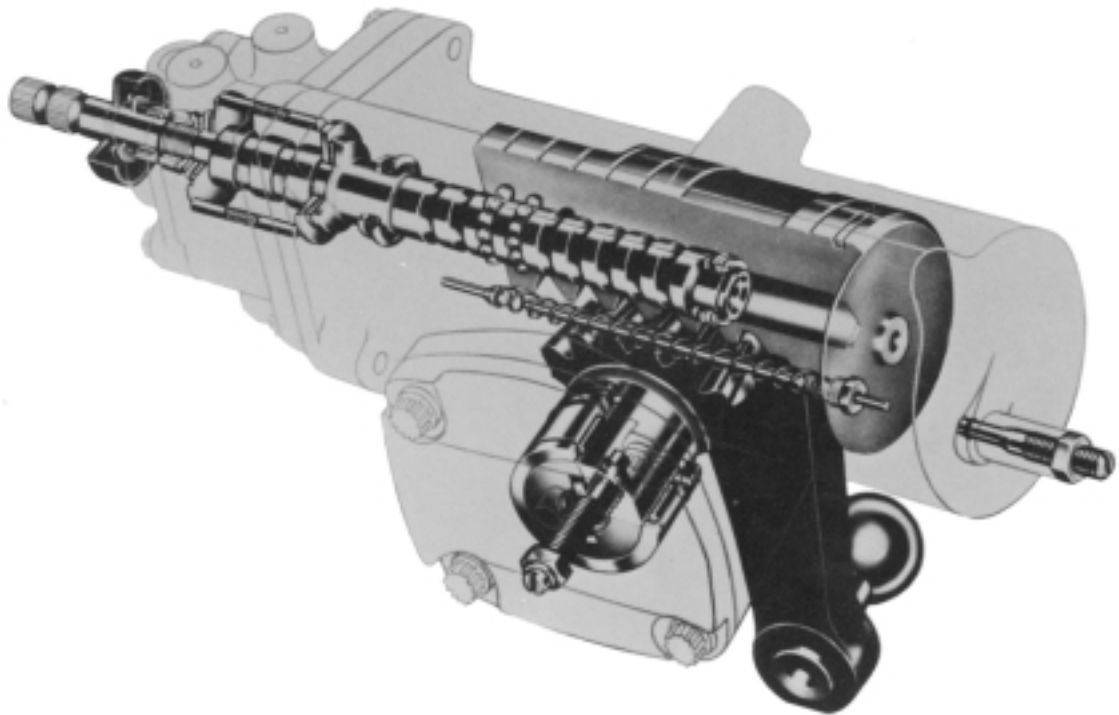




# Hydrapower™ Integral Power Steering Gear

HF54 Service Manual

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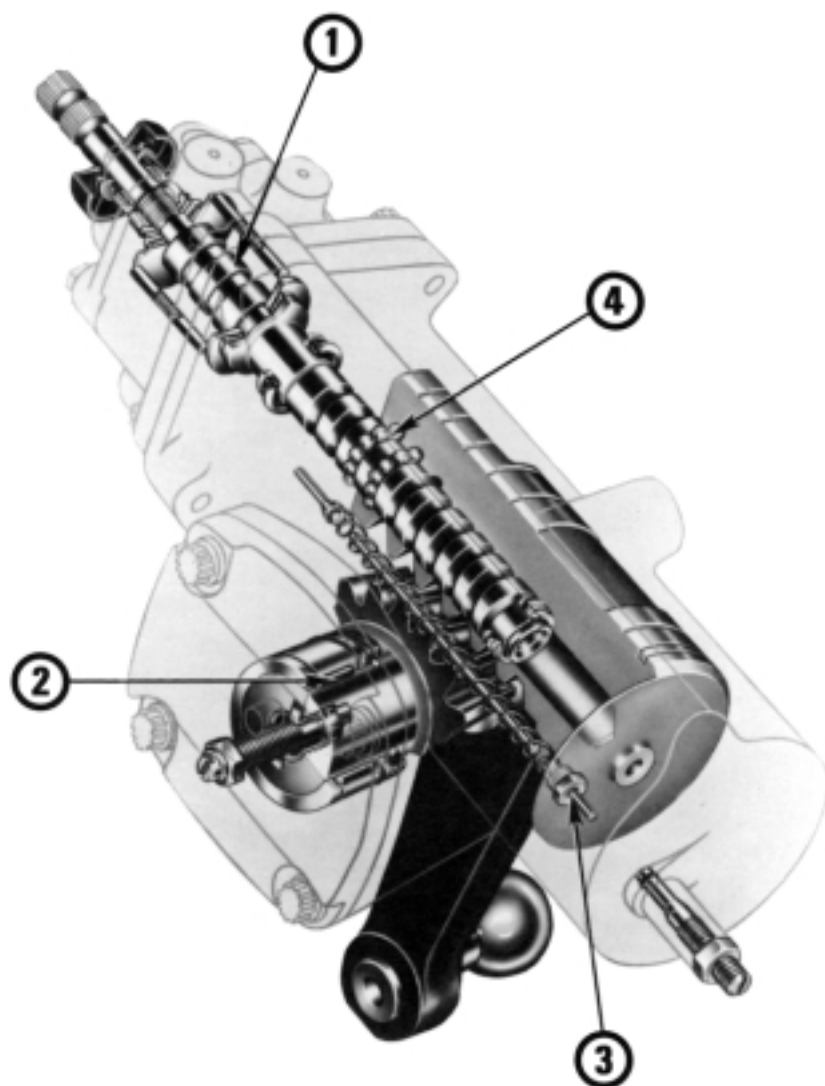
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Ross Gear Division

Price \$3.00

## 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.

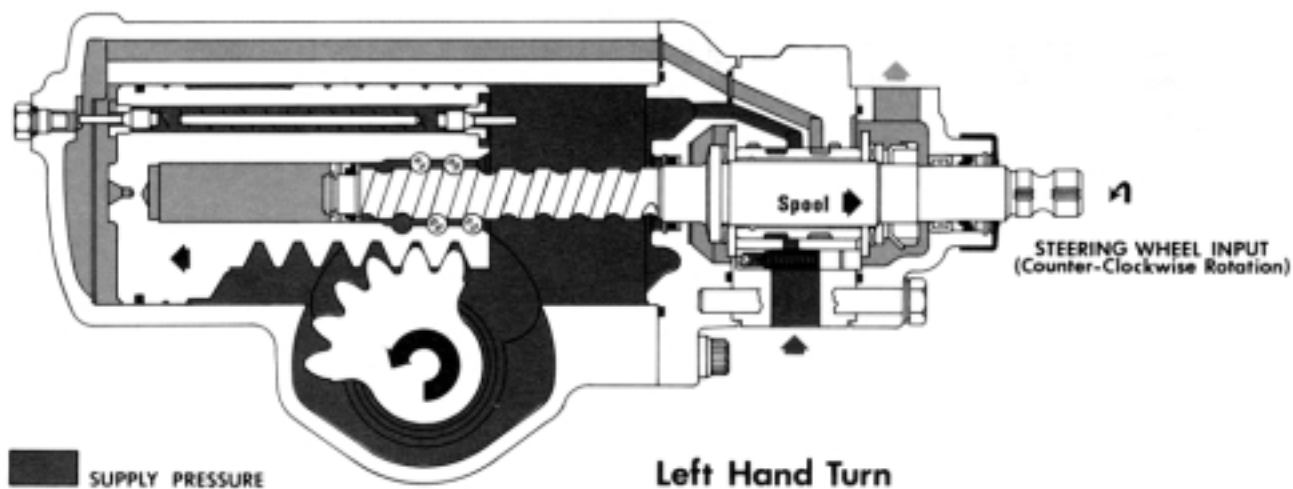
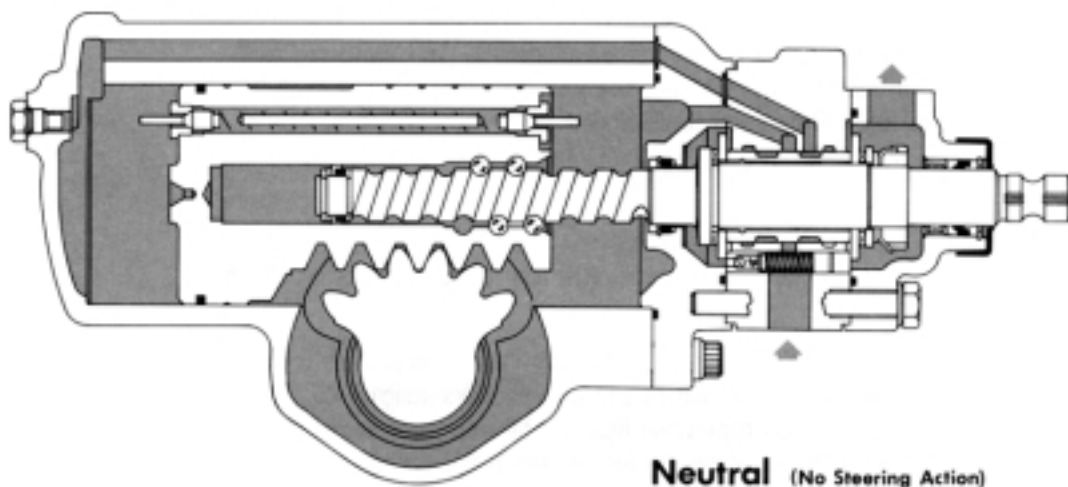
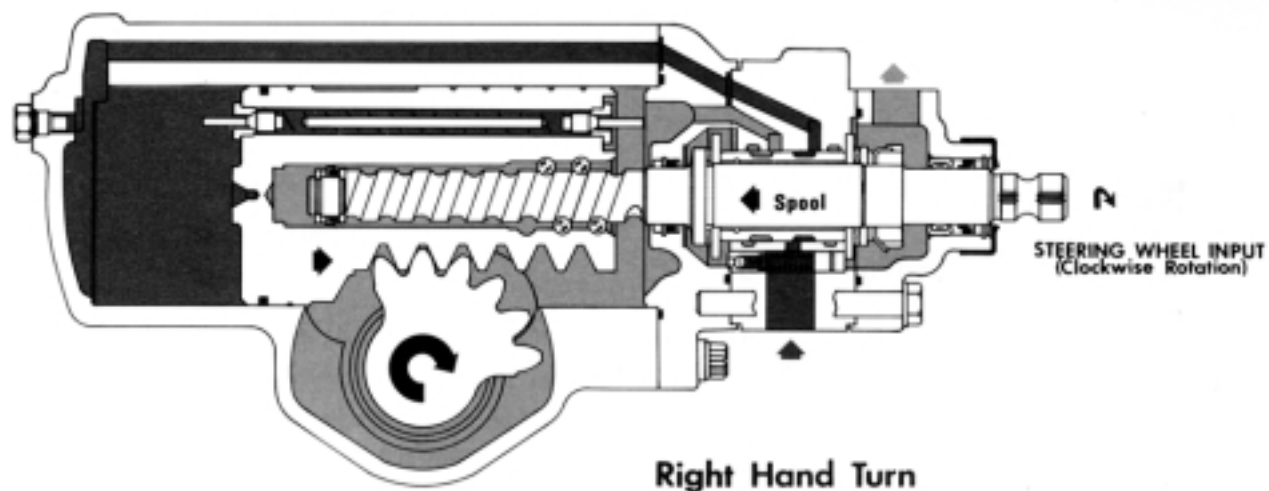
This manual also contains troubleshooting information and checklists. With them, you can diagnose a steering problem without removing the HF54 from the vehicle. If you must service the HF54, the checklists will help you to determine where the problem may be.



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

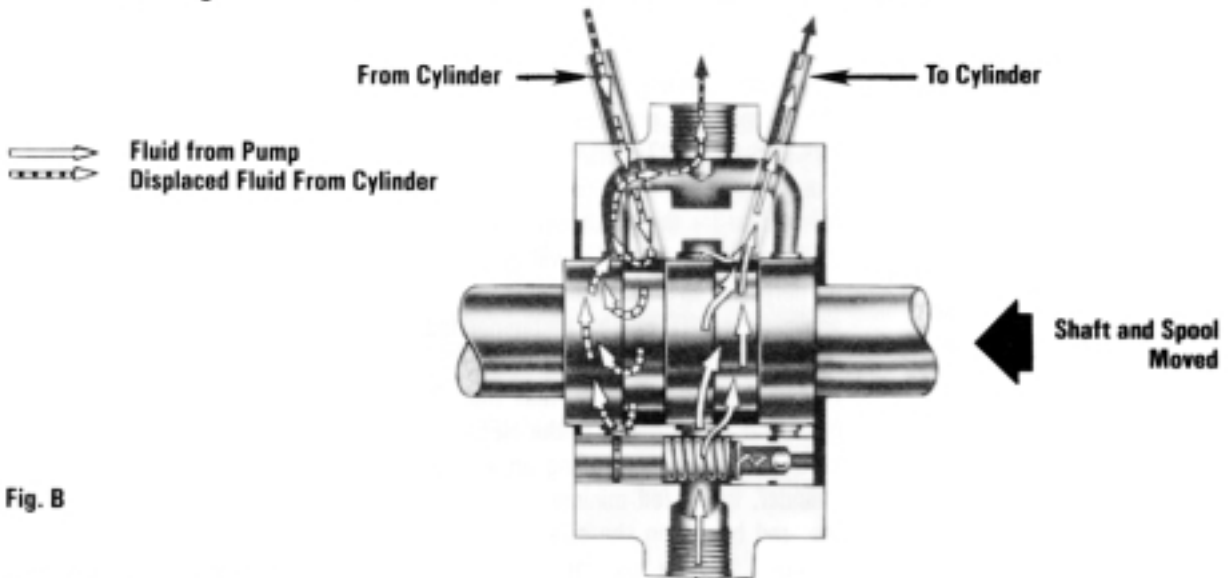


Fig. B

Valve Position and Fluid Flow  
For Right Turning

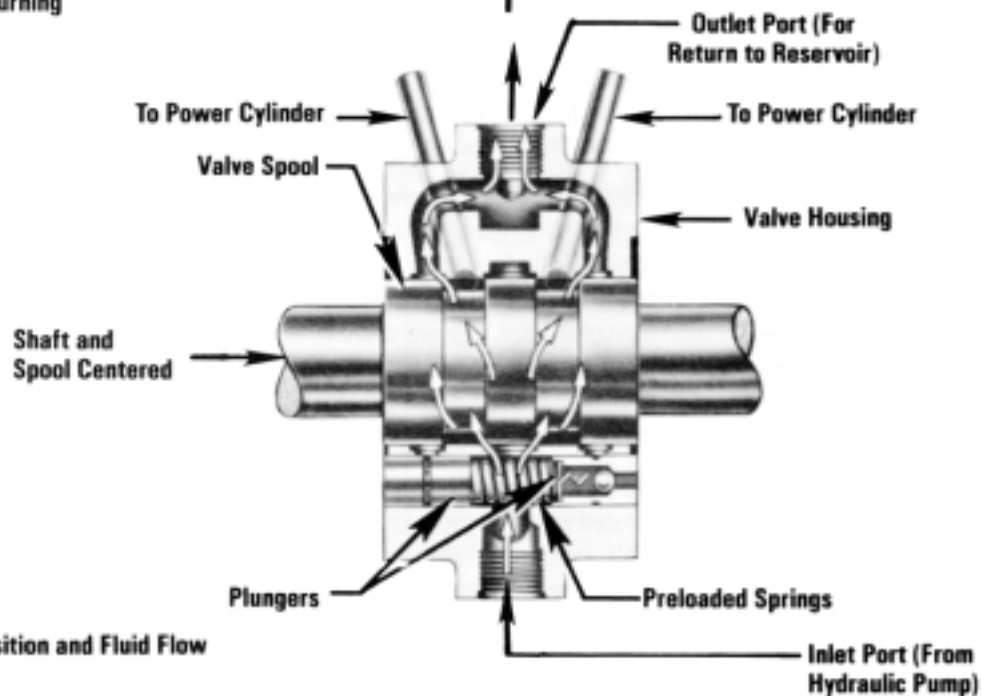


Fig. A

Neutral Valve Position and Fluid Flow

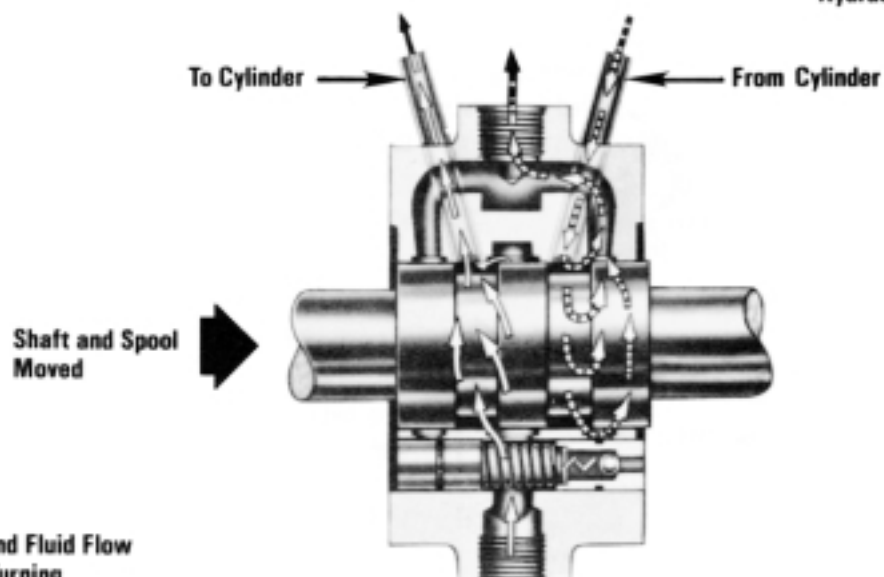


Fig. C

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.

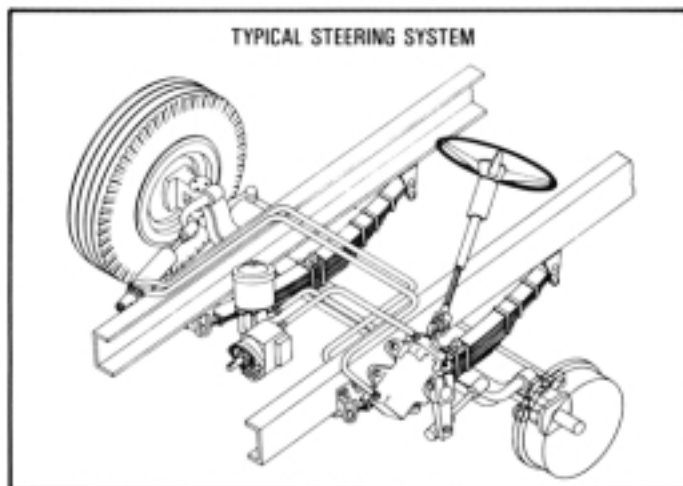


Figure 1

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.

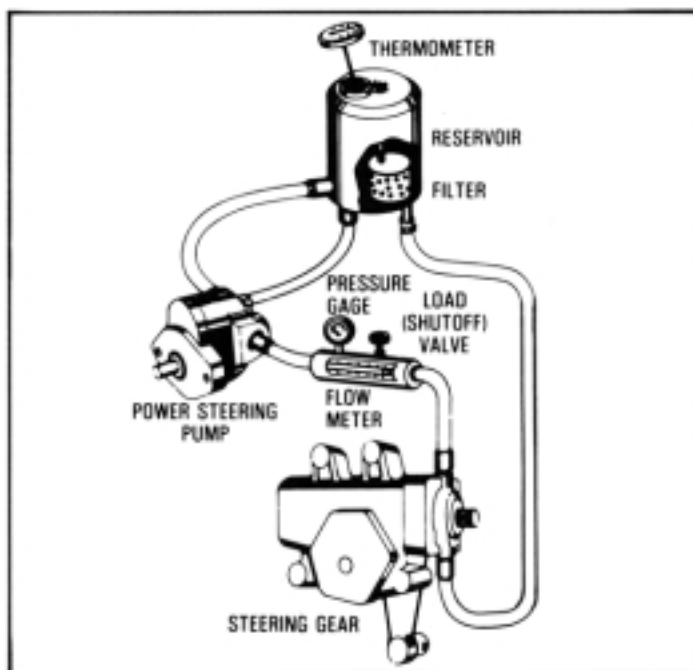


Figure 2

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).

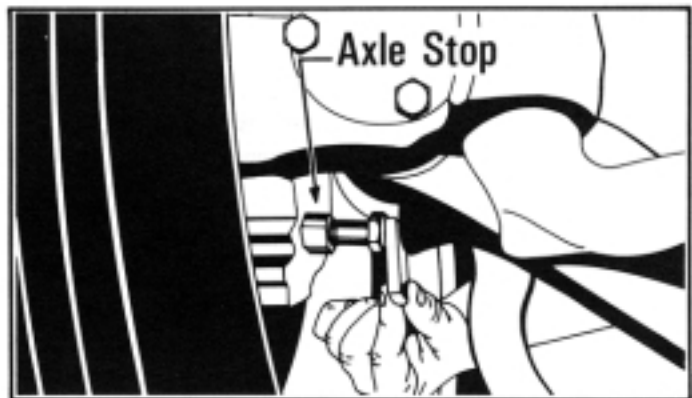


Figure 3

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 Trunnion Cover Seal

remove pitman arm

- 1.1 If a leak is detected in the trunnion cover area, you can remove the trunnion 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 trunnion 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.

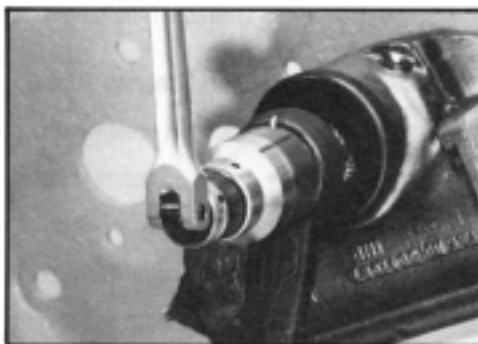


Figure 4

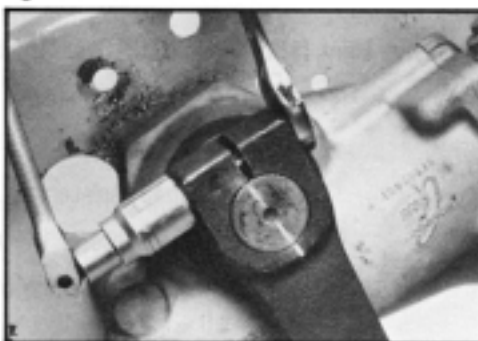


Figure 5

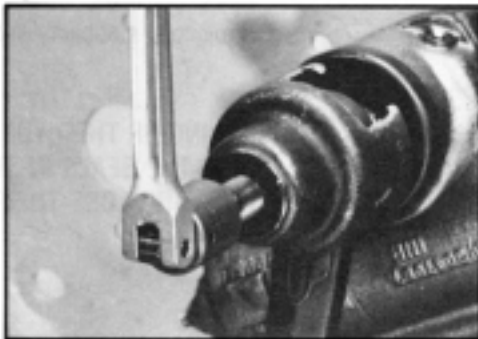


Figure 6



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

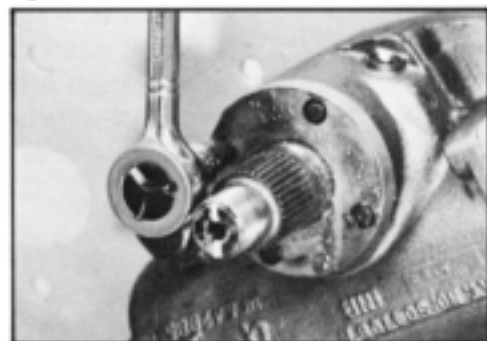


Figure 9



Figure 10

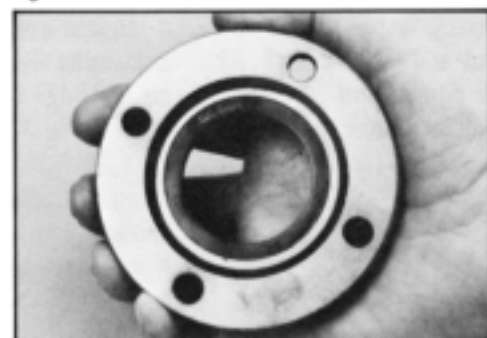


Figure 11



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.

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.

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.

## 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.

## 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 13

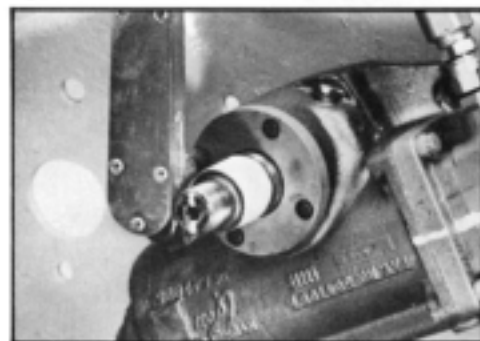


Figure 14



Figure 15



Figure 16



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.**

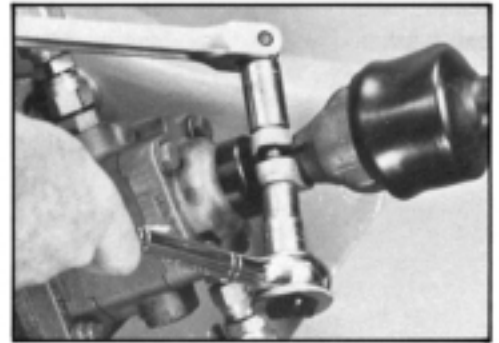


Figure 18



Figure 19

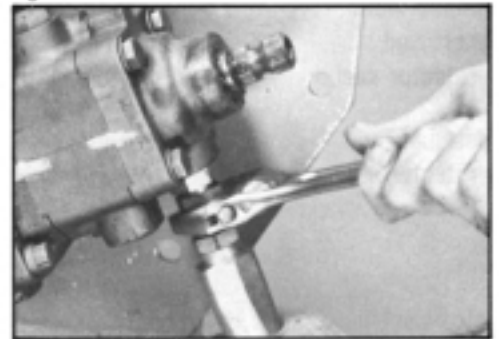


Figure 20

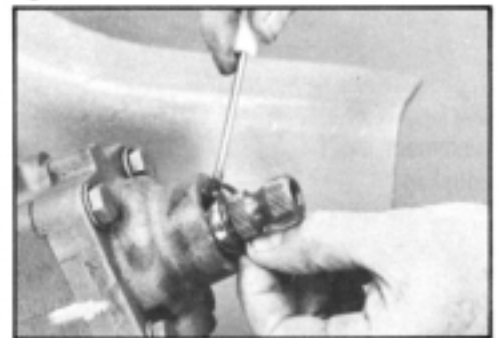


Figure 21

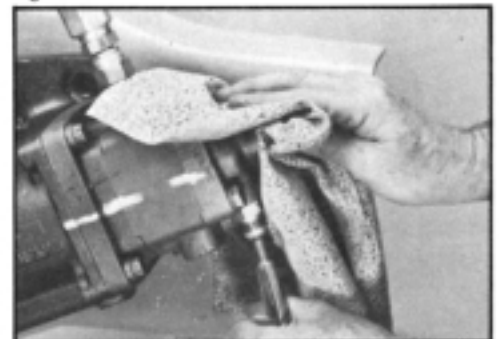


Figure 22

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.

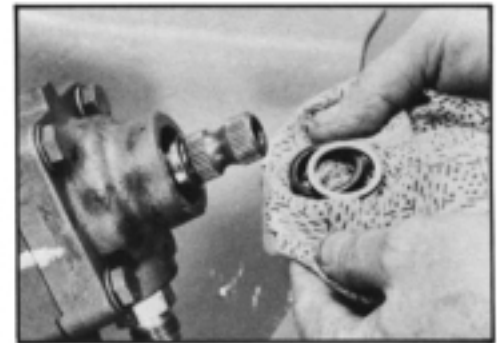


Figure 23

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.



Figure 26

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.

**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.

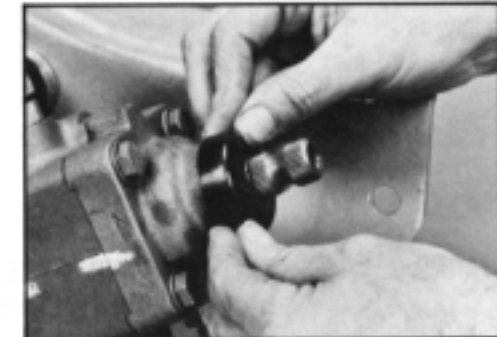


Figure 27



## 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.

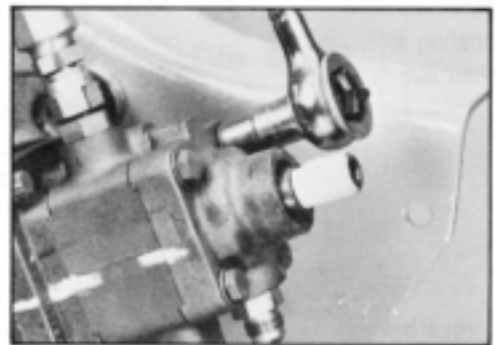


Figure 28

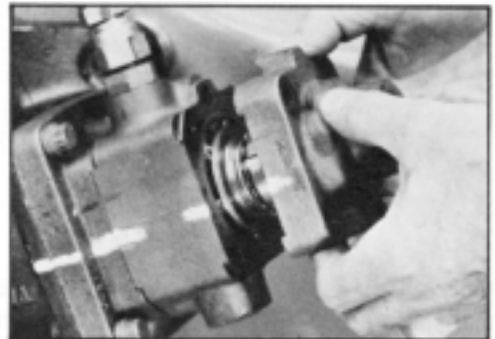


Figure 29

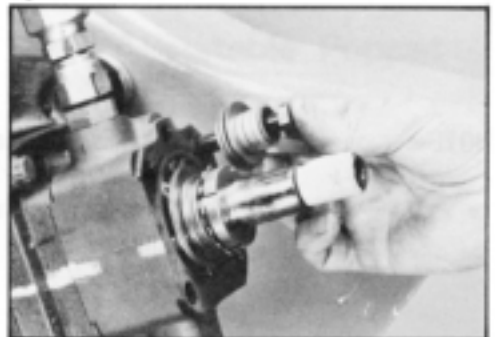


Figure 30

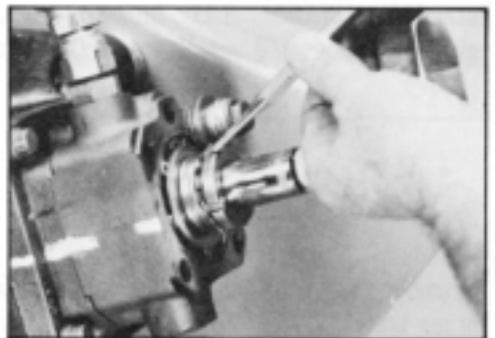


Figure 31



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.

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.

remove bolt and spacers

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

#### 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.

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.

complete the gear reassembly

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



Figure 33



Figure 34



Figure 35

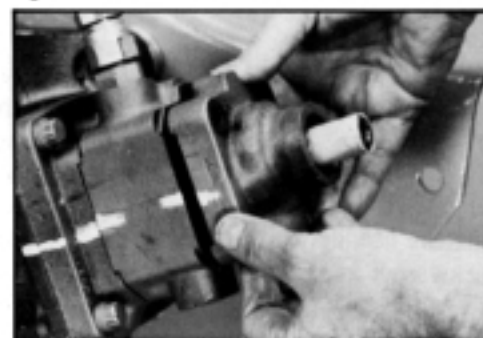


Figure 36

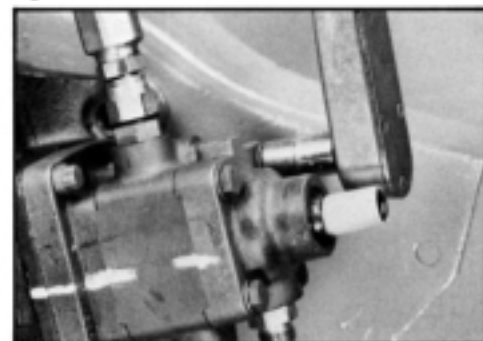


Figure 37



#### 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).

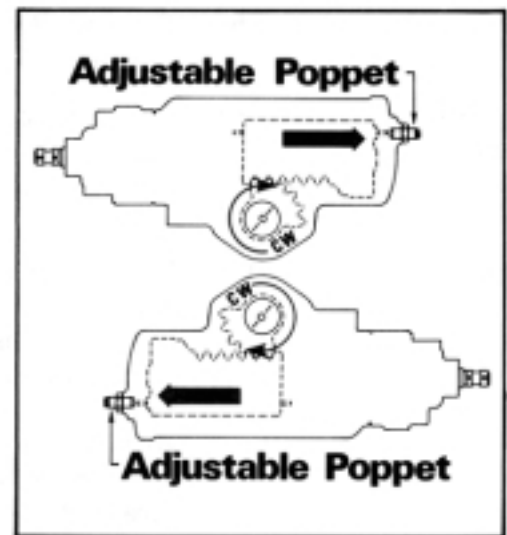


Figure 38

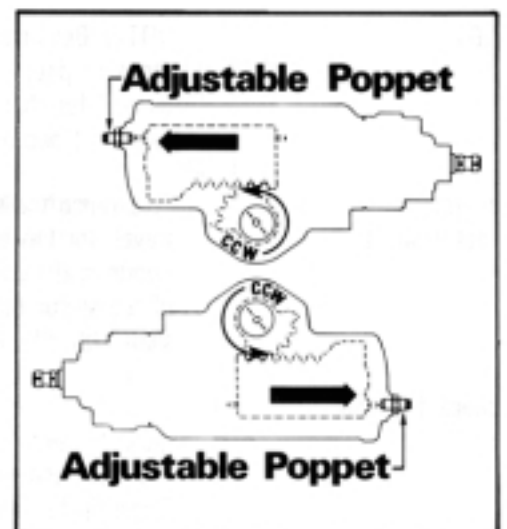


Figure 39

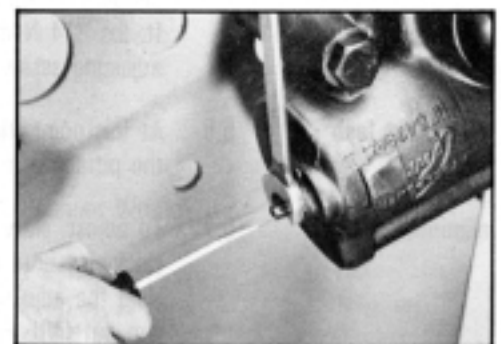


Figure 40

## 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

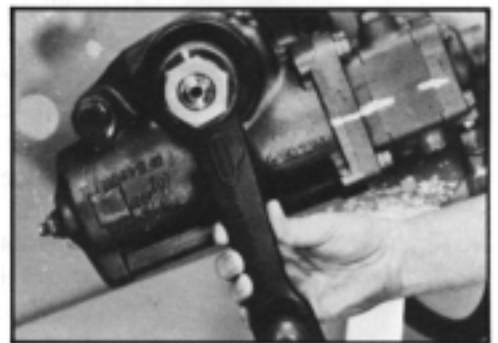


Figure 42

- |                      |     |  |
|----------------------|-----|--|
| recheck<br>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<br>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 in. lbs. (3.1-3.7 N m)
Locknut	9	15- 20 ft. lbs. ( 20- 27 N m)

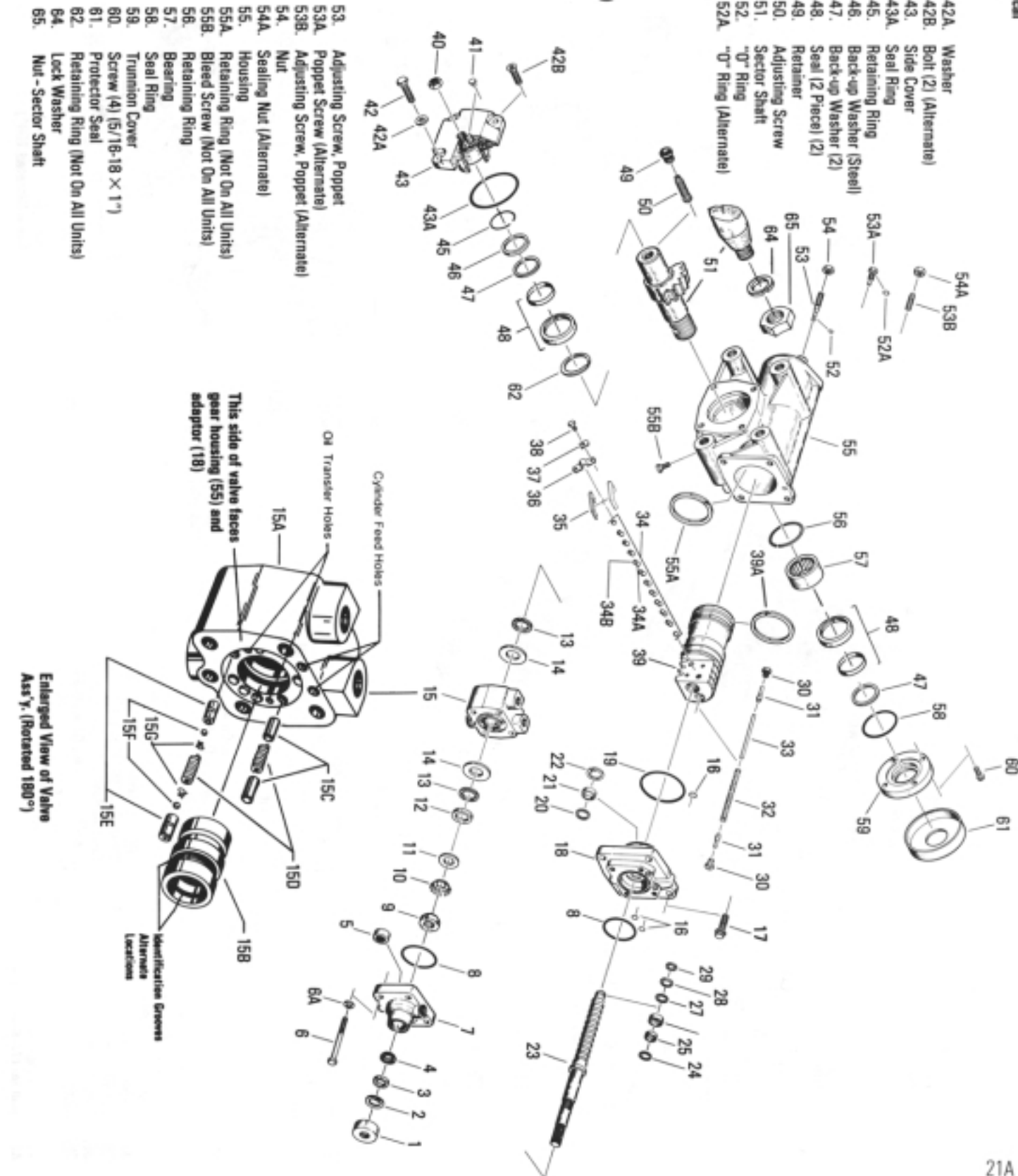
Universal joint bolts—torque to vehicle manufacturer's specifications.  
All torques specified in this manual are for dry/unplated parts unless otherwise specified.

## 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.     | Conical Spring (2)        |
| 16.      | 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")   |



# HF54 Exploded Assembly View - Typical

(Identical to page 21A)

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. 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)
- 34C. Ball Return Guide (2)
- 34D. Ball Return Guide Clip
35. Ball Return Guide (2)
36. Locking Tab (2)
37. Hex Head Bolts (2)
38. Rack Piston
39. Piston Ring
- 39A. Nut
40. Vent Plug
41. Bolt (4) (7/16-14 x 1")
42. Bolt (4) (7/16-14 x 1")
- 42A. Adjusting Screw, Poppet
- 42B. Poppet Screw (Alternate)
43. Adjusting Screw, Poppet (Alternate)
- 43A. Nut
- 43B. Sealing Nut (Alternate)
44. Housing
45. Retaining Ring (Not On All Units)
- 45A. Bleed Screw (Not On All Units)
46. Retaining Ring
47. Bearing
48. Seal Ring
49. Trunnion Cover
50. Screw (4) (5/16-18 x 1")
51. Protector Seal
52. Retaining Ring (Not On All Units)
53. Lock Washer
54. Nut - Sector Shaft
55. Washer
56. Bolt (2) (Alternate)
57. Side Cover
58. Seal Ring
59. Back-up Washer (Steel)
60. Back-up Washer (2)
61. Seal (2 Piece) (2)
62. Retainer
63. Adjusting Screw
64. Sector Shaft
65. "O" Ring
66. "O" Ring (Alternate)
67. Washer
68. Bolt (2) (Alternate)
69. Side Cover
70. Seal Ring
71. Back-up Washer (Steel)
72. Back-up Washer (2)
73. Seal (2 Piece) (2)
74. Retainer
75. Adjusting Screw
76. Sector Shaft
77. "O" Ring
78. "O" Ring (Alternate)
79. Washer
80. Bolt (2) (Alternate)
81. Side Cover
82. Seal Ring
83. Back-up Washer (Steel)
84. Back-up Washer (2)
85. Seal (2 Piece) (2)
86. Retainer
87. Adjusting Screw
88. Sector Shaft
89. "O" Ring
90. "O" Ring (Alternate)
91. Washer
92. Bolt (2) (Alternate)
93. Side Cover
94. Seal Ring
95. Back-up Washer (Steel)
96. Back-up Washer (2)
97. Seal (2 Piece) (2)
98. Retainer
99. Adjusting Screw
100. Sector Shaft
101. "O" Ring
102. "O" Ring (Alternate)
103. Washer
104. Bolt (2) (Alternate)
105. Side Cover
106. Seal Ring
107. Back-up Washer (Steel)
108. Back-up Washer (2)
109. Seal (2 Piece) (2)
110. Retainer
111. Adjusting Screw
112. Sector Shaft
113. "O" Ring
114. "O" Ring (Alternate)
115. Washer
116. Bolt (2) (Alternate)
117. Side Cover
118. Seal Ring
119. Back-up Washer (Steel)
120. Back-up Washer (2)
121. Seal (2 Piece) (2)
122. Retainer
123. Adjusting Screw
124. Sector Shaft
125. "O" Ring
126. "O" Ring (Alternate)
127. Washer
128. Bolt (2) (Alternate)
129. Side Cover
130. Seal Ring
131. Back-up Washer (Steel)
132. Back-up Washer (2)
133. Seal (2 Piece) (2)
134. Retainer
135. Adjusting Screw
136. Sector Shaft
137. "O" Ring
138. "O" Ring (Alternate)
139. Washer
140. Bolt (2) (Alternate)
141. Side Cover
142. Seal Ring
143. Back-up Washer (Steel)
144. Back-up Washer (2)
145. Seal (2 Piece) (2)
146. Retainer
147. Adjusting Screw
148. Sector Shaft
149. "O" Ring
150. "O" Ring (Alternate)
151. Washer
152. Bolt (2) (Alternate)
153. Side Cover
154. Seal Ring
155. Back-up Washer (Steel)
156. Back-up Washer (2)
157. Seal (2 Piece) (2)
158. Retainer
159. Adjusting Screw
160. Sector Shaft
161. "O" Ring
162. "O" Ring (Alternate)
163. Washer
164. Bolt (2) (Alternate)
165. Side Cover
166. Seal Ring
167. Back-up Washer (Steel)
168. Back-up Washer (2)
169. Seal (2 Piece) (2)
170. Retainer
171. Adjusting Screw
172. Sector Shaft
173. "O" Ring
174. "O" Ring (Alternate)
175. Washer
176. Bolt (2) (Alternate)
177. Side Cover
178. Seal Ring
179. Back-up Washer (Steel)
180. Back-up Washer (2)
181. Seal (2 Piece) (2)
182. Retainer
183. Adjusting Screw
184. Sector Shaft
185. "O" Ring
186. "O" Ring (Alternate)
187. Washer
188. Bolt (2) (Alternate)
189. Side Cover
190. Seal Ring
191. Back-up Washer (Steel)
192. Back-up Washer (2)
193. Seal (2 Piece) (2)
194. Retainer
195. Adjusting Screw
196. Sector Shaft
197. "O" Ring
198. "O" Ring (Alternate)
199. Washer
200. Bolt (2) (Alternate)
201. Side Cover
202. Seal Ring
203. Back-up Washer (Steel)
204. Back-up Washer (2)
205. Seal (2 Piece) (2)
206. Retainer
207. Adjusting Screw
208. Sector Shaft
209. "O" Ring
210. "O" Ring (Alternate)
211. Washer
212. Bolt (2) (Alternate)
213. Side Cover
214. Seal Ring
215. Back-up Washer (Steel)
216. Back-up Washer (2)
217. Seal (2 Piece) (2)
218. Retainer
219. Adjusting Screw
220. Sector Shaft
221. "O" Ring
222. "O" Ring (Alternate)
223. Washer
224. Bolt (2) (Alternate)
225. Side Cover
226. Seal Ring
227. Back-up Washer (Steel)
228. Back-up Washer (2)
229. Seal (2 Piece) (2)
230. Retainer
231. Adjusting Screw
232. Sector Shaft
233. "O" Ring
234. "O" Ring (Alternate)
235. Washer
236. Bolt (2) (Alternate)
237. Side Cover
238. Seal Ring
239. Back-up Washer (Steel)
240. Back-up Washer (2)
241. Seal (2 Piece) (2)
242. Retainer
243. Adjusting Screw
244. Sector Shaft
245. "O" Ring
246. "O" Ring (Alternate)
247. Washer
248. Bolt (2) (Alternate)
249. Side Cover
250. Seal Ring
251. Back-up Washer (Steel)
252. Back-up Washer (2)
253. Seal (2 Piece) (2)
254. Retainer
255. Adjusting Screw
256. Sector Shaft
257. "O" Ring
258. "O" Ring (Alternate)
259. Washer
260. Bolt (2) (Alternate)
261. Side Cover
262. Seal Ring
263. Back-up Washer (Steel)
264. Back-up Washer (2)
265. Seal (2 Piece) (2)
266. Retainer
267. Adjusting Screw
268. Sector Shaft
269. "O" Ring
270. "O" Ring (Alternate)
271. Washer
272. Bolt (2) (Alternate)
273. Side Cover
274. Seal Ring
275. Back-up Washer (Steel)
276. Back-up Washer (2)
277. Seal (2 Piece) (2)
278. Retainer
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281. "O" Ring
282. "O" Ring (Alternate)
283. Washer
284. Bolt (2) (Alternate)
285. Side Cover
286. Seal Ring
287. Back-up Washer (Steel)
288. Back-up Washer (2)
289. Seal (2 Piece) (2)
290. Retainer
291. Adjusting Screw
292. Sector Shaft
293. "O" Ring
294. "O" Ring (Alternate)
295. Washer
296. Bolt (2) (Alternate)
297. Side Cover
298. Seal Ring
299. Back-up Washer (Steel)
300. Back-up Washer (2)
301. Seal (2 Piece) (2)
302. Retainer
303. Adjusting Screw
304. Sector Shaft
305. "O" Ring
306. "O" Ring (Alternate)
307. Washer
308. Bolt (2) (Alternate)
309. Side Cover
310. Seal Ring
311. Back-up Washer (Steel)
312. Back-up Washer (2)
313. Seal (2 Piece) (2)
314. Retainer
315. Adjusting Screw
316. Sector Shaft
317. "O" Ring
318. "O" Ring (Alternate)
319. Washer
320. Bolt (2) (Alternate)
321. Side Cover
322. Seal Ring
323. Back-up Washer (Steel)
324. Back-up Washer (2)
325. Seal (2 Piece) (2)
326. Retainer
327. Adjusting Screw
328. Sector Shaft
329. "O" Ring
330. "O" Ring (Alternate)
331. Washer
332. Bolt (2) (Alternate)
333. Side Cover
334. Seal Ring
335. Back-up Washer (Steel)
336. Back-up Washer (2)
337. Seal (2 Piece) (2)
338. Retainer
339. Adjusting Screw
340. Sector Shaft
341. "O" Ring
342. "O" Ring (Alternate)
343. Washer
344. Bolt (2) (Alternate)
345. Side Cover
346. Seal Ring
347. Back-up Washer (Steel)
348. Back-up Washer (2)
349. Seal (2 Piece) (2)
350. Retainer
351. Adjusting Screw
352. Sector Shaft
353. "O" Ring
354. "O" Ring (Alternate)
355. Washer
356. Bolt (2) (Alternate)
357. Side Cover
358. Seal Ring
359. Back-up Washer (Steel)
360. Back-up Washer (2)
361. Seal (2 Piece) (2)
362. Retainer
363. Adjusting Screw
364. Sector Shaft
365. "O" Ring
366. "O" Ring (Alternate)
367. Washer
368. Bolt (2) (Alternate)
369. Side Cover
370. Seal Ring
371. Back-up Washer (Steel)
372. Back-up Washer (2)
373. Seal (2 Piece) (2)
374. Retainer
375. Adjusting Screw
376. Sector Shaft
377. "O" Ring
378. "O" Ring (Alternate)
379. Washer
380. Bolt (2) (Alternate)
381. Side Cover
382. Seal Ring
383. Back-up Washer (Steel)
384. Back-up Washer (2)
385. Seal (2 Piece) (2)
386. Retainer
387. Adjusting Screw
388. Sector Shaft
389. "O" Ring
390. "O" Ring (Alternate)
391. Washer
392. Bolt (2) (Alternate)
393. Side Cover
394. Seal Ring
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396. Back-up Washer (2)
397. Seal (2 Piece) (2)
398. Retainer
399. Adjusting Screw
400. Sector Shaft
401. "O" Ring
402. "O" Ring (Alternate)
403. Washer
404. Bolt (2) (Alternate)
405. Side Cover
406. Seal Ring
407. Back-up Washer (Steel)
408. Back-up Washer (2)
409. Seal (2 Piece) (2)
410. Retainer
411. Adjusting Screw
412. Sector Shaft
413. "O" Ring
414. "O" Ring (Alternate)
415. Washer
416. Bolt (2) (Alternate)
417. Side Cover
418. Seal Ring
419. Back-up Washer (Steel)
420. Back-up Washer (2)
421. Seal (2 Piece) (2)
422. Retainer
423. Adjusting Screw
424. Sector Shaft
425. "O" Ring
426. "O" Ring (Alternate)
427. Washer
428. Bolt (2) (Alternate)
429. Side Cover
430. Seal Ring
431. Back-up Washer (Steel)
432. Back-up Washer (2)
433. Seal (2 Piece) (2)
434. Retainer
435. Adjusting Screw
436. Sector Shaft
437. "O" Ring
438. "O" Ring (Alternate)
439. Washer
440. Bolt (2) (Alternate)
441. Side Cover
442. Seal Ring
443. Back-up Washer (Steel)
444. Back-up Washer (2)
445. Seal (2 Piece) (2)
446. Retainer
447. Adjusting Screw
448. Sector Shaft
449. "O" Ring
450. "O" Ring (Alternate)
451. Washer
452. Bolt (2) (Alternate)
453. Side Cover
454. Seal Ring
455. Back-up Washer (Steel)
456. Back-up Washer (2)
457. Seal (2 Piece) (2)
458. Retainer
459. Adjusting Screw
460. Sector Shaft
461. "O" Ring
462. "O" Ring (Alternate)
463. Washer
464. Bolt (2) (Alternate)
465. Side Cover
466. Seal Ring
467. Back-up Washer (Steel)
468. Back-up Washer (2)
469. Seal (2 Piece) (2)
470. Retainer
471. Adjusting Screw
472. Sector Shaft
473. "O" Ring
474. "O" Ring (Alternate)
475. Washer
476. Bolt (2) (Alternate)
477. Side Cover
478. Seal Ring
479. Back-up Washer (Steel)
480. Back-up Washer (2)
481. Seal (2 Piece) (2)
482. Retainer
483. Adjusting Screw
484. Sector Shaft
485. "O" Ring
486. "O" Ring (Alternate)
487. Washer
488. Bolt (2) (Alternate)
489. Side Cover
490. Seal Ring
491. Back-up Washer (Steel)
492. Back-up Washer (2)
493. Seal (2 Piece) (2)
494. Retainer
495. Adjusting Screw
496. Sector Shaft
497. "O" Ring
498. "O" Ring (Alternate)
499. Washer
500. Bolt (2) (Alternate)
501. Side Cover
502. Seal Ring
503. Back-up Washer (Steel)
504. Back-up Washer (2)
505. Seal (2 Piece) (2)
506. Retainer
507. Adjusting Screw
508. Sector Shaft
509. "O" Ring
510. "O" Ring (Alternate)
511. Washer
512. Bolt (2) (Alternate)
513. Side Cover
514. Seal Ring
515. Back-up Washer (Steel)
516. Back-up Washer (2)
517. Seal (2 Piece) (2)
518. Retainer
519. Adjusting Screw
520. Sector Shaft
521. "O" Ring
522. "O" Ring (Alternate)
523. Washer
524. Bolt (2) (Alternate)
525. Side Cover
526. Seal Ring
527. Back-up Washer (Steel)
528. Back-up Washer (2)
529. Seal (2 Piece) (2)
530. Retainer
531. Adjusting Screw
532. Sector Shaft
533. "O" Ring
534. "O" Ring (Alternate)
535. Washer
536. Bolt (2) (Alternate)
537. Side Cover
538. Seal Ring
539. Back-up Washer (Steel)
540. Back-up Washer (2)
541. Seal (2 Piece) (2)
542. Retainer
543. Adjusting Screw
544. Sector Shaft
545. "O" Ring
546. "O" Ring (Alternate)
547. Washer
548. Bolt (2) (Alternate)
549. Side Cover
550. Seal Ring
551. Back-up Washer (Steel)
552. Back-up Washer (2)
553. Seal (2 Piece) (2)
554. Retainer
555. Adjusting Screw
556. Sector Shaft
557. "O" Ring
558. "O" Ring (Alternate)
559. Washer
560. Bolt (2) (Alternate)
561. Side Cover
562. Seal Ring
563. Back-up Washer (Steel)
564. Back-up Washer (2)
565. Seal (2 Piece) (2)
566. Retainer
567. Adjusting Screw
568. Sector Shaft
569. "O" Ring
570. "O" Ring (Alternate)
571. Washer
572. Bolt (2) (Alternate)
573. Side Cover
574. Seal Ring
575. Back-up Washer (Steel)
576. Back-up Washer (2)
577. Seal (2 Piece) (2)
578. Retainer
579. Adjusting Screw
580. Sector Shaft
581. "O" Ring
582. "O" Ring (Alternate)
583. Washer
584. Bolt (2) (Alternate)
585. Side Cover
586. Seal Ring
587. Back-up Washer (Steel)
588. Back-up Washer (2)
589. Seal (2 Piece) (2)
590. Retainer
591. Adjusting Screw
592. Sector Shaft
593. "O" Ring
594. "O" Ring (Alternate)
595. Washer
596. Bolt (2) (Alternate)
597. Side Cover
598. Seal Ring
599. Back-up Washer (Steel)
600. Back-up Washer (2)
601. Seal (2 Piece) (2)
602. Retainer
603. Adjusting Screw
604. Sector Shaft
605. "O" Ring
606. "O" Ring (Alternate)
607. Washer
608. Bolt (2) (Alternate)
609. Side Cover
610. Seal Ring
611. Back-up Washer (Steel)
612. Back-up Washer (2)
613. Seal (2 Piece) (2)
614. Retainer
615. Adjusting Screw
616. Sector Shaft
617. "O" Ring
618. "O" Ring (Alternate)
619. Washer
620. Bolt (2) (Alternate)
621. Side Cover
622. Seal Ring
623. Back-up Washer (Steel)
624. Back-up Washer (2)
625. Seal (2 Piece) (2)
626. Retainer
627. Adjusting Screw
628. Sector Shaft
629. "O" Ring
630. "O" Ring (Alternate)
631. Washer
632. Bolt (2) (Alternate)
633. Side Cover
634. Seal Ring
635. Back-up Washer (Steel)
636. Back-up Washer (2)
637. Seal (2 Piece) (2)
638. Retainer
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642. "O" Ring (Alternate)
643. Washer
644. Bolt (2) (Alternate)
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647. Back-up Washer (Steel)
648. Back-up Washer (2)
649. Seal (2 Piece) (2)
650. Retainer
651. Adjusting Screw
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655. Washer
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661. Seal (2 Piece) (2)
662. Retainer
663. Adjusting Screw
664. Sector Shaft
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666. "O" Ring (Alternate)
667. Washer
668. Bolt (2) (Alternate)
669. Side Cover
670. Seal Ring
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678. "O" Ring (Alternate)
679. Washer
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682. Seal Ring
683. Back-up Washer (Steel)
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685. Seal (2 Piece) (2)
686. Retainer
687. Adjusting Screw
688. Sector Shaft
689. "O" Ring
690. "O" Ring (Alternate)
691. Washer
692. Bolt (2) (Alternate)
693. Side Cover
694. Seal Ring
695. Back-up Washer (Steel)
696. Back-up Washer (2)
697. Seal (2 Piece) (2)
698. Retainer
699. Adjusting Screw
700. Sector Shaft
701. "O" Ring
702. "O" Ring (Alternate)
703. Washer
704. Bolt (2) (Alternate)
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708. Back-up Washer (2)
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710. Retainer
711. Adjusting Screw
712. Sector Shaft
713. "O" Ring
714. "O" Ring (Alternate)
715. Washer
716. Bolt (2) (Alternate)
717. Side Cover
718. Seal Ring
719. Back-up Washer (Steel)
720. Back-up Washer (2)
721. Seal (2 Piece) (2)
722. Retainer
723. Adjusting Screw
724. Sector Shaft
725. "O" Ring
726. "O" Ring (Alternate)
727. Washer
728. Bolt (2) (Alternate)
729. Side Cover
730. Seal Ring
731. Back-up Washer (Steel)
732. Back-up Washer (2)
733. Seal (2 Piece) (2)
734. Retainer
735. Adjusting Screw
736. Sector Shaft
737. "O" Ring
738. "O" Ring (Alternate)
739. Washer
740. Bolt (2) (Alternate)
741. Side Cover
742. Seal Ring
743. Back-up Washer (Steel)
744. Back-up Washer (2)
745. Seal (2 Piece) (2)
746. Retainer
747. Adjusting Screw
748. Sector Shaft
749. "O" Ring
750. "O" Ring (Alternate)
751. Washer
752. Bolt (2) (Alternate)
753. Side Cover
754. Seal Ring
755. Back-up Washer (Steel)
756. Back-up Washer (2)
757. Seal (2 Piece) (2)
758. Retainer
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760. Sector Shaft
761. "O" Ring
762. "O" Ring (Alternate)
763. Washer
764. Bolt (2) (Alternate)
765. Side Cover
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768. Back-up Washer (2)
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770. Retainer
771. Adjusting Screw
772. Sector Shaft
773. "O" Ring
774. "O" Ring (Alternate)
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786. "O" Ring (Alternate)
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805. Seal (2 Piece) (2)
806. Retainer
807. Adjusting Screw
808. Sector Shaft
809. "O" Ring
810. "O" Ring (Alternate)
811. Washer
812. Bolt (2) (Alternate)
813. Side Cover
814. Seal Ring
815. Back-up Washer (Steel)
816. Back-up Washer (2)
817. Seal (2 Piece) (2)
818. Retainer
819. Adjusting Screw
820. Sector Shaft
821. "O" Ring
822. "O" Ring (Alternate)
823. Washer
824. Bolt (2) (Alternate)
825. Side Cover
826. Seal Ring
827. Back-up Washer (Steel)
828. Back-up Washer (2)
829. Seal (2 Piece) (2)
830. Retainer
831. Adjusting Screw
832. Sector Shaft
833. "O" Ring
834. "O" Ring (Alternate)
835. Washer
836. Bolt (2) (Alternate)
837. Side Cover
838. Seal Ring
839. Back-up Washer (Steel)
840. Back-up Washer (2)
841. Seal (2 Piece) (2)
842. Retainer
843. Adjusting Screw
844. Sector Shaft
845. "O" Ring
846. "O" Ring (Alternate)
847. Washer
848. Bolt (2) (Alternate)
849. Side Cover
850. Seal Ring
851. Back-up Washer (Steel)
852. Back-up Washer (2)
853. Seal (2 Piece) (2)
854. Retainer
855. Adjusting Screw
856. Sector Shaft
857. "O" Ring
858. "O" Ring (Alternate)
859. Washer
860. Bolt (2) (Alternate)
861. Side Cover
862. Seal Ring
863. Back-up Washer (Steel)
864. Back-up Washer (2)
865. Seal (2 Piece) (2)
866. Retainer
867. Adjusting Screw
868. Sector Shaft
869. "O" Ring
870. "O" Ring (Alternate)
871. Washer
872. Bolt (2) (Alternate)
873. Side Cover
874. Seal Ring
- 8

# Disassembly

## Preparation

- THOROUGHLY CLEAN OFF ALL OUTSIDE DIRT, ESPECIALLY FROM AROUND FITTINGS AND HOSE CONNECTIONS, BEFORE YOU REMOVE THE GEAR.
- Drain the steering gear assembly.
- Remove input and output shaft connections per 1.1 and 2.1, Page 12 and 15.
- Remove the supply and return lines from the gear, and immediately plug all port holes and fluid lines.

**WARNING: THIS STEERING GEAR WEIGHS APPROXIMATELY 80 POUNDS, 36 KG, DRY. EXERCISE CAUTION WHEN YOU REMOVE, LIFT, OR CARRY IT. DO NOT POUND THE UNIVERSAL JOINT OR INPUT SHAFT COUPLING ON OR OFF THE INPUT SHAFT. INTERNAL DAMAGE TO THE STEERING GEAR CAN RESULT.**

- Remove the steering gear from the vehicle and take it to a clean surface (a piece of wrapping paper makes an excellent disposable top).
- Clean and dry the gear before you start to disassemble it.
- As you disassemble the gear, clean all parts in clean, petroleum-based solvent, and blow them dry only.

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

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

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

- Keep each part separate to avoid nicks and burrs.
- Discard all seals, O-rings, and gaskets removed from the gear. Replace them with new parts only.

## Disassembly

position gear  
and sector shaft

1. Position the steering gear firmly in a vise, clamping against the housing (55) mounting flange or boss, with the worm shaft (23) in a horizontal direction and components accessible for disassembly. SEE FIGURE 43.

### CAUTION

**CAUTION: Do not clamp against body of the housing as this could damage housing and cause disassembly, assembly difficulties. If housing mounting boss or flange is not accessible for clamping in vise, fabricate and attach a mounting plate to the housing mounting bosses for this purpose.**

drain gear and  
position  
sector shaft

2. Prepare for fluid drainage and unplug hydraulic ports. Using appropriate 3/4 or 11/16 inch 12 point socket on the worm shaft serrations, rotate worm shaft (23) through gear travel a few times to purge hydraulic fluid from gear. Then rotate

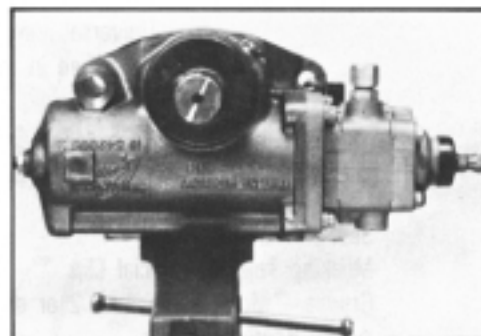


Figure 43

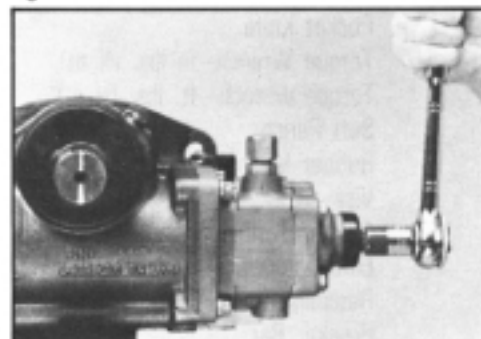


Figure 44

the worm shaft until the timing mark on the end of the sector shaft (51) is vertical to the worm shaft. This will position the gear for sector shaft removal. SEE FIGURE 44.

# NOTE

**NOTE:** If the steering gear does not have a sector shaft timing mark, position sector shaft for removal by rotating worm shaft from end of travel one half of the total worm shaft rotations, counted when rotating worm shaft from one end of travel to the other.

remove  
protector seal

3. Remove protector seal (61) from trunnion cover (59). SEE FIGURE 45.

clean sector  
shaft

4. Remove any paint or corrosion from the exposed area of sector shaft (51) with emery cloth. SEE FIGURE 46.

remove trunnion  
cover bolts

5. Remove the four trunnion cover screws (60). A 5/16 inch 12 point thin wall socket required. SEE FIGURE 47.

remove trunnion  
cover and  
seal package

6. Remove the trunnion cover (59). Remove and discard the seal ring (58), the two piece sector shaft seal (48) and the \*Teflon backup washer (47) from the trunnion cover. SEE FIGURE 48.

loosen sector  
shaft adjusting  
screw jam nut

7. Loosen sector shaft adjusting screw jam nut (40). SEE FIGURE 49. 3/4 inch socket required.

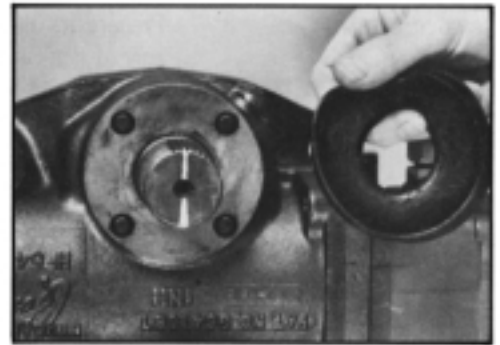


Figure 45



Figure 46

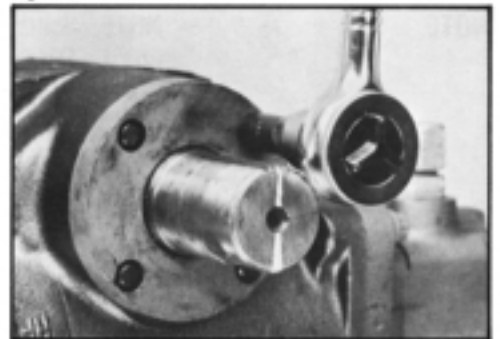


Figure 47



Figure 48

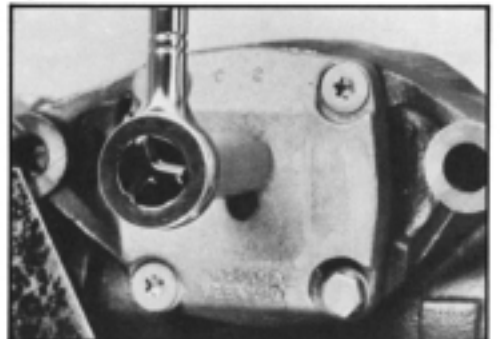


Figure 49



remove side  
cover bolts

8. Prepare for fluid to drain and remove the four special bolts (42) and lockwashers (42A) from the side cover (43). A 5/8 inch socket required. SEE FIGURE 50. Tap lightly with a soft hammer on the end of sector shaft (51) to disengage seal and let drain.

**NOTE**

**NOTE:** These bolts are special because they are equipped with either a ring or washer design on the underside of the head. SEE FIGURE 51. If you replace one or more bolts, you must use bolts of either design and of the SAME SPECIAL TYPE AND LENGTH AS THOSE YOU REMOVED. Do not use a substitute. You can get these bolts through your OEM parts distributor.

**NOTE**

**NOTE:** Some units have a flat head Torx drive bolt (42B) without a lockwasher as one or two of the side cover bolts. A T-50 Torx socket required.

remove side  
cover and sector  
shaft assembly

9. Remove side cover (43) and shaft assembly (51) as a unit from gear assembly. SEE FIGURE 52. Remove and discard seal ring (43A).

**NOTE**

**NOTE:** If sector shaft hangs up on housing face during removal rotate worm shaft until sector shaft is positioned for removal.

remove sector  
shaft from  
side cover

10. Remove jam nut (40) and screw sector shaft adjusting screw (50) out of side cover (43) and lift sector shaft (51) out of side cover. SEE FIGURE 53.

remove side  
seal retainer

11. Remove the side cover retaining ring (62) if there is one in the unit. SEE FIGURE 54.

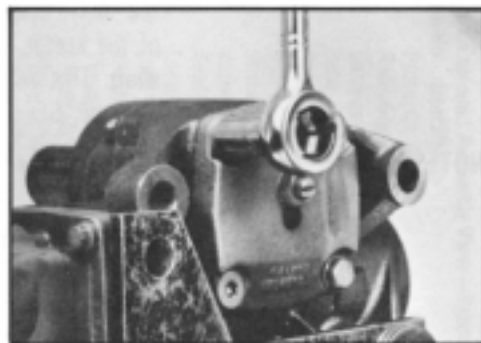


Figure 50

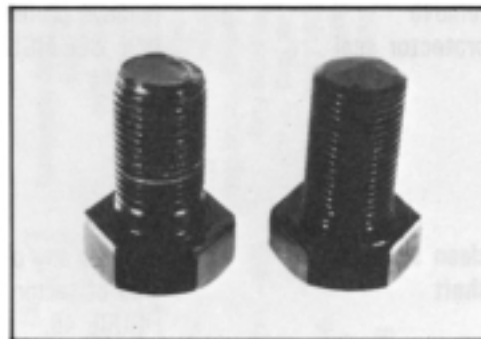


Figure 51

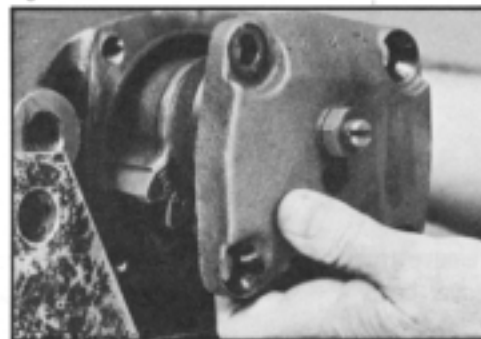


Figure 52

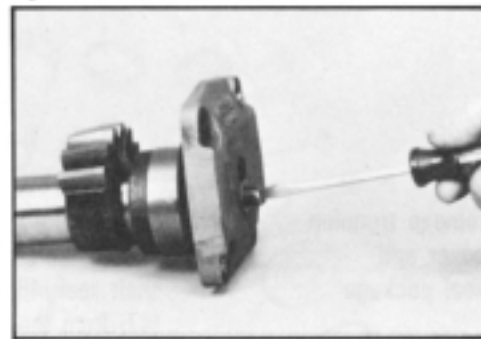


Figure 53



Figure 54



remove seal  
package and  
vent plug

12. Remove the two piece seal (48), the Teflon backup washer (47) and steel backup washer (46) from side cover (43). Discard the two piece seal and Teflon washer. SEE FIGURE 55. Remove and discard vent plug (41).

**NOTE**

**NOTE:** Do not remove retaining ring (45) from side cover (43) unless it must be replaced.

remove retainer  
and adjusting  
screw

13. Only if replacement of retainer (49) and or adjusting screw (50) is required, (see inspection procedure #9, page 34.) place the sector shaft (51) firmly in a soft jawed vise and unstake retainer using a suitable chisel. Turn retainer out of sector shaft pocket and remove adjusting screw. Discard retainer. SEE FIGURE 56.

remove seal  
and clean  
worm shaft

14. Remove protector seal (1) from worm shaft (23). Clean exposed area of the worm shaft with a fine grade of emery paper. SEE FIGURE 57.

**NOTE:**

**NOTE:** Scribing or marking a line across the housing (55) adaptor (18) valve body (15A) and upper cover (7) before disassembly will facilitate correct alignment of these components when reassembled.

loosen upper  
cover bolts and  
adjusting nut

15. Loosen the four upper cover bolts (6) for later removal. A 9/16 inch socket required. SEE FIGURE 58.

remove adaptor  
bolts

16. Remove four adaptor bolts (17). A 7/16 inch 12 point socket required. SEE FIGURE 59.



Figure 55

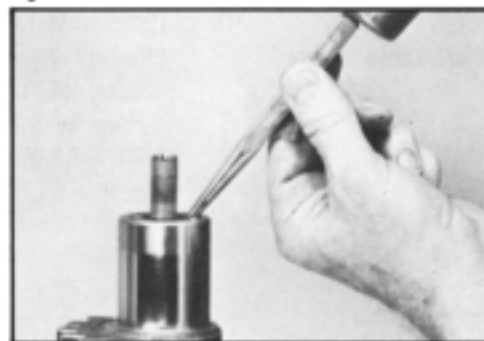


Figure 56

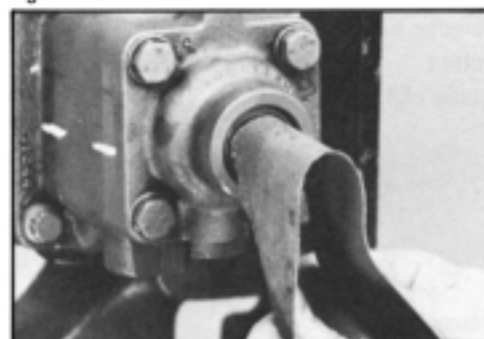


Figure 57

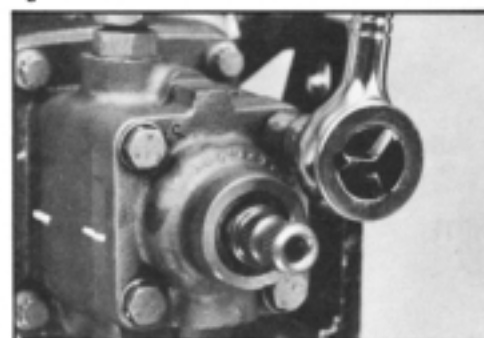


Figure 58

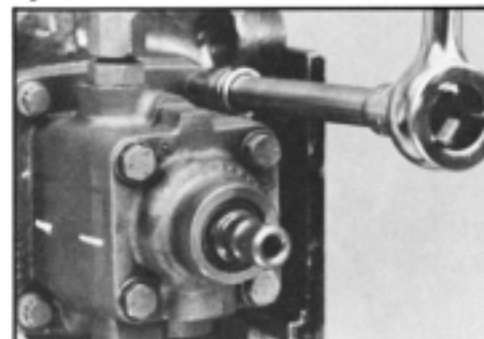


Figure 59

rotate worm  
shaft to  
loosen adaptor

17. Rotate worm shaft (23) until adaptor (18) moves away from housing (55), about 3/4 inch (19 mm) and let drain. SEE FIGURE 60.

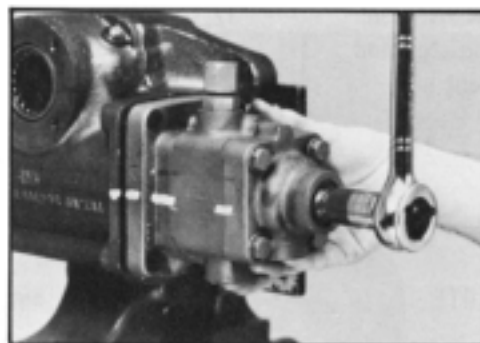


Figure 60

remove worm  
shaft subassembly

18. Remove worm shaft (23), upper cover (7) adaptor (18) rack piston (39) subassembly as a unit from housing (55) and place on a cloth covered work surface, with the ball return guides (35) up. SEE FIGURE 61. Remove and discard seal ring (19) and seal ring (16).



Figure 61

remove ball  
return  
guide clip

19. Bend the tangs down on the two locking tabs (37). SEE FIGURE 62. Remove the two hex bolts (38), locking tabs and ball return guide clip (36). 7/16 inch socket required. SEE FIGURE 63. Discard lock tabs.



Figure 62

remove guides  
and balls

20. Remove the ball return guide halves (35) from the rack piston (39). With the rack piston ball guide holes tilting down, rotate worm shaft (23) to allow all balls (34A, 34B) to fall out. SEE FIGURE 64.



Figure 63

#### NOTE

**NOTE:** The ball return guide is closely fitted with the rack piston, and you may have to remove the halves by carefully inserting a screw driver between the rack and the guide.

#### CAUTION

**CAUTION:** The 22 steel balls are a matched set. Take care not to lose any of them. If you lose any of the balls, you must replace them with a complete, new set.

#### WARNING

**WARNING:** INCORRECT MATCHING OF BALLS, WORMSCREW AND RACK PISTON CAN RESULT IN LOSS OF STEERING, WHICH COULD RESULT IN AN ACCIDENT.

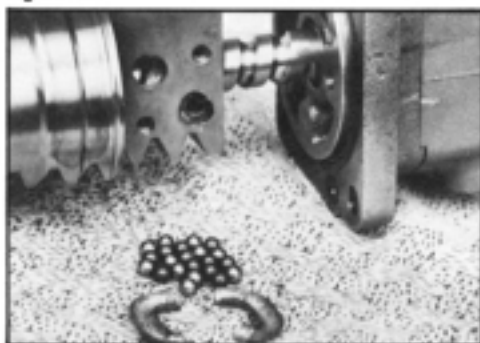


Figure 64

remove rack piston from subassembly

21. Remove rack piston (39) from worm shaft (23) subassembly. SEE FIGURE 65.

**NOTE**

**NOTE:** Do not remove rack piston ring (39A) or poppet (31) components from the rack piston unless replacement is necessary.

**WARNING**

**WARNING:** DURING STEP 22 YOU SHOULD WEAR EYE PROTECTION. AS THE SPRING LOADED POPPETS COULD EJECT, AND CAUSE EYE INJURY.

remove poppets

22. To remove poppets, place rack piston (39) in a soft jawed vise and turn poppet seats (30) out of both ends of rack piston. Remove two poppets (31), the nylon spacer rod (33) and spring (32). A 9/16 inch socket required. SEE FIGURES 66 and 67.

cut and remove worm shaft seal

23. Hold the seal cup (26) and seal (25) in place with pliers and cut, remove, and discard the seal cup and seal from end of worm shaft (23). SEE FIGURE 68.

remove retainers and washers

24. Remove retaining ring (29) using needle nose pliers, then remove retaining washer (28) bronze backup washer (27) and steel washer (24) from end of worm shaft (23). SEE FIGURE 69.

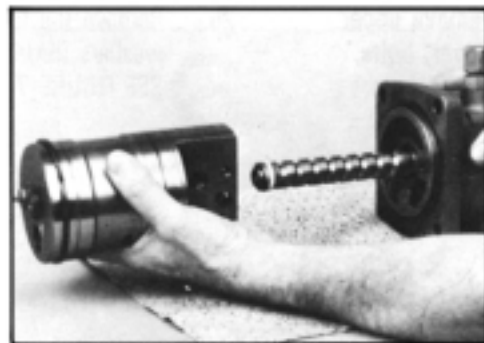


Figure 65

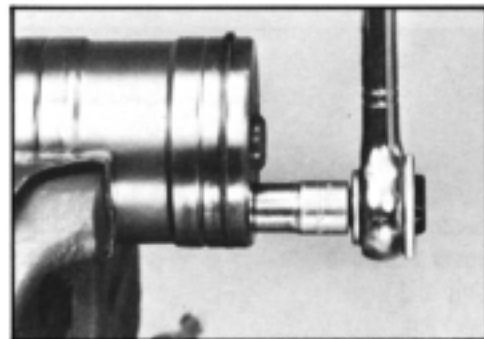


Figure 66

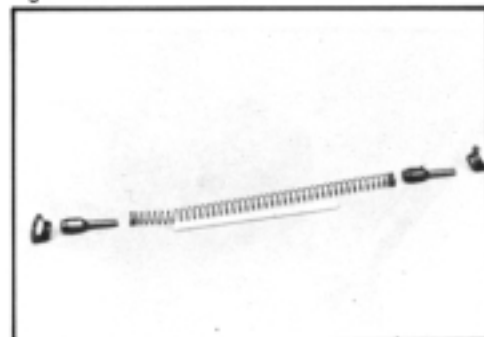


Figure 67

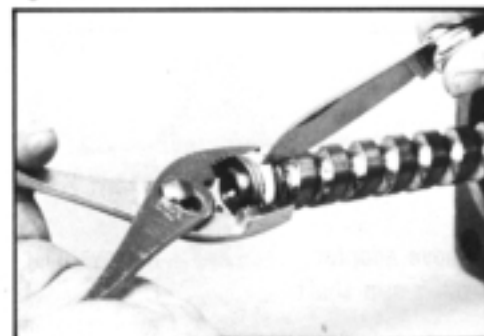


Figure 68



Figure 69

remove upper  
cover, bolts,  
and washers

25. Remove the four loosened upper cover bolts (6), washers (6A) and the upper cover (7) assembly. SEE FIGURE 70. Discard seal ring (8).



Figure 70

remove upper  
cover retaining  
ring and seal  
package

26. Remove retaining ring (2) from upper cover (7) with the appropriate retaining ring pliers or small screw driver. SEE FIGURE 71. Remove backup washer (3) and seal (4). SEE FIGURE 72. Discard seal.

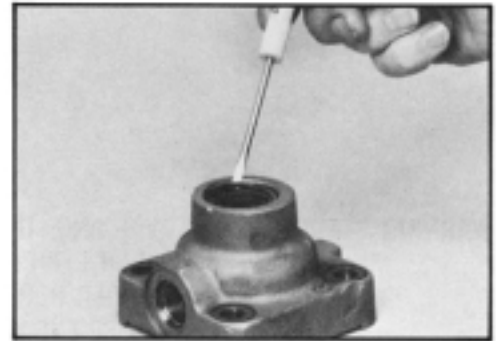


Figure 71

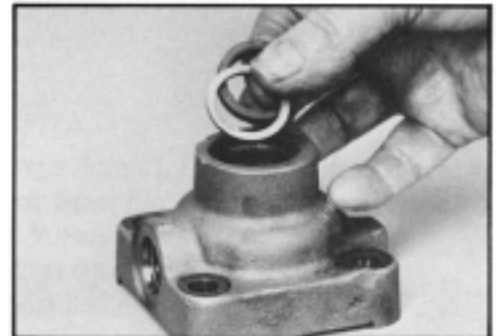


Figure 72

remove adaptor  
from worm shaft

27. Remove adaptor (18) from worm shaft (23). SEE FIGURE 73. Remove and discard seal ring (8) and two seal rings (16).

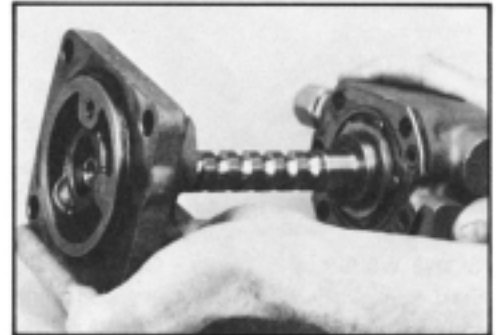


Figure 73

remove retaining  
ring, seal and  
backup washer

28. Remove retaining ring (22) from adaptor (18). SEE FIGURE 74. Remove and discard seal (21) and backup washer (20). SEE FIGURE 75.

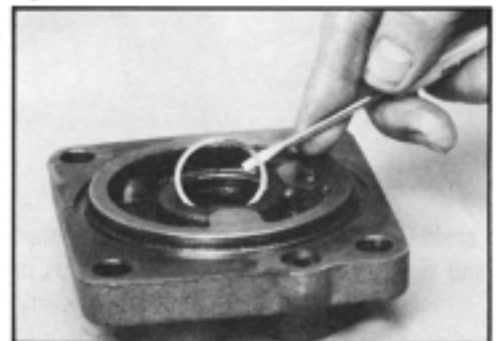


Figure 74

unstake locking washer from nut

29. Unstake the tang on bearing lockwasher (10) that is staked in a slot of bearing (spanner) lock nut (9) on the worm shaft, valve subassembly. SEE FIGURE 76.

remove bearing lock nut

30. Use a breaker bar and the appropriate 3/4 or 11/16 inch 12 point socket on the serrations to hold worm shaft (23) from rotating or clamp worm shaft carefully in a soft jawed vise. Turn off the bearing lock nut (9) from the worm shaft with a hook type spanner wrench or self gripping (groove joint) pliers. SEE FIGURE 77.

#### NOTE

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

remove washer and thrust bearing package

31. Remove and discard bearing lock washer (10) and remove washer (11), thrust washer (12), thrust bearing (13) and thrust washer (14). SEE FIGURE 78.

remove valve assembly

32. Carefully remove valve assembly (15) intact from worm shaft (23) and set aside for inspection and assembly procedures. SEE FIGURE 79.

#### CAUTION

**CAUTION:** The valve assembly (15) is the control center of the hydraulic system. The major parts, which are the body and spool, are machined to very close tolerances and with precision machined edges. The valve spool and valve body are selectively fitted at the factory and therefore these two parts are not separately replaceable. If either is damaged or excessively worn, the whole valve assembly should be replaced - good performance of power steering is not assured if "mis-matched" valve spool and valve body are used. Care should be exercised in the handling of these parts to prevent damage. Sealing edges of the valve body bore and the valve spool should not be broken. This will result in excessive leakage and reduce hydraulic power. Should valve spool (15B) or other valve components become disassembled follow the assembly procedures with care.



Figure 75



Figure 76



Figure 77

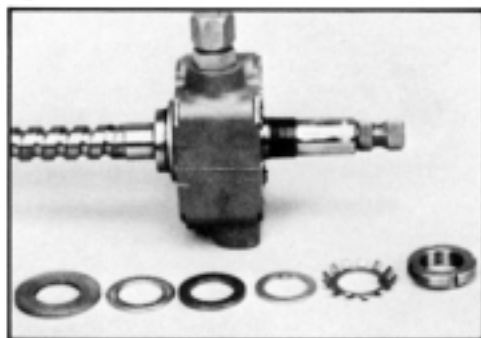


Figure 78

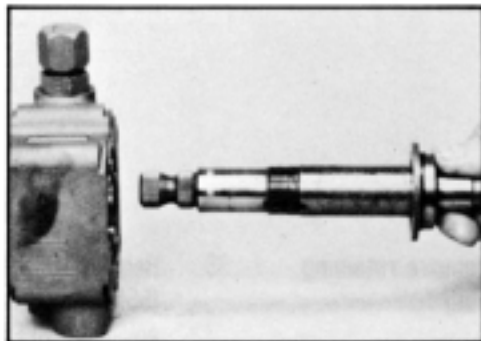


Figure 79

remove second  
thrust bearing  
package

33. Remove the second thrust washer (14) and thrust bearing (15) from worm shaft (23). SEE FIGURE 80.

#### NOTE

**NOTE:** HF54 steering gears may be equipped with one of three alternate types of poppet screws as shown on the exploded assembly view on pages 21A and 21B.

remove and  
disassemble  
poppet screw  
assembly

34. Remove poppet screw assembly or poppet screw and nut assembly from housing (55) as follows:  
  
Remove nut (54), poppet adjusting screw (53) and o-ring (52). Discard o-ring. 11/16 inch socket required. SEE FIGURE 81.

**Or** remove sealing nut (54A) and adjusting screw (53). Discard sealing nut. 3/4 and 5/16 inch socket required. SEE FIGURE 82.

**Or** remove non adjusting hex head poppet screw (53A) and o-ring (52A). Discard o-ring. 1/2 or 9/16 inch socket required. SEE FIGURE 83.

remove retaining  
ring

35. Remove spacer ring (55A) from bottom of housing (55) rack piston bore if the housing is so equipped. SEE FIGURE 84.

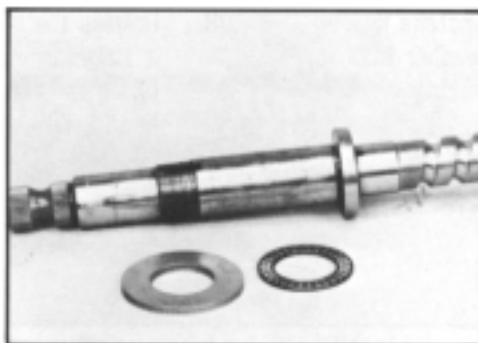


Figure 80

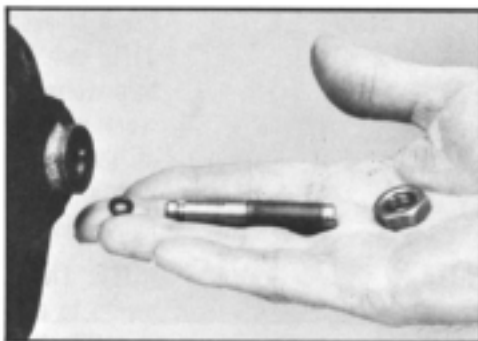


Figure 81

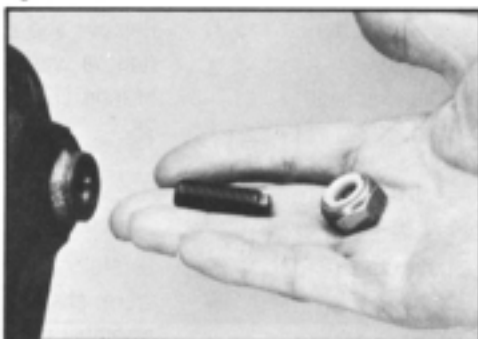


Figure 82

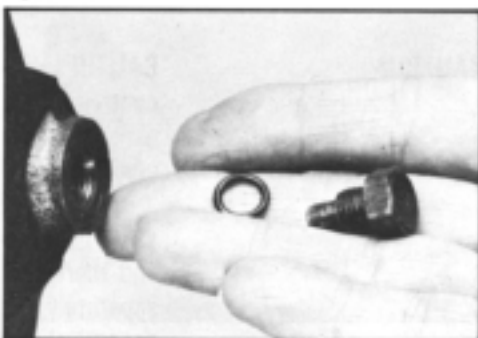


Figure 83



Figure 84

remove bleed  
screw

36. Remove bleed screw (55B) if the housing is so equipped. 5/16 inch socket required. SEE FIGURE 85.

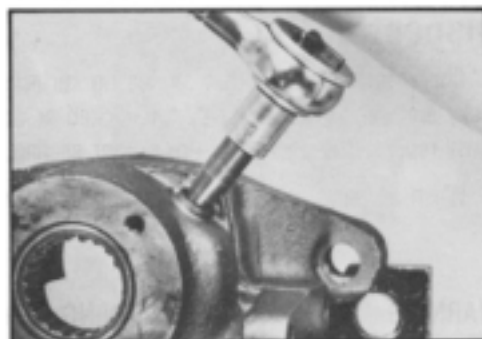


Figure 85

remove housing  
bearing if  
necessary

37. The housing bearing assembly (57) should only be removed if you determine that only the bearing must be replaced after following housing inspection procedures 6, 7, and 8. Place a suitable bearing mandrel that will clear the retaining ring (56) inside diameter to apply pressure from the side cover opening and press the bearing assembly out through the trunnion cover opening. SEE FIGURE 86. Maintain a good square contact between housing and press base to avoid damaging the housing bearing bore. Discard bearing. Do not remove retaining ring (56) unless it must be replaced.

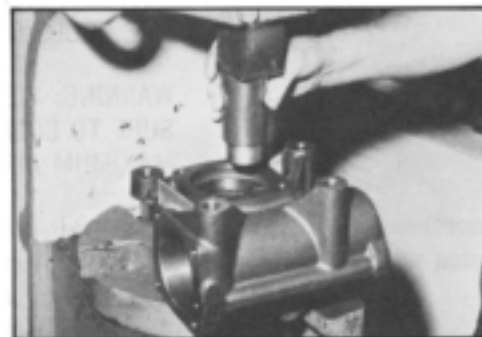


Figure 86

#### CAUTION

**CAUTION:** If the bearing is cocked while you press it out, it will burnish the bore, causing it to become oversized. You will then have to replace the gear housing.

press out  
upper cover  
bearing

38. Press bearing (5) out of upper cover (7) with a bearing mandrel against seal end of bearing and only if it is to be replaced. Discard bearing. SEE FIGURE 87.

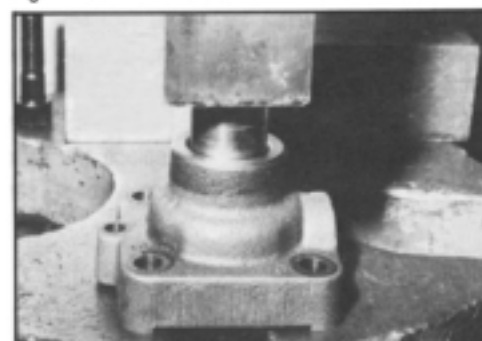


Figure 87

This completes the disassembly of HF54 steering gear.



## Inspection

- Check to make sure that all sealing surfaces and seal cavities are free from nicks and corrosion. If any part is nicked or corroded where sealing occurs, you must replace the part to insure proper sealing.
- Wash all parts in clean petroleum-based solvent. Blow them dry with air only.

### WARNING

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

### WARNING

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

#### inspect rack piston teeth

1. Inspect rack piston (39) teeth for cracks and wear. If you can detect a step by running your fingernail horizontally across the teeth surface, you must replace the rack piston, sector shaft (51) and set of 22 balls (34). SEE FIGURE 88.

#### inspect ball track grooves on rack piston and worm shaft

2. Inspect the rack piston internal ball-track grooves for brinelling (dents) or spalling (flaking). SEE FIGURE 89. If either condition exists, you must replace the rack piston (39), worm shaft (23) and use a set of service balls (34).

### NOTE

**NOTE: If a ball (34A) (34B) is lost during service procedures all 22 balls must be replaced with a service ball kit. Damaged balls would require a matched worm shaft, rack piston and ball set replacement.**

#### inspect worm shaft

3. Inspect the worm shaft (23) ball track grooves for brinelling or spalling. SEE FIGURE 90. If either condition exists, you must replace the worm shaft, rack piston (39), and the set of service balls (34). Visually inspect the sealing surface on the worm shaft for nicks, and run your fingernail edge across the sealing surface to detect steps. These conditions would require worm shaft replacement and a service ball kit. If discoloration from excess heat is detected replace worm shaft, valve rack piston, adaptor and upper cover assembly. SEE FIGURE 91.

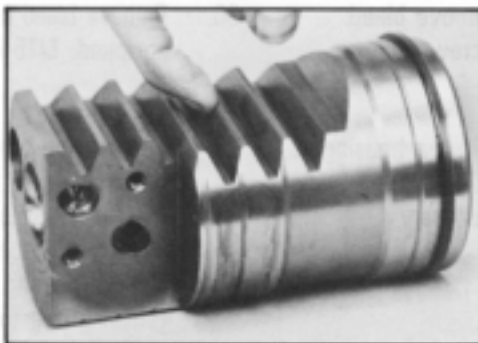


Figure 88

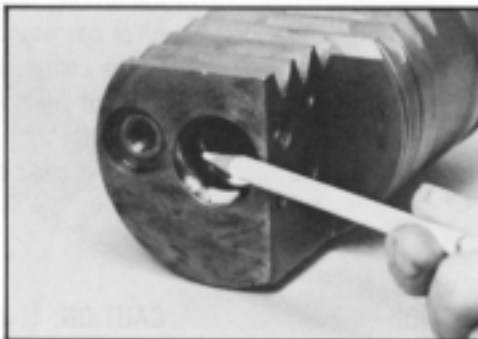


Figure 89

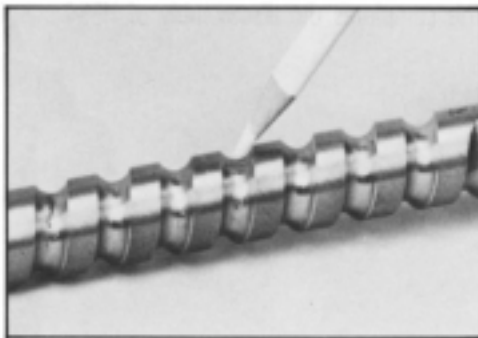


Figure 90

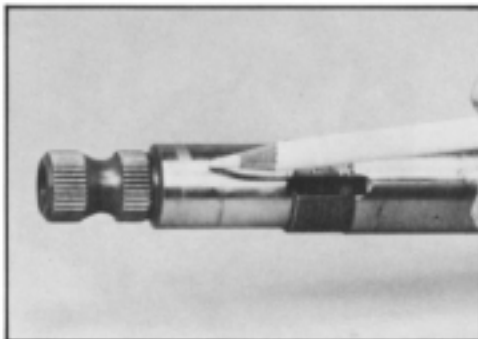


Figure 91



inspect valve assembly

**CAUTION**

4. Inspect valve spool (15B) and valve body (15A) bore for broken sealing edges. SEE FIGURE 92.

**CAUTION:** The valve assembly (15) is the control center of the hydraulic system. The major parts, which are the body and spool, are machined to very close tolerance and with precision machined edges. The valve spool and valve body are selectively fitted at the factory and therefore these two parts are not separately replaceable. If either is damaged or excessively worn, the whole valve assembly should be replaced - good performance of power steering is not assured if "mis-matched" valve spool and valve body are used. Care should be exercised in the handling of these parts to prevent damage. Sealing edges of the valve body bore and the valve spool should not be broken. This will result in excessive leakage and reduce hydraulic power. Should valve spool (15B) or other valve components become disassembled, follow the assembly procedures with care.



Figure 92

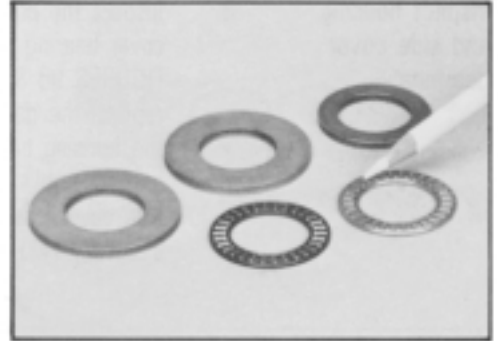


Figure 93

inspect thrust washers and bearing

5. Inspect the thrust bearing (13) rollers for any deterioration. Inspect the thrust washers (12) and (14) for brinelling, spalling, or cracks. SEE FIGURE 93. Replace the part if you detect these conditions.

inspect housing cylinder bore

6. Inspect the housing (55) cylinder bore, SEE FIGURE 94. You will probably notice normal scoring marks running lengthwise through the bore. Since this scoring is normal, you should not compare it to the scoring considered detrimental in the cylinder bores of an internal combustion engine. Replace the housing only if you've tested it for internal leakage (as described in the troubleshooting section on page 7) and you've determined that the scoring, and not damaged seals, is responsible for the excessive internal leakage, greater than 1.5 GPM (5.7 liters/min.).

**NOTE**

**NOTE:** In running the internal leakage test after reassembly of the unit, make sure that internal leakage exceeding 1.5 GPM (5.7 liters/min.) can only be attributed to the housing and not to the improper assembly of the new seals in the worm shaft, rack piston, and valve assembly, before you replace the housing.

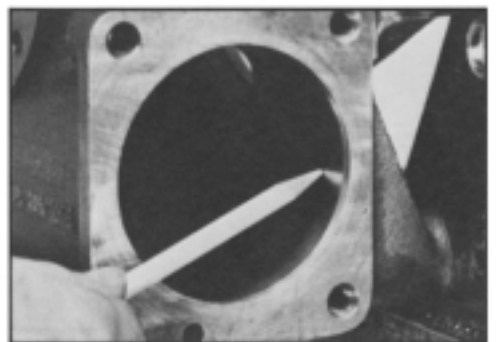


Figure 94

inspect housing  
faces

7. Inspect the housing (55) faces for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a fine-toothed flat file without changing the dimensional characteristics. SEE FIGURE 95.

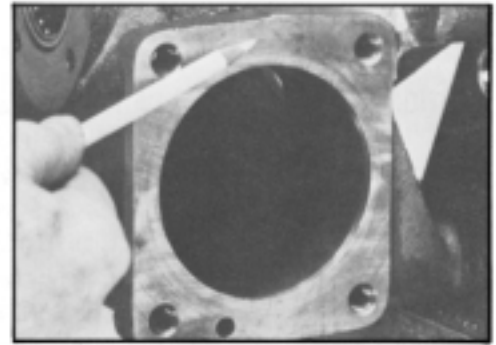


Figure 95

inspect housing  
and side cover  
bearings

8. Inspect the housing bearing (57) and the side cover bearing for brinelling or spalling. SEE FIGURES 96 & 97. If either condition exists, replace the damaged housing bearing (57). For the housing bearing, follow disassembly step 37 and assembly step 1, pages 31 and 35. If the side cover bearing is damaged, replace side cover assembly (43).

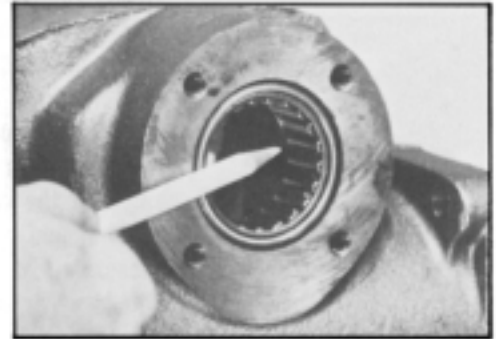


Figure 96

inspect sector  
shaft assembly

9. Inspect the sector shaft (51) bearing and sealing areas and sector teeth contact surfaces for brinelling or spalling. SEE FIGURE 98. Run your fingernail edge across these areas to detect steps. Inspect also for cracks. Remove any masking tape from the shaft serrations and inspect for twisted or otherwise damaged serrations. If any of these conditions exist, replace the sector shaft.



Figure 97

inspect  
adjusting screw  
and retainer

10. Inspect the sector shaft assembly for damaged adjusting screw (50) threads. The staked retainer (49) must be locked in place, and have no cracks. The adjusting screw must rotate by hand with no perceptible end play (lash). Replace adjusting screw, if damaged. Replace the retainer, if damaged, or if the adjusting screw requires replacement or adjustment.

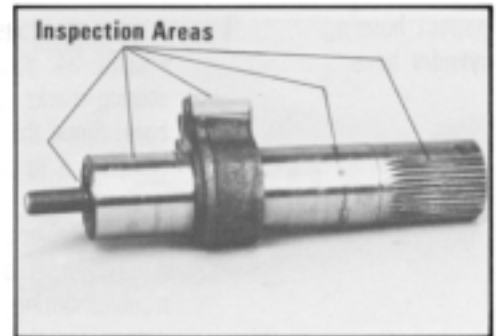


Figure 98

#### NOTE

**NOTE:** A service shaft assembly will have the adjusting screw (50) and retainer (49) assembled into it. The screw (50) and retainer (49) can be serviced separately if required.

This completes inspection of HF54 steering gear.

# Assembly

## Preparation

- Wash all parts in clean petroleum-based solvent. Blow them dry only.

### WARNING

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

### WARNING

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

- Replace all seals and seal rings with **new** ones each time you disassemble the gear.
- Ross Gear does provide individual seals, seal rings, as well as complete and partial seal kits. SEE FIGURE 99. These parts should be available through most OEM parts distributors. (Contact your local dealer for availability.)

## Assembly

install housing bearing and retaining ring

1. If you are installing a **new** housing bearing (57), first install the retaining ring (56) into the groove in the housing bearing (55) bore if it was removed. Place the housing, side cover face down on a wooden block if necessary to protect the cover face. Carefully press the bearing into the housing from the trunnion cover side until the bearing contacts the retaining ring. SEE FIGURE 100. During this procedure be sure the housing is square with the press base and the bearing is not cocked. Lubricate bearing and set housing aside.

install bearing into upper cover

2. If you are installing a **new** needle bearing (5) into the upper cover (7), a suitable pressing mandrel must be fabricated which will pilot on the inner diameter of the needle bearing and have clearance in the bearing bore. Place the mandrel against the lettered end of bearing and press bearing into upper cover bearing bore from the valve face side until the bearing is positioned 1.13 inch (29 mm) from upper cover valve face. After the bearing assembly is pressed in upper cover the bearing rollers must orbit and rotate freely in bearing shell. Lubricate bearing. SEE FIGURE 101.

clamp valve body or assembled valve body in vise

3. Assemble a hydraulic fitting securely in valve body (15A) hydraulic port. Clamp valve body assembled or disassembled securely in a vise, clamping against the hydraulic fitting or port bosses. Position valve body in the vise so that worm shaft, adaptor and upper cover can be assembled. SEE FIGURE 102.

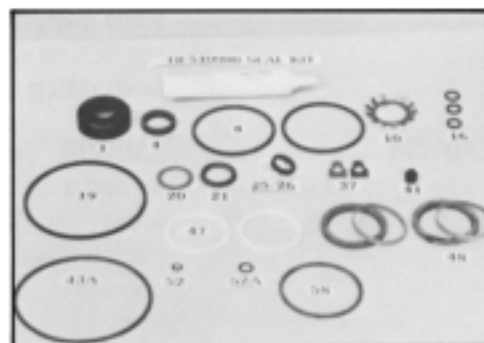


Figure 99

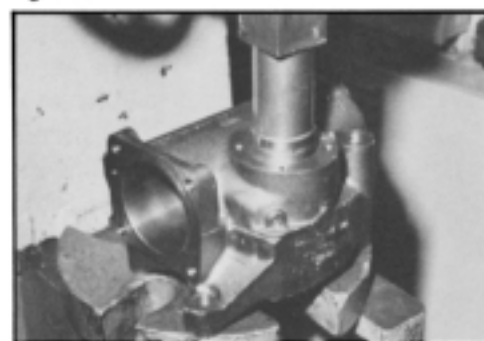


Figure 100

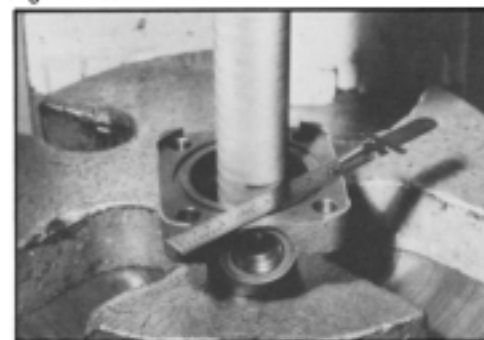


Figure 101

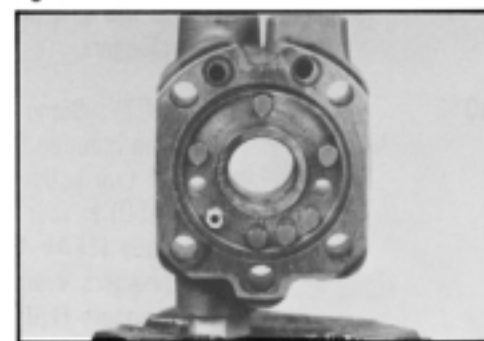


Figure 102

**CAUTION**

**CAUTION:** Use only the correct size standard 3/4-16 or 9/16-18 JIC-SAE hydraulic fitting in the valve ports. The use of a wrong fitting such as pipe fitting will damage the valve port and require replacement of the complete valve assembly.

**CAUTION**

**CAUTION:** Clamp valve body only as directed and use care not to clamp against machined valve faces or sides of valve body. This could damage sealing surfaces or distort valve bore. When clamping against valve port bosses do not tighten vise with extreme force as this could distort valve ports.

**CAUTION**

**CAUTION:** The valve assembly is unique to the particular HF54 steering gear flow rate application. Use only the specified valve assembly replacement to ensure proper operation.

**NOTE**

**NOTE:** If valve assembly components are not disassembled go to assembly procedure #7.

**assembly of  
valve spool**

4. If valve assembly (15) is disassembled, refer to the enlarged exploded view, on pages 21A & 21B. Assemble valve spool (15B) into valve body (15A). The end of the valve spool with identification grooves in the bore or in the undercut or relief on the outside diameter must be toward the adaptor side or face of valve body after assembly. The adaptor side or face of the valve body has two (blind) cylinder feed holes that do not extend through to the opposite side or face. On some valve bodies the cast identification # boss is pointed on the end toward the adaptor side or face. SEE FIGURE 103.

**assemble  
plungers and  
spring sets**

5. Assemble a plunger (15C) a spring (15D) and another plunger (15C) in that order in six through holes in the valve body (15A) as shown in the enlarged exploded view on fold out pages. SEE FIGURE 104.

**NOTE**

**NOTE:** The two oil transfer holes designated in the enlarged view are too small to accept plungers.

**NOTE**

**NOTE:** Some valve assemblies (15) may have one inactive (long) plunger instead of the set of two active plungers (15D) and a spring (15D) in four of the plunger holes in the valve body (15A). Assemble these inactive (long) plungers evenly as possible among the active plungers (15D) sets in the circle of plunger holes if their original positioning was not noted during disassembly.



Figure 103

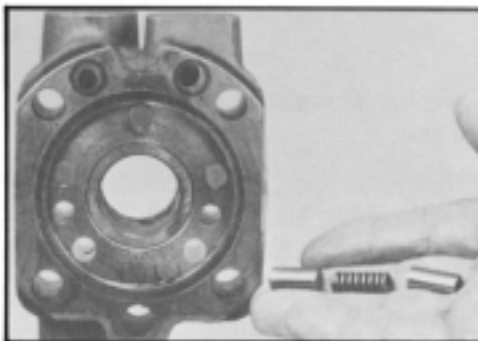


Figure 104

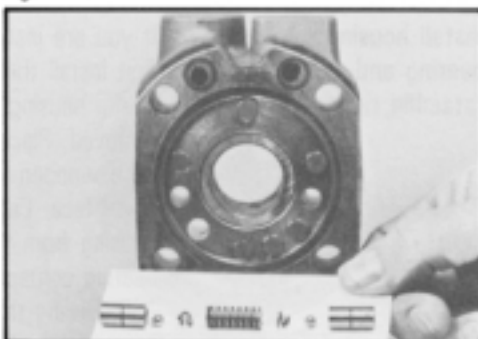


Figure 105

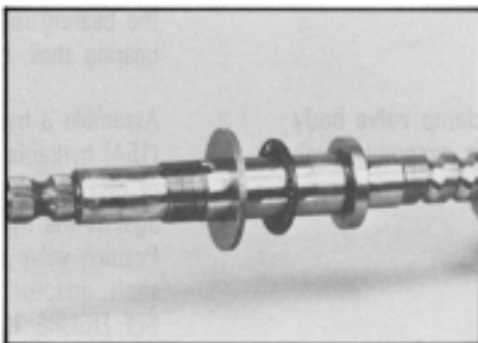


Figure 106

assemble check valve, plungers and spring

6. Assemble a ball (15F) and conical spring (15G), small end first, into the two check valve plungers (15E) if they became disassembled. Assemble one check valve plunger assembly, a spring (15D) and then the other check valve plunger assembly into the remaining valve body plunger hole as shown in the exploded view. The spring end of the check valve plungers must face each other when assembled in valve body. SEE FIGURE 105.

assemble first thrust bearing package on worm shaft

7. Assemble thrust bearing (13) and a thrust washer (14) on the input (serrated) end of worm shaft (23) and against worm shaft shoulder. SEE FIGURE 106.

assemble worm subassembly into valve assembly

8. Assemble the input (serrated) end of the worm shaft (23) with bearing package into the adaptor end of the valve spool (15B) bore as described in procedure #4, until shaft and bearing assembly stops against the spool. SEE FIGURE 107.

assemble thrust bearing package

9. Assemble the other thrust washer (14), thrust bearing (13) and thrust washer (12) onto the input (serrated) end of worm shaft (23) and against the valve spool (15B). SEE FIGURE 108.

assemble bearing lockwasher and nut

10. Assemble washer (11) then a **new** bearing lock-washer (10) onto worm shaft (23). The internal washer tangs must enter slot in worm shaft and the external tangs of bearing lock-washer must face out. SEE FIGURE 109. Assemble bearing lock nut (9), large chamfer side in, onto threaded diameter of worm shaft until components are at solid height and snug against valve spool (15B).

torque bearing lock nut

11. Torque the bearing nut (9) to 30 ft. lbs. (41 N m) to seat the components. Back the nut off and then torque to 15-20 ft. lbs. (20-27 N m). SEE FIGURE 110. Back the nut off approximately 20 degrees and bend one tang of lock-washer (10) into a matching nut slot. SEE FIGURE 111. A hook type spanner wrench, a 3/4 or 11/16 inch 12 point socket and a ft. lb. (N m) torque wrench required.

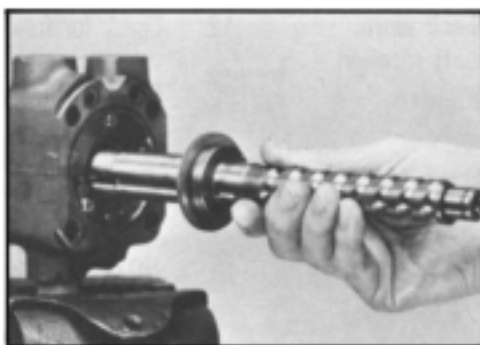


Figure 107

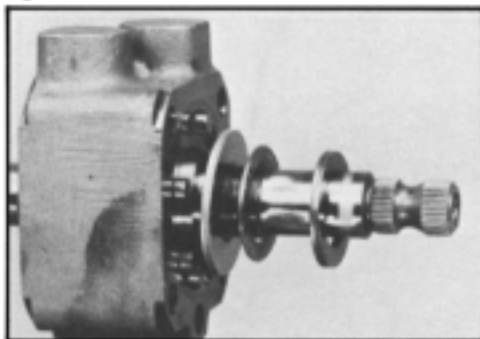


Figure 108

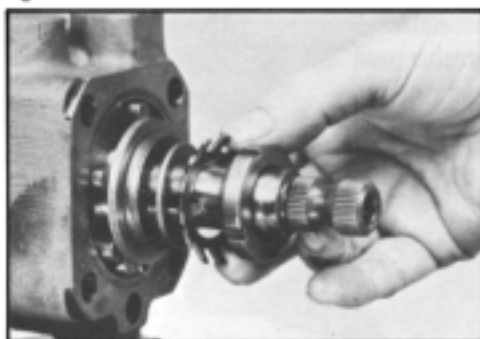


Figure 109

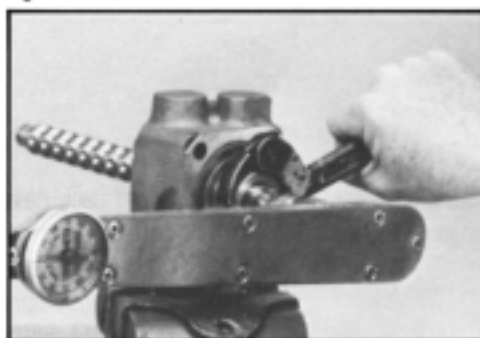


Figure 110

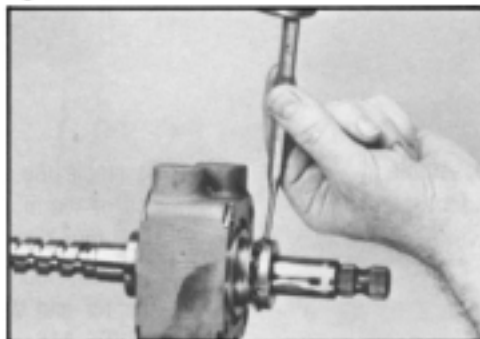


Figure 111

check worm  
shaft rotation

12. Check for free rotation of worm shaft (23) in valve assembly (15) and for perceptible end play. SEE FIGURE 112.

**NOTE**

**NOTE:** The worm shaft in the above assembly should rotate at 3 to 5 inch lbs. (.34 to .57 N m). No end play should be evident.

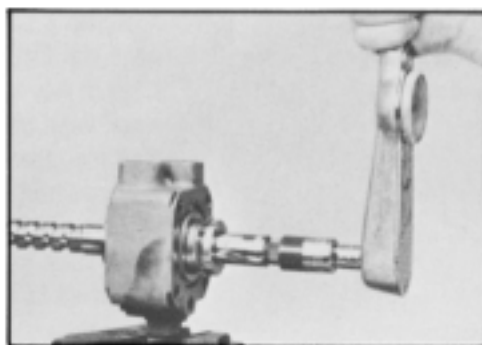


Figure 112

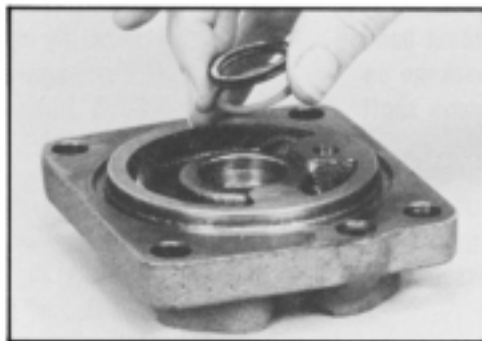


Figure 113

assemble  
washer seal  
and retainer  
into adaptor

13. Assemble back up washer (20) and then **new** seal (21) into adaptor (18) so that seal lip is facing out of seal cavity. SEE FIGURE 113. Assemble retaining ring (22). SEE FIGURE 114.

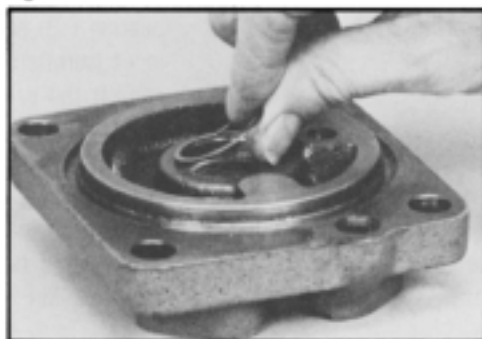


Figure 114

assemble seal  
rings

14. Coat each **new** seal ring liberally with clean grease for retention and assemble **new** seal ring (8), three **new** seal rings (16), **new** seal ring (19) in the appropriate recesses provided in adaptor (18). SEE FIGURE 115.

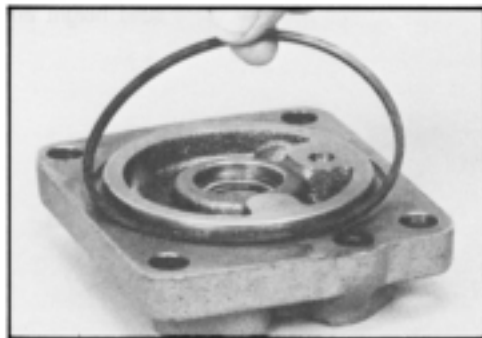


Figure 115

assemble  
adaptor on  
worm assembly

15. Assemble the adaptor (18) onto the rack piston end of worm shaft (23) assembly with the side with four threaded holes against the face of the valve assembly and the cylinder feed holes in adaptor and valve body (15A) aligned. SEE FIGURE 116.

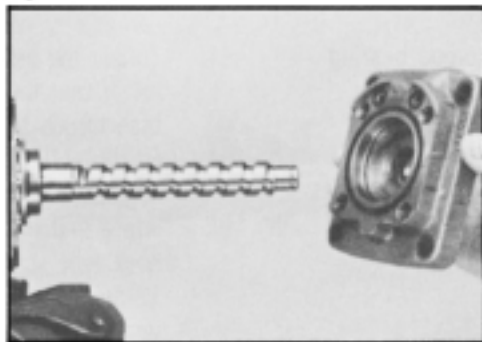


Figure 116



assemble  
upper cover  
seal, spacer,  
retaining  
ring and  
seal ring

16. On a clean work surface, assemble **new** seal (4) into upper cover (7) with the seal lip facing the upper cover bearing. Grease and assemble **new** spacer (3). SEE FIGURE 117. Install retaining ring (2) securely into the upper cover retaining ring groove. SEE FIGURE 118. Retaining ring pliers or small screw driver required. Apply clean grease liberally to **new** seal ring (8) and assemble it into the upper cover recess provided.



Figure 117

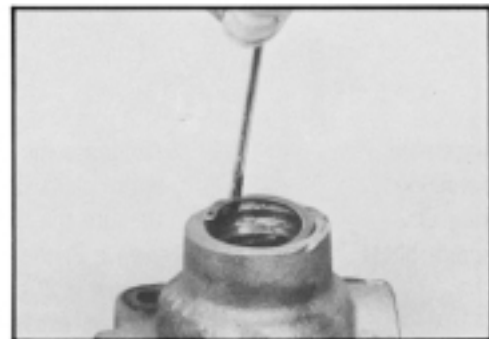


Figure 118

tape worm  
shaft  
serrations

17. Tape the worm shaft (23) serrations and lightly coat the remaining portion of the worm shaft with oil. SEE FIGURE 119.



Figure 119

install upper  
cover

18. Install upper cover (7) assembly carefully over worm shaft (23) serrations, aligning the upper cover, valve body (15A) and adaptor (18) in their original positions. SEE FIGURE 120.

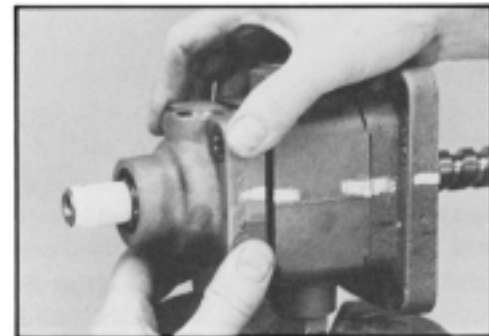


Figure 120

NOTE

**NOTE:** If a line was scribed across these components before disassembly you can now utilize the line to align these components.

assemble  
upper cover  
bolts and  
washer

19. Assemble four upper cover bolts (6) and washers (6A). Carefully tighten the bolts while checking that the adaptor (18) valve assembly (15) and upper cover (7) faces 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. 9/16 inch socket required. SEE FIGURE 121.

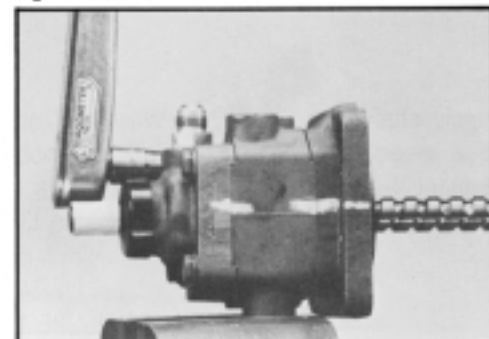


Figure 121



assemble seal  
components  
on worm  
shaft

20. Assemble onto the rack end of worm shaft (23) steel washer (24), **new** seal (25), with sharp corner side toward steel washer, **new** seal cup (26) with counter bore toward seal, bronze back up washer (27) and retaining washer (28) with counter bore out. SEE FIGURE 122.

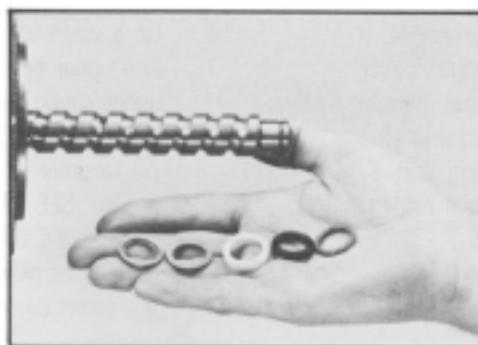


Figure 122

assemble  
retaining  
ring on  
worm shaft

21. Compress the seal components just assembled on worm shaft (23) and assemble retaining ring (29). Be sure the retaining ring is properly seated in its groove in the worm shaft and in the retaining washer (28) counter bore. SEE FIGURE 123. Remove subassembly from vise.

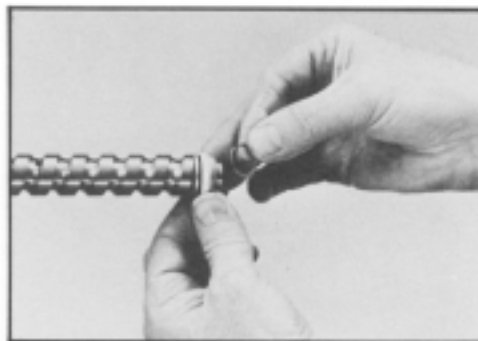


Figure 123

install  
piston  
ring

22. Place rack piston (39) in a soft jawed vise in a horizontal position. Carefully expand piston ring (39A) over end of rack piston and install in the ring groove. SEE FIGURE 124.

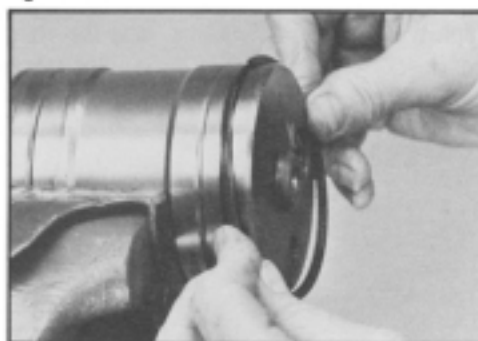


Figure 124

clean and  
apply locquic  
to rack piston  
and poppet  
seats

23. If poppets were removed, clean the two threaded poppet seat holes in the end of the rack piston (39) with clean/clear solvent and blow dry. Apply Locquic grade "T" primer to the threaded holes and to the two poppet seat (30) threads and allow to dry for ten minutes. SEE FIGURE 125.



Figure 125

apply studlock  
and assemble  
poppet seat

24. When the Locquic primer has dried for 10 minutes, apply Stud Lock to poppet seat (30) threads and threaded poppet hole at one end of rack piston (39). Assemble the poppet seat into that end of the rack piston and torque to 20-25 ft. lbs. (27-34 N m). 9/16 inch socket required. SEE FIGURE 126 AND 127.



Figure 126

assemble  
poppet  
components

25. Insert a poppet (31), spring (32), rod (33) and another poppet (31) at the opposite end of rack piston poppet hole. Apply Stud Lock to the second poppet seat (30) threads and its' threaded hole in the rack piston. Assemble the second poppet seat (30) and torque to 20-25 ft. lbs. (27-34 N m). SEE FIGURE 128. Allow Stud Lock to dry 20 minutes before adding hydraulic fluid. Remove the rack piston from vise and place on a clean cloth covered work surface with the ball return guide holes up.



Figure 127

assemble worm  
shaft assembly  
into rack  
piston

26. Lubricate the rack piston (39) worm bore and worm shaft seal (25) with clean grease. And assemble worm shaft (23) as assembled into rack piston bore so that the rack piston ball guide holes are aligned over the worm shaft ball track grooves and the worm seal is positioned in the rack piston worm bore. SEE FIGURE 129.



Figure 128

#### NOTE

**NOTE:** If the original set of 22 balls are being reassembled, they must be segregated by micrometer measurement into a group of 11 large balls (34A) and a group of 11 smaller spacer balls (34B). The small spacer balls were originally colored black for identification as are the spacer balls in a service ball kit. The set of **original large (working) balls** will measure .0005 inch (.01270 mm) larger than the spacer balls. SEE FIGURE 130.

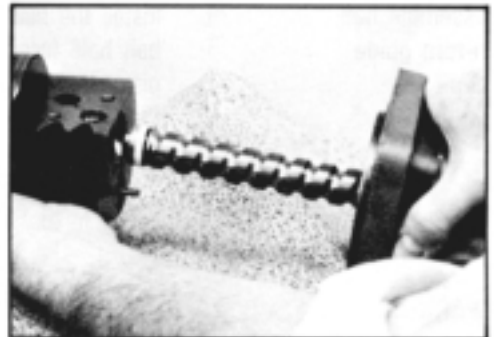


Figure 129

assemble 16  
balls into  
rack piston

27. Insert the eraser end of a pencil into one ball return guide hole in the rack piston (39) as far as it will go. Alternately insert one large ball (34A) then one small (spacer) ball (34B) into the other ball return guide hole while slowly turning the worm shaft (23) to work each ball down the same ball groove path on one side of the worm shaft and up and around toward the other ball return guide hole. When 16 balls are inserted, remove pencil. A ball should be visible at each ball return guide hole. SEE FIGURE 131.

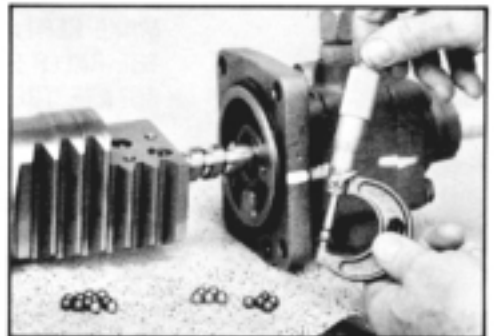


Figure 130

#### WARNING

**WARNING:** BE SURE EACH BALL INSERTED STARTS DOWN THE BALL GROOVE ON THE CORRECT SIDE OF THE WORM SHAFT. DO NOT ALLOW THE WORM SHAFT OR RACK PISTON TO ROTATE AFTER THE PENCIL IS REMOVED UNTIL THE BALL RETURN GUIDES ARE RETAINED IN THE RACK PISTON. SUCH ROTATION COULD MOVE A BALL OR BALLS INTO THE DEAD TRACK BEYOND THE BALL RETURN GUIDE LOOP (PASSAGE) RESULTING IN A STEERING LOCKUP WHICH COULD CAUSE AN ACCIDENT.

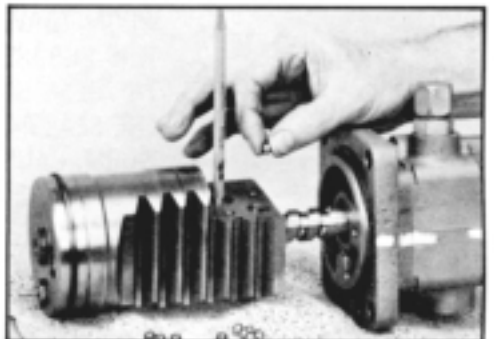


Figure 131

install ball  
return guide  
halves and  
balls

**CAUTION**

**WARNING**

assemble ball  
return guide  
clip

**WARNING**

**WARNING**

position  
housing  
in vise

28. Coat a ball return guide half (35) liberally with grease and insert the remaining 6 balls alternately large (34A) and small (34B) (black) into the greased guide half. SEE FIGURE 132. Join the guides halves together and firmly seat this subassembly into the rack piston (39) ball return guide holes.

**CAUTION:** The grease must hold the balls in the return guides until the guides are seated in the rack piston.

**WARNING:** DO NOT SEAT THE BALL RETURN GUIDES WITH A HAMMER. DAMAGE TO THE GUIDES CAN RESULT IN SUBSEQUENT LOCK-UP OR LOSS OF STEERING.

29. Install the ball return guide clip (36) so that the bolt hole faces are in full contact with the rack piston (39) surface. Install the two **new** lock tabs (37) and the two hex head screws (38). SEE FIGURE 133. Torque screws to 8-10 ft. lbs. (11-14 N m). Bend up lock tabs against the screw heads. 7/16 inch socket required. SEE FIGURE 134.

**WARNING:** ROTATE THE WORM SHAFT WHILE HOLDING THE RACK PISTON, FROM END OF TRAVEL TO END OF TRAVEL, TO MAKE CERTAIN THAT YOU HAVE INSTALLED THE BALLS PROPERLY. IF YOU CANNOT ROTATE THE WORM SHAFT, YOU WILL HAVE TO REMOVE THE BALLS AND REASSEMBLE THEM. IF YOU INSTALL THE GEAR ON A VEHICLE WITH THE SHAFT UNABLE TO ROTATE, THE GEAR WILL NOT FUNCTION. SEE FIGURE 135.

**WARNING:** DO NOT ALLOW RACK PISTON TO ROTATE TO THE EXTREME LOWER END OF WORM TRAVEL BY IT'S OWN WEIGHT WHILE THIS SUBASSEMBLY IS NOT CONTAINED IN THE GEAR HOUSING. THIS COULD DESTROY THE SEAL PACKAGE AT THE LOWER END OF WORM, CAUSING LOSS OF POWER STEERING IN ONE DIRECTION.

30. Position housing (55) firmly in vise positioned as it was for the disassembly procedures. SEE FIGURE 136.

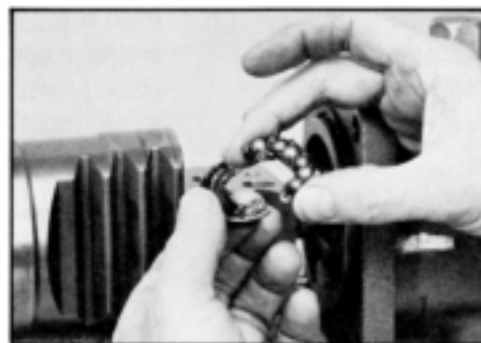


Figure 132



Figure 133

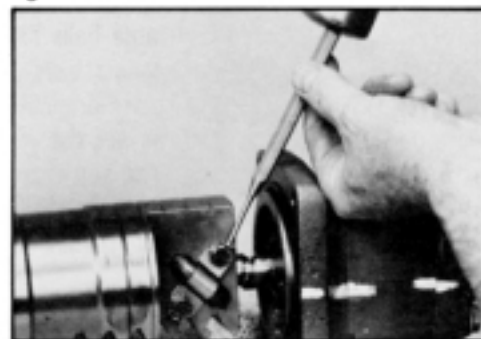


Figure 134

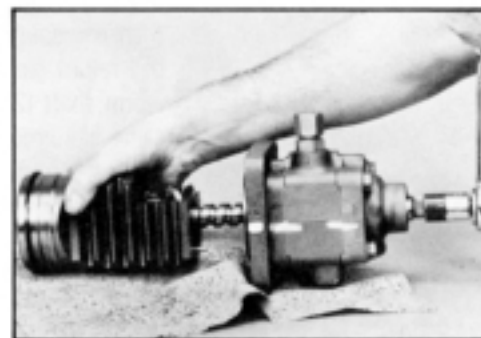


Figure 135

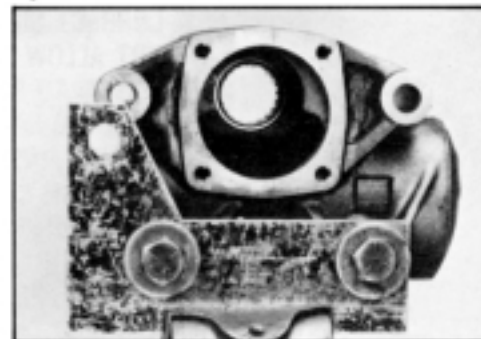


Figure 136

assemble  
retaining  
ring

31. If a spacer ring (55A) was removed from the housing (55) assemble and seat the spacer ring in the bottom of the housing rack piston bore. SEE FIGURE 137.

assemble and  
install  
poppet  
assembly

32. If you removed a non adjustable hex head poppet screw (53A) and o-ring (52A) from the housing, assemble a **new** o-ring (52A) on the poppet screw. Install the poppet screw assembly in housing (55) and torque screw to 15-20 ft. lbs. (20-27 N m). SEE FIGURE 138. 1/2 or 9/16 inch hex socket required.

If you removed nut (54), poppet adjusting screw (53) and o-ring (52), assemble a **new** o-ring (52) and the nut on the adjusting screw and turn the screw assembly into the housing (55) until 7/8 inch (22 mm) of screw thread protrudes from the housing.

If you removed sealing nut (54A) and poppet adjusting screw (53B), turn the threaded end of the adjusting screw into the end of a **new** sealing nut (54A) away from its seal so that the seal will face the housing. Turn the screw assembly a few turns into the housing. The final adjustment of either type of adjustable poppet screw must be made after the reassembled gear is installed on the vehicle.

grease  
piston ring  
and housing  
bore

33. Apply a generous amount of clean grease to the piston ring (39A) on assembled rack piston and to the housing (55) rack piston bore. SEE FIGURE 139.

insert the  
assembled rack  
piston assembly

34. Insert the assembled rack piston (39) into housing (55) and position rack teeth to be visible through the side cover opening and the poppet (31) in line with poppet screw in the housing. As the rack piston enters the lubricated housing bore compress piston ring (39A) and work the rack piston into assembled position. SEE FIGURE 140.

position adaptor  
against housing

35. Move the adaptor (18) against housing (55) with their bolt holes aligned and their cylinder feed (oil transfer) hole aligned. The poppet recess in the adaptor must align with poppet (31) and seal ring (19) and seal ring (16) must be in place. SEE FIGURE 141.

NOTE

**NOTE:** The lines scribed before disassembly can again be used to insure correct assembly alignment.



Figure 137

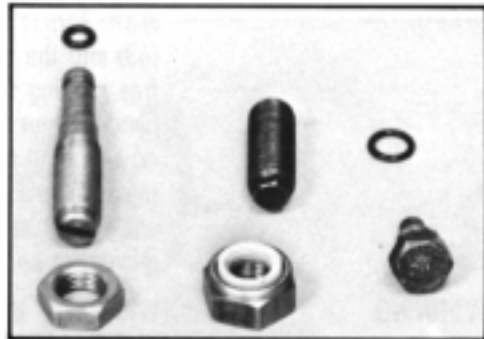


Figure 138



Figure 139

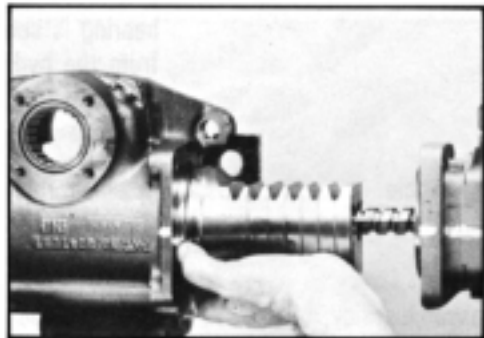


Figure 140

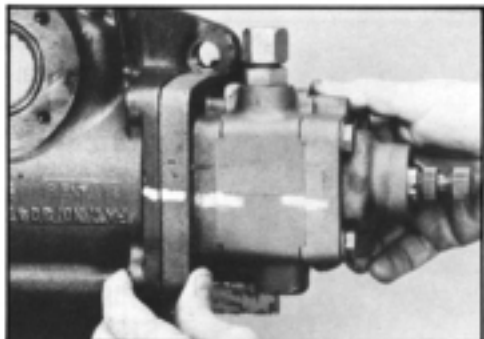


Figure 141

assemble  
adaptor  
bolts and  
washers

36. Assemble four bolts (17) through adaptor (18) into housing (55). Torque bolts to 45-55 ft. lbs. (61-75 N m) if dry or 42-52 ft. lbs. (57-71 N m) if lubricated. A 7/16 inch 12-point socket required. SEE FIGURE 142.

assemble  
adjusting  
screw and  
retainer

37. If the adjusting screw (50) has been removed from the sector shaft (51), clamp the sector shaft into a soft-faced vise by gripping the serrated end. Coat the expanded end of the **new** adjusting screw with a suitable grade of wheel bearing grease and insert into recess in end of sector shaft. Thread a **new** sector shaft screw retainer (49) into the sector shaft and adjust to permit free rotating of sector shaft adjusting screw by hand without perceptible end play, .000 to .002 in. (.05 mm) loose. Stake the new retainer into the two slots provided using a suitable punch and again check freedom of adjusting screw movement and end play. SEE FIGURE 143.

#### WARNING

**WARNING: USE CARE IN SECURELY STAKING THE RETAINER (49) INTO THE SECTOR SHAFT SLOTS. A RETAINER THAT IS BROKEN OR CRACKED DURING THE STAKING PROCEDURE MUST BE REPLACED AS IT COULD RESULT IN THE SECTOR SHAFT NOT BEING RETAINED AND THE LOSS OF MANUAL AND POWER STEERING CONTROL.**

grease side  
cover bearing

38. Apply a generous amount of clean wheel bearing grease (do not substitute another type of grease) to the bearing in side cover (43). SEE FIGURE 144.

#### CAUTION

**CAUTION: Use only wheel bearing grease. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Without wheel bearing grease, the bearing could wear prematurely.**

assemble  
retaining  
ring

39. Assemble retaining ring (45) into side cover (43) ring groove closest to the bearing, if the retaining ring was removed.

assemble side  
cover seal  
pack

40. Assemble the steel backup washer (46) into side cover (43). Assemble a **new** Teflon washer (47) then a **new** two piece seal (48) into the side cover, such that the words "Oilside" are visible after the seal is assembled. SEE FIGURE 145. Grease and assemble **new** seal ring (43A) into side cover. SEE FIGURE 146.

#### WARNING

**WARNING: THE WORDS "OIL SIDE" MUST BE VISIBLE ONCE THE SEAL IS IN PLACE. OTHERWISE, THE SEAL WILL NOT FUNCTION, WHICH COULD RESULT IN A LOSS OF POWER STEERING ASSIST.**

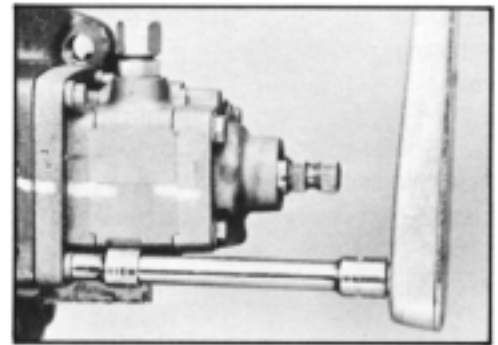


Figure 142



Figure 143



Figure 144



Figure 145



Figure 146



assemble  
retaining  
ring

**NOTE**

41. Assemble retaining ring (62) into its' ring groove in side cover (43). SEE FIGURE 147.

**NOTE:** Retaining ring (62) is not included in all HF54 steering gears.

install  
sector shaft  
into side  
cover

42. Apply a generous amount of clean grease to the short bearing area of the sector shaft (51). Insert the sector shaft carefully into the side cover (43). Screw in the sector shaft adjusting screw (50) counter-clockwise into the side cover until the screw reaches solid height. Then, rotate the adjusting screw clockwise one turn, so that the side cover will rotate freely on the sector shaft. SEE FIGURE 148.

**CAUTION**

**CAUTION:** Be sure the two piece seal remains correctly assembled and that the vent plug (41) has been removed during these procedures.



Figure 147

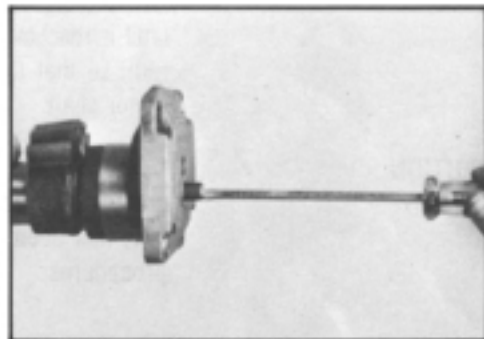


Figure 148

**NOTE**

**NOTE:** If the side cover two piece seal (48) cannot be maintained in position when the shaft (51) is assembled into the shaft side cover (43) using procedures #40, #41, and #42, go to alternate procedures #43, #44, and #45.

assemble seal  
ring and steel  
and Teflon  
washers into  
side cover

43. Grease and assemble seal ring (43A). Assemble the steel backup washer (46) and then the **new** Teflon washer (47) into the side cover (43) bearing bore. SEE FIGURE 149.



Figure 149

assemble  
retaining ring  
and seal

44. Slide retaining ring (62) if required onto the cover end of sector shaft (51). Assemble the **new** two-piece seal (48) onto the end of the sector shaft about 1 inch (25.4 mm). The words "Oil Side" on the seal must face toward the sector shaft. SEE FIGURE 150.

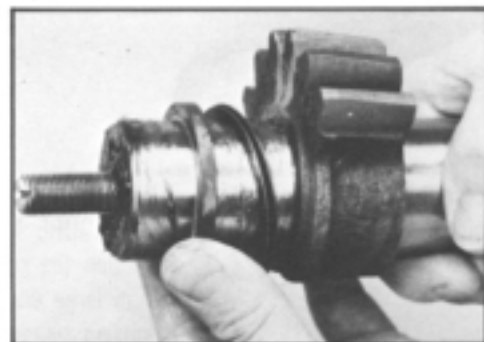


Figure 150

install  
sector  
shaft into  
side cover

45. Be sure the side cover bearing, the sector shaft bearing diameter and seal are well greased, then insert sector shaft (51) assembly into the side cover (43) bearing and turn the adjusting screw (50) into the side cover about 8 turns. Slowly and carefully work the two piece seal (48) down the sector shaft and squarely into the side cover until it is past the retaining ring groove. Then work the retaining ring (62) if included into the retaining ring groove. Use an appropriate blunt end punch or punches. SEE FIGURE 151. Carefully turn the adjusting screw (50) through side cover until it reaches solid height then back screw one turn, so that the side cover rotates freely on sector shaft.

**CAUTION**

**CAUTION:** Be sure the two piece seal remains correctly assembled and that the vent plug (41) has been removed during these procedures.

install jam  
nut

46. Install the sector shaft adjusting screw jam nut (40) onto the sector shaft adjusting screw (50) a few threads. Final adjustment will be made later. SEE FIGURE 152.

assemble vent  
plug

47. Press a **new** vent plug (41) into the hole provided in the side cover (43) until the plug is flush. SEE FIGURE 153.

**WARNING**

**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 SEAL FAILS AND THE PLUG CANNOT VENT, THE STEERING GEAR MAY LOCK UP OR OTHERWISE MALFUNCTION.**

center rack  
piston

48. There are five full teeth on the rack piston (39). SEE FIGURE 154. Rotate the worm shaft (23) to position the center rack piston tooth (third tooth from large end) in line with the center of the housing sector shaft bore. SEE FIGURE 155.



Figure 151

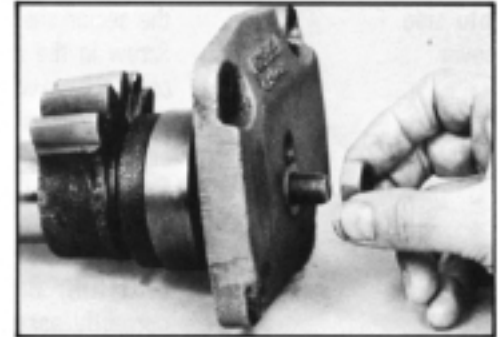


Figure 152

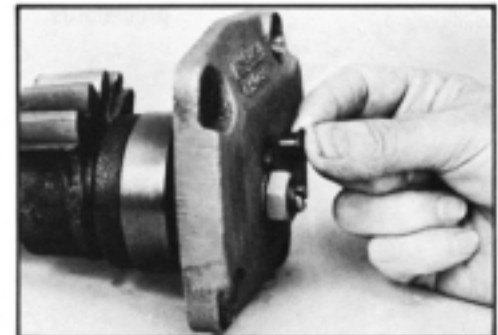


Figure 153

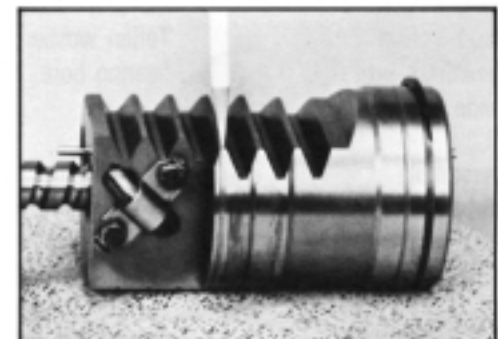


Figure 154



## WARNING

**WARNING: IF THE RACK PISTON IS NOT CENTERED WHEN SECTOR SHAFT IS INSTALLED, GEAR TRAVEL WILL BE SEVERELY LIMITED IN ONE DIRECTION. THIS COULD RESULT IN AN ACCIDENT.**

add timing  
mark to  
sector shaft

49. If there is not a timing mark on the end of sector shaft (51) add a timing mark with chalk or marking pencil on the end of the sector shaft in line with the center of the center tooth **space**. SEE FIGURE 156.

install sector  
shaft and side  
cover assembly

50. Remove any old tape from sector shaft (51) serrations and apply one layer of new tape to shaft serrations and bolt groove if necessary to protect seal. Install sector shaft and side cover assembly into housing (55). The sector shaft center tooth space as indicated by the timing mark on the end of sector shaft must engage the rack piston (39) center tooth. SEE FIGURE 157.

## CAUTION

**CAUTION: Be sure seal ring (43A) is in place.**

install side  
cover bolts

51. Install the four special side cover bolts (42) and washers (42A) into the side cover and torque them to 45-55 ft. lbs. (61-75 N m) if dry or 33-40 ft. lbs. (45-54 N m) if lubricated. 5/8 inch or T-50 Torx socket required. SEE FIGURE 158.

## NOTE

**NOTE: One or more of the side cover bolts may be flat head TORX bolts (42B) for clearance purposes.**

install trunnion  
cover washer  
and seal

52. Place the trunnion cover (59) exterior face down on a bench and install the **new** Teflon backup washer (47) and then the **new** two piece seal (48). The words "Oil Side" on the seal must be visible after assembly. SEE FIGURE 159.

## WARNING

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

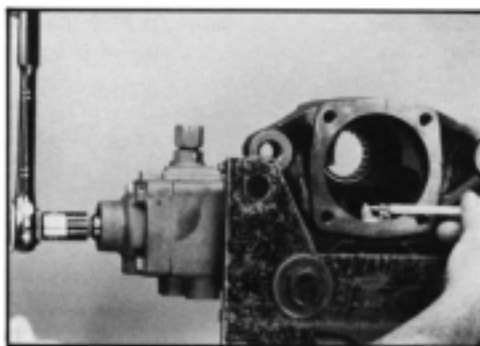


Figure 155



Figure 156

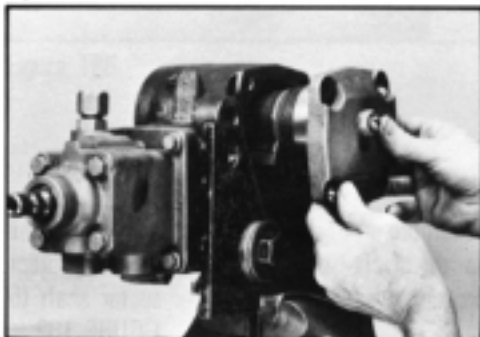


Figure 157



Figure 158



Figure 159

**install seal  
ring**

53. Grease the **new** trunnion cover seal ring (58) and install it into the trunnion cover (59) seal ring groove.

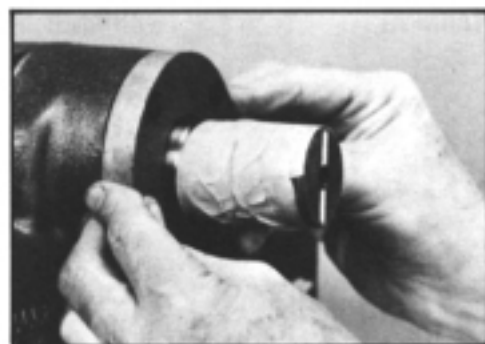


Figure 160

**install  
trunnion cover  
and bolts**

54. Pack seal area of sector shaft (51) with clean high temperature industrial grease per Ross specification 045231, Mobil Temp 1 or 2 or equivalent. Carefully install the trunnion cover (59). SEE FIGURE 160. Install the four trunnion cover screws (60) and torque them to 13-23 ft. lbs. (18-31 N m) if dry or 11-16 ft. lbs. (15-22 N m) if lubricated. A 5/16 inch 12 point thin wall socket required. SEE FIGURE 161.

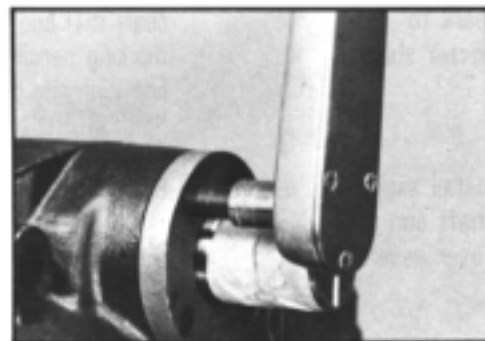


Figure 161

**assemble  
sector shaft  
protector seal**

55. Add more of the special grease to the cupped side of protector seal (61) and assemble over sector shaft (51) and trunnion cover (59). SEE FIGURE 162.

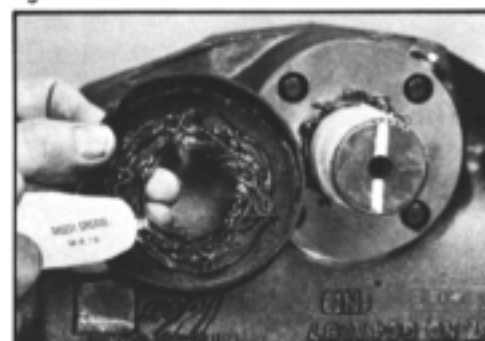


Figure 162

**assemble worm  
shaft protector  
seal**

56. Add the special grease to cupped side of protector seal (1) and assemble seal over worm shaft (23) and upper cover (7). SEE FIGURE 163.



Figure 163

**assemble  
bleed screw**

57. If bleed screw (55B) was removed from housing (55) reassemble and torque to 27-33 in. lbs. (3.1-3.7 N m). SEE FIGURE 164.

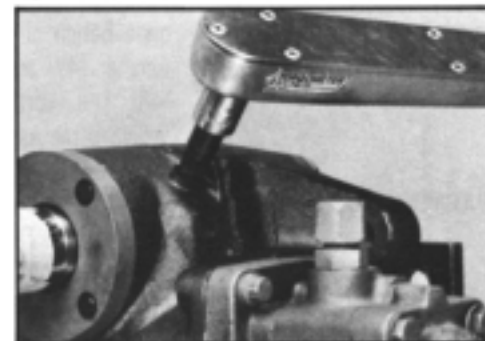


Figure 164

This completes assembly of the HF54 steering gear. Before you install the gear onto the vehicle, make final adjustments described on page 49. All ports should be plugged until unit is installed in vehicle.

## Final Adjustments

center steering gear

1. To center the steering gear, rotate worm shaft (23) until the timing mark on the end of sector shaft (51) is perpendicular to the worm shaft. SEE FIGURE 165. A 12 point 11/16 or 3/4 inch box end or socket required.

NOTE

**NOTE:** Worm, valve thrust bearing preload adjustment was accomplished in assembly procedure 11, page 37.

tighten adjusting screw

2. Tighten sector shaft adjusting screw (50) to provide 20-25 inch lbs. (2.3-2.8 N m) of torque required to rotate the worm shaft (23) through 90 degrees each side of center. SEE FIGURE 166.

NOTE

**NOTE:** This procedure will properly mesh and seat the rack piston teeth and sector shaft teeth for final adjustments.

loosen adjusting screw and note torque

3. Loosen sector shaft adjusting screw (50) one turn and note maximum torque required to rotate the worm shaft (23) through 90 degrees each side of center.

adjust adjusting screw

4. Adjust sector shaft adjusting screw (50) to increase maximum torque noted in procedure #3 by 2 to 4 inch lbs. (.23 to .45 N m). Torque jam nut (40) using a 3/4 inch socket, to 40-45 ft. lbs. (54-61 N m) and check worm shaft torque again. Readjust if worm shaft torque exceeds 15 inch lbs. (1.7 N m).

This completes the final adjustments of the HF54 gear to be made before it is installed into the vehicle's steering system. Install the gear by following instructions in the vehicle shop manual. Then follow the succeeding sections of this service manual HF54 on "HYDRAULIC FLUID" and "FILLING AND AIR BLEEDING THE SYSTEM" which also includes instructions for adjustment of the adjustable poppet valve.

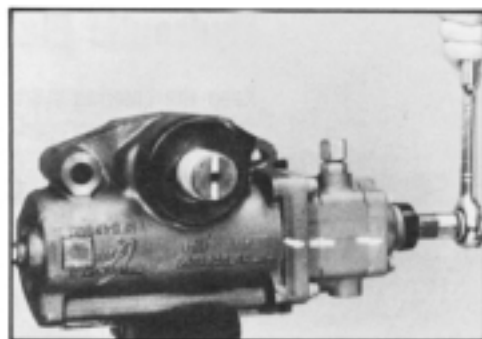


Figure 165

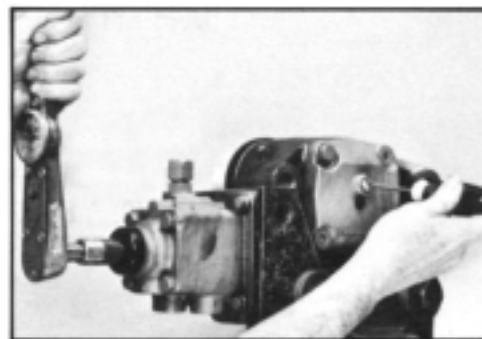


Figure 166

## Hydraulic Fluid

Keep the steering system filled with one of the following fluids:

AUTOMATIC TRANSMISSION FLUID TYPE "E" or "F"

FORD SPEC. M2C138CJ

AUTOMATIC TRANSMISSION FLUID DEXRON II

SHELL ROTELLA T ..... SAE 30

MOBIL ..... SAE 10W30

ASHLAND ..... SAE 10W40

UNION ..... SAE 10W40

TEXACO ..... SAE 10W40

MOBIL ..... SAE 10W40

**WARNING:** COMPLETELY FLUSH THE STEERING SYSTEM WITH ONE OF THE RECOMMENDED FLUIDS ABOVE ONLY. DO NOT MIX OIL TYPES. ANY MIXTURE OR ANY UNAPPROVED OIL COULD LEAD TO SEAL DETERIORATION AND LEAKS. A LEAK COULD ULTIMATELY CAUSE THE LOSS OF FLUID, WHICH COULD RESULT IN A LOSS OF POWER STEERING ASSIST.

## Filling and Air Bleeding the System

**CAUTION:** For steps 1 and 2, do not turn the steering wheel. Otherwise, air may be induced into the system.

1. Fill the reservoir nearly full. Crank the engine for 10 seconds without, if possible, allowing it to start. If the engine does start, shut it down immediately. Check and refill the reservoir. Repeat at least three times, each time checking and refilling the reservoir.

**CAUTION:** Do not allow the fluid to drop significantly or run out of the reservoir. This may induce air into the system.

2. Start the engine and let it idle for 2 minutes. Shut the engine off and check the fluid level in the reservoir.
3. Start the engine again. Steer the vehicle from full left to full right turn several times. Add fluid, as necessary, to the fill line on the dipstick.

**NOTE:** Poppets, equipped on the gear, must be adjusted so that they relieve pressure at full left and right turns to aid in the removing of air from the system. At this time, make sure any poppets are properly adjusted. If they are not, adjust them in accordance with section 4 (page 19) and repeat step 3.

The above procedures should remove all the air from the steering system, unless the gear is mounted in an inverted position and is equipped with the manual bleed screw (55B) (See FIG. 164, Page 48). If this is so, refer to step 4.

4. Remove the air from a gear mounted in an inverted position and equipped with a manual bleed screw (55B) by following steps 1, 2 and 3 above. Then, with the engine idling, steer the gear from full left turn to full right turn several times. Loosen the manual bleed screw about one turn, with the steering gear in neutral (no steering action), allowing air and aerated fluid to "bleed out" around the bleed screw until only clear (non aerated) fluid is bleeding out then close the bleed screw. 5/16 inch socket required. Check and refill reservoir.

Repeat this procedure 3 or 4 times starting with the steering maneuver with bleed screw closed, until only clear (non aerated) fluid is discharged when bleed screw is loosened. Torque the manual bleed screw to 27-33 in. lbs. (3.1-3.7 N m). Check and refill reservoir.

**CAUTION:** Do not turn steering wheel with bleed screw loosened as this could induce air into the system.

## **Warnings for Proper Steering Gear Operation**

**WARNING:** DO NOT WELD, BRAZE OR SOLDER ANY STEERING GEAR OR SYSTEM ARM COMPONENTS.

**WARNING:** MAXIMUM FLOW UNDER ANY CONDITIONS MUST NOT EXCEED VEHICLE MANUFACTURER'S SPECIFICATIONS.

**WARNING:** MAXIMUM OPERATING PRESSURE MUST NOT EXCEED 1500 PSI (103.4 bar).

**WARNING:** ALWAYS CAREFULLY INSPECT ANY STEERING COMPONENT WHICH HAS BEEN (OR IS SUSPECTED TO HAVE BEEN) SUBJECTED TO IMPACT. REPLACE ANY DAMAGED OR QUESTIONABLE COMPONENT.

## Steering System Maintenance Tips

- Prevent internal bottoming of the steering gear. Carefully check axle stops to be sure that they meet the manufacturer's specifications.
- Regularly check the fluid and the fluid level in the power steering reservoir.
- Keep tires inflated to correct pressure.
- Always use a puller, never a hammer or torch, to remove pitman arms.
- Investigate and immediately correct the cause of any play, rattle, or shimmy in any part of the steering linkage or steering mechanism.
- Remove the cause of steering column misalignment.
- Encourage all drivers to report any malfunctions or accidents that could have damaged steering components.
- Do not attempt to weld any broken steering component. Replace the component with original equipment only.
- Do not cold straighten, hot straighten, or bend any steering system component.
- Always clean off around the reservoir filler cap before you remove it. Prevent dirt or other foreign matter from entering the hydraulic systems.
- Investigate and correct any external leaks, no matter how minor.
- Replace filters and pumps in compliance with specification.
- If extended stationary use of vehicle is developing excessive hydraulic fluid temperatures consult vehicle manufacturer for auxiliary cooling method.
- Maintain grease pack applied behind the input and output shaft's protector seal as a general maintenance procedure.





# HF54 Series Service Procedure



WRITE OR CALL FOR INFORMATION AND ADDED DETAILS  
CONCERNING YOUR INSTALLATION AND APPLICATIONS.

PHONE: 317.423.5377  
TELEX: 279413  
WRITE: TRW ROSS GEAR DIVISION  
800 HEATH STREET  
LAFAYETTE, INDIANA 47902