. Normal atmospheric pressure (that is, the pressure caused by the weight of the atmosphere) at sea level is 14.696 psia (101.60 kPa).

Ambient Air Temperature The temperature of air around an object; the outside temperature.

Blower A motor and fan used to draw air through the evaporators, and force it through the heater core and into the cab.

Blower Resistor Block Each blower motor has a resistor that controls the amount of voltage going to it. By controlling the voltage, you can control the fan speed.

Boiling Point The temperature at which a liquid changes to a gas, at a certain pressure.

Bulk Charging Use of large containers of R-12 for charging a refrigerant system. Normally used for charging empty systems.

Carbon Dioxide A colorless, odorless, dry, inert gas that can be used to purge light contaminants (for example, dust) from air conditioner parts.

CFM Cubic feet per minute.

Charge A specific amount of R-12 or oil by volume or weight. Also, the act of placing an amount of R-12 or oil in the air conditioning system.

Clutch Cycling Switch Engages or disengages the compressor depending on changes in system pressure or evaporator temperature.

Cold The absence of heat. (The lowest possible temperature is thought to be 459°F below zero.)

Compressor A unit used to draw low-pressure R-12 gas from the evaporator and squeeze it into a high-temperature, high-pressure gas. This causes the R-12 to have a higher temperature than the surrounding air, allowing the condenser to change the gas back into a liquid. A secondary purpose of the compressor is to move R-12 through the system.

Condensate Water, taken from the air, which forms on the outer surface of the evaporator.

Condenser A heat exchanger that is used to remove heat from R-12, changing it from a high-pressure hot gas to a high-pressure warm liquid.

Condensing Pressure Pressure, as read from the gauge at the discharge service valve; pressure from the discharge side of the compressor into the condenser.

Contaminants Anything other than R-12 or refrigerant oil in the system. Usually means water in the system: when water and R-12 mix, corrosive hydrochloric acid forms.

Cycling Clutch System A system which controls compressor clutch operation in order to raise or lower the temperature in the cab.

Dehumidify To remove water from the air, at the evaporator coil.

Dehydrate To remove all traces of wet air from the refrigerant system. Normally called evacuation.

Desiccant A drying agent used in the refrigerant system (in the receiver-drier) to remove water and create an extremely dry condition.

Dichlorodifluoromethane The chemical name of R-12.

Discharge To bleed some or all of the R-12 from a system by opening a valve or hose connection and letting R-12 escape slowly.

Discharge Line Connects the refrigerant compressor outlet to the condenser inlet.

Discharge Pressure Pressure of the R-12 being discharged from the compressor; high-side pressure.

Discharge Service Valve A device that is attached to the discharge side of the compressor; it allows high-side pressure to be checked and other service operations to be performed.

Drive Pulley A V-pulley attached to the front of the engine crankshaft. It drives the compressor clutch pulley with a belt.

Drying Agent See "Desiccant."

Duct A passageway for the transfer of air from one point to another.

FREIGHTLINER HEATER-AIR CONDITIONER ADVANCED INTERIOR SYSTEM

Evacuate Evacuation places a high vacuum in the refrigeration system and dehydrates or removes all traces of wet air.

Evaporate A change of state from a liquid to a gas.

Evaporator Coil A component in which liquid R-12 changes to a gas after it absorbs heat from the air. Also removes some water from the air.

Expansion Valve A device that causes a pressure-drop of the R-12 and also regulates its flow.

Flooding A condition caused by too much liquid R-12 going into the evaporator; usually caused by an expansion valve that is stuck open.

Flushing A process of placing liquid R-11 in a refrigerant part to flow out dirt and water from the part. R-11 removes heavy contamination, such as gritty dirt and large dirt build-up, which cannot be removed by purging with a gas.

Foaming Bubbles of oil and R-12 caused by a rapid boiling out of R-12 dissolved in the oil when the pressure is suddenly reduced. Foam in the sight glass means a very low R-12 charge.

Freeze-Up Failure of a unit to operate properly because of ice forming at the expansion valve orifice or on the evaporator coils and fins.

Head Pressure R-12 pressure from the discharge side of the refrigerant compressor to the condenser and expansion valves.

Heater Core A part of the heating system in which hot engine coolant flows to provide heat to the cab or to adjust the temperature produced by the air conditioner.

Humidity The amount of water vapor in the air.

Hydraulic Lock The return of liquid R-12 to the compressor, which could destroy the unit.

Hydrochloric Acid A highly caustic substance that forms when water and R-12 mix in a refrigerant system.

Leak Detector Any device used to detect R-12 leaks in a refrigerant system.

Low Head Pressure High-side pressure that is lower than normal due to a system problem.

Low-Pressure Switch Disengages the compressor clutch when the system pressure drops below a preset level. Used only on vehicles equipped with air conditioning and a viscous fan drive.

Low Suction Pressure Low-side pressure that is lower than normal due to a system problem.

Magnetic Clutch An electrical coupling device used to engage or disengage the compressor.

Manifold Designed to control R-12 flow for system test purposes; used with manifold gauges.

Manifold Gauge A calibrated instrument used for measuring system pressures.

Manifold Gauge Set A manifold that is complete with gauges and charging hoses and is used to measure or test pressure.

Micron A metric measurement of mercury; one-tenth of an inch of mercury equals 2540 microns. Measurement in microns is the only accurate way to determine the amount of pressure that is left in a refrigerant system by a high vacuum pump.

Moisture Indicator A gauge that is connected to the R-12 liquid line; shows how much water is in the system.

Nitrogen A colorless, odorless, dry, inert gas that can be used to purge light contaminants (for example, dust) from air conditioner parts.

Opacity A condition that is used to describe contamination of refrigerant oil in the compressor. Fresh refrigerant oil is clear; when contaminated, it appears cloudy or may have fine particles held in suspension.

Overcharge Too much R-12 or oil in the system.

Phosgene Fumes Poisonous gas produced when R-12 contacts an open flame or some other source of intense heat.

psia Pounds per square inch, absolute pressure.

psig Pounds per square inch, gauge pressure.

Purge To remove damp air, traces of R-12, and loose dirt from a system or part by flushing with a dry, inert gas, such as nitrogen.

Receiver-Drier A combination desiccant, filter, and storage container for liquid R-12.

Refrigerant-11 (R-11) A hydrocarbon that is used for flushing, or cleaning out, badly contaminated parts of the air conditioner system. R-11 has a higher boiling point than R-12 and is a very good water-removing agent.

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

Refrigerant-12 (R-12) The cooling agent used in automotive air conditioning systems. See "Dichlorodifluoromethane."

Refrigeration Cycle The complete circulation of R-12 through an air conditioning system, accompanied by changes in temperature and pressure.

Refrigerant Oil Highly refined oil that is free of contaminants.

Relative Humidity The actual water content of the air in relation to the total water the air can hold at a given temperature.

Resistor A voltage-dropping device, usually wirewound, which provides a means of controlling fan speed.

Schrader Valve A spring-loaded valve (similar to but not interchangeable with a tire valve) located inside the compressor service valve fitting to hold R-12 in the system. Special adapters must be used with the gauge hose to get into the system.

Sensor A temperature-sensing unit that is used to sense air temperatures and provide a control voltage for operation of automatic temperature control units.

Sight Glass A window in the liquid line (moisture indicator) used to check the R-12 charge.

Suction Line The line connecting the evaporator outlet to the compressor inlet.

Suction Pressure Compressor inlet pressure (the system's low-side pressure).

Suction Service Valve A device located on the suction side of the compressor that allows low-side pressure to be checked and other service operations to be performed.

Suction Side The low-pressure area of the system, extending from the expansion valve to the compressor inlet.

Thermostatic Vacuum Gauge A high-vacuum gauge sensitive to pressures ranging from atmospheric pressure to less than 10 microns.

Thermostatic Switch A temperature-sensitive switch used to control system temperature and prevent evaporator freeze-up; it does this by cycling the compressor's operation.

Thermistor See "Thermostatic Vacuum Gauge."

Trinary Switch Disengages the refrigerant compressor to protect it from harmful operating conditions. Used only on vehicles equipped with air conditioning and an on-off fan drive.

Undercharge A system low on R-12, resulting in lack of cooling and possible compressor damage.

Vacuum Refers to pressure that is less than atmospheric pressure.

Vacuum Pump A mechanical device used to evacuate and place a high vacuum in the refrigerant system.

Vacuum Pump Oil Water soluble oil used in some vacuum pumps to absorb water from the refrigerant system.

Vapor The gaseous state of a material.

Water Regulating Valve A valve, mechanically operated, for controlling the flow of hot coolant to the heater core.

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

PRINCIPLES OF OPERATION

AIR CONDITIONER (Refer to Fig 12)

When the refrigerant compressor is on, the pistons and cylinders are actuated, drawing in and compressing the gas. The pistons squeeze the R-12 into a high-pressure, high-temperature gas. High pressure raises the condensation point of R-12 gas, which allows the condenser to change it to a liquid. After it is compressed, R-12 gas moves out of the discharge port of the compressor, and on to the condenser.

At the condenser, air passing over the coil's fins absorbs heat from the hot R-12 gas, and causes it to change into a liquid. The liquid moves to the receiver-drier, which filters it and removes traces of water and acids, and then stores the R-12 until it is needed by the system.

From the receiver-drier, liquid R-12 moves to the expansion valve, which meters the flow into the evaporator coil, and acts as a boundary between the high- and low-pressure sides of the system. The metered release of the expansion valve greatly drops the liquid's pressure, causing it to expand. The pressure drop lowers the boiling point of the R-12, and causes it to quickly evaporate as it absorbs heat from air passing over the coil. The resulting cool air is forced into the cab by the blower; the heated R-12 gas is drawn back into the compressor, where the cycle is repeated.

HEATER

Moving the temperature lever slide control to maximum heat opens the water regulating valve, which allows engine-heated coolant to flow through the heater core. Heat absorbed by the air passing over the heater core fins is forced through ducts and into the cab.

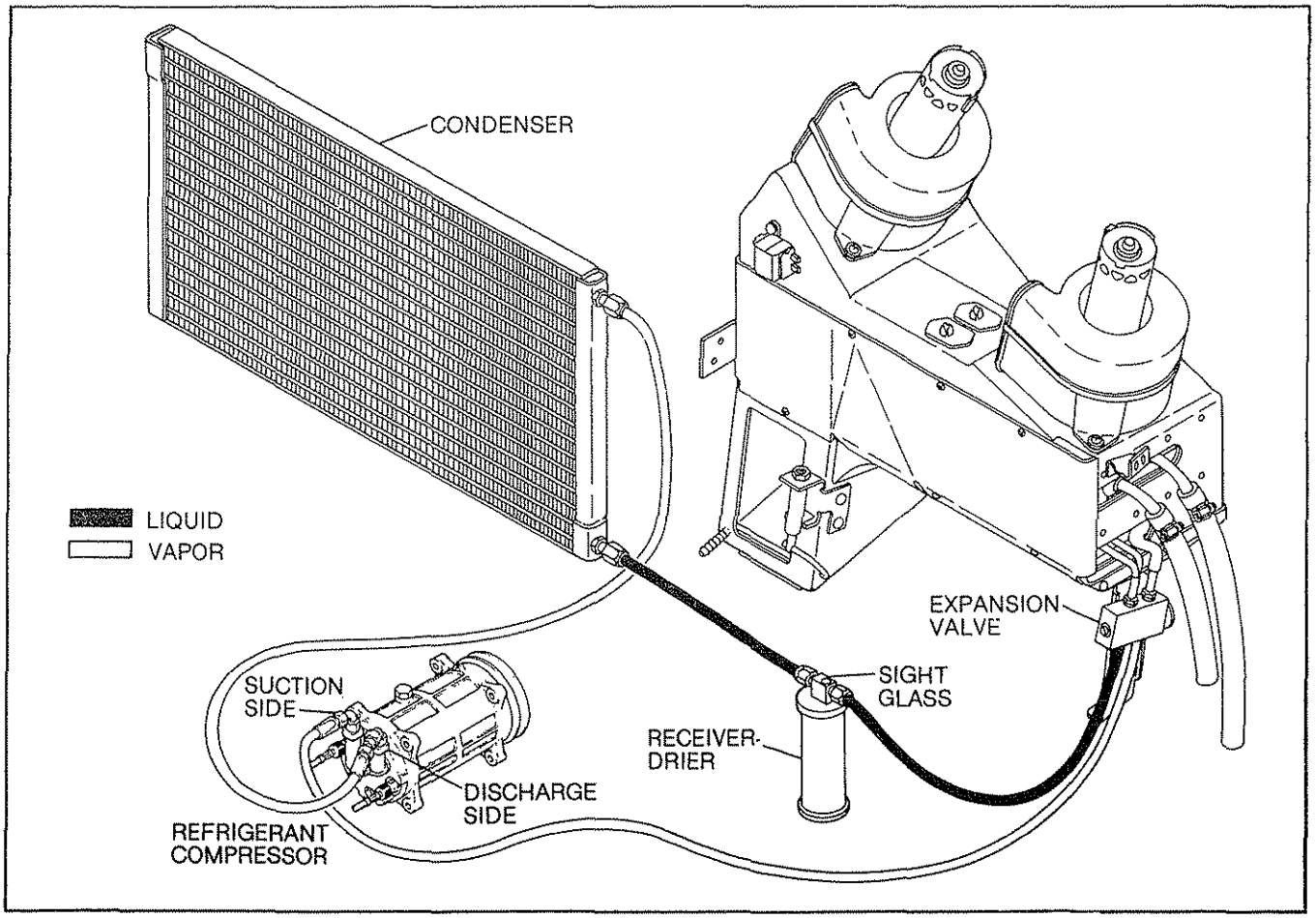

Fig. 12, Air Conditioner System Plumbing Circuit

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

SERVICE OPERATIONS

SAFETY PRECAUTIONS

Whenever repairs are made to any air conditioner parts that hold R-12, you must discharge, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the air conditioning system has been discharged at the compressor.

Refrigerants 11 and 12 are safe when used under the right conditions. Always wear safety goggles and non-leather gloves while discharging, purging, flushing, evacuating, charging, and leak testing the system. Do not wear leather gloves; when R-12 gas or liquid contacts leather, the leather will stick to your skin.

WARNING: Use care to prevent R-12 from touching your skin or eyes, because liquid R-12, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid R-12.

R-12 splash in the eyes should first be treated with a few drops of sterile mineral oil in the eyes, and then rinsed with a weak boric acid solution. Do not rub the eyes. Contact a physician right away.

R-12 splash on the skin should be treated the same as for frostbite: gently pour cool water on the area, but do not rub the skin. Keep the skin warm with layers of soft, sterile cloth. Contact a physician right away.

Even though R-12 does not burn, when it contacts extreme heat or flame, poisonous phosgene gas is created. This gas also occurs when an open flame leak detector is used. Phosgene fumes have an acrid (bitter) smell.

WARNING: Do not work in an area where R-12 may contact an open flame or any burning material, such as a cigarette. When it contacts extreme heat, R-12 breaks down into poisonous phosgene gas which, if breathed, causes severe respiratory irritation. Do not breathe the fumes from an open flame leak detector.

If a refrigerant recovery and recycling station is available, discharge the air conditioning system into the station. Refer to the manufacturer's operating instructions.

If a refrigerant recovery and recycling station is not available, check whether local regulations permit discharging the air conditioning system to the atmosphere. If it is permissible, discharge the air conditioning system outdoors or into a shop exhaust system to be safe. You must work in an area where there is a constant flow of fresh air when the system is discharged, flushed, charged, and leak tested using an open flame leak detector.

Because of its very low boiling point, R-12 must be stored under pressure. To prevent the R-12 cans from exploding, never expose them to temperatures higher than 125°F (52°C). Never leave R-12 cans in the sun, and do not store them in sun-exposed areas where heat can build up, such as in gloveboxes, automobile trunks, etc.

DISCONNECTING AND CONNECTING REFRIGERANT FITTINGS

Whenever a refrigerant line is disconnected, replace the rubber O-ring (Fig. 13). Always lubricate the new O-ring and fitting threads with refrigerant oil before connecting the lines.

Do not disconnect or connect refrigerant fittings using only one wrench. Always hold one fitting stationary using a wrench, and turn the other fitting using a second wrench. Tighten fittings to the torque values in Table 2, under "Specifications."

HEATER-AIR CONDITIONER COMPONENT REPLACEMENT

It is not necessary to remove the entire heater-air conditioner assembly from the vehicle in order to perform the service operations below. Damaged parts can be replaced individually after the front access covers have been removed. For repairs or replacement of the refrigerant compressor, refer to Group 01 of this manual.

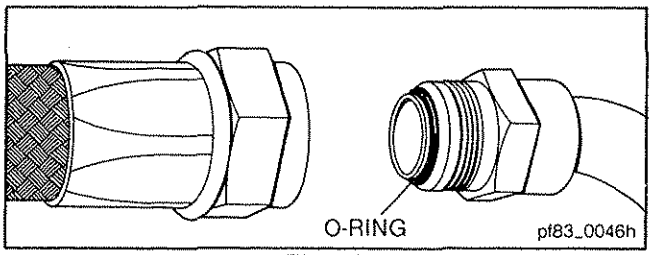

Fig. 13

Control Panel Switch Replacement

CAUTION: Turn off the ignition switch to prevent damage to the electrical system during repairs.

1. Remove (pull off) the knobs from the lever slide controls.

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

2. Remove the screws attaching the control panel to the dash. Move the panel away from the dash to a serviceable position. Refer to Fig. 14.
3. Replace the part(s) as needed.
4. Install the control panel in the dash, and the knobs to the lever slide controls.
5. Test the new part(s) for correct operation.

Heater Core Replacement (Refer to Fig. 7)

1. Move the temperature lever slide control to the far right "Max Heat" position.
2. Drain the heater core and the cooling system at the radiator drain cock; save the coolant for later use.
3. On COEs, remove the screws attaching the right tunnel-side cover to the tunnel, and remove the cover. See Fig. 15.

   On Conventionals, remove the screws attaching the center dash skirt-cover to the dash, and remove the cover. See Fig. 16.
4. Remove the screws attaching the passenger's front cover to the dash, and remove the cover. See Fig. 17.

   Remove the small cover located below the lower right corner of the passenger's front cover by removing the two attaching screws, and lifting off the cover.

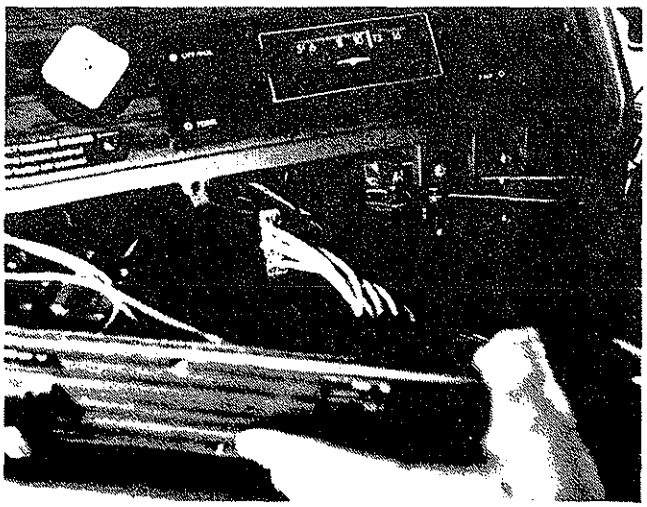

Fig. 14, Control Panel Removal

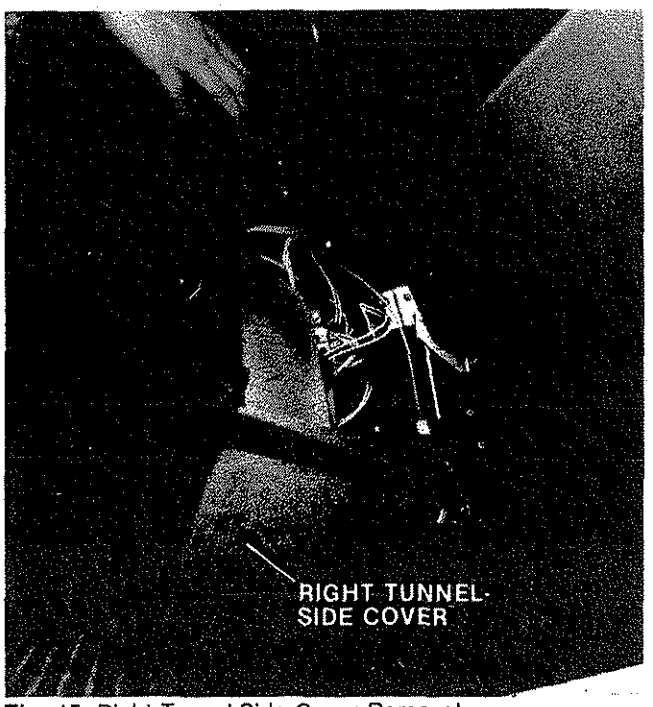

Fig. 15, Right Tunnel-Side Cover Removal

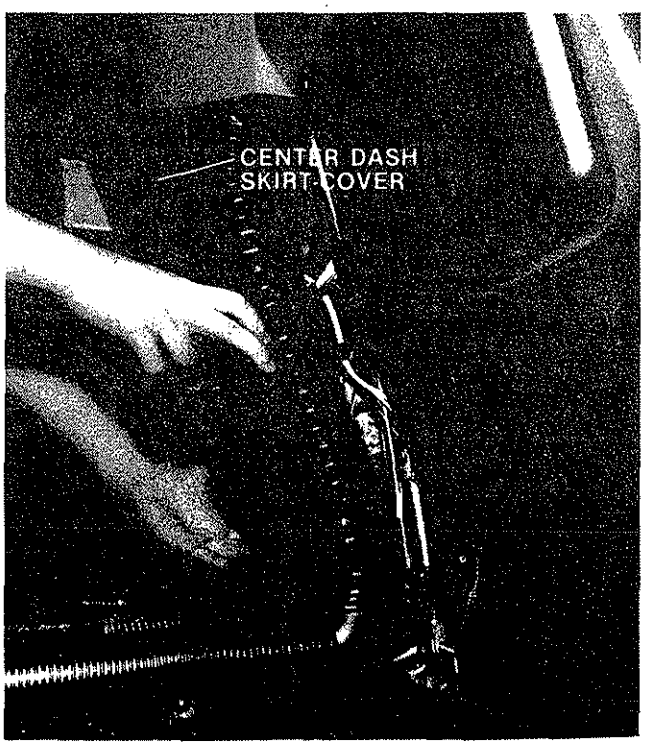

Fig. 16, Center Dash Skirt-Cover Removal

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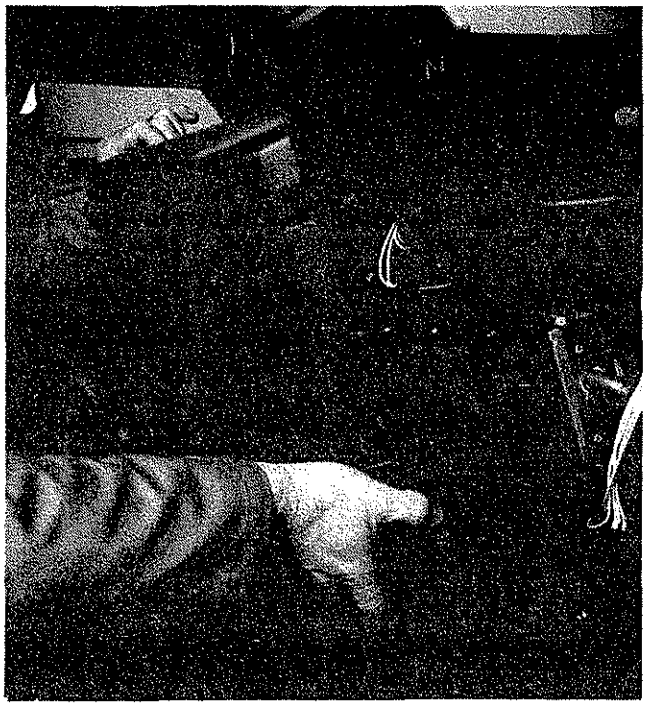

Fig. 17, Passenger's Front Cover Removal

5. Remove the screws attaching the main access cover to the housing, and remove the cover. Refer to Fig. 18.
6. Loosen the clamps attaching the heater hoses to the heater core pipe elbows. Disconnect the heater hoses. Mark the hoses for later reference.
7. Wearing protective gloves, slide the heater core out, and remove it from the housing.

WARNING: Failure to wear protective gloves could result in serious skin cuts due to the sharp edges of the heater core fins.

8. Seat the new heater core in the housing.
9. As referenced earlier, connect the heater hoses to the heater core pipe elbows, and tighten the clamps.
10. Install the main access cover, the passenger's front cover, and the small cover below the lower right corner.

IMPORTANT: When installing the main access cover, place the bottom edge of the access cover gasket between the bottom main housing and the evaporator coil. Do not place the gasket edge between the housing and the access cover.

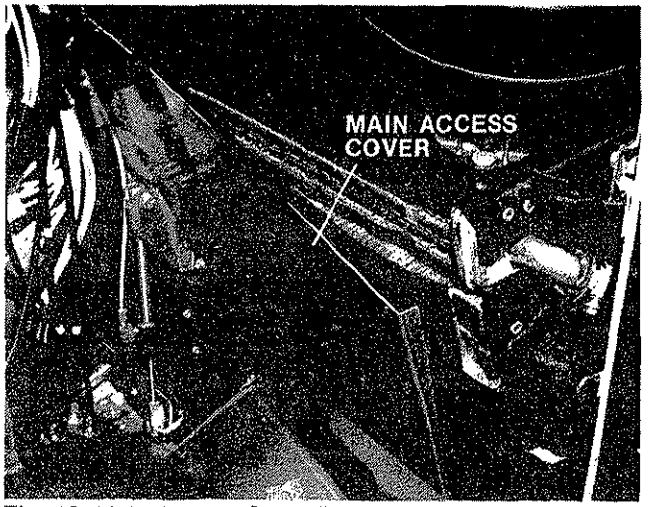

Fig. 18, Main Access Cover Removal

11. On COEs, install the right tunnel-side cover.

    On Conventionals, install the center dash skirt-cover.
12. Fill the cooling system. If necessary, add more coolant to bring the level to within one inch (3 cm) of the filler neck.
13. Start the engine. When the radiator thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again, and fill, if needed, as specified in step 12.

CAUTION: Failure to keep the engine coolant level filled to within one inch (3 cm) of the bottom of the radiator filler neck could result in engine overheating and damage.

Air Cylinder Replacement

1. On COEs, remove the screws attaching the right tunnel-side cover to the tunnel, and remove the cover. See Fig. 15.

   On Conventionals, remove the screws attaching the center dash skirt-cover to the dash, and remove the cover. See Fig. 16.

NOTE: Compare the air cylinders shown in Figs. 19 and 20 with the one installed on the vehicle. Then, proceed to either step 2 or 3 below.

2. For air cylinders identical to the one shown in Fig. 19:

   .1 Move the temperature lever slide control to the far left "Max Cool" position. In this position,

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

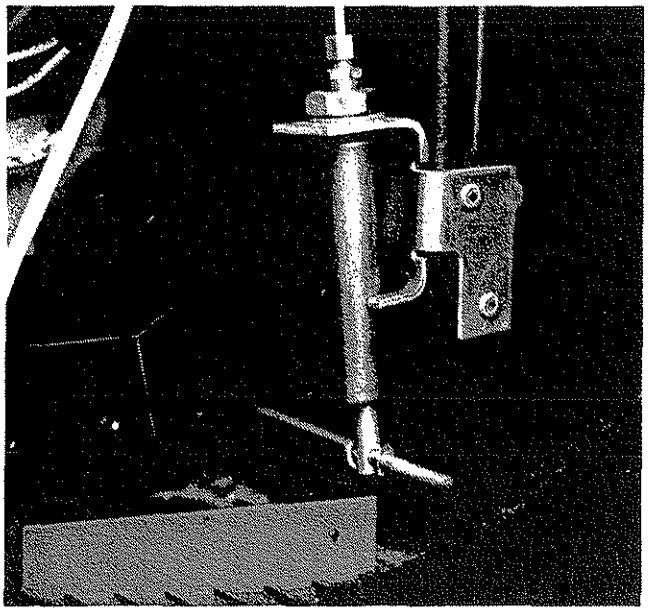

Fig. 19

air pressure will be cut off from the actuator. Disconnect the air hose from the actuator.

.2 Remove the bulkhead nut and the lockwasher from the top of the air cylinder. Remove the retaining ring from the recirculation flap rod. Remove the air cylinder.

.3 Install the new air cylinder on the support bracket, and connect the recirculation flap rod. Install the lockwasher and the bulkhead nut. Tighten the nut finger-tight; using a wrench, further tighten the nut 2-1/2 turns. Install the retaining ring on the recirculation flap rod.

.4 Apply pipe sealant to the external threads of the air hose fitting. Connect the air hose to the air fitting, making sure the tubing is bottomed in the fitting. Tighten the connection to the value in **Table 1** under "Specifications." Use two wrenches to avoid twisting the tubing. Proceed to step 4.

3. For air cylinders identical to those shown in **Fig. 20,** Ref. A or B:

.1 Move the air toggle switch to "Fresh." On control panels not equipped with a toggle switch, move the temperature lever slide control to the far right "Max Heat" position. In this position, air pressure will be cut off from the air cylinder.

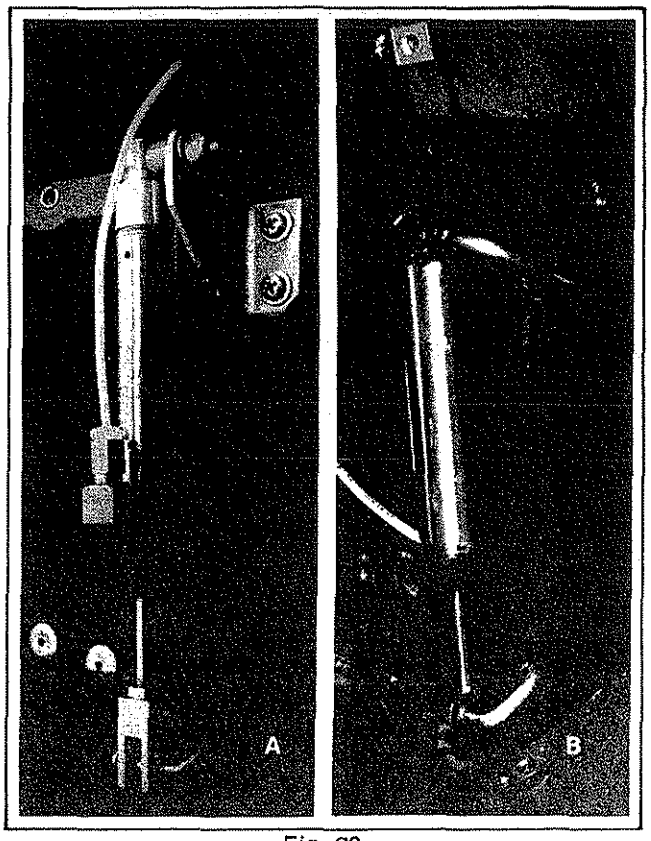

Fig. 20

Disconnect the air hose from the cylinder by pushing down on the white collet while pulling the hose free.

.2 (Ref. A models only) Remove the locknut and washer from the top of the air cylinder. Remove the retaining ring from the recirculation flap rod. Remove the air cylinder.

(Ref. B models only) Remove the retaining rings from the air cylinder bracket and the recirculation flap rod. Remove the air cylinder.

.3 (Ref. A models only) Install the new air cylinder on the support bracket, and connect the recirculation flap rod. Install the washer and locknut. Tighten the locknut snugly, but not so tight as to prevent free movement at the top of the cylinder. Install the retaining ring on the recirculation flap rod.

(Ref. B models only) Install the new cylinder on the air cylinder bracket and the recirculation flap rod. Install the retaining rings.

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.4 Push the end of the air hose through the collet until it bottoms in the fitting. Be sure the hose is fully locked in place.

4. Check the operation of the recirculation flap. Be sure the flap works freely, has full movement, and seals securely.
5. On COEs, install the right tunnel-side cover.

   On Conventionals, install the center dash skirt-cover.

Water Regulating Valve Replacement (See Fig. 7)

1. Move the temperature lever slide control to the far right "Max Heat" position.
2. Drain the heater core and the cooling system at the radiator drain cock; save the coolant for later use.
3. Remove the screws attaching the passenger's front cover to the dash, and remove the cover. See Fig. 17. Remove the small cover located below the lower right corner of the passenger's front cover by removing the two attaching screws, and lifting off the cover.
4. Loosen the clamps that attach the heater hoses to the water regulating valve. Disconnect the hoses from the valve.
5. Loosen the fastener that clamps the temperature lever slide control cable to the water regulating valve.
6. Slip the cable end off the rod on the water regulating valve. Remove the valve.
7. Insert the temperature lever slide control cable through the clamp on the new water regulating valve. Seat the cable end on the valve rod.
8. Tighten the fastener that clamps the temperature lever slide control cable to the water regulating valve.
9. Connect the heater hoses to the water regulating valve, and tighten the clamps.
10. Install the passenger's front cover, and the small cover below the lower right corner.
11. Fill the cooling system. If necessary, add coolant to bring the level to within one inch (3 cm) of the filler neck.
12. Start the engine. When the radiator thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again, and fill, if needed, as specified in step 11.

CAUTION: Failure to keep the engine coolant level filled to within one inch (3 cm) of the bottom of the radiator filler neck could result in engine overheating and damage.

Resistor Block Replacement

The thermal cutout resistor opens the blower motor circuit at temperatures above 257°F (125°C). This occurs if the blower motor stalls, or if there is a short circuit in the motor or between the resistor and the motor. The circuit remains open until the resistor is replaced.

If a non-thermal-cutout resistor becomes damaged, replace it with a thermal cutout model.

CAUTION: Before replacing either resistor model, correct the fault condition.

To replace a resistor block, proceed as follows:

1. Turn off the ignition switch.

WARNING: Failure to turn off the ignition switch could cause accidental blower motor operation during repairs. This could result in personal injury.

2. Remove the screws attaching the passenger's front cover to the dash, and remove the cover. See Fig. 16.
3. Disconnect the connectors from the resistors and blower motors.
4. Remove the blower motors and duct tube, using the procedure under "Blower Motor Assembly Replacement."
5. Using a 3/16-inch drill bit, drill out the resistor's rivets and remove the resistor block.

CAUTION: To avoid damaging the heater core, use minimal drill bit penetration. The heater core is about 2-1/4 inches (6 cm) below the housing.

6. When replacing a non-thermal-cutout resistor with a thermal cutout model, drill new mounting holes before installation. Place the new resistor on the mounting surface and mark the correct hole spacing on the surface. Remove the resistor and drill new holes, using a 3/16-inch drill bit.

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Install the resistor block, using pull rivets. Place two washers between the rivet and the resistor block. See Fig. 21.

7. Install the blower motors and duct tube, using the procedure under "Blower Motor Assembly Replacement."
8. Attach the connectors to the resistors and blower motors.
9. Attach the passenger's front cover to the dash, using the screws.

Blower Motor Assembly Replacement

(Refer to Fig. 7)

1. Turn off the ignition switch.

WARNING: Failure to turn off the ignition switch could cause accidental blower motor operation during repairs. This could result in personal injury or electrical shock.

2. Remove the screws attaching the passenger's front cover to the dash, and remove the cover. See Fig. 17.
3. For later reference, mark the wires connected to the blower motor. Disconnect the wires.

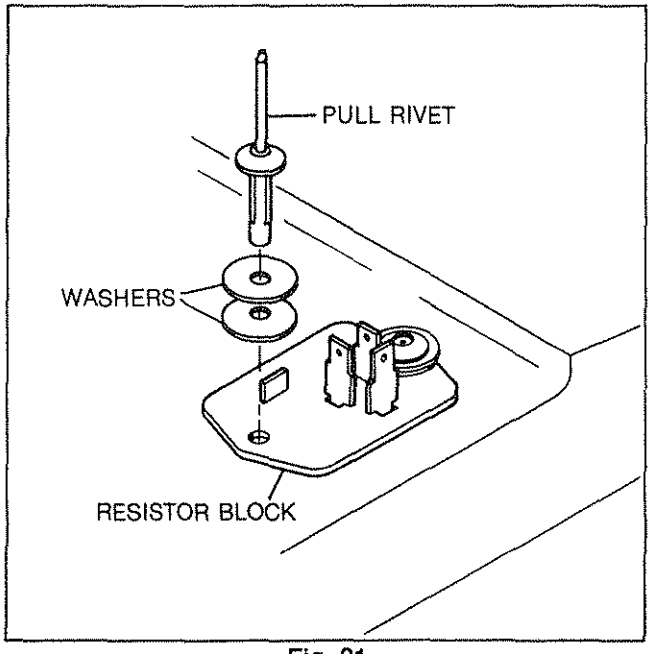

Fig. 21

4. Remove the screws that fasten the blower duct tube to the blower duct boot, and remove the boot. Refer to Fig. 22.

NOTE: Some models have cable ties holding the blower duct boot to the blower duct tube as shown in Fig. 23. If so, remove the ties and slide the boot up the tube far enough to clear the blower housing.

5. Remove the machine screw that locks the blower assembly to the top main housing. Refer to Fig. 24.
6. Turn the blower assembly counterclockwise from the locked position. The blower assembly will unlock, and can be removed by lifting it off the top main housing. Remove the blower assembly.

Replace the parts as needed.

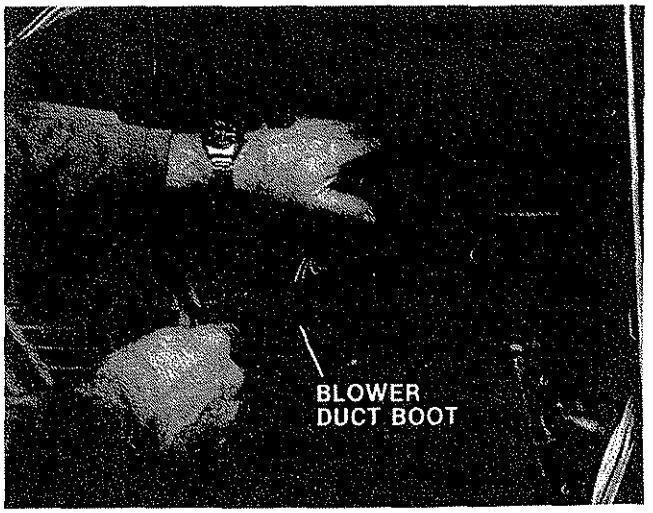

Fig. 22, Blower Duct Boot

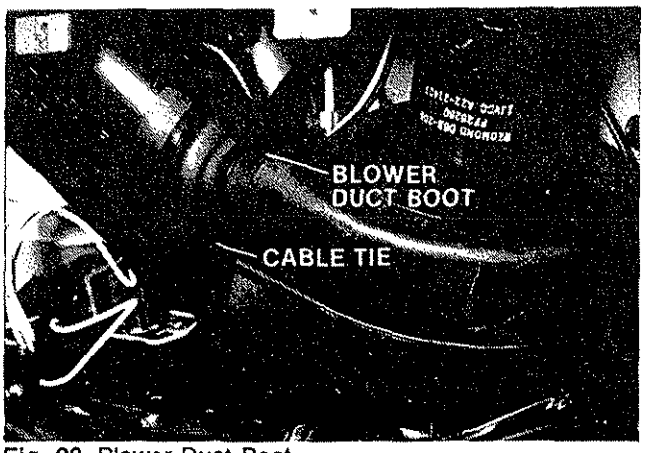

Fig. 23, Blower Duct Boot

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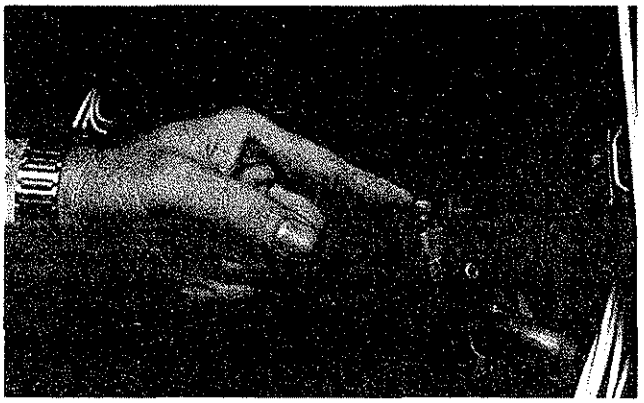

Fig. 24, Machine Screw

7. Install the blower assembly in the top main housing. Turn the blower assembly clockwise to the end of travel.
8. Install the machine screw that locks the blower assembly in place on the top main housing.
9. Connect the blower duct boot to the blower duct tube. Install the attaching screws. If applicable, install cable ties to hold the tube in place.
10. Connect the wires to the blower motor as referenced earlier, or as shown in Fig. 35 or 36 under "Specifications."
11. Test the blower motor for operation. If the motor does not operate, check the wiring, including the ground. Refer to Fig. 35 or 36 under "Specifications."
12. Install the passenger's front cover.

Evaporator Coil Replacement (Refer to Fig. 7)

1. On COEs, remove the screws attaching the right tunnel-side cover to the tunnel, and remove the cover. See Fig. 15.

   On Conventionals, remove the screws attaching the center dash skirt-cover to the dash, and remove the cover. See Fig. 16.

2. Remove the screws attaching the passenger's front cover to the dash, and remove the cover. See Fig. 17. Remove the small cover located below the lower right corner of the passenger's front cover by removing the two attaching screws, and lifting off the cover.
3. Remove the screws attaching the main access cover to the housing, and remove the cover. Refer to Fig. 18.
4. Remove the mastic insulating tape from around the expansion valve.
5. Review the information under "Safety Precautions."

WARNING: Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

6. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to "Discharging."
7. Using two wrenches to avoid twisting the tubing, disconnect the evaporator coil pipe elbows from the expansion valve. Install plugs in the expansion valve ports.

CAUTION: Water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

8. Remove the wires from the thermostatic switch, and mark them for later reference. Remove the two screws attaching the switch to the housing.

NOTE: On some models, the thermostatic switch is mounted on the top of the main housing with the sensing tube routed through the housing, and attached to the evaporator coil. On these models, remove the sensing tube from the coil before removing the coil from the housing.

9. Wearing heavy protective gloves, slide the evaporator coil and thermostatic switch out, and remove the assembly from the housing. Remove the thermostatic switch from the coil.

WARNING: Failure to wear heavy protective gloves could result in serious skin cuts due to the sharp edges of the evaporator coil fins.

NOTE: On some models, the upper support bracket of the air cylinder prevents removal of the evaporator coil. In these cases, remove the screws attaching the air cylinder upper support bracket to the main housing, and move the air cylinder out of the way.

10. Install the thermostatic switch sensing tube on the evaporator coil; the tube must be against the coil,

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and held in place by tie-straps and insulating tape. See Fig. 25.

11. Seat the new evaporator coil in the housing. If applicable, install the air cylinder upper support bracket. Attach the thermostatic switch to the housing, and connect the wires as previously marked. On those models with the thermostatic switch mounted on top of the main housing, attach the sensing tube to the evaporator coil.

12. Remove the plugs from the expansion valve. Apply refrigerant oil to the threads and O-rings. Connect the evaporator pipe elbows to the expansion valve. Using two wrenches to avoid twisting the tubing, tighten the connections to the values in Table 2 under "Specifications."

13. Charge the system with R-12. Refer to "Charging" for instructions.

    If equipped with a York swash plate compressor, be sure to add refrigerant oil to the compressor, to replace that which is lost in the old evaporator; refer to Group 01, "Refrigerant Compressor, York Swash Plate," for instructions.

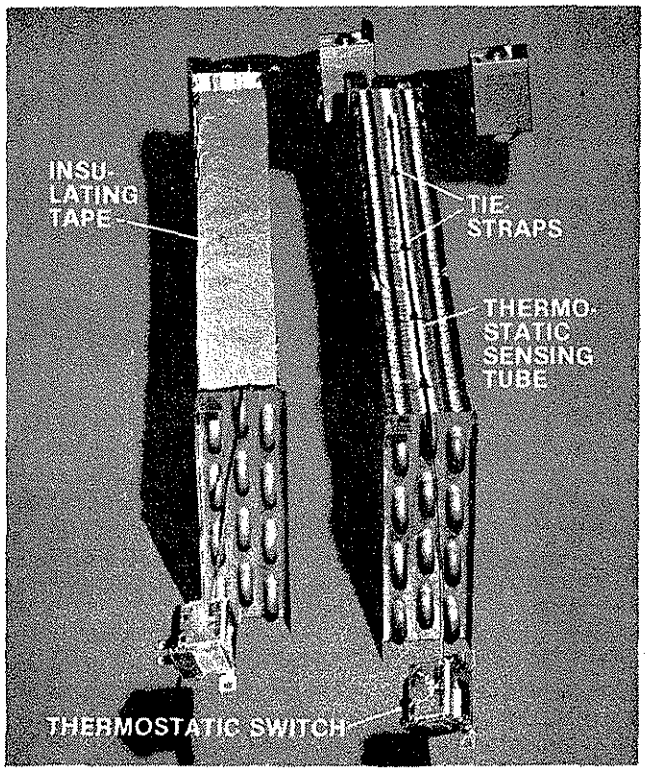

Fig. 25, Thermostatic Sensing Tube Attachment

14. Wipe the expansion valve and the refrigerant lines clean, and wrap them with mastic insulating tape.

15. Install the main access cover, the passenger's front cover, and the small cover below the lower right corner.

IMPORTANT: When installing the main access cover, place the bottom edge of the access cover gasket between the bottom main housing and the evaporator coil. Do not place the gasket edge between the housing and the access cover.

16. On COEs, install the right tunnel-side cover.

    On Conventionals, install the center dash skirt-cover.

Receiver-Drier, Moisture Indicator, Low Pressure Switch, and Trinary Switch Replacement

NOTE: The receiver-drier and moisture indicator are installed as a unit, and cannot be replaced separately.

1. Review the information under "Safety Precautions."

WARNING: Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

2. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to "Discharging."

3. After the system is completely discharged, disconnect the refrigerant lines from the receiver-drier. Use two wrenches to avoid twisting the lines. Install plugs in the refrigerant lines.

CAUTION: Water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

4. Disconnect the wiring connector from the low-pressure switch or trinary switch. Remove the switch from the receiver-drier. Save the switch for later use.

5. Remove the U-bolt assembly that attaches the receiver-drier to the mounting bracket. Remove the receiver-drier.

6. Position the new receiver-drier in the mounting bracket. Install the U-bolt, washers, and nuts. Tighten the U-bolt nuts 13 lbf·ft (18 N·m).

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7. Remove the plugs from the refrigerant lines and the receiver-drier. Replace the O-rings. Apply refrigerant oil to the seal surfaces, O-rings, and threads. Connect the lines to the receiver-drier. Using two wrenches to avoid twisting the tubing, tighten the connections to the values in Table 2 under "Specifications."

8. Remove the plug from the top of the receiver-drier, and install the trinary switch or low-pressure switch. Tighten the switch 84 lbf·in (900 N·cm) or one-eighth turn past hand-tight. Connect the wiring connector to the switch.

9. Charge the system with R-12. Refer to "Charging" for instructions.

   If equipped with a York swash plate refrigerant compressor, be sure to add refrigerant oil to the compressor, to replace that which is lost in the old receiver-drier; refer to Group 01, "Refrigerant Compressor, York Swash Plate," for instructions.

Condenser Replacement (Refer to Fig. 8)

1. Tilt the cab assembly or hood. Refer to the Freightliner *Driver's Manual* for instructions.

2. Review the information under "Safety Precautions."

WARNING: Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

3. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to "Discharging."

4. After the system is completely discharged, disconnect the refrigerant lines at the condenser; use two wrenches to avoid twisting the lines. Install plugs in the refrigerant lines.

CAUTION: Water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

5. Remove the capscrews attaching the support bracket of the condenser to the radiator, and remove the condenser.

6. Place the new condenser and support bracket on the radiator. Install and tighten the capscrews 9 lbf·ft (12 N·m).

7. Remove the plugs from the refrigerant lines and the new condenser. Apply refrigerant oil to the seal surfaces, O-rings, and threads. Connect the refrigerant lines to the condenser. Using two wrenches to avoid twisting the tubing, tighten the connections to the values in Table 2 under "Specifications."

8. Charge the system with R-12. Refer to "Charging" for instructions.

   If equipped with a York swash plate compressor, be sure to add refrigerant oil to the compressor, to replace that which is lost in the old condenser; refer to Group 01, "Refrigerant Compressor, York Swash Plate," for instructions.

Expansion Valve Replacement (Refer to Fig. 7)

1. Remove the screws attaching the passenger's front cover to the dash, and remove the cover. See Fig. 17. Remove the small cover located below the lower right corner of the passenger's front cover by removing the two attaching screws, and lifting off the cover.

2. Review the information under "Safety Precautions."

WARNING: Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

3. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to "Discharging."

4. Remove the mastic insulating tape from around the expansion valve.

5. Using two wrenches to avoid twisting the tubing, disconnect the refrigerant lines and the evaporator coil pipe elbows from the expansion valve. Remove the expansion valve. Install plugs in the refrigerant lines.

CAUTION: Water and dirt can damage the refrigerant system. Five minutes of not being capped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

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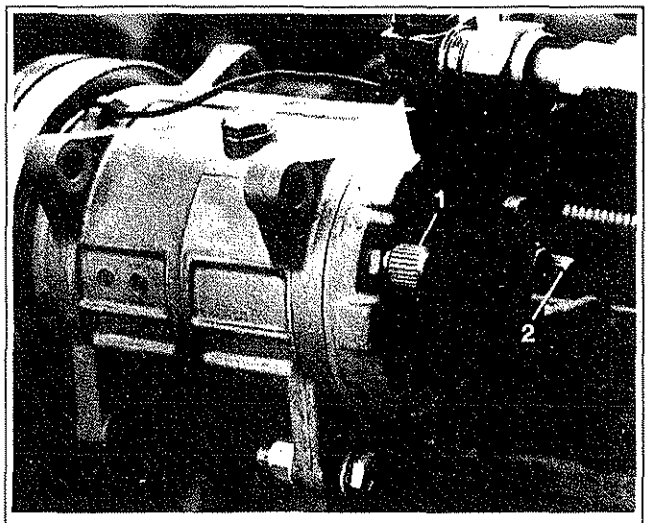
6. Remove the plugs from the refrigerant lines and the new expansion valve. Apply refrigerant oil to the threads and O-rings, and connect the refrigerant lines to the expansion valve. Using two wrenches to avoid twisting the tubing, tighten the connections to the values in Table 2 under "Specifications."
7. Charge the system with R-12. Refer to "Charging" for instructions. If equipped with a York swash plate refrigerant compressor, be sure to add refrigerant oil to the compressor, to replace that which is lost when the system is discharged; refer to Group 01, "Refrigerant Compressor, York Swash Plate," for instructions.
8. Wipe the expansion valve and the refrigerant lines clean, and wrap them with mastic insulating tape.
9. Install the passenger's front cover, and the small cover below the lower right corner.



1. Suction Service Valve 2. Discharge Service Valve

Fig. 26

DISCHARGING

Compressors Equipped With Schrader Service Valves

WARNING: Before doing any of the work below, read the information under "Safety Precautions." Failure to read the safety precautions, and to be aware of the dangers involved when working with R-12, could lead to serious personal injury.

Discharging removes all of the R-12 from the system.

1. Tilt the cab assembly or hood. Refer to the vehicle driver's manual for instructions.
2. Remove the caps from the compressor's suction (labelled "S") and discharge (labelled "D") service valves. Refer to Fig. 26. Wearing protective goggles and nonleather gloves, attach a manifold gauge set to the valves as follows (refer to Fig. 27):

IMPORTANT: The suction and discharge service valves have Schrader valves, which are similar to but not the same as tire valves. Be sure the manifold gauge set has a valve core depressor on the end of each hose.

.1 Close both of the hand valves on the manifold gauge set.

.2 Connect the manifold's high-side hose to the compressor's discharge service valve.

.3 Connect the manifold's low-side hose to the compressor's suction service valve.

3. If a refrigerant recovery and recycling station is used, attach its inlet port to the manifold gauge set center hose. Follow the recycling station manufacturer's instructions.

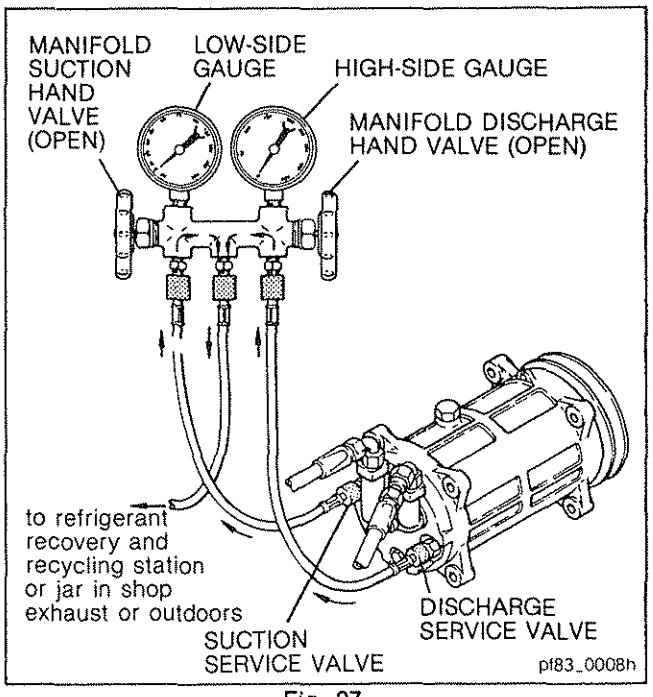


Fig. 27

If no recycling station is available, first check whether local regulations permit discharging R-12

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to the atmosphere. Then, discharge the R-12 from the system as described in steps 4 through 6.

4. To catch any refrigerant oil, place the open end of the manifold's center hose in a clean jar that is outdoors or in a shop exhaust.

5. Slowly open the low-side manifold hand valve and bleed so that little or no oil flows into the jar. As the pressure drops, slowly open the high-side manifold hand valve; be careful that oil doesn't escape with the R-12. Do not discharge the R-12 quickly.

   If oil does escape, it will catch in the jar. Refill the compressor with the same amount of new refrigerant oil, plus an additional amount of oil, depending on which parts of the system are replaced; a minimum amount of oil must also be added to the compressor if only the R-12 charge is being replaced. For more information, refer to Group 01.

6. After the R-12 has been discharged from .the system, close both manifold hand valves and cap the center service hose, to keep out air and other contaminants. Purge the system, if necessary, and replace the receiver-drier.

Compressors Equipped With Hand Shut-Off Service Valves

WARNING: Before doing any of the work below, read the information under "Safety Precautions." Failure to read the safety precautions, and to be aware of the dangers involved when working with R-12, could lead to serious personal injury.

Discharging removes all of the R-12 from the system.

1. Tilt the cab assembly or hood. Refer to the vehicle driver's manual for instructions.

2. With the refrigerant compressor suction and discharge service valves fully back-seated (Fig. 28), remove the caps from the compressor service valve gauge ports. Connect the manifold service gauges to the compressor service valve gauge ports, as shown in Fig. 29.

3. If a refrigerant recovery and recycling station is used, attach its inlet port to the manifold gauge set center hose. Follow the recycling station manufacturer's instructions.

   If no recycling station is available, first check whether local regulations permit discharging R-12 to the atmosphere. Then, discharge the R-12 from the system as described in steps 4 through 6.

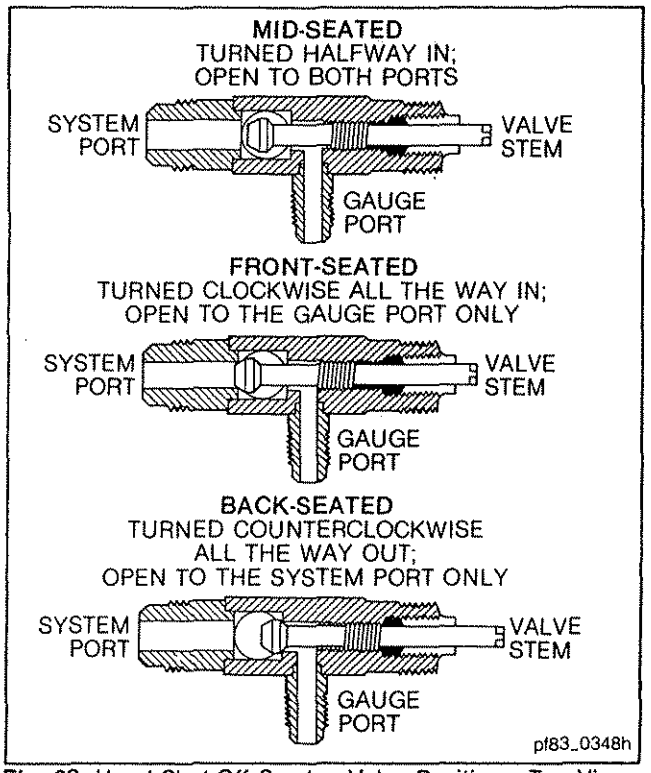

Fig. 28, Hand Shut-Off Service Valve Positions, Top View

4. To catch any refrigerant oil, place the open end of the manifold's center hose in a clean jar that is outdoors or in the shop exhaust system.

5. With both manifold valves closed (turned clockwise all the way in), mid-seat (Fig. 28) both compressor service valves, then slowly open the low-side manifold valve and bleed so that a minimum of oil is escaping into the jar. As the pressure drops, slowly open the high-side manifold valve, being careful to minimize oil escaping with the refrigerant. Do not discharge the refrigerant rapidly.

   If oil does escape, it will collect in the jar. Refill the compressor with the same quantity of new refrigerant oil. If the air conditioner system was contaminated, replace all of the compressor oil with clean oil. For refrigerant compressor oil filling instructions, refer to Group 01 of this manual or to the applicable compressor manufacturer's service manual.

6. After the refrigerant has been discharged from the system, front-seat (Fig. 28) both compressor service valves. Remove the center service hose from the shop exhaust outlet, then disconnect the ser-

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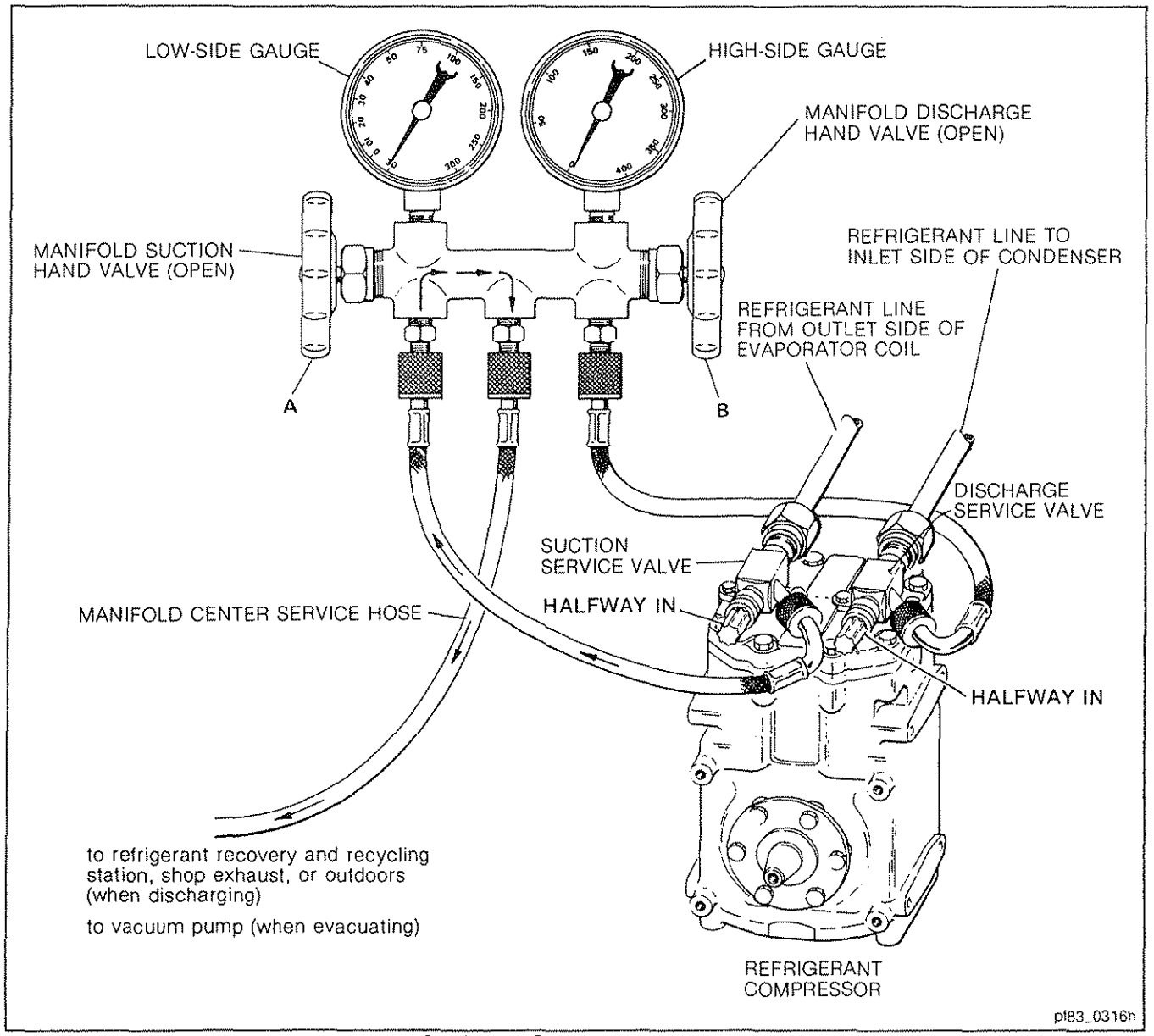

Fig. 29, Discharging and Evacuating the Air Conditioner System

vice gauges from the compressor service valve gauge ports. Cap the ports to prevent the entry of contaminants. Purge the system, if necessary, and replace the receiver-drier, following the instructions in this subject.

PURGING, FLUSHING

WARNING: Before doing any of the work below, read the information under "Safety Precautions."

Failure to read the safety precautions, and to be aware of the dangers involved when working with R-12, could lead to serious personal injury.

Purging removes damp air, traces of R-12, and loose dirt from refrigerant parts by passing a stream of inert, dry gas through the parts. If left in the system, these contaminants would have a bad effect on the life and operation of the air conditioner system.

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Flushing removes heavy contamination, such as gritty oil and large dirt build-up, which can't be removed by purging with gas. When a part is flushed, liquid R-11 is forced through it; the liquid picks up the contaminants and flushes them out. Traces of R-11 that are left behind are later removed when the system is evacuated.

Whether to purge or flush a part depends on how much contamination there is, as described above.

Normally, the system always has pressure in it. Some loss of R-12 from one season to the next is normal, and does not mean that the system is dirty. If R-12 has leaked until the system is nearly empty, or if refrigerant parts show signs of internal corrosion and grit, the system is contaminated.

The entire system or just a small part of it may be contaminated. If contamination is suspected, purge or flush all of the refrigerant parts, and replace the receiver-drier.

Purging and flushing are done one part at a time to lessen the chance of "blowing" bits of dirt or grit against one of the internal screens or openings, where they remain to cause future problems. Fig. 30 shows the basic plumbing circuit and where you should purge/flush the different parts.

NOTE: Any safe, inert, dry gas, such as nitrogen or carbon dioxide, can be used for purging. You must use a pressure regulator with nitrogen and carbon dioxide. Commercial cylinders of nitrogen have pressures higher than 2000 psig (13 780 kPa); this pressure has to be lowered to 200 psig (1378 kPa).

Flushing parts with R-11 requires a source of compressed gas (nitrogen or carbon dioxide) that will build 100 psig (689 kPa) of pressure in the R-11 cylinder.

Don't attempt to use R-12 for flushing. Flushing to remove dirt or grit from parts means that a liquid flushing agent must be used. R-12 will not remain liquid when it is exposed to the air.

Purging or Flushing a Refrigerant Compressor With Schrader Service Valves

(Refer to Fig. 31)

IMPORTANT: Purge the compressor only if its ports have been opened to the air longer than five minutes. Flush the compressor if its oil shows any of the following signs: A) The oil has turned cloudy; B) The oil has changed color to red; C) Foreign bits (metal powder etc.) are present in the oil.

1. If not already done, drain the oil from the compressor. For instructions, refer to the applicable air compressor subject in Group 01. Replace the receiver-drier.
2. Connect the gas pressure hose to the suction port of the compressor. When R-11 is used to flush the unit, connect a hose to the discharge side of the compressor, and place the open end of the hose in a disposal can.
3. Wearing safety goggles, turn on the purge/flush tank. Check the outlet from the discharge port to see that gas or liquid is coming out.

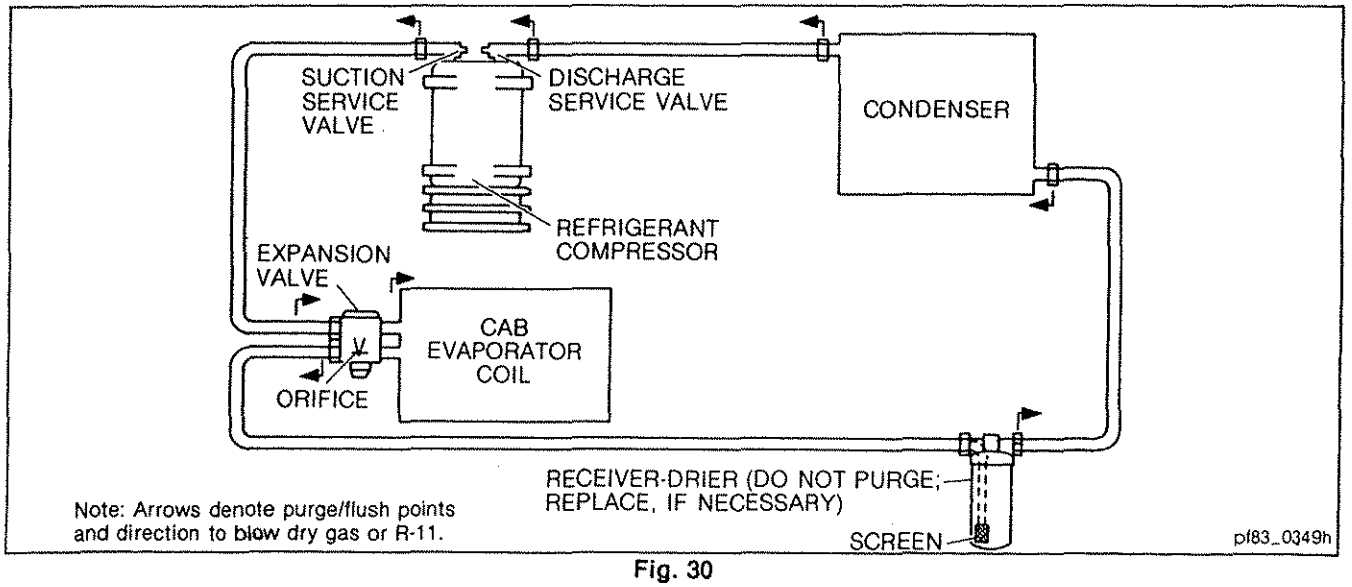

Fig. 30

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

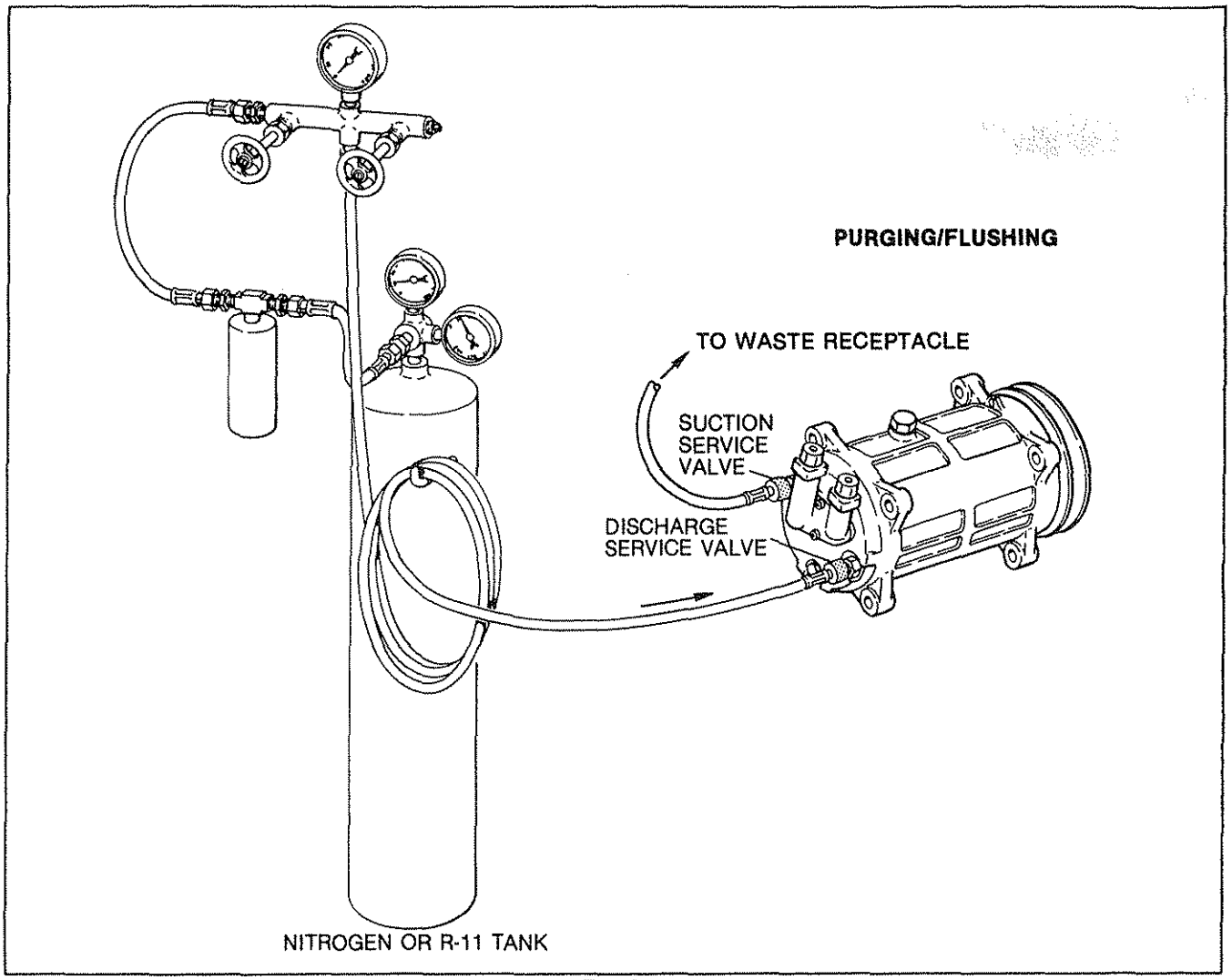

Fig. 31

4. If purging, use nitrogen or another dry, inert gas to purge the compressor for about 30 seconds at 200 psig (1378 kPa). Lower the pressure to 3 to 4 psig (21 to 28 kPa), and keep purging for about 3 minutes. If the system is very wet, keep purging until the dryness of the gas leaving the compressor is the same as when it entered.

   If flushing, use R-11 to flush the compressor long enough to remove all traces of old refrigerant oil and bits of dirt or grit (about 2 to 3 minutes).

5. After purging or flushing, turn off the flow at the tank. Disconnect the hoses from the compressor; quickly cap the suction and discharge ports, or connect the refrigerant hoses to the ports. If the compressor was flushed, drain out any remaining liquid R-11 before capping the ports. Don't keep the ports opened to the air for longer than five minutes.

6. Add oil to the compressor. For instructions, refer to the applicable air compressor subject in Group 01. If running or sliding parts of the compressor have been replaced, do the "Break-In Operations," in the applicable air compressor subject in Group 01. If no other parts need purging, go to "Evacuating."

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

Purging or Flushing a Refrigerant Compressor With Hand Shut-Off Service Valves

(Refer to Fig. 32)

IMPORTANT: Purge the compressor only if its ports have been opened to the air longer than five minutes. Flush the compressor if its oil shows any of the following signs: A) the oil has turned cloudy; B) the oil has changed color to red; C) Foreign bits (metal grit, etc.) are present in the oil.

1. Hook the gas pressure hose onto the uncapped end of the suction service valve gauge port of the compressor.
2. Disconnect the refrigerant line from the discharge service valve of the compressor, and cap the line.
3. Back-seat the compressor discharge service valve. Refer to Fig. 28.
4. Front-seat the compressor suction service valve. Refer to Fig. 28.
5. Wearing safety goggles, turn on the purge/flush tank. Check the outlet from the discharge port to see that gas or liquid is coming out.
6. If purging, use nitrogen or another dry, inert gas to purge the compressor for about 30 seconds at 200 psig (1378 kPa). Lower the pressure to 3 to 4 psig (21 to 28 kPa), and keep purging for about 3 minutes. If the system is very wet, keep purging until the dryness of the gas leaving the compressor is the same as when it entered.

   If flushing, use R-11 to flush the compressor long enough to remove all traces of old refrigerant oil and bits of dirt or grit (about 2 to 3 minutes).
7. After purging, turn off the gas flow at the tank, and front-seat (Fig. 28) the compressor discharge service valve.
8. Disconnect the gas pressure hose from the suction service valve gauge port of the compressor. Cap both ends of the component. (Remove the caps immediately before reconnecting the component to the system.)
9. Remove the cap from the refrigerant line, and connect the line to the discharge service valve of the compressor. Back-seat both of the compressor service valves. See Fig. 28.
10. Check the oil level in the compressor, and add oil, as necessary. For instructions, refer to Group 01. If no other parts need purging, go to "Evacuating."

Purging or Flushing Lines and Parts

To purge or flush parts of the system other than the compressor, do the following:

IMPORTANT: When purging or flushing, always flow the liquid R-11 or the gas in the *opposite* direction of the flow of R-12 (in other words, backflush the parts).

1. Disconnect both ends of the part to be purged. Tightly cap the lines feeding the rest of the system.
2. Connect the gas pressure hose to the *downstream* end of the part; when R-11 is used to flush, connect a hose to the upstream end of the part, and place the open end of the hose in a disposal can. Wearing safety goggles, turn on the purge/flush tank. Check the upstream end to see that there is gas or liquid coming out.
3. If purging, use nitrogen or another dry, inert gas to purge the part for about 30 seconds at 200 psig (1378 kPa). Lower the pressure to 3 to 4 psig (21 to 28 kPa), and keep purging for three minutes.

   If flushing, use R-11 to flush the part for two to three minutes or until there is no trace of refrigerant oil or solid bits of dirt or grit flowing out with the R-11.
4. After purging or flushing, turn off the flow at the tank. Disconnect the hose(s); quickly cap the ports of the part, or connect it to the system. Tighten the fittings to the values in Table 2 under "Specifications." If the part was flushed, drain out any remaining liquid. Don't keep the ports opened to the air for longer than five minutes. Replace the receiver-drier.

EVACUATING[1]

Evacuating, also called dehydrating, places a deep vacuum in the system. When pressure is reduced to 1270 microns, the boiling point of water lowers to about 6°F (−14°C); this causes water and traces of R-11 in the refrigerant system to turn into gas; the gas flows into the pump and is absorbed by the vacuum pump oil; in this way, dehydration takes place. Table A shows the boiling temperature of water at various pressures.

At least a single-stage, ballasted, rotary vacuum pump (3 CFM capacity) is needed for evacuating the system. Pumps that are smaller than this may not lower pressures to 1000 microns or less in the system. Pumps that are larger and more costly will not really do a better or quicker job, due to limits of pulling a vacuum through service valves on the compressor and through small refrigerant lines.

[1] Portions of this information courtesy of Robinair Manufacturing Corp.

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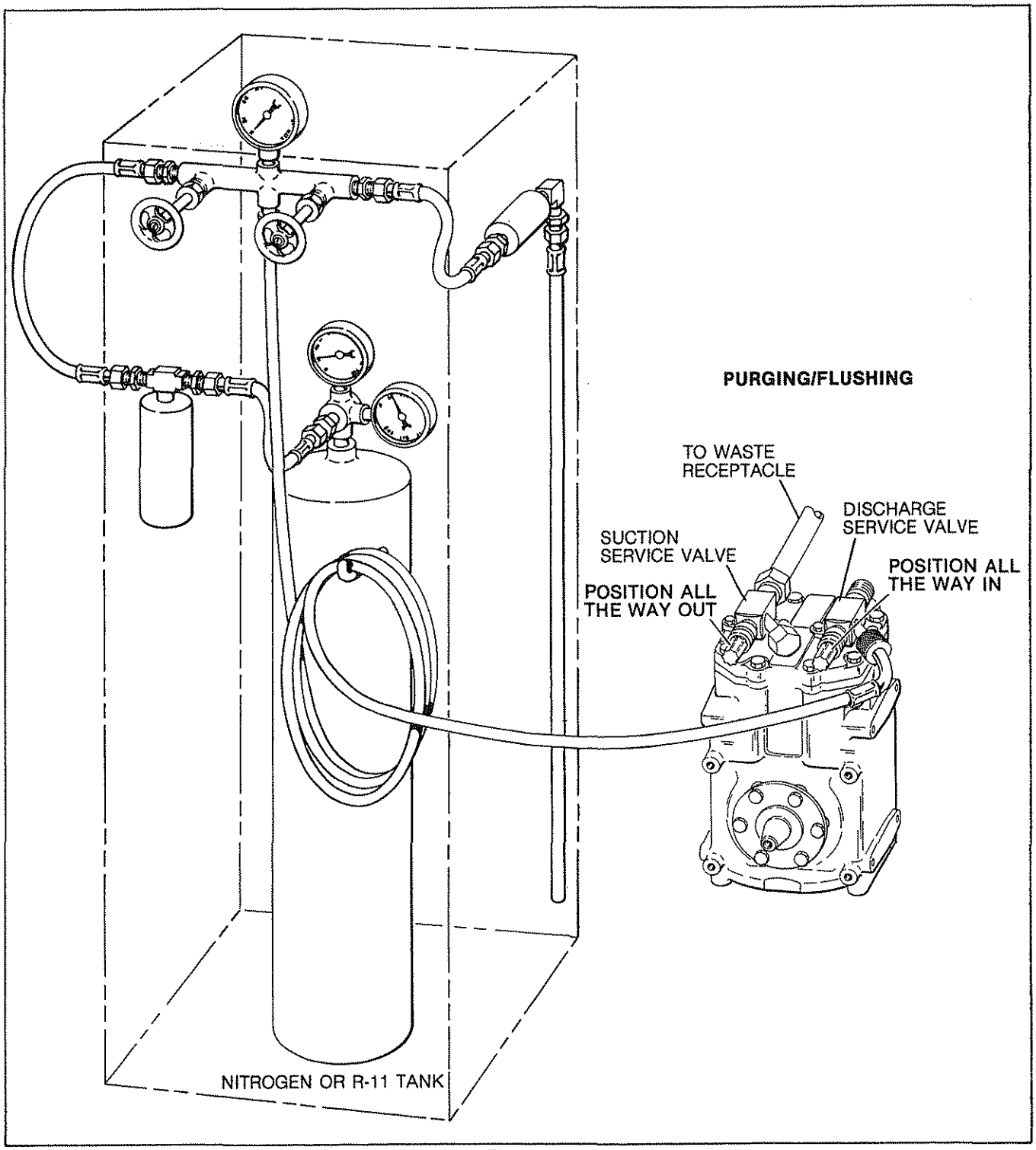

Fig. 32

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Temperature °F	Temperature (°C)	Pressure psia	Pressure inHg	Pressure (mmHg)	Pressure microns	Vacuum inHg	Vacuum (mmHg)
212	(100.00)	14.696	29.921	(759.993)	759993.4	0	(0)
205	(96.11)	12.770	26.000	(660.400)	660400.0	3.921	(0.1544)
194	(90.00)	10.169	20.704	(525.881)	523881.6	9.217	(0.3629)
176	(80.00)	6.8699	13.987	(355.269)	355269.8	15.934	(0.6273)
158	(70.00)	4.5207	9.2042	(233.787)	233786.7	20.7168	(0.81562)
140	(60.00)	2.8900	5.8842	(149.459)	149458.7	24.0368	(0.94633)
122	(50.00)	1.7987	3.6439	(92.555)	92555.1	26.2771	(1.03453)
104	(40.00)	1.0700	2.1786	(55.336)	55336.4	27.7424	(1.09222)
86	(30.00)	0.61540	1.2530	(31.826)	31826.2	28.668	(1.1287)
80	(26.67)	0.50701	1.0323	(26.220)	26220.4	28.8887	(1.13735)
76	(24.44)	0.44435	0.90472	(22.980)	22979.9	29.01628	(1.142373)
72	(22.22)	0.38856	0.79113	(20.095)	20094.7	29.12987	(1.146845)
69	(20.56)	0.35084	0.71432	(18.144)	18143.7	29.20668	(1.149869)
64	(17.78)	0.29505	0.60073	(15.259)	15258.5	29.32027	(1.154341)
59	(15.00)	0.24720	0.50330	(12.784)	12783.8	29.4177	(1.15818)
53	(11.67)	0.19888	0.40492	(10.285)	10285.0	29.51608	(1.162050)
45	(7.22)	0.14746	0.30023	(7.626)	7625.8	29.62077	(1.166172)
32	(0.00)	0.08858	0.1803	(4.580)	4579.6	29.7407	(1.17089)
21	(−6.11)	0.05293	0.1078	(2.738)	2738.1	29.8132	(1.17375)
6	(−14.44)	0.02521	0.05134	(1.304)	1304.0	29.86966	(1.175971)
−24	(−31.11)	0.004905	0.009987	(0.254)	253.7	29.911013	(1.1775989)
−35	(−37.22)	0.002544	0.0057795	(0.132)	131.6	29.915113	(1.1777603)
−60	(−51.11)	0.0004972	0.001012	(0.0257)	25.7	29.919988	(1.1779522)
−70	(−56.67)	0.0002443	0.0004974	(0.0126)	12.6	29.920503	(1.1779725)
−90	(−67.78)	0.0000526	0.0001071	(0.00272)	2.72	29.920893	(1.1779879)

Table A, Boiling Temperatures of Water at Converted Pressures

Proper and timely maintenance of vacuum pumps is important. As recommended by the pump builder, the oil has to be changed at regular intervals to prevent water build-up in the pump case, which will cause pitting and eventual pump failure.

Vacuum pump oil is one of the few water-soluble oils made. It allows the pump to create a high vacuum by absorbing water and sealing the pump's internal areas. Servicing three or four very wet air conditioner systems can completely soak (saturate) the pump oil.

As a rule, the pump should have its old oil flushed out each fourth time it is used and before storing it for long periods. Only vacuum pump oil should be used as a flush and for pump lubricant. Do not use any solvent or any other type of oil. Clean oil should be run through the pump until it runs out clean. Add oil to the fill line shown on the pump, and check the oil before each use.

1. The system must be discharged and, if contaminated, purged or flushed, and the compressor filled with the right amount of refrigerant oil. Make sure the hand valves on the manifold gauge set are closed. Then, tightly connect the manifold's service gauge hoses to the suction and discharge service valves at the compressor. See **Fig. 33**. Connect the manifold's center service hose to the vacuum pump.

NOTE: If a thermostatic vacuum gauge (thermistor) is used, connect the gauge between the manifold's center service hose and the vacuum pump.

2. If the compressor is equipped with Schrader service valves, open the manifold's low- and high-side hand valves. Turn on the vacuum pump.

   If the compressor is equipped with hand shut-off service valves, mid-seat (**Fig. 28**) the suction and discharge service valves. Open the manifold's low- and high-side hand valves. Turn on the vacuum pump.

3. When the low-side gauge reads at least 29.62 inHg (100 kPa) of vacuum, and the high-side gauge reads a little below the zero mark on the gauge, let the pump operate for another ten minutes. After ten minutes, close both of the manifold's hand valves, and shut off the vacuum pump.

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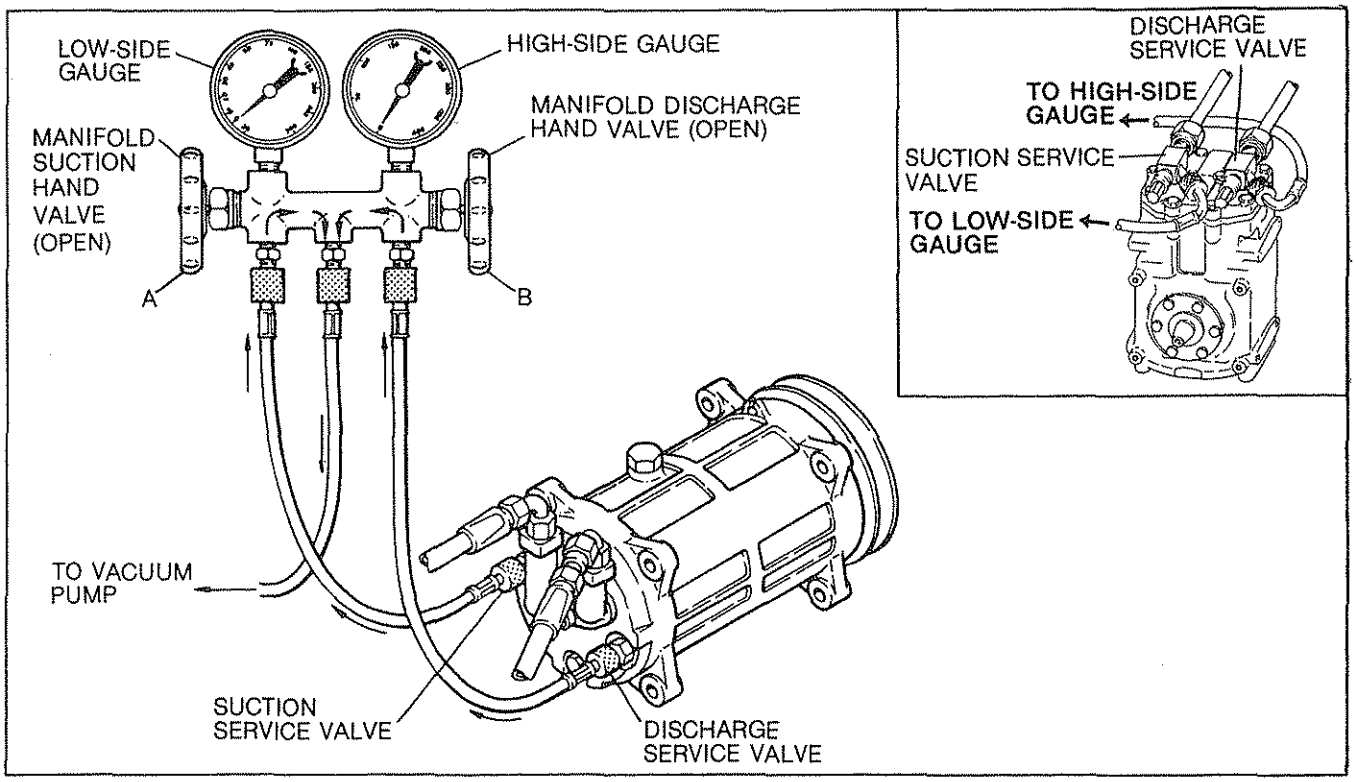

Fig. 33

4. If the low-side gauge reading rises after 15 minutes and keeps rising, the system has a leak. Install a partial charge of R-12, and then leak test the system.

   If the low-side gauge reading does not rise, open the manifold's hand valves, and turn on the vacuum pump. Let the pump run 1 to 1-1/4 hours. After this time, close both of the manifold's hand valves, and shut off the vacuum pump. Go to "Charging: Adding a Full Charge to the System."

CAUTION: It is not enough to evacuate a system until the pressure gauge reads at least 29.62 inHg (100 kPa) of vacuum. This gauge reading marks the point where water removal starts, not where it ends. In order to dehydrate the system, keep evacuating for up to 1-1/4 hours after the correct gauge reading is reached. Failure to do so will leave water in the system.

NOTE: If you are using a thermistor vacuum gauge to measure vacuum pressure, bring the pressure down to 1000 (or less) microns.

CHARGING

WARNING: Before doing any of the work below, read the information under "Safety Precautions." Failure to read the safety precautions, and to be aware of the dangers involved when working with R-12, could lead to serious personal injury.

The recommended way of charging a system is by adding R-12 as a gas. High-side liquid charging may cause liquid R-12 to enter the compressor; if this happens, it may cause a hydraulic lock in the compressor, and destruction of the unit.

If a charging cylinder is used—one that heats R-12 and allows the worker to make exact R-12 measurements—follow the instructions of the equipment manufacturer.

Adding a Full Charge to the System

NOTE: The system must be evacuated, with the manifold gauge set connected to the compressor, before a full charge can be added to the system.

1. If the compressor is equipped with hand shut-off service valves, back-seat (Fig. 28) both refrigerant compressor service valves. Proceed to step 2.

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If the compressor is equipped with Schrader service valves, proceed to step 2.

2. Obtain enough R-12 to fully charge the system. Refer to **Table 3,** under "Specifications," for system refrigerant capacities.

   If a tank (bulk quantities) is used, it should be set on a scale and its weight noted so that the correct amount of R-12 enters the system. This prevents overcharging, which could damage the compressor.

   If one-pound (454-gram) cans of R-12 are used, obtain enough to fully charge the system, with about 8 ounces (227 grams) extra.

NOTE: Each "one-pound" can actually holds 14 ounces (397 grams) of R-12.

3. Connect the manifold's center service hose to the R-12 can, as shown in **Fig. 34.** Do not release the R-12 at this time. Place the can in an upright position so that R-12 enters the system as a gas. *Do not allow liquid R-12 to enter the compressor by tipping the refrigerant can.*

CAUTION: If the R-12 can is tilted during service operations, liquid R-12 could enter the compressor through its suction port, which may damage the unit once it is turned on.

4. Loosen the manifold's center service hose connection two turns at the manifold. Refer to **Fig. 34,** Ref. C.

5. Open the valve on the R-12 can, and allow R-12 gas to escape from the loosened hose connection for 10 seconds or until the fitting is cold. This purges air from the hose, and prevents the air conditioner system from being contaminated with wet air.

   After 10 seconds, tighten the manifold's center service hose and turn off the valve on the R-12 can.

6. If the compressor is equipped with hand shut-off service valves, mid-seat (**Fig. 28**) the compressor suction and discharge service valves with the engine off. Proceed to step 7.

   If the compressor is equipped with Schrader service valves, proceed to step 7.

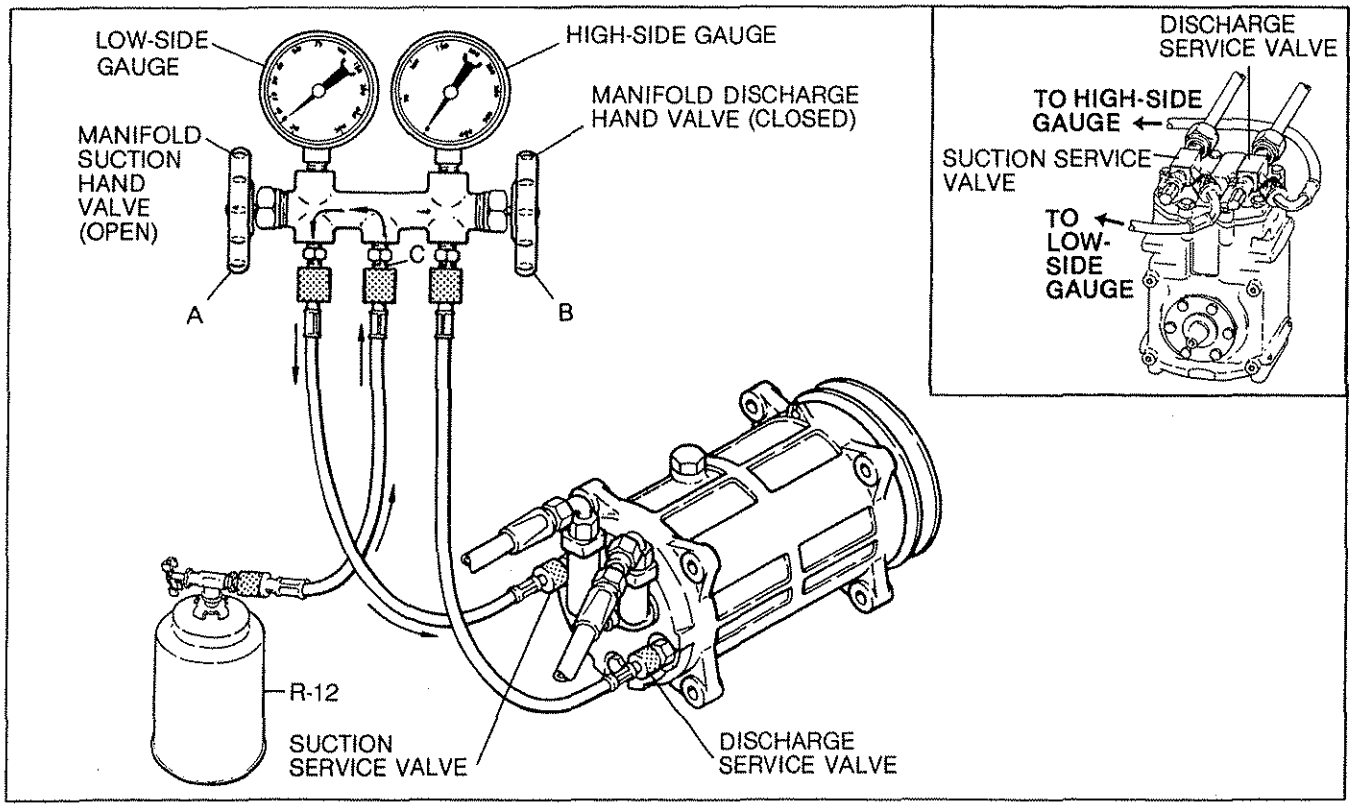

Fig. 34

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7. With the engine off, open the manifold's low-side hand valve (**Fig. 34**, Ref. A). Do not open the manifold's high-side hand valve (**Fig. 34**, Ref. B).

8. Open the valve on the R-12 can, and allow the specified amount of R-12 to enter the system.

IMPORTANT: On bulk quantity tanks, larger hoses are used. These hoses alone may carry 8 ounces (227 grams) or more of R-12.

9. Close the valve on the R-12 can. If a full charge did not enter the system, the rest will be added while the compressor is on.

10. Start the engine and run it at 1500 rpm. Set the cab air conditioner controls at maximum cooling and fan speed; the refrigerant compressor must engage. Open the valve on the R-12 can; leave the valve open until a full charge of R-12 has entered the system. Close the valve on the R-12 can.

    To know when a one-pound can is empty, tap it on the bottom; a hollow ringing will be heard. *Do not tip the refrigerant can.*

NOTE: If R-12 is slow to enter the system because of low outside temperatures, vaporization can be quickened by placing the R-12 can in a tub of warm water, no warmer than 125°F (52°C).

WARNING: Any other way of warming R-12, such as using a torch, is dangerous and should never be tried. Using extreme heat on an R-12 can could cause an explosion and serious bodily injury.

11. When enough R-12 has entered the system, look at the sight glass on the receiver-drier. No frothing or bubbles should appear when the compressor is on. If there are bubbles, there is either a leak in the system or not enough R-12 was installed. If frothing occurs, leak test the system.

12. While the compressor is engaged, check the operating pressures at the suction and discharge ports. Refer to **Table 4** under "Specifications." If the operating pressures are not acceptable, refer to the troubleshooting chart under "Troubleshooting" for possible causes.

13. Stop the engine. Close both manifold hand valves.

    If the compressor is equipped with hand shut-off service valves, back-seat (**Fig. 28**) both of the compressor service valves.

14. All of the manifold gauge hoses are under pressure. *Slowly* disconnect them from the compressor and the R-12 can. Install the caps on the compressor's service valves.

Adding a Partial Charge to the System

1. Leak test the system, to determine if R-12 is being lost at one of the hose connections or other parts. Tighten any loose connections.

2. If the compressor is equipped with hand shut-off service valves, back-seat (**Fig. 28**) both of the compressor service valves. Proceed to step 3.

   If the compressor is equipped with Schrader service valves, proceed to step 3.

3. Make sure the hand valves on the manifold gauge set are *closed.* Then, connect the manifold's service gauge hoses to the suction and discharge service valves at the compressor as shown in **Fig. 34.**

4. Connect the manifold's center service hose to the R-12 can, as shown in **Fig. 34.** Do not release the R-12 at this time. Place the can in an upright position so that R-12 enters the system as a gas. *Do not let liquid R-12 enter the compressor by tipping the refrigerant can.*

CAUTION: If the R-12 can is tilted during service operations, liquid R-12 could enter the compressor, which may damage the unit once it is turned on.

5. Loosen the manifold's center service hose connection two turns at the manifold. Refer to **Fig. 34**, Ref. C.

6. Open the valve on the R-12 can, and allow R-12 gas to escape from the loosened hose connection for 10 seconds or until the fitting is cold. This purges air from the hose, and prevents the air conditioner system from being contaminated with wet air.

   After 10 seconds, tighten the manifold's center service hose and turn off the valve on the R-12 can.

7. With the engine off, open the manifold's *low-side* hand valve (**Fig. 34**, Ref. A). Do not open the manifold's high-side hand valve (**Fig. 34**, Ref. B).

   If the compressor is equipped with hand shut-off service valves, mid-seat (**Fig. 28**) the compressor suction and discharge service valves.

8. Start the engine and run it at 1500 rpm. Set the cab air conditioner controls at maximum cooling and

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fan speed; the refrigerant compressor must engage. Open the valve on the R-12 can, and add a partial charge to the system in 4-ounce (113-gram) increments. *Do not overcharge the system.*

NOTE: If R-12 is slow to enter the system because of low outside temperatures, vaporization can be quickened by placing the R-12 can in a tub of warm water, no warmer than 125°F (52°C).

WARNING: Any other way of warming the R-12, such as using a torch, is dangerous and should never be tried. Using extreme heat on an R-12 can could cause an explosion and serious bodily injury.

9. When 4 ounces (113 grams) of R-12 has entered the system, look at the sight glass on the receiver-drier. No frothing or bubbles should appear when the compressor is on. If there are bubbles, the system needs more R-12. Add increments of R-12 to the system until the bubbles stop.

10. While the compressor is engaged, check the operating presssures at the suction and discharge ports. If the operating pressures are not acceptable, refer to the troubleshooting chart under "Troubleshooting," for possible causes.

11. Stop the engine. Close both manifold hand valves.

    If the compressor is equipped with hand shut-off service valves, mid-seat (**Fig. 28**) the compressor suction and discharge service valves.

12. All of the manifold gauge hoses are under pressure. *Slowly* disconnect them from the compressor and the R-12 can. Install the caps on the compressor's service valves.

R-12 CHARGE CHECKING[1]

WARNING: Before doing any of the work below, read the information under "Safety Precautions." Failure to read the safety precautions, and to be aware of the dangers involved when working with R-12, could lead to serious personal injury.

In a system that is fully charged, at ambient temperatures higher than 70°F (21°C), no bubbles will show in the receiver-drier sight glass when the compressor is operating. Some bubbles will show after the compressor stops. Very high ambient temperatures may cause occasional bubbles when the compressor is running; this is normal.

1. Remove all dirt from the receiver-drier sight glass.

2. Start the engine and set it to run at 1500 rpm. Turn on the heater-air conditioner blower, and set the air conditioner temperature controls to the coldest setting, so that the compressor is operating.

3. After operating the air conditioner for at least five minutes, check for bubbles in the receiver-drier sight glass, while the compressor is on. If no bubbles show, proceed to step 5.

   A constant stream of bubbles or frothing usually means that the system is undercharged. If the outside temperature is cooler than 70°F (21°C), partly block the air to the condenser; look at the sight glass again. If the bubbles disappear, there is enough R-12 in the system and no further checking is necessary. If the bubbles continue, the system needs more R-12.

4. If the system is undercharged, check for and repair any leaks, then add a partial charge to the system, in 1/4-pound (113-gram) increments.

NOTE: In a good system, the refrigerant hoses are always under pressure. A loss of some R-12, from one season to the next, is normal and does not always mean that air has been drawn into the system, or that the R-12 has become contaminated. A complete recharge of the system is needed only when the R-12 has leaked out to where the system is nearly empty.

Repeat steps 2 and 3, above, after adding each 1/4-pound (113-gram) increment of R-12, until the sight glass is clear.

5. If no bubbles show in the sight glass, the R-12 may have leaked out of the system, the system may be overcharged, or the system may have enough R-12.

   Very briefly touch the compressor's suction and discharge hose connections (with the compressor still running). The suction connection should feel cool; the discharge connection should feel warm.

   If no temperature difference is felt, the system is nearly empty. Partially charge and leak test the system; then, discharge the system.

   If a temperature difference is obvious, disengage the compressor clutch by pulling apart the wire connection near the clutch coil; then quickly check for bubbles in the receiver-drier sight glass.

   If bubbles begin to appear in less than fifteen seconds, and R-12 settles away from the sight

[1] Portions of this information courtesy of Draf Industries.

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glass in less than forty-five seconds, it is likely that the system has enough R-12.

If the sight glass remains clear for longer than fifteen seconds, the system has too much R-12.

Partially discharge the system, then repeat the steps above, until normal conditions are seen at the sight glass.

LEAK TESTING[1]

WARNING: Before doing any of the work below, read the information under "Safety Precautions." Failure to read the safety precautions, and to be aware of the dangers involved when working with R-12, could lead to serious personal injury.

R-12 is odorless; as a result, all of it may leak away and not be noticed until the system stops cooling. All vehicle refrigerant systems lose some R-12, depending on the condition of the system. In systems that are in good condition, R-12 losses of up to one-half pound per year are considered normal. Higher loss rates signal a need to locate and repair the leaks.

Leaks are most often found at the compressor hose connections and at the various fittings and joints in the system. R-12 can be lost through hose permeation. Leaks can also be traced to pinholes in the evaporator caused by acid, which forms when water and R-12 mix.

Methods of Leak Detection

There are four ways of finding the locations of leaks. In all cases, focus your attention on the lowest portion of the fitting or part being tested. R-12 is heavier than air and will collect at the low point. Oil will also flow toward the low point. Listed in sequence from least precise to most precise, the methods are:

1. *Sight and touch.* Many larger leaks will cause oil to escape along with R-12 at the point of the leak. A deposit of oil may be a sign of a leak.
2. *Soapsuds solution.* A solution of soap and water can be squirted onto a suspected fitting or part. If the leak is large enough it will cause bubbles to form in the soapy solution at the point of the leak.
3. *Flame-Type propane leak detectors.* A professional leak detector is necessary to find most small leaks and is much less messy than a soapsuds solution as a means for spotting a large leak. A propane leak detector is actually a small torch; when the flame comes in contact with escaping R-12, the flame will change color. The disadvantages of these leak detectors are that *they present a fire hazard if not used with caution* and that when R-12 contacts the flame, *it will give off poisonous phosgene gas.* Therefore, when a flame-type detector must be used, it should be used only in work areas that have a constant supply of fresh air.
4. *Electronic Leak Detectors.* A fairly recent development, electronic leak detectors are battery or 115-volt powered and rely on a very sensitive signal when a leak is found. In addition to being very precise, electronic leak detectors can be used in tight places, do not present a fire hazard, and because no flame is used, will not create phosgene gas.

NOTE: Do not try to use a leak tester right after connecting or disconnecting service hoses. Traces of R-12 at the fittings can falsely signal a leak.

How to Use a Flame-Type Leak Detector

WARNING: If a flame-type leak detector must be used, do the work outdoors where there is a constant supply of fresh air. When in contact with extreme heat, R-12 breaks down into poisonous phosgene gas which, if breathed, causes severe respiratory irritation. Also, keep the flame away from all fire hazards, such as fuel lines and tanks, and ether-injection starting systems. Do not use a flame-type leak detector inside the cab. Before testing for a leak, read "Safety Precautions."

1. Wearing safety goggles, open the propane supply valve and light the torch.
2. Adjust the flame high enough to heat the reactor plate inside the chimney to a bright red color.
3. Lower the flame until it is just high enough to keep the reactor plate bright red.
4. Hold the torch assembly away from any fire hazards, and place it so that you can observe the flame without breathing the fumes that may be emitted.
5. Probe the undersides of suspected parts or fittings with the open end of the pick-up hose.
6. Watch for a flame color change that will occur if R-12 enters the pick-up tube. Following is a guide of color changes:

   .1 Pale blue flame: no R-12 is escaping.

[1] Portions of this information courtesy of Draf Industries.

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.2 Pale yellow flame: very small amount of R-12 is escaping.

.3 Bright yellow flame: small amount of R-12 is escaping.

.4 Purple-tinted blue flame: large amount of R-12 is escaping.

.5 Violet flame: very large amount of R-12 is escaping.

TROUBLESHOOTING

PRELIMINARY CHECKS

Before testing the operation of the air conditioner system, make the following checks:

1. Make sure the refrigerant compressor's drive belt is not damaged and is correctly tensioned. Also check the compressor mountings for tightness. For instructions and other information, refer to Group 01.
2. Using a feeler gauge, check for correct refrigerant compressor clutch clearance. For instructions, refer to Group 01.
3. Check for broken, burst, or cut hoses; also check for loose fittings on all parts.
4. Check for road debris build-up on the condenser coil fins. Using air pressure and a whiskbroom or a soapy spray of water, carefully clean off the condenser; be careful not to bend the fins.
5. Check the moisture indicator sight glass for the moisture content of the R-12 and check the receiver-drier sight glass for the state of the charge. The air conditioner should be on when checking the indicator; you should make this check at the end of a day's run. Replace the charge if it is wet. If there are bubbles in the receiver-drier sight glass, the R-12 charge is probably low; add more R-12 to the system.
6. If there is not enough airflow, make sure that leaves or other debris has not entered the fresh air ports under the windshield. If debris has entered, it could clog the fins of the evaporator coils, and block airflow.

   Also, be sure that all ducts are connected to the dash louvers and that the air-control flaps in the heater housing are moving properly (this requires removal of the right-side dash panel cover and the left-side dash top access cover).

PERFORMANCE TESTS

Following is a brief description of symptoms or conditions that will exist if something goes wrong in a refrigerant part.

Cooling Check

IMPORTANT: When outside temperature and humidity are high, it will take longer to cool the cab, especially if the fresh air vents are left open.

To determine if the air conditioner is cooling enough:

1. Run the engine at 1500 rpm. Turn on the air conditioner; set the controls at maximum cooling (recirculated air) and blower speed. The compressor must be engaged during this test.
2. Allow the system to run for at least 10 minutes (longer on hot and humid days).
3. Place a thermometer inside the louver or air duct that blows on the driver; make sure the controls are set so that air flows out of the duct being tested.
4. When outdoor temperatures are 100°F (38°C) or lower, the duct's air temperature should range between 50° and 60°F (10° and 16°C).

   If outdoor temperatures are higher than 100°F (38°C), the duct's air temperature will rise about 1°F for every 1°F rise above 100°F. For example, if the temperature outside is 105°F (41°C), the duct's air temperature will range between 55° and 65°F (13° and 18°C).

If the system isn't cooling enough, refer to the troubleshooting chart for possible causes.

R-12 Check

There are four conditions to look for when checking R-12 in the sight glass of the receiver-drier.

1. The presence or absence of bubbles tells whether or not the system has enough R-12. If the system is merely low on R-12 (not completely out of R-12) the bubbles that normally show only when the system is started and disappear after a few seconds *will continue all the time* the system is running. Only an occasional bubble should be seen during normal operation.
2. A clear sight glass means that the system has enough R-12 to work properly, that it is completely out of R-12, or that it is overcharged.

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

3. A cloudy sight glass means that dirt or broken-down bits of dessicant are flowing through the system. This is a serious condition that requires a complete flushing out of the system with R-11, installation of a new receiver-drier, and, if the dessicant cartridge of the receiver-drier has fallen apart, installation of a new refrigerant compressor.
4. Oil streaks in the sight glass mean low R-12 or too much oil in the system.

Receiver-Drier

The receiver-drier is normally at ambient temperature. To the touch, the entire length of the unit should be the same temperature. If noticeable cool spots exist, replace the receiver-drier.

A blockage at the inlet of the unit will cause high head pressures; outlet blockages will cause low head pressures and little or no cooling.

If the moisture indicator shows that the system is wet, the receiver-drier is saturated with water and acid, and must be replaced.

Cooling System

Although they are not physically connected, there is a close tie between a vehicle's air conditioner and its cooling system. Poor air conditioner cooling can be the result of a problem in the cooling system.

If the cooling system does not work properly the heat of the engine will rise to abnormal levels. The added heat will transfer to the air conditioner, other underhood parts, and maybe make its way into the cab. The added heat makes it necessary for the air conditioner to work harder and, at the same time, it reduces the air conditioner's ability to cool down the air in the cab.

Refer to Group 20 for cooling system troubleshooting and to the engine manufacturer's service manual for other details about cooling system problems.

Expansion Valve

Problems that start in the expansion valve show up as follows: when stuck closed, the evaporator coil and the expansion valve will be at outside temperature; when stuck open, both the coil and the valve will be extremely cold with frost or ice build-up.

Because the expansion valve is very sensitive to contamination, blockages in the system tend to be found here. Usually, the contaminant is water; less than a drop of water is all it takes to make the valve inoperative. When water reaches the valve, the extreme cold that results from the pressure drop freezes the water, forming a block of ice in the valve. After the system shuts down and the valve warms up, the ice melts, and the valve operates again, only to freeze up when the water returns.

On-and-off operation of the expansion valve means that the receiver-drier is not removing water and acids from the system. These contaminants should cause the moisture indicator's element to turn pink.

Refrigerant Compressor

Compressor problems usually show in one of four ways: abnormal noise; seizure; leakage; or low suction and discharge pressures.

Resonant compressor noises are not causes for alarm; irregular noise or rattles are likely to be caused by broken parts. To check for seizure, de-energize the magnetic clutch and see if the drive plate can be turned. If it won't turn, the compressor has seized.

Low discharge pressure may be caused by not enough R-12 or a blockage somewhere in the system. These things should be checked before servicing the compressor.

Evaporator

The evaporator coil is basically trouble-free when airflow over the fins is not blocked. External or, less often, internal blockages will cause low head pressure as well as little or no cooling.

If hydrochloric acid has formed in the system (the result when R-12 mixes with water), it may cause pinholes to form in the evaporator coil. If a leak exists in the system, and it cannot be traced to other parts or fittings, suspect damage to one of the evaporator coils.

Condenser

The condenser is also usually trouble-free when road debris, such as leaves or dirt build-up, is removed. If debris cakes up, airflow over the condenser fins is blocked; air is not able to absorb enough heat to turn the hot R-12 gas into a liquid. High head pressures will result. In these cases, carefully clean off the outer surfaces of the condenser with compressed air or a soap and water solution; be careful not to bend the fins.

High head pressures will also occur if the condenser's tubing is abnormally bent, blocking the flow of R-12.

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Less common internal blockages (foreign bits or metallic grit build-up) will stop the flow of R-12.

A quick test to check that poor system performance is caused by the condenser is to direct a spray of water onto the condenser while the system is running. If the air conditioner cools better because of the assist provided by the water, it is a sign that the condenser is not working.

When troubleshooting a suspected condenser problem, remember that the problem may be caused by the cooling system transferring high levels of heat to the condenser. Refer to Group 20 for cooling system troubleshooting and to the engine manufacturer's service manual for other details about cooling system problems.

Thermostatic Switch

IMPORTANT: Before troubleshooting the thermostatic switch, *be sure there is a full charge of R-12 in the system.* The compressor will not operate, or will cycle too often, if there is not enough R-12 in the system.

Quick or delayed cycling of the compressor may be caused by a thermostatic switch that is working, but is out of adjustment. If, after doing the tests below, the switch seems to be out of adjustment, replace it (the thermostatic switches cannot be recalibrated).

1. Be sure the compressor clutch is operating correctly. Refer to Group 01 for instructions.
2. Expose the evaporator coil. Refer to "Evaporator Coil Replacement," for instructions.
3. Connect the batteries and start the engine. Place the air conditioner control at its coldest setting; turn on the air conditioner and the fan.
4. Place an accurate thermometer in contact with a tube on the evaporator coil. Be sure the thermometer is in good contact with the tube, or you will get a wrong reading.

   When the temperature drops below 31° to 36°F (−1° to 2°C), the compressor clutch should disengage and remain this way until the temperature rises to 39° to 44°F (4° to 7°C).
5. If the compressor did not engage when the temperature was above the accepted high range, do the following test:

   .1 Connect a voltmeter or a test light from one of the terminals on the thermostatic switch to ground. Repeat this test with the other terminal on the switch.

   .2 With the engine running and the air conditioner and blower on, both terminals will show voltage when the compressor should be engaged; one terminal will show voltage when the compressor should be disengaged.

   If there is no voltage, there is a problem in the electrical system from the batteries to the thermostatic switch. Check all circuits for the cause, and repair or replace the wiring or parts.

   In all other cases where the compressor is not engaging and disengaging properly, the thermostatic switch is the cause. Replace it with a new switch.
6. Shut the engine down and, to prevent accidental electric shock or shorting during dash assembling, disconnect the batteries.
7. Assemble the dash; refer to "Evaporator Coil Replacement," for instructions.

Line Restrictions

A restricted suction line causes low suction pressure at the compressor, low discharge pressure, and little or no cooling. A liquid line blockage can cause low discharge and suction pressure, and insufficient cooling.

Usually, areas of ice or frost build-up mean a blockage. Parts that often freeze up are probably corroded or inoperative and should be replaced. Parts (such as one of the expansion valves) that freeze up once in a while may do so because of water in the system, which will cause the moisture indicator's element to turn pink; if this happens, replace the receiver-drier, purge or flush the lines and parts, and install a new charge.

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

TROUBLESHOOTING CHART

PROBLEM	POSSIBLE CAUSE	CORRECTION
Little or No Airflow	The blowers are not operating.	Check for an open circuit breaker. An open circuit indicates a short in the electrical system, which must be located and repaired.
		Check the air conditioner relays for operation. Replace, as necessary.
		Make sure the blower motor switch is working. Replace, if necessary.
		Check the wiring to the blower motors. If any connections are loose, securely tighten them. Make sure the wiring conforms to the diagram (Fig. 35 or 36) under "Specifications."
		Check the blower motors for operation. Replace if sticking or otherwise inoperative.
		Check for an inoperative resistor block (Fig. 35 or 36). Replace, if necessary.
	There are restrictions or leaks in the air ducts.	Examine all air ducts and remove any blockages. Stop any leaks or replace any portion where the leaks cannot be stopped.
	Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Review "Performance Tests" in this section for possible causes and corrective action.
Warm Airflow When the Air Conditioner Is On	There is no refrigerant charge in the system.	Perform a leak test. Stop any leaks, purge the system, replace the receiver-drier, and add a full charge of refrigerant.
	Moisture is in the system.	If moisture is in the system, ice crystals may form at the expansion valve, blocking the flow of refrigerant (off and on). Exhaust the refrigerant charge, purge the system, replace the receiver-drier, and add a full charge of refrigerant.
	The refrigerant compressor is not operating.	If the ambient temperature is too low, the low-pressure or trinary switch disengages the compressor. Allow the temperature to rise before operating the air conditioner for extended periods.
		The refrigerant compressor clutch or drive belt needs repair or replacement. For instructions, refer to Group 01 of this manual.
		If the refrigerant charge is low, charge and leak test the system. Repair any leaks. When the system is low on refrigerant, the low-pressure or trinary switch will disengage the compressor.

(Continued on next page)

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

TROUBLESHOOTING CHART (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Warm Airflow When the Air Conditioner Is On (continued)	The refrigerant compressor is not operating. (continued)	If equipped, the trinary switch has shut off the compressor because of excessive cylinder head pressure. Check for restrictions at the condenser, expansion valve, and receiver-drier, an overcharge of refrigerant, or radiator shutters that are stuck closed.
		Replace the inoperative low-pressure or trinary switch. For detailed service instructions on the trinary switch, refer to Group 05 of this manual.
	The air conditioner toggle switch is not working.	Replace the toggle switch.
	Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Review "Performance Tests" in this section for possible causes and corrective action.
Foaming in the Receiver-Drier Sight Glass	There is an insufficient refrigerant charge in the system.	Add refrigerant.
	There are leaks in the system.	Perform a leak test. Stop all leaks, exhaust the old refrigerant from the system, and add a new charge.
	Restrictions in the line between the condenser and the receiver-drier are preventing refrigerant flow.	Remove the restrictions from the line. If water or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
Low Evaporator Coil Outlet Pressure (Low Compressor Suction Pressure)	The thermostatic expansion valve is not working.	Replace the thermostatic expansion valve. If water or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
	There are restrictions in the line to the thermostatic expansion valve.	Remove the line restrictions. If water or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
	There is an insufficient refrigerant charge in the system.	Add refrigerant.
High Compressor Discharge Pressure	The shutters are not opening.	Replace the shutter solenoid valve, or the trinary switch, or both.
	Airflow through the condenser is restricted.	Remove the debris from the condenser.
	There is an internal restriction in the condenser. (The return tube bends should all be the same temperature.)	Replace the condenser. If water or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
	Air is present in the system.	Perform a leak test. Stop all leaks, purge the system, and add a full charge of refrigerant.

(Continued on next page)

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

TROUBLESHOOTING CHART (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
High Compressor Discharge Pressure (continued)	The system has too much refrigerant.	Drain some of the refrigerant charge at the compressor discharge service valve.
	Heavy frosting on the suction line suggests that the evaporator coil is flooded.	Defrost the evaporator coil before resuming operation of the air conditioner. If the problem reoccurs, there is probably moisture (ice crystals) blocking the expansion valve. Exhaust the refrigerant charge, purge the components, replace the receiver-drier, and add a full charge of refrigerant.
	The engine is over-heated.	Refer to the engine manufacturer's operations manual for corrective measures.
Evaporator Outlet Air Temperature Increases as the Compressor Discharge Pressure Drops	There are leaks in the system.	Leak test the system. Stop all leaks, exhaust the old refrigerant, and add a full charge of refrigerant.
	The thermostatic expansion valve setting is too low.	Replace the thermostatic expansion valve. Add a full charge of refrigerant.
	Too much oil is in the system. An indication of this is clutch or belt slippage at governed engine speed.	Check and remove excess refrigerant oil. For instructions, refer to Group 01 of this manual.
Compressor Operates Long or Continuously	There is too little refrigerant in the system.	Perform a leak test. Stop any leaks, and add a full charge of refrigerant. Make sure the low-pressure or trinary switch is operative.
	Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Check the operation of the thermostatic switch and replace, as necessary.
	There is a restriction in the refrigeration system.	Remove the restriction from the line. If water or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
	Dirt and debris are clogging the condenser fins.	Remove all dirt and debris from the condenser fins.
	The thermostatic switch isn't working.	Replace the thermostatic switch.
Compressor Is Not Operating *(See "Warm Airflow When the Air Conditioner Is On")*		
Quick or Delayed Cycling of the Compressor	The thermostatic switch operates, but is out of adjustment.	Replace the thermostatic switch. Do not attempt to adjust it.
	Loss of refrigerant is causing a delayed cycling of the compressor.	Leak test and add a full charge of refrigerant.
Temperature in the Cab Too Low or No Heat	The water modulating valve is not opened.	Slide the temperature lever slide control toward "Max Heat."

(Continued on next page)

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

TROUBLESHOOTING CHART (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Temperature in the Cab Too Low or No Heat (continued)	The water regulating valve isn't working.	Replace the water regulating valve.
	A heater hose is pinched or twisted.	Repair or replace the heater hose.
	Coolant is leaking from the system.	Check for leakage at the heater core, and at all hose connections from the heater core to the engine. Check the radiator coolant level, as instructed in the Freightliner *Driver's Manual,* and add coolant, if necessary. Check and stop any leaks at the radiator.
	Dust or dirt is clogging the heater core fins.	Remove and clean the heater core.
Condensed Water Is Leaking From the Air Conditioner	The drain tubes are plugged.	Clean the drain holes and drain tubes.
	There is an improper seal at the main access cover.	Check the rubber seal/angle installation. If broken, crimped, or otherwise damaged, replace the seal.

SPECIFICATIONS

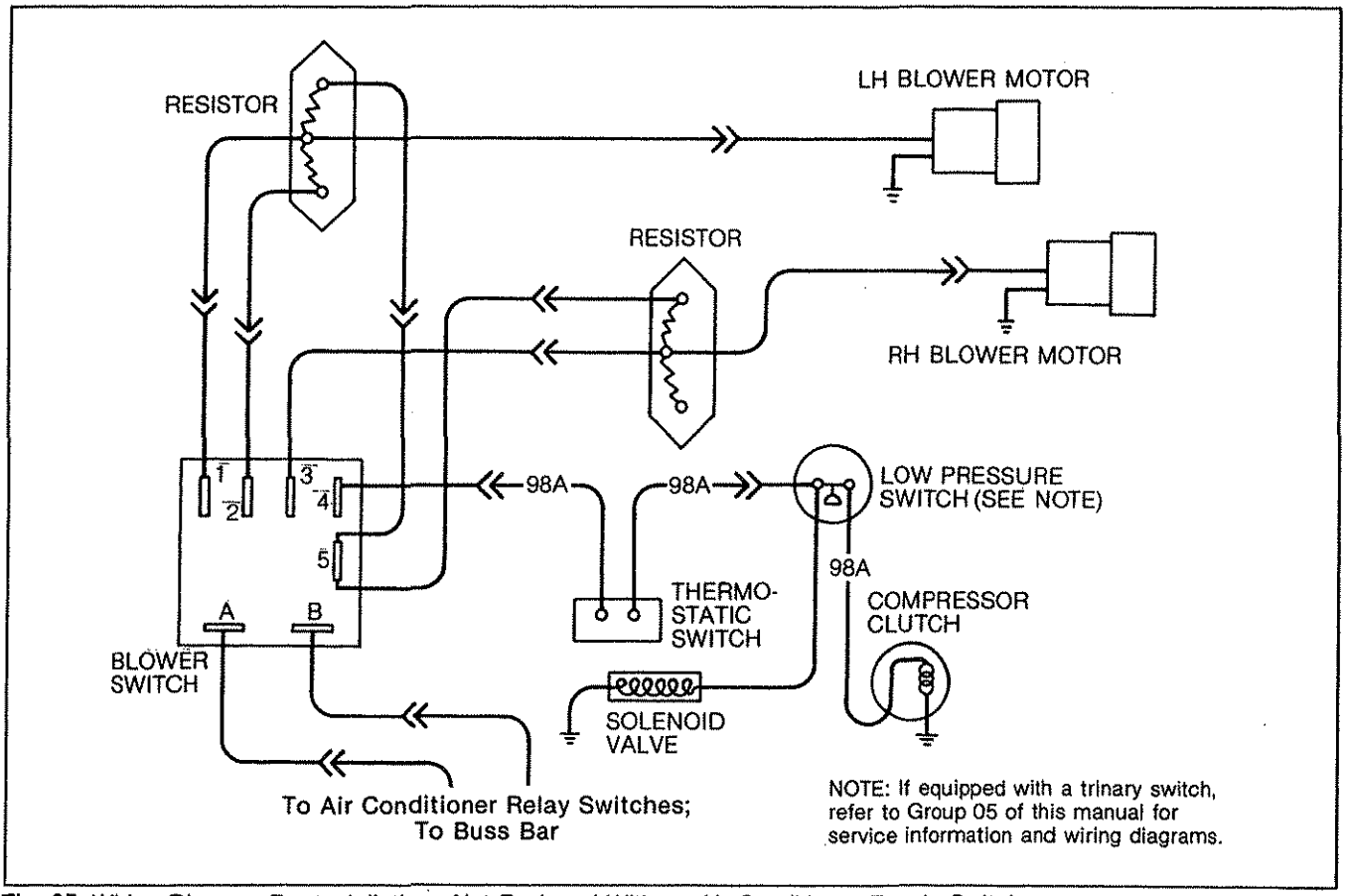


Fig. 35, Wiring Diagram For Installations Not Equipped With an Air Conditioner Toggle Switch

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

SPECIFICATIONS (Continued)

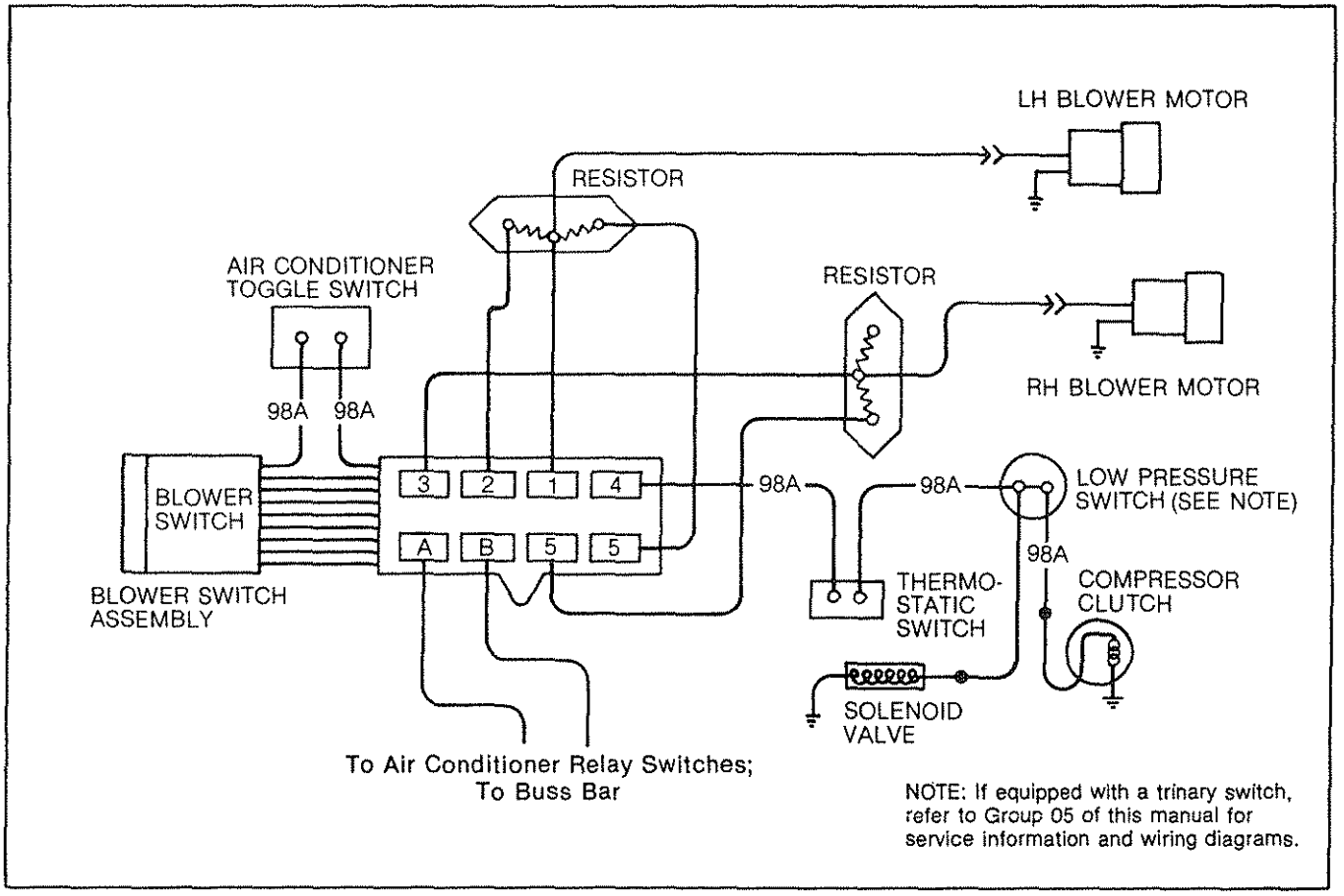


Fig. 36, Wiring Diagram For Installations Equipped With an Air Conditioner Toggle Switch

Tighten Nut Finger-Tight; Then With Wrench, Tighten Further as Follows:				
FITTING SIZE	TUBE (inches)	TURNS REQUIRED TO SEAL FROM FINGER-TIGHT		
		COMPRESSION	THREADED SLEEVE	SAE 45° FLARE
2 3 4	1/8 3/16 1/4	1-1/4	1-1/2	1/6 DO NOT OVERTORQUE
5	5/16	1-3/4		
6 8 10 12 16 20	3/8 1/2 5/8 3/4 1 1-1/4	2-1/4		

Table 1, Air Tubing Fitting Torque Specifications

FREIGHTLINER HEATER-AIR CONDITIONER, ADVANCED INTERIOR SYSTEM

SPECIFICATIONS (Continued)

OUTSIDE DIAMETER FOR METAL TUBE (IN INCHES)	TORQUE FOR STEEL TUBES[1] lbf·ft (N·m)	TORQUE FOR ALUMINUM OR COPPER TUBES[1] lbf·ft (N·m)
1/4	10–15 (14–20)	5–7 (7–9)
3/8	30–35 (41–47)	11–13 (15–18)
1/2	30–35 (41–47)	15–20 (20–27)
5/8	30–35 (41–47)	21–27 (28–37)
3/4	30–35 (41–47)	28–33 (38–45)

Table 2, Refrigerant Line Torque Specifications

[1]When tightening fittings, always use the torque reading for the softer metal when unlike metals are used.

AIR CONDITIONER INSTALLATION		CAB LENGTH	REFRIGERANT CAPACITY[1] ounces (grams)	REFRIGERANT CAPACITY[2] ounces (grams)
COE with radiator-mounted condenser		All	44 (1247)	51 (1446)
COE with roof-mounted condenser		51″ and 63″ 72″, 75″ and 81″ 86″ and 96″ 104″	44 (1247) 46 (1304) 52 (1474) 56 (1587)	51 (1446) 53 (1503) 59 (1673) 63 (1786)
Conventional with radiator-mounted condenser	Without sleeper box heater-air conditioner	115″ and 120″	42 (1191)	49 (1389)
	With sleeper box heater-air conditioner		52 (1474)	59 (1673)
Conventional with roof-mounted condenser	Without sleeper box heater-air conditioner		48 (1361)	55 (1559)
	With sleeper box heater-air conditioner		58 (1644)	65 (1843)

Table 3, System Full-Charge Refrigerant Capacity Specifications

[1] With a six cubic inch receiver-drier
[2] With a twelve cubic inch receiver-drier

AMBIENT TEMPERATURE	SYSTEM PRESSURE	
	LOW-SIDE psig (kPa)	HIGH-SIDE psig (kPa)
70°F (21°C) to 80°F (27°C)	20–25 (138–172)	160–180 (1102–1240)
80°F (27°C) to 90°F (32°C)	25–30 (172–207)	180–200 (1240–1378)
90°F (32°C) or higher	30–35 (207–241)	200–220 (1378–1516)

Table 4, Temperature/Pressure Specifications

Torque for Swashplate Compressor Fittings		
Ports	**Aluminum Valve Body lbf·ft (N·m)**	**Iron Valve Body lbf·ft (N·m)**
#10 Suction	14-18 (19-24)	26-31 (35-42)
#8 Discharge	14-18 (19-24)	24-29 (33-39)

Table 5, Compressor Fitting Torque Specifications

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

GENERAL DESCRIPTION

National Cush-N-Aire® seats, models 95 and 195, are air suspension seats. The seat assembly is equipped with an air spring supplied with air from the vehicle air system. The model 95 seat is equipped with a low back cushion and low upper frame (see Fig. 1), while the model 195 seat is equipped with a high back cushion and high upper frame (see Fig. 2). Both models operate on identical mechanical principles, and have identical adjustments. For operating instructions, refer to the Freightliner Drivers Manual.

SERVICE OPERATIONS

NOTE: Service or replacement of most of the seat components does not require removal of the seat from the vehicle. If the vehicle cab does not provide sufficient work area, the seat can be removed from the vehicle. For instructions, refer to "SEAT ASSEMBLY REMOVAL AND INSTALLATION."

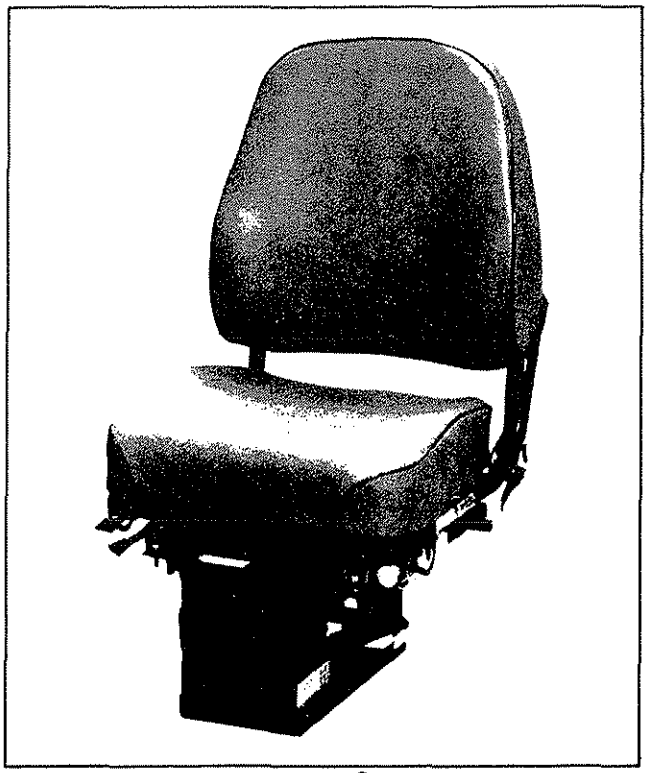


Fig. 1, National Cush-N-Aire® Seat, Model 95

AIR SPRING REPLACEMENT (Refer to Fig. 3)

1. Raise the upper seat assembly to its maximum height, then place a wood block between the lower arm and the base and upright assembly. Pull the air valve knob until all air has been exhausted from the air spring. This will permit removal of the air spring from the front of the seat. See Fig. 4.

2. Remove the seat cushion from the seat assembly, using the following procedure:

   .1 Remove the plastic tie strap that attaches the rear of the seat cushion to the lower frame.

   .2 Remove the capscrews that attach the seat cushion to one of the front cushion brackets (see Fig. 5), then remove the front cushion bracket. The seat cushion and other front cushion bracket can now be worked out of the lower frame knobs.

Fig. 2, National Cush-N-Aire® Seat, Model 195

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

1. Upper Frame
2. Back Polyfiller Cushion
3. Back Cover (Upholstery)
4. Tinnerman U-Clips
5. Seat Cushion (Upholstery) and Polyfiller Cushion
6. Cushion Handle
7. Cushion Handle Capscrew
8. Cushion Bracket Capscrew
9. Front Cushion Bracket
10. Track Knob
11. Lockout Lever
12. Lockout Channel
13. Lockout Spring
14. Track Bolt
15. Bearing Retainer
16. Flat Head Plug
17. Greer Locknut
18. Spring Clip
19. Seat Cushion Plastic Tie Strap
20. Back Pivot Capscrew
21. Back Pivot Sleeve
22. Back Assist Spring
23. Back Release Handle Lockpin
24. Back Release Handle
25. Back Release Handle Spring
26. Washer
27. Hex Nuts
28. Lower Frame
29. Air Valve
30. Hose Fitting
31. Air Hose
32. Tie Strap Assembly (Chugger-Snubber)
33. Tie Rod
34. Greer Locknut
35. Kilian Bearing
36. Track Assembly and Handle
37. Track Assembly
38. Track Bolt
39. Air Spring Capscrew and Lockwasher
40. Sleeve
41. Snap Ring
42. Seat Support Assembly
43. Shaft and Locktab Assembly
44. Upper Arm
45. Air Hose Plastic Tie Strap
46. Air Spring
47. Lower Arm
48. Bearing
49. Air Spring Pal Nut
50. Base and Upright Assembly
51. Shock Absorber Hex Bolt
52. Nylon Bushing
53. Spacer
54. Shock Absorber
55. Hex Nut

NOTE: Some fasteners intentionally omitted to provide clarity to the illustration.

Fig. 3, National Cush-N-Aire® Seat (Model 95 Shown)

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

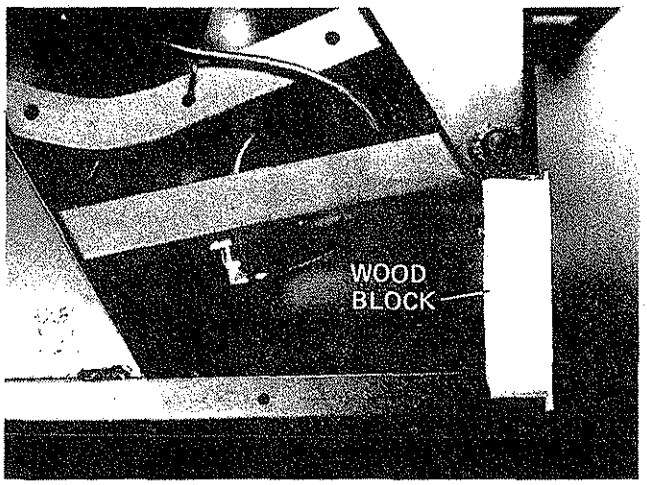


Fig. 4

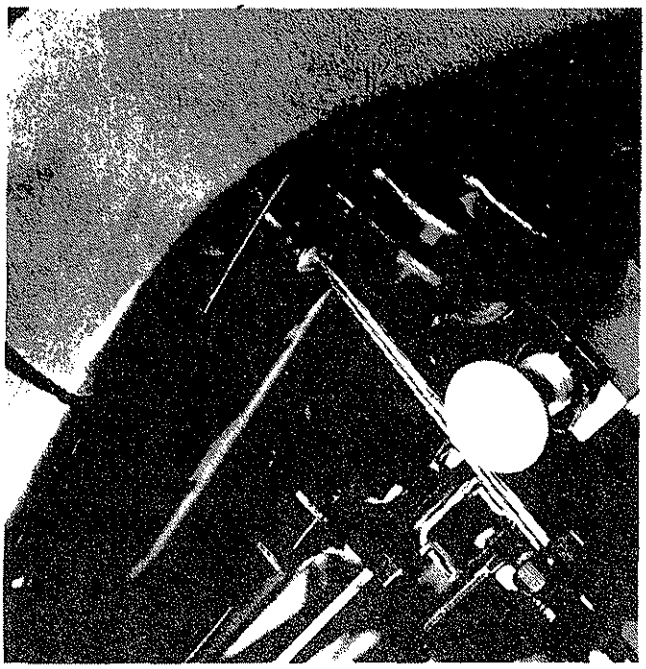


Fig. 5

3. Disconnect the air hose from the air hose fitting (see Fig. 6), then remove the air hose fitting from the bottom of the air spring. Seal off the air hose and fitting to prevent dirt or other foreign material from entering.

4. Remove the pal nut (see Fig. 6) that attaches the air spring to the lower arm.

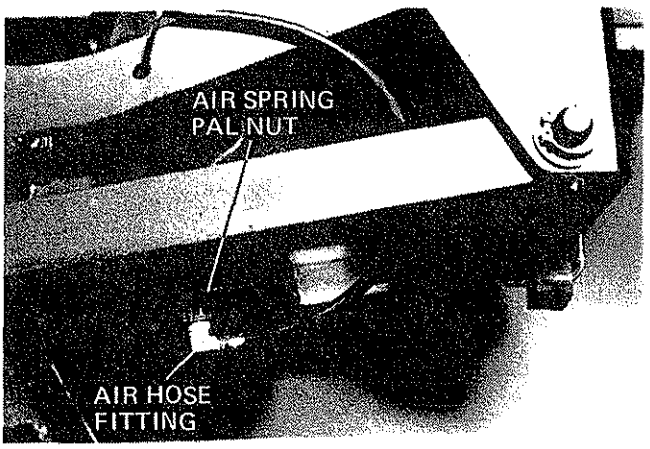


Fig. 6

5. Remove the capscrew and lockwasher that attaches the air spring to the seat support assembly (Fig. 3, Ref. 39). See Fig. 7. Remove the air spring from the seat assembly.

6. Place the bottom of the new air spring into the mounting hole of the lower arm. Install the pal nut. Tighten the nut finger-tight, then using a wrench, tighten the nut one-half turn more.

7. Remove the seal from the air hose fitting, then attach the fitting to the air spring until the fitting bottoms in the air spring. Remove the seal from the air hose, then connect the air hose to the fitting.

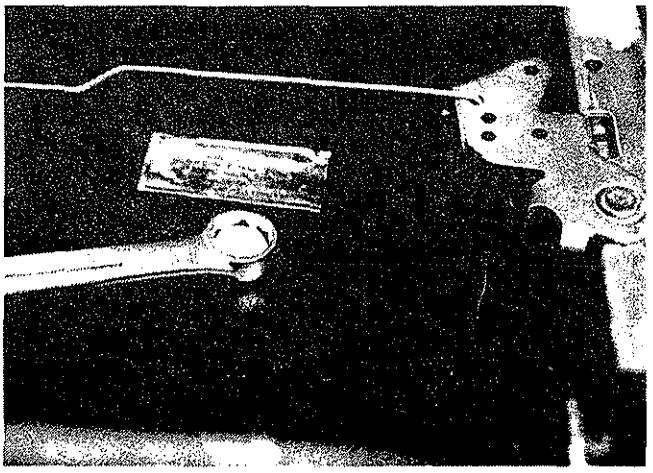


Fig. 7

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

8. Align the top of the air spring with the air spring hole in the seat support assembly. Install the lockwasher and capscrew, then tighten the capscrew to 55-65 lbf·ft (75-88 N·m).

9. Install the seat cushion on the seat assembly, using the following procedure:

   .1 Install the previously removed cushion bracket on the lower frame knob, then place the seat cushion on the lower frame, installing the seat cushion and attached cushion bracket on the lower frame knob. Place the removed cushion bracket on the seat cushion, and attach it with the capscrews.

   .2 Fasten the plastic tie strap around the lower frame and one of the cushion bands of the seat cushion.

10. Push the air valve knob until the seat is fully raised. Remove the wood block. Adjust the seat, as required.

SHOCK ABSORBER REPLACEMENT
(Refer to Fig. 3)

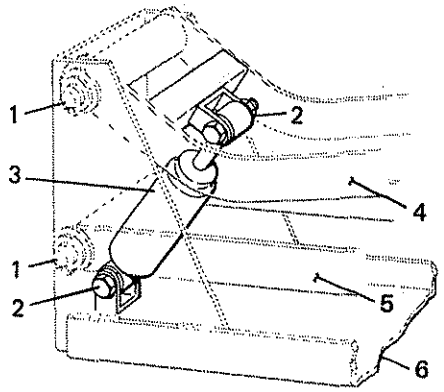
1. Raise the upper seat assembly to its maximum height, then place a wood block between the lower arm and the base and upright assembly. Pull the air valve knob until all air has been exhausted from the air spring. See Fig. 4.

2. Remove the hex nuts and bolts that attach the shock absorber to the upper arm and to the base and upright assembly. See Fig. 8.

3. Remove the shock absorber from the seat assembly.

4. If not previously installed, install the new spacers into the ends of the new shock absorber, then install the new nylon bushings.

5. Place the shock absorber so that the extended-arm end of the shock absorber is installed in the mounting bracket of the upper arm, and the base end of the shock absorber is installed in the mounting bracket of the base and upright assembly. See Fig. 8.



1. Shaft and Locktab Assembly
2. Shock Absorber Hex Nut and Bolt
3. Shock Absorber
4. Upper Arm
5. Lower Arm
6. Base and Upright Assembly

Fig. 8, Shock Absorber Assembly

6. Secure the shock absorber to the upper arm and to the base and upright assembly with the attaching nuts and bolts. Tighten the nuts to 25-30 lbf·ft (34-41 N·m).

7. Push the air valve knob until the seat is fully raised. Remove the wood block. Adjust the seat, as required.

BACK CUSHION AND UPPER FRAME REMOVAL AND INSTALLATION
(Refer to Fig. 3)

Removal

1. If the back cover (upholstery) is to be removed, remove the Tinnerman U-clips that attach the back cover to the upper frame. See Fig. 9. Then, remove the back cover from the upper frame and the polyfiller cushion.

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

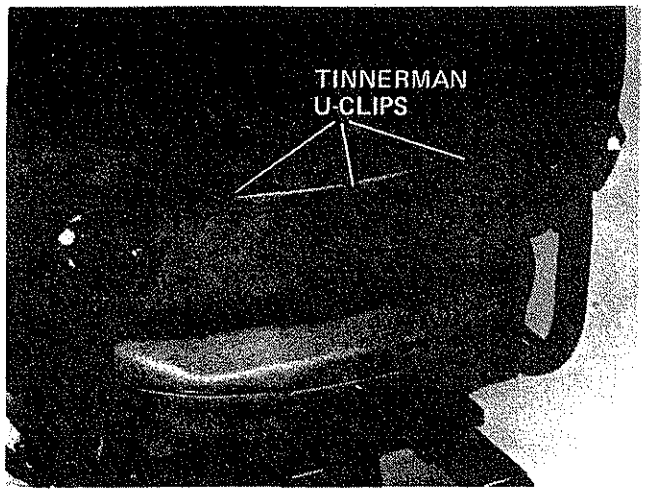


Fig. 9

2. If the polyfiller cushion is to be replaced, remove the polyfiller cushion from the upper frame.

3. Disconnect the back release handle spring from the back release handle. See Fig. 10.

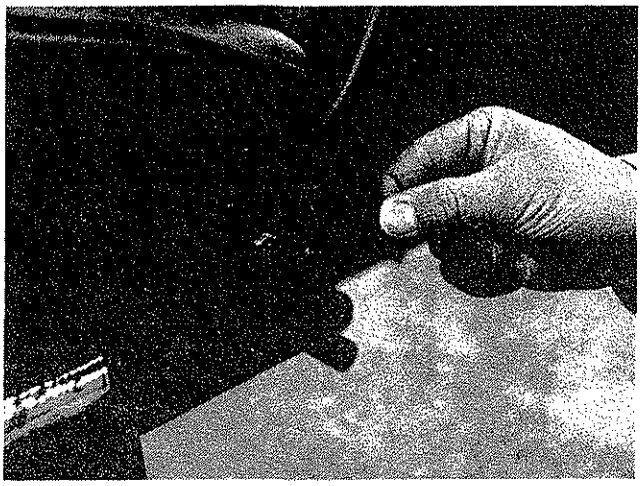


Fig. 10

4. Remove the nuts, washer, and lockpin that attach the back release handle to the upper frame and the lower frame.

5. Remove the back-pivot capscrew (see Fig. 11), sleeve, and back assist spring from the upper and lower frame.

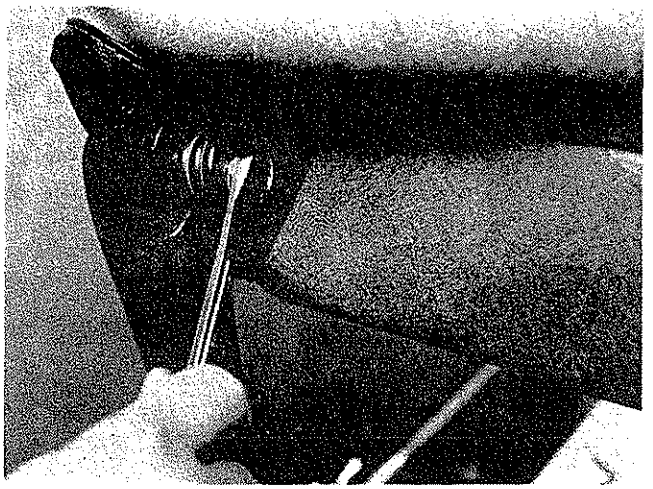


Fig. 11

6. Remove the upper frame from the lower frame.

Installation

NOTE: If the back cover and polyfiller cushion assembly was not removed from the upper frame, proceed to step 3, below.

1. Apply rubber sealant on the upper frame (the areas where the polyfiller cushion contacts the frame), then place the polyfiller cushion on the upper frame.

2. Place the back cover over the polyfiller cushion and upper frame, then attach the back cover to the upper frame with the Tinnerman U-clips (see Fig. 9).

3. Insert the back pivot of the upper frame into the pivot hole of the lower frame. See Fig. 12.

Fig. 12

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

4. Align the other pivot hole of the lower frame with the upper frame, then install the pivot sleeve (see Fig. 13), and secure with the back-pivot capscrew. Attach the back assist spring to the back-pivot sleeve (see Fig. 14), making sure the extended part of the spring engages the notch on the upper frame.

Fig. 13

Fig. 14

5. Attach the back release handle to the upper frame (see Fig. 15), then install the washer and nut. Tighten the nut, making sure the handle is allowed to pivot.

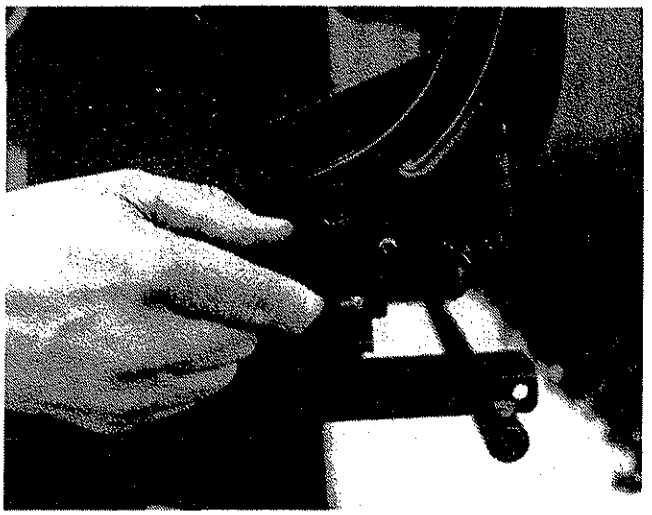


Fig. 15

6. Insert the back release handle lockpin through the lower frame, upper frame, and back release handle. See Fig. 16. Install the attaching nut. Tighten the nut to 7-12 lbf·ft (10-16 N·m).

7. Connect the back release handle spring on the upper frame and back release handle. See Fig. 10.

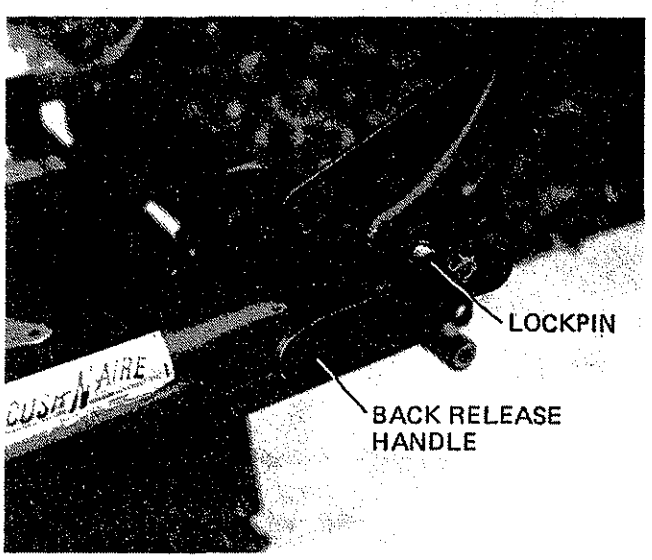


Fig. 16

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

SEAT CUSHION AND LOWER FRAME REMOVAL AND INSTALLATION
(Refer to Fig. 3)

Removal

NOTE: If the upper frame needs to be removed, remove the upper frame from the lower frame at this time. For instructions, refer to "BACK CUSHION AND UPPER FRAME REMOVAL AND INSTALLATION."

1. Remove the plastic tie strap that attaches the rear of the seat cushion to the lower frame.

2. Remove the capscrews that attach the seat cushion to one of the front cushion brackets (see Fig. 17), then remove the front cushion bracket. The seat cushion and other front cushion bracket can now be worked out of the lower frame knobs.

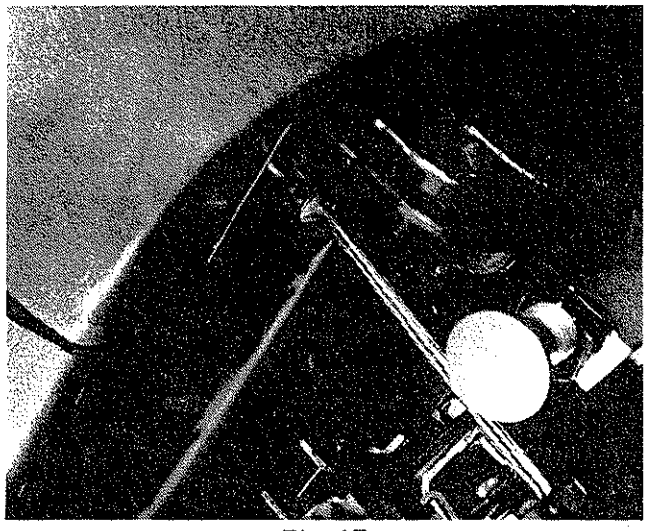


Fig. 17

3. Loosen the pal nut that attaches the air valve to the lower frame (see Fig. 18), then remove the air valve and hose from the lower frame.

4. Using snap ring pliers, remove the spring clips (see Fig. 19) that connect the lower frame to the bearing retainers and tie strap assembly (Chugger-Snubber).

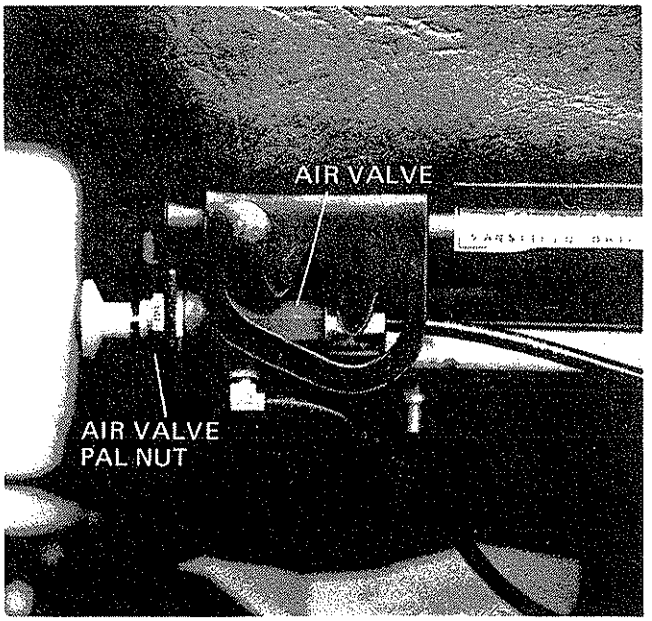


Fig. 18

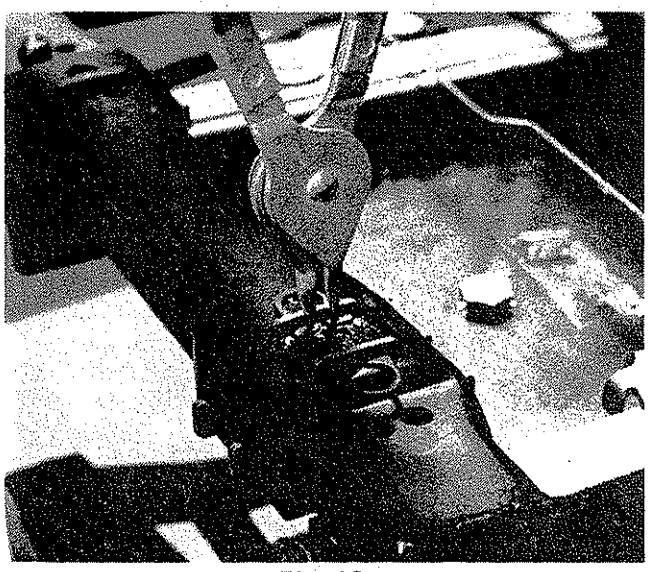


Fig. 19

5. While noting the position of the bearing retainers on the tie strap assembly, lift the lower frame from the seat assembly, then remove the bearing retainers.

6. If the lockout lever on the tie strap assembly needs to be disassembled, use the following procedure:

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

.1 Remove the Greer (lockout lever) locknut (see Fig. 20) and track bolt that attach the lockout lever assembly to the lower frame.

.2 Turn the lockout spring, as shown in Fig. 21, to release the lockout lever and knob from the lockout channel.

7. Remove the Kilian bearings from the tie strap assembly.

8. Remove the tie strap assembly, if needed, from the track assembly by removing the Greer locknuts and bolts.

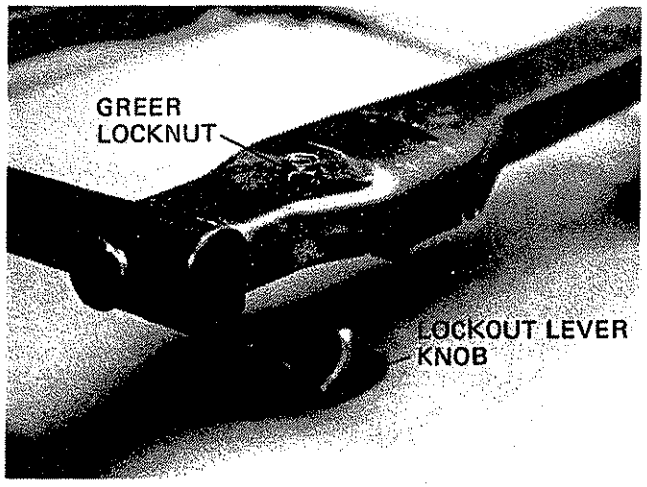


Fig. 20

Fig. 21

9. Remove the track assembly, if needed, from the seat support assembly by removing the Greer locknuts and bolts. Replace any springs or the tie rod, as needed.

Installation

1. Place the track assembly on the seat support assembly, then install the track bolts through the track assembly and seat support assembly. Install the Greer locknuts. Tighten the locknuts to 7-12 lbf·ft (10-16 N·m).

2. Place the tie strap assemblies on the track assembly, then install the track bolts through the track assembly and the tie strap assemblies. Install the Greer locknuts. Tighten the locknuts to 7-12 lbf·ft (10-16 N·m).

3. Apply Lubriplate, or equivalent lubricant, to the Kilian bearings, bearing retainers, and the tie strap assemblies, where the bearings and retainers contact the tie strap assemblies. See Fig. 22.

4. Install the Kilian bearings on the tie strap assemblies.

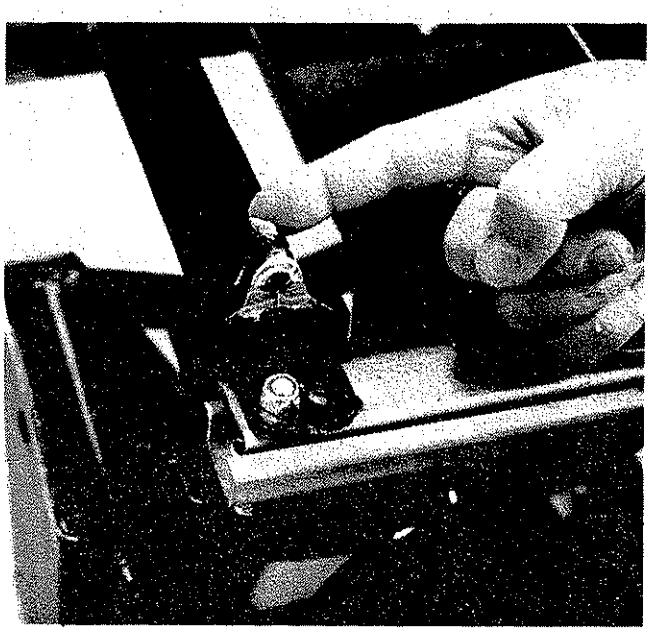


Fig. 22

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

5. If the lockout lever of the tie strap assembly was disassembled, assemble the lever using the following procedure:

   .1 Place the lockout lever in the channel, then place the spring between the lever and channel. See Fig. 21. Align the hole of the spring with the hole of the channel.

   .2 Place the lockout lever assembly on the lower frame, then insert the bolt through the lockout spring, channel, and lower frame. Install the Greer locknut. Tighten the locknut to 7-12 lbf·ft (10-16 N·m).

6. Place the bearing retainers on the tie strap assembly (in the same positions as previously noted). See Fig. 23.

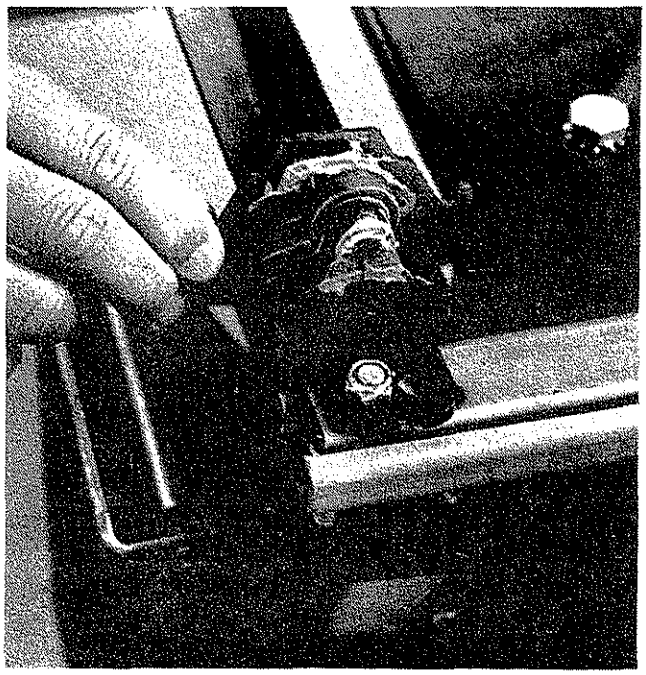


Fig. 23

7. Place the lower frame on the tie rod assembly, making sure the bearing retainers are inserted into the slots of the lower frame. Using snap ring pliers, insert the spring clips into the bearing retainers. See Fig. 19. This will secure the lower frame to the tie rod and track bar assembly.

8. Attach the air valve to the lower frame. Tighten the pal nut (see Fig. 18) finger-tight; using a wrench, tighten the nut one half turn more.

NOTE: If the upper frame was previously removed, install the upper frame on the lower frame at this time. For instructions, refer to "BACK CUSHION AND UPPER FRAME REMOVAL AND INSTALLATION."

9. Install the previously removed cushion bracket on the lower frame knob, then place the seat cushion on the lower frame, installing the seat cushion and attached cushion bracket on the lower frame knob. Place the removed cushion bracket on the seat cushion, and attach it with the capscrews.

10. Fasten the plastic tie strap around the lower frame and one of the cushion bands of the seat cushion.

SEAT SUPPORT AND BASE DISASSEMBLY AND ASSEMBLY (Refer to Fig. 3)

Disassembly

1. Remove the seat assembly from the vehicle. For instructions, refer to "SEAT ASSEMBLY REMOVAL AND INSTALLATION."

2. Remove the Greer locknuts and bolts that attach the track bar and upper seat assembly to the seat support assembly. See Fig. 24. Then, remove the track bar and upper seat assembly from the seat support assembly.

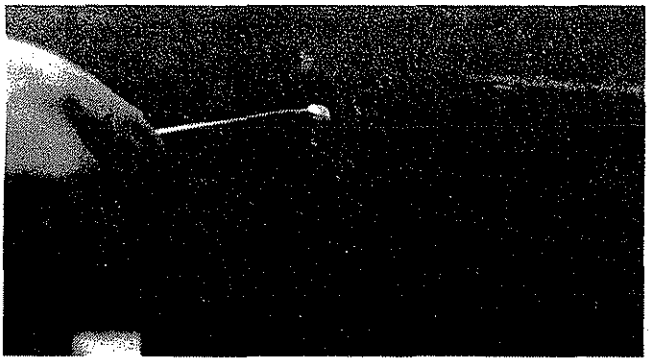


Fig. 24

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

3. Raise the seat support assembly to its maximum height, then place a wood block between the lower arm and the base and upright assembly. See Fig. 25.

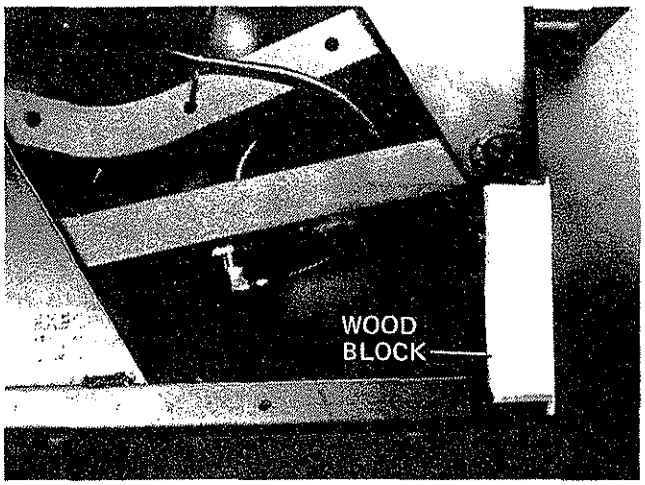


Fig. 25

4. Remove the pal nut that attaches the air spring to the lower arm.

5. Remove the capscrew and lockwasher that attach the air spring to the seat support assembly (see Fig. 26), then remove the air spring from the front of the assembly.

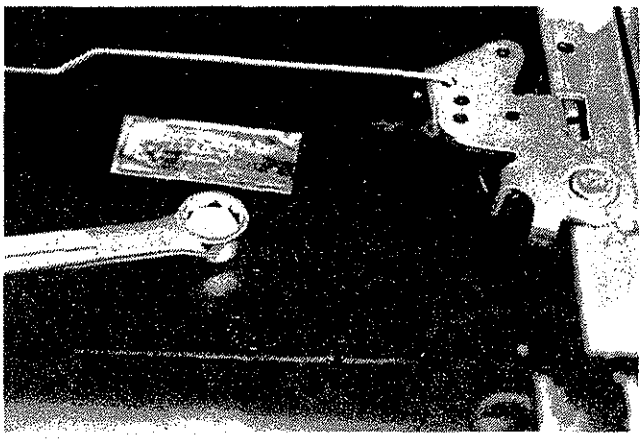
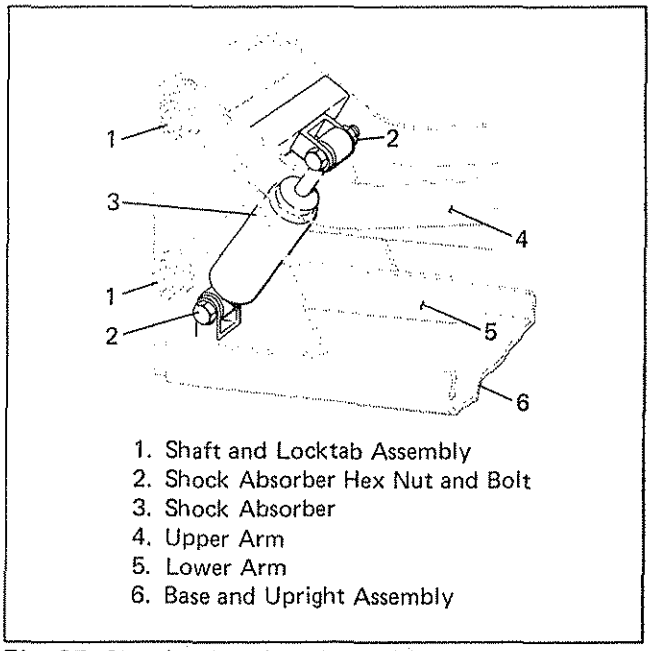


Fig. 26

6. Remove the hex nuts and bolts that attach the shock absorber to the upper arm and to the base and upright assembly. See Fig. 27.



1. Shaft and Locktab Assembly
2. Shock Absorber Hex Nut and Bolt
3. Shock Absorber
4. Upper Arm
5. Lower Arm
6. Base and Upright Assembly

Fig. 27, Shock Absorber Assembly

7. Remove the shock absorber assembly from the seat assembly.

8. Using snap ring pliers, remove the snap rings from the shaft and locktab assemblies. See Fig. 28.

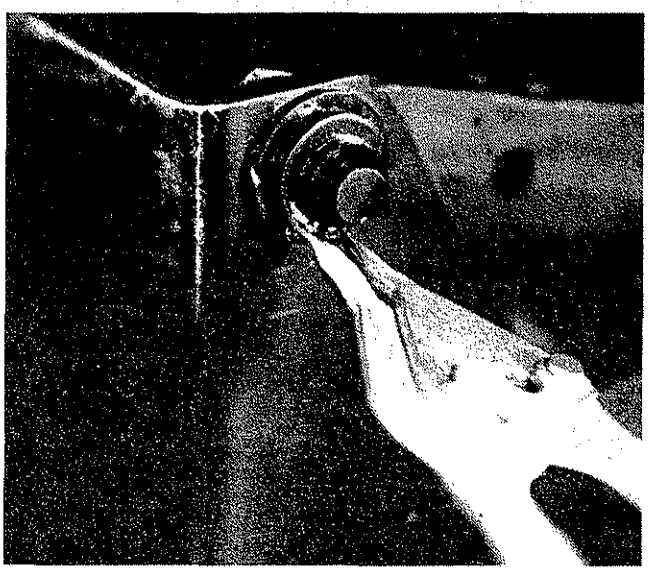


Fig. 28

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

9. Using a drift punch slightly smaller in diameter than the shaft, drive out the shafts from the base and the seat support assembly.

NOTE: Drive the snap ring end of the shafts. Drive each shaft end a little at a time, as the two shafts are connected to each other on the opposite side.

10. Remove the sleeves (see Fig. 3, Ref. 40) from the base and the seat support assemblies. Then, remove the seat support, upper arm, and lower arm, from the base.

11. Remove the bearings from the lower and upper arms.

Assembly

1. Place the lower end of the shock absorber in the shock absorber bracket of the base, then install the attaching hex bolt and nut. Tighten the nut to 25-30 lbf·ft (34-41 N·m).

2. Install the bearings into the upper arm and lower arm shafts.

3. Place the lower and upper arms onto the base, aligning the arm tubes and bearings with the holes in the base. Install the sleeves (see Fig. 3, Ref. 40) into the holes of the base.

4. Install the shaft and locktab assembly through the base and the arm assembly tubes. Using snap ring pliers, install the snap rings to secure the shaft and arm assemblies to the base. See Fig. 28.

5. Align the end of the shock absorber with the upper arm bracket, then install the attaching hex bolt and nut. Tighten the nut to 25-30 lbf·ft (34-41 N·m).

6. Install the lower arm end of the air spring into the mounting bracket hole of the lower arm. Install the pal nut. Tighten the nut finger-tight; using a wrench, tighten the nut one half turn more.

7. Align the lower and upper arm tubes and bearings with the holes in the seat support assembly, then install the sleeves into the seat support holes.

8. Insert the shaft and locktab assembly through the seat support and through the upper arm and lower arm tubes. Using snap ring pliers, install the snap rings to secure the shaft and arm assemblies to the seat support.

9. Align the top of the air spring with the seat support assembly air spring hole. Install the lockwasher and capscrew (see Fig. 26), then tighten the capscrew to 55-65 lbf·ft (75-88 N·m).

10. Place the track bars and upper seat assembly on the seat support assembly, then install the Greer locknuts and bolts. Tighten the locknuts to 7-12 lbf·ft (10-16 N·m).

11. Install the seat assembly in the vehicle. For instructions, refer to "SEAT ASSEMBLY REMOVAL AND INSTALLATION."

SEAT ASSEMBLY REMOVAL AND INSTALLATION (Refer to Fig. 3)

If the seat assembly needs to be removed for service or replacement, use the following removal and installation procedures.

Removal

1. Pull the air valve knob until all air has been exhausted from the air spring.

2. Disconnect the air hose from the air hose fitting (see Fig. 29). Seal off the air hose and fitting to prevent dirt or other foreign material from entering.

3. Loosen the pal nut that attaches the air valve to the lower frame (see Fig. 30), then remove the air valve and hose from the lower frame.

NATIONAL CUSH-N-AIRE® SEATS, MODELS 95 AND 195

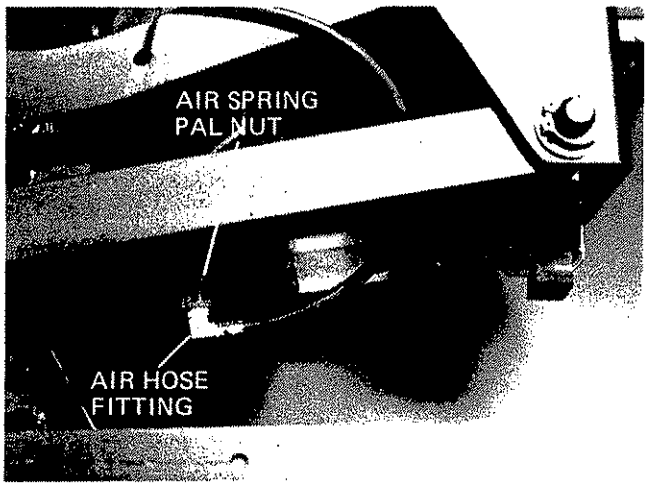


Fig. 29

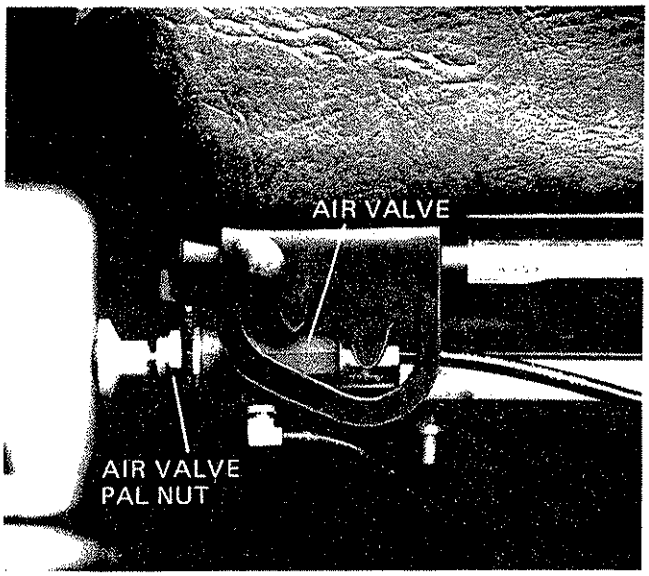


Fig. 30

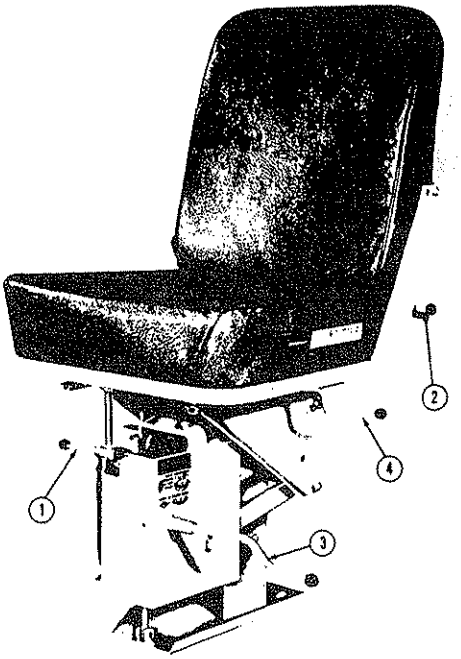
4. Remove the flanged nuts, washers, and hex bolts that attach the seat base and upright assembly to the cab deck and mounting bracket. Remove the seat assembly from the cab.

Installation

1. Place the seat assembly on the cab deck and against the mounting bracket.
2. Insert the hex bolts through the seat base and upright assembly, cab deck, and deck reinforcement. Then, install the flatwashers and the flanged nuts. Tighten the nuts to 20-25 lbf·ft (27-34 N·m).
3. Attach the air valve to the lower frame. Tighten the pal nut finger-tight, then using a wrench, tighten one-half turn more. See Fig. 30.
4. Remove the seals from the air hose and fitting. Attach the air hose to the fitting. See Fig. 29.

TORSION SPRING SUSPENSION SEAT

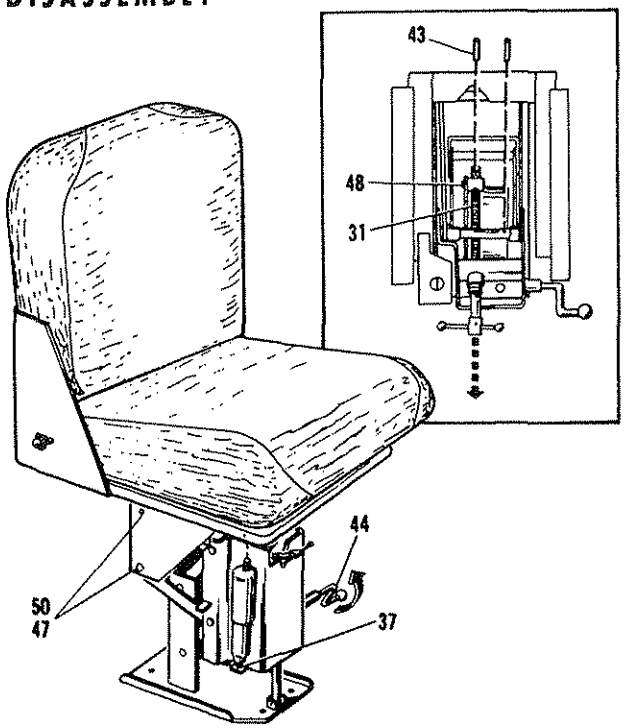
OPERATING INSTRUCTIONS



NOTE: For a good ride, it is essential that each driver properly adjust the torsion spring suspension to his own weight.

1. Handle adjusts torsion spring to driver's weight - 130 to 275 lbs. - (Turn clockwise to tighten). The torsion spring controls 3-3/4" of vertical motion of the seat. Proper adjustment to the individual driver's weight will suspend the seat with the driver on it midway between the vertical limits, thus limiting topping or bottoming.
2. Backrest angle can be set at three different positions for maximum comfort.
3. Height adjustment handle - 3-3/4" vertical adjustment.
4. Horizontal adjustment - Seat assembly moves forward or back 4" along ball-bearing slides.

DISASSEMBLY



To replace the torsion spring, it is not necessary to remove the cushion and seat from the frame assemblies. However, reference to the exploded view will indicate parts to remove if this is required.

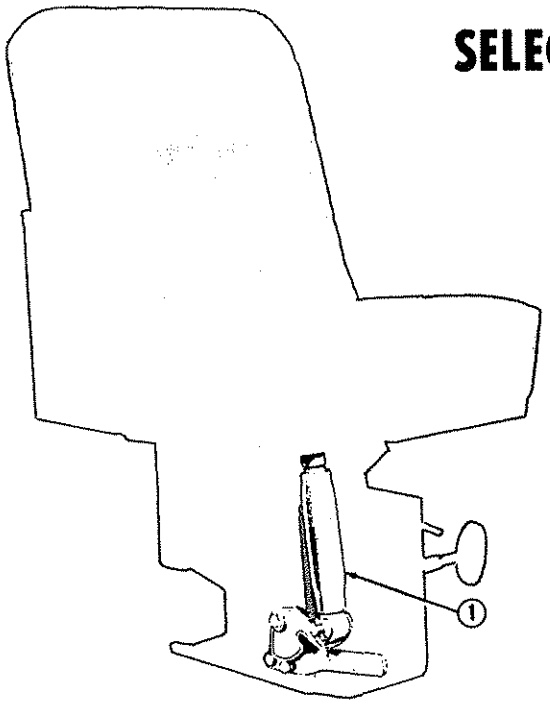
NOTE:
Numbers in parenthesis refer to the index list on both the parts list and exploded views on inside pages.

1. Before starting disassembly, turn vertical height adjustment lever (44) clockwise until seat is at its highest position.
2. Disconnect shock absorber (37) at bottom.
3. Remove the roll pins (50) from the rear hinge pins (47); drive these pins out from the same end from which the roll pins were removed. The opposite end of the hinge pin is serrated. The upper seat structure is now free and can be removed.
4. Knock out the roll pin (43) in the end of the adjuster stud (31). Unscrew the adjuster stud from the adjuster pin (48) and remove entire assembly.

FREIGHTLINER
SERVICE MANUAL
AND FACTORY ASSEMBLY INFORMATION

SUBJECT
SEAT
Bostrom "Westcoaster"

SELECTIVE SHOCK ABSORBER



OPERATING INSTRUCTIONS

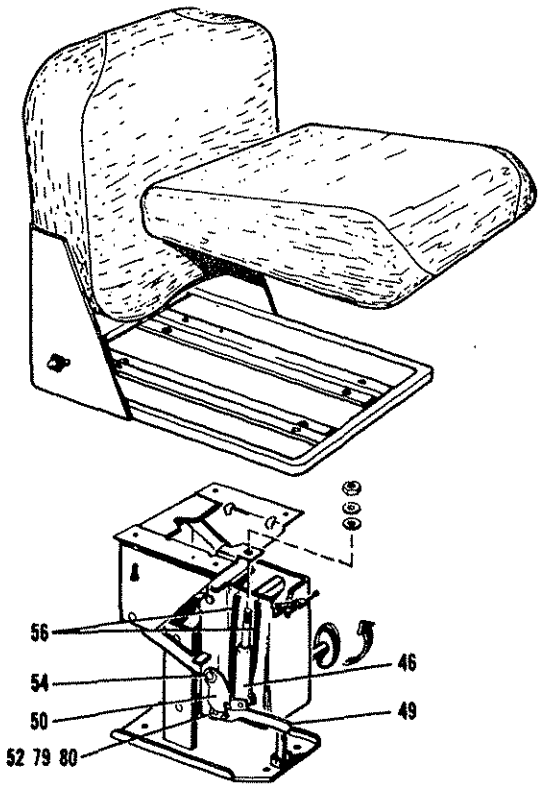
The Selective Shock Absorber is designed to kick in automatically. When the truck reaches a particularly rough, bumpy stretch of road, a sudden jolt will engage the Shock Absorber (1) which then continues to operate. When the road smooths out and additional damping is not necessary, push down the Release Lever with your heel to disengage it. The Shock Absorber is now reset and ready to provide immediate additional damping on the next rough stretch of road.

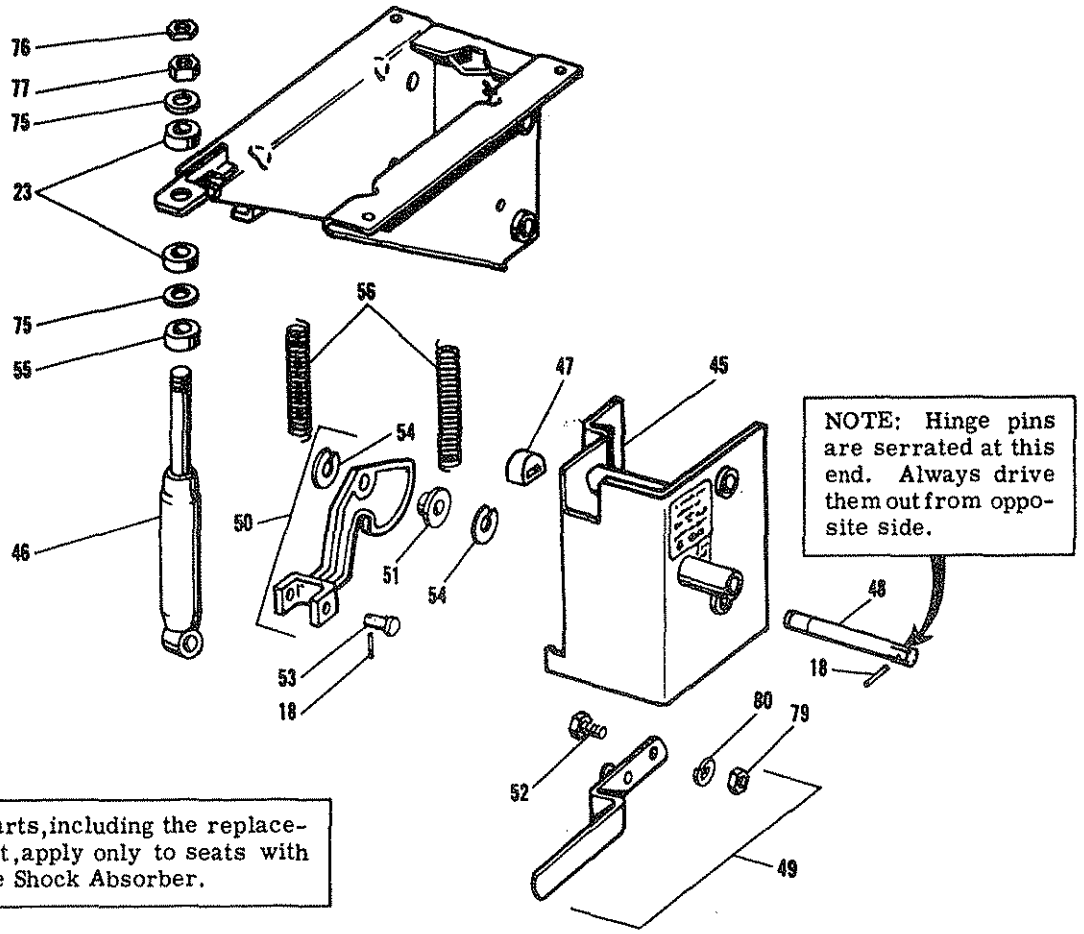
DISASSEMBLY

(Shock Absorber Only)

Remove Tension Springs (56) from Shock Absorber Pivot Lever (50) and Shock Absorber Release Lever (49). Disconnect Shock Absorber (46) at upper end and compress by hand. Disconnect Snap Ring (54) and remove Shock Absorber (46) and Shock Absorber Pivot Lever (50). Disassemble Shock Absorber Release Lever (49) by removing Shoulder Bolt (52), Nut (79) and Lockwasher (80).

Reassemble in reverse order.





NOTE: Hinge pins are serrated at this end. Always drive them out from opposite side.

These parts, including the replacement list, apply only to seats with Selective Shock Absorber.

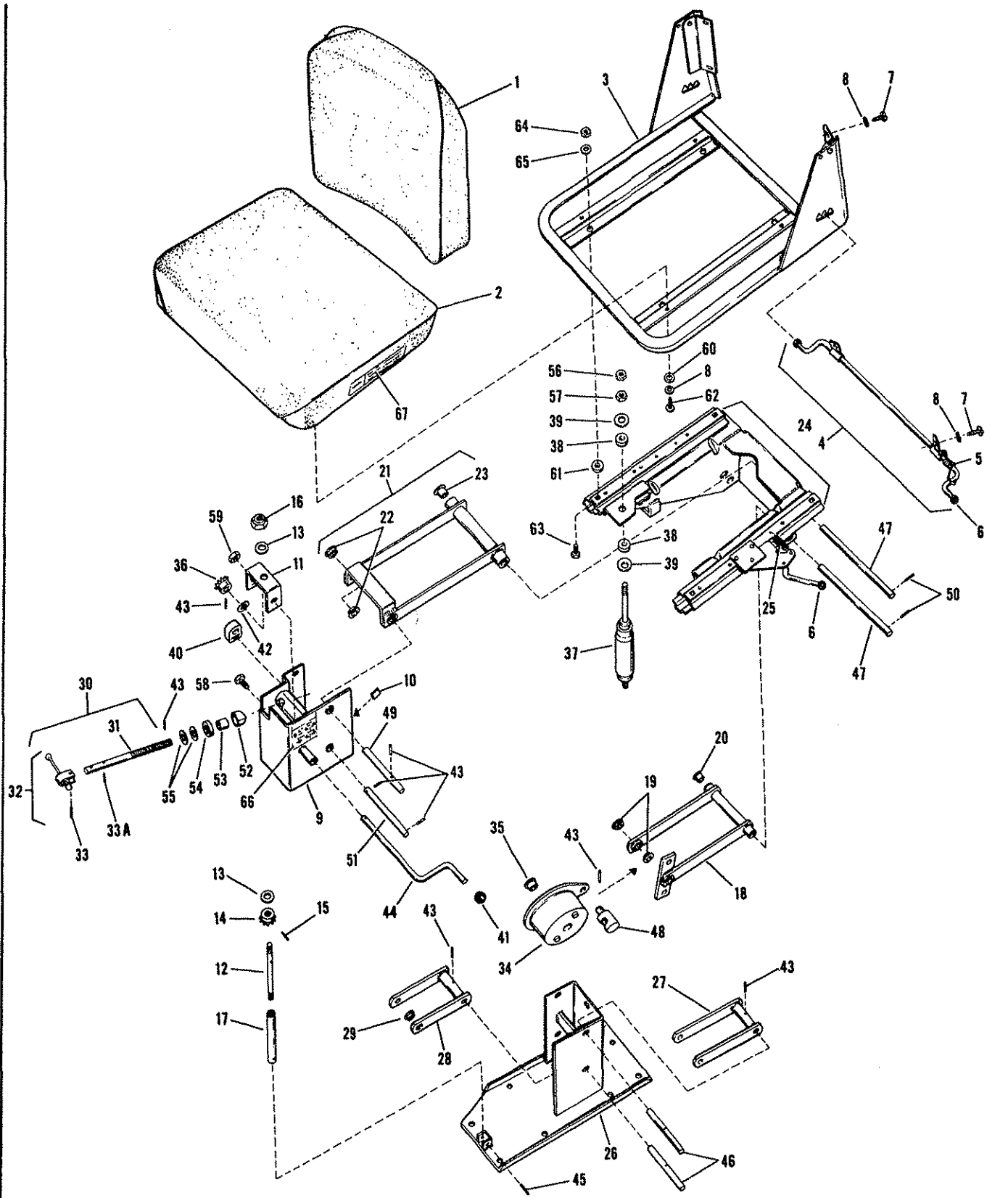
PARTS REPLACEMENT LIST

Index No.	Bostrom Production Part No.	Qty.	Description
18	22525	2	PIN, Roll
23	24128	2	SPACER, Rubber
45	26443-1	1	BRACKET ASSY, Spring Support
46	26298	1	ABSORBER, Shock
47	26444	1	BUMPER, Rubber
48	26228	1	PIN, Front, lower
49	26084-1	1	LEVER ASSY, Shock Absorber Release
50	26082-1	1	PIVOT LEVER AND BEARING ASSY
51	22879	1	. BEARING, Flanged
52	26153	1	BOLT, Shoulder
53	26085	1	PIN, Clevis
54	26343	2	SNAP RING
55	26421	1	SPACER, Rubber
56	26299	2	SPRING, Tension
75	353-14	2	WASHER, 7/16 I.D. x 1 O.D. x .083 SAE std.
76	351-97	1	NUT, Jam, 3/8-24 NF
77	351-113	1	NUT, Hex, 3/8-24 NF
79	351-51J	1	NUT, Hex, 5/16-18 NC-2B
80	353-7	1	WASHER, Lock, 5/16 SAE

FREIGHTLINER SERVICE MANUAL

AND FACTORY ASSEMBLY INFORMATION

SUBJECT
SEAT
Bostrom "Westcoaster"



EXPLODED VIEW DRAWING OF BOSTROM "WESTCOASTER" MODEL PEDESTAL SEAT

DISASSEMBLY (CONT'D)

5. Remove front upper (49) and lower (51) pins similar to step 2. The spring support bracket (9) can now be swung down out of the way, freeing the upper (21) and lower (18) arm assemblies.

6. Remove the lower arm assembly and torsion spring (34). Take adjuster pin off damaged spring.

7. Replace spring and also check all flanged bearings (19, 20, 22, 23, 29 and 35) and replace if necessary.

REASSEMBLY

1. Replace adjuster pin (48) in spring. Seat bushing (35) in spring and reinstall spring in lower arm assembly making sure bearings (19) are in place. The adjuster pin (48) ear on the spring must be to the rear.

2. Raise the spring support bracket (9) and slide the lower arm assembly and lower pivot arm (with bearing((29))in place) into it. Be sure this adjuster pin (48) is on top of the lower pivot arm. Secure these units by replacing the pin (51) and roll pin (43).

3. Place a 2 x 4" block of wood approximately 5" high under the support rod of the lower arm assembly to hold it in the raised position (Fig. A). This raises the adjuster pin to permit reassembling the stud.

4. Using screwdriver or flat bar raise spring so that stud (31) can be screwed back into pin (48) and secure with roll pin (43).

5. Replace upper arm with bearings (22 and 23) in seat adjuster and bracket assembly with upper pin (47). Replace roll pin (50).

6. Reassemble upper seat structure to lower arm assembly with bearings (20) in place by replacing lower pin (47). Insert roll pin (50).

7. Align holes in upper arm (21), pivot arm (27), and spring support bracket (9) and replace pin (49) and roll pin (43).

8. Reconnect shock absorber.

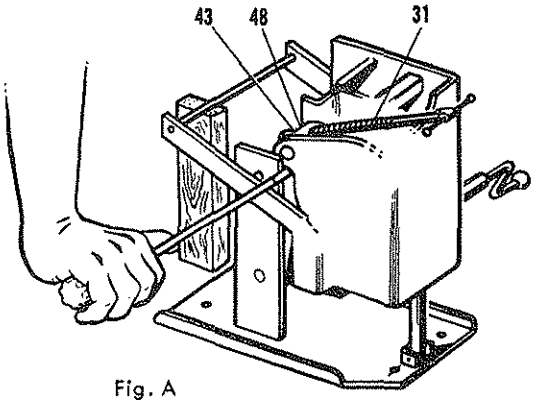


Fig. A

PARTS REPLACEMENT LIST FOR BOSTROM "WESTCOASTER" MODEL PEDESTAL SEAT

Index No.	Bostrom Production Part No.	Qty.	Description
1	24198-1	1	CUSHION, Back
2	24896-1	1	CUSHION, Seat
3	24894-1	1	FRAME ASSY, Seat
4	23893-2	1	ROD ASSY, Adjuster, back cushion
5	22455	1	. SPRING, Torsion
6	22276-35	3	. KNOB, Plastic
7	I-351-30RP*	6	SCREW, Mach, 1/4-20 NC-2A x 3/4 lg. rd. hd.
8	353-4*	10	WASHER, Lock, 1/4 SAE medium

(continued on next page)

9	23554-1	1	BRACKET ASSY, Spring support
10	23554-8	1	. BELTING
11	25700	1	BRACKET, Adjuster, vertical
12	25701	1	STUD, Adjuster
13	23581	2	WASHER, Thrust
14	23569	1	GEAR, Miter
15	22525	1	PIN, Roll
16	25869	1	NUT, Hex, selflocking
17	25695	1	TUBE
18	23567-1	1	ARM ASSY, Spring, lower
19	23783	4	. BEARING, Flanged
20	23784	2	. BEARING, Flanged
21	23566-1	1	ARM ASSY, Upper
22	23783	4	. BEARING, Flanged
23	23784	2	. BEARING, Flanged
24	25804-1	1	SEAT ADJUSTER AND BRACKET ASSY
25	22830	1	. SPRING, Latch
26	25706-1	1	BASE ASSY
27	23565-1	1	PIVOT ARM ASSY, Upper
28	25834-1	1	PIVOT ARM ASSY, Lower
29	25833	1	. BEARING, Flanged
30	25595-1	1	STUD ASSY, Adjuster, rubber spring
31	25594	1	. STUD, Adjuster
32	25595-2	1	. BRACKET AND HANDLE ASSY
33	22525	1	. PIN, Roll
33A	24129	1	. PIN, Driv-lok
34	23188-5	1	SPRING ASSY, Rubber (with bearing)
35	23094	1	. BEARING, Flanged
36	23569	1	GEAR, Miter
37	23771	1	ABSORBER, Shock
38	24128	4	SPACER, Rubber
39	353-29*	4	WASHER, 7/16 I. D. x 1 O. D. x 1/16 SAE std.
40	21070	1	BUMPER, Rubber
41	23775	1	KNOB, Plastic, pedestal
42	23581	1	WASHER, Thrust
43	22525	8	PIN, Roll
44	25807	1	HANDLE
45	22705	1	PIN, Roll
46	23562-2	2	PIN, Center
47	23936	2	HINGE PIN, Rear
48	22453	1	PIN, Adjuster
49	23840	1	PIN, Front, upper
50	22526	2	PIN, Roll
51	23563	1	PIN, Front, lower
52	22517	1	BUSHING, Pivot
53	22519	1	INSERT
54	22518	1	BEARING, Ball
55	353-27*	2	WASHER, 21/32 I. D. x 31/32 O. D. x 11 ga.
56	351-97*	2	NUT, Jam, 3/8-24 NF
57	351-113*	2	NUT, Hex, 3/8-24 NF
58	351-104*	1	CAP SCREW, 3/8-16 NC-2A x 3/4 lg.
59	351-52D*	1	NUT, Hex, 3/8-16 NC-2B
60	353-21*	4	WASHER, 9/32 I. D. x 5/8 O. D. x 16 ga.
61	353-30*	4	WASHER, 3/8 I. D. x 1 O. D. x 1/4 thk.
62	I-351-32R*	4	SCREW, Mach, rd. hd., 1/4-20 NC-2A x 1 lg.
63	351-101*	4	CAP SCREW, Hex Hd., 5/16 NC-2A x 1 lg.
64	351-51J*	4	NUT, Hex, 5/16-18 NC-2B
65	353-7*	4	WASHER, Lock, 5/16 SAE medium
66	24268	1	DECAL, Suspension — Apply with Meyercord Solution
67	24442	1	DECAL, Seat cushion — Apply with Meyercord Solution

*Commercially available at hardware outlets.

DESCRIPTION

The Bostrom Levelaire seat utilizes a rolling lobe air spring, with air supplied by the truck air system. The fore-and-aft isolator eliminates back slap and has push-pull back angle adjustment and seat height adjustment.

DISASSEMBLY OF SEAT

1. Disconnect air line hose from truck at fitting (Fig. 1B, No.1) in valve.
2. Exhaust air by squeezing handle (Fig. 1C, No. 2) and adjusting rod (Fig. 1C, No. 3)
3. Remove seat from truck.
4. Pull adjustment lever on latch assembly (Fig. 1C, No.4), moving seat spring (Fig. 1C, No.5) at rear of seat cushion can be unhooked from latch assembly.
5. Move entire channel assembly forward ahead of rear roller (Fig. 1C, No.6) so they can be removed.
6. Lift rear of seat assembly enough to clear roller axles and slide seat assembly off upper panel assembly. (Fig. 1C, No.7)

NOTE: Springs (No. 8) may catch on forward edge of panel assembly and will have to be pushed up by hand so that seat can be moved back.

7. Remove the capscrews (Fig. 1B, No.10) from top and bottom of air spring assembly (Fig. 1B, No.11)
8. Remove the screw (Fig. 1B, No.12) and washer (Fig. 1B, No.13) freeing valve.
9. Raise arm assembly (Fig. 1B, No.14) to maximum height so that air spring, hose and valve can be taken out through front of seat.

NOTE: If seat is equipped with auto shock, note position of clip (Fig. 1A, No.15) so that it can be positioned properly in reassembly.

10. Remove shaft (Fig. 1B, No. 16) by disengaging snap ring (Fig. 1B No. 17) on either side of arm assembly (Fig. 1B, No.18). This will free tube assembly (Fig. 1B, No.19) for removal.
11. Examine upper and lower rear shafts (Fig. 1C, No.20) connecting arm assemblies (Fig. 1B, Nos.14 & 18) to upper panel assembly (Fig. 1C, No. 7). Disengage snap rings (Fig. 1B, No.25) and roll pins (Fig. 1C, No.20) and remove shafts.
12. Remove upper panel assembly (Fig. 1C, No. 7) by tilting to side so that wear tubes (Fig. 1B, No.21) can be freed from roller guides.

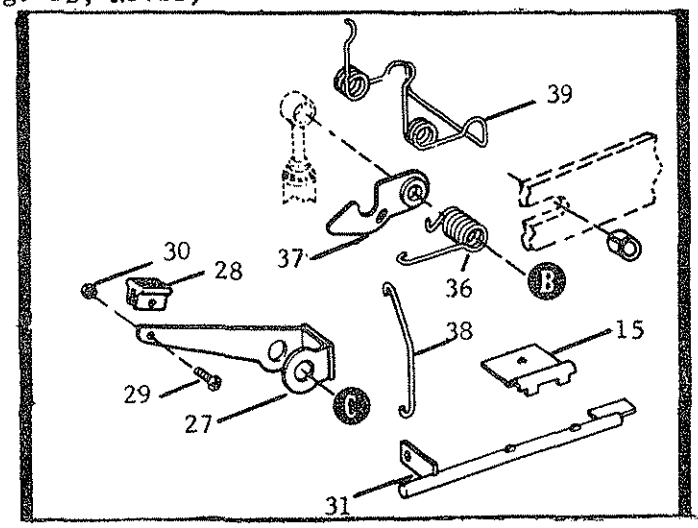


Fig. 1A

FREIGHTLINER
SERVICE MANUAL
AND FACTORY ASSEMBLY INFORMATION

SUBJECT
BOSTROM LELELAIR - SEAT

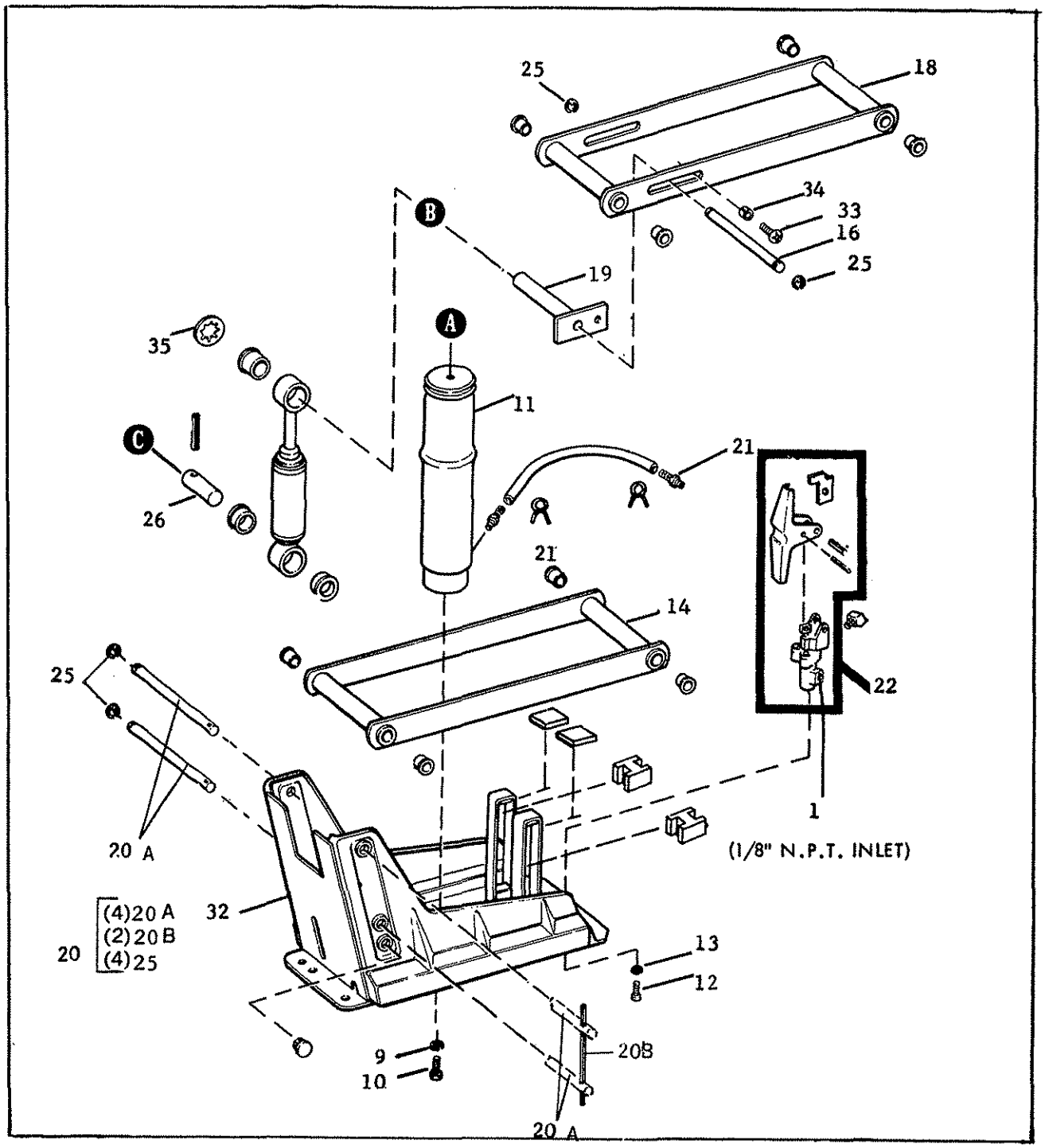


FIG. 1B

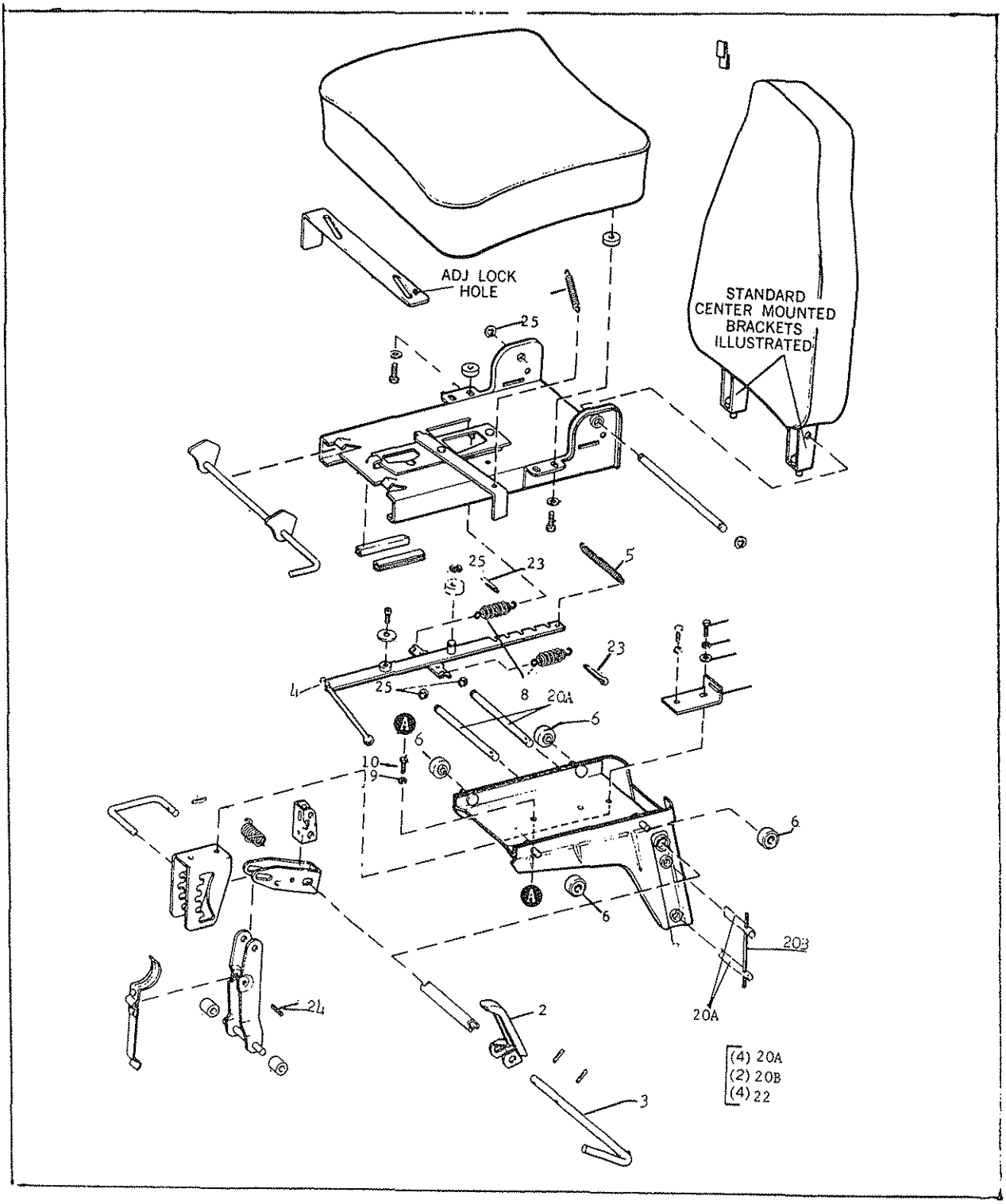

ADJ LOCK HOLE
STANDARD CENTER MOUNTED BRACKETS ILLUSTRATED
25
23
5
4
8
20A
6
10
9
20B
24
2
3
20A
(4) 20A
(2) 20B
(4) 22

FIG. 1C

INSTALLATION OF CUSHIONS

Seat Cushion

1. Seat cushion is placed on channel and latch assembly (Fig. 2, No 1) with rubber washer (Fig. 2, No 2) next to the seat and above the seat.
2. Place the bolting bracket flat washer (Fig. 2, No.3) on capscrew (Fig. 2, No.4)
3. Insert screw through bracket as indicated and secure seat on both sides.

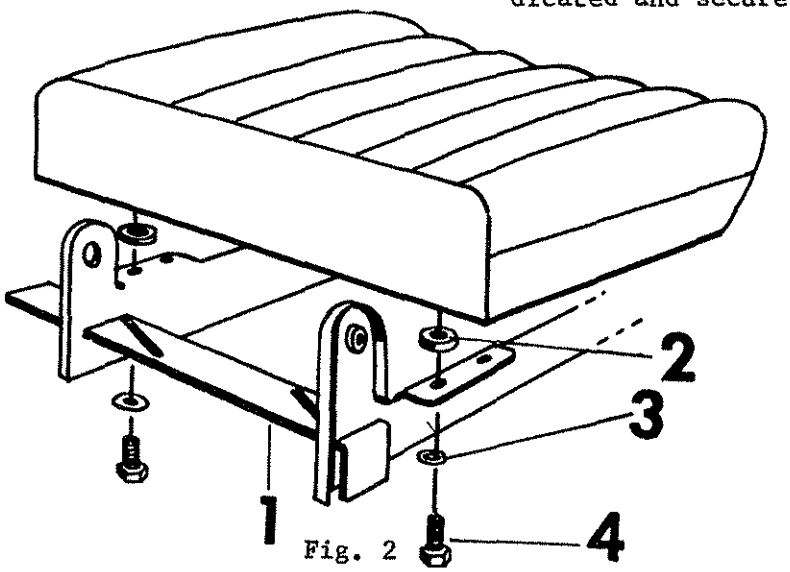


Fig. 2

Back Cushion

1. Place cushion in position on rear of channel and latch assembly (Fig. 3, No. 1) through back cushion adjuster strap with hole for pivot shaft (Fig. 3, No. 2) properly aligned.
2. Insert shaft (from either side) in back support brakcet and tap into position with hammer or similar tool.
3. Shaft will fit snugly in holes and may force strut in back cushion out of vertical alignment causing shaft to bind.
4. Strut should be moved sideways back into position by hand so that shaft can be moved horizontally into final position.
5. To secure shaft, a snap ring (Fig. 3, No. 3) is inserted at both ends.

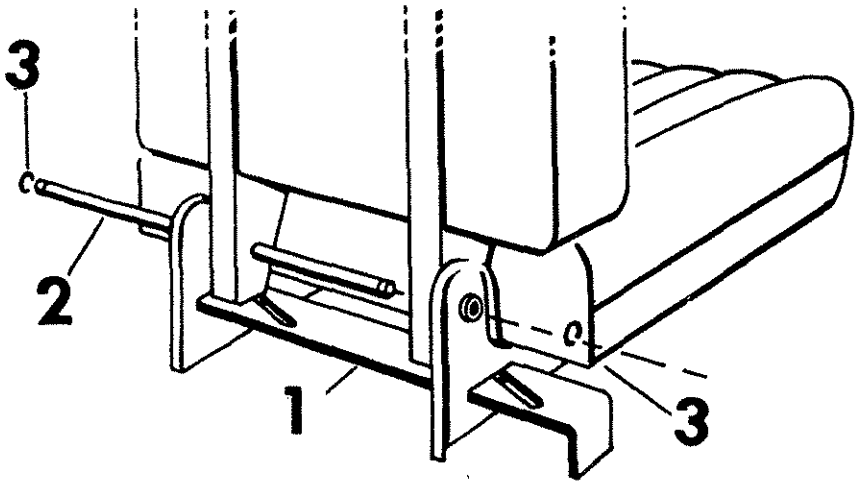


Fig. 3

AIR SPRING DISASSEMBLY

1. Follow steps 1 through 9 of seat DISASSEMBLY.

2. Unscrew air hose fitting (Fig. 1A, No.21) from bottom of air bag.

3. Replace air spring assembly and reverse procedure to reassemble.

ROLLER DISASSEMBLY

1. Follow steps 1 through 6 of the seat DISASSEMBLY.

2. Rollers (Fig. 1C, No.6) should be replaced if and when required.

VALVE DISASSEMBLY

1. Follow steps 1 through 3 in seat DISASSEMBLY.

2. Remove capscrew (Fig. 1B, No.12) and (Fig. 1B, No.13) from bottom of valve (Fig. 1B, No.22).

3. Replace valve and reverse disassembly procedure

ISOLATOR SPRINGS DISASSEMBLY

1. Follow steps 1 through 6 of seat DISASSEMBLY.

2. Turn cushion assembly upside down.

3. Bend tabs down on latch assembly (Fig. 1C, No.4) and unhook front of springs.

4. Remove cotter pins (Fig. 1C, No.23) freeing rear of springs.

5. Replace springs and reverse procedure to reassemble.

AUTO SHOCK KIT

1. Seat must be out of vehicle.

2. Exhaust air and keep in highest position by squeezing weight adjuster handle and rod together (Fig. 1C, Nos. 2 & 3) and rotating downward.

3. Remove capscrew (Fig. 1B, No.10) and lockwasher (Fig. 1B, No.9) from bottom of air spring (Fig. 1B, No.11).

4. Remove roll pin (Fig. 1C, No.24) and shock pin (Fig. 1B, No.26) at bottom end.

5. Install foot release lever (Fig. 1A, No. 27) and replace shock pin (Fig. 1B, No. 26) and roll pin (Fig. 1C, No.24).

6. Attach foot pad (Fig. 1A, No.28) to foot release (Fig. 1A, No.27) with machine screw (Fig. 1A, No.29) and nut (Fig. 1A, No.30).

7. Install trip rod (Fig. 1A, No.31) by positioning it to the left of the air spring (Fig. 1B, No.11) and sliding it through front of bulkhead.

8. Install clip (Fig. 1A, No.15) by placing on rod (Fig. 1A, No.31) between ribs and flat portion of clip under air spring (Fig. 1B, No.11). Replace capscrew (Fig. 1B, No.10) and lockwasher (Fig. 1B, No.9) through base (Fig. 1B, No.32), clip (Fig. 1A, No.15), and into air spring (Fig. 1B, No.11). Two square projections on clip (Fig. 1A, No.15) must fit into the two holes of base.

9. Remove snap ring (Fig. 1B, No.25) from one end of shaft (Fig. 1B, No. 16) and withdraw shaft.

10. Remove machine screw (Fig. 1B, No.33) and spacer (Fig. 1B, No.34) and push nut (Fig. 1B, No.35).

11. Remove tube assembly (Fig. 1B, No.19) and rotate upper loop of shock absorber so that flange of bearing is facing the left side of seat.

12. Slide torsion spring (Fig. 1A, No.36), then lockout latch (Fig. 1A, No.37) over end of tube assembly (Fig. 1B, No. 19) and insert it into loop end of shock absorber. Push on nut (Fig. 1B, No.35) is discarded. Right leg of torsion spring (Fig. 1A, No.36) must be under lockout latch (Fig. 1A, No. 37) while left leg must be above cross tube of arm assembly. (Fig. 1B, No.18).

13. Insert shaft (Fig. 1B, No.16) through slot in arm assembly (Fig. 1B, No.18) and through tube assembly. (Fig. 1B, No. 19). Replace snap ring (Fig. 1B, No. 25) on both ends.

14. Discard spacer (Fig. 1B, No.34) and install spacer (Fig. 1A, No.36) (Fig. 1A, No.36 is longer than Fig. 1B, No.34) and machine screw (Fig. 1B, No. 33).

15. Attach wire hook (Fig. 1A, No.38) to hole in trip rod (Fig. 1A, No.31) and slot in lockout latch (Fig. 1A, No. 37) with hooks facing front of seat.

16. Install torsion spring (Fig. 1A, No.39) Coils are down, open ends press against front cross tube of arm assembly (Fig. 1B, No.18) and joined ends hook over tube assembly (Fig. 1B, No. 19).

DESCRIPTION

The Unison Action seat has a floating back. The two-way contoured back is constructed of a rubber pad,a support pad and no sag springs. The seat is constructed of a cotton pad,a rubber pad, heavy duty latex foam rubber,and coil springs. Covering of the seat and back are of a heavy duty vinyl. The seat is mounted on a frame that is connected to a suspension. The seat has a adjustable height,tilt,back angle, and ride conyrol. The seat and suspension are both maintenance free

PRINCIPLES OF OPERATION

Adjustable height tilt, back angle, and ride control suspension setting adapt the Unison seat to the individual drivers size, posture, weight and road conditions.

All levers are in easy reach and adjustments can be made while the truck is moving. The seat is built so the suspension and seat work together for maintenance-free life.

LUBRICATION

Underneath the seat should be air dusted at frequent intervals and all the attaching parts should be tightened securely. Points indicated in Fig. 1 should be lubricated when necessary with a high grade lubricant that will not run off.

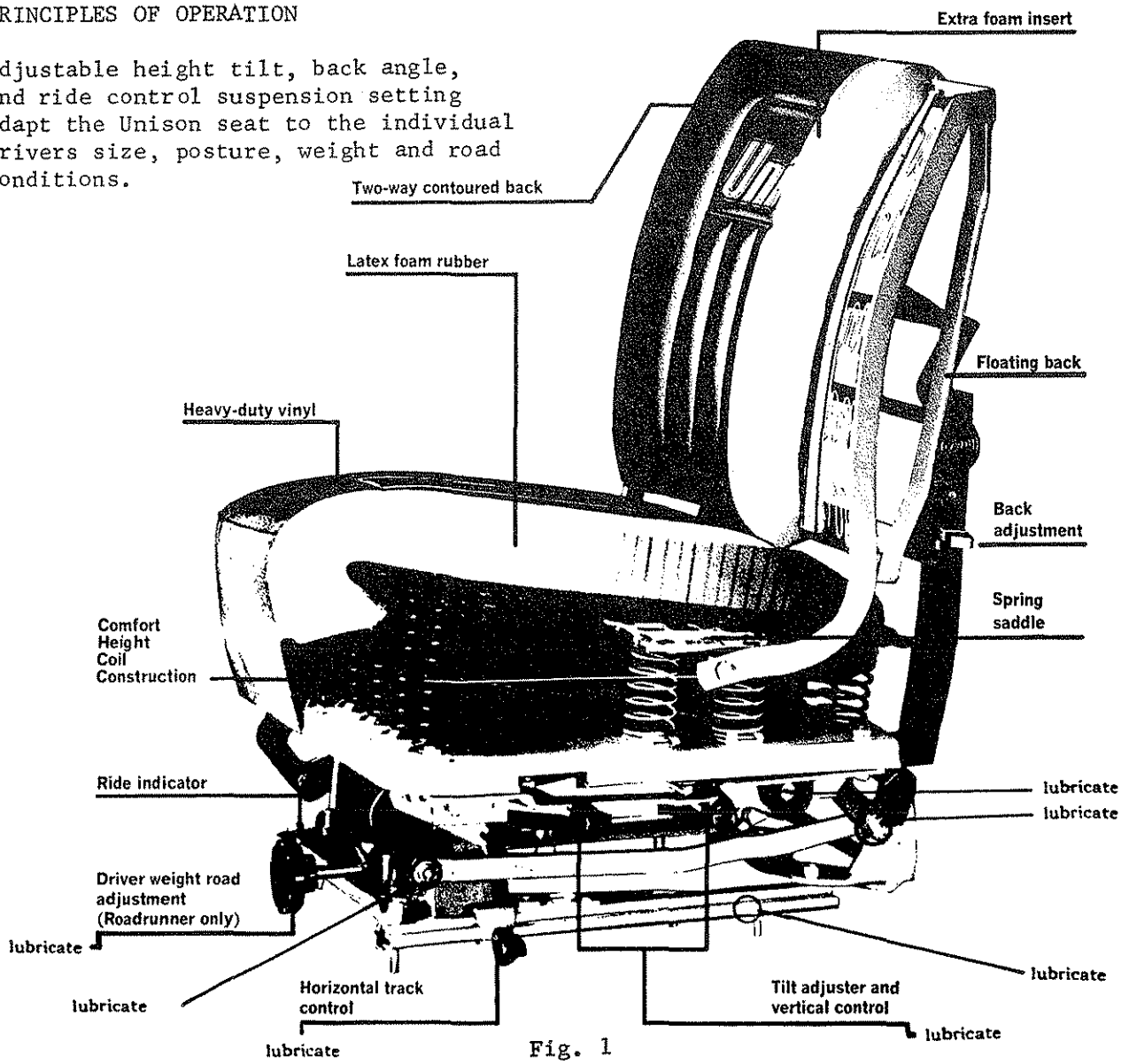


Fig. 1

GENERAL DESCRIPTION

The Viking T-Bar seat has a fully contoured back and seat cushions, a special steel alloy torsion bar that flexes to take the bounce out of the ride. The Viking T-Bar also has a built-in shock absorber to control topping and bottoming. An extra duty shock absorber is available for off the highway trucks.

OPERATING INSTRUCTIONS

1. The seat assembly moves forward or back 4" along ball bearing slides to suit a short or long-legged driver. (Fig. 1, Point 1)

2. To accomodate the different drivers comfort, the Viking T-Bar has a back-rest angle with three positions (Fig. 1, Point 3).

3. The hand-operated lever that controls the rachet mechanism is called the adjuster lever (Fig. 1, Point 2). This lever adjusts the torsion bar to the drivers weight from 130 to 275 pounds. Proper adjustment will position the seat and driver midway in the suspension, thus limiting topping and bottoming.

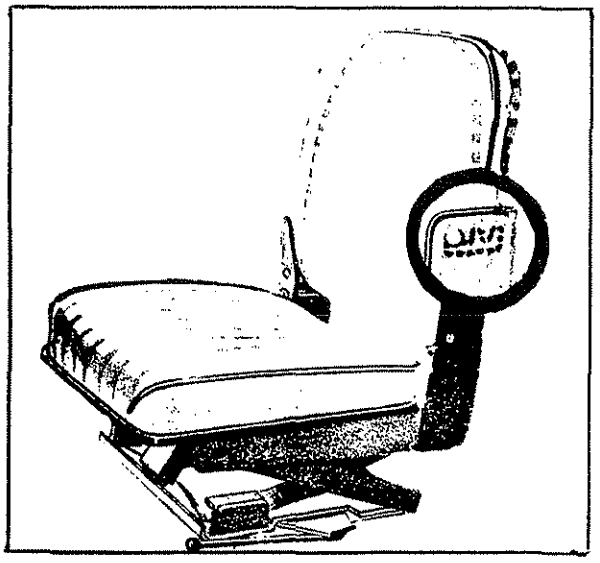


Fig. 1

4. To get proper adjustment,use the ride level indicator (Fig.2). If there is too much preload, the indicator will be forward of the upright (Fig 2, Point 1). If sufficient preload, it will remain behind (Fig. 2, Point 2). Adjust preload, as shown in (Fig. 1, Point 2),in static position until indicator is even with edge (Fig. 2, Point 3).

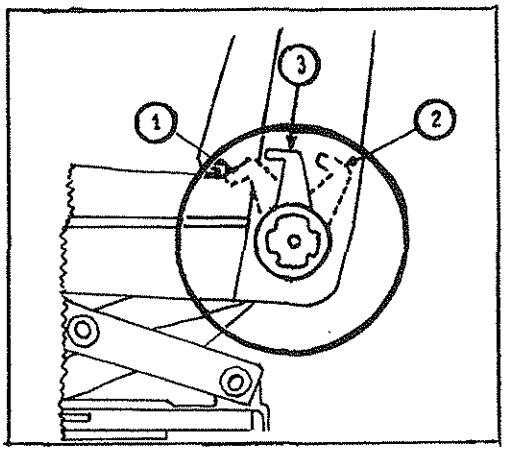


Fig. 2

TORSION BAR

Removal

1. Wedge upper seat in top position by using wood shim under tube located under front of seat cushion or by shim under tube located below back cushion.

2. Remove preload on torsion bars by rotating adjuster lever assembly counter-clockwise until adjuster assembly is disengaged from seat.

3. Disengage back cushion from seat assembly by removing bolts and lockwashers

4. Disengage seat cushion from assembly by removing nuts, lockwashers and washers. Move seat cushion forward to free nylon rollers from housing under seat cushion.

5. Remove right hand side panel assebmly by tapping out sideways. This allows yoke to drop free.

6. Remove torsion bar set from tube.

Assembly

1. Insert torsion bar set (Fig. 3, No. 3) in the tube being sure that the bars are engaged in retainer (Fig. 3, No. 4) inside tube at left hand side of seat.

2. Replace the right hand side panel assembly (Fig. 3, No. 1) with yoke (Fig. 3, No. 2) held in position inside housing on side panel. Engage yoke (Fig. 3, No. 2) on free end of torsion bar set (Fig. 3, No. 3).

3. Lining up the side panels on the right and left hand will retain the 20" dimension over the side panels.

4. To reassemble the seat cushion, move from front of seat toward the rear in order to engage nylon rollers (Fig. 3, No. 5) properly in housing under seat cushion.

5. Reassemble the back cushion.

6. To replace the preload adjuster (Fig. 3, No. 6), be sure that (Fig. 3, Nos.7-9) are in their proper position. Engage yoke (Fig. 3, No. 2) hooked ends over lugs on adjuster pin (Fig. 3, No. 10).

7. The preload bars are preloaded by rotating adjuster lever assembly (Fig. 3, No. 6) clockwise.

8. Remove the wood shims.

SHOCK ABSORBER

Removal

1. Wedge upper seat in top position using a wood shim under the tube located under the front of the seat cushion or by shim under tube located below back cushion.

2. Remove the preload on torsion bars by rotating adjuster lever assembly. DO NOT disengage adjuster assembly from seat.

3. Remove nuts, lockwashers and washer to disengage seat cushion. Wire side panel assemblies (Fig. 3, No. 1, 11) across front of seat to retain their position.

4. Remove the (2) washers (Fig. 3, No. 14)

5. Remove the hinge shaft by tapping out from left to right hand side.

6. Using a small diameter punch, remove the (2) roll pins (Fig. 3, No. 15) from hinge shaft at rear of the shock absorber.

7. To free the shock absorber, the hinge shaft at the rear of the shock absorber has to be removed.

Assembly

1. With the shock absorber (Fig. 3, No. 16) in proper position, replace the hinge shaft (Fig. 3, No. 17) at rear of shock.

2. To replace the (2) roll pins (Fig. 3, No. 15) in the hinge shaft, lock the roll pin on the right side in nibs in bent-up ear.

3. Replace the hinge shaft (Fig. 3, No. 13) at the front of the shock absorber, driving the shaft from the right hand to the left hand side.

4. The serrated end of the shaft is to enter the shock lever (Fig. 3, No. 18) last. Drive the shaft through the (2) washers (Fig. 3, No. 14) and through the shock absorber loop.

5. The (2) snap rings (Fig. 3, No. 12) at the end of the front hinge shaft. (Fig. 3, No. 13) have to be replaced.

6. Side panels on the right and left hand have to be lined up, retaining **the 20" dimension over the side panels.**

7. The seat cushion has to be reassembled.

8. The torsion bars are to be preloaded by rotating the adjuster lever assembly (Fig. 3, No. 6) clockwise.

9. Remove the wood shim. A

Extra Heavy Duty Shock

For severe operating conditions, off highway or over rough terrain, gravel or dump truck, mixers, earth movers or similar equipment. This option can be used if seat to floor clearance is 2 1/2" or more. A

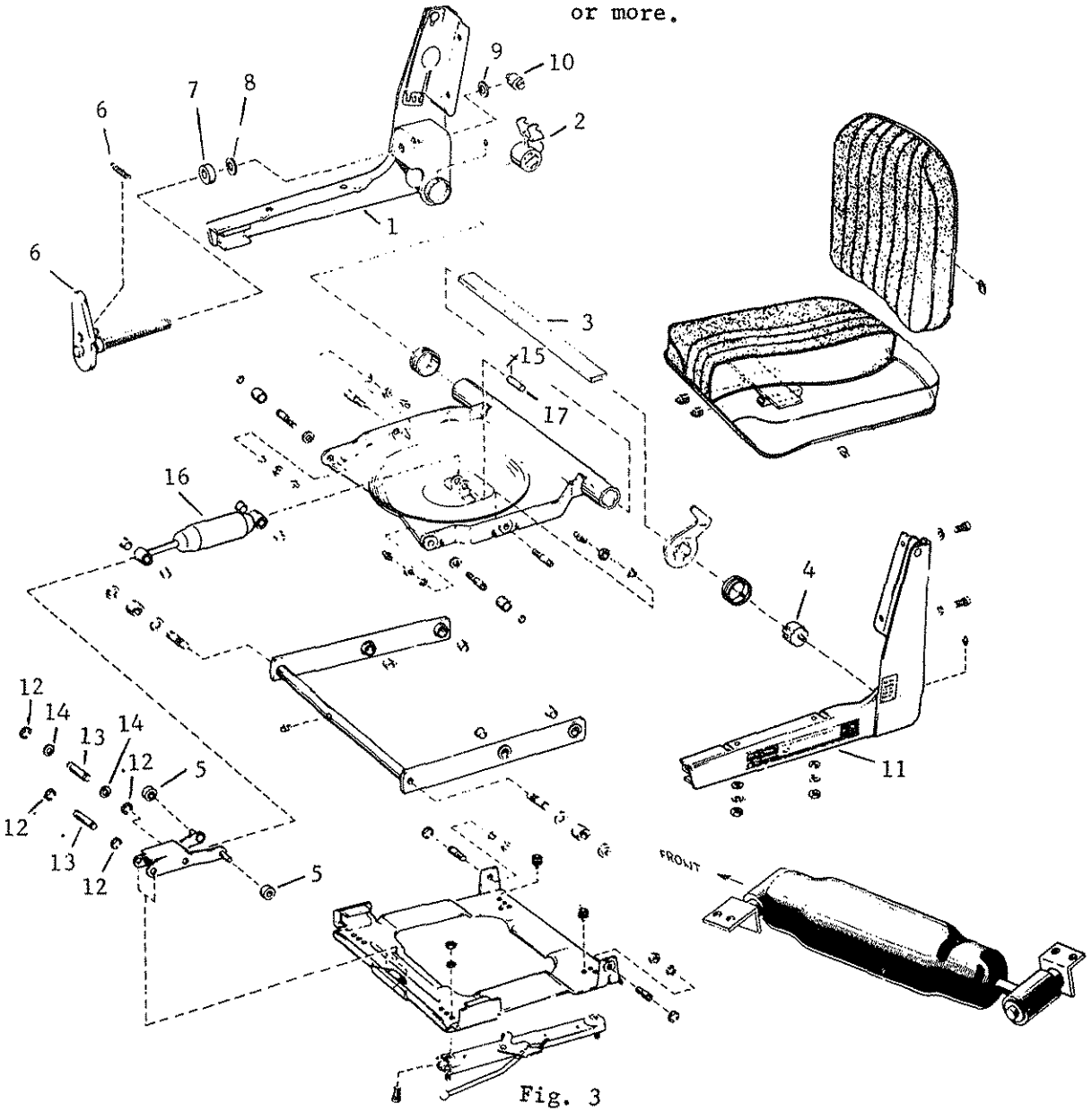


Fig. 3

SEAT CUSHION REBUILD

Cover

A Remove the cushion from the seat frame. The cover is held in place by fastener clips. By opening the clips, the cover is removed easily and replaced.

Foam Cushions

Incorporates contour design for right-posture and can be removed and replaced if and when required.

LUBRICATION

Lubricate with standard chassis grease. Use hand gun. Use Lubriplate on weight adjuster stud and slide rails. See Fig. 4.

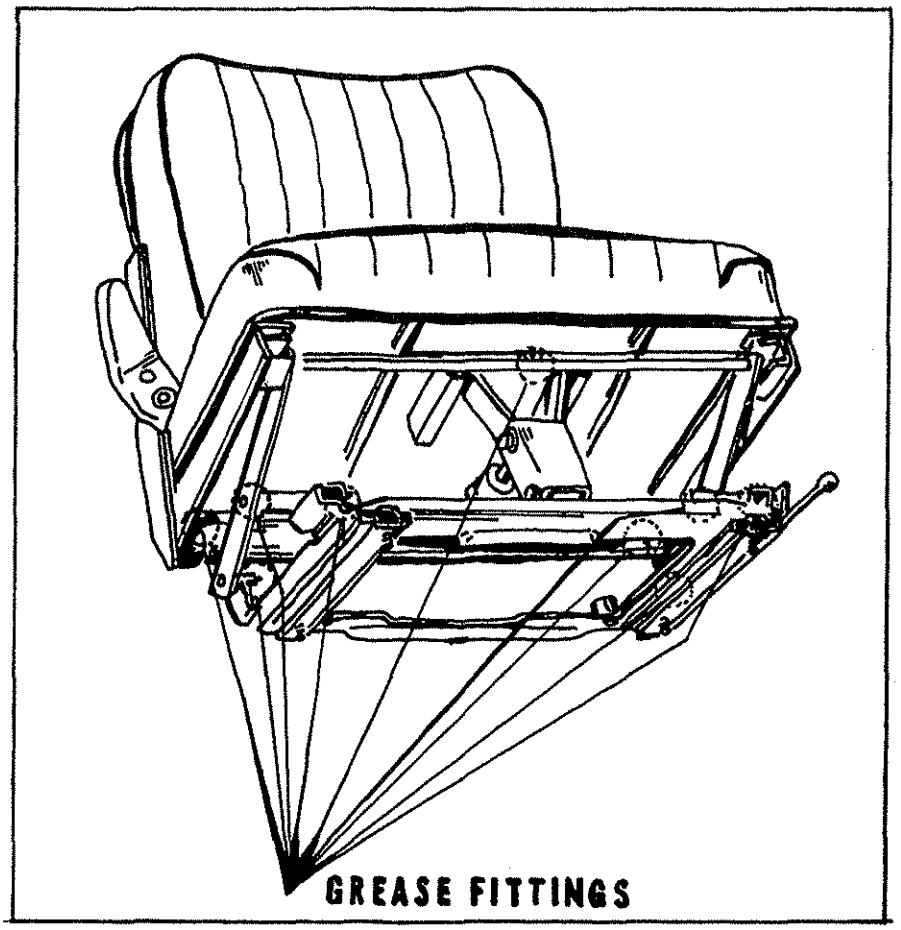


Fig. 4

FREIGHTLINER (MOTOROLA®) ELECTRONIC TACHOMETER

SUBJECT CONTENTS

TOPIC **PAGE NUMBER**

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PRINCIPLES OF OPERATION

SERVICE OPERATIONS

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Installation 2

MAGNETIC PICK-UP REMOVAL, AND INSTALLATION AND ADJUSTMENT
Removal 2
Installation and Adjustment 2

TACHOMETER HEAD CALIBRATION
Calibration Using the Motorola® Model TE100-AC Calibrator 3
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TROUBLESHOOTING

MAGNETIC PICK-UP VOLTAGE CHECK 4

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SPECIFICATIONS

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FREIGHTLINER (MOTOROLA®) ELECTRONIC TACHOMETER

GENERAL DESCRIPTION

Engine speeds are indicated in revolutions-per-minute (rpm) by the electronic tachometer (Fig. 1). The tachometer is used as a guide for shifting, and to keep the engine in the proper rpm range.

The electronic tachometer consists of a gauge, magnetic sensor (pick-up) unit (Fig. 2), and the electrical wires that complete the circuit between the two components.

PRINCIPLES OF OPERATION

A magnetic pick-up is installed in the flywheel housing. See Fig. 3. As the flywheel teeth pass by the magnetic end of the sensor (Fig. 4), the sensor converts magnetic impulses to electrical signals, which are directed to the tachometer head. The tachometer head amplifies the signals and converts them to an rpm reading. When the engine speed changes, the number of magnetic impulses-per-minute changes, thus affecting the reading on the tachometer face.

SERVICE OPERATIONS

TACHOMETER HEAD REMOVAL AND INSTALLATION

Removal

1. Apply the parking brakes.
2. Remove the screws that attach the tachometer/speedometer panel to the dash. See Fig. 1. Pull the panel out to provide access to the tachometer head. See Fig. 5.

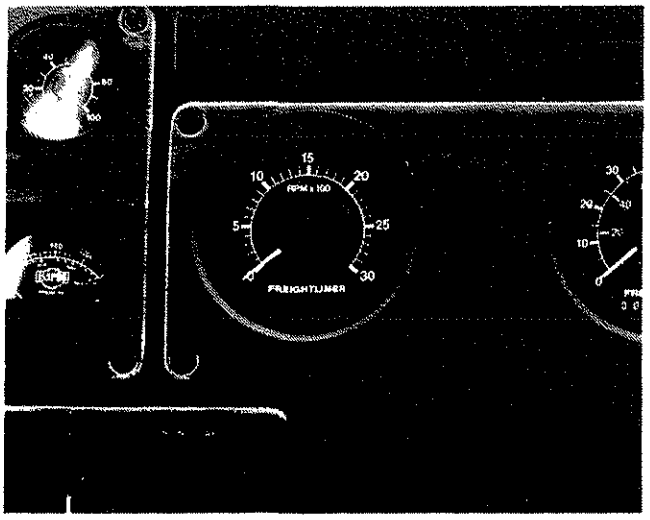
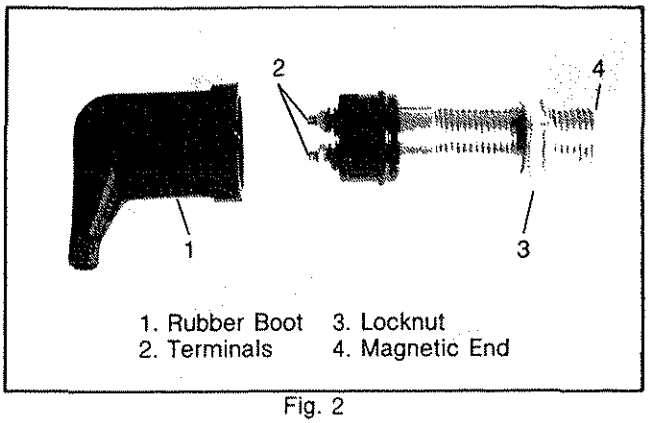
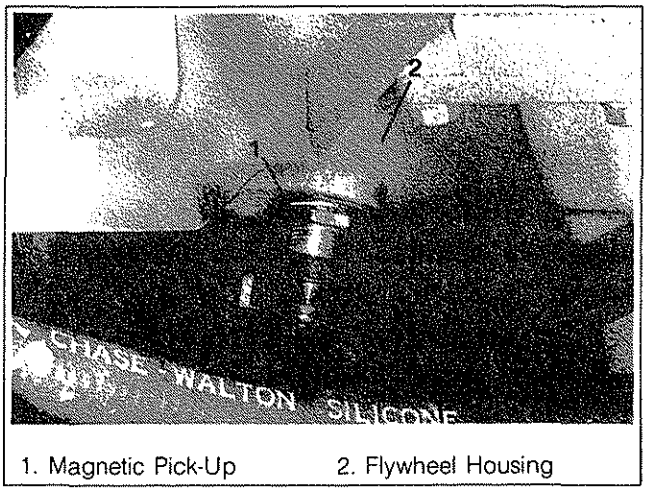


Fig. 1



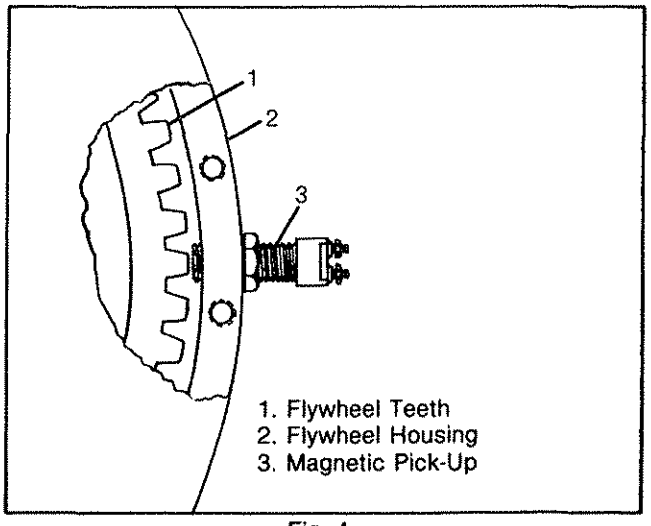
1. Rubber Boot
2. Terminals
3. Locknut
4. Magnetic End

Fig. 2



1. Magnetic Pick-Up
2. Flywheel Housing

Fig. 3



1. Flywheel Teeth
2. Flywheel Housing
3. Magnetic Pick-Up

Fig. 4

FREIGHTLINER (MOTOROLA®) ELECTRONIC TACHOMETER

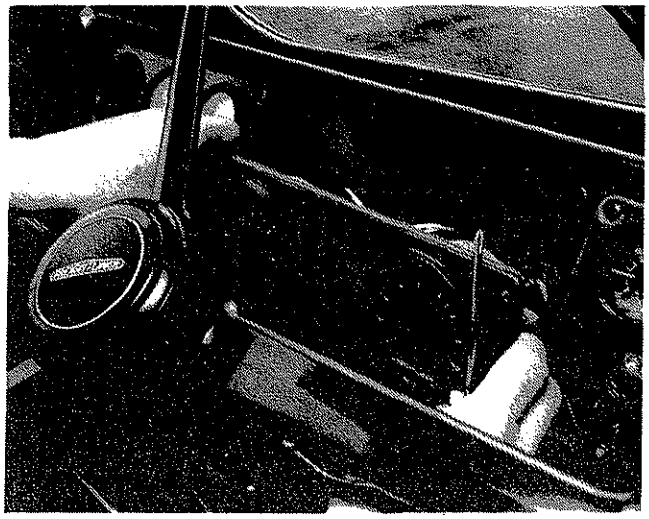


Fig. 5

3. For future reference, mark the wires. Disconnect the wires from the tachometer head.
4. Remove the nuts that attach the mounting bracket to the tachometer. Remove the bracket. Remove the tachometer head from the front of the panel.

Installation

1. Place the tachometer head in the panel.
2. Install the mounting bracket and mounting bracket nuts.
3. As referenced earlier, or using the appropriate wiring diagram under "SPECIFICATIONS" (Fig. 7), connect the electrical wires to the tachometer head.
4. Place the panel in the dash and install the screws.

MAGNETIC PICK-UP REMOVAL, AND INSTALLATION AND ADJUSTMENT

Removal

1. Pull the protective rubber boot back. Disconnect the electrical wires from the magnetic pick-up terminals. Refer to Figs. 2 and 3.
2. Loosen the locknut. Remove the magnetic pick-up.

Installation and Adjustment

1. Screw the magnetic pick-up into the flywheel housing until it bottoms out on the flywheel teeth. Then, unscrew the sensor unit (counterclockwise) one-half to three-fourths of a turn. See Fig. 4.

IMPORTANT: An inaccurate tachometer reading will result if the correct adjustment is not maintained.

2. Hold the magnetic pick-up in place to keep it from turning. Tighten the locknut 15 to 20 lbf·ft (20 to 27 N·m).
3. Connect the wires to the terminals of the magnetic pick-up; place the boot over the terminals.

TACHOMETER HEAD CALIBRATION

If a calibration is required, use one of the following procedures. Although procedures are listed in order of recommendation, the procedure chosen may depend on the calibration equipment available.

The screw for calibrating the tachometer is located near the right-hand top of the head, inside the tachometer case. See Fig. 6. A nylon plug, which covers the hole must be removed for calibration adjustment.

CAUTION: Use care when inserting the screwdriver in the adjustment hole to avoid damaging the nylon screw.

IMPORTANT: The magnetic pick-up must be properly adjusted before the calibration can be performed. To adjust the magnetic pick-up, refer to "MAGNETIC PICK-UP REMOVAL, AND INSTALLATION AND ADJUSTMENT."

In addition to the above, ensure that the calibration equipment is in proper working order and is connected correctly.

Fig. 6

FREIGHTLINER (MOTOROLA®) ELECTRONIC TACHOMETER

Calibration Using the Motorola® Model TE100-AC Calibrator

This calibrator is an audio frequency signal generator used for calibrating sensor-type electronic tachometer and speedometer instruments.

NOTE: This calibrator utilizes several different crystals. Be sure to install the 3225.8 Hz crystal when calibrating the tachometer head.

The calibrator can be powered by a 115-volt AC line or a 12- or 24-volt battery series. The calibrator provides regulated DC voltage and controlled calibration frequency to the instrument.

1. Remove the tachometer head from the panel. Refer to "TACHOMETER HEAD REMOVAL AND INSTALLATION."
2. Set the "DC Selector" switch on the calibrator to "12 Volts."
3. Move the toggle switch to the "OFF" (down) position, and adjust the "Signal Output Adj." control to zero.
4. Connect the calibrator to the power source. If a battery is used, connect the large clips of the supplied red and black wires to the battery terminals (red to positive, and black to negative).
5. Connect the calibrator to the tachometer. Refer to Table 1.

LEAD WIRE COLOR	FROM RECEPTACLE ON CALIBRATOR	TO POST ON TACHOMETER
Black	DC Output GRD (-)	Negative (-)
Red	DC Output +12v	Positive (+)
Green	Signal Output	Tach. Input (P)

Table 1

CAUTION: Before the toggle switch is turned to the "ON" position, ensure that the instructions for connecting the calibrator are followed carefully. Damage to the tachometer head may occur if a wrong connection is made.

6. Move the toggle switch to the "ON" (up) position.
7. Advance the "Signal Output Adj." control knob to "MAX" (full clockwise rotation).
8. Remove the nylon plug from the calibration access hole. Insert the screwdriver and turn the adjusting screw until the tachometer registers the correct rpm, as shown in Table 2 under "SPECIFICATIONS." The adjustment must be within 25 rpm on either side of the prescribed setting.

CAUTION: Use care when inserting the screwdriver in the adjustment hole to avoid damaging the nylon screw.

9. When the tachometer indicates the correct rpm reading, as shown in Table 2 under "SPECIFICATIONS," move the toggle switch to the "OFF" (down) position.
10. Disconnect the calibrator.

NOTE: The "Push-To-Reset" circuit breaker protects the calibrator circuits in case the "DC Output" leads get shorted. When the "Push-To-Reset" circuit breaker is activated, the pilot light stays on, but the "DC Output" positive connection opens. To restore the "DC Output," depress and release the orange button labeled "Push-To-Reset DC Output."

11. Install the tachometer head in the panel and connect the wiring. Refer to "TACHOMETER HEAD REMOVAL AND INSTALLATION."

Calibration Using the Engine Governed Speed

If this procedure is performed, ensure that the engine governed rpm is set according to the engine manufacturer's specifications. Check the engine rpm specifications with an accurate hand tachometer. Note the rpm readings.

NOTE: Calibration of the tachometer requires removing the tachometer from the dash panel. It is necessary to disconnect the wires because of their limited lengths. To calibrate the tachometer, jumper wiring must be used.

1. Adjust the magnetic pick-up. Refer to "MAGNETIC PICK-UP REMOVAL, AND INSTALLATION AND ADJUSTMENT."
2. Remove the tachometer from the panel. Refer to "TACHOMETER HEAD REMOVAL AND INSTALLATION."
3. As referenced earlier, or using the appropriate wiring diagram under "SPECIFICATIONS" (Fig. 7), connect the electrical wires to the tachometer head.
4. Remove the nylon plug from the calibration access hole.

FREIGHTLINER (MOTOROLA®) ELECTRONIC TACHOMETER

5. Operate the engine at idle and governed speeds. Monitor the rpm using the tachometer that is to be calibrated. With a screwdriver, slowly turn the adjusting screw until the tachometer reading matches the idle and governed speeds specified by the engine manufacturer.

CAUTION: Use care when inserting the screwdriver in the adjustment hole to avoid damaging the nylon screw.

6. After the tachometer has been calibrated, install the calibration access hole plug. Install the tachometer head in the panel. Refer to "TACHOMETER HEAD REMOVAL AND INSTALLATION."

TROUBLESHOOTING

Incorrect tachometer head readings can be attributed to one or more possible causes. Inaccurate readings may occur whenever the tachometer head or the engine has been replaced.

Inaccurate readings will occur if the magnetic pick-up is not adjusted correctly. Before troubleshooting the system, ensure that the magnetic pick-up is correctly adjusted. Refer to "MAGNETIC PICK-UP REMOVAL, AND INSTALLATION AND ADJUSTMENT."

NOTE: Before beginning the troubleshooting elimination process, make sure the batteries are neither overcharged nor undercharged. Correct the problem or replace the battery(s), as necessary.

MAGNETIC PICK-UP VOLTAGE CHECK

NOTE: To receive an accurate tachometer reading, a minimum of one volt AC output is required from the magnetic pick-up.

1. Move the rubber boot away from the magnetic pick-up; disconnect the electrical wires. Refer to Fig. 2. Inspect the terminals for corrosion and moisture. Clean the terminals, if necessary.
2. Connect an AC voltmeter to the magnetic pick-up terminals.
3. Run the engine at idle speed, and check the voltage output from the magnetic pick-up. If the voltage is less than one volt, refer to the chart under "TROUBLESHOOTING" for possible causes and corrections.
4. Turn off the engine and disconnect the voltmeter.
5. Connect the electrical wires to the magnetic pick-up terminals; place the boot over the terminals.

MAGNETIC PICK-UP RESISTANCE CHECK USING AN OHMMETER

To evaluate the magnetic pick-up, use an ohmmeter to measure the resistance across the terminals. A normal-operating pick-up measures 240 to 290 ohms. If the ohmmeter shows no response, the coil within the pick-up is open. If a resistance of less than 240 ohms is indicated, a short circuit exists in the magnetic pick-up coil, resulting in a weak signal output. In either situation, replace the magnetic pick-up.

MAGNETIC PICK-UP TO TACHOMETER HEAD WIRING CHECK

1. Remove the screws that attach the tachometer/speedometer panel to the dash. See Fig. 1. Pull the panel out to provide access to the tachometer head. See Fig. 5.
2. Check for an open or short circuit by disconnecting both of the magnetic pick-up leads from the tachometer head. Connect an ohmmeter to the leads. The resistance should measure 265 ohms. A reading between 240 and 290 ohms is acceptable.

   If the above reading is not obtained, and the magnetic pick-up is operative, the problem is in the magnetic-pickup wiring. Repair or replace the damaged wires.

   If the reading is between 240 and 290 ohms, connect the magnetic pick-up leads to the tachometer head, then proceed to "BATTERY VOLTAGE CHECK USING A DC VOLTMETER."

BATTERY VOLTAGE CHECK USING A DC VOLTMETER

1. With the ignition switch off, place the probes of the DC voltmeter across the positive and the negative terminals of the tachometer head.

NOTE: For vehicles with a negative ground, attach the negative (black) probe to the negative terminal and the positive (red) probe to the positive terminal. For vehicles with a positive ground, attach the negative probe to the positive terminal and the positive probe to the negative terminal.

2. Turn the ignition switch on. The voltmeter should read 10 to 15 volts DC.

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If the voltage is between 10 and 15 volts DC, the tachometer head, not the wiring, is causing inaccurate readings. Turn the ignition switch off, then disconnect the voltmeter probes. Replace the tachometer head. Refer to "TACHOMETER HEAD REMOVAL AND INSTALLATION."

If the voltage is not between 10 and 15 volts DC, the wiring between the ignition switch and the tachometer head must be checked. Turn the ignition switch off, then disconnect the voltmeter probes. Repair or replace the wiring. Install the tachometer head. Refer to "TACHOMETER HEAD REMOVAL AND INSTALLATION."

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTIONS
Less Than One Volt Reading From the Magnetic Pick-Up	Spacing between the magnetic pick-up and the flywheel is not correct.	Adjust the magnetic pick-up to specifications.
	The magnetic pick-up is damaged.	Replace the magnetic pick-up.
Tachometer Head Will Not Register	Spacing between the magnetic pick-up and the flywheel is not correct.	Adjust the magnetic pick-up to specifications.
	An incorrect electrical connection was made on one or more wires.	Connect the wiring using the wiring diagram.
	Loose, or corroded terminals, broken contacts, internal breakage in the wires, shorting, or frayed wires is causing an incomplete circuit.	Replace the damaged component(s), as necessary.
	The magnetic pick-up is damaged.	Replace the magnetic pick-up.
	The tachometer head is damaged internally.	Replace the tachometer head.
Inaccurate Tachometer Reading	Spacing between the magnetic pick-up and the flywheel is not correct.	Adjust the magnetic pick-up to specifications.
	Shorts are occuring in the magnetic pick-up.	Check the ohm resistance of the magnetic pick-up. Replace the component, as necessary.
	The tachometer head is incorrectly calibrated.	Calibrate the tachometer head to specifications.
	The governed rpm has been changed.	
	Erratic readings are resulting from loose electrical connections.	Check all the electrical wiring in the tachometer wiring system. Tighten all the connections.
	If the tachometer head was replaced, the wrong model was installed.	Replace with a model designed for the engine specification.

FREIGHTLINER (MOTOROLA®) ELECTRONIC TACHOMETER

SPECIFICATIONS

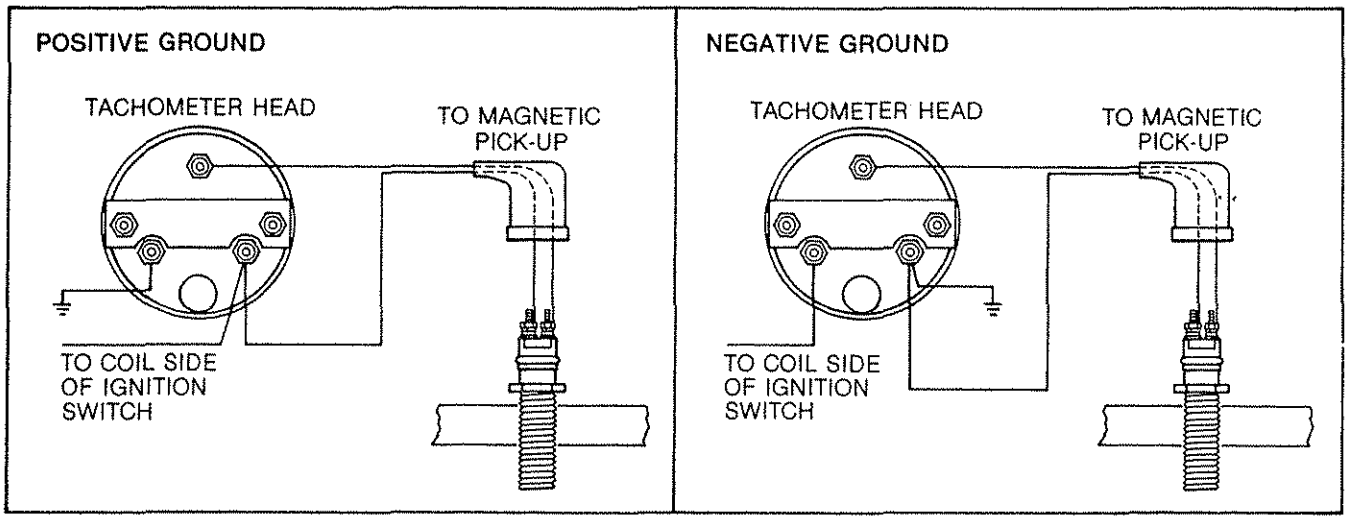

Fig. 7

ENGINE MANUFACTURER	MODEL	NUMBER OF FLYWHEEL TEETH	TACHOMETER POINTER SETTING
Detroit Diesel	All	118	1640
Cummins	All Inlines Except Big Cam III and L10	118	1640
	Big Cam III, V-903 and L10	103	1870
Caterpillar	1673	132	1470
	1674	152	1270
	1693	118	1640
	3208	134	1440
	3306	156	1240
	3406 and 3408	113	1710

Table 2, Calibration Settings Using the Motorola® TE100-AC With a 3225.8 Hz Crystal

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

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FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

GENERAL DESCRIPTION

The Freightliner (Motorola) electronic speedometer utilizing a 45-pulse slotted disc (Fig. 1) is distinguished from other electronic speedometer systems by observing the location of the magnetic sensor (pickup) unit (Fig. 2). The sensor unit is mounted on the front axle flange (usually the driver's side of the vehicle) and extends from the inboard portion of the axle flange (refer to Fig. 3).

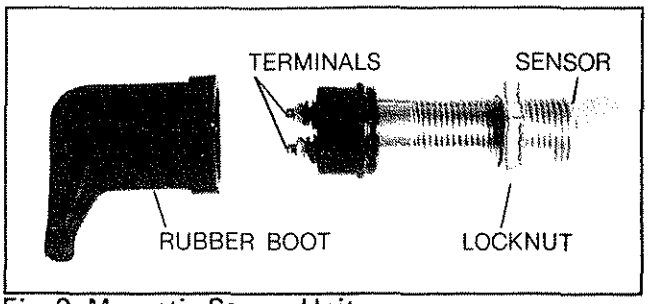

Fig. 2, Magnetic Sensor Unit

PRINCIPLES OF OPERATION (Refer to Fig. 3)

The magnetic sensor unit is stationary mounted on the front axle flange and is wired to the speedometer head (Fig. 4). The sensor unit is positioned so that it extends to within a few hundredths of an inch of the slotted disc, which is mounted on the rotating wheel hub.

When the wheel turns, the ribs and solid portions of the slotted disc cause magnetic pulses between the disc and the sensor unit. From the sensor unit, the pulses are transmitted to the speedometer head. Depending on the frequency of pulses received at the speedometer head, a proportional miles-per-hour (kilometers-per-hour) reading registers on the speedometer face.

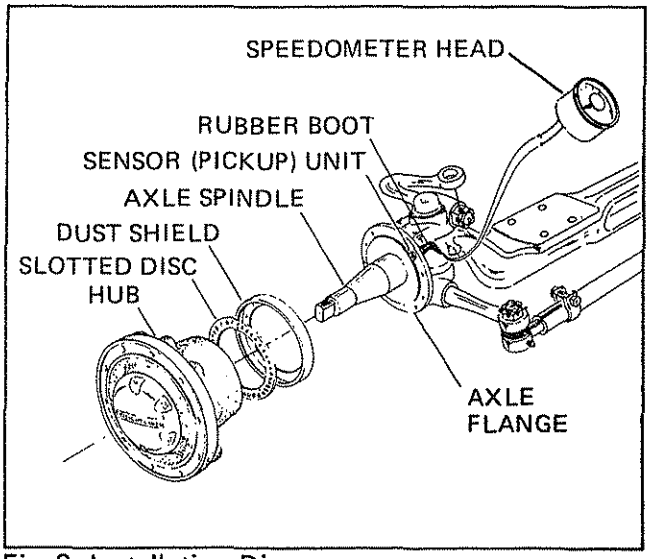

Fig. 3, Installation Diagram

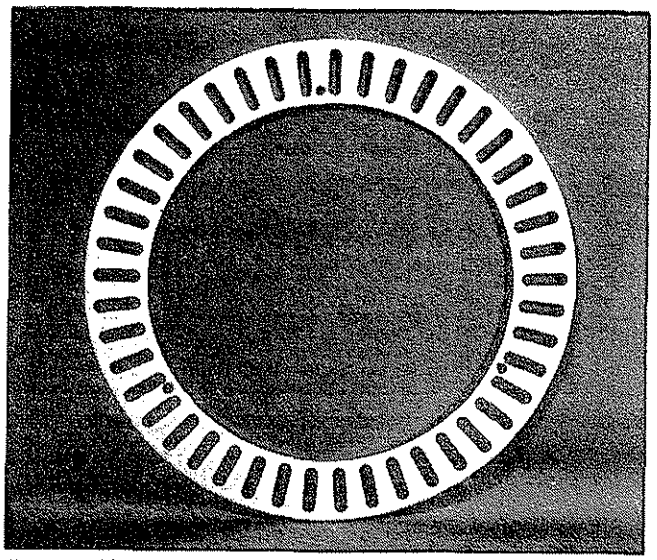
Fig. 1, Slotted Disc

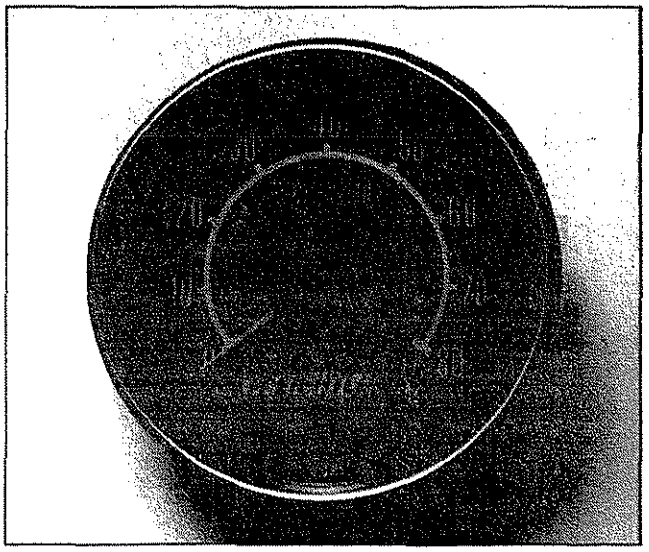
Fig. 4, Electronic Speedometer Head

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SERVICE OPERATIONS

SPEEDOMETER HEAD REMOVAL AND INSTALLATION

Removal

1. Loosen the screws attaching the left hinged portion of the dash to the cowl. Open the hinged dash to provide access to the speedometer head.

2. Mark the electrical wires connected to the speedometer for later assembly reference, then disconnect the wires from the speedometer.

3. Remove the two nuts attaching the speedometer mounting bracket to the speedometer head, then remove the bracket. Remove the speedometer from the front side of the instrument panel.

Installation

1. With the hinged dash in the open position, place the speedometer head through the front side of the instrument panel.

2. Position the mounting bracket in place, then install the nuts attaching the speedometer mounting bracket to the speedometer head.

3. Using the identification previously made, connect the electrical wires to the speedometer head.

4. Close the hinged dash, then tighten the screws attaching it to the cowl.

SENSOR UNIT REMOVAL, AND INSTALLATION AND ADJUSTMENT

Removal

1. Pull back the rubber protective boot, then disconnect the electrical wires from the sensor unit terminals.

2. Loosen the sensor unit locknut, then remove the sensor unit.

Installation And Adjustment

1. Turn the sensor unit into the spindle flange until it bottoms out on the slotted disc. Then, turn the sensor unit back out 1/4 to 1/2 turn. The gap between the sensor unit and the slotted disc should then be .03 to .05 inch (.76 to 1.27 mm).

IMPORTANT: Failure to maintain this adjustment will result in inaccurate speedometer readings.

2. Hold the sensor unit to keep it from turning, then tighten the locknut. Torque the locknut to 15-20 ft-lbs (20-27 N·m).

3. Connect the electrical wires to the sensor unit terminals. Place the boot over the sensor unit.

SLOTTED DISC REMOVAL AND INSTALLATION

Removal

1. Remove the wheel hub and bearing assemblies. Refer to the 10 Group of this manual for instructions.

2. Remove the three fasteners that attach the slotted disc to the back of the wheel hub.

3. Remove the slotted disc from the back of the wheel hub.

Installation

1. Place the slotted disc on the back of the wheel hub, lining up the three screw holes in the disc with the holes in the back of the hub.

2. Install the three screws attaching the disc to the hub, and tighten securely.

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

3. Install the hub and bearing assemblies on the axle spindle. Refer to the 10 Group of this manual for instructions. Adjust the wheel bearings using the procedure given in the 10 Group of the Freightliner Maintenance & Lube Manual.

WARNING: Failure to properly adjust the wheel bearings could result in a hazardous vehicle operating condition.

SPEEDOMETER HEAD CALIBRATION

The speedometer is accurately calibrated at the factory and should not require subsequent recalibration. However, if a new speedometer head is installed, or, if different tires are installed, it will be necessary to recalibrate the speedometer head.

NOTE: The accuracy of speedometer head readings can be tested following the instructions given under "SPEEDOMETER HEAD READING ACCURACY TEST" in this subject.

Speedometer head calibration can be done by any of three methods: the Motorola TE100-AC Instrument Calibrator; the Sine Wave Signal Generator; or the dynamometer. Of the three methods, the Motorola Instrument Calibrator is preferred, but all are acceptable, depending on the equipment available.

NOTE: Before calibrating the speedometer head, insure that the sensor unit is adjusted. Refer to "SENSOR UNIT REMOVAL, AND INSTALLATION AND ADJUSTMENT" in this subject for instructions.

The calibration adjusting screw is located behind a nylon plug in the back of the speedometer head, near the top right-hand side of the speedometer case (Fig. 5).

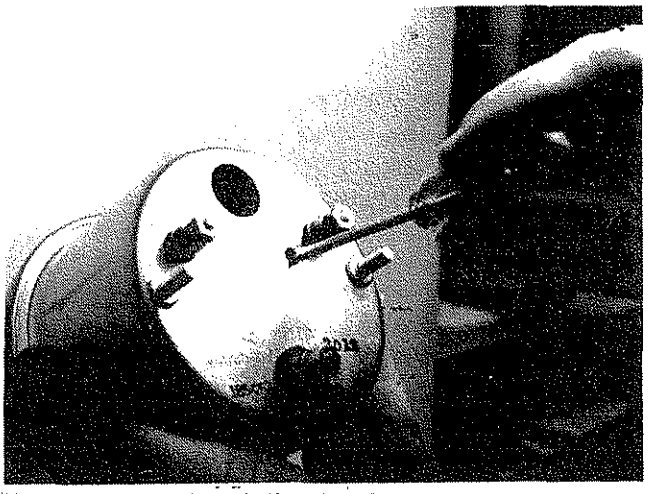

Fig. 5, Calibration Adjusting Screw

Calibration Using The Motorola TE100-AC Instrument Calibrator

The Motorola TE100-AC Instrument Calibrator is an audio frequency signal generator used for calibrating Motorola sensor-type speedometer instruments.

The calibrator can be powered by 115 volt AC line current, or by a 12 or 24 volt vehicle battery. It provides regulated DC voltage and controlled calibration frequency to the speedometer head.

NOTE: The Motorola TE100-AC Instrument Calibrator has two different crystals which can be used. For speedometer calibration, install the 351 Hz crystal.

1. Remove the speedometer head from the instrument panel using the instructions given under "SPEEDOMETER HEAD REMOVAL AND INSTALLATION" in this subject.

2. Set the "DC SELECTOR" switch on the calibrator to "12 VOLTS."

3. Turn the toggle switch "off" (down) and adjust the "SIGNAL OUTPUT ADJ." control to the zero position.

4. Connect the calibrator to either a 115 volt AC line cord, or a 12 volt battery. If a battery is used, connect the large clips of the supplied red and black calibrator wires to the battery terminals (red to positive, black to negative).

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

5. Connect the calibrator to the speedometer as shown in Table 1, located under this heading.

NOTE: The speedometer input post is labled "TACH INP." on the rear of the housing.

6. Move the calibrator toggle switch to the "POWER ON" (up) position. The pilot light should go on unless: (1) the electrical circuit to the power supply is incomplete, (2) the pilot light bulb is burned out, or (3) the calibrator unit is inoperative.

7. Advance the "SIGNAL OUTPUT ADJ." control knob to "MAX" (full clockwise rotation).

8. Adjust the speedometer pointer to the recommended setting shown in Table 2, located under **"SPECIFICATIONS."** Make the adjustment with a thin-bladed screwdriver through the adjusting screw access hole in the back of the speedometer head. See Fig. 5.

NOTE: Most Motorola electronic speedometer heads are equipped with nylon adjusting screws. However, if the adjusting screw is metal, wrap the screwdriver shaft with insulating tape to prevent possible grounding against the sides of the adjusting screw access hole.

9. When the speedometer needle indicates the reading as shown in Table 2, shut off the power at the calibrator (push the toggle switch down).

10. Disconnect the calibrator from the batteries when it is not in operation.

NOTE: The "PUSH-TO-RESET" circuit breaker protects the calibrator circuits in case the "DC OUTPUT" leads are shorted. When the "PUSH-TO-RESET" circuit breaker is activated, the pilot light will stay on but the "DC OUTPUT" positive connection will be opened. To restore "DC OUTPUT," depress and release the orange "PUSH-TO-RESET" button.

Lead Wire Color	From Receptacle On Calibrator	To Terminal On Speedometer
Black	DC Output GRD(-)	Negative(-)
Red	DC Output +12v	Positive(+)
Green	Signal Output	TACH INP.

Table 1

11. Disconnect the calibrator wires from the speedometer head, and replace the nylon plug in the adjusting screw access hole. The speedometer is now calibrated. Install the speedometer head in the instrument panel; refer to "SPEEDOMETER HEAD REMOVAL AND INSTALLATION" in this subject for instructions.

Calibration Using The Sine Wave Signal Generator

The following calibration procedure requires the use of a sine wave signal generator, having a 2 to 4 volt AC signal with the speedometer connected.

1. Remove the speedometer head from the instrument panel, using the procedure given under "SPEEDOMETER HEAD REMOVAL AND INSTALLATION" in this subject.

2. Connect the wires as shown in Fig. 6.

3. Set the output level of the signal generator to produce a 2 to 4 volt AC signal with the speedometer connected. This will place the signal generator control in the 10 volt range on most signal generators.

CAUTION: A signal greater than 4 volts will result in an inaccurate reading, and could result in damage to the speedometer head.

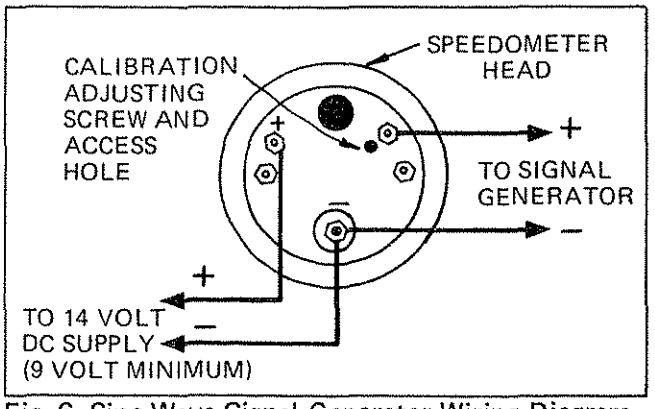

Fig. 6, Sine Wave Signal Generator Wiring Diagram

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

4. Determine the required cycles per second from Table 3, located under **"SPECIFICATIONS,"** then set the signal generator frequency controls to the specified cycles per second. On some signal generators, this requires setting both a frequency control and a multiplier, or frequency range control. For example: a cycles per second setting of "35" and a multiplier setting of "X10" will create an output of 350 cycles per second.

5. Remove the nylon plug from the adjusting screw access hole on the back of the speedometer head, then turn on the signal generator.

6. With a screwdriver, rotate the adjusting screw (Fig. 5) until the speedometer reads 60 mph (97 km/h). The speedometer needle will move in the direction the adjusting screw is turned.

NOTE: If the adjusting screw is metal, wrap the screwdriver blade with insulating tape to prevent grounding against the sides of the adjusting screw access hole.

7. Turn off the signal generator, disconnect the wires, and place the nylon plug in the adjusting screw access hole. The speedometer head is now calibrated. Install the speedometer head in the instrument panel using the procedure given under "SPEEDOMETER HEAD REMOVAL AND INSTALLATION" in this subject.

Calibration Using A Dynamometer

If no electrical calibration devices are available, a dynamometer can be used to calibrate the speedometer. The following guidelines are intended as a supplement to the dynamometer manufacturer's operations manual.

WARNING: Always refer to the dynamometer manufacturer's operations manual for complete operating instructions and precautions. Improper use of the dynamometer can lead to personal injury caused by the person or objects coming in contact with the spinning tires, or the vehicle coming loose from the dynamometer.

1. Position the vehicle front wheels on the dynamometer.

2. Chain the rear of the vehicle as recommended by the dynamometer manufacturer to prevent the vehicle from moving when the dynamometer is in operation.

3. Remove the speedometer head from the instrument panel, but do not disconnect the electrical wiring. Refer to "SPEEDOMETER HEAD REMOVAL AND INSTALLATION" in this subject for instructions.

4. Remove the nylon plug from the adjusting screw access hole at the back of the speedometer head (Fig 5).

5. Stabilize the front wheels in the straight ahead position, as recommended by the dynamometer manufacturer.

WARNING: Failure to perform the guidelines above, plus any precautionary procedures outlined in the dynamometer manufacturer's operations manual, could result in a hazardous work area. Improper use of the dynamometer can lead to personal injury caused by the person or objects coming in contact with the spinning tires, or the vehicle coming loose from the dynamometer.

6. Set the dynamometer to the manufacturer's recommended speed, then start the dynamometer.

7. With the ignition key on, turn the adjusting screw with a screwdriver (Fig. 5) until the speedometer head reading matches the reading on the dynamometer dial.

NOTE: If the adjusting screw is metal, wrap the blade with insulating tape to prevent grounding against the sides of the adjusting screw access hole.

8. After the speedometer is calibrated, turn off the dynamometer, then install the nylon plug in the adjusting screw access hole. Install the speedometer head in the instrument panel

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using the procedure under "SPEEDOMETER HEAD REMOVAL AND INSTALLATION" in this subject.

9. Disconnect the vehicle from the dynamometer.

TROUBLESHOOTING

The following is a troubleshooting elimination process requiring the use of a voltmeter and an ohmmeter. Since the evaluation is an elimination process, the checks should be made in the order in which they are listed.

Incorrect speedometer head readings can be attributed to one or more possible causes. Inaccuracies in speedometer head readings are likely to exist whenever a replacement speedometer head is installed on a vehicle, or whenever different tires are installed. In both cases, the speedometer head must be calibrated using one of the procedures in this subject. To test for the accuracy of a speedometer head reading, refer to "SPEEDOMETER HEAD READING ACCURACY TEST" in this subject.

NOTE: Before beginning the troubleshooting elimination process, insure that the vehicle battery is neither overcharged nor undercharged. Correct or replace the battery as necessary.

SPEEDOMETER HEAD READING ACCURACY TEST

Testing the accuracy of speedometer head readings is best performed by commercial services specializing in such tests. If these commercial services are not available, two alternative methods are described below.

Speedometer Reading Test

For this test, the vehicle in question must follow another vehicle that is known to have an accurate speedometer system. The driver of the lead vehicle should travel a specified road distance at a predetermined speed (or speeds) with the test vehicle keeping pace behind.

After the test, speedometer readings are compared. Discrepancies in the comparisons can usually be attributed to inaccurate speedometer head calibration. Follow the instructions given in steps 5 through 7 under **"Odometer Reading Test"** in this subject.

Odometer Reading Test

For this test, the driver will be comparing the odometer readings at two specified points along a road (the odometer and speedometer readings are interdependent on each other). A stretch of road at least 5 miles (8 km) long, and one that is marked with mileage boundaries, is needed (most major roads and highways are clearly marked at 1 or 5 mile intervals).

1. As the vehicle passes the first mileage marker on the side of the road, note the odometer reading to the nearest tenth of a mile.

2. Travel a minimum distance of 5 miles (8 km).

3. As the vehicle passes the final mileage marker, note the odometer reading to the nearest tenth of a mile.

4. Subtract the first odometer reading from the last, then compare that figure with the total actual miles (km) between the mileage markers on the side of the road.

5. If the mileage figures do not match, the probable cause can be attributed to inaccurate speedometer head calibration. To calibrate accurately, follow one of the speedometer head calibration procedures in this subject.

6. After calibration of the speedometer head, make certain that the speedometer head readings are accurate by repeating one of the accuracy tests above.

7. If incorrect speedometer head readings persist, proceed to "SENSOR OUTPUT VOLTAGE CHECK USING AN AC VOLTMETER" in this subject.

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SENSOR OUTPUT VOLTAGE CHECK USING AN AC VOLTMETER

1. Set the rear parking brakes, then chock block the rear tires to prevent vehicle movement.

2. Raise the front of the vehicle until the tires clear the floor, then place safety stands under the front axle.

3. Insure that the AC voltmeter is operational. Then, disconnect both leads from the sensor terminals and connect the voltmeter across the sensor terminals.

4. Manually rotate the front sensing wheel of the vehicle to 10 mph (16 km/h), or approximately two tire revolutions per second; a minimum of one volt AC is required from the sensor.

   If there is a minimum of one volt AC from the sensor unit, and inaccurate speedometer readings persist, fault lies either in the wiring to the speedometer head or in the speedometer head itself. Proceed to "SENSOR TO SPEEDOMETER HEAD WIRING CHECK" in this subject.

   If the voltage output is less than one volt AC, the source of the problem is due either to a malfunctioning sensor or to excessive spacing between the sensor and the slotted disc. First, insure that the spacing is not excessive; refer to "SENSOR ADJUSTMENT CHECK" in this subject. If the spacing is not at fault, proceed to step 5, and then follow the procedure given under "SENSOR RESISTANCE CHECK USING AN OHMMETER" in this subject.

5. Remove the safety stands from the front axle, then lower the vehicle to the floor. Remove the chock blocks from the rear tires.

SENSOR RESISTANCE CHECK USING AN OHMMETER

1. Pull back the sensor unit rubber boot (Fig. 3), then disconnect the electrical wires from the sensor. Make sure that the sensor terminals are free of corrosion and moisture.

2. Connect the ohmmeter leads to the terminals of the sensor unit. The sensor unit should measure 239-291 ohms.

   If there is an acceptable ohm reading, and inaccurate speedometer readings persist, fault lies either in the wiring to the speedometer head or in the speedometer head itself. Proceed to "SENSOR TO SPEEDOMETER HEAD WIRING CHECK" in this subject.

   If there is an unacceptable ohm reading, replace the sensor unit with a new one. Disconnect the ohmmeter leads, then follow the procedures under "SENSOR UNIT REMOVAL, AND INSTALLATION AND ADJUSTMENT" in this subject.

SENSOR ADJUSTMENT CHECK

1. Adjust the sensor unit spacing, using the procedure given under "SENSOR UNIT REMOVAL, AND INSTALLATION AND ADJUSTMENT" in this subject.

2. Again, measure the voltage output after the spacing has been adjusted (or authenticated). Connect an AC voltmeter across the sensor terminals.

   If the voltage level is still below one volt, check the positioning of the sensor unit in relation to the spaces in the slotted disc. If the sensor is not installed squarely into the spindle flange, the sensor may be pointing outward and contacting the nonwindowed portion of the disc. If the sensor is pointing inward, it may be contacting the edge of the hub.

   Visually inspect the disc location from the rear of the spindle hole. If visual inspection is not possible or is unreliable, the sensor contact point may be determined as follows:

   .1 Remove the sensor unit from the spindle flange.

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

.2 Chalk the end of the sensor that contacts the slotted disc.

.3 Insert the sensor unit back in the spindle flange, insuring that the chalked end bottoms out.

.4 Remove the sensor unit, then remove the wheel, hub, and drum assemblies. Refer to the 10 Group of this manual for instructions.

.5 Observe the chalked contact point to identify the problem. If the sensor appears to be properly positioned, a warped or bent slotted disc may be responsible for inaccurate speedometer head readings. A visual check of the disc will confirm whether it is warped or bent. Replace the slotted disc if it is damaged. Refer to the instructions given under "SLOTTED DISC REMOVAL AND INSTALLATION" in this subject.

.6 Install the hub, drum, and wheel assemblies. Refer to the 10 Group of this manual for instructions.

3. Remove the safety stands from the front axle, then lower the vehicle to the floor.

4. Install, then adjust the sensor unit; for instructions, refer to "SENSOR UNIT REMOVAL, AND INSTALLATION AND ADJUSTMENT" in this subject. Then, remove the chock blocks from the rear tires.

SENSOR TO SPEEDOMETER HEAD WIRING CHECKS

1. Loosen the screws attaching the left hinged portion of the dash to the cowl. Open the hinged dash to provide access to the speedometer head.

2. Check for an open or shorted circuit by disconnecting the sensor leads at both the speedometer head "TACH INP." terminal and the vehicle ground terminal. Insure that the sensor unit is wired at the wheel. The resistance should be the same as the resistance of the sensor itself, 239-291 ohms.

   If the reading is not between 239-291 ohms, and the sensor unit is operational, the wiring between the sensor unit and the speedometer head is at fault. Repair or replace the wiring.

   If the reading is between 239-291 ohms, connect the sensor leads to the speedometer head, then proceed to "BATTERY VOLTAGE CHECK USING A DC VOLTMETER" in this subject.

BATTERY VOLTAGE CHECK USING A DC VOLTMETER

1. Insure that the ignition switch is in the "off" position. Then, place the probes of a DC voltmeter across the positive and negative terminals of the speedometer head.

NOTE: For negative ground vehicles, attach the negative (black) probe to the negative terminal and the positive (red) probe to the positive terminal. For positive ground vehicles, attach the negative probe to the positive terminal and the positive probe to the negative terminal.

2. Turn the ignition switch to the "on" position. A voltage reading of 10.1 to 15.1 volts DC must register in this voltage test.

   If the voltage reading is within 10.1-15.1 volts DC, the speedometer head is inoperative and must be replaced. Turn the ignition switch to the "off" position, then disconnect the voltmeter probes. Next, follow the speedometer head removal, installation, and calibration procedures in this subject.

   If the voltage reading is not within 10.1-15.1 volts DC, and inaccurate speedometer head readings persist, fault lies in the wiring between the ignition switch and the speedometer head. Turn the ignition switch to the "off" position, then disconnect the voltmeter probes. Next, repair or replace the faulty wiring.

3. Close the hinged portion of the dash, then tighten the screws attaching it to the cowl.

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Speedometer Does Not Register	Sensor unit gap is not properly adjusted.	Adjust the gap. Refer to "SENSOR UNIT REMOVAL, AND INSTALLATION AND ADJUSTMENT" in this subject for instructions.
	Improper wiring of the speedometer head.	Make certain the head is wired according to vehicle ground as shown in the wiring diagrams under **"SPECIFICATIONS."**
	Faults in the electrical wiring (loose or corroded terminals, broken contacts, internal breakage, frayed or shorted wires).	Refer to "SENSOR TO SPEEDOMETER HEAD WIRING CHECKS" in this subject for instructions. Repair or replace the wires as needed.
	Inoperative sensor unit.	Before replacing, check the ohm resistance of the sensor unit. Refer to "SENSOR RESISTANCE CHECK USING AN OHMMETER" in this subject for instructions.
	Slotted disc is loose or damaged.	Repair or replace the slotted disc. Refer to "SLOTTED DISC REMOVAL AND INSTALLATION" in this subject for instructions.
	Inoperative speedometer head.	Replace only after checking all other sources of fault. Refer to "SPEEDOMETER HEAD REMOVAL AND INSTALLATION" in this subject for replacement instructions.
	Sensor unit gap is not properly adjusted.	Adjust the gap. Refer to "SENSOR UNIT REMOVAL, AND INSTALLATION AND ADJUSTMENT" in this subject for instructions.

(Continued on next page)

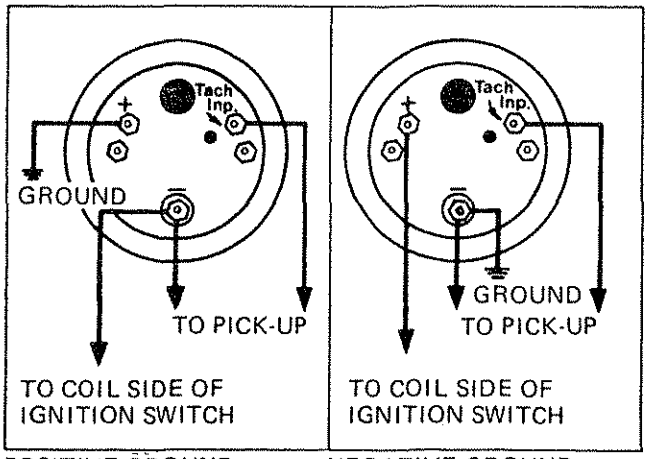
FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Inaccurate Speedometer Reading	Short in the sensor unit.	Check the ohm resistance of the sensor unit. Refer to "SENSOR RESISTANCE CHECK USING AN OHMMETER" in this subject for instructions.
	Speedometer head is incorrectly calibrated.	Refer to "SPEEDOMETER HEAD CALIBRATION" in this subject for calibration procedures.
	Loose connection (erratic reading).	Refer to "SENSOR TO SPEEDOMETER HEAD WIRING CHECKS" in this subject for instructions.
	If the speedometer head was replaced, the wrong model was installed.	Replace an unacceptable speedometer head model with a new, original installation model (or equivalent).

SPECIFICATIONS

Wiring Diagrams



POSITIVE GROUND WIRING

NEGATIVE GROUND WIRING

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	MILES PER HOUR							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
ALLSTATE/SEARS								
Express Cargo	57	60	59	61				
Cargo Lug	57	59						
Century 21	56	59						
Express Hauler	55	58			56	58		
Express 5R	56	59	57	60	56	59		
Cargo Transporter XLW	57	59	58	61	57	59		
Plus Mileage Rib	55	58	57	59	55	58		
Heavy Hauler	55	58			56	59		
Silent Trac	56	59			57			60
ARMSTRONG								
Miracle SD	57	60	58	61	56			
Miracle SL	57	59	58	61	57	59		
Extra Mileage	56	59	58	61	57	59		
Super Heatmaster	56	59	57					
Straight Rib	56	59	58					
ASTROSTAR								
Super Highway	57	59	58	60	56	58		
BRIDGESTONE								
VSRA Highway Rib	57	60	58					
VSXA Mud & Snow	57		59					
VSLA Rib Lug	57							
Super L-Miler	57	60	57	60	55	58		
COOPER								
Roadmaster Extra Mile	56	59	57		56			
Roadmaster Deep Tread	57	59						
Roadgrip Super Tread	57	59	58					
Super Traction	57	59						
Super Powermaster	56	59						
Super Roadmaster	57	59	57	60	56	60		
Super Roadmaster DW	57	59	58		57	60		
DAYTON								
Super EMT	55	58	58	59	55	58		
Premium Cross Bar	56	59	56		56			
Highway EMT	55	57			56			

Table 2, Speedometer Calibration Settings (Motorola TE100-AC Instrument Calibrator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	MILES PER HOUR							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
DUNLOP								
Gold Seal Xtra Hvy Dty 3-Rib	56	58	57	60	56	59		
Gold Cup Xtra Mileage	57	60						
Gold Cup Hiway	56	59			56			
Gold Cup Max-Trakgrip		60	58	61				
FIRESTONE								
Transport 110	56	59	57	60	55	58	57	60
Transport X-Bar	56	59			57	59		
Transport 200	57	59	59	61	57	60		
Power Drive	57	59	59	61	57	60		
Super Transport Premium	57	60	58	61	57	59		
Hvy Duty Transport	55	58	57	60	56	59		
Super All Traction	57				57			
Transport All Traction	57	59	58	61	57	59		
All Traction	57	59	58					
Transport 150	55	58	57	60	55	58		
T-1	55	58	57	60	55	58		
Transteel Traction	57	60	59	61		60		
Transteel	57	63	59	64				
Transport Supreme	56	59	57	60	56	59		
FISK								
Transportation	55	58	57	60	55	58	57	60
Commercial 15	55	58						
GATES								
Cargo Roadmaster	55	58	58	61	55	58		
Cargo Super Tread	54	56						
Cargo Power Drive	56	58	58		57	58		
Cargo Rugged Rib	57	57	55	48				
GENERAL								
Power Jet	55	58	56	59	55	58		
Super Expressway	56	59	58	60	57	62		
Deep Crosslug	57	59	58	60	57	59		
Traction Safety Rib	55	59	57	60	55	58		
H.C.R.	56	59						
H.C.T	56	59	58	60				
Super All Grip	56	59						

Table 2, Speedometer Calibration Settings (Motorola TE100-AC Instrument Calibrator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	MILES PER HOUR							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
GENERAL (Cont.)								
DTN 400	56							
GT-100	55							
Steelex	56	59						
GQT	56	59	57	60	57	59	58	61
QCL	57	60	59	61	57	60		
Super QCL	57	60	59	61	57	60		
ND Lugger	57	59		61				
Steelex Lug	56		58		56	59		
GOODRICH, B.F.								
Milesaver HDB	57	59			57	59		
Milesaver HDR	57	59			57	59		
Super Xpress Premium	58	61	59	62	58	61		
All Purpose Traction		60	58					
Traction Express Premium	57	60	59		57	60		
Extra Miler Premium & R(xc)	55	57	57	60	56	58		
Line Haul	56	60	58	61	57	60		
Line Haul Premium	57	61	59	63	58	61		
GOODYEAR								
Super Hi-Miler	56	59	57	59	56	58	57	
Custom Cross Rib Hi-Miler	56	59	58	61	57	59	58	61
Hi-Miler Xtra Tread			59	62				
Hi-Miler Unisteel	56	59	58	60	56	59		60
Hi-Miler Xtra Grip	57	59	59		57			
Super Road Lug	57	60	58	61	57			
Custom Hi-Miler	55	58	57	59	56	59	57	60
Hi-Miler SXT	56	59			57	60		
Super Hi-Miler Radial	56	59			56	59		
Unisteel II	56		57		56	59	59	58
Custom Quiet Drive	57	61			58	61		
SLR-1	57	60	58	61				
Unisteel Lug Radial	56	59	58	61	57	59	58	
HERCULES								
Extra Tread Express	59	59	57	60	56			
Express	56	59						
Super Hi-Mileage Lug	57	60	58					
Hvy Dty Traction Lug	56	59	58					

Table 2, Speedometer Calibration Settings (Motorola TE100-AC Instrument Calibrator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	MILES PER HOUR							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
HOOD								
HiWay King (Premium)	55	57			56	58		
Super HiWay King	55	58	57		56	58		
Super Traction King	57	60						
Mile King	57	60	59	62	57	59		
KELLY-SPRINGFIELD								
Registered Armor Trac	55	58	57	60	55			
Tractor Rib	57	59	58	61		60		
HDT Armor Trac	55	58						
Dual Trac	59	59	57	60				
Extra Mileage	55	58	57		55			
Registered FW	55	58	57		55			
Registered Extra Tread	59	59	58		57	59		
Registered Steel Radial	57	59			57	59		
LEE								
Premium Highway Rib	56	58	57	59	56	58		
Premium Highway Lug	56	59	59		57	60		
Extra Tred 5-Rib	57	60			57			
F.W.R. Heavy Duty	56	59						
RX-2	56	59			57	59		
Allsteel Radial	56	59			56	59		
Allsteel Radial Lug	56	59						
McCREARY								
Super Transport Grp I	56	59	57	60				
Super Transport Grp II					56	59		
MICHELIN								
XZZ	56	59	58	60	56	59		
XB	56	59	58		56			
S	55	58	56	59				
Y	55	59	58	60				
XM+S	56	59	58		56			
XM+S4	56	59			56	59		
XZA	56	59	57		56	59	57	
XZY	56	59			56	59	57	

Table 2, Speedometer Calibration Settings (Motorola TE100-AC Instrument Calibrator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	MILES PER HOUR							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
MILLER								
Super Hiway King	55	58	57					
Hiway King-Premium	55	57		60	55	58		
Super Traction King	57	59	58	61				
Mile King-Premium	57	61			57	60		
Mile King	56	59						
MOHAWK								
Chief Traction Lug	54	57	57		55	58		
Ultimiler	56	59	57	55	58			
Mighty Mo	57	60	58	61	58	60		
Super Chief	56	59	57	59				
Motrac	56	60	58	61	56	59		
Super Chief Xtra Tread	56	59	59	61	56	59		
PIRELLI								
Cinturato SN 55	56	59	58	61				
SEIBERLING								
Super Hiway 110	55	58	57	59	55	58		
All Rib	55	57	59					
Trans Rib Extra Mileage	55	58	57	60	55	58		
Thruway 125	56	59						
Highway Service or 100	55	58						
Commuter	56							
Super Steel Radial	65	56			57	60		
SEARS-See ALLSTATE/SEARS								
SUMITOMO								
ST-707	57	59			57	59		
SUPERTIRE								
Mile Master XDR	56	59			56	59		
Super Traction Cross Rib QCR	57	60			57	60		
Super Traction SR-3	56	59			56	59		

Table 2, Speedometer Calibration Settings (Motorola TE100-AC Instrument Calibrator)

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FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	MILES PER HOUR							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
TOYO								
B-9	56		58					
B-21	55	58	60					
B-22					55	59		
B-23		49						
G-20	56	59	58					
M-87	56	59	57		56	59		
UNIROYAL								
Fleet Carrier	56	58	57	60	56	58		
Super Fleet Carrier	56	59	58	61	56	59		
Fleetmaster Triple Tread	55	58	57	59	55	58		
Fleetmaster Super Lug	56	59	57	60	56	59		
Fleet Traction	56	59	57					
Super Fleetmaster Rib	57	59	58	61	57			
Fleetmaster Deep Lug	56	59						
UNION OIL 76								
Cross Bar	57	59			57	59		
Super Convoy	55	58	57	60	56	59		
Traction Super Convoy	56							
WARDS RIVERSIDE								
P-142	56	60						
Money Maker	55	58	58	60	57	59		
Hi-way Traction	55	58	57	59	56	59		
Hi-way Commercial	55	58						
Money Maker II	56	60			56	60		
WR-20 Hi-Trac	57	59	59	61	57	59		
Steel Trac Radial	57	63			57	63		
Premium Money Maker	56	58	58		56	59		
Road Guard HD I	56	59			56	59		
Road Guard HD II	56	59			56	59		
YOKOHAMA								
Y-210	56	59			56	59		
Y-304R	56	59			56	59		
Y-770	57	59			57	59		

Table 2, Speedometer Calibration Settings (Motorola TE100-AC Instrument Calibrator)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	CYCLES PER SECOND							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
ALLSTATE/SEARS								
Express Cargo	369	352	360	344				
Cargo Lug	372	355						
Century 21	377	358						
Express Hauler	382	363			379	361		
Express 5R	378	360	369	351	378	360		
Cargo Transporter XLW	373	355	362	345	373	355		
Heavy Hauler	382	363			380	362		
Silent Trac	367	356			370			353
ARMSTRONG								
Miracle SD	371	353	362	345	378			
Miracle SL	373	355	365	348	373	355		
Extra Mileage	374	356	365	348	373	355		
Super Heatmaster	378	360	368					
Straight Rib	374	356	365					
BRIDGESTONE								
VSRA Highway Rib	371	353	361					
VSXA Mud & Snow	371		360					
VSLA Rib Lug	369							
Super L-Miler	368	351	368	350	380	362		
COOPER								
Roadmaster Extra Mile	377	360	368		374			
Roadmaster Deep Tread	372	355						
Super Roadmaster	378	360	370	352	378	352		
Roadgrip Super Tread	372	355	362					
Super Traction-Tread	372	355	362	344				
Super Powermaster	377	358						
Super Roadmaster DW	372	355	362		368	351		
DAYTON								
Super EMT	384	365	365	357	383	365		
Premium Cross Bar	376	359	376		374			
Highway EMT	386	367			374			

Table 3, Speedometer Calibration Settings (Using Sine Wave Signal Generator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	CYCLES PER SECOND							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
DUNLOP								
Gold Seal Xtra Hvy Dty 3-Rib	379	362	370	353	379	360		
Gold Cup Xtra Mileage	369	352						
Gold Cup Hiway	378	360			378			
Gold Cup Max-Trakgrip		353	362	345				
FIRESTONE								
Transport 110	377	359	369	351	380	362	368	350
Transport X-Bar	377	359			372	355		
Transport 200	373	355	360	344	371	353		
Super Transport Premium	371	353	362	345	372	355		
Hvy Duty Transport	380	362	369	351	378	360		
Super All Traction	371				371			
Transport All Traction	372	355	362	345	372	355		
All Traction	372	355	362					
Transport 150	380	363	368	350	380	362		
T-1	380	363	368	350	380	362		
Transteel	371	336	362	328				
Transport Supreme	378	360	367	350	380	360		
Transteel Traction Radial	370	353	354	344		353		
FISK								
Transportation	380	362	369	352	380	362	369	353
Commercial 15	383	365						
GATES								
Cargo Roadmaster	382	364	365	347	382	364		
Cargo Super Tread	392	374						
Cargo Power Drive	378	362	365		378	362		
Cargo Rugged Rib	373	370	380	436				
GENERAL								
Power Jet	385	365	374	356	381	361		
Super Expressway	374	358	365	350	373	338		
Deep Crosslug	371	356	365	350	371	355		
Traction Safety Rib	380	360	371	353	380	361		
H.C.R.	374	357						
H.C.T.	374	357	365	351				
Super All Grip	374	357						
DTN 400	374							

Table 3, Speedometer Calibration Settings (Using Sine Wave Signal Generator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC	CYCLES PER SECOND							
	TUBE TYPE				TUBELESS TYPE			
TIRE BRAND & MODEL	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
GENERAL (Cont.)								
GT-100	385							
GQT	374	359	370	351	372	357	364	347
QCL	372	353	359	344	368	350		
Super QCL	372	353	359	344	368	350		
ND Lugger	369	357		344				
Steelex Lug Radial	377		365		377	359		
GOODRICH, B.F.								
Super Xpress Premium	363	347	356	342	365	348		
All Purpose Traction		354	365					
Traction Express Custom	373	354	360		371	352		
Extra Miler Premium & R(xc)	381	368	371	354	379	365		
Line Haul Premium	365	346	359	339	363	346		
Milesaver Radial HDB	369	356			368	354		
Milesaver Radial HDR	369	356			368	354		
GOODYEAR								
Super Hi-Miler	374	360	368	356	378	362	368	
Custom Cross Rib Hi-Miler	374	358	362	347	372	355	365	348
Hi-Miler Xtra Tread			360	341				
Hi-Miler Unisteel	376	359	366	350	376	359		350
Hi-Miler Xtra Grip	373	356	360		373			
Super Road Lug	368	351	363	343	372			
Custom Hi-Miler	380	362	370	355	376	360	370	355
Hi-Miler SXT	376	358			372	350		
Super Hi-Miler Radial	375	358			375	358		
Unisteel II	374	357	365		374	357	364	
Custom Quiet Drive	365	343			362	341		
SLR-1	368	351	363	343				
Unisteel Lug Radial	374	356	363	347	373	356	363	
HERCULES								
Extra Tread Express	377	359	369	351	374			
Express	376	358						
Super Hi-Mileage Lug	372	354	362					
Hvy Dty Traction Lug	376	357	363					

Table 3, Speedometer Calibration Settings (Using Sine Wave Signal Generator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	CYCLES PER SECOND							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
HOOD								
HiWay King (Premium)	381	368			379	366		
Super HiWay King	382	363	371		379	362		
Super Traction King	373	354						
Mile King	368	352	358	342	373	356		
KELLY-SPRINGFIELD								
Registered Armor Trac	382	364	371	353	380			
Tractor Rib	372	355	362	345		350		
HDT Armor Trac	383	365						
Dual Trac	377	359	369	351				
Extra Mileage	382	363	369		380			
Registered FW	382	363	373		380			
Registered Extra Tread	377	359	365		372	355		
Registered Steel Radial	374	356			373	356		
LEE								
Premium Highway Rib	379	362	370	356	378	362		
Premium Highway Lug	374	358	358		372	351		
Extra Tred 5-Rib	372	349			372			
F.W.R. Heavy Duty	376	360						
RX-2	374	356			373	356		
Allsteel Radial	376	359			376	359		
Allsteel Radial Lug	374	356						
MICHELIN								
XZZ	375	358	365	349	378	359		
XB	375	359	365		378			
S	386	366	374	356				
Y	380	357	366	349				
XM+S	378	358	365		378			
XM+S4	377	358			378	358		
XZA	377	358	365		378	358	365	
XZY	377	358			378	358	365	
MILLER								
Super Hiway King	382	363	371					
Hiway King-Premium	381	368		354	381	365		
Super Traction King	372	355	362	346				
Mile King-Premium	367	347			368	352		
Mile King	378	360						

Table 3, Speedometer Calibration Settings (Using Sine Wave Signal Generator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	CYCLES PER SECOND							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
MOHAWK								
Chief Traction Lug	388	368	368		380	362		
Ultimiler	376	358	368		384	365		
Mighty Mo	370	353	363	347	363	353		
Super Chief	378	360	372	355				
Motrac	374	353	365	348	374	356		
Super Chief Xtra Tread	374	356	360	343	374	356		
PIRELLI								
Cinturato SN 55	374	357	364	347				
SEARS-See ALLSTATE/SEARS								
SEIBERLING								
Super Hiway 110	382	364	373	355	384	365		
All Rib	386	368	377					
Trans Rib Extra Mileage	380	362	368	350	380	362		
Thruway 125	377	359						
Highway Service or 100	382	363						
Commuter 377	377							
SUMITOMO								
St 707	373	359			374	359		
SUPERTIRE								
Super Traction Cross Rib QCR	371	350			367	350		
Super Traction SR-3	377	358			377	358		
TOYO								
B-9	374		365					
B-21	382	363	351					
B-22					380	360		
B-23		427						
G-20	374	356	363					
M-87	376	359	368		376	359		

Table 3, Speedometer Calibration Settings (Using Sine Wave Signal Generator)

(Continued on next page)

FREIGHTLINER (MOTOROLA) ELECTRONIC SPEEDOMETER SYSTEM ON VEHICLES UTILIZING A 45-PULSE SLOTTED DISC

SPECIFICATIONS (Continued)

45-PULSE SLOTTED DISC TIRE BRAND & MODEL	CYCLES PER SECOND							
	TUBE TYPE				TUBELESS TYPE			
	1000 x 20	1000 x 22	1100 x 20	1100 x 22	1100 x 22.5	1100 x 24.5	1200 x 22.5	1200 x 24.5
UNIROYAL								
Fleet Carrier	379	361	368	350	379	361		
Super Fleet Carrier	376	357	365	348	376	357		
Fleetmaster Triple Tread	381	363	372	355	380	362		
Fleetmaster Super Lug	376	359	367	350	376	359		
Fleet Traction	374	357	367					
Super Fleetmaster Rib	372	357	365	348	372			
Fleetmaster Deep Lug	378	360						
UNION OIL 76								
Cross Bar	372	355			372	355		
Super Convoy	380	362	369	350	377	359		
Traction Super Convoy	374							
WARDS RIVERSIDE								
P-142	376	354						
Money Maker	383	361	364	352	373	359		
Hi-way Traction	380	362	370	359	377	360		
Hi-way Commercial	380	362						
Money Maker II	375	353			374	352		
WR-20 Hi-Trac	373	359	360	345	373	359		
Steel Trac Radial	371	336			371	336		
Premium Money Maker	378	362	365		378	359		
Road Guard HD I	378	362			378	360		
Road Guard HD II	380	362			377	362		
YOKOHAMA								
Y-210	374	354			374	354		
Y-304R	375	357			375	357		
Y-770	372	356			372	356		

Table 3, Speedometer Calibration Settings (Using Sine Wave Signal Generator)

The above calibration frequencies are derived from the following formula:

Cycles per second = $\frac{R \times N \times S}{T}$ where:

R = Revolutions per mile
N = Number of slots in disc (45)
S = Speedometer reading (60 mph used)
T = Time constant (3600 seconds/hour)

NOTE: R may be found by dividing the circumference of the tire (inches) into the number of inches in a mile (63,360).

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

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FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

GENERAL DESCRIPTION

This speedometer system differs from other Freightliner electronic speedometer systems in that the magnetic sensor (**Fig. 1**) is located in the transmission output shaft bearing cover instead of the wheel assembly. Refer to **Fig. 2**. The magnetic sensor utilizes pulse feedback from a 16-tooth spacer gear located under the bearing cover on the inboard end of the transmission output shaft.

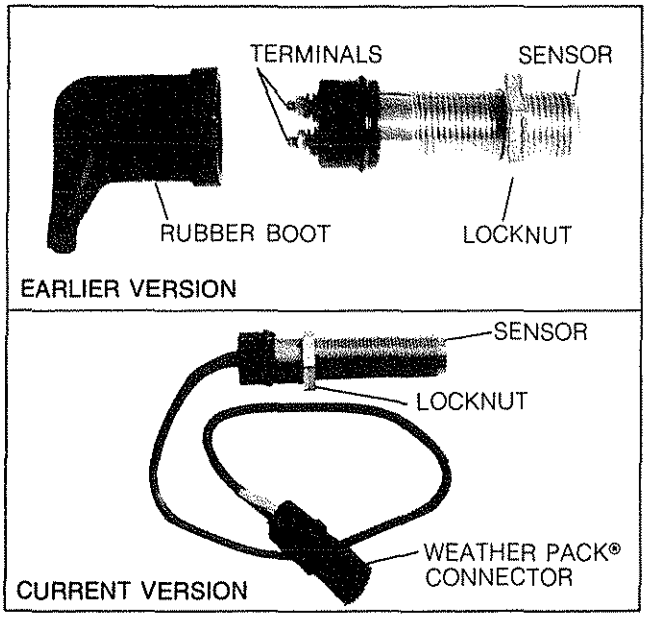


Fig. 1, Magnetic Sensor Assembly

PRINCIPLES OF OPERATION

The electronic speedometer receives signals from a sensor, which extends through a threaded bore in the transmission rear bearing cover. Refer to **Fig. 2**. The end of the sensor is positioned a few hundredths of an inch from the teeth of a spacer gear. This gear turns with the transmission output shaft when the vehicle is moving. Whenever a tooth from the gear passes the sensor, the field from a strong, permanent magnet in the sensor is disturbed, generating a voltage pulse in the sensor coil. These pulses are transmitted to the speedometer head, which amplifies and interprets the pulses as vehicle speed and distance traveled.

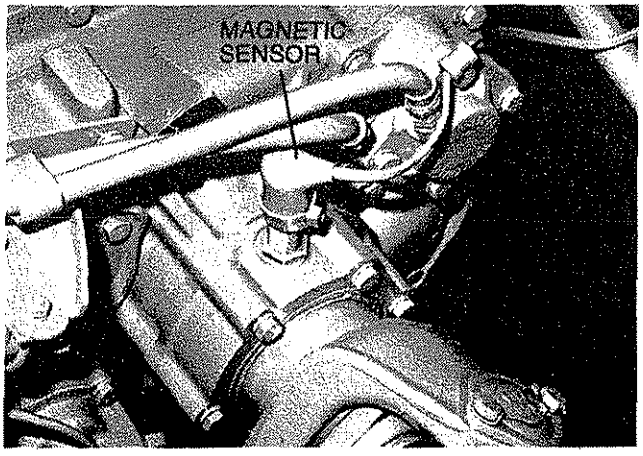


Fig. 2, Magnetic Sensor Installation

SERVICE OPERATIONS

Although identical in appearance to those used on previous speedometer systems, the electronic speedometer head (**Fig. 3**) is not always compatible with other systems. Refer to the Freightliner *COE and 120 Conventional Parts Book* for correct part numbers.

SPEEDOMETER HEAD REMOVAL AND INSTALLATION

Removal

1. Apply the parking brakes.
2. Remove the screws that attach the tachometer/speedometer panel to the dash. Pull the panel out to provide access to the speedometer head. See **Fig. 4**.

   On earlier model trucks, loosen the screws that attach the right-hinged portion of the panel to the dash. Open the hinged dash to gain access to the speedometer head.

3. For later assembly reference, mark the electrical wires connected to the speedometer. Disconnect the wires from the speedometer head.

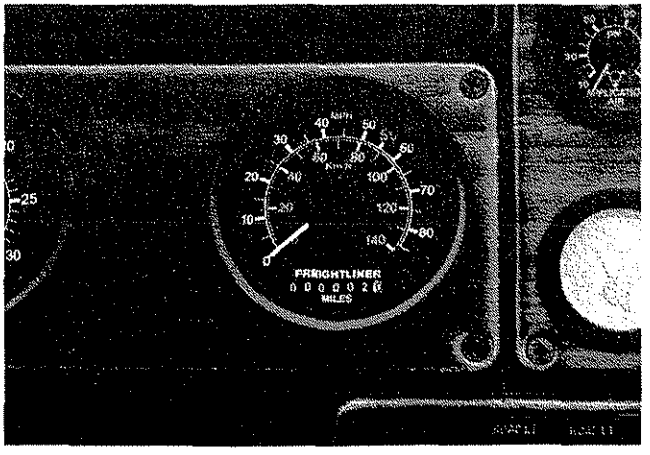


Fig. 3, Speedometer Head

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

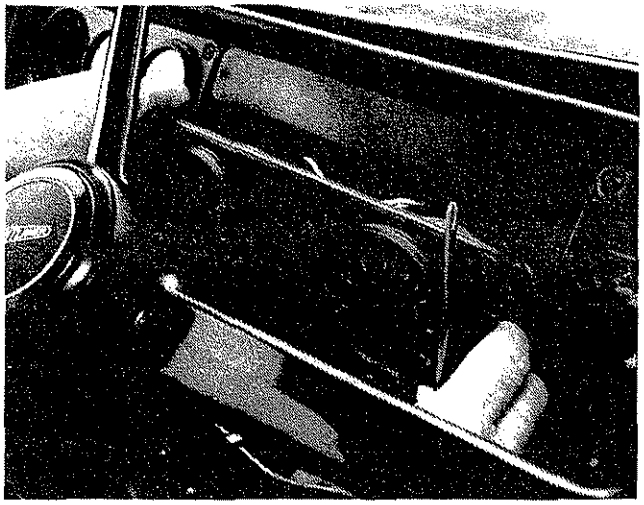


Fig. 4

4. Remove the nuts that attach the mounting bracket to the speedometer, and remove the bracket. Remove the speedometer from the front of the panel.

Installation

1. Place the speedometer head in the panel.
2. Install the mounting bracket and mounting bracket nuts.
3. As referenced earlier, or using the appropriate wiring diagram (**Fig. 8**) under "Specifications," connect the electrical wires to the speedometer head.
4. Place the panel in the dash. Install and tighten the screws. On earlier model trucks, close the hinged dash, and tighten the screws attaching it to the cowl.

MAGNETIC SENSOR REMOVAL, INSTALLATION, AND ADJUSTMENT

Removal

1. On current models, disconnect the electrical connector. On earlier models, pull back the protective rubber boot and disconnect the electrical wires from the magnetic sensor terminals. Refer to **Fig. 1**.
2. Loosen the magnetic sensor locknut. Remove the sensor from the transmission rear bearing cover.

Installation and Adjustment

1. Screw the magnetic sensor into the bearing cover until it bottoms out on the gear teeth. Back the sensor out one-half turn.

IMPORTANT: Inaccurate speedometer and odometer readings will result if the correct adjustment is not maintained.

2. Hold the magnetic sensor in place to keep it from turning. Tighten the locknut 15 to 20 lbf·ft (20 to 27 N·m).
3. Connect the electrical connector. On earlier models, connect the wires to the magnetic sensor terminals. Place the boot over the terminals.

SPEEDOMETER HEAD CALIBRATION

If a new speedometer head is installed, if different tires are installed, or if the rear axle ratio is changed, the speedometer head must be calibrated using the Motorola® TE100-AC Instrument Calibrator.

Calibration Using the Motorola® Model TE100-AC Calibrator

This calibrator is an audio frequency signal generator used for calibrating sensor-type electronic speedometers and tachometers. The calibrator provides regulated DC voltage and controlled calibration frequency to the speedometer head.

NOTE: The TE100-AC calibrator uses several different crystals for different frequencies. Be sure to install the 351 Hz crystal when calibrating the speedometer head.

1. Make sure the sensor is correctly adjusted. For instructions, refer to "Sensor Removal, Installation, and Adjustment."
2. Remove the speedometer head from the panel. For instructions, refer to "Speedometer Head Removal and Installation."
3. Determine the speedometer calibration setting as follows:

   .1 Determine the tire revolutions per mile. Since these specifications can change frequently, consult the tire manufacturer for the most up-to-date, accurate information. Tire revolutions per mile specifications are listed for some tire models in **Table 2.**

   .2 Find the vehicle rear axle ratio in **Table 3.** Next to the listed ratio is a column of tire revolutions per mile. Find the range of tire revolutions per mile that includes the revolutions per mile figure for your brand and model of tire. Next to this range is a miles-per-hour figure. This is the speed to which the speedometer must be calibrated.

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

4. An alternate method for determining the calibration setting uses the Motorola Pulse Counter, model 7TE-2001 or 7TE-2002:

   .1 Connect the pulse counter interconnecting cable to the pulse counter (**Fig. 5**).

   .2 Set the mode switch to the PULSES PER MILE position on the 7TE-2001 or ELECTRONIC position on the 7TE-2002.

   .3 Connect the pulse counter cable to the vehicle wiring harness, as shown in **Fig. 5**. If the vehicle wiring harness doesn't have a connector that matches the Packard connector on the pulse counter cable, connect the pulse counter to the vehicle wiring harness, as shown in **Fig. 6**, using the harness adaptor cable.

   .4 Mark off a distance of exactly one mile (1.61 km) in a straight course. If a one mile course cannot be marked off, mark a distance of 1/10 mile (161 m)—the minimum distance that can be used with this tester. The course should have no curves or stops.

   .5 Drive the vehicle to the start mark of the course.

   .6 Press the pulse counter RESET BAR. The counter should now read zero.

   .7 Drive the vehicle through the marked course, being sure to start and stop exactly at the course markers.

   .8 After stopping at the end of the course, put the mode switch in the OFF position. The counter

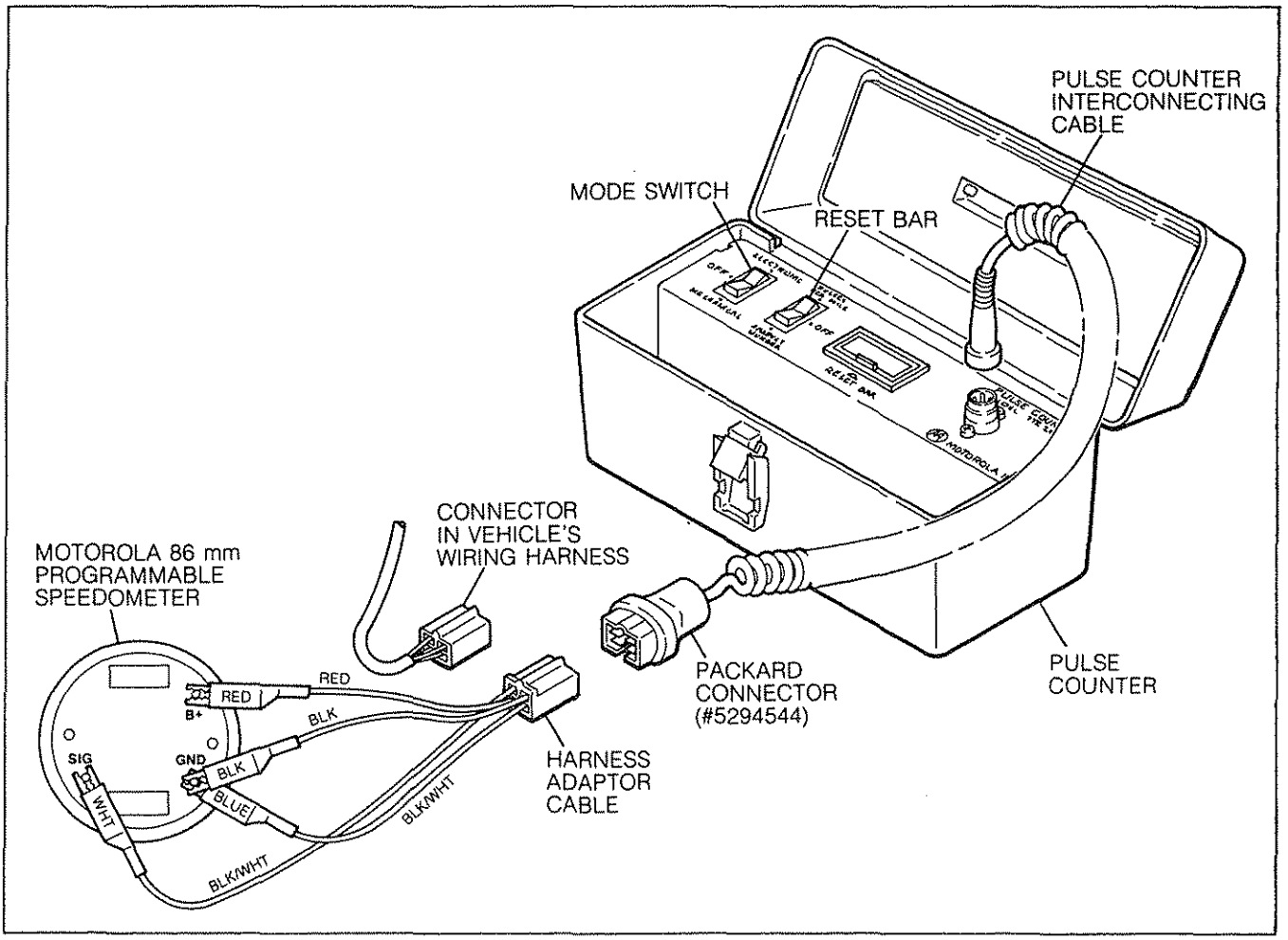


Fig. 5

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

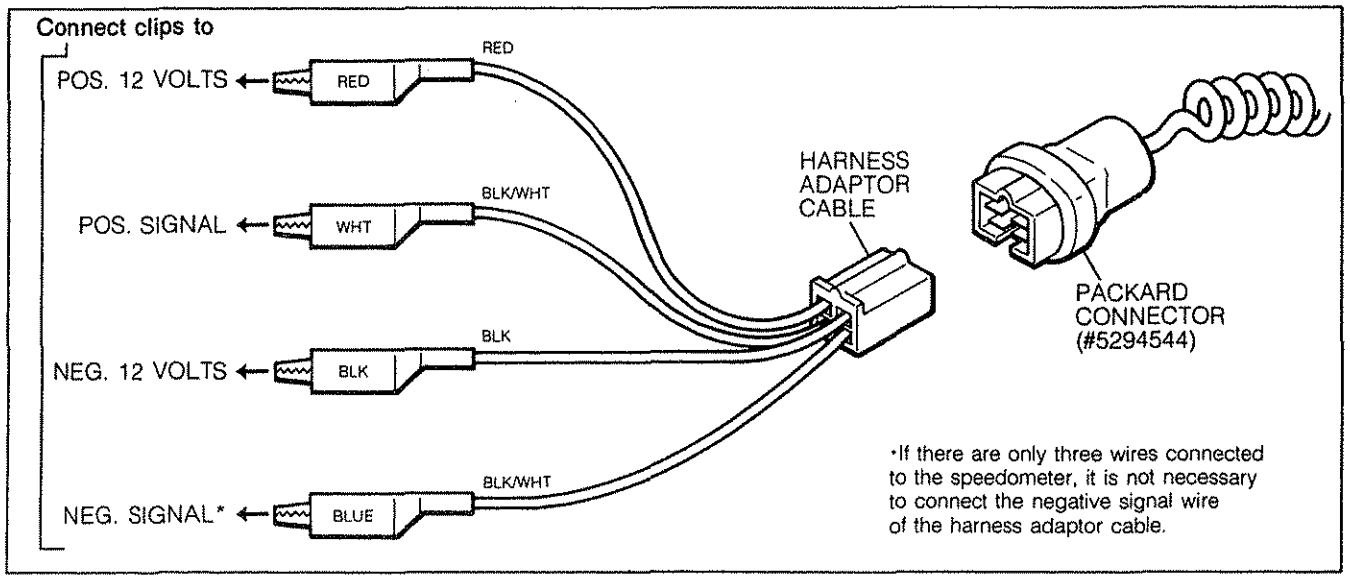


Fig. 6

will display the pulses per mile until the RESET BAR is pressed.

.9 Calculate the calibration setting using the following formula:

$$\text{calibration setting} = \frac{351 \times 3600}{\text{(pulses per mile)}}$$

5. If the electrical pulses are generated by a signal generator mounted at a pencil gear, set the selector switch to the MECHANICAL position on the Pulse Counter model 7TE-2002. To determine the calibration setting, do steps 4.4 through 4.9.
6. Set the DC SELECTOR switch on the TE100-AC calibrator to 12 VOLTS.
7. Move the toggle switch to the OFF (down) position, and adjust the SIGNAL OUTPUT ADJ. control to zero.
8. Connect the calibrator to the power source. If a battery is used, connect the large clips of the supplied red and black wires to the battery terminals (red to positive, black to negative).
9. Connect the calibrator to the speedometer. Refer to **Table 1.**

NOTE: The speedometer input post on the rear of the housing is labeled TACH INP. on speedometer heads with the metal housing and SIG on speedometer heads with the plastic housing.

Lead Wire Color	From Receptacle on Calibrator	To Terminal on Speedometer
Black	DC Output GRD (−)	Negative (−)
Red	DC Output +12v	Positive (+)
Green	Signal Output	Tach Inp.

Table 1

CAUTION: Before the toggle switch is moved to the ON position, ensure that the instructions for connecting the calibrator are followed carefully. Damage to the speedometer head may occur if a wrong connection is made.

10. Move the calibrator toggle switch to the ON (up) position. The pilot light should go on unless: the electrical circuit to the power supply is incomplete; the pilot light bulb is burned out; or the calibrator unit is malfunctioning.
11. Advance the SIGNAL OUTPUT ADJ. control knob to MAX (full clockwise rotation).

CAUTION: If the speedometer has a metal housing, the screwdriver shaft must be wrapped with tape, to avoid a short circuit between the adjusting screw and the housing. A short circuit can damage the speedometer.

12. Remove the seal from the calibration adjusting screw access hole. If the speedometer has a metal housing, wrap a thin-bladed screwdriver with electrical tape. Insert the thin-bladed screwdriver through the hole (**Fig. 7**). Turn the adjusting screw until the

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

Fig. 7, Calibration Adjusting Screw

speedometer reads the MPH setting determined in step 3 or 4.

13. Move the toggle switch to the OFF (down) position.

14. Disconnect the calibrator from the power source.

NOTE: The PUSH-TO-RESET circuit breaker protects the calibrator circuits in case the DC OUTPUT leads are shorted. When the PUSH-TO-RESET circuit breaker is activated, the pilot light stays on, but the DC OUTPUT positive connection opens. To restore DC OUTPUT, depress and release the orange button labeled PUSH-TO-RESET DC OUTPUT.

15. Disconnect the calibrator wires from the speedometer head, and replace the seal in the adjusting screw access hole. Mark the calibration setting on the seal; then, date and initial it. Install the speedometer head in the panel. For instructions, refer to "Speedometer Head Removal and Installation."

TROUBLESHOOTING

TROUBLESHOOTING WITH A VOLT/OHMMETER AND THE TE100-AC CALIBRATOR

The following is a troubleshooting process using a voltmeter, an ohmmeter, and the TE100-AC Calibrator. The checks should be made in the order in which they are listed.

1. Inaccurate readings will occur if the magnetic sensor is not adjusted correctly. Before troubleshooting the system, make sure the magnetic sensor is adjusted correctly. For instructions, refer to "Sensor Removal, Installation, and Adjustment."

2. Check the accuracy of the odometer by driving the vehicle a measured mile. If the odometer reads incorrectly, the speedometer will also read incorrectly.

3. Check the circuit voltage using a DC voltmeter as follows:

   .1 Remove the screws that attach the tachometer/speedometer panel to the dash. Pull the panel out to provide access to the speedometer head.

   On earlier installations, loosen the screws that attach the left-hinged portion of the panel to the dash. Open the hinged dash to gain access to the speedometer head.

   .2 With the ignition switch off, place the probes of the DC voltmeter across the positive and negative terminals of the speedometer head.

   NOTE: For vehicles with a negative ground, attach the negative (black) probe to the negative terminal and the positive (red) probe to the positive terminal. For vehicles with a positive ground, attach the negative probe to the positive terminal and the positive probe to the negative terminal.

   .3 Turn on the ignition switch. The voltmeter should read 10 to 15 volts DC.

   If the voltage is not in this range, check the wiring between the ignition switch and the speedometer head. Turn off the ignition switch, and disconnect the voltmeter probes. Repair or replace the damaged wiring.

   .4 Place the panel in the dash; install and tighten the screws. On earlier installations close the hinged dash, and tighten the screws attaching it to the cowl.

4. To check the wiring from the sensor to the speedometer head for a short or open circuit, disconnect the sensor leads at both the ground terminal and the terminal labeled TACH INP. on speedometer heads with the metal housing or SIG on speedometer heads with the plastic housing. Connect an ohmmeter to the leads. The resistance should measure 265 ohms. A reading between 240 and 290 ohms is acceptable. If the reading is outside this range, the problem is in the sensor or the wiring between the sensor and the speedometer head. Go to step 5.

   If the reading is within this range, the problem is inaccurate calibration or a faulty speedometer head. Go to step 6.

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

5. Check the sensor resistance using an ohmmeter as follows:

   .1 On current models, disconnect the electrical connector. On earlier models pull back the sensor rubber boot, and disconnect the electrical wires from the sensor. Refer to **Fig. 1**. Make sure the terminals and wires are free of corrosion and moisture.

   .2 Connect the ohmmeter leads to the sensor terminals. The resistance should measure 265 ohms. Readings between 240 and 290 ohms are acceptable.

   If the resistance is acceptable and the speedometer readings are inaccurate, then the sensor is adjusted incorrectly or there is a problem in the wiring to the speedometer head or between the sensor and the speedometer head. If the resistance is not acceptable, replace the sensor. For instructions, refer to "Sensor Removal, Installation, and Adjustment."

6. Confirm correct speedometer calibration as follows:

   .1 Check **Tables 2** and **3** to confirm the correct calibration speed in mph for the vehicle rear axle ratio and tire revolutions per mile.

   .2 Check the calibration sticker on the speedometer head. If the speedometer still reads incorrectly and the value on the sticker matches the value from the tables, the speedometer head is malfunctioning. Replace the speedometer head. If the values do not match, then calibrate the speedometer to match the value from the tables. For instructions see "Calibration Using the Motorola TE100-AC Calibrator."

   .3 If you calibrate the speedometer, apply a new sticker 24-00246-0 showing the new calibration speed.

TROUBLESHOOTING WITH THE 7TE-2001 OR 7TE-2002 PULSE COUNTERS

The Motorola Pulse Counters, models 7TE-2001 and 7TE-2002, can be used to troubleshoot speedometer problems.

1. Connect the pulse counter across the sensor leads at both the ground terminal and the terminal labeled TACH INP. on speedometer heads with the metal housing or SIG on speedometer heads with the plastic housing.

2. Move the truck a few feet.

   .1 If the pulse counter registers some pulses, then the speedometer head is malfunctioning and must be replaced.

   .2 If the pulse counter reads no pulses, then the wiring or the sensor is at fault.

3. On current models, unplug the sensor connector, or on earlier models, pull back the sensor rubber boot, and disconnect the electrical wires from the sensor. Connect the pulse counter input leads to the sensor terminals.

4. Move the truck a few feet.

   .1 If the pulse counter registers some pulses, then the wiring from the sensor to the speedometer has a short or open circuit. Repair or replace the wiring.

   .2 If the pulse counter registers no pulses, then the sensor is malfunctioning or adjusted incorrectly.

5. With the pulse counter input leads still connected to the sensor, drive the truck at moderate speeds (at least 20 mph).

   .1 If the pulse counter registers pulses, then the sensor is adjusted incorrectly. Adjust the sensor, using the instructions in "Sensor Removal, Installation, and Adjustment."

   .2 If the pulse counter still registers no pulses, the sensor is malfunctioning. Replace the sensor.

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS

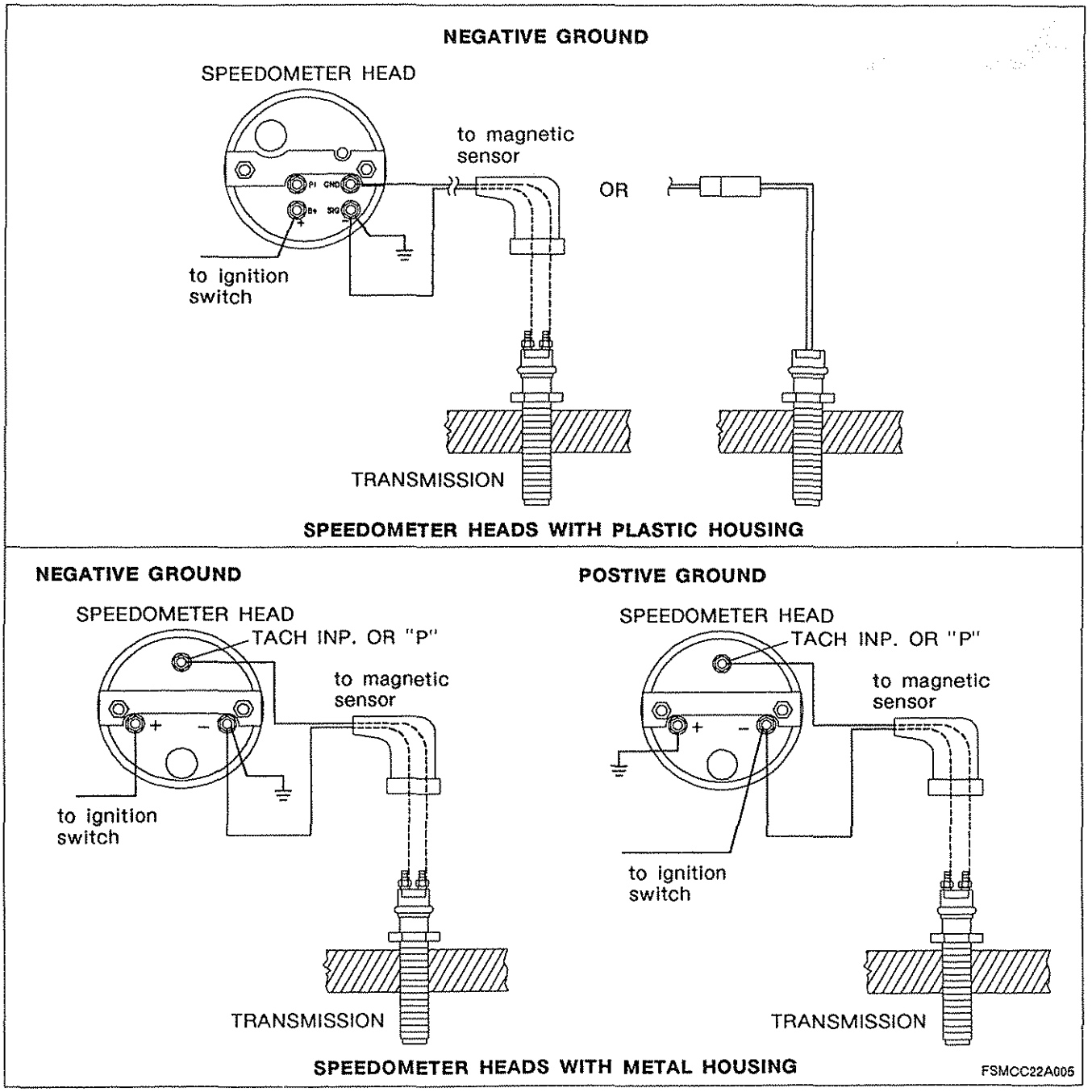


Fig. 8, Wiring Diagrams

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
ALLSTATE-SEARS										
Express Cargo	492	469	—	—	—	—	—	—	—	—
Frontrunner II	507	482	494	—	504	482	—	—	—	—
Heavy Hauler (1200 SRS)	509	484	—	—	506	482	—	—	—	—
Plus Mileage Lug	498	475	484	462	493	470	—	—	—	—
Plus Mileage Rib	509	484	493	470	506	482	—	—	—	—
Steel Radial	498	476	—	—	498	476	—	—	—	—
ARMSTRONG										
H.T. Special	500	476	486	463	497	473	—	—	—	—
Miracle S-D	494	470	481	458	504	480	—	—	—	—
SD-200	505	480	490	—	504	480	—	—	—	—
Super Heatmaster	505	480	490	—	504	480	—	—	—	—
Torque Bar	496	472	—	—	493	469	—	—	—	—
STR-200	499	476	—	—	499	476	—	—	—	—
ATLAS										
Dual Service Lug Grip	497	474	485	—	—	—	—	—	—	—
Tri-Traction	507	483	493	—	—	—	—	—	—	—
Truck Coach	—	—	—	473	—	—	—	—	—	—
BRIDGESTONE										
KM	496	470	485	—	496	470	—	—	—	—
R180	504	481	494	469	505	479	492	—	522	503
R190	504	480	491	468	504	478	491	—	—	—
SLM	496	473	—	—	496	473	—	—	—	—
ULP	491	468	—	—	—	—	—	—	—	—
UTP	491	467	—	—	491	467	—	—	—	—
VSSA	498	475	486	—	498	477	484	—	—	—
VSXA	502	478	489	466	502	477	489	—	—	—
R290	—	—	—	—	505	481	—	—	—	—
M757	504	480	490	—	504	—	—	—	—	—
M767	—	477	—	—	—	477	489	—	—	—
L301	501	481	—	—	—	477	—	—	—	—
M747*	—	—	—	—	—	—	—	—	—	—
VSXX	—	—	—	—	502	478	—	—	—	—
COOPER										
Road Grip Super Tread	496	473	482	—	490	468	—	—	—	—
Roadmaster XDT	496	473	—	—	491	468	—	—	—	—
Roadmaster XLM	496	473	482	—	491	469	—	—	—	—
Super Roadmaster	503	480	494	470	504	470	—	—	—	—
Super Traction Tread	496	473	482	459	—	—	—	—	—	—

Table 2, Tire Revolutions-Per-Mile Values

* For tire size 15R22.5, 494 rpm; tire size 16.5R22.5 477 rpm; tire size 18R22.5, 465 rpm.

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
DAYTON										
Premium Deep Skid	494	470	—	—	—	472	—	—	—	—
Premium ESD	502	477	486	464	502	477	486	464	—	—
Premium X-Bar XM	494	467	479	458	489	466	479	458	—	—
Steel Radial	495	468	—	—	495	468	—	—	—	—
Super EMT	502	476	482	—	502	476	—	—	—	—
DUNLOP										
Gold Seal 3 Rib	501	478	494	—	501	475	—	—	—	—
Gold Seal 5 Rib	501	478	—	—	—	—	—	—	—	—
Gold Seal Plus Bar	489	466	—	—	484	461	—	—	—	—
Super Haul	499	475	—	—	—	—	—	—	—	—
Triple Traction	499	475	—	—	496	473	—	—	—	—
SP777	—	—	—	—	500	475	—	—	—	—
SP311	503	477	—	466	499	—	—	—	—	—
SP411	502	475	486	—	499	475	—	—	—	—
SP331	—	—	—	—	—	—	—	—	517	—
SP431	—	—	—	—	—	—	—	—	510	—
FIRESTONE										
Heavy Duty Transport	507	482	492	469	504	480	—	—	—	—
Lug Radial	498	474	485	461	498	474	484	460	—	—
Power Drive	497	473	481	458	497	473	—	—	—	—
Power Drive Radial	495	471	—	—	495	471	—	—	—	—
Rib Radial	500	475	—	—	500	475	—	—	—	—
Super All-Traction	496	473	482	—	—	—	—	—	—	—
Super Transport Premium	494	471	482	460	497	473	—	—	—	—
T-1	504	480	487	462	504	479	487	—	—	—
Traction Drive Radial	495	471	—	—	495	471	—	—	—	—
Transport 110	502	478	495	469	507	482	489	466	—	—
Transport 200	—	—	—	—	492	—	—	—	—	—
Transport All-Traction	500	478	486	463	500	473	—	—	—	—
Transteel Power Drive Radial XR4	494	470	—	—	494	470	—	—	—	—
Transteel Radial XR4	503	475	485	460	503	477	—	—	—	—
Transteel Radial WXR4	500	475	—	—	500	475	—	—	—	—
Transteel Rib Radial XR4	500	475	—	—	500	475	—	—	—	—
Transteel Traction Drive Radial XR4	494	470	—	—	494	470	—	—	—	—
Super All Traction N. D.	491	—	479	—	—	—	—	—	—	—

Table 2, Tire Revolutions-Per-Mile Values (Continued)

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
GENERAL										
Ameri SRF(GQT)	496	475	479	460	498	473	484	463	—	—
GT-100	506	483	—	—	507	481	—	—	—	—
HCT	492	—	480	458	—	—	478	—	—	—
ND Super Lugger ML4	479	460	—	444	—	—	464	—	—	—
Ameri-Steel (Steelex Plus Radial)	501	477	487	465	500	476	—	—	—	—
Ameri RBL (Steelex Radial Lug)	495	473	—	—	498	473	—	—	—	—
Super II Expressway	499	475	—	—	496	474	478	—	—	—
Super All-Grip	493	476	481	—	—	—	—	—	—	—
Super Expressway	504	476	488	467	499	477	—	—	—	—
Ameri DCL (Super QCL)	487	465	482	457	487	465	476	—	—	—
XTQL	485	462	461	441	491	466	461	—	—	—
Ameri-Steel IV	500	477	—	—	500	477	—	—	—	—
Ameri-Steel	501	477	484	—	500	476	485	—	—	—
Ameri-Lug	495	472	486	—	495	472	—	—	—	—
Ameri-Low Profile	—	—	—	—	—	—	—	—	515	500
Ameri-Lug Low Profile	—	—	—	—	—	—	—	—	510	495
B.F. GOODRICH										
Extra Miler XL	507	482	494	473	504	480	—	—	—	—
Extra Traction	491	465	472	—	—	—	—	—	—	—
Haul Master Rib	495	471	483	460	—	465	—	—	—	—
Line Haul Premium	486	459	472	452	484	457	—	—	—	—
Milesaver Radial (HDR & HDB)	495	472	—	—	496	472	—	—	—	—
Power Express	502	477	475	—	496	472	—	—	—	—
Power Traction	494	470	—	—	—	—	—	—	—	—
Traction Express Custom	486	465	482	457	472	446	—	—	—	—
Traction Express XQ	486	465	—	454	470	446	—	—	—	—
Extra Miler XL II	496	479	485	465	496	472	—	—	—	—
Extra Miler Radial DB	486	463	—	—	—	—	—	—	—	—
GOODYEAR										
Custom Cross Rib Hi-Miler	495	473	482	460	492	469	473	—	—	—
Custom Hi-Miler	495	467	484	464	491	465	485	—	—	—
Custom Quiet Drive	486	457	—	—	483	455	—	—	—	—
Hi-Miler Extra Grip	495	444	479	—	480	—	—	—	—	—
Hi-Miler SXT	490	464	—	—	491	463	—	—	—	—
SRL-1	496	472	480	457	—	—	—	—	—	—
Super Hi-Miler	499	474	482	465	495	473	—	—	—	—
Unisteel II	501	478	486	—	501	478	486	—	—	—
Unisteel L-1	496	473	481	463	—	—	—	—	—	—
Unisteel TD Radial	496	473	—	—	496	473	—	—	—	—
Unisteel G167	493	471	—	—	493	471	—	—	—	—
Unisteel G186	498	475	484	463	498	475	484	—	—	—
Super Hi-Miler Radial	502	479	—	—	502	479	—	—	—	—
G159LP	—	—	—	—	—	—	—	—	517	502
G167LP	—	—	—	—	—	—	—	—	509	495

Table 2, Tire Revolutions-Per-Mile Values (Continued)

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	15 x 22.5	16.5 x 22.5
GOODYEAR (Continued)										
G159	—	—	—	—	501	478	—	—	—	—
G167	493	471	—	—	493	471	—	—	—	—
G186	497	474	483	462	497	474	483	—	—	—
G165 Super Single	—	—	—	—	—	—	—	—	491	—
G186 Super Single	—	—	—	—	—	—	—	—	—	472

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
HERCULES										
Express	501	477	—	—	—	—	—	—	—	—
Extra Tread Express	503	479	492	468	498	—	—	—	—	—
Heavy Duty Traction Lug	501	477	484	—	—	—	—	—	—	—
Super Hi-Mileage Lug	496	473	482	—	—	—	—	—	—	—
HOOD										
Hiway King	508	490	—	—	505	488	—	—	—	—
Mile King	490	469	477	456	497	475	—	—	—	—
Super Hiway King	509	484	495	—	505	488	—	—	—	—
Super Traction King	497	472	—	—	—	—	—	—	—	—
KELLY-SPRINGFIELD										
Custom Armor Trac	493	466	475	452	493	467	—	—	—	—
Dual Trac Special Service	483	457	467	447	—	—	—	—	—	—
Extra Mileage	494	468	—	—	494	467	—	—	—	—
HDT Armor Trac	510	487	—	—	—	—	—	—	—	—
Heavy Duty Explorer Trac	488	—	—	—	—	—	—	—	—	—
Registered Armor Trac	485	464	476	451	494	467	—	—	—	—
Registered Drive Rib	486	460	469	—	486	460	—	—	—	—
Registered Drive Trac	487	454	472	446	483	459	—	—	—	—
Registered Extra Tread	501	478	474	—	496	473	—	—	—	—
Registered FW	492	466	477	452	—	—	—	—	—	—
Registered Steel Radial	501	478	486	—	501	478	486	—	—	—
Registered Whisper Drive	484	456	—	—	483	454	—	—	—	—
Rib Trac Logger	483	455	—	—	—	—	—	—	—	—
Tractor Rib	479	453	482	460	490	466	—	—	—	—
Registered Super Rib Logger	483	452	—	—	—	—	—	—	—	—
Registered Extra Tread II	486	466	474	—	486	460	—	—	—	—
Kelly KDM	493	471	—	—	493	471	—	—	—	—
Kelly KSR	501	478	486	—	501	478	486	—	—	—
Registered Supersteel Radial	499	476	486	—	499	476	486	—	—	—
Registered SS Drive Trac	496	473	—	—	496	473	—	—	—	—
Super Rib Logger	483	452	—	—	—	—	—	—	—	—

Table 2, Tire Revolutions-Per-Mile Values (Continued)

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
LEE										
Alsteel Radial	501	478	—	—	501	478	—	—	—	—
Alsteel Radial Lug	498	474	—	—	—	—	—	—	—	—
Alsteel Radial RX-2	498	475	—	—	497	475	—	—	—	—
Drive Wheel Lug LDL	493	463	—	—	493	460	—	—	—	—
Extra Tread 5-Rib	483	454	—	—	481	—	—	—	—	—
Premium Highway Lug	493	463	464	—	493	460	—	—	—	—
Premium Highway Rib	495	466	477	452	492	465	—	—	—	—
Premium Highway Traction	486	—	—	—	—	—	—	—	—	—
McCREARY										
Silent Service	482	456	—	—	482	455	—	—	—	—
Super Lug Express	502	478	489	466	502	478	—	—	—	—
Super Miles	508	483	494	470	508	483	—	—	—	—
Super Transport	509	484	497	473	509	484	—	—	—	—
MICHELIN										
XB	504	477	487	—	501	479	—	—	—	—
X(M&S), X MTS 4	504	477	487	—	501	479	487	—	—	—
XM+S4	499	476	484	466	498	476	485	—	—	—
XZA	504	477	487	—	501	479	487	—	—	—
XZZ	504	477	487	466	501	479	487	—	—	—
XZY	504	477	487	466	501	479	487	—	—	—
XDL	504	477	487	—	501	479	487	—	—	—
XDA	504	477	487	—	501	479	487	—	—	—
XA Pilote	—	—	—	—	—	—	—	—	516	501
XDA Pilote	—	—	—	—	—	—	—	—	516	501
XM+S4 Pilote	—	—	—	—	—	—	—	—	516	501
XZA Pilote	—	—	—	—	—	—	—	—	516	501
XDHT	—	—	—	—	500	478	—	—	—	—

TIRE BRAND AND MODEL	TIRE SIZE										
	Standard Profile								Low Profile		
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255/70R x 22.5	275/80R x 22.5	275/80R x 24.5
MICHELIN (Continued)											
PXZA Pilot	—	—	—	—	—	—	—	—	567	—	—
PXZA1 Pilot	—	—	—	—	—	—	—	—	—	516	501
PX M&S 4 Pilot	—	—	—	—	—	—	—	—	—	516	501
PXDA Pilot	—	—	—	—	—	—	—	—	567	516	501
XDHT Pilot	—	—	—	—	—	—	—	—	—	515	500

Table 2, Tire Revolutions-Per-Mile Values (Continued)

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
MILLER										
Hiway King Premium	508	490	—	472	508	486	—	—	—	—
Mile King	504	480	—	—	—	—	—	—	—	—
Mile King Premium	489	463	—	—	491	469	—	—	—	—
Super Hiway King	509	484	495	—	—	—	—	—	—	—
Super Traction King	496	473	483	461	—	—	—	—	—	—
MOHAWK										
Chief Traction Lug	517	490	490	—	506	482	—	—	—	—
Drive Miler	515	489	—	—	515	482	—	—	—	—
Mainliner	507	482	490	—	513	488	—	—	—	—
Motrac	498	475	486	464	—	—	—	—	—	—
Ultimiler	501	477	490	—	512	486	—	—	—	—
PIRELLI										
Cinturato	499	476	—	—	—	—	—	—	—	—
REMINGTON										
R415	—	—	—	—	499	—	—	—	—	—
SEIBERLING										
All Rib	510	486	502	—	—	—	—	—	—	—
Commuter	502	—	—	—	—	—	—	—	—	—
Highway 100	509	486	—	—	—	—	—	—	—	—
Highway Service	509	486	—	—	—	—	—	—	—	—
Super Highway 110	509	486	496	474	511	487	—	—	—	—
Thruway 125	502	478	494	471	—	—	—	—	—	—
Trans Highway	506	484	490	466	506	482	—	—	—	—
Trans Rib Extra Mileage	507	482	489	466	507	482	—	—	—	—
SUMITOMO										
ST 2 Highway Traction	502	—	492	—	—	—	—	—	—	—
ST 200 Lug	—	—	—	—	497	471	—	—	—	—
ST 201 X-Bar Hiway Traction	497	475	—	—	499	478	—	—	—	—
ST 202 Logger	497	468	—	—	—	—	—	—	—	—
ST 5 Rib Traction	502	—	490	—	—	—	—	—	—	—
ST 502 Logger	497	468	—	—	—	—	—	—	—	—
ST 7 Highway Rib	—	—	488	—	—	—	—	—	—	—
ST 701 Highway Rib	497	472	—	446	499	471	—	—	—	—
ST 707 Steel Radial	504	479	—	—	506	485	—	—	—	—
ST 708	504	479	—	468	504	479	484	—	—	—
ST 806 All-Season	502	—	—	—	—	—	—	—	—	—
ST 808 Steel Radial	500	478	490	465	497	475	490	—	—	—
ST 717	504	481	490	466	504	479	484	—	—	—
ST 606 Lug	500	475	490	—	497	475	—	—	—	—
ST 704 Logger Rib	—	470	—	—	—	—	—	—	—	—

Table 2, Tire Revolutions-Per-Mile Values (Continued)

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
SUPER TIRE										
Super Traction All-Purpose	487	464	—	—	487	464	—	—	—	—
Super Traction Metal-Radial Milemaster	501	478	—	—	501	478	—	—	—	—
Super Traction Premium Highway Rib	495	466	—	—	495	466	—	—	—	—
Super Traction Safety-Rib	502	475	—	—	498	475	—	—	—	—
Super Traction SR3	502	477	—	—	502	477	—	—	—	—
Super Traction X-Rib (QCR)	494	467	—	—	489	466	—	—	—	—
Super Traction Metal Radial Quadtrac	496	473	—	—	496	473	—	—	—	—
Super Traction Metal Radial Trimax	501	478	—	—	501	478	—	—	—	—
Super Traction Metal Radial 101	501	478	—	—	501	478	—	—	—	—

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	295/75R x 22.5	285/75R x 24.5
TOYO										
M84	504	478	491	—	504	478	491	—	—	—
M87	504	479	488	468	504	479	488	—	—	—
M91	502	477	488	466	502	477	488	466	—	—
M94	501	476	488	—	501	476	—	—	—	—
M59	499	475	489	—	—	—	—	—	—	—
M61	504	477	491	466	—	—	—	—	—	—
M103	—	—	—	—	503	478	—	—	—	—
M603	—	—	—	—	495	473	—	—	—	—
M75	—	—	—	—	—	—	—	—	515	498
M76	—	—	—	—	—	—	—	—	512	498

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
UNIROYAL										
Fleet Carrier	505	481	491	467	505	481	—	—	—	—
Fleetmaster Deep Lug	504	480	—	—	—	—	—	—	—	—
Fleetmaster SFW 74	491	475	—	—	496	473	—	—	—	—
Fleetmaster Super Lug	501	478	489	466	501	478	—	—	—	—
Fleetmaster Triple Tread	508	484	496	473	506	482	483	—	—	—
Fleet Tract	499	476	—	—	—	—	—	—	—	—
Steelmaster R2 & L2	505	481	491	—	505	481	—	—	—	—
Super Fleet Carrier	501	476	486	464	501	476	—	—	—	—
Super Fleetmaster Rib	496	474	486	464	496	—	—	—	—	—

Table 2, Tire Revolutions-Per-Mile Values (Continued)

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	255 275 295 x 22.5	275 285 x 24.5
WARDS-RIVERSIDE										
Highway Commercial	507	482	—	—	—	—	—	—	—	—
Highway Traction	507	482	493	478	502	480	—	—	—	—
Money Maker	511	481	485	469	497	478		—	—	—
Money Maker II	500	470	—	—	499	469	—	—	—	—
P-142	501	472	—	—	—	—	—	—	—	—
Power Grip Heavy Service	489	—	—	—	—	—	—	—	—	—
WR 20 High Trac	497	478	480	460	497	478	—	—	—	—
TIRE BRAND AND MODEL	TIRE SIZE									
	Standard Profile								Low Profile	
	10 x 20	10 x 22	11 x 20	11 x 22	11 x 22.5	11 x 24.5	12 x 22.5	12 x 24.5	275/80R x 22.5	275/80R x 24.5
YOKOHAMA										
Y745B	496	473	—	—	496	473	—	—	—	—
Y304R	—	—	—	—	—	482	—	—	—	—
Y710L	499	472	—	—	—	—	—	—	—	—
Y770L	496	474	—	—	496	474	—	—	—	—
Y98	504	—	492	—	—	—	—	—	—	—
Y713	—	—	—	—	—	479	—	—	—	—
Y793	—	—	—	—	—	481	—	—	—	—
R103	—	—	—	—	—	—	—	—	524	504
R123	—	—	—	—	—	—	—	—	—	502
TY133	—	—	—	—	—	—	—	—	—	495
TY143	—	—	—	—	—	—	—	—	523	502

Table 2, Tire Revolutions-Per-Mile Values (Continued)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

Axle Ratio	Tire Rev/Mile	Calibration Setting in MPH*
3.07	450–455	57
	456–463	56
	464–472	55
	473–481	54
	482–490	53
	491–499	52
	500–509	51
	510–520	50
	521–530	49
	531–542	48
	543–553	47
	554–566	46
	567–578	45
	579–592	44
	593–600	43
3.26	450–453	54
	454–461	53
	462–470	52
	471–480	51
	481–489	50
	490–500	49
	501–510	48
	511–521	47
	522–533	46
	534–545	45
	546–557	44
	558–570	43
	571–584	42
	585–598	41
3.36	450–456	52
	457–465	51
	466–474	50
	475–484	49
	485–494	48
	495–505	47
	506–516	46
	517–528	45
	529–540	44
	541–553	43
	554–566	42
	567–580	41
	581–595	40
3.42	450–457	51
	458–466	50
	467–476	49
	477–486	48
	487–496	47
	497–507	46
	508–518	45
	519–530	44
	531–543	43
	544–556	42
	557–570	41
	571–584	40
	585–599	39
3.55	450–458	49
	459–468	48
	469–478	47
	479–488	46
	489–499	45
	500–511	44
	512–523	43
	524–536	42
	537–549	41
	550–563	40
	564–577	39
	578–593	38
3.58	450–454	49
	455–464	48
	465–474	47
	475–484	46
	485–495	45
	496–507	44
	508–519	43
	520–531	42
	532–544	41
	545–558	40
	559–572	39
	573–588	38
3.70	450–459	47
	460–469	46
	470–479	45
	480–490	44
	491–502	43
	503–514	42
	515–527	41
	528–540	40
	541–554	39
	555–569	38
	570–584	37
	585–600	36
3.73	450–455	47
	456–465	46
	466–475	45
	476–486	44
	487–498	43
	499–510	42
	511–522	41
	523–536	40
	537–549	39
	550–564	38
	565–580	37
	581–596	36
3.90	450–455	45
	456–465	44
	466–476	43
	477–487	42
	488–500	41
	501–512	40
	513–525	39
	526–540	38
	541–554	37
	555–570	36
	571–586	35
	587–600	34
3.91	450–453	45
	454–464	44
	465–475	43
	476–486	42
	487–498	41
	499–511	40
	512–524	39
	525–538	38
	539–553	37
	554–568	36
	569–585	35
	586–600	34
4.10	450–453	43
	454–464	42
	465–475	41
	476–487	40
	488–500	39
	501–513	38
	514–527	37
	528–542	36
	543–558	35
	559–574	34
	575–592	33
4.11	450–452	43
	453–463	42
	464–474	41
	475–486	40
	487–499	39
	500–512	38
	513–526	37
	527–541	36
	542–556	35
	557–573	34
	574–591	33
4.30	450–453	41
	454 -464	40
	465–477	39
	478–489	38
	490–503	37
	504–517	36
	518–532	35
	533–548	34
	549–565	33
	566–583	32
	584–600	31
4.33	451–461	40
	462–473	39
	474–486	38
	487–499	37
	500–513	36
	514–528	35
	529–544	34
	545–561	33
	562–579	32
	580–598	31
4.44	451–462	39
	463–474	38
	475–487	37
	488–501	36
	502–515	35
	516–530	34
	531–547	33
	548–564	32
	565–583	31
	584–600	30

Table 3, Speedometer Head Calibration Settings

* To convert to km/h, multiply the mph value by 1.609.

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

Axle Ratio	Tire Rev/Mile	Calibration Setting in MPH*
4.56	450–461	38
	462–474	37
	475–487	36
	488–502	35
	503–516	34
	517–532	33
	533–549	32
	550–567	31
	568–587	30
	588–600	29
4.62	450–455	38
	456–468	37
	469–481	36
	482–495	35
	496–510	34
	511–525	33
	526–542	32
	543–560	31
	561–579	30
	580–599	29
4.63	450–454	38
	455–467	37
	468–480	36
	481–494	35
	495–509	34
	510–524	33
	525–541	32
	542–559	31
	560–578	30
	579–598	29
4.88	450–455	36
	456–469	35
	470–483	34
	484–497	33
	498–513	32
	514–530	31
	531–548	30
	549–567	29
	568–588	28
	589–600	27
4.89	450–454	36
	455–468	35
	469–482	34
	483–496	33
	497–512	32
	513–529	31
	530–547	30
	548–566	29
	567–587	28
	588–600	27
5.04	450–454	35
	455–467	34
	468–482	33
	483–497	32
	498–513	31
	514–531	30
	532–549	29
	550–569	28
	570–591	27
	592–600	26
5.25	450–462	33
	463–477	32
	478–493	31
	494–509	30
	510–527	29
	528–547	28
	548–567	27
	568–589	26
	590–600	25
5.29	450–459	33
	460–473	32
	474–489	31
	490–506	30
	507–523	29
	524–542	28
	543–563	27
	564–585	26
	586–600	25
5.38	452–466	32
	467–481	31
	482–497	30
	498–515	29
	516–533	28
	534–553	27
	554–575	26
	576–599	25
5.43	450–461	32
	462–476	31
	477–493	30
	494–510	29
	511–528	28
	529–548	27
	549–570	26
	571–593	25
5.57	451–464	31
	465–480	30
	481–497	29
	498–515	28
	516–535	27
	536–556	26
	557–578	25
	579–600	24
5.60	450–462	31
	463–478	30
	479–494	29
	495–512	28
	513–532	27
	533–553	26
	554–575	25
	576–600	24
5.83	450–459	30
	460–475	29
	476–492	28
	493–511	27
	512–531	26
	532–552	25
	553–576	24
	577–600	23
5.86	450–456	30
	457–472	29
	473–490	28
	491–508	27
	509–528	26
	529–550	25
	551–573	24
	574–598	23
5.90	450–453	30
	454–469	29
	470–486	28
	487–505	27
	506–524	26
	525–546	25
	547–569	24
	570–594	23
6.14	452–467	28
	468–485	27
	486–504	26
	505–524	25
	525–547	24
	548–571	23
	572–598	22
6.17	450–465	28
	466–483	27
	484–501	26
	502–522	25
	523–544	24
	545–568	23
	569–595	22
6.21	450–462	28
	463–479	27
	480–498	26
	499–519	25
	520–541	24
	542–565	23
	566–591	22
6.50	450–458	27
	459–476	26
	477–495	25
	496–517	24
	518–540	23
	541–565	22
	566–592	21
6.67	450–464	26
	465–483	25
	484–503	24
	504–526	23
	527–550	22
	551–577	21
	578–600	20

Table 3, Speedometer Head Calibration Settings (Continued)

* To convert to km/h, multiply the mph value by 1.609.

(Continued on next page)

FREIGHTLINER (MOTOROLA®) ELECTRONIC SPEEDOMETER SYSTEM WITH TRANSMISSION-MOUNTED MAGNETIC SENSOR

SPECIFICATIONS (Continued)

Axle Ratio	Tire Rev/Mile	Calibration Setting in MPH*
6.83	450–453	26
	454–471	25
	472–492	24
	493–513	23
	514–537	22
	538–564	21
	565–592	20
7.17	450–468	24
	469–489	23
	490–512	22
	513–537	21
	538–564	20
	565–595	19
7.20	450–466	24
	467–487	23
	488–510	22
	511–535	21
	536–562	20
	563–592	19
7.33	450–458	24
	459–478	23
	479–501	22
	502–525	21
	526–552	20
	553–582	19
	583–600	18
7.39	450–454	24
	455–474	23
	475–497	22
	498–521	21
	522–548	20
	549–577	19
	578–600	18
7.40	450–454	24
	455–474	23
	475–496	22
	497–520	21
	521–547	20
	548–576	19
	577–600	18
7.80	451–470	22
	471–493	21
	494–519	20
	520–547	19
	548–578	18
	579–600	17
8.40	450–458	21
	459–482	20
	483–508	19
	509–537	18
	538–569	17
	570–600	16
8.60	450–470	20
	471–496	19
	497–524	18
	525–556	17
	557–592	16
	593–600	15

Table 3, Speedometer Head Calibration Settings (Continued)

* To convert to km/h, multiply the mph value by 1.609.

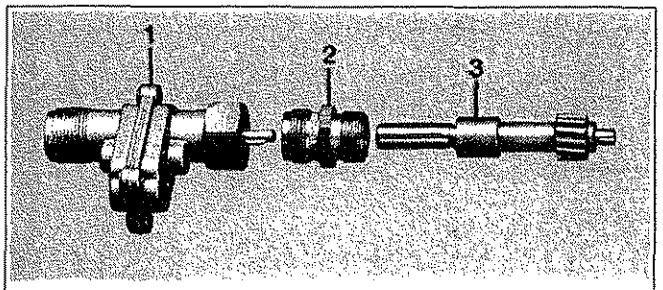
MECHANICAL SPEEDOMETER, SPEEDOGRAPH, AND TACHOGRAPH SYSTEMS

GENERAL DESCRIPTION

Mechanical speedometers, speedographs and tachographs are optional in Freightliner vehicles. They operate by means of a mechanical speedometer cable which is connected either to the engine (in the case of the tachographs) or to a ratio adapter located on the rear of the transmission (speedometers and speedographs). The ratio adapter (see Fig. 1) is connected to a small driven gear inside the transmission, and converts transmission revolutions to revolutions the mechanical instrument head can interpret as miles-per-hour, miles driven, and so forth. The speedometer/odometer indicates only miles-per-hour and miles driven, while the speedographs and tachographs maintain a continuous record, by means of a graph, of information such as miles-per-hour, miles driven, engine rpms, engine idling time, and other such data that pertain to driving efficiency.

Mechanical speedometers currently installed in Freightliner vehicles are manufactured by Stewart-Warner Corp. (see Fig. 2). The speedographs and tachographs are manufactured by either Argo or Sangamo. See Figs. 3 and 4. These units are generally not serviceable; replace them if they malfunction.

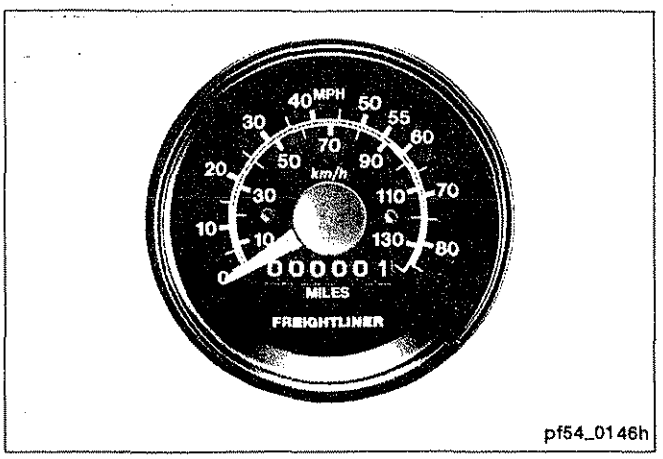
The mechanical speedometer cable is routed from the ratio adapter on the rear of the transmission, via the left frame rail to the inside of the cab, then to the instrument head on the dash panel.



1. Ratio Adapter
2. Sleeve
3. Driven Gear

pf54_0145h

Fig. 1, Ratio Adapter Assembly



pf54_0146h

Fig. 2, Mechanical Speedometer

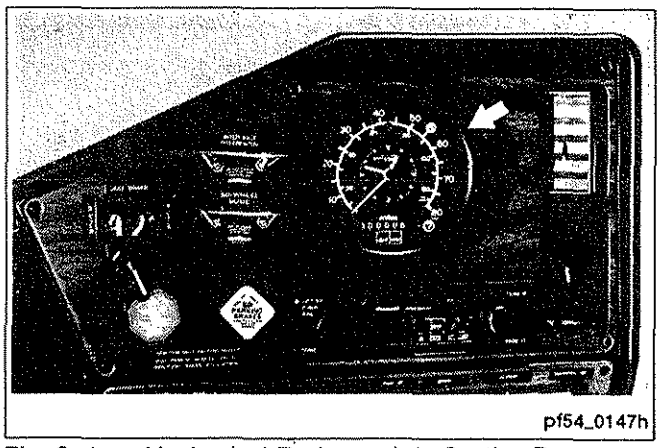


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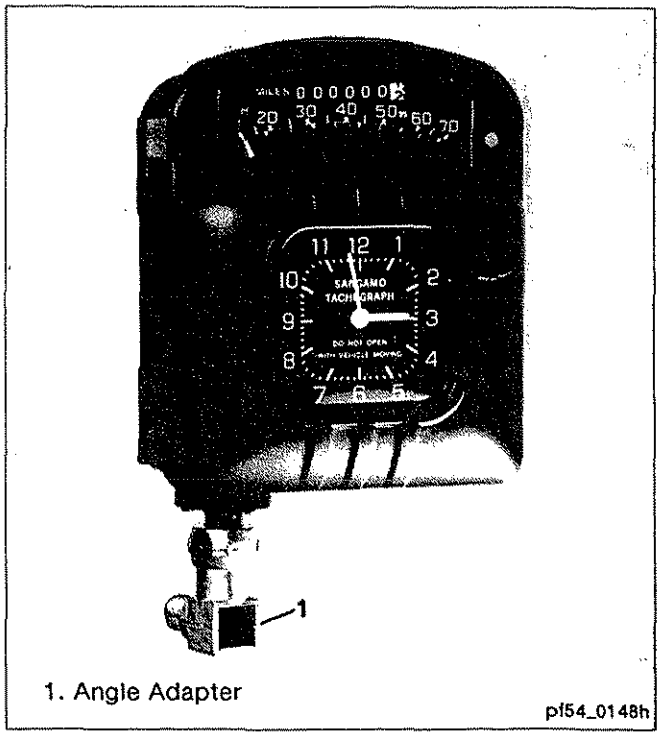
Fig. 3, Argo Mechanical Tachograph in Section B Instrument Panel



1. Angle Adapter

pf54_0148h

Fig. 4, Sangamo Mechanical Tachograph

MECHANICAL SPEEDOMETER, SPEEDOGRAPH, AND TACHOGRAPH SYSTEMS

There are two types of cable routing systems for all vehicles. Earlier model COEs and Conventionals use a two-cable routing system, consisting of one length of cable leading from the transmission to the outside of the cab, and a second length of cable leading to the instrument head on the dash panel (see **Fig. 5**). Later model COEs and Conventionals use a three-cable system, as shown in **Fig. 6**. This system consists of a section of coupler cable leading from the transmission to a point outside of the cab. The coupler cable is connected to an intermediate (32-inch) section of cable, then to another (12-inch), which is connected to the instrument head.

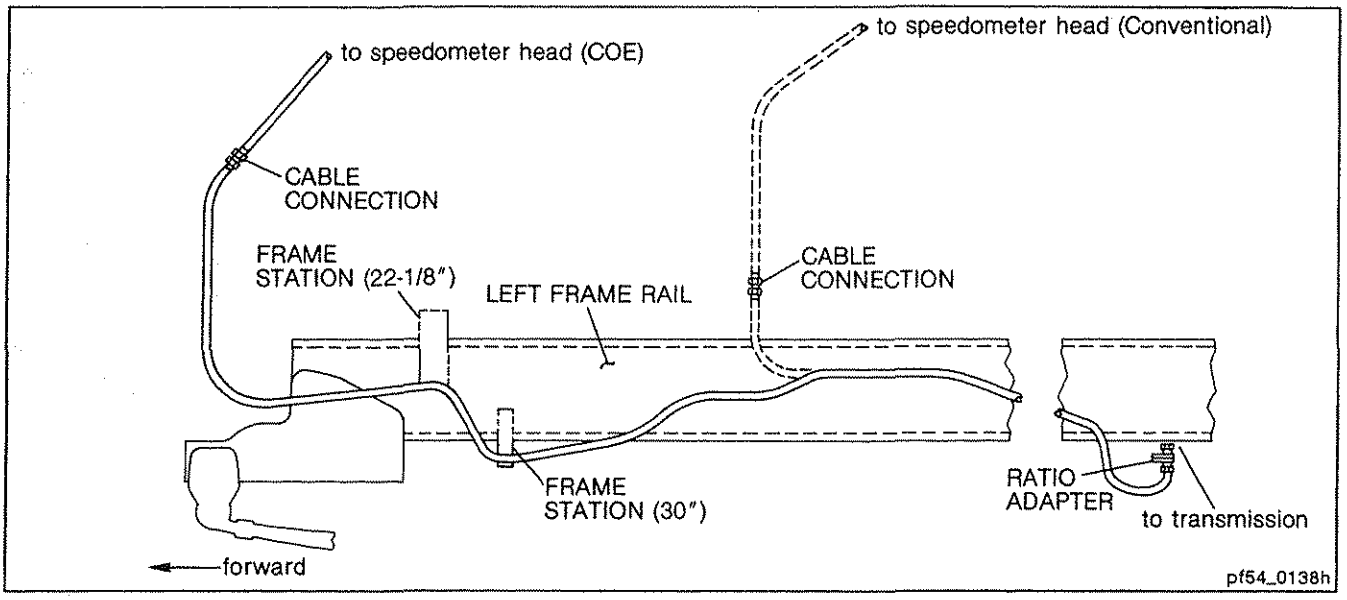


Fig. 5, Two-Cable System

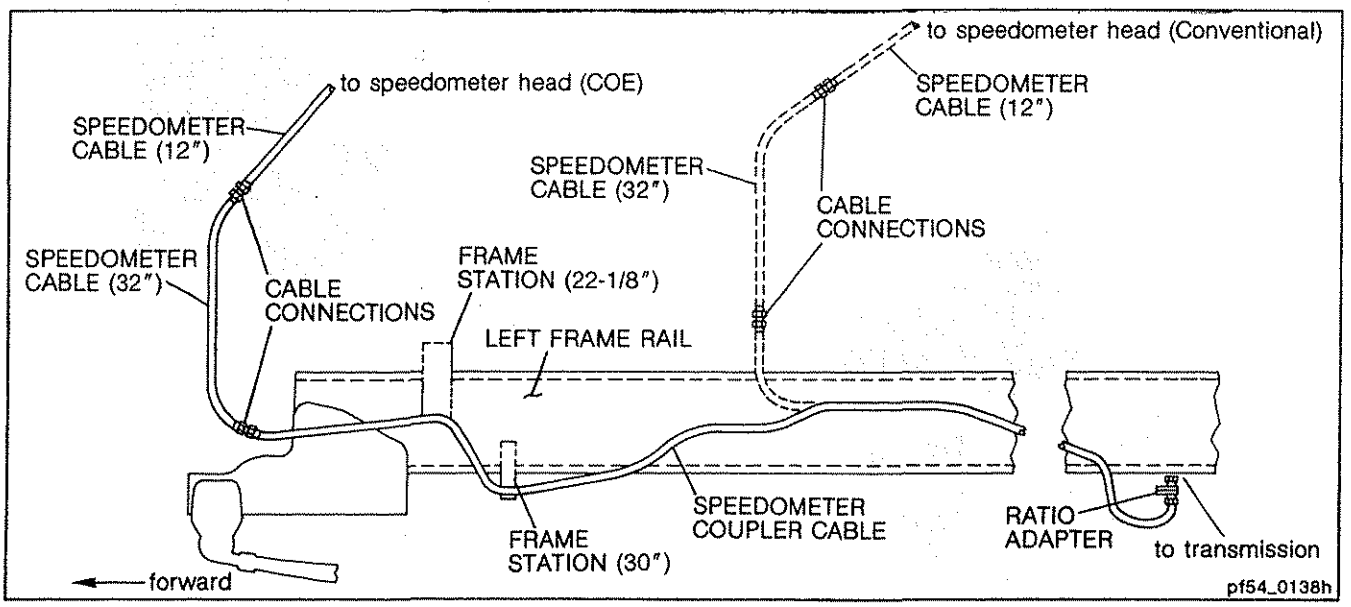


Fig. 6, Three-Cable System

MECHANICAL SPEEDOMETER, SPEEDOGRAPH, AND TACHOGRAPH SYSTEMS

SERVICE OPERATIONS

STEWART-WARNER SPEEDOMETER
REMOVAL AND INSTALLATION

Removal

1. Apply the parking brake.
2. On recent models, remove the screws that attach the speedometer panel to the dash. See Fig. 7. Pull the panel out to provide access to the instrument head.

   On earlier models, loosen the screws that attach the right-hinged portion of the panel to the cowl. Open the hinged panel to gain access to the back of the instrument head.
3. Disconnect the speedometer cable.
4. Remove the nuts that attach the mounting bracket to the instrument head.
5. Remove the mounting bracket from the instrument head, and pull out the light-bulb assembly from the back of the instrument head.
6. Remove the speedometer head from the panel.

Installation

1. Place the new instrument head in the panel.
2. Install the mounting bracket and the mounting bracket nuts.
3. Connect the speedometer cable to the back of the instrument head. Tighten the cable 50 lbf·in (560 N·cm).
4. Push the light-bulb assembly into the hole in the back of the instrument head.
5. Place the panel in the dash. Install and tighten the screws. (On earlier installations, close the hinged dash, and tighten the screws attaching it to the cowl.)

ARGO SPEEDOGRAPH, TACHOGRAPH
REMOVAL AND INSTALLATION

Removal

1. Apply the parking brake.
2. To gain access to the back of the instrument head, loosen the screws that hold the Section B dash top cover in place, and remove the top cover. See Fig. 8.
3. Reach down behind the instrument panel and disconnect the speedometer cable(s) from the angle adapter(s) on the back of the instrument head.
4. Remove the five screws which hold the Section B panel in place.
5. Tilt the panel outward to gain access to the back of the instrument head.
6. For later reference (during assembly), mark any electrical wires connected to the instrument head; pay particular attention to the two ground wires connected to the mounting brackets.

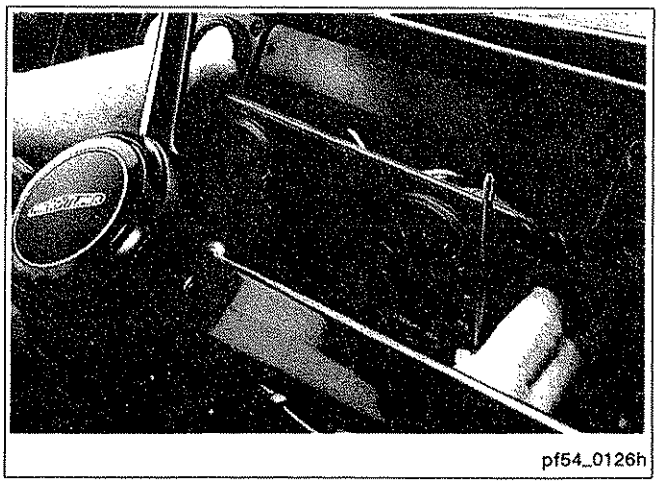
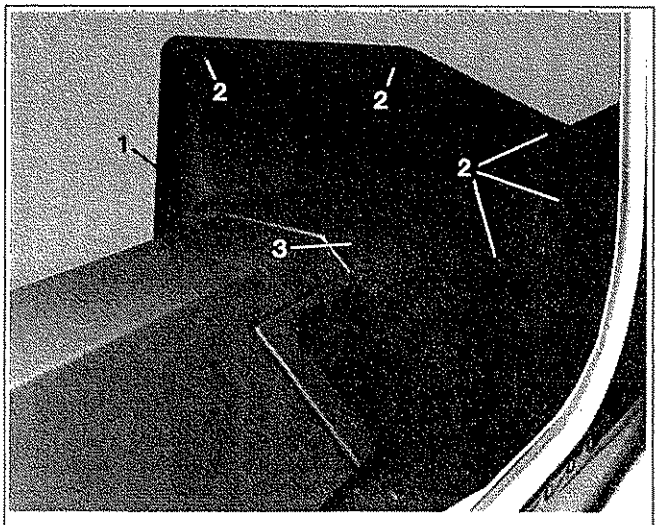


Fig. 7, Removing the Instrument Panel for Mechanical Speedometers



1. Section B Instrument Panel
2. Top Cover Attaching Screws
3. Section B Top Cover

Fig. 8, Top Cover for Instrument Panel, Tachographs and Speedographs

MECHANICAL SPEEDOMETER, SPEEDOGRAPH, AND TACHOGRAPH SYSTEMS

7. Disconnect the 4-pin wiring harness plug from the back of the instrument head.
8. Loosen the nuts holding the mounting brackets to the instrument head, and remove the mounting brackets along with the two ground wires.
9. Remove the instrument head and the extension ring (if present) from the panel.

Installation

1. Following the directions which come with the new unit, install the new angle adapter(s) onto the back of the new instrument head. Be sure to remove all of the felt rings from the shaft(s) on the back of the new instrument head before attaching the new angle adapter(s). Use all of the lubricant provided when lubricating the nylon gears that are installed with the new angle adapter(s). See **Fig. 9**.

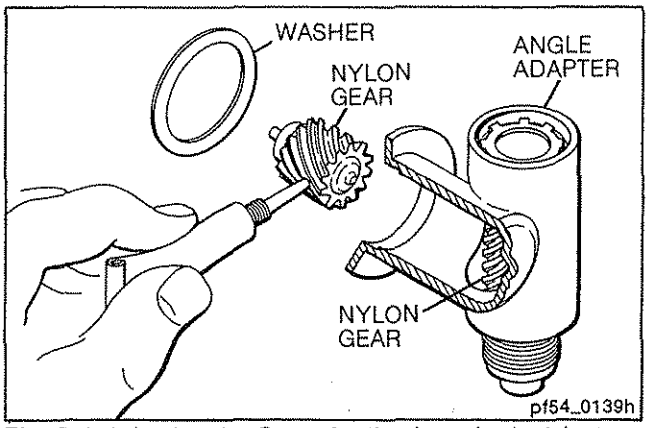


Fig. 9, Lubricating the Gears for the Argo Angle Adapter

2. Place the new instrument head and extension ring (if used) in the panel.
3. Install the mounting brackets, the two ground wires (which were marked earlier), and mounting bracket nuts.
4. Connect the 4-pin wiring harness plug into the back of the new instrument head.
5. Tilt the Section B panel back into the dash, and install and tighten the five screws that hold it in place. See **Fig. 3**.
6. Reach down behind the Section B panel and connect the speedometer cable(s) to the angle adapter(s) on the back of the new instrument head. Tighten the cable(s) 50 lbf·in (560 N·cm).
7. Install the Section B dash top cover and the screws that hold it in place.

SANGAMO SPEEDOGRAPH, TACHOGRAPH REMOVAL AND INSTALLATION

Removal

1. Apply the parking brake.
2. Remove the four screws that hold the plastic mounting bucket to the Section B panel.
3. Partially remove the mounting bucket to gain access to the speedometer cable connection at the bottom of the instrument head.
4. Disconnect the speedometer cable from the angle adapter at the bottom of the instrument head. See **Fig. 4**.
5. Mark and remove the three electrical wires from the back of the instrument head.
6. Remove the instrument head and the mounting bucket from the Section B panel.
7. Disconnect the angle adapter from the bottom drive of the instrument head.
8. Unscrew the three hex nuts and star washers from the three threaded shafts on the back of the instrument head.
9. Remove the aluminum backing plate from the back of the plastic mounting bucket.
10. Remove the instrument head from the plastic mounting bucket.

Installation

1. Test the existing angle adapter, part number SNG 326725-003, by manually rotating it. If the angle adapter functions properly, use it on the new instrument head; otherwise replace it.
2. Apply soapy water to the two stem bumpers, part number 23-11419-000, and push/twist them into the two threaded bosses at the bottom rear of the instrument head.
3. Install the new instrument head to the plastic mounting bucket and place the aluminum backing plate behind the mounting bucket. Using the hex nuts and star washers provided, secure the instrument head to the mounting bucket and the aluminum backing plate.

MECHANICAL SPEEDOMETER, SPEEDOGRAPH, AND TACHOGRAPH SYSTEMS

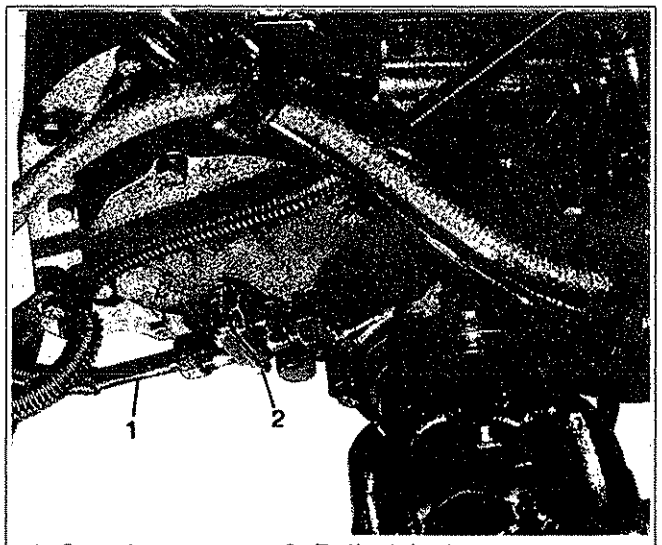
4. Insert the angle adapter (use the existing one if it is functioning properly) through the hole in the bottom of the plastic mounting bucket, and screw it onto the bottom drive of the instrument head.
5. Attach the three electrical wires (which have been marked earlier) to the back of the instrument head.
6. Connect the speedometer cable to the angle adapter. Tighten the cable 50 lbf·in (560 N·cm).
7. Install the instrument head and mounting bucket in the Section B panel. Install the four screws that secure the mounting bucket to the panel.

TROUBLESHOOTING

If the instrument head does not function properly, first check all the speedometer cable connections to make sure that they are tight. If the instrument still does not function, then the problem is either in the instrument head, the speedometer cables, the ratio adapter, or the small driven gear inside the transmission.

RATIO ADAPTER CHECK

1. Unscrew and remove the ratio adapter from the rear of the transmission. Leave the speedometer cable housing connected. See **Fig. 10**.
2. Next, using a 7/8-inch wrench, unscrew the sleeve on the transmission. Remove the sleeve and pull out the small driven gear from the inside of the transmission (see **Fig. 1**). Check the gear for missing teeth and replace it if necessary.
3. Test the ratio adapter by manually rotating the shaft protruding from the end of it. If the shaft doesn't rotate easily, disconnect the speedometer cable from the ratio adapter and rotate the shaft again. If the ratio adapter still doesn't rotate easily, replace it.



1. Speedometer Cable
2. Ratio Adapter

pf54_0149h

Fig. 10, Ratio Adapter on the Transmission

SPEEDOMETER CABLE CHECK

1. With the speedometer cable disconnected from the ratio adapter, check the speedometer cable by rotating the center shaft counterclockwise. The needle indicating miles-per-hour on the instrument head should bounce.
2. If the shaft rotates easily, but the speedometer needle does not bounce, disconnect the cable from the instrument head. Rotate the center shaft once again, and see if the center shaft rotates at the opposite end. If it does, then the instrument head is no good. Replace the head.

   If the speedometer cable center shaft does not rotate along its entire length, then determine where the cable is damaged or broken. Test the cable by rotating the center shaft, starting at the point farthest from the instrument head. Proceed toward the instrument head, disconnecting the cable wherever possible and rotating the center shaft. Repeat this procedure until the damaged or broken section of cable is located, then replace it. Refer to **Figs. 5** and **6** for the location of the cable connections.
3. When you are sure that the speedometer cable is functioning along its entire length, connect it to the instrument head and test the instrument one more time. If the speedometer needle still does not bounce when the cable shaft is rotated, replace the instrument head.

SPEEDOMETER CABLE ROUTING

Proper speedometer cable routing is essential for the accurate operation of mechanical instrument heads. Refer to the parts book for the proper part number and coupler cable length when replacing the speedometer cable in vehicles with a three-cable system. When routing a new speedometer cable, follow the path of the original cable, taking care to keep the cable away from sharp edges, hot surfaces, and moving parts. Do not kink the cable or bend it to a radius of less than six inches. Make sure that all connections are tight, secure, and properly

MECHANICAL SPEEDOMETER, SPEEDOGRAPH, AND TACHOGRAPH SYSTEMS

aligned. Tighten the cable 50 lbf·in (560 N·cm) at the instrument head and 100 lbf·in (1140 N·cm) at the ratio adapter.

NOTE: A good test to determine proper speedometer cable routing is to measure the torque of the center shaft with a torque meter, if one is available.

Disconnect the speedometer cable from the ratio adapter, and rotate the center shaft of the cable with the torque meter. The torque should measure less than 8 ozf·in (6 N·cm). If the torque exceeds 10 ozf·in (7 N·cm), check the speedometer cable routing.

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

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FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

GENERAL DESCRIPTION

This speedometer system includes a magnetic sensor (Fig. 1) mounted on the transmission bearing cover near the output shaft. Refer to Fig. 2. The magnetic sensor uses pulse feedback from a standard 16-tooth spacer gear located under the bearing cover on the inboard end of the transmission output shaft. The magnetic end of the sensor extends through a threaded bore in the bearing cover and stops within a few hundredths of an inch from the teeth of the spacer gear.

When the vehicle is moving, the teeth of the turning spacer gear generate electrical pulses in the sensor's magnetic field. These pulses are transmitted to the speedometer head, which amplifies and interprets the pulses as vehicle speed and distance traveled.

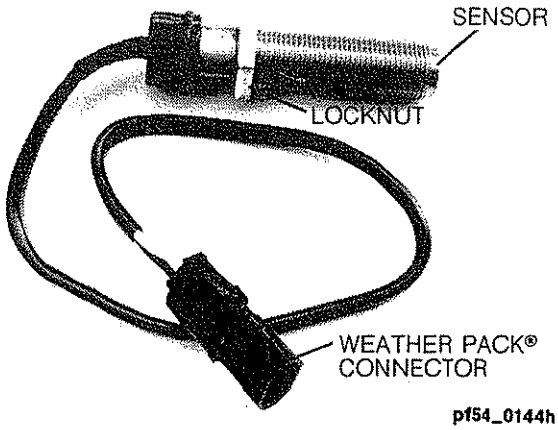

Fig. 1, Magnetic Sensor Assembly

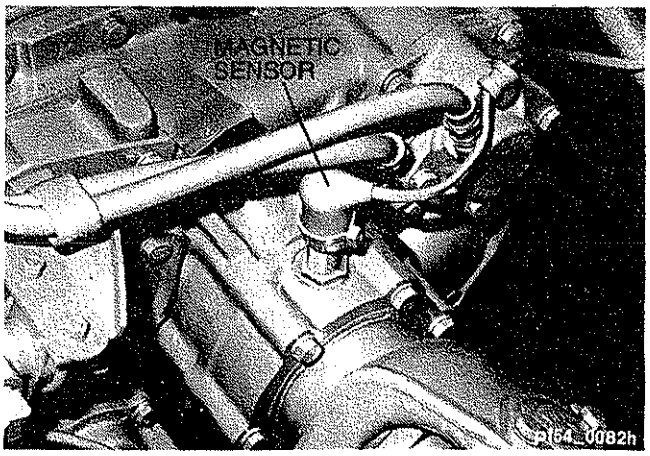

Fig. 2, Magnetic Sensor Installation

Stewart-Warner speedometers can be differentiated from Motorola speedometers used on earlier vehicles by the Freightliner nameplate on the face of the Motorola speedometer head and the calibration adjustment screw on the back of the Motorola speedometer head. The Stewart-Warner speedometer has no nameplate on the speedometer head face (Fig. 3), and there are ten calibration DIP switches on the back of the Stewart-Warner speedometer head.

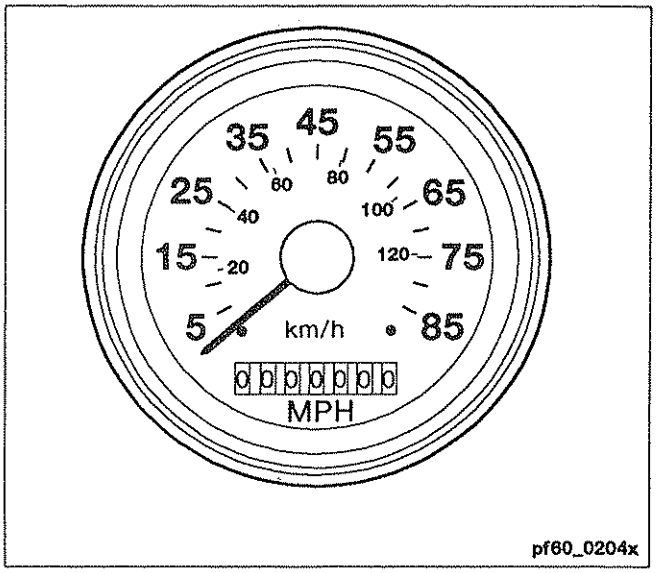

Fig. 3, Stewart-Warner Speedometer

SERVICE OPERATIONS

STEWART-WARNER ELECTRONIC SPEEDOMETER REPLACEMENT AND CALIBRATION

Speedometer Head Replacement

1. Apply the parking brakes.
2. Turn off the ignition
3. Remove the screws that attach the tachometer/ speedometer panel to the dash. Pull the panel out to gain access to the back of the speedometer head. See Fig. 4.
4. Unplug the electrical wiring connectors from the speedometer head.
5. Remove the nuts that attach the mounting bracket to the speedometer head, and remove the bracket. Remove the speedometer head by pulling it out from the front of the panel.

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

6. Place the speedometer head in the dash panel. Attach the mounting bracket to the speedometer head, then tighten the nuts.
7. Connect the electrical wiring at the speedometer head.
8. Position the panel, then install the screws that attach the tachometer/speedometer panel to the dash.

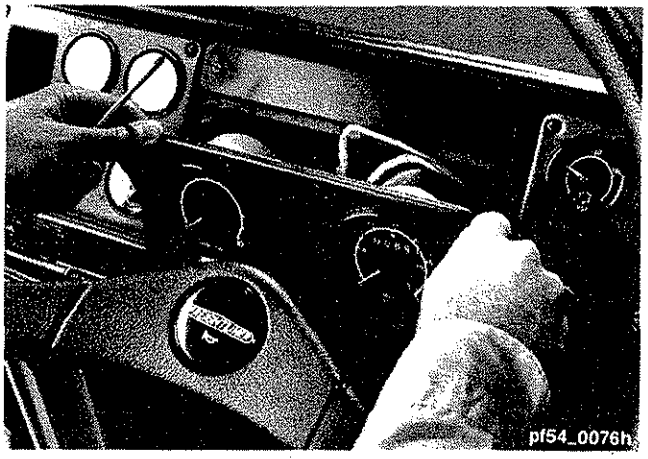

Fig. 4, Remove the Dash Panel to Relocate the Speedometer Head

Magnetic Sensor Replacement and Adjustment

1. Disconnect the Weather Pack® connector. Refer to **Fig. 1**.
2. Loosen the magnetic sensor locknut. Remove the sensor from the transmission housing.
3. Screw the new magnetic sensor into the transmission housing until it bottoms out on the gear teeth. Back off the sensor one-half turn.

IMPORTANT: The speedometer reading will be wrong if a correct adjustment is not maintained.

4. Hold the magnetic sensor in place to keep it from turning. Tighten the locknut 18 lbf·ft (25 N·m).
5. Connect the Weather Pack connector.
6. Test drive the vehicle and check that the speedometer is operating. If there is no speedometer reading, the magnetic sensor was probably not adjusted correctly; readjust the sensor.

Calibrating the Speedometer Head

If a new speedometer head is installed, or if different tires are installed, you must recalibrate the speedometer head.

The Stewart-Warner speedometer is calibrated by setting ten DIP switches at the back of the speedometer head. See **Fig. 5**. The DIP switches are set according to the specifications of a calibration code. Determine the speedometer calibration setting as follows:

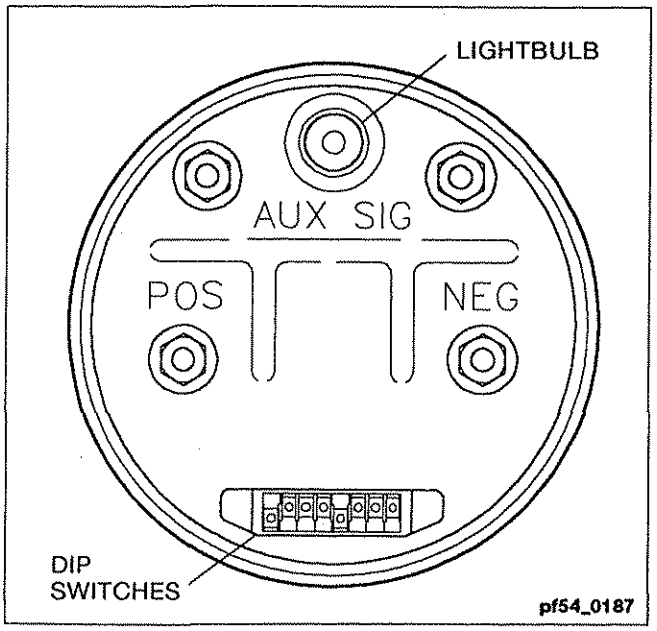

Fig. 5, Calibration DIP Switches on the Speedometer Head

1. Obtain the revolutions-per-mile (rpm), or revolutions-per-kilometer (rpkm) value of the tire brand and model installed on the vehicle. The rpm or rpkm value can be obtained from the tire dealer or manufacturer.
2. Obtain the vehicle axle ratio (ar) from the vehicle specification decal.

NOTE: The vehicle axle ratio is also stamped on the axle housing.

3. Determine the speedometer pulses-per-mile (ppm) as follows:

   .1 Multiply the revolutions-per-mile (rpm) value of the tire brand by the vehicle axle ratio.

   NOTE: To convert from revolutions-per-kilometer (rpkm) to revolutions-per-mile (rpm), multiply the rpkm value by 0.62137.

   .2 Multiply the number obtained in step 3.1 by the total number of teeth (n) on the transmission spacer gear. A 16-tooth spacer gear is standard.

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

Example: 486 (rpm) x 4.63 (ar) x 16 (n) = 36 002.8 (ppm)

4. In **Table 1**, "Specifications," find the ppm value obtained in step 3 (or the value closest to it). In the example above, 36 000 is the closest ppm value to 36 002.8.

   The number to the right of the applicable ppm value is the speedometer calibration code. In this example, the calibration code is 0011010010.

5. Remove the speedometer head from the panel. For instructions, refer to "Speedometer Head Replacement."

6. Remove the plastic cover from the DIP switch panel at the back of the speedometer head. Calibrate the speedometer by moving Up each switch that corresponds to the 0 (zero) positions of the calibration code. See **Fig. 6**.

   Move DOWN each switch that corresponds to the 1 (one) positions of the calibration code. See Fig. 6.

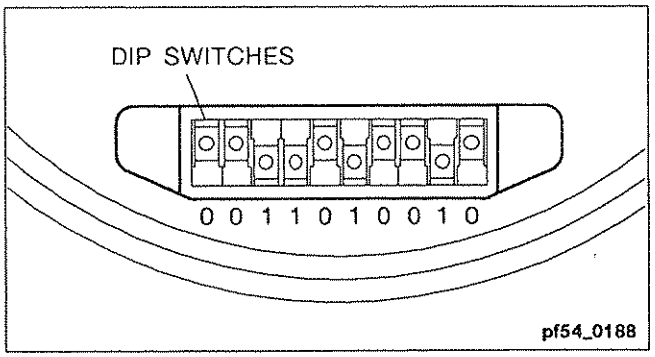

Fig. 6, Speedometer Calibration DIP Switches

7. Install the plastic cover on the DIP switch panel.

8. Install the speedometer head in the panel. For instructions, refer to "Speedometer Head Replacement."

TROUBLESHOOTING

The following is a troubleshooting process requiring the use of a voltmeter and an ohmmeter. Make the checks in the order listed below.

Incorrect speedometer head readings may occur if a new speedometer head or different tires are installed. In each case, calibrate the speedometer head using the procedure in this section.

Inaccurate readings will also occur if the magnetic sensor is not adjusted correctly. Before troubleshooting the system, make sure the magnetic sensor is correctly adjusted. For instructions, refer to "Magnetic Sensor Replacement and Adjustment."

Also, make sure the batteries are fully charged.

SPEEDOMETER HEAD ACCURACY TEST

Testing the accuracy of speedometer head readings is best performed by commercial services specializing in such tests. If these services are not available, do the odometer reading test below.

ODOMETER READING TEST

To check the accuracy of the odometer, drive the vehicle over a measured mile. An inaccurate odometer reading indicates incorrect speedometer head calibration. Calibrate the speedometer head. For instructions, refer to "Calibrating the Speedometer Head."

If inaccurate odometer readings continue after calibration, go to "Magnetic Sensor Resistance Check Using an Ohmmeter."

MAGNETIC SENSOR RESISTANCE CHECK USING AN OHMMETER

1. Disconnect the Weather Pack® connector from the sensor. Make sure the sensor terminals and wires are free of corrosion and moisture.

2. Connect the ohmmeter leads to the terminals of the magnetic sensor. The resistance should measure 876 ohms. Readings between 788 and 963 ohms are acceptable.

   If the resistance is acceptable, then inaccurate speedometer readings are caused by either the wiring to the speedometer head or by the speedometer head itself. Go to "Wiring Check: Magnetic Sensor to Speedometer Head."

   If the resistance is outside the acceptable range, replace the sensor with a new one. For instructions, refer to "Magnetic Sensor Replacement and Adjustment."

WIRING CHECK: MAGNETIC SENSOR TO SPEEDOMETER HEAD

1. Remove the screws that attach the tachometer/speedometer panel to the dash. Pull the panel out to gain access to the back of the speedometer head.

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

2. Unplug the electrical wiring connector from the speedometer head.
3. Check for an open or short circuit by disconnecting the magnetic sensor leads, circuit numbers 117 and 118. Connect the ohmmeter to the leads of circuit numbers 117 and 118. The resistance should measure 876 ohms. A reading between 788 and 963 ohms is acceptable.

   If the above reading is not obtained, and the magnetic sensor is operative, the problem is in the wiring between the magnetic sensor and the speedometer head. Repair or replace the damaged wiring.

   If the reading is between 788 and 963 ohms, connect the magnetic sensor leads to the speedometer head. Go to "Battery Voltage Check Using a DC Voltmeter."

BATTERY VOLTAGE CHECK USING A DC VOLTMETER

1. With the ignition switch off, attach the probes of the DC voltmeter across the positive and negative terminals of the speedometer head.

   NOTE: Attach the negative (black) probe to the yellow wire terminal and the positive (red) probe to the red wire terminal.

2. Turn on the ignition switch. The voltmeter should read 9 to 16 volts DC.

   If the voltage is between 9 and 16 volts DC, but the speedometer and odometer readings are inaccurate, then the speedometer head is causing inaccurate readings. Turn off the ignition switch, and disconnect the voltmeter probes. Replace the speedometer head. For instructions, refer to "Speedometer Head Replacement."

   If the voltage is not between 9 and 16 volts DC, check the wiring between the ignition switch and the speedometer head. Turn off the ignition switch, and disconnect the voltmeter probes. Repair or replace the damaged wiring.

3. Place the panel in the dash; install and tighten the screws.

TROUBLESHOOTING CHART

Problem – Speedometer Head Will Not Register

Possible Cause	Remedy
Magnetic sensor gap is not properly adjusted.	Adjust the magnetic sensor.
Loose or corroded terminals, broken contacts, broken wires, shorting, or frayed wires are causing an incomplete circuit.	Replace the damaged component(s), as necessary.
The magnetic sensor is damaged.	Replace the magnetic sensor.
The speedometer head is damaged internally.	Replace only after checking all other possible causes.

Problem – Inaccurate Speedometer Readings

Magnetic sensor gap is not properly adjusted.	Adjust the magnetic sensor.
Shorts are occurring in the magnetic sensor.	Check the resistance of the magnetic sensor. Replace the sensor, if necessary.
The speedometer head is incorrectly calibrated.	Recalibrate.
Erratic readings are resulting from loose electrical connections.	Check all the wiring in the speedometer system. Tighten all loose connections.

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS

Pulses-Per-Mile (ppm)	Calibration Code
6960	0101110000
7080	1101110000
7200	0011110000
7320	1011110000
7440	0111110000
7560	1111110000
7680	0000001000
7800	1000001000
7920	0100001000
8040	1100001000
8160	0010001000
8280	1010001000
8400	0110001000
8520	1110001000
8640	0001001000
8760	1001001000
8880	0101001000
9000	1101001000
9120	0011001000
9240	1011001000
9360	0111001000
9480	1111001000
9600	0000101000
9720	1000101000
9840	0100101000
9960	1100101000
10080	0010101000
10200	1010101000
10320	0110101000
10440	1110101000
10560	0001101000
10680	1001101000
10800	0101101000
10920	1101101000
11040	0011101000
11160	1011101000
11280	0111101000
11400	1111101000
11520	0000011000
11640	1000011000
11760	0100011000
11880	1100011000
12000	0010011000

Pulses-Per-Mile (ppm)	Calibration Code
12120	1010011000
12240	0110011000
12360	1110011000
12480	0001011000
12600	1001011000
12720	0101011000
12840	1101011000
12960	0011011000
13080	1011011000
13200	0111011000
13320	1111011000
13440	0000111000
13560	1000111000
13680	0100111000
13800	1100111000
13920	0010111000
14040	1010111000
14160	0110111000
14280	1110111000
14400	0001111000
14520	1001111000
14640	0101111000
14760	1101111000
14880	0011111000
15000	1011111000
15120	0111111000
15240	1111111000
15360	0000000100
15480	1000000100
15600	0100000100
15720	1100000100
15840	0010000100
15960	1010000100
16080	0110000100
16200	1110000100
16320	0001000100
16440	1001000100
16560	0101000100
16680	1101000100
16800	0011000100
16920	1011000100
17040	0111000100
17160	1111000100

Pulses-Per-Mile (ppm)	Calibration Code
17280	0000100100
17400	1000100100
17520	0100100100
17640	1100100100
17760	0010100100
17880	1010100100
18000	0110100100
18120	1110100100
18240	0001100100
18360	1001100100
18480	0101100100
18600	1101100100
18720	0011100100
18840	1011100100
18960	0111100100
19080	1111100100
19200	0000010100
19320	1000010100
19440	0100010100
19560	1100010100
19680	0010010100
19800	1010010100
19920	0110010100
20040	1110010100
20160	0001010100
20280	1001010100
20400	0101010100
20520	1101010100
20640	0011010100
20760	1011010100
20880	0111010100
21000	1111010100
21120	0000110100
21240	1000110100
21360	0100110100
21480	1100110100
21600	0010110100
21720	1010110100
21840	0110110100
21960	1110110100
22080	0001110100
22200	1001110100
22320	0101110100

Table 1, Speedometer Calibration Codes

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS (Continued)

Pulses-Per-Mile (ppm)	Calibration Code
22440	1101110100
22560	0011110100
22680	1011110100
22800	0111110100
22920	1111110100
23040	0000001100
23160	1000001100
23280	0100001100
23400	1100001100
23520	0010001100
23640	1010001100
23760	0110001100
23880	1110001100
24000	0001001100
24120	1001001100
24240	0101001100
24360	1101001100
24480	0011001100
24600	1011001100
24720	0111001100
24840	1111001100
24960	0000101100
25080	1000101100
25200	0100101100
25320	1100101100
25440	0010101100
25560	1010101100
25680	0110101100
25800	1110101100
25920	0001101100
26040	1001101100
26160	0101101100
26280	1101101100
26400	0011101100
26520	1011101100
26640	0111101100
26760	1111101100
26880	0000011100
27000	1000011100
27120	0100011100
27240	1100011100
27360	0010011100
27480	1010011100

Pulses-Per-Mile (ppm)	Calibration Code
27600	0110011100
27720	1110011100
27840	0001011100
27960	1001011100
28080	0101011100
28200	1101011100
28320	0011011100
28440	1011011100
28560	0111011100
28680	1111011100
28800	0000111100
28920	1000111100
29040	0100111100
29160	1100111100
29280	0010111100
29400	1010111100
29520	0110111100
29640	1110111100
29760	0001111100
29880	1001111100
30000	0101111100
30120	1101111100
30240	0011111100
30360	1011111100
30480	0111111100
30600	1111111100
30720	0000000010
30840	1000000010
30960	0100000010
31080	1100000010
31200	0010000010
31320	1010000010
31440	0110000010
31560	1110000010
31680	0001000010
31800	1001000010
31920	0101000010
32040	1101000010
32160	0011000010
32280	1011000010
32400	0111000010
32520	1111000010
32640	0000100010

Pulses-Per-Mile (ppm)	Calibration Code
32760	1000100010
32880	0100100010
33000	1100100010
33120	0010100010
33240	1010100010
33360	0110100010
33480	1110100010
33600	0001100010
33720	1001100010
33840	0101100010
33960	1101100010
34080	0011100010
34200	1011100010
34320	0111100010
34440	1111100010
34560	0000010010
34680	1000010010
34800	0100010010
34920	1100010010
35040	0010010010
35160	1010010010
35280	0110010010
35400	1110010010
35520	0001010010
35640	1001010010
35760	0101010010
35880	1101010010
36000	0011010010
36120	1011010010
36240	0111010010
36360	1111010010
36480	0000110010
36600	1000110010
36720	0100110010
36840	1100110010
36960	0010110010
37080	1010110010
37200	0110110010
37320	1110110010
37440	0001110010
37560	1001110010
37680	0101110010
37800	1101110010

Table 1, Speedometer Calibration Codes (Continued)

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS (Continued)

Pulses-Per-Mile (ppm)	Calibration Code
37920	0011110010
38040	1011110010
38160	0111110010
38280	1111110010
38400	0000001010
38520	1000001010
38640	0100001010
38760	1100001010
38880	0010001010
39000	1010001010
39120	0110001010
39240	1110001010
39360	0001001010
39480	1001001010
39600	0101001010
39720	1101001010
39840	0011001010
39960	1011001010
40080	0111001010
40200	1111001010
40320	0000101010
40440	1000101010
40560	0100101010
40680	1100101010
40800	0010101010
40920	1010101010
41040	0110101010
41160	1110101010
41280	0001101010
41400	1001101010
41520	0101101010
41640	1101101010
41760	0011101010
41880	1011101010
42000	0111101010
42120	1111101010
42240	0000011010
42360	1000011010
42480	0100011010
42600	1100011010
42720	0010011010
42840	1010011010
42960	0110011010
43080	1110011010
43200	0001011010
43320	1001011010
43440	0101011010
43560	1101011010
43680	0011011010
43800	1011011010
43920	0111011010
44040	1111011010
44160	0000111010
44280	1000111010
44400	0100111010
44520	1100111010
44640	0010111010
44760	1010111010
44880	0110111010
45000	1110111010
45120	0001111010
45240	1001111010
45360	0101111010
45480	1101111010
45600	0011111010
45720	1011111010
45840	0111111010
45960	1111111010
46080	0000000110
46200	1000000110
46320	0100000110
46440	1100000110
46560	0010000110
46680	1010000110
46800	0110000110
46920	1110000110
47040	0001000110
47160	1001000110
47280	0101000110
47400	1101000110
47520	0011000110
47640	1011000110
47760	0111000110
47880	1111000110
48000	0000100110
48120	1000100110
48240	0100100110
48360	1100100110
48480	0010100110
48600	1010100110
48720	0110100110
48840	1110100110
48960	0001100110
49080	1001100110
49200	0101100110
49320	1101100110
49440	0011100110
49560	1011100110
49680	0111100110
49800	1111100110
49920	0000010110
50040	1000010110
50160	0100010110
50280	1100010110
50400	0010010110
50520	1010010110
50640	0110010110
50760	1110010110
50880	0001010110
51000	1001010110
51120	0101010110
51240	1101010110
51360	0011010110
51480	1011010110
51600	0111010110
51720	1111010110
51840	0000110110
51960	1000110110
52080	0100110110
52200	1100110110
52320	0010110110
52440	1010110110
52560	0110110110
52680	1110110110
52800	0001110110
52920	1001110110
53040	0101110110
53160	1101110110
53280	0011110110

Table 1, Speedometer Calibration Codes (Continued)

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS (Continued)

Pulses-Per-Mile (ppm)	Calibration Code
53400	1011110110
53520	0111110110
53640	1111110110
53760	0000001110
53880	1000001110
54000	0100001110
54120	1100001110
54240	0010001110
54360	1010001110
54480	0110001110
54600	1110001110
54720	0001001110
54840	1001001110
54960	0101001110
55080	1101001110
55200	0011001110
55320	1011001110
55440	0111001110
55560	1111001110
55680	0000101110
55800	1000101110
55920	0100101110
56040	1100101110
56160	0010101110
56280	1010101110
56400	0110101110
56520	1110101110
56640	0001101110
56760	1001101110
56880	0101101110
57000	1101101110
57120	0011101110
57240	1011101110
57360	0111101110
57480	1111101110
57600	0000011110
57720	1000011110
57840	0100011110
57960	1100011110
58080	0010011110
58200	1010011110
58320	0110011110
58440	1110011110
58560	0001011110
58680	1001011110
58800	0101011110
58920	1101011110
59040	0011011110
59160	1011011110
59280	0111011110
59400	1111011110
59520	0000111110
59640	1000111110
59760	0100111110
59880	1100111110
60000	0010111110
60120	1010111110
60240	0110111110
60360	1110111110
60480	0001111110
60600	1001111110
60720	0101111110
60840	1101111110
60960	0011111110
61080	1011111110
61200	0111111110
61320	1111111110
61440	0000000001
61560	1000000001
61680	0100000001
61800	1100000001
61920	0010000001
62040	1010000001
62160	0110000001
62280	1110000001
62400	0001000001
62520	1001000001
62640	0101000001
62760	1101000001
62880	0011000001
63000	1011000001
63120	0111000001
63240	1111000001
63360	0000100001
63480	1000100001
63600	0100100001
63720	1100100001
63840	0010100001
63960	1010100001
64080	0110100001
64200	1110100001
64320	0001100001
64440	1001100001
64560	0101100001
64680	1101100001
64800	0011100001
64920	1011100001
65040	0111100001
65160	1111100001
65280	0000010001
65400	1000010001
65520	0100010001
65640	1100010001
65760	0010010001
65880	1010010001
66000	0110010001
66120	1110010001
66240	0001010001
66360	1001010001
66480	0101010001
66600	1101010001
66720	0011010001
66840	1011010001
66960	0111010001
67080	1111010001
67200	0000110001
67320	1000110001
67440	0100110001
67560	1100110001
67680	0010110001
67800	1010110001
67920	0110110001
68040	1110110001
68160	0001110001
68280	1001110001
68400	0101110001
68520	1101110001
68640	0011110001
68760	1011110001

Table 1, Speedometer Calibration Codes (Continued)

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS (Continued)

Pulses-Per-Mile (ppm)	Calibration Code
68880	0111110001
69000	1111110001
69120	0000001001
69240	1000001001
69360	0100001001
69480	1100001001
69600	0010001001
69720	1010001001
69840	0110001001
69960	1110001001
70080	0001001001
70200	1001001001
70320	0101001001
70440	1101001001
70560	0011001001
70680	1011001001
70800	0111001001
70920	1111001001
71040	0000101001
71160	1000101001
71280	0100101001
71400	1100101001
71520	0010101001
71640	1010101001
71760	0110101001
71880	1110101001
72000	0001101001
72120	1001101001
72240	0101101001
72360	1101101001
72480	0011101001
72600	1011101001
72720	0111101001
72840	1111101001
72960	0000011001
73080	1000011001
73200	0100011001
73320	1100011001
73440	0010011001
73560	1010011001
73680	0110011001
73800	1110011001
73920	0001011001

Pulses-Per-Mile (ppm)	Calibration Code
74040	1001011001
74160	0101011001
74280	1101011001
74400	0011011001
74520	1011011001
74640	0111011001
74760	1111011001
74880	0000111001
75000	1000111001
75120	0100111001
75240	1100111001
75360	0010111001
75480	1010111001
75600	0110111001
75720	1110111001
75840	0001111001
75960	1001111001
76080	0101111001
76200	1101111001
76320	0011111001
76440	1011111001
76560	0111111001
76680	1111111001
76800	0000000101
76920	1000000101
77040	0100000101
77160	1100000101
77280	0010000101
77400	1010000101
77520	0110000101
77640	1110000101
77760	0001000101
77880	1001000101
78000	0101000101
78120	1101000101
78240	0011000101
78360	1011000101
78480	0111000101
78600	1111000101
78720	0000100101
78840	1000100101
78960	0100100101
79080	1100100101

Pulses-Per-Mile (ppm)	Calibration Code
79200	0010100101
79320	1010100101
79440	0110100101
79560	1110100101
79680	0001100101
79800	1001100101
79920	0101100101
80040	1101100101
80160	0011100101
80280	1011100101
80400	0111100101
80520	1111100101
80640	0000010101
80760	1000010101
80880	0100010101
81000	1100010101
81120	0010010101
81240	1010010101
81360	0110010101
81480	1110010101
81600	0001010101
81720	1001010101
81840	0101010101
81960	1101010101
82080	0011010101
82200	1011010101
82320	0111010101
82440	1111010101
82560	0000110101
82680	1000110101
82800	0100110101
82920	1100110101
83040	0010110101
83160	1010110101
83280	0110110101
83400	1110110101
83520	0001110101
83640	1001110101
83760	0101110101
83880	1101110101
84000	0011110101
84120	1011110101
84240	0111110101

Table 1, Speedometer Calibration Codes (Continued)

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS (Continued)

Pulses-Per-Mile (ppm)	Calibration Code
84360	1111110101
84480	0000001101
84600	1000001101
84720	0100001101
84840	1100001101
84960	0010001101
85080	1010001101
85200	0110001101
85320	1110001101
85440	0001001101
85560	1001001101
85680	0101001101
85800	1101001101
85920	0011001101
86040	1011001101
86160	0111001101
86280	1111001101
86400	0000101101
86520	1000101101
86640	0100101101
86760	1100101101
86880	0010101101
87000	1010101101
87120	0110101101
87240	1110101101
87360	0001101101
87480	1001101101
87600	0101101101
87720	1101101101
87840	0011101101
87960	1011101101
88080	0111101101
88200	1111101101
88320	0000011101
88440	1000011101
88560	0100011101
88680	1100011101
88800	0010011101
88920	1010011101
89040	0110011101
89160	1110011101
89280	0001011101
89400	1001011101
89520	0101011101
89640	1101011101
89760	0011011101
89880	1011011101
90000	0111011101
90120	1111011101
90240	0000111101
90360	1000111101
90480	0100111101
90600	1100111101
90720	0010111101
90840	1010111101
90960	0110111101
91080	1110111101
91200	0001111101
91320	1001111101
91440	0101111101
91560	1101111101
91680	0011111101
91800	1011111101
91920	0111111101
92040	1111111101
92160	0000000011
92280	1000000011
92400	0100000011
92520	1100000011
92640	0010000011
92760	1010000011
92880	0110000011
93000	1110000011
93120	0001000011
93240	1001000011
93360	0101000011
93480	1101000011
93600	0011000011
93720	1011000011
93840	0111000011
93960	1111000011
94080	0000100011
94200	1000100011
94320	0100100011
94440	1100100011
94560	0010100011
94680	1010100011
94800	0110100011
94920	1110100011
95040	0001100011
95160	1001100011
95280	0101100011
95400	1101100011
95520	0011100011
95640	1011100011
95760	0111100011
95880	1111100011
96000	0000010011
96120	1000010011
96240	0100010011
96360	1100010011
96480	0010010011
96600	1010010011
96720	0110010011
96840	1110010011
96960	0001010011
97080	1001010011
97200	0101010011
97320	1101010011
97440	0011010011
97560	1011010011
97680	0111010011
97800	1111010011
97920	0000110011
98040	1000110011
98160	0100110011
98280	1100110011
98400	0010110011
98520	1010110011
98640	0110110011
98760	1110110011
98880	0001110011
99000	1001110011
99120	0101110011
99240	1101110011
99360	0011110011
99480	1011110011
99600	0111110011
99720	1111110011

Table 1, Speedometer Calibration Codes (Continued)

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS (Continued)

Pulses-Per-Mile (ppm)	Calibration Code
99840	0000001011
99960	1000001011
100080	0100001011
100200	1100001011
100320	0010001011
100440	1010001011
100560	0110001011
100680	1110001011
100800	0001001011
100920	1001001011
101040	0101001011
101160	1101001011
101280	0011001011
101400	1011001011
101520	0111001011
101640	1111001011
101760	0000101011
101880	1000101011
102000	0100101011
102120	1100101011
102240	0010101011
102360	1010101011
102480	0110101011
102600	1110101011
102720	0001101011
102840	1001101011
102960	0101101011
103080	1101101011
103200	0011101011
103320	1011101011
103440	0111101011
103560	1111101011
103680	0000011011
103800	1000011011
103920	0100011011
104040	1100011011
104160	0010011011
104280	1010011011
104400	0110011011
104520	1110011011
104640	0001011011
104760	1001011011
104880	0101011011
105000	1101011011
105120	0011011011
105240	1011011011
105360	0111011011
105480	1111011011
105600	0000111011
105720	1000111011
105840	0100111011
105960	1100111011
106080	0010111011
106200	1010111011
106320	0110111011
106440	1110111011
106560	0001111011
106680	1001111011
106800	0101111011
106920	1101111011
107040	0011111011
107160	1011111011
107280	0111111011
107400	1111111011
107520	0000000111
107640	1000000111
107760	0100000111
107880	1100000111
108000	0010000111
108120	1010000111
108240	0110000111
108360	1110000111
108480	0001000111
108600	1001000111
108720	0101000111
108840	1101000111
108960	0011000111
109080	1011000111
109200	0111000111
109320	1111000111
109440	0000100111
109560	1000100111
109680	0100100111
109800	1100100111
109920	0010100111
110040	1010100111
110160	0110100111
110280	1110100111
110400	0001100111
110520	1001100111
110640	0101100111
110760	1101100111
110880	0011100111
111000	1011100111
111120	0111100111
111240	1111100111
111360	0000010111
111480	1000010111
111600	0100010111
111720	1100010111
111840	0010010111
111960	1010010111
112080	0110010111
112200	1110010111
112320	0001010111
112440	1001010111
112560	0101010111
112680	1101010111
112800	0011010111
112920	1011010111
113040	0111010111
113160	1111010111
113280	0000110111
113400	1000110111
113520	0100110111
113640	1100110111
113760	0010110111
113880	1010110111
114000	0110110111
114120	1110110111
114240	0001110111
114360	1001110111
114480	0101110111
114600	1101110111
114720	0011110111
114840	1011110111
114960	0111110111
115080	1111110111
115200	0000001111

Table 1, Speedometer Calibration Codes (Continued)

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC SPEEDOMETER

SPECIFICATIONS (Continued)

Pulses-Per-Mile (ppm)	Calibration Code
115320	1000001111
115440	0100001111
115560	1100001111
115680	0010001111
115800	1010001111
115920	0110001111
116040	1110001111
116160	0001001111
116280	1001001111
116400	0101001111
116520	1101001111
116640	0011001111
116760	1011001111
116880	0111001111
117000	1111001111
117120	0000101111
117240	1000101111
117360	0100101111
117480	1100101111
117600	0010101111
117720	1010101111
117840	0110101111
117960	1110101111
118080	0001101111
118200	1001101111
118320	0101101111
118440	1101101111
118560	0011101111
118680	1011101111
118800	0111101111
118920	1111101111
119040	0000011111
119160	1000011111
119280	0100011111
119400	1100011111
119520	0010011111
119640	1010011111
119760	0110011111
119880	1110011111
120000	0001011111
120120	1001011111
120240	0101011111
120360	1101011111
120480	0011011111
120600	1011011111
120720	0111011111
120840	1111011111
120960	0000111111
121080	1000111111
121200	0100111111
121320	1100111111
121440	0010111111
121560	1010111111
121680	0110111111
121800	1110111111
121920	0001111111
122040	1001111111
122160	0101111111
122280	1101111111
122400	0011111111
122520	1011111111
122640	0111111111
122760	1111111111

Table 1, Speedometer Calibration Codes (Continued)

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC TACHOMETER

SUBJECT CONTENTS

TOPIC **PAGE NUMBER**

General Description

Service Operations

General Description 1

Service Operations
- Tachometer Head Replacement 1
- Magnetic Sensor Replacement and Adjustment 2
- Calibrating the Tachometer Head 2

Troubleshooting

Magnetic Sensor Voltage Check 3

Magnetic Sensor Resistance Check Using an Ohmmeter 3

Wiring Check: Magnetic Sensor to Tachometer Head 3

Battery Voltage Check Using a DC Voltmeter 4

Troubleshooting (Chart) 4

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC TACHOMETER

GENERAL DESCRIPTION

Engine speeds are shown in revolutions-per-minute (rpm) by the electronic tachometer (Fig. 1). The tachometer is used as a guide for shifting, and to keep the engine in the proper rpm range.

Stewart-Warner tachometers can be differentiated from Motorola tachometers used on earlier vehicles by the Freightliner nameplate on the face of the Motorola tachometer head and the calibration adjustment screw on the back of the Motorola tachometer head. The Stewart-Warner tachometer has no nameplate on the tachometer head face, and there are eight calibration DIP switches on the back of the Stewart-Warner tachometer head.

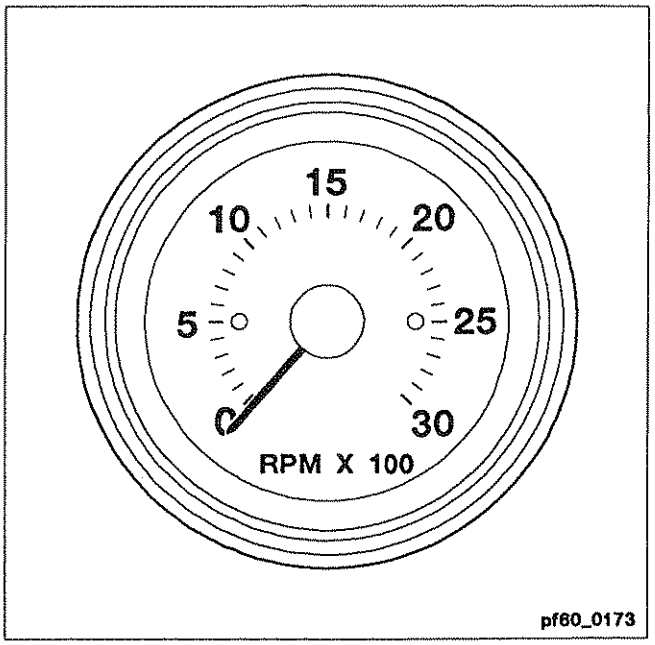

Fig. 1, Stewart-Warner Tachometer

The electronic tachometer consists of a gauge, magnetic sensor (Fig. 2), and the electrical wires that complete the circuit between the two components.

The electronic tachometer receives signals from the magnetic sensor, which extends through a threaded bore in the flywheel housing (Fig. 3). When the vehicle is moving, the teeth of the turning flywheel generate electrical pulses in the sensor's magnetic field. The pulses are transmitted to the tachometer head, which converts the signals to an rpm reading.

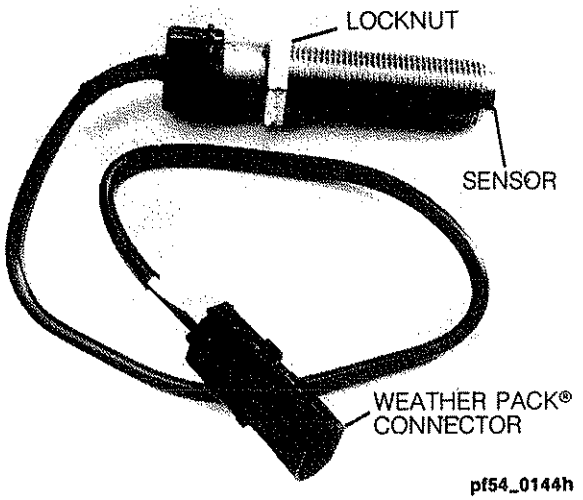

Fig. 2, Magnetic Sensor Assembly

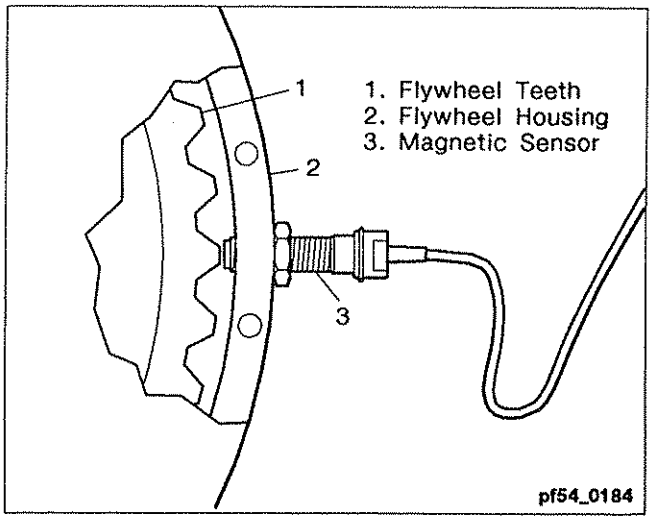

Fig. 3, Magnetic Sensor in Flywheel Housing

SERVICE OPERATIONS

STEWART-WARNER ELECTRONIC TACHOMETER REPLACEMENT AND CALIBRATION

Tachometer Head Replacement

1. Apply the parking brakes.
2. Turn off the ignition.
3. Remove the screws that attach the tachometer/speedometer panel to the dash. Pull the panel out to gain access to the back of the tachometer head. See Fig. 4.

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC TACHOMETER

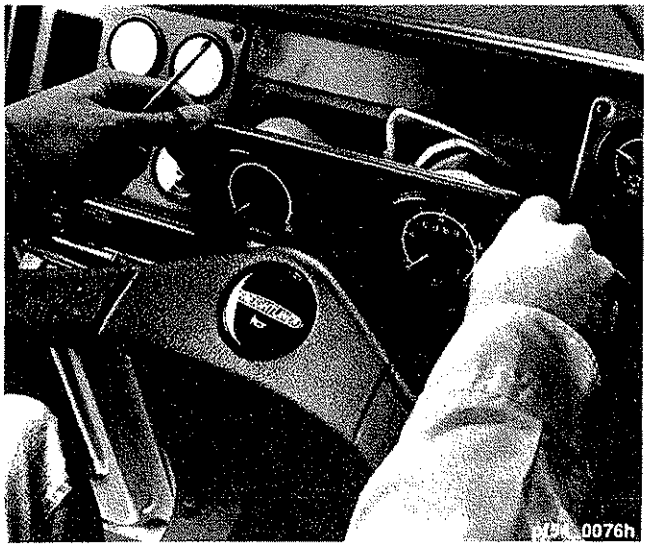

Fig. 4, Removing the Tachometer Head

4. Unplug the electrical wiring connectors from the tachometer head.
5. Remove the nuts that attach the mounting bracket to the tachometer head, and remove the bracket. Remove the tachometer head by pulling it out from the front of the panel.
6. Place the tachometer head in the dash panel. Attach the mounting bracket to the tachometer head, then tighten the nuts.
7. Connect the electrical wiring connectors to the tachometer head.
8. Position the panel, then install the screws that attach the tachometer/speedometer panel to the dash.

Magnetic Sensor Replacement and Adjustment

1. Disconnect the Weather Pack® connector. Refer to **Fig. 2**.
2. Loosen the magnetic sensor locknut. Remove the sensor from the flywheel housing.
3. Screw the new magnetic sensor into the flywheel housing until it bottoms out on the gear teeth. Back off the sensor one-half turn. See **Fig. 3**.

IMPORTANT: The tachometer reading will be wrong if the correct adjustment is not maintained.

4. Hold the magnetic sensor in place to keep it from turning. Tighten the locknut 18 lbf·ft (25 N·m).
5. Connect the Weather Pack connector.
6. Test drive the vehicle and check that the tachometer is operating. If there is no tachometer reading, the magnetic sensor was probably not adjusted correctly; readjust the sensor.

Calibrating the Tachometer Head

If a new tachometer head is installed, or if a new engine is installed, you must also recalibrate the tachometer head.

The Stewart-Warner tachometer is calibrated by setting eight DIP switches at the back of the tachometer head. See **Fig. 5**. The DIP switches are set according to the engine model used in the vehicle.

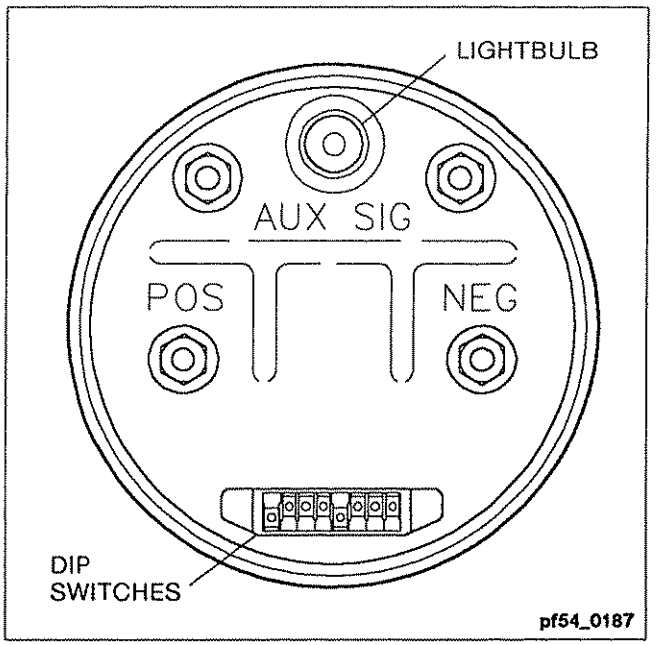

Fig. 5, Calibration DIP Switches on the Tachometer

Determine the tachometer calibration setting as follows:

1. Adjust the magnetic sensor. For instructions, refer to "Magnetic Sensor Replacement and Adjustment."
2. Obtain the calibration code from **Table 1**.
3. Remove the tachometer head from the panel. For instructions, refer to "Tachometer Head Replacement."
4. Remove the plastic cover from the DIP switch panel at the back of the tachometer head. Calibrate the

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC TACHOMETER

tachometer by moving DOWN each switch that corresponds to the 0 (zero) positions of the calibration code. Refer to Fig. 6.

Move UP each switch that corresponds to the 1 (one) positions of the calibration code. See Fig. 6.

Manufacturer	Engine Model	DIP Switch Code
Caterpillar	3306	1001 0111
	3406 and 3176	0111 0001
Cummins	NTC Big Cam I & II	0111 0111
	NTC Big Cam III & IV	0110 0011
	L10 & V Series	
Detroit	All	0111 0111

Table 1

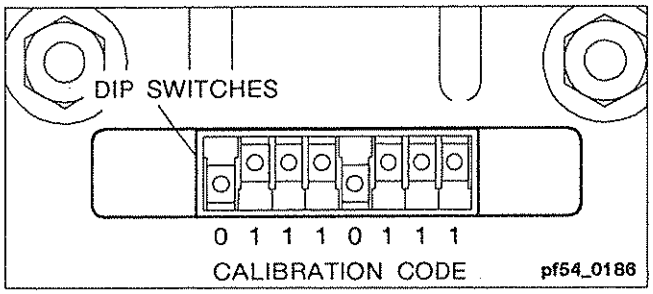

Fig. 6, Tachometer Calibration DIP Switches

5. Install the plastic cover on the DIP switch panel.
6. Install the tachometer head in the panel. For instructions, refer to "Tachometer Head Replacement."

TROUBLESHOOTING

The following is a troubleshooting process requiring the use of a voltmeter and an ohmmeter. Make the checks in the order listed below.

Incorrect tachometer head readings may occur if a new tachometer head or engine is installed. In each case, calibrate the tachometer head using the procedure in this section.

Inaccurate readings will also occur if the magnetic sensor is not adjusted correctly. Before troubleshooting the system, make sure the magnetic sensor is correctly adjusted. For instructions, refer to "Magnetic Sensor Replacement and Adjustment."

Also, make sure the batteries are fully charged.

MAGNETIC SENSOR VOLTAGE CHECK

NOTE: To receive an accurate tachometer reading, at least one volt AC output is needed from the magnetic sensor.

1. Disconnect the electrical connector from the sensor. Make sure the sensor terminals are free of corrosion and moisture.
2. Connect an AC voltmeter to the terminals of the magnetic sensor.
3. Run the engine at idle speed, and check the voltage output from the sensor. If the voltage is less than one volt, refer to the "Troubleshooting Chart" for possible causes and corrections.
4. Turn off the engine and disconnect the voltmeter.

MAGNETIC SENSOR RESISTANCE CHECK USING AN OHMMETER

Connect the ohmmeter leads to the terminals of the magnetic sensor. The resistance should measure 876 ohms. Readings between 788 and 963 ohms are acceptable.

If the resistance is acceptable, then inaccurate tachometer readings are caused by either the wiring to the tachometer head or by the tachometer head itself. Go to "Wiring Check: Magnetic Sensor to Tachometer Head."

If the resistance is outside the acceptable range, replace the sensor with a new one. For instructions, refer to "Magnetic Sensor Replacement and Adjustment."

WIRING CHECK: MAGNETIC SENSOR TO TACHOMETER HEAD

1. Remove the screws that attach the tachometer/speedometer panel to the dash. Pull the panel out to gain access to the back of the tachometer head.
2. Unplug the electrical wiring connector from the tachometer head.
3. Check for an open or short circuit by disconnecting the magnetic sensor leads, circuit numbers 162 and 163. Connect the ohmmeter to the leads of circuit numbers 162 and 163. The resistance should measure 876 ohms. A reading between 788 and 963 ohms is acceptable.

   If the above reading is not obtained, and the magnetic sensor is operative, the problem is in the wiring between the magnetic sensor and the tachometer head. Repair or replace the damaged wiring.

FREIGHTLINER (STEWART-WARNER®) ELECTRONIC TACHOMETER

If the reading is between 788 and 963 ohms, connect the magnetic sensor leads to the tachometer head. Go to "Battery Voltage Check Using a DC Voltmeter."

BATTERY VOLTAGE CHECK USING A DC VOLTMETER

1. With the ignition switch off, attach the probes of the DC voltmeter across the positive and negative terminals of the tachometer head.

NOTE: Attach the negative (black) probe to the yellow wire terminal and the positive (red) probe to the red wire terminal.

2. Turn on the ignition switch. The voltmeter should read 9 to 16 volts DC.

If the voltage is between 9 and 16 volts DC, but the tachometer meter readings are inaccurate, then the tachometer head, not the wiring, is causing inaccurate readings. Turn off the ignition switch, and disconnect the voltmeter probes. Replace the tachometer head. For instructions, refer to "Tachometer Head Replacement."

If the voltage is not between 9 and 16 volts DC, check the wiring between the ignition switch and the tachometer head. Turn off the ignition switch, and disconnect the voltmeter probes. Repair or replace the damaged wiring.

3. Place the panel in the dash; install and tighten the screws.

TROUBLESHOOTING CHART

Problem — Less Than One Volt Reading From the Magnetic Sensor

Possible Cause	Remedy
Magnetic sensor gap is not properly adjusted.	Adjust the magnetic sensor.
The magnetic sensor is damaged.	Replace the magnetic sensor.

Problem — Tachometer Head Will Not Register

Magnetic sensor gap is not properly adjusted.	Adjust the magnetic sensor.
The magnetic sensor is damaged.	Replace the magnetic sensor.
The tachometer head is damaged internally.	Replace only after checking all other possible causes.
Loose or corroded terminals, broken contacts, broken wires, shorting, or frayed wires are causing an incomplete circuit.	Replace the damaged component(s), as necessary.

Problem — Inaccurate Tachometer Readings

Magnetic sensor gap is not properly adjusted.	Adjust the magnetic sensor.
Shorts are occurring in the magnetic sensor.	Check the resistance of the magnetic sensor. Replace the sensor, if necessary.
The tachometer head is incorrectly calibrated.	Recalibrate the tachometer head.
Erratic readings are resulting from loose electrical connections.	Check all the wiring in the tachometer system. Tighten all loose connections.

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

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SPECIFICATIONS

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

GENERAL DESCRIPTION

Sprague Air Push® II wiper motors and wet-arm wiper/washer systems (Figs. 1, 2, and 3) are activated by air pressure from the vehicle's accessory air system.

Vehicles manufactured since the introduction of the Advanced Interior System have a two-valve wiper/washer system. The rotating-type wiper control valves control the starting, stopping, and speed of the wipers, by regulating air pressure admitted to the wiper motors. The left wiper control valve is a dual-purpose valve, combining the washer function with the wiper function. As an option, an intermittent (delay) wiper control regulates wiper sweep during light rains or road splash. See Fig. 4.

Vehicles manufactured before the introduction of the Advanced Interior System have three control valves to operate the wiper and washer systems: two wiper controls function similar to those described above; a separate push-type control valve operates the washer system. See Fig. 5.

The washer reservoir regulating valve (refer to Fig. 2 or 3) automatically purges the lines to the nozzles before and after each wash cycle, to prevent freezing and clogging of the lines and nozzles. Washer fluid is supplied by a hose that runs from the reservoir, through the cab skin (COEs) or cowl (Conventionals), and up the center of the wiper arm, connecting with the nozzle directly behind the wiper blade attachment. A 360-degree adjustable nozzle is attached to each wiper arm by the same bolt that holds the wiper blade in place.

On COEs, the wiper motors are mounted on the firewall (noseskin), under the dash on each side of the console. On Conventionals, the motors are mounted on the exterior of the firewall, under the cowl.

PRINCIPLES OF OPERATION

NOTE: Refer to the Freightliner Driver's Manual for complete operating instructions of the wiper and washer systems.

When the control valve knob is turned clockwise *more* than one-eighth turn, pressurized air flows from the "OUT" port of the control valve to the "IN" port (refer to Fig. 6) of the wiper motor. The wiper motor activates, and increases in speed as the knob is turned to its clockwise limit.

On two-valve systems, when a wiper control valve knob is held in its extreme counterclockwise position, pressurized air flows from both the "OUT" and "PARK" ports of the control valve; on three-valve systems, this occurs when the wiper knob is turned clockwise *no more than* one-eighth turn. Both ports of the motor valve then receive pressurized air, and the wiper motor parks the wiper blade, out of the driver's view.

If the system is equipped with an intermittent (delay) wiper control, all pressurized air flows through an electric solenoid before flowing to the wiper motor. The solenoid delays the passage of pressurized air to the motors for zero to 10 seconds, depending on the setting of the intermittent wiper control knob.

Each wiper motor consists of four major subassemblies: two symmetrical motor housing halves, a motor valve, a symmetrical twin-headed piston-rack assembly, and a transmission shaft-and-sector gear assembly. See Fig.

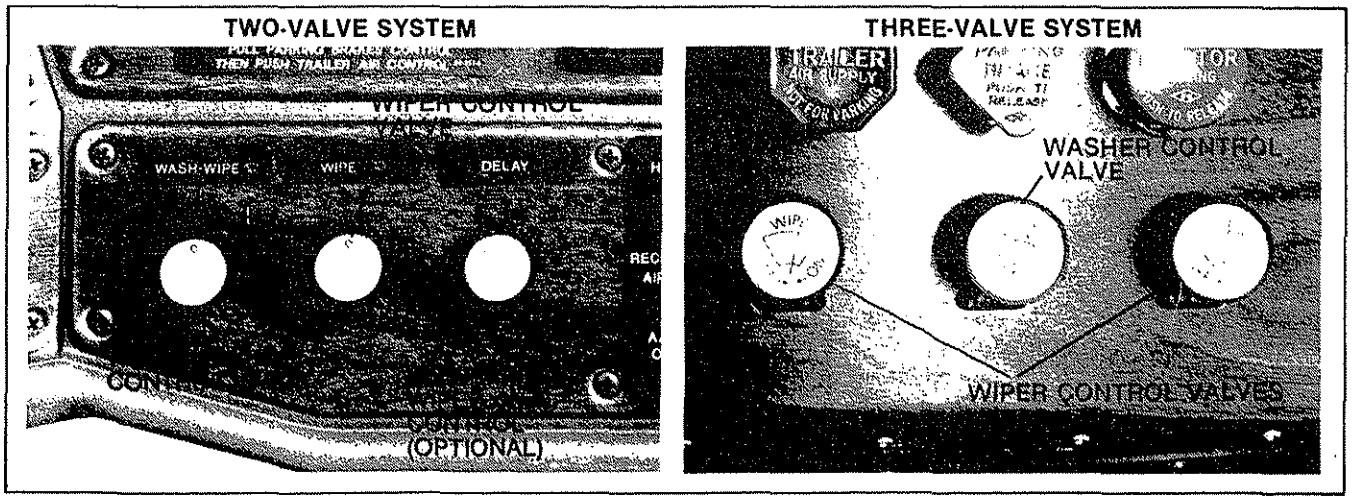


Fig. 1

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

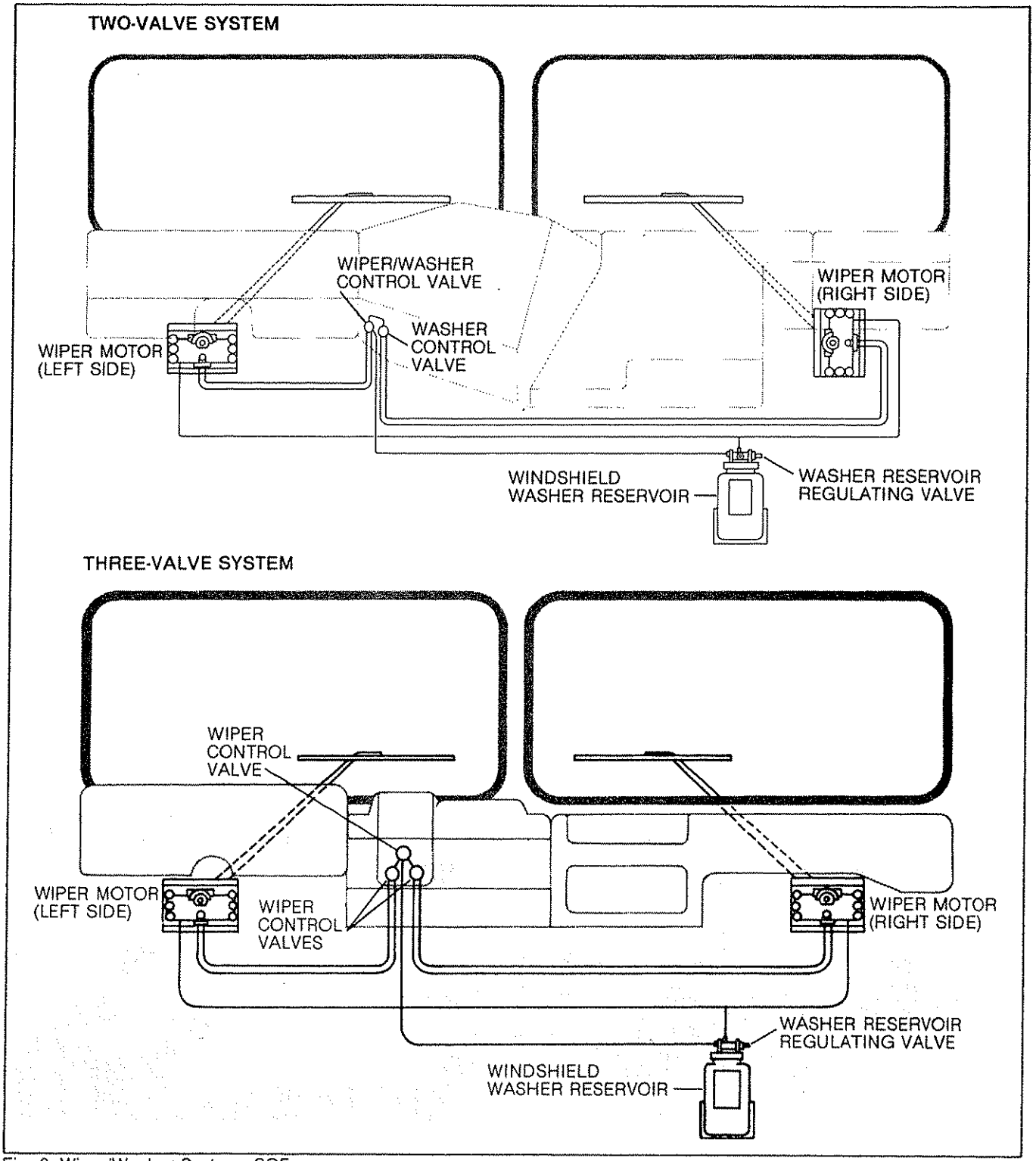


Fig. 2, Wiper/Washer System, COE

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

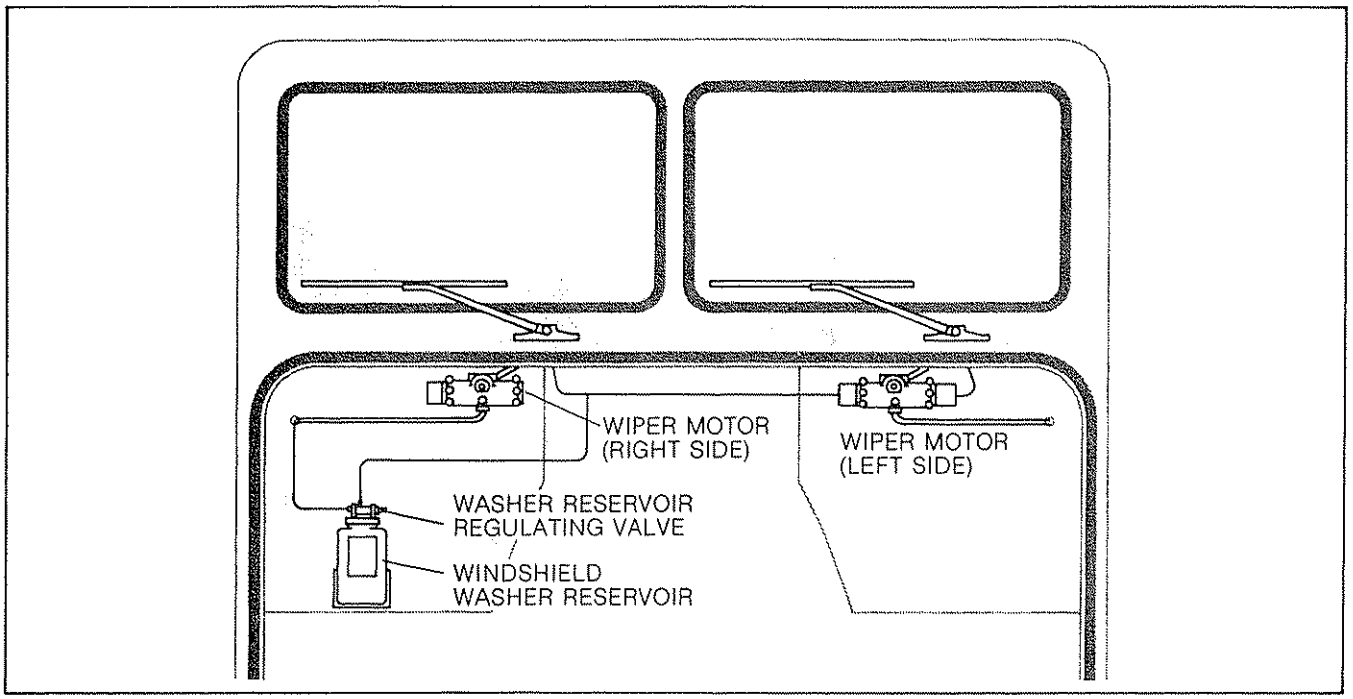


Fig. 3, Wiper/Washer System, Conventional

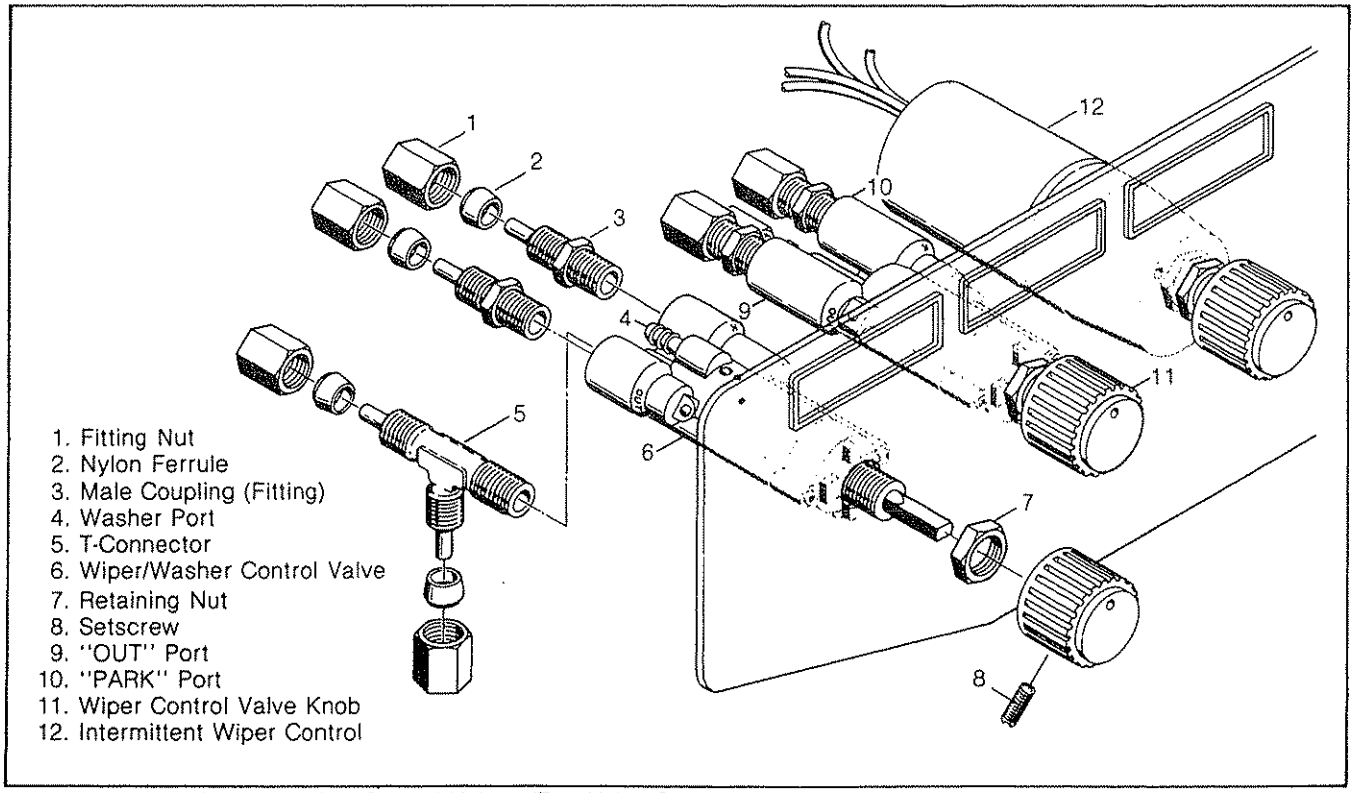


Fig. 4, Wiper and Wiper/Washer Control Valves (Two-Valve System)

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

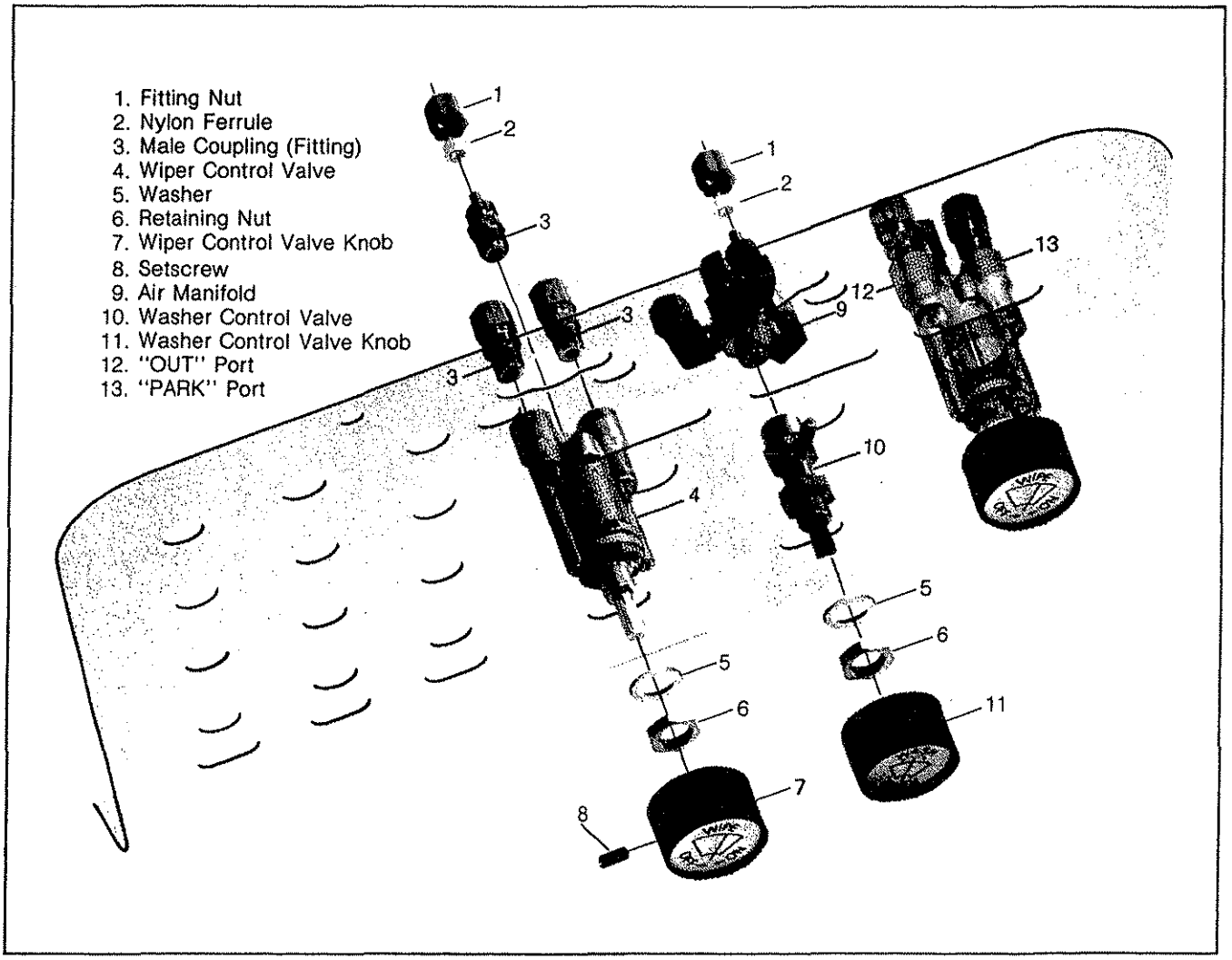


Fig. 5, Wiper and Washer Control Valves (Three-Valve System)

6. The motor valve and the transmission shaft-and-sector gear assembly are held in place between the halves of the motor housing, and are positioned crosswise to the piston-rack assembly. The motor valve directs pressurized air to one end of the motor housing, and then to the other side, to push the piston-rack assembly back and forth. As the piston-rack assembly moves, the sector gear (engaged with the rack) rotates the transmission shaft and wiper through a pre-set sweep. The extent of wiper sweep is determined by the location of air passages in the wiper motor housing halves, and also by the thickness of Delrin® spacers at each end of the twin-headed piston-rack assembly.

The washer system is activated when the knob on the wiper/washer control valve (two-valve systems) or washer control valve (three-valve systems) is pushed in. This enables pressurized air to flow from the washer port of the control valve to the washer reservoir regulating valve. If the knob is held in, air pressure holds the washer regulating valve open, and directs a constant stream of fluid to the windshield. If the knob is pushed in and released, air pressure causes the spring-loaded regulating valve diaphragm to surge until the compressed air is exhausted; this directs an intermittent wash stream to the windshield.

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

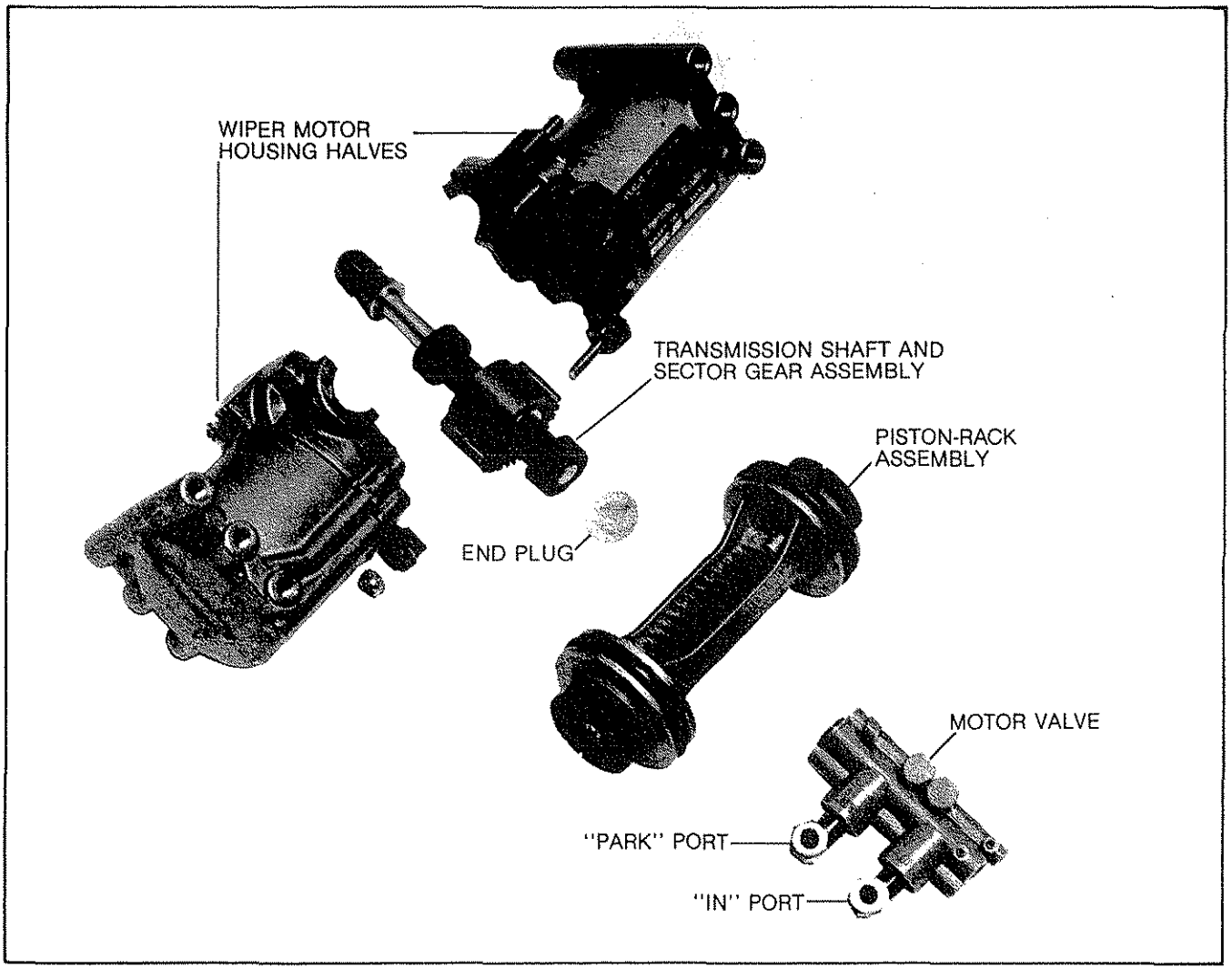


Fig. 6, Major Wiper Motor Components

SERVICE OPERATIONS

WIPER CONTROL VALVE CHECKING

1. Chock the tires and drain the air system.

WARNING: When draining the air system, or allowing air to exhaust from a loosened or disconnected air line, do not look into the air jets or direct them toward another person, as dirt or sludge may be present in the airstream. Hoses which contain pressurized air should be disconnected with extreme care, as they may whip as air escapes. Failure to take all necessary precautions during this operation can result in personal injury.

2. Gain access to the control valve air lines by removing the control panel screws; on Advanced Interior Systems and later models, also remove the knobs on the lever slide controls. Lift the panel to a serviceable level. See Fig. 7.

NOTE: All ports on the control valves are identified by the words "PARK," "IN," or "OUT." Use these references when connecting or disconnecting air lines.

3. Using two wrenches, to prevent twisting of the tubing, disconnect the air lines that run to the wiper motor from the male couplings at the back of the valve. Refer to Fig. 4 or 5. On three-valve systems, do not disconnect the air line that runs from the air

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

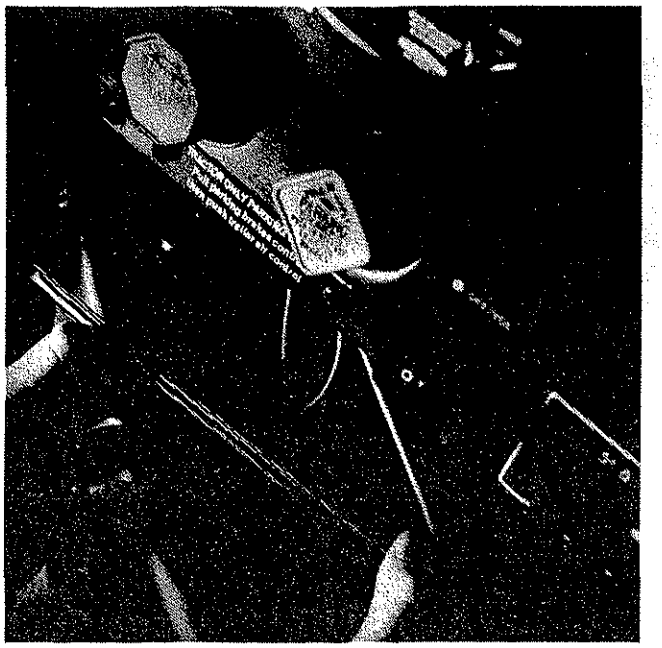


Fig. 7, Control Panel Removal

manifold on the washer control valve. Mark the lines for later reference.

4. On the wiper control valve, turn the knob counterclockwise, to the off position. Start the engine, and build up the air pressure to at least 80 psi (551 kPa).

5. Turn the wiper control valve knob clockwise a minimum of one-quarter turn. Air should flow from the "OUT" port only.

   If air does not flow from the "OUT" port, or flows from both the "OUT" and the "PARK" ports, replace the control valve.

6. Check the wiper park operation as follows:

   A. On two-valve systems, turn the wiper or wiper/washer control valve knob to the counterclockwise position, making sure the detent in the switch is felt as it moves to the full off position. Turn the knob to the extreme counterclockwise position, and hold. Air should flow from both the "OUT" and "PARK" ports. If not, replace the valve.

   B. On three-valve systems, turn the wiper control valve knob to the extreme counterclockwise position, then turn the knob clockwise one-eighth turn only (the park position). Air should flow from both the "OUT" and "PARK" ports. If not, replace the valve.

7. As previously referenced, connect the air lines to their respective ports on the end of the valve body. Insert the squared end of the tubing in the fitting; it must bottom in the body of the fitting. Tighten the fitting nut finger-tight. Using two wrenches, further tighten the nut a minimum of two turns, or until no threads show on the fitting body.

8. Place the control panel in the dash, and install the screws. If applicable, install the knobs on the lever slide controls.

9. Remove the chocks from the tires.

WIPER, WIPER/WASHER, OR WASHER CONTROL VALVE REPLACEMENT (Refer to Fig. 4 or 5)

1. Chock the tires and drain the air system.

2. Loosen the setscrews in the side of the control valve knob. Remove the knob.

3. Remove the retaining nut and, if applicable, washer from the front of the control panel.

4. Remove the control panel screws; on Advanced Interior Systems and later models, also remove the knobs from the lever slide controls. Lift the panel to a serviceable level. See Fig. 7.

5. If replacing a wiper control valve (two- or three-valve system), proceed as follows:

   .1 Using two wrenches, to prevent twisting of the tubing, disconnect the air lines from the male couplings at the back of the valve. Mark the lines for later reference.

   .2 Remove the wiper control valve from the back of the dash. Remove the male couplings from the valve ports.

   .3 Coat the threads on the male couplings with Loctite® 242, or an equivalent sealant. Install the couplings in the valve ports of the new wiper control valve.

   .4 As previously referenced, connect the air lines to the ports on the end of the valve body. Insert the squared end of the tubing in the fitting—it must bottom in the body of the fitting. Tighten the nut finger-tight. Using two wrenches, further tighten the nut a minimum of two turns, or until no threads show on the fitting body.

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

6. If replacing a wiper/washer control valve in a two-valve system, proceed as follows:

   .1 Disconnect the hose that runs from the wiper/washer control valve to the washer reservoir regulating valve.

   .2 Using two wrenches, to prevent twisting of the tubing, disconnect the air lines from the male couplings at the back of the valve. Mark the lines for later reference.

   .3 Remove the wiper/washer control valve from the back of the control panel. Remove the male couplings from the valve ports.

   .4 Coat the threads on the male couplings with Loctite® 242, or an equivalent sealant. Install the couplings in the valve ports of the new wiper/washer control valve.

   .5 As previously referenced, connect the air lines to the ports on the end of the valve body. Insert the squared end of the tubing in the fitting—it must bottom in the body of the fitting. Tighten the nut finger-tight. Using two wrenches, further tighten the nut a minimum of two turns, or until no threads show on the fitting body.

   .6 Connect the hose that runs from the washer reservoir regulating valve to the wiper/washer control valve.

7. If replacing a washer control valve in a three-valve system, proceed as follows:

   .1 Disconnect the hose that runs from the washer control valve to the washer reservoir regulating valve.

   .2 Using two wrenches, hold the air manifold in place, and turn the washer control valve until it is backed out of the air manifold. Remove the control valve from the back of the dash.

   .3 Coat the threads on the air manifold with Loctite® 242, or an equivalent sealant, and install the new washer control valve on the air manifold.

   .4 Connect the hose that runs from the washer control valve to the washer reservoir regulating valve.

8. Insert the control valve cover cap through the back of the dash. On the control valve cover cap protruding through the dash, install the retaining nut and, if applicable, washer. Tighten the retaining nut.

9. Install the control valve knob onto the control valve stem, and tighten the setscrew.

10. Start the engine and build the air pressure to at least 80 psi (551 kPa). Check for air leaks, then activate the appropriate control valve, and check the operation of the wiper or washer. Turn the control valve knob off.

11. Install the control panel. If applicable, also install the knobs on the lever slide controls.

INTERMITTENT WIPER CONTROL REPLACEMENT

IMPORTANT: Before replacing the control unit, be sure that fault does not lie in the fuse, found along the red (power) wire going to the back of the control unit. Replace the fuse with a new 1-amp fuse, if necessary.

1. Make sure the ignition is off.

2. Loosen the setscrews in the side of the control knob. Remove the knob.

3. Remove the retaining nut from the front of the control panel.

4. Remove the control panel screws; also remove the knobs from the lever slide controls. Lift the panel to a serviceable level.

5. For later reference, mark the electric wires of the wiper control. Disconnect the wires and remove the control.

6. Install the new intermittent wiper control using the instructions above, in reverse order.

WINDSHIELD WIPER MOTOR REMOVAL

1. Chock the tires and drain the air system.

WARNING: When draining the air system, or allowing air to exhaust from a loosened or disconnected air line, do not look into the air jets or direct them toward another person, as dirt or sludge may be present in the airstream. Hoses which contain pressurized air should be disconnected with extreme care, as they may whip as air escapes. Failure to take all necessary precautions during this operation can result in personal injury.

2. On COEs, gain access to the left (driver's) side wiper motor by removing the upholstery, as necessary, to expose the wiper motor. Refer to Fig. 2 for the location of the motor.

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

3. On two-valve system COEs, gain access to the right (passenger's) side wiper motor as follows:
   .1 Remove the section E panel, located under the glove box. See Fig. 8.
   .2 Disconnect the blower motor transition duct by removing the attaching screws. Lift out the duct.
   .3 Remove the machine screw holding the right-side blower motor in place. See Fig. 9.
   .4 Turn the blower motor assembly counterclockwise and lift out the motor. See Fig. 10.
4. On three-valve system COEs, gain access to the right (passenger's) side wiper motor by removing the upholstery, as necessary, to expose the wiper motor. Refer to Fig. 2 for the location of the motor.
5. On Conventionals, gain access to the wiper motors by tilting the hood; the motors are mounted on the exterior of the firewall. Refer to Fig. 3.
6. Disconnect the wiper arm from the wiper motor transmission shaft as follows:
   .1 On COEs, from outside the vehicle, disconnect the washer hose from the thru-skin connector. Remove the acorn nut, wiper arm, and serrated arm driver. See Fig. 11.
   .2 On Conventionals, pry the linkage arm socket from the drive bar ball *or,* on earlier models, remove the clip and pull the linkage arm off of the drive bar pin. See Fig. 12.

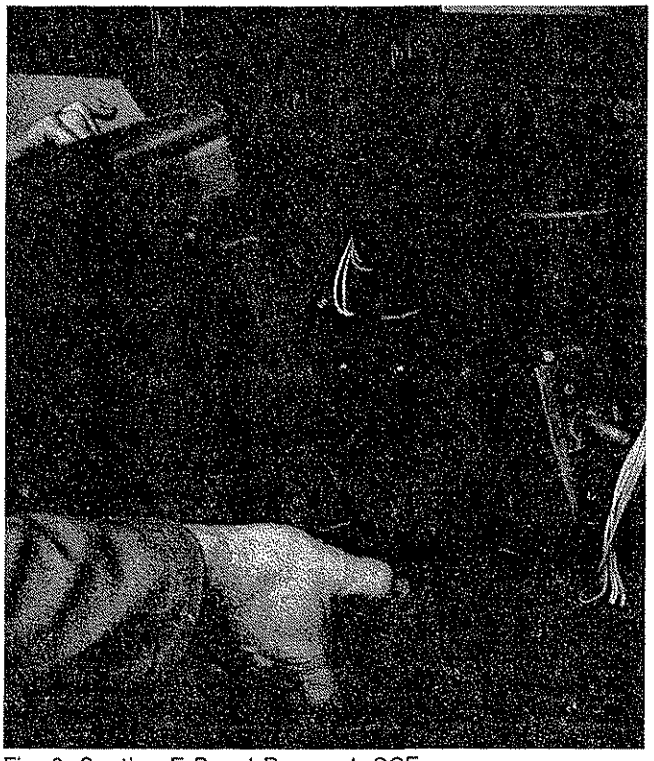


Fig. 8, Section E Panel Removal, COE

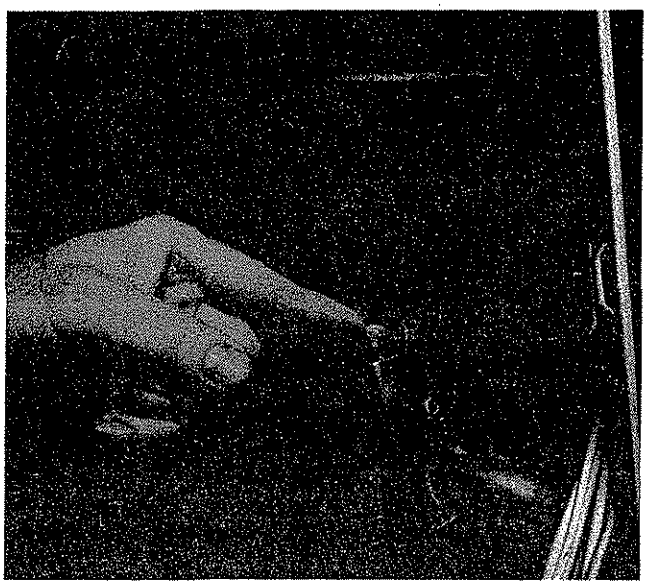


Fig. 9, Blower Motor Machine Screw Removal

Fig. 10, Blower Motor Removal

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

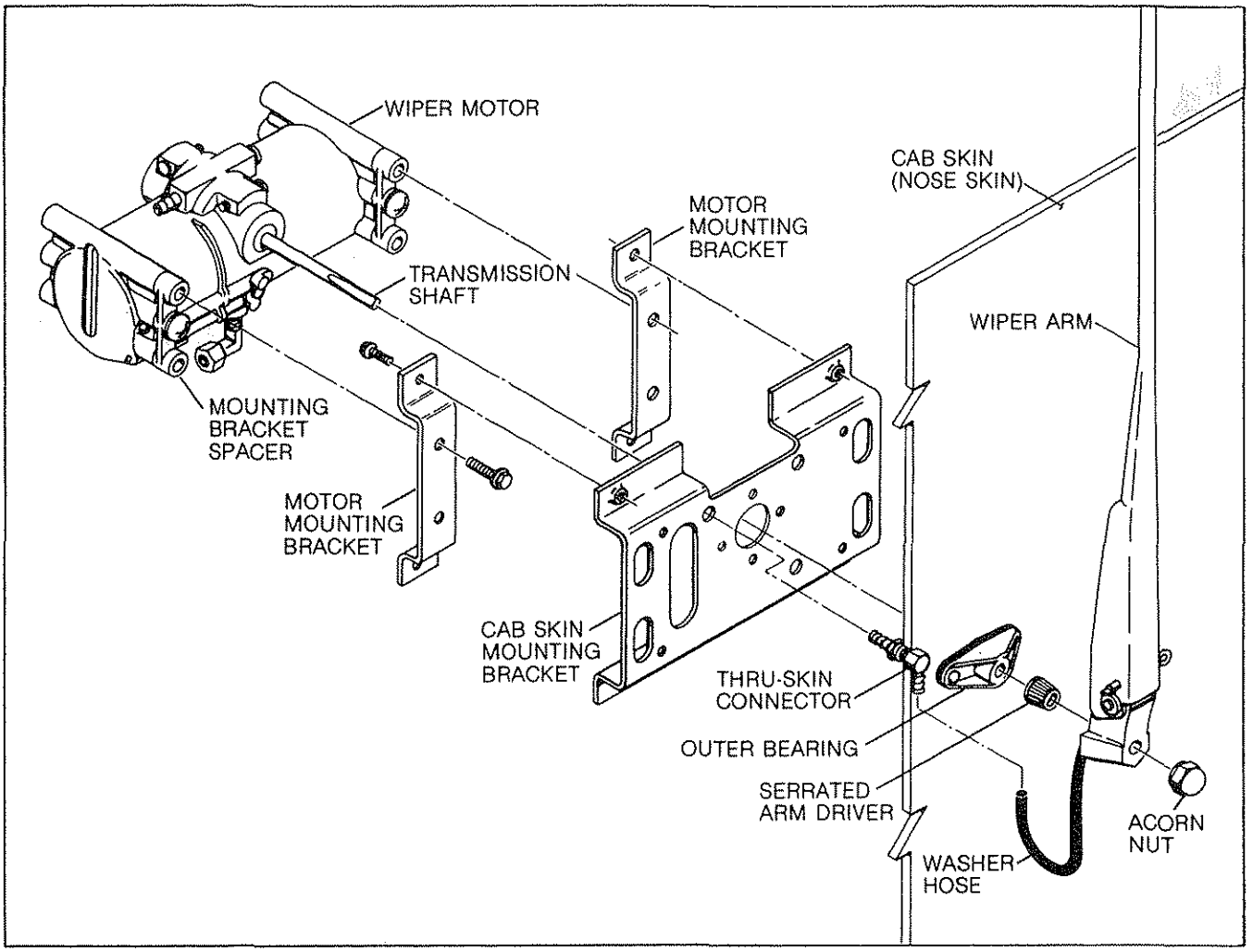


Fig. 11, Wiper Motor and Wiper Arm Attachment, COE

7. For later reference, mark and disconnect the air lines running to the wiper motor ports marked "IN" and "PARK." See Fig. 6. Also, on COEs, disconnect the hose to the exhaust port.

NOTE: If replacing the wiper motor or the motor valve, remove the elbows from the "IN" and "PARK" ports of the old motor valve, and save for later use.

8. Remove the wiper motor mounting bracket from the noseskin or firewall, and detach the wiper motor from the mounting bracket. Refer to Fig. 11 for COEs or to Fig. 12 for Conventionals.

WINDSHIELD WIPER MOTOR DISASSEMBLY

1. Remove the wiper motor from the vehicle.
2. For later reference, note the relative positions of the wiper motor transmission shaft and the motor valve. Reversing (end-for-end) the positions of either of these components with respect to the other will reverse the wiper blade's park and upright positions on the windshield.
3. Remove the two screws and the bolt and nut that hold the wiper motor housing halves together.
4. Stand the motor on end, and lift off the upper half of the motor housing. Lift out the motor valve, the transmission shaft and sector gear assembly, and the piston-rack assembly. Remove and save the four small O-rings found in the air passages of the motor housing halves, or on the motor valve body

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

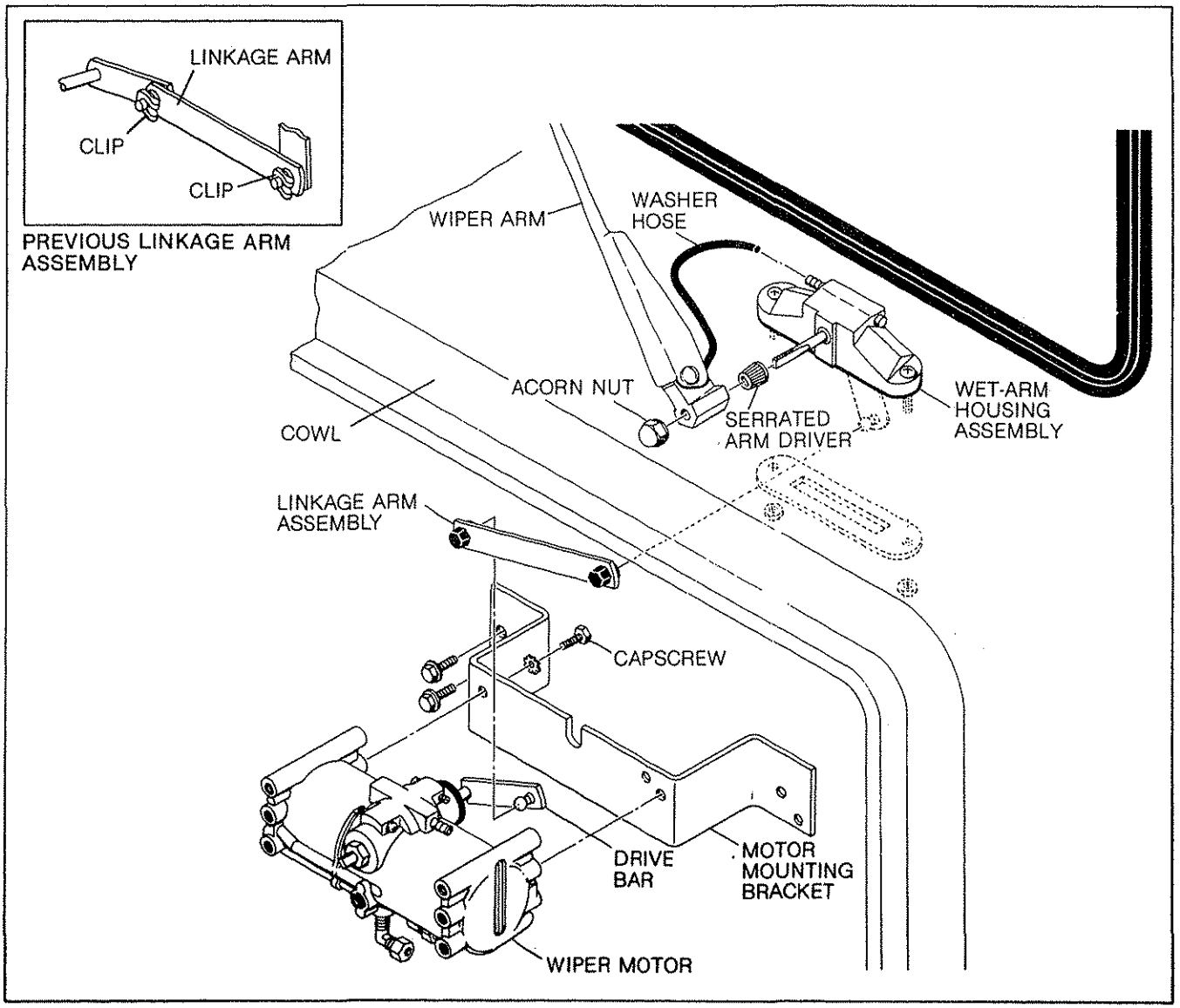


Fig. 12, Wiper Motor and Wiper Arm Attachment, Conventional

at the main surfaces of the motor valve body and the air passages in the motor housing halves. See Fig. 13.

5. Using a small screwdriver, or similar tool, pry the retaining ring from the dead-end plug of the motor valve. Refer to Fig. 14.
6. Remove the brass end plug.
7. Using the eraser end of a pencil, press the dead-end plug out of the motor valve body. This will force out the park piston and valve rod.

INSPECTING AND LUBRICATING

1. Remove and disassemble the windshield wiper motor and motor valve.
2. Check all of the components of the wiper motor and motor valve for dirt, oil, and other contaminants. The presence of contaminants is usually an indication that the vehicle's air compressor requires servicing, or that other air system components require maintenance. Refer to the 01 and 12 Groups of the Freightliner Maintenance and Lube Manual and this

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

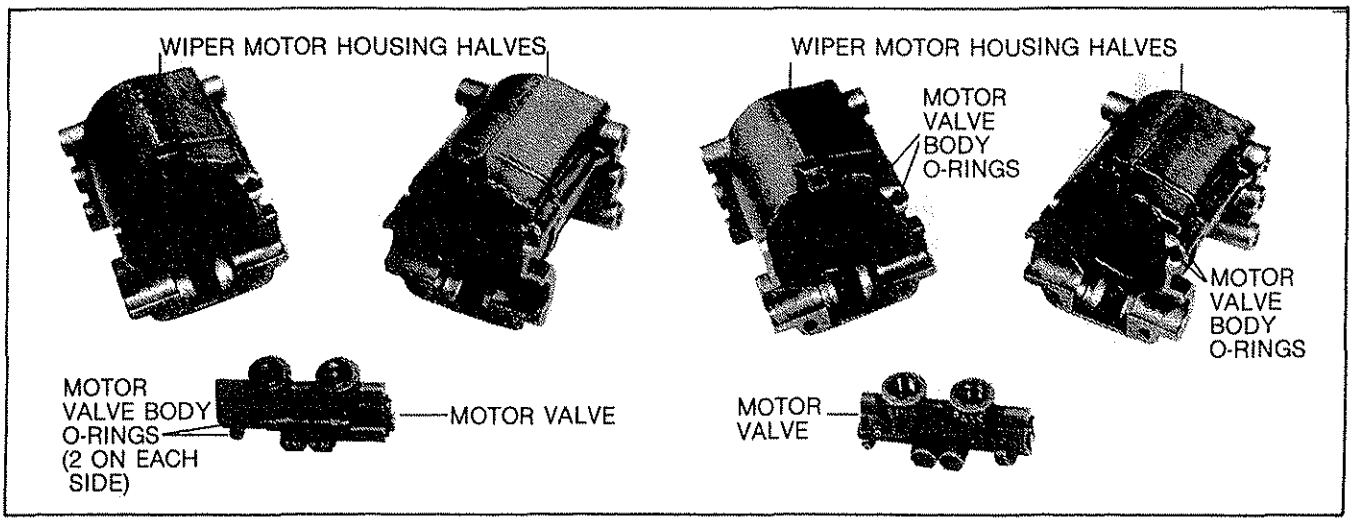
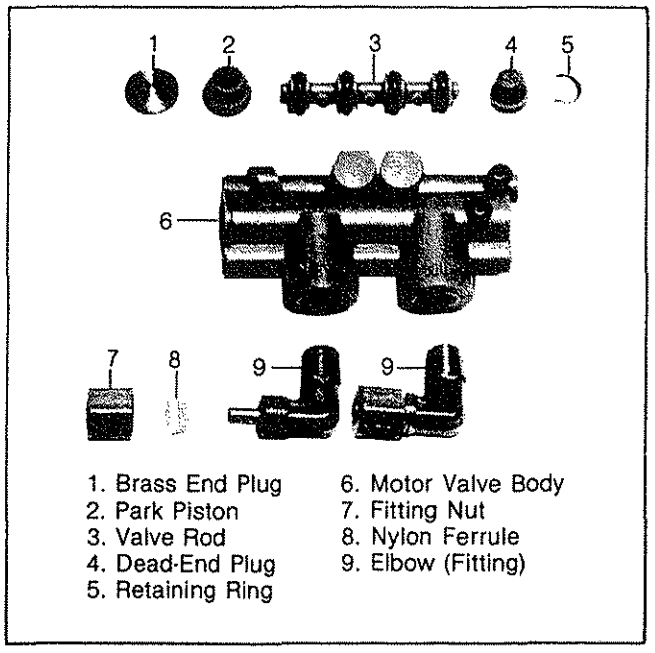


Fig. 13



1. Brass End Plug
2. Park Piston
3. Valve Rod
4. Dead-End Plug
5. Retaining Ring
6. Motor Valve Body
7. Fitting Nut
8. Nylon Ferrule
9. Elbow (Fitting)

Fig. 14, Motor Valve Components

manual, or to the applicable air compressor manufacturer's maintenance manual.

NOTE: Installing an air dryer or moisture ejection valve in the vehicle's air system reduces the possibility of wiper motor contamination.

3. Using a clean cloth, wipe clean all of the components of the wiper motor and motor valve. With compressed air, blow out the passages in the motor housing halves and motor valve body.
4. Check the O-rings on the piston-rack assembly, valve rod, park piston, and dead-end plug for nicks, cracks, or swelling. Replace them, if damaged. Be careful not to nick the new O-rings when slipping them over the walls of the O-ring grooves.
5. Lubricate all of the O-rings, the rubber bumpers, the transmission shaft and sector gear assembly, and both sides of the piston-rack assembly. See Fig. 15. Use Sprague Air Push® grease, or an equivalent.
6. Insert the valve rod (refer to Fig. 14) into the motor valve body. Push the valve rod back and forth several times, using the eraser end of a pencil. Push the rod out of the motor valve body. Insert the park piston, and push it back and forth in the same manner. Push the park piston out.

   If either of the components is sticking, or requires more than a slight amount of force to move, replace the complete motor valve.

WINDSHIELD WIPER MOTOR ASSEMBLY

1. Insert the dead-end plug into the motor valve body. Refer to Fig. 14. Using the eraser end of a pencil, press the dead-end plug through the top of the motor valve body until the retaining ring groove is visible.
2. Using the pencil, hold the dead-end plug in place, and install the retaining ring.

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

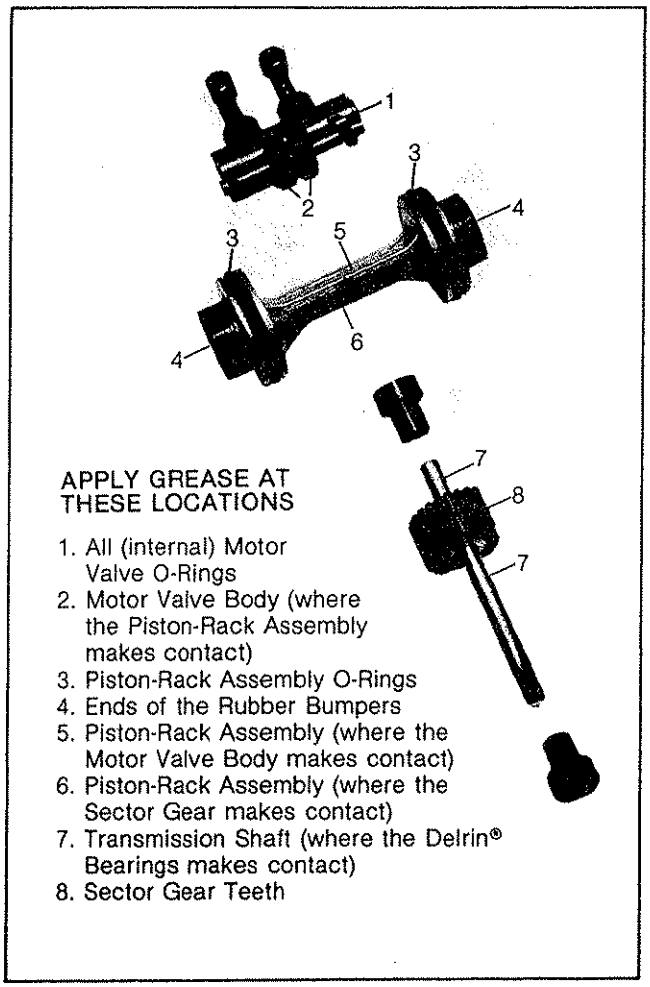


Fig. 15, Locations for Grease Application

3. Insert the valve rod into the motor valve body, and push it flush against the bottom of the dead-end plug.
4. Insert the park piston into the motor valve body. Install the brass end plug. Do not cross-thread the plug, and do not overtighten it.
5. Install the four small O-rings on the motor valve body (two on each side), or in the air passages at the mating surfaces of the motor housing halves. See Fig. 13.
6. Place one of the motor housing halves on end, and insert the piston-rack assembly, with the gear teeth of the rack facing away from the motor valve side of the housing.
7. Tilt the piston-rack assembly toward the motor valve side of the housing; place the transmission shaft and sector gear assembly into the housing.

NOTE: On COEs, the transmission shaft must extend out of the same side of the housing that has the plastic mounting bracket spacers attached to it. See Fig. 11.

Rotate the Delrin® bearing at each end of the transmission shaft until the flat side of the bearing fits against the flat part of the housing projection. See Fig. 16.

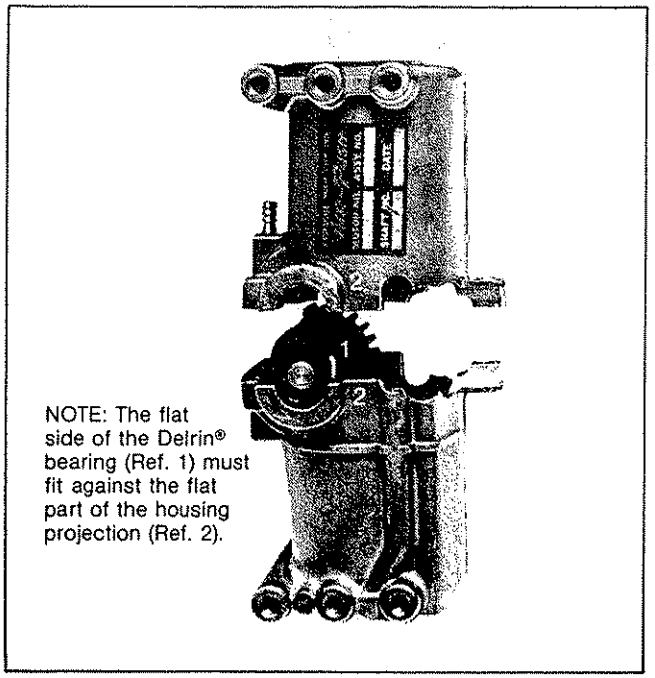


Fig. 16, Transmission Shaft and Sector Gear Assembly Installation

8. With the sector gear rotated out of the way, pull the piston-rack assembly up far enough to align the scribe mark on the side of the rack with the centerline of the transmission shaft. With the piston-rack assembly tilted away from the transmission shaft (for clearance), rotate the sector gear until the punch mark on the side of the gear aligns with the scribe mark on the side of the rack. See Fig. 17. Straighten the piston-rack assembly to a vertical position, meshing it with the sector gear.

IMPORTANT: If the Delrin® bearings are not seated correctly in the housing, or the piston-rack assembly and

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

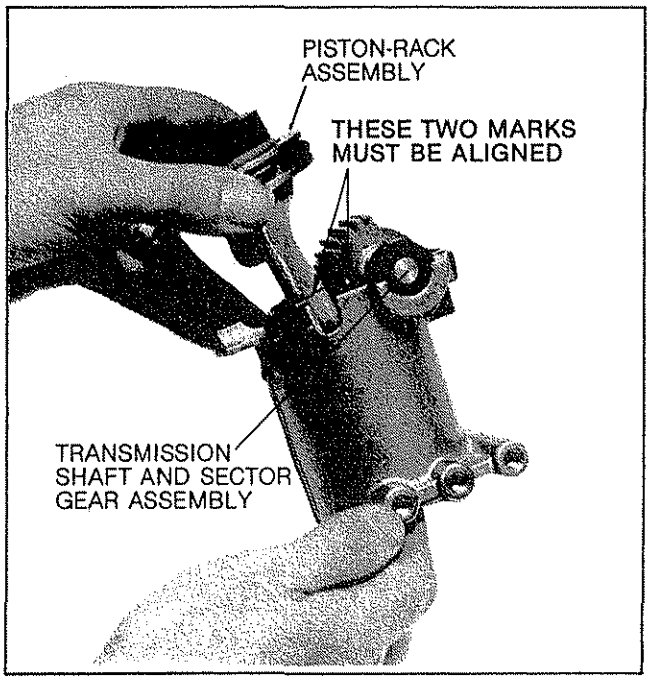


Fig. 17, Sector Gear and Rack Alignment

sector gear are not correctly meshed, the wiper motor will leak air, and will prevent the windshield wiper from making the proper sweep.

9. Hold the rack and the sector gear in mesh while installing the motor valve. Install the motor valve in the same position, relative to the transmission shaft, as referenced during disassembly.

NOTE: Make sure the motor valve body O-rings are still in place. See Fig. 13.

10. Place the other half of the motor housing over the top of the assembly. Push the housing halves together.

11. Install the two screws, and the bolt and nut that hold the motor housing halves together.

WINDSHIELD WIPER MOTOR INSTALLATION

1. On COEs, attach the wiper motor to the brackets. See Fig. 11. On Conventionals, insert the transmission shaft of the wiper motor through its opening in the wiper motor mounting bracket, and install the capscrews and washers. See Fig. 12. Tighten the capscrews 60 to 84 lbf·in (678 to 949 N·cm).

2. With the machine screws, attach the wiper motor and mounting bracket to the noseskin or firewall.

3. If a new motor or motor valve is being installed, install the elbows in the "IN" and "PARK" ports, and tighten them 25 to 40 lbf·in (280 to 450 N·cm).

4. Connect the hose to the exhaust port on COEs. Connect the air lines, as previously referenced, to the ports on the end of the valve body. Insert the squared end of the tubing in the fitting, making sure it bottoms. Tighten the fitting finger-tight. Using two wrenches, further tighten the nut a minimum of two turns, or until no threads show on the fitting body.

5. Start the engine and let the air compressor run until air pressure builds to at least 80 psi (551 kPa). Check the wiper motor and air line connections for air leaks (the wiper control valve must be on).

6. Turn the appropriate wiper control valve knob counterclockwise to the park position.

7. Connect the wiper arm to the transmission shaft, as follows:

   .1 On COEs, install the serrated arm driver on the transmission shaft. Position the end of the wiper arm over the serrated arm driver so that the angle of the wiper blade being installed is the same as the angle of the installed wiper blade. (The serrated arm driver allows adjustment of the wiper blade angle in 5° increments.) Install the acorn nut. See Fig. 11.

   While holding the wiper arm, torque the acorn nut as follows: for COEs, 90 lbf·in (1017 N·cm); for Conventionals, 45 to 60 lbf·in (508 to 678 N·cm). Hold the acorn nut at this torque for several seconds to allow the parts to seat. Check the operation by manually moving the arm through several full cycles. Connect the windshield washer hose to the thru-skin connector.

   Install both wiper blades, if removed. Retorque the acorn nut as follows: for COEs, 90 lbf·in (1017 N·cm); for Conventionals, 45 to 60 lbf·in (508 to 678 N·cm). The wiper's sweep can be adjusted by changing the position of the wiper arm on the serrated arm driver.

   .2 On Conventionals, install the linkage arm socket on the drive bar ball or, on earlier models, insert the drive bar pin through the linkage arm hole, and secure with a clip. See Fig. 12.

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8. On two-valve system COEs:
   .1 Install the blower motor by inserting the bottom flange in the heater air conditioner housing and turning clockwise. Install the machine screw.
   .2 Wrap the duct boot around the transition duct junction; install the attaching screws.
   .3 Install the section E panel.
9. On COEs, install any upholstery that was removed from under the dash.
10. On Conventionals, return the hood to the operating position.
11. Remove the chocks from the tires.

TROUBLESHOOTING

PRELIMINARY CHECKS

Before attempting to isolate the cause(s) of a wiper/washer system problem, make the following checks:

1. Check the operation of the windshield wiper motors and the washer, to determine the parts of the system that do not have to be checked.
2. If no parts of the system are operating:
   .1 Check that the air compressor is operating; repair, if needed.
   .2 Check for air leaks, breaks, kinks, or plugging at all of the air lines from the constant-air cab junction block to the air manifold at the washer control valve or to the wiper/washer control valve. Tighten, clean, or replace the air lines, as needed.
3. If the washer system (only) does not operate:
   .1 Check the level of fluid in the washer reservoir; fill, if needed.
   .2 Check for a plugged filter screen at the bottom of the washer diaphragm, located inside the washer reservoir. Clean, as needed.
   .3 If temperatures are below freezing, check the washer fluid with an antifreeze hydrometer. If the wrong concentration of winter washer fluid is being used, change the concentration, store the vehicle in a heated area (or thaw the frozen components with a defroster gun or hair dryer), then operate the washers to purge the washer system.
   .4 Check all of the air lines from the washer control valve to the washer nozzles for leaks, breaks, kinks, or plugging. Tighten, clean, or replace the air lines, as needed.
   .5 Check the nozzles for clogging. If they are clogged, clean them with compressed air, or replace them if they cannot be cleaned.
4. If the wiper motor will not start, or does not function properly:
   .1 See if the wiper blade is stuck to the windshield. If it is, wet the glass liberally, and carefully pull the wiper away from the glass.
   .2 Check for leaks, breaks, kinks, or plugging at all of the air lines from the air manifold from the washer control valve to the wiper motor. Tighten, clean, or replace the lines, as needed.
5. If equipped with an intermittent (delay) wiper control that will not work:
   .1 Make sure the wiper control valve is fully on.
   .2 Make sure the intermittent wiper control is on at least one-quarter of a turn.
   .3 Check for a blown fuse along the red (power) wire running to the control unit. If needed, replace the fuse with a new 1-amp fuse.

If the above preliminary checks have not solved the problem, perform the maintenance operations in the 22 Group of the Freightliner Maintenance and Lube Manual. If the problem persists, refer to the applicable heading below.

WASHER SYSTEM DOES NOT OPERATE

1. Check the air pressure at the outlet of the washer control valve. If the pressure is below 35 psi (241 kPa), check the valve inlet for clogging, and clean as needed. If the inlet is not clogged, replace the valve.
2. Check the diaphragm in the washer reservoir for damage, and replace it, if necessary.
3. Check the operation of the washer reservoir regulating valve. If the valve is stuck open, remove, clean, and lubricate it, or replace it.

WIPER MOTOR WILL NOT START

1. Check the function of the wiper control valve. For instructions, refer to "WIPER CONTROL VALVE CHECKING."

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

2. Check for clogged air passages in the wiper motor housing halves and the motor valve body. For instructions, refer to "INSPECTING AND LUBRICATING."
3. Check for contamination which may have caused the O-rings on the piston-rack assembly, valve rod, or park piston to swell, thereby restricting their movement. For instructions, refer to "INSPECTING AND LUBRICATING."
4. Check the O-rings on the piston-rack assembly, valve rod, and park piston for lack of lubrication. For instructions, refer to "INSPECTING AND LUBRICATING."
5. Check the valve rod for warpage. For instructions, refer to "INSPECTING AND LUBRICATING."

WIPER MOTOR OPERATES AT LESS THAN FULL POWER

1. Check for air leakage between the wiper motor housing halves. If the housing halves do not fit together tightly, disassemble and assemble the wiper motor, following the applicable procedures in this subject.
2. Disassemble the wiper motor and examine the large O-rings on the piston-rack assembly for wear or flat spots. Replace the O-rings, as needed. Examine the insides of the motor housing halves for scored walls, which may be allowing air to bypass the O-rings. Replace the motor housing halves, if needed.
3. Disassemble the wiper motor and motor valve, and check the valve rod for worn O-rings, allowing air to bypass them. Replace the O-rings, as needed.

WIPER MOTOR OPERATES ERRATICALLY

1. Disassemble the wiper motor and see if the O-rings fit too tightly in the main cylinder bores (motor housing halves). For instructions, refer to "INSPECTING AND LUBRICATING."
2. Disassemble the wiper motor and motor valve, and see if the O-rings fit too tightly in the motor valve, or if the valve rod is warped. For instructions, refer to "INSPECTING AND LUBRICATING."

WIPER ARM DOES NOT MAKE A FULL SWEEP

1. Be sure the windshield wiper blade and arm assembly is positioned correctly on the windshield. If not, remove the blade and arm assembly, and position it on the serrated arm driver so the wiper's sweep area is centered on the windshield. The serrated arm driver allows adjustment of the wiper blade angle in 5° increments.
2. Disassemble the wiper motor and examine the large O-rings on the piston-rack assembly for wear or flat spots. Replace the O-rings as needed. Also, examine the insides of the motor housing halves for scored walls, which may be allowing air to bypass the O-rings. Replace the motor housing halves, if needed.

WIPER MOTOR DOES NOT RETURN TO THE PARK POSITION

1. Check the operation of the wiper control valve. For instructions, refer to "WIPER CONTROL VALVE CHECKING."
2. Check for warpage of the motor valve rod, or for swelling of the motor valve O-rings. For instructions, refer to "MOTOR VALVE CHECKING."

INTERMITTENT WIPER CONTROL DOES NOT OPERATE

1. Check the electrical connections to the control unit and to each solenoid. Clean any corroded terminals. Make sure the unit has a power source. Spray a protective electrical coating over terminals to protect them from corrosion.
2. Check all air lines to and from the solenoids. Refer to Fig. 18 under "SPECIFICATIONS" for plumbing guidelines. If the air lines are not at fault, replace the solenoid.

SPRAGUE AIR PUSH® II WIPER/WASHER SYSTEM

SPECIFICATIONS

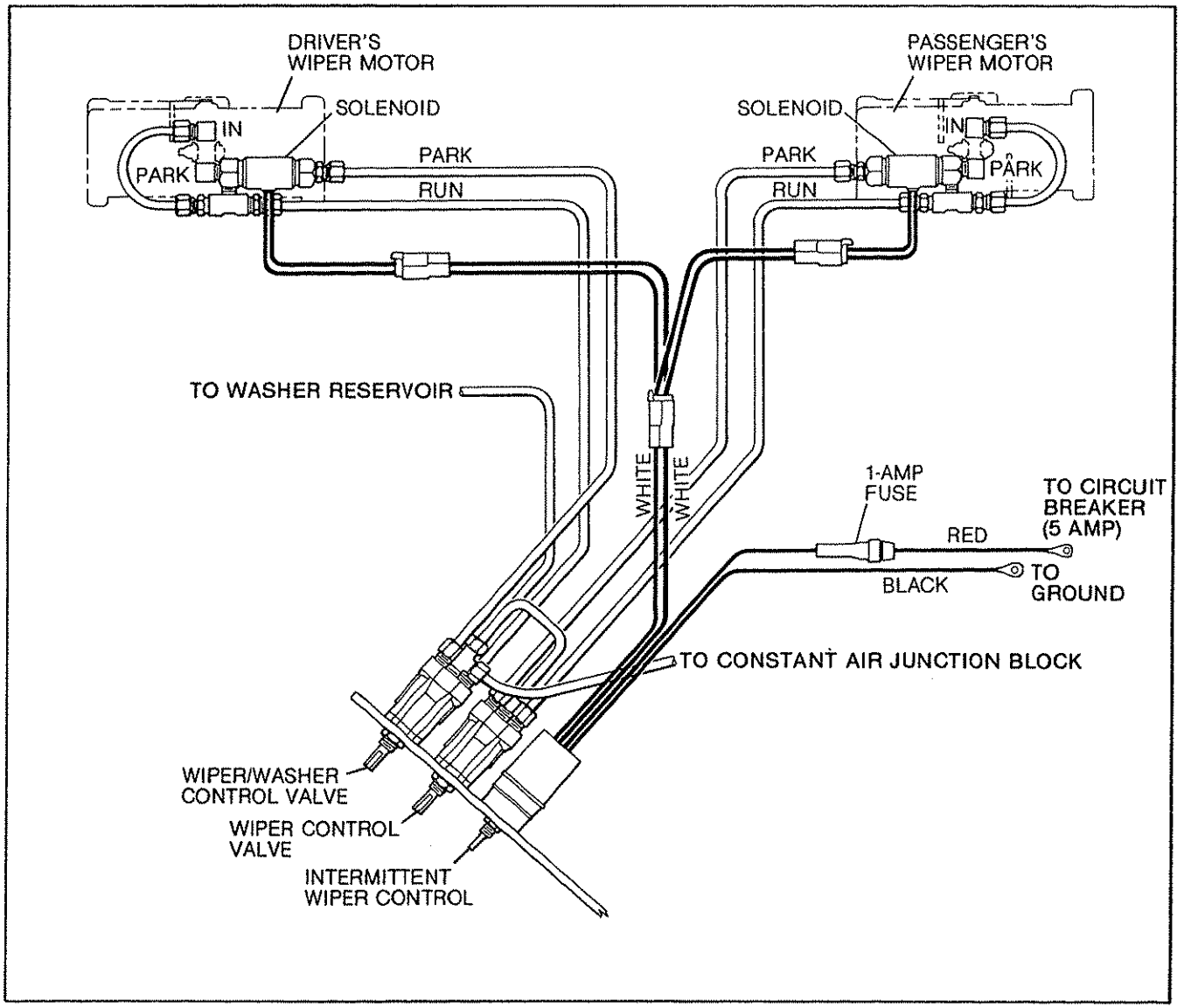


Fig. 18

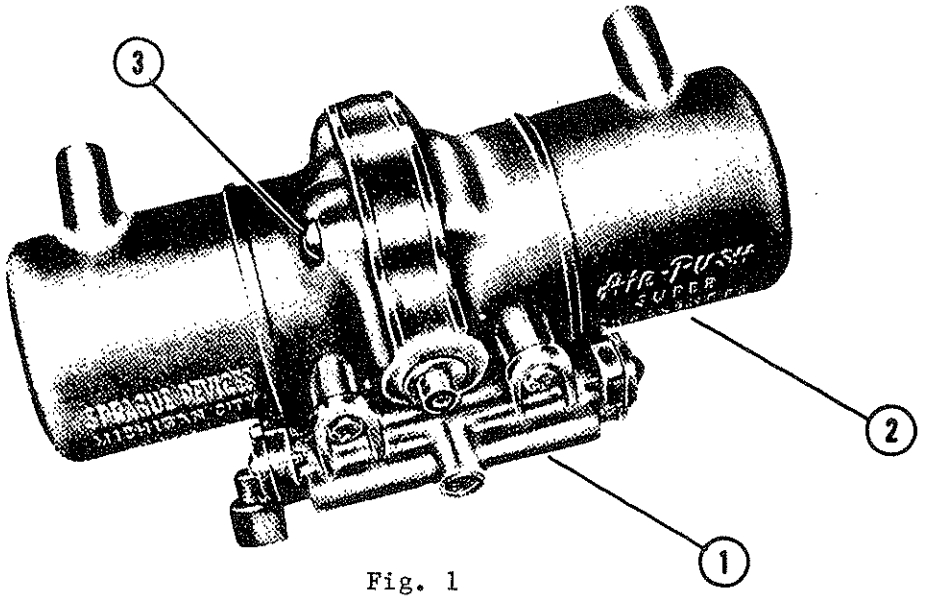


Fig. 1

GENERAL DISCUSSION

The Super Challenger (M531) wiper motor is designed for extra heavy duty applications. It operates at full load with as low as 60 PSI air pressure.

WIPER MOTOR REMOVAL

1. Disconnect windshield wiper arm from shaft.
2. Remove outer shaft support bearing assembly.
3. Disconnect air lines from wiper motor.
4. Remove the four motor mounting bolts.

WIPER MOTOR DISASSEMBLY

1. Remove valve assembly from wiper body carefully so that body seals are intact. (Fig. 1, Ref. 1)
2. Place right half of body (the half with the threaded screw holes, (Fig. 1, Ref. 2) in vice in vertical position. Tighten vice just enough to hold assembly securely.
3. Remove the body joining screws. (Fig. 1, Ref. 3)
4. Holding transmission shaft in one hand, gently lift off upper body half.
5. Note position of gear and rack, then reference mark. Remove shaft and gear assembly. (Fig. 2, Ref. 1)

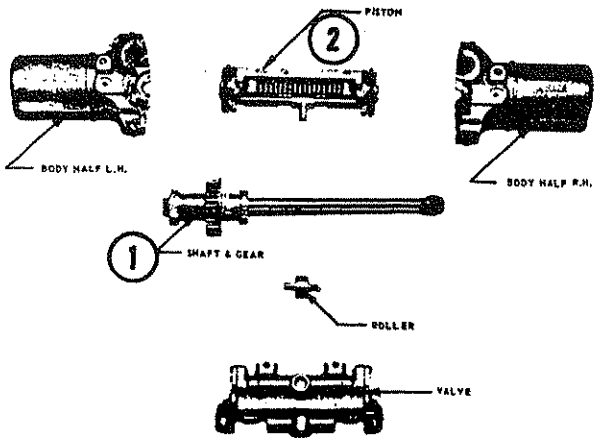


Fig. 2

6. Remove bearing block
7. Note position of valve reverser in body slot, (Fig. 3) then remove piston assembly. (Fig. 2, Ref. 2)

Sweep	Gap	Sweep	Gap
30°	.225 in.	90°	.990 in.
40°	.350 in.	100°	1.115 in.
50°	.475 in.	110°	1.171 in.
60°	.600 in.	120°	1.365 in.
70°	.750 in.	130°	1.505 in.
80°	.850 in.	140°	1.625 in.

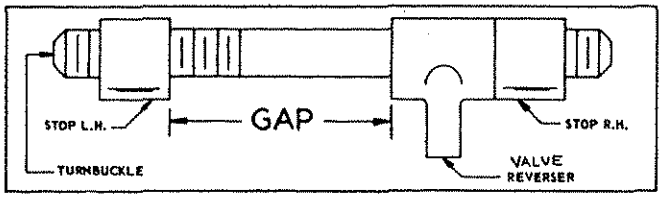


Fig. 3

WIPER MOTOR REPAIR

Any of the sub-assemblies may be replaced if desired. Usually however, the sub-assemblies can be placed in top working order by replacing all worn components individually. Use Sprague Air Push grease for all moving parts. The piston assembly (Fig. 2, Ref. 2) must be ordered in accordance with the particular sweep coverage required; see Fig. 3 for settings.

Air inlet fitting (or regulator valve No. GF 255) is set at the Sprague factory, and is not to be re-set in the field. If adjustments are needed, return to the factory for proper setting.

WIPER MOTOR ASSEMBLY

To assemble motor, reverse disassembly procedure.

WIPER MOTOR INSTALLATION

To install unit in truck, reverse removal steps. Test wiper after installation, preferably on wet glass. If test is made on dry glass, place strip of felt, plastic or masking tape (with back to glass) on the wiper blade, between the blade and the glass. This will simulate a wet glass condition. Open control valve so that motor operates at full speed. Wiper arms should not exceed 120 strokes per minute with control fully open. With wiper motor operating, check for air leaks and proper sweep range. (Fig. 3) Close control valve slowly; check to see that wiper arm speed decreases accordingly.

WINDSHIELD WIPER CONTROL VALVE

For part descriptions of the wiper control valve, refer to Table 1 & Fig. 4. Reconcile as required.

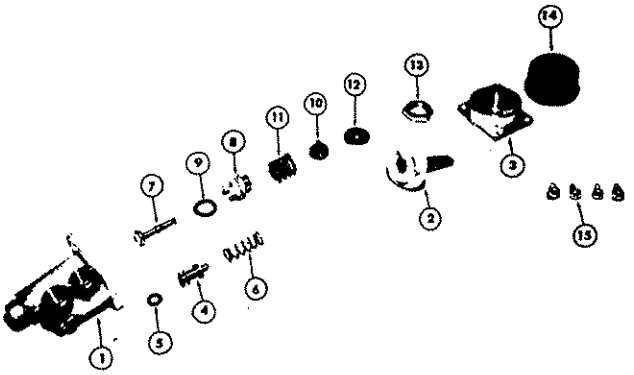


Fig. 4

Item	Req.	Part Name
1	1	Body Assembly
2	1	Cam Rod Assembly
3	1	Cover Cap Machined
4	1	Parking Valve Stem Ass'y.
5	1	"O" Ring
6	1	Coil Spring
7	1	Valve Seat Assembly
8	1	"O" Ring Retainer Ass'y.
9	1	"O" Ring
10	1	Pressure Regulating Ram
11	1	Coil Spring
12	1	Guide Washer
13	1	Hex Nut
14	1	Plastic Knob
15	4	Self Tap Screw
16	1	Coil Spring

Table 1

Control Valve Removal

1. Loosen set screw in knob.
2. Remove nut holding valve to dash.
3. Disconnect air lines at valve.

Control Valve Disassembly

1. Remove four screws holding cover cap, and lift cap from valve. Note position of cam, (Fig. 4, Ref. 2) and reference mark for reassembly in same position.

2. Slide cam rod assembly (Fig.4,Ref.2) out from cover cap. (Fig. 4, Ref. 3) Note position of spring in cap of control valve for later reassembly.

3. Lift out guide washer.(Fig. 4, Ref.12)

4. Lift out pressure regulating ram (Fig. 4, Ref. 10) and coil spring. (Fig. 4, Ref. 11)

5. Lift out parking valve stem assembly and coil spring. (Fig. 4,Refs. 4 & 6) Note that the rounded protrusion of the parking valve's stem assembly is positioned up, or, toward the knob end.

6. A drift or other small tool may be used to press the valve seat assembly (Fig. 4, Ref. 7) from the O-ring retainer assembly.(Fig. 4, Ref. 8) Care must be taken not to damage either of the parts. When assembling the valve section, the valve seat stem should be pressed flush with the retainer.

Control Valve Reassembly

Reassemble by reversing disassembly procedure. Cuation; do not over tighten pipe fittings.

DESCRIPTION AND OPERATION OF WINDSHIELD WASHING SYSTEM

The Freightliner air operated windshield washer model 14, (Sprague MW-10) is designed for heavy duty commercial operation. The main reservoir filler cap (Fig. 2, Ref. 1) has a rubber breathing and sealing disc to prevent leakage when the cab is tilted. Nozzles are secured to the nose skin with wing nuts on the inside. They are adjusted with a small screwdriver. The control valve (Fig. 1) is pressure regulated and permits either intermittent or steady washing at the driver's option. Lines to the nozzles are automatically purged before and after each washing cycle. This feature prevents freezing and clogging of lines and nozzles.

CONTROL VALVE REMOVAL

1. Remove unit from dash by loosening set screw and knob. (Fig. 1, Ref. 1)

2. Remove the nut securing the valve body to the dash (Fig. 1, Ref. 2)

3. Disconnect air lines from the valve. When removing hoses, avoid side pressure, as it could cause plastic connectors on valve to break.

CONTROL VALVE REPAIR

1. Remove control valve end plates. (Fig. 1, Refs. 3 & 4)

2. Inspect, and, clean or replace parts as required.

3. Lubricate the piston,(Fig. 1, Ref. 5) O-rings, (Fig. 1, Ref. 6) and cylinders, using Sprague Air Push grease (or equivalent) before assembling.

NOTE: The control valve has only one O-ring seal located under the air inlet fitting end plate. (Fig. 1, Ref. 7) Since the piston is fitted with O-rings, (Fig. 1, Ref. 6), there is no need for additional gaskets under the end plates.

CONTROL VALVE INSTALLATION

Install valve by reversing removal procedures.

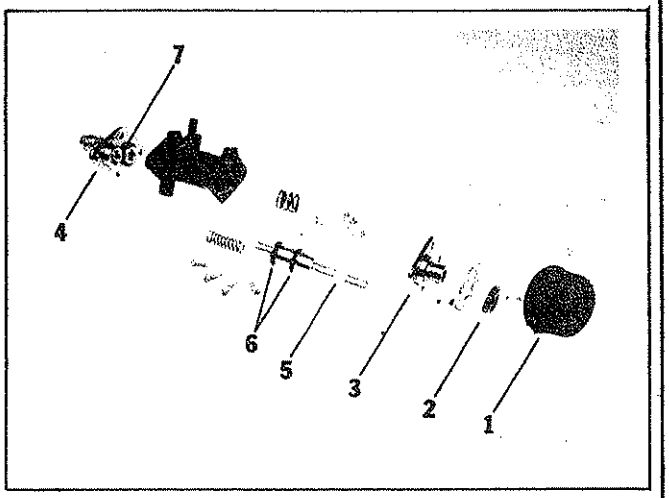


Fig. 1

RESERVOIR REGULATING VALVE REMOVAL

1. To remove regulating valve, disconnect air supply line and water discharge line. When removing hoses, care should be taken to avoid breaking plastic connectors on valve by the use of too much side pressure.

2. Remove screws that attach valve (Fig. 3, Ref. 1) to cap (Fig. 3,Ref.3)

RESERVOIR REGULATING VALVE DISASSEMBLY AND INSPECTION

1. Remove the two end plates,(Fig. 2, Refs. 2 & 3). Disassemble unit.

2. Inspect and clean all parts; replace any that are worn.

RESERVOIR REGULATING VALVE REASSEMBLY

1. Lubricate the piston, (Fig. 2, Ref. 4), O-rings (Fig. 2, Ref. 5), and cylinders using Sprague Air Push grease (or equivalent).

NOTE: Care should be taken to avoid damaging O-ring outer surfaces during valve assembly.

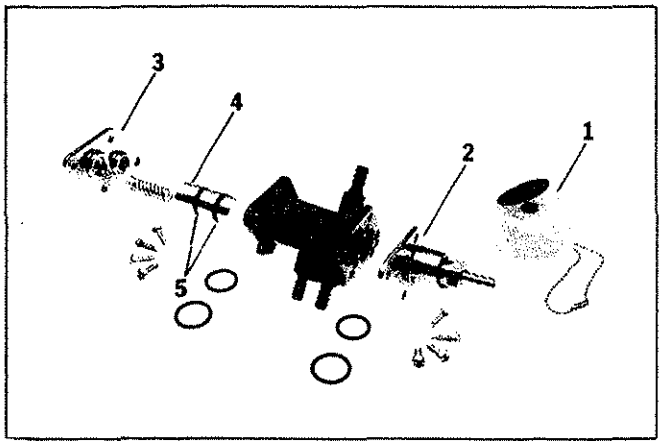


Fig. 2

RESERVOIR REGULATING VALVE INSTALLATION

To install regulating valve (Fig. 3, Ref. 1), reverse removal procedure. Gasket (Fig. 3, Ref. 2) between valve and reservoir cover (Fig. 3, Ref. 3) should be coated with sealing compound.

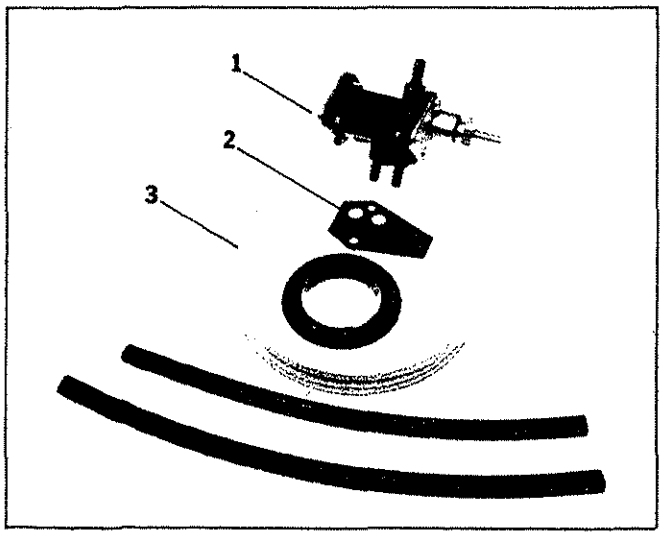


Fig. 3

PUMP DIAPHRAGM

Periodically check the screen at the diaphragm chamber inlet. (Fig. 4, Ref. 1) Clean or replace as necessary.

The pump diaphragm is a sealed unit, if failure occurs, replacement of the entire unit will be required.

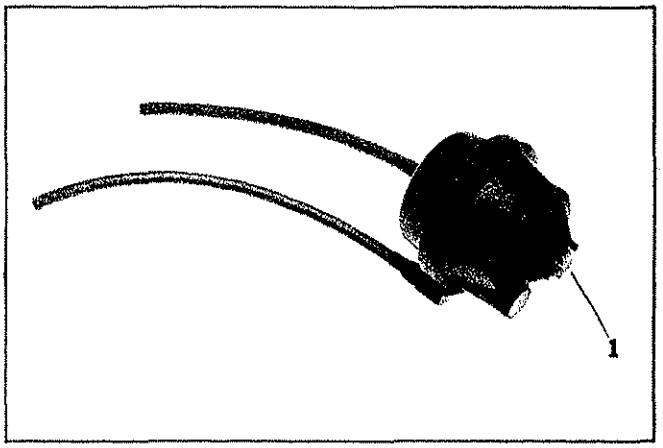


Fig. 4

SPECIFICATIONS & OPERATING CHARACTERISTICS

1. Capacity of diaphragm.....4.5 ozs.
2. Time to complete spray cycle...6.5 secs.
3. Time to complete purge cycle...3.0 secs.
4. Diaphragm refilling time.....6.0 secs.
5. Control valve air pressure regulated at.....30-50 PSI

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

GENERAL DESCRIPTION

The air-operated power window lift assembly consists of a dash-mounted air valve, an air tube mounted in the door, and 1/8-inch (3 mm) diameter nylon hoses. See Fig. 1. An air tube piston arm connects to the window glass channel, and moves up or down, as desired, when air pressure is supplied in the air tube. The air tube is equipped with an internal brake system to prevent the piston arm from lowering when air pressure is exhausted from the air tube.

PRINCIPLES OF OPERATION

Pressurized air is routed from the cab constant-air junction block to the dash-mounted air valve. When the air valve toggle switch (Fig. 2) is pushed up, air is routed to the lower end of the air tube, raising the piston arm

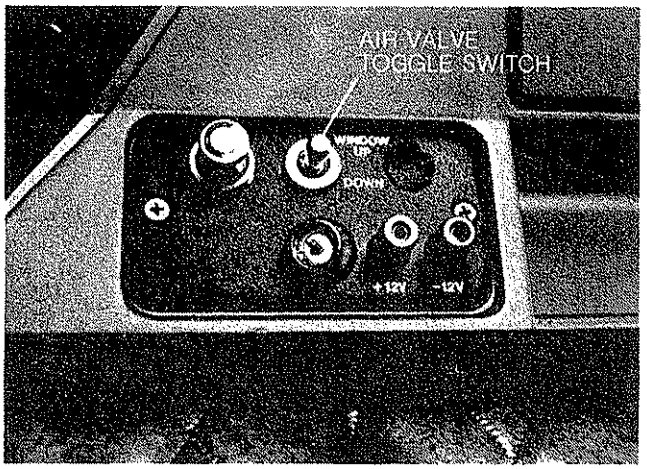


Fig. 2

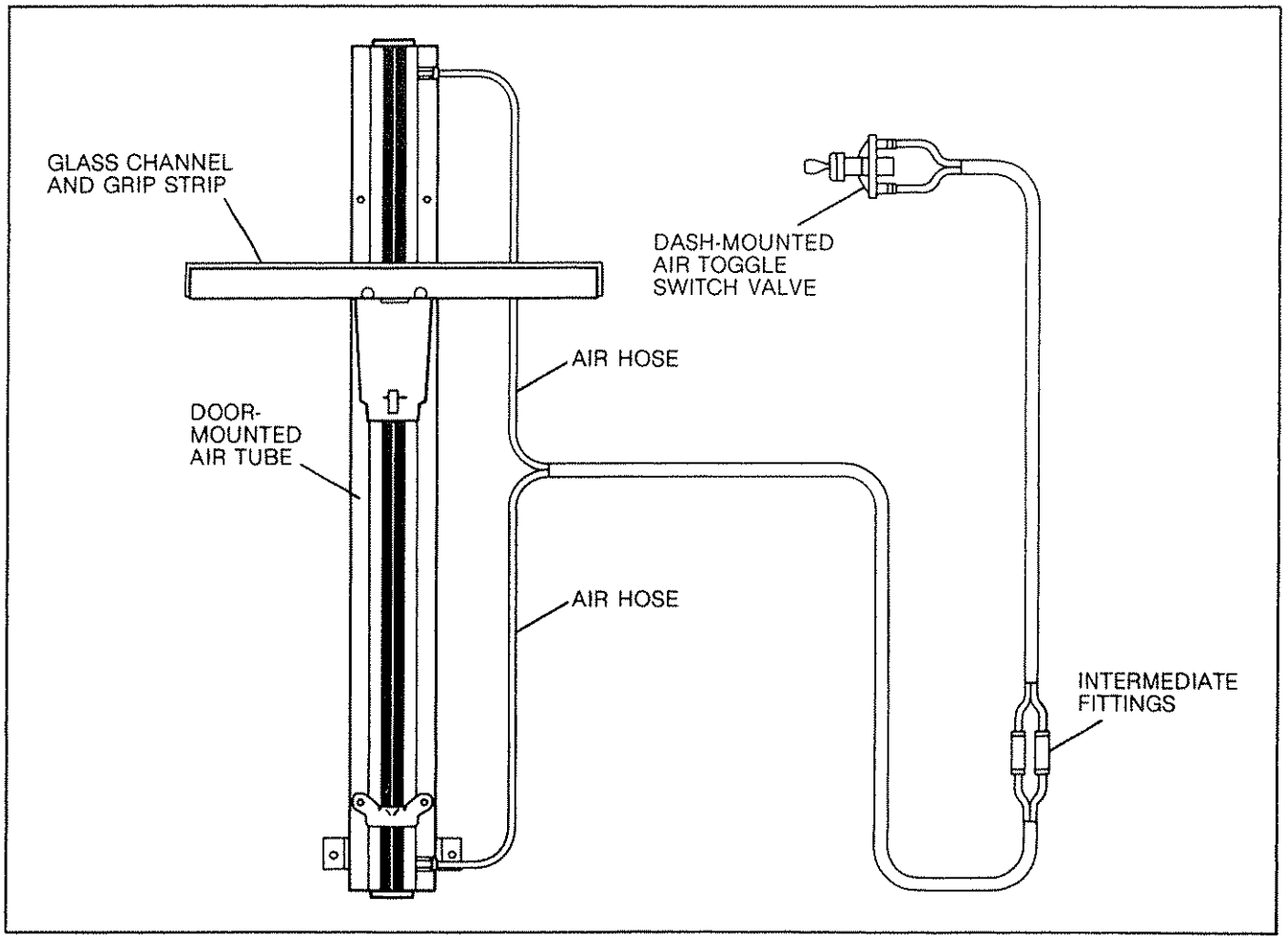


Fig. 1

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

and window glass. When the air valve toggle switch is pushed down, air is routed to the upper end of the air tube, releasing the brake system, and lowering the piston arm and window glass.

When the toggle switch is released, the air valve exhausts all air pressure from the window lift assembly, and the brake system within the air tube is applied.

NOTE: If the vehicle air pressure is depleted, the window glass can be manually raised by placing your hands on each side of the glass and pushing up. The piston arm can be lifted (without air pressure), but not lowered. Do not attempt to manually lower the window glass.

SERVICE OPERATIONS

AIR (TOGGLE SWITCH) VALVE REPLACEMENT
(Refer to Fig. 3)

1. Drain the air system.
2. Remove the machine screws attaching the accessory panel (see Fig. 2) to the dash, then lift off the accessory panel.
3. Remove the face nut from the air valve, and remove the air valve from the panel.
4. Disconnect the air supply hose and coupling from the air valve.
5. Disconnect the black and white air hoses from the air valve. Pull the plastic button (Fig. 3, Ref. A) tight against the fitting body, and while holding the button in, pull the hose out.
6. Attach the black air hose in the "up" port of the new air valve, and the white air hose in the "down" port of the air valve. Push the hoses in until resistance is felt, then push in approximately 3/16-inch (5 mm) more.

NOTE: The "up" port is indicated by the word "UP" and an arrow stamped on the air valve. See Fig. 3, Ref. B.

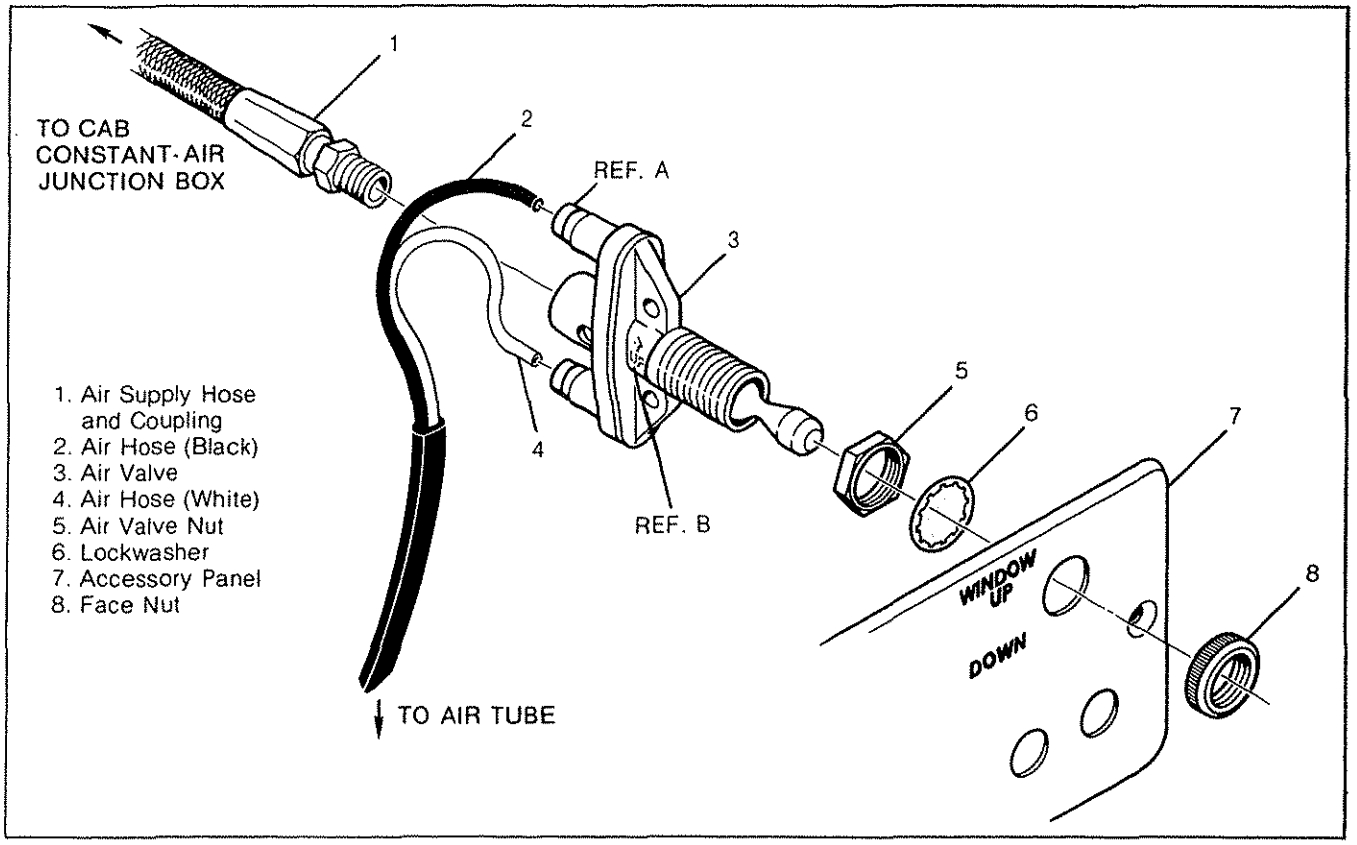


Fig. 3, Air Toggle Switch Valve

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

7. Remove the cap plugging the air supply hose fitting of the new air valve, and discard it. Apply sealant on the threads of the air supply hose coupling, and install the coupling in the air valve fitting. Tighten the coupling nut to 36 lbf·in (407 N·cm).
8. Remove the face nut from the new air valve, and install the air valve with the lockwasher and air valve nut on the inside of the panel. Attach the face nut on the valve, and hand tighten the nut onto the valve.
9. Tighten the air valve nut (after the face nut is hand tightened) to 78 lbf·in (881 N·cm).
10. Install the accessory panel in the dash, and attach with the machine screws.

WINDOW GLASS CHANNEL REPLACEMENT

Remove and install the window glass assembly, using the instructions given in the door subject in the 18 Group of this manual. Remove the glass channel and grip strip assembly from the glass, and attach the new one, as shown in Fig. 4. Before installing the assembly in the door, make sure the window glass is centered on the new glass channel and grip strip assembly. See Fig. 4.

AIR TUBE ASSEMBLY REPLACEMENT

WARNING: Use care when working around or handling glass. It is recommended that you wear protective gloves to eliminate the possibility of personal injury resulting from accidentally breaking or splintering the glass.

1. Apply the parking brakes, and chock the tires.
2. Hold the window air valve toggle switch down to lower the window glass. Open the door.
3. Using an Allen wrench, remove the three socket head capscrews, nuts, and washers that partially attach the outside mirror mounting bracket to the door. See Fig. 5. The capscrews are of varying lengths and should be marked for later assembly reference. If the three window sill spacer tubes and washers can be easily pushed out, they, too, should be referenced and removed.

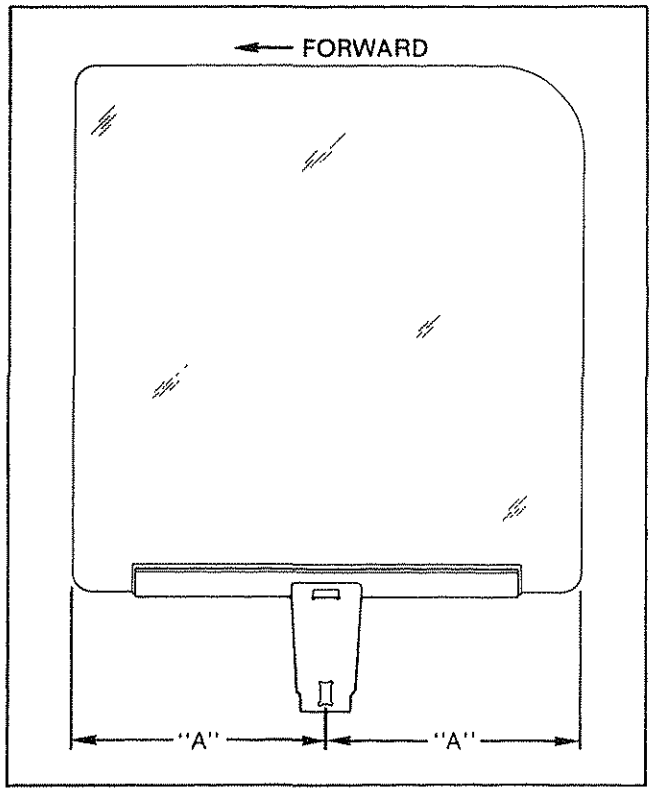


Fig. 4

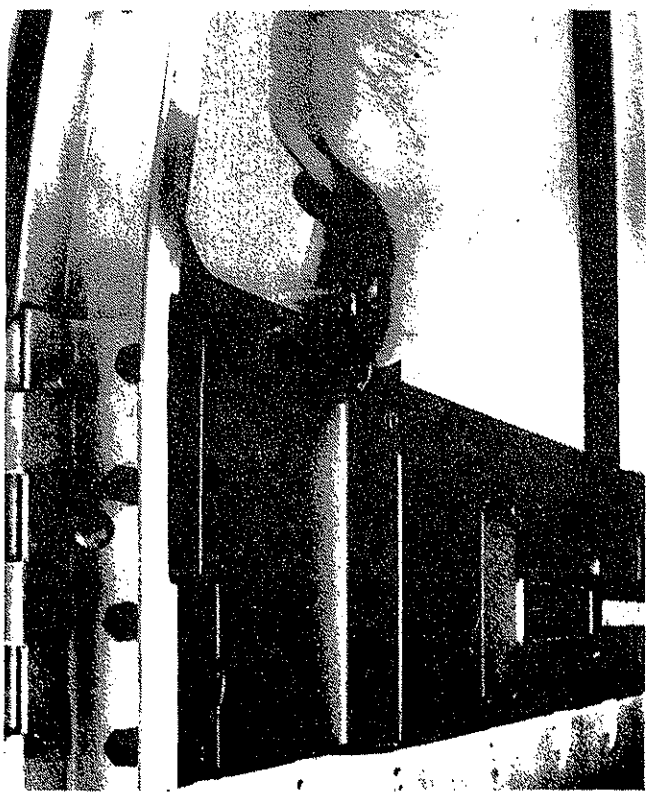


Fig. 5, Window Sill Capscrew Removal/Installation

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

4. Remove the screws that attach the inner panel to the window sill. See Fig. 6. On custom interior installations, it will first be necessary to remove the naugahyde and carpet inserts, and the black lower door cover, which are attached with pan-head screws.
5. Remove the screws that attach the air tube to the window sill. See Fig. 7.
6. Remove the upper four hexhead capscrews located on the hinge side of the door. See Fig. 8. Two of the capscrews attach the door check arm to the door frame. Unseat the door check arm from between the window sill and the door frame. Use care not to let the door freely swing open as the service operations progress. (Normally, the door check arm would prevent this.)
7. Remove the two hexhead capscrews located on the opposite side of the door, above the door latch assembly. See Fig. 9.
8. Carefully remove the window sill using the procedure below:

IMPORTANT: The window sill is not completely unfastened from the door at this point. The rod that connects to the window sill release handle inside the door must first be disconnected.

.1 Gripping the window sill door handle, lean the top of the window sill away from the door so

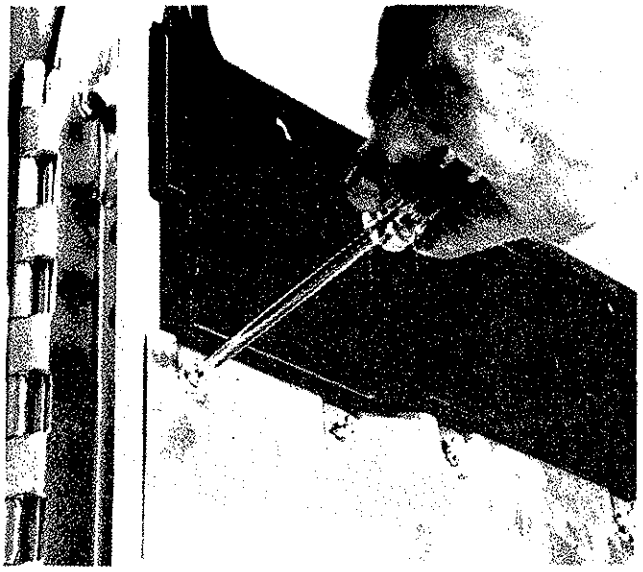


Fig. 6, Inner Panel Screw Removal/Installation

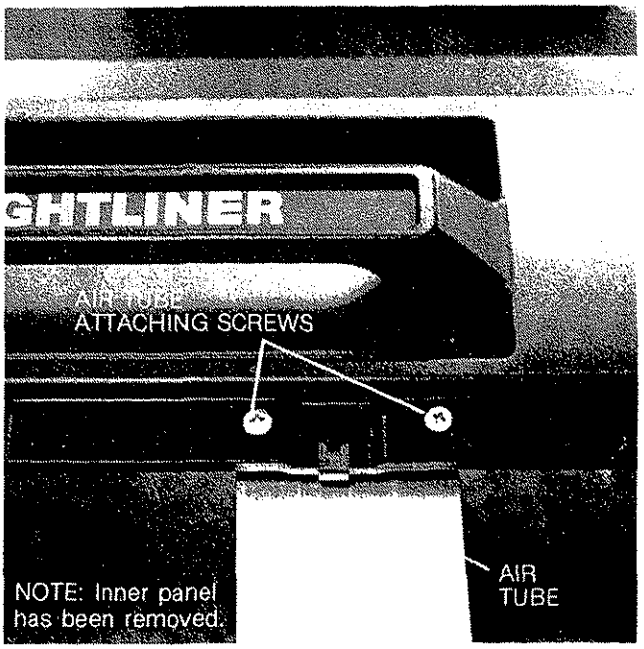


Fig. 7

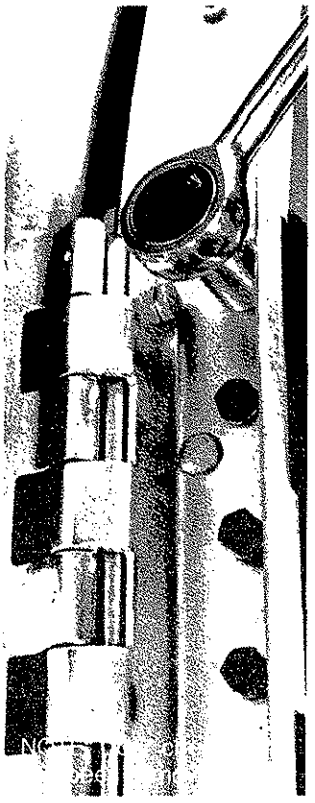


Fig. 8

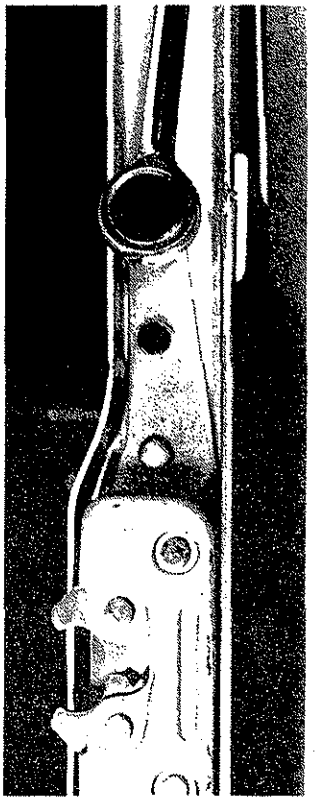


Fig. 9

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

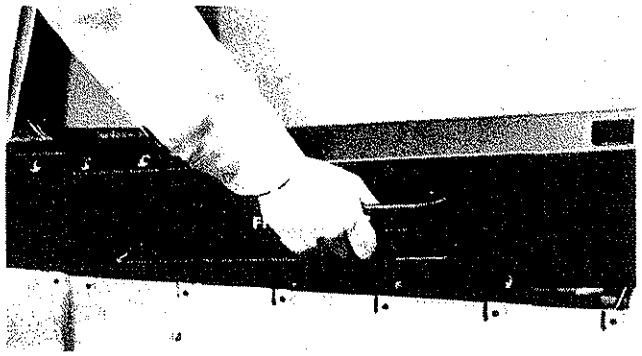


Fig. 10, Unseating the Window Sill

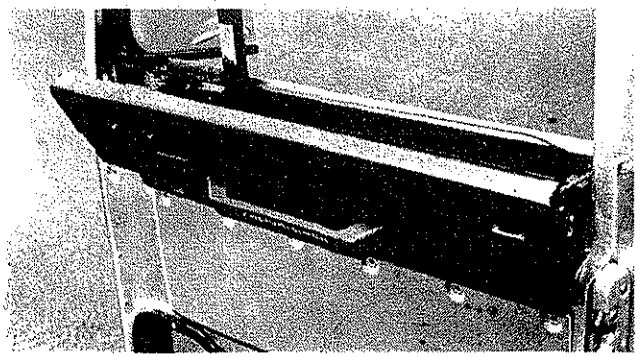


Fig. 11

that it clears the ventilator window seal. Then, with steady, upward movement, pull the window sill until the entire bottom portion unseats from the edge of the inner panel. See Fig. 10. The window sill will resist this movement, but will seem "unsprung" after it is unseated. Do not attempt to completely separate the window sill from the door.

.2 Lean the top of the window sill away from the door after pushing the door lock button free. See Fig. 11. Then, disconnect the plastic keeper from the release handle rod. See Fig. 12. Remove the window sill.

NOTE: As the window sill is pulled away, if not previously removed, be careful not to let the three window sill spacer tubes (see Fig. 13) and washers drop into the door. During removal, keep the window sill tilted as shown in Fig. 11.

.3 If applicable, reference and remove the window sill spacer tubes and washers. See Fig. 13.

9. Disengage the window glass assembly from the air tube using the following procedure:

.1 Remove the exterior door handle access cover from the inner panel.

.2 Because the window is in the lowered position, the piston arm that connects the window lift channel to the air tube (refer to Fig. 14) can be removed by reaching in through the access hole of the exterior door handle. If the piston arm cannot be reached, the work space can be increased by removing the exterior door handle. For instructions, refer to the door subject in the 18 Group of this manual.

.3 After removing the piston arm pin (Fig. 14), unseat the window lift channel from the air tube.

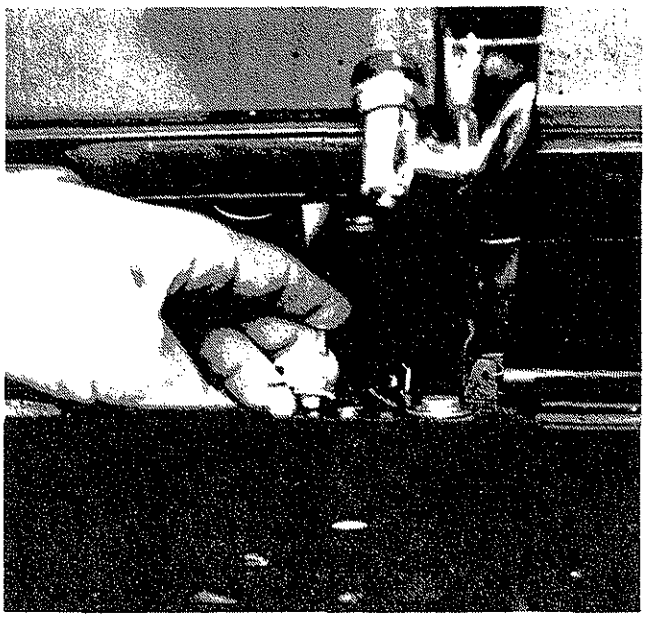


Fig. 12, Disconnecting/Connecting the Release Handle Rod from the Window Sill

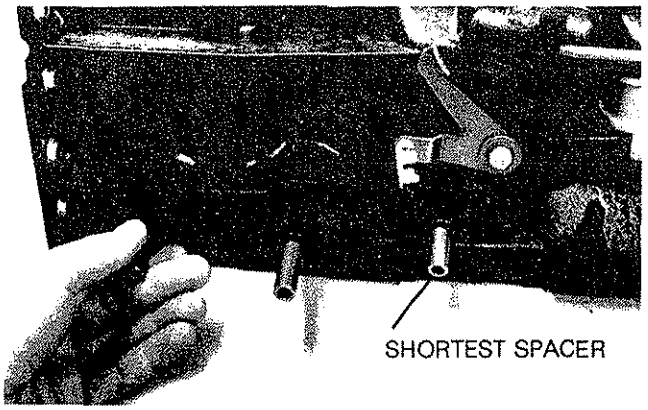


Fig. 13, Window Sill Spacers (Unseated)

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

10. Disconnect the white air hose from the upper fitting (union connector) of the air tube by pulling the plastic button tight against the fitting body; while holding the button in, pull the hose out. If the hose is not being replaced, seal it to prevent foreign material from entering.

NOTE: It is not necessary to drain the air system if the air hoses are disconnected at the fittings. Air is exhausted from the air tube and hoses when the air valve toggle switch is released.

11. To prevent scratching the window glass, lift the glass to the top of the door, and remove the air tube from between the glass and the door until the air tube clears the inner panel, then lower the window glass. Disconnect the black air hose from the air tube lower fitting. Remove the air tube and discard it. If the hose is not being replaced, seal it to prevent foreign material from entering; proceed to step 13.

IMPORTANT: It is recommended that rubber gripper gloves be worn when raising the window glass to insure a secure grip of the glass.

12. If the air hoses are being replaced, proceed as follows:

    .1 Gain access to the intermediate fittings (union connectors) by removing the screws that attach the panel located near the cab door and the door opening frame. See Fig. 15. Remove the panel to expose the hoses and fittings.

    .2 Disconnect the air hoses from the intermediate fittings by pulling the plastic button tight against the fitting body; while holding the button in, pull the hose out.

    .3 Route the new hoses through the door harness conduit (see Fig. 15), and insert the hoses into the intermediate fittings until the hoses bottom (approximately 5/8-inch [16 mm]).

13. Insert the black hose into the lower fitting of the new air tube (see Fig. 16), until the hose bottoms (approximately 5/8-inch [16 mm]). The hose must be fully inserted into the fitting to insure a leak-free connection.

14. With the piston arm of the new air tube in the lowered position, lift the window glass and insert the air tube between the window glass and inner panel. Lower the window glass. Temporarily install the capscrews attaching the upper part of the air

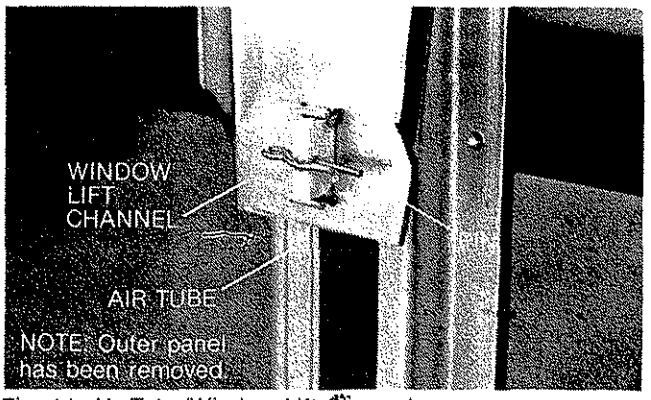


Fig. 14, Air Tube/Window Lift Channel

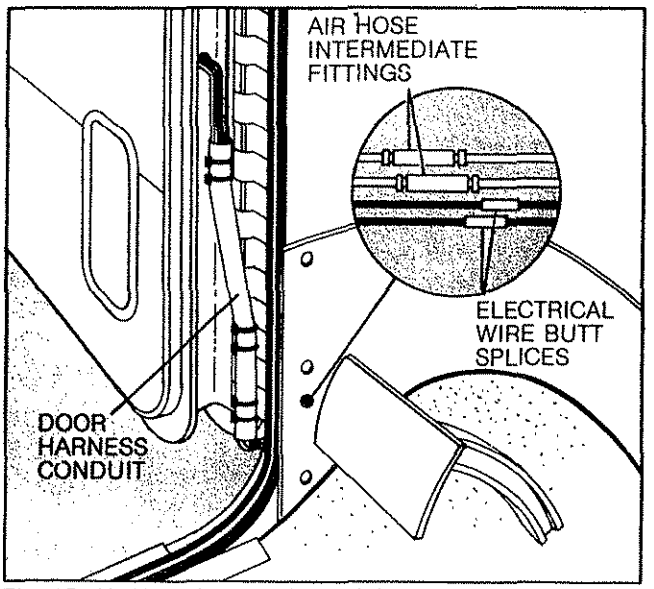


Fig. 15, Air Hose Intermediate Fittings Location

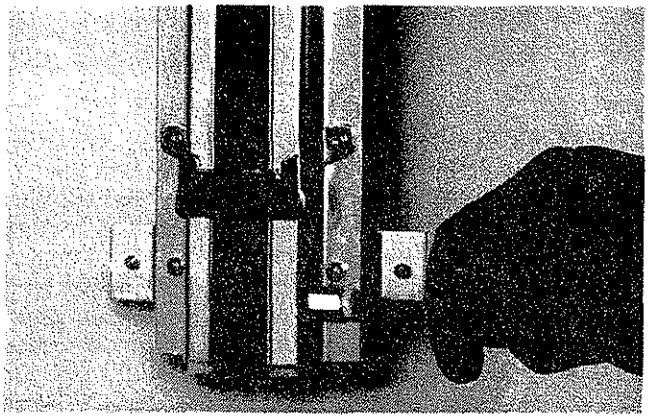


Fig. 16

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

tube to the upper mounting holes of the inner panel. Make sure the door latch rod runs in the slot provided on the air tube. See Fig. 20, under "SPECIFICATIONS." Install the capscrews attaching the lower part of the air tube with the lower mounting holes of the inner panel.

15. Insert the white air hose into the air tube upper fitting, until the hose bottoms (approximately 5/8-inch [16 mm]). The hose must be fully inserted to insure a leak-free connection.

16. Seat the window lift channel in the air tube mounting bracket; access to the components is obtained through the exterior door handle access hole on the inner panel.

17. Install the piston arm in the slot of the window glass channel, and secure it with the piston arm pin. See Fig. 14. Then, if the exterior door handle was removed from the door, install it. For instructions, refer to the door subject in the 18 Group of this manual.

18. Attach the exterior door handle access cover to the inner panel.

19. Operate the window, and check for ease of travel. If binding occurs, check that the piston arm is fully engaged in the window lift channel slot, and that the air tube is in alignment.

20. Tighten the lower mounting capscrews securely. To allow installation of the window sill, remove the capscrews from the upper part of the air tube and the inner panel.

21. Place the window sill in its approximate installed position, with the bottom edge tucked under the inner panel. Use care not to dislodge the Tinnerman clip from the mounting angle of the window sill. Then, insert the door lock button through the hole in the window sill.

22. Insert the release handle rod in the plastic keeper attached to the window sill. See Fig. 12. Make sure that the rod is locked in place.

23. Push the window sill approximately in place; allow about a 1/2-inch (13 mm) or less gap to exist directly under the ventilator window assembly. Open the ventilator window. Then, using a flat, blunt instrument, work out the ventilator window seal flap (in the bottom "corner" nearest the hinge) so that the flap overlaps the window sill. The flap should not go under the window sill. After this has been accomplished, the remaining portion of the ventilator window seal flap can be manually worked out without the use of a tool. See Figs. 17 and 18.

    Push the window sill in place, snug against the door frame. Then, install the two longest window sill spacer tubes and washers, as referenced earlier, in the window sill.

24. Install the last window sill spacer tube through the window sill hole. The spacer should be completely seated. If it does not seat, remove it, then visually check to see if the lower ventilator window guide

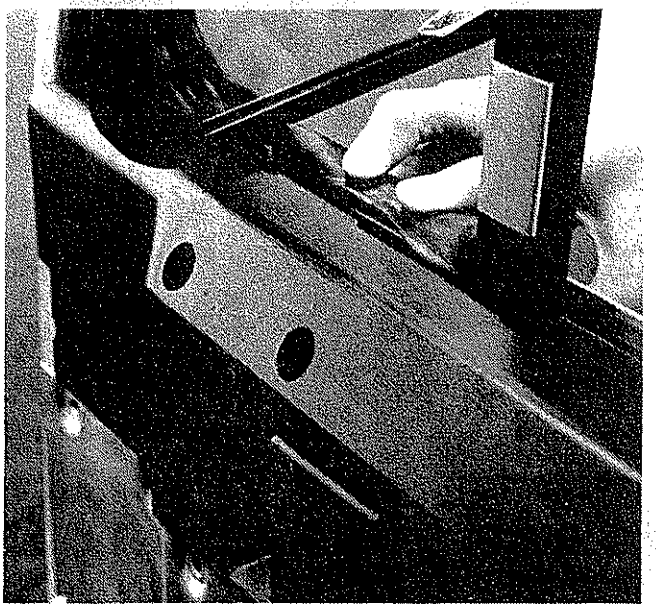


Fig. 17

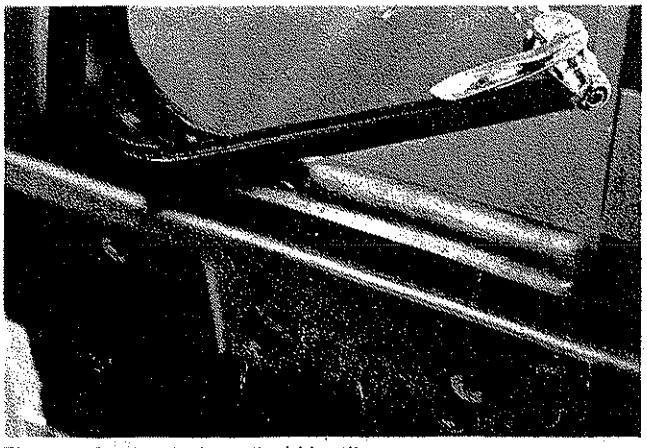


Fig. 18, Correctly Installed Ventilator Window Seal

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

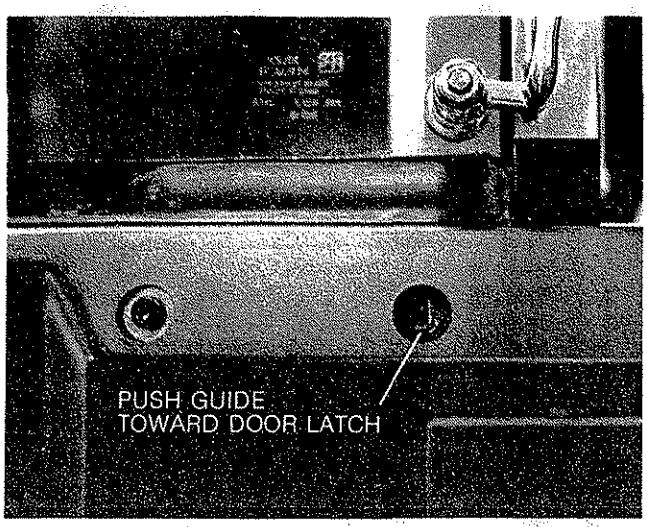


Fig. 19

is tilted out of place. See Fig. 19. Inserting the tip of a small screwdriver through the spacer hole from outside the door, lever the window guide back to a vertical position. At the same time, push the spacer in place. Then, install the washer.

25. Install the door check arm between the window sill and the door frame. Then, install the four hexhead capscrews on the hinge side of the door frame. See Fig. 8. If equipped with 1/4-20, SAE Grade 5 capscrews, tighten them to 5-7 lbf·ft (7-10 N·m); if equipped with 1/4-28, SAE Grade 8 capscrews, tighten them to 10 lbf·ft (14 N·m).

CAUTION: Do not force a capscrew in place. If the capscrew appears to be going in crooked, the holes in the spline nut (which is pressed into the window sill) and the door frame are not properly aligned. The spline nut could be pushed out of the window sill if undue force is applied to the capscrew.

If the holes are misaligned, the probable cause is an improperly installed ventilator window seal (weatherstrip). Refer to step 23 under this heading for information on the proper installation of the ventilator window seal.

26. Install the two hexhead capscrews on the opposite side of the door frame (above the door latch assembly), as shown in Fig. 9. Note the "CAUTION" given in step 25. If equipped with 1/4-20, SAE Grade 5 capscrews, tighten them to 5-7 lbf·ft (7-10 N·m); if equipped with 1/4-28, SAE Grade 8 capscrews, tighten them to 10 lbf·ft (14 N·m).
27. Install the screws that attach the inner panel to the window sill (the longest screw is installed at the door latch end of the panel). See Fig. 6. Also, install the two screws that attach the air tube to the window sill. See Fig. 7.
28. On custom door interiors, install the black lower door cover, and the naugahyde and carpet inserts.
29. As referenced earlier, install the three capscrews (using an Allen wrench), nuts, and washers, that partially attach the outside mirror mounting bracket to the door. See Fig. 5. Tighten the capscrews to 10 lbf·ft (14 N·m).
30. Remove the chocks from the tires.

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Window Will Not Move Up or Down With Air Pressure	Air hoses are damaged due to heat, wear from friction, drilling, or a pinched area.	Inspect the sheathed nylon hoses for holes or other damage. Replace hoses, as required.
	Air hoses are loose in the fittings.	Check the air hoses for proper installation in the fittings. The hoses should bottom in the fittings (approximately 5/8-inch [16 mm]).
	The air tube is damaged.	Inspect the air tube for holes or other damage. Replace the air tube, if damaged.
	The air valve is leaking.	Push the toggle switch in both directions, holding it in position to build up pressure. If a leak is found, replace the air valve.
	The air tube end plug(s) or the tape seal is leaking.	Tighten the screws of the air tube end plugs. Insert a thin 1/2-inch (13 mm) wide strip of heavy plastic between the tube and tape seal to dislodge any foreign material.
Glass Drifts Down	The air tube piston arm is not engaged with the glass channel slot.	Install the piston arm in the glass channel slot. Secure with the piston arm pin. See Fig. 14. Access to the piston arm is obtained by removing the exterior door handle access cover from the inner panel.
	The piston arm is broken.	Replace the air tube assembly.
	Brake mechanism within the air tube is not working.	See if the piston arm is engaged properly with the glass channel slot. If the piston arm can be pushed down manually, replace the air tube.
Binding	Glass channel is not centered on the glass.	Check the location of the glass channel. The piston arm should be centered in the glass channel slot. Disengage the piston arm from the glass channel before making any adjustments.

AIR-OPERATED POWER WINDOW LIFT ASSEMBLY

SPECIFICATIONS

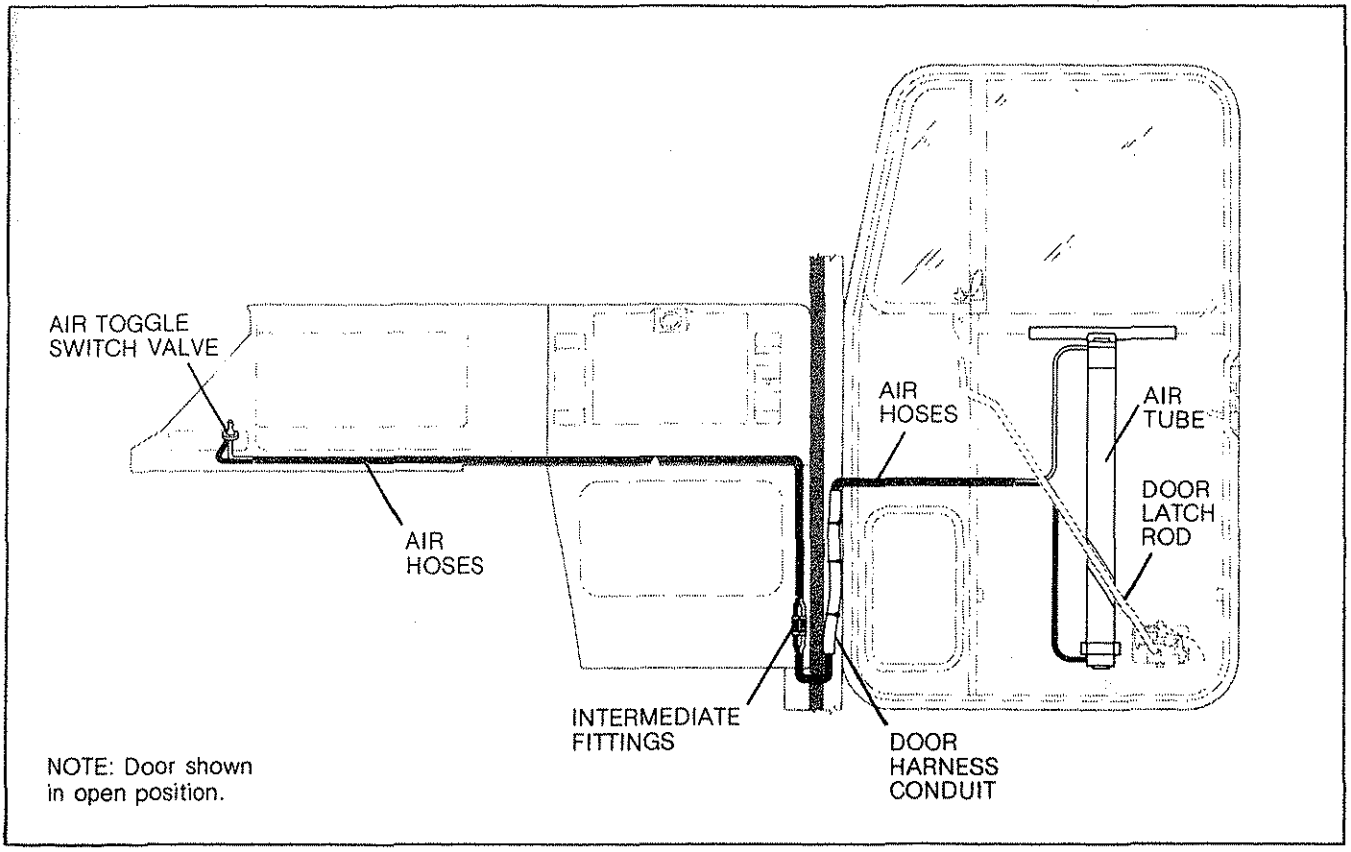


Fig. 20, Plumbing Diagram

HOLLAND MODEL 2000 SERIES FIFTH WHEEL

GENERAL DESCRIPTION

The Holland 2000 series fifth wheel assembly is used for pulling trailers using the standard SAE kingpin. This fifth wheel assembly is bracket-mounted to the tractor frame in a position that best distributes the trailer load over the tractor axles. It has a capacity of 150,000 lbf (667 230 N) maximum drawbar pull and 40,000 lbf (177 930 N) maximum vertical load.

The 2000 series fifth wheel has a cast steel top plate, equipped with a type "A" single "swinging jaw" lock mechanism. See **Fig. 1**. This steel kingpin lock system requires a 300 lbf (1330 N) push to couple, and also includes slack adjustment and the Holland lockguard to prevent high kingpin coupling.

PRINCIPLES OF OPERATION

A spring-tensioned sliding lock operates when the kingpin enters the open lock mechanism. This action swings a gear-driven, hinged lock into place behind the kingpin. A wedge-shaped plunger snaps into place behind the hinged lock, locking the kingpin into place by maintaining a 360-degree grip around the shoulder and neck of the kingpin. The kingpin is released by manually operating the kingpin lock control handle. See **Fig. 2**. The adjustment screw on the wedge compensates for wear on the kingpin or lock.

Refer to the Freightliner driver's manual for complete operating instructions.

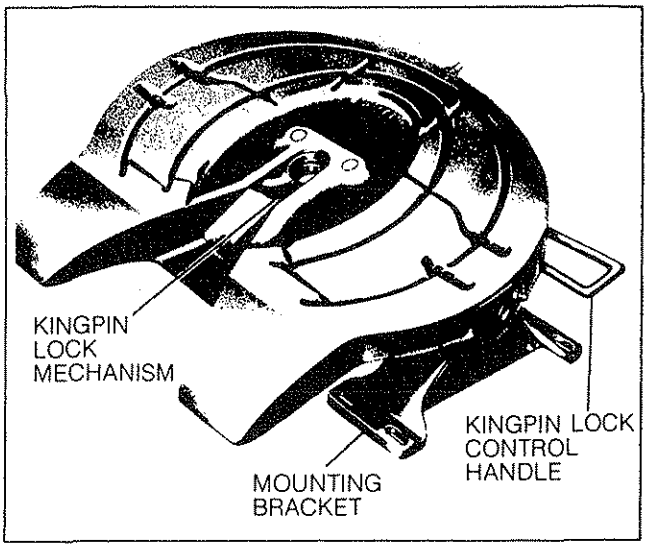


Fig. 2, Stationary Fifth Wheel Assembly

SERVICE OPERATIONS

A fifth wheel rebuild kit is available for servicing the fifth wheel. The kit contains all replacement parts for the fifth wheel, except the fifth wheel plate, mounting brackets, rubber bushings, mounting bracket pins, and spiral pins.

WARNING: All fifth wheel maintenance, adjustment, and rebuilding must be done only by a qualified mechanic. Improper or incomplete procedures could

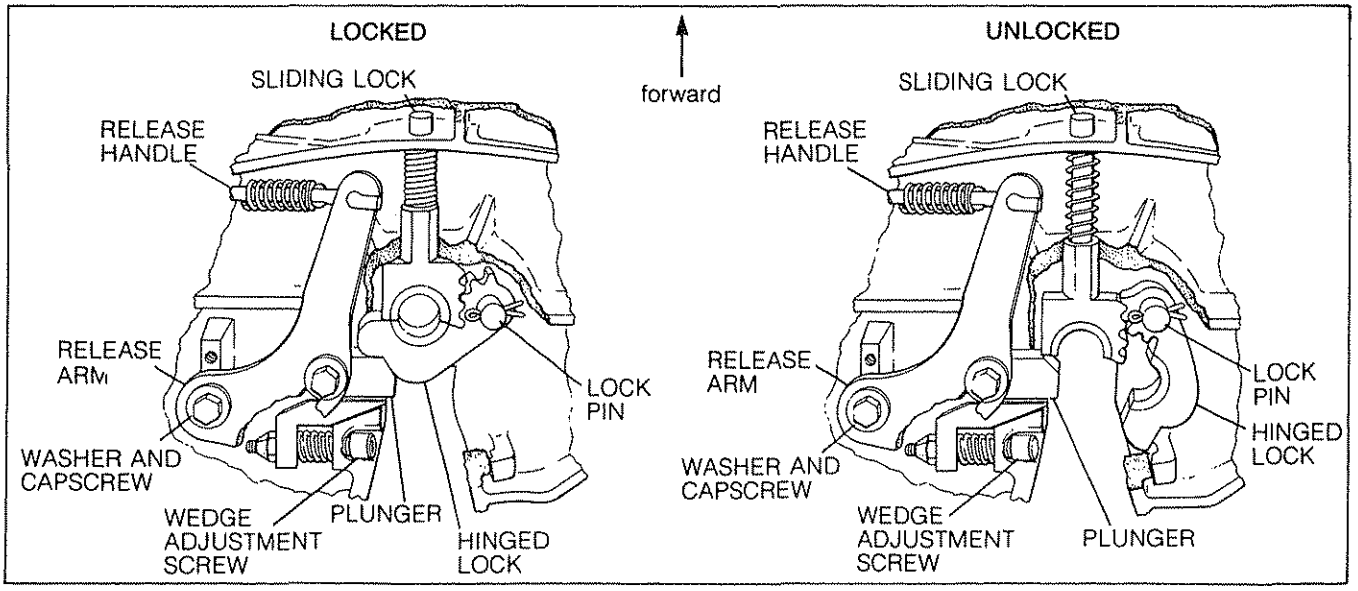


Fig. 1, Type "A" Kingpin Lock Mechanism (bottom view)

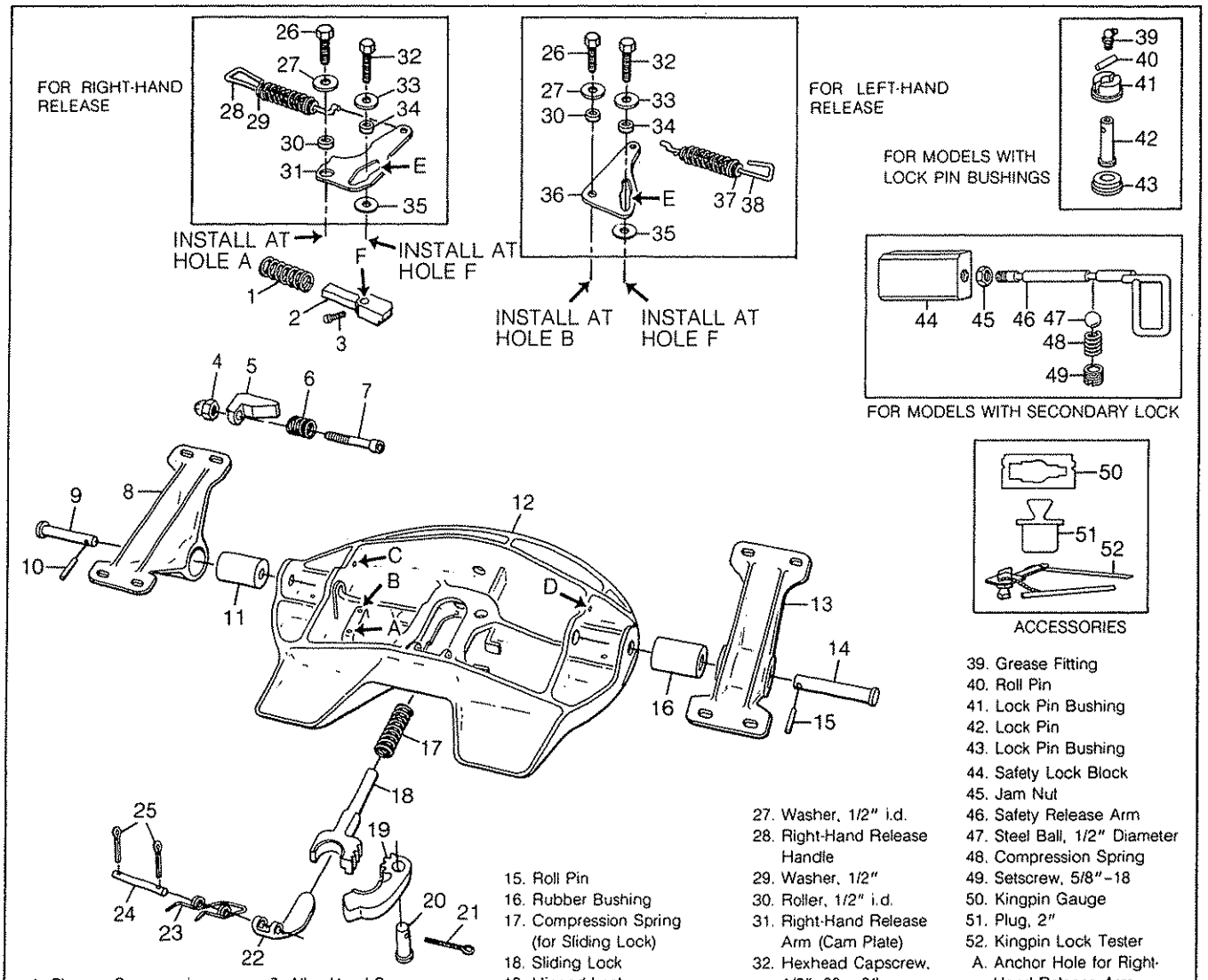
HOLLAND MODEL 2000 SERIES FIFTH WHEEL

result in loss of trailer connection during vehicle travel, possibly causing personal injury and property damage.

Review the troubleshooting section before rebuilding the fifth wheel. Rebuilding may be unnecessary.

REMOVAL AND DISASSEMBLY

1. Steam clean the fifth wheel top plate. Remove it from the mounting brackets (**Fig. 3**, Refs. 8 and 13) by removing the roll pins (Refs. 10 and 15) from the mounting bracket pins (Refs. 9 and 14); then, remove



1. Plunger Compression Spring, 1-5/8" o.d. x 5"
2. Plunger
3. Setscrew, 3/8" Square Head
4. Heavy Huglock Nut, 5/8"-11
5. Lock Adjusting Wedge
6. Compression Spring
7. Allen-Head Screw, 5/8"-11 x 3-3/4"
8. Mounting Bracket
9. Mounting Bracket Pin
10. Roll Pin
11. Rubber Bushing
12. Fifth Wheel Top Plate
13. Mounting Bracket
14. Mounting Bracket Pin
15. Roll Pin
16. Rubber Bushing
17. Compression Spring (for Sliding Lock)
18. Sliding Lock
19. Hinged Lock
20. Lock Pin
21. Cotter Pin, 1/4" x 2"
22. Lock Guard
23. Torsion Spring
24. Torsion Spring Pin
25. Cotter Pins, 1/8" x 1"
26. Hexhead Capscrew, 1/2"-20 x 1-3/4"
27. Washer, 1/2" i.d.
28. Right-Hand Release Handle
29. Washer, 1/2"
30. Roller, 1/2" i.d.
31. Right-Hand Release Arm (Cam Plate)
32. Hexhead Capscrew, 1/2"-20 x 2"
33. Washer, 1/2" i.d.
34. Roller, 1/2" i.d.
35. Washer, 1/2" i.d.
36. Left-Hand Release Arm (Cam Plate)
37. Washer, 1/2"
38. Left-Hand Release Handle
39. Grease Fitting
40. Roll Pin
41. Lock Pin Bushing
42. Lock Pin
43. Lock Pin Bushing
44. Safety Lock Block
45. Jam Nut
46. Safety Release Arm
47. Steel Ball, 1/2" Diameter
48. Compression Spring
49. Setscrew, 5/8"-18
50. Kingpin Gauge
51. Plug, 2"
52. Kingpin Lock Tester
A. Anchor Hole for Right-Hand Release Arm
B. Guide Hole for Right-Hand Release
C. Anchor Hole for Left-Hand Release Arm
D. Guide Hole for Left-Hand Release
E. Cam Profile
F. Threaded Hole in Plunger

Fig. 3

HOLLAND MODEL 2000 SERIES FIFTH WHEEL

the mounting bracket pins from the mounting brackets. Use an overhead hoist to lift the fifth wheel from the mounting brackets and tractor frame.

2. Turn the fifth wheel upside down with the locks open.
3. While disassembling the fifth wheel, check it for cracks and for missing or damaged parts, as follows:

   .1 Remove the lockguard (Fig. 3, Ref. 22), torsion spring (Ref. 23), torsion spring pin (Ref. 24), and the 1/8 x 1 inch cotter pins (Ref. 25).

   .2 Remove the 1/4 x 2 inch cotter pin (Ref. 21), lock pin (Ref. 20), and the hinged lock (Ref. 19).

   .3 Pull the release handle (Ref. 28 or 37) to the unlocked position and remove the sliding lock (Ref. 18) and the sliding lock spring (Ref. 17).

   .4 Using a 1/2-inch allen wrench, remove the allen-head screw (Ref. 7), lock adjusting wedge (Ref. 5), compression spring (Ref. 6), and the heavy huglock nut (Ref. 4).

   .5 It may be necessary to make a helper block from hardwood or steel. See Fig. 4 for the correct dimensions.

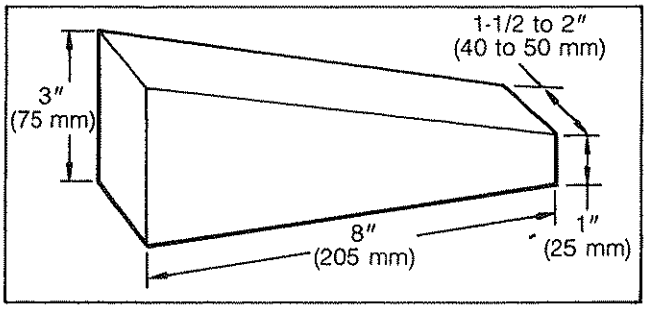


Fig. 4

   .6 To remove the lock plunger (Fig. 3, Ref. 2), place the helper block in the throat of the fifth wheel to hold the plunger out. Loosen the setscrew (Ref. 3). Then, remove the hexhead capscrew (Ref. 32), washers (Refs. 33 and 35), roller (Ref. 34), plunger (Ref. 2), and plunger compression spring (Ref. 1).

   .7 Remove the release arm by removing the hex-head capscrew (Ref. 26) and the washer (Ref. 27). Older models have a splined washer (Fig. 5). Remove the release handle.

   .8 If the helper block was used, remove it.

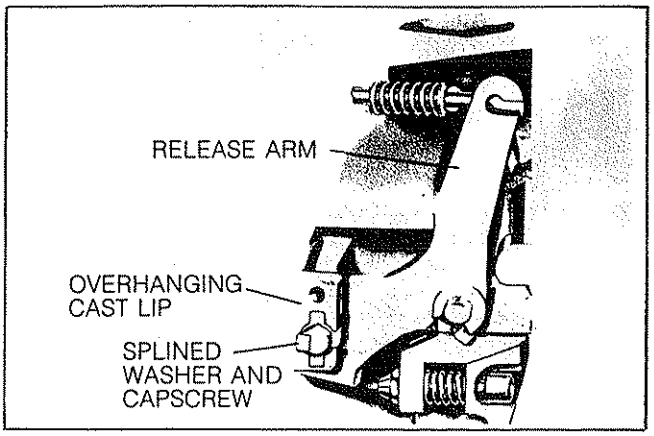


Fig. 5

4. If the plate is cracked, discard it. If the lock pin hole is worn, the top plate can be returned for a factory rebuild.

WARNING: Do not attempt to repair or rebuild the top plate if it is cracked or the lock pin does not fit tightly. The top plate could fail or the locks could malfunction, resulting in personal injury or property damage due to possible separation of the trailer from the tractor.

ASSEMBLY AND INSTALLATION

IMPORTANT: Use only Holland Rebuilding Kits. Replace all roll pins, cotter pins, springs, bolts, nuts, and washers. Check that all parts are present in the kit. Use all the parts in the rebuilding kit.

1. Clean all moving parts with no. 2 diesel oil before assembly.

WARNING: When cleaning parts with no. 2 diesel oil, do not smoke or use an open flame near the area. To do so could result in a possible fire hazard.

2. Install the red, plunger compression spring (Fig. 3, Ref. 1) into the casting.
3. Start the 3/8-inch square-head setscrew (Ref. 3) into the plunger (Ref. 2), and turn it six full turns. Coat the plunger with a light grease.
4. Install the plunger into the casting with the setscrew facing the open end of the top plate. Secure the plunger by compressing the spring (Ref. 1) with the helper block until the plunger is flush with the throat of the casting. See Fig. 6.

HOLLAND MODEL 2000 SERIES FIFTH WHEEL

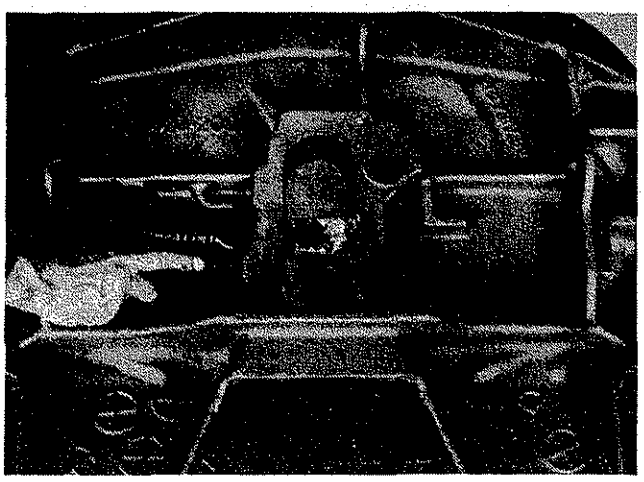


Fig. 6

5. On top plates manufactured before May 1, 1979, cut off the casting lip with a torch about 1 inch (2.5 cm) from the casting rib. See **Fig. 7**.

6. Install a 9/16-inch i.d. washer over the open end of the release handle. Pass the open end of the handle through the guide hole (**Fig. 3**, Ref. C for models with right-hand release, Ref. D for models with left-hand release) toward the outside of the top plate.

7. Inspect the release arm (cam plate) (Ref. 31 for models with right-hand release, Ref. 36 for models with left-hand release) for burrs or rough edges in the cam profile. Remove any burrs or rough edges.

NOTE: Current release arms use a roller (Ref. 30). Older release arms did not use this roller. See **Fig. 8**. Replace older release arms with the new style release arm.

8. Apply a coat of light grease to the cam profile and pivot holes; then, insert the "S" bend of the handle into the small hole in the release arm.

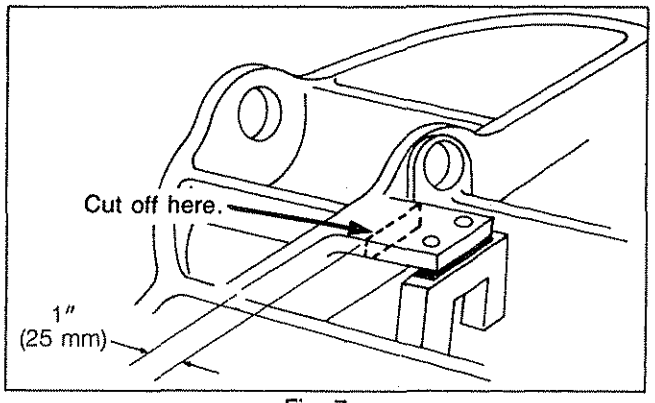


Fig. 7

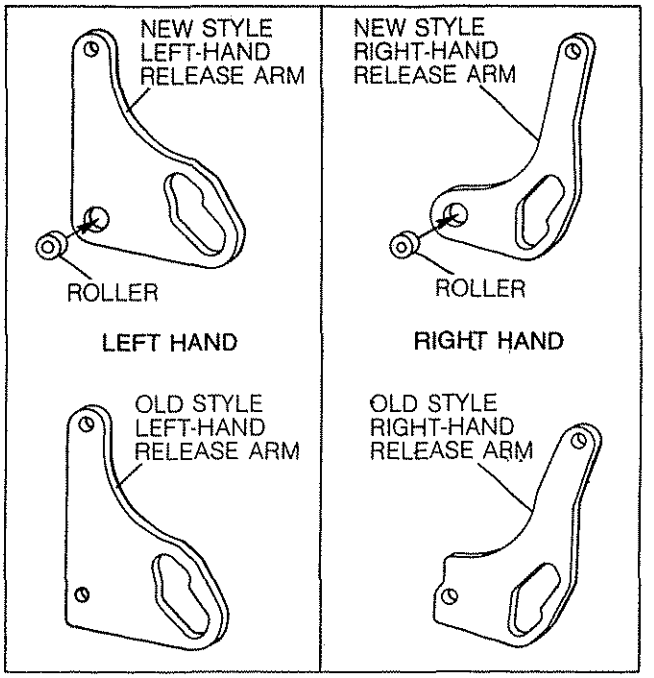


Fig. 8

9. For models with right-hand release, position the release arm on the casting with the large hole in line with the *lower* cam anchor hole (Ref. A). For models with left-hand release, position the release arm on the casting with the large hole in line with the *top* cam anchor hole (Ref. B). See **Fig. 9**.

Fig. 9

HOLLAND MODEL 2000 SERIES FIFTH WHEEL

10. Install a 1/2-inch i.d. roller (Ref. 30) in the cam anchor hole. See Fig. 10.

11. Place a 1/2-inch i.d. washer (Fig. 3, Ref. 27) over the roller. The rounded edge of the washer must face the release arm (cam plate). See Fig. 11.

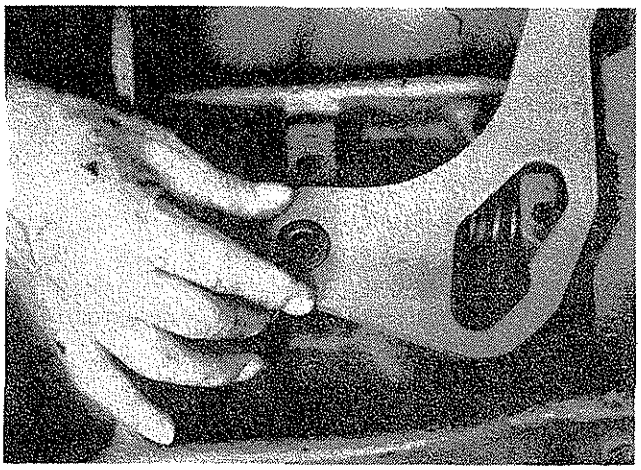


Fig. 10

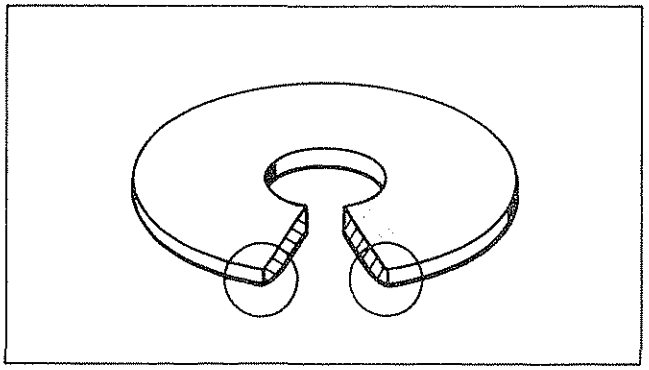


Fig. 11

12. Pass the 1/2-inch hexhead capscrew (Fig. 3, Ref. 26) with the red thread sealant (Vibra-Tite) through the washer and roller and into the casting. Tighten the hexhead capscrew securely.

13. Pull the release handle (Ref. 28 for models with right-hand release, Ref. 37 for models with left-hand release) and check for free movement.

14. Place a 1/2-inch i.d. washer (Ref. 35) between the release arm and plunger.

15. Insert a 1/2-inch i.d. roller (Ref. 34) in the cam profile (Ref. E) on top of washer (Ref. 35).

16. Install another 1/2-inch i.d. washer (Ref. 33) over the roller.

17. Pass a 2-inch long, 1/2-inch diameter hexhead capscrew (Ref. 32) through the assembly into the threaded hole of the plunger (Ref. F). Tighten the capscrew securely; then, loosen it until the top washer spins freely. Older fifth wheel models used a splined lockwasher to secure the capscrew holding the release arm. When rebuilding these models, replace the splined lockwasher with the parts used in the current models.

18. Pull the release handle, remove the helper block, and check for ease of operation.

19. Using a 3/8-inch square deep well-socket, securely tighten the setscrew (Ref. 3) in the plunger. See Fig. 12.

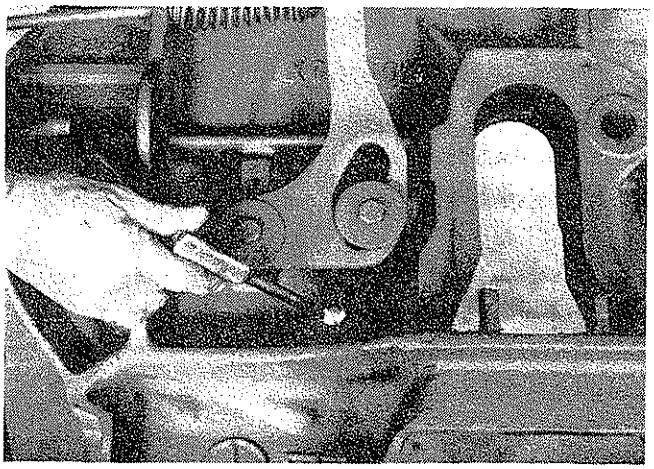


Fig. 12

20. Put the release handle in the closed position.

21. Coat the threads of the allen-head capscrew (Fig. 3, Ref. 7) with Never-Seez. Install the capscrew through the hole in the crotch of the casting.

22. Install the compression spring (Ref. 6) over the capscrew.

23. Slide the adjusting wedge (Ref. 5) along the plunger. Compress the spring and install the 5/8-inch huglock nut (Ref. 4). Using a 1/2-inch allen wrench, tighten the capscrew until the huglock nut and the end of the capscrew are flush. See Fig. 13.

24. Pull the release handle into the unlocked position.

HOLLAND MODEL 2000 SERIES FIFTH WHEEL

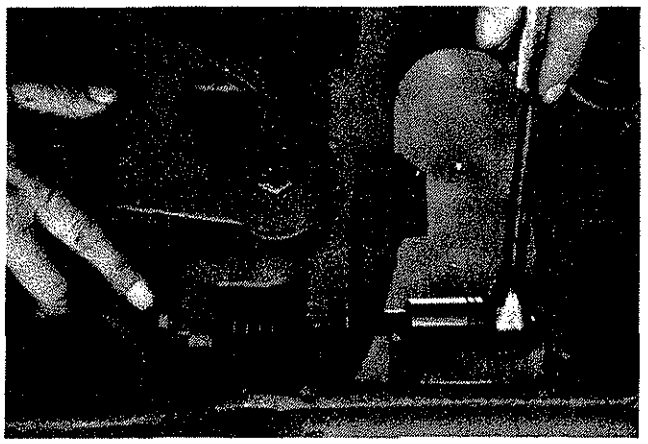


Fig. 13

25. Install the green compression spring (**Fig. 3**, Ref. 17) through the large hole in the crotch of the casting.
26. Apply light grease to all contact surfaces of the sliding lock (Ref. 18). With the large counterbore down, slide the tail of the sliding lock through the spring and compress the spring until the sliding lock is beyond the plunger.
27. Move the release handle to the closed position.

WARNING: Keep your hands away from all moving parts. These parts can move suddenly, causing personal injury.

28. Push the sliding lock forward and insert a 1-inch spacer between the lock and the plunger. See **Fig. 14**.

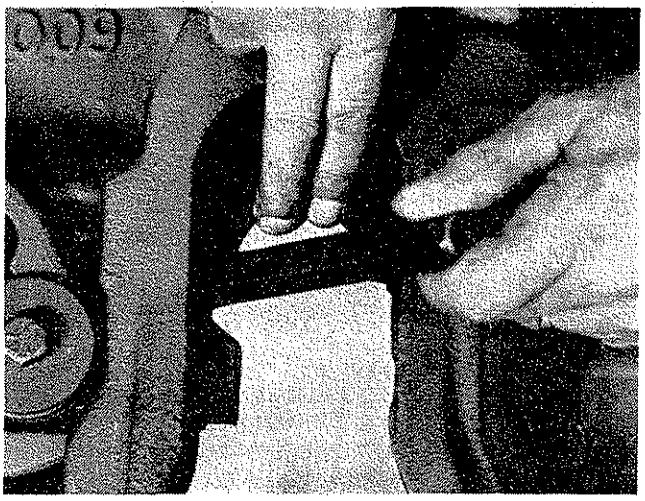


Fig. 14

29. Coat the lock pin hole in the hinged lock (**Fig. 3**, Ref. 19) with Never-Seez.

CAUTION: Use only Never-Seez. Other lubricants can damage the lock pin hole.

30. Apply a coat of light grease to the gear teeth.
31. Place the hinged lock in position. See **Fig. 15**. Drive the lock pin (**Fig. 3**, Ref. 20) through the top plate and pin hole in the hinged lock. Secure the lock pin with a cotter pin (Ref. 21).

NOTE: If the casting is equipped with lock pin bushings (Ref 41), use lock pin (Ref. 42) and roll pin (Ref. 40).

32. Using a Holland TF-TLN-1000 Kingpin Lock Tester (Ref. 52), close the locks. Refer to Holland publication FW 130 for instructions. When operating properly, the plunger (Ref. 2) will slide freely behind the hinged lock (Ref. 19). See **Fig. 16**.

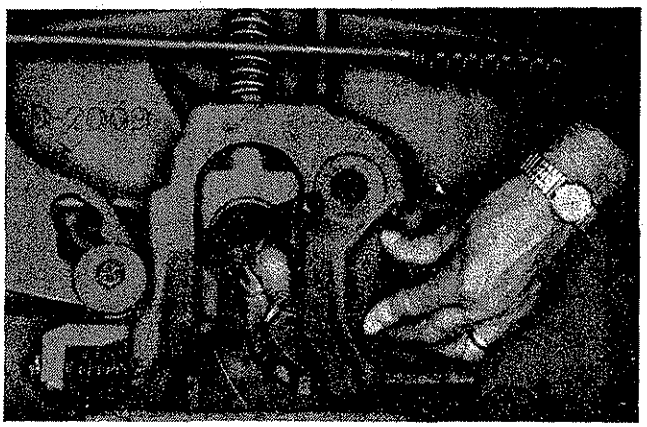


Fig. 15

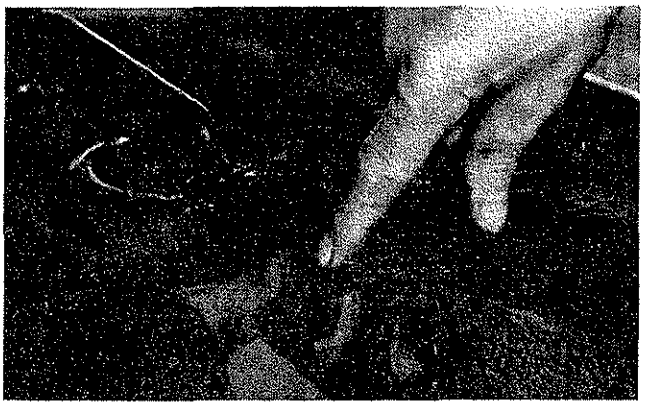


Fig. 16

HOLLAND MODEL 2000 SERIES FIFTH WHEEL

33. Using the Lock Tester, close the locks. Then, using a ratchet with a 1/2-inch allen wrench, turn the adjustment screw (**Fig. 3**, Ref. 7) in the top plate crotch clockwise. Tighten it 15 lbf·ft (20 N·m).

34. Loosen the adjustment screw (counterclockwise) one and one-half turns. The locking mechanism is now properly adjusted.

35. Check the operation by locking and unlocking the mechanism several times. If the top plate does not operate properly, repeat the above procedures or contact your local Holland representative for assistance.

WARNING: Do not use any top plate that does not operate properly. The fifth wheel could malfunction, resulting in personal injury or property damage due to possible separation of the trailer from the tractor.

36. Pull the release handle and remove the lock tester.

37. Assemble the lock guard (Ref. 22) and torsion spring (Ref. 23). See **Fig. 17**.

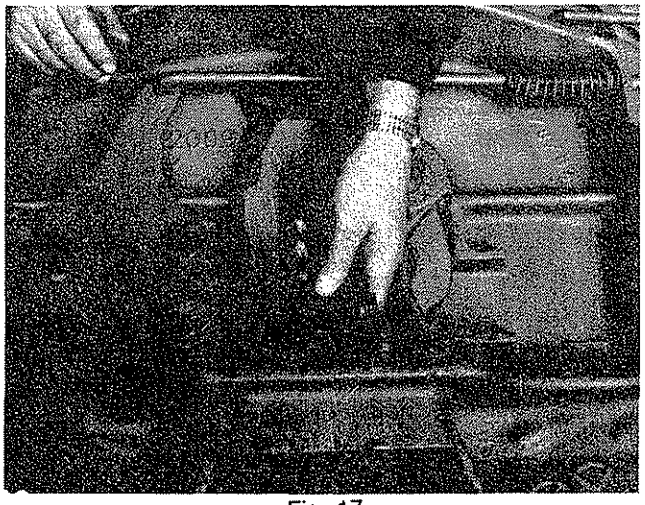


Fig. 17

38. Install the lock guard and secure it with the torsion spring pin (**Fig. 3**, Ref. 24) and cotter pins (Ref. 25).

39. Check the lock guard adjustment. When properly adjusted, the center of the hinged lock (Ref. 19) must contact the lock guard when attempting to swing the hinged lock closed. See **Fig. 18**. Make adjustments as needed.

40. Apply a coat of light grease to all moving parts.

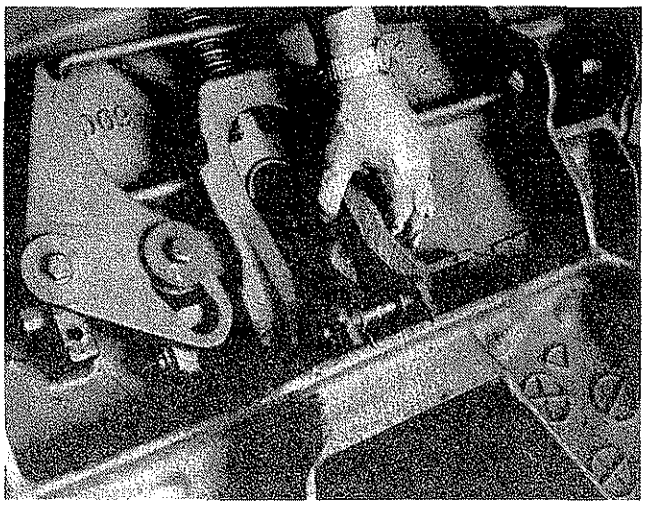


Fig. 18

41. If the fifth wheel casting is equipped with a manual secondary lock, install it as follows:

    .1 Using the Holland Lock Tester, close the locks.

    .2 Insert the safety lock block (**Fig. 3**, Ref. 44) into the casting with the chamfered edges facing the top plate.

    .3 Install the handle (Ref. 46) through the guide holes in the casting (see **Fig. 19**) and attach the jam nut (**Fig. 3**, Ref. 45). Start the handle into the threaded hole of the lock block.

    .4 Insert the ball (Ref. 47), the spring (Ref. 48), and the setscrew (Ref. 49). Tighten the setscrew securely.

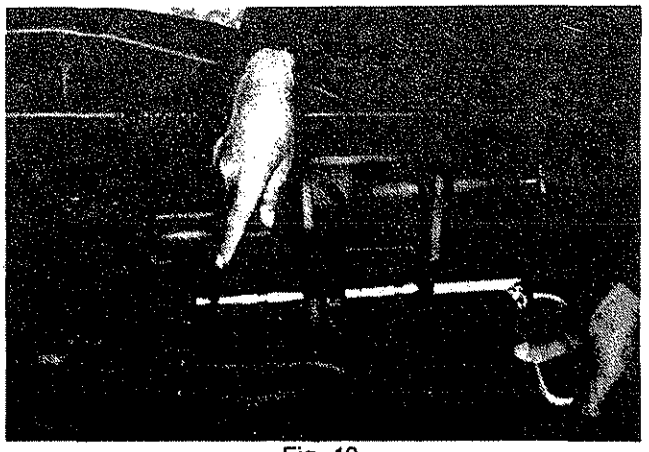


Fig. 19

HOLLAND MODEL 2000 SERIES FIFTH WHEEL

.5 To adjust the manual secondary lock, move the handle until it rests in the closed detent.

.6 The end of the secondary lock bar must be flush with the far edge of the lock guard. Adjust it by turning the handle.

.7 Align the handle with the casting and tighten the jam nut against the safety lock block.

42. Check the mounting brackets before installing the top plate, as follows:

.1 Check the rubber bushings for wear. Replace them if necessary, making sure to use the correct diameter bushing.

.2 Apply grease to the top bearing surface of the mounting bracket before mounting the top plate.

.3 Inspect the bracket pins for wear. Replace them as required.

IMPORTANT: The fifth wheel must be well lubricated to operate correctly. Refer to Group 22 of the Freightliner *COE and 120 Conventional Maintenance Manual* for complete maintenance and lubrication instructions for the fifth wheel assembly.

TROUBLESHOOTING

Problem – The Fifth Wheel Is Hard to Hook Up to the Trailer

Possible Cause	Remedy
The trailer may be too high; the kingpin is not entering the locks properly.	Lower the trailer landing gear.
The locks are closed.	Pull the release handle and force the hinged lock open.
Rust or grime is interfering with the lock operation.	Spray a light lubricant or diesel fuel on all moving parts including the release handle. Operate the release mechanism several times.
The fifth wheel locks are too tight.	Check the lock adjustment. Correct as needed.
A bent release handle, bent kingpin, or damaged bolster plate is interfering with the lock movement.	Check the release handle, kingpin, and bolster plate. Replace parts as required.
The locks are damaged.	Inspect the locks and replace parts as required.
The fifth wheel needs rebuilding.	Rebuild the fifth wheel, using the parts in the appropriate rebuilding kit.

Problem – The Fifth Wheel Is Hard to Unhook from the Trailer

Possible Cause	Remedy
The secondary lock is not released.	Pull the secondary lock release handle until it rests in the unlocked detent.
The tractor is putting pressure against the locks.	Back the tractor into the trailer to relieve pressure and lock the tractor brakes before pulling the release handle.
There is rust or grime on the locking mechanism.	Spray a light lubricant or diesel fuel on all moving parts including the release handle. Operate the release mechanism several times.
The kingpin is bent or the bolster plate is damaged.	Check the kingpin, using a Holland TF-0110 Kingpin Gauge. Check the bolster plate, using a 48-inch straight edge. Repair or replace parts as required.
The fifth wheel locks are too tight.	Check the lock adjustment. Correct as needed.
The release handle will not stay out or must be held out when unlocking.	The fifth wheel needs rebuilding. Rebuild the fifth wheel, using the parts in the appropriate rebuilding kit.

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

GENERAL DESCRIPTION

Holland 3500 and 3600 series fifth wheel assemblies are used for pulling trailers having the standard SAE kingpin. Both fifth wheel assemblies are bracket-mounted to the tractor frame in a position that best distributes the trailer load over the tractor axles. Both assemblies have a capacity of 150,000 lbf (667 230 N) maximum drawbar pull and 40,000 lbf (177 930 N) maximum vertical load.

The 3500 series fifth wheel (**Fig. 1**) has a cast steel top plate, equipped with a "split" type "B" mechanical springlock. The 3600 series fifth wheel (**Fig. 2**) has a fabricated, high strength, low alloy steel, web type top plate. The 3600 is also equipped with a "split" mechanical springlock. This steel kingpin lock system requires a 300 lbf (1330 N) push to couple, and also includes slack adjustment and the Holland lockguard to prevent high kingpin coupling.

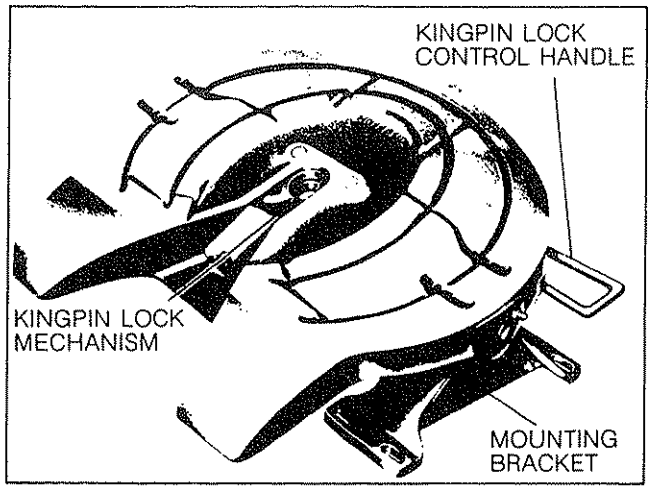


Fig. 1, Holland 3500 Series Fifth Wheel

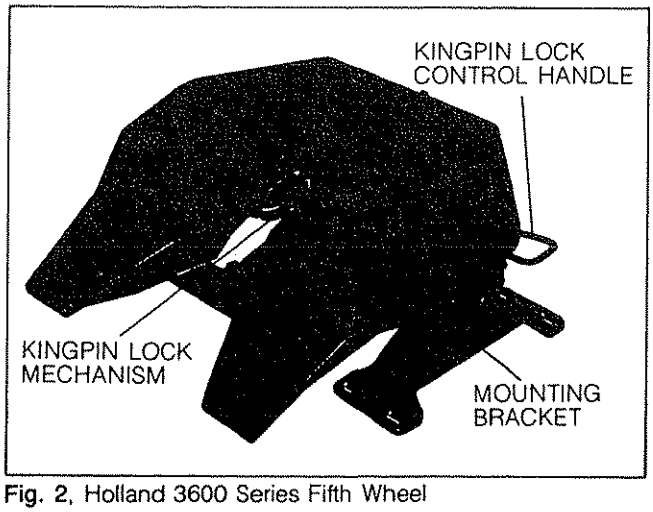


Fig. 2, Holland 3600 Series Fifth Wheel

PRINCIPLES OF OPERATION

The two spring-loaded lock halves separate as the kingpin enters the lock mechanism. See **Fig. 3**. The final forward motion of the kingpin forces the lock to close in a 360-degree grip around the shoulder and neck of the kingpin, and moves the yoke between the lock halves and tapered rib members of the fifth wheel understructure. The kingpin can be released only by manually operating the kingpin lock control handle. See **Fig. 1** or **2**. An adjustment nut compensates for wear on the lock or kingpin, if necessary.

Refer to the Freightliner driver's manual for complete operating instructions.

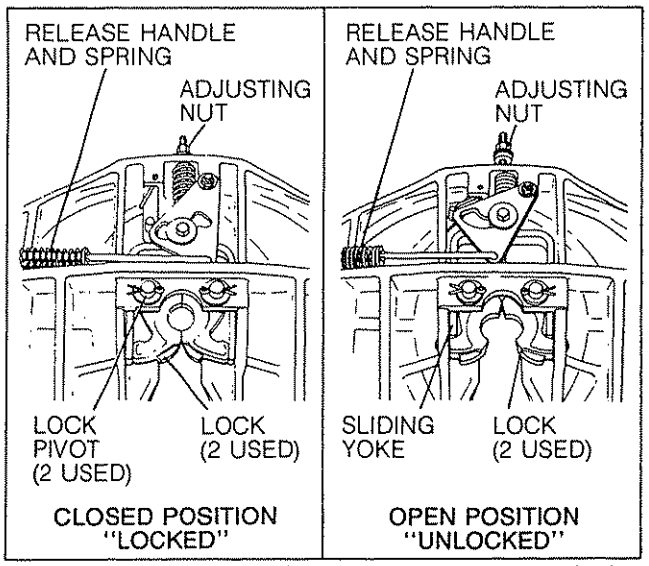


Fig. 3, Type "B" Kingpin Lock Mechanism (bottom view)

SERVICE OPERATIONS

WARNING: All fifth wheel maintenance, adjustment, and rebuilding must be done only by a qualified mechanic. Improper or incomplete procedures could result in loss of trailer connection during vehicle travel, possibly causing personal injury and property damage.

A fifth wheel rebuild kit is available for servicing the 3500 and 3600 series fifth wheels. The kit contains all replacement parts for the fifth wheel, except the fifth wheel plate,

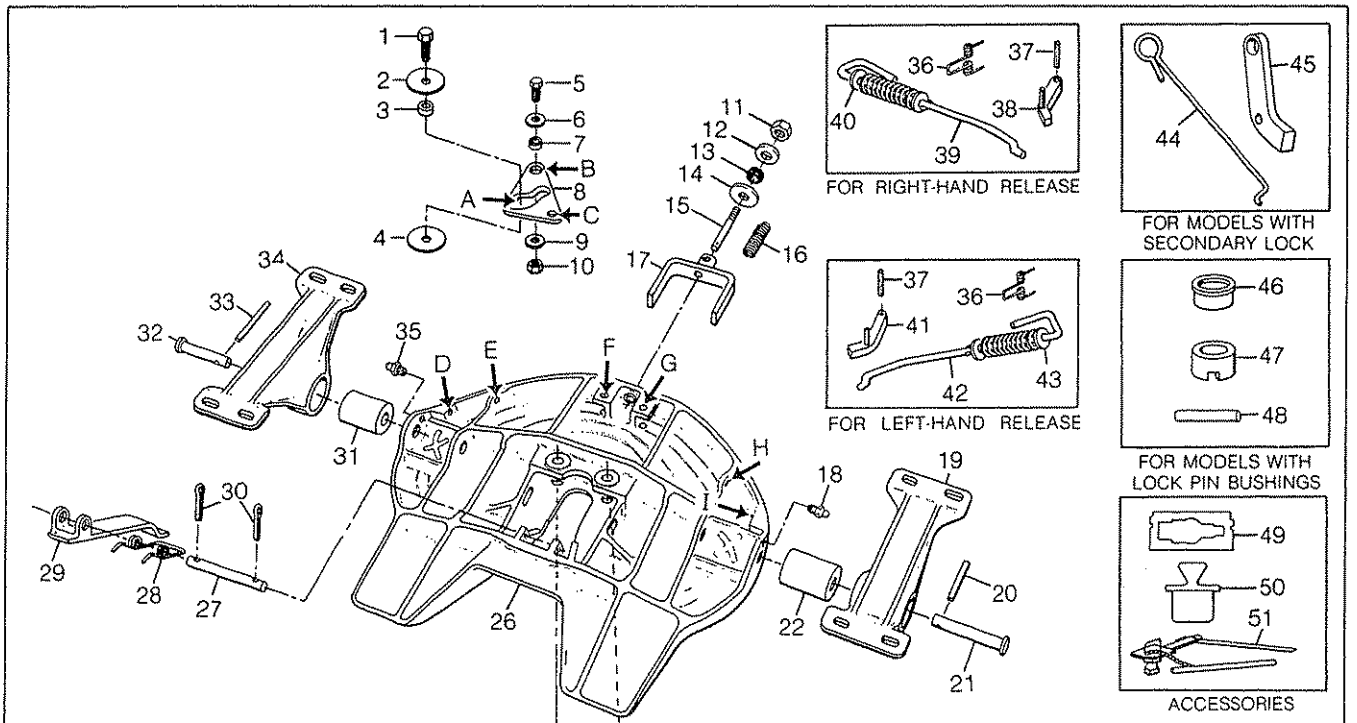
HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

mounting brackets, rubber bushings, mounting bracket pins, and roll pins.

Review the troubleshooting section before rebuilding the fifth wheel. Rebuilding may be unnecessary.

REMOVAL AND DISASSEMBLY

1. Steam clean the top plate. Remove it from the mounting brackets (**Fig. 4**, Refs. 19 and 34) by removing the roll pins (Refs. 20 and 33) from the mounting



1. Capscrew, 5/8-18 x 1-3/4
2. Washer, 5/8" i.d.
3. Roller
4. Washer, 5/8" i.d.
5. Capscrew, 1/2-20
6. Washer, 1-3/4" o.d. x 9/16" i.d.
7. Roller
8. Release Arm (Cam Plate)
9. Washer, 1-3/4" o.d. x 13/16" i.d.
10. Locknut, 1/2-20
11. Locknut, 3/4-16
12. Washer, 1-1/2" o.d. x 13/16" i.d.
13. Rubber Block
14. Lock Adjustment Tag
15. Yoke Shank
16. Yoke Shank Spring
17. Yoke Subassembly
18. Grease Fitting
19. Mounting Bracket
20. Roll Pin
21. Bracket Pin
22. Rubber Bushing
23. Cotter Pins, 1/4" x 2"
24. Lock Pins
25. Lock Jaws
26. Fifth Wheel Top Plate
27. Lockguard Pin
28. Lockguard Torsion Spring
29. Lockguard
30. Cotter Pins, 1/8" x 1"
31. Rubber Bushing
32. Bracket Pin
33. Roll Pin
34. Mounting Bracket
35. Grease Fitting
36. Secondary Lock Torsion Spring
37. Roll Pin
38. Right-Hand Secondary Lock
39. Right-Hand Release Handle
40. Washer, 1-3/4" o.d. x 9/16" i.d.
41. Left-Hand Secondary Lock
42. Left-Hand Release Handle
43. Washer, 1-3/4" o.d. x 9/16" i.d.
44. Manual Secondary Lock Handle
45. Manual Secondary Lock
46. Lock Pin Bushings, 2
47. Lock Pin Bushing, 2
48. Roll Pin, 2
49. Kingpin Gauge
50. Plug, 2"
51. Kingpin Lock Tester

A. Release Arm Cam Profile
B. Release Arm Pivot Hole
C. Hole for Attachment of Release Handle
D. Guide Hole for Right-Hand Release
E. Hole for Left-Hand Manual Secondary Lock Handle
F. Right-Hand Secondary Lock Anchor Hole
G. Left-Hand Secondary Lock Anchor Hole
H. Hole for Right-Hand Manual Secondary Lock Handle
I. Guide Hole for Left-Hand Release
J. Lock Pin Holes

Fig. 4, Holland 3500 and 3600 Series Fifth Wheel Exploded View

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

bracket pins (Refs. 21 and 32); then, remove the mounting bracket pins from the mounting brackets. Use an overhead hoist to lift the fifth wheel from the mounting brackets and tractor frame.

2. Turn the fifth wheel upside down with the locks open.

3. While disassembling the fifth wheel, check it for cracks and for missing or damaged parts, as follows:

   .1 Remove the lockguard (Ref. 29), the lockguard spring (Ref. 28), the lockguard pin (Ref. 27), and the lockguard cotter pins (Ref. 30).

   .2 On fifth wheels with the right-hand release, remove the secondary lock roll pin (Ref. 37) from hole F. Then, remove the right-hand secondary lock (Ref. 38) with the secondary lock spring (Ref. 36) from under hole F.

   On fifth wheels with the left-hand release, remove the secondary lock roll pin from hole G. Then, remove the left-hand secondary lock with the secondary lock spring from under hole G.

   .3 Remove the attaching release arm capscrew (Ref. 1), capscrew washer (Ref. 2), and roller (Ref. 3) from hole A of the release arm (Ref. 8) and yoke (Ref. 17).

   .4 Remove the release arm capscrew (Ref. 5), release arm capscrew washer (Ref. 6), and release arm roller (Ref. 7) from hole G for models with right-hand release or from hole F for models with left-hand release.

   .5 Remove the release handle (Ref. 42 or 39) from the fifth wheel top plate. Remove the washer, release handle spring, and release handle washer from the release handle.

   .6 Remove the yoke shaft locknut (Ref. 11), yoke shaft washer (Ref. 12), and rubber block (Ref. 13) from the yoke shank (Ref. 15). Then, remove the yoke shank and the yoke shank spring (Ref. 16) from the yoke (Ref. 17).

   .7 Remove the yoke from the fifth wheel top plate.

   .8 Remove the lock cotter pins (Ref. 23), lock pins (Ref. 24), and the lock jaws (Ref. 25) from the fifth wheel top plate.

4. If the top plate is cracked, discard it. If the lock pin hole is worn, the top plate can be returned for a factory rebuild.

WARNING: Do not attempt to repair or rebuild the top plate if it is cracked or the lock pin does not fit tightly. The top plate could fail or the locks could malfunction. This could result in loss of trailer connection during vehicle travel, possibly causing personal injury and property damage.

ASSEMBLY AND INSTALLATION

IMPORTANT: Use only Holland Rebuilding Kits. Replace all roll pins, cotter pins, springs, capscrews, nuts, and washers.

1. Clean all moving parts with no. 2 diesel oil before assembly.

WARNING: When cleaning parts with no. 2 diesel oil, do not smoke or use an open flame near the area. To do so could result in a possible fire hazard.

2. Before installing the lock jaws (Fig. 4, Ref. 25), lubricate the lock pin holes (Ref. J) with Never-Seez.

CAUTION: Use only Never-Seez. Other lubricants can damage the lock pin holes.

3. Place the lock jaws in the top plate with the 2-7/8 inch bore toward the face of the top plate. See Fig. 5.

4. Drive the lock pins (Fig. 4, Ref. 24) through the top plate and lock pin holes (Ref. J) in the lock jaws until the head of the pins are flush with the top plate.

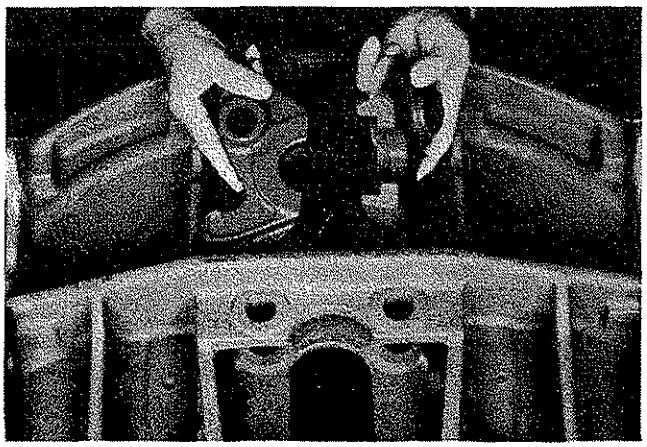


Fig. 5

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

5. If the top plate is equipped with lock pin bushings (Refs. 46 and 47), use roll pins (Ref. 48) instead of cotter pins. See **Fig. 6**.
6. Check that the lock jaws move freely.
7. Install a 2-inch diameter plug (Holland part number TF-0237) in the lock jaws. See **Fig. 7**.

WARNING: Use only Holland part number TF-0237 or a precision plug machined to 2.000 ± 0.005 inch to adjust the locking mechanism. Failure to do so may cause locking mechanism malfunction. This could result in loss of trailer connection during vehicle travel, possibly causing personal injury and property damage.

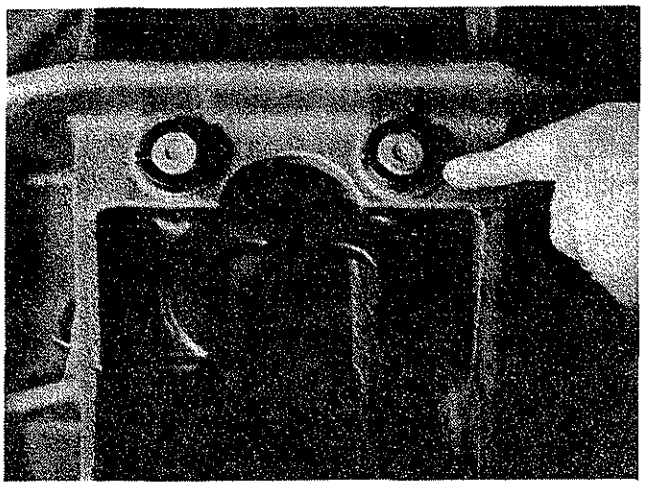


Fig. 6

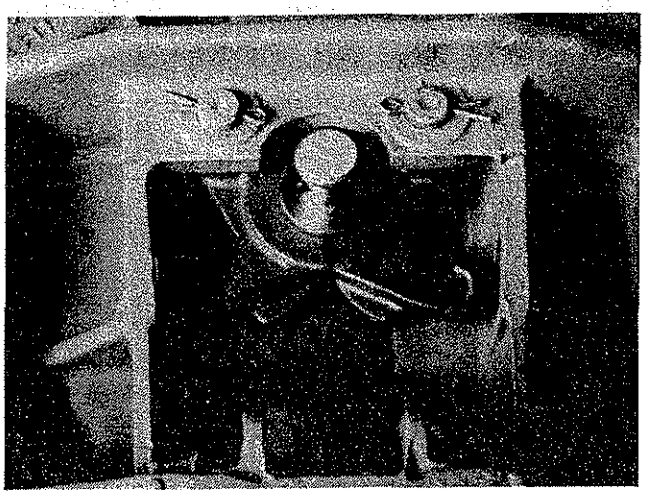


Fig. 7

8. Strike the yoke with a mallet to bend the yoke tips outward slightly. See **Fig. 8**.
9. Slide the yoke into the top plate with the threaded hole facing up and tap the yoke into position.
10. Inspect the yoke tips. They must be flush with or not extend beyond the end of the locks by 1/32 inch (0.8 mm). See **Fig. 9**.

Fig. 8

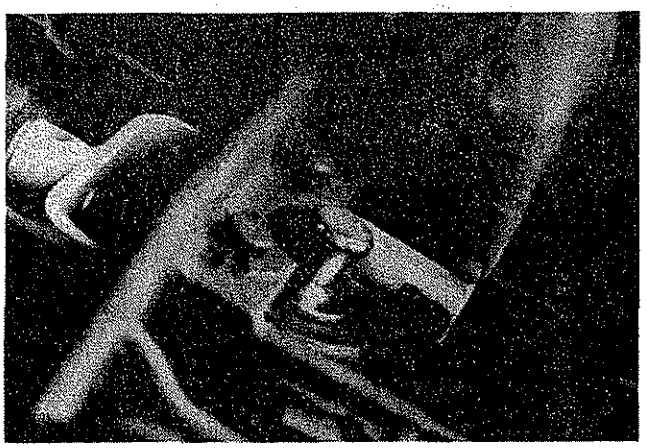


Fig. 9

a. If the yoke tips fall short (**Fig. 10**), use a belt sander or disk grinder to grind the outside surfaces of the yoke until it fits precisely into place. See Fig. 11.

WARNING: Never grind on the inside of the yoke or on the locks. This can weaken the yoke structure, possibly causing the kingpin to fit loosely. This could result in loss of trailer connection

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

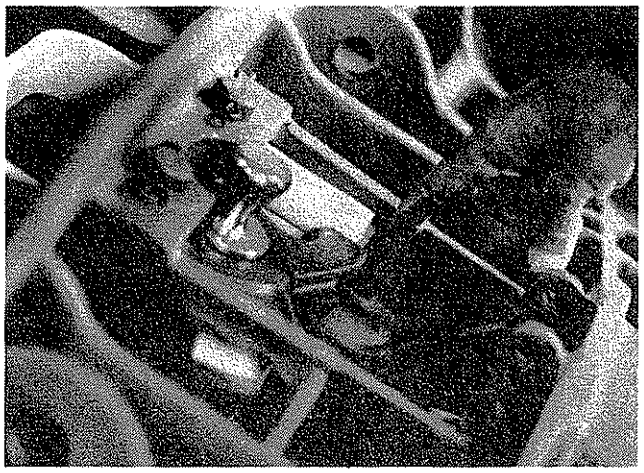


Fig. 10

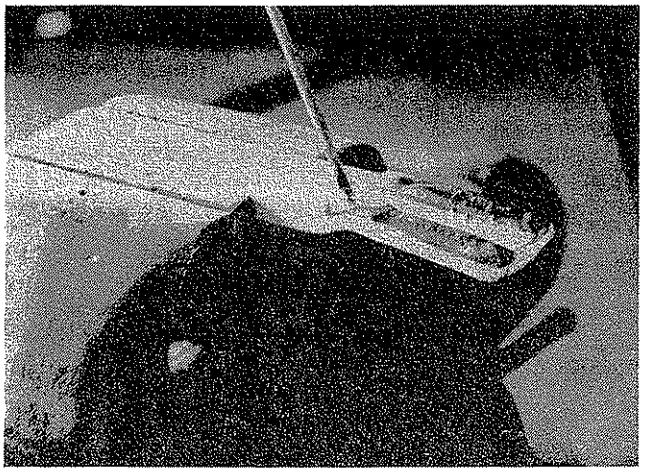


Fig. 12

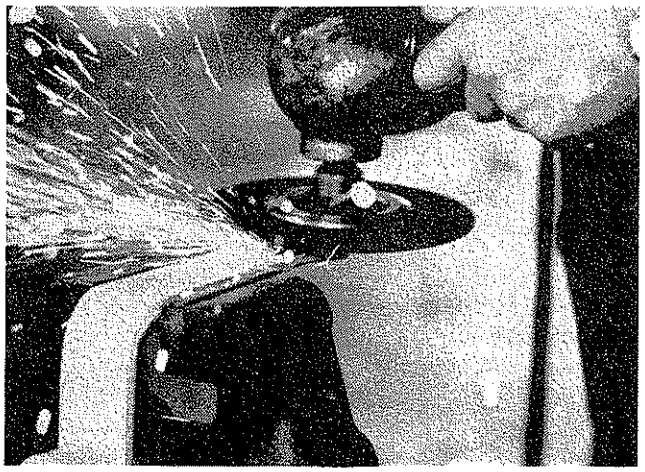


Fig. 11

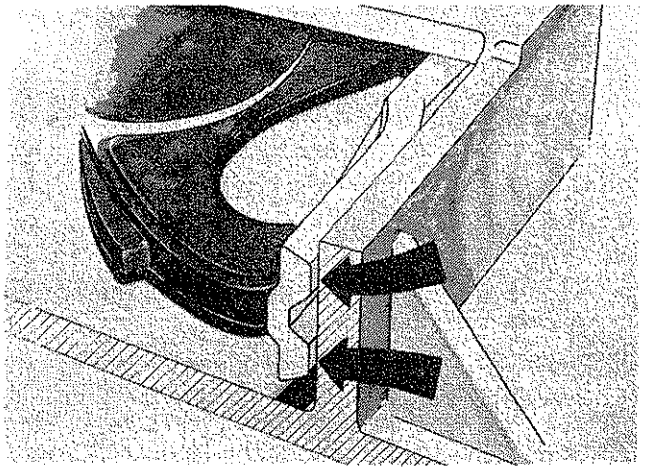


Fig. 13

during vehicle travel, possibly causing personal injury and property damage.

b. If the yoke tips extend beyond the ends of the locks, build up the outer surfaces of the yoke using a low hydrogen E70XX welding rod. See **Fig. 12**. After welding, grind the beads smooth.

11. The outside of each yoke tip has two contact areas. Check that all four surfaces have full area contact with the top plate ribs (**Fig. 13**) after welding and grinding.

12. Continue welding, grinding, and fitting until the yoke has full contact and the yoke tips are flush with the ends of the locks.

13. Apply a coat of light grease to both the inside and outside friction surfaces of the yoke, then slide the yoke into the top plate with the threaded hole facing up.

14. Install the spring (**Fig. 4**, Ref. 16) between the yoke and the top plate. Insert the yoke shank (Ref. 15) through the top plate and spring, then into the yoke. Make sure that the predrilled recess in the yoke shank aligns with the threaded hole in the yoke.

15. Install the lock adjustment tag (Ref. 14), the rubber block, (Ref. 13) a 13/16-inch i.d. steel washer (Ref. 12), and the 3/4-inch locknut (Ref. 11) in the order stated.

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

16. Install the 9/16-inch i.d. washer (Ref. 43) on the release handle as shown in **Fig. 4**.
17. Pass the open end of the release handle through the guide hole (Ref. D for models with right-hand release, Ref. I for models with left-hand release) toward the outside of the top plate.
18. Inspect the release arm (cam plate) (Ref. 8) for burrs or rough edges in the cam profile (Ref. A). Remove any burrs or rough edges.
19. Apply a coat of light grease to the cam profile and pivot holes.
20. Insert the "S" end of the release handle through the small hole in the release arm (cam plate).
21. Place the release arm (cam plate) on the top plate so that the cam profile (Ref. A) is over the hole in the yoke and the large hole (Ref. B) is over the lug in the top plate opposite the release handle. See **Fig. 14**.
22. Slide a 9/16-inch i.d. flatwasher between the plate lug and the release arm with the rounded edge towards the cam. See **Fig. 15**.
23. Install the 1/2-inch i.d. roller (**Fig. 4**, Ref. 7) in the large hole of the release arm.
24. Place a second 9/16-inch i.d. flatwasher over the release arm. Make sure the rounded edge of the washer faces the cam.
25. Install the 1/2-inch diameter capscrew through the washers, roller, and hole in the top plate lug (Ref. G for right-hand release models, Ref. F for left-hand release models).

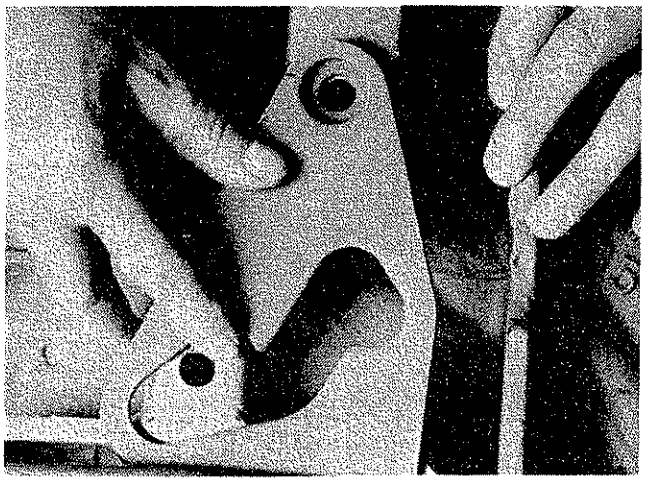


Fig. 14

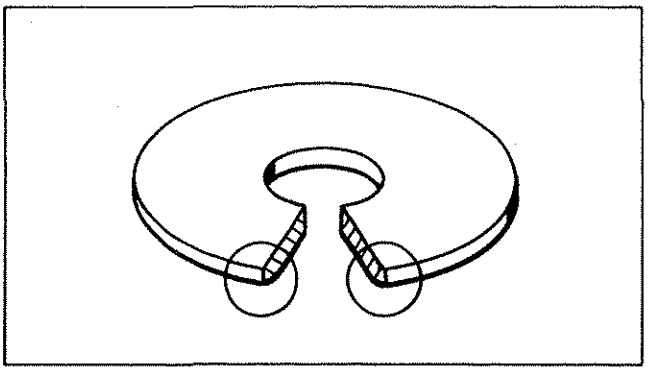


Fig. 15

26. Secure the capscrew with a 1/2-inch locknut. Tighten the locknut; then, check that the release arm moves freely.
27. Place a 5/8-inch i.d. flatwasher (Ref. 4) between the yoke and the release arm. Make sure that the rounded edge of the washer faces the release arm.
28. Insert the 5/8-inch i.d. roller (Ref. 3) in the release arm opening.
29. Install the second 5/8-inch i.d. flatwasher (Ref. 2) on top of the release arm.
30. Pass the 5/8-inch diameter capscrew (Ref. 1) through the assembly. Be certain that the bolt passes through the yoke and into the recess in the yoke shank.
31. Tighten the capscrew securely, but make sure the top washer (Ref. 2) rotates freely.
32. Turn the nut on the yoke shank clockwise until the yoke just begins to move.
33. Check the plug (Holland part number TF-0237). It should fit snugly in the locks, but you should be able to turn it with some force.
34. On models with an automatic secondary lock assembly, proceed as follows:
    - .1 Start the roll pin into the hole in the top plate lug opposite the release arm anchor capscrew (Ref. 5).
    - .2 Install the torsion spring (Ref. 36) on the secondary lock, and position them on the lug. Be sure the open end of the spring faces toward the rib of the lug. See **Fig. 16**.
    - .3 While holding the parts in place, drive the roll pin until it is flush with the lug.

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

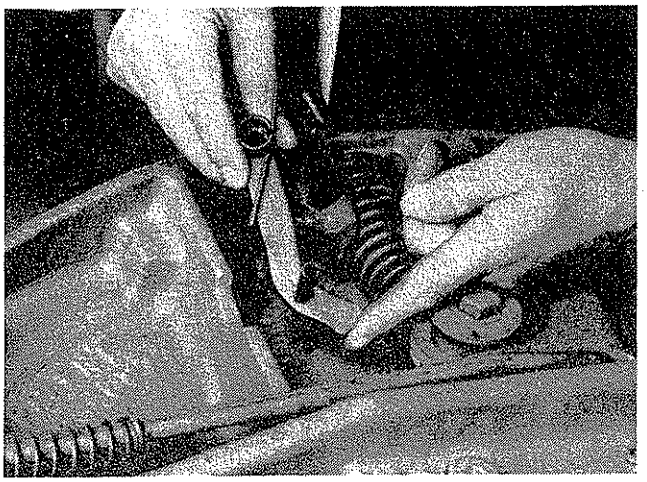


Fig. 16

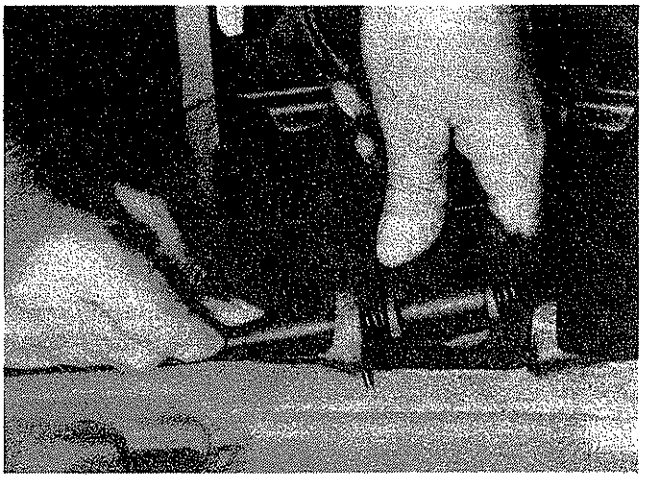


Fig. 17

.4 Check the spring tension on the secondary lock. Check that the lock moves freely.

35. On models with a manual secondary lock assembly, proceed as follows:

.1 Pass the end of the manual secondary lock handle (**Fig. 4**, Ref. 44) through the hole (Ref. E for right-hand release, Ref. H for left-hand release).

.2 Attach the handle to the secondary lock (Ref. 45).

.3 Start the roll pin into the hole in the top plate lug opposite the release arm anchor capscrew (Ref. 5).

.4 Install the torsion spring (Ref. 36) on the secondary lock, and place them in position on the lug. Be sure the open end of the spring faces toward the rib of the lug. See **Fig. 16**.

.5 While holding the parts in place, drive the roll pin until it is flush with the lug.

.6 Check the spring tension on the secondary lock. Check that the lock moves freely.

36. Pull the release handle, remove the plug, and pry open the lock jaws.

37. Assemble the lockguard (Ref. 29) and the torsion spring (Ref. 28).

38. Mount the lockguard using the lockguard pin (Ref. 27) and cotter pins (Ref. 30). See **Fig. 17**.

39. Check the spring tension on the lockguard. Check that the lockguard moves freely.

40. Check the adjustment. The tip of the guard should be even with the edge of the 2-inch bore in the lock jaw. See **Fig. 18**.

41. Adjust the lockguard position by supporting the end of the guard with a short piece of steel placed between the locks and the lockguard. Tap the center of the guard to adjust it. See **Fig. 19**.

42. Using a Holland Lock Tester, close the locks. For instructions, refer to Holland Publication FW 130. Make

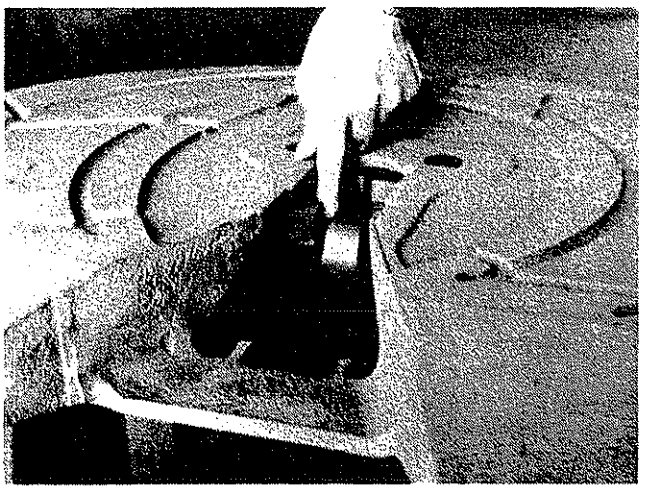


Fig. 18

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

sure that the locking mechanism functions properly. See Fig. 20. If the fifth wheel does not operate properly, repeat the above procedures or contact your local Holland representative for assistance.

IMPORTANT: The fifth wheel must be well lubricated to operate correctly. Refer to Group 22 of the Freightliner *COE and 120 Conventional Maintenance Manual* for complete maintenance and lubrication instructions for the fifth wheel assembly.

WARNING: If the fifth wheel does not operate properly, do not use it.The fifth wheel could malfunction, resulting in personal injury or property damage due to possible separation of the trailer from the tractor.

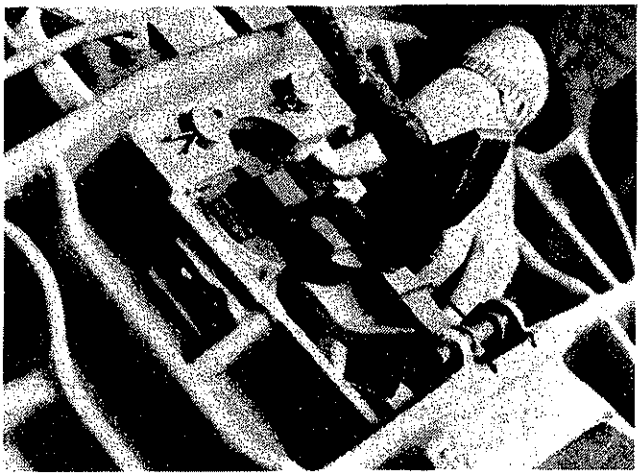


Fig. 19

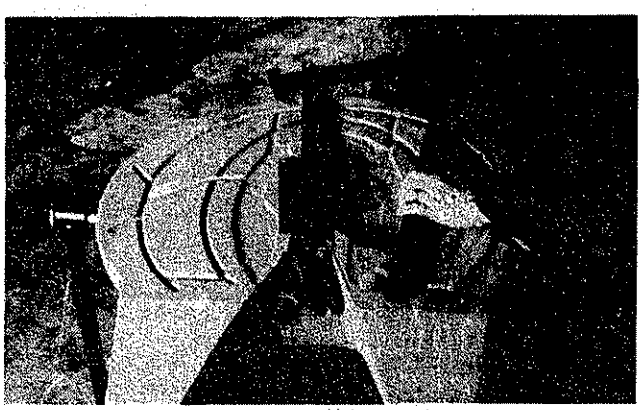


Fig. 20

HOLLAND MODELS 3500 AND 3600 SERIES FIFTH WHEELS

TROUBLESHOOTING

Problem – The Fifth Wheel Is Hard to Hook Up to the Trailer

Possible Cause	Remedy
The trailer may be too high; the kingpin is not entering the locks properly.	Lower the trailer landing gear until the bolster plate contacts the fifth wheel.
The locks are closed.	Pull the release handle and pry open the locks.
Rust or grime is interfering with the lock operation.	Spray a light lubricant or diesel fuel on all moving parts including the release handle. Operate the release mechanism several times.
The fifth wheel locks are too tight.	Check the lock adjustment. Correct as needed.
A bent release handle, bent kingpin, or damaged bolster plate is interfering with the lock movement.	Check the release handle, kingpin, and bolster plate. Replace parts as required.
The locks are damaged.	Inspect the locks and replace parts as required.
The fifth wheel needs rebuilding.	Rebuild the fifth wheel, using the parts in the appropriate rebuilding kit.

Problem – The Fifth Wheel Is Hard to Unhook from the Trailer

Possible Cause	Remedy
The secondary lock is not released.	*Manual secondary lock:* Pull the release handle and lock it open by resting it against the top plate. *Automatic secondary lock:* Inspect the lock for missing or broken parts and repair or replace as required.
The tractor is putting pressure against the locks.	Back the tractor into the trailer to relieve pressure and lock the tractor brakes before pulling the release handle.
There is rust or grime on the locking mechanism.	Spray a light lubricant or diesel fuel on all moving parts including the release handle. Operate the release mechanism several times.
The kingpin is bent or the bolster plate is damaged.	Check the kingpin, using a Holland TF-0110 Kingpin Gauge. Check the bolster plate, using a 48-inch straight edge. Repair or replace parts as required.
The fifth wheel locks are too tight.	Check the lock adjustment. Correct as needed.
The release handle will not stay out or must be held out when unlocking.	Replace the release arm and the release handle spring.

HOLLAND SLIDING FIFTH WHEEL
MODELS 2500, 2535, AND 2536

GENERAL DESCRIPTION

The Holland sliding fifth wheel assembly is designed for general "over-the-road" use, and provides maximum tractor utilization for varied lengths and types of trailers. The Holland models 2500, 2535, and 2536 utilize standard Holland models 2000, 3500, or 3600 fifth wheels, respectively, mounted on sliding brackets. Service instructions for these fifth wheel assemblies are covered in the 22 Group of this manual.

Sliding fifth wheel assemblies are mounted on a full steel baseplate with plungers meshed into teeth on the baseplate rails to lock the mechanism. See Fig. 1. This permits forward or rearward movement of the fifth wheel along the notched rails in order to achieve optimum weight distribution over the tractor axles. The mounting baseplate is bolted to the tractor frame.

PRINCIPLES OF OPERATION

When the fifth wheel is in the desired position, it is locked in place by wedge-shaped plungers that engage in the notched rails under the slide bracket. Disengagement of the sliding member is accomplished by the withdrawal of the plungers. This operation is provided either by an air-operated release slider (Fig. 2), or a double, manual release slider (Fig. 3).

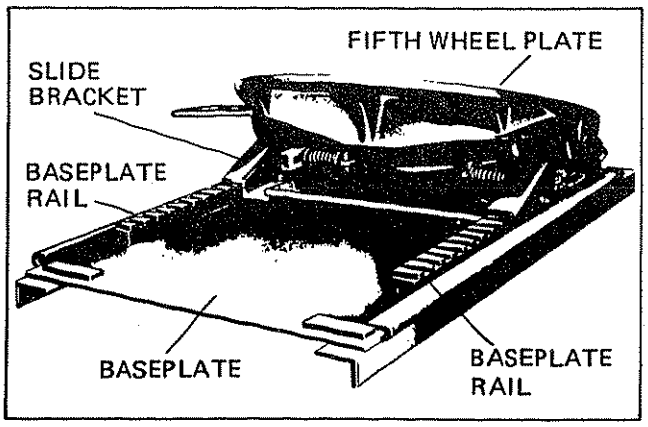


Fig. 1, Sliding Fifth Wheel Mechanism

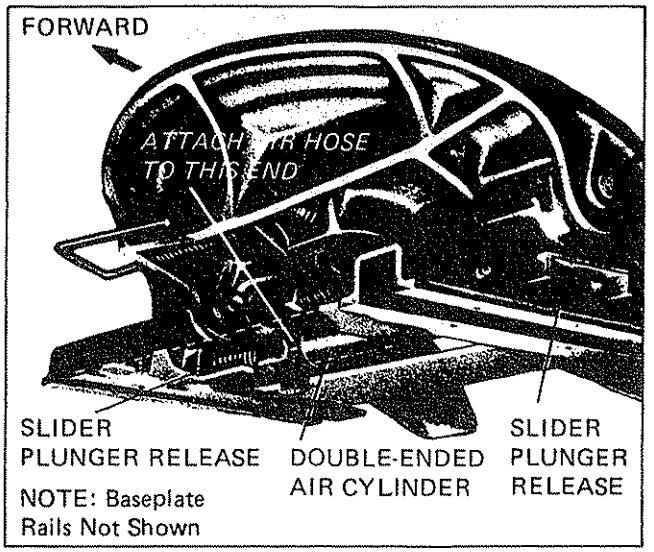


Fig. 2, Air-Operated Release Slider

The air-operated release slider (Fig. 2) contains a double-ended air cylinder which automatically unlocks both sides of the sliding member at the same time. The air cylinder is activated by a cab-operated control switch. See Fig. 4.

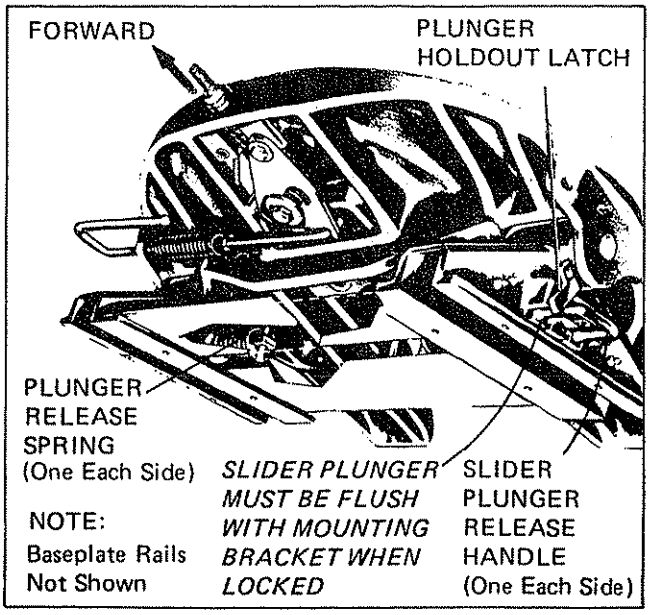


Fig. 3, Double, Manual Release Slider

HOLLAND SLIDING FIFTH WHEEL
MODELS 2500, 2535, AND 2536

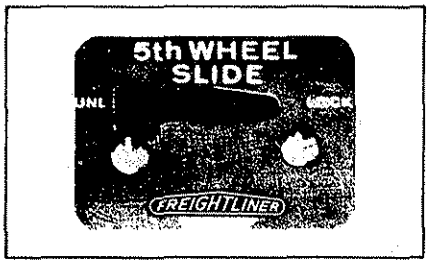


Fig. 4

The double, manual release slider (Fig. 3) contains two slider plunger release handles, one on each side of the assembly. Both handles must be manually unlocked for release of the sliding member.

CAUTION: The preceding is only a brief description of operation. Refer to the Freightliner Drivers Manual for operating instructions on the Holland sliding fifth wheel.

INSPECTION

Inspection of the fifth wheel sliding mount should be conducted at every regular inspection of the fifth wheel. Refer to the maintenance schedule in the Freightliner Maintenance and Lube Manual for inspection intervals.

SERVICE OPERATIONS

WARNING: All fifth wheel maintenance, adjustment, and rebuilding must be done only by a qualified mechanic. Improper or incomplete procedures could result in a hazardous operating condition due to a possible disengagement of the trailer from the tractor.

Safety goggles must be worn during removal, installation, and rebuilding. Failure to do so can result in personal injury, due to parts under spring compression.

FIFTH WHEEL REMOVAL FROM SLIDE BRACKET

1. Disconnect the grounding cable, if applicable, from the fifth wheel.
2. Remove the cotter pins from the inboard ends of the slide bracket rubber bushing pins. Drive the slide bracket rubber bushing pins out of the rubber bushing. See Fig. 5.
3. Use an overhead hoist to lift the fifth wheel off the slide bracket.

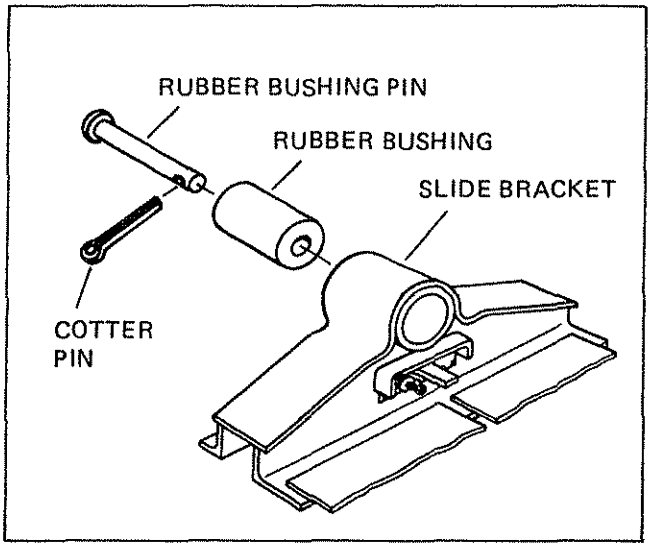


Fig. 5

SLIDING MOUNT DISASSEMBLY
(Refer to Fig. 6 or 7)

1. If the unit is equipped with an air-operated release slider, remove the release air cylinder, using the following procedure:
   - .1 Drain the air from the air reservoirs before disconnecting the air lines from the air cylinder. Taking care to prevent dirt or other foreign matter from entering the air line or cylinder, disconnect the air line from the release air cylinder. Install plugs in the air line and the air cylinder.
   - .2 Remove the slide bracket plunger retaining pins from the slide bracket plungers and the release air cylinder.

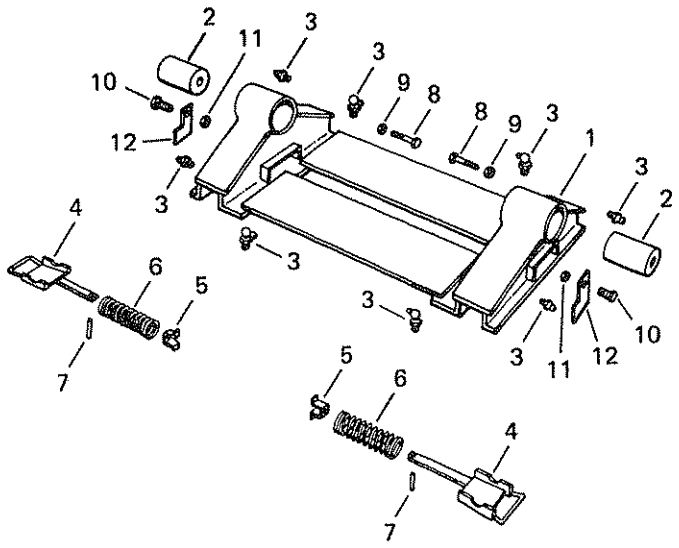
HOLLAND SLIDING FIFTH WHEEL
MODELS 2500, 2535, AND 2536

.3 Remove the release air cylinder from the assembly.

2. If the unit is equipped with a double, manual release slider, remove the slide bracket plunger retaining pins.

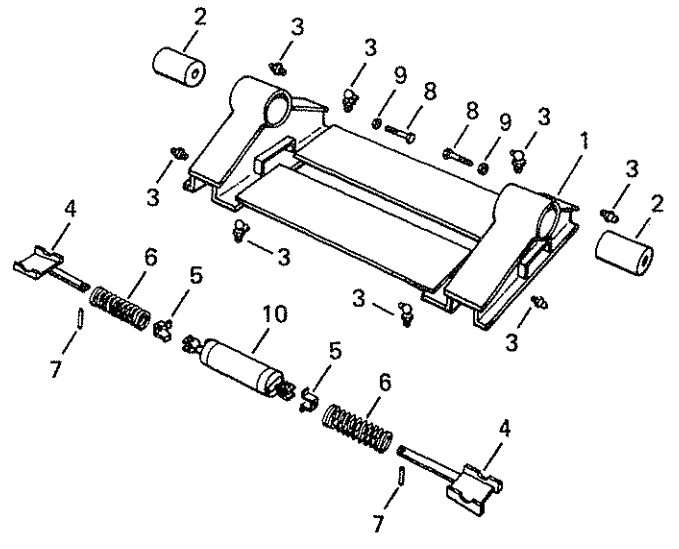
3. Remove the spring retainers and the slide bracket plunger return springs from the slide bracket plungers.

4. Remove the plunger adjusting nuts and bolts from the inside of the sliding brackets.



1. Fifth Wheel Slide Bracket
2. Slide Bracket Rubber Bushing
3. Grease Fitting
4. Slide Bracket Plunger
5. Spring Retainer
6. Slide Bracket Plunger Return Spring
7. Slide Bracket Plunger Retaining Pin
8. Plunger Adjusting Bolt
9. Plunger Adjusting Bolt Nut
10. Plunger Release Lock Bolt
11. Plunger Release Lock Bolt Nut
12. Plunger Release Locks

Fig. 6, Double, Manual Release Slider



1. Fifth Wheel Slide Bracket
2. Slide Bracket Rubber Bushing
3. Grease Fitting
4. Slide Bracket Plunger
5. Spring Retainer
6. Slide Bracket Plunger Return Spring
7. Slide Bracket Plunger Retaining Pin
8. Plunger Adjusting Bolt
9. Plunger Adjusting Bolt Nut
10. Release Air Cylinder

Fig. 7, Air-Operated Release Slider

Service Manual

Service

FREIGHTLINER®

HOLLAND SLIDING FIFTH WHEEL
MODELS 2500, 2535, AND 2536

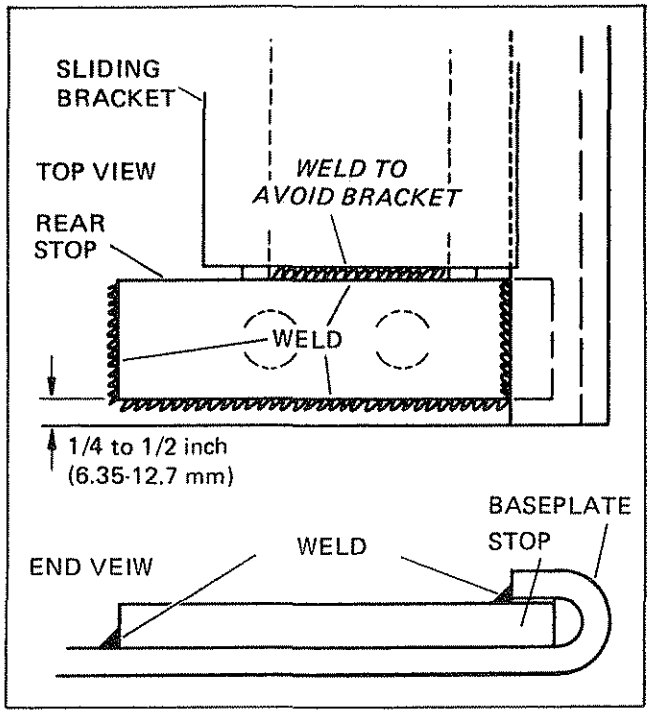


Fig. 8

5. Install the slide bracket plungers into the outboard sides (pocket) of the fifth wheel slide bracket. See Fig. 9.

6. Install the slide bracket plunger return springs on the inboard ends of the slide bracket plunger. Then, install the spring retainers.

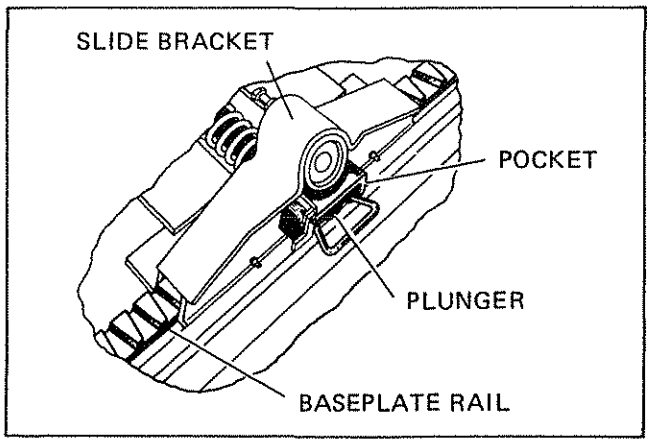


Fig. 9

7. On fifth wheel assemblies equipped with an air-operated release slider, proceed as follows:

   .1 Compress the return spring and spring retainers enough to allow clear access to the hole through the end of the shaft on one of the slide bracket plungers.

   .2 Position the release air cylinder so that its yoke lines up with the hole in the plunger shaft and the spring retainers. Install the slide bracket plunger retaining pin through the hole, attaching the release air cylinder to the plunger shaft.

   .3 Attach the other end of the release air cylinder to its slide bracket plunger, repeating steps 7.1 and 7.2 above.

   .4 Attach the plunger adjusting bolts and nuts to the inside of the slide bracket. Do not tighten the bolt.

   .5 Taking care to prevent dirt or other foreign matter from entering the air line or air cylinder, remove the plugs from the air line and the air cylinder, then, connect the air line to the inlet on the release air cylinder. See Fig. 2.

8. On fifth wheel assemblies equipped with the double, manual release slider, proceed as follows:

   .1 Compress the return spring and spring retainers enough to allow clear access to the hole through the end of the shaft on one of the slide bracket plungers.

   .2 Install the slide bracket plunger retaining pin through the end of the plunger shaft.

   .3 Repeat steps 8.1 and 8.2 above to install the retaining pin in the other slide bracket plunger.

   .4 Attach the adjusting bolts and nuts to the inside of the slide bracket. Do not tighten the bolt.

HOLLAND SLIDING FIFTH WHEEL
MODELS 2500, 2535, AND 2536

.5 Install the plunger release locks and the plunger release lock bolts and nuts. Tighten the nuts to the ends of the bolt threads, leaving the plunger release locks free to pivot on the bolts.

SLIDE BRACKET PLUNGER ADJUSTMENT

NOTE: The slider locking plungers are adjusted at installation and must be adjusted again after one month of use and as needed thereafter.

1. The slide bracket plungers should seat with a small amount of play in the "rack" and "pocket" when retracted (in). See Fig. 9.

2. Position the adjusting bolts (Fig. 10) to obtain this condition. Turning the adjusting bolts clockwise pushes the plunger out, and turning counterclockwise lets the plunger in. Tighten the locking nuts securely after adjusting. Too little adjustment allows the plungers to wedge and bind, and too much adjustment allows excessive play in the bracket on the side plate.

3. If the locking plungers do not release to permit sliding of the fifth wheel; then check the air cylinder, if so equipped, for proper operation, and replace if necessary. If the adjusted plunger binds on the bottom of the plunger pocket, grind the top plunger edges 1/16 inch (1.587 mm) and readjust following steps 1 and 2 above. See Fig. 11.

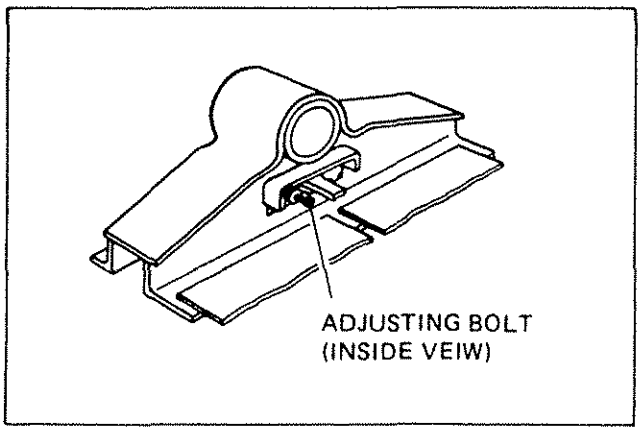


Fig. 10

WARNING: Protective goggles must be worn during the grinding of the top plunger edges. Failure to do so could cause personal injury.

4. When the locking plungers are too loose, check the plunger springs for tension. Fatigue and corrosion may have reduced their ability to hold the plunger in. Replace if necessary. If the plungers are too loose, turn the adjusting bolts (Fig. 10) counterclockwise, so the plungers move further into the rack and take up play. If the plungers are still too loose; then replace the worn plungers and adjust.

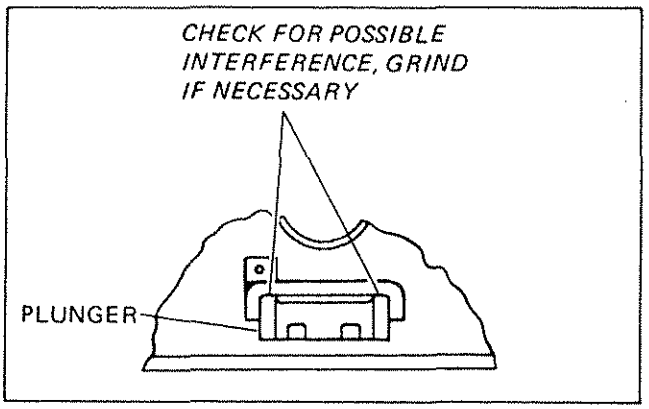


Fig. 11

INSTALLATION OF THE FIFTH WHEEL ON THE SLIDE BRACKET

1. Using an overhead hoist, position the fifth wheel assembly onto the slide bracket.

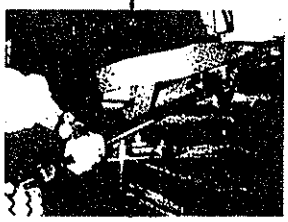
2. Using a pry bar to raise and lower the fifth wheel, line up the fifth wheel mounting holes with the holes in the slide bracket rubber bushings. Drive the slide bracket rubber bushing pins through the bushings, from the outboard sides of the slide bracket, using a hammer and drift, if needed. See Fig. 5.

3. Install new cotter pins through the holes in the ends of the slide bracket rubber bushing pins. See Fig. 5. Lock the cotter pins in place.

4. Connect the grounding cable, if used, to the fifth wheel.

TROUBLE SHOOTING CHART

DIFFICULT COUPLING	1. King pin too high to trip release latch.	Our wheel is so built that king pin must be in proper locking position to couple. This is to prevent "lock out" or improper locking condition where wheel might lock pin in unsafe condition. Check that upper fifth wheel rides on lower wheel when coupling. It is not necessary to "bang" our wheel to lock. The trip latch will operate wheel when the slightest pressure from the king pin.
	2. Misshapen or damaged trailer plate or king pin.	Sometimes operating trailer with small fifth wheel will cause king pin to sag upward in trailer plate. There are also instances where king pin has been banged out of square with top plate and will not lock properly. Check trailer plate for flatness and king pin for squareness with trailer plate.
EXCESSIVE WEAR OR GAULDING ON TOP PLATE OF FIFTH WHEEL	1. There have been instances where upper plate had rough surface or king pin had been improperly welded at bottom of top plate and welds were in contact with top plate and chip off causing roughness on top plate.	Plate or king pin should be removed and properly installed or all contact points ground smooth.
DIFFICULT UNCOUPLING Photo No. 1 Corrective Measure	1. Pressure on locking mechanism caused by truck tending to "drift" away from trailer.	Relieve pressure by "backing up" tractor and setting brakes so there is no "back" pressure of truck against trailer. If this is impossible due to some cramped operating condition, a tap on our wedge where it comes out at the set screw underneath will free the lock. (See photo No. 1 at left).



SLACK	1. Wedge not adjusted correctly.	Open king pin lock and insert 2" diameter shaft vertically. Release the lock by tripping release latch at bottom of throat. Adjust set screw located underneath top plate, to approximately 1/8" clearance from end of wedge. (See photo No. 2 at left).
	2. Squirting of Wedge	Wash off jaw and wedge with thinner or gasoline to remove grease.
		DO NOT GREASE JAW AND WEDGE AT ANY TIME. Grease between the jaw and wedge collects dirt and abrasive matter which give rise to undue wear.
	3. Undersize king pin.	Replace king pin if greater than 1/8" wear at 2" diameter. The "no-slack" mechanism is designed to avoid undue king pin wear. Unusual king pin wear is probably due to improper heat treatment when manufactured. Test for soft king pin with file.
	4. Wear at shaft and brackets.	Normal operational life should be 500,000 miles in 900 series models. When necessary, rotate the shaft 180° at the square end. This, in effect, presents new shaft at the wearing surfaces.
	5. Excessive wear in trailer spring shackles and pins.	Watch for this condition. It has nothing to do with the 5th wheel but the symptoms may appear to be slack in fifth wheel.

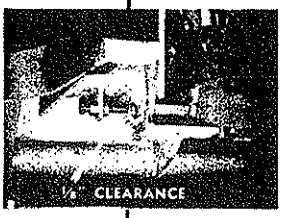


Photo No. 2 Corrective Measure

GENERAL INFORMATION

The fifth wheel is the important connection between the tractor and the trailer. The jaw assembly locks around the trailer kingpin to lock the units together. The top plate is attached to the frame leg mounts by a pivot pin assembly which allows a tilting fore and aft movement to compensate for varying road conditions.

The Fruehauf Fifth Wheel is produced by the Dayton Muncie Manufacturing Co.

OPERATING INSTRUCTIONS

When ready for coupling, the coupler jaws are in the open position. They are held in this position by the jaw spring(4) and plunger(5) shown in Fig. 1.
Upon entry by the kingpin, the coupler jaws are forced to close around the 2" kingpin and the plunger(5) is forced into the locked position by the plunger spring (6). The operating handle(1) is forced to the closed position by the plunger(5) and is locked in place by the locking spring lever(2). These two actions result in a positive lock. The jaws cannot be opened except by deliberate action of the operating handle(1).

To uncouple the fifth wheel, the lock spring(2) is depressed and the operating handle(1) is pulled down and forward toward the cab of the tractor. The plunger (5) is pulled out from the locked position by the operating handle(1). The plunger lock latch(7) which is actuated by the lock latch spring(9), engages the lug on the plunger(5) and holds it in the open position. (Fig. 3)

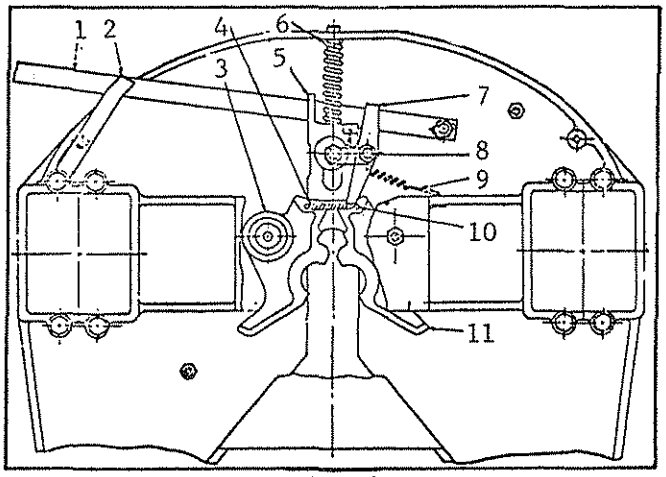


Fig. 1

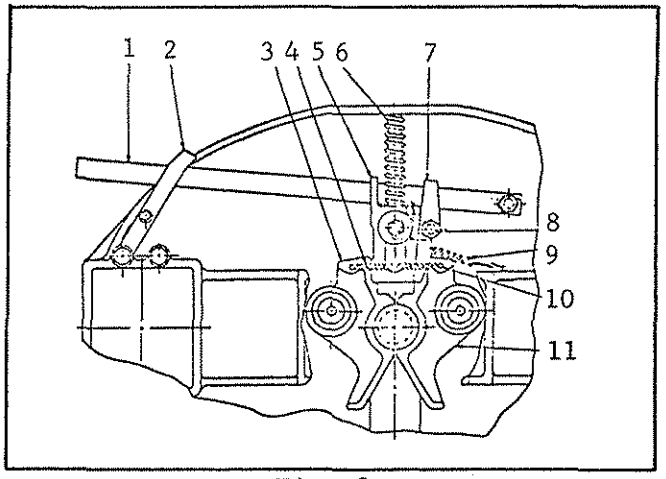


Fig. 2

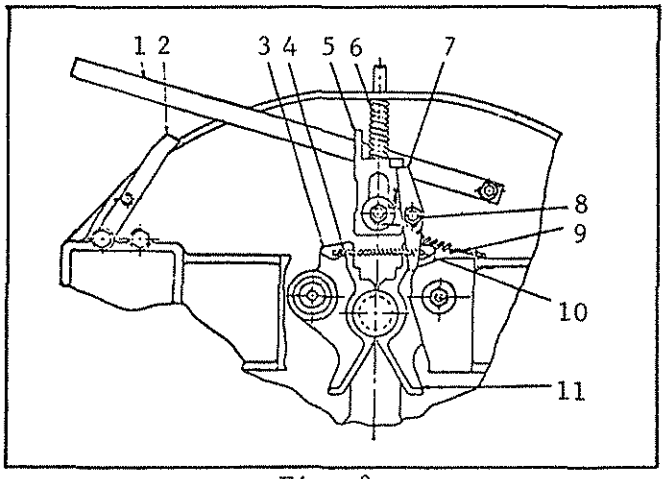


Fig. 3

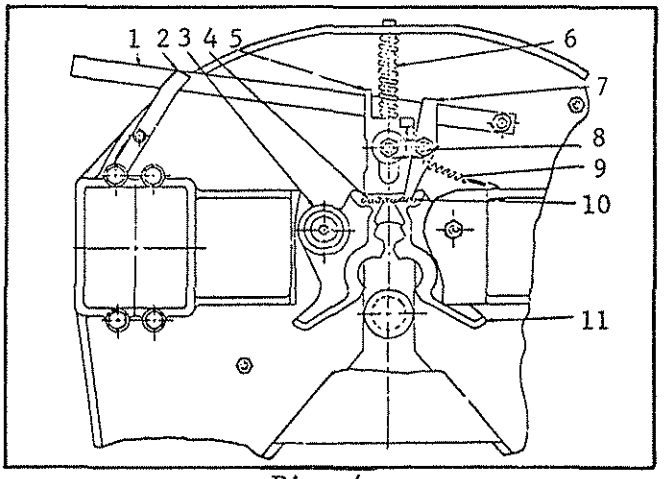


Fig. 4

As the tractor pulls away from the trailer, the kingpin forces the coupler jaws (3 & 11) to open. As the right hand coupler jaw(3) opens, the spring retainer pin(10) engages the lock latch(7) and forces it to turn about the stud(8). As this happens, the plunger(5) is released from the open position and is forced against the jaws(3 & 11). The fifth wheel is then ready to be recoupled to a trailer. (Fig. 4.)

NOTE: For the coupler to be fully locked, the stem of the plunger(5) must be flush with the outer rim of the fifth wheel. Failure to achieve this positioning could result in an unsafe operating condition.

INSPECTION

Refer to Maintenance and Lubrication Manual Subject 35-00500 for recommended inspection intervals and lubrication instructions.

As part of a preventive maintenance program, the manufacturer strongly recommends that during inspection, particular attention be paid to the lock, lock plunger, and lock plunger stud(1), Fig. 5, Ref. 1. If a stud is used to retain the plunger, a safety wire (Dayton #08-204031) should be installed as shown in Fig. 5. The safety wire passes through the plunger stud nut, and the lock lever stud nut. This will prevent the stud from loosening and backing out of the base. Although the stud is welded in place at assembly, it is possible that over the years the weld may be damaged and may crack since it is subjected to a rather severe service life. Inspection of these parts should be made by the operator every 30,000 miles. Any sign of deterioration in this area must be repaired immediately by installing a new pin. All welding of fifth wheel and parts must be performed to high quality standards, as covered in SAE Recommended Practice Specifications #J113. Failure to install new parts, or weld in accordance to specifications #J113, could result in an unsafe operating condition.

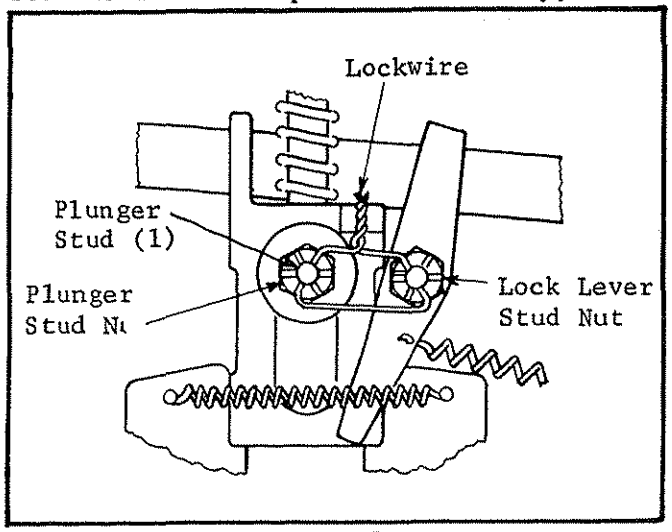


Fig. 5

At the time of inspection, include the following parts:

1. Jaw pins and coupler jaw assembly - for excessive wear and proper lubrication. If the combined wear of jaw pins and the coupler jaws totals 1/8" or more, wear is considered excessive. In such cases, replace worn parts with new ones. Failure to install new parts under such conditions could result in an unsafe operating condition.

2. Release handle - to assure smooth operation without binding and full engagement of the safety hook, or safety spring when in locked position.

3. If the mounting bracket rubber bushings show 1/8" to 3/16" slack, install new bushings.

4. Installation bolts should be Grade 8 U.N.F. with Class C Grade 8 nuts; and torqued to 185 ft. lbs. If the wheel is removed from vehicle, use new bolts and nuts when replacing unit. Refer to subject 32-15810, Table 1 for torquing values.

NOTE: Failure to comply with the above recommendations could result in an unsafe operating condition. If additional service information is desired, contact the Fifth Wheel Manufacturer or authorized distributor.

To compensate for the use of a short non-standard kingpin assembly being used on some trailers, Dayton Muncie is now relieving the top side of the locking jaws. The new style coupler jaws (Part No.'s 59-001506 and 59-001507) are 1/8" thinner than the old style jaws (Part No.'s 59-000372 and 59-000373) and will interchange with the addition of a washer (08-204524) installed below the jaws. All service jaws will be shipped with the 08-204524 washer. (See Fig. 6.)
In addition, when the new jaw dies (Part No.'s 59-001664 and 59-001665) are in production, two washers (Part No. 08-204524) will have to be installed below the jaws. (See Fig. 7.)
The above information is covered in Dayton Muncie Engineering Service Bulletin FWC-B (8-20-1968).

LUBRICATION

Lubricate fittings on jaw pin assembly and top plate. Lubricate the jaw assembly and top plate surface using chassis lubricant as covered in Freightliner Maintenance and Lubrication Manual Subject 35-22100.

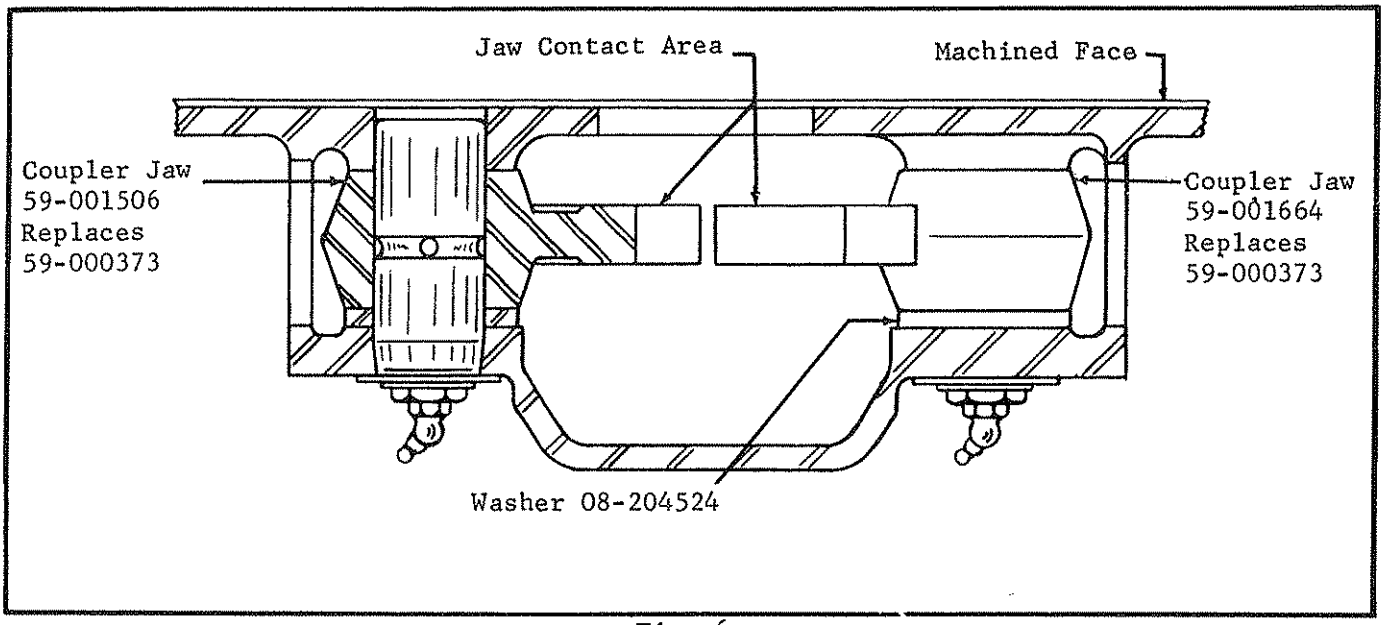


Fig. 6

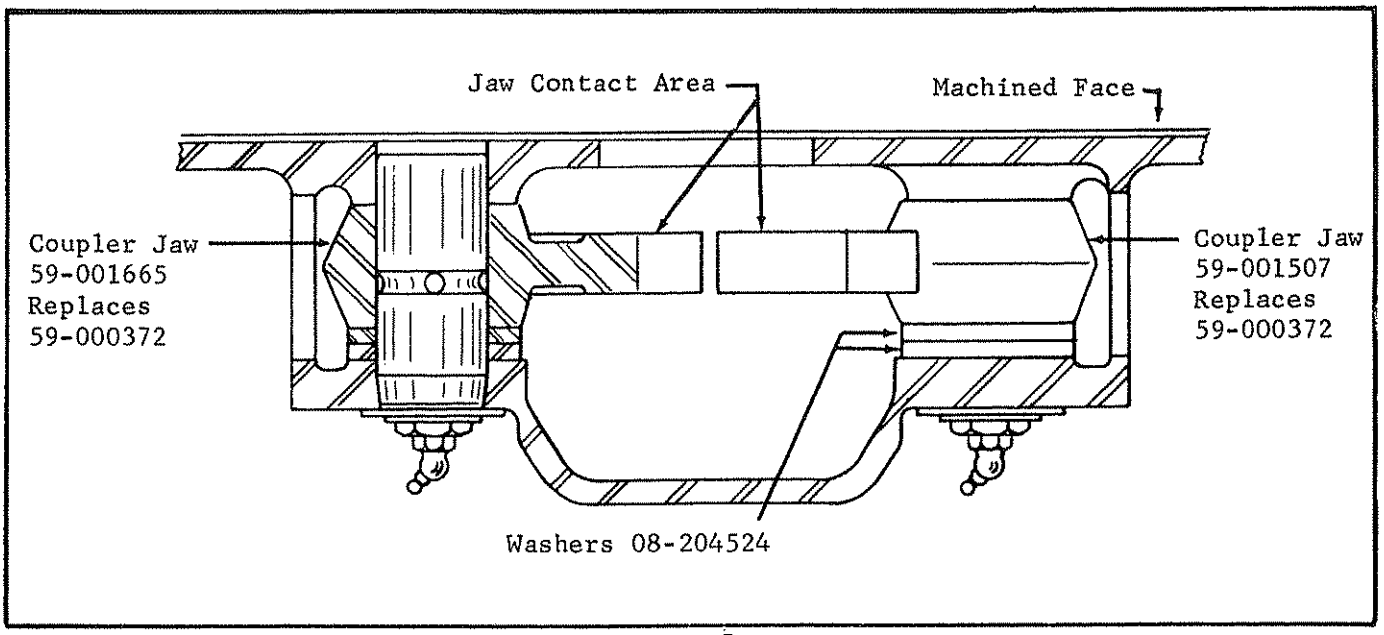


Fig. 7

SIMPLEX SLACK-FREE FIFTH WHEEL

GENERAL INFORMATION

The Simplex Slack-Free fifth wheel assembly (Fig. 1) is designed for pulling legal axle load limits on trailers equipped with the two inch standard S.A.E. kingpin. It is bracket-mounted to the tractor frame in a position that will most advantageously distribute the trailer load over the tractor axles.

The frame brackets are made of cast steel, and are fully cushioned by corrugated rubber bushings which absorb road and traction shock. An oversized replacement rubber bushing can be installed to take up any slack that develops in this area.

The Simplex Slack-Free fifth wheel features a cast steel cover plate that is equipped with a lock mechanism. The lock mechanism consists of a rotating jaw and a spring-actuated lock that grips the trailer kingpin. The jaw rotates on an eccentric pin during coupling and uncoupling operations. The spring-actuated lock holds the jaw in the locked position once kingpin lockup has occurred.

In the locked position, there is approximately 1/16-inch (1.6 mm) clearance between the jaw and the kingpin. The jaw eccentric pin can be removed and rotated to compensate for additional slack, due to wear, and maintain an approximate 1/16-inch (1.6 mm) clearance. This can be done without removing the entire unit from the vehicle.

PRINCIPLES OF OPERATION

NOTE: Refer to the Freightliner Driver's Manual for complete operating instructions.

When the tractor is moved out from under the trailer after unlocking the fifth wheel, the kingpin rotates the jaw until the jaw is in a position that allows the kingpin to disconnect. During coupling, the motion of the kingpin entering the jaw rotates the jaw into the locked position, securely locking the jaw around the kingpin. See Fig. 2.

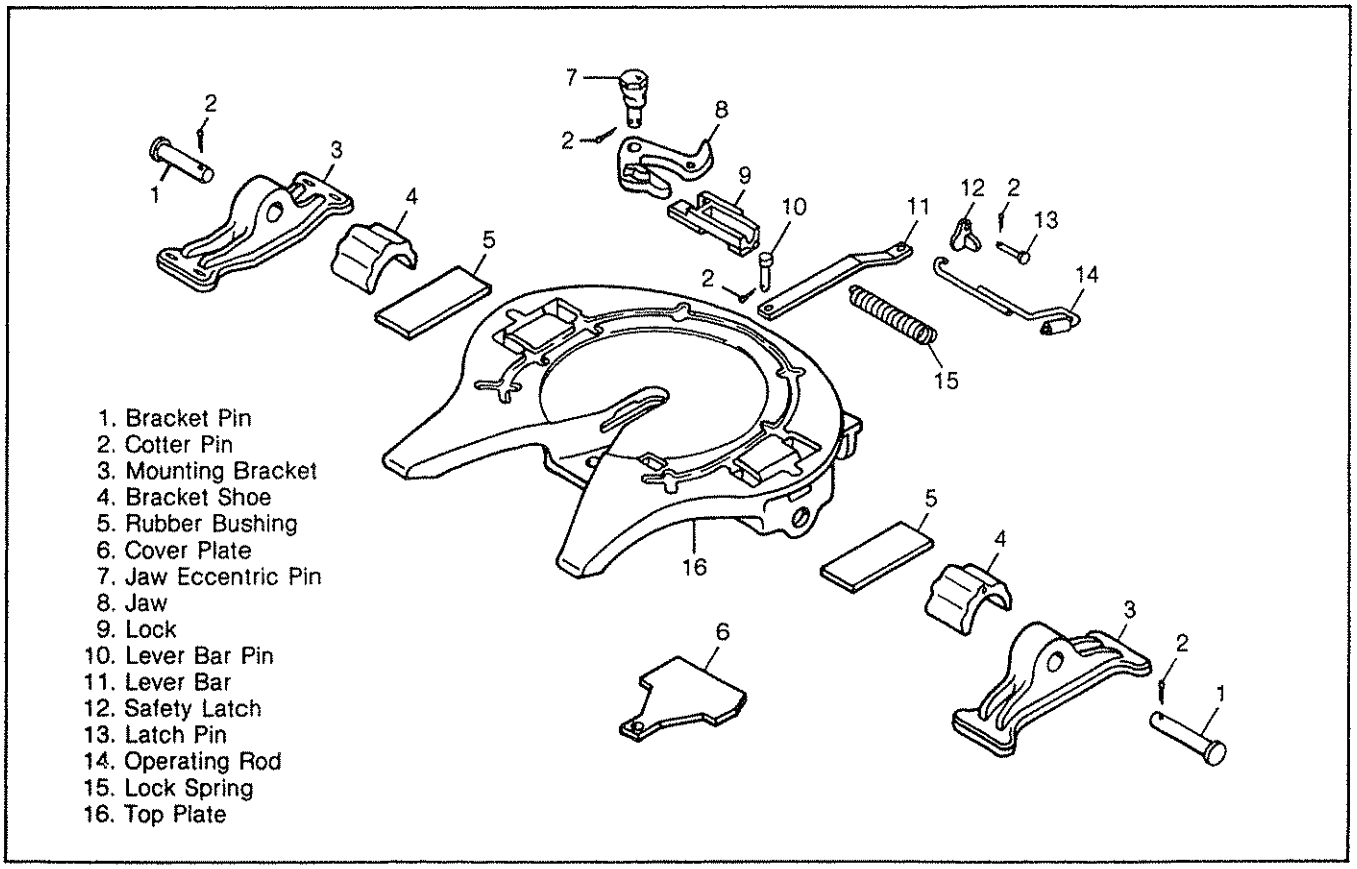


Fig. 1, Simplex Slack-Free Fifth Wheel Assembly

SIMPLEX SLACK-FREE FIFTH WHEEL

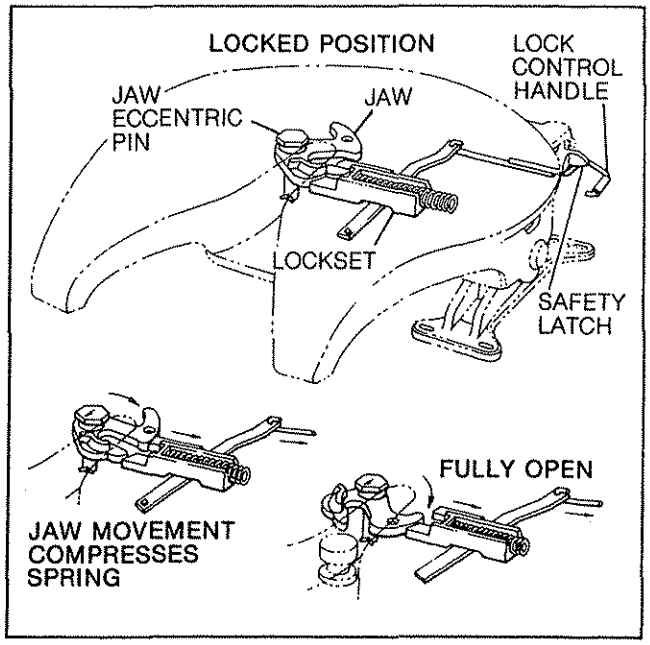


Fig. 2, Simplex Kingpin Locking Mechanism Operation

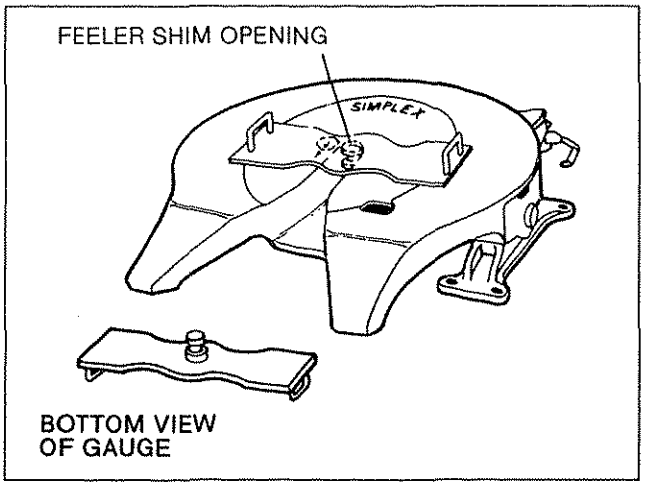
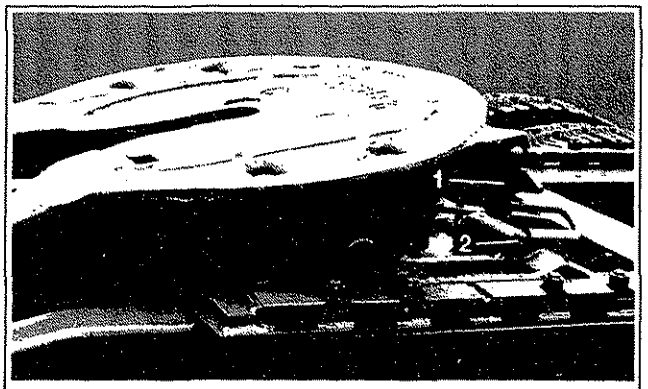


Fig. 3



1. Safety Latch
2. Lock Control Handle (Locked)

Fig. 4

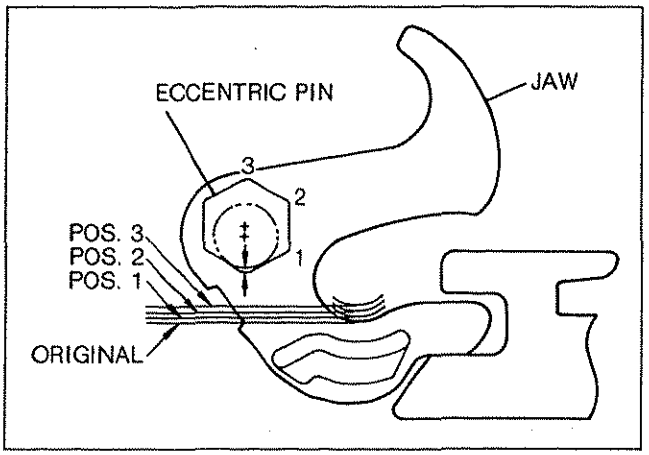


Fig. 5

SERVICE OPERATIONS

IMPORTANT: The fifth wheel must be well lubricated for operation. Refer to the 22 Group of the Freightliner Maintenance and Lube Manual for instructions on the maintenance and lubrication of the fifth wheel assembly.

SLACK ADJUSTMENT (Refer to Fig. 1)

New units provide approximately 1/16-inch (1.6 mm) clearance in the kingpin area. This is desirable to permit proper locking. To maintain an approximate 1/16-inch (1.6 mm) clearance, perform the following procedure:

1. Ram a Simplex gauge (No. 010562-B) or a new kingpin into the fifth wheel to achieve a coupled and locked condition. See Fig. 3. Be certain the safety latch is down. See Fig. 4.
2. Measure longitudinal movement (slack) with the gauge plate flat on the fifth wheel at both the fore and aft positions.
3. Remove the gauge.
4. If the slack is more than 1/8 inch (3.2 mm), it is excessive and may be dialed out using the eccentric pin on which the jaw pivots. Starting from the eccentric pin's original position (arrow straight aft) there are three positions that will take up slack. See Fig. 5. Position 1 will remove 1/16-inch (1.6 mm)

SIMPLEX SLACK-FREE FIFTH WHEEL

slack. Position 2 will remove 5/32-inch (4 mm) slack. Position 3 will remove 7/32-inch (5.6 mm) slack. Use the following instructions to dial out slack:

.1 Close the jaw, and lock the wheel following instructions in the Freightliner Driver's Manual. This removes pressure on the pivot pin.

.2 Remove the cotter pin on the eccentric pin. Lift the eccentric pin sufficiently to clear the indexing head, and rotate the pin to the next higher number position. See Fig. 6.

.3 Measure the slack action after making the change. The proper final adjustment should allow approximately 1/16-inch (1.6 mm) kingpin movement.

.4 If slack is still excessive, repeat steps 2 and 3 until proper adjustment is achieved or until position 3 is reached.

IMPORTANT: Do not go beyond position 3. If excessive slack remains at position 3, follow the instructions under "JAW AND JAW PIN REPLACEMENT" and "LOCK REPLACEMENT."

.5 Install a new cotter pin on the eccentric pin.

.6 Check that a positive lock (safety latch down) can be achieved by ramming the gauge or a new kingpin into the fifth wheel.

JAW AND JAW REPLACEMENT (Refer to Fig. 1)

1. Lock the fifth wheel in place without a kingpin, following instructions in the Freightliner Driver's Manual.
2. Remove the cotter pin from the eccentric pin. Remove the eccentric pin, then remove the jaw by sliding it out.

   The eccentric pin can be re-used, or, if excessive wear has taken place in the area around the hexhead, it can be replaced by a pin that has an oversized hexhead. The diameters of the pin itself are not increased, so the pin with an oversized head should be used with a standard jaw.
3. Clean and grease all parts prior to assembly, particularly the pin hole in the new jaw.
4. Assemble the parts, positioning the eccentric pin arrow to arrow. See Fig. 7.
5. Follow the instructions under "SLACK ADJUSTMENT" to check for and remove any excess slack.

LOCK REPLACEMENT (Refer to Fig. 1)

1. Lock the fifth wheel following instructions in the Freightliner Driver's Manual.
2. Remove the lever pin cotter and the lever pin. Remove the cover plate and the lever bar.
3. Remove the lock and lock spring.

WARNING: Wear safety glasses. Remove the lock and lock spring carefully. The lock spring is under compression and could be discharged with enough force to cause personal injury.

4. Clean the new lock pocket and parts. Coat them with a thin film of grease and assemble the parts in reverse order.

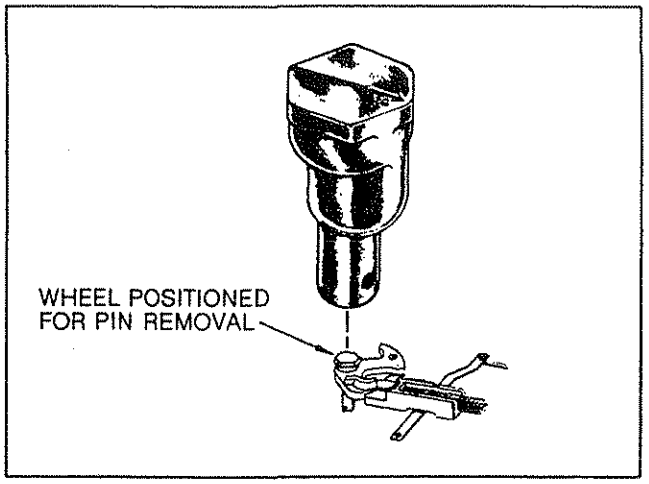


Fig. 6

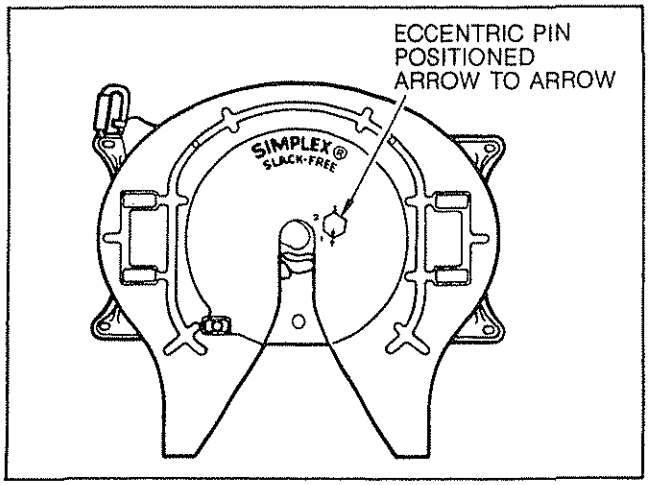


Fig. 7

SIMPLEX SLACK-FREE FIFTH WHEEL

5. Check for proper operation by following the operating instructions in the Freightliner Driver's Manual.

RUBBER BUSHING REPLACEMENT (Refer to Fig. 8)

1. Remove the bracket-pin cotter pins and the bracket pins.

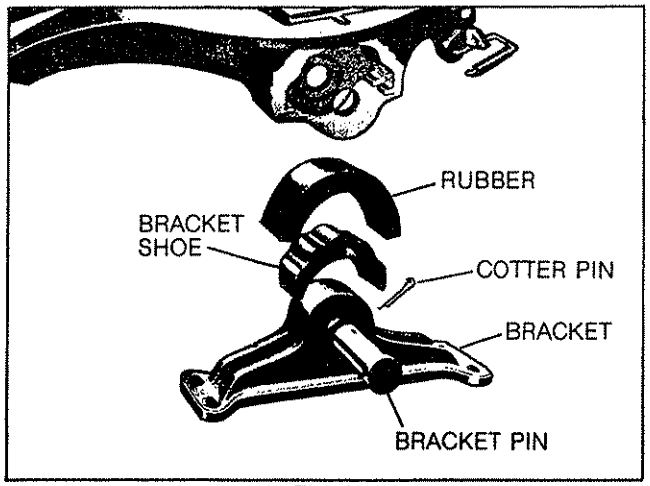


Fig. 8

2. Remove the grease fitting (Fig. 9) and drive out the bracket shoe. See Fig. 10.
3. Replace the rubber bushings using either standard or oversized bushings.

IMPORTANT: Do not grease the bushings or pockets.

4. Drive the bracket shoe in place against the stop and replace the grease fitting.
5. Position the fifth wheel top plate on the brackets, clamp it in place to compress the bushings, then install the bracket pins. Insert and crimp new cotter pins in the bracket pins.

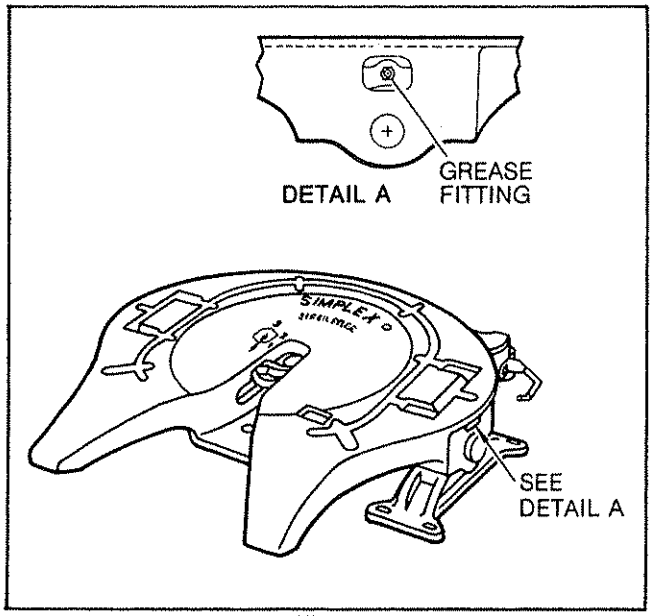


Fig. 9

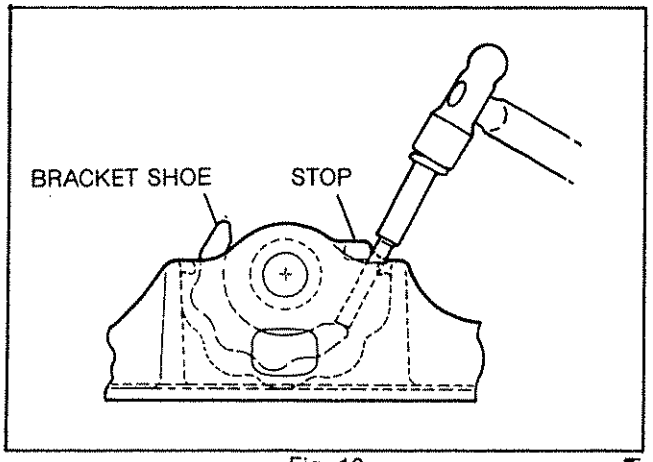


Fig. 10

ASF MODEL 400C SERIES FIFTH WHEEL

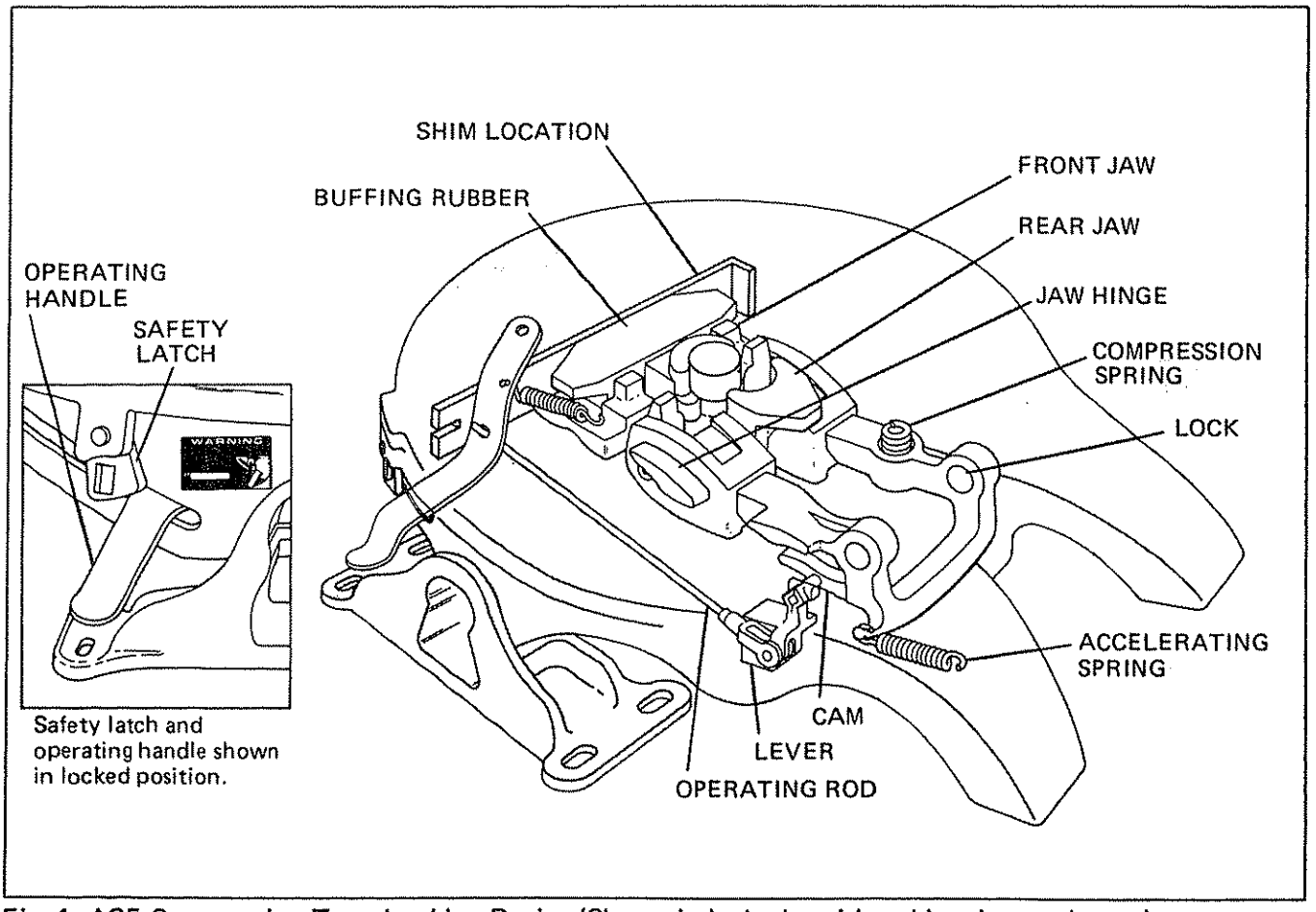
GENERAL DESCRIPTION

The ASF Model 400C series fifth wheel assembly is designed for general "over-the-road" use vehicles, and for standard, state-legal, axle load limits. The fifth wheel is bracket-mounted to the tractor frame in a position that will most advantageously distribute the trailer load over the tractor axles. The high tensile steel mounting brackets have over 26 sq. in. (167 mm^2) trunnion bearing area, with the bracket heights in either a low, intermediate, or high profile.

The fifth wheel plate is a rib reinforced, heat treated, high tensile steel casting with a machined top surface. The ASF 400C kingpin lock is a high tensile steel jawed compression type locking device designed to be used with the 2 inch standard S.A.E. kingpin. See Fig. 1. The jaws encircle the kingpin and grip the kingpin at the top. See Fig. 2. This increases bearing area and reduces bending leverage.

PRINCIPLES OF OPERATION

With the hinged jaws open by previous uncoupling, the lock control handle is placed in the unlocked position. See Fig. 3. The cam moves from the horizontal to the vertical position, entering a notch at the bottom of one lockarm and raises the lockarms so that they clear the rear jaw. This action holds the lock control handle in the unlocked position. When the tractor moves out from under the trailer, the jaws slide to the rear of the jaw



Safety latch and operating handle shown in locked position.

Fig. 1, ASF Compression Type Locking Device (Shown in locked position, kingpin not shown.)

ASF MODEL 400C SERIES FIFTH WHEEL

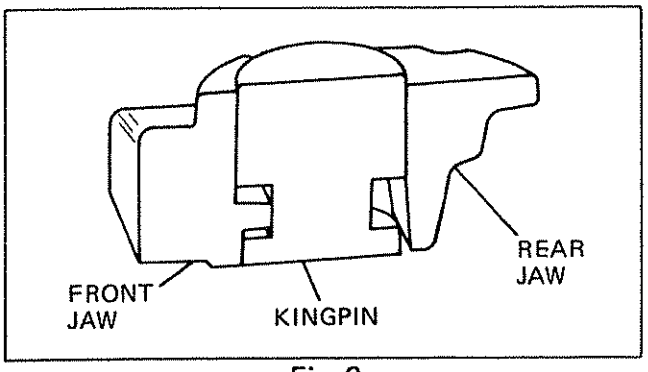


Fig. 2

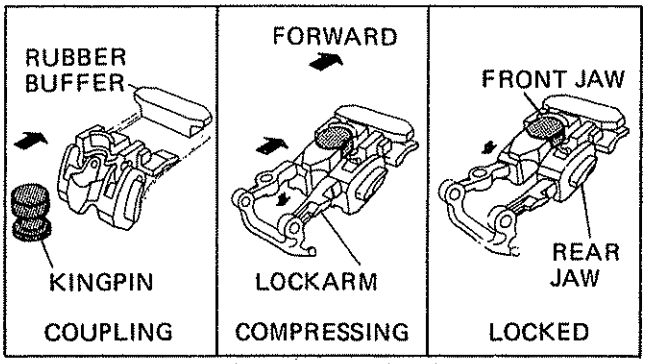


Fig. 4, ASF Kingpin Lock Mechanism

housing. The rear jaw drops clear of the kingpin, allowing the kingpin to move out of the jaw set.

During coupling, the motion of the kingpin entering the jaw moves the hinged jaw assembly forward and closes it around the kingpin. This movement compresses the buffing rubber, and by gravity and spring action, permits the lockarms to fall, allowing the cam to rotate to the locked position. See Fig. 4. When the kingpin enters the jaws, it will spread them to the 2-7/8 inch (73 mm) dimension and place approximately 3000 lbs (292 N) compression on the buffing rubber, proper for this unit. This moves the operating handle below the safety latch and into the locked position. The safety latch provides the operator with a visual indication of a locked condition. Do not force the handle or safety latch.

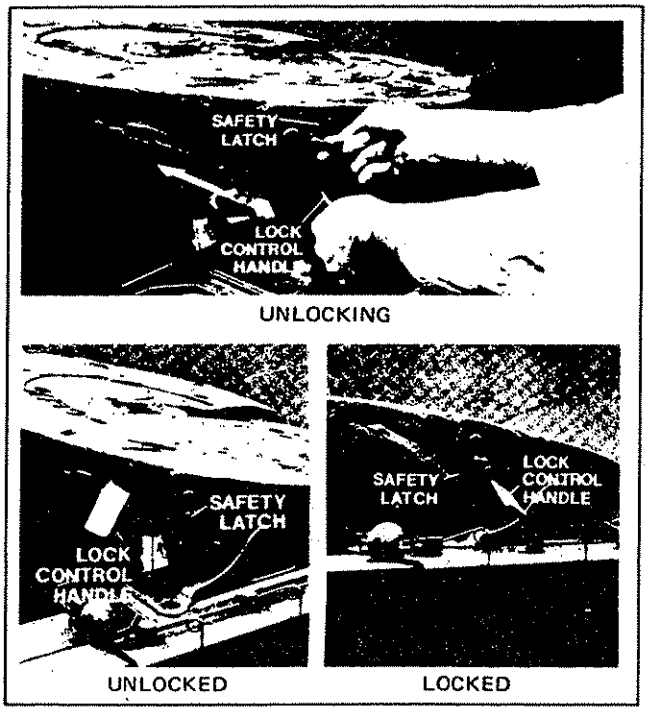


Fig. 3, ASF Fifth Wheel Locking and Unlocking

NOTE: The preceding is a brief description of operation. Refer to the Freightliner Drivers Manual for operating instructions of the ASF 400C fifth wheel.

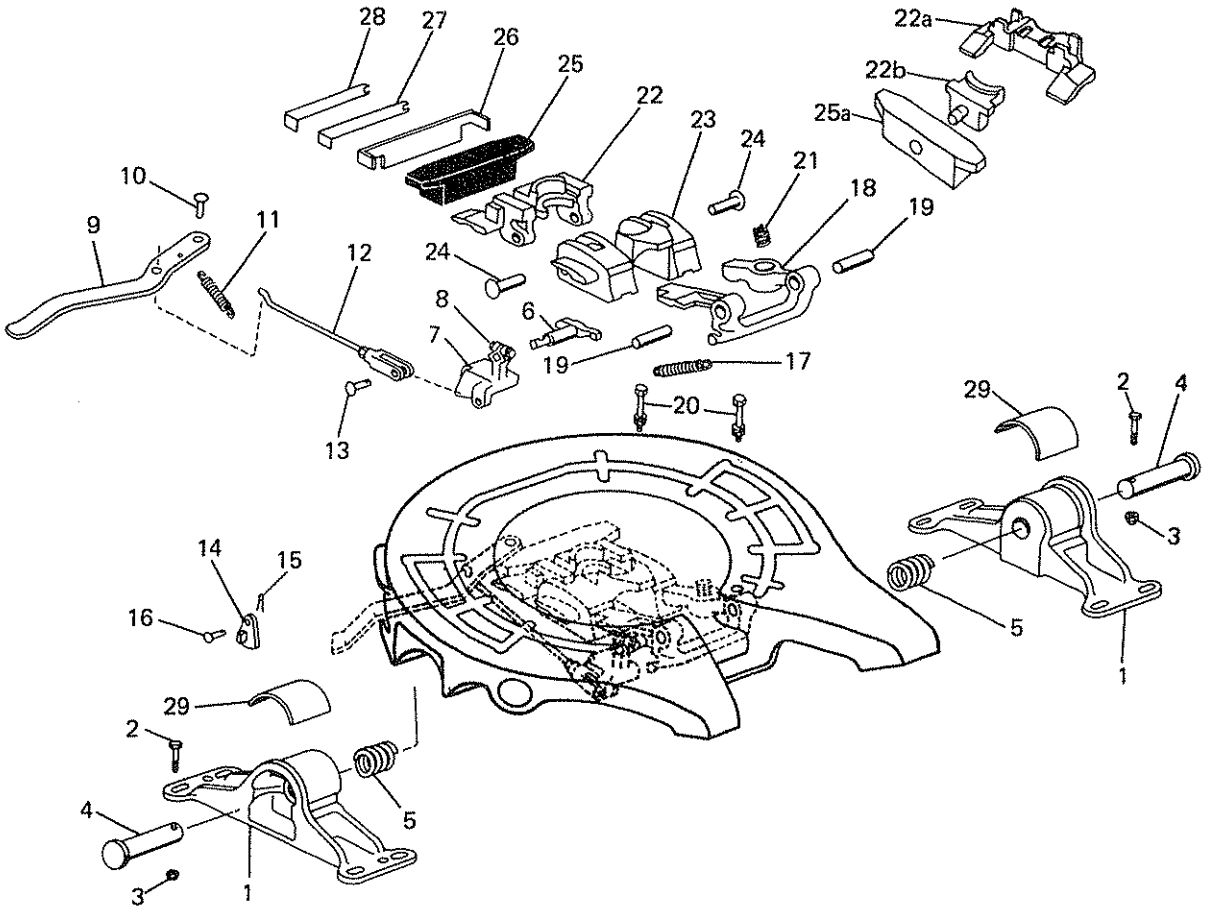
IMPORTANT: The fifth wheel must be well lubricated for operation. Refer to the Freightliner Maintenance and Lube Manual for instructions on maintenance and lubrication of the fifth wheel assembly.

SERVICE OPERATIONS

REMOVAL (Refer to Fig. 5)

1. Steam clean the fifth wheel assembly. Disconnect the ground strap, if applicable, from the fifth wheel.
2. Remove the 1/2-13 UNC-Grade 5 hex head bolt and self-locking nut from the mounting bracket pin; then, remove the mounting bracket pin and the bracket pin washer springs.
3. Remove the fifth wheel, using an overhead hoist. Turn the fifth wheel upside down with the locks in the open position.

ASF MODEL 400C SERIES FIFTH WHEEL



1. Mounting Brackets
2. 1/2-13 UNC-Grade 5 Bolt
3. Self-locking Nut
4. Mounting Bracket Pin
5. Mounting Bracket Pin Spring Washer
6. Cam (R.H. Release)
7. Operating Rod Lever
8. Lever Bolt And Locknut (For Cam Connection)
9. Operating Handle
10. Safety Latch And Lever Pin
11. Operating Handle Accelerating Spring
12. Operating Rod Assembly
13. Clevis Pin
14. Safety Latch (R.H.)
15. Safety Latch Cotter Pin
16. Safety Latch And Lever Pin (Safety Latch)
17. Lock Accelerating Spring
18. Right Hand Lock
19. Lock Pin
20. Lock Pin Bolts, Nuts, And Lockwashers
21. Lock Compression Spring
22. Front Jaw
22a. Front Jaw (2-Piece Jaw)
22b. Kingpin Bearing Block (2-Piece Jaw)
23. Rear Jaw
24. Jaw Hinge Pins
25. Buffing Rubber
25a. Buffing Rubber (2-Piece Jaw)
26. Backing Plate
27. 1/16 Inch Shim
28. 1/22 Inch Shim
29. Bracket Shim

Fig. 5

ACCESSORY 22
32-22300

ASF MODEL 400C SERIES FIFTH WHEEL

DISASSEMBLY (Refer to Fig. 5)

1. Remove the lever bolt and locknut connecting the operating rod lever to the cam. Pull the operating rod lever off from the cam, then, remove the cam from the fifth wheel.

NOTE: If any difficulty is encountered, move the operating handle end up or down until proper clearance is obtained to remove the cam from the lever.

2. Disconnect the operating handle accelerating spring from the fifth wheel. Remove the safety latch and lever pin from the operating handle and the operating handle accelerating spring. Remove the accelerating spring.

3. Remove the clevis pin from the operating rod assembly and the operating rod lever. Remove the operating rod lever from the fifth wheel.

4. Disconnect the operating rod assembly from the operating handle. Remove the operating rod assembly and the operating handle from the fifth wheel.

5. Remove the safety latch cotter pin, the safety latch and lever pin, and the safety latch from the fifth wheel.

6. Disengage the lock accelerating spring from the lock. Remove the lock pin bolts, nuts, and lockwashers from the lock pins, then, remove the lock pins from the lock.

7. Lift the lock and the lock compression spring up and out of the fifth wheel plate. Remove the lock compression spring from the lock.

8. Slide the jaw assembly out of the fifth wheel. Remove the jaw hinge pins from the jaws, and disconnect the front jaw from the rear jaw. Remove the buffing rubber, the backing plate, and the shims, if applicable, from the fifth wheel.

CLEANING AND INSPECTING

1. Clean all removed parts with No. 2 diesel oil, or an equivalent. Check all parts for cracks or wear. Replace all worn or damaged parts with new ones.

WARNING: When cleaning parts with No. 2 diesel oil, or an equivalent, do not smoke or use an open flame near the area. To do so could result in combustion of diesel oil.

2. Check the backing plate, if damaged or worn out of shape, replace with a new one. Check the buffing rubber and shims. Replace if worn or damaged.

ASSEMBLY (Refer to Fig. 5)

1. Attach the backing plate to the buffing rubber by bending over the slotted ends of the backing plate. Then, install the buffing rubber assembly to a new set of front jaws. Assemble the front jaws to the new rear jaws and install the new jaw hinge pins. Lubricate the slide area with grease, and slide the jaw assembly into the fifth wheel.

NOTE: It is recommended that a new set of jaws, jaw hinge pins, and locks be used. However, the original locks may be re-used, if in good condition. After the lock and jaw assembly is installed and the lock pins in position, the lock arms should be pulled into the locked position and should fit very tightly against the rear jaw bearing surface. If there is any gap or distance between the lock arm ends and the rear jaw, then the unit should be shimmed until the proper compression is obtained. Service shims can be added behind the buffing rubber until proper compression is reached, eliminating movement between the tractor and trailer after coupling. See the procedure given under the heading, "ADJUSTMENT," in this subject.

2. Attach the lock compression spring to the lock, then, install the lock assembly to the fifth wheel. Install the lock pins to the lock; then the lock pin bolts, nuts, and lockwashers to the

ASF MODEL 400C SERIES FIFTH WHEEL

lock pins. Be sure that the recessed area of the jaw hinge pins aligns with the tapered lock pin bolts.

3. Install the lock accelerating spring to the lock and the fifth wheel.

4. Install the safety latch and the safety latch and lever pin to the fifth wheel, and secure with the safety latch cotter pin.

5. Connect the operating rod assembly to the operating handle, then, install the operating handle and the operating rod assembly to the fifth wheel.

6. Install the operating rod lever to the operating rod assembly by attaching with the clevis pin. Install the operating rod lever to the fifth wheel.

7. Connect the operating handle accelerating spring to the operating handle; then, install the safety latch lever pin to the operating handle and the operating handle accelerating spring. Install the accelerating spring to the fifth wheel.

8. Connect the cam to the operating rod lever, and secure the cam to the operating rod lever with the lever bolt and locknut.

ADJUSTMENT

1. To adjust the jaws, lock the jaws in the locked position with or without a kingpin. Make sure that the lock arms are completely down on the rear jaw bearing surface, as shown in Fig. 6. Check that the safety latch is in the locked position.

   If any clearance exists between the lock arm ends and the rear jaw surface, a shim the thickness of that dimension should be installed ahead of the buffing rubber. If the jaws are locked without a kingpin in place, the measurement will be 3/16 inch (4.76 mm) less than the upper kingpin dimension of 2-7/8 inch (73 mm).

NOTE: Too much compression will result in difficult coupling and uncoupling. Insufficient compression will result in an undesirable slack between the tractor and the trailer.

After compression adjustment has been achieved, lock the shims in place by bending the tabs of the shims over the backing plate and buffing rubber.

2. To check the operation of the operating rod assembly, operating rod lever, and cam, lock the locks, without a kingpin, using a pry bar. Make sure the lock arms are completely down on the rear jaw bearing surface, as shown in Fig. 6. Check to see if the safety latch is in the locked position.

   Place your hand against the operating rod lever and exert enough pressure to make sure any slack in joints or looseness is taken up. While exerting pressure, make sure the locking end of the cam is up behind the lock shoulder and flush with the bottom of the shoulder.

   If inspection reveals that the cam is not in proper position, check first to see if the operating rod is straight. If necessary, the operating rod should be taken off and replaced or straightened. If the operating rod is straight and the cam is not in the proper position, the operating

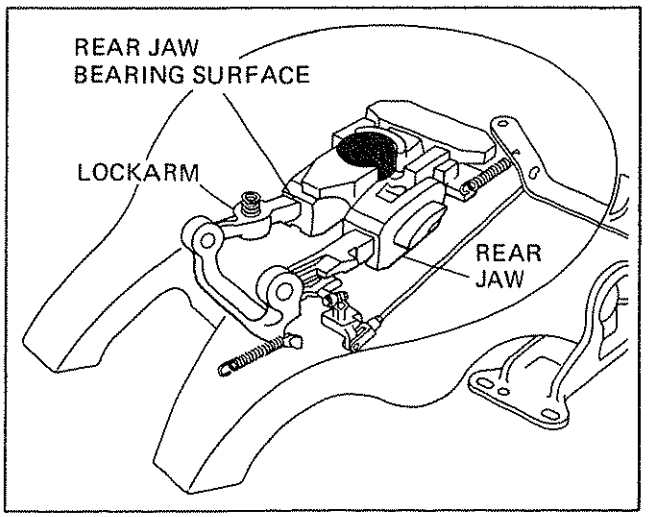


Fig. 6

ASF MODEL 400C SERIES FIFTH WHEEL

rod should be adjusted to the proper length at the operating rod lever.

In making the adjustment, back the locknut off so the operating rod lever can be turned freely. Turn the operating rod lever to the left if you wish to lengthen the operating rod assembly, which will raise the locking end of the cam. Turning the operating rod lever to the right will shorten the operating rod assembly and lower the locking end of the cam.

INSTALLATION

1. Use an overhead hoist to position the fifth wheel plate assembly over the mounting brackets.

2. When the fifth wheel is aligned with the mounting brackets, install the mounting bracket pins through the mounting brackets and fifth wheel. Install the mounting bracket pin washer springs and secure with the 1/2-13 UNC-Grade 5 hex head bolt and self-locking nut. See Fig. 7. Tighten to 55-65 ft-lbs (75-88 N·m).

3. The design of the ASF fifth wheel plate to the bracket connection will allow 1/8 inch (3.175 mm) vertical movement of the plate. When such vertical movement reaches or exceeds 1/4 inch (6.35 mm), it is recommended that a 3/16 inch bracket shim be installed. See Fig. 8. Use the following procedure for bracket shim installation:

   .1 Remove the fifth wheel from the mounting brackets using the procedure given under the heading "REMOVAL," in this subject.

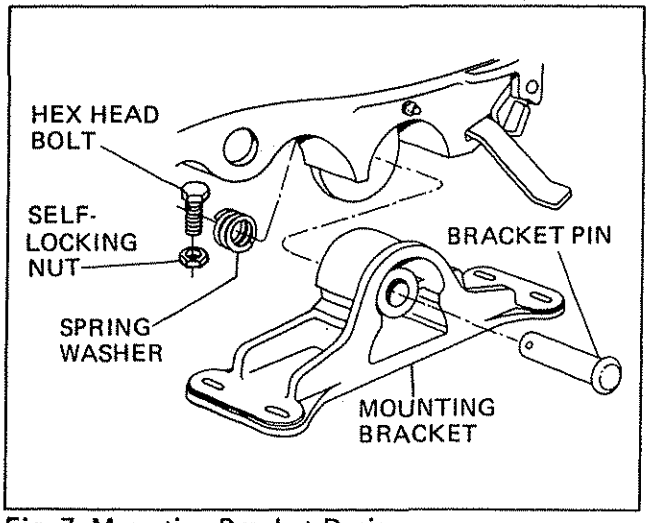
   .2 When installing the bracket shim, any high or uneven spots on the trunnion area should be removed with a hand grinder.

WARNING: Protective goggles must be worn during grinding. Failure to do so can cause personal injury, due to the splash of sparks and metal debris from the grinding process.

   .3 Place the shim over the trunnion area and hold in place with a "C" clamp. The shim should then be welded securely along both bottom edges. Grind off excess weld.

WARNING: Protective welding masks must be worn during the welding of the shim to the bracket. Failure to do so can cause personal injury, due to the intensity and splash of sparks and heat created from welding.

   .4 Install the fifth wheel to the brackets following the procedure given under this heading.



Fig, 7, Mounting Bracket Design

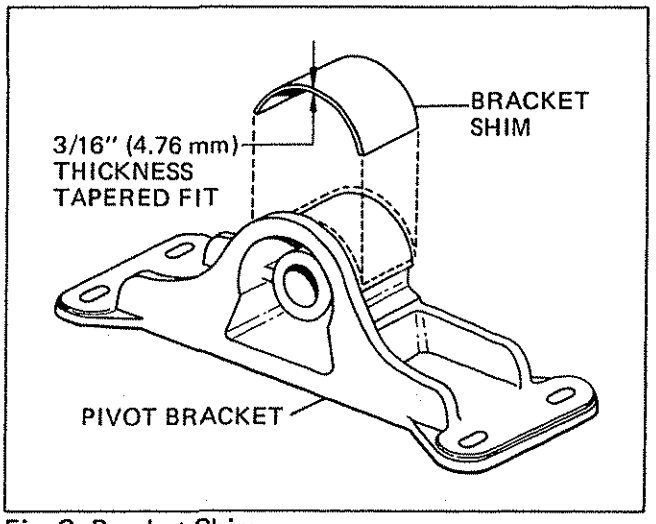


Fig. 8, Bracket Shim

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

GENERAL DESCRIPTION

Freightliner vehicles may use any of three different systems of Kysor engine warning and shutdown components as optional equipment. Each system uses the Kysor "Tem-pressure" components (for that system) in conjunction with the standard tri-diode warning system.

One system provides two-way protection against engine damage: a Kysor alarmstat (Fig. 1) senses high coolant temperature, and a Kysor pressurestat (Fig. 2) senses low oil pressure. The alarmstat and pressurestat are linked (by way of the tri-diode) to a warning bell and individual dash-mounted warning lights to warn the vehicle operator when coolant temperature or oil pressure reaches a dangerous level. If appropriate action is not taken by the vehicle operator, and a critical level is reached, the engine will automatically shut down by cutting off the fuel supply. A four-terminal, solid-state electronic control module (Fig. 3) allows the sensors to be by-passed, permitting starting and running of the engine for 30-second intervals in order to move the vehicle.

Another system provides two-way protection (the same as the first system), but replaces the control module with a dash-mounted push-button manual override for by-passing the sensors. This allows the vehicle to be started and run as long as the push-button is depressed by the operator.

The final system available provides three-way protection, with the addition of a coolant probe (Fig. 4) to sense low coolant level. The coolant probe is also linked (by way of the tri-diode) to the warning bell and to a dash-mounted low-coolant-level light. Automatic override of the sensors is provided by a six-terminal control module (Fig. 5) that by-passes the sensors for 30-second intervals, in addition to providing a 30-second warning before engine shutdown when the coolant level is low.

All three systems use a tri-diode (Fig. 6) in the warning circuit. The tri-diode allows the warning bell to be activated whenever any of the sensors activate their respective dash-mounted warning lights. It uses a separate internal diode (which allows the electrical current to flow in only one direction) between the single warning bell and each of the warning circuits.

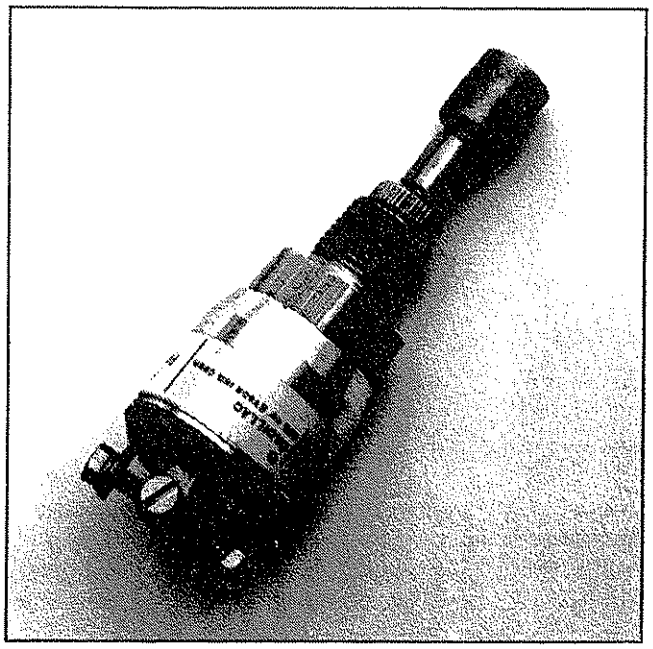


Fig. 1, Alarmstat

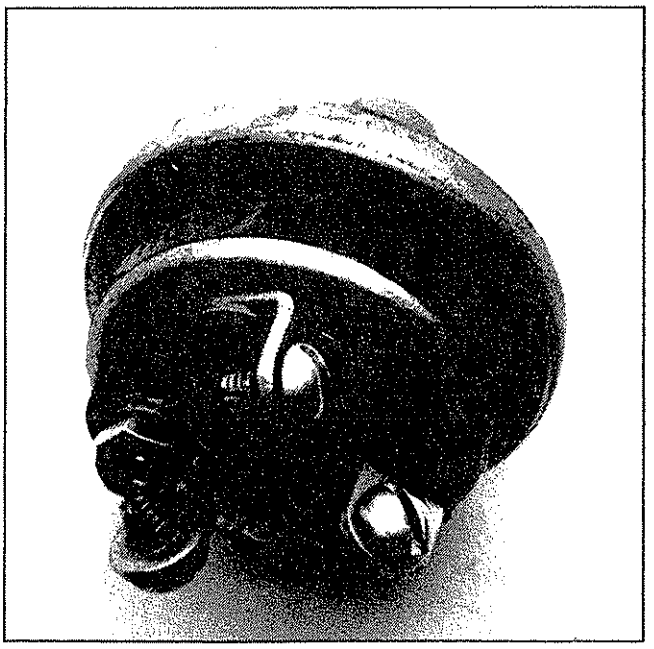


Fig. 2, Pressurestat

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

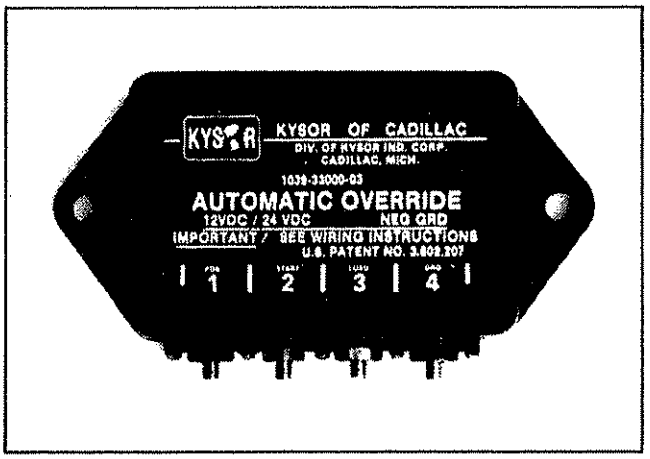


Fig. 3, Four-Terminal Control Module

All three systems use a 10 amp circuit breaker in the run circuit, attached to the hot side of the engine start button. A separate low-air-warning-system (consisting of a low-air sending unit, warning buzzer, and dash-mounted low-air warning light) is also attached to this 10 amp circuit breaker in each of the Kysor systems. The low-air warning system will not cause engine shutdown, and is not linked to the tri-diode, warning bell, or automatic or manual override.

On all three systems, engine shutdown is accomplished by cutting off the fuel supply. On Cummins engines the electrical circuit to the fuel solenoid is interrupted. On engines with governor boxes or fuel shut off levers, such as Detroit Diesel, Caterpillar, and Allis Chalmers engines, an actuator (Fig. 7) is used to shut off the fuel.

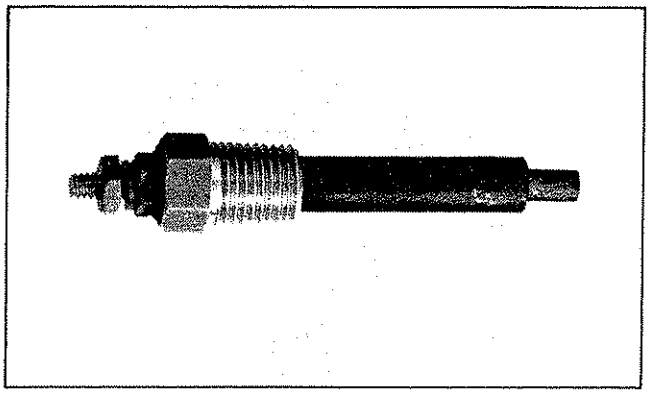


Fig. 4, Coolant Probe

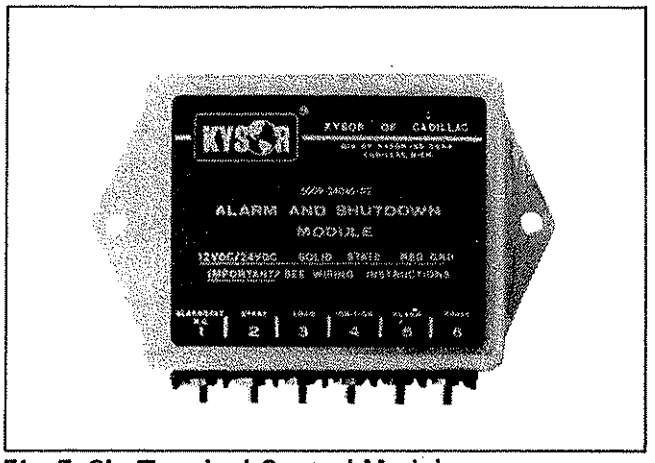


Fig. 5, Six-Terminal Control Module

PRINCIPLES OF OPERATION

Three distinct electrical circuits are involved in the operation of the Kysor engine warning and shutdown systems: the start (override) circuit (Fig. 8), the run circuit (Fig. 9), and the warning circuit (Fig. 10).

The four-terminal or six-terminal control module, or the manual override push-button activates the start (override) circuit.

The alarmstat, pressurestat, and coolant probe are the sensors in the system, and activate the run and warning circuits.

The alarmstat and pressurestat each have three terminal connections. One terminal connection is identified as "C" (common), another as "NC" (normally closed), and the third as "NO" (normally open). The alarmstat and pressurestat each have two internal switches which make and break the run and warning circuits. The common terminal of the alarmstat and the pressurestat transfer the current flow, by way of these switches, to either or both of these other two terminals. See Fig. 11 and 12. "Normally open" and "normally closed" relate to the position of the internal switches when the alarmstat or pressurestat is held in the hand. Normally closed means that current would flow through the switch in that position. Normally open means that current would not flow through the switch.

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

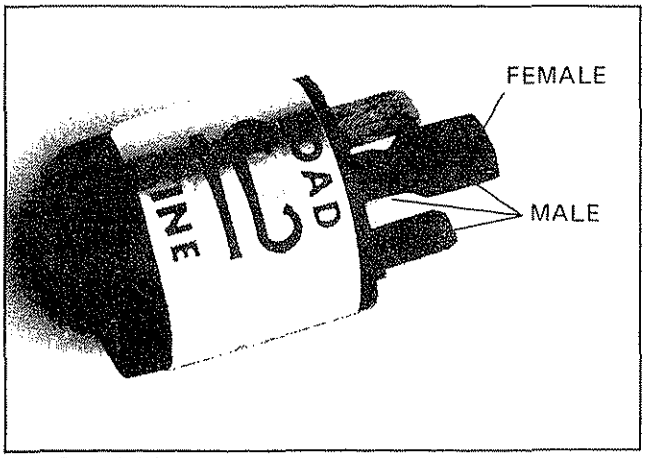


Fig. 6, Tri-Diode

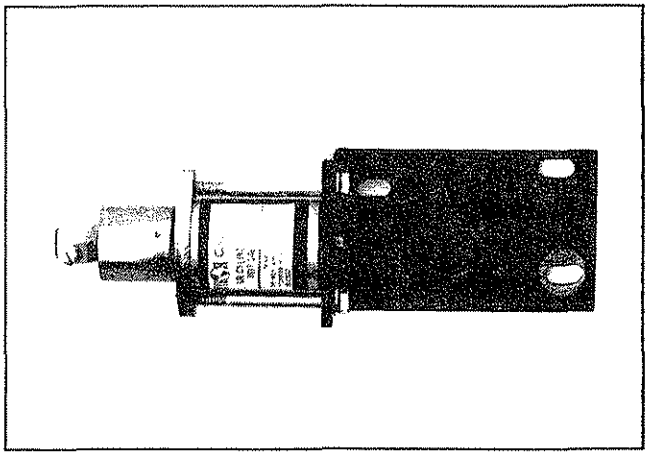


Fig. 7, Actuator

ALARMSTAT

The switches within the alarmstat react to preset temperature levels. On all engines used in Freightliner vehicles the warning level is 204°F (95.5°C) and critical (shutdown) level is 210°F (99°C).

When the engine is running, the coolant temperature is normally below the warning and shutdown levels. Therefore, current flows from the common terminal to the normally closed terminal. This is the run circuit. There is no current flow to the normally open terminal, which is the warning circuit (Fig. 11, Ref. B).

If a problem occurs, and the coolant temperature reaches 204°F (95.5°C), the normally open switch

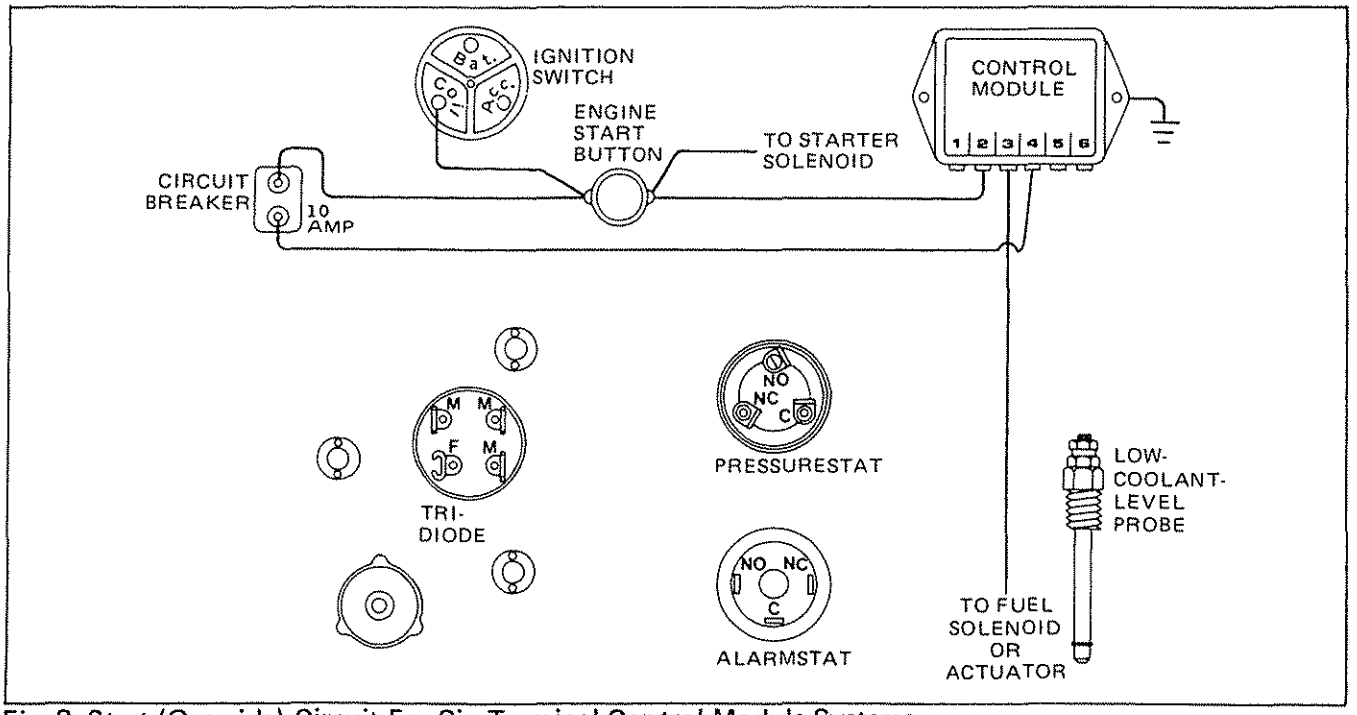


Fig. 8, Start (Override) Circuit For Six-Terminal Control Module Systems

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

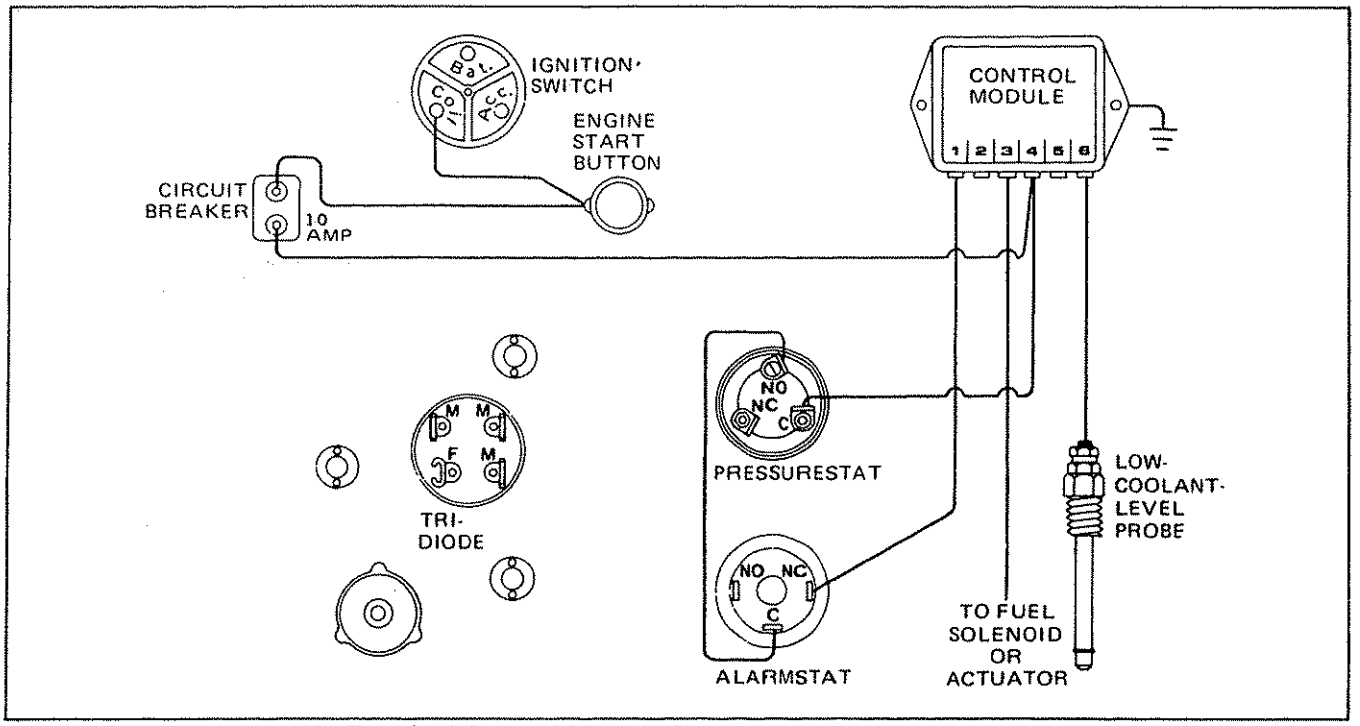


Fig. 9, Run Circuit For Six-Terminal Control Module Systems

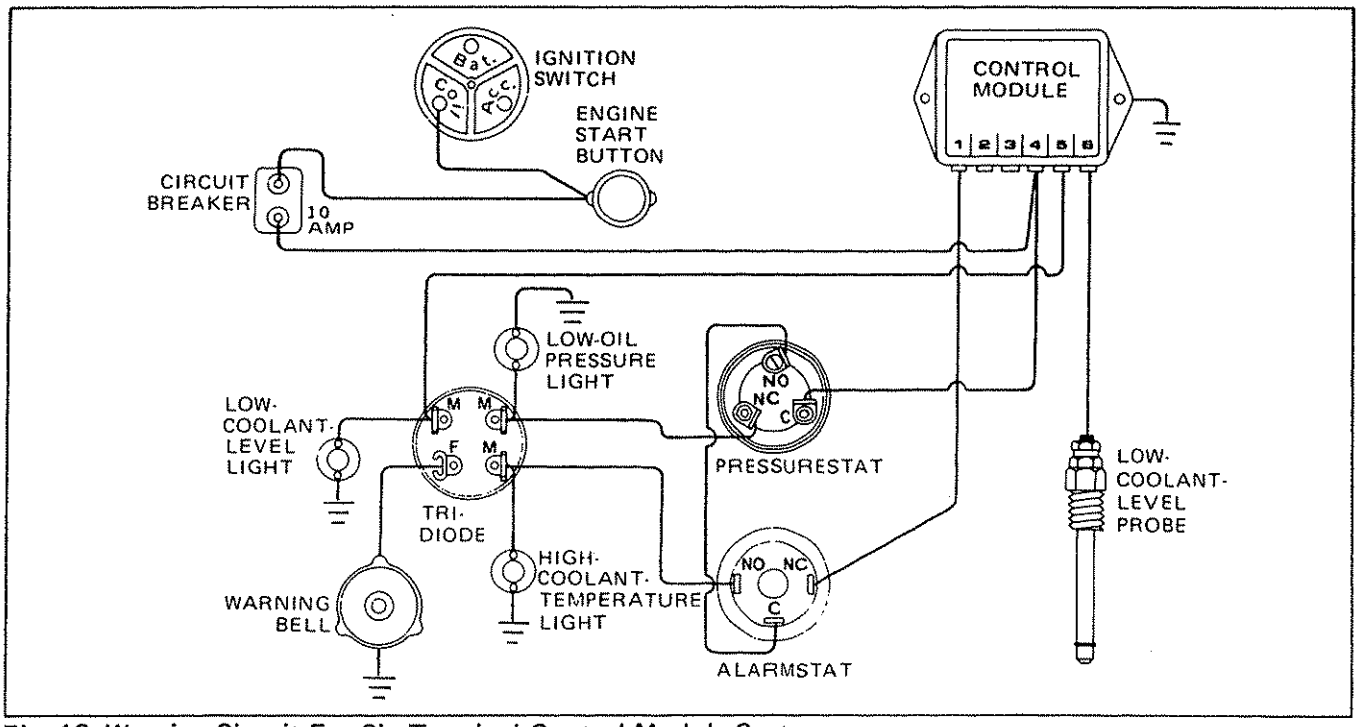


Fig. 10, Warning Circuit For Six-Terminal Control Module Systems

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

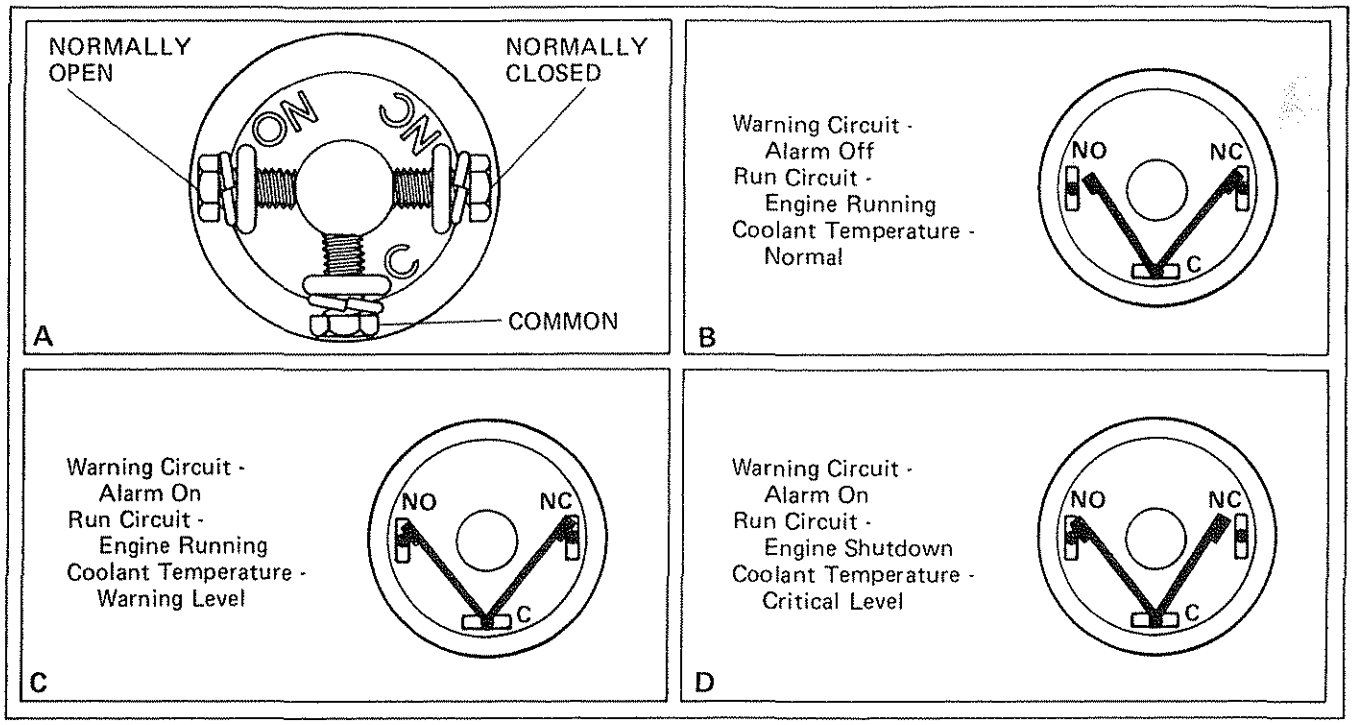


Fig. 11, Alarmstat Terminals And Switch Positions

closes and allows current to flow from the common terminal through the normally open terminal to the tri-diode, warning bell, and high-coolant-temperature light. Current continues to flow from the common terminal to the normally closed terminal to keep the engine running. In this situation, the warning circuit and the run circuit are both energized (Fig. 11, Ref. C).

If the coolant temperature reaches 210°F (99°C), the run circuit is broken, and power is cut off to the fuel solenoid or actuator, causing the engine to shut down. The warning circuit remains energized (Fig. 11, Ref. D).

PRESSURESTAT

The switches within the pressurestat react to preset oil pressure levels. On all Cummins and Caterpillar engines, the warning level is 15 psi (103 kPa) and critical (shutdown) level is 10 psi (69 kPa). On Allis-Chalmers engines, the warning level is 11 psi (76 kPa), and shutdown level is 6 psi (41 kPa). On Detroit Diesel engines, the levels are 7 psi (48 kPa) and 3 psi (21 kPa) respectively.

When the engine is running normally, oil pressure rises to normal operating pressure, causing the normally open switch to close and the normally closed switch to open. This allows current to flow from the common terminal to the normally open terminal, which is the run circuit. Current flow from the common post to the normally closed terminal, which is the warning circuit, is interrupted (Fig. 12, Ref. B).

If a problem occurs, and the oil pressure drops to the warning level, the normally closed switch closes and allows current to flow from the common terminal through the normally closed terminal to the tri-diode, warning bell, and low-oil-pressure light. Current continues to flow from the common terminal to the normally open terminal to keep the engine running. In this situation, the warning circuit and run circuit are both energized (Fig. 12, Ref. C).

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

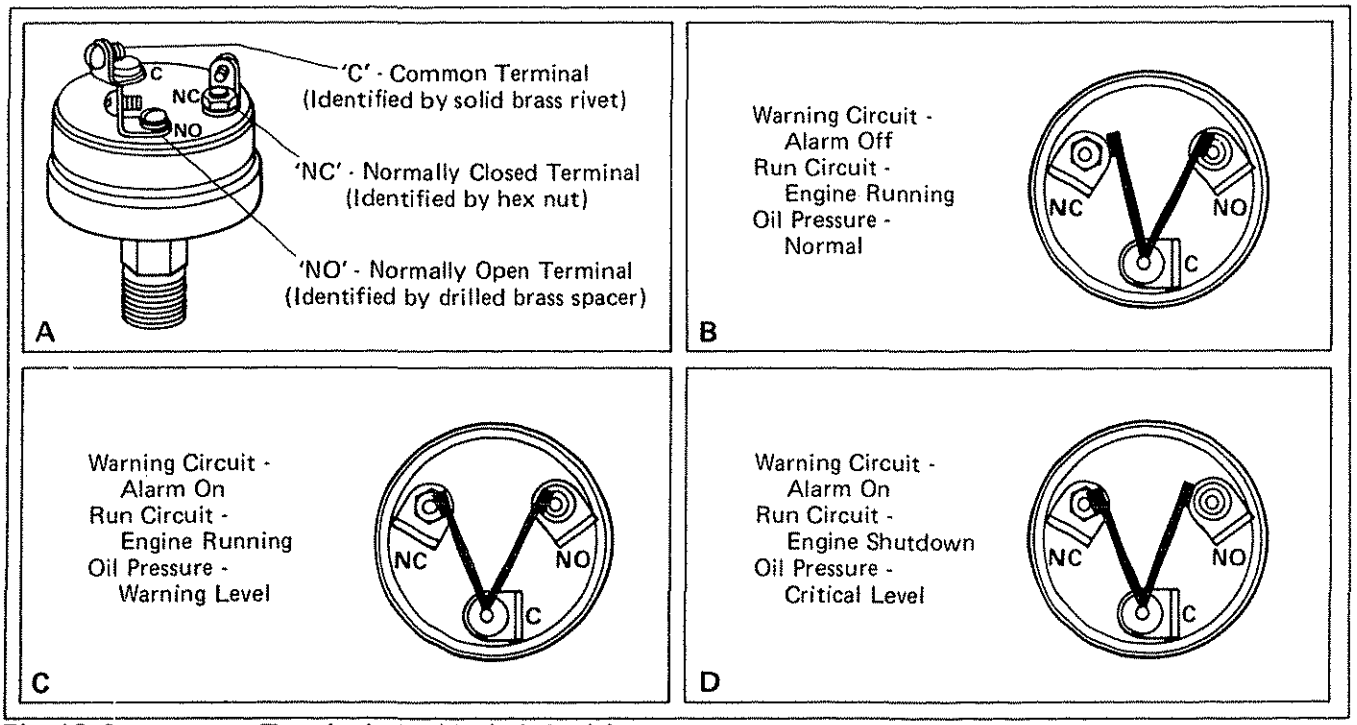


Fig. 12, Pressurestat Terminals And Switch Positions

If the oil pressure drops to the critical level, the run circuit is broken, and power to the fuel solenoid or actuator is cut off, causing the engine to shut down. The warning circuit will remain energized (Fig. 12, Ref. D).

COOLANT PROBE

The coolant probe senses low coolant level. When the level of coolant in the radiator drops below the installed height of the coolant probe (mounted horizontally in the top tank of the radiator) the run circuit through the coolant to ground is interrupted. By way of the six-terminal control module, the warning bell and low-coolant-level light are activated. If the coolant level remains below the probe for longer than 30 seconds, the control module will interrupt the run circuit and shut down the engine.

CONTROL MODULE (OVERRIDE)

Since the run circuit to the fuel solenoid or actuator is connected to the normally open terminal of the pressurestat, current will not flow until there is enough oil pressure to close the normally open switch. To start a cold engine, the control module bypasses (overrides) the pressurestat for 30 seconds.

This allows the engine to build up oil pressure, closing the normally open switch in the pressurestat, allowing the run circuit to be energized. After 30 seconds, the override circuit de-energizes to allow the alarmstat and pressurestat (and coolant probe, if so equipped) to protect against engine damage.

The time delay switch in the control module also allows the engine to be restarted after shutdown, and run for 30 seconds. This gives the vehicle operator time to move the vehicle when cooling or oil pressure problems interrupt the run circuit. This may be repeated as often as needed.

PUSH-BUTTON OVERRIDE

To start a cold engine, or restart an engine after shutdown, the push-button override by-passes the

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

alarmstat and pressurestat, to complete the start (override) circuit. The push-button must be depressed manually, and will continue to bypass the run circuit until the button is released.

WIRING CIRCUITS

Six-Terminal Control Module

Start (Override) Circuit (Refer to Fig. 8)

The start circuit is initiated through the control module by current supplied from the cold side of the engine start button (when the button is depressed), through the connecting wire, to terminal 2. This circuit is closed internally in order to activate the 30 second timer. The control module case must be grounded. To maintain current flow to the start circuit when the engine start button is no longer depressed, the hot side of the engine start button is wired to terminal 4, which connects internally to terminal 3. From there, current flows through the connecting wire to the fuel solenoid or actuator.

Run Circuit (Refer to Fig. 9)

In the run circuit, the alarmstat and pressurestat are wired into the circuit between the hot side of the engine start button and terminal 1 of the control module.

To attach the pressurestat to the hot side of the engine start button, a wire is attached to terminal 4 of the control module, and to the common (C.) terminal of the pressurestat. (Terminal 4 provides a tie point for the pressurestat wire and the wire from the engine start button.)

Another wire runs from the normally open (N.O.) terminal on the pressurestat to the common (C.) terminal on the alarmstat. A wire from the normally closed (N.C.) terminal of the alarmstat completes the circuit to terminal 1 of the control module.

Terminal 1 is connected internally to terminal 3, which then feeds current through the connecting wire to the fuel solenoid or actuator to run the engine.

A low voltage current is supplied to the coolant probe by a wire from terminal 6 of the control module. This circuit is completed to ground through the coolant. The control module case must also be grounded.

Breaking of the run circuit by the alarmstat, pressurestat, or coolant probe will cause engine shutdown.

WARNING CIRCUIT (Refer to Fig. 10)

The warning circuit is completed when current from any of the sensors is routed to ground through its respective dash-mounted warning light. At the same time, the tri-diode allows current from any of the three sensors to flow to ground through the single warning bell, attached to the female terminal of the tri-diode.

When engine coolant temperature reaches the alarmstat's warning level of 204°F (95.5°C), the internal switch from the common terminal to the normally open terminal provides current through a wire from the normally open terminal to one of the three male terminals of the tri-diode. A wire from the same terminal of the tri-diode is attached to the high-coolant-temperature light.

When engine oil pressure reaches the pressurestat's warning level, the internal switch from the common terminal to the normally closed terminal provides current through a wire from the normally closed terminal to another of the three male terminals of the tri-diode. A wire from the same terminal of the tri-diode is attached to the low-oil-pressure light.

When coolant level in the radiator falls below the level of the coolant probe, the circuit for the low voltage current from terminal 6 is interrupted. When this occurs, the control module completes a circuit internally to send current through the wire

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

connecting terminal 5 to the third male terminal of the tri-diode. A wire from the same terminal of the tri-diode is attached to the low-coolant-level light.

Four-Terminal Control Module (Override)

Start (Override) Circuit (Refer to Fig. 13)

The start circuit is initiated through the control module by current supplied from the cold side of the engine start button (when the button is depressed), through the connecting wire, to terminal 2. This circuit is closed internally in order to activate the 30 second timer. A wire must run from terminal 4 to a good ground. To maintain the current flow to the start circuit when the engine start button is no longer depressed, the hot side of the engine start button is wired to terminal 1, which connects internally to terminal 3. From there, current flows through the connecting wire to the normally open terminal of the pressurestat, which acts as a tie point for the wire to the fuel solenoid or actuator.

Run Circuit (Refer to Fig. 14)

In the run circuit, the alarmstat and pressurestat are wired into the circuit between the hot side of the engine start button and the fuel solenoid or actuator.

To attach the alarmstat to the hot side of the engine start button, a wire is attached to terminal 1 of the control module and to the common terminal of the alarmstat. (Terminal 1 provides a tie point for the alarmstat wire and the wire from the engine start button.)

Another wire runs from the normally closed terminal on the alarmstat to the common terminal on the pressurestat.

The circuit is completed by the wire that connects the normally open terminal of the pressurestat to the fuel solenoid or actuator.

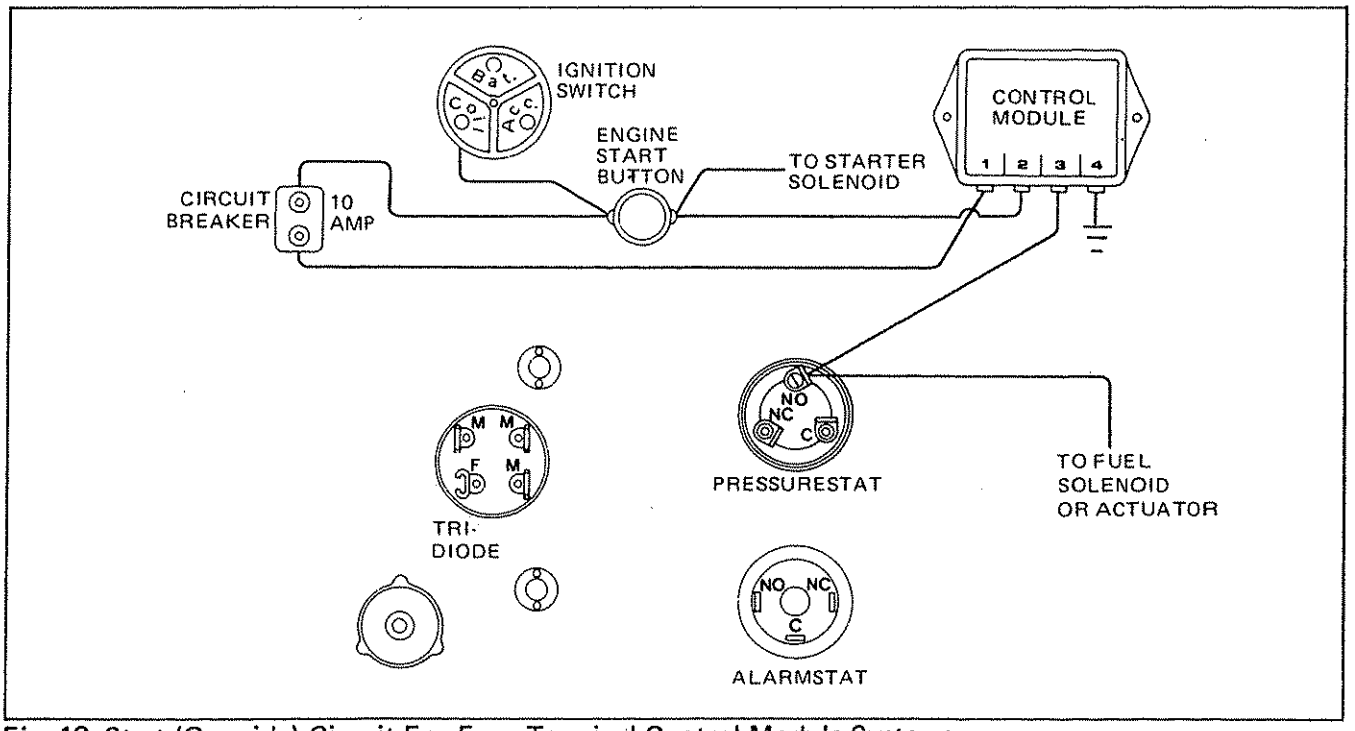


Fig. 13, Start (Override) Circuit For Four-Terminal Control Module Systems

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

Warning Circuit (Refer to Fig. 15)

With the exception of the coolant probe and low-coolant-level light (which are not included in the four-terminal control module system), the warning circuit is the same as the six-terminal control module system's warning circuit.

Push-Button Manual Override

Start (Override) Circuit (Refer to Fig. 16)

The start circuit is initiated by current supplied from the cold side of the manual override push-button (when the button is depressed), through the connecting wire, to the normally open terminal of the pressurestat, which acts as a tie point, for the wire to the fuel solenoid or actuator. The manual override push-button must be depressed manually until the engine builds up enough oil pressure to close the normally open switch in the pressurestat, completing the run circuit.

Run Circuit (Refer to Fig. 17)

In the run circuit, the alarmstat and pressurestat are wired into the circuit between the hot side of the manual override push-button and the fuel solenoid or actuator.

The wire attached to the hot side of the manual override push-button is connected to the common terminal of the alarmstat. Another wire is run from the normally closed terminal on the alarmstat to the common terminal on the pressurestat.

The circuit is completed by the wire that connects the normally open terminal of the pressurestat to the fuel solenoid or actuator.

Warning Circuit (Refer to Fig. 18)

With the exception of the coolant probe and low-coolant-level light (which are not included in the manual override system), the warning circuit is the same as the six-terminal control module system's warning circuit.

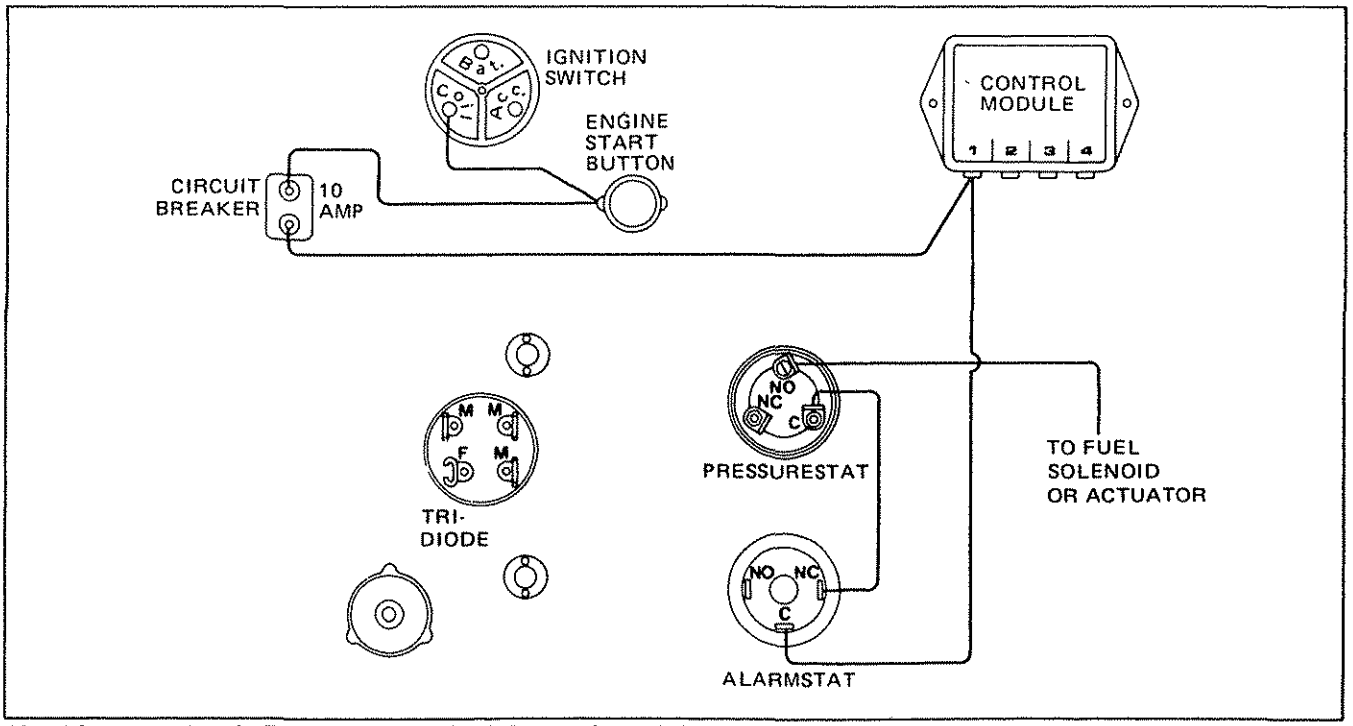


Fig. 14, Run Circuit For Four-Terminal Control Module Systems

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

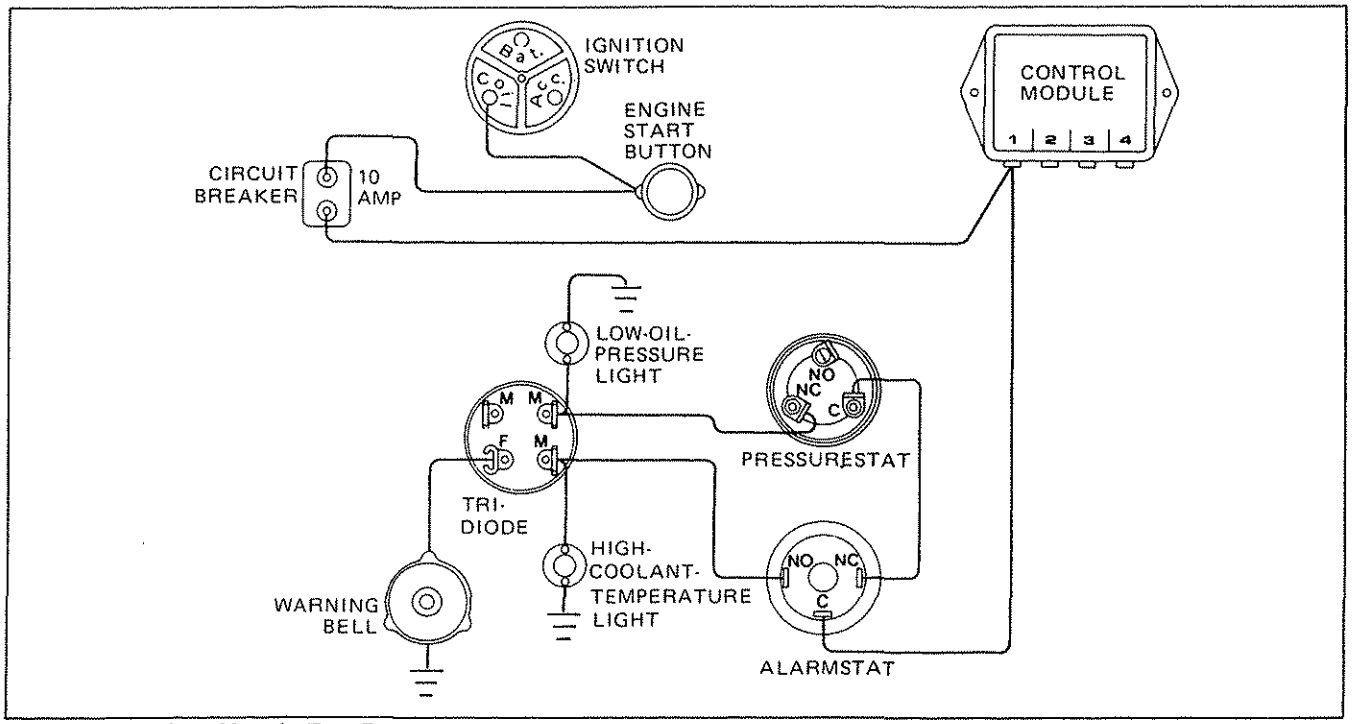


Fig. 15, Warning Circuit For Four-Terminal Control Module Systems

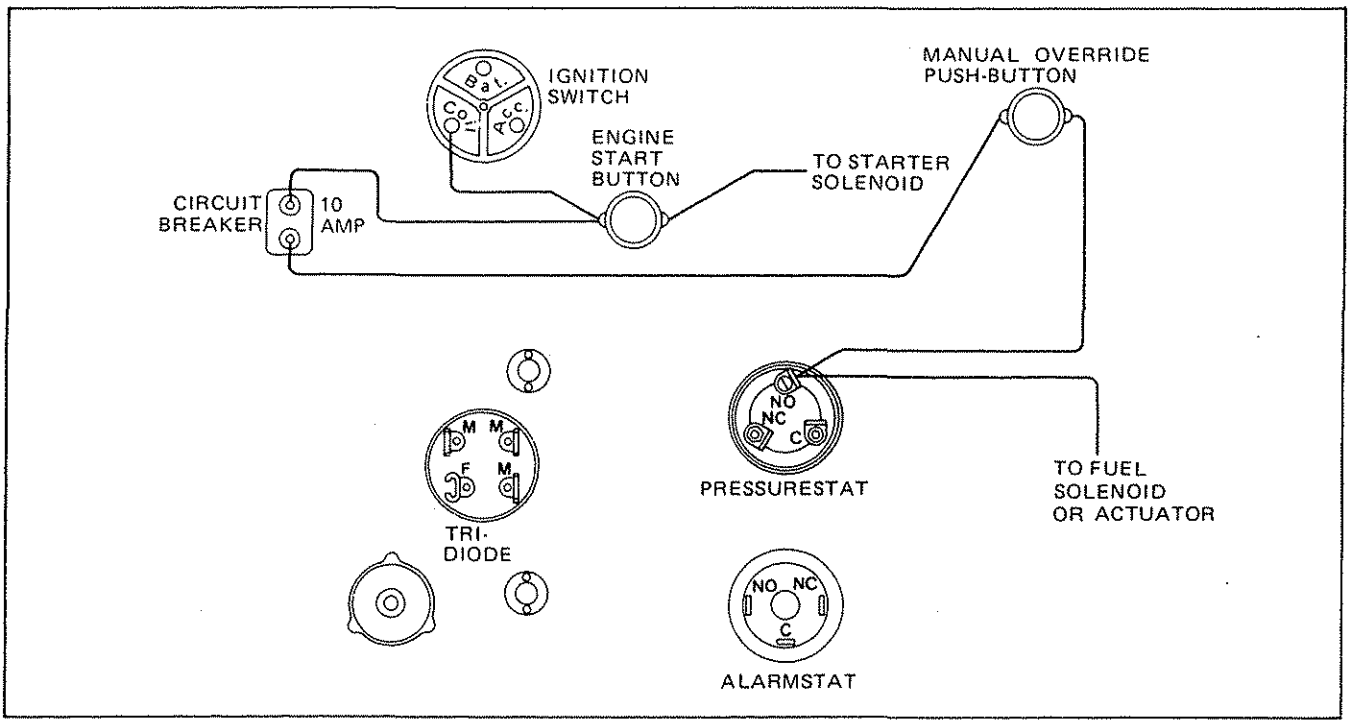


Fig. 16, Start (Override) Circuit For Manual Push-Button Systems

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

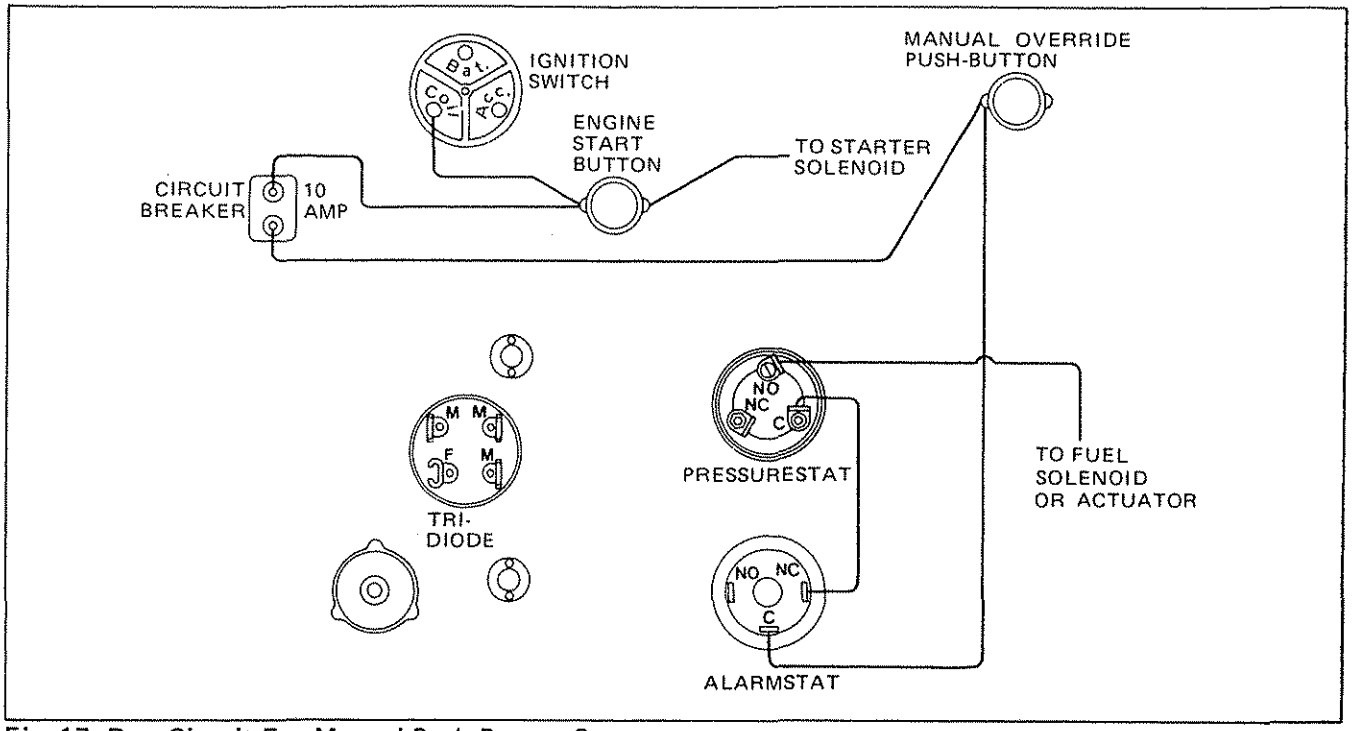


Fig. 17, Run Circuit For Manual Push-Button Systems

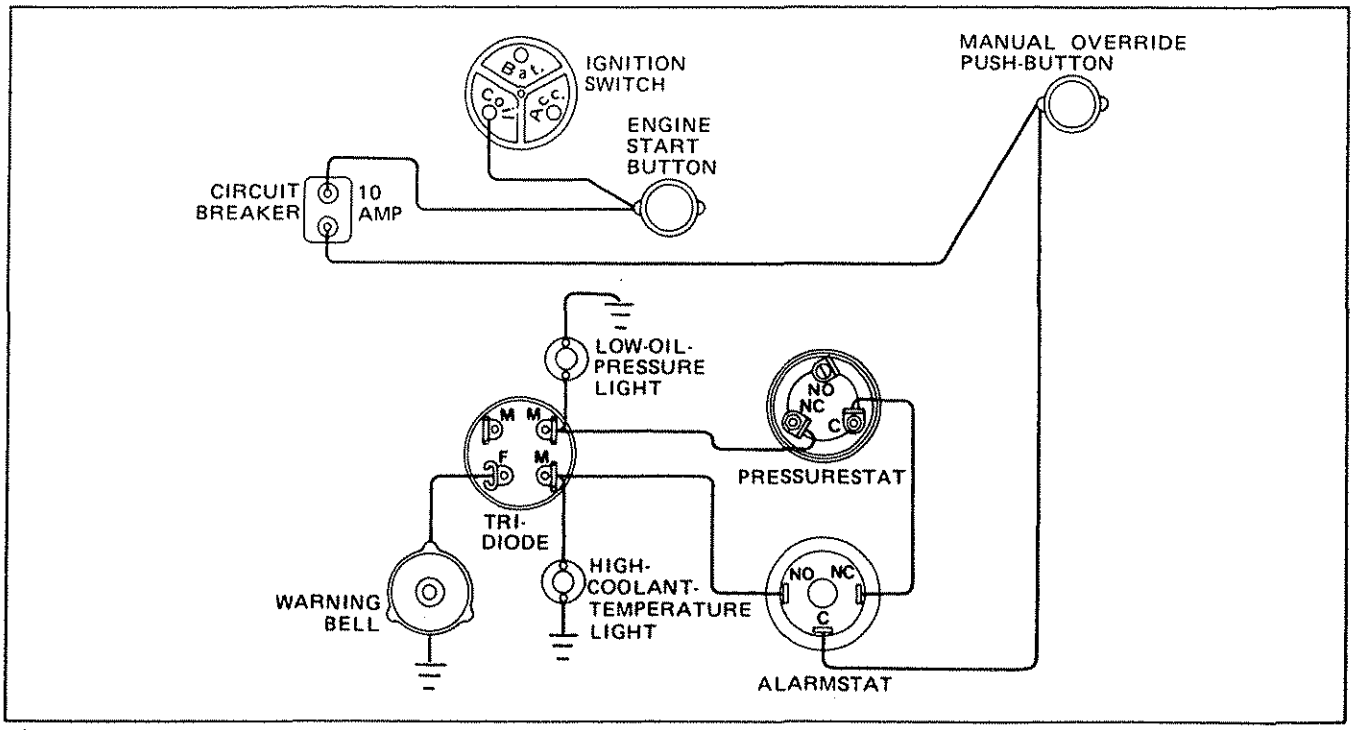


Fig. 18, Warning Circuit For Manual Push-Button Systems

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

SERVICE OPERATIONS

Kysor engine warning and shutdown system components are non-serviceable. If it is determined that any of the components are inoperative or damaged, they must be replaced.

TROUBLESHOOTING

The following troubleshooting procedures are presented to aid in isolating the source of malfunctions within the components of the Kysor engine warning and shutdown systems.

GENERAL INFORMATION AND INSTRUCTIONS

The coolant probe is located in the top tank of the radiator, and the alarmstat is located in the cylinder head of the engine. All other components are located in the vehicle cab, in or behind the dash. Refer to "SPECIFICATIONS" for wiring diagrams.

The only troubleshooting tools needed are a test light with insulated wire leads and an insulated jumper wire.

Whenever instructions are given to attach jumper wires or test lights, to turn on the ignition, or to start the engine, the jumper wires or test lights should be removed, the ignition turned off, and the engine shut off upon completion of the particular step or sub-step that gave any of these instructions.

WARNING: Failure to turn off the ignition, or shut off the engine could result in electrical shock or other personal injury when wires are being attached or detached from the system's components.

WARNING BELL AND/OR LOW-OIL-PRESSURE LIGHT FAILS TO ACTIVATE WHEN THE IGNITION IS TURNED ON

If the engine starts but does not continue to run, proceed to the heading "ENGINE STARTS BUT DOES NOT CONTINUE TO RUN." If the engine will not start, proceed to the heading "ENGINE WILL NOT START." If the engine starts and continues to run, proceed to the appropriate sub-heading below.

Warning Bell Sounds, But Low-Oil-Pressure Light Does Not Light

1. Check all wiring connections between the tri-diode and the low-oil-pressure-light ground. Tighten any loose connections. Turn the ignition on, but do not start the engine. If the warning light does not light, proceed to Step 2.

2. Attach a jumper wire to the ground terminal on the low-oil-pressure light and to a good ground. Turn the ignition on; do not start the engine. If the light does not light, proceed to Step 3. If the light does light, replace the warning light ground wire.

3. Attach a lead of the test light to each of the warning light terminals. Turn the ignition on; do not start the engine. If the test light does not light, replace the wire between the warning light and the tri-diode. If the test light lights, replace the warning light.

Low-Oil-Pressure Light Lights, But Warning Bell Does Not Sound

1. Check all wiring connections between the tri-diode and the warning-bell ground. Tighten any loose connections. Turn the ignition on; do not start the engine. If the warning bell still does not sound, proceed to Step 2.

2. Attach a jumper wire to the ground terminal on the warning bell and to a good ground. Turn on the ignition; do not start the engine. If the bell still does not sound, proceed to Step 3. If the bell now sounds, replace the warning bell ground wire.

3. Attach a lead of the test light to each of the warning bell terminals. Turn on the ignition; do

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

not start the engine. If the test light does not light, proceed to Step 4. If the test light lights, replace the warning bell.

4. Attach a jumper wire to the female terminal of the tri-diode and to the ungrounded terminal of the warning bell. Turn on the ignition; do not start the engine. If the warning bell does not sound, replace the tri-diode with a new tri-diode of the same polarity. If the warning bell does sound, replace the wire from the tri-diode to the warning bell.

Warning Bell Does Not Sound, And Low-Oil-Pressure Light Does Not Light

1. Check the wiring connections at the normally closed terminal of the pressurestat and the interconnected terminal of the tri-diode. Tighten any loose connections. Turn on the ignition; do not start the engine. If the warning light and warning bell still do not operate, proceed to Step 2.

2. Attach a jumper wire to the normally closed terminal of the pressurestat and the interconnected terminal of the tri-diode. Turn on the ignition; do not start the engine. If the warning light and warning bell now operate, replace the interconnecting wire. If the warning light and warning bell still do not operate, replace the pressurestat.

ENGINE SHUTS DOWN WITH PRIOR WARNING

Four-Terminal Control Module And Manual Override Systems

Visually check oil and coolant levels and all possible causes of engine overheating; such as an inoperative thermostat. Do not rely on gauges alone. Add the recommended oil or coolant as needed.

Six-Terminal Control Module Systems

Visually check oil and coolant levels and all possible causes of engine overheating; such as an inoperative thermostat. Do not rely on gauges alone. Add the recommended oil or coolant as needed.

If the cooling and lubricating systems are normal, and the engine still shuts down, proceed as follows:

1. Attach a jumper wire from the coolant probe to a good ground. Start and run the engine. If the engine still shuts down, proceed to Step 2. If the engine continues to run, replace the coolant probe.

2. Attach a jumper wire from terminal 6 of the control module to a good ground. Start and run the engine. If the engine still shuts down, proceed to Step 3. If the engine continues to run, replace the wire between terminal 6 and the coolant probe.

3. Attach a jumper wire from terminal 1 to terminal 3 on the control module. Start and run the engine. If the engine continues to run, replace the control module.

ENGINE SHUTS DOWN WITHOUT PRIOR WARNING (WARNING BELL AND/OR WARNING LIGHT FAILS TO ACTIVATE)

Visually check the oil and coolant levels and all possible causes of engine overheating; such as an inoperative thermostat. Do not rely on gauges alone. Add the recommended oil or coolant as needed.

If an engine malfunction involving the lubricating system is detected, refer to the heading "WARNING BELL AND/OR LOW-OIL-PRESSURE LIGHT FAILS TO ACTIVATE WHEN THE IGNITION KEY IS TURNED ON." If an engine malfunction involving the cooling system is detected, proceed to the sub-heading "NO COOLING SYSTEM WARNING PRIOR TO ENGINE SHUTDOWN," (below). If no engine malfunction involving the cooling or lubricating systems is apparent, try to restart the engine. If the engine starts but does not continue to run, proceed to the heading "ENGINE STARTS BUT DOES NOT CONTINUE TO RUN." If the engine will not restart, proceed to the heading "ENGINE WILL NOT START."

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

No Cooling System Warning Prior To Engine Shutdown

High Coolant Temperature (All Kysor Systems)

If the coolant temperature exceeded 210°F (99°C), but:

A. The warning bell did not sound when the high-coolant-temperature light was lit, proceed to Step 1;

B. the warning bell did sound, but the high-coolant-temperature light was not lit, proceed to Step 2; or,

C. the warning bell did not sound, and the warning light was not lit, proceed to Step 3.

1. Turn on the ignition; do not start the engine. If the warning bell sounds, replace the tri-diode with a new tri-diode of the same polarity. If the warning bell does not sound, proceed to Step 1.1.

   .1 Check all wiring connections between the tri-diode and the warning-bell ground. Tighten any loose connections. Turn the ignition on; do not start the engine. If the warning bell does not sound, proceed to Step 1.2.

   .2 Attach a jumper wire to the ground terminal on the warning bell and to a good ground. Turn on the ignition; do not s the engine. If the warning bell does not sound, proceed to Step 1.3. If the warning bell does sound, replace the warning-bell ground wire.

   .3 Attach a lead of a test light to each of the warning bell terminals. Turn on the ignition; do not start the engine. If the test light does not light, replace the wire from the tri-diode to the warning bell. If the test light lights, replace the warning bell.

2. Check all wiring connections between the tri-diode and the high-coolant-temperature-light ground. Tighten any loose connections. Attach a jumper wire to the normally closed terminal on the pressurestat and to the high-coolant-temperature-light terminal on the tri-diode. Turn on the ignition; do not start the engine. If the warning light does not light, proceed to Step 2.1.

   .1 Attach the jumper wire to the normally closed terminal on the pressurestat and to the ungrounded terminal of the high-coolant-temperature light. Turn on the ignition; do not start the engine. If the warning light lights, replace the wire from the tri-diode to the ungrounded terminal of the high-coolant-temperature light. If the warning light does not light, proceed to Step 2.2.

   .2 Attach the jumper wire to the normally closed terminal of the pressurestat and to the ungrounded terminal of the high-coolant-temperature light. Attach a test light to both terminals of the warning light. Turn on the ignition; do not start the engine. If the test light lights, replace the warning light. If the test light does not light, replace the wire from the warning light to ground.

3. Check the wiring connections at the normally open terminal of the alarmstat and at the interconnected terminal of the tri-diode. Tighten any loose connections. Attach a jumper wire to the common terminal and to the normally open terminal of the alarmstat.

IMPORTANT: On six-terminal control module systems only—attach a jumper wire or test light from the common terminal of the pressurestat to the normally open terminal of the pressurestat.

Turn on the ignition; do not start the engine. If the high-coolant-temperature light does not light, replace the interconnecting wire from the normally open terminal of the alarmstat to the tri-diode. If the high-coolant-temperature light lights, replace the alarmstat.

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

Low Coolant Level (Six-Terminal Control Module System Only)

If the coolant level in the radiator was below the level of the coolant probe, but:

A. The warning bell did not sound when the low-coolant-level light was lit, proceed to Step 1;

B. the low-coolant-level light was not lit when the warning bell sounded, proceed to Step 2; or,

C. the warning bell did not sound, and the warning light was not lit, proceed to Step 3.

1. Turn on the ignition; do not start the engine. If the warning bell sounds, replace the tri-diode with a new tri-diode of the same polarity. If the warning bell does not sound, proceed to Step 1.1.

   .1 Check all wiring connections between the tri-diode and the warning-bell ground. Tighten any loose connections. Turn the ignition on; do not start the engine. If the warning bell does not sound, proceed to Step 1.2.

   .2 Attach a jumper wire to the ground terminal on the warning bell and to a good ground. Turn on the ignition; do not start the engine. If the warning bell still does not sound, proceed to Step 1.3. If the warning bell does sound, replace the warning-bell ground wire.

   .3 Attach a lead of a test light to each of the terminals of the warning bell. Turn on the ignition; do not start the engine. If the test light does not light, replace the wire from the tri-diode to the warning bell. If the test light lights, replace the warning bell.

2. Check all wiring connections between the tri-diode and the low-coolant-level-light ground. Tighten any loose connections. Detach the wire connected to terminal 6 of the control module. Start the engine. If the warning light does not light, proceed to Step 2.1. If the warning light does light, proceed to Step 2.3.

   .1 With the wire to terminal 6 disconnected, attach a jumper wire to the ground terminal on the low-coolant-level light and to a good ground. Start the engine. If the warning light does not light, proceed to Step 2.2. If the warning light does light, replace the warning light ground wire; then, proceed to Step 2.3.

   .2 With the wire to terminal 6 disconnected, attach a lead of the test light to each of the terminals of the warning light. Start the engine. If the test light does not light, replace the wire between the warning light and the tri-diode; then, proceed to Step 2.3. If the test light lights, replace the warning light; then, proceed to Step 2.3.

   .3 Attach the coolant probe wire to terminal 6 of the control module.

3. Check both wiring connections between the tri-diode and terminal 5 of the control module. Tighten any loose connections. Detach the wire connected to terminal 6 of the control module. Start the engine. If the low-coolant-level light does not light, proceed to Step 3.1. If the warning light does light, proceed to Step 3.2.

   .1 With the wire to terminal 6 disconnected, attach a lead of the test light to terminal 5 of the control module, and the other lead to a good ground. Start the engine. If the test light does not light, replace the control module. If the test light does light, replace the wire from terminal 5 to the tri-diode; then, proceed to Step 3.2.

   .2 Attach the coolant probe wire to terminal 6 of the control module.

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

ENGINE STARTS BUT DOES NOT CONTINUE TO RUN

Visually check the oil and coolant levels and all possible causes of engine overheating; such as an inoperative thermostat. Do not rely on gauges alone. Add the recommended oil or coolant as needed.

If no engine malfunction involving the lubricating system or cooling system is apparent, turn the ignition on (without starting the engine) to determine if the low-oil-pressure light is functioning; then, proceed to the appropriate sub-heading below.

Low-Oil-Pressure Light Is Lit When Ignition Key Is On

Six-Terminal Control Module Systems

1. Start the engine and observe the low-coolant-level light. If the low-coolant-level light is not lit, proceed to Step 2. If the warning light is lit, refer to the heading "ENGINE SHUTS DOWN WITH PRIOR WARNING."

2. Check the wiring connections at terminal 1 of the control module, the normally open terminal of the pressurestat, and the common and normally closed terminals of the alarmstat. Tighten any loose connections. Start the engine. If the engine does not continue to run, proceed to Step 3.

3. Attach a jumper wire to the common terminal and the normally open terminal of the pressurestat. Start the engine. If the engine does not continue to run, proceed to Step 4. If the engine continues to run, replace the pressurestat.

4. Attach the jumper wire to the common terminal and the normally closed terminal of the alarmstat. Start the engine. If the engine does not continue to run, proceed to Step 5. If the engine continues to run, replace the alarmstat.

5. Attach one of the leads of a test light to the normally closed terminal of the alarmstat; attach the other lead to a good ground. Start the engine. If the test light is not lit, replace the wire from the normally open terminal of the pressurestat to the common terminal of the alarmstat. If the test light is lit, replace the wire from terminal 1 of the control module to the normally closed terminal of the alarmstat.

Four-Terminal Control Module And Manual Override Systems

Replace the pressurestat.

No Low-Oil-Pressure Light When Ignition Is On

Six-Terminal Control Module System

1. Check both wiring connections between terminal 4 of the control module and the common terminal of the pressurestat. Tighten any loose connections. Start the engine. If the engine does not continue to run, proceed to Step 2.

2. Attach a jumper wire to terminal 4 of the control module and the common terminal of the pressurestat. Start the engine. If the engine does not continue to run, replace the pressurestat. If the engine continues to run, replace the wire between terminal 4 and the pressurestat.

Four-Terminal Control Module And Manual Override Systems

1. Check the wiring connections at terminal 1 of the control module (or hot side of the manual override switch), the common terminal of the pressurestat, and the common and normally closed terminals of the alarmstat. Tighten any loose connections. Start the engine. If the engine does not continue to run, proceed to Step 2.

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

2. Attach a jumper wire to the common terminal and the normally open terminal of the pressurestat. Start the engine. If the engine does not continue to run, proceed to Step 3. If the engine continues to run, replace the pressurestat.

3. Attach the jumper wire to the common terminal and the normally closed terminal of the alarmstat. Start the engine. If the engine does not continue to run, proceed to Step 4. If the engine continues to run, replace the alarmstat.

4. Attach one of the leads of a test light to the normally closed terminal of the alarmstat; attach the other lead to a good ground. Start the engine. If the test light is not lit, replace the wire from the common terminal of the alarmstat to terminal 1 of the control module. If the test light is lit, replace the wire from the common terminal of the pressurestat to the normally closed terminal of the alarmstat.

ENGINE WILL NOT START

Turn the ignition on (without starting the engine) to determine if the low-oil-pressure light is functioning; then, proceed to the appropriate subheading, below.

Low-Oil-Pressure Light Is Lit When Ignition Is On

Six-Terminal Control Module Systems

1. Check the wiring connections at both ends of the control module ground wire, at terminal 2 and terminal 3 of the control module, and at the fuel solenoid or actuator. Tighten any loose connections. Start the engine. If the engine will not start, proceed to Step 2.

2. Attach a test light to terminal 3 of the control module and to a good ground. Turn on the ignition and press the engine start button. If the test light is not lit, proceed to Step 3. If the test light is lit, replace the wire from terminal 3 of the control module to the fuel solenoid or actuator.

3. Attach the test light to terminal 2 of the control module and to a good ground. Turn on the ignition and press the engine start button. If the test light is lit, proceed to Step 4. If the test light is not lit, replace the wire from the cold side of the engine start button to terminal 2 of the control module.

4. Attach the test light to the control-module-case ground connection and to a good ground. Turn on the ignition and press the engine start button. If the test light is lit, replace the control module ground wire. If the test light is not lit, replace the control module.

Four-Terminal Control Module Systems

1. Check the wiring connections at terminals 2, 3, and 4 of the control module, at the ground connection of terminal 4, at the normally open terminal of the pressurestat, and at the fuel solenoid or actuator. Tighten any loose connections. Start the engine. If the engine will not start, proceed to Step 2.

2. Attach a test light to the normally open terminal of the pressurestat and to a good ground. Turn on the ignition and press the engine start button. If the test light is not lit, proceed to Step 3. If the test light is lit, replace the wire from the normally open terminal of the pressurestat to the fuel solenoid or actuator.

3. Attach a test light to terminal 3 of the control module and to a good ground. Turn on the ignition and press the engine start button. If the test light is not lit, proceed to Step 4. If the test light is lit, replace the wire from terminal 3 of the control module to the normally open terminal of the pressurestat.

4. Attach a test light to terminal 2 of the control module and to a good ground. Turn on the

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

ignition and press the engine start button. If the test light is lit, proceed to Step 5. If the test light is not lit, replace the wire from the cold side of the engine start button to terminal 2 of the control module.

5. Attach a test light to terminal 4 of the control module and to a good ground. Turn on the ignition and press the engine start button. If the test light is lit, replace the wire from terminal 4 of the control module to ground. If the test light is not lit, replace the control module.

Manual Override Systems

1. Check the wiring connections at the cold side of the manual override push-button, at the normally open terminal of the pressurestat, and at the fuel solenoid or actuator. Tighten any loose connections. Start the engine. If the engine will not start, proceed to Step 2.

2. Attach a test light to the normally open terminal of the pressurestat and to a good ground. Turn on the ignition and press the manual override push-button. If the test light is not lit, proceed to Step 3. If the test light is lit, replace the wire from the normally open terminal of the pressurestat to the fuel solenoid or actuator.

3. Attach a test light to the cold side of the manual override push-button and to a good ground. Turn on the ignition and press the manual override push-button. If the test light is lit, replace the wire from the cold side of the manual override push-button to the normally open terminal of the pressurestat.

No Low-Oil-Pressure Light When Ignition Is On (All Kysor Systems)

1. Check the wiring connections at both terminals of the 10 amp circuit breaker; and, at terminal 4 of the six-terminal control module (or terminal 1 of the four-terminal control module; or the hot side of the manual override push-button). Tighten any loose connections. Start the engine. If the engine will not start, proceed to Step 2.

2. Attach a jumper wire from terminal 4 of the six-terminal control module (or terminal 1 of the four-terminal control module; or the hot side of the manual override push-button) to the interconnecting terminal of the 10 amp circuit breaker. Start the engine. If the engine will not start, proceed to Step 3. If the engine starts, replace the wire from the circuit breaker to the control module (or manual override push-button).

3. Attach the jumper wire from the hot side of the engine start button to the interconnecting terminal of the 10 amp circuit breaker. Start the engine. If the engine starts, replace the wire from the engine start button to the circuit breaker. If the engine does not start, the circuit breaker is open, due to an overload in one of the circuits. The cause of the overload must be determined and the fault repaired before the circuit breaker will remain closed, allowing operation of the vehicle.

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

SPECIFICATIONS

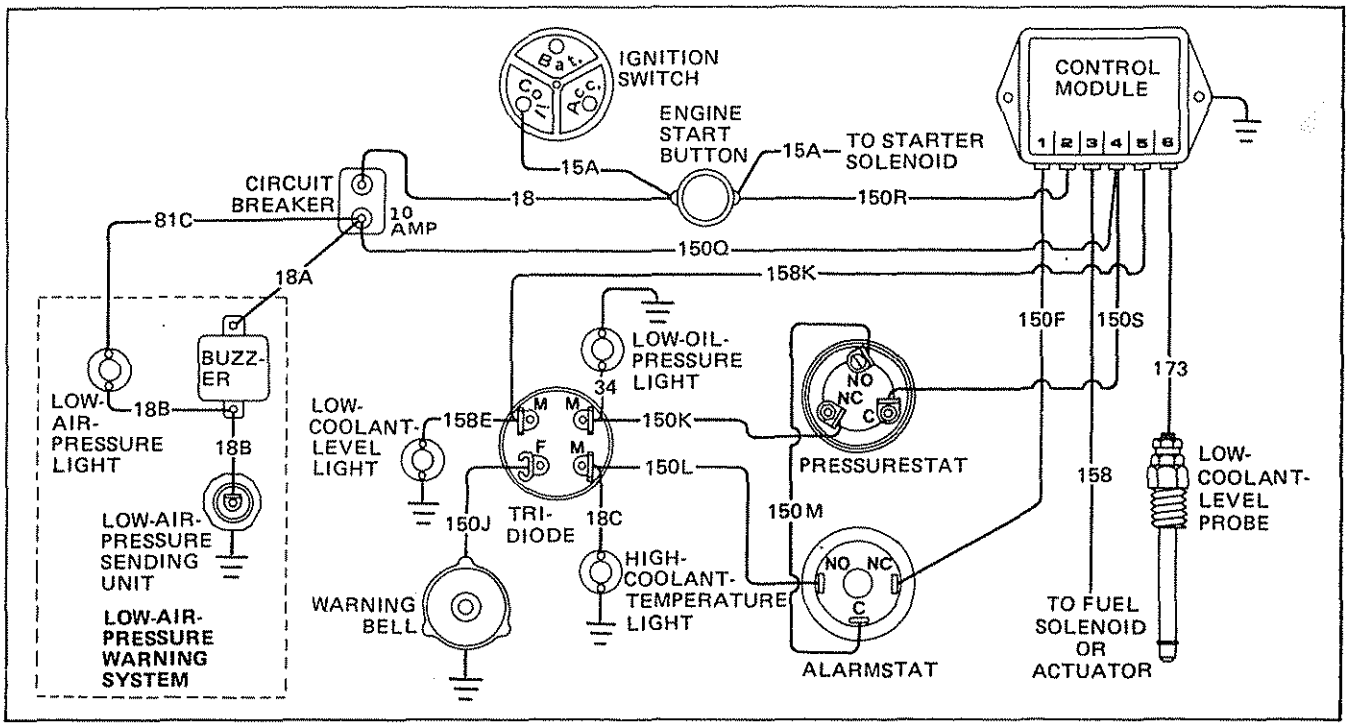


Fig. 19, Six-Terminal System Wiring Diagram

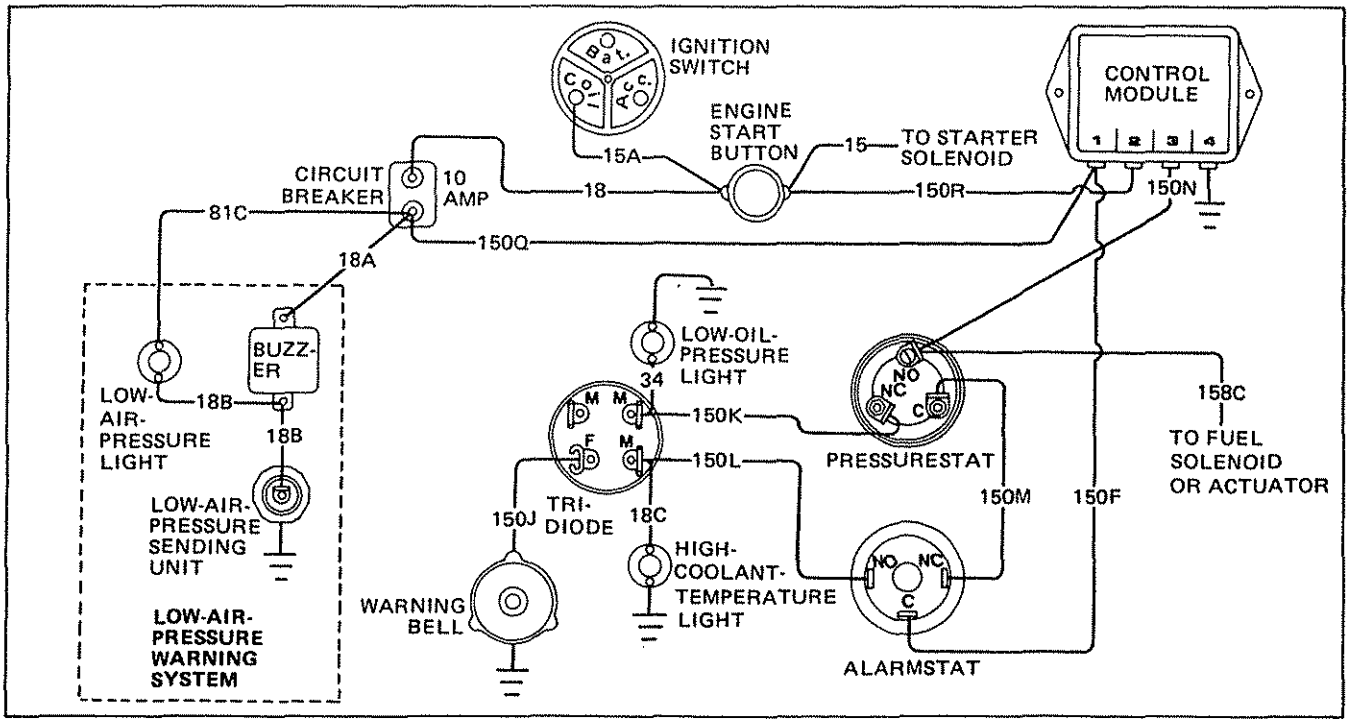


Fig. 20, Four-Terminal System Wiring Diagram

KYSOR ENGINE WARNING AND SHUTDOWN SYSTEMS

SPECIFICATIONS (Continued)

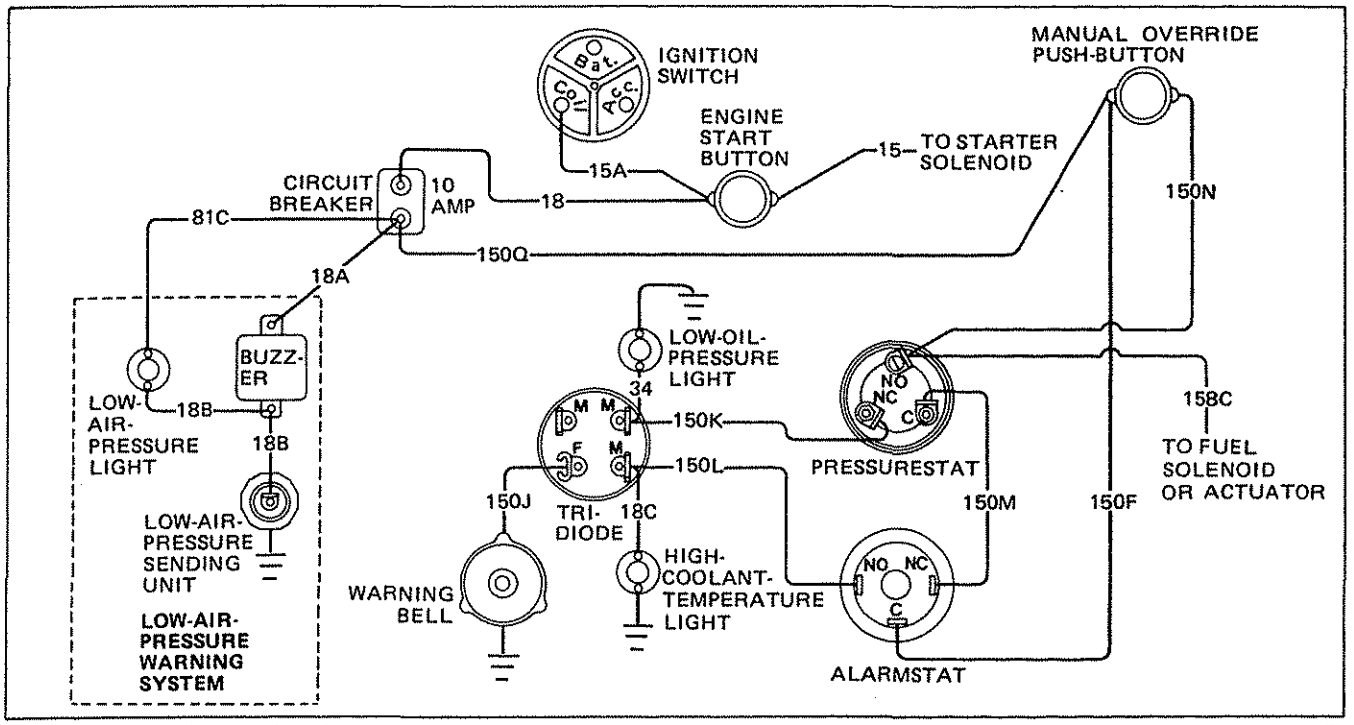


Fig. 21, Manual Override System Wiring Diagram

FLOSCAN FUEL-TACH™

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Flow Sensor Replacement 2

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Specifications

FLOSCAN FUEL-TACH™

GENERAL INFORMATION

The FloScan Fuel-Tach is an electronic monitoring system that records fuel consumption and displays average miles-per-gallon. The gauge provides you with immediate feedback showing a percentage difference between the current fuel consumption rate and the total trip miles-per-gallon average. The gauge serves as a guide for shifting the transmission and keeping the engine in the appropriate rpm range for maximum fuel efficiency.

The Fuel-Tach system allows the driver to select and receive average miles-per-gallon information for each new trip, a series of trips, or for a specific period of time (up to six months).

PRINCIPLES OF OPERATION

The Fuel-Tach gauge (see Fig. 1) is a microcomputer that processes and records vehicle speed and fuel consumption information. A fuel flow sensor (see Fig. 2) is installed in the fuel line and converts the fuel flow rate into electrical signals, which are transmitted to the Fuel-Tach gauge. The vehicle speed signal is received either from a speed signal generator that is located at the mechanical drive tap in the transmission (mechanical speedometers), or from a vehicle speed sensor installed in the transmission bearing retainer (electronic speedometers).

The system is driver-regulated by an "On-Ignition" switch (see Fig. 3).

The "Ignition" position allows the driver to receive average miles-per-gallon information for each new trip. In the "Ignition" position, once the engine is shut down

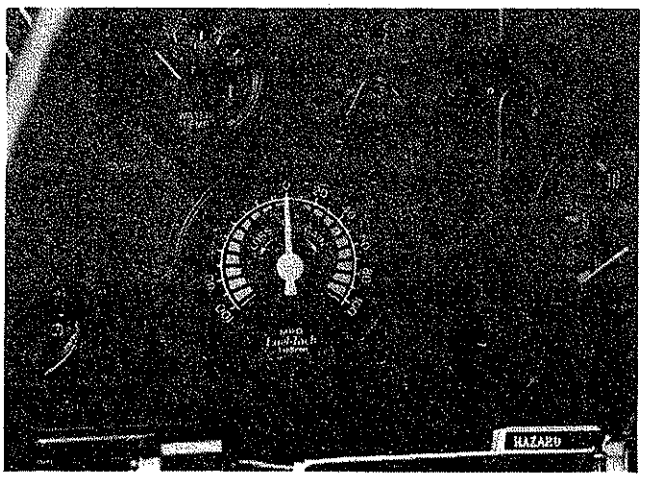

Fig. 1

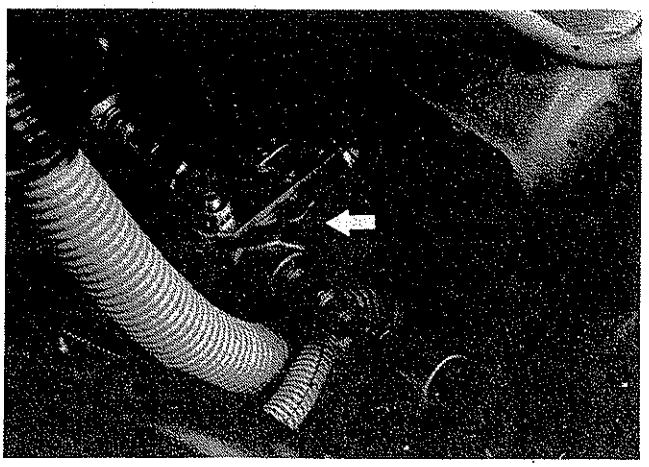

Fig. 2, Fuel Flow Sensor, Cummins Installation

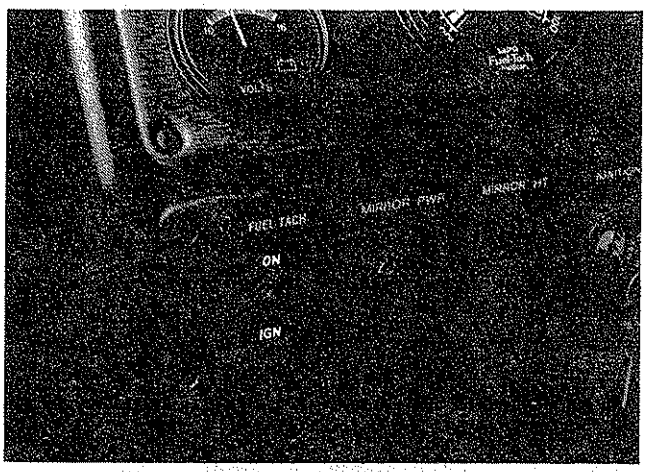

Fig. 3

the Fuel-Tach system is off. The miles-per-gallon average of the just completed trip is not maintained in the system's memory.

The "On" position allows the driver to receive average miles-per-gallon information for longer trips, or for specific periods of time. In the "On" position, the Fuel-Tach system stays on and stores the average miles-per-gallon information in memory, even if the engine is shut down.

SERVICE OPERATIONS

FUEL-TACH GAUGE REPLACEMENT

1. Apply the parking brakes.
2. Turn off the ignition switch.

FLOSCAN FUEL-TACH™

3. Remove the screws that attach the Fuel-Tach gauge panel to the dash. Pull the panel out to gain access to the back of the gauge head.
4. Remove the 6-pin wiring connector and the light bulb assembly from the back of the gauge.
5. Remove the nuts that attach the mounting bracket to the Fuel-Tach gauge, and remove the bracket. Remove the gauge from the front of the panel.
6. Install the new Fuel-Tach gauge using the instructions above, in reverse order.

FLOW SENSOR REPLACEMENT

NOTE: Two flow sensors are used on Caterpillar (see Fig. 4) and Detroit Diesel engines.

1. Clean the area around the flow sensor to prevent contaminants from entering the fuel system. Use shop air to blow the area clean.

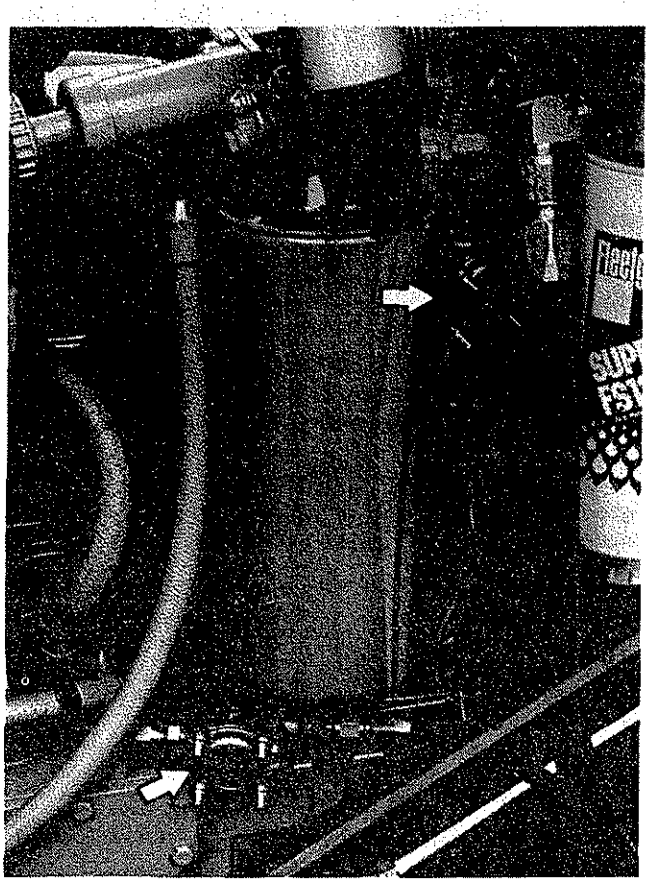

Fig. 4

2. Disconnect the flow sensor wiring connector from the chassis wiring harness. Remove the tie straps as necessary.
3. On Cummins engines (see Fig. 5), disconnect the fuel lines from the sensor. Remove the sensor from the mounting bracket.

   On Caterpillar and Detroit Diesel engines, disconnect the fuel lines from the sensor, then remove the sensor.

IMPORTANT: Collect fuel line drainage and cover the fuel line to prevent contaminants from entering the fuel system.

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

4. If the sensor is used again, clean it with a carburetor cleaning fluid or a solvent.
5. Coat the fuel line pipe threads with Armite "Lead-Plate" No. 250 Anti-Seize Compound, or an equivalent.
6. On Cummins engines, install the flow sensor with the port marked "In" towards the fuel pump.

   On Caterpillar and Detroit Diesel engines, install one sensor in the fuel supply line and one sensor in the fuel return line.

   On all engines, make sure that the sensor wires point down (or in towards the engine), to prevent splash water from entering the sensor amplifier.

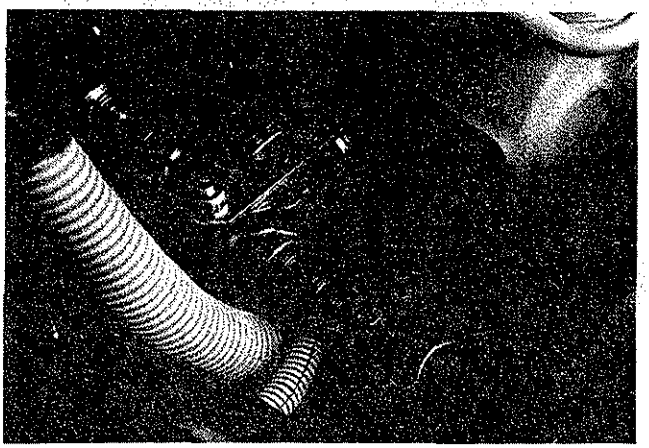

Fig. 5

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7. Tighten the fuel line fittings on each side of the flow sensor.

   On Cummins engines, install the mounting bracket capscrew and tighten the nut 108 lbf·in (1200 N·cm).

8. Connect the flow sensor wiring connector to the chassis wiring harness and secure as necessary with tie straps.

FUEL-TACH GAUGE CALIBRATION

If a new Fuel-Tach gauge is installed, or if different tires are installed, calibrate the Fuel-Tach gauge.

NOTE: The procedures below are not listed in order of recommendation. The procedure chosen depends on the calibration equipment available.

ON-HIGHWAY CALIBRATION USING THE FUEL-TACH 911 CALIBRATOR

IMPORTANT: To ensure driving safety, a passenger must accompany the driver to operate and observe the Fuel-Tach gauge and calibration unit.

1. Remove the screws that attach the Fuel-Tach gauge panel to the dash. Pull the panel out and connect the 911 calibrator as shown in **Fig. 6**.
2. Move the calibrator toggle switch to the single flow sensor position for Cummins engines, or the dual sensor position for all other engines.
3. On Cummins engines, enter the calibration factor in the calibration factor display.

NOTE: For Cummins engines, locate the Cummins fuel pump code number in "Specifications." The number to the right of the fuel pump code number is the calibration factor.

4. Press the calibrator reset button.
5. Accelerate the vehicle and maintain a constant speed.
6. Press the test button and maintain vehicle speed while the test light is on (about 10 seconds).
7. Multiply the vehicle speed by 0.1. For example, if the vehicle speed was maintained at 30 mph while the test light was on, multiply 30 by 0.1 to obtain the average-miles-per-gallon rating.
8. At the back of the gauge head, set the slide switch to a position that will provide the digital display reading that is closest to, but lower than the average-miles-per-gallon rating. See **Fig. 7**.

   At the back of the gauge head, turn the rotary knob (if equipped), or insert a thin-bladed screwdriver into the slot and turn the calibration adjusting screw until the digital display reads the average-miles-per-gallon rating obtained in step 7. See **Fig. 7**.

9. Disconnect the calibrator from the gauge head wiring connector. Connect the gauge head wiring connector to the chassis wiring harness.
10. Install the screws that attach the Fuel-Tach gauge panel to the dash.

IMPORTANT: Keep a record of actual average miles-per-gallon for a few tanks of fuel. If the Fuel-Tach digital

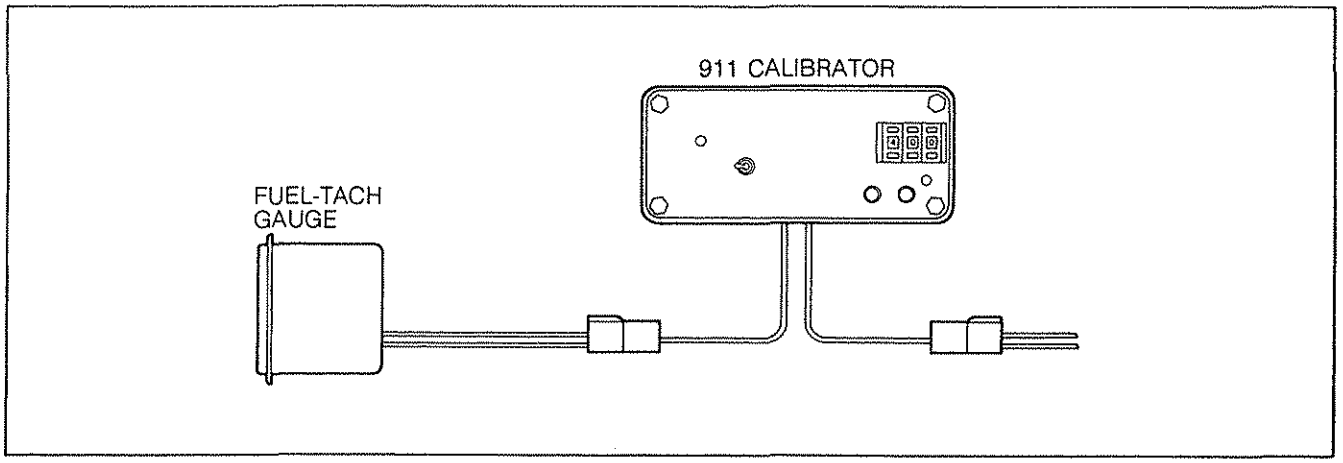

Fig. 6

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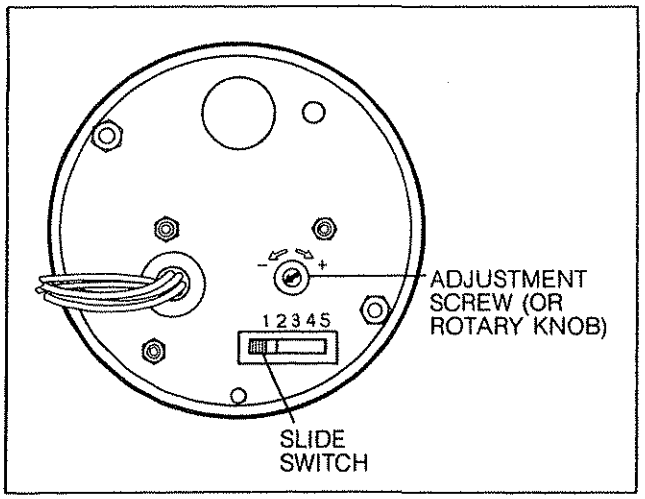

Fig. 7

display consistently differs from the actual average-miles-per-gallon performance, fine-tune the gauge by adjusting the digital display.

IN-SHOP CALIBRATION USING THE FUEL-TACH 911 CALIBRATOR AND THE 915 SPEED SIGNAL MODULE

1. Obtain the revolutions-per-mile value of the tire brand and model installed on the vehicle. The revolutions-per-mile value can be obtained from the tire dealer or manufacturer.
2. Obtain the vehicle axle ratio.

NOTE: The vehicle axle ratio is listed on the vehicle specification decal, and is also stamped on the axle housing.

3. If equipped with a Cummins engine, obtain the fuel pump code number and determine the calibration factor. Refer to "Specifications."
4. Connect the 911 Calibrator and the 915 Speed Signal Module as shown in **Fig. 8.**
5. Move the calibrator toggle switch to the single flow sensor position for Cummins engines, or the dual sensor position for all other engines.
6. On Cummins engine installations, enter the calibration factor in the calibration factor display.
7. Press the test button. The red test light will stay on about 10 seconds.
8. On vehicles equipped with electronic speedometers, make the following calculations:

.1 Multiply the revolutions-per-mile value of the tire brand, the rear axle ratio, and the vehicle speed sensor signal frequency (the standard speed sensor signal frequency is 16).

.2 Divide 1,573,200 (the number of pulses generated per hour by the 915 Speed Signal Module) by the number obtained in step 8.1.

.3 Multiply the number obtained in step 8.2 by 0.1. Enter this number in the digital display using the slide switch and calibration adjusting screw (or rotary knob, if equipped), at the back of the gauge head.

Example (electronic speedometer installation):

470 (tire revolutions-per-mile value) x 5.86 (rear axle ratio) x 16 (vehicle speed sensor signal frequency) = 44,067.20

1,573,200 (915 Speed Signal Module pulse per hour rate) ÷ 44,067.20 = 35.7

35.7 x 0.1 = 3.6 (the average-miles-per-gallon rating).

At the back of the gauge head, set the slide switch to the position that will provide the digital display reading that is closest to, but less than the average-miles-per-gallon rating. Refer to **Fig. 7.**

At the back of the gauge head, turn the rotary knob (if equipped), or insert a thin-bladed screwdriver into the slot and turn the calibration adjusting screw until the digital display reads the average-miles-per-gallon rating. Refer to **Fig. 7.**

9. On vehicles equipped with mechanical speedometers, the standard speed signal generator turns 1000 revolutions for every mile of vehicle travel. The only calculations required to calibrate the gauge head are these:

1,573,200 (915 Speed Signal Module pulse per hour rate) ÷ 8000 (mechanical speed signal generator frequency) = 197

197 x 0.1 = 19.7 (Enter 19.7 in the gauge digital display).

AVERAGE-MILES-PER-GALLON METHOD

NOTE: Use this calibration method if the FloScan calibration equipment is not available. If this method is used, ensure that the vehicle is driven with a full load. Also, this

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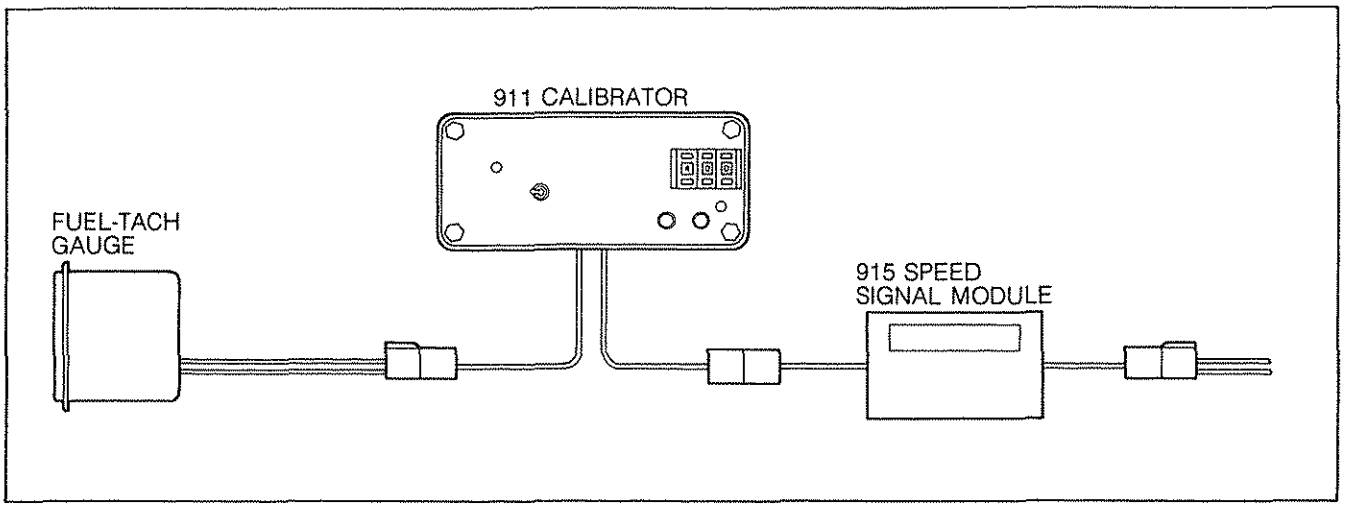

Fig. 8

method requires that you calculate the average-miles-per-gallon rating by recording trip mileage and fuel consumption over at least two tanks of fuel.

IMPORTANT: If using this calibration method, always keep the Fuel-Tach switch in the "On" position.

1. Make sure that the digital reading is 0.0. If it isn't, set the slide switch to 1, and turn the rotary knob (if equipped), or insert a thin-bladed screwdriver into the slot and turn counterclockwise until it stops.
2. Fill the fuel tank and record the vehicle mileage reading.
3. Drive the vehicle with a full load for 2 to 4 tanks of fuel.

NOTE: Try to refill the fuel tank to the same level as the previous fill.

4. Record the number of gallons used after each refill.
5. Subtract your mileage reading taken at the beginning of the trip from the end-of-trip mileage reading.
6. Divide the total miles traveled by the total number of gallons used for the trip. This is the average-miles-per-gallon rate.
7. At the back of the gauge head, set the slide switch to a position that will provide the digital display that is closest to, but lower than the average-miles-per-gallon rate.

   At the back of the gauge head, turn the rotary knob (if equipped), or insert a thin-bladed screwdriver into the slot and turn the calibrating adjusting screw until the digital display reads the exact average-miles-per-gallon rate.

IMPORTANT: Keep a record of actual average miles-per-gallon for a few more tanks of fuel. If the Fuel-Tach digital display consistently differs from the actual average-miles-per-gallon performance, fine-tune the gauge by adjusting the digital display.

FUEL-TACH GAUGE OPERATION CHECK

NOTE: This operation check requires using the Fuel-Tach 911 Calibrator and the 915 Speed Signal Module. These two instruments generate simulated fuel flow and vehicle speed signals that operate the Fuel-Tach gauge.

1. Connect the 911 Calibrator and the 915 Speed Signal Module. Refer to **Fig. 8.**
2. At the back of the gauge head, set the slide switch to position number 2. Refer to **Fig. 7.**
3. At the back of the gauge head, turn the rotary knob, if equipped, or insert a thin-bladed screwdriver into the slot and turn clockwise until it stops.
4. Move the calibrator toggle switch to the single sensor position. Set the calibration factor display to 400.
5. Turn the Fuel-Tach switch to the "On" position.
6. Press the calibrator reset button. The gauge digital display should read 18.8 for one second, and then

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0.0. If there is no gauge digital display after pressing the reset button, refer to "Troubleshooting" for fault diagnosis.

7. Press the calibrator test button so that the red test light is on. The gauge digital display should now read 1.5 or 1.6, and the gauge needle should point to 0.

8. Once the test light is off, press the test button again—the test light will come on again. The gauge digital display should read 1.5 or 1.6, and the gauge needle should point to 0.

   After the test light has been on about 4 seconds, flip the calibrator toggle switch to the dual sensor position.

   The gauge needle should move to about a 60 to 70 percent reading in the green zone, and the gauge digital display should increase steadily until the test light goes off. Then the gauge needle should return to 0, and the digital display reading will stabilize.

9. Press the test button again. The gauge digital display should now read 6.3 or 6.4, and the gauge needle should point to 0.

   After about 4 seconds, flip the calibrator toggle switch to the single sensor position. The gauge needle should move to about a 90 to 100 percent reading in the red zone, and the digital display should decrease steadily until the test light goes out. Then the gauge needle should return to 0, and the digital display reading will stabilize.

10. Press the test button again. The digital display should read 1.5 or 1.6.

    Move the gauge slide switch through the five switch positions. In each switch position the gauge digital display should read as follows:

Position 1	0.0
Position 2	1.5
Position 3	6.3
Position 4	19.9
Position 5	19.9

11. If the gauge operates as described above, it is working properly. If not, refer to "Troubleshooting" for further fault diagnosis procedures.

FLOW SENSOR OPERATION CHECK USING A DC VOLTMETER (Refer to Fig. 9)

WARNING: Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards. When using solvents, follow the safety precautions recommended by the solvent manufacturer.

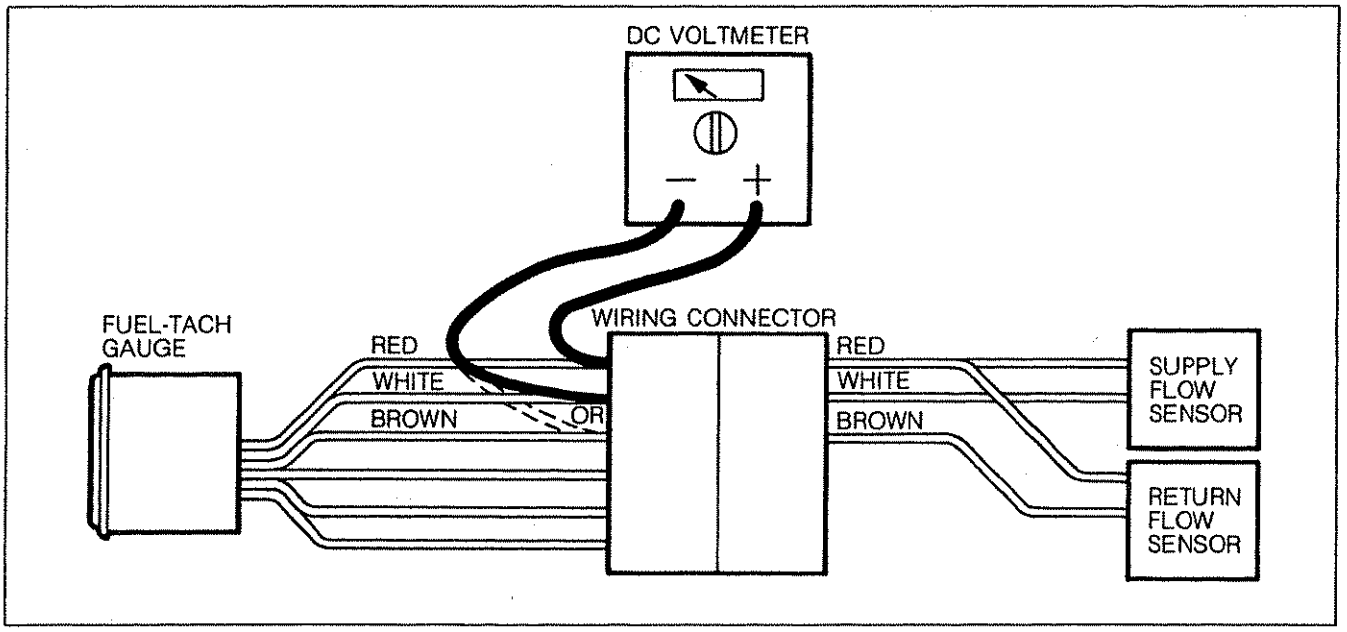

Fig. 9

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1. Remove the sensor(s) and clean it with a carburetor cleaning fluid or a solvent. Install the sensor. For instructions, refer to "Replacing the Flow Sensor."
2. Remove the screws that attach the Fuel-Tach gauge panel to the dash. Pull the panel out to gain access to the back of the gauge head.
3. Turn the Fuel-Tach switch to the "On" position.
4. Locate the Fuel-Tach wiring connector behind the gauge head and place the positive (red) probe of the voltmeter on the red wire. Place the negative (black) probe on the white wire (or brown wire if checking a return flow sensor).

   The voltmeter should read either 0 to 2 volts DC, or 9 to 13 volts DC.
5. Tap the sensor lightly. If the reading in step 4 was 0 to 2 volts DC, the voltmeter should now read 9 to 13 volts DC. If the reading in step 4 was 9 to 13 volts DC, the voltmeter should now read 0 to 2 volts DC.
6. Start the engine. The voltmeter should now read 5 to 7 volts DC. If the voltmeter reading remains unchanged at either 0 to 2 volts DC or 9 to 13 volts DC, replace the sensor.
7. Shut down the engine. Watch the voltmeter as the flow sensor rotor slows down and stops. The readings should change back and forth between the high (9 to 13 volts DC) and low (0 to 2 volts DC) levels until the rotor inside the sensor stops. If the voltmeter readings remain unchanged at either the high or low readings, replace the sensor.

TROUBLESHOOTING

Problem – The digital display is either missing digits, the decimal point, or displays nothing when the ignition is off and the Fuel-Tach switch is in the "On" position.

Possible Cause	Remedy
The gauge is not receiving power. There must be a 12-volt DC reading between the red and black wires of the wiring connector behind the gauge head.	Check all wiring and wiring connectors for looseness or damage. Correct any problems.
	Make sure that each flow sensor is grounded to the engine.
	Check for an open circuit breaker, which may mean a short in the electrical circuit; repair as needed.
The Fuel-Tach on/ignition switch is not working.	Replace the switch if necessary.
The gauge is malfunctioning.	Check the gauge with calibration units 911 and 915. Refer to "Fuel-Tach Gauge Operation Check." If this equipment is not available, replace the gauge.

Problem – If the vehicle is parked with the engine running, the gauge needle moves into the red or green zone and the digital display shows a number with the switch in positions 2 through 5 (this problem occurs on vehicles with electronic speedometers).

Possible Cause	Remedy
The vehicle speed sensor lead wire is not connected correctly to the speedometer head.	Check the wiring connection and correct if necessary.
The gauge is malfunctioning.	Check the gauge with calibration units 911 and 915. Refer to "Fuel-Tach Gauge Operation Check." If this equipment is not available, replace the gauge.

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Problem – During calibration, the gauge needle reads 0 when the vehicle is travelling over 10 mph (16 km/h), and the digital display reads 0.0 in all 5 switch positions.

Possible Cause	Remedy
The gauge is not receiving the vehicle signal (electronic speedometers only).	Check that the correct speed sensor is used and properly installed.
	Check that the black and green wire leads connect to the speed sensor terminals on the back of the speedometer head. Correct if necessary.
	Check the resistance of the speed sensor. Disconnect the wiring connector at the back of gauge and at the speed sensor. The resistance on the gauge side should be about 700 ohms. The resistance on the speed sensor side should be about 900 ohms. Repair or replace damaged wiring.
The gauge is not receiving the vehicle signal (mechanical speedometers only).	Check for an open or short circuit by disconnecting the signal generator leads. The resistance between the leads should measure between 30 and 50 ohms. Replace the sensor if necessary.
The gauge is malfunctioning.	Check the gauge with calibration units 911 and 915. Refer to "Fuel-Tach Gauge Operation Check." If this equipment is not available, replace the gauge.

Problem – The gauge needle moves only in the green zone and the display reads 19.9, or increases to 19.9 in switch positions 2 through 5 (the vehicle is moving).

Possible Cause	Remedy
The fuel flow signal from the sensor(s) is low or nonexistent.	Clean the flow sensor(s). Refer to "Flow Sensor Removal and Installation."
	Check that the wire leads are color matched across the wiring connector located behind the gauge head.
	Check that the wire leads are color matched across the harness connector located at the flow sensor. On vehicles with two flow sensors, the brown wire lead matches to the white wire lead.
	Make sure that each flow sensor is grounded to the engine. Check the resistance between the sensor and the engine block. The resistance should be about 0 ohms.
	Check that the sensor wires point down or in towards the engine. If necessary, redirect the wires to prevent splash water from shorting the sensor amplifier.
	Check that the sensor is operating properly. Refer to "Flow Sensor Operation Check Using a DC Voltmeter."
The gauge is malfunctioning.	Check the gauge with calibration units 911 and 915. Refer to "Fuel-Tach Gauge Operation Check." If this equipment is not available, replace the gauge.

Problem – The gauge needle moves into the green zone as vehicle speed and throttle pressure increases (only on vehicles with two flow sensors).

Possible Cause	Remedy
The supply and return sensors are installed in the wrong fuel lines.	Check the sensors for proper installation. Correct if necessary.
The flow sensor wires are not matched correctly at the wiring connector.	Make sure that the white wire from the supply sensor is connected to the white wire at the wiring connector. Make sure that the white wire from the return sensor is connected to the brown wire lead at the wiring connector.

Problem—The gauge needle moves back and forth in the green and red zones (the vehicle is moving).

Possible Cause	Remedy
The flow sensor is installed backwards, or in the wrong fuel line.	Check each sensor for proper installation. Correct if necessary.

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Problem – After calibration, the digital display reads higher or lower than actual performance.

Possible Cause	Remedy
The Fuel-Tach gauge is calibrated wrong.	Recalibrate the gauge. Refer to "Fuel-Tach Gauge Calibration."

Problem – The gauge needle moves back and forth in the green and red zones, and the display can't be calibrated correctly.

Possible Cause	Remedy
Intermittent power supply.	Check all wiring and wiring connections. Replace parts as necessary.
The gauge is malfunctioning.	Check the gauge with calibration units 911 and 915. Refer to "Fuel-Tach Gauge Operation Check." If this equipment is not available, replace the gauge.

Problem – The gauge needle moves into the red and green zones, but not beyond the 20 to 40 percent range. The digital display reads low, or cannot be calibrated to read consistently (only on vehicles with 2 flow sensors).

Possible Cause	Remedy
The gauge is not receiving the fuel flow signal from the return flow sensor.	Check that the wire leads are color matched across the wiring connector located behind the gauge head.
	Check that the wire leads are color matched across the wiring connector located at the flow sensor. On vehicles with two flow sensors, the brown wire lead matches to the white wire lead.
	Make sure that each flow sensor is grounded to the engine. Check the resistance between the sensor and the engine block. The resistance should be about 0 ohms.
	Check that the sensor is operating properly. Refer to "Flow Sensor Operation Check Using a DC Voltmeter."
The gauge is malfunctioning.	Check the gauge with calibration units 911 and 915. Refer to "Fuel-Tach Gauge Operation Check." If this equipment is not available, replace the gauge.

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SPECIFICATIONS

NOTE: If the Cummins Fuel Pump Code Number is not listed in this section, call the FloScan Instrument Company toll-free at (800) 522-3610.

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
1501	367
1502	356
1953	476
1982	460
1983	452
2046	371
2134	432
2185	397
2242	439
2243	429
2248	437
2300	360
2322	474
2324	459
2344	462
2362	392
2368	431
2380	468
2410	411
2427	412
2433	427
2443	386
2462	515
2464	467
2466	453
2469	412
2480	453
2481	441
2488	396
2495	426
2501	405
2502	374
2512	398
2523	444
2530	360
2532	455
2534	419
2552	458
2589	511
2596	459
2603	462
2604	397
2613	409
2615	511
2616	512
2627	364
2628	374
2635	409
2640	453
2641	447

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
2650	395
2655	364
2662	489
2663	455
2665	458
2666	472
2680	450
2683	441
2689	429
2692	507
2693	498
2708	370
2718	392
2734	515
2735	443
2742	494
2747	435
2761	403
2765	392
2769	461
2777	388
2780	464
2782	440
2789	427
2790	406
2796	461
2801	467
2805	456
2810	511
2812	498
2815	511
2819	468
2834	451
2838	472
2839	451
2842	376
2863	447
2864	431
2865	354
2867	357
2876	442
2878	457
2880	515
2881	409
2884	405
2885	455
2886	431
2899	461
2908	433
2912	429

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
2913	424
2914	357
2915	436
2916	369
2921	464
2922	447
2923	453
2929	464
2930	436
2931	424
2933	419
2937	401
2938	411
2943	455
2944	439
2945	459
2948	498
2949	427
2951	379
2953	351
2954	384
2955	372
2956	351
2958	378
2961	449
2968	479
2972	453
2975	429
2985	382
2992	421
2994	458
2995	406
3001	406
3003	502
3004	399
3005	434
3006	406
3008	456
3009	370
3014	406
3016	460
3019	339
3020	423
3021	423
3022	423
3023	392
3024	392
3025	397
3026	397
3027	426

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CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3028	398
3029	395
3030	409
3033	347
3034	347
3035	376
3036	372
3037	378
3039	412
3040	382
3041	406
3042	406
3043	335
3046	399
3047	392
3048	402
3049	426
3055	427
3056	438
3057	437
3066	464
3069	357
3070	449
3071	446
3073	429
3080	532
3082	523
3087	447
3093	412
3111	396
3114	308
3116	310
3118	466
3121	466
3125	449
3126	462
3128	459
3132	387
3133	378
3160	329
3161	449
3162	453
3167	393
3171	314
3179	464
3190	289
3193	325
3199	332
3201	270
3203	332
3214	332
3218	457
3220	450
3227	455

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3237	314
3239	239
3243	460
3247	303
3250	296
3251	304
3253	480
3257	327
3262	332
3266	469
3275	471
3276	301
3278	463
3279	262
3280	468
3281	434
3287	462
3288	306
3289	329
3297	284
3300	292
3301	297
3302	269
3303	307
3304	331
3305	290
3306	302
3307	283
3308	296
3309	271
3310	387
3321	382
3322	399
3323	424
3329	298
3330	245
3331	292
3332	285
3333	268
3334	441
3335	280
3340	290
3341	298
3342	290
3343	332
3344	314
3345	303
3346	298
3349	332
3350	302
3351	329
3352	307
3353	311
3357	327

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3359	271
3360	280
3361	278
3362	327
3364	275
3367	283
3368	284
3369	279
3372	297
3373	316
3374	315
3375	328
3376	261
3377	332
3378	268
3379	272
3383	314
3386	314
3395	452
3397	331
3398	426
3399	463
3400	322
3401	452
3402	288
3403	464
3404	310
3407	319
3408	297
3409	314
3410	332
3411	314
3412	332
3413	327
3414	289
3415	297
3416	302
3417	347
3418	347
3420	424
3423	332
3424	286
3425	345
3426	332
3428	274
3429	333
3430	336
3431	329
3432	307
3433	329
3434	307
3437	307
3438	316
3439	296

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CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3440	324
3443	455
3445	450
3446	295
3447	443
3450	310
3467	289
3469	444
3477	335
3479	452
3480	425
3483	486
3484	316
3485	315
3490	330
3498	317
3499	406
3502	335
3505	399
3509	330
3511	401
3515	346
3516	375
3517	317
3518	293
3520	397
3521	443
3523	306
3526	446
3527	303
3530	376
3553	318
3554	330
3560	443
3570	274
3573	324
3574	314
3582	325
3585	344
3592	381
3593	359
3594	377
3595	363
3596	368
3597	368
3607	314
3617	337
3618	299
3620	322
3621	315
3622	309
3623	300
3624	261
3625	289

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3626	265
3627	314
3628	344
3630	347
3631	285
3632	289
3634	356
3635	315
3636	281
3638	337
3639	330
3640	344
3641	311
3643	337
3645	344
3650	306
3651	315
3653	396
3654	315
3657	412
3658	406
3665	417
3668	306
3671	324
3672	324
3673	278
3674	310
3675	351
3676	303
3677	305
3678	302
3679	314
3681	318
3683	374
3684	320
3687	368
3701	295
3720	365
3723	342
3724	413
3728	451
3729	289
3733	386
3735	363
3736	353
3741	295
3743	438
3744	330
3747	337
3749	317
3752	282
3753	269
3754	295
3755	263

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3763	337
3766	476
3767	255
3768	267
3769	284
3771	327
3773	306
3775	310
3781	335
3791	419
3799	393
3800	351
3802	371
3803	372
3804	383
3805	403
3806	345
3809	364
3810	375
3811	373
3812	377
3813	366
3817	325
3822	279
3825	412
3826	348
3828	322
3829	315
3837	315
3851	390
3854	372
3865	407
3868	490
3873	367
3874	379
3878	316
3894	328
3896	286
3897	280
3900	321
3909	344
3910	317
3913	317
3914	332
3918	328
3922	308
3924	361
3928	379
3938	320
3943	367
3947	308
3960	314
3963	397
3965	331

FLOSCAN FUEL-TACH™

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3969	339
3970	340
3972	270
3973	279
3975	315
3976	441
3977	449
3979	399
3980	463
3983	404
3986	434
3997	375
3998	388
4001	376
4003	362
4006	329
4008	341
4010	260
4011	327
4016	370
4017	387
4021	332
4027	312
4028	325
4034	331
4039	329
4040	313
4041	308
4042	321
4043	312
4044	344
4045	313
4046	307
4047	321
4048	306
4049	314
4050	303
4051	303
4052	317
4053	317
4054	313
4055	305
4058	307
4059	310
4060	311
4067	313
4068	321
4069	308
4073	313
4074	372
4075	382
4076	339
4078	295
4080	386

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
4086	307
4089	339
4090	395
4091	345
4092	323
4094	368
4095	363
4099	326
4100	319
4101	342
4102	324
4106	335
4108	321
4110	396
4111	321
4112	321
4113	311
4114	310
4115	378
4120	369
4124	346
4135	309
4136	319
4137	324
4138	325
4139	303
4140	326
4141	290
4143	384
4152	394
4153	316
4156	522
4157	329
4158	336
4159	344
4160	323
4161	344
4162	329
4163	341
4164	336
4166	514
4167	357
4170	341
4172	323
4174	312
4176	429
4178	335
4181	480
4182	434
4183	297
4184	316
4185	315
4187	312
4191	325

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
4192	373
4218	309
4219	323
4224	369
4226	292
4227	311
7975	310
7991	388
8875	314
9108	361
9214	381
9215	388
9225	323
9253	388
9262	381
X020	457
X022	423
X031	419
X032	444
X033	432
X045	435
X047	422
X048	421
X049	451
X050	408
X052	415
X053	407
X058	429
X062	404
X063	406
X064	400
X068	379
X069	418
X070	406
X071	392
X072	409
X073	415
X075	431
X076	379
X077	405
X078	426
X080	432
X081	371
X083	420
X084	400
X085	400
3355	304
3613	293
3619	344
3660	304
3690	451
3730	358
3740	320
3748	472

FLOSCAN FUEL-TACH™

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
3751	472
3757	401
3760	361
3765	494
3778	372
3779	375
3818	391
3823	315
3846	316
3847	324
3848	287
3870	398
3892	351
3895	361
3904	336
3919	324
3925	375
3926	372
3935	291
3940	422
3948	311
3949	277
3952	328
3954	444
3955	485
3959	344
3971	310
3978	395
3989	306
3991	266
3994	273
4022	336
4036	300
4064	322
4065	317
4066	307
4070	314
4072	283
4073	320
4084	307
4085	310
4105	312
4107	322
4116	306
4118	284
4121	291
4122	432
4123	435
4128	333
4144	360
4146	335
4168	275
4171	347
4212	391

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
4213	383
4220	293
4221	344
4222	323
4223	310
4228	429
4229	307
4230	310
4231	307
4232	310
4233	307
4234	307
4235	295
4236	312
4237	316
4240	311
4242	325
4244	290
4245	394
4246	287
4249	322
4250	322
4252	285
4258	269
4261	307
4263	311
4265	414
4267	382
4273	393
7900	447
7902	302
7903	302
7904	450
7905	253
7905	285
7908	245
7927	321
7928	299
7929	410
7934	324
7935	300
7936	344
7937	409
7938	344
7939	313
7940	406
7941	409
7942	311
7943	305
7945	315
7946	278
7947	472
7948	510
7949	279

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
7950	317
7952	322
7954	310
7957	332
7959	328
7960	291
7963	329
7964	273
7965	361
7966	306
7967	307
7968	305
7969	263
7970	362
7971	325
7972	310
7973	322
7974	339
7976	340
7977	284
7978	392
7980	329
7981	368
7982	363
7983	288
7984	310
7985	322
7986	422
7987	299
7988	323
7991	388
9017	361
9018	295
9026	310
9048	375
9058	391
9071	295
9081	403
9082	476
9093	351
9109	375
9110	391
9124	322
9129	232
9132	332
9138	321
9141	372
9143	311
9145	291
9148	335
9159	328
9160	441
9166	442
9200	310

FLOSCAN FUEL-TACH™

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
9201	317
9202	311
9203	317
9206	490
9209	332
9211	265
9212	376
9216	310
9217	307
9218	339
9219	340
9220	325
9221	322
9222	340
9223	395
9227	362
9229	307
9231	310
9234	322
9239	363
9240	310
9241	368
9243	322
9245	330
9254	360
9290	310
9375	321
X030	407
X086	429
X087	429
X088	407
X089	419
X090	444
X091	440
X093	435
X095	422
X096	421
X097	451
X098	408
X099	451
X100	407
X103	429
X107	404
X108	406
X109	400
X113	379
X114	418
X115	406
X116	392
X117	409
X118	415
X119	431
X120	379
X121	408

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
X122	426
X123	432
X124	371
X125	400
X126	420
X127	400
X128	400
X129	429
X132	423
X133	359
X134	376
X138	411
X139	444
X527	407
X528	434
X531	432
X546	402
X549	405
X552	408
X553	425
X557	437
X565	429
X567	410
X571	437
X572	433
X573	412
X578	451
X589	407
X590	434
X593	432
X600	402
X603	405
X606	408
X607	425
X611	437
X614	412
X615	420
X617	395
X618	429
X620	410
X624	437
X625	433
X626	412
X630	451
X631	437
X633	396
X634	396
X635	364
X636	364
X637	405
X639	405
X640	405
X647	405
X648	395

CUMMINS FUEL PUMP CODE NUMBER	FUEL-TACH CALIBRATION NUMBER
X649	423
X650	405
X652	432
X659	406
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