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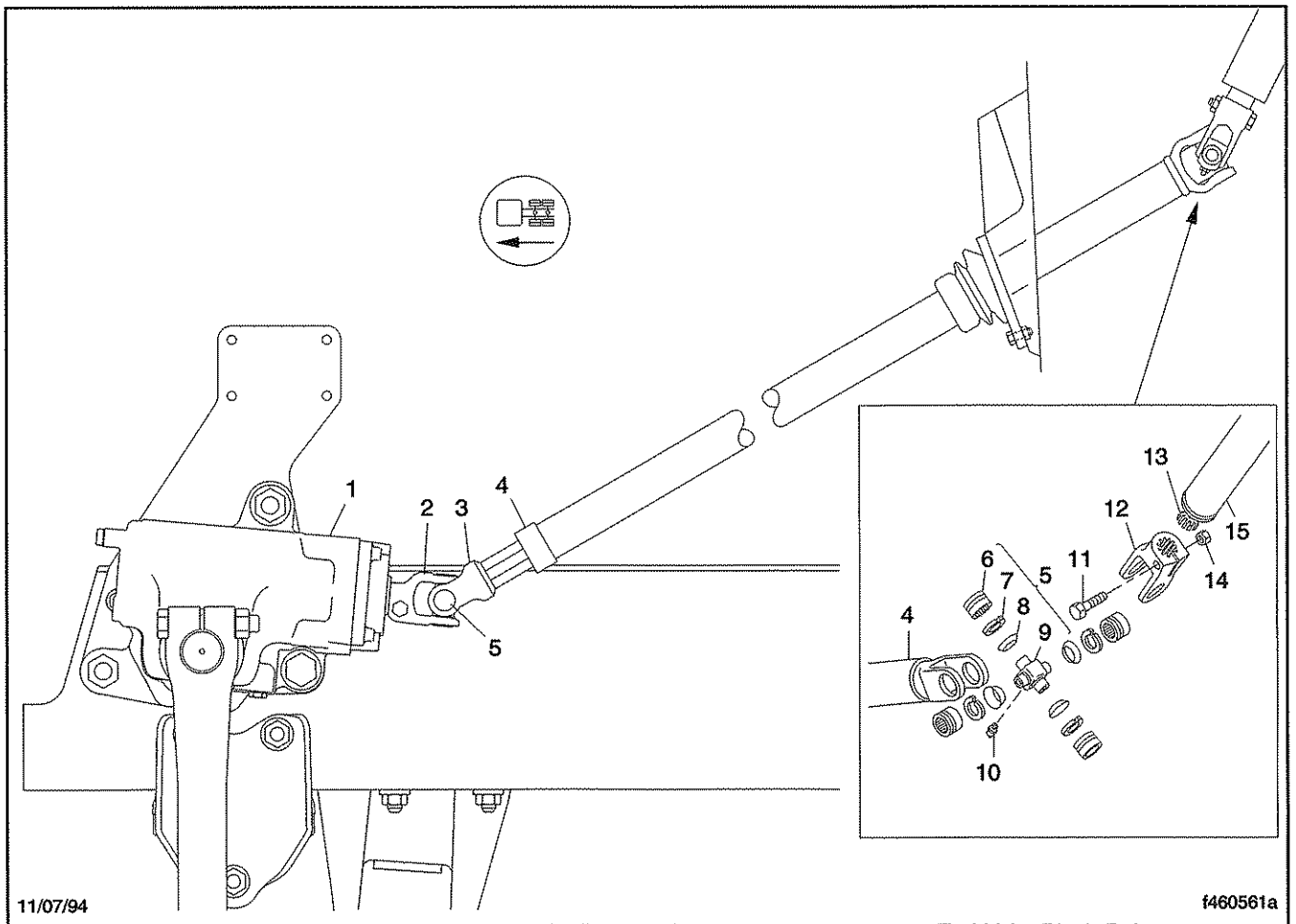
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General Description

The steering driveline connects the steering column and jacket assembly to the steering gear by means of a telescoping shaft with integral yokes, an upper and a lower end yoke, and a pair of universal joints. **See Fig. 1.**

The driveline shaft consists of a tubular upper section, splined on the inside, which mates with an externally splined lower section. The telescoping shaft eases installation and removal of the steering column, steering driveline, and steering gear. It also compensates for changes in distance between the steering column and steering gear, which occur when the relative positions of the frame rails and cab change during vehicle operation.

The upper end yoke is internally serrated to match the external serrations at the end of the steering column



1. Ross Integral Power Steering Gear
2. Lower End Yoke
3. Driveline Shaft and Yoke Assembly
4. Driveline Tube and Yoke Assembly
5. U-Joint Assembly
6. Needle Bearing Cup
7. Needle Bearing Cup Snap Ring
8. U-Joint Cross Seal
9. U-Joint Cross
10. U-Joint Cross Lube Fitting
11. End Yoke Pinch Bolt
12. Upper End Yoke
13. Steering Column Shaft
14. Pinch-Bolt Nut
15. Upper Column and Jacket Assembly

Fig. 1, Steering Driveline

General Description

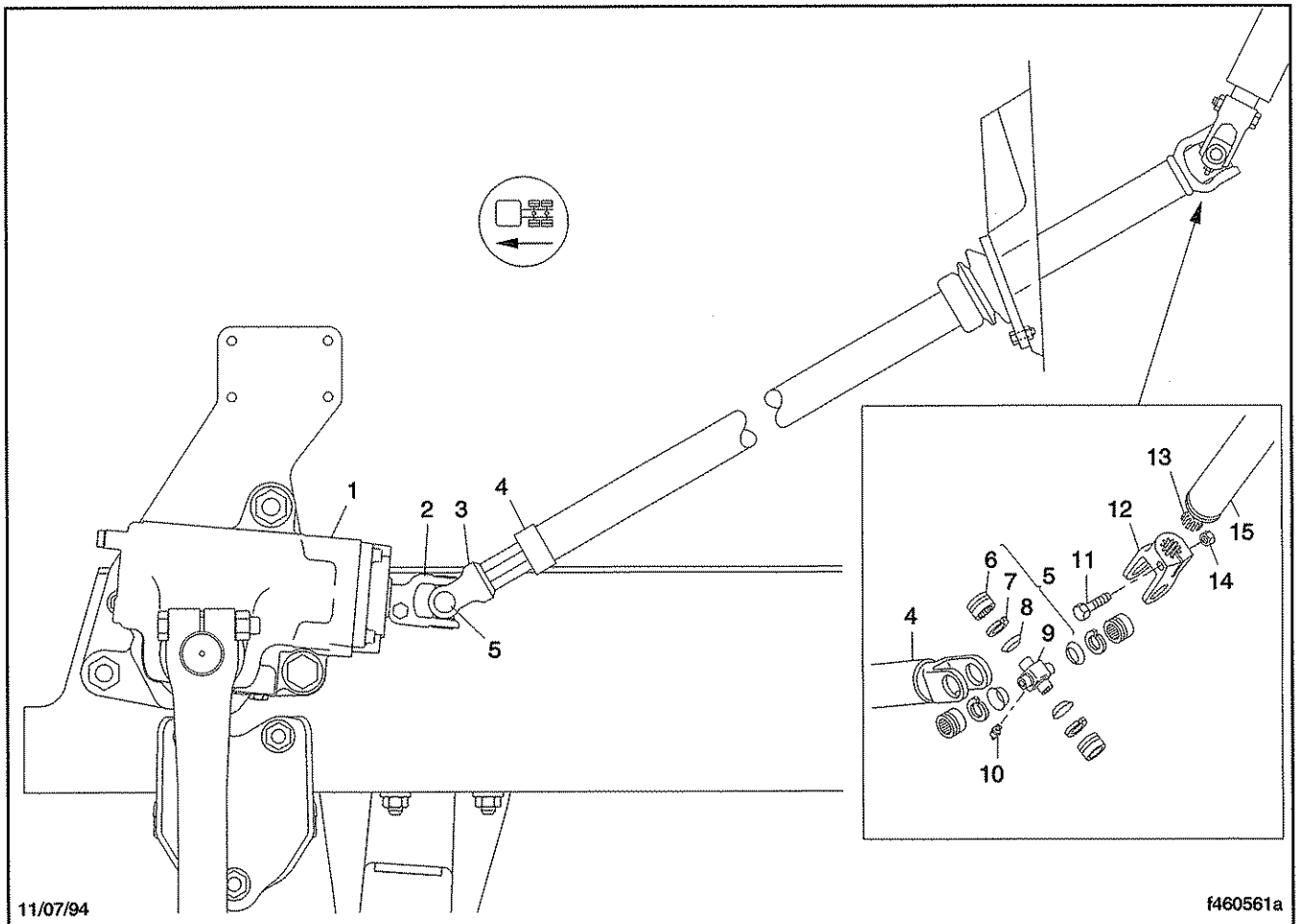
shaft; the lower end yoke is internally serrated to match the external serrations on the steering gear input shaft. Each end yoke is secured to its respective shaft by a pinch bolt that engages a notch in the shaft.

The universal joint at each end of the steering driveline allows the transfer of steering motion from the steering column shaft, to the steering driveline, and to the steering gear input shaft, even though the driveline is at an angle to both of the other shafts. Each universal joint cross rides in four needle bearing cups, two carried in the end yoke, and two carried in the steering driveline's integral yoke. The needle bearing cups are held in place in each yoke by snap rings.

Removal (See Fig. 1)

NOTE: It is not necessary to loosen the steering wheel and column assembly to do this procedure.

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be done.
2. Apply the parking brakes, and chock the tires. Tilt the hood.
3. Disconnect the lower end yoke.
   - 3.1 Remove the pinch-bolt nut and pinch bolt from the lower end yoke. **See Fig. 2.** Discard the nut.
   - 3.2 Remove the yoke from the steering gear input shaft. **See Fig. 3.** Don't turn the



1. Ross Integral Power Steering Gear
2. Lower End Yoke
3. Driveline Shaft and Yoke Assembly
4. Driveline Tube and Yoke Assembly
5. U-Joint Assembly
6. Needle Bearing Cup
7. Needle Bearing Cup Snap Ring
8. U-Joint Cross Seal
9. U-Joint Cross
10. U-Joint Cross Lube Fitting
11. End Yoke Pinch Bolt
12. Upper End Yoke
13. Steering Column Shaft
14. Pinch-Bolt Nut
15. Upper Column and Jacket Assembly

Fig. 1, Steering Driveline

Removal and Installation

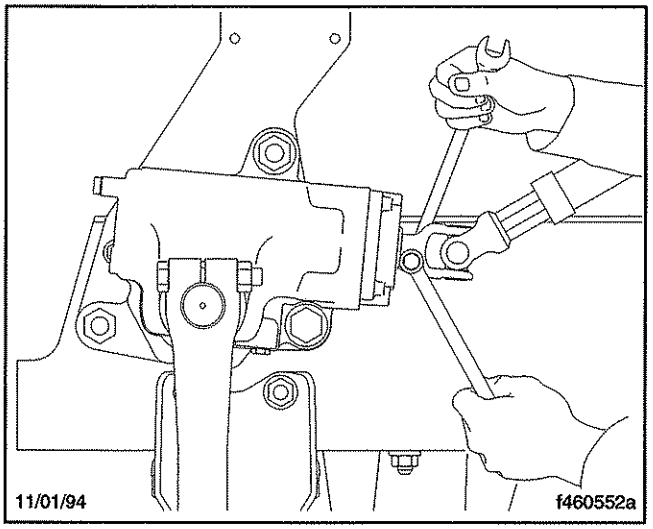


Fig. 2

steering gear input shaft when removing the lower end yoke. Push the driveline shaft into the driveline tube, as you remove the lower end yoke.

4. Disconnect the upper end yoke.

   4.1 Remove the four screws holding the steering driveline boot to the firewall. **See Fig. 4.**

   4.2 Slide the boot down the steering driveline. **See Fig. 5.**

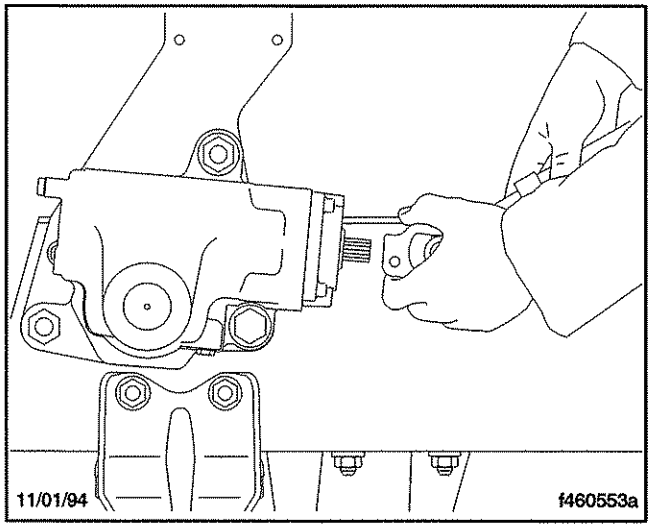


Fig. 3

   4.3 Remove the pinch-bolt nut and pinch bolt from the upper end yoke. **See Fig. 6.** Discard the nut.

   4.4 Remove the upper end yoke from the steering column shaft. **See Fig. 7.**

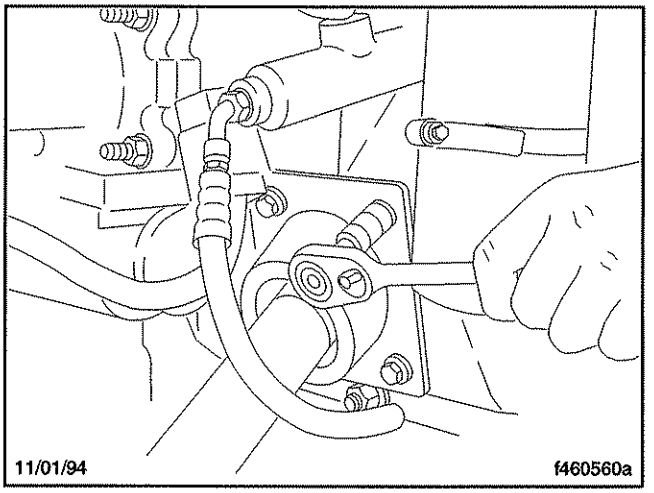


Fig. 4

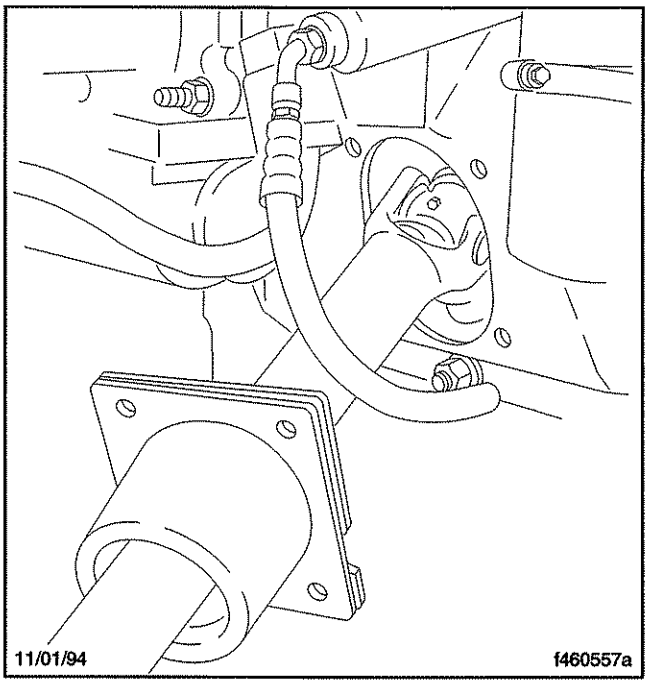


Fig. 5

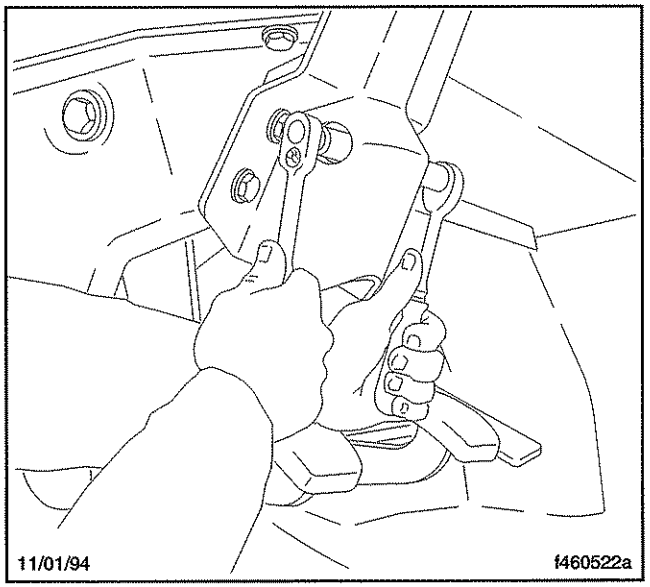


Fig. 6

Installation (See Fig. 1)

1. Clean the steering gear input shaft, steering column, and end yokes.
   - 1.1 Thoroughly clean the end yokes, the steering column shaft, and the steering gear input shaft with a clean, dry cloth.
   - 1.2 Apply a thin film of grease to the yoke splines. Use lithium-based grease, NLGI grade 2.
2. Slide the upper end yoke onto the steering column shaft, then install the end yoke pinch bolt. Before installing the pinch-bolt nut, make sure the pinch bolt is centered in the steering column shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install a new pinch-bolt nut, and tighten it 75 to 88 N·m (55 to 65 lbf·ft).
3. Apply white Torque Seal F-900 to the exposed pinch-bolt thread and to the locknut.
4. Before attaching the lower end yoke to the steering gear input shaft, be sure the front tires are straight ahead, and the steering gear is centered with the timing mark on the end of the sector shaft in line with the mark on the housing trunnion. **See Fig. 8.** Also, be sure the arrows on the driveline shaft and the driveline tube are aligned. **See Fig. 9.**

⚠ CAUTION

CAUTION: If the arrow on the driveline shaft is not aligned with the arrow on the driveline tube, the U-joints will not be correctly oriented. Assembling

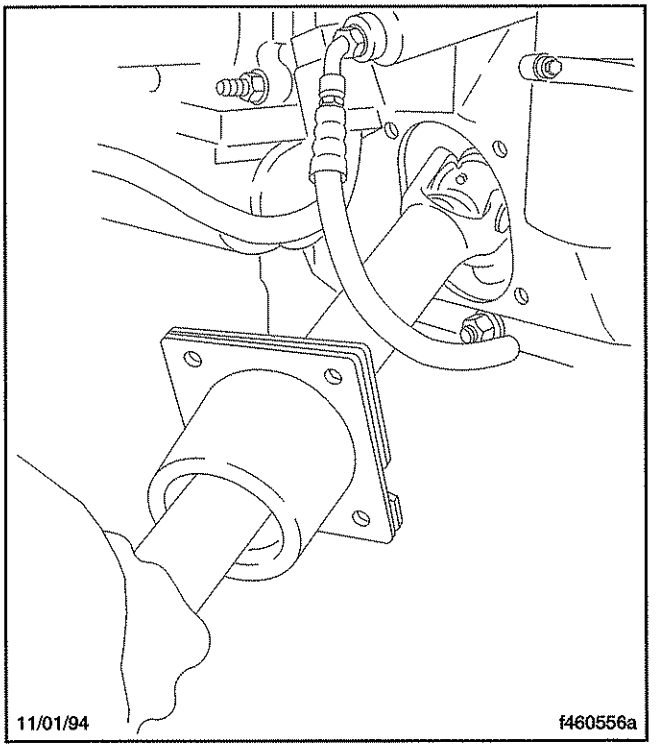
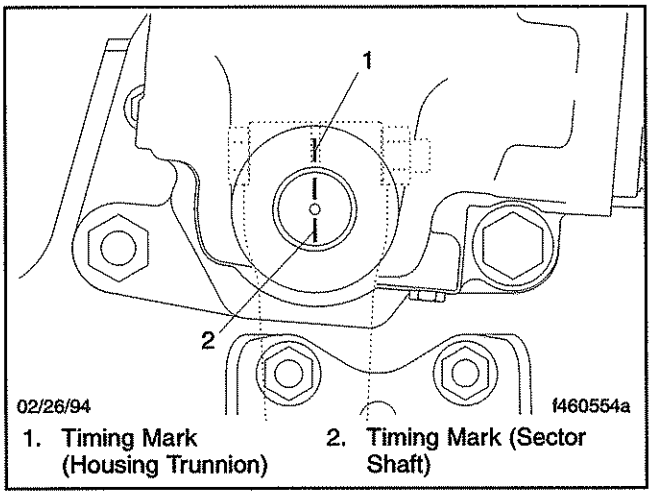


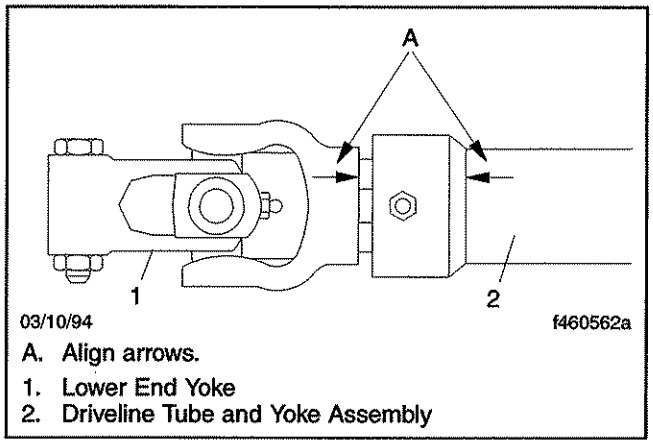
Fig. 7



1. Timing Mark (Housing Trunnion)
2. Timing Mark (Sector Shaft)

Fig. 8

Removal and Installation



A. Align arrows.
1. Lower End Yoke
2. Driveline Tube and Yoke Assembly

Fig. 9

the driveline with the U-joints incorrectly oriented could cause binding at the U-joints.

5. Install the lower end yoke on the steering gear input shaft. Before installing the pinch-bolt nut, make sure the pinch bolt is centered in the steering gear input shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install a *new* pinch-bolt nut, and tighten it 75 to 88 N·m (55 to 65 lbf·ft).
6. Apply white Torque Seal F-900 to the exposed pinch bolt thread and to the locknut. **See Fig. 10.**
7. Lubricate the driveline tube and both U-joints with lithium-based grease, NLGI grade 2. Apply until grease appears at the lower end of the tube splines and all four U-joint cross seals.
8. Align the steering wheel spokes.
   - 8.1 With the front tires pointing straight ahead, check the position of the steering wheel spokes. They must be pointing within ±10 degrees of the 4 o'clock and 8 o'clock positions. **See Fig. 11.**
   - 8.2 If not, remove the steering wheel and install it in the correct position. For instructions, refer to the applicable section in this group.
9. Lower the hood, and secure the hood latches. Leave the parking brakes applied and the chocks at the rear tires.
10. Raise the front of the vehicle, so that the front tires are off the ground, then place safety stands under the frame.

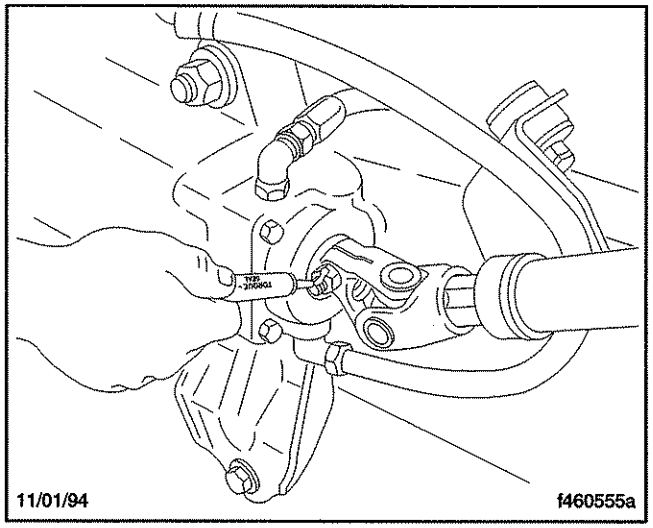
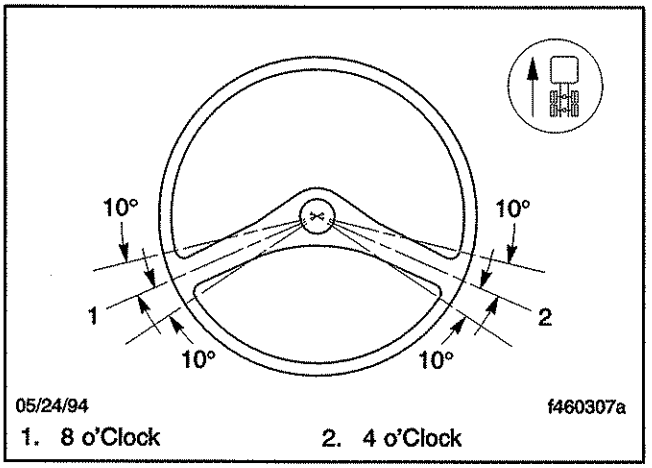


Fig. 10

⚠ WARNING

WARNING: Driving a vehicle with hard steering or binding in the steering system is hazardous and could result in partial or complete loss of steering control during vehicle operation.

11. Turn the steering wheel through full travel, checking for hard steering or binding. If there is difficulty, check the assembly and installation of the driveline parts. If the cause is not the driveline, refer to the applicable steering gear section in this group.



1. 8 o'Clock 2. 4 o'Clock

Fig. 11

12. Remove the safety stands, lower the vehicle to the ground, and remove the chocks.

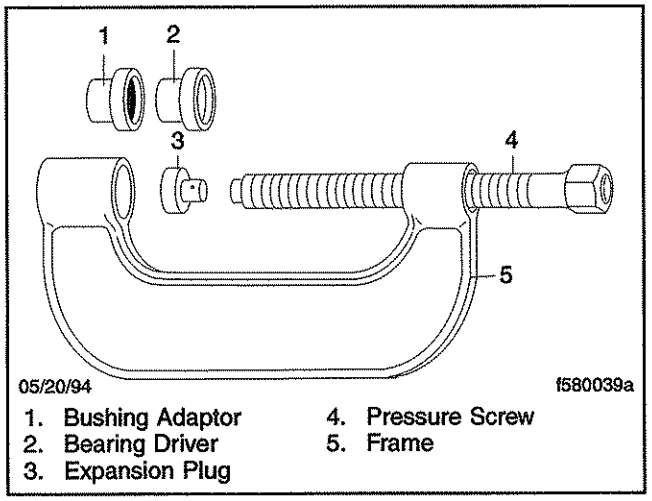
Disassembly

1. Remove the steering driveline from the vehicle. Refer to **Subject 100** for instructions.
2. Slide the driveline shaft and yoke assembly out of the driveline tube and yoke assembly.
3. Remove the steering driveline U-joint.
   - 3.1 Clamp the frame of a U-joint tool **(Fig. 1)** in a vise.
   - 3.2 Wearing safety goggles, remove the needle bearing cup snap rings from the needle bearing cups by pushing an open end of each snap ring with a screwdriver.

⚠ WARNING

WARNING: Snap rings can become potentially harmful projectiles when they are being removed. Wear safety goggles to prevent eye injury.

   - 3.3 Select a U-joint tool expansion plug of slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Select a bushing adapter of slightly larger inside diameter than the needle bearing cup, and place it on the opposite end of the tool.
   - 3.4 Place the integral yoke of the driveline tube in the U-joint tool. Position the bushing adapter to receive a needle bearing cup, and place the expansion plug against the opposite needle bearing cup.
   - 3.5 Tighten the pressure screw to press one needle bearing cup out of the driveline yoke, then remove the cup. In some cases, it might be necessary to give the pressure screw a sharp blow with a brass hammer while the screw is under pressure.
   - 3.6 Reverse the driveline tube and yoke assembly, and press against the U-joint cross to force out the other needle bearing cup.
   - 3.7 Remove the driveline tube and yoke assembly from the U-joint tool, then remove the upper end yoke and the U-joint cross from the driveline yoke.
   - 3.8 Place the upper end yoke in the U-joint tool. Position the bushing adapter to receive a needle bearing cup, and place the expansion plug against the opposite needle bearing cup.
   - 3.9 Tighten the pressure screw to press one needle bearing cup out of the upper end yoke, then remove the cup. In some cases, it might be necessary to give the pressure screw a sharp blow with a brass hammer while the screw is under pressure.
   - 3.10 Reverse the upper end yoke in the U-joint tool, and press against the U-joint cross to force out the other needle bearing cup.
   - 3.11 Remove the upper end yoke from the U-joint tool, then remove the U-joint cross from the upper end yoke.
4. Repeat the applicable steps above for the driveline shaft and yoke assembly and the lower end yoke.



1. Bushing Adaptor
2. Bearing Driver
3. Expansion Plug
4. Pressure Screw
5. Frame

Fig. 1, Universal Joint Tool

Assembly

1. Install the steering driveline U-joint.
   - 1.1 Clamp the frame of a U-joint tool **(Fig. 1)** in a vise.
   - 1.2 Select a U-joint tool expansion plug of a slightly smaller diameter than the needle bearing cup, and place it on the pressure screw. Place a bearing driver on the opposite end of the tool.

Disassembly and Assembly

1.3 Position the U-joint cross in the upper end yoke so that the U-joint cross lube fitting points toward one of the yoke ears.

1.4 Make certain the U-joint cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears from the outside. Place the upper end yoke in the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.

1.5 Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint cross during this operation to ensure free movement. If the needle bearing cups don't seat correctly, or if the U-joint binds, give the yoke shoulder near each cup a sharp blow with a brass hammer.

1.6 Press the needle bearing cup on the screw end of the U-joint tool all the way in, until there is enough clearance to insert a new needle bearing cup snap ring. Insert the snap ring, and fully seat it in its groove.

⚠ WARNING

WARNING: Use new snap rings when assembling the U-joints. Used snap rings are often distorted and overstressed from disassembly. Also, snap rings not fully seated in their grooves could work loose, resulting in a hazardous vehicle operating condition.

1.7 Reverse the upper end yoke in the U-joint tool, and push the other needle bearing cup until there is clearance to insert the other snap ring. Insert the snap ring, then remove the upper end yoke from the U-joint tool.

1.8 With the U-joint cross lube fitting facing away from the base of the upper end yoke, position the U-joint cross and the upper end yoke in the driveline tube and yoke assembly.

NOTE: The U-joint cross lube fitting should face away from the base of the upper end yoke to provide access for lubrication when the steering driveline is installed on the vehicle.

1.9 Make certain the U-joint cross seals are in place on the needle bearing cups, then start both needle bearing cups into the yoke ears. Place the driveline tube and yoke assembly in the U-joint tool with the bearing driver against one of the needle bearing cups and the expansion plug against the opposite needle bearing cup.

1.10 Tighten the pressure screw, making sure that both needle bearing cups press straight and true into the yoke ears. Work the U-joint cross during this operation to ensure free movement. If the needle bearing cups don't seat correctly, or if the U-joint binds, give the yoke shoulder near each cup a sharp blow with a brass hammer.

1.11 Press the needle bearing cup on the screw end of the U-joint tool all the way in, until there is enough clearance to insert a needle bearing cup snap ring. Insert the snap ring. Reverse the driveline tube and yoke assembly in the U-joint tool and push the other needle bearing cup until there is clearance to insert the other snap ring. Insert the snap ring.

2. Remove the driveline tube and yoke assembly from the U-joint tool.

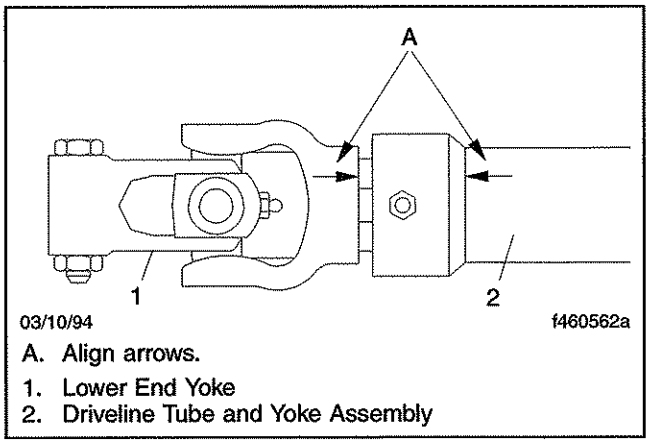
3. Repeat the applicable steps above for the lower end yoke and the driveline shaft and yoke assembly.

4. Slide the lower driveline shaft into the driveline tube, so that the arrow on the driveline shaft yoke is aligned with the arrow on the driveline tube. **See Fig. 2.**

⚠ CAUTION

CAUTION: If the arrow on the driveline shaft yoke isn't aligned with the arrow on the driveline tube, the U-joints will be out of phase. Assembling the driveline with the U-joints out of phase could result in binding at the U-joints.

5. Install the steering driveline in the vehicle. Refer to **Subject 100** for instructions.



A. Align arrows.
1. Lower End Yoke
2. Driveline Tube and Yoke Assembly

Fig. 2

Specifications

Description	Grade	Size	Torque N·m (lbf·ft)
End Yoke Pinch-Bolt Nut	8 or 8.2	7/16–20 UNF	75 to 88 (55 to 65)

Table 1, Torque Values

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General Description

The drag link is nonadjustable, with non-removable socket ball studs at both ends. **See Fig. 1.**

The drag link connects the pitman arm to the front axle steering arm. The socket ball studs, one located at each end, rotate to allow for changing angles between the pitman arm and steering arm as the vehicle is steered and the suspension articulates.

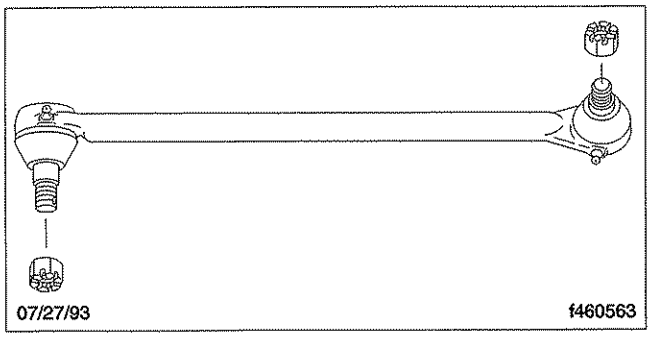


Fig. 1

Removal

1. If ball stud wear or looseness is suspected, check for wear of the ball studs before removing the drag link. Refer to **Subject 110** for instructions.
2. Position the tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. *Do not turn the steering wheel at any time while the drag link is still attached to both the pitman arm and the axle steering arm.* If the steering wheel is turned, the front tires will not be straight ahead.
3. Apply the parking brakes, and chock the rear tires.
4. Release the hood latches, and tilt the hood.
5. Remove the left-hand bumper extension or rotate it out of the way. See **Fig. 1**.
6. Remove the drag link from the vehicle.
   - 6.1 At both ends of the drag link, remove the cotter pins and loosen the nuts on the socket ball studs. See **Fig. 2** and **Fig. 3**. Be sure the nuts are loosened far enough to allow use of a ball stud removal tool.
   - 6.2 Using a ball stud removal tool, loosen the drag link from the pitman arm and the axle steering arm. See **Fig. 4**, **Fig. 5**, and **Fig. 6**.
   - 6.3 Remove the nuts and drag link.

IMPORTANT: Do not steer the gear with the linkage removed; unintended setting of the automatic poppets may result.

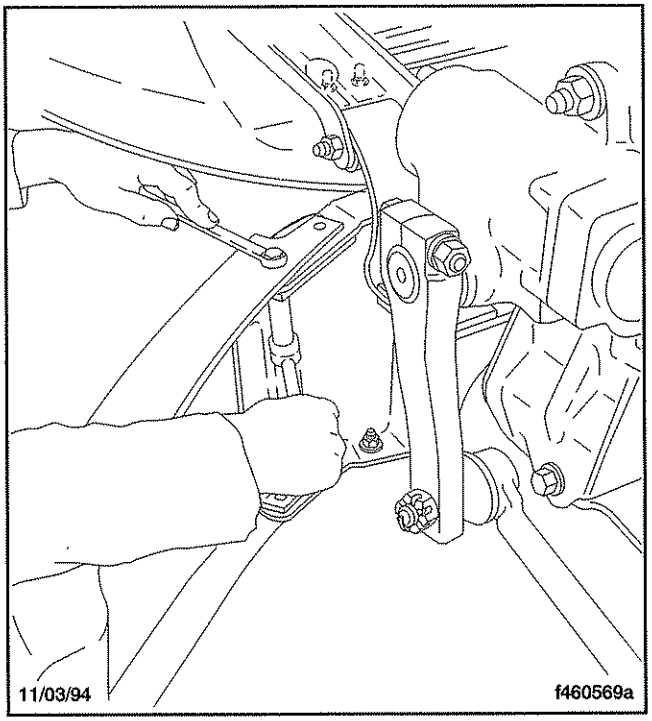


Fig. 1, Moving the Bumper Extension

Installation

1. Before installing the drag link, check for damage or wear. Replace parts as needed.
   - 1.1 Check the ball stud covers or dust caps for extreme wear, cuts, or other damage; replace the covers (seals) if needed.
   - 1.2 Inspect the socket ball studs, ball stud nuts, drag link rod, and grease fittings for wear or damage. Replace the components as needed.
2. Install the drag link.
   - 2.1 When installing the drag link, if needed, slightly turn the steering wheel to change

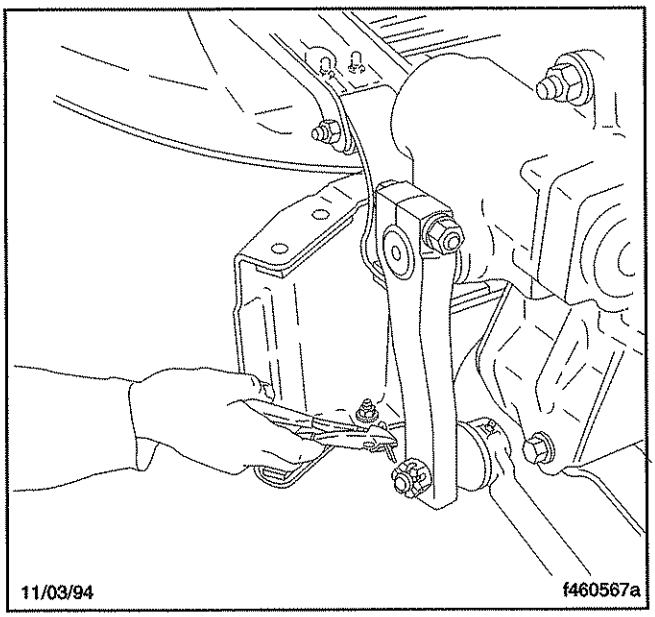


Fig. 2, Remove the Cotter Pin

Removal and Installation

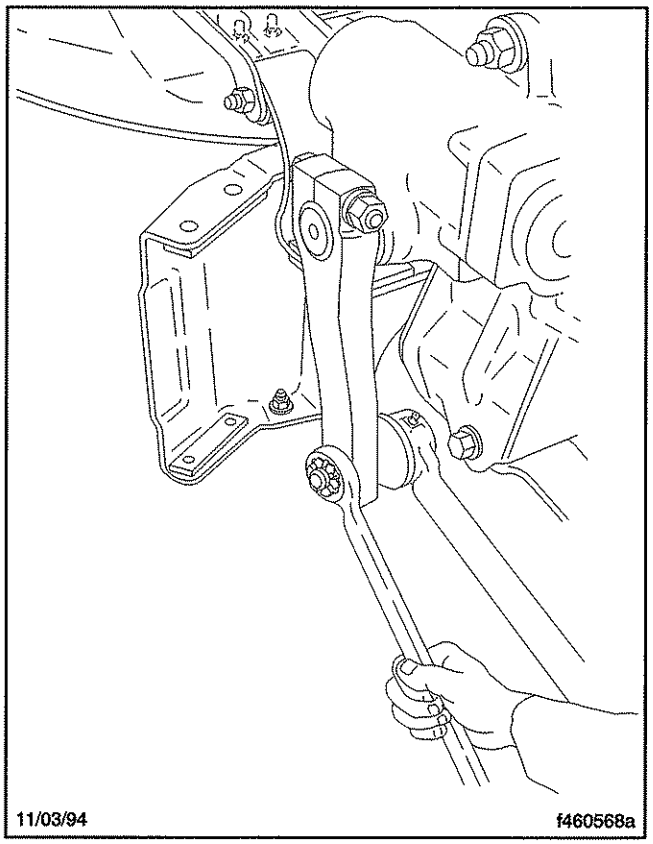


Fig. 3, Loosen the Nut

the distance between the pitman arm and the steering arm.

2.2 Tighten the ball stud nuts as follows:

- 5/8–18, 60 to 115 lbf·ft (81 to 156 N·m)
- 3/4–16, 90 to 170 lbf·ft (122 to 230 N·m)
- 7/8–14, 160 to 300 lbf·ft (217 to 407 N·m)

2.3 If required, continue tightening each nut until a slot on the nut aligns with the hole in the ball stud. *Don't back off the nut when locating the cotter pin hole.*

2.4 Install new cotter pins through the ball studs and nuts, and lock the cotter pins in place.

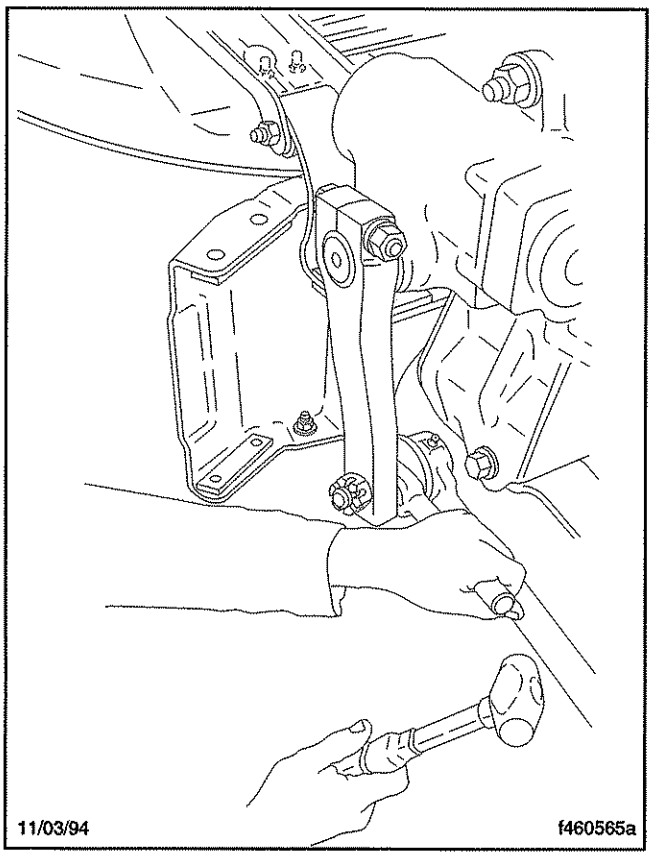


Fig. 4, Loosening the Drag Link from the Pitman Arm

⚠ WARNING

Failure to install and lock new cotter pins in the ball studs and nuts could result in disengagement of the parts and loss of steering control.

3. Wipe the dirt from the grease fittings. Apply chassis grease until the old grease is forced out.
4. Install the left-hand bumper extension.
5. Lower the hood, and fasten the hood latches.
6. Align the steering wheel spokes. With the front tires pointing straight ahead, check the position of the steering wheel spokes. They must be pointing within ±10 degrees of the 4 o'clock and 8 o'clock positions. See **Fig. 7.** If not, remove the steering wheel and install it in the correct position. For instructions, refer to the applicable section in this group.

Removal and Installation

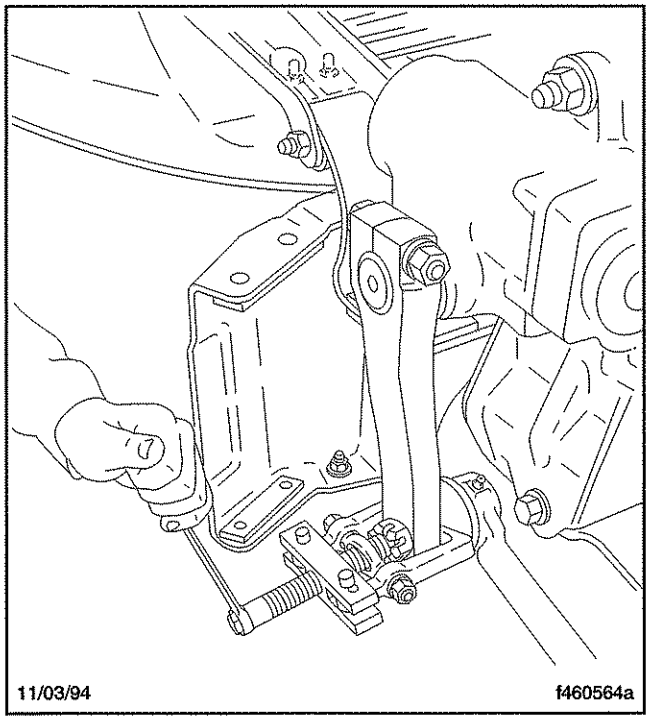


Fig. 5, Loosening the Drag Link from the Pitman Arm

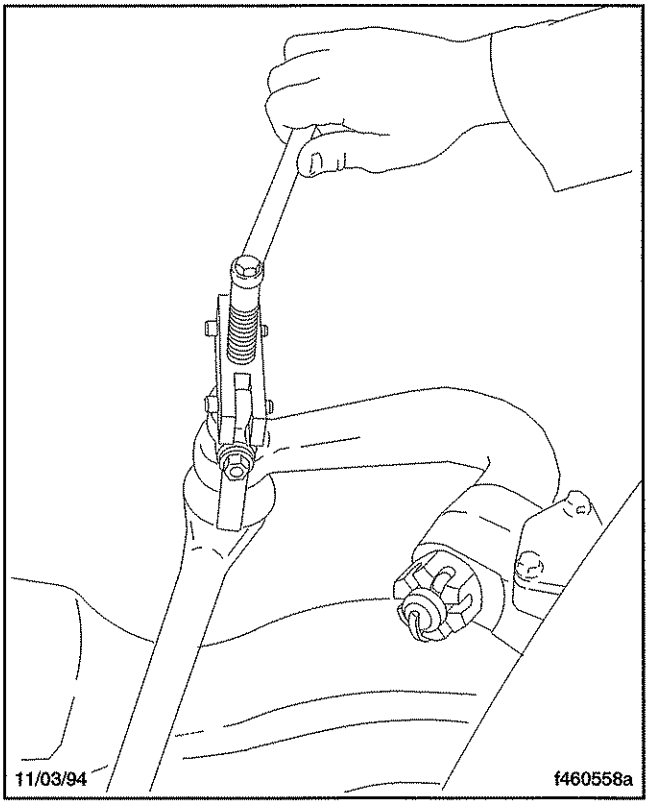


Fig. 6, Loosening the Drag Link from the Axle Steering Arm

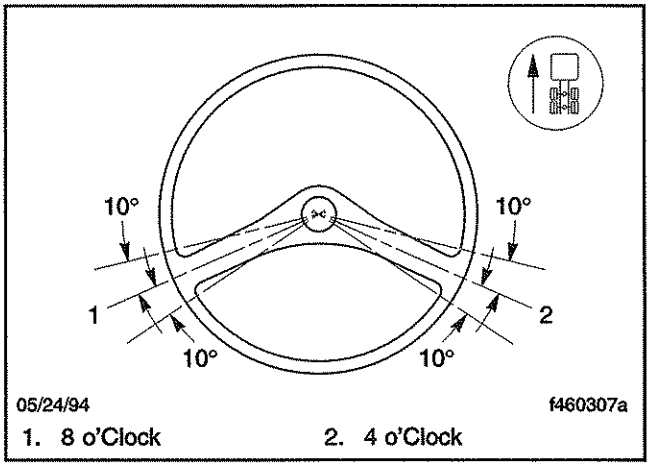


Fig. 7, Proper Steering Wheel Position (with the tires straight ahead)

On-Vehicle Ball Stud Testing

Testing

Check for wear of the drag link ball stud end, and nut tightness as follows:

Have someone gently turn the steering wheel back and forth. Check for looseness between the ball stud end, and both the pitman arm and steering arm. Also check for looseness of the ball stud nut.

If the ball stud *end* is loose, replace the drag link. If the ball stud *nut* is loose, replace the nut and cotter key. Tighten the ball stud nut as follows:

- 5/8–18, 60 to 115 lbf·ft (81 to 156 N·m)
- 3/4–16, 90 to 170 lbf·ft (122 to 230 N·m)
- 7/8–14, 160 to 300 lbf·ft (217 to 407 N·m)

Grasp the drag link near the pitman arm end, push and pull laterally to check for axial looseness in the ball stud end. If there is looseness, replace the drag link. For instructions, refer to **Subject 100**. If there is 1/8 inch (3 mm) looseness or more, do not drive the vehicle until the drag link is replaced.

Grasp the drag link near the steering arm end. Push and pull vertically to check for axial looseness in the ball stud end. If there is looseness, replace the drag link. For instructions, refer to **Subject 100**. If there is 1/8 inch (3 mm) looseness or more, do not drive the vehicle until the drag link is replaced.

Grease the drag link until the old grease is purged.

Specifications

Torque Values	
Nut Size	**Torque lbf.ft (N.m)**
5/8–18	60–115 (81–156)
3/4–16	90–170 (122–230)
7/8–14	160–300 (217–407)

Table 1, Torque Values

Contents

Subject	Subject Number
General Information	050
Service Operations	
Steering Wheel Removal and Installation	100
Steering Column Removal and Installation	110
Steering Column Disassembly and Assembly	120
Horn Contact Assembly Replacement	130
Traverse Shaft Removal and Installation, RH DR	140
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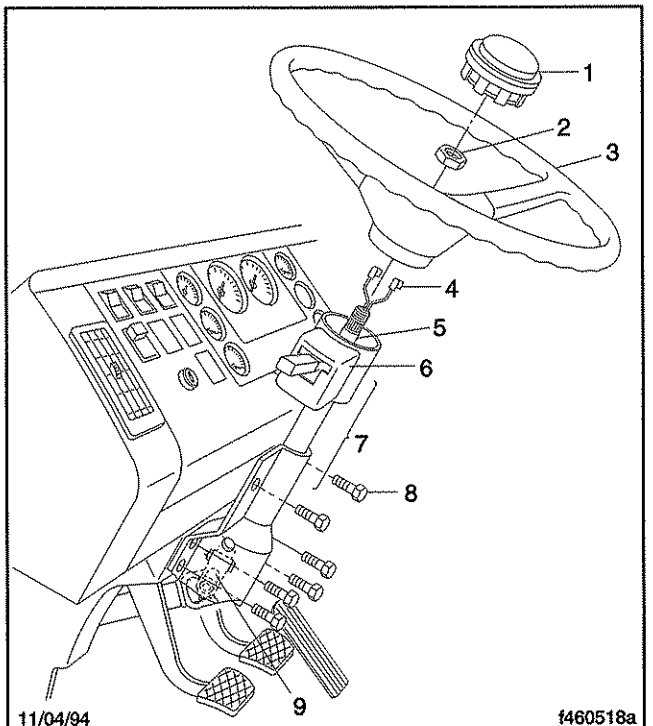
General Information

The steering wheel is cushion-rimmed, with two low-mounted spokes for easy gauge visibility. A horn button is flush-mounted in the center of the wheel hub. See **Fig. 1**.

On both types of steering, left-hand (LH DR), and right-hand drive (RH DR), a turn signal switch is attached to the left side of the column, just below the steering wheel. An optional trailer brake air switch can be installed on the right side of the column.

The major parts of the steering column assembly are the shaft, the bearings (not shown in the figure), and the bracket and bearing tube assembly.

On vehicles with RH DR, a traverse shaft and two miter boxes connect the steering column (on the right-hand side of the vehicle) with the steering driveline (on the left-hand side of the vehicle). See **Fig. 2**.



1. Horn Button
2. Steering Wheel Nut
3. Steering Wheel
4. Horn Wires
5. Steering Shaft
6. Turn Signal Switch
7. Bracket and Bearing Tube Assembly
8. Steering Column Mounting Capscrews
9. Driveline End Yoke

Fig. 1, Steering Column Assembly, Left-Hand Drive

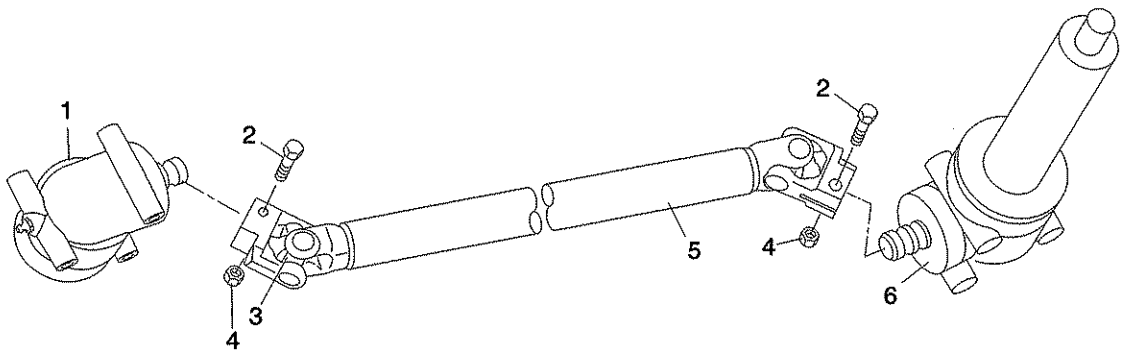
The steering shaft is installed in the bracket and bearing tube assembly, and held in place by the bearings. The top of the shaft is threaded for the steering wheel nut, and just below the threads are splines that correspond to those in the steering wheel.

The lower end of the shaft is splined for the steering driveline end yoke on LH DR, and has a groove for the end-yoke pinch bolt. On RH DR, the lower end of the shaft is attached to a 90-degree miter box which has a splined output shaft on the left (inboard) side that attaches to the end yoke of the traverse shaft. A second 90-degree miter box connects the traverse shaft with the steering driveline.

On LH DR, the steering column assembly is held in place by six capscrews that attach the bracket end of the assembly to the lower dash and the pedal support bracket.

On RH DR, the steering column assembly is held in place by six capscrews that attach the lower mounting plate to the lower dash and the clutch pedal box.

General Information



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1. LH Miter Box
2. Pinch Bolt, 7/16–20
3. U-Joint
4. Prevailing Torque Hexnut
5. Traverse Shaft
6. RH Miter Box

Fig. 2, RH DR Traverse Shaft

Steering Wheel Removal and Installation

Removal

1. Put the front wheels in the straight ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the place where the work will be done.

   Don't turn the steering wheel at any time during the removal procedure.

2. Apply the parking brake and chock the tires.
3. Disconnect the batteries at the negative terminal.
4. Using a small screwdriver, carefully pry out the horn button. Disconnect the two wires from it. **See Fig. 1.**
5. Using a deep socket to avoid damaging the wires, remove the steering wheel nut. **See Fig. 2.**
6. Using 1/4-inch sheet metal stock, make a wire protector about 4 cm x 1.5 cm (1-5/8 inches x 5/8 inch), like the one shown in **Fig. 3.** Then put it over the end of the steering column.
7. Using a steering wheel puller, remove the steering wheel from the steering column. **See Fig. 4.**

IMPORTANT: When you set the steering wheel aside, be careful not to damage the turn signal self-cancelling pin on the underside of the wheel. **See Fig. 5.**

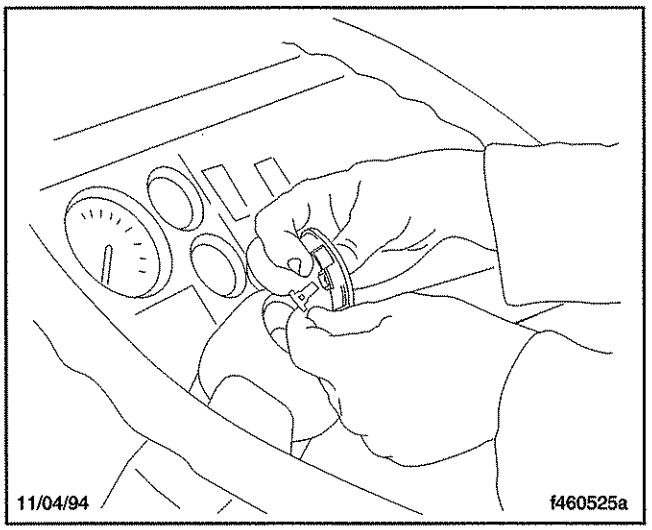


Fig. 1, Pry out the Horn Button

Installation

1. Make sure the front tires are pointed straight ahead and the steering gear is centered.
2. Put the steering wheel on the steering column so that the spokes are within 10 degrees of the 4 o'clock and 8 o'clock positions. **See Fig. 6.**
3. Thread the two horn wires through the steering wheel nut, then install the nut. Tighten it 81 N·m (60 lbf·ft).
4. Connect the two wires to the horn button. Pack the horn wires with dielectric grease.

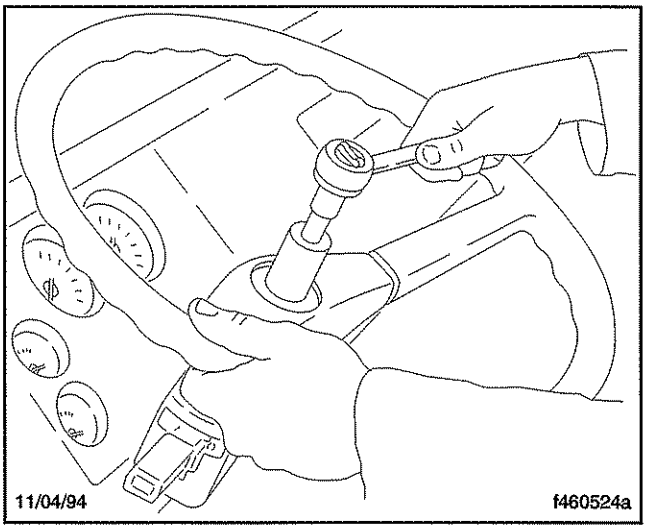


Fig. 2, Remove the Steering Wheel Nut

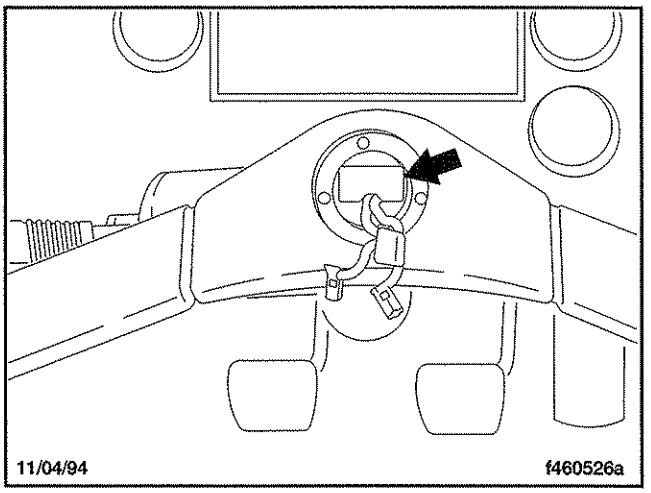


Fig. 3, Make a Wire Protector

Steering Wheel Removal and Installation

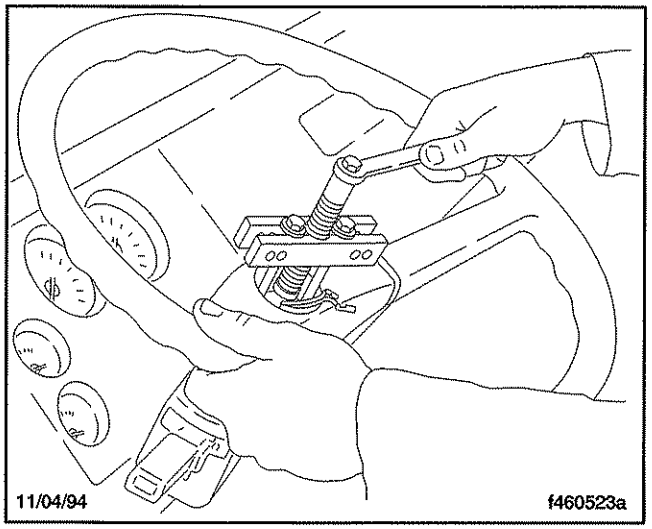


Fig. 4, Remove the Steering Wheel from the Column

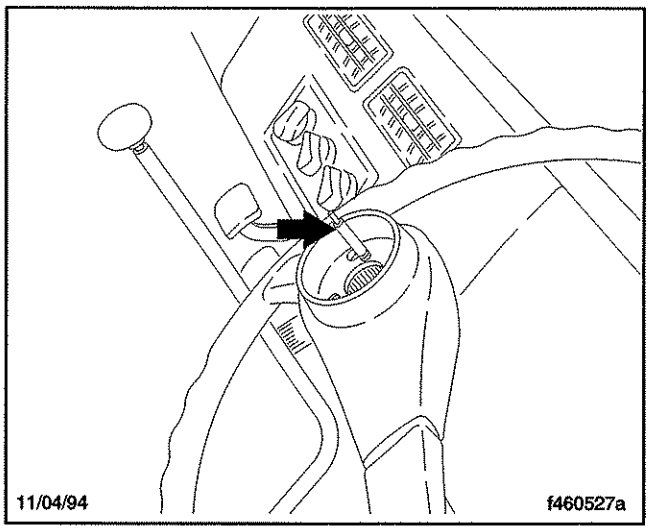


Fig. 5, Turn Signal Self-Cancelling Pin

NOTE: The horn wires may be connected to either terminal.

5. Install the horn button in the steering wheel hub so the logo on it is aligned with the steering wheel spokes. **See Fig. 7.**
6. Take the vehicle for a test drive to make sure the steering wheel is on correctly. If it isn't, remove it and install it again.

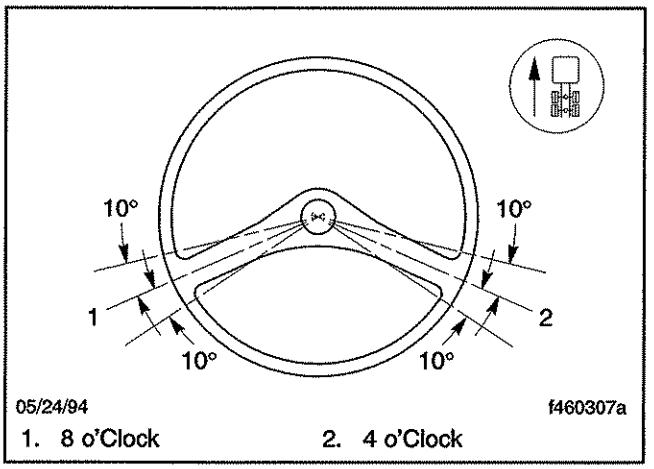


Fig. 6, Center the Steering Wheel

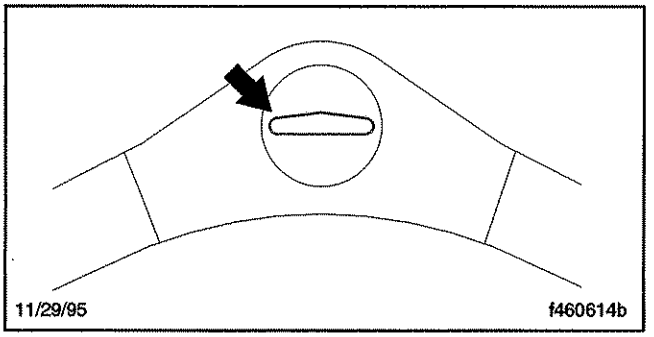


Fig. 7, Align the Logo

Steering Column Removal and Installation

Left-Hand Drive (LH DR)

REMOVAL

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service work will be done. *Do not move the tires from the straight-ahead position during removal or at any time while the steering column is removed.*
2. Apply the parking brakes and chock the tires.
3. Remove the steering wheel, following the instructions in **Subject 100.**
4. Remove the plastic cover from the turn signal switch on the left (outboard) side of the steering column. See **Fig. 1.**
5. Remove the two allen-head screws that attach the turn signal switch to the steering column (see **Fig. 2**), then swing the turn signal switch up and out of the way.
6. Disconnect the horn wire. See **Fig. 3.**
7. If installed, remove the trailer brake air lines from the switch mounted on the right (inboard) side of the steering column. Mark the lines for ease of installation. See **Fig. 4.**
8. Remove and discard the pinch bolt and nut from the steering driveline yoke. See **Fig. 5.**

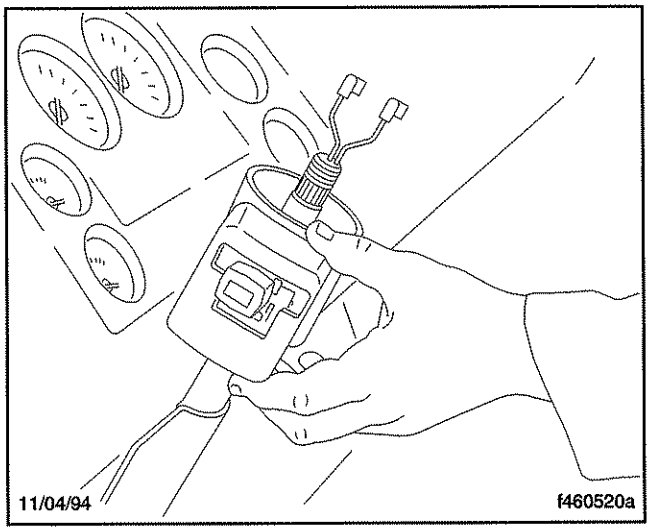


Fig. 1, Removing the Plastic Cover

9. Remove the six capscrews that attach the steering column bracket to the lower dash and to the pedal support bracket. See **Fig. 6.**
10. Disconnect the steering column from the steering driveline U-joint yoke.

INSTALLATION

1. Connect the lower steering column to the steering driveline.
   1.1 Slide the steering driveline U-joint yoke onto the lower end of steering column.

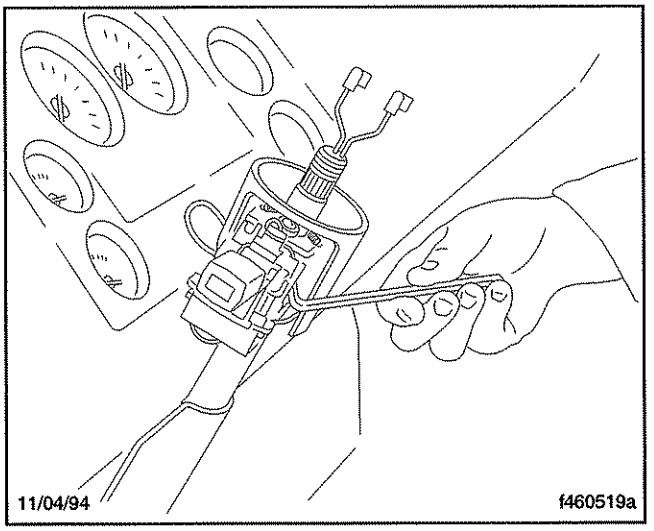


Fig. 2, Removing the Mounting Screws

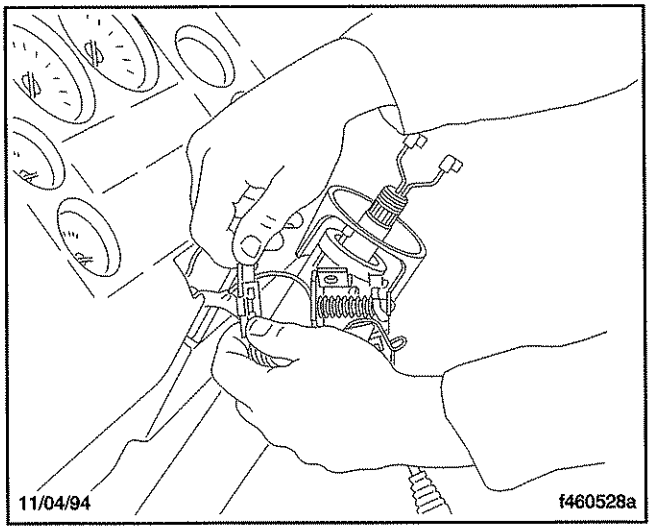
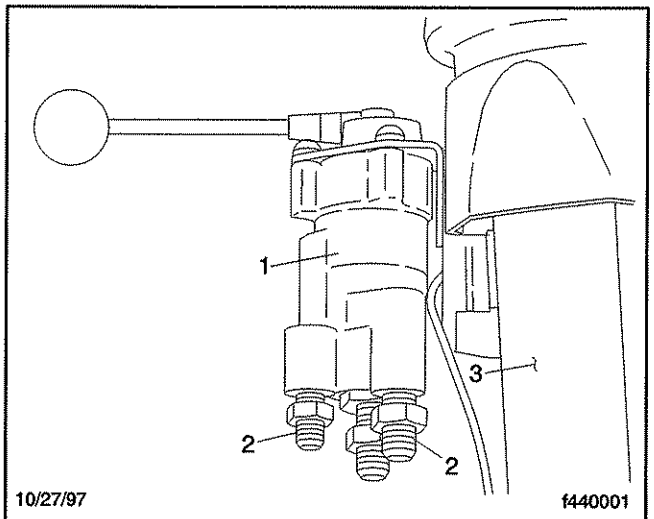


Fig. 3, Disconnecting the Horn Wire

Steering Column Removal and Installation



This switch is mounted on the right side of the steering column on both LH DR and RH DR.

1. Switch
2. Fittings
3. Steering Column

Fig. 4, Trailer Brake Air Switch

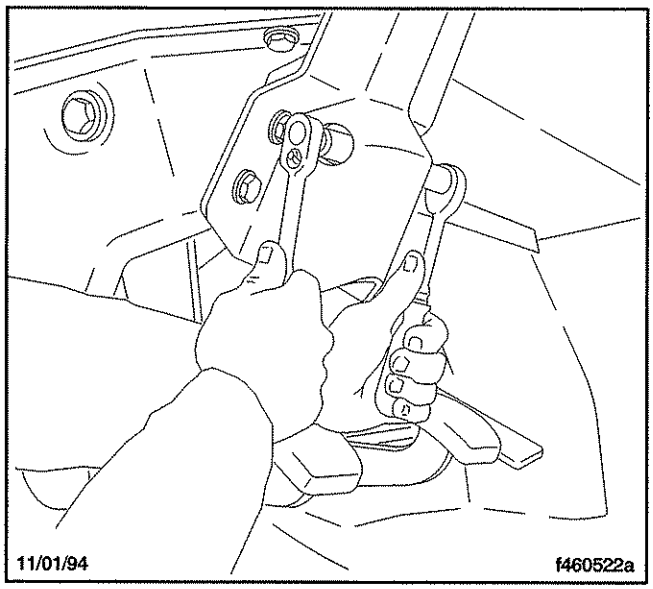


Fig. 5, Removing the Steering Driveline Pinch Bolt

1.2 Install a new pinch bolt and nut. Tighten the nut 37 lbf·ft (50 N·m), then apply white Torque Seal F-900® to the exposed threads of the pinch bolt.

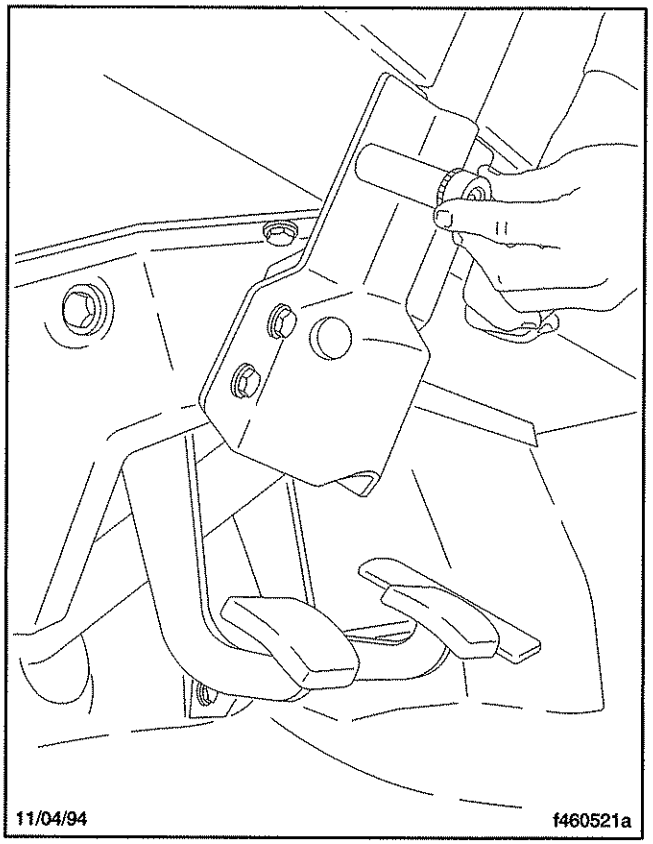


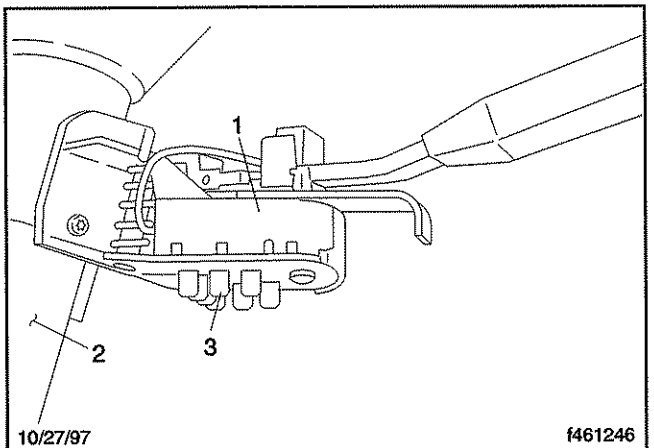
Fig. 6, Removing the Steering Column Mounting Capscrews (LH DR)

2. Line up the holes in the steering column bracket with those in the lower dash and the pedal support bracket.
3. Install the six capscrews (see **Fig. 5**), and tighten them in stages to a final torque of 40 lbf·ft (54 N·m).
4. Connect the horn wire, as shown in **Fig. 3.**
5. Install the turn signal switch on the left (outboard) side of the steering column. See **Fig. 2.** Tighten the screws firmly.
6. Install the trailer brake air lines, as marked. See **Fig. 4.**
7. Install the steering wheel, following the instructions in **Subject 100.**

Right-Hand Drive (RH DR)

REMOVAL

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service work will be done. *Do not move the tires from the straight-ahead position during removal or at any time while the steering column is removed.*
2. Apply the parking brakes and chock the tires.
3. Remove the steering wheel, following the instructions in **Subject 100**.
4. Remove the plastic cover from the turn signal switch on the left (inboard) side of the steering column. Disconnect the electrical connector and pull the turn signal harness down and out of the way. See **Fig. 7**.
5. Disconnect the horn wire. See **Fig. 3**.
6. If installed, remove the trailer brake air lines from the switch mounted on the right (outboard) side of the steering column. Mark the lines for ease of installation. See **Fig. 4**.
7. Remove the three 3/8–16 capscrews attaching the steering column cover to the RH miter box.



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This switch is mounted on the left side of the steering column on both LH DR and RH DR.

1. Switch
2. Steering Column
3. Connector

Fig. 7, Turn Signal Switch Electrical Connector

8. Remove and discard the pinch bolt and nut from the traverse shaft. See **Fig. 8**.
9. Remove the two steering column supports. Remove the support shim behind them.
10. Remove the six 3/8–16 capscrews and lockwashers that attach the steering column to the lower mounting plate and underdash panel. See **Fig. 6**.
11. Remove the steering column from the dash.

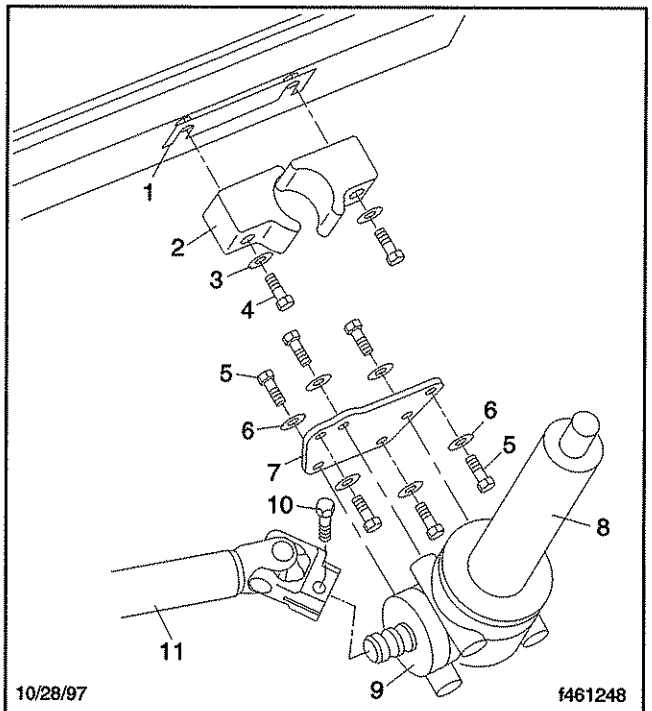
INSTALLATION

1. Position the steering column so that the bolt holes on the lower mounting plate line up with the holes on the pedal box.
2. Install the six capscrews and lockwashers attaching the steering column and lower mounting plate to the pedal box and underdash panel (see **Fig. 8**). Tighten all six capscrews 28 lbf·ft (38 N·m).
3. Attach the two steering column supports to the dash.
   - 3.1 Install the support shim between the supports and the dash.
   - 3.2 Install the two grade 10.9 M10 capscrews and lockwashers.
   - 3.3 Tighten the two capscrews 34 lbf·ft (46 N·m).

NOTE: Allow the turn signal switch harness to come out the left (inboard) side of the steering column.

4. Connect the steering column to the traverse shaft.
   - 4.1 Slide the traverse shaft U-joint yoke onto the splined shaft of the miter box, as marked on removal.
   - 4.2 Install a new pinch bolt and nut. Tighten the nut 60 lbf·ft (81 N·m), then apply white Torque Seal F-900® to the exposed threads of the pinch bolt.
5. Install the steering column cover to the RH miter box. Tighten the three 3/8–16 capscrews 28 lbf·ft (38 N·m).
6. Install the turn signal harness to the connector on the turn signal switch on the left (inboard) side of the steering column. See **Fig. 2**. Tighten the screws firmly and install the plastic cover.

Steering Column Removal and Installation



1. Support Shim
2. Steering Column Support
3. Hardened Washer
4. Capscrew, M10
5. Mounting Capscrew, 3/8–16
6. Lockwasher, 3/8-Inch
7. Lower Mounting Plate
8. Steering Column
9. RH Miter Box
10. Pinch Bolt, 7/16–20
11. Traverse Shaft

Fig. 8, Steering Column Removal, Right-Hand Drive

7. Install the trailer brake air lines, as marked. See **Fig. 4.**
8. Connect the horn wire, as shown in **Fig. 3.**
9. Install the steering wheel, following the instructions in **Subject 100.**
10. Remove the chocks from the tires.

Steering Column Disassembly and Assembly

Disassembly (See Fig. 1)

1. Remove the steering wheel, following the instructions **under Subject 100.**
2. Remove the steering column assembly, following the instructions **under Subject 110.**
3. Unscrew the horn contact assembly (Ref. 4) from the side of the steering column.
4. Remove the retaining ring (Ref. 1) holding the upper shaft bearing (Ref. 2) in place, then remove the bearing. Remove the second retaining ring from the shaft.
5. Remove the retaining ring holding the lower shaft bearing (Ref. 6) in place, then remove the bearing.
6. Slide the shaft out of the bracket and bearing tube assembly (Ref. 5).

Assembly (See 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.

1. Using a solvent, clean all the parts, then check them. If any are worn or damaged, replace them.
2. Grease the bearings, using a lithium based bearing grease.
3. Install the shaft (Ref. 3) into the bracket and bearing tube assembly.
4. Install a retaining ring in the lower groove on the upper part of the shaft, then install the upper bearing. Install a second retaining ring on top of the bearing.
5. Install the lower bearing on the shaft, then install the lower retaining ring.
6. Screw the horn contact assembly into the side of steering column assembly.

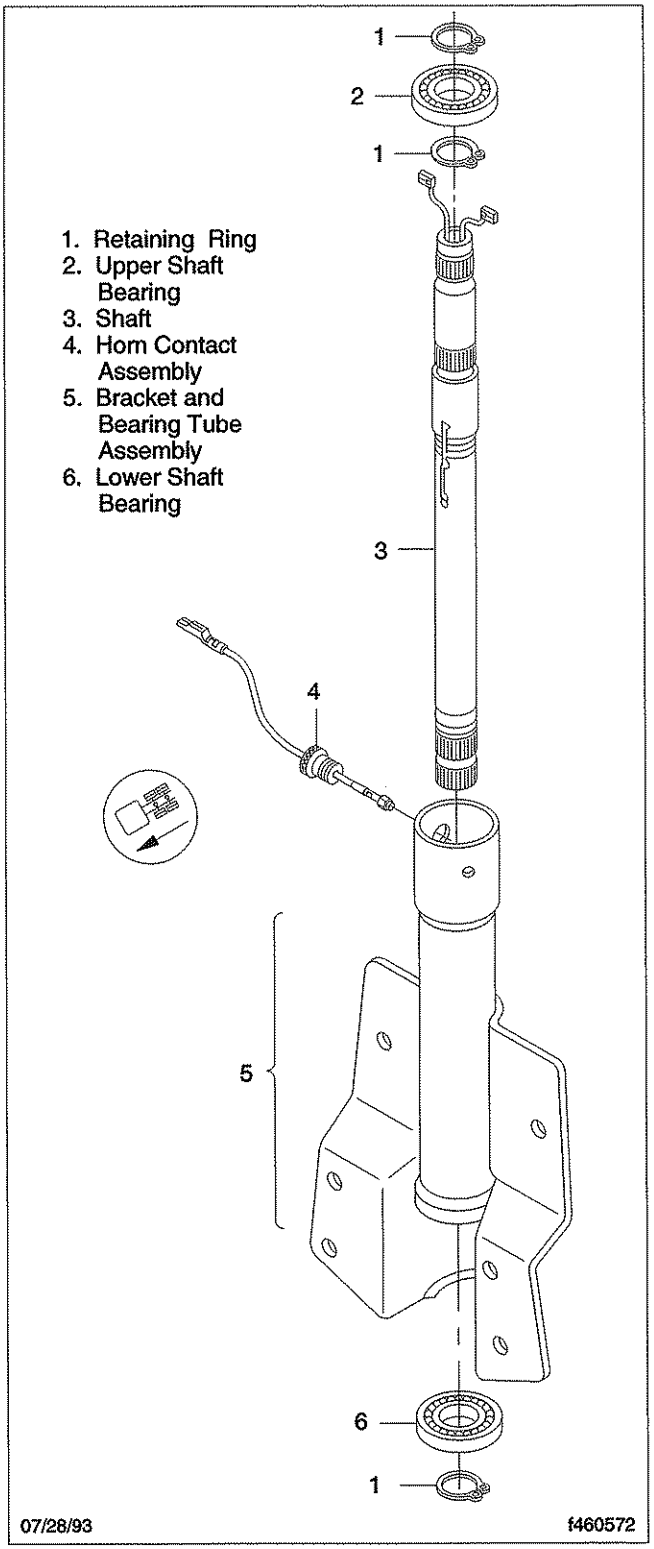


Fig. 1

Steering Column Disassembly and Assembly

7. Install the steering column assembly and the steering wheel, following the instructions in this section.

Horn Contact Assembly Replacement

Replacement

1. Disconnect the horn wire from the wire lead-ing to the back of the dash. **See Fig. 1.**
2. Unscrew the horn contact assembly from the right-hand side of the steering column, and discard it. **See Fig. 2.**
3. Install a new horn contact assembly into the right-hand side of the steering column. Screw in the assembly firmly.

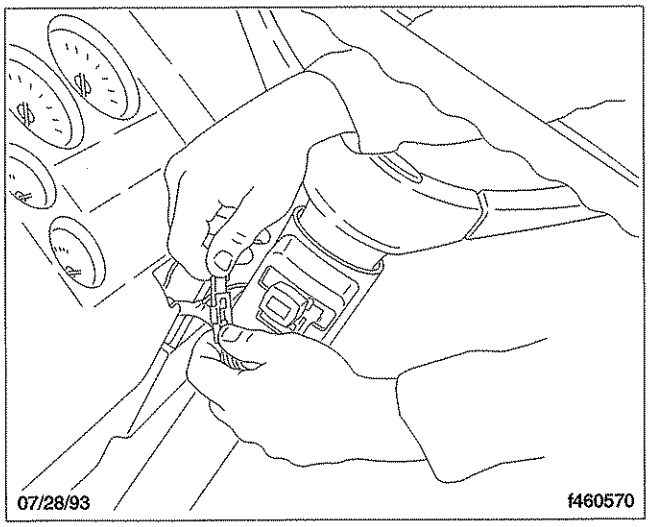


Fig. 1

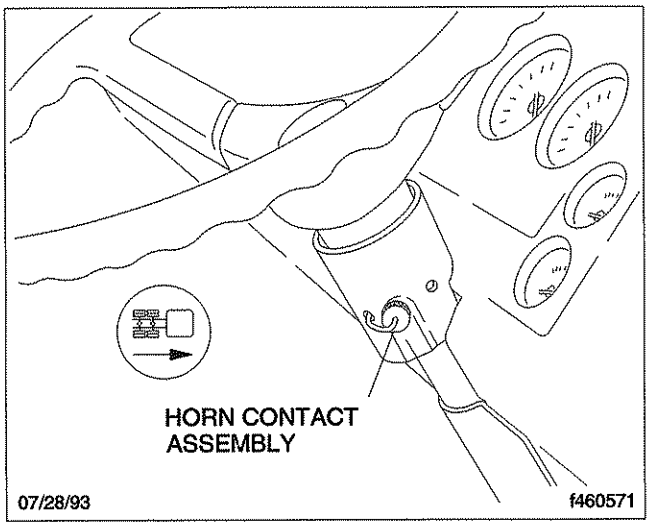


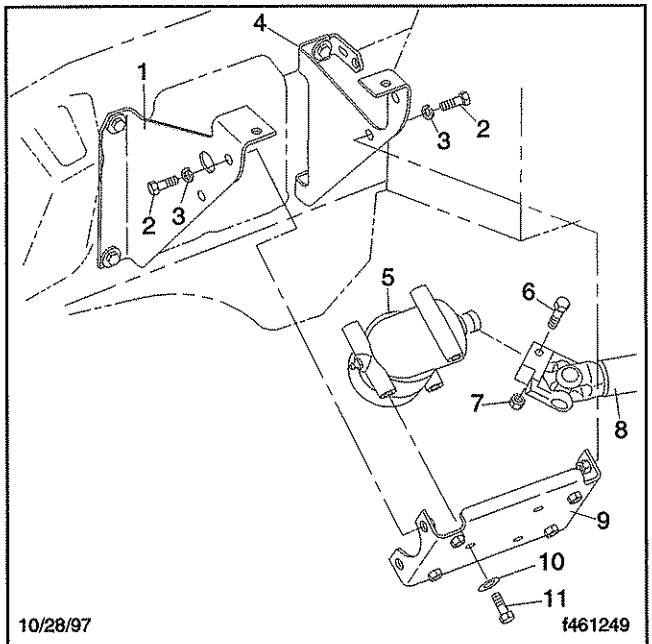
Fig. 2

4. Connect the horn wire to the wire leading to the back of the dash.
5. Check the horn. If it doesn't work, heck the wiring to the horn, the horn itself, and the horn button. Repair or replace parts as needed.

Traverse Shaft Removal and Installation, RH DR

Removal

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service work will be done. *Do not move the tires from the straight-ahead position during removal or at any time while the traverse shaft is removed.*
2. Apply the parking brakes and chock the tires.
3. Remove the dash kick panel. Remove the two shims inside the panel.
4. Remove the face plate. See **Fig. 1**.
   - 4.1 Remove the four face plate mounting capscrews and lockwashers.



1. Outboard (LH) Support Bracket
2. Face Plate Mounting Capscrew, 3/8–16
3. Face Plate Mounting Lockwasher
4. Inboard (RH) Support Bracket
5. LH Miter Box
6. Pinch Bolt, 7/16–20
7. Prevailing Torque Hexnut
8. Traverse Shaft
9. Face Plate
10. Miter Box Mounting Capscrew, 3/8–16
11. Miter Box Mounting Lockwasher

Fig. 1, Face Plate and Miter Box Removal

   - 4.2 Remove the three miter box mounting capscrews and lockwashers.
5. Remove the two pinch bolts that attach the LH miter box to the steering linkage.
   - 5.1 Remove the pinch bolt and prevailing torque hexnut that connect the output shaft of the miter box to the steering driveline. Mark the splines for later assembly.
   - 5.2 Remove the pinch bolt and prevailing torque hexnut that connect the input shaft of the miter box to the traverse shaft. Mark the splines for later assembly.
   - 5.3 Discard the pinch bolts and nuts.
6. Remove the miter box from the vehicle. See **Fig. 2**. Take care not to damage the splined input (clockwise) or output (counterclockwise) shafts.
7. Remove and discard the pinch bolt and prevailing torque hexnut that attach the RH miter box to the traverse shaft. See **Fig. 3**.
8. Remove the traverse shaft from the vehicle. See **Fig. 3**. To gain clearance, loosen the upper bolts on the electrical power center (EPC) panel.

Installation

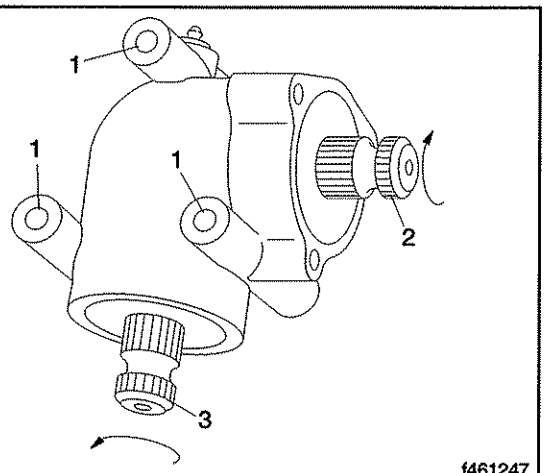
1. Position the traverse shaft through the EPC panel. Install new pinch bolts and prevailing torque hexnuts into the end yokes of the U-joints at each end of the shaft, but do not tighten.
2. Install the LH miter box. See **Fig. 2**.

⚠ CAUTION

The two shafts of the LH miter box turn in opposite directions. If they are not installed correctly, the steering linkage can be damaged when the wheels are turned.

   - 2.1 Using the alignment marks made on removal, install the input (clockwise) shaft of the miter box onto the traverse shaft.
   - 2.2 Using the alignment marks made on removal, install the output (counterclockwise) shaft of the LH miter box onto the steering driveline.

Traverse Shaft Removal and Installation, RH DR



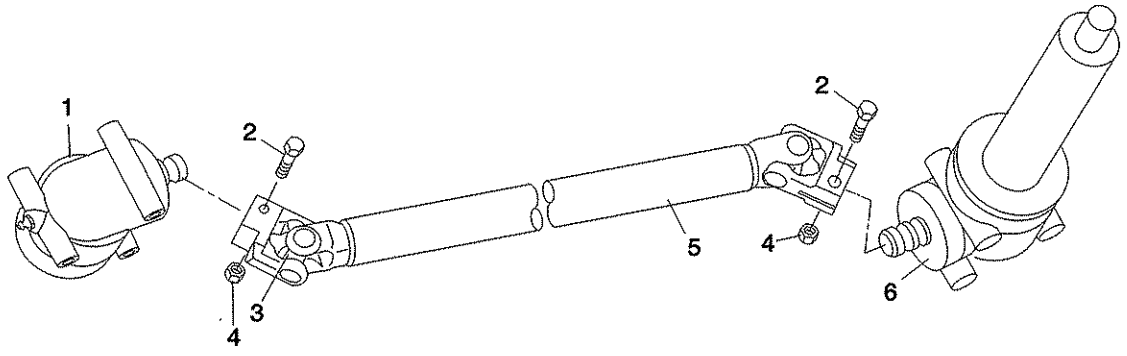
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IMPORTANT: The input and output shafts turn in opposite directions. Be sure to install them correctly.

1. Threaded Hole, 3/8–16
2. Input (clockwise) Shaft
3. Output (counterclockwise) Shaft

Fig. 2, LH Miter Box

3. Connect the traverse shaft to the RH miter box. See **Fig. 3**).
4. Tighten the new pinch bolts and nuts. See **Fig. 3**.
   - 4.1 Tighten each nut 60 lbf·ft (81 N·m).
   - 4.2 Apply white Torque Seal F-900® to the exposed threads of the pinch bolts.
5. Install the face plate as shown in **Fig. 1**. Tighten the LH miter box and face plate mounting capscrews 28 lbf·ft (38 N·m)
6. Line up the shims inside the dash kick panel. Install the dash kick panel.
7. Tighten the bolts loosened on the EPC panel.
8. Remove the chocks from the tires.



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1. LH Miter Box
2. Pinch Bolt, 7/16–20
3. U-Joint
4. Prevailing Torque Hexnut
5. Traverse Shaft
6. RH Miter Box

Fig. 3, Traverse Shaft Pinch Bolts

Specifications

Fastener Torques, Left-Hand Drive	
Description	**Torque Value lbf.ft (N.m)**
Steering Column Bracket Hexbolts	40 (54)
Steering Driveline End-Yoke Pinch Bolt Nut	37 (50)
Steering Wheel Nut	60 (81)

Table 1, Fastener Torques, Left-Hand Drive

Fastener Torques, Right-Hand Drive	
Description	**Torque Value lbf.ft (N.m)**
Face Plate Mounting Capscrews	28 (38)
Miter Box Mounting Capscrews	28 (38)
Steering Column Cover Capscrews	28 (38)
Steering Column Mounting Plate Capscrews	28 (38)
Steering Column Support Capscrews	34 (46)
Steering Driveline End-Yoke Pinch Bolt Nut	60 (81)
Steering Wheel Nut	60 (81)
Traverse Shaft End-Yoke Pinch Bolt Nut	60 (81)

Table 2, Fastener Torques, Right-Hand Drive

VT 7 Series Power Steering Pump 46.03

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General Description

The Luk-Automotive Hydraulics (formerly Vickers) VT 7 Series power steering pump supplies power steering fluid for the operation of the power steering gear, and in vehicles so equipped, for the hydraulic brake power booster.

On Cummins B and C Series engines, the pump is mounted on the driver's side of the engine, at the rear of the gear case. **See Fig. 1.** It is powered by an adaptor gear in the engine.

On Detroit Diesel Series 50 engines, the pump is mounted on the driver's side of the engine at the front of the engine gear case. **See Fig. 2.**

On Dodge Magnum engines, the pump is mounted on the driver's side of the engine and is belt driven by the crankshaft pulley. **See Fig. 3.**

The main parts of the power steering pump are the housing, driveshaft, cam ring, rotor, vanes, and control valve. **See Fig. 4.**

Principles of Operation (See Fig. 5)

The driveshaft, powered by the adaptor gear in the engine gear case, or by the crankshaft pulley, turns the rotor, which is inside the cam ring. As the rotor

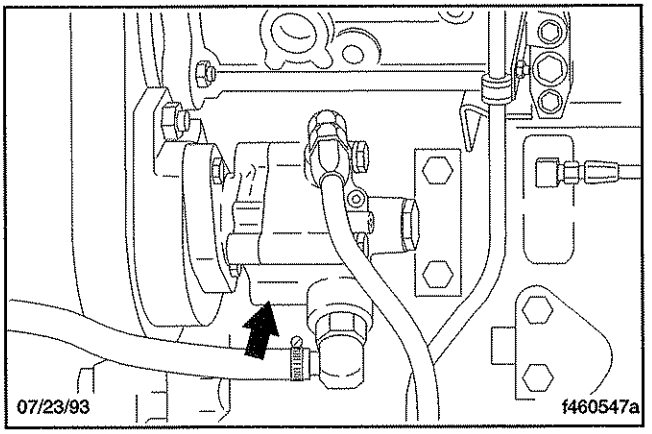
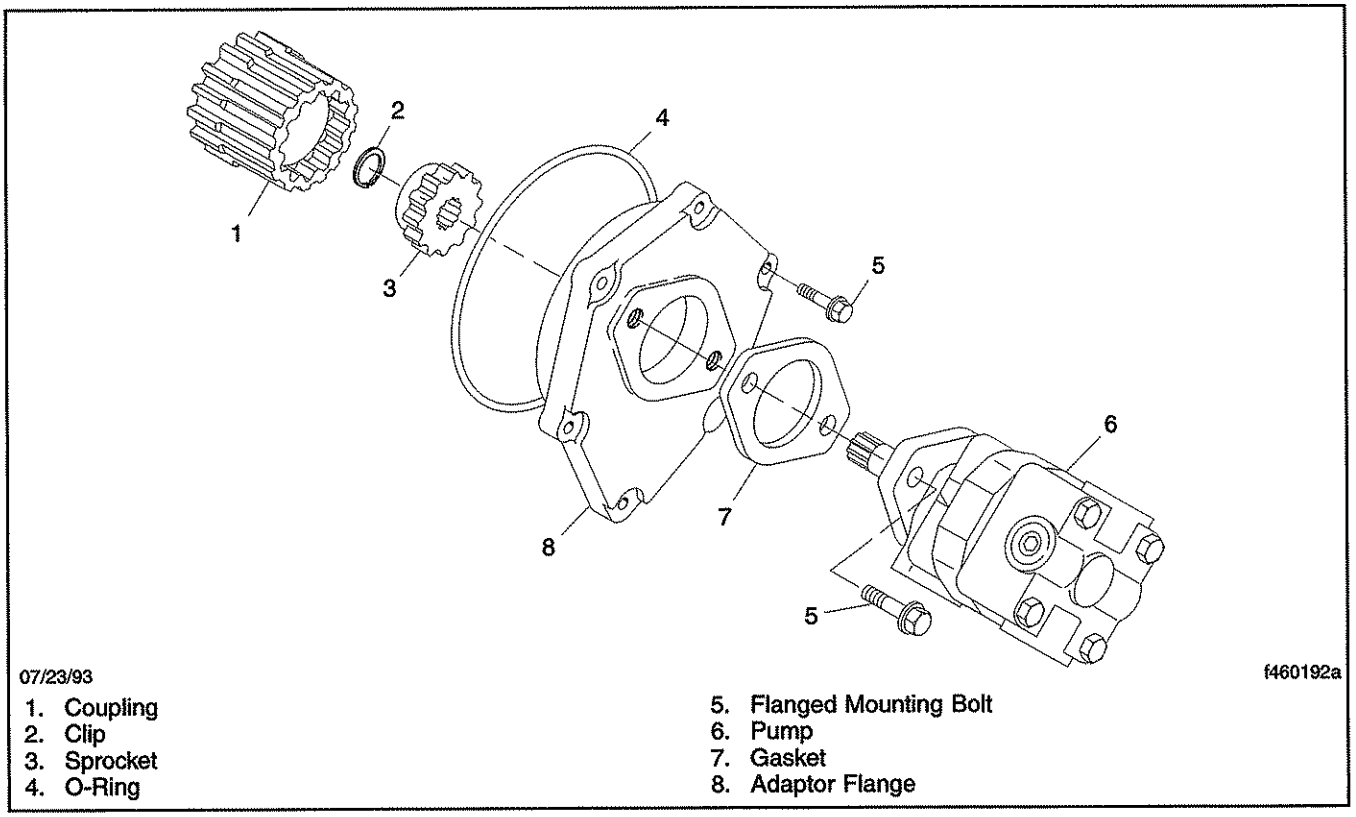


Fig. 1, Cummins B Series Engine Installation



1. Coupling
2. Clip
3. Sprocket
4. O-Ring
5. Flanged Mounting Bolt
6. Pump
7. Gasket
8. Adaptor Flange

Fig. 2, Detroit Diesel Series 50 Engine Installation

General Description and Principles of Operation

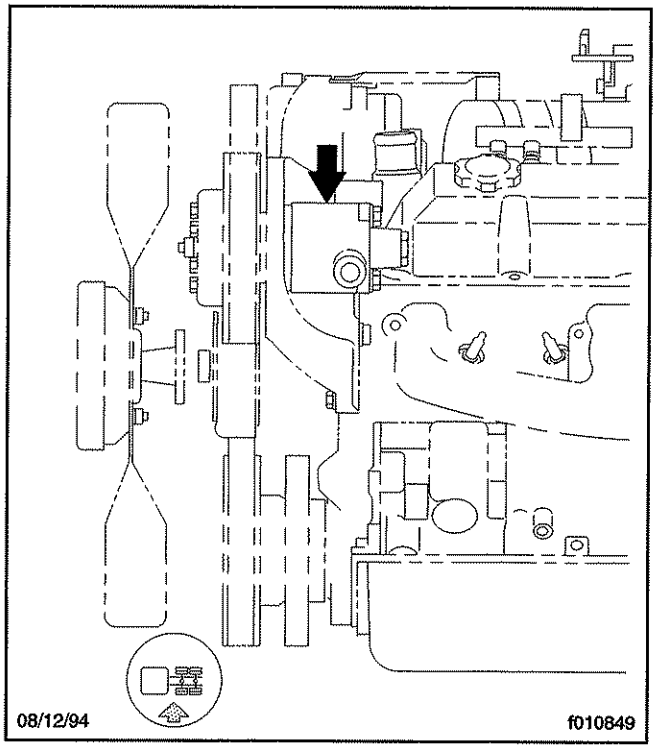
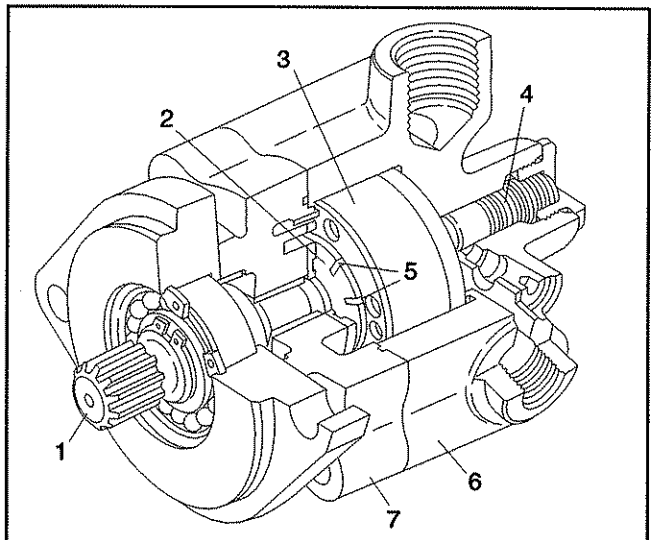


Fig. 3, Dodge Magnum Engine Installation

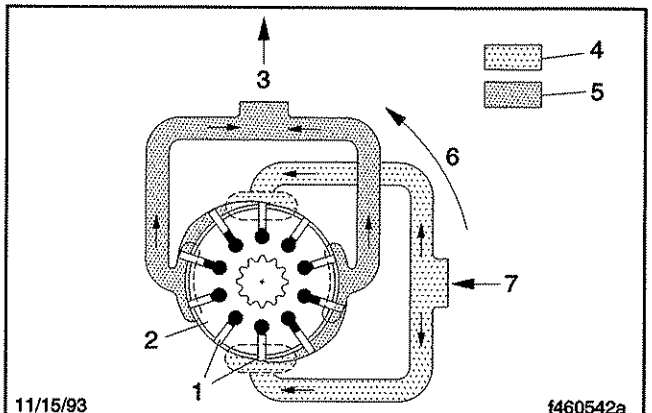


1. Driveshaft
2. Rotor
3. Cam Ring
4. Control Valve
5. Vanes
6. Housing
7. Flange Assembly

Fig. 4

turns, centrifugal force pushes the vanes out toward the surface of the cam ring. As fluid enters the cam ring through the inlet port, the rotor vanes force it out through the outlet port, and into the system. The fluid operates the steering gear, and if the vehicle is so equipped, the hydraulic brake power booster. Eventually the fluid returns to the power steering reservoir, and then back to the power steering pump.

If the system pressure gets too high, a poppet inside the control valve is forced off its seat, shunting fluid into a relief passage connected to the inlet port. The fluid then recirculates inside the pump instead of going to the outlet port. When the system pressure drops to the correct level, the poppet seats, closing off the relief passage to the inlet port. The fluid flow returns to normal, flowing from the inlet port to the outlet port and then into the power steering system.



1. Vanes
2. Rotor
3. Outlet
4. Low Pressure Fluid
5. High Pressure Fluid
6. Rotation
7. Inlet

Fig. 5

Removal

1. Apply the parking brake, chock the tires, then tilt the hood.
2. Clean all outside dirt from around the fittings and hose connections.
3. Put a container under the pump, then disconnect the hoses from the fittings on the pump. Plug the hoses and cap the fittings to keep out dirt and to prevent fluid from leaking.
4. On Cummins engines, remove the pump.
   - 4.1 Remove the mounting bolts that attach the pump to the engine accessory drive mounting flange. See **Fig. 1.** Hold the pump as you remove the second mounting bolt.
   - 4.2 Pull the pump straight out from the engine. See **Fig. 2.** Keep it level to avoid spilling fluid.
5. On Detroit Diesel Series 50 engines, remove the pump.
   - 5.1 Remove the mounting bolts that attach the pump to the adaptor flange. See **Fig. 3.**
   - 5.2 Slide the pump out of the coupling. Remove the sprocket from the shaft if necessary.
   - 5.3 Check around the adaptor flange for oil leaks. If there are leaks, remove the adaptor flange from the engine. Remove all old gasket material.
6. On Dodge Magnum engines, remove the pump.
   - 6.1 Loosen the hexnut from the pulley hub. See **Fig. 4.**
   - 6.2 Loosen the six capscrews on the pulley assembly.
   - 6.3 Turn the belt tensioner counterclockwise to loosen the drive belt.
   - 6.4 Remove the six capscrews from the pulley assembly. Remove the pulley assembly.
   - 6.5 Remove the bearing washer and hexnut from the pulley hub.
   - 6.6 Using an appropriate puller, remove the pulley hub.
   - 6.7 Remove the two capscrews that attach the pump to the mounting bracket. Remove the pump.
7. Turn the pump upside down over a container and let the fluid drain out.
8. Discard the gasket from the pump mounting flange.

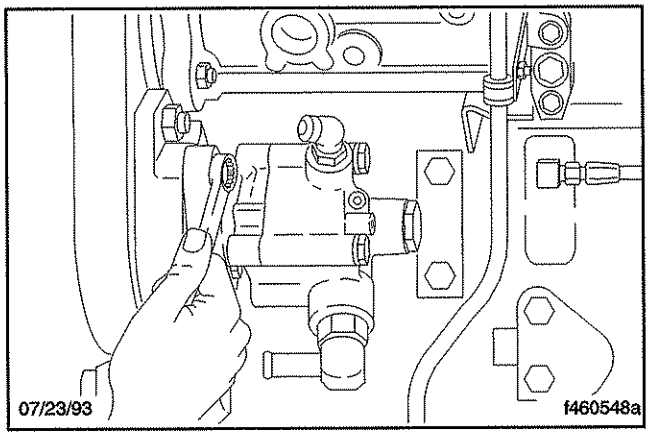


Fig. 1, Pump Fasteners

Installation

1. Using engine oil, lightly lubricate a new gasket and the pump shaft.
2. Install the pump.
   - 2.1 On Cummins engines, install a new gasket on the pump mounting flange, then place the pump on the engine's accessory drive mounting. Install the lockwashers and

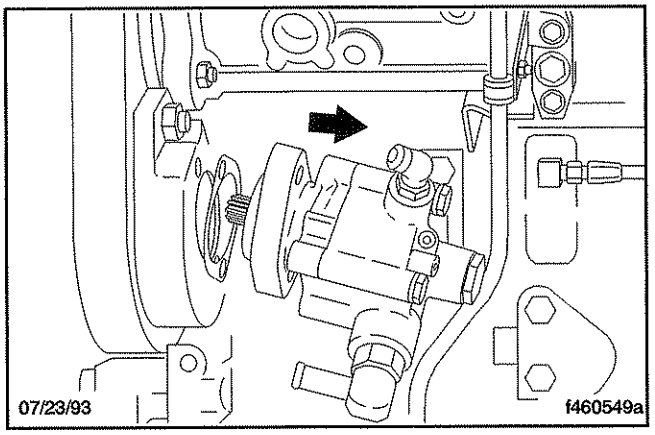
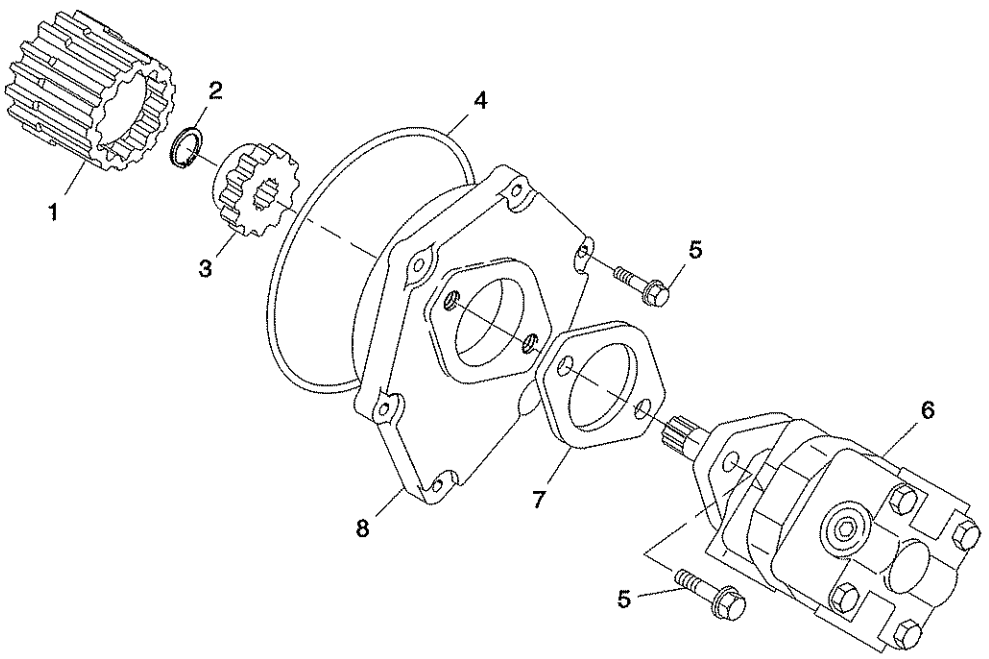


Fig. 2, Pump Removal

Removal and Installation



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1. Coupling
2. Clip
3. Sprocket
4. O-Ring
5. Flanged Mounting Bolt
6. Pump
7. Gasket
8. Adaptor Flange

Fig. 3, Pump Components

mounting bolts, and tighten them 35 lbf·ft (47 N·m).

2.2 On Detroit Diesel Series 50 engines, make sure the clip is installed in the sprocket, and that the coupling and sprocket are installed on the engine's accessory drive. If the adaptor flange was removed, use engine oil to lightly lubricate a new O-ring, install the O-ring on the flange, and install the flange on the engine. Cross tighten the six flange-mounting bolts 22 to 25 lbf·ft (30 to 34 N·m). Install the new gasket on the pump mounting flange, then position the pump on the adaptor flange. Turn the pump or shaft as needed to mesh the shaft with the sprocket. Install the two pump-mounting bolts and tighten them 40 lbf·ft (54 N·m).

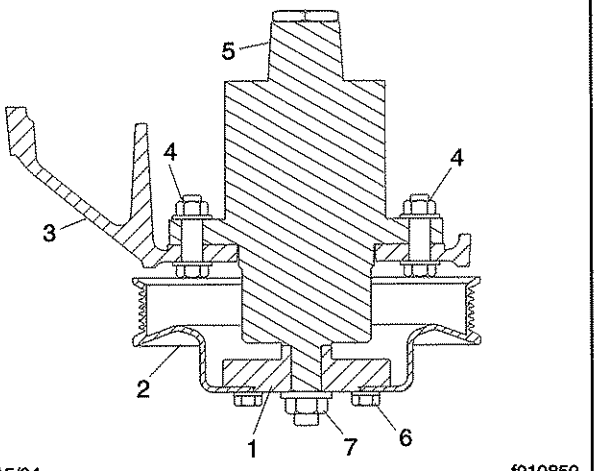
2.3 On Dodge Magnum engines, position the pump on the mounting bracket. See **Fig. 4.** Install the mounting fasteners and tighten them 28 lbf·ft (38 N·m). Using an appropriately sized driver to protect the pump shaft, tap the pulley hub onto the pump shaft. Loosely install the bearing washer and hexnut. Position the pulley assembly and loosely install the six capscrews. Turn the belt tensioner counterclockwise and slip the belt over the pulley. Tighten the hexnut on the pulley hub 59 to 74 lbf·ft (80 to 100 N·m). Tighten the six capscrews on the pulley assembly 16 lbf·ft (22 N·m).

3. Connect the inlet hose (from the power steering reservoir) to the inlet port. Tighten it 20 lbf·ft (27 N·m).

4. Connect the outlet hose (from the power steering gear) to the outlet port. Install the hose clamp, and tighten it firmly.

5. Bleed the power steering system.

   5.1 Check the fluid level in the power steering reservoir and if needed, fill it to the correct level with the fluid shown in **Specifications, 400.**



1. Pully Hub
2. Pully Assembly
3. Mounting Bracket
4. Pump-to-Mounting Bracket Fasteners
5. Steering Pump
6. Pulley Assembly Capscrews
7. Hub-to-Pump Mounting Nut

Fig. 4, Pump Cross Section

5.2 Start the engine and let it idle for several minutes.

5.3 Turn the wheels to a full-left and full-right turn. Repeat about three times.

5.4 Check the fluid level in the power steering reservoir. If needed, add the fluid shown in **Specifications, 400.**

5.5 Shut down the engine.

6. Lower the hood, then remove the chocks.

Disassembly (See Fig. 1)

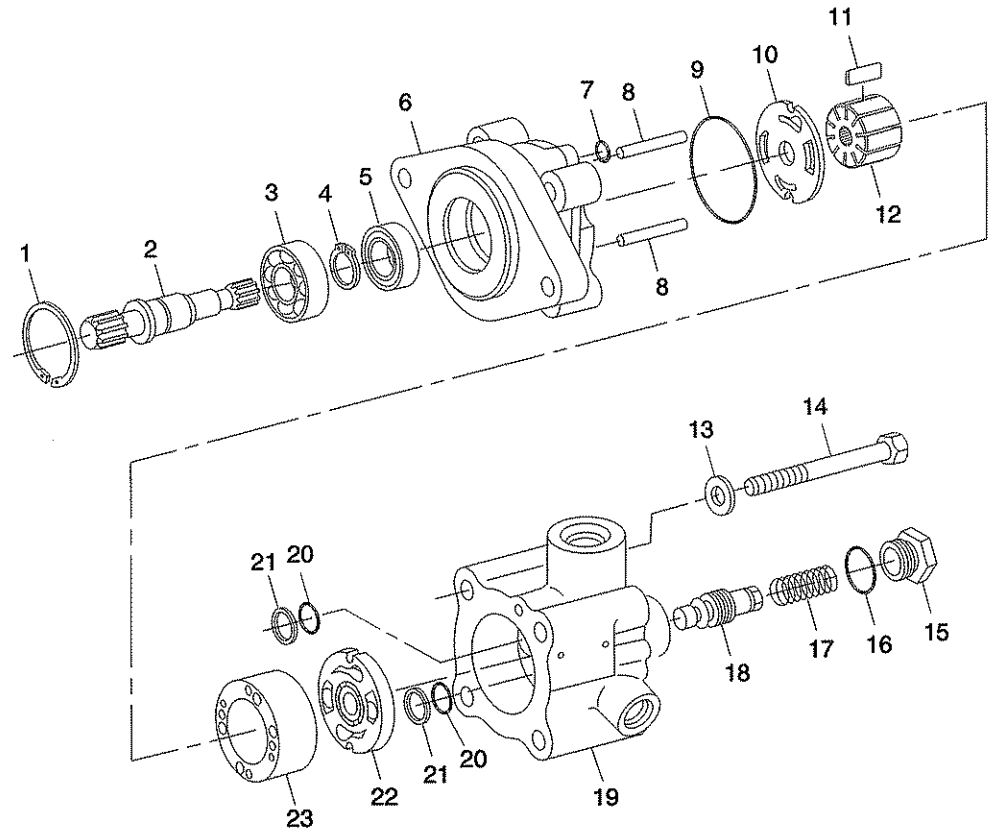
⚠ WARNING

Wear safety goggles or glasses when disassembling the power steering pump. Some of the parts are held in place by springs or snap rings, which can release with considerable force, possibly causing injury.

⚠ CAUTION

Be careful when working on the pump housing; it is aluminum, and can be easily damaged. When putting it in a vise, pad the vise jaws; tighten the vise just enough to hold the pump.

1. Remove the power steering pump from the engine, following the instructions under **Subject 100**.
2. Carefully remove the end plug from the pump body. There is a spring underneath it; remove the



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1. Snap Ring
2. Driveshaft
3. Driveshaft Bearing
4. Snap Ring
5. Shaft Seal
6. Flange Assembly
7. O-Ring
8. Guide Pin
9. O-ring
10. Wear Plate
11. Vane
12. Rotor
13. Washer (4 qty.)
14. Hexbolt (4 qty.)
15. End Plug
16. O-Ring
17. Spring
18. Control Valve
19. Pump Housing
20. O-Ring
21. Back-Up Ring
22. Pressure Plate
23. Cam Ring

Fig. 1, Pump, Exploded View

Disassembly, Inspection, and Assembly

spring, then, slide out the control valve. See **Fig. 2.** Be careful not to scratch the control valve.

3. Remove and discard the O-ring from the plug.
4. Put the pump housing in a padded vise, then remove the four screws holding the housing and the flange assembly together. See **Fig. 3.**
5. Remove the flange assembly from the pump housing. See **Fig. 4.**
6. Remove the pressure plate from the flange assembly. See **Fig. 5.**
7. Remove the cam ring. See **Fig. 6.**
8. Remove the rotor and vanes. See **Fig. 7.**
9. Remove the wear plate. See **Fig. 8.**
10. Remove the two guide pins (**Fig. 1**) from their seats.

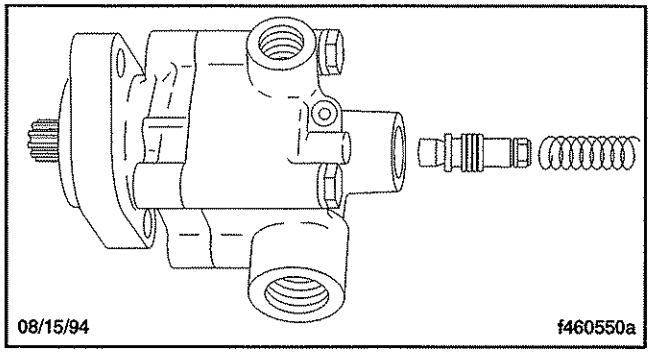


Fig. 2, Control Valve

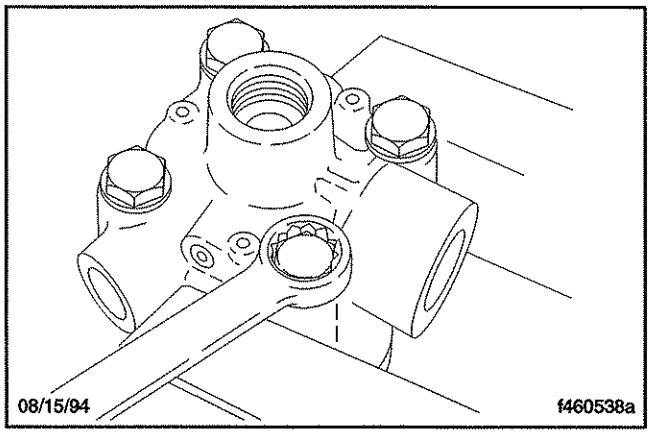


Fig. 3, Flange Fasteners

11. Remove the large O-ring from the flange assembly. See **Fig. 9.**
12. Remove the driveshaft from the flange assembly.
    - 12.1 Remove the snap ring holding the shaft bearing in place. See **Fig. 10.**
    - 12.2 Put the flange assembly in a vise, then carefully tap out the driveshaft. See **Fig. 11.**

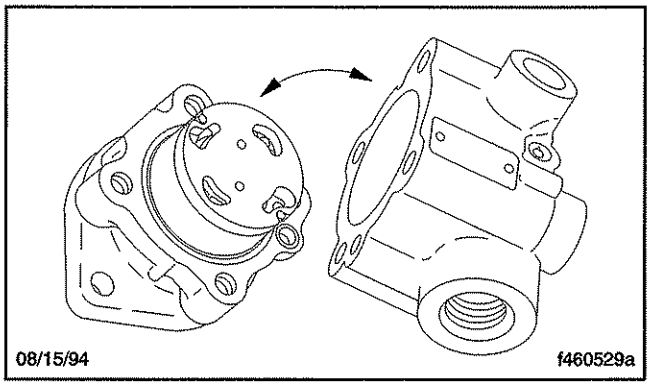


Fig. 4, Flange Removal

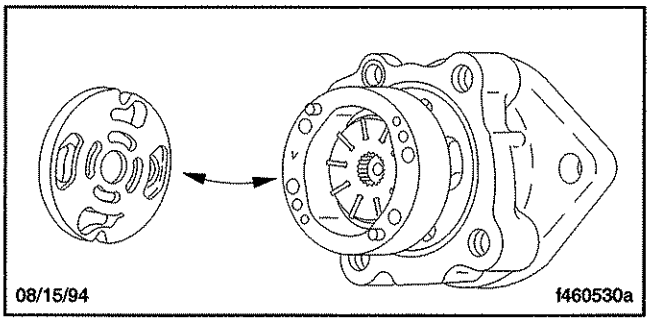


Fig. 5, Pressure Plate Removal

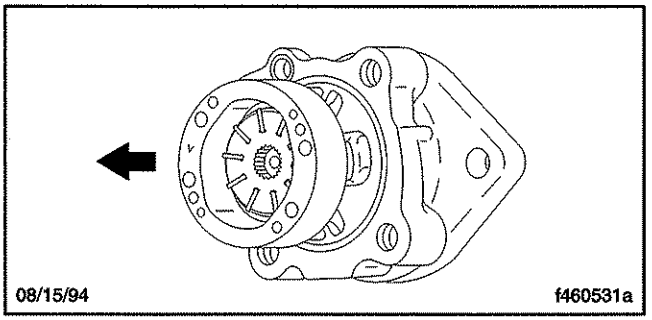


Fig. 6, Cam Ring Removal

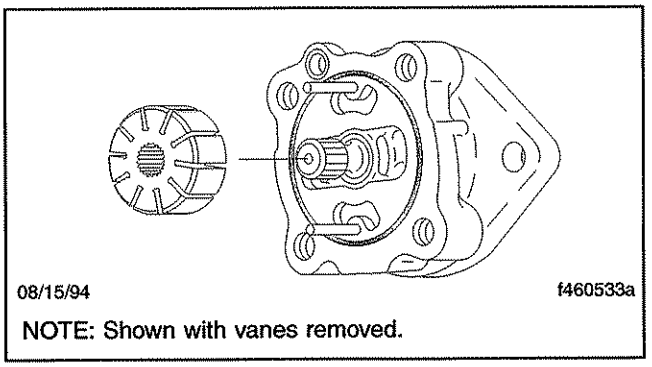


Fig. 7, Rotor and Vanes Removal

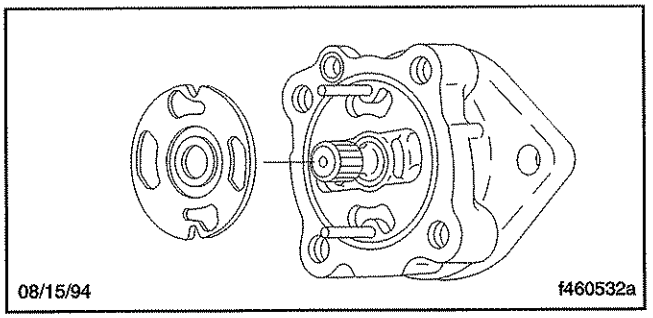


Fig. 8, Wear Plate Removal

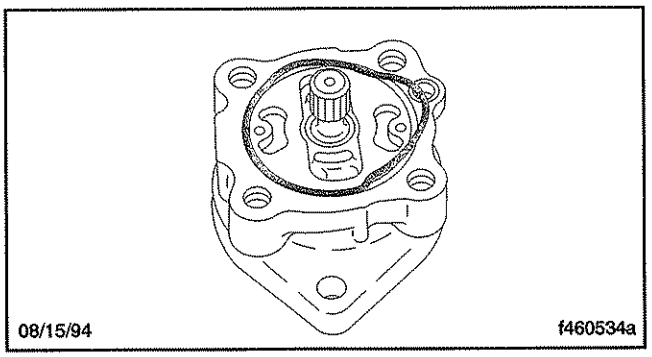


Fig. 9, Large O-Ring

13. Check the driveshaft bearing. If it's damaged or worn, remove it from the driveshaft; otherwise, go to the next step.

    13.1 Remove the small snap ring from the driveshaft. See **Fig. 12.**

    13.2 Being careful to push only on the inner ring of the bearing, press the bearing off the driveshaft.

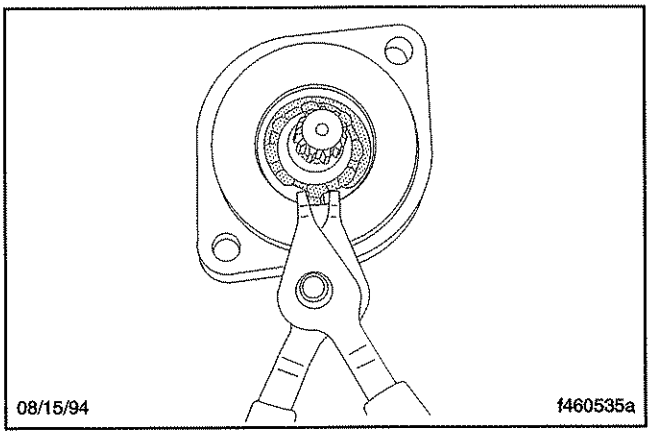


Fig. 10, Bearing Snap Ring

14. Remove and discard the shaft seal (**Fig. 1**) from the flange assembly.

15. Remove and discard the two O-rings and back-up rings from the pump housing. See **Fig. 13.**

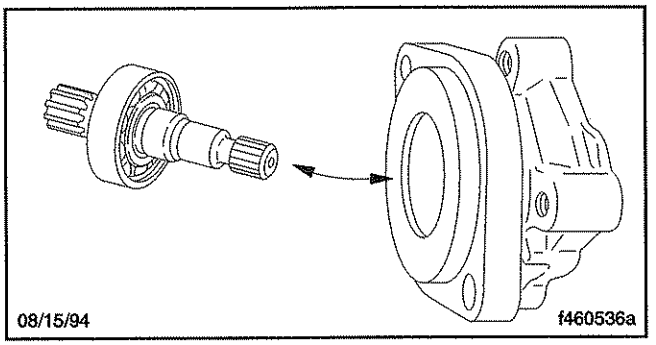


Fig. 11, Driveshaft Removal

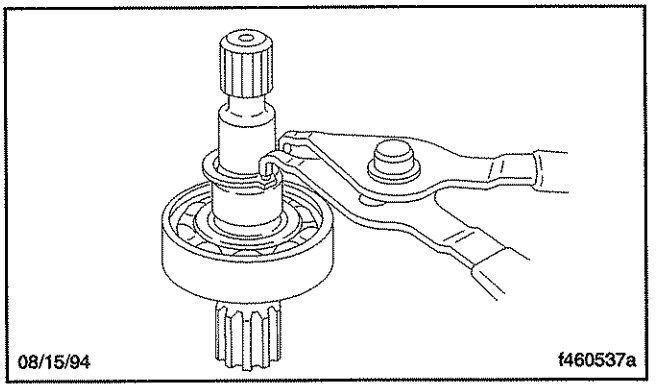


Fig. 12, Small Snap Ring Removal

Disassembly, Inspection, and Assembly

Inspection

1. Clean all the parts, using a solvent compatible with the power steering fluid. Then, using filtered compressed air, dry all the parts.
2. Check all the parts. Replace any that are damaged or worn.
3. Check the vanes on the rotor for damage or too much play in the rotor slots. If you can move the vanes from side-to-side in the slots, replace the whole rotor assembly.
4. Check the control valve (**Fig. 1**).

   If obvious damage or wear is present, replace the control valve. If the control valve doesn't need replacing, continue with the next step.

⚠ CAUTION

When putting the control valve in a vise, put only the bottom part (opposite the hex plug) of the valve into the vise. Don't clamp the sealing surfaces (outer rings), or you will damage the valve.

5. Carefully put the control valve in a padded vise. See **Fig. 14**. Don't damage the sealing surfaces.

   Test the torque of the seat (hex) plug. It should be 6 to 8 lbf·ft (8 to 11 N·m). If it's not, replace the control valve.
6. Coat the control valve with clean power steering fluid specified in **Specifications, 400**, then fit it into its bore in the pump housing.

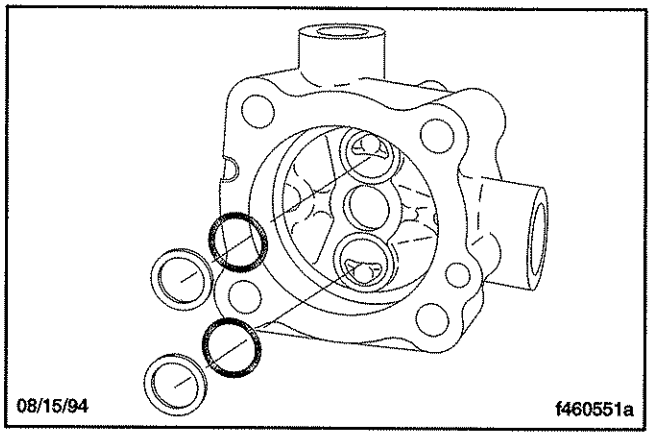


Fig. 13, O-Rings and Back-Up Rings

7. Spin the control valve all the way around in its bore, while moving it in and out. If there is any binding, replace the control valve.

Assembly

NOTE: To correctly install the driveshaft seal and bearing, it's necessary to make suitable drivers from tubular stock. Refer to **Specifications 400** for the applicable dimensions.

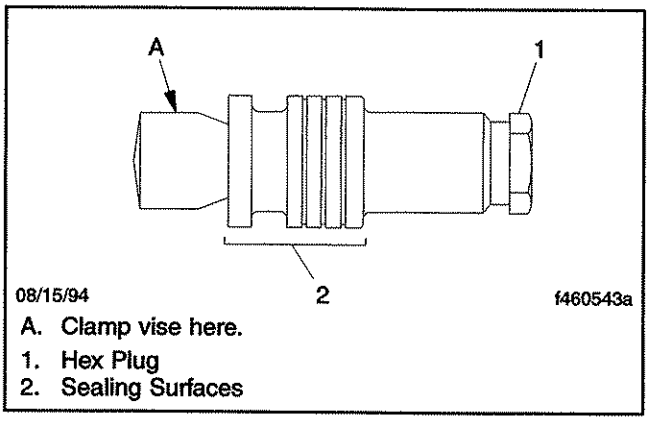
1. Coat all the parts in the power steering fluid specified in **Specifications, 400.**
2. Usin a suitable driver (see "Note" above), install the shaft seal into the bore in the flange assembly. Make sure the spring side of the seal faces the flange. See **Fig. 15.** Seat the seal firmly against the shoulder in the bore.

⚠ CAUTION

When installing the driveshaft bearing, make sure that pressure is exerted only on the inner race of the bearing; don't use any pressure on the outer race, or you may damage the bearing assembly.

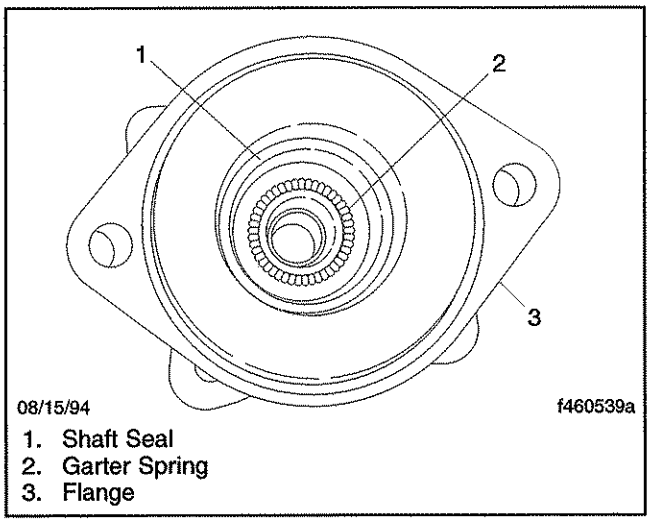
3. If it was removed, install a new bearing onto the driveshaft, using a suitable driver (see "Note" above) and an arbor press.

   Install the small snap ring in its groove on the drive shaft, with the sharp edge facing toward the bearing.
4. Install the driveshaft and bearing assembly in the flange assembly.



A. Clamp vise here.
1. Hex Plug
2. Sealing Surfaces

Fig. 14, Control Valve Components



1. Shaft Seal
2. Garter Spring
3. Flange

Fig. 15, Seal Placement

4.1 Lubricate the shaft with power steering fluid.

4.2 Slide the driveshaft into the bore of the flange assembly, being careful not to damage the shaft seal.

4.3 Install the large snap ring into its groove in the flange assembly. See **Fig. 10.**

5. Using the fluid specified in **Specifications, 400**, lubricate the new O-rings and back-up rings, then install them in the pump housing. See **Fig. 13.**

6. Put the flange assembly in a padded vise, then install a new large O-ring in the flange assembly.

7. Install a new small O-ring (**Fig. 1**) in the flange assembly.

8. Install the two guide pins (**Fig. 1**) in their seats in the flange assembly.

9. Install the wear plate—bronze side up—onto the flange assembly. See **Fig. 8.**

10. Install the rotor on the driveshaft. See **Fig. 7.**

11. Install the vanes—rounded edges outboard—in the rotor. Make sure that none of them are binding.

12. Install the cam ring over the rotor, onto the flange assembly and over the guide pins. Make sure the arrow on the face of the cam ring is pointing in the direction of the shaft rotation. With the flange held shaft-side down, the arrow should be pointing in a counterclockwise direction (left). See **Fig. 16.**

13. Install the pressure plate—bronze side down—onto the rotor and cam ring assembly.

14. Install the pump housing over the flange assembly, lining up the mounting holes.

15. Install the four hexbolts and washers in the pump housing. Tighten them in a cross pattern 29 to 37 lbf·ft (40 to 50 N·m).

16. Install the control valve in the pump housing.

⚠ CAUTION

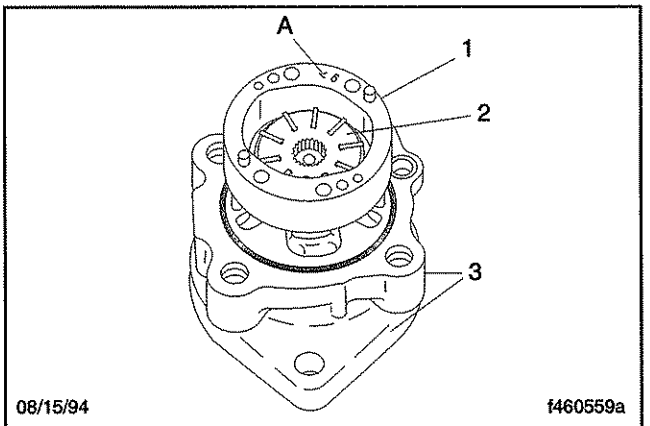
Make sure you install the control valvecorrectly in its bore. If it's installed backwards, the power steering pump won't work, and will quickly overheat, which could cause severe damage to the pump.

16.1 Lubricate the control valve, then install it—with the hex-plug end up— into the bore in the pump housing. See **Fig. 17.**

16.2 Install the spring over the hex-plug end of the control valve.

16.3 Install a new O-ring on the end plug, then install the end plug. Tighten it 33 to 40 lbf·ft (45 to 55 N·m).

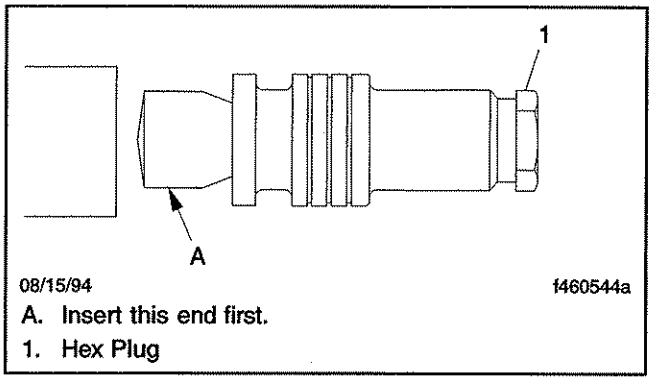
17. Install the power steering pump on the engine, following the instructions under **Subject 100.**



A. Stamped arrow indicates rotation direction.
1. Cam Ring
2. Rotor
3. Flange Assembly

Fig. 16, Cam Ring Placement

Disassembly, Inspection, and Assembly



A. Insert this end first.
1. Hex Plug

Fig. 17, Control Valve Installation

Problem—The Power Steering Pump Doesn't Deliver Fluid

Possible Cause	Remedy
The pump driveshaft is broken, or not engaging.	Remove the pump. Repair or replace parts as needed.
The control valve is stuck open.	Remove and disassemble the pump. Clean the control valve in a solvent. Install the control valve, then check for any binding in its bore. If the control valve binds or feels gritty when you move it, replace it.
One or more rotor vanes is stuck.	Remove and disassemble the pump. Check the rotor and vanes for dirt or damage. If damaged, replace the rotor and vane assembly. If dirty, clean the rotor and vanes in a solvent, then assemble the parts and check for free vane movement. If the problem persists, replace the rotor and vane assembly.
Incorrect power steering fluid is used.	Check for the type of fluid used. If it's incorrect, drain, flush, and fill the system with Dexron II®.
The pump intake port is blocked.	Drain and flush the system. Fill the system with clean Dexron II.
The air vent in the power steering reservoir is clogged, or the filter is dirty.	Remove the filter cap from the reservoir, then clean the air slot. Check the filter and replace it if needed.
A power steering hose is kinked or blocked.	Repair or replace the hose.

Problem—The Power Steering Pump Is Making Noise

Possible Cause	Remedy
The intake line or filter is plugged.	Drain the system. Clear the intake line if needed, then check the filter. Replace it if needed. Fill the system.
There is an air leak at the pump connections, the fittings, the reservoir connections, or the shaft seal.	Check all the connections by pouring power steering fluid over them, then listen for a reduction in sound. Tighten all the connections as needed. If the problem persists, remove the pump, then disassemble it and replace the shaftseal.
The pump driveshaft is misaligned.	Remove and disassemble pump. Replace the shaft seal and bearing.

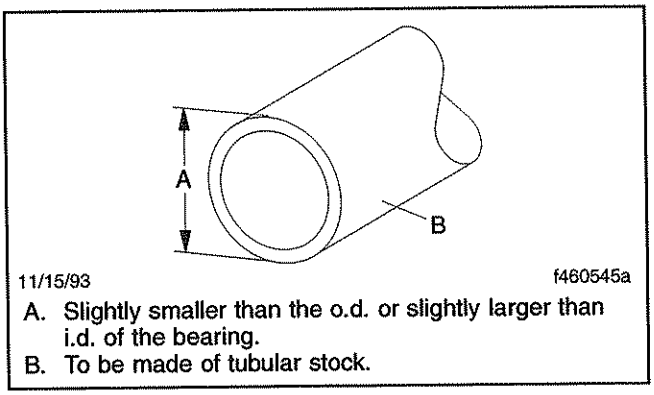
Specifications

Fastener Torques	
Description	**Torque: lbf.ft (N.m)**
Cummins B and C Series Engines Pump Mounting Hexbolts	35 (47)
Detroit Diesel Series 50 Engines Pump Mounting Hexbolts	40 (54)
Dodge Magnum Engines Pump-to-Mounting Bracket Capscrews	28 (38)
Dodge Magnum Engines Hub-to-Pump Hexnut	59–74 (80–100)
Dodge Magnum Engines Pulley Assembly Capscrews	16 (22)
Pump Housing-to-Flange Assembly Hexbolts	29–37 (40–50)
Pump End-Plug	33–40 (45–55)
Pump Inlet Connection	20 (27)

Table 1, Fastener Torques

See **Fig. 1** for the bearing installation tool specifications.

See **Fig. 2** for the shaft seal installation tool specifications.



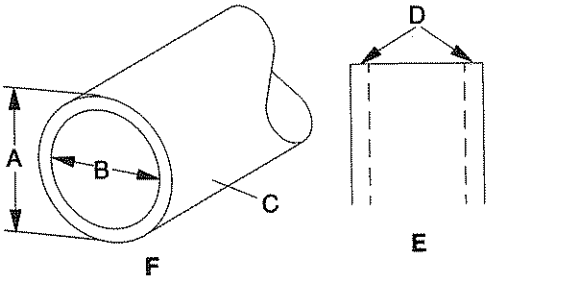
A. Slightly smaller than the o.d. or slightly larger than i.d. of the bearing.
B. To be made of tubular stock.

Fig. 1, Bearing Installation Tool

Approved Power Steering Fluids		
Fluid Type	**Approved Fluid**	
Automatic Transmission Fluid*	Dexron® II	
	Dexron® III	
Heavy-Duty Engine Oil*	Union	10W–40
IMPORTANT: Do not use heavy-duty engine oil in vehicles built from November 4, 2002.	Texaco	10W–40
	Chevron	10W–40
	Mobil Super	10W–40
	Union	15W–40
	Shell Rotella T	30W

* Do not mix engine oil with automatic transmission fluid (ATF). Use the same lubricant for parts as is in the power steering system.

Table 2, Approved Power Steering Fluids



A. Slightly smaller than the o.d. of the shaft seal.
B. Slightly larger than the o.d. of the driveshaft.
C. To be made of tubular stock.
D. The ends must be square.
E. Front View
F. End View

Fig. 2, Shaft Seal Installation Tool

Contents

Subject	Subject Number
General Description	050
Service Operations	
In-Vehicle Adjustments	100
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General Description

The TRW TAS40, TAS55, TAS65, and TAS85 power steering gears use pressurized hydraulic fluid to help the driver turn the front wheels. All four models mount on the left frame rail, and all operate in the same way.

The difference between the four gears is size. The TAS40 can be installed on vehicles with front axle capacities up to 9000 lbs (4086 kg). The TAS55 is for vehicles with front axle capacities up to 12,000 lbs (5448 kg), the TAS65 is for front axle capacities up to 14,300 lbs (6500 kg), and the TAS85 is for front axle capacities up to 18,000 lbs (8200 kg).

All four gears use more pressurized fluid when the driver turns the steering wheel quickly than when the driver turns the steering wheel slowly, but the minimum amount of power steering fluid is different for each model. With the driver turning the steering wheel 1-1/2 turns per second, the TAS40 needs at least 2.2 gallons (8.3 liters) of fluid per minute . At the same turning speed, the TAS55 needs 2.6 gpm (9.8 Lpm), the TAS65 needs 3.0 gpm (11.4 Lpm), and the TAS85 needs 3.6 gpm (13.6 Lpm).

⚠ CAUTION

Never steam clean or high-pressure wash the steering gear. Internal damage to gear seals and ultimately the steering gear can result.

Principles of Operation

When the driver turns the steering wheel, that force travels down through the steering driveline to the steering gear input shaft (**Fig. 1** and **Fig. 2**). The input shaft turns the worm shaft (**Fig. 3**) which moves the rack piston forward or backward in the gear housing by means of a series of recirculating balls in the spiral channels of the worm shaft.

Grooves in the rack piston mesh with teeth in the sector shaft (**Fig. 3**), and as the piston slides back and forth, it turns the sector shaft. The sector shaft swings the pitman arm (**Fig. 1** and **Fig. 2**). The pitman arm pulls or pushes the drag link, and the drag link moves the axle steering arm, steering the vehicle.

Pressurized power steering fluid helps the worm shaft slide the rack piston forward or backward in the gear housing.

The input shaft is not connected directly to the worm shaft. Instead, a thin bar, the torsion bar (**Fig. 3**), holds the input shaft to the worm shaft. The outside end of the torsion bar is fastened to the input shaft, and the inside end is fastened to the worm shaft; thus, the force of the driver turning the steering wheel travels from the input shaft to the worm shaft through the torsion bar.

With the force of the driver alone, the front axle would be difficult to steer. The weight on the front wheels, the friction of the tires against the road, and the inertia of the vehicle traveling in its current direction all combine to hold the sector shaft and the rack piston in place.

To overcome this resistance, the steering gear has a valve for directing pressurized hydraulic fluid either in front of the rack piston or behind it, thus using the fluid to push the rack piston in the direction the worm shaft is trying to slide it.

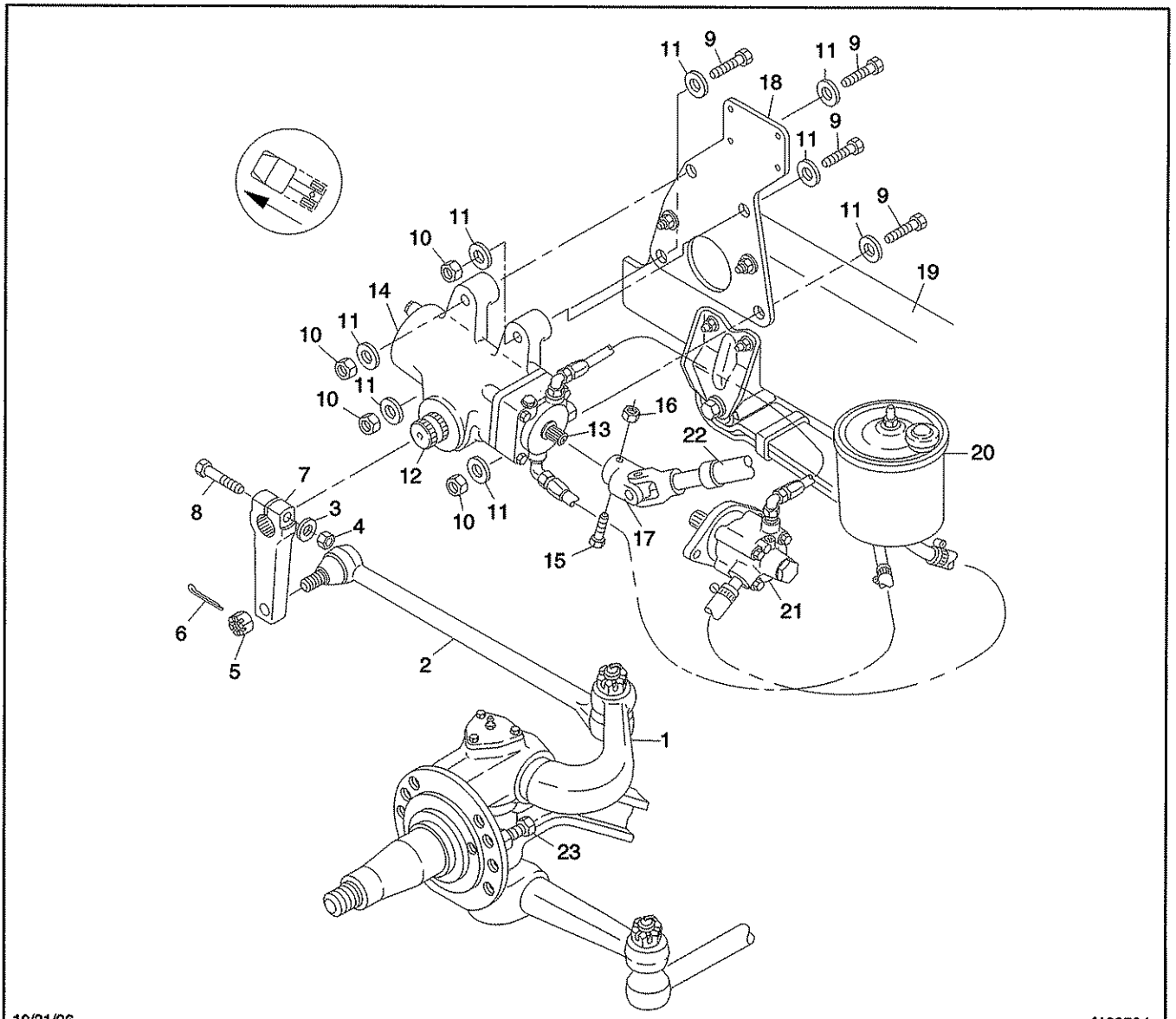
The torsion bar controls the hydraulic fluid. As the driver turns the steering wheel to turn the input shaft, and the front wheels resist turning and hold the rack piston and worm shaft in place, the torsion bar connecting the input shaft and worm shaft twists slightly. That twisting aligns holes in the hydraulic control valve (**Fig. 3**) with channels that carry hydraulic fluid. Depending on the direction the driver turns the steering wheel—the direction the torsion bar twists—the valve aligns the channels to direct hydraulic fluid in front of the rack piston or behind it. The fluid provides the extra force the worm shaft needs to overcome the resistance from the front wheels, and the worm shaft can then slide the rack piston in the gear housing.

The rack piston slides, and turns the sector shaft. The sector shaft swings the pitman arm. The pitman arm pulls or pushes the drag link. The drag link moves the axle steering arm, and the front wheels turn.

As the front wheels reach the axle stop—the farthest the wheels can turn in that direction—a poppet (unloading valve) in the rack piston trips to prevent steering gear damage. The tripped poppet (**Fig. 3**) reduces steering fluid pressure, heat generated by the power steering fluid pump, and outside forces from acting on the steering linkage.

The hydraulic fluid around the rack piston also prevents road shocks from moving the steering wheel. When the vehicle hits an obstacle, the shock travels up through the front tires and the steering linkage to the steering gear. There, the sector shaft would transmit the shock to the rack piston, but the power steering fluid helps to hold the piston in place and dampen the shock before

General Description

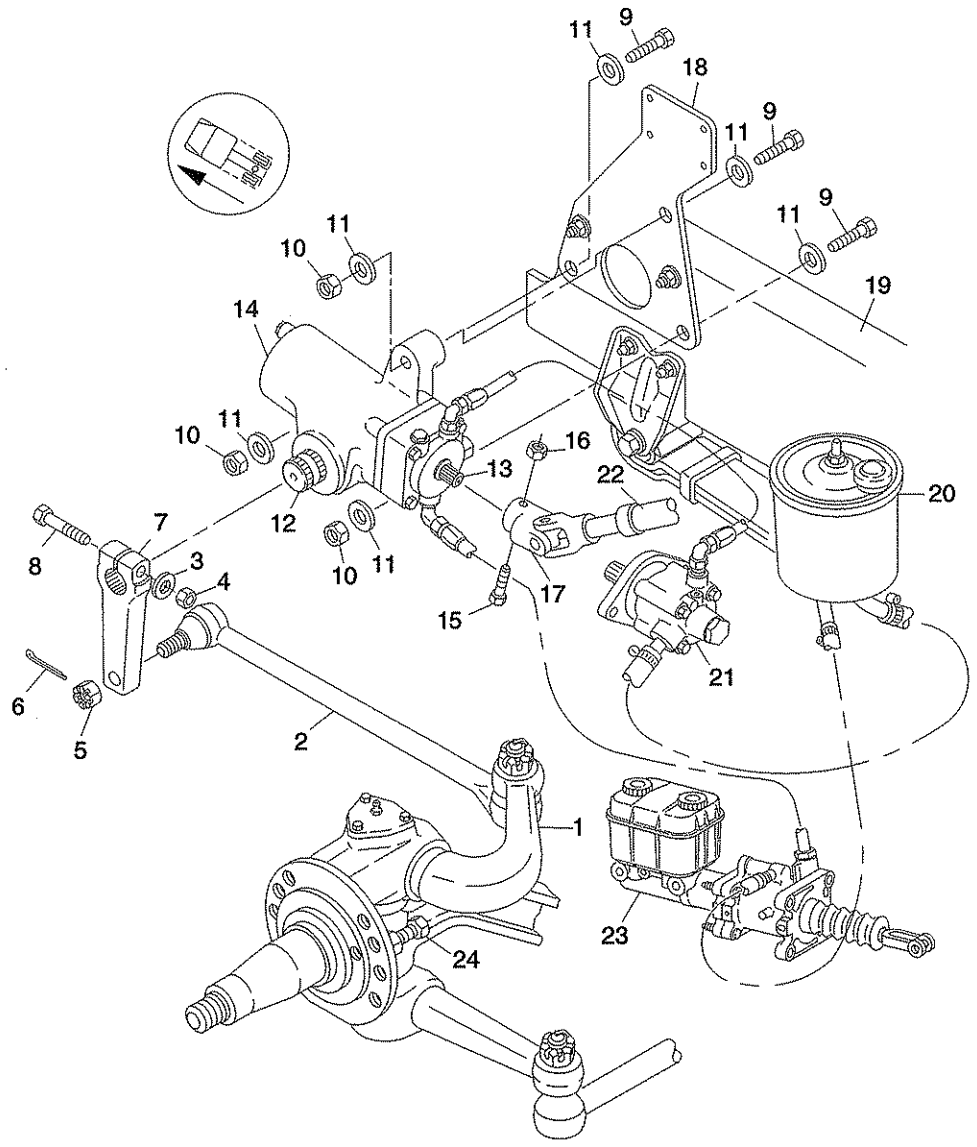


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1. Axle Steering Arm
2. Drag Link
3. Pitman Arm Washer
4. Pitman Arm Pinch Bolt Nut
5. Castle Nut
6. Cotter Pin
7. Pitman Arm
8. Pitman Arm Pinch Bolt
9. Mounting Capscrew
10. Locknut
11. Hardened Washer
12. Sector (output) Shaft
13. Input Shaft
14. Steering Gear
15. Lower End Yoke Pinch Bolt
16. Lower End Yoke Pinch Bolt Nut
17. Lower End Yoke
18. Steering Gear Mounting Plate
19. Left Frame Rail
20. Power Steering Reservoir
21. Power Steering Pump
22. Steering Driveline
23. Axle Stop

Fig. 1, TRW TAS85 Power Steering Installation (vehicles with air brakes)

it can move up the worm shaft to the steering driveline and the steering wheel.

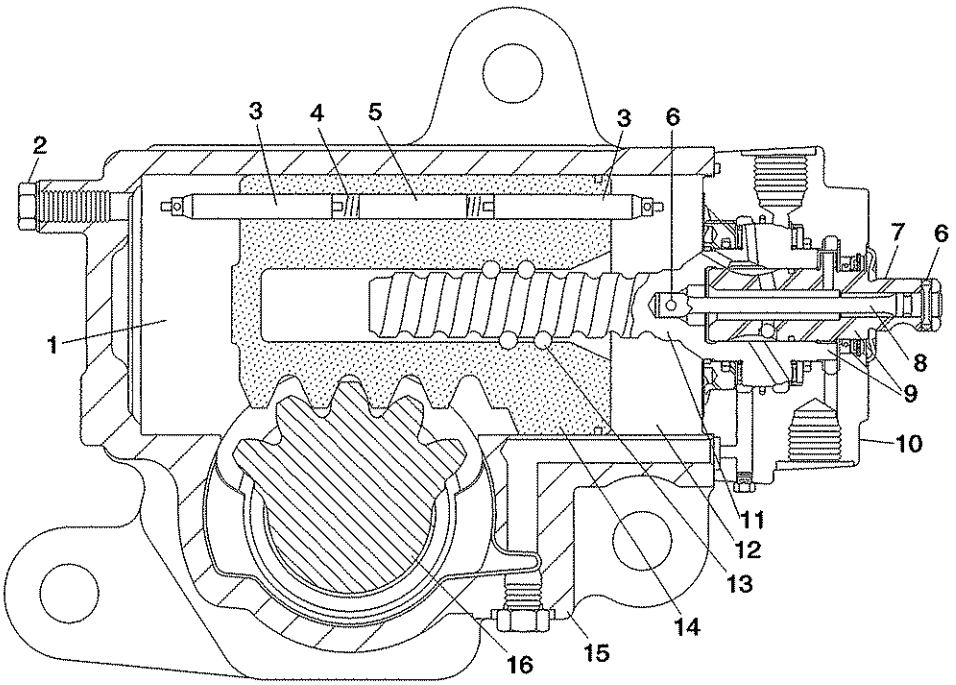


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3. Pitman Arm Washer
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17. Lower End Yoke
18. Steering Gear Mounting Plate
19. Left Frame Rail
20. Power Steering Reservoir
21. Power Steering Pump
22. Steering Driveline
23. Brake Booster
24. Axle Stop

Fig. 2, TRW TAS40/55/65 Power Steering Installation (vehicles with hydraulic brakes)

General Description



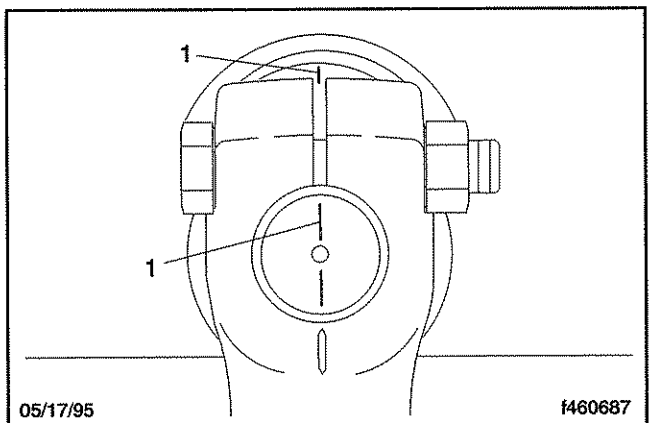
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1. Lower Cylinder Cavity
2. Poppet Fixed Stopscrew
3. Poppet Assembly
4. Poppet Spring
5. Push Tube
6. Pin
7. Input Shaft
8. Torsion Bar
9. Control Valve
10. Valve Housing
11. Worm Shaft
12. Upper Cylinder Cavity
13. Ball (recirculating)
14. Rack Piston
15. Gear Housing
16. Sector Shaft

Fig. 3, Steering Gear Sectional View

Sector (Output) Shaft Adjustment

1. Position the sector shaft at its center of travel by turning the steering wheel until the alignment mark on the sector shaft is at a right angle to the input shaft centerline, and in line with the timing mark on the end of the housing trunnion. See **Fig. 1**.
2. Disconnect the drag link from the pitman arm. Don't turn the input shaft/valve/worm assembly more than 1-1/2 turns in either direction from its center of travel while the drag link is disconnected from the pitman arm. Turning the input shaft more than 1-1/2 turns from center will cause misadjustment of the automatic poppets. This may require the installation of a service poppet adjustment tool to manually reset the poppets.
3. With the sector shaft in the center position, grasp the pitman arm and gently try to move it back and forth. Fingertip force is adequate to detect lash (free play) of a loose sector shaft. See **Fig. 2**. There should be no movement of the input shaft or sector shaft. Loosen the sector shaft adjusting screw jam nut. See **Fig. 3**. If no lash was detected, turn the shaft adjusting screw counterclockwise until lash is detected.
4. To adjust, move the adjusting screw clockwise until no lash is felt at the pitman arm. Use no more than 10 lbf·ft (14 N·m) of torque. Slowly turn the adjusting screw clockwise an additional one-eighth turn. Hold the adjusting screw in place and tighten the jam nut 40 to 45 lbf·ft (54 to 61 N·m).



1. Housing Trunnion Timing Mark
2. Sector Shaft Timing Mark

Fig. 1, Timing Mark Placement

5. Again, check the pitman arm for lash. Turn the steering wheel one-quarter turn each side of center. No lash should be felt. If lash exists, readjust the sector shaft.
6. Connect the drag link to the pitman arm. For instructions, refer to the applicable section in this group.

Poppet Valves Adjustment

TAS40, TAS55, TAS65, and TAS85 steering gears have automatic poppet valves that reset themselves if the axle stops are reset for increased steering travel. However, if the axle stops are reset for *decreased* steering travel, the poppet valves must be reset manually, through the use of a special service poppet adjusting screw and sealing jam nut kit, unless they were

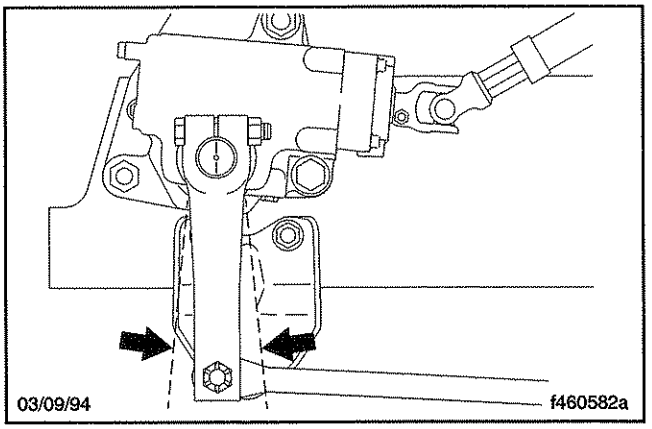


Fig. 2, Free Play Check

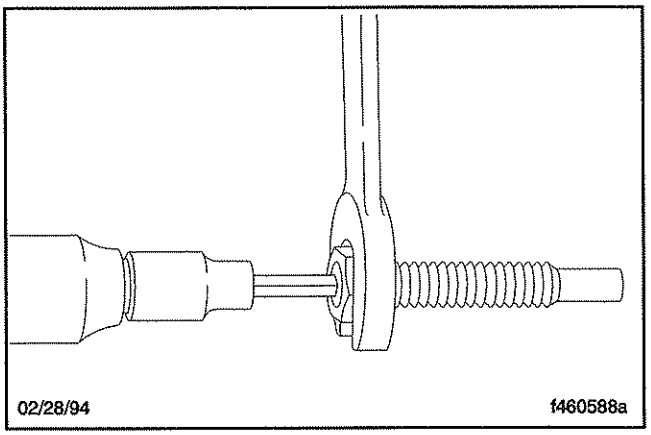


Fig. 3, Jam Nut

In-Vehicle Adjustments

reset for automatic adjustment while the steering gear was disassembled.

Use the following procedure for manually resetting the poppet valves:

1. Verify correct axle stop adjustment. For instructions, refer to **Group 33** of this manual.

IMPORTANT: The axle stops must be set so that there are at least 1-3/4 steering wheel turns from a straight-ahead position to both a full-left and a full-right turn; otherwise the poppet valves will not work.

2. If both axle stops were set for increased travel, the steering gear poppets have reset automatically and gear adjustments are complete. No further action is required.

   If either axle stop was set for decreased travel, the steering gear poppets must be set manually. Continue with the following steps.

3. Install the steering gear manual poppet adjusting screw.

   3.1 Screw the special poppet adjusting screw (from TRW kit number 021407-X1) into the nonsealing end of the sealing jam nut, until the drive end of the screw is flush with the nut. See **Fig. 3**.

   3.2 With the vehicle unloaded, the engine off, and the front wheels in the straight-ahead position, remove and discard the poppet fixed stopscrew and washer from the lower end of the steering gear housing. See **Fig. 4**.

   NOTE: With the wheels straight ahead, and the timing marks on the sector shaft and gear housing aligned (as shown in **Fig. 1**), the steering gear is centered.

   3.3 Using an allen wrench turn the adjusting screw and nut without rotating the nut, into the steering gear housing until the nut is firmly against the housing (see **Fig. 5**). Tighten the nut 33 to 37 lbf·ft (45 to 50 N·m).

   NOTE: It may be necessary to move the sector shaft slightly from the "straight-ahead position" to assemble the service adjusting screw as instructed and then return it to "straight ahead."

4. Adjust the poppets manually.

   4.1 Check the fluid level and fill the power steering reservoir with the power steering fluid specified in **Specifications, 400**.

   4.2 Make sure the engine is off.

   4.3 Place a jack under the center of the front axle, and raise the steer tires off the ground.

   4.4 Turn the steering wheel to the right until the axle stopscrew contacts the axle stop, or the end of the gear travel is reached. This pushes out the left-hand turn poppet to prepare it for setting. See **Fig. 6**.

   4.5 Turn the steering wheel to the left until the left-hand stop makes contact. This sets the left-turn poppet. Release the steering

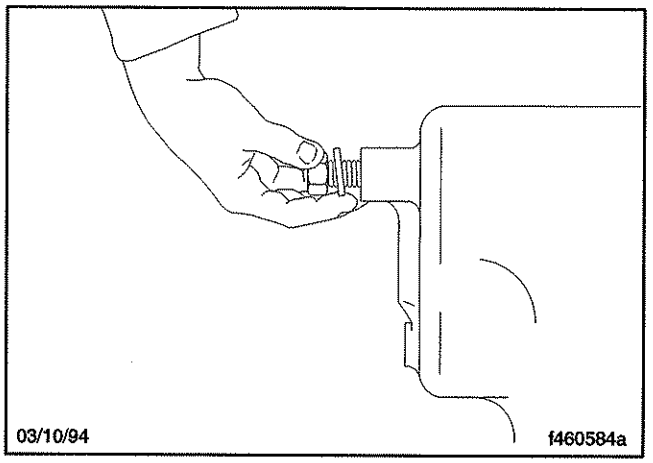


Fig. 4, Poppet Fixed Stopscrew

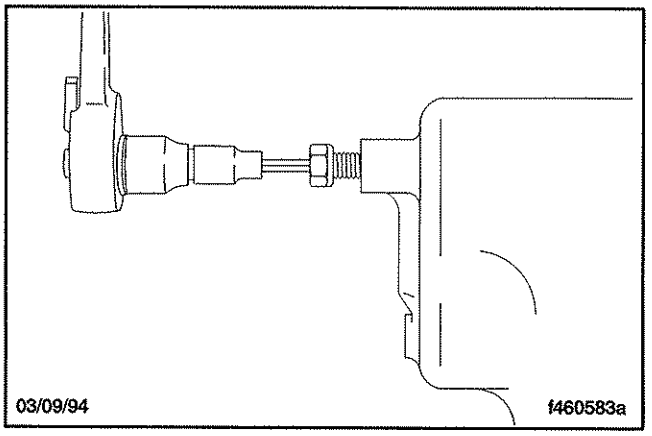


Fig. 5, Stopscrew Adjustment

In-Vehicle Adjustments

reset for automatic adjustment while the steering gear was disassembled.

Use the following procedure for manually resetting the poppet valves:

1. Verify correct axle stop adjustment. For instructions, refer to **Group 33** of this manual.

IMPORTANT: The axle stops must be set so that there are at least 1-3/4 steering wheel turns from a straight-ahead position to both a full-left and a full-right turn; otherwise the poppet valves will not work.

2. If both axle stops were set for increased travel, the steering gear poppets have reset automatically and gear adjustments are complete. No further action is required.

   If either axle stop was set for decreased travel, the steering gear poppets must be set manually. Continue with the following steps.

3. Install the steering gear manual poppet adjusting screw.

   3.1 Screw the special poppet adjusting screw (from TRW kit number 021407-X1) into the nonsealing end of the sealing jam nut, until the drive end of the screw is flush with the nut. See **Fig. 3.**

   3.2 With the vehicle unloaded, the engine off, and the front wheels in the straight-ahead position, remove and discard the poppet fixed stopscrew and washer from the lower end of the steering gear housing. See **Fig. 4.**

   NOTE: With the wheels straight ahead, and the timing marks on the sector shaft and gear housing aligned (as shown in **Fig. 1**), the steering gear is centered.

   3.3 Using an allen wrench turn the adjusting screw and nut without rotating the nut, into the steering gear housing until the nut is firmly against the housing (see **Fig. 5**). Tighten the nut 33 to 37 lbf·ft (45 to 50 N·m).

   NOTE: It may be necessary to move the sector shaft slightly from the "straight-ahead position" to assemble the service adjusting screw as instructed and then return it to "straight ahead."

4. Adjust the poppets manually.

   4.1 Check the fluid level and fill the power steering reservoir with the power steering fluid specified in **Specifications, 400.**

   4.2 Make sure the engine is off.

   4.3 Place a jack under the center of the front axle, and raise the steer tires off the ground.

   4.4 Turn the steering wheel to the right until the axle stopscrew contacts the axle stop, or the end of the gear travel is reached. This pushes out the left-hand turn poppet to prepare it for setting. See **Fig. 6.**

   4.5 Turn the steering wheel to the left until the left-hand stop makes contact. This sets the left-turn poppet. Release the steering

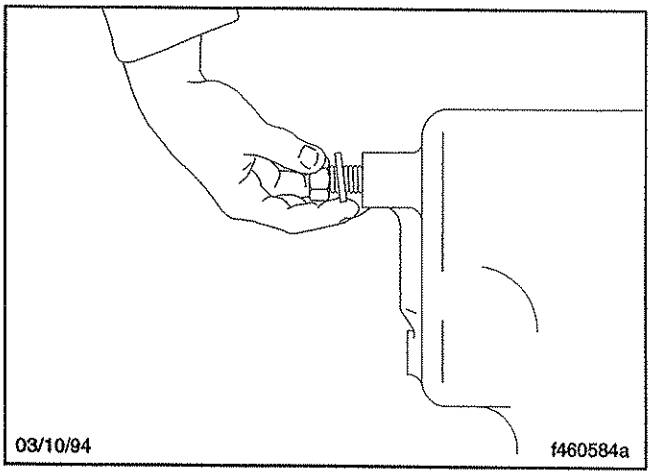


Fig. 4, Poppet Fixed Stopscrew

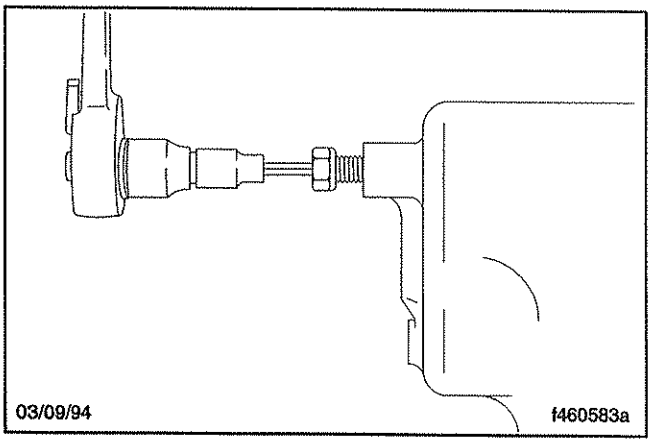
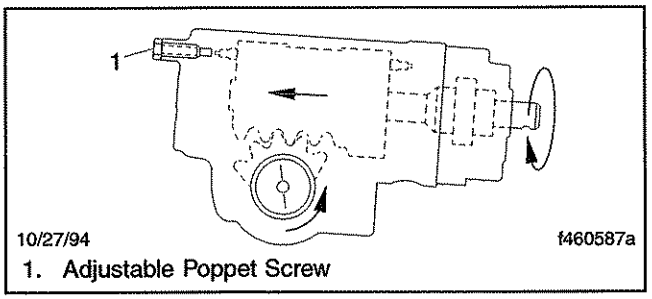


Fig. 5, Stopscrew Adjustment



1. Adjustable Poppet Screw

Fig. 6, Stopscrew Contact

wheel, and do not steer again until the adjusting screw has been backed out and the sealing nut tightened.

4.6 Loosen the sealing nut on the gear housing, and back out the adjusting screw until it is 1 to 1-1/16 inches (25 to 27 mm) beyond the sealing nut. See **Fig. 7**. Tighten the sealing nut 33 to 37 lbf·ft (45 to 50 N·m).

IMPORTANT: Make sure the adjusting screw does not protrude more than 1-1/16 inches (27 mm) beyond the sealing nut.

4.7 Have someone turn the steering wheel all the way to the right, and hold in place when the axle stops are contacted.

4.8 With the steering wheel held in place, loosen the sealing nut one turn, and while holding the sealing nut, turn the adjusting screw using an allen wrench. Don't force the screw. Use one or two fingers and turn the allen wrench until it comes to a stop. When this happens contact has been made with the poppet seat; *don't turn it any further.* Back out the screw 3-1/4 turns. Have the steering wheel released at this time.

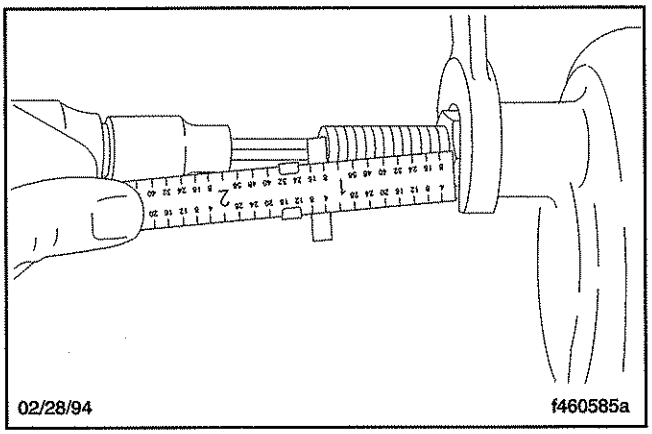


Fig. 7, Backing Out the Adjusting Screw

4.9 While holding the adjusting screw in place, tighten the sealing nut firmly against the gear housing. See **Fig. 8**. Tighten it 33 to 37 lbf·ft (45 to 50 N·m).

Check the adjusting screw. If it extends more than 1-1/16 inches (27 mm) from the sealing nut, loosen the sealing nut, and turn the adjusting screw in as needed. Tighten the sealing nut 33 to 37 lbf·ft (45 to 50 N·m). See **Fig. 7** and **Fig. 8**.

⚠ WARNING

If the adjusting screw protrudes more than 1-1/16 inches (27 mm) from the sealing nut, the screw could fall out of the steering gear, resulting in loss of power steering. This could cause an accident resulting in serious personal injury or property damage.

IMPORTANT: Once the poppet adjusting screw and sealing nut are in place and the poppet valves have been manually adjusted, the adjustment procedure must be repeated if steering travel is either increased or decreased in the future.

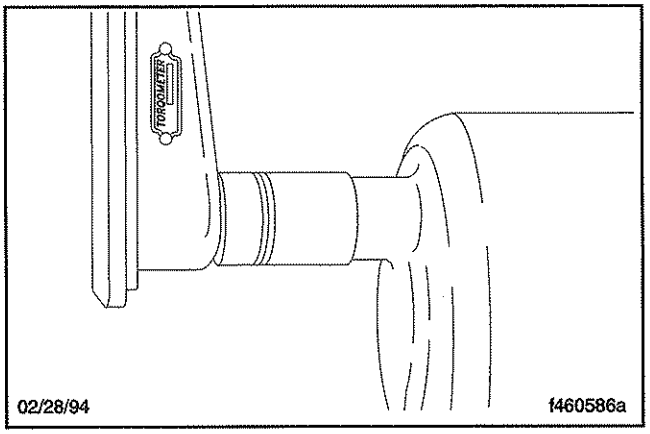
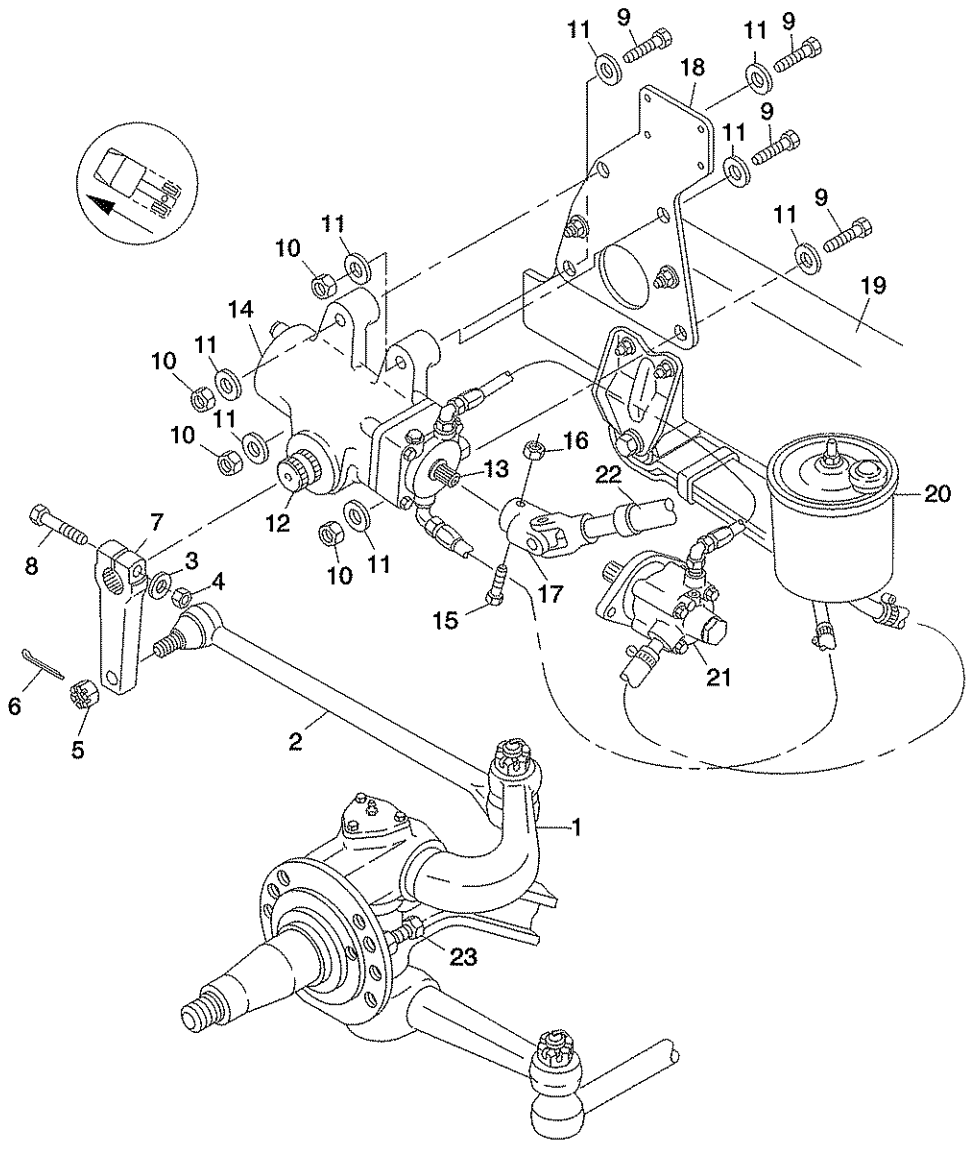


Fig. 8, Tighten the Sealing Nut

Removal (see Fig. 1 and Fig. 2)

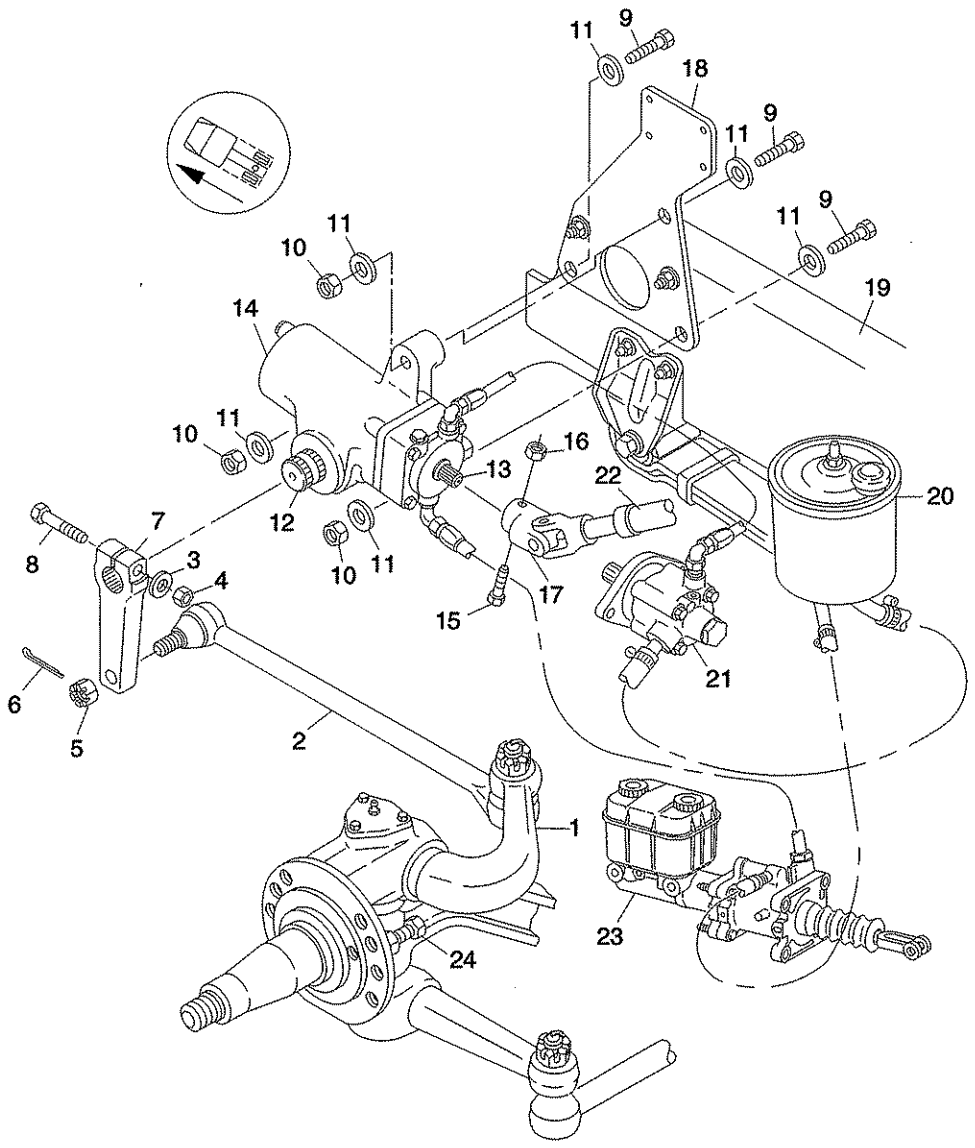


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1. Axle Steering Arm
2. Drag Link
3. Pitman Arm Washer
4. Pitman Arm Pinch Bolt Nut
5. Castle Nut
6. Cotter Pin
7. Pitman Arm
8. Pitman Arm Pinch Bolt
9. Mounting Capscrew
10. Locknut
11. Hardened Washer
12. Sector (output) Shaft
13. Input Shaft
14. Steering Gear
15. Lower End Yoke Pinch Bolt
16. Lower End Yoke Pinch Bolt Nut
17. Lower End Yoke
18. Steering Gear Mounting Plate
19. Left Frame Rail
20. Power Steering Reservoir
21. Power Steering Pump
22. Steering Driveline
23. Axle Stop

Fig. 1, TRW TAS85 Power Steering Installation (vehicles with air brakes)

Steering Gear Removal and Installation



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1. Axle Steering Arm
2. Drag Link
3. Pitman Arm Washer
4. Pitman Arm Pinch Bolt Nut
5. Castle Nut
6. Cotter Pin
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13. Input Shaft
14. Steering Gear
15. Lower End Yoke Pinch Bolt
16. Lower End Yoke Pinch Bolt Nut
17. Lower End Yoke
18. Steering Gear Mounting Plate
19. Left Frame Rail
20. Power Steering Reservoir
21. Power Steering Pump
22. Steering Driveline
23. Brake Booster
24. Axle Stop

Fig. 2, TRW TAS40/55/65 Power Steering Installation (vehicles with hydraulic brakes)

IMPORTANT: Before removing the steering gear, see **Subject 300.**

1. Verify correct axle stop adjustment. For instructions, refer to **Group 33.** Ensuring correct axle stop

adjustment now will eliminate the possibility of re-setting steering gear poppet valves after the gear is reinstalled.

2. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where the work is to be done. Apply the parking brakes and chock the tires.
3. Remove the left-hand bumper extension.
4. Clean all outside dirt from around the fittings and hose connections.
5. Drain the power steering system. Disconnect all hydraulic lines from the gear, marking the lines for later assembly reference. Seal the lines and the fittings to keep out dirt.
6. Disconnect the pitman arm from the steering gear sector shaft.
   - 6.1 Remove the pinch bolt, washer, and nut from the pitman arm. Discard the nut.
   - 6.2 Remove the pitman arm using a suitable puller, and swing the pitman arm and drag link out of the way.
7. Disconnect the steering driveline from the steering gear input shaft.
   - 7.1 Remove the pinch bolt nut and pinch bolt from the steering driveline lower end yoke.

⚠ CAUTION

Do not pound the U-joint or lower end yoke on or off the input shaft. Internal damage to the steering gear can result.

   - 7.2 Remove the lower end yoke from the input shaft.

8. Clean the entire assembly before removing the gear.

IMPORTANT: The TAS40 steering gear weighs 40 lbs (18 kg) dry, the TAS55 weighs 60 lbs (27 kg) dry, the TAS65 weights 80 lbs (36 kg) dry, and the TAS85 weights 110 lbs (50 kg) dry. Use care when removing, lifting, and carrying the steering gear, to avoid injury.

9. Remove the fasteners that attach the steering gear to the frame rail. Remove the steering gear.

Installation (see Fig. 1 and Fig. 2)

IMPORTANT: The TAS40 steering gear weighs 40 lbs (18 kg) dry, the TAS55 weighs 60 lbs (27 kg) dry, the TAS65 weights 80 lbs (36 kg) dry, and the TAS85 weights 110 lbs (50 kg) dry. Use care when removing, lifting, and carrying the steering gear, to avoid injury.

1. Install the steering gear and fasteners as shown in **Fig. 3** or **Fig. 4.**

   Tighten the fasteners to the torque shown in **Table 1.**

Mounting Fastener Torques		
Description	**Bolt or Nut Size**	**Torque lbf·ft (N·m)**
Steering Gear Mounting Hexbolt Nut	7/8–14	278–352 (377–477)

Table 1, Mounting Fastener Torques

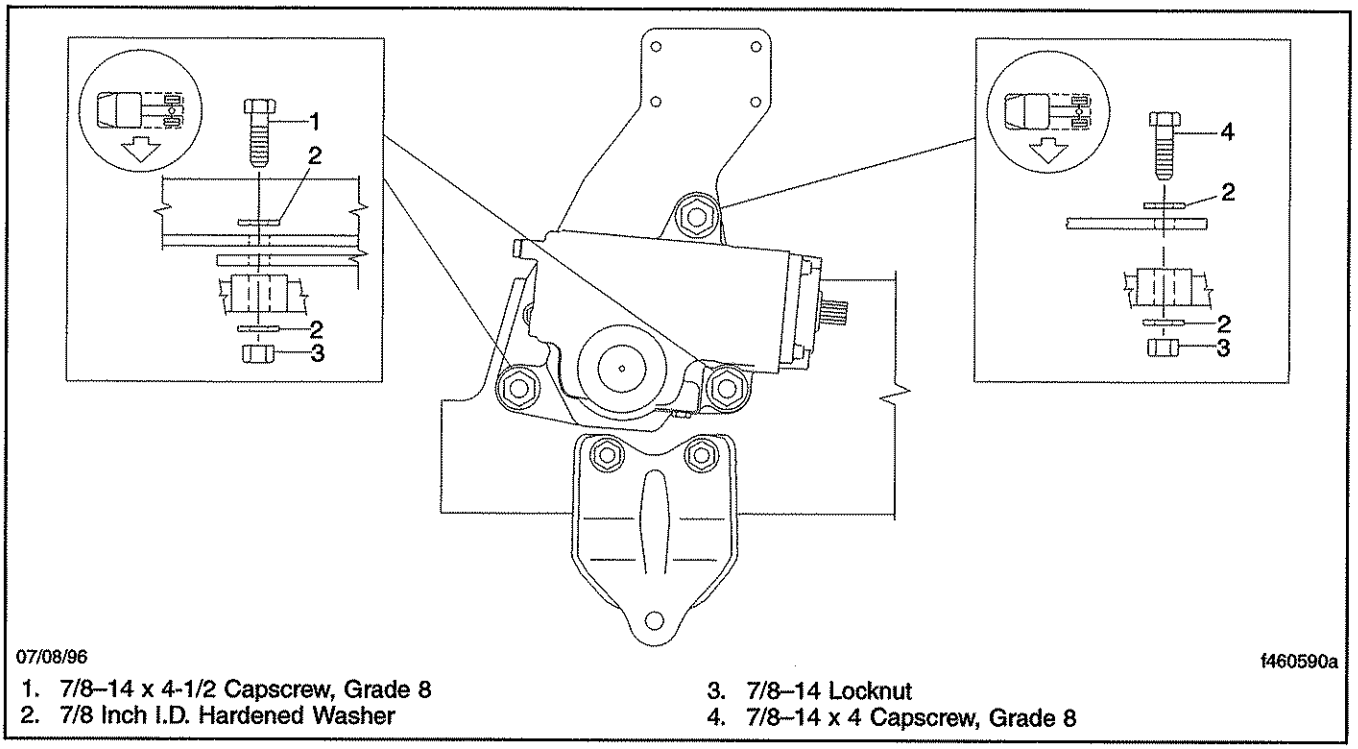
2. If not previously done, center the steering gear. The sector (output) shaft alignment mark must be at a right angle to the steering gear input shaft centerline. Make sure the steering gear remains centralized as the service work continues.
3. Install the pitman arm.
   - 3.1 Position the pitman arm on the steering gear, aligning the timing mark as shown in **Fig. 5.**

⚠ WARNING

Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise the chisel may fly loose, which could cause an injury.

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. Use a ball peen hammer to drive a chisel into the slot. Hold the chisel in place. Install the pitman arm on the sector shaft. Remove the chisel from the slot.

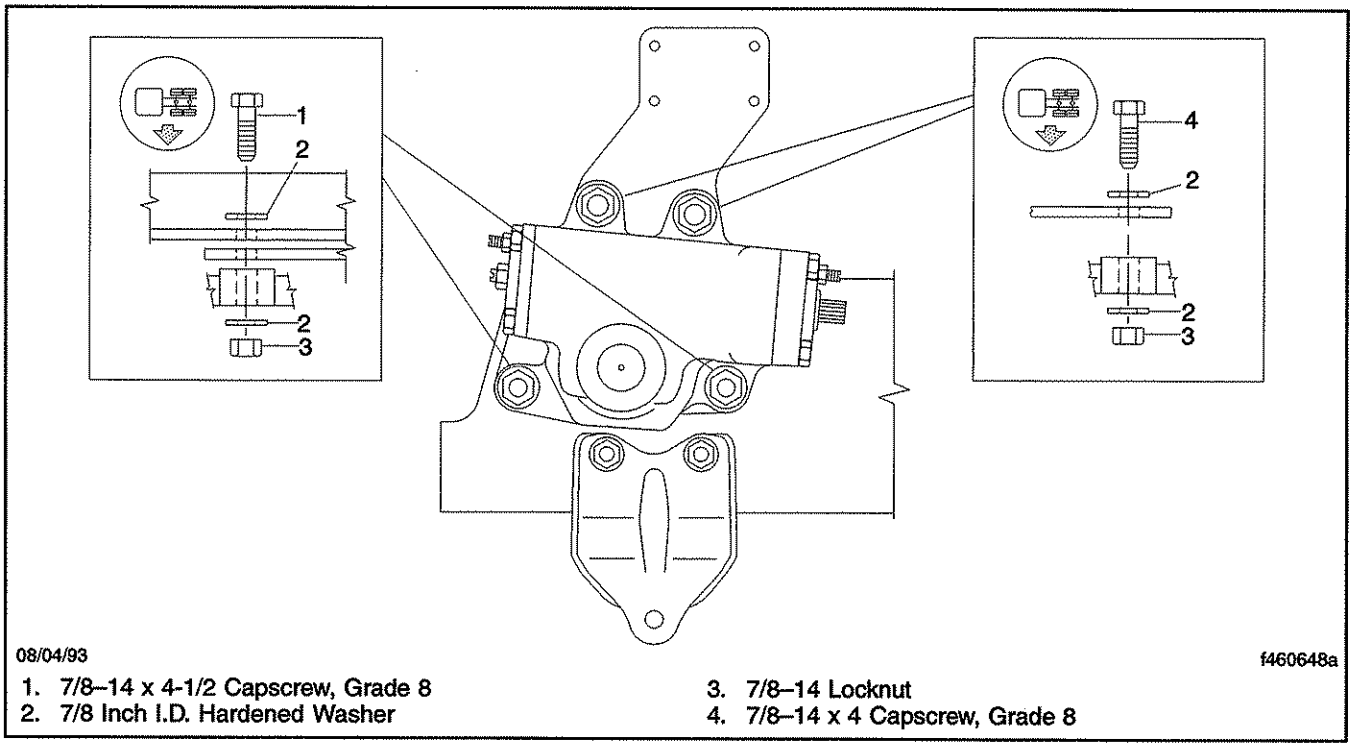
Steering Gear Removal and Installation



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1. 7/8–14 x 4-1/2 Capscrew, Grade 8
2. 7/8 Inch I.D. Hardened Washer
3. 7/8–14 Locknut
4. 7/8–14 x 4 Capscrew, Grade 8

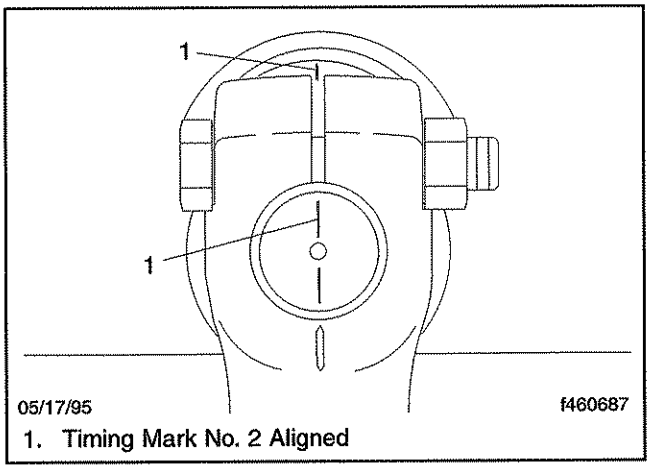
Fig. 3, Steering Gear Installation, TAS40/55/65



08/04/93 f460648a

1. 7/8–14 x 4-1/2 Capscrew, Grade 8
2. 7/8 Inch I.D. Hardened Washer
3. 7/8–14 Locknut
4. 7/8–14 x 4 Capscrew, Grade 8

Fig. 4, Steering Gear Installation, TAS85



1. Timing Mark No. 2 Aligned

Fig. 5, Typical Pitman Arm and Timing Marks

3.2 Install the pitman arm pinch bolt, washer, and a new nut. Tighten the locknut as shown in **Table 2.**

Pinch Bolt Torques		
Description	**Size**	**Torque lbf·ft (N·m)**
Pinch Bolt Locknut	5/8–14	120–140 (163–190)
	3/4–16	215–245 (292–332)

Table 2, Pinch Bolt Torques

3.3 Apply white Torque Seal® F-900 to the exposed threads and the locknut.

4. Connect the steering driveline to the steering gear input shaft.

4.1 Clean the steering gear input shaft and the inside of the driveline yoke.

4.2 Apply a thin film of grease to the yoke spline.

4.3 Slide the yoke onto the input shaft, and install a new yoke pinch bolt and a new pinch bolt locknut. Tighten the pinch bolt nut 55 to 65 lbf·ft (75 to 88 N·m).

4.4 Apply white Torque Seal F-900 to the exposed pinch bolt threads and the locknut.

5. Connect the hydraulic lines.

5.1 If they were removed, attach the hydraulic line elbow fittings to the steering gear. Tighten the fittings 38 lbf·ft (51 N·m). Tighten the pressure line fitting jam nut 41 lbf·ft (56 N·m).

5.2 Remove the plugs from the hydraulic lines. Connect the lines to the steering gear as previously marked. Tighten the nut on each fitting finger-tight. Then, use a wrench to tighten the nut until there is firm resistance. Tighten one-sixth turn more.

6. Fill and bleed the steering system.

IMPORTANT: Do not turn the steering wheel until instructed. Doing so can cause air to enter the system, which can make it more difficult and time-consuming to bleed air from the system.

6.1 Fill the power steering reservoir with the power steering fluid specified in **Specifications, 400** until nearly full. Crank the starter for 10 seconds without allowing the engine to start. If the engine does start, shut it down immediately. Check and fill the reservoir as needed. Repeat this procedure three times, each time checking and filling the reservoir.

6.2 Start the engine and let it idle for two minutes. Shut down the engine, and check the fluid level in the reservoir.

6.3 Start the engine again. Steer the vehicle from full-left to full-right, several times. As necessary, add fluid to the full line on the reservoir dipstick.

IMPORTANT: If the poppet adjuster seat and sleeve assemblies were not set for automatic adjustment during the assembly of the steering gear, AND if the axle stops have been adjusted for *decreased* steering travel or the steering gear is installed on a different vehicle, the poppets must be set manually, following the procedure in **Subject 100.**

7. Go to **Subject 140** and do the checks as instructed.

8. Install the left-hand bumper extension.

9. Test drive the vehicle, or take a ride with the driver.

Steering Gear Removal and Installation

Check the steering wheel spoke position. With the front tires pointing straight ahead, check the position of the steering wheel spokes. They must be pointing within ±10 degrees of the 4 o'clock and 8 o'clock positions. See **Fig. 6**. If not, remove the steering wheel and install it in the correct position. For instructions, refer to the applicable section in this group.

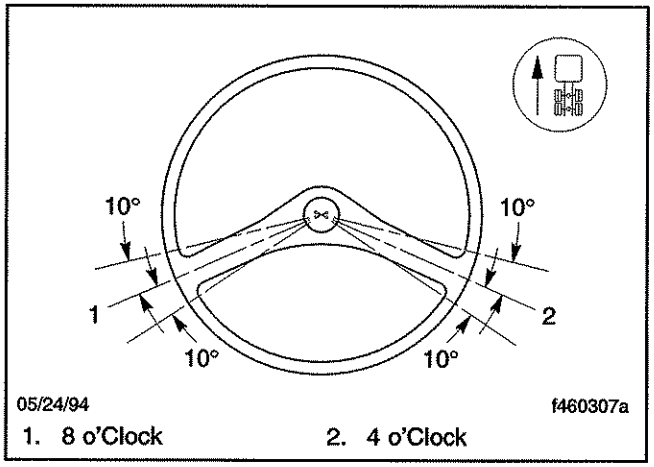


Fig. 6, Steering Wheel Centered

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

Disassembly (See Fig. 1)

⚠ WARNING

All steering mechanisms are safety items. Because of this, follow the instructions in this subject to the letter. Failure to do so may result in the loss of steering, which could cause an accident resulting in personal injury or property damage.

Be sure that required tools are available before beginning the service procedures described here. See the special tools table in **Specifications, 400**. The special tools required for disassembly and assembly of the steering gear components are available from the Kent-Moore Tool Division, or an affiliated dealer.

IMPORTANT: When the sector shaft is disconnected from the vehicle steering linkage, don't allow the input shaft to move more than 1-1/2 turns from the straight-ahead position. If the input shaft moves more than 1-1/2 turns, the initial setting of the poppet valves will be changed.

Make sure that the steering gear is placed on a clean surface. Clean and dry the gear before disassembly. As the gear is disassembled, clean all parts in a clean, petroleum-based solvent, and blow-dry them only.

Never steam clean or high-pressure wash the hydraulic steering components. Don't force or abuse closely fitted parts. Doing so could cause damage to steering system parts.

Keep each part separate to avoid nicks and burrs. Discard all seals, O-rings, and gaskets, and replace them with new parts.

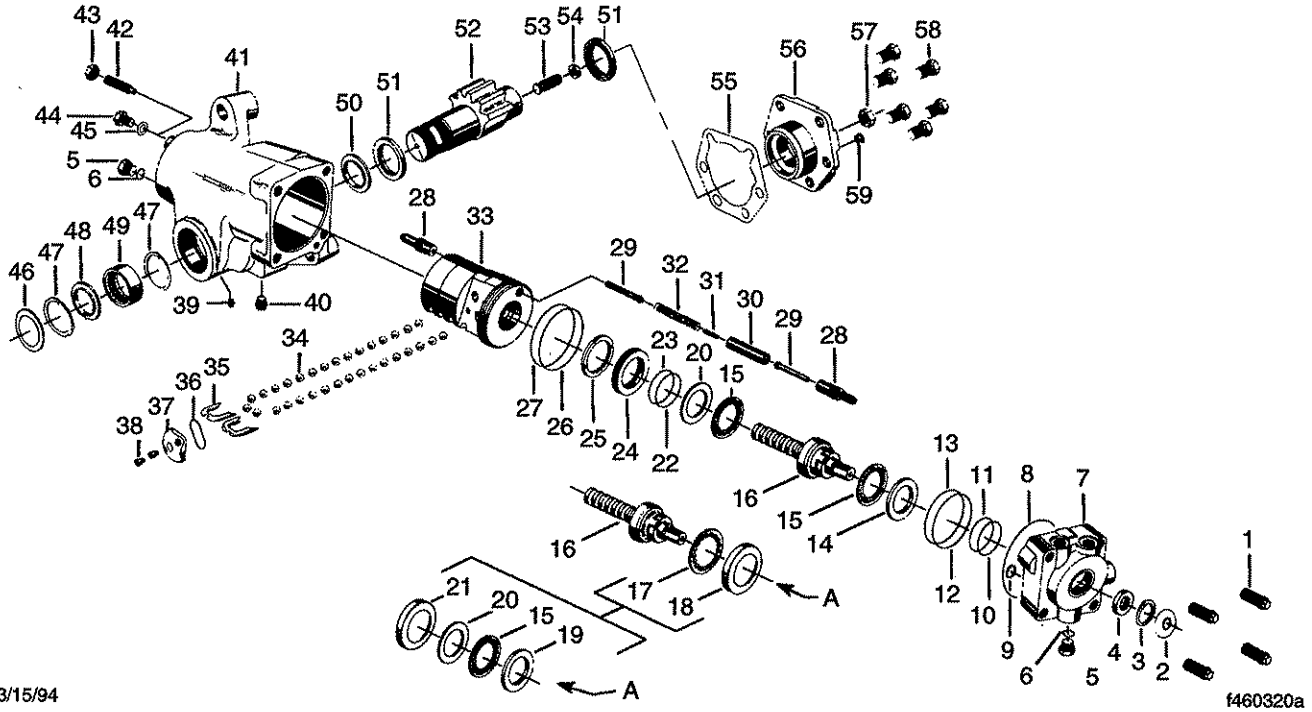
1. Place the steering gear in a vise so that the output shaft is horizontal. Clamp the gear at the mounting flange.
2. Put a basin under the hydraulic ports, and remove both hydraulic port plugs from the gear.
3. Using a 3/4 inch or 11/16 inch socket wrench, turn the input shaft so that the timing mark on the end of the sector shaft is lined up with the timing mark on the end of the housing trunnion. See **Fig. 2**.
4. Remove sector shaft/side cover assembly.
   - 4.1 Using a small screwdriver, remove and discard the water seal from the housing trunnion. See **Fig. 3**. Remove any dirt, paint, or corrosion from the sector shaft with a piece of fine emery cloth. See **Fig. 4**.
   - 4.2 Tape the splines and the bolt groove of the sector shaft, using one layer of masking tape. See **Fig. 5**.
   - 4.3 Using a 3/4-inch socket, remove the jam nut from the sector shaft adjusting screw. See **Fig. 6**.
   - 4.4 Put a container under the side cover to catch any drainage, then remove the special bolts from the side cover. See **Fig. 7**.

   IMPORTANT: These special bolts are equipped with either an integral ring or washer on the underside of the head. See **Fig. 8**. If replacing one or more bolts, use bolts of the *same special type and length as those that were removed.* Don't use a substitute; don't mix different types of bolts.
   - 4.5 Remove the side cover and the sector shaft assembly, as a unit, from the steering gear housing. See **Fig. 9**. If necessary, start the removal by tapping the end of the sector shaft with a rubber or wooden mallet. Remove and discard the side cover gasket.
5. Disassemble the sector shaft/side cover assembly.
   - 5.1 Using a screwdriver, screw the sector shaft adjusting screw into the side cover and remove. See **Fig. 10**.
   - 5.2 Remove the sector shaft from the side cover.
   - 5.3 Remove the side cover seal as follows:

   IMPORTANT: Be careful when you are removing the side cover seal, or you may damage the side cover bore, the "DU" bushing (if a TAS40/55/65 model), or the bearing (if a TAS85 model).
   - 5.4 Screw a 1/2–20 x 3 bolt into the hole in the side cover where the sector shaft adjusting screw was.

     Make sure the bolt is in far enough so that it will support a rolling head (lady-foot) type pry bar. See **Fig. 11**.

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments



1. Bolts, Valve Housing (4 qty.)
2. Dirt and Water Seal
3. Retaining Ring
4. Seal
5. Auxiliary Port Plug (2 qty.)
6. O-Ring, Auxiliary Port Plug (2 qty.)
7. Valve Housing and Ball Plug Assembly
8. Large Seal Ring
9. Small Seal Ring
10. O-Ring
11. Seal Ring
12. Valve Housing O-Ring
13. Seal Ring
14. Thick Thrustwasher
15. Roller Thrust Bearing (1 or 2 qty.)
16. Input Shaft/Valve/Worm Assembly
17. Ball Bearing Assembly (Valve/Worm)
18. Ball Bearing Race
19. Thick Thrustwasher
20. Thin Thrustwasher
21. Spacer Sleeve
22. Seal Ring
23. O-Ring
24. Bearing Adjuster
25. Adjuster Locknut
26. Rack Piston Seal Ring
27. O-Ring (backup)
28. Poppet Adjuster Seat and Sleeve Assembly (2 qty.)
29. Poppet (2 qty.)
30. Push Tube
31. Spacer Rod
32. Poppet Spring
33. Rack Piston
34. Steel Ball (32 qty.)
35. Ball Return Guide Halves (2 qty.)
36. Ball Return Guide Cap Seal
37. Ball Return Guide Cap
38. Torx Screws (2 qty.)
39. Grease Fitting
40. Auto-Bleed Plug
41. Gear Housing
42. Service Poppet Adjusting Screw
43. Service Sealing Jam Nut
44. Fixed Stopscrew, Poppet
45. Washer, Stopscrew
46. Dirt and Water Seal (Trunnion)
47. Retaining Ring (2 qty.)
48. Dirt Seal
49. Roller Bearing
50. Washer (spacer)
51. Output Seal (2 qty.)
52. Sector Shaft
53. Shaft Adjusting Screw
54. Adjusting Screw Retainer
55. Side Cover Gasket
56. Side Cover and Bushing Assembly
57. Jam Nut
58. Special Bolts, Side Cover (6 qty.)
59. Side Cover Vent Plug

Fig. 1, Steering Gear Assembly

5.5 With the pry bar supported by the bolt end, pry up the side cover seal, and remove it. Discard the side cover seal, and remove the 3-inch bolt from the side cover.

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

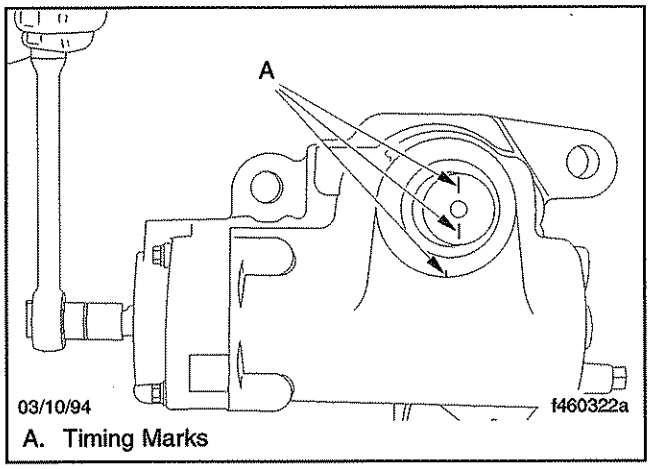


Fig. 2, Line Up the Timing Marks

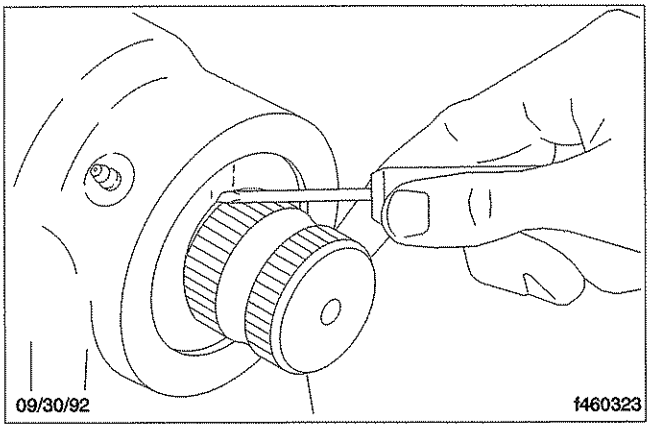


Fig. 3, Remove the Water Seal

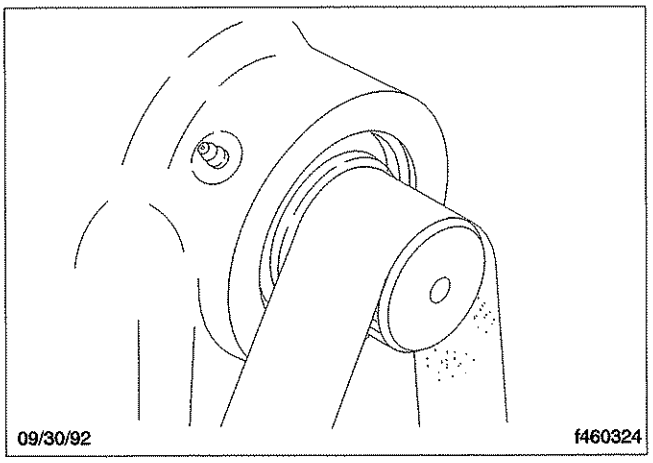


Fig. 4, Clean the Sector Shaft

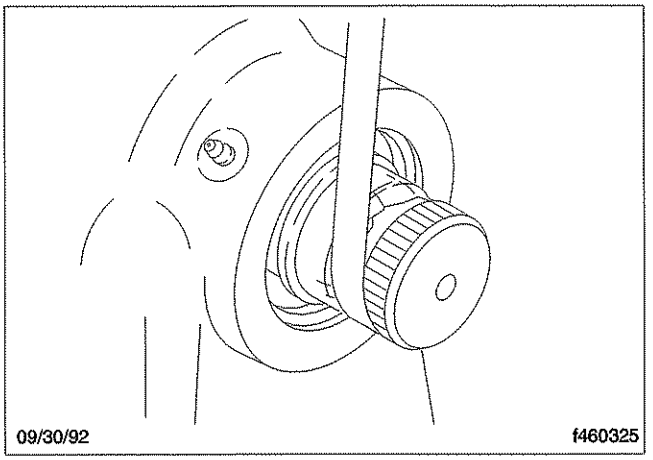


Fig. 5, Tape the Splines and the Bolt Groove

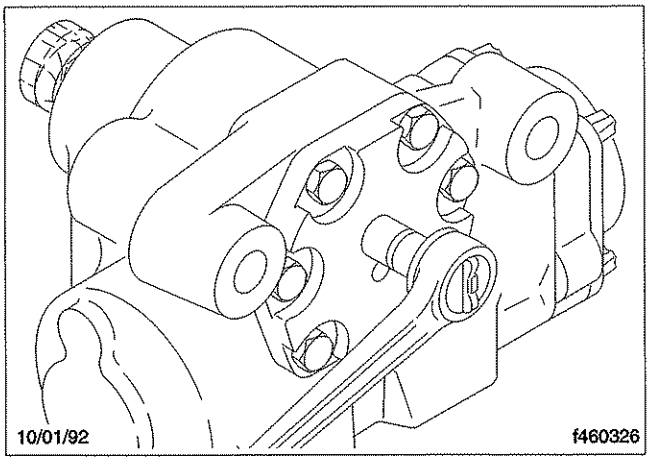


Fig. 6, Remove the Jam Nut

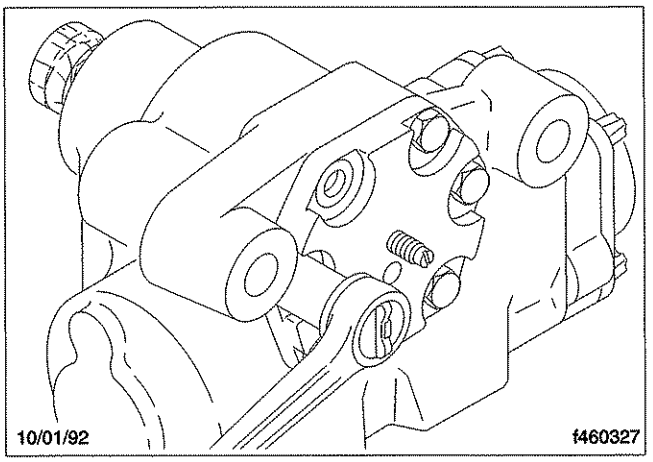


Fig. 7, Remove the Bolts

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

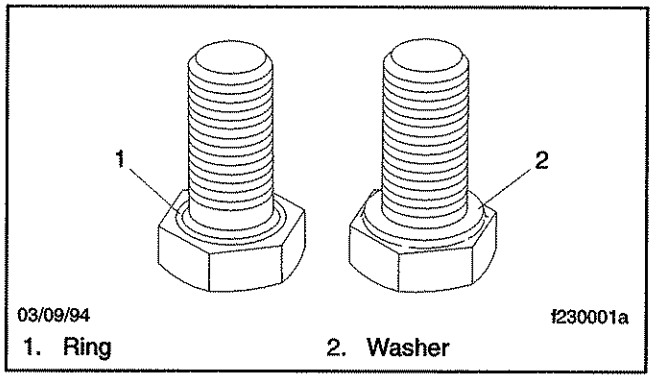


Fig. 8, Bolts With Ring or Washer

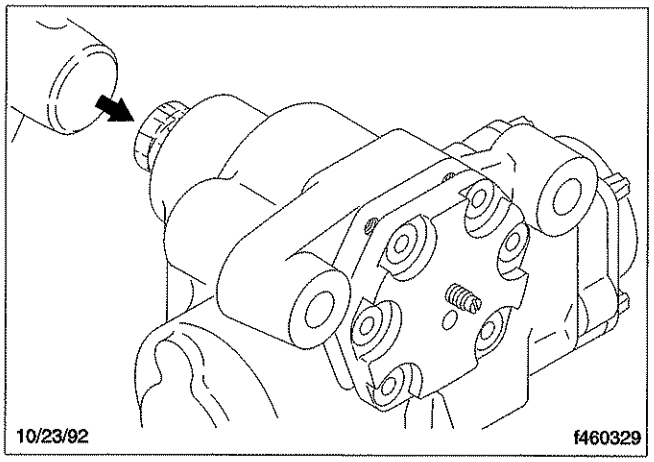


Fig. 9, Remove the Side Cover and Sector Shaft Assembly

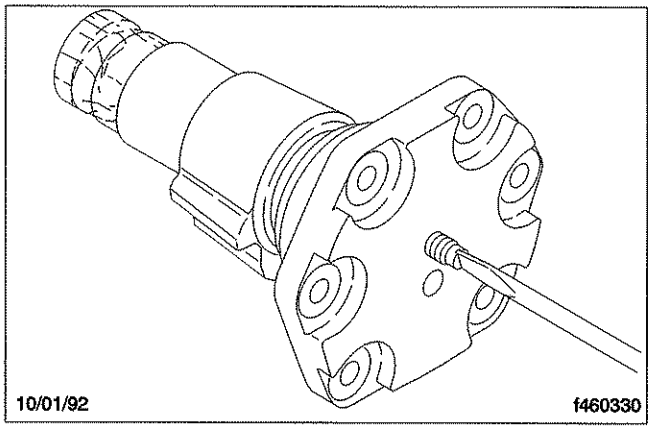


Fig. 10, Disassemble the Sector Shaft/Side Cover Assembly

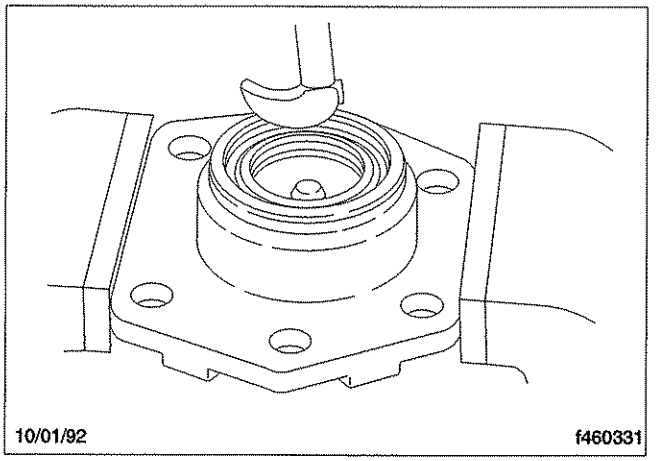


Fig. 11, Rolling Head Pry Bar

5.6 Remove and discard the vent plug from the side cover.

6. Remove the adjusting screw if required. Removal is required only if deemed necessary after the inspection procedure.

6.1 Put the sector shaft in a padded vise and, using a chisel, unstake the adjusting screw retainer. See **Fig. 12.**

6.2 Unscrew the retainer; remove it from the sector shaft.

6.3 Remove the adjusting screw. Discard the retainer.

7. Remove the relief valve components, if equipped: remove the relief valve cap, O-ring, and the two-

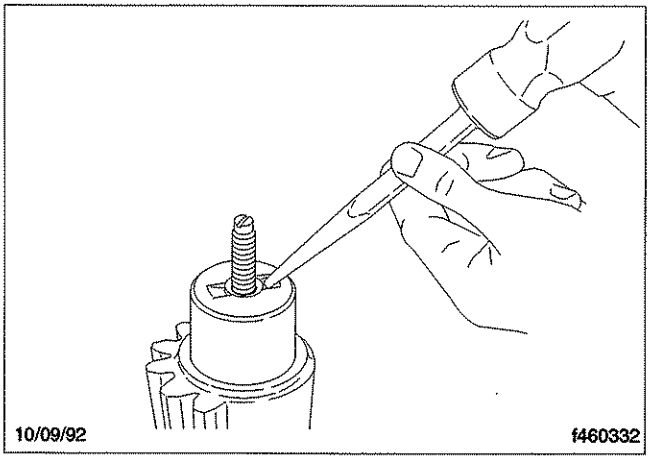


Fig. 12, Unstake the Adjusting Screw Retainer

piece relief valve from the valve housing. Discard the O-ring.

8. Remove the input shaft, valve housing, and rack piston.

   8.1 Remove and discard the dirt and water seal from the input shaft. Clean the exposed part of the input shaft, using a fine grade emery cloth. See **Fig. 13.**

   8.2 Using an E-16 Torx® socket wrench, remove the four valve housing bolts. See **Fig. 14.**

   8.3 Remove the valve housing from the main gear housing, together with the worm shaft and rack piston assembly. See **Fig. 15.** Set the assembly on a clean bench.

   8.4 Remove and discard the seal rings from the valve housing.

   IMPORTANT: If you are not going to remove, reset, or replace the poppet valves on the steering gear, make sure that the setting for them isn't accidentally changed. Mark the gear, identifying the vehicle from which it was removed, and note that the poppet valve adjustments are for that particular vehicle.

9. Remove the steel balls.

   9.1 Remove the two sealing screws holding the ball return guide cap to the rack piston. See **Fig. 16.**

   9.2 Remove the cap and its seal. See **Fig. 17.** Discard the two screws and the seal.

   9.3 Remove the ball return guide halves from the rack piston by carefully prying up on them with a screwdriver. See **Fig. 18.**

   9.4 Remove the 29 (TAS40), 31 (TAS55), 32 (TAS65), or 34 (TAS85) steel balls from the rack piston by turning the worm shaft until all of them are out. See **Fig. 19.** *Don't lose any of these balls, or you will have to replace the entire set.*

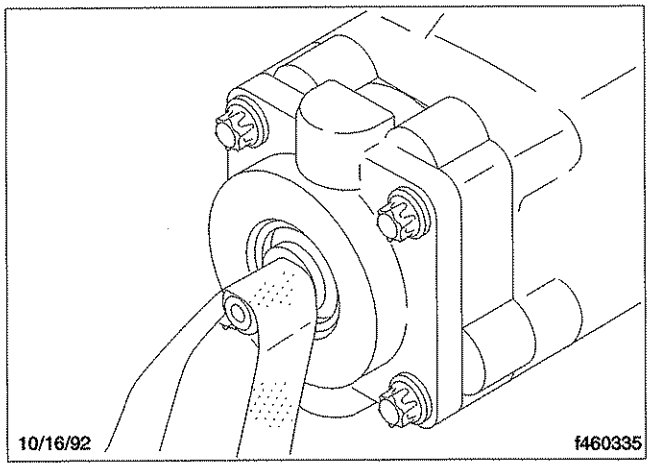


Fig. 13, Clean the Input Shaft

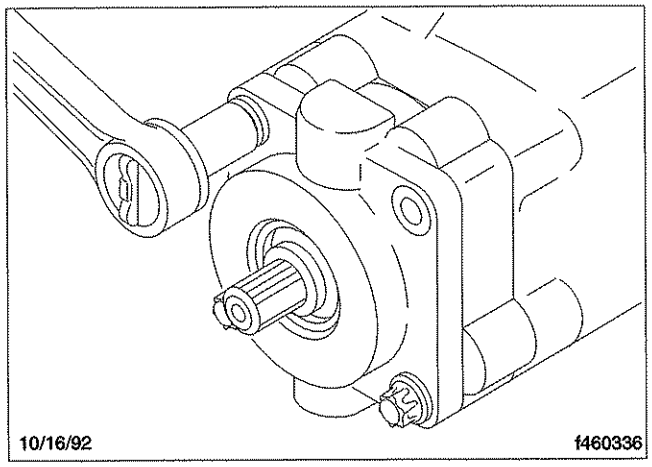


Fig. 14, Remove the Valve Housing Bolts

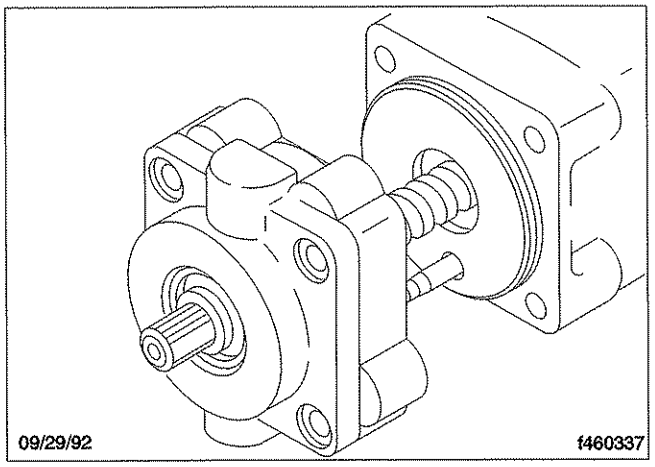


Fig. 15, Remove the Valve Housing

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

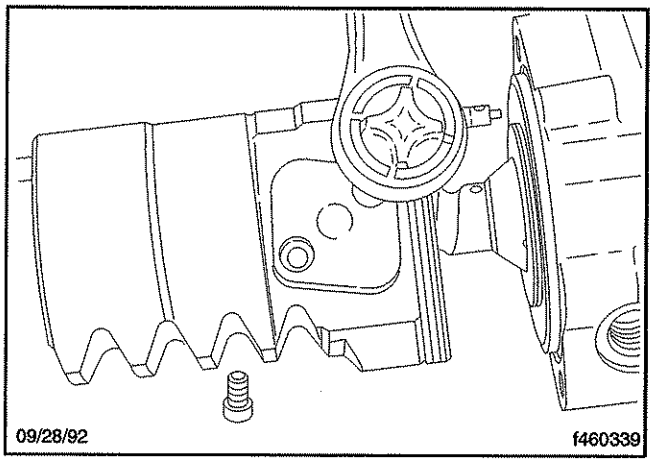


Fig. 16, Remove the Sealing Screws

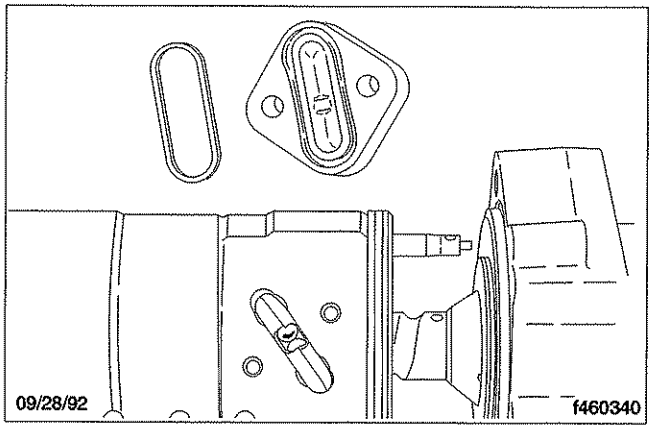


Fig. 17, Remove the Cap and Seal

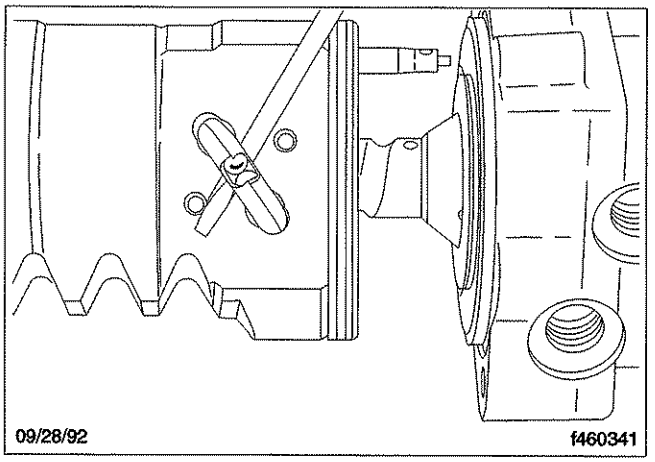


Fig. 18, Remove the Ball Return Guide Halves

⚠ WARNING

Never mix different sets of steel balls. To do so may cause a loss of steering control, which could cause an accident resulting in serious injury or property damage.

10. Remove the worm shaft and valve housing assembly from the rack piston. See **Fig. 20.**
11. Cut and remove the Teflon® seal ring and the O-ring from the rack piston. See **Fig. 21.**
12. If replacing poppet assemblies, remove the poppet valve assemblies.

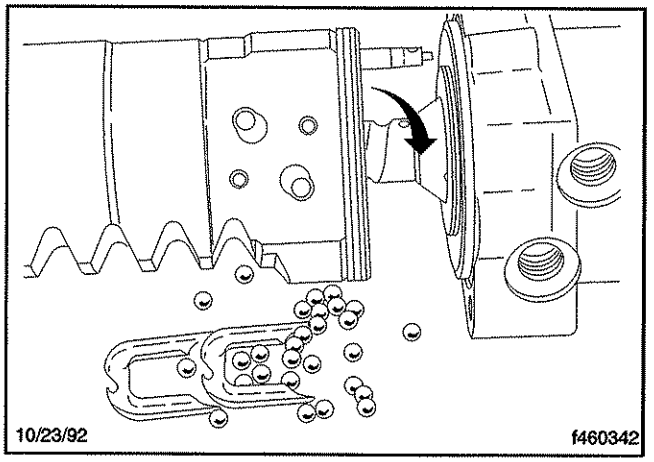


Fig. 19, Remove the Steel Balls

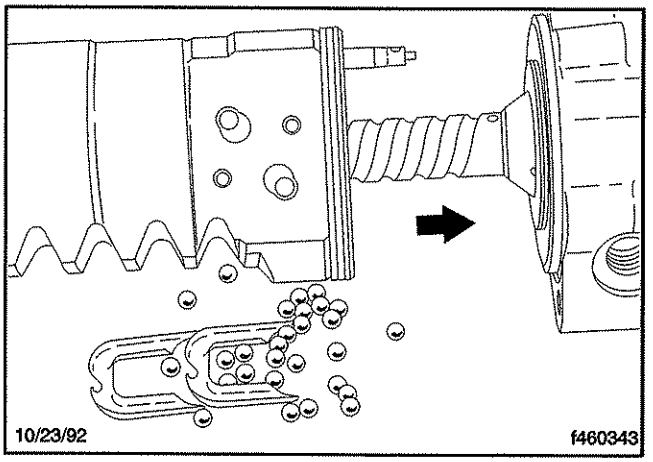


Fig. 20, Remove the Worm Shaft and Valve Housing Assembly

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

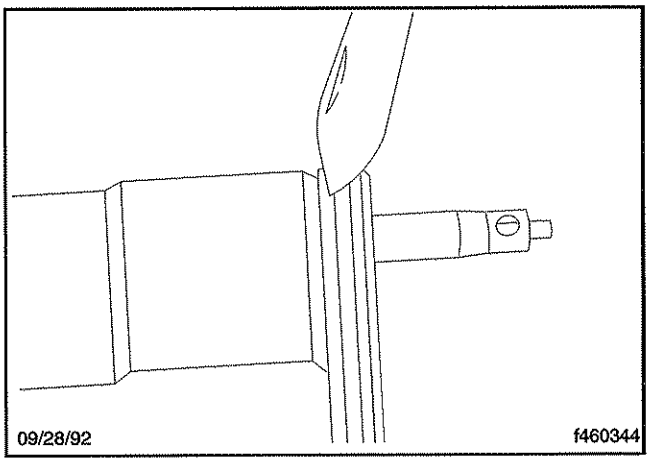


Fig. 21, Remove the Seal Ring and the O-Ring

⚠ CAUTION

The poppet valve assemblies are installed with Loctite®. Be careful when removing them, and use only special tool J36452 or J38713 (preferred). Failure to do so may damage the rack piston, which would require replacing the rack piston, steel ball kit, and the poppet valve assemblies.

IMPORTANT: Don't use special tool J38713 on a rack piston that doesn't have a counterbore in the hole for the seat and sleeve assembly.

12.1 Put the rack piston in a padded vise.

12.2 Slide the special tool J38713 (preferred) or J36452 over the poppet adjuster seat (**Fig. 22**), then turn the tool so that its prongs fit into the slot on the threaded adjustment sleeve. Hit the end of the tool firmly four or five times with a 16 oz. hammer to loosen the Loctite®. See **Fig. 23**.

12.3 Using a breaker bar, unscrew the adjuster seat and sleeve assemblies from the rack piston. If the assembly will not loosen, hit the end of the tool several more times with a hammer.

12.4 Remove both poppets, and the spring, spacer rod, and push tube. See **Fig. 24**.

Repeat the above steps for the other poppet adjuster seat and sleeve assembly.

13. Disassemble the valve housing, if needed.

IMPORTANT: Don't disassemble the valve housing unless you find signs of extreme heat, internal leakage, bearing damage or roughness, or if the worm shaft preload adjustment is needed.

13.1 Put the worm shaft and valve housing assembly into a padded vise, with the worm shaft in a vertical position, as shown in **Fig. 25**.

13.2 Unstake the adjuster locknut, using a punch. See **Fig. 25**.

13.3 Using special tools J37464 and J37070 with a breaker bar, unscrew the adjuster locknut, then the bearing adjuster from the valve housing. See **Fig. 26**.

NOTE: The bearing adjuster has either two slots (new style), or two drill points (old style) on its face. Special tool J37070 can be used for removing and installing either style of bearing adjuster. See **Fig. 26**.

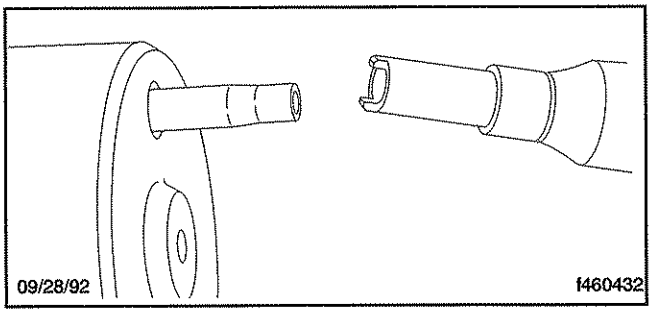


Fig. 22, Slide the Tool Over the Poppet Adjuster

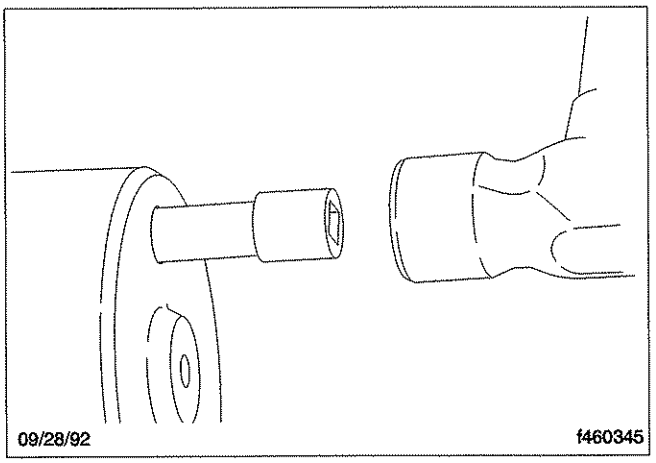
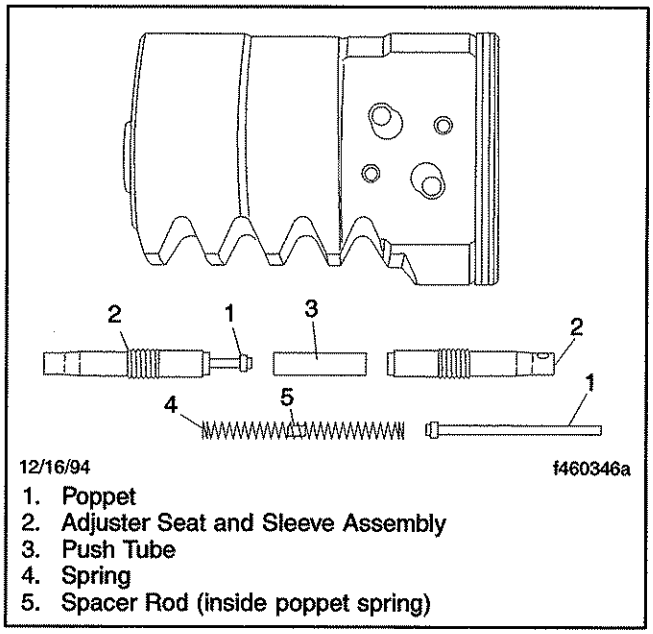


Fig. 23, Use the Tool to Loosen the Loctite®

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments



1. Poppet
2. Adjuster Seat and Sleeve Assembly
3. Push Tube
4. Spring
5. Spacer Rod (inside poppet spring)

Fig. 24, Remove the Poppets Spring, Spacer Rod, and Push Tube

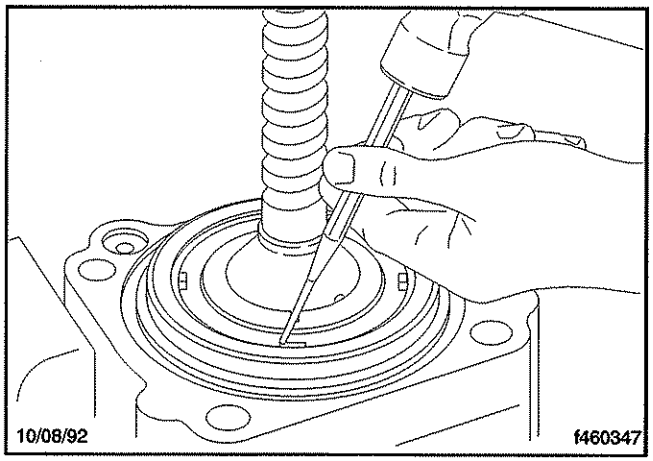


Fig. 25, Unstake the Adjuster Locknut

13.4 Remove and discard the seal ring and the O-ring from the bearing adjuster. See **Fig. 27.**

13.5 Remove the thin washer, thrust bearing, input shaft, rotary valve, and worm shaft assembly from the valve housing. See **Fig. 28.**

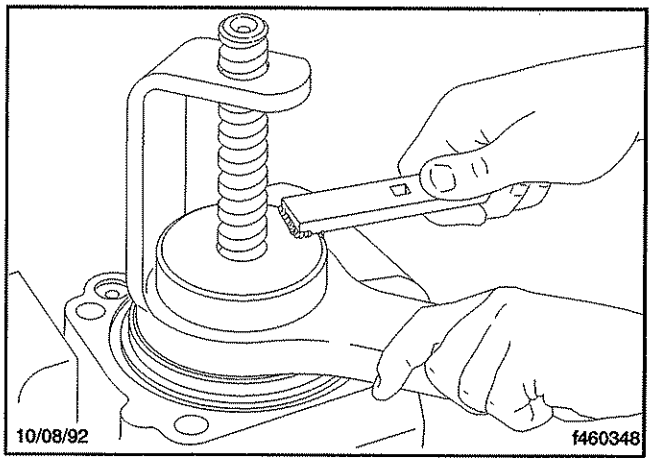


Fig. 26, Unscrew the Adjuster Locknut

IMPORTANT: Don't disassemble the input shaft or worm shaft assembly any further. These aren't serviceable.

13.6 Remove the roller thrust bearing assembly and the thick thrustwasher from the valve housing. See **Fig. 29.**

13.7 Using a small knife, a probe, or a pick, remove and discard the seal rings and O-rings from the valve housing. See **Fig. 30.**

⚠ CAUTION

In the next step, be careful when removing the retaining ring and seal from the valve housing, or

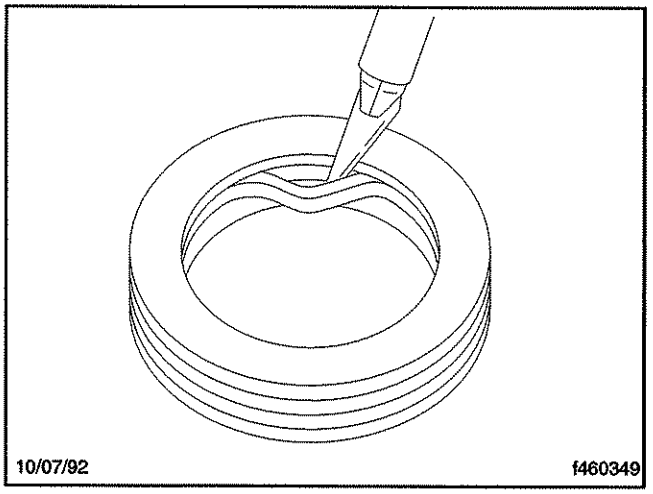


Fig. 27, Remove the Seal Ring

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

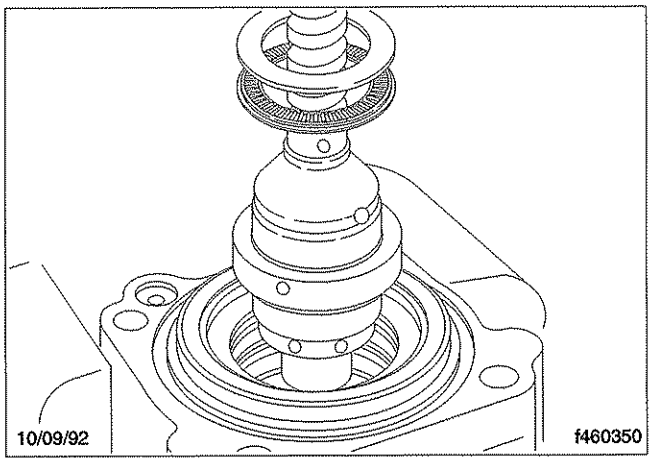


Fig. 28, Remove the Washer, Thrust Bearing, Input Shaft, Rotary Valve, and Worm Shaft Assembly

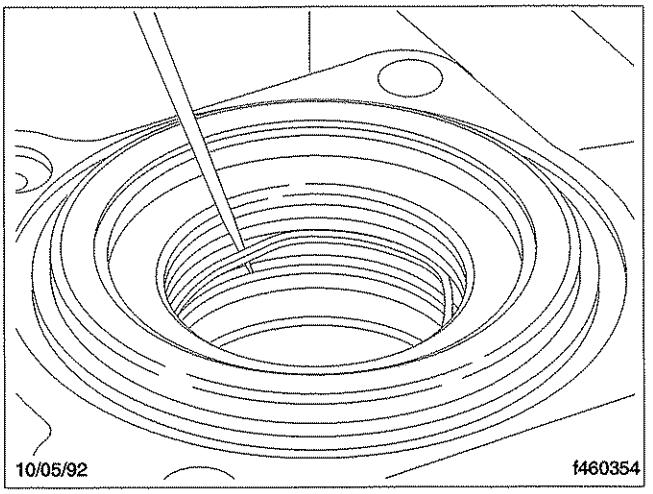


Fig. 30, Remove the Seal Rings and O-Rings

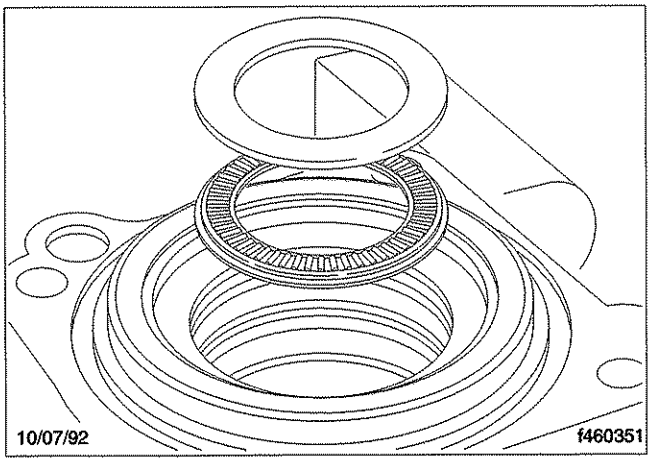


Fig. 29, Remove the Roller Thrust Bearing Assembly

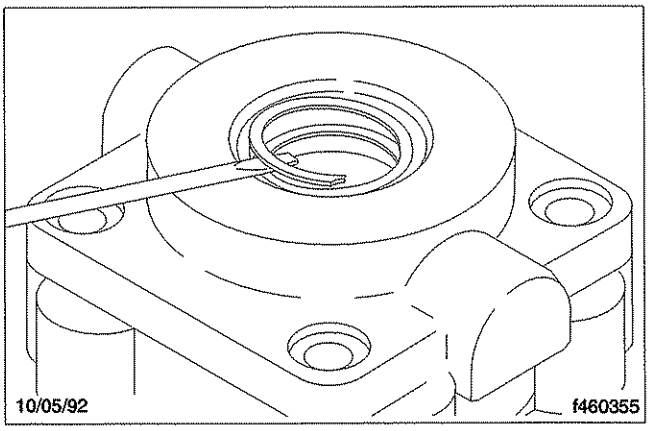


Fig. 31, Remove the Retaining Ring

you may damage the seal bore. If this happens, you will have to replace the gear housing.

13.8 Turn the valve housing over, and remove the retaining ring. See **Fig. 31.**

13.9 Using a 1-1/8 inch socket, tap out the seal from the valve housing. See **Fig. 32.** Discard the seal.

13.10 If replacing either of the auxiliary port plugs, remove them. Be sure to remove and discard the O-rings.

14. Disassemble the housing.

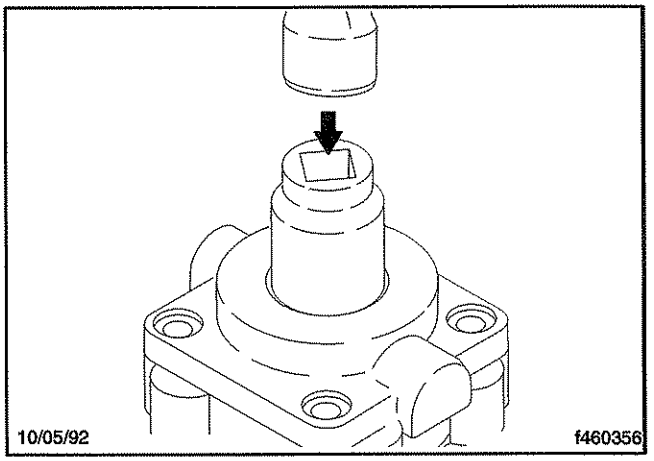


Fig. 32, Tap Out the Seal

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

NOTE: The steering gear is equipped with either a poppet fixed stopscrew, or an adjusting screw and sealing nut. See **Fig. 33**.

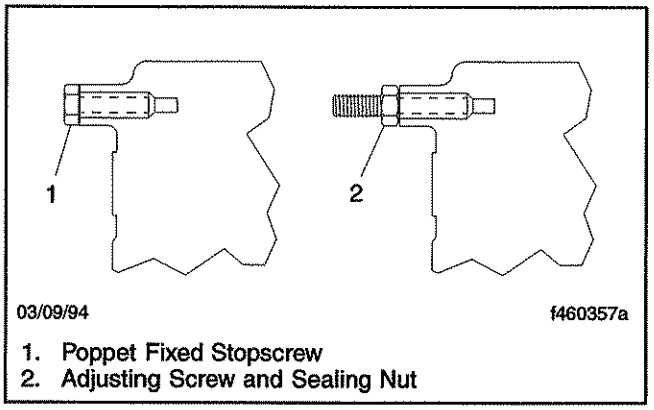
14.1 If the poppet fixed stopscrew needs replacement, remove it.

14.2 If the adjusting screw and sealing nut need replacing, remove them.

14.3 Remove the retaining ring from the output end of the housing trunnion. See **Fig. 34**.

14.4 Remove and discard the dirt seal. See **Fig. 35**.

14.5 Insert a screwdriver into the gear housing, and carefully push the seal and the spacer washer out of the other end of the bearing bore. See **Fig. 36**. Be careful not to damage the sealing area of the bore. Discard the seal.



1. Poppet Fixed Stopscrew
2. Adjusting Screw and Sealing Nut

Fig. 33, Steering Gear Adjusting Screws

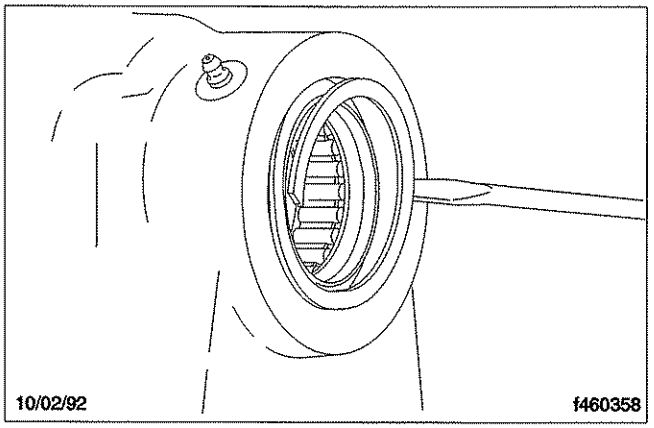


Fig. 34, Remove the Retaining Ring

14.6 If replacing the roller bearing in the housing, remove it, using special tool J37705 (TAS40), J37071 (TAS55/65), or J38779 (TAS85). Press the roller bearing out of the trunnion end of the housing, from the side of the bore where the side cover was attached. See **Fig. 37**.

⚠ CAUTION

Be sure the retaining ring is not damaged when the roller bearing is pressed out.

14.7 If replacing the retaining ring, remove it through the trunnion end, opposite the end where the side cover was attached. See

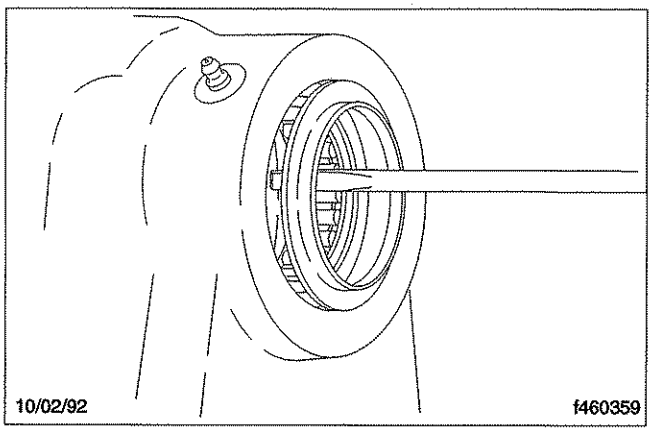


Fig. 35, Remove the Dirt Seal

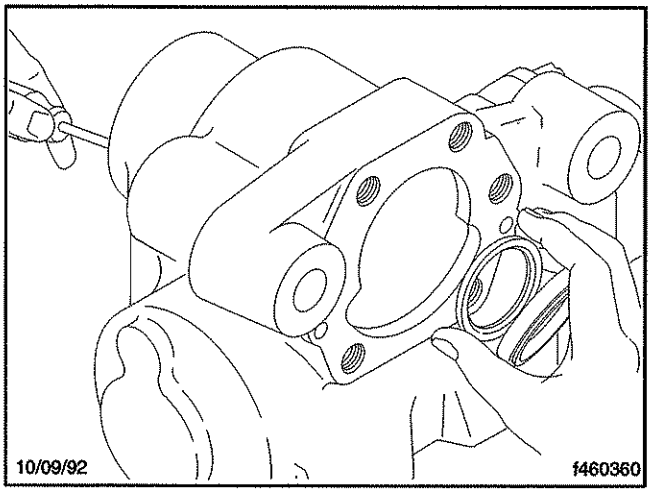


Fig. 36, Remove the Seal and Spacer Washer

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

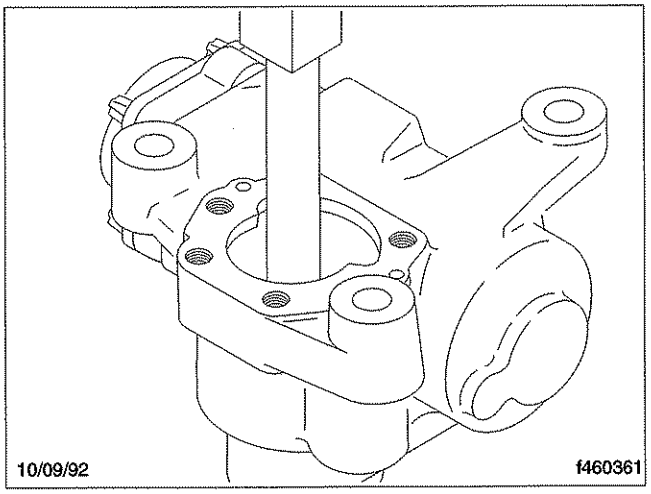


Fig. 37, Press the Roller Bearing Out of the Housing

Fig. 38. Be careful not to damage the pressure seal bore area.

Inspection

All sealing surfaces and seal cavities must be free of nicks and corrosion. If any part is nicked or corroded where sealing occurs, the part must be replaced to ensure proper sealing.

⚠ WARNING

Commercial cleaning solvents are toxic, can cause severe skin irritation, and may be fire hazards.

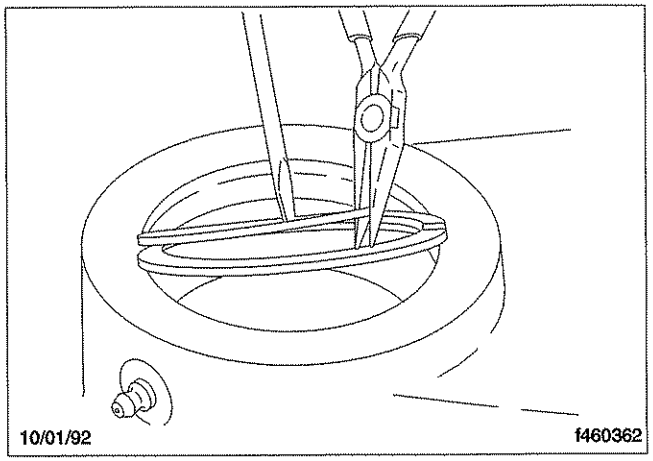


Fig. 38, Remove the Retaining Ring

When using solvents, follow the safety precautions recommended by the solvent manufacturer.

Wash all parts in a clean petroleum-based solvent. Blow-dry them with air.

1. Inspect the rack piston teeth for cracks and wear. See **Fig. 39**. If a step can be detected by running your fingernail horizontally across the teeth surfaces, the rack piston, the sector shaft, and the set of steel balls must be replaced.
2. Inspect the rack piston internal ball-track grooves for brinelling (dents) or spalling (flaking). See **Fig. 40**. If either condition exists, replace the following parts: the rack piston, the valve/worm shaft assembly, and the set of 29 (TAS40), 31 (TAS55), 32 (TAS65), or 34 (TAS85) steel balls.
3. Inspect the worm shaft ball-track grooves for brinelling or spalling. See **Fig. 41**. If either condition exists, replace the following parts: the worm/input shaft assembly, the rack piston, and the set of steel balls. Inspect the upper shaft-seal area, near the input shaft serrations, for nicks. Run your fingernail across the sealing surface to detect steps. See **Fig. 42**.
4. Inspect the housing cylinder bore. See **Fig. 43**. Minor scoring marks running lengthwise through the bore are normal, and should not be compared to the scoring that might be found in the cylinder bores of an internal combustion engine. Replace the housing only if it has been tested for internal leakage, and it is determined that the scoring is the cause of internal leakage greater than 1 gpm (3.8

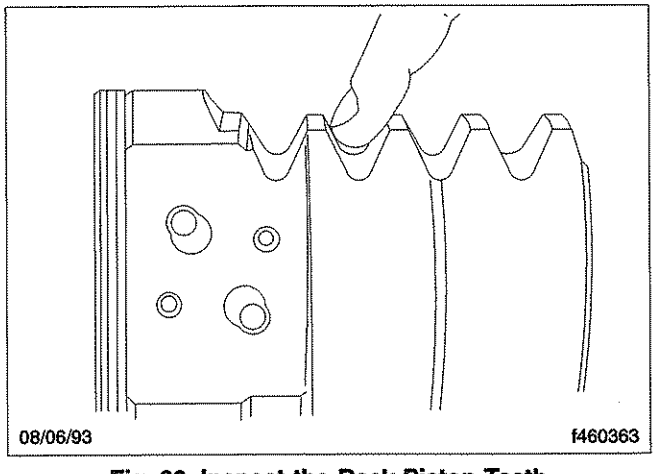


Fig. 39, Inspect the Rack Piston Teeth

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

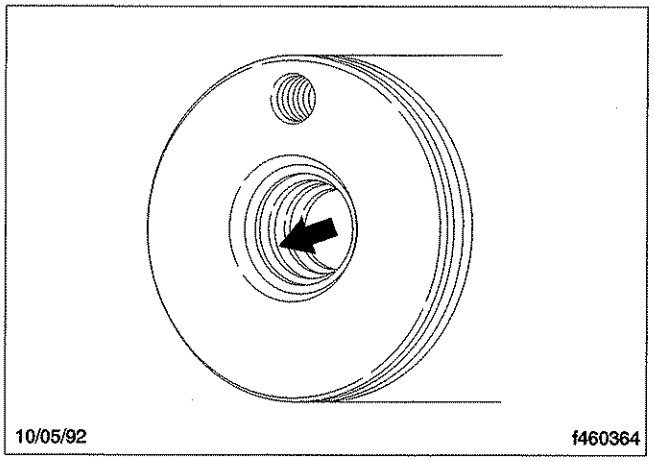


Fig. 40, Inspect the Rack Piston

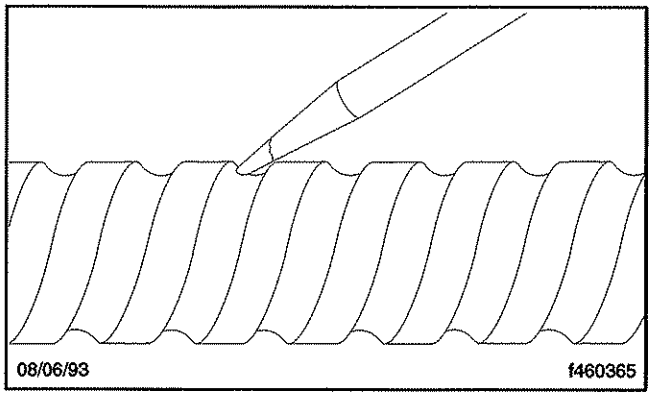


Fig. 41, Inspect the Worm Shaft

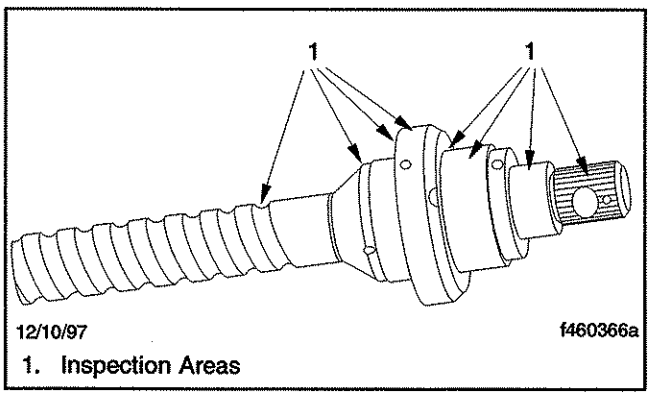


Fig. 42, Inspection Areas on the Upper Worm Shaft

Lpm). For test procedure, see **Troubleshooting and Diagnostic Checks, 300.**

NOTE: In evaluating this test, make sure that internal leakage of more than 1 gpm (3.8 Lpm) can be attributed only to the housing, and not to the seals in the worm shaft, rack piston, and valve assembly.

5. Inspect the housing faces for nicks that would prevent proper sealing. See **Fig. 44.** Replace the gear housing if these nicks cannot be easily removed with a fine-toothed flat file, without changing the dimensional characteristics.

6. Inspect the housing roller bearing (**Fig. 45**) for brinelling or spalling. If either condition exists, replace the housing bearing.

   For a TAS40/55/65 steering gear, inspect the side cover bushing. If the clearance between the bushing and the sector shaft is more than 0.008 inch

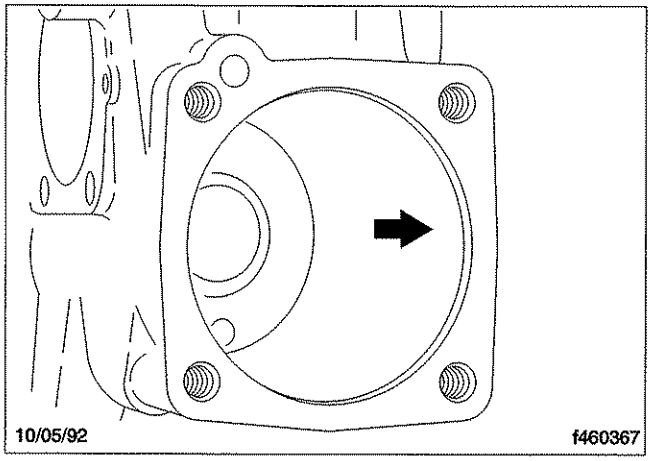


Fig. 43, Inspect the Housing Cylinder Bore

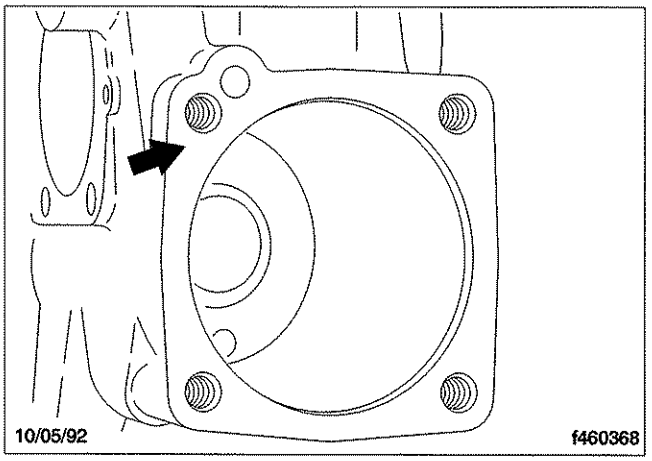


Fig. 44, Inspect the Housing Faces

(0.20 mm), replace the side cover and bushing assembly. See **Fig. 46**.

For a TAS85 steering gear, inspect the side cover bearing for brinelling or spalling. If the bearing is damaged, replace the side cover and bearing assembly.

7. Inspect the sector shaft bearing sealing areas for brinelling or spalling. See **Fig. 47**. Run your fingernail across these areas to detect steps. Also, inspect for cracks. If any of these conditions exist, replace the sector shaft.
8. Check the sector shaft assembly (**Fig. 1**) for damaged adjusting screw threads. Make sure the adjusting screw retainer is locked in place and has no cracks. The adjusting screw must turn by hand with no end play (lash). If the adjusting screw is damaged, replace it and its retainer.

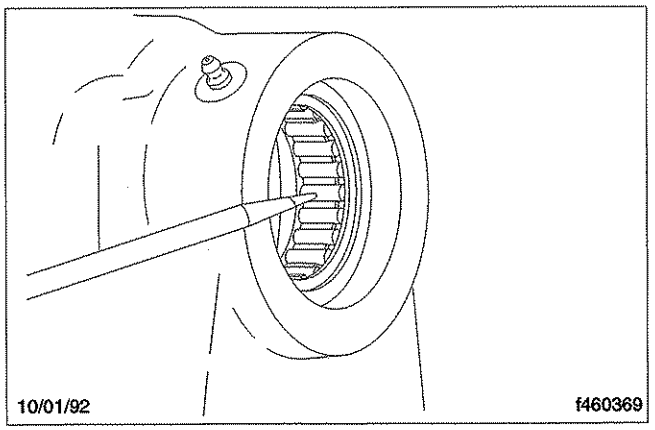


Fig. 45, Inspect the Housing Roller Bearing

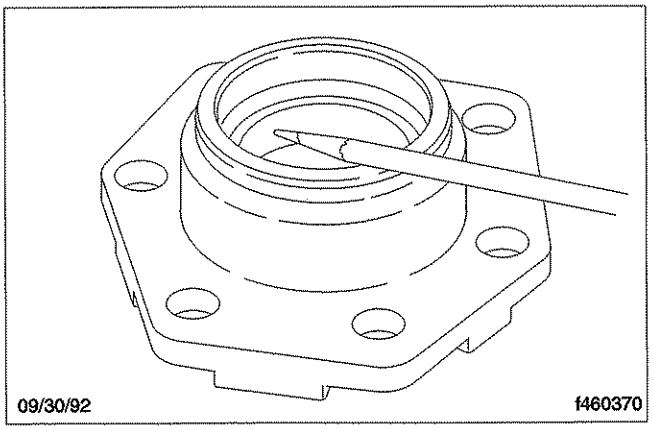


Fig. 46, Inspect the Side Cover Bushing

9. Inspect the thrust bearing rollers for any deterioration. Inspect the thrustwashers for brinelling, spalling, or cracks. See **Fig. 48**. Replace any part if these conditions are detected.

Assembly (See Fig. 1)

IMPORTANT: Be sure that required tools are available before beginning the service procedures described here. See the special tools table in **Specifications, 400**. The special tools required for disassembly and assembly of the steering gear parts are available from the Kent-Moore Tool Division, or an affiliated dealer.

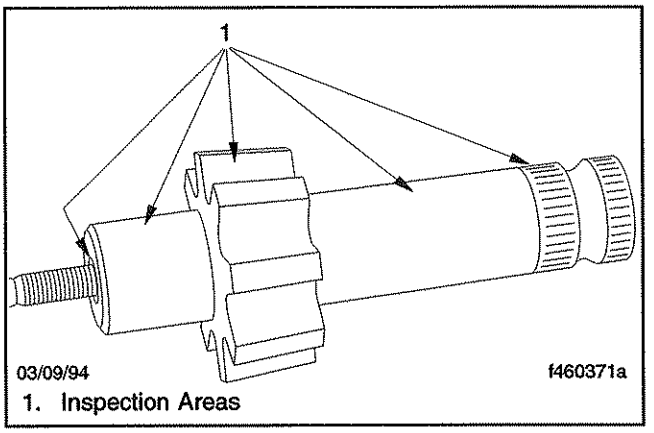


Fig. 47, Inspect the Sector Shaft Bearing Sealing Areas

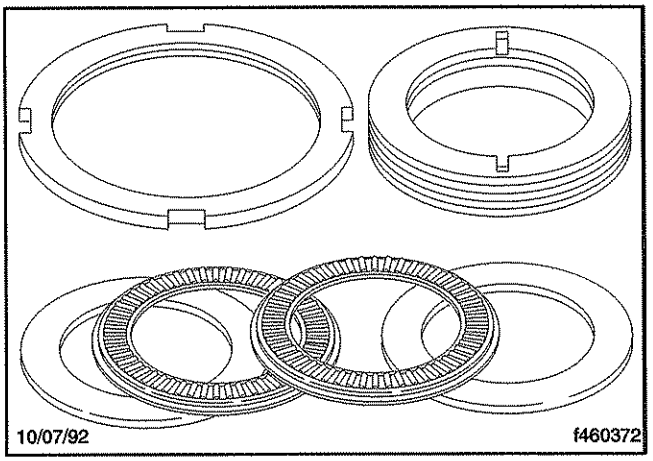


Fig. 48, Thrust Bearing Rollers

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

After inspection, clean all parts again in a clean petroleum-based solvent, and blow-dry them with air.

All seals, seal rings, and gaskets must be replaced with new ones each time the gear is disassembled. Individual seals, seal rings, and gaskets, as well as complete seal kits, are available from Freightliner parts distributors.

1. If required, install a new sector shaft roller bearing; otherwise, go on to the next step.
   - 1.1 Put the gear housing on its side, with the trunnion end of the bore facing up, as shown in **Fig. 49.**
   - 1.2 Install the retaining ring in the groove closest to the side cover end of the bore. See **Fig. 49.** Then lubricate the bore.
   - 1.3 Place the new roller bearing on the housing bore, with the lettered side of the bearing shell facing up.

⚠ CAUTION

When using special tool J37705 (TAS40), J37071 (TAS55/65), or J38779 (TAS85) to install the roller bearing, be sure to use the installation side of the tool, or you may damage the new roller bearing.

   - 1.4 Using the installation end of the special tool, press the roller bearing into the housing, until it seats against the retaining ring. See **Fig. 50.**

2. Install the sector shaft seals.

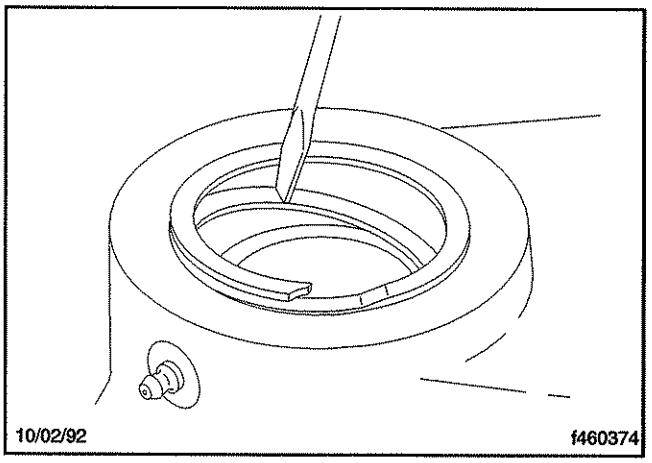


Fig. 49, Install the Retaining Ring

   - 2.1 Put the gear housing on its side, with the side cover end of the bore facing up, as shown in **Fig. 51.**
   - 2.2 Install the washer in the bore, with the small diameter end of it facing the roller bearing retaining ring. See **Fig. 51.**
   - 2.3 Put the new seal on special tool J37705 (TAS40), J37071 (TAS55/65), or J38779 (TAS85) so that the lip of the seal with the garter spring is toward the shoulder of the tool. See **Fig. 52.**
   - 2.4 From the side cover end of the bore, press the new seal onto the washer (and the roller bearing below it) with a force of 100 to 800 lbs (45 to 363 kg).

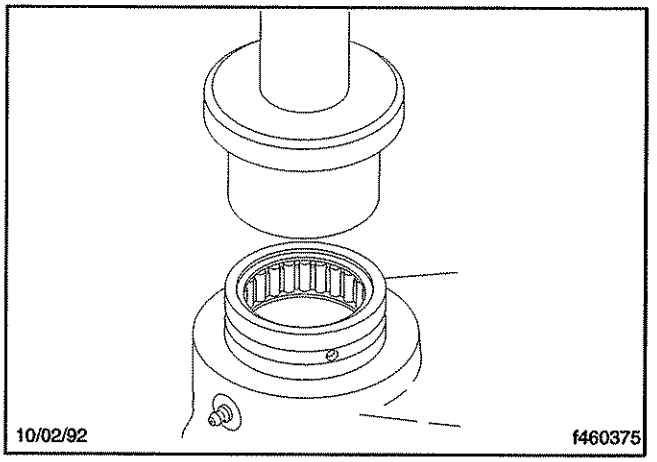


Fig. 50, Press the Roller Bearing into the Housing

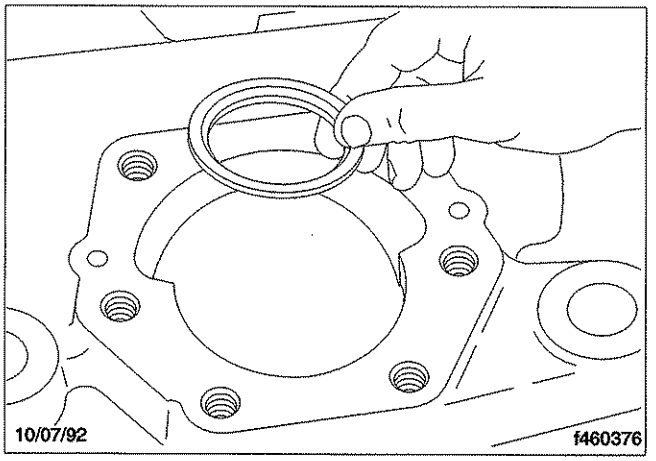


Fig. 51, Install the Washer in the Bore

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

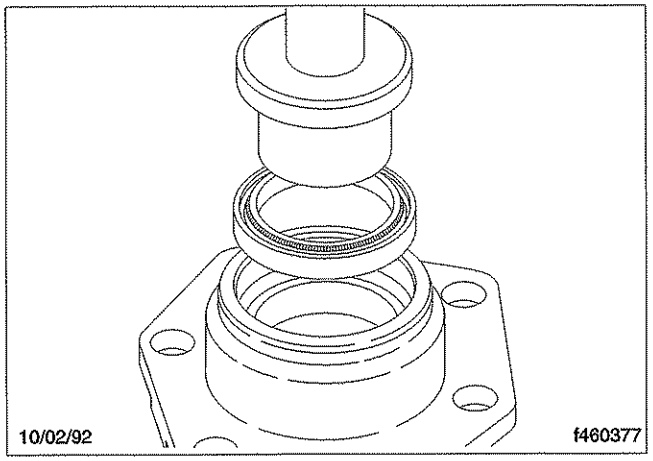


Fig. 52, Attach the New Seal to the Tool

2.5 Turn the gear housing over so that the trunnion end of the bore is up. Install the new dirt seal against the roller bearing, with the lip facing up. See **Fig. 53.**

2.6 Install the second retaining ring, seating it firmly into the groove in the bore. See **Fig. 54.**

2.7 Pack the area between the dirt seal and the pressure seal (including the roller bearing) with Mobil Temp® 1 grease, or equivalent. See **Fig. 55.**

3. Assemble the valve housing.

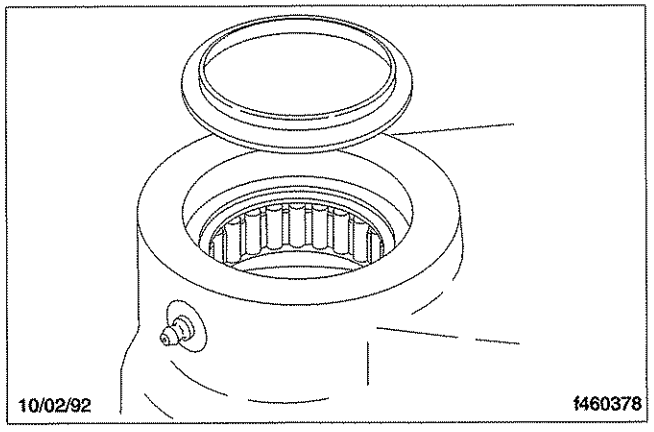


Fig. 53, Install the New Seal

⚠ CAUTION

In the next step, when putting the valve housing in a vise, be careful not to clamp against the threaded port hole or the relief-valve hole sealing faces. To do so may damage these surfaces, which would require the replacement of the valve housing.

3.1 Put the valve housing in a vise so the input/worm shaft can be installed with the worm shaft up.

3.2 Lubricate and install a new O-ring in the valve housing. See **Fig. 56.**

3.3 Lubricate a new large diameter O-ring and a new seal ring, then install them in the valve housing. See **Fig. 56** and **Fig. 57.**

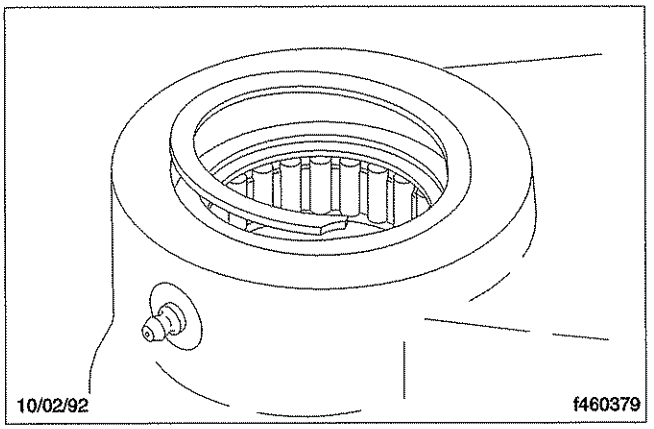


Fig. 54, Install the Second Retaining Ring

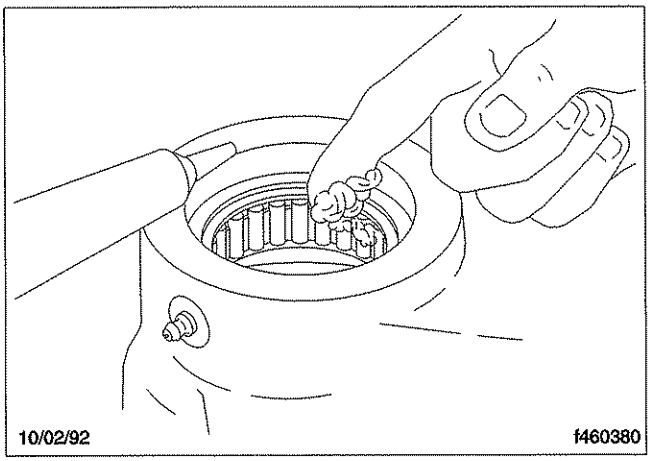


Fig. 55, Lubricate the Area Between the Seals

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

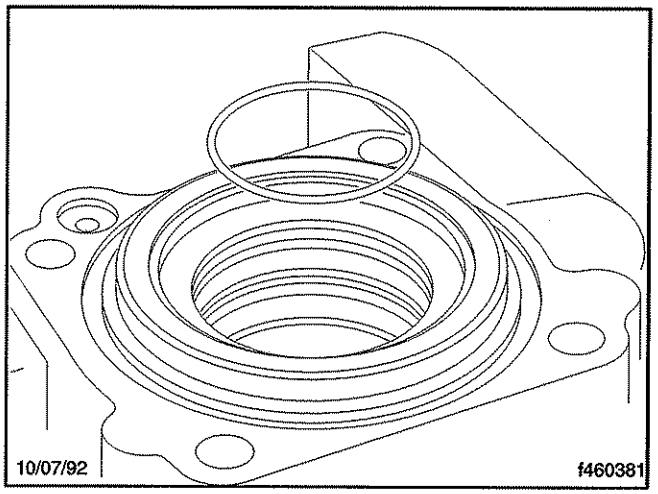


Fig. 56, Install a New O-Ring

3.4 Install the roller thrust bearing and the thick thrustwasher on the input-shaft thrust face. See **Fig. 58**.

3.5 Install a new seal ring (**Fig. 1**) onto the input shaft, and against the thick thrustwasher.

3.6 Lubricate, then install the input shaft/valve/worm assembly in the valve housing, seating it firmly. See **Fig. 59**.

3.7 Lubricate, then install a second thrust bearing and thin washer over the worm shaft. See **Fig. 60**.

3.8 Lubricate the new O-ring and seal ring (**Fig. 1**). Install the O-ring, then the seal ring in the groove of the bearing adjuster. See **Fig. 61**.

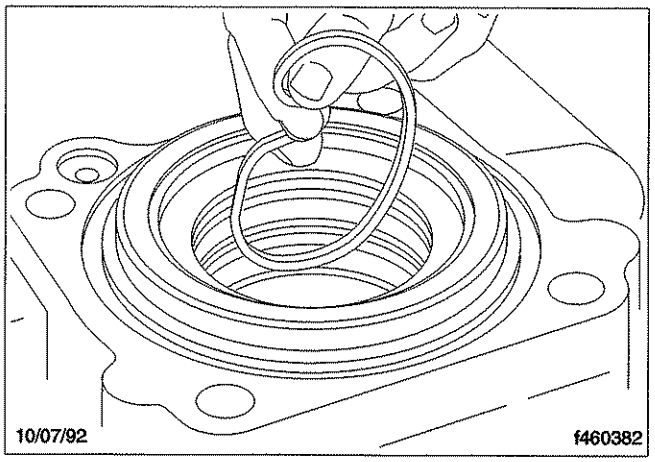


Fig. 57, Installing a New O-Ring

3.9 Making sure the bearing adjuster threads are clean and free of any stake burrs, lubricate and then install the bearing adjuster over the worm shaft, and into the valve housing.

3.10 Using a torque wrench and bearing adjuster tool J37070, tighten the valve adjuster 11 to 15 lbf·ft (15 to 20 N·m), then back it off 1/4 to 1/2 turn. See **Fig. 62**.

3.11 Turn the valve housing over in the vise so that the worm shaft is facing down.

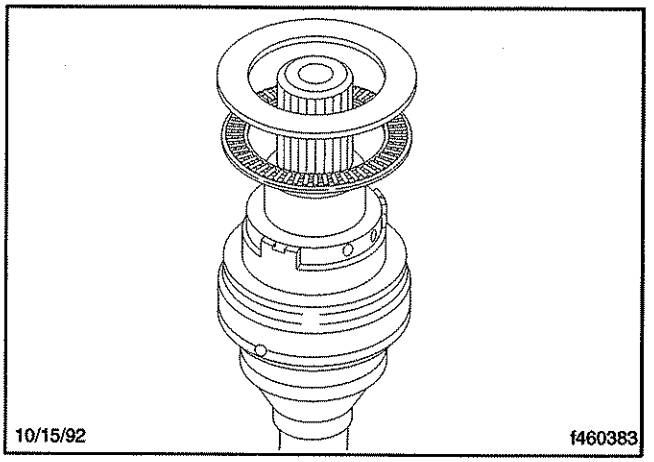


Fig. 58, Installing the Roller Thrust Bearing and Thrustwasher

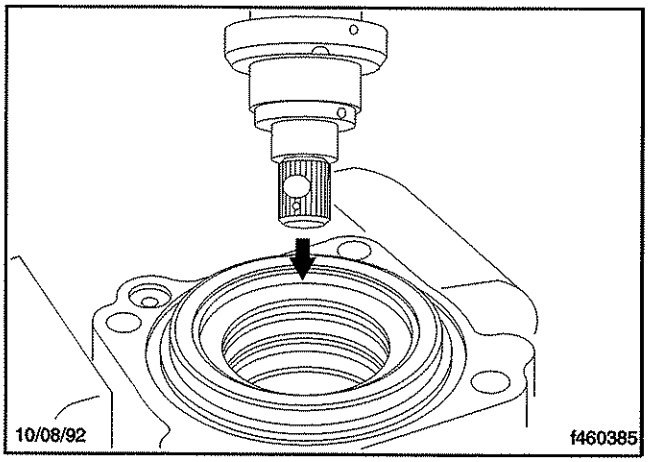


Fig. 59, Install the Input Shaft/Valve/Worm Assembly

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

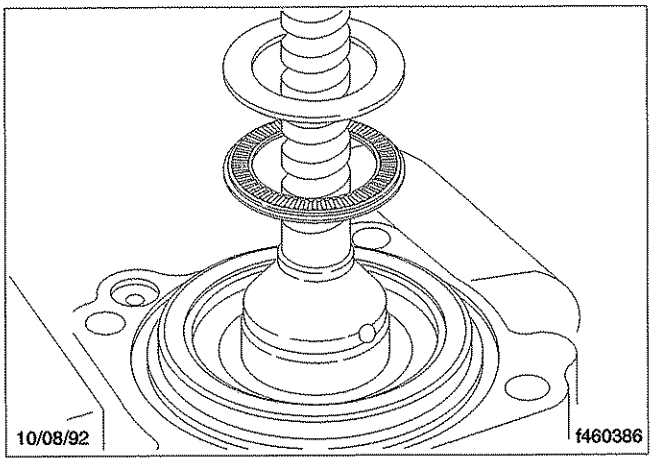


Fig. 60, Installing a Second Thrust Bearing

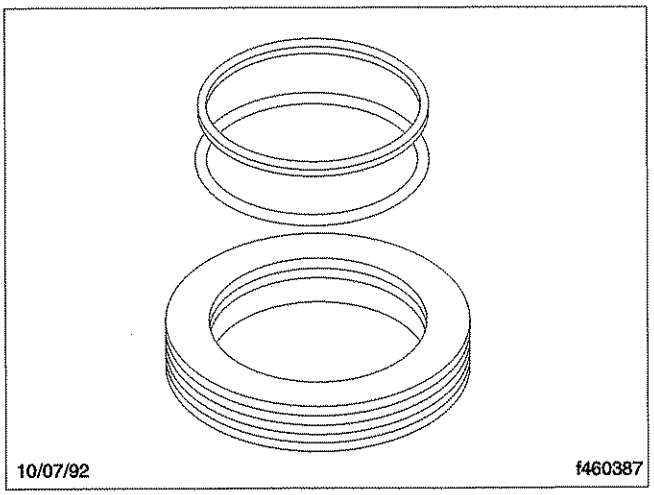


Fig. 61, Installing the O-Ring and Seal Ring

3.12 Using an inch-pound torque wrench, check the torque needed to turn the input shaft slowly 360 degrees clockwise and counterclockwise. Tighten the bearing adjuster until the torque needed to turn the input shaft increases by 5 to 10 lbf·in (60 to 120 N·cm). See **Fig. 63**.

3.13 Turn the valve housing over in the vise again, so that the worm shaft is facing up.

3.14 Oil and install the locknut on the bearing adjuster, and using special tools J37070 and J37464, tighten the locknut 101 to 122 lbf·ft (137 to 165 N·m), while holding the bearing adjuster. See **Fig. 64**.

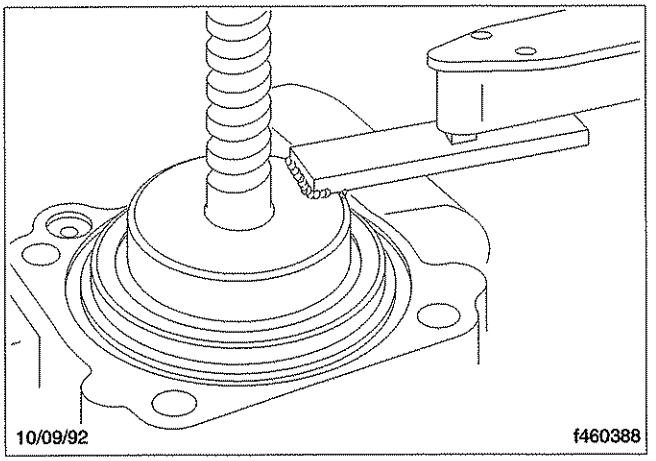


Fig. 62, Tighten the Valve Adjuster

3.15 Check the torque needed to turn the input shaft again. If the torque hasn't increased 5 to 10 lbf·in (60 to 120 N·cm), remove the locknut from the bearing adjuster, and repeat the steps above beginning with tightening the valve adjuster, then backing it off.

3.16 Using a punch, stake the locknut to the valve housing at two opposite slots in the locknut. Stake each slot in the most clockwise corner, as shown in **Fig. 65**.

3.17 Stake the locknut to the bearing adjuster at two places 180 degrees apart. See **Fig. 65**. Don't use a spot that was staked before.

3.18 Check the torque needed to turn the input shaft. If the torque isn't greater than 5

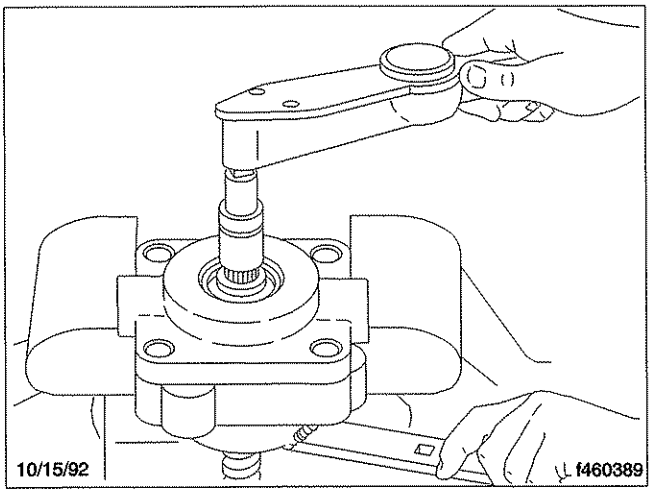


Fig. 63, Checking the Torque

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

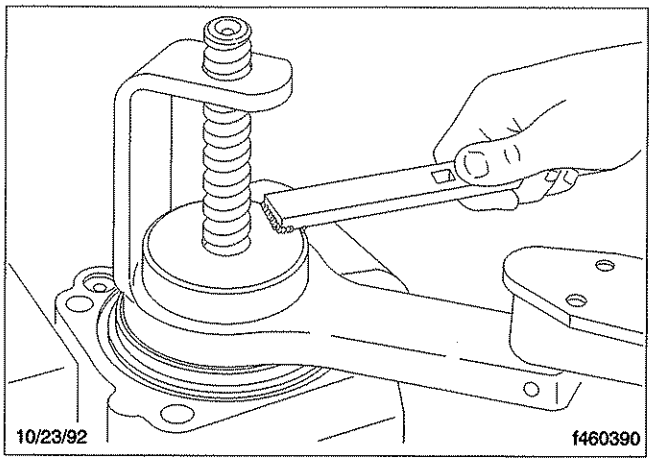


Fig. 64, Installing the Locknut on the Bearing Adjuster

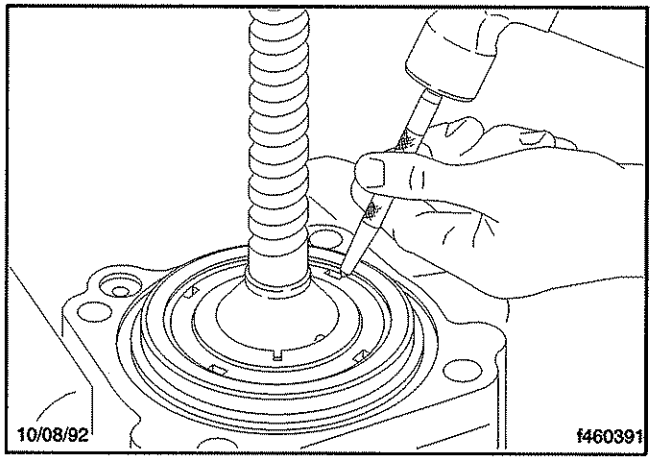


Fig. 65, Stake Each Slot

to 10 lbf·in (60 to 120 N·cm) the torque previously noted, unstake the locknut from the bearing adjuster, and repeat the steps above beginning with tightening the valve adjuster, then backing it off.

NOTE: The torque needed to turn the input shaft must not be more than 22 lbf·in (240 N·cm).

3.19 Oil the new seal rings, and install them in the valve housing. See **Fig. 66.**

4. Reset the automatic poppet valves.

IMPORTANT: Make sure the poppet adjuster seat and sleeve assemblies and the threaded holes in the rack piston are free of Loctite®. Use 7/16-20 thread chasers to remove the Loctite®.

4.1 Turn the poppet adjuster seat and sleeve assembly so that it is in the *opposite* direction in which it was installed, and loosely screw it into the threaded hole in the rack piston. See **Fig. 67.**

4.2 Press the adjuster seat into the adjuster sleeve with a force of 500 to 2500 lbs (227 to 1134 kg), until the shoulder on the seat bottoms on the sleeve. See **Fig. 68** and **Fig. 69.**

4.3 Remove the adjuster seat and sleeve assembly from the rack piston.

4.4 Repeat the previous steps for the other poppet adjuster seat and sleeve assembly.

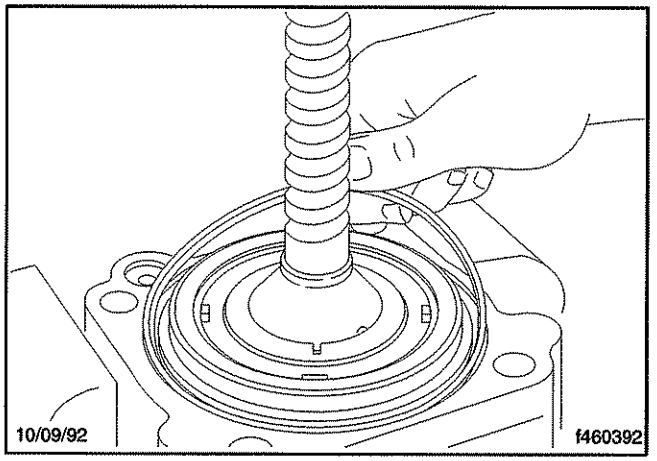


Fig. 66, Installing New Seal Rings

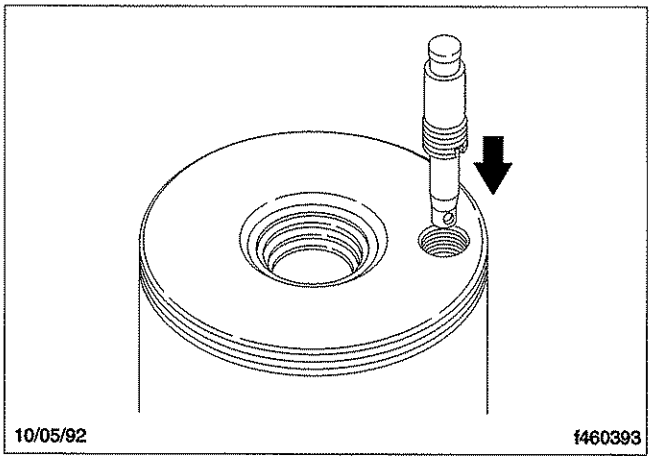


Fig. 67, Installing the Poppet Adjuster Seat and Sleeve Assembly in the Rack Piston

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

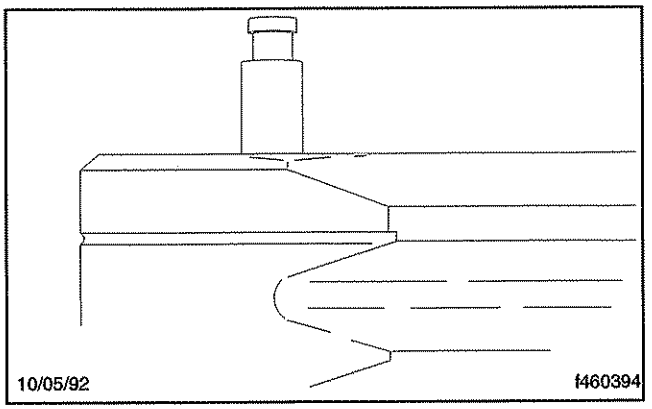


Fig. 68, The Adjuster Seat in the Adjuster Sleeve

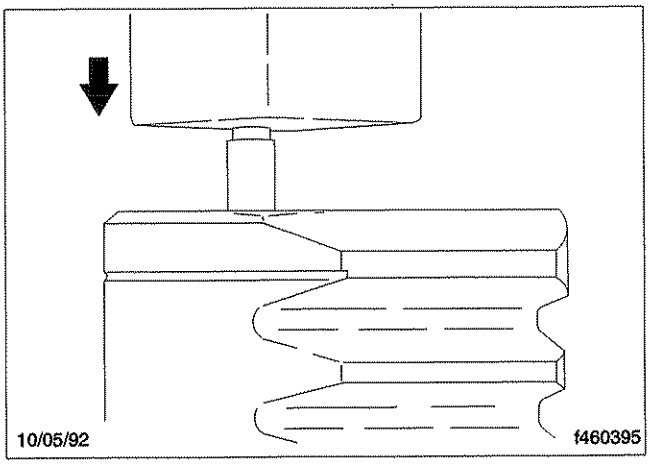


Fig. 69, Installing the Adjuster Seat into the Adjuster Sleeve

5. Install the rack piston seal: install a new backup O-ring and new Teflon® seal ring on the rack piston. See **Fig. 70**. Don't stretch them more than necessary when installing them.

6. Install the automatic poppets.

⚠ CAUTION

When doing the next step, be careful not to get any Loctite® or Locquic on the adjuster seat itself. If this happens, the automatic poppets will not adjust correctly.

NOTE: If you are installing new poppet adjuster seat and sleeve assemblies, they may already have Dri-Loc® 200 on them; if so, more Loctite® is not needed.

6.1 Apply Locquic primer "T" to the threaded poppet holes in the rack piston, and to the threads on the poppet adjuster seat and sleeve assemblies. Let dry for ten minutes, then apply Loctite® RC680 to the same threads. See **Fig. 71**.

6.2 Place the rack piston in a padded vise, and install a poppet adjuster seat and sleeve assembly, slotted end out, into the threaded hole at one end of the rack piston. See **Fig. 72**.

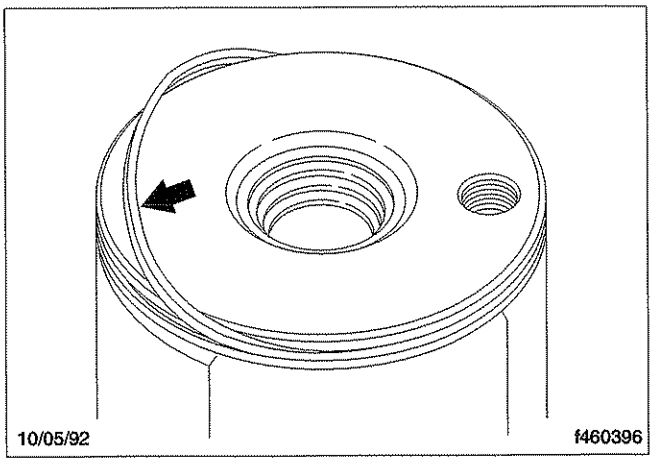


Fig. 70, Installing the Rack Piston Seal

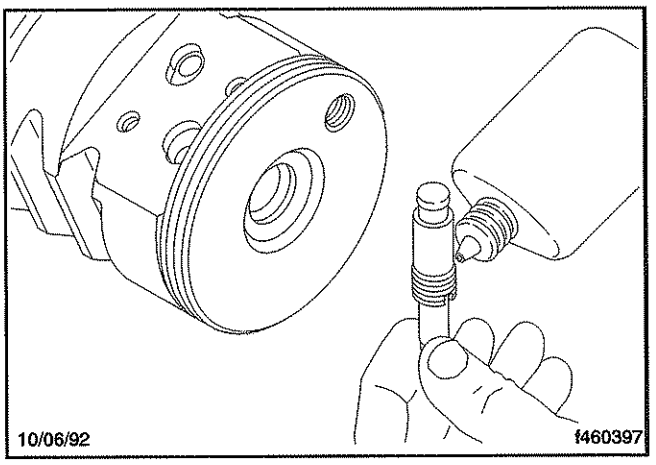


Fig. 71, Apply Primer to the Threaded Poppet Holes

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

⚠ WARNING

Wear eye protection while assembling the poppets. The poppets are spring-loaded, and could be ejected, which could result in serious eye injury.

6.3 In the other end of the hole, install the poppet assembly parts in the following order (**Fig. 73**): one poppet, the poppet spring, the nylon spacer rod, the push tube, the other poppet, and the other poppet adjuster seat and sleeve assembly.

6.4 Using special tool J36452 or J38713 (preferred), tighten both poppet adjuster seat and sleeve assemblies as follows (**Fig. 74**):

TAS40/55/65 steering gear, 10 lbf·ft (14 N·m);

*TAS85 steering gear,*18 lbf·ft (24 N·m).

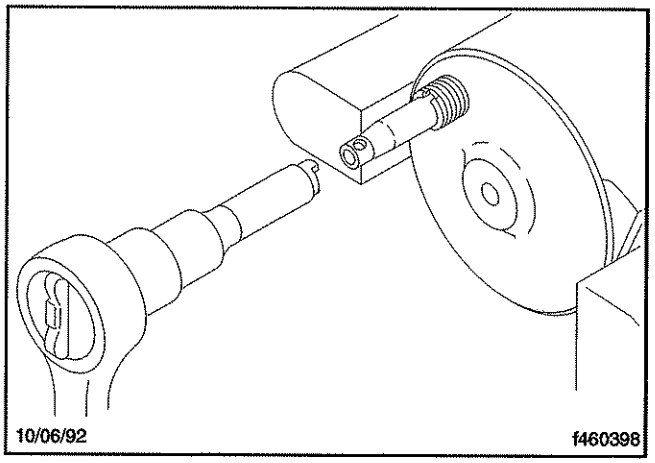


Fig. 72, Installing the Poppet Adjuster Seat and Sleeve Assembly into the Rack Piston

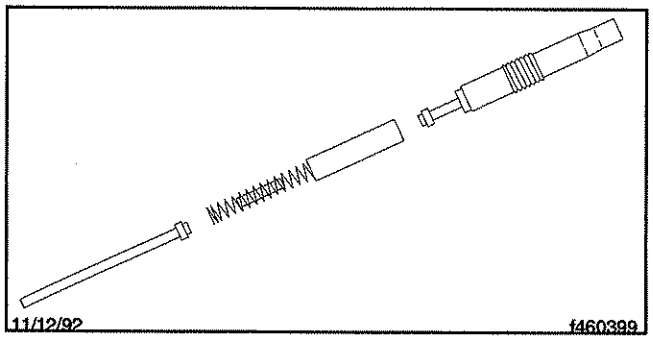


Fig. 73, Installing the Poppet Assembly Parts

7. Install the worm shaft and valve housing assembly into the rack piston.

7.1 Put the rack piston on a clean, cloth-covered bench, with the worm end of the piston near the edge of the bench, and the ball guide holes facing up.

NOTE: When made to the correct dimensions to raise and support the piston, a wooden V-block will make the following steps easier.

7.2 Insert the worm shaft and input shaft assembly into the worm end of the rack piston, close to the maximum depth, without the valve housing contacting the upper poppet. See **Fig. 75**.

7.3 Line up the grooves in the worm shaft with the ball guide holes in the rack piston. Make

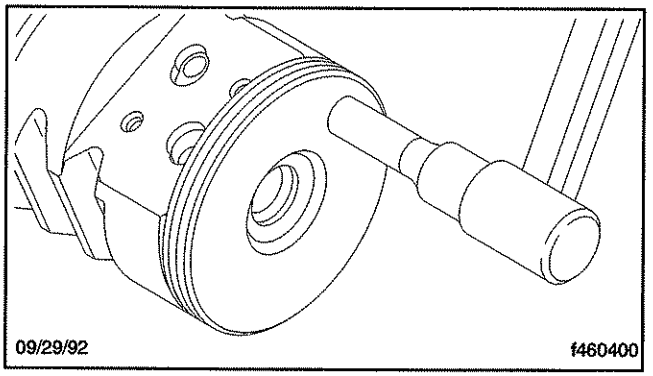


Fig. 74, Tighten the Poppet Adjuster Seat and Sleeve Assemblies

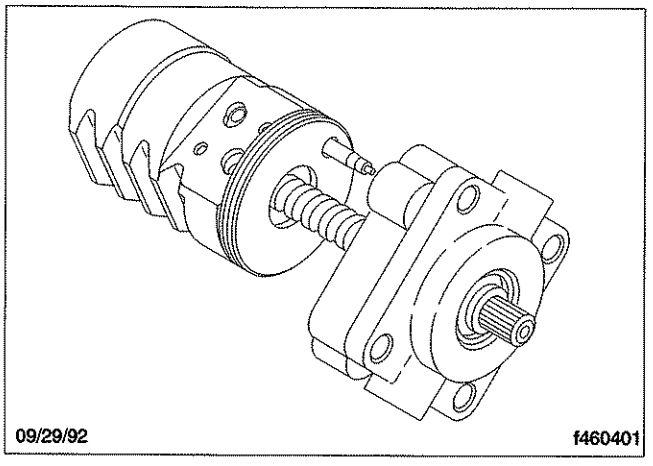


Fig. 75, Inserting the Worm Shaft and Input Shaft Assembly into the Rack Piston

sure the valve housing extends over the edge of the bench (as shown in **Fig. 75**), or the rack piston is put on a V-block, so that the valve housing and worm shaft can turn freely.

⚠ WARNING

In the next step, don't seat the ball return guides with a hammer. This could damage them and cause steering gear lockup or loss of steering, resulting in an accident causing personal injury or property damage.

8. Install the steel balls.

   8.1 Install new ball return guide halves in the rack piston. See **Fig. 76**. Make sure they are correctly seated.

⚠ CAUTION

If you are installing a new rack piston, or a new input shaft/valve/worm assembly, don't install the existing steel balls. Use a new set of steel balls, or damage to the steering gear may result.

NOTE: The worm gear may have to be rotated slightly to seat guide halves. Left-hand ball return guide halves are copper-plated, and right-hand ones are not. Make sure the correct new ball return guide halves are installed by comparing them with the old ones; then discard the old ones.

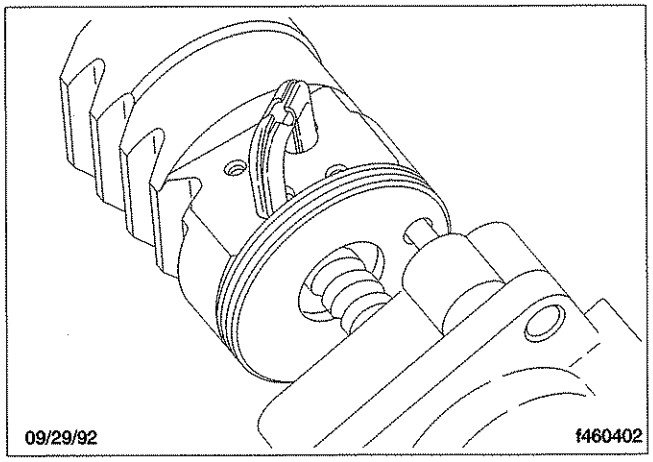


Fig. 76, Installing the New Ball Return Guide Halves

8.2 Insert the 29 (TAS40), 31 (TAS55), 32 (TAS65), or 34 (TAS85) steel balls in the ball return guide hole, as shown in **Fig. 77**. As the balls are dropped into the guide, turn the worm shaft so that the balls are pulled down into its grooves.

⚠ WARNING

Make sure the ball return guide halves stay down and in place while you are inserting the steel balls or turning the input shaft. Failure to hold the ball guide halves down may result in a ball being trapped outside the closed ball-track loop. A trapped ball could cause a steering lockup, which could result in an accident and personal injury or property damage.

8.3 If the ball guide halves rise up at any time during or after the installation of the steel balls, remove all of the balls, and the input shaft/valve/worm assembly from the rack piston. Repeat the previous steps beginning with inserting the worm shaft and input shaft assembly into the worm end of the rack piston.

IMPORTANT: Don't let the valve housing pilot face touch the poppet adjuster, or move more than 2.7 inches (69 mm) from the upper end of the rack piston. See **Fig. 78**. If this happens, the poppet adjuster could be incorrectly preset or the worm could be backed out beyond the closed ball loop.

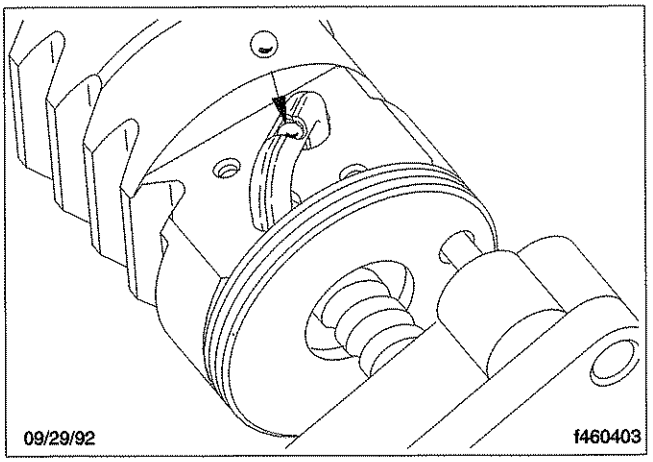


Fig. 77, Inserting the Steel Balls in the Return Guide Hole

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

8.4 Lubricate the new seal for the ball return guide cap, and install it in the groove in the cap. See **Fig. 79.**

8.5 Using a 5/32 inch allen socket and two new 5/32 inch allen head screws (or a T-30 Torx socket and two new Torx head screws), install the ball return guide cap on the rack piston. Make sure the seal makes full contact with the rack piston surface. Tighten the fasteners alternately once or twice, to a final torque of 14 to 22 lbf·ft (19 to 30 N·m).

8.6 To ensure that the steel balls have been correctly installed, turn the worm shaft from one end of travel to the other, without allowing the valve housing to contact the poppet adjuster, and without moving the valve housing pilot face more than 2.7 inches (69 mm) from the input end (upper end) of the rack piston. See **Fig. 78.**

8.7 If the worm shaft doesn't turn, remove all of the steel balls, and install them again.

9. Install the poppet stopscrew. If the poppet stopscrew is being replaced, install the new one and its washer in the gear housing. See **Fig. 80.** Tighten it 38 to 42 lbf·ft (52 to 57 N·m).

10. Preset the poppet adjusting screw, if equipped.

10.1 If the service poppet adjusting screw (**Fig. 1**) and the service sealing jam nut are being used for automatic poppet adjustment, turn the adjusting screw into the jam nut until 1.03 to 1.09 inches (26 to 28 mm) protrudes from the bottom of the jam nut. See **Fig. 81.**

10.2 Install the assembly into the gear housing. Tighten the jam nut 33 to 37 lbf·ft (45 to 50 N·m).

11. Install the rack piston/valve housing assembly into the gear housing.

11.1 Put clean oil on the rack piston Teflon® seal ring and into the bore of the gear housing. Position the rack piston on the worm gear with a gap of 10 to 13 mm (3/8 to 1/2 inch) between the valve housing and the upper poppet adjuster seat and sleeve assembly.

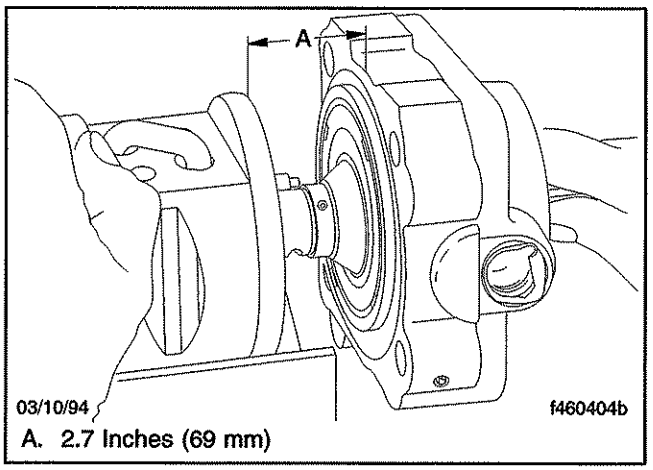


Fig. 78, Maximum Distance Between the Valve Housing Pilot Face and the Upper End of the Rack Piston

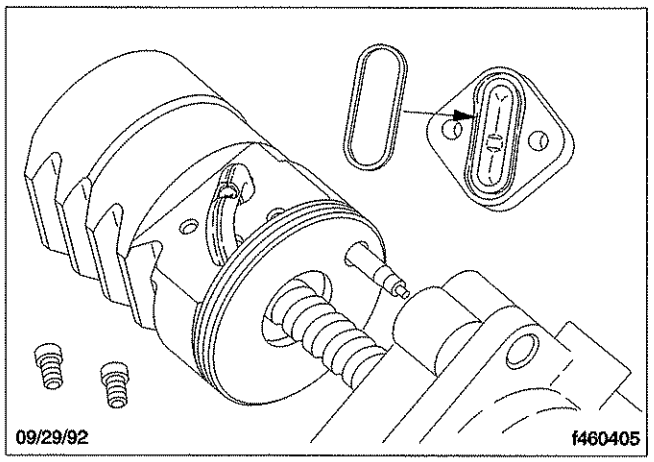


Fig. 79, Install the Seal in the Ball Return Guide

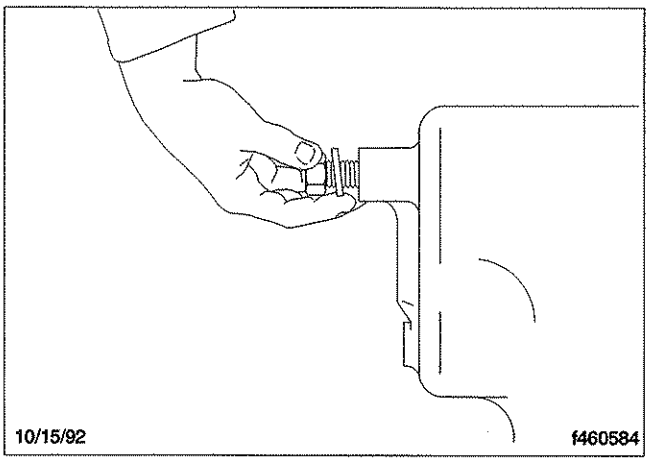
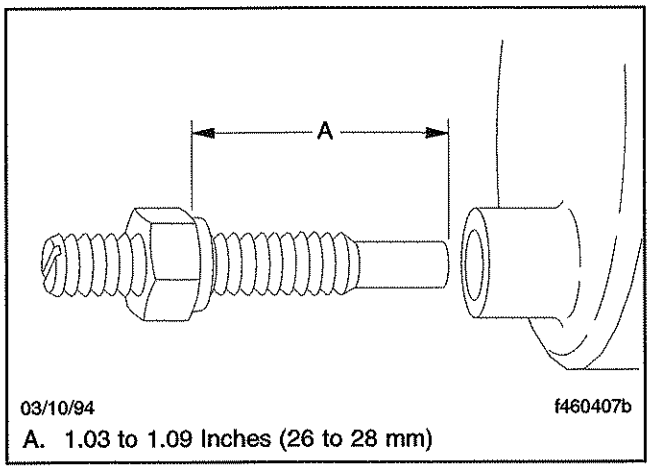


Fig. 80, Installing the Poppet Stopscrew

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments



A. 1.03 to 1.09 Inches (26 to 28 mm)

Fig. 81, Turn the Adjusting Screw into the Jam Nut

⚠ CAUTION

When installing the rack piston in the steering gear housing, be careful not to damage the seal ring on the rack piston, as this could seriously affect the operation of the steering gear.

Don't let the poppet adjuster seat and sleeve assemblies on the rack piston bottom out when installing the rack piston in the gear housing.

IMPORTANT: This gap is to ensure that the poppets don't make contact with anything while the steering gear is being assembled.

11.2 Install the rack piston and worm shaft assembly in the gear housing, being careful not to damage the seal ring on the rack piston. Don't let the poppet adjuster sleeve assemblies bottom out inside the gear housing. Install the piston with the rack teeth toward the sector shaft hole in the housing. See **Fig. 82.** Be sure the valve housing cylinder feed hole lines up with the gear housing feed hole.

11.3 Using an E-16 Torx socket wrench, install and tighten the four valve housing bolts as follows: See **Fig. 83.**

TAS40/55/65 steering gear, 75 to 85 lbf·ft (102 to 115 N·m).

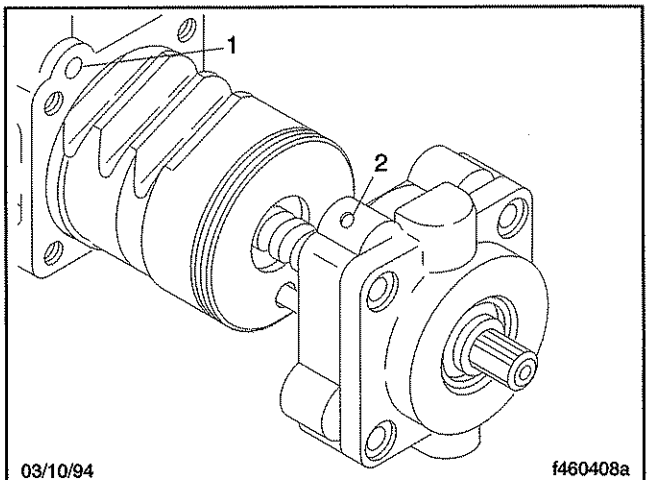
TAS85 steering gear, 108 to 128 lbf·ft (146 to 174 N·m).

12. Install the relief valve components, if equipped.

12.1 Assemble a new O-ring on the relief valve cap.

12.2 Assemble the small end of tapered spring onto the pin on the other part of the relief valve and insert the assembly, tapered spring end first, into the relief valve cap cavity. See **Fig. 84.**

12.3 Turn the relief valve cap as assembled into the valve housing and torque it to 30 lbf·ft (41 N·m). See **Fig. 85.**



1. Gear Housing Feed Hole
2. Valve Housing Cylinder Feed Hole Boss

Fig. 82, Installing the Rack Piston and Worm Shaft Assembly in the Gear Housing

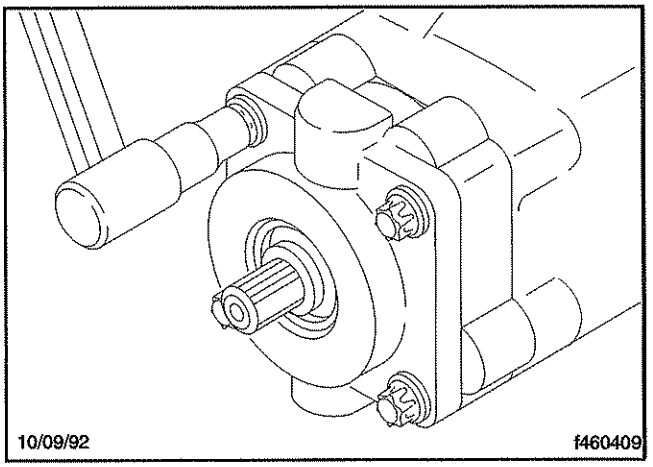


Fig. 83, Install the Valve Housing Bolts

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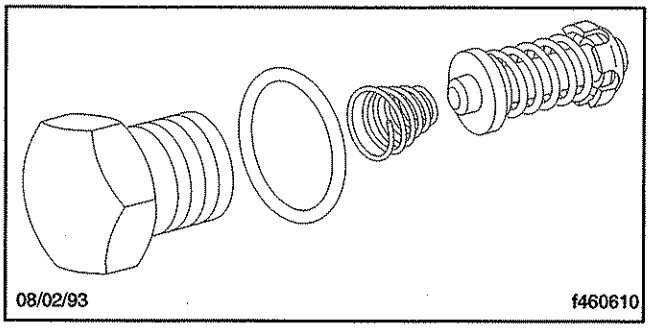


Fig. 84, Assemble the Spring and Pin into the Relief Valve Cap

13. If the sector shaft adjusting screw is being replaced, do the following; otherwise go to the next step and install the sector shaft/side cover components.

    13.1 Coat the end of the new adjusting screw with wheel bearing grease, and with the sector shaft in a padded vise, insert the new adjusting screw into the recess in the sector shaft end.

    13.2 Install a new sector-shaft screw retainer in the sector shaft. Adjust the retainer so that the sector shaft adjusting screw can be turned freely by hand. It should have a maximum end play of 0.002 inch (0.05 mm).

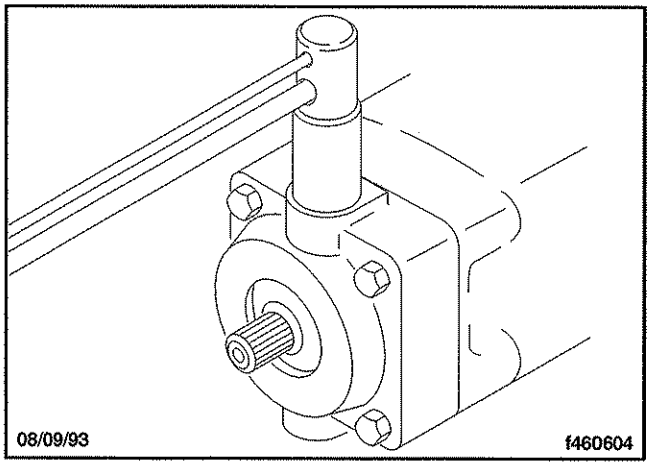


Fig. 85, Turn the Relief Valve Cap into the Valve Housing

⚠ WARNING

Be careful when staking the sector-shaft screw retainer. If the retainer is broken or cracked, the sector shaft could come loose, resulting in loss of manual and power steering control. This could cause an accident resulting in personal injury or property damage. Replace a broken or cracked sector-shaft screw retainer.

    13.3 Stake the sector-shaft screw retainer to the slots in the sector shaft. See **Fig. 86**. Check the adjusting screw again for free movement and end play.

14. Install the sector shaft/side cover components.

    14.1 *For a TAS40/55/65 steering gear,* lightly oil the side cover "DU" bushing. Don't grease it. See **Fig. 87**.

    For a TAS85 steering gear, heavily grease the side cover bearing with Mobile Temp 1 or 2 grease. Don't oil it.

    14.2 Put a new seal on special tool J37705 (TAS40), J37071 (TAS55/65), or J38779 (TAS85) so that the garter spring is against the shoulder of the tool. See **Fig. 88**. Press the new seal into the side cover with a force of 100 to 800 lbs (45 to 363 kg). Make sure the seal is seated against the bottom of the counterbore.

    14.3 *For a TAS40/55/65 steering gear,* lightly oil the short bearing end of the sector shaft.

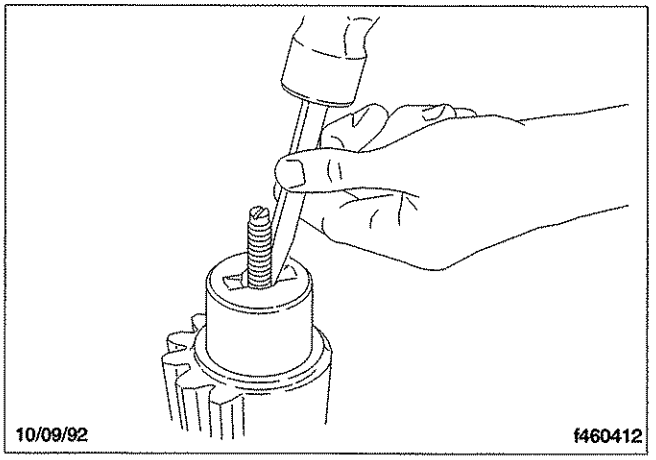


Fig. 86, Stake the Sector-Shaft Screw Retainer to the Sector Shaft

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

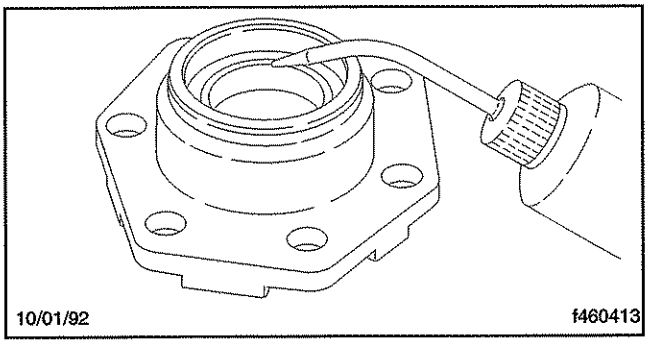


Fig. 87, Oil the Side Cover DU Bushing

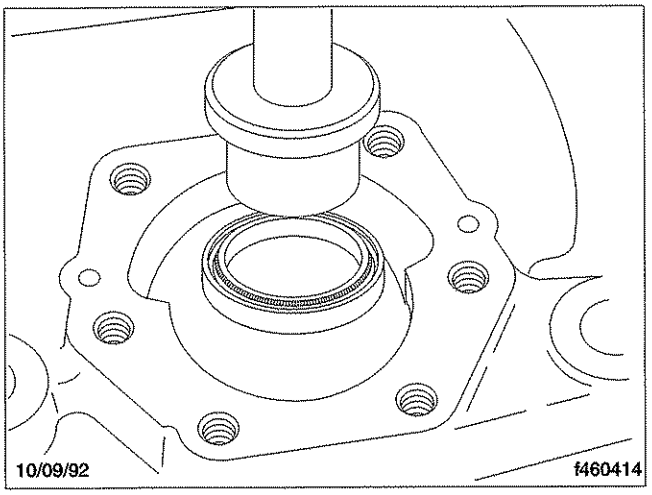


Fig. 88, Put a New Seal on the Tool

For a TAS85 steering gear, heavily grease the short bearing end of the sector shaft.

Insert the sector shaft into the side cover. Screw the sector shaft adjusting screw counterclockwise into the side cover, until the screw seats. See **Fig. 89**. Then rotate the adjusting screw clockwise one turn, so that the side cover rotates freely on the sector shaft.

14.4 Install the sector-shaft adjusting screw jam nut onto the sector-shaft adjusting screw a few threads. See **Fig. 90**. Final adjustment will be made later.

14.5 Press a new rubber plug into the hole provided in the side cover, until the plug is flush. See **Fig. 91**.

⚠ WARNING

Don't weld or plug this hole permanently. This is a safety vent which functions only if the side cover output shaft seal doesn't work. If the seal doesn't work and the plug cannot vent, the steering gear can lock up or otherwise malfunction. This could result in a loss of steering control, which could cause personal injury or property damage.

15. Install the sector shaft/side cover assembly.

15.1 Apply clean grease to a new side cover gasket, and install it on the side cover. See

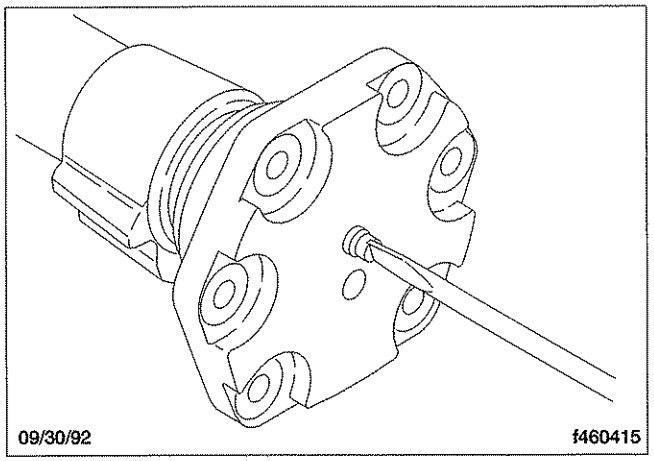


Fig. 89, Screw the Sector Shaft Adjusting Screw into the Side Cover

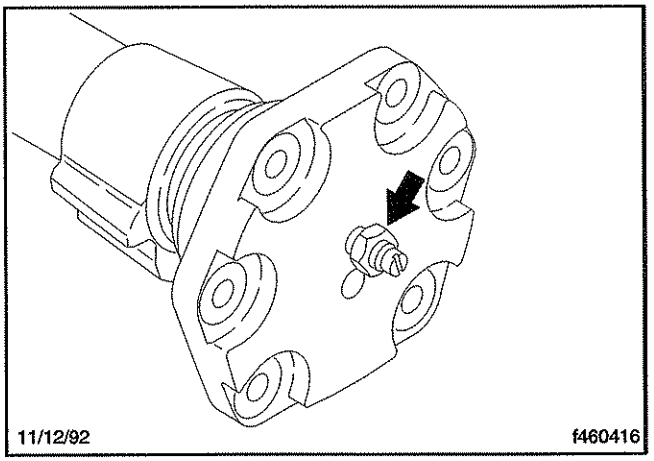


Fig. 90, Install the Jam Nut Onto the Sector-Shaft Adjusting Screw

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

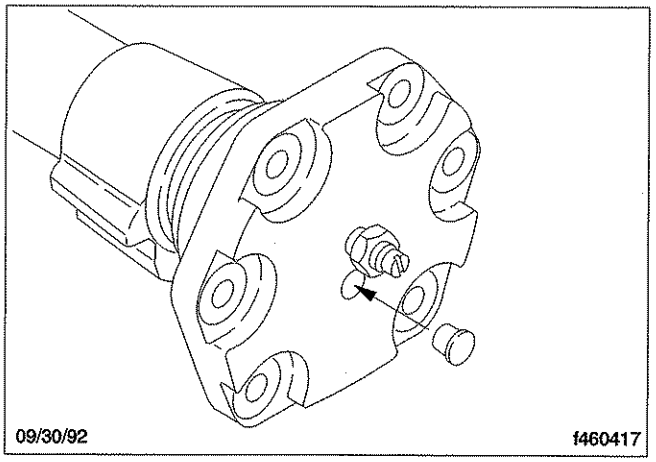


Fig. 91, Install a New Plug into the Side Cover

Fig. 92. Apply enough grease to hold the gasket in place.

15.2 There are four teeth on the rack piston. Turn the input shaft as needed to position the rack piston so that the tooth space identified by the pencil in **Fig. 93** (it is the third space between the second and the third tooth), is in the center of the sector shaft opening. See **Fig. 94**. This will center the rack piston in the opening.

15.3 Remove all tape from the sector shaft splines. Retape the splines and the bolt groove with *one layer* of masking tape.

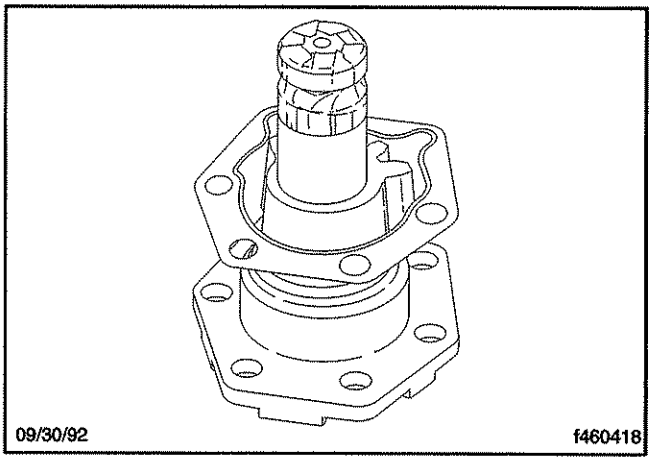


Fig. 92, Install a New Gasket on the Side Cover

⚠ CAUTION

If the splines on the sector shaft are not taped correctly, the spline will damage the housing seal during assembly, causing the seal to leak.

15.4 Install the sector shaft and side cover, as an assembly, in the gear housing. See **Fig. 95.** Make sure the center tooth of the sector engages the center space (between the second and third teeth) of the rack piston.

15.5 Install the special side cover bolts in the side cover. Using the torque pattern shown in **Fig. 96** or **Fig. 97**, tighten as follows:

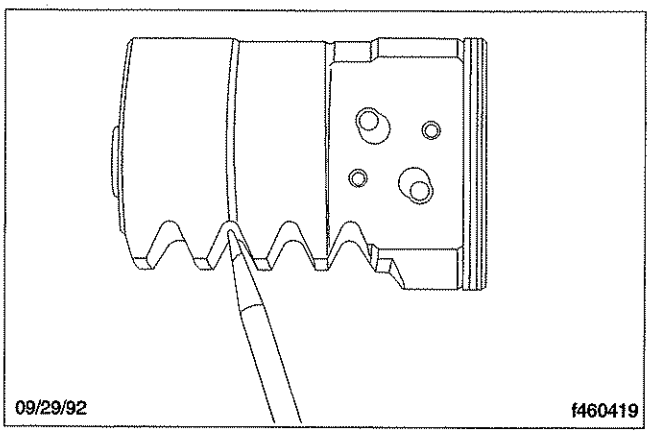


Fig. 93, Positioning the Rack Piston

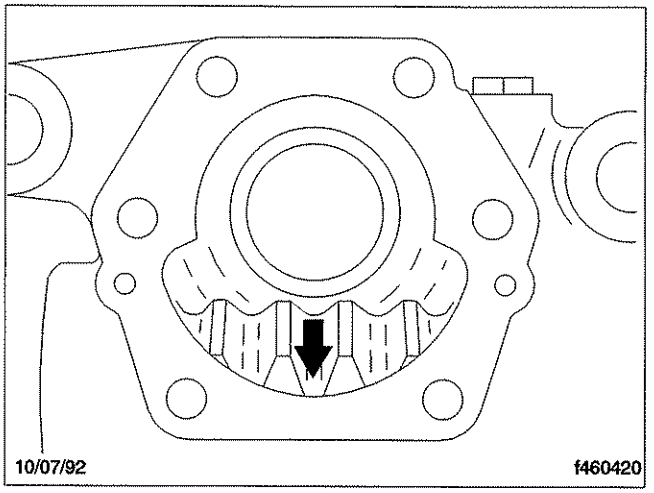


Fig. 94, Positioning the Rack Piston

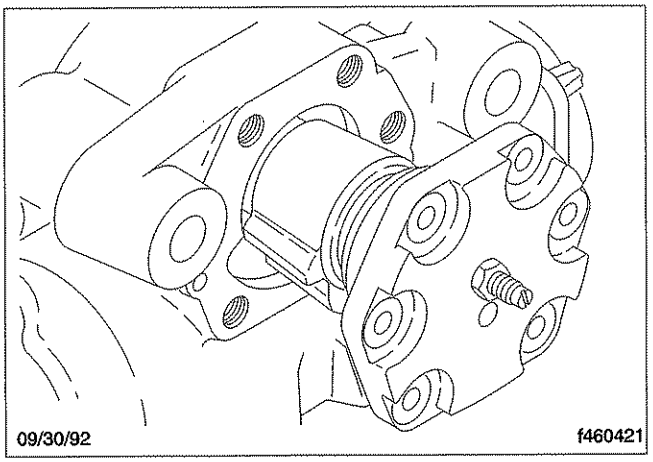


Fig. 95, Install the Sector Shaft/Side Cover Assembly in the Gear Housing

TAS40, dry bolts 160 lbf·ft (217 N·m); lubricated bolts 118 lbf·ft (160 N·m);

TAS55/65/85, dry bolts 230 lbf·ft (312 N·m); lubricated bolts 170 lbf·ft (230 N·m). See **Fig. 98**.

16. Install the sector shaft seal.

    Remove the tape from the sector shaft, and pack the end of the housing trunnion area at the sector shaft with Mobil Temp 1 or 2 grease, or equivalent. Put grease on the new trunnion dirt seal, and install it over the sector shaft and into the trunnion bore. See **Fig. 99**.

17. Install the input shaft seals and retaining ring.

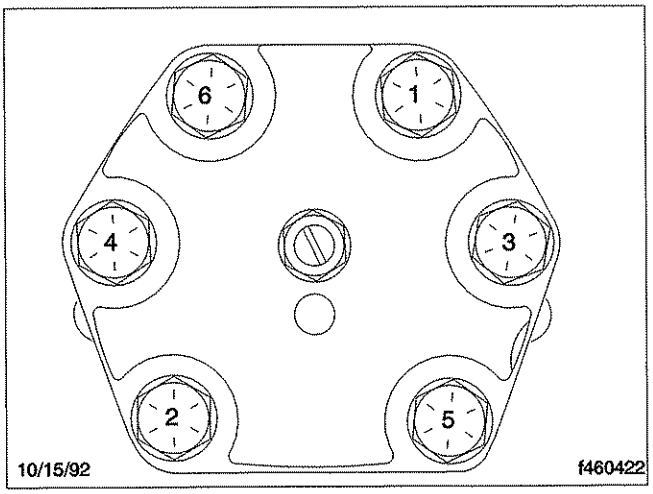


Fig. 96, Tightening Sequence

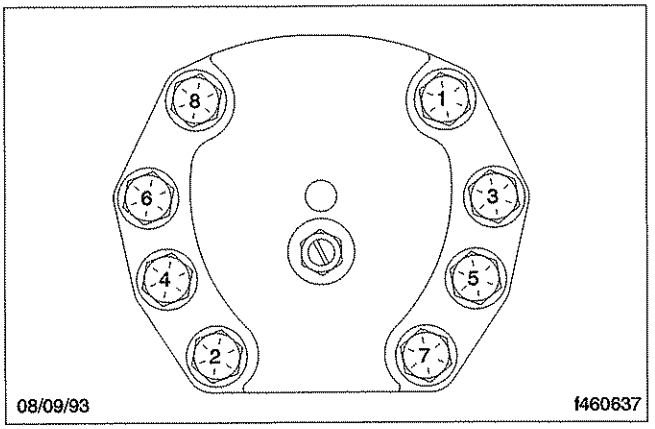


Fig. 97, Tightening Sequence

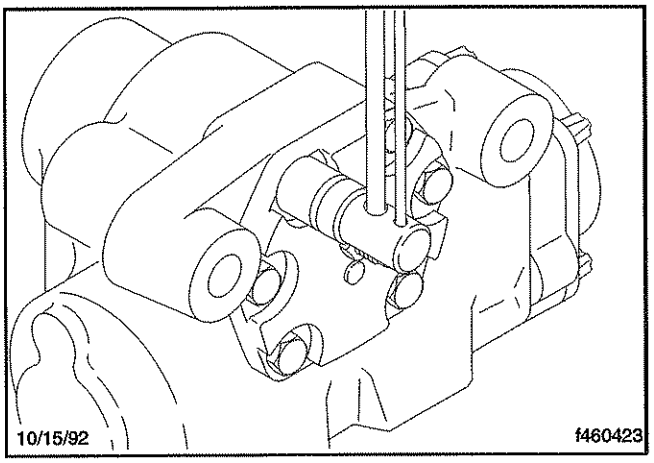


Fig. 98, Install the Bolts in the Side Cover

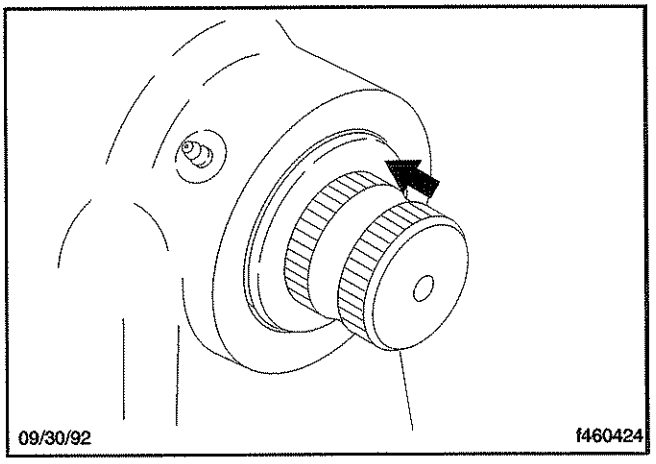


Fig. 99, Install the Sector Shaft Seal

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

IMPORTANT: Make sure the input shaft seal is installed squarely in the seal bore.

17.1 Apply clean grease to the new input shaft seal. Then place it, garter spring side first, over the input shaft. Using special tool J37073 and a mallet, tap the seal installer tool until the tool shoulder is square against the valve housing. See **Fig. 100**. Remove any seal material that may have sheared off in the retaining groove.

17.2 Install a new retaining ring into its groove in the valve housing. See **Fig. 101**.

17.3 Pack the end of the valve housing bore (around the input shaft) with Mobil Temp 1 or 2 grease, or equivalent. Apply grease to the new dirt and water seal, and install it over the input shaft. Seat the dirt and water seal in the groove behind the serrations of the input shaft, and against the valve housing. See **Fig. 102**.

18. Install the grease fitting and auxiliary port plug.

18.1 If the grease fitting is being replaced, install a new one in the gear housing, using a piece of metal tubing over the head of the new fitting, as shown in **Fig. 103**. Tap the new grease fitting in place.

18.2 If the auxiliary port plugs were removed, install new O-rings on them, and install the plugs in the gear housing. Tighten them 25 to 35 lbf·ft (34 to 47 N·m).

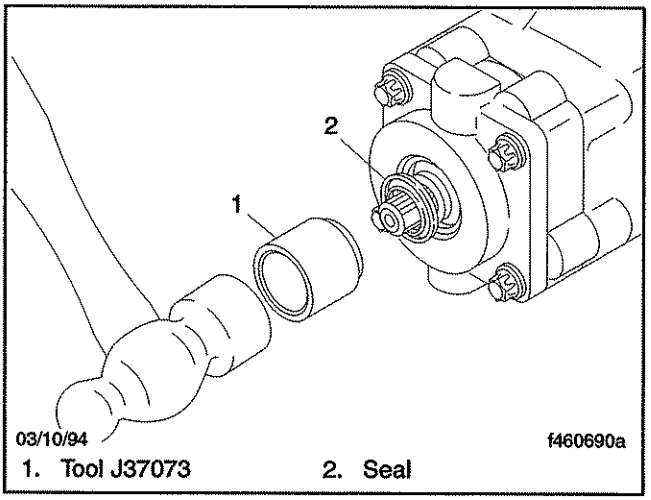


Fig. 100, Tap the Seal Installing Tool Against the Valve Housing

Final Adjustments

Before installing the steering gear on the vehicle, make these adjustments:

NOTE: Worm shaft preload adjustment was done when the input shaft was installed in the valve housing during the assembly procedure.

1. Adjust the sector shaft preload.

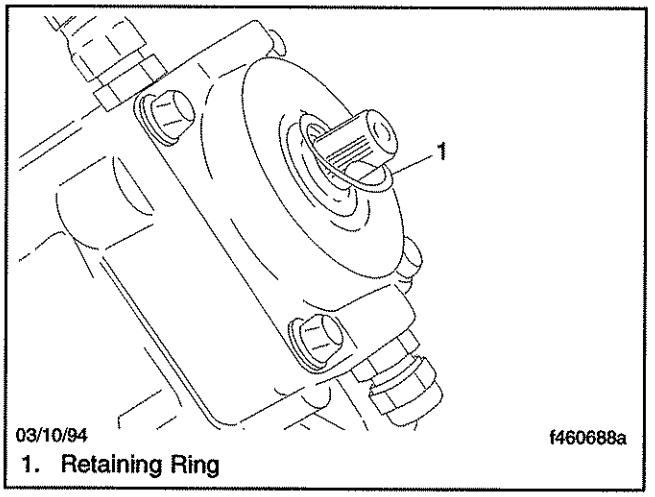


Fig. 101, Install a New Retaining Ring

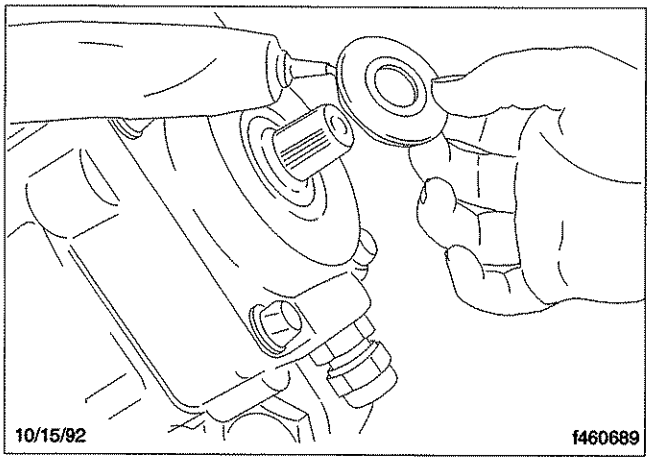


Fig. 102, Install the Dirt and Water Seal

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

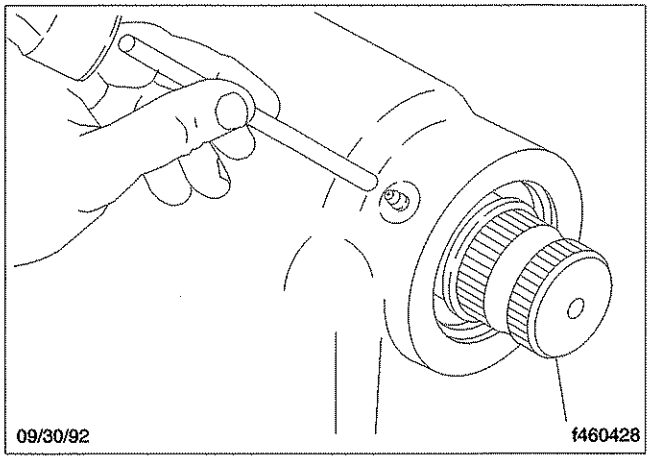


Fig. 103, Tap the Grease Fitting in Place

⚠ CAUTION

When the steering gear is not connected to the steering system, don't turn the input shaft more than 1-1/2 turns from the center position, or the automatic poppets could become inoperative when the steering gear is installed on the vehicle. This would require either disassembling the gear to position the poppet seat and sleeve assemblies for automatic adjustment, or using the special poppet adjusting screw kit 021407-X1 for manual poppet adjustment.

1.1 Center the steering gear by turning the input shaft until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing trunnion. See **Fig. 104**. Use a 12-point, 11/16 or 3/4 inch socket wrench to turn the input shaft. If the input shaft is turned more than 1-1/2 turns from the center position, you will have to either disassemble the gear to adjust the poppets again, or install the special poppet adjusting screw kit 021407-X1.

NOTE: If new or reset poppets are in the gear, they will be moved when the input shaft is turned less than one rotation in either direction from the center position. This will not affect the function of the poppets.

1.2 With the adjusting screw nut loose, adjust the sector shaft adjusting screw while turning the input shaft 180 degrees each side of center, until the input shaft reaches a torque of 45 to 50 lbf·in (500 to 560 N·cm). See **Fig. 105**. Use a 12-point socket and an inch-pound torque wrench to turn the input shaft.

1.3 Back out the sector shaft adjusting screw one-half turn. Note the torque needed to turn the input shaft through 180 degrees each side of center.

1.4 Tighten the sector shaft adjusting screw so that the torque noted in the above substep is increased by 6 to 8 lbf·in (60 to 100 N·cm). Then, while holding the adjusting screw in place, tighten the sector shaft adjusting screw jam nut 40 to 45 lbf·ft (54 to 61 N·m).

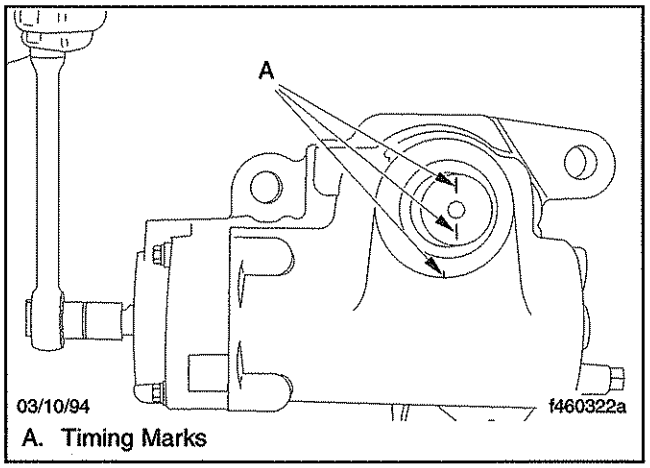


Fig. 104, Line Up the Timing Marks

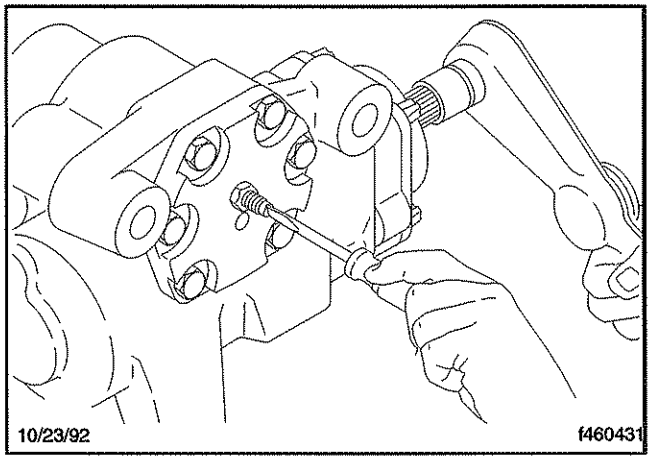


Fig. 105, Adjust the Sector Shaft Adjusting Screw

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

2. Check the torque needed to turn the input shaft. If it is more than 40 lbf·in (452 N·cm), readjust the input shaft.

Input Shaft Seal Removal and Installation

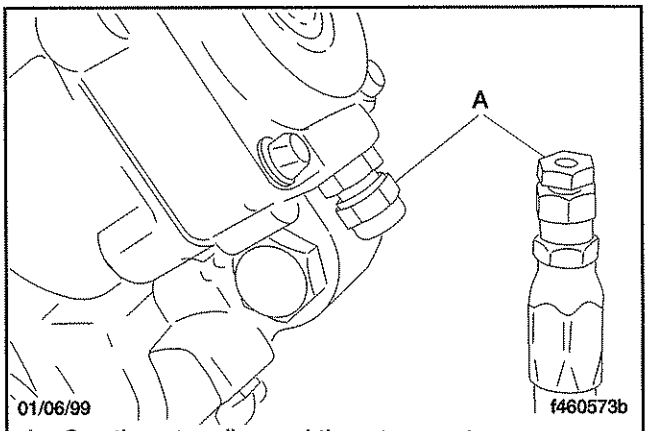
Removal

1. Disconnect the return line from the steering gear and plug the line. See **Fig. 1**. Also cap the return port of the gear with a high pressure fitting.
2. Disconnect the steering driveline from the steering gear input shaft as follows:
   2.1 Remove the pinch bolt nut and pinch bolt from the steering driveline lower end yoke. Discard the nut.

⚠ CAUTION

Do not pound the U-joint or lower end yoke on or off the input shaft. Internal damage to the steering gear can result.

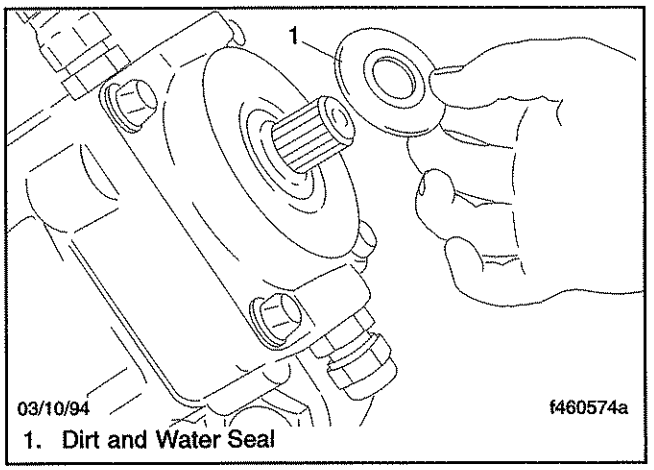
   2.2 Remove the lower end yoke from the input shaft. Don't turn the steering gear input shaft when removing the lower end yoke. Push the driveline shaft into the driveline tube, as you remove the lower end yoke.
3. Remove the dirt and water seal (**Fig. 2**) from the steering gear.
4. Wipe out the grease and then remove the spiral retaining ring (**Fig. 3**). Use a screwdriver inserted into the notch formed in the end of the ring.
5. Slip the input yoke back onto the input shaft with the pinch bolt installed (**Fig. 4**) but not tightened.



A. Cap the return line and the return port.

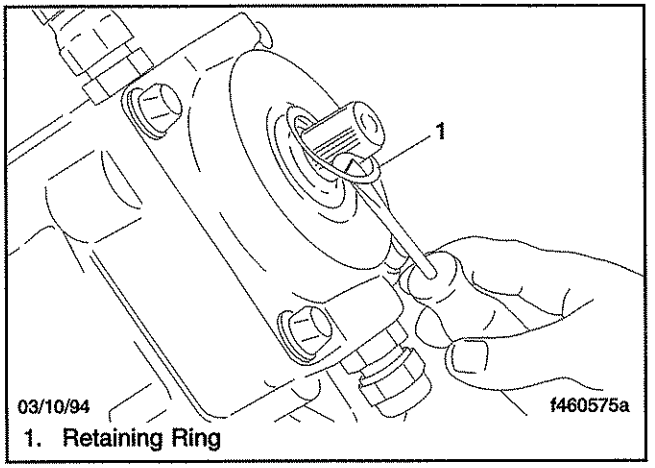
Fig. 1, Disconnect the Return Line

6. Tie or wrap a shop towel around the input shaft area (**Fig. 5**) and place a drip pan under the vehicle to catch the oil.
7. Add the power steering fluid specified in **Specifications, 400** as necessary to the fill line on the dipstick.
8. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).
9. Remove the shop towel, pinch bolt, and input yoke.
10. Remove the seal (**Fig. 6**).
11. Check the seal area of the valve housing for any seal fragments. Remove any that are found.



1. Dirt and Water Seal

Fig. 2, Remove the Dirt and Water Seal



1. Retaining Ring

Fig. 3, Remove the Retaining Ring

Input Shaft Seal Removal and Installation

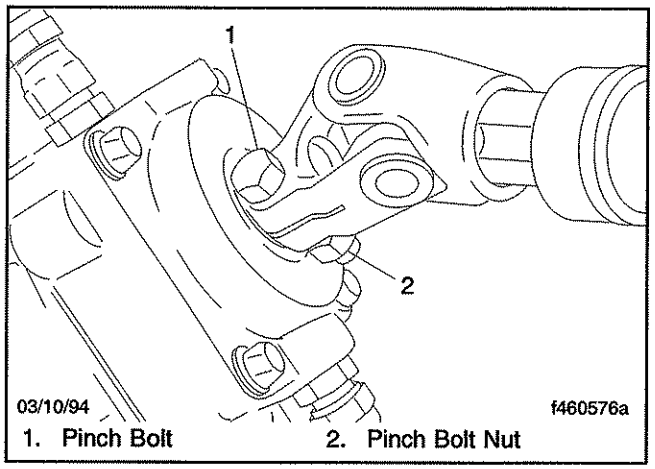


Fig. 4, Install the Pinch Bolt

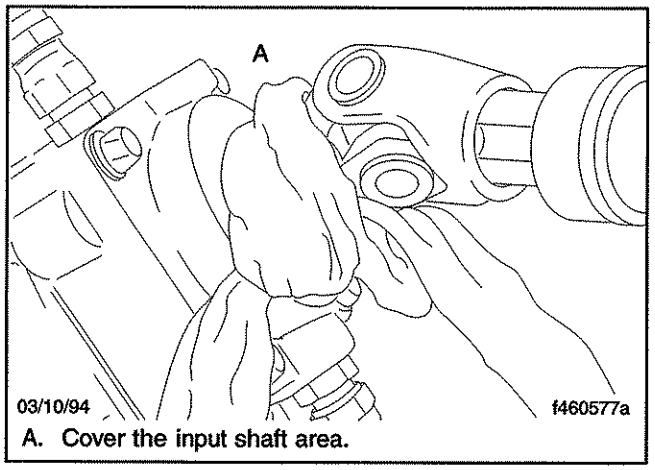


Fig. 5, Shop Towel Covering the Input Shaft

12. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. You need to determine and fix the cause of excessive heat in the vehicle (**Subject 300**).

Installation

1. Put clean grease on the new input shaft seal and place it over the input shaft, garter spring side first (**Fig. 6**). Place seal installer tool J37073 over the input shaft and against the seal, small diameter end first (**Fig. 7**). Tap the seal installer tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.

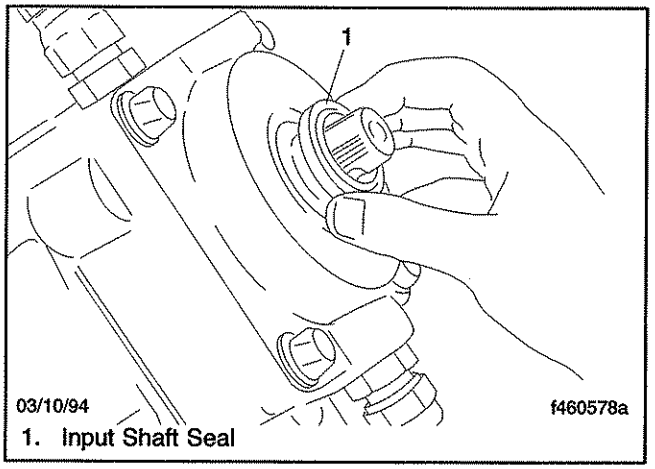


Fig. 6, Remove the Input Shaft Seal

2. Insert the new retaining ring into the groove.
3. Pack the end of the valve housing bore around the input shaft with clean high temperature industrial grease (Mobil Temp 1 or 2 or equivalent). Apply more of the grease to a new dirt and water seal and install it over the input shaft (**Fig. 8**). Seat it in the groove behind the serrations and against the valve housing.
4. Connect the steering driveline to the steering gear input shaft.
   - 4.1 Clean the input shaft and the inside of the driveline yoke.
   - 4.2 Apply a thin film of grease to the yoke splines. Use lithium-based grease, NLGI grade 2.

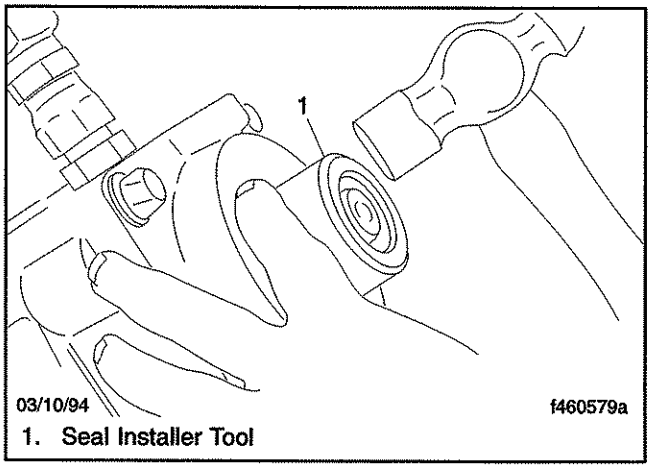
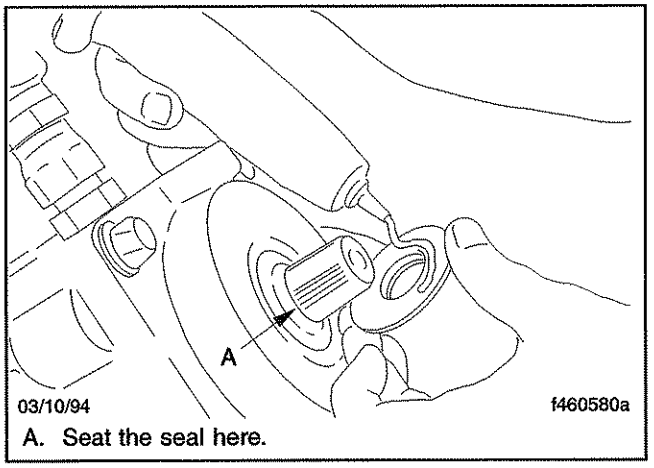


Fig. 7, Position the Seal Installer Tool



A. Seat the seal here.

Fig. 8, Install the Dirt and Water Seal

4.3 Slide the yoke onto the input shaft, and install the new yoke pinch bolt. Before installing the pinch bolt nut, make sure the pinch bolt is centered in the steering column shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install a *new* pinch bolt nut, and tighten it 55 to 65 lbf·ft (75 to 88 N·m).

4.4 Apply white Torque Seal F-900 to the exposed pinch bolt threads and the locknut.

5. Connect the return line to the steering gear return port.

6. Fill and bleed the steering system.

   IMPORTANT: Do not turn the steering wheel in the following steps until instructed. Doing so can cause air to enter the system, which can make it more difficult and time-consuming to bleed air from the system.

   6.1 Fill the power steering reservoir with the steering fluid specified in **Specifications, 400** until nearly full.

   Crank the engine for 10 seconds without allowing it to start. If the engine does start, shut it down immediately. Check and fill the reservoir as needed.

   Repeat this procedure three times, each time checking and filling the reservoir.

   6.2 Start the engine and let it idle for two minutes. Shut down the engine, and check the fluid level in the reservoir.

   6.3 Start the engine again. Steer the vehicle from full-left to full-right, several times. As needed, add fluid to the full line on the reservoir dipstick.

Checks

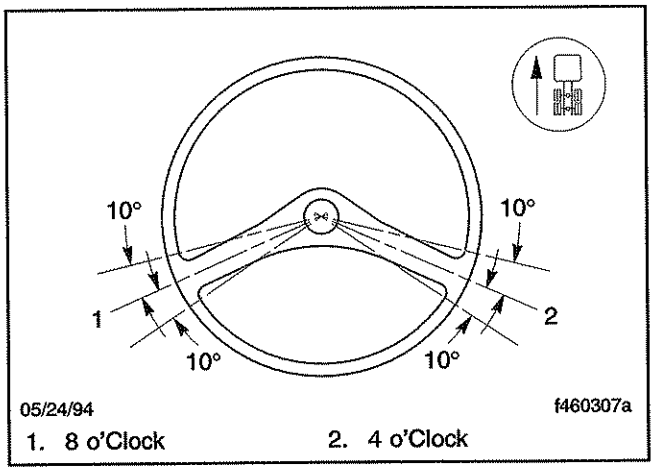
After power steering components have been worked on, and before the vehicle is placed into service, make the following checks.

⚠ WARNING

Failure to make the following checks could result in damage to the power steering system. This could cause a loss of hydraulic assist, which could cause personal injury or property damage.

1. With the engine turned off and warm, check the power steering reservoir fluid level.
2. Check for air in the system.
   - 2.1 Place a thermometer in the power steering reservoir. Then warm the hydraulic system to normal operating temperature of 125° to 135°F (51° to 57°C) by operating the engine at low idle while turning the steering wheel through several full left and right turns.
   - 2.2 With the engine running and the power steering system at operating temperature, turn the steering wheel slowly from stop to stop while checking the power steering reservoir for frothing or a change in the fluid level (a sign that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as needed. Bleed the air from the system.
3. At full-left and full-right wheel cuts, be sure the axle stops (on the rear-side of the spindle) are set so there is at least 1/2-inch (13-mm) clearance between the tires and any fixed components that are attached to the vehicle. Clearance between moving components should be 3/4 inch (19 mm). If clearance is less than this, reset the axle stops.
4. Check that the automatic poppets or the manual poppet adjusting screw (if equipped) are set correctly. If needed, adjust them. For instructions, refer to **Subject 100.**
5. If there are still problems with the power steering system, refer to **Troubleshooting and Diagnostic Checks, 300** and do the steering system tests as instructed. Otherwise, go to the next step.
6. Test drive the vehicle, or take a ride with the driver.

   Check the steering wheel spoke position. With the front tires pointing straight ahead, check the position of the steering wheel spokes. They must be pointing within ±10 degrees of the 4 o'clock and 8 o'clock positions. See **Fig. 1.** If not, remove the steering wheel and install it in the correct position. For instructions, refer to the applicable section in this group.



1. 8 o'Clock 2. 4 o'Clock

Fig. 1, Steering Wheel Centered

Troubleshooting

If there is a complaint about the steering system, do the checks below before servicing the steering gear or pump. This procedure is intended as a general guideline for the mechanic or technician to follow when diagnosing steering complaints.

The first step is always to talk to the driver. Get a detailed explanation of what the problem is and when it happens. Ask about any repairs, modifications, or prior adjustments. Then, if the truck is roadworthy, test drive it or ride with the driver and try to duplicate the problem.

After identifying the complaint, see the appropriate box in **Table 1** that best fits the complaint. Form SD–94, "Checklist for Troubleshooting Hydraulic Power Steering System Performance," should be used to record test information. Form SD–94 can be ordered through your dealer. Dealers can order form SD–94 through the TAO electronic mail system.

- At the TAO Mail Menu, key in B for bulletin boards.
- Tab down to Pub–Forms–FTL and key in L for list.
- At Freightliner Manuals Order Form, key in U.

If you don't have access to the TAO electronic mail system, contact Publishing Distribution at (503) 735–7343.

The table on the form will refer you to a series of checks or tests to do for each type of complaint. The easiest and least costly checks are listed first. By doing the checks in order, starting with the lowest number, you can avoid unnecessary labor and expense. Instructions for doing the checks are given on the following pages. Each numbered step in the instructions corresponds with the diagnostic checks in **Table 1**.

Troubleshooting and Diagnostic Steps										
Step*	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Complaint	**Tire Press./ Vehicle Load**	**Fifth Wheel Lube**	**Vehicle Align-ment**	**Loose/ Binding Compo-nents**	**Noise**	**System Operat-ing Temp.**	**System Leaks or Restric-tions**	**Pump Perfor-mance**	**Gear Poppet Adjust-ment**	**Gear Internal Leakage**
Hard or Heavy Steering	•	•		•		•	•	•	•	•
Low Assist										
Binding	•	•		•		•	•	•	•	•
Locking										
Occasion-al Loss of Assist										
Reduced Wheel Cut									•	
Vehicle Pulls to One Side	•		•					•		
Darting/ Oversteer	•	•	•	•						
Vehicle Wanders										
Noisy Steering					•		•	•		

Troubleshooting and Diagnostic Checks

Troubleshooting and Diagnostic Steps										
Step*	1	2	3	4	5	6	7	8	9	10
Complaint	Tire Press./ Vehicle Load	Fifth Wheel Lube	Vehicle Align-ment	Loose/ Binding Compo-nents	Noise	System Operat-ing Temp.	System Leaks or Restric-tions	Pump Perfor-mance	Gear Poppet Adjust-ment	Gear Internal Leakage
Steering Gear External Seal Leaks						•	•	•		
Excessive Heat										

* The numbers in this table correspond to the numbered steps in the diagnostic checks.

Table 1, Troubleshooting and Diagnostic Steps

Diagnostic Checks

1. Check tire pressure and load.

   1.1 Check the tire pressure. Low pressure causes increased steering effort due to extra friction with the road surface. Check the tires for damage or erratic wear. Make sure the tires on each side of the front and rear axles are inflated to the correct pressure. Unequal tire pressure causes unequal friction between the tire and the road. This can cause pulling to one side. Correct the pressures if needed. See **Fig. 1**.

   1.2 Check whether duplex or oversized tires have been installed, and that the tire sizes are correctly matched. Extra tire width causes increased steering effort due to extra friction with the road surface. Also, the power steering gear poppets will need to be adjusted if the axle stops were turned out to reduce wheel cut due to the change in tires. See **Subject 100** for instructions.

   1.3 Determine whether the vehicle is operated at or over the rated load. Increased load causes greater steering effort. It may be necessary to modify the power steering, wheels, tires, or springs.

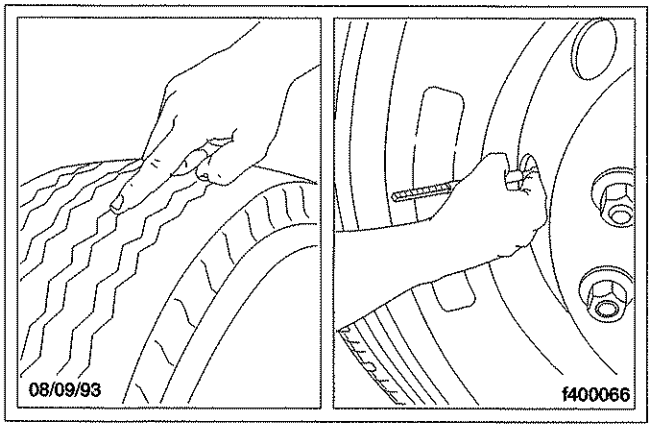


Fig. 1, Check the Tire and the Tire Pressure

2. Check the fifth wheel.

   See if the fifth wheel is adequately lubricated. A dry fifth wheel plate makes it difficult to change direction. See **Fig. 2**. Check the plate surface for burrs, gouges, or irregularities.

3. Check the wheel bearing adjustment and axle alignment.

   3.1 Check wheel bearing adjustment. See **Group 33** and **Group 35** for instructions.

   3.2 Check the front and rear axles for correct alignment. Adjust them back to specifications if necessary. See **Group 33** and **Group 35** for instructions.

4. Check for loose or binding components.

   Check whether any steering components are loose or binding, need maintenance, or need adjustment as follows:

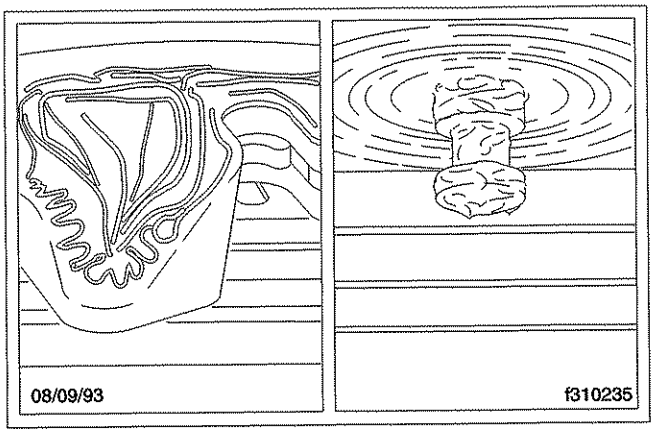


Fig. 2, Check the Fifth Wheel

4.1 Lubricate the drag link, tie rods, and knuckle pins. See **Group 33** and **Group 46** of the *Business Class Trucks Maintenance Manual.*

4.2 Chock the rearmost tires and raise the front tires off the ground. With the engine shut down, turn the steering wheel and check for looseness or binding. Make sure all components are free to move but are not excessively loose.

4.3 Check the steering driveline U-joints for looseness or binding. Lubricate them if needed. For instructions, see **Group 46** of the *Business Class Trucks Maintenance Manual.*

4.4 Check for correct steering driveline phasing. See **Fig. 3**. Reset the phasing if needed.

4.5 Check the sector shaft adjustment. See **Subject 100** for instructions.

⚠ WARNING

Failure to connect the input yoke and the pitman arm, and to tighten all fasteners to the prescribed torque value can cause loss of steering and vehicle control.

4.6 With the engine off, chock the rearmost tires and place the front tires on radius plates (turntables). Disconnect the drag link from the steering arm. See **Fig. 4.**

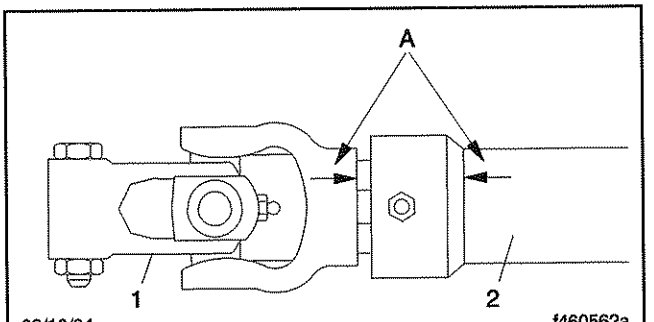
⚠ WARNING

Failure to connect the drag link and the steering arm, and to tighten all fasteners to the prescribed torque value can cause loss of steering and vehicle control.

⚠ CAUTION

Do not steer the gear with the linkage removed as misadjustment of automatic poppets may result.

4.7 By hand, pull the tire to one axle stop and release. The tire should self-return to almost straight ahead. See **Fig. 5**. Repeat in opposite direction. If the tire does not return to near straight ahead, check for a



A. Align arrows.
1. Lower End Yoke
2. Driveline Tube and Yoke Assembly

Fig. 3, Check for Correct Steering Driveline Phasing

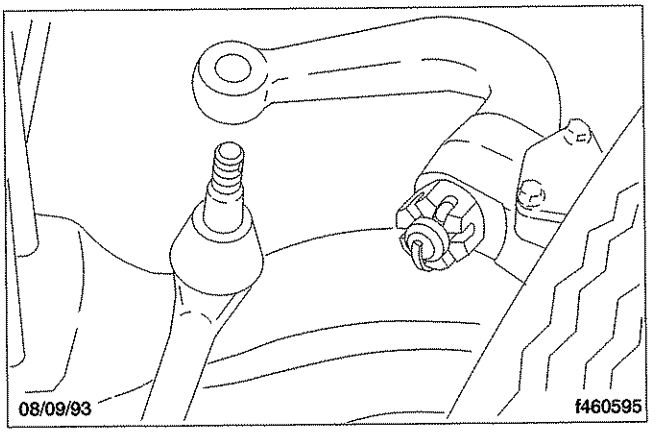


Fig. 4, Disconnect the Drag Link

Troubleshooting and Diagnostic Checks

binding or lack of lubrication problem in the steering axle kingpin bushings or tie rod linkage. Connect the drag link and tighten the castle nut and install a new cotter pin. See **Section 46.01**.

4.8 Visually inspect all suspension fasteners and components for wear or looseness. See **Fig. 6**.

5. Check for noise.

NOTE: Noises from the power steering system do not necessarily mean there is a problem. Some noises are normal and are the result of proper operation. See **Table 2**.

6. Test the system operating temperature.

6.1 Park the vehicle outside.

6.2 Check for the correct fluid level. See **Fig. 7**. If required, fill the power steering fluid reservoir to the correct level with the fluid specified in **Specifications 400**.

6.3 Place a thermometer in the fluid reservoir to monitor fluid temperature.

6.4 Run the vehicle at governed rpm for 40 minutes to bring the fluid to an elevated temperature. Check and record fluid temperature on the checklist (form SD–94) at the start of the 40 minute test, and at 10, 20, 30, and 40 minutes.

Do not allow the temperature to exceed 150°F (66°C) above the outside temperature (ambient), or 250°F (121°C). If this temperature is exceeded, stop the 40 minute test and record the last noted temperature on the checklist.

6.5 If the temperature does not exceed 150°F (66°C) above the outside temperature (ambient), or 250°F (121°C) during the 40 minute test, excessive system heat is probably not the cause of the complaint. Go on to the next test for the complaint. See **Table 1**.

6.6 If at any time the temperature exceeded 150°F (66°C) above the outside temperature (ambient), or 250°F (121°C), the system is operating at excessive temperature levels, and steering system performance and life may be affected. Damage to hoses, seals, and other components may result if the vehicle is operated at excessive steering system temperatures.

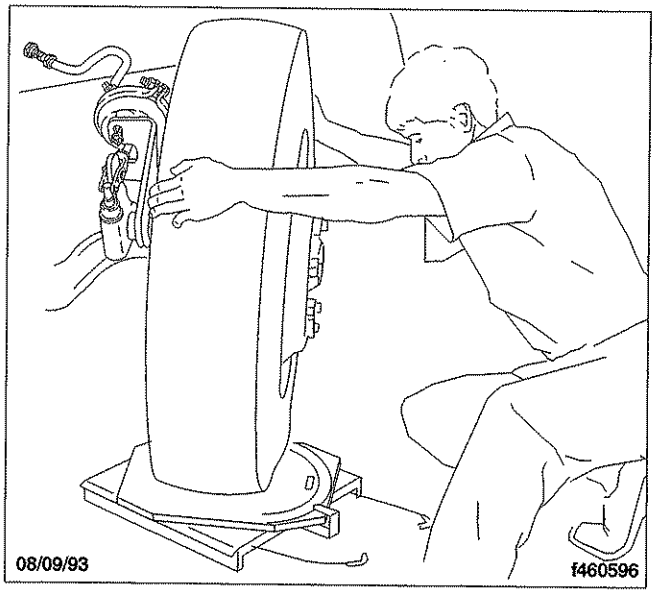


Fig. 5, Pull the Tire to One Axle Stop

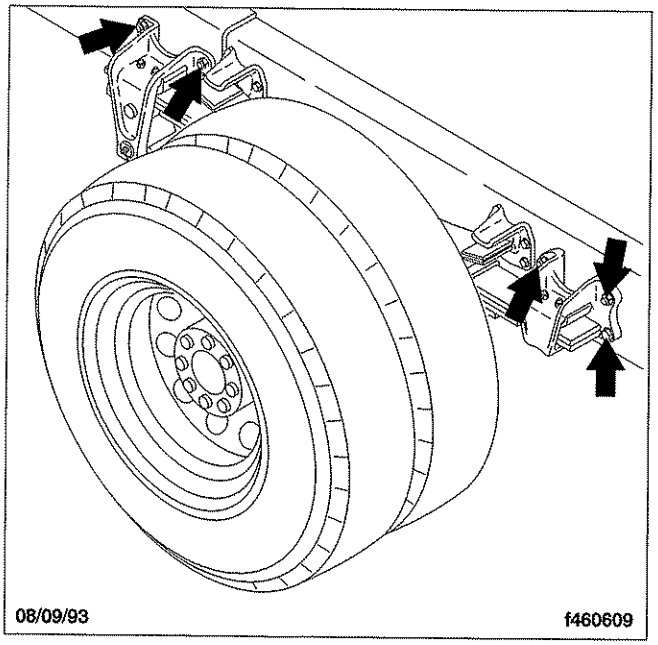
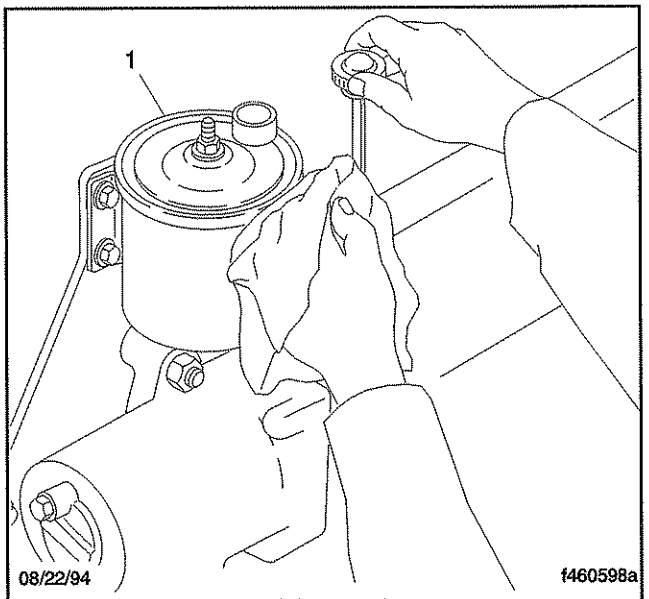


Fig. 6, Inspect All Suspension Fasteners

Power Steering System Noises	
Symptom	**Action to Take**
Growling or Other Abnormal Steering Noise	Check the fluid level. Check for air bubbles or foam. See **Fig. 7** and **Fig. 8**. Check for hose and fitting leaks. Add fluid if needed. If the fluid has air, check for inlet tube/hose leaks. Correct all leaks.
A Change from the Usual Pump Sound	Check the power steering fluid reservoir. Check for air bubbles or foam in the fluid. See **Fig. 8**. If the fluid has air, check for inlet tube/hose leaks. Correct all leaks.
Clicking Noise During a Turn	Check for loose steering components. Check the front suspension for insufficient spring pin shims. Tighten any loose steering components. Add front spring pin shims if needed.
Hissing When the Steering Wheel Is at or Near Full Turn	Fluid flowing past a poppet valve makes a hissing noise. This is normal. No action is needed.
Hissing at Less Than Full Turn	Do check (step) no. 9 (Steering Gear Poppet Test).

Table 2, Power Steering System Noises



1. Power Steering Fluid Reservoir

Fig. 7, Check the Power Steering Fluid Level

6.7 Excessive system restrictions or excessive pump flow may be the cause of the complaint. Go on to the next test for the complaint. See **Table 1**.

7. Check for leaks, restrictions, and test system back pressure.

7.1 Check for the correct fluid level. See **Fig. 7**. If required, fill the power steering fluid reservoir to the correct level with the fluid specified in **Specifications 400**.

7.2 The inspection and test must be done with the power steering fluid at operating temperature 150°F (66°C) to 160°F (71°C). With the engine at idle, monitor the fluid temperature with a thermometer in the fluid reservoir. If the fluid is too cold, raise the temperature by turning the steering wheel from stop to stop until the desired temperature is reached.

7.3 With the engine at idle, visually inspect all hoses and fittings for signs of kinked or collapsed hoses, or leaking fittings. See **Fig. 9**. Visually inspect all external seals. Repair all leaking fittings, and replace parts as required. Replace any leaking seals. Inspect the seal bores and sealing surfaces for scrapes or burrs. Be sure the seals are installed correctly using the recommended tools. If the steering gear input shaft seal is excessively hard, do the "Test the system operating temperature" step, if not already done.

7.4 Install a low pressure gauge 200 (1379 kPa) to 300 psi (2068 kPa) maximum between the pressure line and the pump (location P2). See **Fig. 10**.

Troubleshooting and Diagnostic Checks

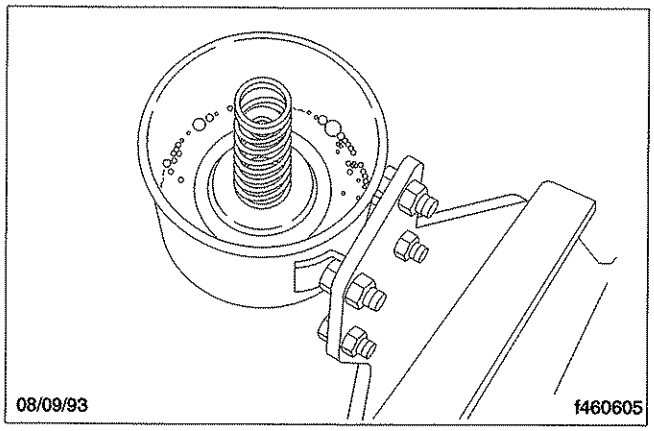


Fig. 8, Check the Power Steering Fluid Reservoir for Bubbles

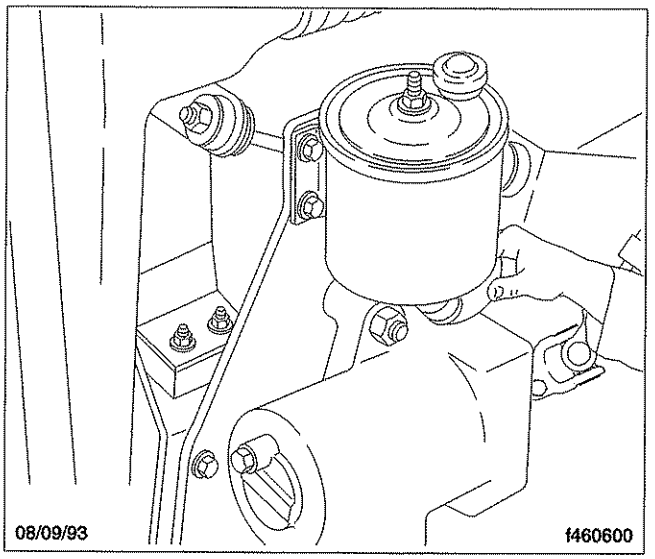


Fig. 9, Inspect All Hoses and Fittings

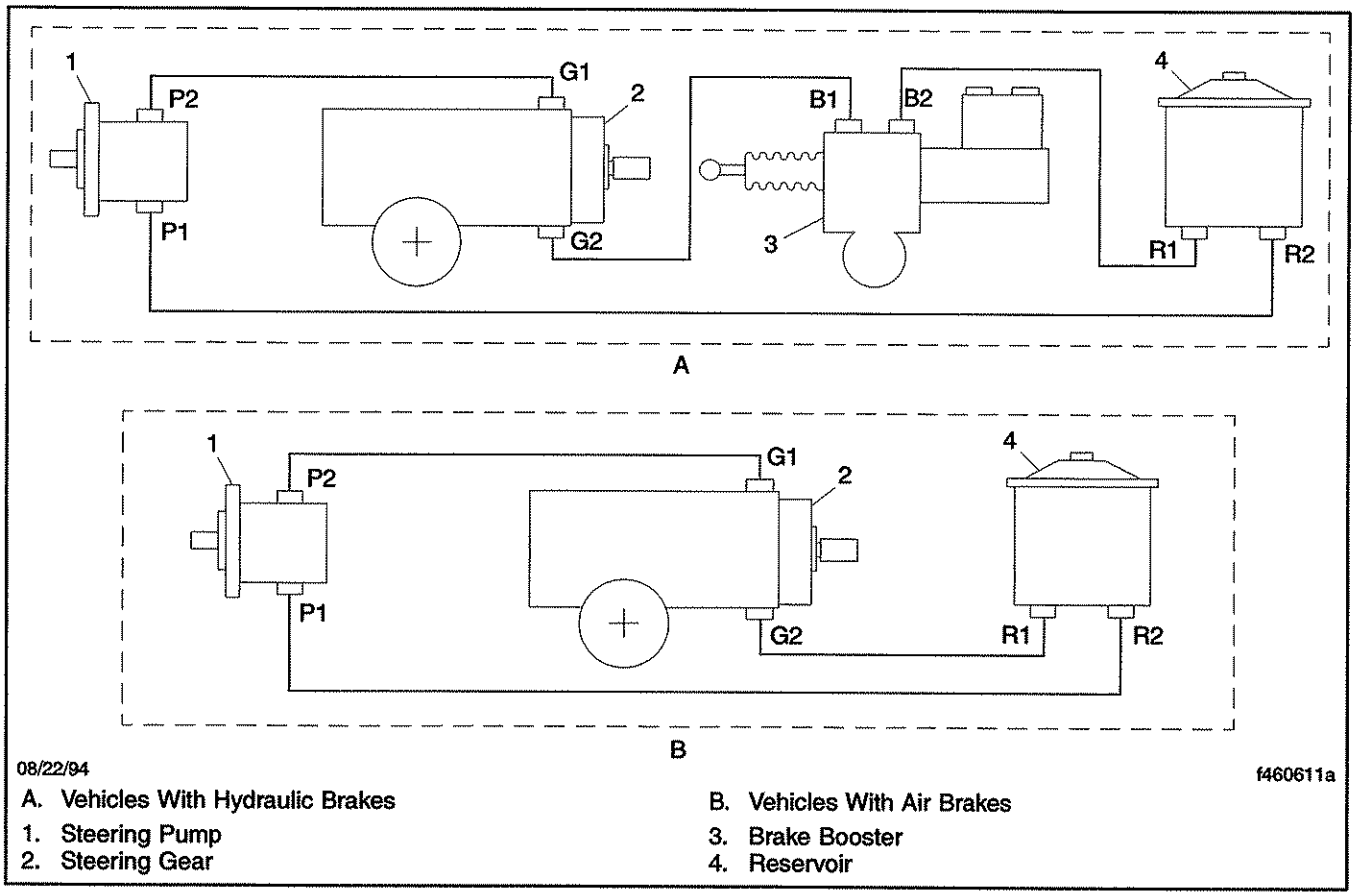


Fig. 10, Locations Where Pressure is Measured

⚠ CAUTION

Don't move the steering wheel or allow the system pressure to exceed the rating of the gauge during the following procedure or damage to the gauge may result.

7.5 Run the engine at idle and check for the correct fluid level. If required, fill the power steering fluid reservoir to the correct level with the fluid specified in **Specifications 400.** If bubbles or foam appear in the reservoir, check the hose fittings for looseness or leaks.

7.6 With the engine at idle, read the total system back pressure on the pressure gauge. Record the reading on the checklist (form SD–94).

7.7 If the total system back pressure (P2) is greater than 140 psi (965 kPa) (vehicles with hydraulic brakes) or 100 psi (689 kPa) (vehicles with air brakes), continue with the next step. If the pressure at P2 is less than these values, restriction is not a problem. Go to the step "Test Pump Performance." See **Table 1.**

7.8 System back pressure has been determined to be excessive and the component at fault can be pinpointed by checking pressures at key locations in the steering system. With the engine at idle, use the low pressure gauge and hose connection adapters necessary to measure pressures at all locations identified in **Fig. 10.** Each time the gauge is moved, ensure that the fluid level is correct, and air is removed from the system.

7.9 Determine the individual component restrictions by subtracting the values shown in **Table 3.** Record the values on form SD–94.

Total System and Component Restrictions		
Total System and Component Restrictions	**Maximum Allowable**	**Action to Take**
P2 = Total System	Hydraulic Brakes: 140 psi (965 kPa) Air Brakes: 100 psi (689 kPa)	Check pressures at the key locations.
P2-G1 = Hose: Pump-to-Gear	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
G1-G2 = Steering Gear	55 psi (379 kPa)	The gear rotary valve is damaged. Replace the gear. See instructions in this manual.
G2-B1 = Hose: Gear-to-Booster	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
G2-R1 = Hose: Gear-to-Reservoir	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
B1-B2 = Booster	40 psi (276 kPa)	Check the internal booster filter for contaminants. Check for contaminants causing binding or blockage of poppet and check valves within the booster.
B2-R1 = Hose: Booster-to-Reservoir	12 psi (83 kPa)	Check for a kinked, collapsed, or plugged hose. Replace the hose if necessary.
R1-R2 = Reservoir	9 qt: 8 psi (55 kPa) 2 qt: 4 psi (28 kPa)	Replace the filter. Check for internal blockage.
R2-P1 = Hose: Pump Supply	12 psi (83 kPa)	Check for a kinked, collapsed, or plugged hose. Replace the hose if necessary.

Table 3, Total System and Component Restrictions

7.10 See the column on the right in **Table 3** for action to take if any component exceeds the maximum allowable restriction as listed for each component.

8. Test pump performance.

8.1 Do the system setup in **Subject 305.**

8.2 Make sure the fluid temperature is 150°F (66°C) to 160°F (71°C) and the vehicle is stationary with the front wheels pointing forward and the rearmost tires chocked.

8.3 Run the engine at idle. See Table 1 in **Subject 305** for the correct engine idle speed.

8.4 Adjust idle speed, if necessary. See the engine manufacturer's instructions.

8.5 Slowly close the load valve. When the valve is completely closed, read the pressure gauge. See **Fig. 11.**

⚠ CAUTION

Don't leave the valve closed for longer than 5 seconds since this could damage the power steering system.

8.6 If the pressure rises rapidly, appears to be uncontrolled, or rises above the maximum pressure of 2465 psi (17 000 kPa) for vehicles with hydraulic brakes, or 2320 psi (16 000 kPa) for vehicles with air brakes, open the load valve immediately. Indicate on form SD–94 whether the pump response was erratic or not. If the response was erratic, replace the pressure relief valve in the pump. For instructions, see the pump section in this group. If the pressure was constant, go to the next. With the fluid temperature at 150°F (66°C) to 160°F (71°C), repeat this step beginning with slowly closing the load valve and reading the pressure gauge again.

8.7 If the pump pressure measures 2320 to 2465 psi (16 000 to 17 000 kPa) for vehicles with hydraulic brakes, or 2175 to 2320 psi (15 000 to 16 000 kPa) for vehicles with air brakes, it is acceptable. Record the relief pressure on form SD–94 and skip the next step. If the pressure is not within this range, replace the pressure relief valve if not done previously in this test. With the fluid temperature at 150°F (66°C) to 160°F (71°C), repeat the previous steps beginning with slowly closing the load valve and reading the pressure gauge again. If the pressure relief valve has been replaced, go to the next step.

8.8 If the pressure was not within the above applicable range, and the relief valve has been previously replaced, replace the pump. For instructions, see the pump section in this group. If the pump was replaced, test the pump performance.

8.9 Record the relief pressure on form SD–94.

8.10 With the engine at idle, test the pump relief valve reaction. Note the flow rate with the load valve open.

8.11 Close the load valve until the pump relief pressure is reached (previously determined). The flow rate should drop to zero.

8.12 Immediately open the load valve and note the flow rate. It should return to the value noted above.

8.13 If the flow rate returns immediately, the relief valve is acceptable. Go to the next step.

If the flow rate does not return immediately, the pump relief valve is not working correctly. Replace the relief valve if not previously done, following the instructions in the pump section in this group.

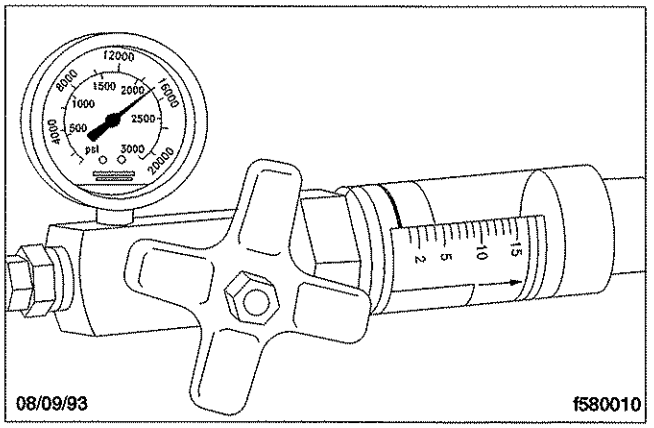


Fig. 11, Pressure Gauge and Flow Meter

8.14 Repeat the previous steps beginning with testing the pump relief valve reaction with the engine at 1500 rpm.

8.15 Record on form SD–94 whether the relief valve operated "OK" or "Not OK" at idle and 1500 rpm. Near the bottom of the form, list any pump repairs that were made.

8.16 With the engine at idle, test the pump flow. Slowly close the load valve until the pressure gauge reads 1000 psi (6895 kPa).

8.17 Read the flow gauge and record the flow rate on form SD–94.

8.18 Open the load valve.

8.19 Run the engine at 1500 rpm. Leave the load valve open, do *not* close the load valve. Read the flow gauge and record the flow rate on form SD–94.

8.20 At idle the minimum flow rate is 3.1 gpm (11.7 Lpm). The maximum flow rate at either engine speed is 4.6 gpm (17.5 Lpm). If the flow rate is below the minimum, repair or replace the pump. For instructions, see the pump section in this group. If the flow rate is above the maximum, replace the flow control and relief valve in the pump. For instructions, see the pump section in this group.

9. Check the steering gear poppet and the axle stop adjustment.

NOTE: Poppets limit the steering assist when the front wheels approach the axle stops. Improper adjustment can apply excessive force to the steering linkage or loss of assist as the steering wheel approaches either full left or full right turns.

9.1 If the turning angle is inadequate, make sure the axle stops are set to the maximum possible turn angle. Make sure the axle stop settings limit the steering travel so there is 1/2-inch (13-mm) clearance from all stationary components, and 3/4-inch (19-mm) clearance from all moving components.

9.2 Make sure the pitman arm is oriented on the steering gear sector shaft correctly. See **Subject 110**.

9.3 Do the system setup in **Subject 305**.

9.4 Make sure the fluid temperature is 150°F (66°C) to 160°F (71°C) and the vehicle is stationary with the front wheels pointing forward.

9.5 Run the engine at idle with the load valve open. See Table 1 in **Subject 305** for the correct engine idle speed.

9.6 Turn the steering wheel to either full-lock position.

⚠ CAUTION

If power steering pump relief pressure is reached while the steering wheel is at full-lock, release the steering wheel from this position. Don't allow the pump relief pressure to be maintained for longer than five seconds, or damage to the pump may result.

9.7 Note the pressure gauge reading.

9.8 Repeat the previous steps beginning with running the engine at idle with the load valve open for the opposite turn direction, and note the pressure gauge reading.

9.9 The pressure readings at the axle stops should not exceed 1200 psi (8200 kPa). If the pressures are acceptable, record on form SD–94 and go on to the next test for the complaint. See **Table 1**. If the pressure is too high, the automatic poppet valves may have been adjusted inward too far and cannot be reset out. If not equipped, install and adjust a special poppet adjusting screw (from TRW kit number 021407-X1) following the instructions in **Subject 100**. Retest following check 9 and record the pressures on form SD–94.

9.10 If the pressure is relieved and assist is lost when the wheel is too far from the axle stop, adjust the automatic poppet valves as follows: (for gears equipped with a poppet adjusting screw, go to the next step) with the engine running at 1500 rpm, turn the steering to full-lock left and full-lock right so that the axle stops are contacted on both sides. This adjusts the poppets inward to

Troubleshooting and Diagnostic Checks

the correct setting. Retest following check 9 and record the pressures on form SD–94.

9.11 If the special poppet adjusting screw has been previously installed and pressure relief with loss of assist is detected too far from the axle stop, the poppets must be readjusted. See **Subject 100**. If the adjustable poppets have been reset properly and after subsequent vehicle operation, loss of assist continues to occur when the wheel is too far from the axle stop, the poppets have become loose due to previous incorrect poppet adjustment, and must be replaced. See **Subject 120**, for replacement instructions. After poppet replacement and adjustment, retest following check 9 for correct poppet relief pressures, and record pressures on form SD–94.

10. Test for steering gear internal leakage.

10.1 If the vehicle has hydraulic brakes, a relief valve is located on the side of the steering gear. To prevent operation of the relief valve, remove the relief valve cap, O-ring, and the two-piece relief valve. See **Fig. 12** and **Fig. 13**. Discard the O-ring and install the relief valve plug Kent-Moore part no. J37130 in its place.

10.2 Do the system setup in **Subject 305**.

10.3 Make sure the fluid temperature is 150°F (66°C) to 160°F (71°C) and the vehicle is stationary with the front wheels pointing forward.

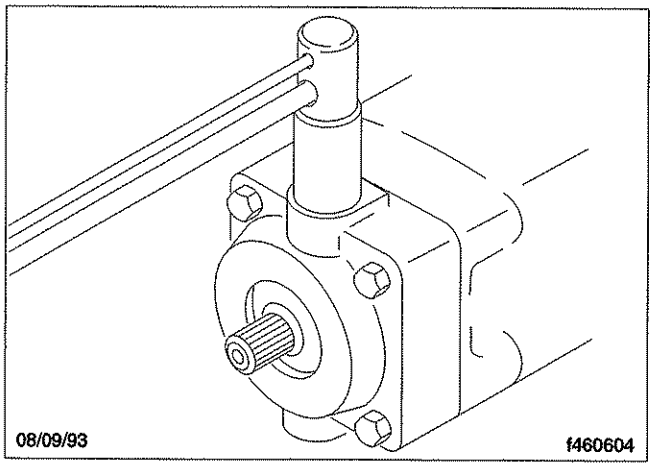


Fig. 12, Steering Gear

10.4 Run the engine at idle with the load valve open. See Table 1 in **Subject 305** for the correct engine idle speed.

10.5 Place an unhardened steel spacer, 1 inch (2.5 cm) thick between the axle and the axle stop at one side of the axle. See **Fig. 14**. The spacer should have an extension or handle long enough to keep your fingers clear of the axle stop area. A brazing rod or welding rod works well for this purpose.

⚠ WARNING

Keep your fingers clear of the axle stops and spacer block during this test. Make sure that the spacer block contacts the axle stop squarely. Contact that is not square could break the axle stop, or dangerously eject the spacer block, causing injury.

While running this test, do not hold the steering wheel in the full turn position for longer than 5 seconds at a time to avoid damaging the pump.

10.6 Have someone turn the steering wheel until the axle stop contacts the spacer block. Apply 20 lb (9 kg) to the rim of the steering wheel. See **Fig. 15**.

10.7 Read the internal leakage rate on the flow meter.

10.8 Record the reading on form SD–94.

10.9 Move the unhardened steel spacer to the other side of the axle and repeat the previous steps for the opposite turn direction.

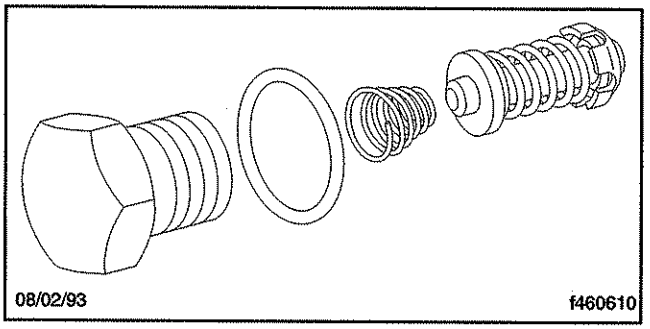


Fig. 13, Relief Valve

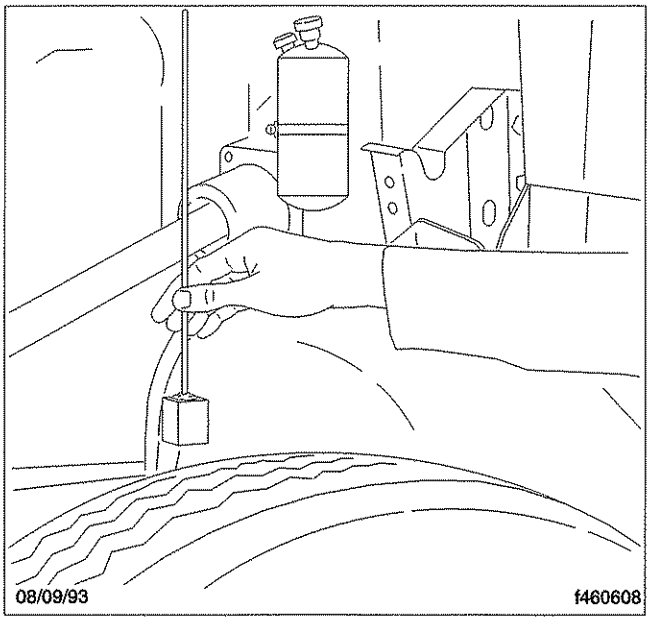


Fig. 14, Position the Steel Spacer

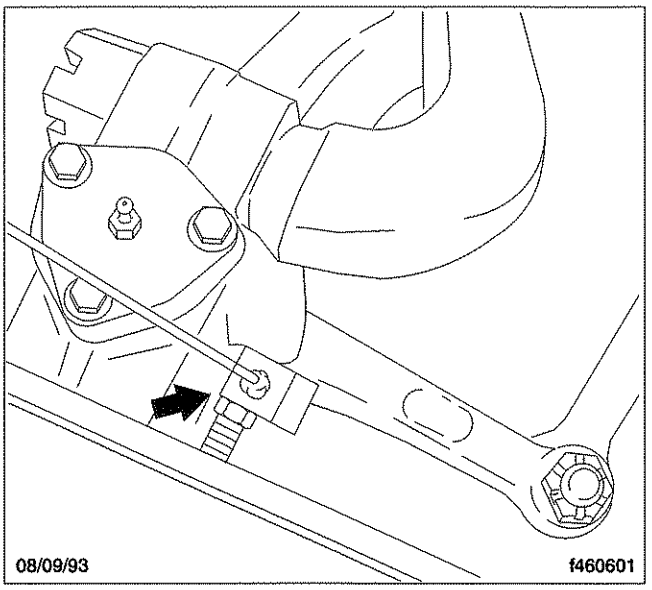


Fig. 15, Axle Stop Contacting the Steel Spacer

10.10 The maximum permissible internal leakage is 1.0 gpm (3.8 Lpm). If leakage is greater in either turning direction, replace the steering gear components as needed following the instructions in **Subject 120.**

IMPORTANT: Be sure to reinstall the relief valve and valve cap (if removed) with a new O-ring. Omission of this valve could result in reduced braking force during a hard, braking turn.

System Setup for Hydraulic Checks

System Setup

NOTE: Use a 1 to 10 gpm (3.8 to 38 Lpm) flow meter, a pressure gauge 0 to 2500 psi minimum (0 to 17 225 kPa), and a load valve, preferably in one test unit.

1. Install the test unit between the pump high-pressure line and the steering gear. See **Fig. 1**.
2. Fill and bleed the steering system. See **Subject 110** for instructions.
3. Checks must be done with the power steering fluid at operating temperature 150° to 160°F (66° to 71°C). Monitor the fluid temperature with a thermometer in the fluid reservoir. See **Fig. 2**. If the fluid is too cold, raise the temperature as follows:

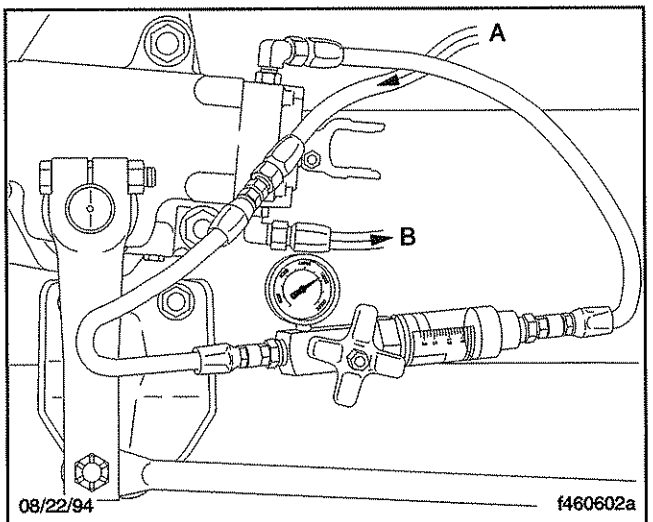
   Run the engine at idle.

   Partially close the load valve on the test unit until the pressure gauge reads 1000 psi (6895 kPa).

⚠ CAUTION

Do not leave the load valve fully closed since this could damage the power steering system.

4. Open the valve when the fluid temperature reaches 150° to 160°F (66° to 71°C).



A. From Power Steering Pump
B. To Brake Booster or Power Steering Reservoir

Fig. 1, Steering System Test Unit

Idle Speed	
Engine Type	**Idle Speed (rpm)**
Cummins "B" (6BTA)	800
Cummins "C" (6CTA)	800
Mercedes-Benz OM 366LA	600

Table 1, Idle Speed

⚠ CAUTION

Do not allow the fluid temperature to exceed 250°F (121°C) since this could damage the power steering system.

NOTE: When checking pump performance, the steering gear poppet and axle stop adjustment, and the steering gear internal leakage, see **Table 1**. Adjust idle speed if necessary. See the engine manufacturer's instructions.

Record all data from the hydraulic checks on form SD–94, "Checklist for Troubleshooting Hydraulic Power Steering System Performance."

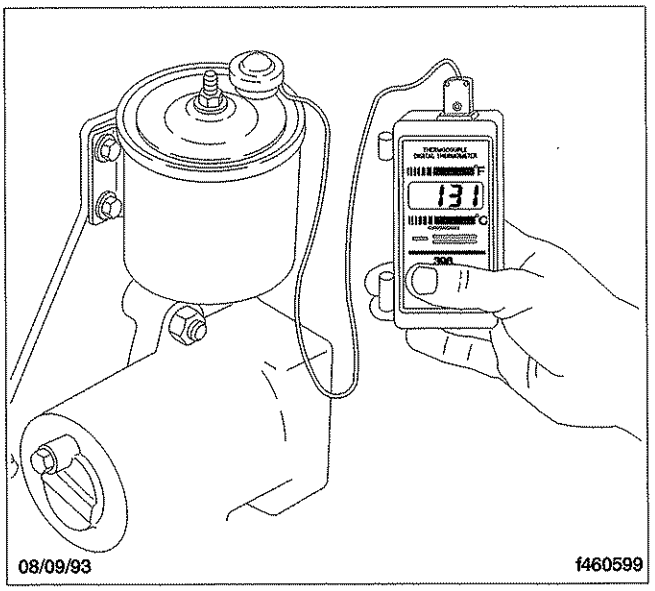


Fig. 2, Monitor the Fluid Temperature

Specifications

Kent-Moore Tools, Kent-Moore Tool Division, 29784 Little Mack, Roseville, MI 48066			
Kent-Moore Part Number			Tool
TAS40	TAS55/65	TAS85	
J37070	J37070	J37070	Adjuster Tool
J37464	J37464	J37464	Adjuster Locknut Tool
J37705	J37071	J38779	Bearing and Seal Tool
J37073	J37073	J37073	Input Seal Installer
J38713	J38713	J38713	Poppet Adjuster Seat Tool, Heavy-Duty (preferred)
J36452	J36452	J36452	Poppet Adjuster Seat Tool
J37130	J37130	J37130	Relief Valve Plug
J8092	J8092	J8092	Tool Handle

Table 1, Kent-Moore Tools, Kent-Moore Tool Division, 29784 Little Mack, Roseville, MI 48066

Steering Gear Torque Values			
Description	Bolt or Nut Size	Grade	Torque: lbf.ft (N.m)
Valve Housing Bolt: TAS40/55/65	1/2–13	—	75–85 (102–115)
TAS85	—	—	108–128 (146–174)
Auxiliary Port Plug	—	—	25–35 (34–47)
Poppet Adjuster Sleeve and Seat Assembly: TAS40/55/65	—	—	10 (14)
TAS85	—	—	18 (24)
Ball Return Guide Bolt	—	—	14–22 (19–30)
Sector Shaft Adjusting Screw Jam Nut	—	—	40–55 (54–75)
Side Cover Bolt	9/16–18	—	118 (160)
	5/8–18	—	170 (230)
Relief Valve Cap	—	—	25–35 (34–47)
Drag Link Castle Nut	5/8–18	C	60–115 (81–156)
	3/4–16	C	90–170 (122–230)
	7/8–14	C	160–300 (217–407)
Steering Driveline Lower End Yoke Pinch Bolt Nut	7/16–20	C	55–65 (75–88)

Specifications

Steering Gear Torque Values			
Description	**Bolt or Nut Size**	**Grade**	**Torque: lbf·ft (N·m)**
Pitman Arm Pinch-Bolt Nut	5/8–18	C	120–140 (163–190)
	3/4–16		215–245 (292–332)
Steering Gear Mounting Hexbolt Nut*	7/8–14	C	377–477 (511–647)

* Torque values are for a plain capscrew with a phosphate and oil coated locknut with a hardened washer.

Table 2, Steering Gear Torque Values

⚠ WARNING

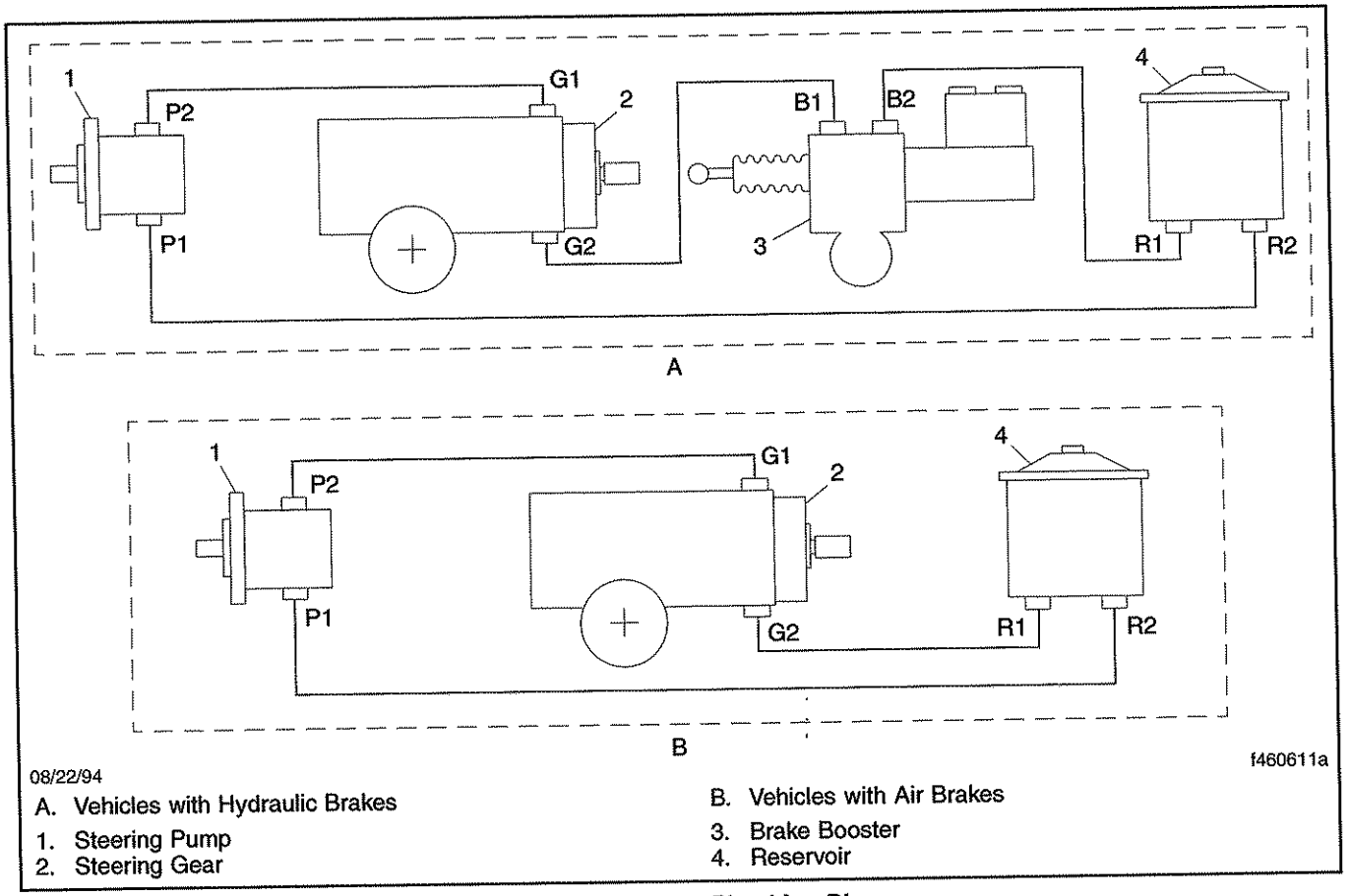
Fill only with approved clean power steering fluid. Any mixture or any unapproved fluid could lead to seal deterioration and leaks. Any fluid leak could eventually cause loss of power steering assist.

Approved Power Steering Fluids		
Fluid Type	**Approved Fluid**	
Automatic Transmission Fluid*	Dexron® II	
	Dexron® III	
Heavy-Duty Engine Oil*	Union	10W–40
IMPORTANT: Do not use heavy-duty engine oil in vehicles built from November 4, 2002.	Texaco	10W–40
	Chevron	10W–40
	Mobil Super	10W–40
	Union	15W–40
	Shell Rotella T	30W

* Do not mix engine oil with automatic transmission fluid (ATF). Use the same lubricant for parts as is in the power steering system.

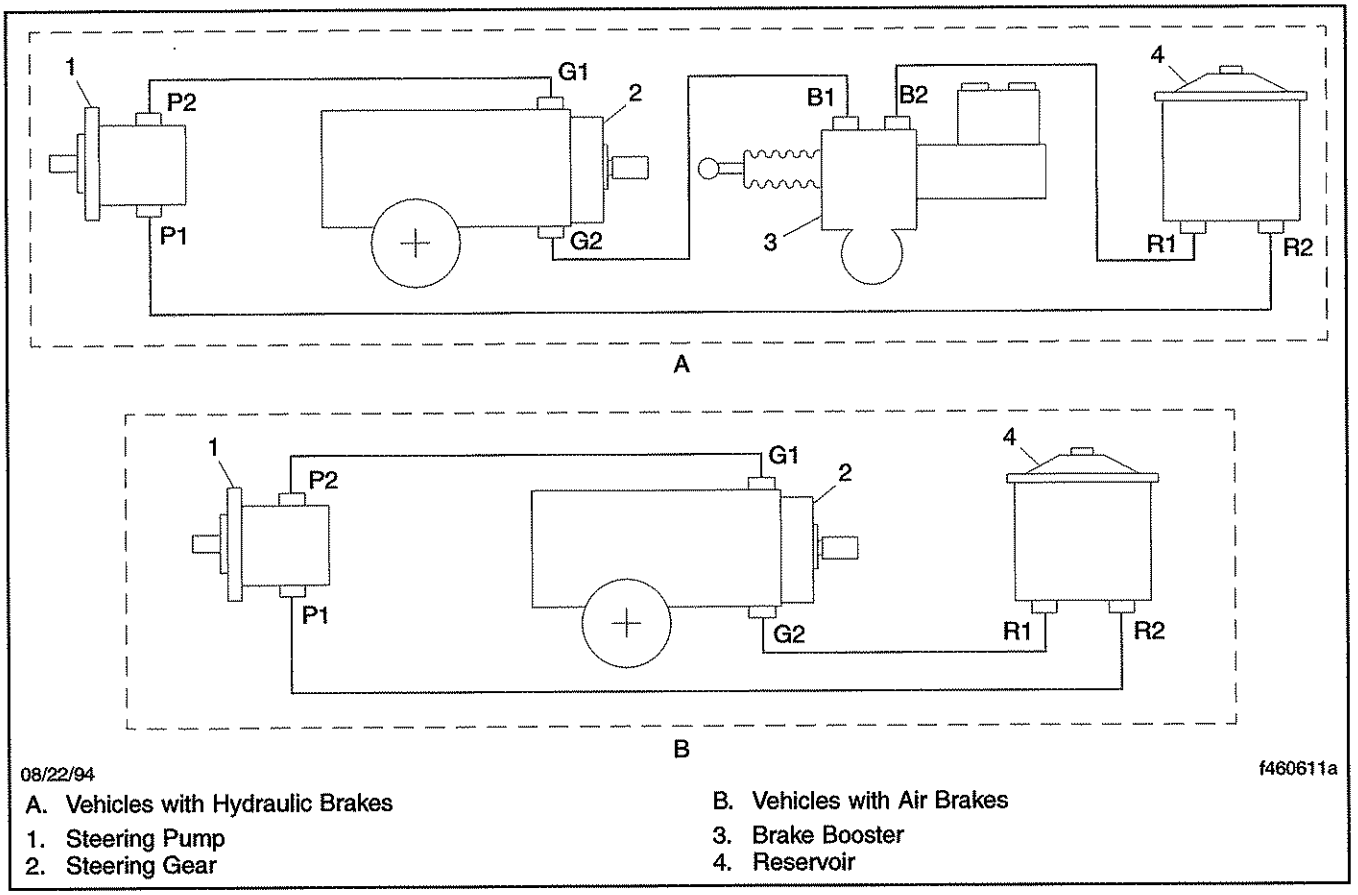
Table 3, Approved Power Steering Fluids

See **Fig. 1** for a steering system plumbing diagram.



A. Vehicles with Hydraulic Brakes
1. Steering Pump
2. Steering Gear
B. Vehicles with Air Brakes
3. Brake Booster
4. Reservoir

Fig. 1, Steering System Plumbing Diagram



A. Vehicles with Hydraulic Brakes
1. Steering Pump
2. Steering Gear

B. Vehicles with Air Brakes
3. Brake Booster
4. Reservoir

Fig. 1, Steering System Plumbing Diagram

Contents

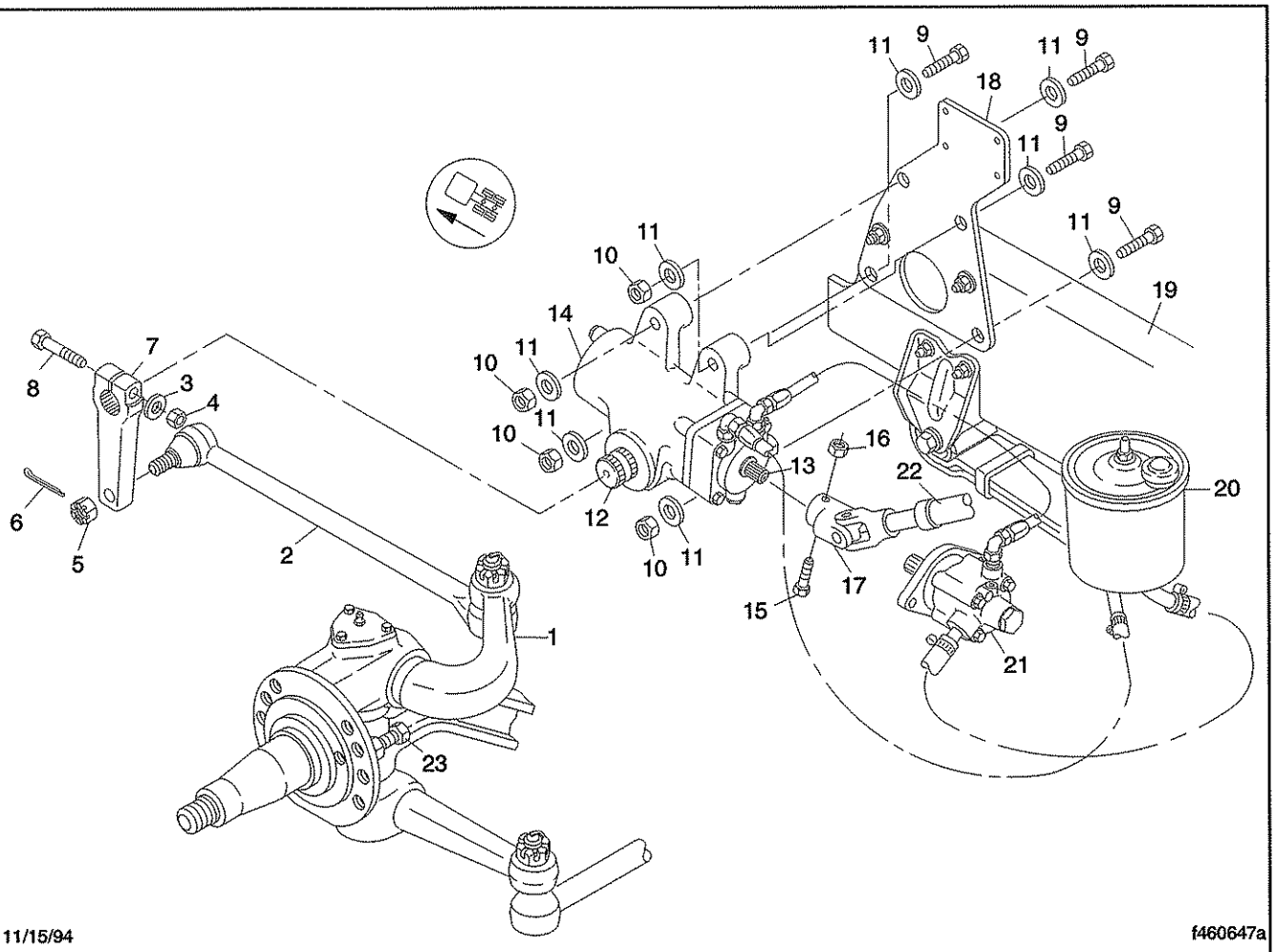
Subject	Subject Number
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General Description

The TRW HFB70 power steering gears can be installed on vehicles with front axle capacities up to 16,000 lbs (7257 kg). The steering gear is mounted on the vehicle frame rail. See **Fig. 1.** The steering gear incorporates a manual steering mechanism, hydraulic control valve, and a hydraulic power cylinder. The control valve is a rotary design, which directs oil flow from the power steering pump to the upper or lower cylinder cavity.

Principles of Operation (See to Fig. 2)

When the steering wheel is turned, force is transmitted from the steering wheel to the steering gear input shaft.

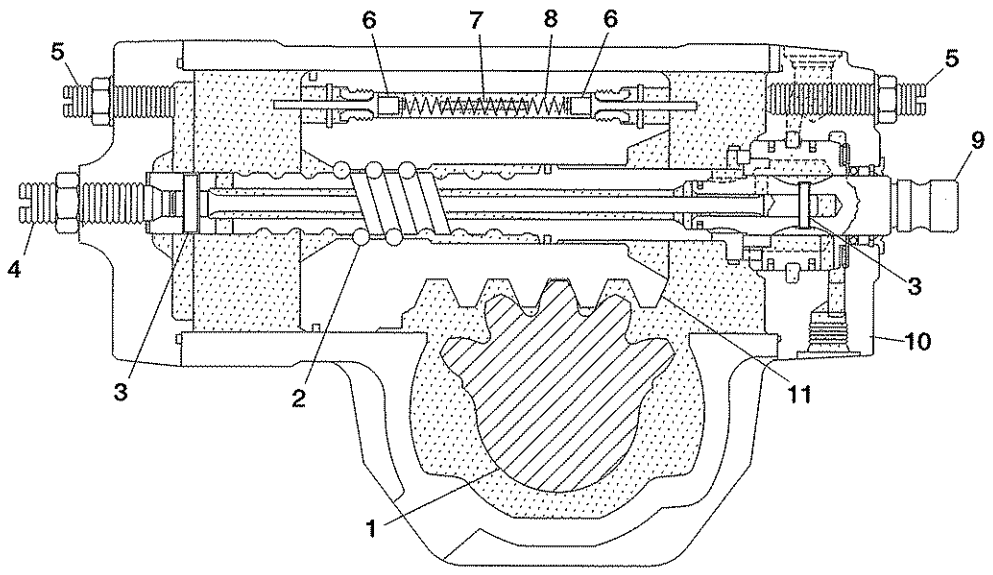


11/15/94 f460647a

1. Axle Steering Arm
2. Drag Link
3. Pitman Arm Washer
4. Pitman Arm Pinch Bolt Nut
5. Castle Nut
6. Cotter Pin
7. Pitman Arm
8. Pitman Arm Pinch Bolt
9. Mounting Capscrew
10. Locknut
11. Hardened Washer
12. Sector (output) Shaft
13. Input (worm) shaft
14. Steering Gear
15. Lower End Yoke Pinch Bolt
16. Lower End Yoke Pinch Bolt Nut
17. Lower End Yoke
18. Steering Gear Mounting Plate
19. Left Frame Rail
20. Power Steering Reservoir
21. Power Steering Pump
22. Steering Driveline
23. Axle Stop

Fig. 1, TRW HFB70 Power Steering Installation

General Description



11/15/94 f460643a

1. Sector Shaft
2. Ball (recirculating)
3. Pin
4. Preload Adjusting Screw
5. Poppet Adjusting Screw
6. Poppet Assembly
7. Spacer Rod
8. Poppet Spring
9. Input Shaft
10. Gear Housing
11. Rack Piston

Fig. 2, Steering Gear Sectional View

A torsion bar, pinned at one end to the input shaft, and at the other to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston up or down (as applicable) in the gear housing cylinder bore.

The rack piston's movement is resisted by its engagement to the sector shaft, which is linked to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve to the upper or lower cylinder cavity (depending on the direction or turn), assist in moving the rack piston up or down (as applicable) in the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

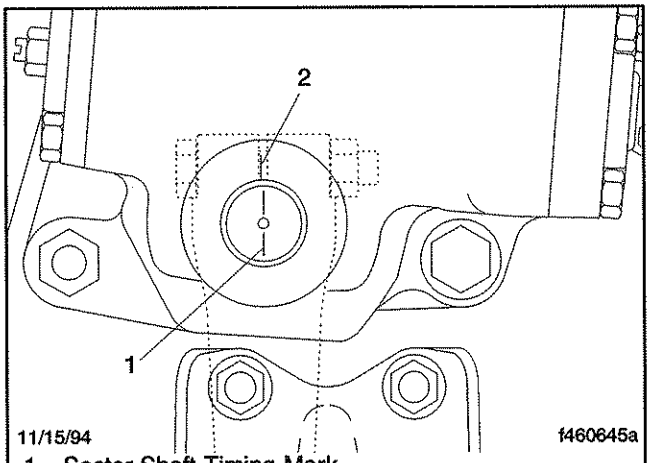
If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal construction of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents kick-back at the steering wheel.

On each end of the rack piston is a poppet (unloading valve). The appropriate poppet will trip as the steered wheels approach the axle stop for that direction of turn. The tripped poppet reduces pressure in the gear, heat generated by the pump, and outside forces acting on the steering linkage.

Sector (Output) Shaft Adjustment

1. Position the sector shaft at its center of travel by turning the steering wheel until the alignment mark on the sector shaft is at a right angle to the input shaft centerline, and in line with the timing mark on the end of the housing trunnion. See **Fig. 1**.
2. Disconnect the drag link from the pitman arm. For instructions, refer elsewhere in this group.
3. With the sector shaft centered, grasp the pitman arm and gently try to move it back and forth. Fingertip force is adequate to detect lash (free play) of a loose sector shaft. See **Fig. 2**. There should be no movement of the input shaft or sector shaft. If there is no lash, no adjustment is needed.

   If there is lash, loosen the sector shaft adjusting screw jam nut, and turn the adjusting screw clockwise until the sector shaft and rack piston are in contact. Use no more than 10 lbf·ft (14 N·m) of torque. Then, turn the adjusting screw counterclockwise one turn. At this point, there should be lash at the pitman arm.
4. To adjust, slowly turn the adjusting screw clockwise until no lash is felt at the pitman arm. Hold the adjusting screw in place and tighten the jam nut 40 to 45 lbf·ft (54 to 61 N·m).
5. Again, check the pitman arm for lash. Turn the steering wheel one-quarter turn each side of center. No lash should be felt. If lash exists, readjust.



1. Sector Shaft Timing Mark
2. Housing Trunnion Timing Mark

Fig. 1, Align the Timing Marks

6. Connect the drag link to the pitman arm. For instructions, refer elsewhere in this group.

Poppet Valves Adjustment

1. Check the settings of the axle stops and adjust them if necessary. For instructions, refer to the front axle section in this manual.
2. Install a flow meter kit in the supply line from the pump to the steering gear. Make sure that the flow meter can be pressurized. Warm the power steering fluid to an operating temperature of 125° to 135°F (51° to 57°C).
3. Loosen both of the poppet valve adjusting screw jam nuts.
4. With the engine at idle, have someone turn the steering wheel to the full-lock right position. Check the pressure gauge.

⚠ CAUTION

If power steering pump relief pressure is reached while the steering wheel is at full-lock, release the steering wheel from this position. Don't allow the pump relief pressure to be maintained for longer than five seconds, or damage to the pump may result.

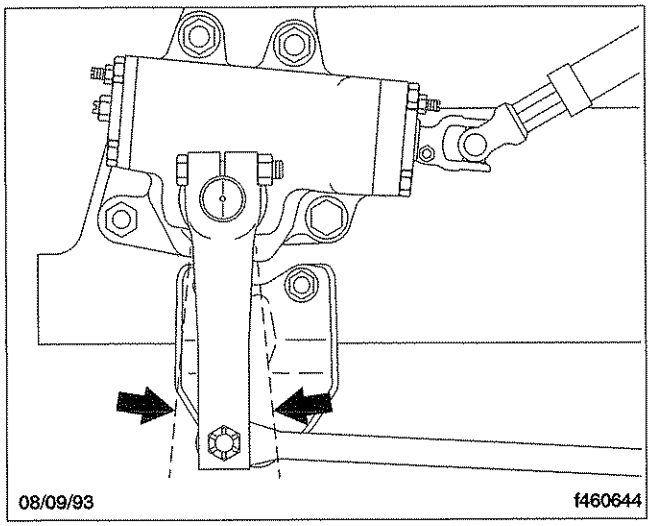


Fig. 2, Check the Free Play

In-Vehicle Adjustments

IMPORTANT: When the steering wheel is at the full-lock position, make sure the stop screw on the back of the wheel spindle contacts the axle boss. Failure to maintain contact while adjusting the poppet valve could cause incorrect adjustment.

5. If the pressure gauge reading is less than 2000 psi (13 800 kPa), back out the poppet valve adjusting screw until the relief pressure reading is 1960 psi (13 514 kPa).

NOTE: The right-turn poppet valve adjusting screw is at the rear of the steering gear.

6. If system pressure exceeds the maximum pump relief pressure, repair the power steering pump. Refer elsewhere in this group for pump repair instructions.
7. Release the steering wheel from the full-lock right position enough to allow insertion of a 1/16- to 1/8-inch (1.6- to 3.2-mm) thick flatwasher between the axle beam and the right-side axle stop pin.
8. Bring the steering wheel back to the full-lock right position, against the flatwasher. While holding the poppet valve adjusting screw jam nut in place with a wrench, immediately screw in the poppet valve adjusting screw until the pressure gauge reading drops by 200 to 400 psi (1379 to 2758 kPa).

   While holding the poppet valve adjusting screw in place, tighten the jam nut 12 to 18 lbf·ft (16 to 24 N·m).
9. With the engine at idle, have someone turn the steering wheel to the full-lock left position. Check the pressure gauge. Adjust the other poppet valve adjusting screw using the applicable steps above.

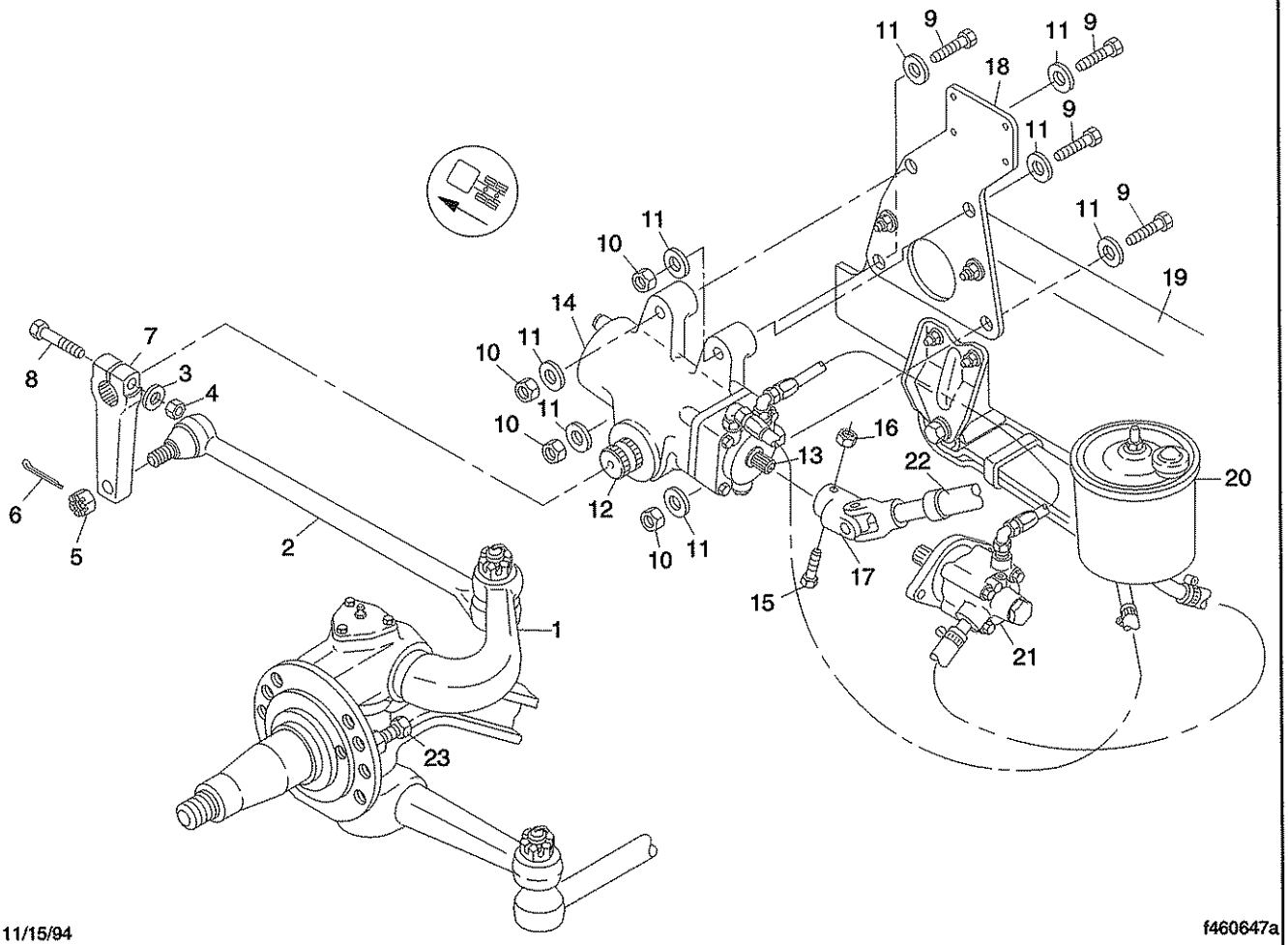
NOTE: The left-turn poppet valve adjusting screw is on the *front* of the steering gear.

Steering Gear Removal and Installation

Removal (See Fig. 1)

IMPORTANT: Before removing the steering gear, see **Subject 300** to identify the problem.

1. Verify correct axle stop adjustment. For instructions, refer to the front axle section in this manual. Ensuring correct axle stop adjustment now will eliminate the possibility of resetting steering gear poppet valves after the gear is reinstalled.
2. Place the front tires in the straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where the work is to be done. Apply the parking brakes and chock the tires.
3. Remove the left-hand bumper extension.



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1. Axle Steering Arm
2. Drag Link
3. Pitman Arm Washer
4. Pitman Arm Pinch Bolt Nut
5. Castle Nut
6. Cotter Pin
7. Pitman Arm
8. Pitman Arm Pinch Bolt
9. Mounting Capscrew
10. Locknut
11. Hardened Washer
12. Sector (output) Shaft
13. Input Shaft
14. Steering Gear
15. Lower End Yoke Pinch Bolt
16. Lower End Yoke Pinch Bolt Nut
17. Lower End Yoke
18. Steering Gear Mounting Plate
19. Left Frame Rail
20. Power Steering Reservoir
21. Power Steering Pump
22. Steering Driveline
23. Axle Stop

Fig. 1, TRW HFB70 Power Steering Installation

Steering Gear Removal and Installation

4. Clean all outside dirt from around the fittings and hose connections.
5. Drain the power steering system. Disconnect all hydraulic lines from the gear, marking the lines for later assembly reference. Seal the lines and the fittings to keep out dirt.
6. Disconnect the pitman arm from the steering gear sector shaft.
   - 6.1 Remove the pinch bolt, washer, and nut from the pitman arm. Discard the nut.
   - 6.2 Remove the pitman arm using a suitable puller, and swing the pitman arm and drag link out of the way.
7. Disconnect the steering driveline from the steering gear input shaft as follows:
   - 7.1 Remove the pinch bolt nut and pinch bolt from the steering driveline lower end yoke.

⚠ CAUTION

Do not pound the U-joint or lower end yoke on or off the input shaft. Internal damage to the steering gear can result.

   - 7.2 Remove the lower end yoke from the input shaft.
8. Clean the entire assembly before removing the gear.

IMPORTANT: The HFB70 steering gear weighs 112 lbs (51 kg) dry. Use care when removing, lifting, and carrying the steering gear, to avoid injury.

9. Remove the fasteners that attach the steering gear to the frame rail. Remove the steering gear.

Installation (see Fig. 1)

IMPORTANT: The HFB70 steering gear weighs 112 lbs (51 kg) dry. Use caution when removing, lifting, and carrying the steering gear, to avoid injury.

1. Install the steering gear and fasteners as shown in **Fig. 2.**

   Tighten the fasteners 427 lbf·ft (579 N·m).

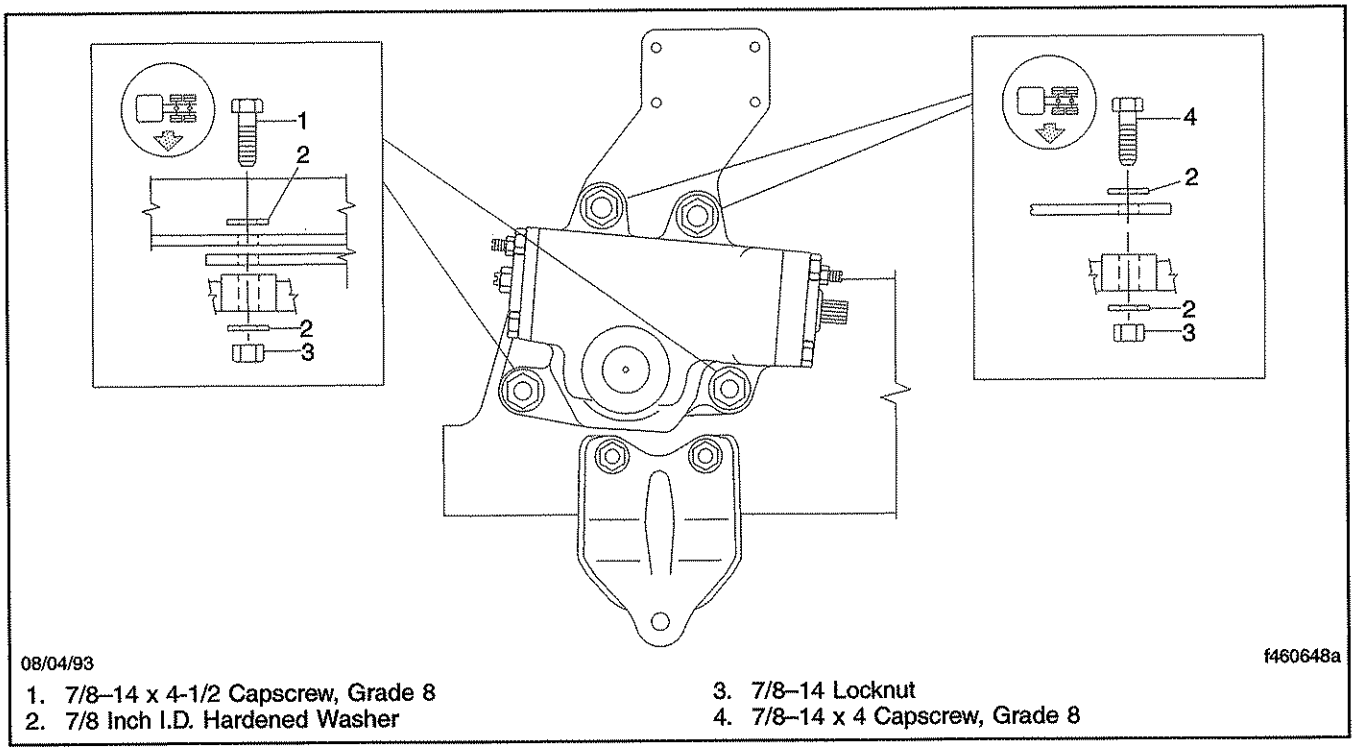
2. If not previously done, center the steering gear. The sector (output) shaft alignment mark must be at a right angle to the steering gear input shaft centerline. Make sure the steering gear remains centralized as the service work continues.
3. Install the pitman arm.
   - 3.1 Position the pitman arm on the steering gear, aligning the timing mark as shown in **Fig. 3.**

⚠ WARNING

Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise the chisel may fly loose, which could cause an injury.

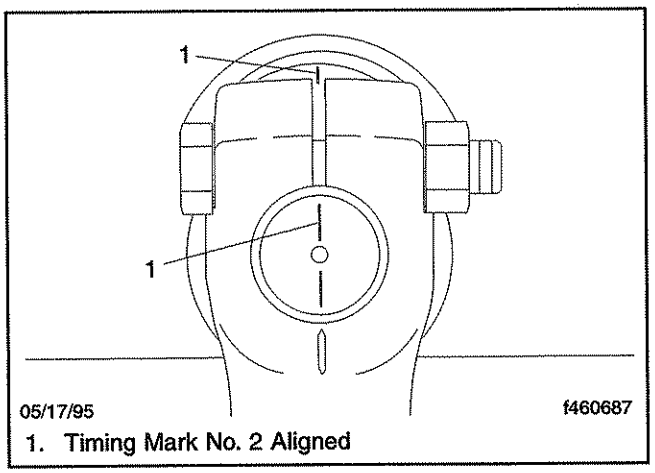
   NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. Use a ball peen hammer to drive a chisel into the slot. Hold the chisel in place. Install the pitman arm on the sector shaft. Remove the chisel from the slot.

   - 3.2 Install the pitman arm pinch bolt, washer, and a new nut. Tighten the locknut 215 to 245 lbf·ft (292 to 332 N·m).
   - 3.3 Apply white Torque Seal® F-900 to the exposed threads and the locknut.
4. Connect the steering driveline to the steering gear input shaft.
   - 4.1 Clean the steering gear input shaft and the inside of the driveline yoke.
   - 4.2 Apply a thin film of grease to the yoke spline.
   - 4.3 Slide the yoke onto the input shaft, and install the yoke pinch bolt and a new pinch bolt locknut. Tighten the pinch bolt nut 55 to 65 lbf·ft (75 to 88 N·m).
   - 4.4 Apply white Torque Seal® F-900 to the exposed pinch bolt threads and the locknut.
5. Connect the hydraulic lines.
   - 5.1 If they were removed, attach the hydraulic line elbow fittings to the steering gear. Tighten the fittings 38 lbf·ft (51 N·m).



1. 7/8–14 x 4-1/2 Capscrew, Grade 8
2. 7/8 Inch I.D. Hardened Washer
3. 7/8–14 Locknut
4. 7/8–14 x 4 Capscrew, Grade 8

Fig. 2, Steering Gear Mounting (top view)



1. Timing Mark No. 2 Aligned

Fig. 3, Typical Pitman Arm and Timing Marks

Tighten the pressure line fitting jam nut 41 lbf·ft (56 N·m).

5.2 Remove the plugs from the hydraulic lines. Connect the lines to the steering gear as previously marked. Tighten the nut on each fitting finger-tight. Then, use a wrench to tighten the nut until there is firm resistance. Tighten one-sixth turn more.

6. Fill and bleed the steering system.

IMPORTANT: Do not turn the steering wheel until instructed in the following steps. Doing so can cause air to enter the system, which can make it more difficult and time-consuming to bleed air from the system.

6.1 Fill the power steering reservoir with the steering fluid specified in **Specifications, 400** until nearly full. Crank the starter for 10 seconds without allowing the engine to start. If the engine does start, shut it down immediately. Check and fill the reservoir as needed. Repeat this procedure three times, each time checking and filling the reservoir.

6.2 Start the engine and let it idle for two minutes. Shut down the engine, and check the fluid level in the reservoir.

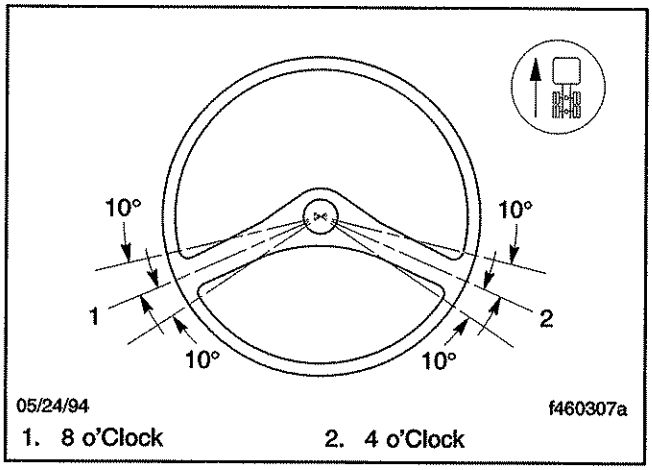
Steering Gear Removal and Installation

6.3 Start the engine again. Steer the vehicle from full-left to full-right, several times. As necessary, add fluid to the full line on the reservoir dipstick.

NOTE: Adjust the poppets following the procedure in **Subject 100**.

7. Go to **Subject 150** and do the checks as instructed.
8. Install the left-hand bumper extension.
9. Test drive the vehicle, or take a ride with the driver.

   Check the steering wheel spoke position. With the front tires pointing straight ahead, check the position of the steering wheel spokes. They must be pointing within ±10 degrees of the 4 o'clock and 8 o'clock positions. See **Fig. 4**. If not, remove the steering wheel and install it in the correct position. For instructions, refer to the applicable section in this group.

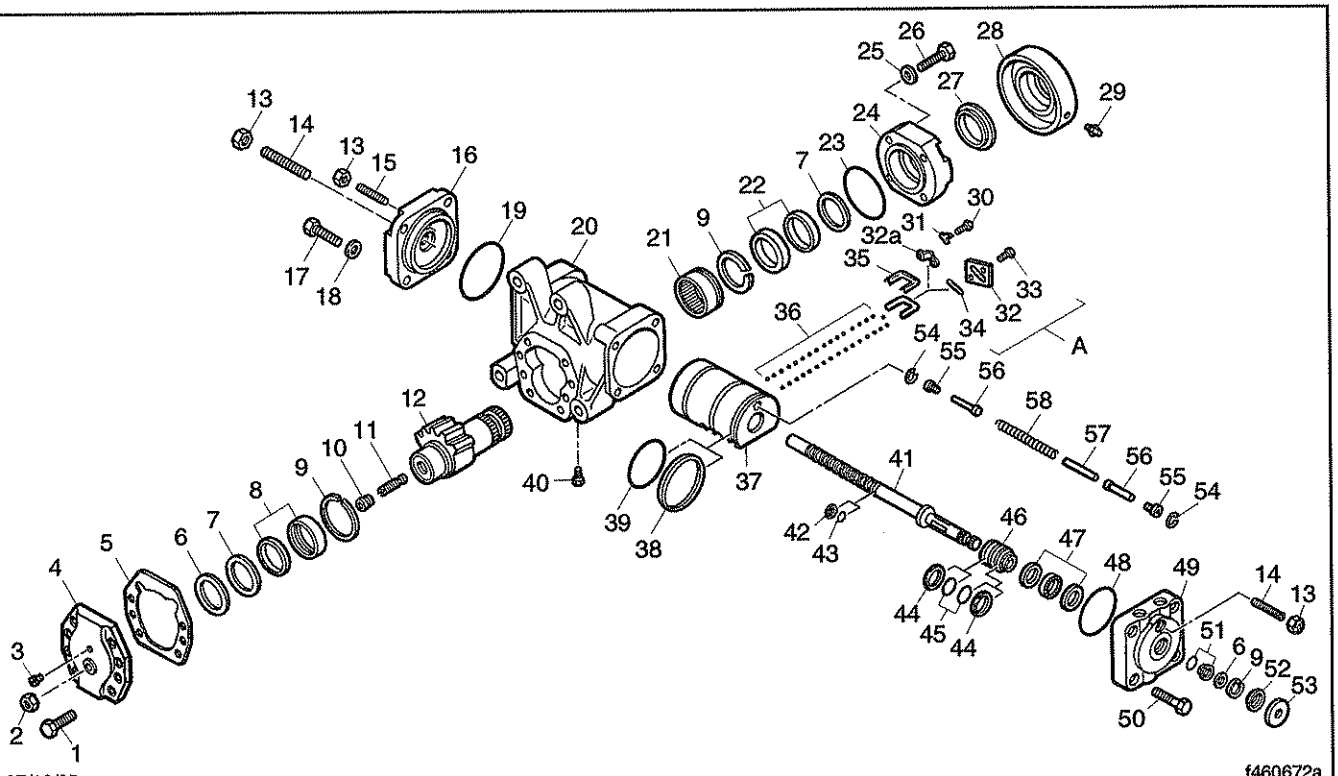


1. 8 o'Clock 2. 4 o'Clock

Fig. 4, Steering Wheel Centered

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

Disassembly (See Fig. 1)



1. Ring Head Bolt
2. Jam Nut
3. Vent Plug
4. Side Cover (with bushing or roller bearing)
5. Side Cover Gasket
6. Backup Washer (steel)
7. Backup Washer (Teflon®)
8. Two-Piece Side Cover Seal
9. Retaining Ring
10. Adjusting Screw Retainer
11. Sector Shaft Adjusting Screw
12. Sector (output) Shaft
13. Adjusting Screw Jam Nut
14. Worm Shaft Adjusting Screw
15. Poppet Adjusting Screw
16. End Cover
17. End Cover Bolt
18. End Cover Washer
19. End Cover O-Ring
20. Gear Housing
21. Housing Bearing
22. Two-Piece Sector Shaft Seal
23. Trunnion Cover O-Ring
24. Trunnion Cover
25. Washer
26. Trunnion Cover Bolt
27. Dirt and Water Seal
28. Protective Boot
29. Grease Fitting
30. Hexhead Bolt
31. Locktab
32. Ball Return Guide Cap
33. Allen Head Screw
34. Guide Cap Seal
35. Ball Return Guide Halves
36. Steel Balls
37. Rack Piston
38. Rack Piston Seal
39. Rack Piston O-Ring
40. Bleed Screw
41. Worm (input) Shaft
42. Worm Shaft Seal
43. Input Shaft O-Ring
44. Valve Sleeve Seal
45. Valve Sleeve O-Ring
46. Valve Sleeve
47. Thrustwashers and Thrust Bearing
48. Valve Housing O-Ring
49. Valve Housing
50. Valve Housing Bolt
51. Two-Piece Input Shaft Seal
52. Dirt and Water Seal, Valve Housing
53. Seal Protector
54. Poppet Retaining Ring
55. Poppet Seal
56. Poppet
57. Nylon Spacer Rod
58. Spring

Fig. 1, Steering Gear Assembly

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

⚠ WARNING

All steering mechanisms are safety items. Because of this, follow the instructions in this subject to the letter. Failure to do so may result in loss of steering, which could cause an accident resulting in personal injury or property damage.

IMPORTANT: The special tools required for disassembly and assembly of the steering gear parts are available from the Kent-Moore Tool Division, or an affiliated dealer. See the special tools Table in **Specifications 400**, to be sure that you have the required tools before beginning the service procedures.

Make sure that the steering gear is placed on a clean surface. Clean and dry the gear before disassembly. As the gear is disassembled, clean all parts in a clean, petroleum-based solvent, and blow-dry them only.

⚠ WARNING

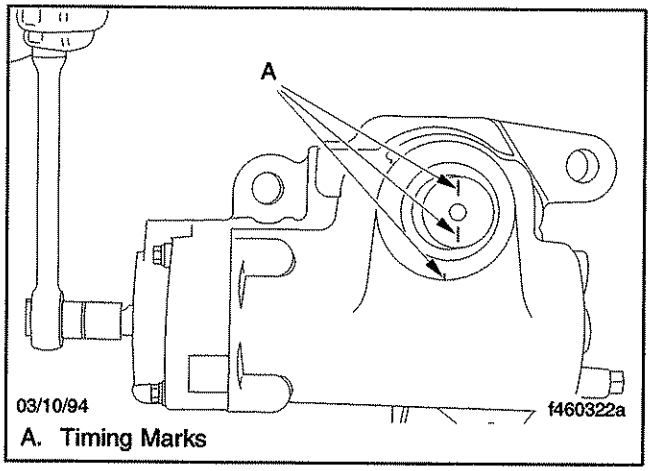
Never steam clean or high-pressure wash the hydraulic steering components. Don't force or abuse closely fitted parts. Doing so could cause damage to steering system parts.

Keep each part separate to avoid nicks and burrs. Discard all seals, O-rings, and gaskets, and replace them with new parts.

1. Clamp the gear mounting bosses in a vise, so that the gear's input shaft is horizontal. Rotate the input shaft to position the alignment mark on the sector shaft halfway between two trunnion cover bolts and pointing up. See **Fig. 2**.
2. Remove the pinch bolt and nut from the pitman arm. Discard the nut. Remove the pitman arm, using a suitable puller.
3. Remove the protective boot, the grease fittings, and the dirt and water seal from the trunnion cover. See **Fig. 3**. Discard the boot and the seal.
4. Using a fine grade of emery paper, remove any paint or corrosion from the nonserrated area of the sector shaft. Loosen the sector shaft adjusting screw jam nut.
5. Remove the four trunnion cover bolts and washers. See **Fig. 4**. Remove the trunnion cover. Remove and discard the trunnion cover O-ring, the Teflon® backup washer, and the two-piece sector shaft seal. See **Fig. 5**.
6. Tape the serrations and bolt groove of the sector shaft, using one *layer* of masking tape. See **Fig. 6**.
7. Prepare for fluid to drain, and remove the eight special bolts from the side cover. See **Fig. 7**.

IMPORTANT: These special bolts are equipped with either a ring or washer-design on the underside of the head. See **Fig. 8**. If replacing one or more bolts, use bolts that are the same *type and length as those that were removed*. Do not use substitutes. Refer to the *Service Parts Catalog* for correct bolt type.

8. Begin to remove the side cover and sector shaft as an assembly. See **Fig. 9**. As a means of starting the removal of the side cover and sector shaft



A. Timing Marks

Fig. 2, Timing Marks

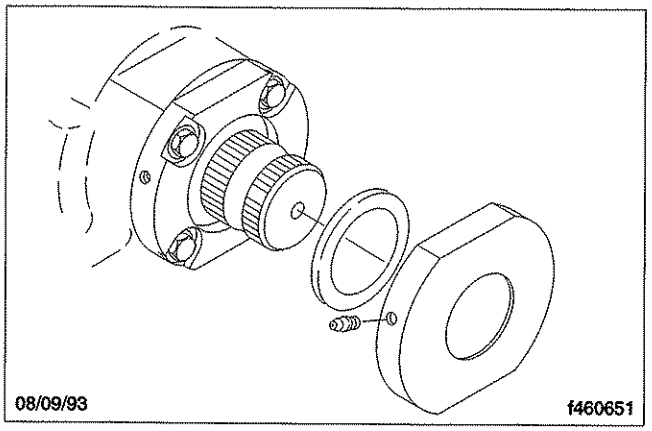


Fig. 3, Remove the Boot, Fittings, and Seal

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

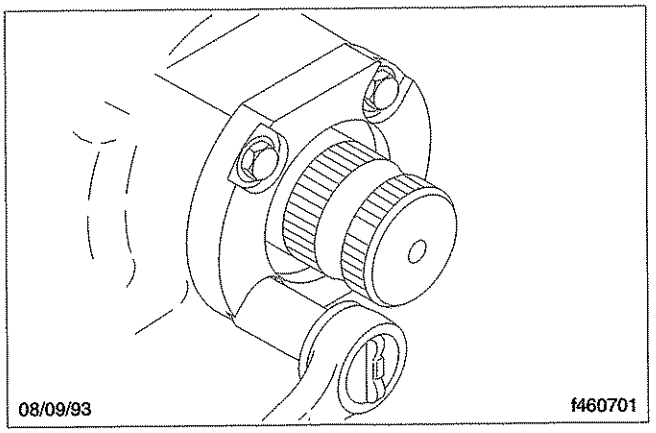


Fig. 4, Remove the Bolts and Washers

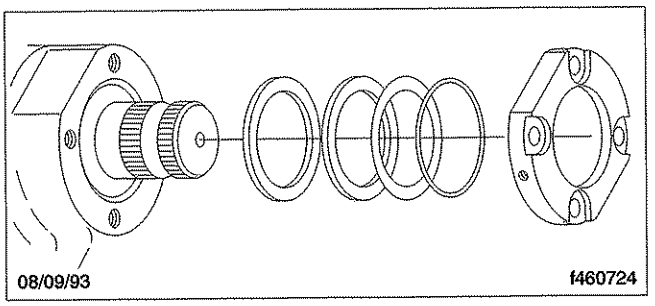


Fig. 5, Remove the Trunnion Cover

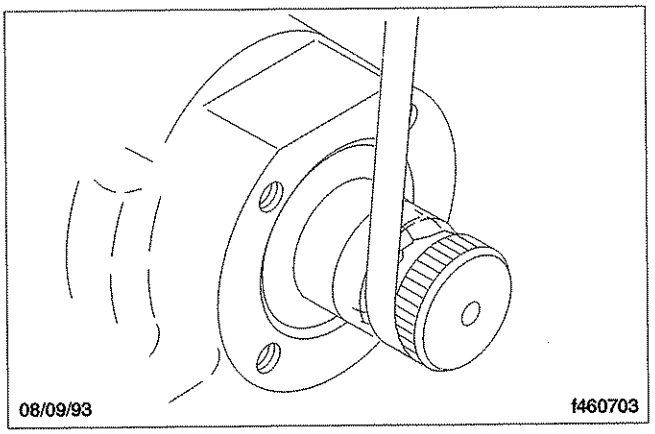


Fig. 6, Tape the Serrations and Bolt Groove

assembly, a soft hammer or wooden handle may be used. Stop removal when the bearing rolls in the housing bearing are half exposed. Coat the bearing rolls with grease. See **Fig. 10.**

IMPORTANT: Be sure that no rolls are lost during disassembly. If one or more of the rolls is lost, the entire bearing must be replaced. If the bearing is identified as BR-970, there are 41 rolls. If the bearing is identified as BR-970-1, there are 42 rolls.

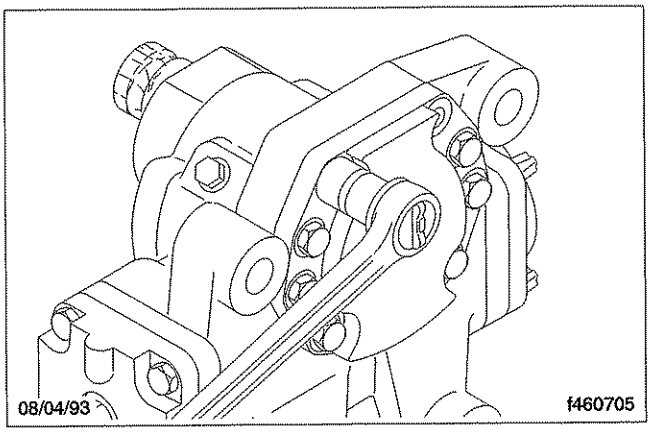


Fig. 7, Remove the Bolts

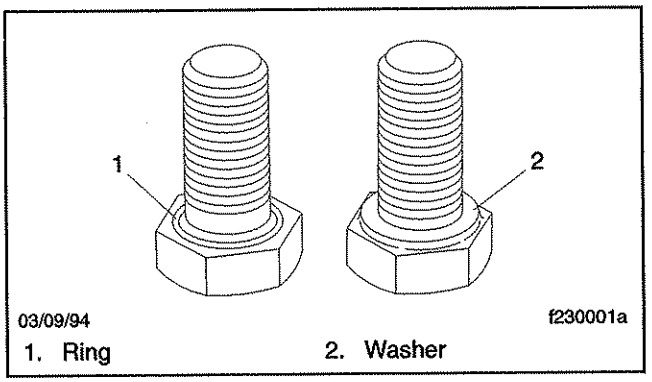


Fig. 8, Bolts With Ring or Washer

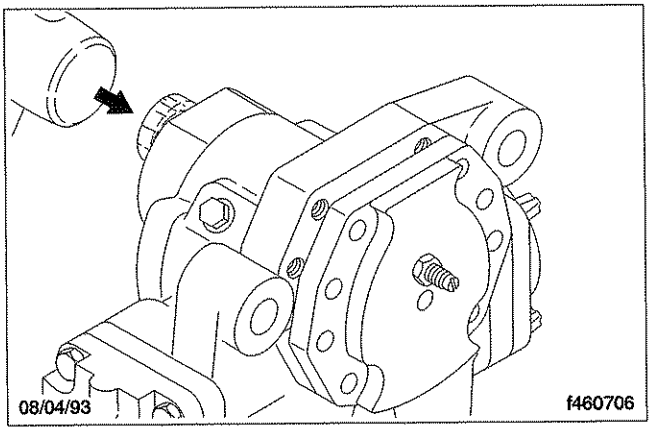


Fig. 9, Remove the Side Cover and Sector Shaft

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

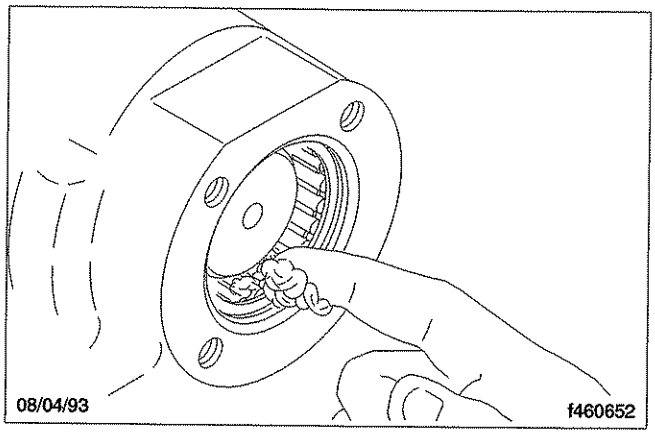


Fig. 10, Lubricate the Bearing Rollers

NOTE: The housing bearing may have caged (retained) rolls, which do not require special precautions. However, if the bearing rolls are not caged, remove this assembly slowly, or it may come out too quickly to allow the bearing rolls in the housing bearing race to be retained. Follow the shaft end with bearing tool J26743 to retain the rolls, or when the rolls are half exposed, coat them with grease to retain them in the housing bearing. See **Fig. 10**.

NOTE: The number on the housing bearing may not be visible while it is in place.

9. Finish removing the side cover and sector shaft as an assembly. Remove and discard the side cover gasket.

10. If the housing bearing race is damaged, or if one or more of the rolls are lost, replace the housing bearing.

    10.1 Using bearing mandrel J26743, apply pressure from the side cover opening and press the bearing and retaining ring out through the trunnion cover opening, away from the cylinder bore.

    NOTE: Maintain firm, square contact between the housing and the base of the press to avoid damaging the housing bearing bore.

    10.2 Remove the retaining ring from the bearing, and discard the bearing.

IMPORTANT: If the bearing is cocked while pressing it out, it will burnish the bore, causing it to become oversized. If this happens, the steering gear housing will have to be replaced.

11. Remove the sector shaft adjusting screw jam nut. See **Fig. 11.**

12. Screw the sector shaft adjusting screw through the side cover. See **Fig. 12.** Place the side cover exterior side down and lift the sector shaft out vertically. See **Fig. 13.**

⚠ WARNING

Do not mix the rolls from the side cover with the rolls from the housing bearing. The bearing race and rolls are a matched set. Interchanging the rolls could result in bearing or seal failure. This could cause a loss of power steering, which could cause personal injury or property damage.

IMPORTANT: his will allow the side cover bearing rolls to fall into the side cover, where they can easily be col-

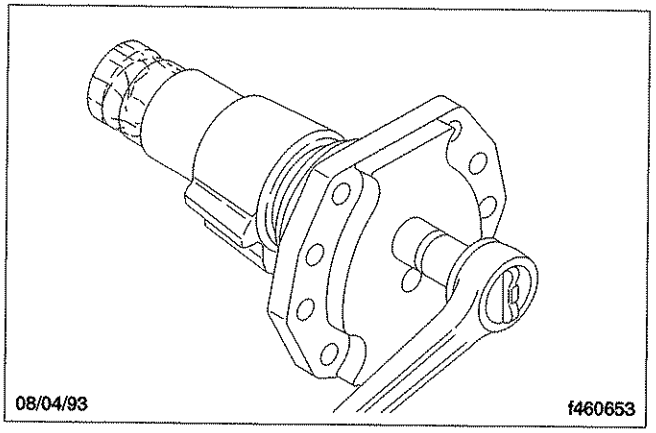


Fig. 11, Remove the Jam Nut

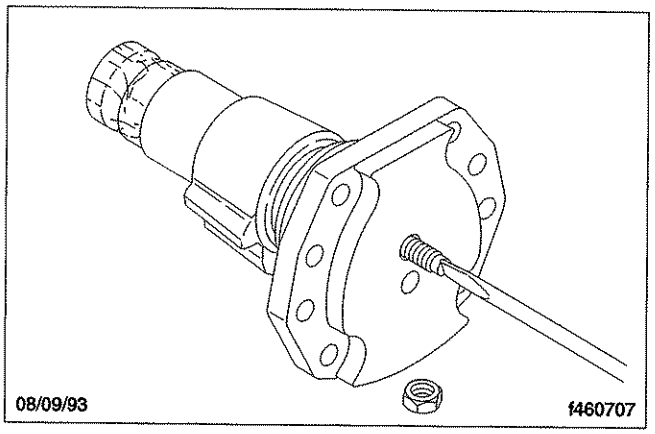


Fig. 12, Sector Shaft Adjusting Screw

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

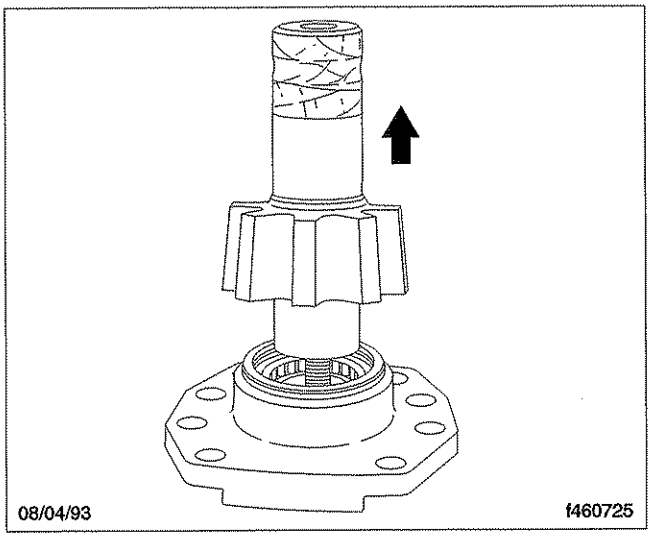


Fig. 13, Lift the Sector Shaft Out Vertically

lected. Immediately collect all of the side cover bearing rolls and count them. Don't lose any rolls during disassembly, or the complete side cover assembly will have to be replaced.

13. Remove the side cover retaining ring (**Fig. 14**), the two-piece side cover seal, the Teflon® backup washer, and the steel backup washer, from the side cover. See **Fig. 15**. Discard the two-piece seal and the Teflon® backup washer. Remove and discard the rubber plug.
14. Loosen the worm shaft preload adjusting screw jam nut. Loosen the worm shaft preload adjusting screw about two turns. See **Fig. 16**. Loosen the poppet adjusting screw jam nut and the poppet adjusting screw about two turns.

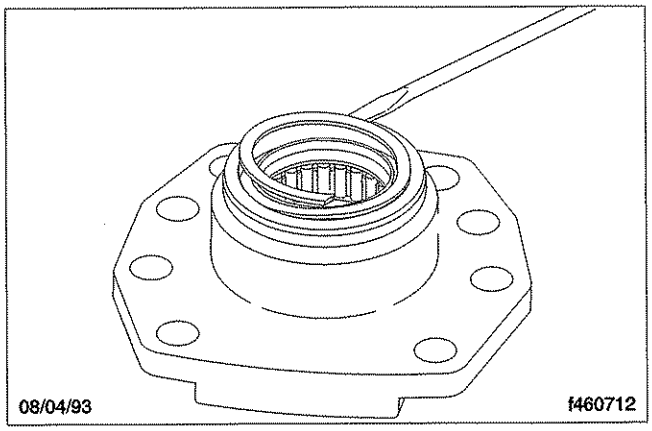


Fig. 14, Remove the Retaining Ring

15. Remove the four end cover bolts (**Fig. 17**). Prepare for some fluid to drain, then remove the end cover. See **Fig. 18**.
16. Remove and discard the end cover O-ring. See **Fig. 19**.
17. Clean any paint or foreign material from the nonserrated area of the input shaft, using a fine grade of emery paper. See **Fig. 20**.
18. Loosen the valve housing poppet adjusting screw jam nut and poppet adjusting screw about two turns.
19. Remove the four valve housing bolts. See **Fig. 21**. Prepare for some fluid to drain, then remove the valve housing. See **Fig. 22**.

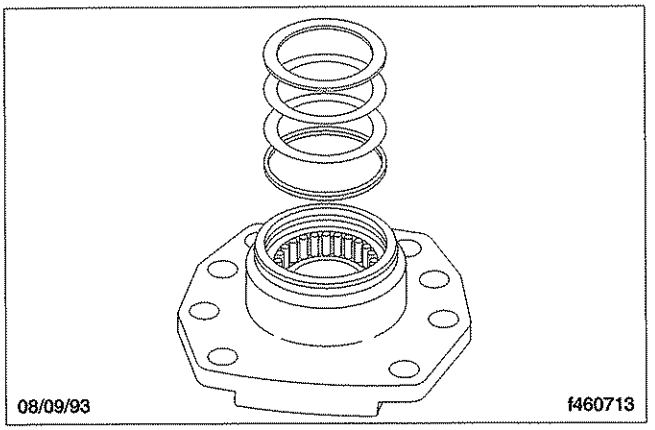


Fig. 15, Remove the Retaining Ring, Seal, and Washers

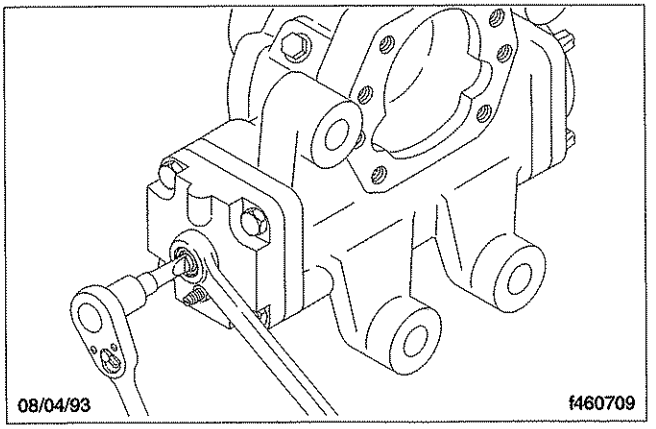


Fig. 16, Loosen the Jam Nut and Adjusting Screw

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

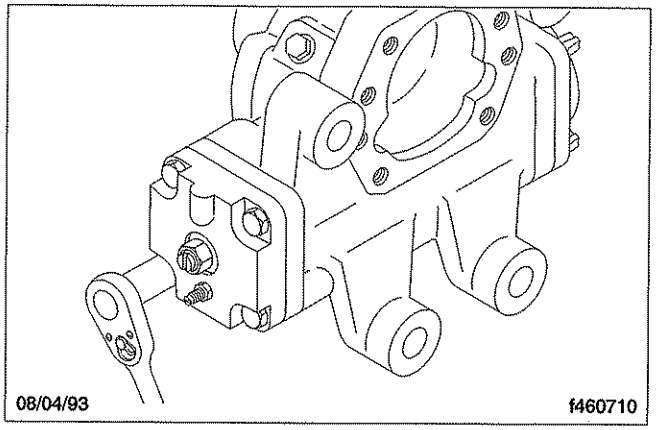


Fig. 17, Remove the End Cover Bolts

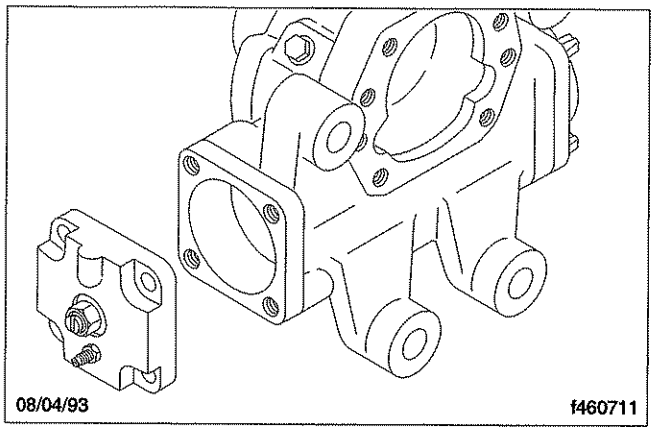


Fig. 18, Remove the End Cover

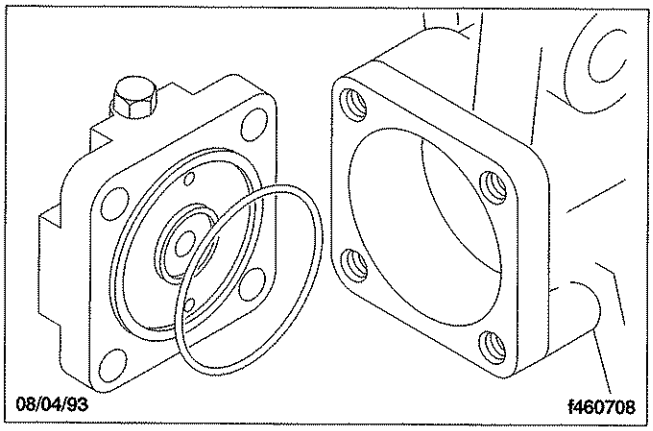


Fig. 19, Remove the O-Ring

20. If the valve sleeve is still in the housing, remove it. See **Fig. 23.**

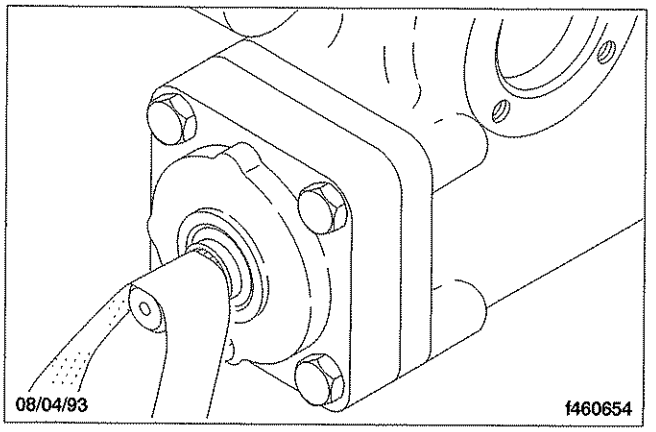


Fig. 20, Clean the Input Shaft

21. Remove the first thrustwasher, the thrust bearing, and the second thrustwasher from the valve housing. See **Fig. 24.**

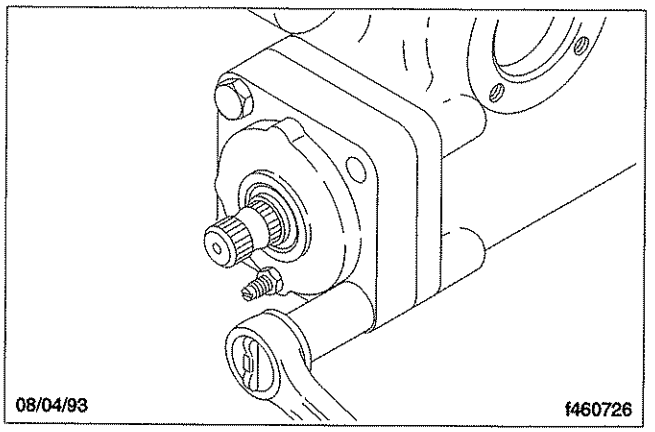


Fig. 21, Remove the Valve Housing Bolts

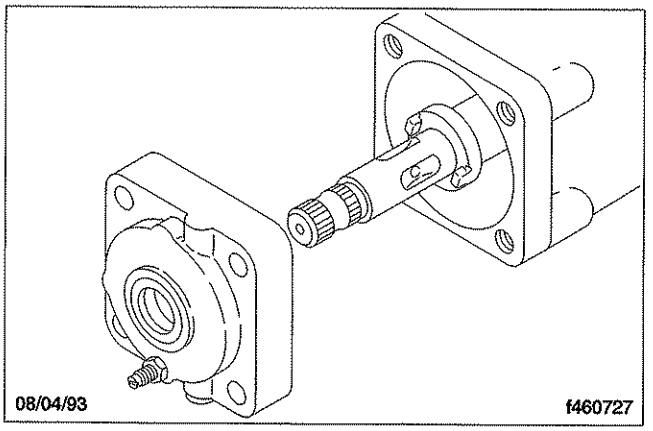


Fig. 22, Remove the Valve Housing

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

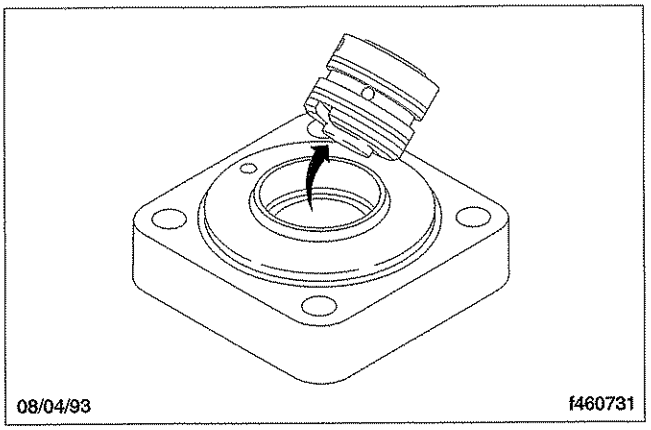


Fig. 23, Remove the Valve Sleeve

NOTE: The first thrustwasher may stay on the end of the valve sleeve. If so, remove it from the sleeve.

22. Remove and discard the valve housing O-ring.
23. Remove and discard the valve housing the dirt and water seal. See **Fig. 25**.
24. Remove the valve housing retaining ring. See **Fig. 26**.
25. Remove the steel backup washer and the two-piece input shaft seal from the valve housing. See **Fig. 27**. Discard the shaft seal.
26. Remove and discard the two Teflon® seal rings from the valve sleeve. See **Fig. 28**.
27. Remove and discard the two backup O-rings from the grooves in the valve sleeve. See **Fig. 29**.

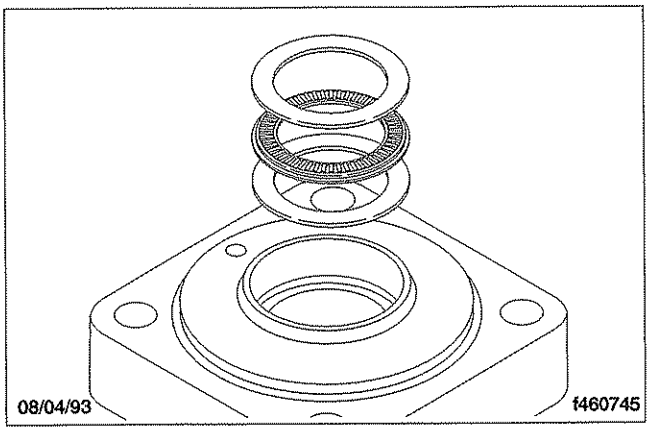


Fig. 24, Remove the Thrustwashers and Thrust Bearing

28. Remove the rack piston and worm shaft from the gear housing as an assembly. See **Fig. 30**.

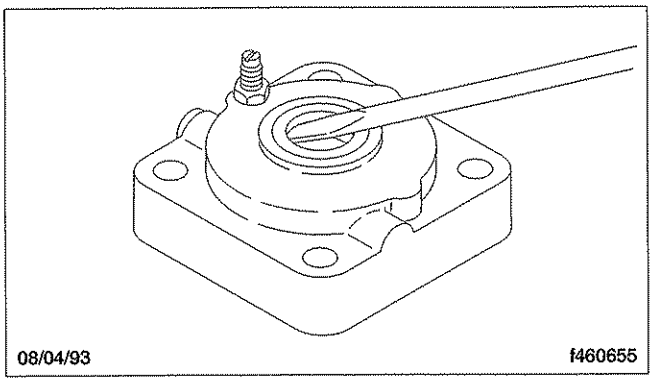


Fig. 25, Remove the Dirt and Water Seal

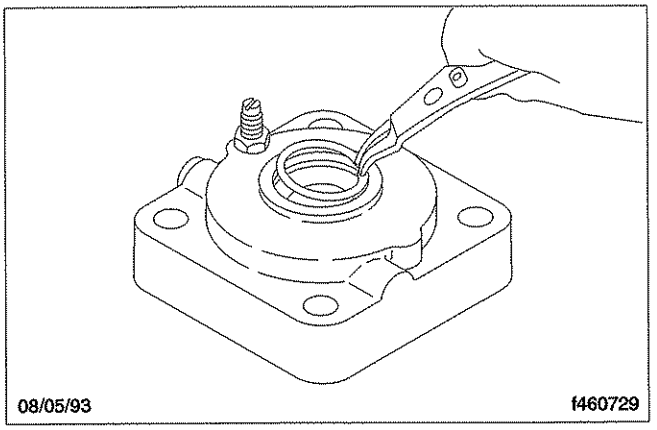


Fig. 26, Remove the Valve Housing Retaining Ring

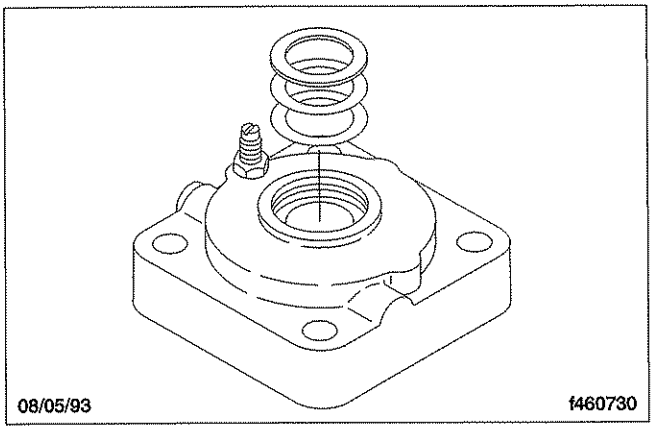


Fig. 27, Remove the Washer and Seals

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

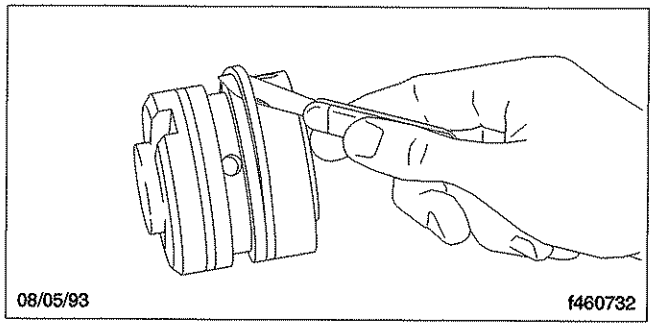


Fig. 28, Remove the Seal Rings

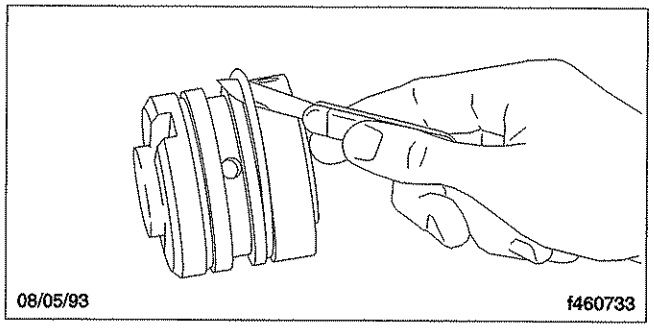


Fig. 29, Remove the O-Rings

NOTE: The worm shaft portion of the assembly will be inside the rack piston, with the input shaft portion of the worm protruding from the rack. Be careful when removing this assembly from the housing. Removing the rack piston assembly from the long end of the housing prevents the Teflon® rack piston seal from getting caught in the sector shaft cavity.

29. Set the rack piston and worm shaft assembly on a clean rag, to keep the piston from rolling.

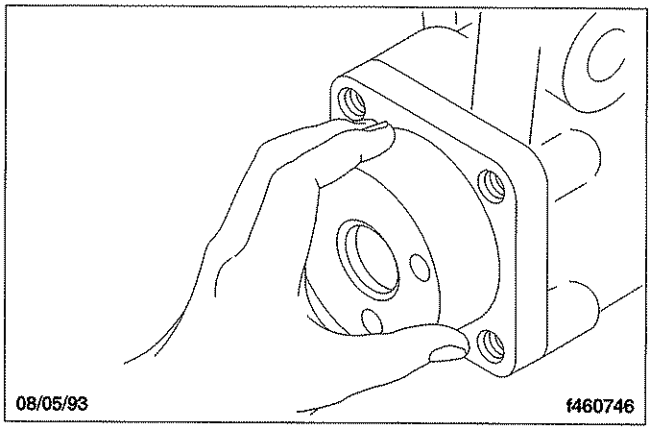


Fig. 30, Remove the Rack Piston and Worm Shaft

30. For rack pistons with a ball return guide clip, bend the tangs down on the two ball return guide clip locking tabs. See **Fig. 31**. Remove the two hexhead bolts, the locking tabs, and the guide clip. Discard the locking tabs. See **Fig. 32**.

    For rack pistons with a ball return guide cap, remove the two allen head screws (**Fig. 33**), the ball return guide cap, and the ball return guide cap seal. See **Fig. 34**. Discard the screws and the cap seal.

31. Remove the halves of the ball return guide. See **Fig. 35**. Then remove the 34 steel balls from the rack piston by rotating the worm shaft until the balls fall out. See **Fig. 36**. *Don't loose any of these balls, or you will have to replace the entire set.*

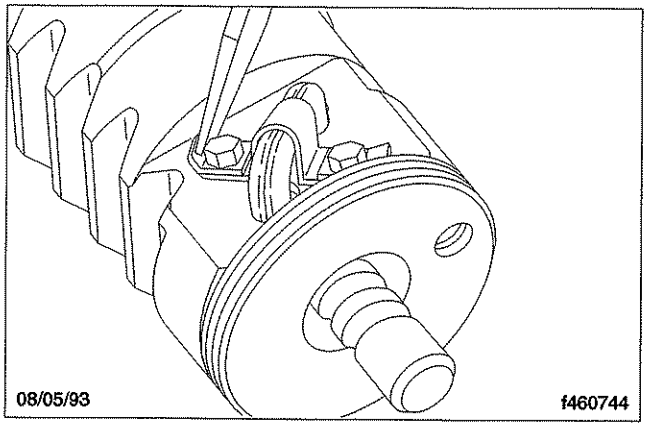


Fig. 31, Bend the Tangs

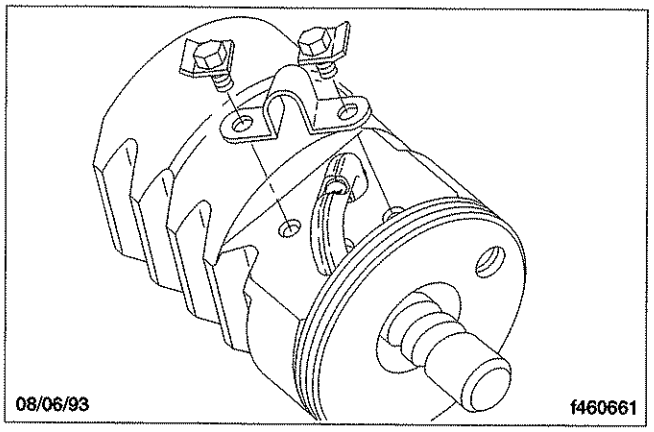


Fig. 32, Remove the Bolts, Tabs, and Guide Clip

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

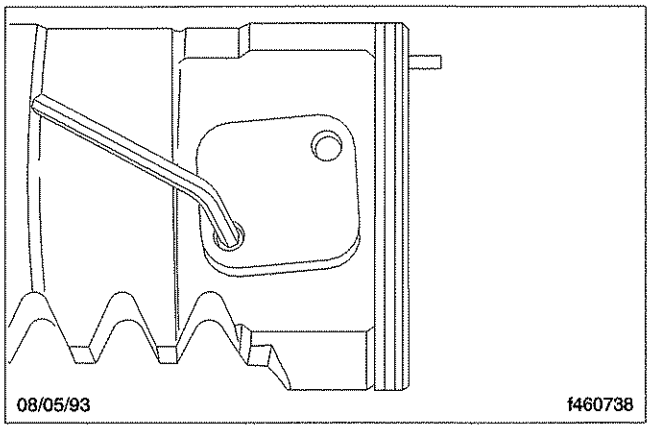


Fig. 33, Remove the Allen Head Screws

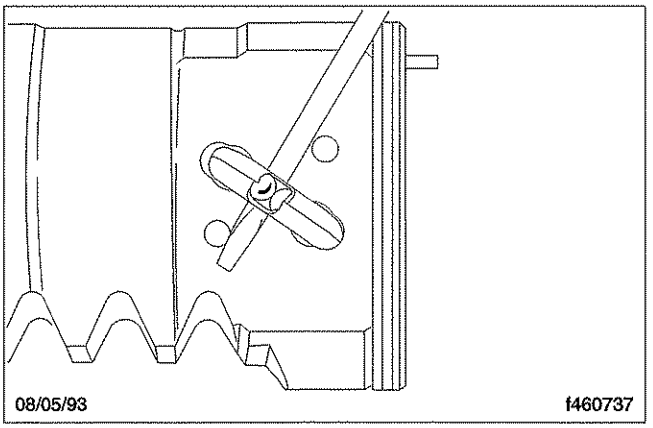


Fig. 35, Remove the Ball Return Guide Halves

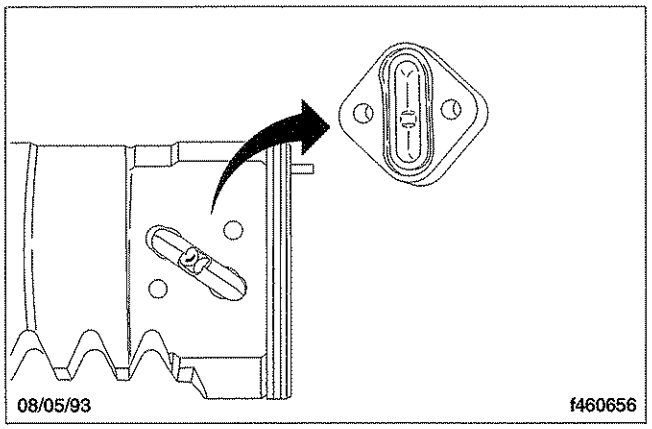


Fig. 34, Remove the Return Guide Cap Seal

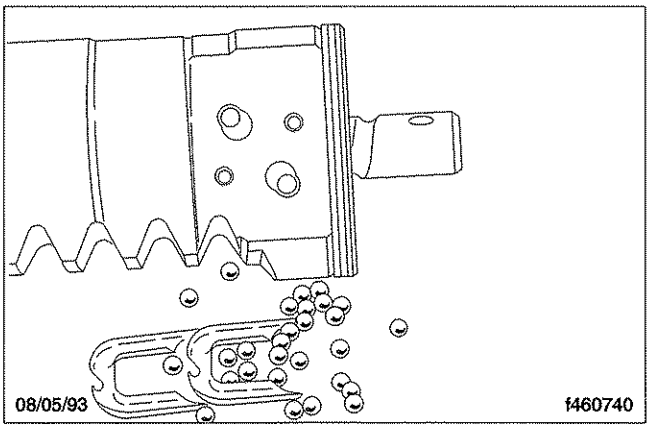


Fig. 36, Remove the Steel Balls

⚠ WARNING

Never mix different sets of steel balls. To do so may cause a loss of steering control, which could cause an accident resulting in serious injury or property damage.

NOTE: The ball return guide is closely fitted with the rack piston. It may be necessary to remove the halves by carefully inserting a screwdriver between the rack and the guide.

32. Remove the worm shaft from the rack piston. See **Fig. 37**.
33. Remove and discard the rack piston seal ring (**Fig. 38**) and the backup O-ring (**Fig. 39**).
34. Remove and discard the worm shaft seal ring and O-ring. See **Fig. 40**.

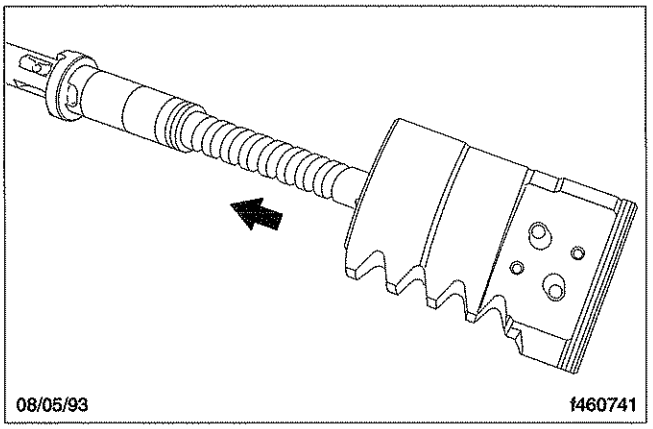


Fig. 37, Remove the Worm Shaft

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

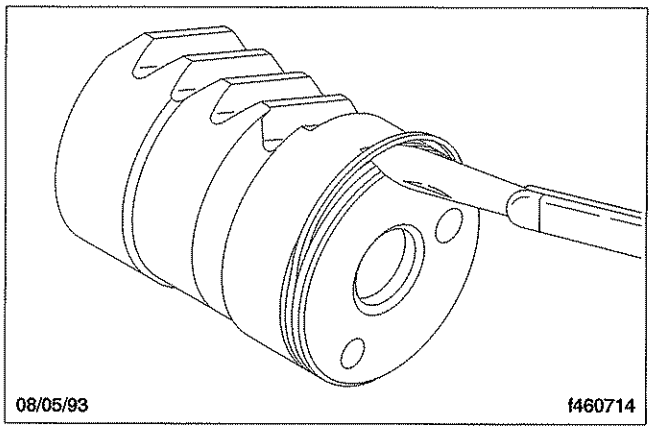


Fig. 38, Remove the Seal Ring

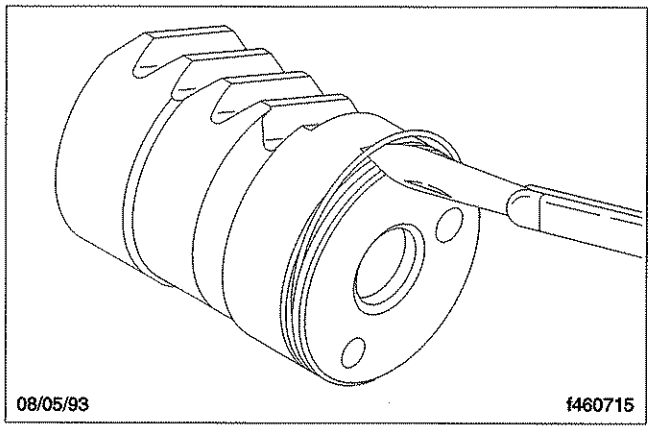


Fig. 39, Remove the O-Ring

⚠ WARNING

Wear eye protection when removing the poppets. The poppets are spring-loaded, and could be ejected, which could result in serious eye injury.

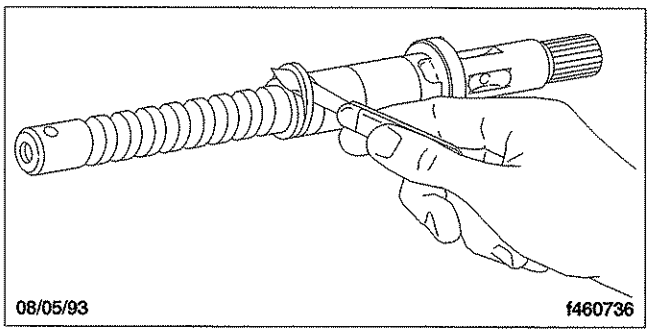


Fig. 40, Remove the Seal Ring and O-Ring

IMPORTANT: Don't disassemble the input shaft or worm shaft assembly any further. These aren't serviceable. See **Fig. 41**.

35. The poppets will usually not require servicing. If it is necessary to service the poppets, position the rack piston in a soft-jawed vise. Remove the two poppet retaining rings (**Fig. 42**), two poppet seats (**Fig. 43**), two poppets, the nylon spacer rod, and the poppet spring. See **Fig. 44**.

Inspection

All sealing surfaces and seal cavities must be free of nicks and corrosion. If any part is nicked or corroded where sealing occurs, replace the part to ensure proper sealing.

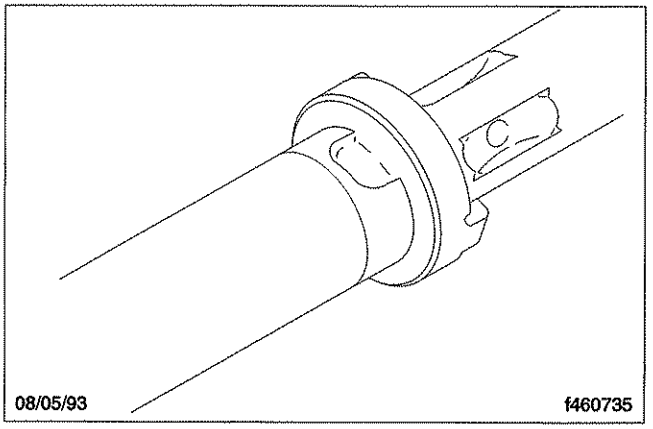


Fig. 41, Input Shaft/Worm Shaft Assembly

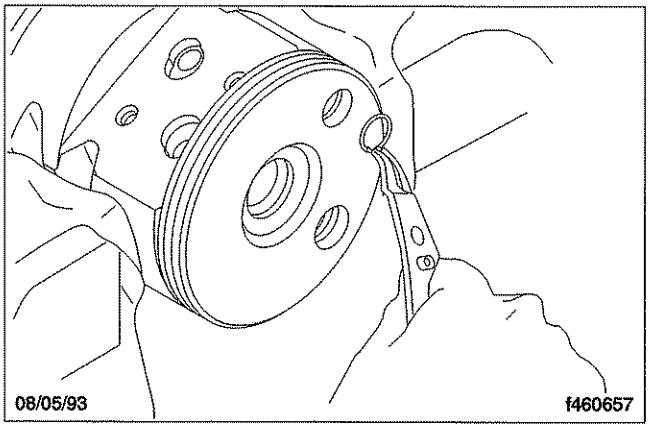


Fig. 42, Remove the Poppet Retaining Rings

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

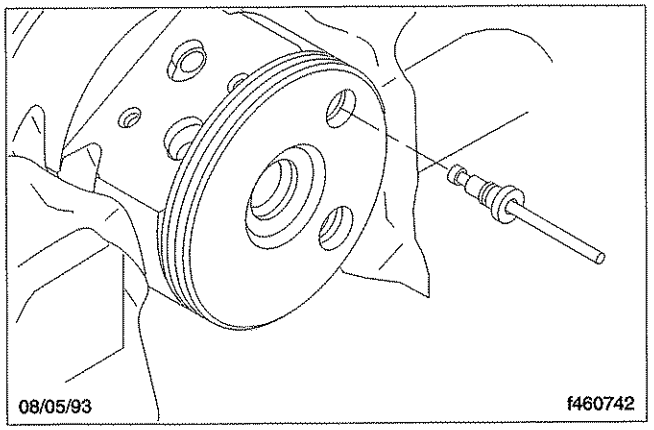


Fig. 43, Remove the Poppet Seats

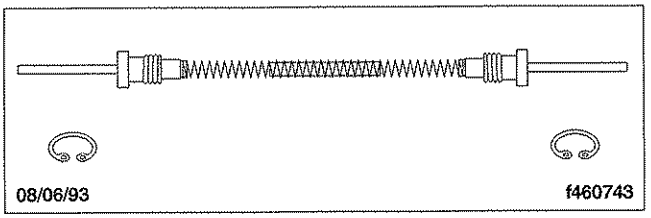


Fig. 44, Remove the Poppets, Spacer Rod, and Spring

Wash all parts in clean petroleum-based solvent, then blow-dry them.

1. Inspect the rack piston teeth for cracks and wear. See **Fig. 45**. If a step can be detected by running your fingernail horizontally across the teeth surfaces, replace both the rack piston and the sector shaft.
2. Inspect the rack piston internal ball-track grooves for brinelling (dents) or spalling (flaking). See **Fig. 46**. If either condition exists, replace the following parts: the rack piston, the worm shaft/ input shaft assembly, the set of 34 steel balls, and the valve sleeve.
3. Inspect the worm shaft ball-track grooves for brinelling or spalling. See **Fig. 47**. If either condition exists, replace the following parts: the worm shaft/input shaft assembly, the rack piston, the set of 34 steel balls, and the valve sleeve. Inspect the upper shaft seal area, near the input shaft serrations, for nicks. Run your fingernail across the sealing surface to detect steps. See **Fig. 48**.

NOTE: The input shaft is pinned to the worm shaft by the torsion bar pin. The assembly is flexible, and may appear slightly bent at this joint. See **Fig. 49**. This slight bend is normal.

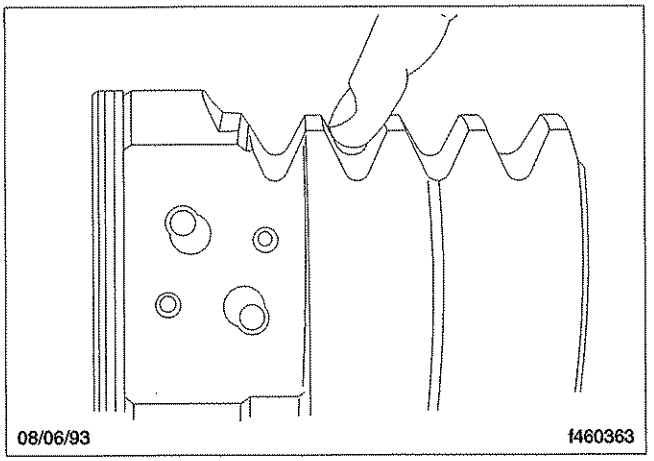


Fig. 45, Inspect the Rack Piston Teeth

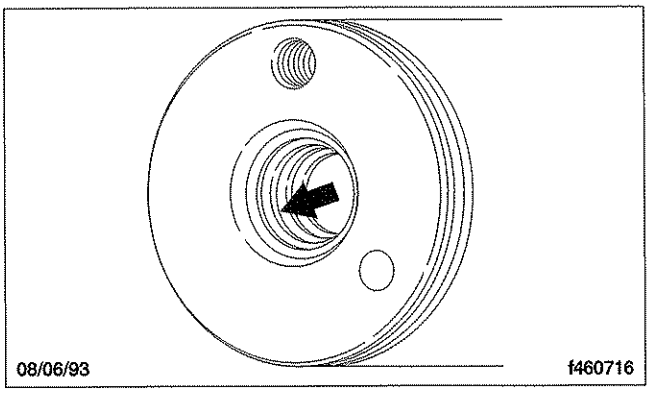


Fig. 46, Inspect the Rack Piston Internal Grooves

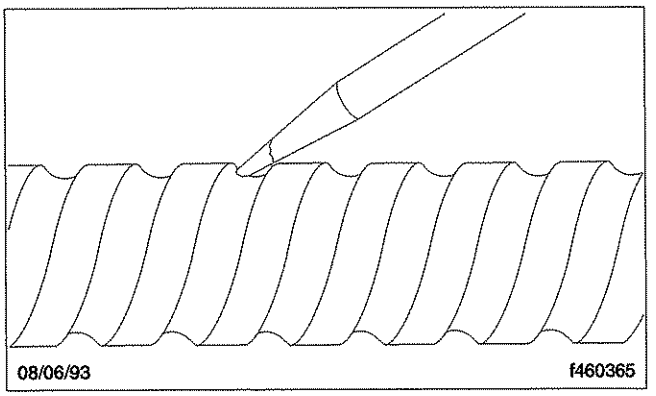


Fig. 47, Inspect the Worm Shaft

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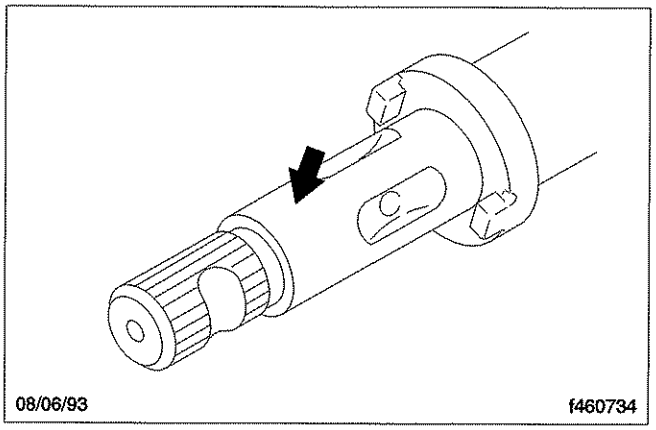


Fig. 48, Inspect the Sealing Surface

4. Inspect the housing cylinder bore. See **Fig. 50**. Minor scoring marks running lengthwise through the bore are normal, and should not be compared to the scoring that might be found in the cylinder bores of an internal combustion engine. Replace the housing only if it has been tested for internal leakage, and it is determined that the scoring is responsible for internal leakage greater than 1.5 gpm (5.7 Lpm). For test procedures, refer to **Troubleshooting 300**.

NOTE: In evaluating the results of this test, make sure that internal leakage exceeding 1.5 gpm (5.7 Lpm) is attributed only to the housing, and not to the seals in the worm shaft, rack piston, and valve assembly.

5. Inspect the housing faces for nicks that would prevent proper sealing. See **Fig. 51**. Replace the gear housing if these nicks cannot be easily removed with a fine-toothed flat file, without changing the dimensional characteristics.

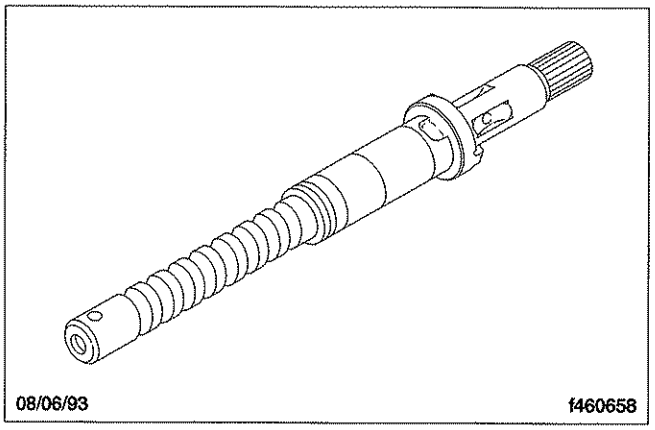


Fig. 49, Input Shaft/Worm Shaft Assembly

6. Inspect the housing bearing (**Fig. 52**) for brinelling or spalling. If either condition exists, replace the housing bearing.

   Inspect the side cover bearing (**Fig. 53**) for brinelling or spalling. If the side cover bearing is damaged, replace the complete side cover assembly.

7. Inspect the sector shaft bearing sealing areas for brinelling or spalling. See **Fig. 54**. Run your fingernail across these areas to detect steps. Also, inspect for cracks. If any of these conditions exist, replace the sector shaft.

8. Check the sector shaft assembly for damaged adjusting screw threads. Make sure the adjusting

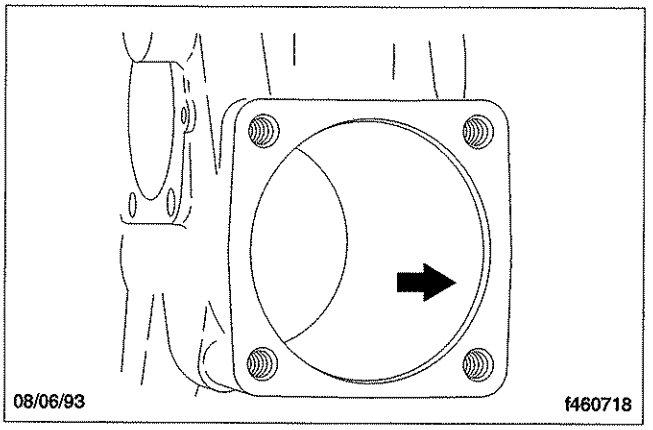


Fig. 50, Inspect the Housing Cylinder Bore

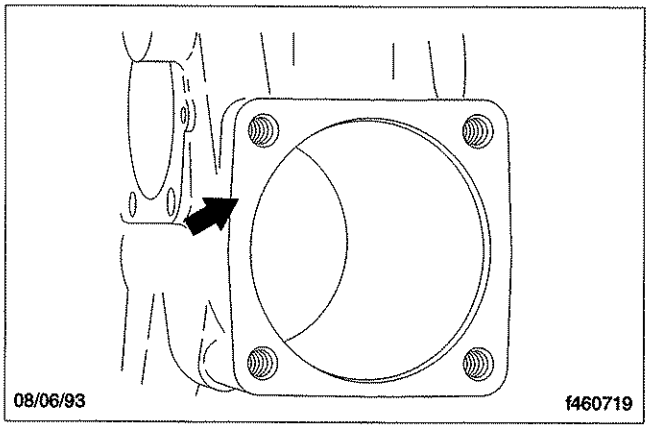


Fig. 51, Inspect the Housing Faces

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

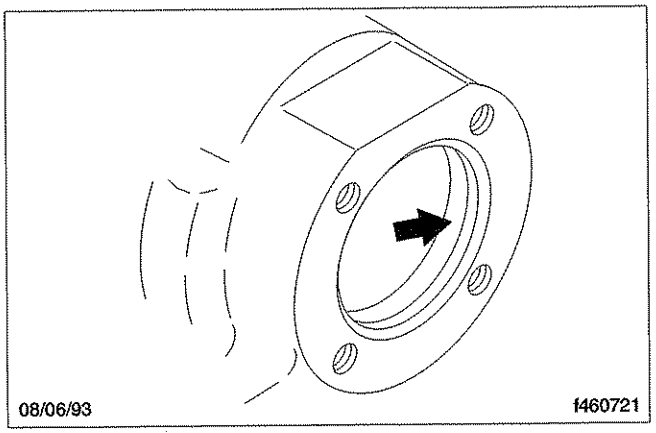


Fig. 52, Inspect the Housing Bearing

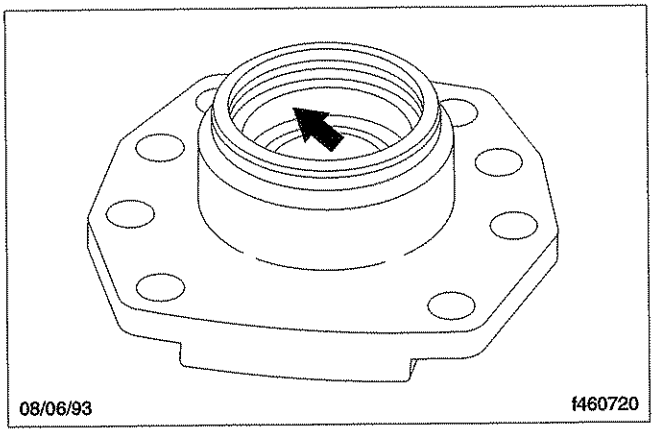


Fig. 53, Inspect the Side Cover Bearing

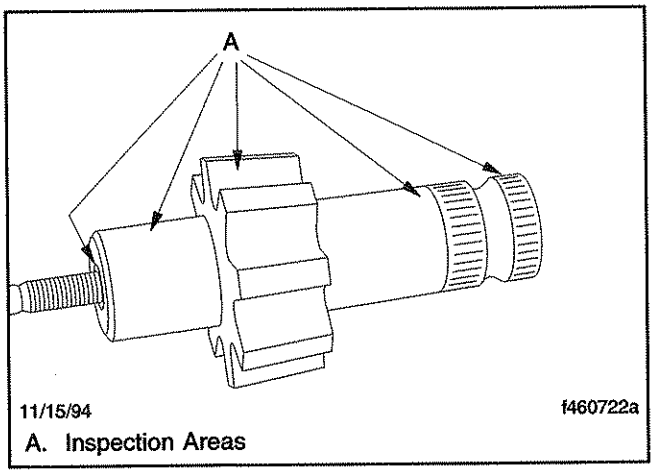


Fig. 54, Sector Shaft Bearing

screw retainer is locked in place and has no cracks. The adjusting screw must turn by hand with no end play (lash). If the adjusting screw is damaged, replace it and its retainer.

9. Inspect the thrust bearing rollers for any deterioration. Inspect the two thrustwashers for brinelling, spalling, or cracks. See **Fig. 55**. Replace any part if these conditions are detected.

Assembly

IMPORTANT: The special tools required for disassembly and assembly of the steering gear parts are available from the Kent-Moore Tool Division, or an affiliated dealer. See the special tools Table in **Specifications, 400** to be sure that you have the required tools before beginning the service procedures.

Replace all seals, seal rings, and gaskets, with new ones each time the gear is disassembled. Individual seals, seal rings, and gaskets, as well as complete seal kits are available from Freightliner part distributors.

1. Using seal installation tool J26739, assemble the new worm shaft backup O-ring (**Fig. 56**), and then the new Teflon® worm shaft seal ring (**Fig. 57**). Compress the seal ring with compression tool J26740 (**Fig. 58**) and set the worm shaft aside for 10 minutes.

⚠ CAUTION

Allow 10 minutes for the ring and seal to properly seat before installing the worm shaft into the rack piston. If not, the seal may tear or be cut when placing the worm into the rack.

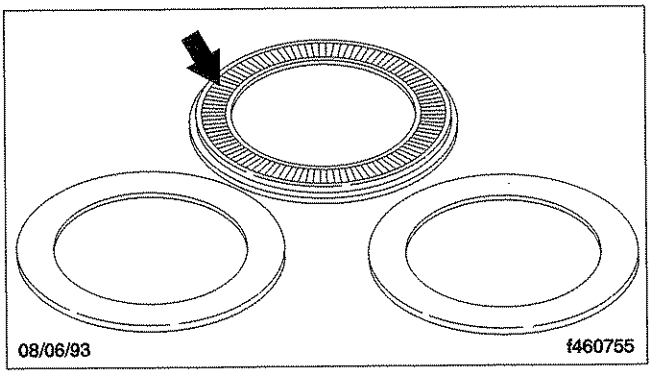
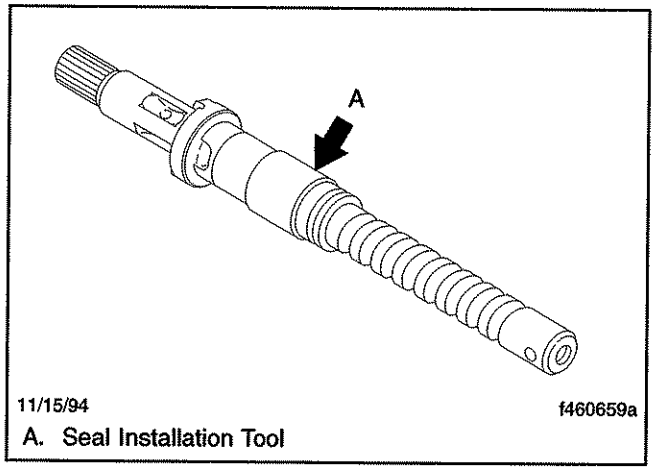


Fig. 55, Thrust Bearing Rollers and Thrustwashers

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments



A. Seal Installation Tool

Fig. 56, Worm Shaft Backup O-Ring

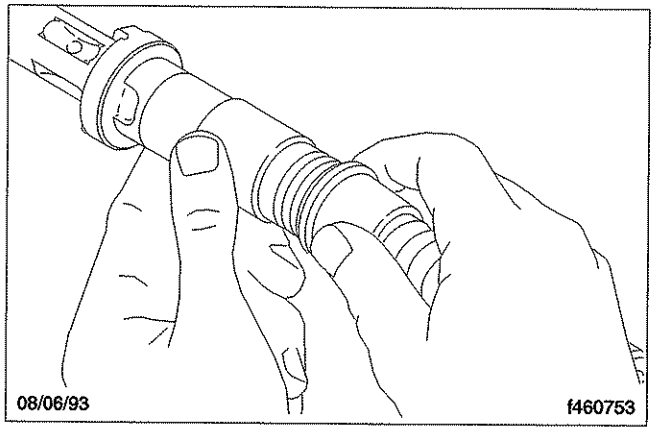


Fig. 57, Worm Shaft Seal Ring

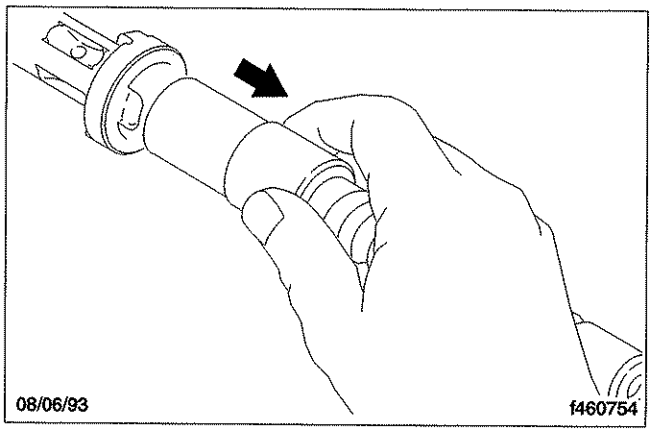


Fig. 58, Compress the Seal Ring

2. If installing a new housing bearing, install the retaining ring into the groove on the bearing's outside diameter. Then, press the bearing into the housing from the trunnion side, using bearing mandrel J26743 against the lettered end of the bearing shell, so the retaining ring end is away from the housing bore. See **Fig. 59**. Be sure the bearing mandrel is clean. Be sure the housing is square with the press base and that the bearing is not cocked.
3. Whether or not a new bearing race was installed, apply a generous amount of clean grease to the bearing race to retain the bearing rolls. Then, place the bearing rolls into the bearing race. Be sure that the rolls have been counted correctly, and the quantity matches the quantity required for the housing bearing part number.

⚠ WARNING

The bearing rolls must be in place to ensure proper installation of the bearing. If the rolls are improperly installed, the bearing race may collapse or the flange may break. Do not mix the housing bearing rolls with the side cover bearing rolls. Interchanging the rolls could result in bearing or seal damage. This could cause a loss of steering, which could result in an accident causing personal injury or property damage.

NOTE: If bearing BR-970 is being installed, install 41 rolls. If bearing BR-970-1 is being installed, install 42 rolls.

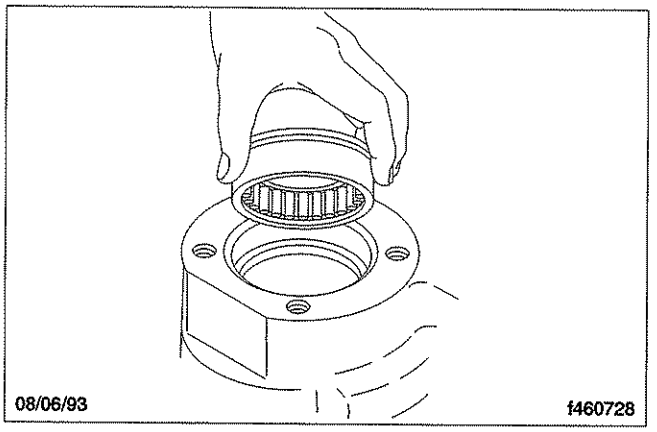


Fig. 59, Press the Bearing into the Housing

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

4. Install a new rack piston backup O-ring (**Fig. 60**), and a new Teflon® rack piston seal ring (**Fig. 61**). Do not stretch these rings when installing them. After they are installed, coat them with a liberal amount of grease.
5. Install the parts of the poppet assembly in the following order: one poppet seat (**Fig. 62**), then (from the other end of the poppet hole in the piston) one poppet, the poppet spring, the nylon spacer rod (**Fig. 63**), the other poppet, and the other poppet seat (**Fig. 64**).

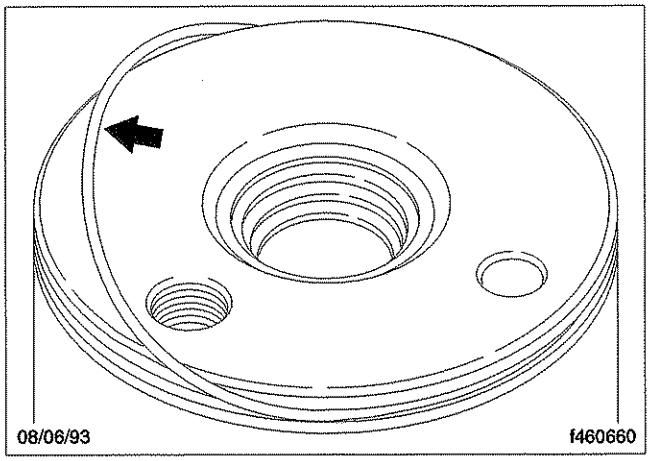


Fig. 60, Install the Backup O-Ring

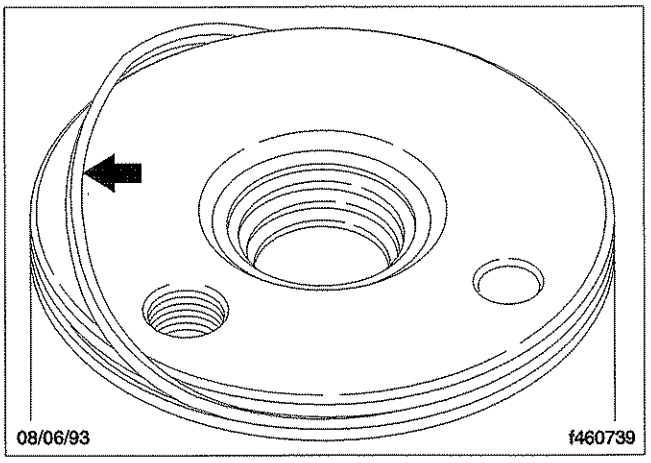


Fig. 61, Install the Seal Ring

⚠ WARNING

Wear eye protection while assembling the poppets. The poppets are spring-loaded, and could be ejected, which could result in serious eye injury.

6. Tighten the poppet seats 20 to 25 lbf·ft (27 to 34 N·m). Install both retaining rings.
7. If more than 10 minutes have passed since installing the worm shaft seal and ring, grease the sealing surface inside the rack piston, and install the worm shaft/input shaft assembly into the rack piston. See **Fig. 65**.
8. Install the ball return guides.

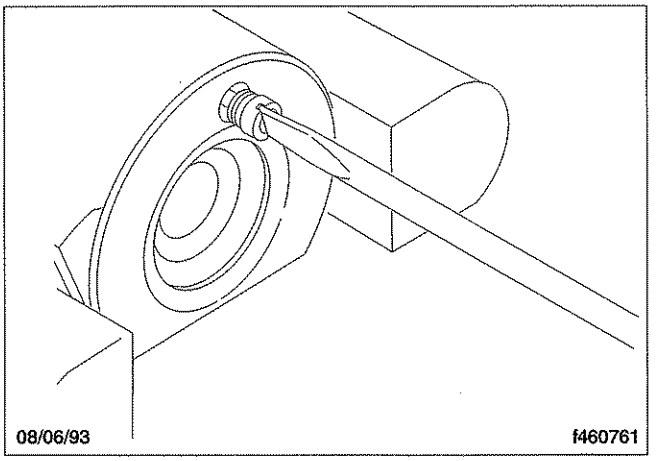


Fig. 62, Install the Poppet Assembly

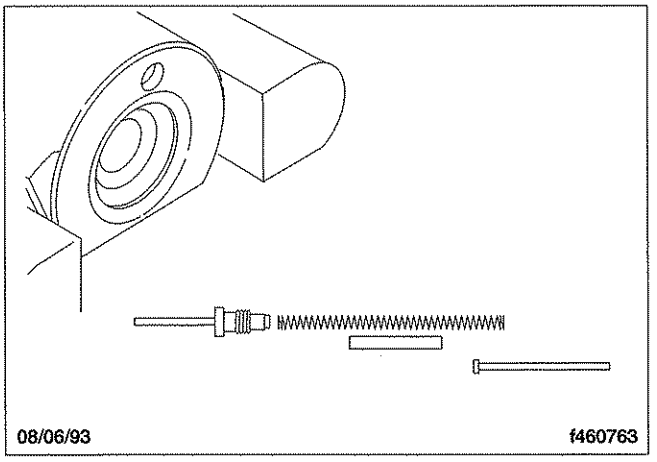


Fig. 63, Poppet, Spring, and Spacer Rod

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

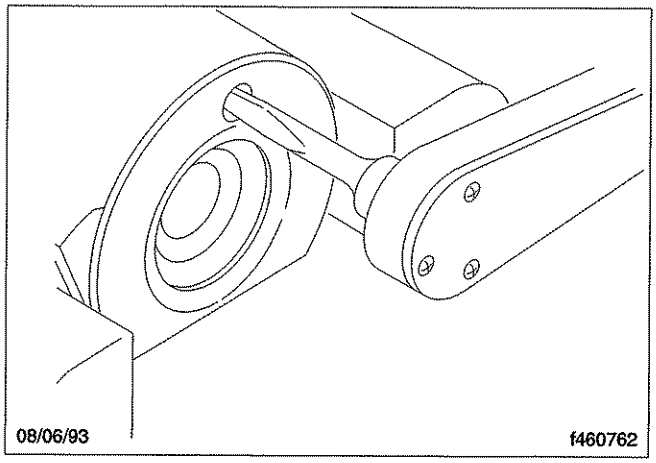


Fig. 64, Poppet and Poppet Seal

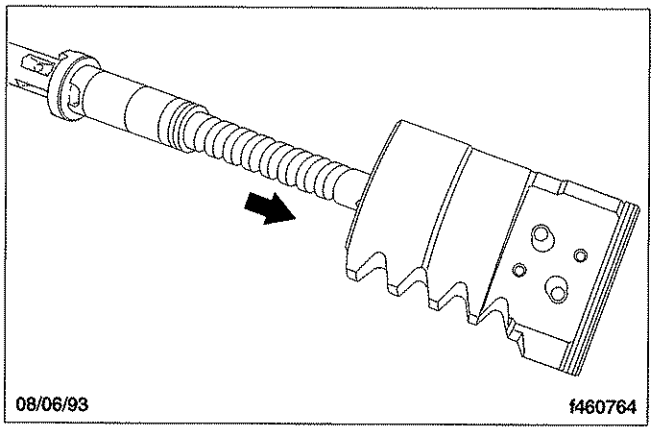


Fig. 65, Install the Worm Shaft/Input Shaft Assembly

8.1 For ball return guides with a hole in the top, install the guides in the rack piston. Make sure they're seated.

⚠ WARNING

Do not seat the guides with a hammer. This could damage them and cause steering gear lockup or loss of steering, resulting in an accident causing personal injury or property damage.

8.2 Place the 34 balls in the ball return guides and rack piston. Drop them through the hole provided in the ball return guides. As the balls are dropped into the guide, turn the worm shaft to pull them down into the grooves. See **Fig. 66.**

⚠ WARNING

Make sure the ball return guide stays down and in place while you are inserting the steel balls or turning the worm shaft. Failure to hold the ball guide down may result in a ball being trapped outside the closed loop. A trapped ball could cause a steering lockup, which could result in an accident causing personal injury or property damage.

8.3 For ball return guides without a hole in the top, insert the eraser end of a pencil into one hole of the rack piston as far as it will go. Drop 22 balls (of the 34 total) into the other hole of the rack piston. See **Fig. 67.** Turn the worm shaft to advance the balls toward the other hole. There will be resistance after the 22nd ball is dropped. A ball will be visible at the base of each hole. Remove the pencil.

⚠ WARNING

Do not turn the worm shaft or allow the rack piston to move after removing the pencil. If the worm shaft or rack piston moves, a ball can move into the dead track beyond the ball return guides. This can result in steering lockup, which could result in an accident causing personal injury or property damage.

8.4 Apply a generous amount of clean grease on the ball return guides, and insert the remaining 12 balls into a guide half. See

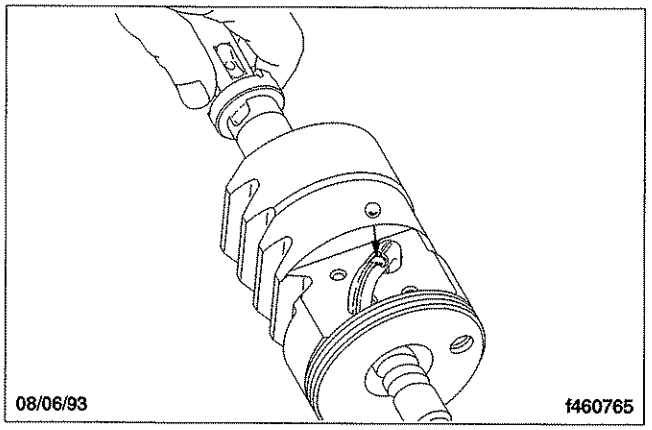


Fig. 66, Install the Steel Balls

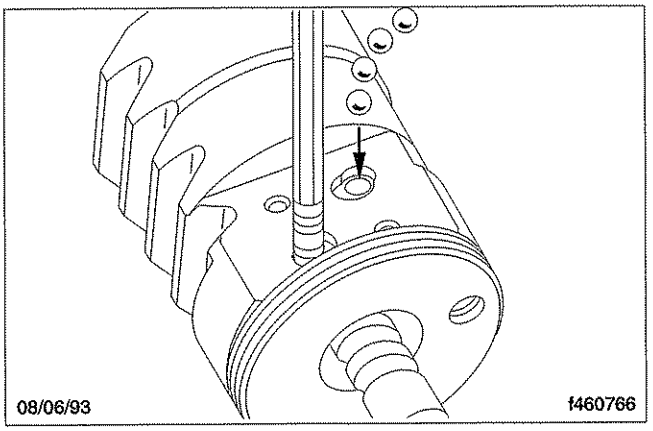


Fig. 67, Install the Steel Balls

Fig. 68. Join the guide halves and install in the rack piston.

9. If equipped with the ball return guide clip (**Fig. 69**), assemble it, and make sure that both bolt hole faces are in full contact with the rack piston surface. Install the two locktabs and the two hexhead bolts. Tighten the bolts 14 to 22 lbf·ft (19 to 30 N·m). See **Fig. 70**. Bend the locking tabs up against the bolt head flats. See **Fig. 71**.

10. If equipped with the ball return guide cap (**Fig. 72**), grease the cap seal and install the seal in the ball return guide cap groove. Install the guide cap so that the seal is in full contact with the rack piston surface. Install two new allen head screws and tighten them 14 to 22 lbf·ft (19 to 30 N·m). See **Fig. 73**.

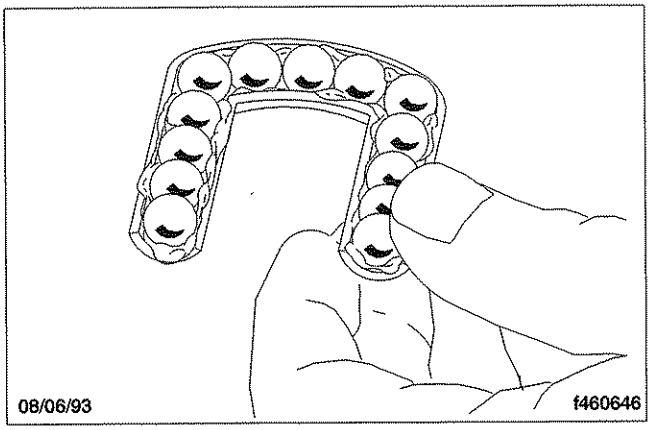


Fig. 68, Steel Balls in a Guide Half

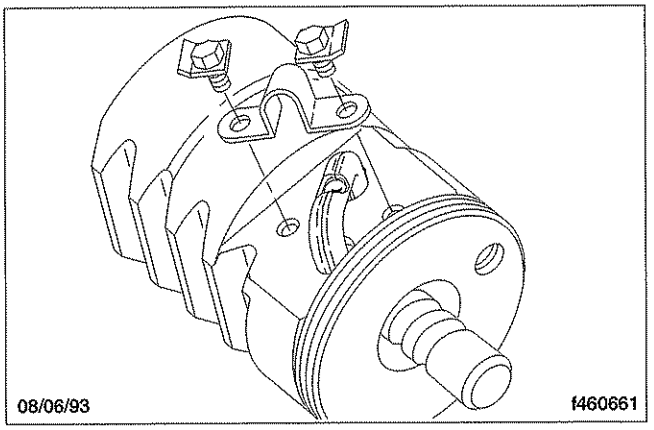


Fig. 69, Install the Ball Return Guide Clip

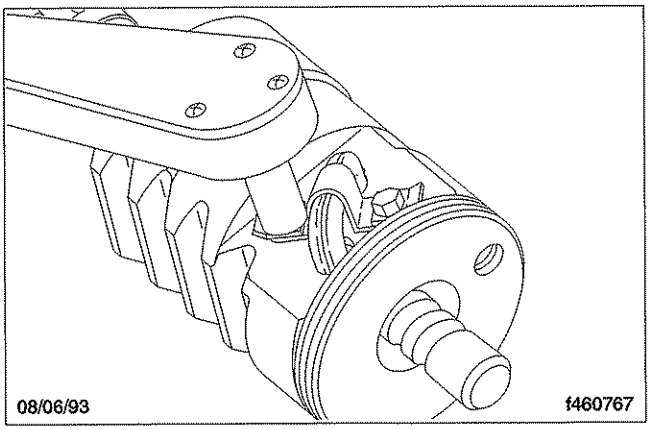


Fig. 70, Tighten the Bolts

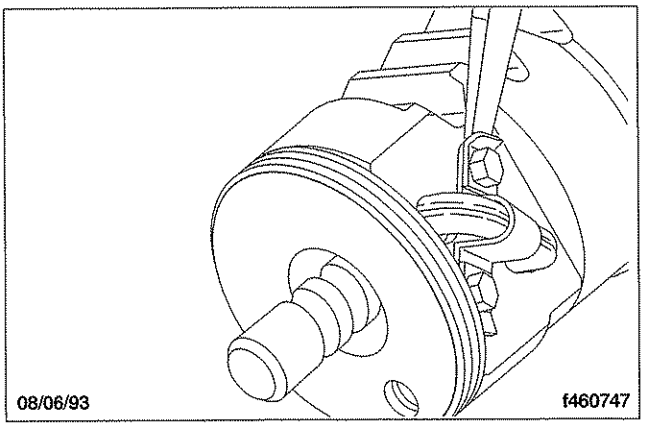


Fig. 71, Bend the Locking Tabs

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

⚠ WARNING

Turn the worm shaft from one end of travel to the other, to be sure the balls are installed properly. If the worm shaft won't turn, remove the balls and install them again. If the steering gear is installed on a vehicle when the worm shaft doesn't turn, the gear will not work correctly. This could cause loss of steering control, which could result in an accident causing personal injury or property damage.

11. Apply a generous amount of clean grease to the Teflon® rack piston seal and to the housing cylinder bore. See **Fig. 74.** Install the rack piston and worm shaft as an assembly in the gear housing, so that the Teflon® rack piston seal goes in last. See **Fig. 75.**

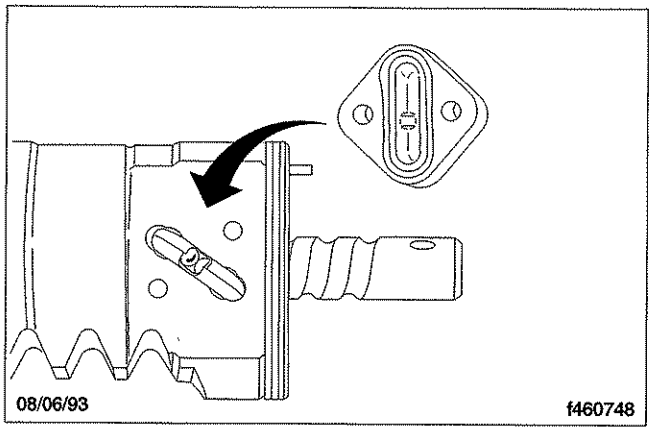


Fig. 72, Install the Ball Return Guide Cap

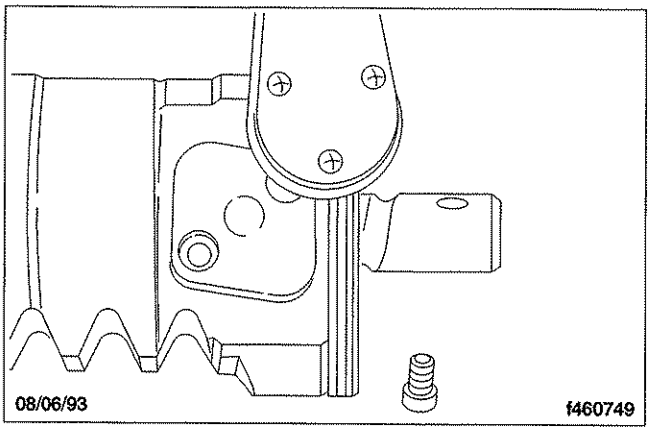


Fig. 73, Tighten the Allen Head Screws

⚠ WARNING

Be sure the seal is placed in the housing last. Otherwise, a large section of the seal will be cut, and the vehicle will have no power steering assist. This could cause an accident resulting in personal injury or property damage.

NOTE: To ease the later assembly of the sector shaft, turn the rack piston and worm shaft assembly in the housing so that the rack teeth are exposed in the sector shaft cavity of the housing.

12. Install the worm shaft adjusting screw jam nut on the nonslotted end of the worm shaft preload adjusting screw, so that the seal on the jam nut faces the end cover.

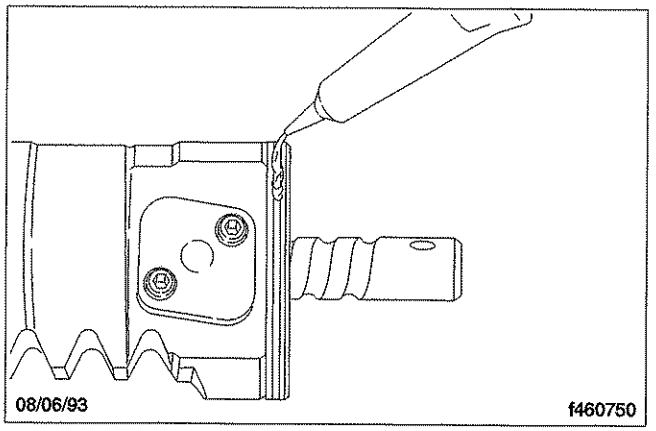


Fig. 74, Lubricate the Seal and Housing Cylinder Bore

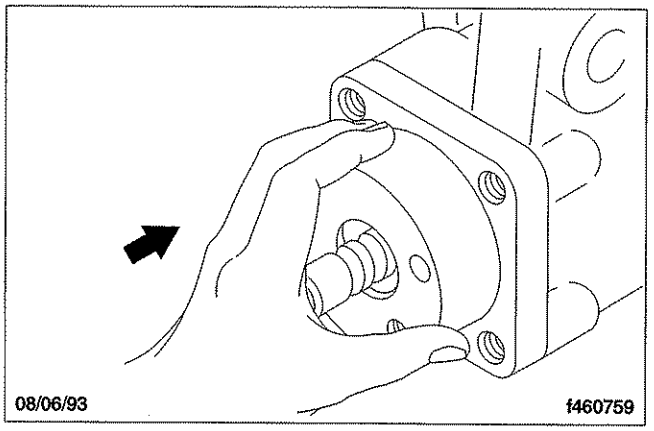


Fig. 75, Install the Rack Piston/Worm Shaft Assembly

13. Assemble and install one poppet valve adjusting screw and jam nut in the same manner. Assemble the other poppet valve adjusting screw jam nut onto the poppet valve adjusting screw.

⚠ WARNING

If the screw lengths are unequal, install the shorter screw in the end cover. Otherwise, the poppet assembly could break and cause a steering lockup, which could result in an accident causing personal injury or property damage.

NOTE: The poppet valve adjusting screws may not be of the same length. If not, insert the shorter adjusting screw into the end cover a few turns.

14. Install the worm shaft preload adjusting screw in the end cover a few turns.

15. Grease the end cover O-ring groove and install the new end cover O-ring. See **Fig. 76**.

NOTE: When installed, the O-ring should extend slightly above the machined surface of the end cover.

16. Position the end cover so that the poppet adjusting screw is aligned with the end of the poppet. See **Fig. 77**.

    Make sure the rack piston teeth are fully visible in the sector shaft cavity of the housing. This ensures proper location of the poppets so that the poppet adjusting screw will contact the poppets.

    Install the four end cover bolts and tighten 150 to 170 lbf·ft (203 to 230 N·m). See **Fig. 78**.

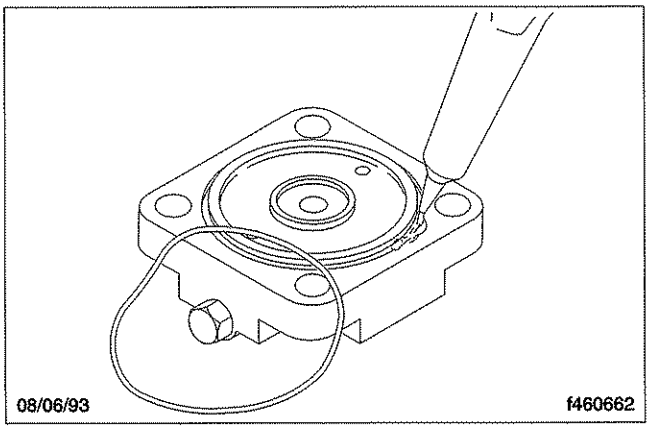


Fig. 76, Lubricate the End Cover O-Ring Groove

17. Grease two new valve-sleeve backup O-rings and two new Teflon® seal rings. Install the backup O-rings on the valve sleeve. See **Fig. 79**. Then use seal installation tool J26741 to install the seal rings on the valve sleeve. See **Fig. 80**.

18. Using special tool J26742, compress the Teflon® seal rings. See **Fig. 81**. Leave the tool on for 10 minutes.

⚠ CAUTION

Allow at least 10 minutes for the seals to properly seat. Otherwise the valve sleeve will be difficult to install in the valve housing, and the seal may be cut during installation.

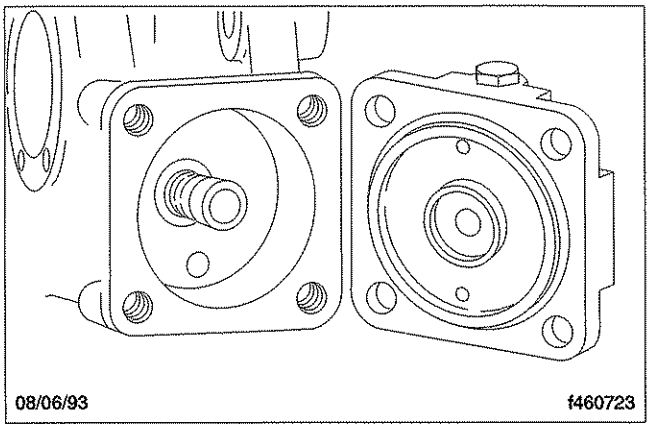


Fig. 77, Position the End Cover

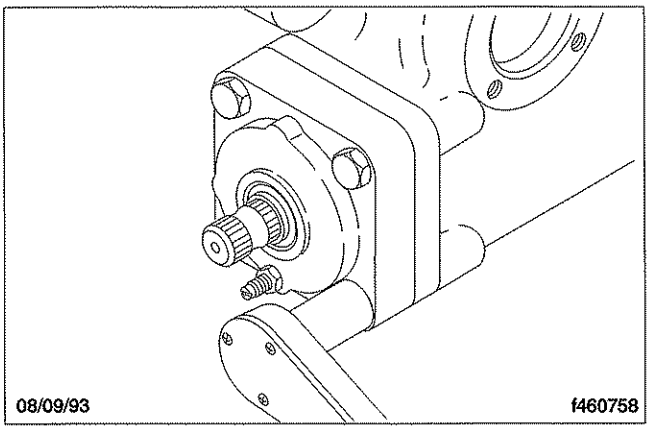


Fig. 78, Install the End Cover Bolts

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

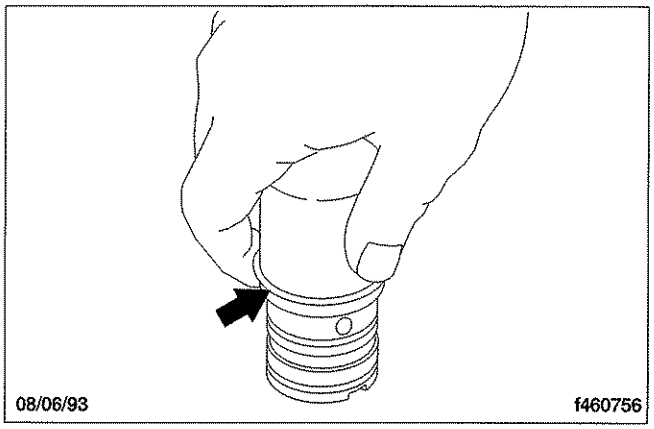


Fig. 79, Install the O-Rings on the Valve Sleeve

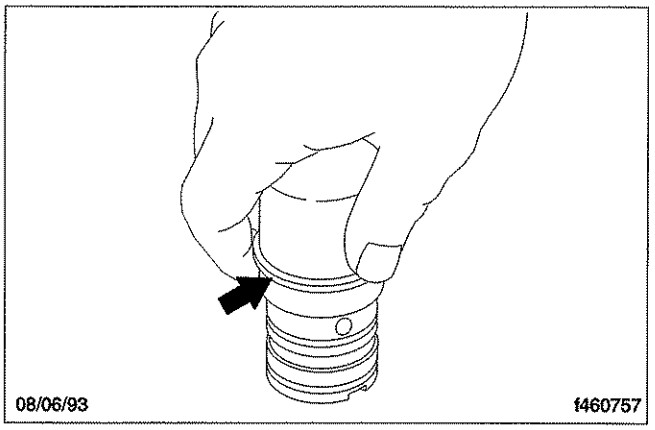


Fig. 80, Install the Seal Rings on the Valve Sleeve

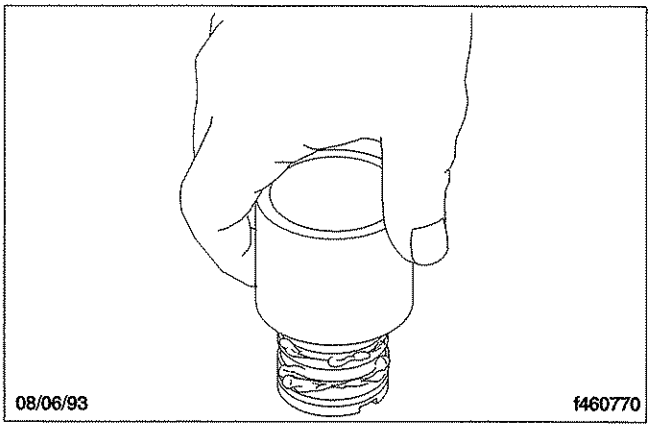


Fig. 81, Compress the Seal Rings

19. Turn the poppet valve adjusting screw into the valve housing 4 or 5 turns. Final adjustments will be made later.

20. Apply clean grease to the O-ring groove in the valve housing. Install a new valve housing O-ring in the groove. See **Fig. 82.**

NOTE: When installed, the valve housing O-ring should extend slightly above the machined surface of the valve housing.

21. Apply a generous amount of clean grease to one thrustwasher. Install the thrustwasher into the valve housing. Be sure the washer is centered. See **Fig. 83.**

22. Apply a generous amount of clean grease to the thrust bearing. Install the bearing in the valve

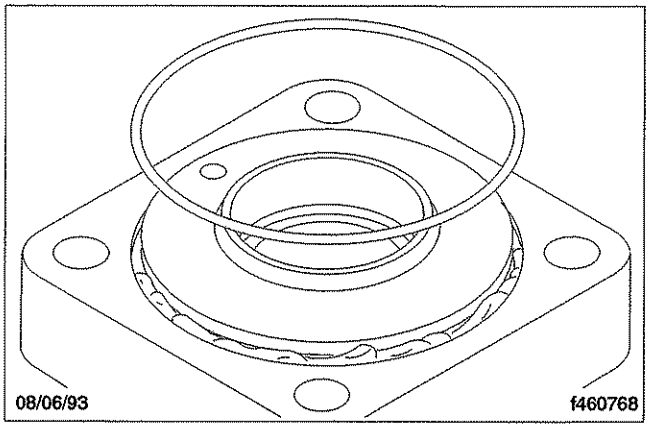


Fig. 82, Install the Valve Housing O-Ring

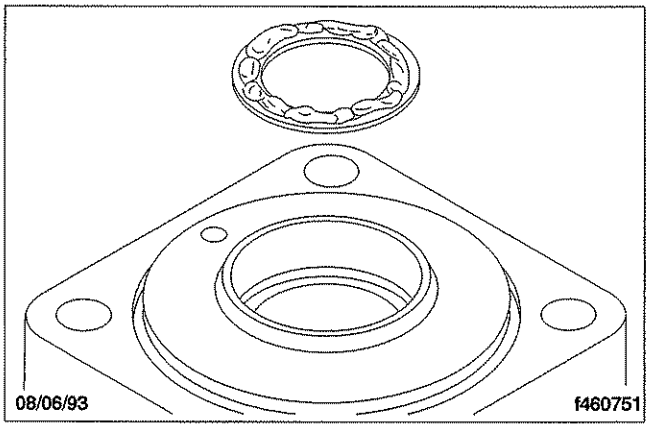


Fig. 83, Install the Thrustwasher in the Valve Housing

housing and onto the first thrustwasher. Be sure the bearing is centered. See **Fig. 84**.

⚠ WARNING

The thrustwasher and thrust bearing must be flat and centered in the counterbore surface of the valve housing. See Fig. 85. Otherwise, the thrustwasher could break when the valve housing is installed on the gear housing. A broken thrustwasher could cause the steering gear to malfunction. This could cause a loss of vehicle control, which could result in an accident causing personal injury or property damage.

23. Remove the compression tool from the valve sleeve. Apply more grease to the valve sleeve seals. Grease the thrustwasher face on the end of the valve sleeve that is without the drive slots. Place the second thrustwasher on this face. See **Fig. 86**.

⚠ WARNING

The thrustwasher must fit securely on the valve sleeve. If not, it can break, and cause a loss of vehicle control. This could cause an accident resulting in personal injury or property damage.

24. Install the valve sleeve and the attached thrustwasher into the valve housing. See **Fig. 87**. When the valve sleeve is in place, it should measure between 0.370 and 0.400 inch (9 and 10 mm) above the face of the valve housing to the end of the valve sleeve nose. See **Fig. 88**.

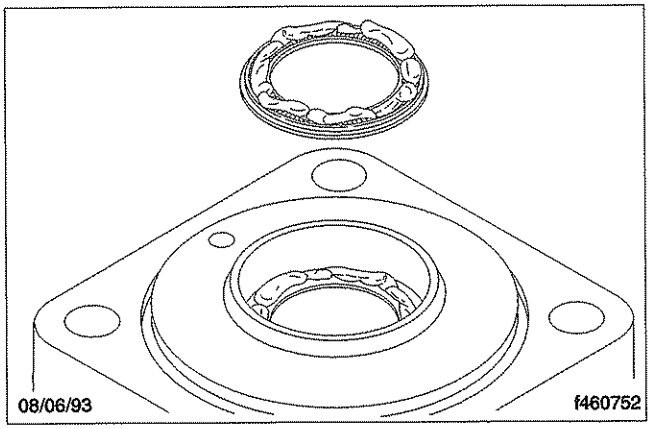


Fig. 84, Install the Bearing in the Valve Housing

⚠ WARNING

Do not force the valve sleeve in the valve housing. Make sure the valve sleeve seal rings are compressed. A bad installation or measurement could cause the thrustwashers or thrust bearing to break during gear operation. This could result in a loss of vehicle control, which could cause an accident resulting in personal injury or property damage.

25. Move the rack piston flush with the open end of the gear housing. Turn the worm shaft until it extends out of the rack piston as far as it will go.

⚠ WARNING

The worm shaft and valve sleeve units are assembled and sold as a matched set. Use only pre-

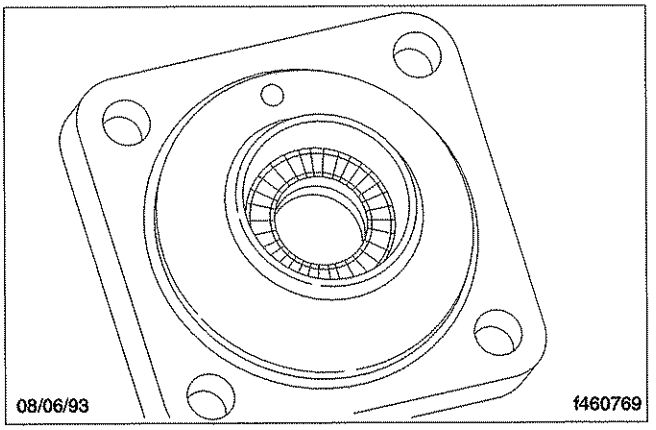


Fig. 85, Thrustwasher and Thrust Bearing

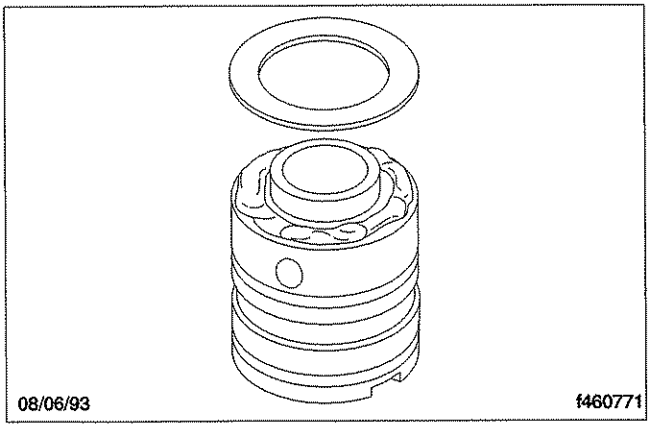


Fig. 86, Install the Second Thrustwasher

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

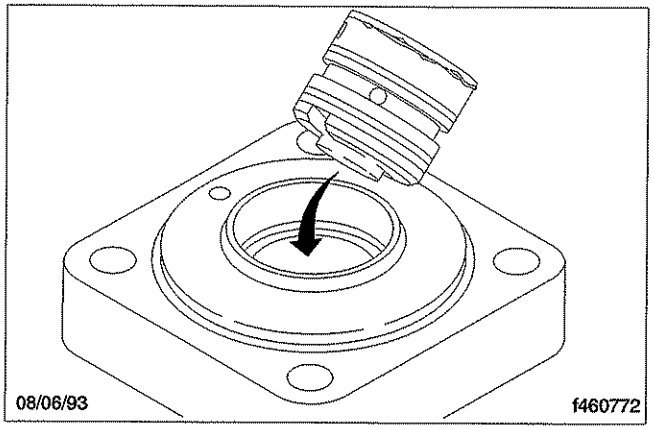


Fig. 87, Install the Sleeve into the Valve Housing

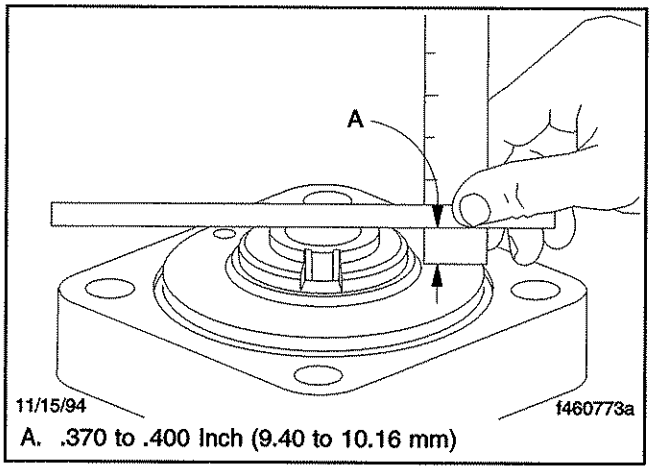


Fig. 88, Measure the Placement of the Valve Sleeve

matched sets for replacement. Never mate an old valve sleeve with a new worm shaft, or an old worm shaft with a new valve sleeve. This can result in damage to the gear and personal injury to the driver during vehicle operation.

26. Locate the timing mark (a faint punched mark on the chamfered edge of the valve sleeve or an indented mark on the front of the sleeve). See **Fig. 89**. Locate the timing mark on the worm shaft. See **Fig. 90**.

    Grasp the valve housing and valve sleeve as an assembly, with your thumbs on the valve housing and your fingers applying pressure on the valve sleeve to keep it in the valve housing. See **Fig. 91**.

    Align the previously located timing marks (**Fig. 89** and **Fig. 90**). Place the valve housing and valve sleeve, as an assembly, on the input-shaft end of the worm shaft, until the drive lugs are fully engaged. See **Fig. 92**.

⚠ WARNING

If an incorrect valve sleeve is placed on a worm, and assembled into the gear, the gear will malfunction. The mechanism will jerk the steering wheel with such force that it could cause a loss of vehicle control. This could cause an accident resulting in personal injury or property damage.

NOTE: Valve sleeves are identified with and matched to a right- or left-hand lead of the worm screw. Because the screw has a right-hand thread (that is, goes into the

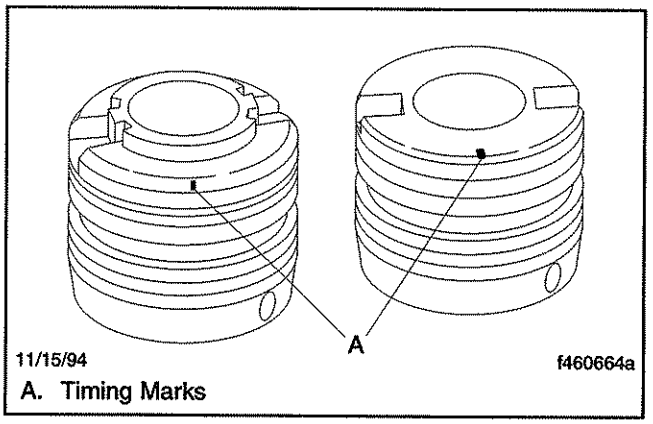


Fig. 89, Locate the Timing Marks

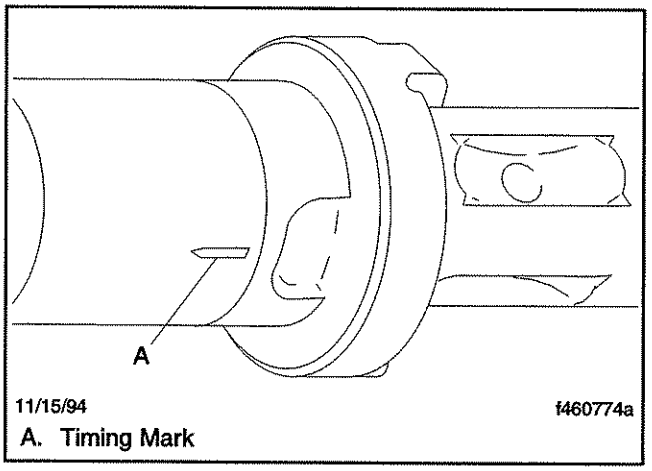


Fig. 90, Timing Mark on the Worm Shaft

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

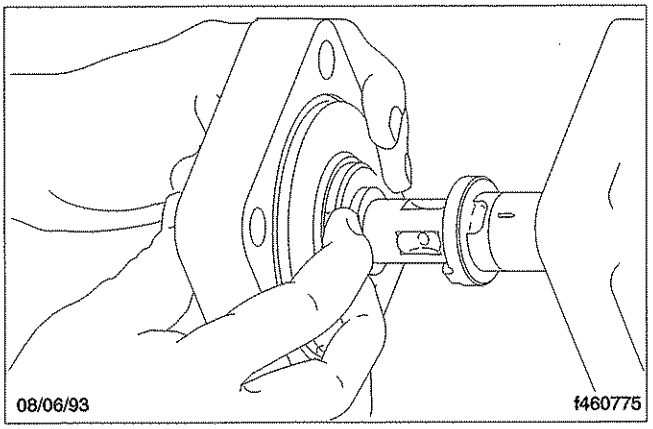


Fig. 91, Valve Housing and Valve Sleeve

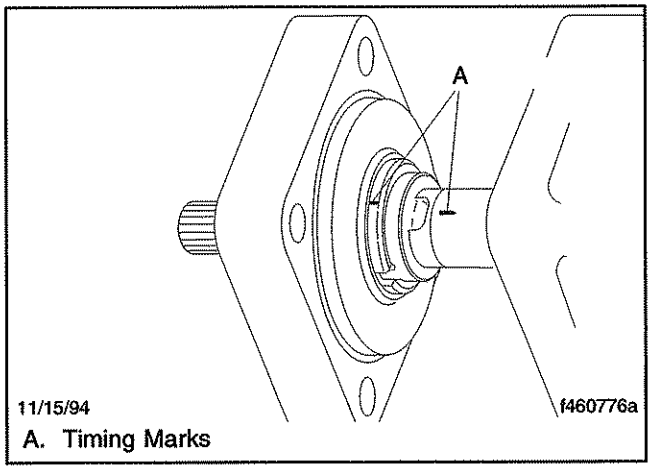


Fig. 92, Install the Valve Housing/Valve Sleeve Assembly on the Worm Shaft

rack piston when turned clockwise), the valve sleeve will have the letter R stamped between the seal lands. For a left-hand worm lead (which will come out of the rack piston when turned clockwise), the mating valve sleeve has no identifying letter or has the letter L stamped between the seal lands.

27. Maintain pressure on the valve end of the valve housing to ensure continued engagement of the drive lugs and thrust bearing package. See **Fig. 93**. While maintaining this pressure, turn the valve housing and align the poppet adjusting screw with the poppet in the rack piston. While continuing pressure, turn the input shaft to bring the valve housing into contact with the gear housing face.
28. Install the four valve housing bolts in the valve housing, and tighten them 145 to 155 lbf·ft (197 to 210 N·m). See **Fig. 94**.
29. Apply a generous amount of clean wheel bearing grease (do not substitute another type of grease) to the bearing race inside the side cover.

⚠ CAUTION

Use only wheel bearing grease. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Without wheel bearing grease, the bearing could wear prematurely.

30. Insert the bearing rolls into the side cover bearing race. See **Fig. 95**. If equipped with bearing BR-970, insert 41 rolls. If equipped with bearing BR-970-1, insert 42 rolls.

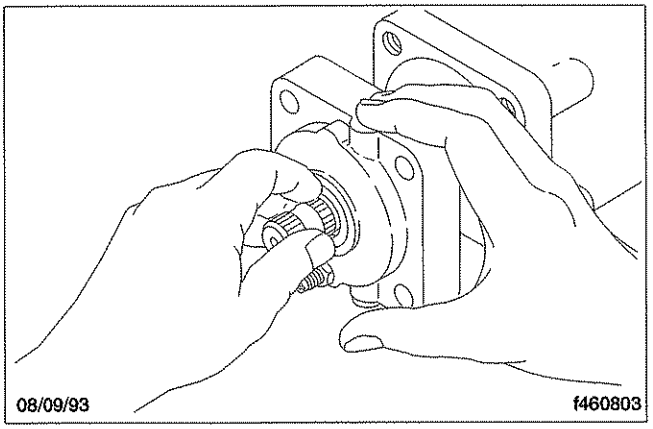


Fig. 93, Valve Housing

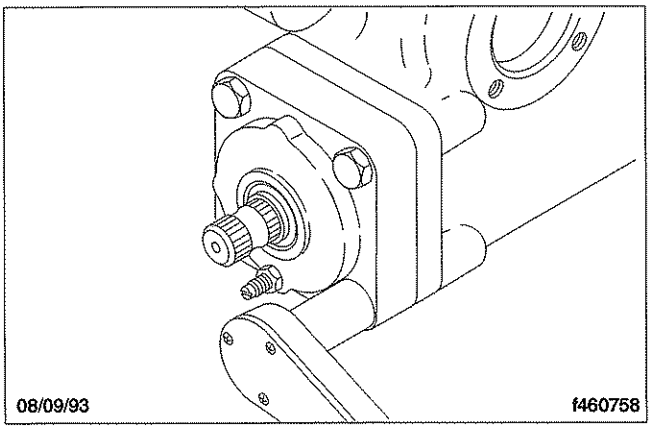


Fig. 94, Install the Valve Housing Bolts

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

NOTE: Apply clean wheel bearing grease to loose rolls, to retain them in the bearing race.

31. Install the steel backup washer, a new Teflon® backup washer, and a new two-piece side cover seal in the side cover. See **Fig. 96**.

NOTE: In newer seal kits and on some units, the Teflon® backup washer is an integral part of the two-piece seal.

32. Assemble the two-piece seal so that the words OIL SIDE are visible after it is installed.

⚠ WARNING

The words OIL SIDE must be visible once the seal is in place. Otherwise, the seal will malfunction.

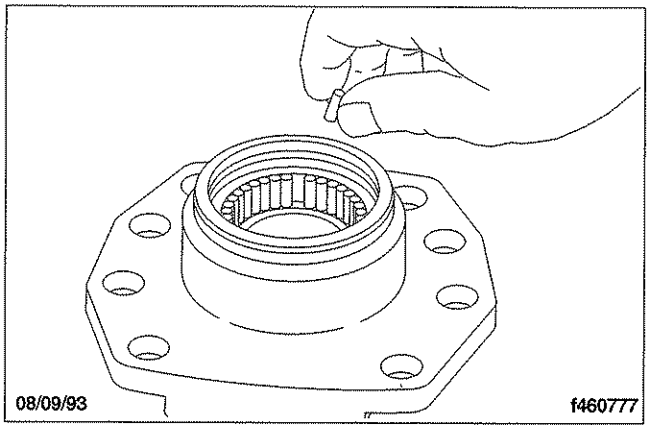


Fig. 95, Insert the Bearing Rolls into the Side Cover Bearing Race

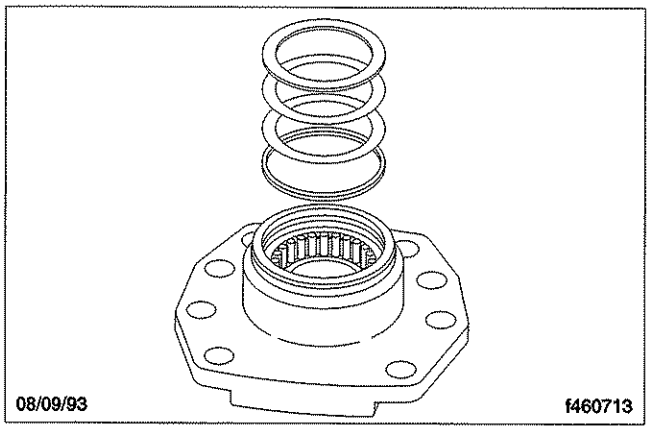


Fig. 96, Install the Washers and the Side Cover Seal

This could result in a loss of power steering assist, which could result in an accident causing personal injury or property damage.

33. Install the side cover retaining ring in the ring groove of the side cover. See **Fig. 97**.

34. Apply a generous amount of clean grease to the short bearing area of the sector shaft. Insert the sector shaft into the side cover. Turn the sector shaft adjusting screw into the side cover, until it seats. See **Fig. 98**. Then back out the adjusting screw one turn, so that the side cover turns freely on the sector shaft.

35. Install the sector shaft adjusting screw jam nut onto the sector shaft adjusting screw a few threads. Final adjustment will be made later.

36. Press a new rubber plug into the hole provided in the side cover until the plug is flush. See **Fig. 99**.

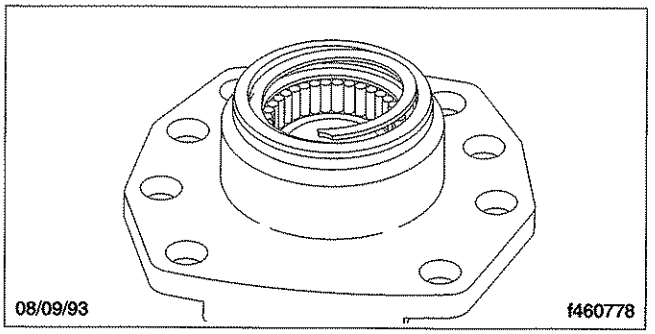


Fig. 97, Install the Retaining Ring

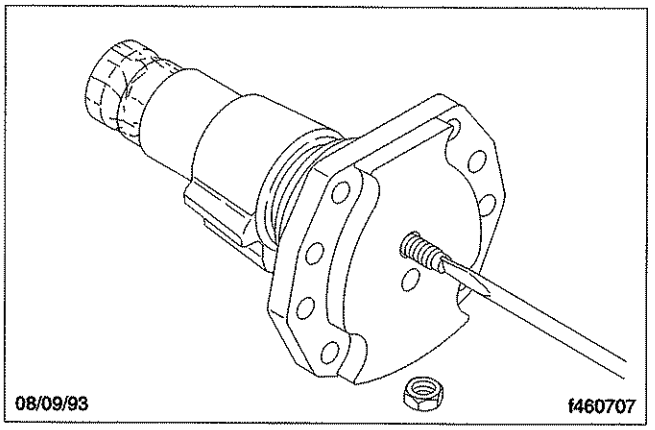


Fig. 98, Install the Sector Shaft Adjusting Screw

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

⚠ WARNING

Do not weld or plug this hole permanently. This is a safety vent that works only if the side cover output shaft seal fails. If the seal fails and the plug cannot vent, the steering gear can lock up or otherwise malfunction. This could result in a loss of steering control, which could result in an accident causing personal injury or property damage.

37. Apply clean grease to a new side cover gasket, and install it on the side cover. See **Fig. 100**. Apply enough grease to hold the gasket in place.

38. There are four teeth on the rack piston (**Fig. 101**). Position the rack piston so that the tooth space identified by the pencil in **Fig. 102** (it is the space between the second and the third tooth) is in the center of the sector shaft opening.

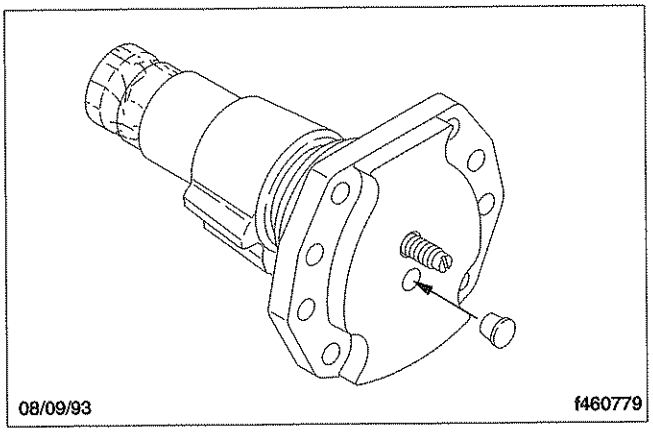


Fig. 99, Install a New Plug in the Side Cover

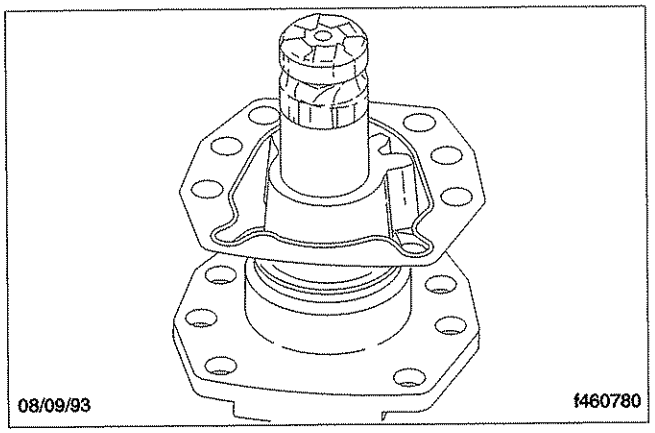


Fig. 100, Install the Side Cover Gasket on the Side Cover

⚠ WARNING

If the rack piston is not centered, steering gear travel will be severely limited in one direction. This could cause an accident resulting in personal injury or property damage.

39. With the rack piston centered, tighten the worm shaft adjusting screw 15 to 20 lbf·ft (20 to 27 N·m). Then loosen the adjusting screw 1/4 to 1/2 turn and note the torque required to rotate the input shaft 90 degrees each side of center. See **Fig. 103**. Loosen the adjusting screw if the noted

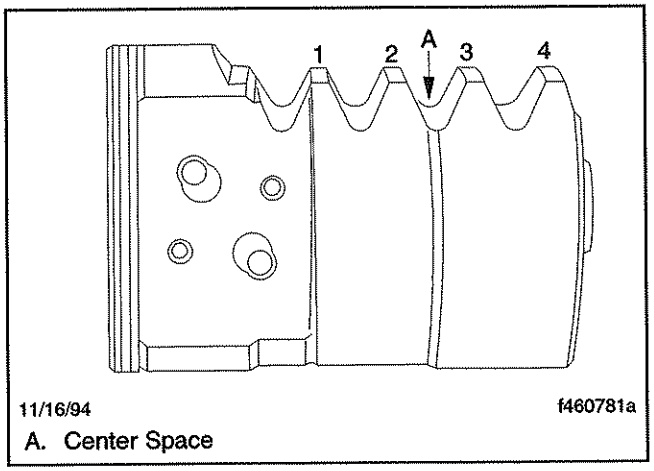


Fig. 101, Rack Piston Teeth

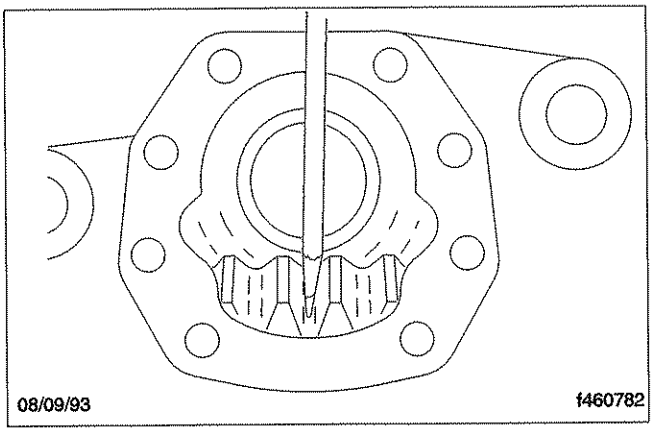


Fig. 102, Position the Rack Piston

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

input shaft torque exceeds 15 lbf·in (169 N·cm). Return the rack piston to the center position.

40. Remove any tape on the sector shaft serrations. Retape the serrations and bolt groove with *one layer* of masking tape. Install the sector shaft and side cover, as an assembly, into the gear housing. Make sure that the center tooth of the sector shaft engages the center space (between the second and third teeth) of the rack piston.

⚠ WARNING

When placing the sector shaft through the housing bearing, do not knock any of the bearing rolls out of the bearing race. Do not pinch the side cover gasket. If either is done, the bearing or seal could be damaged. This could result in a loss of power steering assist, which could result in an accident causing personal injury or property damage.

41. Install the eight special side cover bolts into the side cover, and tighten them 150 to 170 lbf·ft (203 to 230 N·m).

42. Place the trunnion cover on a bench with the exterior side down. Install a new Teflon® backup washer.

43. Install a new two-piece sector shaft seal so that the words OIL SIDE are visible after the seal is in place. See **Fig. 104**.

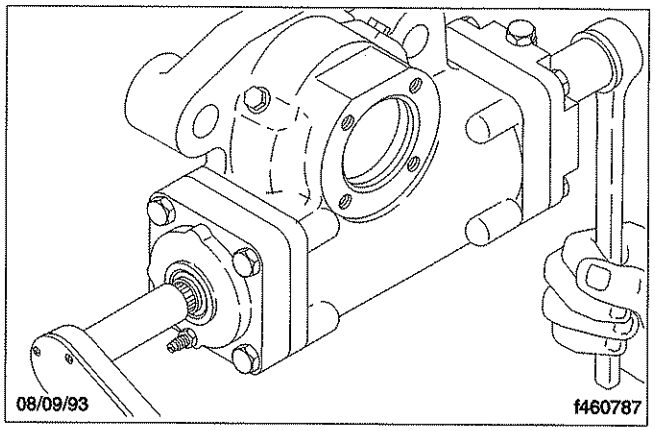


Fig. 103, Loosen the Adjusting Screw

⚠ WARNING

The words OIL SIDE must be visible once the seal is in place. Otherwise, the seal will malfunction. This could result in a loss of power steering assist, which could result in an accident causing personal injury or property damage.

44. Grease a new trunnion cover O-ring, and install it in the trunnion cover O-ring groove.

45. Inspect the housing bearing to make sure that all the bearing rolls are in place. Then install the trunnion cover. See **Fig. 105**. Install the four trunnion cover bolts, and tighten them 15 to 22 lbf·ft (20 to 30 N·m). See **Fig. 106**. Pack the cavity around the seal area of the sector shaft with Mobil Temp 1 or 2 grease, or an equivalent.

    Install a new dirt and water seal, using a suitable blunt-end drift. Install a new protective boot on the sector shaft and trunnion cover. Locate the boot grease fitting hole toward the input shaft end of the gear assembly. See **Fig. 107**. Insert the grease fitting into the protective boot.

46. Apply clean grease to the input shaft seal assembly (seal and O-ring) and to the input shaft. Install a new two-piece input shaft seal (with the flat side out), and the steel backup washer, using seal driving tool J28490. See **Fig. 108** and **Fig. 109**. Install the retaining ring.

47. Pack the area around the input shaft with clean water-resistant grease and install the dirt and water seal, using seal driving tool J28490 or a suitable blunt-end drift.

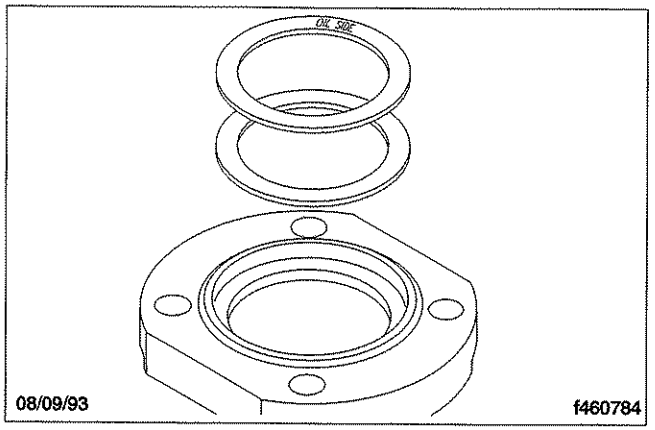


Fig. 104, Install the Sector Shaft Seals

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

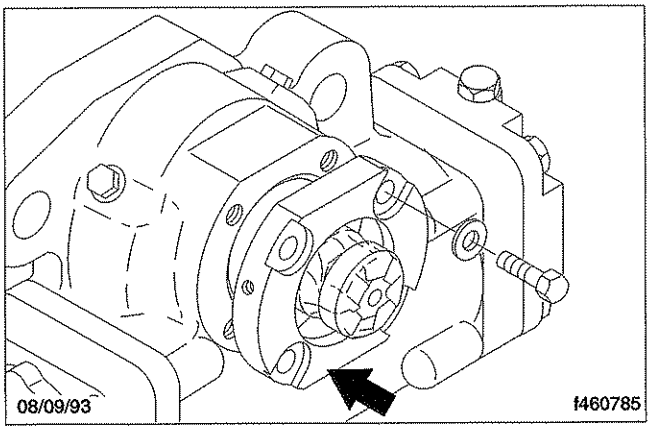


Fig. 105, Install the Trunnion Cover

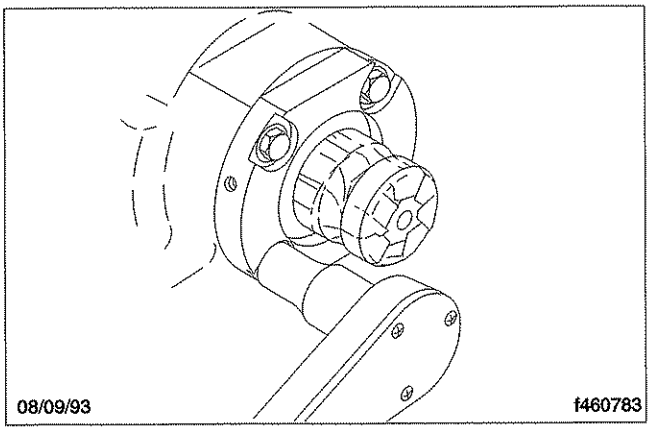


Fig. 106, Install the Trunnion Bolts

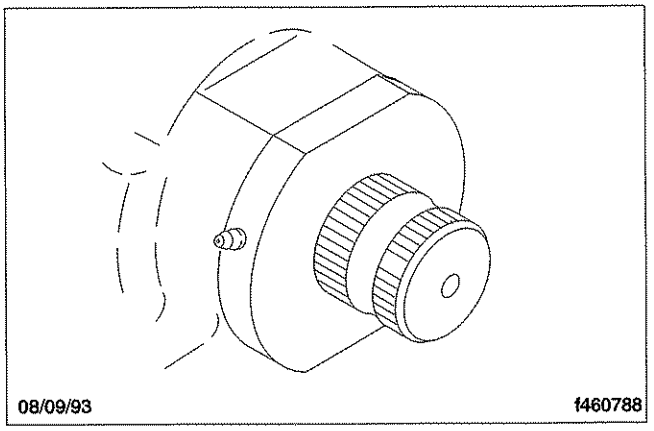


Fig. 107, Position the Grease Fitting Hole

48. Apply clean grease to the cupped side of the new seal protector and install it, cupped side in, on the input shaft and into the serration relief groove. See **Fig. 110.**

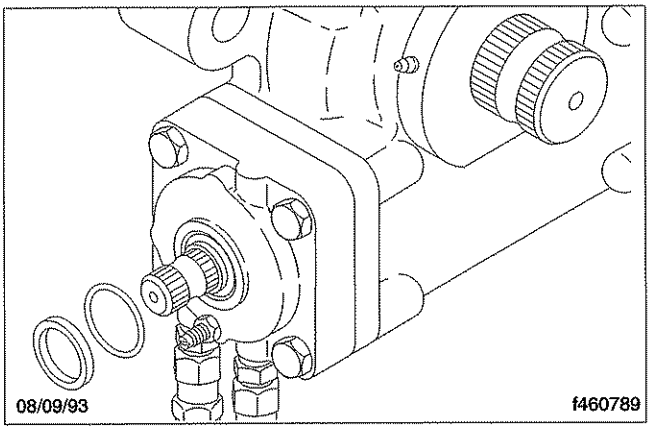
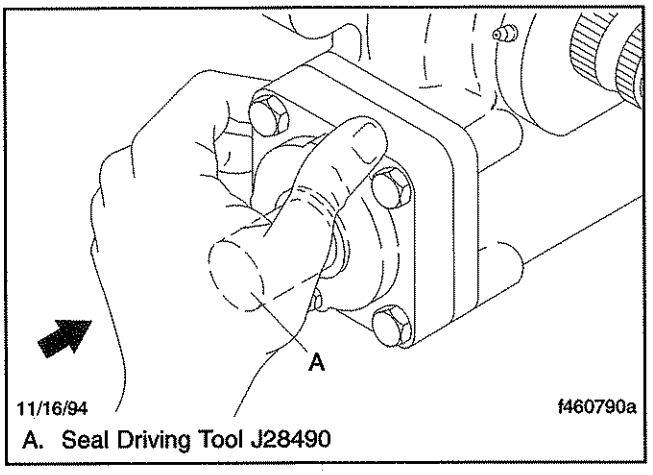


Fig. 108, Install the Input Shaft Seal and Washer



A. Seal Driving Tool J28490

Fig. 109, Install Input Shaft Seal and Backup Washer

49. Install the manual bleed screw (if equipped) and tighten it 27 to 33 lbf·in (305 to 373 N·cm).

Final Adjustments

Before installing the steering gear on the vehicle, make these adjustments.

NOTE: Worm shaft preload adjustment was done when the input shaft was installed in the valve housing during the assembly procedure.

Steering Gear Disassembly, Inspection, Assembly, and Final Adjustments

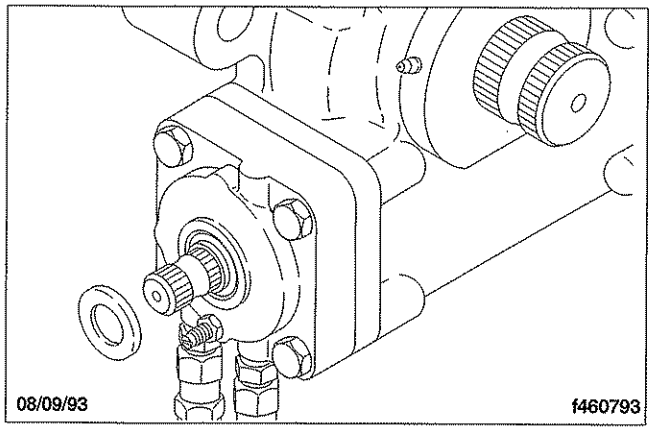


Fig. 110, Install the Seal Protector on the Input Shaft

1. To center the steering gear, turn the input shaft until the timing mark on the end of the sector shaft is at a right angle to the input shaft. See **Fig. 111.**

NOTE: Use a 12-point socket and an inch-pound torque wrench to turn the input shaft.

2. Adjust the sector shaft adjusting screw while turning the input shaft 180 degrees each side of center, until the input shaft reaches a torque of 25 to 30 lbf·in (280 to 340 N·cm). See **Fig. 112.**
3. Back out the sector shaft adjusting screw one turn. Note the torque now required to turn the input shaft 180 degrees each side of center. Then tighten the adjusting screw in, to increase the noted torque by 2 to 4 lbf·in (23 to 45 N·cm).

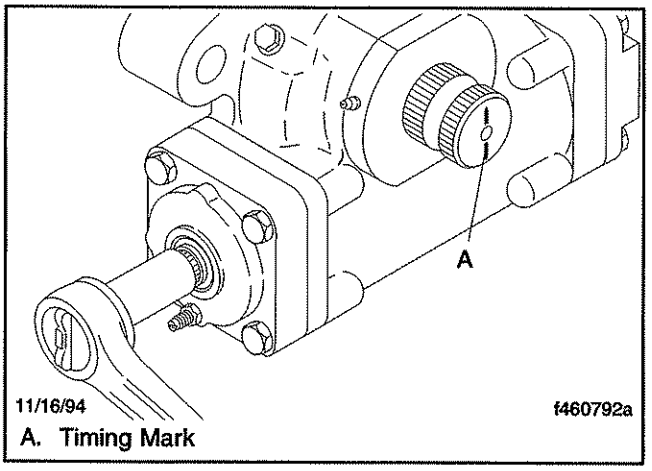


Fig. 111, Center the Steering Gear

4. Tighten the sector shaft adjusting screw jam nut 40 to 45 lbf·ft (54 to 61 N·m). The torque now required to turn the input shaft should not exceed 20 lbf·in (226 N·cm) at any point in the steering gear travel. If it does exceed 20 lbf·in (226 N·cm), repeat the previous steps beginning with the procedure of backing out the adjusting screw one turn and noting the torque required to turn the input shaft 180 degrees.
5. While turning the input shaft back and forth slightly, adjust the worm shaft preload adjusting screw to increase the maximum noted input torque by 10 to 15 lbf·in (113 to 169 N·cm). Make sure that the worm shaft adjusting screw jam nut does not contact the end cover while making this adjustment.

   Tighten the jam nut 70 to 80 lbf·ft (95 to 108 N·m). Be sure that the adjusting screw does not move.
6. The torque now required to turn the input shaft should not exceed 35 lbf·in (395 N·cm). If it does exceed 35 lbf·in (395 N·cm), repeat the previous step.

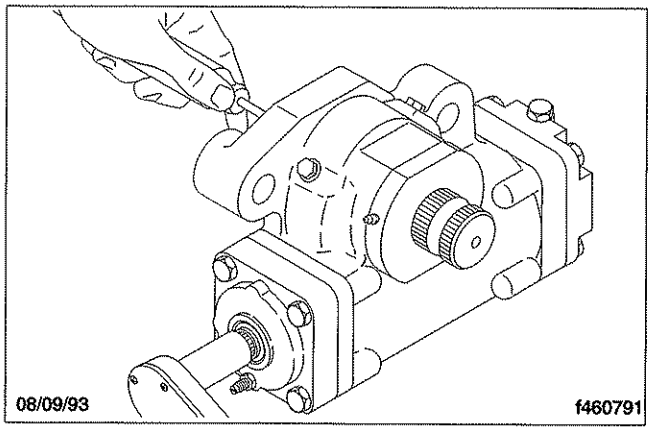


Fig. 112, Adjust the Sector Shaft Adjusting Screw

Input Shaft Seal Removal and Installation

Removal

1. Disconnect the return line from the steering gear and plug the line. See **Fig. 1**. Also cap the return port of the gear with a high pressure fitting.
2. Disconnect the steering driveline from the steering gear input shaft as follows:
   2.1 Remove the pinch bolt nut and pinch bolt from the steering driveline lower end yoke. Discard the nut.

⚠ CAUTION

Do not pound the U-joint or lower end yoke on or off the input shaft. Internal damage to the steering gear can result.

   2.2 Remove the lower end yoke from the input shaft. Don't turn the steering gear input shaft when removing the lower end yoke. Push the driveline shaft into the driveline tube, as you remove the lower end yoke.
3. Remove the dirt and water seal (**Fig. 2**) from the steering gear.
4. Wipe out the grease and then remove the spiral retaining ring (**Fig. 3**). Use a screwdriver inserted into the notch formed in the end of the ring.
5. Slip the input yoke back onto the input shaft with the pinch bolt installed (**Fig. 4**), but not tightened.
6. Tie or wrap a shop towel around the input shaft area (**Fig. 5**), and place a drip pan under the vehicle to catch the oil.

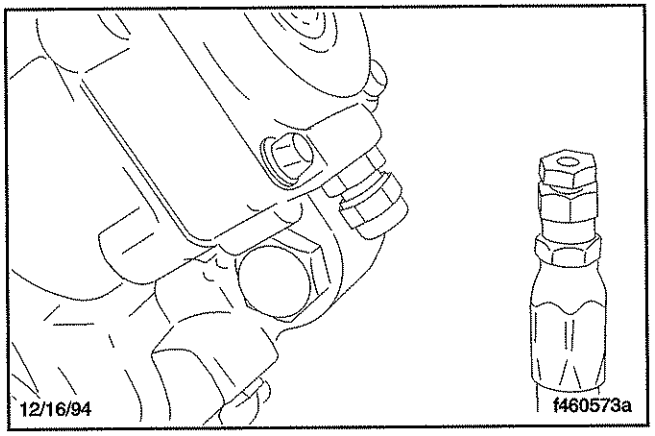


Fig. 1, Disconnect the Return Line

7. Add the power steering fluid specified in **Specifications, 400** as necessary to the fill line on the dipstick.
8. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).
9. Remove the shop towel, pinch bolt, and input yoke.
10. Remove the seal (**Fig. 6**).
11. Check the seal area of the valve housing for any seal fragments. Remove any that are found.
12. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. You need to determine

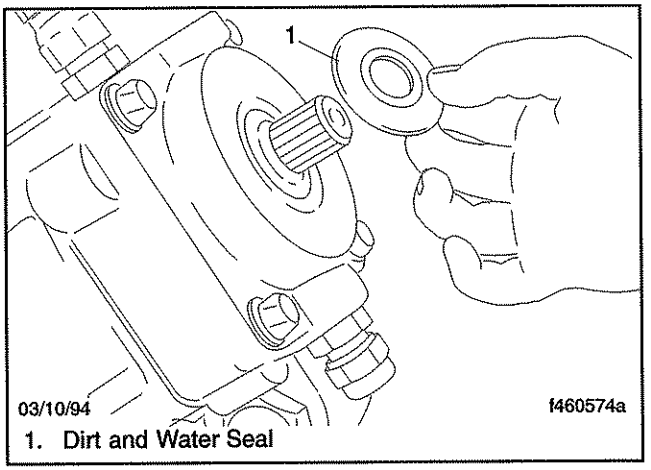


Fig. 2, Remove the Dirt and Water Seal

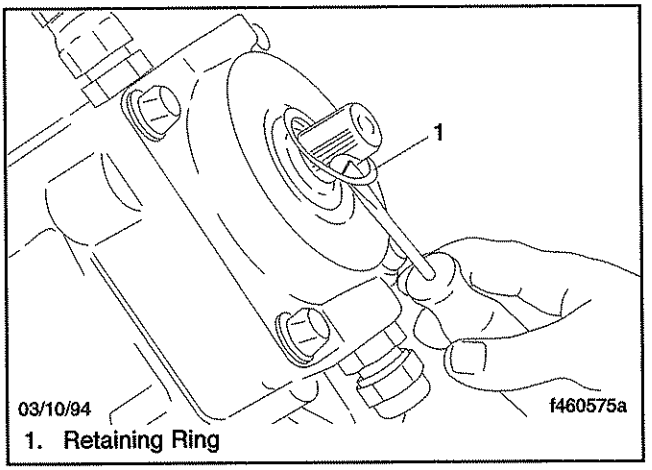


Fig. 3, Remove the Retaining Ring

Input Shaft Seal Removal and Installation

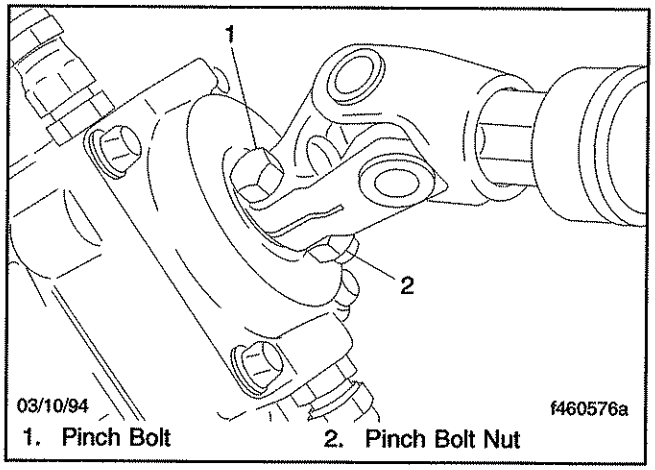


Fig. 4, Install the Pinch Bolt

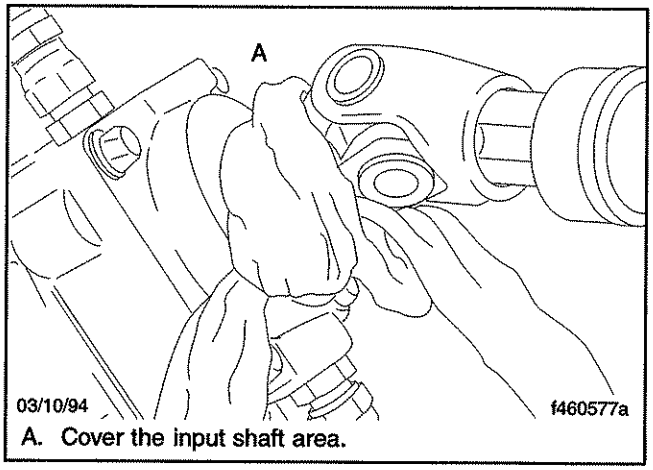


Fig. 5, Shop Towel Covering the Input Shaft

and fix the cause of excessive heat in the vehicle (see **Subject 300**).

Installation

1. Put clean grease on the new input shaft seal, and place it over the input shaft, garter spring side first (**Fig. 6**). Place seal installer tool J37073 over the input shaft and against the seal, small diameter end first (**Fig. 7**). Tap the seal installer tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.
2. Insert the new retaining ring into the groove.

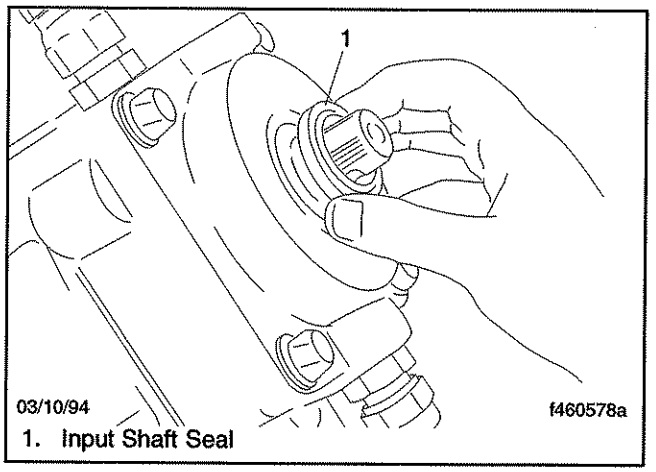


Fig. 6, Remove the Input Shaft Seal

3. Pack the end of the valve housing bore around the input shaft with clean high temperature industrial grease (Mobil Temp 1 or 2 or equivalent). Apply more of the grease to a new dirt and water seal and install it over the input shaft (**Fig. 8**). Seat it in the groove behind the serrations and against the valve housing.
4. Connect the steering driveline to the steering gear input shaft.
   - 4.1 Clean the input shaft and the inside of the driveline yoke.
   - 4.2 Apply a thin film of grease to the yoke splines. Use lithium-based grease, NLGI grade 2.

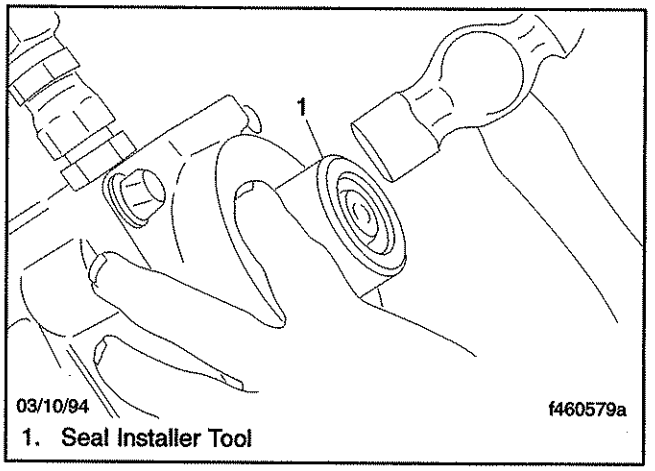
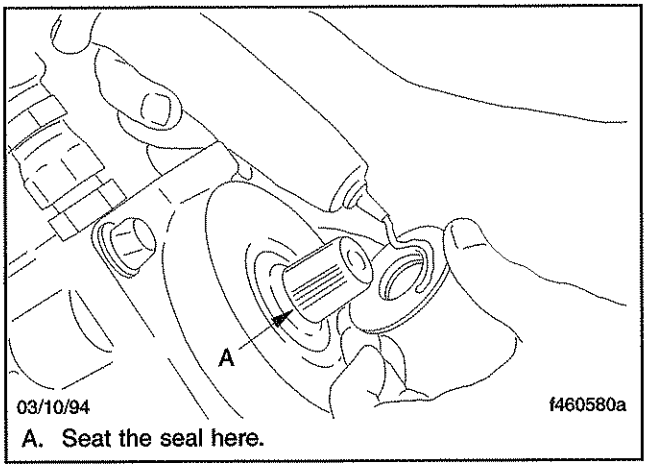


Fig. 7, Position the Seal Installer Tool



A. Seat the seal here.

Fig. 8, Install the Dirt and Water Seal

4.3 Slide the yoke onto the input shaft, and install the new yoke pinch bolt. Before installing the pinch bolt nut, make sure the pinch bolt is centered in the steering column shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install a *new* pinch bolt nut, and tighten it 55 to 65 lbf·ft (75 to 88 N·m).

4.4 Apply white Torque Seal F-900 to the exposed pinch bolt threads and the locknut.

5. Connect the return line to the steering gear return port.

6. Fill and bleed the steering system.

   IMPORTANT: Do not turn the steering wheel in the following steps until instructed. Doing so can cause air to enter the system, which can make it more difficult and time-consuming to bleed air from the system.

   6.1 Fill the power steering reservoir with the steering fluid specified in **Specifications, 400** until nearly full.

   Crank the engine for 10 seconds without allowing it to start. If the engine does start, shut it down immediately. Check and fill the reservoir as needed.

   Repeat this procedure three times, each time checking and filling the reservoir.

   6.2 Start the engine and let it idle for two minutes. Shut down the engine, and check the fluid level in the reservoir.

   6.3 Start the engine again. Steer the vehicle from full-left to full-right several times. As needed, add fluid to the full line on the reservoir dipstick.

Sector (Output) Shaft Seal Removal and Installation

Removal

NOTE: For clarity, the figures in this subject show the steering gear mounted on a mock-up frame and steering driveline.

If there is a leak in the trunnion cover area, remove the trunnion cover and replace the sector shaft seal package as follows:

1. Place the front tires in a straight-ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations are to be performed. Apply the parking brakes and chock the tires.
2. Remove the pinch bolt, washer, and nut from the pitman arm. Discard the nut.

NOTE: If factory alignment marks are not present, use a marking pen or paint to make a reference mark on the pitman arm and the sector shaft.

3. Remove the pitman arm using a suitable puller, and swing the pitman arm and drag link out of the way.
4. Remove the protective boot, the grease fitting, and the dirt and water seal from the trunnion cover. See **Fig. 1** and **Fig. 2**. Discard the protective boot and the dirt and water seal.
5. Clean the nonserrated area of the sector shaft with a fine grade of emery paper as shown in **Fig. 3**. Be sure to remove any paint.
6. Remove the four trunnion cover bolts and trunnion cover, as shown in **Fig. 4**. Remove and discard the sector shaft seal package, consisting of the Teflon® backup washer, the two-piece sector shaft seal, and the trunnion cover O-ring. See **Fig. 5**.

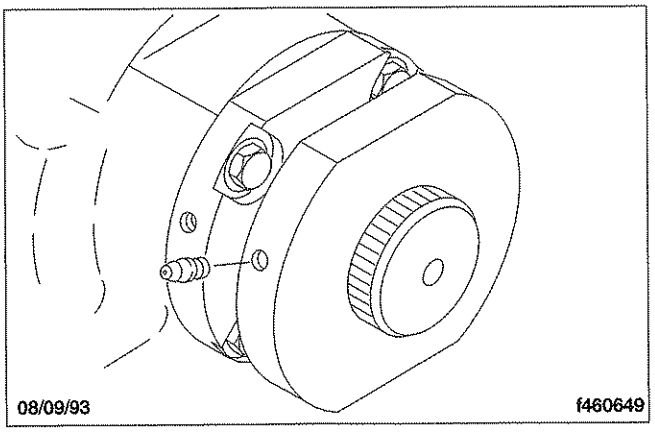


Fig. 1, Grease Fitting, Exploded

Installation

1. Clean the trunnion cover in petroleum-based solvent, and inspect its seal cavity and sealing face for nicks or corrosion. Replace the trunnion cover with a new one if these conditions exist.
2. Place the trunnion cover on a bench to install the new seal package. Start with the new Teflon® backup washer. Next, install the new two-piece sector shaft seal so that the words OIL SIDE are visible after the seal is in place. See **Fig. 6**.

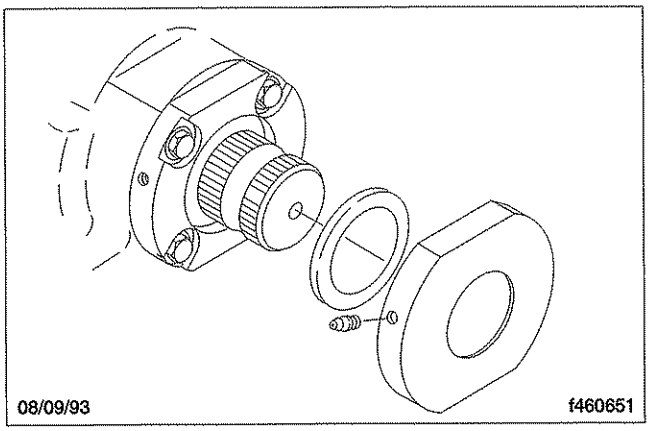


Fig. 2, Protective Boot, Exploded

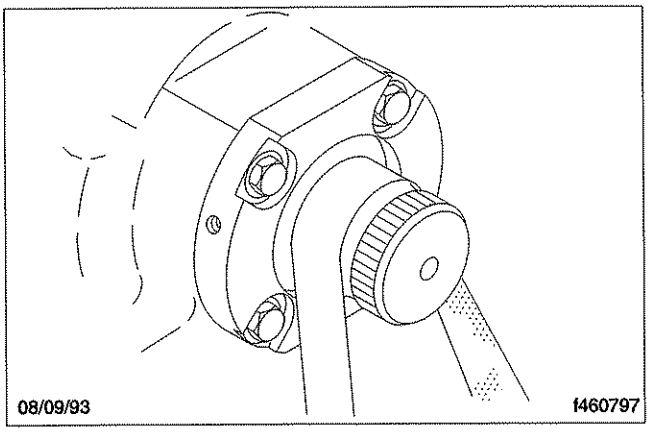


Fig. 3, Clean the Shaft Area

Sector (Output) Shaft Seal Removal and Installation

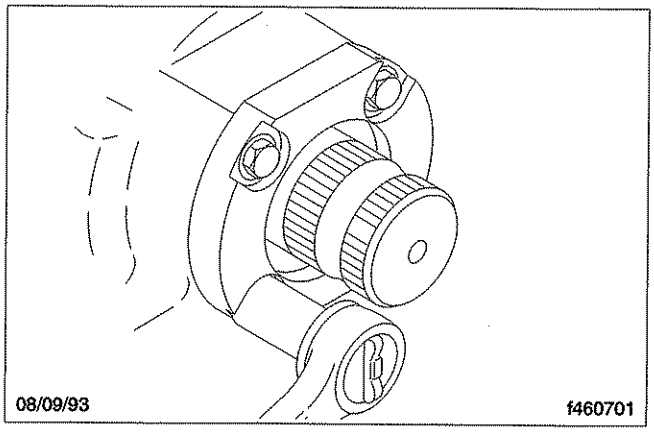


Fig. 4, Removing the Trunnion Cover Bolts

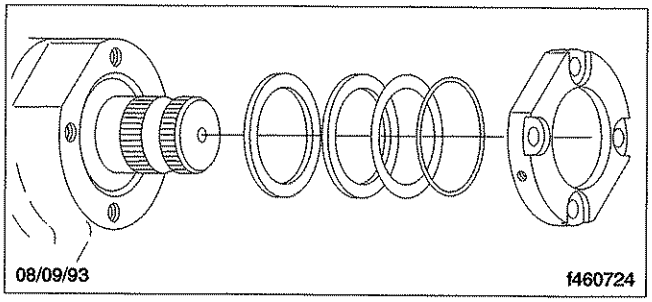


Fig. 5, Trunnion Cover and Seals, Exploded

⚠ WARNING

The words OIL SIDE must be visible after the seal is in place, as shown in Fig. 6. If not, the seal will malfunction. This could cause a loss of power steering assist and result in an accident possibly causing personal injury or property damage.

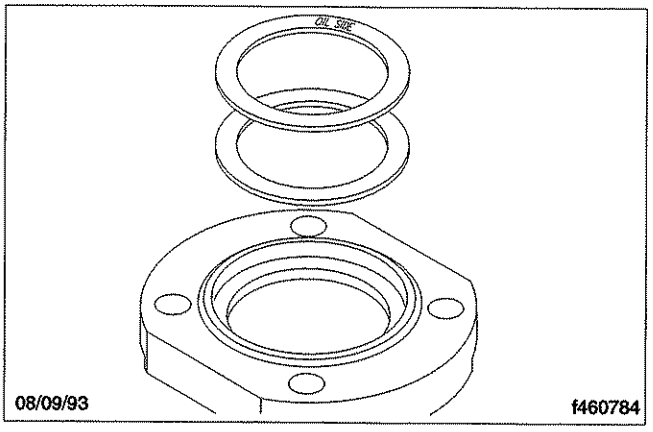


Fig. 6, Sector Shaft Seal Installation

3. Grease the new trunnion cover O-ring and install it in the cover groove.
4. Cover the serrations of the sector shaft with one layer of masking tape to avoid damaging the seals during trunnion cover installation. See **Fig. 7**.
5. Install the trunnion cover. See **Fig. 8**.
6. Install the four trunnion cover bolts. Torque the bolts 15 to 22 lbf·ft (20 to 30 N·m). See **Fig. 9**. Pack the cavity around the seal area of the sector shaft with Mobil Temp® 1 or 2 grease, or an equivalent. Install a new dirt and water seal, using a suitable blunt-end drift, as shown in **Fig. 10**.
7. Grease the new protective boot inside the smaller diameter ring, and install it on the sector shaft (see

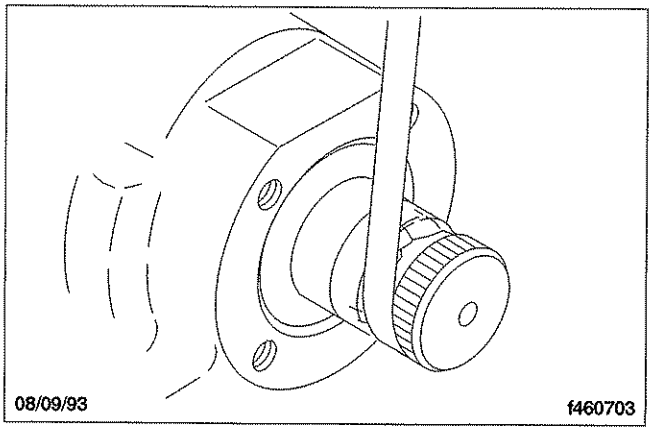


Fig. 7, Masking Tape Cover

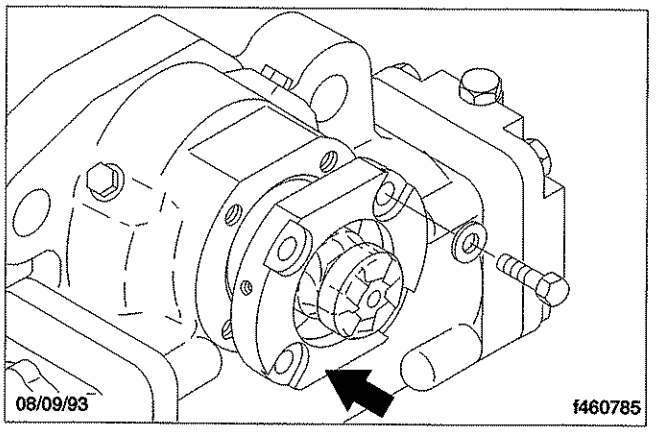


Fig. 8, Trunnion Cover, Installation

Sector (Output) Shaft Seal Removal and Installation

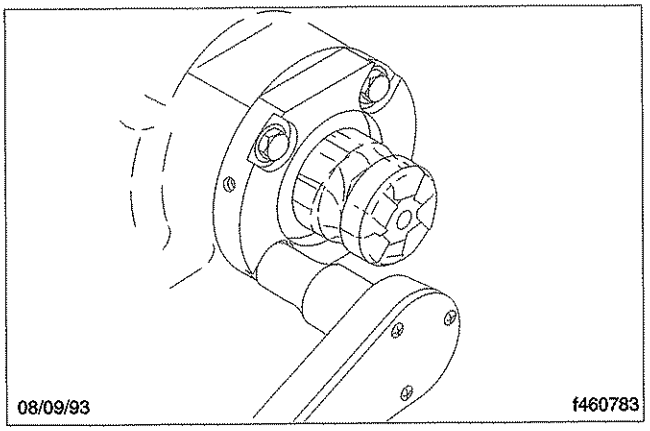


Fig. 9, Tighten Trunnion Cover Fasteners

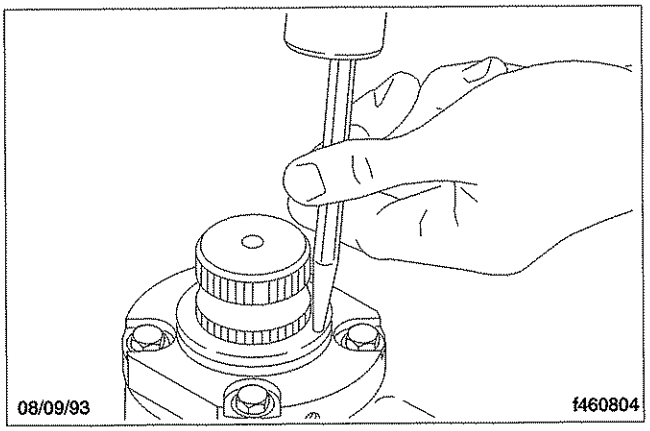


Fig. 10, Dirt and Water Seal Installation

Fig. 11). Position the protective boot so that the grease fitting hole faces toward the input shaft end of the gear assembly.

8. Insert the grease fitting into the protective boot. Remove the tape from the sector shaft.
9. Attach the pitman arm to the sector shaft. Be sure that the mark on the pitman arm aligns with the mark on the sector shaft (see **Fig. 12**).

⚠ WARNING

Never leave a chisel wedged in the pitman arm slot. When using a chisel to spread the slot in the pitman arm, maintain a firm grip on the chisel at all times. Otherwise, the chisel may fly loose, which could cause an injury.

NOTE: The pitman arm may not fit over the splines on the sector shaft without spreading the slot in the arm. Use a ball peen hammer to drive a chisel into the slot. Hold the chisel in place. Install the pitman arm on the sector shaft. Remove the chisel from the slot.

10. Install the pitman arm pinch bolt, washer, and a new nut. See **Fig. 13**. Tighten the pinch bolt nut 215 to 245 lbf·ft (290 to 332 N·m).
11. Fill and bleed the steering system.

    IMPORTANT: Do not turn the steering wheel until instructed in the following steps. Doing so can cause air to enter the system, which can make it more difficult and time-consuming to bleed air from the system.

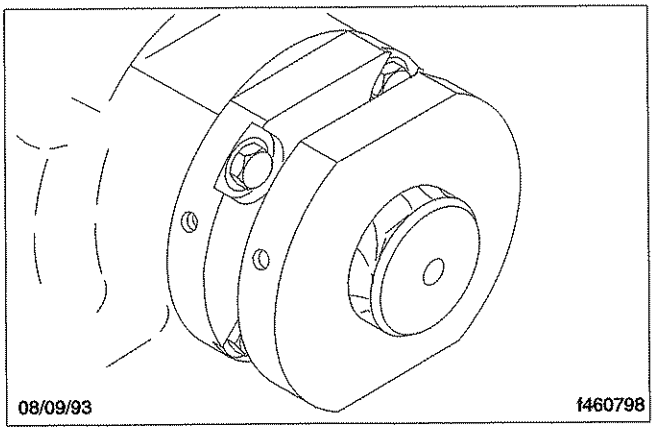


Fig. 11, Boot Installation

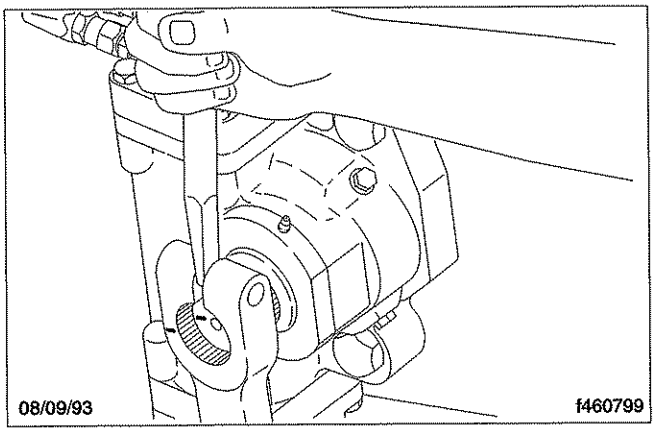


Fig. 12, Pitman Arm Installation

Sector (Output) Shaft Seal Removal and Installation

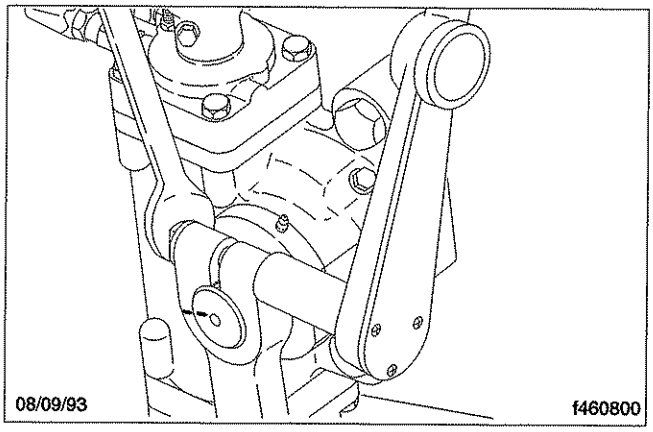


Fig. 13, Pinch Bolt Installation

11.1 Fill the power steering reservoir with the steering fluid specified in **Specifications, 400** until nearly full.

Crank the engine for 10 seconds without allowing it to start. If the engine does start, shut it down immediately. Check and fill the reservoir as needed.

Repeat this procedure three times, each time checking and filling the reservoir.

11.2 Start the engine and let it idle for two minutes. Shut down the engine, and check the fluid level in the reservoir.

11.3 Start the engine again. Steer the vehicle from full-left to full-right, several times. As needed, add fluid to the full line on the reservoir dipstick.

NOTE: If needed, remove air from the system by adjusting the poppets. For instructions, see **Subject 100.**

Checks

After power steering components have been worked on, and before the vehicle is placed into service, make the following checks.

⚠ WARNING

Failure to make the following checks could result in damage to the power steering system. This could cause a loss of hydraulic assist, which could cause personal injury or property damage.

1. With the engine turned off and warm, check the power steering reservoir fluid level.
2. Check for air in the system.
   - 2.1 Place a thermometer in the power steering reservoir, then warm the hydraulic system to normal operating temperature of 125° to 135°F (51° to 57°C) by operating the engine at low idle while turning the steering wheel through several full left and right turns.
   - 2.2 With the engine running and the power steering system at operating temperature, turn the steering wheel slowly from stop to stop while checking the power steering reservoir for frothing or a change in the fluid level (a sign that air is trapped in the system). If air is present, inspect the system for leaking hoses or loose fittings. Replace the hoses or tighten the fittings as needed. Bleed the air from the system.
3. At full-left and full-right wheel cuts, be sure the axle stops (on the rear-side of the spindle) are set so there is at least 1/2-inch (13-mm) clearance between the tires and any fixed components that are attached to the vehicle. Clearance between moving components should be 3/4 inch (19 mm). If clearance is less than this, reset the axle stops.
4. If there are still problems with the power steering system, go to **Troubleshooting 300**, and do the steering system tests as instructed. Otherwise, go to the next step.
5. Test drive the vehicle, or take a ride with the driver.

   Check the steering wheel spoke position. With the front tires pointing straight ahead, check the position of the steering wheel spokes. They must be pointing within ±10 degrees of the 4 o'clock and 8 o'clock positions. See **Fig. 1**. If not, remove the steering wheel and install it in the correct position. For instructions, see the applicable section in this group.

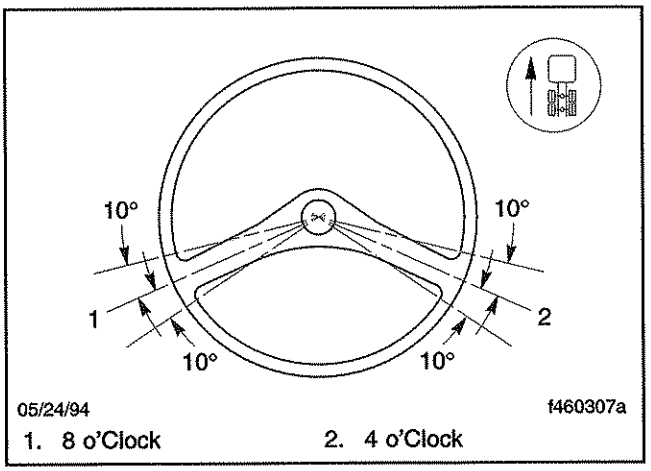


Fig. 1, Steering Wheel Centered

Troubleshooting

If there is a complaint about the steering system, do the checks below before servicing the steering gear or pump. This procedure is intended as a general guideline for the mechanic or technician to follow when diagnosing steering complaints.

The first step is always to talk to the driver. Get a detailed explanation of what the problem is and when it happens. Ask about any repairs, modifications, or prior adjustments. Then, if the truck is roadworthy, test drive it or ride with the driver and try to duplicate the problem.

After identifying the complaint, refer to the appropriate box in **Table 1** that best fits the complaint. Form SD–94, "Checklist for Troubleshooting Hydraulic Power Steering System Performance," should be used to record test information. Form SD–94 can be ordered through your dealer. Dealers can order form SD–94 through the TAO electronic mail system.

- At the TAO Mail Menu, key in B for bulletin boards.
- Tab down to Pub–Forms–FTL and key in L for list.
- At Freightliner Manuals Order Form, key in U.

If you don't have access to the TAO electronic mail system, contact Publishing Distribution at (503) 735–7343.

The table on the form will refer you to a series of checks or tests to do for each type of complaint. The easiest and least costly checks are listed first. By doing the checks in order, starting with the lowest number, you can avoid unnecessary labor and expense. Instructions for doing the checks are given on the following pages. Each numbered step in the instructions corresponds with the diagnostic checks in **Table 1**.

STEERING COMPLAINT AND APPROPRIATE CHECKS

Troubleshooting and Diagnostic Steps										
Step*	1	2	3	4	5	6	7	8	9	10
COMPLAINT	Tire Press./ Vehicle Load	Fifth Wheel Lube	Vehicle Alignment	Loose/ Binding Components	Noise	System Operating Temp.	System Leaks or Restrictions	Pump Performance	Gear Poppet Adjustment	Gear Internal Leakage
Hard or Heavy Steering	•	•		•		•	•	•	•	•
Low Assist										
Binding	•	•		•		•	•	•	•	•
Locking										
Occasional Loss of Assist										
Reduced Wheel Cut									•	
Vehicle Pulls to One Side	•		•					•		
Darting/ Oversteer	•	•	•	•						
Vehicle Wanders										

Troubleshooting and Diagnostic Checks

Troubleshooting and Diagnostic Steps										
Step*	1	2	3	4	5	6	7	8	9	10
COM-PLAINT	Tire Press./ Vehicle Load	Fifth Wheel Lube	Vehicle Align-ment	Loose/ Binding Compo-nents	Noise	System Operat-ing Temp.	System Leaks or Restric-tions	Pump Perfor-mance	Gear Poppet Adjust-ment	Gear Internal Leakage
Noisy Steering					•		•	•		
Steering Gear External Seal Leaks						•	•	•		
Excessive Heat										

* The numbers in this table correspond to the numbered steps in the diagnostic checks.

Table 1, Troubleshooting and Diagnostic Steps

Diagnostic Checks

1. Check tire pressure and load.

   1.1 Check the tire pressure. Low pressure causes increased steering effort due to extra friction with the road surface. Check the tires for damage or erratic wear. Make sure the tires on each side of the front and rear axles are inflated to the correct pressure. Unequal tire pressure causes unequal friction between the tire and the road. This can cause pulling to one side. Correct the pressures if needed. See **Fig. 1**.

   1.2 Check whether duplex or oversized tires have been installed, and that the tire sizes are correctly matched. Extra tire width causes increased steering effort due to extra friction with the road surface. Also, the power steering gear poppets will need to be adjusted if the axle stops were turned out to reduce wheel cut due to the change in tires. See **Subject 100** for instructions.

   1.3 Determine whether the vehicle is operated at or over the rated load. Increased load causes greater steering effort. It may be necessary to modify the power steering, wheels, tires, or springs.

2. Check the fifth wheel.

   See if the fifth wheel is adequately lubricated. A dry fifth wheel plate makes it difficult to change direction. See **Fig. 2**. Check the plate surface for burrs, gouges, or irregularities.

3. Check the wheel bearing adjustment and axle alignment.

   3.1 Check wheel bearing adjustment. Refer to the **Group 33** and the **Group 35** in this manual for instructions.

   3.2 Check the front and rear axles for correct alignment. Adjust them back to specifications if necessary. Refer to the **Group 33** and the **Group 35** in this manual for instructions.

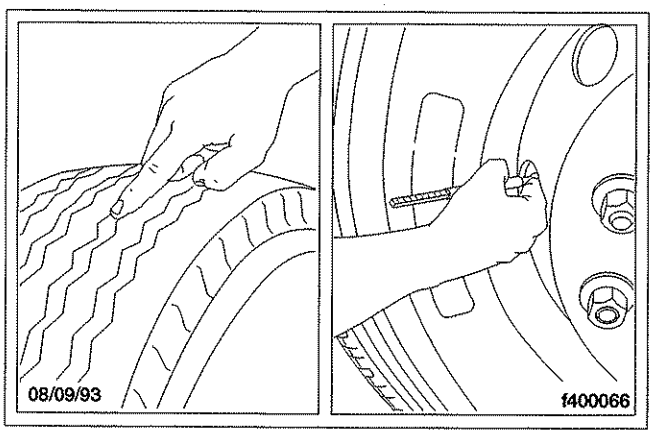


Fig. 1, Check the Tire and the Tire Pressure

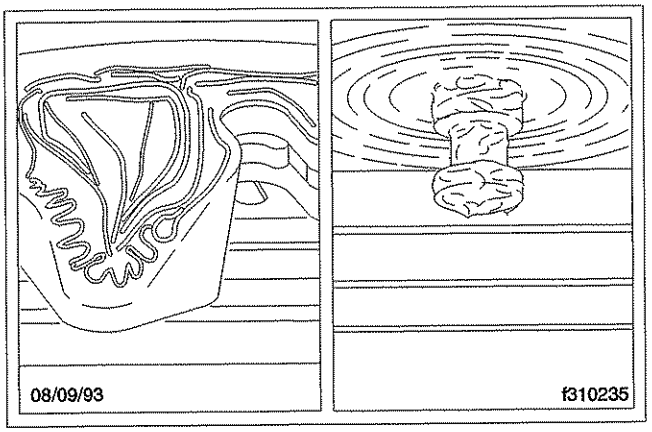


Fig. 2, Check the Fifth Wheel

4. Check for loose or binding components.

   Check whether any steering components are loose or binding, need maintenance, or need adjustment as follows:

   4.1 Lubricate the drag link, tie rods, and knuckle pins. Refer to the applicable sections in the vehicle maintenance manual.

   4.2 Chock the rearmost tires and raise the front tires off the ground. With the engine shut down, turn the steering wheel and check for looseness or binding. Make sure all components are free to move but are not excessively loose.

   4.3 Check the steering driveline U-joints for looseness or binding. Lubricate them if needed. For instructions, refer to the applicable section in the vehicle maintenance manual.

   4.4 Check for correct steering driveline phasing. See **Fig. 3**. Reset the phasing if needed.

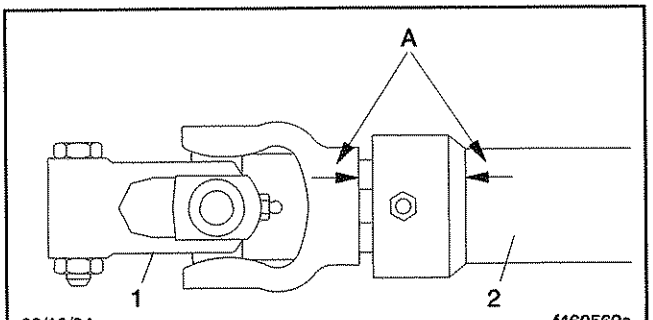
   4.5 Check the sector shaft adjustment. See **Subject 100** for instructions.

⚠ WARNING

Failure to connect the input yoke and the pitman arm, and to tighten all fasteners to the prescribed torque value, can cause loss of steering and vehicle control.

4.6 With the engine off, chock the rearmost tires and place the front tires on radius plates (turntables). Disconnect the drag link from the steering arm. See **Fig. 4**.

By hand, pull the tire to one axle stop and release. The tire should self-return to almost straight ahead. See **Fig. 5**. Repeat in opposite direction. If the tire does not return to near straight ahead, check for a binding or lack of lubrication problem in the steering axle kingpin bushings or tie rod linkage. Connect the drag link and tighten the castle nut and install a new cotter pin. See **Section 46.01** in this manual for drag link instructions.



A. Align Arrows
1. Lower End Yoke
2. Driveline Tube and Yoke Assembly

Fig. 3, Check for Correct Steering Driveline Phasing

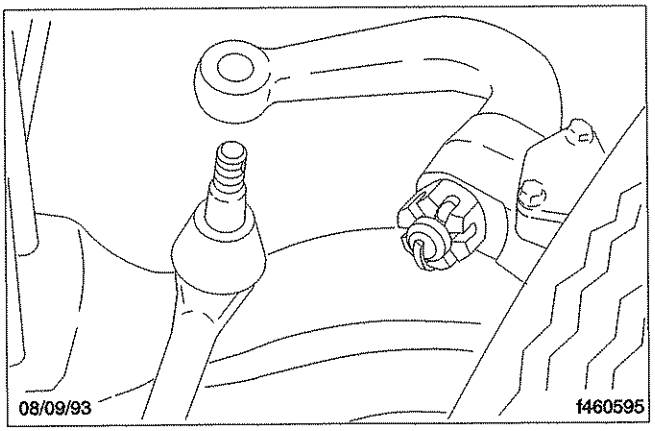


Fig. 4, Disconnect the Drag Link

Troubleshooting and Diagnostic Checks

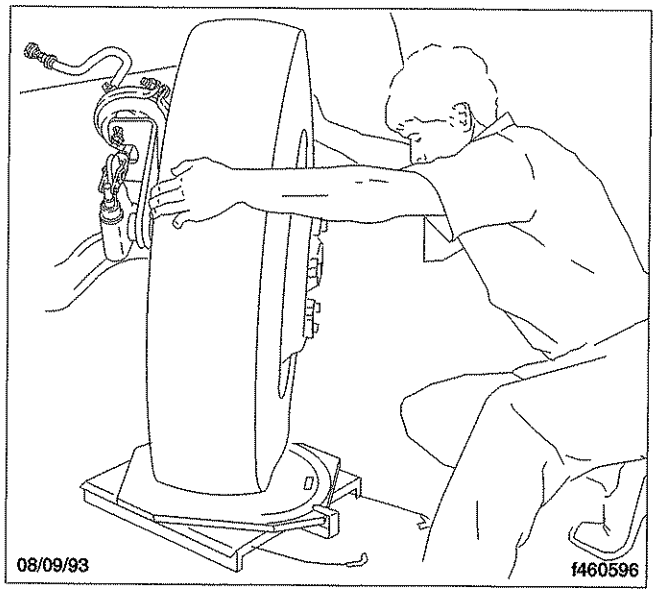


Fig. 5, Pull the Tire to One Axle Stop

⚠ WARNING

Failure to connect the drag link and the steering arm, and to tighten all fasteners to the prescribed torque value, can cause loss of steering and vehicle control.

4.7 Visually inspect all suspension fasteners and components for wear or looseness. See **Fig. 6.**

5. Check for noise.

NOTE: Noises from the power steering system do not necessarily mean there is a problem. Some noises are normal and are the result of proper operation. See **Table 2.**

6. Test the system operating temperature.

6.1 Park the vehicle outside.

6.2 Check for the correct fluid level. See **Fig. 7.** If required, fill the power steering reservoir to the correct level with the fluid specified in **Specifications, 400.**

6.3 Place a thermometer in the fluid reservoir to monitor fluid temperature.

6.4 Run the vehicle at governed rpm for 40 minutes to bring the fluid to an elevated temperature. Check and record fluid temperature on the checklist (form SD–94) at the start of the 40 minute test, and at 10, 20, 30, and 40 minutes.

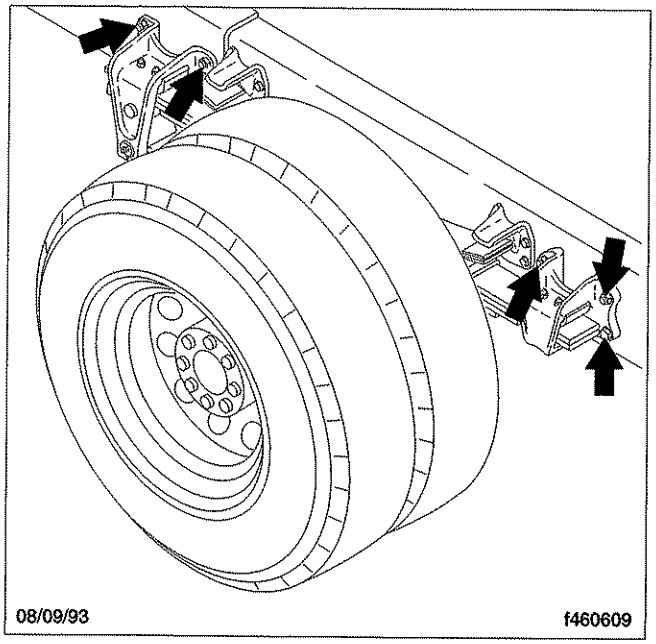
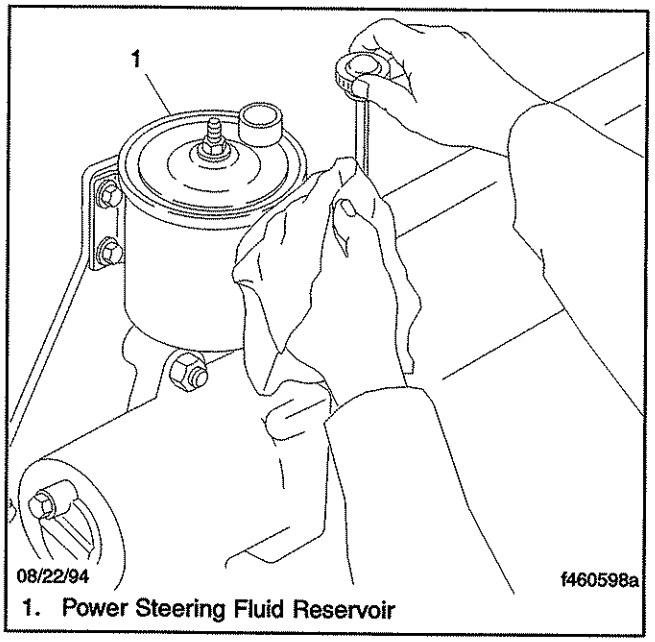


Fig. 6, Inspect All Suspension Fasteners



1. Power Steering Fluid Reservoir

Fig. 7, Check the Power Steering Fluid Level

Do not allow the temperature to exceed 150°F (66°C) above the outside temperature (ambient), or 250°F (111°C). If this temperature is exceeded, stop the 40 minute test and record the last noted temperature on the checklist.

6.5 If the temperature does not exceed 150°F (66°C) above the outside temperature (ambient), or 150°F (111°C) during the 40 minute test, excessive system heat is probably not the cause of the complaint. Go on to the next test for the complaint. See **Table 1.**

6.6 If at any time the temperature exceeded 150°F (66°C) above the outside temperature (ambient), or 250°F (111°C), the system is operating at excessive temperature levels, and steering system performance and life may be affected. Damage to hoses, seals, and other components may result if the vehicle is operated at excessive steering system temperatures.

6.7 Excessive system restrictions or excessive pump flow may be the cause of the complaint. Go on to the next test for the complaint. See **Table 1.**

7. Check for leaks, restrictions, and test system back pressure.

7.1 Check for the correct fluid level. See **Fig. 7.** If required, fill the power steering reservoir to the correct level with the fluid specified in **Specifications, 400.**

7.2 The inspection and test must be done with the power steering fluid at operating temperature 125° to 135°F (51° to 57°C). With the engine at idle, monitor the fluid temperature with a thermometer in the fluid reservoir. If the fluid is too cold, raise the temperature by turning the steering wheel from stop to stop until the desired temperature is reached.

7.3 With the engine at idle, visually inspect all hoses and fittings for signs of kinked or collapsed hoses, or leaking fittings. See **Fig. 9.** Visually inspect all external seals. Repair all leaking fittings, and replace parts as required. Replace any leaking seals. Inspect the seal bores and sealing surfaces for scrapes or burrs. Be sure the seals are installed correctly using the recommended tools. If the steering gear input shaft seal is excessively hard, do check (step) no. 6 (Test System Operating Temperature) if not already done.

7.4 Install a low pressure gauge 200 to 300 psi (1378 to 2069 kPa) maximum between the pressure line and the pump (location P2). See **Fig. 10.**

Power Steering System Noises	
Symptom	**Action to Take**
Growling or Other Abnormal Steering Noise	Check the fluid level. Check for air bubbles or foam. See **Fig. 7** and **Fig. 8.** Check for hose and fitting leaks. Add fluid if needed. If the fluid has air, check for inlet tube/hose leaks. Correct all leaks.
A Change from the Usual Pump Sound	Check the power steering fluid reservoir. Check for air bubbles or foam in the fluid. See **Fig. 8.** If the fluid has air, check for inlet tube/hose leaks. Correct all leaks.
Clicking Noise During a Turn	Check for loose steering components. Check the front suspension or insufficient spring pin shims. Tighten any loose steering components. Add front spring pin shims if needed.
Hissing When the Steering Wheel Is at or Near Full Turn	Fluid flowing past a poppet valve makes a hissing noise. This is normal. No action is needed.
Hissing at Less Than Full Turn	Do the "Steering Gear Poppet Test."

Table 2, Power Steering System Noises

Troubleshooting and Diagnostic Checks

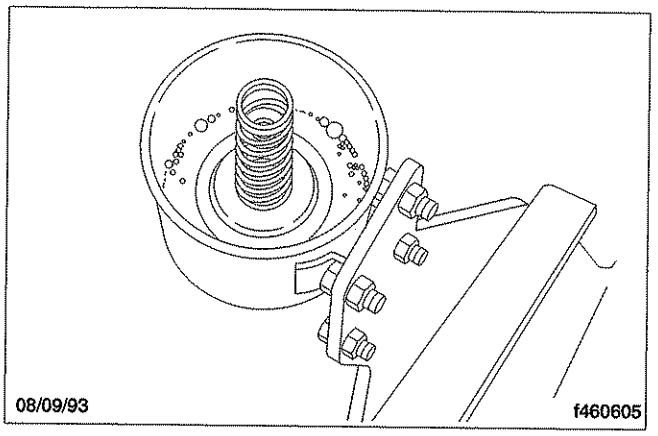


Fig. 8, Check the Power Steering Fluid Reservoir for Bubbles

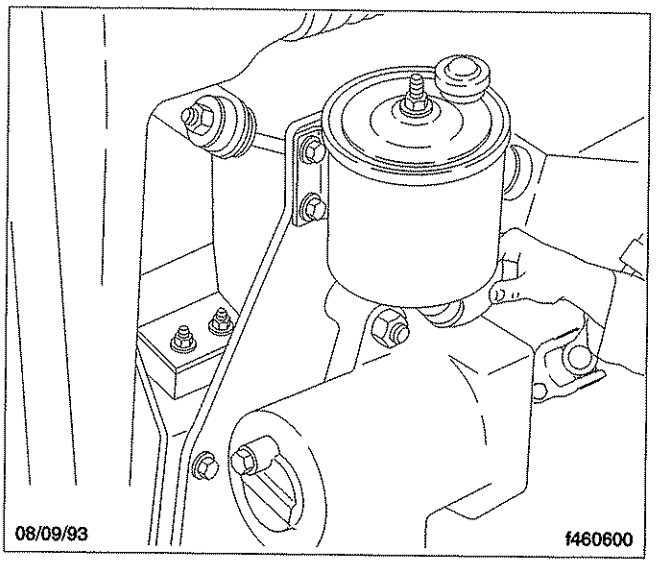


Fig. 9, Inspect All Hoses and Fittings

⚠ CAUTION

Don't move the steering wheel or allow the system pressure to exceed the rating of the gauge during the following procedure or damage to the gauge may result.

7.5 Run the engine at idle and check for the correct fluid level. If required, fill the power steering reservoir to the correct level with the fluid specified in **Specifications, 400.** If bubbles or foam appear in the reservoir, check the hose fittings for looseness or leaks.

7.6 With the engine at idle, read the total system back pressure on the pressure gauge. Record the reading on the checklist (form SD–94).

7.7 If the total system back pressure (P2) is greater than 100 psi (689 kPa), go to step 7.8. If the pressure at P2 is less than these values, restriction is not a problem. Go to the next test for the complaint. See **Table 1.**

7.8 System back pressure has been determined to be excessive and the component at fault can be pinpointed by checking pressures at key locations in the steering system. With the engine at idle, use the low pressure gauge and hose connection adapters necessary to measure pressures at all locations identified in **Fig. 10.** Each time the gauge is moved, ensure that the fluid level is correct, and air is removed from the system by running the engine and adding fluid if needed.

7.9 Determine the individual component restrictions by subtracting the values shown in **Table 3.** Record the values on form SD–94.

7.10 Refer to the column on the right in **Table 3** for action to take if any component exceeds the maximum allowable restriction as listed for each component.

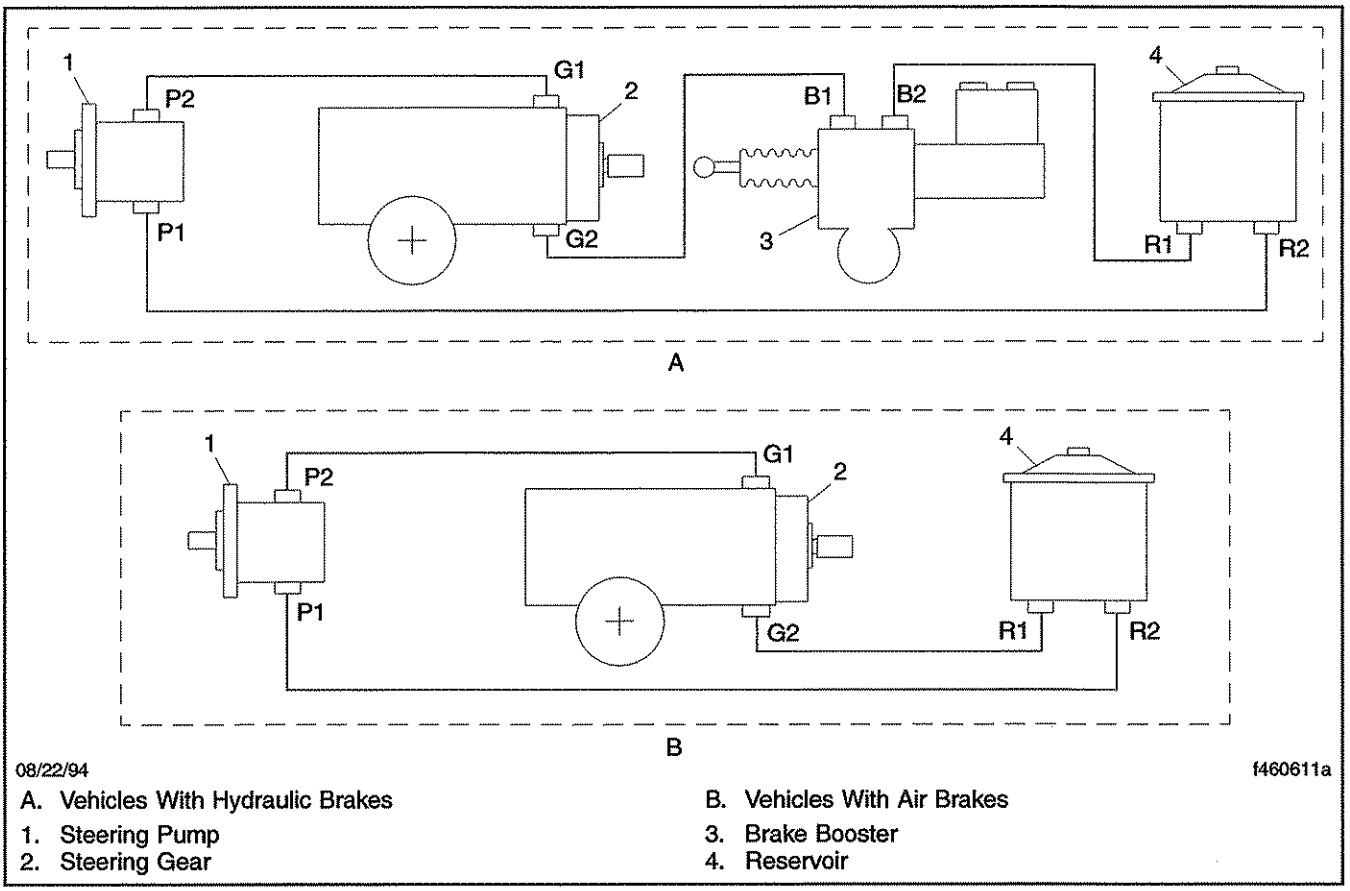
8. Test pump performance.

8.1 Set up the system for hydraulic checks. See **Subject 305** for instructions.

8.2 Make sure the fluid temperature is 125° to 135°F (51° to 57°C) and the vehicle is stationary with the front wheels pointing forward and the rearmost tires chocked.

8.3 Run the engine at idle. Refer to the applicable table in **Subject 305** for the correct engine idle speed.

8.4 Adjust idle speed, if necessary. Refer to the engine manufacturer's instructions.



A. Vehicles With Hydraulic Brakes
1. Steering Pump
2. Steering Gear
B. Vehicles With Air Brakes
3. Brake Booster
4. Reservoir

Fig. 10, Locations Where Pressure is Measured

Total System and Component Restrictions		
Total System and Component Restrictions	**Maximum Allowable**	**Action to Take**
P2 = Total System	Hydraulic Brakes: 140 psi (965 kPa) Air Brakes: 100 psi (689 kPa)	Check pressures at the key locations.
P2-G1 = Hose: Pump-to-Gear	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
G1-G2 = Steering Gear	55 psi (379 kPa)	The gear rotary valve is damaged. Replace the gear. See instructions in this manual.
G2-B1 = Hose: Gear-to-Booster	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
G2-R1 = Hose: Gear-to-Reservoir	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
B1-B2 = Booster	40 psi (276 kPa)	Check the internal booster filter for contaminants. Check for contaminants causing binding or blockage of poppet and check valves within the booster.

Troubleshooting and Diagnostic Checks

Total System and Component Restrictions		
Total System and Component Restrictions	**Maximum Allowable**	**Action to Take**
B2-R1 = Hose: Booster-to-Reservoir	12 psi (83 kPa)	Check for a kinked, collapsed, or plugged hose. Replace the hose if necessary.
R1-R2 = Reservoir	9 qt: 8 psi (55 kPa) 2 qt: 4 psi (28 kPa)	Replace the filter. Check for internal blockage.
R2-P1 = Hose: Pump Supply	12 psi (83 kPa)	Check for a kinked, collapsed, or plugged hose. Replace the hose if necessary.

Table 3, Total System and Component Restrictions

8.5 Slowly close the load valve. When the valve is completely closed, read the pressure gauge. See **Fig. 11.**

⚠ CAUTION

Don't leave the valve closed for longer than 5 seconds since this could damage the power steering system.

8.6 If the pressure rises rapidly, appears to be uncontrolled, or rises above the maximum pressure of 2065 psi (14 240 kPa), open the load valve immediately. Indicate on form SD–94 whether the pump response was erratic or not. If the response was erratic, replace the pressure relief valve in the pump. For steering pump instructions, refer to the steering section in this manual. If the pressure was constant, continue the procedure. With the fluid temperature at 125° to 135°F (51° to 57°C) repeat steps as required.

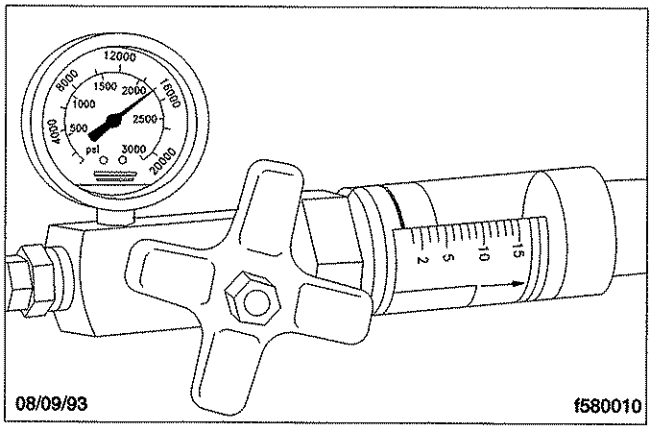


Fig. 11, Pressure Gauge and Flow Meter

8.7 If the pump pressure measures 1960 to 2065 psi (13 515 to 14 240 kPa), it is acceptable. Go on to record the relief pressure on form SD–94. If the pressure is not within this range, replace the pressure relief valve if not done previously in this test. With the fluid temperature at 125° to 135°F (51° to 57°C) repeat steps as required. If the pressure relief valve has been replaced, go to the substep for replacing the pump.

8.8 If the pressure was not within the above applicable range, and the relief valve has been previously replaced, replace the pump. For steering pump instructions, refer to the steering section in this manual. If the pump was replaced, evaluate its performance by repeating this entire check.

8.9 Record the relief pressure on form SD–94.

8.10 With the engine at idle, test the pump relief valve reaction. Note the flow rate with the load valve open.

8.11 Close the load valve until the pump relief pressure is reached (previously determined). The flow rate should drop to zero.

8.12 Immediately open the load valve and note the flow rate. It should return to the value noted earlier.

8.13 If the flow rate returns immediately, the relief valve is acceptable. Continue the procedure.

If the flow rate does not return immediately, the pump relief valve is not working cor-

rectly. Replace the relief valve if not previously done, following the steering pump instructions in the steering section in this manual.

8.14 Repeat steps for testing pump relief valve action with the engine at 1500 rpm.

8.15 Record on form SD–94 whether the relief valve operated "OK" or "Not OK" at idle and 1500 rpm. Near the bottom of the form, list any pump repairs that were made.

8.16 With the engine at idle, test the pump flow. Slowly close the load valve until the pressure gauge reads 1000 psi (6895 kPa).

8.17 Read the flow gauge and record the flow rate on form SD–94.

8.18 Open the load valve.

8.19 Run the engine at 1500 rpm. Leave the load valve open, do *not* close the load valve. Read the flow gauge and record the flow rate on form SD–94.

8.20 At idle the minimum flow rate is 3.3 gpm (12.5 Lpm). The maximum flow rate at either engine speed is 4.4 gpm (16.7 Lpm). If the flow rate is below the minimum, repair or replace the pump. For steering pump instructions, refer to **Group 46** in this manual. If the flow rate is above the maximum, replace the flow control and relief valve in the pump. For instructions, see **Group 46** in this manual.

9. Check the steering gear poppet and the axle stop adjustment.

NOTE: Poppets limit the steering assist when the front wheels approach the axle stops. Improper adjustment can apply excessive force to the steering linkage or loss of assist as the steering wheel approaches either full left or full right turns.

9.1 If the turning angle is inadequate, make sure the axle stops are set to the maximum possible turn angle. Make sure the axle stop settings limit the steering travel so there is 1/2-inch (13-mm) clearance from all stationary components, and 3/4-inch (19-mm) clearance from all moving components.

9.2 Make sure the pitman arm is oriented on the steering gear sector shaft correctly. See **Subject 110.**

9.3 Set up the system for hydraulic checks. See **Subject 305** for instructions.

9.4 Make sure the fluid temperature is 125° to 135°F (51° to 57°C) and the vehicle is stationary with the front wheels pointing forward.

9.5 Run the engine at idle with the load valve open. Refer to the applicable table in **Subject 305** for the correct engine idle speed.

9.6 Turn the steering wheel to either full-lock position.

⚠ CAUTION

If power steering pump relief pressure is reached while the steering wheel is at full-lock, release the steering wheel from this position. Don't allow the pump relief pressure to be maintained for longer than five seconds, or damage to the pump may result.

9.7 Note the pressure gauge reading.

9.8 Run the engine at idle with the load valve open, and repeat steps for the opposite turn direction, and note the pressure gauge reading.

9.9 The pressure readings at the axle stops should be at least 200 psi (1380 kPa) less than pump relief pressure. If the pressures are acceptable, record on form SD–94 and go on to the next test for the complaint. See **Table 1**. If the pressure is too high, adjust the poppet valves. For instructions, see **Subject 100.**

10. Test for steering gear internal leakage.

10.1 Set up the system for hydraulic checks. See **Subject 305** for instructions.

10.2 Make sure the fluid temperature is 150° to 160°F (66° to 71°C) and the vehicle is stationary with the front wheels pointing forward.

Troubleshooting and Diagnostic Checks

10.3 Run the engine at idle with the load valve open. Refer to the applicable table in **Subject 305** for the correct engine idle speed.

10.4 Place an unhardened steel spacer, 1 inch (2.5 cm) thick between the axle and the axle stop at one side of the axle. See **Fig. 12.** The spacer should have an extension or handle long enough to keep your fingers clear of the axle stop area. A brazing rod or welding rod works well for this purpose.

⚠ WARNING

Keep your fingers clear of the axle stops and spacer block during this test. Make sure that the spacer block contacts the axle stop squarely. Contact that is not square could break the axle stop, or dangerously eject the spacer block, causing injury.

While running this test, do not hold the steering wheel in the full turn position for longer than 5 seconds at a time to avoid damaging the pump.

10.5 Have someone turn the steering wheel until the axle stop contacts the spacer block. Apply 20 lb (9 kg) to the rim of the steering wheel. See **Fig. 13.**

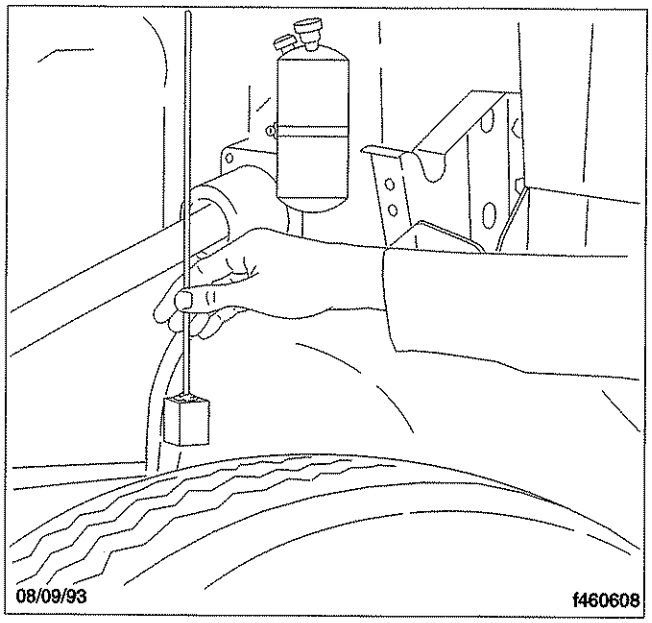


Fig. 12, Position the Steel Spacer

10.6 Read the internal leakage rate on the flow meter.

10.7 Record the reading on form SD–94.

10.8 Repeat steps for the opposite turn direction.

10.9 The maximum permissible internal leakage is 1.0 gpm (3.8 Lpm). If leakage is greater in either turning direction, replace the steering gear components as needed following the instructions in **Subject 120.**

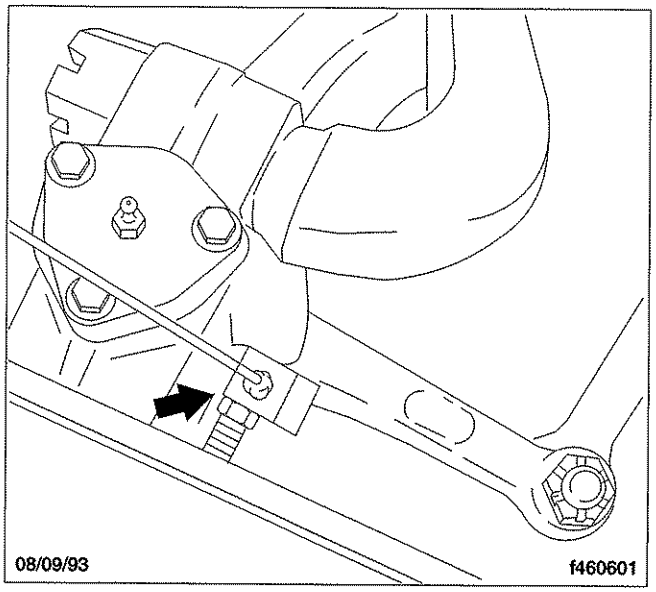


Fig. 13, Axle Stop Contacting the Steel Spacer

System Setup for Hydraulic Checks

System Setup

NOTE: Use a 1 to 10 gpm (3.8 to 38 Lpm) flow meter, a pressure gauge 0 to 2500 psi (0 to 17 225 kPa) minimum, and a load valve, preferably in one test unit.

1. Install the test unit between the pump high-pressure line and the steering gear. See **Fig. 1.**
2. Fill and bleed the steering system. See **Subject 110** for instructions.
3. Checks must be done with the power steering fluid at operating temperature 125° to 135°F (51° to 57°C). Monitor the fluid temperature with a thermometer in the fluid reservoir. See **Fig. 2.** If the fluid is too cold, raise the temperature as follows:
   - 3.1 Run the engine at idle.
   - 3.2 *Partially* close the load valve on the test unit until the pressure gauge reads 1000 psi (6895 kPa).

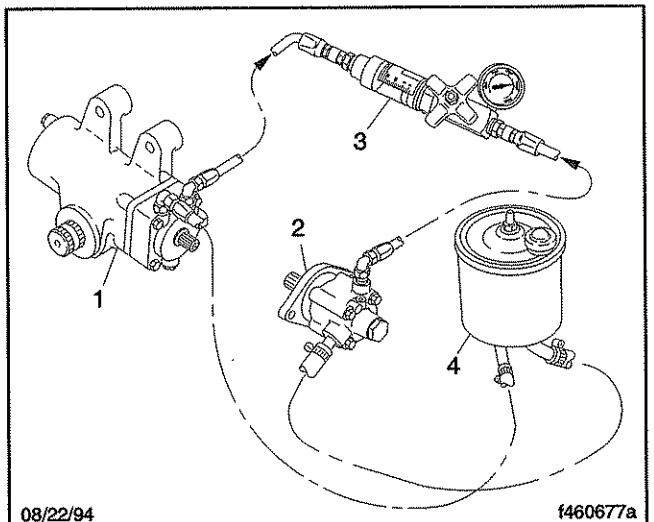
⚠ CAUTION

Do not leave the load valve fully closed since this could damage the power steering system.

NOTE: When checking pump performance, the steering gear poppet and axle stop adjustment, and the steering gear internal leakage, see the engine idle speed in **Table 1.** Adjust idle speed if necessary. See the engine manufacturer's instructions.

Record all data from the hydraulic checks on form SD–94, "Checklist for Troubleshooting Hydraulic Power Steering System Performance."

- 3.3 Open the valve when the fluid temperature reaches 125° to 135°F (51° to 57°C).



1. Steering Gear
2. Pump
3. Test Unit
4. Reservoir

Fig. 1, Test Assembly

Idle Speed	
Engine Type	**Idle Speed (rpm)**
Cummins "B" (6BTA)	800
Cummins "C" (6CTA)	800
Mercedes-Benz OM 366LA	600

Table 1, Idle Speed

⚠ CAUTION

Do not allow the fluid temperature to exceed 250°F (121°C) since this could damage the power steering system.

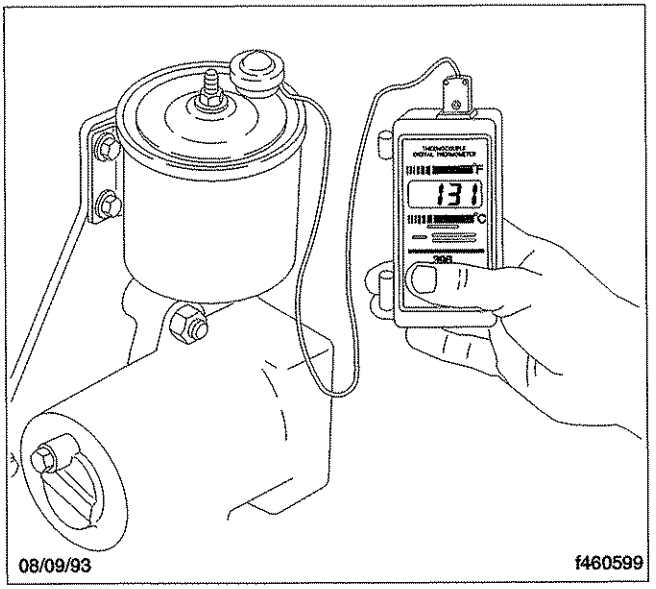


Fig. 2, Monitor the Fluid Temperature

Specifications

Kent-Moore Tools, Kent-Moore Tool Division, 29784 Little Mack, Roseville, MI 48066		
Kent-Moore Part Number	**Tool**	**Application**
J26739	Seal Installation Tool	Worm Shaft Seal Installation
J26740	Seal Compression Tool	Worm Shaft Seal Compression
J26741	Seal Installation Tool	Valve Sleeve Seal Ring Installation
J26742	Seal Compression Tool	Valve Sleeve Teflon Seal Ring Compression
J26743	Bearing Mandrel	Housing Bearing Removal and Installation
J28490	Seal Driving Tool	Input Shaft Seal Installation

Table 1, Kent-Moore Tools, Kent-Moore Tool Division, 29784 Little Mack, Roseville, MI 48066

Steering Gear Torque Values			
Description	**Bolt or Nut Size**	**Torque**	
		lbf·ft (N·m)	**lbf·in (N·cm)**
Trunnion Cover Bolts	5/16–18	15–22 (20–30)	—
Worm Shaft Preload Adjusting Screw	—	—	60–70 (678–791)
Worm Shaft Adjusting Screw Jam Nut	—	70–80 (95–108)	—
Poppet Adjusting Screw Jam Nuts	—	12–18 (16–24)	—
Poppet Seats	—	20–25 (27–34)	—
Ball Return Guide Clip Hexagon Head Bolts	—	14–22 (19–30)	—
Ball Return Guide Cap Allen Head Bolts	—	14–22 (19–30)	—
End Cover Bolts	9/16–18	150–170 (203–230)	—
Valve Housing Bolts	9/16–18	145–155 (197–210)	—
Sector Shaft Adjusting Screw Jam Nut	—	40–45 (54–61)	—
Side Cover Ring-Head Bolts	—	150–170 (203–230)	—
Manual Bleed Screw	—	—	27–33 (305–373)
Pitman Arm Pinch Bolt Nut	3/4–16	215–245 (292–332)	—
Steering Gear Mounting Bolt Nuts*	7/8–14	427 (579)	—

* Torque values are for a plain capscrew with a phosphate- and oil-coated locknut with a hardened washer.

Table 2, Steering Gear Torque Values

⚠ WARNING

Fill only with approved clean power steering fluid. Any mixture or any unapproved fluid could lead to seal deterioration and leaks. Any fluid leak could eventually cause loss of power steering assist.

Specifications

Approved Power Steering Fluids		
Fluid Type	**Approved Fluid**	
Automatic Transmission Fluid*	Dexron® II Dexron® III	
Heavy-Duty Engine Oil* IMPORTANT: Do not use heavy-duty engine oil in vehicles built from November 4, 2002.	Union Texaco Chevron Mobil Super Union Shell Rotella T	10W–40 10W–40 10W–40 10W–40 15W–40 30W

* Do not mix engine oil with automatic transmission fluid (ATF). Use the same lubricant for parts as is in the power steering system.

Table 3, Approved Power Steering Fluids

See **Fig. 1** for a steering system plumbing diagram.

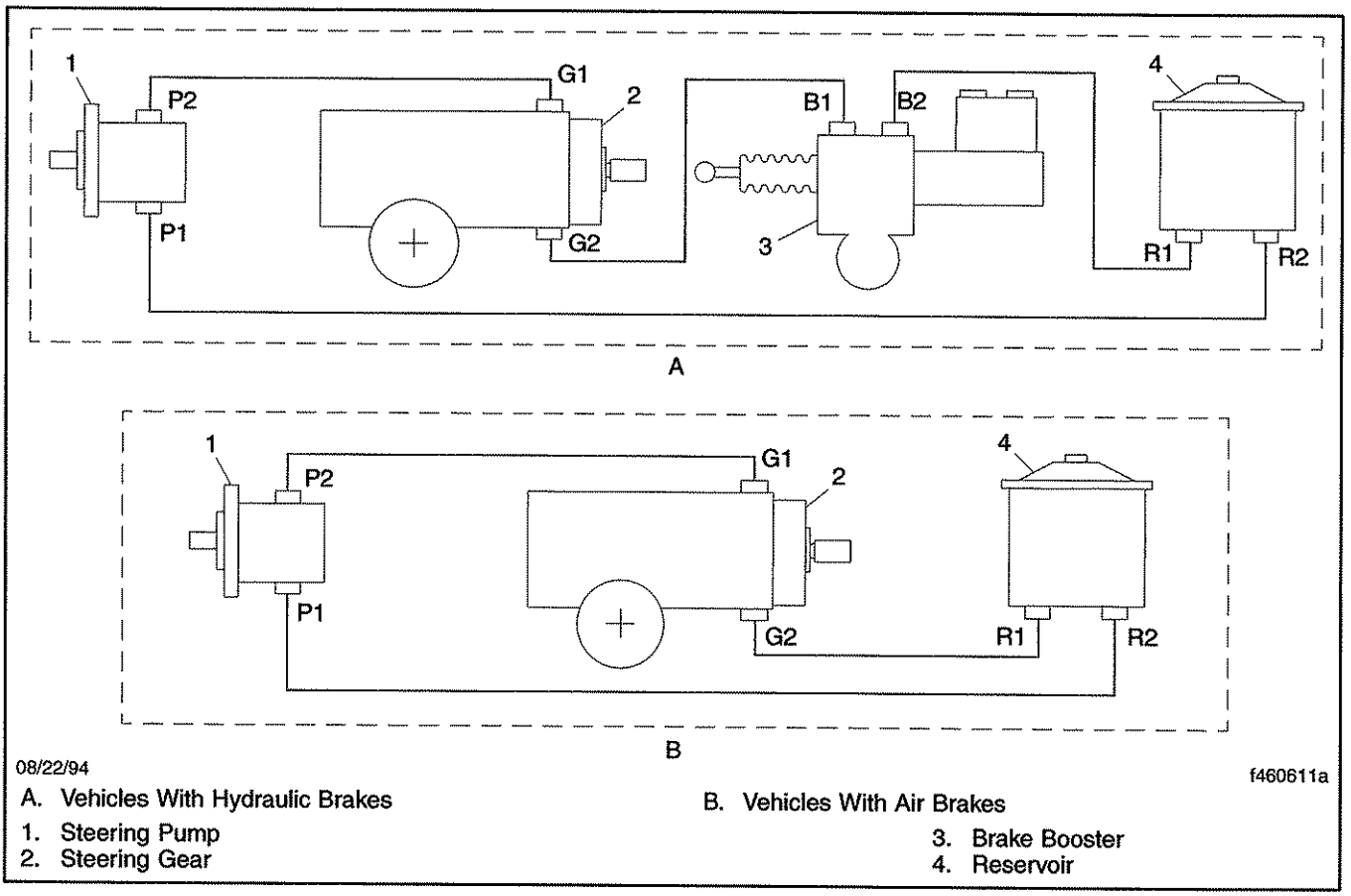


Fig. 1, Steering System Plumbing Diagram

Tilt/Telescoping Steering Column Assembly 46.06

Contents

Subject	Subject Number
General Description	050
Service Operations	
Steering Wheel Removal and Installation	100
Steering Column Removal and Installation	110
Column Disassembly and Assembly	120
Horn Contact Assembly Replacement	130
Specifications	400

General Description (Refer to Fig. 1)

The tilt/telescoping steering column has a tilt range of 15 degrees, and a telescoping range of 67 mm (2-5/8 inches). A control lever is located just below the turn signal switch. For operating instructions, refer to the vehicle driver's manual.

The upper end of the steering column assembly is threaded for the steering wheel nut, and just below the threads are splines that correspond to those in the steering wheel hub. At the lower end, the shaft is splined for the steering driveline end yoke, and has a groove for the end-yoke pinch bolt.

The steering column assembly is held in place by six hexbolts that attach the assembly to the lower dash and the pedal support bracket.

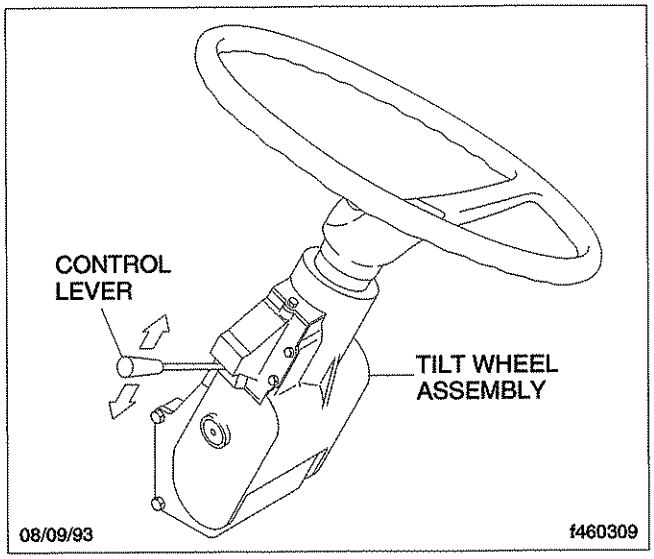


Fig. 1

Steering Wheel Removal and Installation

Removal

1. Put the front wheels in the straight ahead position. If possible, drive the vehicle in a straight line for a short distance, stopping at the place where the work will be done.

   Don't turn the steering wheel at any time during the removal procedure.

2. Apply the parking brake and chock the tires.
3. Disconnect the batteries at the negative terminal.
4. Using a small screwdriver, carefully pry out the horn button. Disconnect the two wires from it. **See Fig. 1.**
5. Using a deep socket to avoid damaging the wires, remove the steering wheel nut. **See Fig. 2.**
6. Using 1/4-inch sheet metal stock, make a wire protector about 4 cm x 1.5 cm (1-5/8 inches x 5/8 inch), like the one shown in **Fig. 3.** Then put it over the end of the steering column.
7. Using a steering wheel puller, remove the steering wheel from the steering column. **See Fig. 4.**

IMPORTANT: When you set the steering wheel aside, be careful not to damage the turn signal self-cancelling pin on the underside of the wheel. **See Fig. 5.**

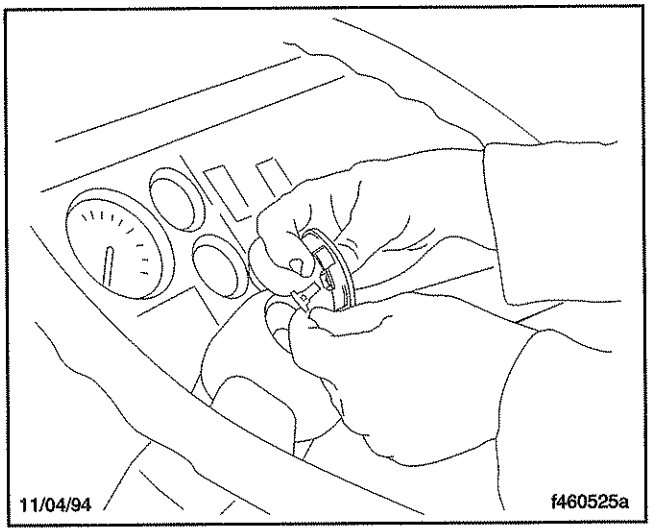


Fig. 1, Pry out the Horn Button

Installation

1. Make sure the front tires are pointed straight ahead and the steering gear is centered.
2. Put the steering wheel on the steering column so that the spokes are within 10 degrees of the 4 o'clock and 8 o'clock positions. **See Fig. 6.**
3. Thread the two horn wires through the steering wheel nut, then install the nut. Tighten it 81 N·m (60 lbf·ft).
4. Connect the two wires to the horn button. Pack the horn wires with dielectric grease.

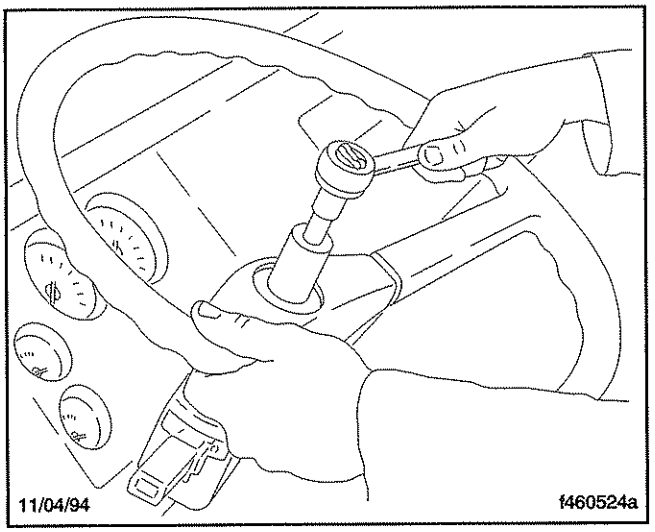


Fig. 2, Remove the Steering Wheel Nut

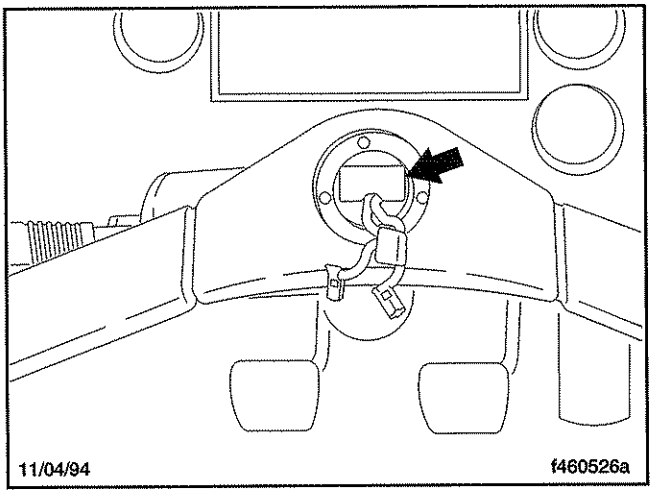


Fig. 3, Make a Wire Protector

Steering Wheel Removal and Installation

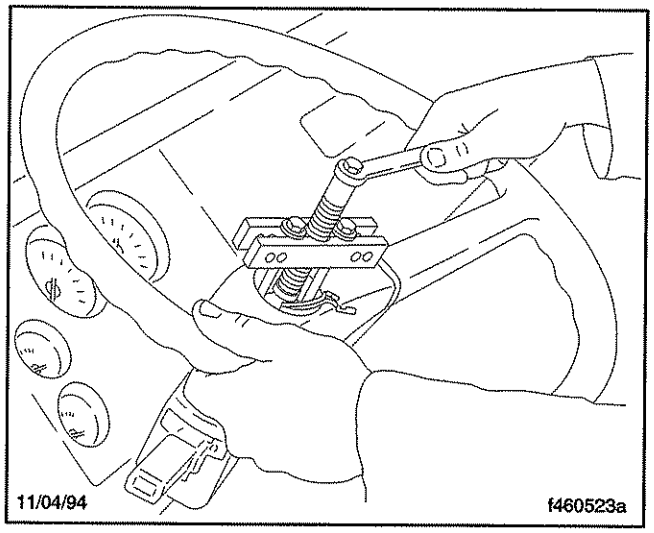


Fig. 4, Remove the Steering Wheel from the Column

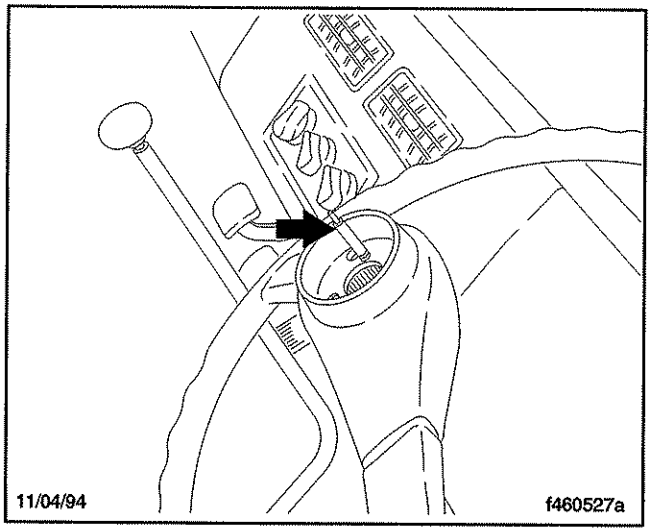


Fig. 5, Turn Signal Self-Cancelling Pin

NOTE: The horn wires may be connected to either terminal.

5. Install the horn button in the steering wheel hub so the logo on it is aligned with the steering wheel spokes. **See Fig. 7.**
6. Take the vehicle for a test drive to make sure the steering wheel is on correctly. If it isn't, remove it and install it again.

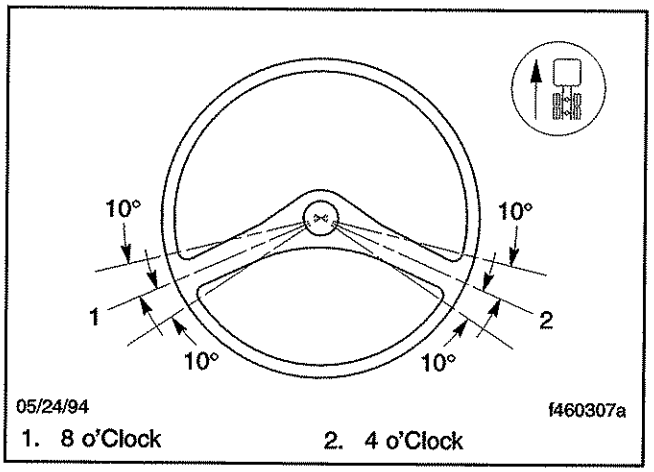


Fig. 6, Center the Steering Wheel

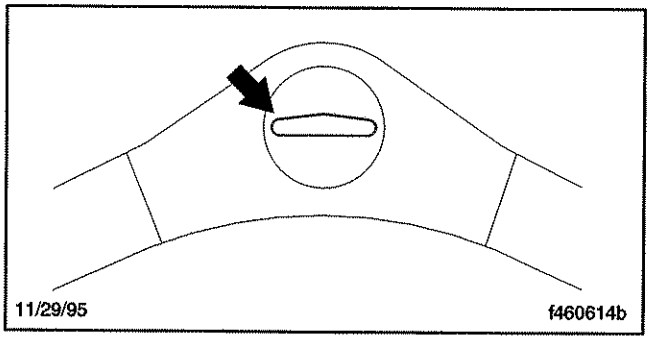


Fig. 7, Align the Logo

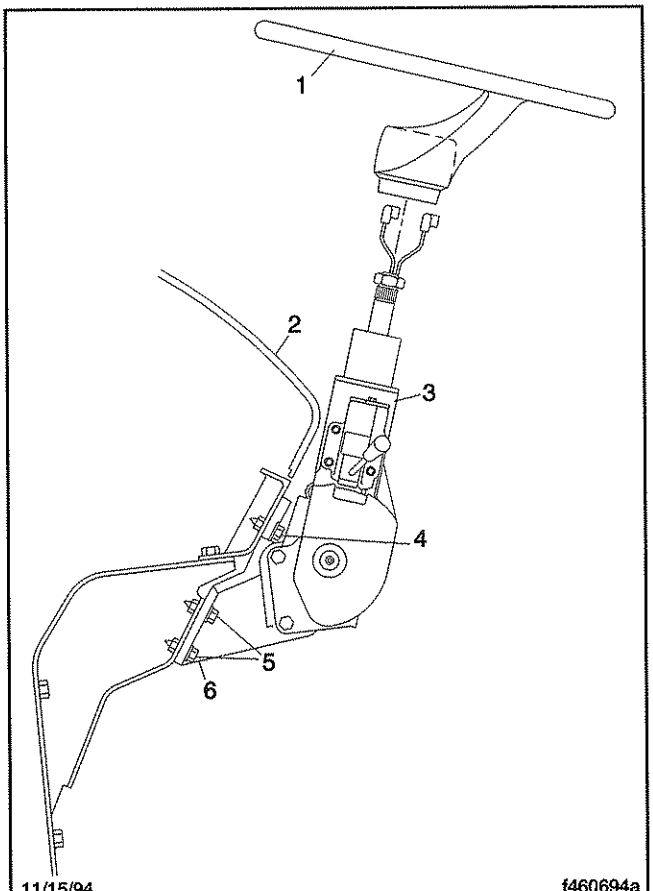
Steering Column Removal and Installation

Removal (See Fig. 1)

1. Park the vehicle on a level surface. Make sure the front tires are pointing forward. Apply the parking brakes. Shut down the engine. Chock the tires.

IMPORTANT: Once the vehicle is parked, do not turn the steering wheel at any time during the following procedures.

2. Disconnect the batteries.
3. Remove the plastic cover from the turn signal switch on the left side of the steering column.



1. Steering Wheel
2. Instrument Panel
3. Tilt Steering Column Assembly
4. Upper Mounting Hexbolts
5. Lower Mounting Hexbolts
6. Steering Column Mounting Bracket

Fig. 1, Steering Column Assembly

4. Remove the two allen-head screws that attach the turn signal switch to the steering column. Swing the turn signal switch up and out of the way.
5. Disconnect the horn wire.
6. Remove and discard the pinch bolt and nut from the steering driveline yoke.
7. Remove the four hexbolts that attach the steering column bracket to the lower dash and to the pedal support bracket.
8. Disconnect the steering column from the steering driveline U-joint yoke.
9. Loosen the two upper mounting bracket hexbolts. Remove the steering column assembly from the vehicle.
10. If replacing the column, remove the steering wheel. For instructions, see **Subject 100.**

Installation (See Fig. 1)

1. Install the steering wheel. For instructions, see **Subject 100.**
2. Wipe the end of the column shaft with a clean, dry cloth.
3. Slide the upper end yoke onto the column shaft. Install a new end yoke pinch bolt. Before installing the pinch-bolt nut, make sure the pinch bolt is centered in the steering column shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install and tighten a new pinch-bolt nut. For the proper torque, see **Specifications, 400.**
4. Apply torque seal OGP F900WHITE to the exposed pinch-bolt threads and to the locknut.
5. Align the upper mounting bracket holes with the upper mounting bracket hexbolts. Position the column assembly under the lower dash.
6. Line up the four lower holes in the steering column bracket with those in the lower dash and the pedal support bracket.
7. Install the four hexbolts and tighten them in stages to a final torque of 40 lbf·ft (54 N·m).
8. Connect the horn wire.

Steering Column Removal and Installation

9. Install the turn signal switch on the left side of the steering column. Tighten the screws firmly. Install the plastic cover.
10. Connect the batteries.
11. Remove the chocks from the tires.
12. Test drive the vehicle and make sure the steering column assembly operates smoothly. If it does not operate smoothly, repeat the service operations.

Column Disassembly and Assembly

Disassembly (Refer to Fig. 1)

⚠ WARNING

WARNING: All steering mechanisms are critical safety items. Because of this, follow the instructions in this subject to the letter. Failure to do so may result in loss of steering, which could cause an accident resulting in personal injury or property damage.

Wear eye protection during disassembly of the tilt steering wheel column assembly. Parts of the assembly are spring-loaded, and could be ejected, which could result in serious eye injury.

NOTE: If replacing only the control lever (Ref. 36), spring cover plate (Ref. 33), actuator housing (Ref. 35), spring (Ref. 31), cam actuator (Ref. 38), pivot pin (Ref. 39), lockpin (Ref. 30), anti-rattle spring (Ref. 37), plate (Ref. 29), spring and wedgelock (Refs. 28 and 40), and spring and lockbar (Refs. 27 and 41), it is not necessary to remove the steering wheel and column assembly from the vehicle.

1. To minimize spring tension within the column assembly, hold the control lever all the way down, then move the steering wheel to the upright (non-tilt) position; release the control lever.

   Pull up the control lever and move the steering wheel up until it stops; release the control lever.

2. Remove the steering wheel from the column assembly. **Refer to Subject 100 for instructions.**

3. Remove the steering column assembly from the vehicle. **Refer to Subject 110 for instructions.**

4. Unscrew the control lever (Ref. 36).

5. Remove the 10-24 x 5/8-inch tapping screw (Ref. 32) from the spring cover plate (Ref. 33). Remove the plate.

6. Remove the four self-tapping screws (Refs. 32 and 34) from the actuator housing and bushing assembly (Ref. 35). Remove the actuator housing.

NOTE: On some tilt/telescoping column assemblies, two of the self-tapping screws (Ref. 32) are 5/8-inch long, and the other two screws (Ref. 34) are 7/8-inch long.

7. Remove the spring (Ref. 31), cam actuator (Ref. 38), pivot pin (Ref. 39), lockpin (Ref. 30), and anti-rattle spring (Ref. 37).

8. Remove the disengagement plate (Ref. 29), spring and wedgelock (Refs. 28 and 40), and spring and lockbar (Refs. 27 and 41).

   Remove all grease from the wedgelock/ lockbar cavity.

9. Detach the springs (Refs. 43 and 45) from the main housing assembly (Ref. 26). Remove the upper spring cover (Ref. 42).

10. Remove the four bolts (Ref. 8) from the support bracket (Ref. 25) and lower bearing housing (Ref. 21).

11. Remove the spring (Ref. 18) from the jacket tube (Ref. 16).

12. Remove the lower spring cover (Ref. 44), springs (Refs. 43 and 45), and spring retaining rod (Ref. 22) from the lower bearing housing.

13. Remove the retaining ring (Ref. 19) from the lower end of the universal joint assembly (Ref. 23). Remove the universal joint assembly from the lower bearing housing.

14. Using a suitable bearing puller, remove the bearings (Ref. 20) from the lower bearing housing.

    Using a 3/16-inch allen wrench, remove the pipe plug (Ref. 24) from the end of the universal joint assembly.

15. Remove the stopscrew (Ref. 2) and lockwasher (Ref. 1) from the main housing assembly (Ref. 26).

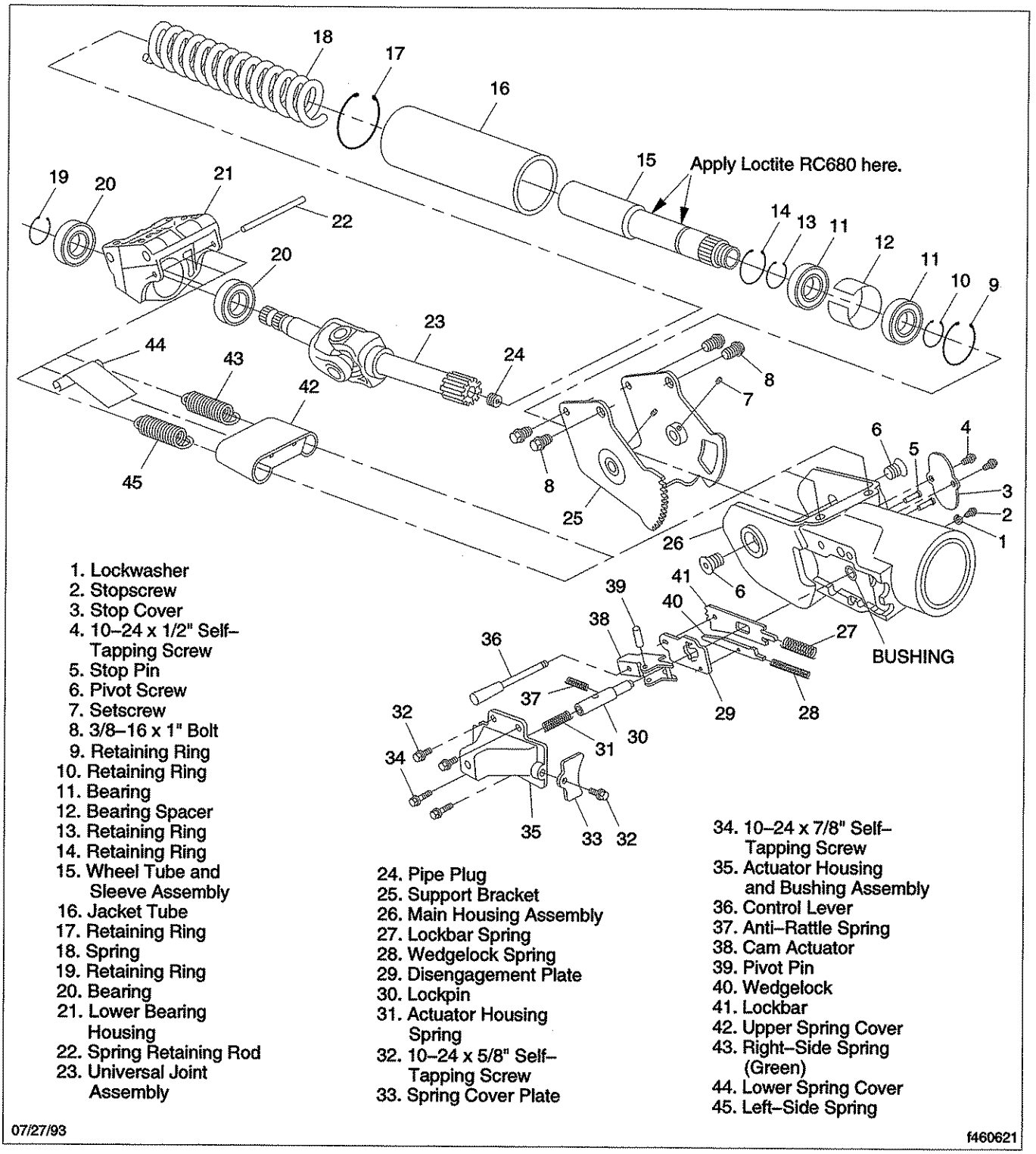
16. Push the wheel tube and jacket tube (Refs. 15 and 16) out through the lower end of the main housing assembly.

17. Remove the two retaining rings (Refs. 9 and 10) from the top end of the wheel tube and sleeve assembly and the jacket tube.

⚠ CAUTION

CAUTION: Keep the jacket tube clean and free of lubricant. Also, don't dent or scratch the jacket tube. Dents or scratches could restrict the telescoping action of the tilt steering column assembly.

Column Disassembly and Assembly



1. Lockwasher
2. Stopscrew
3. Stop Cover
4. 10–24 x 1/2" Self–Tapping Screw
5. Stop Pin
6. Pivot Screw
7. Setscrew
8. 3/8–16 x 1" Bolt
9. Retaining Ring
10. Retaining Ring
11. Bearing
12. Bearing Spacer
13. Retaining Ring
14. Retaining Ring
15. Wheel Tube and Sleeve Assembly
16. Jacket Tube
17. Retaining Ring
18. Spring
19. Retaining Ring
20. Bearing
21. Lower Bearing Housing
22. Spring Retaining Rod
23. Universal Joint Assembly
24. Pipe Plug
25. Support Bracket
26. Main Housing Assembly
27. Lockbar Spring
28. Wedgelock Spring
29. Disengagement Plate
30. Lockpin
31. Actuator Housing Spring
32. 10–24 x 5/8" Self–Tapping Screw
33. Spring Cover Plate
34. 10–24 x 7/8" Self–Tapping Screw
35. Actuator Housing and Bushing Assembly
36. Control Lever
37. Anti–Rattle Spring
38. Cam Actuator
39. Pivot Pin
40. Wedgelock
41. Lockbar
42. Upper Spring Cover
43. Right–Side Spring (Green)
44. Lower Spring Cover
45. Left–Side Spring

07/27/93 f460621

Fig. 1

18. Insert a 20 x 2 cm (8 x 3/4-inch) rod into the splined sleeve end of the wheel tube. Using a press, press out the wheel tube and sleeve assembly. Remove the retaining ring (Ref. 14).
19. Using a suitable bearing removal tool, press the bearings (Ref. 11) off of the wheel tube and sleeve assembly. Remove the retaining ring (Ref. 13).
20. Remove the self-tapping screws (Ref. 4), stop cover (Ref. 3), and the stop pins (Ref. 5) from the main housing assembly.
21. Remove the setscrews (Ref. 7) from the support bracket. Remove the two pivot screws (Ref. 6), then separate the support bracket (Ref. 25) from the main housing.

⚠ 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.

NOTE: For ease of removal, it may be necessary to heat the setscrews and pivot screws. Don't exceed 260°C (500°F) as the material hardness of these fasteners will be affected.

22. Using a petroleum-based solvent, clean the pivot screws, setscrews, and the internal threads of the support bracket.

Assembly (Refer to Fig. 1)

⚠ WARNING

WARNING: Wear eye protection during assembly of the tilt steering wheel column assembly. Parts of the assembly are spring-loaded, and could be ejected, which could result in serious eye injury.

1. Position the support bracket (Ref. 25) in the main housing (Ref. 26). Make sure that the bracket teeth are on the same side of the housing as the cam actuator (Ref. 38).
2. Install but don't tighten the pivot screws (Ref. 6). Insert a 13 x 76 mm (1/2 x 3 inch) bolt and nut through the center of the support bracket, between the bracket flanges.

   Back off the nut to spread the flange bosses against the main housing and provide clearance for installation of the lower bearing housing (Ref. 21).

   Remove the pivot screws (Ref. 6).
3. Apply a light coating of lithium grease under the head of each pivot screw (Ref. 6) then, apply Loctite RC680 to the threads of the pivot screws.

NOTE: Use care and avoid getting any grease on the pivot screw threads, or Loctite RC680 under the pivot screw head.

4. First tighten the pivot screw on the cam-actuator side of the housing 460 to 500 N·cm (40 to 45 lbf·in). Install and tighten the other pivot screw 460 to 500 N·cm (40 to 45 lbf·in).
5. Apply Loctite RC680 to the threads of the setscrews (Ref. 7). Install the setscrews and tighten them 560 to 680 N·cm (50 to 60 lbf·in).

NOTE: Use care and avoid getting any Loctite RC680 under the setscrew head.

6. Remove the 1/2 x 3-inch bolt and nut from the support bracket.
7. Install two new retaining rings (Refs. 13 and 14) on the top end of the wheel tube and sleeve assembly (Ref. 15).
8. Apply Loctite RC680 around the wheel tube in the bearing support area. Install a new bearing (Ref. 11) against the upper retaining ring.
9. Install the bearing spacer (Ref. 12). Install a new bearing (Ref. 11) until it clears the upper retaining ring groove. Install a new retaining ring (Ref. 10).
10. Insert the wheel tube and sleeve assembly (Ref. 15) into the jacket tube (Ref. 16). Align the split in the bearing spacer (Ref. 12) with the screw hole in the top end of the jacket tube.
11. Using a tubular bearing installation tool, apply pressure against the outer race of the upper bearing and press the wheel tube and sleeve assembly into the jacket tube.

    Install retaining rings (Refs. 9 and 17) in the grooves of the jacket tube.

Column Disassembly and Assembly

12. Place the jacket tube assembly spring-end down on a pedestal that is about 10 cm (4 inches) high and 6 cm (2-1/4 inches) in diameter. Make sure that the cutouts on the lower collet in the main housing assembly are aligned with the holes for the lockpin (Ref. 30) and stopscrew (Ref. 2).
13. Slide the main housing assembly down over the jacket tube assembly. As the upper end of the jacket tube approaches the upper tapered collet of the main housing, push the collet down with a screwdriver (or other suitable tool) to pilot the wheel tube assembly into the housing bore.
14. Align the jacket tube's guide slot with the stopscrew (Ref. 2) hole in the main housing assembly (Ref. 26). Install the lockwasher and stopscrew (Refs. 1 and 2). Tighten the stopscrew 14 to 20 N·m (10 to 15 lbf·ft).
15. Press a new bearing (Ref. 20) into each end of the lower bearing housing (Ref. 21).
16. Slide the shaft of the universal joint assembly (Ref. 23) into the lower bearing housing until it seats against the lower bearing.

    Install the retaining ring (Ref. 19) on the universal joint shaft.
17. Install the pipe plug (Ref. 24) in the slotted end of the universal joint shaft. Tighten the pipe plug finger-tight.

NOTE: Don't overtighten the pipe plug. Overtightening will make it difficult to install the universal joint shaft in the wheel tube and sleeve assembly (Ref. 15).

18. Install the spring retaining rod (Ref. 22) in the lower bearing housing.
19. Hook one end of the green spring (Ref. 43) on the right side of the spring retaining rod (Ref. 22). Hook one end of the other spring (Ref. 45) on the left side of the spring retaining rod.
20. Clamp the serrated end of the wheel tube and sleeve assembly (Ref. 15) in a soft-jawed vise.
21. Push all the way down on the jacket tube (Ref. 16), then install the spring (Ref. 18).
22. Install the universal joint assembly (Ref. 23) through the spring (Ref. 18) and into the wheel tube and sleeve assembly (Ref. 15). Make sure that a slot in the splined shaft of the universal joint assembly aligns with the wide groove in the splined sleeve of the wheel tube and sleeve assembly.
23. Holding down on the universal joint assembly, align the lower bearing housing (Ref. 21) and support bracket (Ref. 25) screw holes. Install the bolts (Ref. 8). Tighten them 34 to 47 N·m (25 to 35 lbf·ft).
24. Position the lockbar (Ref. 41) on the main housing. Make sure that the lockbar locating pin is out, and that the teeth mesh with the support bracket teeth.
25. With the tapered end pointing towards the support bracket teeth, place the wedgelock (Ref. 40) on the main housing, under the lockbar.
26. Position the disengagement plate (Ref. 29) over the lockbar and wedgelock locating pins.
27. Insert the lockpin (Ref. 30) into the cam actuator (Ref. 38). Make sure that the spring hole in the cam and lockpin are facing each other.

    Insert the pivot pin (Ref. 39) through the cam actuator and lockpin. Check that the pivot pin is flush at the bottom of the cam actuator.
28. Attach one end of the anti-rattle spring (Ref. 37) to the lockpin, and the other end to the cam actuator.

    Lightly oil the lockpin assembly. Insert the lockpin into the bushing on the main housing assembly. Make sure that the ears on the cam actuator (Ref. 38) fit under the raised tabs on the disengagement plate (Ref. 29).
29. Insert the actuator housing spring (Ref. 31) into the end of the lockpin (Ref. 30). Using four self-tapping screws (Refs. 32 and 34), attach the actuator housing (Ref. 35) to the main housing. Tighten the screws 460 to 680 N·cm (40 to 60 lbf·in).

NOTE: On some tilt/telescoping column assemblies, two of the self-tapping screws (Ref. 32) are 5/8-inch long, and the other two screws (Ref. 34) are 7/8-inch long.

30. Attach the lockbar and wedgelock springs (Refs. 27 and 28). Install the spring cover plate (Ref. 33) over the lockbar and wedgelock springs. Tighten the self-tapping screw (Ref. 32) 460 to 680 N·cm (40 to 60 lbf·in).
31. Screw the control lever (Ref. 36) into the cam actuator (Ref. 38).

32. Push down on the control lever and tilt the steering column all the way down. Release the control lever.
33. Snap the lower spring cover (Ref. 44) onto the retaining rod, between the springs.
34. Slide the upper spring cover (Ref. 42) over the springs, engaging the slot on the lower spring cover.
35. Push down on the control lever, then tilt the steering column all the way up. Release the control lever. Using a suitable spring assembly tool, hook the loose ends of the springs (Refs. 43 and 45) in the holes of the main housing assembly (Ref. 26).
36. Insert and lightly tap the stop pins (Ref. 5) to seat them into the holes lettered "D" and "K."
37. Install the stop cover (Ref. 3) with the self-tapping screws (Ref. 4). Tighten the screws 460 to 680 N·cm (40 to 60 lbf·in).
38. Push the jacket tube (Ref. 16) and wheel tube assembly (Ref. 15) all the way down. Using a 3/16-inch allen wrench that is 30-cm (12-inches) long, tighten the pipe plug (Ref. 24) just enough to keep the jacket tube and wheel tube assembly in position when the lockpin (Ref. 30) is disengaged.

    Loosen the pipe plug about a one-eighth turn to allow the wheel tube assembly to telescope freely under spring tension.
39. Check the operation of the tilt/telescoping column assembly as follows:

    39.1 Unlock the column assembly by pushing and holding the control lever all the way down. Tilt the column to any position, then release the control lever to lock it in place. Tilt the column to several other positions to ensure proper operation.

    39.2 Unlock the column assembly by pulling and holding the control lever all the way up. Move the column up or down to any position, then release the control lever to lock it in place. Telescope the column to several other positions to ensure proper operation.

    If the column telescoping action is sluggish or sticks, spray a small amount of Tri-Flow lubricant, or an equivalent, on the jacket tube (Ref. 16) while the column is all the way up.

NOTE: The tilt/telescoping column assembly must sit at room temperature for 24 hours to allow the Loctite RC680 to dry.

40. Install the tilt/telescoping column assembly. **Refer to Subject 110 for instructions.**
41. Install the steering wheel. **Refer to Subject 100 for instructions.**

Horn Contact Assembly Replacement

Replacement

1. Disconnect the horn wire from the wire lead-ing to the back of the dash. **See Fig. 1.**
2. Unscrew the horn contact assembly from the right-hand side of the steering column, and discard it. **See Fig. 2.**
3. Install a new horn contact assembly into the right-hand side of the steering column. Screw in the assembly firmly.

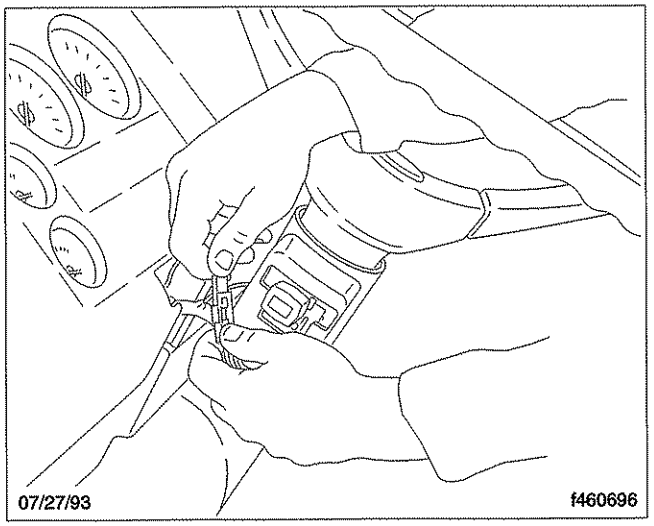


Fig. 1

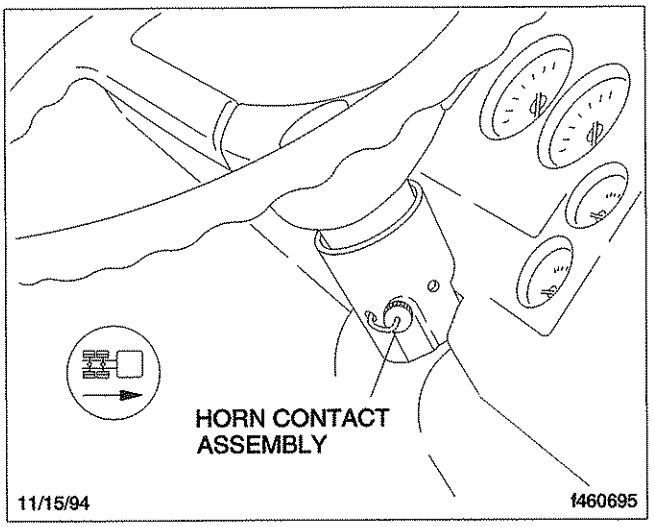


Fig. 2

4. Connect the horn wire to the wire leading to the back of the dash.
5. Check the horn. If it doesn't work, check the wiring to the horn, the horn itself, and the horn button. Repair or replace parts as needed.

Specifications

Fastener Torques			
Description	**Size**	**Torque**	
		lbf·in (N·cm)	**lbf·ft (N·m)**
Self-Tapping Screws	10–24	40–60 (460–680)	—
Bolts	3/8 x 16 x 1 Inch	—	25–35 (34–47)
Main Housing Stopscrew	—	—	10–15 (14–20)
Support Bracket Setscrews	—	50–60 (560–680)	—
Main Housing Pivot Screws	—	40–45 (460–500)	—
Steering Column Mounting Bracket Hexbolts	—	—	40 (54)
Upper End Yoke Pinch Bolt	3/18–16	—	37 (50)
	3/18–24	—	44 (60)
	7/16–20	—	55 (75)
Steering Wheel Nut	—	—	60 (81)

Table 1, Fastener Torques

TRW PS Series Power Steering Pump 46.07

Contents

Subject	Subject Number
General Description and Principles of Operation	050
Service Operations	
Removal and Installation	100
Steering Pump Disassembly, Inspection, and Assembly	110
Troubleshooting	300
Specifications	400

General Description (See Fig. 1)

The TRW PS Series power steering pump supplies power steering fluid for the operation of the power steering gear.

The main parts of the power steering pump are the housing, input shaft, cam ring, rotor, vanes, control valve, and cover assembly.

Principles of Operation

The input shaft, powered by the adaptor gear in the engine gear case, or by the crankshaft pulley, turns the rotor, which is inside the cam ring. As the rotor turns, centrifugal force pushes the vanes out toward the surface of the cam ring. As fluid enters the cam ring through the inlet port, the rotor vanes force it out through the outlet port, and into the system. The fluid operates the steering gear. Eventually the fluid returns to the power steering reservoir, and then back to the power steering pump.

If the system pressure gets too high, a relief valve inside the control valve is forced off its seat, shunting fluid into a relief passage connected to the inlet port. The fluid then recirculates inside the pump instead of going to the outlet port. When the system pressure drops to the correct level, the relief valve seats, closing off the relief passage to the inlet port. The fluid flow returns to normal, flowing from the inlet port to the outlet port and then into the power steering system.

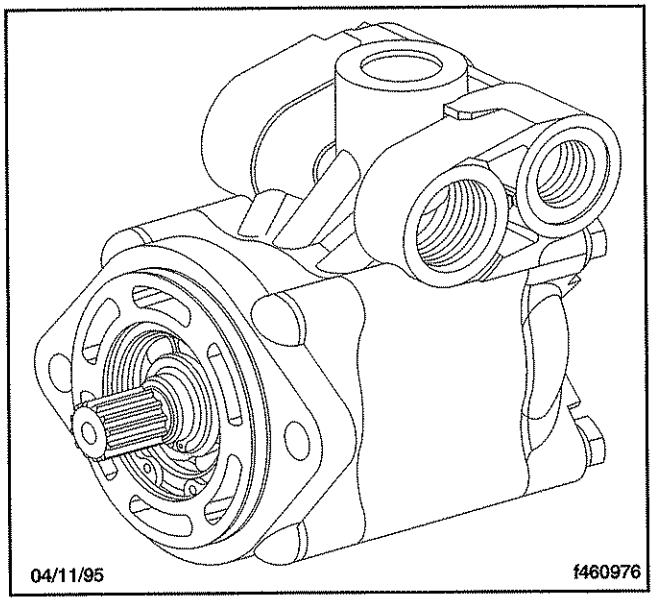
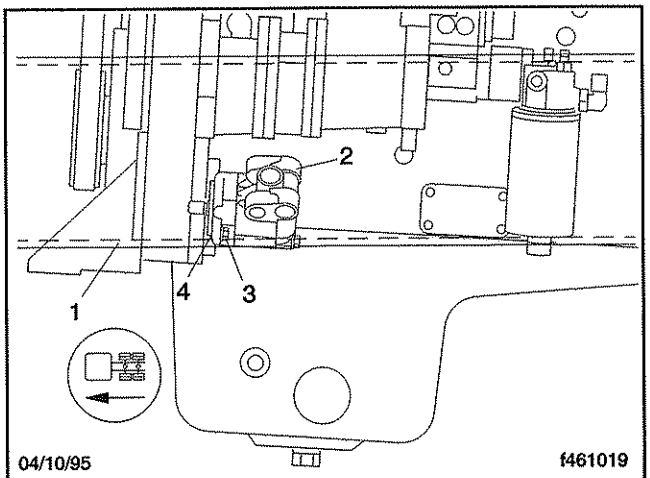


Fig. 1, TRW PS Series Power Steering Pump

Removal

1. Apply the parking brake, chock the tires, then tilt the hood.
2. Clean all outside dirt from around the fittings and hose connections.
3. Put a container under the pump, then disconnect the hoses from the fittings on the pump. Plug the hoses and cap the fittings to keep out dirt and to prevent fluid from leaking.
4. Remove the pump.
   - 4.1 Remove the mounting capscrews and lockwashers that attach the pump to the engine accessory drive mounting flange. **See Fig. 1.** Hold the pump as you remove the second mounting bolt.
   - 4.2 Pull the pump straight out from the engine. Keep it level to avoid spilling fluid.
5. Turn the pump upside down over a container and let the fluid drain out.
6. Discard the gasket from the pump mounting flange.



1. Frame Rail
2. Steering Pump
3. M10 x 35 Capscrew and 7/16-inch Lockwasher
4. Gasket

Fig. 1, TRW PS Series Power Steering Pump Mounting

Installation

1. Using engine oil, lightly lubricate a new gasket and the pump shaft.
2. Install the pump.
   - 2.1 Install a new gasket on the pump mounting flange, then place the pump on the engine's accessory drive mounting.
   - 2.2 Install the lockwashers and capscrews, and tighten them 46 N·m (35 lbf·ft).
3. Connect the inlet hose (from the power steering reservoir) to the inlet port. Tighten it 35 N·m (26 lbf·ft).
4. Connect the outlet hose (from the power steering gear) to the outlet port.
5. Bleed the power steering system.
   - 5.1 Check the fluid level in the power steering reservoir and if needed, fill it to the correct level.
   - 5.2 Start the engine and let it idle for several minutes.
   - 5.3 Turn the wheels to a full-left and full-right turn. Repeat about three times.
   - 5.4 Check the fluid level in the power steering reservoir. Add fluid as necessary to the full line on the reservoir dipstick.
   - 5.5 Shut down the engine.
6. Lower the hood, then remove the chocks.

Steering Pump Disassembly, Inspection, and Assembly

⚠ CAUTION

CAUTION: Be careful when working on the pump housing; it is aluminum, and can be easily damaged. When putting the pump in a vise, pad the vise jaws and clamp only the cover; tighten the vise just enough to hold the pump.

Disassembly (See Fig. 1)

⚠ WARNING

WARNING: Wear safety goggles or glasses when disassembling the power steering pump. Some of the parts are held in place by springs or snap rings, which can release with considerable force, possibly causing injury.

NOTE: Prepare for fluid drainage before disassembling the pump.

1. Remove the power steering pump from the engine, following the instructions in **Subject 100.**
2. Carefully remove the end plug **(Fig. 2)** from the pump housing. Remove the spring **(Fig. 3),** if it didn't come out with the end plug.
3. Remove and discard the O-ring from the plug.

IMPORTANT: TRW does not recommend disassembly of the control valve spool assembly.

4. Remove the control valve spool assembly by hand, or by pushing it with a small rod. **See Fig. 4.** Don't push on the small screen in the relief valve seat assembly.
5. Using a solvent-proof marker, make a mark across the housing and the cover. **See Fig. 5.** Remove the four screws and washers holding the housing and the cover together. **See Fig. 6.** Using a twisting motion, separate the housing from the cover.
6. Remove the spring. **See Fig. 7.**
7. Using a solvent-proof marker, draw a line across the top plate and the bottom plate. **See Fig. 8.**
8. Holding the cam ring in place, remove the top plate. **See Fig. 9.** Remove and discard the O-ring and backup O-ring.
9. Holding the bottom plate in place, remove the cam ring. Note and record whether the dots near the locating pin holes on the cam ring are up or down. **See Fig. 10.**
10. Look for wear on the outside edge of the vanes. Note and record the direction of the wear for assembly. Carefully remove the rotor and vanes, as the vanes will slip from their slots in the rotor. **See Fig. 11.**
11. Remove the locating pins. **See Fig. 12.** Make marks on the outside of the cover (not on the sealing surface) to note from which holes the locating pins were removed.
12. Remove the bottom plate. **See Fig. 13.**
13. Turn the cover over and remove the large retaining ring. **See Fig. 14.**
14. Press out the input shaft and ball bearing assembly. **See Fig. 15.**
15. Remove the spacer from the cover. **See Fig. 16.**
16. Using care not to damage the bore, remove the shaft seal. **See Fig. 17.**

Inspection

1. Clean all the parts, using a solvent compatible with the power steering fluid. Then, using filtered compressed air, dry all the parts.

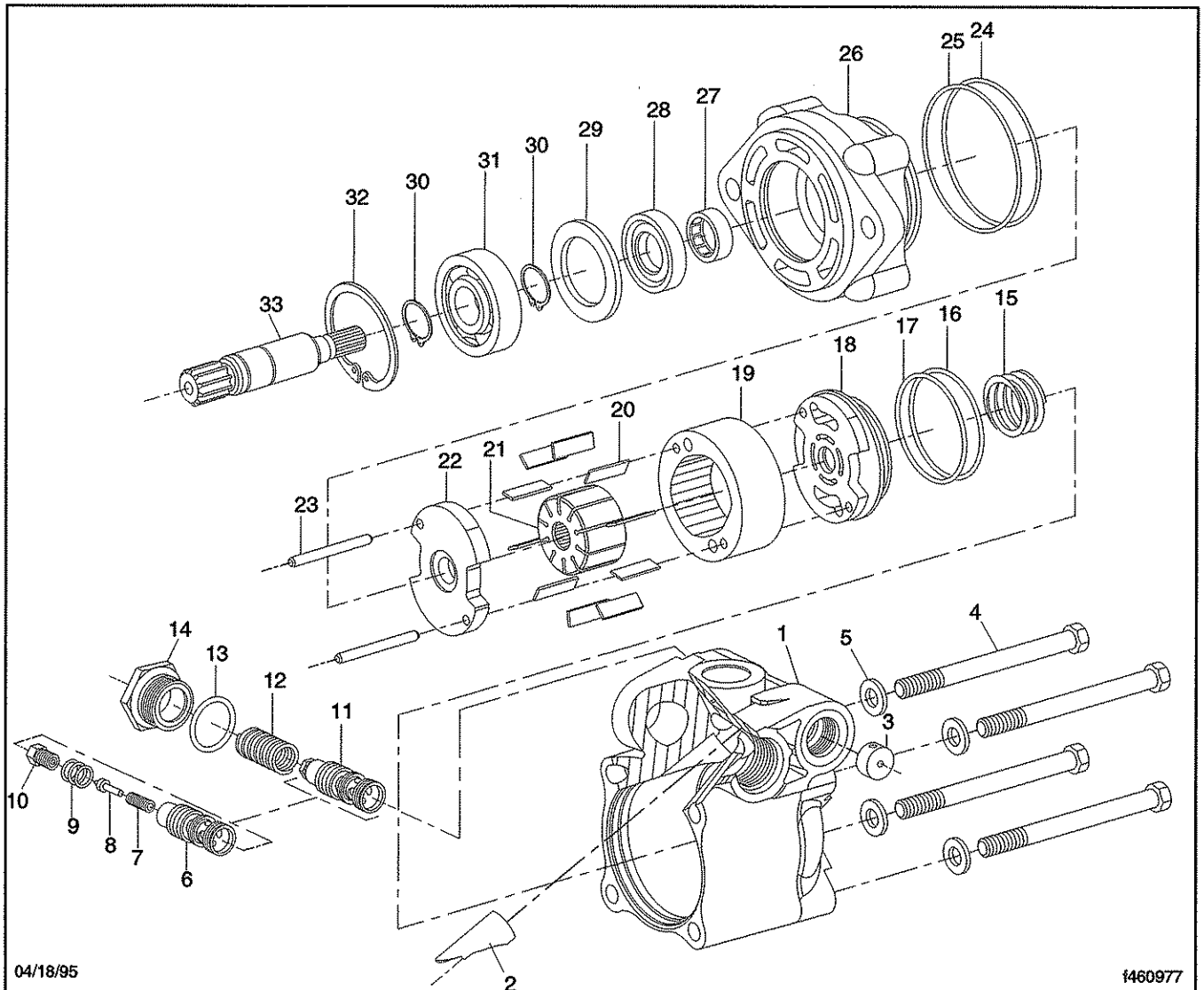
NOTE: Replace any parts that are damaged or worn.

2. Inspect the housing for cracks, stripped threads, a damaged valve bore, and damaged sealing areas. **See Fig. 18.**
3. Inspect the cover for nicks in the O-ring seal grooves. Make sure that the seal drain hole is open, and that the seal bore is free of nicks and other damage. **See Fig. 19.**

   Make sure that the surface on which the bottom plate rests is flat and free of nicks and other damage.
4. Check that the needles roll freely in the needle bearing. If needed, replace the needle bearing.

   4.1 Place the cover in a press with the flange side down. Using an 11/16-inch socket,

Steering Pump Disassembly, Inspection, and Assembly



1. Pump Housing
2. Boost Tube
3. Orifice
4. Mounting Bolt
5. Washer
6. Spool
7. Spring
8. Poppet
9. Shims
10. Relief Valve Seat Assembly
11. Control Valve Spool Assembly
12. Spring
13. O-Ring
14. Plug
15. Spring
16. O-Ring
17. Backup O-Ring
18. Top Plate
19. Cam Ring
20. Vane
21. Rotor
22. Bottom Plate
23. Locating Pin
24. Small O-Ring
25. Large O-Ring
26. Cover
27. Needle Bearing
28. Shaft Seal
29. Spacer
30. Small Retaining Ring (2 qty.)
31. Ball Bearing
32. Large Retaining Ring
33. Input Shaft

Fig. 1, Steering Pump, Exploded View

press the needle bearing out of the cover.
See Fig. 20.

Steering Pump Disassembly, Inspection, and Assembly

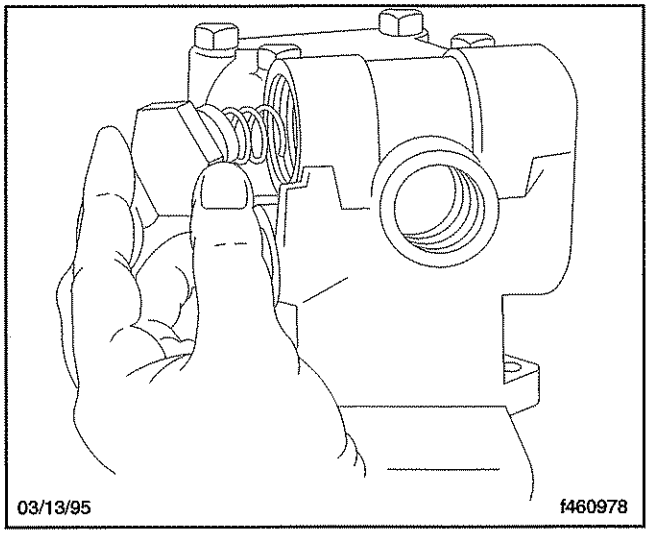


Fig. 2, Removing the End Plug

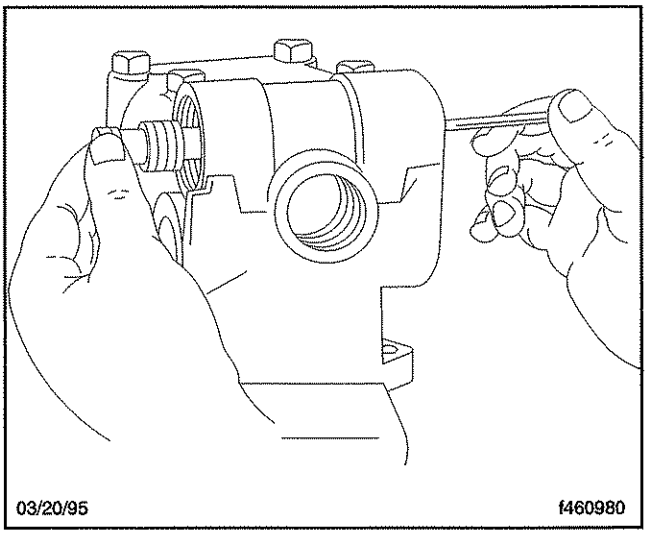


Fig. 4, Removing the Control Valve Assembly

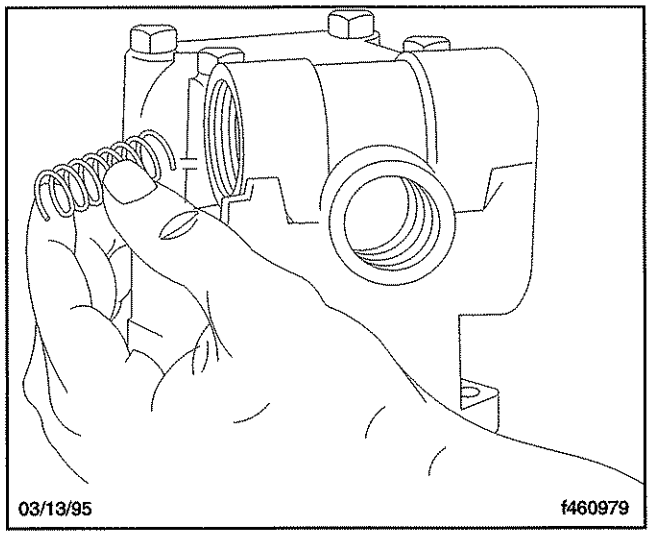


Fig. 3, Removing the Spring

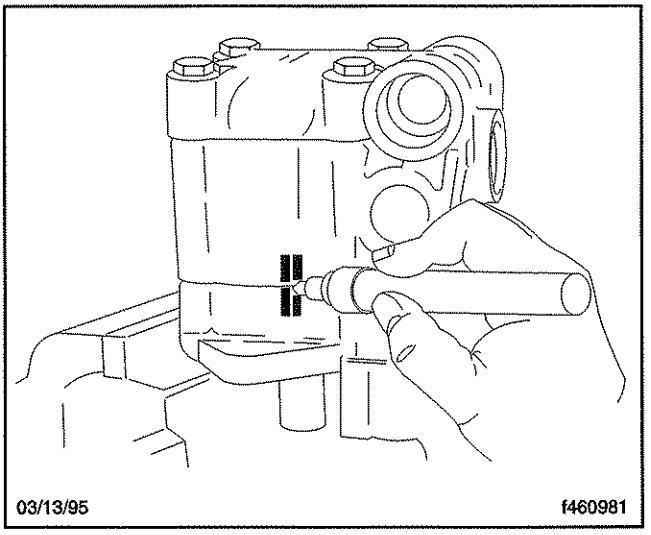


Fig. 5, Marking the Housing and the Cover

⚠ CAUTION

CAUTION: Make sure that the press is clean and free of debris. Debris could damage the face of the cover, which will affect pump operation.

4.2 Put the cover in a clean press with the flange side up. Make sure that the lettered side of the needle bearing is facing toward the press.

4.3 Using a 7/8-inch deep socket, press the new needle bearing into the cover until it is flush with the inside surface of the cover. **See Fig. 21.**

5. Inspect the top plate for seal area nicks, and abnormal wear or erosion. A polished pattern from the rotor and vanes is normal; grooves you can feel with your fingernail are not normal.

6. Look for abnormal wear, erosion, or surface damage on the inside of the cam ring.

Steering Pump Disassembly, Inspection, and Assembly

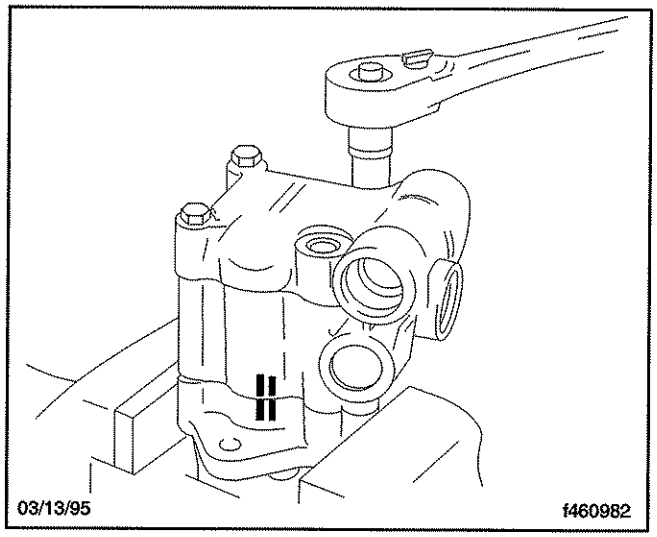


Fig. 6, Removing the Screws and Washers

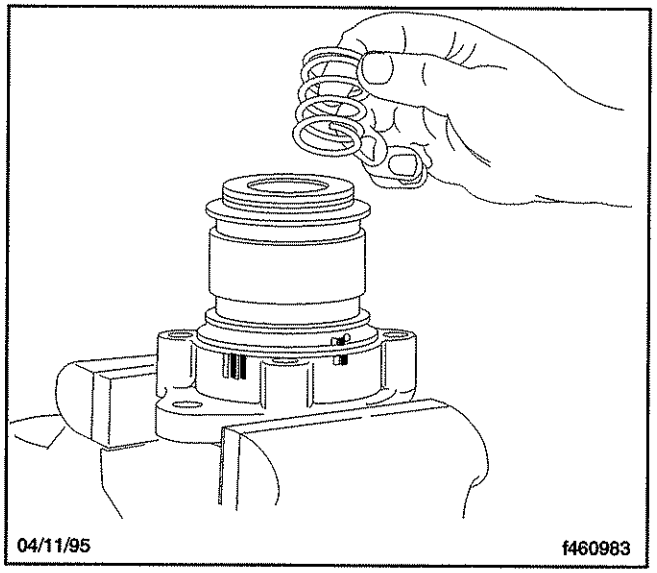


Fig. 7, Removing the Spring

7. Check the vanes on the rotor for damage or too much play in the rotor slots. **See Fig. 22.** If you can move the vanes from side-to-side in the slots, replace the whole rotor assembly.

NOTE: If the vanes are removed, make sure they are installed with the rounded edge out.

8. Check the bottom plate for abnormal wear patterns.

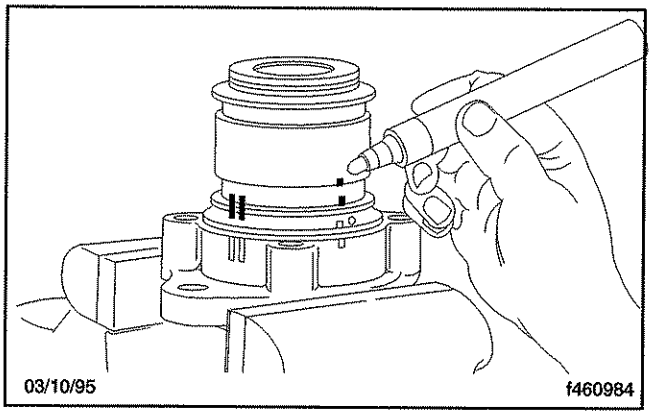


Fig. 8, Marking the Top Plate and the Bottom Plate

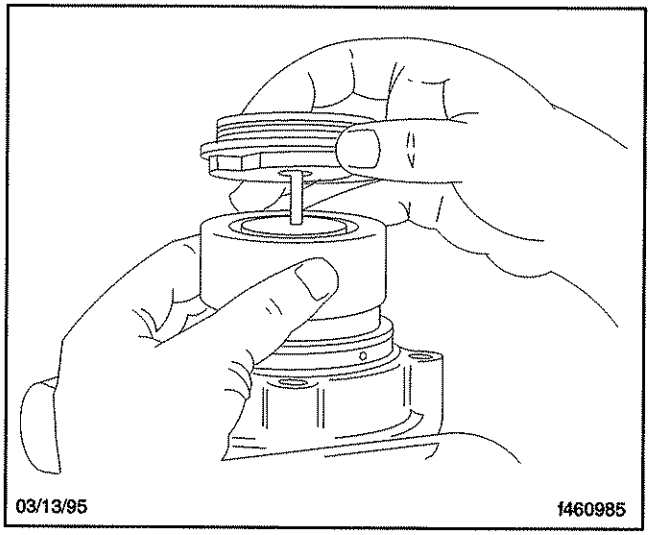


Fig. 9, Removing the Top Plate

9. Check the input shaft for damaged splines and abnormal wear grooves around the seal area. **See Fig. 23.** Replace the input shaft if there are grooves that can be detected with your fingernail.

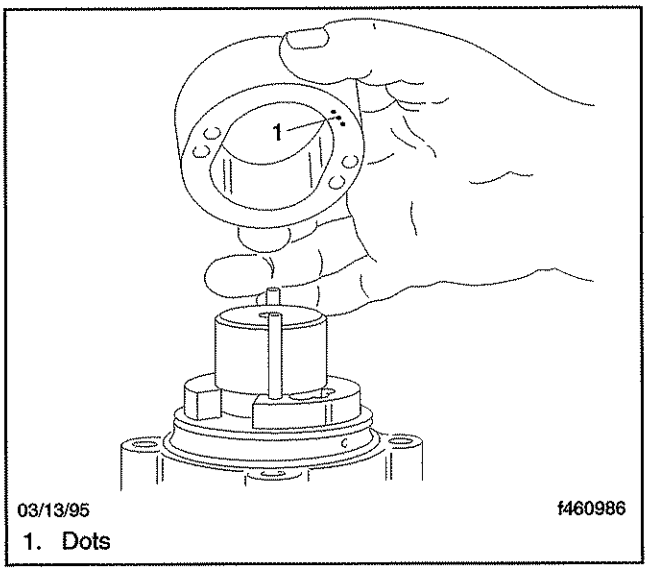
   9.1 Remove the retaining ring (engine drive end) from the shaft. **See Fig. 24.**

   Remove the woodruf key, if equipped.

   9.2 Applying pressure to the engine drive end of the input shaft, press the input shaft from the ball bearing. **See Fig. 25.**

   9.3 Press the new input shaft (from the small splined end) into the ball bearing until the shaft bottoms out on the retaining ring. **See Fig. 26.**

Steering Pump Disassembly, Inspection, and Assembly



1. Dots

Fig. 10, Checking whether the Dots are Up or Down.

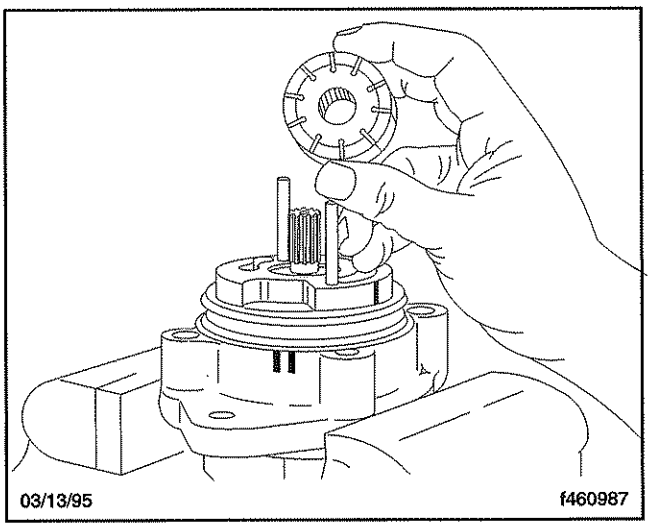


Fig. 11, Removing the Rotor and Vanes

9.4 Install the retaining ring on the input shaft with the sheared edge pointing away from the bearing. Make sure that the retaining ring is properly seated.

IMPORTANT: TRW does not recommend disassembly of the control valve spool assembly.

10. Check the control valve spool assembly for wear or chipping. If needed, back-flush with air and solvent. Check the assembly for nicks or burrs.

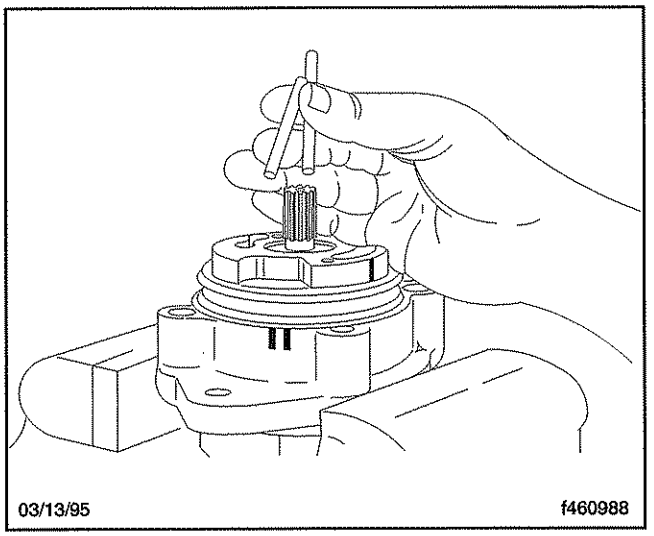


Fig. 12, Removing the Locating Pins

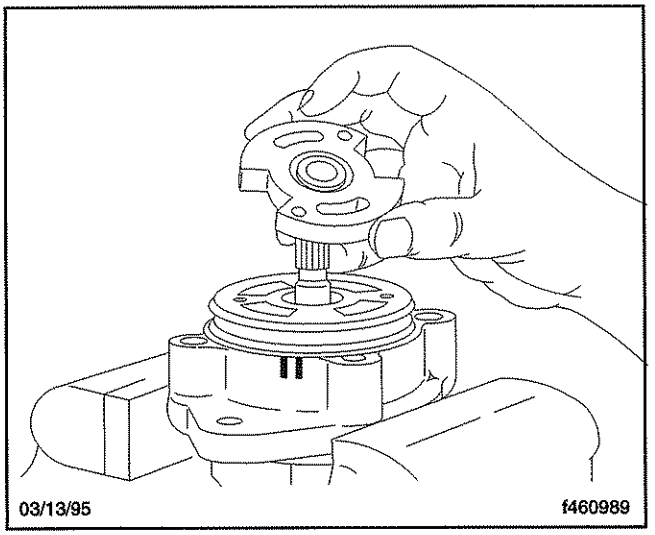


Fig. 13, Removing the Bottom Plate

Assembly

⚠ CAUTION

CAUTION: Make sure that the press is clean and free of debris. Debris could damage the face of the cover, which will affect pump operation.

1. Coat the outside surface of the shaft seal with a petroleum-based chassis grease. With the lettered side facing toward the needle bearing, press the seal into the cover. **See Fig. 27.** The installed seal

Steering Pump Disassembly, Inspection, and Assembly

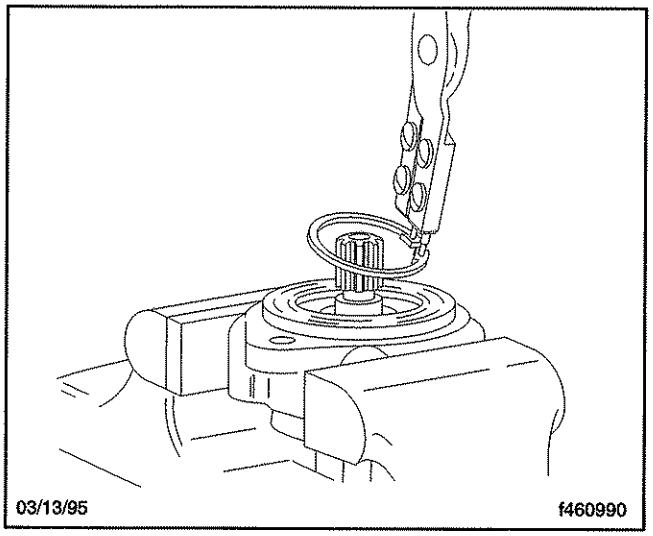


Fig. 14, Removing the Large Retaining Ring

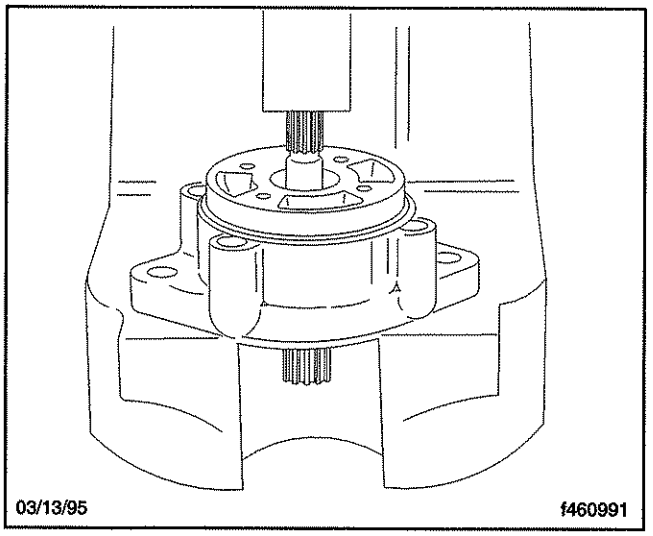


Fig. 15, Pressing out the Input Shaft and Ball Bearing Assembly

should be flush with, or just below, the sealing surface on the cover.

2. Grease the inside surface of the shaft seal using a petroleum-based chassis grease.
3. Install the spacer. **See Fig. 16.** Make sure that it lies flat.

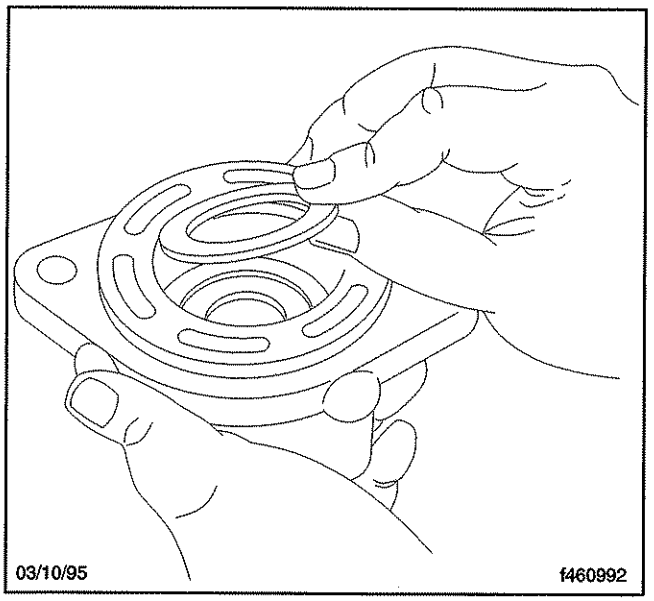


Fig. 16, Removing the Spacer

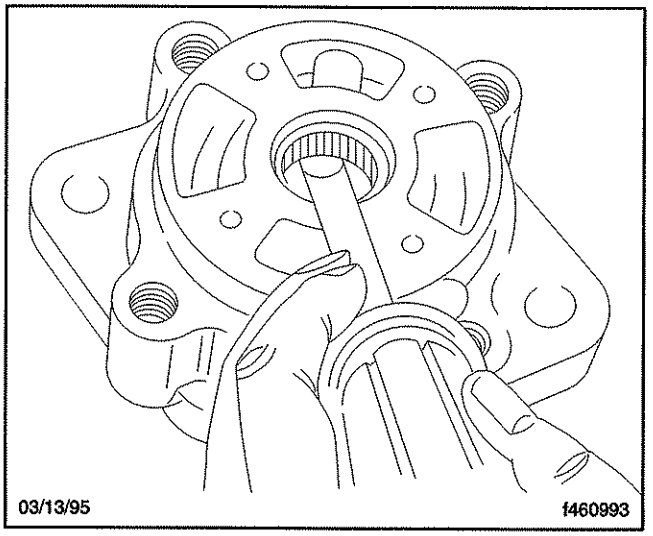


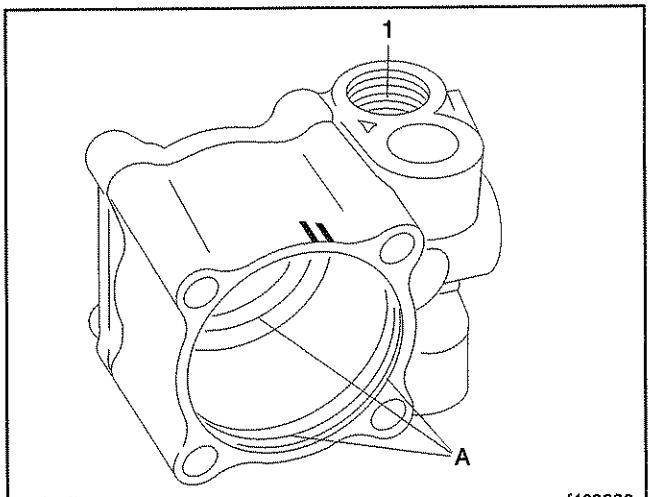
Fig. 17, Removing the Shaft Seal

⚠ CAUTION

CAUTION: Don't allow the splines to contact the shaft seal. The splines could damage the shaft seal.

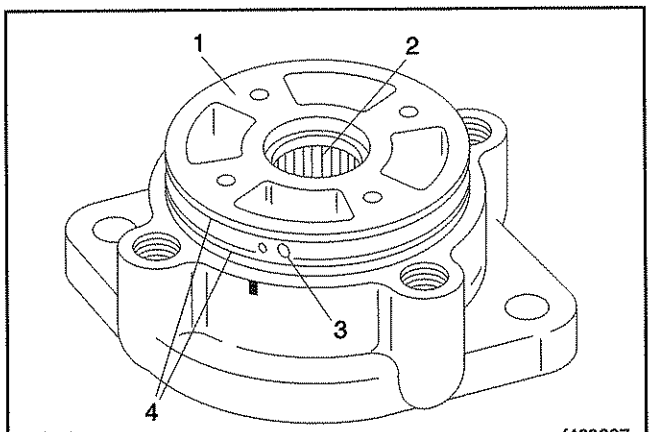
4. Insert the input shaft (small splined end first) into the cover. Don't allow the splines to contact the shaft seal. Insert the shaft into the seal by hand until the ball bearing contacts the cover.

Steering Pump Disassembly, Inspection, and Assembly



A. Sealing Areas
1. Valve Bore

Fig. 18, Inspect the Housing



1. Bottom Plate Surface
2. Needle Bearing
3. Seal Drain Hole
4. Seal Grooves

Fig. 19, Inspect the Cover

Using a 7/8-inch socket, press the shaft and bearing into the cover. **See Fig. 28.**

⚠ CAUTION

CAUTION: When placing the cover in a padded vise, don't use excessive clamping force. This could damage the cover.

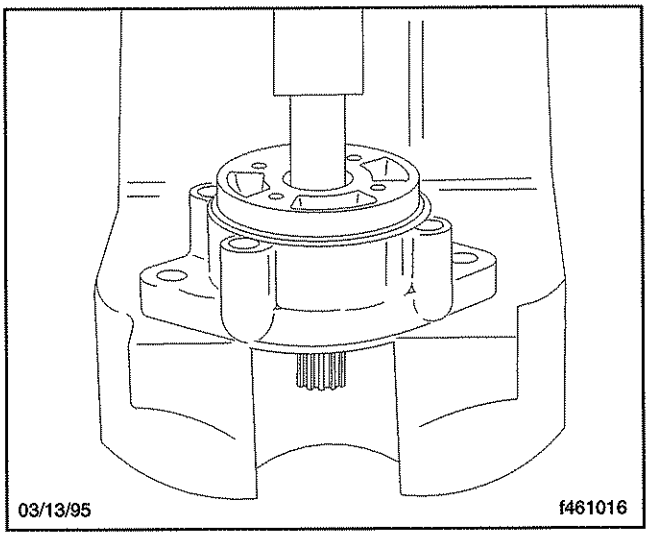


Fig. 20, Pressing the Needle Bearing out of the Cover

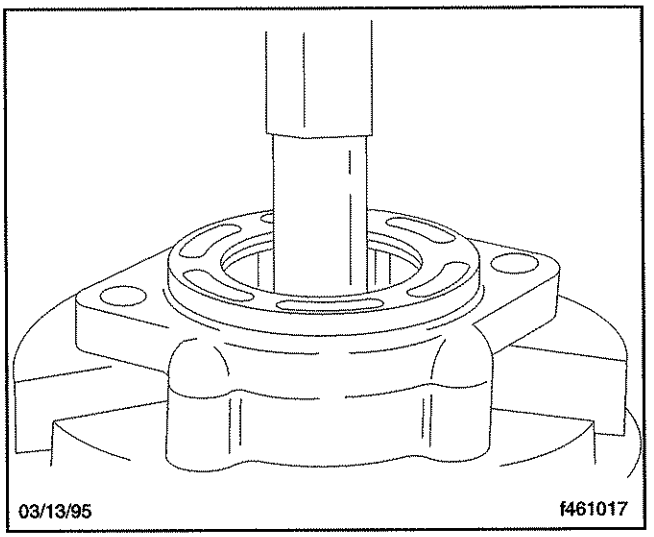


Fig. 21, Pressing a New Needle Bearing into the Cover

5. Place the cover in a padded vise and install the large retaining ring with the sheared edge out.

   Turn the cover assembly over.

6. Install the new large and small O-rings in the cover. Make sure that they are seated properly. **See Fig. 29.**

7. Using the marks made during disassembly as a guide, install the locating pins.

Steering Pump Disassembly, Inspection, and Assembly

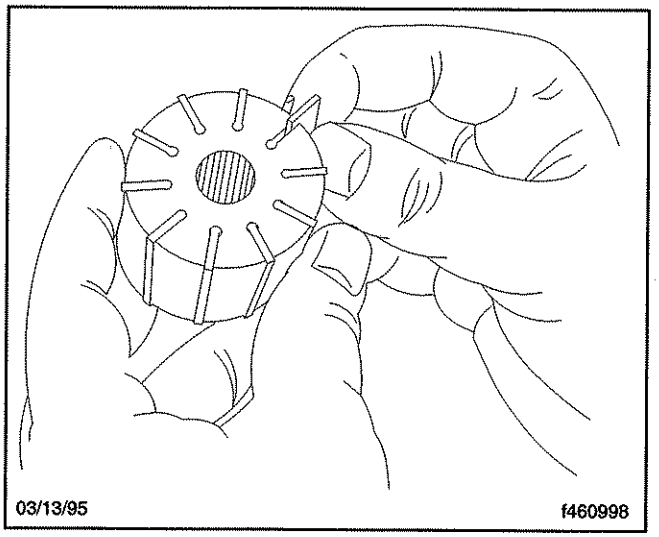
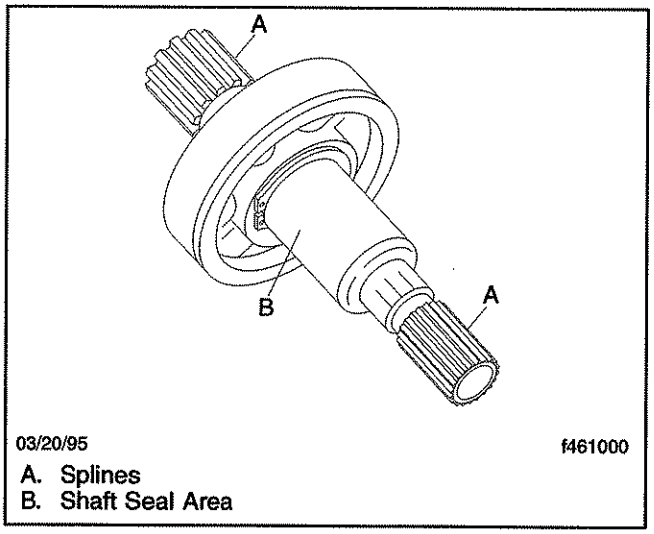


Fig. 22, Checking the Vanes



A. Splines
B. Shaft Seal Area

Fig. 23, Check the Input Shaft

IMPORTANT: In one of the four cutouts in the cover there is a bar. When installed, the bottom plate must cover this bar.

8. Install the bottom plate with the pockets facing up. **See Fig. 30.** Make sure that the marks made during disassembly are aligned.
9. Install the cam ring with the dots facing up or down as noted during disassembly. Make sure that the cam ring is flush with the bottom plates large outside diameter, and that the marks made during disassembly are aligned. **See Fig. 31.**

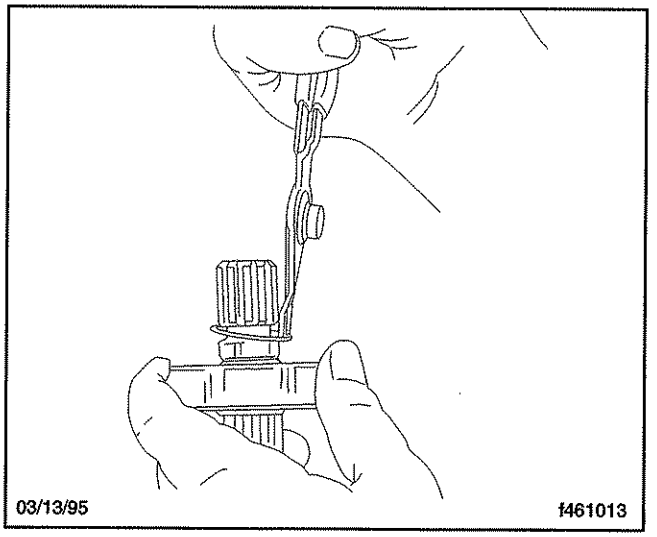


Fig. 24, Removing the Retaining Ring

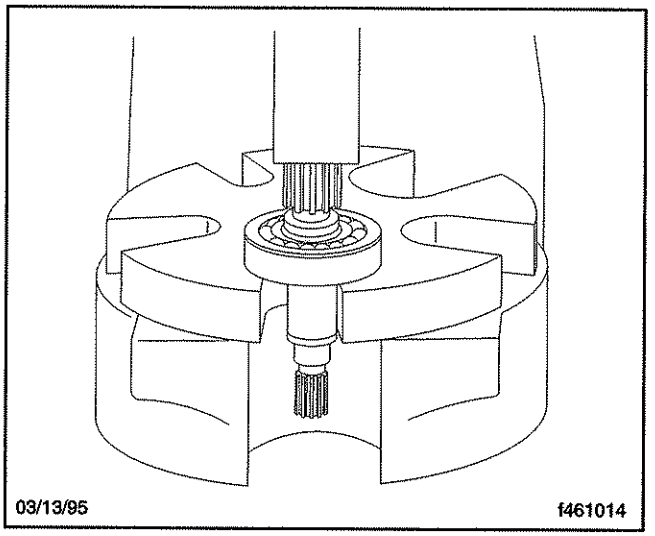


Fig. 25, Pressing the Input Shaft

10. Install the rotor and vanes. Make sure that squared edge on each vane points toward the center of the rotor. **See Fig. 32.**
11. Install the top plate with the pin holes down. Make sure that the locating pins are engaged in the pin holes, not the pockets. **See Fig. 33.**

    Make sure that the top plate is flush with the cam, and that the marks made during disassembly are aligned.

Steering Pump Disassembly, Inspection, and Assembly

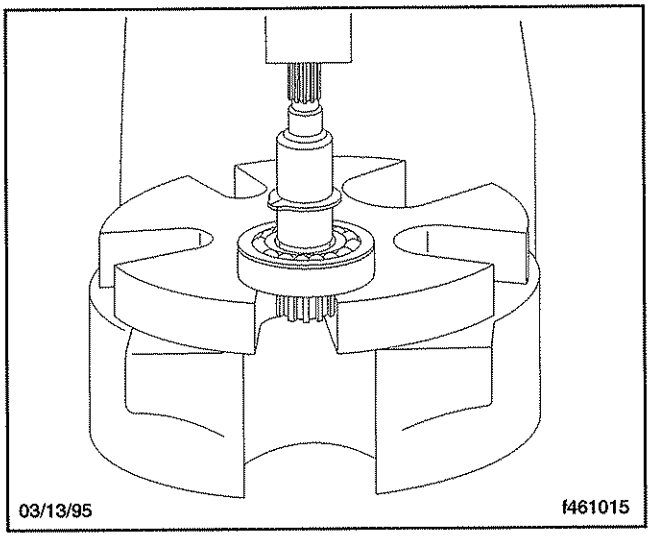


Fig. 26, Pressing the New Input Shaft

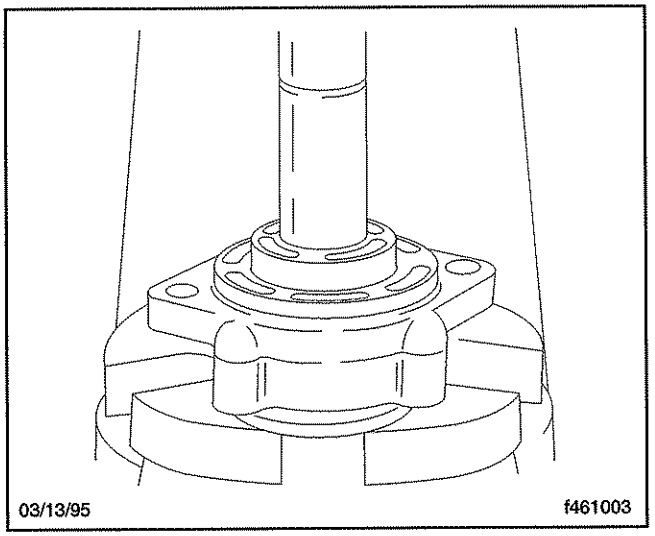


Fig. 28, Pressing the Shaft and Bearing into the Cover.

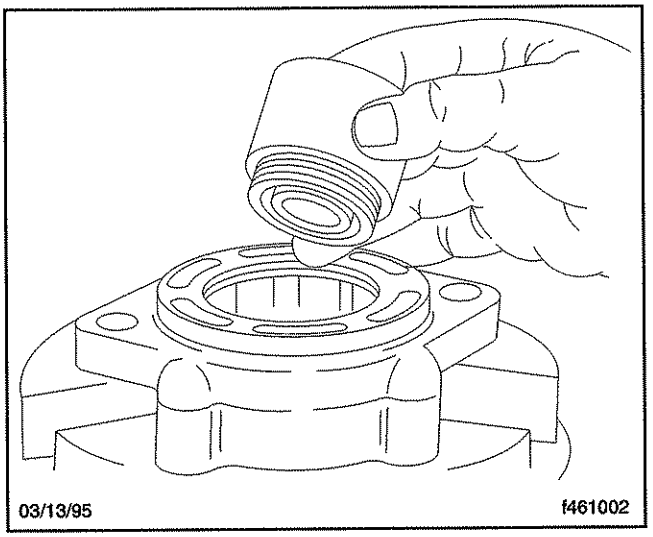


Fig. 27, Installing the Seal in the Cover

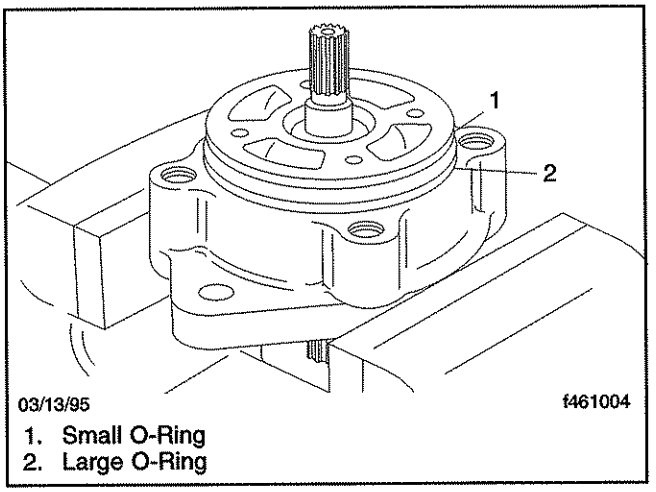


Fig. 29, Installing the O-Rings

NOTE: The backup O-ring will fit tighter on the top plate after loosely wrapping (no twisting) it around two fingers, then allowing it to unwrap.

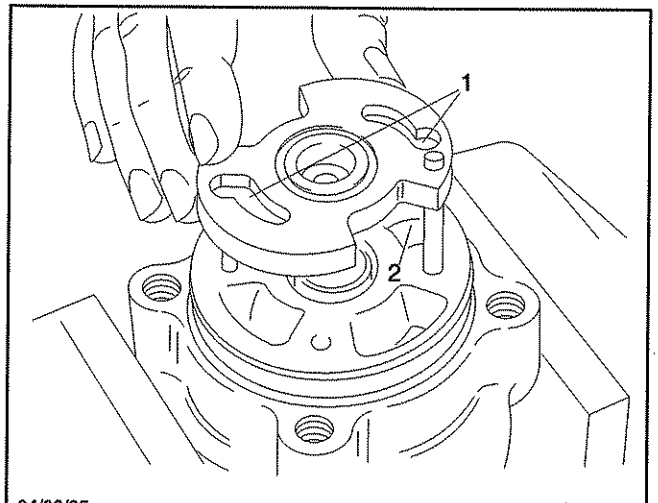
12. Install the backup O-ring on the top plate. Seat the O-ring at the bottom of the groove.
13. Install a new O-ring (without allowing it to roll) on the top plate. Seat the O-ring at the top of the groove.
14. Grease both the O-ring and the backup O-ring. **See Fig. 34.**

⚠ CAUTION

CAUTION: The housing may have sharp edges. Use care to not cut your finger when applying grease to the housing.

15. Grease the sealing areas of the housing. **See Fig. 35.**
16. Place the spring on the top plate.

Steering Pump Disassembly, Inspection, and Assembly



1. Pockets
2. Bar

Fig. 30, Installing the Bottom Plate

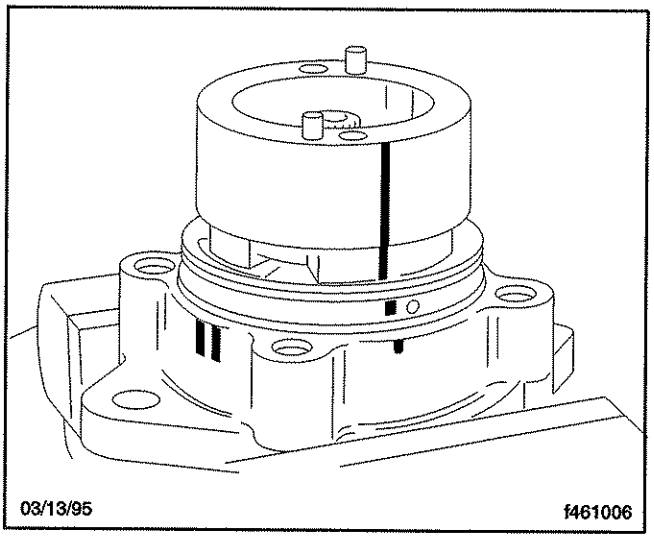
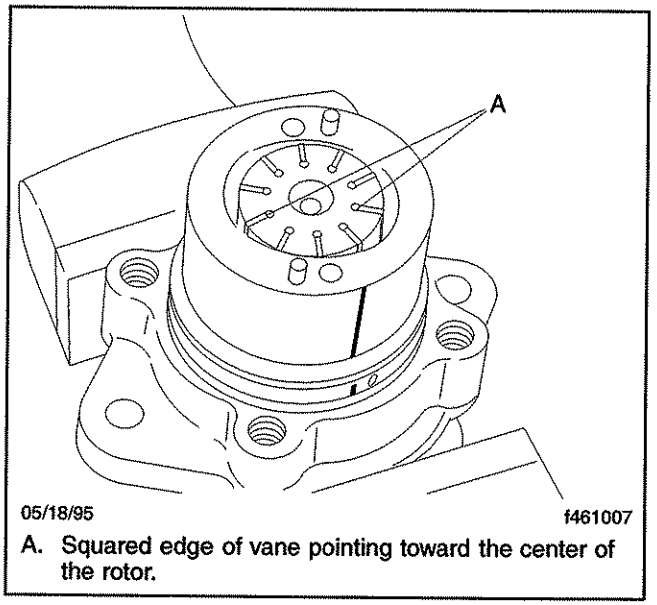


Fig. 31, Installing the Cam Ring

17. Place the housing over the cover assembly. Make sure that the marks made during disassembly are aligned. **See Fig. 36.**

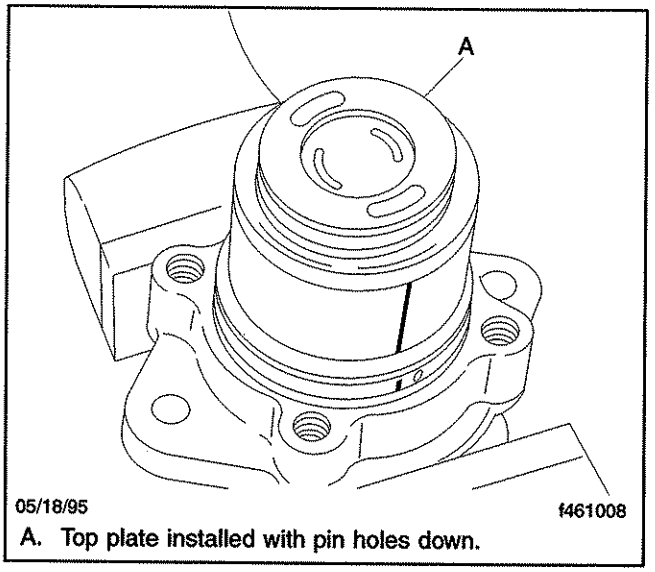
⚠ CAUTION

CAUTION: Evenly thread the mounting bolts into the cover. If not evenly threaded into the cover, damage could occur to the seals, top plate, or housing.



A. Squared edge of vane pointing toward the center of the rotor.

Fig. 32, Installing the Rotor and the Vanes



A. Top plate installed with pin holes down.

Fig. 33, Installing the Top Plate

18. Install the mounting bolts and washers. Evenly thread all four bolts into the cover. Alternately tighten the bolts 41 N·m (30 lbf·ft).

Steering Pump Disassembly, Inspection, and Assembly

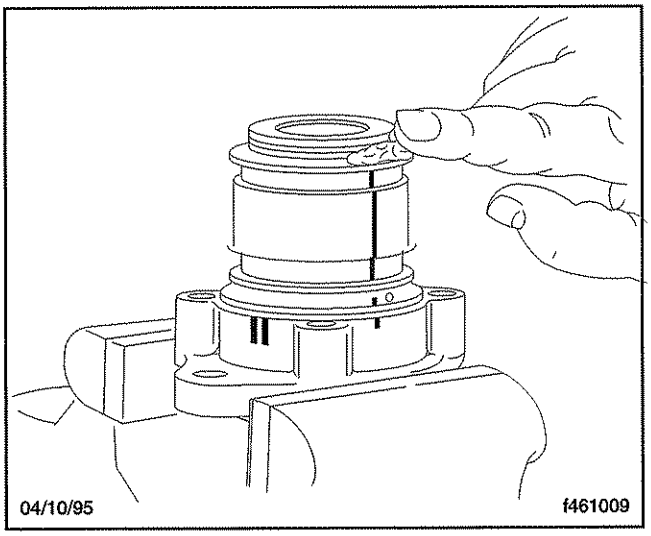


Fig. 34, Greasing the O-Rings

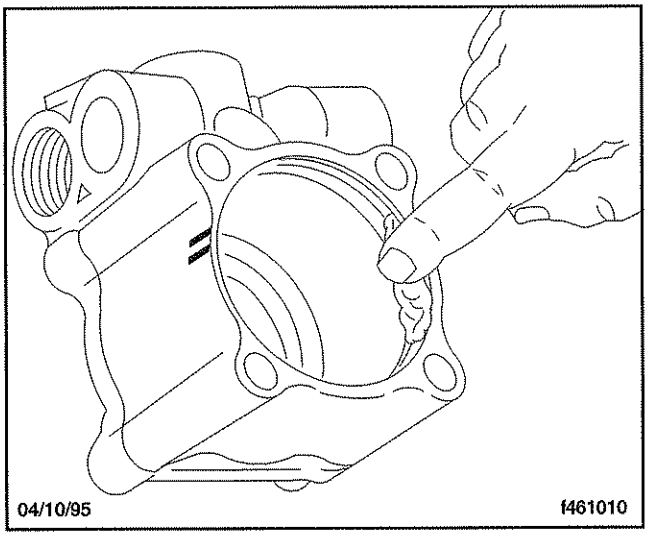


Fig. 35, Greasing the Sealing Areas

19. Screw the relief valve seat assembly into the control valve spool assembly. Tighten the assembly 982 N·cm (87 lbf·in).

NOTE: Placing the spool assembly in a collet will assist the tightening procedure.

20. Insert the valve spool assembly (screen end last) into the housing. Make sure that the spool slides freely in the housing. **See Fig. 37.**

21. Install the spring in the housing.

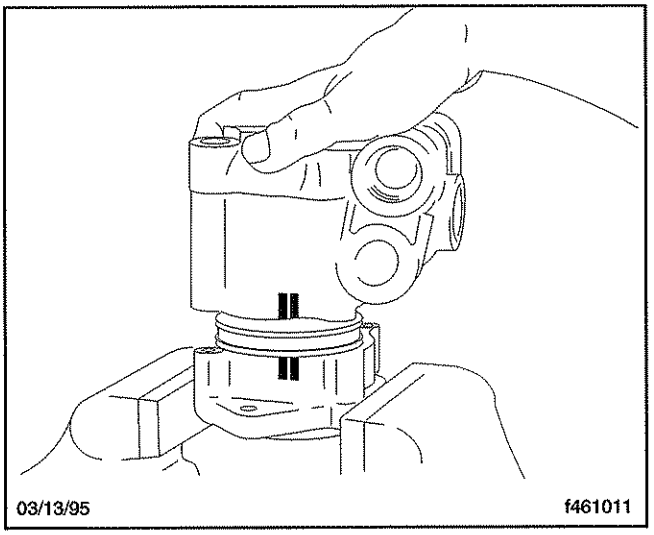


Fig. 36, Installing the Housing

22. Install a new O-ring on the end plug.

23. Lightly grease the O-ring and the end plug threads. Install the end plug and tighten 41 N·m (30 lbf·ft).

24. Install the woodruf key into the new input shaft (if removed during the input shaft replacement).

25. Turn the pump by hand and make sure that it turns freely.

26. Install the power steering pump on the engine, following the instructions in **Subject 100.**

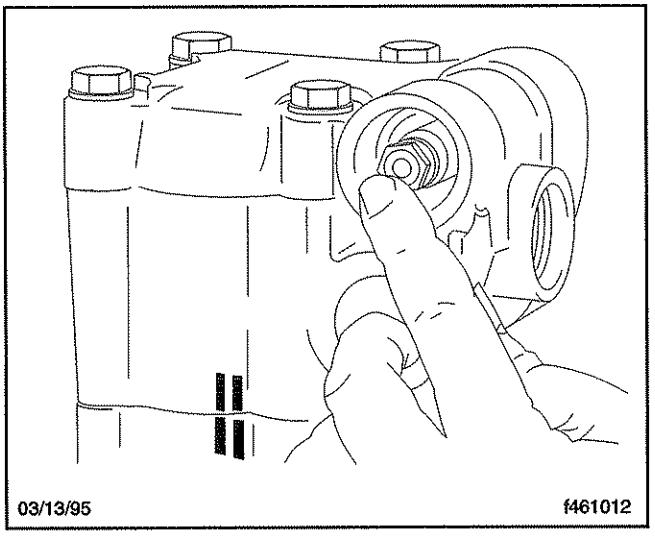


Fig. 37, Installing the Valve Spool Assembly

Problem—The Power Steering Pump Doesn't Deliver Fluid

Possible Cause	Remedy
The pump input shaft is broken, or not engaging.	Remove the pump. Repair or replace parts as needed.
The control valve is stuck open.	Remove and disassemble the pump. Clean the control valve in a solvent. Install the control valve, then check for any binding in its bore. If the control valve binds or feels gritty when you move it, replace the pump.
One or more rotor vanes is stuck.	Remove and disassemble the pump. Check the rotor and vanes for dirt or damage. If damaged, replace the pump. If dirty, clean the rotor and vanes in a solvent, then assemble the parts and check for free vane movement. If the problem persists, replace the pump.
Incorrect power steering fluid is used.	Check for the type of fluid used. If it's incorrect, drain, flush, and fill the system with the correct fluid.
The pump intake port is blocked.	Drain and flush the system. Fill the system with clean fluid.
The air vent in the power steering reservoir is clogged.	Remove the filter cap from the reservoir, then clean the air slot.
A power steering inlet hose is kinked or blocked.	Repair or replace the hose.

Problem—The Power Steering Pump Is Making Noise

Possible Cause	Remedy
The intake line is plugged.	Drain the system. Clear the intake line if needed.
There is an air leak at the pump connections, the fittings, the reservoir connections, or the shaft seal.	Check all the connections by pouring power steering fluid over them, then listen for a reduction in sound. Tighten all the connections as needed. If the problem persists, remove the pump, then disassemble it and replace the shaft seal.
The pump input shaft is misaligned.	Remove and disassemble the pump. Replace the shaft seal and bearing.

Specifications

Fastener Torques	
Description	**Torque: lbf.ft (N.m)**
Pump Mounting Hexbolts	35 (47)
Pump Housing-to-Cover Assembly Bolts	30 (41)
Pump End-Plug	30 (41)
Pump Inlet Connection	26 (35)

Table 1, Fastener Torques

Approved Power Steering Fluids		
Fluid Type	**Approved Fluid**	
Automatic Transmission Fluid*	Dexron® II	
	Dexron® III	
Heavy-Duty Engine Oil*	Union	10W–40
IMPORTANT: Do not use heavy-duty engine oil in vehicles built from November 4, 2002.	Texaco	10W–40
	Chevron	10W–40
	Mobil Super	10W–40
	Union	15W–40
	Shell Rotella T	30W

* Do not mix engine oil with automatic transmission fluid (ATF). Use the same lubricant for parts as is in the power steering system.

Table 2, Approved Power Steering Fluids

Contents

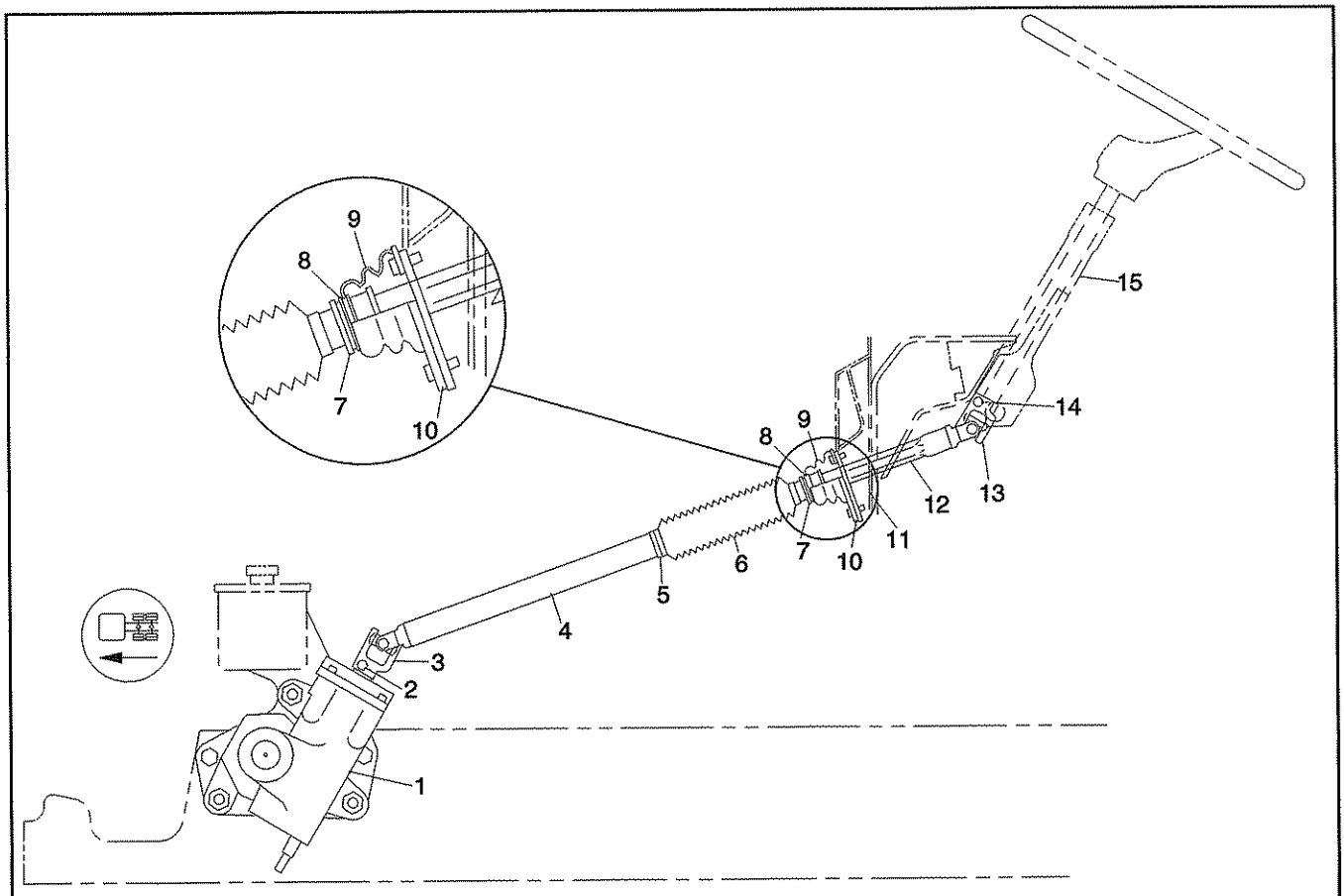
Subject	Subject Number
General Description	050
Service Operations	
Steering Driveline Removal and Installation	100
Steering Driveline Boot and Adaptor Replacement	110
Specifications	400

General Description

The steering driveline connects the steering column and jacket assembly to the steering gear by means of a telescoping shaft with integral yokes, an upper and a lower end yoke, and a pair of universal joints. **See Fig. 1.**

The driveline shaft consists of a tubular upper section, splined on the outside, which mates with an internally splined lower section. The telescoping shaft eases installation and removal of the steering column, steering driveline, and steering gear. It also compensates for changes in distance between the steering column and steering gear, which occur when the relative positions of the frame rails and cab change during vehicle operation.

The upper end yoke is internally serrated to match the external serrations at the end of the steering column shaft; the lower end yoke is internally serrated to match the external serrations on the steering gear input shaft. Each end yoke is secured to its respective shaft by a pinch bolt that engages a notch in the shaft.



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1. Power Steering Gear
2. Lower End Yoke Pinch Bolt and Nut
3. Lower End Yoke Assembly
4. Outer Tube
5. Boot Clamp
6. Steering Driveline Boot
7. Steering Driveline Adaptor
8. Bushing
9. Upper Steering Driveline Boot
10. Retainer
11. Pie Pan Assembly
12. Inner Tube
13. Upper End Yoke Assembly
14. Upper End Yoke Pinch Bolt and Nut
15. Fixed Steering Column Assembly

Fig. 1, Steering Driveline Installation

General Description

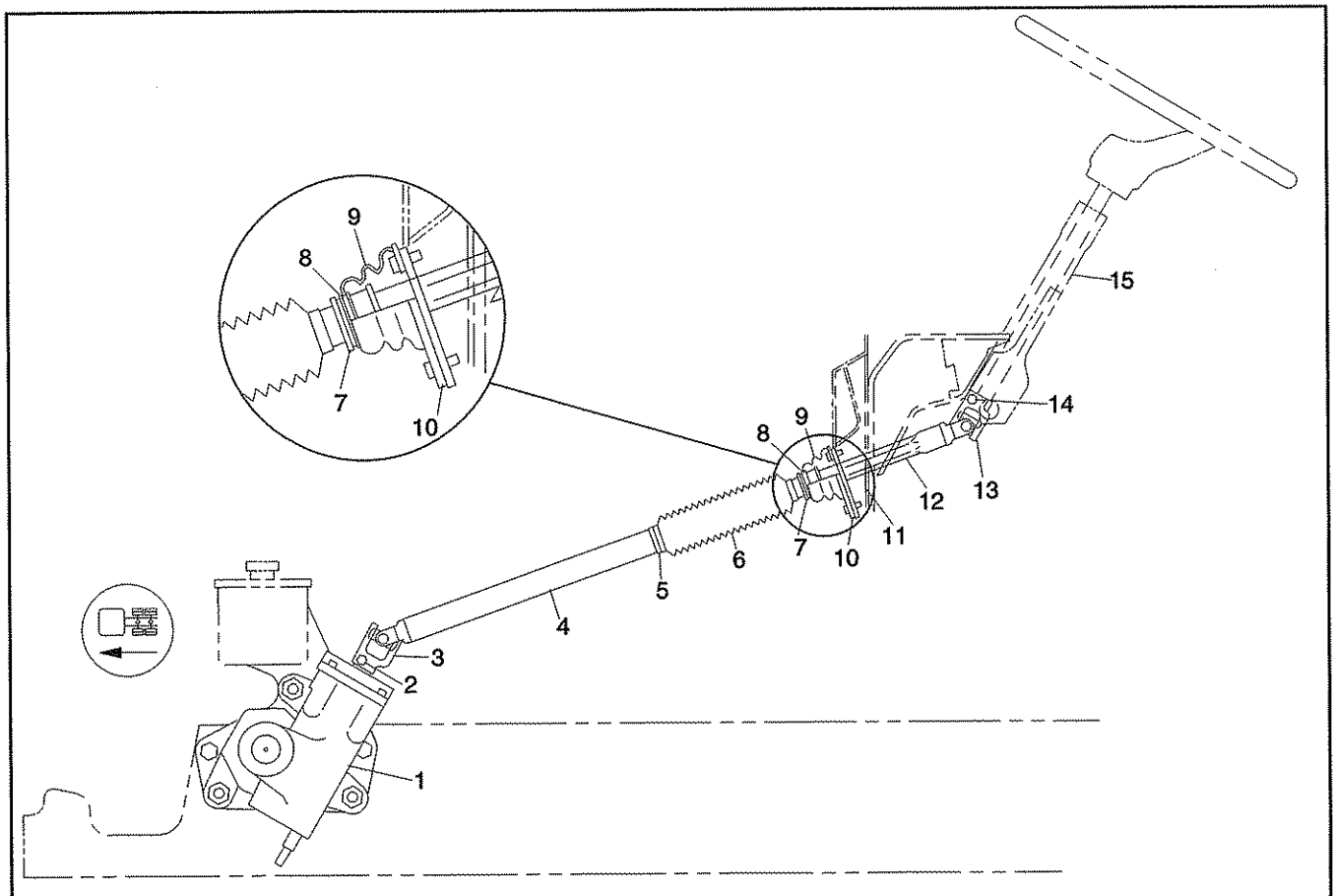
The universal joint at each end of the steering driveline allows the transfer of steering motion from the steering column shaft, to the steering driveline, and to the steering gear input shaft, even though the driveline is at an angle to both of the other shafts. Each universal joint cross rides in four needle bearing cups, two carried in the end yoke, and two carried in the steering driveline's integral yoke. The needle bearing cups are held in place in each yoke by snap rings.

Steering Driveline Removal and Installation

Removal (See Fig. 1)

NOTE: It is not necessary to loosen the steering wheel and column assembly to do this procedure.

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be done.
2. Apply the parking brakes, and chock the tires. Tilt the hood.
3. Disconnect the lower end yoke.
   - 3.1 Remove the pinch-bolt nut and pinch bolt from the lower end yoke. **See Fig. 2.** Discard the nut.
   - 3.2 Remove the yoke from the steering gear input shaft. Don't turn the steering gear input shaft when removing the lower end yoke. Push the driveline shaft into the driveline tube, as you remove the lower end yoke.
4. Disconnect the upper end yoke.



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1. Power Steering Gear
2. Lower End Yoke Pinch Bolt and Nut
3. Lower End Yoke Assembly
4. Outer Tube
5. Boot Clamp
6. Steering Driveline Boot
7. Steering Driveline Adaptor
8. Bushing
9. Upper Steering Driveline Boot
10. Retainer
11. Pie Pan Assembly
12. Inner Tube
13. Upper End Yoke Assembly
14. Upper End Yoke Pinch Bolt and Nut
15. Fixed Steering Column Assembly

Fig. 1, Steering Driveline Installation

Steering Driveline Removal and Installation

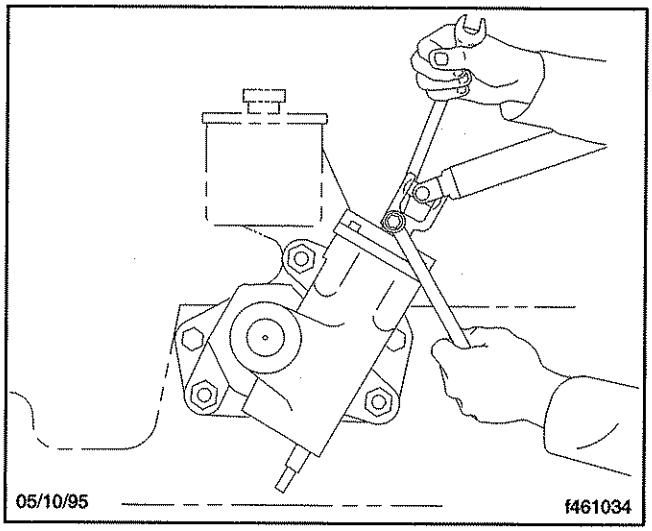


Fig. 2, Disconnect the Lower End Yoke

NOTE: One of the screws must be removed from inside the cab. **See Fig. 3,** Ref. A.

4.1 Remove the four screws holding the upper steering driveline boot to the firewall.

4.2 Remove the pinch-bolt nut and pinch bolt from the upper end yoke. **See Fig. 4.** Discard the nut.

4.3 Remove the upper end yoke from the steering column shaft.

5. Remove the driveline from the engine compartment.

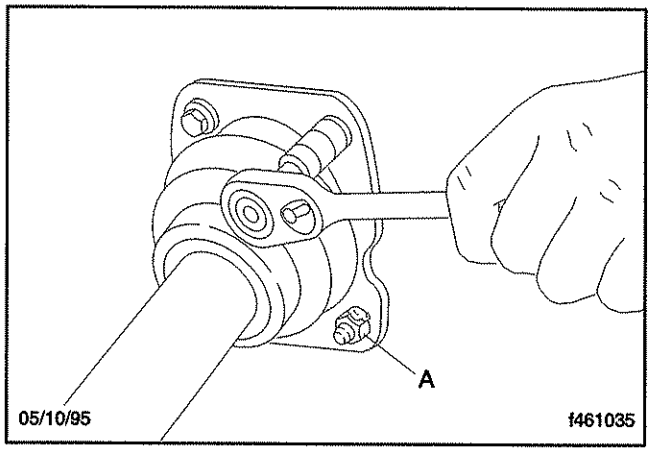


Fig. 3, Remove the Steering Driveline Boot Fasteners

Installation (See Fig. 1)

1. Clean the steering gear input shaft, steering driveline, and end yokes. Do not separate the steering driveline.

   1.1 Thoroughly clean the end yokes, the steering driveline, and the steering gear input shaft with a clean, dry cloth.

   1.2 Apply a thin film of grease to the yoke splines. Use lithium-based grease, NLGI grade 2.

2. Make sure that the upper steering driveline boot is in position on the inner tube.

3. Slide the driveline's upper end yoke onto the steering column shaft, then install the end yoke pinch bolt. Before installing the pinch-bolt nut, make sure the pinch bolt is centered in the steering column shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install a new pinch-bolt nut, and tighten it 75 to 88 N·m (55 to 65 lbf·ft).

4. Apply white Torque Seal F-900 to the exposed pinch-bolt thread and to the locknut.

5. Install the four screws that attach the upper steering driveline boot to the firewall.

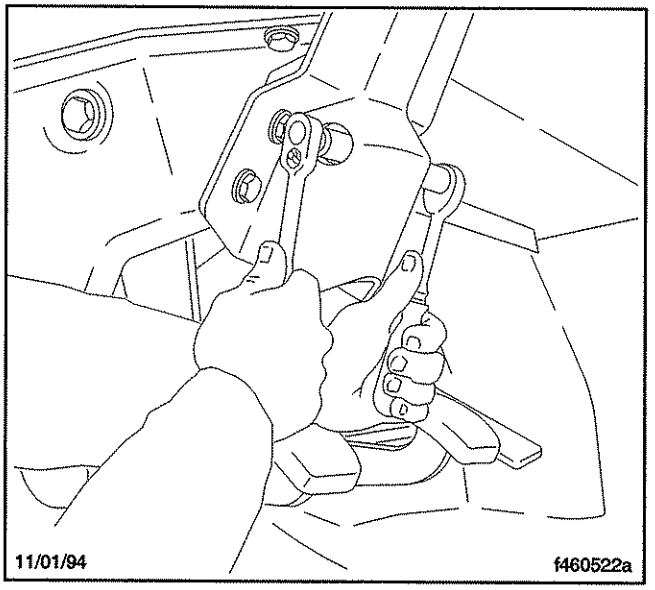


Fig. 4, Remove the Pinch-Bolt Nut and Pinch Bolt from the Upper End Yoke

6. Before attaching the lower end yoke to the steering gear input shaft, be sure the front tires are straight ahead, the steering gear is centered, the arrows on the driveline inner tube and the outer tube are aligned, and the driveline slides freely.

⚠ CAUTION

CAUTION: If the arrow on the driveline inner tube is not aligned with the arrow on the outer tube, the U-joints will not be correctly oriented. Assembling the driveline with the U-joints incorrectly oriented could cause binding at the U-joints.

7. Install the lower end yoke on the steering gear input shaft. Before installing the pinch-bolt nut, make sure the pinch bolt is centered in the steering gear input shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install a *new* pinch-bolt nut, and tighten it 75 to 88 N·m (55 to 65 lbf·ft).
8. Apply white Torque Seal F-900 to the exposed pinch bolt thread and to the locknut. **See Fig. 5.**
9. Using a hand-type grease gun, lubricate the driveline tube at the lower end yoke assembly with lithium-based grease, NLGI grade 2. Apply until grease appears at all four U-joint cross seals.
10. With the front tires pointing straight ahead, check the position of the steering wheel spokes. They must be pointing within ±10 degrees of the 4 o'clock and 8 o'clock positions. **See Fig. 6.**

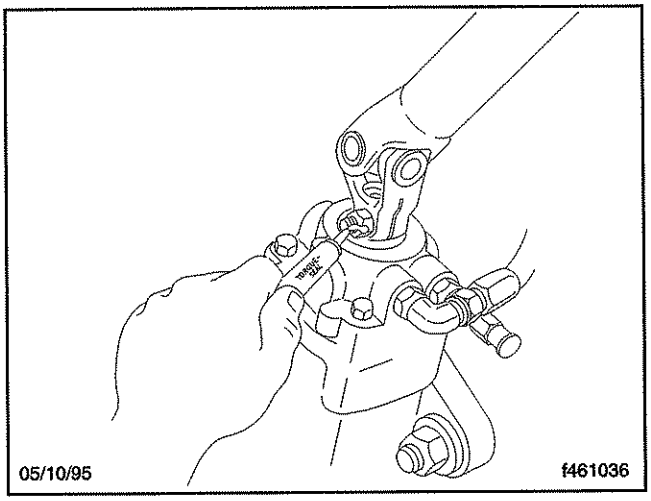


Fig. 5, Apply White Torque Seal F-900

If not, remove the steering wheel and install it in the correct position. For instructions, refer to the applicable section in this group.

11. Lower the hood, and secure the hood latches. Leave the parking brakes applied and the chocks at the rear tires.
12. Raise the front of the vehicle so that the front tires are off the ground, then place safety stands under the frame.

⚠ WARNING

WARNING: Driving a vehicle with hard steering or binding in the steering system could result in partial or complete loss of steering control during vehicle operation, possibly causing personal injury and property damage.

13. Turn the steering wheel through full travel, checking for hard steering or binding. If there is difficulty, check the assembly and installation of the driveline parts. If the cause is not the driveline, refer to the applicable steering gear section in this group.
14. Remove the chocks from the tires, and secure the hood.

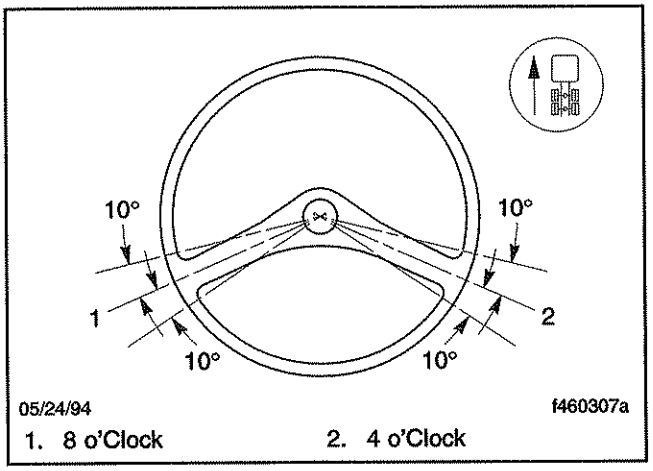
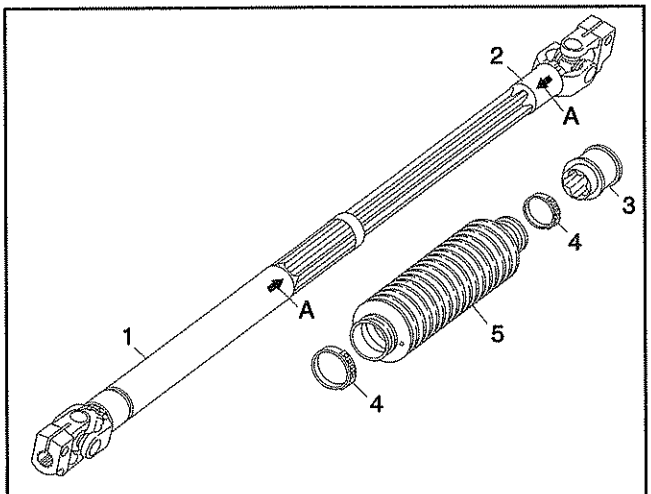


Fig. 6

Steering Driveline Boot and Adaptor Replacement

Replacement (See Fig. 1)

1. Position the front tires straight ahead. If possible, drive the vehicle in a straight line for a short distance, stopping at the spot where service operations will be done.
2. Apply the parking brakes, and chock the tires. Tilt the hood.
3. Disconnect the lower end yoke.
   - 3.1 Remove the pinch-bolt nut and pinch bolt from the lower end yoke. Discard the nut.
   - 3.2 Remove the yoke from the steering gear input shaft. Don't turn the steering gear input shaft when removing the lower end yoke. Push the driveline outer tube into the inner tube as you remove the lower end yoke.
4. Slide the inner tube out of the outer tube. Leave the adaptor in place.
5. Using pliers, remove the clamps that secure the boot on the outer tube and inner tube.



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A. Alignment Arrows
1. Outer Tube (to the steering gear)
2. Inner Tube (to the steering column)
3. Adaptor
4. Clamp
5. Boot

Fig. 1, Steering Driveline

6. Discard the boot, clamps, and the adaptor.
7. Using a clean, dry cloth, clean the splined section of the inner tube.
8. Place the adaptor over the inner tube. Align the arrows on the adaptor and the inner tube.
9. Clamp the small end of the new boot on the adaptor.
10. Apply a thin film of grease to the splined portion of the inner tube. Use lithium-based grease, NLGI grade 2.

⚠ CAUTION

CAUTION: If the arrow on the driveline inner tube is not aligned with the arrow on the outer tube, the U-joints will not be correctly oriented. Assembling the driveline with the U-joints incorrectly oriented could cause binding at the U-joints.

11. Align the arrows on the driveline inner tube and the outer tube.
12. Slide the inner tube into the outer tube.
13. Clamp the boot on the outer tube (just above the formed section).
14. Stroke the driveline several times to ensure that the boot and adaptor are firmly in place, and that the driveline slides freely.
15. Before attaching the lower end yoke to the steering gear input shaft, be sure the front tires are straight ahead, the steering gear is centered, the arrows on the driveline inner tube and the outer tube are aligned, and the driveline slides freely.
16. Install the lower end yoke on the steering gear input shaft. Before installing the pinch-bolt nut, make sure the pinch bolt is centered in the steering gear input shaft notch. The pinch bolt is centered if it can slip in and out of the end yoke with ease. Install a *new* pinch-bolt nut, and tighten it 75 to 88 N·m (55 to 65 lbf·ft).
17. Apply white Torque Seal F-900 to the exposed pinch bolt thread and to the locknut. **See Fig. 2.**
18. Remove the chocks from the tires, and secure the hood.

Steering Driveline Boot and Adaptor Replacement

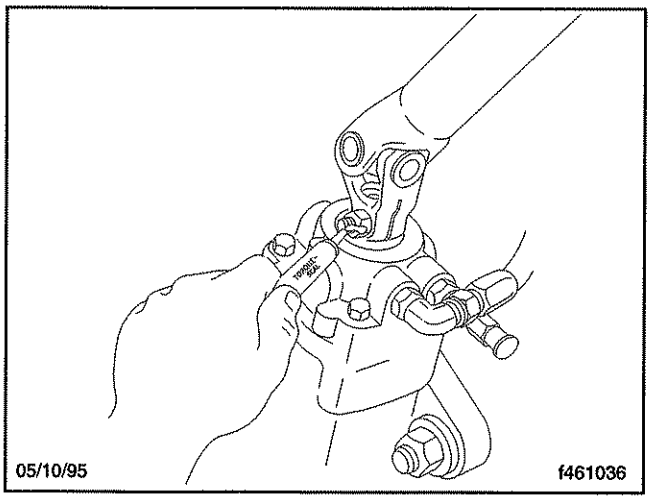


Fig. 2, Apply White Torque Seal F-900

Specifications

Description	Grade	Size	Torque N·m (lbf·ft)
End Yoke Pinch-Bolt Nut	8 or 8.2	7/16–20 UNF	75 to 88 (55 to 65)

Table 1, Torque Values

Contents

Subject	Subject Number
General Information	050
Service Operations	
Steering Pump Removal and Installation	100
Steering Pump Shaft Seal Replacement	110
Troubleshooting	300
Specifications	400

General Information

The LuK Automotive Hydraulics LF 73 power steering pump supplies power steering fluid for the operation of the power steering gear.

The pump (used on Cummins B and C series engines) is mounted on the driver's side of the engine, at the rear of the gear case or the air compressor. See **Fig. 1**. It is powered by an adaptor gear in the engine.

The main parts of the power steering pump are the housing, driveshaft, cam ring, rotor, vanes, and control valve. See **Fig. 2**.

Principles of Operation

The driveshaft, powered by the adaptor gear in the engine gear case, turns the rotor, which is inside the cam ring. As the rotor turns, centrifugal force pushes the vanes out toward the surface of the cam ring. As fluid enters the cam ring through the inlet port, the rotor vanes force it out through the outlet port and into the system. The fluid operates the steering gear. Eventually the fluid returns to the power steering reservoir, and then back to the power steering pump. See **Fig. 3**.

If the system pressure gets too high, a poppet inside the control valve is forced off its seat shunting fluid into a relief passage connected to the inlet port. The fluid then recirculates inside the pump instead of going to the outlet port. When the system pressure drops to the correct level, the poppet seats, closing off the relief passage to the inlet port. The fluid flow returns to normal, flowing from the inlet port to the outlet port and then into the power steering system.

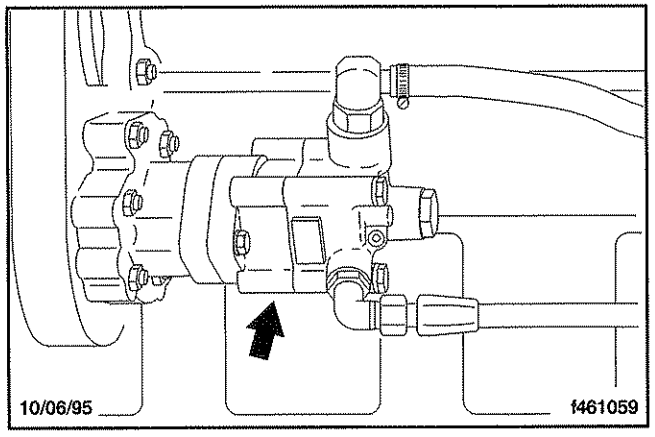
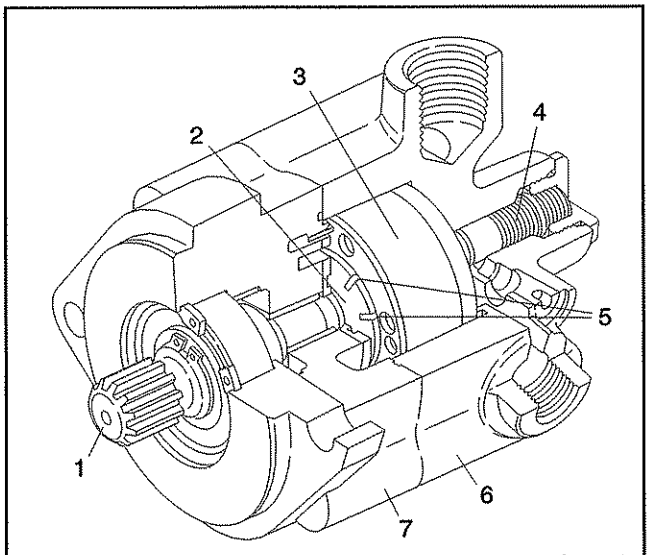
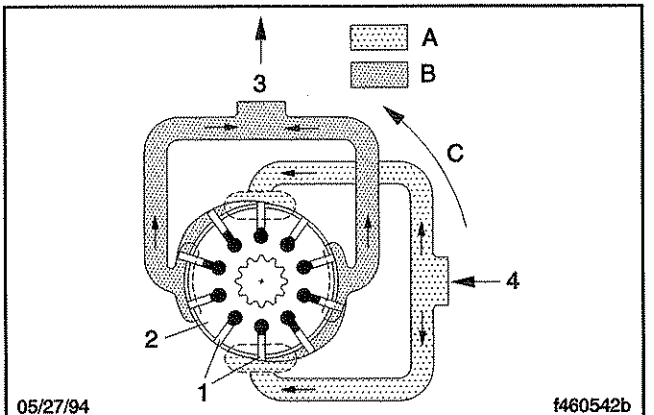


Fig. 1, Pump Mounting (at the rear of the gear case)



1. Driveshaft
2. Rotor
3. Cam Ring
4. Control Valve
5. Vanes
6. Housing
7. Flange Assembly

Fig. 2, Pump Components



A. Low pressure fluid
B. High pressure fluid
C. Rotation

1. Vanes
2. Rotor
3. Outlet
4. Inlet

Fig. 3, Pump Fluid Flow Diagram

Steering Pump Removal and Installation

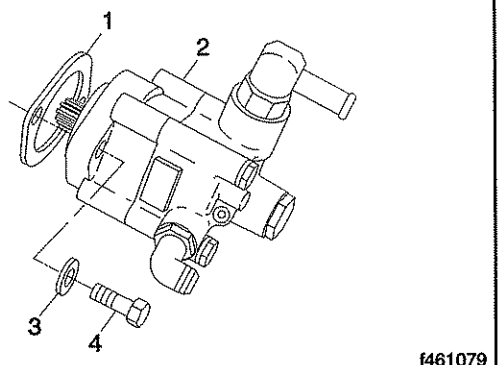
Removal

1. Apply the parking brakes, chock the tires, then tilt the hood.
2. Clean all outside dirt from around the fittings and hose connections.
3. Put a container under the inlet port of the pump, then disconnect the hose from the fitting. Plug the hose to keep out dirt and to prevent fluid from leaking.

   Repeat this step at the pump outlet port.
4. Remove the mounting bolts that attach the pump to the engine accessory drive mounting flange. See **Fig. 1**. Slide the pump out of the shaft sleeve and remove the pump from the engine.

Installation

1. Using engine oil, lightly lubricate a new gasket and the pump shaft.
2. Install the new gasket on the pump mounting flange, then place the pump on the engine's accessory drive mounting. See **Fig. 1**. Turn the pump or shaft as needed to mesh the shaft with the shaft sleeve. Seat the pilot of the pump mounting flange in the accessory drive mounting, without applying unnecessary force. Install the lockwashers and mounting bolts. Tighten the bolts 32 to 37 lbf·ft (43 to 50 N·m).



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1. Gasket
2. Pump
3. Lockwasher
4. Mounting Bolt

Fig. 1, Pump Mounting

3. Connect the hoses to the pump inlet and outlet ports.
4. Check the fluid level of the power steering reservoir and add fluid if necessary. Start the engine and let it idle for two minutes. Do not turn the steering wheel; doing so can cause air to enter the system.

   Turn off the engine and check the fluid level in the reservoir.
5. Start the engine again. To remove air from the system, steer the vehicle from full-left to full-right several times.

   Add fluid as necessary to the full line on the reservoir dipstick.
6. If the steering gear doesn't have a manual bleed screw, turn the steering wheel from full lock to full lock two or three times with the engine running at idle. Repeat this step and add fluid as necessary until there are no bubbles in the reservoir.

   If the steering gear is equipped with a manual bleed screw, turn the steering wheel from full lock to full lock two or three times with the engine running at idle. Then loosen the manual bleed screw about one turn and look for clear fluid or fluid mixed with bubbles at the threaded area of the bleed screw. Repeat this step and add fluid as necessary until only clear fluid shows. Tighten the manual bleed screw 27 to 33 lbf·in (300 to 360 N·cm). Refill the reservoir if necessary to the full line on the dipstick.
7. Lower the hood, then remove the chocks from the tires.

Steering Pump Shaft Seal Replacement

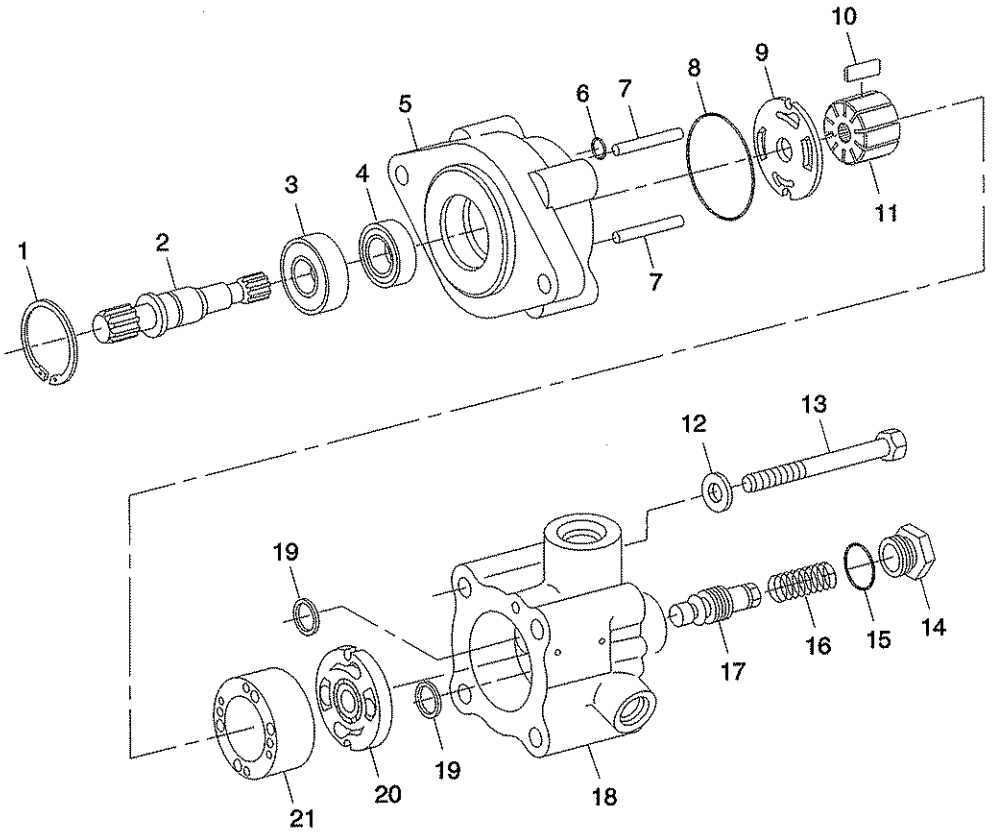
⚠ CAUTION

Be careful when working on the pump housing; it is aluminum, and can be easily damaged. When putting it in a vise, pad the vise jaws. Tighten the vise just enough to hold the pump.

Replacement (See Fig. 1)

⚠ WARNING

Wear safety goggles or glasses when disassembling the power steering pump. Some of the parts are held in place by springs or snap rings, which can release with considerable force, possibly causing injury.



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1. Snap Ring
2. Driveshaft
3. Driveshaft Bushing
4. Shaft Seal
5. Flange Assembly
6. Small O-Ring
7. Guide Pin
8. Large O-Ring
9. Wear Plate
10. Vane
11. Rotor
12. Washer (4 qty.)
13. Hex Bolt (4 qty.)
14. End Plug
15. End Plug O-Ring
16. Spring
17. Control Valve
18. Pump Housing
19. Combination O-Ring/Backup Ring
20. Pressure Plate
21. Cam Ring

Fig. 1, Steering Pump Assembly

Steering Pump Shaft Seal Replacement

NOTE: The shaft seal kit contains a replacement seal for LF and VT series pumps. The seal for the LF-series pump is smaller.

1. Remove the power steering pump from the engine following the instructions under **Subject 100.**
2. Carefully remove the end plug (there is a spring underneath it) from the pump body. Remove the spring, then slide out the control valve as shown in **Fig. 2.** Be careful not to scratch the control valve.
3. Remove and discard the O-ring from the plug.
4. Put the pump housing in a padded vise, then remove the four screws holding the housing and the flange assembly together. See **Fig. 3.**
5. Remove and discard the combination O-rings/ backup rings from the pump housing. See **Fig. 4.**
6. Remove the pressure plate, guide pins, cam ring, rotor, vanes, and wear plate as a unit and set aside.

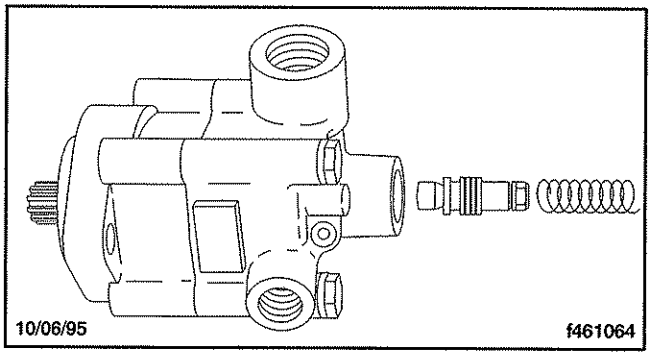


Fig. 2, Slide Out the Control Valve

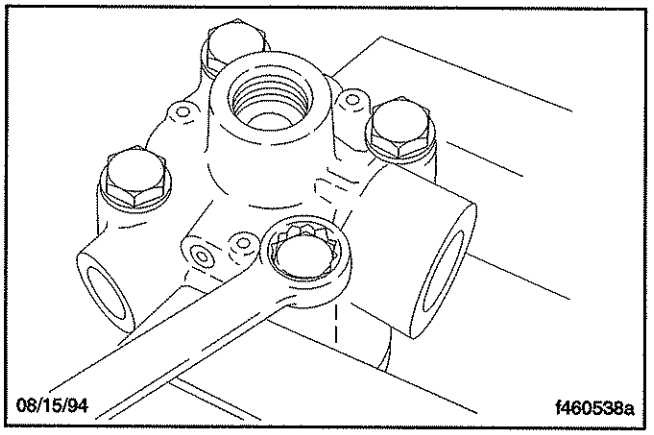


Fig. 3, Remove the Screws

7. Remove and discard the small and large O-rings from the flange assembly. See **Fig. 5.**
8. Remove the snap ring holding the shaft seal in place. Discard the snap ring. See **Fig. 6.**
9. Put the flange assembly in a vise with the inner end of the shaft pointing up. Carefully tap out the driveshaft. See **Fig. 7.**
10. Remove and discard the shaft seal.
11. Clean all the parts using a solvent compatible with the power steering fluid. Then, using filtered compressed air, dry all the parts.
12. Coat all the parts with clean power steering fluid. See the power steering fluid table in **Specifications 400.**
13. Place the spacer over the outer (drive) end of the shaft with the cupped side of the spacer facing the inner end of the shaft.

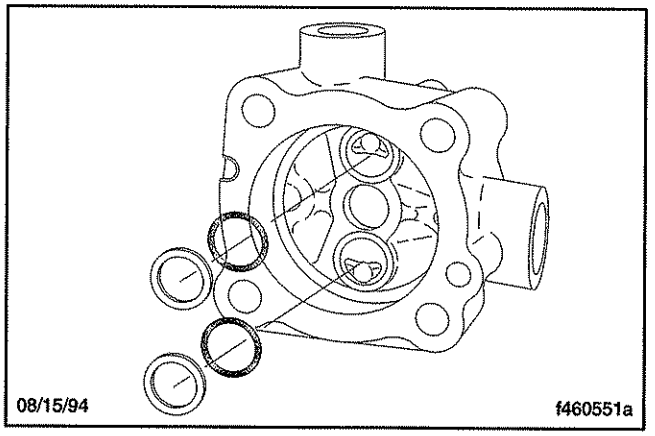


Fig. 4, Remove the Two Combination O-Ring/ Backup Rings

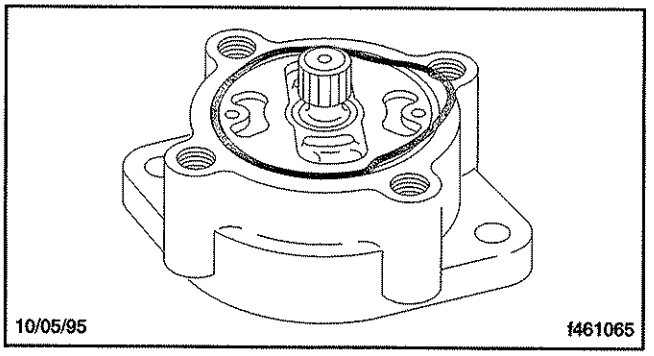


Fig. 5, Remove the Large O-Ring

Steering Pump Shaft Seal Replacement

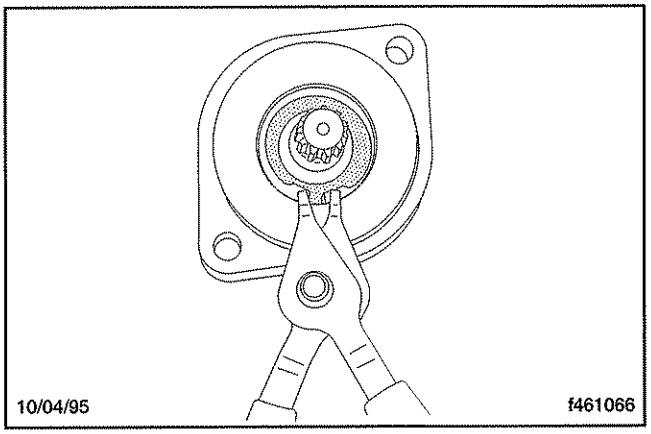


Fig. 6, Remove the Snap Ring

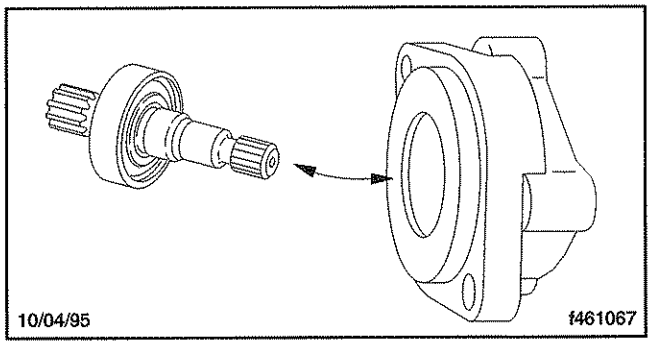


Fig. 7, Tap Out the Driveshaft

14. Using power steering fluid, lubricate the new shaft seal. Carefully place the seal over the outer (drive) end of the shaft up against the spacer. The lettered side of the seal should be visible.

NOTE: To correctly install the driveshaft seal, it is necessary to make a suitable driver from tubular stock. See **Fig. 8** for the applicable dimensions.

15. Using a suitable driver, install the shaft seal into the bore in the flange assembly. Make sure the spring side of the seal faces the flange. See **Fig. 9**. Seat the seal firmly against the shoulder in the bore.

16. Install the small snap ring in its groove on the driveshaft with the sharp edge facing toward the bushing.

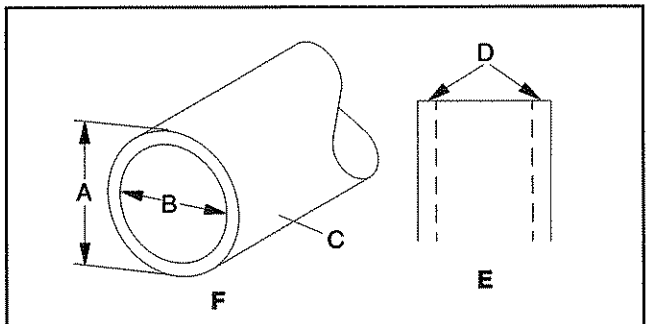
17. Put the flange assembly in a padded vise with the drive end of the shaft pointing up. Install a new large O-ring in the flange assembly.

18. Install a new small O-ring in the flange assembly.

19. Install the pressure plate, guide pins, cam ring, rotor, vanes, and wear plate as a unit. Make sure that the two guide pins are seated in the flange assembly.

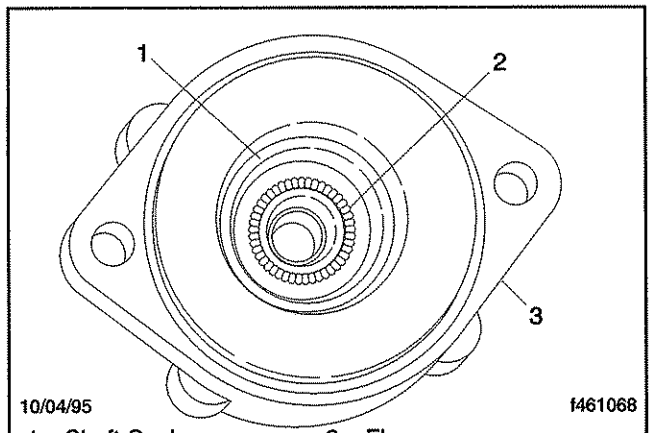
20. Using power steering fluid, lubricate the new combination O-ring/backup rings. Install the rings in the pump housing with the black side facing the housing and the white-plastic side exposed.

21. Install the pump housing over the flange assembly lining up the mounting holes.



A. Slightly smaller than the o.d. of the shaft seal.
B. Slightly larger than the o.d. of the driveshaft.
C. To be made of tubular stock.
D. The ends must be square.
E. Side View
F. Front View

Fig. 8, Shaft Seal Installation Tool



1. Shaft Seal
2. Garter Spring
3. Flange

Fig. 9, Install the Shaft Seal

Steering Pump Shaft Seal Replacement

22. Install the four hex bolts and washers in the pump housing. Tighten them in a cross pattern 29 to 37 lbf·ft (40 to 50 N·m).

23. Install the control valve in the pump housing.

⚠ CAUTION

Make sure you install the control valve correctly in its bore. If it's installed backwards, the power steering pump won't work and will quickly overheat, which could cause severe damage to the pump.

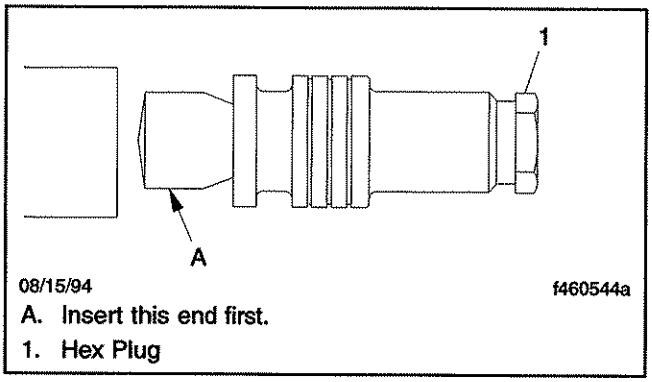
23.1 Lubricate the control valve with power steering fluid (see the power steering fluid table in **Specifications 400**), then install it—with the hex-plug end up—into the bore in the pump housing. See **Fig. 10**.

23.2 Install the spring over the hex-plug end of the control valve.

23.3 Install a new O-ring on the end plug, then install the end plug. Tighten it 33 to 40 lbf·ft (45 to 55 N·m).

24. Turn the shaft by hand. It should turn smoothly and without binding.

25. Install the power steering pump on the engine. For instructions, refer to **Subject 100**.



A. Insert this end first.
1. Hex Plug

Fig. 10, Install the Control Valve

Problem—The Power Steering Pump Doesn't Deliver Fluid

Possible Cause	Remedy
The pump driveshaft is broken, or not engaging.	Replace the pump.
The control valve is stuck open.	Remove the pump. Carefully remove the end plug. Check and see if the control valve is binding in the housing. If it is binding, remove the control valve. If the valve feels gritty, replace it. If not, clean it in a solvent. Install the control valve, then check for any binding in the bore. If the control valve continues to bind, replace it.
Incorrect power steering fluid is used.	Check for the type of fluid used. If it's incorrect, drain, flush, and fill the system with power steering fluid. See the power steering fluid table in **Specifications 400**.
The pump intake port is blocked.	Drain and flush the system. Fill the system with clean power steering fluid. See the power steering fluid table in **Specifications 400**.
The air vent in the power steering reservoir is clogged, or the filter is dirty.	Remove the filter cap from the reservoir, then clean the air slot. Check the filter and replace it if needed.
A power steering hose is kinked or blocked.	Repair or replace the hose.

Problem—The Power Steering Pump Is Making Noise

Possible Cause	Remedy
The intake line or filter is plugged.	Drain the system. Clear the intake line if needed, then check the filter. Replace it if needed. Fill the system. See the power steering fluid table in **Specifications 400**.
There is an air leak at the pump connections, the fittings, the reservoir connections, or the shaft seal.	Check all the connections by pouring power steering fluid over them, then listen for a reduction in sound. Tighten all the connections as needed. If the problem persists, remove the pump, then disassemble it and replace the shaft seal.

Specifications

Model Code Description*										
LF73V	21	16	163	L	P	U	D	02	11	GE11
Flange Type	Displacement (cubic cm/rev)	Control Flow (Lpm)	Pressure Limit (bar)	Direction of Rotation	Inlet Port Connection	Pressure Port Connection	Pressure Port View from Cover End	Shaft	Design Number	With Gear and Locknut

* Model codes contain specifications in metric units.

Table 1, Model Code Description

Pump Specifications			
LuK Model Code	**Pump Displacement cubic inch/rev (cubic cm/rev)**	**Control Flow gpm (Lpm)**	**Maximum Pressure psi (bar)**
LF73V-21-16-163-L-P-U-D-02-11-GE11	1.28 (21)	4.2 (16)	2396 (163)

Table 2, Pump Specifications

Pump Port Specifications			
Code	**Size**	**Shaft Minor Diameter Inches (mm)**	**O-Ring Chamfer**
Inlet Port			
M	M26 x 1.5	0.63 (16)	—
P	1-1/16–12 UN-2B	0.79 (20)	SAE J514
U	1-5/16–12 UN -2B		
Outlet Port			
M	M16 x 1.5	0.55 (14)	—
N	M18 x 1.5		—
U	3/4–16 UNF-2B		SAE J514

Table 3, Pump Port Specifications

Fastener Torques	
Description	**Torque lbf·ft (N·m)**
Pump Mounting Bolts	32–37 (43–50)
Pump Housing-to-Flange Assembly Hexbolts	29–37 (40–50)
Pump End-Plug	33–40 (45–55)
Pump Inlet Connection	26 (35)
Pump Outlet Connection	22 (30)

Table 4, Fastener Torques

Specifications

Power Steering Fluid	
Steering Gear and Lubricant Type	**Recommended Lubricant**
Power Steering Gears With Automatic Transmission Fluid Installed*	Dexron® III
Power Steering Gears With Heavy-Duty Engine Oil Installed*	15W–40

* Do not mix engine oil with automatic transmission fluid (ATF). Use the same lubricant for parts as is in the power steering system.

Table 5, Power Steering Fluid

Pressure Settings	
Code	**Pressure in psi (kPa)**
80	1116.5–1261.5 (7700–8700)
100	1406.5–1551.5 (9700–10 700)
110	1551.5–1696.5 (10 700–11 700)
115	1624–1769 (11 200–12 200)
120	1696.5–1841.5 (11 700–12 700)
130	1841.5–1986.5 (12 700–13 700)
135	1914–2059 (13 200–14 200)
140	1986.5–2131.5 (13 700–14 700)
145	2059–2204 (14 200–15 200)
150	2131.5–2276.5 (14 700–15 700)
155	2204–2349 (15 200–16 200)
163	2320–2465 (16 000–17 000)
000	—

Table 6, Pressure Settings

Model Code Description*	
Model Code	**Description**
LF73V	Flange Type
21	Displacement (cubic cm/rev)
16	Control Flow (L/min)
163	Pressure Limit (bar)
L	Direction of Rotation
P	Inlet Port Connection
U	Pressure Port Connection
D	Pressure Port View from Cover End
02	Shaft
11	Design Number
GE11	With Gear and Locknut

* Model codes contain specifications in metric units.

Table 1, Model Code Description

Pump Specifications			
LuK Model Code	**Pump Displacement: cubic inch/rev (cubic cm/rev)**	**Control Flow: gpm (L/min)**	**Maximum Pressure: psi (kPa)**
LF73V-21-16-163-L-P-U-D-02-11-GE11	1.28 (21)	4.2 (16)	2396 (16 520)

Table 2, Pump Specifications

Pump Port Specifications			
Code	**Size**	**Shaft Minor Diameter: Inches (mm)**	**O-Ring Chamfer**
Inlet Port			
M	M26 x 1.5	0.63 (16)	—
P	1-1/16–12	0.79 (20)	SAE J514
U	1-5/16–12		
Outlet Port			
M	M16 x 1.5	0.55 (14)	—
N	M18 x 1.5		—
U	3/4–16		SAE J514

Table 3, Pump Port Specifications

Specifications

Fastener Torques	
Description	**Torque: lbf·ft (N·m)**
Pump Mounting Bolts	32–37 (43–50)
Pump Housing-to-Flange Assembly Hexbolts	29–37 (40–50)
Pump End-Plug	33–40 (45–55)
Pump Inlet Connection	26 (35)
Pump Outlet Connection	22 (30)

Table 4, Fastener Torques

Approved Power Steering Fluids	
Fluid Type	**Approved Fluid**
Automatic Transmission Fluid*	Dexron® II Dexron® III
Heavy-Duty Engine Oil* IMPORTANT: Do not use heavy-duty engine oil in vehicles built from November 4, 2002.	15W–40

* Do not mix engine oil with automatic transmission fluid (ATF). Use the same lubricant for parts as is in the power steering system.

Table 5, Approved Power Steering Fluids

Pressure Settings	
Code	**Pressure in psi (kPa)**
80	1116.5–1261.5 (7700–8700)
100	1406.5–1551.5 (9700–10 700)
110	1551.5–1696.5 (10 700–11 700)
115	1624–1769 (11 200–12 200)
120	1696.5–1841.5 (11 700–12 700)
130	1841.5–1986.5 (12 700–13 700)
135	1914–2059 (13 200–14 200)
140	1986.5–2131.5 (13 700–14 700)
145	2059–2204 (14 200–15 200)
150	2131.5–2276.5 (14 700–15 700)
155	2204–2349 (15 200–16 200)
163	2320–2465 (16 000–17 000)
000	—

Table 6, Pressure Settings

Contents

Subject	Subject Number
General Information	050
Service Operations	
Steering Pump Replacement	100
Troubleshooting	300
Specifications	400

General Information

The LuK Automotive Hydraulics LF 80 power steering pump supplies power steering fluid for the operation of the power steering gear.

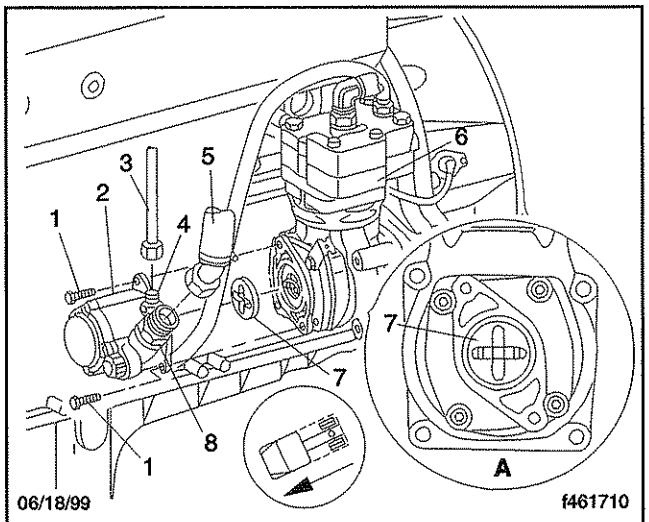
The power steering pump, used on the MBE900 engine, is mounted on the air compressor. See **Fig. 1**. The power steering pump is powered by a cross plate in the air compressor.

The main parts of the power steering pump are the housing, driveshaft, cam ring, rotor, vanes, and control valve.

Principles of Operation

The power steering pump driveshaft is driven by the air compressor, which is powered by the adaptor gear in the engine gear case. As the pump driveshaft turns the pump rotor, centrifugal force throws the vanes out against the surface of the cam ring. As fluid enters the cam ring through the inlet port, the rotor vanes force it out through the outlet port and into the system. The fluid enters the steering gear providing the gear with enough fluid to steer the vehicle. Eventually the fluid returns to the power steering reservoir and then back to the power steering pump. See **Fig. 2**.

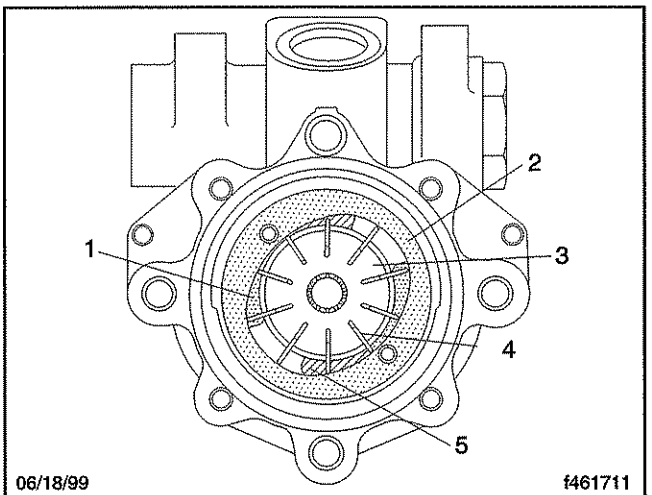
If the system pressure gets too high, a poppet inside the control valve is forced off its seat shunting fluid into a relief passage connected to the inlet port. The fluid then recirculates inside the pump instead of going to the outlet port. When the system pressure drops to the correct level, the poppet seats, closing off the relief passage to the inlet port. The fluid flow returns to normal, flowing from the inlet port to the outlet port and then into the power steering system.



A. Cross plate shown installed on the air compressor.

1. Capscrew
2. Steering Pump
3. Outlet Hose
4. Outlet Port
5. Inlet Hose
6. Air Compressor
7. Cross Plate
8. Inlet Port

Fig. 1, Power Steering Pump Mounting

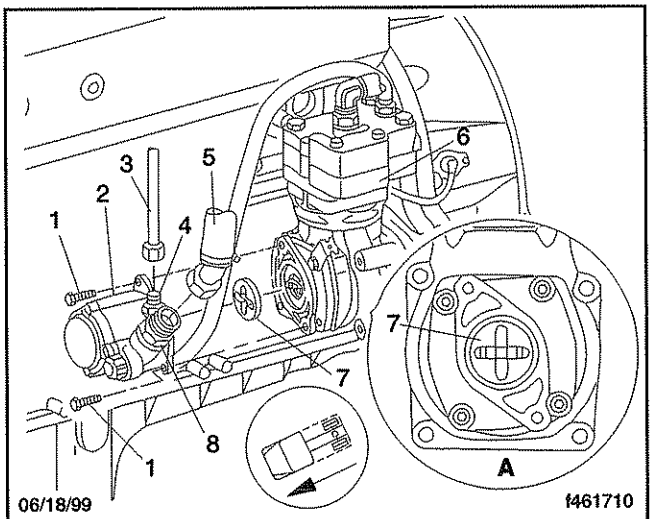


1. Low Pressure Area
2. Ring Contour
3. Rotor
4. Vane
5. High Pressure Area

Fig. 2, Power Steering Pump, Section View

Replacement

1. Turn off the engine, apply the parking brakes, chock the tires, and open the hood.
2. Clean the dirt from around the inlet and outlet ports and from the hose connections. See **Fig. 1.**
3. Put a container under the steering pump. Disconnect the inlet hose and fitting and the outlet hose and fitting from the inlet and outlet ports. Drain the fluid. Plug the hoses to keep out dirt.
4. Remove the capscrews and washers that attach the steering pump to the air compressor. Remove the steering pump from the air compressor.
5. Remove the cross plate and inspect it for excess wear. See **Fig. 1.**
6. Before installing a new steering pump, make sure the cross plate aligns with the air compressor shaft. See **Fig. 1.**
7. Attach the steering pump to the air compressor using capscrews and washers. Tighten the capscrews 32 to 37 lbf·ft (43 to 50 N·m).
8. Connect the inlet and outlet hoses and fittings to the steering pump inlet and outlet ports.



A. Cross plate shown installed on the air compressor.

1. Capscrew	5. Inlet Hose
2. Steering Pump	6. Air Compressor
3. Outlet Hose	7. Cross Plate
4. Outlet Port	8. Inlet Port

Fig. 1, Power Steering Pump Mounting

9. Add fluid to the power steering reservoir. Start the engine and let it idle for two minutes. Do not turn the steering wheel; doing so can cause air to enter the system.

   Turn off the engine and check the fluid level in the reservoir.
10. Start the engine again. To remove air from the system, steer the vehicle from full-left to full-right several times.

    If necessary, add fluid to the full line on the reservoir dipstick.
11. If the steering gear doesn't have a manual bleed screw, turn the steering wheel from full lock to full lock two or three times with the engine running at idle. Repeat this step and add fluid as necessary until there are no bubbles in the reservoir.

    If the steering gear is equipped with a manual bleed screw, turn the steering wheel from full lock to full lock two or three times with the engine running at idle. Then loosen the manual bleed screw about one turn and look for clear fluid or fluid mixed with bubbles at the threaded area of the bleed screw. Repeat this step and add fluid as necessary until only clear fluid shows. Tighten the manual bleed screw 27 to 33 lbf·in (300 to 360 N·cm). Refill the reservoir if necessary to the full line on the dipstick.
12. Close the hood and remove the chocks from the tires.

Problem—The Power Steering Pump Doesn't Deliver Fluid

Possible Cause	Remedy
The pump driveshaft is broken, or not engaging.	Replace the pump.
Incorrect power steering fluid is used.	Check for the type of fluid used. If it's incorrect, drain, flush, and fill the system with power steering fluid. See the power steering fluid table in **Specifications 400**.
The pump intake port is blocked.	Drain and flush the system. Fill the system with clean power steering fluid. See the power steering fluid table in **Specifications 400**.
The air vent in the power steering reservoir is clogged, or the filter is dirty.	Remove the filter cap from the reservoir, then clean the air slot. Check the filter and replace it if needed.
A power steering hose is kinked or blocked.	Repair or replace the hose.

Problem—The Power Steering Pump Is Making Noise

Possible Cause	Remedy
The intake line or filter is plugged.	Drain the system. Clear the intake line if needed, then check the filter. Replace it if needed. Fill the system. See the power steering fluid table in **Specifications 400**.
There is an air leak at the pump connections, the fittings, the reservoir connections, or the shaft seal.	Check the oil level in the reservoir. Check all the connections by pouring power steering fluid over them, then listen for a reduction in sound. Tighten all the connections as needed. If the problem persists, replace the pump.

Model Code Description*	
Model Code	**Description**
LF8	Power Steering Pump Series
0	Flange Type
25	Displacement (cubic cm/rev)
16	Control Flow (L/min)
150	Pressure Relief Valve Setting (bar)
L	Direction of Rotation
P	Inlet Port Size
U	Outlet (pressure) Port Size
MK1	Compressor Driven, Direct Drive
10	Design Number

* Model codes contain specifications in metric units.

Table 1, Model Code Description

Pump Port Specifications						
Code	**Size**	**Shaft Minor Diameter: Inches (mm)**	**Minimum Seal Diameter: Inches (mm)**	**Piping Inside Diameter: Inches (mm)**	**Piping Outside Diameter: Inches (mm)**	**O-Ring Chamfer**
Inlet Port						
M	M26 x 1.5	0.67 (17)	1.30 (33)	0.75 (19)	0.87 (22)	—
P	1-1/16–12		—			SAE J514
Outlet Port						
M	M16 x 1.5	0.55 (14)	0.98 (25)	0.39 (10)	0.47 (12)	—
N	M18 x 1.5			0.47 (12)	0.59 (15)	—
U	3/4–16		—			SAE J514

Table 2, Pump Port Specifications

Pump Specifications			
LuK Model Code	**Pump Displacement: cubic inch/rev (cubic cm/rev)**	**Control Flow: gpm (L/min)**	**Maximum Pressure: psi (kPa)**
LF80-25-16-150-L-P-U-MK1-10	1.53 (25)	4.2 (16)	2205 (15 203)
LF80-25-16-163-L-P-U-MK1-10			2396 (16 520)
LF80-25-16-185-L-P-U-MK1-10			2683 (18 500)
LF80-21-16-150-L-P-U-MK1-10	1.28 (21)		2205 (15 203)
LF80-17-16-185-L-P-U-MK1-10	1.04 (17)		2683 (18 500)

Table 3, Pump Specifications

Specifications

Approved Power Steering Fluids	
Fluid Type	**Approved Fluid**
Automatic Transmission Fluid*	Dexron® II Dexron® III
Heavy-Duty Engine Oil* IMPORTANT: Do not use heavy-duty engine oil in vehicles built from November 4, 2002.	15W–40

* Do not mix engine oil with automatic transmission fluid (ATF). Use the same lubricant for parts as is in the power steering system.

Table 4, Approved Power Steering Fluids

Pressure Settings		
Code	**Pressure: psi (kPa)**	**Tolerance: psi (kPa)**
81	1174.5 (8100)	58 (400)
90	1305 (9000)	
100	1450 (10 000)	
105	1522.5 (10 500)	
110	1595 (11 000)	
120	1740 (12 000)	
125	1812.5 (12 500)	
130	1885 (13 000)	
135	1957.5 (13 500)	
140	2030 (14 000)	
145	2102.5 (14 500)	
150	2175 (15 000)	
155	2247.5 (15 500)	
165	2392.5 (16 500)	
000	—	—

Table 5, Pressure Settings