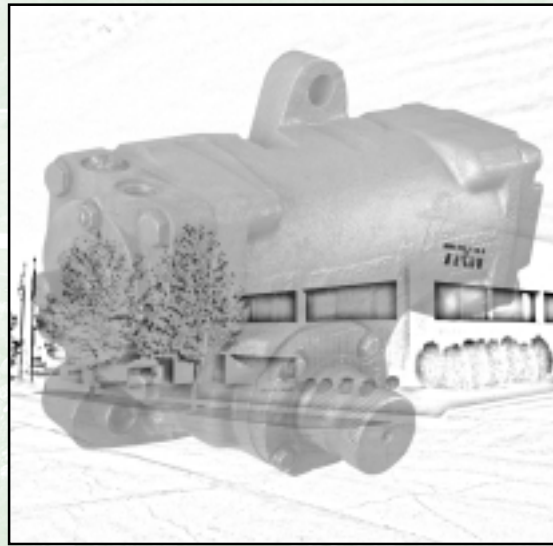


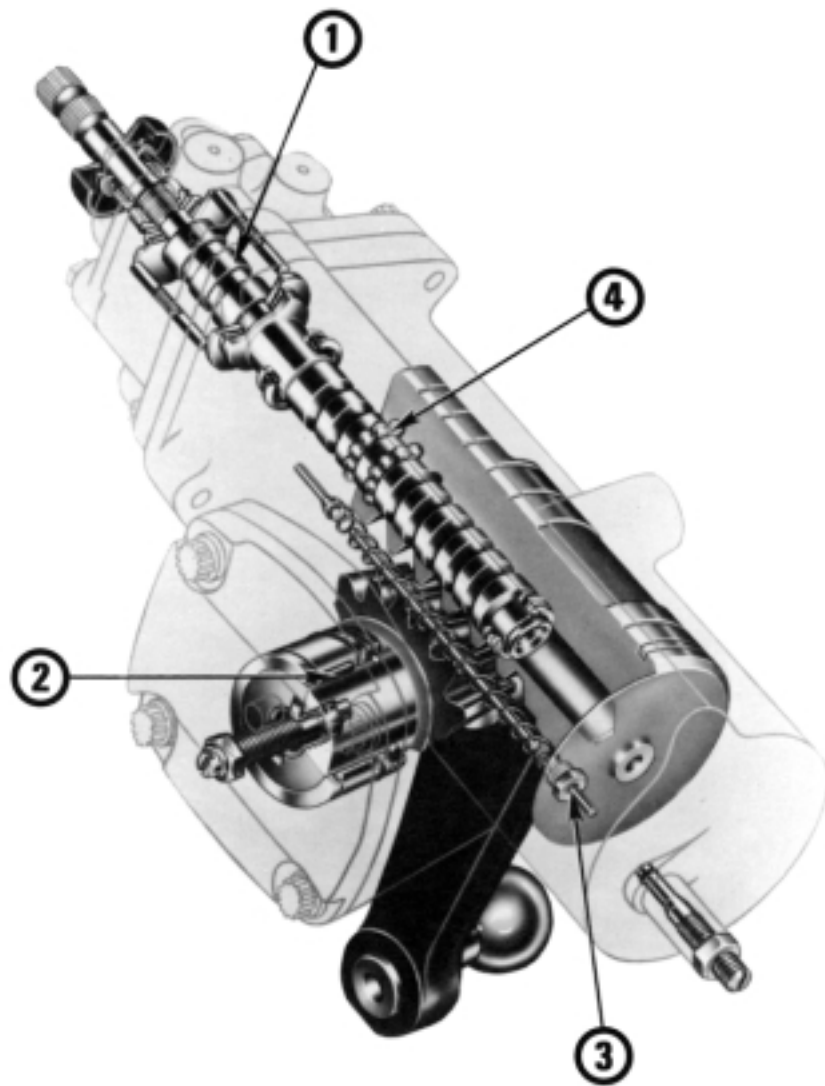
# HF Steering Gear Service Manual

HF54 SERIES



# HF54 Integral Hydraulic Power Steering Gear

This steering gear was specifically designed for motor trucks. Our design experience with previous models of hydraulic power steering gears have been incorporated into this product.



## Design Features

1. **Preloaded Linear Spool Valve**—This device provides responsive steering control
  2. **Precision Roller Bearings**—Allow the steering gear to operate with high efficiency and reversibility
  3. **Unloading Valves**—Furnish power steering pump protection and reduce pressure to unload steering linkage at the ends of steering gear travel
  4. **Recirculating Balls**—Combines high mechanical efficiency with smooth operation
- **High Temperature Seals**—These specially developed seals may be operated intermittently at 250°F (121.1°C)
  - **Manual Steering Capability**—Provides for steering control in the event of hydraulic failure
  - **Auxiliary Porting Available**—For auxiliary cylinder control
  - **Seal Protectors**—Provide protection from harsh environment

## Definitions

**NOTE:** A NOTE gives key information to make a procedure easier or quicker to follow.

**CAUTION:** A CAUTION refers to those procedures that must be followed to avoid damage to a steering component or the gear.

**WARNING:** A WARNING REFERS TO THOSE PROCEDURES THAT MUST BE FOLLOWED FOR THE SAFETY OF THE DRIVER AND THE PERSON INSPECTING OR REPAIRING THE GEAR.

The product represented herein is protected by United States patent No. 3, 047, 087

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**WARNING: ALL STEERING MECHANISMS ARE LIFE AND LIMB ITEMS. AS SUCH, IT IS IMPERATIVE THAT THE INSTRUCTIONS IN THIS BOOKLET ARE FOLLOWED TO THE LETTER. FAILURE TO OBSERVE THE PROCEDURES SET OUT IN THIS PAMPHLET MAY RESULT IN LOSS OF STEERING.**

## **Introduction**

### **Service Manual for Model HF54**

This service manual has one purpose: to guide you in maintaining, troubleshooting and servicing the HF54 Hydrapower™ integral power steering gear.

Material in this manual is organized so you can work on the HF54 and get results without wasting time or being confused. To get these results, you should review the contents of this manual before you begin any work on the HF54.

The section of this manual on General Design and Operation, treats the major parts of the HF54 and explains how they function together. The knowledge you acquire from reviewing this section should assist you in solving your steering problem.

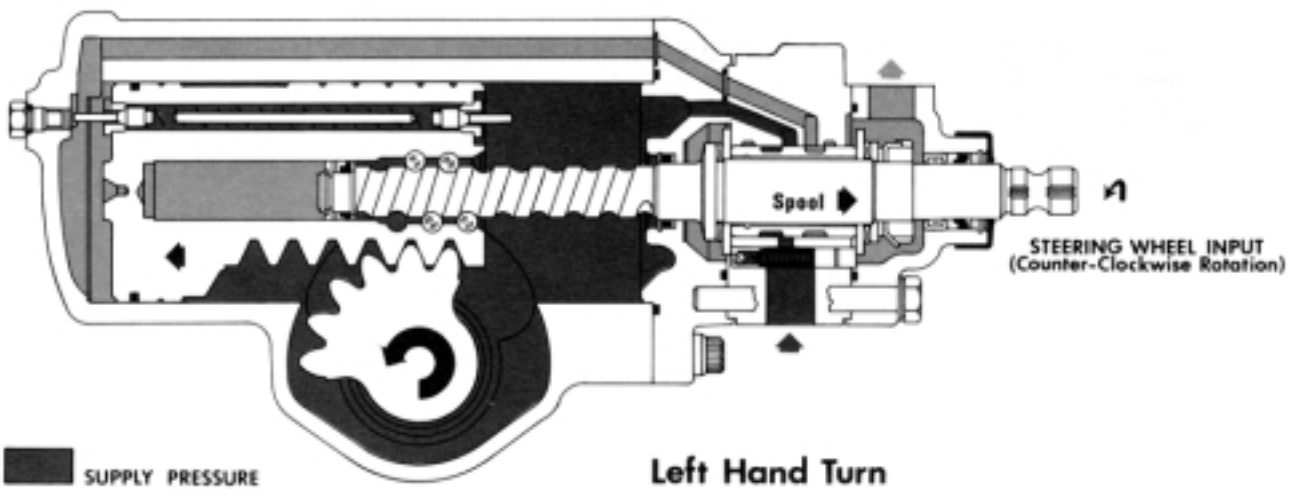
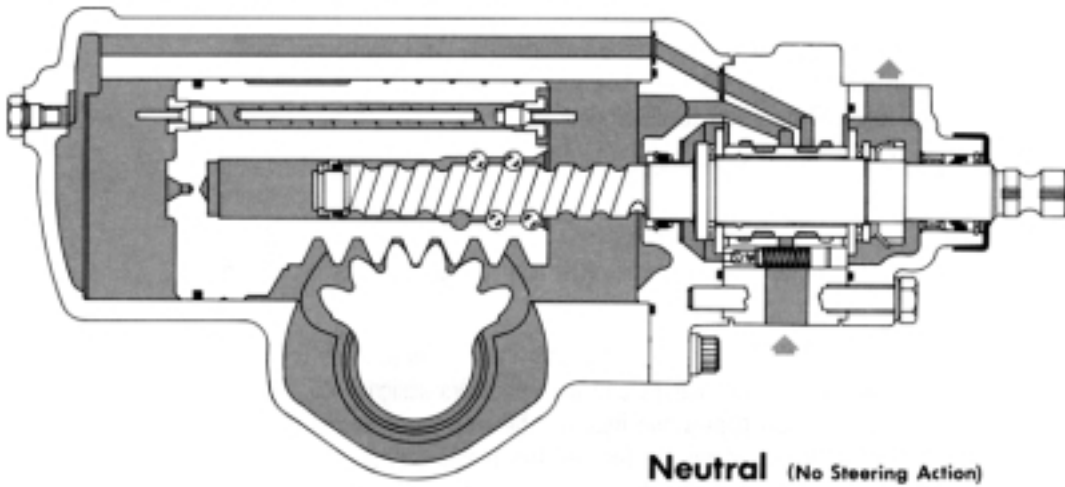
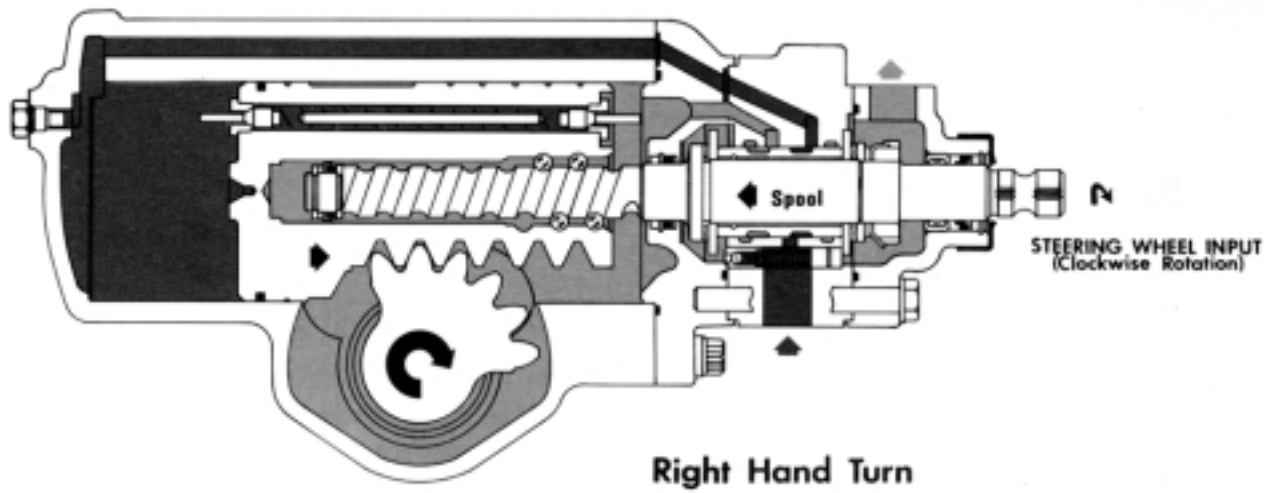
This manual also contains troubleshooting information and checklists. With them, you can diagnose a steering problem without removing the HF54 from the vehicle. If you must service the HF54, the checklists will help you to determine where the problem may be.

The three-column format of the Repairs, Adjustments, Disassembly, Inspection and Assembly sections will make it easier for you to service the HF54. Column 1 gives a brief key for each procedure. Column 2 explains in detail the procedure you should follow. Column 3 illustrates this procedure with photographs. Pay special attention to the notes, cautions and warnings.

A foldout page with the same typical HF54 exploded assembly view on both sides is provided in this manual. The component part names and item numbers assigned on this exploded assembly view correspond with names and item numbers (in parentheses) used in the disassembly, assembly and other procedures set forth in this manual. When this exploded assembly view page is folded out, you can easily identify components and locate their relative position on the exploded assembly view as you follow the disassembly, assembly and other procedures.

As you gain experience in servicing the HF54 you may find that some information in this manual could be clearer and more complete. If so, let us know about it. Don't try to second guess the manual; if you are stuck, contact us. Servicing the HF54 should be a safe and productive procedure.

# HF54 OIL FLOW ILLUSTRATION



■ SUPPLY PRESSURE  
■ RETURN OIL FLOW

# Valve Hydraulic Fluid Flow Illustration

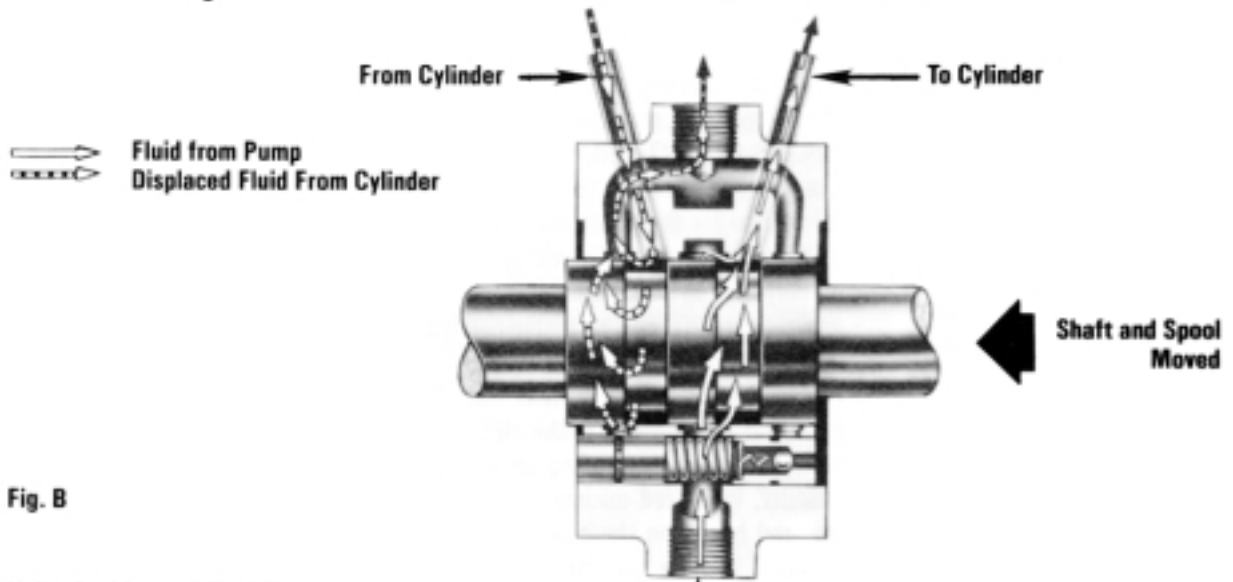


Fig. B

Valve Position and Fluid Flow For Right Turning

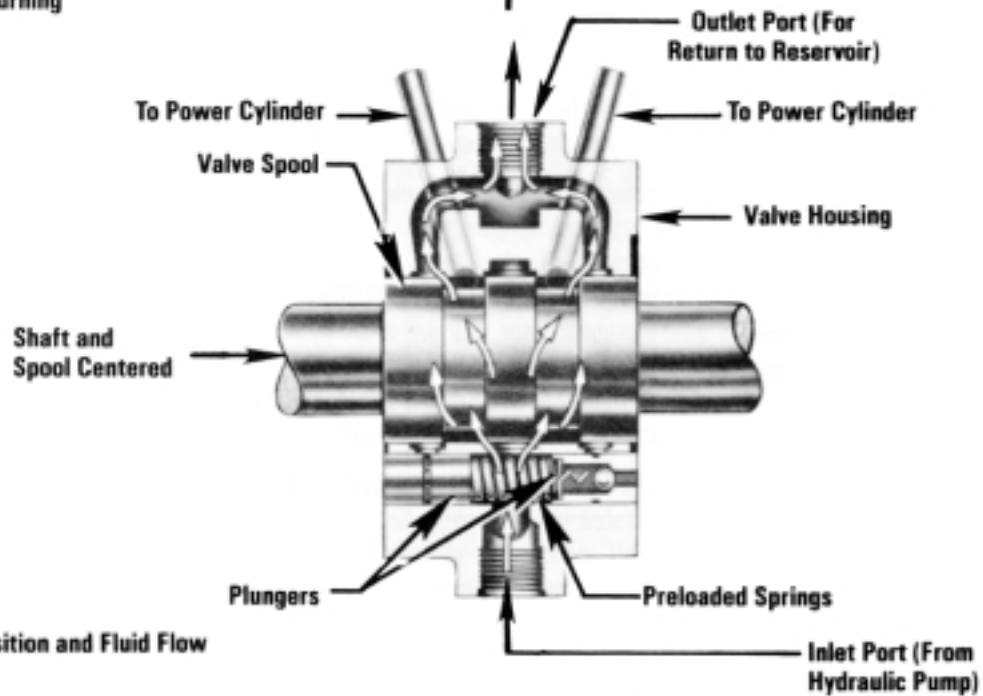


Fig. A

Neutral Valve Position and Fluid Flow

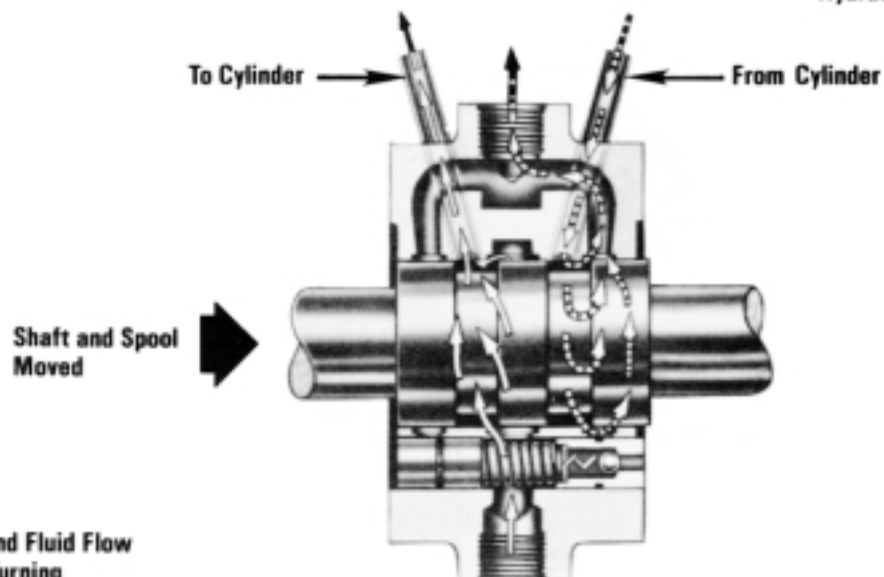


Fig. C

Valve Position and Fluid Flow For Left Turning

# HF54: General Design and Operation

## Design

### Integral Power Steering

The HF54 power steering gear is one of the Ross family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear box contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

### Linear Control Valve

The linear control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute—gpm or Liters/Min.) directed to a cylinder cavity.

The pressure (measured in pounds per square inch—psi or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the cylinder cavity at the proper flow rate and pressure.

### Pressure Means Work, Flow Means Speed

The higher pressure a gear can withstand, the more work it can perform. The HF54 can steer a vehicle with a front-end weight rating of about 7,000 pounds (3175 Kg) through a turn at low vehicle speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear in one minute. For the HF54,

maximum operating pressure is 1500 psi (103.4 bar). The absolute maximum flow rate is 6 GPM (23 liters/min.). The vehicle manufacturer's specifications must be referred to for the maximum flow rate (GPM or liters/min.) as it will be lower on particular HF54 steering gear applications. **NOTE: The recommended minimum flow at 1½ hand wheel turns/second must be no less than 2.5 gpm (9.6 Liters/Min.). If the HF54 steering gear is controlling an auxiliary cylinder, increased minimum flow is required based on the size of the auxiliary cylinder and the vehicle's steering geometry.**

## Operation

### What Happens During a Steering Maneuver

When the driver turns the steering wheel, he transmits rotational force from the steering wheel to the steering gear worm (input) shaft. In response to this rotational force, the worm shaft, acting through the recirculating mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, an axial movement is then transmitted to the worm shaft & valve spool, overcoming the hydraulic & spring forces that center the control valve, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston

axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

### Shock Loads to the Gear

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft, to the rack piston, and onto the worm shaft. The internal geometry 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 objectionable kickback at the steering wheel.

### Unloading (Poppet) Valves

The HF54 gears are equipped with two unloading valves, one at each end of the rack piston travel. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage.

### Bleed System

Some HF54 gears which are mounted with the output shaft above the rack piston bore are equipped with a manual bleed screw.

The procedure for servicing the manual bleed screw is described under "Filling and Air Bleeding" (page 50) in this manual.



# Troubleshooting Information

## Preliminary Checks

When a customer comes to you with a problem related to his truck's steering, you can save a lot of time and work if you first verify the problem. Make sure you're both talking the same language about the same problem. If he says the truck's hard to steer, find out exactly what he means. Is it hard steering into a right or left turn? Only when turning the steering wheel while the truck is sitting still? Is there only intermittent power steering? Or is there no power assist at all?

If at all possible, and if it's safe to do so, test drive the truck. If you're not familiar with the rig, let the customer drive it while you sit beside him. Take hold of the wheel while he drives to get a feel for the problem he's talking about. Since most of his driving will be with his truck hauling a load, arrange for a load if one is required to reproduce the steering problem.

Once you've determined the problem and its symptoms, don't jump right in to tear the steering gear or pump apart. In most cases, in fact, the gear should be the last component you check. There are many other components in the steering system that could be causing the problem (see FIG. 1). These you should check first.

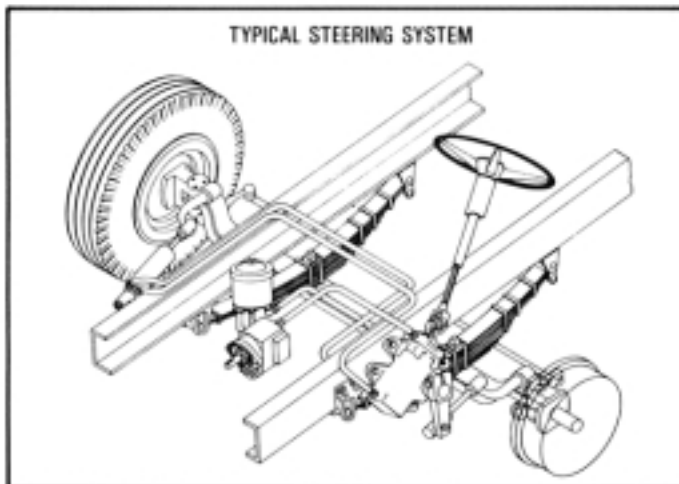


Figure 1

Begin, then, by checking the steered wheels: make sure that the tires are at correct pressure and equal all around, that they are properly sized, and that they are not worn or damaged.

Next, have the front-end alignment checked and look for abnormal looseness or tightness in the steering linkage, ball joints, and king pins.

A service replacement hose or fluid line may be misrouted or may be too small in diameter, or it may be restricted in some other way. Reroute any hose that is kinked or bent sharply. Replace any hoses that are not the same as original equipment.

Continue by checking the power steering fluid reservoir to make sure that oil is up to the correct level. Also, check the pump drive belt, if one is used, to see if it is slipping. The belt may be tight, but it may also be glazed, and a slipping belt doesn't always squeal. If you adjust the belt, check the specifications.

These are just some of the checks you should make before you turn to the steering gear or pump. The Troubleshooting Guide on pages 9 thru 11 explains what to diagnose for a particular steering problem. Match the trouble symptom against the chart and follow the recommended troubleshooting sequence. Doing so will most likely save you time and may prevent unnecessary repairs and costs.

## Hydraulic Tests

If the checks described above all prove satisfactory, it is possible that the cause of the steering problem can be traced to a lack of pressure or insufficient flow. In this case, you may have to do more detailed troubleshooting that involves conducting hydraulic tests.

## Preparation for Hydraulic Tests

To conduct the following hydraulic tests, first install a flow meter, pressure gage and load (shut off) valve in the fluid supply line to the steering gear, as indicated by the instructions that come with the flow meter. Steering system analyzers are available with the 3 units integral. Place a thermometer in the reservoir (FIG. 2). You must use a flow meter, and it is recommended that you use a thermometer, if you are to troubleshoot the hydraulic system accurately.

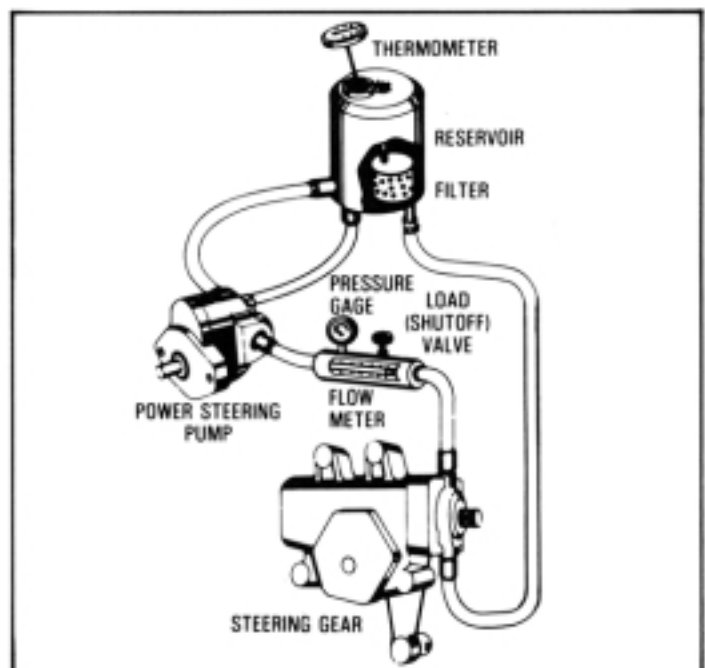


Figure 2

Start the engine and warm the hydraulic system up by partially closing the load valve until the pressure gage reads 1000 psi (69.0 Bar). When the fluid temperature, as indicated on the thermometer, reaches between 125°F (51.7°C) and 135°F (57.2°C), open the load valve. The system is warmed up, and you can conduct the tests.

**CAUTION:** Do not close the load valve completely and leave it closed, or you may damage the pump. At no time allow fluid temperature to exceed 180°F (82.2°C). Run all the tests at the prescribed temperature range of 125°F (51.7°C)-135°F (57.2°C).

### Power Steering Pump Pressure Test

With the engine idling, close the load valve and read the pressure gage. If the pressure reads below the minimum specified by the pump manufacturer, repair or replace the pump.

**CAUTION:** Do not keep the load valve closed for longer than 5 seconds to avoid damaging the pump. Closing the load valve causes the pump to operate at relief pressure and the fluid temperature to increase rapidly. Allow fluid to cool to between 125°F (51.7°C) and 135°F (57.2°C) before you resume with the other tests.

### Power Steering Pump Flow Test

**WARNING:** MAXIMUM FLOW RATE FOR THE PARTICULAR HF54 STEERING GEAR SYSTEM AS SPECIFIED BY THE VEHICLE MANUFACTURER MUST NOT BE EXCEEDED. EXCESSIVE FLOW CAN CAUSE DAMAGE TO INTERNAL PARTS OF THE STEERING GEAR, WHICH COULD RESULT IN A LOSS OF POWER STEERING.

**NOTE:** If methods of checking flow rate are provided by the vehicle manufacturer, you should follow those instructions rather than the procedure described below.

With the engine idling and the fluid temperature between 125°F (51.7°C) and 135°F (57.2°C), check the pump manufacturer's specifications for flow rate. Compare these specifications with the flow rate on the flow meter.

Now, fully close the load valve until the pressure gage registers the pressure at which the pump is relieving. When pump relief is reached, flow rate must be zero. **IMMEDIATELY OPEN THE LOAD VALVE.** The flow rate must instantly return to the original reading. If this rate does not return immediately, the pump is malfunctioning, which can result in intermittent power assist.

Now, set the engine at governed rpm, and fully close the load valve again until pump relief is reached. At pump relief, the flow rate must be zero. **IMMEDIATELY OPEN THE LOAD VALVE.** The flow rate must instantly return to the original reading. If this rate does not return immediately, the pump is malfunctioning, which can result in intermittent power assist.

**NOTE:** Conduct the pump flow test once at idle rpm and three times at governed rpm.

**CAUTION:** Do not allow the fluid temperature to exceed 180°F (82.2°C). Run each phase of this test between 125°F (51.7°C) and 135°F (57.2°C).

### Steering Gear Internal Leakage Test

To test the steering gear for internal leakage, you must first prevent operation of the gear's internal unloading (poppet) valves. This will allow full pump relief pressure to develop. To prevent operation of the poppets, place an unhardened steel spacer block, about 1 inch thick and long enough to keep your fingers clear, between the axle and stop at one wheel (see FIG. 3).

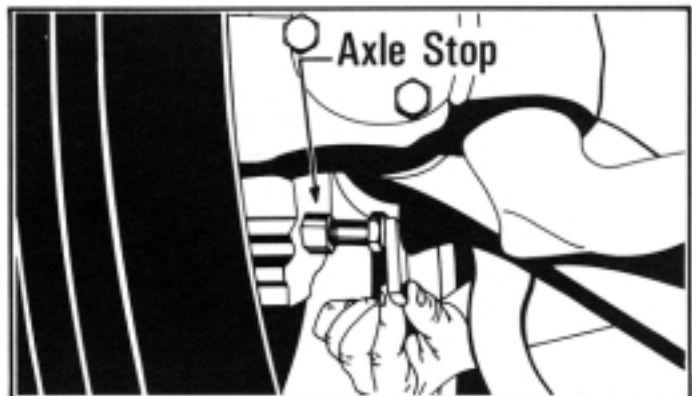


Figure 3

With the fluid temperature between 125°F (51.7°C) and 135°F (57.2°C), turn the steering wheel until the axle stops bottom on the spacer block (FIG. 3).

**CAUTION:** When running this test, do not hold the steering wheel in the full turn position for longer than 5 to 10 seconds at a time to avoid damaging the pump.

**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 STOPS OR DANGEROUSLY THROW OR EJECT THE SPACER BLOCK.

Apply 20 lbs. (9.1 KG) to the rim of the steering wheel during this test to be sure that the steering gear control valve is fully closed. The pressure gage should now read pump relief pressure, as noted during the pump pressure test. You can now read steering gear internal leakage on the flow meter.

Acceptable internal leakage can range from 0 to 1.5 gpm (5.7 Liters/Min.).

Repeat this test for the opposite direction of turn.

If internal leakage is greater than 1.5 gpm (5.7 Liters/Min.) and there is no auxiliary hydraulic cylinder in the system, repair the gear. If the internal leakage is greater than 1.5 gpm (5.7

Liters/Min.) and there is an auxiliary hydraulic cylinder in the system, controlled by the HF54 gear, isolate the auxiliary cylinder from the system by disconnecting the auxiliary cylinder hydraulic lines at the HF54 unit's auxiliary ports. Plug those ports with suitable pressure plugs or caps and plug the

disconnected lines to prevent drainage. Repeat the internal leakage test. If the internal leakage is greater than 1.5 gpm (5.7 Liters/Min.) repair the HF54 gear. If it is less than 1.5 gpm (5.7 Liters/Min.) repair the auxiliary cylinder.

## Troubleshooting Guide

### I. Normal Noises

- You or the driver may hear a hissing noise from the control valve when it is actuated during a steering maneuver.
- You or the driver may hear a noise as fluid bypasses through the poppets at full turn.
- You or the driver may hear a noise from the system relief valve when it is required to actuate.
- You or the driver may hear pump growl from some types of power steering pumps.

### II. Abnormal Noises

- If the power steering pump is belt driven, a squealing noise may indicate that the belts should be tightened or replaced.
- A clicking noise heard during a turn, or when changing directions, may indicate that some component is loose and shifting under load.
- A change in the normal noise of the pump may indicate that air has been induced into the system or that fluid level is low.

### III. Possible Steering Problems and Causes

#### Road Wander

- Tire pressure incorrect or unequal left to right.
- Components in steering linkage loose or worn (Steering wheel to road wheel).
- Wheel bearings improperly adjusted or worn.
- Front end alignment out of specification.
- Dry fifth wheel or poor finish on fifth wheel or trailer plate.
- Steering gear mounting bolts loose on frame.
- Steering gear improperly adjusted.
- Looseness in rear axle assemblies or trailer bogies.

## No Recovery

- Tire pressure low
- Front end components binding
- Front end alignment incorrect
- Tight front axle king pins
- Dry fifth wheel or poor finish on fifth wheel or trailer plate
- Steering column binding
- Pump flow insufficient
- Steering gear improperly adjusted
- Steering gear control valve spool sticking

## Shimmy

- Badly worn or unevenly worn tires
- Improperly mounted tire or wheel
- Wheel bearings improperly adjusted or worn
- Components in steering linkage loose or worn
- Wheels or brake drums out of balance
- Front end alignment incorrect
- Air in the hydraulic system

## External Oil Leakage

- Finding the location of a leak may be difficult, since oil may run away from the leak source, the fittings, hoses, pump, or gear to a low point on the gear or chassis.
- A leak from the vent plug at the side cover indicates failure of the sector shaft oil seal inside the side cover.

## Oversteering or Darting

- Dry fifth wheel or poor finish on fifth wheel or trailer plate
- Front end components binding or loose
- Steering column binding
- Steering gear improperly adjusted
- Steering gear control valve spool sticking
- Rear axle mounts (rear steer)

## High Steering Effort in One Direction

- Unequal tire pressure
- Vehicle overloaded
- Inadequate hydraulic system pressure
- Excessive internal leakage in one direction of turn only (verify with internal leakage test)

### High Steering Effort in Both Directions

- Low tire pressure
- Vehicle overloaded
- Low hydraulic fluid level
- Low pressure or flow from pump
- Components of steering system binding
- Restriction in return line, or line too small in diameter
- Excessive internal leakage (verify with internal leakage test)
- Oversize tires (check manufacturer's specifications)

### Lost Motion (Lash) at the Steering Wheel

- Steering wheel loose on the shaft
- Loose connection between the steering gear, intermediate column, and steering column
- Steering gear loose on frame
- Pitman arm loose on output shaft
- Components in steering linkage loose or worn
- Steering gear improperly adjusted

### Excessive Heat [150 °F (65.6 °C) Over Ambient]

- Excessive pump flow
- Vehicle overloaded
- Undersized replacement hose or line
- Restricted hose or line that is kinked or severely bent or internally blocked
- Restricted recentering of gear valve caused by column bind or side load on the input shaft
- Poppet not adjusted properly
- Prolonged stationary vehicle operation

**WARNING: IF THE HYDRAULIC SYSTEM FLUID BECOMES OVERHEATED, IT CAN CAUSE THE SEALS IN THE STEERING GEAR AND PUMP TO SHRINK, HARDEN, OR CRACK AND LOSE THEIR SEALING ABILITY.**

## Repairs and Adjustments on Vehicle

When you have conducted the checks and tests described in the troubleshooting sections, you may find it necessary to repair or adjust the steering gear. Since removing the gear from the vehicle is usually difficult and time-consuming, you will probably find it easier to perform the following repairs and adjustments with the gear on the vehicle. The photographs in this section show a gear mounted on a mock-up frame for clearer illustration.

### 1 The Sector Shaft And Trunion Cover Seal

#### remove pitman arm

- 1.1 If a leak is detected in the trunion cover area, you can remove the trunion cover on many installations, to gain access to the sector shaft seal package, while the steering gear is on the vehicle. First check the radial position of the pitman arm to the sector shaft (51) and add timing marks to the pitman arm and shaft if necessary to insure correct alignment at reassembly. Remove the sector shaft nut (65) and lockwasher (64) or the pitman arm pinch bolt and nut assembly. SEE FIGURES 4 OR 5. Remove the pitman arm from the sector shaft using a suitable puller as required. SEE FIGURES 6 OR 7.

#### NOTE

**NOTE:** A chisel will help you loosen the pinch bolt type pitman arm. Use only a puller if you cannot remove the pitman arm with your hands.

#### WARNING

**WARNING:** WHEN USING A CHISEL TO SPREAD THE PITMAN ARM BOSS IN ORDER TO LOOSEN THE PITMAN ARM FOR REMOVAL FROM THE SHAFT, MAINTAIN A FIRM GRIP ON THE CHISEL AT ALL TIMES. FAILURE TO DO THIS MAY RESULT IN THE CHISEL FLYING LOOSE WHICH COULD CAUSE AN INJURY. NEVER LEAVE THE CHISEL WEDGED IN THE PITMAN ARM BOSS. IF YOU CANNOT REMOVE THE PITMAN ARM FROM THE SHAFT WITH A CHISEL AND YOUR HANDS, REMOVE THE CHISEL FROM THE PITMAN ARM AND USE A PULLER ONLY TO REMOVE THE PITMAN ARM.

#### CAUTION

**CAUTION:** Do not use a hammer on the pitman arm to remove it from sector shaft as internal damage to steering gear could result.

#### remove protector seal

- 1.2 Remove protector seal (61) from sector shaft (51) and trunion cover (59) if included.

#### clean sector shaft

- 1.3 Clean the sector shaft (51) with a fine grade of emery paper. Be sure to remove any paint. SEE FIGURE 8.

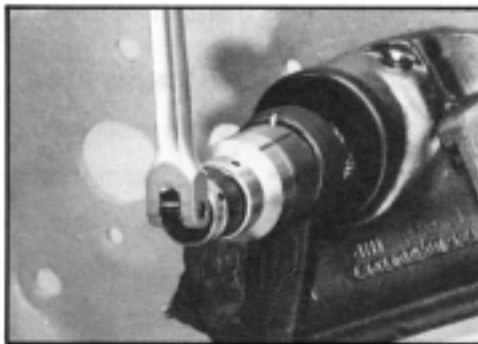


Figure 4

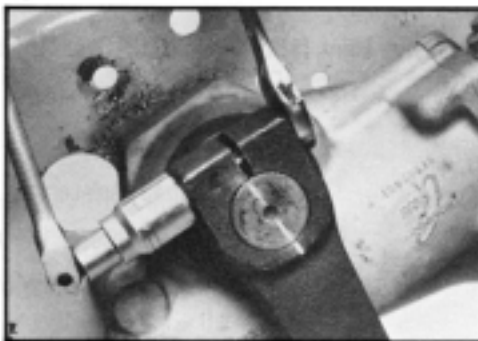


Figure 5

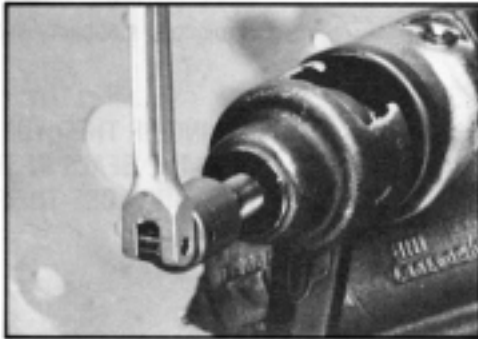


Figure 6

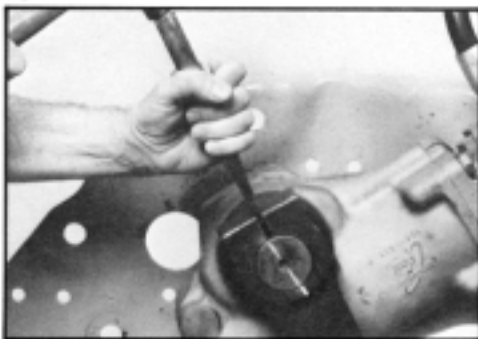


Figure 7

remove trunnion cover and seal package

1.4 Next, remove the four trunnion cover screws (60), and trunnion cover (59). SEE FIGURE 9. A 5/16" 12 point thin wall socket required. Be prepared for fluid loss. Then remove and discard the sector shaft seal package consisting of the two-piece sector shaft seal (48), the \*Teflon backup washer (47), and the trunnion cover seal ring (58). SEE FIGURE 10.

clean and inspect trunnion cover

1.5 Clean the trunnion cover (59) with petroleum based solvent and inspect the seal cavity and sealing face for nicks or corrosion. Replace the trunnion cover with a new one if these conditions exist.

**WARNING**

**WARNING: SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.**

install a new teflon washer and seal package

1.6 Install a new teflon washer (47) and then a new 2 piece seal (48) into trunnion cover (59) so that the surface marked "oil side" is facing out of the counter bore.

**WARNING**

**WARNING: THE WORDS "OIL SIDE" MUST BE VISIBLE ON THE SEAL AFTER IT IS IN PLACE IN TRUNNION COVER. THE SEAL WILL NOT FUNCTION IF THE SEAL IS REVERSED AND A LOSS OF POWER STEERING ASSIST MAY OCCUR.**

install new seal ring

1.7 Grease the new trunnion cover seal ring (58) and install it into the cover ring groove. SEE FIGURE 11.

tape sector shaft

1.8 Cover the serrations of the sector shaft (51) with tape if necessary to avoid damaging the seal during installation. SEE FIGURE 12.

**NOTE**

**NOTE: Use only one layer of tape.**

\*Teflon is a registered trademark of DuPont Corporation

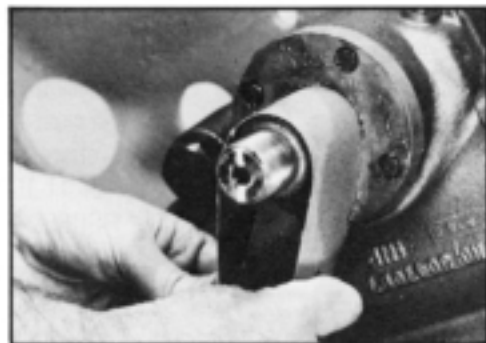


Figure 8

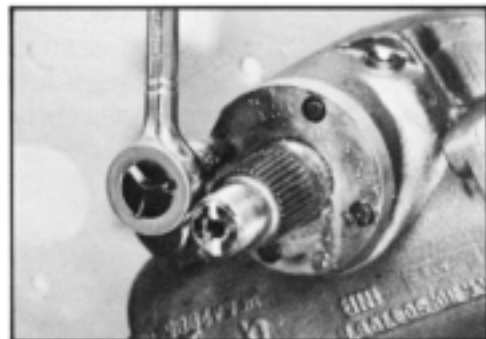


Figure 9



Figure 10

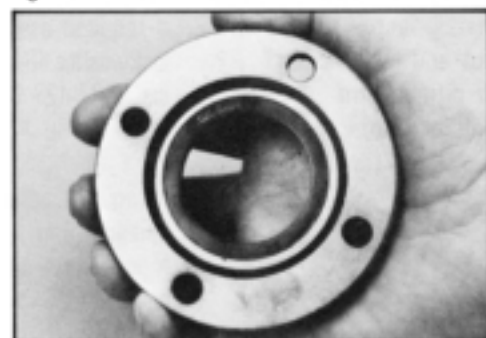


Figure 11



Figure 12

install trunnion cover and screws

- 1.9 Apply clean high temperature industrial grease per Ross specification 045231, Mobil Temp. 1 or 2, or equivalent to sector shaft seal area and install the trunnion cover (59) and four trunnion screws (60). Torque screws to 13-23 ft. lbs. (18-31 N m) if dry or 11-16 ft. lbs. (15-22 N m) if lubricated. SEE FIGURES 13-14. Remove tape from sector shaft.



Figure 13

assemble protector seal

- 1.10 Pack clean high temperature industrial grease per Ross specification 045231, Mobil Temp. 1 or 2 or equivalent to new protector seal (61) cup and install protector seal to sector shaft (51) and trunnion cover (59). SEE FIGURE 15.

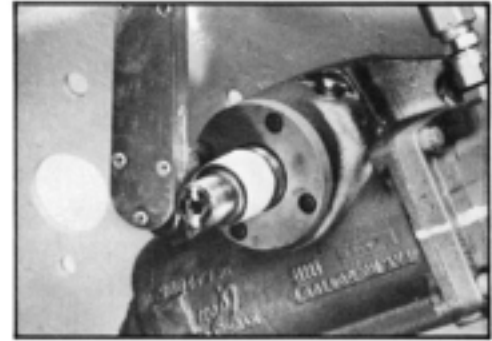


Figure 14

install pitman arm

- 1.11 Reconnect the pitman arm, making sure the timing mark on the pitman arm aligns with the timing mark on the sector shaft. SEE FIGURE 16.



Figure 15

#### WARNING

**WARNING: WHEN USING A CHISEL TO SPREAD THE PINCHBOLT TYPE PITMAN ARM BOSS FOR ASSEMBLY ONTO THE SECTOR SHAFT (51), MAINTAIN A FIRM GRIP ON THE CHISEL AT ALL TIMES. FAILURE TO DO THIS MAY RESULT IN THE CHISEL FLYING LOOSE WHICH COULD CAUSE AN INJURY. NEVER LEAVE THE CHISEL WEDGED IN THE PITMAN ARM BOSS.**

install sector shaft nut and lockwasher or pitman arm bolt and nut

- 1.12 If required assemble the sector shaft nut (65) and lockwasher (64) and torque nut to 300-315 ft. lbs. (407-427 N m). 1-13/16" socket required. SEE FIGURE 17.

If required assemble the pitman arm clamp nut and bolt and torque to 220-240 ft. lbs. (298-325 N m) if dry and unplated or torque to 160-180 ft. lbs. (217-244 N m) if bolt is lubricated or plated.



Figure 16

#### CAUTION

**CAUTION: Be sure there is no spreading wedge left in the pitman arm boss before torquing pitman arm clamp bolt.**

fill and bleed system

- 1.13 Before operating the steering gear, fill the system with the recommended fluid and bleed air from the system by following the Filling and Air Bleeding instructions on page 50.

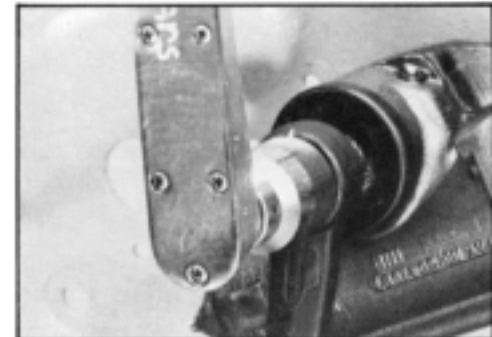


Figure 17



## 2 The Worm (Input) Shaft Seal

remove input coupling; clean input shaft

- 2.1 If there is a leak in the shaft seal, you can usually replace the input shaft seal assembly (4) with the gear on the vehicle. Start by removing the input coupling per the vehicle manufacturers instructions. SEE FIGURE 18. Remove seal protector (1) and clean the area around the worm shaft (23) with a fine grade of emery paper. SEE FIGURE 19.

### WARNING

**WARNING: DO NOT DRIVE OR PRY COUPLING FROM SHAFT. INTERNAL DAMAGE TO THE STEERING GEAR CAN RESULT. IF COUPLING IS TIGHT, INSERT SCREWDRIVER INTO SLOT TO RELEASE.**

remove and plug the return line

- 2.2 Remove and plug the return line in the upper cover (7). SEE FIGURE 20.

remove retaining ring

- 2.3 Remove the seal retaining ring (2) from the upper cover (7). SEE FIGURE 21.

apply air pressure to port

- 2.4 Hold a shop rag over the worm shaft (23) and apply shop air pressure to the return port in upper cover (7). SEE FIGURE 22.

### WARNING

**WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.**

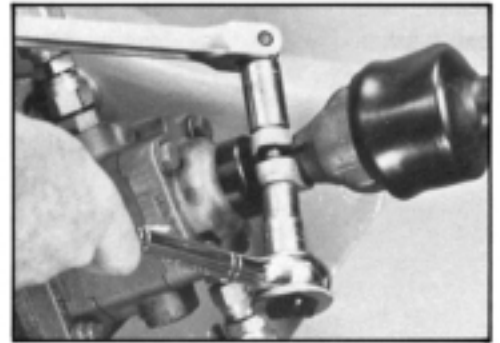


Figure 18



Figure 19

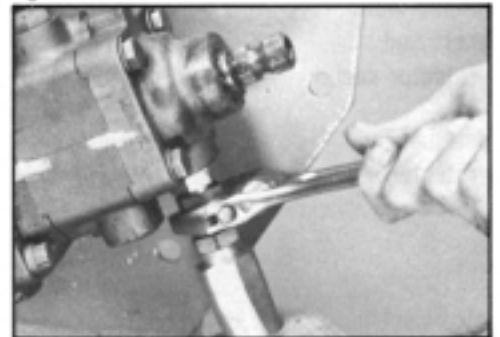


Figure 20

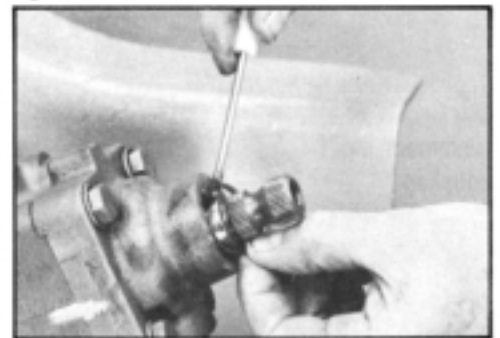


Figure 21

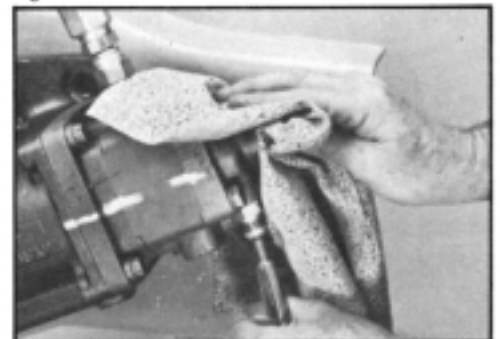


Figure 22

remove seal  
and washer

- 2.5 The air pressure will force the input shaft seal (4) and the steel backup washer (3) to pop out of the gear, and some fluid will leak from the gear. Discard the seal. Disconnect the shop air as soon as the seal assembly is out. SEE FIGURE 23.

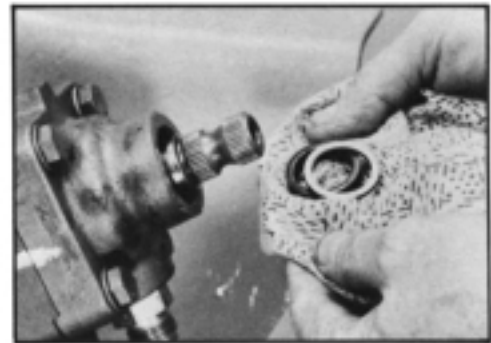


Figure 23

install seal

- 2.6 Tape the worm shaft serrations if necessary to protect seal and assembly **new** seal (4) onto worm shaft (23) and into upper cover (7) with seal lip facing the upper cover bearing (5). SEE FIGURE 24. Apply the special high temperature industrial grease per Ross specification 045231, \*Mobil Temp. 1 or 2 or equivalent to back up washer (3) and install it against seal (4). Assemble retaining ring (2). SEE FIGURE 25.



Figure 24

grease worm  
shaft and  
protector seal

- 2.7 Apply more of the special grease in the seal area of worm shaft (23) and to the **new** protector seal (1). SEE FIGURE 26.

assemble  
protector seal

- 2.8 Assemble **new** seal protector (1) onto worm shaft (23) and upper cover (7). SEE FIGURE 27.



Figure 25

reconnect line

- 2.9 Remove the plug and reconnect the return line.

reconnect input  
coupling

- 2.10 Remove tape from worm shaft (23) and reconnect the input coupling. If the input coupling male assembly slides free of the female end during assembly, realign the timing marks to ensure proper phasing of the U-joints. Refer to vehicle manufacturer for recommended torque.



Figure 26

**WARNING**

**WARNING: MISTIMED U-JOINTS CAN RESULT IN A BUMPY SENSATION AT THE STEERING WHEEL AND POSSIBLY AFFECT STEERING CONTROL.**

fill and bleed  
system

- 2.11 Before operating the steering gear, fill the system with the recommended fluid and bleed air from the system by following the Filling and Air Bleeding instructions on page 50.

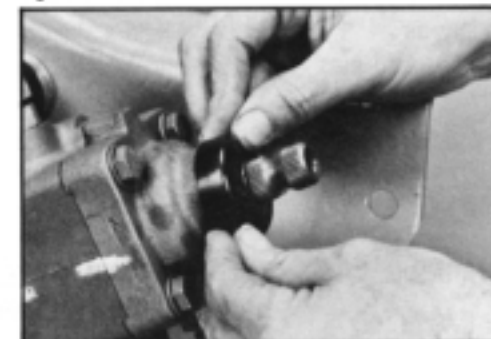


Figure 27

# Adjustments

You can make three adjustments to the gear while it is mounted on the vehicle; the worm shaft and valve thrust bearing preload adjustment, the poppet valve adjustment, and the sector shaft adjustment.

## 3 Worm Shaft, Valve Thrust Bearing Preload Adjustment (With Vehicle Engine Off)

remove input coupling; clean worm (input) shaft

3.1 Remove input coupling and protector (1) and clean worm (input) shaft (23) by following procedure 2.1 and its succeeding warning.

remove and plug return line. Tape serrations

3.2 Remove and plug the return line. SEE FIGURE 20, page 15. Tape serrations with one layer of tape if necessary to protect seal (4).

remove upper cover bolts and washer

3.3 Remove four upper cover bolts (6) and washers (6A). SEE FIGURE 28. 9/16 inch socket required.

remove upper cover assembly

3.4 Carefully remove upper cover (7) assembly from worm shaft (23) while maintaining the valve assembly (15) position. SEE FIGURE 29.

reassemble one bolt

3.5 Reassemble one bolt (6) with a spacer or spacers about the width of the upper cover (7) bolt flange and torque bolt enough to hold assembled components in position. SEE FIGURE 30.

unstake bearing lockwasher

3.6 Unstake the bearing lockwasher (10) tang that is staked into a slot in bearing lock nut (9). SEE FIGURE 31. Remove tape from worm shaft serrations.

remove bearing lockwasher and nut

3.7 Place a 3/4 or 11/16 inch 12 point socket as required on worm shaft serrations and a hook type spanner wrench or self gripping (groove joint) pliers on bearing lock nut (9) and turn nut off of worm shaft (23). Remove and discard bearing lockwasher (10). SEE FIGURE 32.

### NOTE

**NOTE:** The 12 point socket must have sharp points to effectively fit the serrations and rotate the worm shaft.

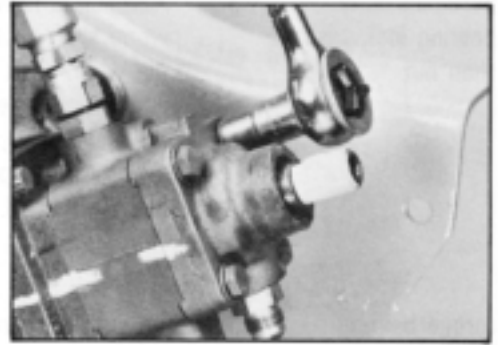


Figure 28

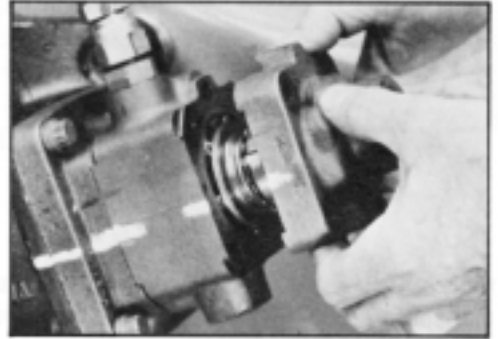


Figure 29



Figure 30

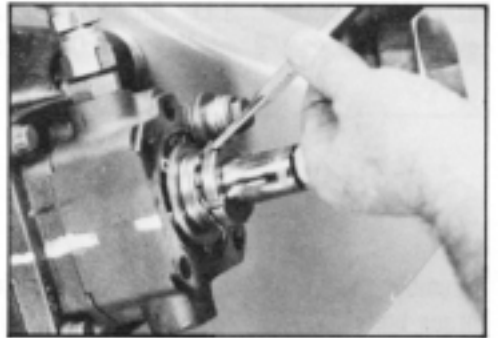


Figure 31



Figure 32

assemble new bearing lockwasher, then nut

3.8 Assemble a **new** bearing lockwasher (10) onto worm shaft (23) with the internal washer tang in the worm shaft slot and the external tangs facing out. Reassemble bearing lock nut (9), large chamfer side in, onto threaded diameter of worm shaft until components are at solid height (snug). SEE FIGURE 33.

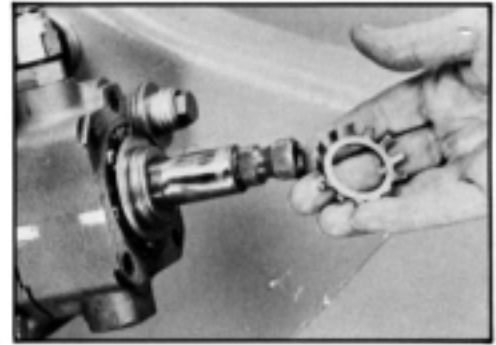


Figure 33

torque bearing lock nut

3.9 Torque the bearing lock nut (9) to 30 ft. lbs. (41 N m) to ensure components are seated. Back the nut off and torque nut to 15-20 ft. lbs. (20-27 N m). SEE FIGURE 34. Back nut off approximately 20 degrees and bend one tang of bearing lockwasher (10) firmly into a mating slot in lock nut. SEE FIGURE 35.

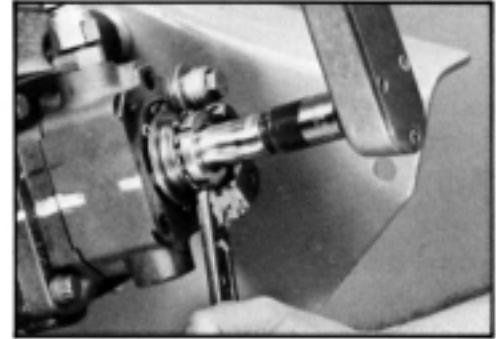


Figure 34

remove bolt and spacers

3.10 Remove the one bolt (6) and spacers used to contain components during adjustment. Tape worm shaft serrations.



Figure 35

**NOTE**

**NOTE:** It is recommended that seal (4) in the removed upper cover (7) be replaced per the disassembly and assembly procedures in this manual before upper cover is reassembled.

assemble upper cover

3.11 Grease and install a **new** seal ring (8) in upper cover (7) and assemble upper cover assembly onto the worm shaft (23). SEE FIGURE 36.

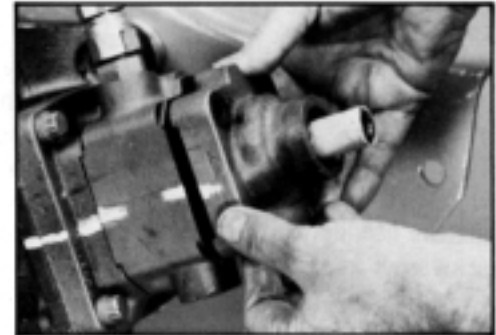


Figure 36

assemble and torque bolts

3.12 Assemble the four bolts (6) and washers (6A) into upper cover (7). Carefully torque the bolts while checking that the adaptor (18), valve assembly (15) and upper cover (7) are properly piloted and positioned with all seal rings in place. Torque bolts to 25-35 ft. lbs. (34-47 N m) if dry, or 21-27 ft. lbs. (28-37 N m) if lubricated. SEE FIGURE 37.

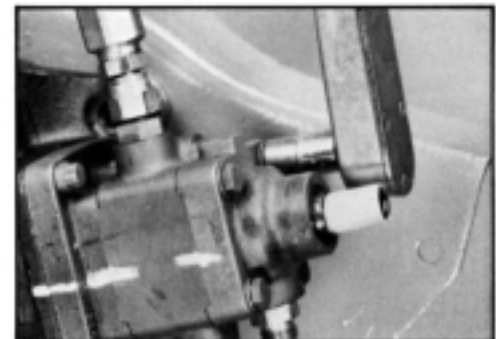


Figure 37

complete the gear reassembly

3.13 Complete the steering gear reassembly by following procedures 2.7 through 2.11.

## 4 Poppet Valve Adjustment

(With vehicle engine on)

set axle stops

- 4.1 Before you adjust the poppet, set the axle stops according to the manufacturers specifications.

NOTE

**NOTE:** Not all HF54 steering gears have an adjustable poppet screw. Only the poppet on the lower end (closed end) of the housing may be adjustable.

install flow meter

- 4.2 Install a pressure gage or a flow meter/pressure gage package into the supply line from the pump to the gear. Make sure that the flow meter can be pressurized. Bring the fluid temperature to between 125°F and 135°F (51.7°C and 57.2°C), using the method to warm the system up described in the troubleshooting section, page 8.

rotate sector shaft to position rack piston

- 4.3 To position the rack piston for poppet adjustment, observe the end of sector shaft (51) for direction of travel with the engine at idle. Have the steering wheel rotate in the direction that will rotate the sector shaft to the end of its travel (axle against axle stop) clockwise (CW) or counter-clockwise (CCW) as indicated by the shaft rotation arrow placed as shown in FIGURE 38 or 39 and pointing toward the adjustable poppet and closed end of housing (55).

CAUTION

**CAUTION:** If relief pressure is reached while the steering wheel is at full lock (axle against axle stop), release the steering wheel from this position. At no time should relief pressure be maintained for longer than 5 seconds as damage to the pump may result.

NOTE

**NOTE:** You must maintain enough force on the steering wheel to assure that the steering gear control valve is completely closed when reading pressure gage.

loosen sealing nut and adjusting screw

- 4.4 Once you have the steering wheel in full lock (axle against axle stop) in the correct direction, loosen the poppet adjusting screw nut (54) or (54A) and the poppet adjusting screw (53) or (53B), until the pressure gage reads maximum pump relief pressure. SEE FIGURE 40. 11/16 inch box end and slot screw driver or 3/4 inch box end and 5/16 inch hex socket required.

set adjusting screw & tighten sealing nut

- 4.5 Screw in the poppet adjusting screw (53) or (53B) until the pressure gage shows less than 500 PSI with the steering wheel in full lock. Tighten the poppet adjusting nut (54) to 17-22 ft. lbs. (23-30 N m). Tighten poppet adjusting nut (54A) to 25-30 ft. lbs. (34-41 N m).

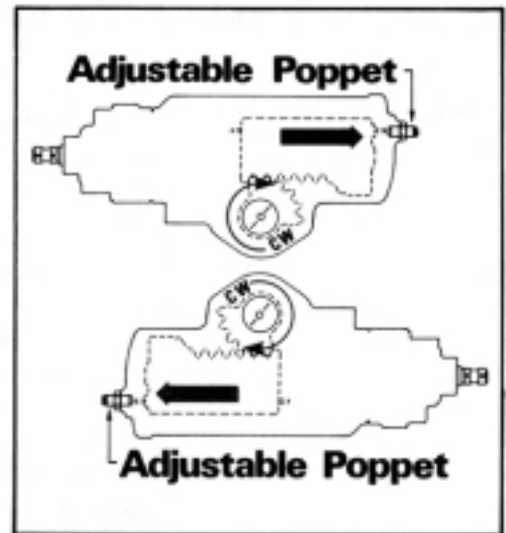


Figure 38

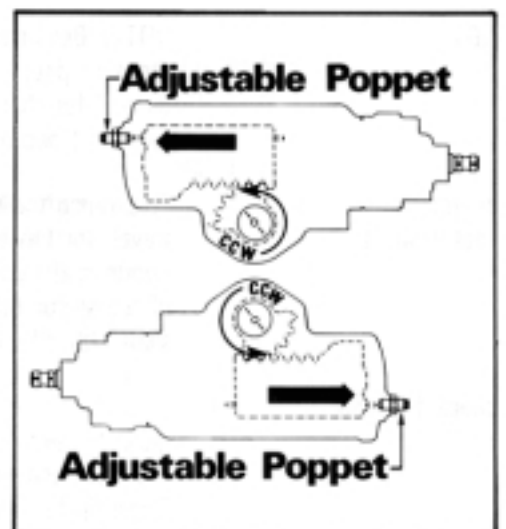


Figure 39

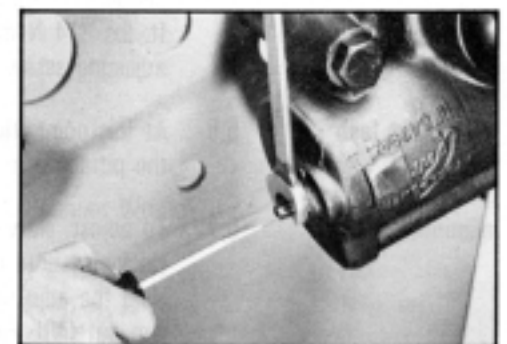


Figure 40

## 5 Cross-shaft or Sector-shaft Adjustment (With vehicle engine off)

locate  
adjusting nut

- 5.1 If the sector shaft adjusting screw jam nut (40) located on the side cover (43), is not accessible, the steering gear must be removed prior to adjustment.

NOTE

**NOTE:** If there is not a timing mark on the end of sector shaft (51) a timing mark must be scribed across the end of the sector shaft perpendicular to the worm shaft (23) while the vehicle's steered wheels are in the straight ahead position and the drag link is in place. The timing mark will indicate the sector shaft "center of travel" position.

remove the  
drag link

- 5.2 If the sector shaft adjusting screw (50) is accessible, remove the drag link from the pitman arm.

CAUTION

**CAUTION:** This adjustment must be performed with the sector shaft on its center of travel.

NOTE

**NOTE:** Because of pitman arm or internal stops or poppet adjustment the "center of travel" for this adjustment may not be the center of sector shaft or handwheel rotation.

center the  
sector shaft

- 5.3 To position the sector shaft (51) on "center of travel" for this adjustment rotate steering wheel (worm shaft) until the timing mark across the end of the sector shaft is perpendicular to the worm shaft (23). SEE FIGURE 41.

check for lash

- 5.4 With the sector shaft (51) in the center position, grasp the pitman arm and gently try to move this arm back and forth in the direction of travel. Finger-tip force is adequate to detect lash of a loose sector shaft. There must be no movement of the input (worm) shaft or sector shaft. If no lash is detected, do not adjust. SEE FIGURE 42.

position adjusting  
screw

- 5.5 If lash is detected, loosen jam nut (40) with a 3/4 inch socket and move the adjusting screw (50) clockwise until the sector shaft (51) and rack piston (39) are in contact. (Use no more than 10 ft. lbs. (14 N m) of torque). Then turn the adjusting screw counterclock-wise one turn.

check for lash

- 5.6 At this point, there should be lash felt through the pitman arm.

eliminate lash

- 5.7 To adjust, slowly turn the adjusting screw (50) clockwise until no lash is felt at the pitman arm. Hold the adjusting screw in place, and tighten the jam nut (40). Final nut torque is 40-45 ft. lbs. (54-61 N m).



Figure 41

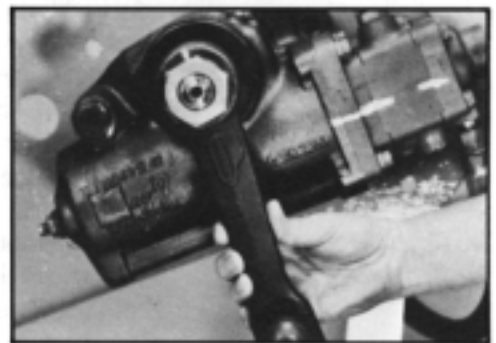


Figure 42

recheck for lash	5.8	Recheck through the pitman arm for lash. Turn the steering wheel 1/4 turn each side of center. No lash should be felt. If lash exists, repeat adjustments 5.3-5.8.
connect drag link	5.9	Reconnect drag link to pitman arm.

## Torque Chart

Part Name	Item Number	Torque
Upper Cover Bolts	6	25- 35 ft. lbs.   34- 47 N m)
Upper Cover Bolts	6 if Lubricated	21- 27 ft. lbs.   28- 37 N m)
Poppet Seat	30	20- 25 ft. lbs.   27- 34 N m)
Adaptor Bolt	17	45- 55 ft. lbs.   61- 75 N m)
Adaptor Bolt	17 if Lubricated	42- 52 ft. lbs.   57- 71 N m)
Side Cover Bolts	42	45- 55 ft. lbs.   61- 75 N m)
Side Cover Bolts	42 if Lubricated	33- 40 ft. lbs.   45- 54 N m)
Trunnion Cover Screws	60	13- 23 ft. lbs.   18- 31 N m)
Trunnion Cover Screws	60 if Lubricated	11- 16 ft. lbs.   15- 22 N m)
Screw-Return Guide	38	8- 10 ft. lbs.   11- 14 N m)
Poppet Screw	53A	15- 20 ft. lbs.   20- 27 N m)
Poppet Adj. Nut	54	17- 22 ft. lbs.   23- 30 N m)
Poppet Adj. Nut	54A	25- 30 ft. lbs.   34- 41 N m)
Adj. Nut (Sector Shaft)	40	40- 45 ft. lbs.   54- 61 N m)
Sector Shaft Nut	65	300-315 ft. lbs. (407-427 N m)
Pitman Arm Bolt & Nut Ass'y.		220-240 ft. lbs. (298-325 N m)
Pitman Arm Bolt & Nut Ass'y.	Lubricated/Plated	160-180 ft. lbs. (217-244 N m)
Bleed Screw	55B	27- 33 <b>in. lbs.</b> (3.1-3.7 N m)
Locknut	9	15- 20 ft. lbs.   20- 27 N m)

Universal joint bolts—torque to vehicle manufacturer's specifications.  
All torques specified in this manual are for dry/unplated parts unless otherwise specified.

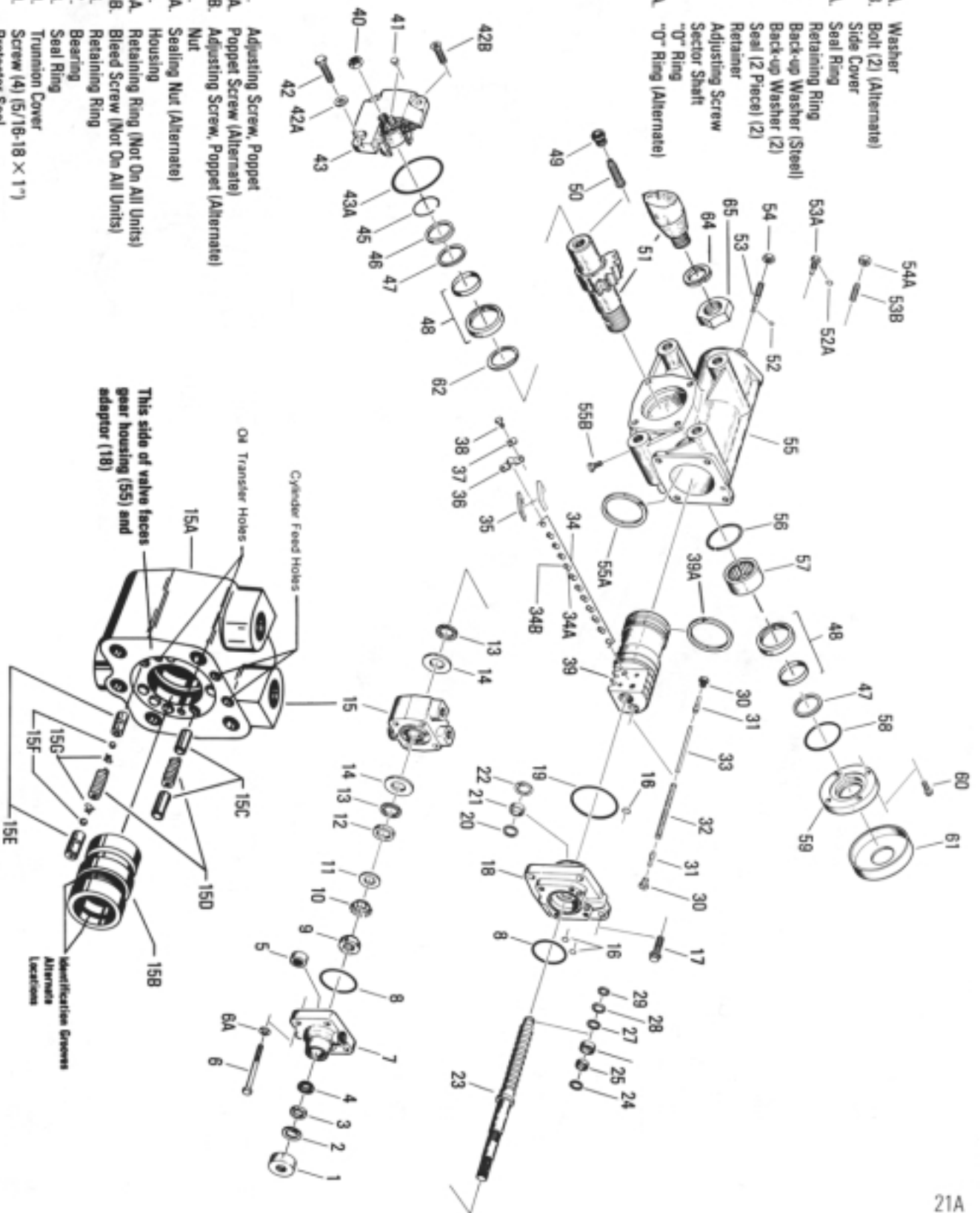
## Tools and Materials Required for Servicing

Service Manual	Ratchet
Masking Tape or Special Clip	Sockets: 1/2, 9/16, 5/8, 1-13/16 inch
Grease—*Mobil Temp 1 or 2 or equivalent	Allen Sockets: 1/4, 3/8 inch
Wheel Bearing Grease	12-Point Sockets: 3/4, 11/16, 5/16, 7/16 inch
Adjustable Wrench	Torx Socket T-50
Pocket Knife	Pitman Arm Puller
Torque Wrench—in lbs. (N m)	Screw Driver
Torque wrench—ft. lbs. (N m)	Slot Type Screwdriver Socket
Soft Punch	Chisel
Rubber Mallet	3/4" to 2" Adjustable Hook Spanner Wrench
Vise	Small Needle Nose Pliers
1" or 25 mm Micrometer	Loquic Grade "T" Primer
Emery Paper	"Stud Lock"
Retaining Ring Pliers	Loctite Hydraulic Sealant
Breaker Bar	

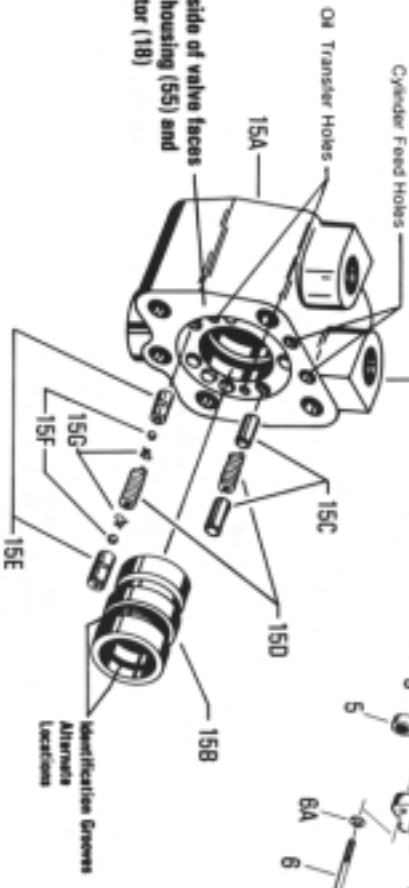
**HF54 Exploded Assembly View - Typical**

- |          |                            |
|----------|----------------------------|
| Item No. | Description                |
| 1.       | Protector Seal             |
| 2.       | Retaining Ring             |
| 3.       | Back-up Washer             |
| 4.       | Seal                       |
| 5.       | Bearing                    |
| 6.       | Bolt (4) (3/8-16 x 3-1/4)  |
| 6A.      | Washer (4)                 |
| 7.       | Upper Cover                |
| 8.       | Seal Ring (2)              |
| 9.       | Lock Nut                   |
| 10.      | Lock Washer                |
| 11.      | Washer                     |
| 12.      | Thrust Washer              |
| 13.      | Thrust Bearing (2)         |
| 14.      | Thrust Washer (2)          |
| 15.      | Valve Assembly             |
| 15A.     | Valve Body                 |
| 15B.     | Valve Spool                |
| 15C.     | Plunger (12)               |
| 15D.     | Spring (7)                 |
| 15E.     | Check Valve Plunger (2)    |
| 15F.     | Ball (2)                   |
| 15G.     | Cotical Spring (2)         |
| 17.      | Seal/Ring (3)              |
| 17.      | Bolt (4) (7/16-14 x 1-1/2) |
| 18.      | Adapter                    |
| 19.      | Seal Ring                  |
| 20.      | Back-up Washer             |
| 21.      | Seal                       |
| 22.      | Retaining Ring             |
| 23.      | Worm Shaft                 |
| 24.      | Washer (Steel)             |
| 25.      | Seal                       |
| 26.      | Seal Cup                   |
| 27.      | Back-up Washer (Bronze)    |
| 28.      | Retaining Washer           |
| 29.      | Retaining Ring             |
| 30.      | Poppet Seat (2)            |
| 31.      | Poppet (2)                 |
| 32.      | Spring                     |
| 33.      | Rod                        |
| 34.      | Ball Set                   |
| 34A.     | Ball (11)                  |
| 34B.     | Ball (Spacer) (11)         |
| 35.      | Ball Return Guide (2)      |
| 36.      | Ball Return Guide Clip     |
| 37.      | Locking Tab (2)            |
| 38.      | Hex Head Bolts (2)         |
| 39.      | Rack Piston                |
| 39A.     | Piston Ring                |
| 40.      | Nut                        |
| 41.      | Vent Plug                  |
| 42.      | Bolt (4) (7/16-14 x 1")    |

- |      |                                     |
|------|-------------------------------------|
| 42A. | Washer                              |
| 42B. | Bolt (2) (Alternate)                |
| 43.  | Side Cover                          |
| 43A. | Seal Ring                           |
| 45.  | Retaining Ring                      |
| 46.  | Back-up Washer (Steel)              |
| 47.  | Back-up Washer (2)                  |
| 48.  | Seal (2 Piece) (2)                  |
| 49.  | Retainer                            |
| 50.  | Adjusting Screw                     |
| 51.  | Sector Shaft                        |
| 52.  | "O" Ring                            |
| 52A. | "O" Ring (Alternate)                |
| 53.  | Adjusting Screw, Poppet             |
| 53A. | Poppet Screw (Alternate)            |
| 53B. | Adjusting Screw, Poppet (Alternate) |
| 54.  | Nut                                 |
| 54A. | Sealing Nut (Alternate)             |
| 55.  | Housing                             |
| 55A. | Retaining Ring (Not On All Units)   |
| 55B. | Bleed Screw (Not On All Units)      |
| 56.  | Retaining Ring                      |
| 57.  | Bearing                             |
| 58.  | Seal Ring                           |
| 59.  | Trunnion Cover                      |
| 60.  | Screw (4) (5/16-18 x 1")            |
| 61.  | Protector Seal                      |
| 62.  | Retaining Ring (Not On All Units)   |
| 64.  | Lock Washer                         |
| 65.  | Nut - Sector Shaft                  |



This side of valve faces gear housing (55) and adaptor (18)

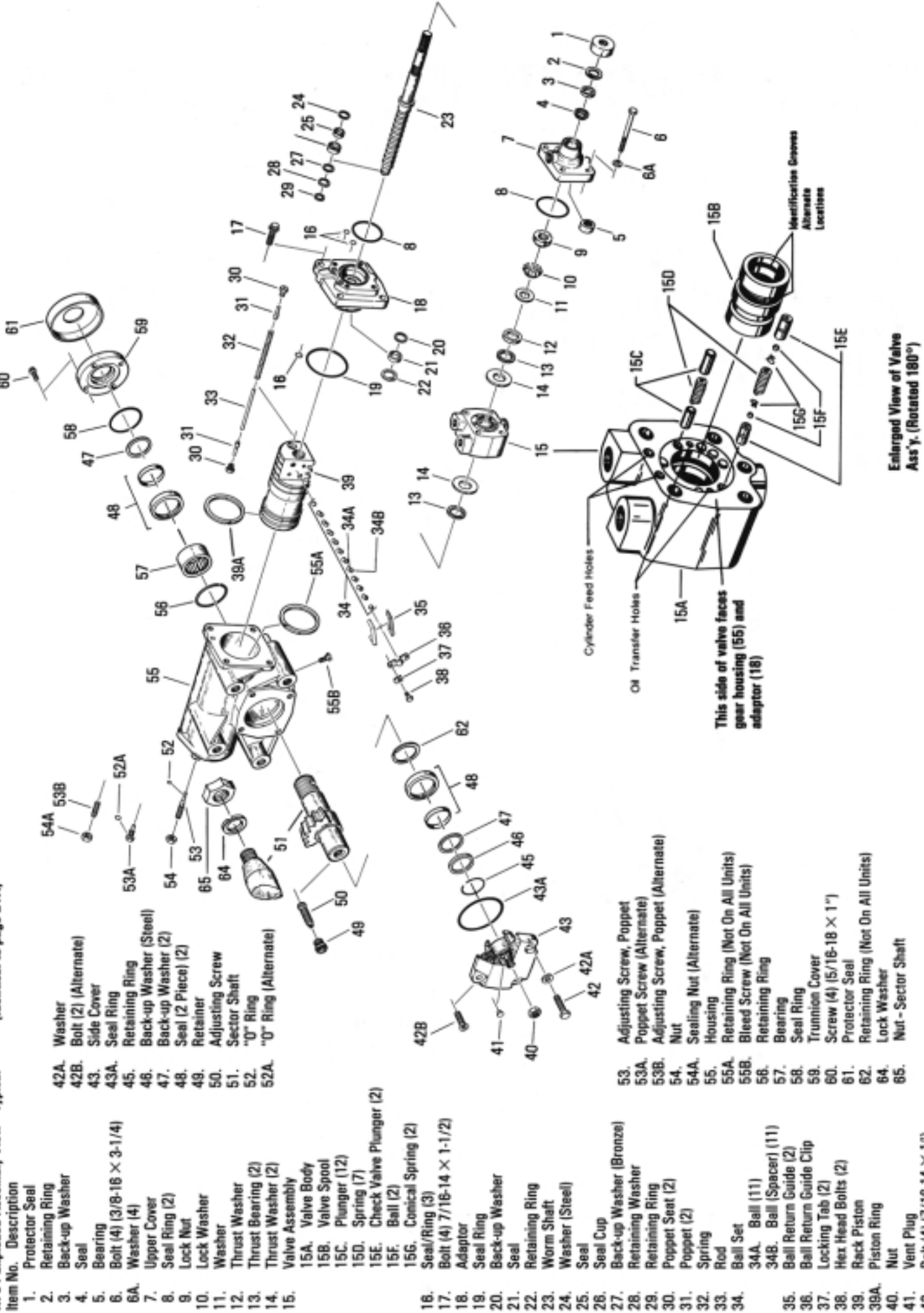


Enlarged View of Valve Ass'y. (Rotated 180°)



HF54 Exploded Assembly View - Typical

(Identical to page 21A)



- 1. Protector Seal
- 2. Retaining Ring
- 3. Back-up Washer
- 4. Seal
- 5. Bearing
- 6. Bolt (4) (3/8-16 X 3-1/4)
- 6A. Washer (4)
- 7. Upper Cover
- 8. Seal Ring (2)
- 9. Lock Nut
- 10. Lock Washer
- 11. Washer
- 12. Thrust Washer (2)
- 13. Thrust Bearing (2)
- 14. Thrust Washer (2)
- 15. Valve Assembly

- 15A. Valve Body
- 15B. Valve Spool
- 15C. Plunger (12)
- 15D. Spring (7)
- 15E. Check Valve Plunger (2)
- 15F. Ball (2)
- 15G. Conical Spring (2)
- 16. Seal/Ring (3)
- 17. Bolt (4) 7/16-14 X 1-1/2
- 18. Adaptor
- 19. Seal Ring
- 20. Back-up Washer
- 21. Seal
- 22. Retaining Ring
- 23. Worm Shaft
- 24. Washer (Steel)
- 25. Seal
- 26. Seal Cup
- 27. Back-up Washer (Bronze)
- 28. Retaining Washer
- 29. Retaining Ring
- 30. Poppet Seat (2)
- 31. Poppet (2)
- 32. Spring
- 33. Rod
- 34. Ball Set

- 34A. Ball (11)
- 34B. Ball (Spacer) (11)
- 35. Ball Return Guide (2)
- 36. Ball Return Guide Clip
- 37. Locking Tab (2)
- 38. Hex Head Bolts (2)
- 39. Rack Piston
- 39A. Piston Ring
- 40. Nut
- 41. Vent Plug
- 42. Bolt (4) (7/16-14 X 1")

- 42A. Washer
- 42B. Bolt (2) (Alternate)
- 43. Side Cover
- 43A. Seal Ring
- 43B. Retaining Ring
- 44. Back-up Washer (Steel)
- 45. Back-up Washer (2)
- 46. Seal (2 Piece) (2)
- 47. Retainer
- 48. Adjusting Screw
- 49. Sector Shaft
- 50. "O" Ring
- 50A. "O" Ring (Alternate)
- 51. Valve Assembly
- 52. Seal (2 Piece) (2)
- 52A. Retainer
- 53. Adjusting Screw, Poppet
- 53A. Poppet Screw (Alternate)
- 53B. Adjusting Screw, Poppet (Alternate)
- 54. Nut
- 54A. Sealing Nut (Alternate)
- 55. Housing
- 55A. Retaining Ring (Not On All Units)
- 55B. Bleed Screw (Not On All Units)
- 56. Retaining Ring
- 57. Bearing
- 58. Seal Ring
- 59. Trunnion Cover
- 60. Screw (4) (5/16-18 X 1")
- 61. Protector Seal
- 62. Retaining Ring (Not On All Units)
- 64. Lock Washer
- 65. Nut - Sector Shaft

Enlarged View of Valve Ass'y. (Rotated 180°)



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