

MC-9 MAINTENANCE MANUAL

SECTION 11

STEERING SYSTEM

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STEERING SYSTEM

The power steering system consists of the following components:

- A. Vane-type Hydraulic Pump, Reservoir, Filter and Interconnecting Lines and Hoses
- B. Steering Wheel and Column
- C. HFB 70 Steering Gear
- D. Steering Linkage consisting of a Pitman arm, drag link, steering arm and tie rod.

Steering action is transferred from the steering wheel and column directly to the HFB 70 steering gear. The Pitman arm on the steering gear moves the drag link to the axle steering arm in the proper direction. See figure 11-1.

Steering system and tire wear are affected by air suspension, brakes, wheel bearings, front suspension and front end alignment. These items are covered in their respective sections of this manual. Steering system specifications are given at the end of this section.

SYSTEM OPERATION

Power steering is accomplished by hydraulic pressure. Steering fluid is supplied by a vane-type hydraulic pump, mounted at the left rear of the engine. Hydraulic fluid lines (figure 11-2) are mounted from the power steering reservoir to the pump. Fluid displaced by the pump circulates through flexible lines to the power steering gear. A return line is connected from the steering gear back to the reservoir.

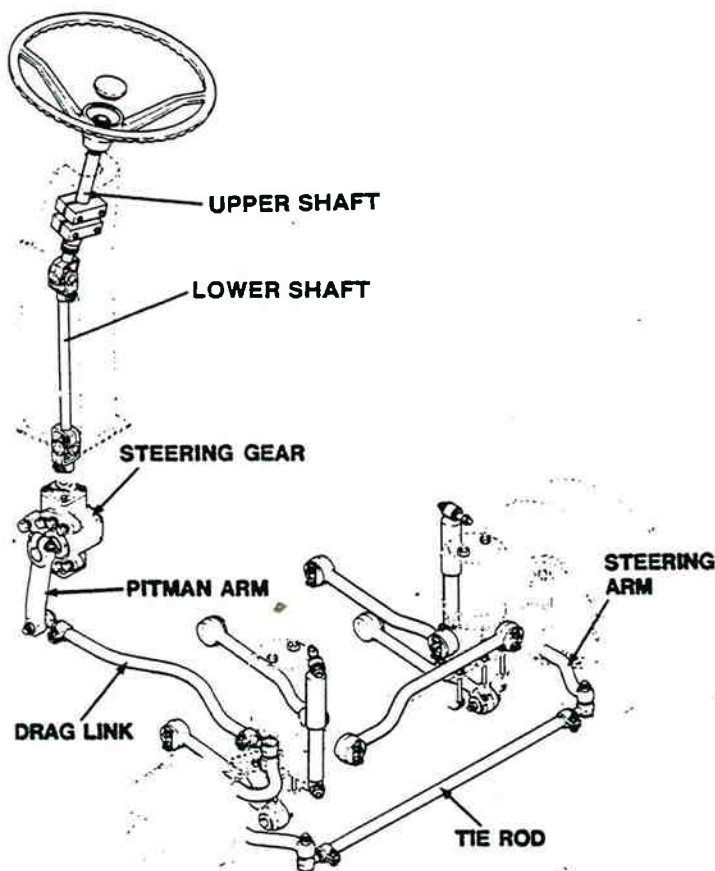


Figure 11-1 . Power Steering System.

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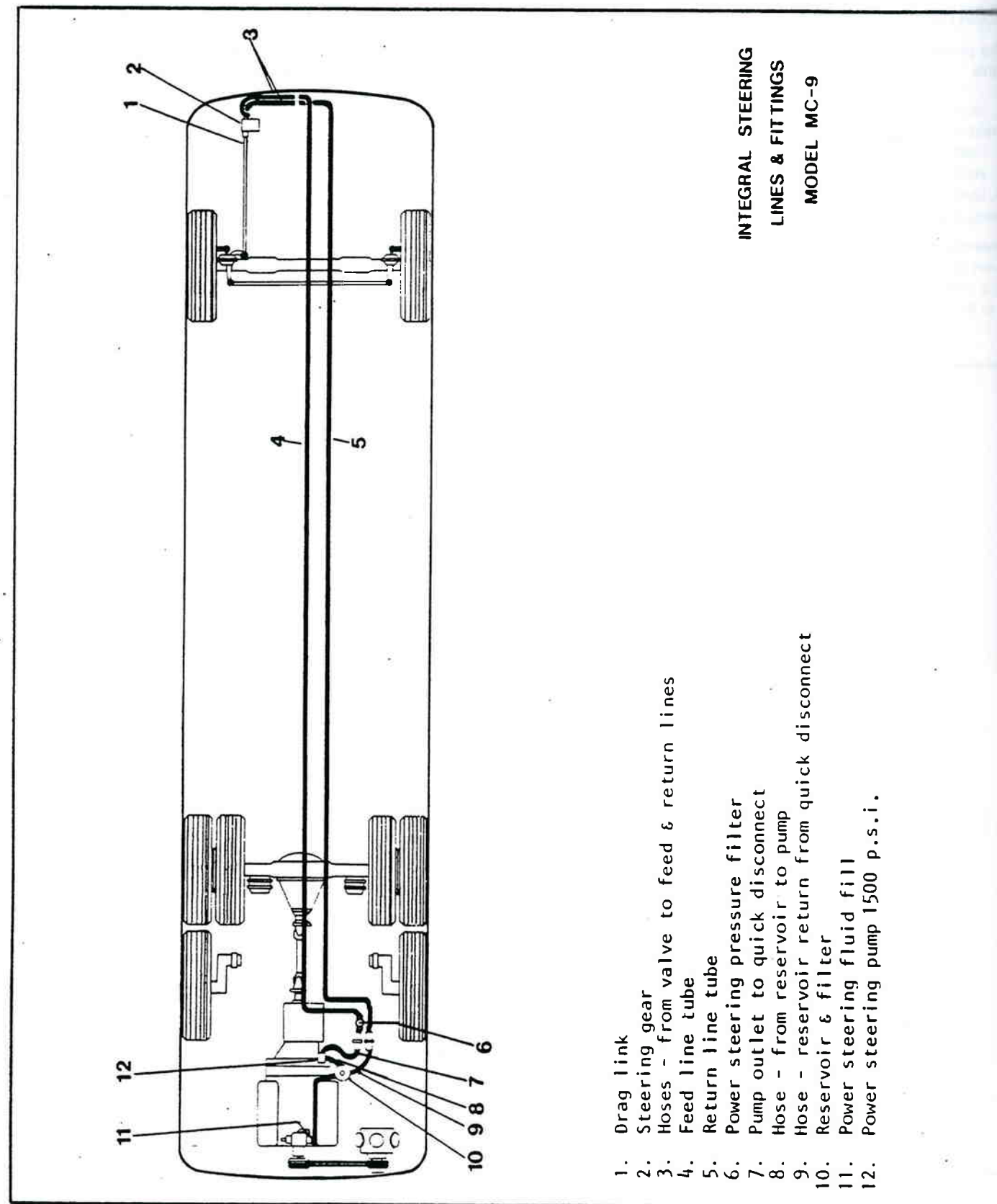


Figure 11-2. Steering Lines and Component Locations.

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When the steering wheel is turned, the steering shaft turns the power steering gear actuating shaft. This motion, combined with hydraulic pressure supplied to the gear by the pump, provides the rotating action of the gear output shaft, which is connected to the Pitman arm.

The power steering hydraulic system has two filters to ensure that foreign matter does not enter the pump or the steering gear. A filter in the reservoir filters the steering fluid before it enters the pump and a supply line filter is used to filter the fluid before it enters the steering gear.

SYSTEM MAINTENANCE

The power steering system requires little maintenance. However, the system should be kept clean to ensure maximum operating performance and trouble free service. Periodic inspection should also be made to check for leaks.

At regular intervals, fluid level in the pump reservoir should be checked and fluid added when required. Refer to Power Steering Reservoir and Filter later in this section.

The fluid reservoir and filter assembly is mounted in the upper right corner of the engine compartment. When the slightest evidence of dirt, sludge or water is discovered in the system, disconnect fluid lines at the power steering gear. Drain, and refill the system with clean, recommended fluid. The power steering fluid reservoir filter should be serviced at regular lubrication intervals.

The power steering fluid line filter is in-line mounted. At regular lubrication intervals, the fluid filter element should be removed and replaced. Refer to Power Steering Filter later in this section for service instructions.

Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled. Bleed the system as described under Bleeding Air From Power Steering System later in this section.

CAUTION: Do not operate the pump without fluid in the pump reservoir.

If the linkage between the steering gear and the front wheels is out of adjustment, bent, twisted or worn, the steering action of the coach will be seriously affected. Whenever any steering linkage parts are repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to Front Axle for front end alignment information (Section 1).

At regular lubrication intervals, the steering linkage should be thoroughly inspected for worn or loose components; Section 10, Lubrication.

After the coach has been operated continually, and high mileage figures have been reached, overhaul of the various steering units will be required.

General overhaul procedure normally requires removal and disassembly of the entire assembly, cleaning and inspection of all parts and final assembly. Careful inspection of all parts during overhaul is very important and must not be neglected.

REMOVAL OF STEERING COLUMN

1. Shut off the battery switch.
 2. Remove steering wheel (refer to Removal of Steering Wheel). Replace the wheel nut on the shaft to avoid losing steering column components.
 3. Disconnect the wire from the contact brush terminal located under the turn signal assembly on the left-hand side of the steering column.
 4. Loosen the two allen head screws securing the turn signal assembly and remove it from the steering column.
 5. Remove the four screws at both the floor and dashboard ends of the fiberglass cover.
 6. Remove the six screws and the aluminum plate from the middle of the cover and remove the cover from the steering column.
 7. Loosen the clamp connecting the steering column to the input shaft of the steering gear.
 8. Remove the four bolts and the U-clamps that secure the steering column to the dashboard.
- The steering column may now be lifted out of the coach as a complete unit.

INTEGRAL STEERING**DISASSEMBLY OF STEERING COLUMN**

1. Remove the steering wheel nut (12).
2. Remove the spring (5), upper spacer (7), washer (8) and nylon bushing (9) from the top of the jacket tube (13).
3. Remove the contact brush (24) from the jacket tube. Slip the upper bearing (14) and jacket tube (13) off the upper wheel shaft. Ensure that the lower bearing remains on the wheel shaft.

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1. Upper Shaft
2. Spacer Collar
3. Washer
4. Cup Washer
5. Spring
6. Lower Spacer
7. Upper Spacer
8. Spring Retainer Washer (2)
9. Nylon Bushing (2)
10. Contact Ring
11. Cable
12. Wheel Nut
13. Jacket Tube
14. Bearing (2)
15. Universal Joint Assembly
16. Universal Joint
17. Flexible Coupling
18. Lower Wheel Shaft
19. Button (2)
20. Pin
21. Bolt (2)
22. Lockwasher (2)
23. Rubber Seal
24. Clamp
25. Capscrew
26. Lockwasher
27. Nut
28. Nut
29. Lockwasher
30. Bolt
31. Screw (2)
32. Contact Brush
33. Fiberglass Cover
34. Lower Cover
35. Seal
36. Seal
37. Seal
38. U-Clamp (4)

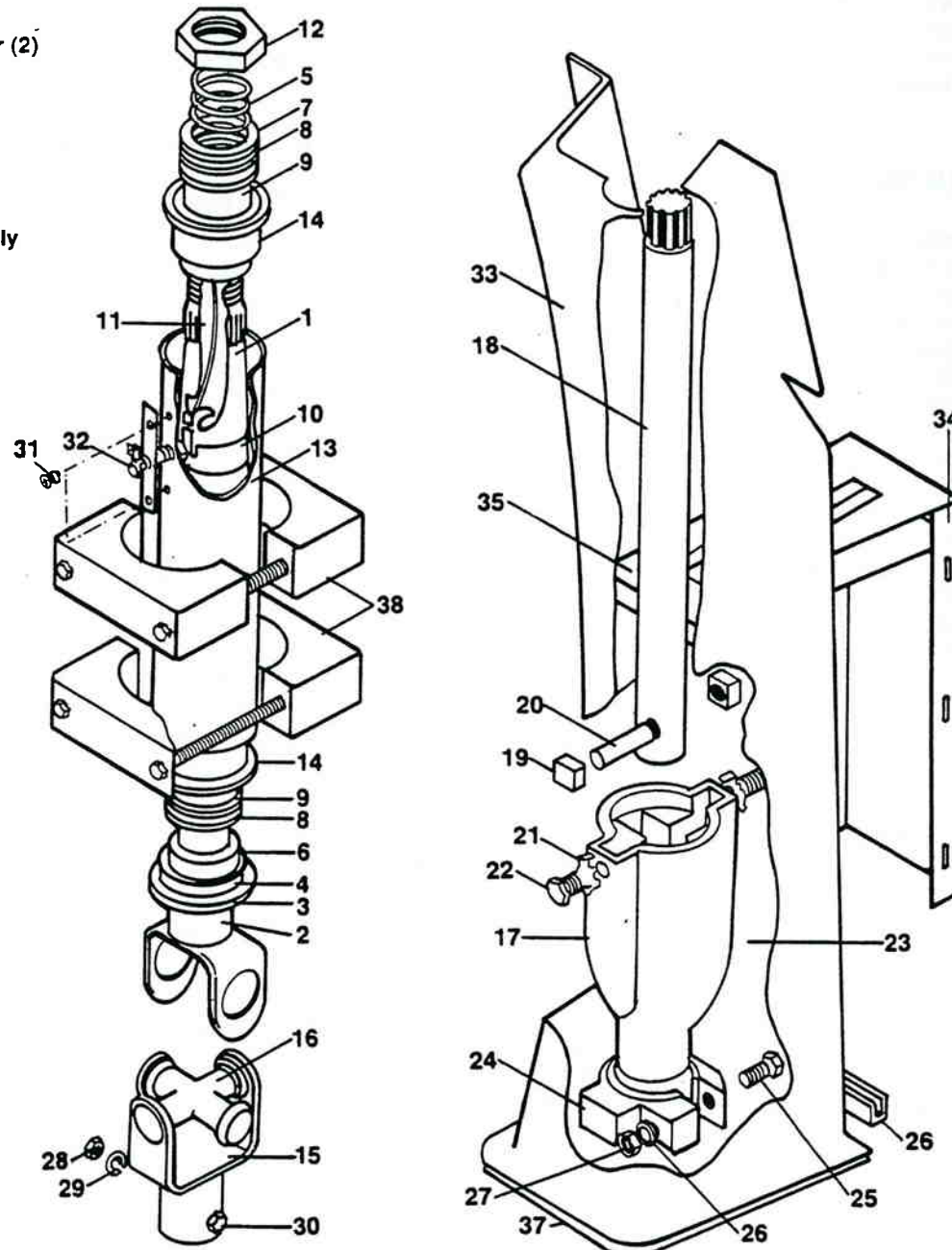


Figure 11-3. Steering Column Disassembled.

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4. Unravel the tape on the contact ring (10). Disconnect the cable (11) from the contact ring and remove it from the wheel shaft.
5. Remove the nylon screw that secures the contact ring to the upper wheel shaft and remove the contact ring.
6. Remove the lower bearing (14), nylon bushing (9), washer (8), lower spacer (6), cup washer (4), flat washer (3), and spacer collar (2) from the wheel shaft.
7. Separate the upper wheel shaft (1) from the lower wheel shaft (18) by removing the nut (28), bolt (30), and lock washer (29) from the lower yoke of the universal joint (15).
8. Remove the two bolts (22) and lock washers (21) from the flexible coupling (17). The lower wheel shaft (18) may now be separated from the coupling, and the two buttons (19) and the pin (20) may be removed from the shaft.
This completes disassembly.

DISASSEMBLY OF BEARINGS

To disassemble the bearing remove the snap ring, retaining washer, and felt washer. Separate the bearing halves and remove the rolls.

CAUTION: The bearing contains 20 rolls. If any of the rolls are lost or damaged, the entire bearing must be replaced.

INSPECTION

Inspect the shaft splines, bearings, universal joint and all threads for unusual signs of wear or damage. Replace all parts not in good condition.

REASSEMBLY

Pack the bearings with clean grease and apply grease to the upper wheel shaft for the nylon bushings. Saturate the felt washers with No. 50 oil. Pack the bottom of the flexible coupling with 1 oz. (30 g) of heavy grease.

1. Insert the pin (20) into the hole on the lower wheel shaft (18) and attach one button (19) to either end of the pin.
2. Insert the shaft into the flexible coupling (17) and install lock washers (21) and bolts (22) onto the coupling. If new lock washers are used bend the large tang over the edge of the flexible coupling.
3. Assemble the upper wheel shaft (1) U-joint assembly onto the lower wheel shaft. Ensure that the cross in the lower yoke of the universal joint is parallel to the pin in the lower wheel shaft.
4. Tighten the bolt (30), lock washer (29) and nut (28) on the U-joint to 35 ft. lbs. (47 Nm).

5. Assemble onto the upper wheel shaft the spacer collar (2), flat washer (3), cup washer (4), lower spacer (6), washer (8), nylon bushing (9) and lower bearing (14).
6. Install the contact ring (10) and connect the cable (11). Secure the cable to the contact ring with tape.
7. Slide the jacket tube (13) onto the wheel shaft (1) and install the contact brush (32).
8. Install the upper bearing (14), nylon bushing (9), washer (8), upper spacer (7) and spring (5) onto the jacket tube.

NOTE: When assembling bearings onto the jacket tube it may be necessary to tap the top of the jacket with a rubber mallet.

INSTALLATION

1. Remove the two screws that secure the instrument panel and partially remove the panel to gain access to the U-clamp tapping plate.
2. Position the U-clamps around the jacket tube and align the tapping plate holes with the U-clamps. Thread the bolts into the tapping plate but do not tighten.
3. Lift the rubber cover off the flexible coupling and locate the hole beneath the bolt and lock washer. Insert a 1/4" (6.35 mm) pin, or drill shank into the hole and lift up on the column assembly until it stops against the pin. Using vise grip pliers, clamp the lower shaft at the flexible coupling to hold the shaft in position against the pin.
4. Align and tighten the bolts on the U-clamps.
5. Slide the turn signal assembly over the steering column but do not secure.
6. Clean, degrease and apply "Locquic Primer T" to the column shaft threads and nut. Apply a film of "Loctite Stud Lock" to the shaft and nut. Mount the steering wheel in a straight ahead position and install the wheel nut using 50 ft. lbs. (68 Nm) of torque.
7. Remove vise grip pliers and pin.
8. Adjust and secure the turn signal assembly ensuring that it functions properly.
9. Install the contact brush wire on the left side of the steering column and connect the horn wires. Mount the steering wheel medallion ensuring that the logo is parallel and centered in the steering wheel cross member.
10. Install the instrument panel and lower steering column cover.

LUBRICATION

Grease the steering column U-joints at 5000 mile intervals using molybdenum disulphide grease. Remove steering column cover for access to grease fitting.

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HFB 70 INTEGRAL STEERING GEAR

The integral power steering gear incorporates a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder. The control valve is a rotary type which directs oil flow from the engine driven power steering pump to either one of the cylinder cavities. The flow directed to a cylinder cavity is dependent upon the speed at which the steering wheel is turned. See figure 11-6.

Force on the steering wheel is transmitted to the steering gear input shaft. The input is connected to the worm shaft by means of a torsion bar. The torsion bar turns with the input shaft, exerting a rotational force on the worm shaft. The worm shaft in turn transmits the force through a ball nut mechanism to axial force on the rack piston. The rack piston resists this force due to its engagement to the sector shaft. With this resistance, the torsion bar is twisted by the input shaft. Pressurized fluid moves the rack piston axially through the cylinder bore and the rack piston then turns the sector shaft and steers the coach.

If the wheels receive a shock load, the shock force is transmitted through the sector shaft to the rack piston and on to the worm shaft. This force causes the control valve to send high pressure fluid to the proper cavity to resist the shock force. By hydraulically absorbing the shock, the steering gear prevents kickback at the steering wheel.

The steering gear is equipped with two unloading valves (poppets) at either end of the housing. As the steered wheels approach the axle stop, the corresponding poppet is opened. This reduces pressure in the gear and helps to reduce heat generated by the pump. The tripped poppet also reduces the load force on the steering linkage. These poppets may be adjusted by the adjusting screws on either end of the steering gear.

CENTERING STEERING

1. Center the steering gearbox by aligning the sector shaft timing mark (scribed line) at a 90 degree angle to the input shaft.

NOTE: The Pitman arm is installed on the sector shafts so the timing marks on the arm and shaft are aligned.

2. Adjust the drag link so that the wheels are straight ahead.
3. If necessary, remove the steering wheel and install it so that the cross pieces are at the 3 and 9 o'clock positions.

AXLE STOP ADJUSTMENT

1. Turn the wheels to the left until there is a minimum 1/16" (1.59 mm) clearance between the left steering arm and any possible contact surfaces.
2. Adjust axle stop screw to provide this clearance.
3. Turn the wheels to the right until there is a minimum 1/16" (1.59 mm) clearance between the right steering arm and any possible contact surfaces.
4. Adjust axle stop screw to provide this clearance.

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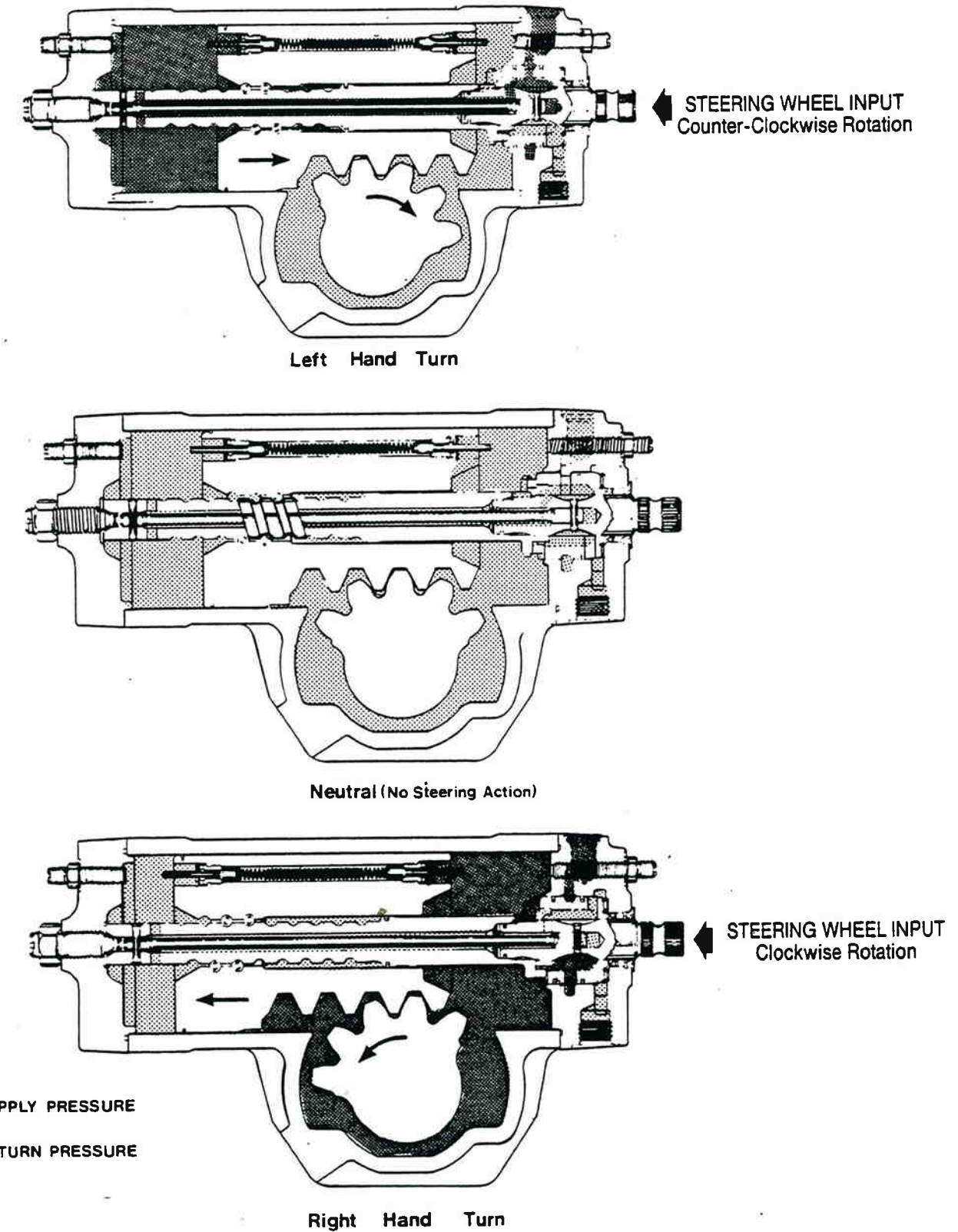


Figure 11-4. Steering Gear Oil Flow.

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POPPET VALVE ADJUSTMENT

1. Before adjusting the poppet valves make sure the axle stops are properly set, and the front wheels are on the floor.
2. Back off the adjusting screw jam nuts and turn the screws all the way into the gearbox.
3. Start the engine and let it idle.

CAUTION: When relief pressure is reached, the gear will produce a hissing sound. This is normal. However, do not hold the gear in this position for longer than five seconds. To do so will damage the pump.

4. Back out the bottom adjusting screw until the gearbox allows the axle to turn to within $\frac{1}{8}$ " (3.175 mm) of the right hand axle stop.
5. Tighten the jam nut to 12-18 ft. lbs. (16.3-24.4 Nm) torque.
6. Repeat this procedure for the left hand turn using the adjusting screw at the top of the gearbox.

NOTE: While tightening the jam nut, make sure that the adjusting screw does not move.

7. Check the clearance at the right hand stop to ensure that it has not changed. If it has, readjust the poppet.

REMOVAL OF STEERING GEAR (96A3/102A3/102C3)

1. Remove the steering column. (Refer to Removal of Steering Column.)
2. Remove the pinch bolt on the Pitman arm.
3. Drive a wedge into the groove at the top of the arm to loosen it from the sector shaft. Slide the Pitman arm off the shaft.
4. Clean the area around the fittings.
5. Disconnect the hoses and plug the holes to prevent contamination.

WARNING: The steering gear weighs approximately 110 lbs. (50 kg) dry. Before continuing with the removal procedure, support the gear to prevent it from falling from the frame after the mounting bolts have been removed.

6. Take out the bolts that mount the gear to the frame and carefully remove the gear.

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1. Housing
2. Bearing (2)
3. Retaining Ring
4. Ball Return Guide Assembly
- 4a. Allen Head Bolts (2)
- 4b. Ball Return Guide Cap
- 4c. Ball Return Guide Cap Seal
- 4d. Ball Return Guides
5. Worm and Valve Assembly
- 5a. Worm Shaft
- 5b. Valve Sleeve
- 5c. Drive Ring
6. Teflon Seal Ring (2)
7. Backup O-ring (2)
8. Worm Shaft Backup O-ring
9. Teflon Worm Shaft Seal
10. Rack Piston
11. Spring
12. Nylon Spacer Rod
13. Poppet (2)
14. Poppet Seat (2)
15. Retaining Ring (2)
16. Rack Piston Backup O-ring
17. Teflon Rack Piston Seal
18. Balls (34)
19. Valve Housing

20. Poppet Adjusting Screw
2.313" (58.75 mm) Long (2)
21. Poppet Adjusting Screw
Jam Nut (2)
22. Thrust Washer (2)
23. Thrust Bearing
24. End Cover & Valve Housing
O-ring (2)
25. Valve Housing Bolts
2.125" (53.98 mm) Long (4)
26. End Cover
27. Worm Shaft Preload
Adjusting Screw
28. Worm Shaft Preload
Adjusting Screw Jam Nut
29. End Cover Washer (4)
30. End Cover Bolts 1.625"
(41.275 mm) Long (4)
31. Trunnion Cover O-ring
32. Trunnion Cover Bolts (4)

33. Trunnion Cover Washers (4)
34. Dirt & Water Seal
35. Input Shaft Seal
36. Steel Backup Washer
37. Retaining Ring
38. Dirt & Water Seal
39. Sector Shaft
40. Sector Shaft Adjusting
Screw
41. Retainer
42. Side Cover
43. Steel Backup Washer

44. Teflon Backup Washer
45. Side Cover Seal (Two Piece)
46. Retaining Ring
47. Vent Plug
48. Side Cover Gasket
49. Trunnion Cover
50. Teflon Backup Washer
51. Sector Shaft Seal
(Two Piece)
52. Side Cover Bolts (8)
53. Sector Shaft Adjusting
Screw Jam Nut

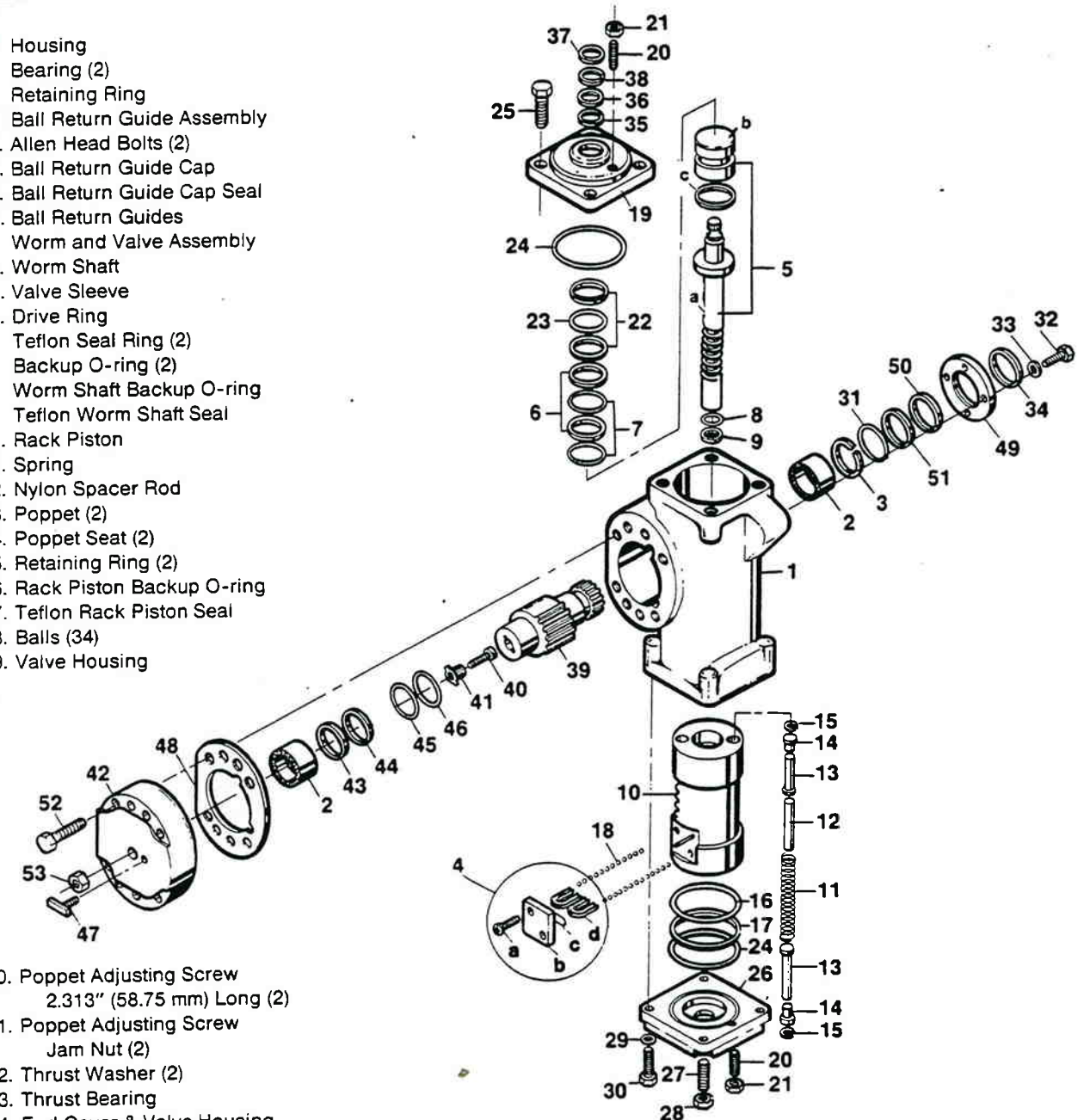


Figure 11-5. Steering Gear.

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DISASSEMBLY OF STEERING GEAR

Throughout the disassembly and assembly instructions, key numbers are called out to aid in parts identification. These numbers refer to the exploded view of the steering gear (figure 11-5).

1. Drain steering gear and clean the outer surface.

CAUTION: Never steam clean or high-pressure wash any hydraulic steering components. Do not force or abuse closely fitted parts.

2. Position the steering gear in a vise with the worm shaft (5a) in a horizontal position.
3. Rotate the worm shaft to the end of the sector shaft (39) travel.
4. Position the timing mark on the sector shaft in a vertical direction (halfway between two capscrews). The steering gear is now in its center of travel.
5. Clean the serrated end of the sector shaft and loosen the jam nut (53) on the sector shaft adjusting screw (49) (figure 11-6).
6. Remove and discard the dirt and water seal (34) from the trunnion cover (49) (figure 11-7).

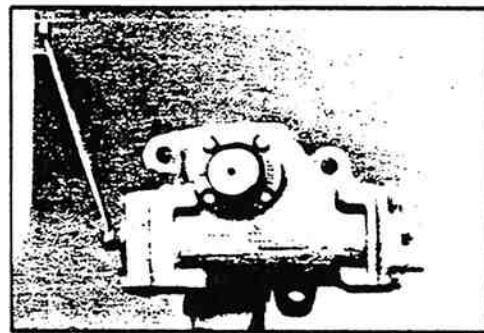


Figure 11-6. Loosening Sector Shaft From Nut.

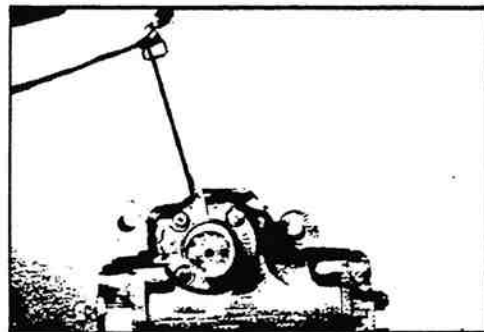


Figure 11-7. Removing Seal.

7. Remove the four bolts (32) from the trunnion cover with a 1/2 inch socket (figure 11-8).
8. Remove the trunnion cover (figure 11-10).
9. Turn the serrations and bolt groove of the sector shaft (figure 11-11).

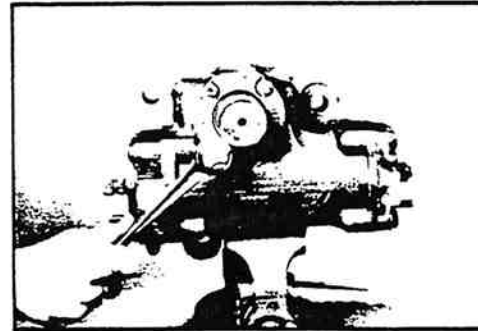


Figure 11-8. Bolt Removal.

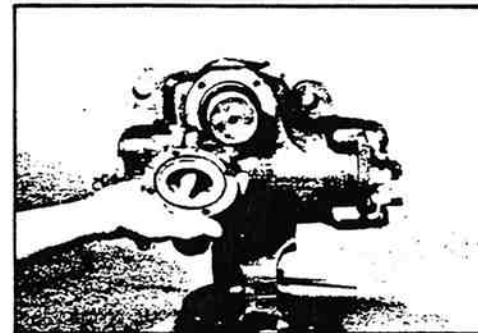


Figure 11-10. Trunnion Cover Removal.

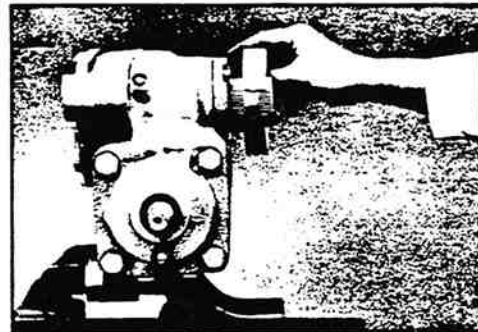


Figure 11-11. Applying Tape to Sector Shaft.

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10. Remove the eight special ring head bolts (52) from the side cover (42) with a 13/16 inch socket (figures 11-11 and 11-12). There will be some draining of fluid at this point.

NOTE: These eight bolts have a special sealing ring located on the underside of the bolt head. If it is necessary to replace any of these bolts, use only the same special type and length of bolts.

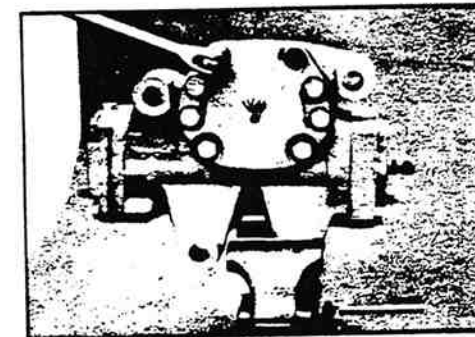


Figure 11-11. Removing Ring Head Bolts.

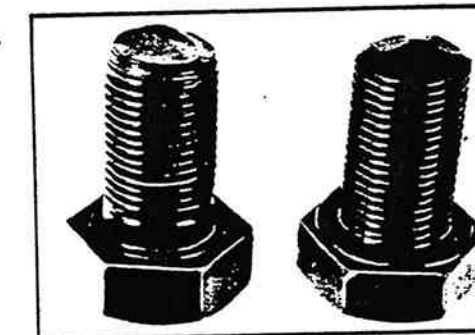


Figure 11-12. Ring Head Bolts.

11. Begin to remove the side cover (42) and sector shaft (39) assembly (figure 11-13) and stop when the bearing rollers are half exposed. A soft hammer may be needed to start the removal of the side cover sector shaft assembly.

NOTE: Exercise care in removing this assembly slowly. If the assembly is removed too quickly, it will be difficult to retain the bearing rollers in the race.

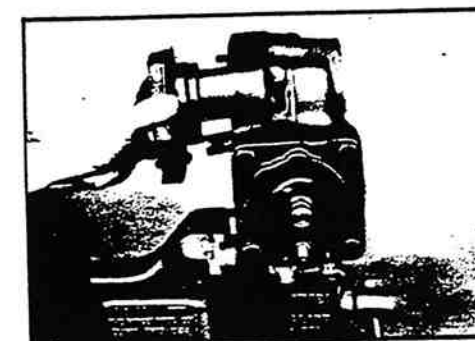


Figure 11-13. Sector Shaft Partial Removal.

12. When the rollers are half exposed, apply enough grease to retain them in the housing bearing (2) (figure 11-14).

CAUTION: If one or more of the bearing rollers is lost, it is necessary to replace the entire bearing.

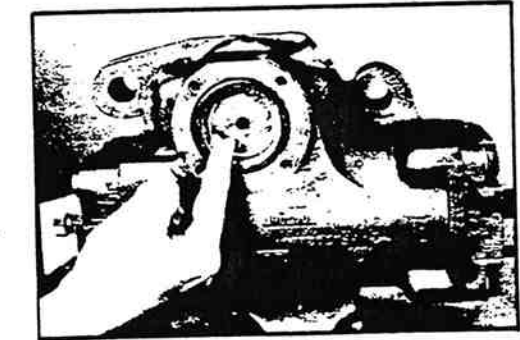


Figure 11-14. Apply Grease to Retain Bearing Rollers.

13. Complete removal of the side cover sector shaft assembly.

If the bearing is damaged, or it becomes necessary to replace the housing bearing (2), remove the bearing in the following manner: Using bearing mandrel J26743, apply pressure from the side cover opening and press the bearing out through the trunnion cover opening (figure 11-15). Care must be taken to maintain a good, square contact between the housing and press base to avoid damaging the bearing bore. If the bearing is cocked during removal, it may burnish the bore, causing it to become oversized and to require replacement of the steering gear housing.

CAUTION: The bearing may contain either 41 or 42 rollers, depending upon the type of bearing used. Bearing BR-970 has 41 rolls. Bearing BR-970-1 has 42 rolls. The bearing identification number is on the outside edge of bearing rollers inside the side cover with either 41 or 42 rollers. The quantity may not be the same as in the housing bearing. In any case, do not mix these rollers.

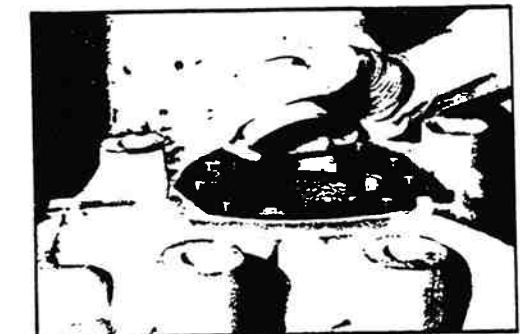


Figure 11-15. Removing Bearing.

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14. Remove the sector shaft adjusting screw jam nut (53) (figure 11-16).

15. Screw the sector shaft adjusting screw (40) through the side cover (42) (figure 11-17). Place the side cover exterior face down and lift the sector shaft out vertically.

CAUTION: Removal of the sector shaft will allow the side cover bearings to fall into the side cover cavity. Immediately collect and count all the side cover bearings at this time.



Figure 11-16. Removing Jam Nut.



Figure 11-17. Turning Adjusting Screw.

16. Remove the retaining ring (46) (figure 11-18), the two-piece side cover seal (45), the teflon backup washer (44), and the steel backup washer (43) from the side cover (figure 11-19). Discard the seal and the teflon washer.



Figure 11-18. Retaining Ring Removal.

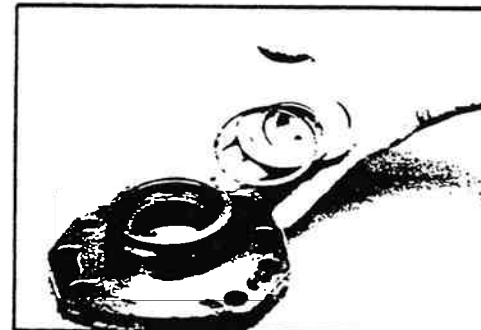


Figure 11-19. Rings and Washers Removal.



Figure 11-20. O-ring Removal.

17. Remove the trunnion cover O-ring (31) (figure 11-20), the two-piece sector shaft seal (51), and the teflon backup washer (50) from the trunnion cover (49) (figure 11-21). Discard seal, washer and O-ring.

18. Loosen the worm shaft adjusting screw jam nut (28) with 15/16 inch socket, and loosen the worm shaft preload adjusting screw (27) two turns with a 15/16 Allen socket or screwdriver (figure 11-22). Loosen the poppet adjusting screw jam nut (21) and the poppet adjusting screw (20) two turns.

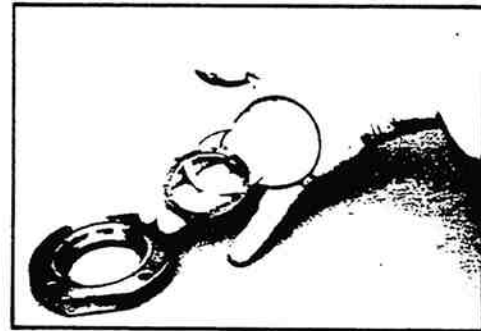


Figure 11-21. Seals and Washers Removal.

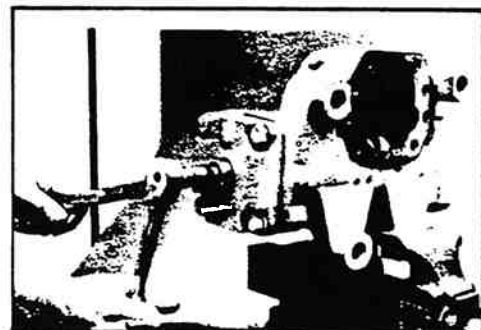


Figure 11-22. Loosening Adjusting Screw.

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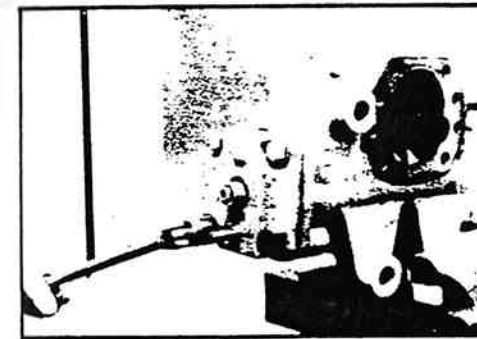


Figure 11-23. Removing Bolts.

19. Remove the four end cover bolts (30) with a 13/16 inch socket and remove the four washers (29) (figure 11-23).

20. Remove the end cover (26) (figure 11-24). Some fluid will drain at this point.

21. Remove and discard the end cover O-ring (24) from the end cover (26) (figure 11-25).

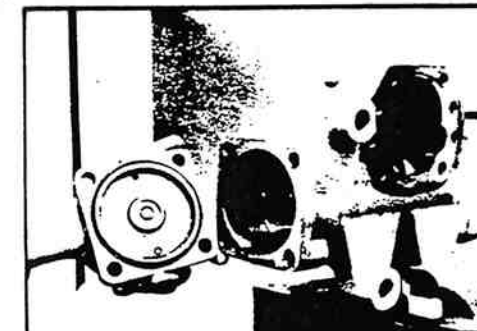


Figure 11-24. Removing End Cover.

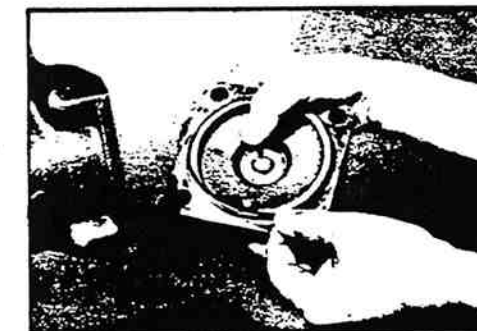


Figure 11-25. O-ring Removal.

22. Clean the input shaft with a fine grade emery paper (figure 11-26).

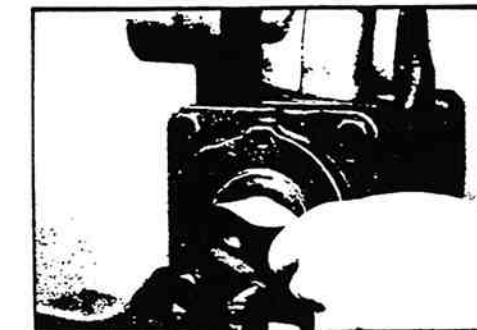


Figure 11-26. Cleaning Shaft.

23. Loosen the poppet adjusting screw jam nut (21) and the poppet adjusting screw (20) two turns.

24. Remove the four valve housing bolts (25) with a 13/16 inch socket (figure 11-27).

25. Remove the valve housing (19) (figure 11-28). Some fluid will drain.

NOTE: The valve sleeve (5b) will probably remain in the valve housing.

CAUTION: Do not remove the drive ring (5c) from the worm shaft (5a) or attempt to distort the tangs which hold the drive ring in place on the worm shaft. Doing either will alter the valve timing and could cause the coach to pull to one side after the steering gear is installed.

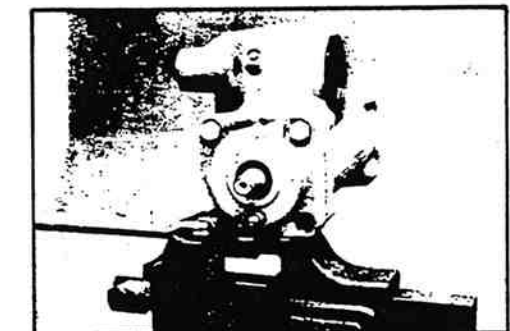


Figure 11-27. Housing Bolt Removal.

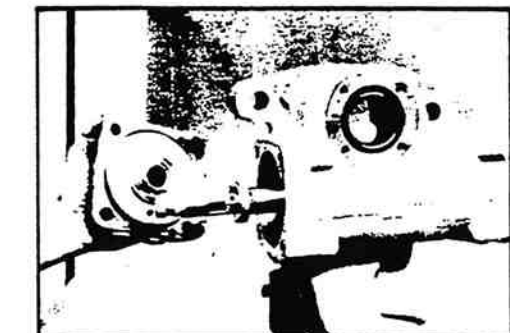


Figure 11-28. Valve Housing Removal.

26. Remove the valve sleeve (5b) from the valve housing (19) (figure 11-29).



Figure 11-29. Removing the Valve Sleeve.

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27. Remove the first thrust washer (22), the thrust bearing (23), and the second thrust washer (22) from the valve housing (figure 11-30).

NOTE: The second thrust washer may remain on the end of the valve sleeve.



Figure 11-30. Washer and Bearing Removal.

28. Remove and discard the valve housing O-ring (24) from the valve housing (19).

29. Remove and discard the dirt and water seal (37) (figure 11-31).

30. Remove the retaining ring (38) (figure 11-32).

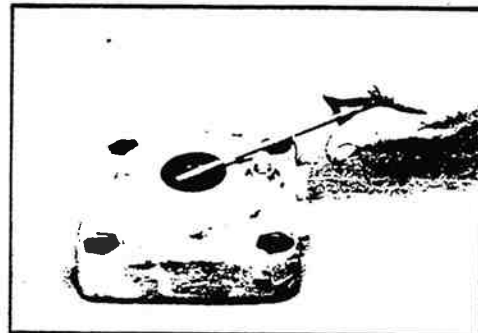


Figure 11-31. Seal Removal.

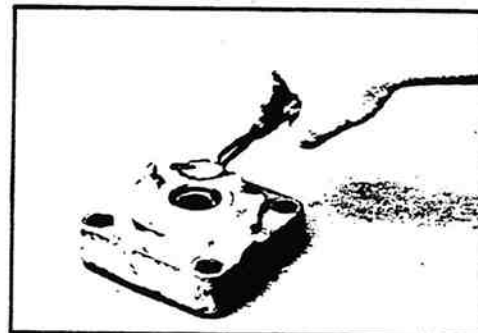


Figure 11-32. Retaining Ring Removal.

31. Remove the steel backup washer (36) and the two-piece input shaft seal (37) from the valve housing (figure 11-33). Discard the seal.



Figure 11-33. Seal and Washers Removed.

32. Remove and discard the two teflon seal rings (6) from the valve sleeve (figure 11-34).

33. Remove the two backup O-rings (7) (figure 11-35) from the valve sleeve grooves.



Figure 11-34. Removing Teflon Ring.

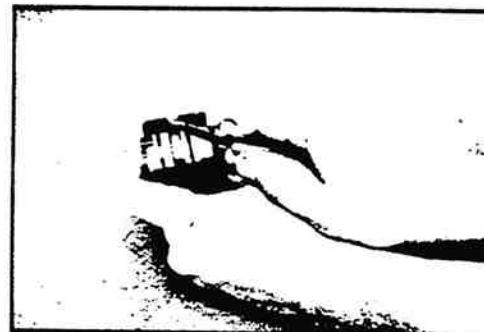


Figure 11-35. Removing O-rings.

34. Remove the rack piston (10) worm shaft (5a) assembly from the gear housing (figure 11-36).

CAUTION: The worm shaft will be inside the rack piston with the input part of the worm protruding from the rack piston. When removing the assembly from the housing, take care to prevent the teflon rack piston seal (17) from getting caught in the sector shaft cavity. Remove the assembly from the long end of the housing.

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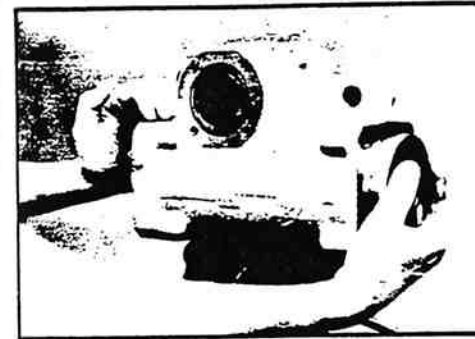


Figure 11-36. Removing the Rack Piston.

35. Place the rack piston worm shaft assembly on a clean cloth to prevent the piston from rolling.

36. Remove the two Allen head bolts (4d) (Figure 11-37) from the ball return guide cap (4e); remove the ball return guide cap (Figure 11-38) and the ball return guide cap seal (4f).

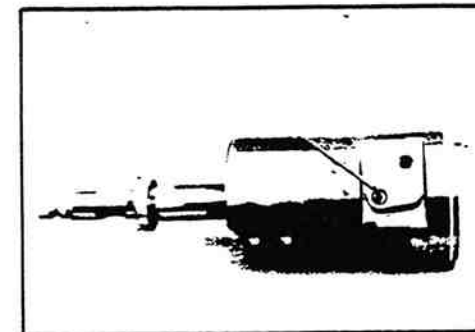


Figure 11-37. Allen Head Bolt Removal.

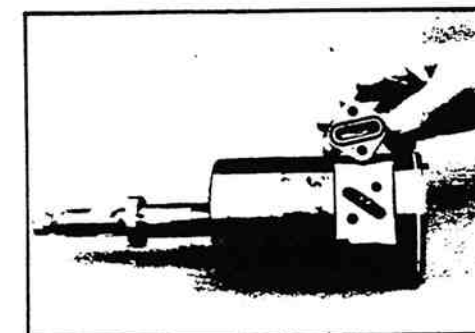


Figure 11-38. Removing Guide Cap.

37. Remove the two ball return guides (4c or 4g) (figure 11-39) and the balls (18) from the rack piston (10) by rotating the worm shaft (5a) until the balls fall out (figure 11-40).

NOTE: Ball return guides are closely fitted with the rack piston and you may have to remove them by carefully inserting a screwdriver between the rack piston and ball return guides.

CAUTION: Assembly contains a set of 34 matched balls, and you must take special care not to lose any. If any balls are lost, a complete, new set of matched balls will be required.

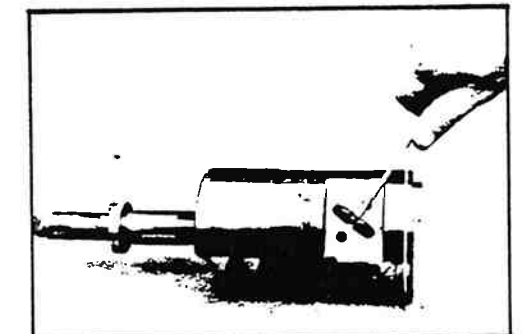


Figure 11-39. Loosening Ball Return Guides.

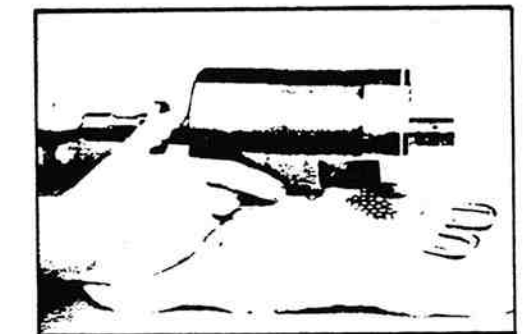


Figure 11-40. Removal of Balls.

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38. Remove the worm shaft (5a) from the rack piston (10) (figure 11-41).

39. Remove and discard the rack piston seal ring (17) (figure 11-42).

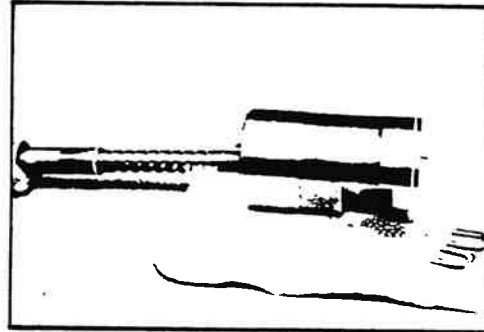


Figure 11-41. Removing Worm Gear.

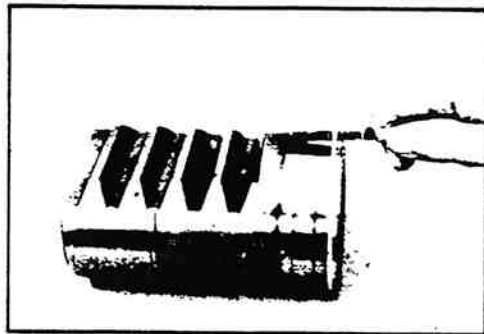


Figure 11-42. Seal Ring Removal.

40. Remove and discard the rack piston backup O-ring (16) (figure 11-43) from the rack piston.

41. Remove and discard the worm shaft seal ring (9). Then, remove and discard the worm shaft O-ring (8) from the worm shaft (figure 11-44).

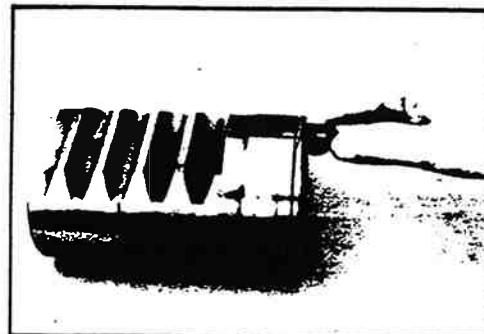


Figure 11-43. O-ring Removal.

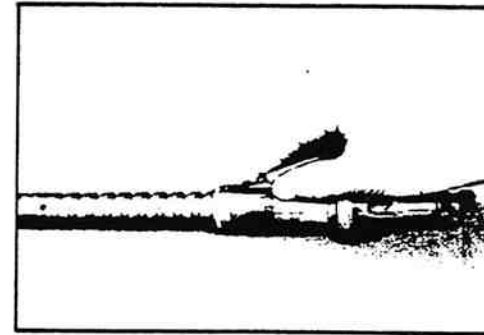


Figure 11-44. Removing Seal Ring.

42. It is not usually required to service the poppet assembly. If required, however, position the rack piston (10) carefully in a vise equipped with soft jaws. Then remove two retaining rings (15) (figure 11-45), two poppet seats (14) (figure 11-46), two poppets (13), nylon spacer rod (12), and spring (11) (figure 11-47).



Figure 11-45. Retaining Ring Removal.

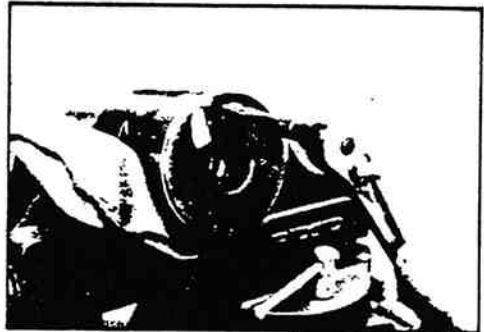


Figure 11-46. Poppet Seal Removal.

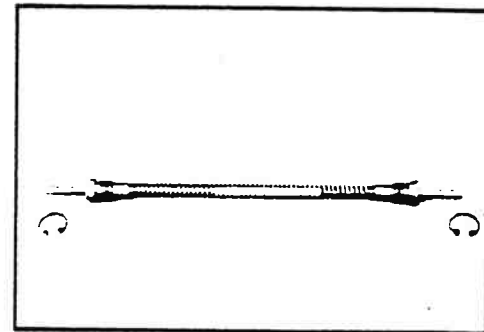


Figure 11-47. Poppets, Rod and Spring.

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INSPECTION

All sealing surfaces and seal cavities must be free from nicks and corrosion. If you detect any nicks or corrosion, you must replace the part to ensure proper sealing. Before you inspect the steering gear, wash all parts in clean, clear solvent and blow dry with compressed air.

1. Inspect rack piston (10) teeth for cracks and wear. If you can detect a step by running your fingernail edge horizontally across the teeth surface, replace the rack piston.

2. Inspect the rack piston ball track grooves (helical shaped) for brinelling (dents) or spalling (flakes) (figure 11-48). If either condition exists, the rack piston (10), valve sleeve (5b), sector

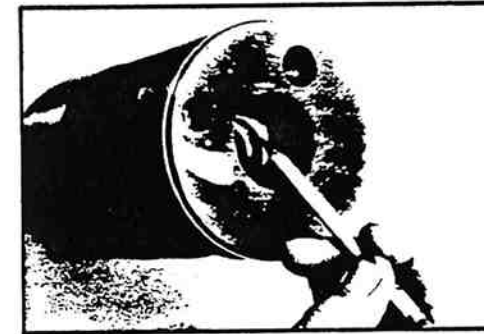


Figure 11-48. Location of Ball Track Grooves in Rack Piston.

shaft (39) and worm shaft (5a) must all be replaced.

3. Inspect the worm shaft (5a) ball track grooves (helical shaped) for brinelling or spalling. See figure 11-49 for an example of how ball sits properly on the track and normal machine marks on the shaft.

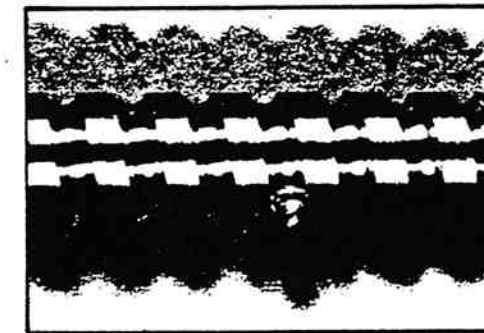


Figure 11-49. Worm Shaft with Ball in Track.

4. Visually inspect the upper input shaft seal area near serrations for nicks, and run your fingernail edge across the sealing surface to detect steps.

NOTE: The input shaft is pinned to the worm shaft by a torsion bar pin, and the worm shaft/input shaft assembly is flexible at this joint. As a result, the assembly may be slightly bent at this joint. This slight bend is normal.

As you inspect the housing cylinder bore, you will notice scoring marks running lengthwise through the bore. This scoring is normal. The scoring in the steering gear cylinder should

not be compared to the scoring you might see in the cylinder bores of an internal combustion engine.

5. Check the housing (1) faces for nicks which would prevent proper sealing. Replace the housing if these nicks are present (figure 11-50).

6. Inspect the housing bearing (2) for brinelling or spalling (figure 11-51). If either condition exists, or if one or more of the rollers is lost, replace the bearing (figure 11-53).



Figure 11-50. Inspect for Nicks.

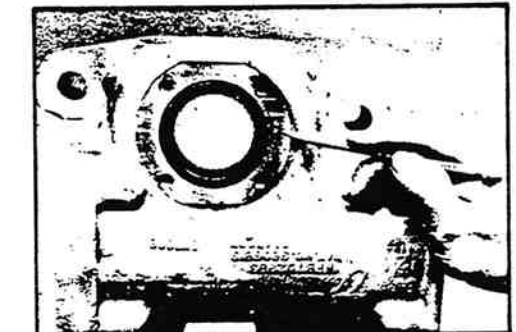


Figure 11-51. Inspect Housing Bearing.

7. Inspect the sector shaft (39) bearing sealing areas for brinelling or spalling. Run your fingernail edge across these areas to detect steps. Inspect for cracks. If any of these conditions exist, replace the sector shaft (figure 11-52).

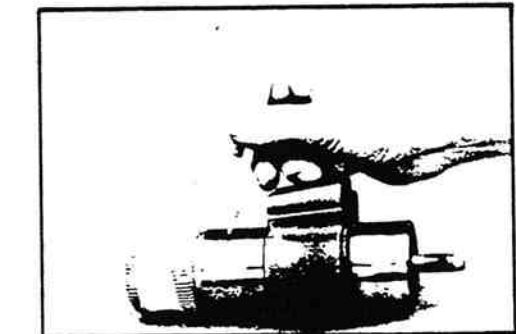


Figure 11-52. Shaft Bearing Seal Area.

8. Inspect the thrust bearing rollers (23) for any deterioration. Inspect the two thrust washers (22) for brinelling, spalling or cracks. Replace any part if you detect these conditions (figure 11-53).

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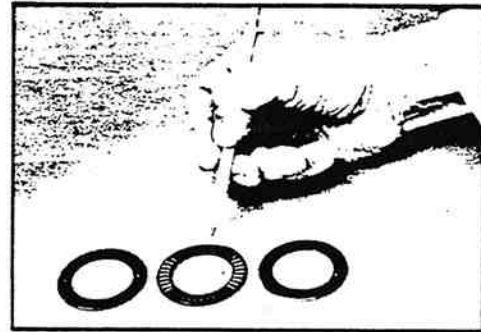


Figure 11-53. Thrust Bearing and Washers.

ASSEMBLY

Once you have completed your inspection and are ready to assemble the gear (including new parts, if necessary), wash all parts again in clean, clear solvent and blow dry. All gaskets, seals and seal rings must be replaced with new ones each time the gear is disassembled. Replace those gasket seals and seal rings with seal kits (figure 11-54).

1. Using seal installation tool J26739, assemble the new worm shaft backup O-ring (8) (figure 11-55), then the new teflon worm shaft seal (9) into the worm shaft ring groove (figure 11-56).

2. Compress the seal with seal compression tool J26740, and set the worm shaft aside for 10 minutes (figure 11-57).

NOTE: Allow for time to ensure that the ring and seal are properly seated when you assemble the worm shaft into the rack piston. If you do not allow for this time, the seal may break when you put the worm shaft into the rack piston.

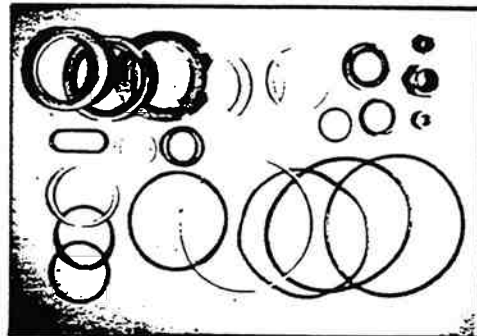


Figure 11-54. Seal Kit Contents.

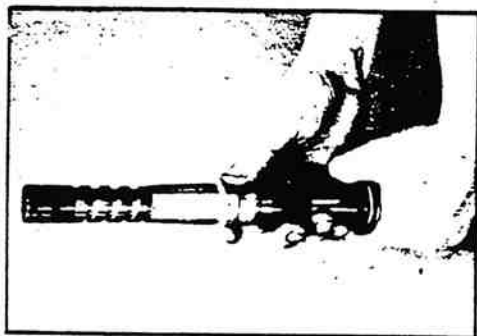


Figure 11-55. Installing O-ring.

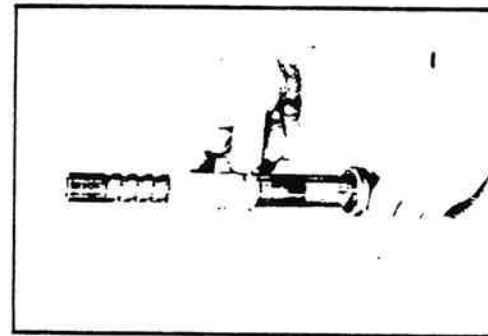


Figure 11-56. Installing Teflon Seal.

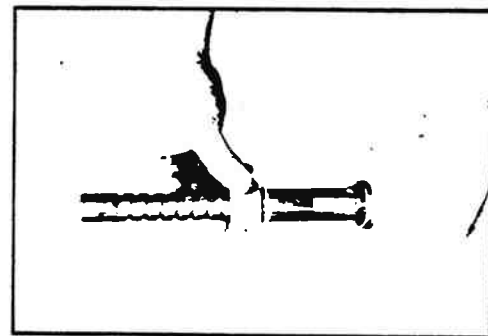


Figure 11-57. Use of Compression Tool.

3. Apply a generous amount of clean wheel bearing grease to the bearing race to retain the bearing rollers. Assemble either 41 or 42 rollers, depending on the type of bearing used (41 rollers - BR970; 42 rollers - BR-970-1). Grease must retain rollers.

CAUTION: Rollers must be in place to ensure proper installation of bearing. If rollers are not in place, bearing race may collapse and fail. The flange may become damaged or broken, causing premature bearing failure. Again, do not mix housing bearing rollers with side cover bearing rollers.

4. If required, press the new housing bearing (2) into the housing from side cover, using bearing mandrel J26743 (figure 11-58). Care must be taken during this procedure to make certain that the housing is square with the press base and that the bearing is not cocked.



Figure 11-58. Installing Housing Bearing.

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5. Install the new rack piston backup O-ring (16) (figure 11-59), the new teflon rack piston seal ring (17) (figure 11-60) into the rack piston (10) ring groove. Do not stretch the rings as you install them. Coat with a liberal amount of grease.

WARNING: During the following step, you should wear eye protection.



Figure 11-59. New O-ring.



Figure 11-60. New Seal Ring.

6. If the poppets were removed, then install into the rack piston (10) one poppet seat (14), one poppet (13), the spring (11), the nylon spacer rod (12), the other poppet (13), and the other poppet seat (14). Tighten both poppet seats to 20-25 ft. lbs. (27.1-33.8 Nm) torque. Install both retaining rings (30) (figures 11-61, 11-62, 11-63).

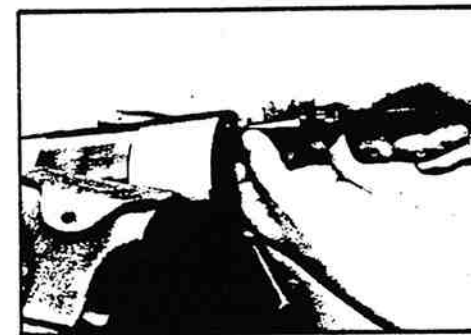


Figure 11-61. Installing Poppet Seat.

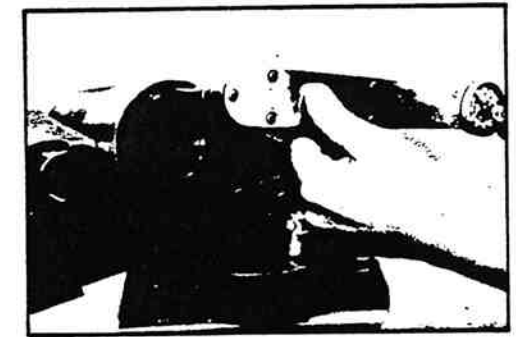


Figure 11-62. Tightening Seat.

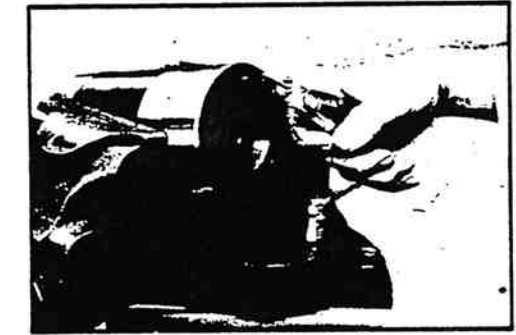


Figure 11-63. Retaining Ring Installation.

7. Grease the seal ring cavity in the rack piston (10) and install the worm shaft (5a) into the rack piston (figure 11-64).

8. Assemble the ball return guides (4c) into the rack piston (10). Make sure that the ball return guides are seated.

WARNING: Make sure the ball return guides stay down in place while you assemble the balls. Failure to hold the guides down may result in a ball being trapped outside the closed loop. A trapped ball can result in a steering lockup.

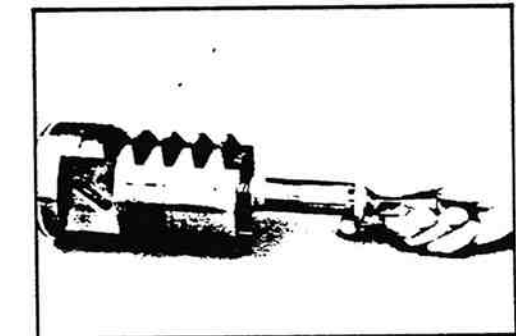


Figure 11-64. Installing Worm Shaft.

9. Assemble 34 balls (18) into the ball return guides (4c) and rack piston (10). Drop the balls through the hole provided in the ball return guides. As you drop the balls, rotate the worm shaft (5a) to pull the balls down into the grooves (figure 11-65).

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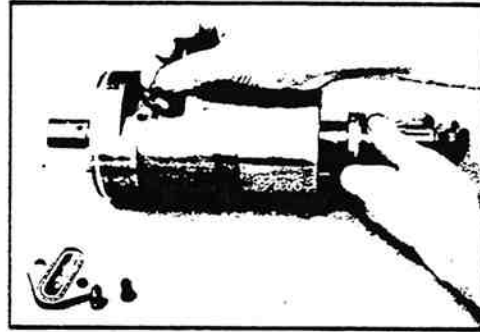


Figure 11-65. Ball Insertion.

10. Grease the ball return guide cap seal (4f) and place it in the ball return guide cap (4e) groove. Assemble the ball return guide cap so that the seal is in full contact with the rack piston (10) surface (figure 11-66). Install the two Allen head bolts (4d) and tighten them to 15-19 ft. lbs. (20-26 Nm) (figure 11-67).

11. Rotate the worm shaft from end of travel to end of travel, to make certain that you have installed the balls properly.

WARNING: If you cannot rotate the shaft, you will have to remove the balls and reassemble them. If you install the gear on a coach with shaft unable to rotate, the gear will not function.

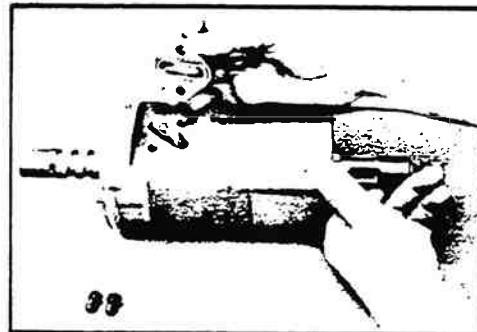


Figure 11-66. Installing Guide Cap Seal.

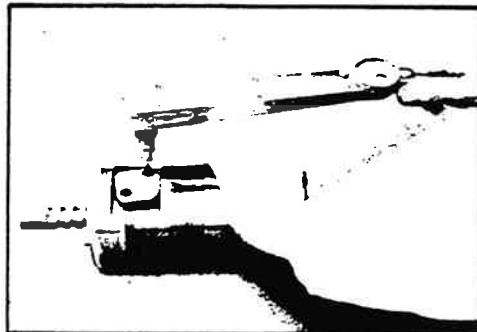


Figure 11-67. Bolt Tightening.

12. Apply a generous amount of clean grease to the Teflon rack piston seal (17) (figure 11-68), and to the housing cylinder bore.



Figure 11-68. Grease Piston Seal.

13. Install the rack piston (10) worm shaft (5a) assembly into the long end of the housing (1) so that the Teflon rack piston seal goes in last (figure 11-69).

CAUTION: Be certain that the seal enters the long end last; otherwise, a large section of the seal will be cut and the coach will have no power steering assist.

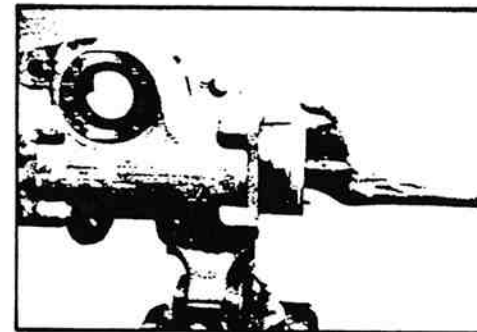


Figure 11-69. Piston and Shaft Assembly Installation.

14. To ease the later assembly of the sector shaft (39), rotate the rack piston worm shaft assembly in the housing so that the rack piston teeth are exposed in the sector shaft cavity of the housing.

15. Assemble the worm shaft adjusting screw jam nut (28) onto the solid (non-slotted) end of the worm shaft preload adjusting screw (27) so that the seal on the jam nut faces the end cover (26). Assemble the poppet valve adjusting screw jam nuts (21) onto the poppet valve adjusting screws (20) in the same manner as described for parts (27) and (28).

16. If the poppet valve adjusting screws are not the same length, assemble the shorter adjusting screw (20) 92.25 in./5.715 cm long) into the end cover (26) a few turns.

WARNING: If the screws are of unequal length, you must install the shorter screw into the end cover. Otherwise, the poppet assembly may break and cause the steering gear to lock up.

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17. Assemble the worm shaft preload adjusting screw (27) into the end cover (26) a few turns. Final adjustments will be made later.

18. Apply clean grease to the end cover O-ring groove on the end cover (26). Install the new end cover O-ring (24) into the end cover O-ring groove (figure 11-70).

NOTE: When installed, the end cover O-ring should extend slightly above the machined surface of the end cover.

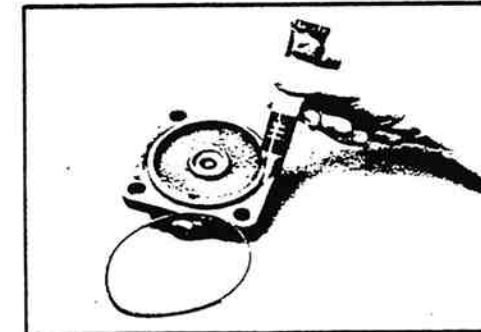


Figure 11-70. Applying Grease to O-ring Groove.

19. Make sure that the rack piston (10) teeth are fully visible in the sector shaft cavity of the housing. This is necessary to ensure proper location of the poppets, and to ensure that the poppet adjusting screw will contact the poppets.

20. Position the end cover (26) so that the poppet adjusting screw (20) is aligned with the end of the poppet (13) (figure 11-71).



Figure 11-71. Positioning End Cover.

21. Install the four end cover bolts (30) and washers (29) and tighten the bolts to 145-155 ft. lbs. (196-210 Nm) torque (figure 11-72).

22. Grease the two new backup O-rings (7) and the two new Teflon seal rings (6). Using seal installation tool J26741, assemble the backup O-rings (figure 11-73), then the Teflon seal rings into the valve sleeve (5b) (figure 11-74).

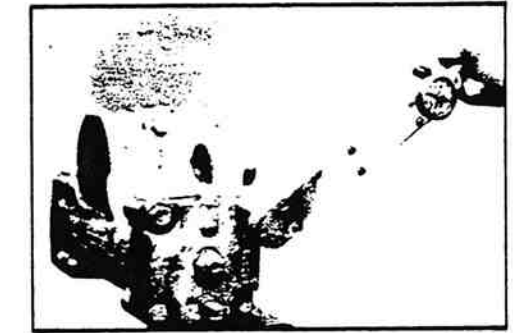


Figure 11-72. Tightening End Cover Bolts.

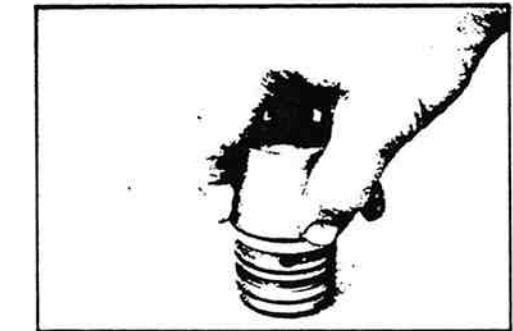


Figure 11-73. Installing O-rings.

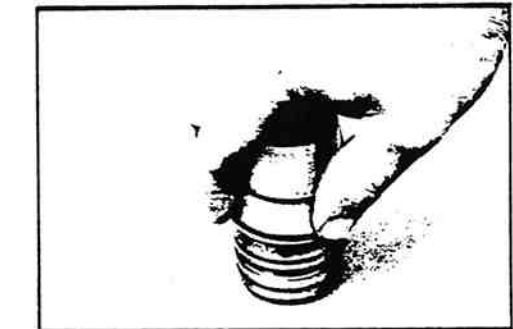


Figure 11-74. Installing Seal Rings.

23. Use compression tool J26742 to compress the Teflon seal rings (figure 11-75). Leave the compression tool in place for 10 minutes.

NOTE: If you do not allow for this compression time, the valve sleeve assembly will be difficult to assemble into the valve housing.

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24. Assemble the poppet valve adjusting screw (20) into the valve housing (19) 4 or 5 turns. Final adjustment will be made later.



Figure 11-75. Compressing Seal Rings.

25. Apply clean grease to the valve housing (19) O-ring groove. Install the new valve housing O-ring (24) into the valve housing O-ring groove (figure 11-76).

NOTE: When installed, the valve housing O-ring should extend slightly above the machined surface of the valve housing.

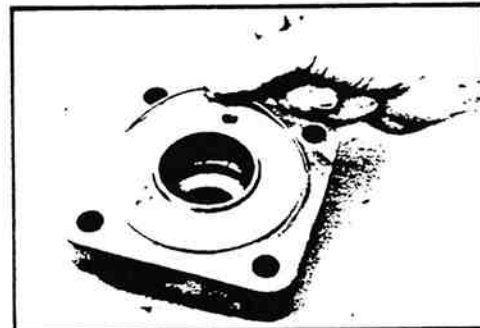


Figure 11-76. O-ring Installation.

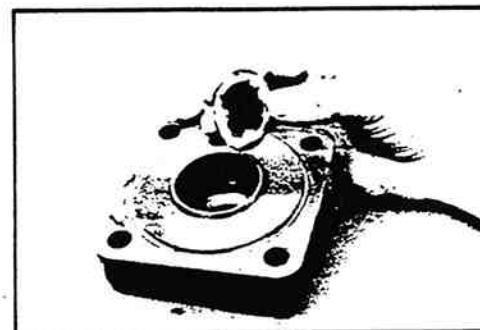


Figure 11-77. Installing Thrust Washer.

26. Apply a generous amount of clean grease to one thrust washer (22). Install the thrust washer into the valve housing (19), making sure to center the thrust washer in the counterbore (figure 11-77).

27. Apply a generous amount of clean grease to the thrust bearing (23). Install the thrust bearing into the valve housing (onto the thrust washer), making sure to center the bearing on the washer (figure 11-78).

WARNING: The thrust washer and thrust bearing must be flat and centered in the counterbore surfaces. Otherwise, the thrust washer could break when you assemble the valve housing into the gear housing (1). A broken washer could cause uncontrollable steering.

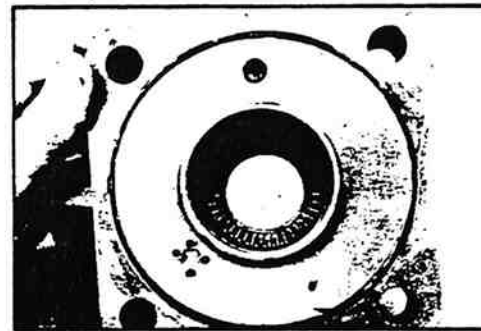


Figure 11-78. Bearing Centered in Counterbore.

28. Remove the compression tool J26742 from the valve sleeve (5b). Apply more grease to the valve sleeve seals, and grease the thrust washer face on the end of the valve sleeve without the drive slots. Place the other thrust washer (22) onto the valve sleeve end without the drive slots (figure 11-79).

WARNING: This thrust washer must be secure on the valve sleeve. If not, it can break and cause uncontrollable steering.

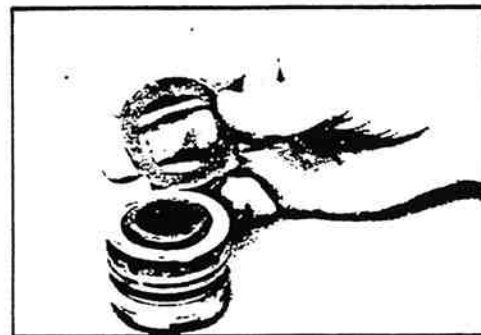


Figure 11-79. Placing Thrust Washer on Valve Sleeve.

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29. Assemble the valve sleeve (5b) with attached thrust washer down into the valve housing (19) (figure 11-80).

30. Measure height of valve sleeve to face of valve housing (figure 11-81); should be .370-.400" (.929-1.01 cm). If not as required, repeat steps 25 thru 33.

WARNING: Do not force valve sleeve down into valve housing. Make sure valve sleeve seal rings are compressed. Misassembly or incorrect measurement may cause the thrust washers or thrust bearing to break during gear operation, which will result in uncontrollable steering.



Figure 11-80. Valve Sleeve into Valve Housing.



Figure 11-81. Checking Height of Valve Sleeve.

31. Position the rack piston (10) so that it is flush with the open end of the gear housing (1). Rotate the worm shaft (5a) until it extends out of the rack piston as far as it will go.

WARNING: Worm shaft and valve sleeve units are manufactured and sold as matched sets. Use only prematched sets for replacement. Never mate an old sleeve with a new worm or an old worm with a new sleeve. To do so may damage the gear or injure the driver, or both during operation.

32. Locate the timing mark on the valve sleeve (5b): a faint, punched mark on the chamfered edge of the valve sleeve (figure 11-82).

33. Locate the scribed timing mark on the worm shaft. (See figure 11-83.) Next, grasp the valve housing/valve sleeve assembly with your thumbs on the valve housing face and your fingers applying pressure to keep the valve sleeve in the valve housing (figure 11-84).

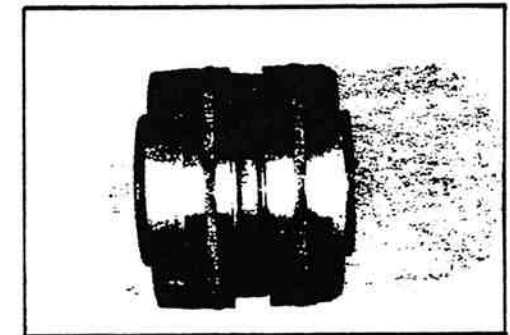


Figure 11-82. Valve Sleeve.

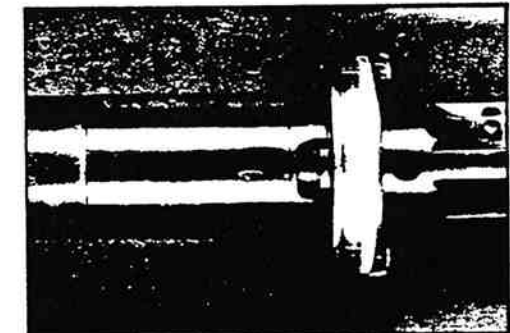


Figure 11-83. Worm Shaft Timing Mark.



Figure 11-84. Positioning Housing/Sleeve Assembly.

34. Align the previously located timing marks and place the valve housing/valve sleeve assembly onto the input shaft end of the worm shaft until the drive lugs are fully engaged (figure 11-85).

NOTE: Valve sleeves are identified and matched to the right or left hand lead of the worm screw. If the screw has a right hand thread (that is, goes into the rack piston when turned clockwise), then the correct valve spool will have the letter "R" stamped between the lands. For a left hand worm lead (which will come out of the rack piston when turned clockwise), the valve spool has no identifying mark between the lands.

WARNING: If an incorrect valve spool is placed on a worm and assembled into the gear, the gear will malfunction by turning the steering wheel with such force that it could injure the driver.

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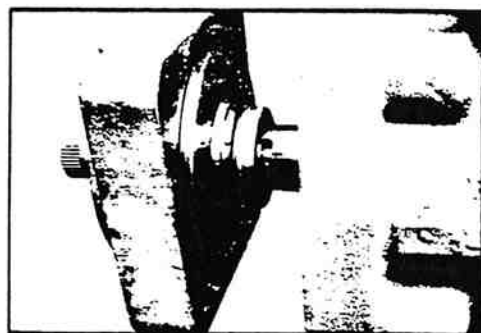


Figure 11-85. Housing and Sleeve Assembled on Worm Shaft.

35. Maintain pressure on the valve end of the valve housing to ensure continued engagement of the drive lugs and thrust bearing package (figure 11-86). While maintaining pressure, rotate the valve housing to align the poppet adjusting screw with poppet in the rack piston. Continuing pressure, rotate the input shaft to bring the valve housing into contact with gear housing face.



Figure 11-86. Installing Valve Housing Assembly.

36. Assemble four valve housing bolts (25) into the housing (1) and tighten to 145-155 ft. lbs. (196-210 Nm) torque (figure 11-87).

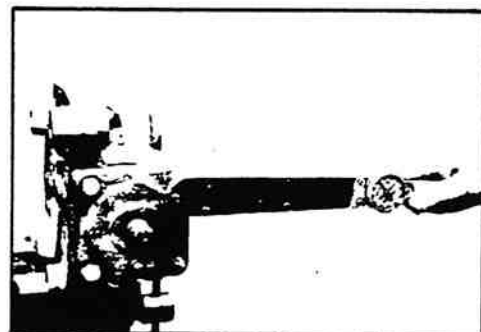


Figure 11-87.

37. Apply a generous amount of clean wheel bearing grease (do not substitute another type of grease) to the bearing race inside the side cover (42).

CAUTION: Use only wheel bearing grease. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use wheel bearing grease could result in premature steering gear failure.

NOTE: You will have 41 or 42 rollers to assemble into the side cover bearing: 41 rollers - BR-970; 42 rollers - BR-970-1. Do not mix these rollers for the side cover with the rollers for the trunnion cover side of the gear housing.

38. Assemble 41 or 42 rollers into the side cover bearing race. Grease must retain rollers (figure 11-88).

39. Assemble the steel backup washer (43), the new Teflon backup washer (44), and the new two-piece side cover seal (45)

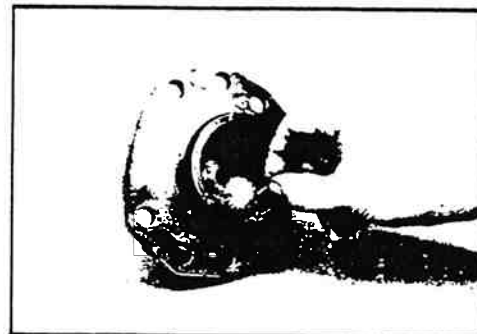


Figure 11-88. Installing Rollers.

into the side cover (42). Assemble two-piece seal so that words "oil side" are visible (figure 11-89).

CAUTION: The words "oil side" must be visible once the seal is in place. Otherwise, the seal will not function, which could result in a loss of power steering assist.



Figure 11-89. Assembling Washers and Seals.

40. Assemble retaining ring (46) into the ring groove in the side cover (figure 11-90).



Figure 11-90. Installing Retaining Ring.

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41. Apply a generous amount of clean grease to the short bearing area of the sector shaft (39), and insert the sector shaft into the side cover (42). Screw the adjusting screw into the side cover until it reaches solid height. Then, back out the adjusting screw one turn, so that the side cover rotates freely on the sector shaft (figure 11-91).

42. Assemble the jam nut (53) onto the adjusting screw (40) a few threads. Final adjustment will be made later.

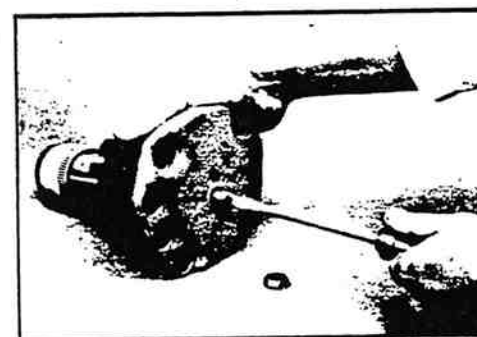


Figure 11-91. Setting Adjusting Screw.

43. Assemble the vent plug (47) into the hole provided on the side cover (42). Press the vent plug in flush with the side cover (figure 11-92).

WARNING: Do not weld or otherwise plug this hole in any permanent manner. This is a safety vent which functions only if the side cover seal fails. If the plug cannot vent, the steering gear may lock up or otherwise malfunction.



Figure 11-92. Installing Vent Plug.

44. Apply clean grease to the new side cover gasket (48) and assemble it onto the side cover (42). There must be enough grease to hold the gasket in place (figure 11-93).

There are four teeth on the rack piston (10) (figure 11-94).

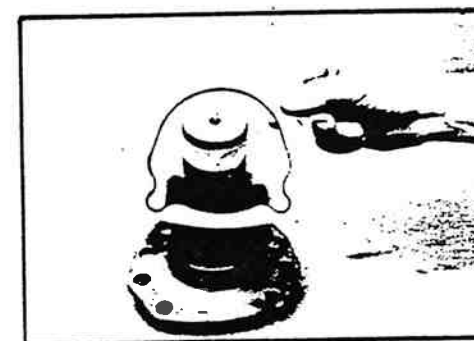


Figure 11-93. Side Cover Gasket.

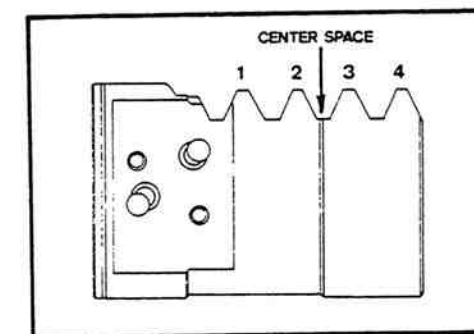


Figure 11-94. Rack Piston Teeth.

45. Position the tooth-space between the second and third teeth in the center of the sector shaft cavity (figure 11-95).

CAUTION: If the rack piston is not centered, the gear travel will be severely limited in one direction of travel, and significant internal damage to the steering gear can occur when the gear is operated.



Figure 11-95. Centering Gear Tooth Space.

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46. Clean off any old tape on the sector shaft (39) serrations. Retape the serrations and bolt groove with one layer of tape. Assemble the sector shaft (39) side cover (42) assembly into the gear housing (1), with the center tooth of the sector shaft engaging the tooth space between the second and third teeth on the rack piston (figures 11-96 and 11-97).

CAUTION: As you place the sector shaft through the housing bearing (2), be careful not to dislodge any of the bearing rollers. Be careful also not to pinch the side cover gasket (48). Should the bearing rollers be dislodged, or the side cover gasket pinched, premature bearing and seal failure may occur, which could result in a loss of power steering assist.



Figure 11-96. Installing Side Cover Assembly.

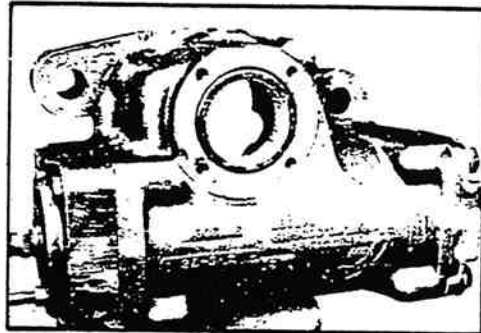


Figure 11-97. Bearing Rollers Installed.

47. Assemble the eight special ring head bolts (52) and tighten them to 150-170 ft. lbs. (203-230 Nm) torque.

48. Place the trunnion cover (49) on a bench to install the new seal package. Start with the Teflon backup washer (50).

49. Assemble the two-piece sector shaft seal (51) so that the words "oil side" are visible.

CAUTION: The words "oil side must be visible. If not, the seal will not function and a loss of power steering assist may occur.

50. Grease the new trunnion cover O-ring (31) and install it into the trunnion cover O-ring groove

51. Before installing the trunnion cover (49) and seal assembly onto the housing (1), visually inspect the housing bearing (24) to ensure that all bearing rollers are properly in place. Then install the trunnion cover (figure 11-98).



Figure 11-98. Installing Trunnion Cover.

52. Install a new dirt and water seal (34). Install four trunnion cover bolts (32) and tighten the bolts to 15-22 ft. lbs. (20-29 Nm) torque (figure 11-99).

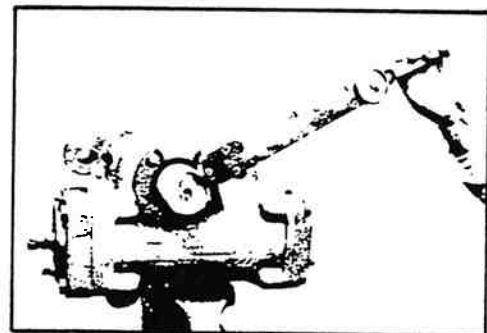


Figure 11-99. Tightening Trunnion Cover Bolts.

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53. Apply clean grease to the input shaft seal assembly (35 & 36) and to the input shaft. Install the new two-piece input seal (35) flat side up and the steel backup washer (36), using the seal driving tool J28490. Install the retaining ring (38) (figures 11-100 and 11-101).

54. Pack the area around the input shaft with clean grease and install the dirt and water seal (37).

This completes assembly. Before installing gear onto coach, make the final adjustments as follows:



Figure 11-100. New Seal and Washer.

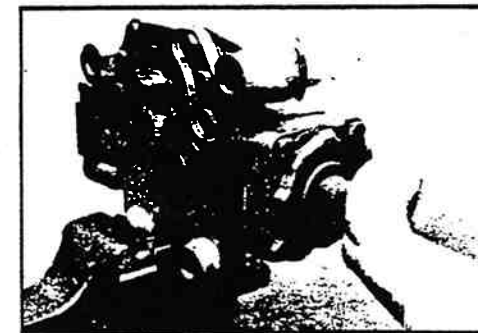


Figure 11-101. Use of Seal Driving Tool.

FINAL ADJUSTMENTS

1. Screw the worm shaft preload adjusting screw (27) finger tight until it contacts the worm shaft (5a).

2. Adjust the sector shaft adjusting screw (40) while rotating the input shaft 90 degrees each direction until the input shaft torque reaches 25-30 in. lbs. (2.825-3.39 Nm) (figure 11-102).

NOTE: Use a 12-point socket and an in. lb. (Nm) torque wrench to rotate the input shaft.

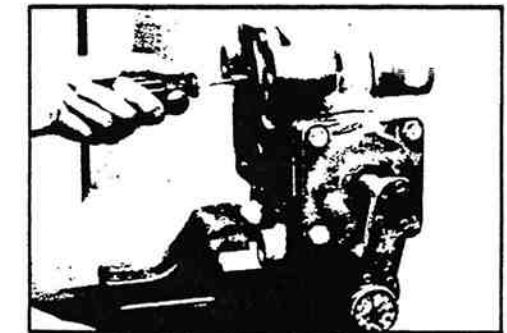


Figure 11-102. Shaft Adjusting Screw.

3. Center the steering gear by aligning the sector shaft timing mark halfway between two trunnion cover bolts. The timing mark will be perpendicular to the center line of the cylinder bore.

4. Back out the sector shaft adjusting screw (40) one turn and note the torque required to rotate the input shaft through 90 degrees each side of center.

5. Move the adjusting screw to provide a rise in torque of 2-4 in. lbs. (.226-452 Nm) at this point within 45 degrees each side of center.

6. After tightening the jam nut (53) to 40-45 ft. lbs. (54.2-60.98 Nm), the torque now required to rotate the input shaft must not exceed 29 in. lbs. (3.28 Nm) at any point in the steering gear travel.

7. Tighten the worm shaft preload adjusting screw (27) to 60-70 in. lbs. (6.78-7.91 Nm) torque, making sure the jam nut (28) does not contact the end cover (26).

8. Tighten the jam nut to 70-80 ft. lbs. (94.85-108.4 Nm), making sure the adjusting screw does not move.

9. Confirm that the torque now required to rotate the input shaft through complete travel does not exceed 50 in. lbs. (5.65 Nm).

NOTE: 55 in. lbs. (6.215 Nm) is allowable if fluid is in the gear.

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INSTALLATION OF STEERING GEAR

1. Align steering gear housing with mounting holes in undercarriage frame. Install bolts with hard steel washers and tighten the $\frac{3}{8}$ " bolt to 475-525 ft. lbs. (644-712 Nm) torque. Tighten the $\frac{3}{4}$ " bolts to 295-325 ft. lbs. (400-441 Nm) torque.
2. Install Pitman arm on gear output shaft with alignment marks aligned. Tighten Pitman arm nut to 310-320 ft. lbs. (420-434 Nm) torque.
3. Bleed air from power steering system, as detailed below.
4. Attach drag link to Pitman arm. Install end clamp bolt and tighten to 60-80 ft. lbs. (81-108 Nm) torque.
5. Connect steering shaft to steering gear actuating shaft. Install clamp bolt with washer and nut. Tighten to 25-30 ft. lbs. (34-41 Nm) torque.
6. Remove protective caps from power steering gear supply and return lines and connect the lines to the gear.
7. Connect height control valve link to mounting bracket. Raise coach to normal ride height and remove the spacers from the axle.
8. Check the fuel oil level in the hollow center axle. Replace any loss that occurred during power steering gear removal. The axle holds two quarts of fuel oil.
9. Fill the power steering reservoir to FULL mark on sight glass. Use oil specified in Lubrication, Section 10.
10. Bleed the hydraulic system as directed under Bleeding Air from System, below.

BLEEDING AIR FROM POWER STEERING SYSTEM

NOTE: This procedure is to be followed any time the hydraulic loop has been opened, depending on what area has been worked on. The time to bleed the system could be considerably less than for a total system purge.

1. Ensure all power steering connections have been made and are properly tightened.

2. Add fluid (10W-40 oil) to reservoir and fill until oil is to bottom of fill spout in reservoir cover.
3. Start engine, but do not operate at higher than idle rpm.
4. At the instant the engine starts, oil level will drop in the reservoir as oil fills the supply line to the power steering gear. Oil must be continually added to ensure pump inlet is not allowed to starve or run dry.
5. When oil level stabilizes within the reservoir, the oil level should be brought to the sight glass level.
6. With the engine at idle speed, the steering wheel should be turned lock to lock at least six times. When all air is removed from the system, air bubbles will no longer surface through the oil in the reservoir. While air bubbles are still surfacing, it indicates that the system is not completely bled. In this case the steering wheel must continue to be cycled lock to lock and the oil level must be constantly monitored and oil replenished.
7. With the system fully bled, fill the reservoir to specified levels. Replace cap on reservoir.



Figure 11-103. Power Steering Pump - Installed.

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POWER STEERING PUMP

The power steering pump is gear driven and mounted on the flywheel housing. Refer to figure 11-103. It is a balanced vane pump with a constant delivery per revolution and a capacity of 4 gallons (15.2 liters) per minute at idle speed. The maximum pump relief pressure is 1,500 psi (10,350 kPa).

REMOVAL AND INSTALLATION

The pump is accessible through the right hand engine compartment door. It is removed by disconnecting the outlet hose and removing the inlet at the rubber hose connecting pump inlet to reservoir outlet. Then remove the two mounting bolts. The mounting flange gasket should be replaced whenever the pump is removed. To install the pump, reverse the above procedure.

DISASSEMBLY

During the disassembly, special attention should be given to identification of parts for proper reassembly. (See figure 11-104).

1. Using a suitable cleaning solvent, thoroughly clean the exterior of the power steering pump to prevent entry of dirt or other foreign matter into the pump during overhaul procedures.
2. Remove the three manifold capscrews (24) and washers (25).
3. Remove manifold (26); remove and discard manifold gasket (10).
4. Remove cover mounting capscrews (22) and separate the cover from the pump body (11).
5. Remove pressure plate spring (18) and pressure plate (17).
6. Remove pump ring (15) locating pins (16), rotor (13) vanes (14) and the two O-rings (7 & 8).

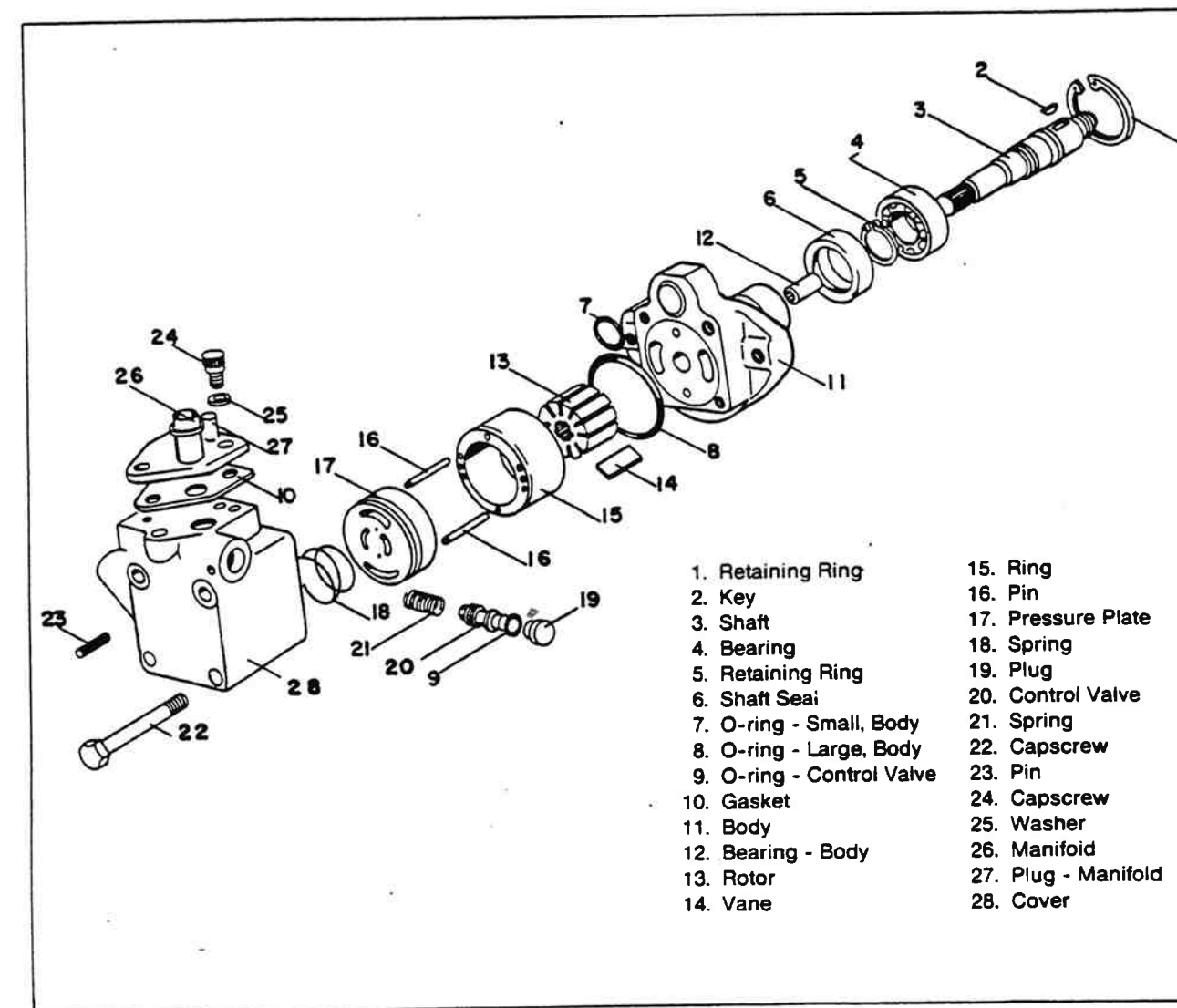


Figure 11-104. Power Steering Pump.

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7. Mount the cover in a vise. Drive out the retaining pin (23) with a suitable punch.

8. Protect the control valve plug (19) and subassembly against falling from the bore. Work the plug (19), control valve (20) and spring (21) from the bore.

NOTE: Access to the control valve plug and control valve subassembly may be gained through the large chamfered hole which leads to the control valve bore from inside the cover.

9. Remove outer retaining ring (1) from the pump body (11).

10. Support the shaft end (3) of the pump body (11) in a 2 inch (50.8 mm) straight pipe coupling, and using an arbor press, remove shaft (3). The shaft assembly should drop through a slot in the press table so that the shaft will not be damaged.

11. Remove inner retaining ring (5) and ball bearing (4) from shaft (3).

12. Press shaft seal (6) from the pump body.

INSPECTION AND REPAIR

1. Wash all parts, except seals, in clean mineral spirits and lay them aside for inspection. Replace all old seals and O-rings at reassembly.

2. Inspect surfaces of ring (15) rotor (13), vanes (14), pressure plate (17) and body (11) which are subject to wear. Light scoring may be removed from the faces of the body or wear plate with crocus cloth (by placing the cloth on a flat surface), medium India stone or by lapping.

3. Check edges of vanes (14) for wear. Vanes must not have excessive play in slots or burrs on edges. Replace if necessary.

4. Check each rotor slot for sticky vanes or wear. Vanes should drop into rotor slots by their own weight when both slot and vane are dry.

5. Insert the control valve (20) in its bore in pump cover. There should be no binding.

6. Check the valve (20) and bore for excessive wear and scoring. Replace if necessary.

7. Wash bearing (4) thoroughly. Inspect and replace if worn or damaged.

8. Replace the shaft seal (6) at each overhaul to prevent oil leakage. Check the drive shaft oil seal diameter for wear and scoring. Do not install a new seal on a shaft which is worn or damaged at the oil seal diameter. Replace the shaft (3) if worn.

9. Stone and polish the sharp edges on the shaft to prevent damage to the seal (6).

10. Stone all mating surfaces of body and cover with a medium India stone to remove all burrs and sharp edges. Re-wash all parts after stoning.

REASSEMBLY

NOTE: Immerse all parts in clean 10W-40 engine oil to facilitate reassembly.

1. Starting with the shaft end, press the inner needle bearing (12) in the pump body (11) using an arbor press.

2. Assemble the retaining ring (5) on the shoulder portion of the shaft (3) and install the shaft in the pump body (11).

3. Press the outer bearing onto the shaft. The edge of the bearing must be 1/64" (.39 mm) below the shaft seal shoulder when assembled. This provides for shaft end play of .010-.015" (.254-.381 mm).

NOTE: Tools for installing bearings can be made from round stock with an outside diameter slightly smaller than that of the bearing and the inside diameter slightly larger than the shaft diameter. Do not score or damage the shaft (3) during this operation.

4. Position the shaft seal (6) on the shaft end of the body (11), being careful not to damage the seal.

5. Using the special tool mentioned above, press seal (6) in until it locates against the shoulder in the pump body (11). This shoulder acts as a positive stop for the seal. Do not overpress as this will result in damage to the seal.

6. Install the locating pins (16) in the pump body (11).

7. Install the ring (15) over the pins (16) according to the correct direction of rotation.

8. Install the rotor (13) with the chamfered edge of the splined hole "in" toward the pump body (11).

9. Install the vanes (14) with their radius edge toward the inner ring contour.

10. Oil the cartridge with clean engine oil and install the pressure plate (17).

11. Install the pressure plate spring (18) and cover (28).

12. Tighten cover screws to 25-30 ft. lbs. (34-40 Nm) torque.

13. Install the pressure compensating spring (21) into the control valve bore.

14. Insert the valve assembly (20) with the hex toward the spring (21).

15. Install plug (19) with the O-ring into the bore and hold it in position while driving in a new retaining pin (23).

16. Install the O-rings (7 & 8) in the pump body (11) and secure the manifold (26) to the pump cover (28) with three screws (24). The copper washers (25) are used on the three screws (24) where the tapped hole enters the oil passage.

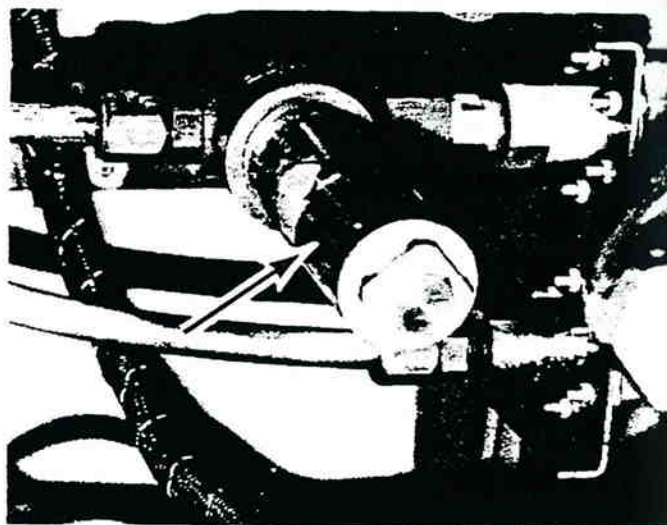


Figure 11-105. Power Steering Filter - Installed.

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POWER STEERING PRESSURE FILTER

The power steering filter is located in the upper right side of the engine compartment (figure 11-105). This is a pressure line filter. At regular intervals or 50,000 miles (80,000 km), the filter should be removed and replaced.

NOTE: This filter should be replaced in conjunction with servicing and replacing the reservoir filter element. The power steering system should be bled at this time.

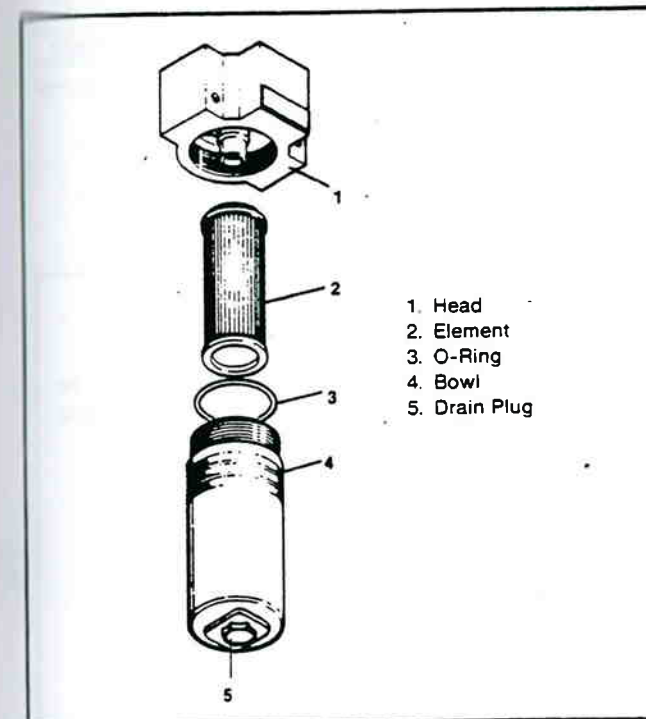


Figure 11-106. Power Steering Filter.

1. Shut down the system and release all pressure in filter line.

2. Unscrew the bowl and lower it vertically to clear the element assembly. See figure 11-106.

3. Remove the element from the filter head by pulling it from the element locator. Discard and replace with new element.

4. Install new element by pushing it onto the locator.

5. It is recommended that the bowl O-ring be replaced before refitting to the housing.

POWER STEERING RESERVOIR AND FILTER

A power steering reservoir, filter and sight gauge (figure 11-107) are located in the upper right hand side of engine compartment. The filter element should be serviced at the same intervals as replacing the power steering pressure filter element, approximately 50,000 miles (80,000 km), depending on operating conditions. When replacing the element refer to figure 11-108.

NOTE: After new element and gaskets are installed, install cover and bolt assembly. Check for leaks after operating system.



Figure 11-107. Power Steering Reservoir and Filter.

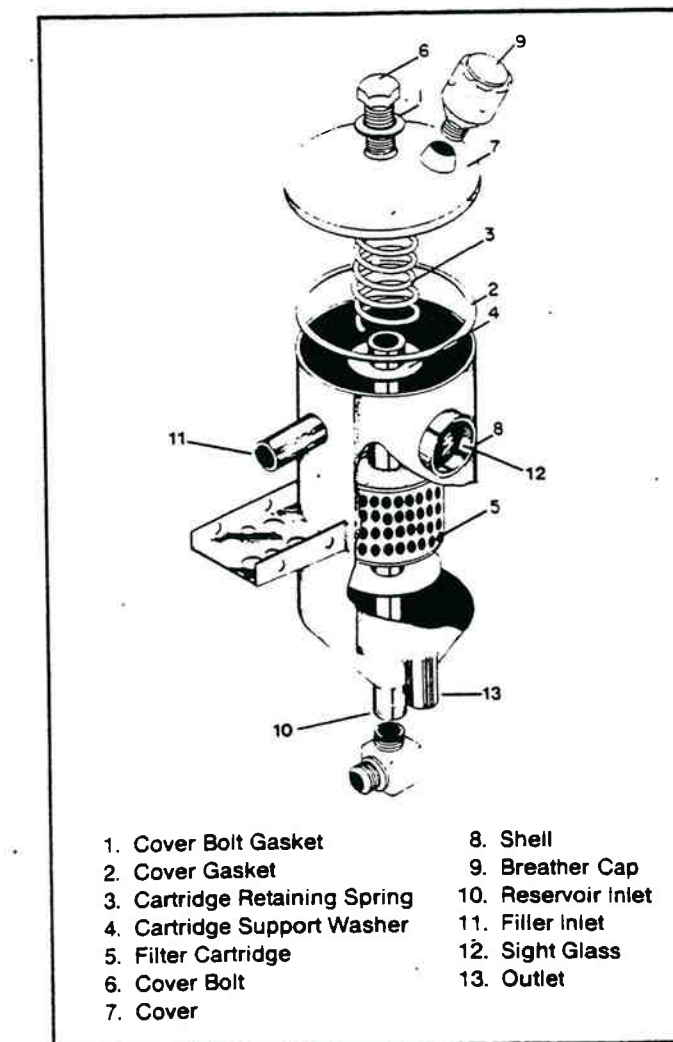


Figure 11-108. Reservoir Filter Parts.

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FILLING POWER STEERING SYSTEM

NOTE: For steps 1 and 2, do not turn the steering wheel. Otherwise, air will enter the system.

1. Fill the reservoir nearly full. See figures 11-107 and 11-109. Crank the engine for 10 seconds without allowing it to start. If the engine does start, shut it off immediately.

2. Check and refill the reservoir as necessary. Perform this procedure three times, each time checking and refilling the reservoir.

CAUTION: Do not allow the fluid to drop significantly or run out of the system. This will allow air into the system.

3. Start the engine and let it idle for two minutes, shut the engine off and check the fluid level in the reservoir.

4. Start the engine. Steer the coach from full left to full right several times.

5. Add fluid to reservoir until it reaches the halfway point in the sight glass.

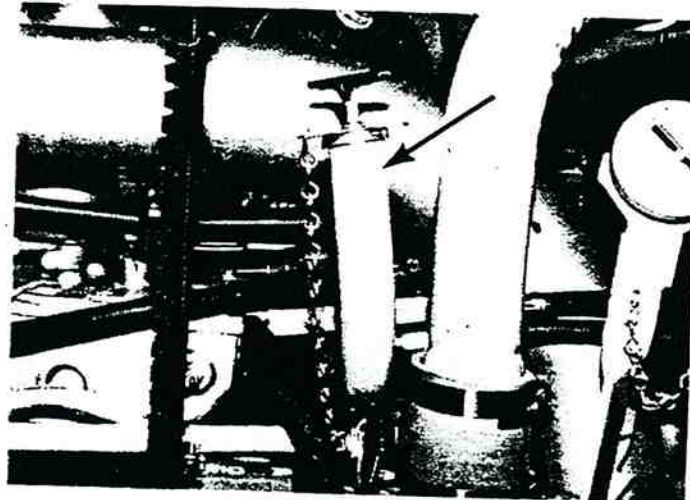


Figure 11-109. Power Steering Reservoir Fill.

SAFETY INSPECTION

It is the manufacturer's recommendation that at major inspections or every 300,000 miles (480,000 km), depending on operating conditions, the front end steering components be Magnaflux or Magnaglo inspected. This also applies when purchasing a used coach.

This recommendation is due to various hazards while coach is in service; extremely rough road surfaces, curbing of tires, or accidents. In some instances at disassembly of steering components, damage may also be caused due to heavy hammering or application of heat.

Important steering parts to be Magnaflux or Magnaglo inspected are the following:

- Pitman Arm
- Drag Link Ends
- All Ball Studs
- Cross Tube End and Steering Arms
- Main Steering Arm
- Lever Shaft (Sector)
- Worm Shaft
- Axle Spindles

Other components being visually inspected that may be doubtful should also be included in the Magnaflux or Magnaglo inspection.

CAUTION: Do not utilize any methods for repair on steering components such as welding, metal plating, etc. Replace with genuine new parts.

DRAG LINK

The steering drag link assembly is a three-piece type. It consists of a long tube and two stud ends, one of which joins to the steering Pitman arm and one that joins to the main steering arm at the front axle. Clamps at both ends are used for positive adjustment and locking.

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REMOVAL AND INSPECTION

1. Refer to figure 11-110. Remove the cotter pins and castle nuts from the drag link ends.

2. Remove the drag link.

3. Loosen the clamps and unscrew the ends from the drag link rod.

4. Carefully inspect all parts and replace any that are worn or damaged. Magnaflux or Magnaglo inspection procedure is recommended.

5. Clean components with a suitable cleaning fluid.

6. Lubricate all studs and tapers. Reassemble them in reverse order of disassembly. Tighten clamp bolts and the castle nuts at each end of drag link to torques shown in the torque specification illustration at the end of this section.

NOTE: When installing the clamps on the drag link ends, the open side of the clamps must be turned downward and the clamp bolts inserted as shown in figure 11-117.

INSPECTION PROCEDURE FOR DRAG LINK/PITMAN ARM CONNECTION

1. Remove the cotter pin and loosen the castellated nut fastening the steering drag link and back off three full turns.

2. Check for looseness in the tapered connection by applying hand pressure against the drag link in a direction away from the pitman arm. DO NOT hit the ball stud or drag link with a hammer, pry bar or other object in an attempt to unseat the taper. If the taper connection is not properly seated, hand pressure alone will be sufficient to separate the parts.

3. If the tapered connection remains together, reinstall the castellated nut and torque to 230-260 ft. lbs. (311-353 Nm). Install a NEW cotter pin (1/8" x 1 1/2"). Do not back off the nut to insert the cotter pin into the ball stud cotter hole. If necessary, tighten the nut further to the next closest slot, to install the cotter pin.

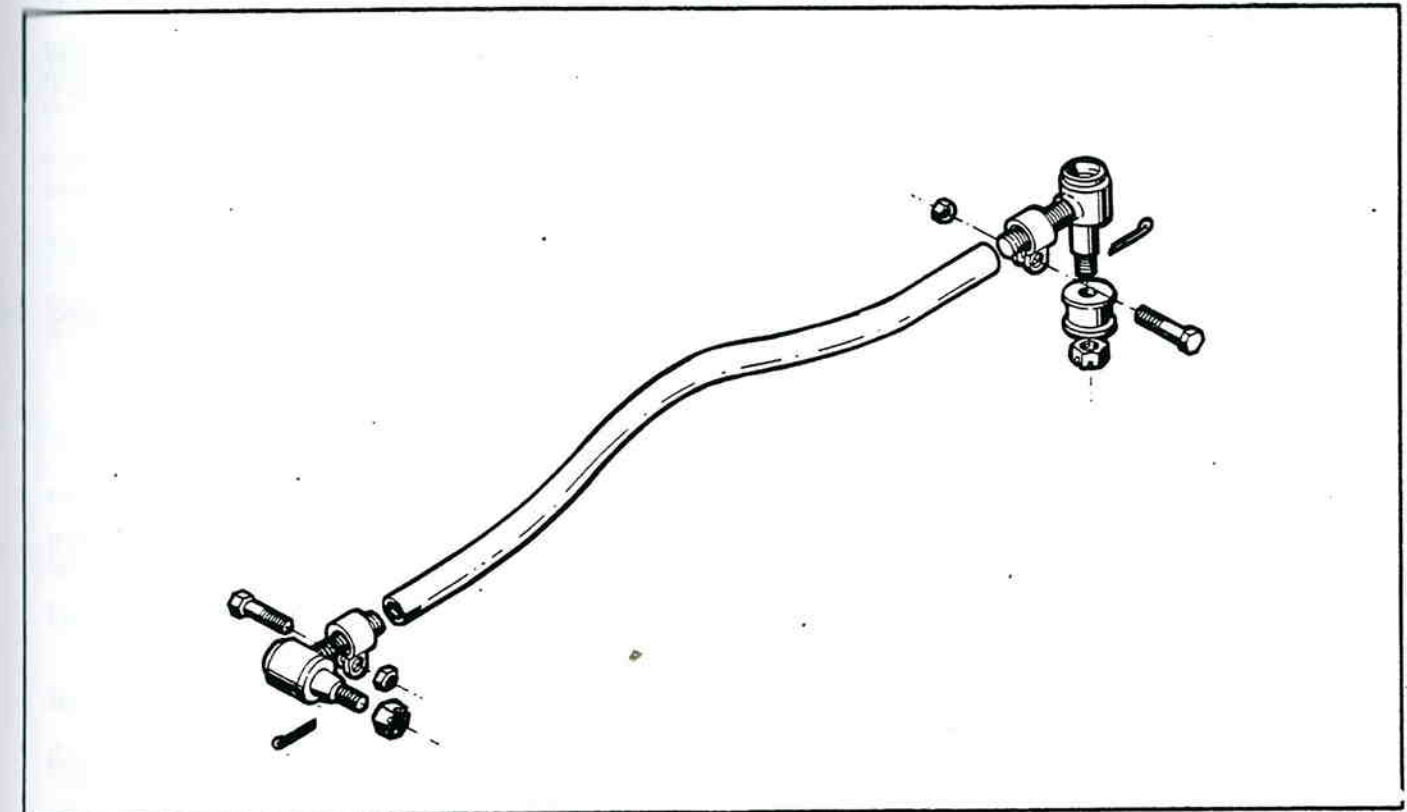


Figure 11-110. Drag Link.

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TROUBLESHOOTING

TROUBLE	REMEDY
PUMP NOT DELIVERING FLUID Drive in wrong direction of rotation. Pump driveshaft disengaged or sheared.	<ol style="list-style-type: none"> 1. Check direction of pump shaft rotation. 2. Remove pump; determine damage to cartridge parts (see disassembly instructions); replace sheared shaft and damaged parts. Refer to Power Steering Pump.
Flow control valve stuck open.	<ol style="list-style-type: none"> 1. Disassemble pump and wash control valve in a clean solvent. 2. Return valve to its bore and slide it back and forth. No stickiness in movement should occur. If a gritty feeling is noted on the valve O.D., it may be polished with crocus cloth. Avoid removal of excess material or round off of valve edges during this operation. Do not attempt to polish the valve bore. 3. Wash all parts before reassembly of pump. 4. Flush entire system thoroughly and fill with clean oil as recommended.
Vane(s) stuck in rotor slots.	<ol style="list-style-type: none"> 1. Disassemble pump, examine rotor slots for dirt, grime or small metal chips. 2. Clean rotor and vanes in a good grade solvent (mineral spirits or kerosene); reassemble parts and check for free vane movement.
Fluid viscosity too heavy to prime. Pump intake partially blocked.	<ol style="list-style-type: none"> 1. Use fluid of the viscosity as recommended. 2. Drain system completely; flush to clear pump passages. 3. Flush and refill system with clean oil as recommended.
Air vent for oil reservoir clogged, or dirty strainer.	<ol style="list-style-type: none"> 1. Remove filler cap and clean air vent slot. 2. Check filter or strainer in tank for clogged condition. 3. Drain, flush and add clean oil to system if strainer was clogged.
PUMP MAKING NOISE Restricted or partially clogged intake line or clogged filter.	<p>Pump must receive intake oil freely or cavitation will result.</p> <ol style="list-style-type: none"> 1. Drain system, and clean intake line and strainers. 2. Add new oil and strain by recommended procedures.
Air leak at pump intake piping joints or pump shaft seal.	<ol style="list-style-type: none"> 1. Test by pouring oil on joints and around drive shaft. 2. Listen for change in operation. 3. Tighten joints affected and replace pump drive shaft seal according to service instructions; refer to Power Steering Pump.
Coupling misalignment.	Realign and replace oil seal and bearings if damaged by shaft misalignment.
Reservoir or manifold seal leakage. Leakage between manifold or reservoir at replenishing hole due to O-ring damage.	<ol style="list-style-type: none"> 1. The reservoir inlet-tube-to-pump-cover O-ring should be carefully examined for damage such as cuts, nicks or dirt. 2. Replace as necessary. Refer to Power Steering Reservoir and Filter.
HARD STEERING EITHER WHILE PARKING OR EXISTING ALL THE TIME. Insufficient pump pressure.	<ol style="list-style-type: none"> 1. Check pump pressure with gauge. 2. If sufficient, check for cause — sticky relief valve in pump or flow control.
Defective pump.	Repair or replace defective parts.
Sticky control valve in pump or flow control which prevents pressure build-up.	Replace valve. (May require total pump replacement.) Refer to Power Steering Pump.
"LUMPY" FEELING (SPOTS OF HARD STEERING) Delayed power application.	Check and eliminate excessive free play in steering linkage.

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TROUBLE	REMEDY
Air in steering system.	Bleed system as per previous instruction.
Loose joints or linkage.	Tighten where necessary.
Insufficient oil flow.	<ol style="list-style-type: none"> 1. Check for damaged hoses, weak or sticking valve spring, or worn pump parts. 2. Repair or replace as necessary.
Low oil supply.	Check level and refill.
HARD STEERING ACCOMPANIED BY ABNORMAL NOISE Air in system.	Bleed as per instructions in Bleeding Air from Power Steering System.
HARD STEERING ACCOMPANIED BY ABNORMAL NOISE Pump malfunction.	See Power Steering Pump, Inspection and Repair.
Low oil supply	See Power Steering Pump, Inspection and Repair.
NO RECOVERY FROM TURN TO STRAIGHT AHEAD Insufficient caster.	Increase caster; refer to Front Axle Specifications Chart, Section 1.
Tight ball socket connections and other linkage connections.	Loosen connections but keep them snug.
Tight front axle spindles.	Adjust linkage; refer to Section 1.
Spool in steering gear valve sticking. (Prevents centering of valve.)	<ol style="list-style-type: none"> 1. Disassemble valve and inspect for sticking. 2. Clean. 3. Reassemble valve or replace and reinstall on gear. See HFB70 Integral Steering Gear.
Tire pressure low.	Check pressure and inflate tires.
Front end out of alignment.	Align front end; refer to Section 1.
Steering column binding.	Eliminate bind; refer to Steering Column.
Pump flow insufficient.	Check pump pressure with gauge. If insufficient check for cause and repair pump and/or lines; refer to Power Steering Pump.
Steering gear improperly adjusted.	Adjust to specifications.
SHIMMY Loose ball socket connections or other linkage connections.	Tighten; see Section 1.
Wheels out of balance.	Balance.
Wheel bearings improperly adjusted or worn.	Check bearings; replace if necessary.
Excessive caster.	Correct and have front alignment checked to specifications.
EXTERNAL OIL LEAKAGE	<p>Finding location of leak may be difficult, as oil may "run" away from leak point on the gear of chassis.</p> <ol style="list-style-type: none"> 1. Check all fittings, clamps, hoses, and pump. 2. Repair or replace any possible causes of leakage.

