Air Brake Plumbing, Cab Diagram

42.00

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See **Fig. 1** for a full view of the air brake plumbing (cab) diagram. See **Fig. 2** or **Fig. 3** for partial (detailed) views of this diagram.

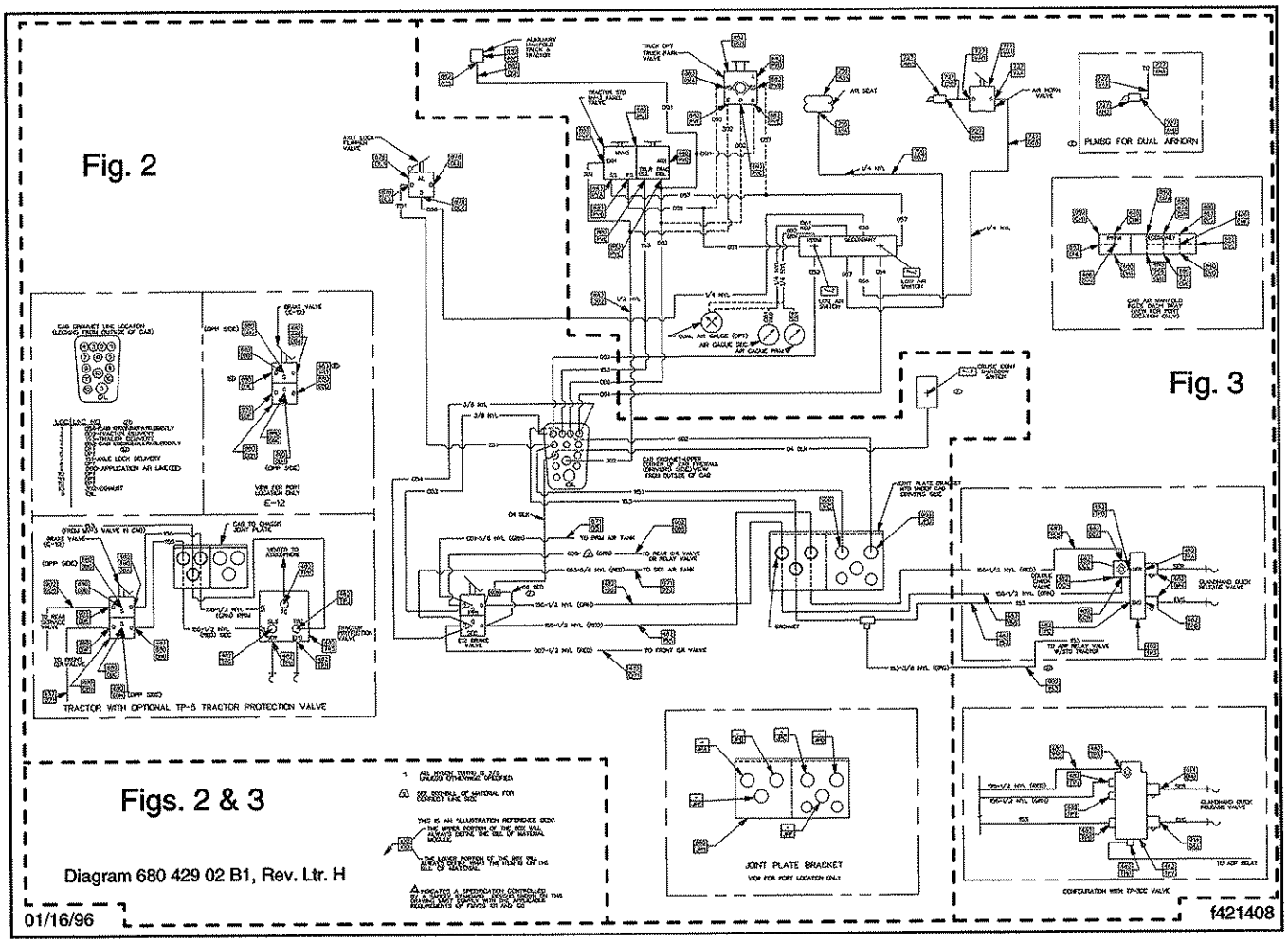


Fig. 1, Cab Air Brake Plumbing Diagram

Cab Diagram

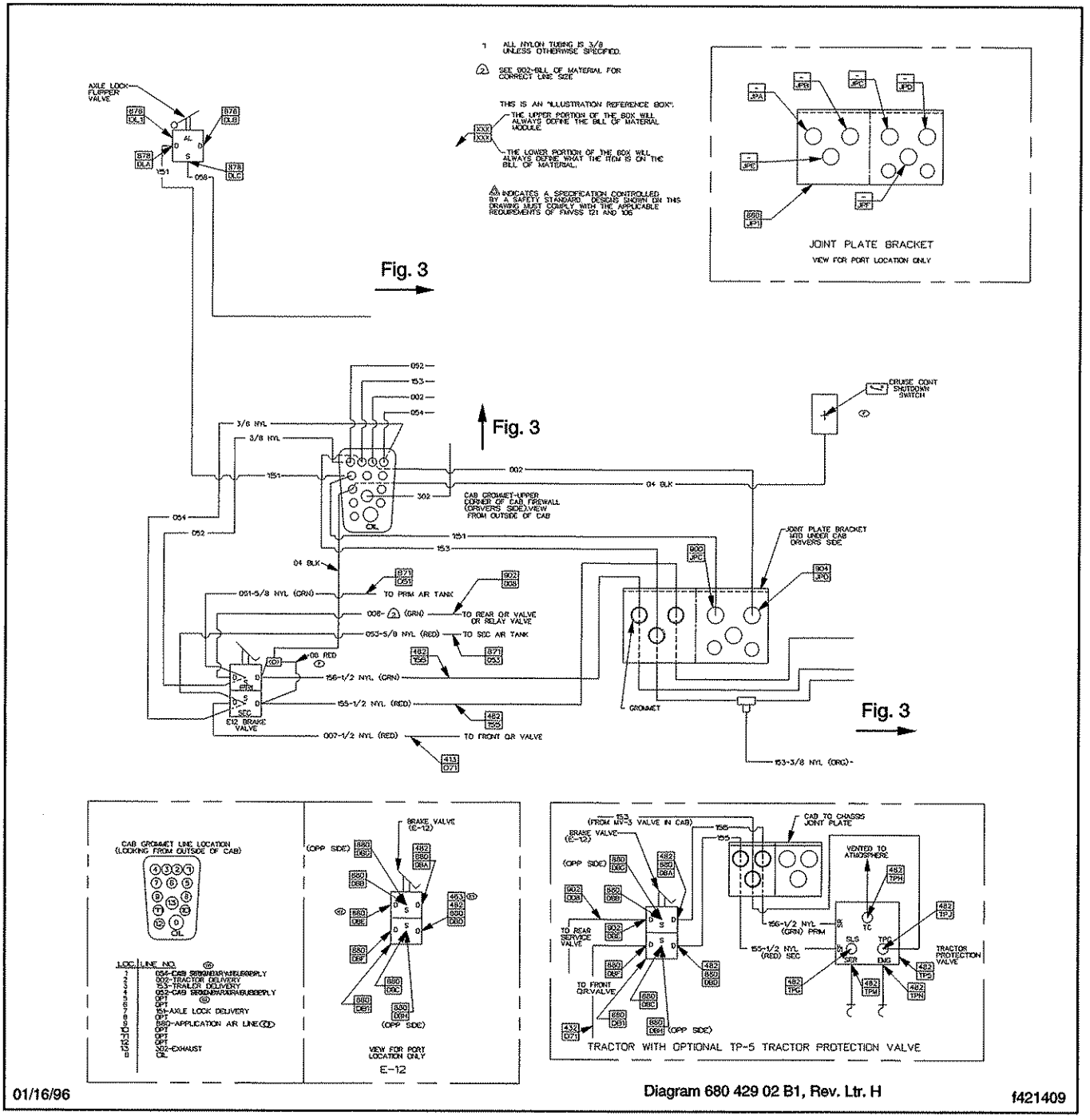


Fig. 2, Cab Air Brake Plumbing Diagram (detailed view)

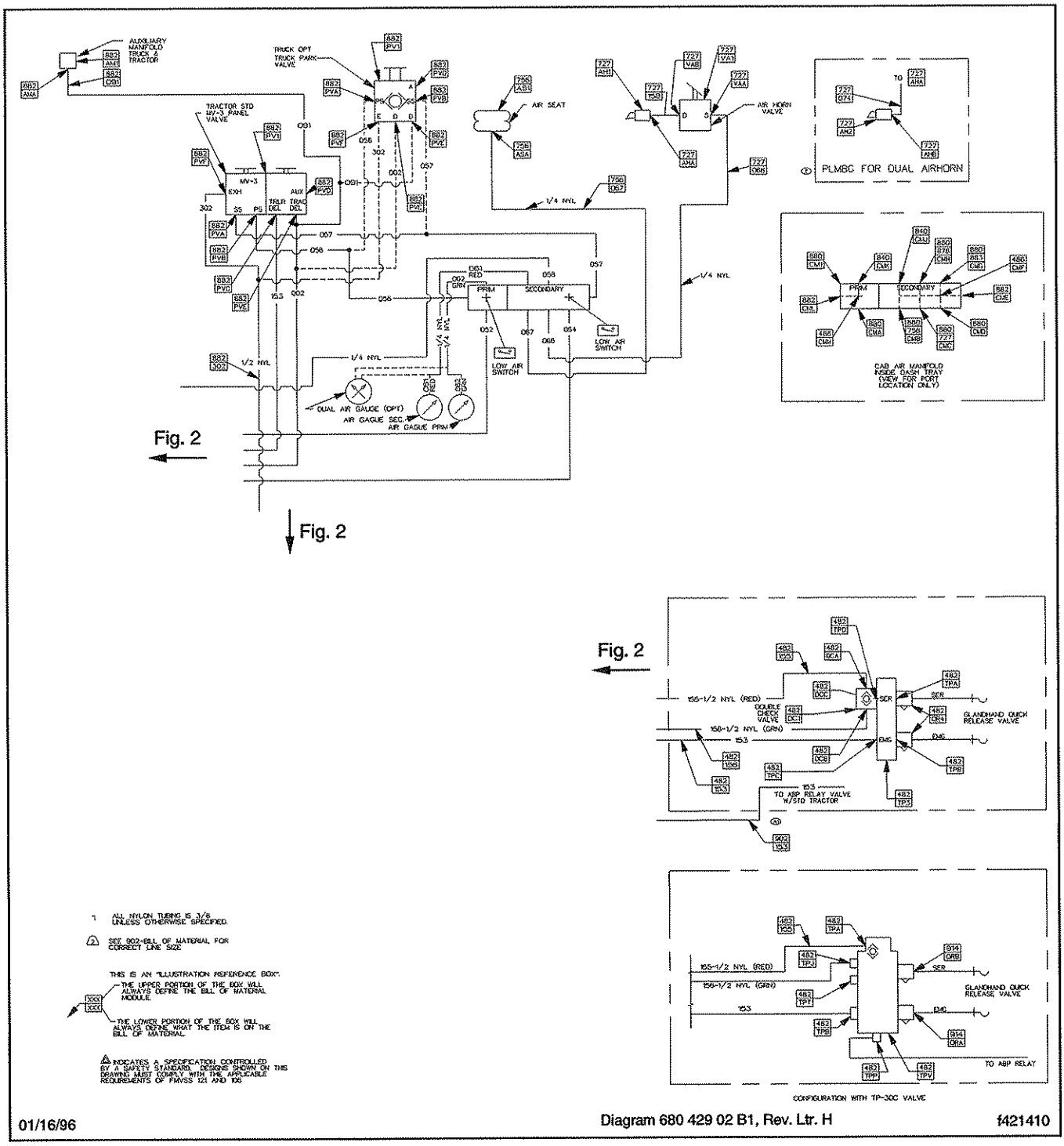


Fig. 3, Cab Air Brake Plumbing Diagram (detailed view)

Air Brake Plumbing, Chassis Diagram 42.01

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See **Fig. 1** for a full view of the air brake plumbing (chassis) diagram. See **Fig. 2**, **Fig. 3** or **Fig. 4** for partial (detailed) views of this diagram.

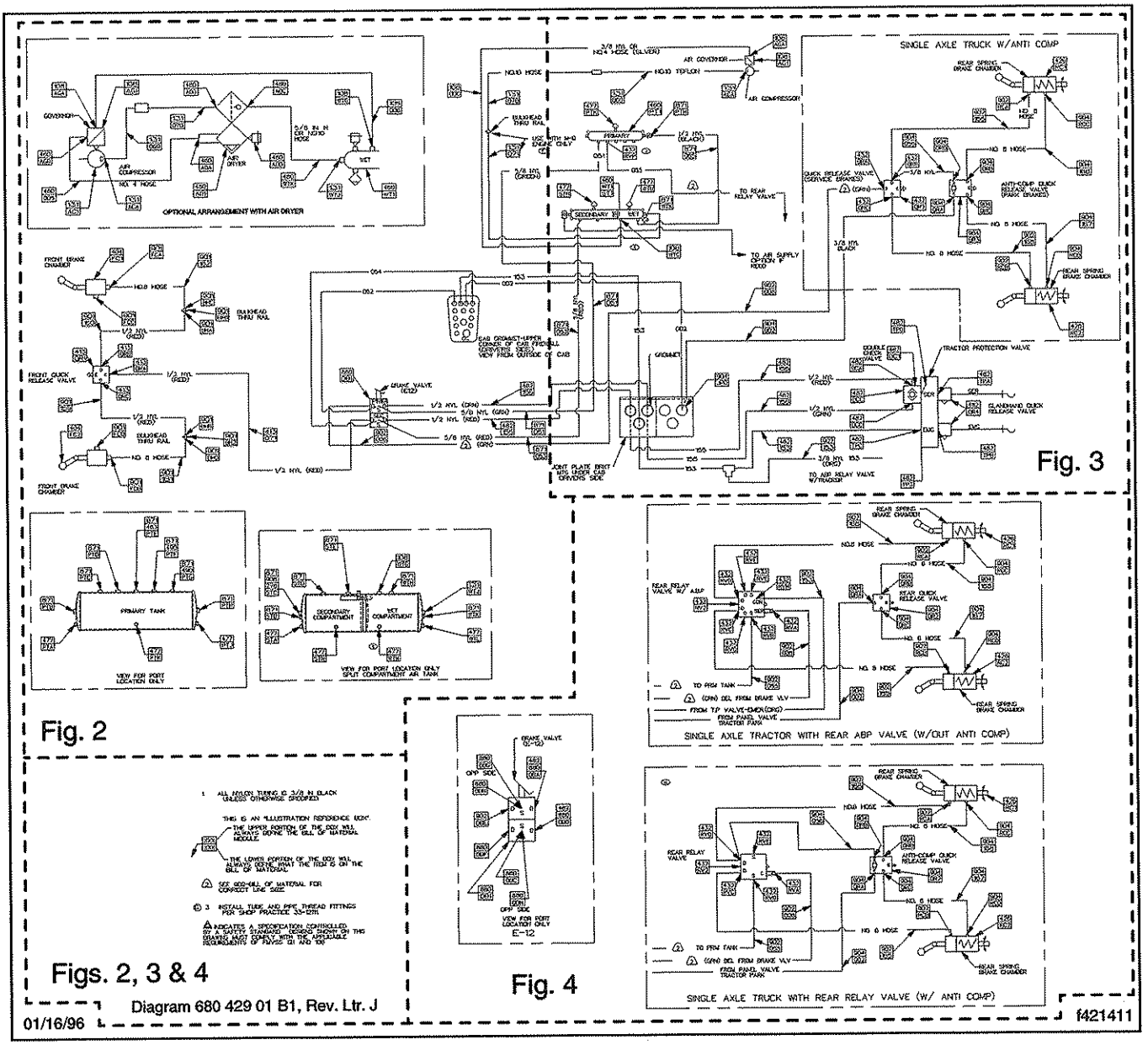


Fig. 1, Air Brake Plumbing, Chassis Diagram

Chassis Diagram

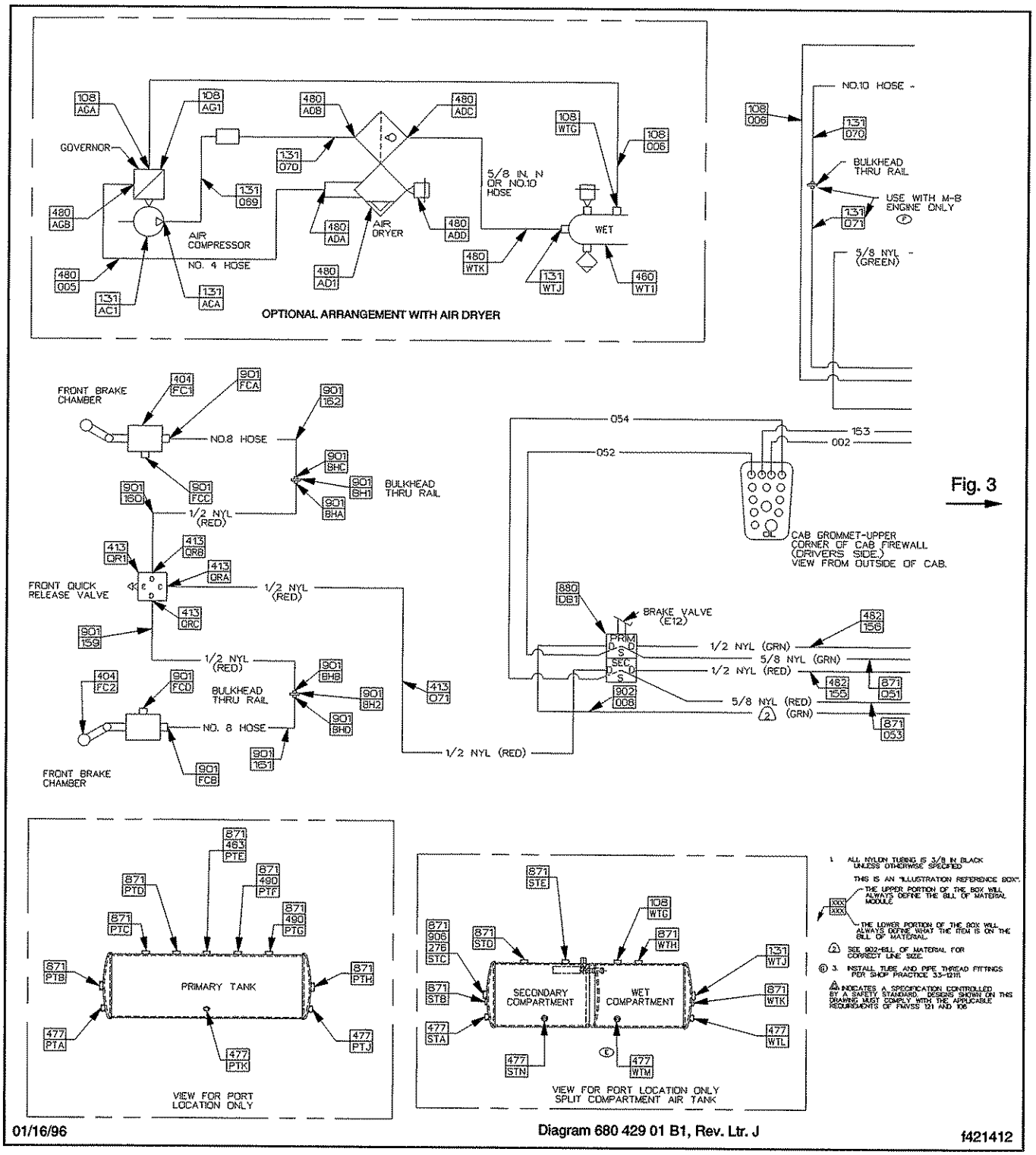


Fig. 2, Air Brake Plumbing, Chassis Diagram (detailed view)

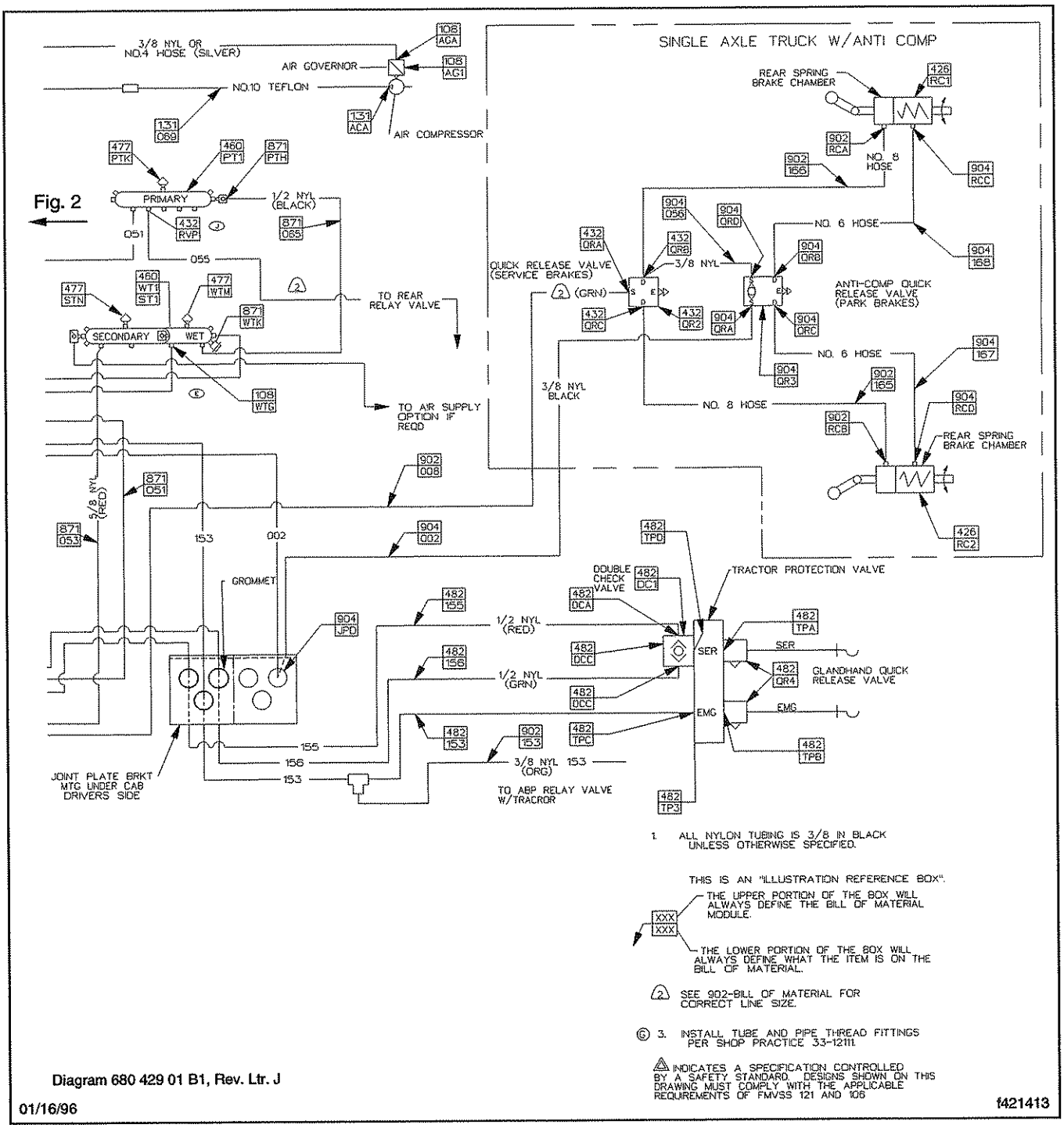


Fig. 3, Air Brake Plumbing, Chassis Diagram (detailed view)

Chassis Diagram

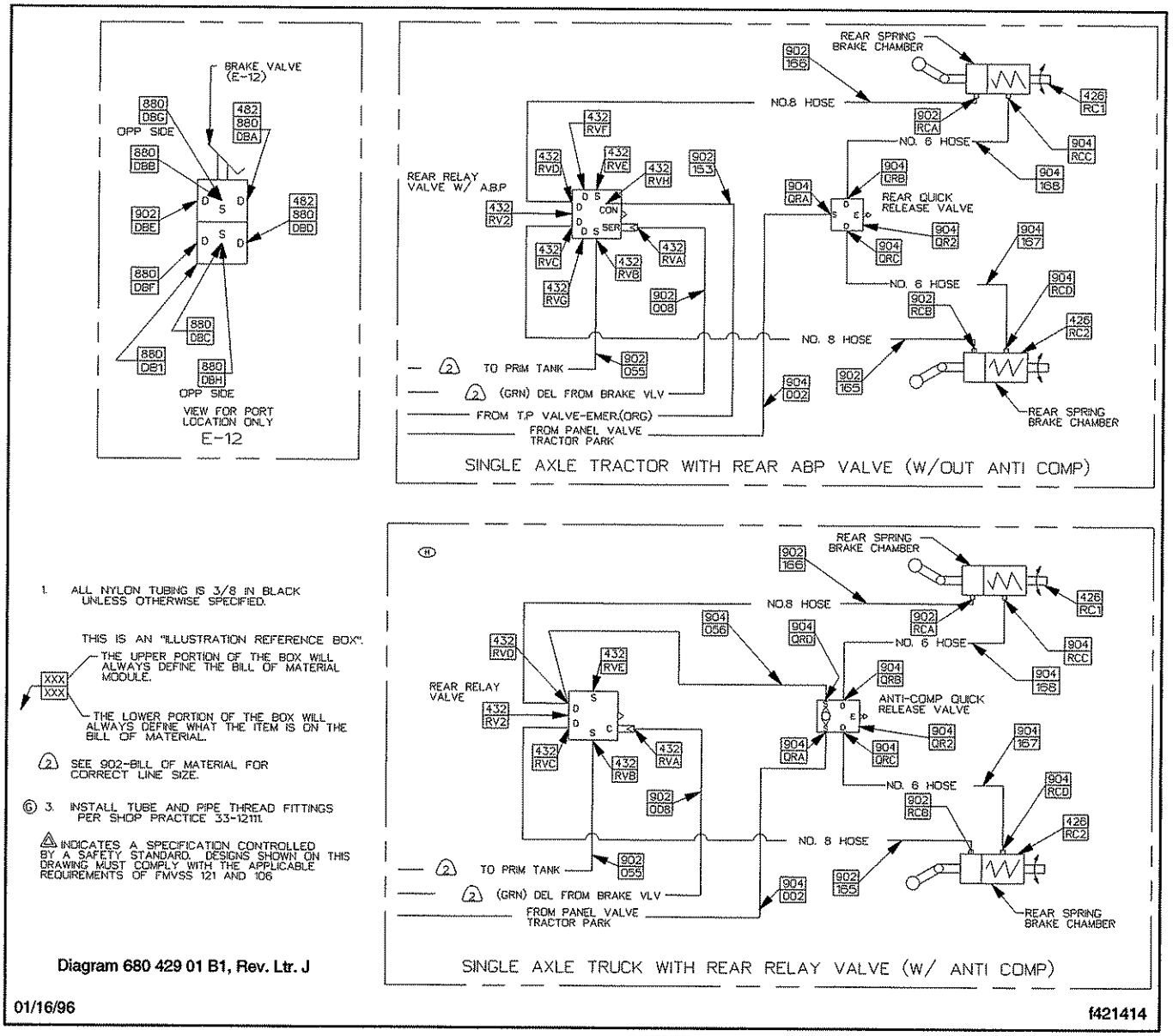


Fig. 4, Air Brake Plumbing, Chassis Diagram (detailed view)

Air Brake System Troubleshooting 42.02

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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

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.

Problem—Vehicle Does Not Slow Down Quickly Enough When Brakes Are Applied

Possible Cause	Remedy
The vehicle is overloaded.	Observe the recommended maximum load limits.
There is low air pressure in the brake system, about 413 kPa (60 psi) or lower.	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 parking 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.
The brake linings are worn or glazed.	Install new brake linings on the brake shoes on both sides of the axle.
The brakes need adjustment or lubrication.	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. Replace the brake drums if needed.
Flat spots or dents on the roller surface were caused by skidding of the roller or incorrect handling of the rollers during installation.	Clean, then inspect the bearing rollers. Replace the rollers if damaged.
One or more of the brake drums is broken or cracked.	Replace the brake drum(s).
Wrong size brake linings were installed.	Replace the brake linings with the recommended size.
Wrong 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 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.
The brake drums are glazed.	Turn the brake drums, if possible. If the maximum allowable diameter is exceeded, replace the drum. Do the same for both ends of the axle.

Problem—Service Brakes Release Too Slowly

Possible Cause	Remedy
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.
The brake foot valve push rod may be incorrectly adjusted.	Readjust the push rod and/or pedal stop bracket.
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.

Troubleshooting

Possible Cause	Remedy
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 not working.	Overhaul or replace the applicable 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 incorrect handling of the rollers during installation.	Clean, then inspect the rollers. Replace the rollers if damaged.

Problem—Service Brakes Do Not Apply or Apply Too Slowly

Possible Cause	Remedy
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 quick-release valve is not working.	Repair or replace the brake foot valve or quick-release valve.
The camshaft bushings are binding.	Clean and lubricate the camshaft bushings.

Problem—Service Brakes Apply When the Parking Brakes Are Released With Air Pressure

Possible Cause	Remedy
The air delivery 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 parking 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.

Problem—Service Brakes Do Not Release

Possible Cause	Remedy
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 adjustment of the brake foot valve push rod.
The brake foot valve is not working.	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 parking brake piston movement.	Replace the power spring or replace the parking brake assembly, whichever is recommended by the parking brake manufacturer.

Problem—Service Brakes Grab or Pull

Possible Cause	Remedy
There is not enough weight on the vehicle (underloaded).	Add weight to the vehicle, reducing brake sensitivity.
Adjustment of the brakes on one axle is uneven.	Adjust the brakes.
Lubrication of the brake system components is inadequate.	Lubricate those components requiring periodic lubrication.
The brake mechanism is binding.	Lubricate the brake mechanism and make sure all parts are aligned with each other and are securely fastened.
The clevis pin or camshaft is binding at one or more wheels.	Clean and lubricate the camshaft bushings.
A brake spider is loose.	Tighten the mounting bolts or replace the brake spider.
A slack adjuster is damaged.	Replace the damaged component.
The air chamber push rods or slack adjusters are a different length.	Replace the components with the correct size and material.
The brake foot valve is not working.	Overhaul or replace the brake foot valve, as needed.
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).
Grease has saturated the brake linings or the linings are glazed.	Install a matched set of linings on both sets of brake shoes on that axle. Clean, replace, or turn both brake drums. For instructions on turning drums, refer to the brake manufacturer's service manual. Find out what is causing the saturation and repair as needed.
The brake linings are loose or broken.	Install a matched set of linings on both sets of brake shoes on that axle.
The brake linings are not a matched set. Different friction codes or different brands of brake linings are installed.	Install a new, matched set of brake linings. Clean, replace, or turn both brake drums on that axle. For instructions on turning drums, refer to the brake manufacturer's service manual.
A brake shoe is distorted or broken.	Replace the brake shoe. Install a new, matched set of linings on both sets of brake shoes on that axle.
The pilot pads are damaged, allowing the brake drum to be installed out-of-round.	Replace the wheel hub.
A brake drum is out-of-round to unacceptable limits.	Turn both the brake drums on that axle. If the maximum allowable diameter of either drum has been exceeded, replace that drum. For instructions on turning drums, refer to the brake manufacturer's service manual.
One or more brake drums is scored or broken.	Replace both of the drums on that axle.

Problem—Uneven Service Brakes

Possible Cause	Remedy
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. Find the cause of saturation, and repair as needed.
The return spring for the brake shoe release or the service brake has broken.	Replace all broken springs.

Troubleshooting

Possible Cause	Remedy
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 front axle group or the rear axle group of the vehicle maintenance 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. Find the cause of contamination and remedy it.

Problem—Dragging Service Brake

Possible Cause	Remedy
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.
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 brake foot valve push rod may be incorrectly adjusted.	Readjust the push rod and/or pedal stop bracket.

Problem—Insufficient Parking Brake Application When Dash Control Valve Is Activated

Possible Cause	Remedy
The parking brake is not set for full stroke.	Adjust the brakes.
A power spring is broken.	Replace the parking brake chamber.
A power spring in a parking brake is manually caged.	Uncage the power spring, using the release bolt.

Problem—Dragging Brakes Due to Parking Brake Mechanism

Possible Cause	Remedy
The system air pressure is insufficient to fully release the parking brake.	Be sure that all air lines are clear. Check that the air governor cutout settings meet recommended specifications.
A parking brake diaphragm is ruptured or a piston seal is ineffective.	Replace the diaphragm or parking brake piston seal.
There is a broken return spring in the parking brake (double-diaphragm type brake chambers only).	Replace the parking brake chamber.

Problem— Air Pressure Will Not Rise to Normal

Possible Cause	Remedy
The air pressure gauge(s) on the dash is (are) 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 not working (including excessive leakage of the compressor).	Rebuild or replace the compressor.
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.

Problem— Air Pressure Rises Above Normal

Possible Cause	Remedy
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 closed.	
The air compressor unloading valve cavities or the unloading valve passage is blocked with carbon.	

Troubleshooting

Problem—Air Pressure Drops Quickly With the Engine Stopped and the Brakes Released

Possible Cause	Remedy
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.
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.

Problem—Air Pressure Drops Quickly With the Engine Stopped and the Brakes Fully Applied

Possible Cause	Remedy
A service or parking brake chamber is leaking.	Tighten the clamp ring(s). If leaks persist, replace the service brake diaphragm or the parking brake chamber, as applicable.
The brake foot valve or quick-release valve is leaking.	Repair or replace the component(s) or assembly.
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.

Problem—Compressor Knocks (Continuously or Intermittently)

Possible Cause	Remedy
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 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.

Problem—Safety Valve Activates

Possible Cause	Remedy
The safety valve is out of adjustment.	Adjust the safety valve, or install a new one.
There is too much air pressure in the brake system.	Refer to the problem "Air Pressure Rises Above Normal."
The air reservoirs need to be drained more often.	Drain the air reservoirs daily.

Problem—Oil or Water in the Brake System

Possible Cause	Remedy
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.

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Safety Precautions

Before attempting to work on the air brake system, observe the following precautions:

- Since the compression and storage of air can be compared to energy in a coiled spring, when released, it can present a hazard if not properly recognized. The wheels of the vehicle must always be chocked so that depletion of air will not permit the vehicle to roll.
- When draining the system, do not look into the air jets or direct them toward a person, as dirt or sludge particles can be carried in the air stream.
- Air lines will whip dangerously if disconnected under pressure. Follow the manufacturer's recommended procedures when working on any air devices so as to avoid injury or damage from parts which, when released, are subject to mechanical (spring) or pneumatic propulsion.
- As system pressure is drained and the emergency brakes apply, hands must be away from the air chamber pushrods and spring actuators that apply automatically with the loss of pressure. This also applies when checking the service brake system.
- Reservoirs that are closest to the sources of compressed air (compressors or auxiliary sources) must contain a safety valve in known working order and sufficient capacity to limit the reservoir pressure to a safe maximum level.
- Used reservoirs must not be used as replacements in order to eliminate the possibility of component failure.
- The safety valves must not be reset higher than specified by the reservoir manufacturer, vehicle manufacturer, or code to which the reservoir had been manufactured in order to prevent valve failure.
- Various actuators contain powerful internal springs that require special handling procedures. Note and be guided by the warning tags on such units to avoid personal injury or property damage.
- To avoid injury, keep clear of the air chamber pushrod when brakes are applied or when air is exhausted from the system.

Specifications

213 Wire Braid Air Lines*			
Number	Inside Diameter Inch	Outside Diameter Inch	Minimum Bend Radius inches (mm)
4	3/16	0.49	0.75 (20)
5	1/4	0.55	1.00 (25)
6	5/16	0.62	1.25 (30)
8	13/32	0.74	1.75 (45)
10	1/2	0.83	2.25 (55)
12	5/8	0.96	2.75 (70)
16	7/8	1.21	3.50 (90)
20	1-1/8	1.49	4.50 (115)

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

Table 1, 213 Wire Braid Air Lines

Nylon Air Lines			
Number	Inside Diameter Inch	Outside Diameter Inch	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	0.441	5/8	2.50 (64)
12	0.566	3/4	3.00 (76)

Table 2, Nylon Air Lines

KV2 Stud End Torque into Metallic Ports*		
Thread, NPTF Inch	Torque†	
	lbf·in (N·cm)	lbf·ft (N·m)
1/16	62–80 (700–900)	—
1/8	62–80 (700–900)	—
1/4	106–124 (1200–1400)	—
3/8	—	16–18 (22–24)
1/2	—	21–22 (28–30)

* Aluminum, zinc, steel and brass ports.

† The component in which the KV2 One-Touch fitting is being installed may have torque values lower than those listed here. Please see the component supplier's recommended torque specifications.

Table 3, KV2 Stud End Torque into Metallic Ports

Brass or Steel Pipe Fittings on Plastic Components			
Description	Port Size Inch	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. If needed, turn the fittings to allow for the proper routing of the air lines.

Table 4, Brass or Steel Pipe Fittings on Plastic Components

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General Description and Principles of Operation (Refer to Fig. 1)

The dual circuit brake valve (foot valve) controls the air supply and delivery of the dual circuit brake system. The brake valve is mounted on the firewall .

APPLYING

The primary circuit of the brake valve is controlled by the brake pedal and a push rod. When the brake pedal is depressed, the push rod applies pressure on the spring retainer (Ref. 1), rubber spring, and the primary (upper) piston (Ref. 2). The downward movement of the primary piston closes the upper exhaust valve, and then opens the upper inlet valve, allowing high-pressure air from port 11 (Ref. 5) to flow to low-pressure port 21 (Ref. 12).

The secondary circuit is air operated by the pressure from the primary circuit. Primary circuit pressure on top of the secondary piston (Ref. 6) first closes the lower exhaust valve, and then opens the lower inlet valve, allowing high-pressure from port 12 (Ref. 7) to flow to low-pressure port 22 (Ref. 11).

HOLDING

As air pressure builds in the primary circuit, the pressure under the primary piston will match the pressure of the rubber spring. This allows the piston to move up enough to close the upper inlet valve, and prevent the flow of air from the primary air tank into the brake valve. The exhaust port remains closed.

RELEASING

When the pedal is released, the push rod releases pressure from the spring retainer, rubber spring, and the primary (upper) piston. Air pressure builds to push the piston up, opening the upper exhaust valve and allowing air from the primary circuit to escape through the exhaust port.

In the secondary circuit, the release of primary air pressure allows air under the secondary piston, pushing the piston up and opening the lower exhaust valve (Ref. 9). All remaining air pressure is vented through the exhaust port (Ref. 10).

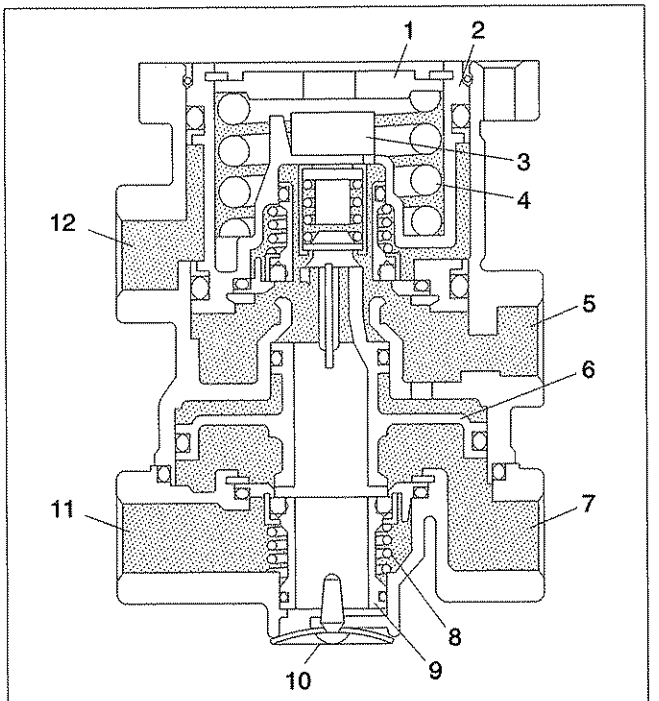


Fig. 1, Bendix E-12 Dual Circuit Foot Valve (sectional view)

Operating Check

IMPORTANT: If there is a change in the way a vehicle brakes, or if low pressure warnings occur, check the operation of the brake air system. Although the brake system may continue to work, do not operate the vehicle until the braking circuits, including the pneumatic and mechanical devices, have been repaired and are operating normally. Always check the brake system for correct operation after doing brake work, and before returning the vehicle to service.

Check for the correct brake valve operation as follows:

1. Apply the parking brake, then chock the tires.
2. Connect test gauges to the primary and secondary delivery ports on the brake valve. **See Fig. 1.**

NOTE: When checking the delivery pressure of the primary and secondary circuits, use test gauges that are accurate.

3. Start the engine and build air pressure to 827 kPa (120 psi).
4. Depress the pedal to several different positions; check the pressure on the test gauges to ensure that it varies equally and proportionally with the movement of the brake pedal.

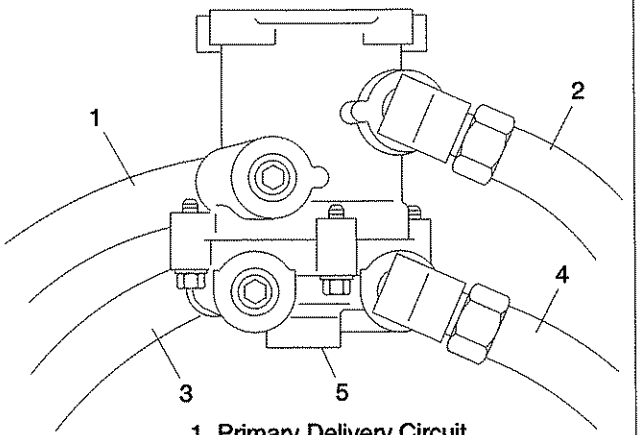


Fig. 1

5. Fully depress the brake pedal, then release it. After a full application is released, the reading on the test gauges should promptly fall to zero.

NOTE: Pressure in the primary delivery circuit will be about 14 kPa (2 psi) greater than pressure in the secondary delivery circuit (if both supply reservoirs are at the same pressure). This is normal for this valve.

6. Go to "Leakage Check."

Leakage Check

1. Make and hold a pressure application of 552 kPa (80 psi).
2. Check the air line fittings for leaks: tighten or replace fittings as needed.
3. Coat the exhaust port and body of the valve with a soap solution, and check for leakage. The leakage permitted is a 2.5-cm (1-inch) bubble in 3 seconds.

   If the brake valve does not function as described above, or if leakage is excessive, replace it with a new or remanufactured unit.

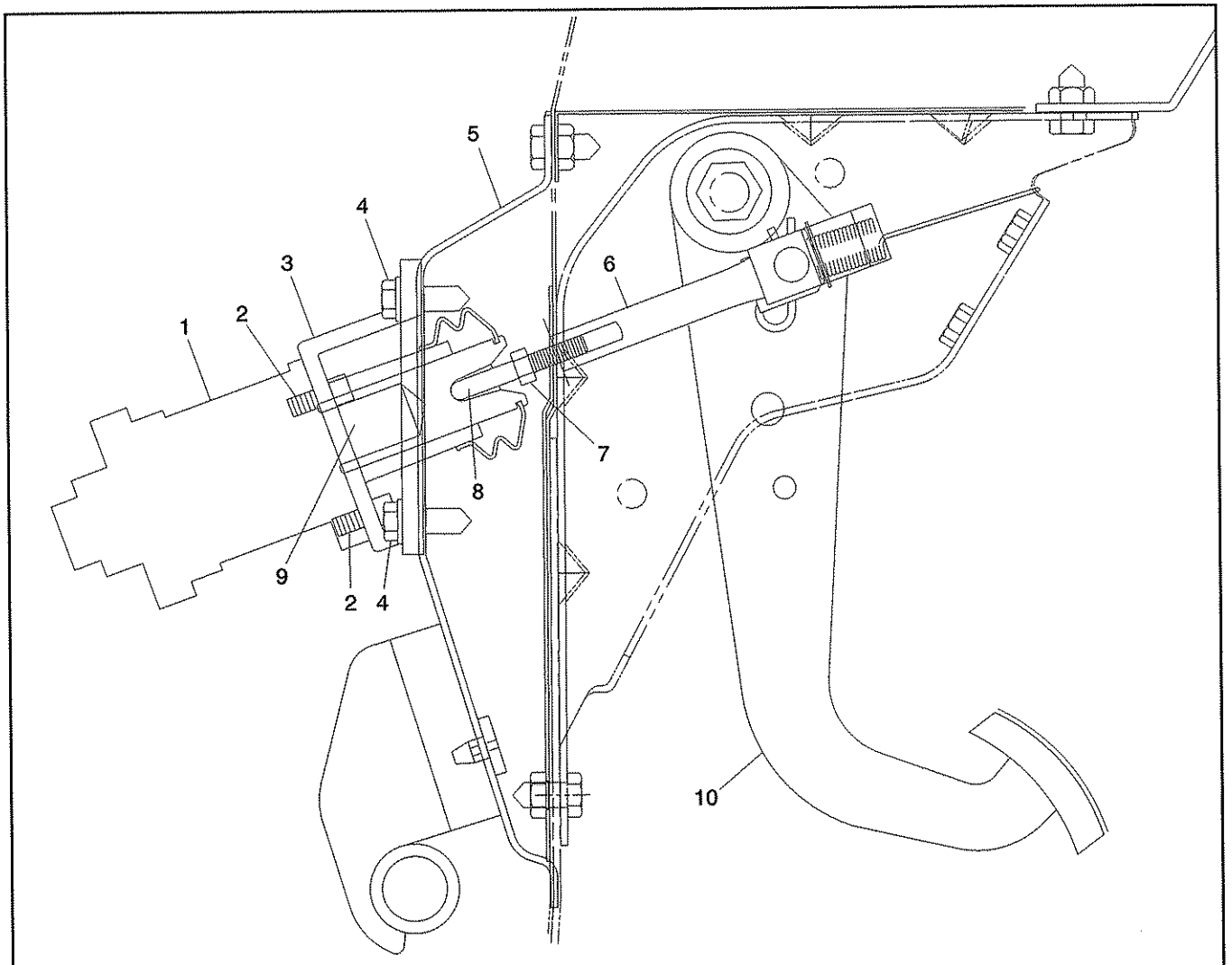
   Repeat the leakage test before placing the brake valve in service.
4. Remove the chocks from the tires.

Removal (See Fig. 1 and Fig. 2)

1. Chock the tires, then tilt the hood. For instructions, refer to the vehicle driver's manual.

⚠ WARNING

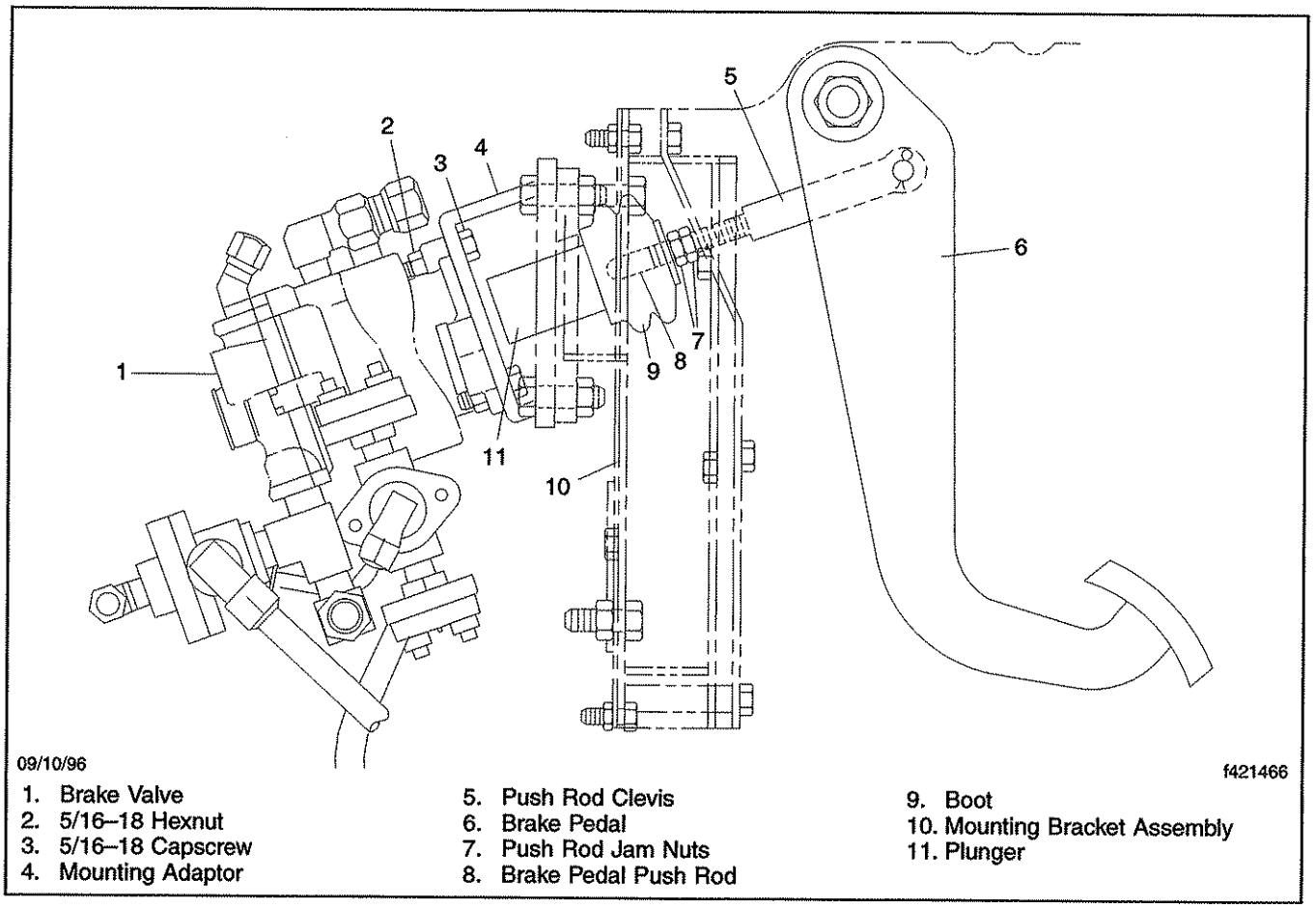
WARNING: When draining the air system, don't look into the air jets or direct them toward anyone, because dirt or sludge particles may be in the airstream. Don't disconnect pressurized hoses because they may whip as air escapes from the line. Failure to take all necessary precautions dur-



1. Brake Valve
2. Brake Valve Mounting Fasteners
3. Mounting Adaptor
4. Capscrew and Flatwasher
5. Front Cab Mount Plate
6. Push Rod Clevis
7. Push Rod Jam Nut
8. Brake Pedal Push Rod
9. Plunger
10. Brake Pedal Assembly

Fig. 1, Brake Valve Mounting, Left-Hand-Drive Vehicles

Removal and Installation



1. Brake Valve
2. 5/16–18 Hexnut
3. 5/16–18 Capscrew
4. Mounting Adaptor
5. Push Rod Clevis
6. Brake Pedal
7. Push Rod Jam Nuts
8. Brake Pedal Push Rod
9. Boot
10. Mounting Bracket Assembly
11. Plunger

Fig. 2, Brake Valve Mounting, Right-Hand-Drive Vehicles

ing service operations of the air brake system can result in personal injury.

2. Drain all of the air reservoirs.
3. Mark the brake valve air supply and delivery lines for assembly reference. Carefully disconnect the air lines from the brake valve, and plug them to keep out contaminants.
4. Remove the capscrews and flatwashers that attach the brake valve and mounting adaptor to the front cab mount plate or the mounting bracket assembly.

   Remove the fasteners that attach the brake valve to the mounting adaptor.
5. Remove the plunger (and boot, if equipped) from the mounting adaptor. Wipe off the old grease from the plunger, boot, and adaptor.
6. Check the bore of the adaptor and the sliding surface of the plunger for corrosion; there should be no pitting or roughness. Check the boot (if equipped) for damage. Replace parts as needed.
7. Note the locations and positions of the elbows, then remove them from the brake valve. Clean off the dirt and old sealant from the threads of the elbows.

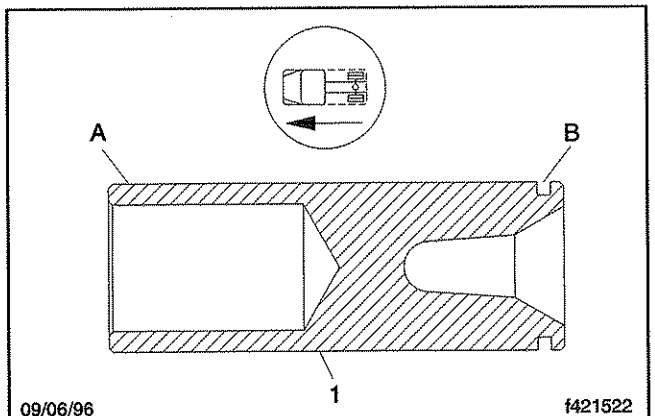
Installation (See Fig. 1 and Fig. 2)

⚠ WARNING

WARNING: When applying sealant, make sure that excess sealant doesn't get inside either the male or the female fittings. Loose foreign material inside

the air plumbing may clog a valve, causing a loss of brake control, which could result in personal injury.

1. Apply a small quantity of Loctite® Pipe Sealant (with Teflon® 59241), or an equivalent sealant, to the male threads of each of the elbows.
2. Install the elbows in the ports of the brake valve. Tighten them finger-tight, then tighten them one additional turn with a wrench. As needed, further tighten them until they are correctly positioned.
3. Lubricate the sliding surface of the brake plunger and the adaptor bore with a silicone-based grease, Dow Corning 55 O-Ring Lubricant or Loctite V–755 O-Ring Lubricant. Install the plunger in the mounting adaptor. Make sure the plunger is positioned correctly (see **Fig. 3**). Install the boot (if equipped) on the mounting adaptor.
4. Attach the mounting adaptor to the brake valve. Tighten the hexnuts 15 lbf·ft (20 N·m).
5. Loosen the jam nuts on the brake pedal push rod, then turn the push rod into the clevis at least three full turns.
6. Check that the front face of the brake pedal pad is flush with the front face of the throttle pedal. See **Fig. 4**. If it isn't, adjust the brake pedal height as follows:



A. This end toward brake valve.
B. This end toward brake pedal push rod.
1. Plunger

Fig. 3, Plunger Installation

⚠ CAUTION

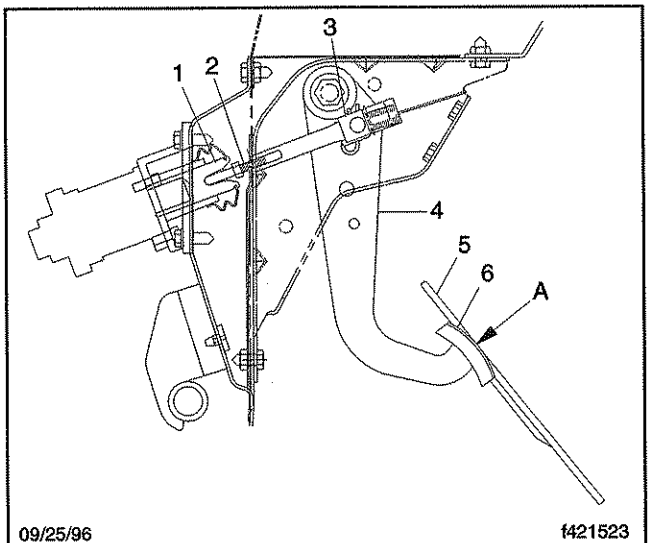
CAUTION: If you loosen the pedal stop bracket capscrews or remove the pedal stop bracket, don't lift the brake pedal past where the stop bracket was located. To do so could bend the push rod.

6.1 Loosen the pedal stop bracket capscrews.

6.2 Adjust the position of the pedal stop bracket, until the front face of the brake pedal pad is flush with the front face of the throttle pedal.

6.3 Tighten the pedal stop bracket capscrews 13 lbf·ft (18 N·m).

7. Install the brake valve, mounting adaptor, and new adaptor gasket (if equipped) on the outside of the front cab mount plate or mounting bracket assembly. Make sure the forward end of the brake pedal push rod enters the plunger. Install the adaptor mounting capscrews and flatwashers. Tighten the capscrews 23 lbf·ft (31 N·m).



A. Front face of brake pedal pad must be flush with front face of throttle pedal.
1. Plunger
2. Brake Pedal Push Rod
3. Push Rod Clevis
4. Brake Pedal Assembly
5. Throttle Pedal
6. Brake Pedal Pad

Fig. 4, Brake Pedal and Valve Installation (left-hand-drive shown)

Removal and Installation

8. Connect the air lines as previously marked. Tighten the nuts finger-tight. Using a wrench, further tighten the nuts until there is resistance, then tighten one-sixth additional turn.
9. Inside the cab, push the plunger into the mounting adaptor until increased resistance is felt. Turn the push rod into the clevis until you are certain that there is space between the end of the push rod and its seat in the plunger.
10. With the brake pedal released (in the up position), use your fingers and turn the push rod out of the clevis until it bottoms in the plunger without pushing the plunger further.

IMPORTANT: Be sure the push rod and plunger aren't "preloading" the brake valve, which could keep the brake valve from exhausting.

11. Check the pedal for free play. There should be no pedal free play and no brake valve preloading. Use a wrench to hold the push rod to keep it from turning, then tighten the double jam nuts against the clevis 15 lbf·ft (20 N·m).
12. Check and secure the air lines and electrical wires so they can't interfere with the movement of the brake pedal or push rod.
13. Lower the hood.
14. Do the operating and leakage checks. For instructions, refer to **Subject 100**.
15. Remove the chocks from the tires.
16. Test drive the vehicle in a safe area at low speed. Make several brake applications to be sure the vehicle comes to a safe stop.

Disassembly, Cleaning and Inspecting, and Assembly

Disassembly (See Fig. 1)

1. Remove the valve from the vehicle, following instructions in **Subject 110**.
2. Mark the upper and lower valve bodies for later assembly, then remove the four capscrews that hold them together.
3. Pull the secondary piston (Ref. 21) out of the upper valve body, then remove and discard the O-ring (Ref. 22) from it.
4. While manually depressing the valve seat (Ref. 24), remove and discard the beveled retaining ring (Ref. 23) from the lower valve body (Ref. 29).
5. Carefully release the valve seat (Ref. 24), then remove it from the lower valve body.
6. Remove and discard the O-ring (Ref. 25).
7. Remove and discard the valve assembly and its O-ring (Refs. 26 and 27) from the lower valve body.
8. Remove the valve assembly return spring (Ref. 28).
9. Remove the retainer, plunger, plunger return spring, and O-ring (Refs. 17, 18, 19, and 20) from the secondary piston.
10. Remove and discard the exhaust diaphragm retainer and the exhaust diaphragm (Refs. 32 and 33) from the lower valve body.

⚠ WARNING

WARNING: The primary piston is held down by a graduating spring, which is under tension. Be careful when removing the retaining ring and graduating spring retainer, because the spring or the piston may release suddenly, which could cause personal injury. Hold the graduating spring and the primary piston down when removing the retaining ring and spring retainer.

11. Push the primary piston (Ref. 8) into the upper body until the retaining ring (Ref. 1) is visible.
12. Being careful not to damage the piston bore, remove the retaining ring.
13. Gently tap the upper body on a padded surface to remove the primary piston. Re-move and discard the two O-rings and wear rings (Refs. 6 and 7).
14. Put the primary piston on a flat surface, then hold down the spring retainer (Ref. 2). Remove and discard the retaining ring (Ref. 1) from the piston.
15. Slowly release the spring retainer, and ease it out of the piston. Remove it and the graduating spring (Ref. 5) from the piston.
16. Remove and discard the rubber spring (Ref. 4) from inside the piston.
17. While holding down the valve seat (Ref. 13), remove and discard the beveled retaining ring (Ref. 14) from the primary piston.
18. Slowly release the valve seat, and ease it out of the piston. Remove and discard the O-ring (Ref. 10).
19. Remove and discard the valve assembly and its O-ring (Refs. 11 and 10) from the primary piston, then remove the return spring (Ref. 9).

Cleaning and Inspecting

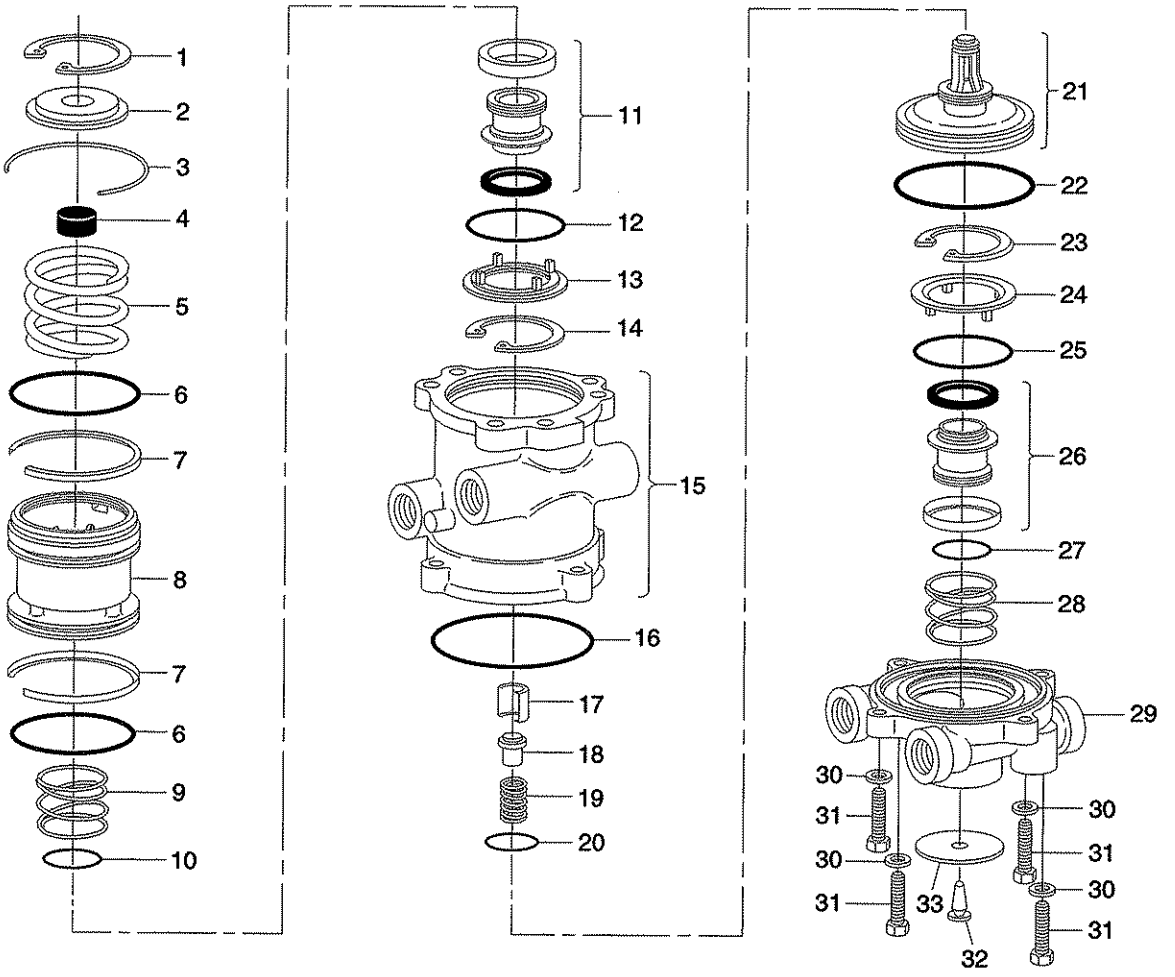
⚠ WARNING

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 all the metal parts in mineral spirits, then dry them with compressed air.
2. Check all the parts. If any corrosion, wear, or damage is found, replace the part.
   - 2.1 Check the bores of both valve bodies for deep scoring.
   - 2.2 Make sure the vents on the primary piston are free of obstructions.
   - 2.3 Make sure the vent in the upper valve body is open.
   - 2.4 Check the plunger (**Fig. 2**) for wear or damage.

Disassembly, Cleaning and Inspecting, and Assembly

2.5 Check all the air line fittings, and clean any thread sealant from them.



1. Retaining Ring
2. Graduating Spring Retainer
3. Piston Retaining Ring
4. Rubber Spring
5. Graduating Spring
6. O–Ring
7. Wear Ring
8. Primary Piston
9. Valve Assembly Return Spring
10. O–Ring
11. Valve Assembly
12. O–Ring
13. Valve Seat
14. Beveled Retaining Ring
15. Upper Valve Body
16. O–Ring
17. Retainer
18. Plunger
19. Plunger Return Spring
20. O–Ring
21. Secondary Piston
22. O–Ring
23. Beveled Retaining Ring
24. Valve Seat
25. O–Ring
26. Valve Assembly
27. O–Ring
28. Valve Assembly Return Spring
29. Lower Valve Body
30. Washer
31. Capscrew
32. Exhaust Diaphragm Retainer
33. Exhaust Diaphragm

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Fig. 1

Assembly (See Fig. 1)

IMPORTANT: Keep the work area, tools, and brake valve parts clean during assembly.

1. Using Dow Corning 55-M pneumatic grease or equivalent, lightly grease all the new O-rings, O-ring grooves, piston bores, and all sliding surfaces.
2. Put the primary piston on a flat surface, then install the rubber spring (Ref. 4) and the metal graduating spring (Ref. 5).
3. Install the graduating spring retainer (Ref. 2) on top of the graduating spring.
4. While holding down the spring retainer in the primary piston, install the retaining ring (Ref. 1). Make sure it's completely seated in its groove.
5. Install new O-rings on both valve assemblies.
6. Install the valve assembly return spring (Ref. 9) in the primary piston, then install the valve assembly (Ref. 11).
7. Install a new O-ring into its groove on the primary piston, then install the valve seat (Ref. 13) onto the valve assembly.
8. Hold down the valve seat in the piston, then install the beveled retaining ring (Ref. 14) with the flat side of the ring against the valve seat (beveled side of the ring up). Make sure the ring is seated completely.

IMPORTANT: Make sure the beveled retaining ring is installed correctly. The flat side of it must be against the valve seat, and the beveled side must be facing up. If it's not, remove the ring and install it again.

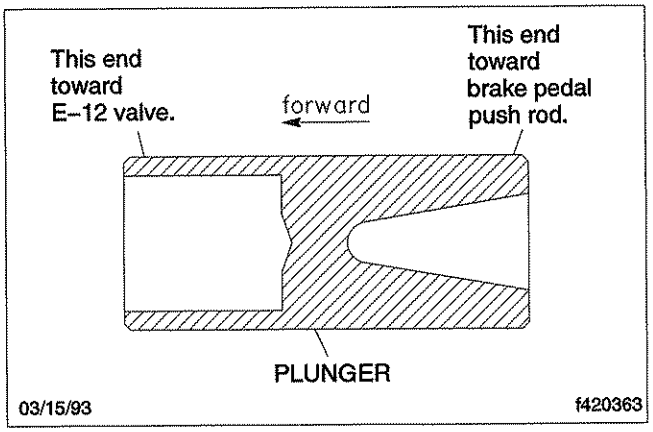


Fig. 2

9. Install new O-rings on the primary piston.
10. Install the wear rings (Ref. 7) on the primary piston.
    - 10.1 Position a wear ring so one flange of it is in the O-ring groove, and the opposite flange faces away from the end of the piston (toward the middle of the piston).

      Repeat this step for the other wear ring.
    - 10.2 Check the wear rings; make sure they are not overlapping or covering the O-rings. If they are, remove them and install them again.
11. Being careful not to damage the piston O-rings and wear rings, install the primary piston— valve end first— in the upper valve body. Push the piston down until the piston retaining groove at the top of the bore is visible.

⚠ CAUTION

CAUTION: Don't force the piston into its bore, or you will damage its sealing surfaces. If the piston doesn't fit correctly, check the wear rings. If they were installed incorrectly, remove them and install them again.

12. Install the piston retaining ring (Ref. 3) in its groove. Make sure it's fully seated.
13. Install the plunger (Ref. 18) in the plunger return spring (Ref. 19), then install them both on the secondary piston.
14. While holding the plunger and return spring on the secondary piston, install the retainer (Ref. 17) on the piston. Make sure the retainer flanges are secure around the piston lip and the plunger groove.
15. Install new O-rings on the secondary piston.
16. Install a new exhaust diaphragm (Ref. 33) on the lower valve body, then install the diaphragm retainer.
17. Install the valve assembly return spring (Ref. 28) in the lower valve body, then install the valve assembly (Ref. 26).

Disassembly, Cleaning and Inspecting, and Assembly

18. Install the O-ring in its groove on the primary piston, then install the valve seat (Ref. 24) on the valve assembly.

19. While holding the valve seat in the lower valve body, install the beveled retaining ring with the flat side of the ring against the valve seat (beveled side of the ring up). Make sure it is seated completely.

IMPORTANT: Make sure the beveled retaining ring is installed correctly. The flat side of it must be against the valve seat, and the beveled side must be facing up. If it's not, remove the ring and install it again.

20. Being careful not to damage the O-rings, install the secondary piston in the upper valve body.

21. Install a new O-ring in the upper valve body.

22. Using the reference marks made during disassembly, install the lower valve body on the upper valve body. Tighten the capscrews 60 N·m (45 lbf·ft).

23. Install the valve on the vehicle, following instructions in **Subject 110.**

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Safety Precautions	100
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General Description and Principles of Operation (Refer to Fig. 1 and Fig. 2)

The BP-R1 bobtail proportioning relay valve is a combination of two individual valves in a single housing. The lower portion (body) of the BP-R1 contains a standard service brake relay valve, which functions as a relay station to speed up brake application and release. The upper portion (cover) houses a brake proportioning valve, which adjusts the proportion of normal service brake application pressure to the rear brake chambers when the tractor is not towing a trailer.

Used in tractor air brake systems only, the BP-R1 is installed in place of a standard relay valve. It functions as a standard service relay during operation of a tractor-trailer combination. During bobtail tractor operation, the BP-R1 improves controllability and reduces stopping distances by limiting air pressure to the rear brake chambers, whose axle load has been greatly reduced, while retaining normal air pressure to the front brake chambers. This reduces the chance of wheel lock and instability in emergency stops.

The rear brake proportioning system is standard on all class 6 and 7 tractors. The valve is mounted on the crossmember between the rear brake chambers. See the plumbing diagram in **"Specifications, 400."**

A control line from the control port of the BP-R1 valve is connected by a tee to the inlet supply port of the tractor protection valve. This line is charged with full line pressure when a trailer is connected and its spring brakes are released; or is completely exhausted when the tractor is bobtailed and the dash valve trailer charge knob is not applied.

TRAILER SUPPLY VALVE APPLIED (TRACTOR/TRAILER MODE)

On vehicles equipped with a proportioning system, air pressure at the control port allows full service air from the foot valve to pass through the proportioning portion of the valve. This gives full braking effort to the rear axles when a trailer is connected.

TRAILER SUPPLY VALVE PULLED OUT (BOBTAIL MODE)

When the trailer supply valve is activated to disconnect the trailer, air in the BP-R1 control port is exhausted to atmosphere. In this mode, service application air exerts force on one side of the blend-back piston and also flows through the piston to exert force on the proportioning piston. The blend-back piston remains stationary at application pressures below 551 kPa (80 psi). Air also flows through the proportioning piston to exert force on both sides of it. Proportioning occurs due to the difference in effective area on each end of the proportioning piston. Service applications of more than 551 kPa (80 psi) cause the blend-back piston to begin to move. Above 551 kPa (80 psi) the different pressures on each side of this piston cause a "blend back" from proportioned delivery to a full one-to-one delivery.

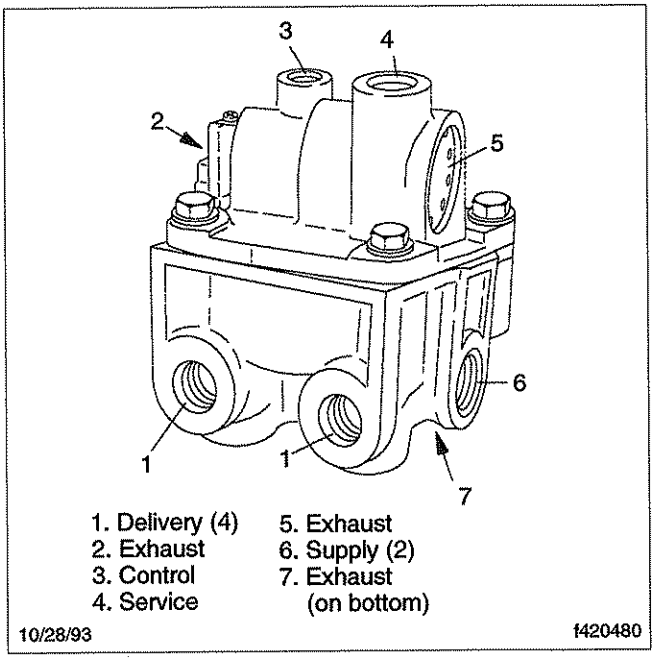


Fig. 1

General Description and Principles of Operation

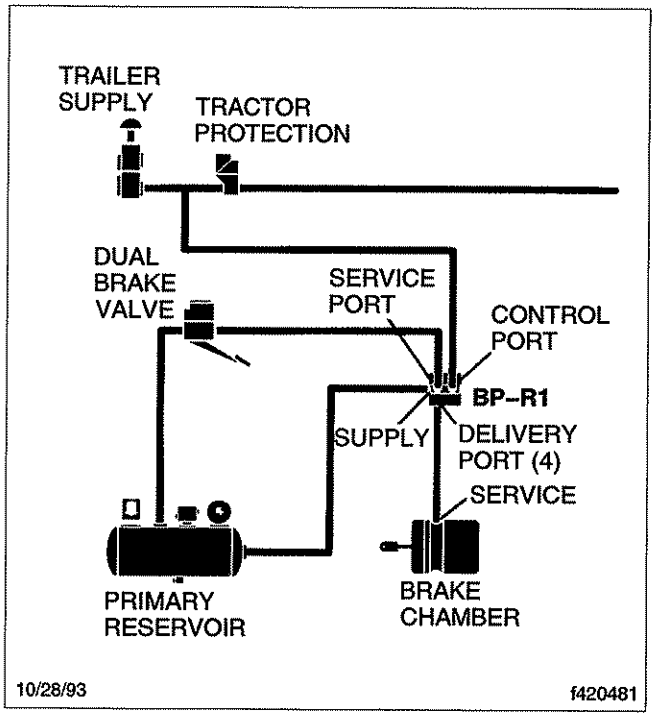


Fig. 2

Safety Precautions

⚠ WARNING

WARNING: Wear safety goggles when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct the airstreams at anyone. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

When working on or around air brake systems and components, observe the following precautions.

1. Apply the parking brakes, chock the tires, and stop the engine when working under the vehicle. Keep hands away from brake chamber push rods and slack adjusters, which may apply as air system pressure drops.
2. Wear safety goggles.
3. Never connect or disconnect a hose or line containing air under pressure; it may whip as air escapes. Never remove a component or pipe plug unless you are sure all system pressure has been depleted.
4. Don't disassemble a component before reading and understanding recommended procedures. Use only the correct tools and follow basic tool safety.
5. Replacement hardware, tubing, hose, fittings, etc. should be the same size, type, length, and strength as the original equipment. When replacing tubing or hose, be sure that all of the original supports, clamps, or suspending devices are installed or replaced.
6. Replace any components that have stripped threads or damaged parts. Don't attempt to repair parts by machining.
7. Never exceed recommended air pressure.

BP-R1 Brake Proportioning Valve Operating Tests

Operating Tests

1. Park the vehicle on a level surface and chock the tires.
2. Before testing the air brake proportioning system, do the following:
   - 2.1 Check the operation of the air compressor. Check the pressure levels of the air reservoirs.
   - 2.2 Be sure that all related valves are operating, and the system is plumbed as shown in **"Specifications, 400."**
   - 2.3 Check the operation of the brake chambers following the instructions in the brakes group of the vehicle maintenance manual.
   - 2.4 Inspect all tubing for kinks, dents, and other damage. Replace damaged tubing.
   - 2.5 Inspect all hoses for cracks, drying out, overheating, and other damage. Replace damaged hoses.
   - 2.6 Inspect all air line fittings. Tighten loose connections; replace fittings that are damaged.
3. Drain all air tanks to zero pressure.
4. Install a "tee" at the BP-R1 service port and at one of the delivery ports, then install a gauge in each.
5. Connect the tractor service and emergency gladhands to hose couplings that have been plugged; or, connect them to a trailer. Build the tractor system air pressure to governor cut-out.
6. With the dashboard trailer supply valve and system park control valve activated for tractor/trailer operation, apply, *hold,* and then release the brakes several times, varying the application pressures while watching the reaction of the gauges installed on the BP-R1. Note that a prompt application occurs and that it can be held, then promptly released.
7. Check the BP-R1 differential pressure by applying 69 kPa (10 psi) to the service port and noting the pressure registered at the delivery port. Subtract delivery port pressure from the 69 kPa (10 psi) service pressure to obtain the differential.

NOTE: For BP-R1 valves that *don't incorporate* a relay piston spring (**Fig. 1**, Ref. 9), the measured differential should be about 28 kPa (4 psi). When a spring is in use, the differential will be higher.

8. Make and hold a full brake application of 689 kPa (100 psi) or greater, and note that full pressure is delivered to the chambers.
9. Activate the dash mounted trailer supply valve for bobtail tractor operation. Then make a *slow* brake application, increasing the pressure at the BP-R1 service port to 138 kPa (20 psi) while watching the reaction at the delivery port gauge. Note that delivery pressure rises to about 34 to 69 (5 to 10 psi) and remains constant while service pressure continues to rise to 138 kPa (20 psi). Release the application.
10. Make another brake application and *slowly* increase the pressure at the BP-R1 service port to between 414 to 483 kPa (60 and 70 psi) while observing the gauge installed at the delivery port. Note that when service port pressure rises to between 138 to 207 kPa (20 and 30 psi), delivery pressure begins to rise above the initial pressure noted above. The rise of delivery pressure should be at a proportioned rate of *about* three-to-one. At 483 kPa (70 psi) service pressure, delivered pressure should be 103 to 172 kPa (15 to 25 psi).
11. Make a full brake application, and note that both test gauges register the same pressure.
12. Remove the test gauges from the BP-R1.
13. Remove the chocks from the tires. Test drive the vehicle in a safe area at slow speed with the trailer supply valve pulled out (bobtail position). Make several brake applications to become familiar with the feel of the system before placing the vehicle back in service.

BP-R1 Brake Proportioning Valve Operating Tests

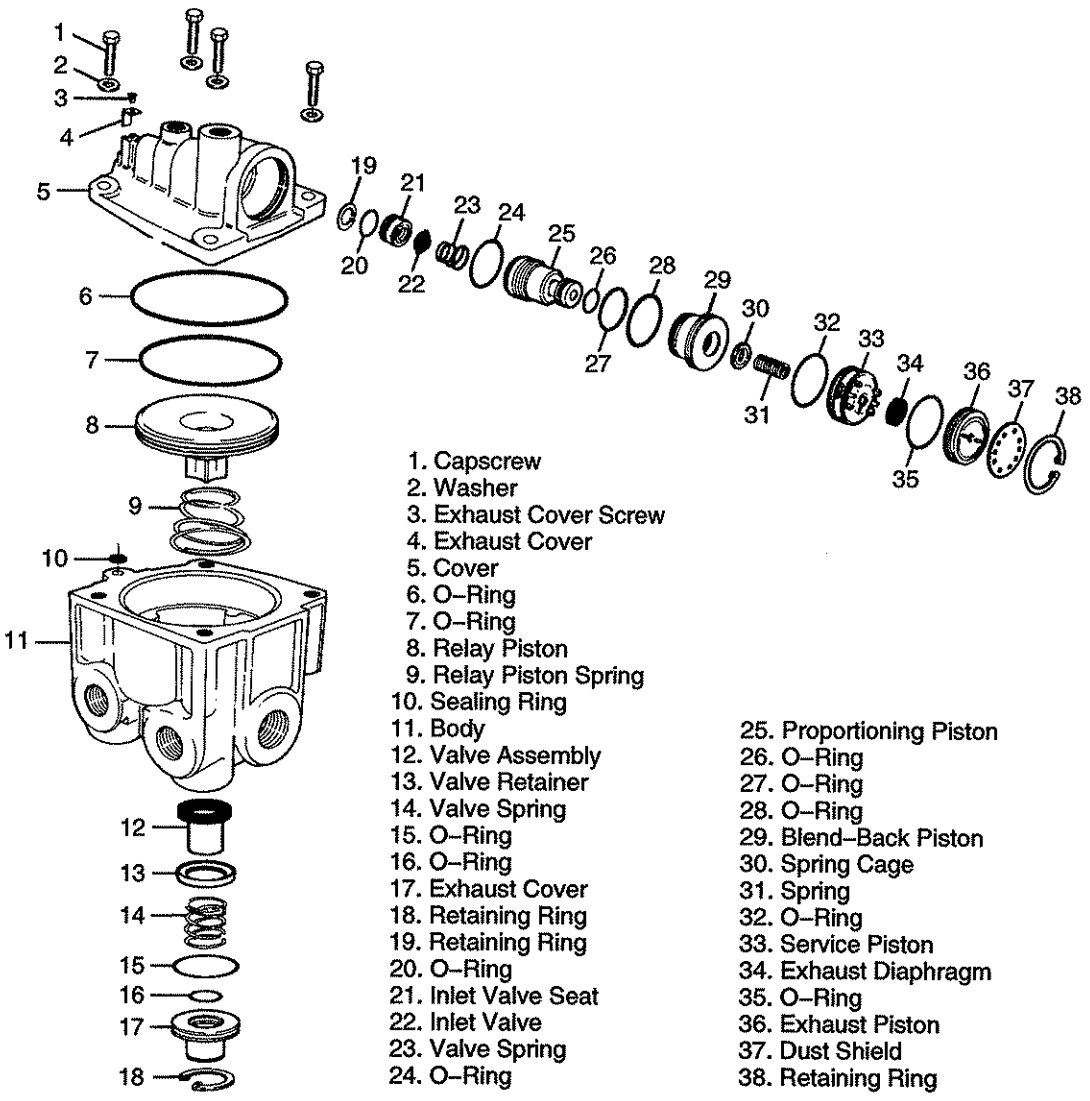


Fig. 1

BP–R1 Brake Proportioning Valve Removal and Installation

Removal

1. Park the vehicle on a level surface, apply the parking brake, chock the tires, and drain all air tanks to zero pressure.

⚠ WARNING

WARNING: Wear safety glasses when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

2. Mark and then disconnect the air lines from the valve.
3. Remove the two bolts attaching the valve to the vehicle. Remove the valve.

Installation

1. Install the valve on the vehicle. Tighten the bolts 20 N·M (15 lbf·ft).
2. Connect the air lines to the proper ports, as marked during removal.
3. Check the proportioning valve operation **using the instructions in Subject 110.**

BP-R1 Brake Proportioning Valve Disassembly, Cleaning and Inspecting, and Assembly

Disassembly

⚠ CAUTION

CAUTION: The BP-R1, See Fig. 1, may be lightly clamped in a bench vise during disassembly, however, over-clamping will cause damage to the valve and result in leakage or malfunction.

If a vise is to be used, position the valve so that the jaws bear on the supply ports on opposing sides of the valve's body.

1. Remove all air fittings and plugs from the valve.
2. Mark the relationship of the valve cover to the body, and if the valve is equipped with a mounting bracket, mark the relationship of the bracket to the cover.

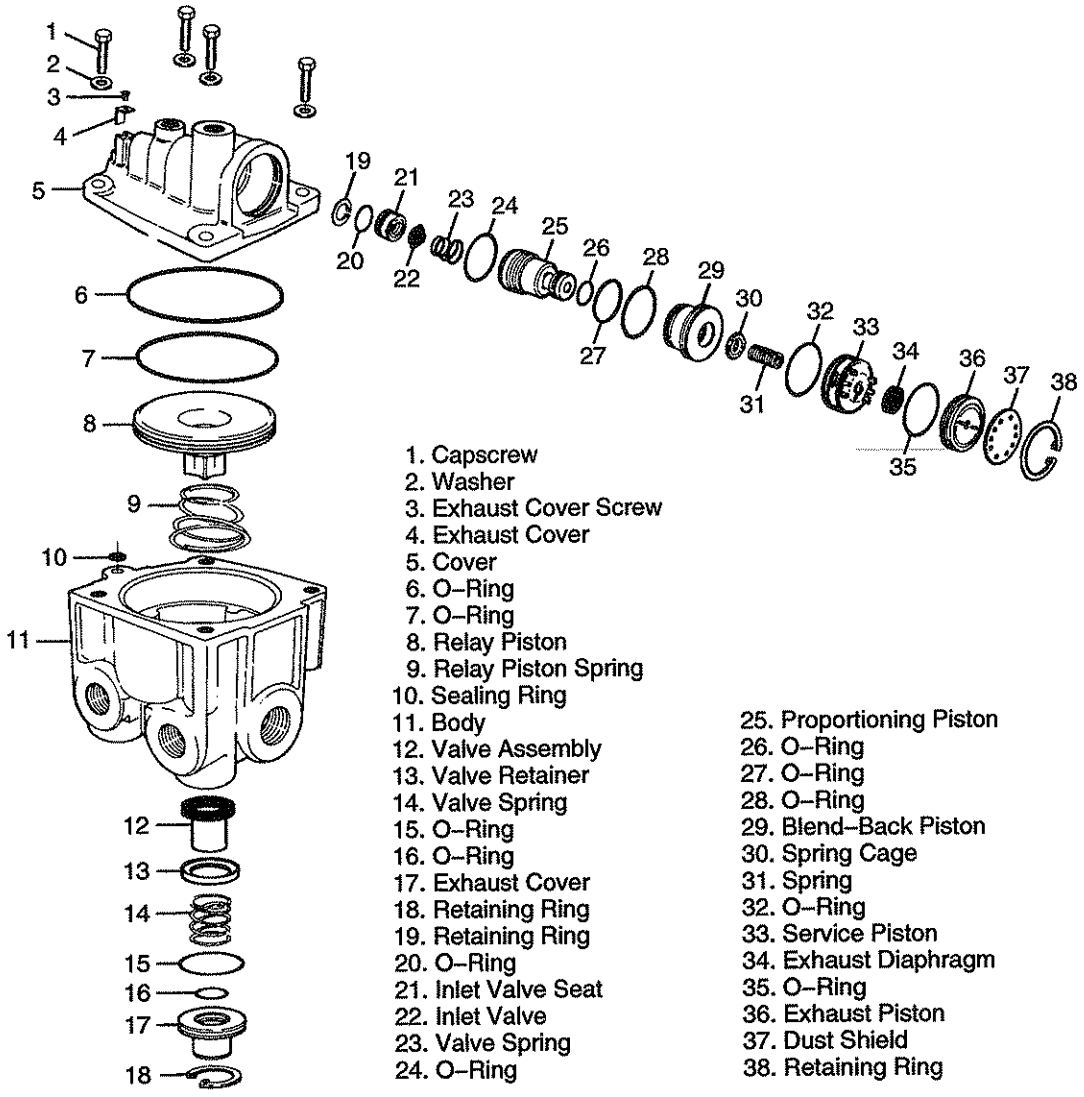


Fig. 1, BP-R1 Brake Proportioning Valve (exploded view)

BP-R1 Brake Proportioning Valve Disassembly, Cleaning and Inspecting, and Assembly

3. While holding the exhaust cover (Ref. 17), remove and discard the retaining ring (Ref. 18) that secures it to the body (Ref. 11).
4. Remove and discard the exhaust cover along with both O-rings (Refs. 15 and 16).
5. Remove and discard the valve spring (Ref. 14), valve retainer (Ref. 13), and the valve assembly (Ref. 12) from the body.
6. Remove and retain the four capscrews and washers (Refs. 1 and 2) that secure the cover (Ref. 5) to the body.
7. Separate the cover from the body, then remove and discard the sealing ring and O-ring (Refs. 10 and 6).
8. Remove and retain the relay piston (Ref. 8) and relay piston spring (Ref. 9) from the body.

NOTE: The relay piston spring is *not used in all valves*.

9. Remove and discard the O-ring (Ref. 7) from the relay piston.
10. Remove and discard the dust shield (Ref. 37) and the retaining ring (Ref. 38) from the valve cover, then remove and save the exhaust piston (Ref. 36).
11. Remove and discard the exhaust piston O-ring (Ref. 35) and the exhaust diaphragm (Ref. 34).
12. Remove and save the service piston (Ref. 33) from the valve cover, then remove and discard the service piston O-ring (Ref. 32).
13. Remove the spring (Ref. 31) and spring cage (Ref. 30) from the valve cover. Discard the spring and retain the spring cage.
14. Remove and retain the blend-back piston (Ref. 29) from the valve cover, then remove and discard both O-rings (Refs. 27 and 28).
15. Remove and save the proportioning piston (Ref. 25) from the valve cover, then remove and discard both O-rings (Refs. 26 and 24).
16. While holding the inlet valve seat (Ref. 21) in place, remove and discard the retaining ring (Ref. 19) from the proportioning piston.
17. Remove the inlet valve seat, the inlet valve (Ref. 22), and the valve spring (Ref. 23) from the proportioning piston, then remove and discard the O-ring (Ref. 20) from the valve seat. Discard the valve and spring also.
18. Remove and discard the exhaust cover screw (Ref. 3) and exhaust cover (Ref. 4).

Cleaning and Inspection

⚠ WARNING

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.

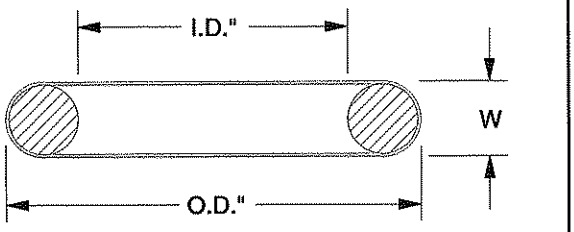
1. Using mineral spirits or an equivalent solvent, clean and thoroughly dry all metal parts. Don't damage any bores with metal tools.
2. Wash all non-metallic parts (Refs. 8, 17, 21, 25, 29, 30, 33, and 36) in a soap and water solution, making certain to rinse and dry thoroughly.
3. Inspect the interior and exterior of all metal parts that will be re-used. Check for severe corrosion, pitting, gouges and cracks. Superficial corrosion or pitting of the exterior portion of the body and cover is acceptable. Replace the entire valve if the interior of the body or cover show signs of corrosion or pitting.
4. Inspect each non-metallic part for cracks, wear or distortion. Replace the entire valve if these conditions exist.
5. Replace all rubber parts.
6. Make certain the air channel running between the top surface of the body and its supply port is clear and free of blockages.
7. Make certain all air channels and exhaust passages in the valve cover are clear and free of blockages.
8. Inspect the pipe threads in the body and valve cover. Make certain they are clean and free of thread sealant.
9. If the valve was equipped with a relay piston spring, check it for signs of corrosion, pitting, and cracks. Replace as needed.

BP-R1 Brake Proportioning Valve Disassembly, Cleaning and Inspecting, and Assembly

10. Inspect all air line fittings for corrosion; replace as needed. Be sure to remove all old thread sealant before re-use.

Assembly

1. Prior to assembly, lubricate all O-rings (identify them by referring to **Table 1**), seals, and pistons, as well as body and cover bores, using the lubricant provided in the Bendix maintenance kit. Use all of the lubricant, and spread it evenly on the rubbing surfaces.



f420483

Key No.	I.D.	O.D.	W
6	3.487	3.693	0.103
7	3.234	3.512	0.139
15	1.424	1.630	0.103
16	0.862	1.068	0.103
20	0.489	0.629	0.070
24	0.739	0.879	0.070
26	0.412	0.552	0.070
27	0.737	0.943	0.103
28	1.112	1.318	0.103
32	1.176	1.316	0.070
35	1.356	1.496	0.070

Table 1, O-Ring Identification (Sectional View)

2. Install the O-ring (**Fig. 1**, Ref. 20) on the inlet valve seat (Ref. 21).
3. Install the small end of the valve spring (Ref. 23) over the rubber of the inlet valve (Ref. 22), making sure the spring coils rest on the valve's four tabs.
4. Insert the spring and valve into the valve seat, making sure the four tabs are inside the seat's bore.
5. Insert the valve, seat, and spring assembly into the proportioning piston (Ref. 25)— large end of the spring first.
6. While holding the seat in place, install the retaining ring (Ref. 19) to secure it in the piston. Make certain the retaining ring is fully seated in its groove. Make sure the valve is straight against the exhaust seat and free to move.
7. Install both the large and small diameter O-rings (Refs. 24 and 26) on the proportioning piston.
8. Install both the large and small diameter O-rings (Refs. 28 and 27) on the blend-back piston (Ref. 29), then insert the small diameter of the proportioning piston into the small diameter end of the blend-back piston.
9. Carefully insert the assembled proportioning and blend-back pistons to the edge of the bore in the cover (Ref. 5). Don't cut or pinch the O-rings.
10. With the bore of the cover facing up, install the spring cage (Ref. 30) in the blend-back piston so that its flat side rests against the blend-back piston (its depressed side out towards spring [Ref. 31]).
11. Install the O-ring (Ref. 32) on the service piston (Ref. 33), then install the spring (Ref. 31) in the cage (Ref. 30) so that its coils are in the inside diameter of the cage.
12. Install the O-ring (Ref. 35) on the exhaust piston (Ref. 36), and place the exhaust diaphragm (Ref. 34) between the six posts of the service piston.
13. Place the exhaust piston on the service piston with its six-ribbed side facing the service piston. Then install both pistons while pushing the proportioning and blend-back pistons all the way into the cover.
14. Install the dust shield (Ref. 37) in the cover.
15. While holding the dust shield in the cover, install the retaining ring (Ref. 38), making certain it is fully seated in its groove.
16. Install the exhaust cover (Ref. 4) using the screw (Ref. 3) to retain it. Torque the screw 100 to 160 N·cm (8 to 15 lbf·in).

BP-R1 Brake Proportioning Valve Disassembly, Cleaning and Inspecting, and Assembly

17. Install the valve retainer (Ref. 13) on the valve assembly (Ref. 12) so that the flange of the retainer (Ref. 13) surrounds the rubber portion of the valve. Install the valve assembly in the body.
18. Install the valve spring (Ref. 14) in the body.
19. Install the large and small diameter O-rings (Refs. 15 and 16) in the exhaust cover (Ref. 17), then install the exhaust cover in the body, taking care not to damage the O-rings. Hold the exhaust cover in place.
20. While depressing the exhaust cover, install the retaining ring (Ref. 18) in the body. Make sure this ring is fully seated in its groove in the body.
21. If the BP-R1 was equipped with a relay piston spring (Ref. 9), install the spring in the body, large diameter first.
22. Using lubricant to hold them in place, install the large O-ring and small sealing ring (Refs. 6 and 10) on the cover.
23. Install the O-ring (Ref. 7) on the relay piston (Ref. 8), then install the piston in the body.
24. After noting the relationship marks made prior to disassembly, install the mounting bracket (not shown) on the cover, then secure the cover and mounting bracket on the body using the four capscrews and washers (Refs. 1 and 2). Torque the capscrews 1360 to 1700 N·cm (120 to 150 lbf·in).

Refer to Fig. 1 for a diagram of the Bendix air brake proportioning system.

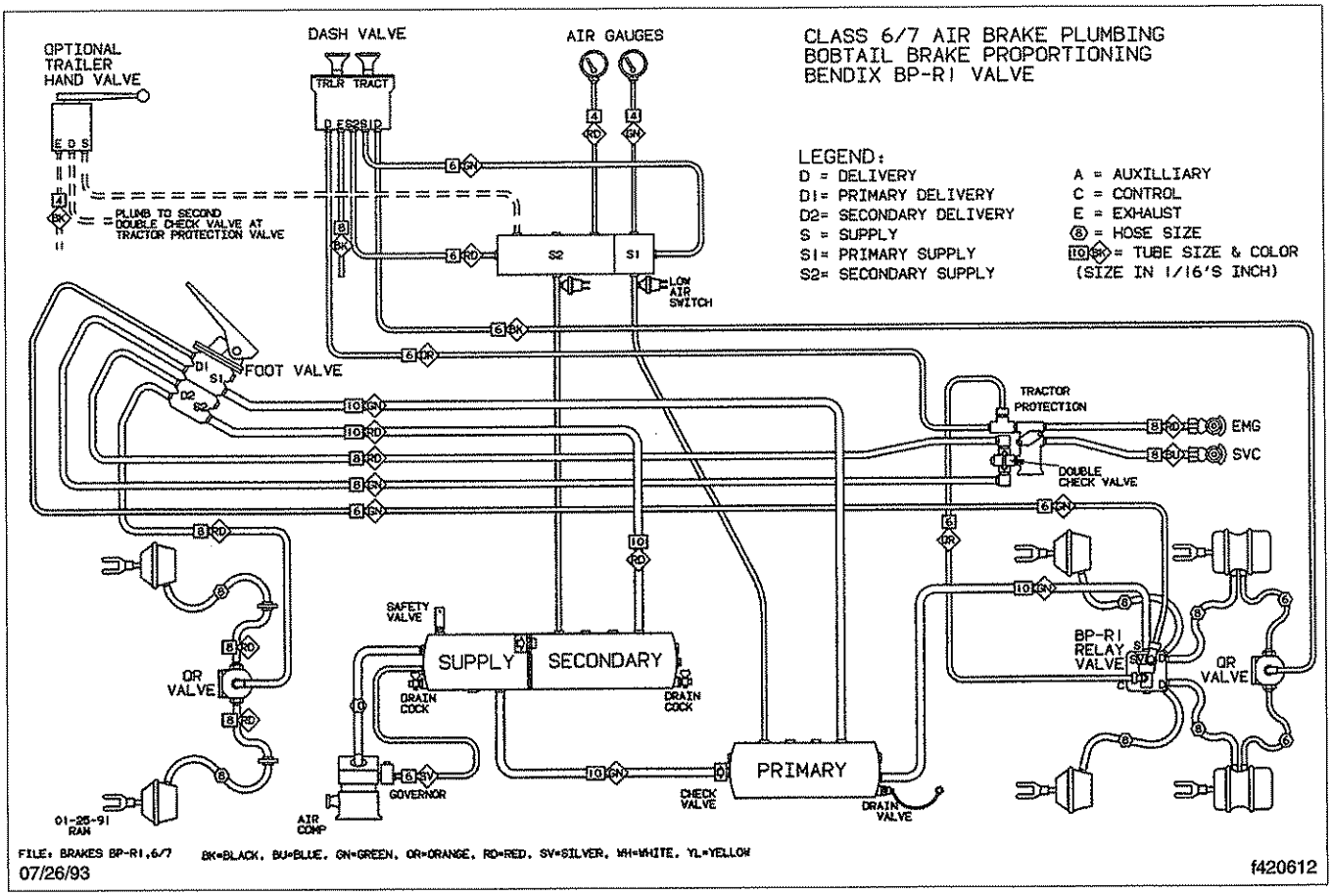


Fig. 1

Contents

Subject	Subject Number
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General Description

The function of the Bendix AD-9 air dryer (**Fig. 1**) is to collect and remove air system contaminants in solid, liquid, and vapor form before they enter the brake system.

The AD-9 air dryer consists of the desiccant cartridge and a die-cast aluminum end cover secured to a cylindrical steel outer shell with eight capscrews and nuts. The end cover contains a check valve assembly, a safety valve, three threaded air connections and the purge valve housing assembly. The removable purge valve housing assembly features a purge valve mechanism and a turbocharger cutoff that are designed to prevent loss of engine turbo boost pressure during the purge cycle of the air dryer.

To ease servicing, the desiccant cartridge and discharge check valve assembly are screw-in types. The purge valve housing assembly, which includes the heater and thermostat assembly, and the discharge check valve assembly, can be serviced without removing the air dryer from the vehicle. The screw-in desiccant cartridge requires removal of the air dryer assembly from the vehicle.

The AD-9 has three female pipe thread air connections; each is identified as follows (see **Table 1**):

Port I. D.	Function/Connection
4–CON	Control Port (purge valve control and turbo cutoff)
11–SUP	Supply Port (air in)
2–DEL	Delivery Port (air out)

Table 1, AD-9 Pipe Thread Connections

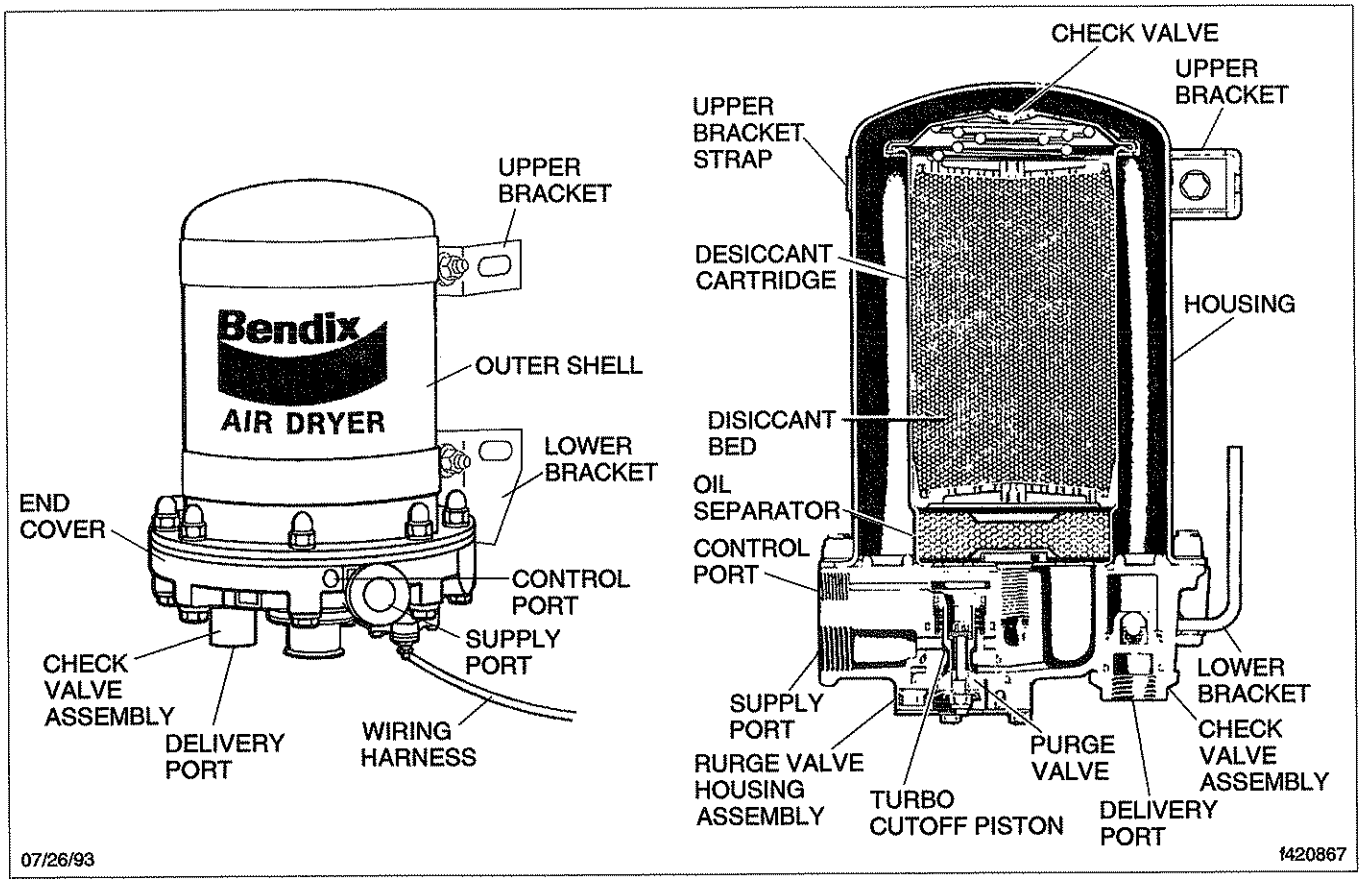


Fig. 1, Bendix AD-9 Air Dryer and Cutaway View

General Description and Principles of Operation

Principles of Operation

The AD-9 air dryer alternates between two operational modes or cycles during operation: the charge cycle and the purge cycle.

CHARGE CYCLE (See Fig. 2)

When the compressor is loaded (compressing air), pressurized air, along with oil, oil vapor, water, and water vapor flow through the compressor discharge line to the supply port of the air dryer end cover. As air travels through the end-cover assembly, its direction of flow changes several times, reducing the temperature, causing contaminants to condense and drop to the bottom or sump of the air dryer end cover.

After exiting the end cover, air flows into the desiccant cartridge. Once in the cartridge, air first flows through an oil separator, which removes water, oil, oil vapor, and solid contaminants.

Air exits the oil separator and enters the desiccant drying bed. Air flowing through the column of desiccant becomes progressively drier as water vapor sticks to the desiccant material in a process known as adsorption. The desiccant cartridge, using the adsorption process typically removes 95 percent of the water vapor from the pressurized air.

Most of the dry air exits the desiccant cartridge through its integral single check valve to fill the purge volume between the desiccant cartridge and outer shell. Some

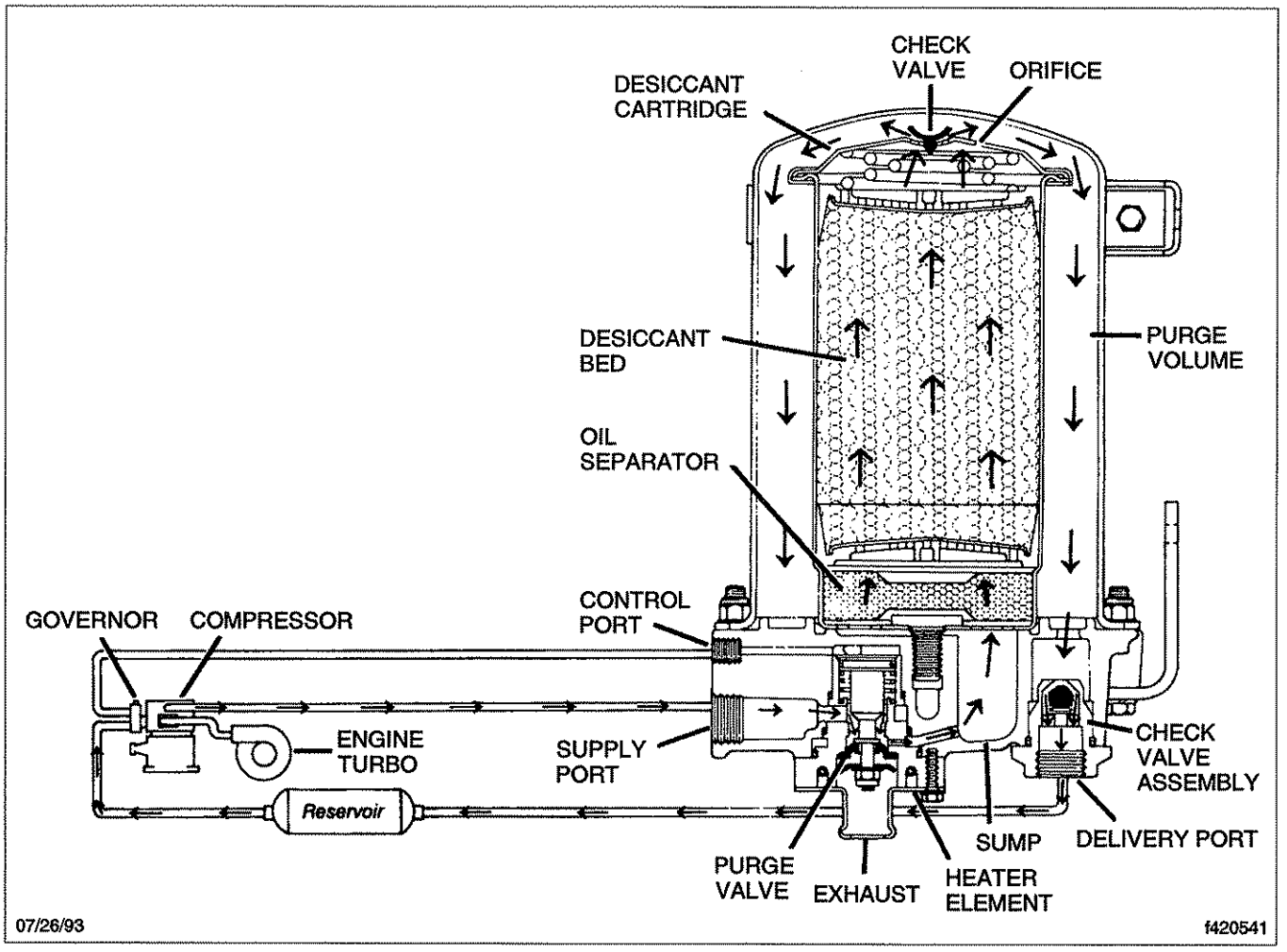


Fig. 2, AD-9 Charge Cycle

air also exits the desiccant cartridge through the purge orifice adjacent to the check valve.

Dry air flows out of the purge volume through the single check valve assembly and out the delivery port to the first (supply) reservoir of the air system.

The air dryer remains in the charge cycle until air brake system pressure builds to the governor cutout setting.

PURGE CYCLE **(See Fig. 3)**

When the brake system pressure reaches the governor cutout setting, the compressor unloads (air compression stopped), and the purge cycle of the air dryer begins. When the governor unloads the compressor, it pressurizes the unloader mechanism and line connecting the governor unloader port to the AD-9 end cover control port. The purge piston moves in response to air pressure causing the purge valve to open to atmosphere and partially close off the suppl of air from the compressor. This is further discussed under "Turbo Cutoff Feature."

Contaminants in the end cover sump are expelled immediately when the purge valve opens. Also, air that was flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve. Oil and solid contaminants collected by the oil separator are removed by air flowing from the desiccant drying bed to the open purge valve.

The initial purge and desiccant cartridge decompression last only a few seconds and are signaled by an audible burst of air at the AD-9 exhaust. The actual re-

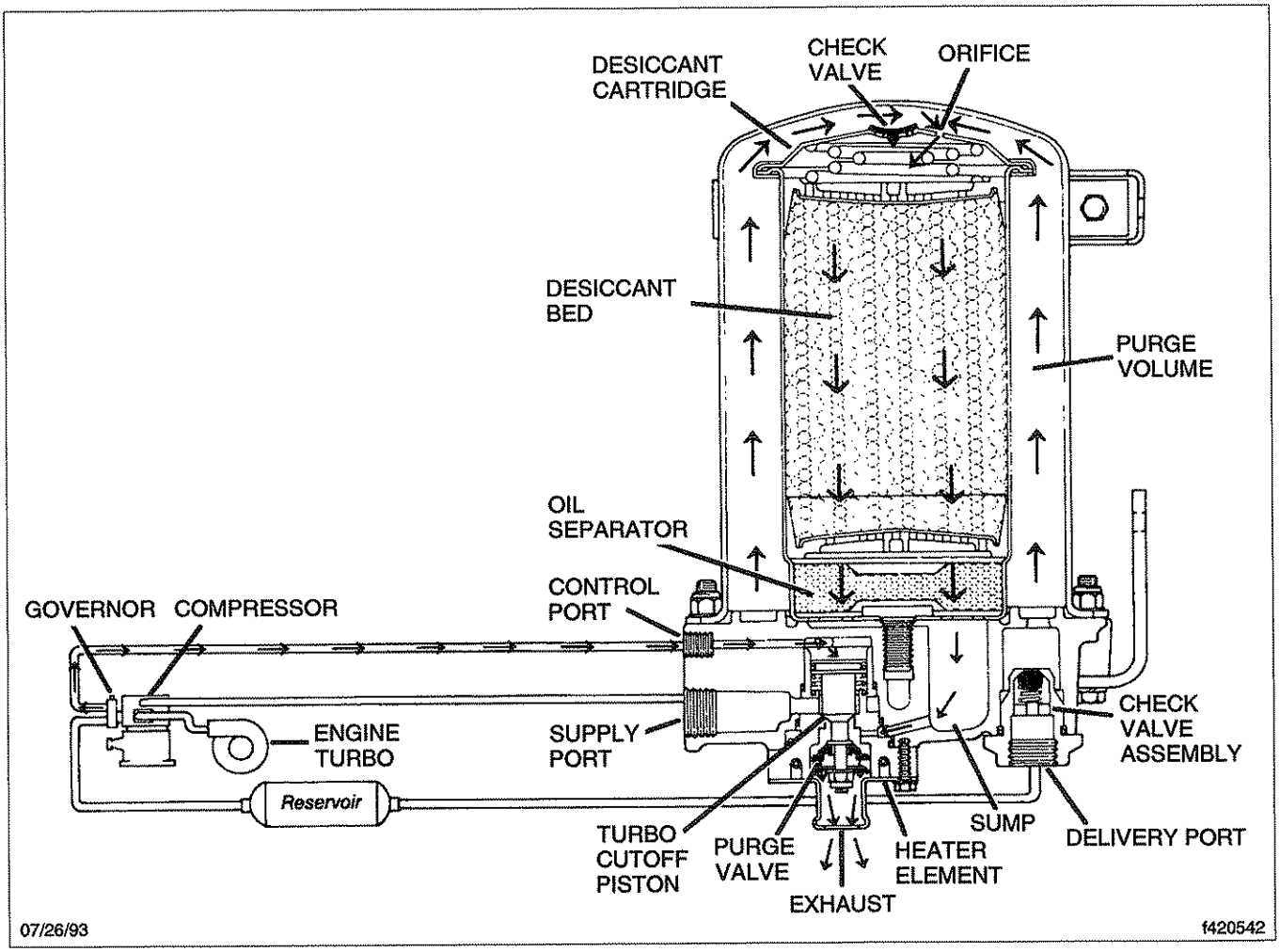


Fig. 3, AD-9 Purge Cycle

General Description and Principles of Operation

activation of the desiccant drying bed begins as dry air flows from the purge volume through the desiccant cartridge purge orifice and into the desiccant drying bed. Pressurized air from the purge volume expands after passing through the purge orifice; its pressure is lowered and its volume increased. Dry air flowing through the drying bed reactivates the desiccant material by removing the water vapor sticking to it. Generally, it takes 15 to 30 seconds for the entire purge volume of a standard AD-9 to flow through the desiccant drying bed.

The end cover single check valve assembly prevents compressed air in the brake system from returning to the air dryer during the purge cycle. After the 30 second purge cycle is complete, the air dryer is ready for the next charge cycle to begin.

The purge valve will remain open after the purge cycle is complete, and will not close until air brake system pressure is reduced and the governor signals the compressor to charge.

NOTE: The air dryer should be periodically checked for operation and tested for leaks. See **Group 42** of the *Business Class Trucks Maintenance Manual* for intervals and procedures.

TURBO CUTOFF FEATURE (See Fig. 4)

Primarily, the turbo cutoff valve prevents loss of engine turbocharger air pressure through the AD-9 in systems where the compressor intake is connected to the engine turbocharger. The turbo cutoff valve also reduces the puffing of air out the open exhaust when a naturally aspirated, single cylinder compressor equipped with an inlet check valve is in use.

At the beginning of the purge cycle, the downward travel of the purge piston is stopped when the turbo cutoff valve (tapered portion of the purge piston) contacts its mating metal seat in the purge valve housing. With the turbo cutoff valve seated (closed position), air in the discharge line and AD-9 supply port is restricted from entering the air dryer. While the turbo cutoff *effectively* prevents loss of turbocharger boost pressure to the engine, some seepage of air may be detected under certain conditions of compressor, engine, and turbocharger operation. Even so, there will be low pressure trapped in the discharge line.

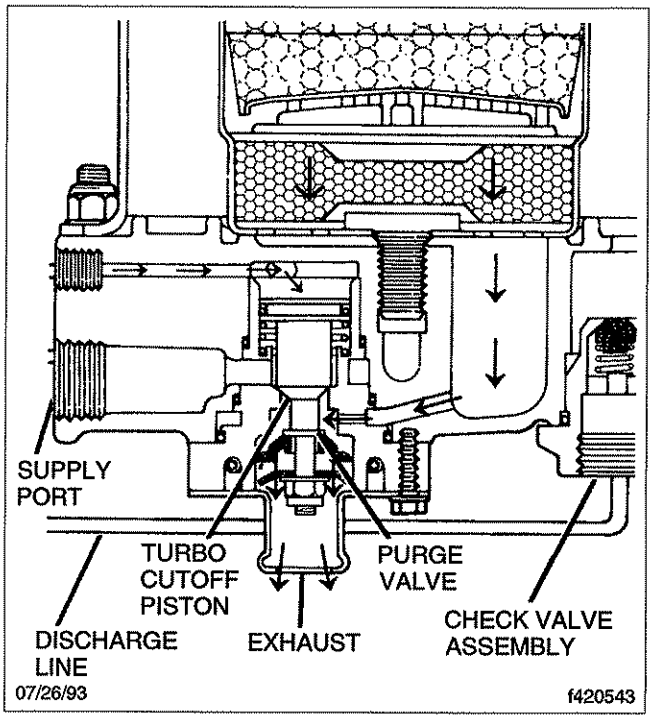


Fig. 4, AD-9 Turbo Cutoff

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

1. Chock the tires and stop the engine before working under a vehicle. Depleting air system pressure may cause the vehicle to roll. Keep hands away from brake chamber push rods and slack adjusters, which may apply as air pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure, and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Don't disassemble a component until you have read and understood the service procedures. Some components contain powerful springs, and injury can result if not properly disassembled. Use the correct tools, and observe all precautions pertaining to use of those tools.
5. Replacement hardware, tubing, hose, fittings, etc. should be the equivalent size, type, length, and strength of the original equipment.

   Make sure that when replacing tubing or hose, all of the original supports, clamps, or suspending devices are installed or replaced.
6. Replace devices with stripped threads or damaged parts. Repairs requiring machining should not be attempted.

Removal

IMPORTANT: Before working on or around air brake systems and components, read **"Safety Precautions, 100."**

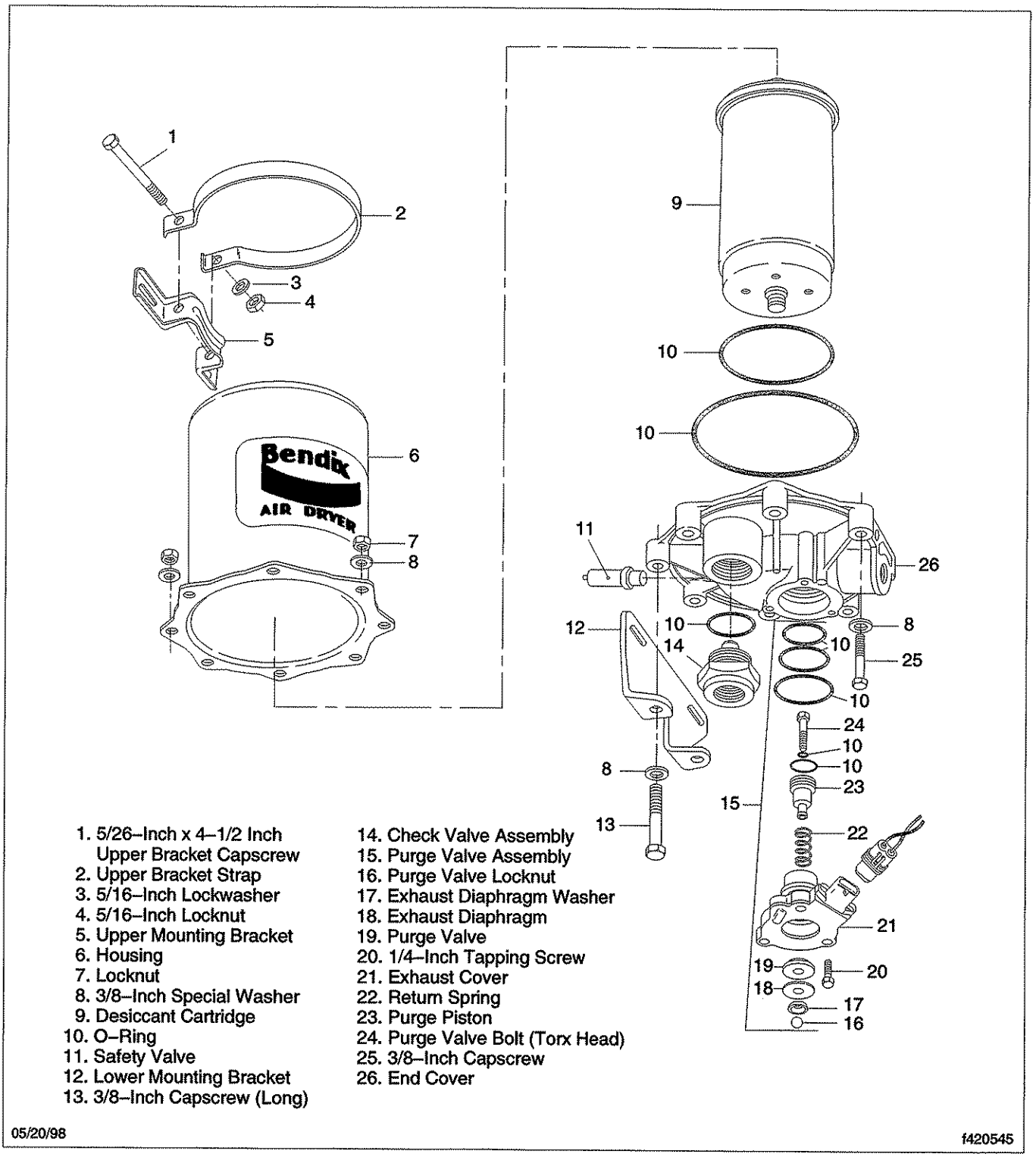
1. Park the vehicle on a level surface and chock the tires.
2. Drain all reservoirs to zero pressure.
3. Remove the air dryer.
   - 3.1 Identify and disconnect the three air lines from the end cover, and note the position of end cover ports relative to the vehicle.
   - 3.2 Unplug the vehicle wiring harness from the heater and thermostat assembly connector on the purge valve housing assembly.
   - 3.3 Loosen the hex bolt securing the upper mounting strap.
   - 3.4 Remove, save, and *mark* the two end cover capscrews, locknuts, and four special washers that retain the lower mounting bracket to the end cover. Also mark the two holes of the end cover. (These bolts are longer than the other six bolts.)
   - 3.5 Remove the air dryer from its mounting brackets.

Installation (Refer to Fig. 1)

IMPORTANT: Before working on or around air brake systems and components, read **"Safety Precautions, 100."**

1. Install the assembled air dryer on the vehicle.
   - 1.1 Position the air dryer up into the upper mounting bracket and strap. Align the two unused holes in the end cover with the bottom mounting bracket so that the bottom bracket supports the air dryer. The end cover should rest on the bracket.
   - 1.2 Using the remaining two capscrews (Ref. 16), four special washers (Ref. 15), and two locknuts (Ref. 17), secure the air dryer to the lower bracket. Tighten the two remaining capscrews 3060 to 4340 N·cm (270 to 385 lbf·in).
   - 1.3 Tighten the bolt and nut on the upper mounting bracket strap 900 to 1360 N·cm (80 to 120 lbf·in).
   - 1.4 As referenced earlier in "Removal", connect the three air lines to the ports on the end cover.
   - 1.5 Connect the vehicle wiring harness to the air dryer heater and thermostat assembly connector by plugging it into the air dryer connector until its lock tab snaps in place.
2. Test the air dryer following instructions in the brakes group of the vehicle maintenance manual.

Removal and Installation



1. 5/26–Inch x 4–1/2 Inch Upper Bracket Capscrew
2. Upper Bracket Strap
3. 5/16–Inch Lockwasher
4. 5/16–Inch Locknut
5. Upper Mounting Bracket
6. Housing
7. Locknut
8. 3/8–Inch Special Washer
9. Desiccant Cartridge
10. O–Ring
11. Safety Valve
12. Lower Mounting Bracket
13. 3/8–Inch Capscrew (Long)
14. Check Valve Assembly
15. Purge Valve Assembly
16. Purge Valve Locknut
17. Exhaust Diaphragm Washer
18. Exhaust Diaphragm
19. Purge Valve
20. 1/4–Inch Tapping Screw
21. Exhaust Cover
22. Return Spring
23. Purge Piston
24. Purge Valve Bolt (Torx Head)
25. 3/8–Inch Capscrew
26. End Cover

Fig. 1, AD-9 Exploded View

Disassembly, Cleaning and Inspection, and Assembly

When a major rebuild of the air dryer is undertaken, several replacement parts and maintenance kits are available that do not require full disassembly. Use the instructions provided with these parts or kits. **Refer to Fig. 1** during disassembly.

Disassembly

IMPORTANT: Before working on or around air brake systems and components, read **"Safety Precautions, 100."**

⚠ CAUTION

CAUTION: While servicing the air dryer, don't use a clamping device (vise, C-clamp, etc.) to hold any die cast aluminum part, as damage may result. To hold the end cover, install a pipe nipple in the supply port, and clamp the nipple in a vise.

1. Remove the air dryer from the vehicle. **Refer to "Removal and Installation, 110."**
2. Remove the check valve assembly (Ref. 13) and O-ring (Ref. 1). Remove the O-ring from the check valve assembly.
3. Remove the purge valve housing assembly.
   - 3.1 Remove the three self-tapping screws (Ref. 3) that secure the purge valve housing assembly to the end cover assembly.
   - 3.2 Pull the purge valve housing assembly out of the end cover assembly.
   - 3.3 Remove the three O-rings (Refs. 5, 6, and 7) from the exterior of the purge valve housing assembly.

   NOTE: O-rings (Refs. 5 and 6) may lodge in and have to be removed from the end cover bores.
4. Disassemble the purge valve housing assembly.
   - 4.1 If a flat non-extended exhaust cover (Ref. 28) is used, leave it intact while servicing the purge valve housing assembly.

     If an extended type exhaust cover is used for the attachment of an exhaust hose, *carefully* peel off the exhaust cover from the purge valve housing. *Use a thin flat blade to pry the exhaust cover off, taking care not to damage the potting material (RTV sealant) under the cover.*
   - 4.2 Remove the locknut (Ref. 4) from the bottom of the purge valve housing assembly. A Torx head or 12-point socket is used to hold the head of the bolt (Ref. 29). If present, remove the diaphragm washer (Ref. 30) and diaphragm (Ref. 2), and the purge valve (Ref. 10) from the purge valve housing.
   - 4.3 Remove the Torx head bolt (Ref. 29) from the opposite end, then the purge piston (Ref. 31), the return spring (Ref. 11) and two O-rings (Refs. 9 and 12) (one on the outside diameter and the other in the inside of the purge piston).

⚠ CAUTION

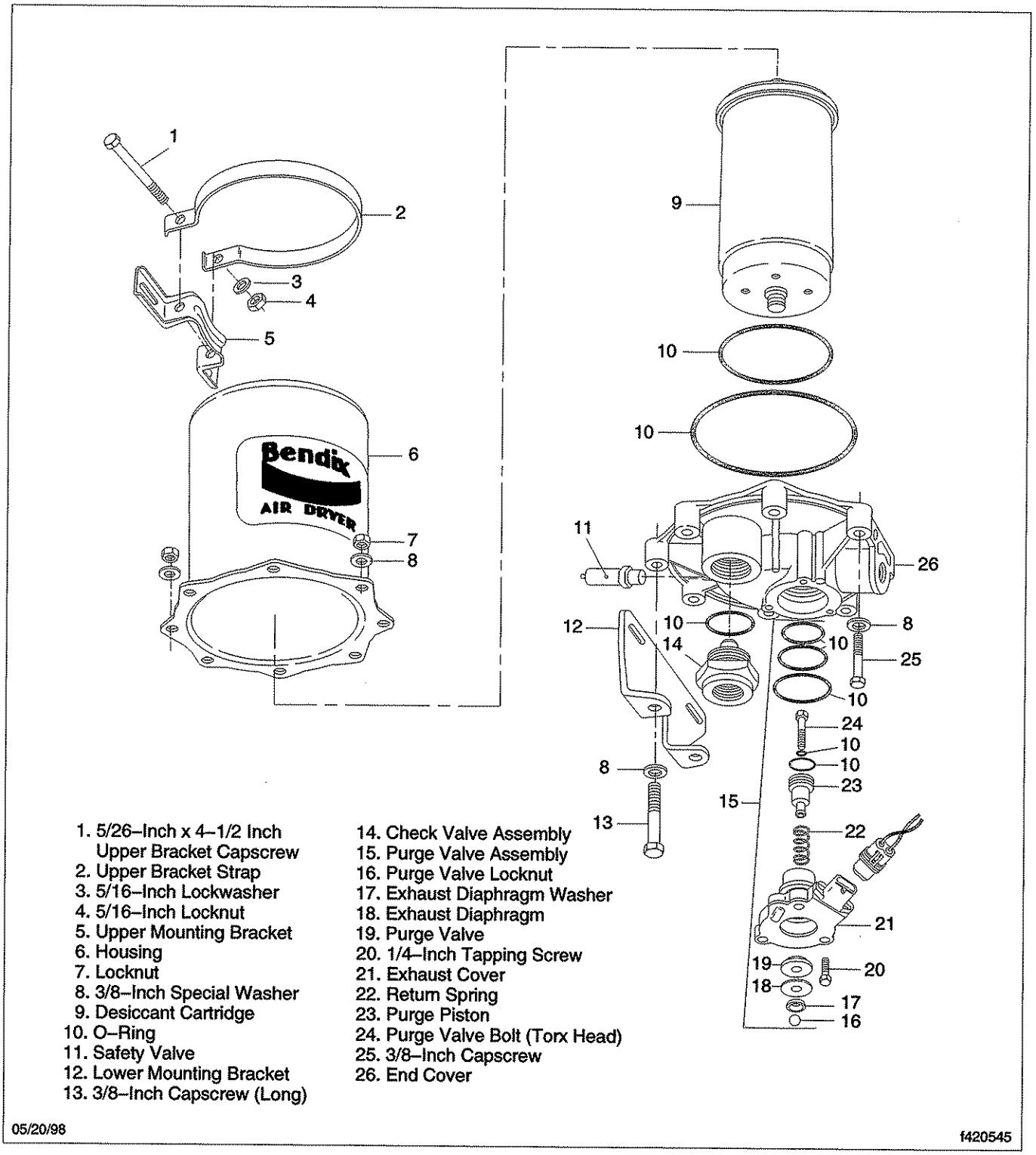
CAUTION: The heater and thermostat assembly is not available as a service part. Don't remove it; if the heater and thermostat are inoperative, replace the entire purge valve housing assembly, which includes these parts.

5. Remove the remaining six capscrews (Ref. 14), locknuts (Ref. 17), and twelve special washers (Ref. 15) that secure the end cover to the housing (Ref. 22). Separate the end cover and desiccant cartridge (Ref. 20) from the housing (Ref. 22).
6. Remove the end-cover-to-outer-housing O-ring (Ref. 21).
7. Don't remove the safety valve from the end cover unless it is known to be inoperative. If replacement is needed, apply thread sealant or Teflon® tape on the threads of the replacement valve and tighten 1360 to 4520 N·m (120 to 400 lbf·in). Make sure the drain hole (slot) is facing down.
8. Place a strap or chain wrench around the desiccant cartridge (Ref. 20) so that it is about 5 to 8 cm (2 to 3 inches) away from the end cover. Rotate the cartridge counterclockwise until it completely separates from the end cover.

NOTE: Torque of up to 68 N·m (50 lbf·ft) may be needed to do this disassembly.

9. Remove the desiccant cartridge O-ring (Ref. 19) from the end cover.

Disassembly, Cleaning and Inspection, and Assembly



1. 5/26–Inch x 4–1/2 Inch Upper Bracket Capscrew
2. Upper Bracket Strap
3. 5/16–Inch Lockwasher
4. 5/16–Inch Locknut
5. Upper Mounting Bracket
6. Housing
7. Locknut
8. 3/8–Inch Special Washer
9. Desiccant Cartridge
10. O–Ring
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12. Lower Mounting Bracket
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15. Purge Valve Assembly
16. Purge Valve Locknut
17. Exhaust Diaphragm Washer
18. Exhaust Diaphragm
19. Purge Valve
20. 1/4–Inch Tapping Screw
21. Exhaust Cover
22. Return Spring
23. Purge Piston
24. Purge Valve Bolt (Torx Head)
25. 3/8–Inch Capscrew
26. End Cover

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Fig. 1

Cleaning and Inspection

IMPORTANT: Before working on or around air brake systems and components, read **"Safety Precautions, 100."**

⚠ WARNING

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 metal parts thoroughly, using a quality commercial solvent, such as mineral spirits.
2. Check for severe corrosion, pitting, and cracks on the inside and outside of all metal parts that will be reused. Superficial corrosion and pitting on the outside of the upper and lower body halves is acceptable.
3. Inspect the bores of both the end cover and the purge-valve housing for deep scuffing or gouges.
4. Make sure that all purge-valve housing and end cover passages are open and free of blockages.
5. Inspect the pipe threads in the end cover. Make sure they are clean and free of thread sealant.
6. Inspect the purge-valve housing bore and seats for excessive wear and scuffing.
7. Inspect the purge valve piston seat for excessive wear.
8. Inspect all air line fittings for corrosion. Clean all old thread sealant from the pipe threads.
9. Replace all removed O-rings with new ones that are provided in the kits.

   Replace parts that show any of the conditions described.

Assembly (Refer to Fig. 1)

IMPORTANT: Before working on or around air brake systems and components, read **"Safety Precautions, 100."**

1. Before assembly, coat all O-rings, O-ring grooves, and bores with a generous amount of barium-base lubricant. **Refer to Fig. 1** during assembly unless otherwise advised.
2. Assemble the purge-valve housing.
   - 2.1 Install the O-ring (Ref. 12) on the purge piston. Place the return spring (Ref. 11) in the purge-valve housing. Place the O-ring (Ref. 9) in the bore of the purge piston. Install the Torx head bolt (Ref. 29) in the purge piston. Insert the purge piston (Ref. 31) in the inside diameter of the spring (Ref. 11). Push the piston into the purge-valve housing until it bottoms.
   - 2.2 While holding the purge piston in, install the following parts over the purge valve bolt (Ref. 29) from the opposite end of the purge-valve housing: the purge valve (Ref. 10) with its rubber side first, followed by the diaphragm (Ref. 2) (if present) and the diaphragm washer (Ref. 30) (if present) or the flatwasher, and finally the locknut (Ref. 4). Torque the purge valve locknut and bolt (Refs. 4 and 29) 680 to 900 N·cm (60 to 80 lbf·in).
   - 2.3 Install the three O-rings (Refs. 5, 6, and 7) in their correct locations on the purge-valve housing.
   - 2.4 If the exhaust cover (Ref. 28) was removed, install it on the purge-valve housing assembly, making sure the "bubble" portion is positioned over the thermostat.
   - 2.5 Install the assembled purge-valve housing in the end cover; make sure you orient both parts so that the connector is about 10 degrees clockwise from the supply port. Also, make sure the purge-valve housing is fully seated against the end cover.
   - 2.6 Secure the purge-valve housing to the end cover using the three self-tapping screws (Ref. 3). Start all three screws by hand, then torque 960 to 1400 N·cm (85 to 125 lbf·in).
3. Install the O-ring (Ref. 1) on the check-valve assembly (Ref. 13), then install the assembly in the end cover using a socket. Tighten 2260 to 2820 N·cm (200 to 250 lbf·in).
4. Install the desiccant cartridge in the end cover.

Disassembly, Cleaning and Inspection, and Assembly

4.1 Install the desiccant O-ring (Ref. 19) in its groove in the end cover. Using a light coat of barium grease, lubricate the bottom of the desiccant cartridge in the area that will contact the O-ring and end cover.

4.2 Screw the desiccant cartridge into the end cover until the cartridge contacts the O-ring. Using a strap or chain wrench positioned 5 to 8 cm (2 to 3 inches) from the bottom of the cartridge, turn the desiccant cartridge clockwise 180 to 225 degrees beyond the position where initial contact was made with the end cover O-ring. Torque should not exceed 68 N·m (50 lbf·ft).

5. Install the end cover housing over the desiccant cartridge.

5.1 Install the end cover outer housing O-ring (Ref. 21) on the shoulder in the end cover. Place the housing (Ref. 22) over the desiccant cartridge and align the holes.

5.2 Install the six capscrews (Ref. 14), locknuts (Ref. 17), and the twelve special washers (Ref. 15), making sure they are positioned as referenced earlier. The two longer capscrews (Ref. 16) will be used to secure the air dryer to its mounting bracket.

5.3 Tighten the six capscrews and nuts in a star pattern **as shown in Fig. 2,** depending on lower bracket location. Tighten 3060 to 4340 N·cm (270 to 385 lbf·in).

NOTE: The two remaining bolt holes in the end cover and two 3/8-inch capscrews must be the ones marked during disassembly to ensure correct orientation of the ports and adequate length of the capscrews.

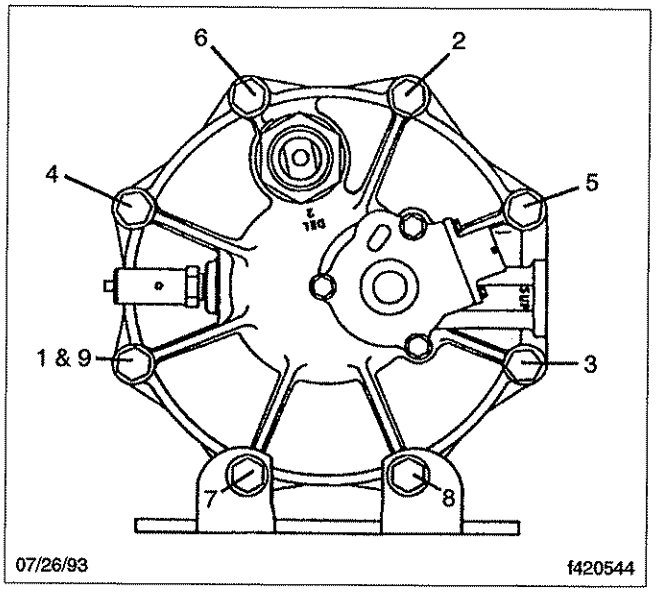


Fig. 2, End Cover to Housing Torque Pattern

Testing

During cold-weather operation, check the operation of the end cover heater and thermostat assembly.

1. With the ignition on, check for voltage to the heater and thermostat assembly. Unplug the electrical connector at the air dryer, and place the test leads on each of the pins of the male connector. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check that a good ground path exists.
2. Check the thermostat and heater operation. Turn off the ignition switch and cool the end cover assembly to below 4°C (40°F). Using an ohmmeter, check the resistance between the electrical pins in the female connector. The resistance should be 1.5 to 3.0 ohms for the 12-volt heater assembly.

NOTE: Some early models of the AD-9 will have resistance readings of 1.0 to 2.5 ohms for the 12-volt heater assembly. If the resistance is higher than this, replace the purge-valve housing assembly, which includes the heater and thermostat assembly.

3. Warm the end cover assembly to over 32°C (90°F) and again check the resistance. It should exceed 1000 ohms. If it does, the thermostat and heater assembly is operating properly. If it doesn't, replace the purge-valve housing assembly, which includes the heater and thermostat assembly.

Problem—Air Dryer Is Constantly Cycling or Purging

Possible Cause	Remedy
Excessive system leakage.	Test for excessive leakage. Eliminate leaks, as needed. Allowable leakage is as follows: • Single Vehicle—7 kPa/min (1 psi/min) per service reservoir • Tractor/Trailer—21 kPa/min (3 psi/min) per service reservoir
There is excessive leakage in the fittings, hoses, and tubing connected to the compressor, air dryer, and wet tank.	Using a soap solution, test for leakage at the fittings, drain valve, and safety valve in the wet tank. Repair or replace as needed.
Check valve assembly in the air dryer end cover is not working.	Remove the check valve assembly from the end cover. Apply compressed air to the delivery side of the valve. Apply a soap solution at opposite end, and check for leakage. Permissible leakage is a 2.5-cm (1-inch) bubble in 5 seconds. If there is excessive leakage, replace the check valve assembly.
Governor is inoperative.	Test the governor for proper cut-in or cut-out pressures and excessive leakage in both positions.
Leaking purge-valve housing assembly or O-rings in the air dryer end cover.	With the supply port open to atmosphere, apply 830 kPa (120 psi) at the control port. Apply a soap solution to the supply port and exhaust port (purge valve seat area). Permissible leakage is a 2.5-cm (1-inch) bubble in 5 seconds. Repair or replace as needed.
Compressor unloader mechanism is leaking excessively.	Remove the air strainer or fitting from the compressor inlet cavity. With the compressor unloaded, check for unloader piston leakage. Slight leakage is allowed.
Holset "E" type compressor.	Test the air dryer system. For instructions, refer to Bendix Product Bulletin PRO-08-19 entitled "Troubleshooting the Holset "E" Compressor System with Bendix Air Dryer."
Lack of air at the governor RES port (rapid cycling of the governor).	Test the governor for proper pressure at the RES port. Pressure should not drop below cut-in pressure when the compressor begins the unloaded cycle. If the pressure does drop, check for kinks or restrictions in the line connected to the RES port. The line connected to the RES port on the governor must be the same diameter, or larger than the lines connected to the UNL ports on the governor.

Problem—Water in the Vehicle Reservoirs

Possible Cause	Remedy
Desiccant cartridge assembly contains excessive contaminants.	Replace the desiccant cartridge.
Discharge line is of improper length or material.	Discharge line must consist of at least 1.8 m (6 ft) of wire braid Teflon hose, copper tubing, or a combination of both between the discharge port of the compressor and the air dryer supply port. Discharge line lengths and inside diameter requirements are dependent on the vehicle application. Contact your local Bendix representative for further information.
Air system was charged from an outside air source that did not pass through an air dryer.	If the system must have an outside air fill provision, the outside air should pass through an air dryer. This practice should be minimized.
Air dryer is not purging.	Refer to "Problem—Air Dryer Does Not Purge or Exhaust Air."
Purge (air exhaust) is insufficient due to excessive system leakage.	Refer to "Problem—Air Dryer Is Constantly Cycling or Purging."

Troubleshooting

Possible Cause	Remedy
Air bypasses the desiccant cartridge assembly.	Replace the desiccant cartridge/end cover O-ring. Make sure the desiccant cartridge assembly is properly installed.
Purge (air exhaust) time is significantly less than the minimum allowable.	Replace the desiccant cartridge/end cover O-ring. Make sure the desiccant cartridge assembly is properly installed. Replace the desiccant cartridge assembly.
Excessive air usage—air dryer not compatible with vehicle air system.	Install an accessory bypass system. Consult your Bendix representative for additional information.

Problem—Safety Valve on Air Dryer Is Popping Off or Exhausting Air

Possible Cause	Remedy
Desiccant cartridge is plugged or saturated.	Check the compressor for excessive oil passing, or incorrect installation. Repair or replace as needed.
The check valve in the air dryer air cover is inoperative.	Test to determine if air is passing through the check valve. Repair or replace as needed.
There is a problem in the fittings, hose, or tubing between the air dryer and the wet tank.	See if air is reaching the first reservoir. Inspect for kinked tubing or hose. Check for undrilled or restricted hose or tubing fittings.
Pinging noise is due to a single cylinder compressor with high pulse cycles.	A slight pinging sound may be heard during system build-up when a single cylinder compressor is used. If this sound is deemed objectionable, it can be reduced substantially by increasing the discharge line volume. This is done by adding a 1475 cm^3 (90 in^3)reservoir between the compressor and the air dryer.
Safety valve setting is lower than the maximum system pressure.	Reduce the system pressure, or install a safety valve with a higher pressure setting.

Problem—Constant Exhaust of Air at the Air Dryer Purge Valve Exhaust; Unable to Build System Pressure

Possible Cause	Remedy
Air dryer purge valve is leaking excessively.	With the compressor loaded, apply a soap solution on the purge valve exhaust to test for excessive leakage. Repair the purge valve as needed.
The governor is inoperative.	Check the governor for proper cut-in and cut-out pressures, and excessive leakage in both positions. Repair or replace as needed.
Purge control line is connected to the reservoir or exhaust port of the governor.	Connect the purge control line to the unloader port of the governor.
Purge valve is frozen open due to an inoperative heater or thermostat, bad wiring, or a blown fuse.	Test the heater and thermostat, following instructions in this manual.
Inlet and outlet air connections are reversed—unable to build system pressure.	Reconnect the lines properly.
Discharge line is kinked or blocked.	See if air passes through the discharge line. Check for kinks, bends, or excessive carbon deposits.
There are excessive bends in the discharge line. Water is collecting and freezing.	Discharge line should be constantly sloping from the compressor to the air dryer with as few bends as possible.

Possible Cause	Remedy
System is leaking excessively.	Test for excessive leakage. Eliminate leaks, as needed. Allowable leakage is as follows: • Single Vehicle—7 kPa/min (1 psi/min) per service reservoir • Tractor/Trailer—21 kPa/min (3 psi/min) per service reservoir
Purge valve stays open; supply air leaks to control side.	Replace the purge valve assembly O-rings.

Problem—Air Dryer Does Not Purge or Exhaust Air

Possible Cause	Remedy
Purge control line is broken, kinked, frozen, plugged, or disconnected.	See if air flows through the purge control line when the compressor is unloaded. The purge control line must be connected to the unloader port of the governor.
Air dryer purge valve isn't working.	See if air reaches the purge valve. If it does, repair the purge valve.
The governor is inoperative.	Check the governor for proper cut-in and cut-out pressures, and excessive leakage in both positions. Repair or replace as needed.
Inlet and outlet air connections are reversed—unable to build system pressure.	Reconnect the lines properly.
Discharge line is kinked or blocked.	See if air passes through the discharge line. Check for kinks, bends, or excessive carbon deposits.
There are excessive bends in the discharge line. Water is collecting and freezing.	Discharge line should be constantly sloping from the compressor to the air dryer with as few bends as possible.

Problem—Desiccant Is Being Expelled from the Air Dryer Purge Valve Exhaust (May Look Like Whitish Liquid, Paste, or Small Beads); or, Unsatisfactory Desiccant Life

Possible Cause	Remedy
This problem usually occurs with one or more of the previous problems.	Refer to the appropriate corrections listed previously.
Air dryer is not securely mounted; there is excessive vibration.	Vibration should be held to a minimum. Tighten the mounting fasteners.
Cloth-covered perforated plate in the air dryer desiccant cartridge is damaged, or the cartridge was rebuilt incorrectly.	Replace the plate or cartridge as needed. High operating temperatures may cause deterioration of filter cloth. Check the installation.
Compressor is passing excessive oil.	Check for proper compressor installation; if symptoms persist, replace the compressor.
Heater and thermostat, wiring, or a fuse is at fault, and isn't allowing the air dryer to purge during cold weather.	Test the heater and thermostat, following instructions in this manual.
Desiccant cartridge not attached properly to the end cover.	Check the torque and tighten if necessary. Refer to **Subject 120 for instructions.**

Troubleshooting

Problem—Pinging Noise Is Excessive During Compressor Loaded Cycle

Possible Cause	Remedy
Pinging noise is due to a single cylinder compressor with high pulse cycles.	A slight pinging sound may be heard during system build-up when a single cylinder compressor is used. If this sound is deemed objectionable, it can be reduced substantially by increasing the discharge line volume. This is done by adding a 1475 cm^3 (90 in^3) reservoir between the compressor and the air dryer.

Problem—Constant Air Seepage at the Purge Valve (Non-Charging Mode)

Possible Cause	Remedy
Air compressor inlet is pressurized by the engine turbocharger.	Some pressure leakage past the metal seat of the turbocharger cutoff feature of the AD-9 air dryer is normal, and may be heard. This slight loss of air will not affect the engine or turbocharger performance.
Check valve assembly in the air dryer end cover is not working.	Remove the check valve assembly from the end cover. Apply compressed air to the delivery side of the valve. Apply a soap solution at opposite end, and check for leakage. Permissible leakage is a 2.5-cm (1-inch) bubble in 5 seconds. If there is excessive leakage, replace the check valve assembly.

Problem—Air Dryer Purge Piston Cycles Rapidly in the Unloaded Mode

Possible Cause	Remedy
Compressor does not "unload."	Check the governor installation: there is no air line from the governor to the compressor, or the line is restricted. Repair or replace as needed.

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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 air reservoirs. Each reservoir is identified as one of three types: supply, primary, and secondary.

The supply reservoir (or wet tank) receives compressed air directly from the compressor. It collects most of the water and oil condensate from the air, and feeds 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 primary reservoir is the air source for the brakes on the rear axle. 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.

The secondary reservoir is the air source for the front axle brakes. It is equipped with an internal check valve.

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.

On vehicles equipped with an air dryer, the supply reservoir and the secondary reservoir are in a common tank. If there is no air dryer, the supply reservoir is a separate tank, mounted vertically in front of the secondary reservoir.

Tests

NOTE: If equipped with an automatic drain 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. Go to **"Drain Valve Replacement and Leak Elimination, 110."**

If leaks occur on the surfaces of the air reservoir, replace the tank; refer to **"Air Reservoir Replacement, 120."**

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 vehicle 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 coupler, tighten the valve up to one additional turn to stop the leaks.
6. Remove the chocks from the tires.

Air Reservoir Replacement

Replacement

1. Apply the parking brakes, and chock the tires.
2. Drain the air system, using instructions in the vehicle driver's manual.
3. Mark all reservoir air lines, couplers, and valves for later assembly. Carefully disconnect the parts. Cap the exposed ports tightly to keep out contaminants. If access is limited, remove the parts after removing the reservoir from its mount.
4. Remove the reservoir strap fasteners. Remove the reservoir.
5. If access is limited, do the next step 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 nut 20 lbf·ft (27 N·m).
6. As referenced earlier, connect all air lines, couplers, and valves to the new reservoir, removing the caps as each part is installed.
7. Remove the chocks from the tires.

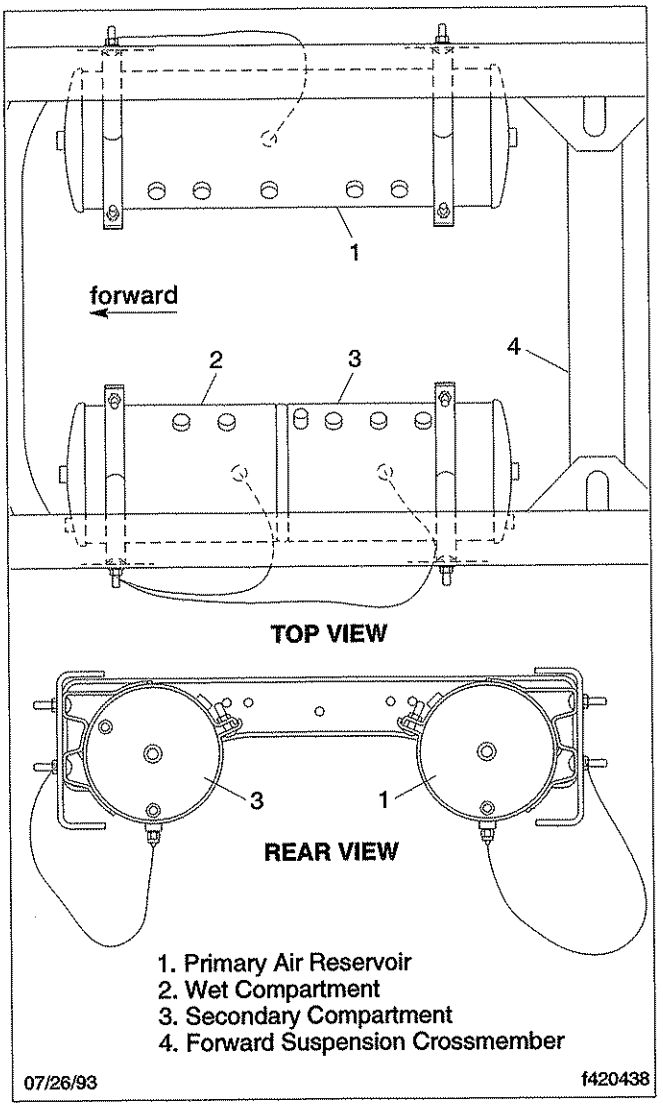


Fig. 1, Chassis Mounted Air Reservoirs (Vehicle Equipped With an Air Dryer)

Air Reservoir Replacement

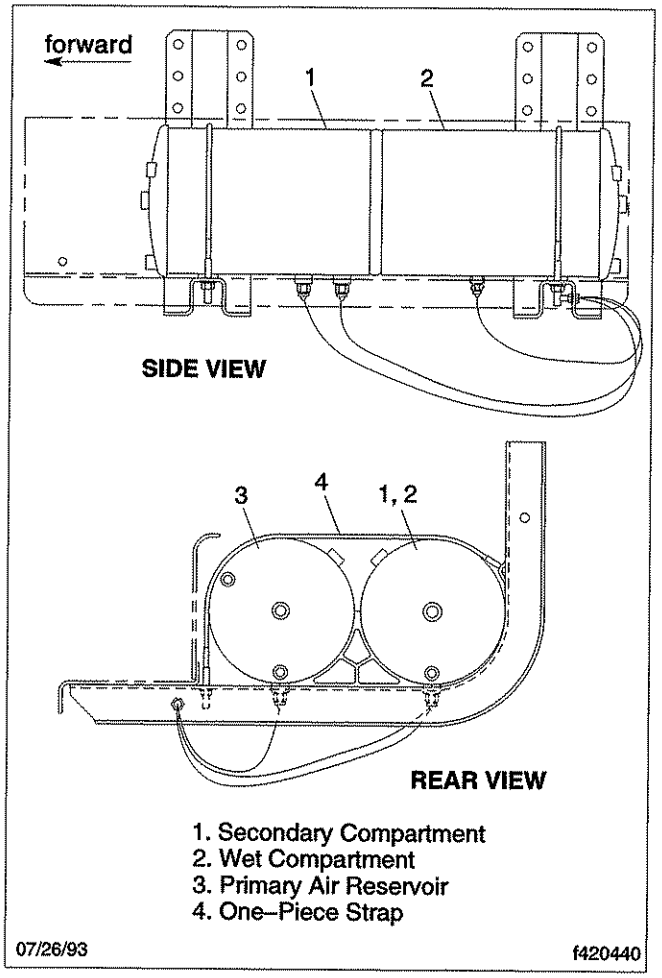


Fig. 2, Air Reservoirs Mounted on Left Step (Vehicle Equipped With an Air Dryer)

Automatic Drain Valve, Bendix DV–2

42.08

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General Information

The DV-2 automatic reservoir drain valve **(Fig. 1)** automatically removes contaminants and water from the wet-air tank each time the brakes are applied. The drain valve is attached to a drain cock located on the bottom of either end of the wet-air tank. Since the brake foot valve is protected by a check valve between the wet-and dry-air tanks, any leak or sticking valve will not reduce the supply of air that is in the dry part of the system.

Principles of Operation

With no pressure in the system, the drain valve's inlet and exhaust valves are closed. **See Fig. 2.** Upon charging the system, a slight pressure opens the inlet valve which permits air and contaminants to collect in the sump. **See Fig. 3.** The inlet valve remains open when pressure is rising in the system until the air compressor cuts off, allowing the spring action of the valve guide in the sump cavity to close the inlet valve. The inlet valve and the exhaust valve are now both closed. **See Fig. 4.** When the wet tank pressure drops about 14 kPa (2 psi), the air pressure in the sump cavity opens the exhaust valve and allows moisture and contaminants to be ejected from the sump cavity until pressure in the sump cavity drops enough to close the exhaust valve. **See Fig. 5.**

The length of time the exhaust valve remains open and the amount of moisture and contaminants ejected depends upon the sump pressure and the wet tank pressure drop that occurs each time air is used from the system.

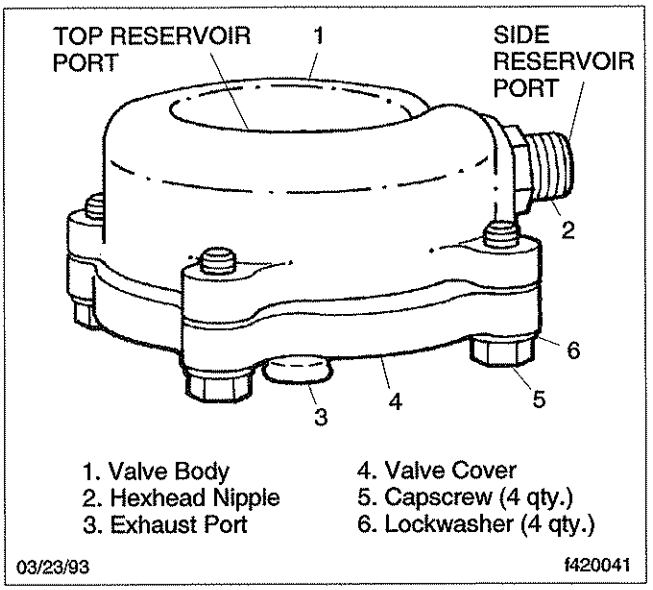


Fig. 1, DV-2 Valve

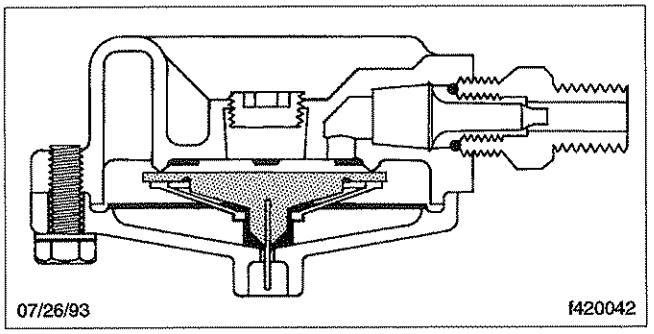


Fig. 2

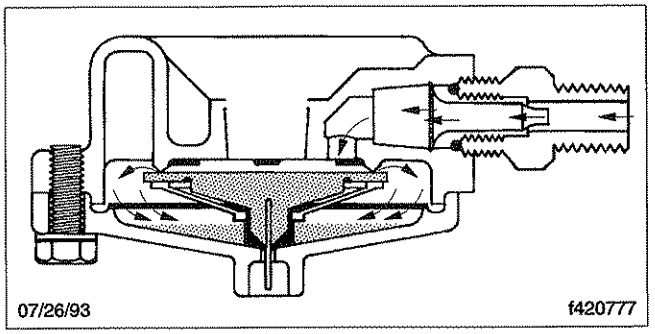


Fig. 3

General Information and Principles of Operation

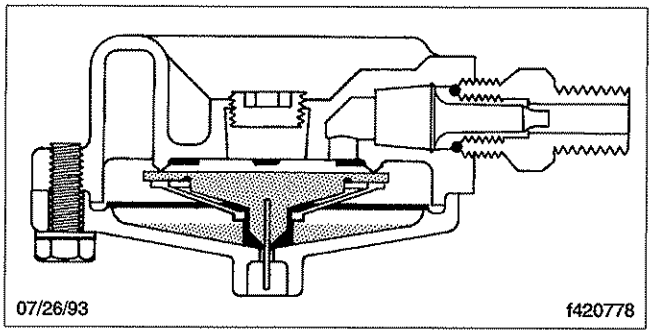


Fig. 4

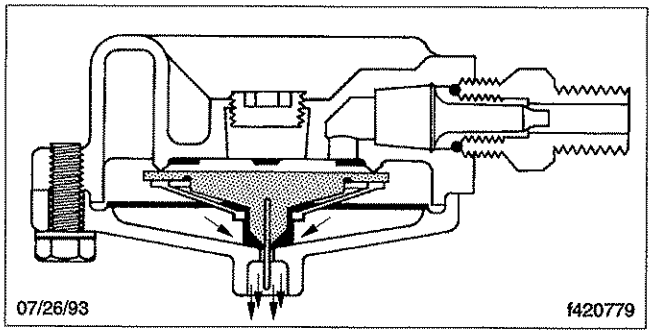


Fig. 5

Safety Precautions

When working on or around air brake systems and components, the following precautions should be observed:

1. Always chock the vehicle's wheels and stop the engine when working under a vehicle. Keep hands away from brake chamber push rods and slack adjusters; they may apply as air system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood the recommended procedures. Some components contain powerful springs, and injury can result if not properly disassembled. Use only the correct tools and observe all precautions pertaining to use of those tools.

Operating Test

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

Do the following test after repairing or replacing the DV-2 valve to ensure that the valve is functioning correctly.

With the system charged, apply the brakes several times. Each time the brakes are applied, an exhaust of air should occur from the exhaust port of the drain valve. If no air comes out, push the wire stem located inside the exhaust port. If no air comes out after pushing the wire stem, there may be a plugged filter in the adapter which should be replaced.

If the drain valve does not function correctly, repair or replace it following instructions in this section.

Leakage Test

Perform the following test after repairing or replacing the DV-2 valve to ensure that the valve is functioning correctly.

With the system charged and pressure stabilized in the system, there should be no leaks at the drain valve exhaust port. A constant slight exhaust of air at the drain valve exhaust port could be caused by excessive leakage in the air brake system.

If the drain valve is leaking excessively, repair or replace it following instructions in this section.

Removal

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Chock the tires, and drain the reservoirs.
2. Remove the drain valve assembly from the end of the wet tank reservoir.

Installation

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

⚠ WARNING

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 an approved cleaning solvent, flush and clean the wet tank reservoir to avoid early fouling at the drain valve. Aerate the wet tank completely if solvents were used during cleaning.
2. Install the drain valve assembly on the wet tank by tightening the hexagonal nipple until the drain valve is positioned so that the valve body is parallel to the bottom of the wet tank with the exhaust port facing straight down. Make sure that the exhaust port is clear of any air, electric, or fuel lines. Make sure the drain valve is attached tight enough to prevent leakage.
3. Close the drain cocks to the wet and dry air reservoirs. Start the vehicle engine to pressurize the air system.
4. Leak test the drain valve following the instructions under **"Operating and Leakage Tests, 110."**

Disassembly, Cleaning and Inspection, and Assembly

Disassembly (Refer to Fig. 1)

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Remove the drain valve following the instructions under **"Removal and Installation, 120."**
2. Remove the four capscrews (Ref. 11) that hold the valve cover (Ref. 7) to the valve body (Ref. 1).
3. Remove the valve cover (Ref. 7) and sealing ring.
4. Remove the valve guide (Ref. 6) and the inlet and exhaust valve (Ref. 4) from the valve body.
5. Remove the hexhead nipple (Ref. 3) from the valve body.

Cleaning and Inspection

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

⚠ WARNING

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.

Use eye protection when using compressed air to clean or dry parts, as permanent harm to eyes could result from flying debris.

1. Wash all metal parts of the drain valve in an approved cleaning solvent. Dry the metal parts of the disassembled moisture ejection valve with compressed air.
2. Wipe all rubber parts clean with a clean cloth. Examine all rubber parts. If any rubber parts are worn, cracked, torn or otherwise deteriorated, replace them with new parts.
3. Examine all metal parts. If any metal parts are worn, cracked, or otherwise damaged, replace them with new parts.
4. Clean and examine the filter. If it will not clean completely, or is torn or damaged, replace it with a new filter.

⚠ CAUTION

CAUTION: Do not reassemble the drain valve with a dirty filter; to do so could result in failure of the drain valve in service.

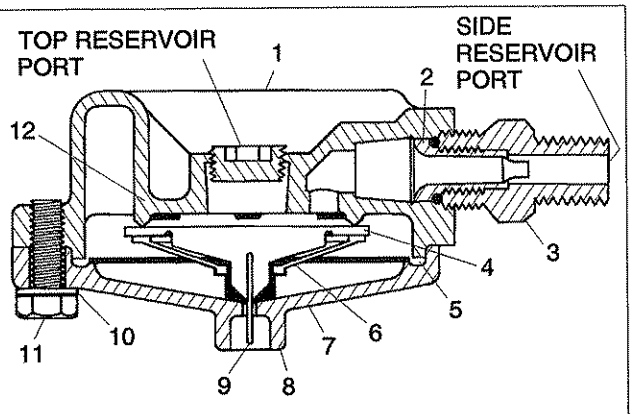
Assembly (Refer to Fig. 1)

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

Before assembling the drain valve, apply a light film of grease on the inlet valve seat. See Ref. 12.

IMPORTANT: Do not apply oil to the inlet and exhaust valve.

1. Install the valve sealing ring (Ref. 5) into its groove in the valve cover.
2. Install the valve guide (Ref. 6) over the inlet and exhaust valve (Ref. 4).



1. Valve Body
2. Filter Retainer
3. Hexhead Nipple
4. Inlet and Exhaust Valve
5. Valve Seating Ring
6. Valve Guide
7. Valve Cover
8. Exhaust Port
9. Wire Stem
10. Lockwasher (4 qty.)
11. Capscrew (4 qty.)
12. Insle Valve Seat

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Fig. 1, DV-2 Valve, Cutaway View

Disassembly, Cleaning and Inspection, and Assembly

3. Install the valve guide, and the inlet and exhaust valve as an assembly into the valve cover. The wire stem (Ref. 9) will project through the exhaust port (Ref. 8).
4. Install the valve body on the valve cover and install the lockwashers and capscrews. Tighten the capscrews 820 to 1080 N·cm (72 to 96 lbf·in).
5. Install the hexhead nipple onto the valve body, and tighten it 540 to 820 N·cm (48 to 72 lbf·in).
6. Install the drain valve on the wet tank following the instructions under **"Removal and Installation, 120."**

Specifications

This subject contains the following table:

•Torque Values

Description	Torque N·cm (lbf·in)
Valve Cover Capscrews	820-1080 (72-96)
Hexhead Nipple (to valve body)	540-820 (48-72)

Table 1, Torque Values

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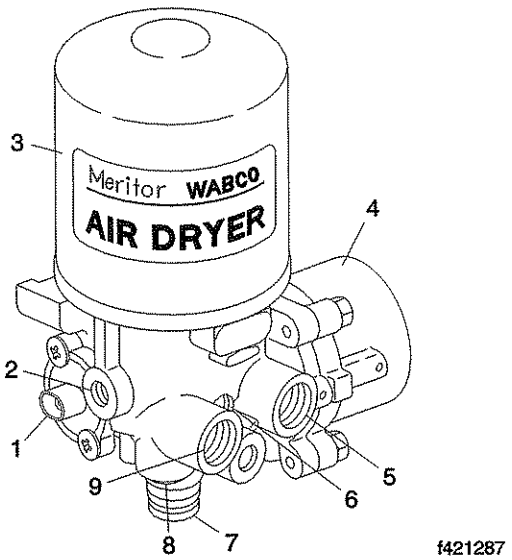
General Information

The System Saver 1000 air dryer **(Fig. 1)** is a desiccant 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, reducing the build-up of dirt and moisture in the vehicle air system.

The air dryer consists of a light weight aluminum and steel body. The desiccant cartridge is contained in a spinoff canister at the top of the air dryer.

The bottom half of the air dryer houses the following components.

- Bypass Valve–this valve allows air flow in the air dryer to go directly to the outlet port, bypassing the desiccant filter.
- Desiccant Canister–a cylindrical steel housing that contains the filter elements and the desiccant needed to filter and dry the air that passes through it.



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1. Heater/Thermostat Assembly
2. Governor Port (to air governor)
3. Desiccant Canister
4. Regeneration Valve Assembly
5. Outlet Port (to air supply reservoir)
6. Bypass Valve Assembly
7. Exhaust Port (Purge Valve Assembly)
8. Turbocharger Cutoff Valve
9. Inlet Port (from air compressor)

Fig. 1

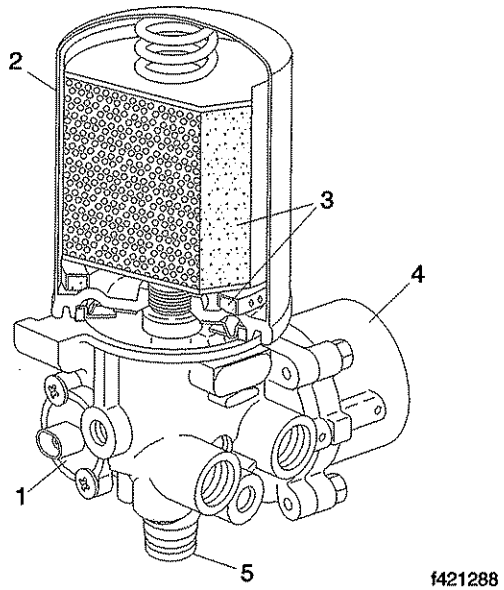
- Heater/Thermostat Assembly–located in the air dryer base, this assembly is designed to prevent the collected moisture from freezing.
- Outlet Check Valve–this valve prevents air in the system from flowing back through the air dryer and escaping out the purge valve during the compressor unload cycle.
- Pressure-Controlled Check Valve–this valve is separate from the air dryer and is installed on the secondary air tank. The valve allows air to back flow from the secondary tank to the supply tank as long as air system pressure remains between the normal cut in and cut out range of the air governor.
- Purge Valve–this valve allows the collected moisture and contaminants to be expelled from the air dryer during the purge cycle.
- Regeneration Valve–this valve allows air from the supply and secondary tanks to bypass the outlet check valve and flow into the regeneration valve. Air then flows through an orifice where the air expands and back flushes moisture off of the desiccant. The air is then exhausted through the purge valve.
- Silencer (Muffler)–an optional component that is attached to the purge valve and used to eliminate most of the noise during the air dryer purge cycle.
- Turbocharger Cut-Off Valve–this valve closes the path between the air compressor and the air dryer purge valve to help maintain boost pressure for maximum engine horsepower during the compressor unload cycle.

Principles of Operation

Hot, compressed air enters the air dryer through the inlet port. As the hot air is forced into the desiccant cartridge, the temperature of the compressed air falls to nearly ambient. Oil and water vapor condense and initially settle into the base of the dryer. The moisture-laden air also passes through the desiccant bed, where any remaining moisture is retained by the desiccant. The clean air then passes through the air dryer outlet port to the supply reservoir. **See Fig. 2.**

When the compressor reaches 827 kPa (120 psi), the purge valve opens allowing the initial decompression of the dryer and expels the water and contaminants

General Information and Principles of Operation



1. Heater/Thermostat Assembly
2. Desiccant Canister
3. Filter
4. Regeneration Valve Assembly
5. Exhaust Port (Purge Valve Assembly)

Fig. 2

collected in the base of the dryer. The regeneration valve, along with the pressure-controlled check valve, allows the system air to flow back through the dryer. This back flow dries the desiccant for the next cycle.

Safety Precautions

⚠ WARNING

WARNING: When draining the air system, don't look into the air jets or direct them toward another person, as dirt or sludge particles may be in the airstream. Don't disconnect pressurized hoses because they may whip as air escapes from the line. Failure to take all necessary precautions during service operations of the air brake system can cause personal injury.

When working on or around air brake systems and components, observe the following precautions.

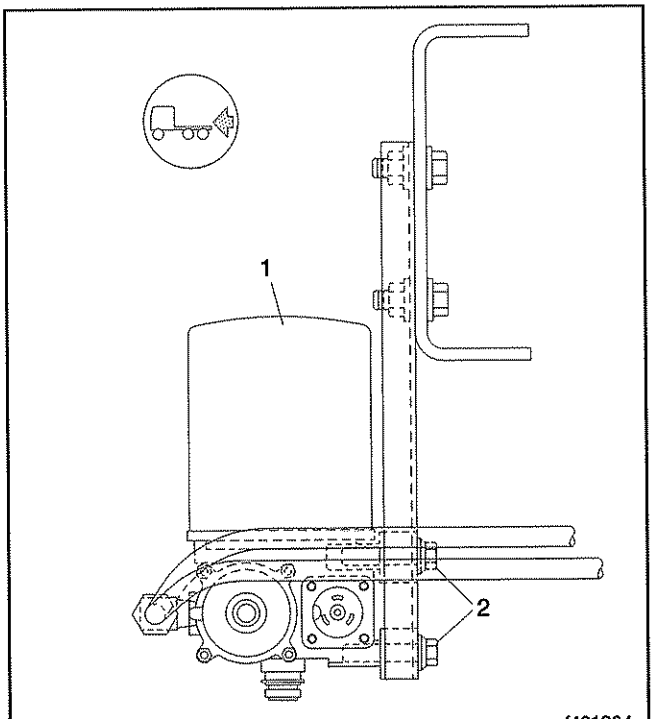
1. Apply the parking brake, chock the tires, and stop the engine when working under the vehicle. Draining the air system may cause the vehicle to roll. Keep hands away from brake chamber push rods and slack adjusters, which may apply as air system pressure drops.
2. Wear safety goggles.
3. Never connect or disconnect a hose or line containing air under pressure; it may whip as air escapes. Never remove a component or pipe plug unless you are sure all system pressure has been depleted.
4. Don't disassemble a component before reading and understanding recommended procedures. Use only the correct tools and follow basic tool safety.
5. Replacement hardware, tubing, hose, fittings, etc. should be the same size, type, length, and strength as the original equipment. When replacing tubing or hose, be sure that all of the original supports, clamps, or suspending devices are installed or replaced.
6. Replace any components that have stripped threads or damaged parts. Don't attempt to repair parts by machining.
7. Never exceed recommended air pressure.

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

Removal (See Fig. 1)

1. Drain the air system.
2. Disconnect the wiring harness from the air dryer.
3. Mark the air lines for later reference; then, disconnect them from the air dryer.
4. Remove the capscrews, washers, and spacers that attach the air dryer to the mounting bracket.
5. Remove the air dryer.



1. Desiccant Canister
2. 1/2" Capscrew, Washer, and Spacer

Fig. 1, Air Dryer Installation (outboard rail mounting shown)

Installation (See Fig. 1)

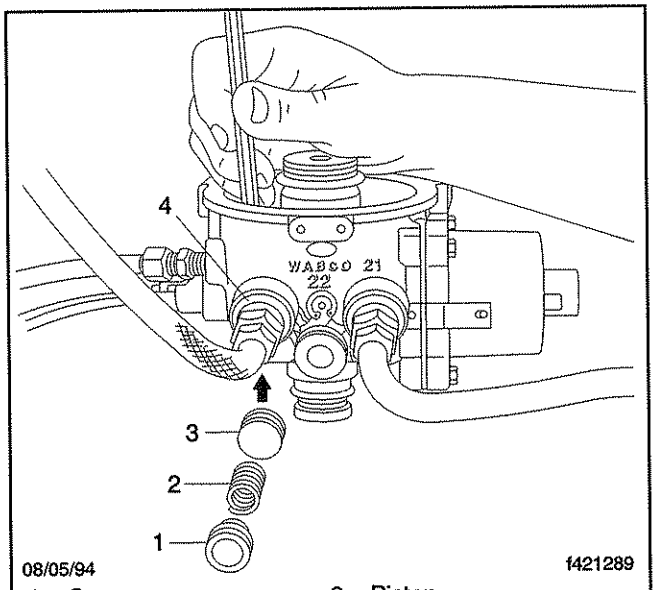
1. Position the air dryer on the mounting bracket. Install the spacers, washers, and capscrews. Tighten them 30 to 41 N·m (22 to 30 lbf·ft).
2. Make sure the air lines are clean. Replace any line or fitting that is crimped or damaged.
3. Connect the remaining air lines to the air dryer as previously marked. Tighten the nut on each fitting finger-tight. Then, using two wrenches to prevent twisting the hose, further tighten the nut until there is firm resistance.
4. Connect the air dryer wiring harness.

Replacement

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Drain the air system.
2. Remove the snap ring at the bottom of the valve assembly. The valve cover and spring may fall out of the cavity when the snap ring is removed. **See Fig. 1.**
3. Using a strap wrench, turn the desiccant cartridge counterclockwise and remove it.
4. Using a wooden stick, push the piston, spring, and the cover out of the valve cavity.
5. Clean the valve cavity with a commercial cleaning solvent.
6. Install new O-rings on the piston and the cover.



1. Cover
2. Spring
3. Piston
4. Inlet Port

Fig. 1

7. Using a multipurpose, high-temperature grease that resists water, steam, and alkali, lightly coat the surfaces of the new O-rings and the valve cavity.
8. Install the new piston with its hollow side facing out.

If the valve cavity is damaged, preventing a tight seal, replace the air dryer.

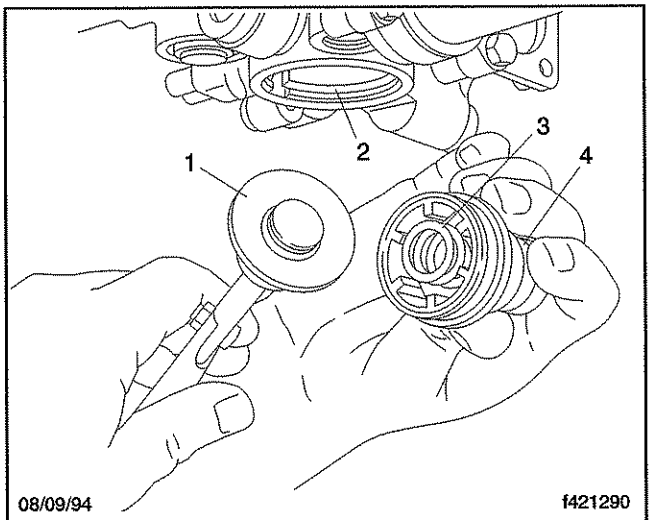
9. Install the new spring, cover, and snap ring to hold the components in place.
10. Thread the desiccant cartridge onto the dryer base (turn clockwise). When the seal contacts the base, tighten the cartridge one complete turn more. Do not over tighten.

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Drain the air system.
2. Remove the snap ring, valve head, and the spring from the exhaust port.
3. Pull the valve assembly out of the exhaust port.
4. Remove the O-ring from the base of the exhaust port.
5. Clean the purge valve cavity area with a commercial cleaning solvent.
6. Using a multipurpose, high-temperature grease that resists water, steam, and alkali, lightly coat the surfaces of the valve cavity and to all of the new O-rings. Install the O-rings in the base of the exhaust port and on the valve head.
7. Position the new valve assembly in the valve cavity.



1. Valve Assembly
2. Exhaust Port
3. Spring
4. Valve Head

Fig. 1

If the valve cavity is damaged, preventing a tight seal, replace the air dryer.

8. Install the spring in the valve head, and position them in the valve cavity.
9. Install the snap ring to secure the valve head in position.

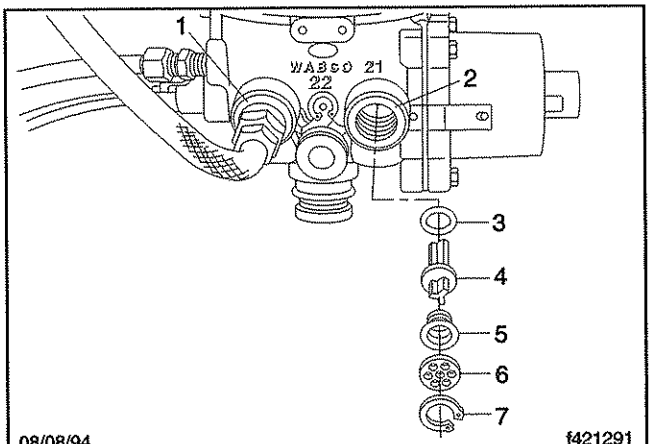
Outlet Check Valve Assembly Replacement

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Drain the air system.
2. Disconnect the air line from the outlet port.
3. Remove the snap ring, washer, valve body, and the O-ring.
4. Clean the cavity area with a commercial cleaning solvent.
5. Install a new O-ring on the valve body.
6. Using a multipurpose, high-temperature grease that resists water, steam, and alkali, lightly coat the surfaces of the new O-ring and the valve cavity.
7. Install the new valve body. Make sure that the long end of the body is inserted first into the valve cavity.
8. Install the new spring with its small end around the "Y" shaped fins on the valve body.



1. Inlet Port
2. Outlet Port
3. O-Ring
4. Valve Body
5. Spring
6. Washer
7. Snap Ring

Fig. 1

If the valve cavity is damaged, preventing a tight seal, replace the air dryer.

9. Install a new washer and snap ring to secure the assembly in the valve cavity.
10. Connect the air line to the outlet port. Tighten the nut on the fitting finger-tight. Then, using two wrenches to prevent twisting the hose, further tighten the nut until there is firm resistance. Tighten the nut one-sixth turn more.

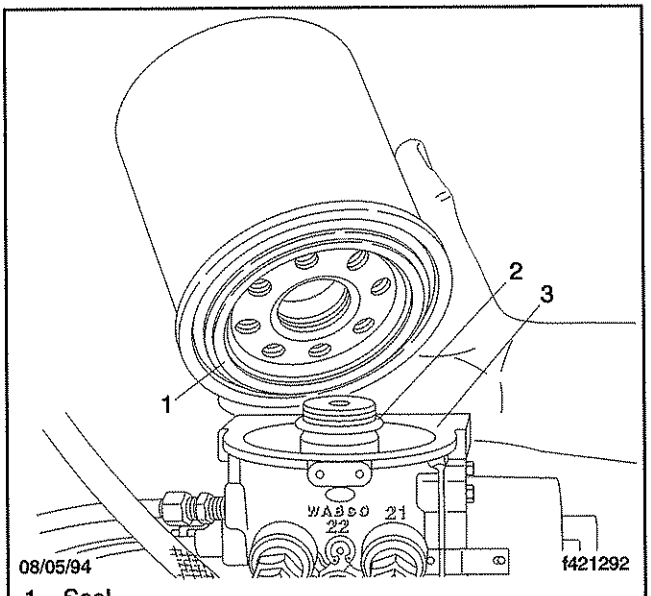
Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Drain the air system.
2. Using a strap wrench, turn the desiccant cartridge counterclockwise and remove it.
3. Remove and discard the O-ring.
4. Clean the top surface of the dryer base with a commercial cleaning solvent.
5. Using a multipurpose, high-temperature grease that resists water, steam, and alkali, lightly coat the surfaces of the new O-ring and the dryer base. Install the O-ring.
6. Thread the desiccant cartridge onto the dryer base (turn clockwise). When the seal contacts the base, tighten the cartridge one complete turn more. Do not over tighten.

If the air dryer base is damaged, preventing a tight seal, replace the air dryer.



1. Seal
2. O-Ring
3. Air Dryer Base

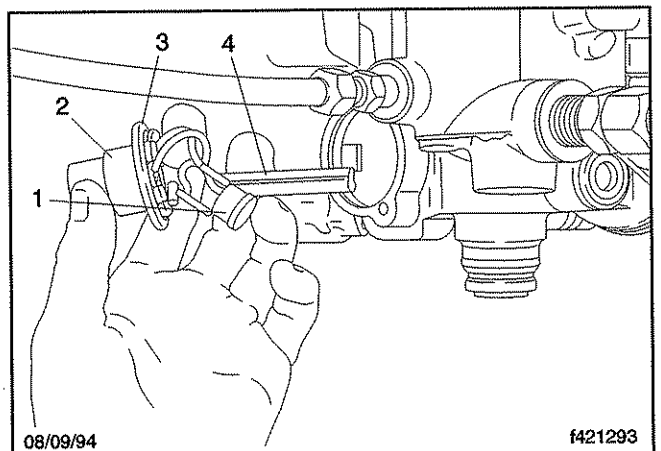
Fig. 1

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Drain the air system.
2. Disconnect the wiring harness.
3. Remove the screws that attach the heater/thermostat receptacle. Remove the receptacle and the O-ring.
4. Remove the retaining screw that holds the assembly in place. Remove and discard the heater/thermostat assembly.
5. Clean the heater/thermostat assembly area with a commercial cleaning solvent.
6. Position the new heater/thermostat assembly in the cavity. Install the retaining screw.
7. Position the new receptacle and O-ring, and install the screws. Tighten the screws securely.
8. Connect the wiring harness.



1. Thermostat
2. Receptacle
3. O-Ring
4. Element

Fig. 1

Regeneration Valve Replacement

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

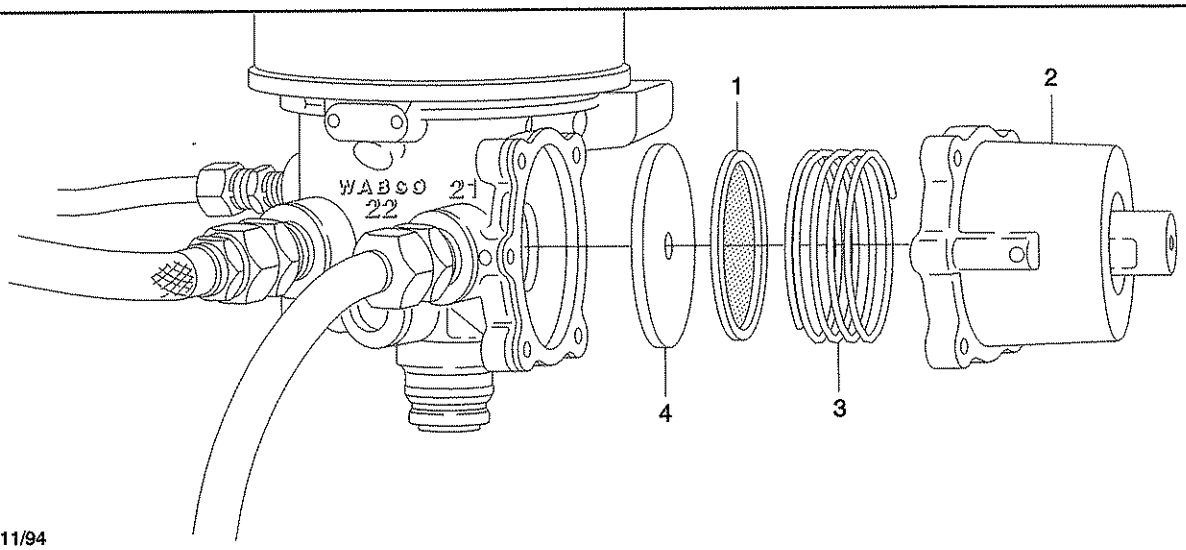
1. Drain the air system.

NOTE: When the valve housing is removed, the spring and the retainer will fall out of the housing.

2. Remove the four mounting bolts and remove the valve housing assembly.
3. Remove the rubber diaphragm.
4. Clean the groove where the diaphragm lip fits with a commercial cleaning solvent.
5. Install a new diaphragm with its lip in the groove.

If the groove is damaged, preventing a tight seal, replace the air dryer.

6. Install the new spring and retainer (with the retainer lip facing out).
7. Position the valve housing on the air dryer. Install the bolts and tighten them to 600 N·cm (53 lbf·in).



1. Retainer
2. Valve Housing Assembly
3. Spring
4. Diaphragm

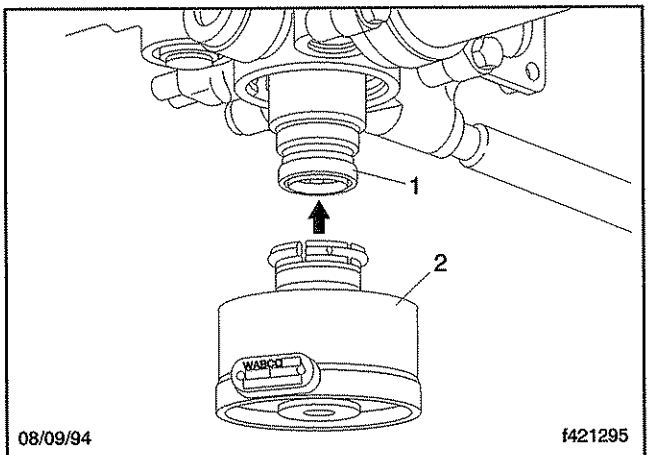
Fig. 1

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Using snap ring pliers, expand the snap ring and pull the silencer off of the purge valve head.
2. Push the new silencer onto the purge valve head until the silencer snaps into place.



1. Purge Valve Head
2. Silencer

Fig. 1

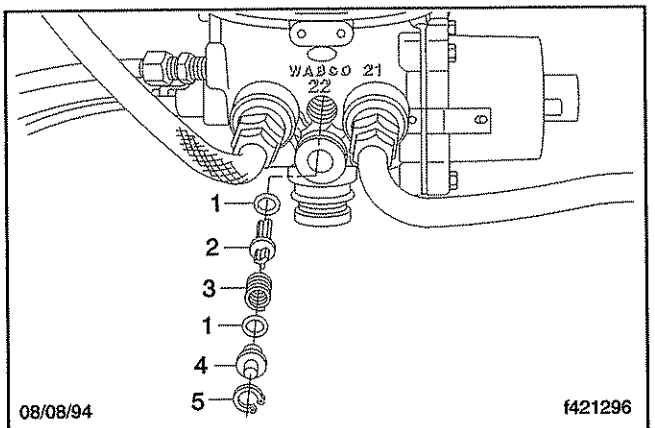
Bypass (Relief) Valve Replacement

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Drain the air system.
2. Remove the snap ring, cover, spring, and valve body.
3. Clean the cavity area with a commercial cleaning solvent.
4. Install new O-rings on the valve body and cover.
5. Using a multipurpose, high-temperature grease that resists water, steam, and alkali, lightly coat the surfaces of the new O-rings and the valve cavity.
6. Install the new valve body. Make sure that the long end of the body is inserted first into the valve cavity.
7. Install the new spring so it fits around the "Y" shaped fins on the valve body.



1. O-Ring
2. Valve Body
3. Spring
4. Cover
5. Snap Ring

Fig. 1

If the valve cavity is damaged, preventing a tight seal, replace the air dryer.

8. Install the new cover and snap ring to secure the assembly in the valve cavity.

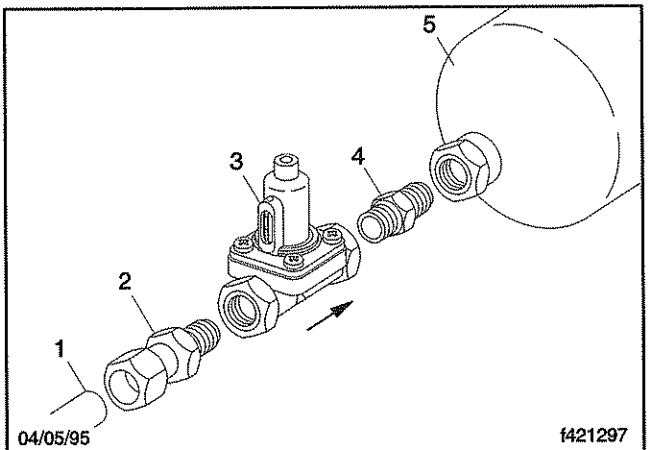
Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

1. Drain the air system.
2. Disconnect the air line from the pressure-controlled check valve.
3. Remove the valve and the hex nipple fitting from the air tank.
4. Install the pipe fitting on the new valve.
5. Install the new valve on the air tank with the arrow on the valve pointing towards the tank.
6. Apply liquid Loctite® Hydraulic Sealant (brown), or an equivalent, to the air line threads. Connect the air line to the valve. Tighten the air line securely.

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



1. Air Line
2. Nylon Tube Connector
3. Pressure-Controlled Check Valve
4. Hex Nipple Pipe Fitting
5. Air Tank

Fig. 1

Operating Tests

⚠ WARNING

WARNING: Before starting the procedures below, read the information in Safety Precautions 100. Failure to follow the safety precautions during service operations on the air brake system can cause personal injury.

Air Dryer Operating Check

1. Drain the air system.
2. Start the engine and build the air pressure to as close to cutout pressure as possible (about 827 kPa [120 psi]).
3. When the compressor reaches the unload cycle, the air dryer purges, beginning regeneration of the air dryer.
4. During the purge cycle, which lasts about 10 to 15 seconds, the wet tank and secondary tank will drop about 69 kPa (10 psi). Check the secondary air gauge in the cab dash panel.
5. If the gauge needle does not show a pressure drop of about 69 kPa (10 psi), one of the following problems may exist.
   - A pressure-controlled check valve is not installed.
   - The pressure-controlled check valve is installed in the wrong air tank.
   - The pressure-controlled check valve is installed on a one-way check valve, instead of in place of a one-way check valve.
   - There is an extra check valve located somewhere between the air dryer and the secondary air tank (usually at the wet tank).
   - The secondary air gauge is not plumbed to the secondary air system.
6. If secondary air pressure drops 103 kPa (15 psi) or more during the purge cycle, and there are no other air-operated components in use, then there are air leaks or other system problems. Refer to **Troubleshooting 300** for other possible causes.

Pressure-Control Check Valve Operating Check

IMPORTANT: Install a calibrated air gauge (accurate to within 7 kPa [1 psi]) in the secondary air tank to check the control valve. Do not use the cab air gauges.

1. Start the engine and build the air pressure to as close to cutout pressure as possible (about 827 kPa [120 psi]).
2. Stop the engine after the air compressor has unloaded.
3. Drain the primary air tank(s) down to about 552 kPa (80 psi).
4. Check the calibrated air gauge. It should read 655 ± 34 kPa (95 ± 5 psi).

   If the gauge reading is less that 586 kPa (85 psi), either the pressure-control check valve is installed backwards, it is damaged, or there are air leaks in the secondary air system.

   If the gauge reading does not change, or the reading does not fall below 724 kPa (105 psi), make the checks under "Air Dryer Operating Check." If none of those problems exist, replace the control valve.

Troubleshooting Tables

Problem—Purge Cycle is too Long (more than 30 seconds)

Possible Cause	Remedy
The air dryer outlet check valve is stuck open.	Replace the check valve assembly.
The turbocharger cutoff valve is leaking.	Replace the turbocharger cutoff valve.
The regeneration valve is not working correctly.	Replace the regeneration valve.

Problem—Purge Cycle is too Short (less than 8 seconds)

Possible Cause	Remedy
The air governor is not working.	Replace the air governor.
The pressure-control check valve is not working correctly.	Replace the pressure-control check valve.
The regeneration valve is not working correctly.	Replace the regeneration valve.

Problem—System Air Pressure Drops Rapidly

Possible Cause	Remedy
Fittings are loose or damaged.	Tighten or replace loose or damaged fittings.
Air reservoir, tubing, or hoses are damaged.	Repair or replace damaged items.
The air dryer outlet check valve is stuck open.	Clean or replace the outlet check valve assembly.

Problem—Excessive Cycling of the Air Dryer

Possible Cause	Remedy
Fittings are loose or damaged.	Tighten or replace loose or damaged fittings.
Air reservoir, tubing, or hoses are damaged.	Repair or replace damaged items.
The air dryer outlet check valve is leaking or stuck open.	Replace the outlet check valve assembly.
High air usage or demand for a particular system.	Increase air system capacity or reduce air demand.
The governor is not working properly.	Replace the air governor.
The air compressor needs to be serviced or replaced.	Rebuild or replace the air compressor.

Troubleshooting

Problem—Water and/or Oil in the Vehicle Air Reservoirs

Possible Cause	Remedy
The desiccant cartridge contains excessive contaminants.	Replace the desiccant cartridge.
Purge cycle is too short.	Refer to "Problem—Purge Cycle is too Short (less than 8 seconds)."
The bypass (relief) valve is leaking.	Replace the bypass valve.
Too much oil is pumped from the air compressor.	Rebuild or replace the air compressor.
The regeneration valve is not working correctly.	Replace the regeneration valve.
The air dryer is mounted too close to a heat source.	Locate the air dryer away from heat sources and where air can flow around it.
Discharge line is of improper length or material.	Discharge line must consist of at least 6 ft. (1.8 m) of wire braid Teflon hose, copper tubing, or a combination of both between the discharge port of the compressor and the air dryer supply port. Discharge line lengths and inside diameter requirements are dependent on the vehicle application. Contact your local Rockwell WABCO representative for further information.

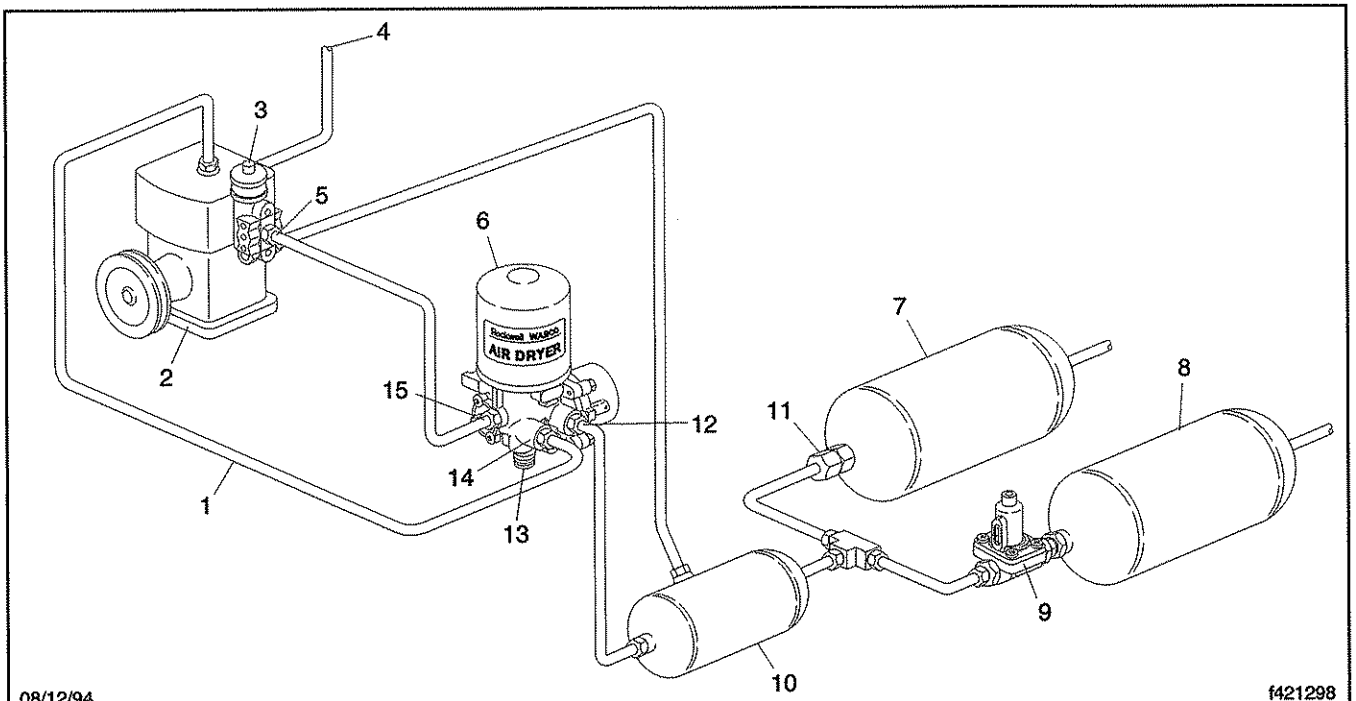
Problem—The Air Compressor Runs Continuously (System Pressure Will Not Build Up)

Possible Cause	Remedy
Fittings are loose or damaged.	Tighten or replace loose or damaged fittings.
Air reservoir, tubing, or hoses are damaged.	Repair or replace damaged items.
The air compressor needs to be serviced or replaced.	Rebuild or replace the air compressor.
The purge valve is stuck open.	Replace the purge valve.
The line between the air compressor and the air dryer is blocked, leaks, or is plumbed incorrectly.	Repair or replace the line as needed.
The governor is not working properly.	Replace the air governor.
The turbocharger cutoff valve or the outlet check valve is stuck in the closed position.	Replace the turbocharger cutoff valve or the outlet check valve.
The desiccant cartridge or cartridge seal is leaking.	Tighten or replace the desiccant cartridge.
The wrong air line is connected to port 4 on the air dryer.	Correct the air line plumbing.
The air dryer outlet port is plumbed incorrectly.	Connect the outlet port line to the supply air tank.
The air dryer base is cracked.	Replace the air dryer.

Problem—The Air Dryer Does Not Unload When the Air Compressor Goes Into Standby Mode

Possible Cause	Remedy
The line between the air governor and the air dryer purge port is missing, loose, or damaged.	Install or replace the air line, or tighten the fittings.
The heater/thermostat assembly is not working.	Replace the heater/thermostat assembly or check the electrical connections.

See Fig. 1 for the plumbing diagram.



1. Compressor Discharge Line
2. Air Compressor
3. Air Governor
4. Compressor Intake Line
5. Unloader Port
6. Air Dryer
7. Primary Reservoir
8. Secondary Reservoir
9. Pressure-Control Check Valve
10. Supply Tank
11. Check Valve
12. Air Dryer Outlet
13. Purge Valve
14. Air Dryer Inlet
15. Air Governor Port

Fig. 1, Air Dryer Plumbing Diagram

Parking Brake Hand Valve, Sloan PV–1

42.10

Contents

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General Description

The Sloan PV-1 parking brake air valve is installed on trucks with air brakes, and is used to control the rear axle parking brakes. It is a push-pull type of valve, and is mounted on the right side of the dash. **See Fig. 1.**

Principles of Operation

When the valve knob is pulled out, air is exhausted from the rear parking brake chambers, releasing the springs, and applying the parking brakes. When the knob is pushed in, air flows into the parking brake chambers from one of the reservoirs, and compresses the springs, releasing the parking brakes.

The PV-1 has a double check valve feature. If the pressure drops in either air system (primary or secondary), the valve will automatically use air pressure from the system with the higher pressure for the parking brakes. This prevents the parking brakes from applying unless pressure is lost from both systems.

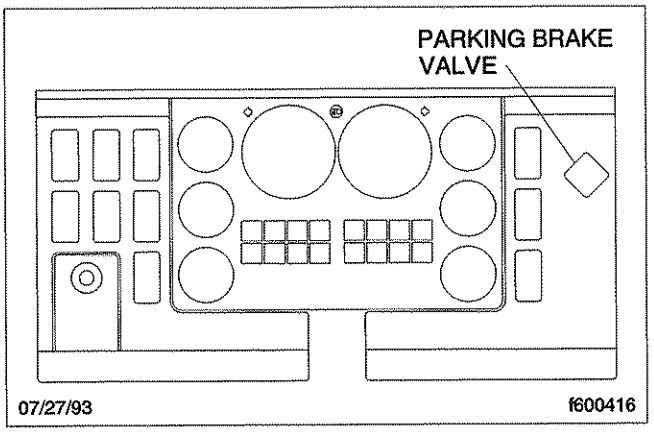


Fig. 1

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

1. Chock the tires and stop the engine before working under a vehicle. Keep hands away from brake chamber push rods and slack adjusters; they may apply as air system pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

Operating Test

1. Chock the tires.
2. Start the engine and build up the air pressure to the normal operating level.
3. Push the parking brake knob in to release the parking brakes.
4. Turn off the engine, then drain one of the air reservoirs.
5. Check if the parking brakes apply.

   If they do, the double check valve feature isn't working; replace the entire PV-1 valve assembly.

   If the parking brakes don't apply, go to the next step.
6. Start the engine again, and build up the air pressure to the normal operating level.
7. With the parking brakes still released, turn off the engine; then drain the other air reservoir.
8. Check if the parking brakes apply.

   If they do, the double check valve feature isn't working; replace the entire PV-1 valve assembly.

   If the parking brakes don't apply, the double check valve feature is working.

Leak Testing

1. Chock the tires.
2. Start the engine, and build up the air pressure to the normal operating level.
3. Coat the delivery line and exhaust line fittings on the parking valve with a soapy solution.
4. Release the parking brakes.
5. Check the leakage. Leakage at the fittings should not exceed a 2.5-cm (1-inch) bubble every three seconds. If it does, replace or rebuild the valve, following instructions under **Subject 120** or **Subject 130.**
6. Apply the parking brakes.

Removal (Refer to Fig. 1)

⚠ WARNING

WARNING: Review the precautions under "Safety Precautions, 100" before doing any work on the parking brake valve. Failure to do so could result in personal injury.

1. Chock the tires.
2. Discharge the air system reservoirs.
3. Drive out the roll pin (Ref. 5), then remove the knob from the valve stem.
4. Mark the air supply, delivery, and exhaust lines for later reference, then disconnect them from the valve assembly.
5. Remove the panel mounting nut (Ref. 3), then remove the valve assembly from the dash panel.

Installation

1. Put the valve assembly into the dash, then install the panel mounting nut. Don't tighten the nut completely.
2. Turn the valve assembly so the air lines will reach their fittings.
3. Connect the air supply, delivery, and exhaust lines to the applicable fittings.
   - 3.1 Tighten the fitting hand tight.
   - 3.2 Using a wrench, tighten the fitting until the connection feels firm.
   - 3.3 Tighten the fitting an additional one-sixth turn.
4. Tighten the panel mounting nut firmly.
5. Put the knob onto the valve stem, making sure the label on the valve is parallel with the top of the dash, **as shown in Fig. 1.** Then drive in the roll pin.
6. Leak test the fittings, following the instructions under **"Leak Testing, 110."**

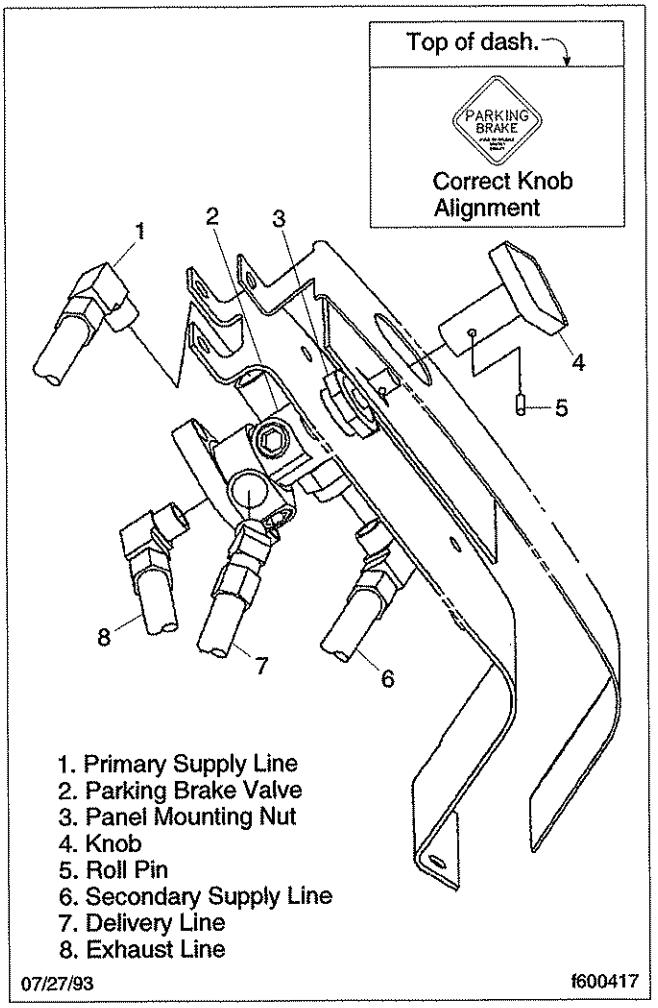


Fig. 1

Disassembly (See Fig. 1)

1. Remove the valve assembly from the dash, following instructions in **Subject 120**.
2. Put the valve assembly in a soft-jawed or padded vise.
3. Remove the screws (Ref. 9) from the cover (Ref. 11).
4. Carefully remove the cover, cover seal (Ref. 12), and spring (Ref. 10). Discard the cover seal.
5. Insert a rod through the pin hole (Ref. 1) of the shaft to keep it from turning, then remove the hexnut (Ref. 8) from the bottom of the shaft.
6. Remove and discard the seal cup (Ref. 14), seal (Ref. 7), and the washer (Ref. 5) from the shaft.
7. Remove the shaft (Ref. 4) from the valve body.
8. Remove and discard the O-ring (Ref. 2) from the shaft.

Assembly (See Fig. 1)

1. Clean and dry all the parts.
2. Check all the parts. If any wear or damage is found, replace the entire valve assembly.
3. Lightly grease all the parts— including the new parts from the seal kit— with Dow Corning 55 silicone pneumatic grease or equivalent.
4. Install a new O-ring (Ref. 2) on the shaft (Ref. 4).
5. Install the shaft in the valve body.
6. Install a new washer (Ref. 5) on the step of the shaft.
7. Assemble a new seal (Ref. 7) into the new seal cup (Ref. 14), then install them on the step of the shaft, with the seal against the washer (Ref. 5).
8. Apply Loctite 222® or equivalent on the threads of the new hexnut (Ref. 8).
9. Install the hexnut— counter-bored side toward the seal (Ref. 7)—on the end of the shaft. Tighten the nut 460 N·cm (40 lbf·in).
10. Install a new cover seal (Ref. 12) in the cover with the raised lip (Ref. 13) on the cover seal toward the valve.
11. Grease the sealing surfaces of the seal cup (Ref. 14), and the cover seal (Ref. 12).
12. Install the spring (Ref. 10) and then the cover (Ref. 11).
13. Install the cover screws. Tighten them firmly.
14. Install the valve in the dash, then leak test it. Follow instructions in **Subject 120** and **Subject 110**.

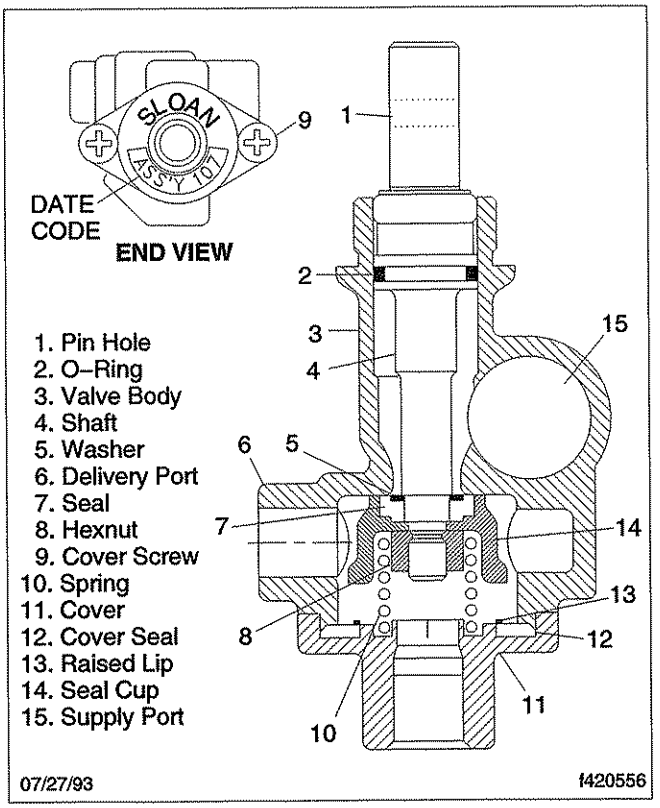


Fig. 1, Valve Assembly

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General Description and Principles of Operation

General Description

The dash-mounted MV-3 control module is a two-button, push-pull control valve housed in a single body, which includes a dual circuit supply valve and a check valve.

The valve body, plungers, and spools are made out of a nonmetallic, noncorrosive material. All air connections are at the back of the valve with the exception of the optional auxiliary port, which is located in the side of the valve. **See Fig. 1.**

The MV-3 module has several uses: 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-3 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 207 kPa (30 psi) 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.

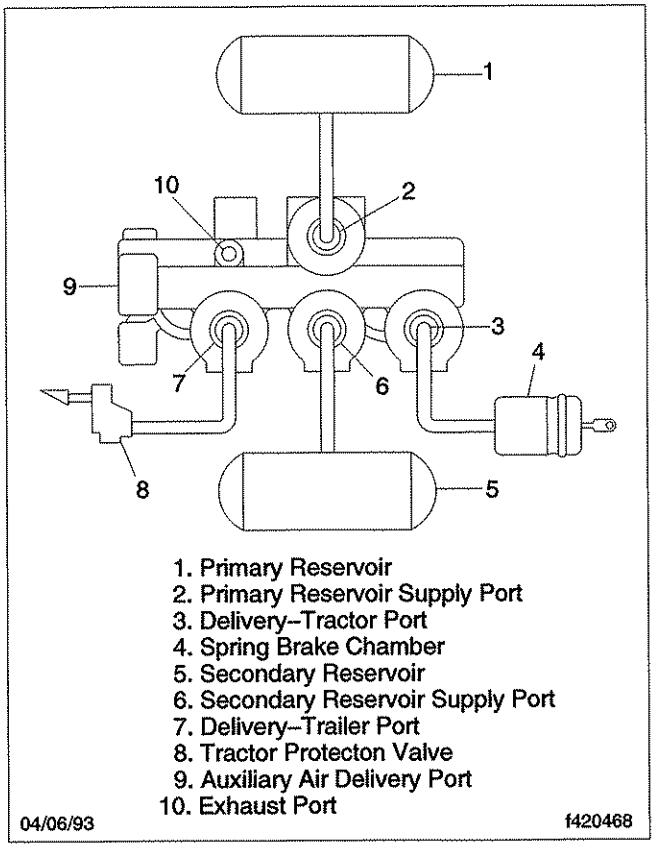


Fig. 1

NOTE: The primary air reservoir supplies the rear tractor axle; the secondary air reservoir supplies the front axle.

The trailer air supply valve **(refer to Fig. 2),** actuated by a red knob, delivers air to the trailer supply line. The parking brake valve, actuated by a yellow knob **(Fig. 2),** controls the spring 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 448 kPa (65 psi), 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 OPERATION 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.

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.**

General Description and Principles of Operation

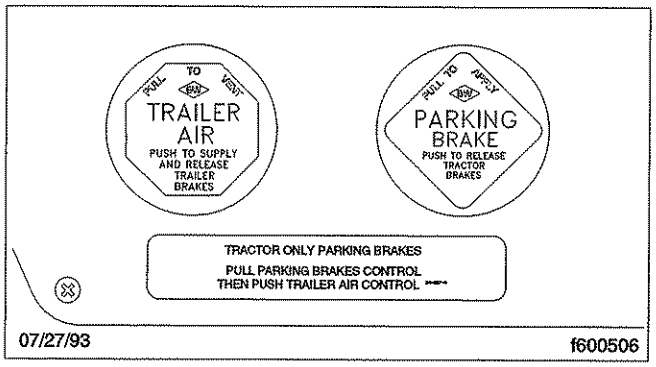


Fig. 2

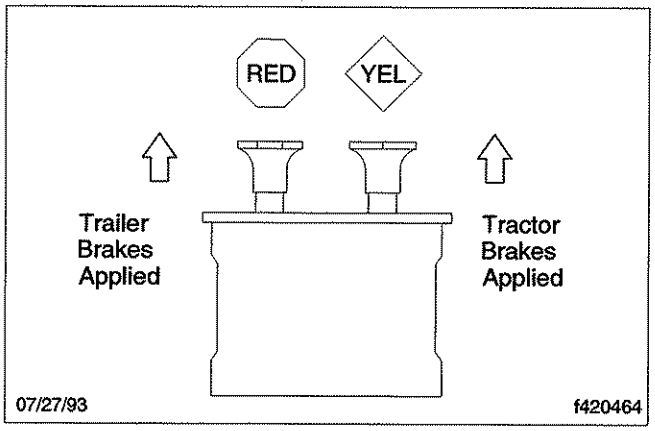


Fig. 3

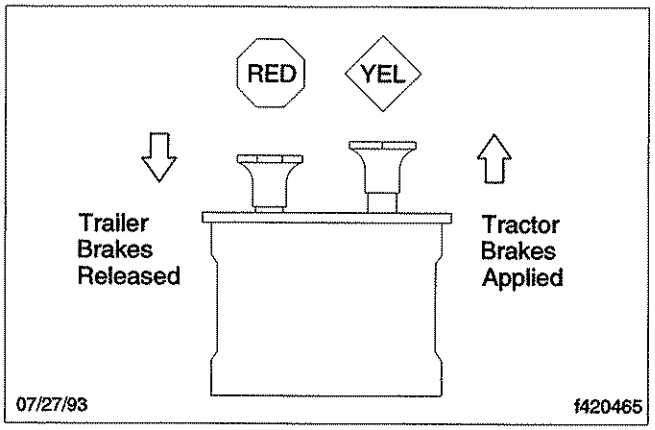


Fig. 4

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 the tractor spring brakes only. **See Fig. 4.**

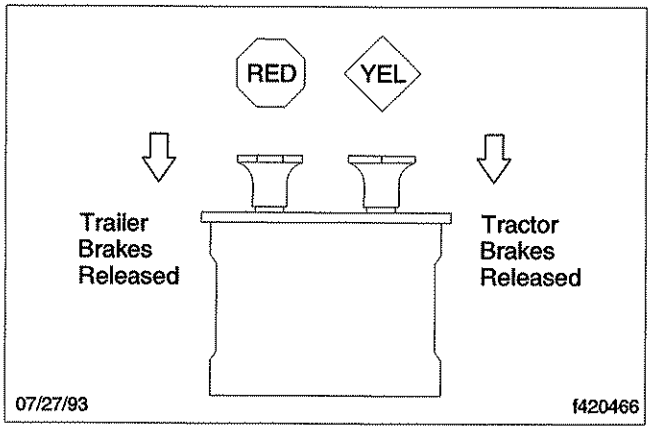


Fig. 5

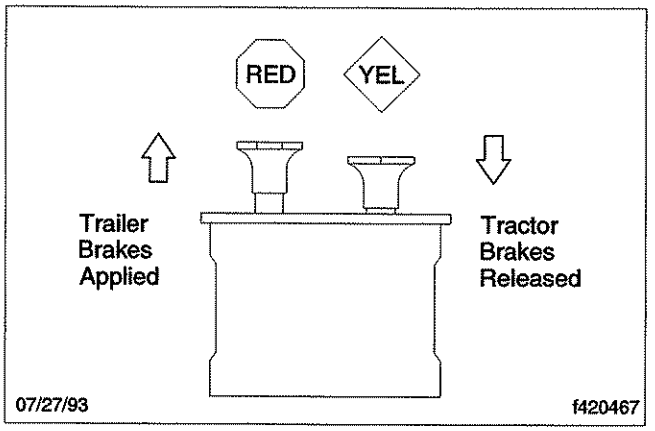


Fig. 6

AUTOMATIC APPLICATION

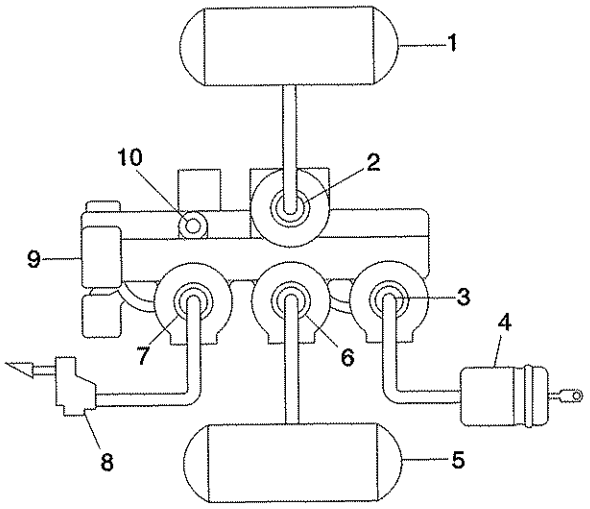
If air pressure drops to 241 to 310 kPa (35 to 45 psi) in both the primary and the secondary systems, the red knob (trailer air supply valve) will automatically pop out, applying the emergency or parking brakes on the trailer. If the red knob is held in manually and the pressure decreases to 172 to 241 kPa (25 to 35 psi), a tripper piston within the MV-3 valve will move upward, exhausting the trailer supply, and applying the trailer parking brakes. If air pressure drops in both the primary and the secondary systems, the yellow (parking brake) knob will pop out at about 138 to 207 kPa (20 to 30 psi), applying the tractor parking brakes.

A warning buzzer and light are activated when pressure in either the primary or the secondary system drops below 441 to 524 kPa (64 to 76 psi).

Tests

With the air brake system charged to 827 kPa (120 psi), check for leaks, using the following instructions. Repair or replace components as needed.

1. Check for leakage between the body and cover plate. No leakage is permitted.
2. Push in the red knob. The knob must stay in. Leakage at the exhaust port (**Fig. 1**, Ref. 10) must not exceed a 25-mm (1-inch) bubble in 5 seconds.
3. Slowly reduce pressure in both service reservoirs. The red knob must pop out at 241 to 310 kPa (35 to 45 psi) and maintain the supply pressure. Leakage at the exhaust port must not exceed a 25-mm (1-inch) bubble in 5 seconds.
4. Hold the red knob in and continue to reduce pressure in all service reservoirs. Air must start to escape from the exhaust port when the trailer line pressure reaches 138 to 241 kPa (20 to 35 psi).
5. Release the red knob and rebuild the supply pressure to 827 kPa (120 psi). Push in the yellow knob; the yellow knob must remain in. Leakage at the exhaust port should not exceed a 25-mm (1-inch) bubble in 5 seconds.
6. Pull the red knob out. Slowly reduce pressure in all service reservoirs. The yellow knob must pop out at 138 to 207 kPa (20 to 30 psi) and maintain supply pressure. Leakage at the exhaust port should not exceed a 25-mm (1-inch) bubble in 5 seconds.
7. Charge the system to 827 kPa (120 psi), and push both knobs in. Pull the red knob out. The yellow knob must remain in. Push the red knob in and pull the yellow knob out. The red knob must pop at once.
8. Install a gauge to monitor tractor spring brake delivery pressure. Build 827 kPa (120 psi) pressure in 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 621 to 724 kPa (90 to 105 psi), at which point the dual-circuit supply valve shuttle should switch to the secondary air reservoir; 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. Stop the leak that was created in the primary air reservoir.
9. Leaving the yellow knob in, recharge the secondary air reservoir to 827 kPa (120 psi). The delivery pressure should also read 827 kPa (120 psi). Recharge the primary air reservoir to 689 kPa (100 psi). Slowly vent the secondary air reservoir. As the secondary air reservoir pressure and the delivery line pressure descend, pressure should stabilize at about 689 kPa (100 psi).
10. Close all leakage points and charge both reservoirs to 827 kPa (120 psi). Position the red knob out and the yellow knob in. Develop a leak in the spring brake delivery line (**Fig. 1**, Ref. 3) and hold the yellow knob in. The primary air reservoir pressure will go to zero; and the secondary air reservoir pressure will drop to 138 to 207 kPa (20 to 30 psi).



1. Primary Reservoir
2. Primary Reservoir Supply Port
3. Delivery–Tractor Port
4. Spring Brake Chamber
5. Secondary Reservoir
6. Secondary Reservoir Supply Port
7. Delivery–Trailer Port
8. Tractor Protecton Valve
9. Auxiliary Air Delivery Port
10. Exhaust Port

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Fig. 1

Operating Tests

The dual-circuit supply valve shuttle should cycle several times during the leak-down period.

Removal

1. Park the vehicle on a level surface, apply the parking brakes, chock the tires, and drain all air tanks to zero pressure.

⚠ WARNING

WARNING: Wear safety goggles when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct the airstreams at anyone. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

2. Unscrew the red and yellow buttons from the stems of the spools on the MV-3 valve by turning in a counterclockwise direction. Mark these buttons in relation to the valve for later reference.
3. Remove the dash panel and foam gasket, and then remove the dash bracket. Save all six screws.
4. Remove and save the mounting hardware from the four corners of the cover plate.
5. Pull the valve forward, mark and then remove the air lines from the back of the valve.

Installation

1. Connect the air lines to the proper ports as marked during removal.
2. Align the valve in the dash and install the four screws into the corners of the cover plate.
3. Replace the dash bracket, gasket and dash panel with the hardware previously removed.
4. Attach the red and yellow buttons onto the threaded stems of the spools, making sure that they are oriented correctly as noted during removal.

Disassembly, Cleaning and Inspection, and Assembly

Disassembly

1. Remove the six screws (**Fig. 1**, Ref. 3) from the cover plate (Ref. 4) and carefully remove the cover plate from the valve.
2. Remove the cap (Ref. 5) and O-ring (Ref. 6) from the bore of the tripper valve. Remove the piston (Ref. 7), spring (Ref. 8), spring (Ref. 9), and check valve (Ref. 10). These parts will all fall out of the cavity of the MV-3 by tilting the body forward. Remove the O-ring (Ref. 11) from its groove on the piston.
3. Remove the two main spools from the body of the MV-3 valve by grasping the stem and pulling firmly. Remove the two springs (Ref. 21) from the bottom of each spool cavity.
4. Pull the guide cap (Ref. 12) and guide spool (Ref. 14) over the threaded end of one of the plungers (Ref. 18). Remove the O-ring (Ref. 13) from the guide cap and the O-ring (Ref. 15) from the guide spool. Remove O-rings (Refs. 16, 17, and 20) and the exhaust seal (Ref. 19) from the plunger.
5. Repeat step(s) as required on the remaining spool assembly.
6. Remove the retaining ring (Ref. 22) from the cavity of the MV-3 body that contains the dual circuit supply valve.
7. Using a pair of needle nose pliers, grasp the bar in the center of the cap (Ref. 23) and remove the dual circuit valve assembly. Remove the three O-rings (Refs. 24, 25, and 26) from the valve or from the cavity of the body, if some have remained there. Other than the three external O-rings, don't disassemble the piston assembly further.

NOTE: If during the removal of this assembly from the body the cap dislodges from the rest of the valve, the remaining parts can be removed using bent wire. The spring, piston and O-ring that are internal to the dual circuit valve assembly are non-serviceable.

Cleaning and Inspection

The nonmetallic components making up most of the parts of the MV-3 *should not be immersed in any solvent type cleaner.* Old lubricant should be wiped out with a clean dry cloth.

If any visible damage to the body or the spools is found, replace the complete unit.

Assembly

DUAL CIRCUIT SUPPLY VALVE

1. Lubricate all O-rings, bores, and sliding surfaces with silicone lubricant Bendix 291126, Dow Corning 55-M, or equivalent.
2. Install O-rings (Refs. 24, 25, and 26) onto the dual circuit supply valve (Ref. 23). Then install the assembly— small diameter first— into its cavity in the body.
3. Install the retaining ring (Ref. 22) making sure it is fully seated in its groove.

SPOOLS

1. Install the O-rings (Refs. 16, 17, and 20) and the exhaust seal (Ref. 19) onto the stem of plungers (Ref. 18).

⚠ CAUTION

The exhaust seal (Ref. 19) must be installed so that its beveled surface mates with the beveled surface of the plunger (Fig. 2).

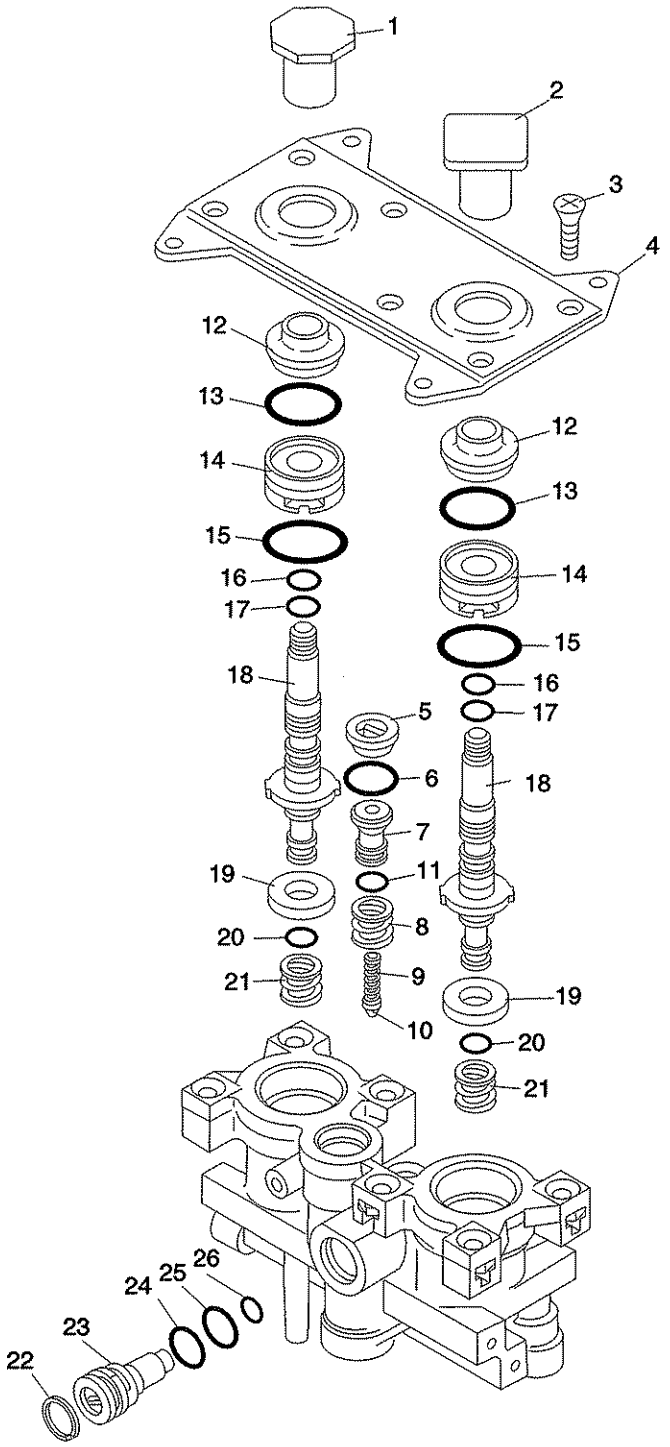
2. Install the O-ring (Ref. 15) onto the guide spool (Ref. 14) and the O-ring (Ref. 13) onto the guide cap (Ref. 12). Place the guide cap on top of the guide spool and install the entire assembly over the threaded end of the plunger (Ref. 18), and press down firmly until it snaps into place.
3. Install the spring (Ref. 21) over the boss in the bottom of the spool cavity in the body of the MV-3 valve. Place the spool assembly into the body, keeping the spool square to the body. Press and turn the stem until the spool is fully seated in its cavity. Note the assembly is keyed and can be installed one way only.
4. Repeat step(s) as required for the opposite spool.

SHUTTLE AND CHECK VALVE

1. Install the O-ring (Ref. 11) into its groove on the piston (Ref. 7); then install the O-ring (Ref. 6) onto the cap (Ref. 5).

Disassembly, Cleaning and Inspection, and Assembly

1. Red Button
2. Yellow Button
3. Screw
4. Cover Plate
5. Cap
6. O–Ring
7. Tripper Piston
8. Spring, Large Diameter
9. Spring, Small Diameter
10. Check Valve
11. O–Ring
12. Guide Cap
13. O–Ring
14. Guide Spool
15. O–Ring
16. O–Ring
17. O–Ring
18. Plunger
19. Exhaust Seal, Beveled
20. O–Ring
21. Spring
22. Retaining Ring
23. Cap and Dual Circuit Valve Assembly
24. O–Ring
25. O–Ring
26. O–Ring



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Fig. 1

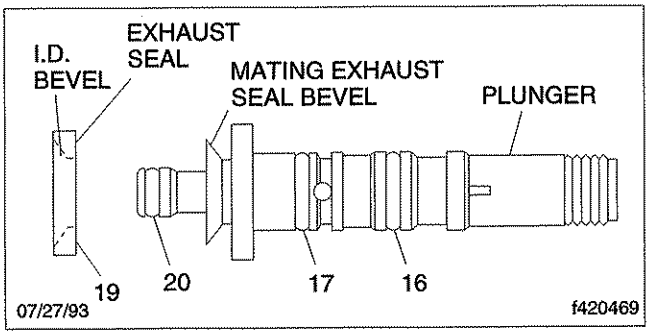


Fig. 2

2. Install the spring (Ref. 8) on the piston (Ref. 7) and the spring (Ref. 9) on the boss of the check valve (Ref. 10).
3. Install the spring and check valve into their cavity in the body of the MV-3 valve (tapered end of the valve to enter cavity first). Make sure the spring (Ref. 9) is centered in the bore.
4. Install the piston assembly into the cavity, making sure the spring (Ref. 9) mates with the bore of the piston.
5. Install the cap (Ref. 5) with O-ring (Ref. 6).
6. Attach the cover plate (Ref. 4) to the valve body using the six screws. Torque them 280 N·cm (25 lbf·in).
7. Check the operation of the valve using the instructions under **Subject 100**.

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General Information

The function of the QR-1 quick release valve **(Fig. 1)** is to speed up the release of compressed air from the brake chambers. If the front brake chambers, for example, are equipped with a QR-1 valve, and the brakes are released, the exhaust port of the quick release valve opens and the air from the front brake chambers is exhausted through the quick release valve. This speeds up the release of the front brakes.

When the front brake chambers are equipped with a QR-1 valve, it is located on the rear cab mount crossmember.

When the parking brake chambers are equipped with a QR-1 valve, it is located on the rear suspension crossmember.

A delivery line from the foot valve is connected to the port on top of the QR-1 quick release valve; the two side ports are for brake chamber connections, and the exhaust port is located at the bottom of the valve.

Principles of Operation (Refer to Fig. 1)

When the service brakes are applied, delivery air enters the brake valve port on the QR-1 quick release valve; the diaphragm moves down, sealing the exhaust port. At the same time, air pressure forces the edges of the diaphragm down, allowing air to flow out the brake chamber ports, filling the chambers and applying the front axle brakes.

When the brake chamber air pressure (beneath the diaphragm) equals the air pressure being delivered by the foot valve (above the diaphragm), the outer edge of the diaphragm will seal against the valve body seat. The exhaust port is still sealed by the center portion of the diaphragm. When the foot brake is released, the air above the diaphragm is released back through the foot brake valve exhaust, while the air beneath the diaphragm forces the diaphragm to rise, opening the exhaust port, and allowing air in the brake chambers to exhaust.

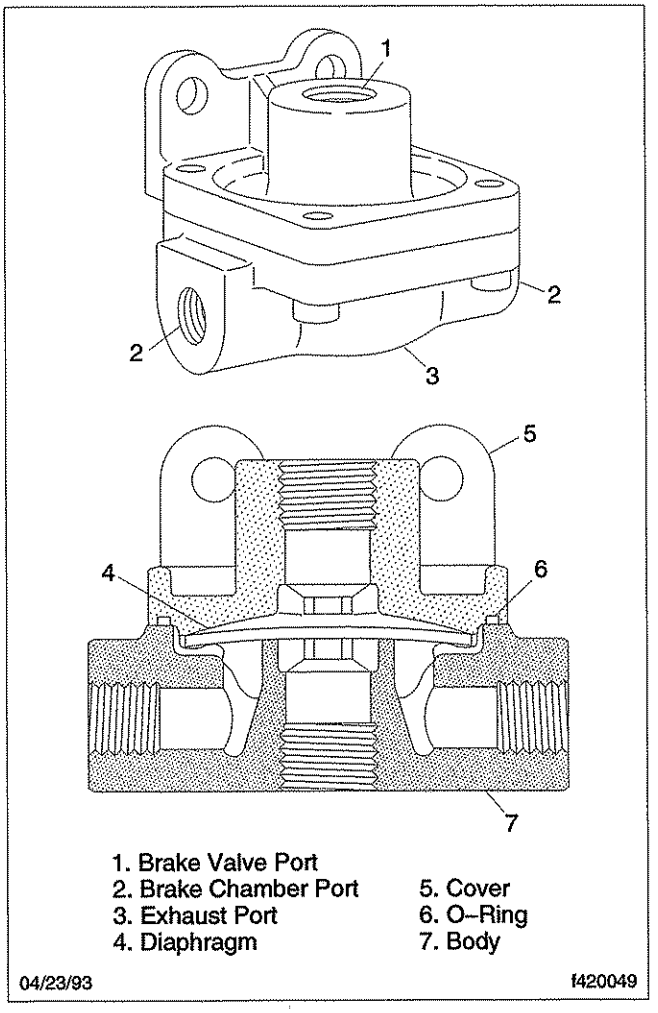


Fig. 1, QR-1 Valve and Cross Section

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

1. Chock the tires and stop the engine before working under a vehicle. Keep hands away from brake chamber push rods and slack adjusters; they may apply as air system pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

Tests

The following tests should also be done after repairing or replacing the QR-1 valve to ensure that it is functioning correctly.

1. With the brakes applied (pedal pushed in) do the following checks:

   1.1 Coat the exhaust port with a soap solution; leakage of a 2.5-cm (1-inch) bubble in three seconds is allowable.

   1.2 Coat the valve body and cover with a soap solution. No leakage is permitted between the valve body and cover.

2. If the valve does not function correctly, or if there is too much leakage, repair or replace it following the instructions in this section.

Removal

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Chock the tires or hold the vehicle by means other than air brakes.
2. Drain the air brake system by opening the reservoir drain cocks.
3. Mark and disconnect the air lines from the quick release valve.
4. Remove the mounting bolts and the valve.

Installation

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Install the quick release valve with the exhaust port facing down. Securely tighten the mounting bolts.
2. Connect the air lines to the quick release valve as previously marked.
3. Do the tests under **"Operating and Leakage Tests, 110."**

Disassembly, Cleaning and Inspection, and Assembly

Disassembly

1. Remove the quick release valve from the vehicle following the instructions under **"Removal and Installation, 120."**
2. Remove the four screws holding the valve cover on the valve body.
3. If equipped, remove the spring and spring seat.
4. Remove the diaphragm.
5. Remove the cover O-ring.

Cleaning and Inspection

⚠ WARNING

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 all metal parts in mineral spirits. Wipe all rubber parts clean.
2. It is recommended that all rubber parts and any other part showing signs of wear or deterioration be replaced with genuine Bendix parts.

Assembly

1. If the quick release valve is not equipped with a spring, install the diaphragm into the valve body.

   If the quick release valve is equipped with a spring, position the spring in the valve body. Then, position the diaphragm over the spring seat.
2. Install the O-ring in the valve cover groove and install the valve cover. Tighten the screws 340 to 680 N·cm (30 to 60 lbf·in) evenly and securely.
3. Install the quick release valve, following the instructions under **"Removal and Installation, 120."**

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General Description

The GTD 4000-2 quick release valve provides fast release of the trailer brake. It is installed on the tractor protection valve on vehicles equipped with a tractor/ trailer air system, and connects to the trailer air brake line.

The valve is screwed into the service delivery port of the tractor protection valve. On some vehicles a second quick-release valve is screwed into the parking brake delivery port of the tractor protection valve. **See Fig. 1.**

Principles of Operation (Refer to Fig. 2)

When the brakes are applied, air passes through the quick-release valve to the trailer service brakes (and to the trailer parking brake, if applicable). When the brakes are released slowly, air passes from the trailer brakes through the quick release valve, and exhausts at the foot valve.

When the brakes are released quickly, the sudden pressure drop moves the diaphragm inside the quick release valve, which prevents the air from exhausting through the foot valve. Instead, it exhausts through the quick-release valve, which releases the trailer brakes more quickly.

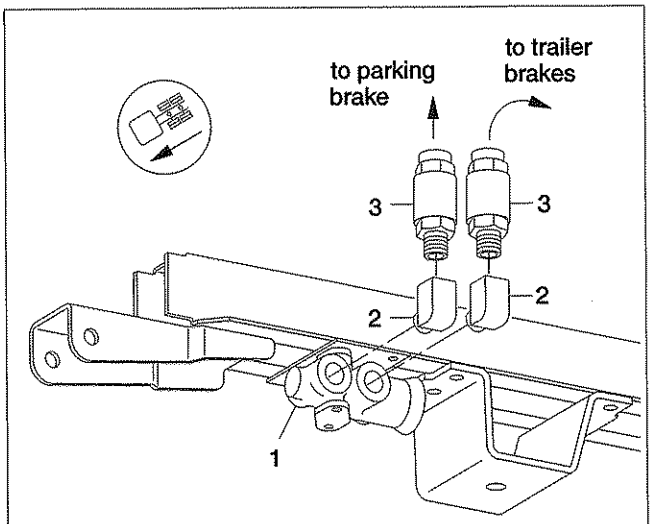


Fig. 1

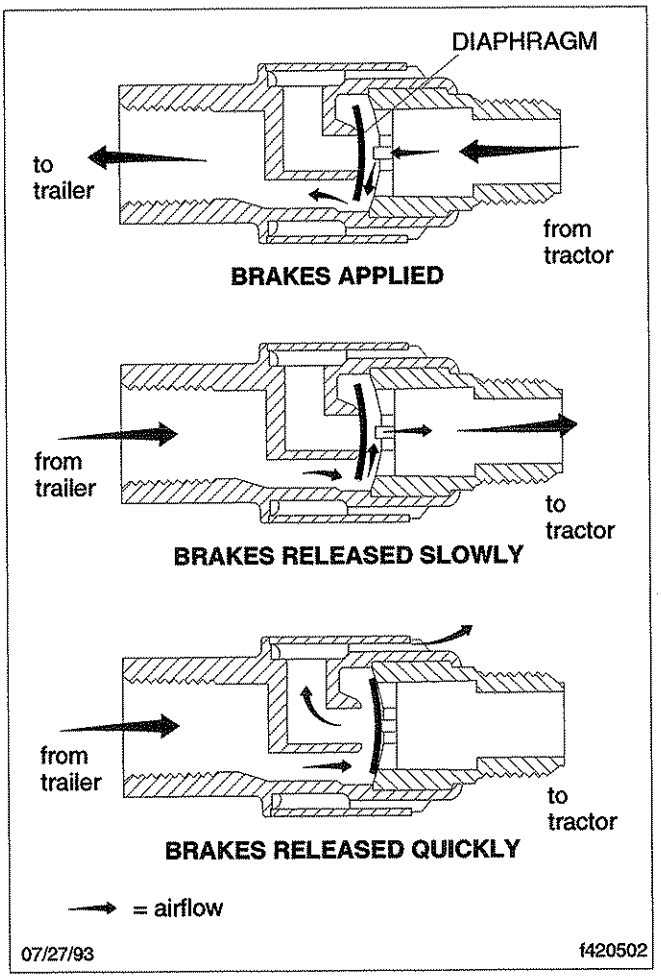


Fig. 2

Operation Test

1. With the system pressurized and the trailer brakes connected, apply the brakes, then slowly release them. There should be no audible leakage or exhaust from the quick-release valve.
2. Apply the brakes a second time, then release them quickly. Air should exhaust through the quick-release valve.

   If the valve fails the above test, replace it.

Leakage Test

1. Pressurize the air system.
2. Coat the quick-release valve with a soapy solution. Leakage resulting in a 2.5-cm (1-inch) bubble or less every ten seconds is acceptable. If the leakage is more than above, replace the valve.

Removal

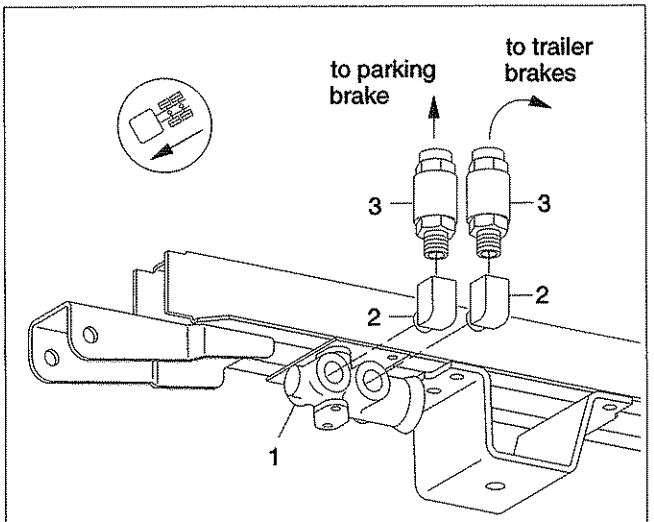
⚠ WARNING

WARNING: Wear safety goggles when draining the air system or disconnecting an air line because dirt or sludge particles could fly out at high speeds. Don't direct the air stream at other people. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

1. Drain the air from the air reservoirs.
2. Carefully disconnect the air line from the quick-release valve.
3. Unscrew the quick-release valve from the 90-degree elbow on the tractor protection valve. **See Fig. 1.**

Installation

1. Screw the quick-release valve into the 90-degree elbow on the applicable delivery port of the tractor protection valve.



1. Tractor Protection Valve
2. 90–Degree Elbow
3. Quick–Release Valve

NOTE: Not all parts are shown.

07/27/93 f420475

Fig. 1

Make sure the arrow stamped on the valve is pointing toward the trailer air line.

2. Connect the air line to the quick-release valve. Tighten the connection firmly.

Contents

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General Description and Principles of Operation

General Description

The Bendix driveline parking brake is designed to hold the vehicle on a grade, and to stop a slow moving vehicle if the service brakes aren't working. The parking brake is manually operated, and has a mechanical linkage; it doesn't rely on hydraulic or air pressure. It is installed only on vehicles with hydraulic brakes.

The parking brake is mounted on the rear of the transmission, between it and the driveshaft. **See Fig. 1.** The main parts of the brake are the drum, brake shoes, return springs, support plate, cam, actuating lever, brake cable, and brake lever assembly. **See Fig. 2** and **Fig. 3.**

The brake drum and the driveline companion flange are bolted to the transmission companion flange, which is attached to the transmission shaft. The support plate is bolted to the rear of the transmission. The brake shoes are held in place by the return springs, the shoe-to-shoe spring, and by the support plate. The brake cable runs from the actuating lever to inside the cab, where it is controlled by the parking brake lever assembly. **See Fig. 4.** A ring at the end of the parking brake lever is used to adjust the cable length to compensate for brake shoe wear.

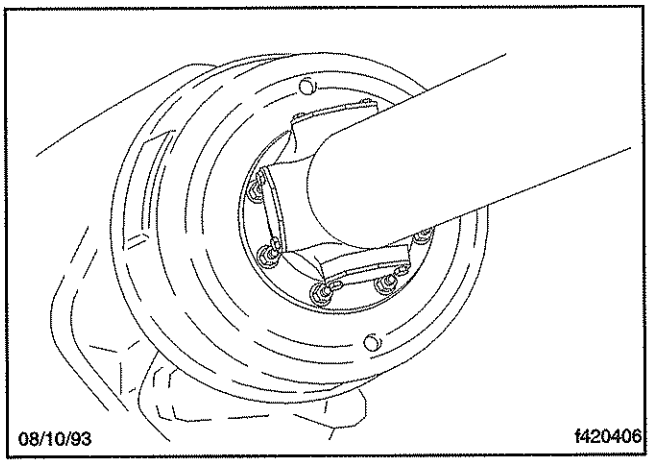
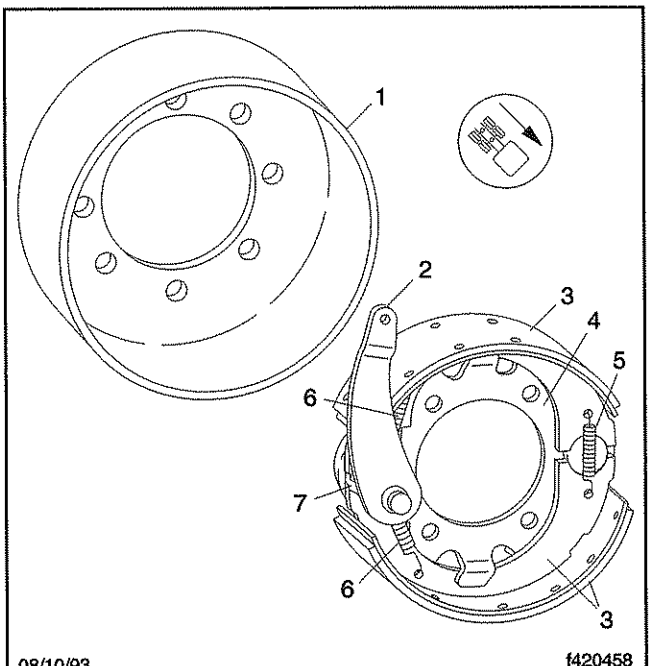


Fig. 1

Principles of Operation (Fig. 5)

When the brake lever is pulled up, the brake cable pulls the actuating lever, turning the cam. The cam pushes the brake shoes outward against the brake drum. Because the support plate and the shoes are mounted in a fixed position on the transmission, and the brake drum is attached to the end of the driveshaft, the driveshaft is prevented from turning. This keeps the vehicle from rolling.

When the parking brake lever is released, the tension on the cable is removed. The actuating lever and cam return to their original position, and the brake return springs and shoe-to-shoe spring pull the brake shoes away from the brake drum. The driveshaft is then free to move, and the vehicle can be moved.

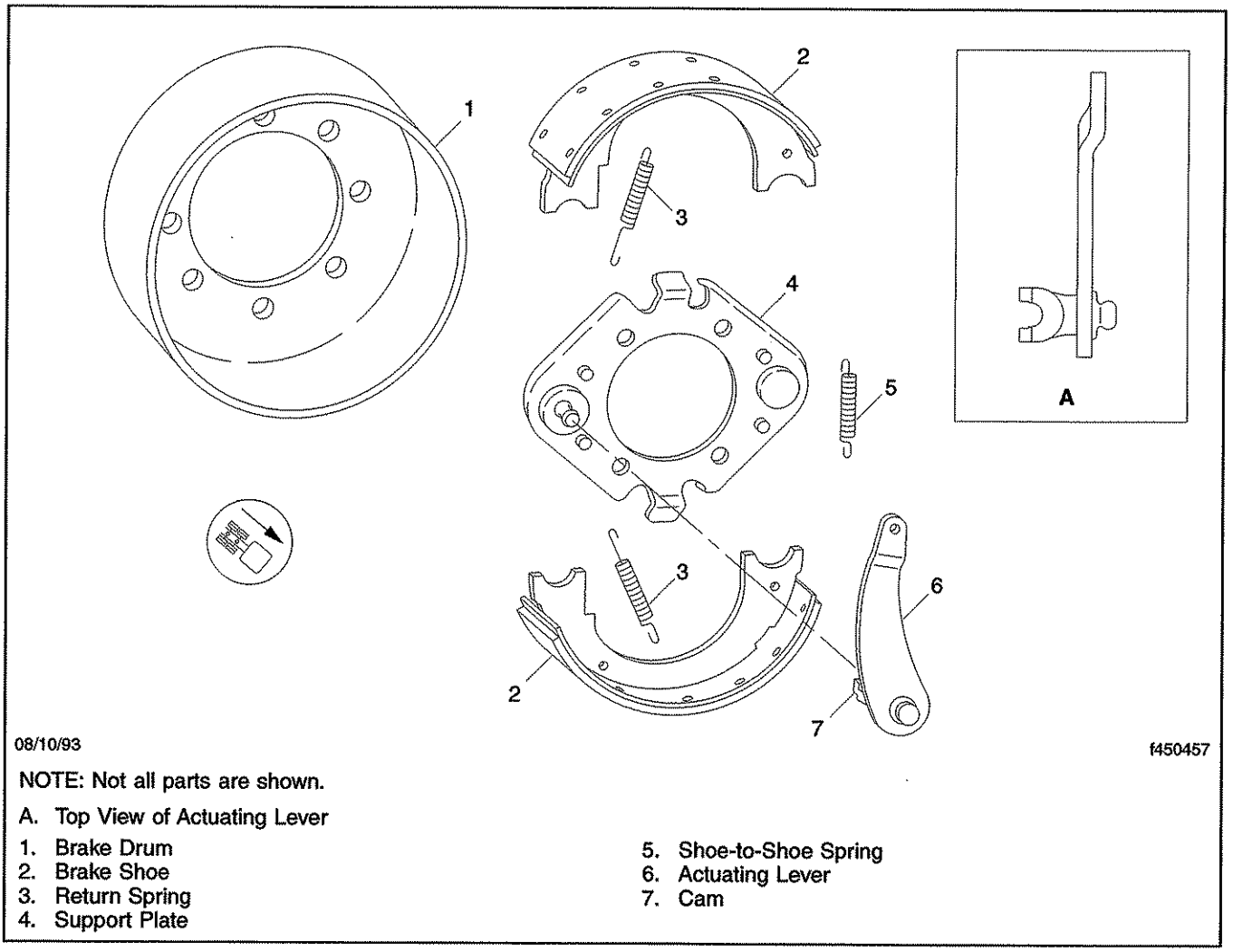


NOTE: Not all parts are shown.

1. Brake Drum
2. Actuating Lever
3. Brake Shoe
4. Support Plate
5. Shoe-to-Shoe Spring
6. Return Spring (2 qty.)
7. Cam

Fig. 2, Assembled Parts

General Description and Principles of Operation



NOTE: Not all parts are shown.

A. Top View of Actuating Lever

1. Brake Drum
2. Brake Shoe
3. Return Spring
4. Support Plate
5. Shoe-to-Shoe Spring
6. Actuating Lever
7. Cam

Fig. 3, Exploded View

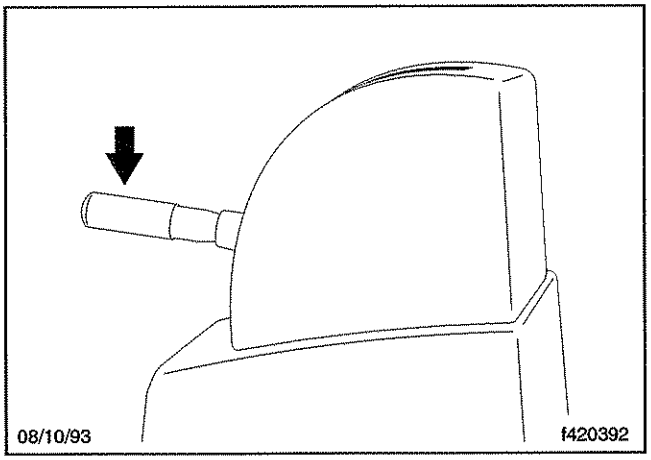
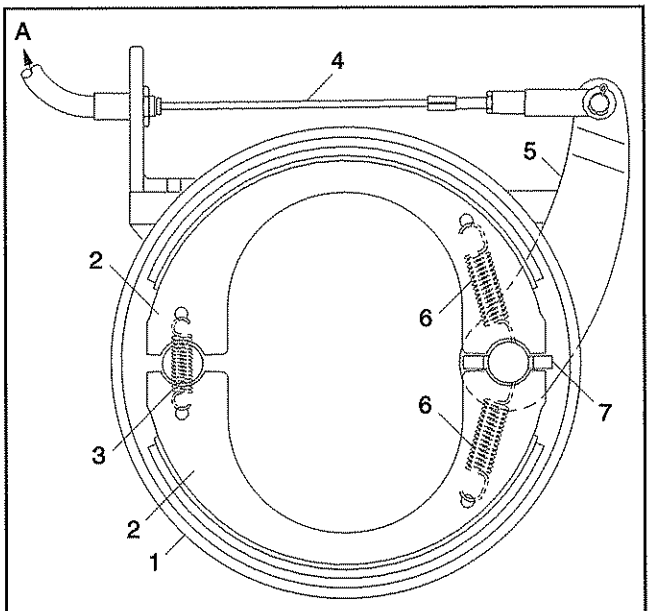


Fig. 4



NOTE: Not all parts are shown.

A. To parking brake lever in the cab.

1. Brake Drum
2. Brake Shoe
3. Shoe-to-Shoe Spring
4. Brake Cable
5. Actuating Lever
6. Return Spring
7. Cam

Fig. 5, Fuller Transmission Installation Shown

Safety Precautions

Because most brake linings contain asbestos, you should know the potential hazards of asbestos and the precautions to be taken. Because medical experts believe that long-term exposure to some non-asbestos fibers could also be a health hazard, also observe the following precautions if servicing non-asbestos brake linings.

Exposure to airborne brake lining dust can cause serious and possibly fatal diseases such as asbestosis (a chronic lung disease) and cancer.

During brake servicing, wear an air purifying respirator with high-efficiency filters. The respirator and filter must be approved by NIOSH or MSHA, and worn during all procedures.

OSHA recommends that enclosed cylinders equipped with vacuums and high-efficiency (HEPA) filters be used during brake repairs. Under this system, the entire brake assembly is placed within the cylinder and the mechanic works on the brake through sleeves attached to the cylinder. Compressed air is blown into the cylinder to clean the assembly, and the dirty air is then removed from the cylinder by the vacuum.

If such an enclosed system is not available, or can't be used, clean the brake assembly in the open air. During disassembly, carefully place all parts on the floor to minimize creating airborne dust. Using an industrial vacuum cleaner with an HEPA filter system, remove dust from all the brake parts. After vacuuming, remove any remaining dust using a rag soaked in water and wrung until nearly dry.

⚠ WARNING

WARNING: Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by NIOSH or MSHA. Wear a respirator at all times when disassembling the parking brake, starting with removal of the drum and continuing through assembly.

Replacement

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Chock the tires. Apply the parking brake to keep the brake drum in place when the driveline is disconnected.
2. Remove the driveline midship bearing carrier from the frame crossmember.
   - 2.1 Put a jackstand under the driveline at the rear of the midship bearing.
   - 2.2 Remove the bolts holding the midship bearing carrier to the bracket on the frame crossmember. **See Fig. 1.**
   - 2.3 Lower the driveline and midship bearing carrier onto the jackstand. It should rest securely on the jackstand.
3. Disconnect the driveline companion flange from the transmission companion flange. **See Fig. 2.**

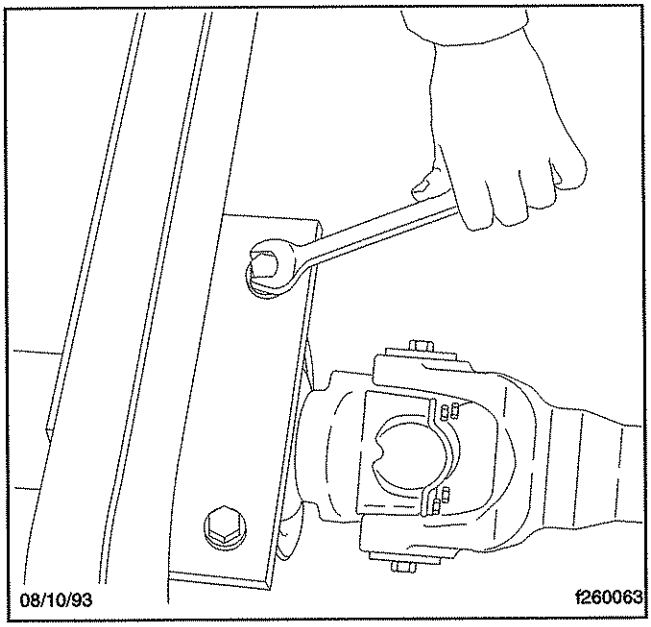


Fig. 1

Slide out the driveline, and lower it to the floor. **See Fig. 3.**

4. Release the parking brake.
5. Pull the brake drum off the transmission companion flange. **See Fig. 4.**

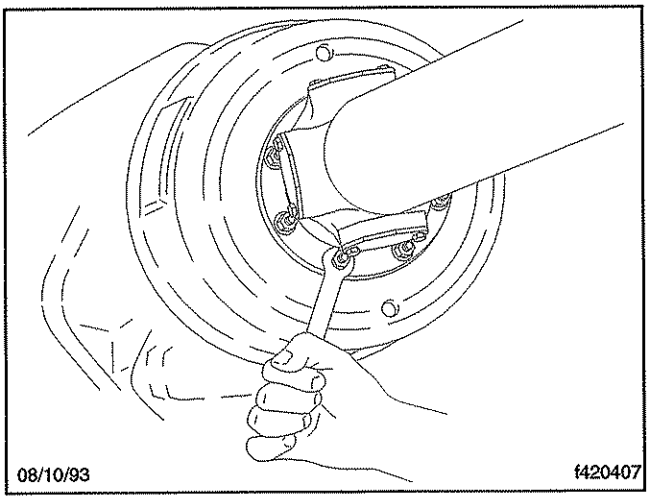


Fig. 2

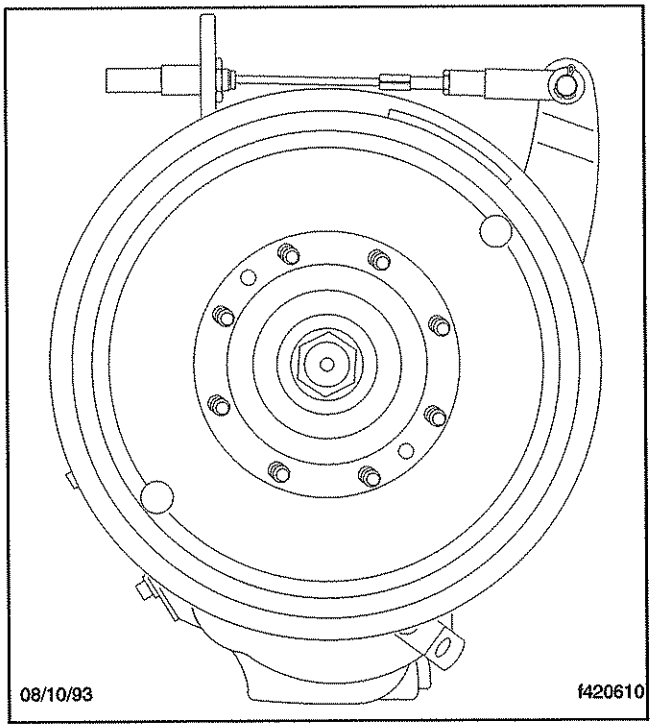


Fig. 3, Driveline Removed

Brake Shoe Replacement

6. Disconnect the brake cable from the actuating lever. **See Fig. 5.**
7. Remove the large end-nut from the transmission shaft. **See Fig. 6.** Remove the companion flange.
8. Remove the supporting plate and brake shoes as a unit.
9. Disassemble the brake parts. **See Fig. 7.**

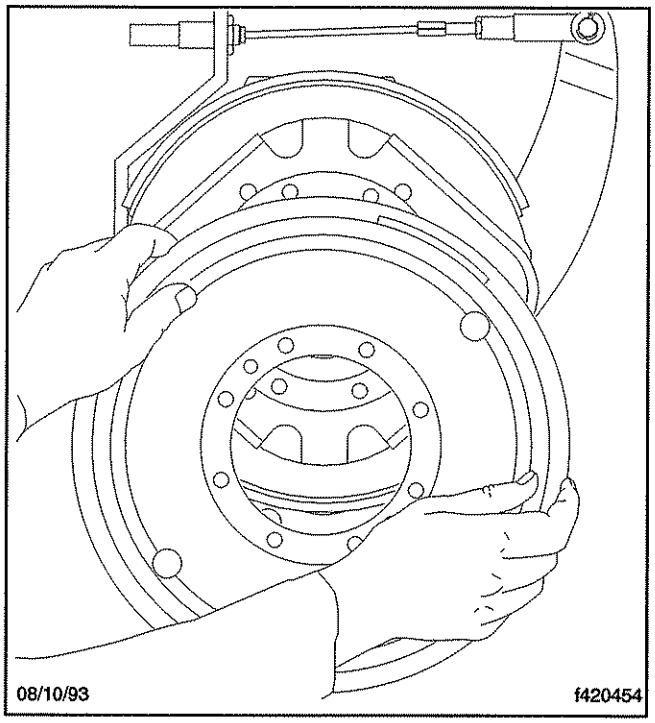


Fig. 4

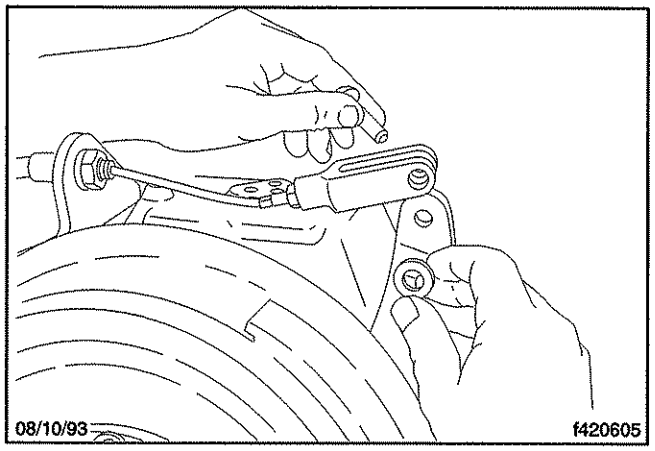


Fig. 5

9.1 Remove the actuating lever and cam assembly.

9.2 Remove the brake shoes from the supporting plate.

⚠ WARNING

WARNING: Brake shoe return springs are under tension, and may release unexpectedly, which could cause injury. Wear safety glasses when removing them.

9.3 Using a suitable spring removal tool, carefully remove the two brake shoe return springs.

9.4 Spread the brake shoes apart to release tension on the shoe-to-shoe spring.

9.5 Remove both brake shoes from the support plate, then remove the shoe-to-shoe spring.

10. Clean all the parts. Check for damage and corrosion, and replace parts if needed. Check the

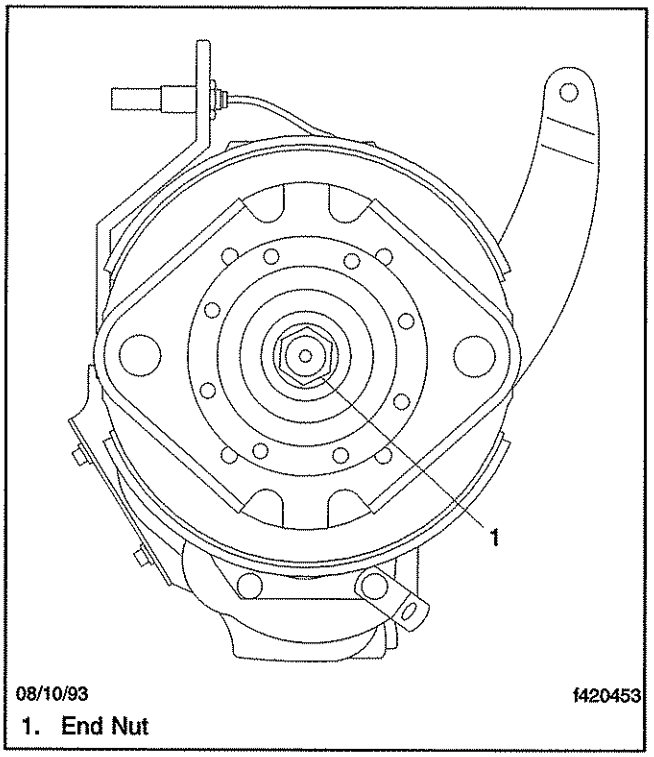
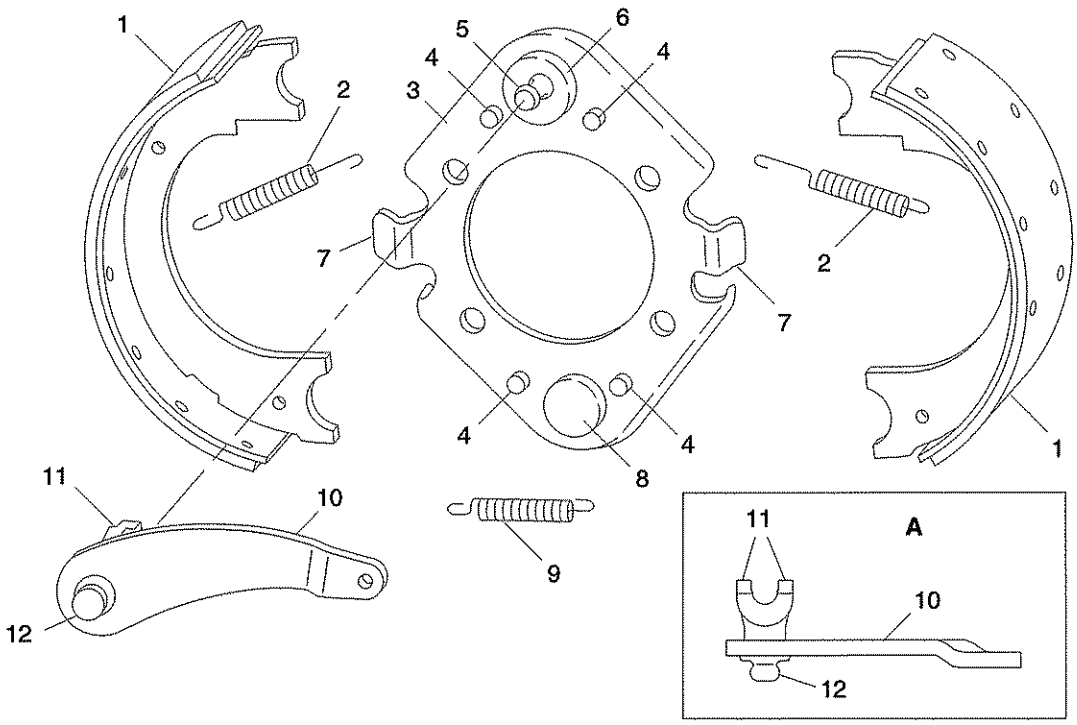


Fig. 6



A. Top view of actuating lever.

1. Brake Shoe
2. Return Spring
3. Support Plate
4. Shoe Bearing Surface
5. Nib
6. Upper Anchor Pin
7. Support Plate Lug
8. Lower Anchor Pin
9. Shoe-to-Shoe Spring
10. Actuating Lever
11. Cam Lugs
12. Cam Ball

Fig. 7

support plate for cracks or bending. Replace it if needed.

⚠ CAUTION

CAUTION: Don't let any grease get on the brake drum or linings. Grease on these parts will reduce the effectiveness of the driveline parking brake. If brake linings become contaminated, replace them.

11. Using NLGI grade 2 brake grease, lightly grease the following parts (**see Fig. 7**):
    - the cam lugs and ball;
    - the mating surfaces of the brake shoe webs and the support plate lugs;
    - the support plate anchor pins;
    - the shoe bearing surfaces;
    - the ends of the brake shoe webs.
12. Install new brake shoes. **See Fig. 7** and **Fig. 8.**

    12.1 Position the brake shoes on the support plate.

    NOTE: Position the support plate so the anchor pin with the nib is at the top.

    12.2 Install a new shoe-to-shoe spring in the hole of each brake shoe.

Brake Shoe Replacement

12.3 Using a twisting motion, install the lower ends of the brake shoes over the lower anchor pin.

12.4 Put the upper ends of the brake shoes against the upper anchor pin, making sure the shoe webs are underneath the guide lugs of the support plate.

12.5 Install two new return springs on the nib of the upper anchor pin and in the hole of each brake shoe.

12.6 Install the actuating lever and cam assembly on the anchor pin with the nib.

13. Using the four hexbolts, nuts, and washers, position the support plate and brake shoe assembly on the transmission adapter. **See to Fig. 8**. Tighten the nuts 115 N·m (85 lbf·ft).

14. Install the transmission companion flange over the splines of the transmission shaft.

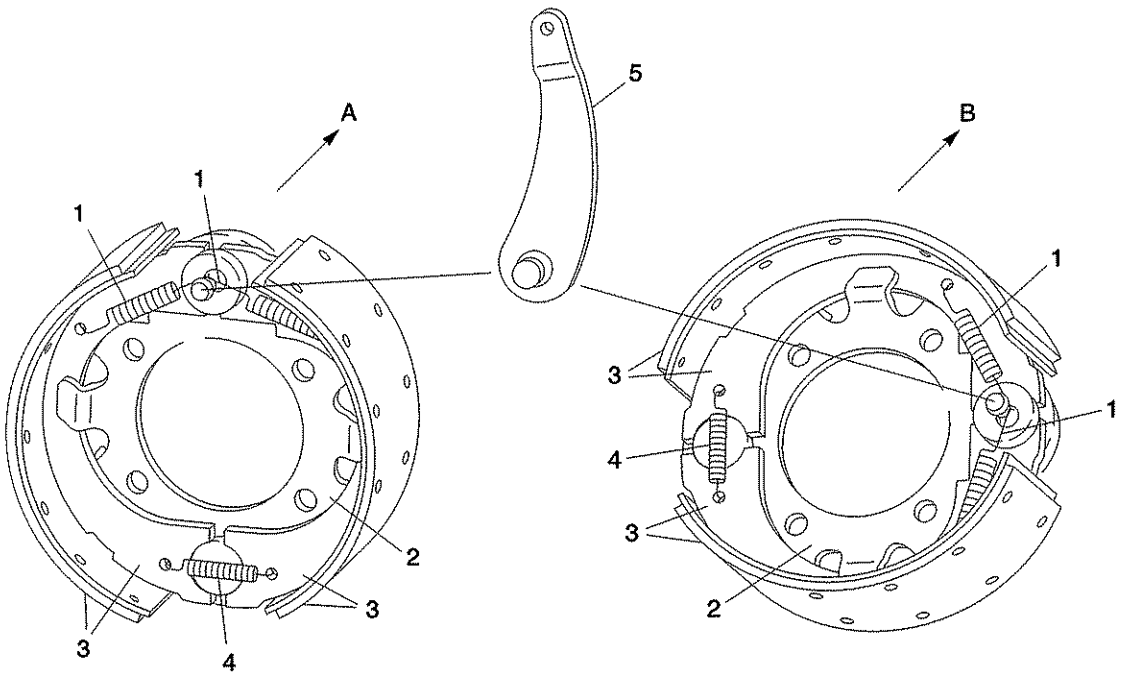
15. Install the large end-nut on the end of the transmission shaft. **See Fig. 6**. Tighten the nut.

    - On Fuller transmissions—440 N·m (325 lbf·ft).
    - On Allison transmissions—197 N·m (145 lbf·ft).

16. Install the brake drum onto the studs of the transmission companion flange.

17. Connect the driveline companion flange to the transmission companion flange.

    17.1 Place the driveline companion flange so its holes fit over the studs on the transmission companion flange.



A. To Allison transmission.
B. To Fuller transmission.

1. Return Spring
2. Support Plate
3. Brake Shoe
4. Shoe-to-Shoe Spring
5. Actuating Lever and Cam Assembly

Fig. 8

17.2 Install the eight nuts and washers on the studs. **See Fig. 2.** Tighten them 61 N·m (45 lbf·ft).

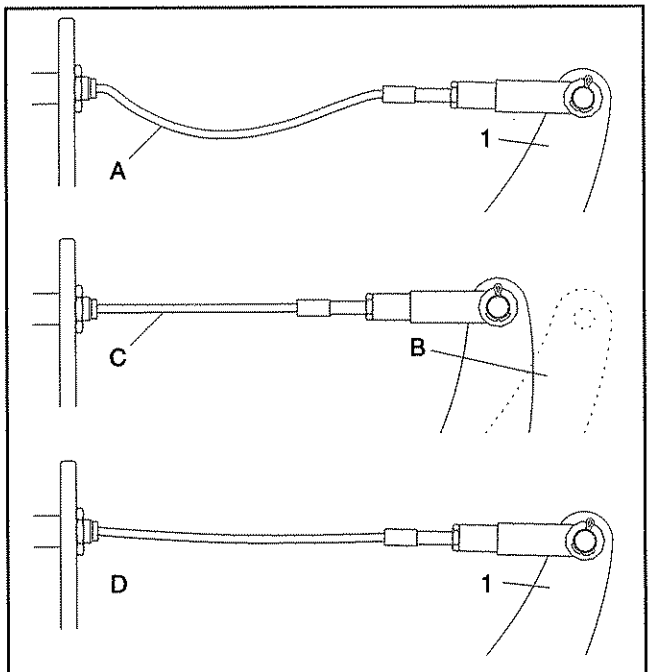
18. Connect the brake cable to the brake lever.

18.1 Check the length of the brake cable. It should be just long enough to let the clevis hole align with the hole in the brake lever, without moving the actuating lever. **See Fig. 9.**

If the brake cable is too loose or too tight, loosen the jam nut, then screw the clevis in or out until its holes line up with the hole in the actuating lever (without moving the lever). **See Fig. 10.**

18.2 Tighten the jam nut firmly.

18.3 Install the clevis pin through the clevis and actuating lever holes.



A. Too loose.
B. Correct position of actuating lever.
C. Too tight.
D. Correct cable adjustment.
1. Actuating Lever

Fig. 9, Brake Cable Tightness

18.4 Install the washer and a new cotter pin on the clevis pin.

18.5 Check the brake cable again for any slack. If it still needs adjusting, do it in the cab by turning the ring on the handle of the parking brake lever, **See Fig. 11.**

19. Attach the driveline midship bearing carrier to the bracket on the frame crossmember. Tighten the fasteners 123 N·m (91 lbf·ft).

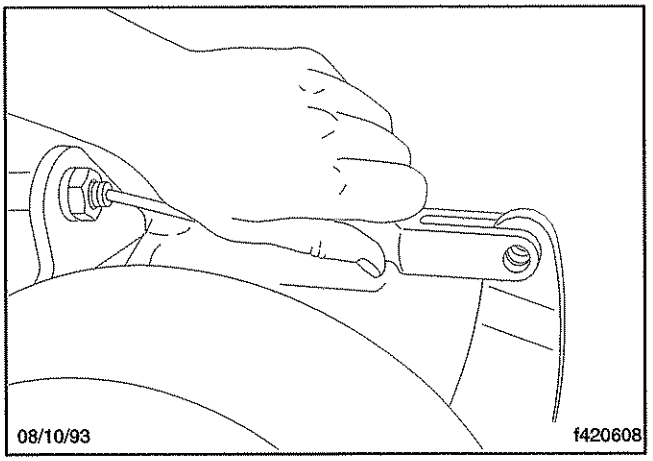


Fig. 10

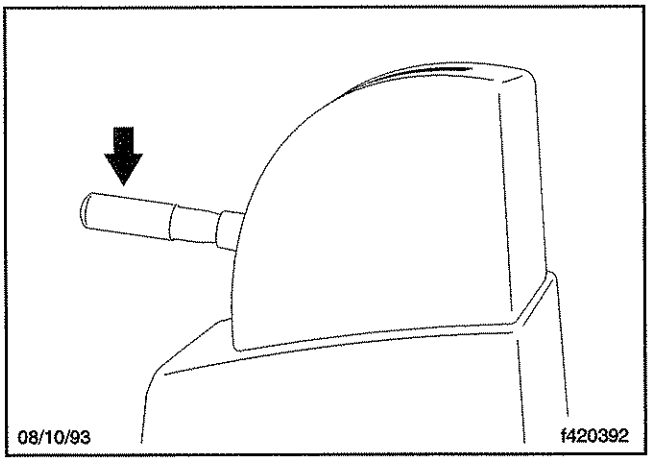


Fig. 11

Parking Brake Cable Replacement

Replacement

1. Chock the front and rear tires.
2. Release the parking brake.
3. At the driveline end, disconnect the brake cable from the actuating lever. **See Fig. 1.**
4. Unscrew the clevis from the cable (**see Fig. 2**); put the clevis aside.
5. Remove and save the small jam nut from the threaded end of the cable that was installed in the clevis.
6. Remove the brake cable jam nut and lock washer from the cable bracket on top of the transmission. **See Fig. 3.**

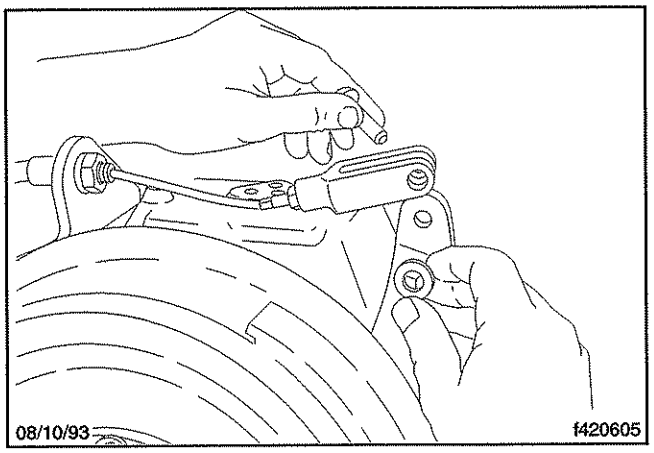


Fig. 1

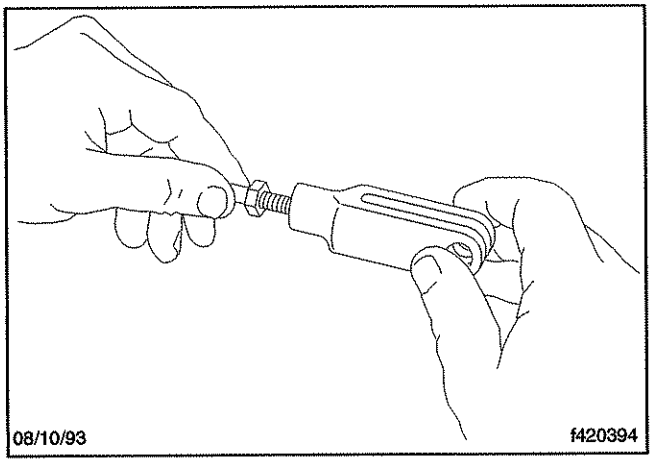


Fig. 2

7. Push the brake cable end through the "D" hole in the bracket. **See Fig. 4.**
8. In the cab, remove the plastic boot covering the brake lever assembly.
9. Remove the nut from the double cable clamp on the side of the transmission (**see Fig. 5**), then remove the brake cable from its half of the clamp.
10. Disconnect the parking brake cable from the parking brake lever. **See Fig. 6.**
11. Remove the parking lever assembly from the cab deck.
    - 11.1 Disconnect the electrical wire from the right side of the parking brake lever assembly. **See Fig. 7.**
    - 11.2 Remove the four mounting bolts and washers that hold the lever assembly to the cab floor. **See Fig. 8.**

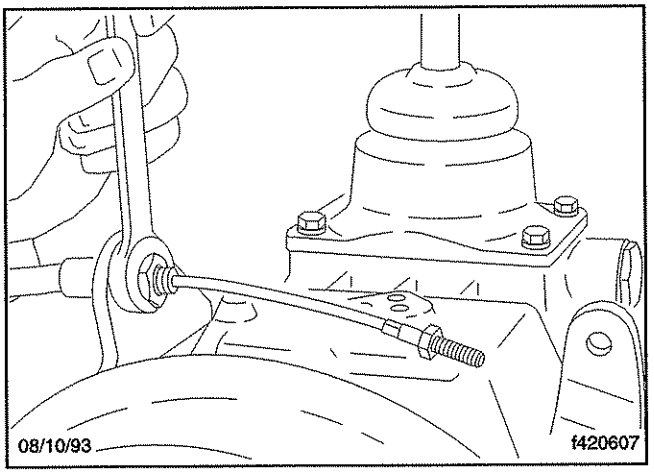


Fig. 3, Fuller Transmission Installation Shown

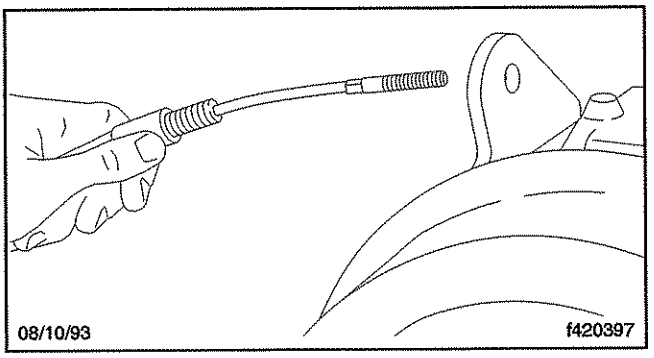


Fig. 4

Parking Brake Cable Replacement

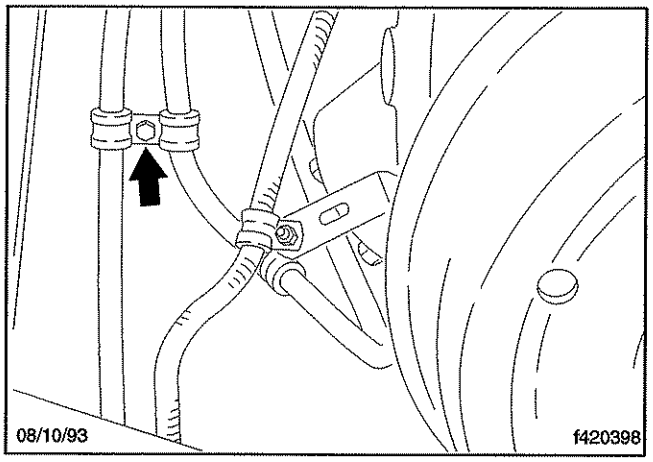


Fig. 5

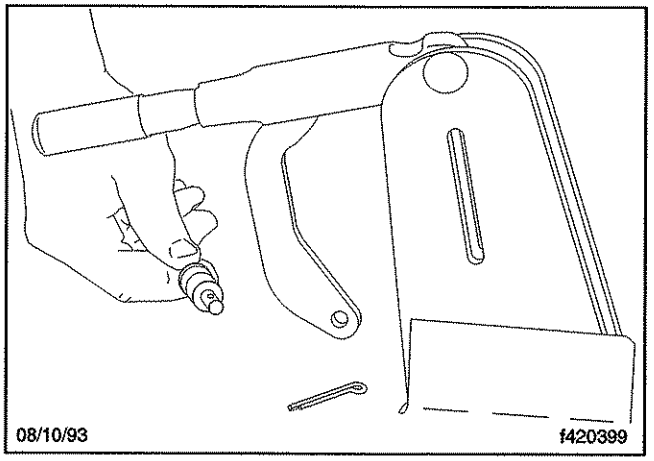


Fig. 6

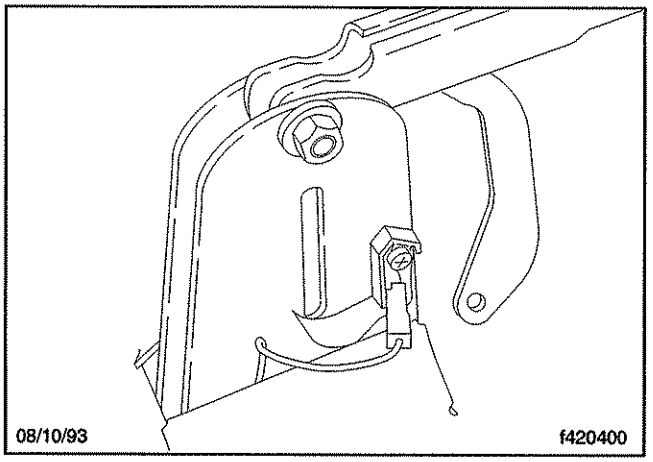


Fig. 7

11.3 Lift the lever assembly off the floor, and set it aside.

12. Remove the jam nut and lockwasher from the threaded end of the cable sheath coming through the hole in the cab deck. **See Fig. 9.**
13. Remove the baseplate by sliding the parking brake cable through the slot in the baseplate. **See Fig. 10.**
14. Pull the entire length of the parking brake cable up through the hole in the cab deck.
15. Check the parking brake lever assembly for wear and damage. Replace it if needed.
16. Put the clevis end of the new parking brake cable assembly in the slot of the baseplate, so that the

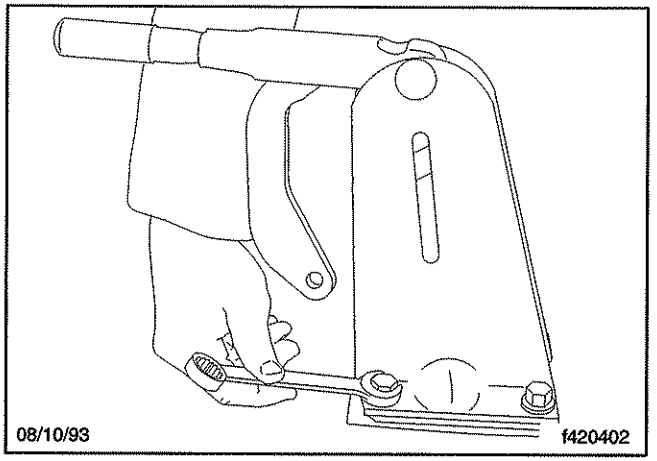


Fig. 8

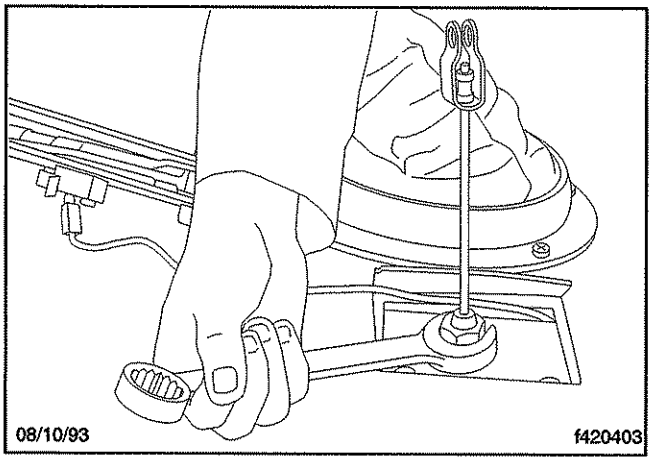


Fig. 9

Parking Brake Cable Replacement

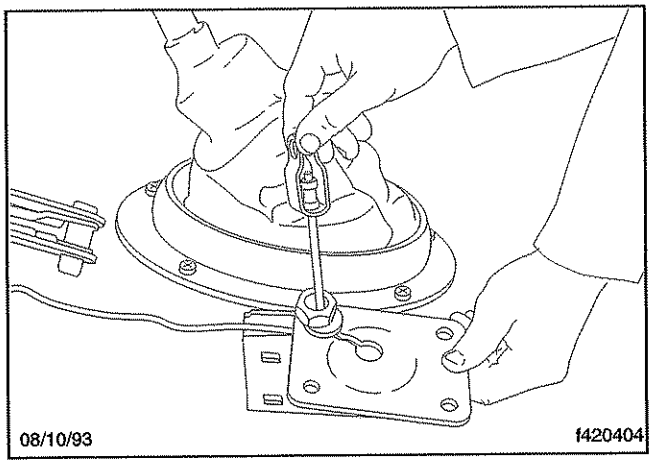


Fig. 10

jam nut and washer are on top of the base plate. **See Fig. 10.**

17. Install the lockwasher and jam nut on the cable sheath. Tighten the nut firmly. **See Fig. 9.**
18. Install the free end of the parking brake cable through the hole in the deck. Pull about a foot of the cable up through the sheath.
19. Connect the new cable to the parking brake lever assembly.
    - 19.1 Install the bushing on the clevis pin. **See Fig. 6.**
    - 19.2 Put the clevis end of the cable up through the middle of the parking brake lever assembly.
    - 19.3 Put the curved brake lever arm (**Fig. 6**) into the middle of the brake lever assembly, and into the clevis.
    - 19.4 Line up the slots in the brake lever assembly, the hole in the curved arm, and the holes in the clevis.
    - 19.5 Install the clevis pin (with the bushing on it) from the side of the lever assembly with the electric wire connector (**Fig. 7**).
    - 19.6 Install the washer and cotter pin on the clevis pin.
20. Install the parking brake lever assembly on the cab deck.
    - 20.1 Put the baseplate on the deck, lining up the holes in the plate with those in the deck.
    - 20.2 Put the lever assembly in place so that its holes and those of the baseplate and the deck all line up.
    - 20.3 Install the four mounting bolts and washers. Tighten the fasteners firmly.
21. Connect the electrical wire to the passenger's side of the parking brake lever assembly. **See Fig. 7.**
22. Underneath the cab, route the parking brake cable through the double cable clamp on the side of the transmission (**Fig. 5**), and then up to the cable bracket on the top of the transmission.
23. Put the cable through the "D" hole in the bracket, then install the lockwasher and jam nut on the threaded end of the cable sheath. Don't tighten the nut all the way. **See Fig. 3.**
24. Connect the parking brake cable to the parking brake actuating lever.
    - 24.1 Screw the threaded end of the cable into the clevis far enough so the clevis holes will line up with the hole in the actuating lever. There should be no slack in the cable. **See Fig. 11.**
    - 24.2 Install the clevis pin in the holes of the clevis and that of the actuating lever.
    - 24.3 Tighten the jam nut 900 N·cm (80 lbf·in).
    - 24.4 Install the washer and a new cotter pin.
25. If a final cable adjustment is needed, make it in the cab, by turning the ring on the parking brake lever. **See Fig. 12.**

Parking Brake Cable Replacement

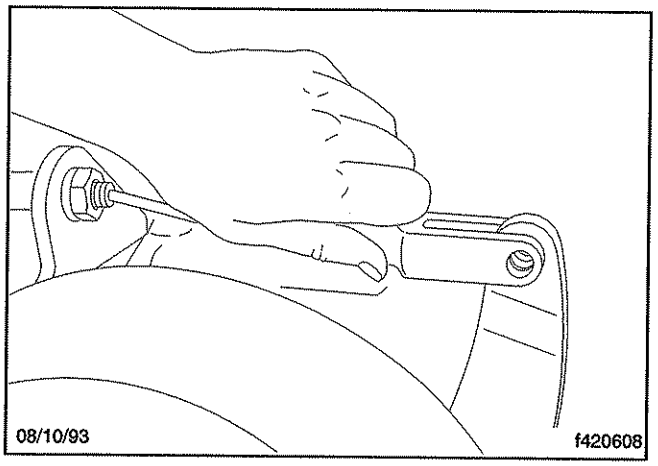


Fig. 11

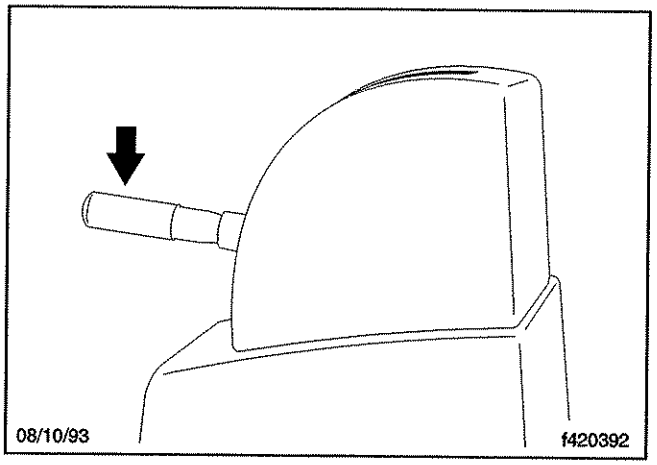


Fig. 12

Troubleshooting

This subject contains the following troubleshooting tables:

- The Parking Brake Won't Hold the Vehicle on a Grade
- The Parking Brake Won't Release
- The Parking Brake Makes Noises While the Vehicle Is Moving

Problem—The Parking Brake Won't Hold the Vehicle on a Grade

Possible Cause	Remedy
The brake shoe linings are worn down.	Replace the brake shoes.
The brake drum is cracked.	Replace the drum.
The brake drum lining is worn down, or heavily scored.	Replace the drum.
The brake cable is binding.	Repair or replace the cable.
There is too much slack in the brake cable.	Adjust the brake cable.
The brake shoe linings have grease on them.	Replace the brake shoes, then clean the inside of the drum.

Problem—The Parking Brake Won't Release

Possible Cause	Remedy
The brake cable is too tight.	Adjust the brake cable.
The brake shoe return springs are missing, detached, or broken.	Check the return springs. Install them or replace them as needed.
The contact points between the brake shoe webs and the actuator strut are corroded or dirty.	Check the area, and clean and lubricate as needed.
The parking brake lever in the cab is binding.	Check the parking brake lever assembly for damage or corrosion. Repair or replace as needed.

Problem—The Parking Brake Makes Noises While the Vehicle Is Moving

Possible Cause	Remedy
The parking brake drum is loose.	Check the brake drum mounting bolts. Tighten as needed.
The brake shoes or backing plate is loose.	Check the brake shoes, return springs, and backing plate mounting bolts. Tighten, repair, or replace, as needed.
There is dirt inside the brake drum.	Remove the brake drum and clean it. Also clean the other brake parts.

Specifications

Description	Torque	
	N·m (lbf·ft)	N·cm (lbf·in)
Transmission End-Nut Fuller Allison	 440 (325) 197 (145)	—
Support Plate Mounting Bolts	115 (85)	—
Brake Drum Mounting Bolts	61 (45)	—
Midship Bearing Carrier Mounting Bolts	123 (91)	—
Cable Bracket Jam Nut (on top of transmission)	—	900 (80)

Table 1, Fastener Torques

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NOTE: The Midland check valve is not serviceable.

General Information

The single check valve **(Fig. 1 and Fig. 2)** is installed in an air line to allow air flow in one direction and prevent air flow in the reverse direction. The check valve is installed in the upstream ends of the primary and secondary brake system air reservoirs to protect brake system air pressure in case the compressor, air pressure regulator or other air delivery component malfunctions.

Principles of Operation

When air in the system moves in the normal direction— from the compressor to the air reservoir— the check valve disk (**Fig. 3**, Ref. 4) compresses the spring (Ref. 2) and allows air to pass. When there is a drop in air pressure on the supply side of the valve, the spring pushes the check valve disk against the valve seat (Ref. 5) and prevents air from leaving the brake system.

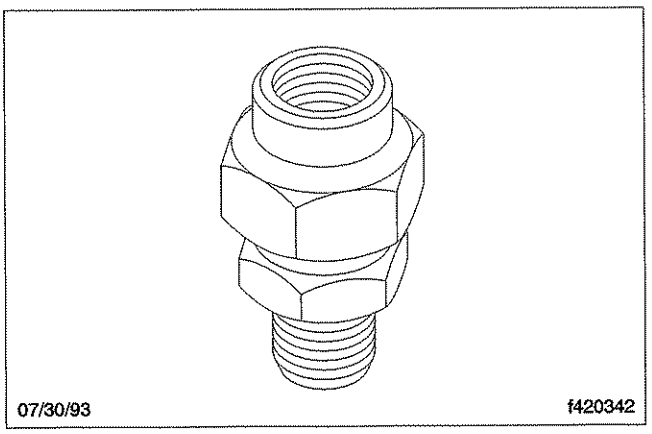


Fig. 1, Single Check Valve, Bendix

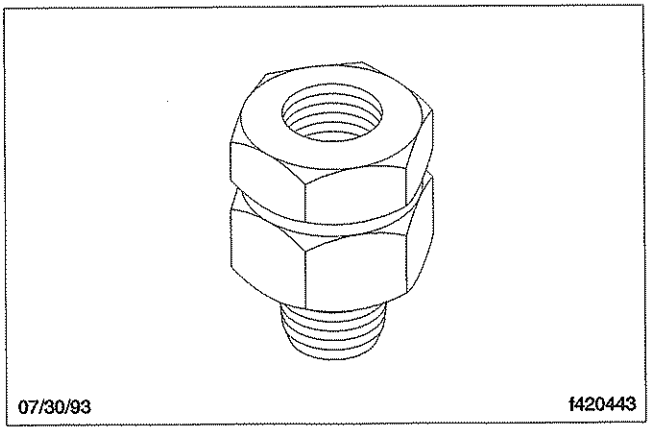


Fig. 2, Single Check Valve, Midland

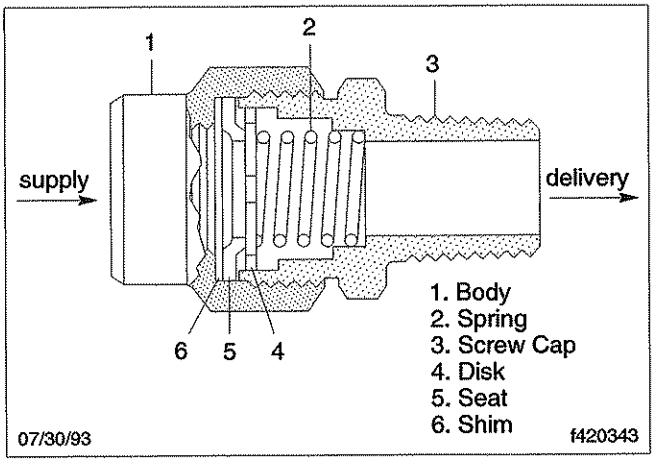


Fig. 3, Cross-Section (Bendix shown)

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

1. Chock the wheels and stop the engine before working under the vehicle. Keep hands away from brake chamber push rods and slack adjusters; they will apply as air pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs, and injury can result if not correctly disassembled. Use only the correct tools and observe all precautions regarding use of those tools.

Leakage Test

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

After repairing or replacing the single check valve, do the following test:

With the brake air system fully pressurized, drain the air from the supply reservoir (wet tank), and remove the air line from the supply side of the check valve. Coat the open end of the check valve with soap suds. A 2.5-cm (1-inch) or smaller bubble in five seconds is acceptable.

If the check valve is leaking too much, repair or replace it.

IMPORTANT: The Midland check valve is not serviceable. If it leaks or doesn't work, replace it.

Removal

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Chock the tires, then drain the air reservoirs.
2. Remove the supply line from the check valve.
3. Remove the check valve from the air reservoir.

Installation

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Screw the check valve into the supply end of the air reservoir. To ensure the valve is not reversed, the arrow marked on the valve body must point in the direction of air flow.
2. Leak test the check valve following the instructions under **"Leakage Test, 110."**
3. Connect the supply line to the open end of the check valve.

Disassembly, Cleaning and Inspection, and Assembly (Bendix only)

Disassembly

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Remove the check valve following the instructions under **"Removal and Installation, 120."**
2. Remove the screw cap from the body. **See Fig. 1.**
3. Remove the shim, seat, disk, and spring.

Cleaning and Inspection

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

⚠ WARNING

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.

Use eye protection when using compressed air to clean or dry parts, as permanent harm to eyes could result from flying debris.

1. Wash all parts of the check valve in cleaning solvent. Dry the parts of the disassembled check valve with compressed air.

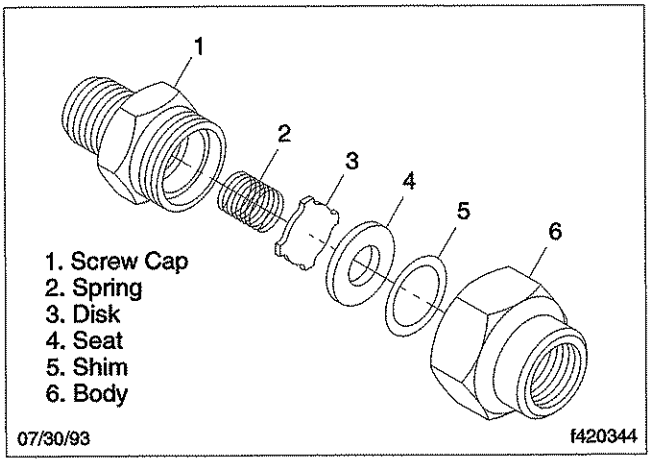


Fig. 1

2. Inspect the disk for signs of wear or deterioration.
3. Check the spring for cracks, corrosion, or damage.
4. Inspect the body and screw cap for cracks or damage. Replace all worn or damaged parts with new parts.

Assembly

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Position the shim, seat, disk, and spring in the body.
2. Screw the screw cap into the body over the other parts. Tighten it securely.
3. Install the check valve following the instructions under **"Removal and Installation, 120."**

Double Check Valve, Bendix or Midland 42.16

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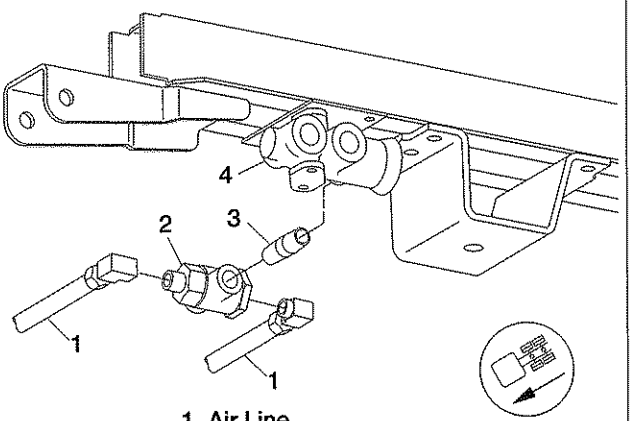
NOTE: The Midland check valve is not serviceable.

General Information

The double check valve is used in the air brake system to direct a flow of air into a common line from either of two sources, whichever is at the higher pressure. The double check valve is used only on tractors. It allows the air circuit with the higher pressure to operate the trailer service brakes. Tractors equipped with a trailer control valve have two double check valves installed; otherwise, just one is installed. The valve(s) is installed on the service port of the tractor protection valve, at the back of the cab. **See Fig. 1.**

Principles of Operation

The double check valve has movable shuttles that seal off the lower pressure air source. As pressurized air enters either end of the double check valve inlet port, the moving shuttle responds to the greater pressure source and seals the opposite port. The air flow travels out the delivery port of the valve. The position of the shuttle will reverse if the pressure levels are reversed. The double check valve is designed so the shuttle cannot interfere with the backflow of air in the exhaust mode.



1. Air Line
2. Double Check Valve
3. Nipple
4. Tractor Protection Valve

NOTE: Not all parts are shown.

09/29/94 f420503

Fig. 1

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

1. Chock the tires and stop the engine before working under a vehicle. Keep hands away from brake chamber push rods and slack adjusters; they will apply as air pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs, and injury can result if they are not correctly disassembled. Use only the correct tools, and observe all precautions regarding use of those tools.

Operating and Leakage Test

1. If the vehicle is not a tractor with a trailer, go to the step for testing the check valve on the bench.

   If the vehicle is a tractor with a trailer, proceed as follows:

   1.1 Depress the foot brake pedal and re-lease it while checking that the brakes apply and release on both the tractor and trailer.

   1.2 Apply and release the trailer control valve while checking that only the trailer brakes apply and release.

   1.3 Apply the trailer control valve and check the exhaust port of the foot brake valve for leakage using a soap solution. A 2.5-cm (1-inch) bubble or less in five seconds is allowable. Release the valve.

   1.4 Disconnect the air line from the trailer control valve exhaust port. Depress the foot brake pedal until it stops and hold it in place. Check the trailer control valve exhaust port for leakage using a soap solution. A 2.5-cm (1-inch) bubble or less in five seconds is allowable.

   1.5 Connect the air line to the trailer control valve exhaust port.

2. If the double check valve is to be tested on the bench, connect two separately controlled air supplies to the inlet ports.

3. Connect an accurate test gauge to the double check valve outlet port or to a line from the outlet port.

4. Apply and release air to one inlet port (foot brake pedal) while checking that the test gauge registers the application and release.

5. Apply and release air to the other inlet port (trailer control valve) while checking that the gauge registers the application and release.

6. Disconnect the line from one of the double check valve inlet ports. Apply air to the opposite inlet port while checking the first port for leakage using a soap solution. A 2.5-cm (1-inch) bubble or less in five seconds is allowable. Connect the line to the inlet port. Repeat this step, checking the opposite inlet port for leaks.

7. If the double check valve does not function as described, or if the leakage is excessive, replace it. Refer to **"Removal and Installation, 120"** for instructions.

   The Bendix valve can be also repaired, using Bendix parts. Refer to **"Disassembly, Cleaning and Inspection, and Assembly (Bendix only), 130"** for instructions.

   The Midland valve is not serviceable.

Removal

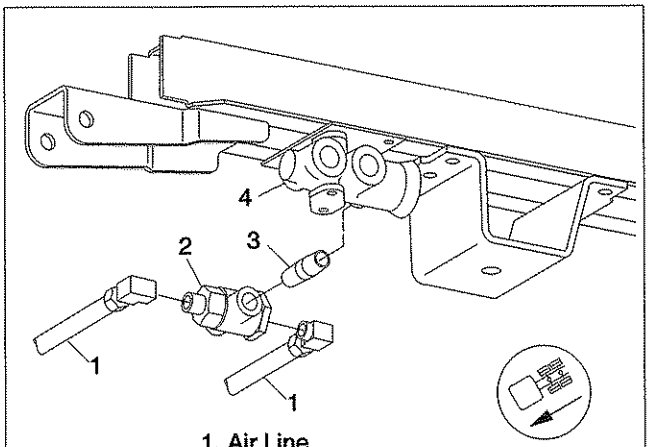
⚠ WARNING

WARNING: Wear safety goggles when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct the airstreams at anyone. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

1. Drain the air from the air reservoirs.
2. For later reference, mark the air lines to the double check valve(s). Then carefully disconnect them **(see Fig. 1.)**.
3. Unscrew the double check valve(s) from the tractor protection valve. **See Fig. 1.**

Installation

1. Screw the double check valve(s) into the tractor service port of the tractor protection valve.
2. Connect the air lines to the double check valve as marked. Tighten the air lines firmly.



1. Air Line
2. Double Check Valve
3. Nipple
4. Tractor Protection Valve

NOTE: Not all parts are shown.

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Fig. 1

Disassembly, Cleaning and Inspection, and Assembly (Bendix only)

Disassembly (Refer to Fig. 1)

1. Remove the valve from the vehicle. Refer to **"Removal and Installation, 120"** for instructions.
2. Remove the end cap from the valve.
3. Remove the O-ring.
4. Remove the shuttle valve and shuttle guide.

Cleaning and Inspection

⚠ WARNING

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 all metal parts in a cleaning solvent.
2. Inspect all metal parts for signs of cracks, wear, or deterioration. Replace all parts not considered serviceable.
3. Replace all rubber parts.

Assembly

1. Install the shuttle valve and shuttle guide in the valve body.
2. Coat the O-ring with BW 650M silicone lubricant (BW 291126). It is not necessary to lubricate the shuttle valve.
3. Install the O-ring.
4. Install the end cap on the valve body.
5. Install the valve on the vehicle. Refer to **"Removal and Installation, 120"** for instructions.
6. Test the valve. Refer to **"Operating and Leakage Test, 110"** for instructions.

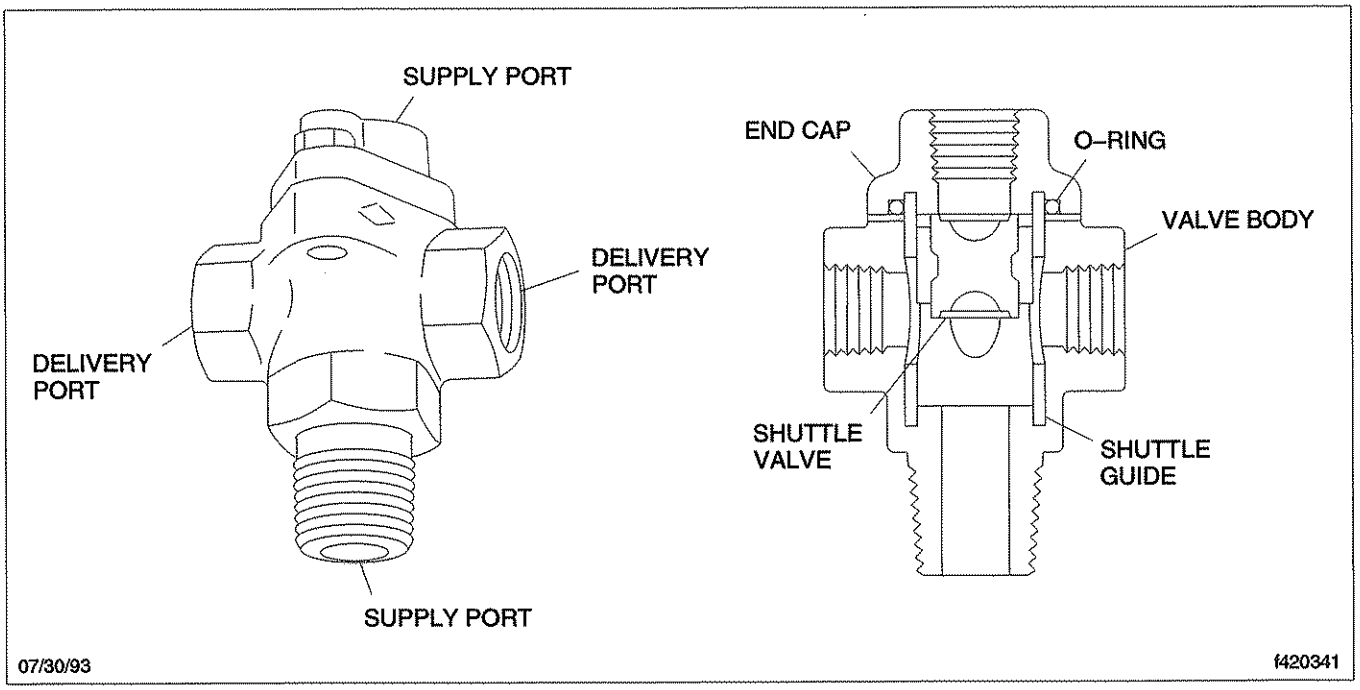


Fig. 1, Double Check Valve, Bendix

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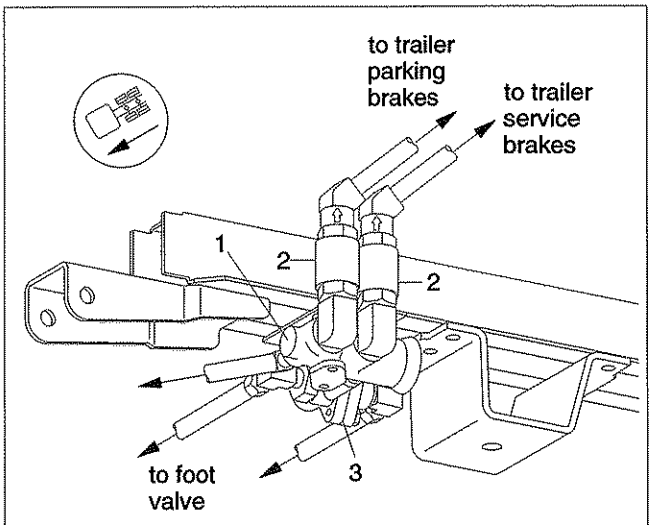
General Information

The Bendix TP-3 tractor protection valve is mounted on the back of the cab. **See Fig. 1.** Air hoses from the foot valve are connected to a double check valve on the tractor service port, and an air hose from the dash valve is connected to the tractor emergency port. **See Fig. 1 and Fig. 2.** One or two quick-release valves are installed between the trailer hoses and the trailer ports on the TP-3. **See Fig. 1.**

Principles of Operation

When the trailer air supply valve is open, air flows through the TP-3 valve emergency ports **(see 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.

At least 310 kPa (45 psi) pressure 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 min-imum 310 kPa (45 psi), the plunger rises, seating the inlet valve and closing the service ports to protect the tractor brake system pressure.

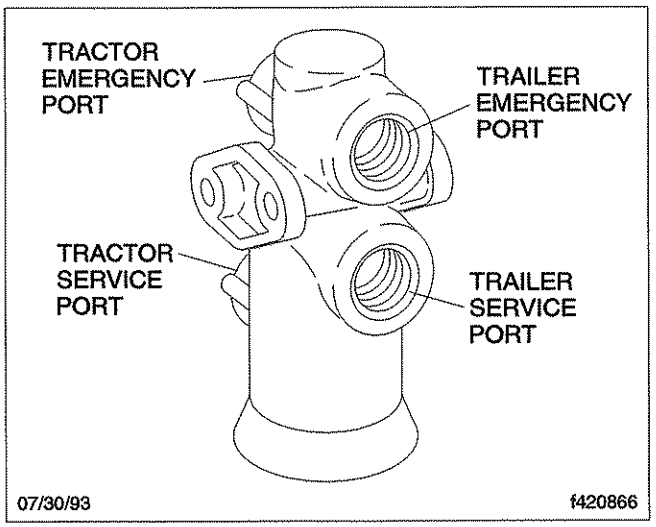


1. TP–3 Valve
2. Quick Release Valve
3. Double Check Valve

NOTE: Not all parts are shown.

07/30/93 f420504

Fig. 1



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Fig. 2

General Information and Principles of Operation

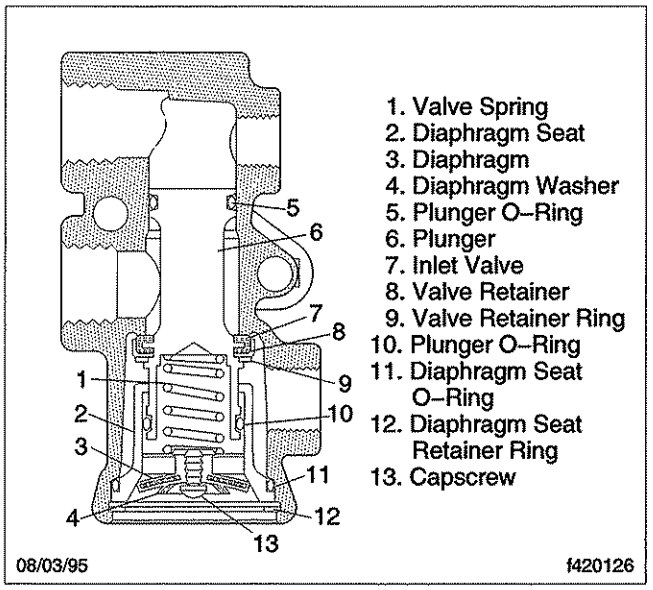


Fig. 3

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

1. Chock the tires and stop the engine before working under the vehicle. Keep hands away from brake chamber push rods and slack adjusters; they will apply as air pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs, and injury can result if not correctly disassembled. Use only correct tools and observe all precautions regarding use of those tools.

Test

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Chock the tires. Place the trailer air supply valve in the emergency position, and disconnect the trailer air lines from the trailer supply and service couplings. Apply a soap-water solution to the couplings.
2. With tractor reservoirs charged to at least 689 kPa (100 psi) make and hold a full service brake application. Leakage at either tractor hose coupling should not exceed a 2.5-cm (1-inch) bubble in five seconds.
3. Connect the trailer supply line hose coupling, and place the trailer supply valve in the "run" position. Leakage at the service coupling should not exceed a 2.5-cm (1-inch) bubble in five seconds.
4. Connect the service brake coupling, and make and hold a full service brake application. Leakage at the diaphragm end of the TP-3 valve should not exceed a 2.5-cm (1-inch) bubble in three seconds.

IMPORTANT: If leakage is excessive, replace the valve.

5. Remove the chocks.

Removal

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Chock the tires, and drain the air reservoirs.
2. Remove the trailer hose assemblies from the TP-3 valve. Mark the tractor service and supply lines for later assembly reference, and carefully disconnect them. Cap the air lines tightly to keep out contaminants.
3. Remove the fasteners attaching the TP-3 valve to the vehicle, then remove the valve.

Installation

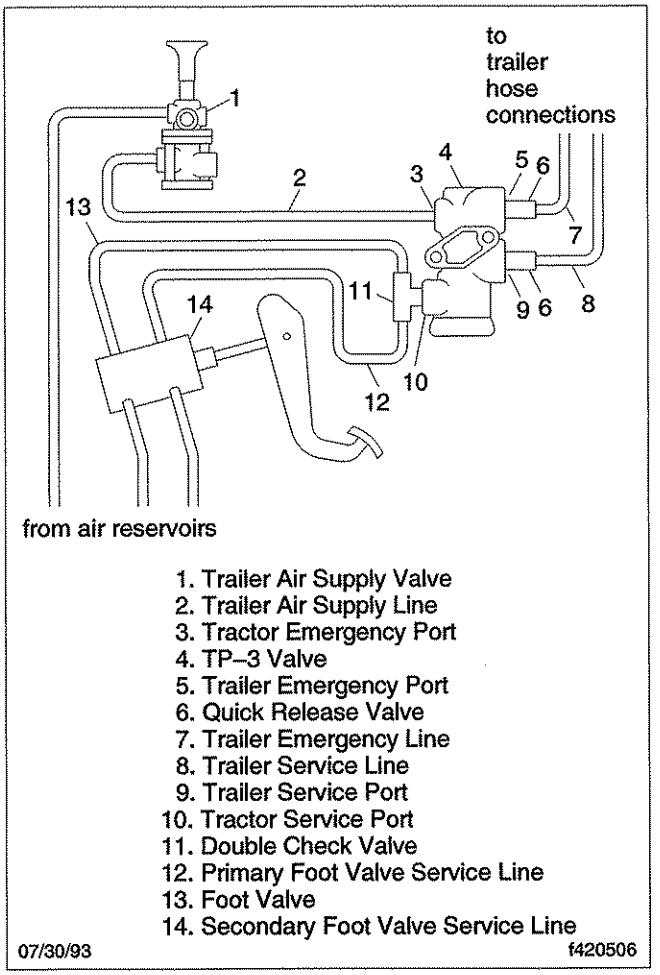
IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Place the TP-3 valve on the vehicle, and attach it with bolts, washers, and nuts. Tighten the nuts 15 to 20 N·m (11 to 15 lbf·ft).
2. Remove the caps from the air lines, then connect them to the TP-3, the double check valve, and the quick-release valve(s) **as shown in Fig. 1,** and as previously marked.

   NOTE: The trailer emergency line (Ref. 7) may not be connected to a quick-release valve; it may connect directly to the port on the TP-3 valve.

   2.1 Connect the hose fittings to their applicable ports or valves, and tighten them finger-tight.

   2.2 Using a wrench, tighten the nuts at least two turns, or until no threads show on the fitting.
3. Close the drain cocks to the air reservoirs. Start the engine to pressurize the air system.
4. Leak test the TP-3 valve following the instructions under **"Leakage Test, 110."**



1. Trailer Air Supply Valve
2. Trailer Air Supply Line
3. Tractor Emergency Port
4. TP–3 Valve
5. Trailer Emergency Port
6. Quick Release Valve
7. Trailer Emergency Line
8. Trailer Service Line
9. Trailer Service Port
10. Tractor Service Port
11. Double Check Valve
12. Primary Foot Valve Service Line
13. Foot Valve
14. Secondary Foot Valve Service Line

Fig. 1, Plumbing Diagram

Disassembly, Cleaning and Inspection, and Assembly

Disassembly

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Remove the valve from the vehicle. For instructions, refer to **"Removal and Installation, 120."**
2. Holding the diaphragm seat in the body, remove the diaphragm seat retainer ring. **Refer to Fig. 1**, Refs. 2 and 12.
3. Allow the valve spring to expand until the valve diaphragm seat assembly, valve spring, and plunger assembly can be removed.
4. Remove the diaphragm seat O-ring (Ref. 11) from the valve housing.
5. Remove the capscrew (Ref. 13) and diaphragm washer (Ref. 4) from the diaphragm seat assembly.
6. Remove the valve retainer ring (Ref. 9), valve retainer (Ref. 8), inlet valve (Ref. 7), and O-rings (Refs. 5 and 10) from the plunger.

Cleaning and Inspection

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

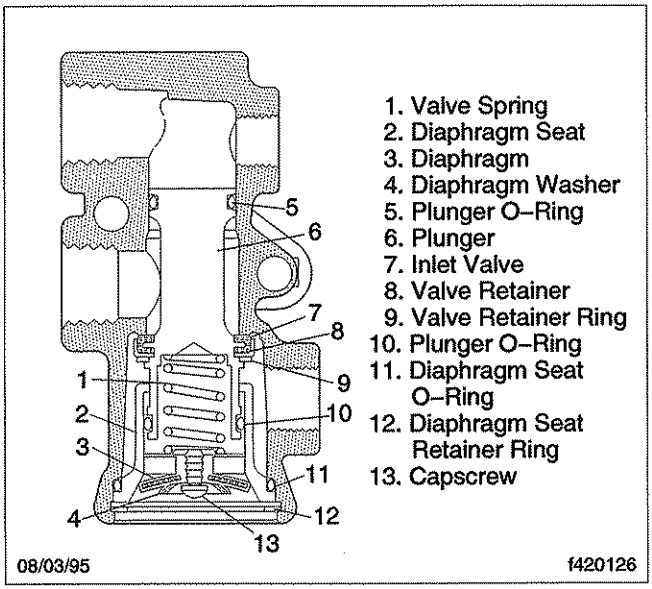


Fig. 1

⚠ WARNING

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.

Wear goggles when using compressed air to clean or dry parts, as permanent harm to eyes could result from flying debris.

1. Wash all metal parts of the TP-3 valve in cleaning solvent. Dry the metal parts of the disassembled valve with compressed air.
2. Wipe all rubber parts clean with a clean cloth. Examine all rubber parts. If any rubber parts are worn, cracked, torn or otherwise damaged, replace them with new parts.
3. Examine all metal parts. If any metal parts are worn, cracked or otherwise damaged, replace them with new parts.
4. Check the spring. If the spring is distorted or corroded, replace it.

Assembly

IMPORTANT: Before working on or around air brake systems and components, review **"Safety Precautions, 100."**

1. Lubricate the O-rings and all sliding parts with Dow Corning 55-M pneumatic grease or equivalent.
2. Install the inlet valve (**Fig. 1**, Ref. 7) on the plunger.
3. Install the valve retainer (Ref. 8) 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 capscrew (Ref. 13), diaphragm washer (concave side down, Ref. 4), and diaphragm (Ref. 3) into the diaphragm seat (Ref. 2).

Disassembly, Cleaning and Inspection, and Assembly

8. Place the inlet valve spring (Ref. 1) into the plunger.
9. Install the diaphragm seat O-ring (Ref. 11) in the body.
10. Install the diaphragm seat assembly over the spring and plunger assembly, and force them into the valve body.
11. Install the diaphragm seat retainer ring, making sure the retainer ring snaps fully into the groove.
12. Install the TP-3 valve on the vehicle following the instructions under **"Removal and Installation, 120."**

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General Description and Principles of Operation

General Description

The Rockwell driveline parking brake is designed to hold the vehicle on a grade, and to stop a slow moving vehicle if the service brakes aren't working. The parking brake is manually operated, and has a mechanical linkage; it doesn't rely on hydraulic or air pressure. It is installed only on vehicles with hydraulic brakes.

The parking brake is mounted either on the rear of the transmission (**Fig. 1**), between it and the driveshaft, or on the rear drive axle (**Fig. 2**). The main parts of the brake are the drum, brake shoes, return springs, backing plate, cam, actuator strut, actuating lever, brake cable, and brake lever assembly. **See Fig. 3.**

The brake drum is bolted onto the driveline companion flange, and the backing plate is bolted to the rear of the transmission, or on the rear axle. The brake shoes are held in place by the return springs. The brake cable runs from the actuating lever to inside the cab, where it is controlled by the parking brake lever assembly. **See Fig. 4.** A ring at the end of the parking brake lever is used to adjust the cable length to compensate for brake shoe wear.

Principles of Operation (Fig. 5)

When the brake lever is pulled up, the brake cable pulls the actuating lever, turning the cam. The cam fits into an oblong hole in the actuator strut, and rotates the strut slightly. This pushes the brake shoes outward against the brake drum. Because the backing plate and brake shoes are mounted in a fixed position on either the transmission or rear axle, and the drum is attached to the end of the driveshaft, the driveshaft is prevented from turning. This keeps the vehicle from rolling.

When the parking brake lever is released, the tension on the cable is removed. The actuating lever, cam, and actuator strut all return to their original positions, and the brake return springs pull the brake shoes away from the brake drum. The driveshaft is then free to move, and the vehicle can be moved.

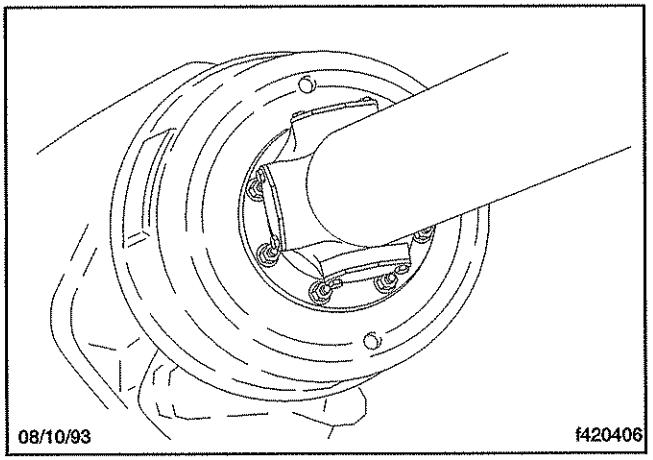


Fig. 1

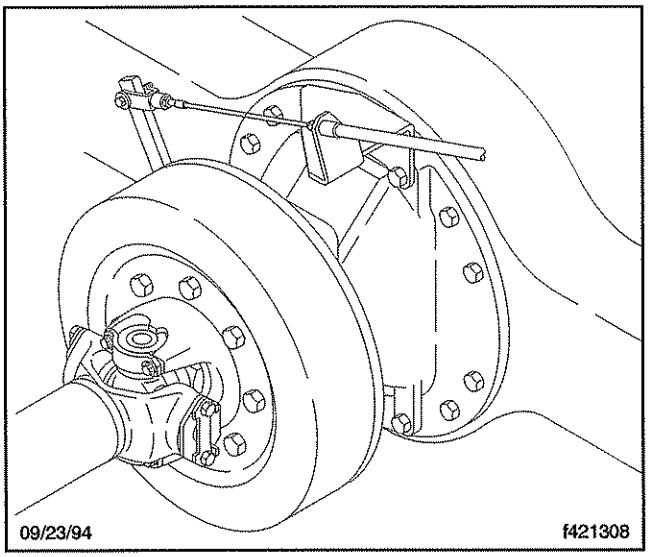
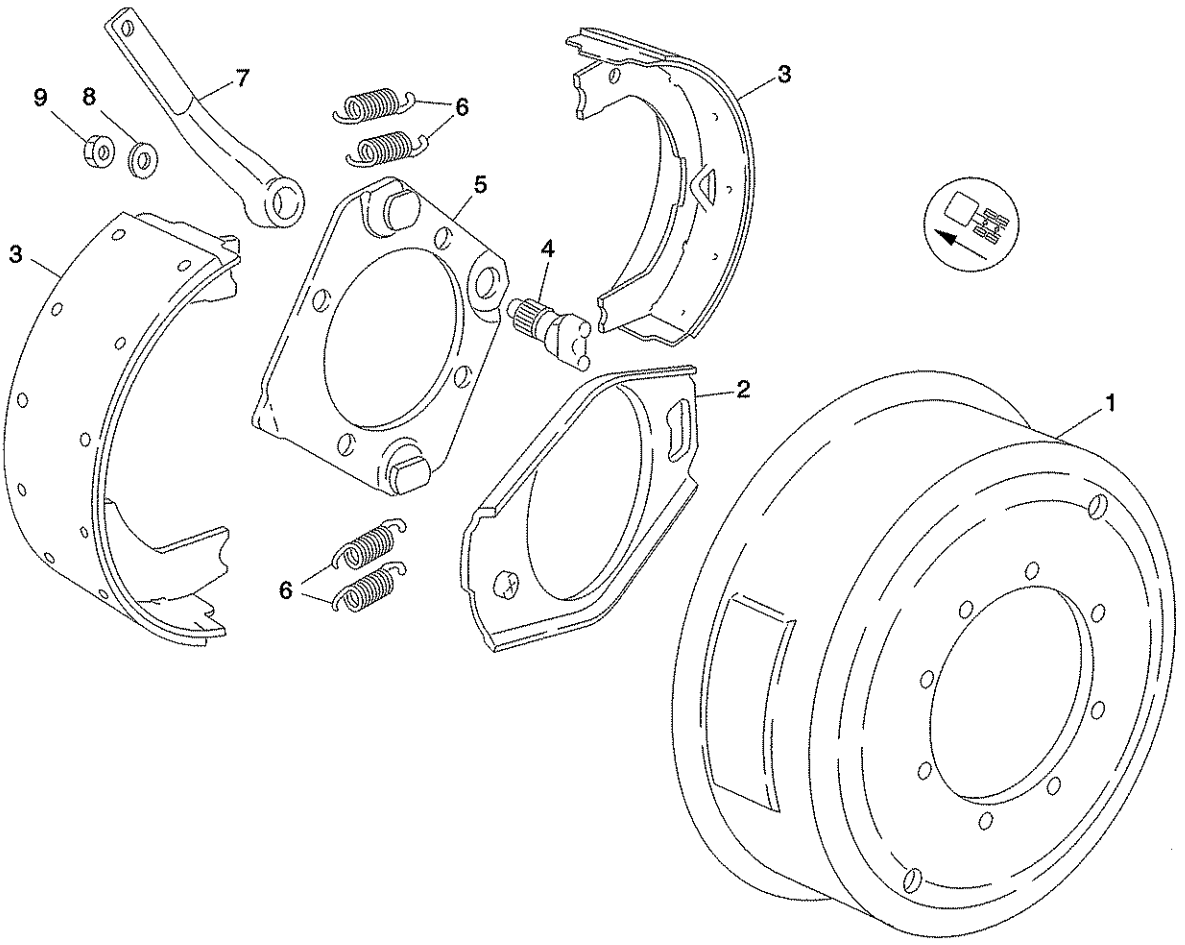


Fig. 2

General Description and Principles of Operation



NOTE: Not all parts are shown.

1. Drum
2. Actuator Strut
3. Brake Shoe
4. Cam
5. Backing Plate
6. Return Springs
7. Actuating Lever
8. Washer
9. Nut

Fig. 3

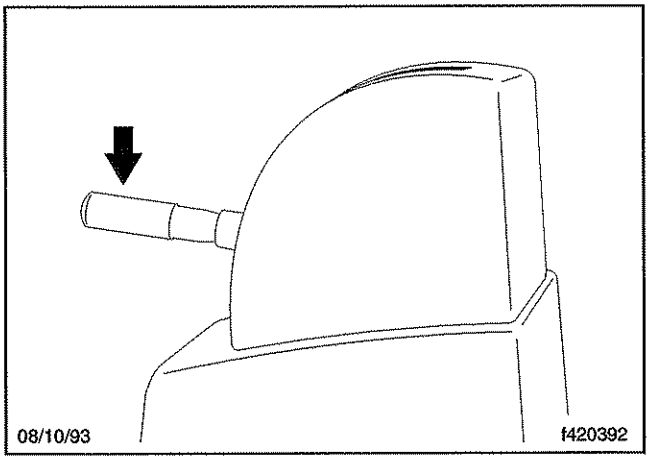
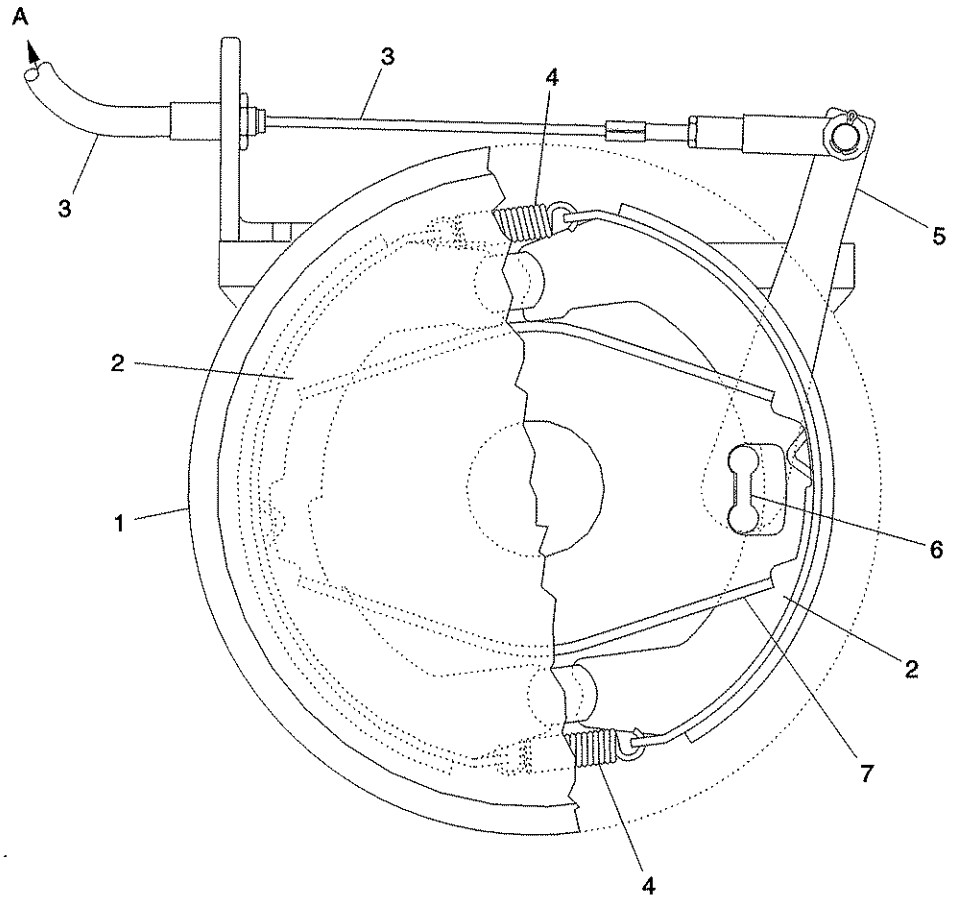


Fig. 4

General Description and Principles of Operation



09/20/93 f420389

A. To parking brake lever in the cab.

1. Brake Drum (shown cut away)
2. Brake Shoe
3. Brake Cable
4. Return Springs
5. Actuating Lever
6. Cam
7. Actuator Strut

Fig. 5, Transmission-Mounted Parking Brake Shown

Safety Precautions

Because most brake linings contain asbestos, you should know the potential hazards of asbestos and the precautions to be taken. Because medical experts believe that long-term exposure to some non-asbestos fibers could also be a health hazard, also observe the following precautions if servicing non-asbestos brake linings.

Exposure to airborne brake lining dust can cause serious and possibly fatal diseases such as asbestosis (a chronic lung disease) and cancer.

During brake servicing, wear an air purifying respirator with high-efficiency filters. The respirator and filter must be approved by NIOSH or MSHA, and worn during all procedures.

OSHA recommends that enclosed cylinders equipped with vacuums and high-efficiency (HEPA) filters be used during brake repairs. Under this system, the entire brake assembly is placed within the cylinder and the mechanic works on the brake through sleeves attached to the cylinder. Compressed air is blown into the cylinder to clean the assembly, and the dirty air is then removed from the cylinder by the vacuum.

If such an enclosed system is not available, or can't be used, clean the brake assembly in the open air. During disassembly, carefully place all parts on the floor to minimize creating airborne dust. Using an industrial vacuum cleaner with an HEPA filter system, remove dust from all the brake parts. After vacuuming, remove any remaining dust using a rag soaked in water and wrung until nearly dry.

⚠ WARNING

WARNING: Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by MSHA or NIOSH. Wear a respirator at all times when servicing the parking brake, starting with removal of the brake drum and continuing through assembly.

Removal

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions 100." Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Chock the tires. Apply the parking brake to keep the brake drum in place when the driveline is disconnected.
2. Remove the driveline midship bearing carrier from the frame crossmember.
   - 2.1 Put a jackstand under the driveline at the rear of the midship bearing.
   - 2.2 Remove the bolts holding the midship bearing carrier to the bracket on the frame crossmember. **See Fig. 1.**
   - 2.3 Lower the driveline and midship bearing carrier onto the jackstand. It should rest securely on the jackstand.
3. Disconnect the driveline companion flange from either the transmission or rear axle companion flange. **See Fig. 2.**

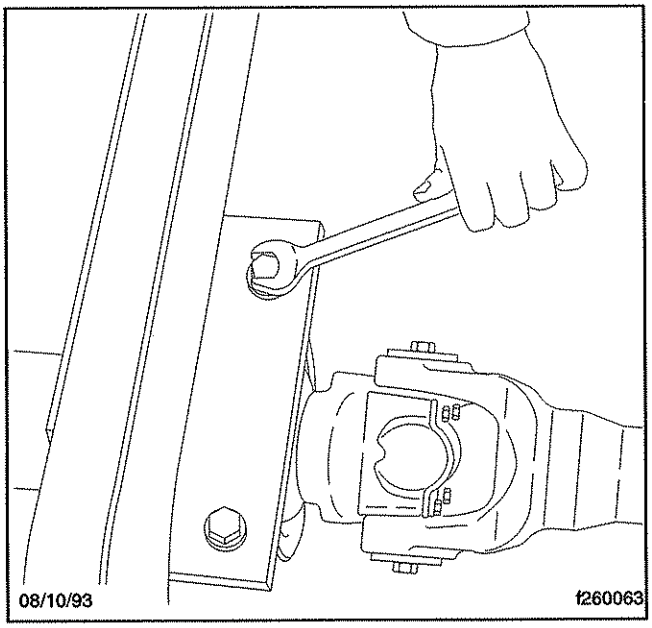


Fig. 1

4. Slide out the driveline, and lower it to the floor. **See Fig. 3.**
5. Release the parking brake.
6. Disconnect the brake cable from the actuating lever. **See Fig. 4.**

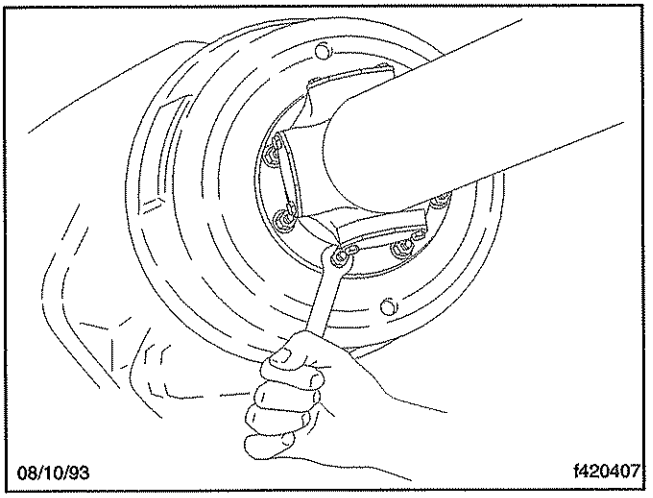


Fig. 2

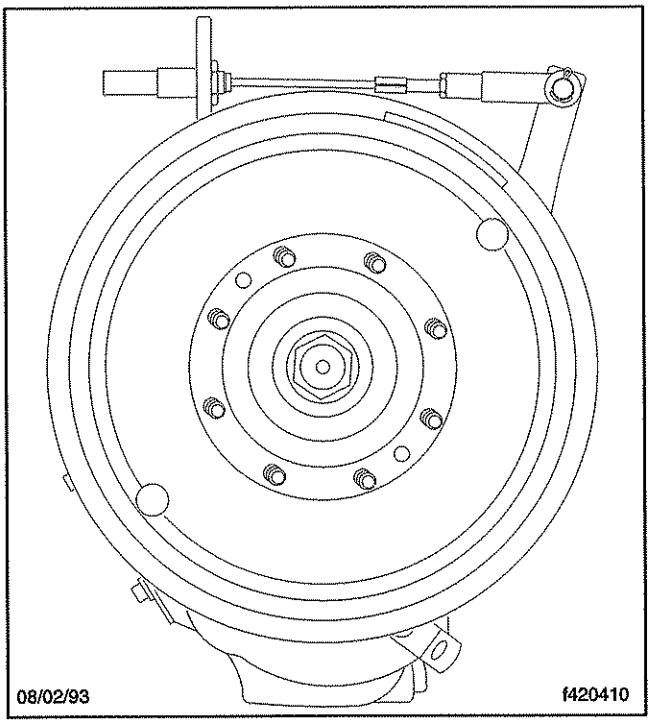


Fig. 3, Driveline Removed (transmision-mounted parking brake shown)

Removal and Installation

7. Pull the brake drum off either the transmission or rear axle companion flange. **See Fig. 5.**
8. Remove the brake shoes.
   8.1 Carefully remove the lower brake shoe return springs. **See Fig. 6.**

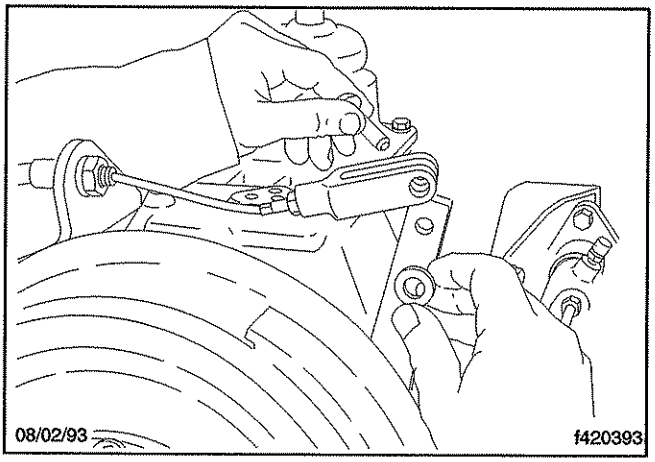


Fig. 4, (Transmision-mounted parking brake shown)

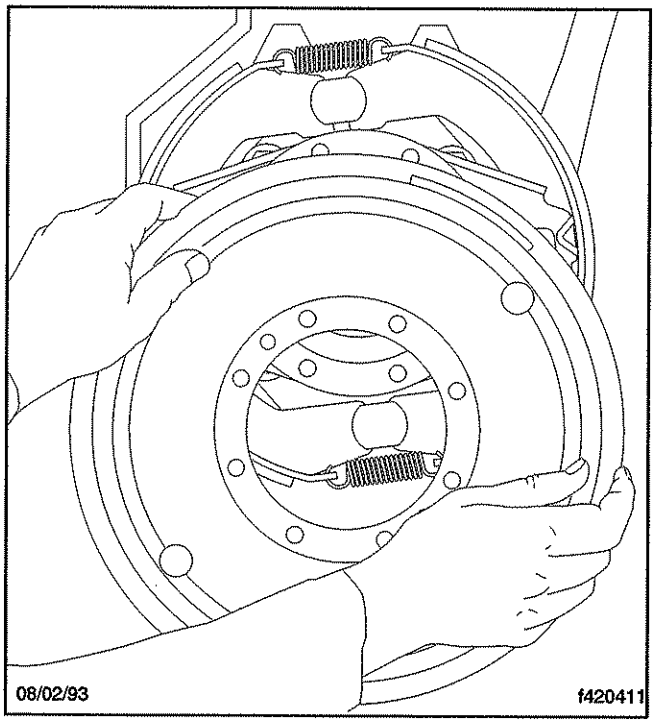


Fig. 5

   8.2 Pull the bottom of one brake shoe out, releasing the pressure on the upper return springs. **See Fig. 7.** Then remove the upper return springs.
   8.3 Remove both brake shoes.
9. Remove the actuator strut.
   9.1 Remove the large end-nut from either the transmission or rear axle shaft. **See Fig. 8.**
   9.2 Remove the companion flange that holds the actuator strut in place. **See Fig. 9.**
   9.3 Remove the actuator strut. **See Fig. 10.**
10. Remove the four hexbolts, washers, and nuts holding the backing plate to the square adapter on the end of the transmission (or rear axle), then remove the backing plate. **See Fig. 11** and **Fig. 12.**
11. If replacing the actuating lever or cam, remove them from the backing plate.
    11.1 Mark the splines of the lever and cam for later reference.

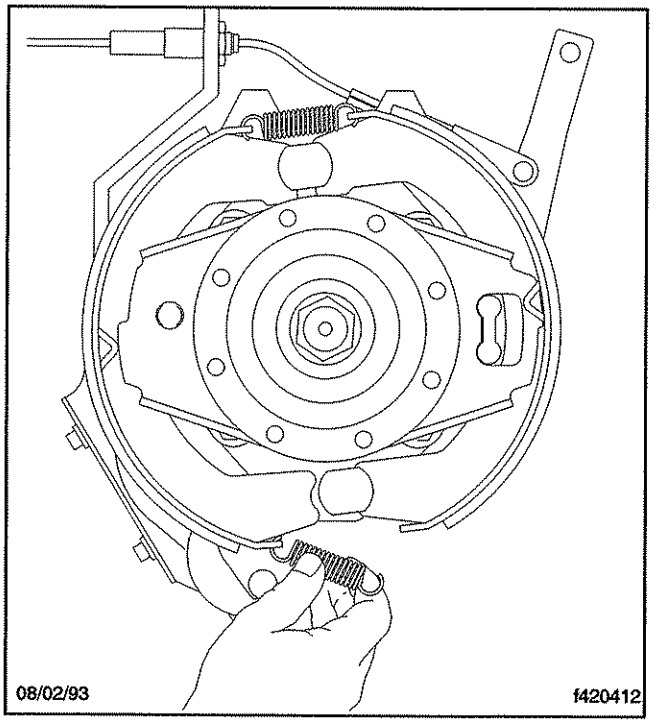


Fig. 6

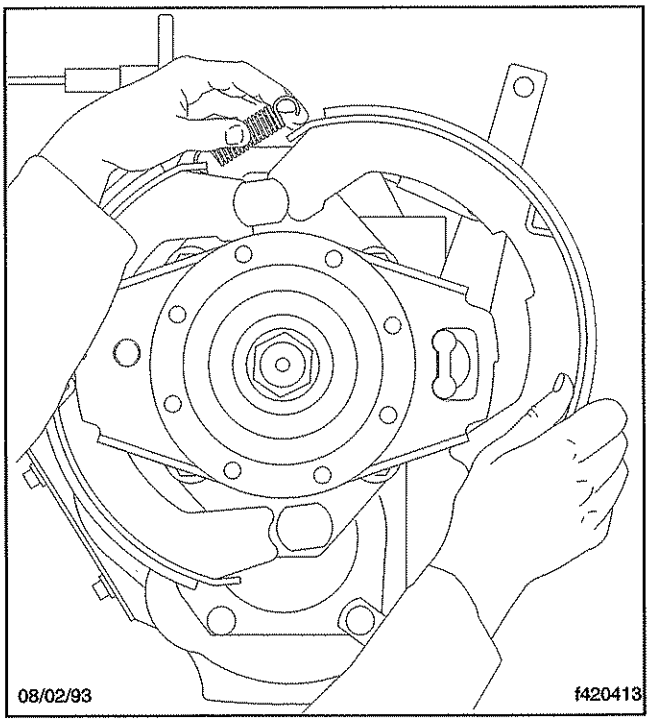


Fig. 7

11.2 Put the backing plate in a padded vise, then remove the nut and washer holding the lever and the cam together. Remove them from the backing plate. **See Fig. 13** and **Fig. 14.**

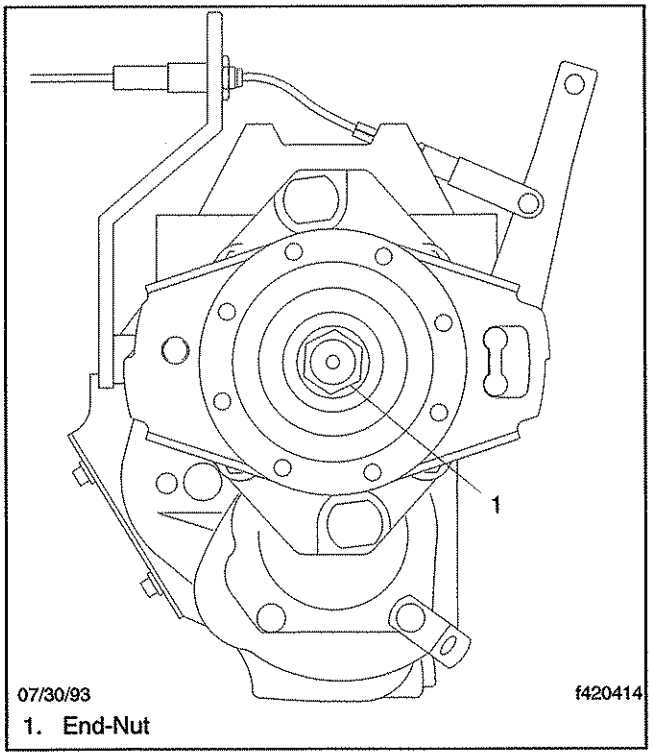
Installation

1. Clean all the parts. Check for damage and corrosion, and replace parts if needed. Check the backing plate for cracks or bending. Replace it if needed.

⚠ CAUTION

CAUTION: Don't let any grease get on the brake drum or linings. Grease on these parts will reduce the effectiveness of the driveline parking brake. If brake linings become contaminated, replace them.

2. Using NLGI grade 2 brake grease, lubricate the following parts (**see Fig. 15**):
   - cam head face and journals;
   - the mating surfaces of the brake shoe webs and the actuator strut;
   - at both sides of the cam hole in the backing plate.
3. If the cam and actuating lever were removed, install them on the backing plate.
   - 3.1 Put the cam through the hole in the backing plate. **See Fig. 14.**
   - 3.2 Using the reference marks made during removal, align the splines of the actuating lever with those of the cam, then install the lever on the cam.
   - 3.3 Install the nut and washer on the cam. **See Fig. 13.** Tighten the nut until there is 0.025 to 0.25 mm (0.001 to 0.010 inch) clearance between the actuating lever and the backing plate.
4. Using the four hexbolts, nuts, and washers, install the backing plate on the transmission or rear axle. **See Fig. 11.** Tighten the nuts.



1. End-Nut

Fig. 8

Removal and Installation

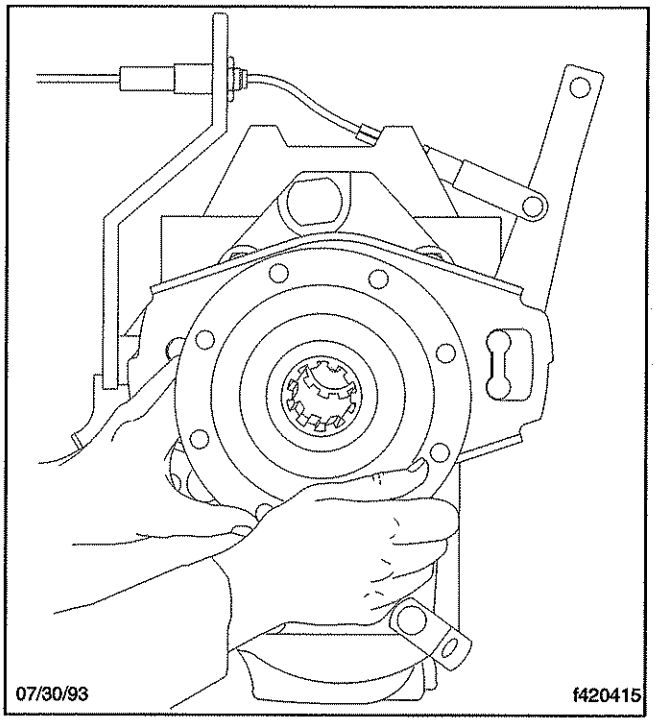
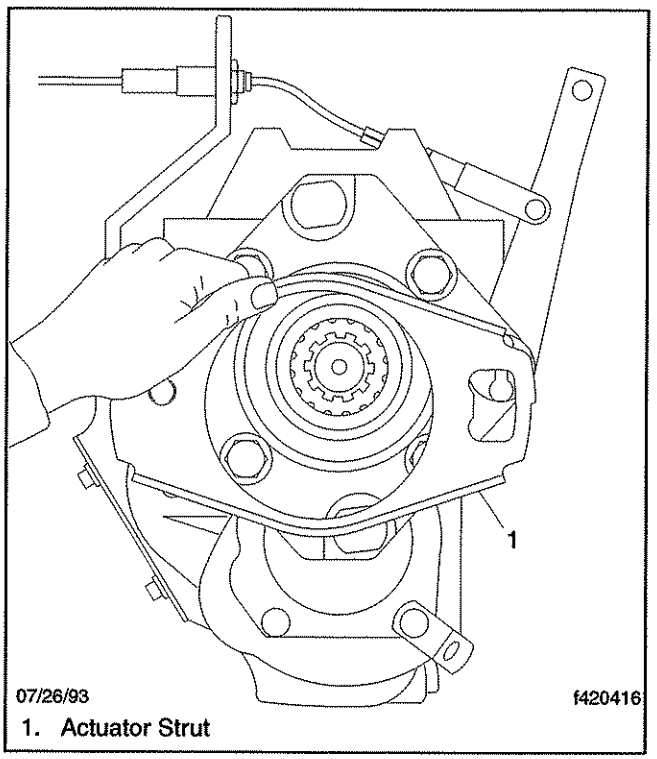


Fig. 9

- If mounted on Fuller transmissions—230 to 251 N·m (170 to 185 lbf·ft)
- If mounted on Allison transmissions—203 to 224 N·m (150 to 165 lbf·ft)
- If mounted on the rear axle—203 to 224 N·m (150 to 165 lbf·ft)

5. Install the brake shoes on the backing plate so that the web ends are up against the bosses on the backing plate.
6. Install four new brake return springs.
7. Install the actuator strut on the backing plate.
   - 7.1 Put the actuator strut on the backing plate so its pressure points are against those of the brake shoe webs, and so the slot in the actuator strut will go over the cam.
   - 7.2 Install the companion flange over the splines of the transmission shaft (or rear axle shaft). **See Fig. 9.**
   - 7.3 Install the large end-nut on the end of the transmission or rear axle shaft. **See Fig. 8.** Tighten the nut.



1. Actuator Strut

Fig. 10

- If mounted on Fuller transmissions—440 N·m (325 lbf·ft)
- If mounted on Allison transmissions—950 N·m (700 lbf·ft)
- If mounted on the rear axle—1000–1250 N·m (740–920 lbf·ft)

8. Install the brake drum onto the studs of the transmission (or rear axle) companion flange. **See Fig. 5.**
9. Connect the driveline companion flange to the transmission (or rear axle) companion flange.
   - 9.1 Place the driveline companion flange so its holes fit over the studs on the transmission (or rear axle) companion flange.
   - 9.2 Install the eight nuts and washers on the studs. **See Fig. 3.** Tighten them 61 N·m (45 lbf·ft).
10. Connect the brake cable to the brake lever.

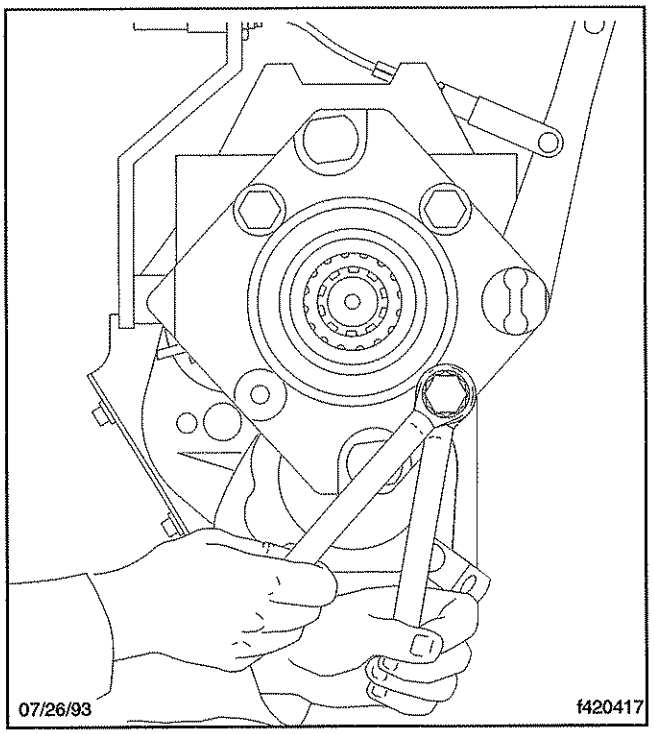


Fig. 11

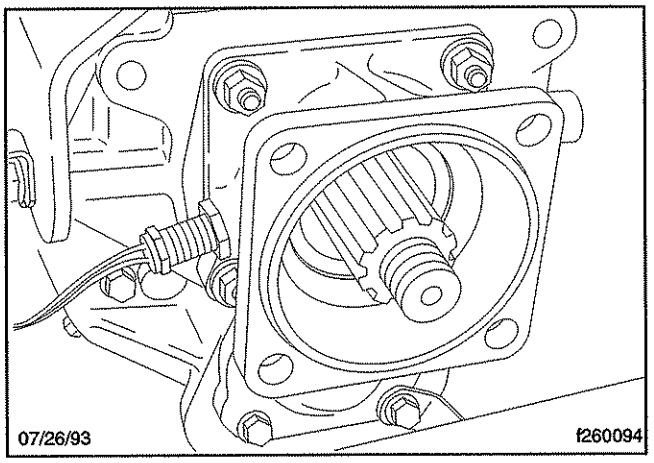


Fig. 12, Backing Plate Removed

10.1 Check the length of the brake cable. It should be just long enough to let the clevis hole align with the hole in the actuating lever, without moving the actuating lever. **See Fig. 16.**

If the brake cable is too loose or too tight, screw the clevis in or out until the its holes line up with the hole in the actuating lever (without moving the lever). **See Fig. 17.**

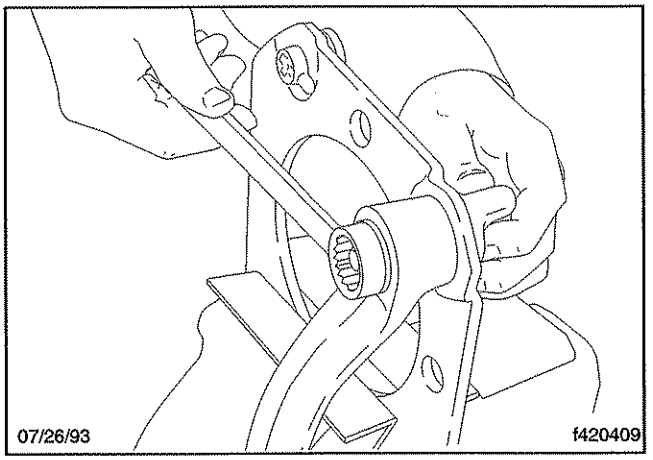


Fig. 13

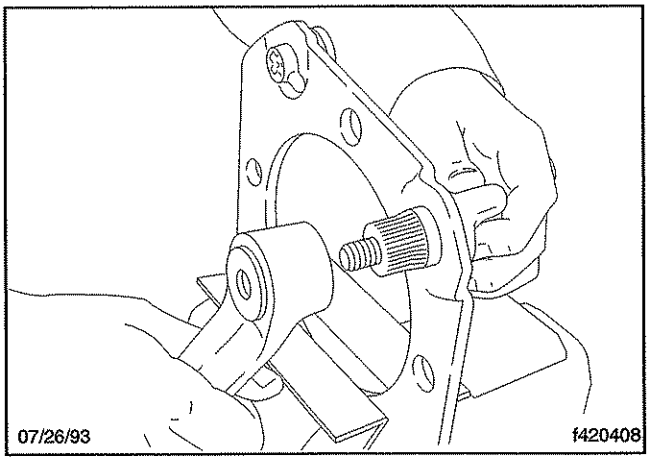


Fig. 14

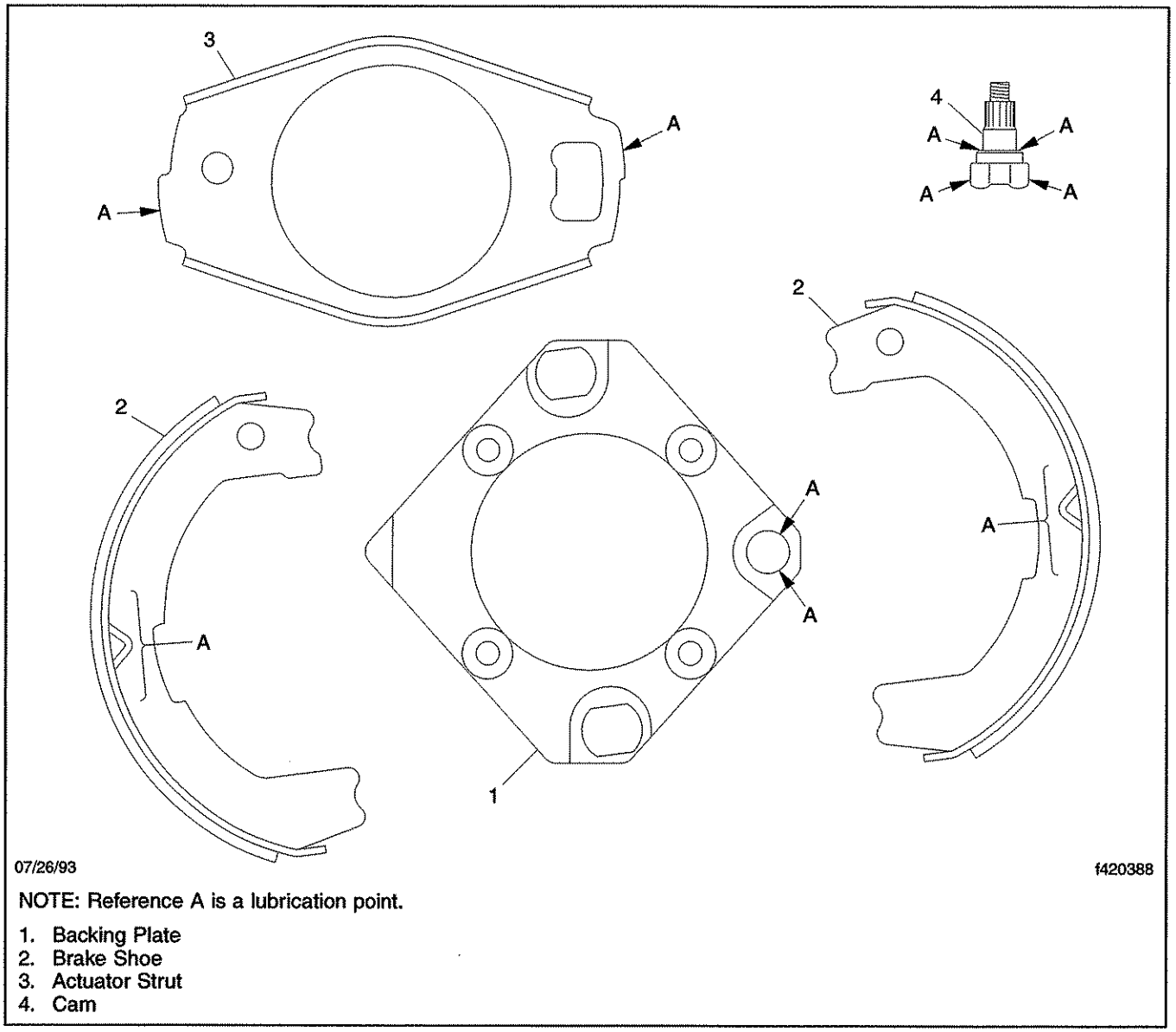
10.2 Install the clevis pin through the clevis and actuating lever holes.

10.3 Install the washer and a new cotter pin on the clevis pin.

10.4 Check the brake cable again for any slack. If it still needs adjusting, do it in the cab by turning the ring on the handle of the parking brake lever. **See Fig. 18.**

11. Attach the driveline midship bearing carrier to the bracket on the frame crossmember. Tighten the fasteners 123 N·m (91 lbf·ft).

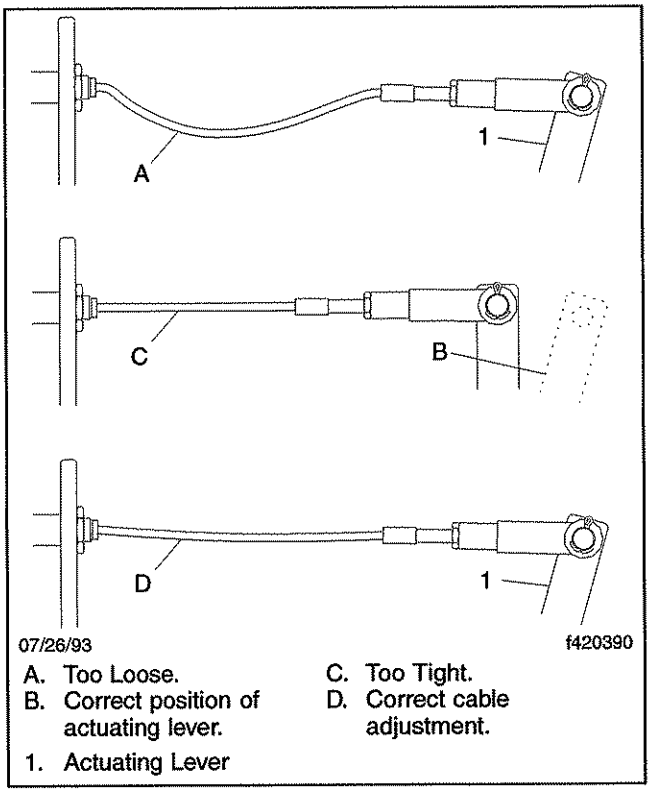
Removal and Installation



NOTE: Reference A is a lubrication point.

1. Backing Plate
2. Brake Shoe
3. Actuator Strut
4. Cam

Fig. 15



A. Too Loose.
B. Correct position of actuating lever.
C. Too Tight.
D. Correct cable adjustment.
1. Actuating Lever

Fig. 16, Brake Cable Tightness

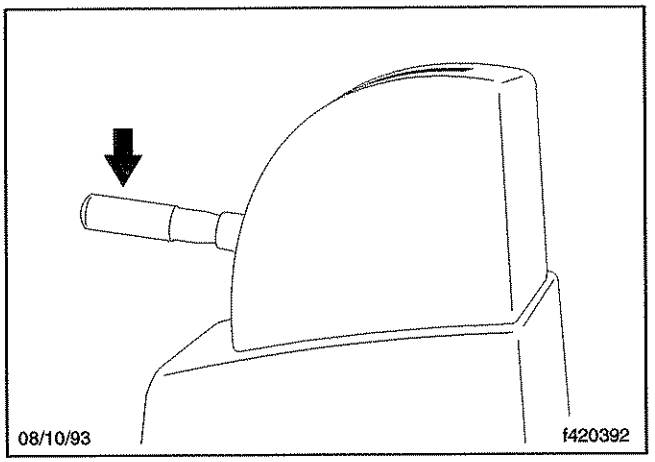


Fig. 18

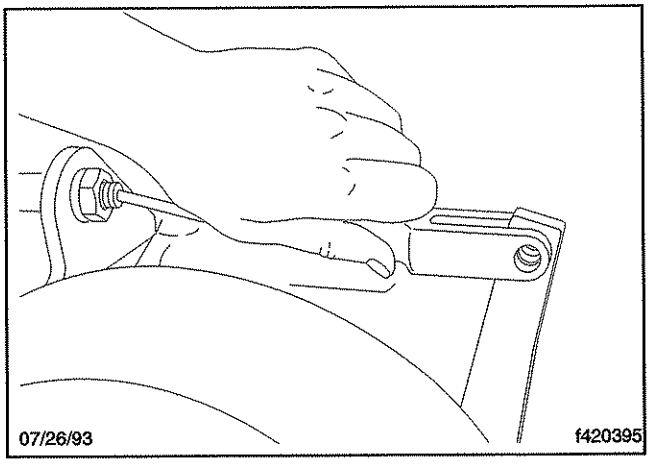


Fig. 17

Brake Shoe Replacement

Replacement

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Chock the tires. Apply the parking brake to keep the brake drum in place when the driveline is disconnected.
2. Remove the brake drum. For instructions, refer to **Subject 110.**
3. Check the inside of the brake drum for cracking, scoring, or other damage. If needed, resurface or replace the drum. If the inside diameter of the drum is more than 307 mm (12.09 inches), replace the drum.
4. Remove the old brake shoes.
   - 4.1 Carefully remove the lower brake shoe return springs. **See Fig. 1.**
   - 4.2 Pull the bottom of one brake shoe out, releasing the pressure on the upper return springs, then remove the upper return springs. **See Fig. 2.**
   - 4.3 Remove both brake shoes.

⚠ CAUTION

CAUTION: Don't let any grease get on the brake drum or linings. Grease on these parts will reduce the effectiveness of the driveline parking brake. If brake linings become contaminated, replace them.

5. Using NLGI grade 2 brake grease, lubricate the following parts (**see Fig. 3**):
   - cam head face and journals;
   - the mating surfaces of the brake shoe webs and the actuator strut;
   - at both sides of the cam hole in the backing plate.
6. Install new brake shoes.
   - 6.1 Install the brake shoes on the backing plate so that the web ends are up against the bosses on the backing plate.
   - 6.2 Install four new brake return springs.
7. Install the brake drum and connect the driveline. For instructions, refer to **Subject 110.**
8. Adjust the brake cable by turning the ring on the end of the parking brake lever in the cab.

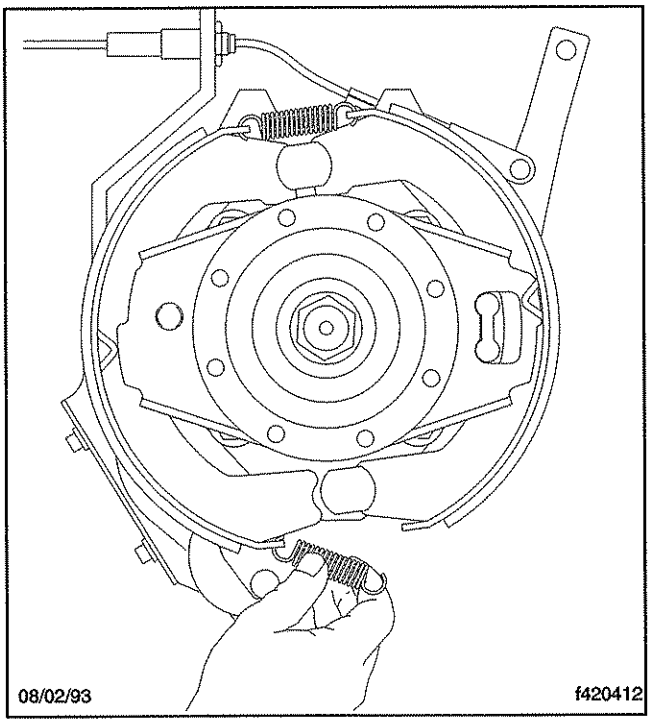


Fig. 1

Brake Shoe Replacement

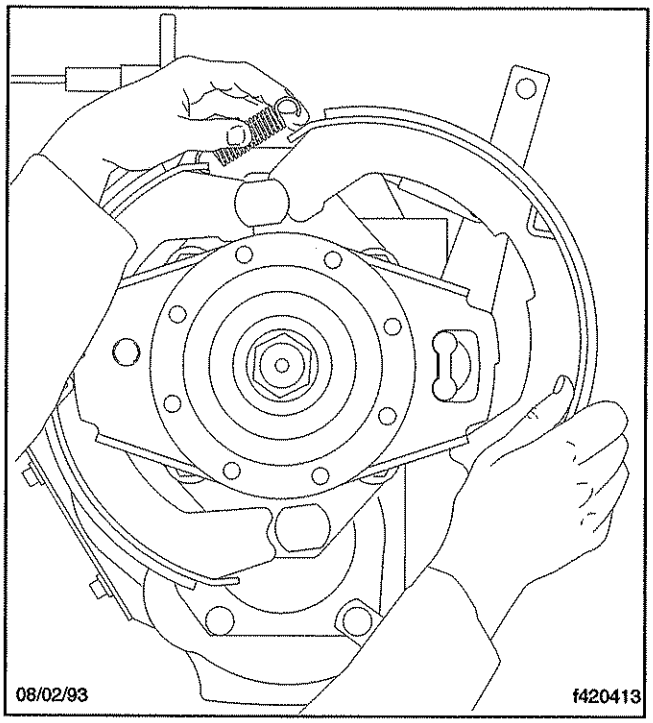
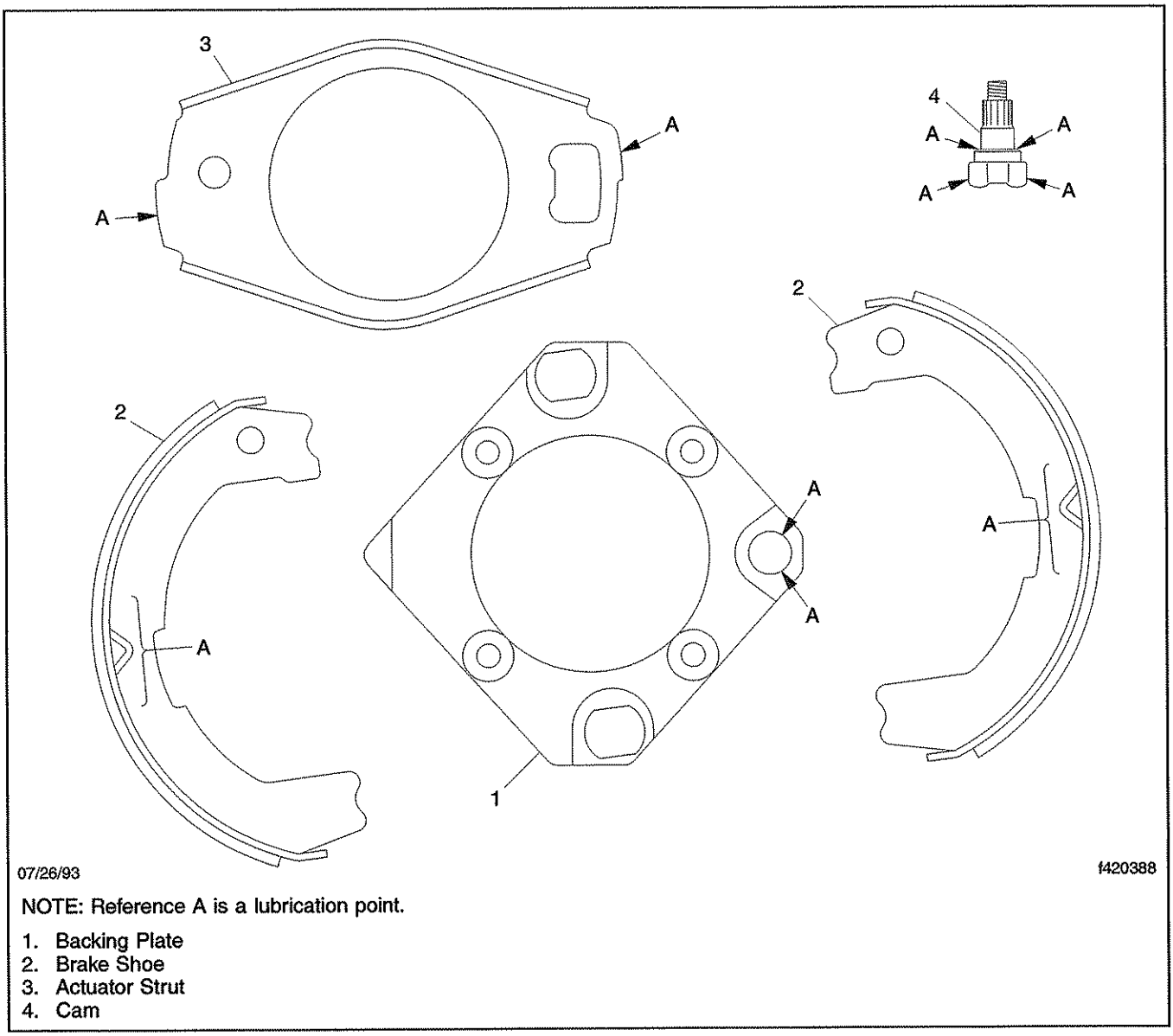


Fig. 2



NOTE: Reference A is a lubrication point.

1. Backing Plate
2. Brake Shoe
3. Actuator Strut
4. Cam

Fig. 3

Parking Brake Cable Replacement

Replacement

1. Chock the front and rear tires.
2. Release the parking brake.
3. At the driveline end, disconnect the brake cable from the actuating lever. **See Fig. 1.**
4. Unscrew the clevis from the cable (**see Fig. 2**); put the clevis aside.
5. Remove and save the small jam nut from the threaded end of the cable that was installed in the clevis.
6. Remove the brake cable jam nut and lock washer from the cable bracket on top of the transmission. **See Fig. 3.**

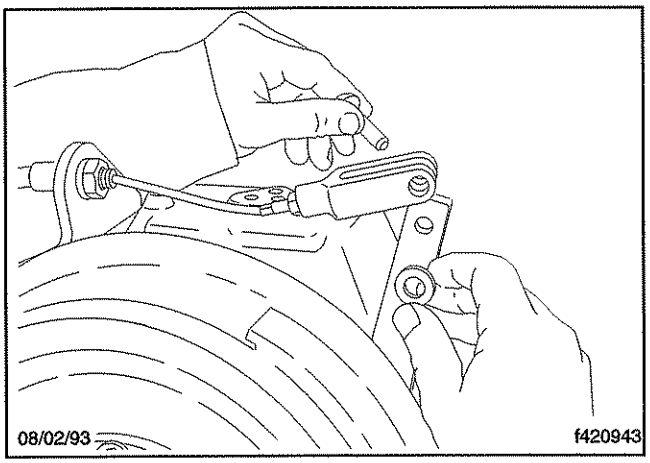


Fig. 1

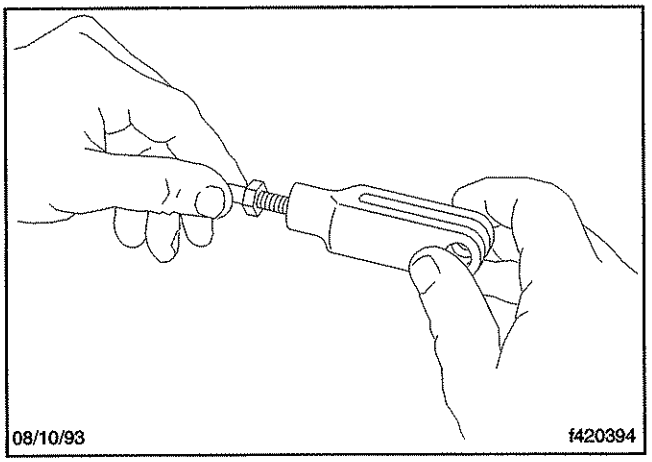


Fig. 2

7. Push the brake cable end through the "D" hole in the bracket. **See Fig. 4.**
8. In the cab, remove the plastic boot covering the brake lever assembly.
9. Remove the nut from the double cable clamp on the side of the transmission (**see Fig. 5**), then remove the brake cable from its half of the clamp.
10. Disconnect the parking brake cable from the parking brake lever. **See Fig. 6.**
11. Remove the parking lever assembly from the cab deck.
    - 11.1 Disconnect the electrical wire from the right side of the parking brake lever assembly. **See Fig. 7.**
    - 11.2 Remove the four mounting bolts and washers that hold the lever assembly to the cab floor. **See Fig. 8.**

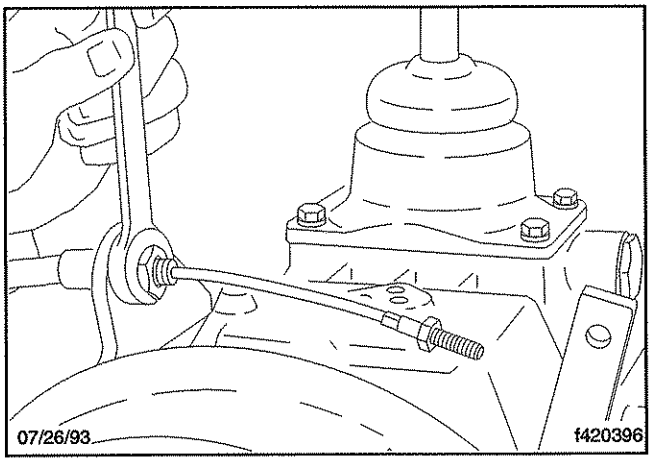


Fig. 3, Fuller Transmission Installation Shown

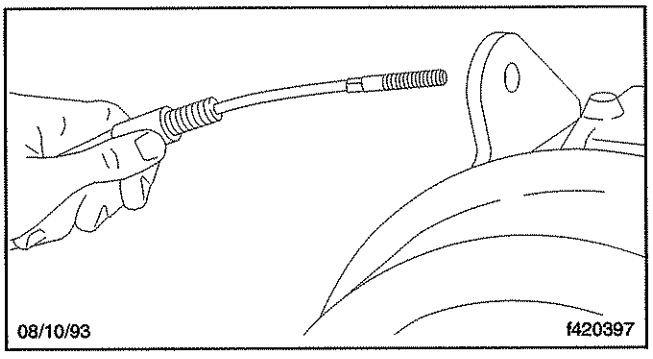


Fig. 4

Parking Brake Cable Replacement

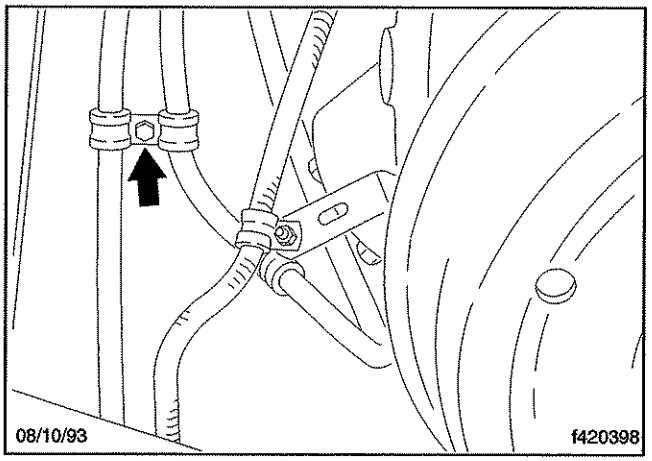


Fig. 5

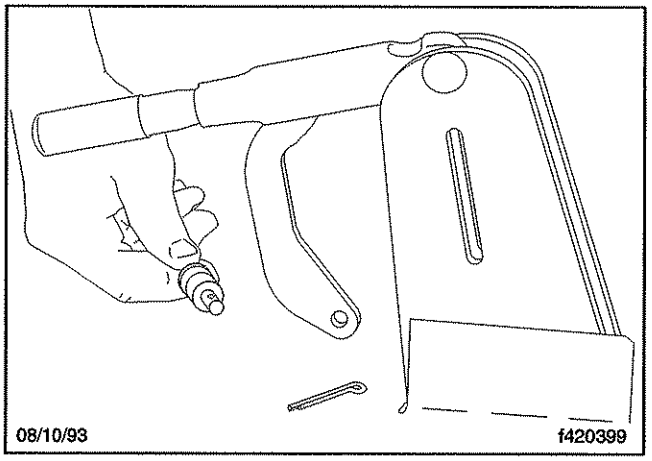


Fig. 6

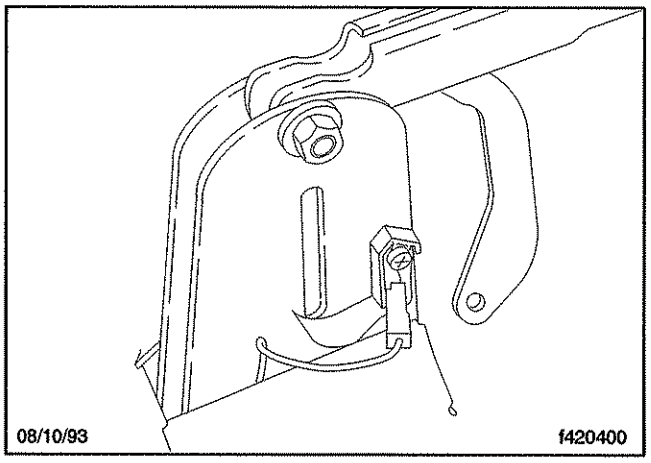


Fig. 7

11.3 Lift the lever assembly off the floor, and set it aside.

12. Remove the jam nut and lockwasher from the threaded end of the cable sheath coming through the hole in the cab deck. **See Fig. 9.**
13. Remove the baseplate by sliding the parking brake cable through the slot in the baseplate. **See Fig. 10.**
14. Pull the entire length of the parking brake cable up through the hole in the cab deck.
15. Check the parking brake lever assembly for wear and damage. Replace it if needed.
16. Put the clevis end of the new parking brake cable assembly in the slot of the baseplate, so that the

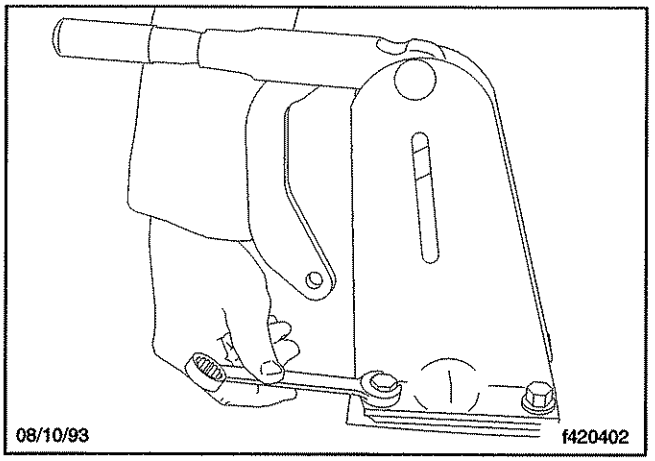


Fig. 8

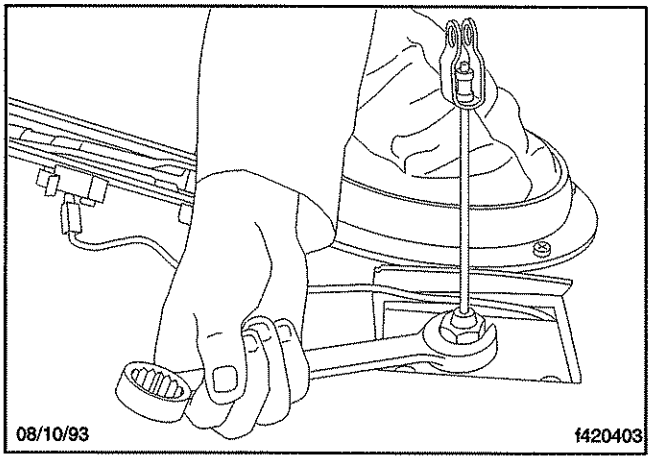


Fig. 9

Parking Brake Cable Replacement

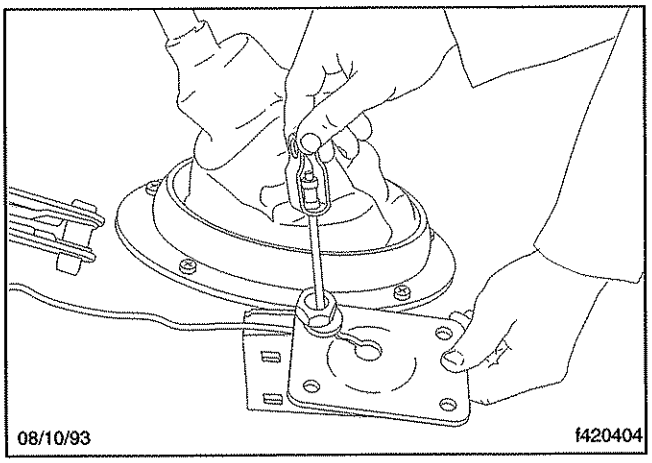


Fig. 10

jam nut and washer are on top of the base plate. **See Fig. 10.**

17. Install the lockwasher and jam nut on the cable sheath. Tighten the nut firmly. **See Fig. 9.**
18. Install the free end of the parking brake cable through the hole in the deck. Pull about a foot of the cable up through the sheath.
19. Connect the new cable to the parking brake lever assembly.
    - 19.1 Install the bushing on the clevis pin. **See Fig. 6.**
    - 19.2 Put the clevis end of the cable up through the middle of the parking brake lever assembly.
    - 19.3 Put the curved brake lever arm (**Fig. 6**) into the middle of the brake lever assembly, and into the clevis.
    - 19.4 Line up the slots in the brake lever assembly, the hole in the curved arm, and the holes in the clevis.
    - 19.5 Install the clevis pin (with the bushing on it) from the side of the lever assembly with the electric wire connector (**Fig. 7**).
    - 19.6 Install the washer and cotter pin on the clevis pin.
20. Install the parking brake lever assembly on the cab deck.
    - 20.1 Put the baseplate on the deck, lining up the holes in the plate with those in the deck.
    - 20.2 Put the lever assembly in place so that its holes and those of the baseplate and the deck all line up.
    - 20.3 Install the four mounting bolts and washers. Tighten the fasteners firmly.
21. Connect the electrical wire to the passenger's side of the parking brake lever assembly. **See Fig. 7.**
22. Underneath the cab, route the parking brake cable through the double cable clamp on the side of the transmission (**Fig. 5**), and then up to the cable bracket on the top of the transmission (or rear axle).
23. Put the cable through the "D" hole in the bracket, then install the lockwasher and jam nut on the threaded end of the cable sheath. Don't tighten the nut all the way. **See Fig. 3.**
24. Connect the parking brake cable to the parking brake actuating lever.
    - 24.1 Screw the threaded end of the cable into the clevis far enough so the clevis holes will line up with the hole in the actuating lever. There should be no slack in the cable. **See Fig. 11.**
    - 24.2 Install the clevis pin in the holes of the clevis and that of the actuator lever.
    - 24.3 Tighten the jam nut (installed previously) 900 N·cm (80 lbf·in).
    - 24.4 Install the washer and a new cotter pin.
25. If a final cable adjustment is needed, make it in the cab, by turning the ring on the parking brake lever. **See Fig. 12.**

Parking Brake Cable Replacement

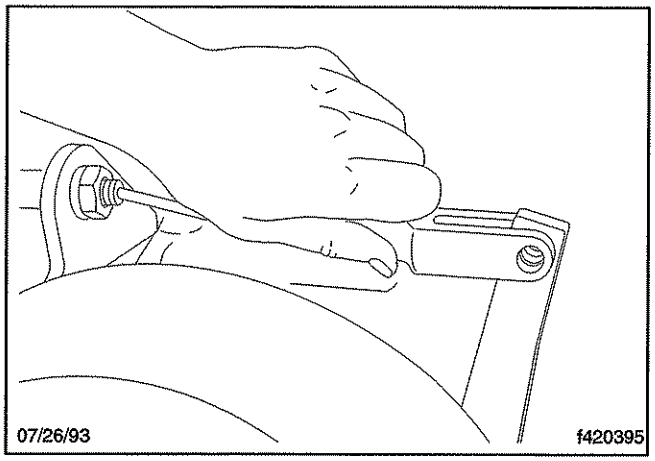


Fig. 11

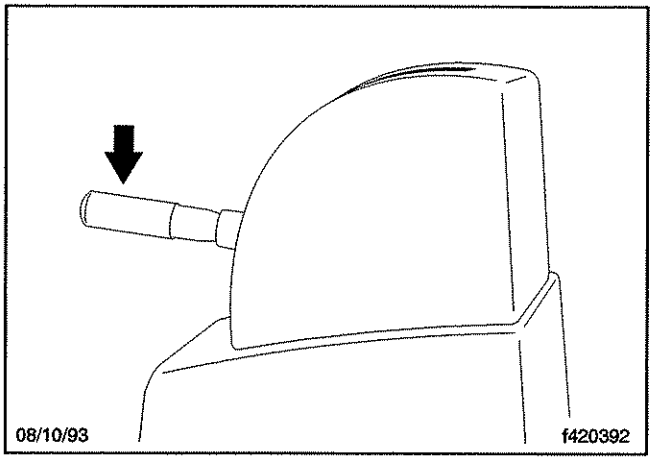


Fig. 12

Troubleshooting

This subject contains the following troubleshooting tables:

- The Parking Brake Won't Hold the Vehicle on a Grade
- The Parking Brake Won't Release
- The Parking Brake Makes Noises While the Vehicle Is Moving

Problem—The Parking Brake Won't Hold the Vehicle on a Grade

Possible Cause	Remedy
The brake shoe linings are worn down.	Replace the brake shoes.
The brake drum is cracked.	Replace the drum.
The brake drum lining is worn down, or heavily scored.	Replace the drum.
The brake cable is binding.	Repair or replace the cable.
There is too much slack in the brake cable.	Adjust the brake cable.
The brake shoe linings have grease on them.	Replace the brake shoes, then clean the inside of the drum.

Problem—The Parking Brake Won't Release

Possible Cause	Remedy
The brake cable is too tight.	Adjust the brake cable.
The brake shoe return springs are missing, detached, or broken.	Check the return springs. Install them or replace them as needed.
The contact points between the brake shoe webs and the actuator strut are corroded or dirty.	Check the area, and clean and lubricate as needed.
The parking brake lever in the cab is binding.	Check the parking brake lever assembly for damage or corrosion. Repair or replace as needed.

Problem—The Parking Brake Makes Noises While the Vehicle Is Moving

Possible Cause	Remedy
The parking brake drum is loose.	Check the brake drum mounting bolts. Tighten as needed.
The brake shoes or backing plate is loose.	Check the brake shoes, return springs, and backing plate mounting bolts. Tighten, repair, or replace, as needed.
There is dirt inside the brake drum.	Remove the brake drum and clean it. Also clean other brake parts.

Specifications

Description	Torque	
	N·m (lbf·ft)	N·cm (lbf·in)
Transmission End-Nut		
Fuller	440 (325)	—
Allison	950 (700)	
Rear Axle End-Nut (Input Shaft)		
Rockwell RS-13-120, RS-15-120, RS-17-145 and -220, RS-19-145 and -220, and RS-21-145 and -230	1000–1250 (740–920)	—
Backing Plate Mounting Bolts:		
Fuller Transmissions	230–251 (170–185)	—
Allison Transmissions	203–224 (150–165)	
Rear Axle	203–224 (150–165)	
Brake Drum Mounting Bolts	61 (45)	—
Midship Bearing Carrier Mounting Bolts	123 (91)	—
Cable Bracket Jam Nut (on top of transmission or rear axle)	—	900 (80)

Table 1, Fastener Torques

Contents

Subject	Subject Number
General Description and Principles of Operation	050
Service Operations	
Removal and Installation	100
Disassembly, Cleaning and Inspection, and Assembly	110
Specifications	400

General Description and Principles of Operation

General Description

The Rockwell automatic slack adjuster has two main functions:

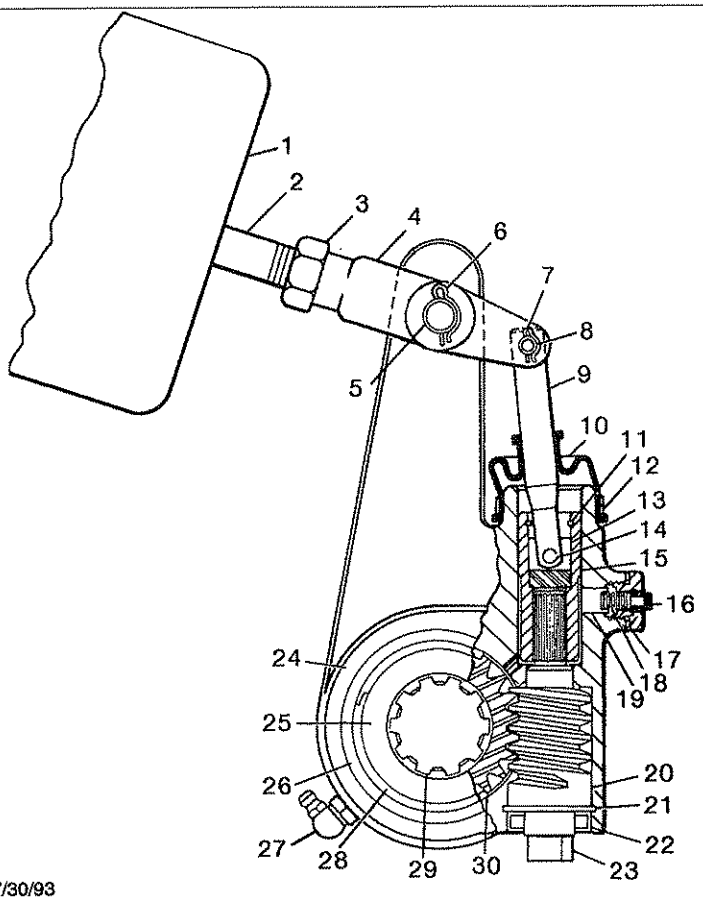
- As a lever, it converts the straight-line force of the brake chamber push rod to torque on the brake camshaft. Rotation of the camshaft forces the brake shoes against the brake drum.
- As an automatic adjuster, it automatically maintains brake chamber push-rod stroke, which controls lining-to-drum clearance during operation.

With an automatic slack adjuster, brakes are adjusted only when needed. As long as the push-rod stroke doesn't exceed the desired length, no adjustment takes place. Adjustment is made on the return stroke, as air is released and the forces in the gearset are low. The force to make an adjustment comes directly from the brake shoe return spring and the brake chamber return spring.

Principles of Operation (Refer to Fig. 1)

The externally splined end of the worm (Ref. 20) fits the internal splines on the actuator (Ref. 15). Angled serrations on the spring-held pawl (Ref. 19) correspond with serrations on the actuator exterior. The serrations are formed to allow free upward movement of the actuator, and to lock in on the actuator serrations on a downward movement.

As the brake is applied, the brake chamber push rod, connected to the end of the clevis, moves outward, forcing the slack adjuster arm to turn on the brake camshaft centerline. The actuator rod (Ref. 9) is connected to the clevis at one end, and to a small piston at the other end. As the slack adjuster arm



1. Brake Air Chamber
2. Brake Chamber Push Rod
3. Clevis Jam Nut
4. Clevis
5. Clevis Pin (large)
6. Cotter Pin (large)
7. Cotter Pin (small)
8. Clevis (small)
9. Actuator Rod
10. Boot
11. Piston Retaining Ring
12. Boot Retaining Clamp
13. Actuator Piston
14. Roller (Pin)
15. Actuator (Adjusting Screw)
16. Pressure Relief Capscrew (shown 90 degrees out of position)
17. Gasket
18. Pawl Spring
19. Pawl Assembly
20. Worm
21. Worm Retaining Snap Ring
22. Worm Seal
23. Manual (Worm) Adjusting Nut End
24. Slack Adjuster
25. Gear
26. Gear Thrustwasher
27. Grease Fitting
28. Gear Retaining Ring
29. Camshaft Splines
30. Gear–to–Body Seal

Fig. 1

General Description and Principles of Operation

moves, the actuator rod is moved upward and outward, pulling the piston (Ref. 13) upward.

When lining wear becomes excessive, the brake chamber push-rod stroke goes beyond the desired length. The piston then makes contact with the retaining ring (Ref. 11) and pulls up the actuator. As the actuator moves upward and reaches a preset distance, it slides over one serration on the pawl. When the push rod moves back toward the brake chamber, the actuator is forced downward. Because the serrations in the pawl and actuator are now locked in, the actuator, following the curve of its serrations as it moves downward, turns slightly. This action causes the worm to turn, advancing the gear (Ref. 25) and the camshaft to automatically adjust the brake.

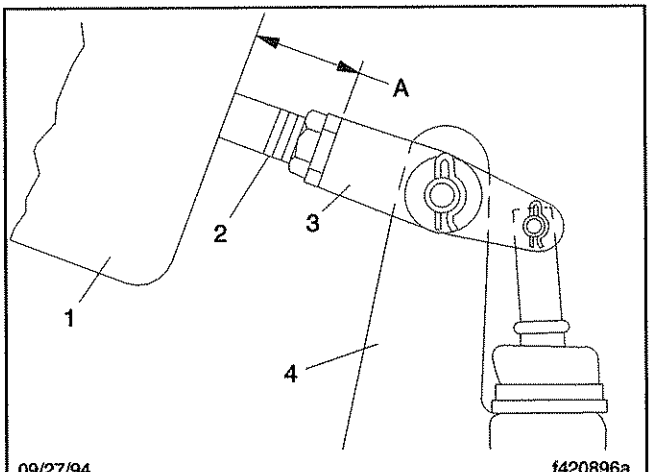
Removal

1. Park the vehicle on a level surface, and chock the tires. If the rear slack adjusters will be removed, release the parking brakes, then cage the power spring of the parking brake chamber.

⚠ WARNING

WARNING: Loss of brake chamber air pressure will cause sudden application of the parking brakes, which could result in personal injury. Manually cage each parking brake chamber power spring in the release (no application) position before continuing.

2. Mark or measure the position of the clevis on the brake chamber push rod. **See Fig. 1.**
3. Remove the cotter pins from the clevis pins. Remove the clevis pins.
4. Remove the pressure relief capscrew, spring, and pawl assembly from the slack adjuster housing. **See Fig. 2**, Refs. 17, 19, and 20. If equipped with a pull-pawl assembly **(Fig. 3),** carefully insert a screwdriver and raise the relief cap about 1/8 inch (3.2 mm).



A. Mark or measure this distance.
1. Brake Chamber
2. Brake Chamber Push Rod
3. Clevis
4. Slack Adjuster

Fig. 1, Mark or Measure the Clevis Position

⚠ CAUTION

CAUTION: Before turning the adjusting nut, remove the pressure relief capscrew, spring, and pawl assembly. If equipped with a pull-pawl assembly, raise the relief cap about 1/8 inch (3.2 mm). Failure to do so could strip the teeth on the pawl.

5. Using a wrench, turn the manual adjusting nut, and move the slack adjuster away from the clevis. **See Fig. 4.**
6. Remove the snap ring and washers that attach the slack adjuster to the brake camshaft and save them for later installation.
7. Remove the slack adjuster from the camshaft.
8. Note the location and number of any remaining spacing washers on the camshaft, and then remove them. Save them for later installation.
9. If replacing the clevis, loosen the clevis jam nut. Remove the clevis and jam nut from the brake chamber push rod.

Installation

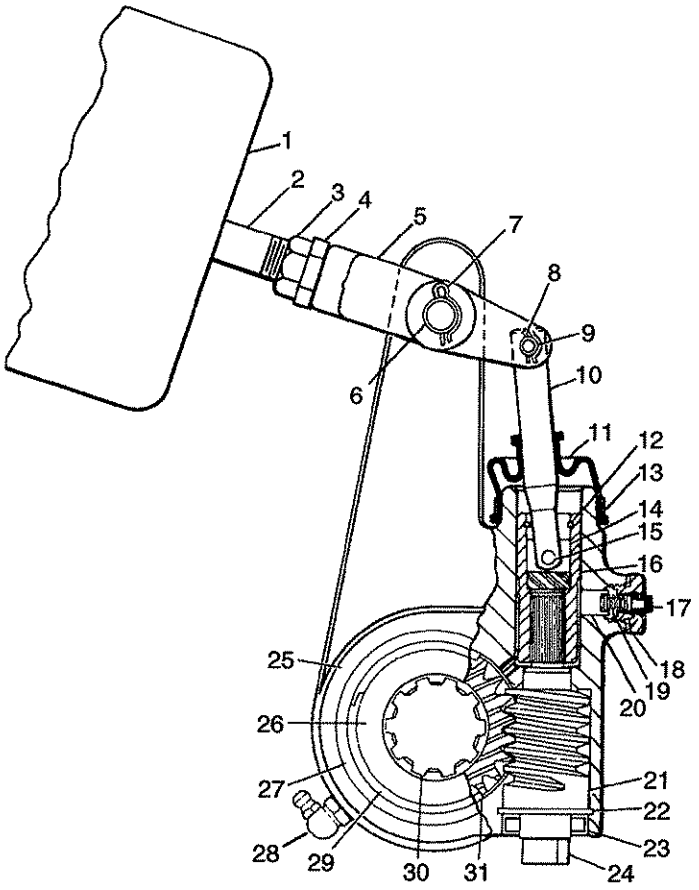
1. Inspect parts, and then prepare the slack adjuster for installation.
   - 1.1 Check the brake camshaft splines for wear or corrosion.
   - 1.2 Coat the camshaft splines and the splines of the slack adjuster gear with Rockwell lubricant 0-637, Southwest SA 8249496, or an equivalent.

   IMPORTANT: These lubricants provide corrosion protection. Do not mix these lubricants with other types.

   - 1.3 Apply the service brake and parking brake several times. Make sure the return spring retracts the push rod quickly and completely. Replace the return spring or brake chamber if needed.
2. If previously removed, install the clevis and jam nut.

   Check that the clevis is in the same position on the brake chamber push rod as marked or measured

Removal and Installation



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1. Brake Air Chamber
2. Brake Chamber Push Rod
3. Clevis Jam Nut
4. Quick-Connect Collar (if equipped)
5. Clevis
6. Clevis Pin (large)
7. Cotter Pin (large)
8. Cotter Pin (small)
9. Clevis Pin (small)
10. Actuator Rod
11. Boot
12. Piston Retaining Ring
13. Boot Retaining Clamp
14. Actuator Piston
15. Roller (Pin)
16. Actuator (Adjusting Screw)
17. Pressure Relief Capscrew (shown 90 degrees out of position)
18. Gasket
19. Pawl Spring
20. Pawl Assembly
21. Worm
22. Worm Retaining Snap Ring
23. Worm Seal
24. Manual (Worm) Adjusting Nut End
25. Slack Adjuster
26. Gear
27. Gear Thrustwasher
28. Grease Fitting
29. Gear Retaining Ring
30. Camshaft Splines
31. Gear-to-Body Seal

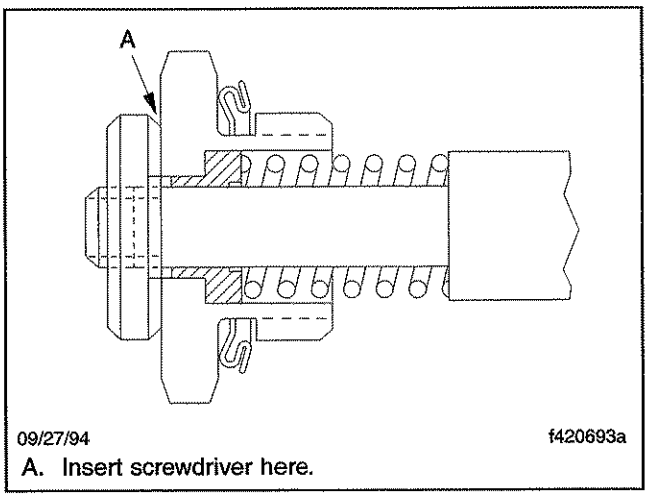
Fig. 2, Rockwell Automatic Slack Adjuster

during removal. Do not tighten the jam nut against the clevis.

NOTE: Use a clevis with a 1/2-20 UNF thread if equipped with type 9, 12, or 16 brake chambers. Use a clevis with a 5/8-18 UNF thread size if equipped with type 20, 24, 30, or 36 brake chambers.

3. Install the slack adjuster.

3.1 If installing a new slack adjuster, use an installation template **(Fig. 5)** and measure the new slack adjuster to make sure it is the same length as the slack adjuster that was removed. Refer to the appropriate table in **Specifications 400** for the length of slack



A. Insert screwdriver here.

Fig. 3, Pull-Pawl Assembly (sectional view)

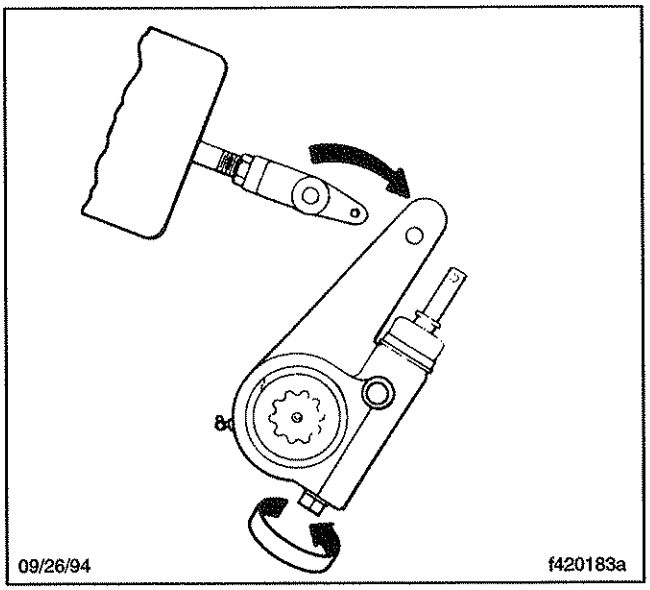


Fig. 4, Move the Slack Adjuster Away from the Clevis

adjusters that should be used with various sizes of brake chambers.

NOTE: Depending on the type of brakes used (disc or drum) on a tractor or trailer, several types of installation templates are used. They can be made using the measurements provided in **Fig. 6.** Or, they can be ordered from:

Attn: Literature Distribution Rockwell International 2135 W. Maple Road Troy, Michigan 48084

3.2 Position the slack adjuster on the camshaft.

3.3 Install the spacing washers and the snap ring that attach the slack adjuster to the camshaft. Add enough washers to limit the camshaft end play to 0.060 inch (1.5 mm). Check the end play using the instructions in the applicable brake chamber section in this manual.

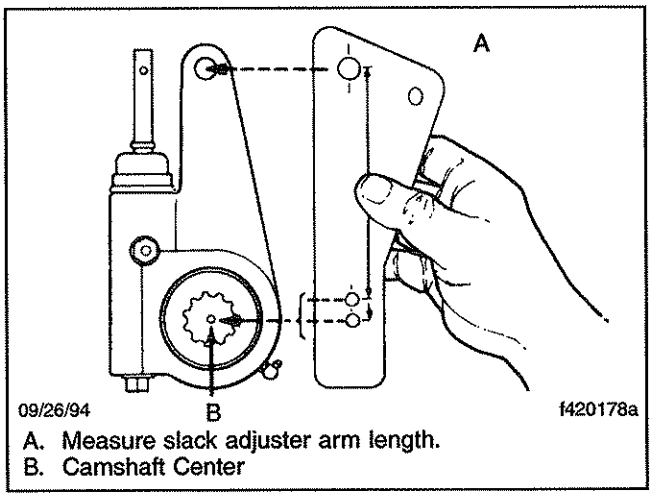
3.4 If installing a new slack adjuster, remove the pressure relief capscrew, spring, and pawl assembly from the slack adjuster housing. If equipped with a pull-pawl assembly **(Fig. 3),** carefully insert a screwdriver and raise the relief cap about 1/8 inch (3.2 mm).

⚠ CAUTION

CAUTION: Before turning the adjusting nut, remove the pressure relief capscrew, spring, and pawl assembly. If equipped with a pull-pawl assembly, raise the relief cap about 1/8 inch (3.2 mm). Failure to do so could strip the teeth on the pawl.

3.5 Using a wrench, turn the manual adjusting nut to align the hole in the slack adjuster housing with the large hole in the clevis. **See Fig. 7.** Insert the large clevis pin.

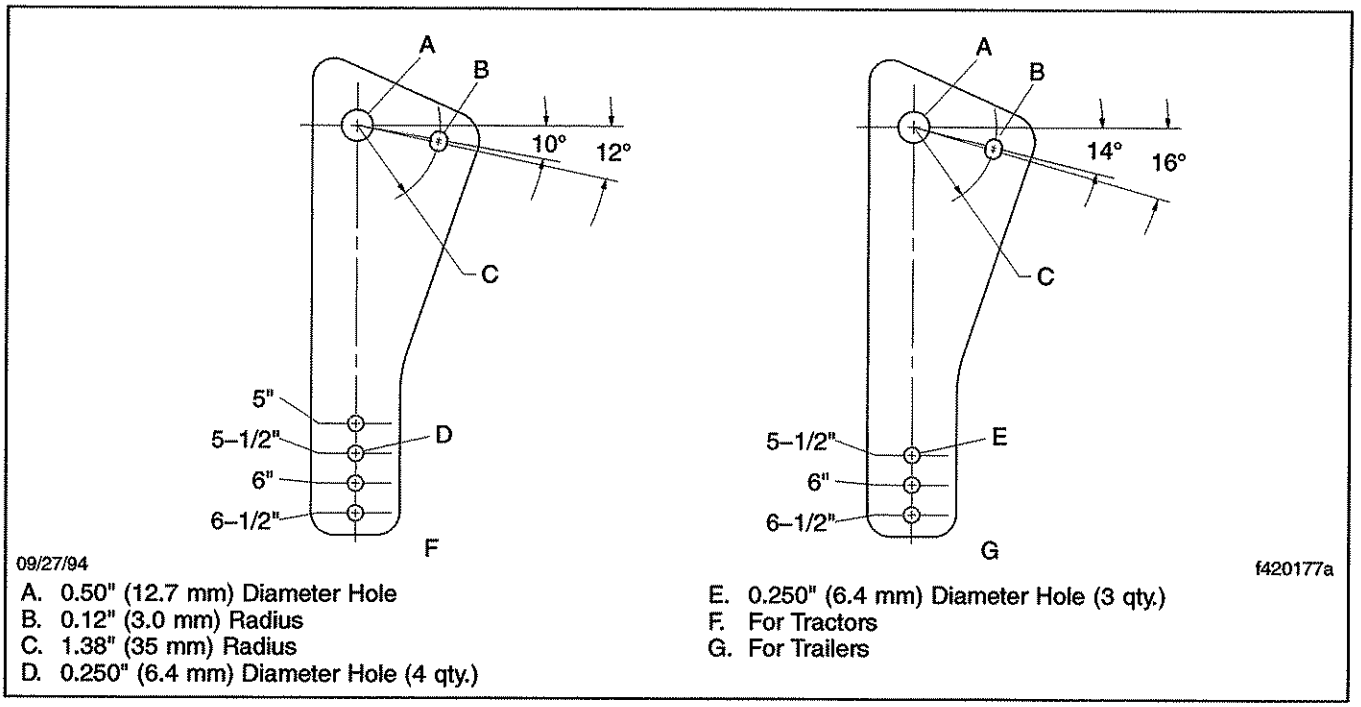
3.6 With the brakes fully released, place the applicable installation template over the clevis and camshaft end. **See Fig. 8.**



A. Measure slack adjuster arm length.
B. Camshaft Center

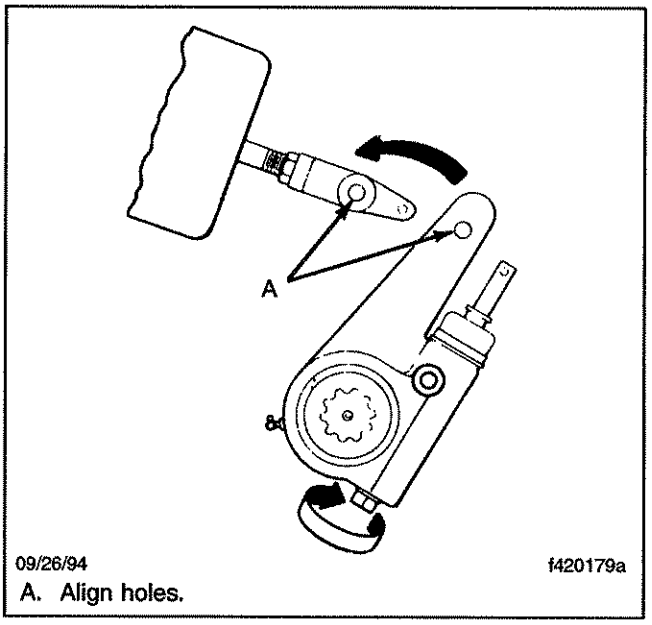
Fig. 5, Measure the New Slack Adjuster

Removal and Installation



A. 0.50" (12.7 mm) Diameter Hole
B. 0.12" (3.0 mm) Radius
C. 1.38" (35 mm) Radius
D. 0.250" (6.4 mm) Diameter Hole (4 qty.)
E. 0.250" (6.4 mm) Diameter Hole (3 qty.)
F. For Tractors
G. For Trailers

Fig. 6, Installation Template Specifications



A. Align holes.

Fig. 7, Aligning the Holes

3.7 Temporarily insert the large clevis pin through the large holes in the template and the clevis.

3.8 Select the hole in the template that matches the length of the slack adjuster. Hold the template in place on the center of the camshaft with a pencil.

3.9 Look through the small hole in the template and see if the small hole in the clevis is completely visible. If the hole in the clevis is not completely visible, adjust the position of the clevis on the push rod until the small clevis hole is completely visible. Temporarily place the small clevis pin through the template and clevis to make sure the alignment is correct. Remove both pins and the template. Insert both clevis pins with the pin head on the inboard side of the slack adjuster. Be sure the small clevis pin is inserted through the hole in the actuator rod. Install and lock new cotter pins to secure the clevis pins.

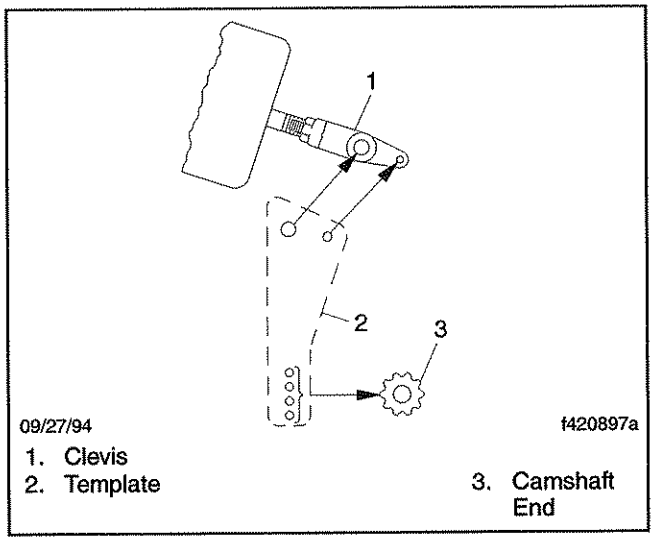


Fig. 8, Position the Installation Template

IMPORTANT: Make sure that there is at least 1/2 inch (13 mm) of thread engagement between the clevis and the push rod. Also, check that the push rod doesn't extend through the clevis more than 1/8 inch (3.2 mm). **See Fig. 9.** If needed, either cut the push rod, install a new push rod, or install a new brake chamber.

3.10 For 1/2-20 UNF threads, tighten the clevis jam nut 20 to 30 lbf·ft (27 to 41 N·m). For 5/8-18 UNF threads, tighten the jam nut 25 to 50 lbf·ft (34 to 68 N·m).

4. Set the free-stroke.

4.1 Turn the manual adjusting nut counterclockwise until the brake linings contact the brake drum.

4.2 Set the approximate clearance between the linings and the drum: turn the adjusting nut clockwise one-half turn.

4.3 With the brakes fully released, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 10**, Ref. B.

4.4 Use a pry bar to move the slack adjuster, and apply the brakes. Again, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 10**, Ref. A.

The difference between the two measurements is the initial free-stroke, and sets the clearance between the linings and the drum.

The free stroke must be:

drum brakes—5/8 to 3/4 inch (16 to 19 mm);

disc brakes—7/8 to 1-1/8 inch (22 to 29 mm).

If the free stroke is incorrect, turn the adjusting nut one-eighth turn, as shown in **Fig. 11.** Measure the stroke again, and adjust until it is correct.

5. Measure the brake chamber stroke, and adjust as needed.

5.1 With the brakes fully released, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 12**, Ref. A.

5.2 Build air pressure to 100 psi (689 kPa). Shut down the engine. Fully apply the brakes, then measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 12**, Ref. B. The difference between the measurements is the brake chamber stroke.

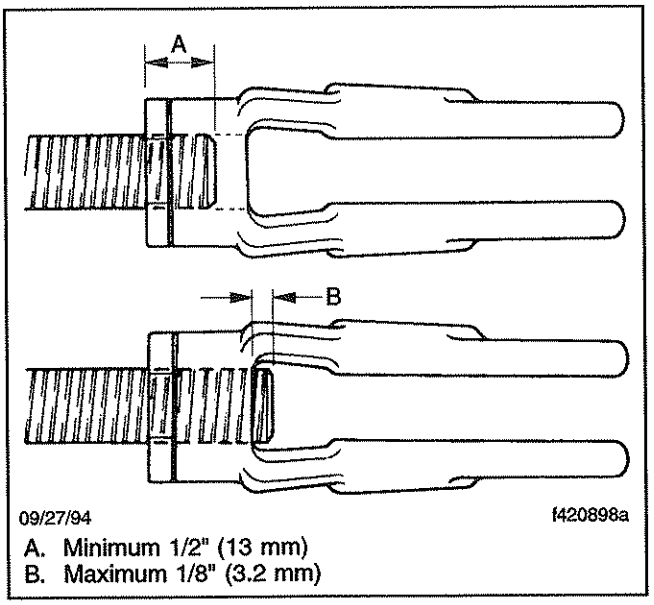
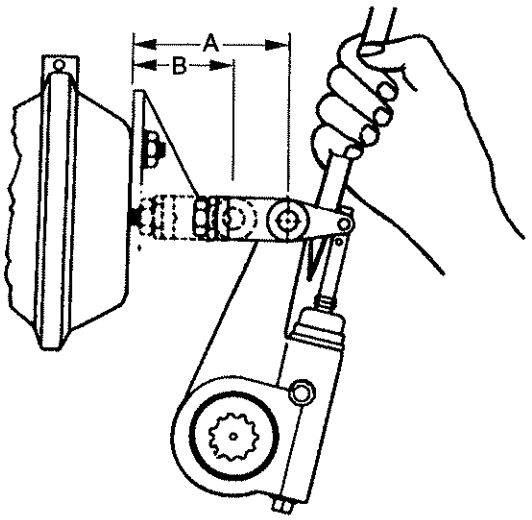


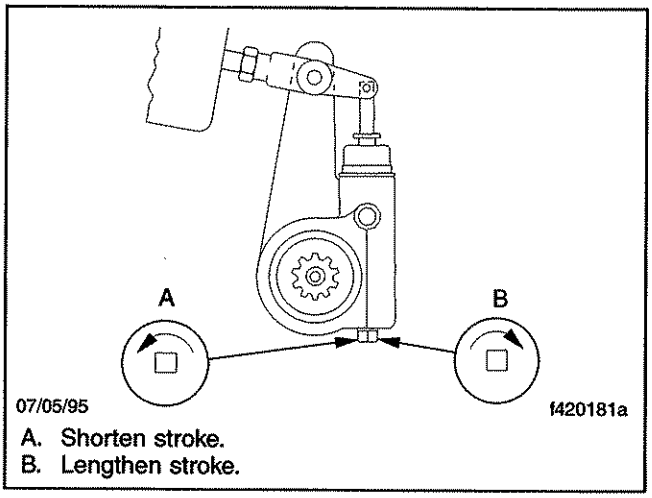
Fig. 9, Check Thread Engagement

Removal and Installation



NOTE: For a drum brake, A minus B must equal 5/8" to 3/4" (16 to 19 mm). For a disc brake, A minus B must equal 7/8" to 1-1/8" (22 to 29 mm).

Fig. 10, Measuring Free-Stroke

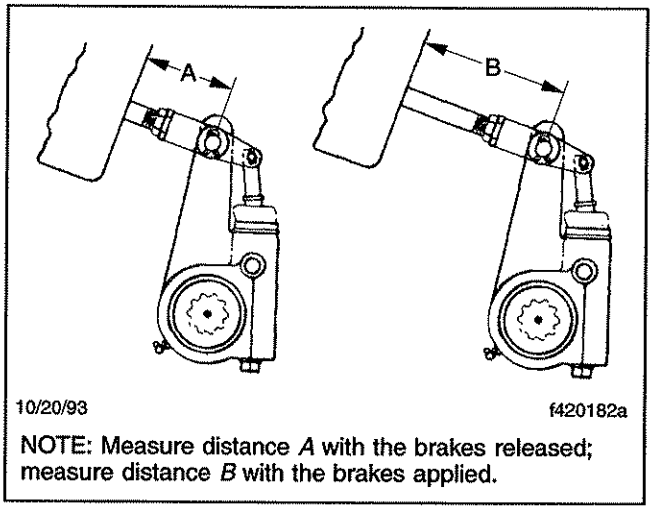


A. Shorten stroke.
B. Lengthen stroke.

Fig. 11, Turn the Adjusting Nut

5.3 The brake chamber stroke must be less than the measurements shown in the appropriate table in **Specifications 400.** If needed, turn the adjusting nut to adjust the brake chamber stroke.

If the stroke varies or remains greater than the specified range, check the brake components, including the camshafts, camshaft bushings, anchor pins, rollers, chamber brackets, clevis, and clevis pins. For instructions, refer to the brake section in this manual.



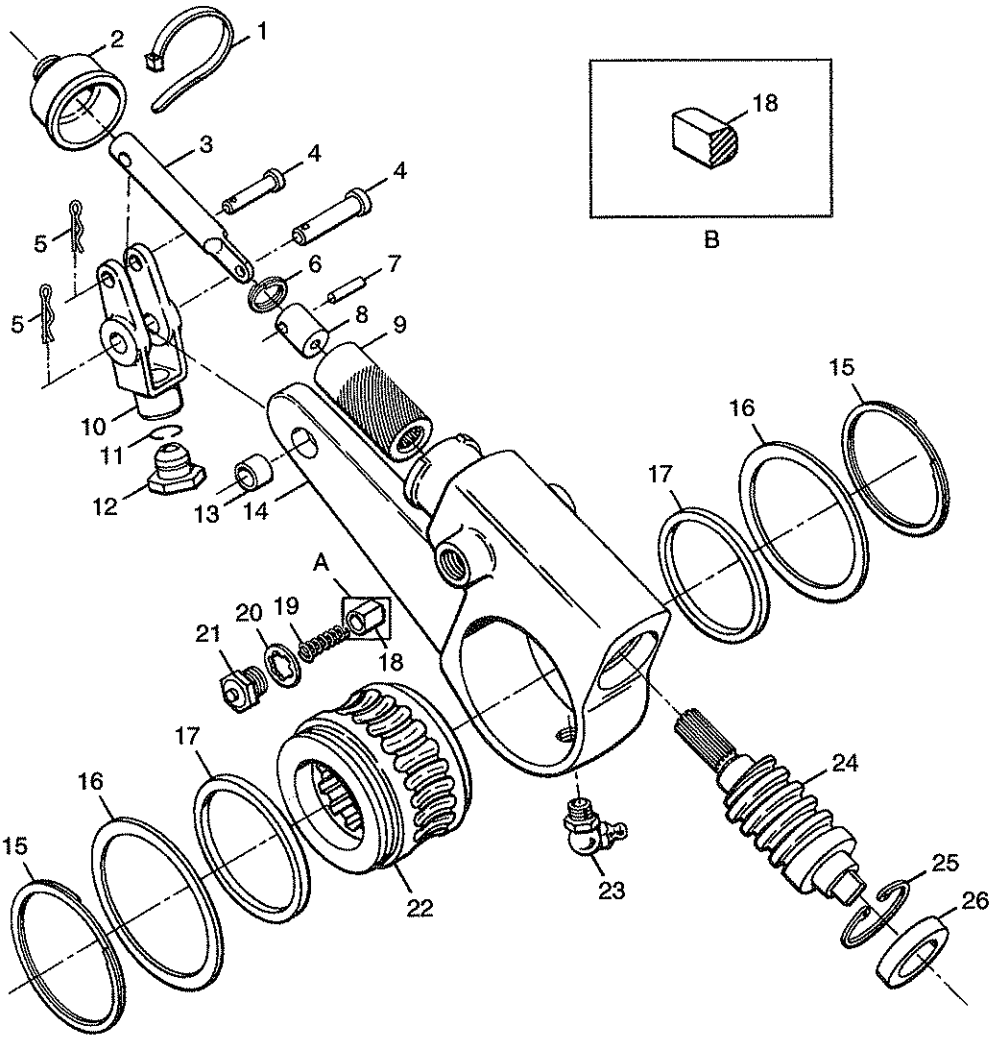
NOTE: Measure distance *A* with the brakes released; measure distance *B* with the brakes applied.

Fig. 12, Measuring Adjusted Brake Chamber Stroke

6. Install the pawl assembly, spring, and the pressure relief capscrew. Tighten the capscrew 15 to 20 lbf·ft (20 to 27 N·m). Or, remove the screwdriver from the pull-pawl assembly (if equipped).
7. Lube the slack adjuster through the grease fitting until the lubricant is forced out through the pressure relief fitting (or pawl slot), or through the gear splines around the inboard snap ring.
8. If a rear axle slack adjuster was installed, manually uncage the parking brake. For instructions, refer to the applicable brake chamber section in this manual.
9. Remove the chocks from the tires.

Disassembly, Cleaning and Inspection, and Assembly

Disassembly (See Fig. 1)



A. See Detail B.

B. End view showing serrations.

1. Boot Retaining Clamp
2. Boot
3. Actuator Rod
4. Clevis Pin
5. Cotter Pin
6. Piston Retaining Ring
7. Roller (Pin)
8. Actuator Piston
9. Actuator
10. Clevis
11. Clevis Retaining Ring (if equipped)
12. Quick-Connect Collar (if equipped)
13. Large Clevis Pin Bushing
14. Slack Adjuster Housing
15. Gear Retaining Ring
16. Gear Thrustwasher
17. Gear-to-Body Seal
18. Adjusting Pawl
19. Pawl Spring
20. Gasket
21. Pressure Relief Capscrew
22. Gear
23. Grease Fitting
24. Worm
25. Worm Retaining Snap ring
26. Worm Grease Seal

Fig. 1, Slack Adjuster Assembly (slack adjuster produced before January 1993 shown)

Disassembly, Cleaning and Inspection, and Assembly

1. Remove the slack adjuster. For instructions, refer to **Subject 100.**
2. Cut the boot retaining clamp, and remove the clamp from the rubber boot.
3. Remove the boot and the actuator (adjusting sleeve) from the housing. **See Fig. 2.** You may need to first work the boot off of the housing before removing the actuator.
4. Using a small screwdriver, press down the piston retaining ring and force it out of the groove **(Fig. 3).** Using pliers, unwind the ring and pull it out.
5. Pull the actuator rod, piston, and pin from the actuator bore.
6. Using a small hammer and brass drift punch, remove the pin from the rod and piston. **See Fig. 4.**

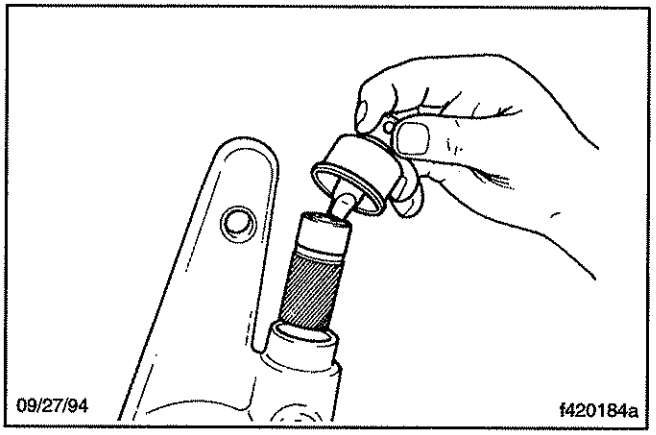
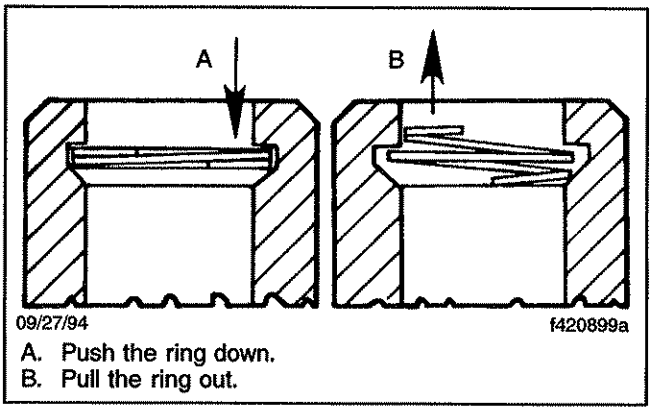


Fig. 2, Removal of the Actuator



A. Push the ring down.
B. Pull the ring out.

Fig. 3, Removal of the Internal Piston Retaining Ring

7. Using a small screwdriver, pry the grease seal from around the worm. **See Fig. 5.**
8. Using snap ring pliers, remove the retaining ring from the worm. **See Fig. 6.**

IMPORTANT: The following steps apply only to slack adusters produced before January 1993. On slack adjusters produced since January 1993, the gear and seals are not serviceable.

9. Using a wrench, turn the manual adjusting nut, and wind the worm out of the bore.

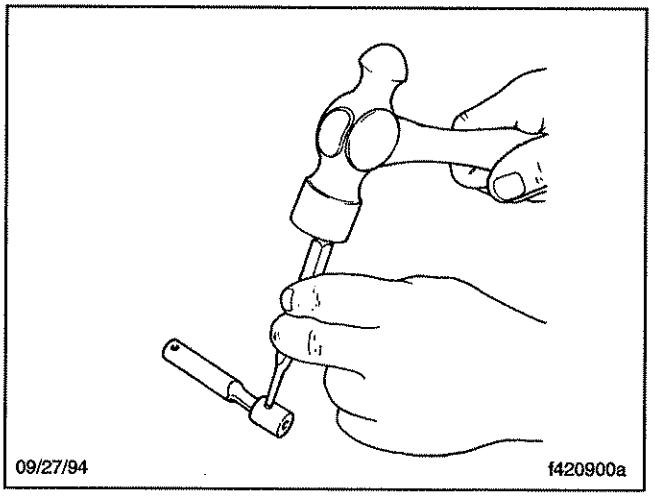


Fig. 4, Remove the Pin from the Rod and Piston

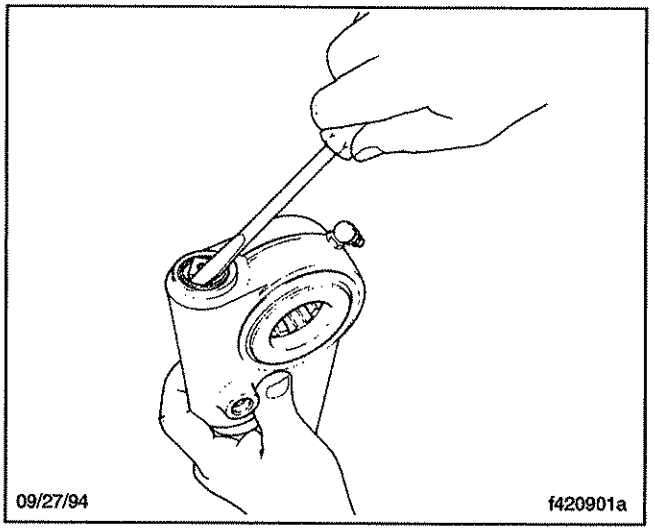


Fig. 5, Pry the Grease Seal from around the Worm

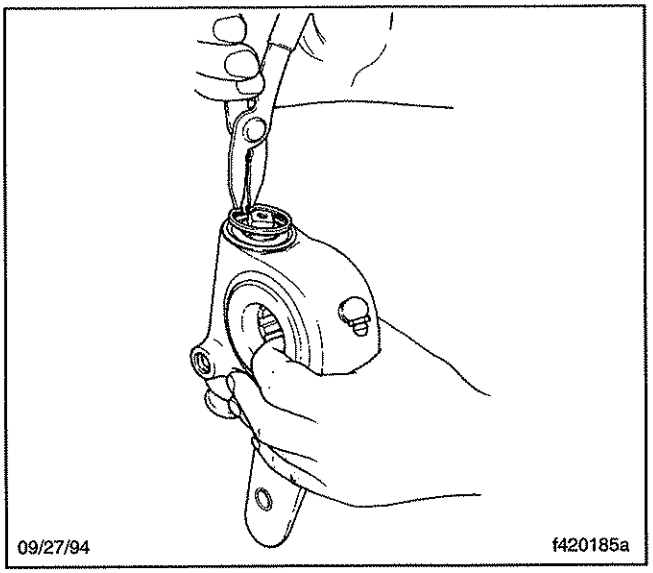


Fig. 6, Remove the Retaining Ring

10. On one side of the housing, insert a small screwdriver into the notch at the end of the gear retaining ring. Remove the end of the retaining ring from the groove.

    Unwind the ring by hand and pull it out of the groove. **See Fig. 7**. Remove the thrustwasher.

11. Push the gear far enough out of the housing to remove one gear seal.

    Push the gear far enough out of the opposite side of the housing to remove the other gear seal. Remove the gear from the housing.

Cleaning and Inspection

⚠ CAUTION

CAUTION: Don't clean ground or polished parts in a hot solution tank or with water-and-alkaline solutions, such as sodium hydroxide, orthosilicates, or phosphates. Also, don't use solvent-type cleaners on any nonmetallic parts. Doing so could damage the parts.

1. Clean the slack adjuster parts.

    1.1 Clean all parts having ground and polished surfaces (such as the worm, worm gear, and inner bores of the slack housing) with solvent-type cleaners, such as emulsion cleaners, carbon tetrachloride, or petroleum solvents (excluding gasoline).

    1.2 Dry all parts immediately after cleaning. Use soft, clean, lint-free absorbent paper towels, or wiping rags free of abrasive material such as lapping compound, metal filings, or contaminated oil.

2. Inspect all parts for wear or damage.

    2.1 Inspect all parts for wear or stress. Replace as needed.

    2.2 Inspect the seals, and discard if they show any signs of damage.

    2.3 Check the condition and fit of the large clevis pin bushing in the arm of the slack adjuster. Don't remove the bushing unless it is worn or egg-shaped.

3. If storing parts for any length of time, treat them with a good rust preventative, and wrap them in special paper or other material designed to prevent corrosion.

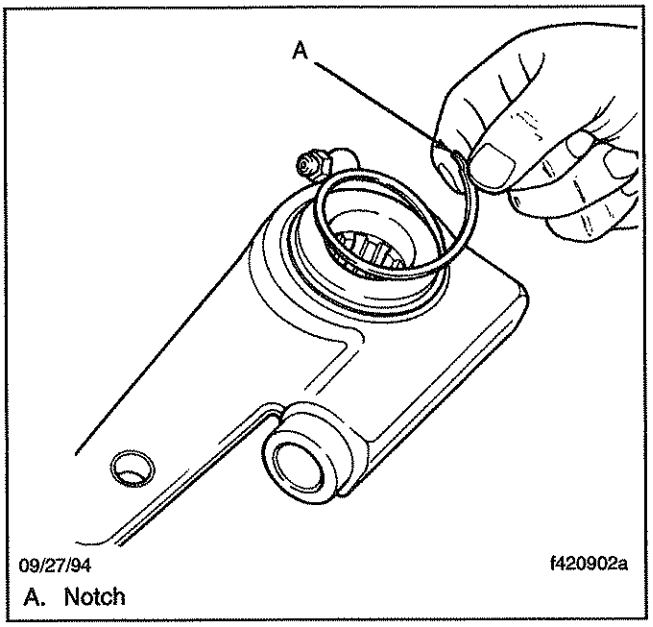


Fig. 7, Removal of the Gear Retaining Rings

Disassembly, Cleaning and Inspection, and Assembly

Assembly (See Fig. 1)

IMPORTANT: The first two steps that follow apply only to slack adusters produced before January 1993. On slack adjusters produced since January 1993, the gear and seals are not serviceable.

1. Coat all parts and the gear bore with a grease recommended in the appropriate table in **Specifications 400.**
2. Install the gear into the housing.
   - 2.1 Place the gear, without the gear seals, into the housing. Keep one seal groove outside the housing.

     Make sure the gear goes straight into the bore. If needed, use a small rawhide mallet to tap the gear into place.
   - 2.2 Install a seal into the groove. **See Fig. 8.**

⚠ CAUTION

CAUTION: Do not push the side of the gear that has the seal installed through the housing. Damage to the seal will occur when it passes the sharp edges of the intersecting worm bore.

   - 2.3 Push the gear far enough out the opposite side of the housing so you can see the other seal groove.

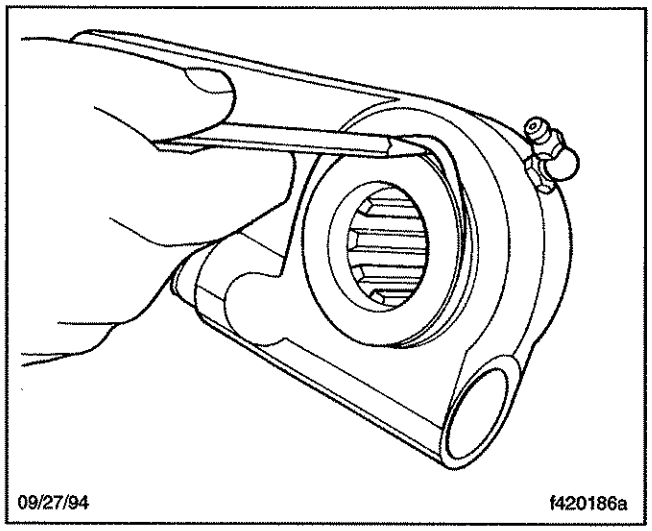


Fig. 8, Install a Seal into the Groove

   - 2.4 Install the seal in the groove, and push the gear into the housing.
   - 2.5 On one side of the gear, position a thrust-washer around the gear and against the housing. Spread out the retaining ring coil. Put one end of the coil into the groove in the outer diameter of the gear. Work around the gear and press the coil into the groove.
   - 2.6 Repeat this step for the other side of the gear.
3. Install the worm into the housing.
   - 3.1 Place the worm into the bore, then turn the adjusting nut to wind the worm to the bottom of the bore.
   - 3.2 Install the retaining snap ring.
   - 3.3 Place the grease seal over the worm bore, with the lips facing outward and the metal retainer facing toward the inside of the bore. **See Fig. 9.** Using a hammer and a 1-3/16 inch seal driver, install the seal.

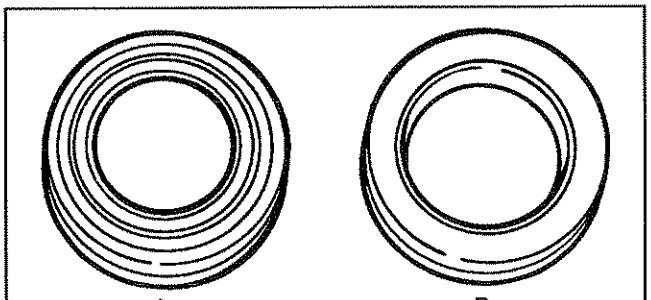
⚠ CAUTION

CAUTION: Failure to install the grease seal properly could allow contaminants to enter the housing and damage the parts.

4. Assemble the actuator, rod, and piston.
   - 4.1 Using a small hammer and brass drift punch, install the pin that connects the piston and actuator rod.
   - 4.2 Insert the actuator rod and piston into the actuator (adjusting sleeve).
   - 4.3 Slide the piston retaining ring over the rod. Spread out the coils of the ring. Using a small screwdriver, press one end of the ring into the groove. **See Fig. 10.** Press on the ring and work it around the groove until it is completely seated in the groove.

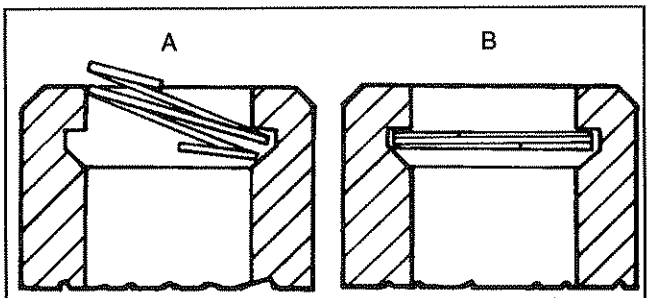
     See if the ring is seated correctly. You will not be able to pull the piston out of the actuator if the ring is seated correctly.
5. Slide the actuator assembly along the splines of the worm and into the slack housing.

Disassembly, Cleaning and Inspection, and Assembly



A. Outside
B. Inside

Fig. 9, Worm Seal



A. Start bottom coil.
B. Tuck ring into groove.

Fig. 10, Installation of the Internal Piston Retaining Ring

6. Lubricate the actuator rod with grease, then slip the boot over the rod. Attach the boot to the housing with a silastic coating and a new retaining clamp.

   Make sure that the top of the boot fits on the round part of the rod, not the tapered part.

   Seal the top part of the boot with a silastic coating.

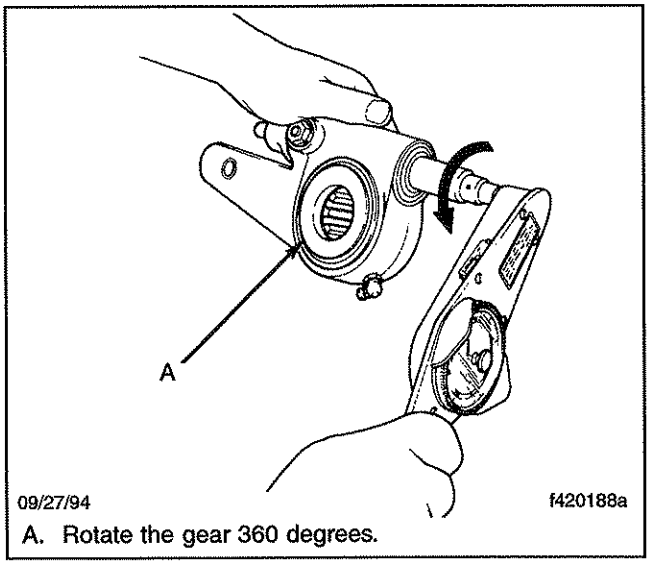
7. If previously removed, install a new bushing into the large clevis pin hole in the arm of the slack adjuster.

8. Lubricate the slack adjuster through the grease fitting until the lubricant is forced out through the pressure relief fitting (or pawl slot), or through the gear splines around the inboard snap ring.

9. Attach a lbf·in/N·cm torque wrench to the adjusting nut. Watch the torque scale while turning the gear 360 degrees. **See Fig. 11.** If the torque remains 25 lbf·in (280 N·cm) or less, the slack adjuster is working correctly.

   If the torque is more than 25 lbf·in (280 N·cm), the slack adjuster is not working correctly. Disassemble the slack, and check for correct assembly and alignment of parts.

10. Install the slack adjuster. For instructions, refer to **Subject 100.**



A. Rotate the gear 360 degrees.

Fig. 11, Slack Adjuster Torque Check

Specifications

Lubricant Type	Temperature
Amoco Super Permalube No. 2 Aralub 3837 Citco Premium Lithium EP No. 2 Exxon Ronex MP No. 2 Kendall L-427 Super Blu No. 2 Mobilith AW No. 1 Rockwell 0-616-A Rockwell 0-692 Shell Darina No. 1 Sohio Factran EP No. 2 Texaco Hytherm EP No. 1 Texaco Thermotex EP No. 1 Tribolube 12, Grade 1	-40°C (-40°F) or Above
Mobil 28 Rockwell 0-645	Below -40°C (-40°F)

Table 1, Lubricant Specifications

Slack Adjuster Arm Length	Chamber Size
127 mm (5 inches)	9, 12, 16, 20, 24, 30
140 mm (5-1/2 inches)	9, 12, 16, 20, 24, 30
152 mm (6 inches)	24, 30
165 mm (6-1/2 inches)	30

Table 2, Slack Adjuster Arm Lengths

Chamber Size	Maximum Chamber Stroke for Cam Brake
9	Less than 38 mm (1-1/2 inches)
12	Less than 38 mm (1-1/2 inches)
16	Less than 44 mm (1-3/4 inches)
20	Less than 44 mm (1-3/4 inches)
24	Less than 48 mm (1-7/8 inches)
24*	Less than 51 mm (2 inches)
30	Less than 51 mm (2 inches)

* Long stroke.

Table 3, Maximum Adjusted Brake Chamber Strokes

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General Description and Principles of Operation

General Description

The Haldex (SAB) automatic slack adjuster serves two main functions:

- As a lever, it converts the straight-line force of the air brake chamber push rod to torque on the brake camshaft. Rotation of the camshaft spreads the brake shoes out against the brake drum, applying the brakes.
- As an adjuster, it maintains cam brake chamber push rod stroke and lining-to-drum clearance automatically during normal use.

Principles of Operation

When the brakes are applied, the slack adjuster rotates and moves the shoes into contact with the drum. The clearance notch (**Fig. 1**, Ref. 4) corresponds to the normal lining-to-drum clearance. Different notches are available to meet the requirements of various vehicles and brake duty cycles. As the brake application continues, the rack (Ref. 3) moves upward and rotates the one-way clutch (Ref. 1) which slips in this direction.

As the brake pressure increases, the torque increase on the slack adjuster causes a relative movement between the body and the camshaft. This motion forces the worm shaft (Ref. 8) over to compress the coil spring (Ref. 7), releasing the cone clutch (Ref. 2). If the brakes are out of adjustment, any further torque will change the position of the one-way clutch in relation to the cone clutch.

When the brake begins its return stroke, the coil spring load returns to normal and the cone clutch is again engaged. The rack is pulled back to its original position in the notch. Any additional travel brought about by brake lining wear causes the rack to turn the locked one-way clutch and rotates the worm shaft through the locked cone clutch. The worm shaft then rotates the worm wheel (Ref. 6) and camshaft, adjusting the brakes.

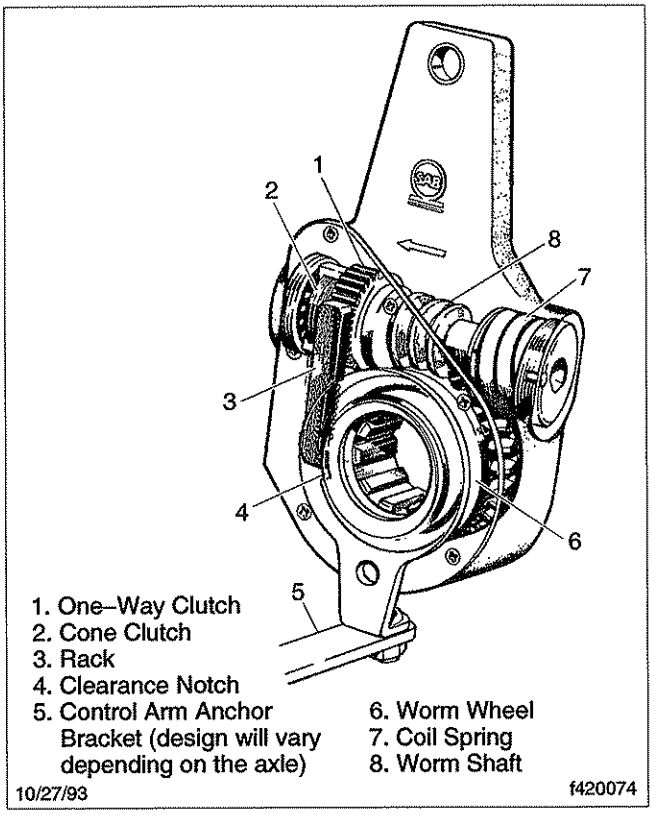


Fig. 1

Removal

1. Park on a level surface and chock the tires.
2. Release the parking brakes.

⚠ WARNING

WARNING: Before continuing, mechanically cage the power spring on each parking brake chamber to prevent the parking brakes from applying unexpectedly during the procedures. The parking brakes could suddenly apply due to a loss of air system pressure, and this could result in personal injury.

3. Remove the anchor bracket fasteners and the anchor bracket (**Fig. 1**).
4. Remove the cotter pin from the clevis pin. Remove the clevis pin.
5. Remove the snap ring holding the slack adjuster to the camshaft.
6. Turn the adjusting hexnut counterclockwise, to move the adjuster arm out of the clevis. A ratcheting sound may occur.
7. Remove the slack adjuster from the camshaft.

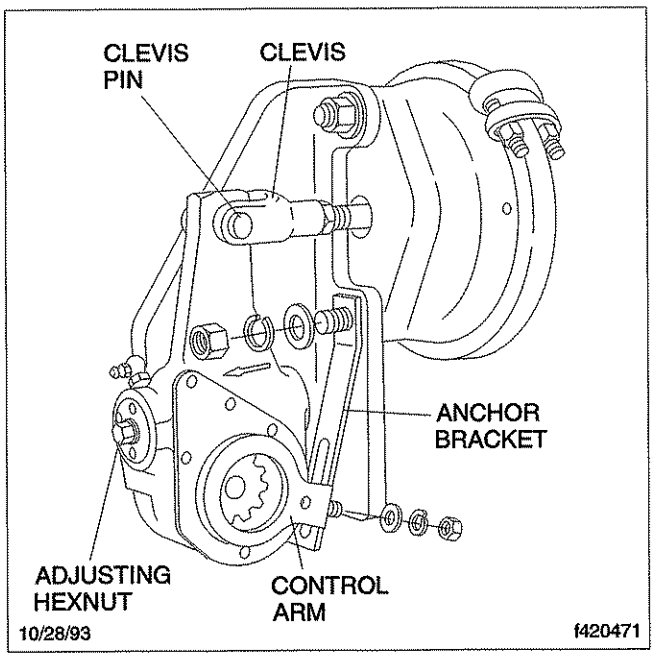


Fig. 1

Installation

1. Check that the brake chamber push rod is fully released (parking brakes off).
2. Lubricate the camshaft splines with anti-corrosive grease.
3. Install the slack adjuster onto the camshaft with the adjusting hexnut (**Fig. 2**) pointing away from the brake chamber.

IMPORTANT: When correctly installed, the brake chamber push rod pushes in the direction of the arrow (**Fig. 2**) on the adjuster arm.

4. Install the snap ring, securing the slack adjuster on the camshaft.
5. Turn the adjusting hexnut as shown in **Fig. 2** until the clevis hole lines up with the slack adjuster hole.
6. Insert the clevis pin, but do not install the cotter pin now.

IMPORTANT: Never push the slack adjuster into position. Always turn the adjusting hexnut for positioning.

7. Rotate the control arm away from the adjusting hexnut towards the brake chamber until it comes to a definite internal stop. See **Fig. 3.**

IMPORTANT: Never hammer the control arm.

8. Install the anchor bracket. See **Fig. 1.**

NOTE: The anchor bracket design will vary, depending on the axle.

9. Tighten the anchor bracket fastener at the control arm 10 to 15 lbf·ft (14 to 20 N·m), making sure the control arm does not move from its position. Tighten the fastener at the brake chamber mounting stud according to the brake chamber manufacturer's specifications.
10. Adjust the brake lining clearance by turning the adjusting hexnut *clockwise* until the brake lining meets the brake drum, then back off *counterclockwise* 3/4 turn. A ratcheting sound may occur.
11. Check the installation by removing the clevis pin. Push the slack adjuster into the clevis, and then release it. See **Fig. 4.**

    If the slack adjuster hole did not stay aligned with the clevis pin hole, move the slack adjuster until the holes are aligned. Replace the clevis pin. Loosen

Removal and Installation

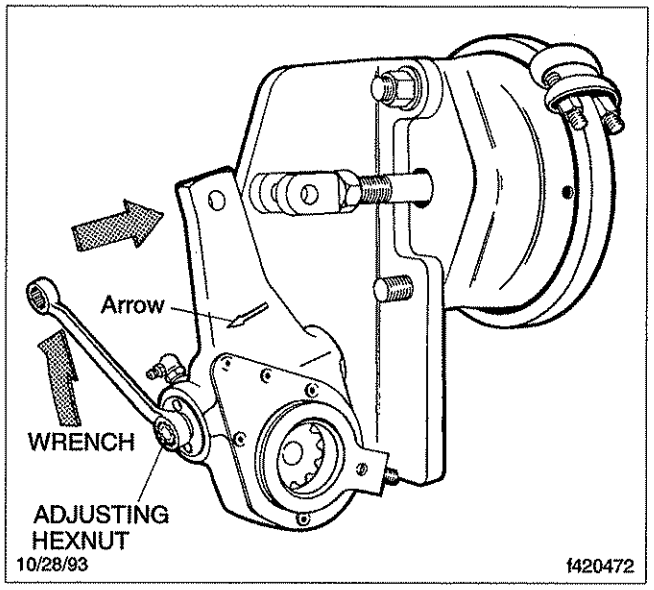


Fig. 2

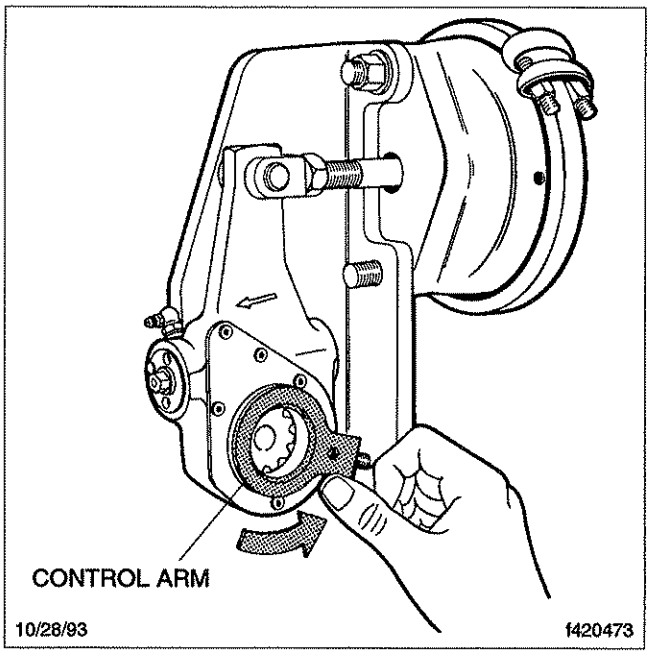


Fig. 3

the control arm fasteners, and move the control arm towards the brake chamber until it comes to a definite stop. Tighten the bracket fasteners.

When the slack adjuster hole and clevis pin hole remain in alignment on release, the installation is correct.

Insert the clevis pin in the clevis. Install and lock a new cotter pin in the clevis pin.

⚠ WARNING

WARNING: Failure to install and lock a new cotter pin could allow the push rod to disengage from the slack adjuster, resulting in a loss of braking ability.

NOTE: Incorrect installation can cause dragging brakes.

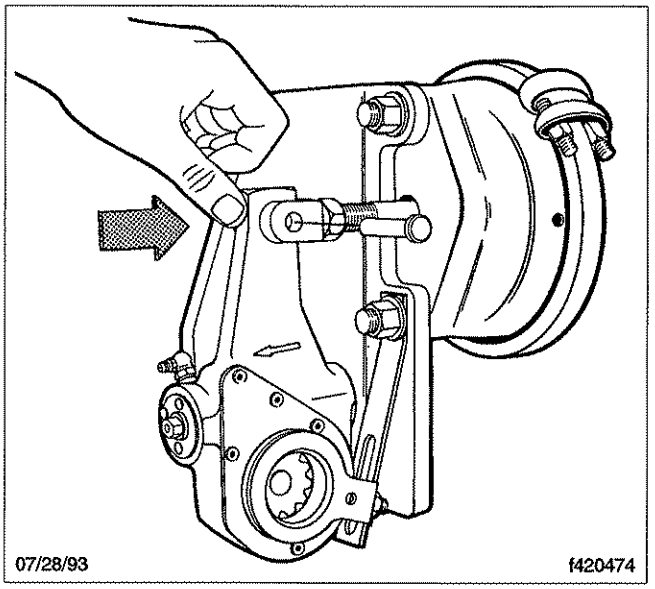


Fig. 4

Troubleshooting

This subject contains the following troubleshooting tables:

- Tight or Dragging Brakes
- Brake Chamber Push Rod Travel Is Excessive

Problem – Tight or Dragging Brakes

Possible Cause	Remedy
The control arm anchor bracket is not positioned properly.	See instructions under "Removal and Installation, 100."
System air pressure is too low to fully release the spring brake.	Check that the air governor cuts out at the recommended setting.
A spring brake diaphragm is ruptured or a piston seal is leaking.	Replace the diaphragm or spring brake piston seal.
A return spring in the brake chamber is broken.	Replace the spring brake return spring.
The push rod binds on the chamber housing.	Check for correct alignment and correct chamber mounting bracket. Adjust or replace parts as needed.
The air supply does not exhaust completely.	Test the air system valves for leakage and correct operation.
The brake drums are out-of-round.	Turn the brake drums, if possible. If the maximum allowable diameter of any brake drum has been exceeded, replace the drum. Also, turn or replace the other drum on the axle. For turning the drums, refer to the brake manufacturer's service manual.
Extreme differences exist in lining-to-drum clearances between shoes on the same wheel.	Check for proper operation of the brake mechanism. Lubricate or overhaul as needed.
The wheel bearings are out of adjustment.	Adjust the wheel bearings, or replace them if damaged. For instructions refer to the **front axle group** and the **rear axle group** of the vehicle service manual.
The brake shoe return spring is broken.	Replace the brake shoe return spring.

Problem – Brake Chamber Push Rod Travel Is Excessive

Possible Cause	Remedy
The control arm anchor bracket is loose, broken, or bent.	Tighten or replace the anchor bracket as required.
There is excessive wear between the anchor bracket bolt and the control arm slot.	Replace the worn parts.
The control arm assembly is damaged or worn, resulting in lateral movement between the control arm and the cover plate.	Replace the slack adjuster.
The camshaft bushings are worn.	Replace the worn camshaft bushings.
The camshaft binds.	Lubricate the camshaft or overhaul the brake mechanism as needed.
The brake chamber mounting is loose.	Tighten the brake chamber mounting fasteners.

Troubleshooting

Possible Cause	Remedy
The slack adjuster is bound against the camshaft housing. There is no end play.	Check that the correct camshaft and camshaft tube have been used and that they are assembled correctly. Overhaul the brake mechanism as needed.
The slack adjuster clutch assembly is worn.	Replace the slack adjuster.

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General Description and Principles of Operation

General Description

In an S-cam type foundation brake, the final link between the air system and the foundation brake is the slack adjuster **(Fig. 1).** The arm of the slack adjuster fastens (using a yoke) to the push rod of the brake chamber, and the slack adjuster spline is installed on the brake camshaft.

Primarily, the slack adjuster is a lever, converting the linear force of the air chamber push rod into a torque that turns the brake camshaft and applies the brakes.

Standard slack adjusters contain four basic parts: the body, the worm, the gear, and the adjusting screw. The adjusting screw is provided to remove the slack caused by the wear of the brake lining.

All slack adjusters use the worm and gear principle and differ only in torque limit specifications. For example, a type 20 slack adjuster has a limit of 20,000 lbf·in; a type 30 slack adjuster has a limit of 30,000 lbf·in.

Slack adjusters are produced in various arm lengths and configurations (such as "straight" and "offset"), to satisfy a variety of installation needs.

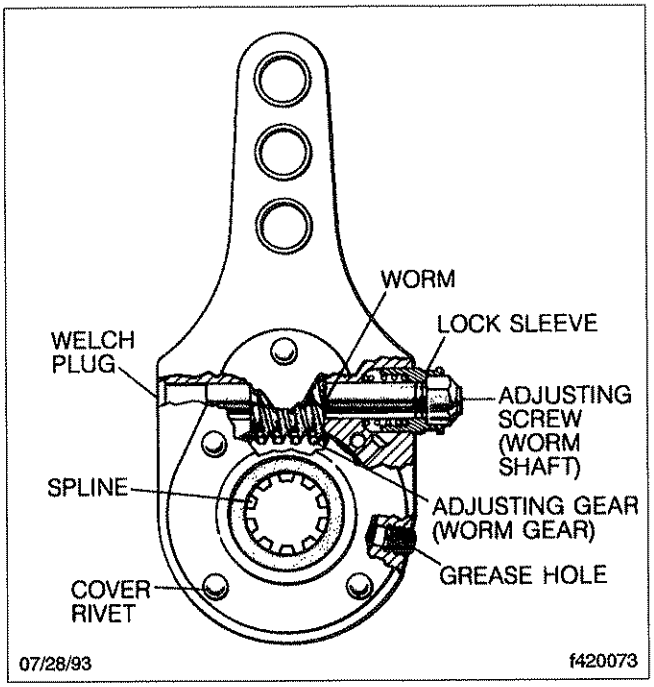


Fig. 1, Manual Slack Adjuster

Principles of Operation

When the brakes are applied, compressed air forces the air service brake chamber diaphragm and push rod to move, rotating the slack adjuster. This in turn rotates the camshaft, causing the S-cam to spread the brake shoes, which contact the brake drum.

When the brakes are released, air pressure is exhausted from the brake chamber. The chamber return spring and the brake shoe return springs return the brake cam, camshaft, slack adjuster, and chamber push rod to the released positions.

The adjusting mechanism of a slack adjuster consists of an adjusting screw (worm shaft), worm, and slack adjuster worm gear. Turning the adjusting screw nut on the end of the worm shaft rotates the worm shaft and worm. The worm meshes with and rotates the slack adjuster worm gear, which is connected to the brake cam by a splined camshaft. The turning of the worm gear rotates the camshaft and brake cam, spreading the brake shoes, thereby compensating for brake lining wear.

Manual slack adjusters feature a positive lock mechanism to maintain the adjustment setting. This mechanism consists of a spring-loaded lock sleeve, which, when positioned properly, engages the adjusting screw nut to prevent the adjusting screw (worm shaft) from rotating.

Removal

1. Chock the tires and, if a rear-axle slack adjuster is being removed, release the parking brakes, and then cage the power spring of the parking brake chamber. For instructions, **refer to the brakes group.**

⚠ WARNING

WARNING: Possible loss of brake chamber air pressure will cause sudden application of the parking brakes, which could result in personal injury. Manually cage each parking brake chamber power spring in the release (no application) position before continuing.

2. Remove the slack adjuster from the brake camshaft.
   - 2.1 Remove the cotter pin from the brake chamber push-rod yoke pin; remove the yoke pin.
   - 2.2 Remove the snap ring and spacing washers from the end of the brake camshaft, and save them for later installation.
   - 2.3 Wipe off the adjusting screw nut and the locking sleeve area. Place a wrench or socket over the adjusting screw and depress the locking screw sleeve to disengage it. Turn the adjusting screw nut until the slack adjuster is clear of the brake camshaft.
   - 2.4 Pull the slack adjuster off the brake camshaft.
   - 2.5 Note the location and number of any remaining spacing washers from the camshaft, and then remove them. Save them for later installation.

Installation

1. Wipe the camshaft clean of any dirt or old grease.
2. As referenced earlier, install the inner camshaft washers on the camshaft.
3. Apply a thin film of fresh chassis grease to the slack adjuster splines.
4. Install the slack adjuster on the brake camshaft.
   - 4.1 Position the slack adjuster on the camshaft with the adjuster nut on the side opposite of the brake.
   - 4.2 Install the spacing washers and snap ring on the end of the camshaft.
   - 4.3 Check the slack adjuster end play, and add washers as needed to ensure a maximum end play of 1.57 mm (0.062 inch).
   - 4.4 Place a wrench or socket over the adjusting screw and depress the locking sleeve to disengage it. Rotate the adjusting screw nut until the hole in the slack adjuster arm aligns with the yoke pin hole. Install the yoke pin and lock it with a new cotter pin.
5. If a rear-axle slack adjuster was installed, manually uncage the parking brake. For instructions, **refer to the brakes group.**
6. With the parking brakes released, continue to rotate the adjusting screw until the brakes begin to drag when the drum is turned; then, back off the adjustment until the wheel turns freely. Turn the adjusting screw nut until the locking sleeve engages it.
7. Check the slack adjuster for smooth operation.
   - 7.1 Start the engine and bring the air pressure to approximately 550 kPa (80 psi).
   - 7.2 Apply the brakes, and check that the slack adjuster rotates freely and without binding.
   - 7.3 Release the brakes, and check that the slack adjuster returns to the released position without binding.
8. Check the brake chamber stroke.
   - 8.1 Bring the air pressure to approximately 550 kPa (80 psi).
   - 8.2 With the brakes released, measure distance *A* . **See Fig. 1.**
   - 8.3 Make and hold a full brake application. Measure distance *B* . **See Fig. 1.**
   - 8.4 Determine brake chamber stroke (distance *B* minus distance *A*).

Removal and Installation

8.5 Readjust the brakes if the chamber stroke exceeds the maximum stroke. **See Table 1.**

9. Remove the chocks from the tires.

Chamber Size	Maximum Chamber Stroke for Cam Brake
9	Less than 38 mm (1-1/2 inches)
12	Less than 38 mm (1-1/2 inches)
16	Less than 44 mm (1-3/4 inches)
20	Less than 44 mm (1-3/4 inches)
24	Less than 48 mm (1-7/8 inches)
24*	Less than 51 mm (2 inches)
30	Less than 51 mm (2 inches)

* Long stroke.

Table 1, Maximum Adjusted Brake Chamber Strokes

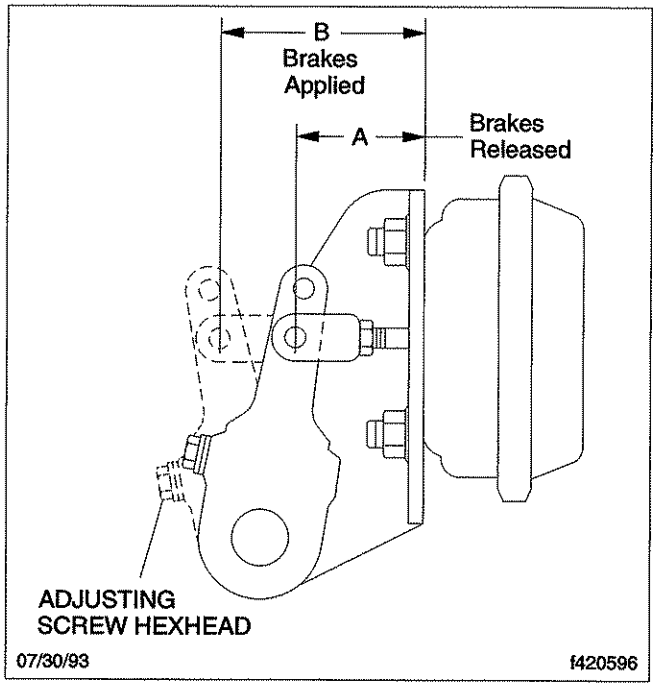


Fig. 1

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General Description

The front and rear axle full-floating wheel hub assembly is made up of four major components: tapered wheel bearings, the wheel hub, wheel studs, and the brake drum. **See Fig. 1 and Fig. 2.**

The brake drum and lining work together as a mated friction pair, with the drum responsible for both heat absorption and dissipation. Lining performance and life largely depend on the condition of the drum and whether it can adequately absorb and dissipate heat generated by braking action.

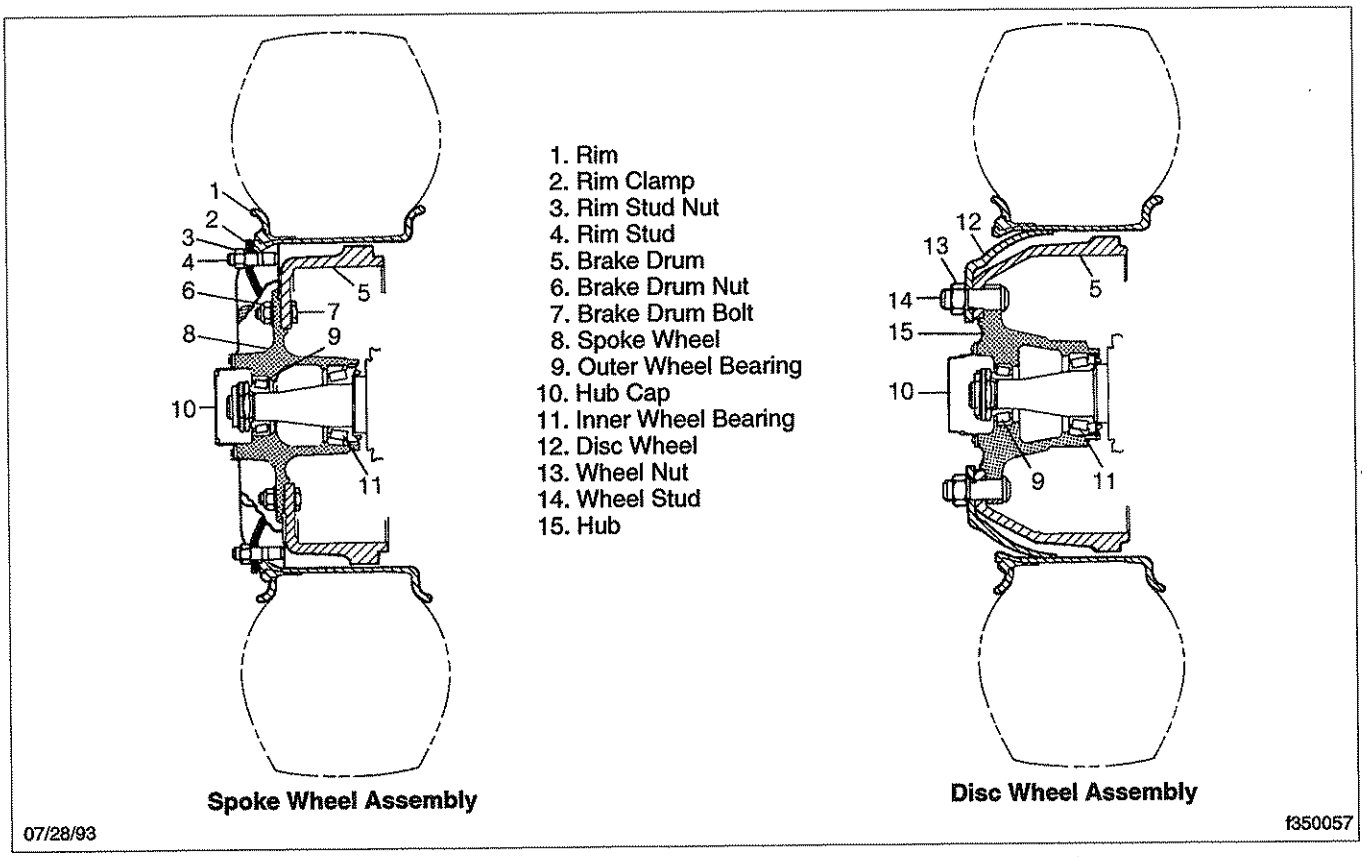
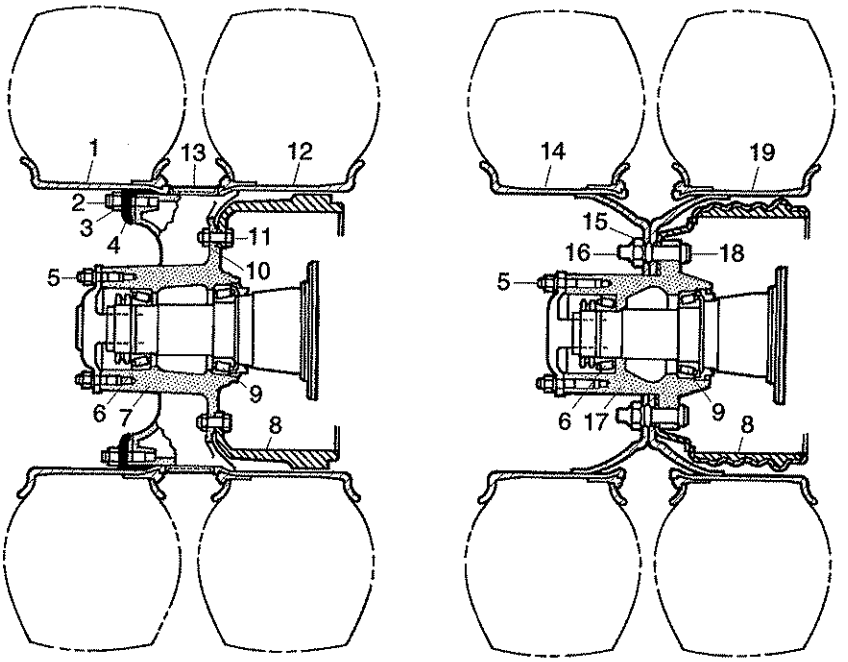


Fig. 1, Sectional View of Spoke and Disc Wheel Assemblies, Front Axle

General Description

1. Outer Rim
2. Rim Stud
3. Rim Stud Nut
4. Rim Clamp
5. Drive Axle Stud
6. Outer Wheel Bearing
7. Spoke Wheel
8. Brake Drum
9. Inner Wheel Bearing
10. Brake Drum Nut
11. Brake Drum Bolt
12. Inner Rim
13. Rim Spacer
14. Outer Wheel
15. Outer Wheel Nut
16. Inner Wheel Nut
17. Wheel Hub
18. Wheel Stud
19. Inner Wheel



SPOKE WHEEL AND BRAKE DRUM ASSEMBLY

DISC WHEEL, WHEEL HUB, AND BRAKE DRUM ASSEMBLY

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Fig. 2, Sectional View of Spoke and Disc Wheel Assemblies, Drive Axle

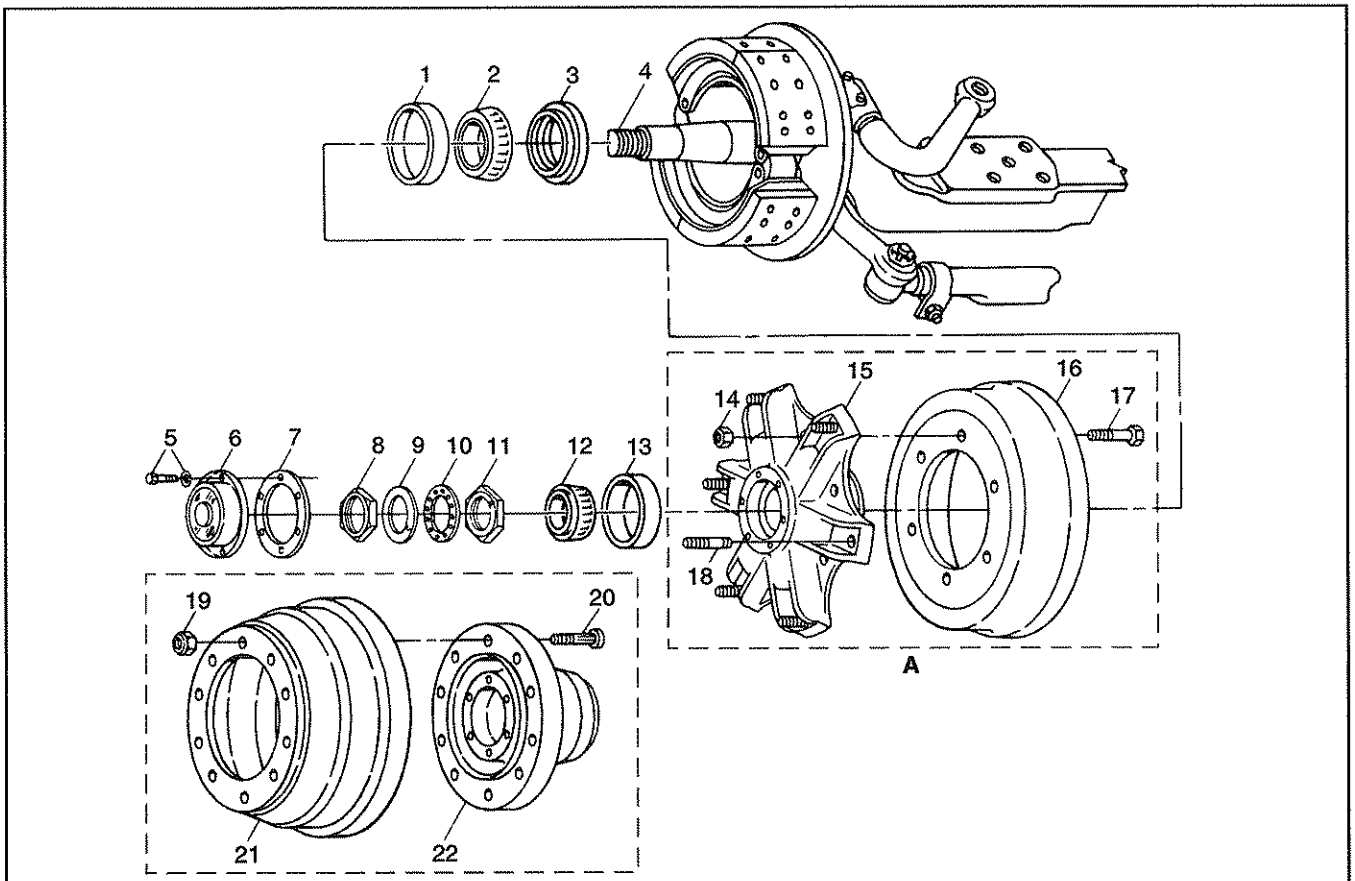
Outboard-Mounted Drum Removal and Installation

Removal (See Fig. 1and Fig. 2)

1. Before working on the front axle, chock the rear tires and apply the parking brakes.

   Before working on the rear axle, chock the front tires and release the parking brakes.

2. Raise the vehicle until the tires clear the ground. Then place safety stands under the axle.

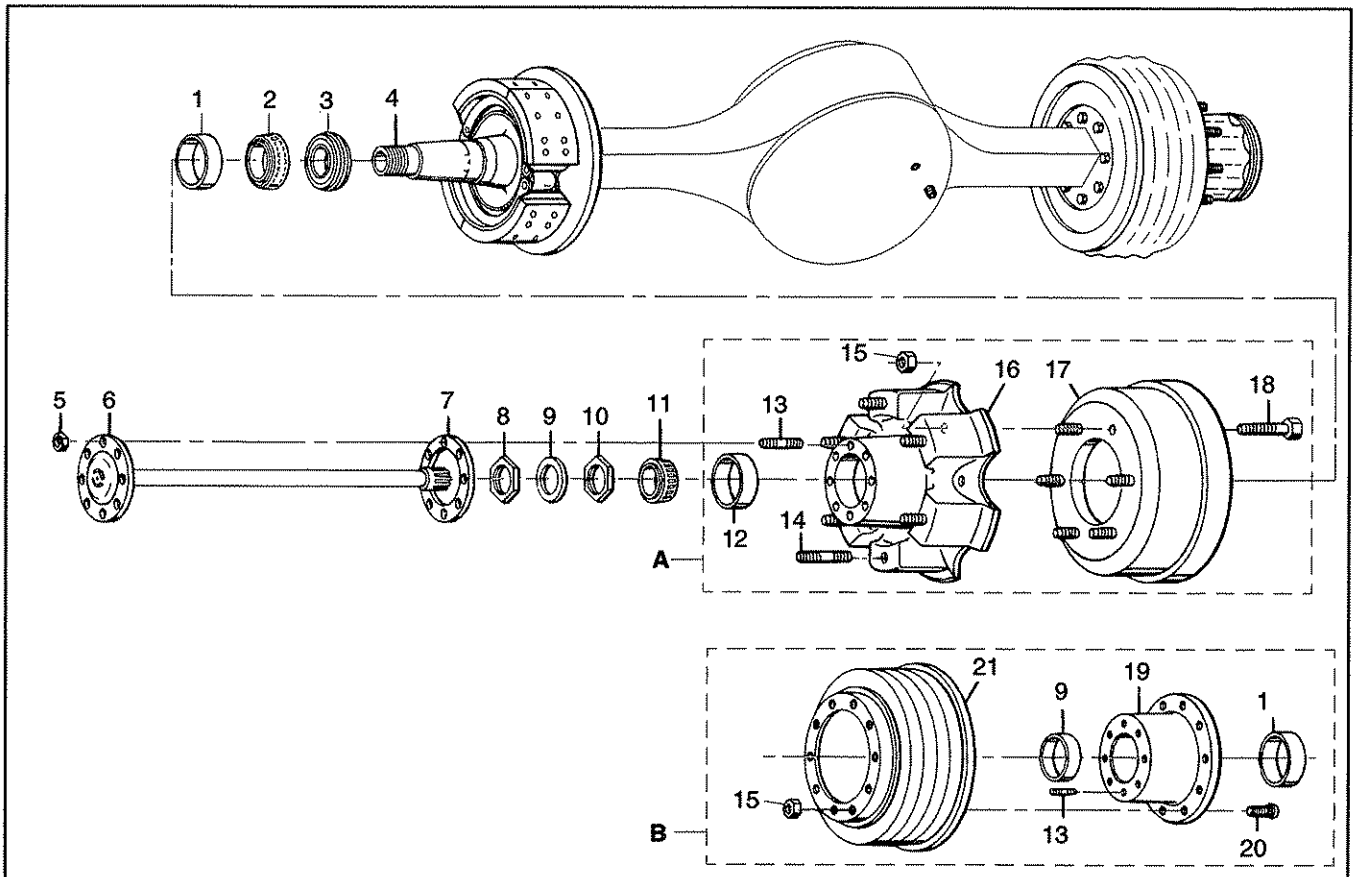


A. Spoke Wheel and Inboard-Mounted Drum Assembly
B. Disc Wheel, Hub, and Outboard-Mounted Drum Assembly

1. Inner Wheel Bearing Cup
2. Inner Wheel Bearing
3. Oil Seal
4. Axle Spindle (Steering Knuckle)
5. Hub Cap Capscrew and Washer
6. Hub Cap
7. Hub Cap Gasket
8. Jam Nut
9. Lockwasher
10. Lockring
11. Wheel Bearing Adjusting Nut
12. Outer Wheel Bearing
13. Outer Wheel Bearing Cup
14. Brake Drum Nut
15. Spoke Wheel
16. Brake Drum, Inboard-Mounted
17. Brake Drum Bolt
18. Rim Stud
19. Wheel Nut
20. Wheel Stud
21. Brake Drum, Outboard-Mounted
22. Wheel Hub

Fig. 1, Typical Front Axle (exploded view)

Outboard-Mounted Drum Removal and Installation



A. Spoke Wheel and Drum Assembly

1. Inner Wheel Bearing Cup
2. Inner Wheel Bearing
3. Oil Seal
4. Axle Spindle
5. Drive Axle Stud Nut
6. Drive Axle Flange and Shaft
7. Gasket
8. Jam Nut
9. Lockring
10. Wheel Bearing Inner Adjusting Nut
11. Outer Wheel Bearing
12. Outer Wheel Bearing Cup
13. Drive Axle Stud
14. Rim Stud

B. Disc Wheel, Hub, and Drum Assembly

15. Brake Drum Nut
16. Spoke Wheel
17. Brake Drum, Inboard-Mounted
18. Brake Drum Bolt
19. Wheel Hub
20. Wheel Stud
21. Brake Drum, Outboard-Mounted

Fig. 2, Typical Drive Axle (exploded view)

3. Back off the slack adjuster to release the brake shoes. For instructions, see the applicable slack adjuster section in **Group 42.**

⚠ WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

To reduce asbestos exposure below legal limits, apply one of the following methods: (1) An enclosed-cylinder vacuum system equipped with a High Efficiency Particulate Air (HEPA) filter; (2) A solvent spray system that keeps the asbestos-contaminated parts wet until they can be placed in a sealed and labelled plastic bag.

4. Remove wheel and tire assemblies. See **Group 40** for instructions.
5. Remove the brake drum.

   To minimize the possibility of creating airborne brake lining dust, clean the dust from the brake drum, brake backing plate, and brake assembly, using an industrial-type vacuum cleaner equipped with a high-efficiency filter system. Then, using a rag soaked in water and wrung until nearly dry, remove any remaining dust. Don't use compressed air or dry brushing to clean the brake assembly.
6. Inspect the drum. See **Subject 110** for instructions.

Installation

1. Install the brake drum on the wheel hub.

   1.1 On hub-piloted drums, position the brake drum on the top step of the pilot pad. One of the hub's pilot pads should be at the twelve o'clock (top center) position. See **Fig. 3**.

   IMPORTANT: If the drum is not positioned correctly, the pilot pad could be damaged when the wheel nuts are torqued.

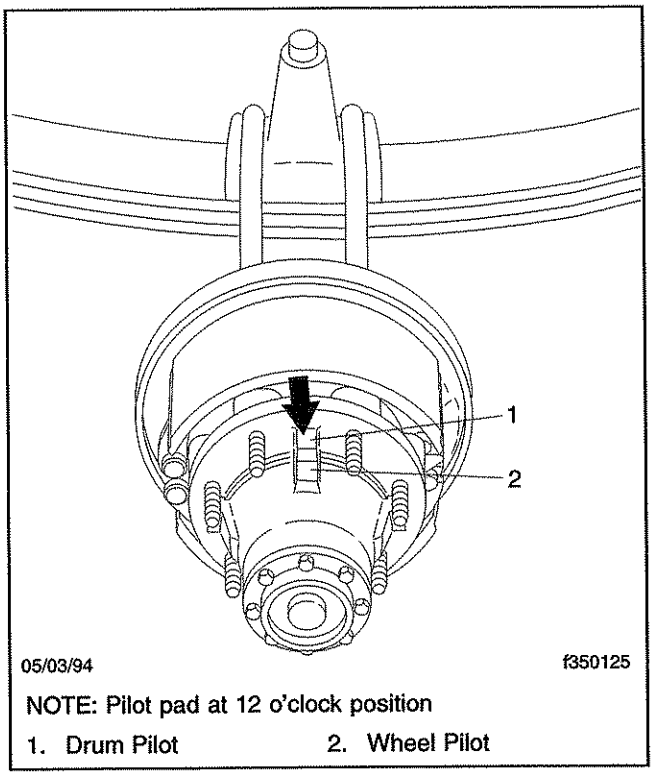
   1.2 Make sure that the pilot pads securely center the drum (space between drum and hub is equal all around the hub).

   IMPORTANT: If damage to the pads prevents the drum from centering, replace the hub. If necessary, to hold the drum in position, adjust the brakes before installing the wheels.
2. Install the wheel and tire assemblies. See **Group 40** for instructions.

⚠ WARNING

If the wheel nuts cannot be tightened to minimum torque values, the wheel studs have lost their locking ability, and the hub flange is probably damaged. In this case, replace it with a new wheel hub assembly. Failure to replace the wheel hub assembly when the conditions described above exist, could result in the loss of a wheel or loss of vehicle control, and possible personal injury.

3. Adjust the brakes at the slack adjusters. For instructions, see **Group 42** of the *Business Class Trucks Maintenance Manual.*
4. Remove the safety stands from under the axle; lower the vehicle.
5. Apply the parking brakes (if not already applied); then remove the chocks from the tires.



NOTE: Pilot pad at 12 o'clock position

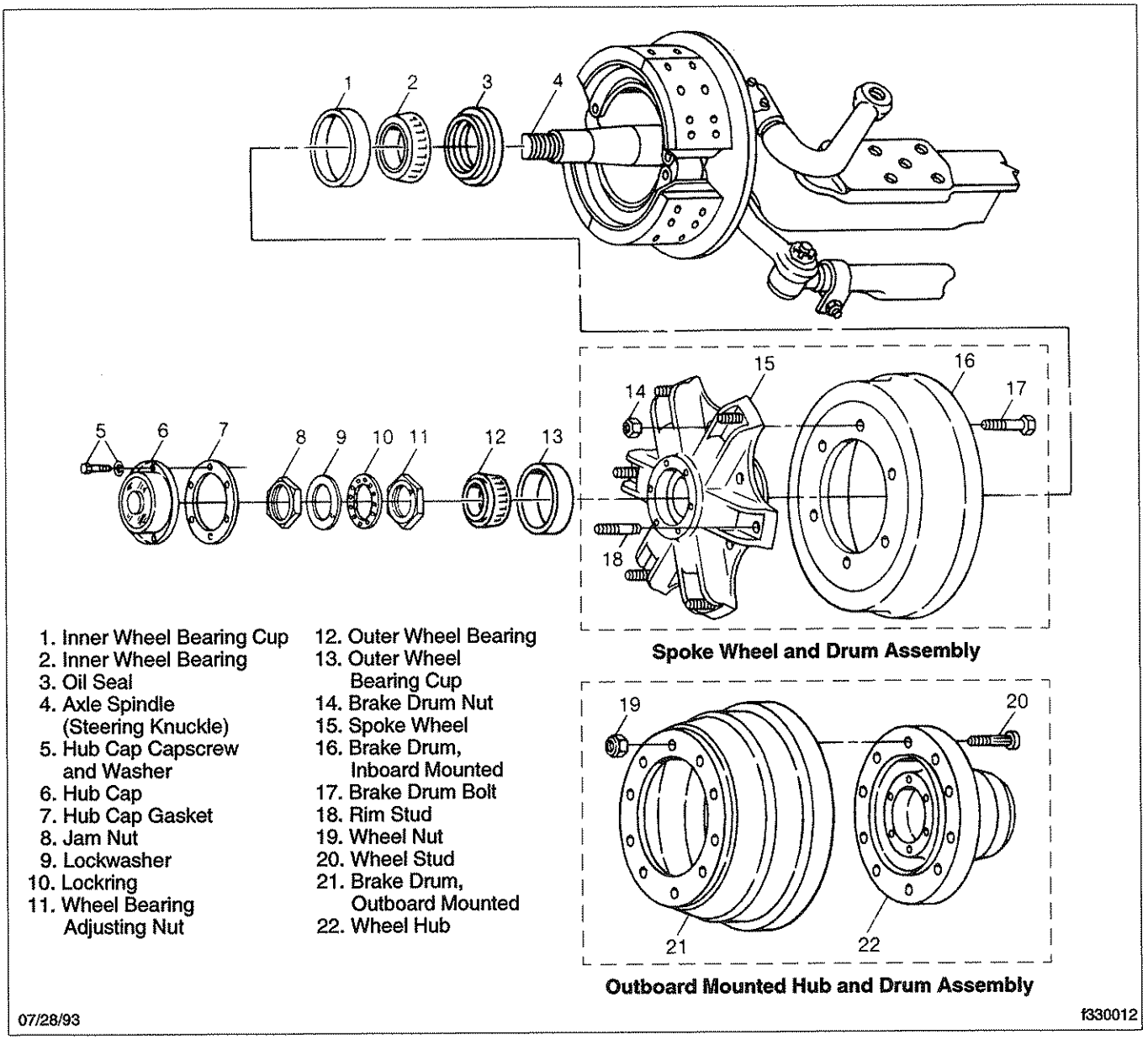
1. Drum Pilot 2. Wheel Pilot

Fig. 3, Front Axle Drum and Wheel Pilots (rear axle similar)

Inboard Mounted Drum Removal and Installation

Removal (Refer to Fig. 1)

1. If the front axle is being worked on, chock the rear wheels; if the rear axle is being worked on, chock the front wheels. Release the parking brakes.
2. Raise the vehicle until the tires clear the ground. Then place safety stands under the axle to be serviced. Position a jack or wheel-and-tire dolly under the tires.
3. Back off the slack adjuster to release the brake shoes. For instructions, refer to the applicable slack adjuster section **in the brakes group** of this manual.
4. Remove rim and tire assemblies. Refer to the **wheels and tires group** for instructions.



1. Inner Wheel Bearing Cup
2. Inner Wheel Bearing
3. Oil Seal
4. Axle Spindle (Steering Knuckle)
5. Hub Cap Capscrew and Washer
6. Hub Cap
7. Hub Cap Gasket
8. Jam Nut
9. Lockwasher
10. Lockring
11. Wheel Bearing Adjusting Nut
12. Outer Wheel Bearing
13. Outer Wheel Bearing Cup
14. Brake Drum Nut
15. Spoke Wheel
16. Brake Drum, Inboard Mounted
17. Brake Drum Bolt
18. Rim Stud
19. Wheel Nut
20. Wheel Stud
21. Brake Drum, Outboard Mounted
22. Wheel Hub

Fig. 1, Typical Front Axle

Inboard Mounted Drum Removal and Installation

5. Remove the wheel hub. Refer to the **front axle group** or the **rear axle group** for instructions.
6. Remove the brake drum nuts **(Fig. 1 and Fig. 2)** and detach the brake drum from the wheel.

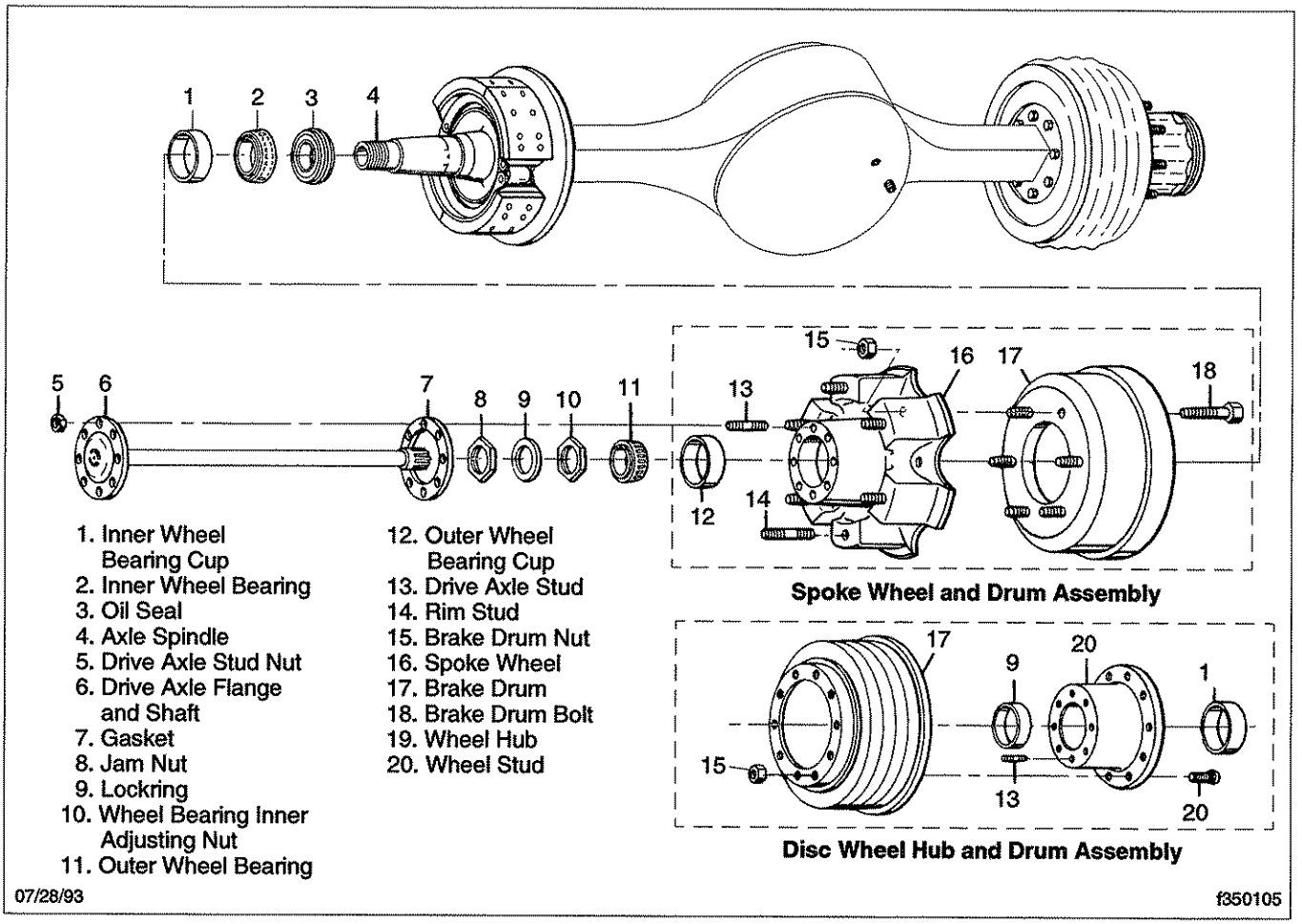
⚠ WARNING

WARNING: Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by MSHA or NIOSH. Wear a respirator at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

7. To minimize the possibility of creating brake lining dust, clean the dust from the brake drum, brake backing plate, and brake assembly, using an industrial-type vacuum cleaner equipped with a high-efficiency filter system. Then, using a rag soaked in water and wrung until nearly dry, remove any remaining dust. Don't use compressed air or dry brushing to clean the brake assembly.

Installation

1. Attach the brake drum to the wheel. Install the brake drum bolts and nuts, then tighten the nuts 325 N·m (240 lbf·ft).



1. Inner Wheel Bearing Cup
2. Inner Wheel Bearing
3. Oil Seal
4. Axle Spindle
5. Drive Axle Stud Nut
6. Drive Axle Flange and Shaft
7. Gasket
8. Jam Nut
9. Lockring
10. Wheel Bearing Inner Adjusting Nut
11. Outer Wheel Bearing
12. Outer Wheel Bearing Cup
13. Drive Axle Stud
14. Rim Stud
15. Brake Drum Nut
16. Spoke Wheel
17. Brake Drum
18. Brake Drum Bolt
19. Wheel Hub
20. Wheel Stud

Fig. 2, Typical Drive Axle Exploded View

2. Install the hub and wheel bearings. Refer to the **front axle group** or the **rear axle group** for instructions.
3. Install the wheel and tire assembly. Refer to the **wheels and tires group** for instructions.
4. Adjust the brakes at the slack adjusters. For instructions, refer to the brakes group in the vehicle maintenance manual.
5. Remove the safety stands from under the axle; lower the vehicle.
6. Remove the chocks from under the tires.

Inspection

New brake drums are purposely undersized to allow for turning, which may be needed if the drum is non-concentric when mounted on the hub. If a new drum is installed, the protective coating on the inner friction surface must first be removed with a solvent, and then rinsed with a hot water wash. Use a clean rag to remove any oily residue or metal chips from the friction surface.

If a drum must be turned or replaced, the other same-axle drum must be similarly turned or replaced to provide the same braking power on both wheels. Turned drums should not exceed the maximum allowable diameter, which is stamped on the outside surface of the drum. **Refer to Fig. 1** for a typical location of this stamp.

NOTE: Drums that have been turned should then be cleaned by using fine emery cloth followed with a hot water wash. Drums that have been renewed using emery cloth should also be cleaned with a hot water wash.

⚠ WARNING

WARNING: Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by MSHA or NIOSH. Wear a respirator at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

Failure to replace drums when worn or turned to limits exceeding the maximum allowable diameter will cause drum weakness and reduced braking capacity, which can lead to distortion, higher drum temperatures, and ultimate drum breakage.

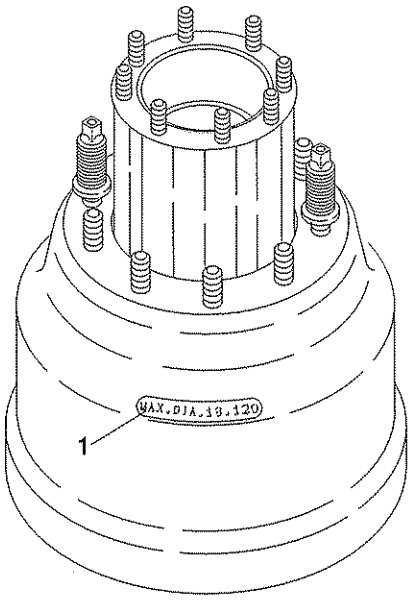
To minimize the possibility of creating airborne brake lining dust, clean the dust from the brake drum, brake backing plate, and brake assembly, using an industrial-type vacuum cleaner equipped with a high-efficiency filter system. Then, using a rag soaked in water and wrung until nearly dry, remove any remaining dust. Don't use compressed air or dry brushing to clean the brake assembly.

If the drums are turned or replaced, replace the brake linings. **Refer to the brakes group** for instructions.

1. Inspect the inner friction surface. If a veneered (highly glossed) or glazed surface exists, renew the drum by using 80-grit emery cloth or by turning the drums. **See Fig. 2.**
2. Inspect for heat checking, which is a form of buckling (cracking) resulting from a temperature differential in the drum wall between a relatively cool exterior and a hot friction surface. Heat checking is normal on all drums and may not reduce performance and lining life if the network of fine hairline cracks remains small. **See Fig. 3.** Examine heat checks of drums often to be sure the checks have not widened into drum weakening cracks (substantial cracks extending to the open edge of the drum). **See Fig. 4.**

   Replace the same-axle drums if substantial cracks are present, or if widening of the fine hairline cracks occurs.

NOTE: If there is normal heat checking as described above, inspect the drums at least every 19 300 km (12,000 miles) thereafter. If the vehicle is not equipped with brake dust shields, inspect the drums (using a flashlight from the inboard side of the wheels) every



1. Maximum Diameter Stamp

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Fig. 1

Inspection

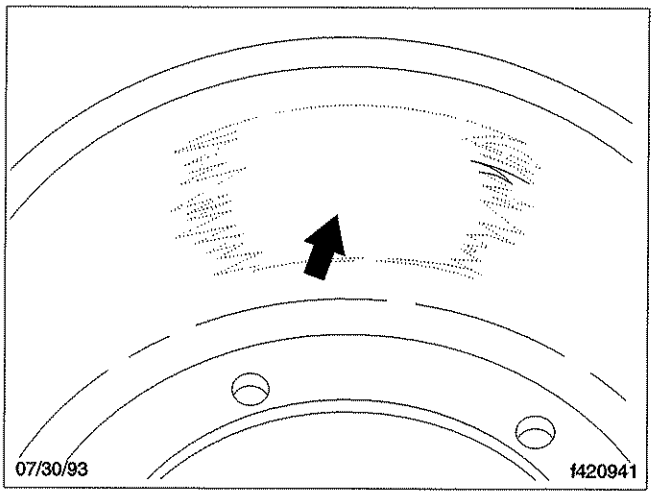


Fig. 2, Polished Drums

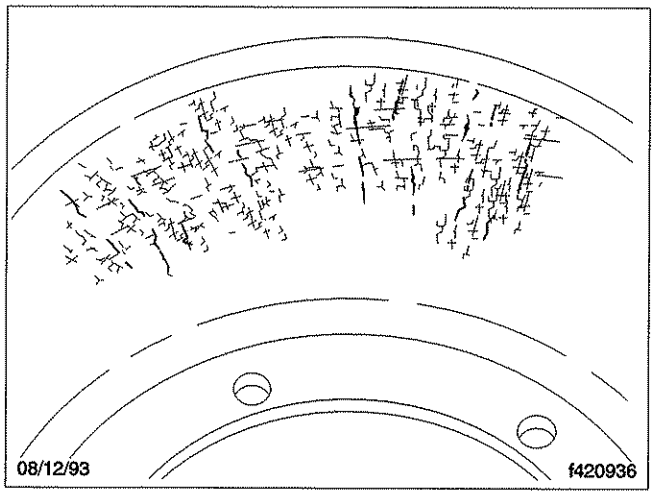


Fig. 3, Heat Checking

9700 km (6000 miles). Inspect more often under adverse operating conditions.

3. Check for a contaminated inner friction surface. If fluids are present, such as oil or grease, remove them. Locate and correct the source of the contamination. If the brake drums are contaminated with fluids, the brake linings will also be affected. Since oil-or grease-saturated linings cannot be salvaged, they must be replaced. For instructions, **refer to the brakes group.**

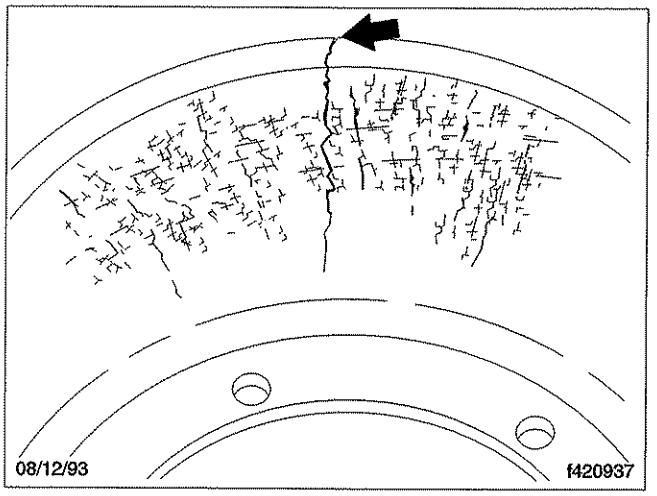


Fig. 4, Cracked Drums

⚠ WARNING

WARNING: Failure to replace fluid-contaminated brake linings could result in a partial loss of braking capacity.

4. Measure the inside diameter of the drum. If this measurement is greater than the maximum allowable diameter, replace the same-axle drums and linings. **See Fig. 5.**

5. Check for a variation in gauge readings at different points on the radius of the drum's working surface. If the variation is more than 0.25 mm (0.010 inch) at any point, the drum is out-of-round to unacceptable limits. Remachine or replace the same-axle drums. **See Fig. 5.**

6. Inspect the outside surface of the drum. Remove any accumulation of mud, dirt, or rust; foreign matter acts as an insulator, trapping heat within the drum.

7. Check for hard, slightly raised, dark-colored spots on the inner friction surface **(see Fig. 6)** or for a bluish cast on the brake parts **(see Fig 7),** both of which are caused by high temperatures. If the drums' maximum allowable diameters have not been exceeded, remachine both same-axle drums. If spots or discoloration cannot be removed, or if remachining is not possible, replace the drums. Also replace the brake shoe return springs. **Refer to the brakes group** for instructions.

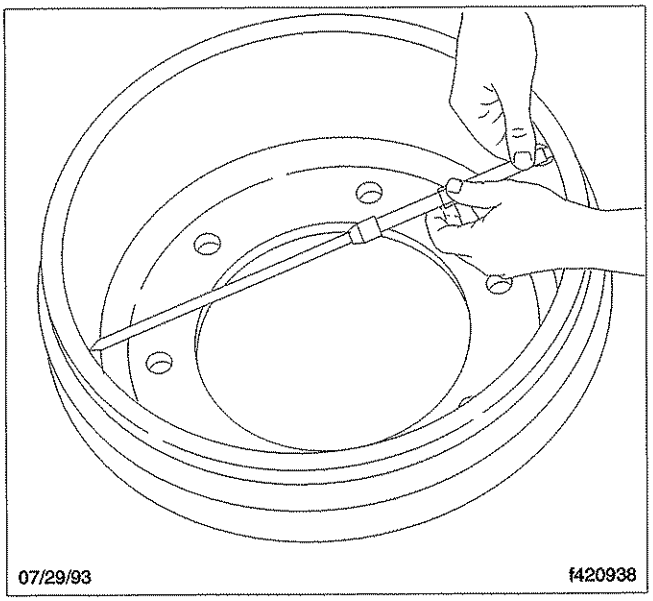


Fig. 5, Oversized Drums

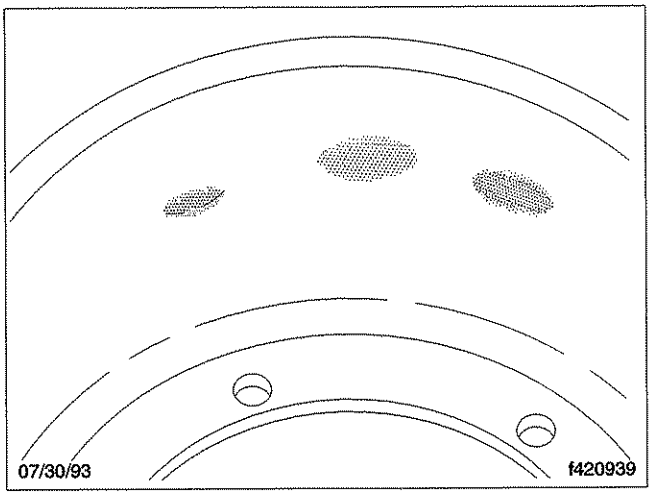


Fig. 6, Heat Spotted Drums

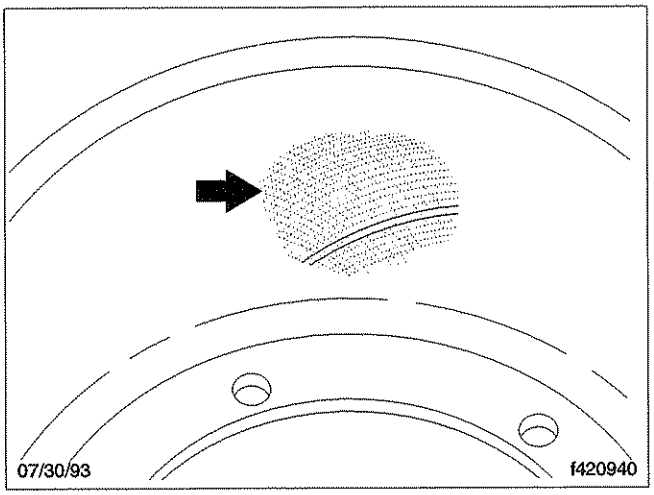


Fig. 7, Blue Drums

Specifications

This subject contains the following table:

•Fastener Torque

Description	Grade	Size	Torque N·m (lbf·ft)
Brake Drum Bolt	8	3/4-10	325 (240)

Table 1, Fastener Torque

Contents

Subject	Subject Number
General Description and Principles of Operation	050
Service Operations	
Safety Precautions	100
Brake Shoe Removal and Installation	110
Brake Shoe and Lining Inspection	120
Brake Adjustment	125
Brake Shoe Lining Replacement	130
Brake Components Disassembly and Inspection, Cleaning, and Assembly	140
Specifications	400

Refer to the **front axle group** *for wheel hubs, brake drums, and wheel bearings, and to the* **brake group** *for air brake system troubleshooting.*

Safety Precautions

Because some brake linings contain asbestos, you should know the potential hazards of asbestos and the precautions to be taken. Because medical experts believe that long-term exposure to some *non-asbestos* fibers could also be a health hazard, the following precautions should also be observed if servicing non-asbestos brake linings.

Exposure to airborne brake lining dust can cause serious and possibly fatal diseases such as asbestosis (a chronic lung disease) and cancer.

During brake servicing, an air purifying respirator with high-efficiency filters must be worn. The respirator and filter must be approved by MSHA or NIOSH, and worn during all procedures.

OSHA recommends that enclosed cylinders equipped with vacuums and high-efficiency particulate air (HEPA) filters be used during brake repairs. Under this system, the entire brake assembly is placed within the cylinder and the mechanic works on the brake through sleeves attached to the cylinder. Compressed air is blown into the cylinder to clean the assembly, and the dirty air is then removed from the cylinder by the vacuum.

If such an enclosed system isn't available, the brake assembly must be cleaned in the open air. During disassembly, carefully place all parts on the floor to minimize creating airborne dust. Using an industrial vacuum cleaner with a HEPA filter system, remove dust from the brake drums, brake backing plates, and brake parts. After vacuuming, any remaining dust should be removed using a rag soaked in water and wrung until nearly dry.

⚠ WARNING

WARNING: Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by MSHA or NIOSH. Wear a respirator at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

To minimize the possibility of creating airborne brake lining dust, clean the dust from the brake drum, brake backing plate, and brake assembly, using an industrial-type vacuum cleaner equipped with a high-efficiency filter system. Then, using a rag soaked in water and wrung until nearly dry, remove any remaining dust. Don't use compressed air or dry brushing to clean the brake assembly.

Brake Shoe Removal and Installation

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

Removal

1. Park the vehicle on a level surface, apply the parking brakes, and chock the tires.
2. Raise the front or rear axle, then place safety stands under the frame or axle. Be sure the stands will support the weight of the vehicle.
3. Remove the wheels and brake drums. For instructions, refer to the **front axle group** or the **rear axle group** in this manual.

⚠ CAUTION

CAUTION: Before you back off automatic slack adjusters, refer to the brakes group in this manual, or to the manufacturer's service information for instructions. Failure to do so could damage the slack adjusters.

4. Back off the slack adjusters.

   On manual slack adjusters, back off each until the cam is in the start or released position.

   On automatic slack adjusters, refer to the brake section in this manual for instructions on backing off the slack adjuster.

5. If equipped with 15-inch "Q" Series brakes, go to step 6.

   If equipped with "Q" Plus Series brakes, or 16-1/2 inch "Q" Series brakes, remove the brake shoes.

   5.1 Push down on the bottom brake shoe, then pull on the roller retaining clip to remove the bottom cam roller. **See Fig. 1.**

   5.2 Lift the top brake shoe and pull on the roller retaining clip to remove the top cam roller.

   5.3 Lift the bottom shoe to release tension on the brake return spring. Remove the spring. **See Fig. 2.**

   5.4 Rotate the bottom shoe to release tension on the two retaining springs. Remove the springs and the brake shoes. **See Fig. 3.**

6. If equipped with 15-inch "Q" Series brakes, remove the brake shoes.

   6.1 Push down on the bottom brake shoe, then remove the bottom cam roller.

   6.2 Lift the top brake shoe and remove the top cam roller.

   6.3 Remove the brake shoe return spring.

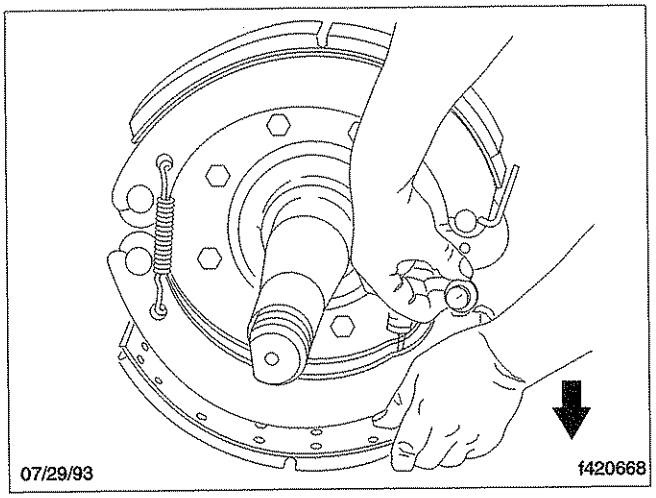


Fig. 1

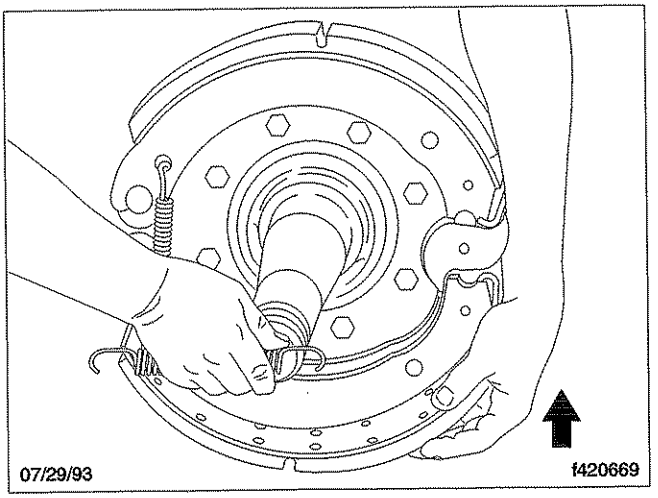


Fig. 2

Brake Shoe Removal and Installation

6.4 Rotate the bottom shoe to release tension on the retaining spring. Remove the spring and the brake shoes.

7. Inspect the brake shoes and linings for wear or damage. **Refer to Subject 120.**

Installation

IMPORTANT: For best brake performance, don't mix "Q" and "Q" Plus Series brakes. Use the same brake series on the entire vehicle.

1. Apply a thin film of a temperature resistant grease (Rockwell 0-616, or an equivalent) on the anchor pins where they touch the brake shoes. Also, apply a multipurpose chassis grease (Rockwell 0-617-A or 0-617-B, or an equivalent) on the retainer clips, spider, and shoe rollers where they touch the brake shoes.

IMPORTANT: Don't apply any grease on the outer diameter of the roller that touches the cam head.

2. Go to the step for installing the brake shoes on 15-inch "Q" Series brakes, if so equipped.

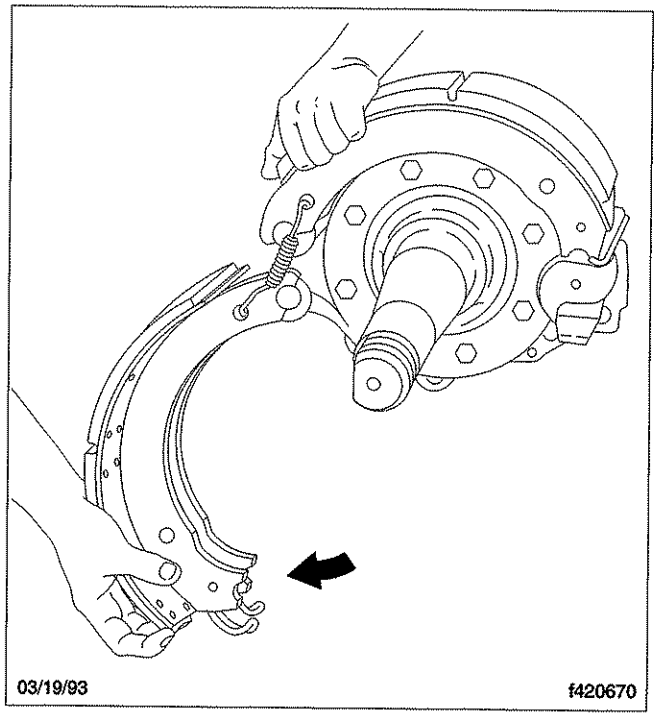


Fig. 3

If equipped with "Q" Plus Series brakes, or 16-1/2 inch "Q" Series brakes, install the brake shoes.

2.1 Place the upper brake shoe in position on the top anchor pin. Hold the lower brake shoe on the bottom anchor pin and attach two new brake shoe retaining springs. **See Fig. 4.**

2.2 Turn the lower brake shoe forward and attach a new brake shoe return spring. **See Fig. 5.**

2.3 Pull each brake shoe away from the cam to allow enough space to install the cam rollers and retainers. Press the ears of the retainer together to permit the retainer to fit between the brake shoe webs. **See Fig. 6.**

2.4 Push the retainer into the brake shoe until the ears lock in the holes in the shoe webs. **See Fig. 7.**

3. If equipped with 15-inch "Q" Series brakes, install the brake shoes.

3.1 Install the retainer spring on the shoes and install the shoes on the anchor pins. **See Fig. 8.** Hold the bottom shoe in position and install the return spring.

3.2 Pull each shoe away from the cam to allow enough space, then install the cam rollers.

4. Install the wheels and brake drums. For instructions, refer to the **front axle group** or the **rear axle group** in this manual.

5. Adjust the brakes at the slack adjusters. For instructions, **refer to Subject 125.**

6. Remove the safety stands, lower the vehicle, and remove the chocks from the tires.

⚠ WARNING

WARNING: Don't operate the vehicle until you have adjusted the brakes and checked for their proper operation. Failure to do so could result in inadequate or no braking ability, which could cause personal injury or death, and property damage.

7. Check for proper brake operation.

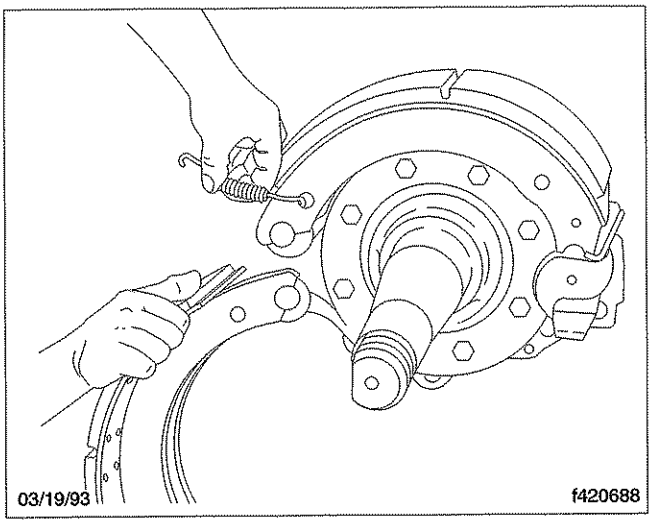


Fig. 4

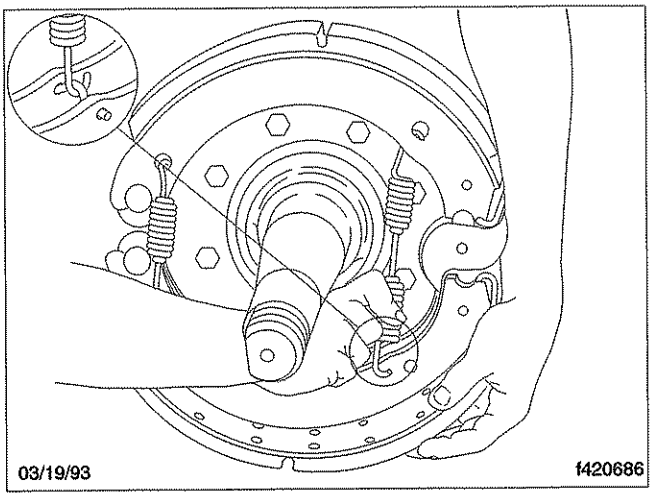


Fig. 5

7.1 To ensure that the braking system is working correctly, make ten 60 to 30 km/h (40 to 20 mph) snubs to seat the linings.

7.2 Make ten stops from 30 km/h (20 mph) at 50 percent air pressure.

7.3 Make a full-pressure stop from 30 km/h (20 mph).

7.4 Immediately after doing the above stops, check the drum temperatures. Any drums that are significantly cooler than the others shows a lack of braking effort on those wheels.

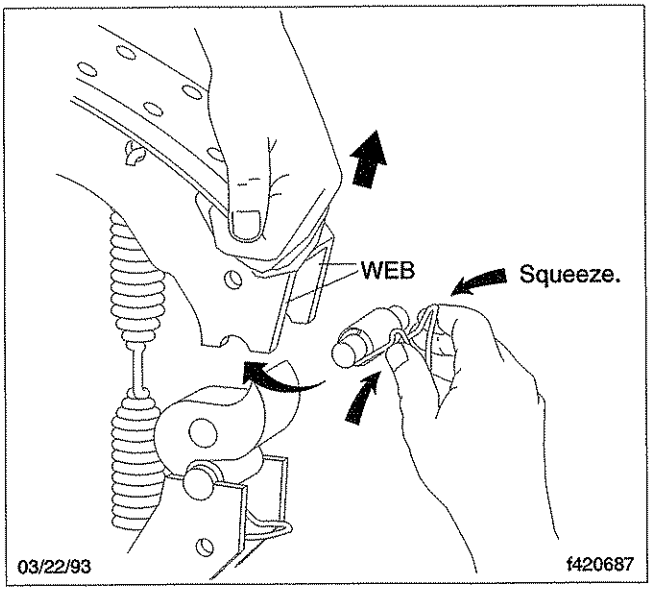


Fig. 6

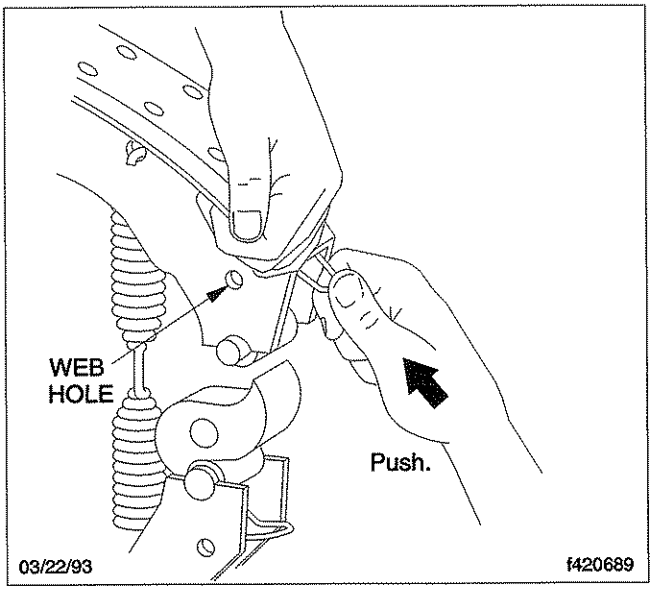


Fig. 7

Brake Shoe Removal and Installation

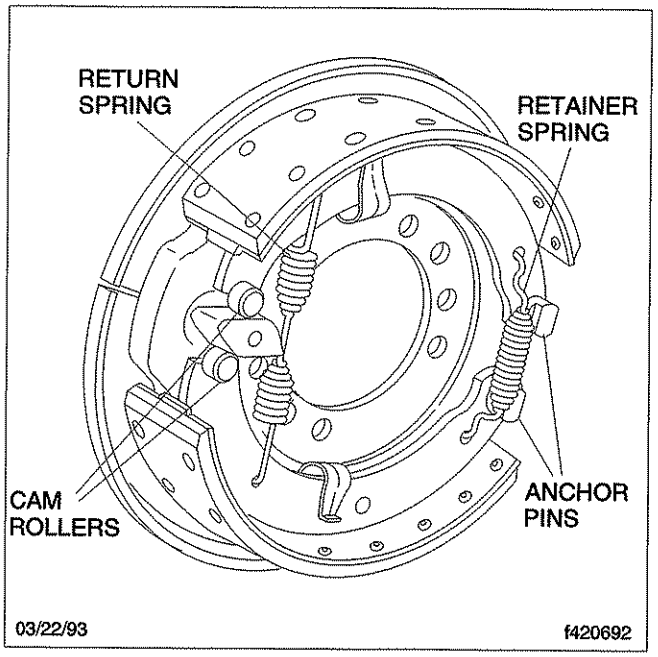


Fig. 8

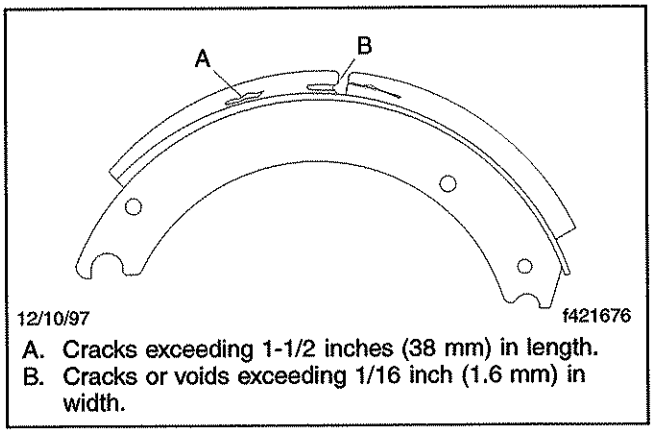
Brake Shoe and Lining Inspection

⚠ WARNING

Before starting the procedure below, read the information in Safety Precautions, 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

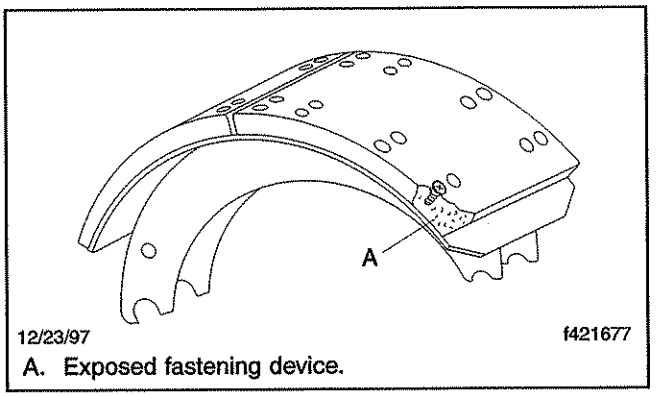
Inspection

1. Remove the brake shoes, using the instructions in **Subject 110.**
2. Check the linings.
   - 2.1 If the linings are grease-or oil-soaked, cracked, or worn to less than 1/4-inch (6.4-mm) thickness at any point, replace them.
   - 2.2 Replace the linings if the lining surface is closer than 1/32 inch (0.8 mm) to any rivet head.
   - 2.3 The lining is considered worn-out and the vehicle should not be driven if:
     - Cracks on the lining surface exceed 1/16 inch (1.6 mm);
     - The lining edge shows cracks or voids over 1/16 inch (1.6 mm) in width and 1-1/2 inches (38 mm) in length. See **Fig. 1**;
     - Portions of the lining are missing exposing a rivet when viewed from the edge. See **Fig. 2**;
     - Cracks extend across the lining face and through the lining edge, or the lining is loose on the shoe. See **Fig. 3**.
   - 2.4 The vehicle is still operational but linings should be replaced as soon as possible if:
     - Horizontal or vertical cracks in the lining edge exhibit no loss of material and do not exceed 1/16 inch (1.6 mm) in width or 1-1/2 inch (38 mm) in length. See **Fig. 4**;
     - Corner portions of the lining are missing with no fastener exposed. See **Fig. 5**;
     - Surface cracks extend from hole to hole or if there is scoring and contamination from road debris. See **Fig. 6**.
3. Check the shoes for bent or cracked webs or tables, broken welds, loose or out-of-round rivet or bolt holes. Replace the shoes if any of these conditions exist.
4. Check the anchor pin for looseness and camshaft roller recesses in the shoe webs for visible wear. Replace the shoe if needed.
5. Check the shoe span. Measure the distances between the centerlines of the anchor pin and the camshaft roller pin recesses in the shoe web. If



A. Cracks exceeding 1-1/2 inches (38 mm) in length.
B. Cracks or voids exceeding 1/16 inch (1.6 mm) in width.

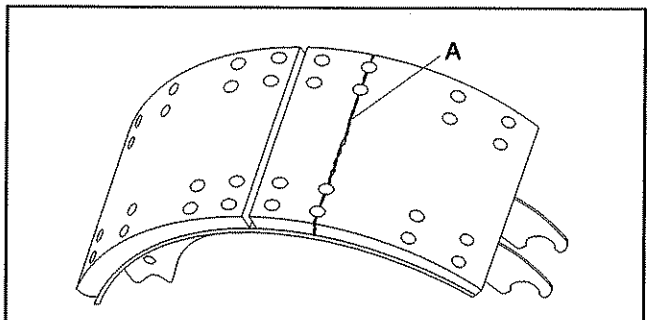
Fig. 1, Cracks and Voids



A. Exposed fastening device.

Fig. 2, Portions of the Brake Lining Missing

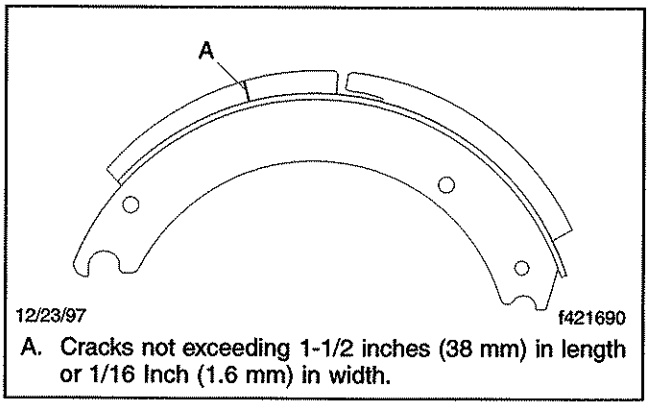
Brake Shoe and Lining Inspection



12/10/97 f421678

A. Cracks extending through the lining edge.

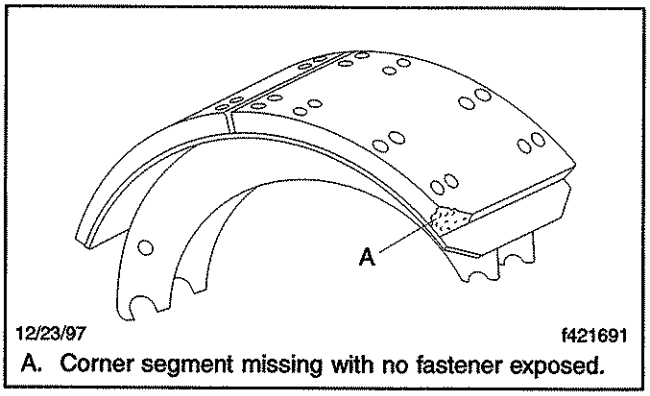
Fig. 3, Cracks in the Brake Lining



12/23/97 f421690

A. Cracks not exceeding 1-1/2 inches (38 mm) in length or 1/16 Inch (1.6 mm) in width.

Fig. 4, Cracks and Voids

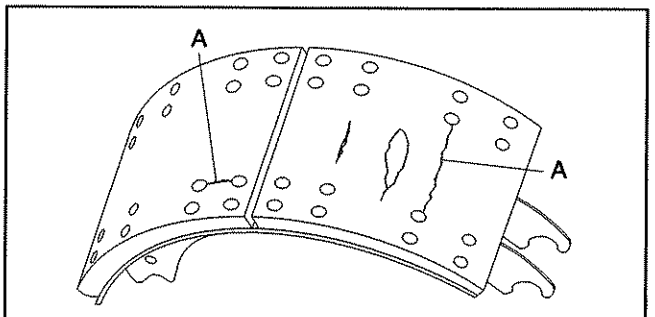


12/23/97 f421691

A. Corner segment missing with no fastener exposed.

Fig. 5, Portions of the Brake Lining Missing

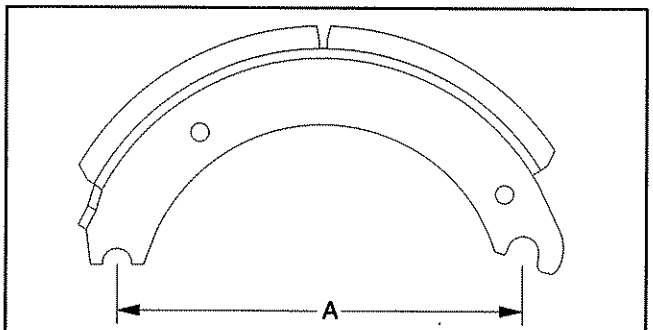
the measurement is more than 12-7/8 inches (327 mm), replace the shoe. See **Fig. 7**.



12/23/97 f421692

A. Cracks extending from hole to hole.

Fig. 6, Cracks in the Brake Lining



08/09/94 f420068a

A. 12-7/8 inches (327 mm)

Fig. 7, Measuring the Shoe Span

Adjustment

ROCKWELL AUTOMATIC SLACK ADJUSTER

1. Check the free-stroke.

   1.1 With the brakes fully released, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 1**, Ref. *A*.

   1.2 Use a pry bar to move the slack adjuster and apply the brakes. Again, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 1**, Ref. *A*.

   1.3 The difference between the two measurements is the initial free-stroke, and sets the clearance between the linings and the drum.

   1.4 The free-stroke must be 16 to 19 mm (5/8 to 3/4 inch);

   If the free-stroke is correct, go to the step for checking brake chamber stroke.

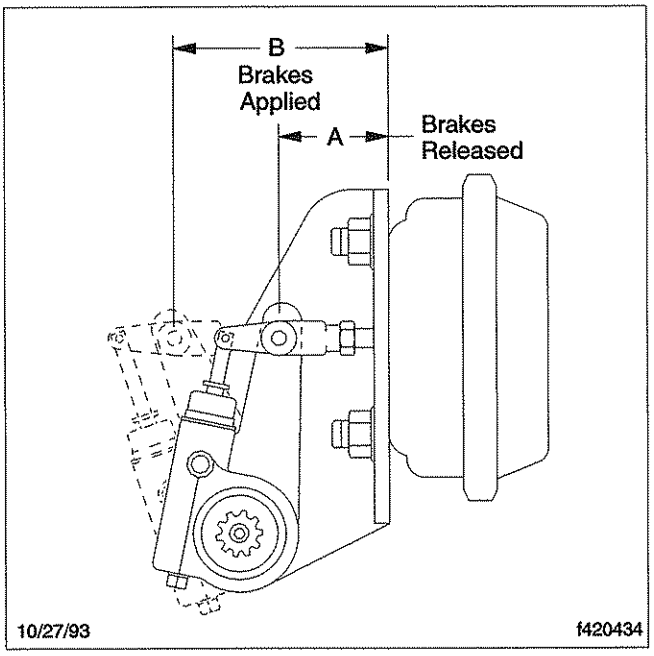


Fig. 1

   1.5 If the free-stroke is incorrect, remove the pressure relief capscrew (**Fig. 2**, Ref. 16), spring (Ref. 18), and pawl assembly (Ref. 19) from the slack adjuster housing. If equipped with a pull-pawl assembly **(Fig. 3),** carefully insert a screwdriver and raise the relief cap about 3.2 mm (1/8 inch).

⚠ CAUTION

CAUTION: Before turning the adjusting nut, remove the pressure relief capscrew, spring, and pawl assembly. If equipped with a pull-pawl assembly, raise the relief cap about 3.2 mm (1/8 inch). Failure to do so could strip the teeth on the pawl.

   1.6 Turn the adjusting nut 1/8 turn, **as shown in Fig. 4.** Measure the stroke again, and adjust until it is correct.

2. Check for correct brake chamber stroke.

   2.1 With the brakes fully released, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 1**, Ref. *A* .

   2.2 Build air pressure to 689 kPa (100 psi). Shut down the engine. Fully apply the brakes, then measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 1**, Ref. *B* . The difference between the measurements is the brake chamber stroke.

   2.3 The brake chamber stroke must be less than the measurements shown in **Table 1.** If the brake chamber stroke is incorrect, remove the pressure relief capscrew **(Fig. 2,** Ref. 16), spring (Ref. 18), and pawl assembly (Ref. 19) from the slack adjuster housing. If equipped with a pull-pawl assembly **(Fig. 3),** carefully insert a screwdriver and raise the relief cap about 3.2 mm (1/8 inch).

Brake Adjustment

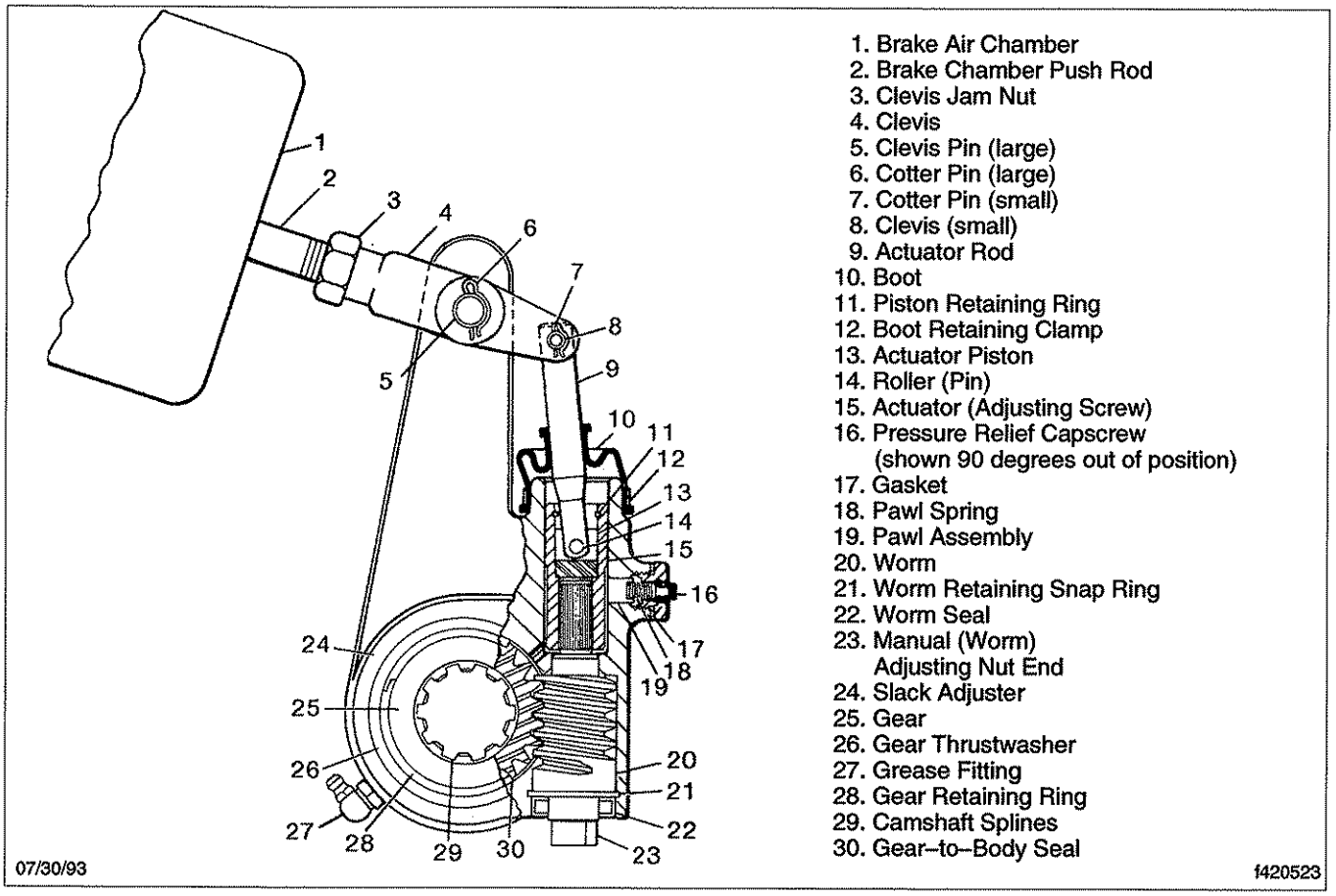


Fig. 2, Rockwell Automatic Slack Adjuster

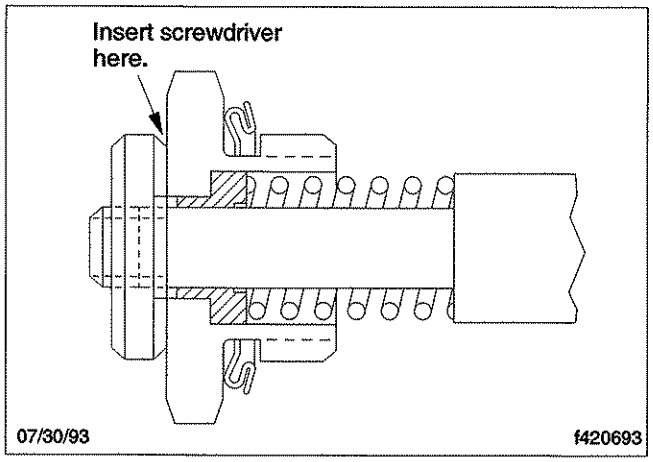


Fig. 3, Pull-Pawl Assembly (sectional view)

Chamber Size	Stroke mm (inch)
9, 12	Less than 35 (1-3/8)
16, 20, 24	Less than 44 (1-3/4)
24*, 30	Less than 51 (2)
36	Less than 57 (2-1/4)

* Long Stroke

Table 1, Maximum Adjusted Brake Chamber Stroke

⚠ CAUTION

CAUTION: Before turning the adjusting nut, remove the pressure relief capscrew, spring, and pawl assembly. If equipped with a pull-pawl assem-

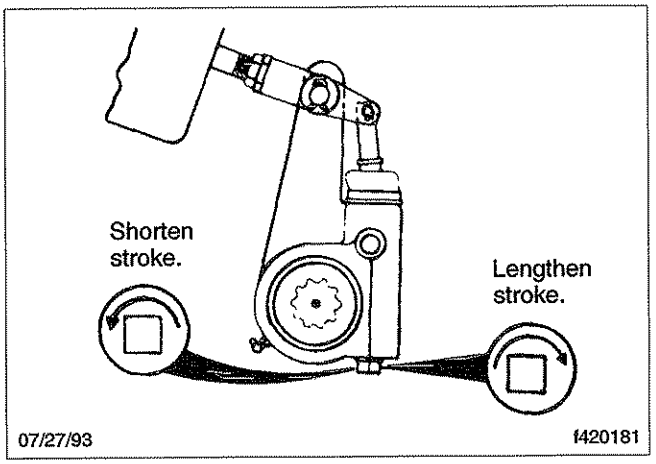


Fig. 4

bly, raise the relief cap about 3.2 mm (1/8 inch). Failure to do so could strip the teeth on the pawl.

2.4 Turn the adjusting nut 1/8 turn, **as shown in Fig. 4.** Measure the stroke again, and adjust until correct.

⚠ CAUTION

CAUTION: Don't make the adjusted chamber stroke too short. The free-stroke must not be less than 16 to 19 mm (5/8 to 3/4 inch). If the chamber stroke is too short, the linings can drag and damage the brake.

If the stroke varies or remains greater than the specified range, check the brake components. For instructions, refer to Subject 140.

2.5 If necessary, replace the slack adjuster. For instructions, refer to the applicable slack adjuster section in this group.

2.6 If removed, install the pawl assembly, spring, and the pressure relief capscrew. Tighten the capscrew 20 to 27 N·m (15 to 20 lbf·ft). Or, remove the screwdriver from the pull-pawl assembly (if equipped).

HALDEX AUTOMATIC SLACK ADJUSTER

1. Turn the adjusting hexnut clockwise until the brake lining meets the brake drum, then back off counterclockwise 3/4 turn. **Refer to Fig. 5.** There will be a ratcheting sound.
2. Measure the distance from the bottom of the air chamber to the far side of the clevis-pin hole (**Fig. 6**, Ref. *A*). Record the exact distance as measurement A. Apply and hold a 551 kPa (80 psi) brake application. Measure the distance from the bottom of the brake chamber to the far side of the clevis-pin hole (**Fig. 6**, Ref. *B*). Record the exact distance as measurement B. Subtract measurement A from measurement B to determine the applied stroke. Compare this value to the value in **Table 2.**

   If the stroke varies or remains greater than the specified range, check the brake components. For instructions, **refer to Subject 140.** If necessary, replace the slack adjuster. For instructions, refer to the applicable slack adjuster section in this manual.

Chamber Size	Stroke mm (inch)
16	19 to 44 (3/4 to 1-3/4)
20	25 to 44 (1 to 1-/34)
24	25 to 48 (1 to 1-7/8)
30	38 to 51 (1-1/2 to 2)

Table 2, Maximum Adjusted Brake Chamber Strokes With Haldex Automatic Slack Adjusters

BENDIX MANUAL SLACK ADJUSTER

1. With the parking brakes released, rotate the adjusting screw until the brakes begin to drag when the drum is turned; then, back off the adjustment until the wheel turns freely. Turn the adjusting screw nut until the locking sleeve engages it.
2. Measure the distance from the bottom of the brake chamber to the centerline of the clevis (**Fig. 7**, Ref. *A*). Record the exact distance as measurement A. Apply and hold a 551 kPa (80 psi) brake application. Measure the distance from the bottom of the brake chamber to the centerline of the clevis-pin (**Fig. 7**, Ref. *B*). Record the exact distance as measurement B. Subtract measurement A from measurement B to determine the applied stroke. Compare this value to the value in **Table 3.**
3. If the applied stroke equals or exceeds the maximum applied stroke, adjust the brakes.

Brake Adjustment

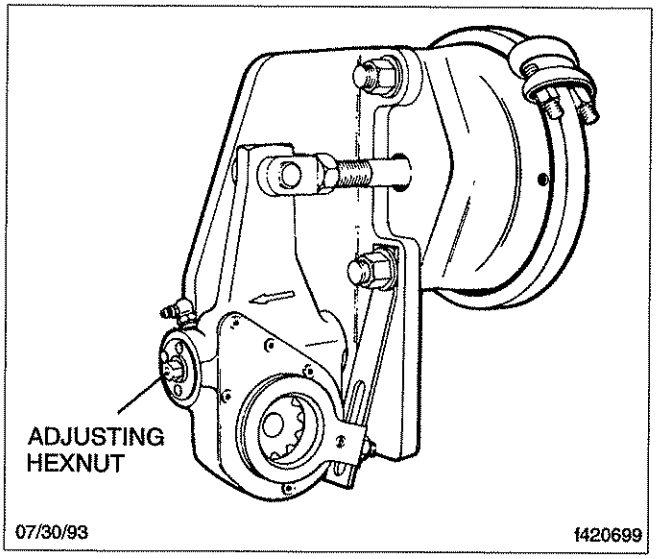


Fig. 5

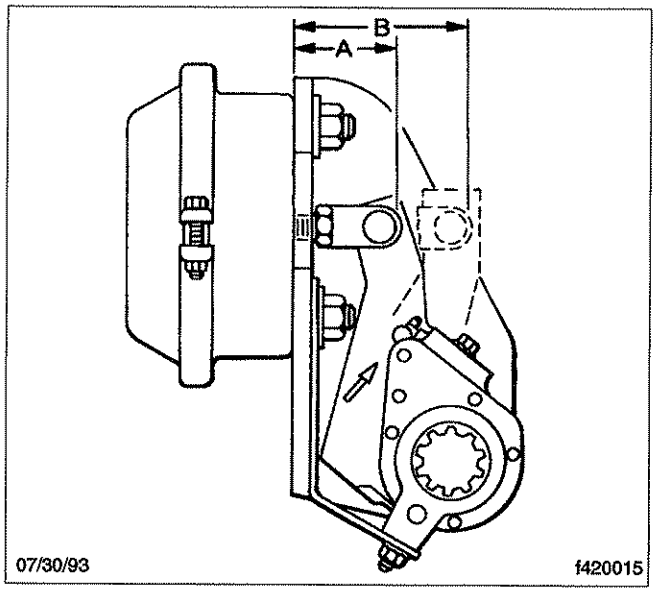


Fig. 6, Brake Stroke Check, Haldex (SAB) Automatic Slack Adjuster

Chamber Size	Stroke mm (inch)
9, 12	Less than 38 (1-1/2)
16, 20	Less than 44 (1-3/4)
24	Less than 48 (1-7/8)
24*, 30	Less than 51 (2)
36	Less than 57 (2-1/4)

* Long Stroke

Table 3, Maximum Adjusted Brake Chamber Strokes With Bendix Manual Slack Adjusters

3.1 Wipe clean the adjusting screw hexhead. **Refer to Fig. 7.** Position a wrench or socket over the adjusting screw hexhead.

IMPORTANT: On slack adjusters equipped with an adjusting screw locking sleeve, wipe clean the locking sleeve area, and depress the locking sleeve when positioning the wrench or socket over the adjusting screw. Do not try to turn the adjusting screw without fully depressing the locking sleeve.

3.2 Turn the adjusting screw until it is tight; then, back off the adjustment until the drum is free. Normally, the adjusting screw will need to be backed off 2 or 3 clicks.

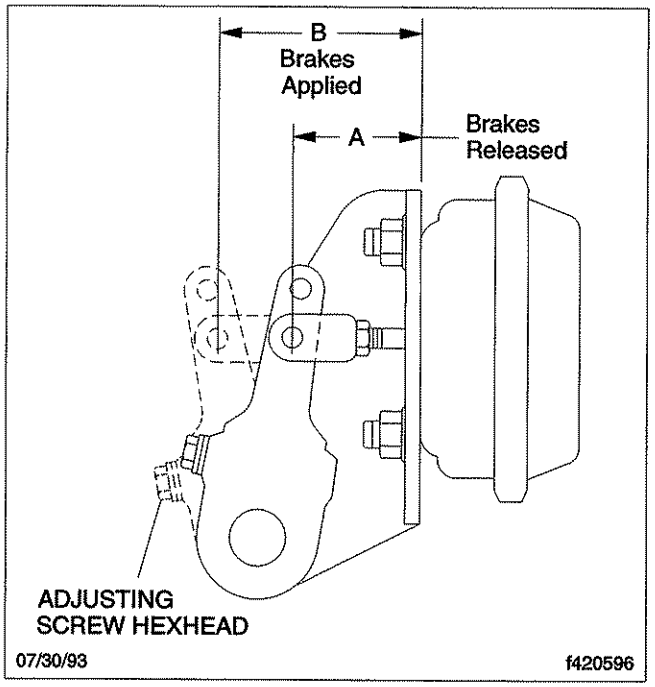


Fig. 7

3.3 To see if the drum is free, strike the brake drum with a steel tool and listen for a clear ringing sound. If a dull thud is heard, the brake is dragging.

IMPORTANT: Checking the brake adjustment when the wheel is off the ground may be unreliable. Looseness or wear anywhere in the wheel bearings will cause the drum to be misaligned while the wheel is off the ground. Check the brake adjustment with the wheel on the ground.

On slack adjusters equipped with an adjusting screw locking sleeve, make sure that the locking sleeve is engaged around the adjusting screw hexhead after adjustment, thus locking the adjusting screw in place.

Brake Shoe Lining Replacement

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

Replacement

IMPORTANT: For the best brake performance, don't mix brake linings between axles. When relining brake shoes, both wheel ends of each axle must have the same linings. On tandem axles, all four wheel ends must also have the same linings. However, it is not necessary for the steering axle brakes to have the same linings as the rear drive axle brakes. Also, when the minimum thickness is reached for any of the brake linings on an axle, reline both brakes on that axle at the same time.

Combination linings with different friction ratings for the primary and secondary shoes are often used. When combination linings are used, install the forward blocks on the primary shoe (following the rotation of the drum, the first shoe after passing the cam or wheel cylinder is the primary shoe).

If the cam is behind the axle, the top shoe is the primary and the lower shoe is the secondary shoe. **See Fig. 1.** If the cam is in front of the axle, the lower shoe is the primary shoe. **See Fig. 2.**

Replacement Using Rivets

With the brake shoe removed, do the following:

1. Using a suitable riveting mandrel, push out the old rivets.

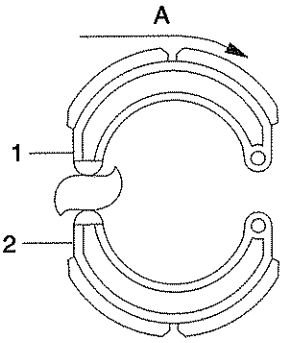
⚠ CAUTION

CAUTION: Drilling out rivets or cutting off rivet heads with a chisel can cause the rivet hole to become out-of-round. This could damage the brake shoe.

2. Clean the shoe table. For instructions, refer to **Subject 140.**
3. Align the brake shoe and lining rivet holes. Using a C-clamp, clamp the lining to the brake shoe.
4. Insert the correct sized rivets into all holes and threads, and temporarily hold them in place with masking tape.

IMPORTANT: Use rivets that have the correct material, shank diameter, length, head size, and shape. Use tubular rivets that are 1/4-inch diameter by 9/16-inch long, SAE no. 10, made of plated steel or brass.

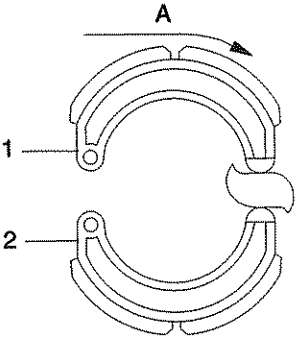
5. Begin riveting at the center of each edge of the shoe and lining, and work toward each end. **See Fig. 3.**
6. Check for a close fit between the lining and shoe table.



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A. Right wheel rotation
1. Primary Shoe
2. Secondary Shoe

Fig. 1, Camshaft Behind Axle

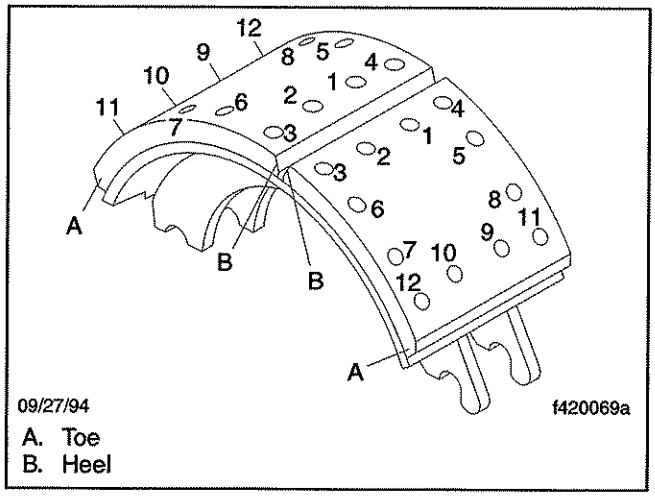


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A. Right wheel rotation
1. Secondary Shoe
2. Primary Shoe

Fig. 2, Camshaft Ahead of Axle

Brake Shoe Lining Replacement



A. Toe
B. Heel

Fig. 3, Rivet or Bolt Attachment Sequence

Try to insert a 0.25-mm (0.010-inch) feeler gauge between the lining and shoe table along the edges. **See Fig. 4**, Ref. A. It should not be possible to insert the feeler gauge anywhere along the edge, except at each end beyond the last row of rivets. **See Fig. 5**, Ref. A. A larger clearance, up to 0.64 mm (0.025 inch), may exist in these areas.

7. Circle grind the brake lining to obtain the correct lining-to-drum contact. With the cam in the full-release position, the new brake linings must be ground 1.8 mm (0.070 inch) less than the drum diameter. The cam must be adjusted and the lining ground until there is an 80 percent lining-to-drum contact, which must be continuous and in the center of the lining.

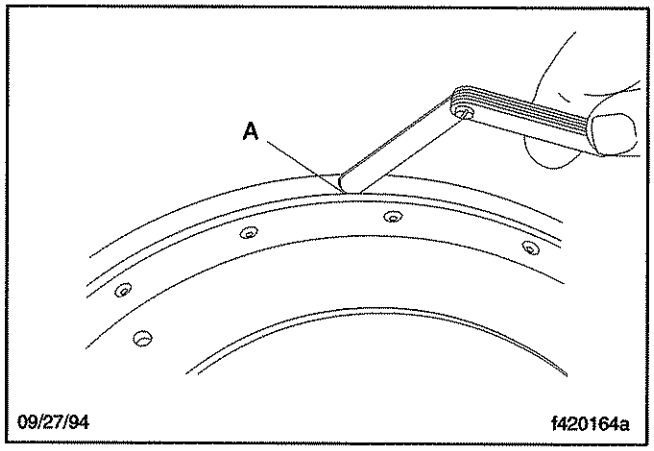


Fig. 4

Replacement Using Bolts

1. Clean the shoe table. For instructions, refer to **Subject 140.**
2. Align the brake shoe and lining bolt holes. Using a C-clamp, clamp the lining to the brake shoe.
3. Insert the correct sized bolts, and new lockwashers, into all holes and threads. Loosely install the nuts.
4. Tighten the nuts as follows in the sequence **shown in Fig. 3**: on 3/8-inch brass bolts 24 to 31 N·m (18 to 23 lbf·ft); on 1/4-inch brass bolts 900 to 1120 N·cm (80 to 100 lbf·in).
5. Circle grind the brake lining to obtain the correct lining-to-drum contact. With the cam in the full-release position, the new brake linings must be ground 1.8 mm (0.070 inch) less than the drum diameter. The cam must be adjusted and the lining ground until there is an 80 percent lining-to-drum contact, which must be continuous and in the center of the lining.

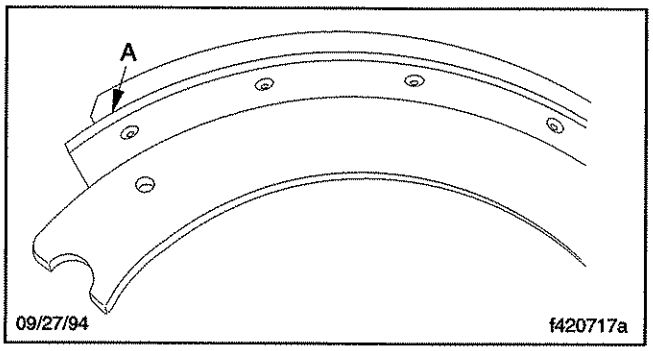


Fig. 5

Brake Components Disassembly and Inspection, Cleaning, and Assembly

Disassembly and Inspection (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedure below, read the information in Safety Precautions, 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Check the drum for cracks, heat-checks, glazing, grooving, and run-out. **See Fig. 2.** Measure the drum diameter. Replace the drum if it exceeds the maximum diameter stamped on it. Replace cracked drums. Some drums that are glazed, grooved, or out-of-round can be repaired. For detailed instructions, refer to **Group 33** or **Group 35** in this manual.
2. Disconnect the slack adjuster from the push rod clevis. For manual slack adjusters, remove the cotter pin and clevis pin from the brake chamber push rod clevis. For automatic slack adjusters, refer elsewhere in this group, or to the slack adjuster manufacturer's service information for instructions.
3. With the brake shoes removed, use a dial indicator to measure the up-and-down and side-to-side end play of the camshaft. Replace the bushings if there is more than 0.8 mm (0.030 inch) of movement.
4. Remove the slack adjuster.
   - 4.1 For automatic slack adjusters, refer elsewhere in this group, or to the manufacturer's service information for instructions.
   - 4.2 For manual slack adjusters, while depressing the locking sleeve, turn the adjuster nut until the slack adjuster is clear of the brake chamber push rod clevis. Remove the lockring and the outer spacing washers from the camshaft. Using a suitable puller, remove the slack adjuster.

⚠ CAUTION

CAUTION: Don't hammer on the slack adjuster to remove it. Damage to the adjuster or camshaft spline may result.

5. Check the slack adjuster for damage and for binding.
   - 5.1 Check the slack adjuster clevis for cracks or bushing wear. Check the splines for chipped teeth and deformation. Replace as needed.
   - 5.2 Depress the locking sleeve, and turn the adjuster nut with a wrench at least one turn in each direction. If there is binding, or if excessive force is needed to turn the slack adjuster, replace it. For instructions, refer elsewhere in this group

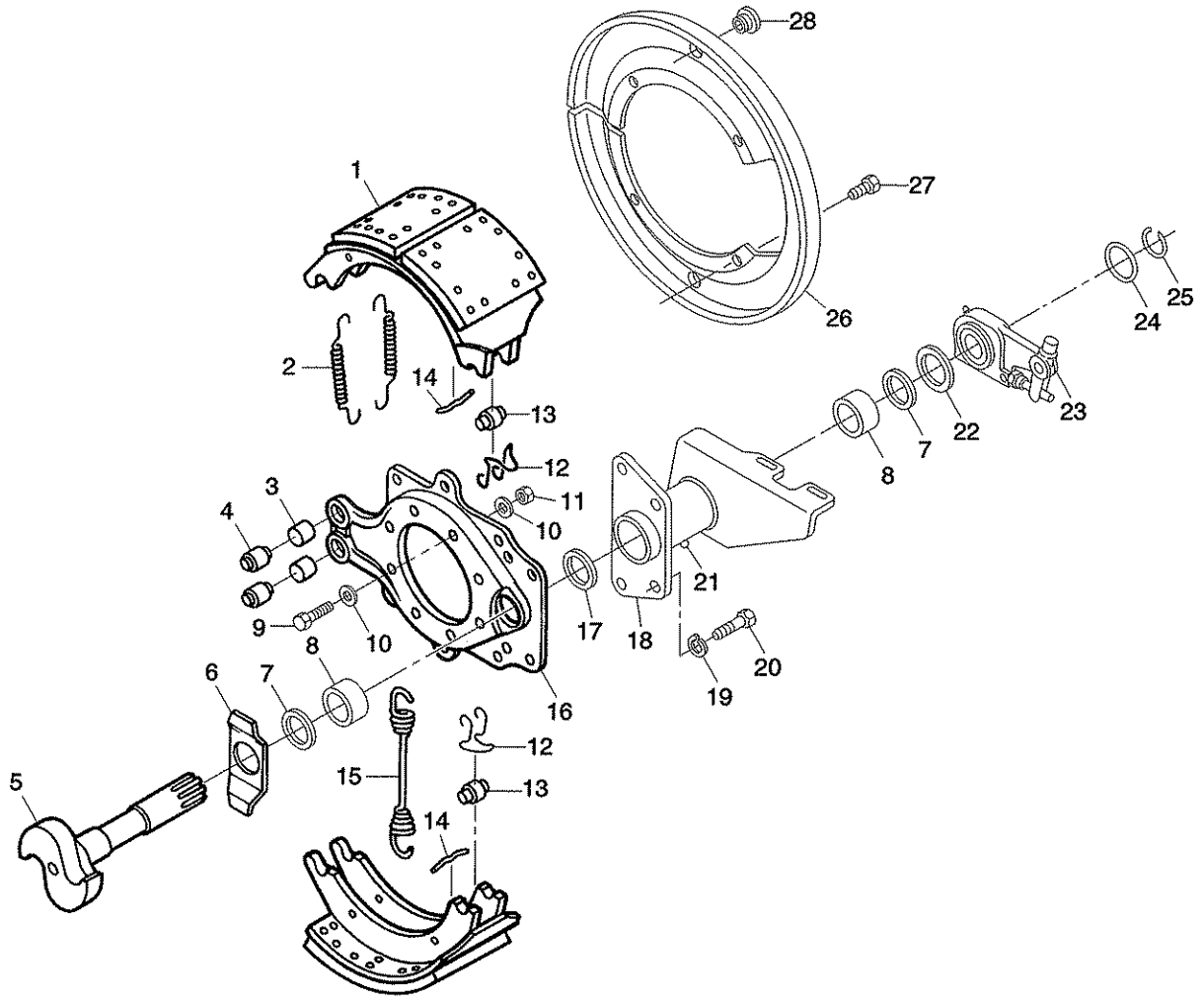
IMPORTANT: If any slack adjuster problem is found, repair or replace the unit, depending on the manufacturer's recommendations.

6. Remove the camshaft by grasping its head and pulling the camshaft outboard.
7. Check the camshaft spline end for cracks, or worn or deformed splines. Replace the camshaft if damaged.
8. Check the camshaft bushing journals for wear or corrosion. Replace the camshaft if it is worn or if roughness is felt in the journal area.
9. Inspect the camshaft head for brinelling, cracking, or flat spots. Replace the camshaft if a ridge can be felt between the worn area and the cam head surface.
10. Remove the brake chamber stud nuts and lockwashers that attach the brake chamber to the camshaft support bracket.

    Check the chamber for a cracked housing, bent push rod, loose clamp ring, loose air fitting, air leaks, or clogged vent holes. Repair or replace brake chamber parts as needed.
11. Remove and inspect the camshaft support bracket. Remove and discard its gasket.

    Check the bracket for a bent, broken or cracked arm, and cracked welds. Replace the bracket if any of these conditions exist.
12. Remove and inspect the old bushing and the grease seal.
    - 12.1 Check the camshaft bushing for wear. The inner surface must be smooth; if rough or abrasive, replace the bushing.

Brake Components Disassembly and Inspection, Cleaning, and Assembly



NOTE: 16–1/2 inch "Q" series and all "Q" Plus series shown.

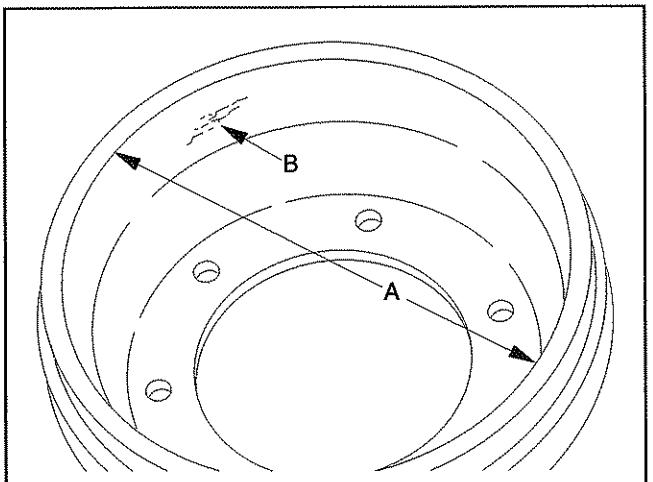
1. Brake Shoe and Lining Assembly
2. Brake Shoe Retaining Spring
3. Anchor Pin Bushing
4. Brake Shoe Anchor Pin
5. S-Head Camshaft
6. Camhead Washer
7. Camshaft Grease Seal
8. Camshaft, Spider, and Bracket Bushing
9. Spider Mounting Bolt
10. Hardened Washer
11. Nut
12. Brake Shoe Roller Retainer
13. Brake Shoe Roller
14. Brake Shoe Return Spring Pin
15. Brake Shoe Return Spring
16. Brake Spider
17. Camshaft Support Bracket Gasket
18. Camshaft Support Bracket
19. Bracket Capscrew Washers
20. Camshaft Support Bracket Capscrew
21. Grease Fitting
22. Camshaft Washer
23. Automatic Slack Adjuster Assembly
24. Spacing Washer
25. Camshaft Lockring
26. Dust Shield
27. Dust Shield Capscrew
28. Plug

Fig. 1, Cam-Master Q Series Brakes

12.2 Inspect the seal. Replace it if the lip is nicked, cut, or distorted.

13. Install the new bushing or seal with a suitable piloted driver.

Brake Components Disassembly and Inspection, Cleaning, and Assembly



A. Check for diameter and for out-of-round.
B. Check for cracks, heat checks, glazing, and grooves.

Fig. 2

IMPORTANT: Grease seals are installed in both the bracket and the brake spider so that the seal lip is facing toward the slack adjuster end of the bracket tube. **See Fig. 3.**

14. Remove the spider-to-axle attaching nuts, hardened washers, and bolts. Remove the spider from the axle flange.
15. If equipped, remove the four capscrews that attach the dust shield to the spider; remove the dust shield.
16. Inspect the spider and parts for damage; replace as needed.
    - 16.1 Check for cracks at the bolt holes, cam area, and around the anchor pin. Replace if damaged.
    - 16.2 Check the anchor pin. If worn or loose, replace it.
    - 16.3 Check the anchor pin and brake spider bushings for wear. The inner surfaces must be smooth. If any surface is rough or abrasive, replace the part.
    - 16.4 Inspect the seal. Replace it if its lip is nicked, cut, or distorted.
17. Using a suitable piloted driver, install the new bushings and seal.

IMPORTANT: Grease seals are installed in both the bracket and the brake spider so that the seal lip is toward the slack adjuster end of the bracket tube. **See Fig. 3.**

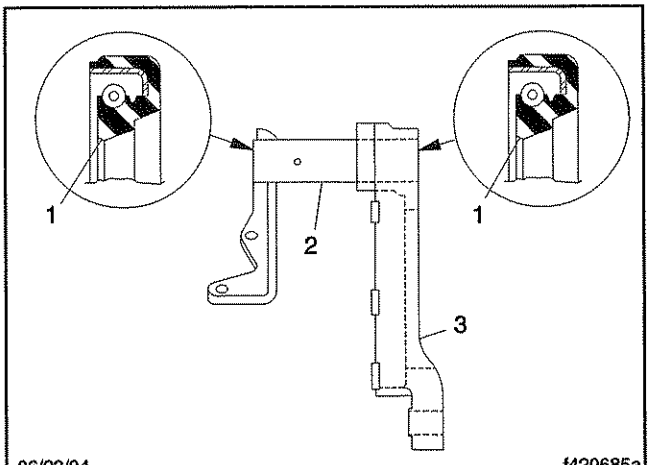
Cleaning

⚠ WARNING

WARNING: Before starting the procedure below, read the information in Safety Precautions, 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

After removing the brake parts being serviced, do the following:

1. Wire brush all parts exposed to mud, road dirt, and salt, including the exterior of the drum, spider, brake chamber bracket, and dust shields (if equipped). If relining the shoes, thoroughly wire-brush the shoe tables, and paint them with a rust inhibitive coating.



NOTE: The seal lip is facing toward the slack adjuster.

1. Seal Lip
2. Camshaft Support Bracket
3. Brake Spider

Fig. 3, Positioning of Seals on the Camshaft

Brake Components Disassembly and Inspection, Cleaning, and Assembly

⚠ CAUTION

CAUTION: A thick layer of oxidation and dirt on the outside of a brake drum acts as an insulator and may hinder normal heat dissipation. Make sure oxidation and dirt are removed by wire brushing, or damage to brake components could occur.

2. Using an industrial vacuum cleaner with a HEPA filter system, pick up excessive dust accumulation. Wipe the interior of the drums with a greaseless solvent to remove lining dust.
3. Thoroughly clean all remaining brake parts with a suitable shop solvent. Wipe dry with a clean, lint-free cloth, or use low-pressure, filtered and compressed air.

Assembly (See Fig. 1)

⚠ WARNING

WARNING: Before starting the procedure below, read the information in Safety Precautions, 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Install the dust shield, if equipped.

   Position the dust shield against the spider, and install the capscrews. Tighten the capscrews to the torque provided in **Specifications 400.**

2. Install the spider.

   Place the spider on the axle flange. Using a hardened washer under the bolt head and the nut, install the mounting fasteners. Tighten the bolts in a cross pattern to the torque provided in **Specifications 400.**

3. Install the brake chamber and bracket.

   3.1 Place the brake chamber on the mounting bracket with the chamber mounting studs through the bracket holes. Install the hardened flatwashers and locknuts. Tighten the nuts to the torque provided in **Specifications 400.**

   NOTE: If replacing a brake chamber, make sure that the new chamber is the same size and make as the brake chamber on the other side of the axle.

   3.2 Place the bracket against the spider, and install the lockwashers and capscrews. Tighten the capscrews to the torque provided in **Specifications 400.**

4. Install the camshaft and parts in the spider; install the slack adjuster.

   4.1 Apply a thin film of chassis grease on the inside of the camshaft bushings and journals. Don't grease the camshaft head area.

   4.2 Apply a thin film of rust preventive grease (Rockwell 0-637, or an equivalent) on the camshaft splines.

   4.3 Carefully slip the camshaft into the spider and the mounting bracket tube.

   4.4 Install the thick camshaft washer on the camshaft.

   4.5 Install the slack adjuster on the camshaft, with the adjuster nut on the side opposite of the brake chamber.

   4.6 Install the outer washers and snap ring.

5. Use a dial indicator to measure the end-play of the camshaft. There should be no more than 1.5 mm (0.060 inch) movement.
6. Pressure lube the camshaft bracket bushings.

   Pump multipurpose chassis grease (NLGI grade 1 or 2) into the chamber bracket until it appears at the slack adjuster end of the bracket. Use care that no grease enters the drum cavity. If grease leaks out under the camhead, the camshaft grease seal is worn or damaged, or is installed backwards.

NOTE: The use of meter-type fittings, having a maximum 276 kPa (40 psi) pressure relief at shutoff, is recommended.

7. For manual slack adjusters, while depressing the locking sleeve, turn the adjusting nut counterclockwise until the appropriate hole in the adjuster is aligned with the hole in the brake chamber pushrod clevis. For automatic slack adjusters, refer elsewhere in this group or to the manufacturer's service information.

8. Install the brake shoes. For instructions, refer to **Subject 110**.

Specifications

Description	Grade	Size	Torque	
			N.cm (lbf.in)	N.m (lbf.ft)
Brake Shoe Lining Nuts	—	3/8	—	24–31 (18–23)
		1/4	900–1120 (80–100)	—
Dust Shield Capscrews	5	3/8–16	—	34–47 (25–35)
	8			47–68 (35–50)
Spider Mounting Bolts: Customary Thread Capscrew	8	1/2–13	—	81–108 (60–80)
Hexhead Capscrew		5/8–11		176–217 (130–160)
Flanged Hexhead Capscrew		5/8–11		217–271 (160–200)
Midland Brake Chamber Mounting-Stud Locknuts (chamber size in^2)	8		—	
12		7/16–14 stud		52–58 (38–43)
16		7/16–14 stud		52–58 (38–43)
16		1/2–13 stud		81–88 (60–65)
16		1/2–20 stud		88–95 (65–70)
20		5/8–11 stud		162–176 (120–130)
24		5 /8–11 stud		162–176 (120–130)
MGM Brake Chamber Mounting-Stud Locknuts (chamber size in^2)	8		—	
16		7/16–14 stud		47–54 (35–40)
20		5 /8–11 stud		136–156 (100–115)
24		5 /8–11 stud		136–156 (100–115)
Brake Chamber Bracket-to-Spider Capscrews	8	1/2–13	—	81–108 (60–80)
		5/8–11		142–196 (105–145)

Table 1, Torque Values

General Description

Rockwell "Q" and "Q" Plus Series brakes are actuated by an S-type cam head, which is forged integrally with the camshaft and supported with nylon bushings. Cam pressure is applied through the cam rollers.

These brakes are used on both the front steer axle and rear axles.

Rockwell steer axles have seven holes for attaching the spider to the axle flange. There is an eighth hole left open on the brake spider, on both left and right sides of the steer axle. **See Fig. 1.** The seven holes used for attachment of the spider to the axle flange are 0.656 inch in diameter. The eighth hole is oversized at 0.687 inch in diameter.

As of March 1, 1994, Rockwell began attaching an identifying label to the web of all on-highway shoe and lining assemblies. The label is made of Mylar, and is attached with a heat-resistant adhesive. At the same time, the lining edge code changed to the new Rockwell lining designation. The new lining edge code will show the supplier lining designation and the corresponding Rockwell designation. **See Table 1.**

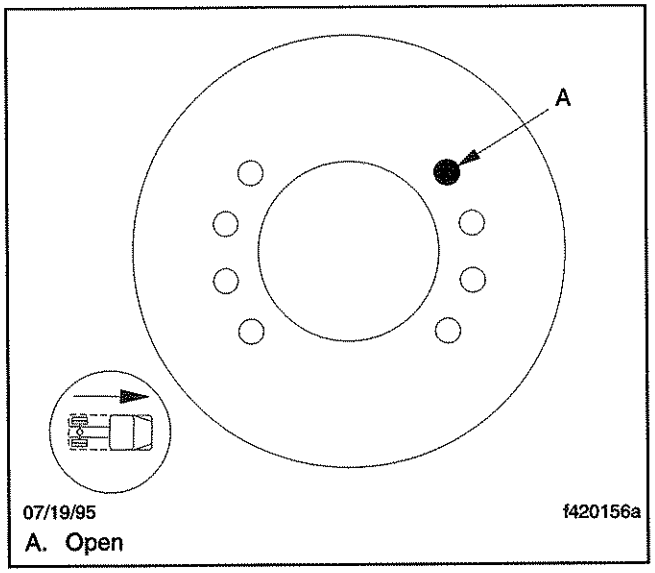


Fig. 1

Vendor Code		Rockwell Designation
Abex	931–162	R301
	197	R201
	1083–7	R501
	1083–63	R401
Carlisle	E145–A	R202
	NAB–9ML	R302
	NAB10	R502
	NAB11	R402
Ferodo	NAB456	R403
	867	R203

Table 1, Edge Codes

The label will include three lines of information. **See Fig. 2.** The first line identifies the shoe as "Q PLUS" or "BRAKES" (non-Q Plus). The second line gives the new Rockwell aftermarket lining material designation. See "Rockwell Designation" in **Table 1.** The third line gives the service part number to use for replacing the shoe and lining assembly.

Principles of Operation

When the brake pedal is depressed, compressed air enters the brake chamber, causing the diaphragm to move a push rod assembly.

The push rod, which is connected to a slack adjuster, turns the slack adjuster and brake camshaft. As the camshaft turns, the S-head, which is between the brake shoe rollers, forces the brake shoes against the brake drum, and braking occurs.

When the brakes are released and air is exhausted from the brake chamber, the actuator return spring (within the brake chamber) and the brake shoe return spring, return the camshaft, brake shoes, slack adjuster, and the push rod to their released positions.

General Description and Principles of Operation

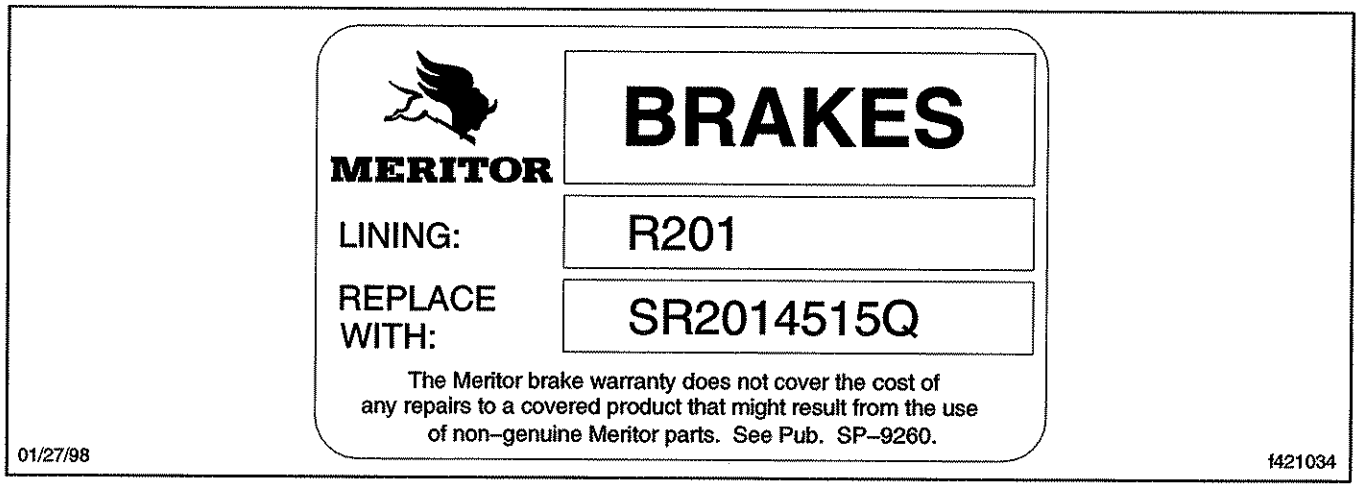


Fig. 2, Rockwell Brake Shoe Lable, Example

Midland Service Brake Chamber 42.24

Contents

Subject	Subject Number
General Description and Principles of Operation	050
Service Operations	
Operating and Leakage Tests	100
Diaphragm Replacement	110
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General Description and Principles of Operation

General Description

Brake chambers convert the energy of compressed air into the mechanical force and motion needed to apply the brakes. Two chambers operate the brakes, one on each side of the axle.

Each brake chamber consists of two dished metal sections: the cover assembly and the body assembly, which are separated by a nylon-neoprene diaphragm. A metal two-segment clamp ring holds the assemblies together. **See Fig. 1.**

In front of the diaphragm are the body, piston rod assembly, and a piston rod spring. The threaded piston rod assembly extends through the bottom of the body and connects to the clevis. **See Fig. 1.**

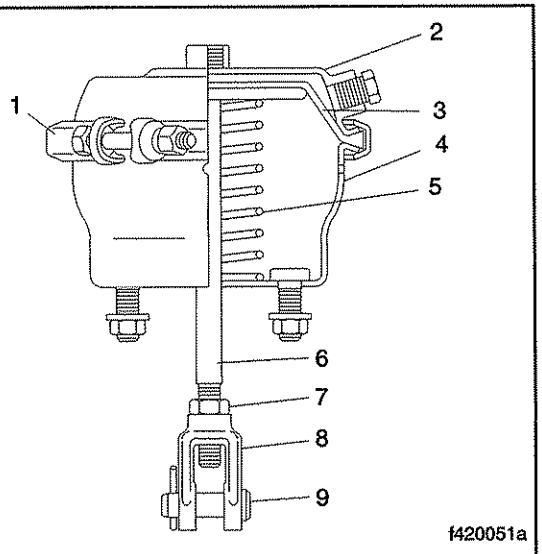
Different sized brake chambers are identified by numbers, which specify the effective area of the diaphragm. For example, a type 16 brake chamber has 16 square inches of effective area.

Principles of Operation

The greater the air pressure admitted to the brake chamber, the greater the force applied by the piston rod. Piston rod force is determined by multiplying the delivered air pressure by the effective diaphragm area. For example, if 415 kPa (60 psi) is admitted to a type 16 brake chamber, the force on the end of the piston rod is about 436 kg (960 lb).

When the brake pedal is depressed, air pressure from the brake valve passes through the port in the brake chamber cover to move the diaphragm and piston rod assembly forward. This compresses the spring, and applies a straight-line force to the slack adjuster, which converts it to a rotational force. This in turn rotates the camshaft and applies the brakes.

When the brake pedal is released, compressed air behind the diaphragm exhausts through the quick release valve. The spring then allows the piston rod assembly and diaphragm to return to their previous positions.



1. Clamp Ring
2. Cover Assembly
3. Diaphragm
4. Body Assembly
5. Piston Rod Spring
6. Piston Rod Assembly
7. Piston Rod Nut
8. Clevis
9. Clevis Pin

Fig. 1, Sectional View

NOTE: For both of these tests, the air system must be pressurized to at least 550 kPa (80 psi).

Operating Test

1. Chock the tires.
2. Apply the brakes. Check that each piston rod moves out promptly, without binding.
3. Release the brakes. Check that each piston rod returns to the released position promptly, without binding.
4. Check the brake chamber stroke. It should be as short as possible without causing the brakes to drag. If needed, adjust the travel of the piston rod at the slack adjuster. Refer to the vehicle maintenance manual for instructions.

Leakage Test

1. Apply the brakes and hold them on full line pressure of at least 550 kPa (80 psi).
2. Using a soap solution, coat the clamp ring. Leakage is excessive if it produces a 25-mm (1-inch) bubble within five seconds.

⚠ CAUTION

CAUTION: Don't overtighten the clamp ring. This can distort the flange sealing surface, or the clamp ring itself.

3. If the leakage is excessive, tighten the clamp ring flange nuts evenly until the leakage is reduced. For acceptable torque ranges, refer to **Specifications, 400.**
4. Using a soap solution, coat the area around the piston-rod hole. No leakage is permitted. If there is leakage, replace the diaphragm. For instructions, refer to **Subject 110.**

Diaphragm Replacement

NOTE: This procedure is for service of a leaking brake chamber *diaphragm only*. If there are any other problems, refer to the applicable subjects elsewhere in this section.

Replacement

1. Chock the tires.

⚠ WARNING

WARNING: Wear safety goggles when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct the airstreams at anyone. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

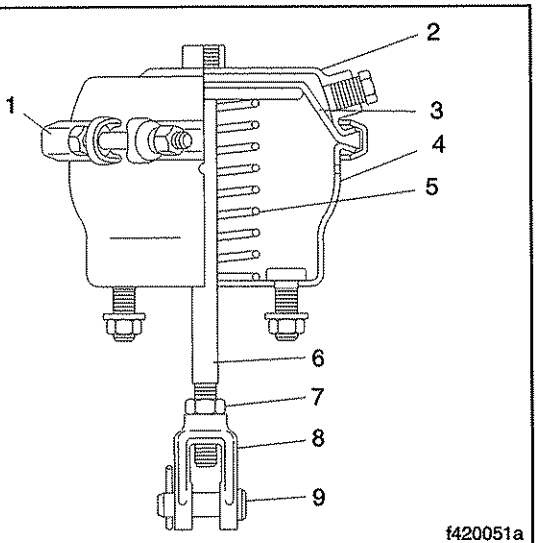
Follow the manufacturer's recommendations when working on any air device so as to avoid injury or damage from parts which, when re-leased, are subject to mechanical (spring) or compressed-air propulsion.

2. Drain the air reservoirs and lines.
3. Back off the slack adjuster; for instructions, refer to the applicable slack adjuster section in this manual. Pull out the piston rod. **See Fig. 1.** Clamp the rod at the chamber body to protect it from damage.
4. Before disassembly, mark a reference line along the chamber to allow the parts to be reassembled later in their old positions. **See Fig. 2.**
5. Replace the diaphragm.
   - 5.1 Remove one clamp ring bolt and flange nut completely and loosen the other bolt and flange nut enough to remove the clamp ring.
   - 5.2 Remove the cover assembly, and replace the diaphragm.

⚠ CAUTION

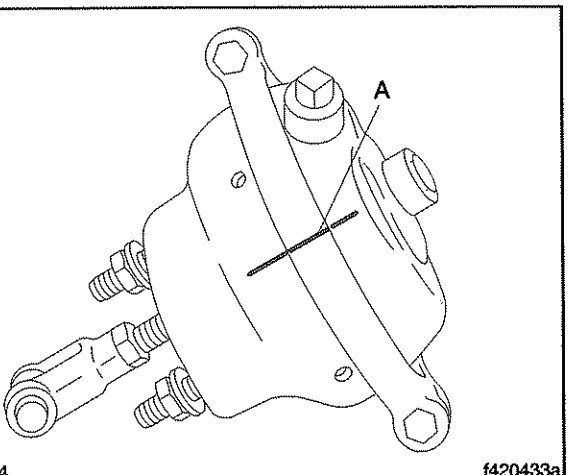
CAUTION: Don't overtighten the clamp ring. This can distort the flange sealing surface, or the clamp ring itself.

   - 5.3 Position the cover assembly and clamp ring (aligning the reference marks), and install the clamp ring bolt and flange nut. Tighten the flange nuts evenly to eliminate leakage. For acceptable torque ranges, refer to **Specifications, 400.**



1. Clamp Ring
2. Cover Assembly
3. Diaphragm
4. Body Assembly
5. Piston Rod Spring
6. Piston Rod Assembly
7. Piston Rod Nut
8. Clevis
9. Clevis Pin

Fig. 1, Sectional View



A. Reference Line

Fig. 2

Diaphragm Replacement

6. Release the clamp on the piston rod.
7. Do both of the tests **in Subject 100.**
8. Adjust the brakes at the slack adjuster. For instructions, refer to the applicable foundation brake section in this manual.
9. Remove the chocks from the tires.

Brake Chamber Removal and Installation

Removal (See Fig. 1)

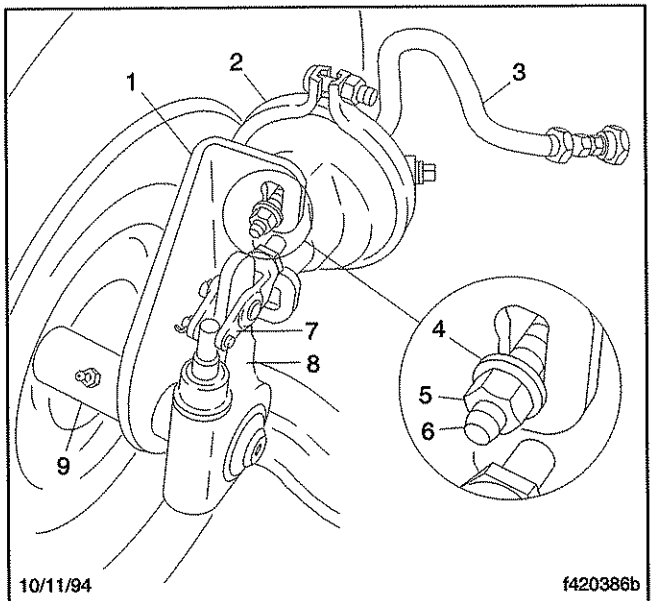
1. Chock the tires.

⚠ WARNING

WARNING: Wear safety goggles when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct the airstreams at other people. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

Follow the manufacturer's recommendations when working on any airdevice so as to avoid injury or damage from parts which, when released, are subject to mechanical (spring) or compressed-air propulsion.

2. Drain the air reservoirs and lines.



1. Chamber Mounting Bracket
2. Brake Chamber
3. Air Line
4. Hardened Flatwasher (2 qty.)
5. Prevailing Torque Locknut (2 qty.)
6. Chamber Mounting Stud (2 qty.)
7. Clevis Assembly
8. Slack Adjuster (Automatic Type)
9. Camshaft Tube

Fig. 1

3. Carefully disconnect the air line from the brake chamber.
4. Remove the brake chamber.
   - 4.1 Remove the cotter pin(s) from the clevis pin(s).

   NOTE: Gunite and Rockwell automatic slack adjusters have two clevis pins, one large and one small, each locked by a cotter pin.

   - 4.2 Remove the clevis pin(s) from the slack adjuster.
   - 4.3 From each mounting stud, remove any installed nuts and washers. Remove the brake chamber from the vehicle.

Installation (See Fig. 1)

1. Before installing a new chamber, be sure the new chamber is the same size and make as the brake chamber on the other side of the axle.
2. Install the brake chamber.
   - 2.1 Attach the brake chamber to the mounting bracket using a hardened flatwasher and prevailing torque locknut. Install the flatwasher between the locknut and the mounting bracket.
   - 2.2 Tighten the locknuts. **See Table 1** for the correct torque value.
   - 2.3 Connect the clevis pin(s) to the slack adjuster.

   NOTE: Gunite and Rockwell automatic slack adjusters have two clevis pins, one large and one small, each locked by a cotter pin.

   - 2.4 Install and lock the cotter pin(s) to secure the clevis pin(s).
3. Adjust the brakes at the slack adjuster. For instructions, refer to the applicable foundation brake section in this manual.
4. Connect the air line to the brake chamber.

Brake Chamber Removal and Installation

Description	Chamber Size (in^2)	Torque N·m (lbf·ft)
Brake Chamber Mounting-Stud Locknuts	12	52–58 (38–43)
	16 (7/16–14 stud)	52–58 (38–43)
	16 (1/2–13 stud)	81–88 (60–65)
	16 (1/2–20 stud)	88–95 (65–70)
	20	162–176 (120–130)
	24	162–176 (120–130)

Table 1, Mounting-Stud Locknut Torque Values

4.1 Check that the hoses are properly supported and, if needed, clamped to provide good clearance.

4.2 Before connecting the air line, make sure the fittings are clean and free of debris.

4.3 Connect the air line as follows: tighten the nut finger-tight. Using a wrench, further tighten the nut until there is resistance, then tighten one-sixth turn more.

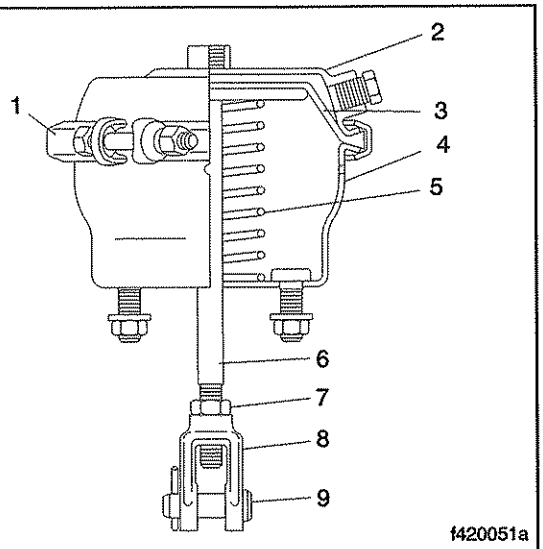
5. Do both of the tests **in Subject 100.**
6. Remove the chocks from the tires.

Brake Chamber Disassembly, Inspection and Cleaning, and Assembly

Disassembly (See Fig. 1)

NOTE: If the brake chamber is to be disassembled without removing the body assembly from the vehicle, first back off the slack adjuster. For instructions, refer to the applicable slack adjuster section in this manual.

1. Before disassembly, mark a reference line along the chamber to allow the parts to be reassembled later in their old positions. **See Fig. 2.**
2. Pull out the piston rod. Clamp the rod at the chamber body to protect it from damage.
3. Disassemble the brake chamber.
   - 3.1 Remove one clamp ring bolt and flange nut completely and loosen the other bolt and flange nut enough to remove the clamp ring.
   - 3.2 Remove the cover assembly and the diaphragm.
   - 3.3 Remove the clevis locknut and clevis from the piston rod, and release the clamp on the piston rod, being careful to contain the piston rod assembly and body until the return spring is relaxed.
   - 3.4 Remove the piston rod assembly and spring.



1. Clamp Ring
2. Cover Assembly
3. Diaphragm
4. Body Assembly
5. Piston Rod Spring
6. Piston Rod Assembly
7. Piston Rod Nut
8. Clevis
9. Clevis Pin

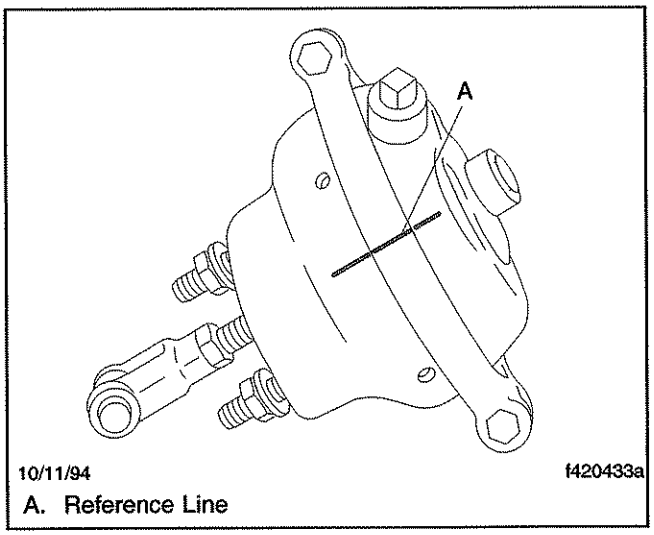
Fig. 1, Sectional View

Inspection and Cleaning

1. Clean all metal parts with cleaning solvent.
2. Inspect all parts for wear or damage; replace as needed.
   - 2.1 Check the cover and the body for dents. If any are too deep to be pounded out, replace as needed.
   - 2.2 Check the diaphragm for wear or deterioration and replace it if necessary. Midland recommends replacement of the diaphragm whenever the service brake chamber is opened for inspection.
   - 2.3 Inspect all other parts not considered serviceable. Replace if necessary.

Assembly (See Fig. 1)

1. Stand the piston rod assembly upright on a flat surface (if the chamber was removed from the vehicle).



A. Reference Line

Fig. 2

Brake Chamber Disassembly, Inspection and Cleaning, and Assembly

2. Assemble the brake chamber.

   2.1 Place the return spring on the piston rod.

   2.2 Place the body on the piston rod assembly, and press the body down, working 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 piston rod assembly through the body and clamp the rod (if the body wasn't removed from the vehicle).

   2.3 Place the diaphragm in the body.

⚠ CAUTION

CAUTION: Don't overtighten the clamp ring. This can distort the flange sealing surface, or the clamp ring itself.

   2.4 Position the cover assembly and clamp ring (aligning the reference marks), and install the clamp ring bolt and flange nut. Tighten the flange nuts evenly to eliminate leakage. For acceptable torque ranges, refer to **Specifications, 400**.

3. Install the clevis locknut and clevis, and release the clamp on the piston rod.

4. If the brake chamber was removed from the vehicle, install it. For instructions, refer to **Subject 120**.

5. Do both of the tests found **in Subject 100**.

Description	Chamber Size (in²)	Torque N·m (lbf·ft)
Brake Chamber Mounting-Stud Locknuts	12	52–58 (38–43)
	16 (7/16–14 stud)	52–58 (38–43)
	16 (1/2–13 stud)	81–88 (60–65)
	16 (1/2–20 stud)	88–95 (65–70)
	20	162–176 (120–130)
	24	162–176 (120–130)

Table 1, Mounting-Stud Locknut Torque Values

Description	Chamber Size (in²)	Torque N·cm (lbf·in)
Clamp Ring Flange Nuts	12	2260 to 2820 (200 to 250)
	16	2260 to 2820 (200 to 250)
	20	1240 to 2540 (110 to 225)
	24	1700 to 2540 (150 to 225)

Table 2, Clamp Ring Torque Values

Description	Chamber Size (in²)	Torque N·m (lbf·ft)
Piston Rod Nuts	12	27–41 (20–30)
	16 (7/16-inch Stud)	27–41 (20–30)
	16 (1/2-inch Stud)	27–41 (20–30)
	20	45–122 (33–90)
	24	45–122 (33–90)

Table 3, Piston Rod Nut Torque Values

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Parking Brake Diaphragm Replacement	115
Combination Service and Parking Brake Chamber Removal and Installation	120
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General Information and Principles of Operation

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

IMPORTANT: On MGM "TR" Series chambers, the parking/emergency brake section is factory sealed (no clamp ring) and is a *non-serviceable* unit. On "E" Series chambers, the parking/emergency brake section is attached with a clamp ring. *Do not ever perform any service on this clamp ring.*

General Information

MGM "E" and "TR" Series tandem cam brake chambers consist of a service brake section and a parking/emergency spring brake section. **See Fig. 2** and **Fig. 3**. The service brake section is the smaller section near the clevis assembly.

In the service brake section, the flange case and non-pressure chamber contain a service return spring, piston rod assembly, and service brake diaphragm.

In the parking/emergency brake section, the flange case and the head contain a return spring, a push rod assembly, a parking (spring) brake diaphragm, a piston, a power spring, and a detachable release bolt.

All MGM brake chambers are mounted to the frame using prevailing torque locknuts and hardened flatwashers.

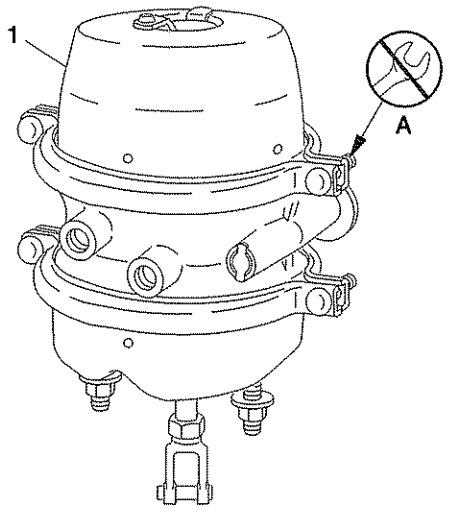
MGM "E" and "TR" Series chambers may be equipped with an external breather tube that protects the parking brake chamber from contaminants. These chambers are called Model "E-T" or "TR-T" chambers. **See Fig. 3.**

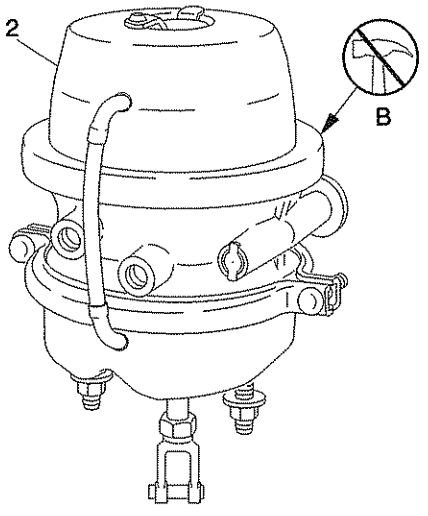
Periodic maintenance of the brake chambers is required. Also, whenever the service brake chamber is disassembled (*do not attempt to disassemble the parking brake chamber*), the parts should be inspected for damage. For maintenance schedules and procedures, and for inspection of brake chamber parts, refer to the vehicle maintenance manual.

Principles of Operation

SERVICE BRAKES

As the brake pedal is depressed, compressed air enters the service brake chamber through a port.



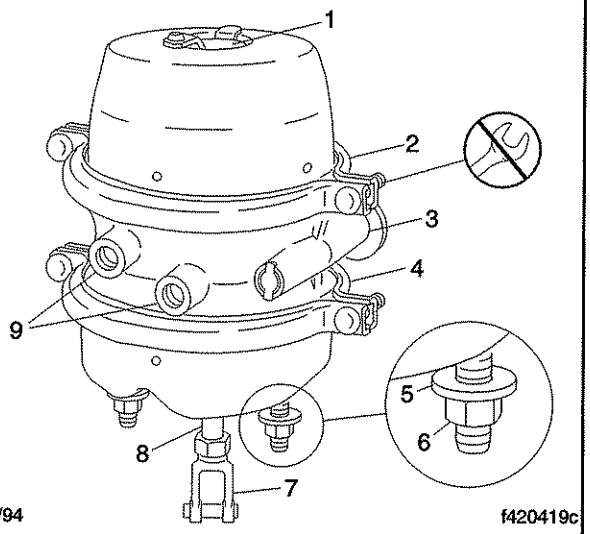


06/25/93 f420731a

A. Do not remove this clamp ring.
1. Model E (E Series) Brake Chamber
B. Do not remove the factory-sealed clamp ring.
2. Model TR-T (TR Series) Brake Chamber

Fig. 1

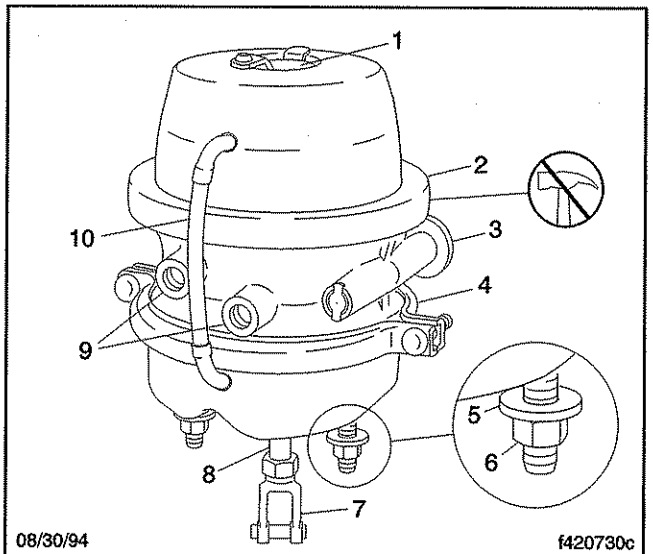
General Information and Principles of Operation



Do not remove the parking brake clamp ring.

1. End Cover Cap
2. Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports

Fig. 2, Model E (E Series) Brake Chamber



Do not remove the factory-sealed clamp ring.

1. End Cover Cap
2. Factory Sealed Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports
10. External Breather Tube

Fig. 3, Model TR-T (TR Series) Brake Chamber

Air pressure acts upon a diaphragm, which forces the piston rod toward the non-pressure chamber, applying a straight-line force to the slack adjuster, which converts it to a rotational force. This in turn rotates the camshaft and applies the brakes.

Then, when the brake pedal is released, air is exhausted from the service brake chamber, and the return spring allows the diaphragm, piston rod, and slack adjuster to return to their normal positions, releasing the brakes.

PARKING/EMERGENCY BRAKES

During parking brake release, compressed air enters the parking brake chamber and acts upon the diaphragm and piston, fully compressing 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 toward the flange case. The resulting motion on the push rod forces the service brake diaphragm and piston rod outward, applying the brakes.

Power Spring Manual Compression and Reset

⚠ DANGER

Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Manual Compression (Parking Brake Release)

1. Chock the tires.
2. Remove the end cover cap from the center-hole in the head of the chamber. See **Fig. 2.**

⚠ DANGER

Do not attempt to cage the power spring if the parking brake chamber is damaged severely enough to lose its structural integrity. If the power spring were to break loose, it could result in death, severe personal injury, or property damage.

A DAMAGED PARKING BRAKE CHAMBER IS EXTREMELY DANGEROUS! Only qualified service personnel should attempt to remove and disarm a damaged chamber. Using a torch, burn off the piston rod in the space between the clevis and the base of the service chamber.

Remove the chamber carefully from its bracket, and disarm it inside a suitable container. For disarming procedures, consult the MGM service manual.

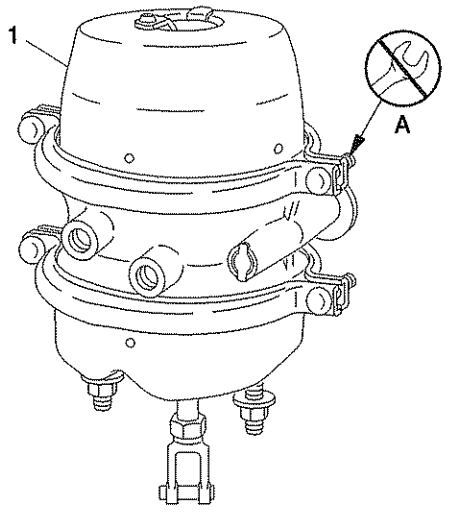
3. Manually release the parking brake (cage the power spring).

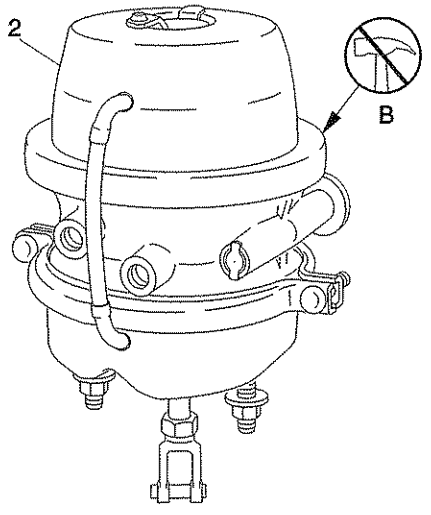
   3.1 Using a hand wrench, (*don't use an impact wrench*), unscrew the release nut, and remove the nut, flatwasher, and release bolt from the storage pocket on the side of the chamber. See **Fig. 3.**

   IMPORTANT: If these parts are not stored on the chamber, they must be otherwise obtained or purchased; the parking brake cannot be manually released without them.

   3.2 Apply at least 620 kPa (90 psi) air pressure to the parking brake inlet port (set parking brake in the "release" position).

   3.3 Insert the release bolt into the center-hole in the chamber head (**see Fig. 4**). Insert





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A. Do not remove this clamp ring.
1. Model E (E Series) Brake Chamber
B. Do not remove the factory-sealed clamp ring.
2. Model TR-T (TR Series) Brake Chamber

Fig. 1

Power Spring Manual Compression and Reset

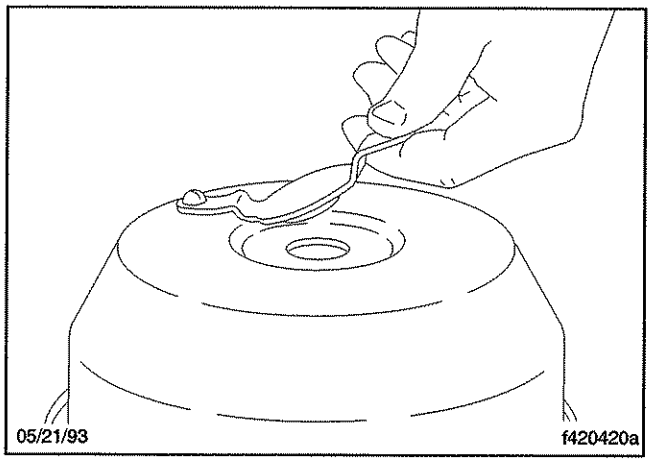


Fig. 2

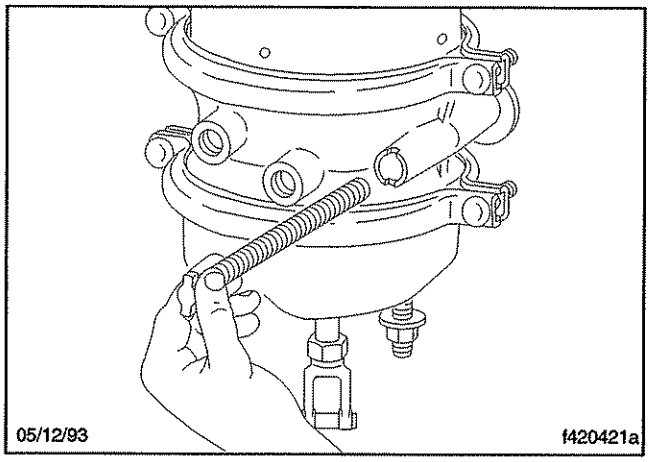


Fig. 3

the bolt until it bottoms out into the hole in the piston inside the chamber.

IMPORTANT: If you are not absolutely sure that the formed end of the bolt has engaged the piston correctly, repeat this step. Repeat it until you are absolutely sure.

3.4 Turn the release bolt one-quarter turn clockwise, and pull the bolt out to lock its formed end into the piston.

IMPORTANT: If the bolt doesn't lock into the piston in less than 13-mm (1/2-inch) outward movement, repeat these steps until you are sure it does lock.

3.5 Then, holding the bolt locked into the piston, install the flatwasher and release nut on the end of the release bolt, and turn down the nut against the flatwasher until it is finger-tight. See **Fig. 5**.

⚠ CAUTION

Don't exceed 68 N·m (50 lbf·ft) torque on the release nut; and don't use an impact wrench on this nut. Too much torque could distort the head of the chamber and prevent manual release of the parking brake.

3.6 Using a hand wrench (*don't use an impact wrench*), turn the release nut clockwise until the bolt extends 76 mm (3 inches) above the nut. See **Fig. 6**.

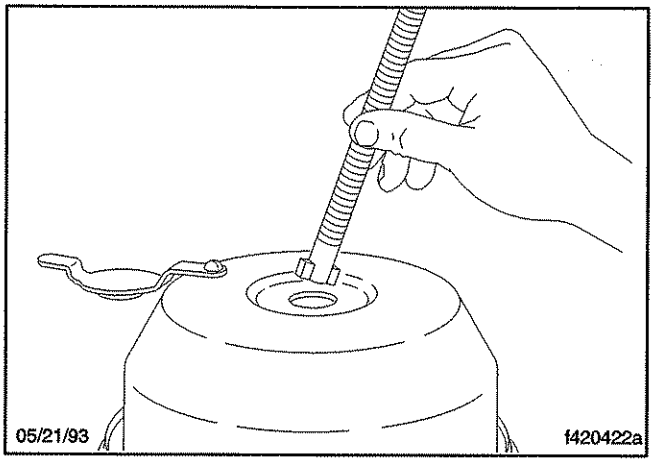


Fig. 4

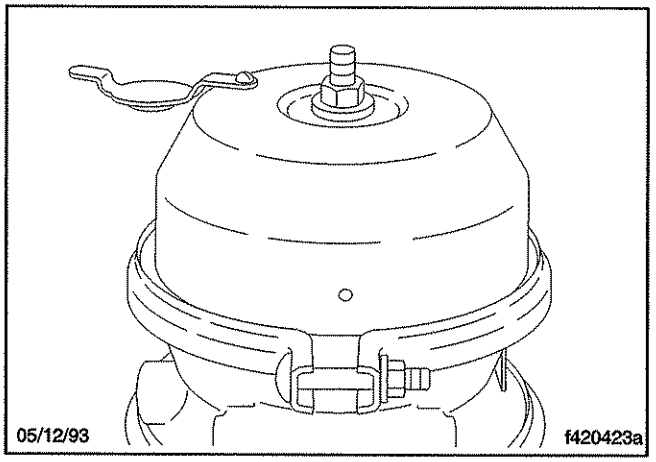


Fig. 5

IMPORTANT: Don't exceed the 76-mm (3-inch) length.

4. Once the power spring has been caged, exhaust the compressed air from the parking brake.

Manual Reset (Parking Brake Reset)

1. Uncage the power spring.

   1.1 Apply at least 620 kPa (90 psi) air pressure to the parking brake inlet port (set parking brake in the "release" position).

⚠ CAUTION

Don't exceed 68 N·m (50 lbf·ft) torque on the release nut; and don't use an impact wrench on this nut. Too much torque could distort the head of the chamber and prevent manual release of the parking brake.

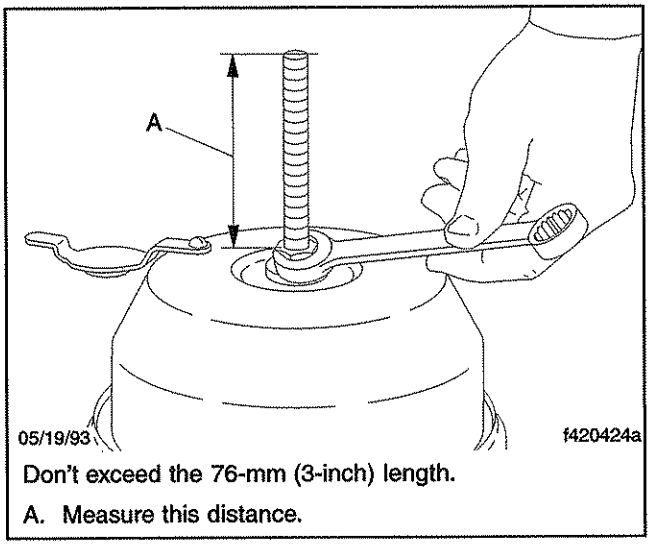
   1.2 With air applied to the parking brake section (the parking brake control valve is in the "release" position), use a hand wrench to turn the release nut *counterclockwise* until the bolt bottoms out in the unit.

   1.3 Remove the nut and flatwasher.

   1.4 Push the release bolt into the piston and turn the release bolt one-quarter turn counterclockwise to unlock its formed end from the piston. Remove the release bolt from the center-hole of the chamber.

2. Using a hand wrench (*don't use an impact wrench*), install the release bolt, flatwasher, and release nut in the storage pocket. MGM recommends 14 N·m (10 lbf·ft) torque on the nut against the flatwasher (see **Fig. 7**).

3. Snap the end cover cap in place over the center-hole in the chamber head. See **Fig. 8**.



Don't exceed the 76-mm (3-inch) length.

A. Measure this distance.

Fig. 6

⚠ CAUTION

If the external breather tube or end cover cap is missing or incorrectly installed, road dirt and debris can adversely affect the operation of the brake chamber. Once inside the chamber, dirt and

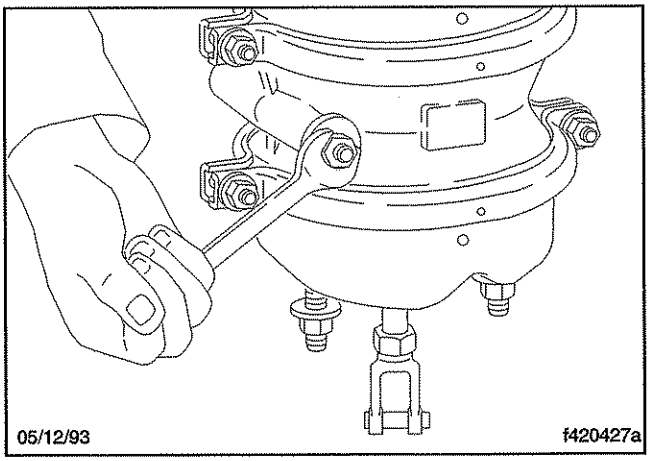


Fig. 7

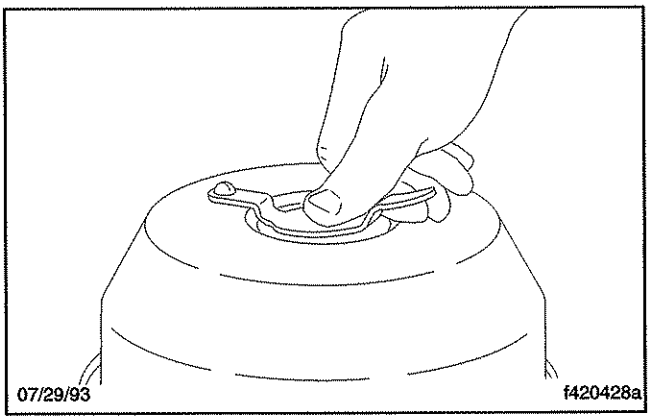


Fig. 8

Power Spring Manual Compression and Reset

debris cause the internal parts to deteriorate and shorten their lives. Operating the unit without the external breather tube or end cover cap in place voids the MGM warranty.

4. Check the plastic end cover cap periodically, and replace it with a new one at once if damaged or missing. For intervals, refer to the vehicle maintenance manual.
5. Remove the chocks from the tires.

Service Brake Diaphragm Replacement

⚠ DANGER

Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Removal

1. To make removal and installation of the parking brake section easier (without removing the service brake chamber), lock off the service chamber piston rod.

   1.1 Apply the service brakes by actuating the driver's foot brake treadle valve.

   1.2 With the brakes applied, clamp a pair of locking-jaw pliers on the piston rod to lock the rod in place when the air pressure is released (see **Fig. 2**).

⚠ WARNING

Before caging (compressing) the power spring, chock the vehicle tires and read the warnings and instructions in this section (see Subject 100). When the power spring is caged, the vehicle may be without brakes, allowing it to roll out of control, possibly resulting in personal injury or property damage.

2. Manually release the parking brake (cage the power spring). For instructions, see **Subject 100**.

3. Mark the air lines for later reference. Then carefully disconnect them from the brake chamber.

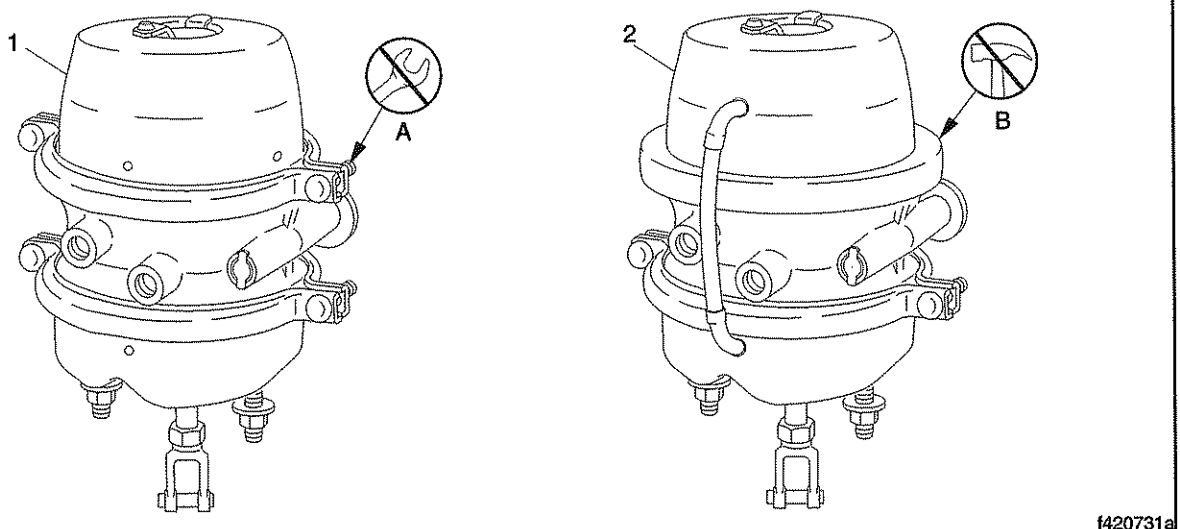
   On chambers equipped with an external breather tube, disconnect the tube and elbow from the service brake chamber.

⚠ DANGER

Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

4. Remove the parking brake section from the service brake section.

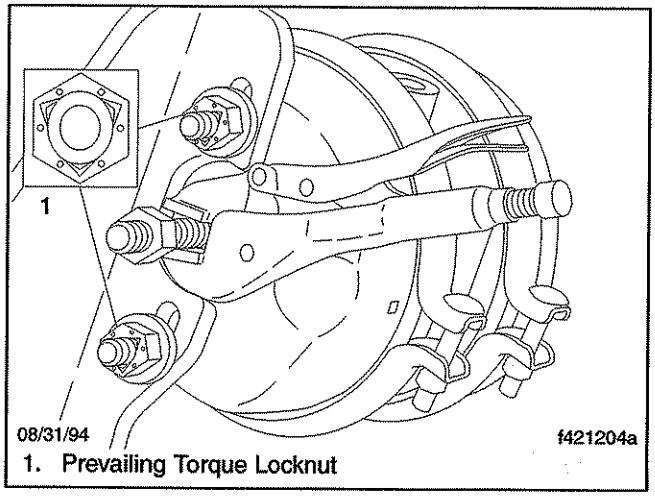
   4.1 Using a hand wrench (*don't use an impact wrench*), remove the clamp nuts on the



A. Do not remove this clamp ring.
1. Model E (E Series) Brake Chamber
B. Do not remove the factory-sealed clamp ring.
2. Model TR-T (TR Series) Brake Chamber

Fig. 1

Service Brake Diaphragm Replacement



1. Prevailing Torque Locknut

Fig. 2

service clamp ring (*do not disassemble the parking brake section*).

4.2 While holding the parking brake section securely in place, remove the service clamp ring. Then remove the parking brake section from the service brake non-pressure chamber (see **Fig. 3**).

5. Remove the service brake diaphragm from the bottom of the parking brake section.

Installation

IMPORTANT: At this time, take the opportunity to inspect the parking/emergency brake section, and replace it if it shows signs of damage, corrosion, or rust. Follow the detailed inspection instructions in the vehicle maintenance manual.

1. Inspect all parts in the service (non-pressure) chamber. Replace any damaged or worn parts with genuine MGM-engineered replacement parts.
2. Place the new service brake diaphragm in the bottom recess of the parking brake section (see **Fig. 4**).
3. Install the (new, if needed) parking/emergency brake section.

3.1 If installing a new parking brake section, be sure it is the same size and make as the old one.

3.2 Check that the release bolt is fully extended outward. For instructions, refer to **Subject 100.**

3.3 Install the parking brake section on the service chamber so that all mating parts are aligned straight and the air lines are positioned to mate with the vehicle air supply lines.

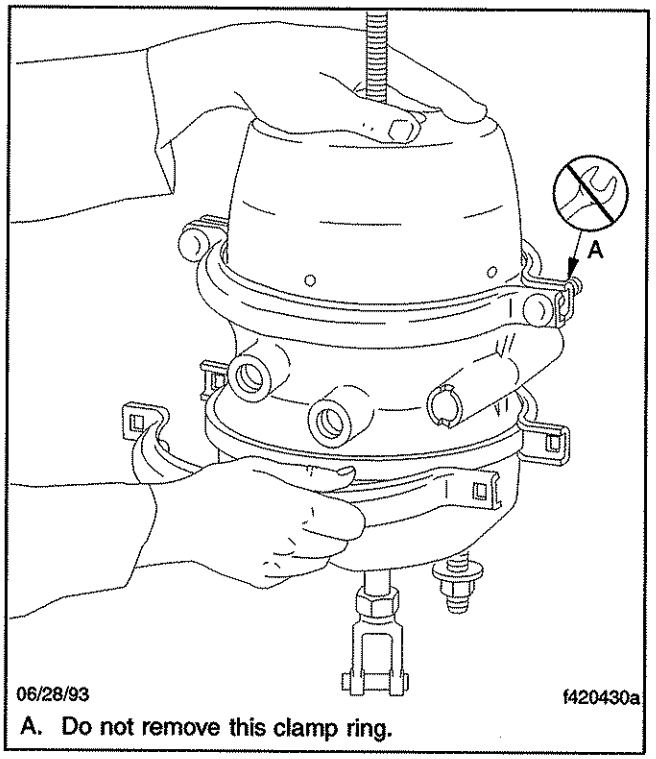
4. Install the service brake clamp ring.

4.1 With the service brake clamp ring in place, install the clamp bolts and nuts.

4.2 Using a hand wrench (*don't use an impact wrench*), alternately tighten each clamp nut in increments of 680 to 1360 N·cm (60 to 120 lbf·in) while constantly rechecking the alignment of mating parts.

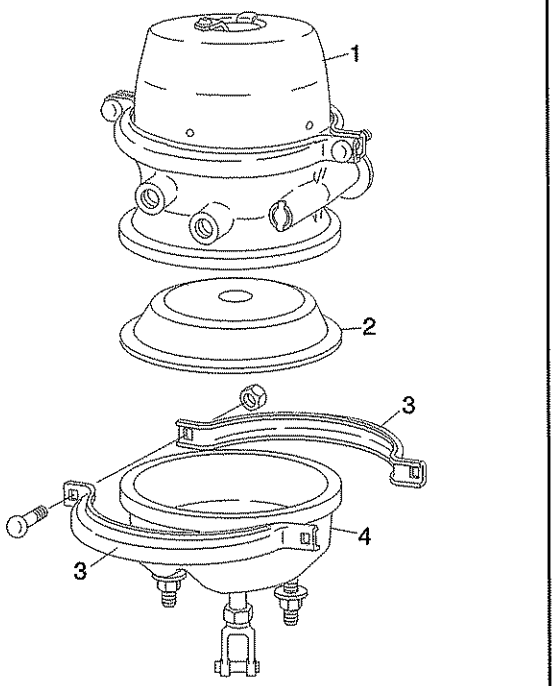
If realignment is needed, loosen the nuts again, and repeat this substep.

4.3 Firmly tap around the circumference of the service clamp ring with a rubber mallet to ensure full seating of the clamp. Tighten the



A. Do not remove this clamp ring.

Fig. 3



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1. Parking/Emergency Brake Section
2. Service Brake Diaphragm
3. Service Brake Clamp Ring
4. Service Brake (Non-Pressure) Chamber

Fig. 4

nuts to a final torque of 34 to 41 N·m (25 to 30 lbf·ft).

5. Make sure the air hose fittings are free of grease, dirt, and other debris. Then, apply Loctite® 242 sealant, or an equivalent, to the fittings, and install, as referenced earlier. Using a hand wrench (*don't use an impact wrench*), tighten the fittings 34 N·m (25 lbf·ft).

6. Using the vehicle system air, charge the parking brake with full line pressure—at least 690 kPa (100 psi). Using only soapy water (*never any type of oil,* which could deteriorate rubber parts), check for air leaks at the air lines and fittings. If bubbles or leaks appear, tighten the fittings slightly, but not over 34 N·m (25 lbf·ft).

7. With the parking brake still charged with full line pressure, apply and hold the foot brake treadle valve down to charge the service brake chamber. Remove the locking-jaw pliers from the service piston rod so that the piston returns to a normal position in the chamber.

⚠ DANGER

Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

8. Test for air leaks around the circumference of the *service* brake clamp ring. If bubbles or leaks appear, firmly tap the circumference of the clamp ring with a rubber mallet, and retighten the clamp nuts until leaks cease (*do not touch the parking brake section*). MGM recommends 34 to 41 N·m (25 to 30 lbf·ft) torque on the clamp hexnuts.

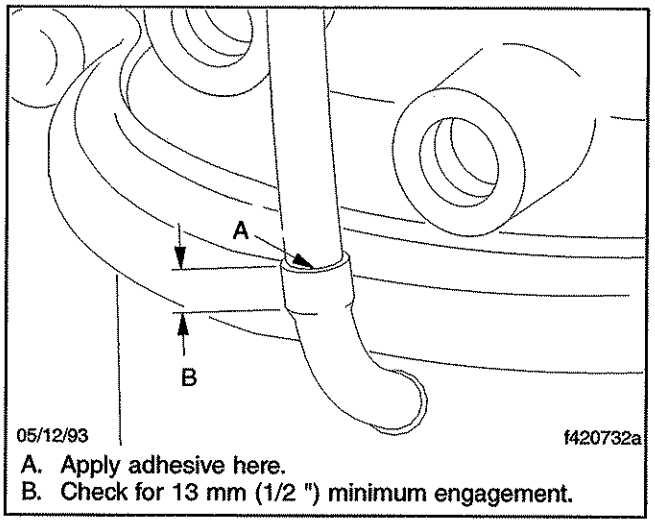
9. On chambers equipped with an external breather tube, make sure that the open end of the tube is free of grease, dirt, and other debris. Then, apply a high-quality rubber cement to the tube and insert it into the elbow at least 13 mm (1/2 inch). See **Fig. 5**. Insert the tube into the service brake chamber.

10. With air pressure now exhausted from the service brake chamber, but held on the parking brake, reset the parking brakes by uncaging the power spring, and snap the end cover cap in place. For instructions, see **Subject 100**.

11. Adjust the brakes at the slack adjuster.

IMPORTANT: After replacing any brake chamber components, check the piston rod stroke and actuating alignment to ensure correct installation and foundation brake adjustment. No foundation brake adjustments, parking brake or service brake, can be made at the chamber and all "stroke" adjustments must be made at the slack adjuster. For instructions, see the applicable slack adjuster section in **Group 42** in this manual.

Service Brake Diaphragm Replacement



A. Apply adhesive here.
B. Check for 13 mm (1/2 ") minimum engagement.

Fig. 5

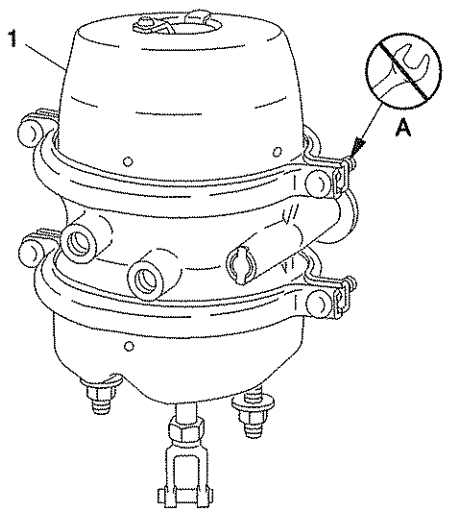
Parking Brake Diaphragm Replacement

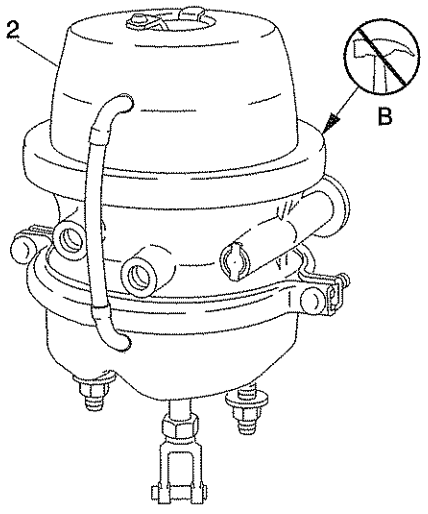
Replacement

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

IMPORTANT: The parking/emergency brake section can be replaced as a unit. For instructions, refer to **Subject 110.**





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A. Do not remove this clamp ring.
1. Model E (E Series) Brake Chamber
B. Do not remove the factory-sealed clamp ring.
2. Model TR-T (TR Series) Brake Chamber

Fig. 1

Combination Service and Parking Brake Chamber Removal and Installation

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Removal (See Fig. 2 or Fig. 3)

⚠ WARNING

WARNING: Before caging (compressing) the power spring, chock the vehicle tires and read the warnings and instructions in this section (see Subject 100). When the power spring is caged, the vehicle may be without brakes, allowing it to roll out of control, possibly resulting in personal injury or property damage.

1. Manually release the parking brake (cage the power spring). For instructions, refer to **Subject 100.**
2. Mark the air lines for later reference. Then carefully disconnect them from the brake chambers.
3. Remove the brake chamber from the vehicle.

   3.1 Remove the cotter pin(s) from the clevis pin(s), then remove the clevis pin(s) from the clevis. Disconnect the clevis from the slack adjuster.

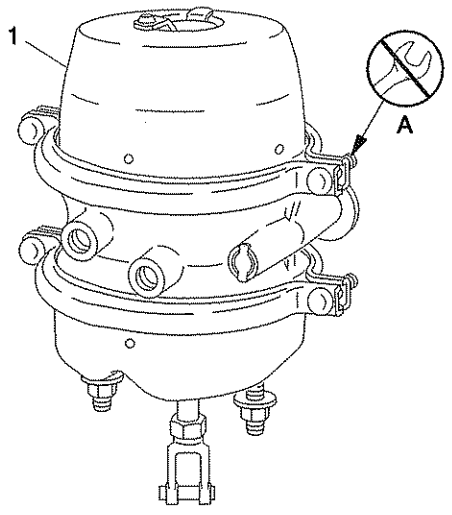
   NOTE: Gunite and Rockwell automatic slack adjusters have two clevis pins, one large and one small, each locked by a cotter pin.

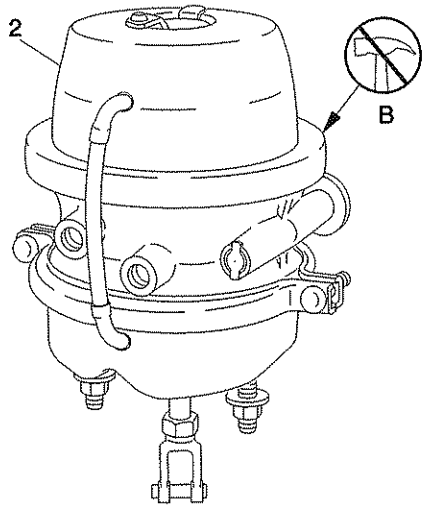
   3.2 Make sure the parking brake has been released manually (the power spring has been caged). For instructions, refer to **Subject 100.** Also, make sure that the service brake piston is fully retracted (in the brakes "OFF" position). Then, record both of the following dimensions in either mm or inches, measuring outward from the base of the service brake chamber (**see Fig. 4**):

   X dimension: to end of threaded piston rod

   Y dimension: to centerline of (large) clevis pin

IMPORTANT: If new chambers are to be attached to manual slack adjusters, the Y dimension is the



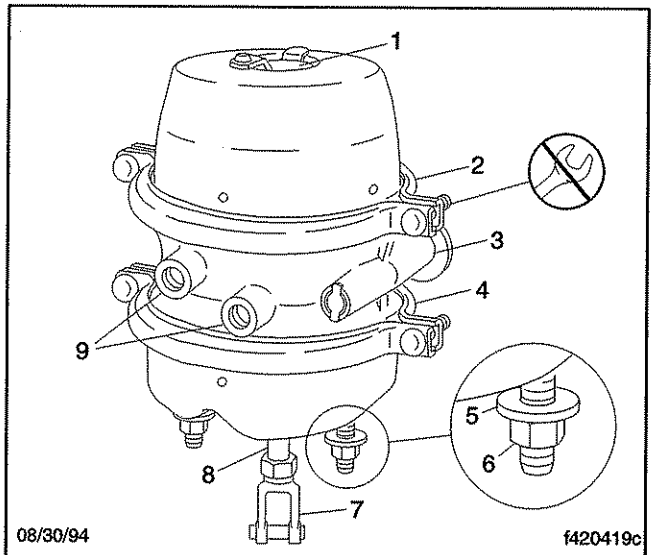


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A. Do not remove this clamp ring.
1. Model E (E Series) Brake Chamber
B. Do not remove the factory-sealed clamp ring.
2. Model TR-T (TR Series) Brake Chamber

Fig. 1

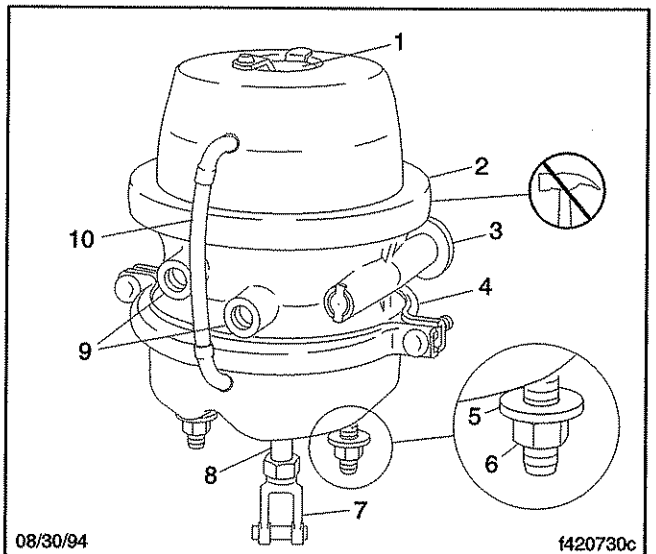
Combination Service and Parking Brake Chamber Removal and Installation



Do not remove the parking brake clamp ring.

1. End Cover Cap
2. Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports

Fig. 2, Model E (E Series) Brake Chamber



Do not remove the factory-sealed clamp ring.

1. End Cover Cap
2. Factory Sealed Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports
10. External Breather Tube

Fig. 3, Model TR-T (TR Series) Brake Chamber

most critical measurement. When installing the new assembly, its service piston rod must be cut (**see Fig. 5**) to exactly duplicate this "rod-plus-clevis" length *after* the clevis assembly is installed on the piston rod.

If new chambers are to be attached to automatic slack adjusters, the X dimension is the most critical measurement. When installing the new assembly, its service piston rod must be cut (**see Fig. 5**) to exactly duplicate the "rod only" length *before* the clevis assembly is installed on the piston rod.

3.3 From each mounting stud, remove any installed nuts and washers. Then, cautiously remove the brake chamber from the mounting bracket.

Installation (See Fig. 2 or Fig. 3)

1. If installing a new brake chamber unit, do the following steps:

   1.1 First, make sure the power spring is caged (release bolt fully extended outward). If not, **go to Subject 100** and do the applicable steps.

   1.2 Make sure that the piston rod is the same length as the rod on the old unit (measure the rods when *both* chambers are caged).

   1.3 Be sure the new chamber is the same size and make as the brake chamber installed on the other side of the axle.

   1.4 Remove the prevailing torque locknut and hardened flatwasher from each of the mounting studs on the chamber.

Combination Service and Parking Brake Chamber Removal and Installation

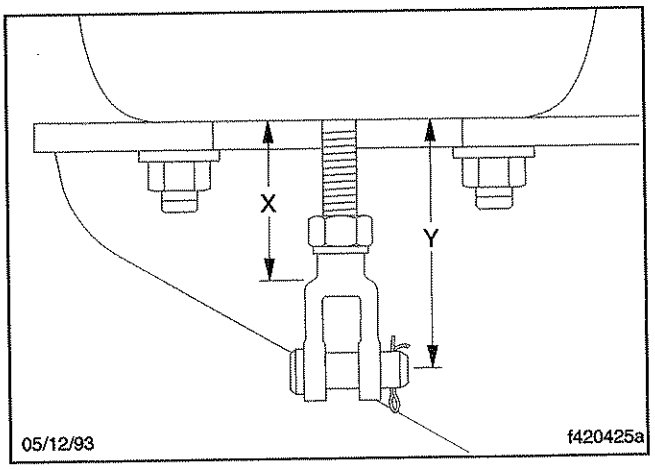


Fig. 4

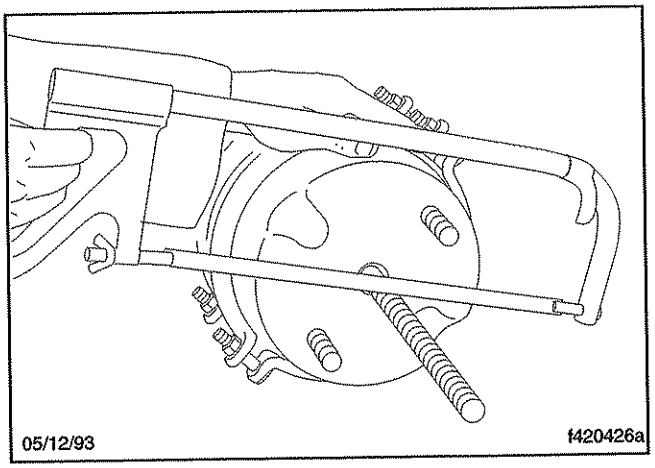


Fig. 5

2. Clean the face of the mounting bracket, and install the chamber on the bracket, paying close attention to positioning the chamber air inlet ports for correct alignment to the vehicle air lines.

⚠ WARNING

WARNING: Tighten the mounting nuts with a hand wrench, not an impact wrench. An impact wrench could damage the mounting fasteners, reducing the force of the brakes. This could result in personal injury or property damage.

3. Install one hardened flatwasher and prevailing torque locknut on each mounting stud. Using a hand wrench (*don't use an impact wrench*), tighten the nuts 136 to 156 N·m (100 to 115 lbf·ft). Make sure the flatwasher is installed between the locknut and the mounting bracket.

   On chambers equipped with an external breather tube, make sure that the tube is installed in the side of the chamber that faces away from the road surface. An improperly installed breather tube voids the MGM warranty.

4. Check mating and alignment with the vehicle air lines.

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

4.1 Using a hand wrench (*don't use an impact wrench*), loosen the clamp nuts on the *service* clamp ring (*do not disassemble the parking brake section*).

4.2 Reposition the air inlet ports, as needed, to mate with vehicle air supply lines.

Alternately tighten each clamp nut in increments of 680 to 1360 N·cm (60 to 120 lbf·in) while constantly rechecking the alignment of mating parts.

If realignment is needed, loosen the nuts again, and repeat this substep.

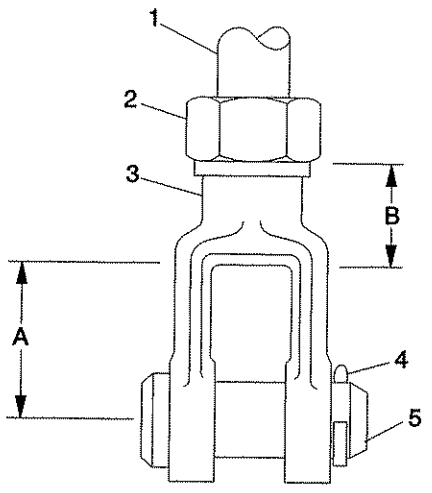
4.3 Firmly tap around the circumference of the service clamp ring with a rubber mallet to ensure full seating of the clamp. Tighten the nuts to a final torque of 34 to 41 N·m (25 to 30 lbf·ft).

5. With manual slack adjusters, connect the slack adjuster to the clevis, then install the clevis pin. Insert the cotter pin in the clevis pin, and lock it in place. Check the piston-rod engagement with the clevis. At least seven threads of engagement is required; there should be 25-mm (1-inch) clearance from the centerline of the clevis pin hole to the end of the piston rod. **See Fig. 6.** Adjust if needed.

   With automatic slack adjusters, refer to the applicable slack adjuster section in **Group 42** for installation instructions.

Combination Service and Parking Brake Chamber Removal and Installation

6. Inspect the piston rod to be sure it is working free, not binding, and is square with the chamber bottom within ±3° in any direction from zero to full stroke. If there is misalignment, make corrections by loosening the locknuts and repositioning the chamber on the mounting bracket, or by shimming the slack adjuster to the right or left on the camshaft.
7. Make sure the air hose fittings are free of grease, dirt, and other debris. Then, apply Loctite® 242 sealant, or an equivalent, to the fittings, and install, as referenced earlier. Using a hand wrench (*don't use an impact wrench*), tighten the fittings 34 N·m (25 lbf·ft).
8. Using the vehicle system air, charge the parking brake with full line pressure, at least 690 kPa (100 psi). Using only soapy water (*never any type of oil,* which could deteriorate rubber parts), check for air leaks at the air lines and fittings. If bubbles or leaks appear, tighten the fittings slightly, but not over 34 N·m (25 lbf·ft).



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A. Minimum of 25 mm (1 inch) clearance between centerline of clevis pin hole and piston rod end.
B. Minimum of 7 threads engagement.

1. Piston Rod
2. Piston Rod Nut
3. Clevis
4. Cotter Pin
5. Clevis Pin

Fig. 6, Piston Rod Engagement With the Clevis

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

IMPORTANT: If the service brake clamp ring was loosened to reposition the air inlet ports, apply air to the parking brake, and then apply and hold the foot brake treadle valve down to charge the service brake chamber. Now test for air leaks around the circumference of the *service* brake clamp ring. If bubbles or leaks appear, firmly tap the circumference of the clamp ring with a rubber mallet, and retighten the clamp nuts until leaks cease (*do not touch the parking brake section*). MGM recommends 34 to 41 N·m (25 to 30 lbf·ft) torque on the clamp hexnuts.

9. With air pressure now exhausted from the service brake chamber, but held on the parking brake, reset the parking brakes by uncaging the power spring, and snap the end cover cap in place. For instructions, refer to **Subject 100.**
10. Adjust the brakes at the slack adjuster. For instructions, refer to the applicable slack adjuster section in this manual.

IMPORTANT: After replacing any brake chamber, check the piston rod stroke and actuating alignment to ensure correct installation and foundation brake adjustment. No foundation brake adjustments, parking brake or service brake, can be made at the chamber and all "stroke" adjustments must be made at the slack adjuster. For instructions, refer to the applicable slack adjuster section in **Group 42** in this manual.

This subject contains the following table: •Torque Values

Description	Torque N·m (lbf·ft)
Spring Brake Release Bolt Nut (in storage pocket)	14 (10)
Service Brake Clamp Ring Nut	34-41 (25-30)
Brake Chamber Mounting Stud Nut	136-156 (100-115)
Air Hose Fitting-to-Chamber	34 (25)

Table 1, Torque Values

Contents

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General Description

The Bendix hydraulic disk brake system consists of a power booster, a master cylinder and reservoir, hydraulic lines (both rigid and flexible), a brake rotor on each wheel hub, and a brake caliper and pad assembly at each rotor. **See Fig. 1.**

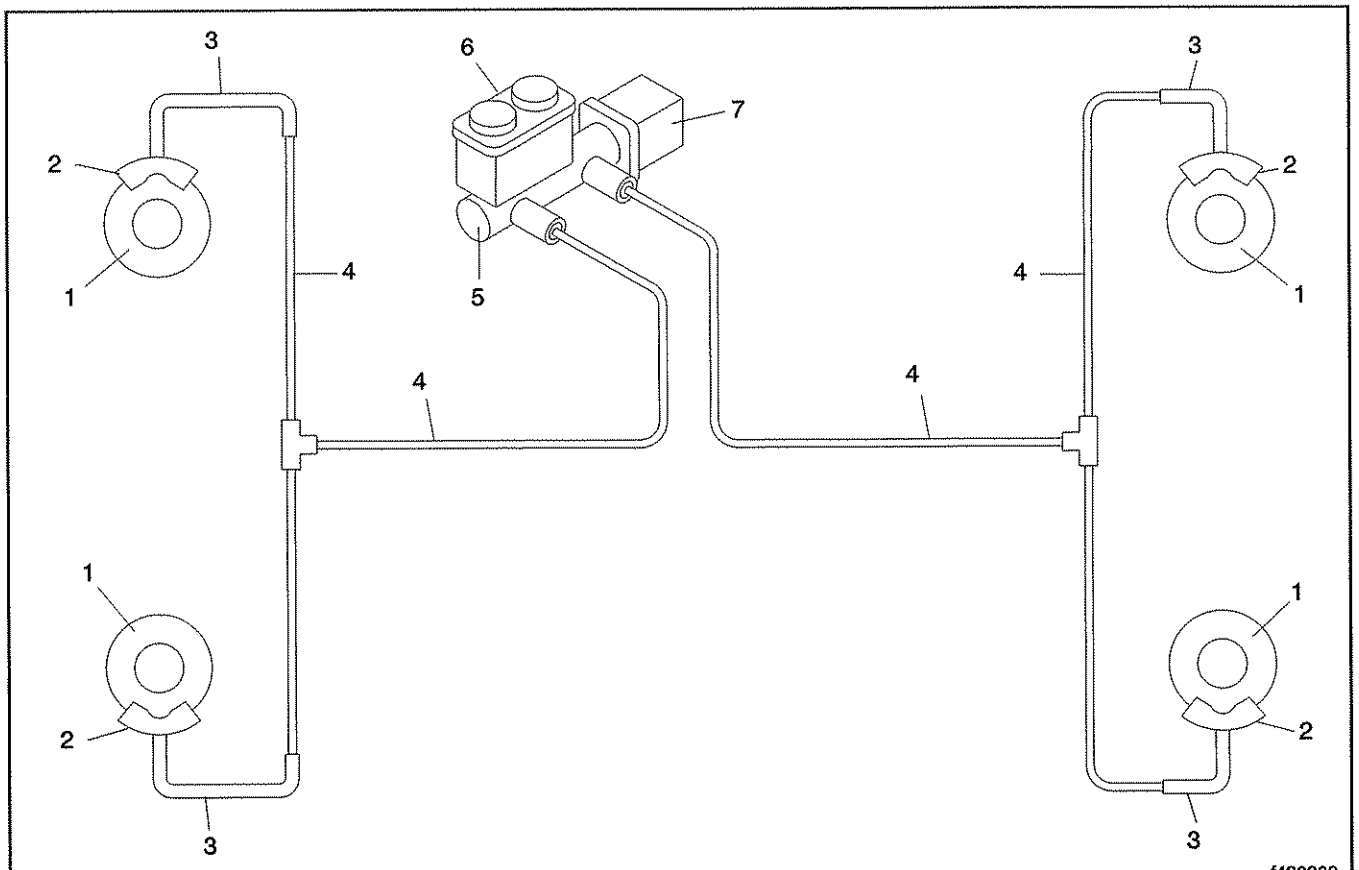
There are two completely separate hydraulic systems, which use different and incompatible hydraulic fluids, lines, and seals (**see Fig. 2**):

- The power booster system, which provides power to the brake master cylinder, and uses power steering fluid. It is plumbed into the power steering system.
- The service brake system, consisting of the master cylinder, the brake hydraulic lines, and the brake calipers. It uses DOT 3 approved brake fluid.

POWER BOOSTER (Fig. 3)

The Bendix Hydro-Max II® power booster, mounted on the firewall (Ref. 4), is attached to the rear of the master cylinder (Ref. 11). It consists basically of a reaction piston (Ref. 7), a power piston assembly (Ref. 8), an end-cap assembly (Ref. 10), and a back-up electric pump (Ref. 9).

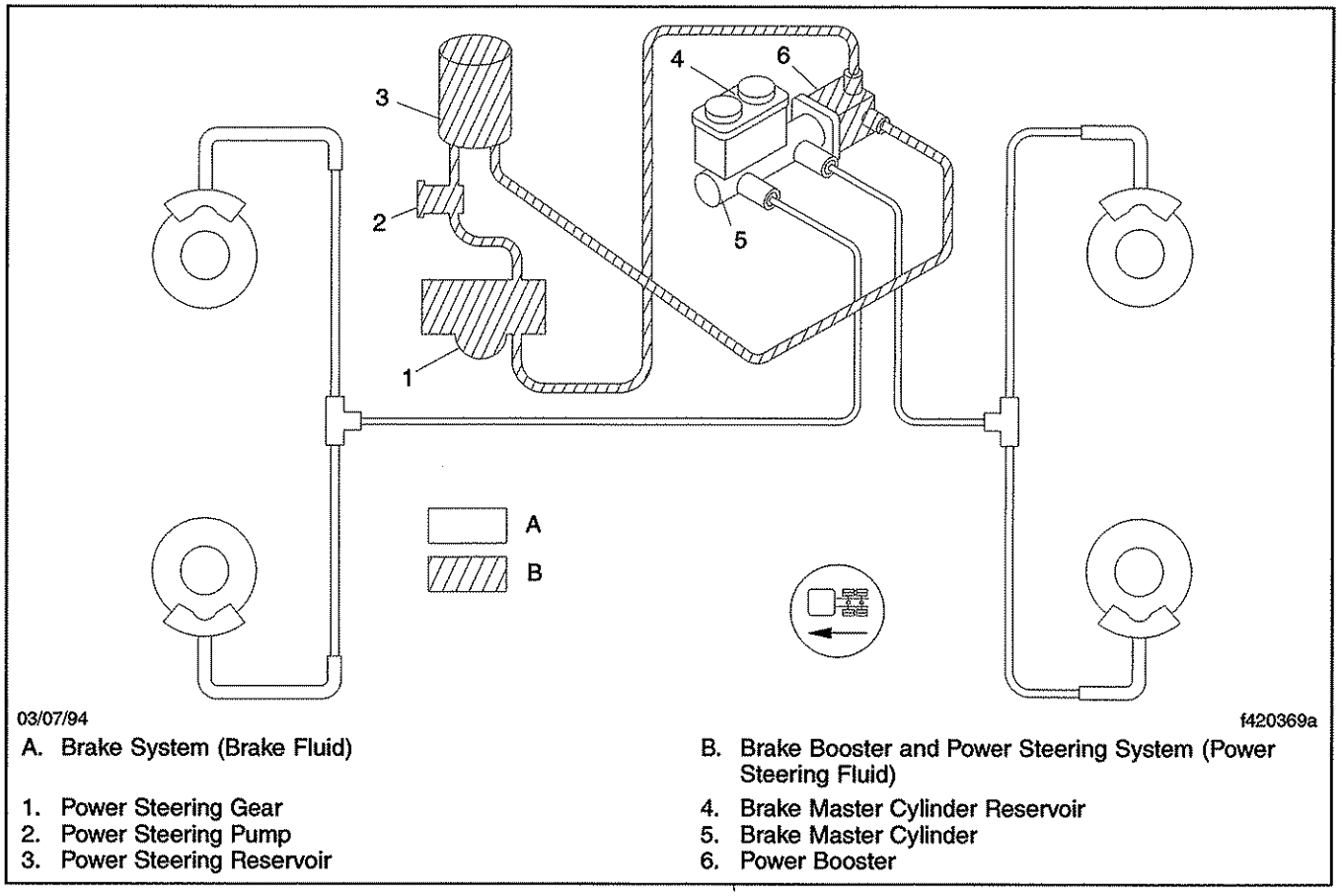
At the rear of the power piston—and inside it—is the reaction piston (Ref. 7). The power piston assembly (Ref. 8) is connected to the brake pedal by way



1. Rotor
2. Caliper and Pad Assembly
3. Flexible Brake Line
4. Rigid Brake Line
5. Master Cylinder
6. Reservoir
7. Power Booster

Fig. 1, Brake System Major Parts

General Description and Principles of Operation



A. Brake System (Brake Fluid)
B. Brake Booster and Power Steering System (Power Steering Fluid)

1. Power Steering Gear
2. Power Steering Pump
3. Power Steering Reservoir
4. Brake Master Cylinder Reservoir
5. Brake Master Cylinder
6. Power Booster

Fig. 2, Brake System Major Parts

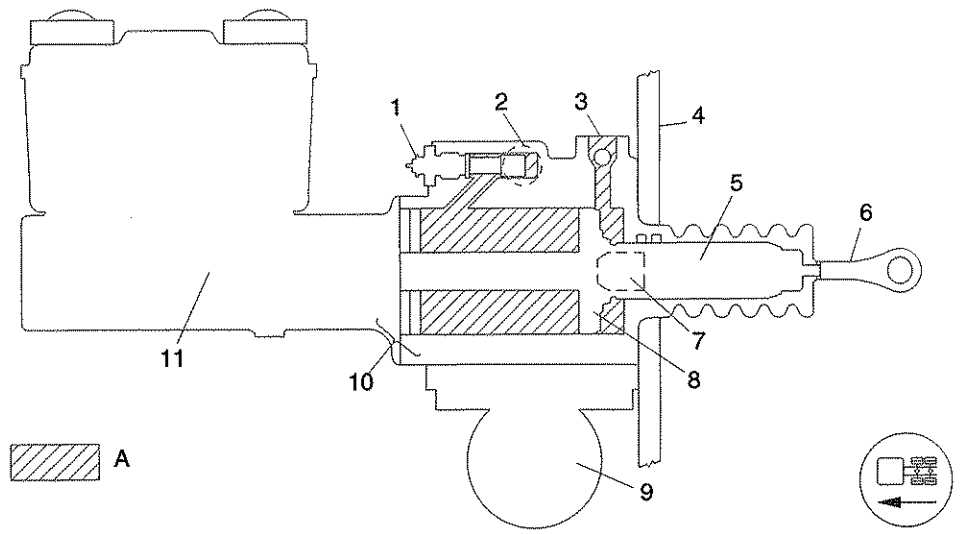
of the brake pedal rod (Ref. 6). Surrounding the reaction piston is the power piston assembly (Ref. 8), the forward end of which fits through the end-cap assembly, and rests against the rear of the brake master cylinder (Ref. 11). The end-cap assembly prevents the power steering fluid in the power booster from mixing with the brake fluid in the master cylinder.

The power booster is connected to the vehicle's power steering system, which supplies it with pressurized power steering fluid. The power booster supply port (Ref. 3) is connected to the power steering pump via the steering gear, and the return port is connected to the power steering reservoir. A flow switch (Ref. 1) activates the back-up pump if, for any reason, the power steering pump doesn't supply the power booster with fluid.

MASTER CYLINDER (Fig. 4 and Fig. 5)

The brake master cylinder functions as a dual supply system: the primary system supplies pressurized brake fluid to the rear brakes; the secondary system supplies it to the front brakes. **See Fig. 4.** For safety, each system is independent of the other, so a problem with one set of brakes won't affect the function of the other.

The master cylinder, attached to the front of the power booster (**Fig. 5**, Ref. 7), consists mainly of the primary pressure chamber (Ref. 9), the primary piston/actuator assembly and return spring (Refs. 10 and 11), the primary reservoir section (Ref. 5), and the secondary pressure chamber, piston/actuator assembly, return spring, and reservoir section (Refs. 13, 12, 15, and 2). Both pressure chambers have outlet ports that connect them to either the front or rear brake caliper assemblies by way of hydraulic lines. At the bottom of each reservoir section is a compensating valve



NOTE: Not all parts are shown.

1. Flow Switch
2. Return Port
3. Supply Port
4. Firewall
5. Rubber Boot
6. Brake Pedal Rod
7. Reaction Piston
8. Power Piston Assembly
9. Backup Electric Pump
10. End-Cap Assembly
11. Master Cylinder and Reservoir

A. Power Steering Fluid

Fig. 3

(Refs. 1 and 6), which when open, connects that reservoir section with the applicable pressure chamber in the master cylinder. A pressure differential valve operates a pressure differential switch (not shown), which activates a dash warning system, should one brake system not work.

BRAKE CALIPER ASSEMBLIES (Fig. 6 and Fig. 7)

Each brake caliper assembly, attached to a wheel, consists of a housing with dual cylinders and pistons (**Fig. 6**), a supply port (**Fig. 7**, Ref. 11), and a bleeder fitting (Ref. 10). The assembly fits over the rotor (Ref. 1) like a "U", with the pistons on the inboard face of the rotor. The caliper fits onto an anchor plate (Ref. 2) at the top and bottom, and the anchor plate is attached to the axle. The caliper is held in place on the anchor plate by a key (Ref. 4), a spring (not shown), and bolt (Ref. 5). The brake pads (Refs. 6 and 9) fit into slots in the caliper housing.

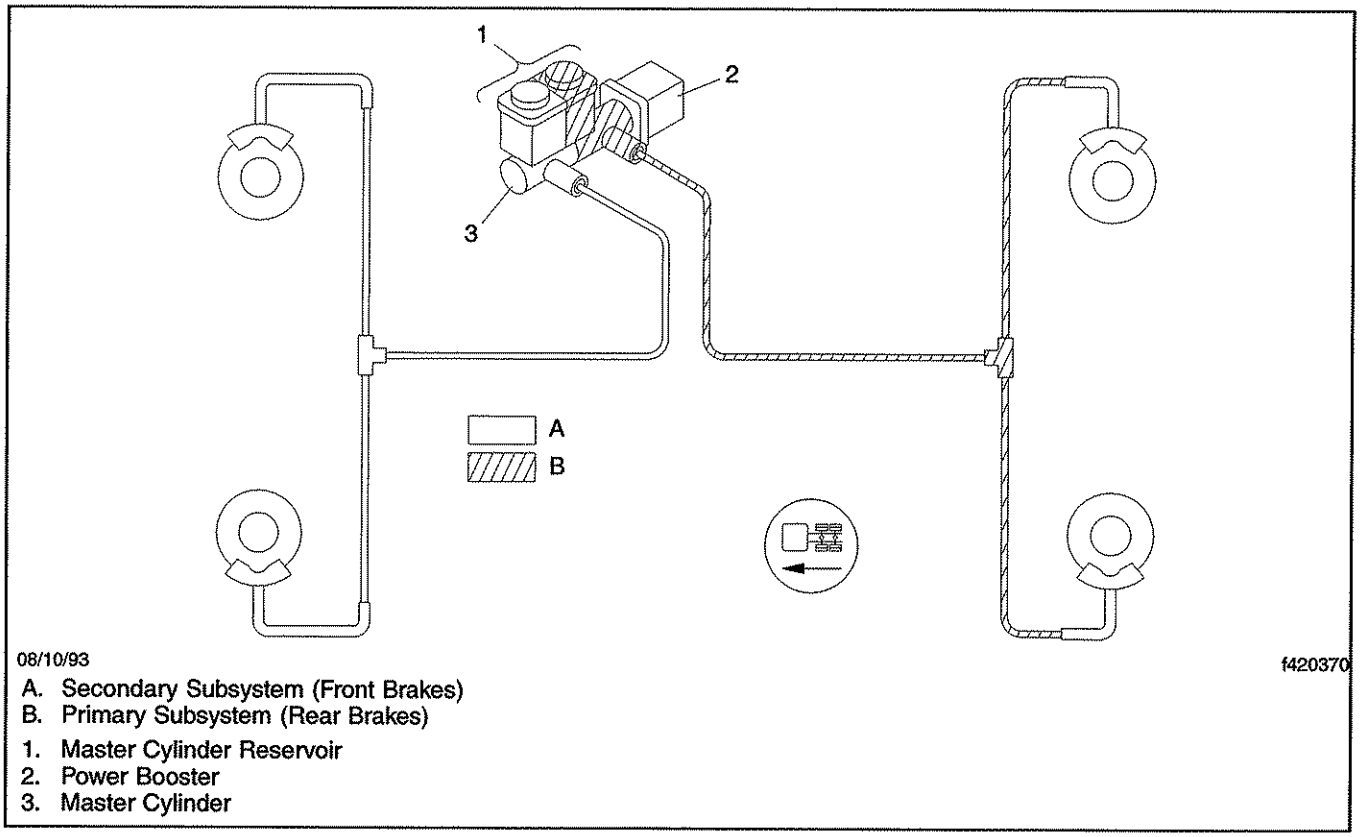
BRAKE CONTROL MODULE

The brake control module, located behind dash panel B (**see Fig. 8**), monitors electronic signals from various sensors in the brake system. If a problem is detected, the module activates the applicable warning light and buzzer on the dashboard.

The control module has nine input terminals and three output terminals (one terminal is a ground). **See Fig. 9**. The output terminals are used for the brake system pressure and parking brake warning lights (**see Fig. 10**), and a buzzer; the input terminals are connected to sensors in the brake system that detect problems.

See Table 1 for identification of the output and input terminals on the back of the module, and the circuits to which they are connected.

General Description and Principles of Operation



A. Secondary Subsystem (Front Brakes)
B. Primary Subsystem (Rear Brakes)
1. Master Cylinder Reservoir
2. Power Booster
3. Master Cylinder

Fig. 4

Terminal Number	Function	Circuit Number
1	Light "P" (Parking Brake) Output	394
2	Buzzer Output	396
3	Light "R" (Brake System Pressure) Output	390
4	Ground	GND
7	Ignition Input	388
8	Parking Brake Input	309
9	Relay Input	389
10	Door Open Input	397
11	Pressure Differential Switch Input	36F
12	Brake Pedal Input	500
13	Pump Motor Input	398
14	Fluid Level Input	395
15	Flow Switch Input	393

Table 1, Control Module Terminal Identification

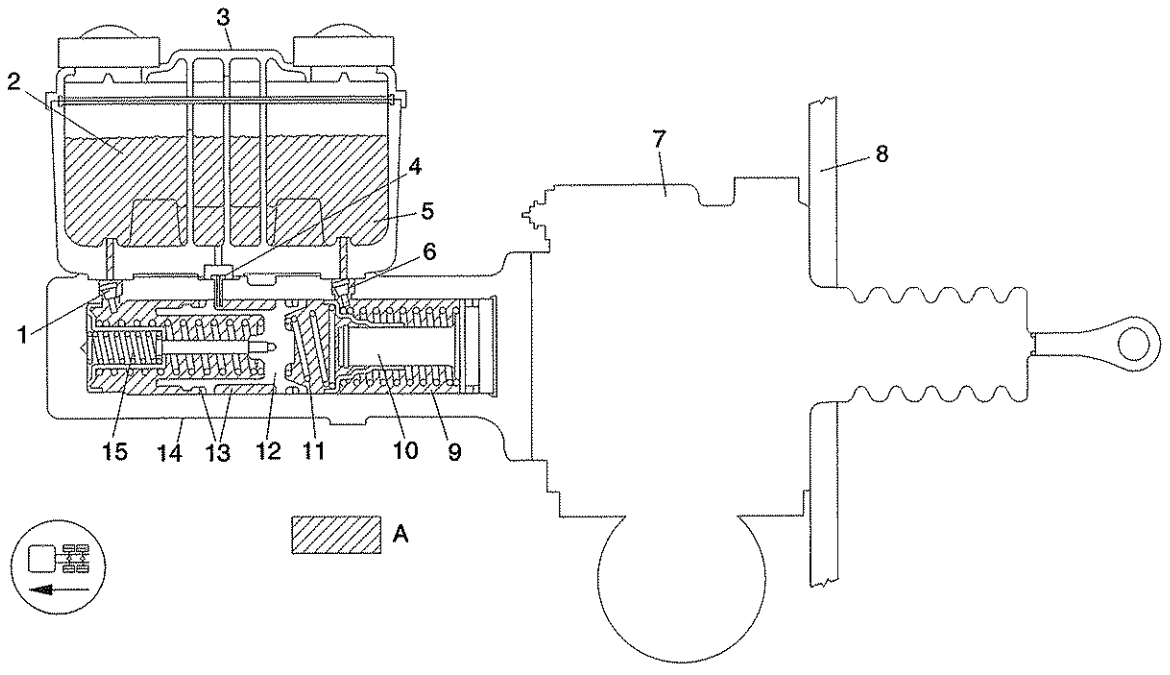
Principles of Operation (Fig. 11)

APPLYING THE BRAKES

When the brake pedal is applied, the brake pedal rod (Ref. 11) pushes the actuator pin (Ref. 10) which pushes the reaction piston (Ref. 12) forward inside the power piston (Ref. 13). This closes the pressure valve (Ref. 16), which restricts the flow of power steering fluid through the power piston (Ref. 13). The increased fluid pressure pushes the power piston forward, through the end-cap assembly (Ref. 18), and into the master cylinder primary piston/actuator assembly (Ref. 19).

As the primary piston/actuator assembly moves forward in the master cylinder, the primary compensating valve closes (Ref. 4). This closes the outlet to the primary reservoir section (Ref. 3), and causes hydraulic pressure to build up in the primary pressure chamber (Ref. 20).

General Description and Principles of Operation



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NOTE: Not all parts are shown.

A. Brake Fluid
1. Secondary Compensating Valve (open)
2. Secondary Reservoir Section
3. Brake Fluid Reservoir
4. Piston Stop
5. Primary Reservoir Section
6. Primary Compensating Valve (open)
7. Power Booster Assembly
8. Firewall
9. Primary Pressure Chamber
10. Primary Piston/Actuator Assembly
11. Primary Piston Return Spring
12. Secondary Piston/Actuator Assembly
13. Secondary Pressure Chamber
14. Housing
15. Secondary Piston Return Spring

Fig. 5

The primary piston/actuator assembly continues moving forward, and moves the secondary piston/actuator assembly (Ref. 22). This closes the secondary compensating valve (Ref. 1), pressurizing the secondary pressure chamber (Ref. 23).

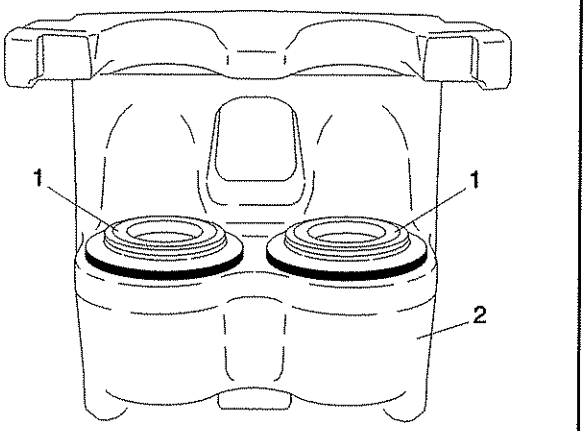
The primary and secondary pressure chambers are connected by outlet ports (not shown) to the primary and secondary brake lines and caliper assemblies. When pressurized brake fluid enters the caliper housings from the brake lines, the dual pistons in each caliper move outward toward the rotors, pushing the inboard brake pads against the rotors. At the same time, the caliper assemblies slide slightly inboard, causing both inboard and outboard pads to squeeze the rotors tightly, which slows down or stops the wheels.

If for any reason the power steering pump doesn't supply the power booster with fluid, the flow switch assembly (Ref. 5) turns on the electric pump (Ref. 15) and closes the return port (Ref. 6). The check valve (Ref. 8) in the power booster supply port (Ref. 7) closes, and the check valve (Ref. 14) in the electric pump opens. The electric pump then recirculates the fluid in the power booster, maintaining emergency pressure. This provides enough reserve power for the master cylinder to pressurize the brake lines.

RELEASING THE BRAKES

When the brake pedal is released, a return spring (Ref. 17) in the power booster pushes the power piston and the reaction piston (inside the power piston) toward

General Description and Principles of Operation



1. Piston
2. Housing

Fig. 6

the rear of the booster housing, and away from the master cylinder primary piston/actuator assembly. This reduces the fluid pressure in the power booster.

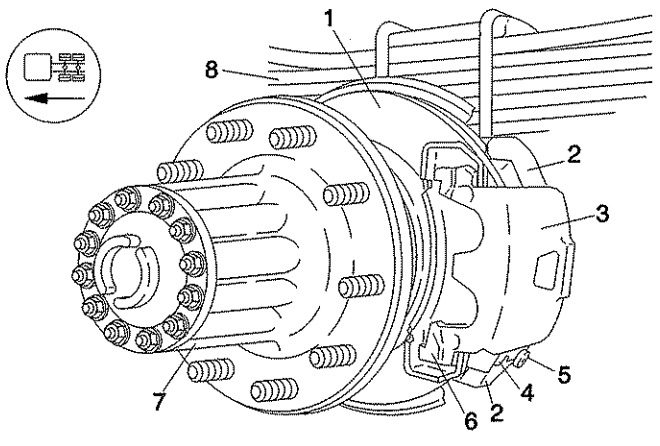
In the master cylinder, the return springs (Refs. 24 and 21) center the primary and secondary pistons. This opens up the primary and secondary compensating valves (Refs. 4 and 1), decreasing hydraulic pressure throughout the master cylinder. The pressure in the hydraulic lines drops, which allows the dual pistons in each caliper housing to retract. The calipers slide back outboard, and the brake pads no longer squeeze the rotors, allowing the rotors and wheel hubs to turn freely.

BRAKE CONTROL MODULE

The control module, which operates on 9 to 16 volts DC, is active (monitoring the hydraulic brake system) under any of the following conditions:

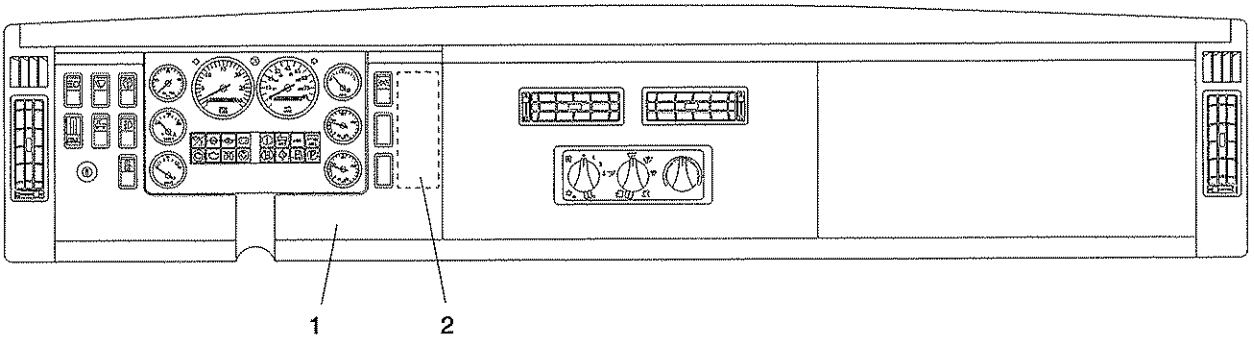
- When the ignition is on;
- When the brake pedal switch is powered;
- If the ignition is off, but the driver's door is open and the parking brake is not applied.

When the ignition is turned on, the control module starts a self-test mode, which lasts from about one to three seconds. The warning lights and buzzer come on, then go off if the system is working all right. The module then goes into the active mode, monitoring the hydraulic brake system. If a problem is detected,



1. Rotor
2. Anchor Plate
3. Caliper Assembly
4. Key
5. Bolt
6. Brake Pad (outboard)
7. Wheel Hub
8. Leaf Spring
9. Brake Pad (inboard)
10. Bleeder Fitting
11. Supply Port

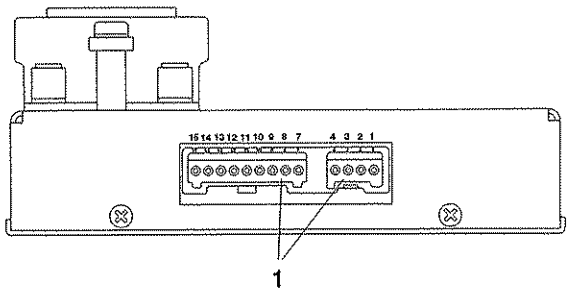
Fig. 7, Rear Brake Caliper



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1. Panel B
2. Control Module

Fig. 8



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1. Terminals

Fig. 9

the applicable input or output terminal is activated, and a warning light and buzzer come on. The output terminals are activated as follows:

The "R" light (brake pressure) output—terminal 3—is activated when any of the following conditions exist:

- The flow switch on the power booster closes, due to a reduced flow of power steering fluid;
- The pressure differential switch on the master cylinder closes, due to a drop in pressure in either the front or rear brake system;
- The fluid level switch on the master cylinder reservoir closes, due to a drop in the fluid level;
- Too much electrical resistance is in the backup pump motor.

The "P" light (parking brake) output—terminal 2—is activated when any of the following conditions exist:

- The parking brake is applied, and the ignition is on;
- The driver's door is open, the parking brake is not applied, and the ignition is off. This condition will also cause the control module buzzer to come on.

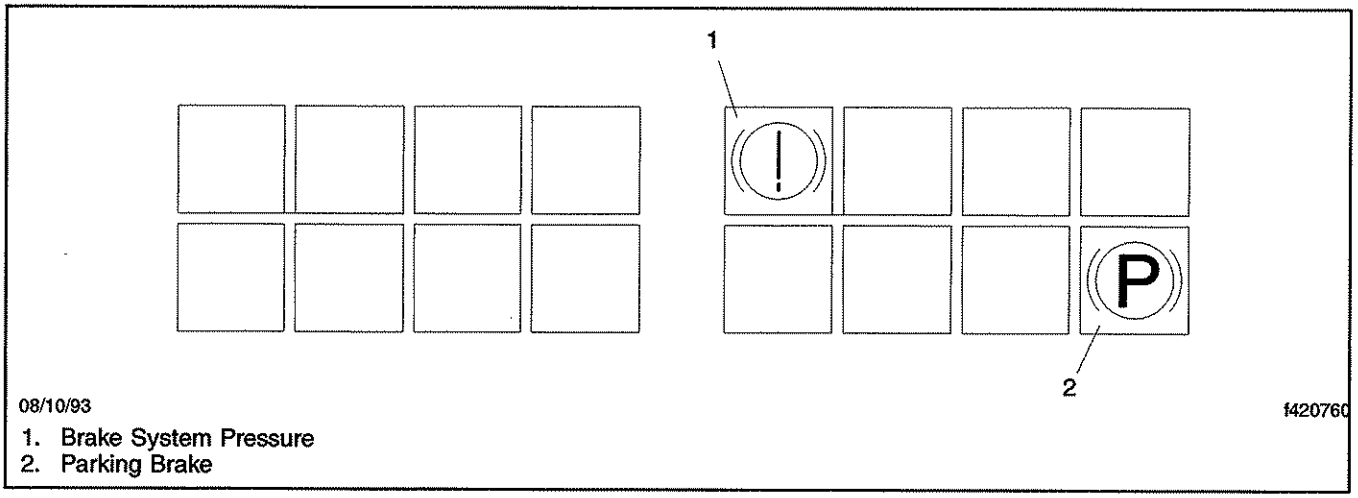
NOTE: The vehicle is equipped with two dash buzzers: one on the control module itself, which comes on when the light "P" output (parking brake) is activated due to the driver's door being open and the parking brake not applied; and one mounted separately from the control module, which comes on when the light "R" output (brake system pressure) is activated.

See Table 2 for information on when the input terminals are activated.

General Description and Principles of Operation

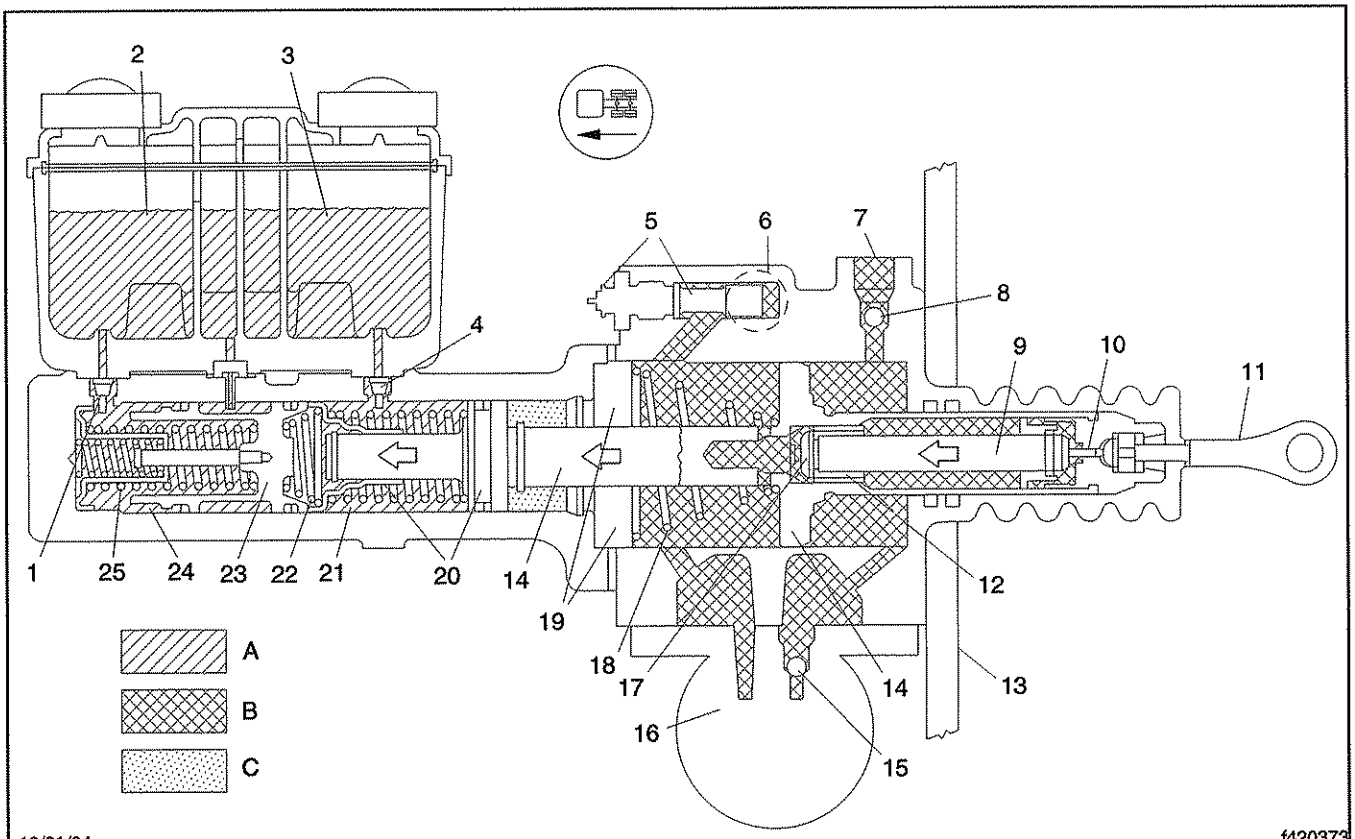
Terminal Number	Function	Circuit Number	Activated if
7	Ignition Input	388	The ignition is on.
8	Parking Brake Input	309	Parking brake is applied.
9	Relay Input	389	The ignition is on or brake pedal is depressed.
10	Door Open Input	397	Driver's door open, and parking brake not applied.
11	Pressure Differential Switch Input	36F	Pressure difference between front and rear systems becomes more than 483 kPa (70 psi).
12	Brake Pedal Input	500	Brake pedal depressed.
13	Pump Motor Input	398	Electrical resistance of backup pump motor too high.
14	Fluid Level Input	395	Fluid level of master cylinder below 25 percent capacity.
15	Flow Switch Input	393	No hydraulic flow through power booster.

Table 2



1. Brake System Pressure
2. Parking Brake

Fig. 10



NOTE: Not all parts shown.

A. Brake Fluid
B. Power Steering Fluid
C. Air Space

1. Secondary Compensating Valve
2. Secondary Reservoir Section
3. Primary Reservoir Section
4. Primary Compensating Valve
5. Flow Switch Assembly
6. Return Port
7. Supply Port
8. Check Valve (shown open)
9. Pressure Regulator Assembly
10. Actuator Pin
11. Brake Pedal Rod
12. Reaction Piston
13. Firewall
14. Power Piston
15. Check Valve (shown closed)
16. Electric Motor Pump Assembly
17. Pressure Valve
18. Return Spring
19. End-Cap Assembly
20. Primary Piston/Actuator Assembly
21. Primary Pressure Chamber
22. Primary Piston Return Spring
23. Secondary Piston/Actuator Assembly
24. Secondary Pressure Chamber
25. Secondary Piston Return Spring

Fig. 11

Safety Precautions

Because many brake linings contain asbestos, you should know the potential hazards of asbestos and the precautions to be taken. Because medical experts believe that long-term exposure to some non-asbestos fibers could also be a health hazard, also observe the following precautions if servicing non-asbestos brake linings.

NOTE: The vehicle is originally equipped with non-asbestos brake linings.

Exposure to airborne brake lining dust can cause serious and possibly fatal diseases such as asbestosis (a chronic lung disease) and cancer.

During brake servicing, wear an air purifying respirator with high-efficiency filters. The respirator and filter must be approved by NIOSH or MSHA, and worn during all procedures.

OSHA recommends that enclosed cylinders equipped with vacuums and high-efficiency particulate air (HEPA) filters be used during brake repairs. Under this system, the entire brake assembly is placed within the cylinder and the mechanic works on the brake through sleeves attached to the cylinder. Compressed air is blown into the cylinder to clean the assembly, and the dirty air is then removed from the cylinder by the vacuum.

If such an enclosed system is not available, or can't be used, clean the brake assembly in the open air. During disassembly, carefully place all parts on the floor to minimize creating airborne dust. Using an industrial vacuum cleaner with an HEPA filter system, remove dust from the brake rotors, caliper assemblies, dust shields, and brake pads. After vacuuming, remove any remaining dust using a rag soaked in water and wrung until nearly dry.

⚠ WARNING

WARNING: Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by NIOSH or MSHA. Wear a respirator at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

Hydraulic brake fluid is hazardous, and can cause blindness if it gets in your eyes. Always wear safety glasses when handling brake fluid or bleeding brake components. Brake fluid may also be a skin irritant. If you get it on your skin, wash it off as soon as possible.

Special care must be taken when disposing of used brake fluid. Put the fluid in a sealed plastic container and label it "Used Brake Fluid." Then dispose of it in an approved manner. Check with local and state regulations as to the correct disposal procedure.

Hydraulic System Bleeding

⚠ WARNING

WARNING: Before doing any of the work below, read the information under "Safety Precautions, 100". Failure to read the safety precautions, and to be aware of the dangers of brake fluid, could result in injury.

Whenever any hydraulic system fitting is loosened or disconnected, the entire system must be bled to remove any air that may have entered it.

⚠ CAUTION

CAUTION: Power steering fluid and brake fluid are incompatible. Never mix these two fluids, or serious damage to both hydraulic systems will result. Use only brake fluid for the master cylinder and brake lines. Use only power steering fluid for the power booster.

Always use new, clean brake fluid that meets DOT 3 specifications when bleeding the master cylinder and service brake system. Never reuse brake fluid, and don't use brake fluid containers for any other purpose. Keep brake fluid containers tightly closed to keep new brake fluid clean and dry.

IMPORTANT: Don't let brake fluid touch any painted surfaces, as it will remove the paint. Brake fluid may also damage certain non-metal surfaces. Don't let it get on brake pads or rotors.

PRESSURE BLEEDING, SERVICE BRAKE SYSTEM

Pressure bleeding is the preferred method for bleeding the service brake system. It requires the use of a special pressure bleeder kit, consisting of a tank, pressure pump and valve, gauge, tubing, and adapter. These are available from a number of manufacturers, and include instructions for use. **See Fig. 1.**

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Connect the pressure bleeder to the brake master cylinder reservoir, following the manufacturer's instructions.
   - 2.1 Fill the pressure bleeder with new DOT 3 approved brake fluid, then pressurize it according to the manufacturer's instructions.
   - 2.2 Using the supplied adapter, connect the pressure bleeder to the rear compartment of the master cylinder reservoir.
3. Bleed the hydraulic connections at the rear wheel calipers, starting on the right side.
   - 3.1 Put a wrench on the bleeder fitting at the caliper, then attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. **See Fig. 2.**
   - 3.2 Loosen the bleeder fitting about 3/4 turn, and let the brake fluid flow out of the fitting until it is free of air bubbles. **See Fig. 2 and Fig. 3.** Then tighten the fitting firmly.
   - 3.3 Move to the left rear caliper, and repeat steps for bleeding the caliper.
4. Disconnect the pressure bleeder from the rear compartment of the master cylinder reservoir, then connect it to the front compartment of the reservoir.
5. Bleed the front wheel brake calipers, starting at the right side.

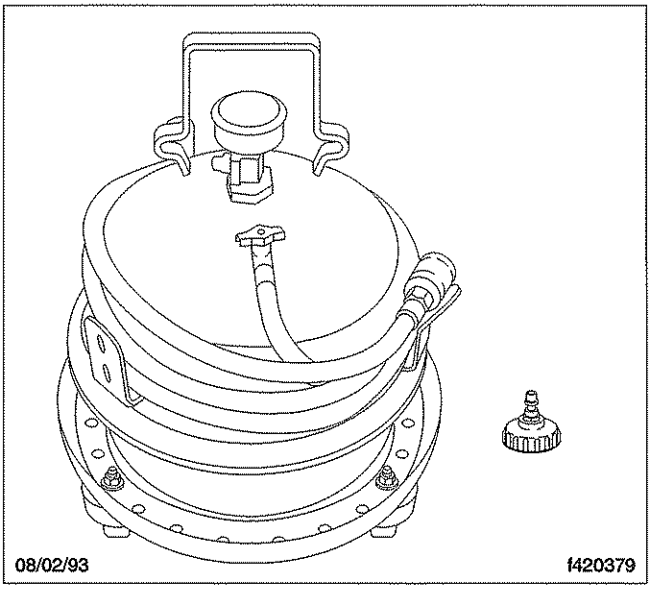


Fig. 1

Hydraulic System Bleeding

5.1 Put a wrench on the bleeder fitting at the caliper, then attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. **See Fig. 2.**

5.2 Loosen the bleeder fitting about 3/4 turn, and let the brake fluid flow out of the fitting until it is free of air bubbles. **See Fig. 2 and Fig. 3.** Then tighten the fitting firmly.

5.3 Move to the left front wheel caliper, and repeat steps for bleeding the caliper.

6. Check the brake fluid level in both compartments of the reservoir. Add new DOT 3 approved brake fluid if needed.

7. Check the operation of the brakes by depressing the brake pedal several times, until if feels firm. The brake pedal should not go all the way down to the floor. If it does, go to **"Troubleshooting, 300"** and find the problem.

8. Lower the hood and remove the chocks.

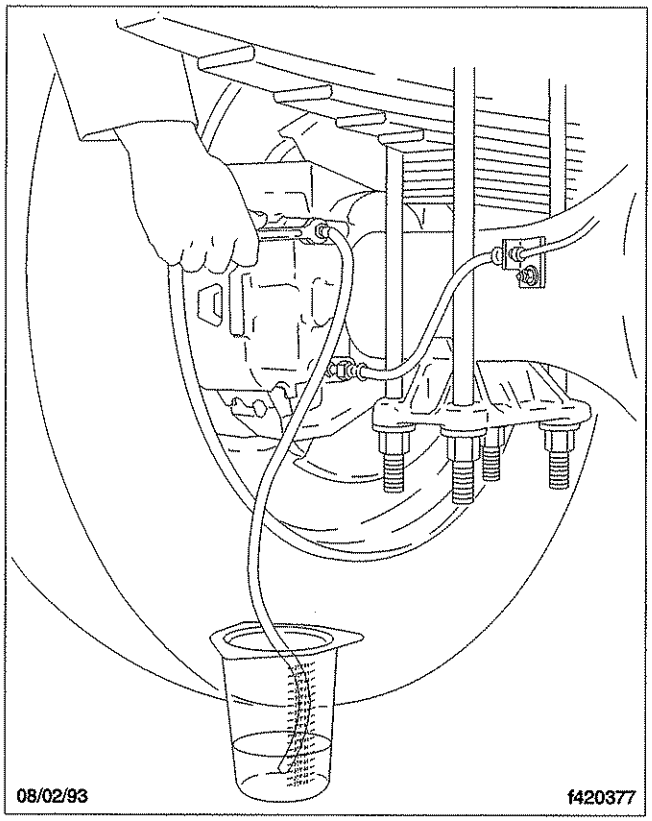


Fig. 2

MANUAL BLEEDING, SERVICE BRAKE SYSTEM

If you don't have pressure bleeding equipment, you can use the manual bleeding procedure.

⚠ WARNING

WARNING: Read over the information under "Safety Precautions, 100" before starting the procedure below. Failure to do so may result in either serious injury to yourself, or damage to the brake system, resulting in an accident causing serious personal injury or property damage.

IMPORTANT: Don't let the brake master cylinder run dry during manual bleeding operations. Keep the master cylinder reservoir filled with new, DOT 3 approved brake fluid. Failure to keep the brake reservoir filled could result in more air entering the system, making it impossible to effectively bleed the system.

1. Apply the parking brake, chock the tires, and tilt the hood.

2. Bleed the master cylinder.

2.1 Using a wrench (and a rag to absorb leaking brake fluid), loosen the fitting at the rear outlet port on the master cylinder. **See Fig. 4.** Loosen the fitting about one turn.

2.2 Have someone push the brake pedal down slowly— by hand— to the floor. Brake fluid, and any air in the master cylinder, will squirt from the fitting.

2.3 *With the brake pedal held down,* tighten the rear hydraulic line fitting firmly.

IMPORTANT: Don't release the brake pedal until the fitting is tightened, or more air will get into the system.

2.4 Release the brake pedal.

2.5 Loosen the fitting again, and repeat steps for bleeding as required until no air escapes from the fitting, and the brake pedal feels firm.

2.6 Check the level of the rear compartment of the reservoir, then add new DOT 3 approved brake fluid if needed.

Hydraulic System Bleeding

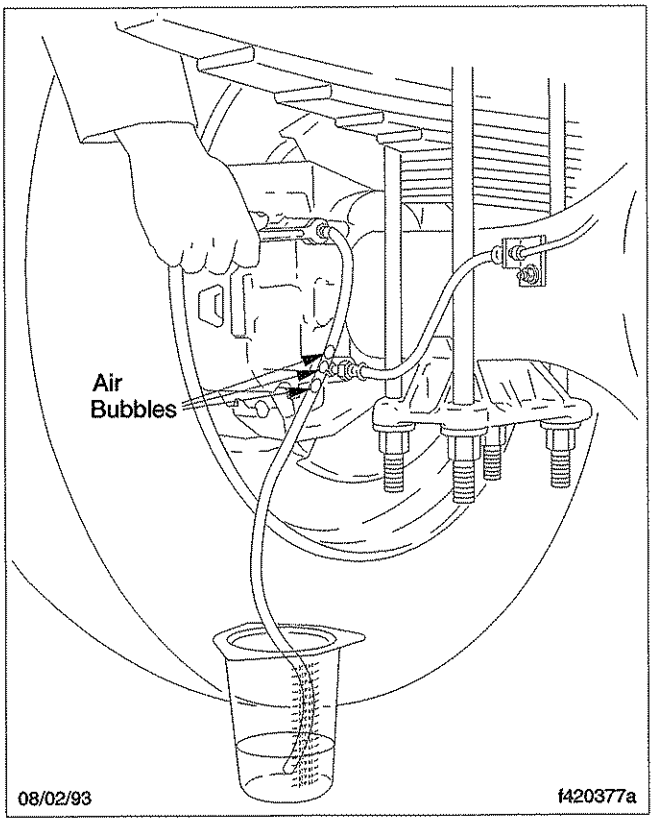


Fig. 3

2.7 Using a wrench (and a rag to absorb leaking brake fluid), loosen the fitting at the front outlet port on the master cylinder. **See Fig. 5.** Loosen the fitting about one turn.

2.8 Repeat steps as required for the front outlet port.

2.9 Check the brake fluid level in the front compartment of the reservoir. Add new DOT 3 approved brake fluid if needed.

3. Bleed the hydraulic connections at the wheel calipers, starting at the right rear wheel caliper.

3.1 Put a wrench on the bleeder fitting at the caliper, then attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. **See Fig. 2.**

3.2 Loosen the bleeder fitting about 3/4 turn.

3.3 Have someone slowly push the brake pedal to the floor, then *with the brake pedal depressed,* tighten the bleeder fitting.

IMPORTANT: Make sure the brake pedal stays depressed while you tighten the fitting. If it's released before you tighten the fitting, more air will get into the system.

3.4 Release the brake pedal. Check the fluid in the tube. If there are air bubbles present **(Fig. 3),** repeat steps as required until the fluid in the tube is completely free of air bubbles, **as shown in Fig. 2.**

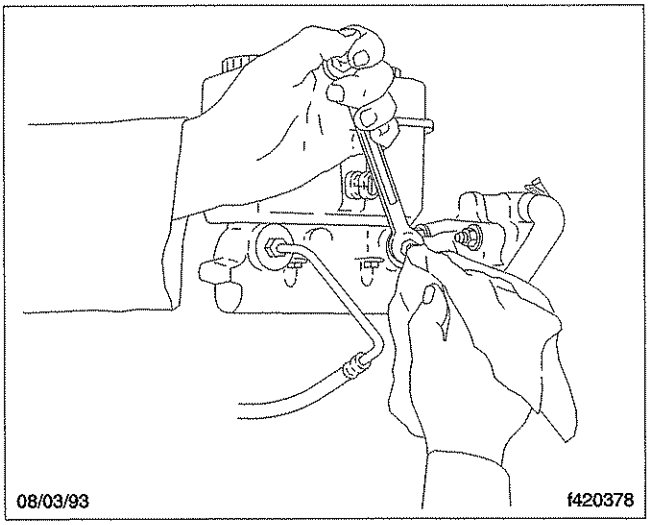


Fig. 4

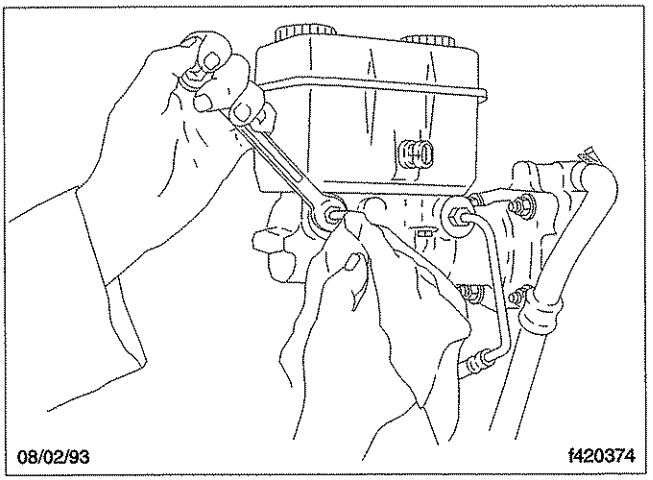


Fig. 5

Hydraulic System Bleeding

3.5 Check the brake fluid level in the reservoir. Add new DOT 3 approved brake fluid if needed.

3.6 Repeat steps for bleeding the connections for the left rear caliper, then the right front caliper, and finally for the left front caliper.

4. Lower the hood and remove the chocks.

Hydro-Max II® Power Booster Bleeding

Booster Bleeding

⚠ WARNING

WARNING: Use only clean, approved power steering fluid for the procedure below. Do not use brake fluid. Mixing brake fluid with power steering fluid will damage the seals and O-rings in the power booster, the power steering pump, and the power steering gear, resulting in possible loss of steering.

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Check the level of fluid in the power steering reservoir. **See Fig. 1.** If needed, fill it with approved power steering fluid. **See "Specifications, 400"** for approved power steering fluid.
3. Crank the starter several times, but don't start the engine.
4. Check the fluid level in the power steering reservoir. Fill it if needed.
5. Crank the starter and check the fluid level again.
6. Check the operation of the brakes.
   - 6.1 With the engine off, depress the brake pedal. The dash warning light and buzzer should come on, and the electric motor assist should come on.
   - 6.2 Start the engine. Depress the brake pedal. The dash warning light and buzzer should not come on; neither should the electric motor. If they do, go to **"Troubleshooting, 300"** and find the problem; otherwise, stop the engine. Check the fluid level in the power steering reservoir. Fill it if needed.
7. Lower the hood, then remove the chocks.

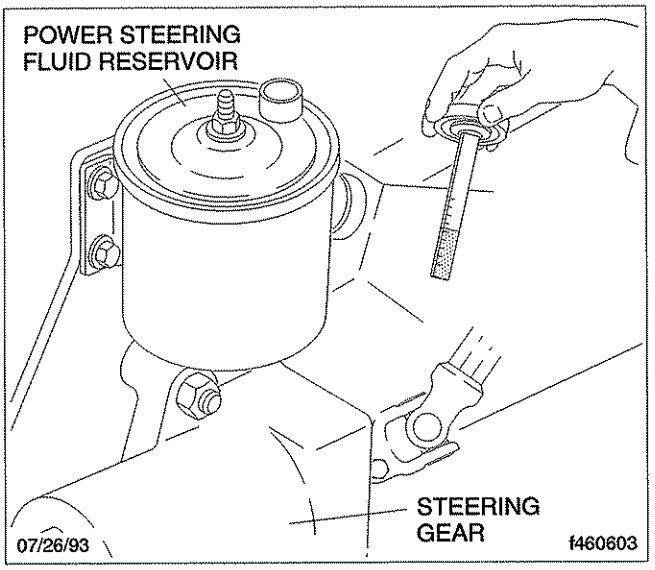


Fig. 1

Master Cylinder Removal and Installation

Removal

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake fluid exposure could result in serious and permanent health damage.

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Disconnect the wires from the pressure differential switch (**Fig. 1**, Ref. 4) on the master cylinder, and the fluid level sensor (Ref. 5) on the reservoir.
3. Remove the accelerator cable clamp (**Fig. 2**, Ref. 2) from the L-bracket (Ref. 1) attached to the front inboard side of the master cylinder.

⚠ CAUTION

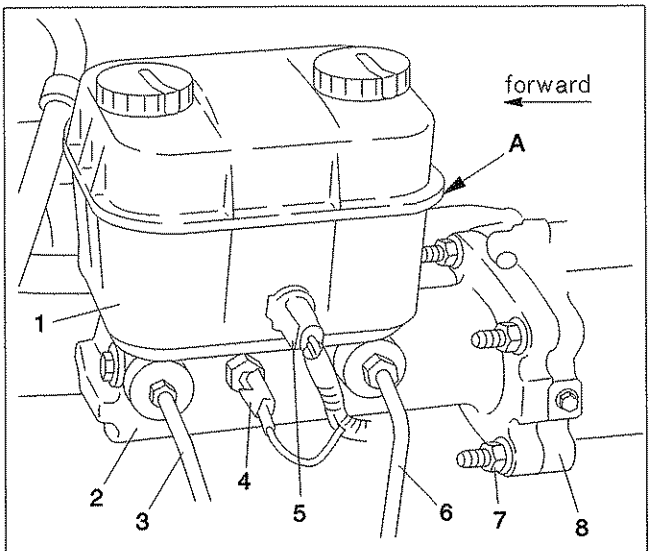
CAUTION: Do not let the brake fluid get on any painted surface, as it will dissolve the paint. Use a rag around fittings, or put a container underneath it to catch any fluid.

4. Disconnect the brake lines from the front and rear outlet ports of the master cylinder. **See Fig. 3.** Plug the brake lines.
5. Remove the four flanged hexnuts that attach the master cylinder to the power booster unit. **See Fig. 4.**

   Remove the master cylinder and reservoir assembly from the vehicle. **See Fig. 5.** Keep it upright so you don't spill any brake fluid from the reservoir.
6. Remove the caps from the master cylinder reservoir, then carefully invert the master cylinder and reservoir assembly, and dump the brake fluid into a container. Dispose of the brake fluid in an approved manner.

Installation

1. Bench bleed the master cylinder.
   - 1.1 Put the master cylinder and reservoir assembly in a vise.
   - 1.2 Install a plastic adapter and clear rubber hose on the primary and secondary outlet ports, **as shown in Fig. 6.**
   - 1.3 Put the other end of each tube into its section of the reservoir, **as shown in Fig. 6.**
   - 1.4 Fill the reservoir sections about half-full with new DOT 3 approved brake fluid.
   - 1.5 Using a metal rod with a rounded end, depress and release the primary piston several times.
   - 1.6 Reposition the master cylinder in the vise, with the front (closed) end tilted slightly up. Depress and release the primary piston again until you feel increased resistance.
2. Position the master cylinder on the front of the power booster.



1. Reservoir
2. Master Cylinder
3. Front (Secondary) Circuit Brake Line
4. Pressure Differential Switch
5. Fluid Level Sensor
6. Rear (Primary) Ciruit Brake Line
7. Flanged Hexnut
8. Power Booster

A = Fill reservoir sections to this level.

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Fig. 1

Master Cylinder Removal and Installation

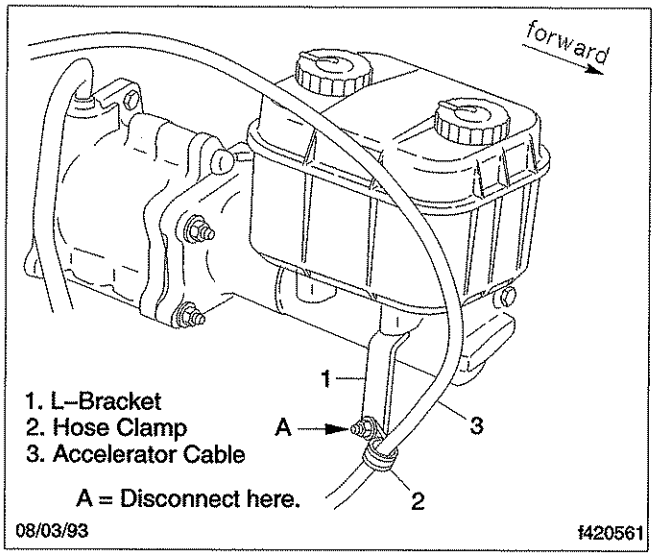


Fig. 2

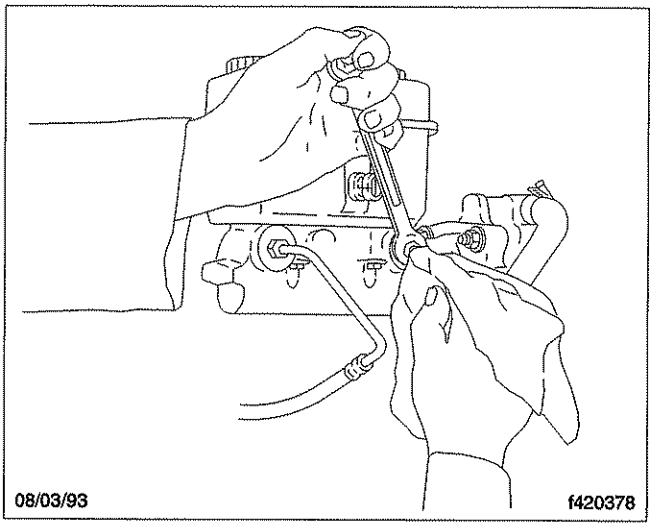


Fig. 3

3. Install the four flanged nuts on the studs of the power booster, then tighten them 34 N·m (25 lbf·ft).
4. Connect the rear brake (primary circuit) line to the rear outlet port on the master cylinder, then the front brake (secondary circuit) line to the front outlet port. Tighten the fittings 20 N·m (15 lbf·ft).
5. Connect the accelerator cable clamp (**Fig. 2**, Ref. 2) to the L-bracket (Ref. 1) on the front inboard side of the master cylinder.

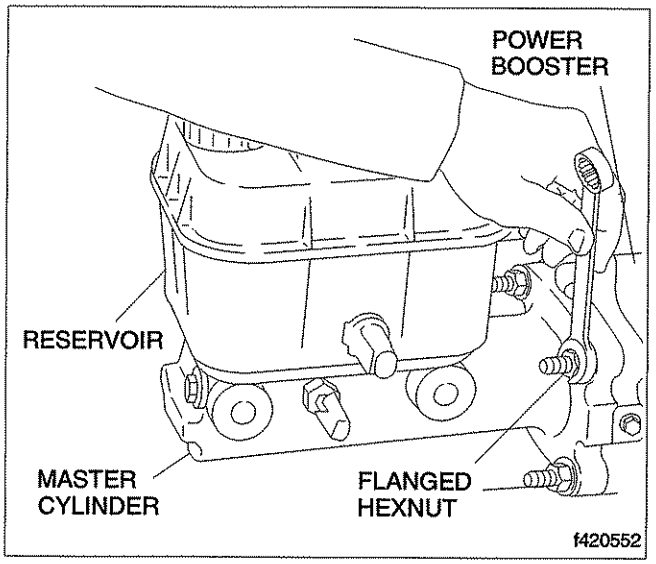


Fig. 4

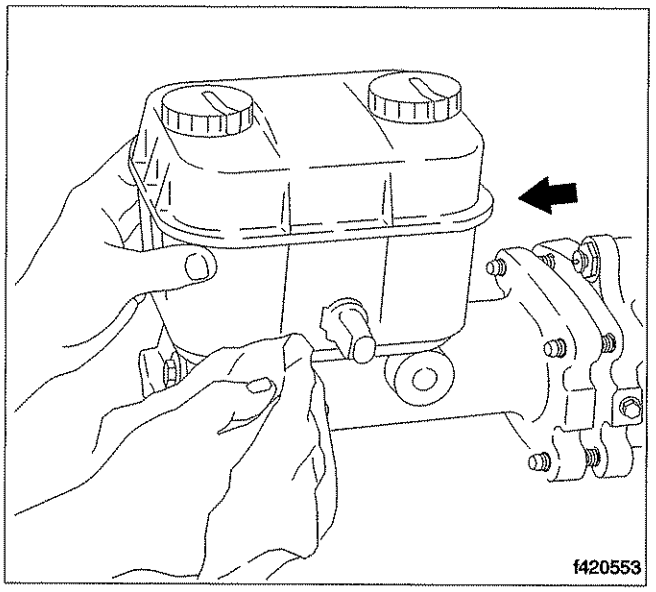


Fig. 5

6. Connect the wires to the pressure differential switch and the fluid level sensor. **See Fig. 1**, Refs. 4 and 5.
7. Fill both sections of the reservoir with new DOT 3 approved brake fluid. Fill to the raised seam on the outside of the reservoir. **See Fig. 1**, Ref. A.

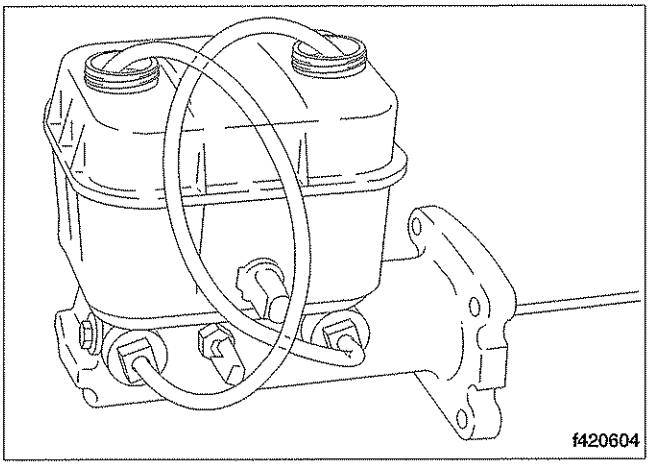


Fig. 6

8. Bleed the entire brake system, following the instructions under **"Hydraulic System Bleeding, 110."**
9. Lower the hood, then remove the chocks.

Hydro-Max II® Power Booster Removal and Installation

Removal

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Disconnect the batteries at the negative cable.
3. If not already done, disconnect the master cylinder from the power booster, following the instructions **in Subject 170.**
4. From inside the cab, disconnect the push rod from the brake pedal.
   - 4.1 Below the dash, find the clevis pin, washer, and cotter key that hold the power booster push rod to the brake pedal. **See Fig. 1.**
   - 4.2 Remove the cotter key, washer and clevis pin.
5. Disconnect the wiring from the auxiliary electric pump assembly. **See Fig. 2.**
6. Disconnect the wiring from the flow switch at the front of the power booster. **See Fig. 2.**
7. Using a shop towel or a container to catch any power steering fluid, disconnect the hydraulic supply and return lines from the power booster. **See Fig. 3.** Plug the lines.

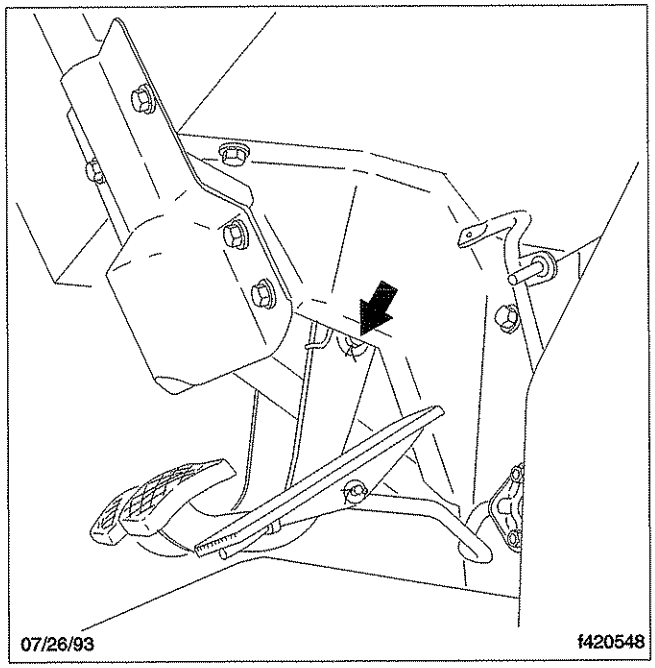


Fig. 1

8. Remove the four hexbolts and washers **(Fig. 4)** holding the power booster to the firewall, then pull the power booster straight out from the firewall, **as shown in Fig. 5.**

Installation

1. Position the power booster on the firewall so the push rod fits through the large hole and into the cab, and the four holes in the power booster line up with those on the firewall. **See Fig. 5.**
2. Install the four mounting hexbolts and washers. **See Fig. 4.** Tighten them 27 N·m (15 lbf·ft).
3. Install the master cylinder on the power booster, following the instructions **in Subject 170.**
4. Connect the hydraulic supply and return lines **(Fig. 3).** Tighten the supply line 20 N·m (20 lbf·ft). Tighten the hose clamp on the return line firmly.
5. Connect the wiring to the auxiliary electric pump assembly, and to the flow switch assembly. **See Fig. 2.**
6. Check the fluid level in the power steering reservoir **(Fig. 6).** Add approved power steering fluid if needed. **Refer to "Specifications, 400"** for the approved power steering fluid.
7. Connect the batteries.
8. Lower the hood, then remove the chocks.
9. Bleed the power booster, following the instructions **in Subject 115.**

Hydro-Max II® Power Booster Removal and Installation

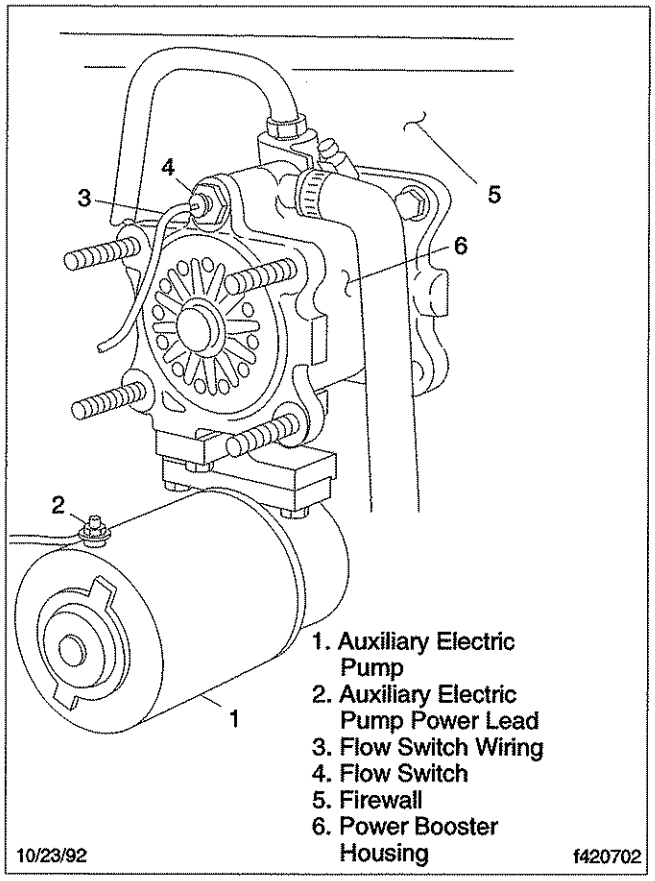


Fig. 2

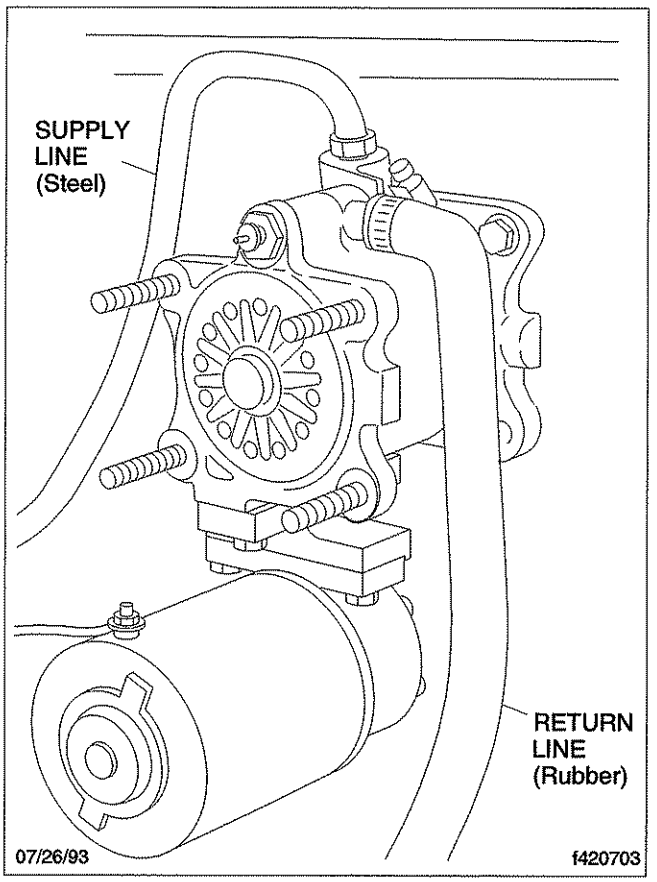


Fig. 3

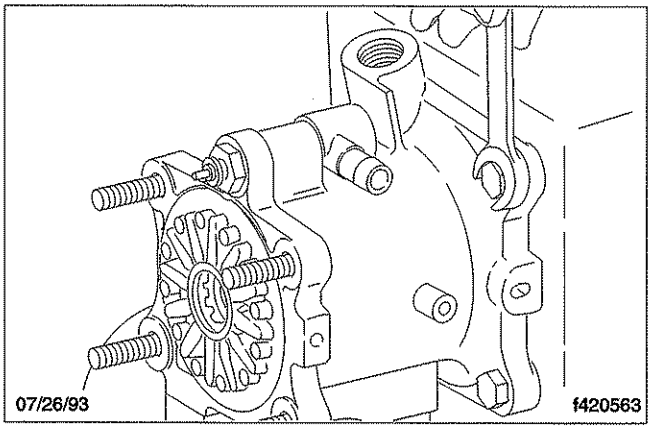


Fig. 4

Hydro-Max II® Power Booster Removal and Installation

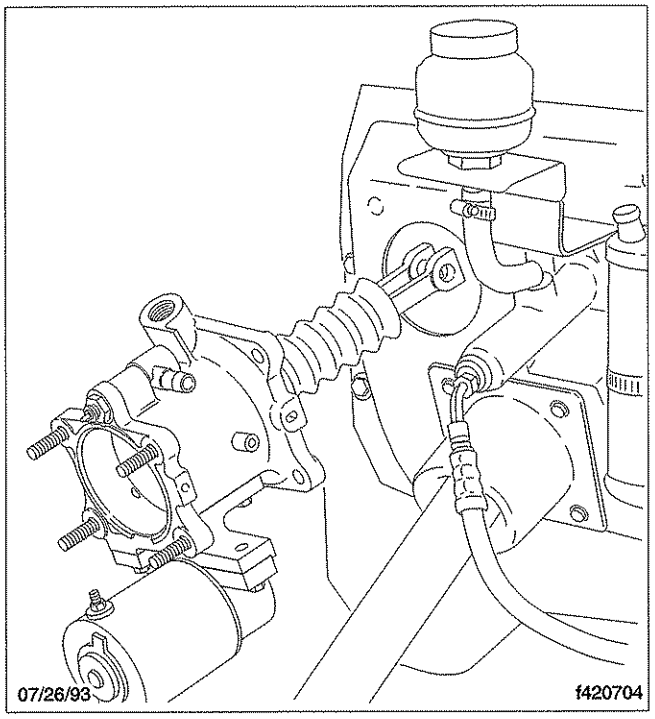


Fig. 5

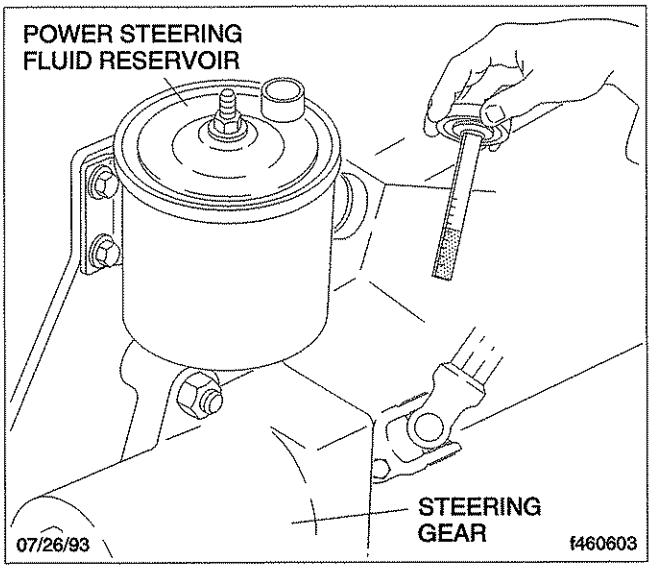


Fig. 6

Hydraulic Brake Control Module Removal and Installation

Removal

1. Disconnect the batteries at the negative terminals.
2. Access the control module.
   - 2.1 Remove the extruded rubber strip from the top of the dashboard. **See Fig. 1.**
   - 2.2 Remove dash panels B and D. **See Fig. 2.** Mark and disconnect any electrical wires from the back of panel B.
   - 2.3 Remove the screws from panel C, then swing it down.
3. Find the control module (**see Fig. 3**). Remove the four Torx® head screws holding the module and bracket assembly to the dash, then pull out the module and bracket assembly.

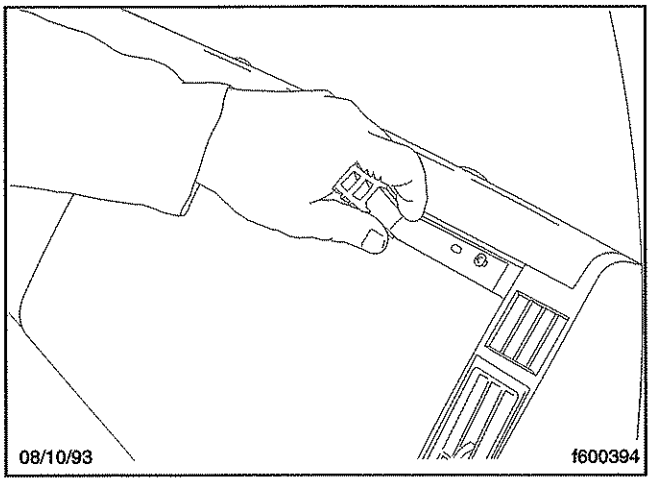
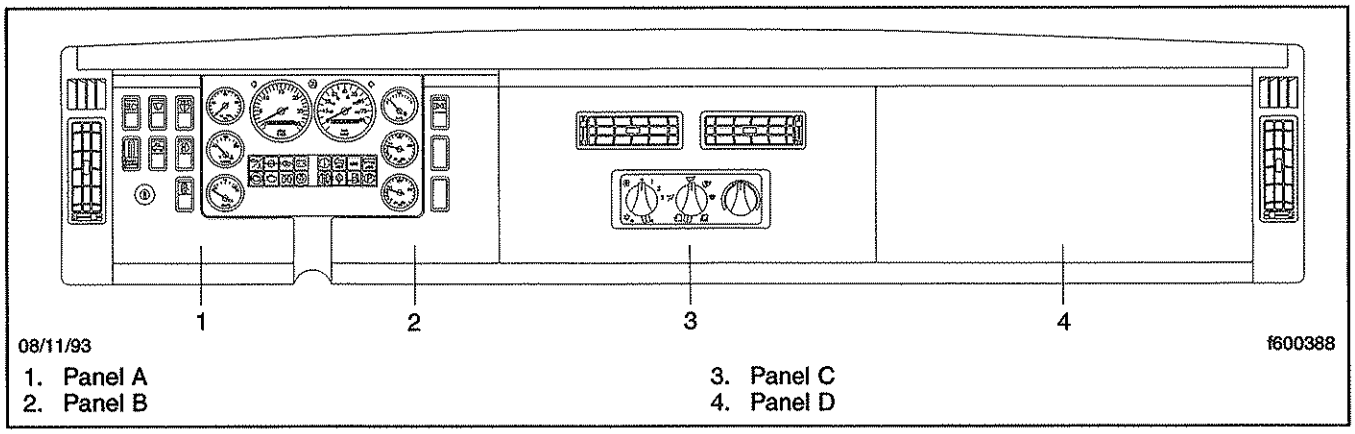


Fig. 1

4. Disconnect the 9-pin connector, the 4-pin connector, and the two buzzer wires from the back of the module. **See Fig. 4.**
5. Remove the two Torx head screws that attach the module to the mounting bracket, then remove the mounting bracket.
6. Remove and save the two clips from the ears of the module. **Refer to Fig. 5.**

Installation

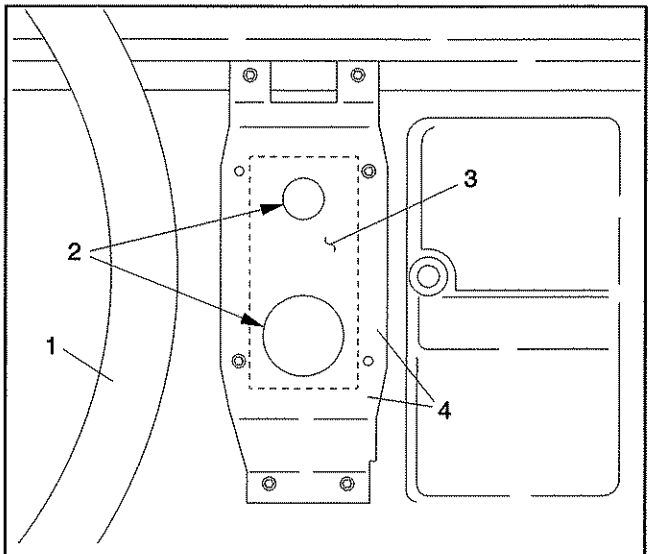
1. Install the two clips on the ears of the control module, then install the control module on the mounting bracket.
2. Connect the two buzzer wires to the posts on the back of the control module (it doesn't matter which wire goes to which post), then connect the 9-pin and the 4-pin connectors to the back of the control module. **See Fig. 4.**
3. Install the control module and mounting bracket assembly in the dash, using the four Torx head screws.
4. Connect any electrical wires (if present) to the back of dash panel B.
5. Swing dash panel C into place, and then install its mounting screws.
6. Install dash panels B and D.
7. Install the extruded rubber strip in the top of the dashboard.



1. Panel A
2. Panel B
3. Panel C
4. Panel D

Fig. 2

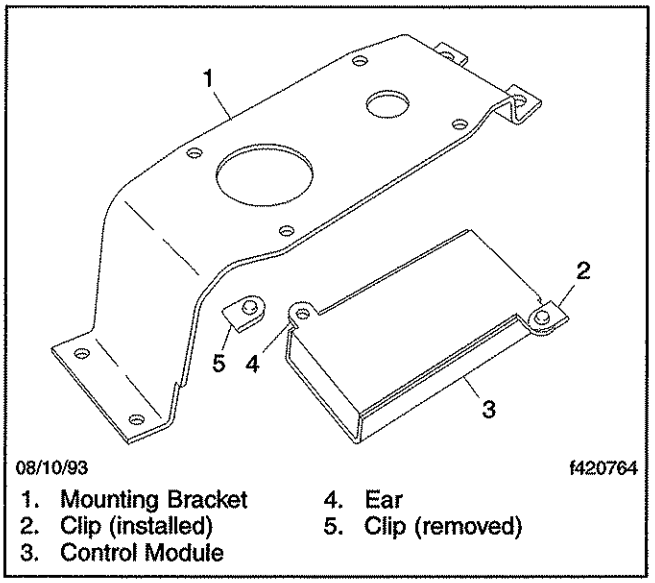
Hydraulic Brake Control Module Removal and Installation



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1. Steering Wheel
2. Holes
3. Control Module (mounted under bracket)
4. Mounting Bracket

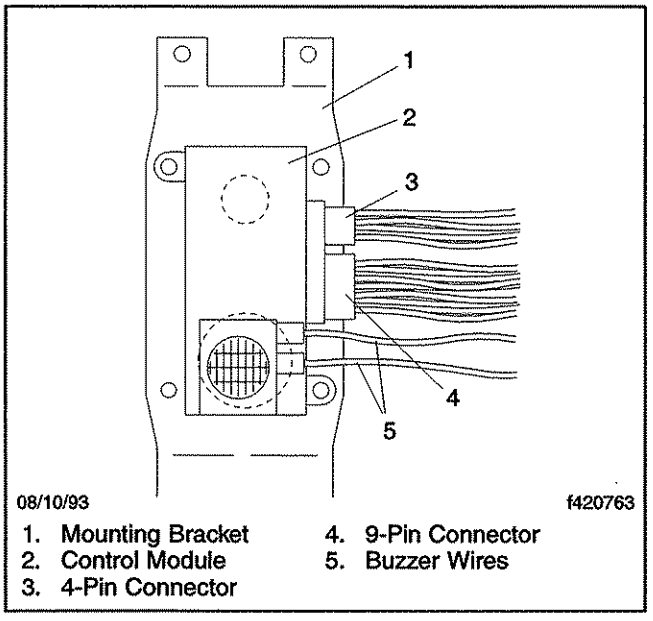
Fig. 3



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1. Mounting Bracket
2. Clip (installed)
3. Control Module
4. Ear
5. Clip (removed)

Fig. 5

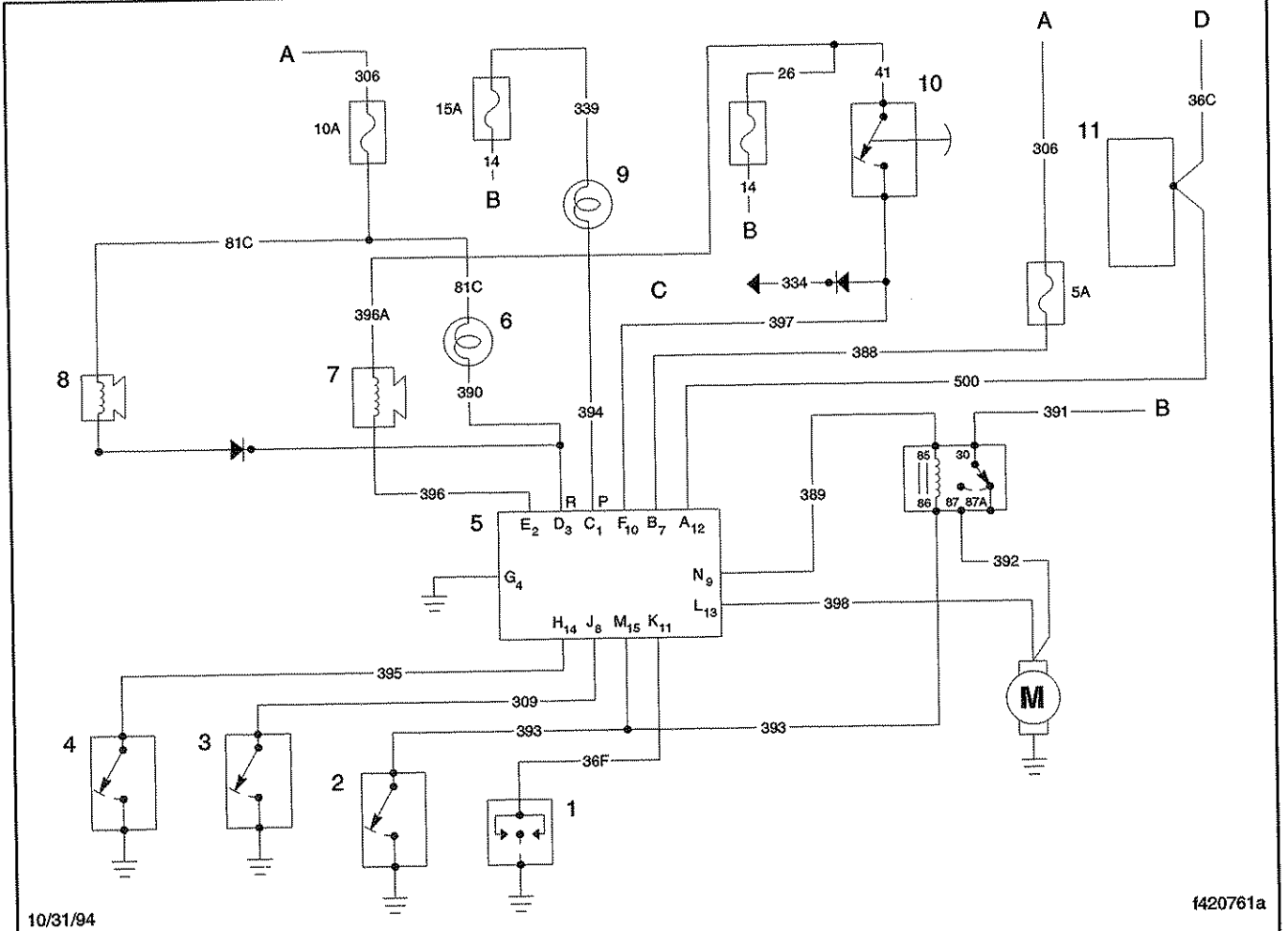


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1. Mounting Bracket
2. Control Module
3. 4-Pin Connector
4. 9-Pin Connector
5. Buzzer Wires

Fig. 4

8. Connect the batteries.



NOTE: Key off, door closed.

A. To ignition switch.
B. To positive battery post.
C. To right-side door switch and dome lamp.
D. To stoplight switch relay.

1. Pressure Differential Switch
2. Flow Switch
3. Parking Brake Switch (Hydraulic)
4. Fluid Indicator Switch
5. Brake Control Module
6. Brake Pressure Indicator
7. Control Module Buzzer
8. Dash Buzzer
9. Parking Brake Indicator
10. Left-Side Door Switch
11. Turn Signal Switch

Fig. 2, Brake Control Module Wiring

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the safety precautions could result in personal injury.

Replacement (Refer to Fig. 1)

1. Chock the tires or hold the vehicle on a level surface by means other than the air brakes.
2. Drain the air system by opening both the primary and secondary reservoir drain cocks.
3. For later assembly reference, mark the three air lines connected to the valve. Disconnect the air lines from the valve.
4. Remove the two screws which hold the valve and the valve mounting bracket to the steering column. Remove the valve and the mounting bracket from the steering column.
5. Remove the three screws that attach the valve to the mounting bracket.
6. Install the mounting bracket on the new valve. Tighten the three screws firmly.
7. Position the mounting bracket and the valve on the steering column. Install and tighten the two mounting screws firmly.
8. Attach the air lines to the valve. Using two wrenches, tighten the lines firmly.
9. Do the operating and leakage test in **Subject 110.**

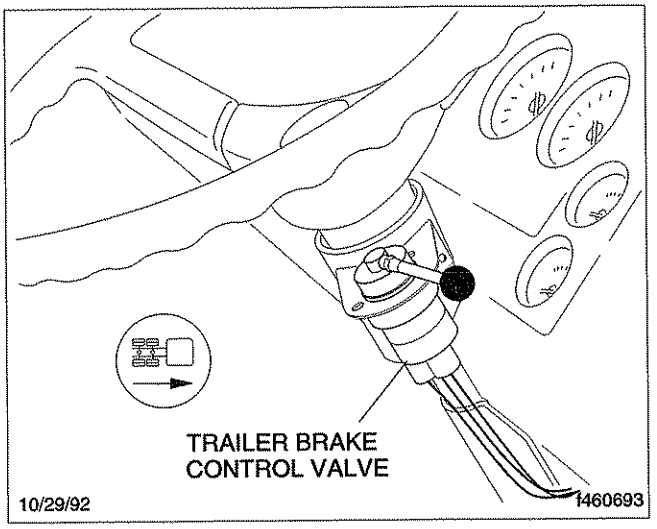


Fig. 1

Replacing Hydraulic Lines

POWER BOOSTER SYSTEM

The power booster is plumbed into the power steering system, and uses the same type of high pressure rubber hoses as that system.

The power booster has two hoses connected to it: one from the steering gear to the booster supply port, and one from the booster return port to the power steering reservoir. See **Fig. 1**.

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Replace the power booster hoses if they are leaking or show signs of cracking, softening, or bulging. Replace the entire hose if there are problems; don't repair it.
   - 2.1 Remove all hose clamps and tie straps used for routing the hose.
   - 2.2 Using a shop towel over the fittings to catch any power steering fluid, disconnect both ends of the hose being replaced.
   - 2.3 Install the new hose.

     If replacing the booster supply hose, tighten the supply port connection 22 lbf·ft (30 N·m), and the outlet connection on the power steering gear 41 lbf·ft (56 N·m).

     If replacing the booster return hose, tighten the hose clamps at the booster return fitting and the power steering reservoir firmly.
   - 2.4 Install the hose clamps and replace any tie straps removed above.

     Check the routing of the hose. Make sure it's away from heat sources and moving parts, such as the steering driveline.
3. Bleed the power booster system, following instructions in **Subject 115**.
4. Lower the hood, then remove the chocks.

SERVICE BRAKE SYSTEM

The service brake system has two types of hydraulic brake lines: rigid steel tubing and flexible rubber hose. See **Fig. 2**.

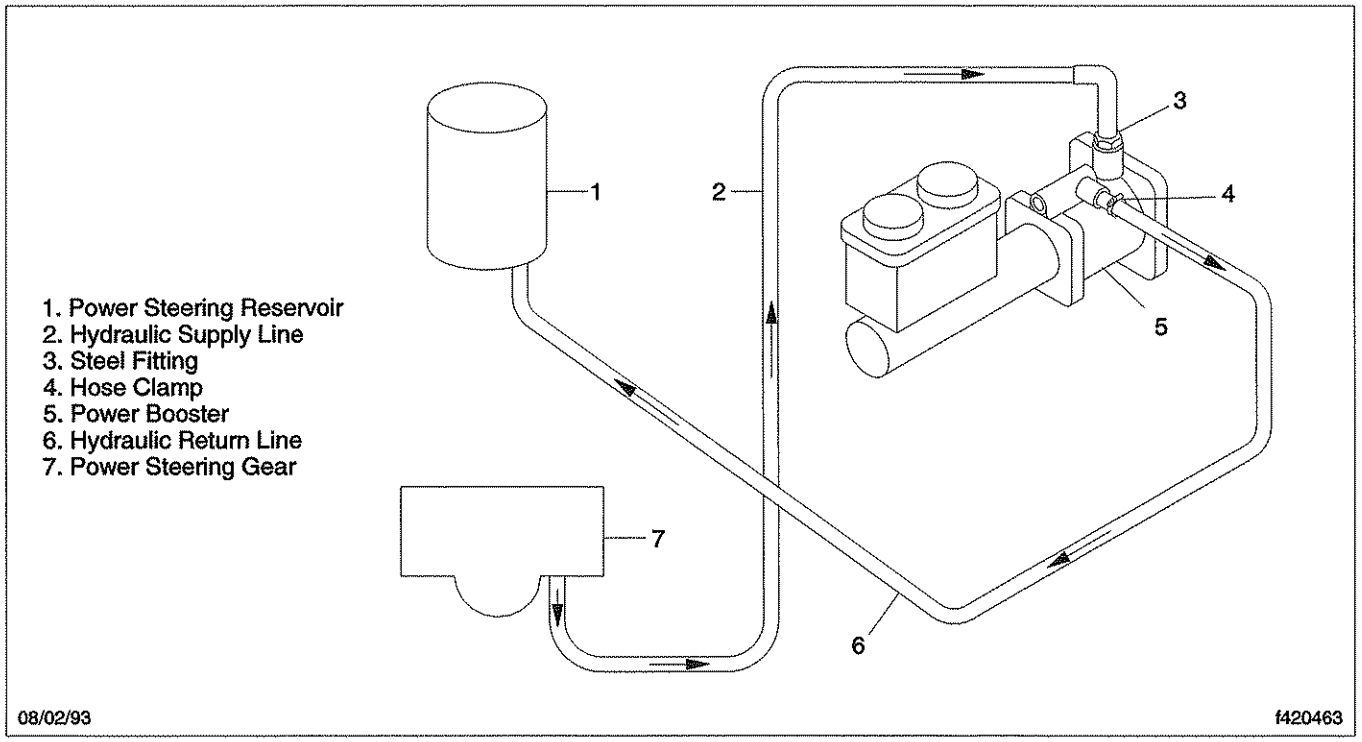


Fig. 1

Replacing Hydraulic Lines

The steel brake lines are 1/4-inch o.d. double-walled tubing, and run from the master cylinder to points on the chassis near each wheel. The rubber brake hoses are 1/8-inch i.d. low-expansion rubber; they connect the end of each rigid line to the caliper assembly at each wheel.

If a brake line is leaking, replace the whole section of line. Replace flexible brake hoses if they show signs of cracking, softening, or bulging.

1. Apply the parking brake and chock the tires.
2. Locate the leak in the brake line, then determine the length and configuration (if a steel line) of the section involved.
3. If necessary, loosen and remove any brackets holding the brake line to the frame or axle, so that you can remove the damaged section.

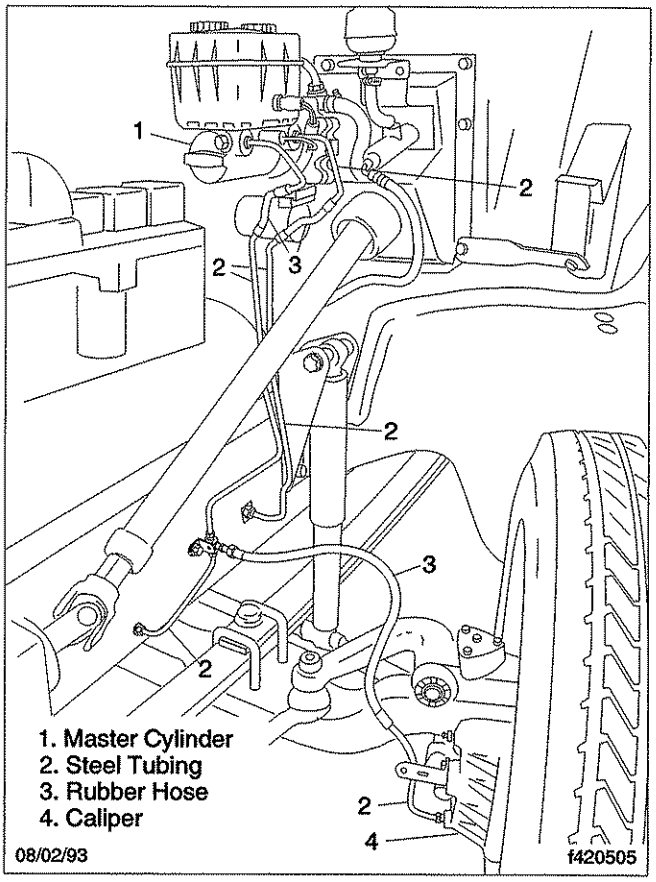


Fig. 2

4. Put a container under the connection on one side of the leak, then disconnect the line. Plug both ends of the connection.

   Repeat at the connection on the other side of the leak.
5. Remove the plugs installed earlier, then install the new section of brake line, and tighten the connections 15 lbf·ft (20 N·m).
6. Install any brackets that were removed above.
7. Bleed the brake system, following the procedure in **Subject 110**.

Brake Pad Replacement

Replacement

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

IMPORTANT: When replacing brake pads, always replace them on both wheels of the axle (right and left side). If the brake pad linings are worn down to the minimum thickness of 1.6 mm (1/16 inch), you must also rebuild the calipers, as dirt has probably gotten into the caliper cylinders. Refer to **"Brake Caliper Removal and Installation, 140"** and **"Brake Caliper Rebuild, 142"** for instructions.

1. Apply the parking brake and chock the tires of the axle you will not be working on.
2. Remove the brake caliper from the wheel. Refer to **"Brake Caliper Removal and Installation, 140"** for instructions.
3. Remove the brake pads.
   - 3.1 Remove the outboard brake pad from the caliper assembly.
   - 3.2 Pull the inboard pad away from the rotor and the anchor plate. **See Fig. 1.**
4. Using a wet rag that is wrung out until nearly dry, clean the caliper housing (especially around the piston boots), and the dust shield.
5. Check the rotor.
   - 5.1 Check the rotor surface for discoloration, cracks, scoring, and heat checking. **See Fig. 2.**

     If the rotor is cracked, has a bluish color, or has severe heat checking, replace it. If it has minor heat checking or is scored **(refer to Fig. 2),** have it resurfaced.

     IMPORTANT: If the rotor will be 33.5 mm (1.32 inches) or less after it's resurfaced, replace it.
   - 5.2 Using a vernier caliper, check the thickness of the rotor. If it is less than 33.5 mm (1.32 inches) thick, replace it.
   - 5.3 Check for runout and parallelism. Refer to **"Brake Rotor Runout and Parallelism Checking, 152"** for instructions.
6. Check the caliper.
   - 6.1 Check the piston dust boots for cracks or leaks. **See Fig. 3.** Also check the piston heat shields for damage. If a problem is found, disconnect the brake hose from the caliper, plug the hose, then rebuild the caliper, following the instructions under **"Brake Caliper Rebuild, 142."**
   - 6.2 Check the supply port and bleeder fitting **(Fig. 4)** on the caliper housing for damage or leaks. If a problem is found, replace the fitting, following the instructions under **"Brake Caliper Rebuild, 142."**
7. Clean and lubricate the sliding surfaces (V-ways) of the caliper housing and the anchor plate rails with anti-corrosion grease. **See Fig. 5.**
   - 7.1 Using a fine file or emery cloth, clean the sliding surfaces (V-ways) of the caliper housing, and the corresponding surfaces of the anchor plate.

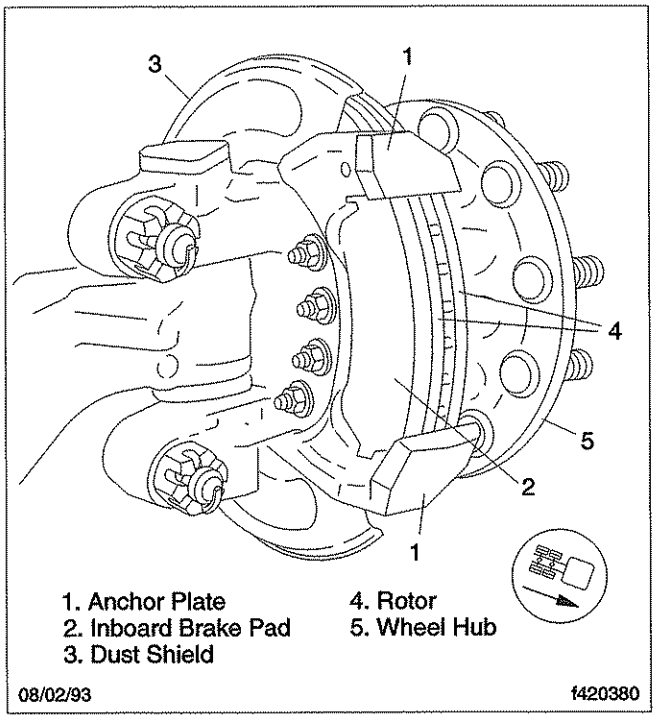


Fig. 1, Left Front Wheel Shown; Caliper Removed

Brake Pad Replacement

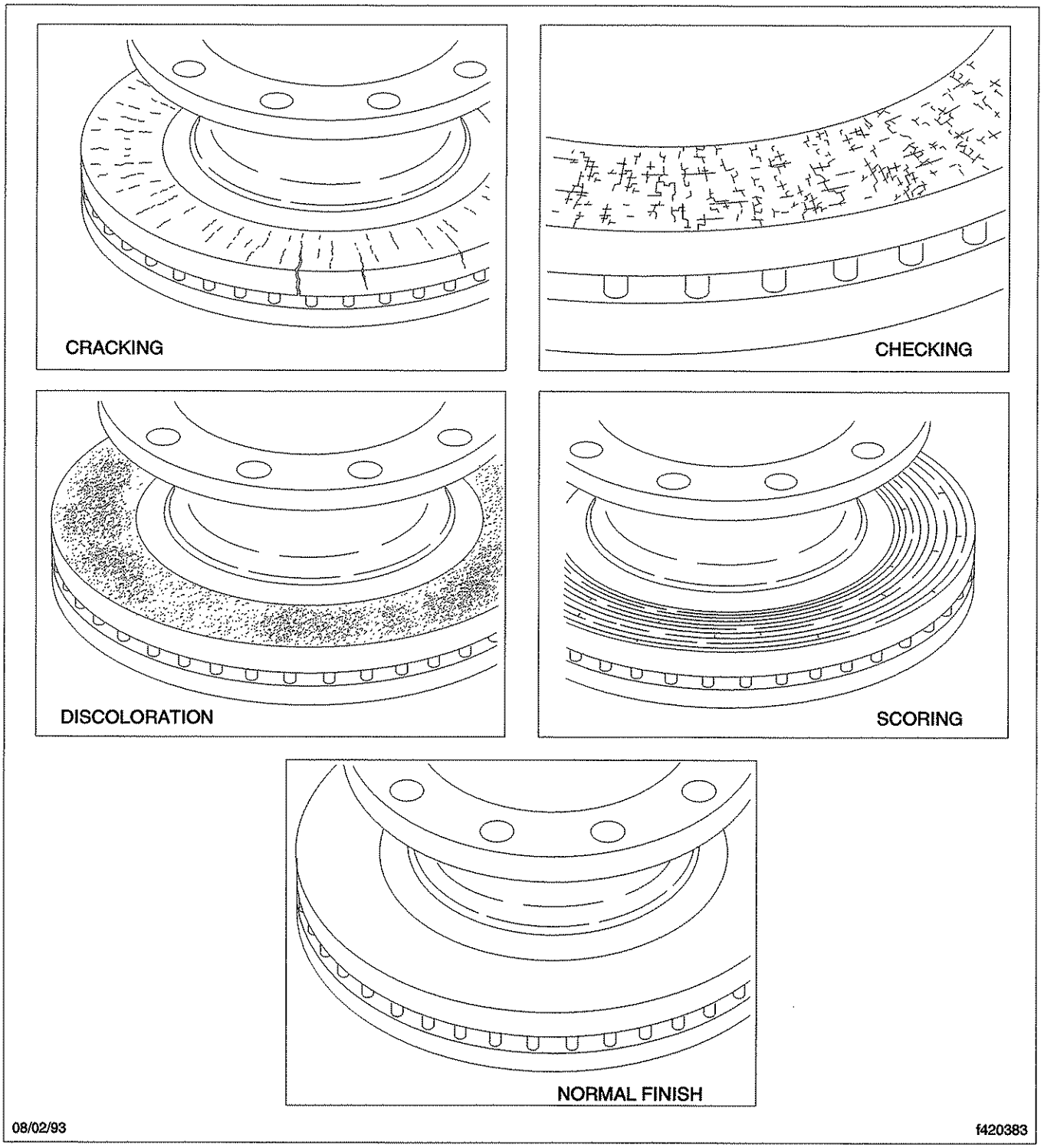
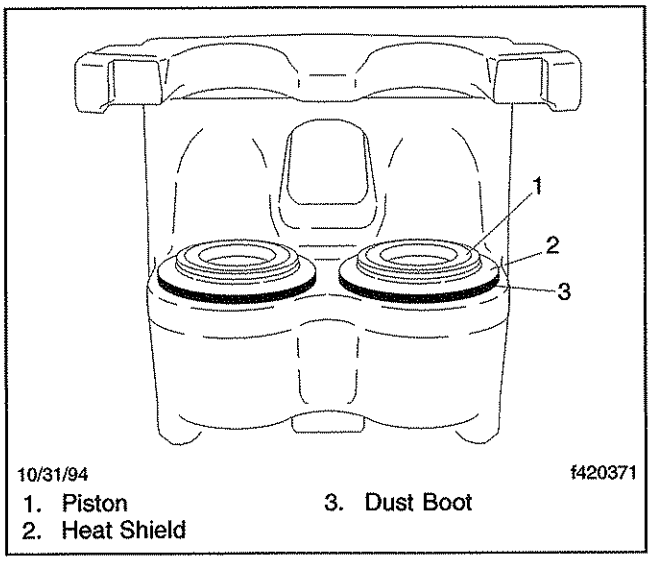


Fig. 2

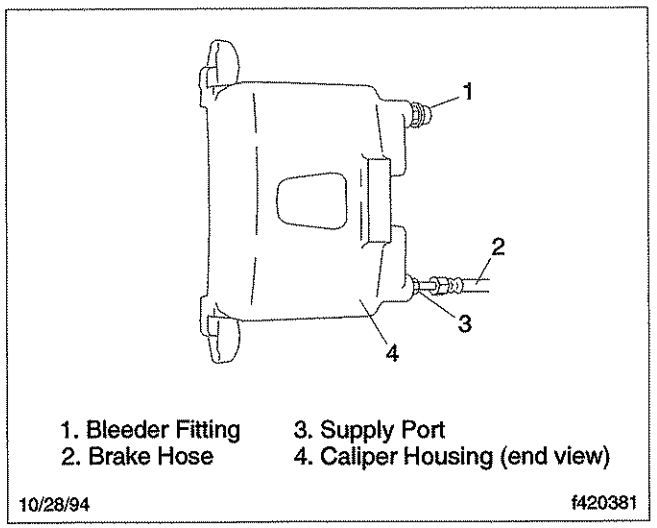
Brake Pad Replacement



10/31/94 f420371

1. Piston
2. Heat Shield
3. Dust Boot

Fig. 3



1. Bleeder Fitting
2. Brake Hose
3. Supply Port
4. Caliper Housing (end view)

10/28/94 f420381

Fig. 4

7.2 Grease the surfaces lightly with anti-corrosion grease.

8. Install the new brake pads.

⚠ WARNING

WARNING: Don't get any dirt, oil, grease, or brake fluid on the brake lining material or the rotor surfaces. To do so could cause loss of brake control, which could result in an accident causing personal injury or property damage.

8.1 Install the inboard (smaller) brake pad into the mating notches of the anchor plate, **as shown in Fig. 1.** Make sure the pad lining is facing the rotor.

8.2 Using a piece of wood and a C-clamp, push the pistons all the way into the caliper housing. **See Fig. 6.** Be careful not to damage the piston heat shields. Remove the C-clamp and block of wood.

8.3 Install the outboard (larger) brake pad in the housing, with the pad lining facing the piston, **as shown in Fig. 7.**

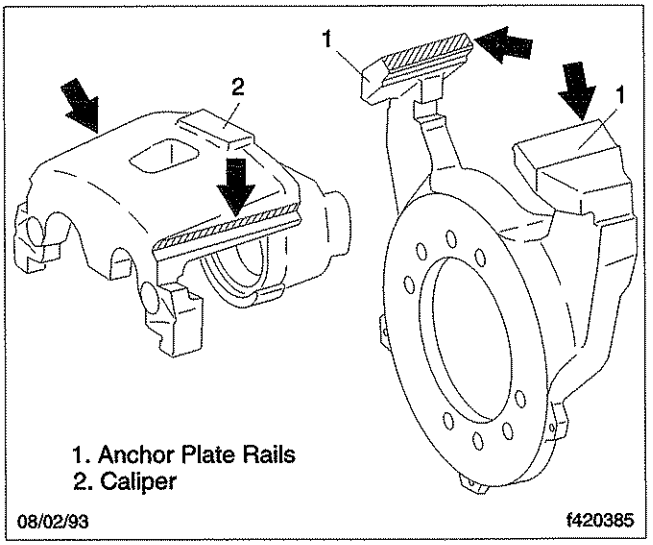
9. Install the caliper, following the instructions under **"Brake Caliper Removal and Installation, 140."**

10. Install the tires, then remove the jackstands and lower the vehicle. Remove the chocks.

11. Pump the brake pedal until it feels firm. If it doesn't get firm, check for leaks or air in the brake system. Repair any leaks, if needed, then bleed the system, following the instructions under **"Hydraulic System Bleeding, 110."**

⚠ WARNING

WARNING: Do not move the vehicle until the brake pedal feels firm. To do otherwise could result



1. Anchor Plate Rails
2. Caliper

08/02/93 f420385

Fig. 5

Brake Pad Replacement

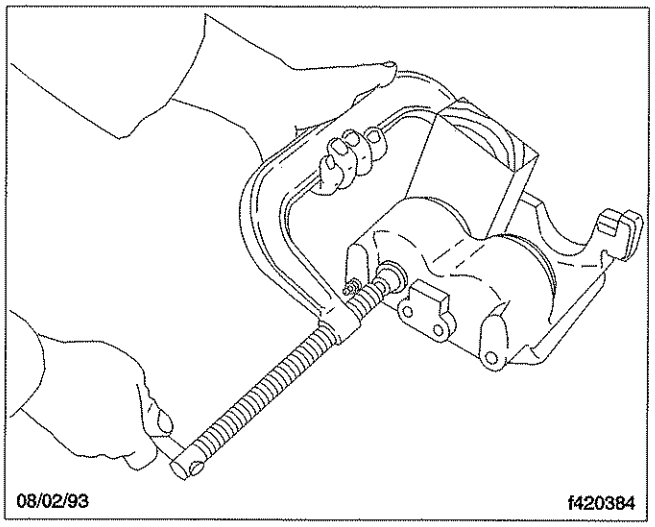
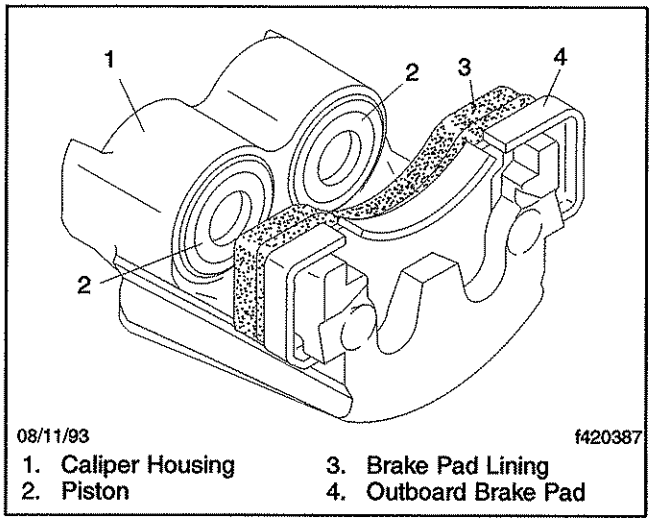


Fig. 6



1. Caliper Housing
2. Piston
3. Brake Pad Lining
4. Outboard Brake Pad

Fig. 7

in loss of vehicle control, causing an accident resulting in personal injury or property damage.

12. Road test the vehicle, and seat the brake pads.

    Accelerate the vehicle to 30 mph (48 km/h), then brake to a stop, using medium brake pedal pressure. *Do not slam on the brakes.*

    Repeat this step between 20 and 30 times, allowing a one-minute interval between brake applications.

Brake Caliper Removal and Installation

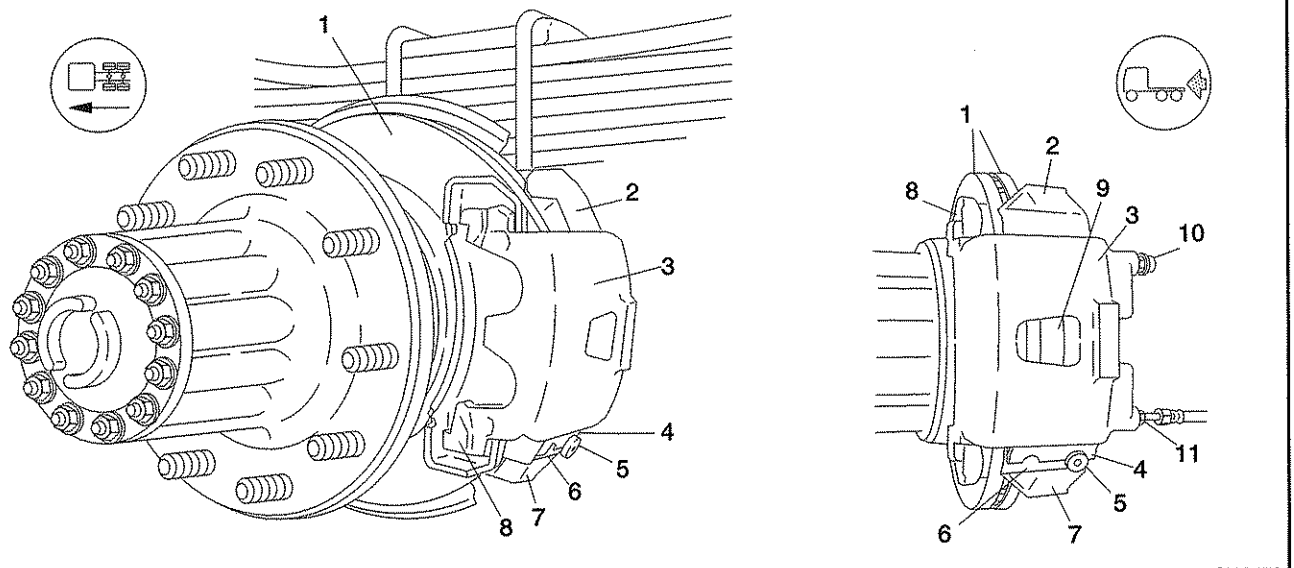
Removal

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Apply the parking brake, chock the tires, and tilt the hood.
2. If you are removing the rear wheel caliper(s), remove half the fluid from the rear section of the master cylinder reservoir. If you are removing the front wheel caliper(s), remove half the fluid from the front section.
3. Chock the front or rear tires, depending on which axle you are working on. Then jack up the axle, and support it with jackstands.
4. Remove the tires.
5. Remove the brake caliper.
   - 5.1 If you are going to do work on the caliper, disconnect and plug the brake supply hose; otherwise, leave it attached.
   - 5.2 Remove the allen-head bolt that holds the key and spring assembly in place (on the upper anchor plate rail for the front wheel; on the lower rail for the rear wheel). **See Fig. 1.**
   - 5.3 Using a punch, drive out the key and spring from between the caliper and the anchor plate rail, **as shown in Fig. 2.** Save the parts.
   - 5.4 Tilt the caliper up so the outboard brake pad clears the rotor, then slide the caliper off the anchor plate rails. **See Fig. 3.** Be careful not to stretch the brake hose.

     The inboard brake pad will stay in place between the upper and lower rails of the anchor plate.

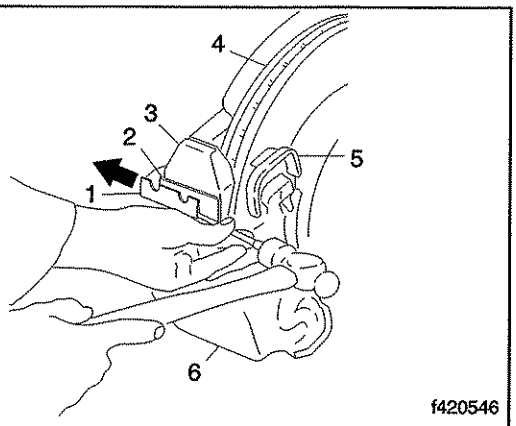


08/11/93 f420478

1. Rotor
2. Upper Anchor Plate Rail
3. Caliper Housing
4. Key
5. Allen-Head Bolt
6. Spring
7. Lower Anchor Plate Rail
8. Outboard Brake Pad
9. Inspection Hole
10. Bleeder Fitting
11. Supply Port

Fig. 1, Rear Caliper Shown

Brake Caliper Removal and Installation



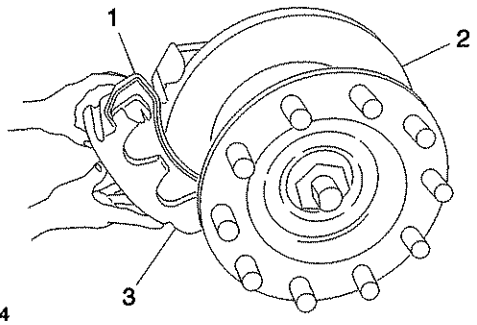
1. Key
2. Spring
3. Upper Rail of Anchor Plate
4. Rotor
5. Outboard Brake Pad
6. Caliper Housing

Fig. 2, Front Caliper Shown

5.5 If the brake supply hose is attached, support the caliper with a wire, or rest it on the axle suspension. *Don't let the caliper hang by its brake hose.*

6. Remove the outboard brake pad from the caliper housing.

7. Remove the inboard brake pad from the anchor plate. **See Fig. 4.**



1. Outboard Brake Pad
2. Rotor
3. Caliper

Fig. 3

Installation

1. Check the brake pad linings for wear and damage.

   1.1 Check the linings for wear. If they are 1.6 mm (1/16 inch) or less thick, replace the brake pads, following the instructions under **Subject 130.**

   1.2 Check the linings for pits, cracks (**see Fig. 5**), separation of the material (delaminating), or other damage. Replace the brake pads if they are damaged.

   1.3 Check the linings for glazing. If they are glazed but not otherwise damaged, deglaze the linings, using deglazing compound. Follow the manufacturer's directions.

2. Check the caliper.

   2.1 Check the piston dust boots for damage or leaks. **See Fig. 6.** If a problem is found, rebuild the caliper, following the instructions under **Subject 142.**

   2.2 Check the bleeder fitting for leaks or damage. If there are signs of leakage, check the tightness of the fitting. If the fitting is damaged, replace it. Refer to **Subject 142** for instructions.

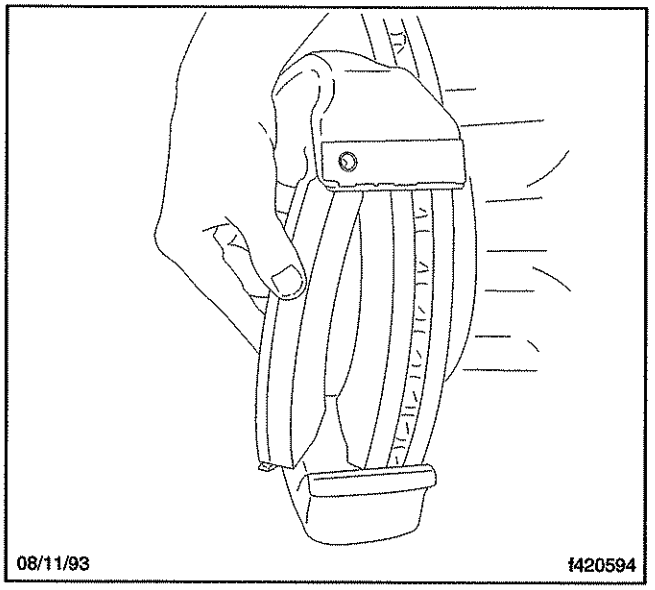
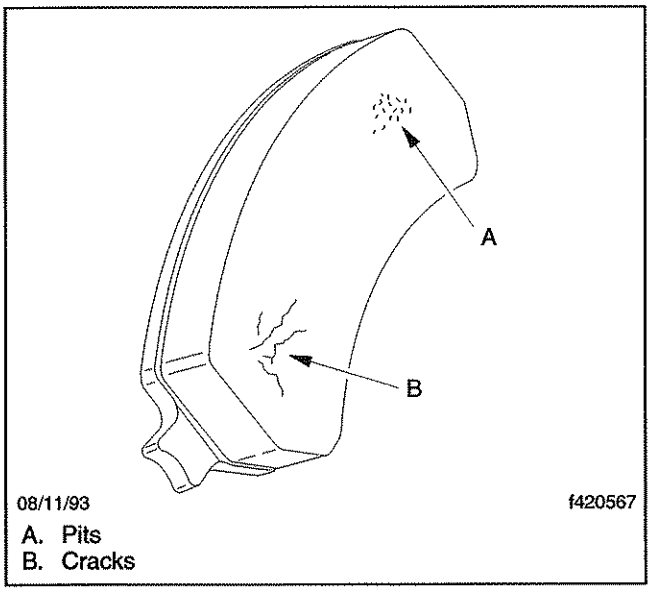


Fig. 4

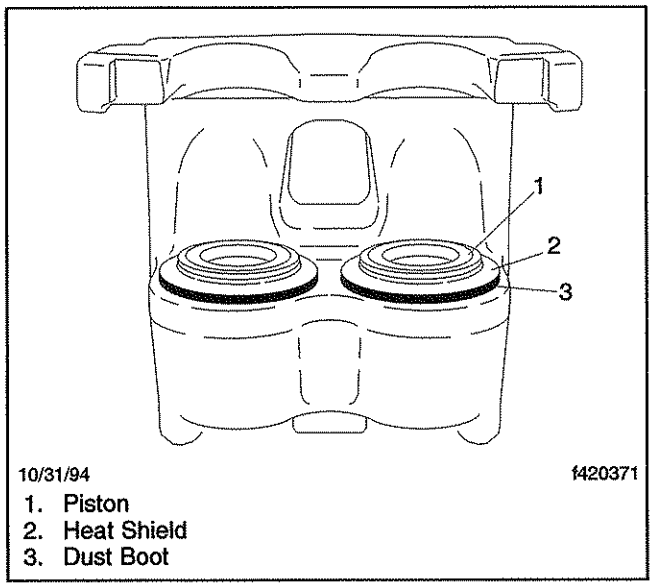
Brake Caliper Removal and Installation



08/11/93 f420567

A. Pits
B. Cracks

Fig. 5



10/31/94 f420371

1. Piston
2. Heat Shield
3. Dust Boot

Fig. 6

3. Check the rotor, following the instructions under **Subject 130.**

4. Clean and lightly lubricate the sliding surfaces (V-ways) of the caliper housing and the anchor plate rails with Aeroshell Grade 5 (ES-1246) grease (don't use any type of anti-seize compound, such as Never-Seeze). **See Fig. 7.**

   4.1 Using a fine file or emery cloth, clean the sliding surfaces (V-ways) of the caliper housing, and the corresponding surfaces of the anchor plate rails.

   4.2 Grease the surfaces lightly with Aeroshell Grade 5 (ES-1246) grease (don't use any type of anti-seize compound, such as Never-Seeze).

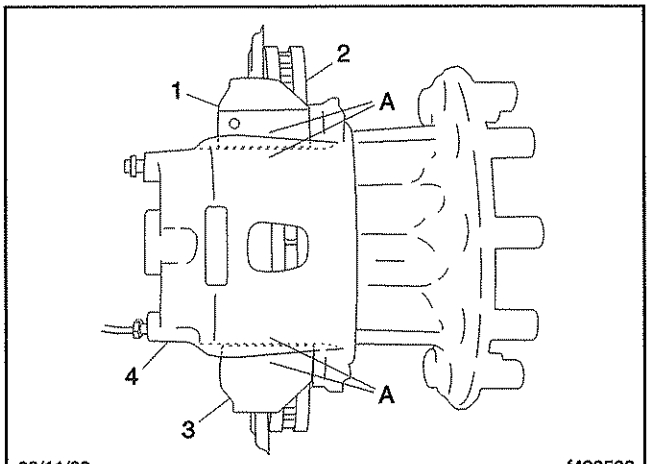
5. Install the inboard (smaller) brake pad between the upper and lower rails of the anchor plate. Make sure the lining material is facing the rotor.

6. Install the caliper.

   6.1 Using a piece of wood and a C-clamp, push the pistons all the way into the caliper housing. **See Fig. 8.** Be careful not to damage the piston heat shields (**Fig. 6,** Ref. 2).

   6.2 Install the outboard (larger) brake pad in the housing, with the pad lining facing the piston, **as shown in Fig. 9.**

   6.3 Tilt the caliper housing so that the outboard brake pad will fit over the rotor, then push the caliper down onto the anchor plate rails. **See Fig. 10.**



08/11/93 f420599

A. V-ways
1. Upper Rail of Anchor Plate
2. Rotor
3. Lower Rail of Anchor Plate
4. Caliper Housing

Fig. 7

Brake Caliper Removal and Installation

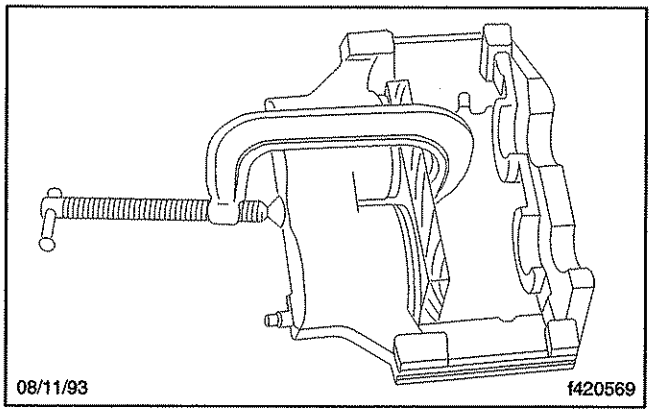
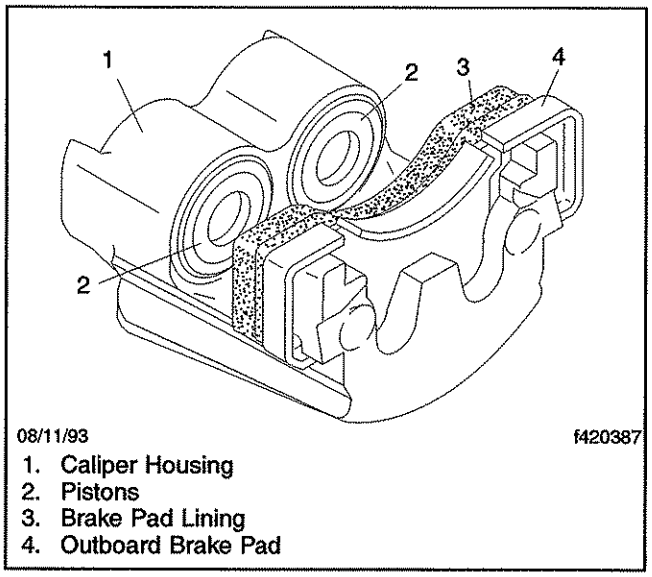


Fig. 8



1. Caliper Housing
2. Pistons
3. Brake Pad Lining
4. Outboard Brake Pad

Fig. 9

IMPORTANT: 2.88-inch calipers have pads that are chamfered on one end. Depending on mounting location (steer axle or rear axle), make sure that the 2.88-inch calipers are installed **as shown in Fig. 11.**

6.4 Assemble the spring and key **as shown in Fig. 12,** then install them between the caliper housing and the anchor plate rail (the upper rail for front wheel calipers, or the lower rail for rear wheel calipers).

6.5 Drive the key and spring into place, using a punch and mallet. **See Fig. 13.** Make sure the notch in the key lines up with the hole in the anchor plate rail.

6.6 Install the allen-head bolt, and tighten it 20 N·m (15 lbf·ft).

7. If the brake supply hose was disconnected, connect it; otherwise go to the next step and check the fluid level.

   7.1 Tighten the brake supply hose fitting 20 N·m (15 lbf·ft).

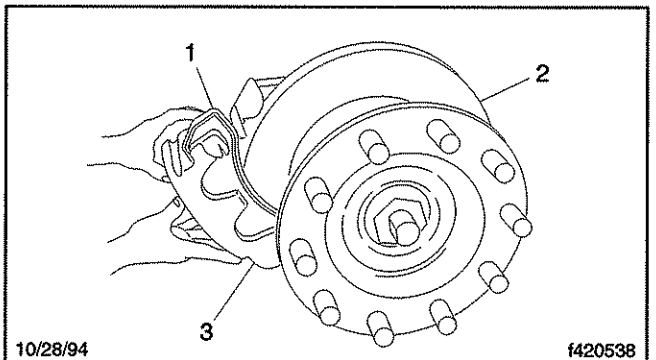
   7.2 Bleed the brake supply line to the caliper, following the instructions under **Subject 110.** If you have removed more than one brake caliper, bleed the entire brake system.

8. Check the fluid level in the master cylinder reservoir, and add the necessary amount of new DOT 3 approved brake fluid.

9. Seat the brake pads by pressing firmly on the brake pedal several times.

   If new brake pads were installed, seat them following the instructions under **Subject 130.**

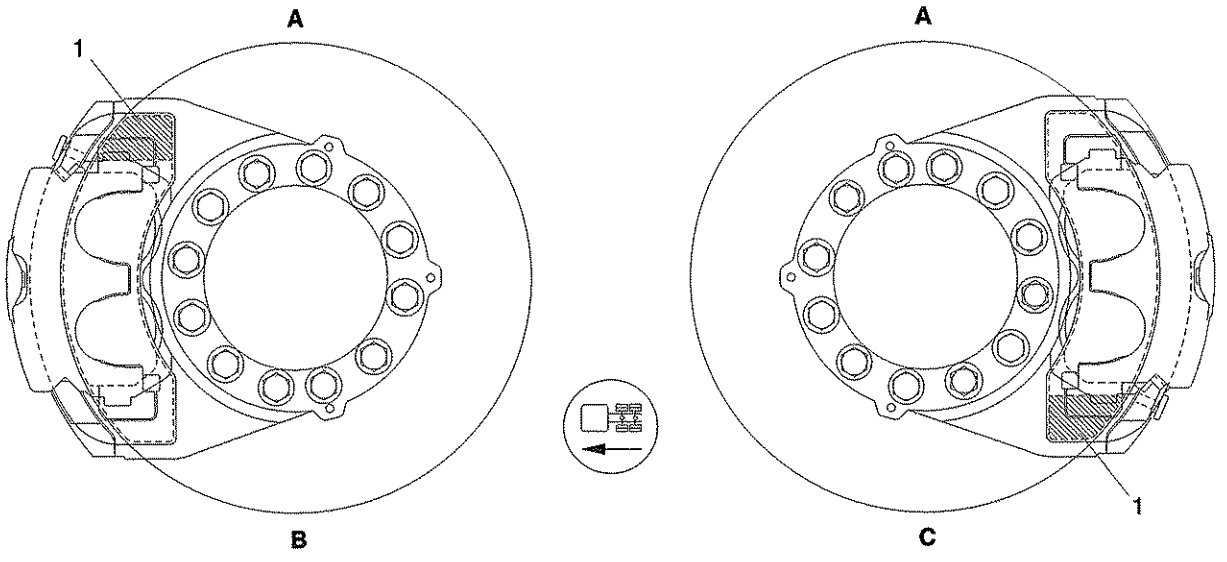
10. Lower the hood, then remove the chocks.



1. Outboard Brake Pad
2. Rotor
3. Caliper

Fig. 10

Brake Caliper Removal and Installation



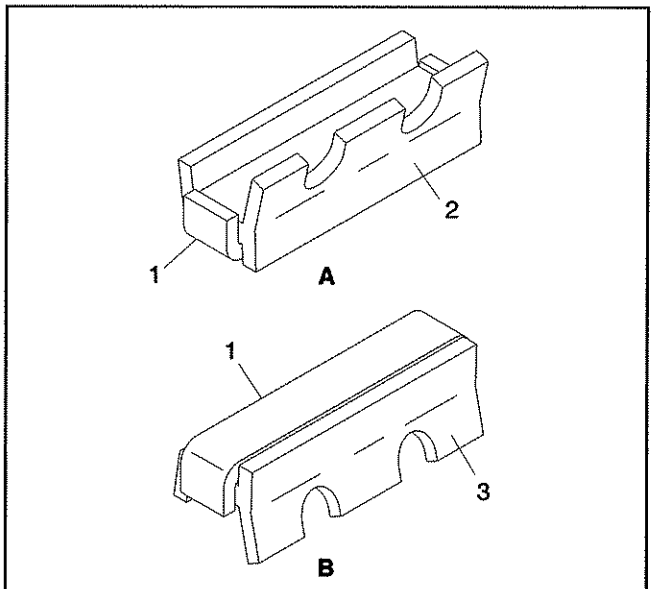
08/11/93 f420946

NOTE: Left-side mountings shown.

A. Top
B. Front Steer Axle Installation
C. Rear Axle Installation
1. Chamfer

Fig. 11

Brake Caliper Removal and Installation

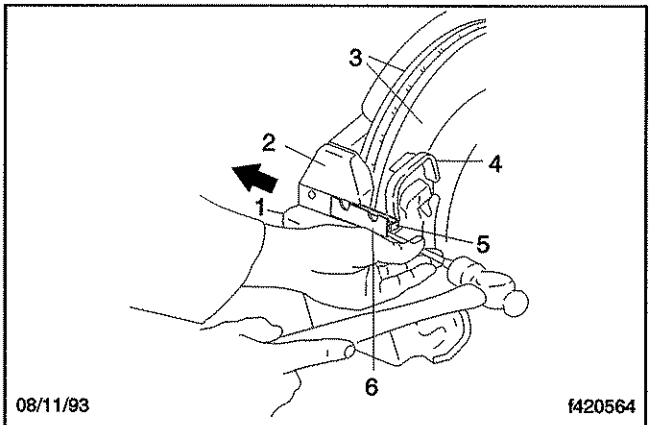


08/11/93 f420551

A. Front Caliper
B. Rear Caliper

1. Spring
2. Key (notches up)
3. Key (notches down)

Fig. 12



08/11/93 f420564

1. Caliper
2. Upper Rail of the Mounting Bracket
3. Rotor
4. Outboard Brake Pad
5. Spring
6. Key

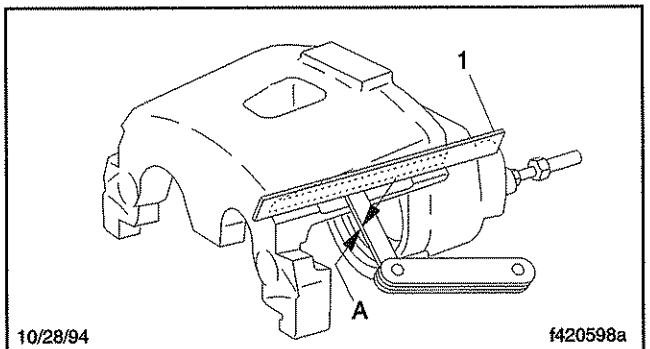
Fig. 13

Rebuild

⚠ WARNING

WARNING: Before starting the procedure below, read the information in Safety Precautions, 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Apply the parking brake, then chock the tires of the axle(s) you are not working on.
2. Remove the tire.
3. Clean the outside of the caliper housing, using a damp rag.
4. Remove the caliper from the wheel, following the instructions under **Subject 140.**
5. Drain any remaining brake fluid from the caliper housing. Discard the fluid.
6. Measure the wear depth of both caliper V-ways.
   - 6.1 Using a wire brush, clean the V-way surfaces of the caliper housing. File smooth any deep nicks or gouges.
   - 6.2 Lay the caliper housing on a bench, then put a straight edge on a V-way surface, as shown in **Fig. 1.**
   - 6.3 Using a feeler gauge, measure the gap between the V-way surface and the straight edge. **See Fig. 1.** Record the measurement.



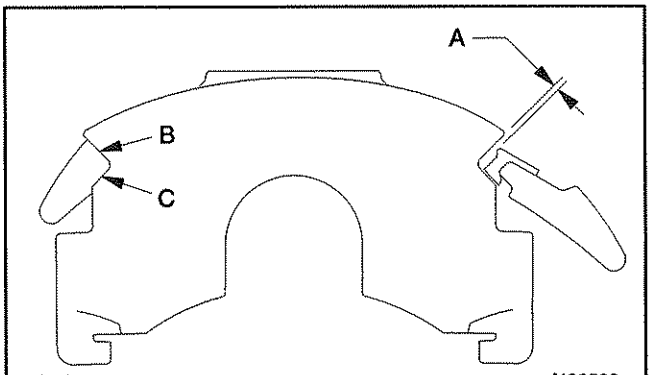
A. 1.27 mm (0.05 in)
1. Straightedge

Fig. 1

Repeat this measurement for all the V-way surfaces. If any measurement is 1.27 mm (0.05 inch) or more, replace the caliper housing; otherwise, go to the step for checking caliper-to-anchor plate looseness.

7. Check for caliper-to-anchor plate looseness.
   - 7.1 Install the caliper on the rotor.
   - 7.2 Install a new key and the existing allen head bolt, but don't install the spring.
   - 7.3 Put a screwdriver in the gap (bumper gap) between the key and the V-way of the caliper. Pry up to seat the caliper against the sliding surfaces B and C, as shown in **Fig. 2.**
   - 7.4 Using a feeler gauge, measure the bumper gap (the distance between the key and the caliper V-way). **See Fig. 2.**
   - 7.5 If the bumper gap is more than 3.68 mm (0.145 inch), replace the caliper, and repeat steps checking caliper-to-anchor plate looseness. If the bumper gap is more than 3.68 mm (0.145 inch) with the new caliper installed, replace the anchor plate.

     If the bumper gap is 3.68 mm (0.145 inch) or less, check **Table 1** for the correct size wear shim to install on the anchor plate. Then remove the caliper from the rotor, and go to the step for removing the pistons from the caliper housing.



A. 3.68 mm (0.145 inch)

Fig. 2

Brake Caliper Rebuild

Bumper Gap mm (inch)		Shim Thickness
More than	But Not Over	
0	1.47 (0.058)	None needed
1.47 (0.058)	2.57 (0.101)	0.025
2.57 (0.101)	3.68 (0.145)	0.045
3.68 (0.145)	—	Replace the caliper

Table 1, Bumper Gap Sizes

8. Remove the pistons from the caliper housing.

8.1 Connect a compressed air line with a control nozzle to the supply port of the caliper housing. **See Fig. 3.**

8.2 Put a padded block of wood up against the outboard legs of the caliper, opposite the pistons, as shown in **Fig. 4.**

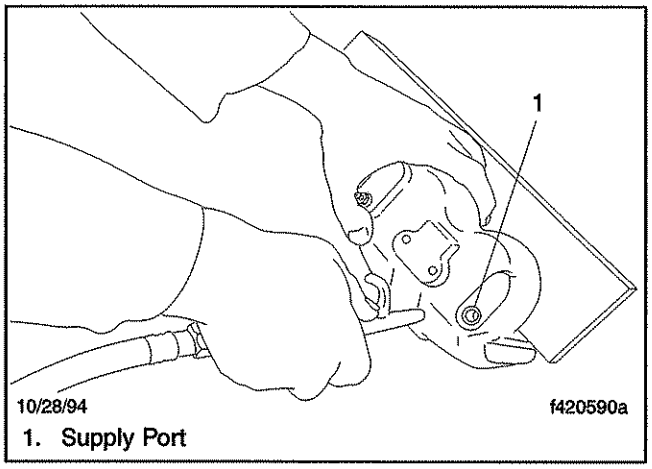
⚠ WARNING

WARNING: Be careful when using compressed air to remove the caliper pistons from their cylinders. Keep your hands away from the front of the pistons. Use only enough air pressure to ease out the pistons, or they may fly out forcibly, which could cause personal injury, or damage the pistons.

8.3 Slowly release compressed air, and ease the pistons out of the cylinders until they are up against the wooden block. Don't pop the pistons out.

8.4 Using tin snips, cut both piston heat shields **(Fig. 5),** then remove them from the pistons.

8.5 Pry the dust boot of one of the pistons from its seat in the cylinder, then do the same for the other dust boot. Remove and discard both dust boots.



1. Supply Port

Fig. 3

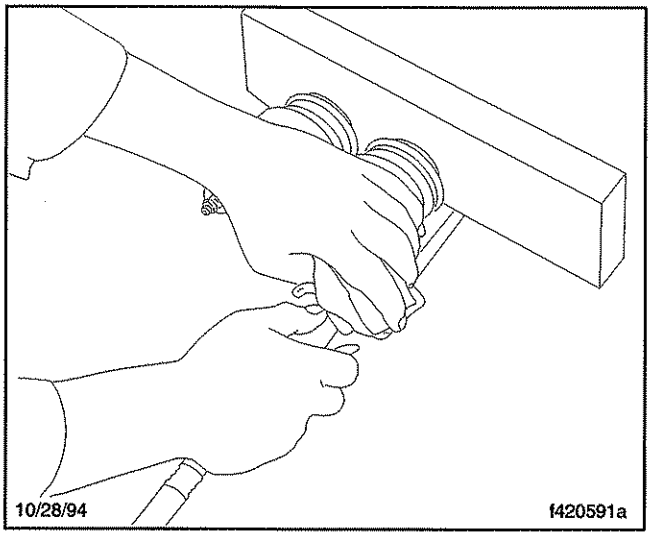
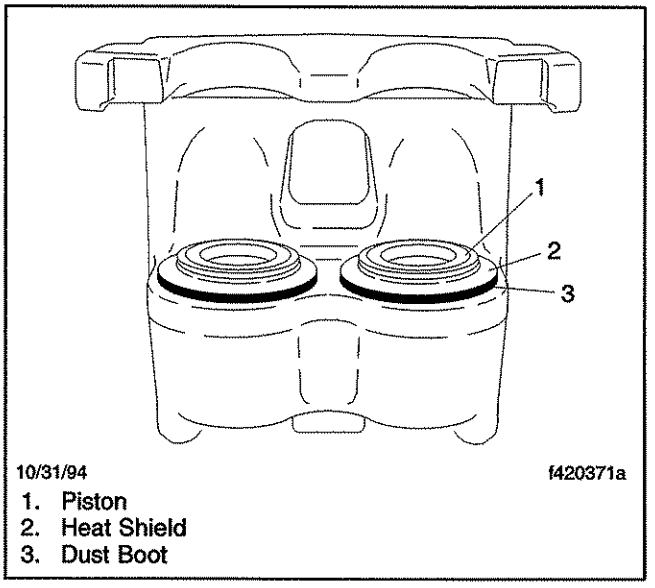


Fig. 4



1. Piston
2. Heat Shield
3. Dust Boot

Fig. 5

8.6 Remove both pistons from their cylinders. **See Fig. 6.**

8.7 Remove the piston seal **(Fig. 7)** from inside each cylinder.

9. Using denatured alcohol, clean the pistons and the caliper housing. Clean both the outside of the caliper and the piston cylinders. Blow dry all the parts with compressed air.

10. Check the outside of the pistons for pitting, scoring, corrosion, or damage. If any problem is found, replace the piston.

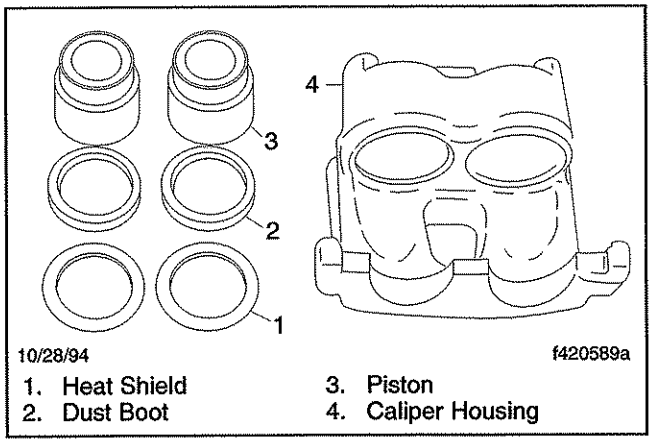
11. Check the caliper seal grooves and dust boot seats for pitting. **See Fig. 8.** If pitting is found, replace the caliper housing. Clean any corrosion from the area between the seal groove and dust boot seat.

12. Check the bleeder fitting **(Fig. 9)** for damage or wear. If a problem is found, replace the fitting.

13. Install new piston seals.

    IMPORTANT: Two different types of brake calipers are used on Freightliner vehicles: calipers with 2.6 inch-diameter pistons, and those with 2.88 inch-diameter pistons. Make sure you use the right seals, dust boots, and heat shields, for the type of caliper you are rebuilding.

    To determine the type of caliper, check the inspection hole on the rear of the caliper housing. If it's large, the pistons are 2.6 inches in diameter; if the hole is small, they are 2.88 inches. **See Fig. 10.**



1. Heat Shield
2. Dust Boot
3. Piston
4. Caliper Housing

Fig. 6

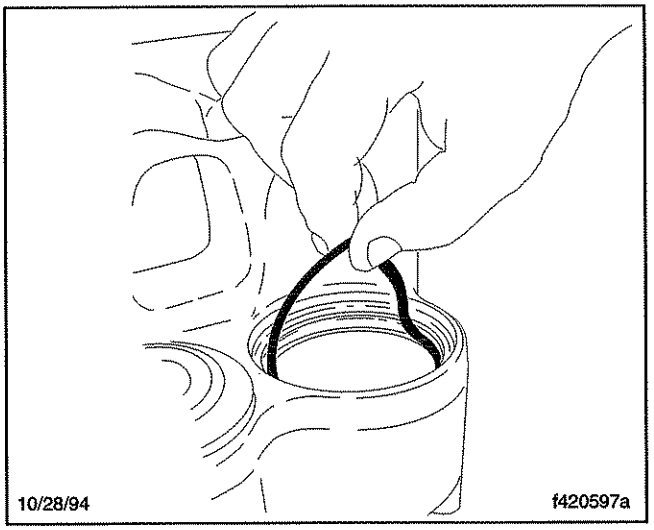


Fig. 7

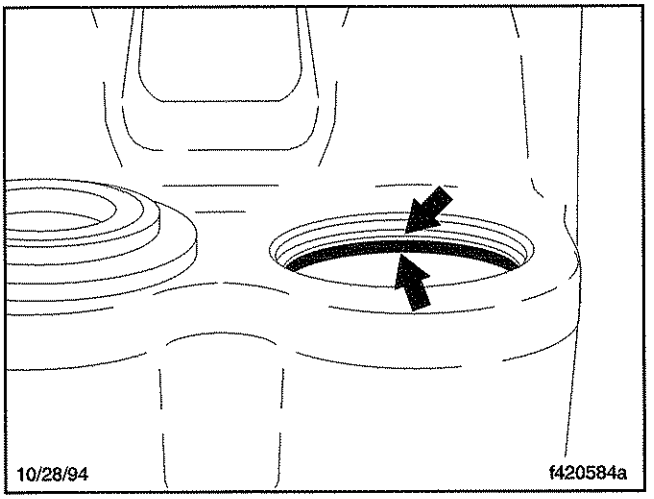
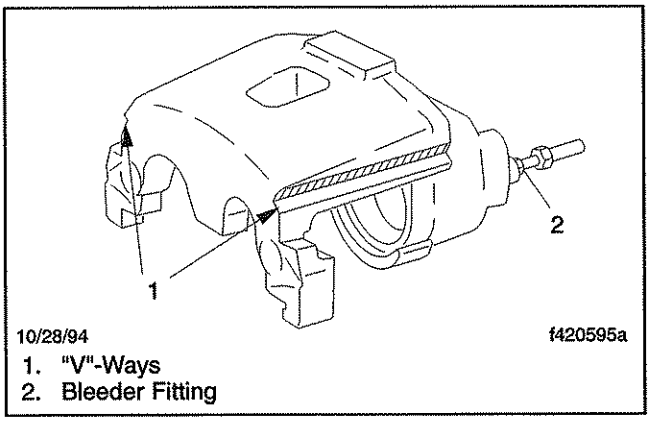


Fig. 8



1. "V"-Ways
2. Bleeder Fitting

Fig. 9

Brake Caliper Rebuild

13.1 Coat a new piston seal with new, clean brake fluid **See Fig. 11.**

13.2 Install a new piston seal in each of the cylinders. Make sure the seal is not twisted.

14. Install new dust boots on the pistons, as shown in **Fig. 12.**

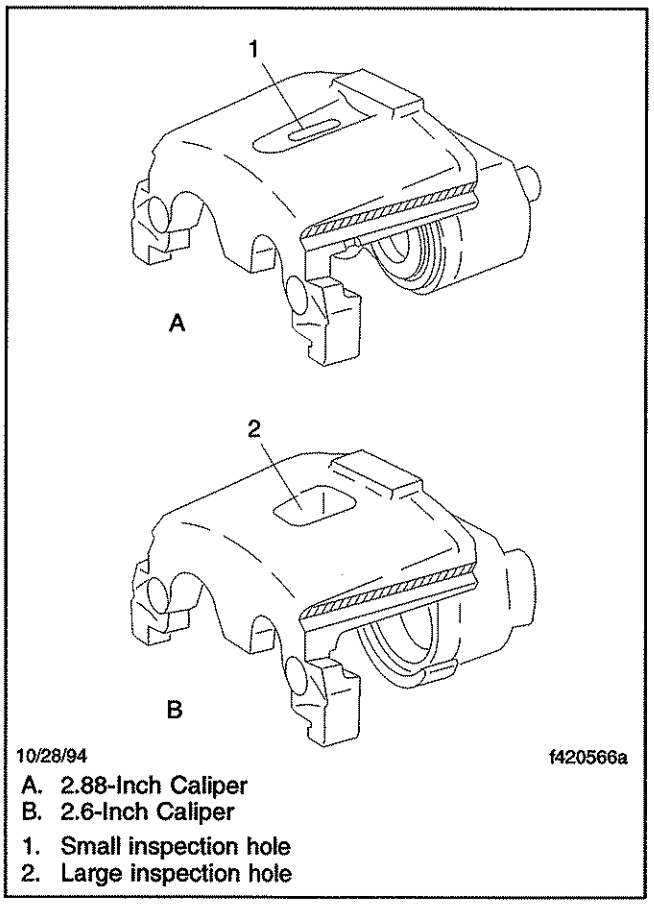
15. Install the pistons.

15.1 Coat the bottom half (closed end) of one of the pistons with new brake fluid. *Don't get any brake fluid on the dust boot.*

15.2 Place the bottom (closed end) of the piston into its cylinder, making sure it is perfectly straight. **See Fig. 13.**

IMPORTANT: Make sure the piston is lined up in the cylinder perfectly straight before you install it; otherwise it will bind. If the piston binds in the cylinder, it will be impossible to install, and very difficult to remove.

15.3 Put a piece of thick metal or a block of wood over the top (open end) of the piston. Then, using a C-clamp, push the piston all the way into the cylinder until it bottoms out. **See Fig. 14.** Be careful not to damage the



A. 2.88-Inch Caliper
B. 2.6-Inch Caliper
1. Small inspection hole
2. Large inspection hole

Fig. 10

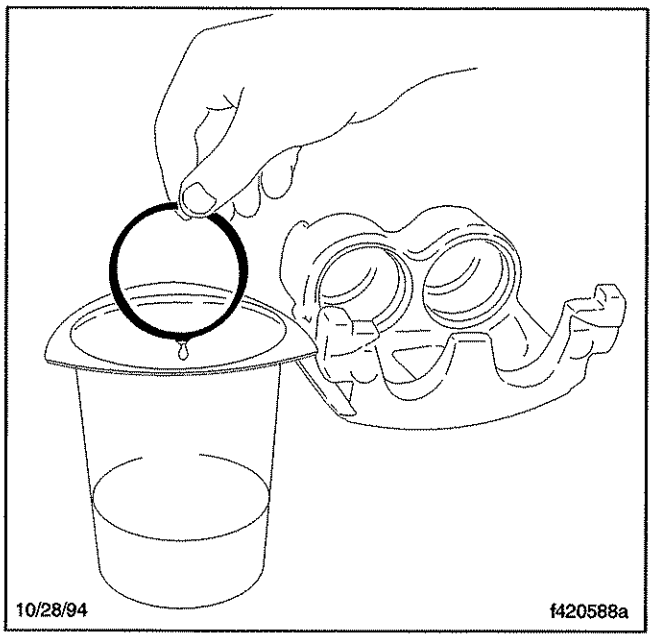


Fig. 11

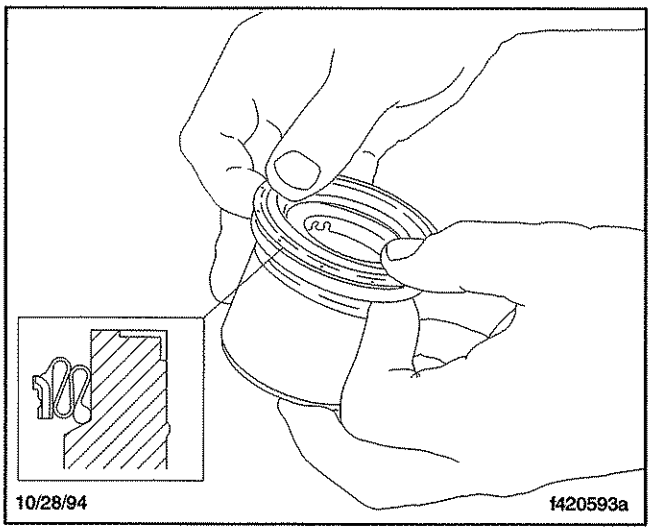


Fig. 12

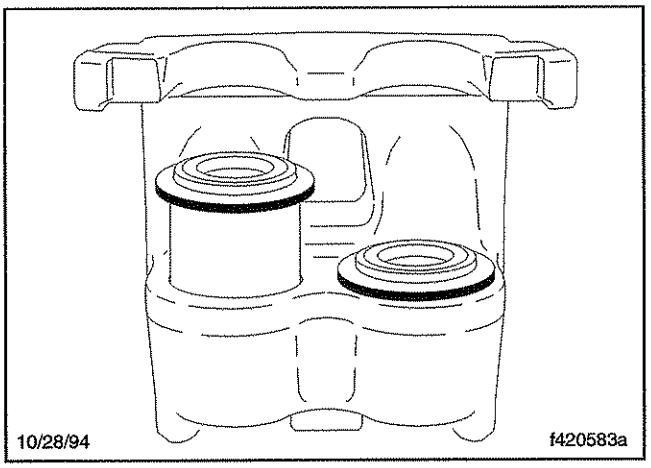


Fig. 13

dust boot. If you feel resistance, the piston is in crooked. Remove it and start over.

15.4 Take the Kent-Moore special tool (KMS/ZTSE4275 for 2.88-inch pistons, or KMS/ZTSE4343 for 2.60-inch pistons), and put the side of the tool marked "Boot" against the dust boot. Then using the C-clamp, seat the dust boot into its groove in the cylinder.

15.5 Repeat the previous steps as needed for installing the other piston.

16. Install the heat shields on the pistons.

16.1 Put a new heat shield over the top of one piston as shown in **Fig. 15.** Make sure the heat shield is positioned correctly.

16.2 Put the side of the Kent-Moore special tool (KMS/ZTSE4275 for 2.88-inch pistons, or KMS/ZTSE4343 for 2.6-inch pistons) marked "Heat Shield" against the heat shield. **See Fig. 16.** Using the C-clamp, seat the new heat shield onto the piston.

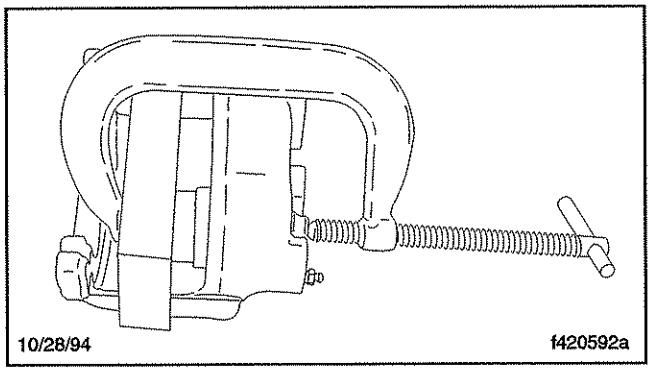


Fig. 14

17. If a wear shim is required, install the applicable wear shim (chosen according to **Table 1**) on the

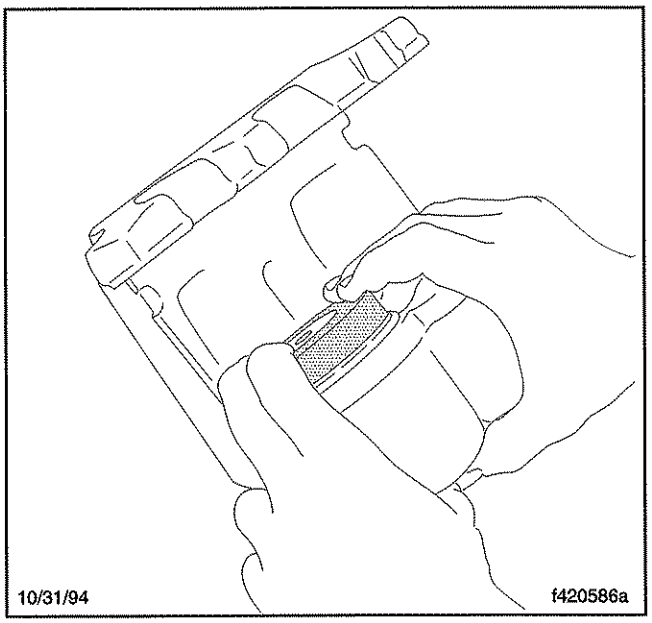


Fig. 15

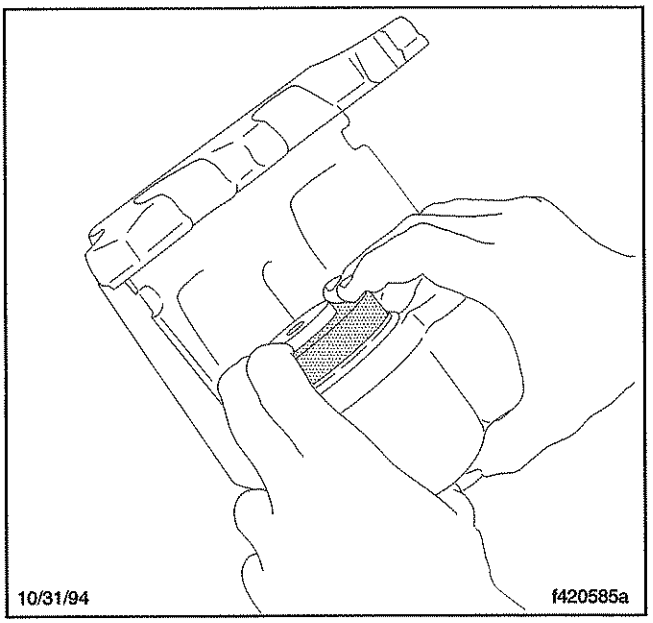


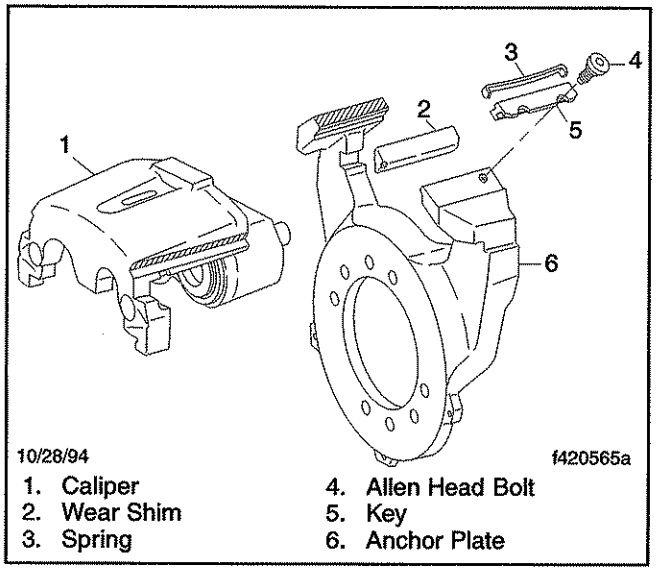
Fig. 16

Brake Caliper Rebuild

opposite anchor plate V-way from which the key and spring are installed. **See Fig. 17.**

18. Install the caliper on the rotor following the instructions under **Subject 140.**

19. Install the tire. Remove the chocks.



1. Caliper
2. Wear Shim
3. Spring
4. Allen Head Bolt
5. Key
6. Anchor Plate

Fig. 17

Brake Rotor Removal and Installation

⚠ WARNING

Before starting the procedure below, read the information in Safety Precautions, 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

Removal

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Remove about half the brake fluid from the front section (if removing a front-axle rotor) or the rear section (rear-axle rotor) of the master cylinder reservoir. See **Fig. 1**.
3. Chock the front or rear tires, as required.
4. Jack up the vehicle, then support the axle with jackstands.
5. Remove the tire.
6. Remove the brake caliper from the rotor, following the instructions in **Subject 140.**
7. Remove the hub and rotor assembly from the axle, following the instructions in **Group 33** or **Group 35.** Put the hub on the floor so the rotor is facing up.
8. Remove the brake rotor from the wheel hub.
   - 8.1 Remove the hexbolts and washers that attach the rotor to the hub. See **Fig. 2.**
   - 8.2 Lift the brake rotor off the hub.

Installation

1. Install the rotor on the wheel hub.
   - 1.1 Position the rotor on the hub as shown in **Fig. 3.** Make sure the holes in the rotor are lined up with those of the hub.
   - 1.2 Install the mounting hexbolts and washers. Using a star pattern, tighten the hexbolts 175 N·m (130 lbf·ft). See **Fig. 4.**
2. Install the hub and rotor assembly on the axle, following the instructions in **Group 33** or **Group 35.**
3. Install the brake caliper on the rotor, following the instructions in **Subject 140.**
4. Install the tire.
5. Remove the jackstands, then lower the vehicle.
6. Fill the applicable section of the master cylinder reservoir with new DOT 3 approved brake fluid. The brake fluid level should be even with the

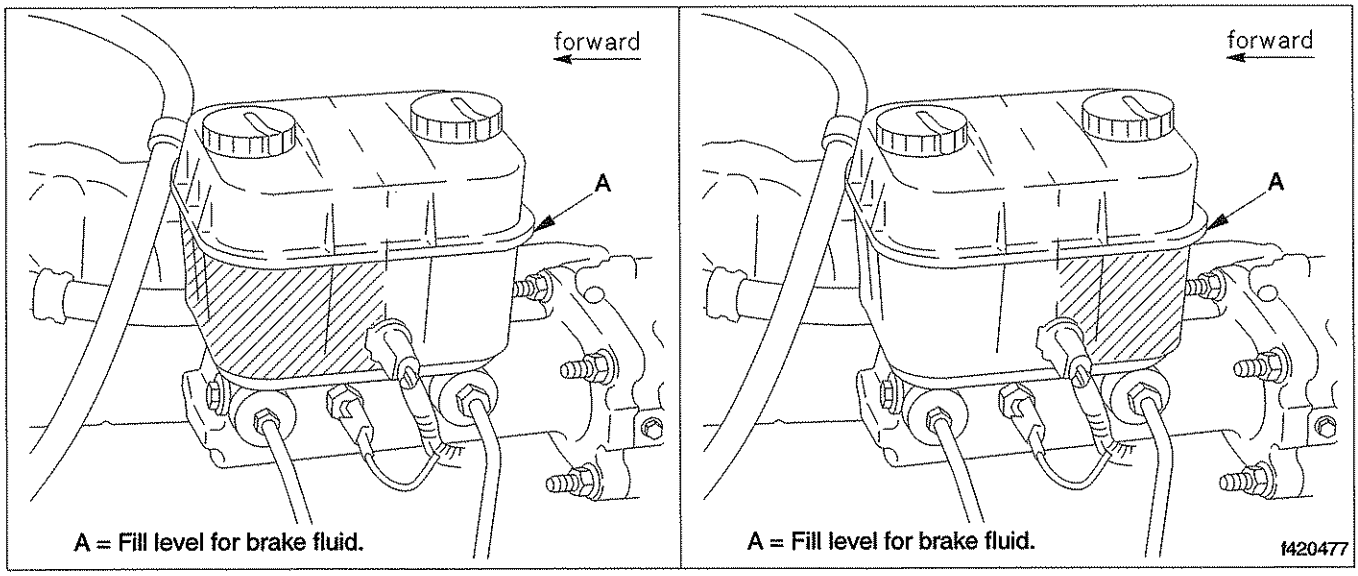


Fig. 1

Brake Rotor Removal and Installation

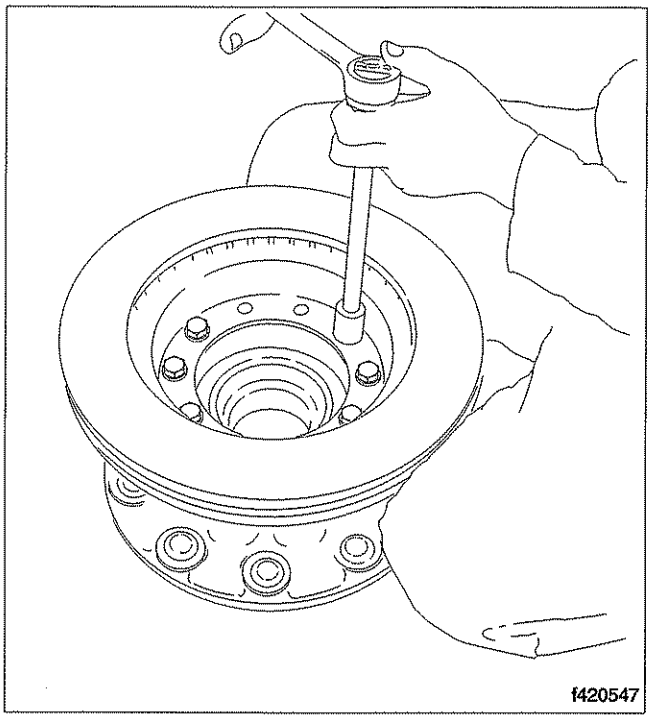


Fig. 2

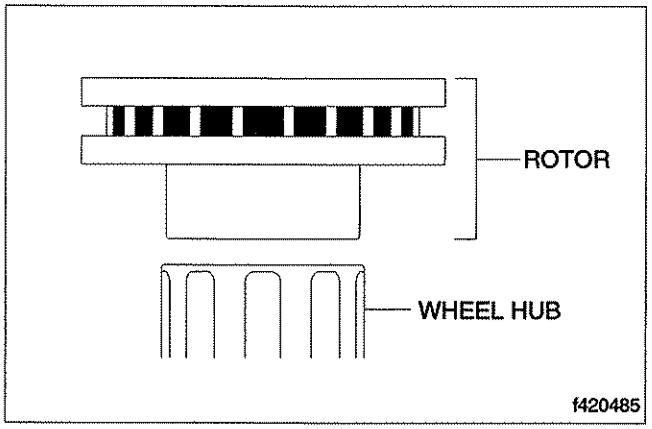


Fig. 3

raised seam on the outside circumference of the reservoir. See **Fig. 1**, Ref. A.

7. Lower the hood, then remove the chocks.

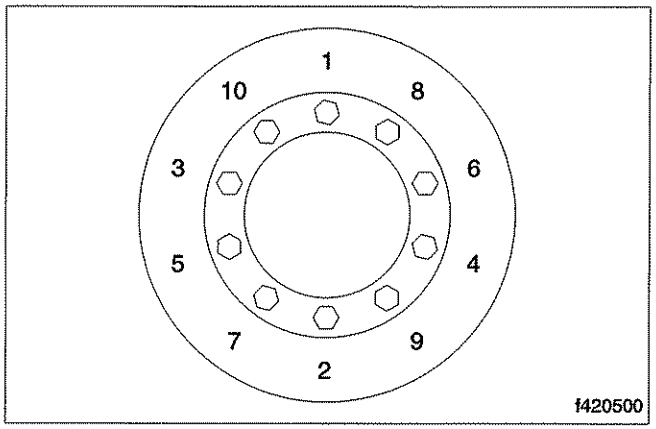


Fig. 4

Brake Rotor Runout and Parallelism Checking

Runout Checking

Brake rotor runout refers to the amount of lateral wobble the rotor has when it is turning, with the wheel bearings correctly adjusted. **See Fig. 1.** Check the rotor runout whenever you replace the brake pads.

1. If not already done, chock the tires, jack up the axle you are working on and support it with jackstands. Then remove the wheels and tires.
2. If working on the rear axle, put the transmission in neutral.
3. Using a dial indicator, measure the amount of runout while spinning the rotor, **as shown in Fig. 2.** Make sure the indicator is centered on the rotor face (between the outer and inner edges).
4. If the runout is more than 0.38 mm (0.015 inch), check that the rotor is securely mounted to the hub. Also check the wheel bearing end-play, following the instructions **in the front axle group** or **the rear axle group.**
5. Repeat the runout measurement. If the runout is still more than 0.38 mm (0.015 inch), replace the rotor.

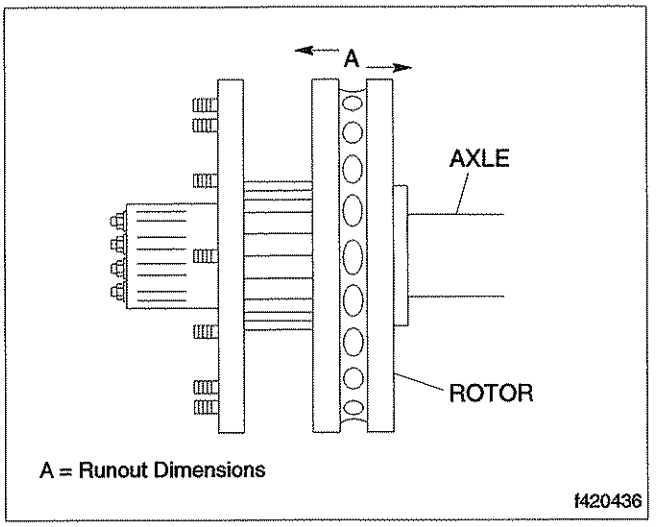


Fig. 1

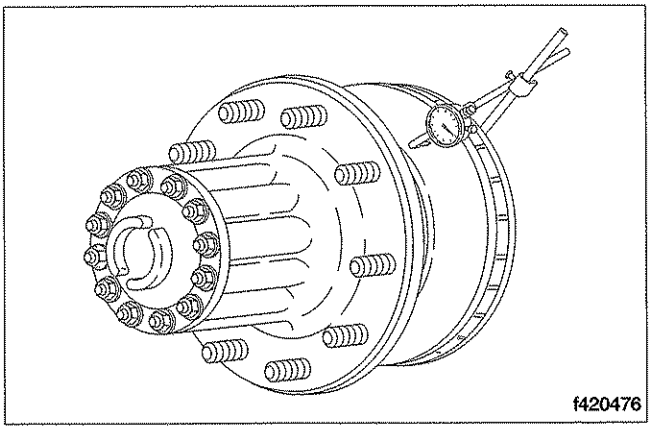


Fig. 2

Parallelism Checking

Parallelism is the difference in rotor thickness at different points around the rotor. It should be checked whenever the brake pads are replaced.

1. Using a vernier caliper or a micrometer, measure the thickness of the rotor (between the inboard and outboard faces) at four or more equally spaced points around the rotor. **See Fig. 3.**
2. If there is a difference of more than 0.13 mm (0.005 inch) between any two measurements, have the rotor resurfaced. If resurfacing will decrease the overall thickness of the rotor to 33.5 mm (1.32 inches) or less, replace the rotor.

Brake Rotor Runout and Parallelism Checking

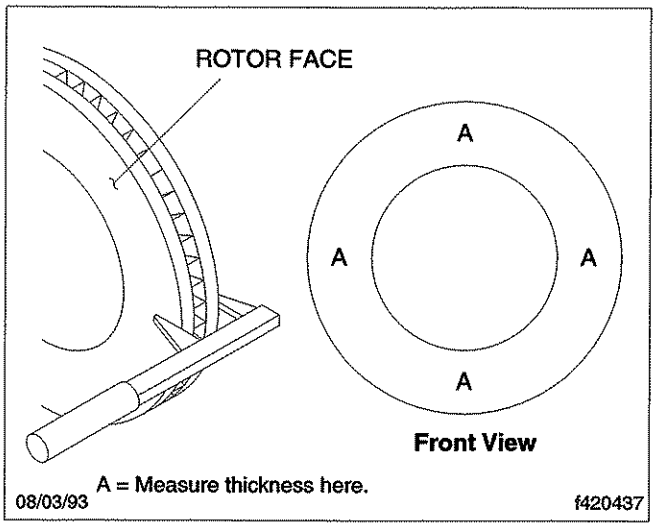


Fig. 3

Anchor Plate Removal and Installation

Removal

1. Chock the rear or front tires, as required.
2. Jack up the vehicle, then support the axle with jackstands.
3. Remove the tire.
4. Remove the brake caliper from the anchor plate, following the instructions under **"Brake Caliper Removal and Installation, 140."**
5. Remove the wheel hub and rotor assembly from the axle, following the instructions in **the front axle group** or **the rear axle group.**
6. Remove the anchor plate from the axle.
   - 6.1 Remove the three screws holding the dust shield to the anchor plate, then remove the dust shield.
   - 6.2 Remove the hexbolts, washers, and nuts that hold the anchor plate to the axle. **See Fig. 1.**
   - 6.3 Remove the anchor plate from the axle.

Installation

1. Install the anchor plate on the axle.
   - 1.1 Position the anchor plate in place against the outboard side of the axle flange, making sure the holes in both are lined up.
   - 1.2 From the outboard side of the anchor plate, install the hexbolts and washers, then install the nuts and remaining washers. **See Fig. 1.** Using a star pattern, tighten the hexnuts as follows:
     - Rear Axle; 142 N·m (105 lbf·ft)
     - Front Axle Type FC; 102 N·m (75 lbf·ft)
     - Front Axle Type FD/FF; 197 N·m (145 lbf·ft)
2. Install the dust shield on the anchor plate. **See Fig. 1.**
3. Install the wheel hub and rotor assembly onto the axle, following the instructions in **the front axle group** or **the rear axle group.**
4. Install the brake caliper on the anchor plate, following the instructions under **"Brake Caliper Removal and Installation, 140."**
5. Install the tire.
6. Remove the jackstands, then lower the vehicle.
7. Remove the chocks.

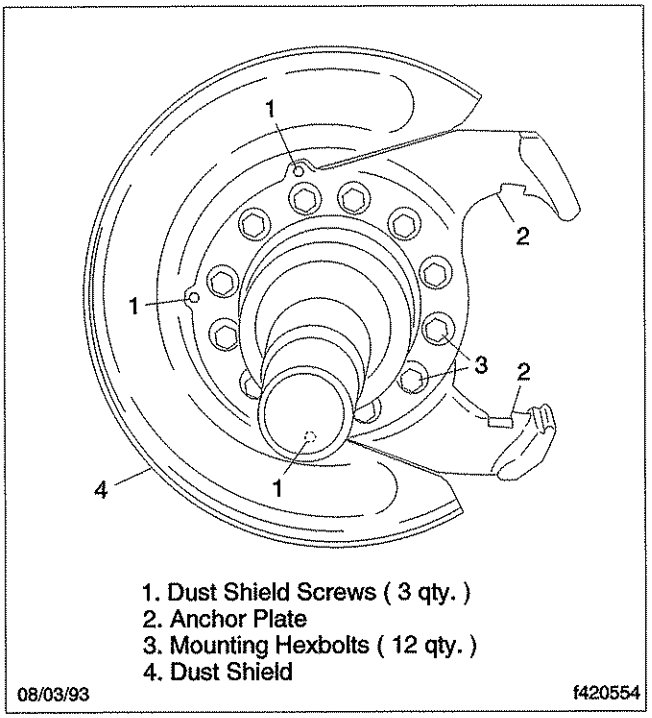


Fig. 1

Master Cylinder Disassembly, Inspection, and Assembly

⚠ WARNING

WARNING: Before starting the procedure below, read the information in "Safety Precautions, 100." Failure to be aware of the dangers of brake fluid exposure could result in serious and permanent health damage.

Disassembly (Refer to Fig. 1)

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Remove the master cylinder and reservoir assembly from the vehicle, following the instructions under **"Master Cylinder Removal and Installation, 170."**
3. Remove the reservoir from the master cylinder.
   - 3.1 Remove the four flanged hexbolts that attach the reservoir to the top of the master cylinder. **See Fig. 2.** Note that one of the bolts has an L-bracket on it.
   - 3.2 Lift the reservoir off the master cylinder. Turn the reservoir over, then remove the two compensating valve seals from the bottom of it. **See Fig. 3.**
4. Remove the small O-ring, then the two compensating valves and their springs from the top of the master cylinder housing. **See Fig. 4 and Fig. 5.**

⚠ CAUTION

CAUTION: Don't remove the piston stop at this time, or you may damage it and the piston bore in the master cylinder housing.

5. Remove the differential pressure indicator assembly from the front of the housing.
   - 5.1 Unscrew the aluminum plug at the front end of the housing. **See Fig. 6.**
   - 5.2 Using an allen wrench, remove the nylon insert underneath the aluminum plug. **See Fig. 7.**
   - 5.3 Remove the differential pressure switch from the side of the housing. **See Fig. 8.**
   - 5.4 Put a compressed air hose into the port on top of the housing where the primary compensating valve was. Put a shop towel over the hole at the front end of the housing, then place the housing so that the front end is facing down toward a padded surface; keep your hands away from the front of the master cylinder housing.

⚠ WARNING

WARNING: Be careful when using compressed air to remove the differential pressure indicator assembly from the master cylinder housing. It may come out of the housing with considerable force, which could cause personal injury or damage to the part.

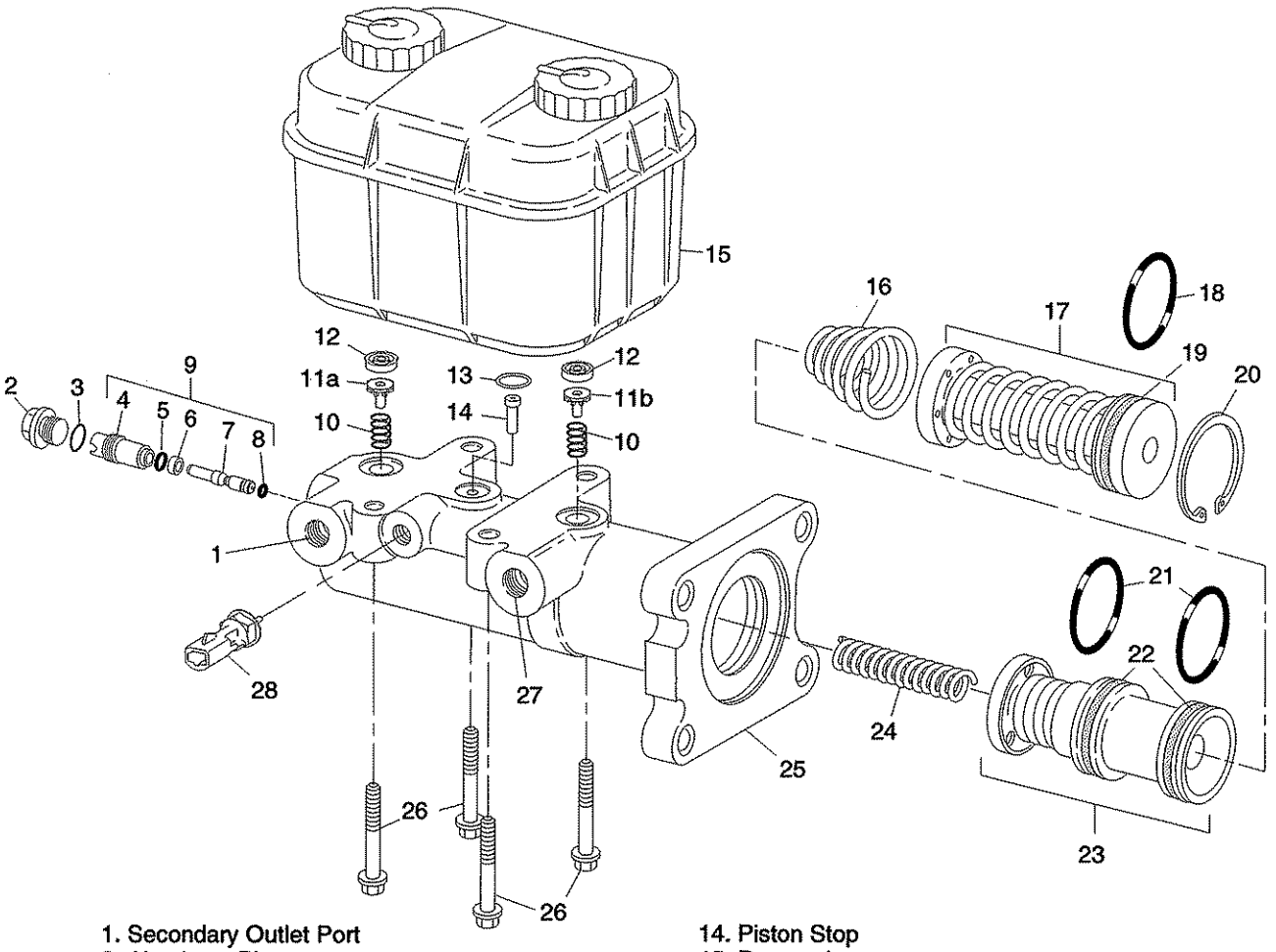
   - 5.5 Plug the primary circuit outlet (**Fig. 1**, Ref. 27), then release just enough air pressure to force out the brass spool, O-ring, and collar (Refs. 5, 6, and 7). Discard the O-ring.

     Remove and discard the small O-ring (Ref. 8) from the brass spool.
6. Remove the primary piston assembly from the master cylinder bore.
   - 6.1 Put the master cylinder in a vise.
   - 6.2 Using a crossbar puller, a C-clamp, or other suitable tool, push the primary piston about 13 mm (1/2 inch) into the bore. **See Fig. 9.**
   - 6.3 With the primary piston pushed in, remove the lock ring from the open end of the bore. **See Fig. 9.** Then remove the small piston stop from the top of the master cylinder housing. **See Fig. 10.**
   - 6.4 Carefully release the tension on the primary piston, and ease it and its return spring out of the bore. **See Fig. 11.**
   - 6.5 Remove and discard the pressure seal and back-up ring (**Fig. 1**, Refs. 18 and 19) from the primary piston.

⚠ WARNING

WARNING: Be careful when using compressed air to remove the secondary piston and actuator

Master Cylinder Disassembly, Inspection, and Assembly



1. Secondary Outlet Port
2. Aluminum Plug
3. O–Ring
4. Nylon Insert
5. Large O–Ring
6. Brass Collar
7. Brass Spool
8. Small O–Ring
9. Pressure Differential Indicator Assembly
10. Compensating Valve Spring (2 qty.)
11a. Secondary Compensating Valve
11b. Primary Compensating Valve
12. Compensating Valve Seal (2 qty.)
13. O–Ring
14. Piston Stop
15. Reservoir
16. Primary Piston Return Spring
17. Primary Piston Assembly
18. Primary Pressure Seal
19. Primary Back–Up Ring
20. Lock Ring
21. Secondary Pressure Seal (2 qty.)
22. Secondary Back–Up Ring (2 qty.)
23. Secondary Piston Assembly
24. Secondary Return Spring
25. Master Cylinder Housing
26. Flanged Hexbolts (4 qty.)
27. Primary Outlet Port
28. Pressure Differential Switch

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Fig. 1

Master Cylinder Disassembly, Inspection, and Assembly

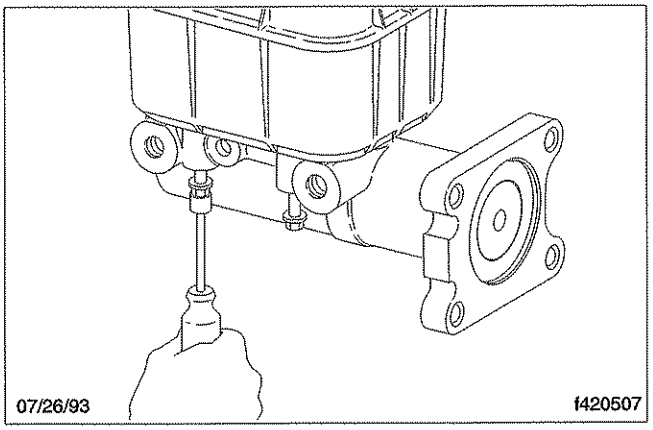


Fig. 2

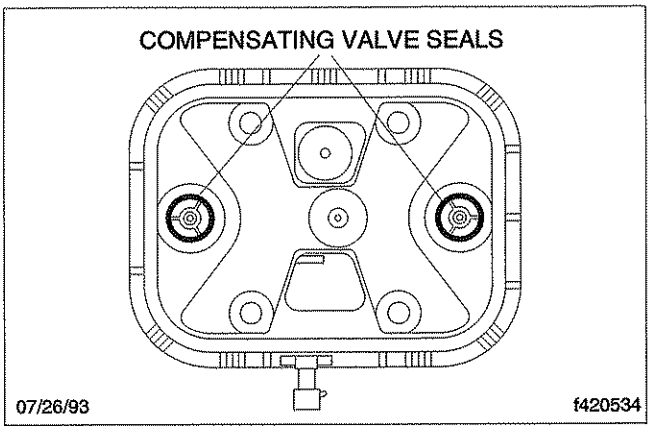


Fig. 3

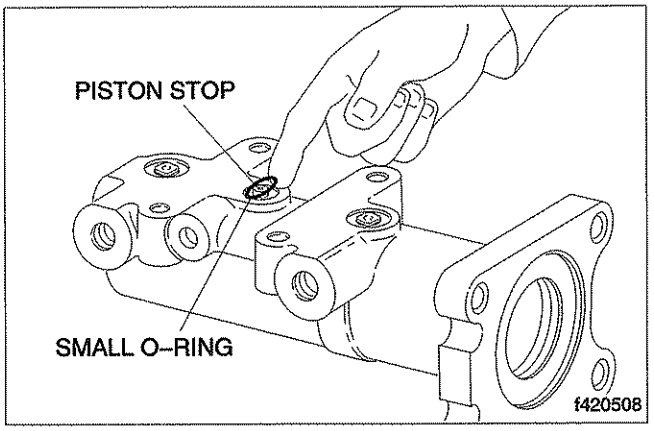


Fig. 4

assembly from the master cylinder bore. Make sure the open end of the bore is pointed down toward

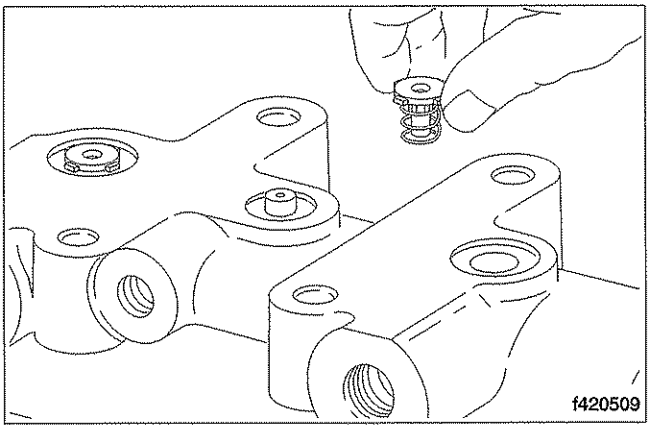


Fig. 5

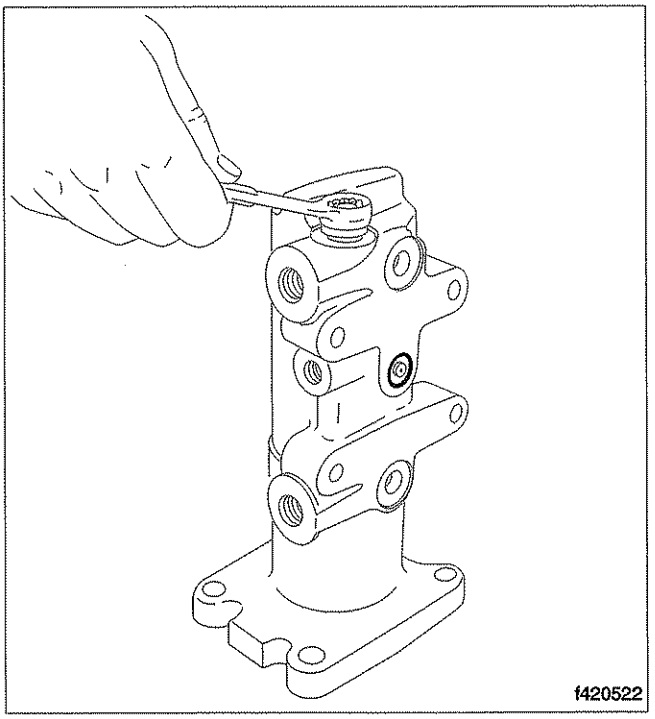


Fig. 6

a padded surface. Keep your hands away from the open end of the bore to prevent injury.

7. Using compressed air, remove the secondary piston assembly from the master cylinder bore.

   7.1 Connect a compressed air hose to the front compensating valve port **(Fig. 12)** on top of the housing.

Master Cylinder Disassembly, Inspection, and Assembly

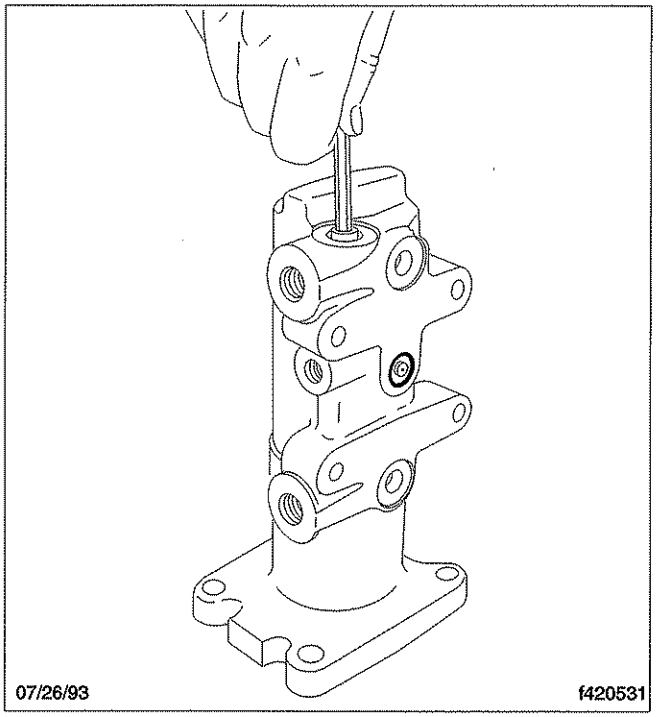


Fig. 7

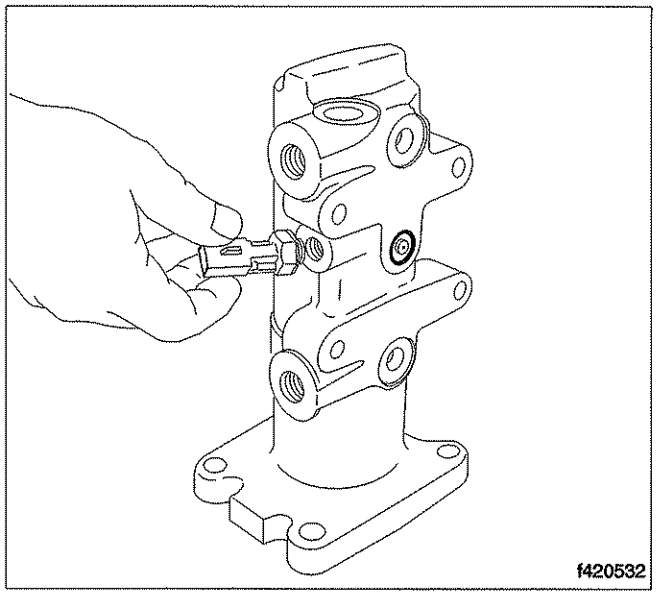


Fig. 8

7.2 Plug the secondary outlet port (**Fig. 1**, Ref. 1) and the hole where the pressure differential indicator (Ref. 9) was on the housing.

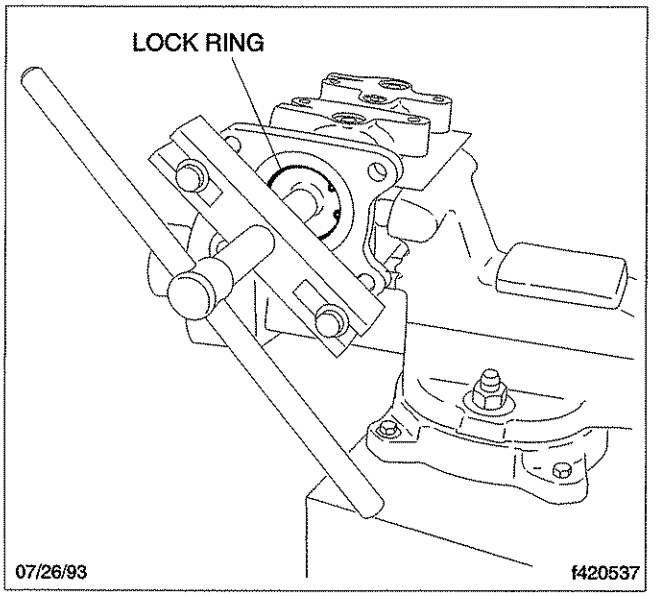


Fig. 9

7.3 With the open end of the housing bore facing down, and about an inch away from a padded surface, carefully apply just enough air pressure to remove the secondary piston assembly and its return spring from the bore **(see Fig. 13)**; don't pop it out.

7.4 Remove and discard the pressure seal and back-up ring from the secondary piston.

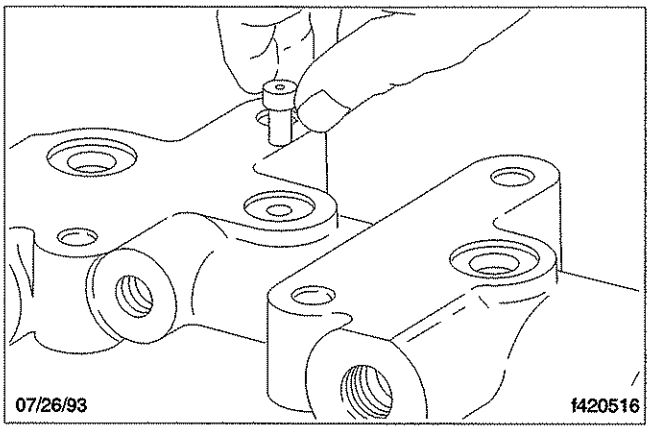


Fig. 10

Master Cylinder Disassembly, Inspection, and Assembly

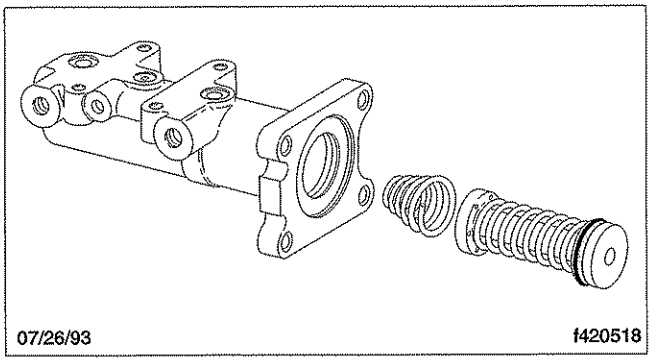


Fig. 11

Inspection

1. Check the master cylinder bore for scoring or corrosion. If the master cylinder housing is pitted, rough, or corroded, replace the entire master cylinder assembly.
2. If needed, polish any discolored or stained areas in the bore with a crocus cloth. *Don't use emery cloth or sandpaper; they could scratch the bore, which could cause leakage.*

Assembly (Refer to Fig. 1)

IMPORTANT: When assembling the master cylinder, use new seals and rings. Don't reuse old ones.

1. Wash all the parts and the cylinder bore in clean, new DOT 3 approved brake fluid. Discard the brake fluid afterward.

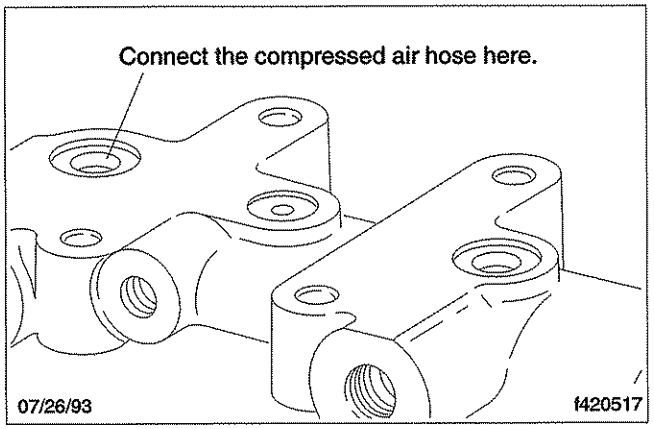


Fig. 12

2. Install the secondary piston assembly in the master cylinder bore.
   - 2.1 Install two new pressure seals and back-up rings (**Fig. 1**, Refs. 21 and 22) on the secondary piston.
   - 2.2 Lubricate the piston assembly, the seals, and the cylinder bore **(see Fig. 14)** with clean DOT 3 approved brake fluid.
   - 2.3 Put the secondary return spring (**Fig. 1**, Ref. 24) on the actuator (flanged) end of the secondary piston assembly, then insert the piston assembly, spring end first, into the cylinder bore. **See Fig. 15.** Push it all the way to the bottom of the bore.
3. Install the primary piston assembly in the master cylinder bore.
   - 3.1 Install a new pressure seal and back-up ring (**Fig. 1**, Refs. 18 and 19) on the primary cylinder.
   - 3.2 Lubricate the piston assembly and the seal with new DOT 3 approved brake fluid.
   - 3.3 Insert the small end of the primary return spring (**Fig. 1**, Ref. 16) into the master cylinder bore.
   - 3.4 Insert the primary piston assembly into the master cylinder bore, actuator (flanged) end first. **See Fig. 16.**
4. Put the master cylinder housing into a vise, then using a crossbar puller or a C-clamp, push the pistons far enough into the master cylinder bore to install the lock ring in its groove. **See Fig. 17.**

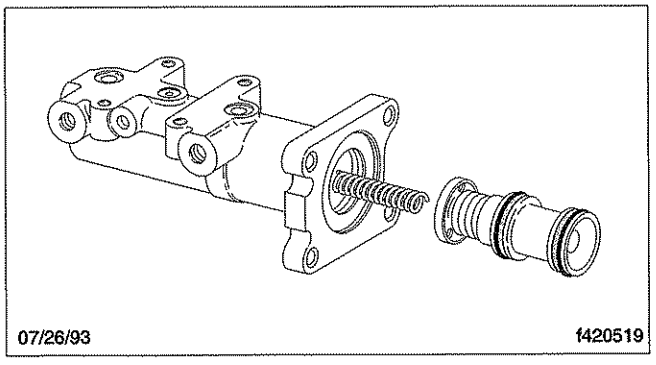


Fig. 13

Master Cylinder Disassembly, Inspection, and Assembly

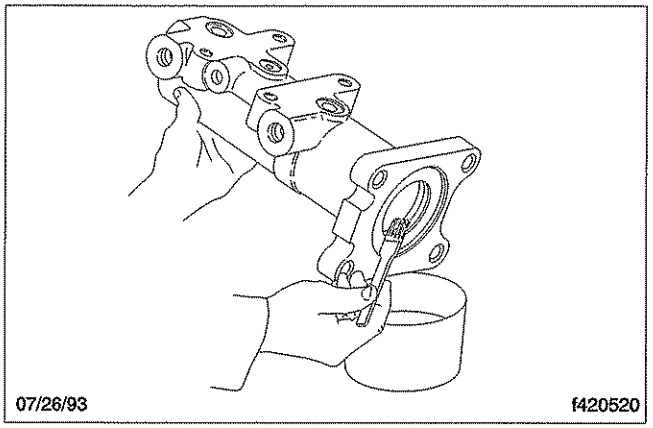


Fig. 14

5. Install the compensating valve seals on the bottom of the reservoir. **See Fig. 18.** Make sure the seals are completely seated.
6. Using a crossbar puller or a C-clamp, push the primary piston 25 mm (1 inch) into the bore. **See Fig. 19.**

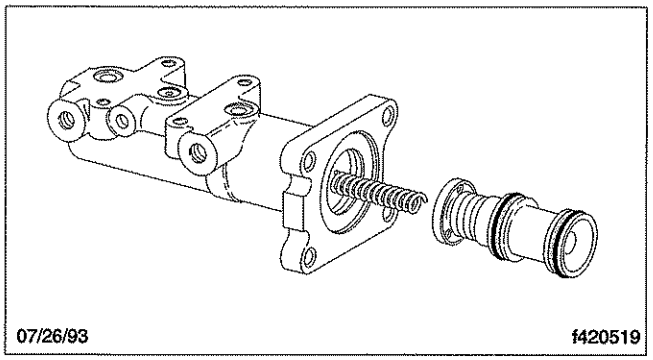


Fig. 15

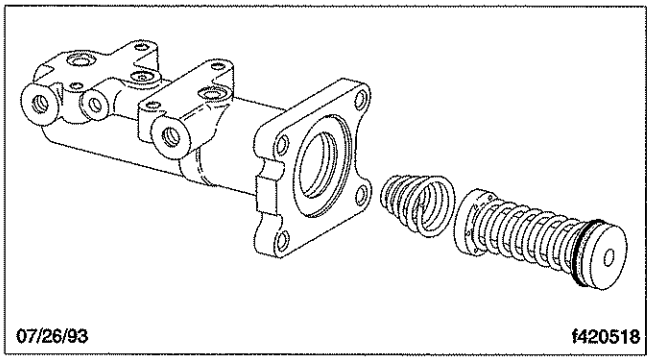


Fig. 16

7. Install the compensating valve poppets and their springs in the top of the master cylinder housing. Also install the piston stop and the O-ring. **See Fig. 20.**
8. With the primary piston still pushed in, install the reservoir onto the top of the master cylinder, using the four mounting hexbolts. **See Fig. 21.** Make sure the L-bracket goes on the front inboard (when the master
9. cylinder is installed on the vehicle) mounting hexbolt. Tighten the bolts 20 N·m (15 lbf·ft).

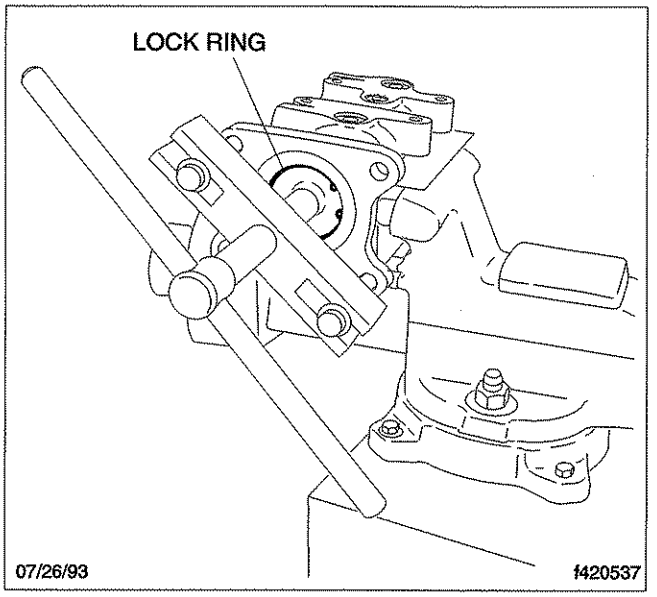


Fig. 17

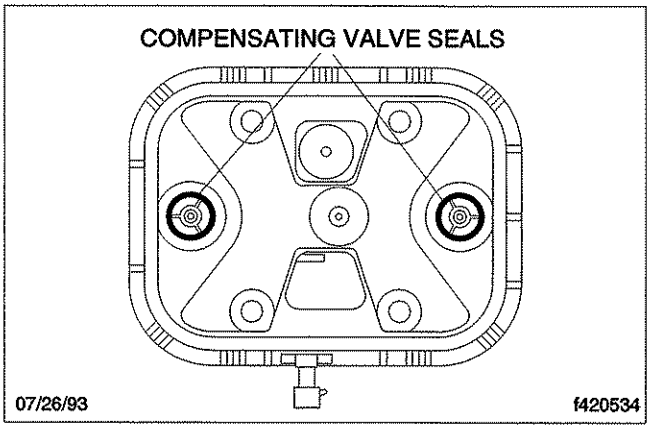


Fig. 18

10. Assemble the pressure differential indicator **(refer to Fig. 22).**

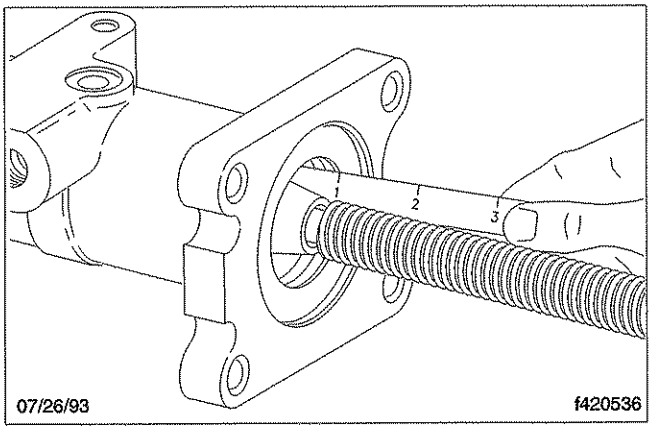


Fig. 19

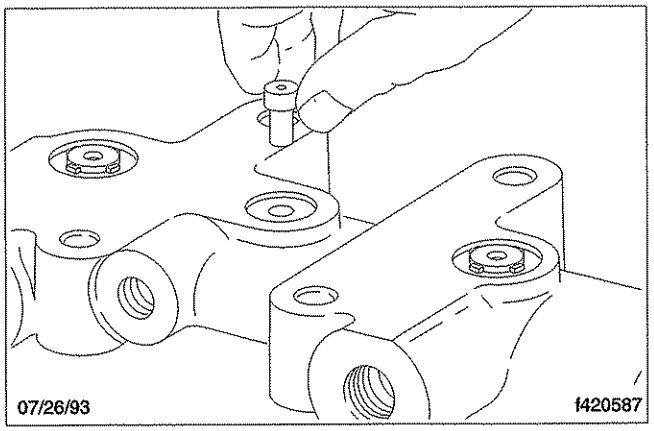


Fig. 20

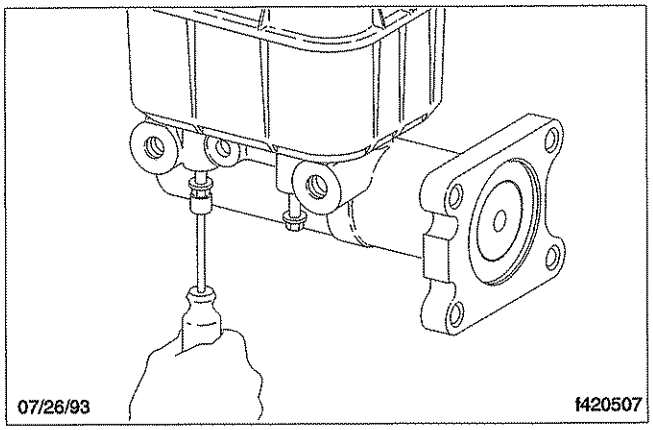


Fig. 21

10.1 Install a new small O-ring (Ref. 3) in the groove on the end of the brass spool (Ref. 4).

10.2 Install the collar (Ref. 2) on the brass spool.

10.3 Install a new large O-ring (Ref. 1) onto other end of the brass spool, and push it down onto the collar, **as shown in Fig. 22.**

11. Install the spool and collar assembly— with the collar end up— into the hole at the front of the master cylinder housing, **as shown in Fig. 23.** Using a small piece of wood, seat the assembly at the bottom of its hole.

12. Using an allen wrench, install the nylon insert on top of the brass spool. **See Fig. 24.**

13. Install a new O-ring on the aluminum plug (**Fig. 1**, Refs. 3 and 2), then install the plug into the hole at the front of the master cylinder housing. Tighten the plug firmly.

14. Install the pressure differential switch in the side of the master cylinder housing, **as shown in Fig. 25.** Tighten it finger-tight.

15. Check the operation of the compensating valves by poking a wire through the hole in the bottom of each reservoir section. The compensating valves should depress easily, about 1.5 mm (1/16 inch), then spring back. If not, remove the reservoir and install it again. Check the valves again.

16. Remove the cross-bar puller or C-clamp installed to push the primary piston into the bore.

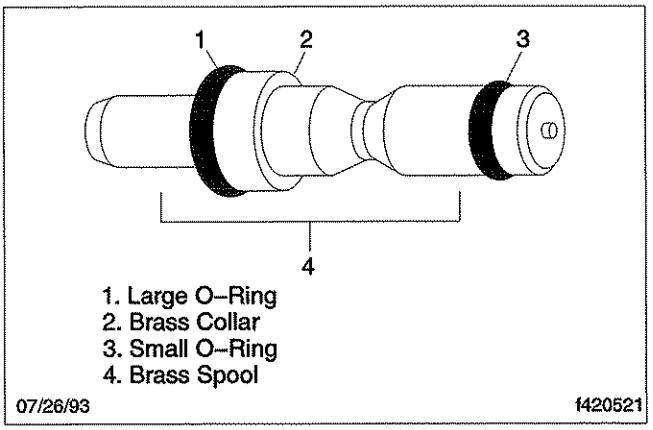


Fig. 22

Master Cylinder Disassembly, Inspection, and Assembly

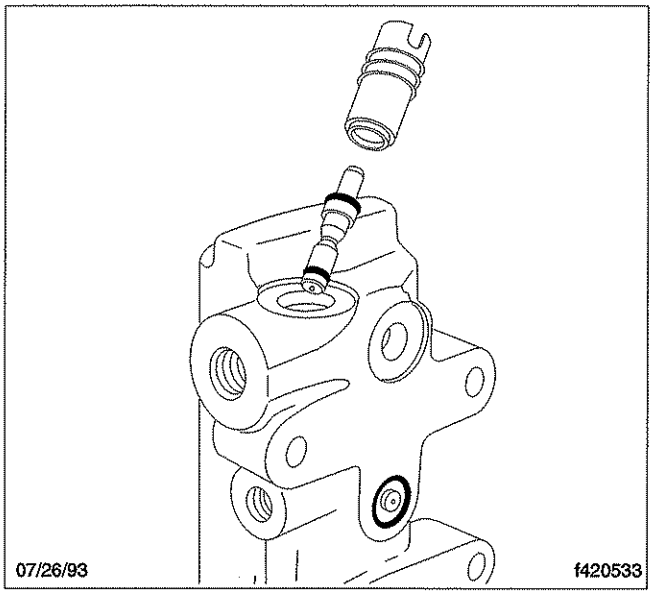


Fig. 23

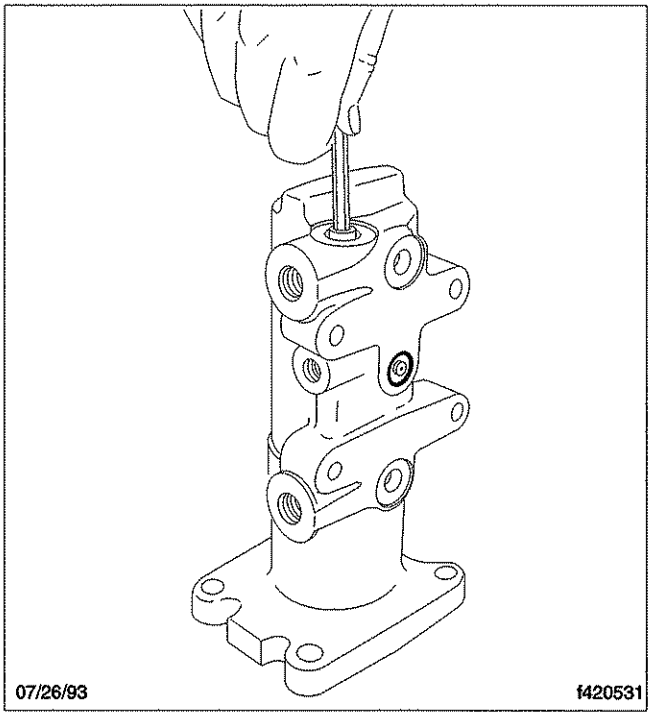


Fig. 24

17. Bench bleed, then install the master cylinder on the booster, following the instructions under **"Master Cylinder Removal and Installation, 170."**

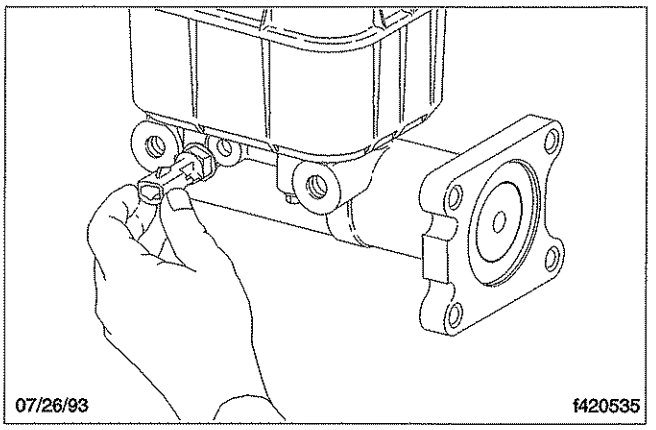


Fig. 25

18. Lower the hood, then remove the chocks.

Hydro-Max II® Power Booster Disassembly Inspection, and Assembly

Disassembly (Fig. 1)

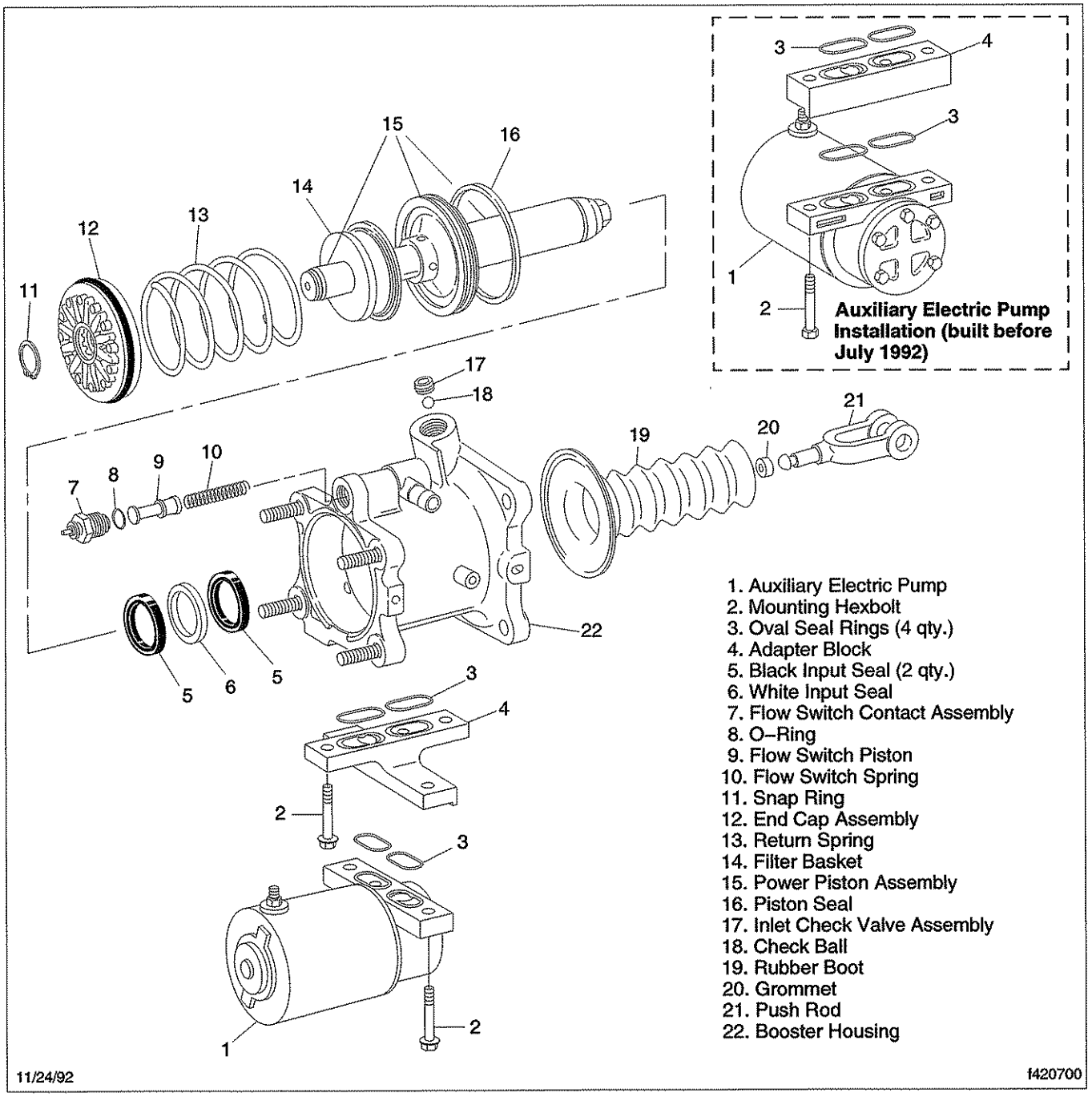


Fig. 1

Hydro-Max II® Power Booster Disassembly Inspection, and Assembly

⚠ WARNING

WARNING: Always wear safety goggles or glasses when working on the power booster. Some power booster parts are under compression (such as springs, snap-rings, and the like), and they could release with some force, possibly causing injury.

1. Apply the parking brakes, chock the tires, and tilt the hood.
2. Remove the power booster from the vehicle, following instructions in **Subject 180**.
3. Remove the auxiliary electric pump (**Fig. 1**, Ref. 1) from the power booster housing.
   - 3.1 Hold the booster and pump assembly over a container. There are about 3 cups of fluid in the assembly.
   - 3.2 Remove the two screws that hold the pump and the adapter block to the bottom of the booster. See **Fig. 2.**

     Remove the two screws that attach the pump to the adapter (if applicable).
   - 3.3 After the power steering fluid has been drained, remove and discard the oval seal rings (**Fig. 1**, Ref. 3) from the electric pump and the adapter block.
4. Remove and discard the rubber boot (**Fig. 1**, Ref. 19) from the push rod.
5. Remove push rod (**Fig. 1**, Ref. 21) from the end of the power piston (Ref. 15).
   - 5.1 Put the booster unit in a padded vise so the wrench flats at the end of the power piston are in the vise jaws, as shown in **Fig. 3.**
   - 5.2 Put a round pry bar through the eyes of the push rod clevis, then pry the push rod out of the end of the power piston. See **Fig. 3.**
   - 5.3 Remove all the plastic grommet pieces from inside the power piston end and the push rod.
6. Remove the power piston assembly and the end cap from the booster housing.
   - 6.1 Place the booster housing on a padded surface, with the end cap facing down.

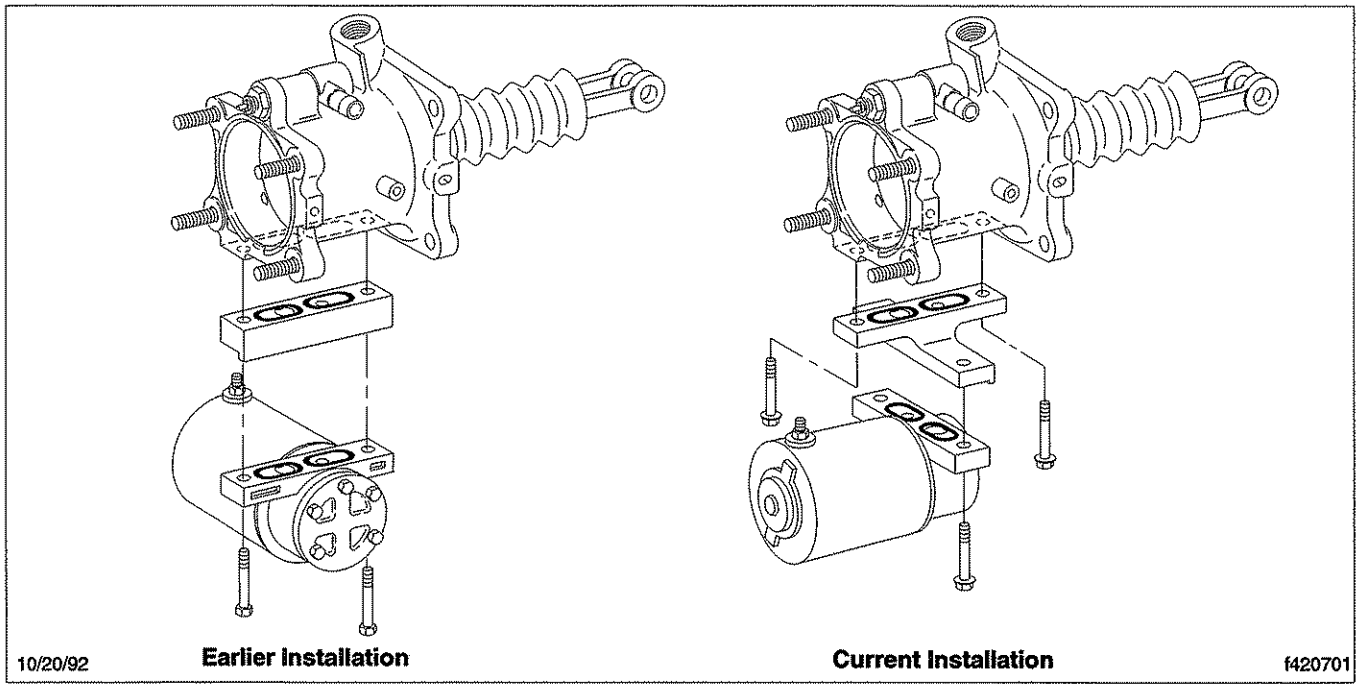


Fig. 2

Hydro-Max II® Power Booster Disassembly Inspection, and Assembly

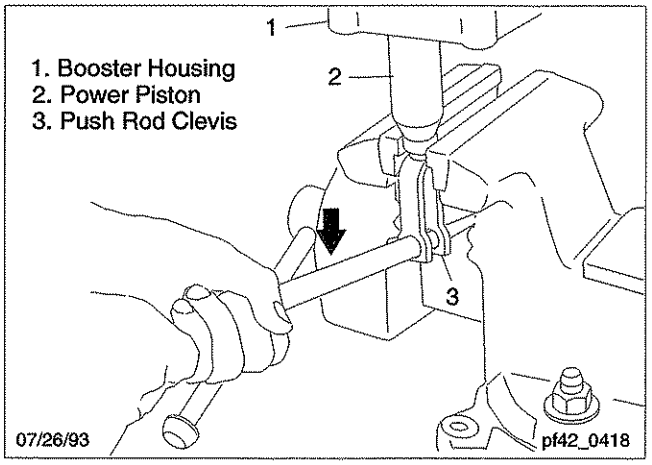


Fig. 3

6.2 Push down on the end of the power piston until the end cap and power piston come out of the front of the housing.

6.3 Pull the power piston and end cap straight out of the booster housing (see **Fig. 4**); be careful not to scratch the piston or the housing bore.

7. Remove and discard the three input seals from the small bore at rear of the booster housing. See **Fig. 1**, Refs. 5 and 6.

8. Remove and discard the piston seal (Ref. 16) from the power piston.

9. Remove the end cap and the filter basket from the power piston.

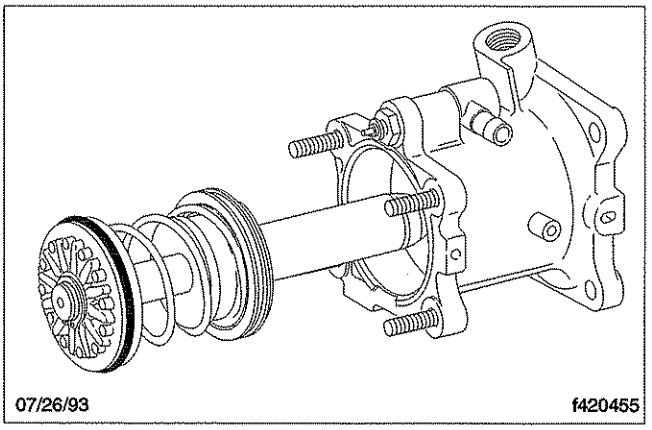


Fig. 4

9.1 Put the end cap and power piston on a padded surface.

9.2 Push down on the end cap to release the pressure on the snap ring, as shown in **Fig. 5**.

9.3 Remove and discard the snap ring from the output shaft of the power piston. See **Fig. 6**.

9.4 Remove and discard the end cap and the return spring. See **Fig. 6**.

9.5 Remove the filter basket.

10. Remove the flow switch assembly from the front of the booster housing.

10.1 Unscrew the nylon flow switch contact assembly from the housing. See **Fig. 7**.

10.2 Using a small magnet, remove the flow switch piston and spring (**Fig. 8**) from the booster housing.

10.3 Remove and discard the O-ring from the nylon contact assembly.

11. Using a hooked piece of wire, remove the inlet check valve from the inlet port on the booster

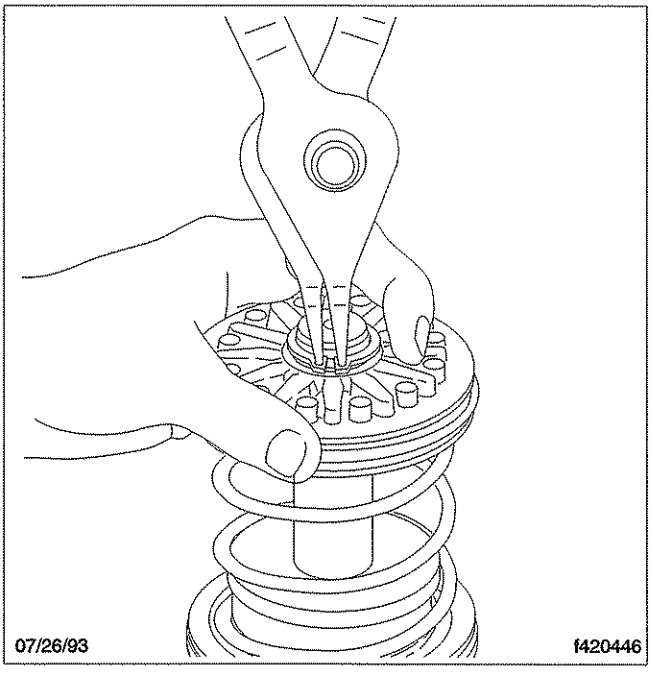


Fig. 5

Hydro-Max II® Power Booster Disassembly Inspection, and Assembly

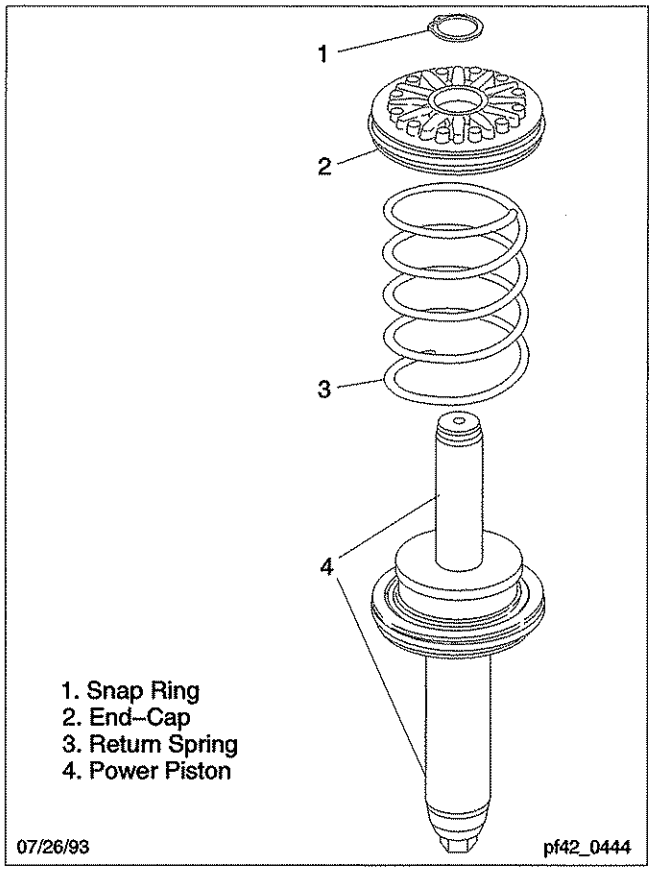


Fig. 6

housing. Then remove the check ball. Discard both parts. See **Fig. 9**, **Fig. 10**, and **Fig. 11**.

Inspection

1. Check the power piston surface for nicks or scratches. Pay special attention to the sealing surface and the input and output shafts. See **Fig. 12**. If there is any damage, replace the power piston assembly.
2. Check the bore in the booster housing. If it is grooved, nicked, or otherwise damaged, replace the entire power booster assembly.

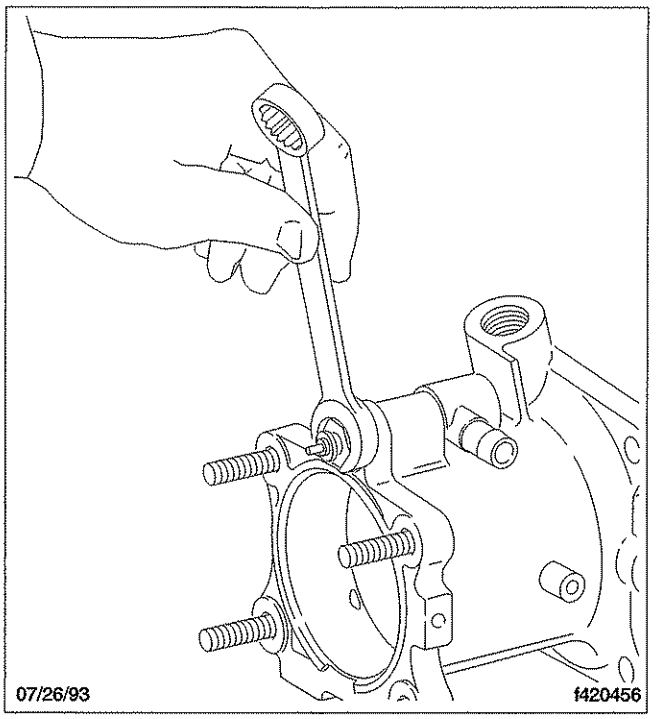


Fig. 7

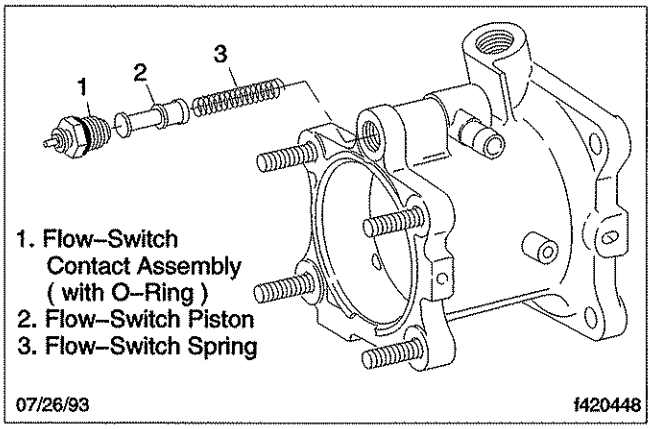


Fig. 8

Assembly (Fig. 1)

⚠ WARNING

WARNING: Use only clean Dexron II® ATF for cleaning or lubricating power booster parts. Don't use brake fluid. Using other types of fluids may

Hydro-Max II® Power Booster Disassembly Inspection, and Assembly

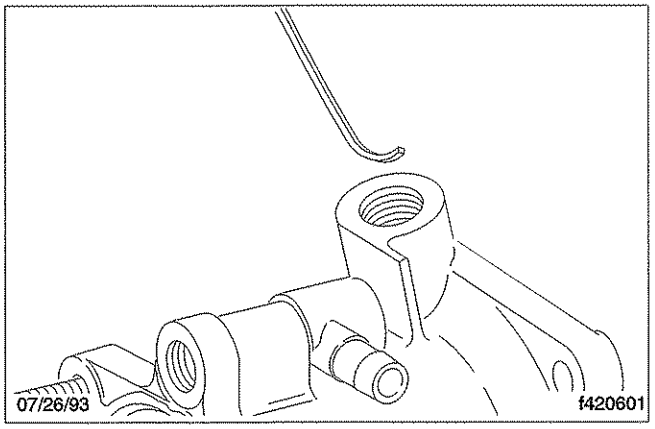


Fig. 9

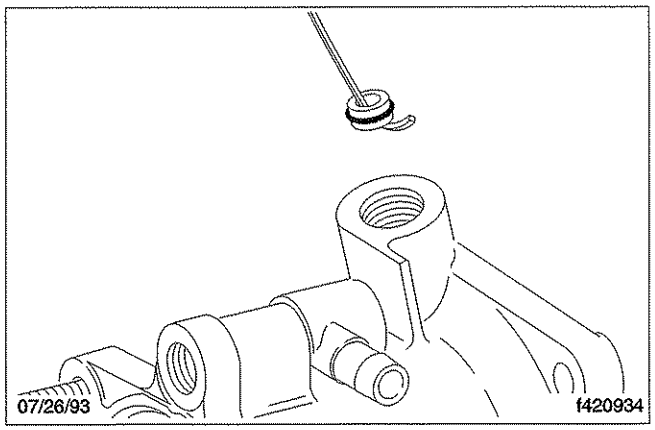


Fig. 10

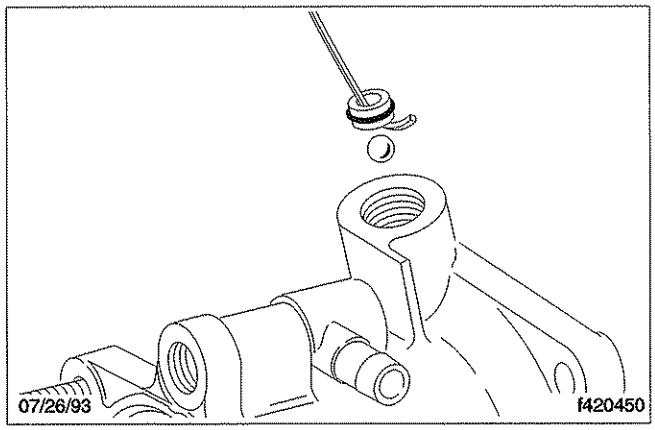


Fig. 11

destroy seals and O-rings, which could cause the eventual loss of brake control.

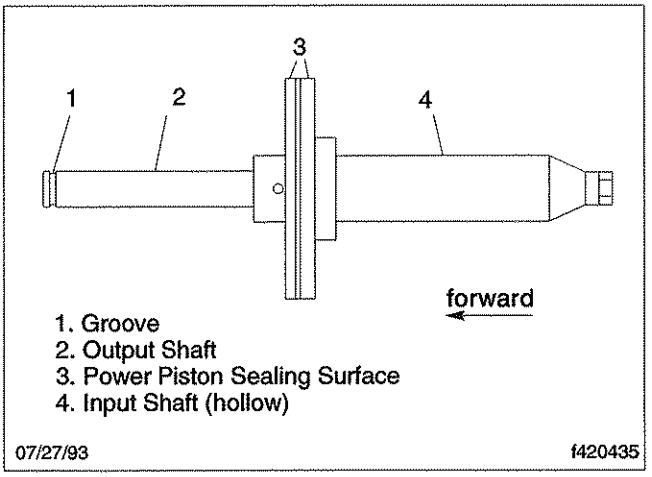


Fig. 12, Power Piston Assembly

1. Using clean power steering fluid, clean and lightly lubricate all the power booster parts.
2. Install new input seals in the small bore of the booster housing. Install the white seal between the two black ones, as shown in **Fig. 13.**
3. Install a new check ball in the inlet port on top of the booster housing, then install a new inlet check valve assembly. Make sure it's seated firmly.
4. Install the flow switch assembly in the front of the booster housing. See **Fig. 14.**

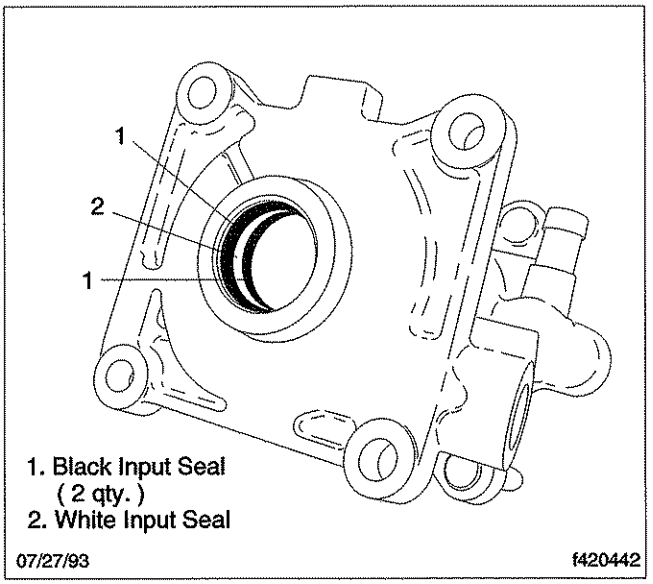


Fig. 13

Hydro-Max II® Power Booster Disassembly Inspection, and Assembly

4.1 Install the flow switch spring in its hole at the front of the booster housing.

4.2 Install the flow switch piston.

4.3 Install a new O-ring on the flow-switch contact assembly, then install the assembly in the hole at the front of the booster housing. Tighten it finger-tight.

5. Install a new filter basket— open end first— over the power piston output shaft, and push it up against the power piston.

6. Install the return spring on the power piston output shaft.

7. Install a new end-cap assembly on the power piston output shaft.

7.1 Install a new square cut seal on the outside diameter of the new end cap, then install a new O-ring inside the small bore of the end cap.

7.2 Lubricate the O-ring and lip seal in the end-cap hole with power steering fluid.

7.3 Carefully install the end-cap assembly (ribbed side up) on the power piston output shaft.

7.4 Keeping the end cap pushed down, install the snap ring in the groove of the power piston output shaft. See **Fig. 15.**

8. Install the power piston assembly in the booster housing.

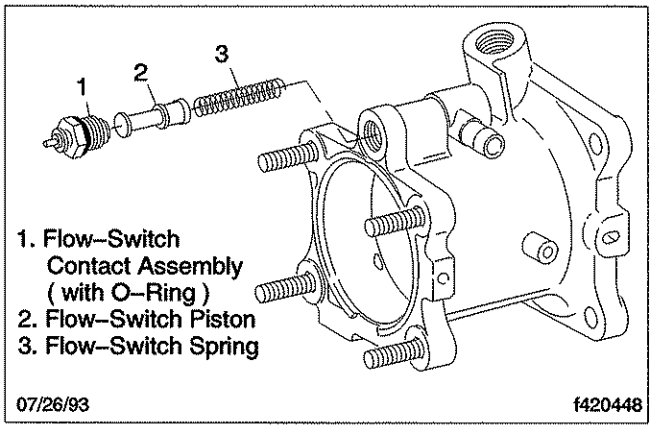


Fig. 14

8.1 Install the power piston, larger shaft first, into the large bore at the front of the booster housing.

⚠ WARNING

WARNING: Be careful not to damage the input seals in the small bore of the booster housing when you install the power piston shaft through the small bore. If these seals are damaged, the booster assembly will leak, causing loss of braking power.

8.2 Carefully work the end of the power piston shaft through the small bore of the booster housing. Use a gentle twisting motion to work the shaft past the two seals (**Fig. 13**) in the bore.

IMPORTANT: If the seals are damaged by the power piston shaft, replace them. Then repeat steps for installation of the power piston.

8.3 Seat the end cap in the large bore of the housing.

9. Install a new boot on the push rod.

10. Install the push rod on the end of the power piston.

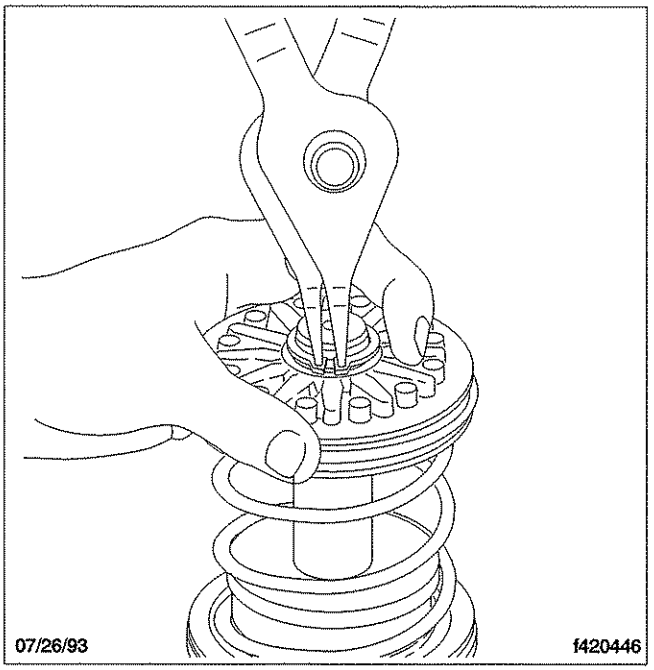


Fig. 15

Hydro-Max II® Power Booster Disassembly Inspection, and Assembly

10.1 Install a new grommet on the push rod.

10.2 Put the flats of the power piston end into a padded vise, then install the push rod and the grommet firmly into the end of the power piston.

⚠ WARNING

WARNING: Be sure the push rod is seated all the way into the power piston end. If it's not, it could become disconnected later, which could result in the loss of braking control.

11. Install new oval face seals on the mating surface of the auxiliary electric pump. See **Fig. 16.**

12. Install the adapter block on the electric pump, with the machined lip on the block down, and hanging over the front edge of the electric pump. See **Fig. 17.** Tighten the mounting bolts 30 N·m (22 lbf·ft).

13. Install new oval face seals on the top of the adapter block, then install the adapter block and electric pump assembly on the bottom of the booster housing, as shown in **Fig. 18.** Tighten the two mounting bolts 30 N·m (22 lbf·ft).

14. Install the power booster assembly on the vehicle, following instructions in **Subject 180.**

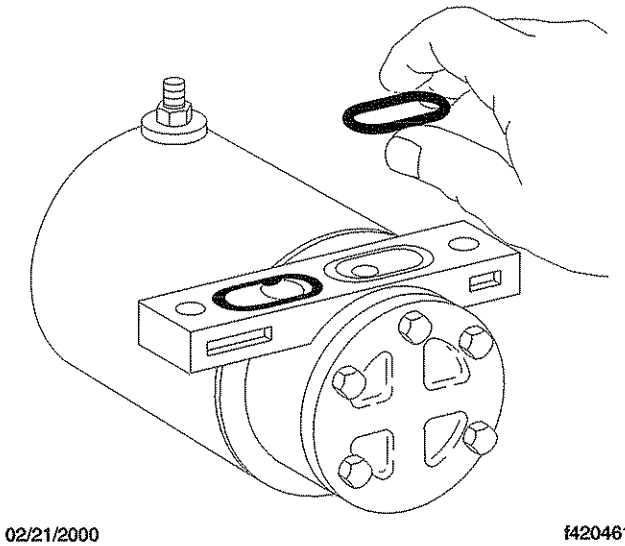


Fig. 16

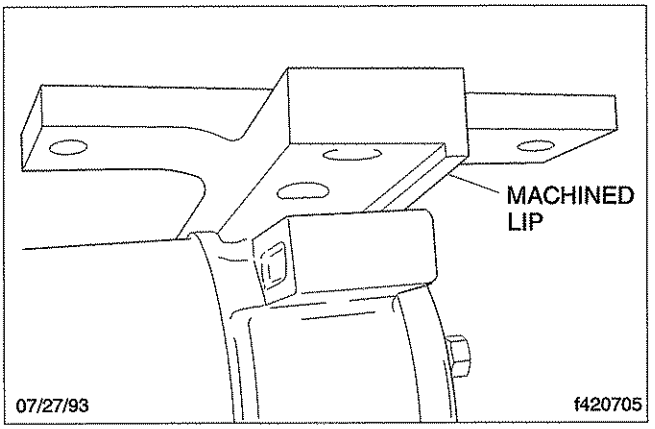


Fig. 17

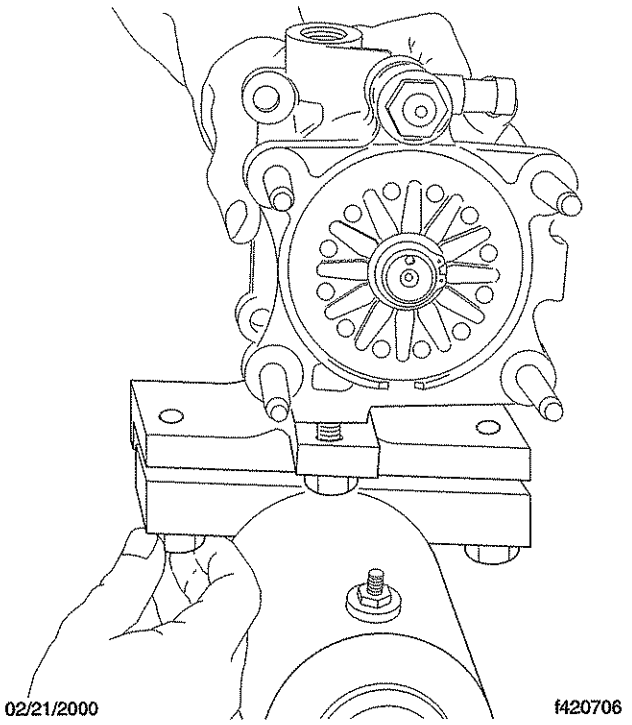


Fig. 18

Troubleshooting Tables

Pedal

Problem—The Power Booster Works Sluggishly or Not at All

Problem—The Power Booster Works Sluggishly or Not at All	
Possible Cause	**Remedy**
Binding power booster push rod	Check the linkage between the brake pedal and the power booster push rod. Check the hole in the cab front wall through which the push rod fits. Repair or replace parts as needed.

Problem—The Auxiliary Electric Pump Runs Continuously When the Ignition Is Off and the Brake Pedal Is Not Depressed

Problem—The Auxiliary Electric Pump Runs Continuously When the Ignition Is Off and the Brake Pedal Is Not Depressed	
Possible Cause	**Remedy**
Brake pedal linkage	Check the brake pedal linkage. Repair or replace as needed.

Problem—Pedal Does Not Return, The Brakes are Dragging, Grabbing, or the Brake Action is Uneven

Problem—Pedal Does Not Return, The Brakes are Dragging, Grabbing, or the Brake Action is Uneven	
Possible Cause	**Remedy**
Brake pedal binding or restricted from returning	Check the brake pedal for a restriction. Repair as needed.

Problem—The Brake Pedal Is Hard to Depress With the Engine Running

Problem—The Brake Pedal Is Hard to Depress With the Engine Running	
Possible Cause	**Remedy**
Binding brake pedal	Check the brake pedal linkage. Repair or replace as needed.
Pedal misalignment (side-to-side)	

Wheel-End Components

Problem—Fluid Level Indicator Light Illuminated

Problem—Fluid Level Indicator Light Illuminated	
Possible Cause	**Remedy**
Brake pads worn out	Inspect the brake pads and replace as necessary in axle sets. Add fluid as required.

Troubleshooting

Problem—The Brakes Grab

Problem—The Brakes Grab	
Possible Cause	**Remedy**
Incorrect pads or loose pads on plate	Replace with the correct pads in axle sets.
Grease or brake fluid on pads	Repair grease seal or caliper as required. Replace pads in axle sets.

Problem—The Brakes Pull To the Left or Right

Problem—The Brakes Pull To the Left or Right	
Possible Cause	**Remedy**
Low tire pressure	Inflate the tires to the correct pressure.
Front wheels out of alignment	Align the front wheels. See **Section 33.00**.
Mismatched tires	Check the tire sizes and correct as needed.
Kinked brake lines	Check the routing of the brake lines and hoses. Repair or replace as needed.
Loose or not working caliper	Repair the caliper.
Oily brake pads	Replace the brake pads in axle sets.
Rear brakes not working	Check the rear brakes and repair or replace parts as needed.
Loose suspension parts	Check the front and rear suspension, and repair as needed.
Mismatched or worn brake pads	Replace the brake pads in axle sets. Repair or replace the rotor(s) as needed.
Grease on pads or rotor	Clean the parts as needed.
Caliper piston sticking	Replace caliper as required.
Caliper or anchor plate V-ways sticking	Clean V-ways and anchor plate rails thoroughly and lubricate with approved grease.

Problem—Brake Noises With the Brakes Not Applied

Problem—Brake Noises With the Brakes Not Applied	
Possible Cause	**Remedy**
Worn out front pads	Replace the pads in axle sets.
Dust or oil on rotors	Clean the rotors. Check for and repair an oil leak.

Problem—Brake Noises With the Brakes Applied

Problem—Brake Noises With the Brakes Applied	
Possible Cause	**Remedy**
Bent, damaged or incorrect brake pads installed	Install the correct brake pads in axle sets.
Loose caliper	Install wear shims, or replace worn parts as needed.

Problem—Roughness, Chattering, or Pulsating Is Felt When the Brakes are Applied

Problem—Roughness, Chattering, or Pulsating Is Felt When the Brakes are Applied	
Possible Cause	**Remedy**
Too much rotor lateral runout	Check the lateral runout on the rotors. Repair or replace as needed.
Rotor parallelism not to specifications	Check the parallelism of the rotors. Repair or replace as needed.
Incorrectly adjusted wheel bearings	Check the end play of the front and rear wheel bearings. Adjust as needed. See **Group 33** for front axles and **Group 35** for rear axles.
Brake pad installed backwards (steel side toward the rotor face)	Install the brake pad correctly.
Foreign material imbedded in pads	Replace pads in axle sets.

Problem—Too Much Effort Is Needed to Apply the Brakes (Hard Pedal)

Problem—Too Much Effort Is Needed to Apply the Brakes (Hard Pedal)	
Possible Cause	**Remedy**
Worn brake pads	Replace the brake pads in axle sets.
Stuck or binding caliper piston	Check the caliper pistons. Rebuild the caliper(s) as needed.
Fading brakes due to incorrect pads	Install the correct brake pads in axle sets.
Glazed rotors or brake pads	Replace the glazed rotors or brake pads in axle sets.
Grease or oil on brake pads or rotors	Clean the brake pads or rotors.
Overloaded vehicle	Do not exceed rated vehicle loads.

Problem—The Brakes are Dragging

Problem—The Brakes are Dragging	
Possible Cause	**Remedy**
Kinked or pinched brake lines or hoses	Check the brake lines and hoses. Repair or replace as needed.
Incorrectly installed inboard brake pad	Check the inboard brake pads. Install them correctly as needed.
Brake caliper pistons not returning	Repair or replace the caliper(s) as needed. Check the brake fluid for water. Drain, flush and fill the system if water is found.
Stuck or bound caliper pins or rails	Repair or replace the caliper(s) as needed.
Soft or swollen rubber parts caused by incorrect or contaminated brake fluid	Replace all rubber parts including calipers (which have internal rubber seals). Flush the hydraulic system and fill with approved fluid.

Problem—Excessive Pedal Travel (Low Pedal)

Problem—Excessive Pedal Travel (Low Pedal)	
Possible Cause	**Remedy**
Worn brake pads	Replace the brake pads in axle sets.
Pad and piston knockback caused by loose wheel bearings	Adjust, tighten or replace parts as necessary.

Troubleshooting

Problem—One Brake Drags

Problem—One Brake Drags	
Possible Cause	**Remedy**
Loose or worn front wheel bearings	Adjust to specifications or replace.
Worn or damaged brake hose or hydraulic tube preventing return of brake fluid	Replace worn or damaged hose or tube as necessary.
Sticking caliper piston	Repair or replace the caliper.
Swollen caliper piston seal	Replace the caliper. Flush hydraulic brake system and fill with clean, approved brake fluid.
Sticking caliper V-ways	Clean the V-ways and anchor plate rails and thoroughly lubricate with approved grease.

Hydro-Max II® Power Booster and Master Cylinder

Problem—The Auxiliary Electric Pump Does Not Work With the Engine Off and the Brake Pedal Depressed

Problem—The Auxiliary Electric Pump Does Not Work With the Engine Off and the Brake Pedal Depressed	
Possible Cause	**Remedy**
Loose, broken or disconnected wiring to flow switch on power booster	Check the wiring and repair or replace as needed.
Power booster flow switch not working	Replace the flow switch.

Problem—Fluid Level Indicator Light Illuminated

Problem—Fluid Level Indicator Light Illuminated	
Possible Cause	**Remedy**
Low fluid level	Inspect brake pads, replace as necessary in axle sets. Add fluid as required.
Fluid level indicator switch not working	Replace the master cylinder.

Problem—Silicon Floating in Master Cylinder

Problem—Silicon Floating in Master Cylinder	
Possible Cause	**Remedy**
None	This material is an assembly lubricant and is harmless.

Problem—Noise or Whistle

Problem—Noise or Whistle	
Possible Cause	**Remedy**
None	This noise is inherent in some power boosters (whistle).

Problem—Brakes Self-Apply

Problem—Brakes Self-Apply	
Possible Cause	**Remedy**
Constricted master cylinder reservoir vent	Clean the vent passage in the reservoir cap.

Problem—Pedal Does Not Return

Problem—Pedal Does Not Return	
Possible Cause	**Remedy**
Fluid contamination	Drain the system and fill with the correct type of fluid. Bleed the air from the system. Replace the power booster or master cylinder as needed. Replace the power steering reservoir filter as needed.
Master cylinder not working	Replace the master cylinder.
Binding power booster	Replace the power booster.

Problem—Soft, Spongy Brakes

Problem—Soft, Springy or Spongy Brakes	
Possible Cause	**Remedy**
Air in the hydraulic system	Bleed the brake hydraulic system and the power steering system as needed.
Poor quality brake fluid (low boiling point)	Drain the system, flush and refill with the recommended fluid.
Weak brake hoses that expand under pressure	Replace the hoses as needed.

Problem—Too Much Effort Is Needed to Apply the Brakes (Hard Pedal)

Problem—Too Much Effort Is Needed to Apply the Brakes (Hard Pedal)	
Possible Cause	**Remedy**
Overloaded vehicle	Do not exceed rated vehicle loads.
Power booster not working	Go to "System Pressure Test," under "Pressure Tests" in this subject.
Master cylinder not working	Replace the master cylinder.
Tube and hose passages blocked shut	Replace the parts containing blocked passages.

Problem—Too Much Brake Pedal Travel (Low Pedal)

Problem—Too Much Brake Pedal Travel (Low Pedal)	
Possible Cause	**Remedy**
Leak in hydraulic system	Check for and repair any leaks found in either the power booster (power steering) hydraulic system or the brake hydraulic system.
Low fluid level or leak in master cylinder	Find the cause of the low fluid level and remedy the problem. Fill the master cylinder compartments to the correct level.
Air in the hydraulic system	Bleed the brake hydraulic system and the power steering system as needed.
Plugged master cylinder cap	Clean or replace the master cylinder cap.

Troubleshooting

Problem—Too Much Brake Pedal Travel (Low Pedal)	
Possible Cause	**Remedy**
Wrong type of brake fluid in system	Drain the system and fill with the correct type of brake fluid. Bleed the air from the system.
Master cylinder not working	Replace the master cylinder.
Weak brake hoses that expand under pressure	Replace the hoses.

Problem—The Brake Pedal Travel is Decreasing

Problem—The Brake Pedal Travel is Decreasing	
Possible Cause	**Remedy**
Plugged compensating port in master cylinder	Check the compensating ports in the master cylinder through the openings at the bottom of each reservoir compartment. Unplug them if needed. If the compensating valves are stuck, remove the reservoir. Install the compensating valves correctly.
Master cylinder pistons not returning	Repair or replace the master cylinder.

Problem—The Brakes are Dragging

Problem—The Brakes are Dragging	
Possible Cause	**Remedy**
Master cylinder pistons not returning	Repair or replace the master cylinder.
Kinked or pinched brake lines or hoses	Check the brake lines and hoses. Repair or replace as needed.
Power piston in power booster not returning	Repair or replace the power booster.
Restriction or blockage inside a brake line or hose	Go to "Residual Pressure Test," under "Pressure Tests" in this subject.
Soft or swollen master cylinder seals due to brake fluid contamination	Flush out the old brake fluid and replace the master cylinder. Fill the system with new brake fluid.
Soft or swollen rubber parts caused by incorrect or contaminated brake fluid	Replace all rubber parts including calipers (which have internal rubber seals). Flush the hydraulic system and fill with approved fluid.
Trapped pressure in brake lines caused by master cylinder or power booster not fully releasing	Repair or replace the master cylinder or power booster as necessary.

Problem—The Brakes are Grabbing or the Brake Action is Uneven

Problem—The Brakes are Grabbing or the Brake Action is Uneven	
Possible Cause	**Remedy**
Power booster not working	Repair or replace the power booster.

Troubleshooting

Problem—Fluid Is Leaking Between the Power Booster and the Master Cylinder (a slight amount of moisture between the power booster and master cylinder is normal)

Problem—Fluid Is Leaking Between the Power Booster and the Master Cylinder (a slight amount of moisture between the power booster and master cylinder is normal)	
Possible Cause	**Remedy**
Worn or damaged master cylinder primary pressure seal or backup ring	Repair or replace the master cylinder.
Worn or damaged seals or O-rings in the power booster end-cap assembly	Repair or replace the power booster.

Problem—Fluid Is Leaking at the Power Booster or the Power Steering Pump

Problem—Fluid Is Leaking at the Power Booster or the Power Steering Pump	
Possible Cause	**Remedy**
Worn or damaged seals between the auxiliary electric pump and the power booster	Replace the seals.
Loose hexbolts attaching the auxiliary electric pump to the power booster	Tighten the hexbolts 22 lbf·ft (30 N·m).
Worn or damaged power booster housing	Replace the power booster.
Worn or damaged power booster flow switch seals	Repair the power booster.
Leaking master cylinder reservoir vent caps	Replace the diaphragms and the caps.
Fluid contamination	Drain the system and fill with the correct type of fluid. Bleed the air from the system. Replace the power booster or master cylinder as needed. Replace the power steering reservoir filter as necessary.
Leaking flow switch seal	Replace the O-ring.
Leaking hydraulic fittings and connections	Check the fittings and connections. Tighten and replace as necessary.

Problem—The Power Booster Works Sluggishly or Not at All

Problem—The Power Booster Works Sluggishly or Not at All	
Possible Cause	**Remedy**
Binding power booster push rod	Check the linkage between the brake pedal and the power booster push rod. Check the hole in the cab front wall through which the push rod fits. Repair or replace parts as needed.
Worn or damaged power booster	Replace or rebuild the power booster.

Troubleshooting

Auxiliary Electric Pump

Problem—Fluid is Leaking at the Power Booster or the Power Steering Pump

Problem—Fluid is Leaking at the Power Booster or the Power Steering Pump	
Possible Cause	**Remedy**
Worn or damaged seals between the auxiliary electric pump and the power booster	Replace the seals.
Worn or damaged auxiliary electric pump	Replace the auxiliary electric pump.
Loose hexbolts attaching the auxiliary electric pump to the power booster	Tighten the hexbolts 22 lbf·ft (30 N·m).
Leaking auxiliary electric pump mounting seals	Replace the seals.

Problem—The Power Booster Works Sluggishly or Not at All

Problem—The Power Booster Works Sluggishly or Not at All	
Possible Cause	**Remedy**
Leakage around the check ball in the auxiliary electric pump	Install a flow gauge on the power booster inlet port. Check the pressure with the engine on, and the brakes fully applied. If the pressure is less than 800 psi (5515 kPa), replace the auxiliary electric pump.

Problem—The Auxiliary Electric Pump Does Not Work With the Engine Off and the Brake Pedal Depressed

Problem—The Auxiliary Electric Pump Does Not Work With the Engine Off and the Brake Pedal Depressed	
Possible Cause	**Remedy**
Disconnected or damaged wiring to auxiliary electric pump	Check the wiring. Repair or replace as needed.
Dead batteries	Check the batteries. Recharge them as needed.
Out of adjustment brake switch	Check the brake switch and adjust it as needed.
Worn or damaged brake switch	Replace the brake switch.
Relay to the auxiliary electric pump not working	Check the relay. Replace it if needed.
Auxiliary electric pump not working	Check the operation of the auxiliary electric pump and replace as needed.
Open circuit	Repair the circuit.

Problem—The Auxiliary Electric Pump Runs Continuously When the Ignition Is Off and the Brake Pedal Is Not Depressed

Problem—The Auxiliary Electric Pump Runs Continuously When the Ignition Is Off and the Brake Pedal Is Not Depressed	
Possible Cause	**Remedy**
Brake light switch not working or incorrectly adjusted	Check the brake light switch and repair or replace as needed.
Relay to the auxiliary electric pump not working	Check the relay. Replace if needed.
Flow switch not working	Remove the switch components, clean and inspect them for damage or contamination. Repair or replace as necessary.

Problem—The Auxiliary Electric Pump Is Working, But There Is No Boost Power to the Brakes

Problem—The Auxiliary Electric Pump Is Working, But There Is No Boost Power to the Brakes	
Possible Cause	**Remedy**
Low battery voltage	Check the batteries and recharge them as needed.
Low auxiliary electric pump voltage	Disconnect the wiring from the auxiliary electric pump. Check the voltage at the wire. If the voltage is 10 volts or less, replace the wire. If it is more than 10 volts, replace the auxiliary electric pump.

Power Steering Pump

Problem—The Brakes Are Dragging, Brakes Self-Apply or Pedal Does Not Return

Problem—The Brakes Are Dragging, Brakes Self-Apply or Pedal Does Not Return	
Possible Cause	**Remedy**
Self-applied booster (fluid flow too high)	Repair or replace the power steering pump.

Problem—Too Much Effort Is Needed to Apply the Brakes (Hard Pedal)

Problem—Too Much Effort Is Needed to Apply the Brakes (Hard Pedal)	
Possible Cause	**Remedy**
Overloaded vehicle	Do not exceed rated vehicle loads.
Low power booster supply flow	Repair or replace the power steering pump. Check the belt for tightness.
Power steering pump flow control valve not working	Repair or replace the power steering pump. Check the belt for tightness.
Power steering pump relief valve setting too low	Replace the power steering pump.
Tube and hose passages blocked shut	Replace the parts containing blocked passages.

Troubleshooting

Problem—Fluid Is Leaking at the Power Booster or the Power Steering Pump

Problem—Fluid Is Leaking at the Power Booster or the Power Steering Pump	
Possible Cause	**Remedy**
Worn or damaged power steering pump	Replace the power steering pump.
Fluid contamination	Drain the system and fill with the correct type of fluid. Bleed the air from the system. Replace the power booster or master cylinder as needed. Replace the power steering reservoir filter as necessary.
Leaking hydraulic fittings and connections	Check the fittings and connections. Tighten and replace as necessary.

Problem—The Power Steering Pump Is Noisy

Problem—The Power Steering Pump Is Noisy	
Possible Cause	**Remedy**
Hydraulic supply and return lines touching chassis	Reroute the power booster supply and return lines.
Low fluid level in power steering reservoir	Fill the power steering reservoir to the correct level.
Air in power steering fluid	Bleed the power steering system.
Contaminated power steering fluid	Change the power steering fluid or replace the power steering pump.

Problem—The Power Booster Works Sluggishly or Not at All

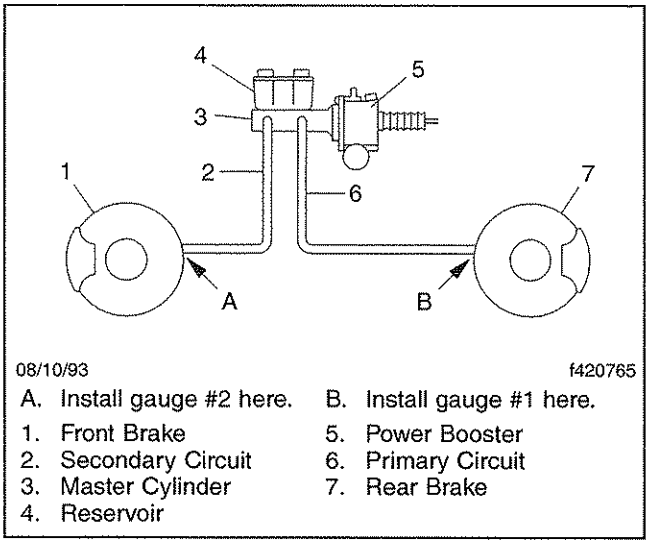
Problem—The Power Booster Works Sluggishly or Not at All	
Possible Cause	**Remedy**
Low fluid level in power steering reservoir	Fill the power steering reservoir to the correct level.
Restriction in power steering hydraulic lines	Check all the power steering system hydraulic lines. Replace as needed.
Air in power steering hydraulic system	Bleed the power steering hydraulic system.
Worn or damaged power steering pump	Repair or replace the power steering pump.

Pressure Tests

Residual Pressure Test

1. Install two pressure gauges with a range of 0 to 50 psi (345 kPa)—one in the primary circuit (at the rear wheel), and one in the secondary circuit (at the front wheel). See **Fig. 1**.
2. Bleed the two circuits following the procedure in **Subject 110**.
3. With the ignition off, lightly apply the brakes several times. Do not apply full pressure to the brake pedal or you may damage the pressure gauges.
4. Release the brakes. Read the residual pressure on the two gauges. Record the information.
5. If the residual pressure on one or both gauges is less than 2 psi (14 kPa), go to "System Pressure Test" in this subject.

   If the residual pressure on one or both gauges is more than 2 psi (14 kPa), check the linkage between the brake pedal and the booster. Adjust or repair the linkage as needed. Repeat steps 3 and 4. If the problem is solved, go to "System Pressure Test" in this subject. If the problem is not solved, continue with the procedure.
6. If the check ports of the master cylinder have check valves, replace the master cylinder. Repeat steps 2 and 3. If the problem is solved, go to "System Pressure Test" in this subject. If the problem is not solved, continue with the procedure.



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A. Install gauge #2 here.
B. Install gauge #1 here.
1. Front Brake
2. Secondary Circuit
3. Master Cylinder
4. Reservoir
5. Power Booster
6. Primary Circuit
7. Rear Brake

Fig. 1, Gauge Installation

If the check ports of the master cylinder do not have check valves, check the hydraulic lines for internal blockage. Repair or replace lines as needed. Repeat steps 3 and 4. If the problem is solved, go to "System Pressure Test" in this subject. If the problem is not solved, continue with the procedure.

7. Check the master cylinder function. Repair or replace as needed. Go to "System Pressure Test" in this subject.

System Pressure Test

1. Install two pressure gauges with a range of 0 to 2500 psi (17 237 kPa)—one in the primary circuit (at the rear wheel), and one in the secondary circuit (at the front wheel). See **Fig. 1**.

   If you have previously done the residual pressure test, remove the two low-pressure gauges installed for that test, and replace them with the two high-pressure gauges.

2. Bleed the primary and secondary brake circuits following the procedure under **Subject 110**.

3. Make a copy of **Table 1**. Use this copy to record the results from the next step.

Test Results				
Pressure Test	**Gauge 1 (installed at rear wheel)**		**Gauge 1 (installed at front wheel)**	
Rapid Pressure Rise	Yes	No	Yes	No
Slow Pressure Rise	Yes	No	Yes	No
Highest Reading (psi)		psi		psi
Pressure Constant	Yes	No	Yes	No

Table 1, Test Results

4. Start the engine. Quickly apply the brakes using full pedal force. Hold the pedal down for 15 to 20 seconds. Record the speed of the pressure rise, the highest pressure registered on each gauge and whether the pressure stayed constant while the pedal was depressed. See **Table 1**.

5. If the pressure reading on both gauges is not within 10 percent, repair or replace the master cylinder as needed. Remove the pressure gauges. Bleed the system following the instructions in **Subject 110**.

6. If the pressure reading on both gauges is within 10 percent, but the gauges show less than 1170 psi (8067 kPa), turn off the engine; ignition on. Apply the brakes hard, hold the pedal down 15 to 20 seconds.

   If both gauges show at least 860 psi (5930 kPa), repair or replace the power booster. Remove the pressure gauges. Bleed the system following the instructions in **Subject 110**.

   If both gauges do not show at least 860 psi (5930 kPa), repair or replace the power steering pump. Bleed the system following the instructions in **Subject 110**.

7. If the pressure reading on both gauges is within 10 percent and the gauges show at least 1170 psi (8067 kPa), but the pressure came up slowly on both gauges, turn off the engine; ignition on. Apply the brakes hard, hold down the pedal 15 to 20 seconds. If there was an instant pressure rise on both gauges, repair or replace the power steering pump. Remove the pressure gauges. Bleed the system following the instructions in **Subject 110**.

   If there was not an instant pressure rise on both gauges, repair or replace the power booster.

Troubleshooting

Remove the pressure gauges. Bleed the system following the instructions in **Subject 110**.

8. If the pressure reading on both gauges is within 10 percent and the gauges show at least 1170 psi (8067 kPa), but the pressure came up fast on one gauge and slowly on the other gauge, locate the restriction in the circuit having the slow gauge. Remove and install the gauge closer to the master cylinder until the pressure rises quickly. The restriction is between that point and the point of previous installation. Repair or replace the brake line as needed. Remove the pressure gauges. Bleed the system following the instructions in **Subject 110**.
9. If the pressure reading on both gauges is within 10 percent, the gauges show at least 1170 psi (8067 kPa) and the pressure came up instantly on both gauges, but there was not constant gauge pressure while the pedal was depressed, turn off the engine; ignition on. Apply the brakes hard, hold down the pedal for 15 to 20 seconds. If there is constant pressure on both gauges while the pedal is down, repair or replace the power steering pump. Bleed the system following the instructions in **Subject 110**.

   If there is not constant pressure on both gauges while the pedal is down, repair or replace the power booster. Bleed the system following the instructions in **Subject 110**.
10. If the pressure reading on both gauges is within 10 percent, the gauges show at least 1170 psi (8067 kPa), the pressure came up instantly on both gauges and there was constant gauge pressure while the pedal was depressed, but the brake pedal did not stay firm, repair or replace the master cylinder as needed. Bleed the system following the instructions in **Subject 110**.
11. If the pressure reading on both gauges is within 10 percent, the gauges show at least 1170 psi (8067 kPa), the pressure came up instantly on both gauges, there was constant gauge pressure while the pedal was depressed and the brake pedal stayed firm, remove the pressure gauges. Bleed the system following the instructions in **Subject 110**. If the problem still exists, check the foundation brakes.

Specifications

See Fig. 1 for the hydraulic brake system plumbing diagram. **See Fig. 2** for the brake control module wiring diagram.

Kent-Moore Part Number	Tool
KMS/ZTSE4276	Seating Tool for 2.88-Inch Caliper Pistons
KMS/ZTSE4343	Seating Tool for 2.6-Inch Caliper Pistons

Table 1, Kent-Moore Tools, Kent-Moore Tool Division, 29784 Little Mack, Roseville, MI 48066

Description	Bolt or Nut Size	Grade	Torque N·m (lbf·ft)
Power Booster Mounting Bolts	—	—	27 (20)
Master Cylinder Mounting Nuts	—	—	38 (28)
Brake Line Tube Nuts	7/16–24	—	20 (15)
Caliper Supply Fitting	7/16–24	—	20 (15)
Allen-Head Key Retainer Bolts	—	—	24 (18)
Reservoir Mounting Hexbolts	—	—	20 (15)
Anchor Plate Mounting Hexbolts	1/2–13	8	95 (70)
Rotor Mounting Hexbolts	9/16–12	8	175 (130)
Dust Shield Mounting Bolts	—	—	20 (15)
Master Cylinder Outlet Fittings	7/16–24	—	20 (15)
Power Booster Supply Line Fitting	—	—	27 (20)

Table 2, Fastener Torques

Fluid Type	Recommended Fluid
Automatic Transmission Fluid	Dexron II®

Table 3, Approved Power Steering Fluid for Power Booster

Fluid Type	Recommended Fluid
DOT 3	Wagner-Premium Plus Super HD Delco Supreme II Dow HD 50-4

Table 4, Approved Brake Fluid for Brake System

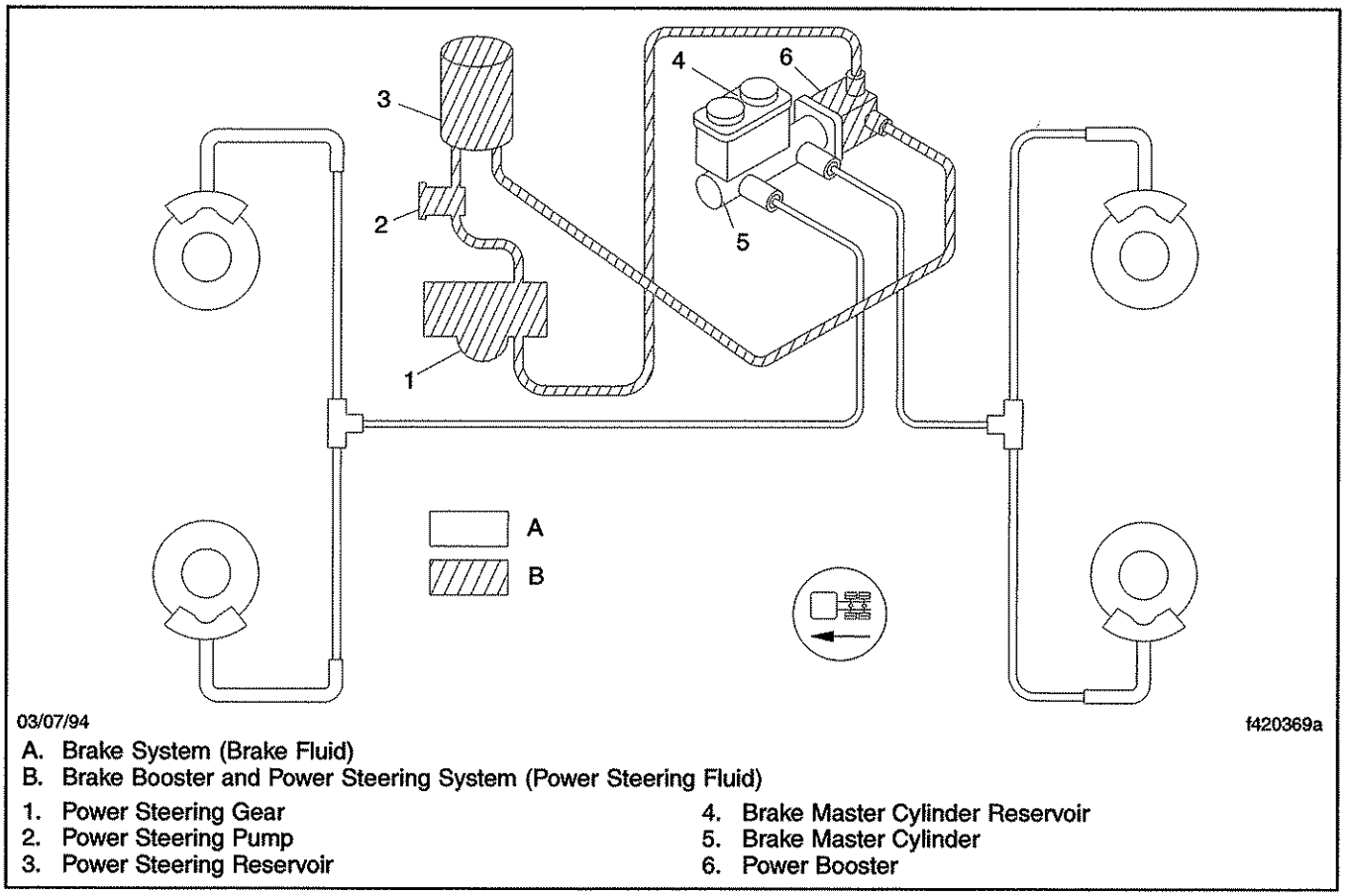
Maximum Allowable Lateral Runout mm (inch)	Minimum Allowable Thickness mm (inch)	Maximum Difference in Parallelism mm (inch)
0.38 (0.015)	33.5 (1.32)	0.13 (0.005)

Table 5, Rotor Specifications

Specifications

Component	Recommended Grease
Brake Caliper V-Ways and Anchor Plate Rails	Aeroshell Grade 5 (ES-1246)

Table 6, Approved Brake System Grease



A. Brake System (Brake Fluid)
B. Brake Booster and Power Steering System (Power Steering Fluid)

1. Power Steering Gear
2. Power Steering Pump
3. Power Steering Reservoir
4. Brake Master Cylinder Reservoir
5. Brake Master Cylinder
6. Power Booster

Fig. 1, Hydraulic Brake System Plumbing Diagram

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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.

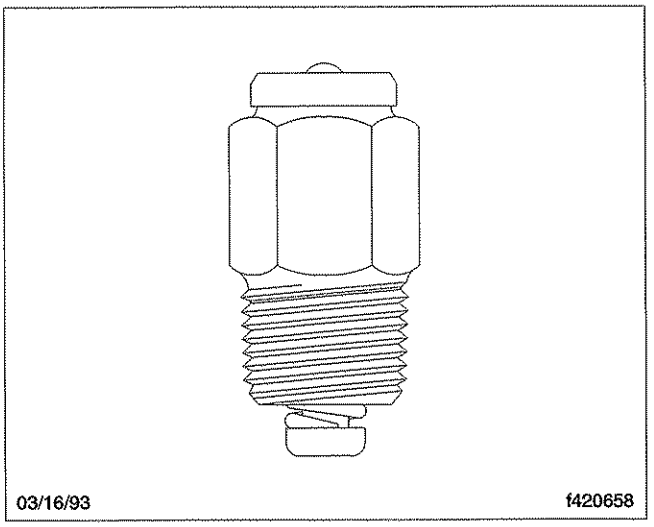


Fig. 1

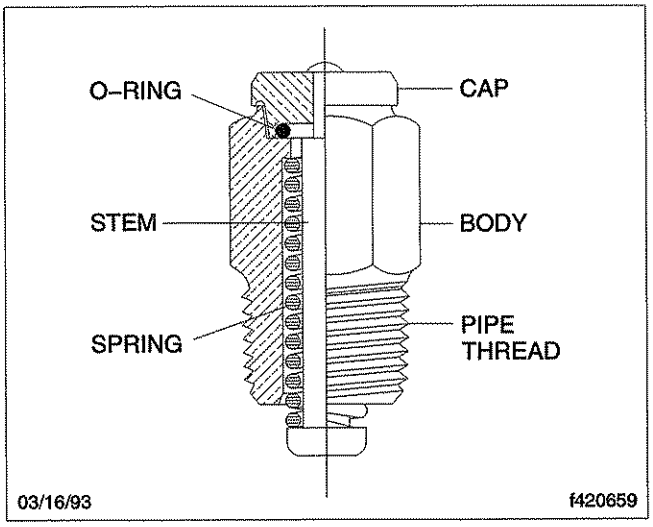


Fig. 2

Operating Check (Refer to Fig. 1)

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

⚠ WARNING

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.

   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.

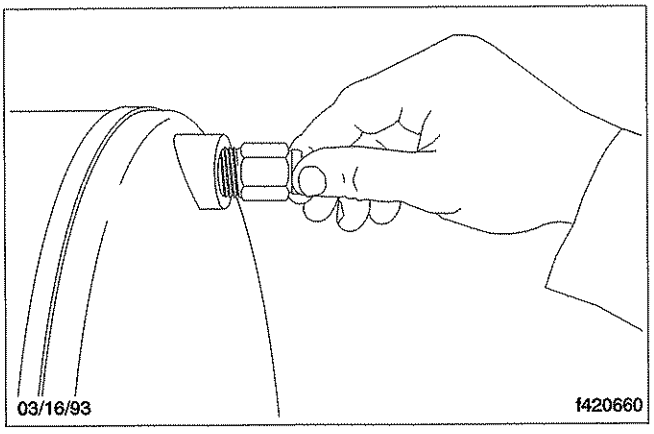


Fig. 1

Removal

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

Installation

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

⚠ WARNING

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.

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 Subject 100.**

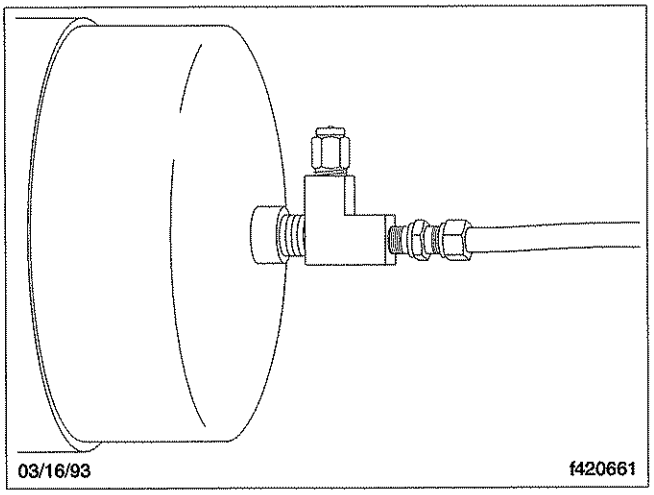


Fig. 1

Contents

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General Description (Refer to Fig. 1)

The Gunite [1] automatic slack adjuster has two main functions:

- As a lever it converts the straight-line force of the brake chamber push rod to torque on the brake camshaft. Rotation of the camshaft forces the brake shoes against the drum.
- As an automatic adjuster, it maintains the lining-to-drum clearance needed for proper brake chamber push rod stroke.

The slack adjuster is installed between the brake chamber push rod and the brake camshaft. A clevis connects the brake chamber push rod to the top of the slack adjuster. The bottom of the slack adjuster is splined to the brake camshaft. The splines hold the slack adjuster internal gear to the camshaft, so the camshaft turns when the slack adjuster moves. When the brakes are applied, the brake chamber push rod moves outward forcing the slack adjuster and camshaft to rotate. This movement forces the brake shoes against the drum.

The brakes are adjusted when the slack adjuster senses an increase in the lining-to-drum clearance. The slack adjuster's internal worm shaft and ratchet shorten excessive lining-to-drum clearance. This provides maximum leverage for the brake chamber push rod. The automatic slack adjuster adjusts the brakes at the beginning of the brake application.

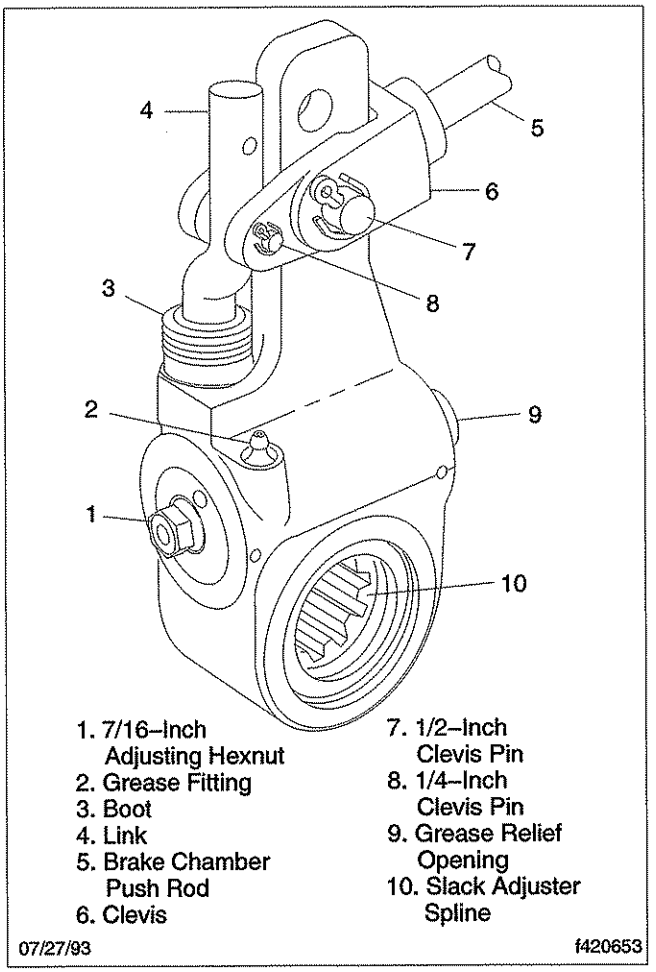


Fig. 1

[1] Formerly Kelsey-Hayes

IMPORTANT: This automatic slack adjuster cannot be rebuilt. If it is damaged or inoperative, replace the unit. Also, when installing or replacing a Gunite automatic slack adjuster, a new clevis must be installed.

Removal (Refer to Fig. 1)

1. Park the vehicle on a level surface, and chock the tires. If you are removing a rear slack adjuster, release the parking brake, then cage the parking brake power spring. For instructions, refer to the brake chamber section in this manual.
2. Back off the clevis jam nut.
3. Remove the cotter pins, clevis pins, and link.
4. Rotate the adjusting hexnut counterclockwise until the slack adjuster clears the clevis.
5. Remove the snap ring from the brake camshaft, then slide the slack adjuster off the camshaft.
6. Remove the clevis from the brake chamber push rod.

Installation (Refer to Fig. 2)

1. Coat the end of the brake chamber push rod, the camshaft splines, and the splines of the slack adjuster gear with an anticorrosive grease.
2. Make sure that the jam nut is on the brake chamber push rod. Tighten a new snap nut (Ref. 4) until the push rod is flush with the end of the snap nut. Do not tighten the jam nut.
3. Using the cotter pins and clevis pins, install a new clevis on the slack adjuster.
4. Using the old snap ring, install the automatic slack adjuster on the brake camshaft.
5. Turn the adjusting hexnut (Ref. 1) clockwise to rotate the slack adjuster toward the brake chamber until the clevis (Ref. 3) contacts the snap nut. Then, push the clevis and snap nut together.

⚠ WARNING

WARNING: Make sure that the snap nut contacts the clevis and that there is proper engagement. If the snap nut and clevis are not installed correctly, the brakes may not work properly. This could result in an accident causing personal injury and property damage.

⚠ CAUTION

CAUTION: Once attached to the clevis, the snap nut cannot be removed from the clevis. If the snap nut is removed, the clevis and/or snap nut will be damaged.

6. Pull on the clevis to make sure that it and the snap nut are properly engaged.
7. Using the gauge supplied with the new slack adjuster, adjust the clevis. **See Fig. 3.**

   7.1 Position the 1/2-inch hole in the gauge over the end of the 1/2-inch clevis pin.

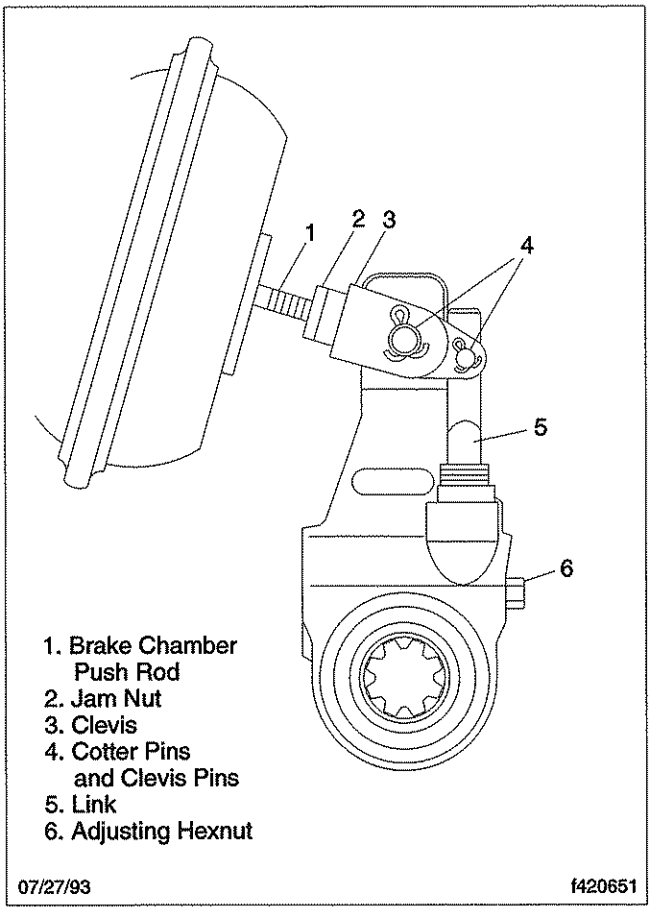


Fig. 1

Removal and Installation

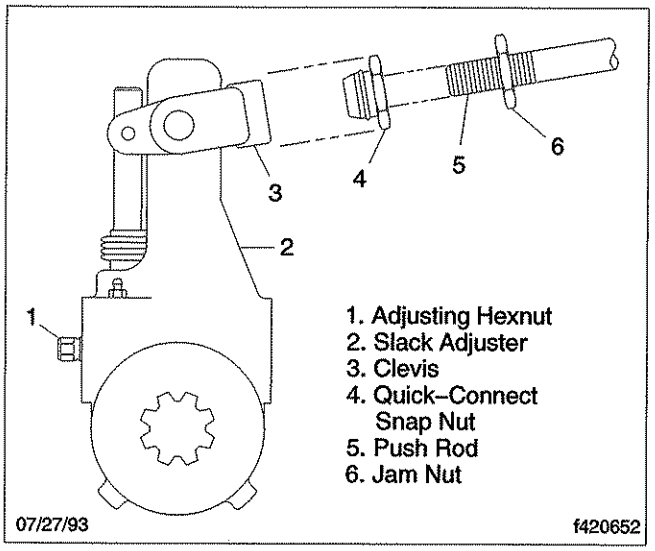


Fig. 2

7.2 Align the applicable 1/4-inch hole in the bottom of the gauge over the center hole of the camshaft.

7.3 Turn the snap nut and adjust the clevis so all of the 1/4-inch pin is visible in the notched area of the gauge. Make sure the push rod doesn't extend into the clevis opening more than 1.5 mm (1/16 inch) past the snap nut.

7.4 Tighten the jam nut.

⚠ CAUTION

CAUTION: Be sure to tighten the jam nut. Failure to do so may allow the snap nut to turn, which could prevent the automatic slack adjuster from working correctly.

NOTE: Make sure there is clearance between the slack adjuster and other vehicle components when the brakes are applied and the push rod travels its maximum stroke.

8. Set the initial free-stroke.

8.1 Turn the adjusting hexnut clockwise until the brake linings contact the drum.

8.2 Turn the adjusting hexnut counterclockwise one-half turn. There should be about 41 N·m (30 lbf·ft) resistance, and a ratcheting sound will be heard.

9. Measure the brake chamber stroke.

9.1 With the brakes fully released, use a ruler to measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 4,** Ref. *A* .

9.2 Build air pressure to at least 586 kPa (85 psi). Apply the brakes, then measure the distance from the bottom of the brake chamber to the center of the large clevis pin. **See Fig. 4**, Ref. *B* . The difference between the measurements is the brake chamber stroke.

9.3 The brake chamber stroke must be less than the measurements shown in the applicable table in **"Specifications, 400."** If it isn't, check the foundation brakes for problems such as worn cams, bushings, pins and rollers, or broken springs. Repair or replace as needed. For instructions, refer to the foundation brake section in this man-

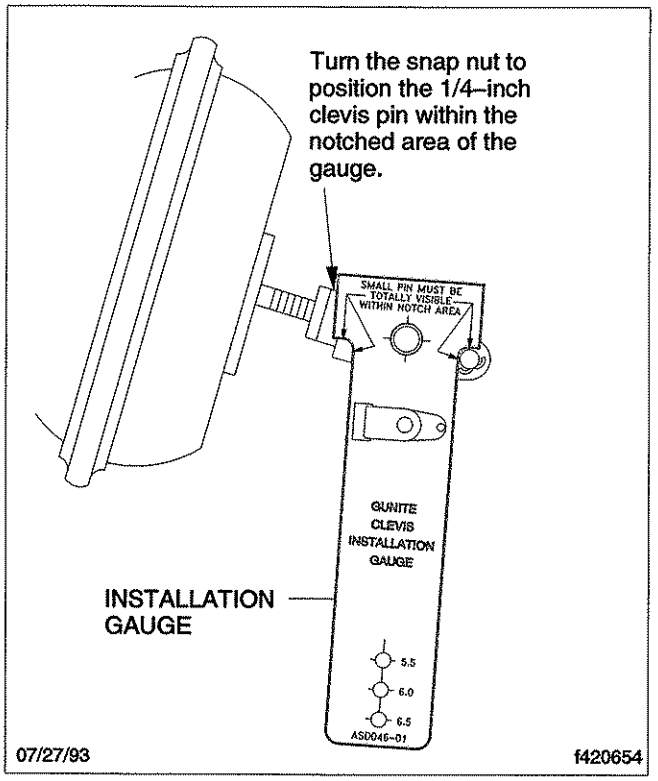


Fig. 3

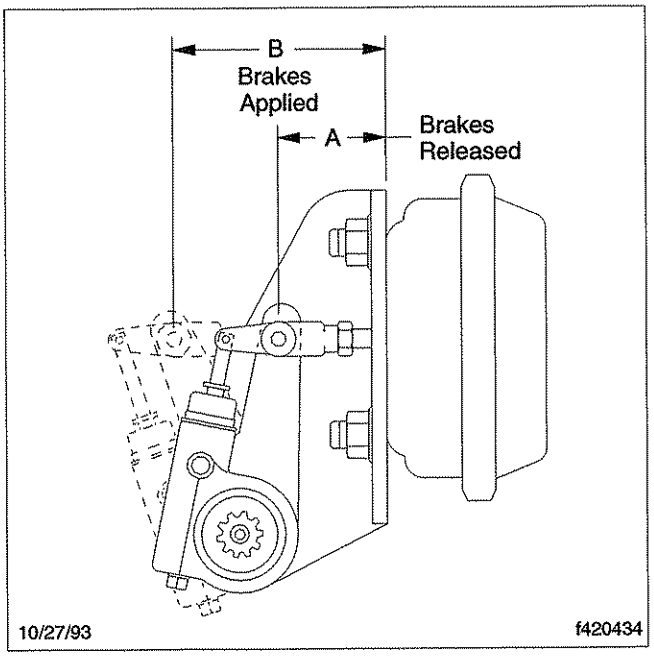


Fig. 4

ual. Then, repeat steps for setting the initial free-stroke, and measuring the brake chamber stroke.

10. If a rear axle slack adjuster was installed, manually uncage the parking brake. For instructions, refer to the brake chamber section in this manual.

11. Apply the parking brakes. Remove the chocks from the tires.

Specifications

Lubricant Type	Temperature
Lubriplate Aero	Above -40°C (-40°F)
Texaco Multifak EP-2 Mobil Grease 77	Above -29°C (-20°F)

Table 1, Approved Lubricants

Chamber Size	Maximum Chamber Stroke
16 20 24	Less than 44 mm (1-3/4 inches)
24* 30	Less than 51 mm (2 inches)

* Long stroke.

Table 2, Maximum Adjusted Brake Chamber Strokes

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General Information

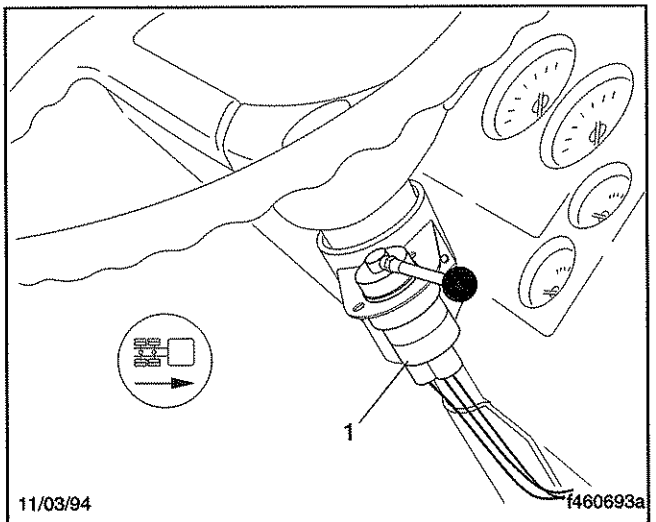
A hand-operated brake valve is included in some air brake systems for tractor units pulling trailers, in addition to the standard foot brake valve and related equipment. This valve allows the driver independent control of the trailer brakes, which can be useful when checking trailer brakes, or changing adjustable fifth wheel locations.

The brake valve is mounted on the right side of the steering column. See **Fig. 1.**

Principles of Operation (See Fig. 2)

When the valve's control handle is moved in a clockwise direction, the cam (Ref. 13) compresses the graduating spring (Ref. 14), which in turn forces the piston (Ref. 15) to move down. As the piston moves down, compressed air from the supply port flows to the delivery port, applying the trailer brakes through the trailer service line.

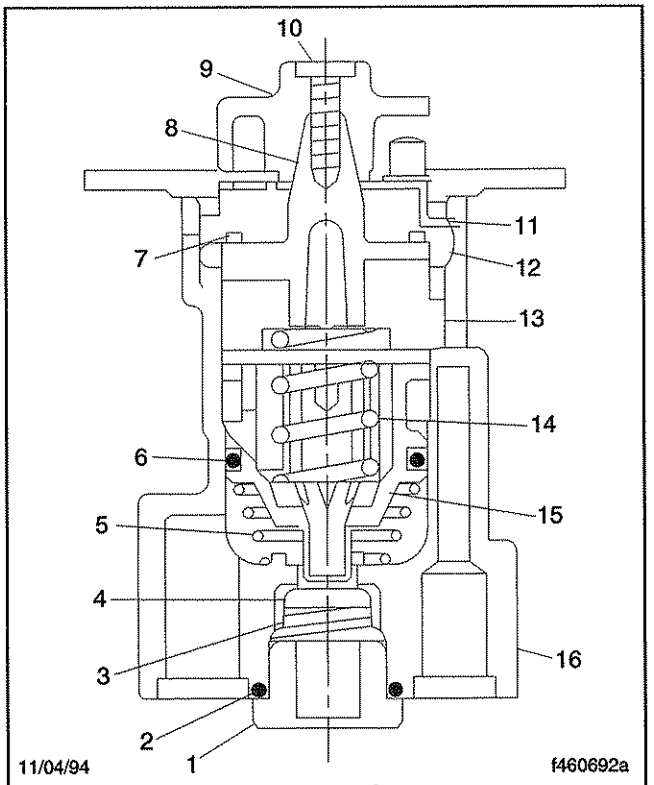
As air pressure builds in the trailer air system, the pressure under the piston will match the pressure of the compressed graduating spring. This moves the piston up enough to stop air flow through the valve, allowing air pressure in the trailer service brake system to remain constant.



1. Trailer Break Control Valve

Fig. 1, Trailer Brake Control Valve Installed on the Steering Column

When the control handle is moved counterclockwise, the cam moves up, releasing tension on the graduating spring. This allows the pressure below the piston to increase. The air pressure will then move the piston up and allow air in the service line to flow out of the exhaust port, releasing the trailer brakes.



1. End Cap
2. O-Ring
3. Valve Spring
4. Valve Disc Assembly
5. Piston Return Spring
6. Piston O-Ring
7. Bushing
8. Camshaft
9. Cover
10. Screw, Handle
11. Lock
12. Bearing
13. Cam
14. Graduating Spring
15. Piston
16. Body

Fig. 2, Trailer Brake Control Valve (sectional view)

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

1. Chock the tires and stop the engine before working under a vehicle. Depleting air system pressure may cause the vehicle to roll. Keep hands away from brake chamber push rods and slack adjusters; they may apply as air system pressure drops.
2. Never connect or disconnect a hose or line containing compressed air— it may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released. Even when compressed air has been released at the reservoirs, residual air may still be trapped in the air lines.
3. Never exceed recommended air pressure, and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood the recommended procedures. Some components contain powerful springs, and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to the use of those tools.

⚠ WARNING

WARNING: Don't use the hand brake valve to apply the trailer brakes for parking. It is not designed for this purpose. The air could bleed out of the trailer air tank allowing the vehicle to roll, which could cause personal injury, property damage, or damage to the vehicle.

Test

1. Park the vehicle on a level surface and chock the tires.
2. Connect an accurate test gauge to the delivery port of the valve, or connect the gauge to the service hose coupling located behind the cab. When the gauge is connected to the service hose coupling, install a dummy hose coupling on the supply (emergency) hose coupling, and place the dash valve in the trailer charge position. When the valve control handle is moved to the fully applied position, the gauge should register full reservoir pressure.

NOTE: Midland valves are set to deliver full reservoir pressure. Intermediate positions should deliver proportional intermediate pressures. Upon manual release, the gauge should immediately register zero.

3. Locate the exhaust port or exhaust line and apply a soap solution.
4. With the valve in the released position, exhaust leakage should not exceed a 2.5-cm (1-inch) bubble in 5 seconds.

   With the valve fully applied, exhaust leakage should not exceed a 2.5-cm (1-inch) bubble in 5 seconds.
5. If the valve does not function properly or if leakage is excessive, replace the valve following the instructions **in Subject 120.**
6. Remove the chocks from the tires.

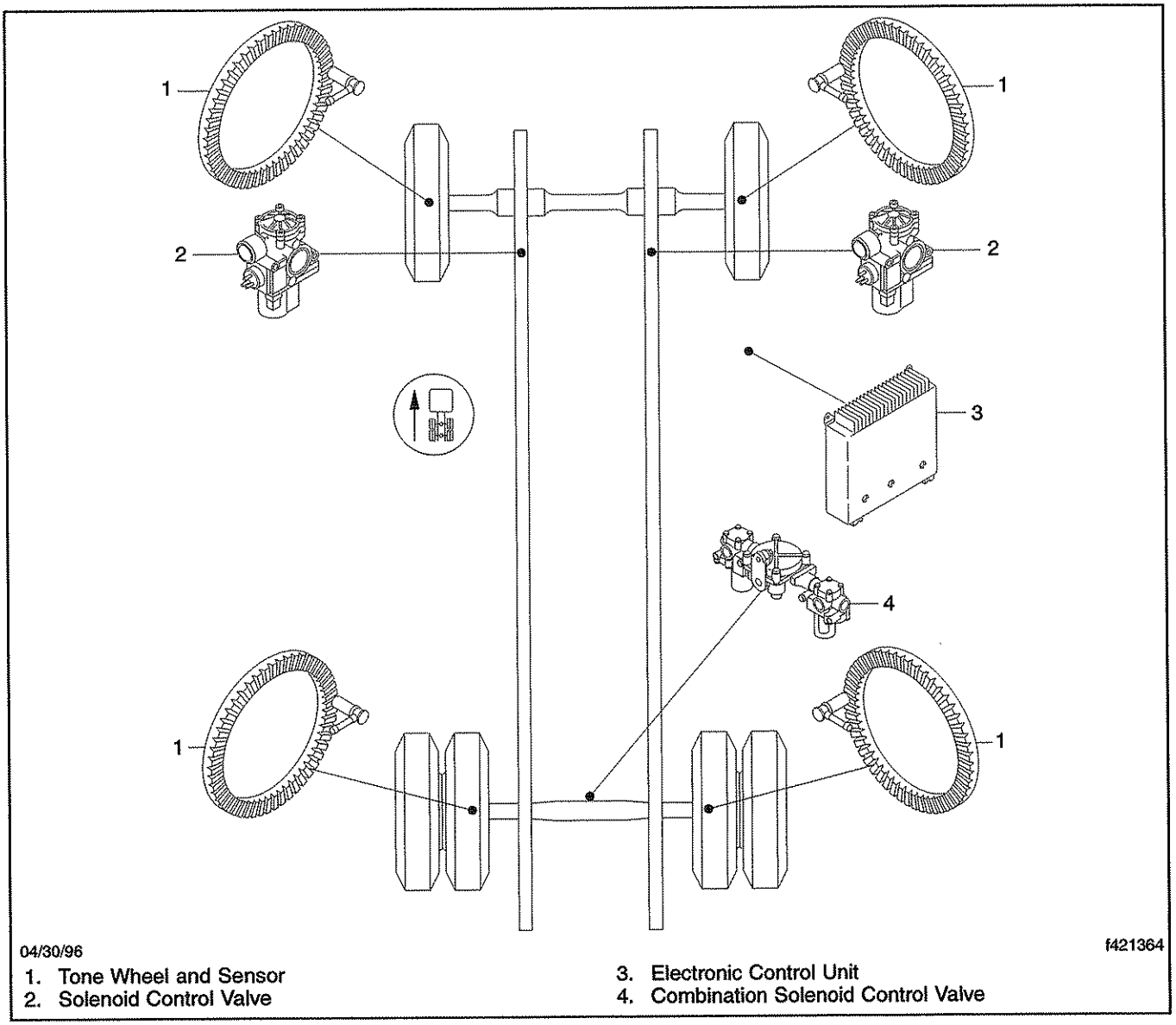
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General Description (See Fig. 1)

The WABCO Antilock Braking System (ABS) is an electronic wheel speed monitoring and control system that works with the air brake system. ABS passively monitors vehicle wheel speed at all times, and controls wheel speed during emergency stops. If equipped with Traction Control or Automatic Traction Control, wheel spin is controlled during reduced-traction situations. In normal braking applications, the air brake system is in effect.

ABS includes signal-generating tone wheels and sensors located in the wheel hubs of each sensed wheel. 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



1. Tone Wheel and Sensor
2. Solenoid Control Valve
3. Electronic Control Unit
4. Combination Solenoid Control Valve

Fig. 1, Location of ABS Components, Four-Channel System

enhances steering control during emergency braking situations. If equipped with Traction Control or Automatic Traction Control (ATC), two additional solenoid valves are installed. During reduced-traction situations, these valves increase or reduce air pressure supply in the brake chamber to provide better traction whenever wheel spin occurs.

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**).

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 teeth of the tone wheel cause interruptions in a magnetic field created by the sensor. The interruptions created in the magnetic field in turn create electrical pulses that are sent by the sensor to the electronic control unit.

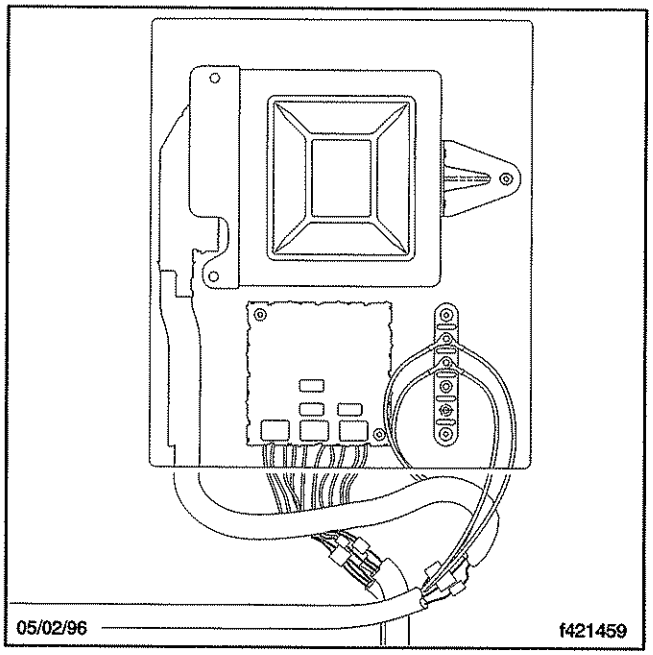


Fig. 2, Electronic Control Unit

Electronic Control Unit

The WABCO ABS system combines one front-axle control channel with one rear axle to form a control circuit. For example, the sensor and solenoid control valve on the left-front axle form a control circuit with the sensor and solenoid control valve on the right-rear axle.

The electronic control unit (ECU), located behind the passenger seat, contains microcomputers to monitor both control circuits. The ECU receives speed sensor pulses and interprets these signals to calculate wheel speed and a vehicle reference speed. If the calculations indicate wheel spin or lockup, the appropriate control circuit signals the solenoid control valve(s) to increase or decrease braking pressure.

The ECU contains another microcomputer that provides a safety circuit to constantly monitor the wheel sensors, traction control valves (if equipped), solenoid control valves, and the electrical circuitry. After the engine is started, the tractor warning light (TRAC ABS) comes on. See **Fig. 4**. Once the vehicle moves faster than about 4 mph (6 km/h), the warning light goes out if all of the tractor's ABS components are working properly.

A wheel spin (WHL SPIN) indicator light (if equipped) will come on if one of the drive wheels spins during reduced-traction situations. See **Fig. 4**. Refer to the vehicle driver's manual for operating instructions.

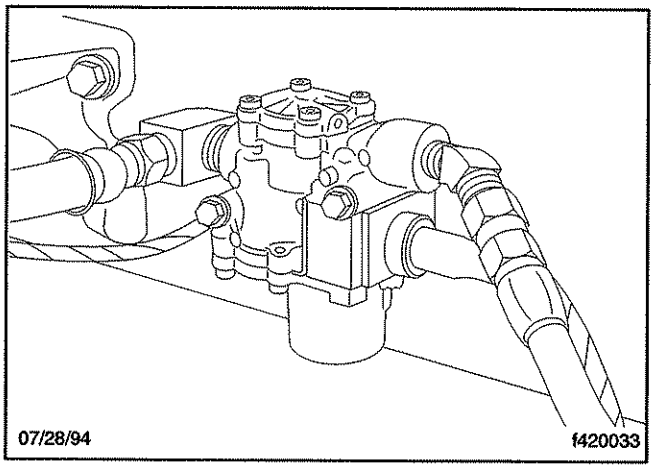
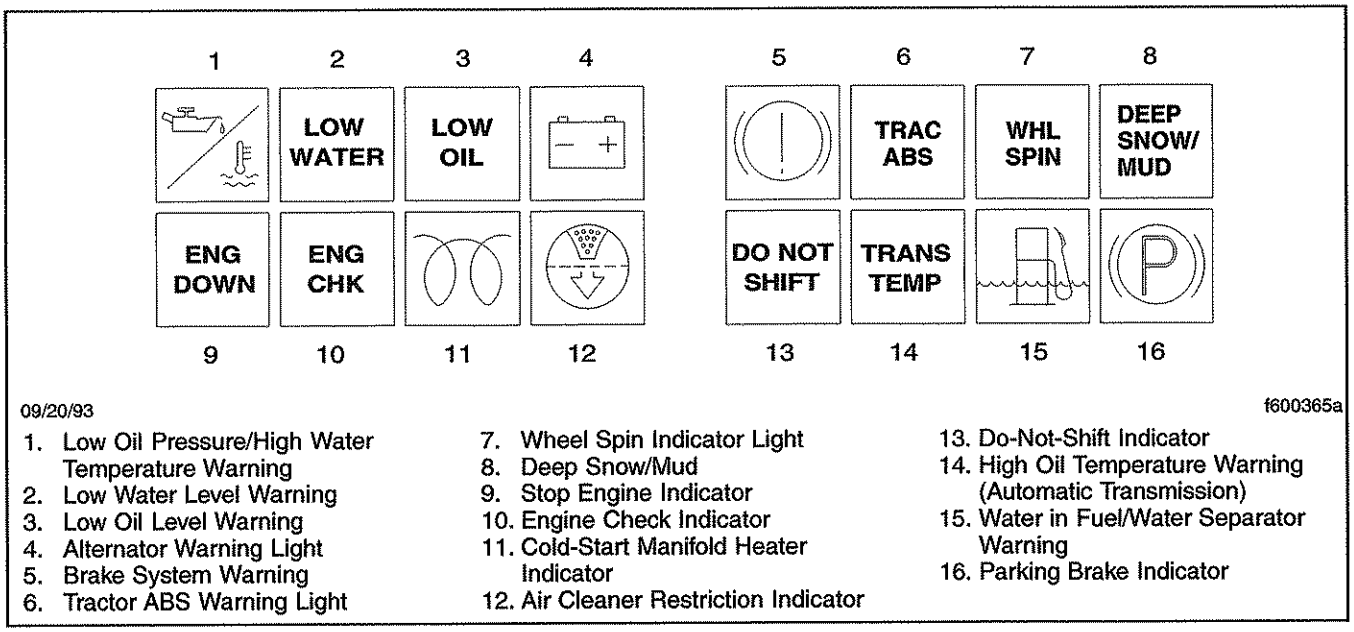


Fig. 3, Solenoid Control Valve



1. Low Oil Pressure/High Water Temperature Warning
2. Low Water Level Warning
3. Low Oil Level Warning
4. Alternator Warning Light
5. Brake System Warning
6. Tractor ABS Warning Light
7. Wheel Spin Indicator Light
8. Deep Snow/Mud
9. Stop Engine Indicator
10. Engine Check Indicator
11. Cold-Start Manifold Heater Indicator
12. Air Cleaner Restriction Indicator
13. Do-Not-Shift Indicator
14. High Oil Temperature Warning (Automatic Transmission)
15. Water in Fuel/Water Separator Warning
16. Parking Brake Indicator

Fig. 4, Dash Warning and Indicator Lights

If equipped with an electronic engine, an automatic traction control (ATC) system may be installed. On these vehicles, the ATC system automatically reduces wheel spin during reduced-traction situations.

An "ATC Function" switch (if equipped), may be used under more adverse conditions. Turning on this switch illuminates the DEEP SNOW/MUD indicator light (**Fig. 4**). The ATC system now allows some wheel spin (for example, to help burn through a thin layer of ice) during reduced-traction situations.

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. An exception would be if a solenoid control valve (or combination solenoid control valve) is damaged and inoperative. As these components are an integral part of the air brake system, normal braking may be impaired or inoperative.

IMPORTANT: If the TRAC ABS warning light does not work as described above, repair the ABS system. See **"Troubleshooting, 300"** for fault diagnosis.

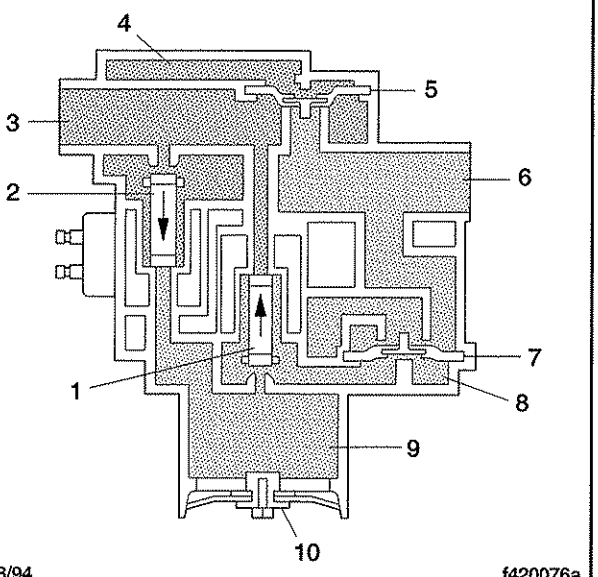
Solenoid Control Valve and Combination Valve

The solenoid control valves are attached to the frame crossmember near the brake chambers. The combination solenoid control valve (for vehicles without traction control manufactured November, 1995 or later), which includes a relay valve, is also attached to the frame crossmember near the rear brake chambers. Depending on the signal received from the electronic control unit, the control valve 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. Solenoid valve 1 opens allowing compressed air to enter the inlet chamber and pilot chamber 1. See **Fig. 5**.

At the same time, solenoid valve 1 closes off 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

General Description and Principles of Operation



1. Solenoid Valve No. 2
2. Solenoid Valve No. 1
3. Inlet Chamber
4. Pilot Chamber No. 1
5. Diaphragm Valve No. 1
6. Delivery Chamber
7. Diaphragm Valve No. 2
8. Pilot Chamber No. 2
9. Exhaust Chamber
10. Exhaust Port

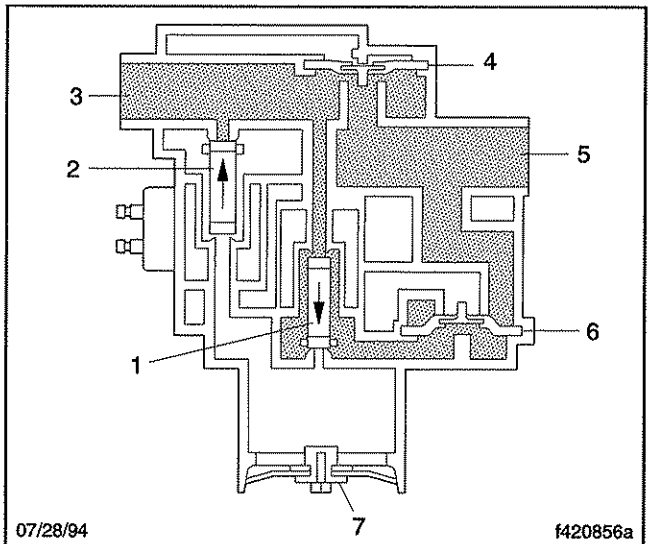
Fig. 5, Wheel Lockup Cycle

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.

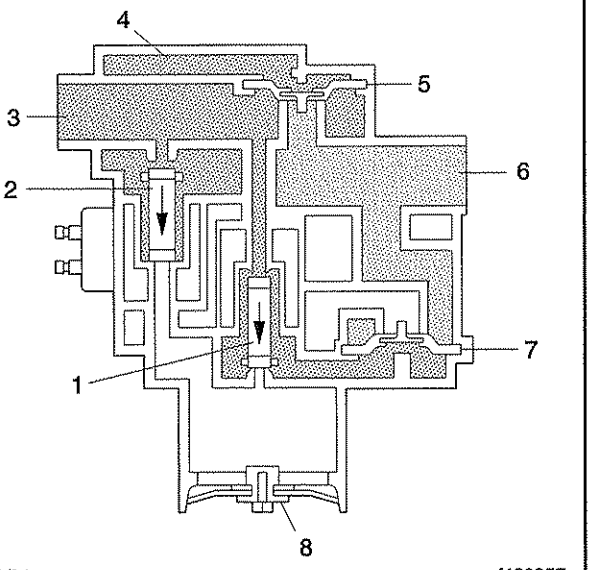
During the pressure increase cycle (**Fig. 6**), both solenoid valves are closed. Compressed air entering through the inlet chamber forces diaphragm valve 1 open, allowing air to pass through the delivery chamber into the brake chamber. At the same time, pressure within the control valve keeps diaphragm valve 2 closed, preventing air from releasing through the exhaust port.

If maintaining brake air pressure (**Fig. 7**), 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.



1. Solenoid Valve No. 2
2. Solenoid Valve No. 1
3. Inlet Chamber
4. Diaphragm Valve No. 1
5. Delivery Chamber
6. Diaphragm Valve No. 2
7. Exhaust Port

Fig. 6, Pressure Increase Cycle



1. Solenoid Valve No. 2
2. Solenoid Valve No. 1
3. Inlet Chamber
4. Pilot Chamber No. 1
5. Diaphragm Valve No. 1
6. Delivery Chamber
7. Diaphragm Valve No. 2
8. Exhaust Port

Fig. 7, Maintaining Brake Air Pressure Cycle

Wheel Speed Sensor Replacement

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. Refer to the electrical section (wiring) in this manual for information on special terminals and connectors, and on ordering tools for them.

Front Axle

1. Chock the rear tires to prevent vehicle movement. Apply the parking brakes.
2. Gently twist and pull the sensor, to remove it from the steering knuckle (**Fig. 1**).
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.

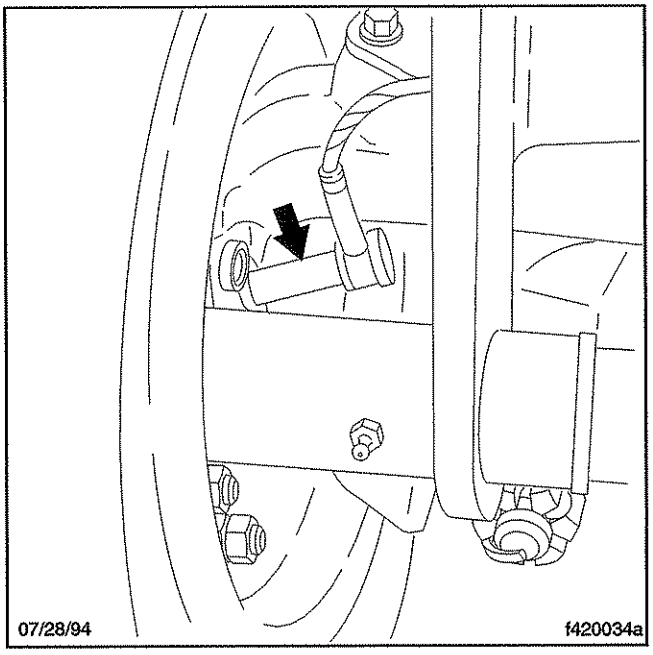


Fig. 1

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, 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. Apply 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.
4. Remove the wheel and tire assembly from the rear axle. For instructions, refer to the wheels and tires section in this manual.
5. Remove the brake drum. For instructions, refer to the rear axle section in this manual.
6. Gently twist and pull the sensor, to 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. Coat the sensor with Mobil HP, Valvoline EP633, Penzoil 707L, or an equivalent. 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 the brake section in the vehicle maintenance manual.

Wheel Speed Sensor Replacement

16. Install the wheel and tire assembly, and tighten the wheel nuts. Use the tightening sequence and torque values listed in the wheels and tires section in this manual.
17. Remove the safety stands, lower the vehicle, and remove the chocks from the front tires.

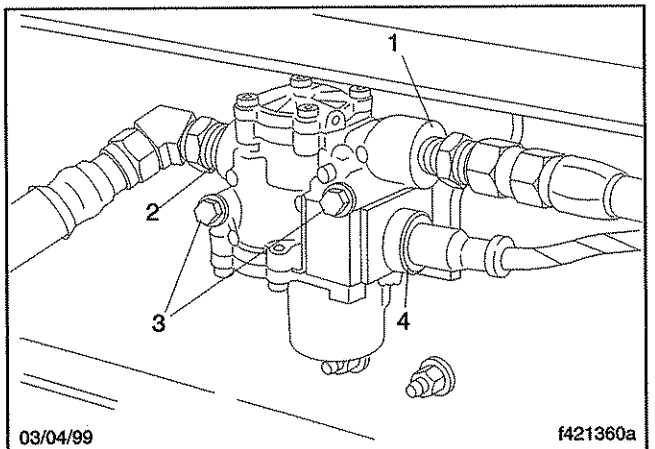
Solenoid Control Valve Removal and Installation

Removal (See Fig. 1 or Fig. 2)

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. See **Group 54** in this manual for information on special terminals and connectors, and on ordering tools for them.

1. Chock the front and rear tires.
2. Release the pressure from the air reservoirs.
3. Disconnect the wiring from the solenoid control valves or combination solenoid control valve.
4. Mark the air lines for ease of installation. Disconnect the air lines.
5. Remove the two mounting capscrews, washers, and nuts.
6. Remove the solenoid control valves or combination solenoid control valve.

NOTE: The combination solenoid control valve can be disassembled if replacement of the relay valve or one of the solenoid control valves is needed. For disassembly and assembly instructions, see **Subject 140.**



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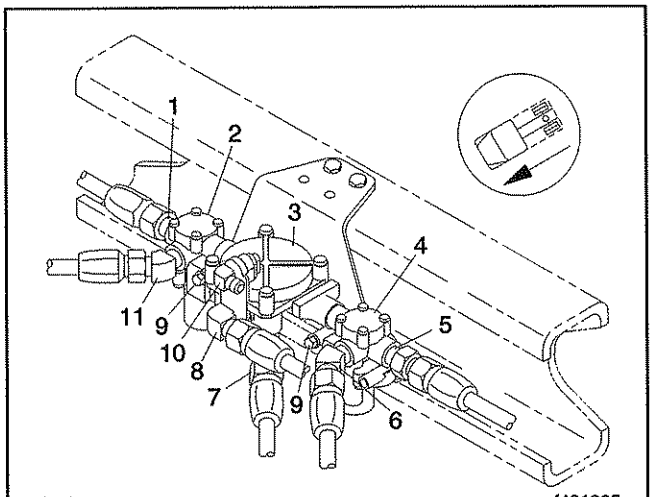
1. Supply Port 1 (from steer axle quick release)
2. Delivery Port 2 (to brake chamber)
3. Mounting Fasteners
4. Electrical Connection

Fig. 1, Solenoid Control Valve

Installation

IMPORTANT: It is possible for the solenoid valves to be installed backward. See **Fig. 1** to be sure the valves are installed correctly.

1. Install the solenoid valves or the combination solenoid control valve.
2. Install the two mounting capscrews, washers, and nuts. Tighten the mounting nuts 15 lbf·ft (20 N·m).
3. Connect the air lines.
4. Connect the wiring to the solenoid control valves, or combination solenoid control valve.
5. Start the engine and allow the air reservoirs to fill.
6. Remove the chocks from the front and rear tires.



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1. Delivery Port (to right rear brake chamber)
2. Right Modulator Valve
3. Relay Valve
4. Left Modulator Valve
5. Delivery Port (to left rear brake chamber)
6. Delivery Port (to left forward brake chamber)
7. Delivery Port (to park brake quick release valve)
8. Relay Supply Port (from primary air tank)
9. Mounting Fasteners
10. Relay Control Port (from foot valve)
11. Delivery Port (to right forward brake chamber)

Fig. 2, Combination Solenoid Control Valve

Replacement

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. Refer to the electrical section (wiring) in this manual for information on special terminals and connectors, and on ordering tools for them.

1. Chock the front and rear tires.
2. Disconnect the wiring from the traction control valve.
3. Disconnect the air supply and air discharge lines.
4. Remove the two mounting capscrews, washers, and nuts.
5. Remove the traction control valve.
6. Install the traction control valve using the above instructions in reverse order. Tighten the mounting nuts 24 N·m (18 lbf·ft).

Wheel Speed Sensor Adjustment, Rear Axle

Adjustment

NOTE: The following adjustment procedure requires the use of special tool T11–17556–000. Use of this tool, available through the PDCs, eliminates the time-consuming task of removing the wheel and tire assembly, and the brake drum. **See Fig. 1.**

1. Park the vehicle on level ground, set the parking brake, and shut down the engine.
2. Chock the front tires.
3. Find the sensor access hole in the rear axle flange.
   - 3.1 View the brake drum and axle from the rear. The ABS sensor wiring harness should be visible passing through a hole in the 12 o'clock position.
   - 3.2 Find the S cam at either the 3 o'clock or 9 o'clock position.
   - 3.3 Just opposite the S cam is the sensor access hole, approximately 19 mm (3/4 inch) diameter.
4. Insert the service tool T11–17556–000 into this hole.
5. Position the slide of the tool on the axle flange to align the tool. **See Fig. 2.**
6. Tap the tool lightly with the palm of your hand. This will ensure the sensor is touching the tone wheel.
7. Remove the tool from the wheel and repeat the procedure on the other rear axle speed sensor.
8. Remove the chocks from the tires.

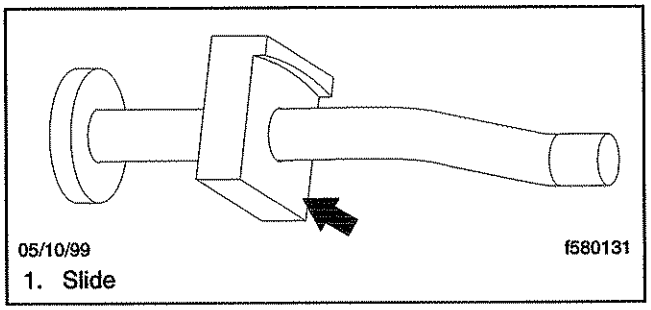
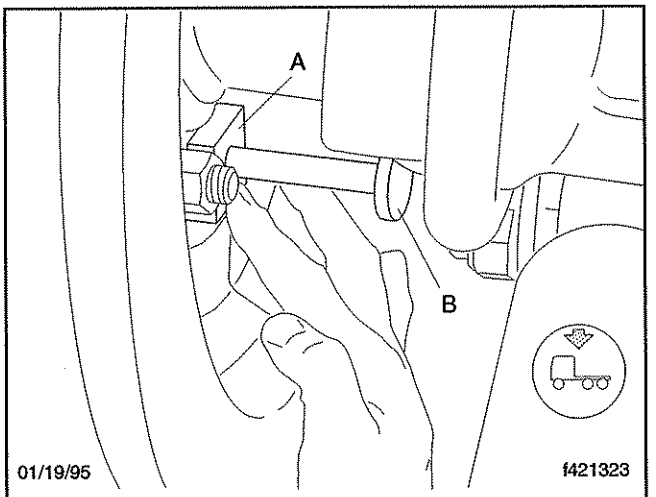


Fig. 1, ABS sensor Adjustment Tool



A. Position slide against the axle flange.

B. Tap here with your hand.

Fig. 2, Position the Tool

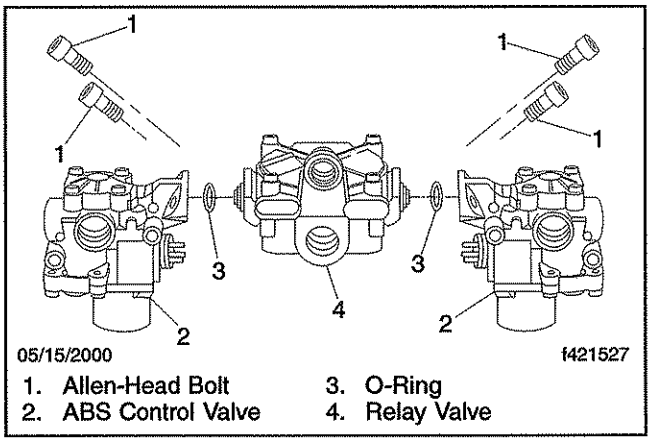
Combination Solenoid Control Valve Disassembly and Assembly

Disassembly (See Fig. 1)

1. Using a 6 mm allen-head wrench, remove the allen-head bolts.
2. Carefully separate the ABS control valve(s) from the relay valve.
3. Remove and discard the old O-rings.

Assembly (See Fig. 1)

1. Lubricate the replacement O-rings with grease.
2. Plug any unused ports on the replacement valve(s).
3. Attach the ABS control valve(s) to the relay valve. Tighten the allen-head bolts 13 to 15 lbf·ft (18 to 20 N·m).



1. Allen-Head Bolt
2. ABS Control Valve
3. O-Ring
4. Relay Valve

Fig. 1, Combination Solenoid Control Valve

ABS Tone Ring Installation on Service Hubs

Installation

IMPORTANT: Some ABS service hubs do not have a tone ring installed on the hub. The tone ring must be ordered separately and installed on the hub before installation of the hub onto the axle. Tone rings are made of a special material and require a specific installation procedure for proper installation.

⚠ WARNING

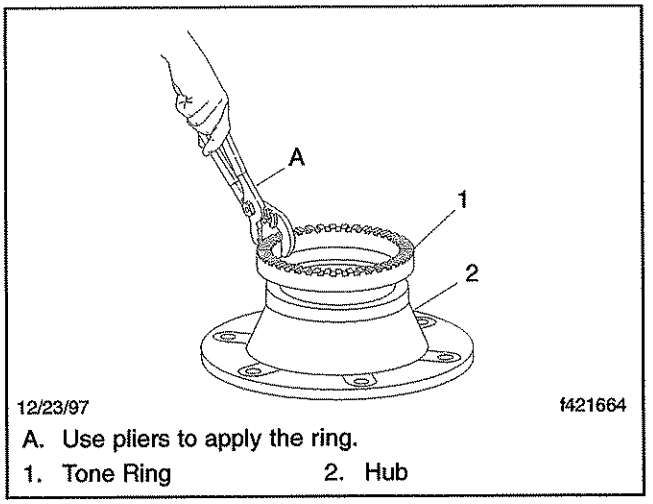
When installing an ABS system, special ABS hubs must be ordered. Machining of older hubs to accommodate the installation of tone rings can cause problems due to insufficient hub bore wall thickness. Machining an older hub with insufficient hub bore wall thickness could result in cracking, causing bearing damage and wheel loss. This could cause an accident resulting in personal injury and property damage.

1. Submerge the tone ring in boiling water or place it in an oven at 250°F (121°C) for approximately 15 minutes.

⚠ CAUTION

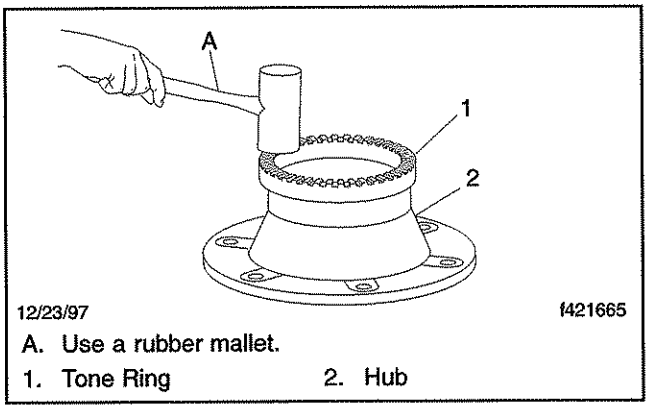
Do not attempt to heat the tone ring with a torch as this can damage the ring.

2. Using pliers, remove the tone ring from the boiling water or oven and center it on the machined area of the hub bore. See **Fig. 1**.
3. While the tone ring is still hot, make sure that it is properly centered on the machined surface. Using a rubber mallet, tap the tone ring until it bottoms out around the machined surface on the hub. See **Fig. 2**.
4. Install the hub on the axle. Position a dial indicator with a magnetic base so the dial indicator is against the tone ring teeth. See **Fig. 3**.
5. Rotate the hub and check the ring for runout. The runout should be less than 0.005 inch (0.13 mm). See **Fig. 4**.
6. Install the wheel. For instructions, see **Group 40** of this manual.



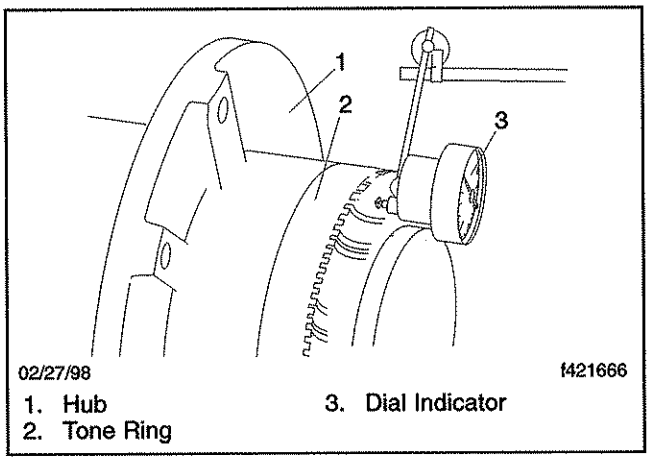
A. Use pliers to apply the ring.
1. Tone Ring 2. Hub

Fig. 1, Install the Ring on the Hub



A. Use a rubber mallet.
1. Tone Ring 2. Hub

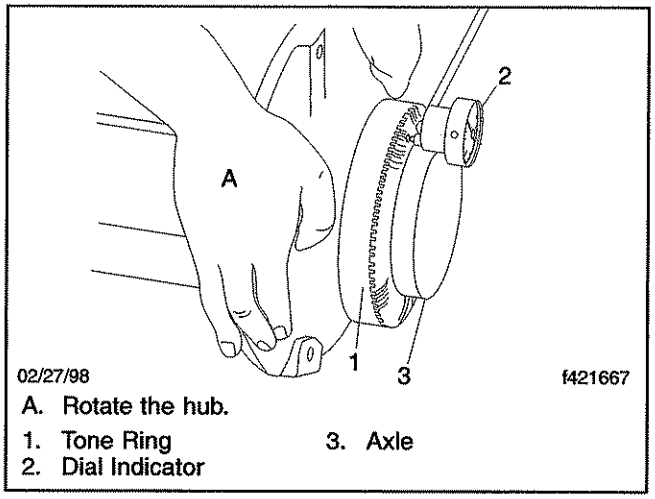
Fig. 2, Tap the Tone Ring



1. Hub 3. Dial Indicator
2. Tone Ring

Fig. 3, Position the Dial Indicator

ABS Tone Ring Installation on Service Hubs



A. Rotate the hub.
1. Tone Ring
2. Dial Indicator
3. Axle

Fig. 4, Check Tone Ring Runout

Using the Instrument Panel Blink Codes

This system has built-in diagnostics to ensure that all components are operating properly. Under normal conditions, the tractor warning light (TRAC ABS) comes on after the engine is started. Once the vehicle moves faster than about 4 mph (6 km/h) the warning light should go out if all of the tractor's ABS components are working. If the light stays on, or comes back on later, a problem within the ABS system has occurred. The vehicle can continue to be driven, but the ABS system could be partially or completely inoperative. However, normal braking ability is maintained.

To check the type of fault code recorded, stop the vehicle and turn off the engine. Then, turn on the ignition switch, but don't start the engine. If the warning light is still on, there is an "existing" system fault that must be repaired to ensure proper system operation. If the warning light is not on, an "intermittent" fault (indicating a loose connector or broken wire) has been recorded in the ECU memory.

Fault codes can be erased one at a time from the ECU memory. Erase a fault code by turning off the "ABS CHK" switch. After the WHL SPIN light stops flashing, turn off the ignition switch, then turn it back on.

NOTE: An "existing" fault code cannot be erased from ECU memory until the fault is corrected. An "intermittent" fault can be erased from ECU memory without being repaired. However, make sure that an "intermittent" fault code is recorded because it should be repaired as soon as possible if the code occurs again.

IMPORTANT: If the vehicle is equipped with an electronic engine and automatic traction control, don't turn on the "ABS CHK" switch while driving the vehicle. Activating the switch will reduce the engine speed to idle. Always park the vehicle before using the "ABS CHK" switch to read the instrument panel blink codes.

Before troubleshooting with the instrument panel blink codes, check all fuses in the control unit panel, and replace if necessary. Check the wiring to the "ABS CHK" switch and the warning lamps. See **Table 1**, and repair or replace the wiring as needed. Make sure that a charged 12-volt battery is available (the ABS system needs at least 11 volts to work).

NOTE: If troubleshooting the system with the Pro-Link 9000, use the instruction booklet that is supplied with the data cartridge.

Use the "ABS CHK" switch (**Fig. 1**) and the WHL SPIN light to display system faults. Turn on the ignition switch, then move the "ABS CHK" switch up (on position). After a five second pause, the WHL SPIN light will come on for two and one-half seconds (this is the start flash), then the diagnostic code cycle begins. After a two and one-half second pause, the three digit fault code will be displayed.

For example (**Fig. 2**), after the start flash, fault code 271 is shown by two flashes (each lasting one-half second and separated by a one-half second pause), a pause of two and one-half seconds, followed by seven flashes (each lasting one-half second and separated by a one-half second pause), another pause, followed by one flash for one-half second. After a seven and one-half second pause, the same fault code will continue to repeat beginning with the two and one-half second "start" flash and ending with a seven and one-half second pause.

Wiring Tested	Test These Pins	Volt/Ohmmeter Reading	Possible Cause	Remedy
Tractor Warning (TRAC ABS) Light	9 and 26	2 to 50 ohms (depends on bulb wattage)	Wiring light is shorted or open; or the bulb needs replacing.	Repair the wiring, or replace the bulb.
Blink Code (Whl Spin) Light	3 and 9	2 to 50 ohms (depends on bulb wattage)	Wiring light is shorted or open; or the bulb needs replacing.	Repair the wiring, or replace the bulb.
ABS CHK Switch	14 and 27 (also, turn the ABS CHK switch on).	0 to 2 ohms	Wiring light is shorted or open; or the switch needs replacing.	Repair the wiring, or replace the switch.

Table 1

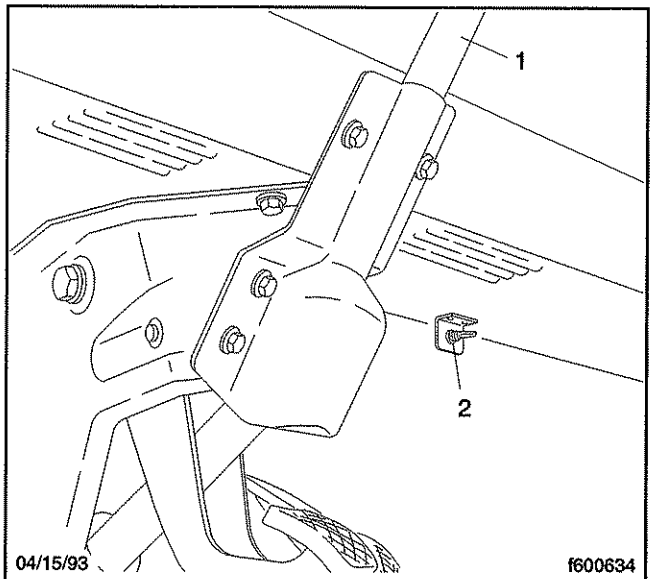
Troubleshooting

IMPORTANT: The key switch must be off when doing the tests in **Table 1**.

See **Fig. 3** for another example of a fault code reading.

NOTE: When there are no fault codes in the ECU memory, blink code 2–0–0 is displayed.

Once a fault code has been identified, use a volt/ohmmeter to check the electrical harness at the ECU's 35-pin connector (**Fig. 4**). Connect the ohmmeter leads to the applicable pins on the connector. A Rockwell WABCO test adaptor (part number 446 300 314 0) is also available and connects to the 35-pin connector.



1. Steering Column
2. ABS Check Switch

Fig. 1

IMPORTANT: The ignition switch must be off when connecting or disconnecting the ECU.

After attaching the adaptor (**Fig. 5**) to the 35-pin connector, insert the leads from an ohmmeter into the numbered holes on the adaptor.

NOTE: Regardless of the ECU model installed (B3, C1, or C2), the test adaptor can be used to troubleshoot all 4-channel ABS systems.

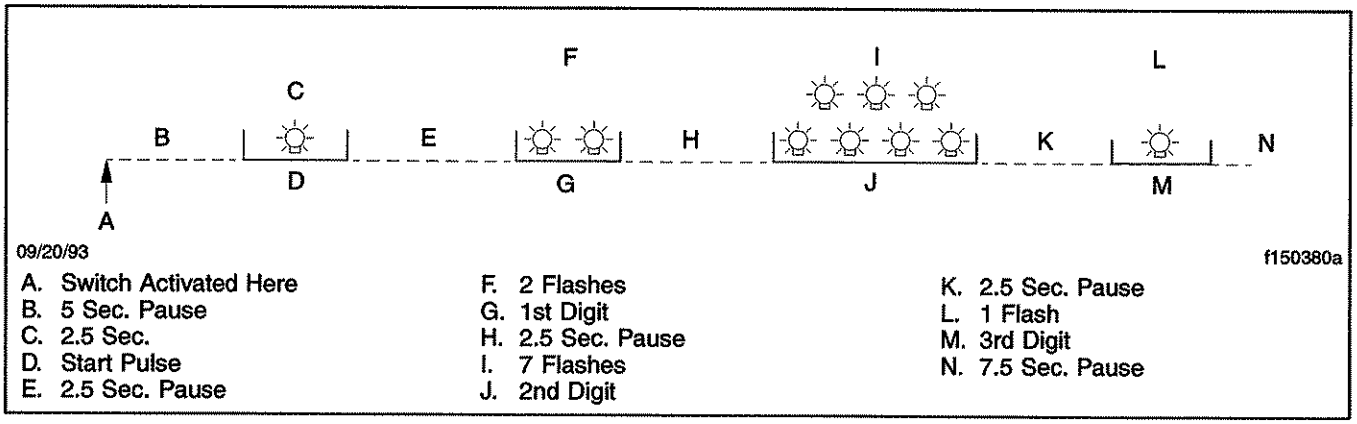
See **Table 2** for a listing of all fault codes, pins to be tested, and the correct volt/ohmmeter readings. Repair or replace the components and/or wiring if the readings are not correct.

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals.

See the electrical section (wiring) of this manual for information on special terminals and connectors, and ordering tools for them.

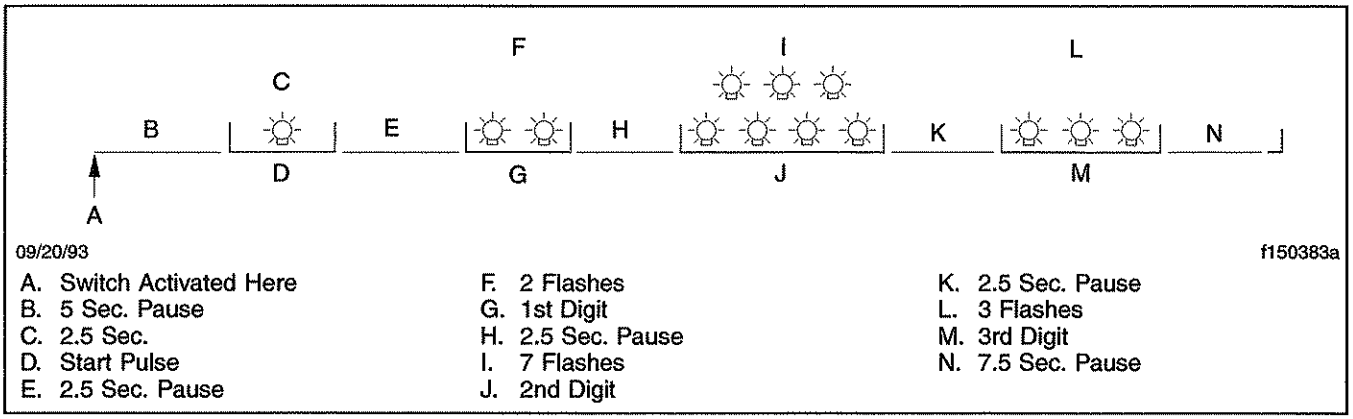
See the wiring diagram in **Subject 400**, when troubleshooting the ABS system equipped with the instrument panel blink codes. The key switch must be turned on (engine off) to activate the blink codes. However, if using the test adaptor 446 300 314 0, the key switch must be off, unless otherwise noted.

If a blink code is displayed that is not in **Table 2**, try to erase the code from ECU memory. If a fault can't be repaired, or erased from ECU memory, test the operation of the solenoid control valves and the traction control valves. For instructions, see **Table 3**. If a fault



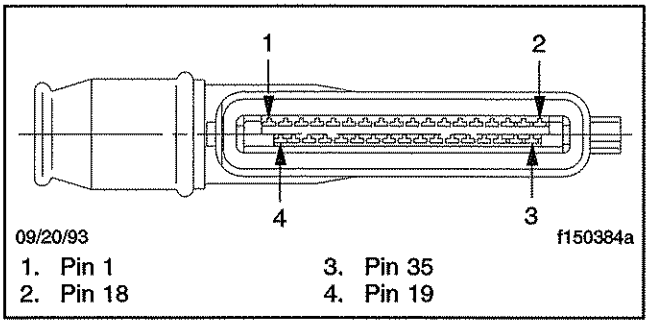
A. Switch Activated Here
B. 5 Sec. Pause
C. 2.5 Sec.
D. Start Pulse
E. 2.5 Sec. Pause
F. 2 Flashes
G. 1st Digit
H. 2.5 Sec. Pause
I. 7 Flashes
J. 2nd Digit
K. 2.5 Sec. Pause
L. 1 Flash
M. 3rd Digit
N. 7.5 Sec. Pause

Fig. 2



A. Switch Activated Here
B. 5 Sec. Pause
C. 2.5 Sec.
D. Start Pulse
E. 2.5 Sec. Pause
F. 2 Flashes
G. 1st Digit
H. 2.5 Sec. Pause
I. 7 Flashes
J. 2nd Digit
K. 2.5 Sec. Pause
L. 3 Flashes
M. 3rd Digit
N. 7.5 Sec. Pause

Fig. 3



1. Pin 1
2. Pin 18
3. Pin 35
4. Pin 19

Fig. 4

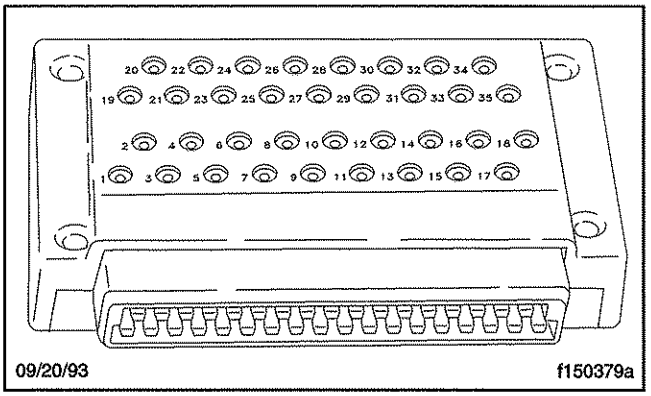


Fig. 5

still can't be repaired, or erased from ECU memory, contact your Rockwell District Service Manager.

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.

⚠ CAUTION

CAUTION: When doing the tests in Table 3, don't leave the positive volt/ohmmeter test lead connected to pin 9 for more than 10 seconds. Momentarily touch the positive test lead to pin 9 only when you are ready to observe the reading. Leaving the test lead connected to pin 9 for more than 10 seconds could damage the solenoid or traction control valve, or the volt/ ohmmeter.

When testing the solenoid control valves or the traction control valves in **Table 3**, always connect the *positive* volt/ohmmeter test lead to pin 9. Connect the *negative* test lead to the other pin referenced in **Table 3**. Set the volt/ohmmeter to 10 amps.

NOTE: If a 10-amp capacity meter is not available, a jumper wire can be used.

IMPORTANT: The key switch must be on when doing the tests in **Table 3**.

Troubleshooting

WABCO ABS Fault Codes/Tests					
Key Switch On to Determine Fault Code			Key Switch Off to Test System		
Fault Code		Problem	Test These Pins	Volt/Ohmmeter Reading	Remedy
2–0–0		No faults.	—	—	—
2–6–6 (VR1)	2–6–7 (VR2)	Battery voltage to the relay is low, or the relay is not working properly.	+1 and –27 (VR1)* +19 and –27 (VR2)*	0.0 volt	Problem found with key switch on. Repair or replace as needed.
2–6–8 Right Front (RF)	2–6–9 Left Front (LF)	Wheel speed signal is erratic.	15 and 32 (LF)† 17 and 34 (RF) †	Above 0.2 volt AC	A damaged tone wheel, a sensor needs adjustment, or there is excessive hub runout. Repair or replace as needed.
2–6–10 Right Front (RF)	2–6–11 Left Front (LF)	Sensor circuit damage.	15 and 27 (LF) 15 and 32 (LF) 17 and 27 (RF) 17 and 34 (RF)	Above 30.0 kilo ohms 1.0 to 1.99 kilo ohms Above 30.0 kilo ohms 1.0 to 1.99 kilo ohms	On the steer axle, there is damage to the wheel sensor and/or sensor wiring to the ECU. Repair or replace as needed.
2–6–12 Right Front (RF)	2–6–13 Left Front (LF)	Sensor out of adjustment.	15 and 32 (LF) † 17 and 34 (RF) †	Above 0.2 volt AC	On the steer axle, adjust the wheel sensor.
2–7–0 Left Rear (LR)	2–7–1 Right Rear (RR)	Wheel speed signal is erratic.	18 and 35 (LR)† 16 and 33 (RR)†	Above 0.2 volt AC	On the drive axle, a damaged tone wheel, a sensor needs adjustment, or there is excessive hub runout. Repair or replace as needed.
2–7–2 Left Rear (LR)	2–7–3 Right Rear (RR)	Sensor circuit damage.	18 and 27 (LR) 18 and 35 (LR) 16 and 27 (RR) 16 and 33 (RR)	Above 30.0 kilo ohms 1.0 to 1.99 kilo ohms Above 30.0 kilo ohms 1.0 to 1.99 kilo ohms	On the drive axle, damage to the wheel sensor and/or sensor wiring to the ECU. Repair or replace as needed.
2–7–4 Left Rear (LR)	2–7–5 Right Rear (RR)	Sensor out of adjustment.	18 and 35 (LR)† 16 and 33 (RR) †	Above 0.2 volt AC	On the drive axle, adjust the wheel sensor.
2–8–3 2–8–5	2–8–7 2–8–9	J1922 electronic engine data link is not working properly.	Idle the engine at about 1500 rpm. Short 14 to 27, or turn on the ABS CHK switch. The rpm should decrease.		Damage to the data link and/or data link wiring connections. Repair or replace as needed.

WABCO ABS Fault Codes/Tests					
Key Switch On to Determine Fault Code			Key Switch Off to Test System		
Fault Code		Problem	Test These Pins	Volt/Ohmmeter Reading	Remedy
2–8–10 Right Front (RF)	2–8–11 Left Front (LF)	On the steer axle, there is a short circuit in the ABS solenoid control valve to ground connection.	23 and 27 (LF) 24 and 27 (LF) 6 and 27 (RF) 7 and 27 (RF)	4 to 8 ohms	Check the ABS solenoid valve and cab wiring connections. Repair or replace as needed.
2–8–12 Right Front (RF)	2–8–13 Left Front (LF)	On the steer axle, there is an open circuit in the ABS solenoid control valve and/or wiring to the ground connection.			
2–8–14 Right Front (RF)	2–8–15 Left Front (LF)	On the steer axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the ground connection.			
2–9–0 Right Front (RF)	2–9–1 Left Front (LF)	On the steer axle, there is an open circuit in the ABS solenoid control valve and/or wiring.			
2–9–2 Left Rear (LR)	2–9–3 Right Rear (RR)	On the drive axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the ground connection.	21 and 27 (LR) 22 and 27 (LR) 4 and 27 (RR) 5 and 27 (RR)	4 to 8 ohms	Check the ABS solenoid valve and cab wiring connections. Repair or replace as needed.
2–9–4 Left Rear (LR)	2–9–5 Right Rear (RR)	On the drive axle, there is an open circuit in the ABS solenoid control valve and/or wiring.			
2–9–6 Left Rear (LR)	2–9–7 Right Rear (RR)	On the drive axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the ground connection.			
2–9–8 Left Rear (LR)	2–9–9 Right Rear (RR)	On the drive axle, there is an open circuit in the ABS solenoid control valve and/or wiring.	21 and 27 (LR) 22 and 27 (LR) 4 and 27 (RR) 5 and 27 (RR)	4 to 8 ohms	Check the ABS solenoid valve and cab wiring connections. Repair or replace as needed.
2–10–2 Left Rear (LR)	2–10–3 Right Rear (RR)	Short circuit in the traction control valve and/or wiring to the ground connection.	2 and 27 (LR) 20 and 27 (RR)	8 to 14 ohms	Check the traction control valve and cab wiring connections. Repair or replace as needed.
2–10–4 Left Rear (LR)	2–10–5 Right Rear (RR)	Open circuit in the traction control valve and/or wiring.			

Troubleshooting

WABCO ABS Fault Codes/Tests					
Key Switch On to Determine Fault Code			Key Switch Off to Test System		
Fault Code		Problem	Test These Pins	Volt/Ohmmeter Reading	Remedy
2–10–7		Short circuit in the wiring or the relay that controls the engine brake.	With key switch on, short 11 to 27 and 9 to 19 at the same time. The relay contacts should open, disabling the engine brake.		Check the engine brake relay and wiring. Repair or replace as needed.
2–10–8 Left Rear (LR)	2–10–9 Right Rear (RR)	Excessive wheel spin caused by driver or dynamometer. Erase the fault.	—	—	—
2–11–12 Right Front (RF)	2–11–13 Left Front (LF)	On the steer axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the power supply connection.	23 and 27 (LF) 24 and 27 (LF) 6 and 27 (RF) 7 and 27 (RF)	4 to 8 ohms	Check the ABS solenoid valve, wiring, and cab wiring connections. Repair or replace as needed.
2–11–14 Left Rear (LR)	2–11–15 Right Rear (RR)	On the drive axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the power supply connection.	21 and 27 (LR) 22 and 27 (LR) 4 and 27 (RR) 5 and 27 (RR)		
2–12–2 Left Rear (LR)	2–12–3 Right Rear (RR)	Short circuit in the traction control valve and/or wiring to the power supply connection.	2 and 27 (LR) 20 and 27 (RR)	8 to 14 ohms	
2–12–7		Short circuit in the engine brake relay and/or wiring to the ground connection.	—	—	Check the engine brake relay and wiring. Repair or replace as needed.
2–12–8 Right Front (RF)	2–12–9 Left Front (LF)	On the steer axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the battery.	23 and 27 (LF) 24 and 27 (LF) 6 and 27 (RF) 7 and 27 (RF)	4 to 8 ohms	Check the ABS solenoid valve, wiring, and cab wiring connections. Repair or replace as needed.
2–12–10 Left Rear (LR)	2–12–11 Right Rear (RR)	On the drive axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the battery.	21 and 27 (LR) 22 and 27 (LR) 4 and 27 (RR) 5 and 27 (RR)		
2–12–14 Left Rear (LR)	2–12–15 Right Rear (RR)	Short circuit in the traction control valve and/or wiring to the battery.	2 and 27 (LR) 20 and 27 (RR)	8 to 14 ohms	

Refer to Fig. 1 for a full view of the WABCO ABS wiring diagram. **Refer to Fig. 2, Fig. 3, Fig. 4, or Fig. 5** for sectional views as shown in the full view of the WABCO ABS wiring diagram.

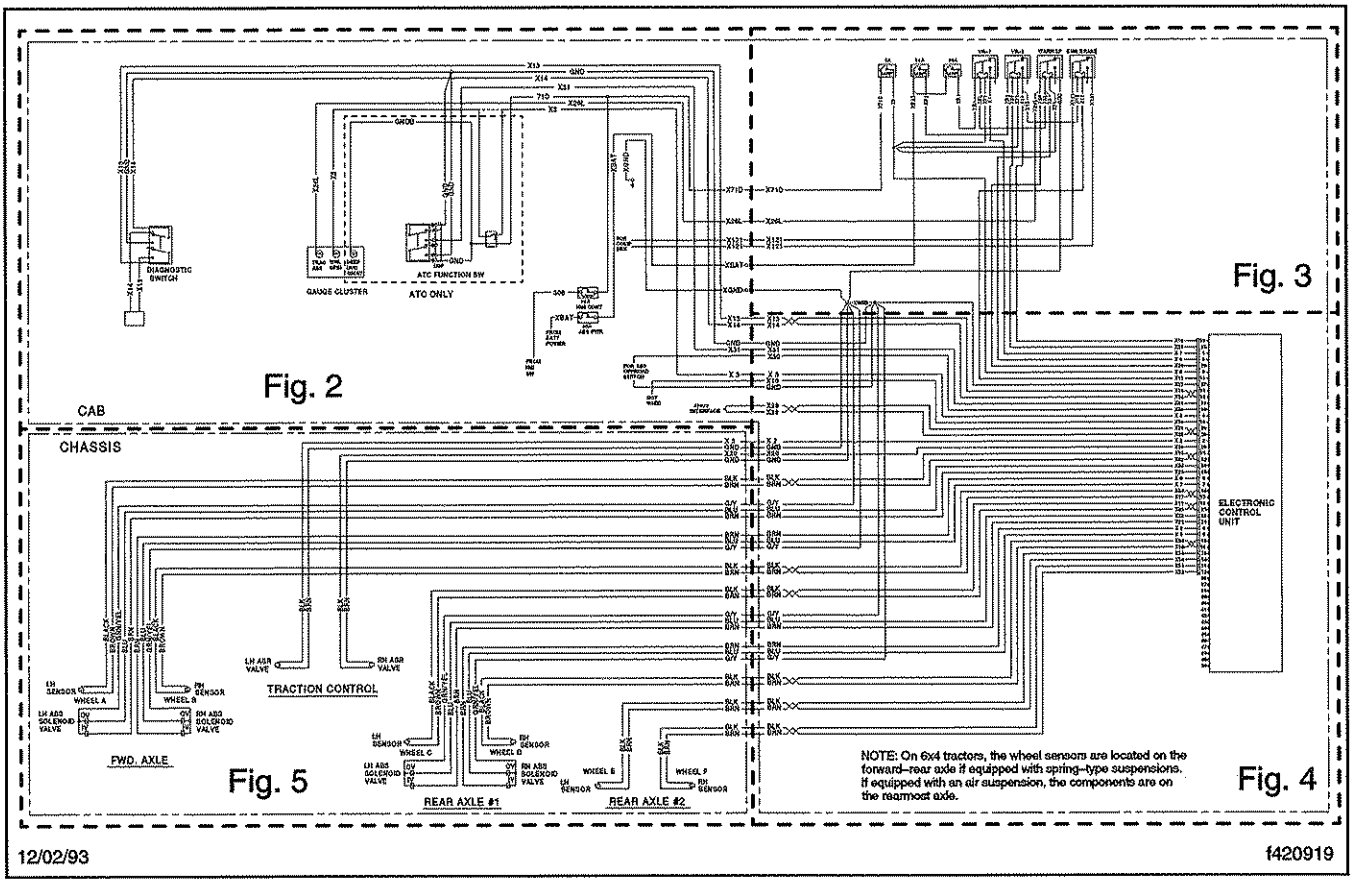


Fig. 1, Wiring Diagram for Troubleshooting ABS Systems Using Instrument Panel Blink Codes

Specifications

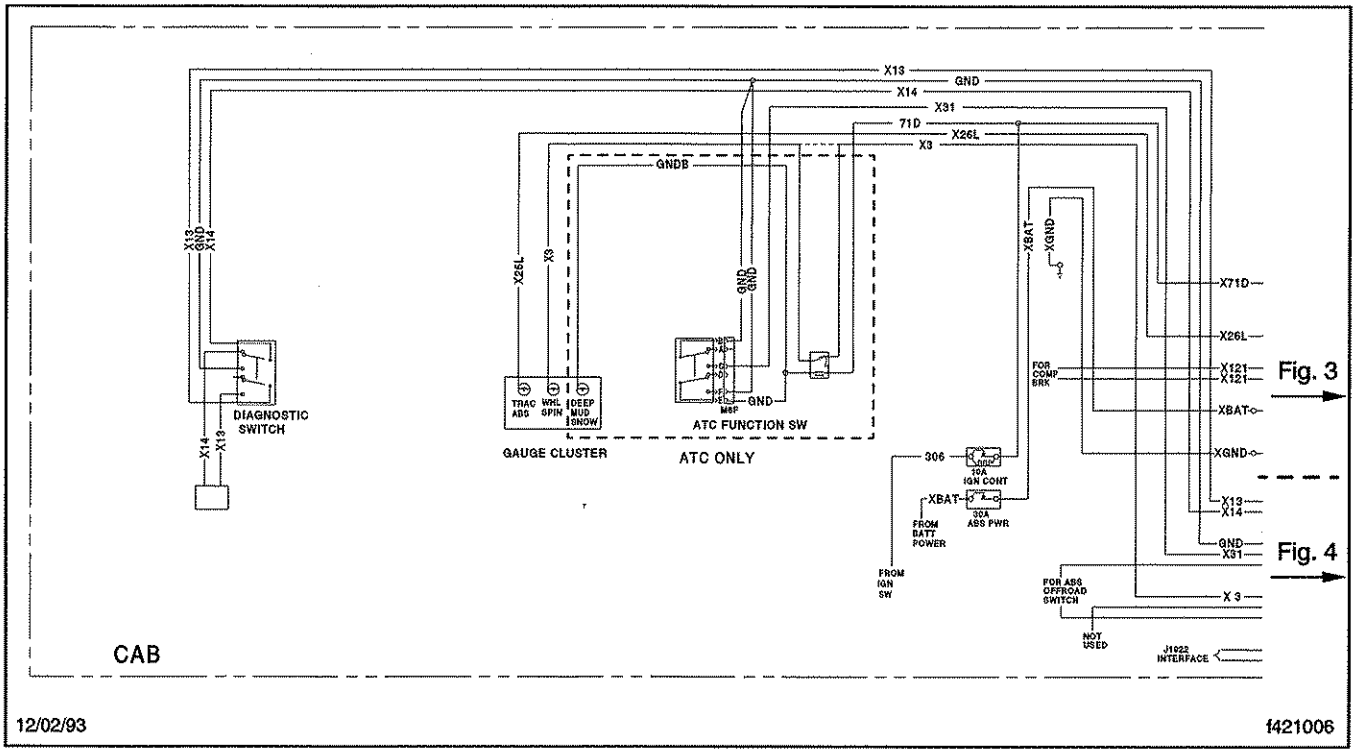


Fig. 2

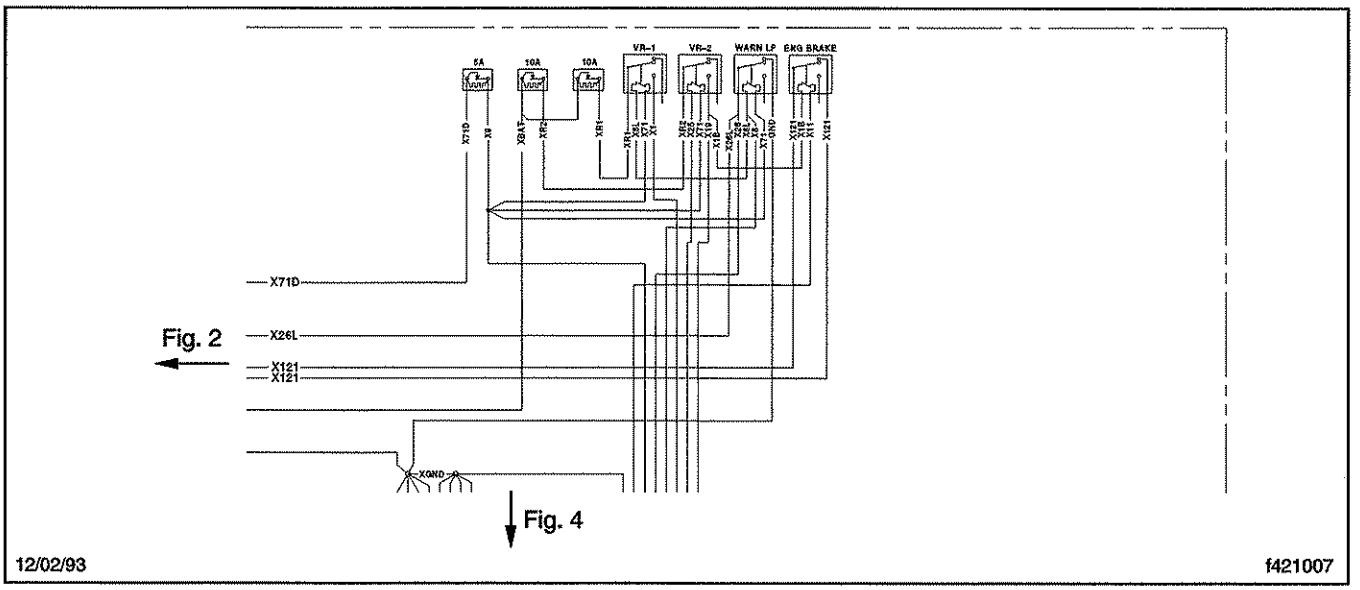


Fig. 3

Using the Instrument Panel Blink Codes

This system has built-in diagnostics to ensure that all components are operating properly. Under normal conditions, the tractor warning light (TRAC ABS) comes on after the engine is started. Once the vehicle moves faster than about 4 mph (6 km/h) the warning light should go out if all of the tractor's ABS components are working. If the light stays on, or comes back on later, a problem within the ABS system has occurred. The vehicle can continue to be driven, but the ABS system could be partially or completely inoperative. However, normal braking ability is maintained.

To check the type of fault code recorded, stop the vehicle and turn off the engine. Then, turn on the ignition switch, but don't start the engine. If the warning light is still on, there is an "existing" system fault that must be repaired to ensure proper system operation. If the warning light is not on, an "intermittent" fault (indicating a loose connector or broken wire) has been recorded in the ECU memory.

Fault codes can be erased one at a time from the ECU memory. Erase a fault code by turning off the "ABS CHK" switch. After the WHL SPIN light stops flashing, turn off the ignition switch, then turn it back on.

NOTE: An "existing" fault code cannot be erased from ECU memory until the fault is corrected. An "intermittent" fault can be erased from ECU memory without being repaired. However, make sure that an "intermittent" fault code is recorded because it should be repaired as soon as possible if the code occurs again.

IMPORTANT: If the vehicle is equipped with an electronic engine and automatic traction control, don't turn on the "ABS CHK" switch while driving the vehicle. Activating the switch will reduce the engine speed to idle. Always park the vehicle before using the "ABS CHK" switch to read the instrument panel blink codes.

Before troubleshooting with the instrument panel blink codes, check all fuses in the control unit panel, and replace if necessary. Check the wiring to the "ABS CHK" switch and the warning lamps. See **Table 1**, and repair or replace the wiring as needed. Make sure that a charged 12-volt battery is available (the ABS system needs at least 11 volts to work).

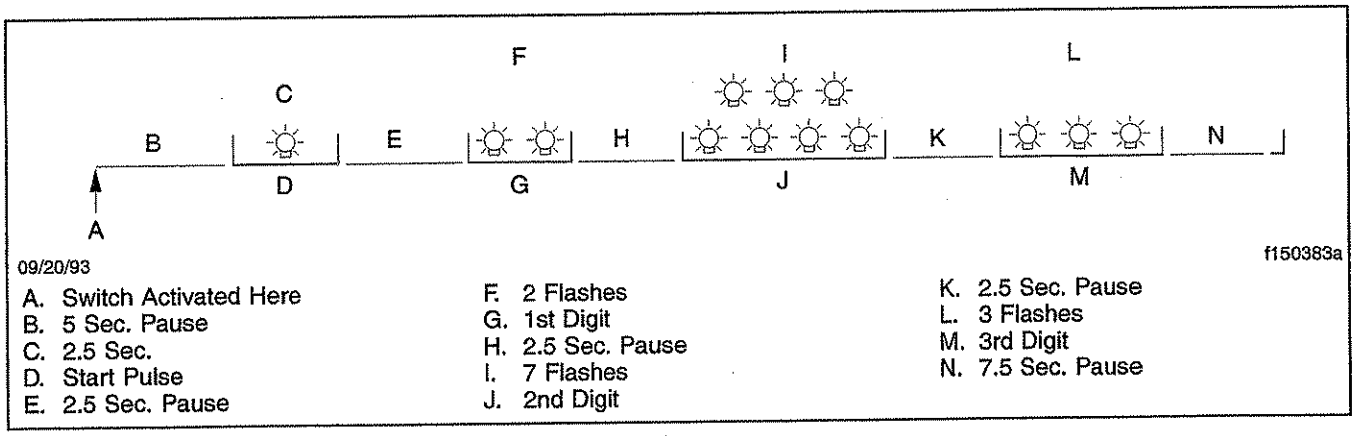
NOTE: If troubleshooting the system with the Pro-Link 9000, use the instruction booklet that is supplied with the data cartridge.

Use the "ABS CHK" switch (**Fig. 1**) and the WHL SPIN light to display system faults. Turn on the ignition switch, then move the "ABS CHK" switch up (on position). After a five second pause, the WHL SPIN light will come on for two and one-half seconds (this is the start flash), then the diagnostic code cycle begins. After a two and one-half second pause, the three digit fault code will be displayed.

For example (**Fig. 2**), after the start flash, fault code 271 is shown by two flashes (each lasting one-half second and separated by a one-half second pause), a pause of two and one-half seconds, followed by seven flashes (each lasting one-half second and separated by a one-half second pause), another pause, followed by one flash for one-half second. After a seven and one-half second pause, the same fault code will continue to repeat beginning with the two and one-half second "start" flash and ending with a seven and one-half second pause.

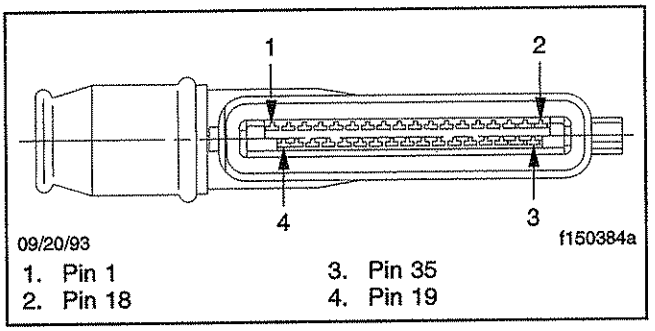
Wiring Tested	Test These Pins	Volt/Ohmmeter Reading	Possible Cause	Remedy
Tractor Warning (TRAC ABS) Light	9 and 26	2 to 50 ohms (depends on bulb wattage)	Wiring light is shorted or open; or the bulb needs replacing.	Repair the wiring, or replace the bulb.
Blink Code (Whl Spin) Light	3 and 9	2 to 50 ohms (depends on bulb wattage)	Wiring light is shorted or open; or the bulb needs replacing.	Repair the wiring, or replace the bulb.
ABS CHK Switch	14 and 27 (also, turn the ABS CHK switch on).	0 to 2 ohms	Wiring light is shorted or open; or the switch needs replacing.	Repair the wiring, or replace the switch.

Table 1



A. Switch Activated Here
B. 5 Sec. Pause
C. 2.5 Sec.
D. Start Pulse
E. 2.5 Sec. Pause
F. 2 Flashes
G. 1st Digit
H. 2.5 Sec. Pause
I. 7 Flashes
J. 2nd Digit
K. 2.5 Sec. Pause
L. 3 Flashes
M. 3rd Digit
N. 7.5 Sec. Pause

Fig. 3



1. Pin 1
2. Pin 18
3. Pin 35
4. Pin 19

Fig. 4

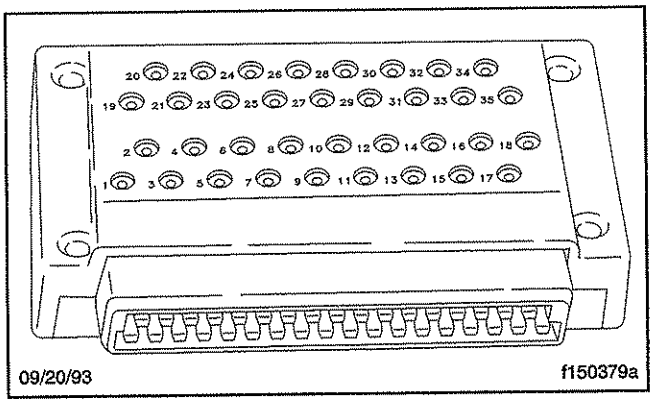


Fig. 5

still can't be repaired, or erased from ECU memory, contact your Rockwell District Service Manager.

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.

⚠ CAUTION

CAUTION: When doing the tests in Table 3, don't leave the positive volt/ohmmeter test lead connected to pin 9 for more than 10 seconds. Momentarily touch the positive test lead to pin 9 only when you are ready to observe the reading. Leaving the test lead connected to pin 9 for more than 10 seconds could damage the solenoid or traction control valve, or the volt/ ohmmeter.

When testing the solenoid control valves or the traction control valves in **Table 3**, always connect the *positive* volt/ohmmeter test lead to pin 9. Connect the *negative* test lead to the other pin referenced in **Table 3**. Set the volt/ohmmeter to 10 amps.

NOTE: If a 10-amp capacity meter is not available, a jumper wire can be used.

IMPORTANT: The key switch must be on when doing the tests in **Table 3.**

WABCO ABS Fault Codes/Tests					
Key Switch On to Determine Fault Code			Key Switch Off to Test System		
Fault Code		Problem	Test These Pins	Volt/Ohmmeter Reading	Remedy
2–8–10 Right Front (RF)	2–8–11 Left Front (LF)	On the steer axle, there is a short circuit in the ABS solenoid control valve to ground connection.	23 and 27 (LF) 24 and 27 (LF) 6 and 27 (RF) 7 and 27 (RF)	4 to 8 ohms	Check the ABS solenoid valve and cab wiring connections. Repair or replace as needed.
2–8–12 Right Front (RF)	2–8–13 Left Front (LF)	On the steer axle, there is an open circuit in the ABS solenoid control valve and/or wiring to the ground connection.			
2–8–14 Right Front (RF)	2–8–15 Left Front (LF)	On the steer axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the ground connection.			
2–9–0 Right Front (RF)	2–9–1 Left Front (LF)	On the steer axle, there is an open circuit in the ABS solenoid control valve and/or wiring.			
2–9–2 Left Rear (LR)	2–9–3 Right Rear (RR)	On the drive axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the ground connection.	21 and 27 (LR) 22 and 27 (LR) 4 and 27 (RR) 5 and 27 (RR)	4 to 8 ohms	Check the ABS solenoid valve and cab wiring connections. Repair or replace as needed.
2–9–4 Left Rear (LR)	2–9–5 Right Rear (RR)	On the drive axle, there is an open circuit in the ABS solenoid control valve and/or wiring.			
2–9–6 Left Rear (LR)	2–9–7 Right Rear (RR)	On the drive axle, there is a short circuit in the ABS solenoid control valve and/or wiring to the ground connection.			
2–9–8 Left Rear (LR)	2–9–9 Right Rear (RR)	On the drive axle, there is an open circuit in the ABS solenoid control valve and/or wiring.	21 and 27 (LR) 22 and 27 (LR) 4 and 27 (RR) 5 and 27 (RR)	4 to 8 ohms	Check the ABS solenoid valve and cab wiring connections. Repair or replace as needed.
2–10–2 Left Rear (LR)	2–10–3 Right Rear (RR)	Short circuit in the traction control valve and/or wiring to the ground connection.	2 and 27 (LR) 20 and 27 (RR)	8 to 14 ohms	Check the traction control valve and cab wiring connections. Repair or replace as needed.
2–10–4 Left Rear (LR)	2–10–5 Right Rear (RR)	Open circuit in the traction control valve and/or wiring.			

WABCO ABS Fault Codes/Tests					
Key Switch On to Determine Fault Code			Key Switch Off to Test System		
Fault Code		Problem	Test These Pins	Volt/Ohmmeter Reading	Remedy
2–13–4 (VR1)	2–13–5 (VR2)	The valve relay is not operating properly.	VR1) – With the key on, short 8 to 27. Vehicle voltage should read 11.0 to 15.4 volts DC between pins 1 and 27.(VR2) – With the key on, short 25 to 27. Vehicle voltage should read 11.0 to 15.4 volts DC between pins 19 and 27.		Replace the valve relay.
2–13–8 (VR1)	2–13–9 (VR2)	Vehicle power supply is too high.			Check the vehicle power supply system. Repair as needed.

* Connect the positive volt/ohmmeter test lead to pins 1 and 19. Connect the negative test lead to pin 27.

† After connecting the volt/ohmmeter test leads, rotate the applicable tire at about 30 rpm (1 revolution every 2 seconds).

Table 2

Valve Tested	What to Do	Desired Result	Problem	Remedy
Left Front Solenoid Control Valve	Depress the brake pedal; connect pins 9 and 24. Release the brake pedal.	Left front brake chamber exhausts.	The electrical lines of the two control valves are crossed; the air supply and discharge lines are crossed; the electrical connector at the valve is not correctly plugged in; or, the control valve needs replacing.	Repair or replace as needed.
	Connect pins 9 and 23; depress the brake pedal.	No pressure build up in left front brake chamber.		
Right Front Solenoid Control Valve	Depress the brake pedal; connect pins 9 and 7. Release the brake pedal.	Right front brake chamber exhausts.		
	Connect pins 9 and 6; depress the brake pedal.	No pressure build up in right front brake chamber.		
Left Rear Solenoid Control Valve	Depress the brake pedal; connect pins 9 and 22. Release the brake pedal.	Left rear brake chamber exhausts.		
	Connect pins 9 and 21; depress the brake pedal.	No pressure build up in left rear brake chamber.		
Right Rear Solenoid Control Valve	Depress the brake pedal; connect pins 9 and 5. Release the brake pedal.	Right rear brake chamber exhausts.		
	Connect pins 9 and 4; depress the brake pedal.	No pressure build up in right rear brake chamber.		
Left Rear Traction Control Valve	Connect pins 9 and 2.	Pressure build up in left rear brake chamber(s).	The air supply and discharge lines are crossed or, the air supply and discharge lines are blocked.	
Right Rear Traction Control Valve	Connect pins 9 and 20.	Pressure build up in right rear brake chamber(s).		

Table 3

Refer to Fig. 1 for a full view of the WABCO ABS wiring diagram. **Refer to Fig. 2, Fig. 3, Fig. 4,** or **Fig. 5** for sectional views as shown in the full view of the WABCO ABS wiring diagram.

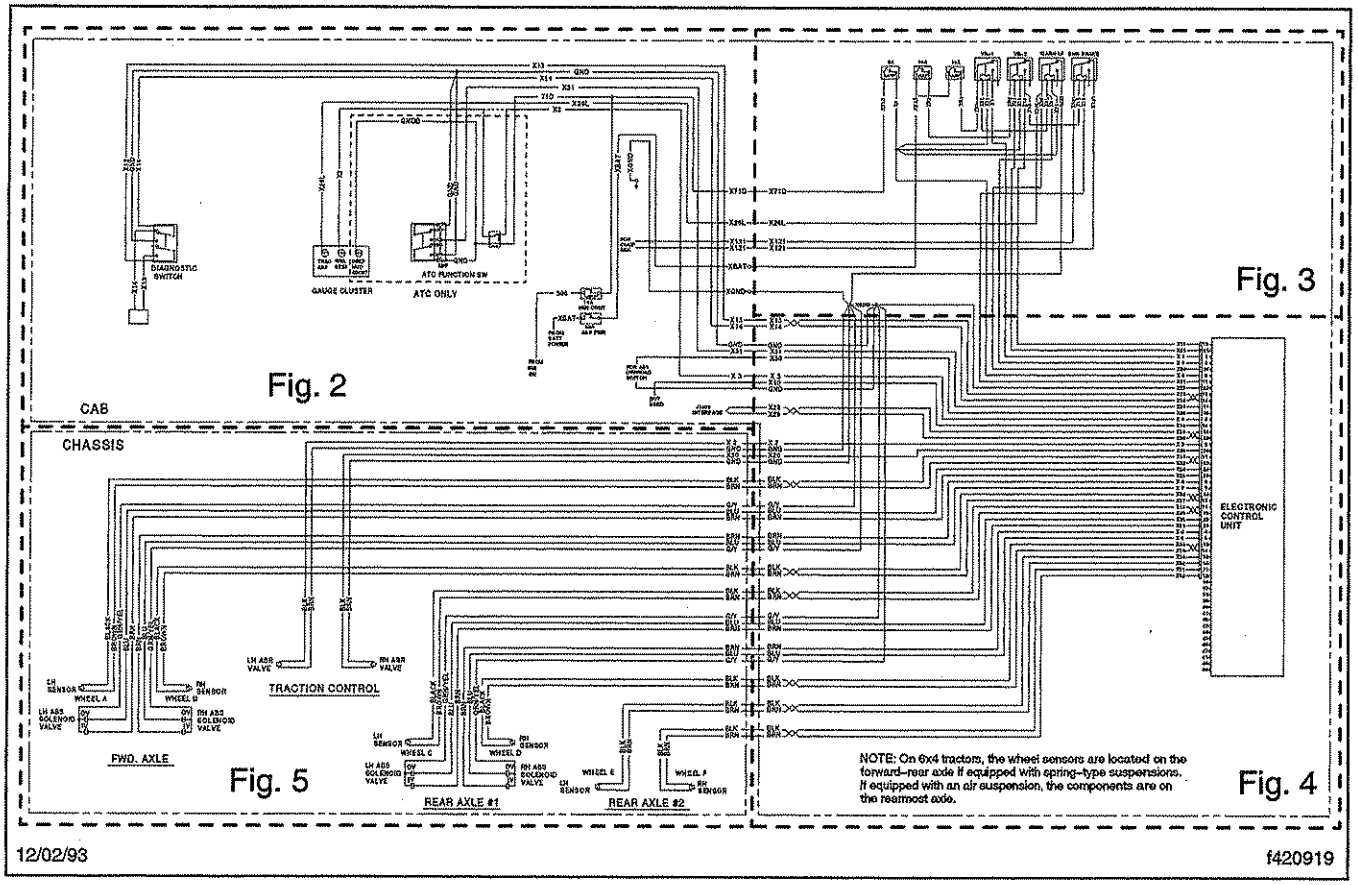


Fig. 1, Wiring Diagram for Troubleshooting ABS Systems Using Instrument Panel Blink Codes

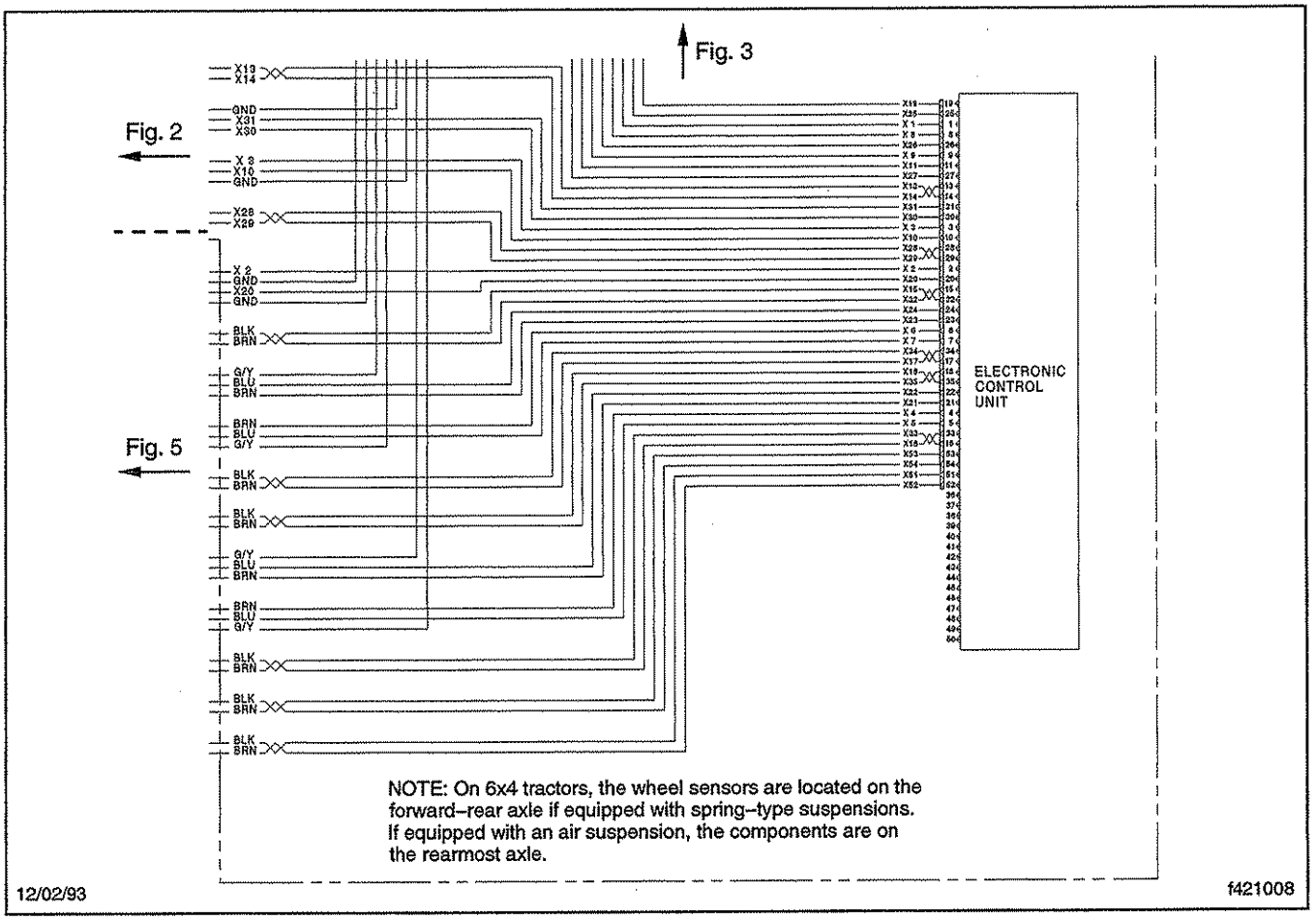

Fig. 3
Fig. 2
Fig. 5
X13
X14
GND
X31
X30
X 3
X10
GND
X28
X29
X 2
GND
X20
GND
BLK
BRN
G/Y
BLU
BRN
BRN
BLU
G/Y
BLK
BRN
BLK
BRN
G/Y
BLU
BRN
BRN
BLU
G/Y
BLK
BRN
BLK
BRN
BLK
BRN
ELECTRONIC
CONTROL
UNIT
NOTE: On 6x4 tractors, the wheel sensors are located on the forward–rear axle if equipped with spring–type suspensions. If equipped with an air suspension, the components are on the rearmost axle.
12/02/93
f421008

Fig. 4

Parking Brake Hand Valve Removal and Installation

Removal (See Fig. 1)

⚠ WARNING

WARNING: Review the precautions under Safety Precautions, 100 before doing any work on the parking brake valve. Failure to do so could result in personal injury.

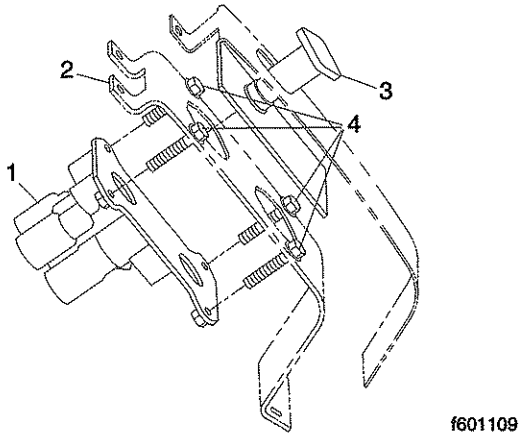
1. Park the vehicle on a level surface, apply the parking brakes, chock the tires, and drain the air tanks.
2. Turn the valve knob (Ref. 3) counterclockwise and remove it from the valve stem.
3. Mark the air lines for later reference, then disconnect them from the valve assembly.

NOTE: The primary supply line is green; the secondary supply line is red; the exhaust line is black and 1/2-inch (13-mm) in diameter; the delivery line is black and 3/8-inch (9.6-mm) in diameter.

4. Remove the four screws (Ref. 4) that attach the valve (Ref. 1) to the bracket (Ref. 2). Remove the valve.

Installation

1. Position the valve assembly in the bracket. Install the four mounting screws.



1. Parking Brake Valve
2. Bracket
3. Knob
4. Mounting Screws

Fig. 1, Parking Brake Hand Valve Mounting

2. Connect the air lines to the applicable fittings.
   - 2.1 Tighten the fittings hand tight.
   - 2.2 Using a wrench, tighten the fittings until the connections feel firm.
   - 2.3 Tighten the fittings an additional one-sixth turn.
3. Screw the valve knob onto the valve stem.
4. Leak test the fittings, following the instructions in **Subject 110.**

Removal

IMPORTANT: Before working on or around air brake systems and components, review **Safety Precautions, 100.**

1. Chock the tires, and open the air reservoir drain cocks to bleed the air from the system.
2. Remove the trailer hose assemblies from the TP–3DC 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–3DC valve to the vehicle, and remove the valve.

Installation

IMPORTANT: Before working on or around air brake systems and components, review **Safety Precautions, 100.**

1. Place the TP–3DC valve on the vehicle, and attach it with bolts, washers, and nuts. Tighten the nuts 11 to 15 lbf·ft (15 to 20 N·m).

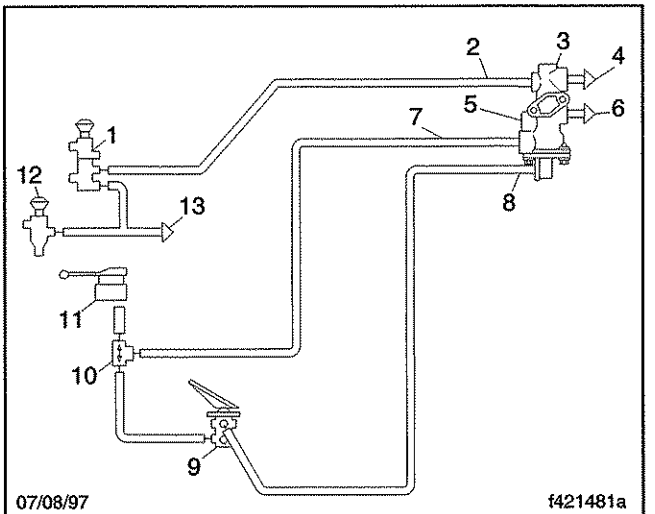
NOTE: The delivery line from the trailer air supply valve is connected to the tractor emergency port of the TP–3DC valve. See **Fig. 1**. The delivery line from the brake valve (double check valve) is connected to the tractor service port of the TP–3DC valve. Trailer hose assemblies are installed in the trailer emergency and trailer service ports of the TP–3DC valve.

2. 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–3DC 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 at least two turns, or until no threads show on the fitting.

   If equipped with wire braid hoses, connect the hose fittings to the valve ports, and hand-tighten the nuts. Using a wrench, tighten the nuts until there is resistance. Tighten one-sixth turn more. Do not overtighten.

3. Close the drain cocks to the air reservoirs. Start the vehicle engine to pressurize the air system.
4. Leak test the TP–3DC valve following the instructions in **Subject 110.**



1. Trailer Air Supply Valve
2. Tractor Supply
3. Auxiliary Supply Port
4. Trailer Supply
5. Stop Lamp Switch Port
6. Trailer Control
7. Tractor Control (Secondary)
8. Tractor Control (Primary)
9. Foot Brake Valve
10. Double Check Valve
11. Trailer Control Valve
12. Parking Brake Valve
13. To Tractor Spring Brakes

Fig. 1, Partial Plumbing Diagram, With TP–3DC

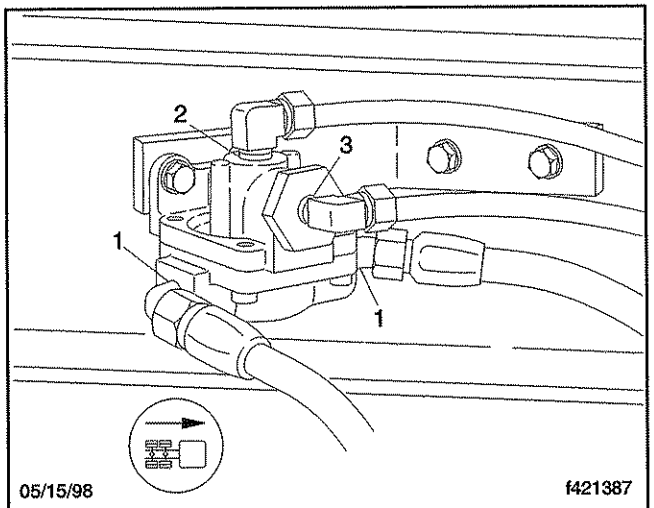
QR–1C Quick Release Valve Removal and Installation

Removal (See Fig. 1)

⚠ WARNING

Before working on or around air brake systems and components, review the safety precautions in Subject 100. Failure to do so could result in personal injury.

1. Chock the tires or hold the vehicle by means other than air brakes.
2. Drain the air brake system.
3. Mark and disconnect the air lines from the quick release valve.
4. Remove the mounting bolts and the valve.



NOTE: Valve mounting inside the left frame rail shown.

1. Delivery Port
2. Balance Port
3. Supply Port

Fig. 1, QR-1C Valve Mounting (plumbing and location will vary depending on vehicle configuration)

Installation (See Fig. 1)

⚠ WARNING

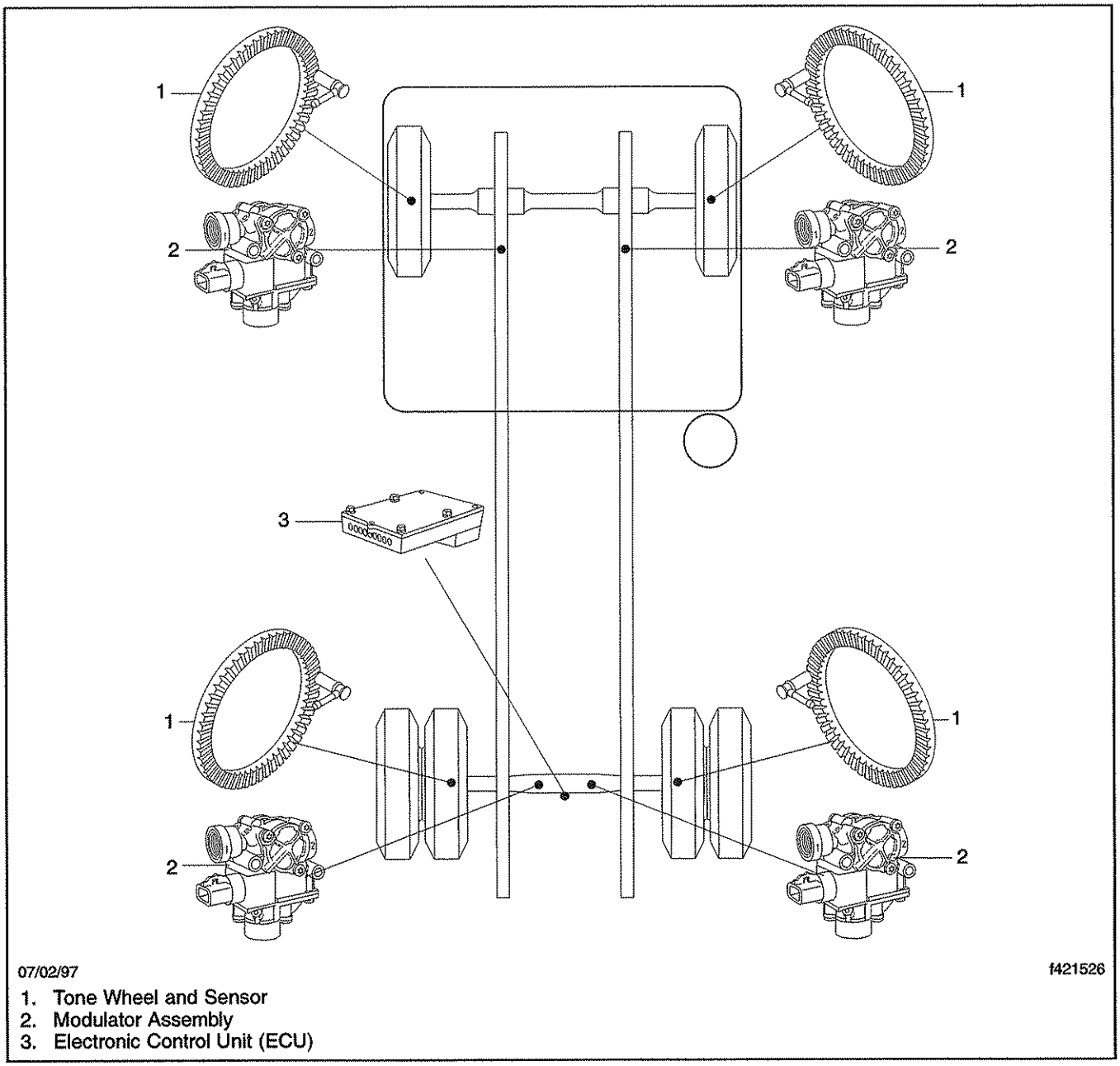
Before working on or around air brake systems and components, review the safety precautions in Subject 100. Failure to do so could result in personal injury.

1. Install the quick release valve with the exhaust port facing down. Securely tighten the mounting bolts.
2. Connect the air lines to the quick release valve in the locations previously marked.
3. Perform the operating and leakage tests in **Subject 110.**

General Information (See Fig. 1)

The Bendix® 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 emergency stops. 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 sensed wheel. The sensors transmit vehicle wheel speed information



1. Tone Wheel and Sensor
2. Modulator Assembly
3. Electronic Control Unit (ECU)

Fig. 1, Location of ABS Components, Four-Channel System

to an electronic control unit (ECU). According to programmed specifications, the ECU signals the appropriate modulator assembly to increase, reduce, or maintain air pressure supply in the brake chamber. This prevents front and rear wheel lockup, and enhances steering control during emergency braking situations.

Principles of Operation

The ABS electronic control unit (ECU) (**Fig. 2**) is a digital microcomputer that serves as the information processing and command center for the ABS. The ECU receives and processes vehicle wheel speed information from the sensors. During emergency brake applications, the ECU regulates the braking force applied to each wheel by sending control signals to the modulator assembly (**Fig. 3**).

ABS MAJOR COMPONENTS

Wheel Speed Sensor

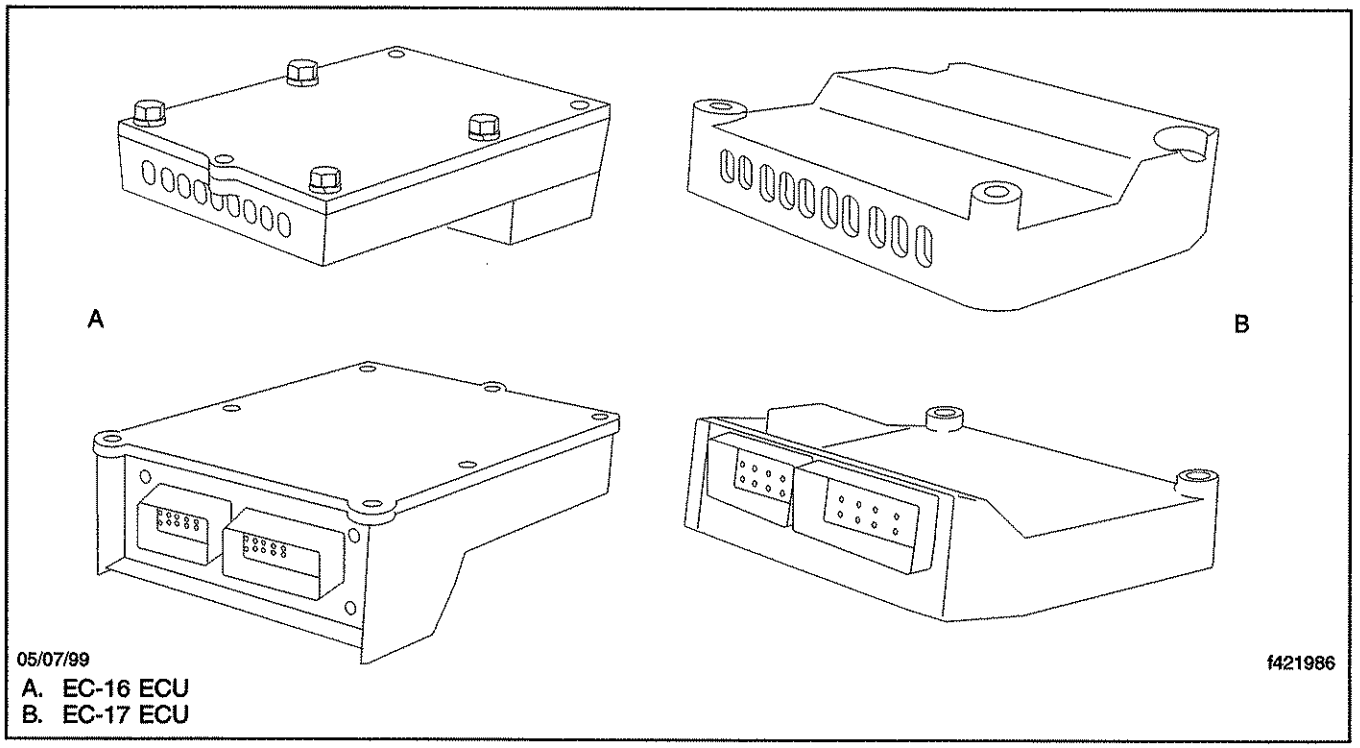
The wheel speed sensors use pulse feedback from 100-tooth tone wheels located in the front and rear axle wheel hubs. When the vehicle is moving, the teeth of the tone wheel cause interruptions in a magnetic field created by the sensor. The interruptions created in the magnetic field in turn create electrical pulses that are sent by the sensor to the ECU.

Electronic Control Unit (ECU)

The ECU receives speed sensor pulses and interprets these signals to calculate wheel speed and a vehicle reference speed. If the calculations indicate wheel slip or lockup, the appropriate control circuit signals the modulator assembly to increase or decrease braking pressure.

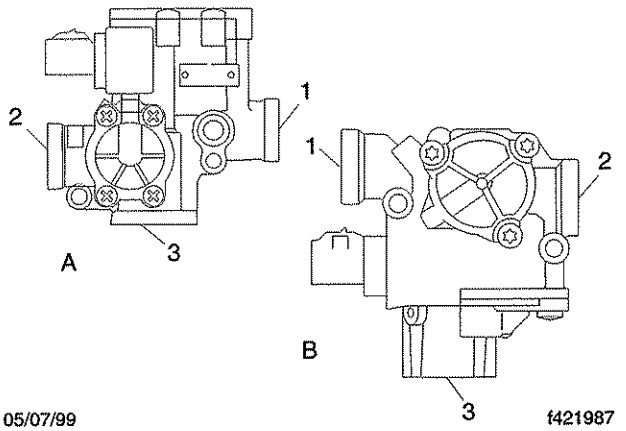
There are three versions of the ECU. The older versions (EC-15 and EC-16) are factory programmed with vehicle particulars, such as the number of speed sensors, if the traction control feature was enabled and the type of traction control (torque limiting, differential braking, or both).

The current, self-configuring ECU (EC-17) can be most easily identified while installed on the vehicle. Identification can be made by observing the reaction of the diagnostic display when the ignition is turned on and power is applied to the ECU. The current configuration of the ECU is displayed via the troubleshooting LEDs



A. EC-16 ECU
B. EC-17 ECU

Fig. 2, EC-16 and EC-17 ABS Electronic Control Units



A. M-21 Modulator
B. M-22 Modulator
1. Supply
2. Delivery
3. Exhaust

Fig. 3, M-21 and M-22 Modulator Assemblies

and occurs during the normal self-test sequence. Only the LEDs that correspond to the sensors identified during the self-configuration will illuminate. If all antilock components are working properly, the red LEDs will turn off and the single, green, VLT LED will be illuminated. This configuration review is repeated each time the ignition is turned on.

IMPORTANT: The LED display is optional on the EC-17. The EC-17N control unit does not have an LED display and the AlliedSignal Bendix Diagnostic Communication Interface (DCI) must be used for diagnostics or reconfiguration.

On the older versions of the ECU, *all* diagnostic LEDs will illuminate and then go out if all antilock components are working properly. During normal operation, all the red LEDs will be off and the single, green, VLT LED will be illuminated. See **Troubleshooting, 300** for more information on the LED display.

The ECU contains a safety circuit to constantly monitor the wheel sensors, modulator assemblies, and the electrical circuitry. After the ignition is switched on, the tractor warning light (TRAC ABS) comes on. See **Fig. 4**. On vehicles with newer ECUs, the TRAC ABS light will go out shortly after the ignition is turned on. On vehicles with the older ECUs, the TRAC ABS light will stay lit until the vehicle reaches 7 mph (11 km/h). The TRAC ABS light will stay on if the tractor's ABS components are not working properly.

When vehicle power is supplied to the EC-17, a modulator "chuff" test is performed. When the brake pedal is depressed while the ECU is powered up, the modulator "chuff" test can be heard. This test will verify if the modulator is connected correctly and is functional. The modulators will exhaust air in the sequence of right front, left front, right rear and left rear. If they do not follow this sequence, proceed with modulator troubleshooting. See **Troubleshooting, 300**.

If, during vehicle operation, the safety circuit senses a failure in any part of the ABS system (a sensor, modulator assembly, wiring connection, short circuit, etc.), the TRAC ABS light comes on, and the control circuit where the failure occurred is switched to normal braking action. Remaining control circuits will retain the ABS effect. Even if the ABS system is completely inoperative, normal braking is maintained. The vehicle is not disabled.

IMPORTANT: If the ABS warning lights do not work as described above, there is a possible system malfunction. If this occurs, the vehicle will continue to have normal braking ability, but without ABS. Service the ABS as soon as possible. See **Troubleshooting, 300** for fault diagnosis.

Modulator Assembly

To ensure proper operation, ABS solenoid/modulator valves must be plumbed properly. If the valve plumbing is removed during service, care must be taken to ensure the air lines are plumbed to the correct valve ports when reinstalled.

Depending on the signal received from the ECU, the modulator assembly 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 modulator assembly.

If the ECU receives signals indicating wheel lockup during a brake application, the ECU energizes both the supply and exhaust solenoids in the modulator assembly. See **Fig. 5**. Energizing the supply solenoid causes its exhaust to close and its inlet to open. With the inlet of the supply solenoid open, application air is permitted to flow to the control side of the supply diaphragm. Air pressure acting on the supply diaphragm causes it to close the supply diaphragm and prevent further delivery of air to the brake chamber.

Energizing the exhaust solenoid closes its inlet and opens its exhaust. By closing the exhaust solenoid

General Information

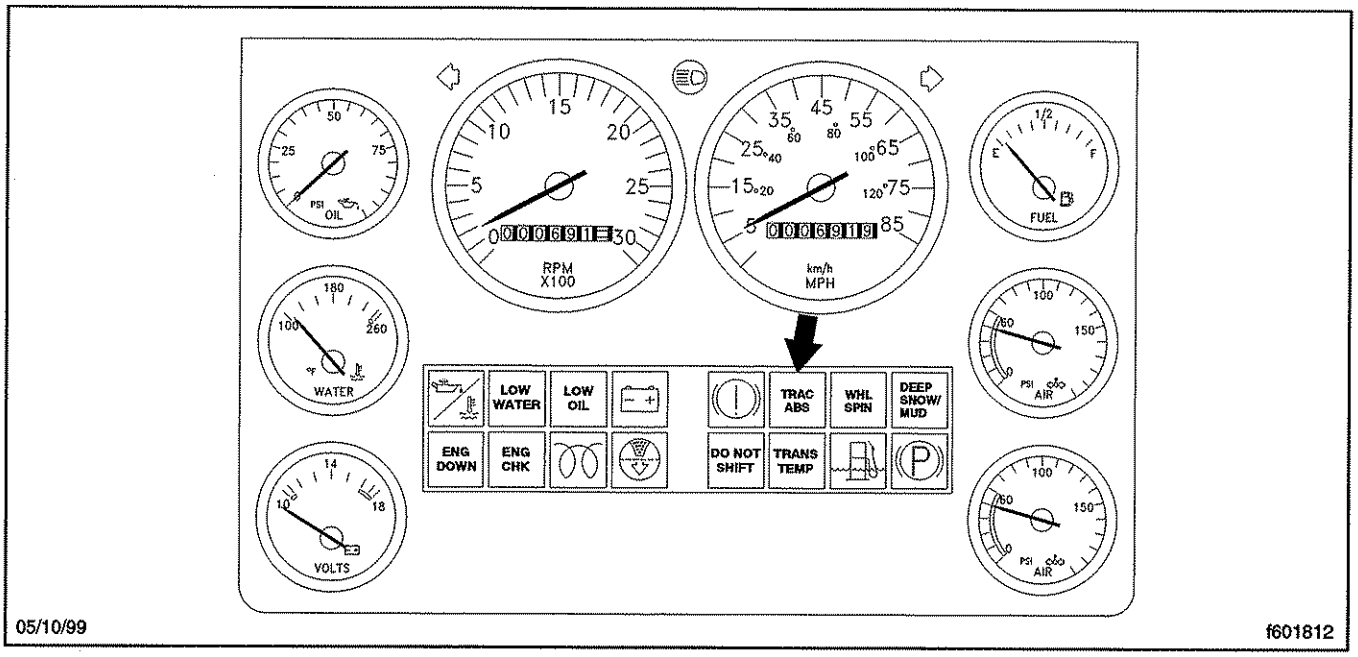
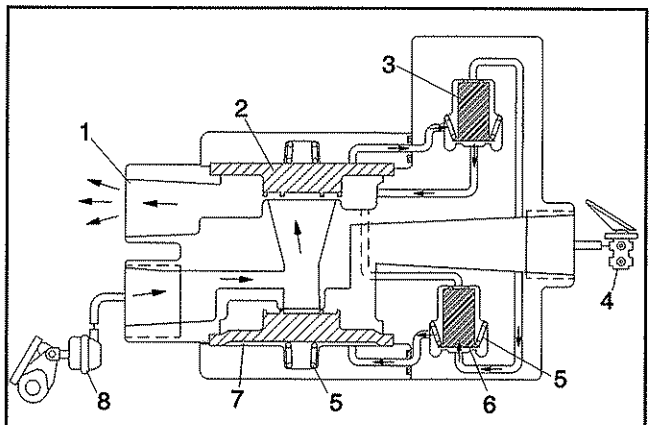


Fig. 4, TRAC ABS Indicator Light



1. Exhaust Port
2. Exhaust Diaphragm
3. Exhaust Solenoid Energized
4. Brake Valve
5. Spring
6. Supply Solenoid Energized
7. Supply Diaphragm
8. Brake Chamber

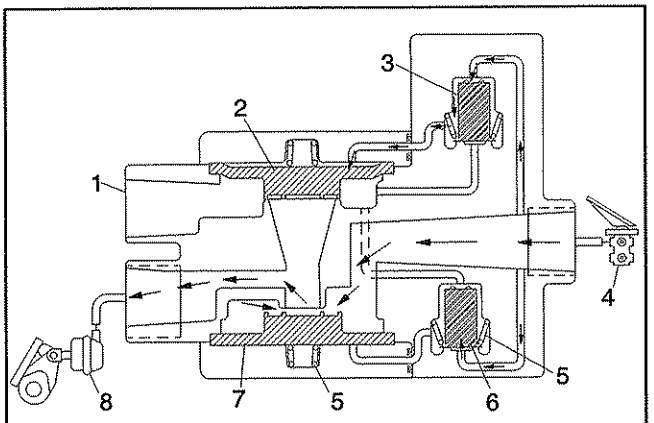
Fig. 5, Wheel Lockup

inlet, application air is prevented from flowing to the control side of the exhaust diaphragm. Air pressure, which was present on the control side of the exhaust diaphragm flows out the exhaust port of the modulator assembly. With control air pressure removed from the exhaust diaphragm, brake application air forces the exhaust diaphragm to unseat which allows it to flow out the modulator exhaust port.

As wheel speed increases, the modulator assembly 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. 6**), brake application air enters the supply port of the modulator assembly and flows to, and through, the open exhaust solenoid, then to the exhaust diaphragm. Air pressure, along with spring force, seats the exhaust diaphragm on the exhaust passage thus preventing the escape of service air. At the same time, application air flows to the supply diaphragm and forces it away from its seat. Air flows past the open supply and out the modulator assembly delivery port to the service brake chambers.

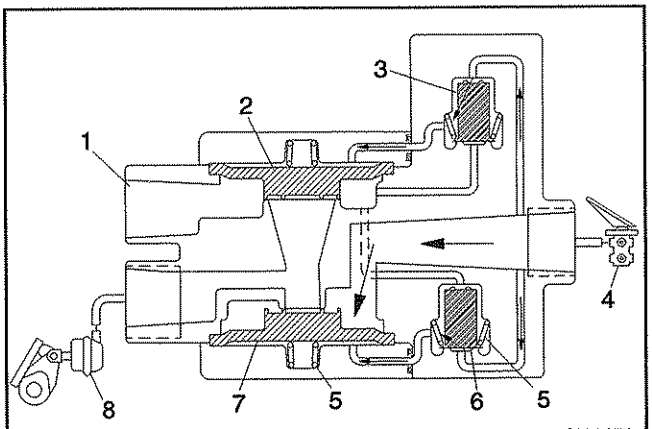
If maintaining brake air pressure (**Fig. 7**), the ECU energizes the supply solenoid and de-energizes the exhaust solenoid. This seats both diaphragms and prevents further exhaust of brake chamber air pressure



1. Exhaust Port
2. Exhaust Diaphragm
3. Exhaust Solenoid
4. Brake Valve
5. Spring
6. Supply Solenoid
7. Supply Diaphragm
8. Brake Chamber

Fig. 6, Pressure Increase

and prevents the application air from flowing out of the delivery port to the brake chamber.



1. Exhaust Port
2. Exhaust Diaphragm
3. Exhaust Solenoid
4. Brake Valve
5. Spring
6. Supply Solenoid
7. Supply Diaphragm
8. Brake Chamber

Fig. 7, Maintaining Pressure

See **Fig. 1** for a full view of the wiring diagram for the Bendix ABS system. See **Fig. 2** and **Fig. 3** for partial (detailed) views of **Fig. 1**.

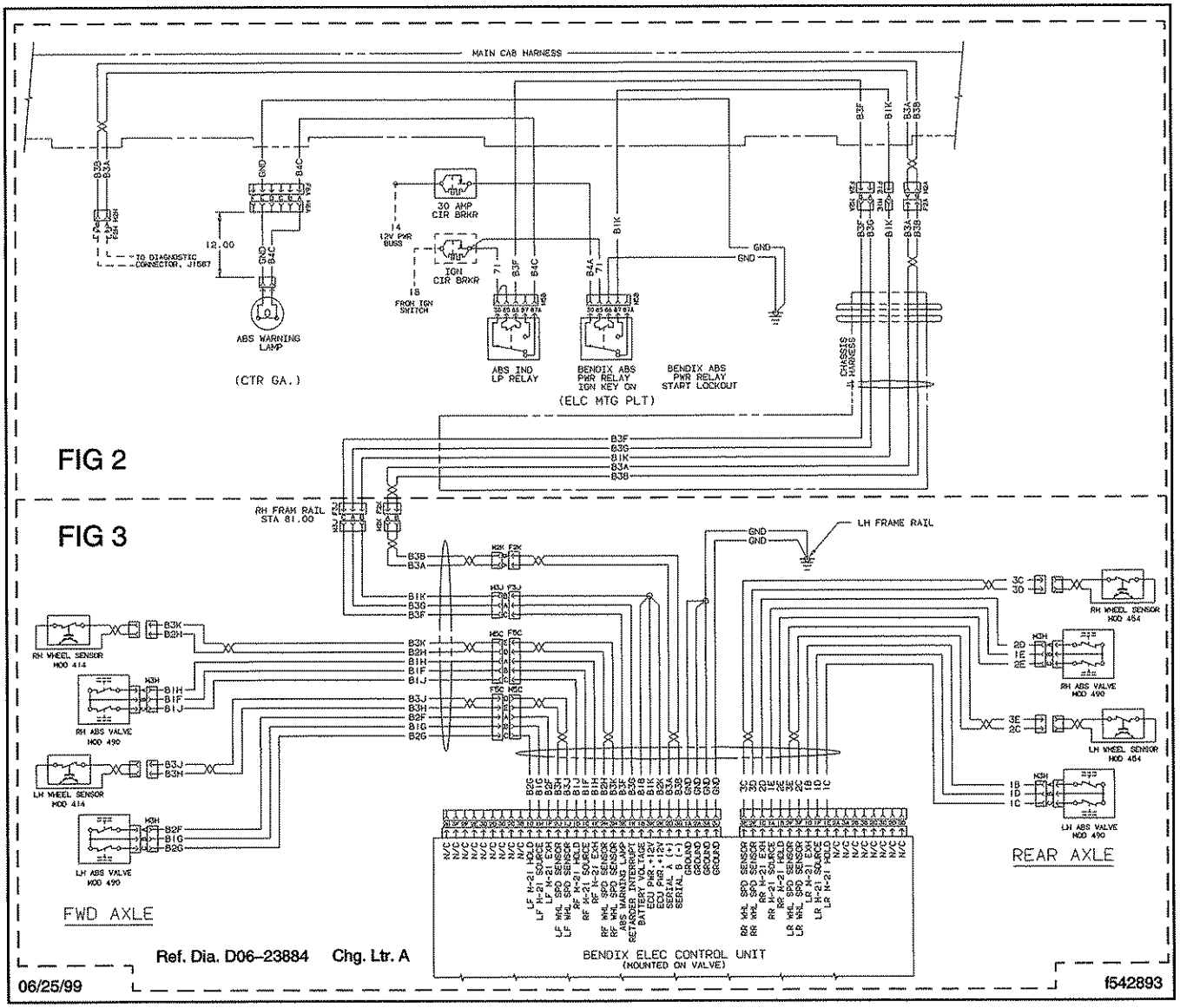


Fig. 1, Wiring Diagram for the Bendix ABS System

Specifications

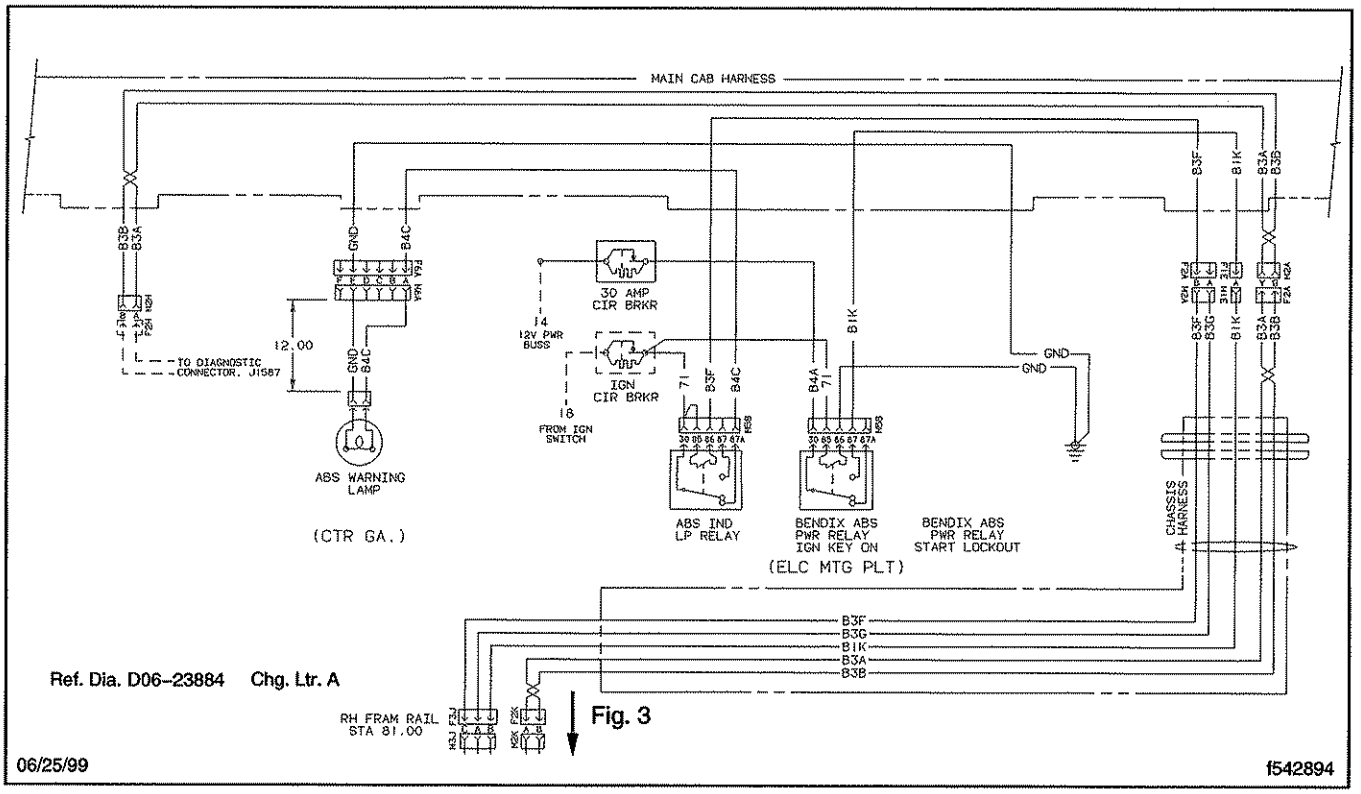


Fig. 2, Partial View of the Bendix ABS System Wiring Diagram

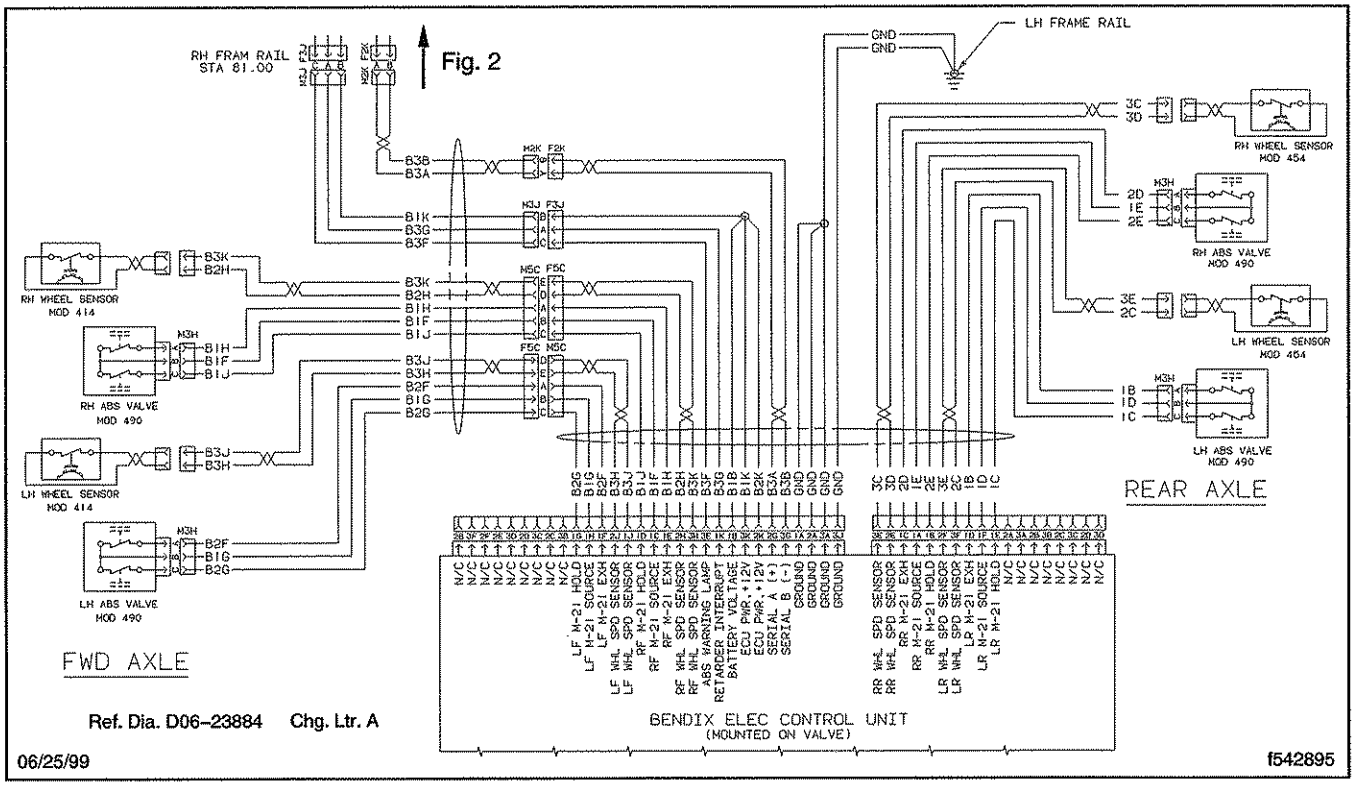


Fig. 3, Partial View of the Bendix ABS System Wiring Diagram

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General Information and Principles of Operation

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

General Information

MGM "L" series tandem cam brake chambers consist of a service brake section and a parking/emergency spring brake section. **See Fig. 2.** The service brake chamber is in the smaller section near the clevis assembly. Some installations include the service brake chamber only. **See Fig. 3.**

In the service brake section, the flange case (or pressure cap for service-only chambers) and non-pressure chamber contain a service return spring, piston rod assembly, and service brake diaphragm.

In the parking/emergency brake section, the flange case and the head assembly contain a return spring, a push rod assembly, a parking (spring) brake diaphragm, a piston, a power spring, and an integral (contained inside the chamber) release bolt and nut.

All MGM brake chambers are mounted to the frame using prevailing torque locknuts and hardened flatwashers.

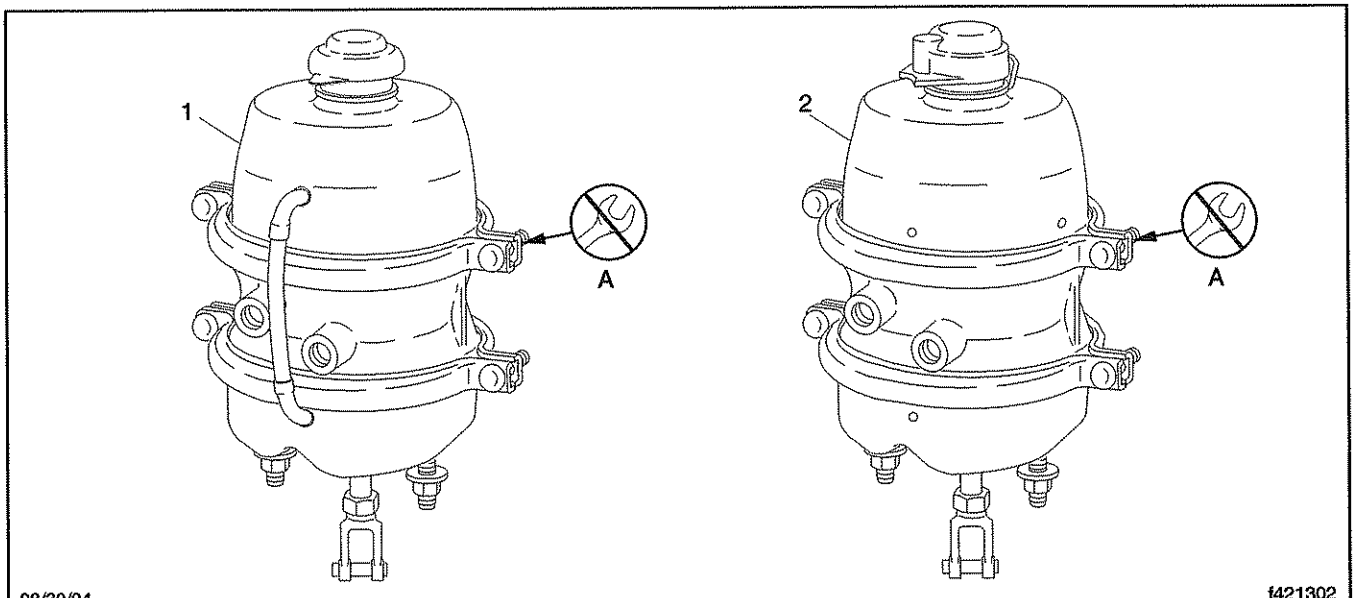
To protect internal components from contaminants, MGM Model "L-T" brake chambers are equipped with an external breather tube. Model "L" employs a filtered breather cap. **See Fig. 2.**

Periodic maintenance of the brake chamber is required. Also, whenever the service brake chamber is disassembled (*do not attempt to disassemble the parking brake chamber*), the parts should be inspected for damage. For maintenance schedules and procedures, and for inspection of brake chamber parts, refer to the vehicle maintenance manual.

Principles of Operation

SERVICE BRAKES

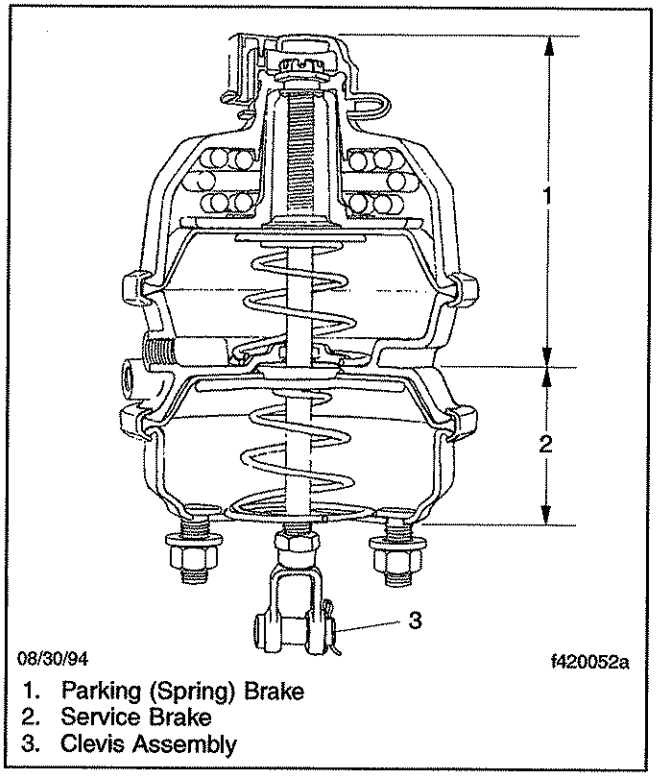
As the brake pedal is depressed, compressed air enters the service brake chamber through a port. Air pressure acts upon a diaphragm, which forces



A. Do not remove this clamp ring.
1. Model L-T Brake Chamber
2. Model L Brake Chamber

Fig. 1, L Series Brake Chambers

General Information and Principles of Operation



1. Parking (Spring) Brake
2. Service Brake
3. Clevis Assembly

Fig. 2, L Series Cam Brake Chambers (sectional view)

the piston rod toward the non-pressure chamber, applying a straight-line force to the slack adjuster, which converts it to a rotational force. This in turn rotates the camshaft and applies the brakes.

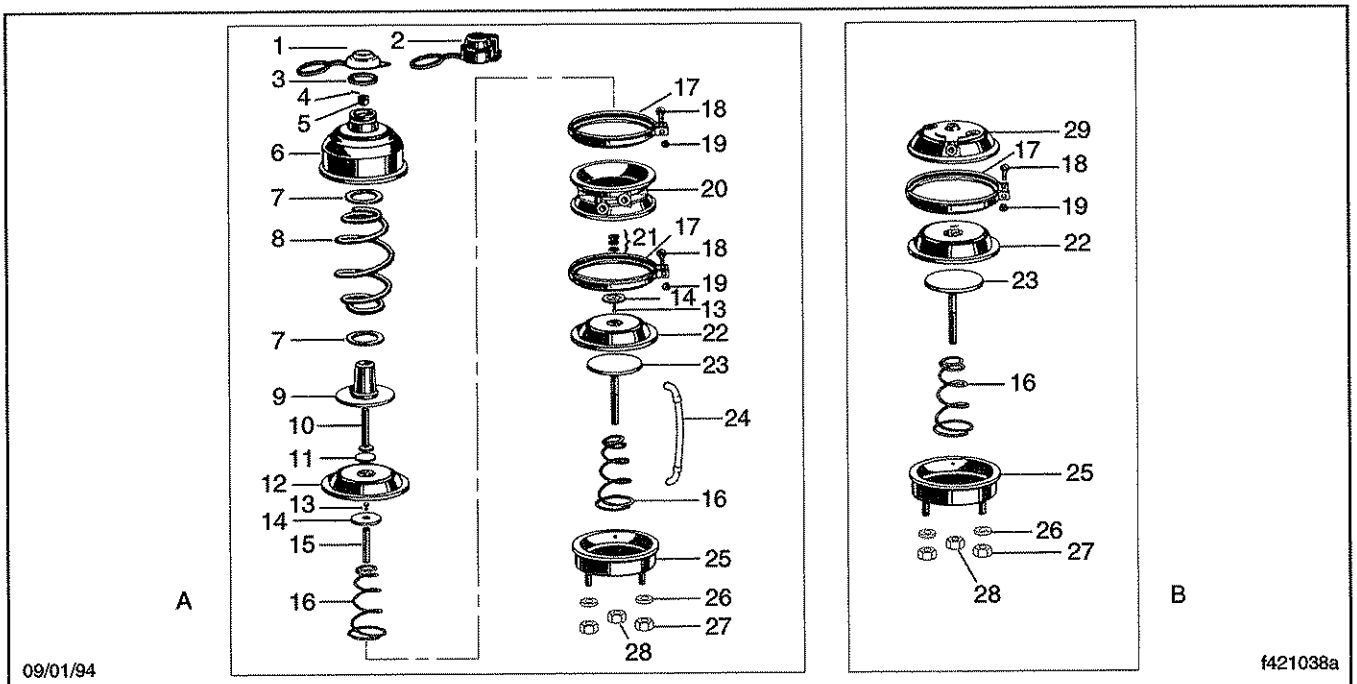
Then, when the brake pedal is released, air is exhausted from the service brake chamber. The return spring allows the diaphragm, piston rod, and slack adjuster to return to their normal positions, releasing the brakes.

PARKING/EMERGENCY BRAKES

During parking brake release, compressed air enters the parking brake chamber and acts upon the diaphragm and piston, fully compressing 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 toward the flange case. The resulting motion on the push rod forces the service brake diaphragm and the piston rod outward, applying the brakes.

Emergency brake application automatically begins when the air pressure in the brake system drops below approximately 550 kPa (80 psi). Full emergency brake application occurs when the air pressure drops below aproximately 275 kPa (40 psi).



A. Combined Service Brake and Parking/Emergency Brake Chamber

1. End Cap and Retainer (on Model L-T only)
2. Breather Cap (on Model L only)
3. Filter (on Model L only)
4. Lockpin
5. Release Nut
6. Head Assembly
7. Thrustwasher
8. Power Spring
9. Piston
10. Integral Release Bolt
11. Piston Plug
12. Parking (Spring) Brake Diaphragm
13. Screw
14. Push Rod Plate
15. Push Rod

B. Service Brake Chamber

16. Return Spring
17. Clamp Ring
18. Clamp Ring Bolt
19. Clamp Ring Nut
20. Flange Case
21. Seal and Guide
22. Service Brake Diaphragm
23. Piston Rod
24. Breather Tube and Elbows (on Model L-T only)
25. Non-Pressure Chamber
26. Hardened Flatwasher
27. Prevailing Torque Locknut
28. Piston Rod Jam Nut
29. Pressure Cap

Fig. 3, L Series Cam Brake Chambers (exploded view)

Power Spring Manual Compression and Reset

⚠ DANGER

Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Manual Compression (Parking Brake Release)

1. Chock the tires.
2. Remove the end cap (breather cap if so equipped). See **Fig. 2.**

⚠ DANGER

Do not attempt to cage the power spring if the parking brake chamber is damaged severely enough to lose its structural integrity. If the power spring were to break loose, it could result in death, severe personal injury, or property damage.

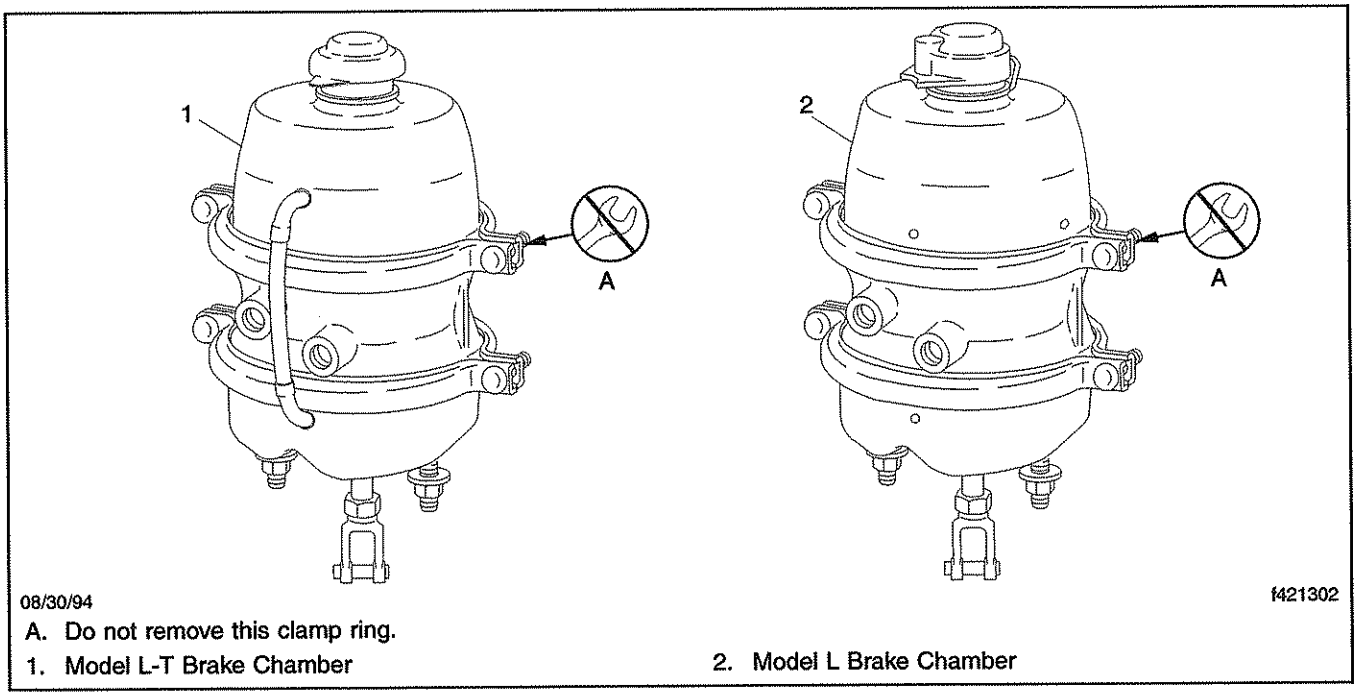
A DAMAGED PARKING BRAKE CHAMBER IS EXTREMELY DANGEROUS! Only qualified service personnel should attempt to remove and disarm a damaged chamber. Using a torch, burn off the piston rod in the space between the clevis and the base of the service chamber.

Remove the chamber carefully from its bracket, and disarm it inside a suitable container. For disarming procedures, consult the MGM service manual.

3. Manually release the parking brake (cage the power spring).
   - 3.1 Apply at least 620 kPa (90 psi) air pressure to the parking brake inlet port (set parking brake in the "release" position).

⚠ CAUTION

Don't exceed 68 N·m (50 lbf·ft) torque on the release bolt; and don't use an impact wrench on this bolt. Too much torque could distort the head of the chamber and prevent manual release of the parking brake.



A. Do not remove this clamp ring.
1. Model L-T Brake Chamber
2. Model L Brake Chamber

Fig. 1, L Series Brake Chambers

Power Spring Manual Compression and Reset

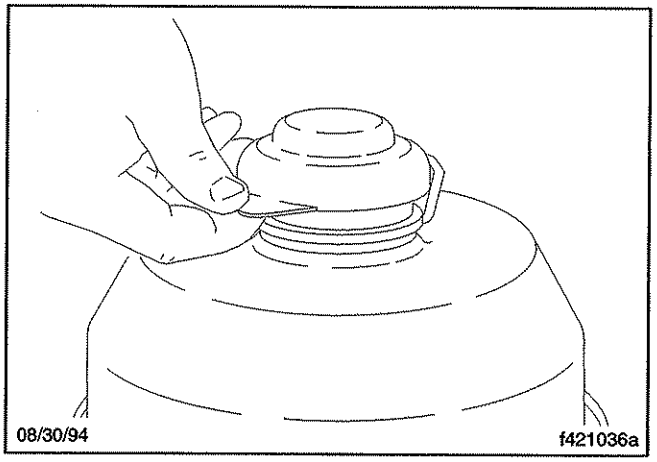
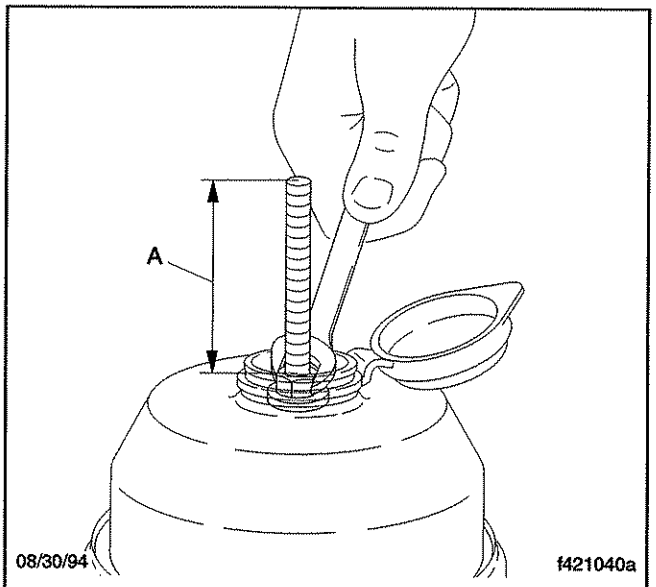


Fig. 2

3.2 Using a hand wrench, (*don't use an impact wrench*), turn the release bolt *counterclockwise* until the bolt is fully extended, or about 57 to 64 mm (2-1/4 to 2-1/2 inches). See **Fig. 3**, dimension A.

4. Once the power spring has been caged, exhaust the compressed air from the parking brake.



Make sure the bolt extends at least 57 mm (2-1/4 inches) above the lip on the chamber head.

A. Measure this distance.

Fig. 3

Manual Reset (Parking Brake Reset)

1. If the threads of the release bolt are dry, coat them with a light film of low-temperature molybdenum (moly) grease.
2. Uncage the power spring.

   2.1 Apply at least 620 kPa (90 psi) air pressure to the parking brake inlet port (set parking brake in the "release" position).

⚠ CAUTION

Don't exceed 68 N·m (50 lbf·ft) torque on the release bolt; and don't use an impact wrench on this bolt. Too much torque could distort the head of the chamber and prevent manual release of the parking brake.

   2.2 Using a hand wrench (*don't use an impact wrench*), turn the release bolt *clockwise* until the bolt is fully engaged into the unit and the slotted nut bottoms out onto the head insert.

   2.3 Tighten the release bolt 61 to 68 N·m (45 to 50 lbf·ft). See **Fig. 4**.

3. Snap the end cap tightly into place. On chambers equipped with a breather cap, make sure the drain tab is pointing to the ground. Regardless of the position in which the brake chamber is installed, the arrow on the drain tab must be pointed downwards. See **Fig. 5**, Reference A.

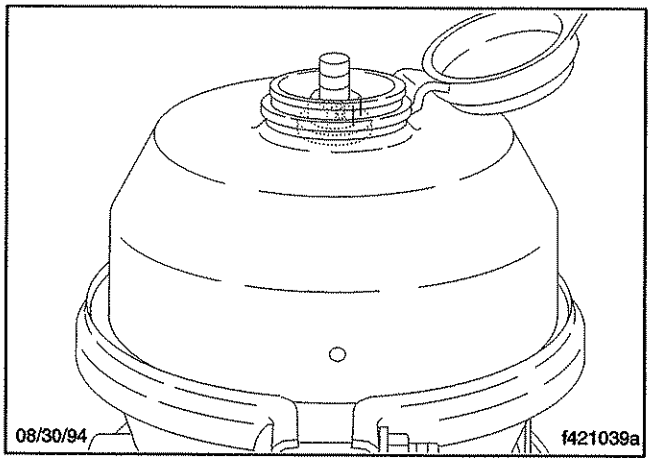


Fig. 4

⚠ CAUTION

If the external breather tube or breather cap is missing or incorrectly installed, road dirt and debris can adversely affect the operation of the brake chamber. Once inside the chamber, dirt and debris cause the internal parts to deteriorate and shorten their lives. Operating the unit without the external breather tube or breather cap in place voids the MGM warranty.

4. Check the breather tube or cap periodically, and replace it with a new one at once if damaged or missing. Also replace the breather cap if the foam filter is contaminated with dirt or debris. For intervals, see the vehicle maintenance manual.

5. Remove the chocks from the tires.

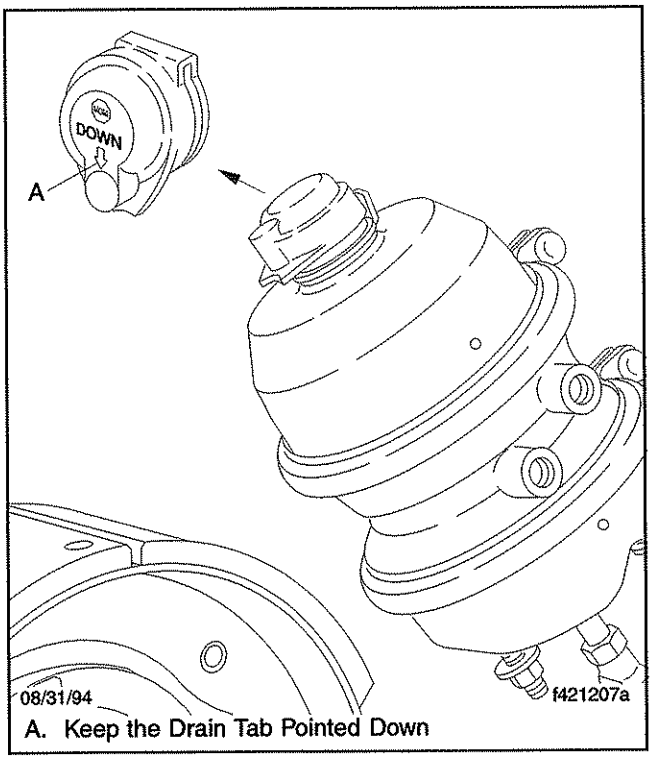


Fig. 5, Breather Cap Installation (on Model L only)

Service Brake Diaphragm Replacement

⚠ DANGER

Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Removal

1. To make removal and installation of the parking brake section easier (without removing the service brake chamber), lock off the service chamber piston rod.

   1.1 Apply the service brakes by actuating the driver's foot brake treadle valve.

   1.2 With the brakes applied, clamp a pair of locking-jaw pliers on the piston rod to lock the rod in place when the air pressure is released (see **Fig. 2**).

⚠ WARNING

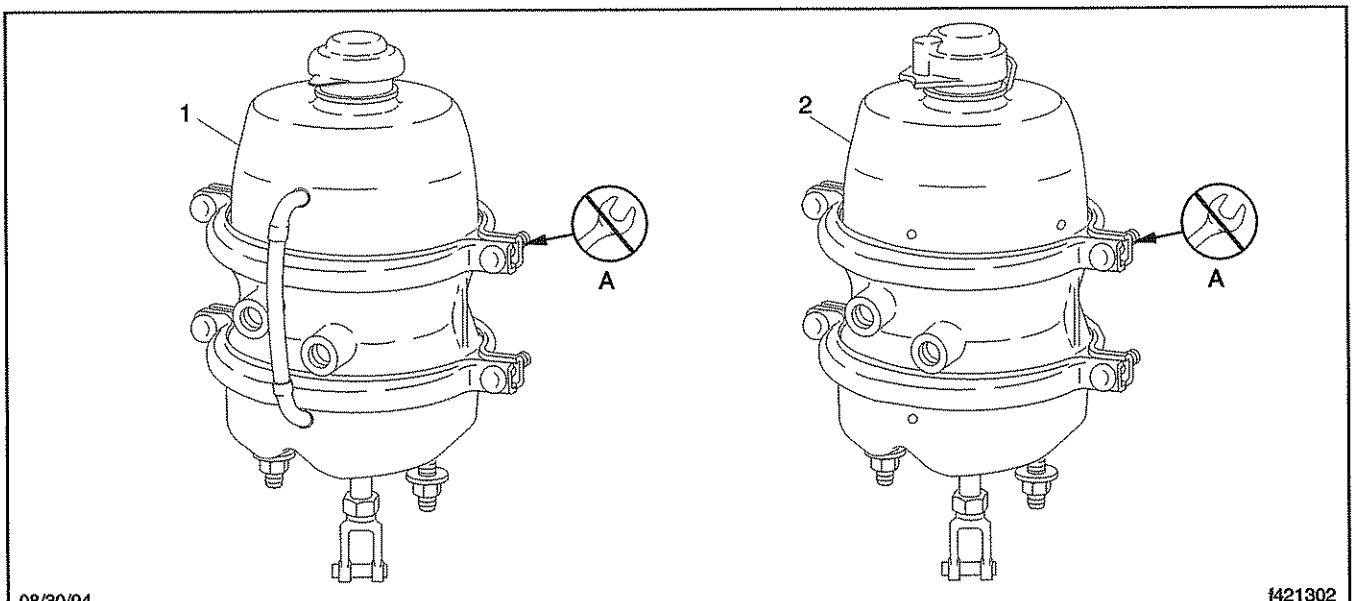
Before caging (compressing) the power spring, chock the vehicle tires and read the warnings and instructions in this section (see Subject 100). When the power spring is caged, the vehicle may be without brakes, allowing it to roll out of control, possibly resulting in personal injury or property damage.

2. Manually release the parking brake (cage the power spring). For instructions, see **Subject 100.**
3. Mark the air lines for later reference. Then carefully disconnect them from the brake chamber.

   On chambers equipped with an external breather tube, disconnect the tube and elbow from the service brake chamber.

⚠ DANGER

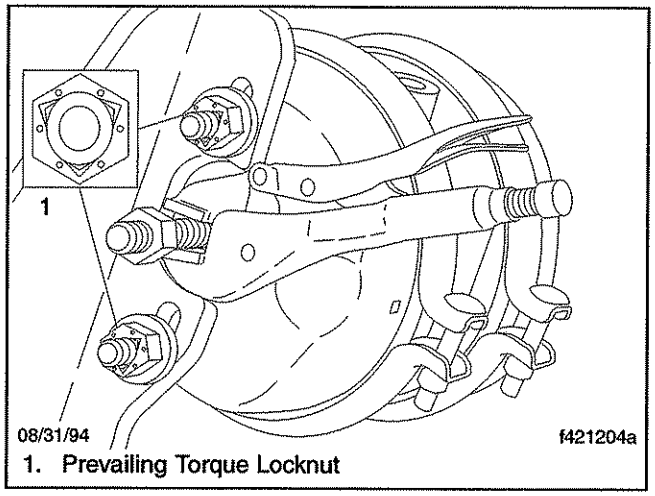
Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.



A. Do not remove this clamp ring.
1. Model L-T Brake Chamber
2. Model L Brake Chamber

Fig. 1

Service Brake Diaphragm Replacement



1. Prevailing Torque Locknut

Fig. 2

4. Remove the parking brake section from the service brake section.

   4.1 Using a hand wrench (*don't use an impact wrench*), remove the clamp nuts on the *service* clamp ring (*do not disassemble the parking brake section*).

   4.2 While holding the parking brake section securely in place, remove the service clamp ring. Then remove the parking brake section from the service brake non-pressure chamber (see **Fig. 3**).

5. Remove the service brake diaphragm from the bottom of the parking brake section.

Installation

IMPORTANT: At this time, take the opportunity to inspect the parking/emergency brake section, and replace it if it shows signs of damage, corrosion, or rust. Follow the detailed inspection instructions in the vehicle maintenance manual.

1. Inspect all parts in the service (non-pressure) chamber. Replace any damaged or worn parts with genuine MGM-engineered replacement parts.
2. Place the new service brake diaphragm in the bottom recess of the parking brake section (see **Fig. 4**).
3. Install the (new, if needed) parking/emergency brake section.

   3.1 If installing a new parking brake section, be sure it is the same size and make as the old one.

   3.2 Check that the release bolt is fully extended outward. For instructions, refer to **Subject 100.**

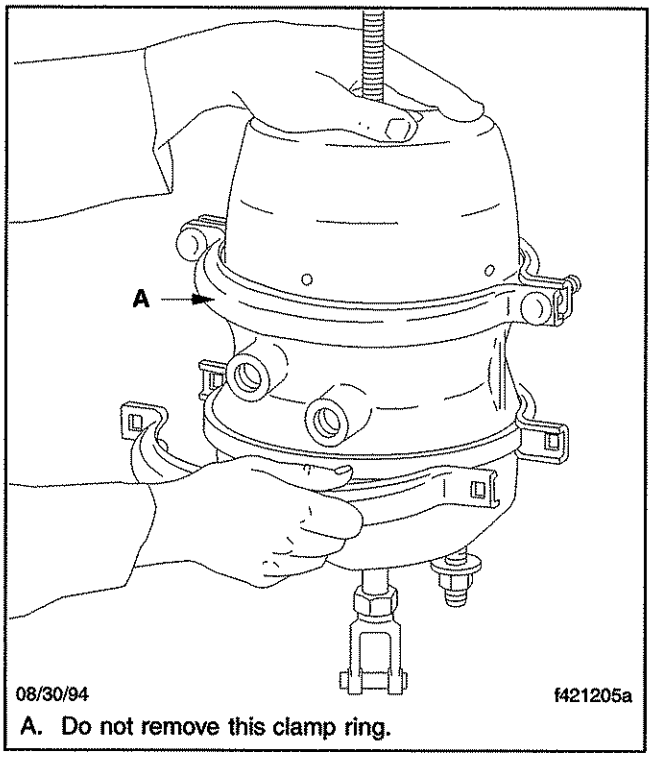
   3.3 Install the parking brake section on the service chamber so that all mating parts are aligned straight and the air lines are positioned to mate with the vehicle air supply lines.

4. Install the service brake clamp ring.

   4.1 With the service brake clamp ring in place, install the clamp bolts and nuts.

   4.2 Using a hand wrench (*don't use an impact wrench*), alternately tighten each clamp nut in increments of 680 to 1360 N·cm (60 to 120 lbf·in) while constantly rechecking the alignment of mating parts.

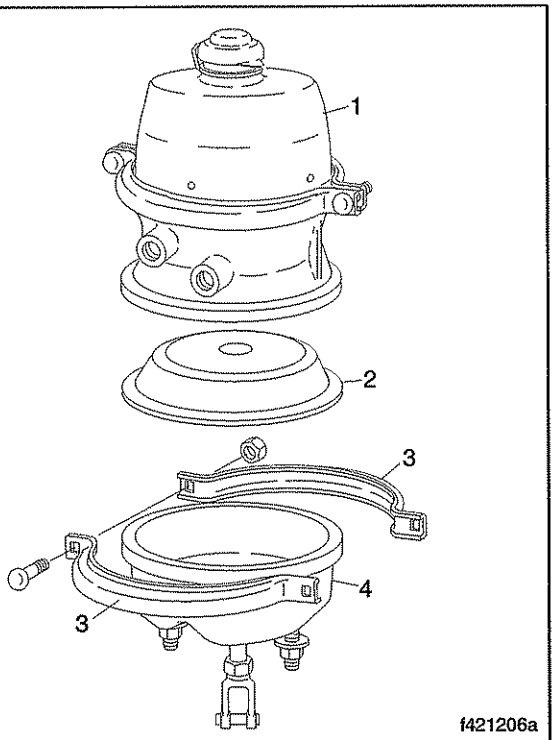
   If realignment is needed, loosen the nuts again, and repeat this substep.



A. Do not remove this clamp ring.

Fig. 3

Service Brake Diaphragm Replacement



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1. Parking/Emergency Brake Section
2. Service Brake Diaphragm
3. Service Brake Clamp Ring
4. Service Brake (Non-Pressure) Chamber

Fig. 4

4.3 Firmly tap around the circumference of the service clamp ring with a rubber mallet to ensure full seating of the clamp. Tighten the nuts to a final torque of 34 to 41 N·m (25 to 30 lbf·ft).

5. Make sure the air hose fittings are free of grease, dirt, and other debris. Then, apply Loctite® 242 sealant, or an equivalent, to the fittings, and install, as referenced earlier. Using a hand wrench (*don't use an impact wrench*), tighten the fittings 34 N·m (25 lbf·ft).

6. Using the vehicle system air, charge the parking brake with full line pressure—at least 690 kPa (100 psi). Using only soapy water (*never any type of oil,* which could deteriorate rubber parts), check for air leaks at the air lines and fittings. If bubbles or leaks appear, tighten the fittings slightly, but not over 34 N·m (25 lbf·ft).

7. With the parking brake still charged with full line pressure, apply and hold the foot brake treadle valve down to charge the service brake chamber. Remove the locking-jaw pliers from the service piston rod so that the piston returns to a normal position in the chamber.

⚠ DANGER

Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

8. Test for air leaks around the circumference of the *service* brake clamp ring. If bubbles or leaks appear, firmly tap the circumference of the clamp ring with a rubber mallet, and retighten the clamp nuts until leaks cease (*do not touch the parking brake section*). MGM recommends 34 to 41 N·m (25 to 30 lbf·ft) torque on the clamp hexnuts.

9. On chambers equipped with an external breather tube, make sure that the open end of the tube is free of grease, dirt, and other debris. Then, apply a high-quality rubber cement to the tube and insert it into the elbow at least 13 mm (1/2 inch). See **Fig. 5**. Insert the tube into the service brake chamber.

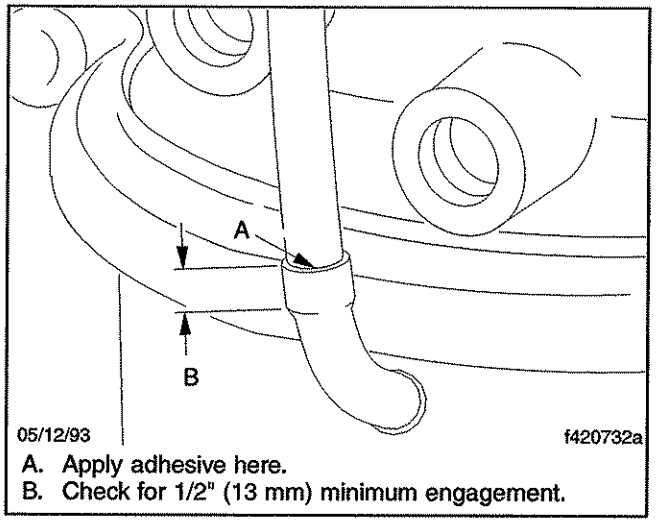
10. With air pressure now exhausted from the service brake chamber, but held on the parking brake, reset the parking brakes by uncaging the power spring, and snap the end cover cap in place. For instructions, see **Subject 100.**

11. Snap the end cap into place. On chambers equipped with a breather cap, snap the breather cap into place, taking care to point the drain tab downwards. Replace the breather cap if the foam filter is contaminated with dirt or debris.

12. Adjust the brakes at the slack adjuster.

IMPORTANT: After replacing any brake chamber components, check the piston rod stroke and actuating alignment to ensure correct installation and foundation brake adjustment. No foundation brake adjustments, parking brake or service brake, can be made at the chamber and all "stroke" adjustments must be made at the slack adjuster. For instructions, see the applicable slack adjuster section in **Group 42.**

Service Brake Diaphragm Replacement



A. Apply adhesive here.
B. Check for 1/2" (13 mm) minimum engagement.

Fig. 5

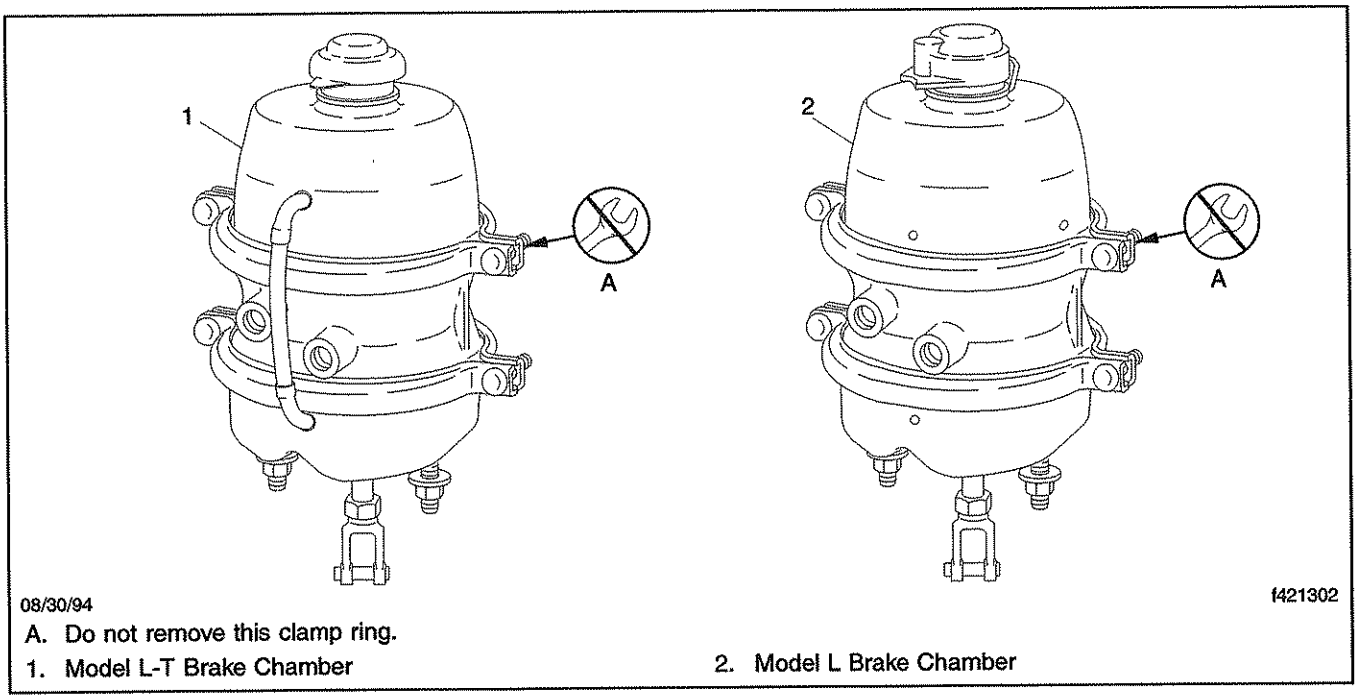
Parking Brake Diaphragm Replacement

Replacement

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

IMPORTANT: The parking/emergency brake section can be replaced as a unit. For instructions, refer to **Subject 110.**



A. Do not remove this clamp ring.
1. Model L-T Brake Chamber
2. Model L Brake Chamber

Fig. 1, L Series Brake Chambers

Combination Service and Parking Brake Chamber Removal and Installation

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Removal (See Fig. 2 or Fig. 3)

⚠ WARNING

WARNING: Before caging (compressing) the power spring, chock the vehicle tires and read the warnings and instructions in this section (see Subject 100). When the power spring is caged, the vehicle may be without brakes, allowing it to roll out of control, possibly resulting in personal injury or property damage.

1. Manually release the parking brake (cage the power spring). For instructions, refer to **Subject 100.**
2. Mark the air lines for later reference. Then carefully disconnect them from the brake chamber.
3. Remove the brake chamber from the vehicle.

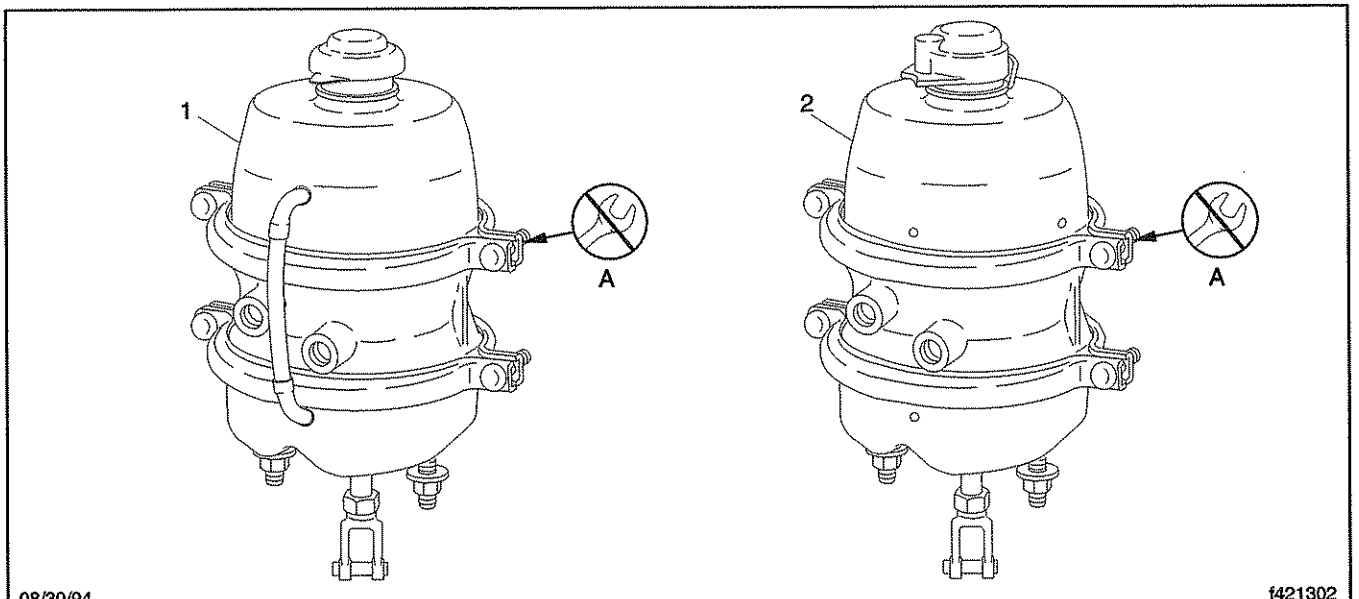
   3.1 Remove the cotter pin(s) from the clevis pin(s), then remove the clevis pin(s) from the clevis. Disconnect the clevis from the slack adjuster.

   NOTE: Gunite and Rockwell automatic slack adjusters have two clevis pins, one large and one small, each locked by a cotter pin.

   3.2 Make sure the parking brake has been released manually (the power spring has been caged). For instructions, refer to **Subject 100.** Also, make sure that the service brake piston is fully retracted (in the brakes "OFF" position). Then, record both of the following dimensions in either mm or inches, measuring outward from the base of the service brake chamber **(see Fig. 4)**:

   X dimension: to end of threaded piston rod

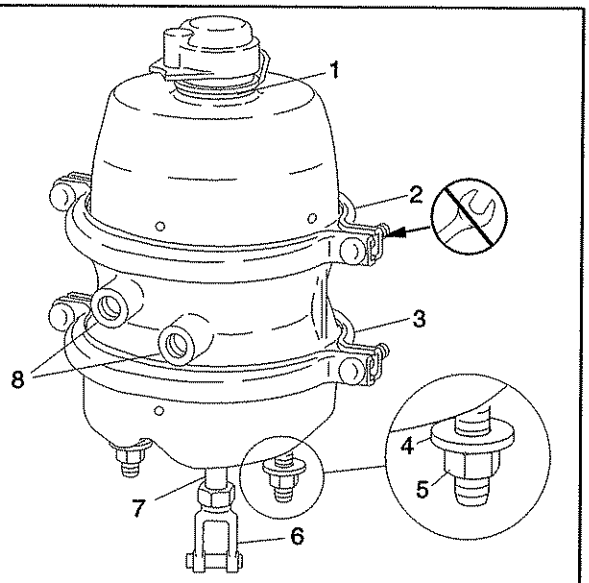
   Y dimension: to centerline of (large) clevis pin



A. Do not remove this clamp ring.
1. Model L-T Brake Chamber
2. Model L Brake Chamber

Fig. 1, L Series Brake Chambers

Combination Service and Parking Brake Chamber Removal and Installation



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Do not remove the parking brake clamp ring.

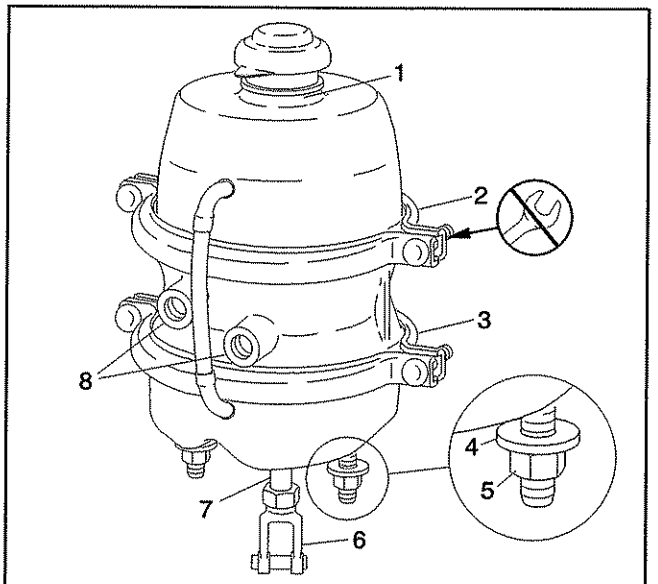
1. Breather Cap
2. Parking Brake Clamp Ring
3. Service Brake Clamp Ring
4. Hardened Flatwasher
5. Prevailing Torque Locknut
6. Clevis Assembly
7. Piston Rod
8. Air Inlet Ports

Fig. 2, Model L Brake Chamber

IMPORTANT: If new chambers are to be attached to manual slack adjusters, the Y dimension is the most critical measurement. When installing the new assembly, cut its service piston rod (**see Fig. 5**) to exactly duplicate this "rod-plus-clevis" length *after* the clevis assembly is installed on the piston rod.

If new chambers are to be attached to automatic slack adjusters, the X dimension is the most critical measurement. When installing the new assembly, cut its service piston rod (**see Fig. 5**) to exactly duplicate the "rod only" length *before* the clevis assembly is installed on the piston rod.

3.3 From each mounting stud, remove any installed nuts and washers. Then, cautiously remove the brake chamber from the mounting bracket.



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Do not remove the parking brake clamp ring.

1. End Cap
2. Parking Brake Clamp Ring
3. Service Brake Clamp Ring
4. Hardened Flatwasher
5. Prevailing Torque Locknut
6. Clevis Assembly
7. Piston Rod
8. Air Inlet Ports
9. External Breather Tube

Fig. 3, Model L-T Brake Chamber

Installation (See Fig. 2 or Fig. 3)

1. If installing a new brake chamber unit, do the following steps:

   1.1 First, make sure the power spring is caged (release bolt fully extended outward). If not, **go to Subject 100** and do the applicable steps.

   1.2 Make sure that the piston rod is the same length as the rod on the old unit (measure the rods when *both* chambers are caged).

   1.3 Be sure the new chamber is the same size and make as the brake chamber installed on the other side of the axle.

Combination Service and Parking Brake Chamber Removal and Installation

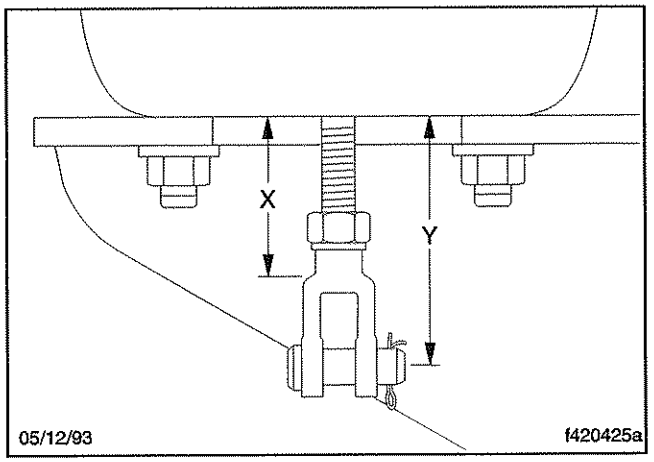


Fig. 4

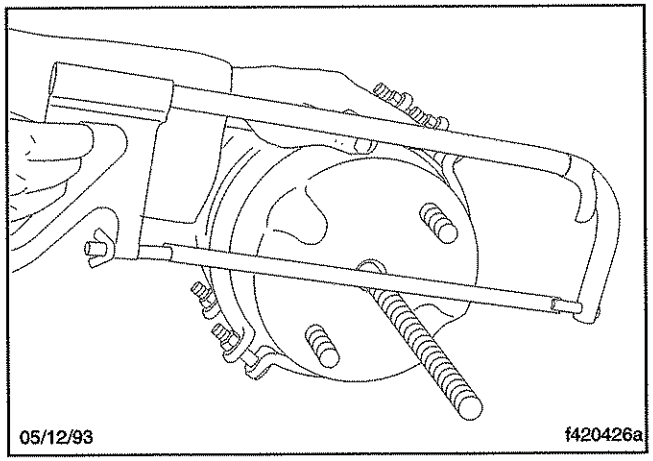


Fig. 5

1.4 Remove the prevailing torque locknut and hardened flatwasher from each of the mounting studs on the chamber.

2. Clean the face of the mounting bracket, and position the chamber on the bracket. Pay close attention to positioning the chamber air inlet ports for correct alignment to the vehicle air lines.

⚠ WARNING

WARNING: Tighten the mounting nuts with a hand wrench, not an impact wrench. An impact wrench could damage the mounting fasteners, reducing the force of the brakes. This could result in personal injury or property damage.

3. Install one hardened flatwasher and prevailing torque locknut on each mounting stud. Using a hand wrench (*don't use an impact wrench*), tighten the nuts 136 to 156 N·m (100 to 115 lbf·ft). Make sure that the hardened flatwasher is installed between the locknut and the mounting bracket.

   On chambers equipped with an external breather tube, make sure that the tube is installed in the side of the chamber that faces away from the road surface. An improperly installed breather tube voids the MGM warranty.

4. Check mating and alignment with the vehicle air lines.

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

4.1 Using a hand wrench (*don't use an impact wrench*), loosen the clamp nuts on the *service* clamp ring (*do not disassemble the parking brake section*).

4.2 Reposition the air inlet ports, as needed, to mate with vehicle air supply lines.

Alternately tighten each clamp nut in increments of 680 to 1360 N·cm (60 to 120 lbf·in) while constantly rechecking the alignment of mating parts.

If realignment is needed, loosen the nuts again, and repeat this substep.

4.3 Firmly tap around the circumference of the service clamp ring with a rubber mallet to ensure full seating of the clamp. Tighten the nuts to a final torque of 34 to 41 N·m (25 to 30 lbf·ft).

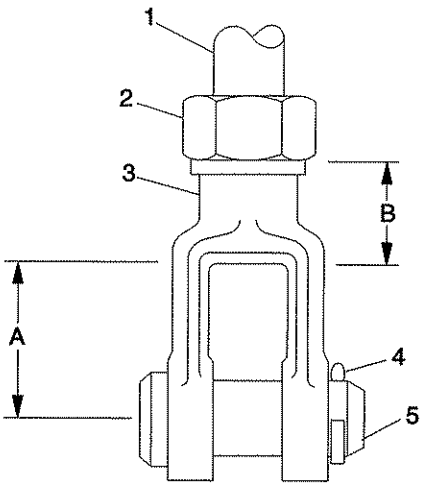
5. With manual slack adjusters, connect the slack adjuster to the clevis, then install the clevis pin. Insert the cotter pin in the clevis pin, and lock it in place. Check the piston-rod engagement with the clevis. At least seven threads of engagement are required; there should be 25-mm (1-inch) clearance from the centerline of the clevis pin hole

Combination Service and Parking Brake Chamber Removal and Installation

to the end of the piston rod. **See Fig. 6.** Adjust as needed.

With automatic slack adjusters, refer to the applicable slack adjuster section in **Group 42** in this manual for installation instructions.

6. Inspect the piston rod to be sure it is working free, not binding, and is square with the chamber bottom within ±3° from zero to full stroke. If there is misalignment, make corrections by loosening the locknuts and repositioning the chamber on the mounting bracket, or by shimming the slack adjuster to the right or left on the camshaft.
7. Make sure the air hose fittings are free of grease, dirt, and other debris. Then, apply Loctite® 242 sealant, or an equivalent, to the fittings, and install, as referenced earlier. Using a hand wrench (*don't use an impact wrench*), tighten the fittings 34 N·m (25 lbf·ft).
8. Using the vehicle system air, charge the parking brake with full line pressure, at least 690 kPa (100 psi). Using only soapy water (*never any type of oil,* which could deteriorate rubber parts), check for air leaks at the air lines and fittings. If bubbles or leaks appear, tighten the fittings slightly, but not over 34 N·m (25 lbf·ft).



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A. Minimum clearance of 25 mm (1 inch) between centerline of clevis pin hole and piston rod end.
B. Minimum of 7 threads engagement.

1. Piston Rod
2. Piston Rod Nut
3. Clevis
4. Cotter Pin
5. Clevis Pin

Fig. 6, Piston Rod Engagement With the Clevis

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

IMPORTANT: If the service brake clamp ring was loosened to reposition the air inlet ports, apply air to the parking brake, and then apply and hold the foot brake treadle valve down to charge the service brake chamber. Now test for air leaks around the circumference of the *service* brake clamp ring. If bubbles or leaks appear, firmly tap the circumference of the clamp ring with a rubber mallet, and retighten the clamp nuts until leaks cease (*do not touch the parking brake section*). MGM recommends 34 to 41 N·m (25 to 30 lbf·ft) torque on the clamp hexnuts.

9. With air pressure now exhausted from the service brake chamber, but held on the parking brake, reset the parking brakes by uncaging the power spring. For instructions, refer to **Subject 100.**
10. Snap the end cap into place. On chambers equipped with a breather cap, snap the breather cap into place, taking care to point the drain tab downwards. Replace the breather cap if the foam filter is contaminated with dirt or debris.
11. Adjust the brakes at the slack adjuster. For instructions, refer to the applicable slack adjuster section in this manual.

IMPORTANT: After replacing any brake chamber, check the piston rod stroke and actuating alignment to ensure correct installation and foundation brake adjustment. No foundation brake adjustments, parking brake or service brake, can be made at the chamber and all "stroke" adjustments must be made at the slack adjuster. For instructions, refer to the applicable slack adjuster section in **Group 42** in this manual.

Specifications

Description	Torque N.m (lbf.ft)
Parking Brake Release Bolt Nut	68 (50)
Service Brake Clamp Ring Nut	34-41 (25-30)
Brake Chamber Mounting Stud Locknut	136-156 (100-115)
Air Hose Fitting-to-Chamber	34 (25)

Table 1, Torque Values

Contents

Subject	Subject Number
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Parking Brake Diaphragm Replacement	115
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⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

NOTE: On some Anchorlok models, the parking/emergency brake section is factory sealed (no clamp ring) and is a *non-serviceable* unit. On other models, the parking/emergency brake section is attached with a clamp ring. *Do not ever perform any service on this clamp ring.*

General Information

Anchorlok brake chambers consist of a service brake section and a parking/emergency spring brake section. **See Fig. 1**. The service brake section is the smaller section near the clevis assembly.

In the service brake section, the service brake chamber contains a service return spring, piston rod assembly, and service brake diaphragm.

In the parking/emergency brake section, the adaptor and the chamber contain a return spring, a push rod assembly, a parking (spring) brake diaphragm, a pressure plate, a power spring, and a detachable release bolt.

All Anchorlok brake chambers are mounted to the frame using prevailing torque locknuts and hardened flatwashers.

Periodic maintenance of the brake chambers is required. Also, whenever the service brake chamber is disassembled (*do not attempt to disassemble the parking brake chamber*), the parts should be inspected for damage. For maintenance schedules and procedures, and for inspection of brake chamber parts, refer to the vehicle maintenance manual.

Principles of Operation

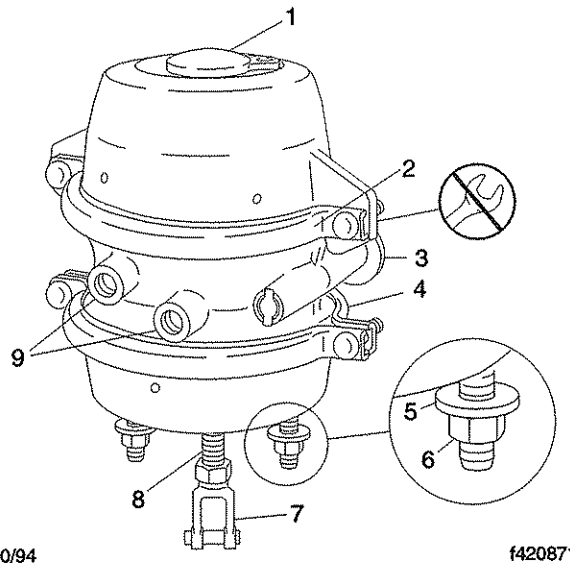
SERVICE BRAKES

As the brake pedal is depressed, compressed air enters the service brake chamber through a port. Air pressure acts upon a diaphragm, which forces the piston rod toward the non-pressure chamber, applying a straight-line force to the slack adjuster, which converts it to a rotational force. This in turn rotates the camshaft and applies the brakes. **See Fig. 2.**

Then, when the brake pedal is released (**Fig. 3**), air is exhausted from the service brake chamber, and the return spring allows the diaphragm, piston rod assembly, and slack adjuster to return to their normal positions, releasing the brakes.

PARKING/EMERGENCY BRAKES

During parking brake release, compressed air enters the parking/emergency brake chamber below the diaphragm, forcing the diaphragm against the pressure plate to compress the power spring and release the parking/emergency brake. **See Fig. 4.** During parking brake application, a control valve in the cab exhausts air from the parking/emergency brake

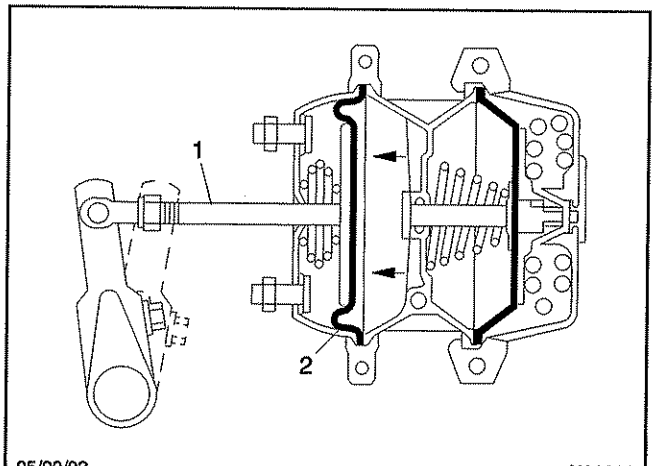


NOTE: On some models, the parking brake clamp ring is permanently sealed.

1. Dust Plug
2. Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports

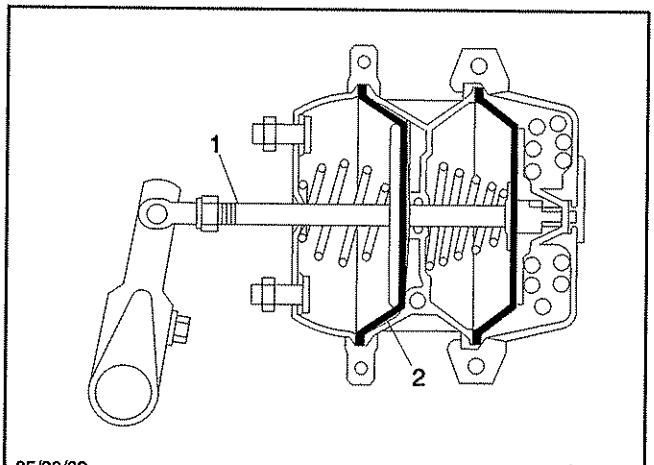
Fig. 1

General Information and Principles of Operation



05/20/93 f420889
1. Piston Rod Assembly
2. Service Brake Diaphragm

Fig. 2, Service Brake Applied

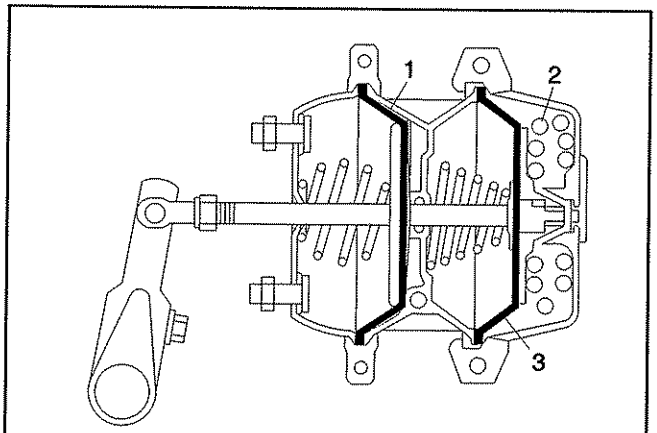


05/20/93 f420885
1. Piston Rod Assembly
2. Service Brake Diaphragm

Fig. 3, Service Brakes Applied

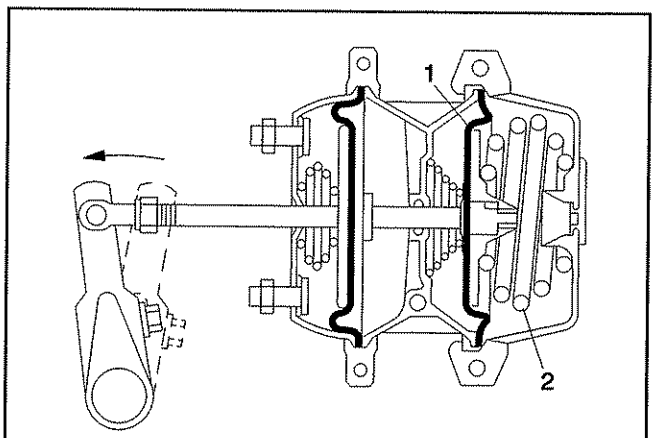
chamber. This allows the power spring to extend and apply the brakes. **See Fig. 5.**

Emergency brake application begins when air pressure in the service brake reservoir drops below about 550 to 585 kPa (80 to 85 psi). Maximum spring brake force is applied when air is entirely exhausted from the parking/ emergency brake chamber.



07/02/93 f420888
1. Service Brake Diaphragm
2. Power Spring
3. Parking/Emergency Brake Diaphragm

Fig. 4, Parking/Emergency Brakes Released



09/11/98 f420924
1. Parking/Emergency Brake Diaphragm
2. Power Spring

Fig. 5, Parking/Emergency Brakes Applied

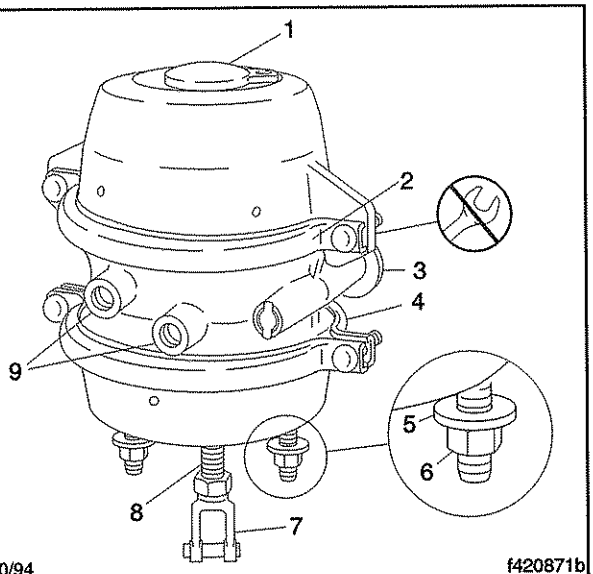
Power Spring Manual Compression and Reset

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Manual Compression (Parking Brake Release)

1. Chock the tires.
2. Remove the dust plug from the center-hole in the head of the chamber. **See Fig. 2.**



NOTE: On some models, the parking brake clamp ring is permanently sealed.

1. Dust Plug
2. Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports

Fig. 1

⚠ DANGER

DANGER: Do not attempt to cage the power spring if the safety hooks have been removed, or if the parking brake chamber is damaged severely enough to lose its structural integrity. If the power spring were to break loose, it could result in death, severe personal injury, or property damage.

A DAMAGED PARKING BRAKE CHAMBER IS EXTREMELY DANGEROUS! Only qualified service personnel should attempt to remove and disarm a damaged chamber. Using a torch, burn off the piston rod in the space between the clevis and the base of the service chamber.

Remove the chamber carefully from its bracket, and disarm it inside a suitable container. For disarming procedures, consult the Anchorlok installation instructions.

3. Manually release the parking brake (cage the power spring).

⚠ CAUTION

CAUTION: Don't use an impact wrench on this nut. Too much torque could damage the pressure plate and prevent manual release of the parking brake.

3.1 Using a hand wrench, (*don't use an impact wrench*), unscrew the release nut, and remove the nut, flatwasher, and release bolt from the storage pocket on the side of the chamber. **See Fig. 3.**

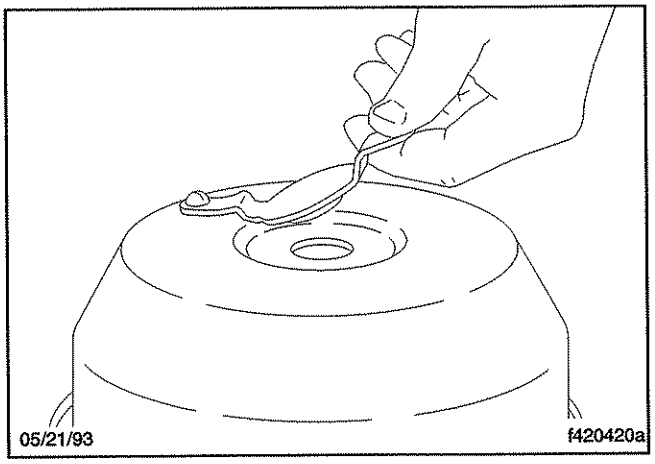


Fig. 2

Power Spring Manual Compression and Reset

IMPORTANT: If these parts are not stored on the chamber, they must be otherwise obtained or purchased; the parking brake cannot be manually released without them.

3.2 Insert the release bolt into the center-hole in the chamber head (**see Fig. 4**). Continue to insert the bolt until it bottoms out into the hole in the pressure plate inside the chamber.

IMPORTANT: If you are not absolutely sure that the formed end of the bolt has engaged the pressure plate correctly, repeat this step. Repeat it until you are absolutely sure.

3.3 Turn the release bolt one-quarter turn clockwise. Pull to seat the formed end of the release bolt in the recess of the pressure plate.

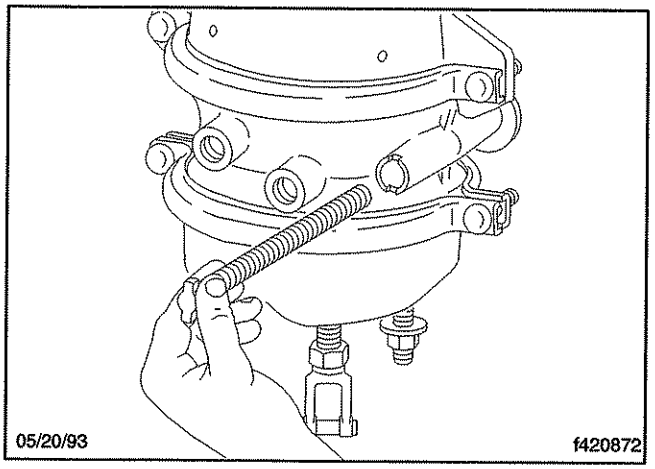


Fig. 3

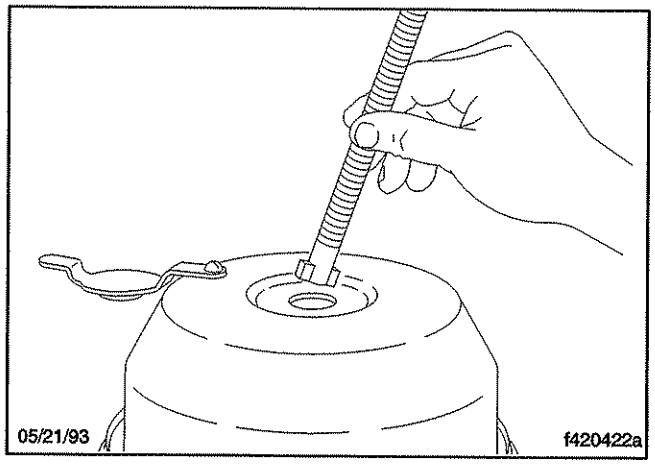


Fig. 4

3.4 Holding the release bolt locked into the pressure plate, install the flatwasher and release nut on the end of the bolt, and turn down the nut against the flatwasher until it is finger-tight. **See Fig. 5.**

⚠ DANGER

DANGER: Exhaust all air pressure before tightening the release nut more than finger-tight. Tightening this nut under pressure can damage the pressure plate and result in sudden release of the power spring, causing death or severe personal injury.

⚠ CAUTION

CAUTION: If equipped with S-cam or disc brakes, don't exceed 47 N·m (35 lbf·ft) torque on the release nut; if equipped with wedge brakes, don't exceed 27 N·m (20 lbf·ft) torque on the release nut.

3.5 Using a hand wrench (*don't use an impact wrench*), turn the release nut clockwise until the power spring is caged (**see Fig. 6**):

On parking/emergency brake chambers that are permanently sealed (no clamp ring), the bolt should extend above the nut at least 74 mm (2.9 inches) on 24-inch chambers, or 73 mm (2.875 inches) on 30-inch chambers.

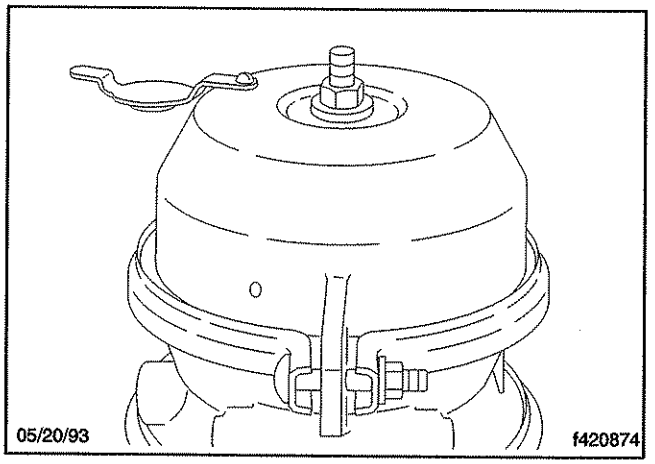


Fig. 5

On parking/emergency brake chambers that are sealed with a clamp ring, the bolt should extend above the nut at least 71 mm (2.8 inches) on 24-inch chambers, or 69 mm (2.7 inches) on 30-inch chambers.

IMPORTANT: Don't exceed these bolt lengths. If the bolt lengths can't be obtained without exceeding the recommended maximum torque values, replace the tandem brake chamber.

Manual Reset (Parking Brake Reset)

1. Uncage the power spring.

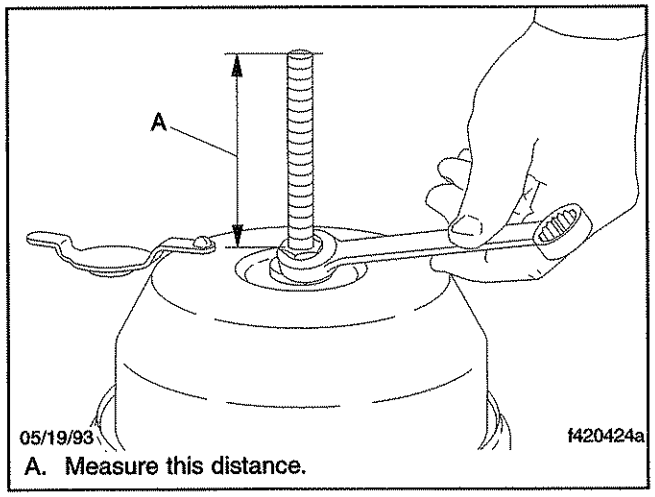
⚠ CAUTION

CAUTION: Don't use an impact wrench on this nut. Too much torque could damage the pressure plate and prevent manual release of the parking brake.

1.1 With air applied to the parking brake section (the parking brake control valve is in the "release" position), use a hand wrench and turn the release nut *counterclockwise* until the power spring extends back into the parking/emergency brake chamber.

NOTE: When the power spring is fully extended, force will no longer be felt on the release nut.

1.2 Remove the nut and flatwasher.



A. Measure this distance.

Fig. 6

1.3 Turn the release bolt one-quarter turn counterclockwise and unlock the bolt from the receptacle in the pressure plate. Remove the release bolt from the center-hole of the chamber.

2. Install the release bolt, flatwasher, and release nut in the storage pocket. Tighten the nut 680 to 1080 N·cm (60 to 96 lbf·in). **See Fig. 7.**

3. Snap the dust plug in place over the center-hole in the chamber head. **See Fig. 8.**

⚠ CAUTION

CAUTION: If a dust plug is missing or incorrectly installed, road dirt and debris can adversely affect the operation of the brake chambers. Once inside the chambers, dirt and debris cause the internal parts to deteriorate and shorten their lives.

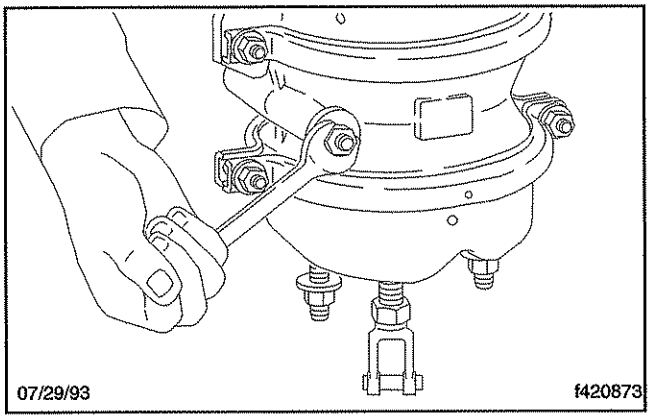


Fig. 7

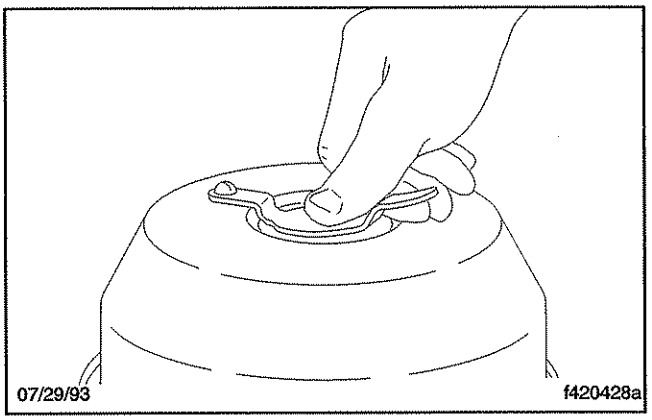


Fig. 8

Power Spring Manual Compression and Reset

4. Check the plastic dust plug periodically, and replace it with a new one at once if damaged or missing. For intervals, refer to the vehicle maintenance manual.
5. Remove the chocks from the tires.

Service Brake Diaphragm Replacement

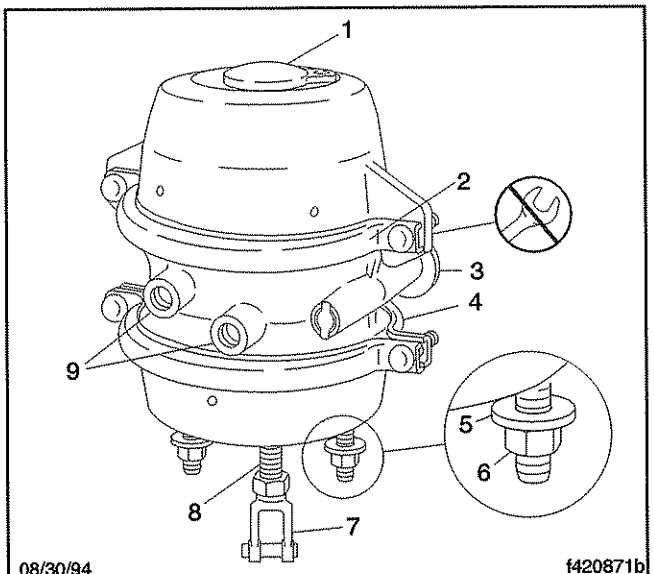
⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Removal

1. To make removal and installation of the parking brake section easier (without removing the service brake chamber), lock off the service chamber piston rod.

   1.1 Apply the service brakes by actuating the driver's foot brake treadle valve.



NOTE: On some models, the parking brake clamp ring is permanently sealed.

1. Dust Plug
2. Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports

Fig. 1

   1.2 With the brakes applied, clamp a pair of locking-jaw pliers on the piston rod to lock the rod in place when the air pressure is released (**see Fig. 2**).

⚠ WARNING

WARNING: Before caging (compressing) the power spring, chock the vehicle tires and read the warnings and instructions in this section (see Subject 100). When the power spring is caged, the vehicle may be without brakes, allowing it to roll out of control, possibly resulting in personal injury or property damage.

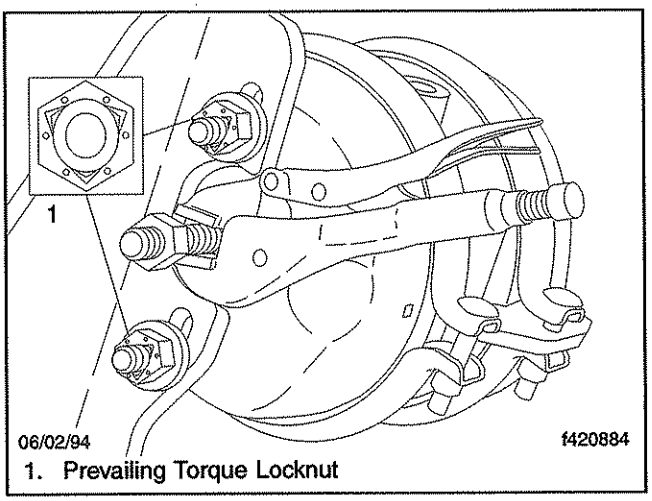
2. Manually release the parking brake (cage the power spring). For instructions, refer to **Subject 100.**

3. Mark the air lines for later reference. Then carefully disconnect them from the brake chamber.

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

4. Remove the parking brake and adaptor from the service brake section.



1. Prevailing Torque Locknut

Fig. 2

Service Brake Diaphragm Replacement

4.1 Using a hand wrench (*don't use an impact wrench*), remove the clamp nuts on the *service* brake clamp ring (*do not disassemble the parking brake section*).

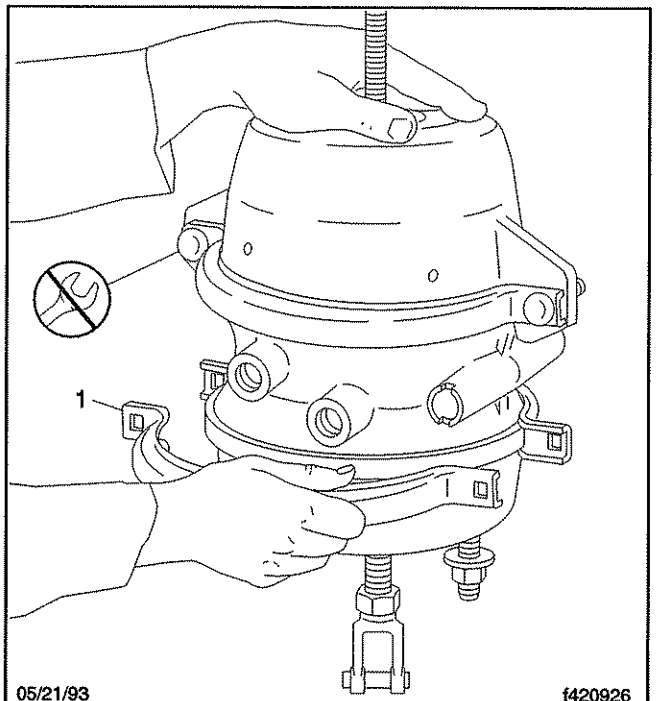
4.2 While holding the parking brake section securely in place, remove the service clamp ring. Then remove the parking brake section from the service brake non-pressure chamber (**see Fig. 3**).

5. Remove the service brake diaphragm from the bottom of the parking brake section.

Installation

IMPORTANT: At this time, take the opportunity to inspect the parking/emergency brake section, and replace it if it shows signs of damage, corrosion, or rust. Follow the detailed inspection instructions in the vehicle maintenance manual.

1. Inspect all parts in the service (non-pressure) chamber. Replace any damaged or worn parts.



1. Service Brake Clamp Ring

Fig. 3

2. Place the new service brake diaphragm in the bottom recess of the adaptor (**see Fig. 4**).

3. Install the (new, if needed) parking/emergency brake section.

3.1 If installing a new parking brake section, be sure it is the same size and make as the old one.

3.2 Check that the release bolt is fully extended outward. For instructions, refer to **Subject 100.**

3.3 Install the parking brake section on the service chamber so that all mating parts are aligned straight and the air lines are positioned to mate with the vehicle air supply lines.

4. Install the service brake clamp ring.

4.1 With the service brake clamp ring in place, install the clamp bolts and nuts.

4.2 Using a hand wrench (*don't use an impact wrench*), alternately tighten each clamp nut in increments of 680 to 1360 N·cm (60 to 120 lbf·in) while constantly rechecking the alignment of mating parts.

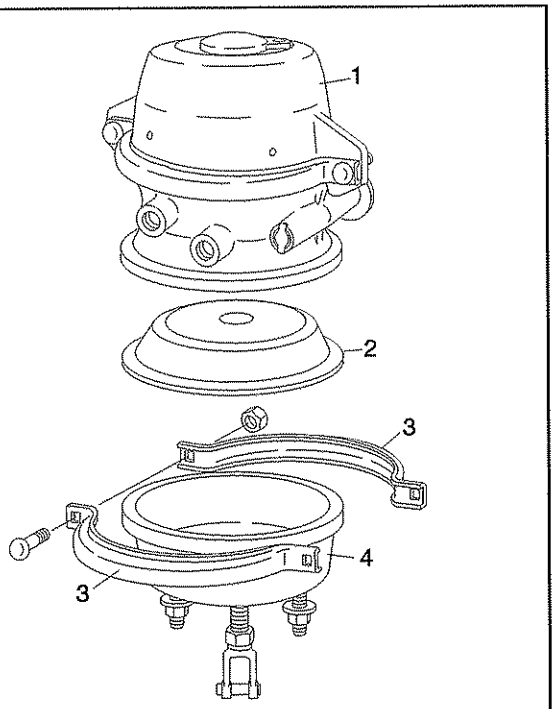
If realignment is needed, loosen the nuts again, and repeat this substep.

4.3 Lightly tap around the circumference of the service clamp ring with a rubber mallet to ensure full seating of the clamp. Tighten the nuts to a final torque of 24 to 34 N·m (18 to 25 lbf·ft).

5. Make sure the air hose fittings are free of grease, dirt, and other debris. Then, apply Loctite® 242 sealant, or an equivalent, to the fittings, and install, as referenced earlier. Using a hand wrench (*don't use an impact wrench*), tighten the fittings 34 N·m (25 lbf·ft).

6. Using the vehicle system air, charge the parking brake with full line pressure—at least 690 kPa (100 psi). Using only soapy water (*never any type of oil,* which could deteriorate rubber parts), check for air leaks at the air lines and fittings. If bubbles or leaks appear, tighten the fittings slightly, but not over 34 N·m (25 lbf·ft).

7. With the parking brake still charged with full line pressure, apply and hold the foot brake treadle



05/20/93 f420925

1. Parking/Emergency Brake and Adaptor
2. Service Brake Diaphragm
3. Service Brake Clamp Ring
4. Service Brake (Non-Pressure) Chamber

Fig. 4

valve down to charge the service brake chamber. Remove the locking-jaw pliers from the service piston rod so that the piston returns to a normal position in the chamber.

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

8. Test for air leaks around the circumference of the *service* brake clamp ring. If bubbles or leaks appear, release all air pressure from the chamber, then retighten the clamp nuts until leaks cease (*do not touch the parking brake section*). Anchorlok recommends 24 to 34 N·m (18 to 25 lbf·ft) torque on the clamp hexnuts.
9. With air pressure now exhausted from the service brake chamber, but held on the parking brake, reset the parking brakes by uncaging the power spring, and snap the dust plug in place. For instructions, refer to **Subject 100.**
10. Adjust the brakes at the slack adjuster.

IMPORTANT: After replacing any brake chamber components, check the piston rod stroke and actuating alignment to ensure correct installation and foundation brake adjustment. No foundation brake adjustments, parking brake or service brake, can be made at the chamber and all "stroke" adjustments must be made at the slack adjuster. For instructions, refer to the applicable slack adjuster section in **Group 42** in this manual.

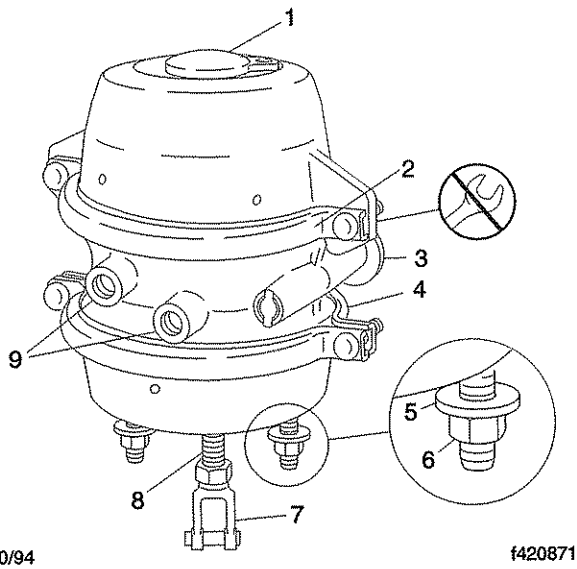
Parking Brake Diaphragm Replacement

Replacement

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the compression spring.

IMPORTANT: The parking/emergency brake section can be replaced as a unit. For instructions, refer to **Subject 110.**



08/30/94 f420871b

NOTE: On some models, the parking brake clamp ring is permanently sealed.

1. Dust Plug
2. Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports

Fig. 1

Combination Service and Parking Brake Chamber Removal and Installation

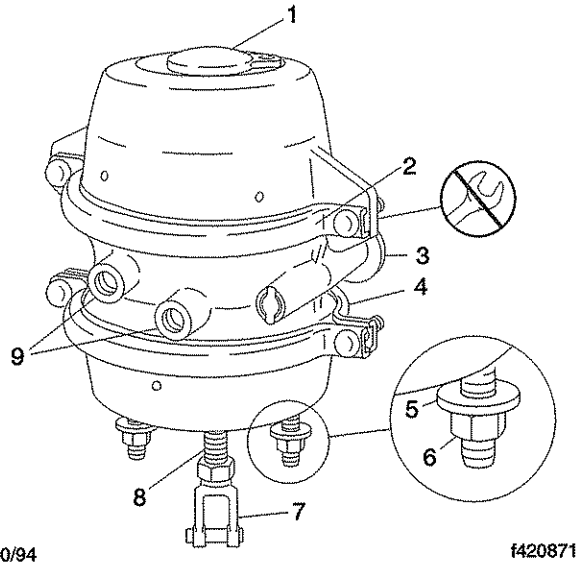
⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

Removal

⚠ WARNING

WARNING: Before caging (compressing) the power spring, chock the vehicle tires and read the warnings and instructions in this section (see Subject 100). When the power spring is caged, the vehicle may be without brakes, allowing it to roll out of control, possibly resulting in personal injury or property damage.



NOTE: On some models, the parking brake clamp ring is permanently sealed.

1. Dust Plug
2. Parking Brake Clamp Ring
3. Release Bolt Storage Pocket
4. Service Brake Clamp Ring
5. Hardened Flatwasher
6. Prevailing Torque Locknut
7. Clevis Assembly
8. Piston Rod
9. Air Inlet Ports

Fig. 1

1. Manually release the parking brake (cage the power spring). For instructions, refer to **Subject 100.**
2. Mark the air lines for later reference. Then carefully disconnect them from the brake chambers.
3. Remove the brake chamber from the vehicle.

   3.1 Remove the cotter pin(s) from the clevis pin(s), then remove the clevis pin(s) from the clevis. Disconnect the clevis from the slack adjuster.

   NOTE: Gunite and Rockwell automatic slack adjusters have two clevis pins, one large and one small, each locked by a cotter pin.

   3.2 From each mounting stud, remove any installed nuts and washers. Then, cautiously remove the brake chamber from the mounting bracket.

Installation

1. If installing a new brake chamber unit, do the following steps:

   1.1 First, make sure the power spring is caged (release bolt fully extended outward). If not, **go to Subject 100** and do the applicable steps.

   1.2 Make sure that the piston rod is the same length as the rod on the old unit (measure the rods when *both* chambers are caged).

   1.3 Be sure the new chamber is the same size and make as the brake chamber installed on the other side of the axle.

   1.4 Remove the prevailing torque locknut and hardened flatwasher from each of the mounting studs on the chamber.

2. Clean the face of the mounting bracket, and position the chamber on the bracket. Pay close attention to positioning the chamber air inlet ports for correct alignment to the vehicle air lines.

Combination Service and Parking Brake Chamber Removal and Installation

⚠ WARNING

WARNING: Tighten the mounting nuts with a hand wrench, not an impact wrench. An impact wrench could damage the mounting fasteners, reducing the force of the brakes. This could result in personal injury or property damage.

3. Install one hardened flatwasher and prevailing torque locknut on each mounting stud. Using a hand wrench (*don't use an impact wrench*), tighten the nuts 149 to 203 N·m (110 to 150 lbf·ft). Make sure that the hardened flatwasher is installed between the locknut and the mounting bracket.
4. Check proper mating and alignment with the vehicle air lines.

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

4.1 Using a hand wrench (*don't use an impact wrench*), loosen the clamp nuts on the *service* clamp ring (*do not disassemble the parking brake section*).

4.2 Reposition the air inlet ports, as needed, to mate with vehicle air supply lines.

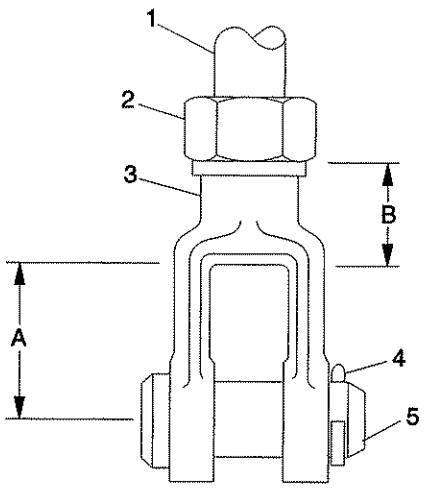
Alternately tighten each clamp nut in increments of 680 to 1360 N·cm (60 to 120 lbf·in) while constantly rechecking the alignment of mating parts.

If realignment is needed, loosen the nuts again, and repeat this substep.

4.3 Lightly tap around the circumference of the service clamp ring to ensure full seating of the clamp. Tighten the nuts to a final torque of 24 to 34 N·m (18 to 25 lbf·ft).

5. With manual slack adjusters, connect the slack adjuster to the clevis, then install the clevis pin. Insert the cotter pin in the clevis pin, and lock it in place. Check the piston-rod engagement with the clevis. At least seven threads of engagement are required; there should be 25-mm (1-inch) clearance from the centerline of the clevis pin hole to the end of the piston rod. **See Fig. 2.** Adjust as needed.

   With automatic slack adjusters, refer to the applicable slack adjuster section in **Group 42** for installation instructions.
6. Inspect the piston rod to be sure it is working free, not binding, and is square with the chamber bottom from zero to full stroke. If there is misalignment, make corrections by loosening the locknuts and repositioning the chamber on the mounting bracket, or by shimming the slack adjuster to the right or left on the camshaft. If loosened, tighten the clamp nuts 24 to 34 N·m (18 to 25 lbf·ft).
7. Make sure the air hose fittings are free of grease, dirt, and other debris. Then, apply Loctite® 242 sealant, or an equivalent, to the fittings, and install, as referenced earlier. Using a hand wrench (*don't use an impact wrench*), tighten the fittings 34 N·m (25 lbf·ft).
8. Using the vehicle system air, charge the parking brake with full line pressure, at least 690 kPa (100 psi). Using only soapy water (*never any type of oil,*



A. Minimum clearance of 25 mm (1 inch) between centerline of clevis pin hole and piston rod end.
B. Minimum of 7 threads engagement.

1. Piston Rod
2. Piston Rod Nut
3. Clevis
4. Cotter Pin
5. Clevis Pin

Fig. 2, Piston Rod Engagement With the Clevis

which could deteriorate rubber parts), check for air leaks at the air lines and fittings. If bubbles or leaks appear, tighten the fittings slightly, but not over 34 N·m (25 lbf·ft).

⚠ DANGER

DANGER: Don't loosen or remove the parking brake clamp ring (see Fig. 1) for any purpose at any time. The parking/emergency brake section is not intended to be serviced. Serious injury or death may result from the sudden release of the power spring.

IMPORTANT: If the service brake clamp ring was loosened to reposition the air inlet ports, apply air to the parking brake, and then apply and hold the foot brake treadle valve down to charge the service brake chamber. Now test for air leaks around the circumference of the *service* brake clamp ring. If bubbles or leaks appear, release all air pressure from the chamber, then retighten the clamp nuts until leaks cease (*do not touch the parking brake section*). Anchorlok recommends 24 to 34 N·m (18 to 25 lbf·ft) torque on the clamp hexnuts.

9. With air pressure now exhausted from the service brake chamber, but held on the parking brake, reset the parking brakes by uncaging the power spring, and snap the dust plug in place. For instructions, refer to **Subject 100**.

10. Adjust the brakes at the slack adjuster. For instructions, refer to the applicable slack adjuster section in this manual.

IMPORTANT: After replacing any brake chamber, check the piston rod stroke and actuating alignment to ensure correct installation and foundation brake adjustment. No foundation brake adjustments, parking brake or service brake, can be made at the chamber and all "stroke" adjustments must be made at the slack adjuster. For instructions, refer to the applicable slack adjuster section in **Group 42** in this manual.

Specifications

Description	Torque	
	N·m (lbf·ft)	N·cm (lbf·in)
Parking Brake Release Bolt Nut (in storage pocket)	—	680 to 1080 (60 to 96)
(caged—on S-cam or disc brakes)	47 (35)	—
(caged—on wedge brakes)	27 (20)	—
Service Brake Clamp Ring Nut	24 to 34 (18 to 25)	—
Brake Chamber Mounting Stud Locknut	149 to 203 (110 to 150)	—
Air Hose Fitting-to-Chamber	34 (25)	—

Table 1, Torque Values

Contents

Subject	Subject Number
General Description and Principles of Operation	050
Service Operations	
Service Brake Chamber Operating and Leakage Tests	100
Service Brake Chamber Diaphragm Replacement	110
Service Brake Chamber Removal and Installation	120
Service Brake Chamber Disassembly, Inspection and Cleaning, and Assembly	130
Specifications	400

General Description and Principles of Operation

General Description

Brake chambers convert the energy of compressed air into the mechanical force and motion needed to apply the brakes. Two chambers operate the brakes, one on each side of the axle.

Each brake chamber consists of two dished metal sections: the pressure cap and the chamber, which are separated by a nylon-reinforced diaphragm. A metal two-segment clamp ring holds the assemblies together. **See Fig. 1.**

In front of the diaphragm are the piston rod assembly, and a piston rod spring. The threaded piston rod assembly extends through the bottom of the chamber and connects to the clevis. **See Fig. 1.**

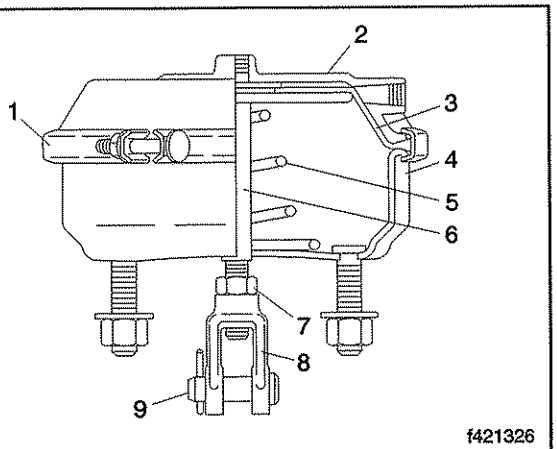
Different sized brake chambers are identified by numbers, which specify the effective area of the diaphragm. For example, a type 16 brake chamber has 16 square inches of effective area.

Principles of Operation

The greater the air pressure admitted to the brake chamber, the greater the force applied by the piston rod. Piston rod force is determined by multiplying the delivered air pressure by the effective diaphragm area. For example, if 415 kPa (60 psi) is admitted to a type 16 brake chamber, the force on the end of the piston rod is about 4270 N (960 lb).

When the brake pedal is depressed, air pressure from the brake valve passes through the port in the brake chamber pressure cap to move the diaphragm and piston rod assembly forward. This compresses the spring, and applies a straight-line force to the slack adjuster, which converts it to a rotational force. This in turn rotates the camshaft and applies the brakes.

When the brake pedal is released, compressed air behind the diaphragm exhausts through the quick release valve. The spring then allows the piston rod assembly and diaphragm to return to their previous positions.



1. Clamp Ring
2. Pressure Cap
3. Diaphragm
4. Chamber Assembly
5. Piston Rod Spring
6. Piston Rod Assembly
7. Clevis Jam Nut
8. Clevis
9. Clevis Pin

Fig. 1, Sectional View

Service Brake Chamber Operating and Leakage Tests

NOTE: For both of these tests, the air system must be pressurized to at least 550 kPa (80 psi).

Operating Test

1. Chock the tires.
2. Apply the brakes. Check that each piston rod moves out promptly, without binding.
3. Release the brakes. Check that each piston rod returns to the released position promptly, without binding.
4. Check the brake chamber stroke. It should be as short as possible without causing the brakes to drag. If needed, adjust the travel of the piston rod at the slack adjuster. For instructions, refer to the applicable slack adjuster section in this group.

Leakage Test

1. Apply the brakes and hold them on full line pressure of at least 550 kPa (80 psi).
2. Using a soap solution, coat the clamp ring. Leakage is excessive if it produces a 25-mm (1-inch) bubble within five seconds.

⚠ CAUTION

CAUTION: Don't overtighten the clamp ring. This can distort the flange sealing surface, or the clamp ring itself.

3. If the leakage is excessive, tighten the clamp ring flange nuts evenly until the leakage is reduced. Do not tighten more than 34 to 41 N·m (25 to 30 lbf·ft).
4. Using a soap solution, coat the area around the piston-rod hole. No leakage is permitted. If there is leakage, replace the diaphragm. For instructions, refer to **Subject 110.**

Service Brake Chamber Diaphragm Replacement

NOTE: This procedure is for service of a leaking brake chamber *diaphragm only*. If there are any other problems, refer to the applicable subjects elsewhere in this section.

Replacement

1. Chock the tires.

⚠ WARNING

WARNING: Wear safety goggles when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct the airstreams at anyone. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

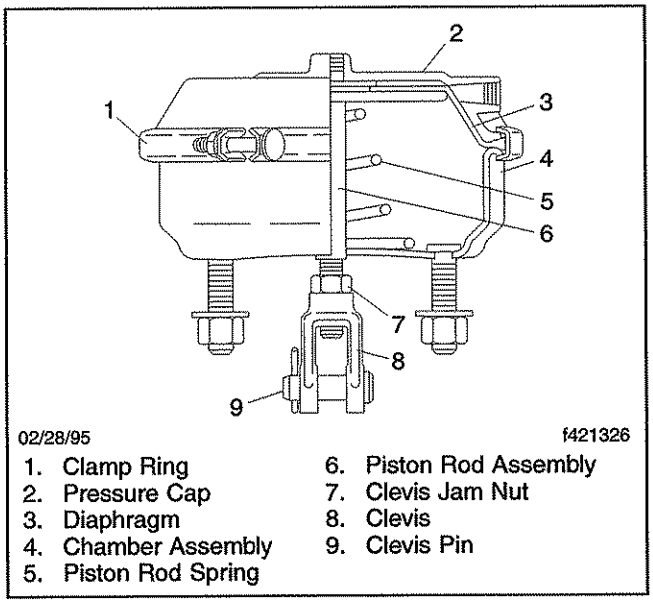
Follow the manufacturer's recommendations when working on any air device so as to avoid injury or damage from parts which, when released, are subject to mechanical (spring) or compressed-air propulsion.

2. Drain the air reservoirs and lines.
3. Back off the slack adjuster; for instructions, refer to the applicable slack adjuster section in this group. Pull out the piston rod. **See Fig. 1.** Clamp the rod at the chamber body to protect it from damage.
4. Before disassembly, mark a reference line along the chamber to allow the parts to be reassembled later in their old positions. **See Fig. 2.**
5. Replace the diaphragm.
   - 5.1 Remove one clamp ring bolt and flange nut completely and loosen the other bolt and flange nut enough to remove the clamp ring.
   - 5.2 Remove the pressure cap, and replace the diaphragm.

⚠ CAUTION

CAUTION: Don't overtighten the clamp ring. This can distort the flange sealing surface, or the clamp ring itself.

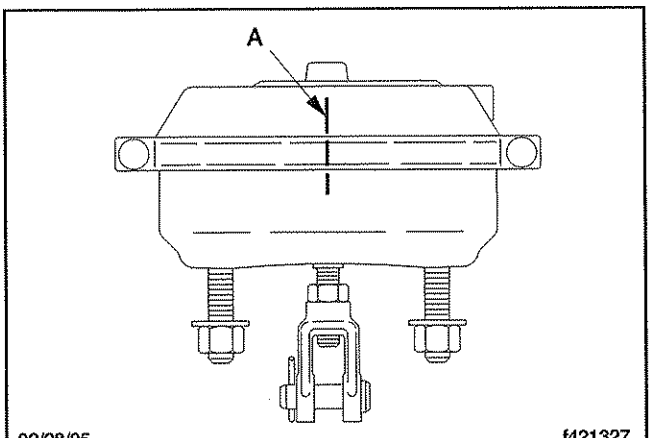
   - 5.3 Position the pressure cap and clamp ring (aligning the reference marks), and install the clamp ring bolt and flange nut. Tighten the flange nuts evenly 34 to 41 N·m (25 to 30 lbf·ft) to eliminate leakage.
6. Release the clamp on the piston rod.
7. Do both of the tests **in Subject 100.**



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1. Clamp Ring
2. Pressure Cap
3. Diaphragm
4. Chamber Assembly
5. Piston Rod Spring
6. Piston Rod Assembly
7. Clevis Jam Nut
8. Clevis
9. Clevis Pin

Fig. 1, Sectional View



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A. Reference Line

Fig. 2

Service Brake Chamber Diaphragm Replacement

8. Adjust the brakes at the slack adjuster. For instructions, refer to the applicable brake section in this group.
9. Remove the chocks from the tires.

Service Brake Chamber Removal and Installation

Removal (See Fig. 1)

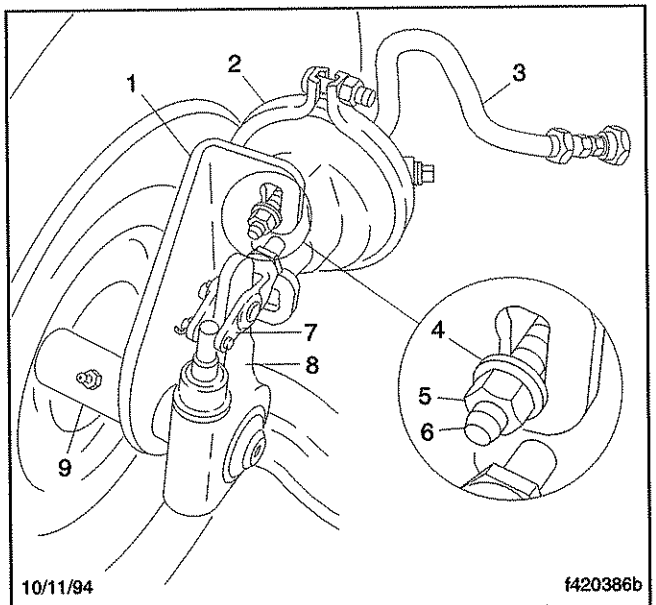
1. Chock the tires.

⚠ WARNING

WARNING: Wear safety goggles when draining the air system or loosening an air line because dirt or sludge could fly out at high speeds. Don't direct the airstreams at other people. Don't disconnect pressurized hoses, since they may whip as air escapes. Failure to take all necessary precautions could result in severe personal injury.

Follow the manufacturer's recommendations when working on any air device so as to avoid injury or damage from parts which, when released, are subject to mechanical (spring) or compressed-air propulsion.

2. Drain the air reservoirs and lines.



1. Chamber Mounting Bracket
2. Brake Chamber
3. Air Line
4. Hardened Flatwasher
5. Prevailing Torque Locknut
6. Chamber Mounting Stud
7. Clevis Assembly
8. Slack Adjuster (Automatic Type)
9. Camshaft Tube

Fig. 1

3. Carefully disconnect the air line from the brake chamber.
4. Remove the brake chamber.
   - 4.1 Remove the cotter pin(s) from the clevis pin(s).

   NOTE: Gunite and Rockwell automatic slack adjusters have two clevis pins, one large and one small, each locked by a cotter pin.

   - 4.2 Remove the clevis pin(s) from the slack adjuster.
   - 4.3 From each mounting stud, remove any installed nuts and washers. Remove the brake chamber from the vehicle.

Installation (See Fig. 1)

1. Before installing a new chamber, be sure the new chamber is the same size and make as the brake chamber on the other side of the axle.
2. Install the brake chamber.
   - 2.1 Attach the brake chamber to the mounting bracket using a hardened flatwasher and prevailing torque locknut. Install the flatwasher between the locknut and the mounting bracket.
   - 2.2 Tighten the locknuts. **See Table 1** for the correct torque value.

Description	Chamber Size (in^2)	Torque N.m (lbf.ft)
Brake Chamber Mounting-Stud Locknuts	16	47–54 (35–40)
	20	136–156 (100–115)
	24	136–156 (100–115)

Table 1, Mounting Stud Locknut Torque Values

   - 2.3 Connect the clevis pins to the slack adjuster.
   - 2.4 Install and lock the cotter pin(s) to secure the clevis pin(s).

Service Brake Chamber Removal and Installation

NOTE: Gunite and Rockwell automatic slack adjusters have two clevis pins, one large and one small, each locked by a cotter pin.

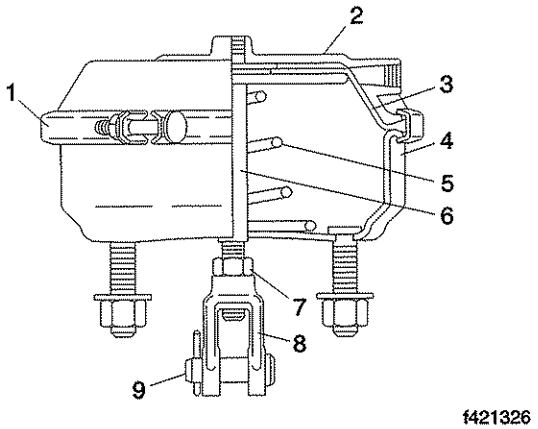
3. Adjust the brakes at the slack adjuster. For instructions, refer to the applicable brake section in this group.
4. Connect the air line to the brake chamber.
   - 4.1 Check that the hoses are properly supported and, if needed, clamped to provide good clearance.
   - 4.2 Before connecting the air line, make sure the fittings are clean and free of debris.
   - 4.3 Connect the air line as follows: tighten the nut finger-tight. Using a wrench, further tighten the nut until there is resistance, then tighten one-sixth turn more.
5. Do both of the tests **in Subject 100.**
6. Remove the chocks from the tires.

Service Brake Chamber Disassembly, Inspection and Cleaning, and Assembly

Disassembly (See Fig. 1)

NOTE: If the brake chamber is to be disassembled without removing the body assembly from the vehicle, first back off the slack adjuster. For instructions, refer to the applicable slack adjuster section in this manual.

1. Before disassembly, mark a reference line along the chamber to allow the parts to be reassembled later in their old positions. **See Fig. 2.**
2. Pull out the piston rod. Clamp the rod at the chamber body to protect it from damage.
3. Disassemble the brake chamber.
   - 3.1 Remove one clamp ring bolt and flange nut completely and loosen the other bolt and flange nut enough to remove the clamp ring.
   - 3.2 Remove the pressure cap and the diaphragm.
   - 3.3 Remove the clevis locknut and clevis from the piston rod, and release the clamp on the piston rod, being careful to contain the piston rod assembly and body until the return spring is relaxed.
   - 3.4 Remove the piston rod assembly and spring.



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1. Clamp Ring
2. Pressure Cap
3. Diaphragm
4. Chamber Assembly
5. Piston Rod Spring
6. Piston Rod Assembly
7. Clevis Jam Nut
8. Clevis
9. Clevis Pin

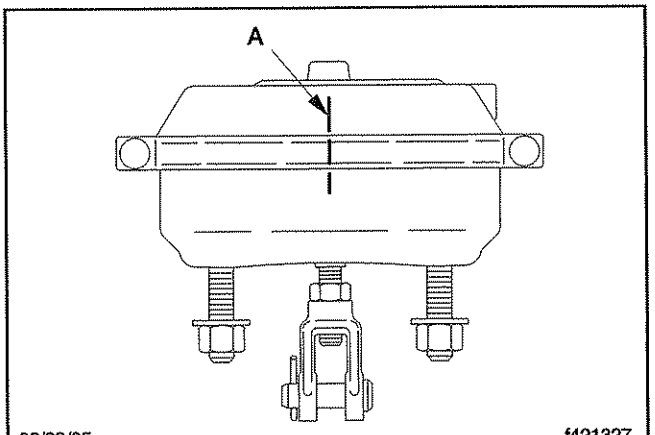
Fig. 1, Sectional View

Inspection and Cleaning

1. Clean all metal parts with cleaning solvent.
2. Inspect all parts for wear or damage; replace as needed.
   - 2.1 Check the pressure cap and the chamber for dents. If any are too deep to be pounded out, replace as needed.
   - 2.2 Check the diaphragm for wear or deterioration and replace it if needed.
   - 2.3 Inspect all other parts not considered serviceable. Replace if needed.

Assembly (See Fig. 1)

1. Stand the piston rod assembly upright on a flat surface (if the chamber was removed from the vehicle).
2. Assemble the brake chamber.
   - 2.1 Place the return spring on the piston rod.
   - 2.2 Place the chamber on the piston rod assembly, and press the chamber down, working against the tension of the spring, until the chamber bottoms out on the flat surface. Clamp the rod at the chamber, making sure to protect the rod from damage. Insert the piston rod assembly



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A. Reference Line

Fig. 2

Service Brake Chamber Disassembly, Inspection and Cleaning, and Assembly

through the chamber and clamp the rod (if the chamber wasn't removed from the vehicle).

2.3 Place the diaphragm in the chamber.

⚠ CAUTION

CAUTION: Don't overtighten the clamp ring. This can distort the flange sealing surface, or the clamp ring itself.

2.4 Position the pressure cap and clamp ring (aligning the reference marks), and install the clamp ring bolt and flange nut. Tighten the flange nuts evenly 34 to 41 N·m (25 to 30 lbf·ft) to eliminate leakage.

3. Install the clevis locknut and clevis, and release the clamp on the piston rod.
4. If the brake chamber was removed from the vehicle, install it. For instructions, refer to **Subject 120.**
5. Do both of the tests found **in Subject 100.**

Specifications

Mounting-Stud Locknut Torque Values		
Description	**Chamber Size (in^2)**	**Torque lbf·ft (N·m)**
Brake Chamber Mounting-Stud Locknuts	16	35 to 40 (47 to 54)
	20	100 to 115 (136 to 156)
	24	100 to 115 (136 to 156)

Table 1, Mounting-Stud Locknut Torque Values

Contents

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General Information

The automatic slack adjuster has two main functions:

- As a lever it converts the straight-line force of the brake chamber push rod to torque on the brake camshaft. Rotation of the camshaft forces the brake shoes against the drum.
- As an automatic slack adjuster, it maintains the lining-to-drum clearance needed for proper brake chamber push rod stroke.

The slack adjuster is installed between the brake chamber push rod and the brake camshaft. A clevis connects the brake chamber push rod to the top of the slack adjuster. The bottom of the slack adjuster is splined to the brake camshaft. The splines hold the slack adjuster internal gear to the camshaft, so the camshaft turns when the slack adjuster moves.

When the brakes are applied, the brake chamber push rod moves outward forcing the slack adjuster and camshaft to rotate. This movement forces the brake shoes against the drum.

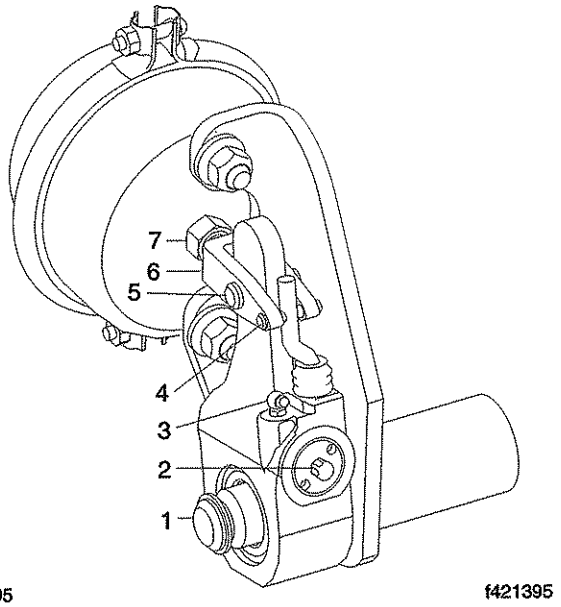
Whenever the brakes are released, the slack adjuster detects any increase in the lining-to-drum clearance. Excessive brake clearance is eliminated internally by the adjuster's one-way clutch and worm shaft, thus ensuring optimum leverage for the brake chamber push rod.

Slack Adjuster Removal and Installation

IMPORTANT: This automatic slack adjuster cannot be rebuilt. If it is damaged or inoperative, replace the unit. Also, when installing or replacing the automatic slack adjuster, a new clevis must be installed.

Removal (See Fig. 1)

1. Park the vehicle on a level surface, and chock the tires. If you are removing a rear slack adjuster, release the parking brake, then cage the parking brake power spring. For instructions, see the applicable brake chamber section in this group.
2. Back off the clevis jam nut.
3. Remove the cotter pins and clevis pins.
4. Rotate the manual adjuster shaft counterclockwise until the slack adjuster clears the clevis.
5. Remove the snap ring from the brake camshaft, then slide the slack adjuster off the camshaft.



1. Camshaft
2. Manual Adjuster Shaft
3. Grease Fitting
4. 1/4" (6.4 mm) Clevis Pin
5. 1/2" (13 mm) Clevis Pin
6. Clevis
7. Clevis Jam Nut

Fig. 1, Slack Adjuster Mounting

6. Remove the clevis from the brake chamber push rod.

Installation (See Fig. 2)

1. Coat the end of the brake chamber push rod, the camshaft splines, and the splines of the slack adjuster gear with an anticorrosive grease.
2. Install the new clevis (with the 1/2-inch [13-mm] clevis pin) on the brake chamber push rod. Thread the clevis up to the jam nut. Do not tighten the jam nut.
3. Fit the installation guide over the camshaft splines so the 1/2-inch (13-mm) clevis-pin slot on the guide faces the brake chamber.
4. Swing the installation guide into the clevis until the slot (top or bottom) engages the 1/2-inch (13-mm) pin.
5. Check the alignment of the 1/4-inch (6.4-mm) holes in the guide and the clevis. Screw the clevis on or off the push rod until the 1/4-inch (6.4-mm) clevis pin can be inserted through the clevis and the guide. Tighten the jam nut against the clevis 50 lbf·ft (68 N·m).

   Remove the installation guide from the camshaft.

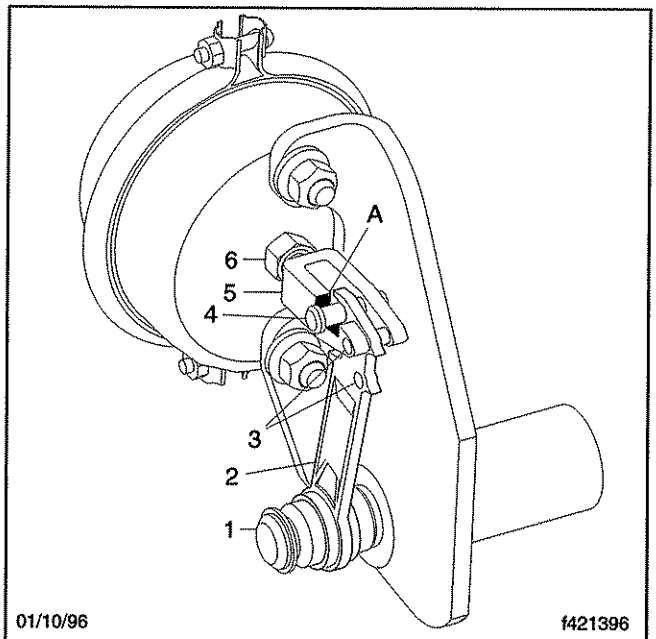
IMPORTANT: If the push rod extends through the clevis more than 1/16 inch (1.6 mm), remove the clevis and cut the rod to length. If the push rod does not engage a minimum 1/2 inch (13 mm) in the clevis body, cut a new push rod to length and install it. For instructions, see the applicable brake chamber section in this group.

6. Using the original snap ring, install the automatic slack adjuster on the brake camshaft.
7. Turn the manual adjuster shaft clockwise until the clevis pin holes align with the clevis. Install the 1/2-inch (13-mm) and 1/4-inch (6.4-mm) clevis pins and secure with new cotter pins.

NOTE: Make sure there is clearance between the slack adjuster and other vehicle components when the brakes are applied and the push rod travels its maximum stroke.

8. Set the initial free-stroke.

Slack Adjuster Removal and Installation



A. Clevis shown cut away for clarity.

1. Camshaft
2. Installation Guide
3. 1/4" (6.4 mm) Holes
4. 1/2" (13 mm) Clevis Pin
5. Clevis
6. Clevis Jam Nut

Fig. 2, Slack Adjuster Installation Guide Use

8.1 Turn the adjusting hexnut clockwise until the brake linings contact the drum.

8.2 Turn the adjusting hexnut counterclockwise one-half turn.

9. If a rear axle slack adjuster was installed, manually uncage the parking brake. For instructions, see the applicable brake chamber section in this group.

10. Measure the brake chamber stroke.

10.1 With the brakes fully released, use a ruler to measure the distance from the bottom of the brake chamber to the centerline of the 1/2-inch (13-mm) clevis pin. See **Fig. 3**, Ref. A.

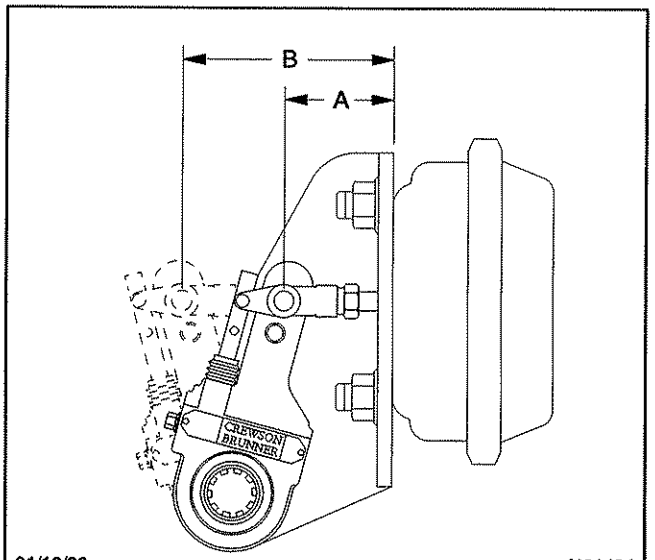
10.2 Build air pressure to at least 85 psi (586 kPa). Apply the brakes, then measure the distance from the bottom of the brake chamber to the centerline of the 1/2-inch (13-mm) clevis pin. See **Fig. 3**, Ref. B. The difference between the measurements is the brake chamber stroke.

10.3 The brake chamber stroke must be less than the measurements shown in **Table 1**. If it isn't, check the foundation brakes for problems such as worn cams, bushings, pins and rollers, or broken springs. Repair or replace as needed. For instructions, see the applicable brake section in this group. Then, repeat the previous steps as needed.

Chamber Size	Maximum Chamber Stroke
16	Less than 1-1/2 inches (38 mm)
20 24	Less than 1-3/4 inches (44 mm)
30	Less than 2 inches (51 mm)
36	Less than 2-1/2 inches (64 mm)

Table 1, Maximum Adjusted Brake Chamber Strokes

11. Apply the parking brakes. Remove the chocks from the tires.



A. Brakes Released B. Brakes Applied

Fig. 3, Brake Stroke Check

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General Description and Principles of Operation

General Description

The Bendix PP–DC parking brake air valve is installed on trucks with air brakes, and is used to control the rear axle parking brakes. It is a push-pull type of valve, and is mounted on the right side of the dash.

Principles of Operation

When the valve knob is pulled out, air is exhausted from the parking brake chambers, releasing the springs, and applying the parking brakes. When the knob is pushed in, air flows into the parking brake chambers from one of the reservoirs, and compresses the springs, releasing the parking brakes.

The PP–DC has a double check valve feature. The valve uses air pressure from the air system (primary or secondary) with the higher pressure for the parking brakes. If the pressure drops below 20 to 30 psi (138 to 207 kPa) in both air systems, the brakes will automatically apply. The parking brakes will not apply automatically unless pressure is lost from both systems.

Safety Precautions

When working on or around air brake systems and components, observe the following precautions:

- Chock the tires and stop the engine before working under a vehicle. Keep hands away from brake chamber push rods and slack adjusters; the brakes may apply as air system pressure drops.
- Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
- Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
- Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

Parking Brake Hand Valve Tests

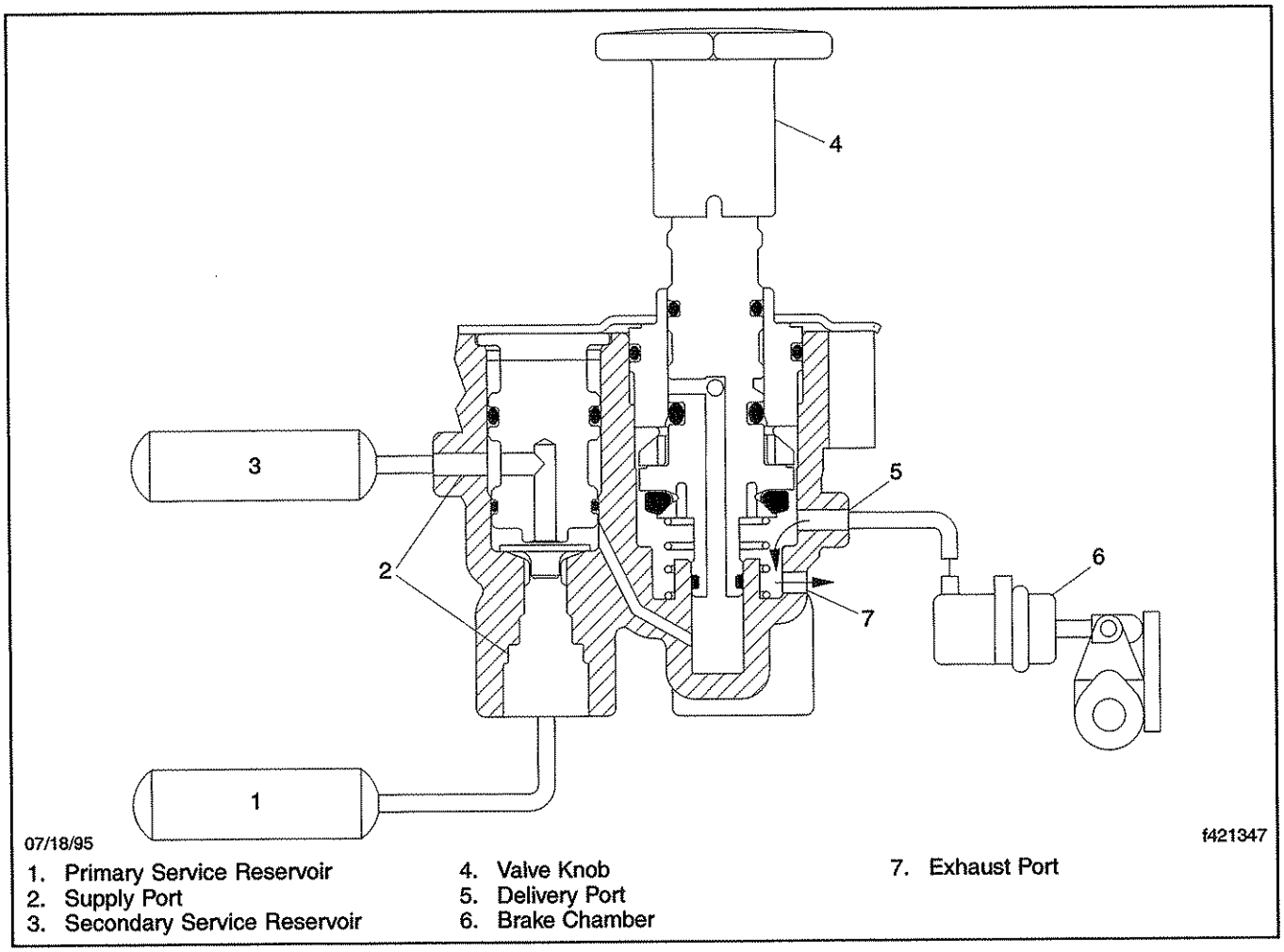
IMPORTANT: To do the following tests, connect two separate 120 psi (827 kPa) air sources to the PP–DC supply ports. See **Fig. 1.** Tee an accurate test gauge into the supply lines, and provide for a means to control supply line pressure. Connect a small volume air source with a gauge to the delivery port.

Operating Test

1. Chock the tires.
2. Start the engine and build up the air pressure to the normal operating level.
3. With the valve knob pulled out, supply either supply port with 120 psi (827 kPa) of pressure. Push the valve knob in. Air pressure should rise in the delivery line and equal supply line pressure.

   Pull the valve knob out. Delivery pressure should exhaust to zero.
4. Build air pressure to each supply source to 120 psi (827 kPa). Decrease supply pressure at the secondary service reservoir supply port at a rate of 10 psi (69 kPa) per second.

   Primary supply pressure and delivery pressure should not drop below 100 psi (689 kPa). Repeat this step for decreasing primary service reservoir pressure.
5. Build air pressure to each supply source to 120 psi (827 kPa). Then, decrease both supply pressures



1. Primary Service Reservoir
2. Supply Port
3. Secondary Service Reservoir
4. Valve Knob
5. Delivery Port
6. Brake Chamber
7. Exhaust Port

Fig. 1, Parking Brake Hand Valve (sectional view)

Parking Brake Hand Valve Tests

to below 20 to 30 psi (138 to 207 kPa). The valve knob should automatically pop out when the pressure is within that range.

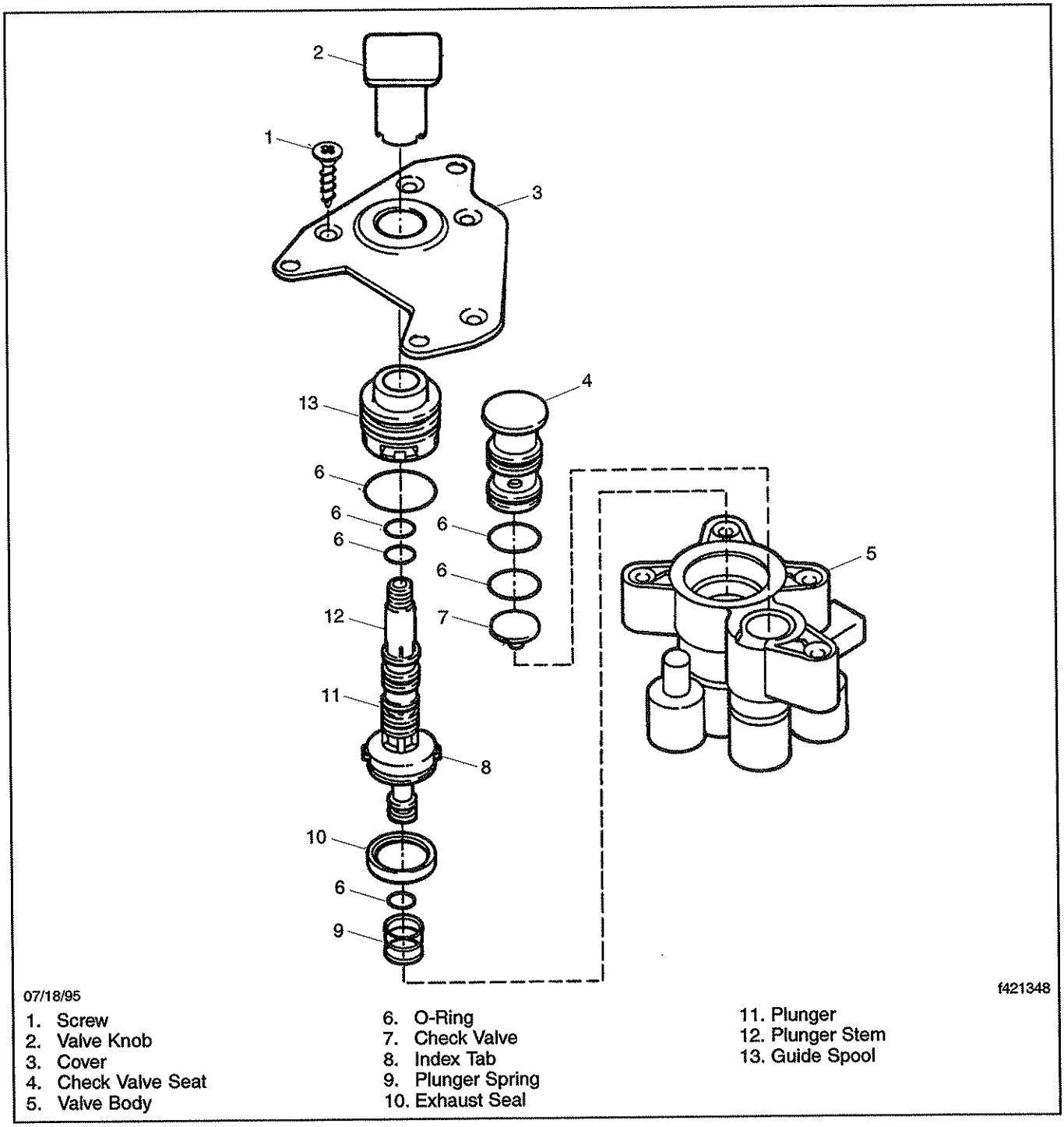
6. If the valve does not work as described, repair the valve or replace it following instructions under **Subject 130.**

Leak Testing

1. Chock the tires.
2. Supply the valve with 120 psi (827 kPa) from the primary reservoir supply port.
3. With the valve knob pulled out, coat the exhaust port and the plunger stem with a soapy solution. Leakage at either fitting should not exceed a 1-inch (2.5-cm) bubble every five seconds.There should be no leakage from the secondary reservoir supply port.
4. Supply the valve with 120 psi (827 kPa) from the secondary reservoir supply port. There should be no leakage from the primary reservoir supply port.
5. With the valve knob pushed in, coat the exhaust port and the plunger stem with a soapy solution. Leakage at the fittings should not exceed a 1-inch (2.5-cm) bubble every three seconds. If it does, replace or repair the valve, following instructions in **Subject 130.**

Parking Brake Hand Valve Disassembly and Assembly

Disassembly (See Fig. 1)



1. Screw
2. Valve Knob
3. Cover
4. Check Valve Seat
5. Valve Body
6. O-Ring
7. Check Valve
8. Index Tab
9. Plunger Spring
10. Exhaust Seal
11. Plunger
12. Plunger Stem
13. Guide Spool

Fig. 1, Exploded View

Parking Brake Hand Valve Disassembly and Assembly

1. Remove the valve assembly from the dash, following the instructions in **Subject 120.**
2. Put the valve assembly in a soft-jawed or padded vise.
3. Remove the screws that attach the cover to the body. Remove the cover.
4. Pull the plunger stem and remove the plunger and guide spool from the body.
5. Remove and discard the plunger spring.
6. Using a screwdriver (if needed), carefully remove the check valve seat from the body. Use care not to damage either the check valve seat or the valve body.
7. Remove and discard the check valve seat O-rings.
8. Turn the body upside down and gently tap it on a flat surface to remove the check valve. Discard the check valve.
9. Remove the guide spool from the plunger. Remove and discard the O-ring.
10. Remove and discard the O-rings from the plunger. Also, remove and discard the exhaust seal.

Assembly (See Fig. 1)

1. Clean and dry all the parts.
2. Check all the parts. Replace a part if any wear or damage is found.
3. Lightly grease all the parts—including the new parts from the maintenance kit—with Dow Corning 55 silicone pneumatic grease or equivalent.
4. Position the check valve in its seat in the body with the flat surface of the valve facing up. If needed, reach into the body to make sure that the valve is seated evenly in the bore.
5. Install the O-rings on the check valve seat and install the assembly into the body. Make sure that the check valve seat is even with the valve body surface.
6. Install the plunger spring into the body. Make sure that the spring is upright and seated properly in the body bore.

NOTE: The plunger spring should surround the protrusion or "lip" at the bottom of the body bore.

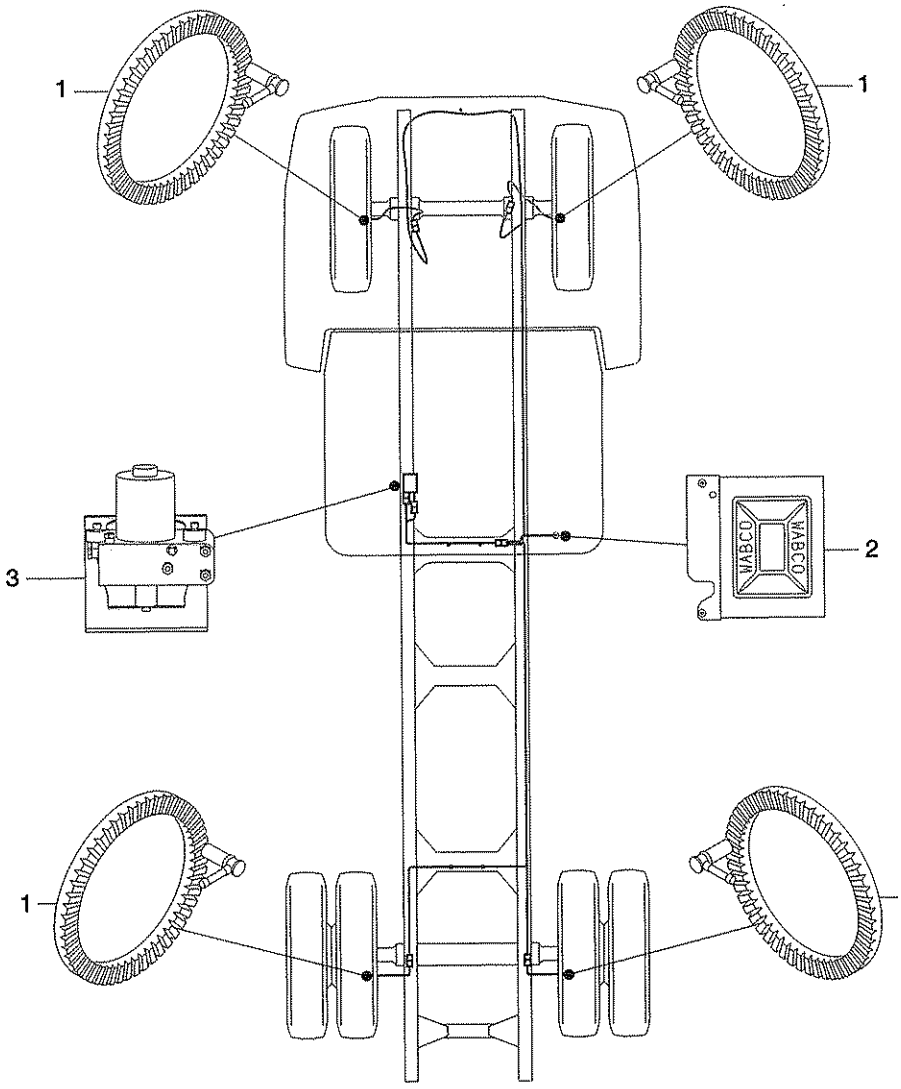
7. Install the O-rings onto the plunger, then install the plunger into the body.

   For ease of installation, line up the plunger's index tabs with the spaces in the body bore.
8. Install the O-ring on the guide spool. Install the spool over the plunger and into the body. Firmly press the guide spool into position.
9. Install the screws that attach the cover to the body. Tighten the screws 35 lbf·in (400 N·cm).
10. Install the valve in the dash, then leak test it. Follow the instructions in **Subject 120** for installation and **Subject 110** for leak testing.

General Description (See Fig. 1)

The Rockwell WABCO Antilock Braking System (ABS) is an electronic wheel speed monitoring and control system that works with the hydraulic brake system. ABS passively monitors vehicle wheel speed at all times, and controls wheel speed during emergency stops. In normal braking applications, the hydraulic brake system is in effect.

ABS includes signal-generating tone wheels and sensors located in the rotor assembly of each sensed wheel. The sensors transmit vehicle wheel speed information to an electronic control unit. During emergency braking, the control unit signals the brake pressure



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1. Tone Wheel and Sensor
2. Electronic Control Unit
3. Brake Pressure Modulator

Fig. 1, Location of ABS Components, Four-Channel System

modulator to reduce, maintain, or increase hydraulic fluid pressure to the brake caliper housing. This prevents front and rear wheel lockup, and enhances steering control during emergency braking situations.

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 brake pressure modulator (**Fig. 3**).

ABS MAJOR COMPONENTS

Wheel Speed Sensor

The wheel speed sensors use pulse feedback from tone wheels located in the front and rear axle wheel hubs. When the vehicle is moving, the teeth of the tone wheel cause changes in the magnetic field created by the sensor. The changes create an AC volatage signal that is sent by the sensor to the electronic control unit.

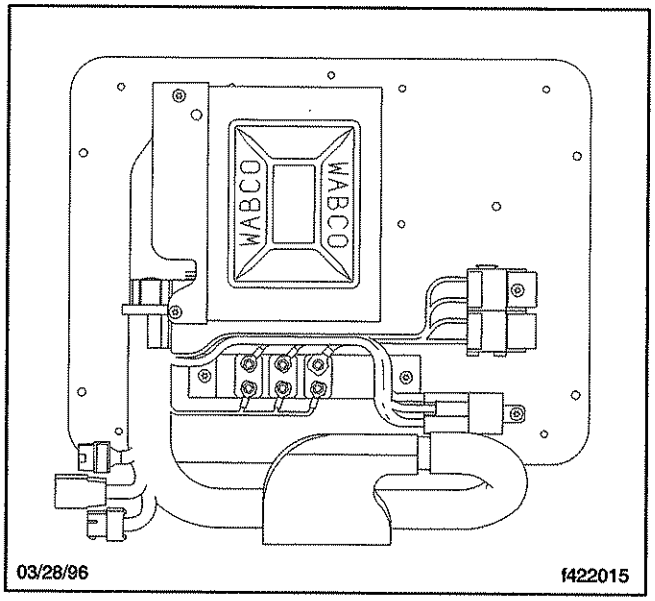


Fig. 2, Electronic Control Unit

Electronic Control Unit (ECU)

The electronic control unit (ECU), located just behind the passenger's seat, contains microcomputers to monitor the front and rear control channels. The ECU receives wheel speed signals and interprets these signals to calculate wheel speed and a vehicle reference speed. If the calculations indicate a high degree of wheel slip the ECU signals the brake pressure modulator to adjust braking pressure.

The ECU contains another microcomputer that provides a safety circuit to constantly monitor the wheel sensors, the brake pressure modulator, and the electrical circuitry.

IMPORTANT: After the ignition switch is turned on, the tractor warning light (ABS) comes on for about three seconds. See **Fig. 4**. After about three seconds, the light goes out only if all of the tractor's ABS components are working correctly.

If, during vehicle operation, the safety circuit senses a failure in any part of the ABS system (a sensor, brake pressure modulator, wiring connection, short circuit, etc.), the tractor warning light (ABS) comes on, and the control circuit where the failure occurred is switched to normal braking action. Even if the ABS system is completely inoperative, normal braking is maintained. Refer to the vehicle driver's manual for complete operating instructions.

Brake Pressure Modulator

The brake pressure modulator is attached to the left frame rail just ahead of the center or forward rear-suspension crossmember. Depending on the signal received from the electronic control unit, the modu-

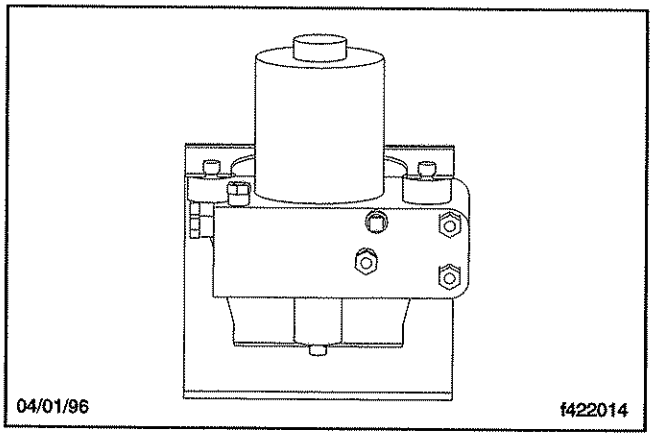
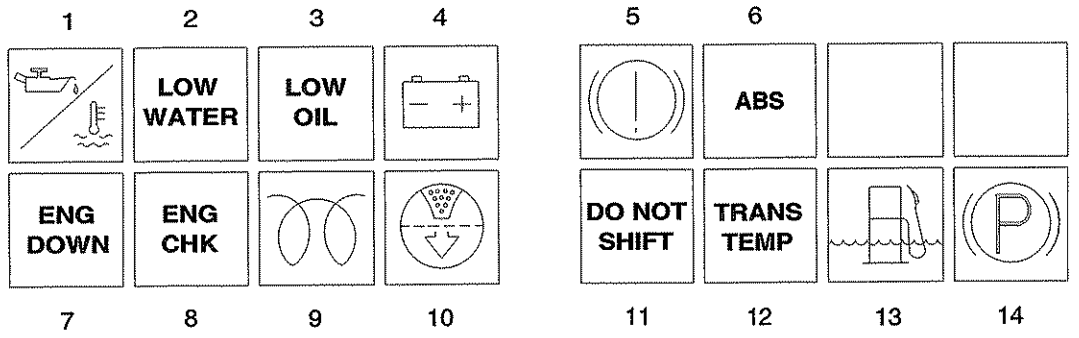


Fig. 3, Brake Pressure Modulator



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1. Low Oil Pressure/High Water Temperature Warning
2. Low Water Level Warning
3. Low Oil Level Warning
4. Alternator Warning Light
5. Brake System Warning
6. Tractor ABS Warning Light
7. Stop Engine Indicator
8. Engine Check Indicator
9. Cold-Start Manifold Heater Indicator
10. Air Cleaner Restriction Indicator
11. Do-Not-Shift Indicator
12. High Oil Temperature Warning (Automatic Transmission)
13. Water in Fuel/Water Separator Warning
14. Parking Brake Indicator

Fig. 4, Dash Warning and Indicator Lights

lator prevents wheel lockup by adjusting the hydraulic fluid pressure. During normal braking applications, hydraulic fluid flows freely to the brake caliper housing through the modulator.

Within the modulator are an inlet and outlet control valve for each sensed wheel. If the electronic control unit signals indicate wheel lockup is close to occurring, fluid pressure to the brake caliper of the sensed wheel is reduced. The inlet valve of the sensed wheel closes, preventing fluid delivery to the brake caliper. At the same time, the outlet valve opens, allowing fluid to flow to an accumulator within the module. From the accumulator, a recirculation pump within the module delivers brake fluid back to the master cylinder.

As wheel speed increases, the brake pressure modulator allows increases (inlet valve opens and outlet valve closes), or maintains brake pressure until the proper wheel speed is obtained, or until wheel lockup occurs and the control cycle starts again.

If maintaining brake pressure, both valves are closed, preventing fluid delivery and maintaining fluid pressure.

Contents

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Hydraulic System Bleeding	120
Troubleshooting Using Blink Codes	300
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Wheel Speed Sensor Replacement

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. Refer to **Group 54** (wiring) in this manual for information on special terminals and connectors, and on ordering tools for them.

FRONT AXLE

1. Apply the parking brakes. Chock the rear tires to prevent vehicle movement.
2. Twist and pull the sensor to remove it from the sensor bracket (**Fig. 1**).
3. Remove the sensor cable clip from the top cap.
4. Disconnect the sensor cable from the chassis harness.
5. Remove the clamping bushing from the sensor bracket.
6. Connect the sensor cable to the chassis harness.
7. Attach the sensor cable to the steering knuckle top cap.
8. Press the clamping bushing into the sensor bracket at the brake spider hole until it stops.

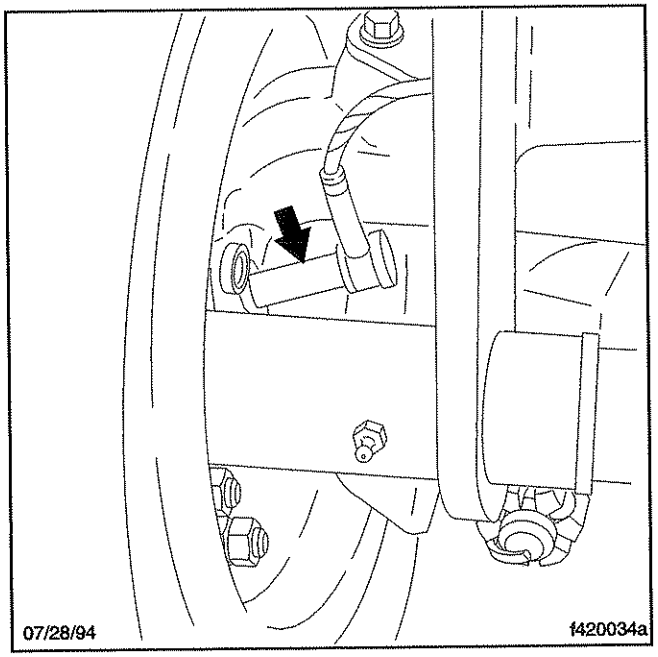


Fig. 1, Remove the Wheel Speed Sensor

9. Coat the sensor with Mobil HP, Valvoline EP 633, Penzoil 707L, 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

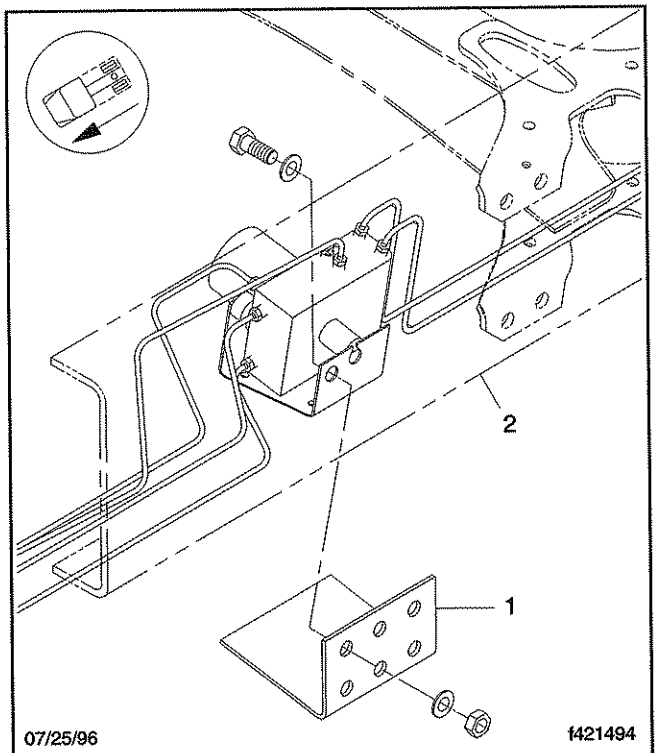
1. Apply the parking brakes. Chock the front tires to prevent vehicle movement.
2. Raise the rear of the vehicle until the tires clear the ground. Place safety stands under the axle.
3. Twist and pull the sensor to remove it from the mounting block in the axle housing.
4. Remove the clamping bushing.
5. Remove the capscrew that attaches the sensor cable and the hose clamp to the axle tube.
6. Disconnect the sensor cable from the chassis harness.
7. Connect the new sensor cable to the chassis harness.
8. Attach the hose clamp and sensor cable to the axle tube located between the backing plate and the spring plate.
9. Press the clamping bushing into the mounting block until it stops.
10. Coat the sensor with Mobil HP, Valvoline EP633, Penzoil 707L, or an equivalent. Using your hand, push the sensor into the clamping bushing until it is stopped by the tone wheel.
11. Remove the safety stands, lower the vehicle, and remove the chocks from the front tires.

Brake Pressure Modulator Replacement

Replacement (See Fig. 1)

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. Refer to **Group 54** in this manual for information on special terminals and connectors, and on ordering tools for them.

1. Chock the front and rear tires.
2. Put a container under the modulator to catch leaking brake fluid.
3. Disconnect the wiring from the modulator.
4. Mark the brake lines for ease of installation. Disconnect the lines.
5. Remove the mounting capscrews, washers, and nuts that attach the modulator and bracket assembly to the bracket on the frame rail.
6. Remove the modulator and bracket assembly.



1. Modulator Mounting Bracket
2. Left Frame Rail

Fig. 1, Brake Pressure Modulator Mounting

IMPORTANT: When replacing the modulator, make sure the new modulator is pre-charged.

7. Install the new modulator using the above instructions in reverse order. Tighten the modulator and bracket assembly mounting nuts 132 lbf·in (1500 N·cm). Tighten the brake line connections 108 lbf·in (1220 N·cm).
8. Bleed the brake system following the instructions in **Subject 120.**

Hydraulic System Bleeding

Whenever any hydraulic system fitting is loosened or disconnected, the entire system must be bled to remove any air that may have entered it.

⚠ CAUTION

Power steering fluid and brake fluid are incompatible. Never mix these two fluids, or serious damage to both hydraulic systems will result. Use only brake fluid for the master cylinder and brake lines. Use only power steering fluid for the power booster.

Always use new, clean brake fluid that meets DOT 3 specifications when bleeding the master cylinder and service brake system. Never reuse brake fluid, and don't use brake fluid containers for any other purpose. Keep brake fluid containers tightly closed to keep new brake fluid clean and dry.

IMPORTANT: Don't let brake fluid touch any painted surfaces, as it will remove the paint. Brake fluid may also damage certain non-metal surfaces. Don't let it get on brake pads or rotors.

PRESSURE BLEEDING, SERVICE BRAKE SYSTEM

Pressure bleeding is the preferred method for bleeding the service brake system. It requires the use of a special pressure bleeder kit, consisting of a tank, pressure pump and valve, gauge, tubing, and adapter. These are available from a number of manufacturers, and include instructions for use. See **Fig. 1**.

1. Apply the parking brake, chock the tires, and tilt the hood.
2. Connect the pressure bleeder to the brake master cylinder reservoir, following the manufacturer's instructions.
   - 2.1 Fill the pressure bleeder with new DOT 3 approved brake fluid, then pressurize it according to the manufacturer's instructions.
   - 2.2 Using the supplied adapter, connect the pressure bleeder to the rear compartment of the master cylinder reservoir.
3. Bleed the hydraulic connections at the rear wheel calipers, starting on the right side.
   - 3.1 Put a wrench on the bleeder fitting at the caliper, then attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. See **Fig. 2**.
   - 3.2 Loosen the bleeder fitting about 3/4 turn, and let the brake fluid flow out of the fitting until it is free of air bubbles. See **Fig. 2** and **Fig. 3**. Then tighten the fitting firmly.
   - 3.3 Move to the left rear caliper, and repeat steps for bleeding the caliper.
4. Disconnect the pressure bleeder from the rear compartment of the master cylinder reservoir, then connect it to the front compartment of the reservoir.
5. Bleed the front wheel brake calipers, starting at the right side.
   - 5.1 Put a wrench on the bleeder fitting at the caliper, then attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. See **Fig. 2**.
   - 5.2 Loosen the bleeder fitting about 3/4 turn, and let the brake fluid flow out of the fitting until it is free of air bubbles. See **Fig. 2** and**Fig. 3**. Then tighten the fitting firmly.

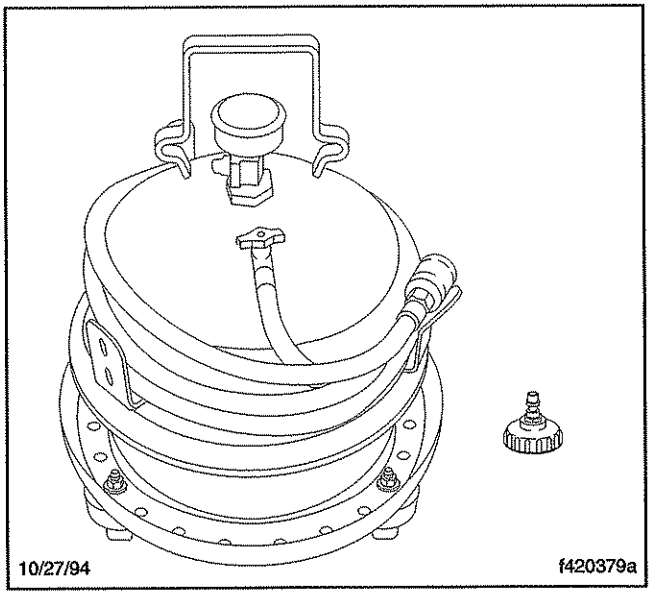


Fig. 1, Pressure Bleeder Kit

Hydraulic System Bleeding

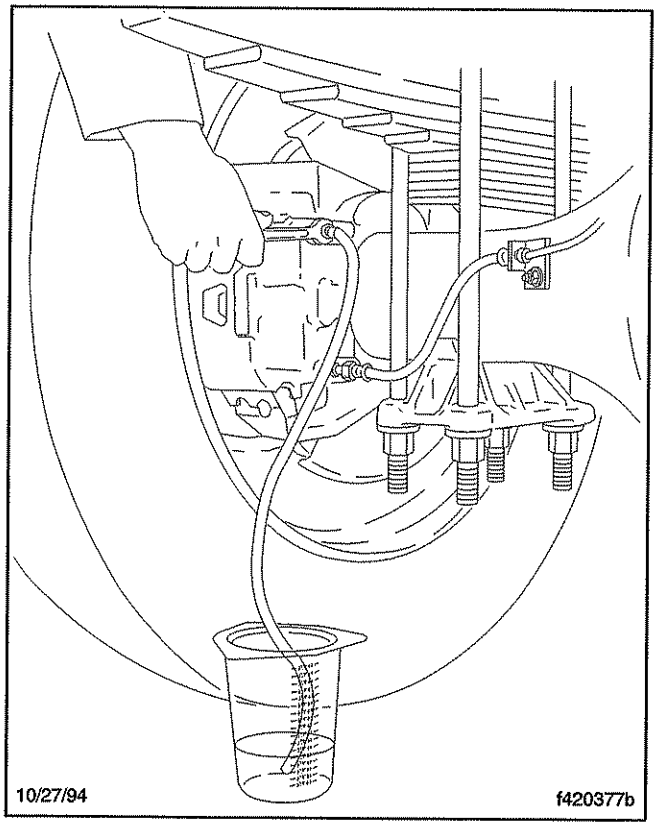


Fig. 2, Bleed the Connections at the Rear Wheel Calipers

5.3 Move to the left front wheel caliper, and repeat steps for bleeding the caliper.

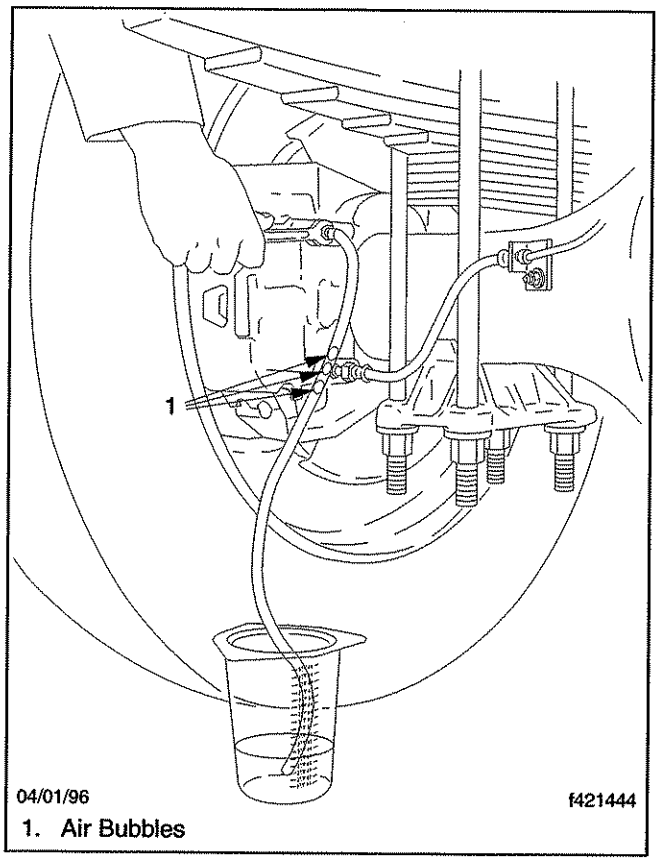
6. Check the brake fluid level in both compartments of the reservoir. Add new DOT 3 approved brake fluid if needed.

7. Check the operation of the brakes by depressing the brake pedal several times, until if feels firm. The brake pedal should not go all the way down to the floor. If it does, go to the troubleshooting subject in **Section 42.26** (Hydraulic Brake System) and find the problem.

8. Lower the hood and remove the chocks.

MANUAL BLEEDING, SERVICE BRAKE SYSTEM

If you don't have pressure bleeding equipment, you can use the manual bleeding procedure.



1. Air Bubbles

Fig. 3, Loosen the Bleeder Fitting

IMPORTANT: Don't let the brake master cylinder fluid level get too low during manual bleeding operations. Keep the master cylinder reservoir filled with new, DOT 3 approved brake fluid. Failure to keep the brake reservoir filled could result in more air entering the system, making it impossible to effectively bleed the system.

1. Apply the parking brake, chock the tires, and tilt the hood.

2. Bleed the master cylinder.

2.1 Using a wrench (and a rag to absorb leaking brake fluid), loosen the fitting at the rear outlet port on the master cylinder. See **Fig. 4**. Loosen the fitting about one turn.

2.2 Have someone push the brake pedal down slowly—by hand—to the floor. Brake fluid, and any air in the master cylinder, will squirt from the fitting.

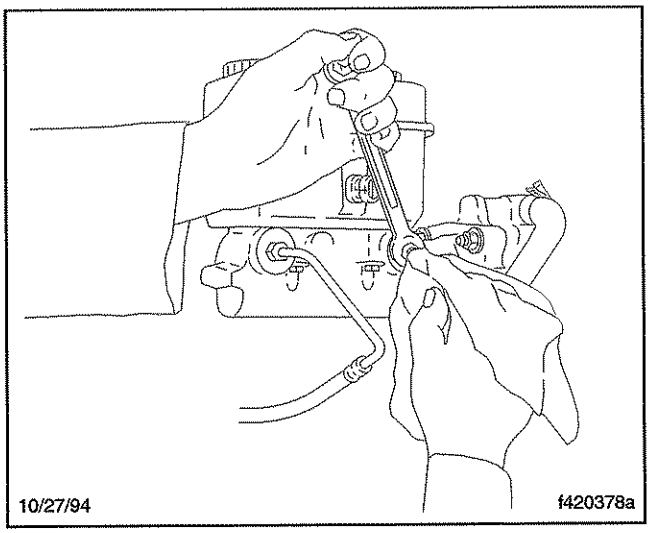


Fig. 4, Loosen the Fitting at the Rear Outlet Port

2.3 *With the brake pedal held down,* tighten the rear hydraulic line fitting firmly.

IMPORTANT: Don't release the brake pedal until the fitting is tightened, or more air will get into the system.

2.4 Release the brake pedal.

2.5 Loosen the fitting again, and repeat steps for bleeding as required until no air escapes from the fitting, and the brake pedal feels firm.

2.6 Check the level of the rear compartment of the reservoir, then add new DOT 3 approved brake fluid if needed.

2.7 Using a wrench (and a rag to absorb leaking brake fluid), loosen the fitting at the front outlet port on the master cylinder. See **Fig. 5**. Loosen the fitting about one turn.

2.8 Repeat steps as required for the front outlet port.

2.9 Check the brake fluid level in the front compartment of the reservoir. Add new DOT 3 approved brake fluid if needed.

3. Bleed the hydraulic connections at the wheel calipers, starting at the right rear wheel caliper.

3.1 Put a wrench on the bleeder fitting at the caliper, then attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. See **Fig. 2.**

3.2 Loosen the bleeder fitting about 3/4 turn.

3.3 Have someone slowly push the brake pedal to the floor, then *with the brake pedal depressed,* tighten the bleeder fitting.

IMPORTANT: Make sure the brake pedal stays depressed while you tighten the fitting. If it's released before you tighten the fitting, more air will get into the system.

3.4 Release the brake pedal. Check the fluid in the tube. If there are air bubbles present (**Fig. 3**), repeat steps as required until the fluid in the tube is completely free of air bubbles, as shown in **Fig. 2.**

3.5 Check the brake fluid level in the reservoir. Add new DOT 3 approved brake fluid if needed.

3.6 Repeat steps for bleeding the connections for the left rear caliper, then the right front caliper, and finally for the left front caliper.

4. Lower the hood and remove the chocks.

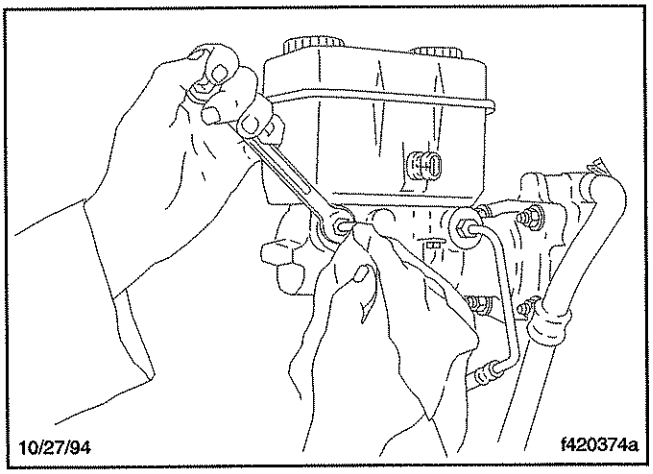


Fig. 5, Loosen the Fitting at the Front Outlet Port

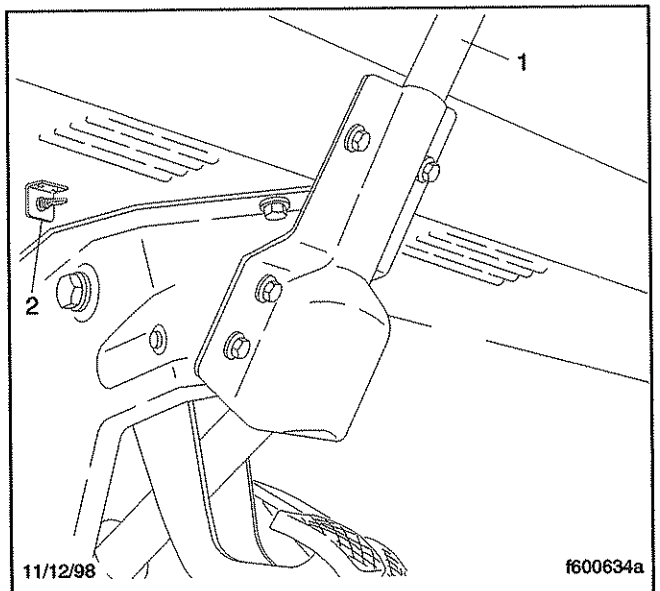
Troubleshooting Using the Instrument Panel Blink Codes

Using the Instrument Panel Blink Codes

This system has built-in diagnostics to ensure that all components are operating properly. Under normal conditions, the tractor warning light (ABS) comes on when the ignition is turned on. After about three seconds the light should go out if all of the tractor's ABS components are working. If the light stays on, or comes back on later, a problem within the ABS system has occurred. The vehicle can continue to be driven, but the ABS system could be partially or completely inoperative. To check the fault code recorded, stop the vehicle and turn off the engine. Then, turn on the ignition switch, but don't start the engine. If the light is still on, there is an "active" system fault that must be repaired to ensure proper system operation.

IMPORTANT: Remove the ABS light relay from the power distribution module (PDM). See **Group 54**. It is necessary to remove the relay in order to display multiple fault codes.

Use the ABS CHECK switch (see **Fig. 1**), located under the driver's left-side dash, and the ABS light to display system faults. With the ignition switch on, turn on the ABS CHK switch. The ABS light should go out. After a one-second pause, the ABS light will blink the first digit of the two-digit configuration code.



1. Steering Column
2. ABS Check Switch

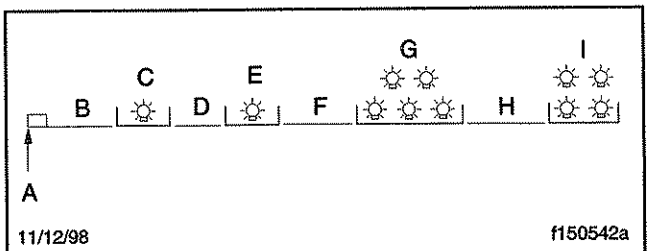
Fig. 1, ABS Check Switch Location

This code is indicated by one long flash, a two-second pause, then one short flash (1–1). Any active fault codes will be displayed following this configuration code. There will be a two-second pause between the last configuration code flash and the first set of flashes of the fault code. The fault code will be indicated by two sets of flashes. The number of blinks displaying the first digit will be a number between one and six. After another two and one-half second pause, the second digit will be displayed. The number of blinks displaying the second digit will be a number between one and fifteen. After a two and one-half second pause, the diagnostic code cycle continues to repeat the configuration code and fault code until the fault is repaired.

For example (**Fig. 2**), after the ABS CHECK switch has been turned on, the configuration code (1–1) will blink followed by fault code 5–4, shown by five flashes, a pause of two and one-half seconds, followed by four flashes. After a two and one-half second pause, the same configuration and fault code will continue to repeat, always ending with a two and one-half second pause.

Once a fault code has been identified, use a volt/ohmmeter to check the electrical harness at the ECU's 35-pin connector, which is located just behind the passenger's seat. Connect the ohmmeter leads to the applicable pins on each connector. See **Fig. 3** and **Table 1**, for a description of the circuit wire numbers and their location within the pin connectors.

Make the necessary repairs and clear the fault code from the ECU memory as outlined at the end of this



NOTE: This sequence will repeat until the fault is repaired or cleared.

A. ABS CHECK Switch Activated Here
B. 1 Second Pause
C. 1 Long Flash
D. 2 Second Pause
E. 1 Short Flash
F. 2 Second Pause
G. 5 Flashes
H. 2.5 Second Pause
I. 4 Flashes

Fig. 2, Fault Code 5-4 shown

Troubleshooting Using the Instrument Panel Blink Codes

section. If more than one fault exists, it will be displayed after the first one has been cleared from memory.

To make testing easier, use the Meritor WABCO test adaptor. See **Fig. 4.**

The Meritor WABCO test adaptor is used to service and troubleshoot the Meritor WABCO ABS system. *It can not be used with a vehicle frame-mounted ECU.* A volt ohmmeter (VOM) can determine the condition of the ABS valves, wheel end sensors and associated wiring. When used with the procedures and blink codes in *Meritor WABCO Maintenance Manual No. 38, Rev. 6/98,* it allows you to measure voltages and resistances of components in the system.

The receptacles of the Meritor WABCO test adaptor accept the tips of standard VOM cables. These tips are about 0.080 inch diameter (2 mm). Any good quality digital or analog VOM can be used. A meter with automatic polarity sensing is recommended so you do not have to worry about correct polarity of the meter leads during voltage measurements.

The test adaptor lets you access the 35-pins in the connector that attaches to the Meritor WABCO Electronic Control Unit (ECU). By inserting the probes of a VOM into the proper holes of the adaptor, sensor resistances, solenoid resistances, power, and grounds can be measured and compared to acceptable values. Sensor adjustment and tone ring runout can also be checked using the adaptor.

IMPORTANT: The ignition switch must be off when connecting or disconnecting the ECU.

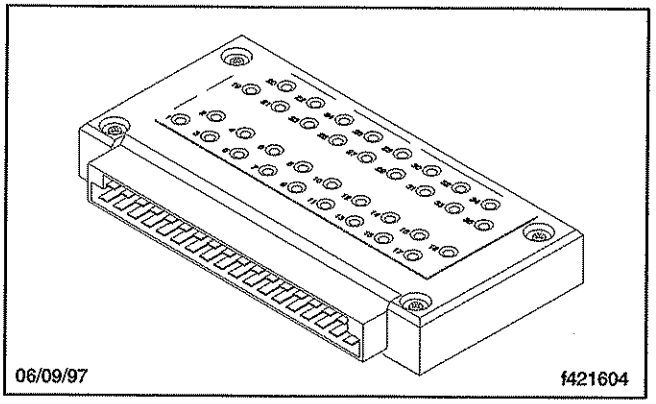


Fig. 4, Test Adaptor

NOTE: The blink codes are erased from ECU memory as repairs are made. Once a repair has been made, cycle the ignition to ensure the blink code does not reappear. If there are any other outstanding faults, the next blink code will be displayed.

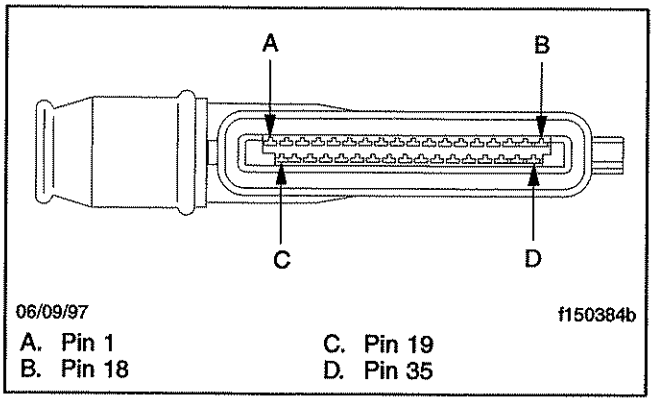


Fig. 3, ECU 35-Pin Connector

Circuit Wire Numbers and Descriptions		
Pin Number	**Freightliner Wire Number**	**WABCO Circuit Description**
1	X1	ECU Supply/Battery
2	—	—
3	—	—
4	X4	Right Rear Inlet Valve
5	X5	Right Rear Outlet Valve
6	X6	Right Front Inlet Valve
7	X7	Right Front Outlet Valve
8	X8	Valve Relay
9	X9	ECU Ignition Supply

Troubleshooting Using the Instrument Panel Blink Codes

section. If more than one fault exists, it will be displayed after the first one has been cleared from memory.

To make testing easier, use the Meritor WABCO test adaptor. See **Fig. 4**.

The Meritor WABCO test adaptor is used to service and troubleshoot the Meritor WABCO ABS system. *It can not be used with a vehicle frame-mounted ECU.* A volt ohmmeter (VOM) can determine the condition of the ABS valves, wheel end sensors and associated wiring. When used with the procedures and blink codes in *Meritor WABCO Maintenance Manual No. 38, Rev. 6/98*, it allows you to measure voltages and resistances of components in the system.

The receptacles of the Meritor WABCO test adaptor accept the tips of standard VOM cables. These tips are about 0.080 inch diameter (2 mm). Any good quality digital or analog VOM can be used. A meter with automatic polarity sensing is recommended so you do not have to worry about correct polarity of the meter leads during voltage measurements.

The test adaptor lets you access the 35-pins in the connector that attaches to the Meritor WABCO Electronic Control Unit (ECU). By inserting the probes of a VOM into the proper holes of the adaptor, sensor resistances, solenoid resistances, power, and grounds can be measured and compared to acceptable values. Sensor adjustment and tone ring runout can also be checked using the adaptor.

IMPORTANT: The ignition switch must be off when connecting or disconnecting the ECU.

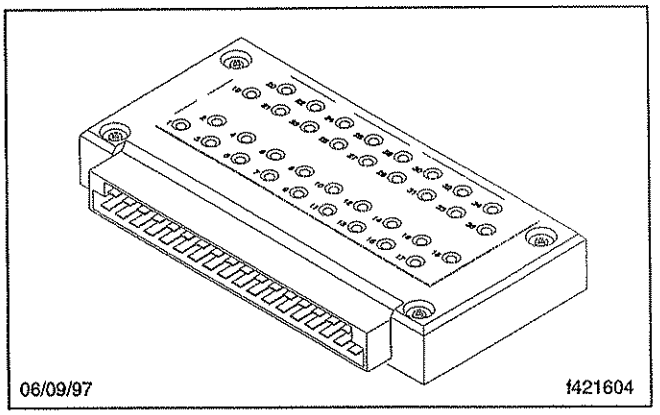


Fig. 4, Test Adaptor

NOTE: The blink codes are erased from ECU memory as repairs are made. Once a repair has been made, cycle the ignition to ensure the blink code does not reappear. If there are any other outstanding faults, the next blink code will be displayed.

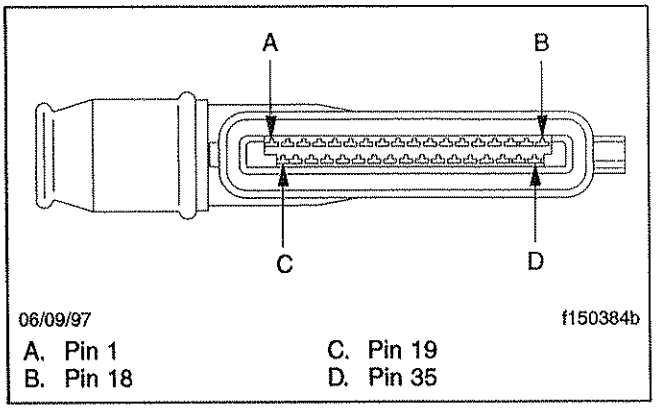


Fig. 3, ECU 35-Pin Connector

Circuit Wire Numbers and Descriptions		
Pin Number	**Freightliner Wire Number**	**WABCO Circuit Description**
1	X1	ECU Supply/Battery
2	—	—
3	—	—
4	X4	Right Rear Inlet Valve
5	X5	Right Rear Outlet Valve
6	X6	Right Front Inlet Valve
7	X7	Right Front Outlet Valve
8	X8	Valve Relay
9	X9	ECU Ignition Supply

Troubleshooting Using the Instrument Panel Blink Codes

Circuit Wire Numbers and Descriptions		
Pin Number	**Freightliner Wire Number**	**WABCO Circuit Description**
10	X10	Brake Light Input
11	X11	Recirculation Pump Relay
12	—	—
13	X13	Diagnostic Interface
14	X14	Diagnostic Interface/Blink Code Activation
15	X15	Left Front Sensor
16	X16	Right Rear Sensor
17	X17	Right Front Sensor
18	X18	Left Rear Sensor
19	X19	ECU Supply
20	—	—
21	X21	Left Rear Inlet Valve
22	X22	Left Rear Outlet Valve
23	X23	Left Front Inlet Valve
24	X24	Left Front Outlet Valve
25	X25	Brake Light Input
26	X26	ABS Warning Light
27	X27	ECU Ground
28	—	—
29	—	—
30	X30	Recirculation Pump Control
31	X31	Modulator Ground
32	X32	Left Front Sensor
33	X33	Right Rear Sensor
34	X34	Right Front Sensor
35	X35	Left Rear Sensor

Table 1, Circuit Wire Numbers and Descriptions

If the ABS light does not operate correctly after the ignition is turned on (the light doesn't come on at all or it doesn't go out after about three seconds), check all circuit breakers in the control unit panel, and replace if necessary. Check the wiring to the ABS CHECK switch and the warning lamp, and repair or replace the wiring as needed. When checking the warning lamp, do the following:

- Replace the bulb.
- Check voltage potential at the socket.
- Check continuity of the wires to the socket.

When checking the switch, do the following:

- Check the resistance between the terminals while cycling the switch.
- Check the continuity of the wires to the switch.

Troubleshooting Using the Instrument Panel Blink Codes

Make sure that a charged 12-volt battery is available (the ABS system needs at least 11 volts to work).

See **Table 2** for a listing of all fault codes, pins to be tested, and the correct volt/ohmmeter readings. Repair or replace the components and/or wiring if the readings are not correct.

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals.

Refer to **Group 54** in this manual for information on special terminals and connectors, and ordering tools for them.

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
2–0	Internal electronic control unit fault.	—	—	Replace the electronic control unit.
2–1	Internal electronic control unit fault.	—	—	Replace the electronic control unit.
2–2	Recirculation pump operates continuously.	—	—	Check the recirculation pump wiring (circuits 11 & 30), the pump relay, and the wiring connections. Repair or replace as needed.
2–3	Recirculation pump does not work.	—	—	Jump pins 9 and 11, and you should hear the pump motor run. Check the recirculation pump wiring, the relay circuit, and the pump connections.
2–4	Recirculation pump motor locked.	—	0.30 A	Jump pins 9 and 11, and you should hear the pump motor run. Check the recirculation pump wiring, the relay circuit, and the pump connections.
2–6	Stop light switch has failed.	10 and 25	—	Repair the wiring if needed (circuits 10 & 25). Also, make sure that the 35-pin connector is secure at the ECU.
2–7	Continuous power supply to the ECU with ignition off.	9 and 27	0 DCV	With the ignition off, check the valve relay and wiring connections. Repair or replace as needed.
2–8	No voltage to the inlet or outlet valve.	1, 9 and 27	12 V	Check the valve relay, the wiring (circuits 1 & 8), and the wiring connections. Repair or replace as needed.
2–9	Inlet valve supervision time exceeded.	—	—	Check the valves for normal operation. If okay, clear the faults.
2–10	Modulator reference ground interrupted.	31	—	Repair or replace wiring (circuit 31) as needed. Check the chassis ground circuit.
2–11	Recirculation pump cycle time is excessive.	—	—	Check the recirculation pump operation. If okay, clear the fault.

Troubleshooting Using the Instrument Panel Blink Codes

Make sure that a charged 12-volt battery is available (the ABS system needs at least 11 volts to work).

See **Table 2** for a listing of all fault codes, pins to be tested, and the correct volt/ohmmeter readings. Repair or replace the components and/or wiring if the readings are not correct.

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals.

Refer to **Group 54** in this manual for information on special terminals and connectors, and ordering tools for them.

WABCO ABS Fault Codes and Tests

Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
2–0	Internal electronic control unit fault.	—	—	Replace the electronic control unit.
2–1	Internal electronic control unit fault.	—	—	Replace the electronic control unit.
2–2	Recirculation pump operates continuously.	—	—	Check the recirculation pump wiring (circuits 11 & 30), the pump relay, and the wiring connections. Repair or replace as needed.
2–3	Recirculation pump does not work.	—	—	Jump pins 9 and 11, and you should hear the pump motor run. Check the recirculation pump wiring, the relay circuit, and the pump connections.
2–4	Recirculation pump motor locked.	—	0.30 A	Jump pins 9 and 11, and you should hear the pump motor run. Check the recirculation pump wiring, the relay circuit, and the pump connections.
2–6	Stop light switch has failed.	10 and 25	—	Repair the wiring if needed (circuits 10 & 25). Also, make sure that the 35-pin connector is secure at the ECU.
2–7	Continuous power supply to the ECU with ignition off.	9 and 27	0 DCV	With the ignition off, check the valve relay and wiring connections. Repair or replace as needed.
2–8	No voltage to the inlet or outlet valve.	1, 9 and 27	12 V	Check the valve relay, the wiring (circuits 1 & 8), and the wiring connections. Repair or replace as needed.
2–9	Inlet valve supervision time exceeded.	—	—	Check the valves for normal operation. If okay, clear the faults.
2–10	Modulator reference ground interrupted.	31	—	Repair or replace wiring (circuit 31) as needed. Check the chassis ground circuit.
2–11	Recirculation pump cycle time is excessive.	—	—	Check the recirculation pump operation. If okay, clear the fault.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
2–12 Right Front (RF) 2–14 Left Front (LF)	Wheel speed signal is erratic.	(RF), pins 17 and 34* (LF), pins 15 and 32*	above 0.20 volt AC	A damaged tone wheel, a sensor needs adjustment, or there is excessive hub runout. Repair or replace as needed.
2–13 Left Rear (LR) 2–15 Right Rear (RR)	Wheel speed signal is erratic.	(LR), pins 18 and 35* (RR), pins 16 and 33*	above 0.20 volt AC	A damaged tone wheel, a sensor needs adjustment, or there is excessive hub runout. Repair or replace as needed.
3–0 Right Front (RF)	On the steer axle, there is an open circuit in the RF inlet control valve and/or wiring to the modulator connection.	6 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 6). Repair or replace wiring as needed.
3–1 Right Front (RF)	On the steer axle, there is an open circuit in the RF outlet control valve and/or wiring to the modulator connection.	7 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 7). Repair or replace wiring as needed.
3–2 Left Front (LF)	On the steer axle, there is an open circuit in the LF inlet control valve and/or wiring to the modulator connection.	23 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 23). Repair or replace the wiring as needed.
3–3 Left Front (LF)	On the steer axle, there is an open circuit in the LF outlet control valve and/or wiring to the modulator connection.	24 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 24). Repair or replace the wiring as needed.
3–4 Right Rear (RR)	On the rear axle, there is an open circuit in the RR inlet control valve and/or wiring to the modulator connection.	4 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 4). Repair or replace the wiring as needed.
3–5 Right Rear (RR)	On the rear axle, there is an open circuit in the RR outlet control valve and/or wiring to the modulator connection.	5 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 5). Repair or replace the wiring as needed.
3–6 Left Rear (LR)	On the rear axle, there is an open circuit in the inlet control valve and/or wiring to the modulator connection.	21 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 21). Repair or replace the wiring as needed.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
3–7 Left Rear (LR)	On the rear axle, there is an open circuit in the outlet control valve and/or wiring to the connection.	22 and 31	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
3–8	Open circuit between the ECU and the recirculation pump relays.	22 and 31	—	Jump pins 9 & 11, and if the pump doesn't run, check circuit 11 and the recirculation pump relay.
4–0 Right Front (RF)	On the steer axle, there is a short circuit to ground between the ECU and the RF inlet control valve.	6 and 27	5 to 7.5 ohms 1.6 amps†	Check the inlet control valve wiring (circuit 6). Repair or replace the wiring as needed.
4–1 Right Front (RF)	On the steer axle, there is a short circuit to ground between the ECU and the RF outlet control valve.	7 and 27	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 7). Repair or replace the wiring as needed.
4–2 Left Front (LF)	On the steer axle, there is a short circuit to ground between the ECU and the LF inlet control valve.	23 and 27	5 to 7.5 ohms 1.6 amps†	Check the inlet control valve wiring (circuit 23). Repair or replace the wiring as needed.
4–3 Left Front (LF)	On the steer axle, there is a short circuit to ground between the ECU and the LF outlet control valve.	24 and 27	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 24). Repair or replace the wiring as needed.
4–4 Right Rear (RR)	On the rear axle, there is a short circuit to ground between the ECU and the RR inlet control valve.	4 and 27	5 to 7.5 ohms 1.6 amps†	Check the inlet control valve wiring (circuit 4). Repair or replace the wiring as needed.
4–5 Right Rear (RR)	On the rear axle, there is a short circuit to ground between the ECU and the RR outlet control valve.	5 and 27	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 5). Repair or replace the wiring as needed.
4–6 Left Rear (LR)	On the rear axle, there is a short circuit to ground between the ECU and the LR inlet control valve.	21 and 27	5 to 7.5 ohms 1.6 amps†	Check the inlet control valve wiring (circuit 21). Repair or replace the wiring as needed.
4–7 Left Rear (LR)	On the rear axle, there is a short circuit to ground between the ECU and the LR outlet control valve.	22 and 27	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
4–8	Short circuit to ground between the ECU and the recirculation pump relay.	11, 30 and 27	Open Circuit	Check continuity through the pump to ground. Check the pump connector. Repair or replace wiring as needed.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
3–7 Left Rear (LR)	On the rear axle, there is an open circuit in the outlet control valve and/or wiring to the connection.	22 and 31	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
3–8	Open circuit between the ECU and the recirculation pump relays.	22 and 31	—	Jump pins 9 & 11, and if the pump doesn't run, check circuit 11 and the recirculation pump relay.
4–0 Right Front (RF)	On the steer axle, there is a short circuit to ground between the ECU and the RF inlet control valve.	6 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 6). Repair or replace the wiring as needed.
4–1 Right Front (RF)	On the steer axle, there is a short circuit to ground between the ECU and the RF outlet control valve.	7 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 7). Repair or replace the wiring as needed.
4–2 Left Front (LF)	On the steer axle, there is a short circuit to ground between the ECU and the LF inlet control valve.	23 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 23). Repair or replace the wiring as needed.
4–3 Left Front (LF)	On the steer axle, there is a short circuit to ground between the ECU and the LF outlet control valve.	24 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 24). Repair or replace the wiring as needed.
4–4 Right Rear (RR)	On the rear axle, there is a short circuit to ground between the ECU and the RR inlet control valve.	4 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 4). Repair or replace the wiring as needed.
4–5 Right Rear (RR)	On the rear axle, there is a short circuit to ground between the ECU and the RR outlet control valve.	5 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 5). Repair or replace the wiring as needed.
4–6 Left Rear (LR)	On the rear axle, there is a short circuit to ground between the ECU and the LR inlet control valve.	21 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 21). Repair or replace the wiring as needed.
4–7 Left Rear (LR)	On the rear axle, there is a short circuit to ground between the ECU and the LR outlet control valve.	22 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
4–8	Short circuit to ground between the ECU and the recirculation pump relay.	11, 30 and 27	Open Circuit	Check continuity through the pump to ground. Check the pump connector. Repair or replace wiring as needed.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
4–12 Right Front (RF) 4–14 Left Front (LF)	Sensor open circuit.	(RF), pins 17 and 34* (LF), pins 15 and 32*	above 0.20 volt AC	Check the sensor wiring. Repair or replace as needed.
4–13 Left Rear (LR) 4–15 Right Rear (RR)	Sensor open circuit.	(LR), pins 18 and 35* (RR), pins 16 and 33*	above 0.20 volt AC	Check the sensor wiring. Repair or replace as needed.
5–0 Right Front (RF)	On the steer axle, there is a short circuit to the battery between the ECU and the RF inlet control valve.	6 and 9	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 6). Repair or replace the wiring as needed
5–1 Right Front (RF)	On the steer axle, there is a short circuit to the battery between the ECU and the RF outlet control valve.	7 and 9	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 7). Repair or replace the wiring as needed.
5–2 Left Front (LF)	On the steer axle, there is a short circuit to the battery between the ECU and the LF inlet control valve.	23 and 9	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 23). Repair or replace the wiring as needed.
5–3 Left Front (LF)	On the steer axle, there is a short circuit to the battery between the ECU and the LF outlet control valve.	24 and 9	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 24). Repair or replace the wiring as needed.
5–4 Right Rear (RR)	On the rear axle, there is a short circuit to the battery between the ECU and the RR inlet control valve.	4 and 9	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 4). Repair or replace the wiring as needed.
5–5 Right Rear (RR)	On the rear axle, there is a short circuit to the battery between the ECU and the RR outlet control valve.	5 and 9	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 5). Repair or replace the wiring as needed.
5–6 Left Rear (LR)	On the rear axle, there is a short circuit to the battery between the ECU and the LR inlet control valve.	21 and 9	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 21). Repair or replace the wiring as needed.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
5–7 Left Rear (LR)	On the rear axle, there is a short circuit to the battery between the ECU and the LR outlet control valve.	22 and 9	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
5–8	Short circuit to battery between the ECU and the recirculation pump relay.	30 and 11	Open Circuit	Repair or replace wiring as needed. Check the pump ground connection.
5–12 Right Front (RF) 5–14 Left Front (LF)	Wheel speed signal is erratic.	pins 17 and 34 pins 15 and 32	Above 0.2 volts AC	An incorrect or damaged tone wheel. Replace the tone wheel and rotor if needed. Also, check the tire sizes for possible mismatch, and check for correct wheel bearing adjustment.
5–13 Left Rear (LR) 5–15 Right Rear (RR)	Wheel speed signal is erratic.	pins 18 and 35 pins 16 and 33	Above 0.2 volts AC	An incorrect or damaged tone wheel. Replace the tone wheel and rotor if needed. Also, check the tire sizes for possible mismatch, and check for correct wheel bearing adjustment.
6–0 Right Front (RF)	On the steer axle, there is a short circuit in the RF inlet control valve wiring to other wiring.	4, 5, 6, 7, 21, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 6 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–1 Right Front (RF)	On the steer axle, there is a short circuit in the RF outlet control valve wiring to other wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 7 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–2 Left Front (LF)	On the steer axle, there is a short circuit in the LF inlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 23 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–3 Left Front (LF)	On the steer axle, there is a short circuit in the LF outlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 24 and the other control valve circuits. Replace the modulator if the short is located within the valve.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
5–7 Left Rear (LR)	On the rear axle, there is a short circuit to the battery between the ECU and the LR outlet control valve.	22 and 9	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
5–8	Short circuit to battery between the ECU and the recirculation pump relay.	30 and 11	Open Circuit	Repair or replace wiring as needed. Check the pump ground connection.
5–12 Right Front (RF) 5–14 Left Front (LF)	Wheel speed signal is erratic.	pins 17 and 34 pins 15 and 32	Above 0.2 volts AC	An incorrect or damaged tone wheel. Replace the tone wheel and rotor if needed. Also, check the tire sizes for possible mismatch, and check for correct wheel bearing adjustment.
5–13 Left Rear (LR) 5–15 Right Rear (RR)	Wheel speed signal is erratic.	pins 18 and 35 pins 16 and 33	Above 0.2 volts AC	An incorrect or damaged tone wheel. Replace the tone wheel and rotor if needed. Also, check the tire sizes for possible mismatch, and check for correct wheel bearing adjustment.
6–0 Right Front (RF)	On the steer axle, there is a short circuit in the RF inlet control valve wiring to other wiring.	4, 5, 6, 7, 21, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 6 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–1 Right Front (RF)	On the steer axle, there is a short circuit in the RF outlet control valve wiring to other wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 7 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–2 Left Front (LF)	On the steer axle, there is a short circuit in the LF inlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 23 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–3 Left Front (LF)	On the steer axle, there is a short circuit in the LF outlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 24 and the other control valve circuits. Replace the modulator if the short is located within the valve.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
6–4 Right Rear (RR)	On the rear axle, there is a short circuit in the RR inlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 4 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–5 Right Rear (RR)	On the rear axle, there is a short circuit in the RR outlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 5 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–6 Left Rear (LR)	On the rear axle, there is a short circuit in the LR inlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 21 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–7 Left Rear (LR)	On the rear axle, there is a short circuit in the LR outlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 22 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–8	Short circuit to the battery between a solenoid valve and recirculation pump relay.	11 and 27	—	Check the 35-pin connector and the ECU.
6–12 Right Front (RF) 6–14 Left Front (LF)	Wheel speed signal is missing.	pins 17 and 34 pins 15 and 32	Above 0.2 volts AC	The gap is too large, adjust the sensor.
6–13 Left Rear (LR) 6–15 Right Rear (RR)	Wheel speed signal is missing.	pins 18 and 35 pins 16 and 33	Above 0.2 volts AC	The gap is too large, adjust the sensor.

* After connecting the volt/ohmmeter test leads, rotate the applicable tire at about 30 rpm (1 revolution every 2 seconds).
† Desired readings are with the battery potential at approximately 12.5 volts.

Table 2, WABCO ABS Fault Codes and Tests

Refer to the wiring diagram in **Specifications 400** when troubleshooting the ABS system. The key switch must be turned on (engine off) to activate the blink codes.

Troubleshooting Using the Instrument Panel Blink Codes

If a fault still can't be repaired, or erased from ECU memory, contact your Meritor District Service Manager, or call Meritor WABCO at 1-800-535-5560.

ERASING A FAULT FROM THE ECU MEMORY

NOTE: An existing fault cannot be erased until it has been corrected.

Meritor WABCO recommends that you erase all faults from the ECU memory after they have been noted and corrected.

Faults can only be erased one at a time. A fault is erased from the ECU memory by doing the following:

1. Turn the ignition switch on.
2. Turn the blink code switch on.
3. Wait until the blink code begins to flash.
4. Turn the blink code switch off.
5. Wait for the ABS lamp to stop flashing.
6. Turn the ignition switch off, then back on.
7. Turn the blink code switch off, then back on.
8. Check for additional faults. If they are present, repair and clear them.

   When all faults are repaired and cleared, only the configuration code (1–1) will be displayed.

Troubleshooting Using the Instrument Panel Blink Codes

If a fault still can't be repaired, or erased from ECU memory, contact your Meritor District Service Manager, or call Meritor WABCO at 1-800-535-5560.

ERASING A FAULT FROM THE ECU MEMORY

NOTE: An existing fault cannot be erased until it has been corrected.

Meritor WABCO recommends that you erase all faults from the ECU memory after they have been noted and corrected.

Faults can only be erased one at a time. A fault is erased from the ECU memory by doing the following:

1. Turn the ignition switch on.
2. Turn the blink code switch on.
3. Wait until the blink code begins to flash.

   Turn the blink code switch off.
5. Wait for the ABS lamp to stop flashing.
6. Turn the ignition switch off, then back on.
7. Turn the blink code switch off, then back on.
8. Check for additional faults. If they are present, repair and clear them.

   When all faults are repaired and cleared, only the configuration code (1–1) will be displayed.

See **Fig. 1** for a full view of the wiring diagram for troubleshooting 4S/4M ABS systems using instrument panel blink codes. See **Fig. 2**, or **Fig. 3** for partial (detailed) views of the wiring diagram. See **Fig. 4** for a plumbing diagram of the hydraulic ABS system.

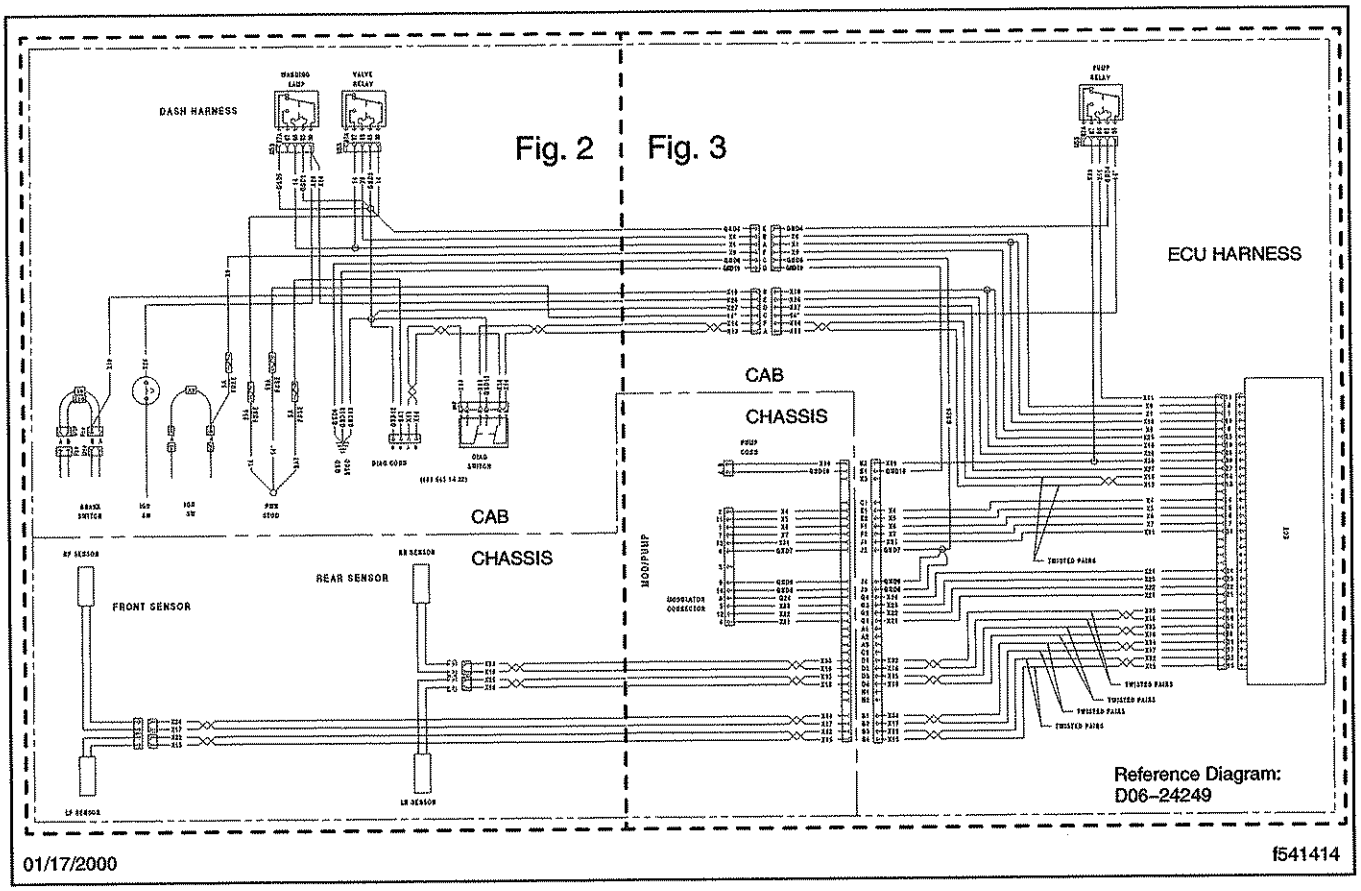


Fig. 1, Full View of the Cab and Chassis Wiring Diagram

Specifications

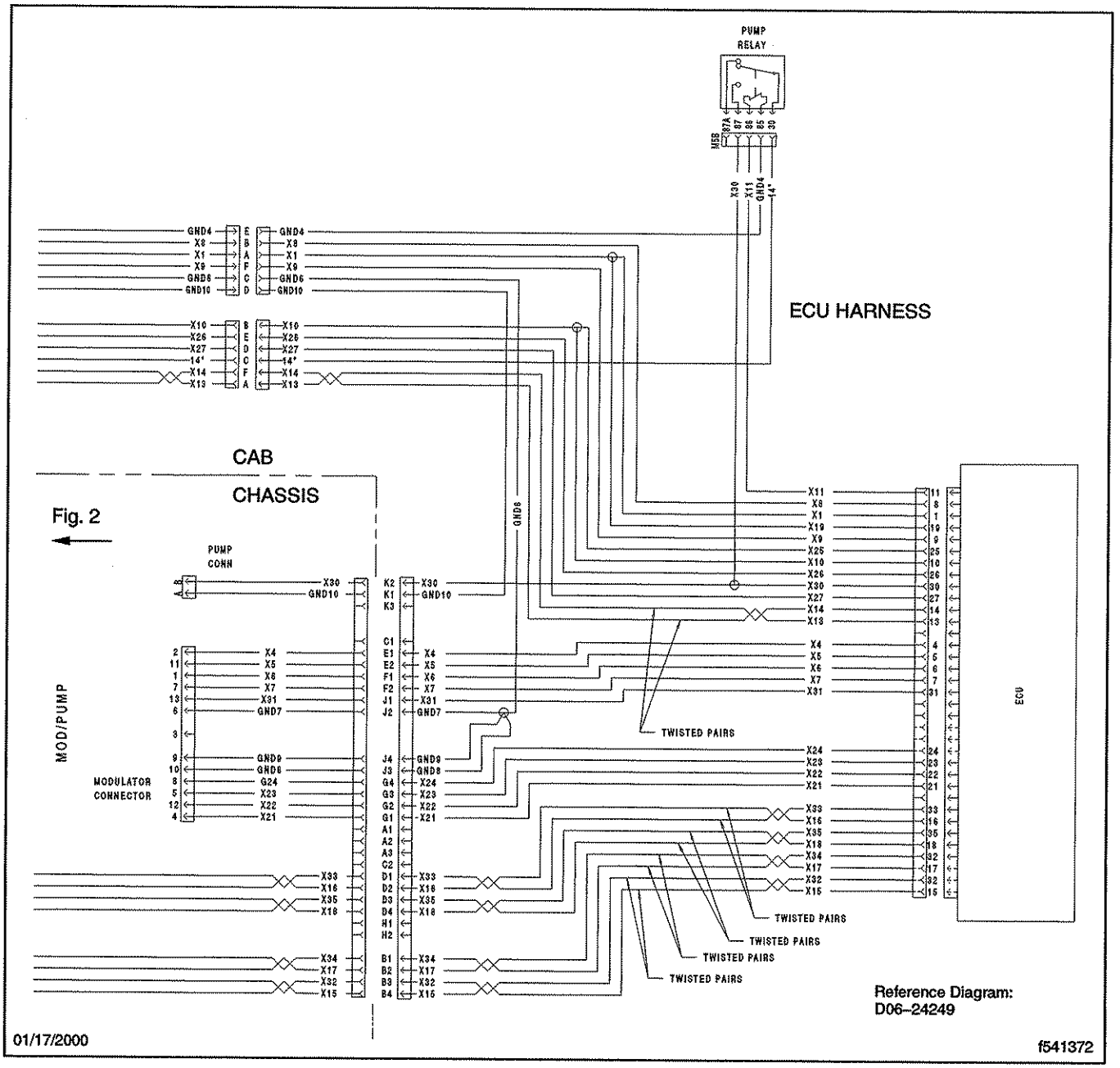


Fig. 2, Partial View of the Cab and Chassis Wiring Diagram

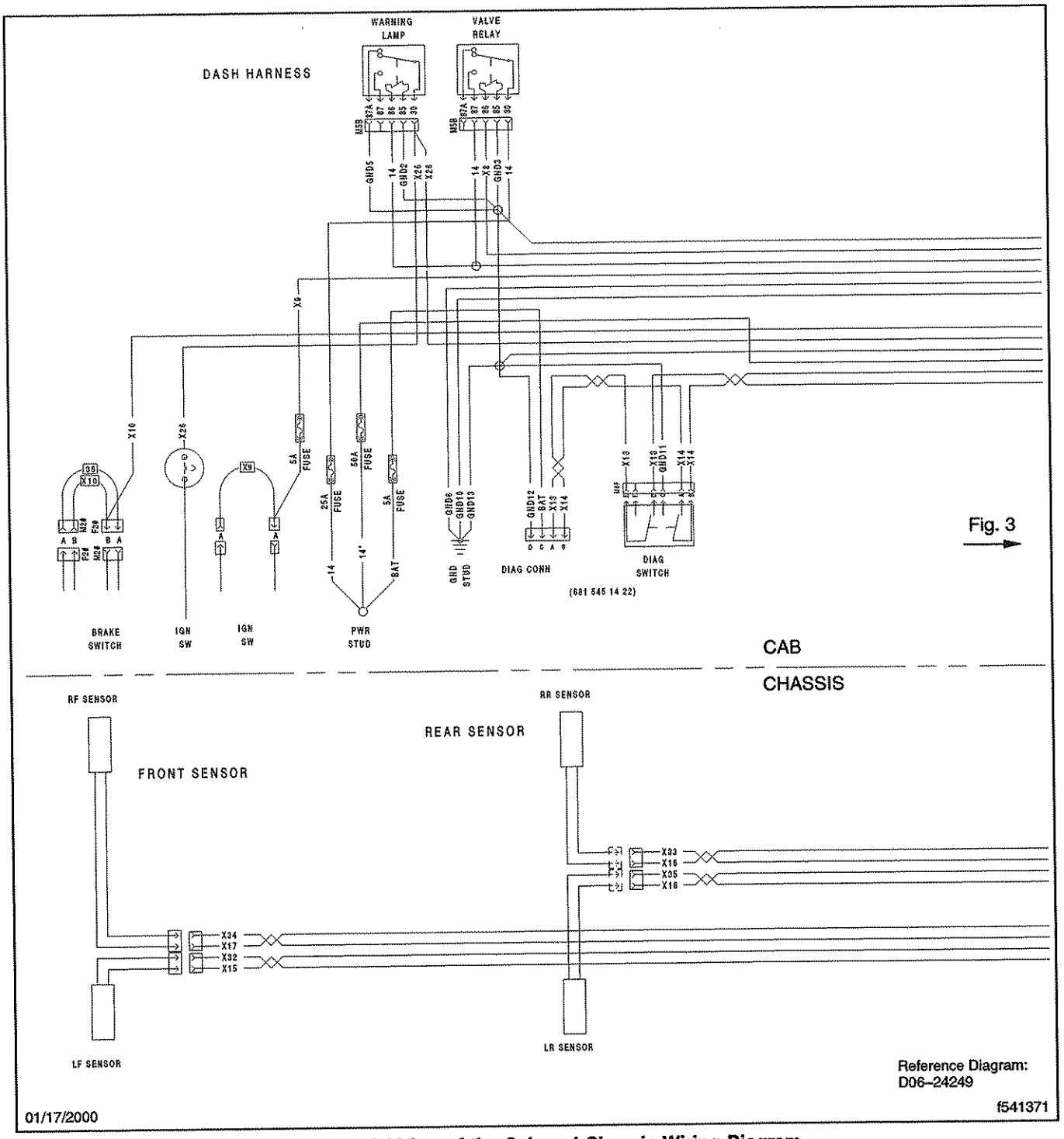
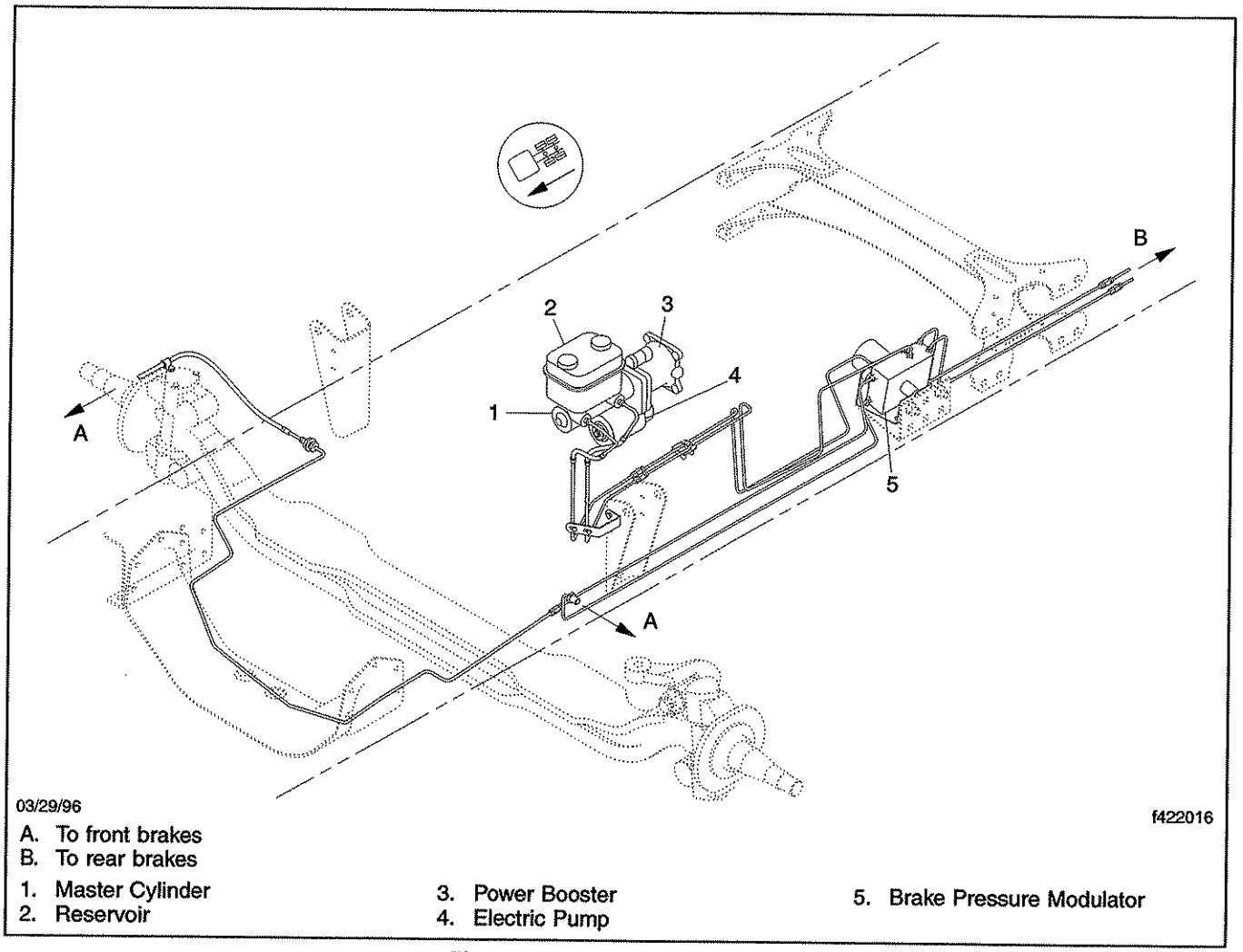


Fig. 3, Partial View of the Cab and Chassis Wiring Diagram

Specifications



03/29/96 f422016

A. To front brakes
B. To rear brakes

1. Master Cylinder
2. Reservoir
3. Power Booster
4. Electric Pump
5. Brake Pressure Modulator

Fig. 4, Hydraulic ABS Plumbing

Troubleshooting Using the Instrument Panel Blink Codes

Make sure that a charged 12-volt battery is available (the ABS system needs at least 11 volts to work).

See **Table 2** for a listing of all fault codes, pins to be tested, and the correct volt/ohmmeter readings. Repair or replace the components and/or wiring if the readings are not correct.

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals.

Refer to **Group 54** in this manual for information on special terminals and connectors, and ordering tools for them.

WABCO ABS Fault Codes and Tests

Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	**Problem**	**Begin by Testing These Pins**	**Volt, Amp, and Ohmmeter Reading**	**Remedy**
2–0	Internal electronic control unit fault.	—	—	Replace the electronic control unit.
2–1	Internal electronic control unit fault.	—	—	Replace the electronic control unit.
2–2	Recirculation pump operates continuously.	—	—	Check the recirculation pump wiring (circuits 11 & 30), the pump relay, and the wiring connections. Repair or replace as needed.
2–3	Recirculation pump does not work.	—	—	Jump pins 9 and 11, and you should hear the pump motor run. Check the recirculation pump wiring, the relay circuit, and the pump connections.
2–4	Recirculation pump motor locked.	—	0.30 A	Jump pins 9 and 11, and you should hear the pump motor run. Check the recirculation pump wiring, the relay circuit, and the pump connections.
2–6	Stop light switch has failed.	10 and 25	—	Repair the wiring if needed (circuits 10 & 25). Also, make sure that the 35-pin connector is secure at the ECU.
2–7	Continuous power supply to the ECU with ignition off.	9 and 27	0 DCV	With the ignition off, check the valve relay and wiring connections. Repair or replace as needed.
2–8	No voltage to the inlet or outlet valve.	1, 9 and 27	12 V	Check the valve relay, the wiring (circuits 1 & 8), and the wiring connections. Repair or replace as needed.
2–9	Inlet valve supervision time exceeded.	—	—	Check the valves for normal operation. If okay, clear the faults.
2–10	Modulator reference ground interrupted.	31	—	Repair or replace wiring (circuit 31) as needed. Check the chassis ground circuit.
2–11	Recirculation pump cycle time is excessive.	—	—	Check the recirculation pump operation. If okay, clear the fault.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
3–7 Left Rear (LR)	On the rear axle, there is an open circuit in the outlet control valve and/or wiring to the connection.	22 and 31	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
3–8	Open circuit between the ECU and the recirculation pump relays.	22 and 31	—	Jump pins 9 & 11, and if the pump doesn't run, check circuit 11 and the recirculation pump relay.
4–0 Right Front (RF)	On the steer axle, there is a short circuit to ground between the ECU and the RF inlet control valve.	6 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 6). Repair or replace the wiring as needed.
4–1 Right Front (RF)	On the steer axle, there is a short circuit to ground between the ECU and the RF outlet control valve.	7 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 7). Repair or replace the wiring as needed.
4–2 Left Front (LF)	On the steer axle, there is a short circuit to ground between the ECU and the LF inlet control valve.	23 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 23). Repair or replace the wiring as needed.
4–3 Left Front (LF)	On the steer axle, there is a short circuit to ground between the ECU and the LF outlet control valve.	24 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 24). Repair or replace the wiring as needed.
4–4 Right Rear (RR)	On the rear axle, there is a short circuit to ground between the ECU and the RR inlet control valve.	4 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 4). Repair or replace the wiring as needed.
4–5 Right Rear (RR)	On the rear axle, there is a short circuit to ground between the ECU and the RR outlet control valve.	5 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 5). Repair or replace the wiring as needed.
4–6 Left Rear (LR)	On the rear axle, there is a short circuit to ground between the ECU and the LR inlet control valve.	21 and 27	5 to 7.5 ohms 1.6 ampst	Check the inlet control valve wiring (circuit 21). Repair or replace the wiring as needed.
4–7 Left Rear (LR)	On the rear axle, there is a short circuit to ground between the ECU and the LR outlet control valve.	22 and 27	3 to 5 ohms 2.5 ampst	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
4–8	Short circuit to ground between the ECU and the recirculation pump relay.	11, 30 and 27	Open Circuit	Check continuity through the pump to ground. Check the pump connector. Repair or replace wiring as needed.

Troubleshooting Using the Instrument Panel Blink Codes

WABCO ABS Fault Codes and Tests				
Key Switch On to Determine ABS Blink Fault Code		Key Switch Off to Test System		
WABCO Fault Code	Problem	Begin by Testing These Pins	Volt, Amp, and Ohmmeter Reading	Remedy
5–7 Left Rear (LR)	On the rear axle, there is a short circuit to the battery between the ECU and the LR outlet control valve.	22 and 9	3 to 5 ohms 2.5 amps†	Check the outlet control valve wiring (circuit 22). Repair or replace the wiring as needed.
5–8	Short circuit to battery between the ECU and the recirculation pump relay.	30 and 11	Open Circuit	Repair or replace wiring as needed. Check the pump ground connection.
5–12 Right Front (RF) 5–14 Left Front (LF)	Wheel speed signal is erratic.	pins 17 and 34 pins 15 and 32	Above 0.2 volts AC	An incorrect or damaged tone wheel. Replace the tone wheel and rotor if needed. Also, check the tire sizes for possible mismatch, and check for correct wheel bearing adjustment.
5–13 Left Rear (LR) 5–15 Right Rear (RR)	Wheel speed signal is erratic.	pins 18 and 35 pins 16 and 33	Above 0.2 volts AC	An incorrect or damaged tone wheel. Replace the tone wheel and rotor if needed. Also, check the tire sizes for possible mismatch, and check for correct wheel bearing adjustment.
6–0 Right Front (RF)	On the steer axle, there is a short circuit in the RF inlet control valve wiring to other wiring.	4, 5, 6, 7, 21, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 6 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–1 Right Front (RF)	On the steer axle, there is a short circuit in the RF outlet control valve wiring to other wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 7 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–2 Left Front (LF)	On the steer axle, there is a short circuit in the LF inlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 23 and the other control valve circuits. Replace the modulator if the short is located within the valve.
6–3 Left Front (LF)	On the steer axle, there is a short circuit in the LF outlet control valve wiring to other valve wiring.	4, 5, 6, 7, 21, 22, 23, and 24	Open circuit	Repair or replace the wiring if continuity exists between circuit 24 and the other control valve circuits. Replace the modulator if the short is located within the valve.

Troubleshooting Using the Instrument Panel Blink Codes

If a fault still can't be repaired, or erased from ECU memory, contact your Meritor District Service Manager, or call Meritor WABCO at 1-800-535-5560.

ERASING A FAULT FROM THE ECU MEMORY

NOTE: An existing fault cannot be erased until it has been corrected.

Meritor WABCO recommends that you erase all faults from the ECU memory after they have been noted and corrected.

Faults can only be erased one at a time. A fault is erased from the ECU memory by doing the following:

1. Turn the ignition switch on.
2. Turn the blink code switch on.
3. Wait until the blink code begins to flash.
4. Turn the blink code switch off.
5. Wait for the ABS lamp to stop flashing.
6. Turn the ignition switch off, then back on.
7. Turn the blink code switch off, then back on.
8. Check for additional faults. If they are present, repair and clear them.

   When all faults are repaired and cleared, only the configuration code (1–1) will be displayed.

Contents

Subject	Subject Number
Cab and Chassis Plumbing Diagram	100

Cab and Chassis Plumbing Diagram

See **Fig. 1** for a full view of the cab and chassis plumbing diagram. See **Fig. 2**, **Fig. 3**, and **Fig. 4** for partial (detailed) views of the plumbing diagram.

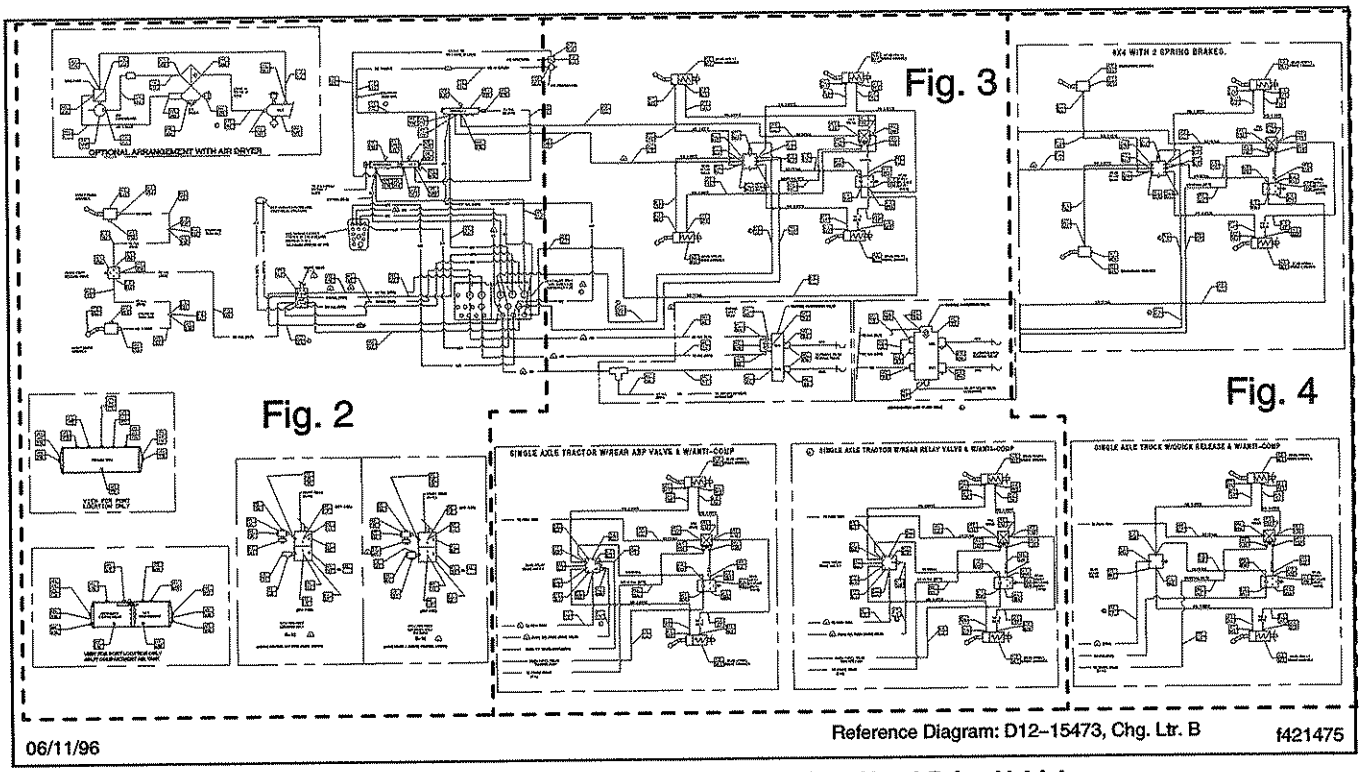


Fig. 1, Cab and Chassis Plumbing Diagram, Right-Hand-Drive Vehicles

Cab and Chassis Plumbing Diagram

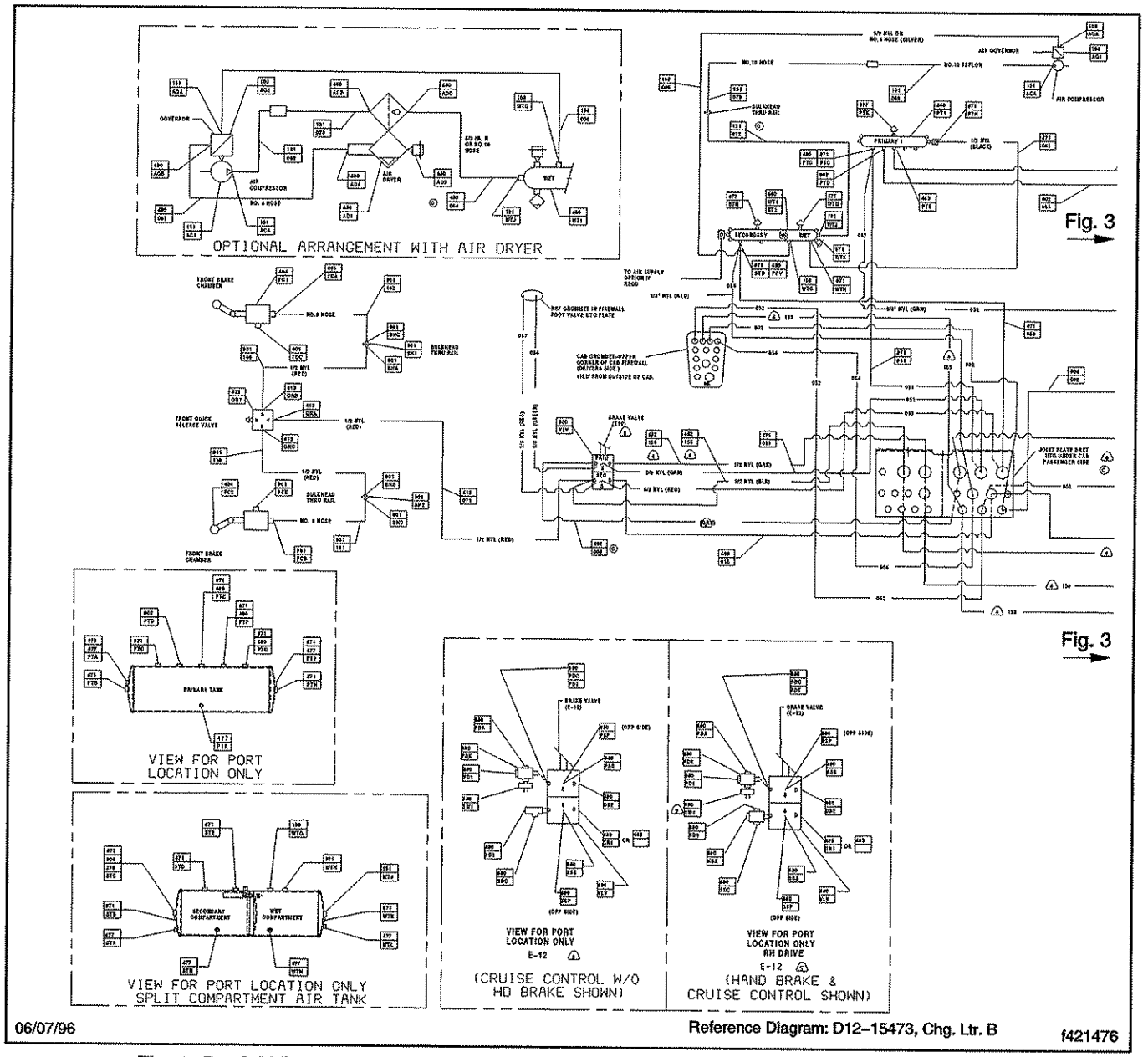


Fig. 2, Partial View of the Cab and Chassis Plumbing Diagram, Right-Hand-Drive Vehicles

Cab and Chassis Plumbing Diagram

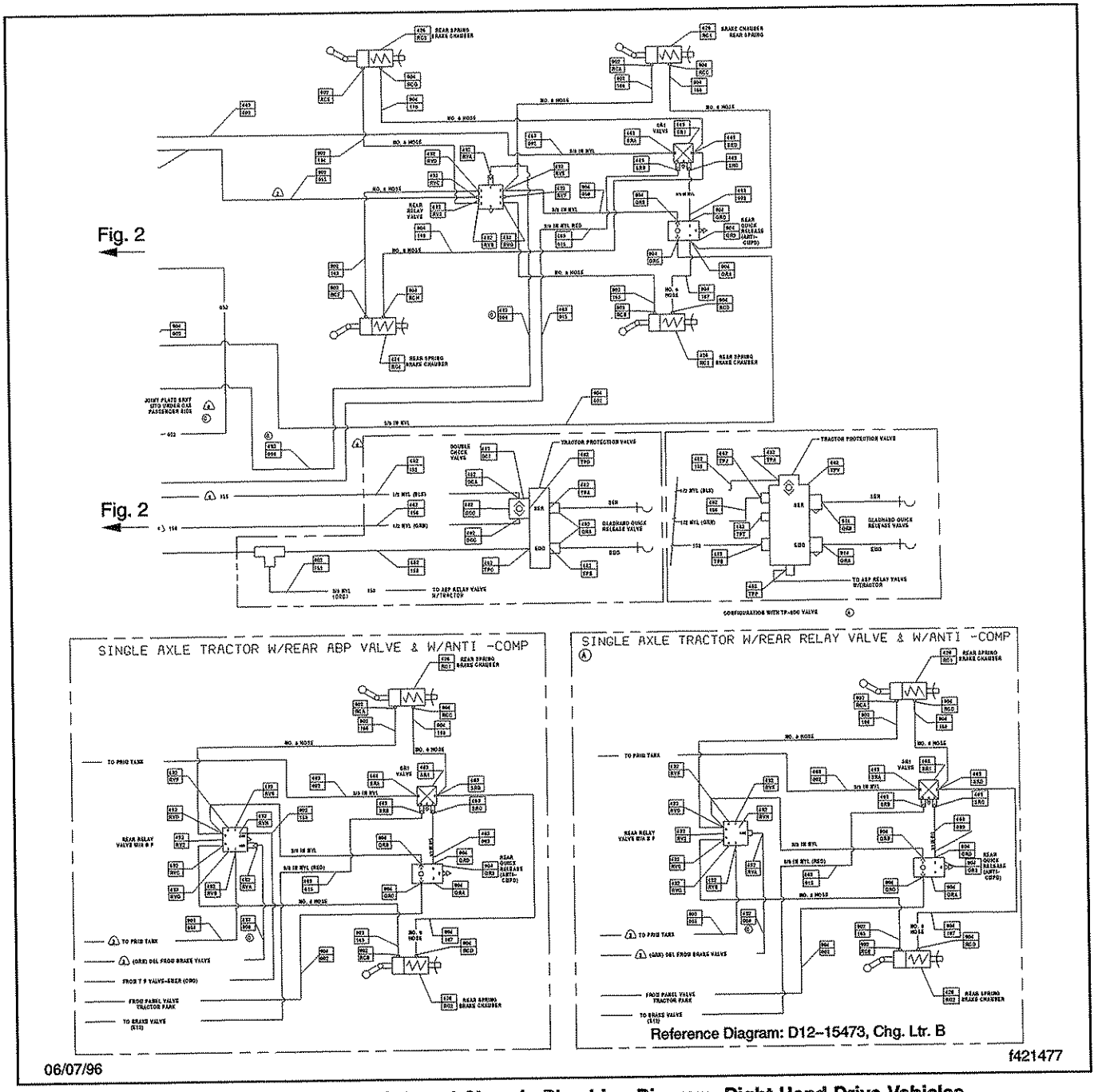
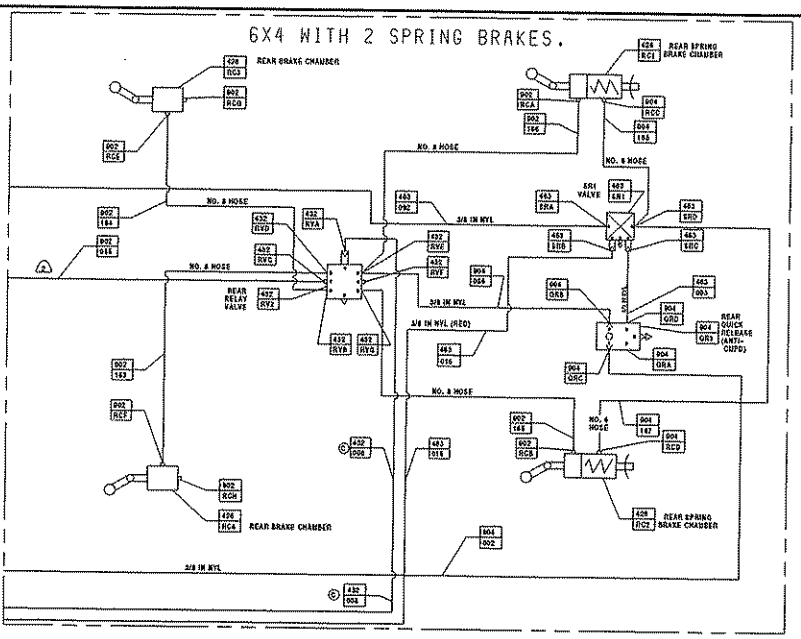
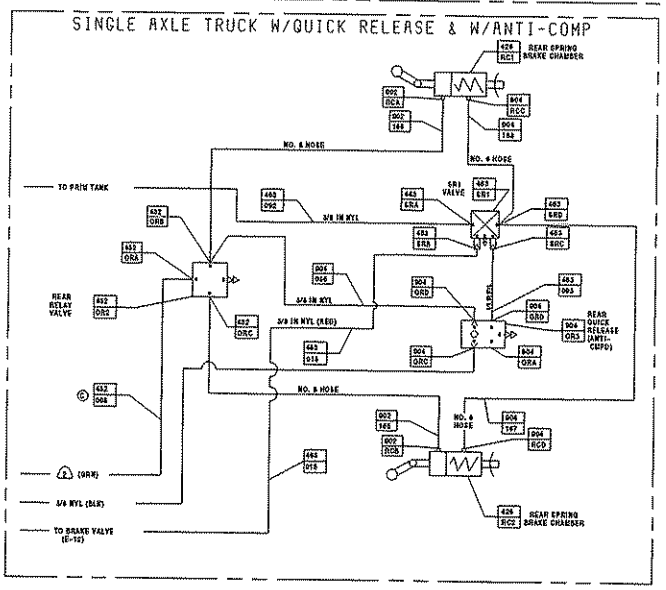


Fig. 3, Partial View of the Cab and Chassis Plumbing Diagram, Right-Hand-Drive Vehicles

Cab and Chassis Plumbing Diagram





06/11/96

Reference Diagram: D12–15473, Chg. Ltr. B

f421478

Fig. 4, Partial View of the Cab and Chassis Plumbing Diagram, Right-Hand-Drive Vehicles

Contents

Subject	Subject Number
General Information and Principles of Operation	050
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Removal and Installation	120
Disassembly, Cleaning and Inspection, and Assembly	130
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General Information

The Allied Signal/Bendix TP–3DC is a tractor protection valve which includes an integral double check valve. The TP–3DC serves two purposes. First, as required by Federal law, the valve protects the tractor brakes in the event of trailer breakaway or a severe air system leak. Second, when used with a dash-mounted trailer supply control valve, the TP–3DC valve can be used to shut off the trailer control line before the trailer is disconnected.

The TP–3DC also includes an integral single check valve which prevents air from getting trapped in the trailer control line. Trapped air in this line could cause service/spring brake compounding and, if the trailer is parked with air applied, a trailer roll-away situation.

On Business Class vehicles, the TP–3DC tractor protection valve is mounted under the left rear cab corner (see **Fig. 1**).

TP–3DC valve port designations and internal components are shown in **Fig. 2**.

Principles of Operation

INITIAL CHARGE (See Fig. 3)

Pushing in the red trailer air supply knob (Ref. 1) on the instrument panel causes air to flow into the TP–3DC valve at the tractor supply port (Ref. 2). Air flows through the valve housing, exiting via the auxiliary supply port (if used) and the trailer supply port (Ref. 4), to pressurize the trailer brake system and release the trailer parking brakes.

As air pressure builds in the trailer supply circuit, the single check valve (Ref. 5) seats, and the valve plunger (Ref. 16) begins to move (against spring pressure) toward the guide (Ref. 8). When pressure reaches about 45 psi (310 kPa), the plunger bottoms against the guide and the inlet valve is open.

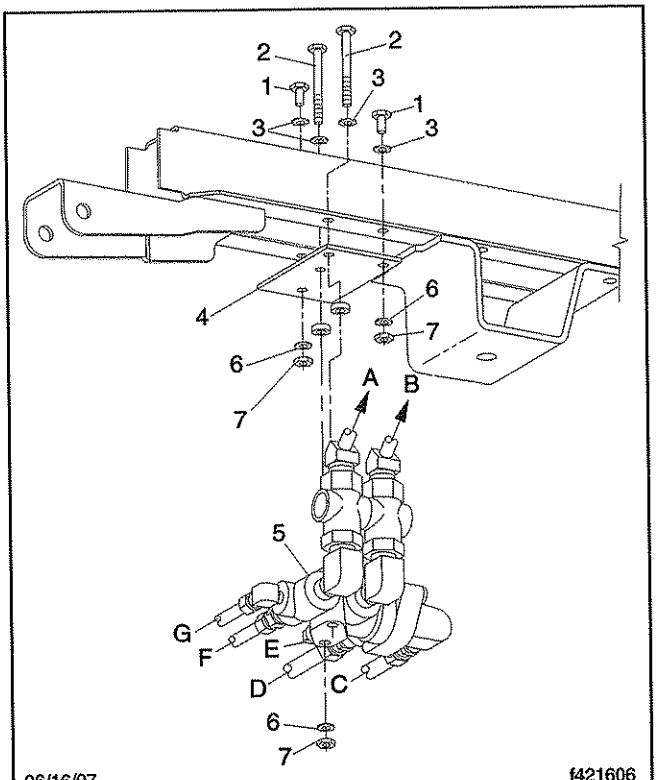
The TP–3DC valve is in the "run" mode, and ready to receive and deliver a service brake application from either the foot valve or the hand valve.

SERVICE BRAKE APPLICATION (See Fig. 4)

When the foot pedal is pressed, air flows to the TP–3DC valve tractor control primary (Ref. 10) and secondary (Ref. 13) ports. If the trailer control valve (Ref. 14) is also used, the external double check (Ref. 12) delivers the higher pressure (trailer control or foot valve secondary) to the TP–3DC Tractor Control secondary port.

Inside the TP–3DC valve, the higher pressure (primary or secondary) moves the diaphragm (Ref. 9) to seal off the port at the lower pressure.

With the plunger bottomed against the guide and the inlet valve open (as described earlier), the higher

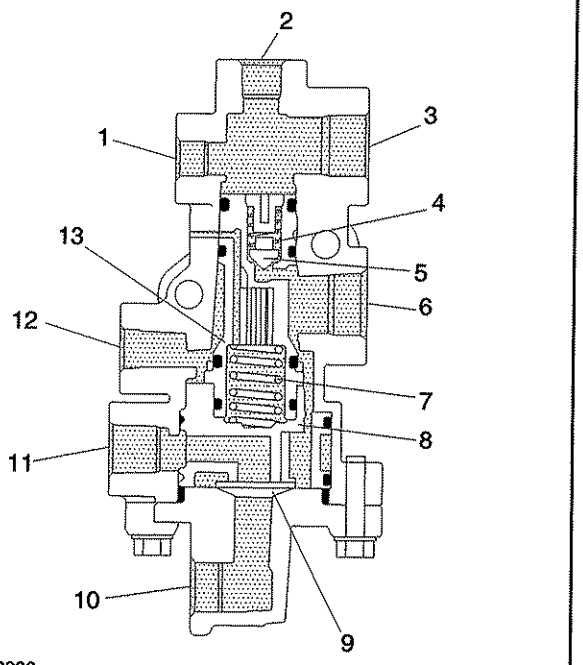


A. To trailer emergency port
B. To trailer service port
C. From service brake foot valve, primary circuit
D. From service brake foot valve, secondary circuit
E. Pipe Plug
F. From trailer supply valve
G. To proportioning relay (if installed)

1. 5/16–18 x .75" Capscrew
2. 5/16–18 x 3" Capscrew
3. Flatwasher
4. Mounting Plate
5. TP–3DC Tractor Protection Valve
6. 5/16" Lockwasher
7. 5/16" Locknut

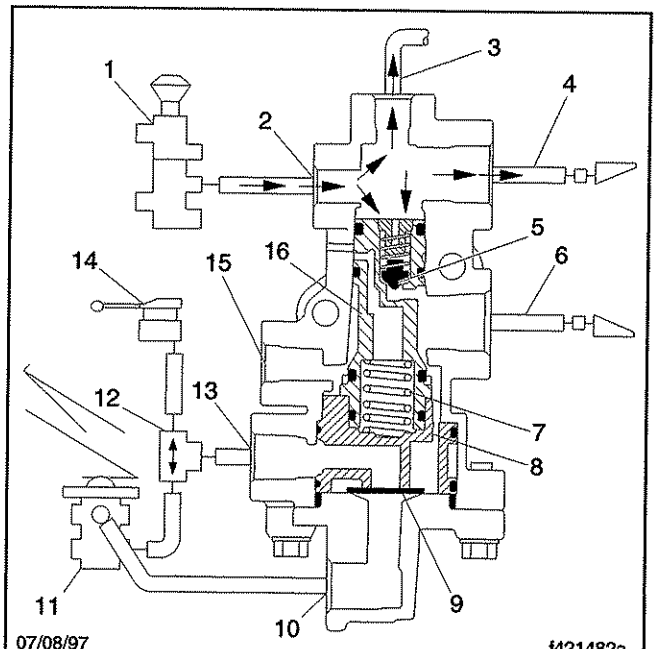
Fig. 1, TP–3DC Mounting Location and Connections

General Information and Principles of Operation



1. Tractor Supply
2. Auxiliary Supply
3. Trailer Supply
4. Tee Plug and Spring
5. Single Check Valve
6. Trailer Control
7. Spring
8. Guide
9. Diaphragm (Double Check Valve)
10. Tractor Control (Primary)
11. Tractor Control (Secondary)
12. Stop Lamp Switch
13. Plunger

Fig. 2, TP–3DC, Sectional View



1. Trailer Air Supply Valve
2. Tractor Supply Port
3. Auxiliary Supply Port
4. Trailer Supply Port
5. Single Check Valve
6. Trailer Control Port
7. Spring
8. Guide
9. Diaphragm (Double Check Valve)
10. Tractor Control Port (Primary)
11. Foot Valve
12. Double Check Valve
13. Tractor Control Port (Secondary)
14. Hand Valve
15. Stop Lamp Switch Port
16. Plunger

Fig. 3, Initial Charge

pressure air flows through the valve to the trailer control port (Ref. 6) and the stop lamp switch, applying the brakes and activating the stop lamps.

NOTE: While air pressure also reaches the TP–3DC single check valve, the valve stays closed because supply pressure is acting on the other side.

SERVICE BRAKE RELEASE (See Fig. 5)

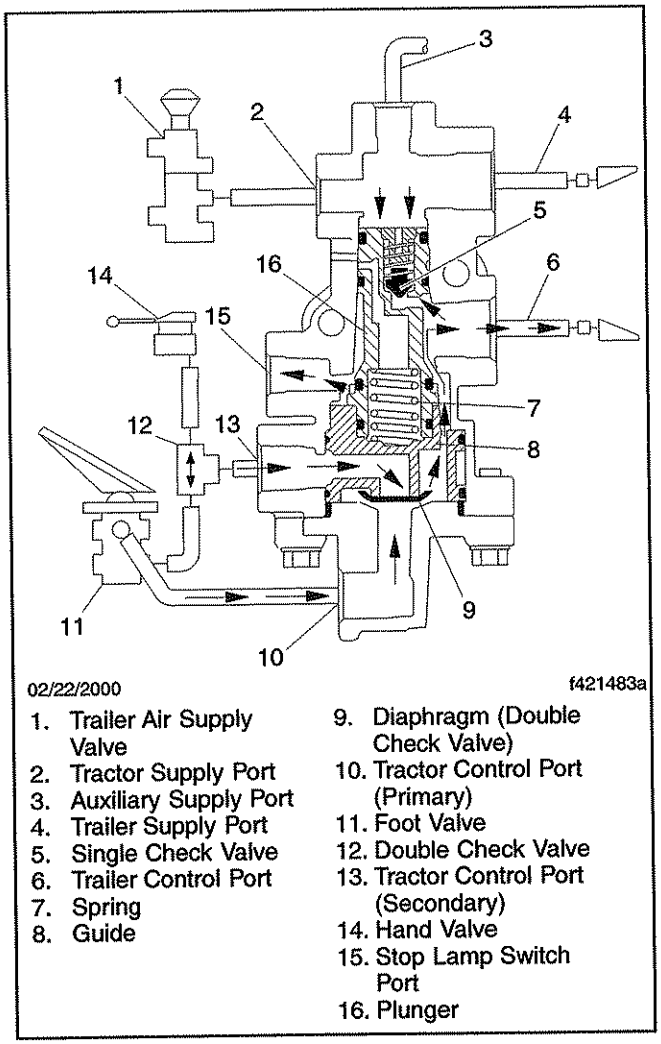
When the foot pedal is released, air stops flowing into the TP–3DC valve at the tractor control primary (Ref. 10) or secondary (Ref. 13) port. At the same time, air in the trailer control line (Ref. 6) returns to the valve, flowing back through the open inlet valve.

The air forces the diaphragm (Ref. 9) to seat, sealing off the tractor control primary port. The air then exits the valve at the tractor control (secondary) port (Ref. 13) and flows to the foot valve or hand valve where it is exhausted.

TRACTOR PROTECTION (See Fig. 6)

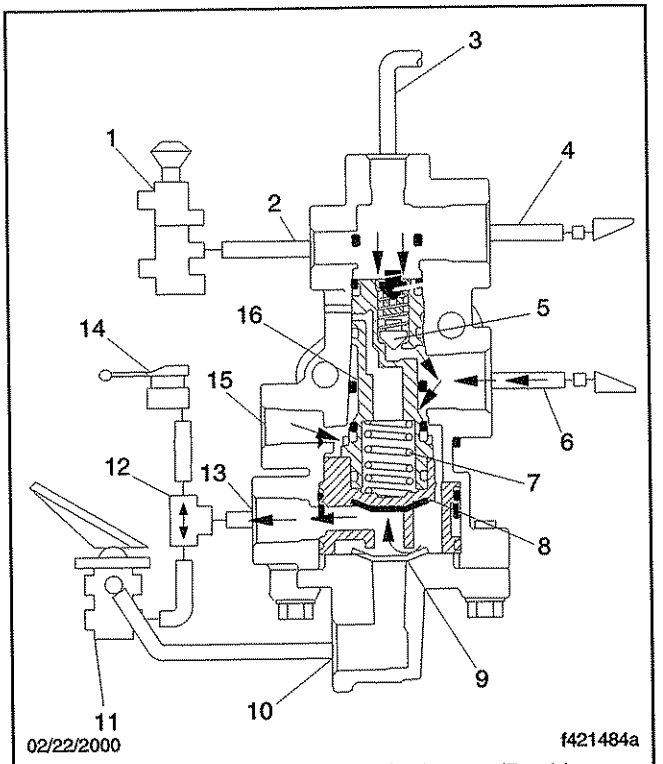
If the red trailer air supply knob on the instrument panel is pulled out (or if a large leak develops in the trailer supply circuit), pressure in the trailer supply circuit (and the auxiliary supply circuit, if used) is vented. When pressure drops to about 20 to 30 psi (138 to 207 kPa), the pressure can no longer overcome the spring force inside the TP–3DC valve and the inlet valve closes.

With the inlet valve closed, air pressure from the brake foot or hand control valves will not reach the trailer control circuit when the brakes are applied.



1. Trailer Air Supply Valve
2. Tractor Supply Port
3. Auxiliary Supply Port
4. Trailer Supply Port
5. Single Check Valve
6. Trailer Control Port
7. Spring
8. Guide
9. Diaphragm (Double Check Valve)
10. Tractor Control Port (Primary)
11. Foot Valve
12. Double Check Valve
13. Tractor Control Port (Secondary)
14. Hand Valve
15. Stop Lamp Switch Port
16. Plunger

Fig. 4, Service Brake Application



1. Trailer Air Supply Valve
2. Tractor Supply Port
3. Auxiliary Supply Port
4. Trailer Supply Port
5. Single Check Valve
6. Trailer Control Port
7. Spring
8. Guide
9. Diaphragm (Double Check Valve)
10. Tractor Control Port (Primary)
11. Foot Valve
12. Double Check Valve
13. Tractor Control Port (Secondary)
14. Hand Valve
15. Stop Lamp Switch Port
16. Plunger

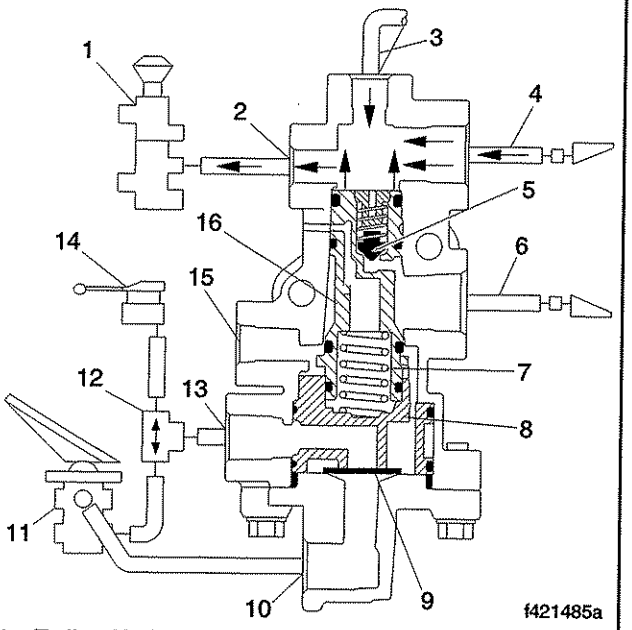
Fig. 5, Service Brake Release

ANTI-COMPOUNDING (See Fig. 7)

If the red trailer air supply knob on the instrument panel is pulled out while the service brakes are applied, the single check valve (Ref. 5) in the TP–3DC prevents simultaneous spring and service brake application. As pressure in the trailer supply circuit drops, the spring (Ref. 7) in the TP–3DC valve forces the inlet valve closed (as described above in "Tractor Protection." Any pressure in the trailer control circuit (Ref. 6) is relieved by passing first through the single check valve and then exhausting at the trailer supply valve.

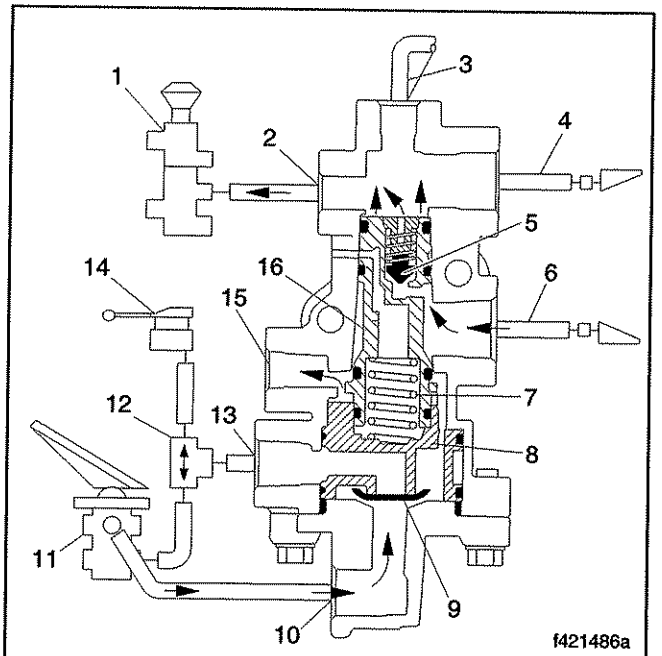
If the service brakes (hand or foot) are released and applied again, the closed inlet valve prevents air pressure from reaching the trailer control circuit.

General Information and Principles of Operation



1. Trailer Air Supply Valve
2. Tractor Supply Port
3. Auxiliary Supply Port
4. Trailer Supply Port
5. Single Check Valve
6. Trailer Control Port
7. Spring
8. Guide
9. Diaphragm (Double Check Valve)
10. Tractor Control Port (Primary)
11. Foot Valve
12. Double Check Valve
13. Tractor Control Port (Secondary)
14. Hand Valve
15. Stop Lamp Switch Port
16. Plunger

Fig. 6, Tractor Protection



1. Trailer Air Supply Valve
2. Tractor Supply Port
3. Auxiliary Supply Port
4. Trailer Supply Port
5. Single Check Valve
6. Trailer Control Port
7. Spring
8. Guide
9. Diaphragm (Double Check Valve)
10. Tractor Control Port (Primary)
11. Foot Valve
12. Double Check Valve
13. Tractor Control Port (Secondary)
14. Hand Valve
15. Stop Lamp Switch Port
16. Plunger

Fig. 7, Anti-Compounding

Safety Precautions

When working on or around air brake systems and components, observe the following precautions.

1. Chock the tires and stop the engine before working under the vehicle. Releasing air from the system may cause the vehicle to roll. Keep hands away from brake chamber push rods and slack adjusters; they will apply as air pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs, and injury can result if not correctly disassembled. Use only correct tools and observe all precautions regarding use of those tools.

Leakage Test

IMPORTANT: Before working on or around air brake systems and components, review **Safety Precautions, 100.**

1. Chock the tires, start the engine, and run it until the air system is fully charged.
2. Shut down the engine and place the trailer air supply valve in the emergency position.
3. Disconnect the trailer control line hose coupling and apply a soap-water solution to the coupling.
4. With tractor reservoirs charged to at least 100 psi (689 kPa) make and hold a full service brake application using either the foot valve or the trailer control valve. Leakage at the hose coupling should not exceed a 1-inch (2.5-cm) bubble in five seconds.
5. Release the service brake application and place the trailer supply valve in the "run" position. Connect the trailer control valve to a test gauge.
6. Make a service brake application and note that service air pressure is present at the trailer control line hose coupling.
7. Disconnect the air line at the TP–3DC tractor control port (primary), plug the line, and apply a soap-water solution to the valve.
8. Make a service brake application and check for leakage at the open tractor control port. Leakage should not exceed a 1-inch (2.5-cm) bubble in five seconds.
9. Reconnect the air line to the tractor control port (primary) and disconnect the air line at the tractor control port (secondary). Then, plug the disconnected line and apply a soap-water solution to the valve.
10. Make and service brake application and check for leakage at the open tractor control port. Leakage should not exceed a 1-inch (2.5-cm) bubble in five seconds.

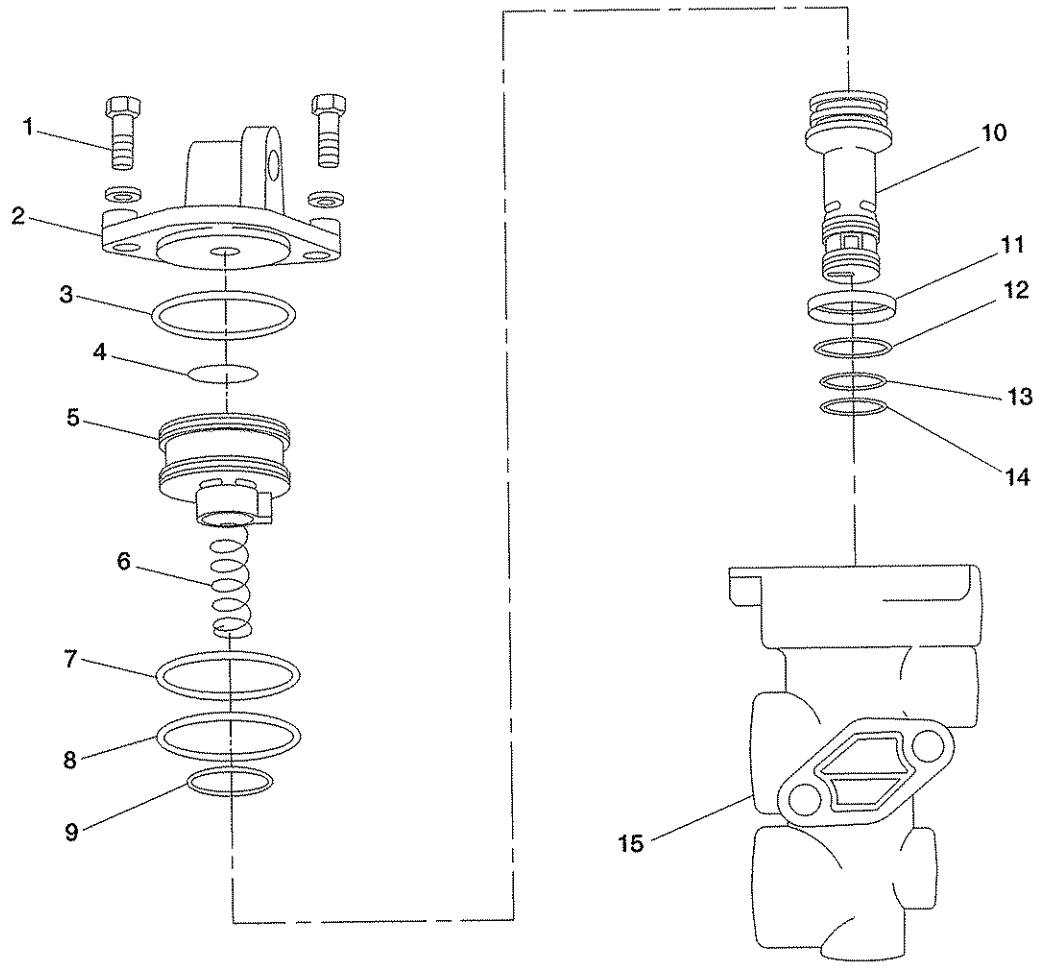
IMPORTANT: If the valve does not function as described, or if leakage is excessive, repair or replace the valve.

Disassembly, Cleaning and Inspection, and Assembly

Disassembly (See Fig. 1)

IMPORTANT: Before working on or around air brake systems and components, review **Safety Precautions, 100.**

1. Remove the valve from the vehicle, retaining the mounting hardware. For instructions, see **Subject 120.**
2. Scribe a line across the valve cover (Ref. 2) and valve body (Ref. 15) to ensure proper alignment during assembly.
3. Remove the two 1/4-inch screws (Ref. 1) which secure the valve cover to the valve body and allow the valve spring to expand until the valve cover can be removed.
4. Remove the cover O-ring (Ref. 3) and discard it.



06/10/96

1. 1/4" Hex/Torx Screw
2. Valve Cover
3. Cover O-Ring
4. Diaphragm
5. Guide
6. Valve Spring
7. Guide O-Ring
8. Guide O-Ring
9. Plunger O-Ring
10. Plunger
11. Collar
12. O-Ring
13. Plunger O-Ring
14. Plunger O-Ring
15. Valve Body

Fig. 1, Exploded View of TP–3DC Valve

Disassembly, Cleaning and Inspection, and Assembly

5. Remove the diaphragm (Ref. 4) from the valve body and discard it.
6. Remove the guide (Ref. 5) from the valve body.
7. Remove the O-rings (Refs. 7 and 8) from the guide and discard them.
8. Remove the valve spring from the plunger, then the plunger from the valve body.
9. Remove the O-rings (Refs. 9, 13, and 14) from the plunger and discard them.
10. Remove the collar (Ref. 11) and the O-ring (Ref. 12) from the plunger. Discard the O-ring, but keep the collar.

Cleaning and Inspection

IMPORTANT: Before working on or around air brake systems and components, review **Safety Precautions, 100.**

⚠ WARNING

Wear goggles when using compressed air to clean or dry parts, as permanent harm to eyes could result from flying debris.

1. Wash all metal parts of the TP–3DC valve in cleaning solvent, then dry them using compressed air.
2. Examine the cover, body, guide, and plunger for corrosion, excessive wear, cracks, or other damage. If any of these conditions are found on a part, replace the part with a new one.
3. Check the spring for distortion and corrosion. If the spring is distorted or corroded, replace it.
4. Check the valve body bores for deep scratches or gouging

Assembly

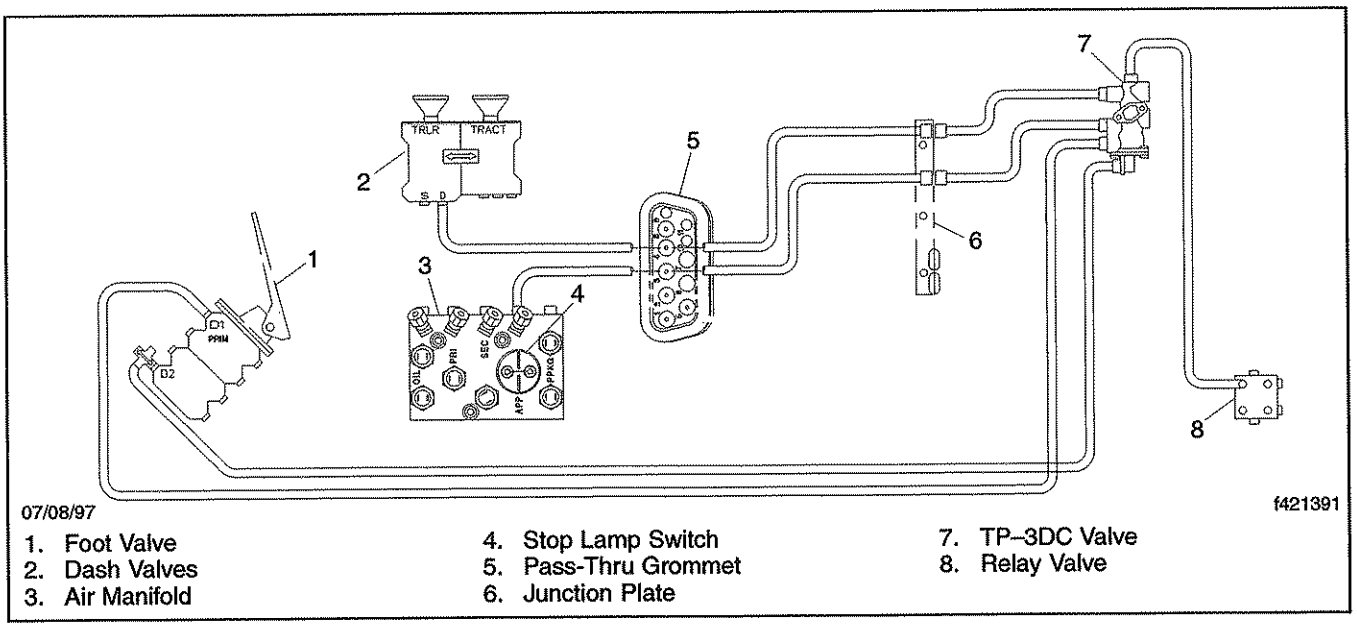
IMPORTANT: Before working on or around air brake systems and components, review **Safety Precautions, 100.**

1. Lubricate the O-rings, O-ring grooves, body bores, and all sliding parts with the lubricant provided in the overhaul kit (Bendix silicone lubricant #291126 or equivalent).
2. Install the O-rings (Refs. 9, 13, and 14) on the plunger.
3. Install the O-ring (Ref. 12) on the plunger and then the collar (Ref. 11) over the O-ring. Make sure that the collar is fully seated and firmly in place over the O-ring.
4. Install the plunger into the valve body and the spring (Ref. 6) into the plunger.
5. Install the O-rings (Refs. 7 and 8) in their grooves on the guide.
6. Align the indexing tab on the guide with the notch in the valve body and install the guide in the valve body.
7. Place the diaphragm (Ref. 4) in its recess on the guide.
8. Place the O-ring (Ref. 3) on the cover.
9. Place the cover on the guide and press them down, against spring pressure, until the cover is seated against the valve body.
10. Install the two 1/4-inch screws and tighten them 30 to 60 lbf·in (340 to 675 N·cm).
11. Install the TP–3DC valve on the vehicle following the instructions in **Subject 120.**

See **Fig. 1** for a TP–3DC plumbing diagram.

Torque Values		
Description	**Torque lbf.in (N.cm)**	**Torque lbf.ft (N.m)**
Valve Cover Capscrews	30–60 (340–675)	—
Valve Mounting Capscrews	—	11–15 (15–20)

Table 1, Torque Values



1. Foot Valve
2. Dash Valves
3. Air Manifold
4. Stop Lamp Switch
5. Pass-Thru Grommet
6. Junction Plate
7. TP–3DC Valve
8. Relay Valve

Fig. 1, TP–3DC Plumbing Diagram

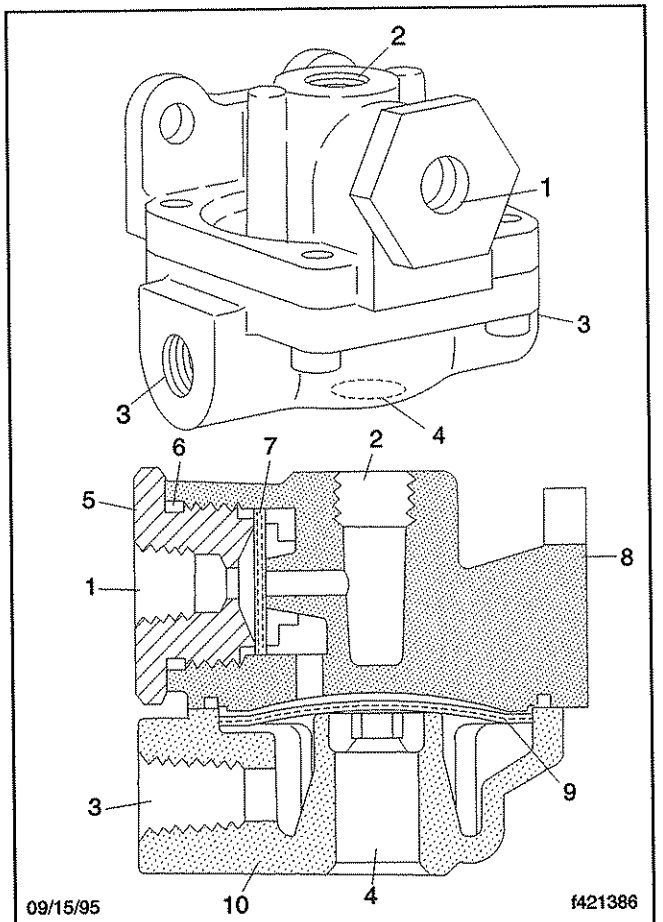
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General Information

The QR–1C quick release valve **(Fig. 1)** is a dual function valve. Its primary function is to speed up the release of air pressure from the service brake chambers. Additionally, the valve works as an anti-compound device. The double check valve feature prevents a service and parking brake application from occuring at the same time.

The QR–1C valve is generally mounted near the rear axle. A balance line from the relay valve delivery port (port 2 on the WABCO combination valve) is connected to the balance port on top of the QR–1C quick release valve; the two side ports are for brake chamber connections; the supply port is connected to the delivery port of the parking brake control valve, and the exhaust port is located at the bottom of the valve.



1. Supply Port
2. Balance Port
3. Delivery Port
4. Exhaust
5. Cap Nut
6. Sealing Ring
7. Double Check Diaphragm
8. Body
9. Quick Release Diaphragm
10. Cover

Fig. 1, QR-1C Valve and Cross Section

Principles of Operation (See Fig. 1)

Parking Brakes Released

When the parking brakes are released, air from the parking brake control valve flows through the QR–1C valve. This forces the double check diaphragm and the quick release diaphragm to flex and seal the balance and exhaust ports. Air flows into the inlet ports of the parking brake chambers from the QR–1C valve delivery ports.

Parking Brakes Applied

When the parking brakes are applied, supply line air pressure to the QR–1C valve is exhausted through the parking brake control valve. As air pressure is exhausted from one side of the double check diaphragm and the quick release diaphragm, both diaphragms flex in the opposite direction to open the balance and exhaust ports. Parking brake pressure is released at the exhaust port of the QR–1C valve while a small amount of air trapped between the two diaphragms is released through a relay valve or the foot valve exhaust port.

Anti-Compounding

When a service brake application is made with the parking brakes applied, service air enters the balance port and flows through the QR–1C valve into the inlet ports of the parking brake chambers. This prevents application of the service and parking brakes at the same time. Service air passing through the QR–1C valve flexes the double check and quick release diaphragms, sealing the supply and exhaust ports. When the service brake application is released, air is exhausted from the parking brakes.

Safety Precautions

When working on or around air brake systems and components, observe the following precautions.

1. Chock the tires and stop the engine before working under a vehicle. Depleting air system pressure may cause the vehicle to roll. Keep hands away from brake chamber push rods and slack adjusters; they may apply as air system pressure drops.
2. Never connect or disconnect a hose or line containing compressed air. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been released.
3. Never exceed recommended air pressure and always wear safety glasses when working with compressed air. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understood recommended procedures. Some components contain powerful springs, and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

QR–1C Quick Release Valve Operating and Leakage Tests

Operating and Leakage Tests

⚠ WARNING

Before working on or around air brake systems and components, review the safety precautions in Subject 100. Failure to do so could result in personal injury.

The following tests should also be performed after repairing or replacing the QR–1C valve to ensure that it is functioning properly.

1. Chock the tires.
2. Drain the air system.
3. Release the parking brakes.
4. Remove the air line from the valve balance port. Build system air pressure to 120 psi (827 kPa). Coat the exhaust and balance ports with a soap solution; leakage of a one-inch bubble in five seconds at either port is allowable. Install the air line at the balance port.
5. Apply the parking brakes. Step on the foot brake; the QR–1C valve should exhaust air at the exhaust port.
6. Drain the air system.
7. Remove the air line from the valve supply port. Build system air pressure to 120 psi (827 kPa). With the foot valve depressed, coat the supply port and the seam between the body and cover with a soap solution; leakage of a one-inch bubble in five seconds at the supply port is allowable. No leakage between the body and cover is permitted. Install the air line at the supply port.
8. If the valve does not function properly, or if leakage is excessive, repair or replace it following the instructions in this section.

QR–1C Quick Release Valve Disassembly, Cleaning and Inspection, and Assembly

Disassembly (See Fig. 1)

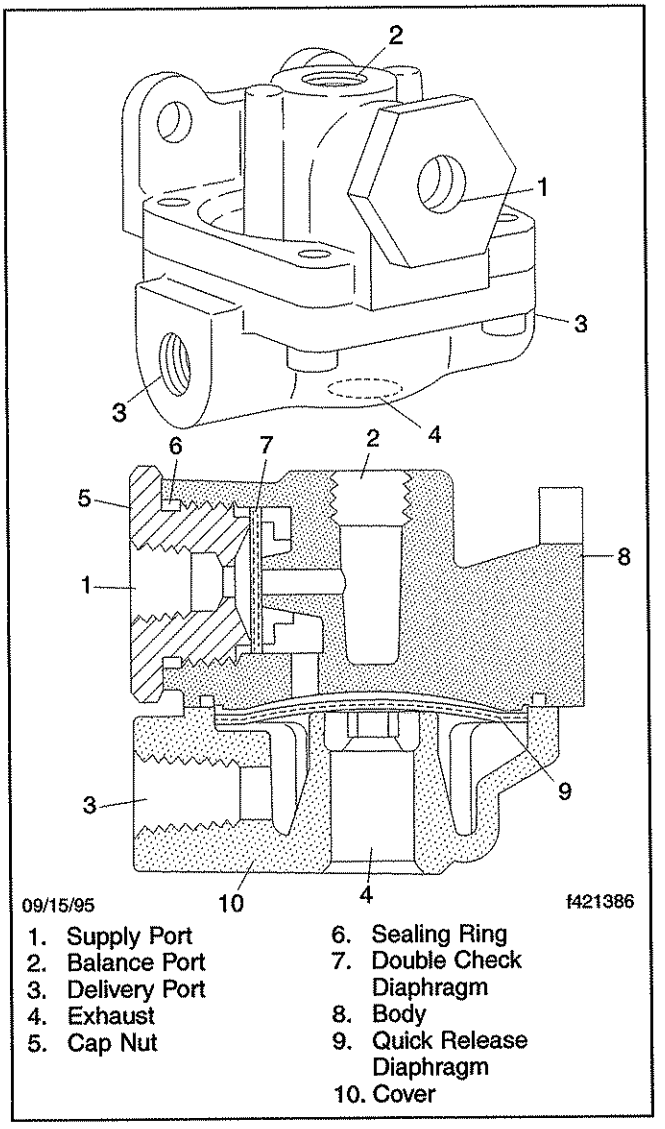
1. Remove the quick release valve from the vehicle following the instructions in **Subject 120.**
2. Mark the valve body and cover for ease of installation.
3. Remove the cap nut at the supply port. Remove the sealing ring from the cap nut.
4. Remove the double check diaphragm.
5. Remove the four screws holding the valve cover on the valve body.
6. Separate the cover from the body and remove the sealing ring and the quick release diaphragm.

Cleaning and Inspection

1. Clean all metal parts in mineral spirits. Wipe all rubber parts clean.
2. It is recommended that all rubber parts and any other part showing signs of wear or deterioration be replaced with genuine Bendix parts.

Assembly

1. Install the sealing ring on the cap nut.
2. Install the double check diaphragm in the valve body.
3. Install the cap nut. Tighten the nut 150 to 400 lbf·in (1700 to 4520 N·cm).
4. Install the quick release diaphragm in the cover.
5. Install the valve cover on the body. Tighten the screws 30 to 60 lbf·in (340 to 680 N·cm) evenly and securely.
6. Install the quick release valve, following the instructions in **Subject 120.**
7. Do the operating and leakage test as instructed in **Subject 110.**



1. Supply Port
2. Balance Port
3. Delivery Port
4. Exhaust
5. Cap Nut
6. Sealing Ring
7. Double Check Diaphragm
8. Body
9. Quick Release Diaphragm
10. Cover

Fig. 1, QR-1C Valve and Cross Section

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Wheel Speed Sensor Replacement

Replacement

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. See **Group 54** of this manual for information on special terminals and connectors, and on ordering tools for them.

FRONT AXLE

1. Chock the rear tires to prevent vehicle movement. Apply the parking brakes.
2. Twist and pull the sensor to remove it from the steering knuckle (see **Fig. 1**).
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 brake spider hole.
6. Connect the sensor cable to the chassis harness.
7. Attach the sensor cable to the steering knuckle top cap.
8. Push the clamping bushing into the brake spider hole until it stops.

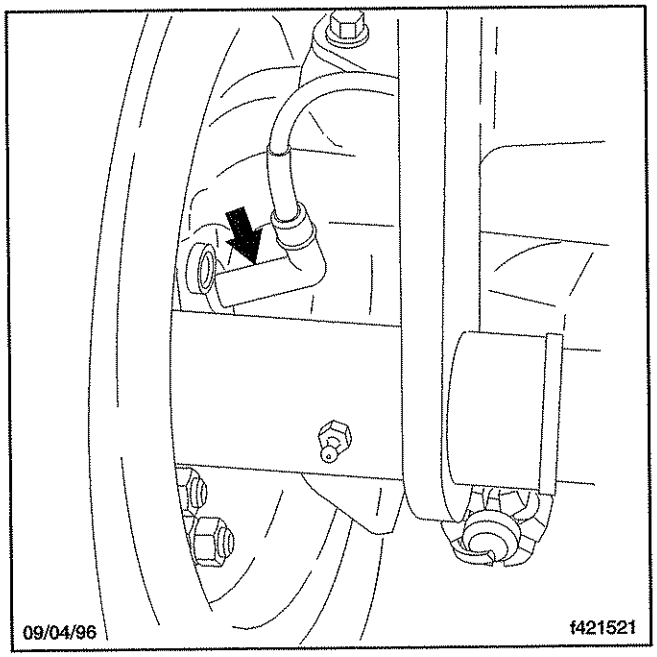


Fig. 1, Wheel Speed Sensor

9. Coat the sensor with Mobil HP, Valvoline EP 633, Penzoil 707L, or an equivalent grease. Push 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. Apply 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.
4. Remove the wheel and tire assembly from the rear axle. For instructions, see **Group 40** of this manual.
5. Remove the brake drum. For instructions, see **Group 35** of this manual.
6. Twist and pull the sensor to 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. Push the clamping bushing into the mounting block until it stops.
13. Coat the sensor with Mobil HP, Valvoline EP633, Penzoil 707L, or an equivalent grease. 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, see **Group 42** of this manual.
16. Install the wheel and tire assembly, and tighten the wheel nuts. Use the tightening sequence and torque values listed in **Group 40** of this manual.

Wheel Speed Sensor Replacement

17. Remove the safety stands, lower the vehicle, and remove the chocks from the front tires.

Modulator Assembly Replacement

Replacement

⚠ WARNING

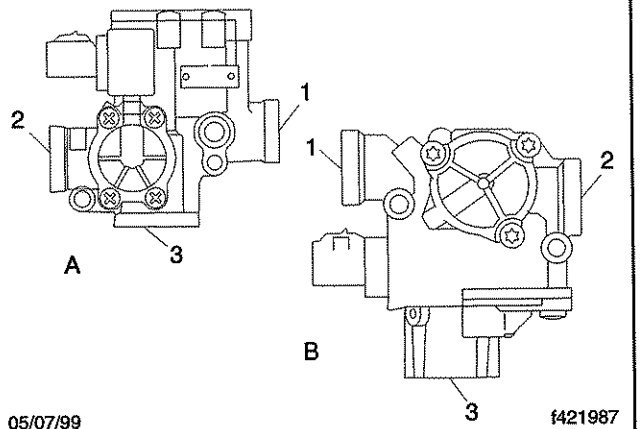
Reversal of supply and delivery air lines plumbed to the modulator could cause the vehicle brakes to lock up, and remain locked, during a hard brake application. Locked brakes may cause the vehicle to slide or cause loss of steering and/or stability, possibly resulting in vehicle damage or personal injury.

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. See **Group 54** of this manual for information on special terminals and connectors, and on ordering tools for them.

1. Chock the front and rear tires.
2. Release the pressure from the air reservoirs.
3. Disconnect the wiring from the modulator assembly.
4. Disconnect the air supply line (**Fig. 1**) and the air discharge line.

IMPORTANT: Modulator porting is reversed on the M-21 modulator.

5. Remove the two mounting capscrews and nuts.



A. M-21 Modulator
B. M-22 Modulator
1. Supply
2. Delivery
3. Exhaust

Fig. 1, M-21 and M-22 Modulator Assemblies

6. Remove the modulator assembly.
7. Position the modulator assembly and install the two mounting capscrews and nuts. Tighten the mounting nuts 18 lbf·ft (24 N·m).
8. Connect the air supply line (**Fig. 1**) and the air discharge line.

IMPORTANT: Modulator porting is reversed on the M-21 modulator.

9. Connect the wiring to the modulator assembly.
10. Remove the chocks from the front and rear tires.

Rear Axle Wheel Speed Sensor Adjustment

Adjustment

NOTE: The following adjustment procedure requires the use of special tool T11–17556–000. Use of this tool, available through the PDCs, eliminates the time-consuming task of removing the wheel and tire assembly, and the brake drum. See **Fig. 1**.

1. Park the vehicle on level ground, set the parking brake, and shut down the engine.
2. Chock the front tires.
3. Find the sensor access hole in the rear axle flange.
   - 3.1 View the brake drum and axle from the rear. The ABS sensor wiring harness should be visible passing through a hole in the 12 o'clock position.
   - 3.2 Find the S-cam at either the 3 o'clock or 9 o'clock position.
   - 3.3 Just opposite the S-cam is the sensor access hole, approximately 3/4 inch (19 mm) diameter.
4. Insert the service tool T11–17556–000 into this hole.
5. Position the slide of the tool on the axle flange to align the tool. See **Fig. 2**.
6. Tap the tool lightly with the palm of your hand. This will ensure the sensor is touching the tone wheel.
7. Remove the tool from the wheel and repeat the procedure on the other rear axle speed sensor.
8. Remove the chocks from the tires.

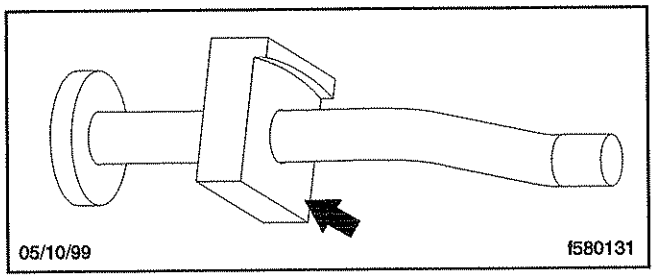
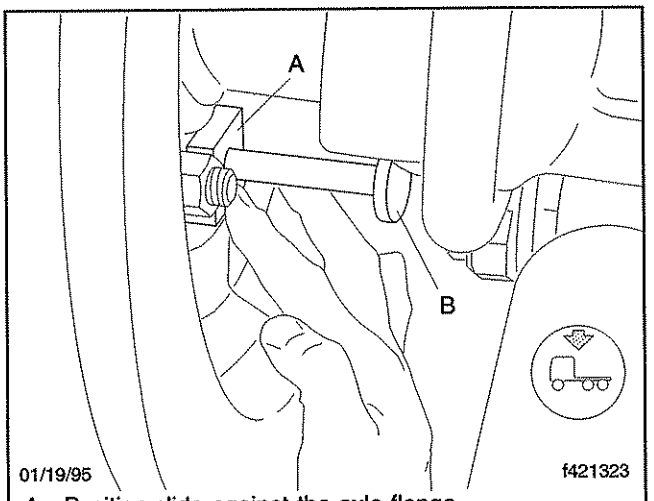


Fig. 1, ABS Sensor Adjustment Tool Slide



A. Position slide against the axle flange.
B. Tap here with your hand.

Fig. 2, Position the Tool

Using the Electronic Control Unit (ECU) Panel Lights (LEDs)

This system has built-in diagnostics to ensure that all components are operating properly. After the ignition is turned on, the tractor warning light (TRAC ABS) comes on. On vehicles with newer ECUs, the TRAC ABS light will go out shortly after the ignition is turned on. On vehicles with the older ECUs, the TRAC ABS light will stay lit until the vehicle reaches 7 mph (11 km/h). The TRAC ABS light will go out if the tractor's ABS components are working properly. See "Electronic Control Unit (ECU)" in **Subject 050** for more information. If the light stays on, or comes back on later, a problem within the ABS system has occurred. The vehicle can continue to be driven, but the ABS system could be partially or completely inoperative. However, normal braking ability is maintained. To check the type of fault code recorded, stop the vehicle and turn off the engine. Then, turn on the ignition switch, but do not start the engine. If the warning light is still on, there is a system fault that must be repaired to ensure proper system operation. Faults are displayed by the ECU panel lights. See **Fig. 1**. If the warning light is not on, an "intermittent" fault has occurred. An intermittent fault could involve a power surge, taking the system out of voltage range for a moment. In such cases, the problem basically corrects itself; the ECU memory is cleared and the system is restored to full ABS capability.

NOTE: LED lamps are not serviceable.

Following is a list of the faults displayed by the ECU panel lights (**Fig. 1**). Once a fault has been recorded, turn on the ignition switch, but do not start the engine.

- FRT (front): This red lighted display indicates the location of a malfunctioning component or its wiring. This light will always come on with either the right (RHT) or left (LFT) display light, and the modulator (MOD) or sensor (SEN) display light.
- MID (middle or forward sensed rear axle on 6S/4M systems only): This red lighted display indicates the location of a malfunctioning sensor or its wiring. This light will always come on with either the RHT or LFT display light, and the SEN display light.
- RER (rear): This red lighted display indicates the location of a malfunctioning component or its wiring. This light will always come on with either the RHT or LFT display light, and the MOD or SEN display light.
- RHT (right): This red lighted display indicates the location of a malfunctioning component or its wiring. This light will always come on with either the FRT or RER display light, and the MOD or SEN display light.
- LFT (left): This red lighted display indicates the location of a malfunctioning component or its wiring. This light will always come on with either the FRT or RER display light, and the MOD or SEN display light.
- TRC (traction control, if equipped): This red lighted display indicates a problem within the traction control system. This light may come on by itself, or with the MOD display light (indicating a problem within the automatic traction control relay valve).
- MOD (modulator): This red lighted display indicates an open or short circuit in the solenoid(s) of one of the modulators. This light will always come on with two positioning display lights RHT or LFT plus FRT or RER. The light may also come on with the TRC display light which would indicate a problem within the automatic traction control relay valve or its wiring. Also, the red MOD light will come on if:
  - The traction enable/disable switch is in the wrong position;
  - Traction engine serial communication is lost;

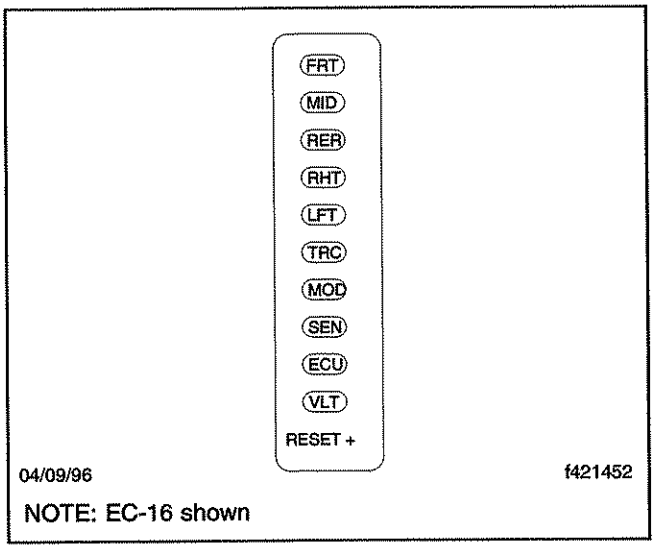


Fig. 1, ECU Panel Lights (LEDs)

Troubleshooting

– The traction solenoid is not connected or not operating properly.

- SEN (sensor): This red lighted display indicates an open or short circuit in the sensor circuit. This light will always come on with two positioning display lights RHT or LFT plus FRT, MID, or RER.
- ECU (electronic control unit): This red lighted display indicates that the ECU is inoperative.
- VLT (voltage): This green lighted display is always on during vehicle operation. The light indicates proper system voltage. If vehicle power is out of range (below 11 or above 17 volts), the light will flash until the power problem is corrected.
- RESET: Beneath the reset display is a magnetically sensitive switch used to clear fault codes and reset the ABS diagnostic system. This switch is also used to self-configure the ECU.

A system fault cannot be cleared from ECU memory until the fault is corrected. Once corrected, faults can be cleared one at a time from ECU memory. To clear a fault, pass a small magnet (capable of lifting a three ounce weight) over the RESET display on the ECU (**Fig. 1**). Once all of the lights on the ECU come on, remove the magnet. Holding the magnet against the RESET display for longer than 10 to 20 seconds could cause the ECU to go into a self-configuration mode.

Before troubleshooting, check all fuses in the control unit panel, and replace if necessary. Check the wiring to the warning lights. Refer to **Table 1**, and repair or replace the wiring as needed. Make sure that a charged 12-volt battery is available (the ABS system needs at least 11 volts to work).

IMPORTANT: The key switch must be on when doing the tests in **Table 1.**

Once a fault code has been identified, use a volt/ohmmeter to check the electrical harness at the ECU's 30-pin or 18-pin connector. See **Fig. 2** and **Fig. 3.** Touch the ohmmeter leads to the applicable terminals on the connector, not the ECU.

IMPORTANT: The ignition switch must be off when connecting or disconnecting the ECU.

Refer to the problem charts for a listing of all diagnostic panel displays (system faults), terminals to be tested, and the correct volt/ohmmeter readings. Repair or replace the components and/or wiring if the readings are not correct.

NOTE: If a dealer has Freightliner Service Link, fault code information can be read from Service Link. For more information, see **Service Bulletin 00-20.**

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals.

See **Group 54** of this manual for information on special terminals and connectors, and for information on ordering tools for them.

See the appropriate wiring diagram in **Specifications, 400** when troubleshooting the ABS system.

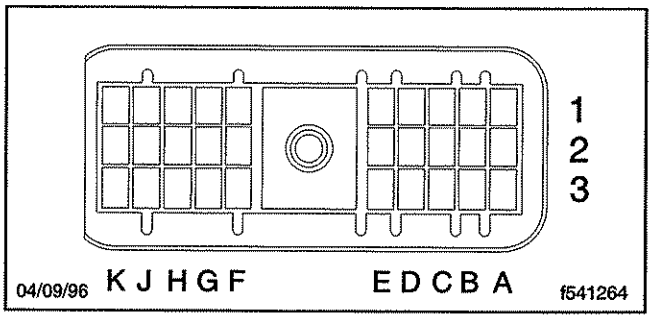


Fig. 2, 30-Pin Connector, Terminal View

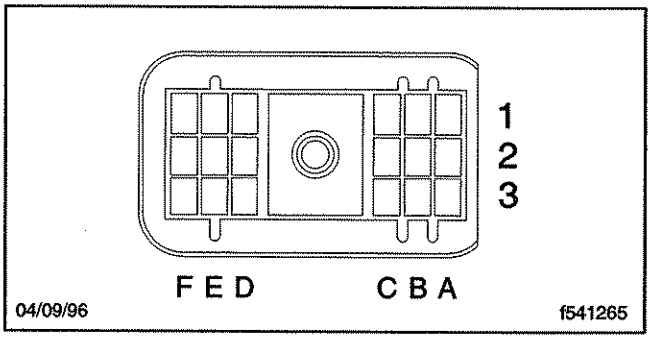


Fig. 3, 18-Pin Connector, Terminal View

Troubleshooting

– The traction solenoid is not connected or not operating properly.

- SEN (sensor): This red lighted display indicates an open or short circuit in the sensor circuit. This light will always come on with two positioning display lights RHT or LFT plus FRT, MID, or RER.
- ECU (electronic control unit): This red lighted display indicates that the ECU is inoperative.
- VLT (voltage): This green lighted display is always on during vehicle operation. The light indicates proper system voltage. If vehicle power is out of range (below 11 or above 17 volts), the light will flash until the power problem is corrected.
- RESET: Beneath the reset display is a magnetically sensitive switch used to clear fault codes and reset the ABS diagnostic system. This switch is also used to self-configure the ECU.

A system fault cannot be cleared from ECU memory until the fault is corrected. Once corrected, faults can be cleared one at a time from ECU memory. To clear a fault, pass a small magnet (capable of lifting a three ounce weight) over the RESET display on the ECU (**Fig. 1**). Once all of the lights on the ECU come on, remove the magnet. Holding the magnet against the RESET display for longer than 10 to 20 seconds could cause the ECU to go into a self-configuration mode.

Before troubleshooting, check all fuses in the control unit panel, and replace if necessary. Check the wiring to the warning lights. Refer to **Table 1**, and repair or replace the wiring as needed. Make sure that a charged 12-volt battery is available (the ABS system needs at least 11 volts to work).

IMPORTANT: The key switch must be on when doing the tests in **Table 1.**

Once a fault code has been identified, use a volt/ohmmeter to check the electrical harness at the ECU's 30-pin or 18-pin connector. See **Fig. 2** and **Fig. 3.** Touch the ohmmeter leads to the applicable terminals on the connector, not the ECU.

IMPORTANT: The ignition switch must be off when connecting or disconnecting the ECU.

Refer to the problem charts for a listing of all diagnostic panel displays (system faults), terminals to be tested, and the correct volt/ohmmeter readings. Repair or replace the components and/or wiring if the readings are not correct.

NOTE: If a dealer has Freightliner Service Link, fault code information can be read from Service Link. For more information, see **Service Bulletin 00-20.**

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals.

See **Group 54** of this manual for information on special terminals and connectors, and for information on ordering tools for them.

See the appropriate wiring diagram in **Specifications, 400** when troubleshooting the ABS system.

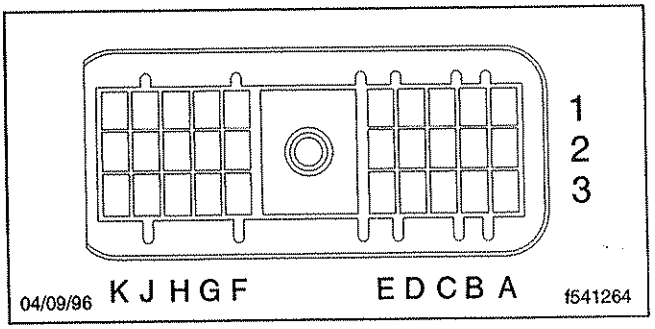


Fig. 2, 30-Pin Connector, Terminal View

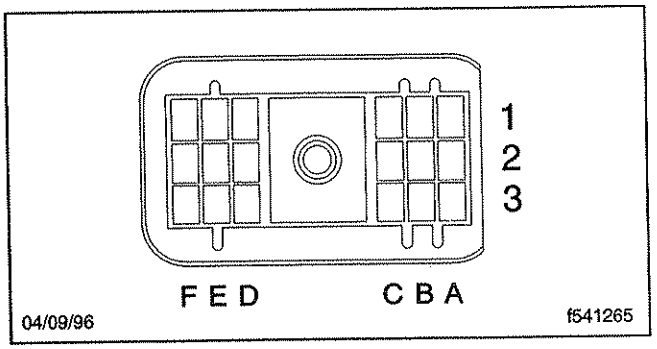


Fig. 3, 18-Pin Connector, Terminal View

Warning Lamp Wiring Check				
Wiring Tested	**Test These Pins**	**Volt/Ohmmeter Reading**	**Possible Cause**	**Remedy**
Tractor Warning (TRAC ABS) Light	On the 30-pin connector, pins E3 and A1, E3 and A2, and E3 and A3.	Voltage should be the same as battery voltage.	Wiring to the light is shorted or open; or the bulb needs replacing.	Repair the wiring, or replace the bulb.
WHL SPIN Light (if equipped with ATC)	On the 30-pin connector, pin C2.			

Table 1, Warning Lamp Wiring Check

Problem—Battery Voltage is Too Low or Too High (Green VLT LED is Flashing)

Problem—Battery Voltage is Too Low or Too High (Green VLT LED is Flashing)	
Possible Cause	**Remedy**
Damaged ECU or unsatisfactory battery voltage and wiring continuity	If VLT or ECU is displayed, test the voltage on the 30-pin connector between battery terminals B1, K2, K3, and ground terminals A1, A2, and A3. Voltage between the terminals should be 11 to 17 volts. If the voltage readings are okay, replace the ECU. If the voltage readings are incorrect, check the battery voltage and wiring continuity. Repair or replace as needed.

Problem—Sensor Out of Adjustment, Wheel Speed Erratic, or Sensor Circuit Damage (Red SEN LED is On)

Problem—Sensor Out of Adjustment, Wheel Speed Erratic, or Sensor Circuit Damage (Red SEN LED is On)	
Possible Cause	**Remedy**
Damage to the tone wheel, wheel sensor, and/or sensor wiring to the ECU on the axle	If RHT or LFT and FRT plus SEN is displayed, measure the resistance on the 30-pin connector between terminals J1 and J2 (left front), and H2 and H3 (right front). If the readings are not 1500 to 2500 ohms, measure the resistance between the terminals at the sensor. Repair or replace as needed. If RHT or LFT and RER plus SEN is displayed, measure the resistance on the 18-pin connector between terminals F2 and F3 (left rearmost), and E2 and E3 (right rearmost). If the readings are not 1500 to 2500 ohms, measure the resistance between the terminals at the sensor. Repair or replace as needed. If RHT or LFT and MID plus SEN is displayed on the 18-pin connector, measure the resistance between terminals C2 and C3 (left rear), and B2 and B3 (right rear). If the readings are not 1500 to 2500 ohms, measure the resistance between the terminals at the sensor. Repair or replace as needed.
A sensor may be out of adjustment, or there is excessive hub runout	
Tire size is mismatched	Repair or replace as needed.

Troubleshooting

Problem—Open or Short Circuit in the Modulator, and/or Wiring to the Ground Connection (Red MOD LED is On)

Problem—Open or Short Circuit in the Modulator, and/or Wiring to the Ground Connection (Red MOD LED is On)	
Possible Cause	**Remedy**
Damage to the modulator valve and cab wiring connections on the axle	If RHT or LFT and FRT plus MOD is displayed, measure the resistance on the 30-pin connector between terminals G1 and H1 (left front), C1 and D1 (right front), F1 and H1 (left front), and C1 and E1 (right front). The resistance between the terminals should read 3.5 to 5.0 ohms. Measure the resistance between terminals G1 and F1 (left front), and D1 and E1 (right front). Resistance between the terminals should read 7 to 10 ohms. Also, there should be no continuity between any of the previously referenced terminals, and ground terminals A1, A2, A3, and J3. If the above readings are not correct, check the resistance between the pins at the modulator valve (see **Fig. 4**). Resistance between pins A and B, and B and C should be 3.5 to 5.0 ohms. Resistance between pins A and C should be 7 to 10 ohms. There should be no continuity between any of these pins and ground. Repair or replace as needed. If RHT or LFT and RER plus MOD is displayed, measure the resistance on the 18-pin connector between terminals E1 and F1 (left rear), A1 and B1 (right rear), D1 and F1 (left rear), and A1 and C1 (right rear). Resistance should read 3.5 to 5.0 ohms. Measure the resistance between terminals D1 and E1 (left rear), and B1 and C1 (right rear). Resistance between the terminals should read 7 to 10 ohms. Also, there should be no continuity between any of the previously referenced terminals, and ground terminals A1, A2, A3, and J3. If the above readings are not correct, check the resistance between the pins at the modulator valve (see **Fig. 4**). Resistance between pins A and B, and B and C should be 3.5 to 5.0 ohms. Resistance between pins A and C should be 7 to 10 ohms. There should be no continuity between any of these pins and ground. Repair or replace as needed.

Problem—Open or Short Circuit in the Traction Control Relay Valve and/or Wiring to the Ground Connection (Red TRC LED and Red MOD LED are On)

Problem—Open or Short Circuit in the Traction Control Relay Valve and/or Wiring to the Ground Connection (Red TRC LED and Red MOD LED are On)	
Possible Cause	**Remedy**
Open or shorted circuit in the traction control relay valve and/or cab wiring connections	If TRC and MOD is displayed, measure the resistance on the 18-pin connector between terminals D2 and D3. Resistance between the terminals should be 10 to 12 ohms. Check continuity at the 30-pin connector between terminals A1, A2, A3, and terminals D2 and D3. There should be no continuity between these terminals. If the above readings are not correct, check the resistance between the pins at the connector at the relay valve. Resistance between the pins should be 10 to 12 ohms. There should be no continuity between ground pins A1, A2, and A3 (on the 30-pin connector), and the pins D2 and D3 at the valve connector. Repair or replace as needed.

Troubleshooting

Problem—Open or Short Circuit in the Modulator, and/or Wiring to the Ground Connection (Red MOD LED is On)

Problem—Open or Short Circuit in the Modulator, and/or Wiring to the Ground Connection (Red MOD LED is On)	
Possible Cause	**Remedy**
Damage to the modulator valve and cab wiring connections on the axle	If RHT or LFT and FRT plus MOD is displayed, measure the resistance on the 30-pin connector between terminals G1 and H1 (left front), C1 and D1 (right front), F1 and H1 (left front), and C1 and E1 (right front). The resistance between the terminals should read 3.5 to 5.0 ohms. Measure the resistance between terminals G1 and F1 (left front), and D1 and E1 (right front). Resistance between the terminals should read 7 to 10 ohms. Also, there should be no continuity between any of the previously referenced terminals, and ground terminals A1, A2, A3, and J3. If the above readings are not correct, check the resistance between the pins at the modulator valve (see **Fig. 4**). Resistance between pins A and B, and B and C should be 3.5 to 5.0 ohms. Resistance between pins A and C should be 7 to 10 ohms. There should be no continuity between any of these pins and ground. Repair or replace as needed. If RHT or LFT and RER plus MOD is displayed, measure the resistance on the 18-pin connector between terminals E1 and F1 (left rear), A1 and B1 (right rear), D1 and F1 (left rear), and A1 and C1 (right rear). Resistance should read 3.5 to 5.0 ohms. Measure the resistance between terminals D1 and E1 (left rear), and B1 and C1 (right rear). Resistance between the terminals should read 7 to 10 ohms. Also, there should be no continuity between any of the previously referenced terminals, and ground terminals A1, A2, A3, and J3. If the above readings are not correct, check the resistance between the pins at the modulator valve (see **Fig. 4**). Resistance between pins A and B, and B and C should be 3.5 to 5.0 ohms. Resistance between pins A and C should be 7 to 10 ohms. There should be no continuity between any of these pins and ground. Repair or replace as needed.

Problem—Open or Short Circuit in the Traction Control Relay Valve and/or Wiring to the Ground Connection (Red TRC LED and Red MOD LED are On)

Problem—Open or Short Circuit in the Traction Control Relay Valve and/or Wiring to the Ground Connection (Red TRC LED and Red MOD LED are On)	
Possible Cause	**Remedy**
Open or shorted circuit in the traction control relay valve and/or cab wiring connections	If TRC and MOD is displayed, measure the resistance on the 18-pin connector between terminals D2 and D3. Resistance between the terminals should be 10 to 12 ohms. Check continuity at the 30-pin connector between terminals A1, A2, A3, and terminals D2 and D3. There should be no continuity between these terminals. If the above readings are not correct, check the resistance between the pins at the connector at the relay valve. Resistance between the pins should be 10 to 12 ohms. There should be no continuity between ground pins A1, A2, and A3 (on the 30-pin connector), and the pins D2 and D3 at the valve connector. Repair or replace as needed.

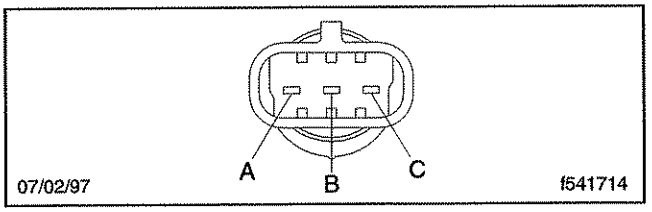


Fig. 4, Modulator Valve Connector Pin Identification

Problem—J 1922 Electronic Engine Data Link is Not Working Properly (Red TRC LED is On)

Problem—J 1922 Electronic Engine Data Link is Not Working Properly (Red TRC LED is On)	
Possible Cause	**Remedy**
Damage to the data link and/or data link wiring	If TRC is displayed, check for continuity between terminals B2 and B3 on the 30-pin connector, and the two corresponding terminals on the engine's electronic control module. Repair or replace as needed.

Contents

Subject	Subject Number
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General Description

DURAPARK® rear hydraulic drum brakes are self-adjusting and include a parking brake function as an integral part of the brake assembly. Each DURAPARK brake consists of a backing plate, two brake shoes and lining assemblies, an adjuster cylinder, and a park cylinder. See **Fig. 1**.

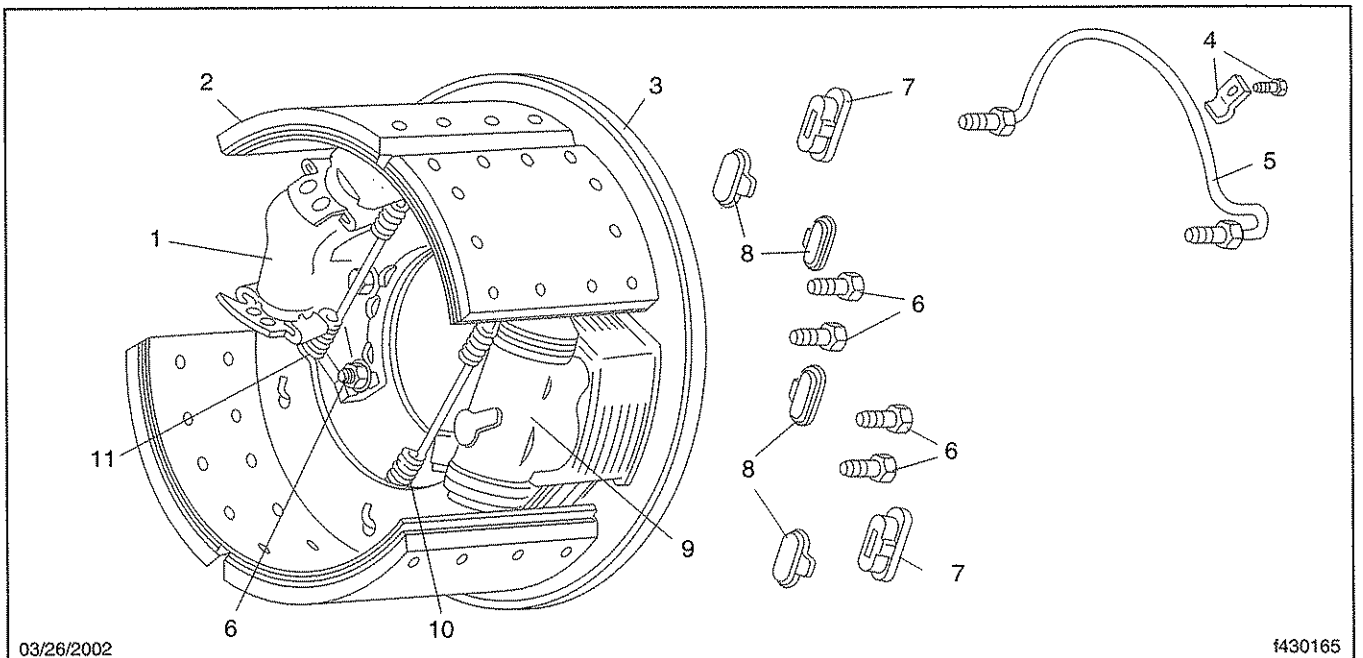
IMPORTANT: The figures in this subject illustrate installation of brakes on vehicles with spring suspensions. On vehicles with Freightliner AirLiner suspensions, the park cylinder and adjuster cylinder positions are reversed. See **Fig. 2**.

The two cylinders are conventional wheel cylinders with special functions. The adjuster cylinder contains automatic adjusters that maintain the shoe-to-drum clearance within a specified range. The park cylinder applies and releases the brake shoes for parking.

The backing plate has six mounting holes:

- Two lining inspection holes allow for inspection and measurement of the shoe-to-drum clearance.
- Two adjuster slots provide access to the manual override wheel of the adjuster cylinder to increase or decrease the shoe-to-drum clearance. This should only be needed to set a specific shoe-to-drum clearance during initial installation or for backing the shoes off to enable a lipped drum to be removed.
- Two adjuster sight holes are used to make sure the adjusting tool is inserted in the adjusting slot correctly without damaging the dust boot on the cylinder.

NOTE: There are more than six total holes in the backing plate. Additional holes are used for mounting the ABS sensor on some applications.

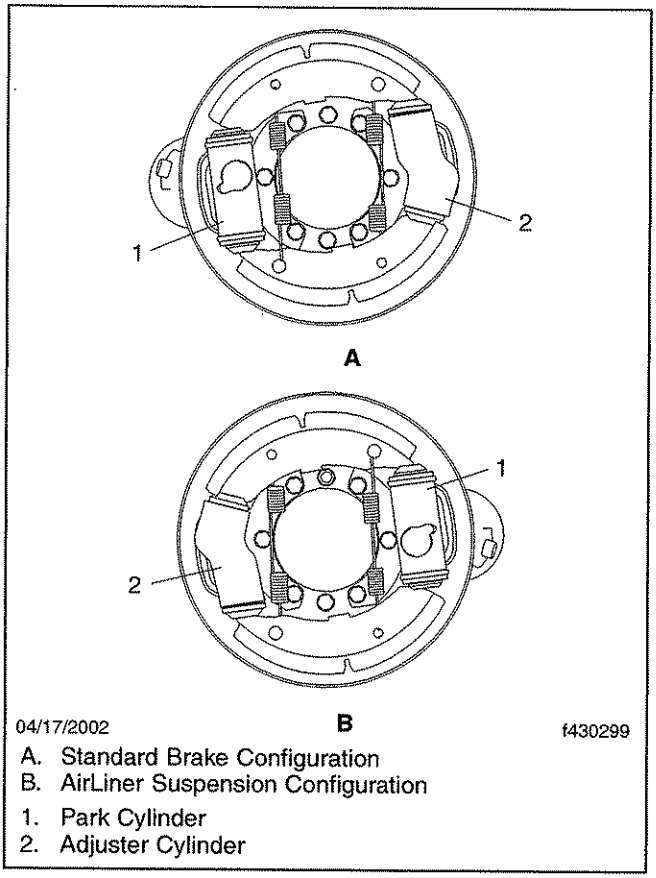


NOTE: Brake configuration for spring suspensions shown.

1. Adjuster Cylinder Assembly
2. Brake Shoe and Lining
3. Backing Plate
4. Retaining Clip and Screw
5. Bridge Pipe
6. Cylinder Mounting Bolts, 7/32-inch
7. Manual Override Access Plug
8. Inspection Plugs
9. Park Cylinder Assembly
10. Return Spring, Orange or White
11. Return Spring, Green or Yellow

Fig. 1, DURAPARK Rear Hydraulic Drum Brake Assembly

General Information



A. Standard Brake Configuration
B. AirLiner Suspension Configuration
1. Park Cylinder
2. Adjuster Cylinder

Fig. 2, DURAPARK Brake Configurations

Principles of Operation

Service Brake Operation

The adjuster and park cylinders are connected to each other through a bridge pipe. As a result, increasing the hydraulic pressure in one also increases the pressure in the other.

When the brake pedal is applied, increased hydraulic pressure in the adjuster cylinder forces two pistons outward, moving one end of each shoe toward the drum. At the same time, increased pressure in the park cylinder forces its pistons outward, moving the other end of each shoe toward the drum.

When the shoes contact the drum, they are forced around in whichever direction the drum is moving until the pistons stop against the cylinder body. Thus, regardless of forward or reverse rotation, the brake is always a two leading-shoe brake.

In the forward direction the torque load is taken by one adjuster cylinder piston bottoming in its bore, and by the park cylinder abutment piston head resting against the cylinder body. In the reverse direction, the torque is taken by the other adjuster cylinder piston bottoming and the expander piston head resting against the park cylinder body.

Parking Brake Operation

When the parking brakes are applied, the hydraulic pressure in the spring chamber is released. A spring in the parking brake chamber then forces a wedge and roller assembly into the park cylinder and forces the pistons outward, pressing the shoes against the drums.

Automatic Adjustment

In the DURAPARK brake, automatic adjustment is carried out by the adjuster cylinder. The adjuster cylinder contains two adjuster units, each unit individually adjusting the appropriate shoe. The clearance between the shoe and the drum is governed by the axial clearance (backlash) built into each adjuster mechanism.

Automatic brake shoe adjustment as the lining material wears has important advantages:

- An optimum shoe-to-drum clearance is maintained.
- Response time of the brake is kept to a minimum.
- Hydraulic brake fluid movement is kept to a minimum.
- Excessive taper wear of the lining along the shoe is avoided and lining life maximized.
- Vehicle downtime for adjustment is eliminated.

Although DURAPARK brakes adjust automatically and maintain the shoe-to-drum clearance within a specified range, correct and full adjustment occurs only when the drum is rotating. Pumping the brake pedal with the vehicle stationary will not achieve the proper adjustment.

⚠ WARNING

Wear a respirator at all times when servicing the brakes, starting with the removal of the wheels and continuing through assembly. Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by MSHA or NIOSH.

⚠ WARNING

Hydraulic brake fluid is hazardous, and can cause blindness if it gets in your eyes. Always wear safety glasses when handling brake fluid or bleeding brake components. Brake fluid may also be a skin irritant. If you get it on your skin, wash it off as soon as possible.

Safety Precautions

Medical experts believe that long-term exposure to some brake lining fibers could be a health hazard, so the following precautions should be observed when servicing all brake linings.

Areas where brake work is done should be separate from other operations, if possible. As required by regulations, the entrance to the areas should have a sign displayed indicating the health hazard.

During brake servicing, an air purifying respirator with high-efficiency filters must be worn. The respirator and filter must be approved by MSHA or NIOSH, and worn during all procedures.

OSHA recommends that enclosed cylinders equipped with vacuums and high-efficiency (HEPA) filters be used during brake repairs. Under this system, the entire brake assembly is placed within the cylinder and the mechanic works on the brake through sleeves attached to the cylinder. Compressed air is blown into the cylinder to clean the assembly, and the dirty air is then removed from the cylinder by the vacuum.

If such an enclosed system is not available, the brake assembly must be cleaned in the open air. During disassembly, carefully place all parts on the floor to minimize creating airborne dust. Using an industrial vacuum cleaner with a HEPA filter system, remove dust from the brake drums, brake backing plates, and brake parts. After vacuuming, any remaining dust should be removed using a rag soaked in water and wrung until nearly dry. Do not use compressed air or dry brushing to clean the brake assembly.

Work areas should be cleaned by industrial vacuums with HEPA filters or by wet wiping. Compressed air or dry sweeping should never be used for cleaning. Respirators should be used when emptying vacuum cleaners and handling asbestos waste products.

Special care must be taken when disposing of used brake fluid. Put the fluid in a sealed plastic container and label it "Used Brake Fluid." Then dispose of it in an approved manner. Check with local and state regulations as to the correct disposal procedure.

Brake Shoe Removal and Installation

Removal

⚠ WARNING

Before doing this procedure, read the information in Safety Precautions 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Park the vehicle on a level surface and chock the front tires.
2. Make sure the parking brakes are released. Releasing the parking brakes pressurizes the spring chambers and compresses the parking brake springs. The engine must be running while the parking brakes are released.

⚠ WARNING

When work is being done on the spring chamber, carefully follow the service instructions of the chamber manufacturer. The sudden release of a compressed spring can cause serious personal injury.

3. Carefully cage and lock the springs so that the springs cannot actuate during disassembly.
4. Set the parking brakes to release the parking brake system pressure, then shut down the engine.
5. Raise the rear axle and place safety stands under the frame or axle. Be sure the stands will support the weight of the vehicle.
6. Remove the wheels. For instructions, see **Section 40.00**, Subject 100.
7. Remove six rubber plugs from the backing plate. See **Fig. 1**.
   - two lining inspection hole plugs
   - two adjustment slot plugs
   - two adjuster sight hole plugs

⚠ CAUTION

When backing off the brake shoes, brake fluid will be displaced from the adjuster cylinder bore. Make sure this action does not displace other pistons on the axle.

IMPORTANT: The adjustment procedures in this subject are for vehicles with spring suspensions. On vehicles with Freightliner AirLiner suspensions, the park cylinder and adjuster cylinder positions are reversed. Therefore, the adjustment procedure should be adjusted accordingly when working on a vehicle with AirLiner suspensions.

8. Back off the brake shoes.

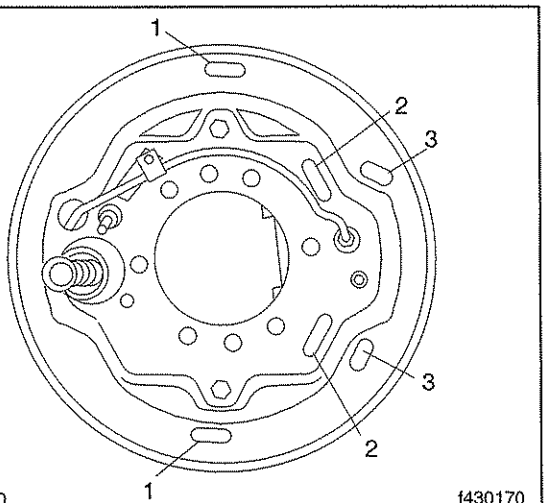
⚠ CAUTION

Take care not to damage the dust boot with the adjusting tool.

8.1 Insert the adjusting tool (OTC part number D90T-2588-AR) in the upper adjustment slot in the backing plate. See **Fig. 3**.

IMPORTANT: A 1/16-inch gap must exist between the override wheel assembly and the dust boot. See **Fig. 2**. The 1/16-inch gap is necessary to ensure that the internal adjuster does not bottom-out in the piston, as this will prevent the adjust from operating.

8.2 With the brake shoes and return springs in place, manually back off (de-adjust) the



1. Lining Inspection Hole
2. Adjustment Slot
3. Adjuster Sight Hole

Fig. 1, Backing Plate Access Holes

Brake Shoe Removal and Installation

upper brake shoe by pushing the adjusting tool to the right.

Back off the shoe enough to ensure that any drum lip will clear the brake shoes during drum removal. View the clearance through the lining inspection holes.

8.3 Move the adjusting tool to the lower adjustment slot.

8.4 Back off the lower brake shoe by pushing the adjustment tool to the left.

9. Remove the brake drums. For instructions, see **Section 35.01**, Subject 100.

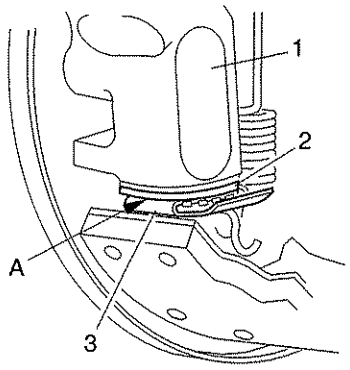
⚠ CAUTION

Do not apply service or parking brakes after the brake drums are removed. The unrestricted brake shoe movement may damage the cylinders.

IMPORTANT: Additional de-adjustment can be done at this time before the brake shoes are removed. Once the shoes are removed, the previous procedure cannot be used to de-adjust the adjuster cylinder.

⚠ CAUTION

When removing the brake shoes, do not allow the brake shoe assembly to contact the dust boots on the adjuster or park cylinder. To do so could damage the boots.



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A. 1/16-inch gap between override wheel assembly and dust boot.
1. Adjuster Cylinder
2. Dust Boot
3. Override Wheel Assembly

Fig. 2, Gap Measurement at Cylinder

10. Remove the brake shoes. Vehicles with rotated brakes are those equipped with AirLiner suspensions.

10.1 Place a durable load plate (at least 4 x 1 x 1/8-inch) against the brake lining on the adjuster cylinder end of the upper shoe (lower shoes on rotated brake). See **Fig. 4**.

10.2 Using a 12-inch (or larger) adjustable wrench to grip the shoe and load plate, lift the upper shoe (lower shoe for rotated brake) out of the slot on the top of the adjuster cylinder.

10.3 Rotate the shoe slightly outboard, then lower it with the shoe web resting as far down on the protective shield (next to the slot) as possible. This reduces the tension on the spring for the next step. Remove the wrench and load plate.

10.4 Insert the spring tool, OTC part number 7462 or equivalent (**Fig. 5**), in the loop on the lower end of the adjuster cylinder return spring. See **Fig. 6**. Unhook the spring from the lower shoe.

10.5 Place the load plate against the brake lining on the park cylinder end of the lower shoe (upper shoe for rotated brake).

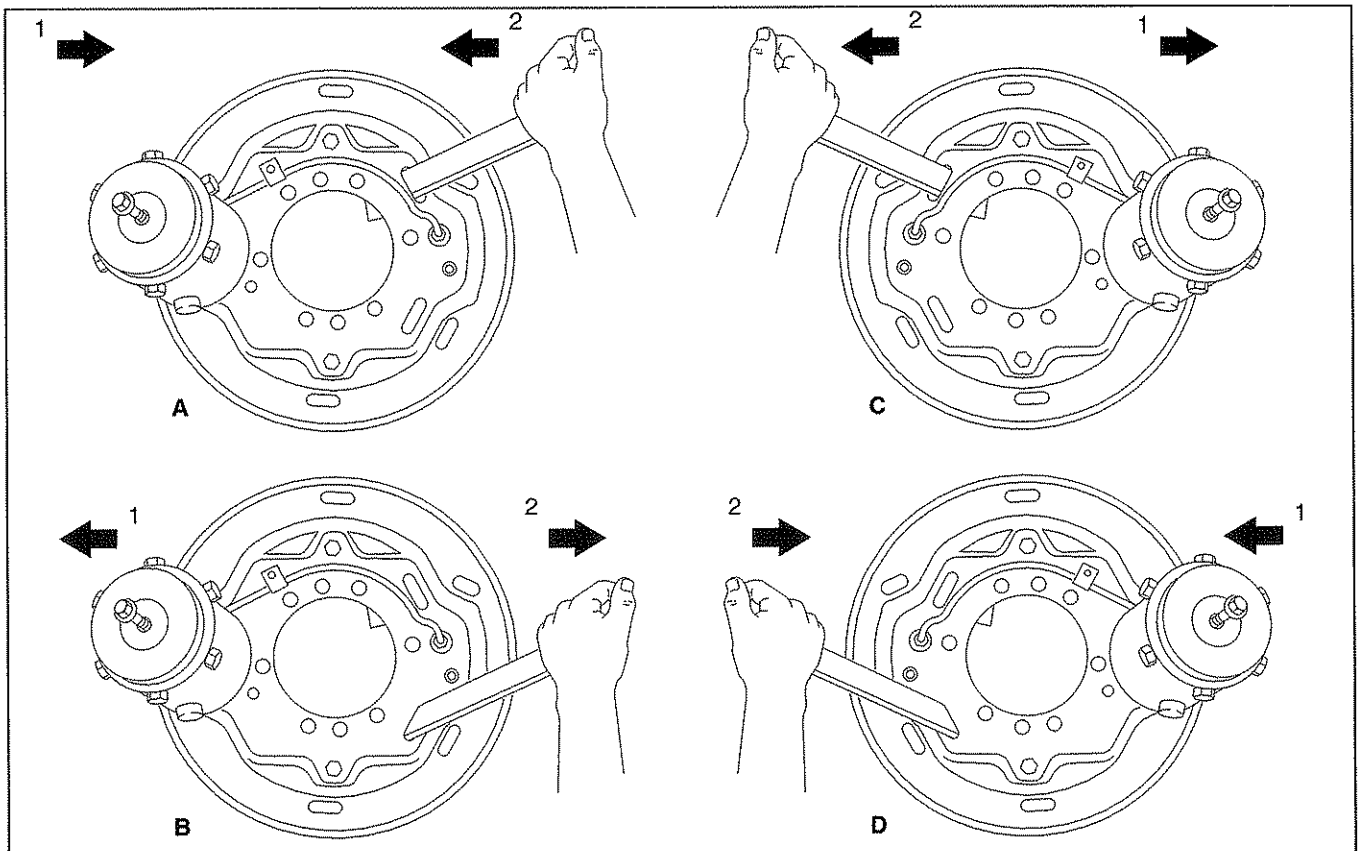
⚠ CAUTION

Do not allow the brake shoe or web to contact the dust boot on the park cylinder. To do so could damage the boot.

10.6 Using the adjustable wrench to grip the lower shoe (upper shoe for rotated brake) and load plate, lower the shoe out of the slot on the bottom of the park cylinder.

10.7 Rotate the shoe outboard, then place the shoe on the end of the park cylinder. Remove the wrench and load plate.

10.8 While supporting the lower shoe (upper shoe for rotated brake), unhook the lower end of the park cylinder return spring. Remove the lower shoe (upper shoe for rotated brake).



NOTE: Arrows on the back plate indicate the adjustment direction.

A. Left wheel, upper shoe
B. Left wheel, lower shoe
C. Right wheel, upper shoe
D. Right wheel, lower shoe

1. Increase Lining-to-Drum Clearance
2. Decrease Lining-to-Drum Clearance

Fig. 3, Brake Shoe Adjustment (vehicles with spring suspensions)

10.9 Remove the upper shoe (lower shoe for rotated brake).

IMPORTANT: Do not de-adjust the adjuster cylinder with the shoes removed. If further de-adjustment is required, contact your district service manager for technical support.

11. Remove and discard the return springs.

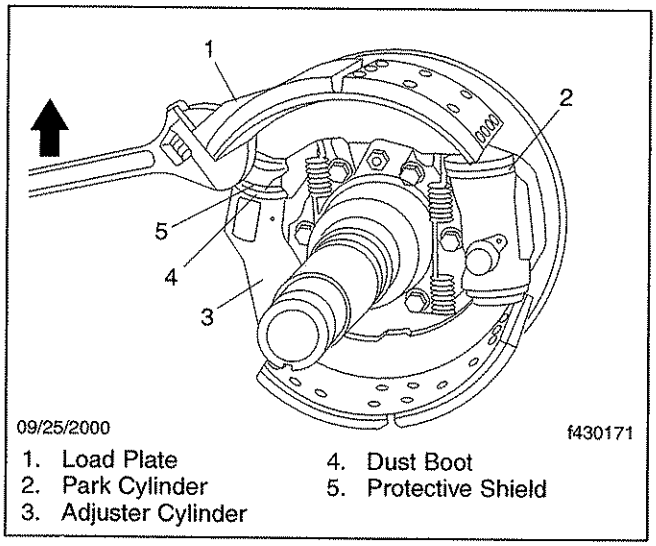
12. Secure both lower pistons to pervent them from falling out of the housing.

13. Inspect the dust boots for damage; replace as needed. The dust boots can be replaced without removing either cylinder from the backing plate.

- To replace a dust boot on the park cylinder, remove and replace the dust boot on the top (expander) piston or bottom (abutment) piston. No disassembly is required.
- To replace a dust boot on the adjuster cylinder, remove the slotted cap (manual override wheel assembly) from the applicable end of the adjuster cylinder. See **Fig. 7**.

  The manual override wheels are snapped onto the pistons. Pull to remove, being careful not to remove the piston. Install a new dust boot and snap the cap back on the housing.

Brake Shoe Removal and Installation



1. Load Plate
2. Park Cylinder
3. Adjuster Cylinder
4. Dust Boot
5. Protective Shield

Fig. 4, Lift Upper Brake Shoe

14. Inspect the brake shoes and linings for wear or damage. For instructions, see **Subject 120.**

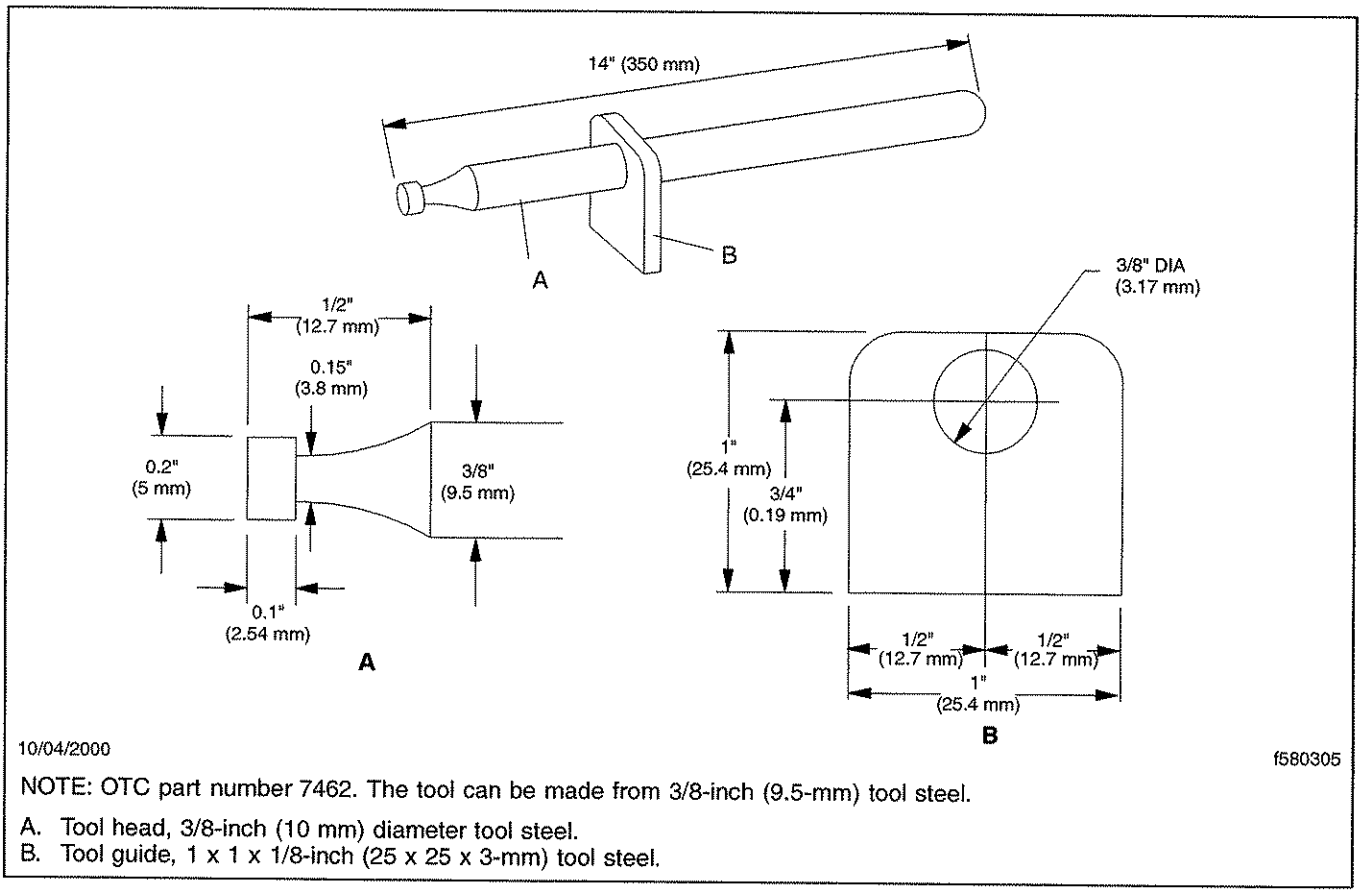
Installation

⚠ WARNING

When installing new brake shoes, always install new return springs. Also, turn or replace the drums according to the manufacturer's recommendations.

IMPORTANT: Use the same brake series on both ends of the axle.

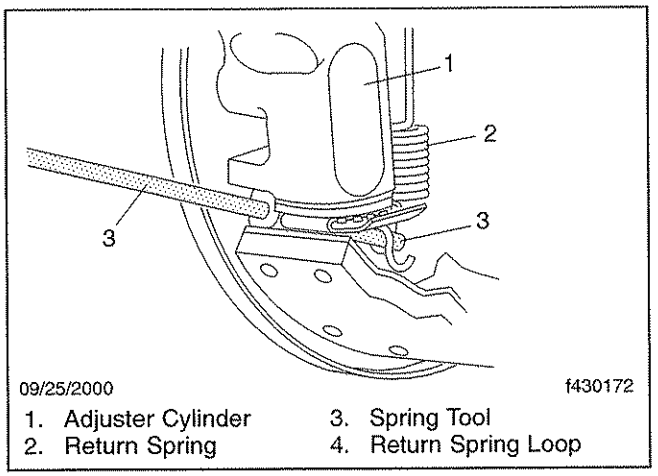
1. Arrange the brake shoe assemblies on the floor in the positions you will view them on the vehicle. See **Fig. 8.** Although all four shoes are identical, they are not symmetrical and must be correctly oriented to the adjuster and park cylinders.



NOTE: OTC part number 7462. The tool can be made from 3/8-inch (9.5-mm) tool steel.

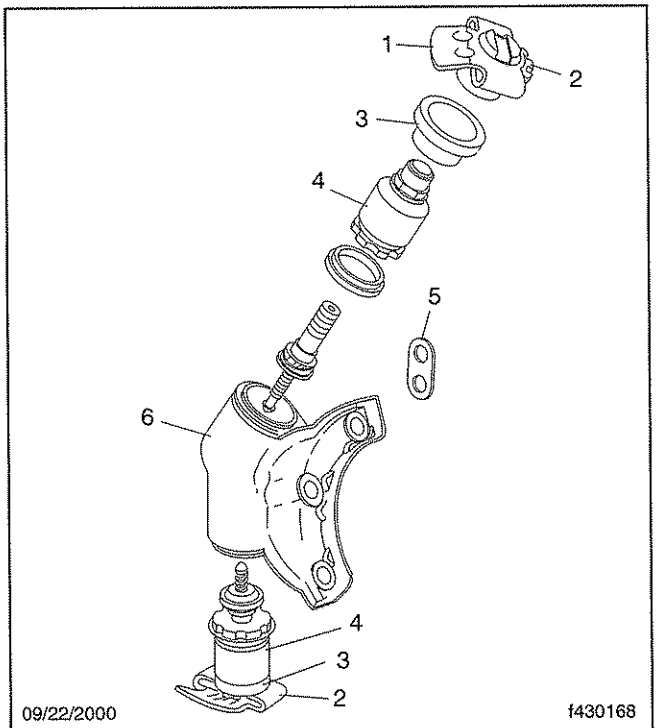
A. Tool head, 3/8-inch (10 mm) diameter tool steel.
B. Tool guide, 1 x 1 x 1/8-inch (25 x 25 x 3-mm) tool steel.

Fig. 5, Spring Tool



1. Adjuster Cylinder
2. Return Spring
3. Spring Tool
4. Return Spring Loop

Fig. 6, Unhook the Return Spring



1. Protective Shield
2. Slotted Cap (Manual Override Wheel Assembly)
3. Dust Boot
4. Piston
5. Gasket
6. Housing

Fig. 7, Adjuster Cylinder

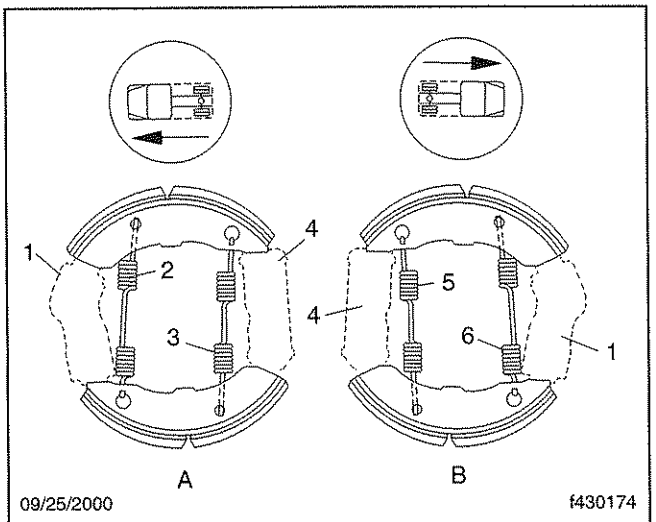
2. Hook the return springs in the upper shoe from the underside of the web. Leave the bottom of the springs free.
3. Install the brake shoes.

   3.1 Lift the upper shoe and springs. Place the shoe webs in the slots on the top of the adjuster and park cylinders.

   NOTE: The following is a seesaw procedure to provide anchor points for installing the return springs.

   3.2 Hold the lower shoe near (not under) the park cylinder and install the free end of the return spring in the lower shoe web.

   3.3 Place the other end of the lower shoe web in the slot on the bottom of the adjuster cylinder.



NOTE: If the springs cannot be identified by color, the springs with a loop at the bottom are next to the adjuster cylinders and the straight center section of the spring is closest to the front of the vehicle. When the top J-hook on a park cylinder spring is installed, the opening in the lower hook faces forward.

A. Left-side brake.
B. Right-side brake.
1. Adjuster Cylinder
2. Green Return Spring
3. Orange Return Spring
4. Park Cylinder
5. White Return Spring
6. Yellow Return Spring

Fig. 8, Brake Shoe Assembly Orientation (spring suspensions)

Brake Shoe Removal and Installation

3.4 Place the load plate against the brake lining on the park cylinder end of the lower shoe.

3.5 Using the adjustable wrench to grip the lower shoe and load plate, press the shoe down far enough to place the web in the slot on the bottom of the park cylinder.

3.6 Move the load plate to the adjuster cylinder end of the lower shoe.

3.7 Using the adjustable wrench, press the shoe down just far enough to remove the web from the slot on the bottom of the adjuster cylinder. Allow the web to rest against the protective shield at the base of the adjuster cylinder.

3.8 Insert the spring tool in the loop at the bottom of the return spring. See **Fig. 6**. Hook the return spring in the lower shoe web.

3.9 Using the load plate and adjustable wrench, press the shoe down and place the web in the slot on the bottom of the adjuster cylinder again.

4. Install the brake drums. For instructions, see **Section 35.01**, Subject 100.

⚠ WARNING

Always wear safety glasses when handling brake fluid or bleeding brake components. Hydraulic brake fluid is hazardous and can cause blindness if it gets in your eyes. Brake fluid may also be a skin irritant. If you get it on your skin, wash it off as soon as possible.

IMPORTANT: Use only new brake fluid.

5. Fill the master cylinder reservoir, if needed, with new brake fluid that meets DOT 3 specifications. Cover the reservoir.

6. Make two slow, hard applications of the brake foot pedal to center the shoes. Repeat before each evaluation of the shoe-to-drum clearance.

7. Manually adjust the upper and lower shoes. See **Subject 160** for instructions.

8. Start the engine and check the brake pedal travel. If the pedal travel is excessive, shut down the engine and bleed the hydraulic system. For instructions, see **Subject 170**.

9. Install the six rubber plugs in the backing plate.

10. Start the engine and run it long enough to pressurize the parking brake system. The parking brake should still be in the released position. Shut down the engine.

11. Manually uncage the power spring in the parking brake chamber. For instructions, refer to the applicable brake chamber section in this manual.

12. Install the wheels. For instructions, see **Section 40.00**, Subject 100.

13. Rotate each wheel by hand to verify that the parking brakes are fully released.

14. Apply the parking brake and check that the wheels cannot be rotated by hand.

15. Remove the safety stands, lower the vehicle, and remove the chocks from the tires.

⚠ WARNING

Do not operate the vehicle until the brakes have been adjusted and checked for proper operation. To do so could result in inadequate or no braking ability, which could cause personal injury or death, and property damage.

16. Before you put the vehicle in service, check for proper brake operation in a safe area.

16.1 Start the engine and release the parking brake.

16.2 Apply and release the brakes several times to check for leaks and proper operation.

16.3 Perform several low-speed stops to ensure correct parts replacement and full vehicle control.

Inspection

⚠ WARNING

Before starting this procedure, read the information in Safety Precautions 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

1. Remove the rear brake shoes. Refer to **Subject 110** for instructions.
2. Inspect the rear brake shoe linings. If the linings are grease- or oil-soaked, cracked, or worn to the lining wear groove, replace them.

NOTE: The lining wear groove is approx. 3/8-inch (9.5 mm) thick.

3. Check the shoes for bent or cracked webs or tables, broken welds, loose rivets, or out-of-round rivet holes. Replace the shoes if any of these conditions exist.

Replacement

⚠ WARNING

Before starting this procedure, read the information in Safety Precautions 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

IMPORTANT: Vehicle brake systems require the correct lining material to perform as originally designed. The type of lining material that is specified for the vehicle is based on several technical considerations and Department of Transportation (DOT) braking performance regulations. To ensure fewer relines and greater compatibility with the vehicle's brake system, use the same quality of friction lining material that was installed at the factory.

Always reline both wheels of a single axle and all wheels of a tandem axle at the same time.

Always install the same linings and drums on both wheels of a single axle and all four wheels of a tandem axle. It is not necessary for the steering axle brakes to have the same linings as the rear drive axle brakes.

When the minimum thickness is reached for any of the brake linings on an axle, reline both brakes on that axle at the same time.

NOTE: Replace the return springs each time the brakes are relined.

1. Remove the brake shoes. For instructions, see **Subject 110**.

⚠ CAUTION

Drilling out rivets or cutting off rivet heads with a chisel can cause the rivet hole to become out-of-round. This could damage the brake shoe.

2. Using a suitable riveting mandrel, push out (do not drill out) the old rivets.
3. Clean the shoe table. For instructions, see **Subject 150**, "Cleaning."

⚠ CAUTION

Make sure that the replacement lining material conforms to FMSI 1308, a standard for lining size and shape only. Use of an improper FMSI lining specification or friction material type may cause brake dragging or grabbing, or improper brake performance.

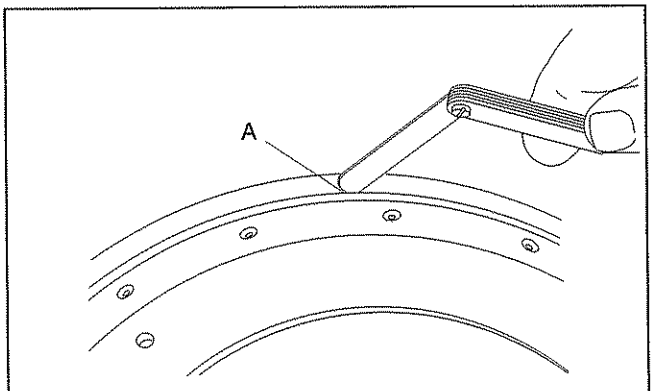
4. Align the brake shoe and lining rivet holes. Using a C-clamp, clamp the lining to the brake shoe.

IMPORTANT: Use rivets supplied with Meritor lining kits.

5. Insert the rivets into all the holes in the new block. Temporarily hold them in place with masking tape.
6. Secure the rivets in the correct sequence. Start with two of the middle holes and work toward the ends in a crisscross pattern.
7. Check for a close fit between the lining and shoe table.

   Try to insert a 0.010-inch (0.254-mm) feeler gauge between the lining and shoe table along the edges. See **Fig. 1**. It should not be possible to insert the gauge anywhere along the edge, except at each end beyond the last row of rivets. A larger clearance may exist in these areas.
8. Remove the C-clamp and masking tape.

IMPORTANT: Always adjust the brakes after replacing the linings. For instructions, see **Subject 160**.



A. The clearance between the brake lining and shoe table must be less than 00.010-inch (0.254-mm).

Fig. 1, Check Fit Between Lining and Shoe Table

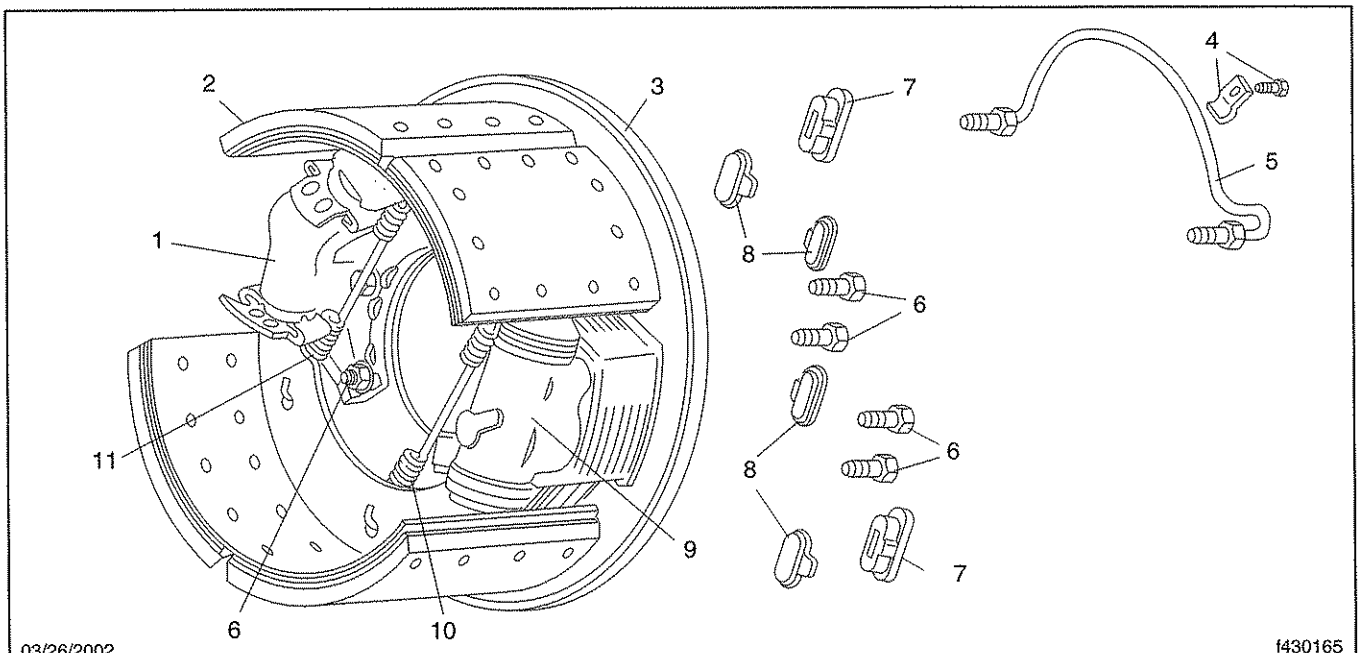
Adjuster and Park Cylinder Removal and Installation

⚠ WARNING

Before starting this procedure, read the information in Safety Precautions 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

Clyinder Removal

1. Remove the brake shoes. For instructions, see **Subject 110**.
2. Remove the bridge pipe retaining clip and screw from the backing plate. See **Fig. 1**.
3. Remove the park cylinder.
   - 3.1 Clean the bridge pipe and disconnect it from the cylinder.
   - 3.2 Remove the parking brake spring chamber. See **Section 42.25** for instructions.
   - 3.3 Remove three 9/16–18 bolts, hexnuts, and washers securing the park cylinder to the backing plate and axle flange.
   - 3.4 Remove the two 7/32-inch Allen-head bolts (if installed) securing the park cylinder to the backing plate. Discard the Allen-head bolts; they were originally installed for shipping.
   - 3.5 Remove the park cylinder and gasket from the backing plate. Discard the gasket.
4. Remove the adjuster cylinder.
   - 4.1 Clean the bridge pipe and disconnect it from the cylinder.
   - 4.2 Remove three 9/16–18 bolts, hexnuts, and washers securing the adjuster cylinder to the backing plate and axle flange.
   - 4.3 Remove the two 7/32-inch Allen-head bolts (if installed) securing the park cylinder to



1. Adjuster Cylinder Assembly
2. Brake Shoe and Lining
3. Backing Plate
4. Retaining Clips and Screw
5. Bridge Pipe
6. Cylinder Mounting Bolts
7. Manual Override Access Plug
8. Inspection Plugs
9. Park Cylinder Assembly
10. Return Spring, Orange (LH brake) or White (RH brake)
11. Return Spring, Green (LH brake) or Yellow (RH brake)

Fig. 1, DURAPARK Rear Hydraulic Drum Brake Assembly

Adjuster and Park Cylinder Removal and Installation

the backing plate. Discard the Allen-head bolts; they were originally installed for shipping.

4.4 Remove the adjuster cylinder and gasket from the backing plate. Discard the gasket.

Clyinder Installation

1. Install the adjuster cylinder.
   1.1 Using a new gasket, install the adjuster cylinder on the backing plate. Insert three 9/16–18 x 1-1/2 inch bolts through the axle flange, backing plate, and cylinder housing.
   1.2 Secure the bolts with hardened washers and 9/16–18 hexnuts. Torque the nuts 135 to 160 lbf·ft (185 to 215 N·m).
   1.3 Connect the bridge pipe to the cylinder. Torque the capscrew 10 to 15 lbf·ft (14 to 20 N·m).
2. Install the park cylinder.
   2.1 Using a new gasket, install the park cylinder on the backing plate. Insert three 9/16–18 x 1-1/2 inch bolts through the axle flange, backing plate, and cylinder housing.
   2.2 Secure the bolts with hardened washers and 9/16–18 hexnuts. Torque the nuts 135 to 160 lbf·ft (185 to 215 N·m).
   2.3 Connect the bridge pipe to the cylinder. Torque the capscrew 10 to 15 lbf·ft (14 to 20 N·m).
   2.4 Install the parking brake spring chamber. See **Section 42.25** for instructions.
3. Install the bridge pipe retainer and screw on the backing plate.
4. Install the brake shoes, drums, and wheels. For instructions, see **Subject 110**.

⚠ WARNING

Do not operate the vehicle until the brakes have been adjusted and checked for proper operation. To do so could result in inadequate or no braking ability, which could cause personal injury or death, and property damage.

5. Bleed the hydraulic brake system. For instructions, see **Subject 170**.

Brake Components Disassembly and Inspection, Cleaning, and Assembly

⚠ WARNING

Before starting this procedure, read the information in Safety Precautions 100. Failure to be aware of the dangers of brake lining dust exposure could result in serious and permanent health damage.

Figure 1 shows a DURAPARK® rear hydraulic drum brake.

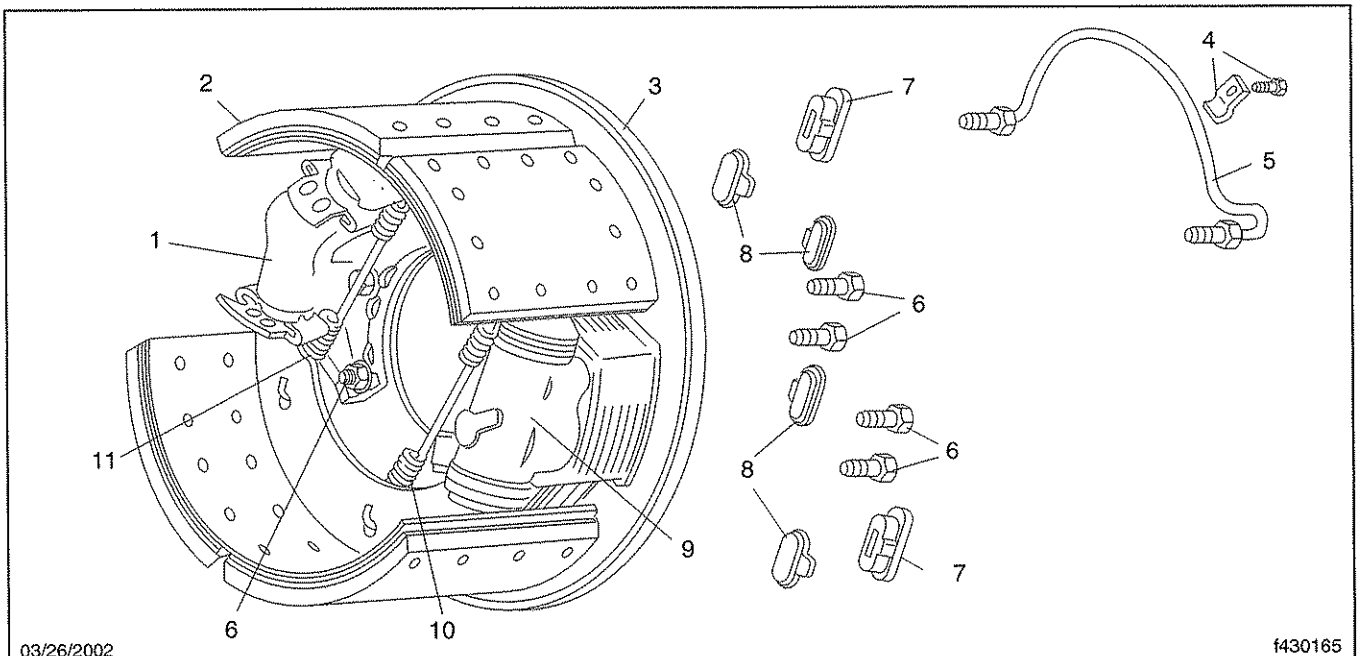
IMPORTANT: The figures and instructions in this subject illustrate installation of brakes on vehicles with spring suspensions. On vehicles with Freightliner AirLiner suspensions, the park cylinder and adjuster cylinder positions are reversed. See **Fig. 2**.

Disassembly

Adjuster Cylinder

Refer to **Fig. 3** while performing the following procedures.

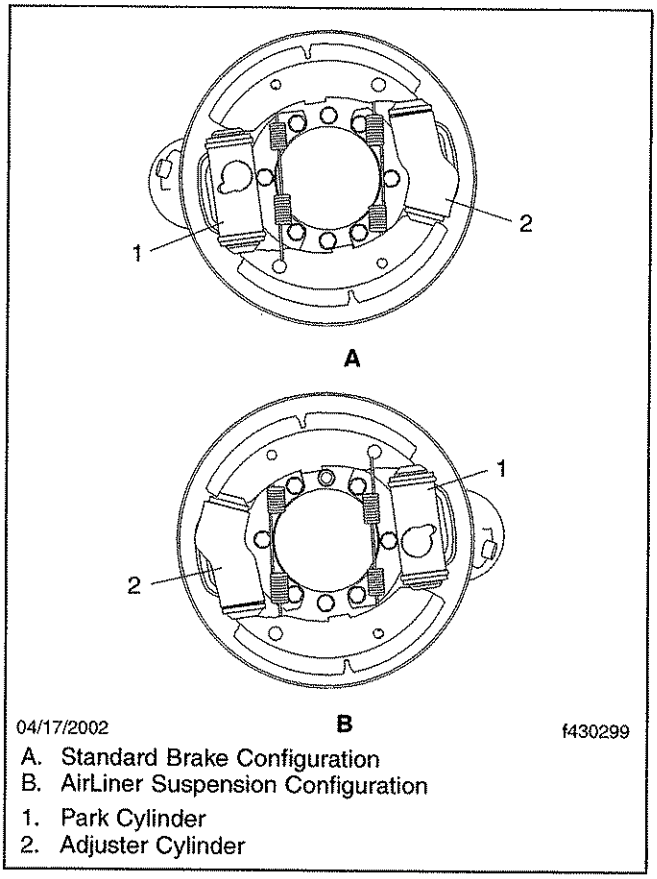
1. Park the vehicle on a level surface, shut down the engine, and chock the tires.
2. Remove the adjuster cylinder. See **Subject 140**.
3. Remove and inspect the manual override wheels. Clean the manual override wheels by soaking them in clean DOT 3 heavy duty brake fluid. Remove the dust boots from the housing. Discard the boots.
4. Remove the pistons and adjuster assemblies from housing, being careful not to cock them and scratch the housing bore. Inspect the pistons. Replaced if any pitting, peeling, or scoring is found. Some discoloration of the piston diameter may



1. Adjuster Cylinder Assembly
2. Brake Shoe and Lining
3. Backing Plate
4. Retaining Clips and Screw
5. Bridge Pipe
6. Cylinder Mounting Bolts
7. Manual Override Access Plug
8. Inspection Plugs
9. Park Cylinder Assembly
10. Return Spring, Orange (LH brake) or White (RH brake)
11. Return Spring, Green (LH brake) or Yellow (RH brake)

Fig. 1, DURAPARK Rear Hydraulic Drum Brake Assembly

Brake Components Disassembly and Inspection, Cleaning, and Assembly



A. Standard Brake Configuration
B. AirLiner Suspension Configuration

1. Park Cylinder
2. Adjuster Cylinder

Fig. 2, DURAPARK Brake Configurations

be apparent. This is the natural result of brake actuation over a period of operation.

5. Remove the adjuster shaft from the piston. Keep the adjuster shafts and pistons together as sets.

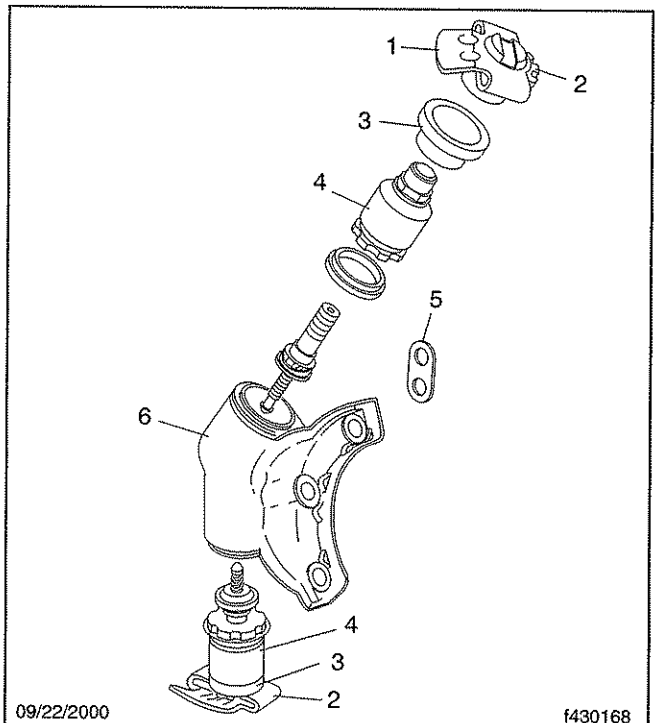
IMPORTANT: Do not remove the drive ring from the adjuster shaft.

6. Remove the seals from the pistons. Use care not to score the seal groove. Discard the seal.

Park Cylinder

Refer to **Fig. 4** while performing the following procedures.

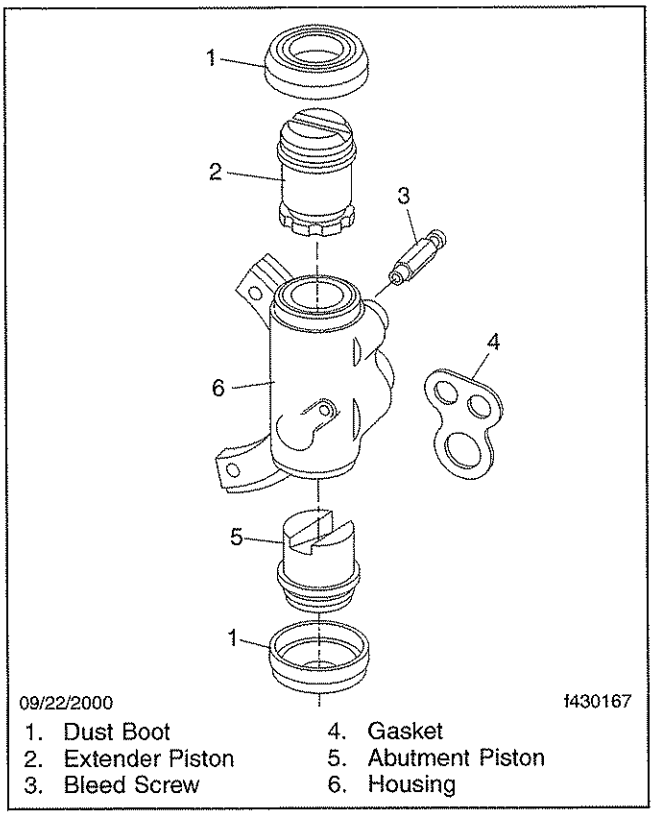
1. Park the vehicle on a level surface, shut down the engine, and chock the tires.
2. Remove the park cylinder. See **Subject 140**.
3. Place the cylinder in a soft jawed vise.



1. Protective Shield
2. Slotted Cap (Manual Override Wheel Assembly)
3. Dust Boot
4. Piston
5. Gasket
6. Housing

Fig. 3, Adjuster Cylinder

4. Remove the bleed screw
5. Remove the dust boots from the housing and discard the boots.
6. Remove the abutment piston.
7. Remove the Allen-head 5/32-inch stop pin from the housing.
8. Push the expander piston and the handbrake piston out of the housing.
9. Remove and discard the seals and O-ring from the pistons.
10. Press down on the wedge assembly sleeve and return spring to remove the pin from the shaft. Slowly release the wedge return spring and remove the sleeve and return spring from the shaft.



1. Dust Boot
2. Extender Piston
3. Bleed Screw
4. Gasket
5. Abutment Piston
6. Housing

Fig. 4, Park Cylinder

11. Remove the snap ring that retains the shaft, retainer and washer in the housing. Remove the wedge and roller assembly.

Inspection and Cleaning

After removing the brake parts being serviced, do the following:

Brake Drums and Chambers

⚠ CAUTION

Do not clean ground or polished metal parts in a hot solution tank or with water, steam, or alkaline solutions. These solutions will cause parts to corrode.

IMPORTANT: Do not apply brake grease or corrosion-preventive materials to the brake linings or the brake drum.

1. Inspect the drum.

   1.1 Check the drum for cracks. Replace any cracked drum.

   1.2 Using a drum caliper or other measuring device, measure the inside diameter of the drum in several places. Replace the drum if it exceeds the maximum diameter stamped on it.

   1.3 Check the drum for heat checks, glazing, grooving, run-out, and out-of-round. See **Fig. 5**. Some drums that are glazed, grooved, or out-of-round can be repaired. For detailed instructions, see **Section 35.01**.

2. Check the brake chamber for a cracked housing, loose fittings, and leakage. Repair or replace parts as needed.

3. Wire brush all parts that have been exposed to mud, road dirt, and salt, including the exterior of the drum.

   If relining the shoes, thoroughly wire-brush the shoe tables and paint them with a rust-inhibitive coating.

⚠ CAUTION

A thick layer of oxidation and dirt on the outside of a brake drum acts as an insulator and may hinder normal heat dissipation. Make sure oxidation and dirt are removed by wire brushing, or damage to brake components could occur.

4. Using a wire brush, remove any rust or corrosion from the backing plate.

5. Using an industrial vacuum cleaner with a HEPA filter system, remove any dust accumulation from the brake parts.

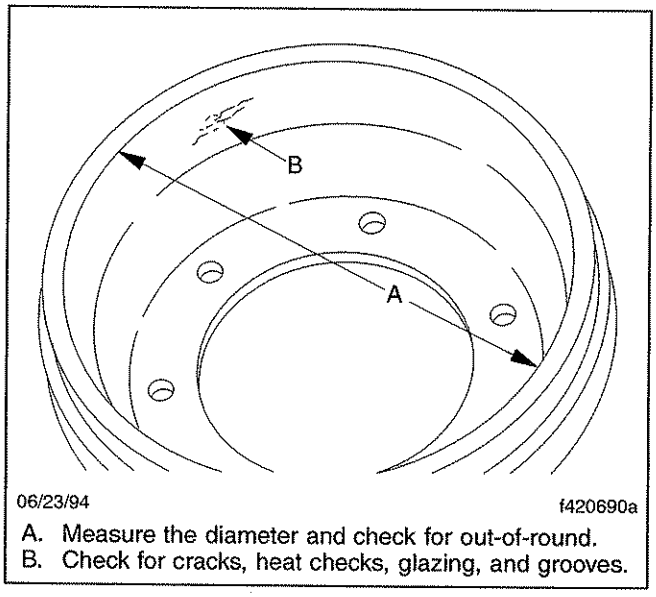
6. Wipe the inside of the drums with a damp rag to remove lining dust.

7. Prepare the brake parts for assembly.

   7.1 Thoroughly clean all the brake parts.

   For ground or polished metal parts, use a cleaning solvent to clean the parts and surfaces.

Brake Components Disassembly and Inspection, Cleaning, and Assembly



A. Measure the diameter and check for out-of-round.
B. Check for cracks, heat checks, glazing, and grooves.

Fig. 5, Check the Drum

For rough metal parts, use a cleaning solvent or a weak alkaline solution in a hot solution tank to clean the parts. If a hot solution tank is used, leave the rough parts in the hot solution tank until they are completely cleaned and heated. Remove the rough parts from the hot solution tank and wash them with water until the alkaline solution is removed.

7.2 Thoroughly dry all the brake parts with a clean, lint-free cloth or paper towel, or use low-pressure filtered and compressed air.

⚠ WARNING

All worn or damaged brake parts must be replaced. If the brakes are assembled with worn or damaged parts, they may not perform to their capacity and a brake failure could occur, which could cause personal injury and property damage.

7.3 Inspect all the brake parts for wear or damage. It is very important that all the parts be carefully inspected before they are assembled. Repair or replace any worn or damaged parts.

7.4 For parts that will be assembled, apply a thin layer of brake grease to the parts after they have been cleaned, dried, and inspected to protect them from corrosion.

If the parts will be stored, apply a special material that prevents corrosion and rust on all surfaces. The parts should be stored in special paper (or other material) that prevents corrosion and rust.

Adjuster Cylinder

Refer to **Fig. 3** while performing the following procedures.

1. Wash all parts with clean DOT 3 heavy duty brake fluid. Placed the cleaned parts on a clean sheet of paper.
2. Clean the adjust shaft hole in the piston.
   - 2.1 Fill the threaded hole half-full with new brake fluid.
   - 2.2 Cover the hole and shake the piston vigorously.
   - 2.3 Rapidly turn the piston upside down and drain the brake fluid.

   IMPORTANT: Do not use a cleaning brush on any of the parts.

NOTE: Some discoloration of the bore surface near the mouth of the cylinder may be apparent. This is the natural result of brake actuation over a period of operation.

3. Inspect the cylinder bore and pistons for evidence of corrosion, ridges or scoring. If scratches or scoring are present in the bore, hosing is allowed. However, the bore diameter must not be larger than 1.75 inches (44.5 mm) after honing. If larger than specified, replace the cylinder housing. Hone the cylinder bore using a 220 spring loaded wheel cylinder stone that gives a smooth finish. If any defects are present after honing the cylinder housing much be replaced.

   Clean the cylinder bore with isopropyl alcohol to remove all honing residue.

Park Cylinder

Refer to **Fig. 4** while performing the following procedures.

1. Inspect all three pistons. Replace the pistons if any pitting, peeling, or scoring is found. Some discoloration of the piston diameter may be apparent. This is the natural result of the brake actuation over a period of operation.
2. Inspect the wedge components for any signs of wear, replace as needed.
3. Wash all parts in clean DOT 3 heavy duty brake fluid.

NOTE: Some discoloration of the bore surface near the mouth of the cylinder may be apparent. This is the natural result of brake actuation over a period of operation.

4. Inspect the cylinder bore and pistons for evidence of corrosion, ridges or scoring. If scratches or scoring are present in the bore, honing is allowed. However, the bore diameter must not be larger than 1.75 inches (44.5 mm) after honing. If larger than specified, replace the cylinder housing. Hone the cylinder bore using a 220 spring loaded wheel cylinder stone that gives a smooth finish. If any scoring is present after honing, the housing must be replaced.

IMPORTANT: Clean the cylinder bore with the isopropyl alcohol to remove all honing residue.

Assembly

Adjuster Cylinder

Refer to **Fig. 3** while performing the following procedures.

⚠ WARNING

The use any mineral based grease will cause contamination of the seals and may result in brake failure. Use only the specified lubricants.

1. Coat the adjuster shaft threads with new brake fluid.
2. Assemble piston and adjuster shaft, adjuster shaft must turn freely and smoothly without roughness or drag over its full length. Turn the adjuster shaft all the way in then back out one full turn. This will insure the shaft is not locked in the piston.

NOTE: It is essential that the adjuster shaft rotates freely in the piston to allow for the initial self-adjuster movement to take place. If the shaft binds or does not rotate freely in the piston, replace the piston and adjuster assembly.

3. Coat the new seal with the clean DOT 3 heavy duty brake fluid. Install the new seal in the groove on the piston so that the lip seal faces toward the adjuster shaft.
4. Lubricate the pistons and seals with clean DOT 3 heavy duty brake fluid. Install the piston assemblies into the cylinder bores.
5. Lubricate the inside of the dust boot with synthetic lube provided with the adjuster cylinder parts kit available from Meritor.

⚠ WARNING

The use of any mineral based grease will cause contamination of the seals and may result in brake failure. Use only the specified lubricants.

6. Install the dust boot onto the housing.
7. Install the manual override wheel.

NOTE: Be sure the tappet head ears are properly located in the corresponding flats in the piston.

8. Install the adjuster cylinder. See **Subject 140**.

Park Cylinder

Refer to **Fig. 4** while performing the following procedures.

⚠ WARNING

The use any mineral based grease will cause contamination of the seals and may result in brake failure. Use only the specified lubricants.

1. Assemble and install the wedge assembly into the housing.
2. Coat the outside diameter and the ramp of the abutment piston with synthetic grease included in the seal kit. Install the abutment piston into the bore the ramp engages the wedge and roller assembly. Install a new dust boot over the abutment piston and onto the housing.

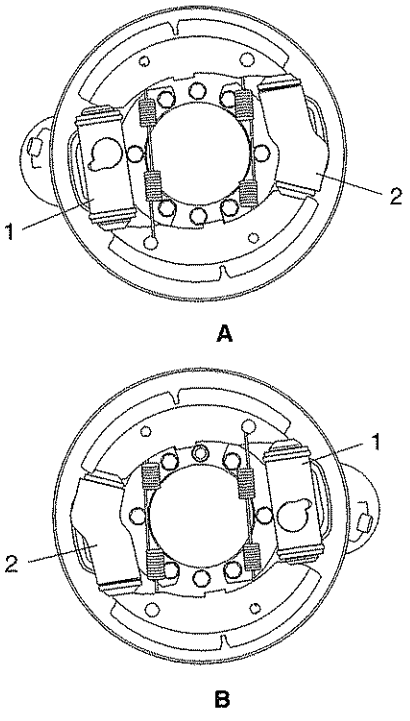
Brake Components Disassembly and Inspection, Cleaning, and Assembly

3. Coat the handbrake piston ramp and O-ring with grease and install the O-ring onto the piston.
4. Coat the seals with clean DOT 3 heavy duty brake fluid. Install the seal on the handbrake piston so that the seal lip faces away from the wedge and roller slot. Install the seal on the expander piston so the seal lip faces away from the shoe web slot.
5. Install the handbrake piston into the bore, aligning the slot on the side of the piston with the stop pin hole.
6. Install the stop pin. Tighten to 16 lbf·ft (21.5 N·m).
7. Install the expander piston into the bore. Install a new dust boot over the expander piston onto the housing.
8. Install the park brake cylinder. See **Subject 140**.

IMPORTANT: The figures and instructions in this subject illustrate installation of brakes on vehicles with spring suspensions. On vehicles with Freightliner AirLiner suspensions, the park cylinder and adjuster cylinder positions are reversed. See **Fig. 1**.

Pre-Adjustment Checks

1. Park the vehicle on a level surface and chock the front tires.
2. Make sure the parking brakes are released. Releasing the parking brakes pressurizes the spring chambers and compresses the parking brake springs. The engine must be running while the parking brakes are released.



A. Standard Brake Configuration
B. AirLiner Suspension Configuration
1. Park Cylinder
2. Adjuster Cylinder

Fig. 1, DURAPARK Brake Configurations

⚠ WARNING

When work is being done on the spring chamber, carefully follow the service instructions of the chamber manufacturer. The sudden release of a compressed spring can cause serious personal injury.

3. Carefully cage and lock the springs so that the springs cannot actuate during disassembly.
4. Set the parking brakes to release the parking brake system pressure, then shut down the engine.
5. Raise the rear axle and place safety stands under the frame or axle. Be sure the stands will support the weight of the vehicle.

Shoe-to-Drum Clearance Measurement

1. Center the shoes in the drum by making two slow, hard applications and releases of the service brakes.
2. Remove the rubber plugs from the inspection holes in the backing plate. See **Fig. 2**.

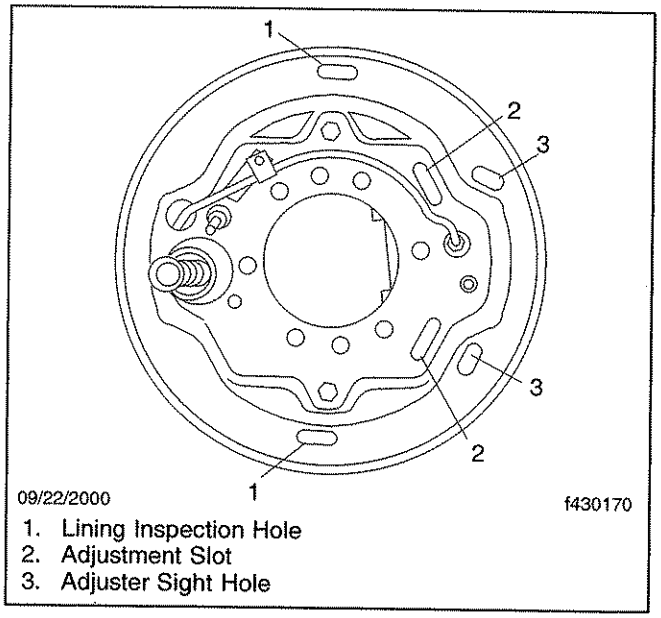
NOTE: Make sure the feeler gauge is on the lining surface, not in the area between the two lining blocks.

3. Insert feeler gauges between the lining and the drum, about half way across the width of the lining. See **Fig. 3**.

NOTE: The clearance between the drum and brake lining may vary from top to bottom, and from the left side of the vehicle to the right. This is normal and does not indicate that service is required.

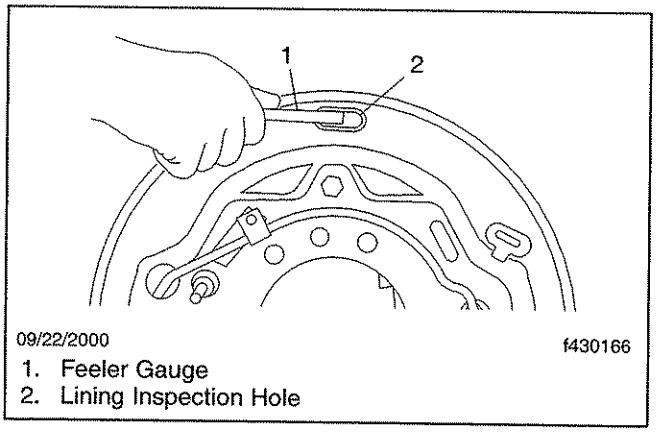
4. If the shoe-to-drum clearance meets either of the following criteria, do not adjust the brake.
   - The shoe-to-drum clearance should be 0.020 to 0.050 inch (0.508 to 1.27 mm).
   - If it is not, add the clearance for the top and bottom shoes. The sum should be 0.040 to 0.100 inch (1.016 to 2.54 mm).
5. If the shoe-to-drum clearance does not meet the criteria above, manually adjust the brakes. Otherwise, skip to "Assembly and Test."

Manual Brake Adjustment



1. Lining Inspection Hole
2. Adjustment Slot
3. Adjuster Sight Hole

Fig. 2, Backing Plate Access Holes



1. Feeler Gauge
2. Lining Inspection Hole

Fig. 3, Clearance Measurement

Manual Adjustment

IMPORTANT: The adjustment procedures in this subject are for vehicles with spring suspensions. On vehicles with Freightliner AirLiner suspensions, the park cylinder and adjuster cylinder positions are reversed. Therefore, the adjustment procedure should be adjusted accordingly when working on a vehicle with AirLiner suspensions.

⚠ CAUTION

Take care not to damage the dust boot with the adjusting tool.

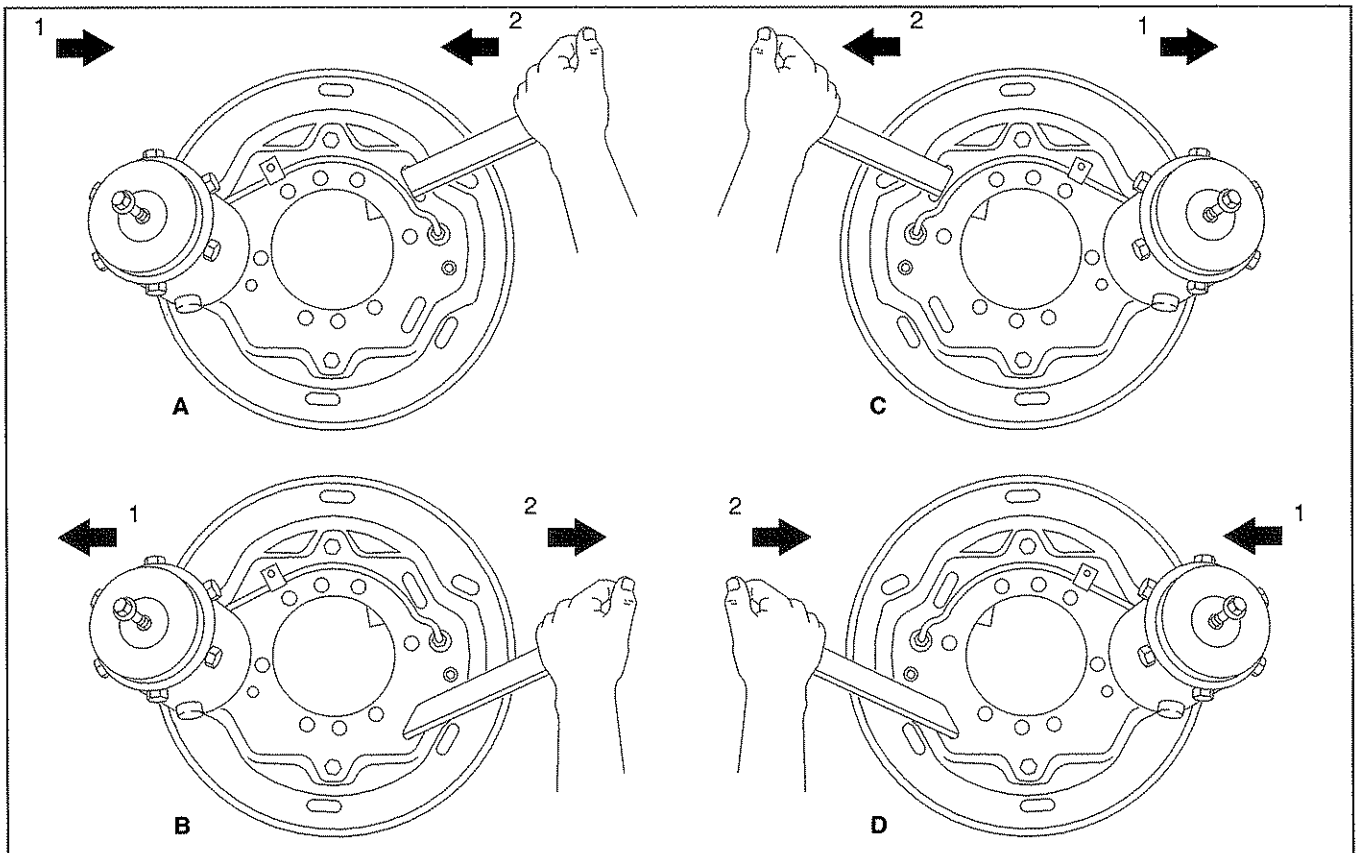
1. Insert the adjusting tool (OTC part number D90T-2588-AR) in the upper adjustment slot on the back side of the backing plate. See **Fig. 4**.
2. Manually adjust the upper shoe by pushing or pulling the adjusting tool (OTC part number D90T-2588-AR) in the direction shown in **Fig. 4**.
   - Adjust burnished shoes to 0.020 inch (0.508 mm) clearance.
   - Adjust new shoes to 0.030 inch (0.732 mm) clearance.
3. Insert the adjusting tool in the lower adjustment slot on the backing plate. Repeat the previous procedure to adjust the lower shoe.

Assembly and Test

1. With the parking brake still in the released position, start the engine to pressurize the parking brake system.
2. Manually uncage the power spring of the parking brake chamber. For instructions, refer to the applicable brake chamber section in this manual.
3. Rotate each wheel by hand to make sure the hydraulic system has fully released the parking brakes.
4. Apply the parking brakes and verify that the wheels cannot be rotated by hand.
5. Remove the safety stands, lower the vehicle, and remove the chocks from the tires.
6. With the engine running, release the parking brakes.

⚠ WARNING

Do not operate the vehicle until the brakes have been adjusted and checked for proper operation. To do so could result in inadequate or no braking ability, which could cause personal injury or death, and property damage.



NOTE: Arrows on the back plate indicate the adjustment direction.

A. Left wheel, upper shoe
B. Left wheel, lower shoe
C. Right wheel, upper shoe
D. Right wheel, lower shoe

1. Increase Lining-to-Drum Clearance
2. Decrease Lining-to-Drum Clearance

Fig. 4, Brake Shoe Adjustment (vehicles with spring suspensions)

7. Before you put the vehicle in service, check for proper brake operation in a safe area.

   7.1 Drive the vehicle slowly and check the service and parking brakes.

   7.2 Apply and release the brakes several times to check for air leaks and proper operation.

   7.3 Perform several low-speed stops to ensure correct parts replacement and full vehicle control.

System Bleeding

NOTE: The following manual bleed procedure has been proven to be more effective than using pressure bleed equipment when working with Durapark brakes. Please use only the following manual pressure bleed procedure.

IMPORTANT: The ignition must remain off for the entire bleed procedure.

1. Fill the reservoir with DOT 3 hydraulic fluid.

IMPORTANT: Do not allow the brake master cylinder fluid to fall below the minimum level during the bleeding operation. Keep the master cylinder reservoir filled with new DOT-3 approved brake fluid as specified by the original equipment manufacturer. Failure to keep the brake reservoir level above minimum could result in more air entering the system, making it impossible to effectively bleed the system.

2. Place a wrench on the right rear bleeder fitting. Attach a length of clear plastic tubing to the bleeder fitting. The tube must fit tight over the fitting.
3. Submerge the opposite end of the tubing in a container of clean brake fluid.

NOTE: Both the tubing and container must be able to withstand the effects of brake fluid.

4. Press the brake pedal. Loosen the bleeder fitting until the fluid begins to flow (about 3/4 turn) while pressing the brake pedal through its maximum available stroke. Continue to press on the brake pedal for 5 to 8 seconds after the brake fluid stops flowing from the bleeder fitting.
5. Tighten the bleeder fitting firmly, then release the brake pedal. The bleeder fitting must be tightened prior to releasing the brake pedal. Failure to perform the operations in this sequence will result in the discharged fluid and air being drawn back into the system.
6. Repeat steps 4 and 5 several times until the discharged fluid is clear and free of bubbles.
7. Repeat steps 2 through 6 for the left rear brake, right front brake, and then left front brake in this sequence.
8. Check the fluid level in the reservoir and fill if required. Replace reservoir cap and dispose of used brake fluid.
9. Remove the chocks from the tires.

Contents

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General Information

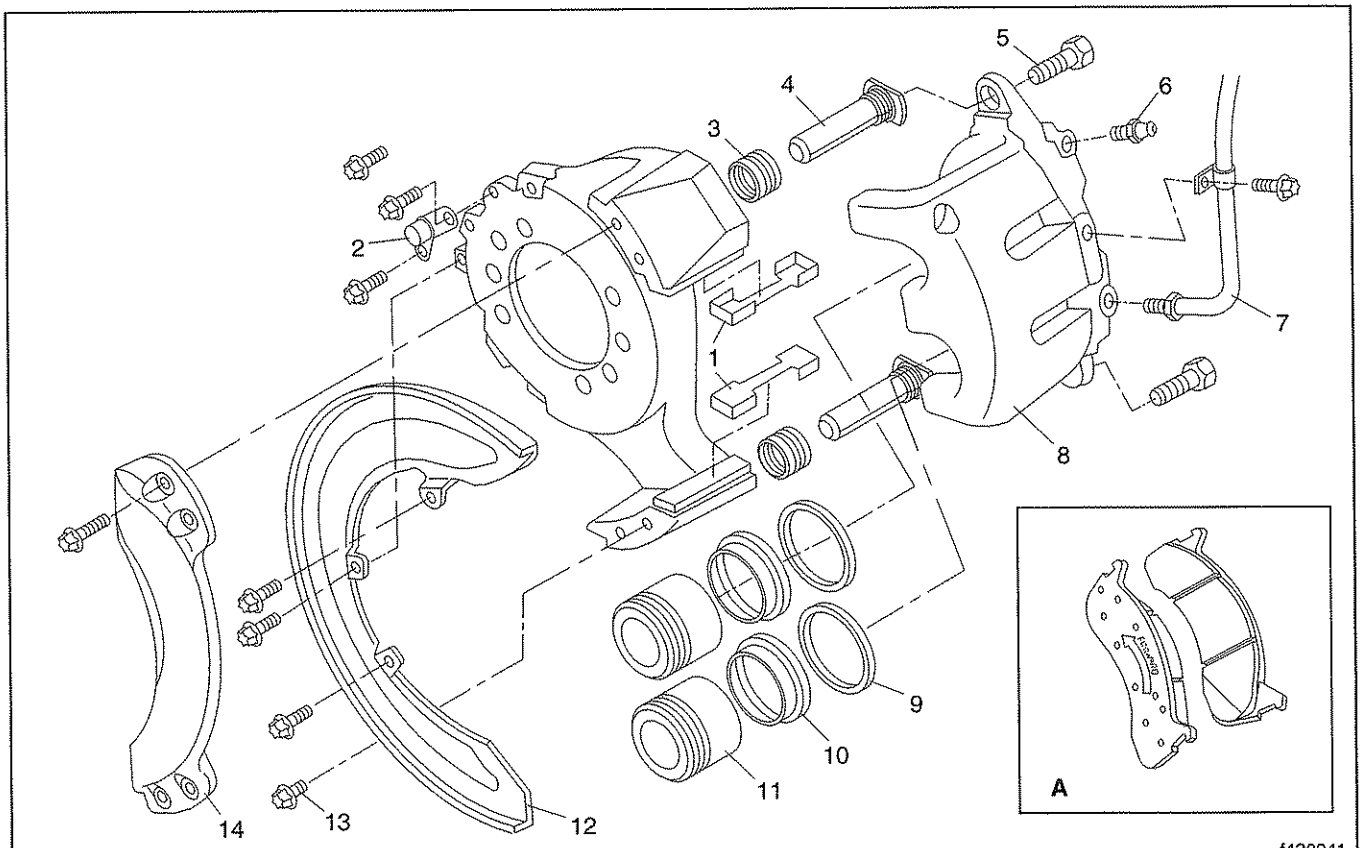
Bosch hydraulic pin slide disc brakes are two piston sliding caliper brakes for use at both front and rear wheels. See **Fig. 1**. Each pin slide caliper disc brake wheel installation is comprised of three major components. See **Fig. 2**.

Caliper Assembly

The caliper assembly includes two hydraulic piston bores. The piston bores contain the pistons, piston seals and piston boots. The caliper assembly attaches to and slides on sealed pins located in an anchor plate. The anchor plate is mounted on the steering knuckle flange on front axles or on the axle flange on rear axles. Two sizes of calipers are used: 66mm Twin (2 piston) and 73mm Twin (2 piston). See **Fig. 3**.

Disc Brake Pads

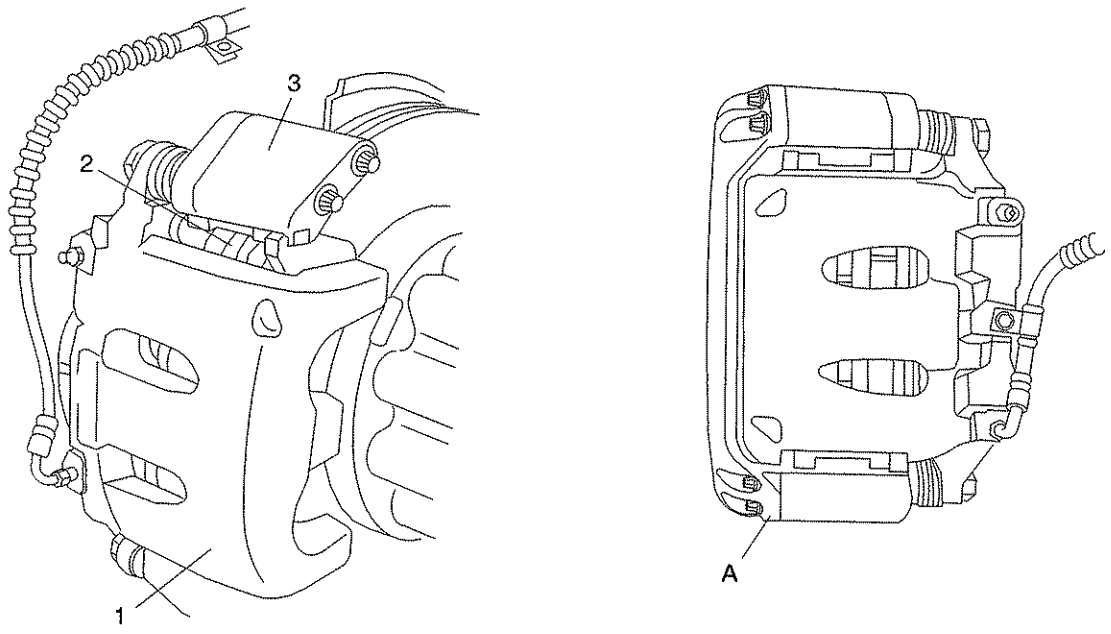
The inboard and outboard disc brake pads are positioned with both ends mounted on the anchor plate pad abutments. The pads rest on stainless steel slippers covering the anchor plate pad abutments. Inboard and outboard disc brake pads may be chamfered, and



A. Brake Pads
1. Slipper
2. Antilock Brakes Sensor Bracket
3. Guide Pin Boot
4. Guide Pin
5. Guide Pin Bolt
6. Bleed Screw
7. Brake Line
8. Caliper
9. Caliper Boot Seal
10. Piston Boot
11. Caliper Piston
12. Splash Shield
13. Plug (66mm only)
14. Tie Bar (73mm only)

Fig. 1, Pin Slide Brake (exploded view)

General Information



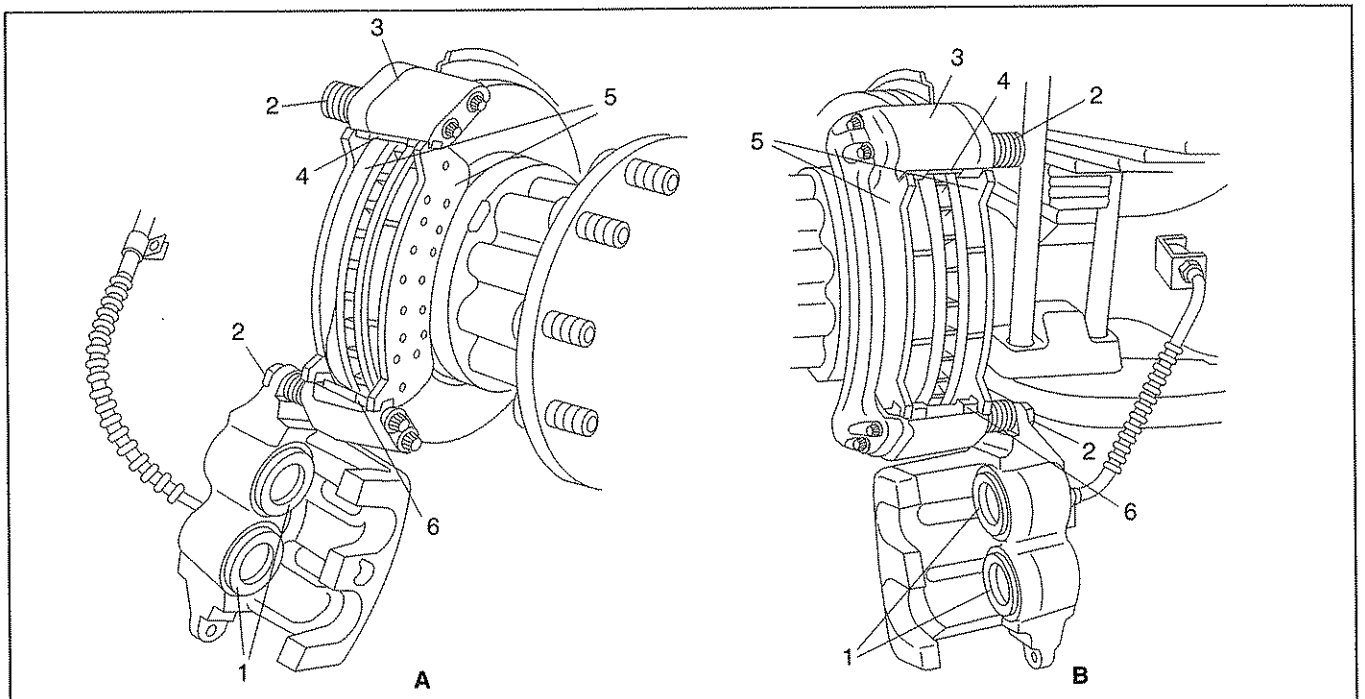
A. 73mm slider disc brakes incorporate a tie bar between the anchor plate abutment arms.
1. Caliper Assembly
2. Brake Pads
3. Anchor Plate Assembly

Fig. 2, Major Components

if so are marked with an arrow and the word "FORWARD" for proper installation. Brake pads may not be interchangeable inner to outer, so correct location is required during assembly.

Anchor Plate Assembly

The anchor plate includes lubricated floating guide pins sealed by rubber boots and anchor plate pad abutments protected by stainless steel slippers. A tie bar which spans the anchor plate abutment arms is used on 73mm pin slide disc brake installations only. A splash shield on the back of the rotor helps protect the brake assembly from road contamination. Bosses are provided for mounting an antilock brake system speed sensor. See **Fig. 4**.



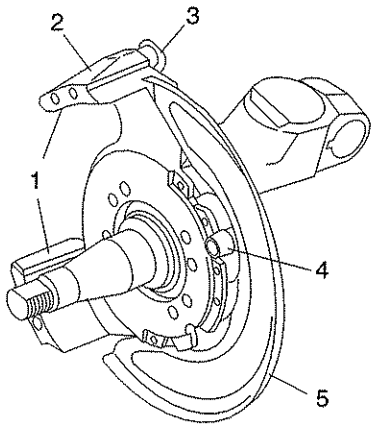
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A. Front (66mm shown)
1. Hydraulic Pistons with Seals and Boots
2. Sealed Pins
3. Anchor Plate

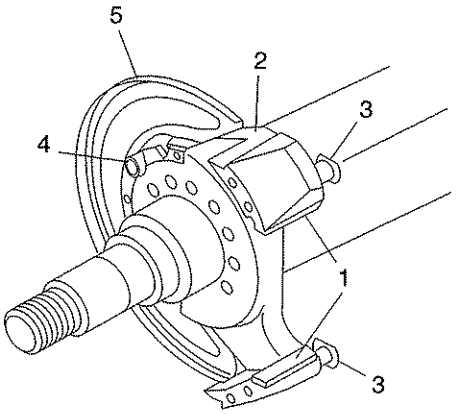
B. Rear (73mm shown)
4. Upper Slipper
5. Brake Pads
6. Lower Slipper

Fig. 3, System Components

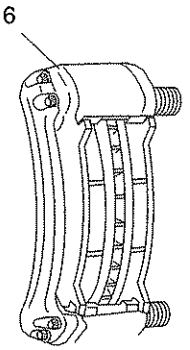
General Information



A



B



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A. Front
1. Pad Abutment
2. Anchor Plate
3. Floating Guide Pin

B. Rear
4. Antilock Braking System Sensor Mounting
5. Splash Shield
6. Tie Bar (73mm brakes only)

Fig. 4, Anchor Plate and Splash Shield

Safety Precautions

⚠ WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. OSHA has set maximum levels of exposure and requires workers to wear an air purifying respirator approved by NIOSH or MSHA. Wear a respirator at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

Because many brake linings contain asbestos, you should know the potential hazards of asbestos and the precautions to be taken. Because medical experts believe that long-term exposure to some non-asbestos fibers could also be a health hazard, also observe the following precautions if servicing non-asbestos brake linings.

NOTE: The vehicle is originally equipped with non-asbestos brake linings.

Exposure to airborne brake lining dust can cause serious and possibly fatal diseases such as asbestosis (a chronic lung disease) and cancer.

During brake servicing, wear an air purifying respirator with high-efficiency filters. The respirator and filter must be approved by NIOSH or MSHA, and worn during all procedures.

OSHA recommends that enclosed cylinders equipped with vacuums and high-efficiency particulate air (HEPA) filters be used during brake repairs. Under this system, the entire brake assembly is placed within the cylinder and the mechanic works on the brake through sleeves attached to the cylinder. Compressed air is blown into the cylinder to clean the assembly, and the dirty air is then removed from the cylinder by the vacuum.

If such an enclosed system is not available, or can not be used, clean the brake assembly in the open air. During disassembly, carefully place all parts on the floor to minimize creating airborne dust. Using an industrial vacuum cleaner with an HEPA filter system, remove dust from the brake rotors, caliper assemblies, dust shields, and brake pads. After vacuuming, remove any remaining dust using a rag soaked in water and wrung until nearly dry.

⚠ WARNING

Hydraulic brake fluid is hazardous, and can cause blindness if it gets in your eyes. Always wear safety glasses when handling brake fluid or bleeding brake components. Brake fluid may also be a skin irritant. If you get it on your skin, wash it off as soon as possible.

Special care must be taken when disposing of used brake fluid. Put the fluid in a sealed plastic container and label it "Used Brake Fluid." Then dispose of it in an approved manner. Check with local and state regulations as to the correct disposal procedure.

IMPORTANT: During service procedures, keep grease and other foreign material away from caliper assemblies, disc brake pads, brake rotors and external surfaces of the hub. Handle parts carefully to avoid damage to the caliper, rotor, disc brake pads or brake lines.

Brake Pad Removal, Inspection and Installation

⚠ WARNING

Before starting the procedures below, read the information in Subject 100. Failure to do so could result in serious and permanent health damage.

IMPORTANT: It is recommended that all disc brake pads on the vehicle be replaced at the same time. This will maintain balanced braking. If complete replacement is not desirable or necessary, make sure that at a minimum all disc brake pads on one axle (both ends) are replaced at the same time.

Removal

1. Park the vehicle on a level surface. Shut down the engine and apply the parking brake.
2. Open the hood.
3. If removing rear axle wheel pads, remove about half of the fluid from the rear section of the master cylinder reservoir. If removing front axle wheel pads, remove about half of the fluid from the front section.
4. Chock the front or rear tires, depending on which axle is being worked on. Jack up the axle and support it with jackstands.
5. Remove the tires.
6. Visually inspect all brake pad linings. Lining pads should be replaced when the remaining lining reaches 3/16-inch (5-mm) thickness or less.

⚠ CAUTION

Care must be taken when positioning the pry bar. Incorrect positioning of the pry bar could result in damage to the caliper.

7. Insert a pry bar in one of the rotor cooling fin slots and pry the caliper outboard, pushing the caliper pistons into the piston bores. See **Fig. 1**.
8. On front axles only, remove the brake line retaining clip from its support mounting. This will allow the brake line hose to hang free. See **Fig. 1**.

IMPORTANT: When servicing disc brake pads only, loosen and remove the upper (top) caliper pin mounting bolt. Do not loosen the lower (bottom) pin mounting bolt.

9. Remove only the upper (top) pin mounting bolt. See **Fig. 2**.

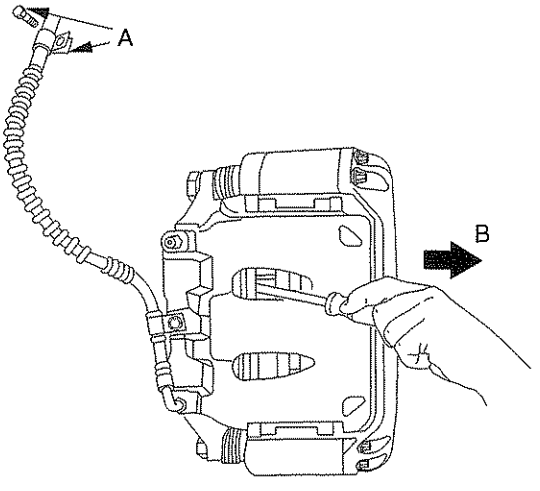
⚠ CAUTION

Do not pull on the guide pins. This may dislodge the guide pin boot from the guide pin or anchor plate grooves, which could damage the guide pin boot.

10. Swing the caliper assembly away from the rotor by carefully rotating the caliper on the lower pin mounting bolt and guide pin. See **Fig. 3**. Do not allow the brake line hose to become pinched or kinked.
11. Remove the inboard and outboard disc brake pads from the anchor plate pad abutment slippers.

IMPORTANT: Do not mark on the pad face.

12. If the original disc brake pads are to be reused, be sure to mark them in some manner so that they are installed in the same location.

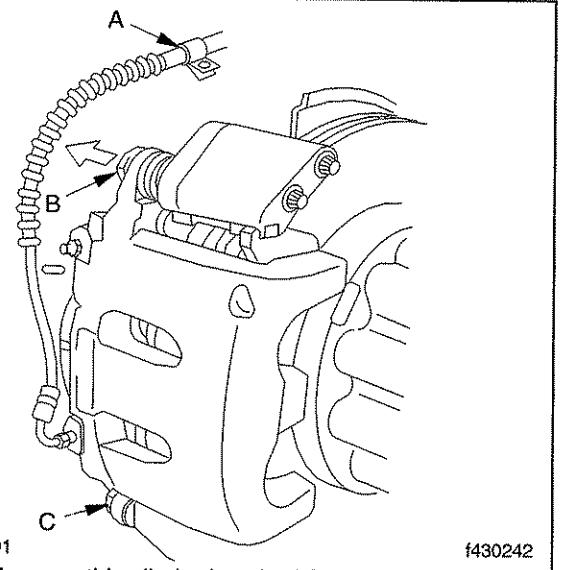


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A. Remove this screw and clip on front axles only.
B. Move the caliper outboard to push the pistons in.

Fig. 1, Piston Retraction and Brake Line Clip Removal

Brake Pad Removal, Inspection and Installation



A. Make sure this clip is detached from the support bracket.
B. Loosen and remove the upper pin mounting bolt.
C. Do not loosen the lower pin mounting bolt.

Fig. 2, Remove Upper Pin Mounting Bolt

Inspection

IMPORTANT: Do not damage or dislodge the guide pin boots while cleaning the machined surfaces.

1. Inspect the machined surfaces of the caliper, guide pin mounting face, and anchor plate. If rust or corrosion is present, use a hand-held wire brush to clean the surfaces.
2. Inspect the caliper, piston seals, and pistons for leakage or damage. If leakage or damage is found, repair or replace the piston(s) as required.
3. Inspect the anchor plate for damage to the mating surfaces at the anchor plate pad abutment slippers and guide pin heads. If damage is found, repair or replace as required.
4. Inspect the rotor for scoring, warping, cracks bluing, heat spots or other damage. See **Fig. 4**. If any damage is found, repair or replace the rotor. For instructions, see **Subject 140**.

Installation

1. Position a metal plate across both caliper pistons. Use a C-clamp to push both pistons into the caliper to provide clearance for the new disc brake pads. See **Fig. 5**.

⚠ CAUTION

When replacing disc brake pads, make sure to use the same lining material on both axles. Mixing lining types can result in unbalanced braking, increased pad wear, or degraded stopping performance.

IMPORTANT: Inboard and outboard brake pads may not be interchangeable. The word "Forward" and a forward rotor rotation direction arrow may appear on each pad backing plate. Orient the pads as indicated by the arrow.

2. Position the inboard and outboard disc brake pads onto the anchor plate pad abutment slippers with the lining facing toward the rotor. See **Fig. 6**.

⚠ CAUTION

Use care when positioning the caliper over the disc brake pads, rotor and upper guide pin head to avoid tearing, cutting or dislodging the piston boots or guide pin boot.

3. Carefully rotate the caliper closed about the lower pin mounting bolt and guide pin. Do not allow the brake line hose to become pinched or kinked. Align the flat on the upper guide pin head with the flat on the caliper upper guide pin boss. See **Fig. 7**.

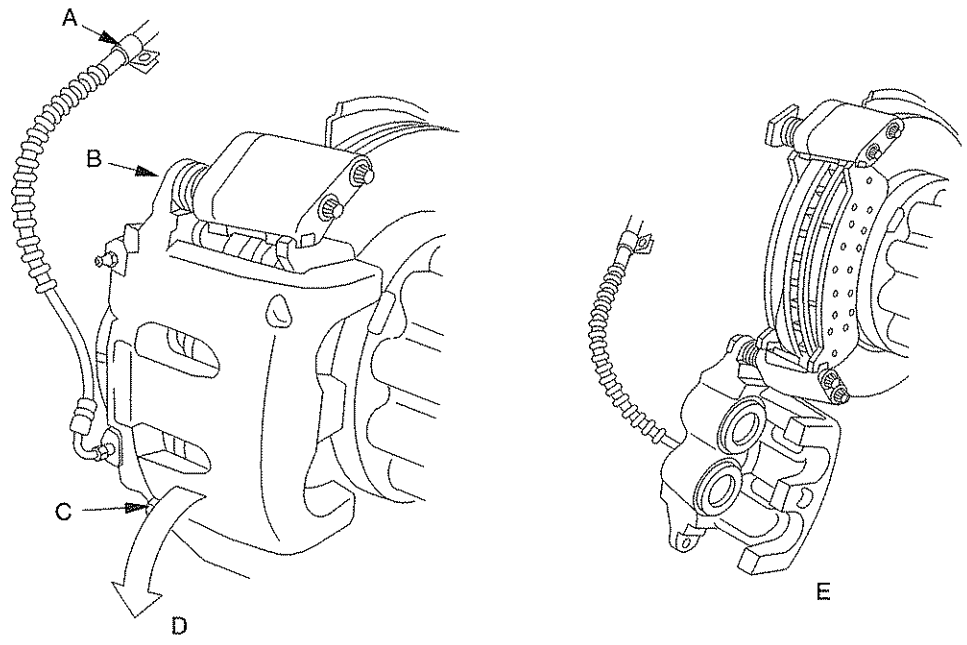
⚠ CAUTION

Do not overtighten caliper pin mounting bolts. Increased brake drag may result from incorrect tightening.

IMPORTANT: If the lower mounting bolt was loosened, see **Fig. 8** before tightening either the upper or lower mounting bolt.

4. Hold the caliper in the closed position with the caliper upper guide pin boss hole aligned with the threaded hole in the upper guide pin head. Hand

Brake Pad Removal, Inspection and Installation



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A. Make sure this clip is detached from the support bracket.
B. Guide pin bolt has been removed.
C. Do not loosen the lower pin mounting bolt.
D. Swing the caliper down until it stops.
E. Caliper in the lowered position.

Fig. 3, Open Caliper to Access Brake Pads and Pistons

thread the pin mounting bolt. Tighten the bolt 70 to 80 lbf·ft (95 to 108 N·m). See **Fig. 8**.

5. On front axles only, install the previously removed brake line retaining clip. Make sure the brake line hose is not pinched or kinked.
6. Visually inspect all components serviced. Make sure the mounting pins are torqued according to the specifications in this procedure. Make sure the pads are seated and positioned to slide along the pad abutment slippers.
7. Install the tires, remove the jackstands and lower the vehicle.
8. Check the fluid level in the master cylinder reservoir and add the necessary amount of new DOT 3 approved brake fluid.
9. Pump the brake pedal until it feels firm. If it does not get firm, check for leaks or air in the brake system. Repair any leaks, if needed, then bleed the system, following the instructions in **Subject 170**.

⚠ WARNING

Do not move the vehicle until the brake pedal feels firm. To do otherwise could result in loss of vehicle control, causing an accident resulting in personal injury or property damage.

10. Close the hood and remove the chocks from the tires.
11. Road test the vehicle and seat the brake pads.
    - 11.1 Accelerate the vehicle to 30 mph (48 km/h), then brake to a stop, using medium brake pedal pressure. *Do not slam on the brakes.*
    - 11.2 Repeat this step between 20 and 30 times, allowing a 1-minute interval between brake applications.

Brake Pad Removal, Inspection and Installation

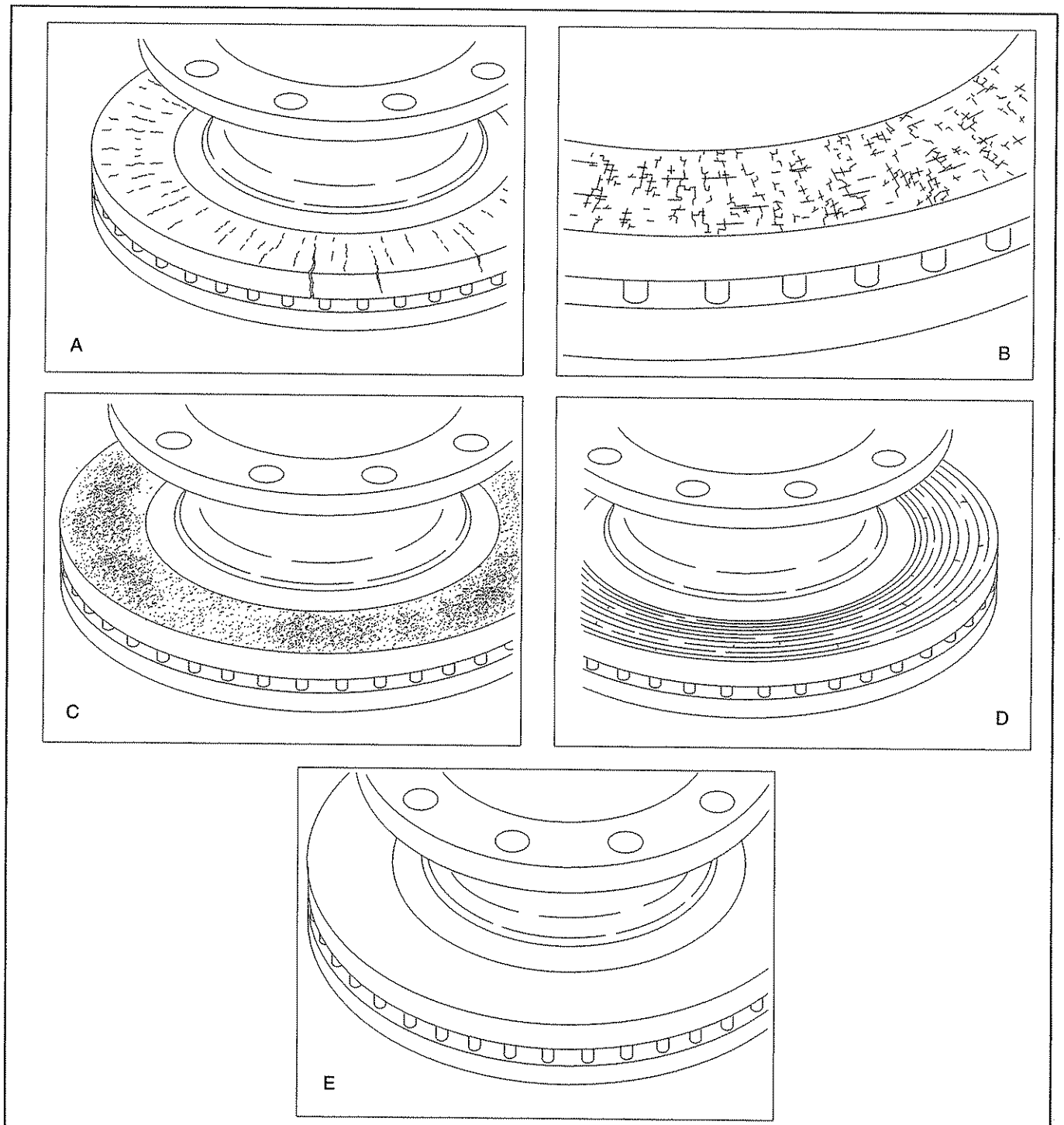


Fig. 4, Rotor Surface Check

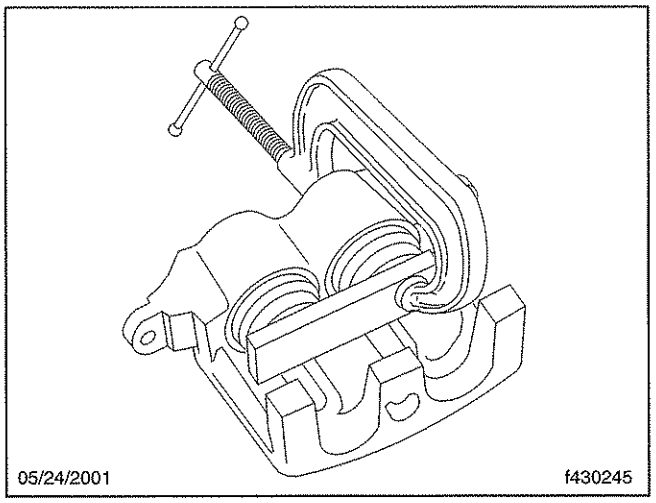
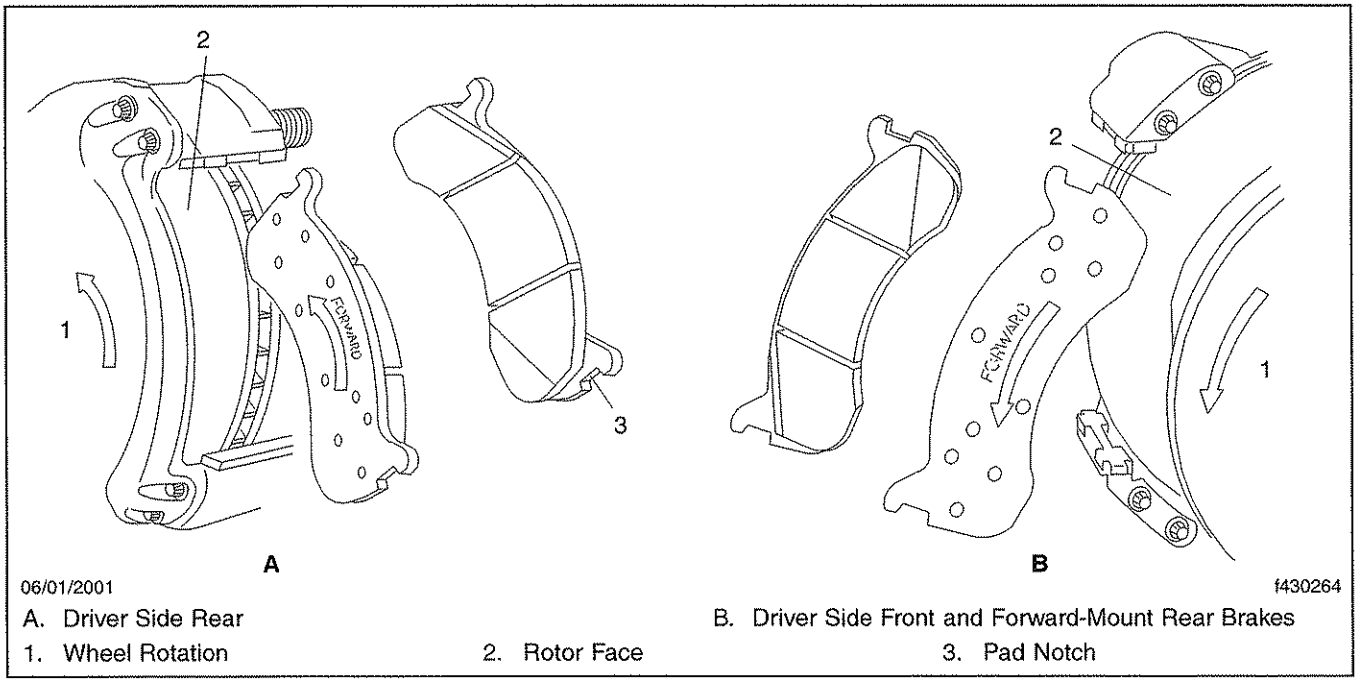


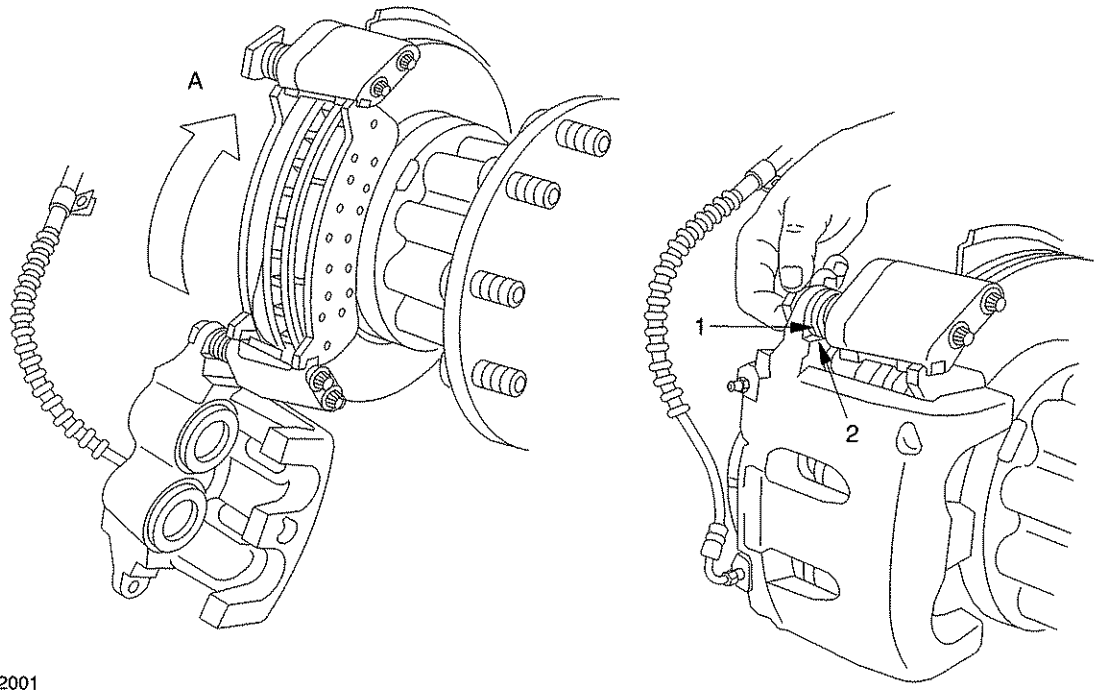
Fig. 5, Retract Pistons Into Caliper



A. Driver Side Rear
B. Driver Side Front and Forward-Mount Rear Brakes
1. Wheel Rotation
2. Rotor Face
3. Pad Notch

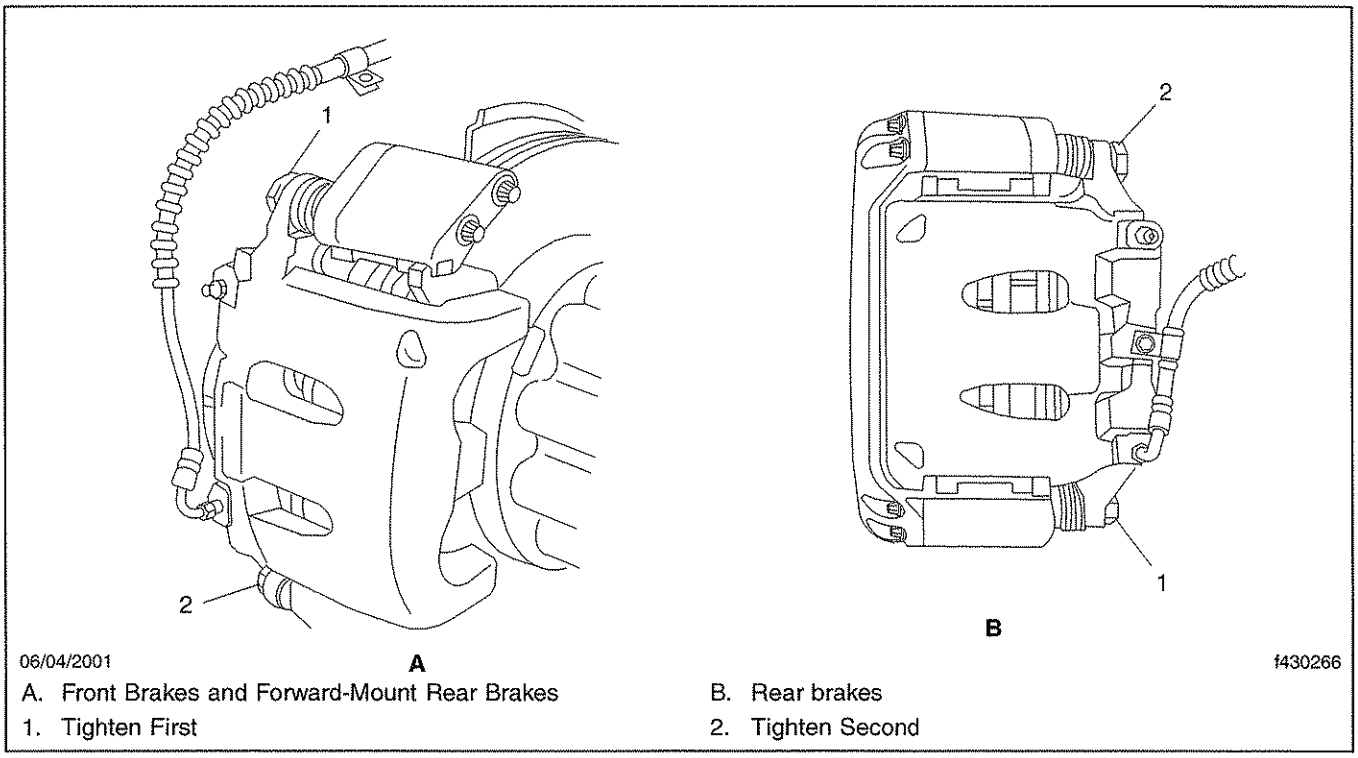
Fig. 6, Replacing Brake Pads on Front and Rear Brakes

Brake Pad Removal, Inspection and Installation



A. Swing the caliper up into position.
1. Flat on Guide Pin
2. Flat on Caliper

Fig. 7, Close Caliper Over Brake Pads and Rotor



A. Front Brakes and Forward-Mount Rear Brakes
1. Tighten First
B. Rear brakes
2. Tighten Second

Fig. 8, Tightening Sequence for Caliper Mounting Bolts

Brake Caliper Removal and Installation

⚠ WARNING

Before starting the procedures below, read the information in Subject 100. Failure to do so could result in serious and permanent health damage.

Removal

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine.
2. Open the hood.
3. If removing the rear wheel caliper(s), remove half the fluid from the rear section of the master cylinder reservoir. If removing the front wheel caliper(s), remove half the fluid from the front section.
4. Chock the front or rear tires, depending on which axle is being worked on. Jack up the axle and support it with jackstands.
5. Remove the tires.
6. On front axles only, remove the brake line retaining clip from its support mounting. This will allow the brake line hose to hang free. See **Fig. 1**.
7. Remove the upper (top) guide pin mounting bolt. See **Fig. 1**.

⚠ CAUTION

Do not pull on the guide pins. This may dislodge the guide pin boot from the guide pin or anchor plate grooves, which could damage the guide pin boot.

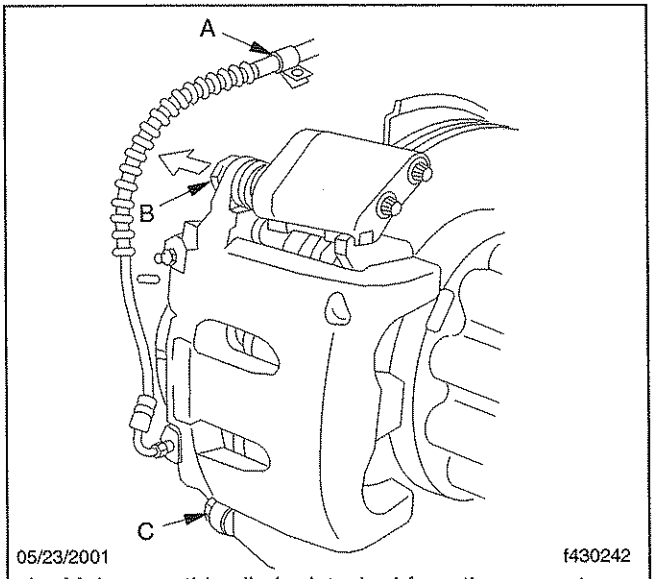
8. Swing the caliper assembly away from the rotor by carefully rotating the caliper on the lower pin mounting bolt and guide pin. See **Fig. 2**. Do not allow the brake line hose to become pinched or kinked.
9. Disconnect the brake fluid line from the caliper. See **Fig. 3**.
10. Remove the lower guide pin mounting bolt and remove the caliper from the anchor plate.

Installation

⚠ CAUTION

Use isopropyl alcohol to clean brake seals, boots and pistons. Do not soak components for an extended period of time.

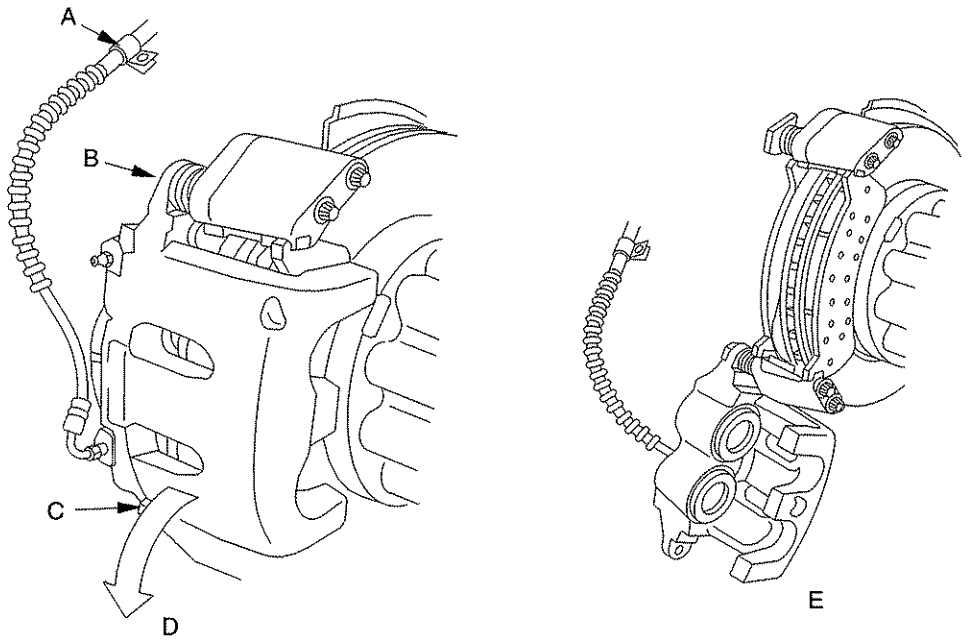
1. Clean contamination, dirt and debris from the exterior of the caliper, machined faces and around the caliper piston boots.
2. Visually inspect the caliper for brake fluid leakage or damage to pistons or piston boots. If there is leakage or damage, the caliper should be repaired or replaced. For repair instructions, see **Subject 130**.
3. Make sure the pistons are fully retracted into the caliper. Piston boots must be fully seated in the piston boot groove and boot grooves in the caliper face.
4. Position the caliper on the anchor plate with the caliper lower guide pin boss hole aligned with the threaded hole in the lower guide pin head. Hand thread the pin mounting bolt through the caliper and into the anchor plate.



A. Make sure this clip is detached from the support bracket.
B. Loosen and remove the upper pin mounting bolt.
C. Do not loosen the lower pin mounting bolt.

Fig. 1, Remove Upper Pin Mounting Bolt

Brake Caliper Removal and Installation



05/24/2001 f430244

A. Make sure this clip is detached from the support bracket.
B. Guide pin bolt has been removed.
C. Lower Guide Pin Bolt
D. Swing the caliper down until it stops.
E. Caliper in the lowered position.

Fig. 2, Open Caliper

⚠ CAUTION

Use care when positioning the caliper over the disc brake pads, rotor and upper guide pin head to avoid tearing, cutting or dislodging the piston boots or guide pin boot.

5. Carefully rotate the caliper closed about the lower pin mounting bolt and guide pin. Do not allow the brake line hose to become pinched or kinked. Align the flat on the upper guide pin head with the flat on the caliper upper guide pin boss. See **Fig. 4**.

⚠ CAUTION

Do not overtighten caliper pin mounting bolts. Increased brake drag may result from incorrect tightening.

IMPORTANT: See **Fig. 5** before tightening either the upper or lower mounting bolt.

6. Hold the caliper in the closed position with the caliper upper guide pin boss hole aligned with the threaded hole in the upper guide pin head. Hand thread the upper pin mounting bolt. Tighten the bolts 70 to 80 lbf·ft (95 to 108 N·m) in the order shown in **Fig. 5**.
7. On front axles only, install the previously removed brake line retaining clip. Make sure the brake line hose is not pinched or kinked.
8. If the brake supply hose was disconnected, connect it.
   - 8.1 Tighten the brake supply hose fitting 15 lbf·ft (20 N·m).
   - 8.2 Bleed the brake supply line to the caliper, following the instructions in **Subject 170**. If you have removed more than one brake caliper, bleed the entire brake system.
9. Install the tires, remove the jackstands and lower the vehicle.

Brake Caliper Removal and Installation

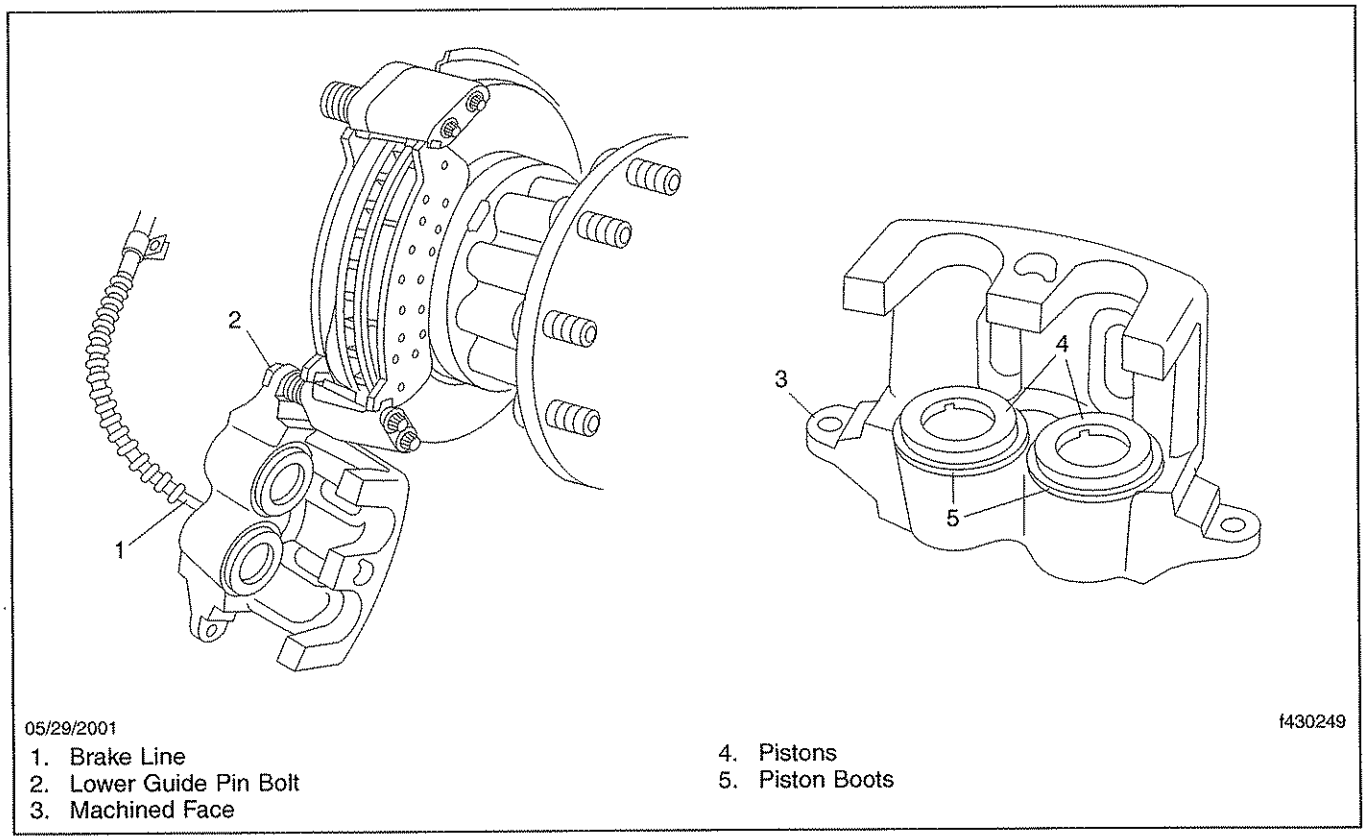


Fig. 3, Remove Caliper From Anchor Plate

10. Check the fluid level in the master cylinder reservoir and add the necessary amount of new DOT 3 approved brake fluid.

11. Close and latch the hood.

12. Remove the chocks from the tires.

⚠ WARNING

Do not move the vehicle until the brake pedal feels firm. To do otherwise could result in loss of vehicle control, causing an accident resulting in personal injury or property damage.

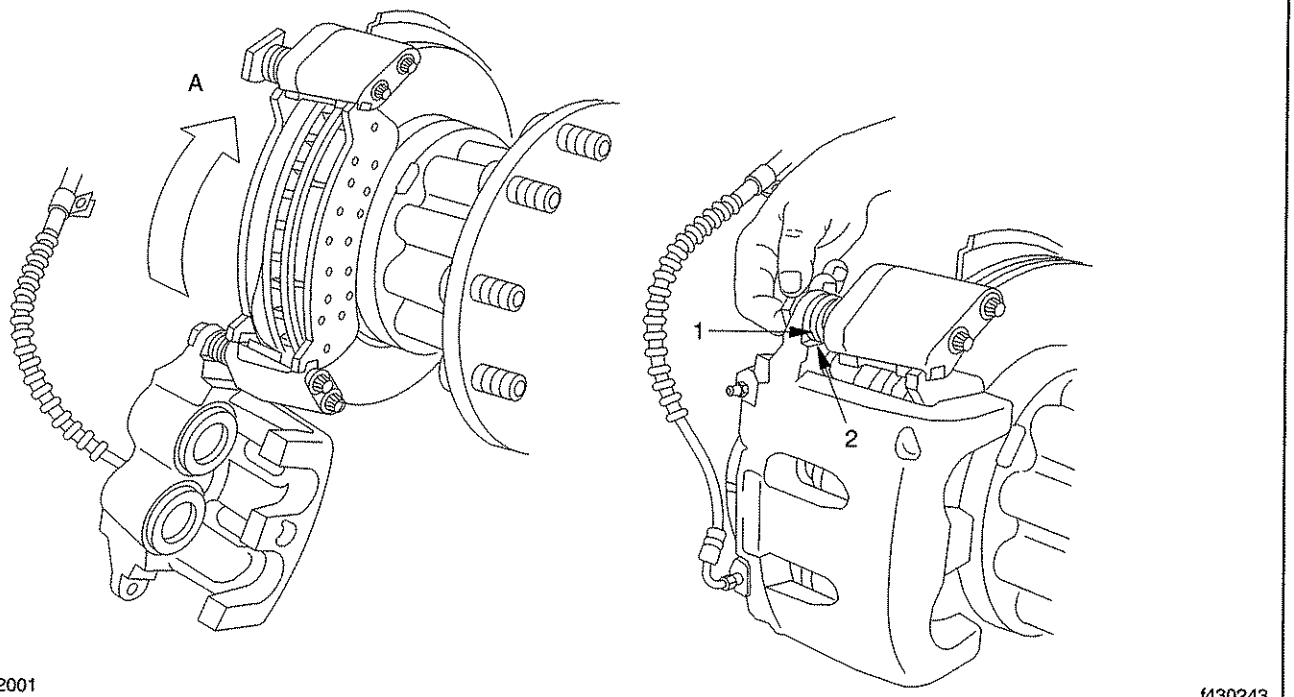
13. Seat the brake pads by pressing firmly on the brake pedal several times.

    If new brake pads were installed, road test the vehicle to seat the brake pads.

13.1 Accelerate the vehicle to 30 mph (48 km/h), then brake to a stop, using medium brake pedal pressure. *Do not slam on the brakes.*

13.2 Repeat this step between 20 and 30 times, allowing a 1-minute interval between brake applications.

Brake Caliper Removal and Installation

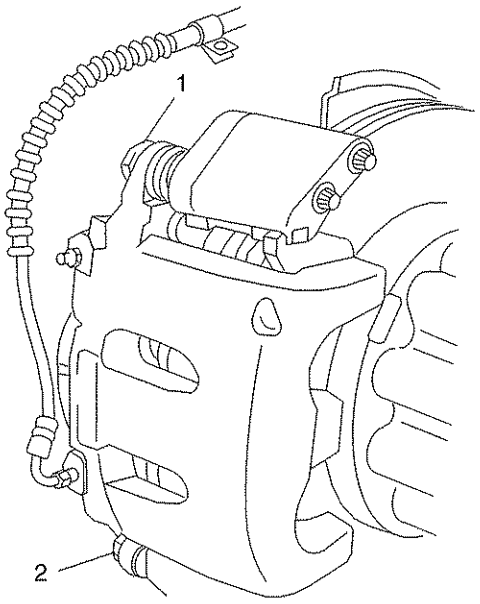


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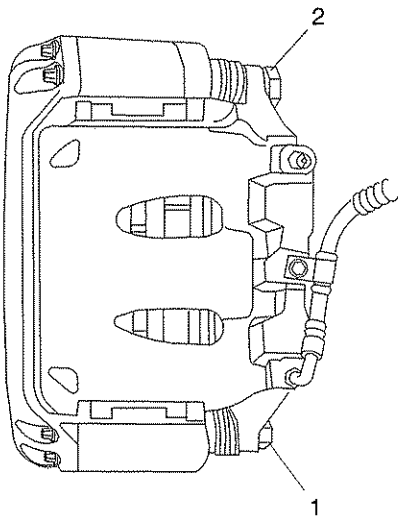
A. Swing the caliper up into position.
1. Flat on Guide Pin
2. Flat on Caliper

Fig. 4, Close Caliper Over Brake Pads and Rotor

Brake Caliper Removal and Installation



A



B

06/04/2001 f430266

A. Front Brakes and Forward-Mount Rear Brakes
1. Tighten First

B. Rear Brakes
2. Tighten Second

Fig. 5, Tightening Sequence for Caliper Mounting Bolts

⚠ WARNING

Before starting the procedure below, read the information in Subject 100. Failure to do so could result in serious and permanent health damage.

⚠ CAUTION

Use isopropyl alcohol to clean brake seals, boots and pistons. Do not soak components for an extended period of time.

IMPORTANT: When using compressed air, use air lines that are completely free of oil and moisture.

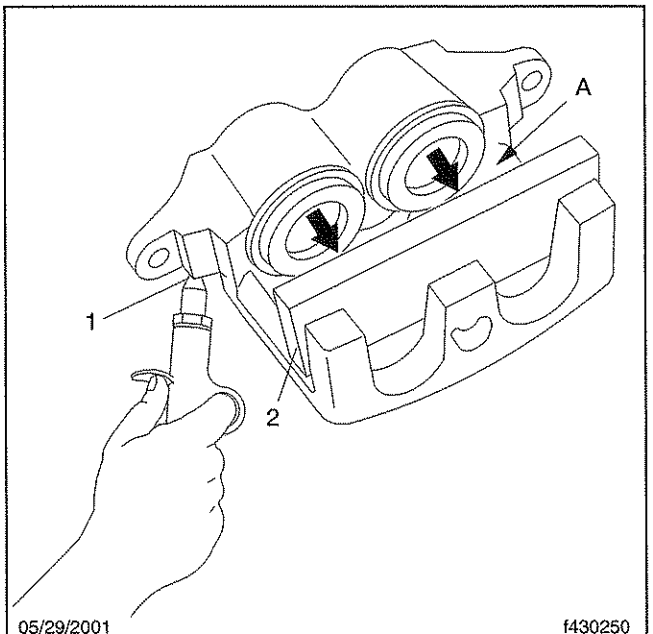
Rebuild

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine.
2. Open the hood.
3. Remove the caliper. For instructions, see **Subject 120**.
4. Clean contamination, dirt and debris from the exterior of the caliper, machined faces and around the caliper piston boots.
5. Drain all fluid from the caliper.
6. Place a block of wood between the caliper and piston faces. Leave approximately 1 to 1.5 inch clearance between the pistons and the block of wood. See **Fig. 1**.

⚠ WARNING

Always wear eye protection. Use just enough air pressure to ease the piston from the caliper bore. Keep hands clear of the piston face to avoid possible injury if the piston pops from its bore. Cover the pistons with a shop cloth to prevent brake fluid spray as the piston clears the bore.

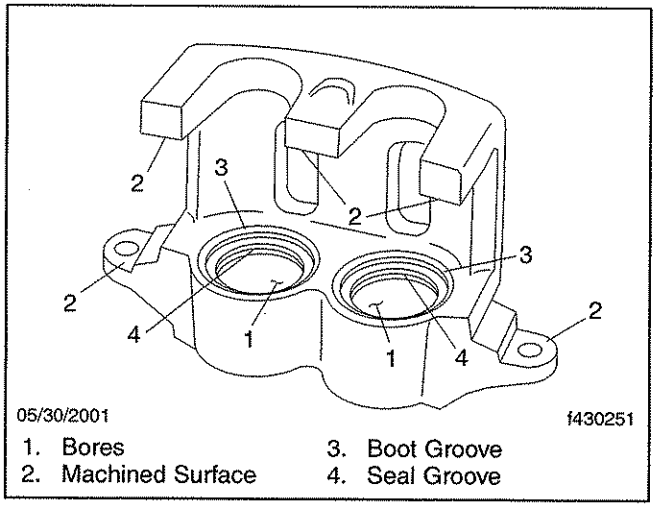
7. Cover the pistons with a shop cloth to prevent brake fluid spray. Use an air blow gun to carefully apply low air pressure into the open caliper port to slowly push the pistons out of the caliper bores. The pistons should push out beyond the seal compression.
8. Remove the block of wood and remove each piston from its piston boot.
9. Remove each piston boot from its boot groove in the caliper.
10. Using your fingers or a wooden or other non-metallic device, remove and discard the seals from the caliper bores. Do not nick, scratch or otherwise scar the piston bores or seal grooves.
11. Inspect the caliper for damage to the piston bores and boot grooves. If damage is found, repair or replace the caliper.
12. Check the machined surfaces of the caliper that come in contact with the guide pin heads, pistons, piston seals, piston boots and brake pads. See **Fig. 2**. If any rust or corrosion is present at these locations, carefully clean the surfaces with a hand-held wire brush.
13. Clean the caliper, caliper piston bores and fluid ports with solvent. Use compressed air to clean out and dry grooves and passages. If the piston bores are not clean, wipe out the bores with a clean, dry cloth and use 320 to 400 grit emery



A. Keep hand clear of this area.
1. Brake Line Orifice
2. Wood Block

Fig. 1, Remove Pistons from Caliper Bore

Brake Caliper Rebuild



1. Bores
2. Machined Surface
3. Boot Groove
4. Seal Groove

Fig. 2, Caliper Machined Surfaces

cloth to lightly clean the piston bores. Using a pick-type tool, make sure the caliper piston seal and boot grooves in the caliper are free of all foreign material.

14. Inspect the caliper piston bores and piston seal and boot grooves. Make sure they are free of foreign matter, pitting, scoring or corrosion. If damage or defects are found, repair or replace the caliper.

15. Inspect the tube seats in the caliper fluid ports. Make sure they are free of foreign matter and are in good condition. Replace tube seats if damaged.

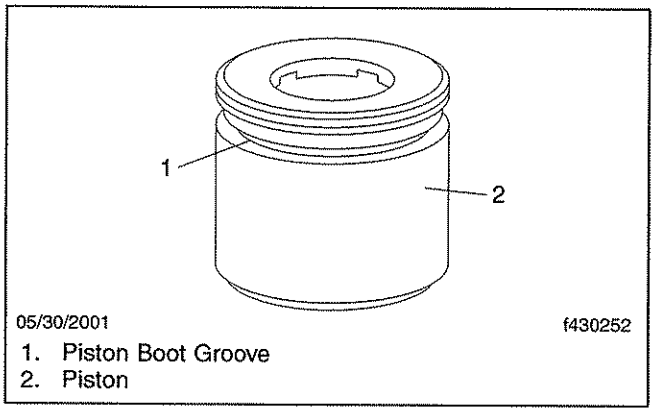
16. Clean caliper pistons with isopropyl alcohol. Visually inspect each piston for pitting, scoring or excessive wear. If damage or defects are found, replace the piston. If foreign material is found in the caliper piston boot groove, use a fiber brush to remove it. See **Fig. 3**.

17. Clean the piston boots with isopropyl alcohol and visually inspect both the inside and the outside of the piston boot for cracks, tears, holes and flexibility. See **Fig. 4**. If damage or defects are found, the boot must be replaced.

NOTE: All brake parts must be clean and completely dried of cleaning fluids before assembly.

18. Dip new piston seals in clean DOT 3 or DOT 4 hydraulic brake fluid. Install the piston seal in the piston seal groove of the caliper piston bores. See **Fig. 5**.

19. With the piston seal positioned on the groove, gently work around the groove with clean fingers



1. Piston Boot Groove
2. Piston

Fig. 3, Caliper Piston

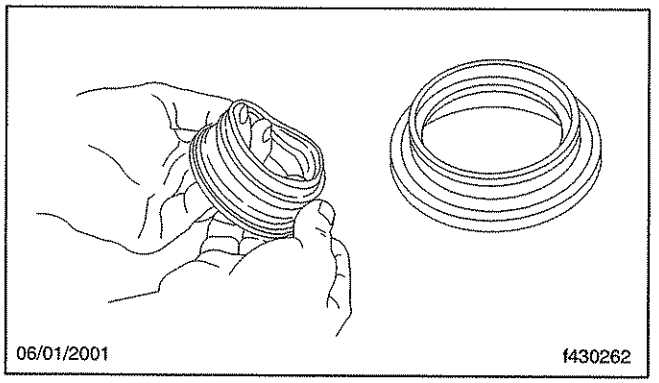
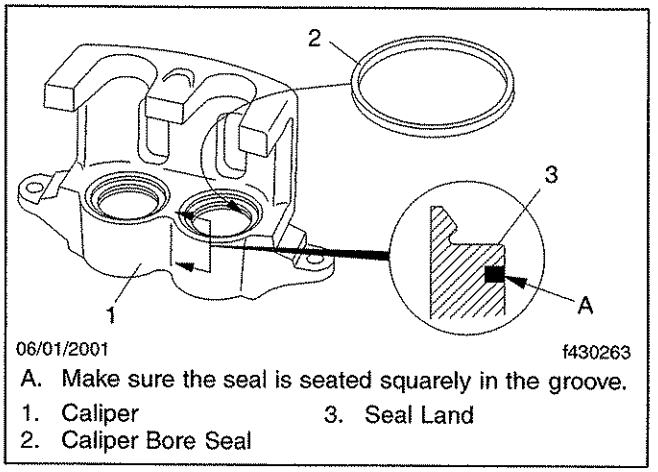


Fig. 4, Piston Boot



A. Make sure the seal is seated squarely in the groove.
1. Caliper
2. Caliper Bore Seal
3. Seal Land

Fig. 5, Piston Seal Installation

until the seal is properly seated into the groove. Make sure the seal is not twisted or rolled.

IMPORTANT: Use only silicone grease on the seal bead. Other greases may cause the seal to swell (grow) and impair proper piston movement.

20. Apply a thin film of silicone grease to the caliper bore seal land between the piston boot and seal grooves. Apply the grease around the entire circumference of the caliper bore.

NOTE: Clean DOT 3 or DOT 4 hydraulic brake fluid may be used on the boot inner bead and outer ring to ease assembly. Do not use any other lubricant.

21. Position the boot on top of the caliper piston with the boot flange properly oriented. See **Fig. 6**. Carefully pull the piston boot down over the top of the piston until the inner bead of the boot is seated in the piston boot groove. Return the boot to the collapsed or folded position. Make sure the boot is fully seated in the piston boot groove by grasping the piston boot flange and rotating the piston back and forth.

22. Apply DOT 3 or DOT 4 hydraulic brake fluid to the outside of the caliper piston and carefully position the piston with the piston boot into the caliper piston bore. See **Fig. 7**.

23. Position the caliper piston and boot installation tool (ZTSE4417 for 66mm brakes, ZTSE4418 for 73mm brakes) on top of a piston and piston boot so the word "Boot" is on the underside of the tool, toward the piston. See **Fig. 8**. Make sure to use the correct tool for the pistons being installed.

24. Using a "C" clamp or arbor press, gently press the piston past the piston seal and partially into the bore. Avoid cocking or binding the piston during installation. Continue to press the piston and piston boot into the bore until they are fully seated into the caliper.

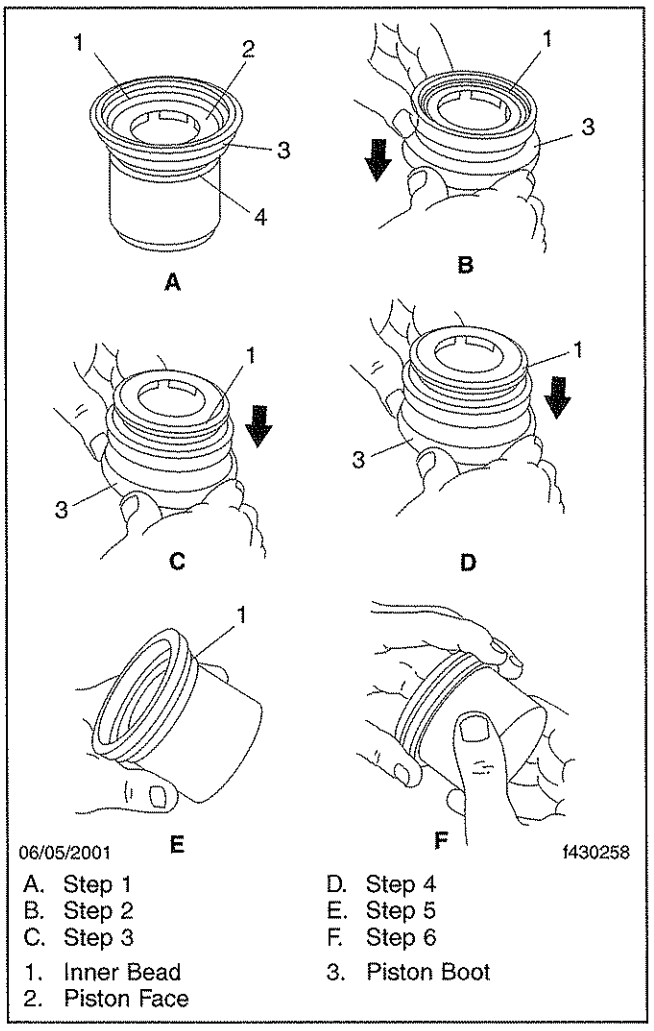
25. Remove the "C" clamp or arbor press. Make sure the piston boot flange ring is fully seated into the top groove of the piston bore in the caliper face.

26. Repeat the procedure for the other piston.

27. Inspect the caliper prior to installing it on its anchor plate. Pistons must be fully retracted into the caliper. Piston boots must be fully seated in the piston boot groove and boot grooves in the caliper face.

28. If the caliper bleed screw was removed, make sure that a bleed screw has been installed in the upper brake fluid port.

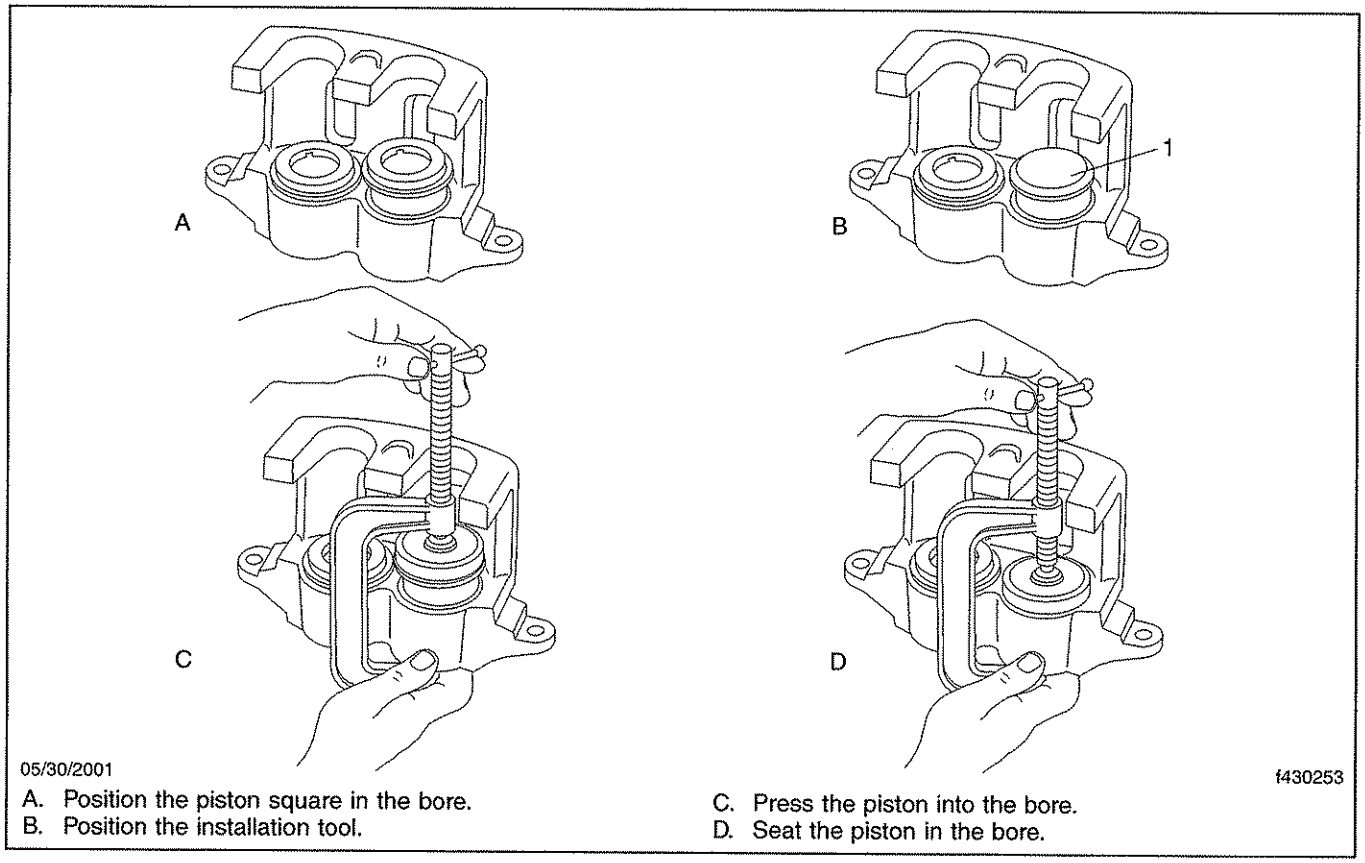
29. Install the caliper on the anchor plate. For instructions, see **Subject 120**.



A. Step 1
B. Step 2
C. Step 3
D. Step 4
E. Step 5
F. Step 6
1. Inner Bead
2. Piston Face
3. Piston Boot

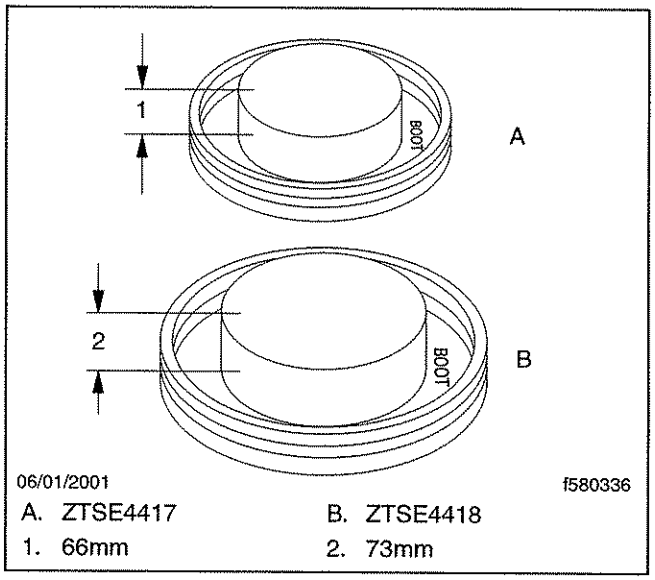
Fig. 6, Installing Piston Boot to Piston

Brake Caliper Rebuild



A. Position the piston square in the bore.
B. Position the installation tool.
C. Press the piston into the bore.
D. Seat the piston in the bore.

Fig. 7, Pressing Pistons into Caliper Bores



A. ZTSE4417
B. ZTSE4418
1. 66mm
2. 73mm

Fig. 8, Piston and Boot Installation Tools

Brake Rotor Removal and Installation

⚠ WARNING

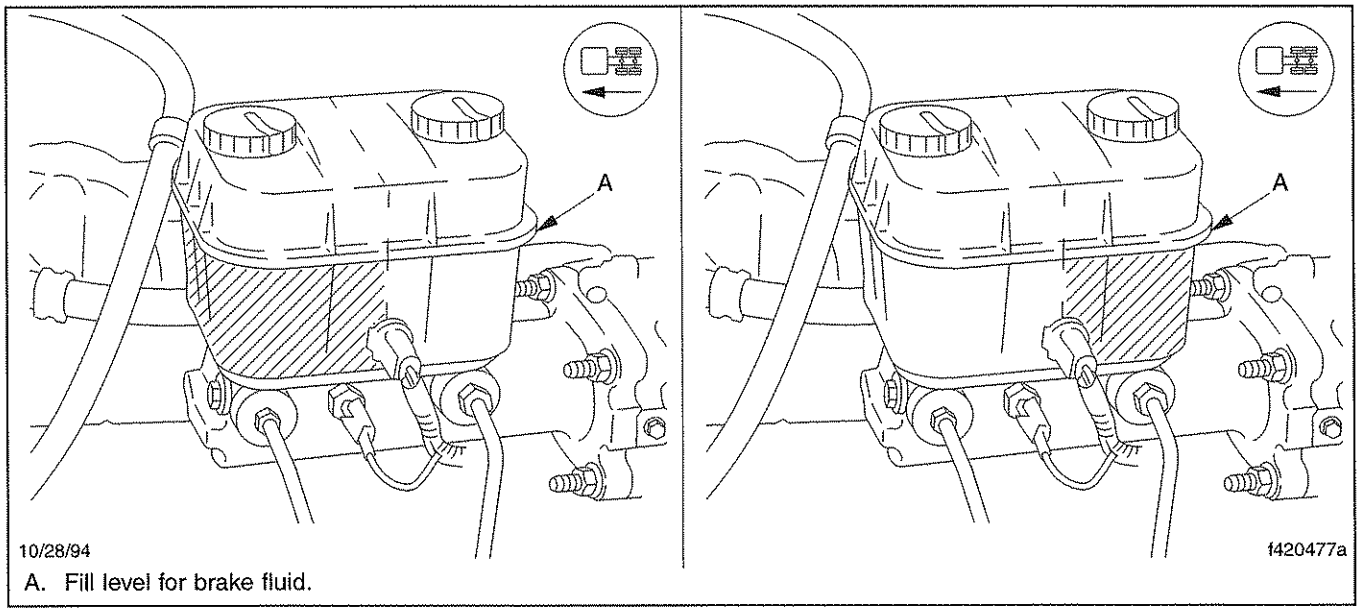
Before starting the procedures below, read the information in Subject 100. Failure to do so could result in serious and permanent health damage.

Removal

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine. Chock the tires.
2. Open the hood.
3. Remove about half the brake fluid from the front section (if removing a front-axle rotor) or the rear section (rear-axle rotor) of the master cylinder reservoir. See **Fig. 1**.
4. Chock the front or rear tires, as required.
5. Jack up the vehicle. Support the axle with jackstands.
6. Remove the tire.
7. Remove the brake caliper from the rotor, following the instructions in **Subject 120**.
8. Remove the hub and rotor assembly from the axle, following the instructions in **Group 33** for the front axle or **Group 35** for the rear axle. Put the hub on the floor so the rotor is facing up.
9. Remove the brake rotor from the wheel hub.
   - 9.1 Remove the hexbolts and washers that attach the rotor to the hub. See **Fig. 2**.
   - 9.2 Lift the brake rotor off the hub.

Installation

1. Visually inspect the rotors for scoring, warping, cracks, bluing or heat spots, or other damage. See **Fig. 3**. If signs of damage are found, the rotor should be resurfaced or replaced.
2. Install the rotor on the wheel hub.
   - 2.1 Position the rotor on the hub as shown in **Fig. 4**. Make sure the holes in the rotor are lined up with those of the hub.
   - 2.2 Install the mounting hexbolts and washers. Using a star pattern, tighten the hexbolts 130 lbf·ft (175 N·m). See **Fig. 5**.
3. Install the hub and rotor assembly on the axle, following the instructions in **Group 33** for the front axle or **Group 35** for the rear axle.



A. Fill level for brake fluid.

Fig. 1, Master Cylinder Reservoir

Brake Rotor Removal and Installation

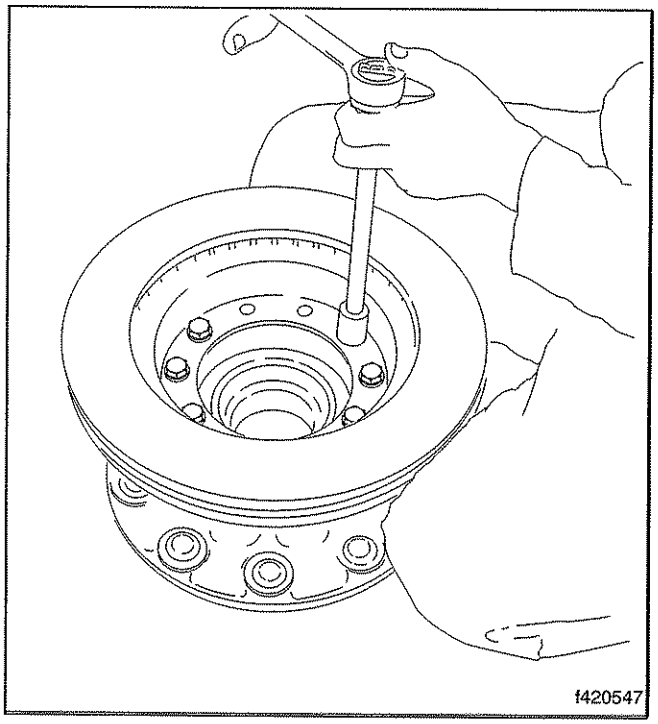
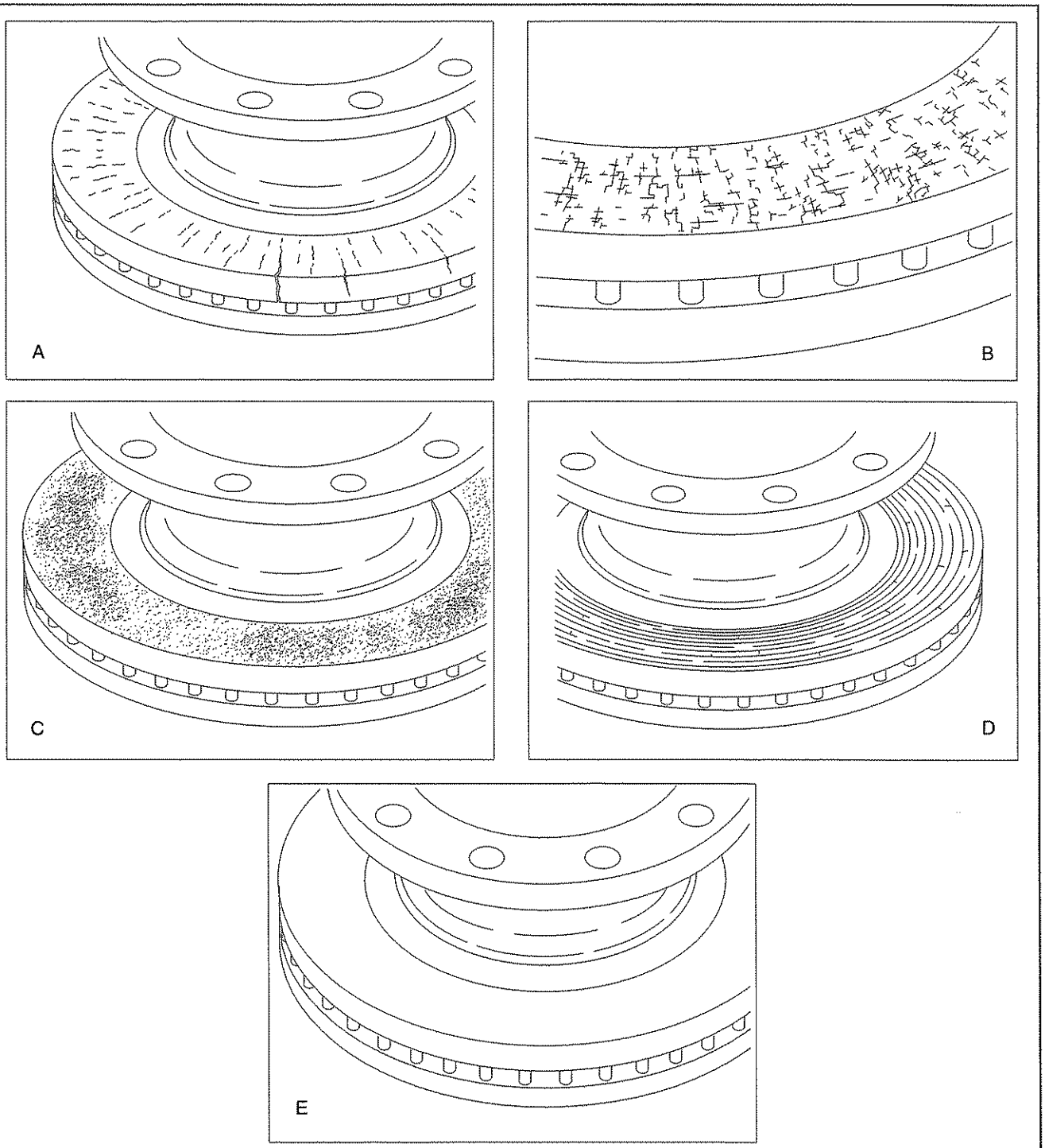


Fig. 2, Rotor-to-Hub Fasteners

4. Check rotor runout and parallelism. For instructions, see **Subject 150**.
5. Install the brake caliper on the rotor, following the instructions in **Subject 120**.
6. Install the tire.
7. Remove the jackstands. Lower the vehicle.
8. Fill the applicable section of the master cylinder reservoir with new DOT 3 approved brake fluid. The brake fluid level should be even with the raised seam on the outside circumference of the reservoir. See **Fig. 1**.
9. Close and latch the hood.
10. Remove the chocks from the tires.



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A. Cracking
B. Heat Checking
C. Discoloration
D. Scoring
E. Normal Finish

Fig. 3, Rotor Surface Check

Brake Rotor Removal and Installation

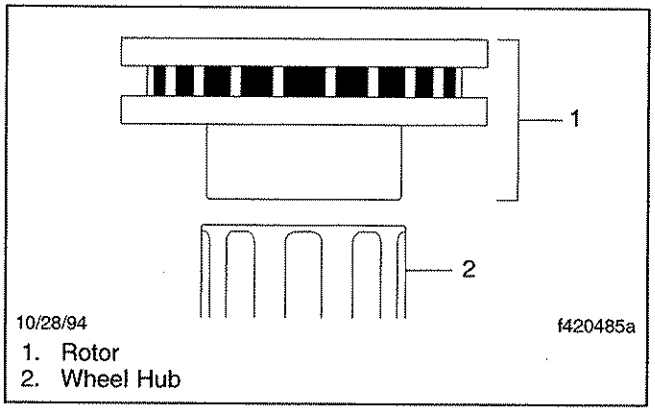


Fig. 4, Rotor-to-Hub Position

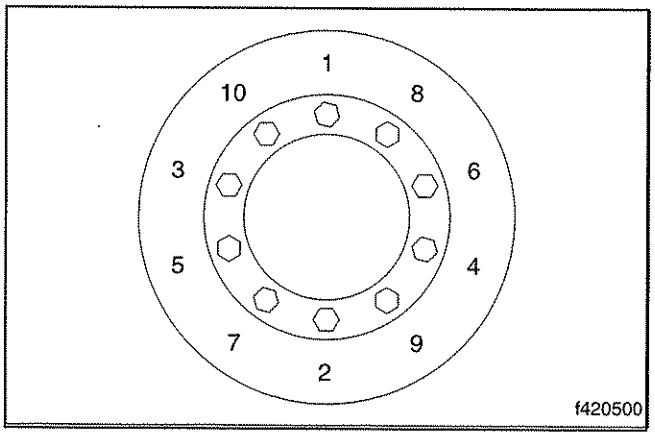


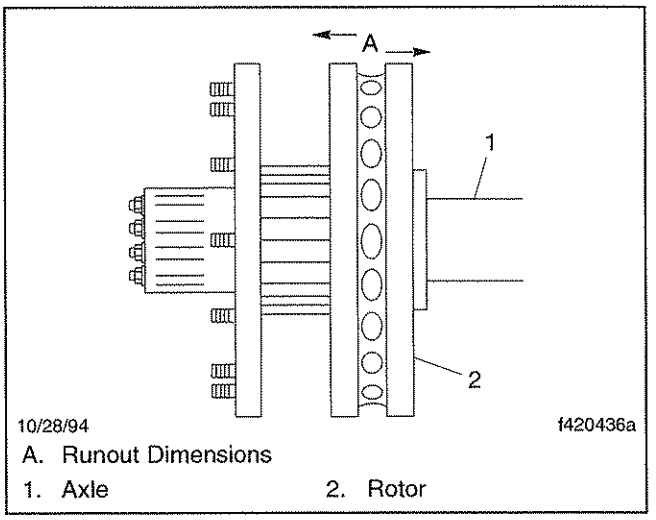
Fig. 5, Tightening Pattern

Brake Rotor Runout and Parallelism Check

Runout Check

Brake rotor runout refers to the amount of lateral wobble the rotor has when it is turning, with the wheel bearings correctly adjusted. See **Fig. 1**. Check the rotor runout whenever you replace the brake pads.

1. If not already done, chock the tires, jack up the axle you are working on and support it with jackstands. Remove the wheels and tires.
2. If working on the rear axle, put the transmission in neutral.
3. Using a dial indicator, measure the amount of runout while spinning the rotor, as shown in **Fig. 2**. Make sure the indicator is centered on the rotor face (between the outer and inner edges).
4. If the runout is more than 0.015 inch (0.38 mm), check that the rotor is securely mounted to the hub. Also check the wheel bearing end-play, following the instructions in **Group 33** for the front axle or **Group 35** for the rear axle.
5. Repeat the runout measurement. If the runout is still more than 0.015 inch (0.38 mm), replace the rotor.



A. Runout Dimensions
1. Axle 2. Rotor

Fig. 1, Brake Rotor Runout

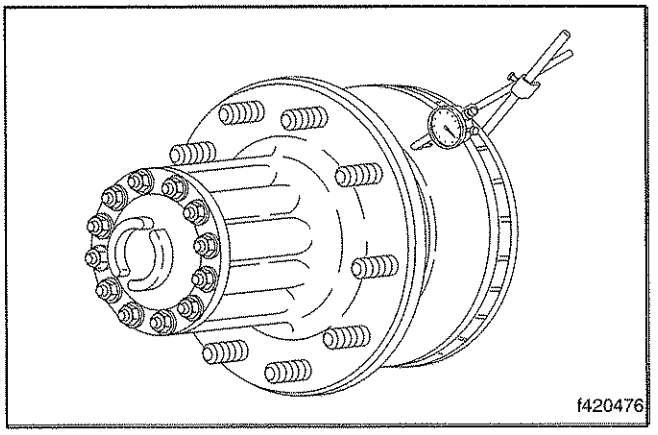


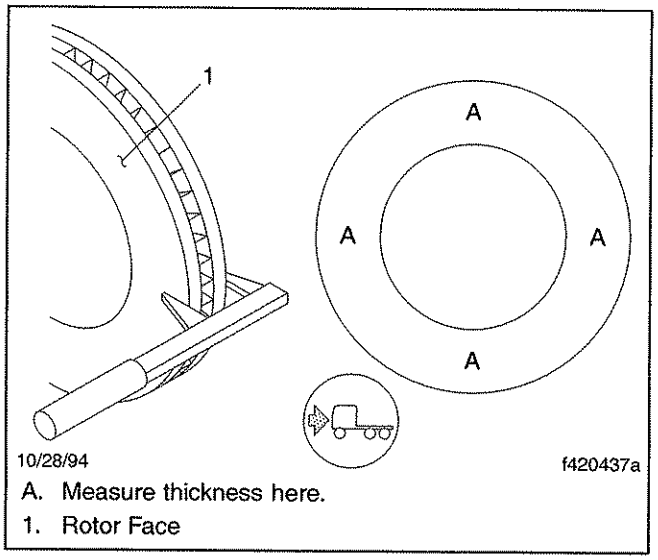
Fig. 2, Measure Runout

Parallelism Check

Parallelism is the difference in rotor thickness at different points around the rotor. It should be checked whenever the brake pads are replaced.

1. Using a vernier caliper or a micrometer, measure the thickness of the rotor (between the inboard and outboard faces) at four or more equally spaced points around the rotor. See **Fig. 3**.
2. If there is a difference of more than 0.005 inch (0.13 mm) between any two measurements, have the rotor resurfaced. If resurfacing will decrease the overall thickness of the rotor to 1.32 inches (33.5 mm) or less, replace the rotor.

Brake Rotor Runout and Parallelism Check



A. Measure thickness here.
1. Rotor Face

Fig. 3, Measure Rotor Thickness

Anchor Plate Disassembly, Clean and Inspection, and Assembly

⚠ WARNING

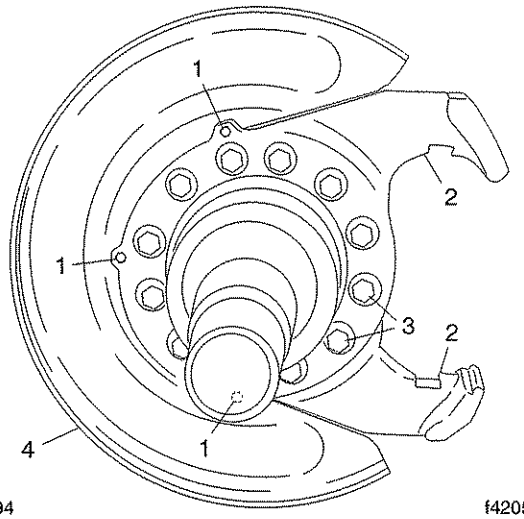
Before starting the procedures below, read the information in Subject 100. Failure to do so could result in serious and permanent health damage.

Disassembly

1. Park the vehicle on a level surface. Chock the rear or front tires, as required.
2. Jack up the vehicle. Support the axle with jack-stands.
3. Remove the tire.
4. Remove the brake caliper from the anchor plate following the instructions in **Subject 120**.
5. Remove the tie bar from the anchor plate on 73mm brakes, or remove the plugs from the anchor plate on 66mm brakes.
6. Remove the brake pads from the anchor plate. For instructions, see **Subject 110**.
7. Remove the wheel hub and rotor assembly from the axle, following the instructions in **Group 33** for the front axle or **Group 35** for the rear axle.
8. Remove the anchor plate from the axle.
   - 8.1 Remove the three screws holding the dust shield to the anchor plate and remove the dust shield.
   - 8.2 Remove the hexbolts, washers and nuts that hold the anchor plate to the axle. See **Fig. 1**.
   - 8.3 Remove the anchor plate from the axle.
9. Remove contamination, dirt and debris from the exterior of the anchor plate.
10. Remove the brake pad abutment slipper using a blunt nose drift pin or screwdriver and a light hammer. Avoid marring the anchor plate abutment surfaces. See **Fig. 2**.
11. Remove the guide pins and guide pin boots by pulling out the guide pin with a slight twisting motion.
12. Remove the splash shield and antilock braking system sensor bracket from the anchor plate. See **Fig. 3**.

Clean and Inspection

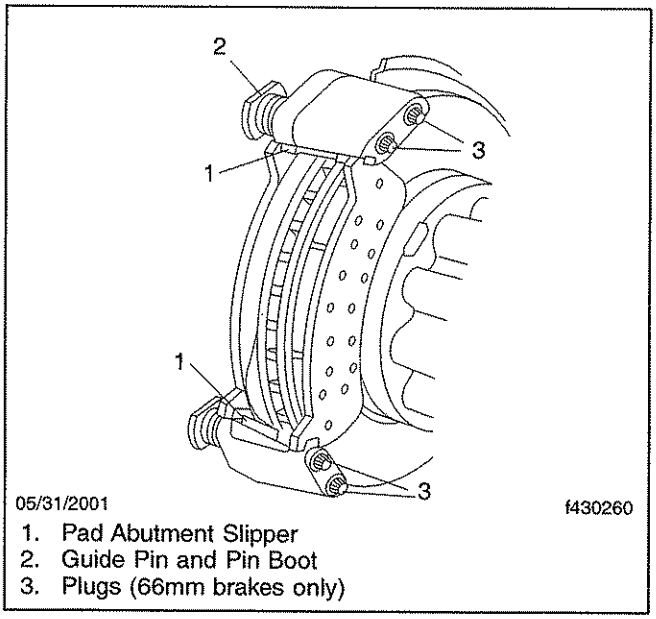
1. Clean the anchor plate with a brush and solvent. Make sure the anchor plate abutments, anchor plate tie bar mounting surfaces, axle flange mounting surface and anchor plate boot grooves are clean and free of any rust or corrosion. See **Fig. 4**. Use a hand-held wire brush to clean these surfaces. It is important to clean these areas of the anchor plate. Also make sure the tie bar bolt hole threads are clean and free of foreign matter.
2. Clean the guide pin bores with a bore brush and solvent. Use compressed air to clean out and dry guide pin bores. Check the guide pin bores for excessive wear. Replace the anchor plate, if necessary.
3. Clean the guide pin boots with isopropyl alcohol. Do not use solvent to clean the boots. Inspect each guide pin boot for cracks, tears, holes and flexibility. If damage is found, the boot must be replaced. See **Fig. 5**.



1. Dust Shield Screw
2. Anchor Plate
3. Mounting Hexbolts
4. Dust Shield

Fig. 1, Axle End (typical)

Anchor Plate Disassembly, Clean and Inspection, and Assembly



1. Pad Abutment Slipper
2. Guide Pin and Pin Boot
3. Plugs (66mm brakes only)

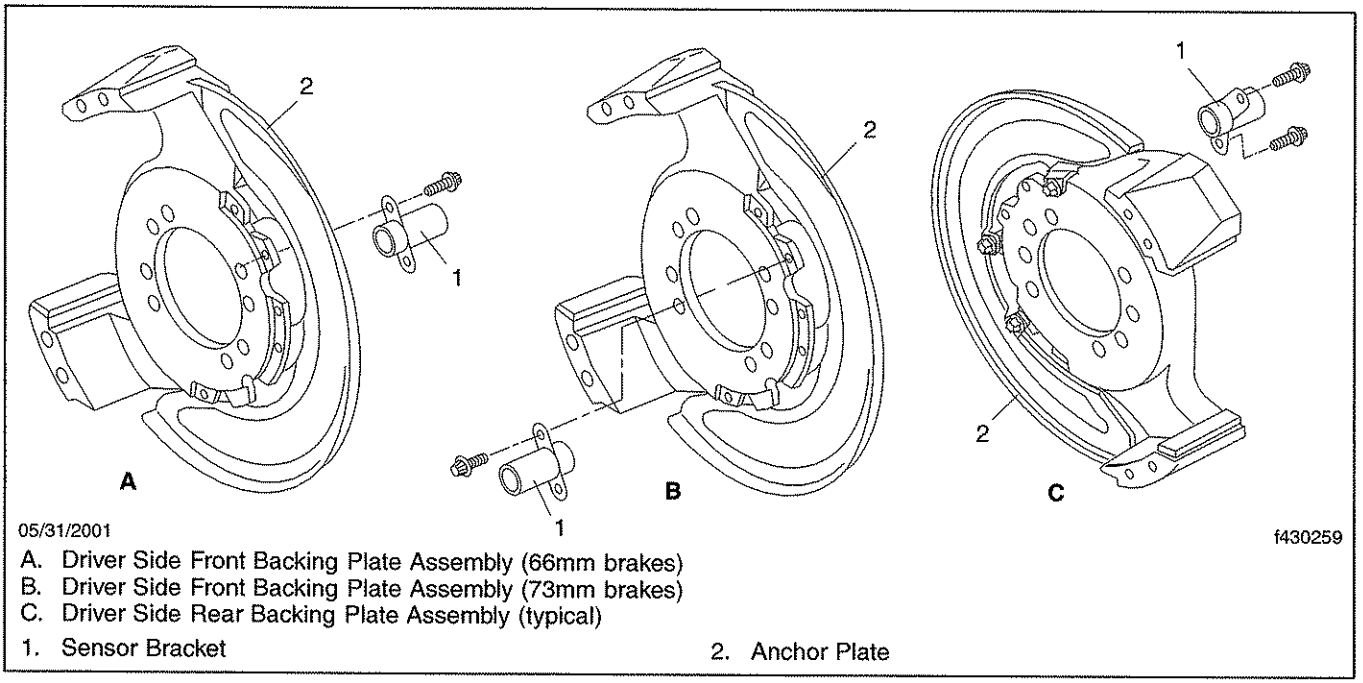
Fig. 2, Anchor Plate Components

4. Clean the guide pins with isopropyl alcohol. Make sure the guide pins, and the threads in the guide pins, are free of foreign matter and corrosion. Use compressed air to clean out and dry guide pins and bolt threads in the guide pins. Check the guide pins for wear. Replace them if excessive wear is detected.
5. Inspect the pad abutment slippers for damage or wear and clean them with solvent. Replace them if damaged or excessive wear is detected.
6. Visually inspect the anchor plate for worn or damaged slippers, and damaged or dislodged guide pin boots. If signs of wear or damage are found, the anchor plate should be repaired or replaced.

Assembly

NOTE: All brake parts must be clean and completely dry of cleaning fluids before assembly.

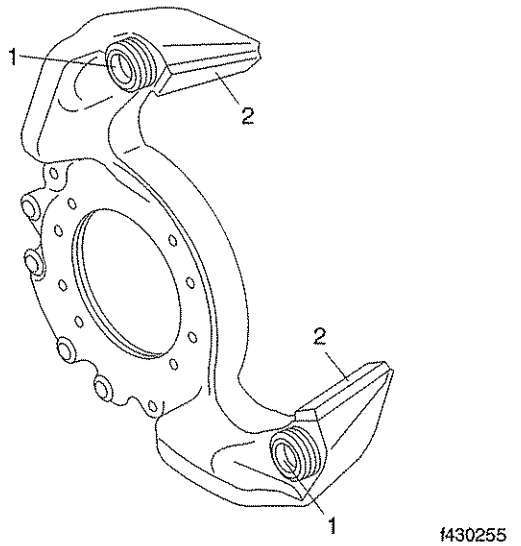
1. Uniformly apply Aeroshell Grade 5 grease to the entire guide pin bore and on the guide pin shaft. Use 1/8 ounce (3 grams) of grease to thoroughly lube each guide pin and guide pin bore set. See **Fig. 6**.
2. Apply a thin coat of Aeroshell Grade 5 grease to the inside opening at each end of the boot.
3. Slide the guide pin into the guide pin boot.



A. Driver Side Front Backing Plate Assembly (66mm brakes)
B. Driver Side Front Backing Plate Assembly (73mm brakes)
C. Driver Side Rear Backing Plate Assembly (typical)
1. Sensor Bracket
2. Anchor Plate

Fig. 3, Splash Shield and Sensor Mounting Bracket

Anchor Plate Disassembly, Clean and Inspection, and Assembly

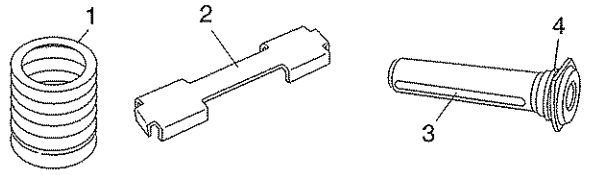


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1. Guide Pin Bore and Boot Groove
2. Pad Abutment Slipper Mounting

Fig. 4, Anchor Plate Machined Surfaces

4. Insert the guide pin with the boot into the anchor plate guide pin bore until the boot is completely compressed.
5. Rotate the guide pin 1/4 to 1/2 turn back and forth in order to seat the guide pin boot.



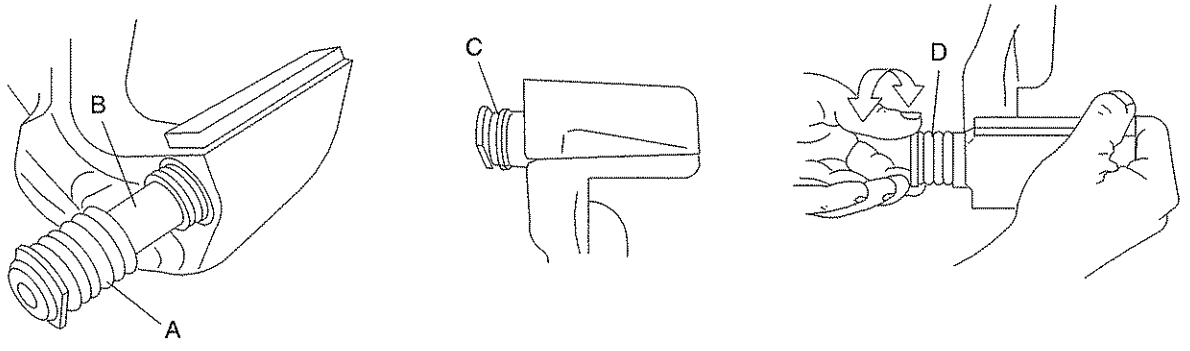
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1. Guide Pin Boot
2. Pad Abutment Slipper
3. Guide Pin
4. Boot Groove

Fig. 5, Loose Anchor Plate Components

6. Inspect the guide pin boot to make sure the boot is fully seated all around the guide pin and the anchor plate retaining grooves.
7. Install an anchor plate pad abutment slipper onto each anchor plate abutment. See **Fig. 7**. Use a soft brass or other light hammer to be sure the slipper is seated on the abutment. Avoid marring anchor plate abutment slipper surfaces.
8. Install the splash shield and antilock braking system sensor bracket to the anchor plate.

   When installing the splash shield and sensor bracket on the anchor plate for 66mm front and all rear brakes, the splash shield and sensor bracket are mounted on the inboard side of the anchor plate and the five bolts are installed from the inboard side. Tighten the bolts 12 to 16 lbf·ft (17 to 21 N·m).



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A. Lube the inside of the boot, both ends.
B. Apply Aeroshell Grade 5 grease to the bore and the pin.
C. Boot and pin in place.
D. Twist to seat in the groove.

Fig. 6, Install Guide Pins and Boots

Anchor Plate Disassembly, Clean and Inspection, and Assembly

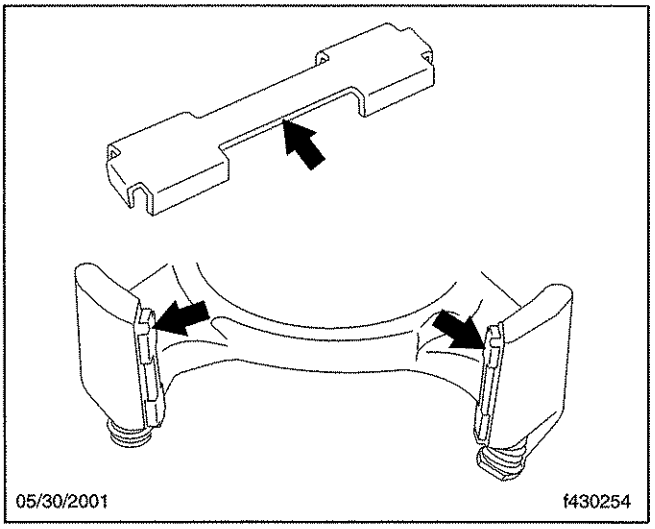
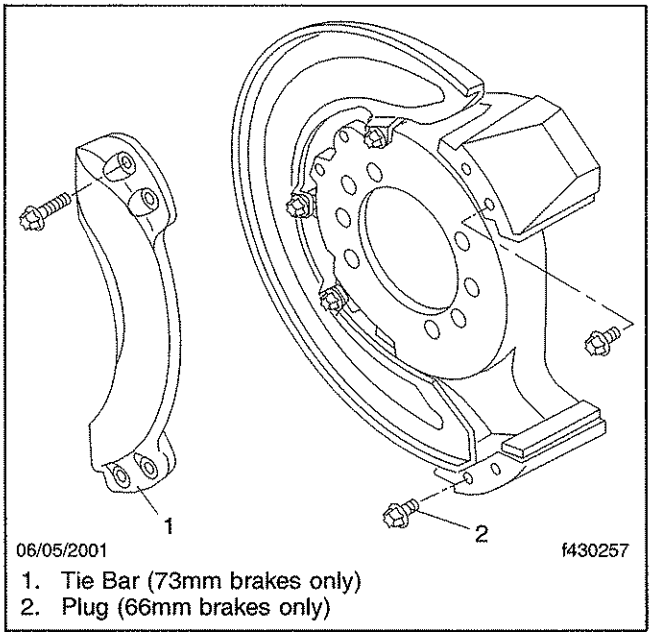


Fig. 7, Pad Abutment Slipper

For 73mm front brakes, the splash shield and sensor bracket are mounted on the outboard side of the anchor plate and the five bolts are installed from the outboard side. Tighten the bolts 12 to 16 lbf·ft (17 to 21 N·m).

9. Remove all traces of dirt, grease and oil from the knuckle and axle brake flange.
10. Install the anchor plate on the axle.
    - 10.1 Position the anchor plate against the outboard side of the axle flange, making sure the holes in both are lined up.
    - 10.2 From the outboard side of the anchor plate, install the hexbolts and washers. Install the nuts and remaining washers. See **Fig. 1**. Using a star pattern, tighten the hexnuts as follows:
      - Rear Axle; 105 lbf·ft (142 N·m)
      - Front Axle Type FC; 75 lbf·ft (102 N·m)
      - Front Axle Type FD/FF; 145 lbf·ft (197 N·m)
11. Install the dust shield on the anchor plate. See **Fig. 1**.
12. Install the wheel hub and rotor assembly onto the axle, following the instructions in **Group 33** for the front axle or **Group 35** for the rear axle.
13. On 66mm brakes, install the four bolt plugs into the anchor plate face. Tighten 16 to 27 lbf·ft (22 to 37 N·m). See **Fig. 8**.

    On 73mm brakes, install the anchor plate tie bar and the four tie bar bolts to the anchor plate face. Tighten 40 to 50 lbf·ft (54 to 68 N·m).
14. Install the brake caliper on the anchor plate following the instructions in **Subject 120**.
15. Install the brake pads into the anchor plate. For instructions, see **Subject 110**.
16. Install the tire.
17. Remove the jackstands. Lower the vehicle.
18. Remove the chocks.



1. Tie Bar (73mm brakes only)
2. Plug (66mm brakes only)

Fig. 8, Plugs and Tie Bar

Bleeding

⚠ WARNING

Before starting the procedure below, read the information in Subject 100. Failure to do so could result in serious and permanent health damage.

Whenever any hydraulic system fitting is loosened or disconnected, the entire system must be bled to remove any air that may have entered it.

⚠ CAUTION

Power steering fluid and brake fluid are incompatible. Never mix these two fluids or serious damage to both hydraulic systems will result. Use only brake fluid for the master cylinder and brake lines. Use only power steering fluid for the power booster.

Always use new, clean brake fluid that meets DOT 3 specifications when bleeding the master cylinder and service brake system. Never reuse brake fluid and do not use brake fluid containers for any other purpose. Keep brake fluid containers tightly closed to keep new brake fluid clean and dry.

IMPORTANT: Do not let brake fluid touch any painted surfaces, as it will remove the paint. Brake fluid may also damage certain non-metal surfaces. Do not let it get on brake pads or rotors.

Pressure Bleeding

NOTE: Pressure bleeding is the preferred method for bleeding the service brake system. It requires the use of a special pressure bleeder kit, consisting of a tank, pressure pump and valve, gauge, tubing and adapter. These are available from a number of manufacturers and include instructions for use. See **Fig. 1**.

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine. Chock the rear tires.
2. Open the hood.
3. Connect the pressure bleeder to the brake master cylinder reservoir following the manufacturer's instructions.
   - 3.1 Fill the pressure bleeder with new DOT 3 approved brake fluid. Pressurize it according to the manufacturer's instructions.
   - 3.2 Using the supplied adapter, connect the pressure bleeder to the rear compartment of the master cylinder reservoir.
4. Bleed the hydraulic connections at the rear wheel calipers starting on the right side.
   - 4.1 Put a wrench on the bleeder fitting at the caliper. Attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. See **Fig. 2**.
   - 4.2 Loosen the bleeder fitting about 3/4 turn and let the brake fluid flow out of the fitting until it is free of air bubbles. Tighten the fitting firmly.
   - 4.3 Move to the left rear caliper and repeat steps for bleeding the caliper.
5. Disconnect the pressure bleeder from the rear compartment of the master cylinder reservoir. Connect it to the front compartment of the reservoir.
6. Bleed the front wheel brake calipers starting at the right side.

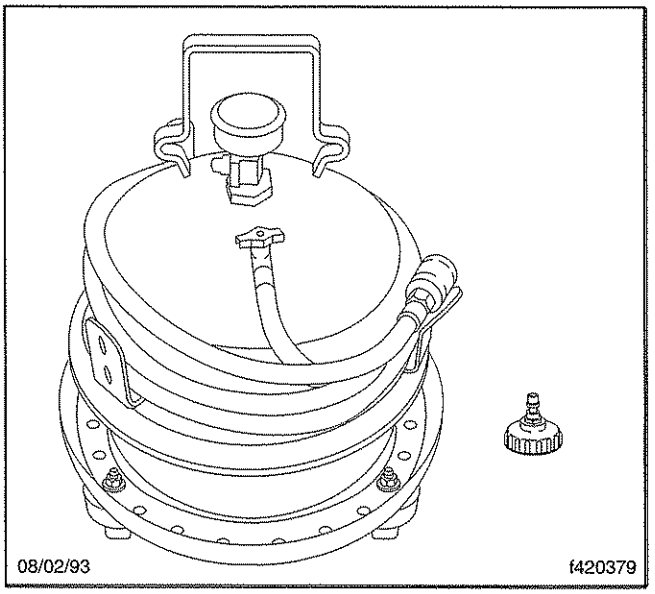


Fig. 1, Pressure Bleeder Kit

System Bleeding

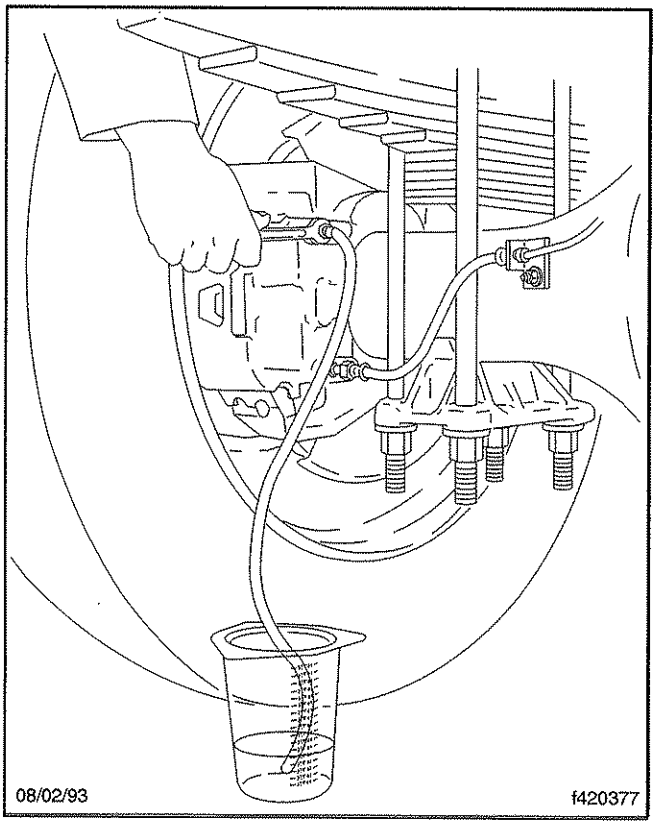


Fig. 2, Bleed the Hydraulic Connection

6.1 Put a wrench on the bleeder fitting at the caliper. Attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. See **Fig. 2**.

6.2 Loosen the bleeder fitting about 3/4 turn and let the brake fluid flow out of the fitting until it is free of air bubbles. Tighten the fitting firmly.

6.3 Move to the left front wheel caliper and repeat steps for bleeding the caliper.

7. Check the brake fluid level in both compartments of the reservoir. Add new DOT 3 approved brake fluid if needed.

8. Check the operation of the brakes by depressing the brake pedal several times, until if feels firm. The brake pedal should not go all the way down to the floor. If it does, see **Troubleshooting, 300** and find the problem.

9. Close and latch the hood.

10. Remove the chocks from the rear tires.

Manual Bleeding

NOTE: If you do not have pressure bleeding equipment, you can use the manual bleeding procedure.

⚠ WARNING

Read over the information in Subject 100 before starting the procedure below. Failure to do so may result in either serious injury to yourself, or damage to the brake system, resulting in an accident causing serious personal injury or property damage.

IMPORTANT: Do not let the brake master cylinder run dry during manual bleeding operations. Keep the master cylinder reservoir filled with new, DOT 3 approved brake fluid. Failure to keep the brake reservoir filled could result in more air entering the system, making it impossible to effectively bleed the system.

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine. Chock the rear tires.

2. Open the hood.

3. Bleed the master cylinder.

3.1 Using a wrench (and a rag to absorb leaking brake fluid), loosen the fitting at the rear outlet port on the master cylinder. See **Fig. 3**. Loosen the fitting about one turn.

3.2 Have someone push the brake pedal down slowly by hand to the floor. Brake fluid, and any air in the master cylinder, will squirt from the fitting.

3.3 *With the brake pedal held down*, tighten the rear hydraulic line fitting firmly.

IMPORTANT: Do not release the brake pedal until the fitting is tightened, or more air will get into the system.

3.4 Release the brake pedal.

3.5 Loosen the fitting again, and repeat steps for bleeding as required until no air escapes from the fitting, and the brake pedal feels firm.

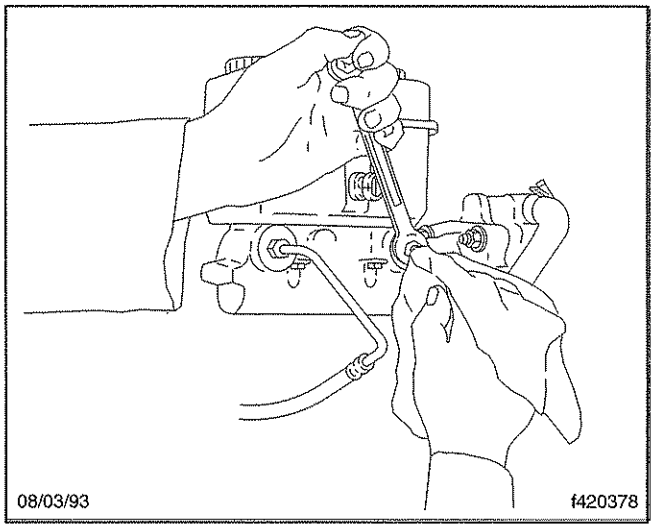


Fig. 3, Rear Outlet Port

3.6 Check the level of the rear compartment of the reservoir, then add new DOT 3 approved brake fluid if needed.

3.7 Using a wrench (and a rag to absorb leaking brake fluid), loosen the fitting at the front outlet port on the master cylinder. See **Fig. 4**. Loosen the fitting about one turn.

3.8 Repeat steps as required for the front outlet port.

3.9 Check the brake fluid level in the front compartment of the reservoir. Add new DOT 3 approved brake fluid if needed.

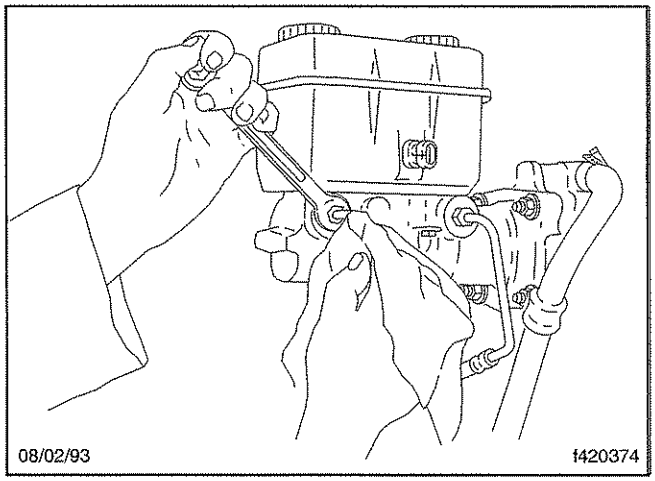


Fig. 4, Front Outlet Port

4. Bleed the hydraulic connections at the wheel calipers, starting at the right rear wheel caliper.

   4.1 Put a wrench on the bleeder fitting at the caliper, then attach a length of clear tubing to the bleeder fitting. Make sure the tube fits snugly. Submerge the tubing in a container of clean brake fluid. See **Fig. 2**.

   4.2 Loosen the bleeder fitting about 3/4 turn.

   4.3 Have someone slowly push the brake pedal to the floor. *With the brake pedal depressed*, tighten the bleeder fitting.

   IMPORTANT: Make sure the brake pedal stays depressed while you tighten the fitting. If it is released before you tighten the fitting, more air will get into the system.

   4.4 Release the brake pedal. Check the fluid in the tube. If there are air bubbles present, repeat the steps as required until the fluid in the tube is completely free of air bubbles.

   4.5 Check the brake fluid level in the reservoir. Add new DOT 3 approved brake fluid if needed.

   4.6 Repeat the steps for bleeding the connections for the left rear caliper, the right front caliper and the left front caliper.

5. Close and latch the hood.

6. Remove the chocks from the rear tires.

Troubleshooting Tables

Problem—Noise and Chatter

Problem—Noise and Chatter	
Possible Cause	**Remedy**
Bent, damaged or incorrect pads	Replace with the correct pads in axle sets.
Worn out lining plates (plates rubbing rotor)	Resurface or replace the rotor. Replace the pads in axle set.
Rotor polished or linings glazed	Remove the polish or glaze.
Foreign material embedded in linings	Replace the pads in axle sets.
Excessive rotor thickness variations or lateral runout	Resurface or replace the rotor.

Problem—Brakes Grab

Problem—Brakes Grab	
Possible Cause	**Remedy**
Incorrect pads or pads loose on plate	Replace with the correct pads in axle sets.
Grease or brake fluid on linings	Repair the grease seal or caliper. Replace the pads in axle sets.
Loose caliper at anchor plate pins	Tighten to specifications.
Excessive rotor lateral runout	Check the bearing adjustment. Resurface or replace the rotor.

Problem—Vehicle Pulls to One Side

Problem—Vehicle Pulls to One Side	
Possible Cause	**Remedy**
Incorrect pads or loose lining on plates	Replace with the correct pads in axle sets.
Grease or brake fluid on linings	Repair the grease seal or caliper. Replace the pads in axle sets.
Loose caliper or anchor plate	Tighten to specifications.
Caliper piston sticking	Repair or replace the piston or replace the caliper.
Caliper guide pins sticking	Repair or replace the guide pins and boots. Clean the pin bores and lubricate.
Excessive rotor lateral runout	Check the bearing adjustment. Resurface or replace the rotor.

Problem—Pulsating Brake Pedal

Problem—Pulsating Brake Pedal	
Possible Cause	**Remedy**
Worn or damaged front wheel bearings	Replace the wheel bearings.
Excessive variation in rotor thickness	Resurface or replace the rotor.

Troubleshooting

Problem—Springy or Spongy Pedal

Problem—Springy or Spongy Pedal	
Possible Cause	**Remedy**
Excessive rotor lateral runout	Resurface or replace the rotor.
Poor quality brake fluid (low boiling point)	Drain and clean the system. Refill with the approved brake fluid.
Weak brake hoses that expand under pressure	Replace the hoses.
Air in hydraulic system	Bleed the system. For instructions, see **Subject 170**.

Problem—All Brakes Drag (or Both Brakes on Same Axle)

Problem—All Brakes Drag (or Both Brakes on Same Axle)	
Possible Cause	**Remedy**
Binding brake pedal	Free-up and lubricate the pedal.
Soft or swollen rubber parts caused by incorrect or contaminated brake fluid	Replace rubber parts. Flush the system and refill with approved brake fluid. For instructions, see **Subject 170**.
Trapped pressure in brake lines caused by master cylinder and/or booster not fully releasing	Repair or replace the master cylinder and/or booster as necessary.

Problem—One Brake Drags

Problem—One Brake Drags	
Possible Cause	**Remedy**
Loose or worn front wheel bearings	Adjust to specifications or replace.
Defective brake hose or hydraulic tube (preventing return of fluid)	Replace the hose or tube.
Sticking caliper piston	Repair or replace the caliper.
Swollen caliper piston seal	Replace the seal. Drain and flush the system. Refill with the approved brake fluid.
Sticking caliper guide pin(s)	Repair or replace the pin(s). Lubricate the pins and boots.

Problem—Low Pedal

Problem—Low Pedal	
Possible Cause	**Remedy**
Leak in hydraulic brake system	Check the master cylinder, calipers, hoses and tubes. Replace as necessary.
Air in hydraulic brake system	Bleed the system. For instructions, see **Subject 170**.
Poor quality brake fluid (low boiling point)	Drain the system. Flush and refill with approved brake fluid.
Weak brake hoses that expand under pressure	Replace the defective hoses.
Pad and piston knockback caused by loose wheel bearings	Adjust or tighten parts or replace faulty parts as necessary.

Specifications

Kent-Moore Tools	
Kent-Moore Part Number	**Tool**
ZTSE4417	Seating Tool for 66mm Caliper Pistons
ZTSE4418	Seating Tool for 73mm Caliper Pistons

Table 1, Kent-Moore Tools

Fastener Torques			
Description	**Size**	**Grade**	**Torque lbf.ft (N.m)**
Caliper Pin Mounting Bolts	M12 x 1.75	—	70–80 (95–108)
Brake Supply Hose Fitting	—	—	15 (20)
Tie Bar-to-Anchor Plate Mounting Bolt (73mm only)	M10 x 1.5	—	40–50 (54–68)
Tie Bar-to-Anchor Plate Hole Plug (66mm only)	M10 x 1.5	—	16–27 (22–37)
Splash Shield, ABS Sensor Mounting Bracket and Brake Line Clip Screw	5/16–18	—	12–16 (17–21)
Anchor Plate Mounting Hexnuts	—	—	Rear Axle: 105 (142) Front Axle Type FC: 75 (102) Front Axle Type FD/FF: 145 (197)
Caliper Bleed Screw	7/16–24	—	8–15 (10–20)
Rotor Mounting Hexbolts	9/16–12	8	130 (175)

Table 2, Fastener Torques

Approved Brake Fluid for Brake System	
Fluid Type	**Recommended Fluids**
DOT 3	Wagner-Premium Plus Super HD
	Delco Supreme II
	Dow HD 50-4

Table 3, Approved Brake Fluid for Brake System

Approved Brake System Grease	
Component	**Recommended Grease**
Anchor Plate Guide Pins, Guide Pin Boots, Guide Pin Bores	Aeroshell Grade 5 (ES-1246)
Caliper Piston Bores	Dow Corning DC-4

Table 4, Approved Brake System Grease

Component Specifications		
Item	**66mm Caliper**	**73mm Caliper**
Lining, Per Pad		
Thickness, New	0.49 inch (12.45 mm)	0.74 inch (18.79 mm)
Thickness, Discard	3/32 inch (2.38 mm)	
Area	20.85 square inch (530 square mm)	
Volume	10.22 cubic inch (259.59 cubic mm)	15.43 cubic inch (391.92 cubic mm)
Rotor (Typical)		
Outside Diameter	15.0 inch (381 mm)	

Specifications

Component Specifications		
Item	**66mm Caliper**	**73mm Caliper**
Thickness, New	1.435 inch (36.45 mm)	
Thickness, Discard	1.320 inch (33.53 mm)	
Total Swept Area	52.02 square inch (1321.31 square mm)	
Surface Finish	40–120 micro inch 40–100 micro inch (preferred)	
Torque Output (Typical), Post Burnish at 1800 psi*		
30 mph	83,800 lbf.in (946 820 N.cm)	106,100 lbf.in (1 198 780 N.cm)
60 mph	67,600 lbf.in (763 780 N.cm)	78,400 lbf.in (885 802 N.cm)
Caliper Fluid Displacement at 1800 psi		
Static†	0.38 cubic inch (9.65 cubic mm)	0.55 cubic inch (13.97 cubic mm)
Dynamic*	0.58 cubic inch (14.73 cubic mm)	0.82 cubic inch (20.83 cubic mm)
Reservoir Fluid Requirement Per Caliper (Typical)	10.24 cubic inch (260.09 cubic mm)	19.16 cubic inch (486.66 cubic mm)

* Typical, may change with friction material and wheel load.
† Typical, may change with friction material.

Table 5, Component Specifications