

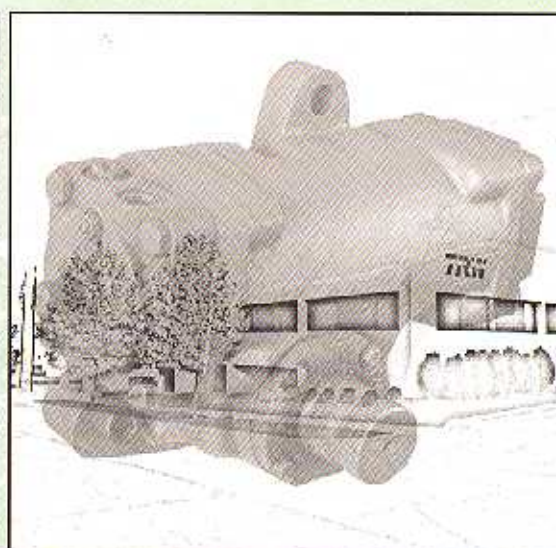
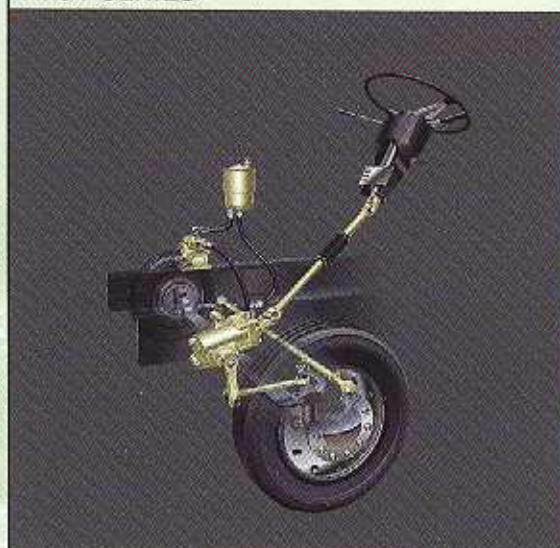
TRW Automotive

Commercial Steering Systems



HF Steering Gear Service Manual

HF64 SERIES



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

©TRW INC. 1995

Table of Contents

	Page
HF64 Design Features and Phantom View	Inside Front Cover
Definitions and Patents	1
Introduction	3
HF64 Hydraulic Fluid Flow Illustration	4
Valve Hydraulic Fluid Flow Illustration	5
HF64 General Design and Operation	6
Troubleshooting Information	7
Troubleshooting Guide	9
Repairs and Adjustments on Vehicle	12
—The Sector Shaft Trunnion Cover Seal	12
—The Worm (Input) Shaft Seal	15
—Worm Shaft, Valve Thrust Bearing Preload Adjustment	17
—Poppet Valve Adjustment	19
—Cross Shaft or Sector Shaft Adjustment	20
Torque Chart	21
Tools and Materials Required for Servicing	21
HF64 Exploded Assembly View-Typical	21A and 21B
Disassembly	22
Inspection	33
Assembly	36
Final Adjustments	52
Hydraulic Fluid	53
Filling and Air Bleeding the System	53
WARNINGS for Proper Steering Gear Operation	54
Steering System Maintenance Tips	54

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 HF64

This service manual has one purpose: to guide you in maintaining, troubleshooting and servicing the HF64 Hydrapower™ integral power steering gear.

Material in this manual is organized so you can work on the HF64 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 HF64.

The section of this manual on General Design and Operation, treats the major parts of the HF64 and explains how they function together. The knowledge you acquire from reviewing this section should assist you in solving your steering problem.

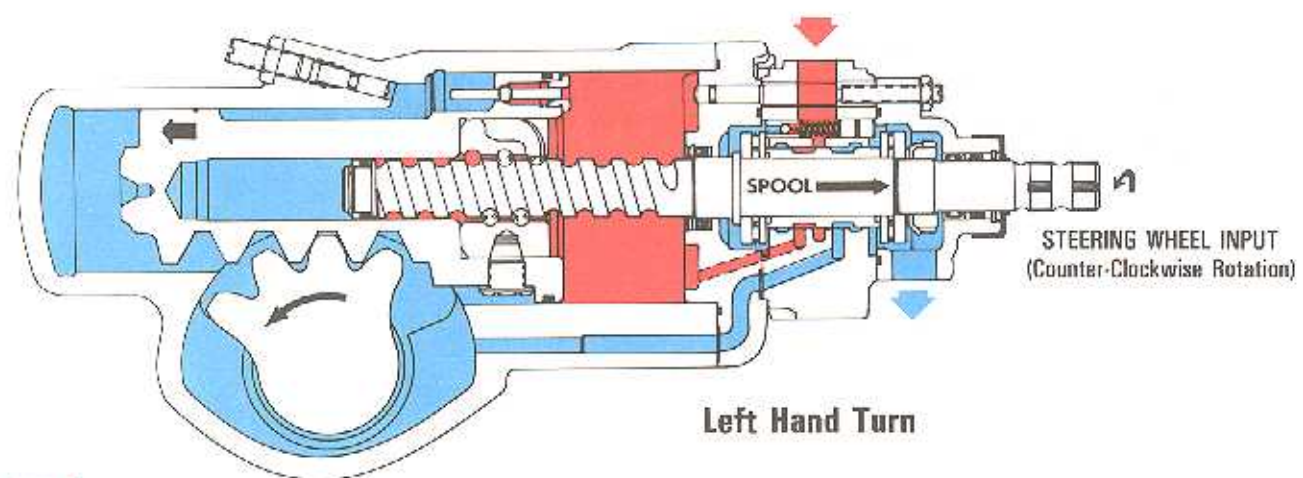
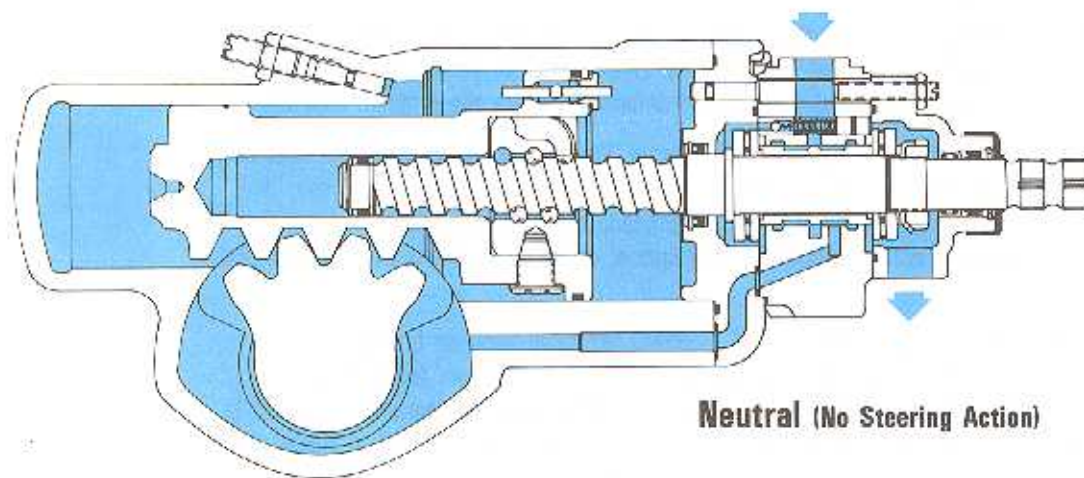
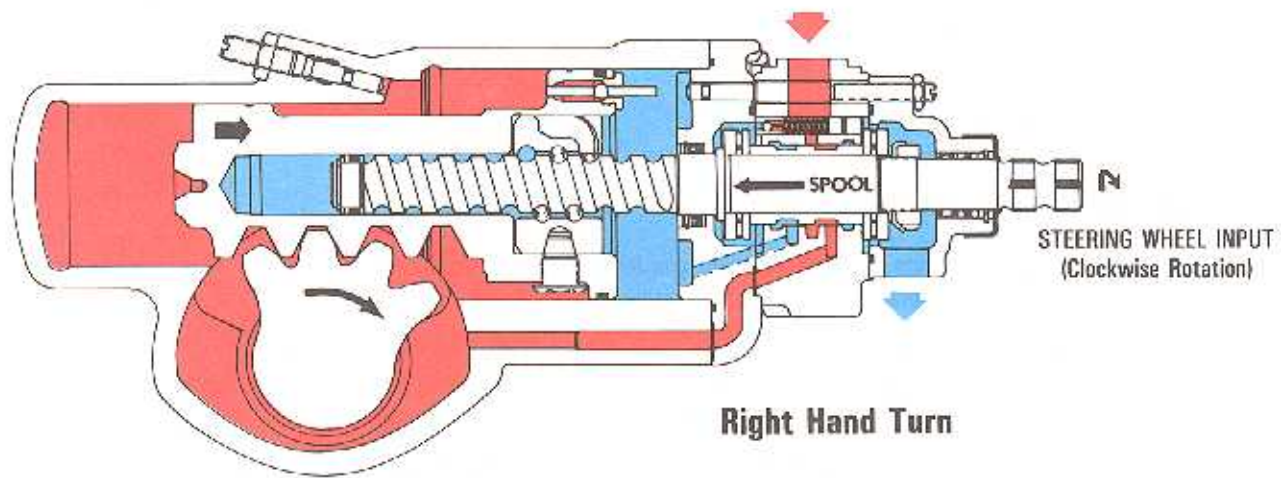
This manual also contains troubleshooting information and checklists. With them, you can diagnose a steering problem without removing the HF64 from the vehicle. If you must service the HF64, the checklists will help you to determine where the problem may be.

The three-column format of the Repairs, Adjustments, Disassembly, Inspection and Assembly sections will make it easier for you to service the HF64. 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 HF64 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 HF64 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 HF64 should be a safe and productive procedure.

HF64 Hydraulic Fluid Flow Illustration



Valve Hydraulic Fluid Flow Illustration



 FLUID FROM PUMP
 DISPLAYED FLUID FROM CYLINDER

FIG. B

VALVE POSITION AND FLUID FLOW
FOR RIGHT TURNING

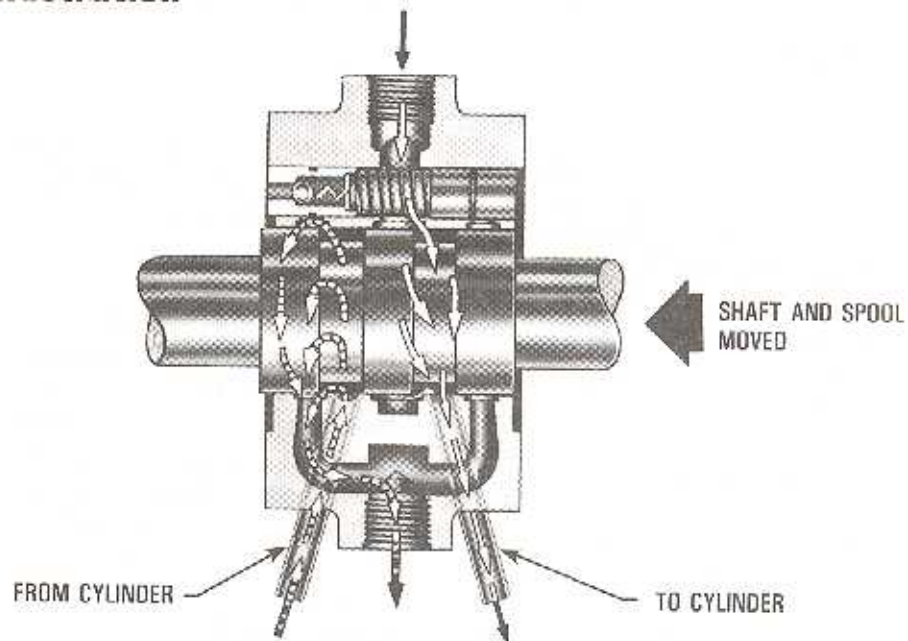


FIG. A

NEUTRAL VALVE POSITION AND FLUID FLOW

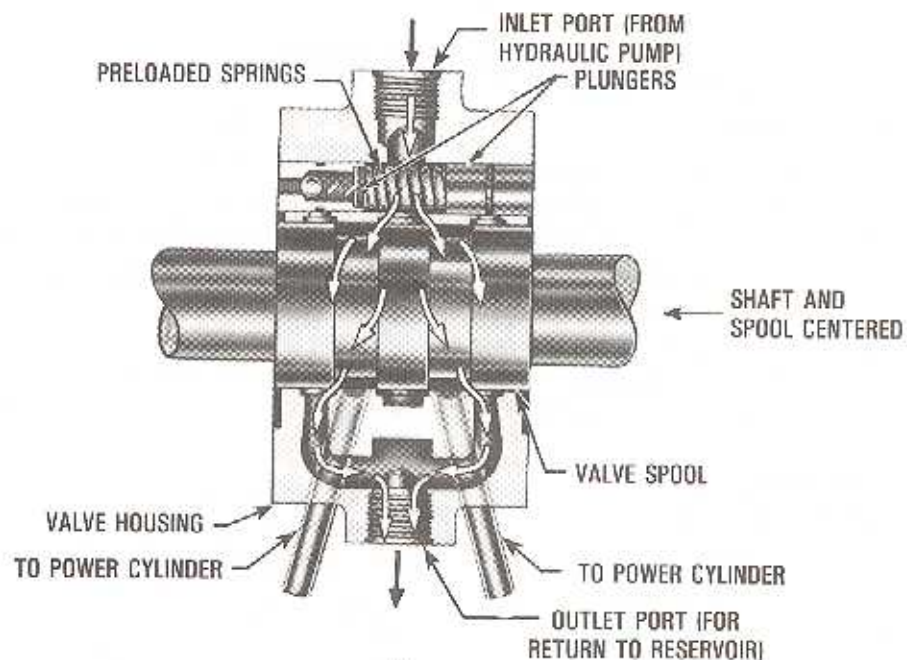
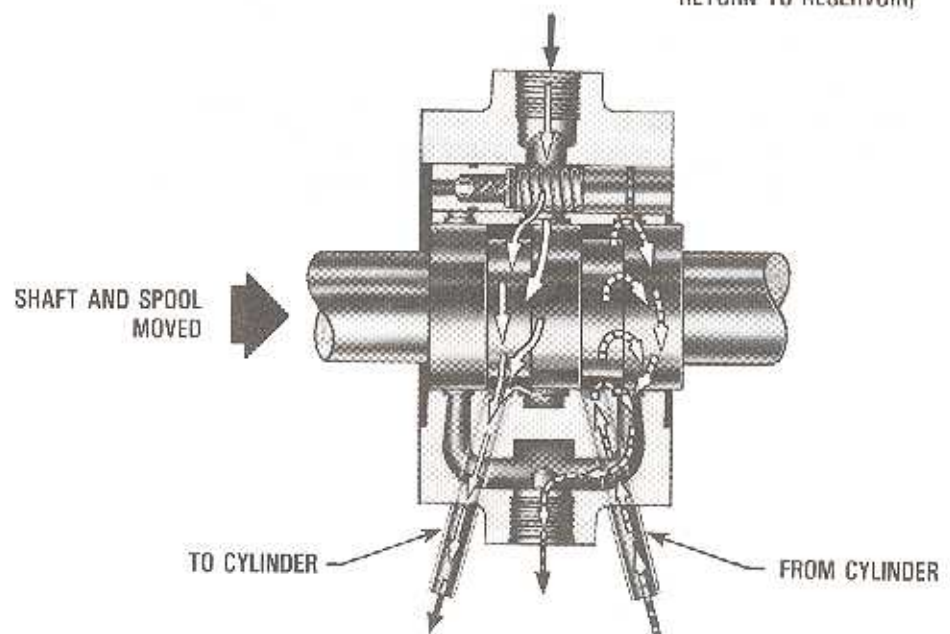


FIG. C

VALVE POSITION AND FLUID FLOW
FOR LEFT TURNING



HF64: General Design and Operation

Design

Integral Power Steering

The HF64 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 HF64 can steer a vehicle with a front end weight rating of about 12,000 pounds (5433 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 HF64,

maximum operating pressure is 1750 PSI (120.7 BARI). The absolute maximum flow rate is 8 GPM (30 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 HF64 steering gear applications. **NOTE: The recommended minimum flow at 1½ hand wheel turns/second must be no less than 3.2 gpm (12.1 Liters/Min.). If the HF64 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 HF64 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.

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.

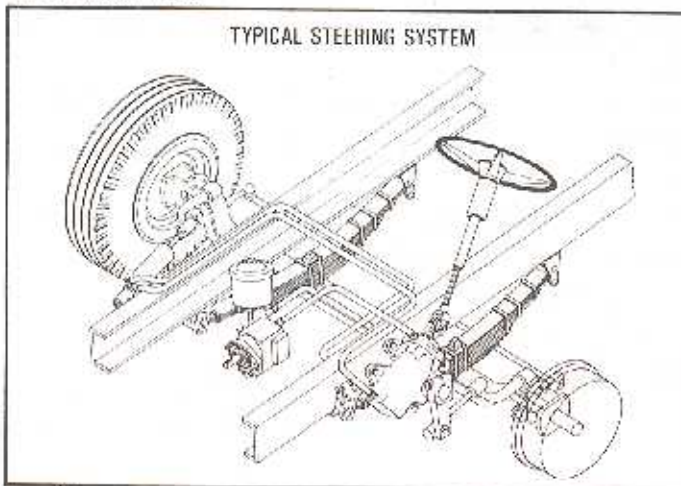


Figure 1

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.

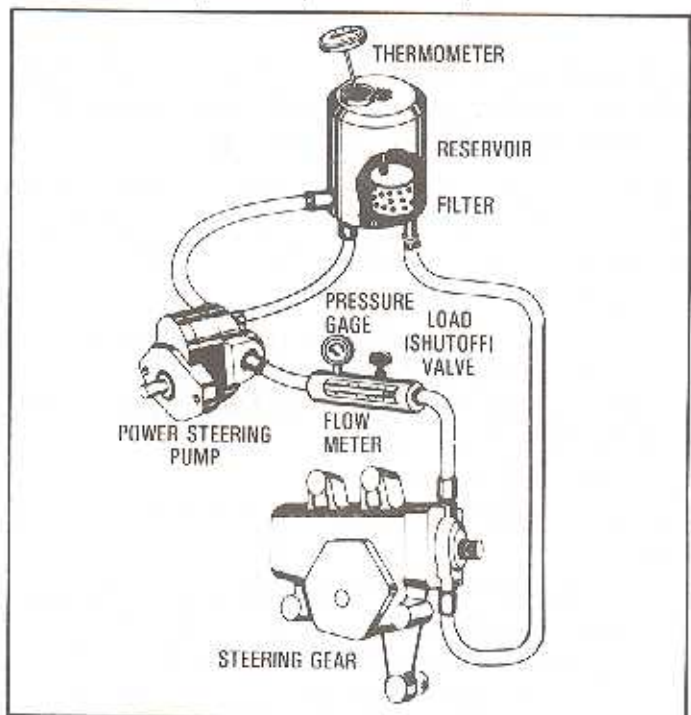


Figure 2

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 HF64 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).

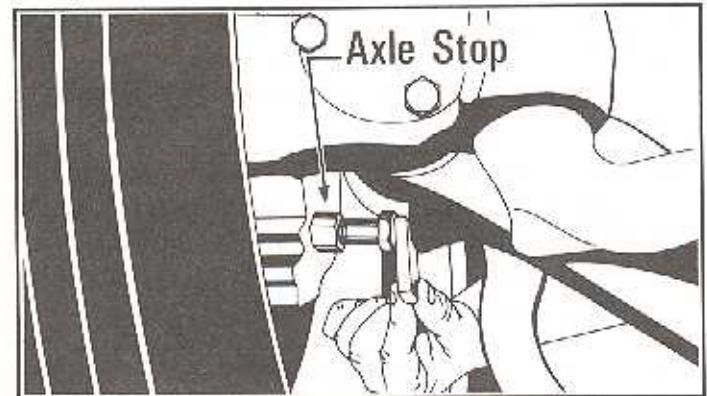


Figure 3

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 HF64 gear, isolate the auxiliary cylinder from the system by disconnecting the auxiliary cylinder hydraulic lines at the HF64 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 HF64 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 leak may be difficult, since oil may run away from 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 Trunion Cover Seal

remove pitman arm

- 1.1 If a leak is detected in the trunion cover area, on many HF64 installations, you can remove the trunion cover to gain access to the sector shaft seal package, while the steering gear is on the vehicle. First remove pitman arm nut and bolt or the sector shaft nut (54C) and lockwasher (54B) and then the pitman arm from the sector shaft (46). SEE FIGURES 4 & 5. Check the radial position of the pitman arm to the sector shaft prior to removal of pitman arm. Add timing marks to the arm and shaft if necessary to ensure correct alignment at reassembly.

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 (53). SEE FIGURE 6.

clean sector shaft

- 1.3 Clean the sector shaft (46) with a fine grade of emery paper. Be sure to remove any paint. SEE FIGURE 7.

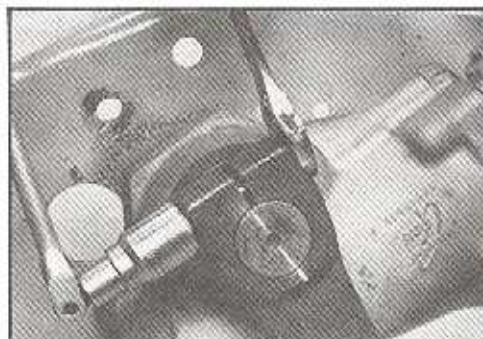


Figure 4



Figure 5



Figure 6

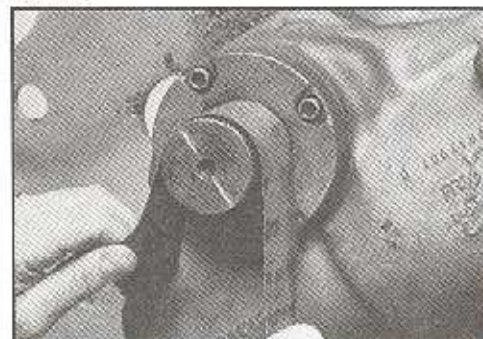


Figure 7

remove trunnion cover and seal package

- 1.4 Next, remove the four trunnion cover screws (52A), and trunnion cover (52). SEE FIGURE 8. A 1/4 inch Allen socket required. Be prepared for fluid loss. Then remove and discard the sector shaft seal package consisting of the two-piece sector shaft seal (43), the *Teflon backup washer (42), and the trunnion cover seal ring (51). SEE FIGURE 9.

clean and inspect trunnion cover

- 1.5 Clean the trunnion cover (52) 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 new Teflon washer and seal package

- 1.6 Place the trunnion cover (52) on a clean work surface. Install a **new** Teflon washer (42) then a **new** two piece seal (43), or the latest **new** service two piece seal (42/43) that has the Teflon washer integral to it. See alternate service construction on exploded assembly review. SEE FIGURE 10.

CAUTION

CAUTION: Be sure that a separate Teflon washer (42) is not used with the service two piece seal (42/43) that has the Teflon washer integral to it.

install new seal ring

- 1.7 Grease the **new** trunnion cover seal ring (51) and install it into the cover ring groove.

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. SEE FIGURE 11

tape sector shaft

- 1.8 Cover the serrations of the sector shaft (46) with tape to avoid damaging the seals during installation. SEE FIGURE 12.

NOTE

NOTE: Use only one layer of tape.



Figure 8



Figure 9

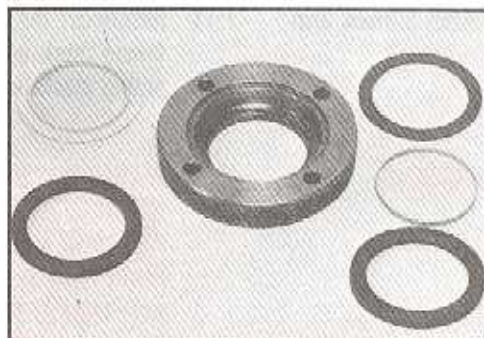


Figure 10



Figure 11



Figure 12

install trunnion
cover and screws

- 1.9 Apply clean high temperature grease per Ross specification 045231, Mobil Temp. 1 or 2, or equivalent to sector shaft seal area and install the trunnion cover (52) and four trunnion Screws (52A). Torque screws to 13-23 ft. lbs. (18-31 N m) if dry or 11-16 ft. lbs. (15-22 N m) if lubricated. SEE FIGURES 13, 14. Remove tape from sector shaft.

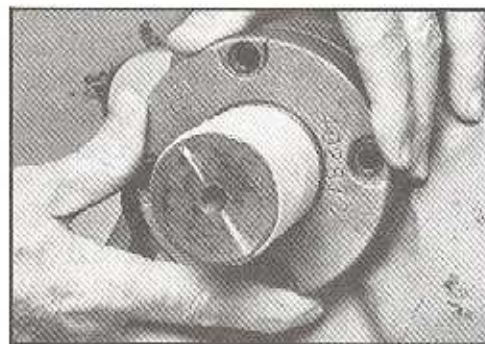


Figure 13

assemble
protector
seal

- 1.10 Pack clean high temperature industrial grease per Ross specification 045231, Mobil Temp. 1 or 2 or equivalent to protector seal (53) and install protector seal to sector shaft (46) and trunnion cover (52). SEE FIGURE 15.

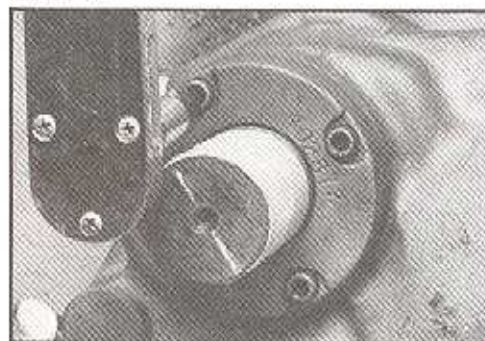


Figure 14

install pitman arm

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

WARNING

WARNING: WHEN USING A CHISEL TO SPREAD THE PITMAN ARM BOSS FOR ASSEMBLY ONTO THE SECTOR SHAFT (46), 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.

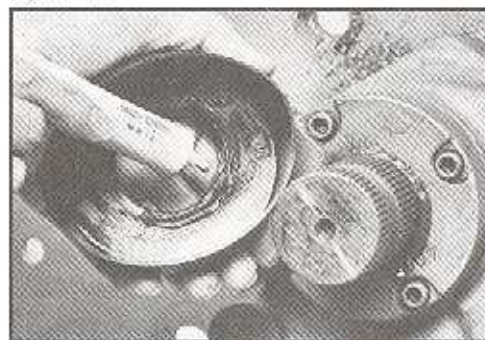


Figure 15

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

- 1.12 If required assemble the sector shaft washer (54B) and nut (54C). Torque nut to 475-500 ft. lbs. (644-678 N m). If required assemble the pitman arm clamp nut and bolt. Torque bolt to 380-420 ft. lbs. (515-569 N m) if dry and unplated. Torque bolt to 300-320 ft. lbs. (407-434 N m) if bolt is lubricated or plated. SEE FIGURE 17.



Figure 16

CAUTION

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

fill and bleed
system

- 1.13 Before operating the steering gear, fill the system with the recommended fluid and bleed air from the system by following the Filling and Air Bleeding instructions on page 53.



Figure 17

2 The Worm (Input) Shaft Seal

remove input
coupling; clean
input shaft

- 2.1 If there is a leak in the worm 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 (25B) 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 (25B) 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.

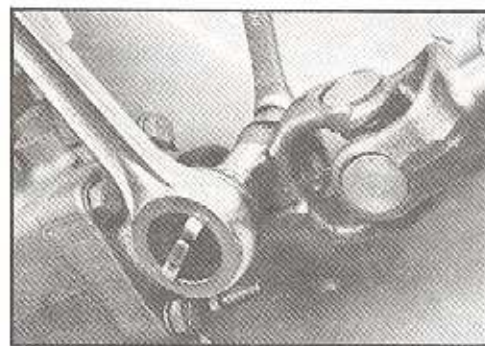


Figure 18



Figure 19



Figure 20



Figure 21



Figure 22

remove seal
and washer

- 2.5 The air pressure will force the two-piece 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 two-piece seal. Disconnect the shop air as soon as the seal assembly is out. SEE FIGURE 23.



Figure 23

install seal
package

- 2.6 Tape the worm shaft serrations. Assemble **new** seal (4) onto worm shaft (25B) and into upper cover (7) with seal lip facing the upper cover bearing (5). Remove tape. 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 24 and 25.



Figure 24

grease worm
shaft and
protector seal

- 2.7 Apply more of the special grease in the seal area of worm shaft (25B) and to the **new** protector seal (1). SEE FIGURE 26.

assemble
protector seal

- 2.8 Assemble **new** protector seal (1) onto worm shaft (25B) and upper cover (7). SEE FIGURE 27.



Figure 25

reconnect line

- 2.9 Remove the plug and reconnect the return line.

reconnect input
coupling

- 2.10 Reconnect the input coupling to worm shaft (25B). 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. Reconnect the return line.



Figure 26

WARNING

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

fill and bleed
system

- 2.11 Before operating the steering gear, fill the system with the recommended fluid and bleed air from the system by following the Filling and Air Bleeding instructions on page 53.



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 (25B) 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.

remove upper cover bolts and washers

- 3.3 Remove four upper cover bolts (7A) and washers (7B). SEE FIGURE 28. 9/16 inch socket required.

remove upper cover assembly

- 3.4 Carefully remove upper cover (7) assembly from worm shaft (25B) while maintaining the valve assembly (18) position. SEE FIGURE 29.

reassemble one bolt

- 3.5 Reassemble one bolt (7A) 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 (12) tang that is staked into a slot in bearing lock nut (11). SEE FIGURE 31. Remove tape from serrations.

remove bearing lockwasher and nut

- 3.7 Place a 3/4 or 13/16 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 (11) and turn nut off of worm shaft. Remove and discard bearing lockwasher (12). SEE FIGURE 32.

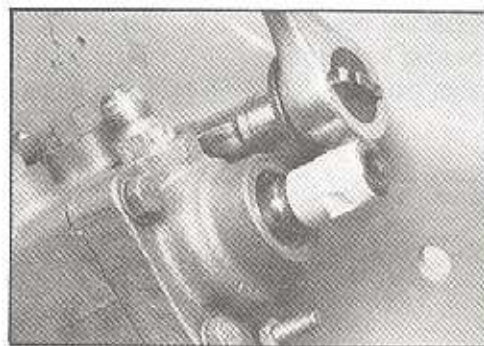


Figure 28



Figure 29



Figure 30



Figure 31



Figure 32

assemble new bearing lockwasher, then nut

- 3.8 Assemble a **new** bearing lockwasher (12) onto worm shaft (25B) with the internal washer tang in the worm shaft slot and the external tangs facing out. Reassemble bearing lock nut (11), large chamfer side in, onto threaded diameter of worm shaft until components are at solid height (snug). SEE FIGURE 33.



Figure 33

torque bearing lock nut

- 3.9 Torque the bearing lock nut (11) to 30 ft. lbs. (41 N m) to ensure components are sealed. Back the nut off and torque nut to 15-20 ft. lbs. (20-27 N m). SEE FIGURE 34. Back nut off approximately 20° and bend one tang of bearing lockwasher (12) firmly into a mating slot in lock nut. SEE FIGURE 35.

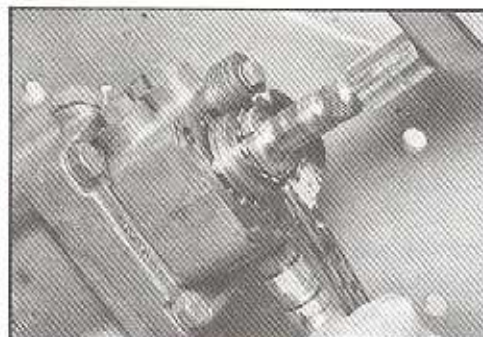


Figure 34

NOTE

NOTE: It is recommended that seal (4) in the removed upper cover (7) and backup washer (10) and o-ring (10A) on poppet adjusting screw (9) be replaced per the disassembly and assembly procedures in this manual before upper cover is reassembled.

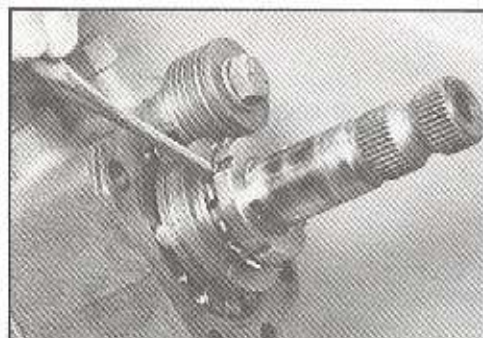


Figure 35

remove bolt and spacers

- 3.10 Remove the one bolt (7A) and spacers used to contain components during adjustment. Tape worm shaft serrations.

assemble upper cover

- 3.11 Grease and install a **new** seal ring (8) in upper cover (7) and assemble upper cover and adjusting screw assembly onto the worm shaft (25B), inserting the poppet adjusting screw (9) into valve (18) and adaptor (20) as required. SEE FIGURE 36.



Figure 36

assemble and torque bolts

- 3.12 Assemble the four bolts (7A) and washers (7B) into upper cover (7). Carefully torque the bolts while checking that the adaptor (20), valve assembly (18) and upper cover are properly piloted and positioned with all seal rings in place. Torque bolts to 25-35 ft. lbs. (34-47 N m) if dry, or 21-27 ft. lbs. (28-37 N m) if lubricated. SEE FIGURE 37.

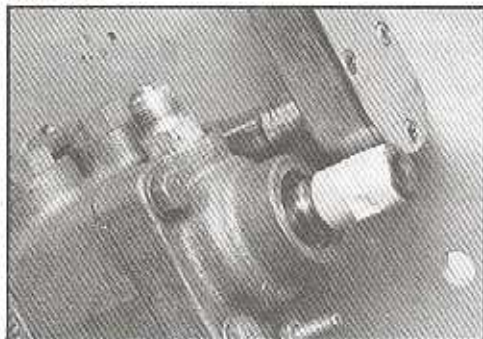


Figure 37

complete the gear reassembly

- 3.13 Complete the steering gear reassembly by following procedures 2.8 through 2.11.

4 Poppet Valve Adjustment (With Vehicle Engine On)

set axle stops

- 4.1 Before you adjust the poppets, set the axle stops according to the manufacturer's specifications.

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

- 4.3 With the engine at idle, have someone turn the steering wheel to full lock, (axle against axle stop) while you observe the rotation of the sector shaft (46). SEE FIGURE 38. If the sector shaft rotates counter-clockwise as shown, adjust the poppet adjusting screw identified in the appropriate view shown in figure 38. If the sector shaft rotates clockwise, adjust the other poppet adjusting screw.

CAUTION

CAUTION: If system 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 system 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 jam nut and adjusting screw

- 4.4 Once you have determined which poppet to adjust, loosen the poppet adjusting screw jam nut (6 or 49) and the poppet adjusting screw (9 or 48) until the pressure gage reads maximum system pressure with steering wheel at full lock. SEE FIGURE 39.

set adjusting screw and tighten jam nut

- 4.5 Manually (no power tool) and carefully screw in the poppet adjusting screw (9 or 48) that is being adjusted until pressure gage shows a significant pressure drop (200-400 psi) with the axle contacting axle stop (full lock). Torque the related adjusting screw jam nut (6) to 15-20 ft. lbs. (20-27 N m) or jam nut (49) to 20-25 ft. lbs. (27-34 N m). 1/2 inch or 11/16 inch socket required.

adjust other poppet

- 4.6 To adjust the other poppet, repeat these instructions for full lock in the other direction. SEE FIGURE 40.

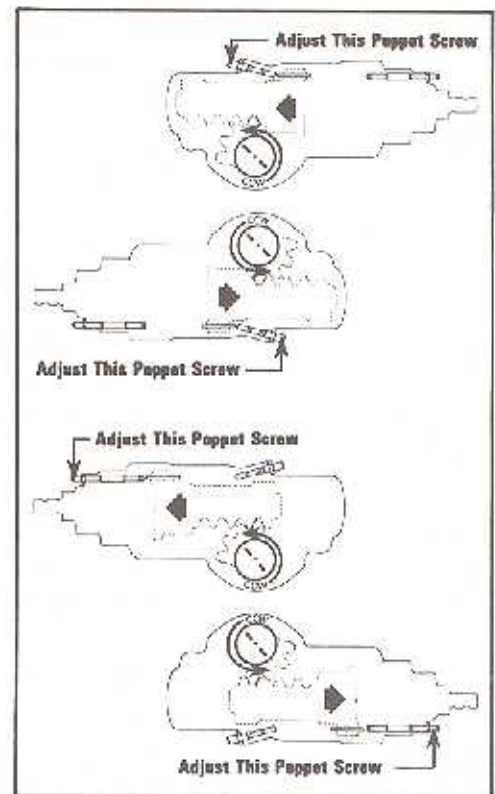


Figure 38

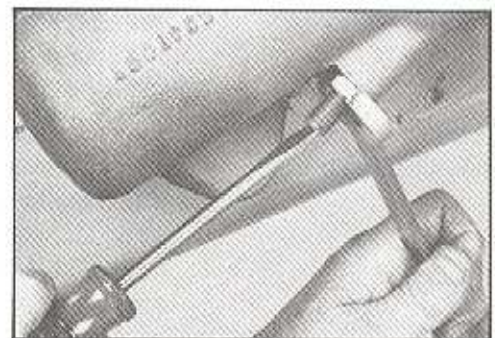


Figure 39

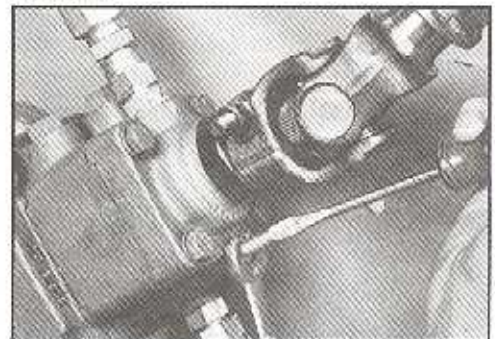


Figure 40

5 Cross-shaft or Sector-shaft Adjustment

(With vehicle engine off)

locate
adjusting nut

- 5.1 If the sector shaft adjusting screw jam nut (37) located on the side cover (38), 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 (46) a timing mark must be scribed across the end of the sector shaft perpendicular to the worm shaft (25B) 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 (45) 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 (46) 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 (25B). SEE FIGURE 41.

check for lash

- 5.4 With the sector shaft (46) 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 (37) with a 3/4 inch socket and move the adjusting screw (45) clockwise until the sector shaft and rack piston (35) are in contact. (Use no more than 10 ft. lbs. (14 N m) of torque). Then turn the adjusting screw counterclockwise one turn.

check for lash

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

eliminate lash

- 5.7 To adjust, slowly turn the adjusting screw (45) clockwise until no lash is felt at the pitman arm. Hold the adjusting screw in place, and tighten the jam nut (37). Then torque nut to 40-45 ft. lbs. (54-61 N m).

recheck
for lash

- 5.8 Recheck the pitman arm for lash. Turn the steering wheel 1/4 turn each side of center. No lash should be felt. If lash exists, repeat adjustments 5.3-5.8.

connect
drag link

- 5.9 Reconnect drag link to pitman arm.



Figure 41



Figure 42

Torque Chart

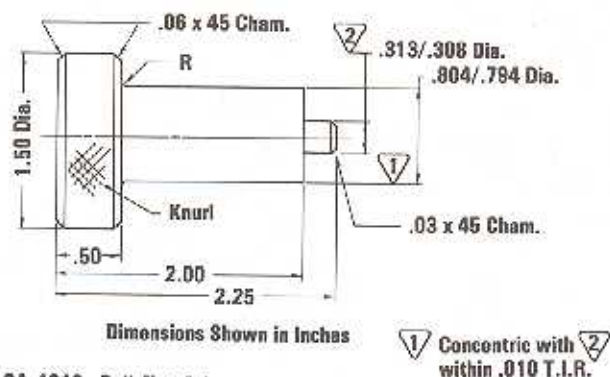
Part Name	Item Number	Torque
Upper Cover Bolts	7A	25- 35 ft. lbs. (34- 47 N m)
Upper Cover Bolts	7A if Lubricated	21- 27 ft. lbs. (28- 37 N m)
Poppet Seat	32	25- 30 ft. lbs. (34- 41 N m)
Locking Screw (Ball Nut)	36	30- 35 ft. lbs. (41- 47 N m)
Adaptor Bolt	20A	70- 80 ft. lbs. (95-108 N m)
Adaptor Bolt	20A if Lubricated	47- 57 ft. lbs. (64- 77 N m)
Side Cover Bolts	38A	150-170 ft. lbs. (203-230 N m)
Side Cover Bolts	38A if Lubricated	108-128 ft. lbs. (146-174 N m)
Trunnion Cover Screws	52A	13- 23 ft. lbs. (18- 31 N m)
Trunnion Cover Screws	52A if Lubricated	11- 16 ft. lbs. (15- 22 N m)
Puppet Adj. Nut	6	15- 20 ft. lbs. (20- 27 N m)
Poppet Adj. Nut (Hsg.)	49	20- 25 ft. lbs. (27- 34 N m)
Poppet Adj. Nut (Hsg.)	49	20- 25 ft. lbs. (27- 34 N m)
Adj. Nut (Sector Shaft)	37	40- 45 ft. lbs. (54- 61 N m)
Sector Shaft Nut	54R	475-500 ft. lbs. (644-678 N m)
Pitman Arm Bolt & Nut Ass'y.		380-420 ft. lbs. (515-569 N m)
Pitman Arm Bolt & Nut Ass'y.	Lubricated/Plated	300-320 ft. lbs. (407-434 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, 11/16 inch
Grease—*Mobil Temp 1 or 2 or equivalent	Allen Sockets: 1/4, 3/8 inch
Wheel Bearing Grease	12-Point Sockets: 3/4, 13/16 inch
Adjustable Wrench	Pitman Arm Puller
Pocket Knife	Screw Driver
Torque Wrench—in lbs. (N m)	Slot Type Screwdriver Socket
Torque wrench—ft. lbs. (N m)	Chisel
Soft Punch	3/4" to 2" Adjustable Hook Spanner Wrench
Rubber Mallet	Small Needle Nose Pliers
Vise	Bearing Mandrel
1" or 25 mm Micrometer	Loquic Grade "1" Primer
Emery Paper	Stud Lock
Special Arbor #GA1913 (See Sketch)	Loctite Hydraulic Sealant
Retaining Ring Pliers	
Breaker Bar	

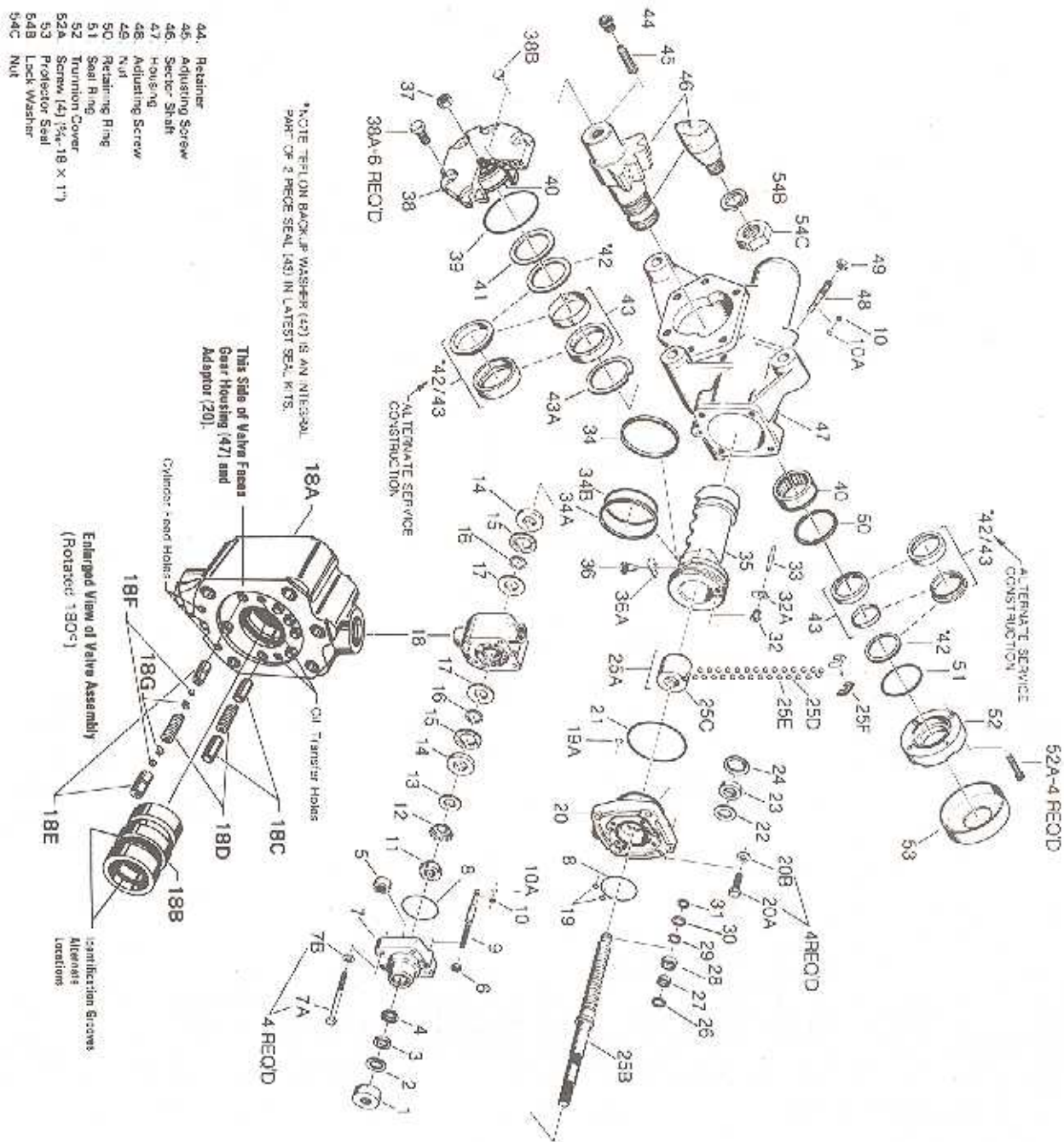


GA 1913—Ball Nut Arbor
To be Fabricated By Customer

*Mobil Temp is a Registered Trademark of Mobil Oil Co.

HF64 Exploded Assembly View — Typical

Item No.	Description
1	Protector Seal
2	Retaining Ring
3	Back-Up Washer
4	Seal
5	Bearing
6	Nut
7	Upper cover
7A	Bolt (4) 1/2" x 3/8"
7B	Washer
8	Seal Ring (2)
9	Adjusting Screw
10	Back-Up Washer (2)
10A	"O" Ring (2)
11	Nut
12	Lock Washer
13	Washer
14	Thrust Washer (2)
15	Thrust Bearing (2)
16	Spacer Washer (2)
17	Thin Thrust Washer (2)
18	Valve Assy
18A	Valve Body
18B	Valve Spec
18C	Plunger (12)
18D	Spring (7)
18E	Check Valve Plunger (2)
18F	Ball (2)
18G	Conical Spring (2)
19	"O" Ring (2)
19A	Seal Ring
20	Adaptor
20A	Bolt (4) 1/2" x 3/8"
20B	Washer (4)
21	Seal Ring
22	Back-Up Washer
23	Seal
24	Retaining Ring
25	Worm and Nut Assy
25A	Ball Nut Assy
25B	Ball Nut
25C	Ball Nut
25D	Ball (Spacer) (14)
25E	Ball (Return Guide) (2)
25F	Worm Shaft
26	Washer (Steel)
27	Seal
28	Seal Cup
29	Back-Up Washer
30	Retaining Washer
31	Retaining Ring
32	Poppet Seal
32A	Lock Washer
33	Poppet
34	Piston Ring
34A	Seal Ring
34B	"O" Ring
35	Rack Piston
36	Locking Washer
38A	Locking Washer
37	Nut
38	Side Cover (Incl. Seal Bearing)
38A	Special Bolt (5) (1/2" x 18 x 1")
38B	Vent Plug
39	Seal Ring
40	Bearing
41	Back-Up Washer (Steel)
42	Back-Up Washer
43	Seal Assembly
43A	Retaining Ring

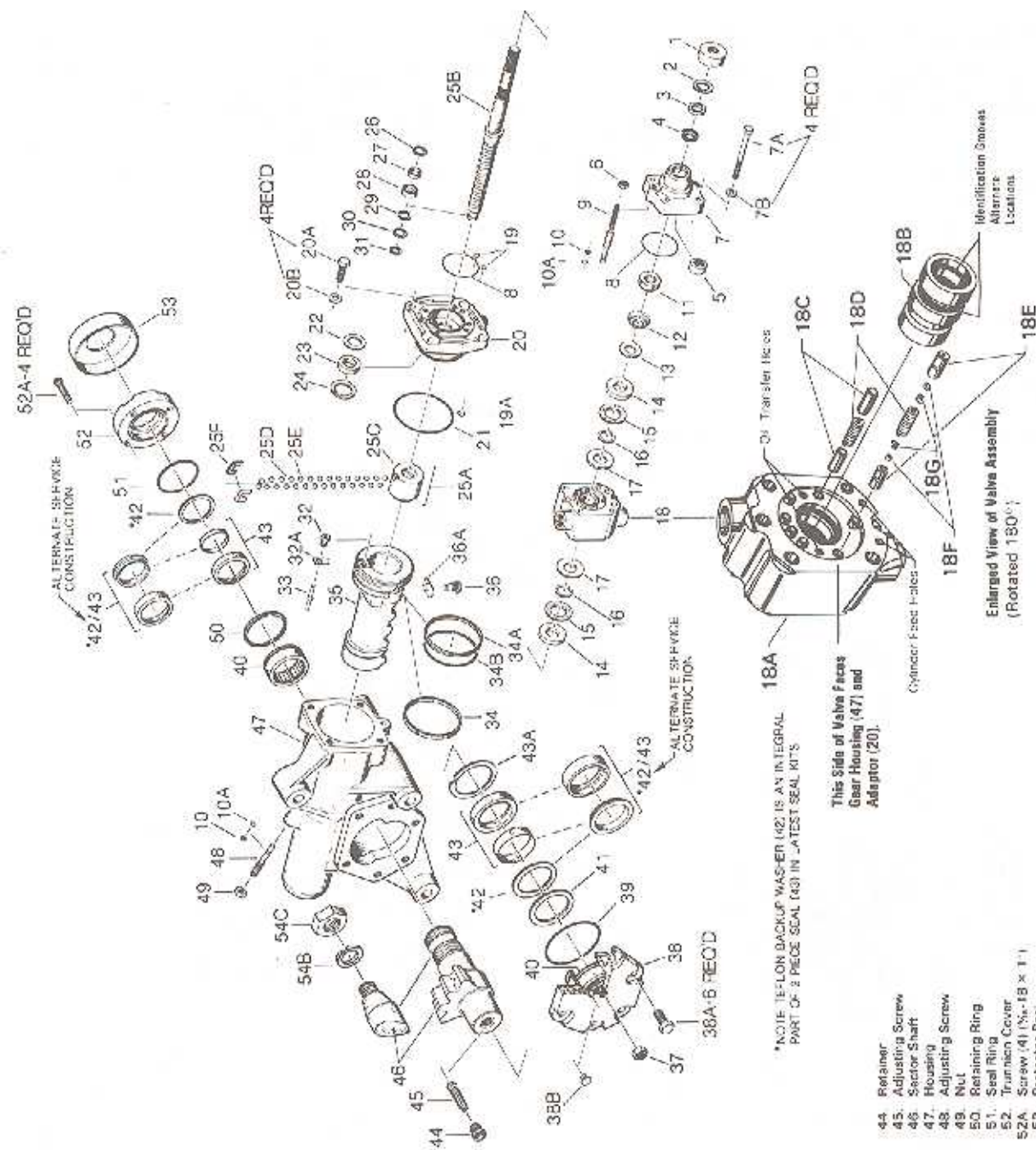


HF64 Exploded Assembly View — Typical

(Identical to page 214)

Item No. Description

1. Protector Seal
2. Retaining Ring
3. Back-Up Washer
4. Seal
5. Bearing
6. Nut
7. Upper cover
- 7A. Bolt (4) $\frac{1}{4}$ -16 \times 3 $\frac{1}{2}$ "
- 7B. Washer
8. Seal Ring (2)
9. Adjusting Screw
10. Back-Up Washer (2)
- 10A. "O" Ring (2)
11. Nut
12. Lock Washer
13. Washer
14. Thick Thrust Washer (2)
15. Thrust Bearing (2)
16. Spacer Washer (2)
17. Thin Thrust Washer (2)
18. Valve Assy
- 18A. Valve Body
- 18B. Valve Spec
- 18C. Plunger (12)
- 18D. Spring (7)
- 18E. Check Valve Plunger (2)
- 18F. Ball (2)
- 18G. Conical Spring (2)
- 18H. "O" Ring (2)
19. Seal Ring
- 19A. Seal Ring
20. Adapter
- 20A. Bolt (4) $\frac{1}{4}$ -13 \times 1 $\frac{1}{2}$ "
- 20B. Washer (4)
21. Seal Ring
22. Back-Up Washer
23. Seal
24. Retaining Ring
25. Worm and Nut Assy
- 25A. Ball Nut Assy
- 25B. Ball Nut
- 25C. Ball (14)
- 25D. Ball (14)
- 25E. Ball Spacer (14)
- 25F. Ball Return Guide (2)
- 25B. Worm Shaft
- 25B. Washer (Steel)
26. Washer
27. Seal
28. Seal Cup
29. Back-Up Washer
30. Retaining Ring
31. Retaining Ring
32. Poppet Seal
- 32A. Lock Washer
33. Poppet
34. Piston Ring
- 34A. Seal Ring
- 34B. "O" Ring
35. Rack Piston
36. Locking Screw
- 36A. Locking Washer
37. Nut
38. Side Cover (Includes Bearing)
- 38A. Special Bolt (6) $\frac{1}{4}$ -18 \times 1"
- 38B. Vent Plug
- 38C. Seal Ring
40. Bearing
41. Back-Up Washer (Steel)
- *42. Back-Up Washer
43. Seal Assembly
- 43A. Retaining Ring
44. Retainer
45. Adjusting Screw
46. Sector Shaft
47. Housing
48. Adjusting Screw
49. Nut
50. Retaining Ring
51. Seal Ring
52. Trunnion Cover
- 52A. Screw (4) $\frac{1}{4}$ -18 \times 1"
53. Protector Seal
- 54B. Lock Washer
- 54C. Nut



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 74 POUNDS 34 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
in vise

1. Position the steering gear firmly in a vise, clamping against the housing (47) mounting flange or boss, with the worm shaft (25B) in a horizontal direction and components accessible for disassembly. SEE FIGURE 43.

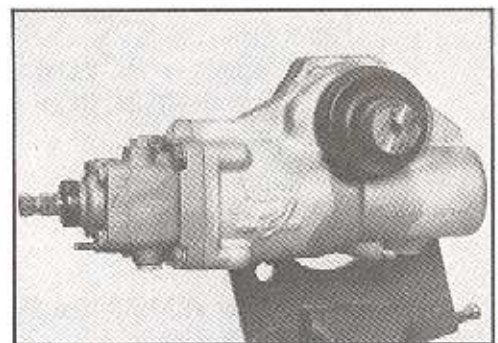


Figure 43

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 the appropriate 3/4 or 13/16 inch 12 point socket on the worm shaft serrations, rotate worm shaft (25B) through gear travel a few times to purge hydraulic fluid from gear. Then

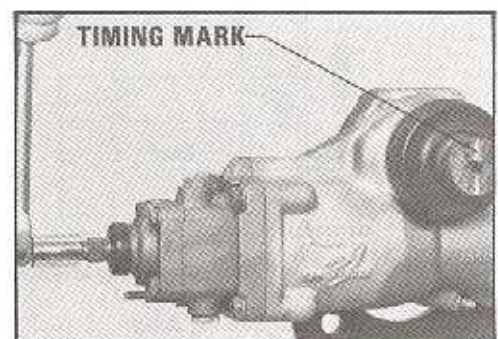


Figure 44

rotate the worm shaft until the timing mark on the end of the sector shaft (46) is vertical (90°) 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 (53) from trunnion cover (52). SEE FIGURE 45.

clean sector
shaft

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

remove trunnion
cover screws

5. Remove the four trunnion cover screws (52A). A 1/4 inch Allen socket required. SEE FIGURE 47.

remove trunnion
cover and
seal package

6. Remove the trunnion cover (52). Remove and discard the seal ring (51), the two piece sector shaft seal (43) and the Teflon backup washer (42) from the trunnion cover. SEE FIGURE 48.

loosen sector
shaft adjusting
screw jam nut

7. Loosen sector shaft adjusting screw nut (37). SEE FIGURE 49. A 3/4 inch socket is required.

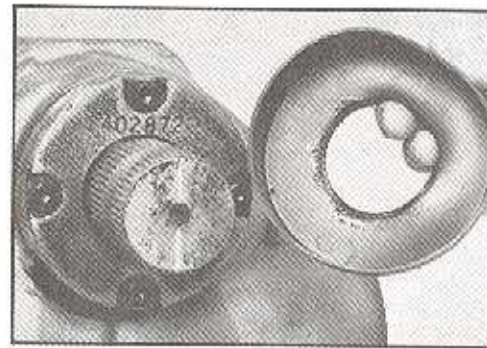


Figure 45



Figure 46

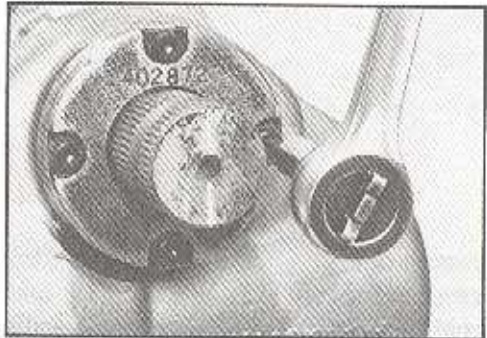


Figure 47

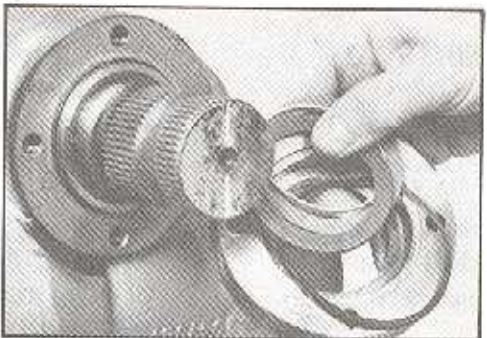


Figure 48

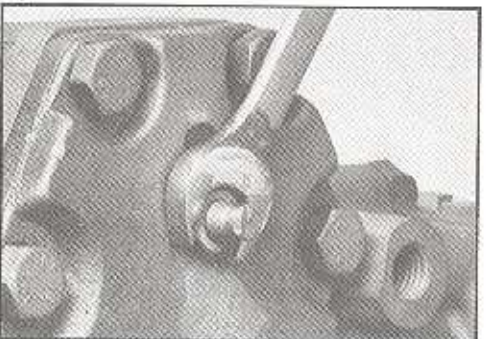


Figure 49

remove side
cover bolts

8. Prepare for fluid to drain and remove the six special bolts (38A) from side cover (38). A 13/16 inch socket required. SEE FIGURE 50. Tap lightly with soft face hammer on the end of sector shaft (46) to disengage seal and let drain.



Figure 50

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 DEM parts distributor.

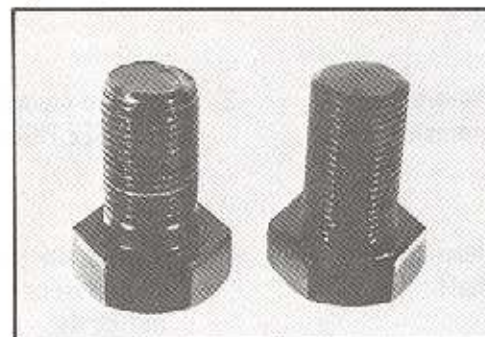


Figure 51

remove side
cover and sector
shaft assembly

9. Remove side cover (38) and shaft assembly (46) as a unit from gear assembly. SEE FIGURE 52. Remove and discard seal ring (39).



Figure 52

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 (37) and screw sector shaft adjusting screw (45) out of side cover (38) and lift sector shaft (46) out of side cover. SEE FIGURE 53.

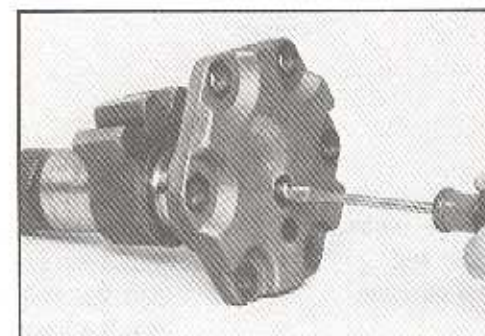


Figure 53

remove side
seal retainer

11. Remove the side cover retaining ring (43A). SEE FIGURE 54.



Figure 54

remove seal
package and
vent plug

12. Remove the two piece seal (43), the Teflon backup washer (42) and steel backup washer (41) from side cover (38). Discard the two piece seal and Teflon washer. SEE FIGURE 55. Remove and discard vent plug (38B).



Figure 55

remove retainer
and adjusting
screw

13. Only if replacement of retainer (44) and/or adjusting screw (45) is required, (see inspection procedure #9, page 35.) place the sector shaft (46) firmly in a soft jawed vise and unstick retainer using a suitable chisel. Turn retainer out of sector shaft pocket and remove adjusting screw. Discard retainer. SEE FIGURE 56.



Figure 56

remove seal
and clean
worm shaft

14. Remove protector seal (11) from worm shaft (25B). Clean exposed area of the worm shaft with a fine grade of emery paper. SEE FIGURE 57.

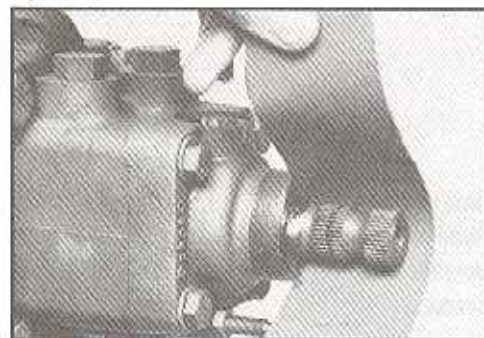


Figure 57

NOTE:

NOTE: Scribing or marking a line across the housing (47) adaptor (20) valve body (18) 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 (7A) and poppet adjusting screw nut (6) for later removal. A 9/16 inch and 1/2 inch socket required. SEE FIGURE 58.

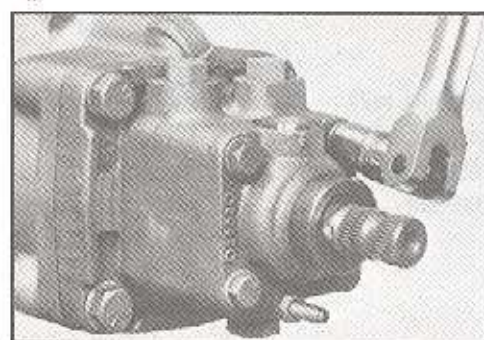


Figure 58

remove adaptor
bolts

16. Remove four adaptor bolts (20A) and washers (20B). A 3/4 inch socket required. SEE FIGURE 59.



Figure 59

rotate worm
shaft to
loosen adaptor

17. Rotate worm shaft (25B) until adaptor (20) moves away from housing (47), about 3/4 inch (19 mm) and let drain. SEE FIGURE 60.

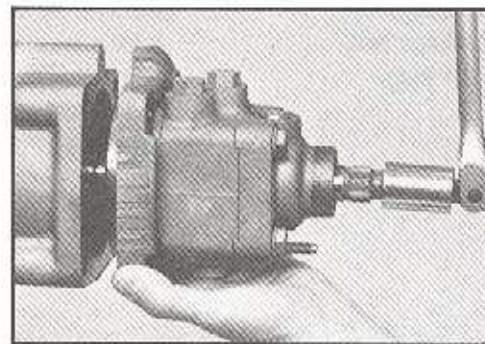


Figure 60

remove worm
shaft subassembly

18. Remove worm shaft (25B), upper cover (7) adaptor (20) rack piston (35) subassembly as a unit from housing (47) and place on a cloth covered work surface, with the rack teeth up. SEE FIGURE 61. Remove and discard seal ring (21) and seal ring (19A).

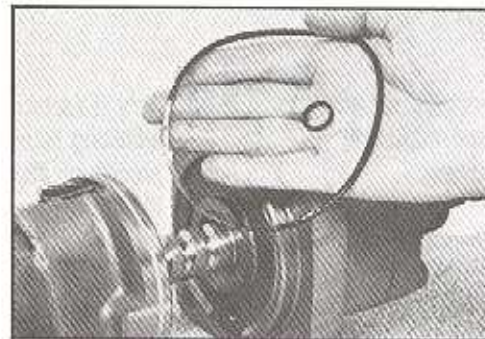


Figure 61

unstake and
remove locking
washer and
screw

19. Unstake locking washer (36A) from locking screw (36) in the rack piston (35) with suitable chisel. SEE FIGURE 62. Remove locking screw and locking washer from rack piston. Discard washer. A 3/8 inch Allen socket required. SEE FIGURE 63.



Figure 62

position rack
piston and
disengage from
ball nut

20. Position the rack piston (35) with rack teeth down and disengage rack slowly from subassembly until approximately 1 inch (25.4 mm) of the assembled ball nut (25A) is exposed. Wipe the exposed ball nut dry and place retaining clip or tape over ball return guide (25F) to retain the guide and balls in ball nut. Complete the removal of rack piston from subassembly. SEE FIGURE 64.



Figure 63

WARNING

WARNING: IF BALL NUT, BALL RETURN GUIDES AND BALLS BECOME DISASSEMBLED, EXTREME CARE MUST BE EXERCISED TO REASSEMBLE THESE PARTS. IT IS IMPERATIVE THAT THE BALL NUT ASSEMBLY PROCEDURES IN THIS MANUAL BE FOLLOWED. INCORRECT ASSEMBLY CAN RESULT IN A BALL ESCAPING AND CAUSING A LOCK UP OF THE STEERING GEAR. THIS COULD RESULT IN AN ACCIDENT.



Figure 64

cut and remove
rack piston
seal ring and
o-ring

21. Position the rack piston (35) in a vise clamping against unmachined surfaces. Cut and remove seal ring (34A) and o-ring (34B) from rack piston. SEE FIGURE 65. If the rack piston has cast metal ring (34) remove it only if it is to be replaced. Discard removed rings.

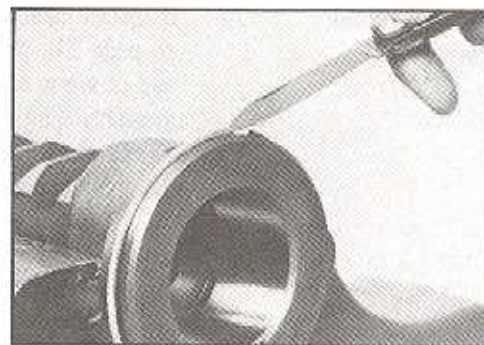


Figure 65

unstake poppet
lockwasher

22. Only if poppet (33) is to be replaced, unstake lockwasher (32A) from poppet seat (32) in rack piston (35) with suitable chisel. SEE FIGURE 66.



Figure 66

remove poppet
seat, lockwasher
and poppet

23. Then remove poppet seat (32) lockwasher (32A) and poppet (33) from rack piston (35). A 9/16 inch socket required. SEE FIGURE 67.



Figure 67

cut and remove
worm shaft seal

24. While holding them stationary with pliers to prevent slipping, cut, remove, and discard the seal cup (28) and seal (27) from ball nut end of worm shaft (25B). SEE FIGURE 68.



Figure 68

remove retainers
and washers

25. Remove retaining ring (31) using needle nose pliers, then remove retaining washer (30) bronze washer (29) and steel washer (26) from ball nut end of worm shaft (25B). SEE FIGURES 69 & 70.



Figure 69

remove ball nut
assembly

26. If special mandrel GA1913 is available (see tools on page 21), place mandrel in hole at ball nut end of worm shaft (25B) and screw the ball nut assembly (25A) onto mandrel. SEE FIGURES 71 & 72. Carefully remove mandrel and ball nut assembly and set aside with ball nut up.

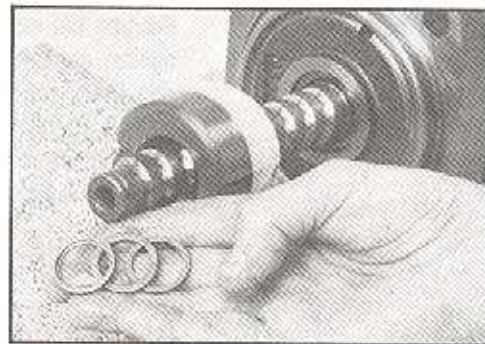


Figure 70



Figure 71

disassemble ball
nut assembly
if necessary

27. If the special ball nut mandrel (GA1913) is not available, turn the ball nut assembly (25A) off the worm shaft (25B) over the cloth work surface to catch the balls (25D and 25E) that will fall out. SEE FIGURE 73.

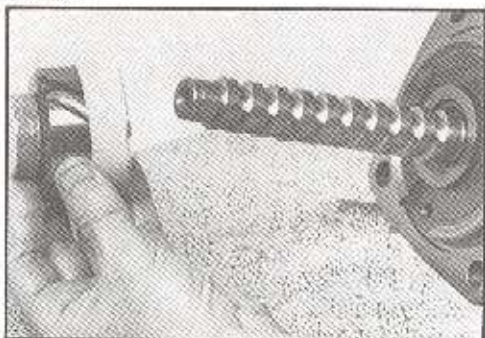


Figure 72

CAUTION

CAUTION: If one or more balls are lost or damaged, the complete set of 28 balls must be replaced with a service ball kit.

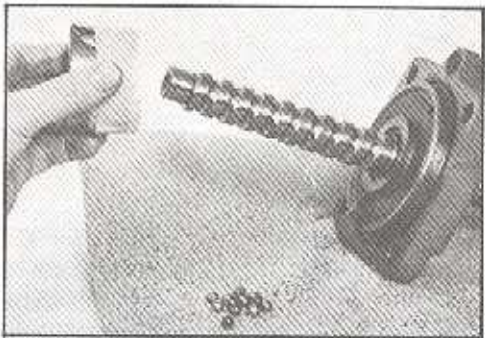


Figure 73

remove ball
return guides
and balls

28. Then remove the tape or clip, the ball return guides (25F) and the balance of balls (25D, 25E) from the ball nut (25C). SEE FIGURE 74.

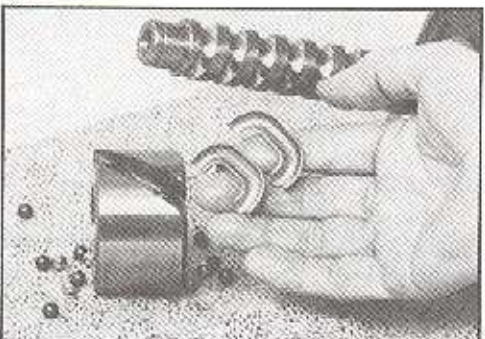


Figure 74

NOTE

NOTE: If the set of 28 balls removed from ball nut are to be reassembled set them aside for cleaning, measuring, and segregating by size into two groups.

remove upper
cover, bolts,
and washers

29. Remove the four loosened upper cover bolts (7A), washers (7B) and the upper cover (7) assembly from the worm shaft (25B) subassembly. SEE FIGURE 75. Discard seal ring (8).



Figure 75

remove poppet
adjusting screw
and nut

30. Remove the loosened nut (6) from the poppet adjusting screw (9). Then turn the adjusting screw out of the upper cover (7). Remove and discard back washer (10) and O-ring (10A) from adjusting screw. SEE FIGURE 76.

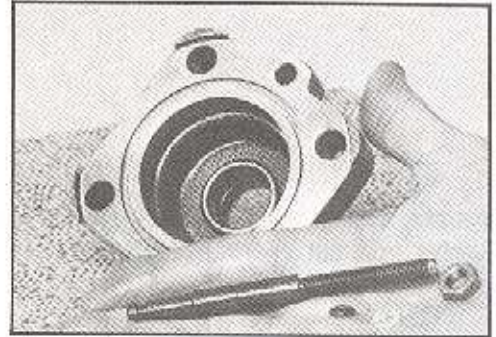


Figure 76

NOTE

NOTE: The adjusting screw (9) and nut (6) do not have to be removed from upper cover if only the backup washer (10) and o-ring (10A) are to be replaced.



Figure 77

remove upper
cover retaining
ring and seal
package

31. Remove retaining ring (2) from upper cover (7) with the appropriate retaining ring pliers. SEE FIGURE 77. Remove backup washer (13) and seal (14). SEE FIGURE 78.



Figure 78

remove adaptor
from worm shaft

32. Remove adaptor (20) from worm shaft (25B). SEE FIGURE 79. Remove and discard seal ring (8) and two seal rings (119).

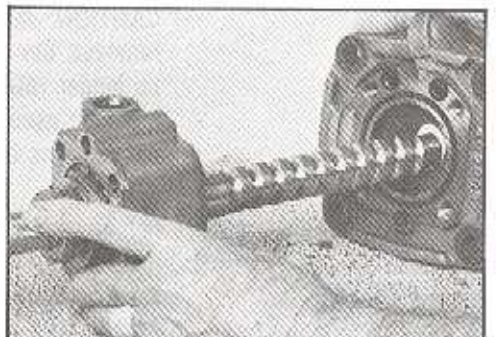


Figure 79

remove retaining
ring, seal and
backup washer

33. Remove retaining ring (24) from adaptor (20). SEE FIGURE 80. Remove and discard seal (23) and backup washer (22). SEE FIGURE 81.



Figure 80

unstake locking
washer from nut

34. Unstake the tang on bearing lockwasher (12) that is staked in a slot of bearing (spanner) lock nut (11) on the worm shaft, valve subassembly. SEE FIGURE 82.



Figure 81

remove bearing
lock nut

35. Use a breaker bar and the appropriate 3/4 or 13/16 inch 12 point socket on the serrations or clamp worm shaft carefully in a soft jawed vise to hold worm shaft (25B) from rotating. Turn off the bearing lock nut (11) from the worm shaft with a hook type spanner wrench or self gripping (groove joint) pliers. SEE FIGURE 83.



Figure 82

CAUTION

CAUTION: When the bearing locknut (11) is removed the valve assembly components are no longer retained in the valve body. Care must be used to keep the valve assembly components assembled.



Figure 83

remove washer
and thrust
bearing package

36. Remove and discard bearing lock washer (12) and remove washer (13), thrust washer (14), thrust bearing (15) spacer washer (16) and thrust washer (17). SEE FIGURE 84.

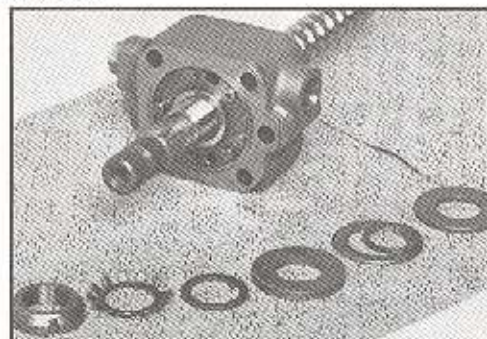


Figure 84

remove valve assembly

CAUTION

37. Carefully remove valve assembly (18) intact from worm shaft (25B) and set aside for inspection and assembly procedures. SEE FIGURE 85.

CAUTION: The valve assembly (18) 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 (18B) or other valve components become disassembled, follow the assembly procedures with care.

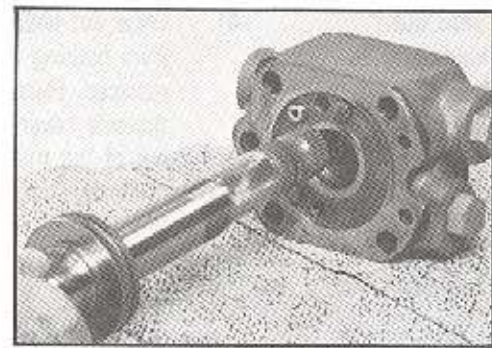


Figure 85

remove second thrust bearing package

38. Remove the second thin thrust washer (17), spacer washer (16) thrust bearing (15) and the thick thrust washer (14) from worm shaft (25B). SEE FIGURE 86.

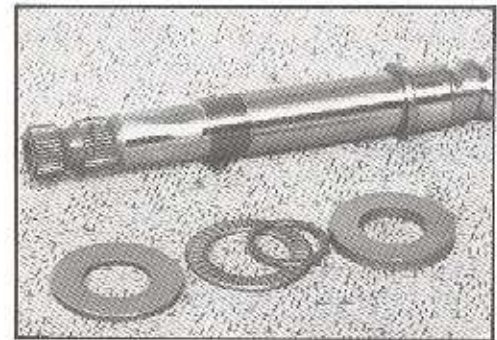


Figure 86

remove poppet adjusting screw and nut from housing

39. Loosen nut (49) and remove nut and poppet adjusting screw (48) from housing (47). SEE FIGURE 87.



Figure 87

remove and discard backup washer and o-ring

40. Remove and discard backup washer (10A) and o-ring (10) from adjusting screw (48). Remove nut (49) if replacement is required. SEE FIGURE 88.

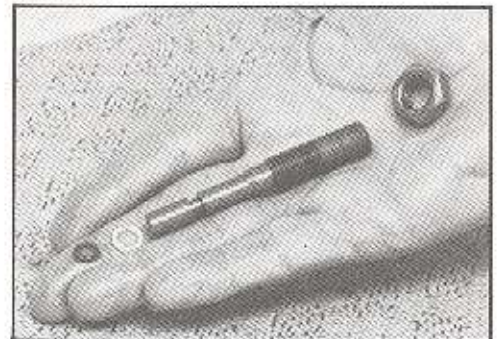


Figure 88

press out
housing
bearing
assembly

41. Press out bearing (40) and retaining ring (50) from housing (47) only if the bearing is to be replaced. Place suitable bearing mandrel against the side cover end of bearing and press bearing out of the trunnion end of bearing bore. Remove retaining ring from bearing and discard bearing. SEE FIGURE 89.

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.

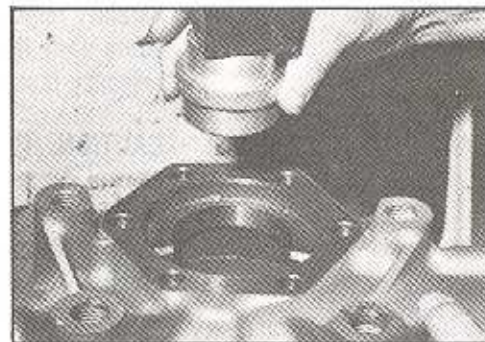


Figure 89

press out
upper cover
bearing

42. Press bearing (5) out of upper cover (7) with the bearing mandrel against seal end of bearing and only if it is to be replaced. SEE FIGURE 90.



Figure 90

This completes the disassembly of HFB4 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 (35) 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 and sector shaft (46). Carefully inspect the rack piston bores and outer ground surfaces for damage and stone off any burrs. SEE FIGURES 91 and 92.



Figure 91



Figure 92

inspect worm shaft & ball nut

2. Inspect the worm shaft (25B) and the ball nut (25C) ball track grooves for brinelling or spalling. SEE FIGURE 93. If either condition exists, in either components, you must replace worm shaft and ball nut assembly (25). Visually inspect the worm shaft upper seal area near the serrated end for nicks, and run your fingernail edge across the sealing surface to detect steps. SEE FIGURE 94. Visually inspect the valve spool (18B) contact area of the worm shaft for discoloration from excess heat. If either of these conditions exist you must replace the worm shaft, ball nut, valve, rack piston, adaptor, upper cover assembly.

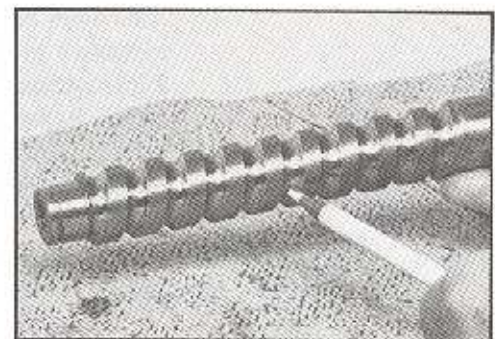


Figure 93

NOTE

NOTE: If a ball (25D) or (25E) in the ball nut assembly (25A) is lost during disassembly or assembly procedures, all 28 balls must be replaced as a set utilizing a service ball kit. Damaged balls would require you replace worm shaft and ball nut assembly.

inspect valve assembly

3. Inspect valve spool (18B) and valve body (18A) bore for broken sealing edges. SEE FIGURE 95.

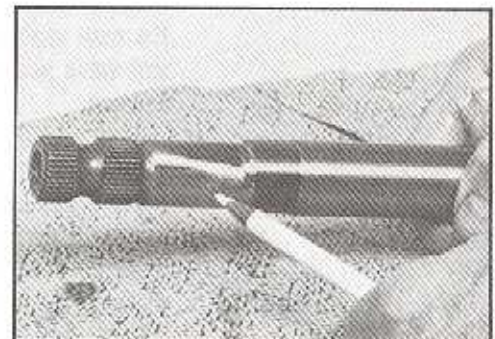


Figure 94

CAUTION

CAUTION: The valve assembly (18) 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 (18B) or other valve components become disassembled, follow the assembly procedures with care.

inspect thrust washers and bearing

4. Inspect the thrust bearing (15) rollers for any deterioration. Inspect the thrust washers (17) and (14) for brinelling, spalling, or cracks. SEE FIGURE 96. Replace the part if you detect these conditions.

inspect housing cylinder bore

5. Inspect the housing (47) cylinder bore. SEE FIGURE 97. 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.

inspect housing faces

6. Inspect the housing (47) faces for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a finetoothed flat file without changing the dimensional characteristics. SEE FIGURE 98.

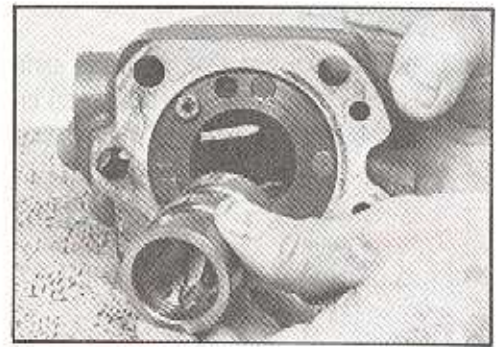


Figure 95

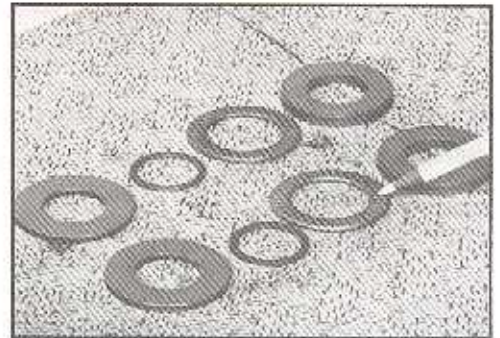


Figure 96

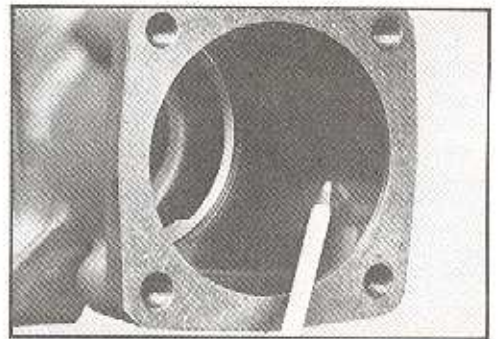


Figure 97

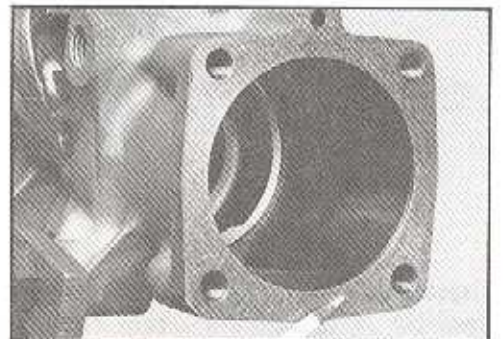


Figure 98

inspect housing
and side cover
bearings

7. Inspect the housing bearing (40) and the side cover bearing for brinelling or spalling. SEE FIGURES 99 & 100. If either condition exists, replace the damaged housing bearing (40). For the housing bearing, follow disassembly step 41 and assembly step 1, pages 32 and 36. If the side cover bearing is damaged, replace side cover assembly (38).

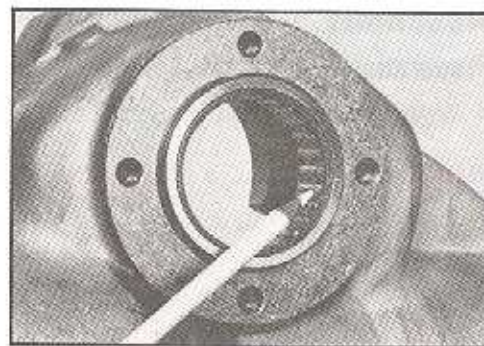


Figure 99

inspect sector
shaft assembly

8. Inspect the sector shaft (46) bearing and sealing areas and sector teeth contact surfaces for brinelling or spalling. SEE FIGURE 101. 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 100

NOTE

NOTE: A service shaft assembly will have the adjusting screw (45) and retainer (44) assembled into it. The screw (45) and retainer (44) can be serviced separately if required.



Figure 101

inspect
adjusting screw
and retainer

9. Inspect the sector shaft assembly for damaged adjusting screw (45) threads. The staked retainer (44) 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. Refer to the assembly and disassembly procedures.

This completes inspection of the HF64 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 102. 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 (40), first install the retaining ring (50) into the groove on the bearing's outside diameter. Place the housing (47), side cover face down on a wooden block to protect the face. Using a suitable bearing mandrel, carefully press the long end of the bearing into the housing from the trunnion cover side until the retaining ring contacts the housing. SEE FIGURE 103. During this procedure be sure the housing is square with 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 104.

clamp valve body or assembled valve body in vise

3. Assemble a hydraulic fitting securely in valve body (1BA) hydraulic port. Clamp valve body assembled or disassembled securely in a vise, clamping against the hydraulic fitting or port bushes. Position valve body in the vise so that worm shaft, adaptor and upper cover can be assembled. SEE FIGURE 105.

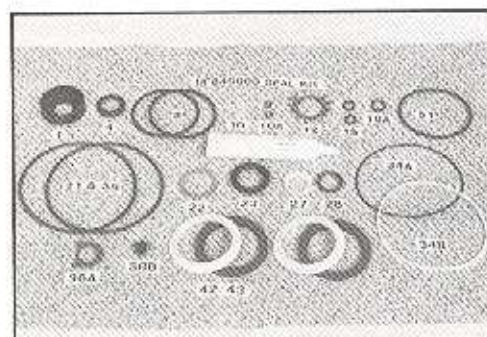


Figure 102



Figure 103

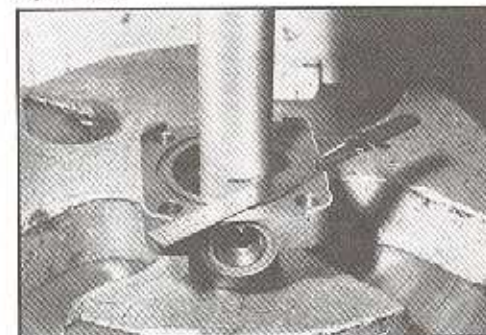


Figure 104

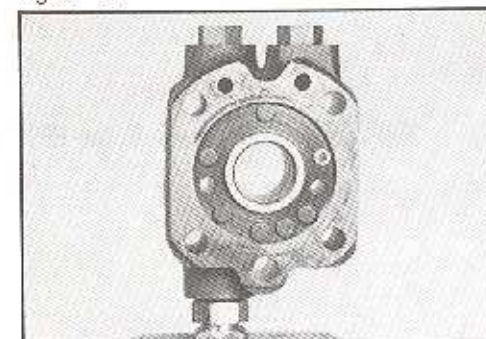


Figure 105

CAUTION

CAUTION: Use only the correct size standard 3/4-16 (#8) or 9/16-18 (#6) JIC straight threaded port, o-ring hydraulic fitting in the valve ports. The use of a wrong fitting such as a 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 HF64 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 (18) has become disassembled, refer to the enlarged exploded view on pages 21A & 21B. Assemble valve spool (18B) into valve body (18A). 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 face. On some valve bodies the cast identification # boss is pointed on the end toward the adaptor side or face. SEE FIGURE 106.

assemble
plungers and
spring sets

5. Assemble a plunger (18C), a spring (18D), and another plunger (18C) in that order in the six through holes in the valve body (18A) as shown in the enlarged auxiliary view on fold out pages. SEE FIGURE 107.

NOTE

NOTE: Some valve assemblies (18) may have one inactive (long) plunger instead of the set of two reaction plungers (18C) and a spring (18D) in four of the plunger holes in the valve body (18A). Assemble these inactive (long) plungers evenly as possible among the reaction plungers (18C) sets in the circle of plunger holes if their original positioning was not noted during disassembly.

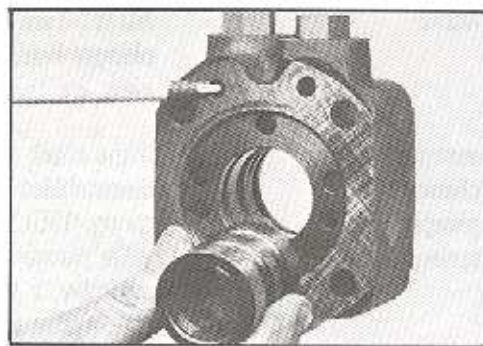


Figure 106



Figure 107

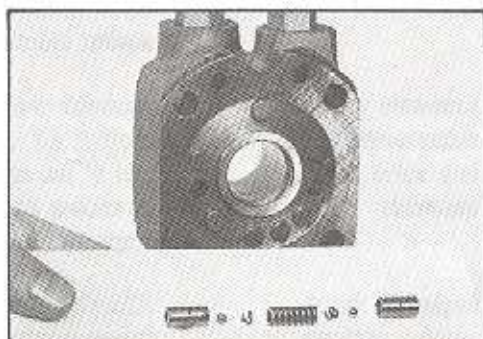


Figure 108

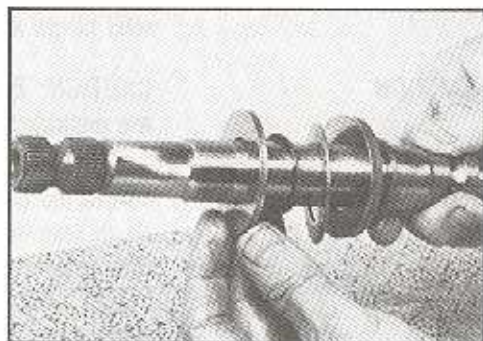


Figure 109

NOTE

NOTE: Two oil transfer holes in the circle of plunger holes as designated in the enlarged view are too small to accept plungers.

assembly of
check valve
plungers and
springs

6. If the check valve plungers have become disassembled. Assemble a ball (18F) and conical spring (18G), small end first, into the two check valve plungers (18E). Assemble one check plunger assembly, a spring (18D) and then the other check valve assembly into a plunger hole as shown in the exploded view. Spring end of check valve plungers must be facing toward the spring (18D). SEE FIGURE 108.

CAUTION

CAUTION: You must have a full complement of reaction plunger sets, inactive plungers and a check valve plunger in the circle of plunger holes for the valve assembly to function properly. Only two oil transfer holes in the circle of plunger holes should be empty.

assemble first
thrust bearing
package on
worm shaft

7. Assemble a thick thrust washer (14), spacer washer (16), thrust bearing (15) over spacer washer, and a thin thrust washer (17) on the input (serrated) end of worm shaft (25B) and against worm shaft shoulder. SEE FIGURE 109.

assemble worm
subassembly
into valve
assembly

8. Assemble the input (serrated) end of the worm shaft (25B) with bearing package into the adaptor end of the valve spool (18B) bore as described in procedure #4, until shaft and bearing assembly stops against the spool. SEE FIGURE 110.

assemble thrust
bearing package

9. Assemble the other thin thrust washer (17), spacer washer (16), thrust bearing (15) over spacer washer and thick thrust washer (14) onto the input (serrated) end of worm shaft (25B) and against the valve spool (18B). SEE FIGURE 111.

assemble
bearing
lockwasher
and nut

10. Assemble washer (13) then a new bearing lockwasher (12) onto worm shaft (25B). The internal washer tangs must enter slot in worm shaft and the external tangs of bearing lockwasher must face out. SEE FIGURE 112. Assemble bearing lock nut (11), large chamfer side in, onto threaded diameter of worm shaft until components are at solid height and snug against valve spool (18B).

CAUTION

CAUTION: Be sure that spacer washers (16) are encircled by thrust bearings (15).

torque bearing
lock nut

11. Torque the bearing nut (11) 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 113. Back the nut off approximately 20 degrees and bend one tang of lockwasher (12) into a matching nut slot. SEE FIGURE 114. A



Figure 110

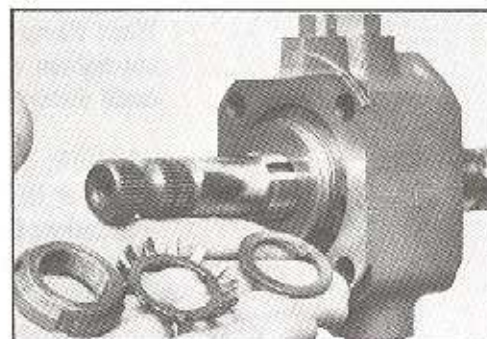


Figure 111



Figure 112

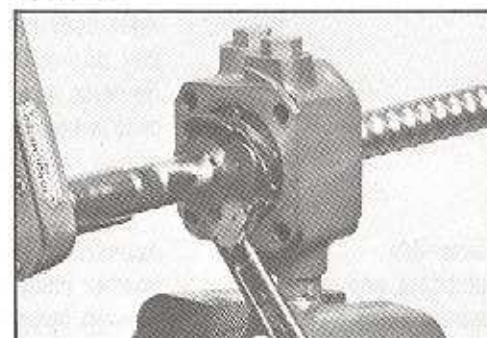


Figure 113

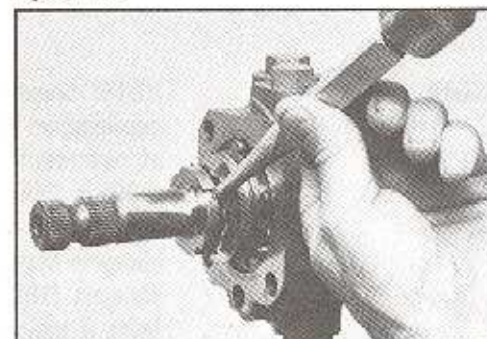


Figure 114

hook type spanner wrench, a 3/4 or 13/16 inch 12 point socket and a ft. lb. (N m) torque wrench required.

check worm
shaft rotation

12. Check for free rotation of worm shaft (25B) in valve assembly (18) and for perceptible end play. SEE FIGURE 115.

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.

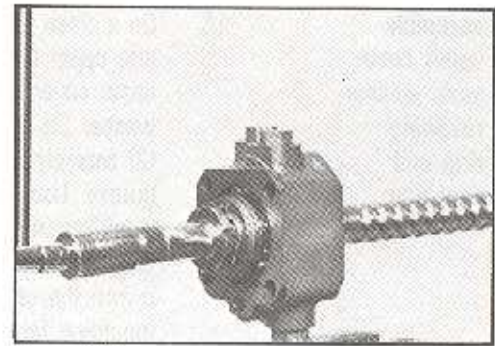


Figure 115

assemble
washer seal
and retainer
into adaptor

13. Assemble **new** back up washer (22) and then **new** seal (23) into adaptor (20) so that seal lips are facing out of seal cavity. SEE FIGURE 116. Assemble retaining ring (24). SEE FIGURE 117.



Figure 116



Figure 117

assemble seal
rings

14. Coat each new seal ring liberally with clean grease for retention and assemble **new** seal ring (21), and **new** seal ring (19A), **new** seal ring (B) and two **new** seal rings (19A) in the appropriate recesses provided in both sides of adaptor (20). SEE FIGURE 118.

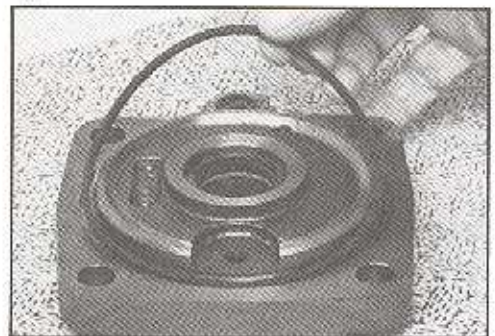


Figure 118

assemble
adaptor on
worm assembly

15. Assemble the adaptor (20) onto the rack piston end of worm shaft (25A) assembly with the side with four threaded holes against the face of the valve assembly and the poppet adjusting screw holes and cylinder feed holes in adaptor and valve body aligned (18). SEE FIGURE 119.

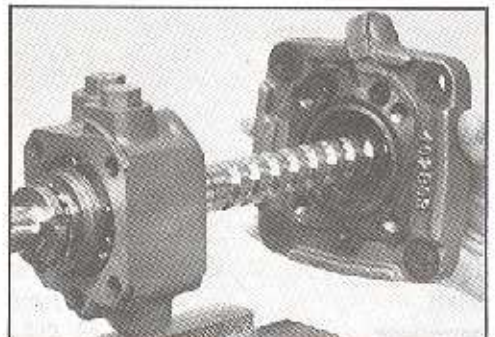


Figure 119

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
seal, washer,
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 back-up washer (3). SEE FIGURE 120. Install retaining ring (2) securely into the upper cover retaining ring groove. Use appropriate retaining ring pliers or a small screw driver. SEE FIGURE 121. Apply clean grease liberally to **new** seal ring (8) and assemble it into the recess provided in the upper cover mounting face.



Figure 120



Figure 121

assemble poppet
adjusting screw

17. Assemble **new** back up ring (10) on adjusting screw (9). Coat **new** o-ring (10A) liberally with clean grease or oil and assemble it carefully over the non-threaded end of adjusting screw. SEE FIGURE 122. If the adjusting screw has been removed from the upper cover, thread the screw through the upper cover (7) from the adaptor face side until .56 inch (14 mm) of thread is exposed beyond the boss. SEE FIGURE 123.



Figure 122

assemble poppet
adjusting
screw nut

18. Assemble poppet adjusting screw nut (6), if it was removed, onto the adjusting screw (9) finger tight. Final adjustment and torque must be made later.

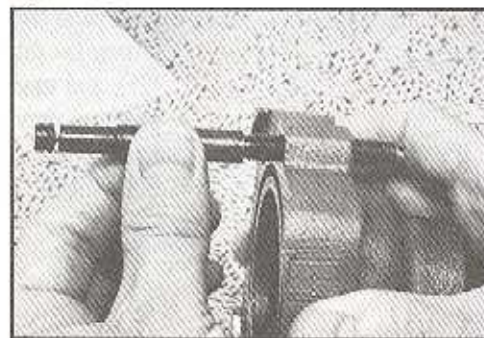


Figure 123

tape worm
shaft
serrations

19. Tape the worm shaft (25B) serrations and lightly coat the remaining portion of the worm shaft with oil. SEE FIGURE 124.

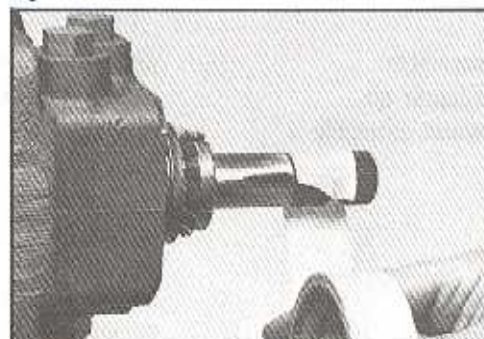


Figure 124

install upper
cover

20. Install upper cover (7) assembly carefully over worm shaft (25B) serrations aligning the poppet adjusting screw (9) with the adjusting screw hole in the valve assembly (18) and adaptor assembly (20). Insert the poppet adjusting screw through it's hole in the valve assembly and engage the adjusting screw hole in the adaptor until the adaptor and upper cover are piloted and positioned against the valve assembly mating faces. SEE FIGURE 125.

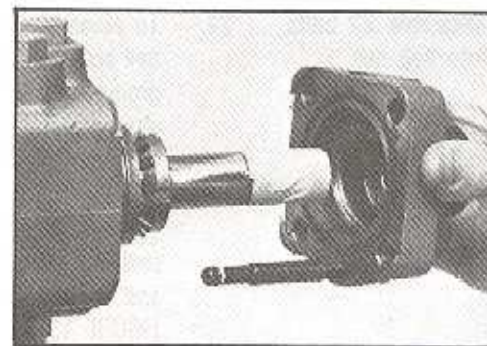


Figure 125

assemble
upper cover
bolts and
washers

21. Assemble four upper cover bolts (7A) and washers (7B). Carefully tighten the bolts while checking that the adaptor (20) valve assembly (18) 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 126.

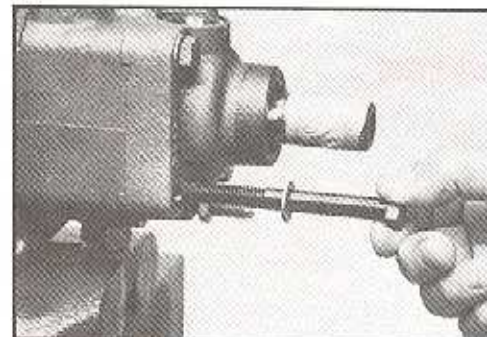


Figure 126

assemble ball
nut assembly
on worm shaft

22. Remove worm shaft as assembled from vise and place it on a clean cloth covered work surface to retain loose balls. Hold the piloted end of mandrel and ball nut assembly (25A) against the bottom end of the worm shaft (25B). Rotate worm shaft to engage ball nut assembly in the worm ball groove and position ball nut halfway along the worm shaft ball groove length. SEE FIGURE 127.

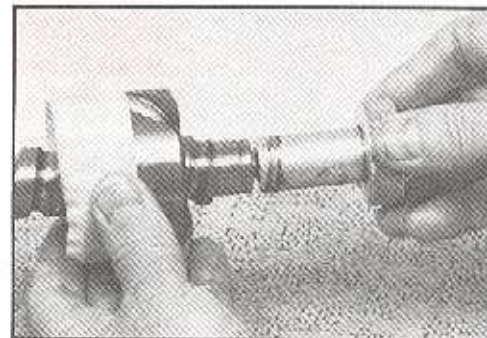


Figure 127

install ball nut
on worm shaft

23. If ball nut (25C) is completely disassembled install it onto shaft (25B) so that the end with a large chamfer goes on last. SEE FIGURE 128.

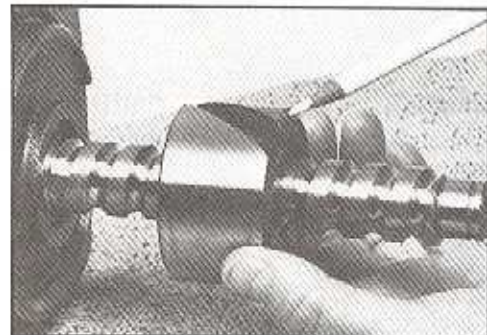


Figure 128

WARNING

WARNING: INCORRECT BALL NUT ASSEMBLY CAN RESULT IN A BALL ESCAPING AND CAUSING A LOCK UP OF THE STEERING GEAR. THIS COULD CAUSE AN ACCIDENT. EXTREME CARE MUST BE EXERCISED TO ASSEMBLE THE BALL NUT, BALLS AND BALL RETURN GUIDES CORRECTLY.

NOTE

NOTE: If the original set of balls are being reassembled, they must be segregated by micrometer measurement into a group of 14 large balls (25D) and a group of 14 smaller spacer balls (25E). 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 129.

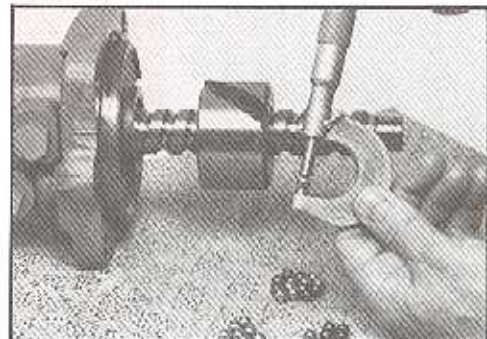


Figure 129

assemble 22 balls
into ball nut

24. To assemble the set of balls align ball nut (25C) ball access holes over the worm shaft ball grooves. Insert 22 balls (of the 28 total) alternately one large ball (25D) then one small (spacer) ball (25E) into the same ball access hole. SEE FIGURE 130. Use the eraser end of a pencil to work each ball down the same ball groove path on one side of the worm shaft and around and up toward the other ball access hole. SEE FIGURE 131. When the 22nd ball is inserted, the first ball will be visible at the second ball access hole and on the opposite side of the worm shaft.

WARNING

WARNING: BE SURE EACH BALL INSERTED STARTS DOWN THE BALL GROOVE ON THE SAME SIDE OF THE WORM SHAFT. DO NOT ALLOW THE WORM SHAFT OR BALL NUT TO ROTATE DURING BALL ASSEMBLY PROCEDURES UNTIL THE BALL RETURN GUIDES ARE RETAINED IN THE BALL NUT. SUCH ROTATION COULD MOVE A BALL OR BALLS INTO THE DEAD TRACK BEYOND THE BALL RETURN GUIDE PASSAGE OR LOOP RESULTING IN BALL LOSS OR STEERING GEAR LOCK-UP.

install ball
return guide halves
and balls

25. Coat the ball return guides (25F) liberally with grease and insert the remaining 6 balls alternately large and small (black) into a guide half. SEE FIGURE 132. Join the guide halves together and firmly seat this subassembly into the ball access holes in the ball nut (25C). SEE FIGURE 133.

CAUTION

CAUTION: The grease must hold the balls in the return guides until the guides are seated in ball nut.

WARNING

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.

retain ball return
guide with tape
or clip

26. Apply tape or clip to ball nut assembly to retain the ball return guides in place. SEE FIGURE 134.



Figure 130

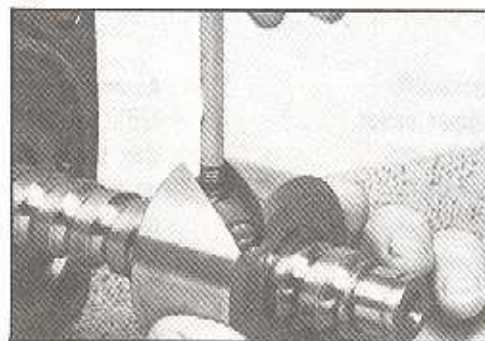


Figure 131



Figure 132



Figure 133



Figure 134

check ball nut
operation

27. Carefully rotate the ball nut (25A) assembly for its full travel, while checking for binding and assuring that all 28 balls are in the correct closed recirculating path or loop. SEE FIGURE 135.

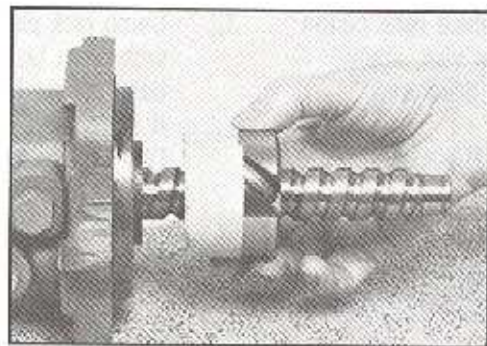


Figure 135

assemble seal
components on
worm shaft

28. Assemble steel washer (26) on the lower end of worm shaft (25B). Assemble **new** seal (27) with the sharp edged face against the steel washer, the **new** seal cup (28) with the cupped side over the chamfered face of the seal, bronze backup washer (29) and the retaining washer (30) with its counter bore facing out. SEE FIGURE 136.

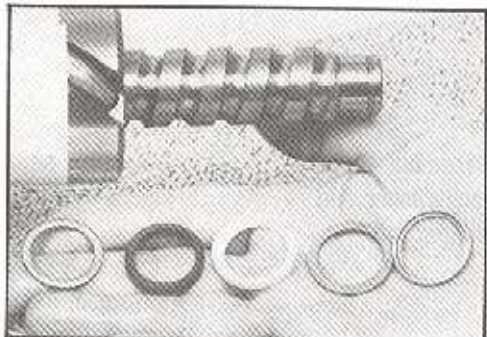


Figure 136

CAUTION

CAUTION: Use care that the above seal components are assembled in correct sequence and that the seal, seal cup and retaining washer are facing in the direction stated to insure proper sealing.

assemble
retaining
ring

29. Compress the components just assembled against the shoulder of the worm shaft and assemble retaining ring (31). Be sure the retaining ring is firmly seated in its groove in the worm shaft and in the retaining washer (30) counter bore. SEE FIGURE 137.

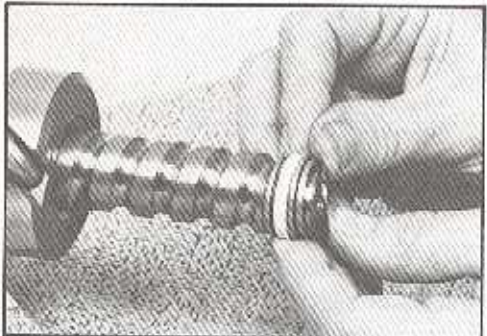


Figure 137

WARNING

WARNING: IF THE RETAINING RING IS NOT PROPERLY SEATED THE SEAL PACKAGE MAY BE DISLODGED DURING OPERATION CAUSING LOSS OF POWER STEERING IN ONE DIRECTION.

prime coat rack
piston threaded
holes and mating
parts

30. The threaded hole on top of the rack piston (35) and if the poppet seat (32) is removed, the threaded hole in large end face of the rack piston must be cleaned with clean clear solvent and blown dry with clean air. Apply "Locquic" Grade "T", primer to these two threaded holes in the rack piston, to the "cleaned" locking screw (36) threads and to the **new** poppet seat (32) threads. Allow ten minutes for threads to dry. SEE FIGURE 138.

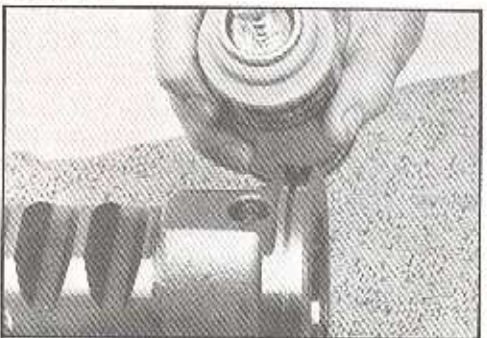


Figure 138

install rack
piston, O-ring
and seal ring

31. Install **new** rack piston back up O-ring (34B) and then the **new** Teflon seal ring (34A) or if applicable, just the cast metal piston ring (34) onto rack piston (35). SEE FIGURE 139. Do not over expand these rings as you install them.



Figure 139

CAUTION

CAUTION: The O-ring (34B) and Teflon ring (34A) are not interchangeable with the cast metal ring (34).

place rack piston
in vise, apply
"Stud Lock"

32. Clamp rack piston (35) firmly in a soft jawed vise with teeth facing up and access to worm shaft bore, poppet hole and ball nut locking screw hole. If the poppet (33) is being replaced, apply "Stud Lock" to the **new** poppet seat (32) threads and the rack piston poppet hole threads. SEE FIGURE 140.



Figure 140

assemble poppet,
lockwasher and
poppet seat

33. Assemble **new** poppet (33) and **new** lockwasher (32A) into rack piston (35) poppet hole. Screw **new** poppet seat (32) into the poppet hole with the lockwasher correctly positioned in the slot provided. SEE FIGURE 141. Torque poppet seat to 25-30 ft. lbs. (34-41 N m).



Figure 141

bend lockwasher
to head of seat

34. Bend up the radiused side of lockwasher (32A) firmly against the adjacent side of the poppet seat head. SEE FIGURE 142.



Figure 142

WARNING

WARNING: IF POPPET ASSEMBLY PROCEDURES ARE NOT ADHERED TO, THE POPPET SEAT COULD BACK OUT CAUSING DAMAGE THAT COULD RESULT IN LOSS OF POWER ASSIST.

begin to
assemble worm
shaft and ball
nut into rack
piston

35. Apply clean grease to seal cup (28) and enter the worm shaft (25B) and ball nut assembly (25A) into the rack piston (35) bore. As the ball nut approaches the large bore, align the conical hole in the ball nut with the threaded locking screw (36) hole in the rack piston. SEE FIGURE 143. Slip ball nut into piston bore until the ball guides are held in place by the rack piston and about 1 inch (25 mm) of ball nut is out of the rack piston. Remove the guide retaining clip or tape from ball nut and complete the entry of ball nut into rack piston bore. SEE FIGURE 144.

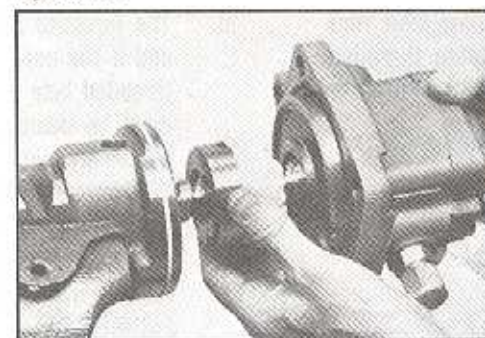


Figure 143



Figure 144

assemble locking
screw and washer

36. Apply "Loctite Hydraulic Sealant" to the threads of locking screw (36) and assemble locking screw and the **new** locking washer (36A) into rack piston (35). Position the tabs on the locking washer toward the ball nut end of the rack piston. SEE FIGURE 145. Torque locking screw to 30-35 ft. lbs. (41-47 N m). 3/8 inch Allen socket required. SEE FIGURE 146.

NOTE

NOTE: The locking screw head and locking washer will not necessarily be seated against the rack piston when screw is properly torqued.

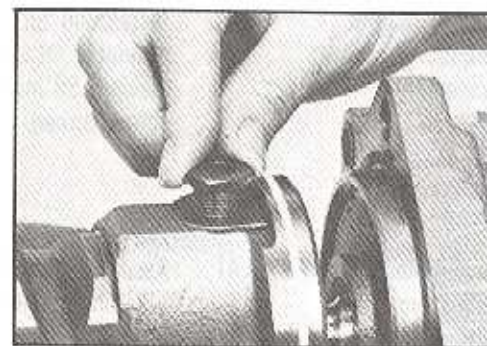


Figure 145

stake locking
washer

37. Stake (bend up) the radiused side of the locking washer (36A) firmly against one flat of hex head on locking screw (36). Remove subassembly from vise. SEE FIGURE 147.



Figure 146

WARNING

WARNING: IF THE BALL NUT LOCKING SCREW IS NOT STAKED CORRECTLY IT CAN BACK OUT AND HEAVILY SCORE THE CYLINDER WALL. THIS COULD RESULT IN LOSS OF POWER STEERING.

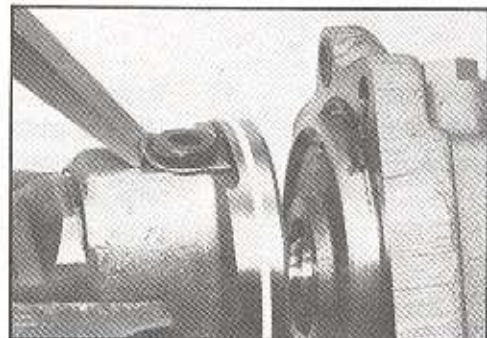


Figure 147

NOTE

NOTE: Allow "Loctite Hydraulic Sealant" 20 minutes to dry before adding oil to gear.

WARNING

WARNING: DO NOT ALLOW BALL NUT AND 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.

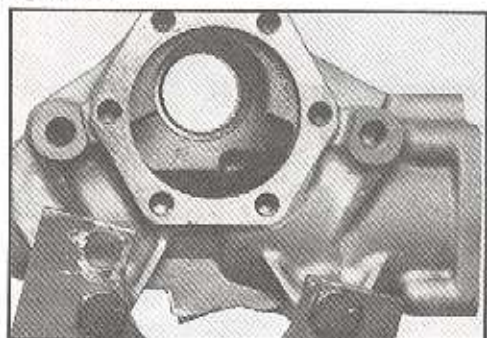


Figure 148

position housing
in vise

38. Position the housing (147) firmly in vise as it was for disassembly procedures. SEE FIGURE 148.

assemble
poppet
adjusting screw

39. If poppet adjusting screw (48) has been disassembled, apply clean grease or oil liberally to a **new** back up washer (10) and **new** O-ring (10A). Assemble new back up washer then new O-ring carefully onto non-threaded end of poppet adjusting screw and into groove provided. SEE FIGURE 149.



Figure 149

install poppet
adjusting screw
assembly

40. Install and turn poppet adjusting screw (48) assembly into the hole provided in housing (47) leaving .88 inch (22 mm) of exposed adjusting screw thread. SEE FIGURE 150.

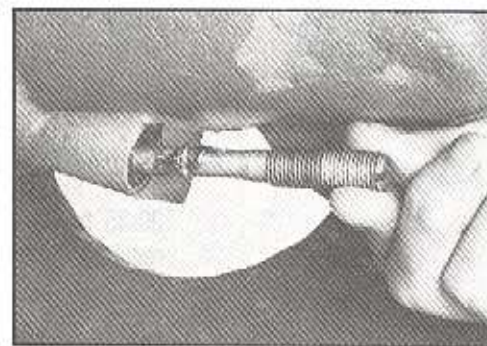


Figure 150

assemble
adjusting
screw nut

41. Assemble nut (49) onto exposed adjusting screw (48) finger tight. Final adjustment to be made later.

grease seal and
housing bore

42. Apply a generous amount of clean grease to the Teflon piston ring (34A) or cast metal ring (34) on assembled rack piston and to the housing rack piston bore. SEE FIGURE 151.

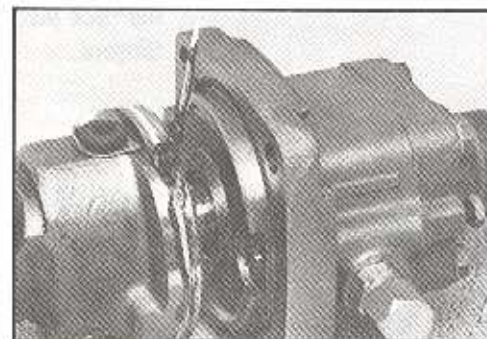


Figure 151

insert the
assembled rack
piston assembly

43. Insert the assembled rack piston (35) into housing (47) and position rack teeth to be visible through the side cover opening and the poppet (33) in line with poppet adjusting screw (48). As the rack piston enters the housing bore compress piston ring (34) or (34A) with your fingers and work the rack piston into the assembled position. SEE FIGURE 152.

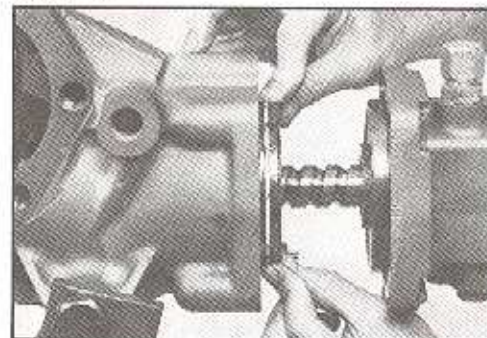


Figure 152

position adaptor
against housing

44. Align the bolt holes and oil transfer hole in the adaptor (20) with the bolt holes and oil transfer hole in the gear housing (47). The poppet adjusting screw (9) in the adaptor must align with poppet (33) and seal ring (19A) and (21) must be in place. Remove tape from worm shaft serrations and rotate worm shaft if required to position adaptor against housing. SEE FIGURE 153.

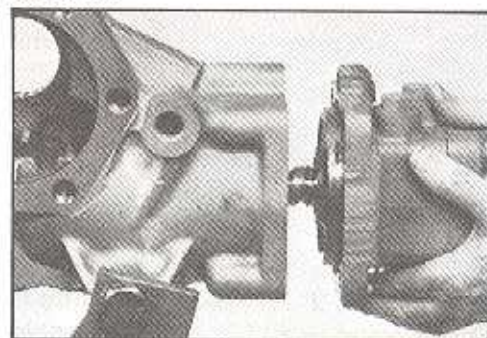


Figure 153

NOTE

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

assemble adaptor
bolts and
washers

45. Assemble four bolts (20A) with washers (20B) through adaptor (20) into housing (47). Torque bolts to 70-80 ft. lbs. (95-108 N m) if dry or 47-57 ft. lbs. (64-77 N m) if lubricated. A 3/4 inch socket required. SEE FIGURE 154.

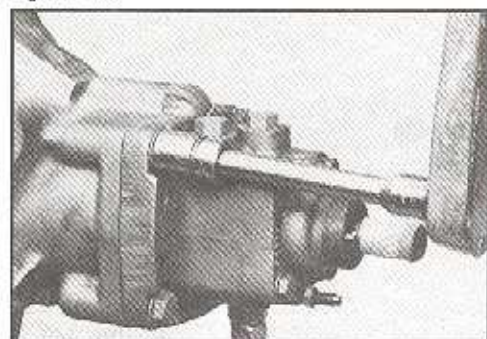


Figure 154

assemble
adjusting screw
and retainer

46. If the adjusting screw (45) has been removed from the sector shaft (46), 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 (44) into the sector shaft and adjust to permit free rotation 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 155.

WARNING

WARNING: USE CARE IN SECURELY STAKING THE RETAINER (44) 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

47. Apply a generous amount of clean wheel bearing grease (do not substitute another type of grease) to the bearing in side cover (38). SEE FIGURE 156.

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.

NOTE

NOTE: If the service replacement Teflon backup washer (42) is not an integral part of the service replacement seal (43), see alternate service construction on exploded assembly foldout page, examine the lead-in chamfer or radius on the side cover (short) end of sector shaft (46) bearing diameter. SEE FIGURE 157. If rough edges can be felt by drawing a thumb nail across the lead-in chamfer or radius on the end of sector shaft, skip procedures #48, #49, #50 and follow procedures #51, #52, #53.

CAUTION

CAUTION: Following procedures #48, #49, #50 with the sector shaft that does not pass the "thumb nail test", and a replacement seal (43) that does not have the Teflon washer (42) integral to it can result in the seal being destroyed when assembling sector shaft into side cover.

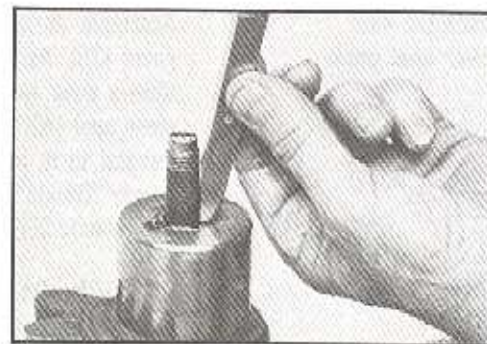


Figure 155



Figure 156



Figure 157

assemble side
cover seal pack

48. Assemble the steel backup washer (41) into side cover (38). Assemble a **new** Teflon washer (42) then a **new** two piece seal (43), or a new two piece seal (42/43) that has the Teflon washer integral to it, into the side cover, such that the words "Oilside" are visible after the seal is assembled. SEE FIGURE 158.

CAUTION

CAUTION: Be sure that a separate Teflon washer (42) is not used with a service two piece seal (42/43) that has the Teflon washer integral to it.

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.

assemble
retaining ring

49. Assemble the side cover retaining ring (43A) into the ring groove of the side cover (38). SEE FIGURE 159.

install sector
shaft into
side cover

50. Apply a generous amount of clean grease to the short bearing area of the sector shaft (46). Insert the sector shaft carefully into the side cover (38). Screw in the sector shaft adjusting screw (45) counter-clockwise in 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 160. Go to procedure #54.

assemble steel
and Teflon
washers into
side cover

51. If the replacement Teflon washer (42) is not an integral part of the two-piece seal (43) and the sector shaft (46) did not pass the "thumb nail test", assemble the steel backup washer (41) and then the **new** Teflon washer (42) into the side cover (38) bearing bore. SEE FIGURE 161.

assemble
retaining ring
and seal

52. Slide retaining ring (43A) onto the side cover end of sector shaft (46). Assemble the **new** two-piece seal (43) 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 162.

CAUTION

CAUTION: Be sure the two piece seal remains correctly assembled and that the vent plug (38B) has been removed during these procedures.

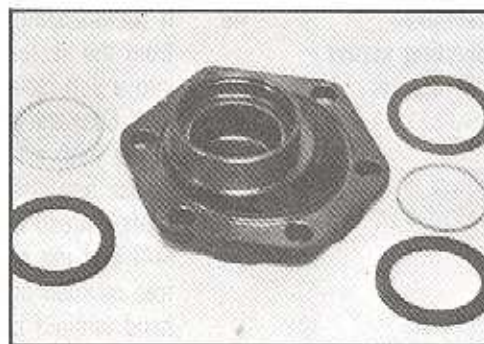


Figure 158



Figure 159

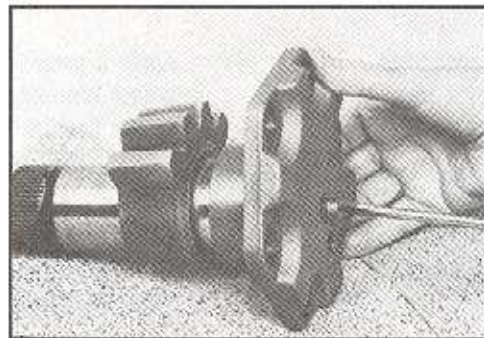


Figure 160



Figure 161



Figure 162

install sector
shaft into
side cover

53. Be sure the side cover bearing, the sector shaft bearing diameter and seal are well greased, then insert sector shaft (46) assembly into the side cover (38) bearing for about 8 turns of the adjusting screw (45). Slowly and carefully work the two piece seal (43) down the sector shaft and squarely into the side cover until it is past the retaining ring groove. Then work the retaining ring (43A) into the retaining ring groove. Use an appropriate blunt end punch or punches. SEE FIGURE 163. Carefully turn the adjusting screw (45) through side cover until it reaches solid height then back screw one turn, so that the side cover rotates freely on sector shaft.

install jam nut

54. Install the sector shaft adjusting screw jam nut (37) onto the sector shaft adjusting screw (45) a few threads. Final adjustment will be made later. SEE FIGURE 164.

assemble vent plug

55. Press a new vent plug (38B) into the hole provided in the side cover (38) until the plug is flush. SEE FIGURE 165.

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 LOCKUP OR OTHERWISE MALFUNCTION.

install side
cover seal ring

56. Apply clean grease to the new side cover seal ring (39), and assemble it onto the side cover (38). Apply enough grease to hold the seal ring in place. SEE FIGURE 166.

center rack
piston

57. Rotate the worm shaft (25B) until the timing mark that is at the center of the rack piston (35) is in the center of sector shaft opening in housing (47). This will center the rack piston. SEE FIGURE 167.

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.



Figure 163

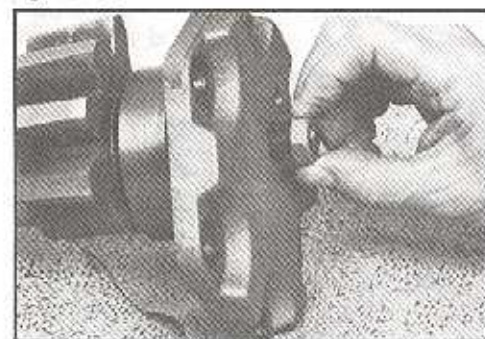


Figure 164



Figure 165

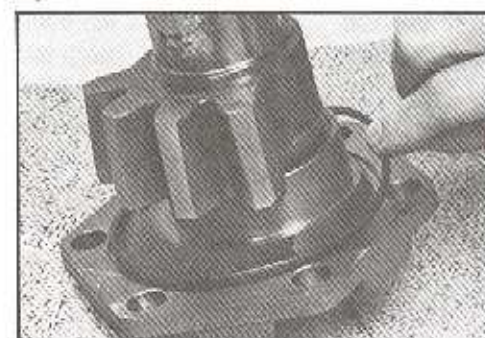


Figure 166

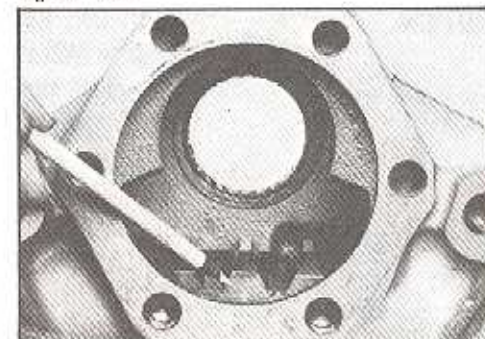


Figure 167

install sector
shaft and side
cover assembly

58. Remove any old tape from sector shaft (46) serrations and apply one layer of new tape to shaft serrations and bolt groove. Install sector shaft and side cover assembly into housing (47). The sector shaft center tooth space or tooth as indicated by the timing mark on the end of sector shaft must engage the rack piston (35) center tooth or tooth space as indicated by a timing mark on the rack piston. SEE FIGURE 168 & 169.

NOTE

NOTE: The earliest model HF64 steering gears were manufactured with a sector shaft tooth and a rack piston tooth space in the center of travel position.

NOTE

NOTE: If there is not a timing mark on the end of sector shaft (46) add a timing mark before assembly, with chalk or marking pencil on the end of the sector shaft in line with the center of the center tooth space or center tooth, whichever is central on your sector shaft.

CAUTION

CAUTION: Be sure seal ring (39) is in place.

install side
cover bolts

59. Install the six special side cover bolts (38A) into the side cover and torque them to 150-170 ft. lbs. (203-230 N m) if dry or 108-128 ft. lbs. (146-174 N m) if lubricated. 13/16 inch socket required. SEE FIGURE 170.

install trunnion
cover washer
and seal

60. Place the trunnion cover (52) exterior face down on a bench and install the new Teflon backup washer (42) and then the new two piece seal (43) or the new two piece seal (42/43) that has the Teflon washer integral to it. The words "Oil Side" on the seal must be visible after assembly. SEE FIGURES 171 and 172.

CAUTION

CAUTION: Be sure that a separate Teflon washer (42) is not used with a new service two piece seal (42/43) that has the Teflon washer integral to it.

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 168



Figure 169



Figure 170

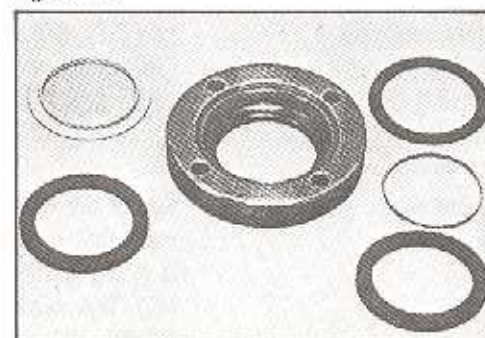


Figure 171



Figure 172

**install seal
ring**

61. Grease the **new** trunnion cover seal ring (51) and install it into the trunnion cover (52) seal ring groove.

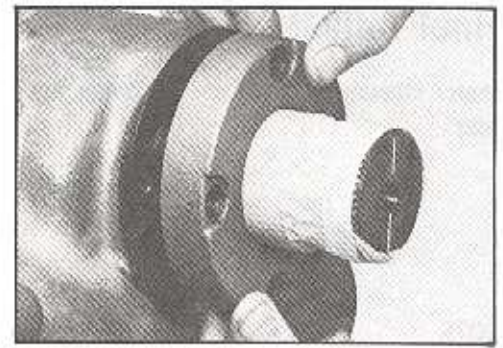


Figure 173

**install
trunnion cover
and screws**

62. Pack seal area of sector shaft (46) with clean high temperature industrial grease per Ross specification D45231, Mobil temp 1 or 2 or equivalent. Install the trunnion cover (52). SEE FIGURE 173. Install the four trunnion cover screws (52A) 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. SEE FIGURE 174.

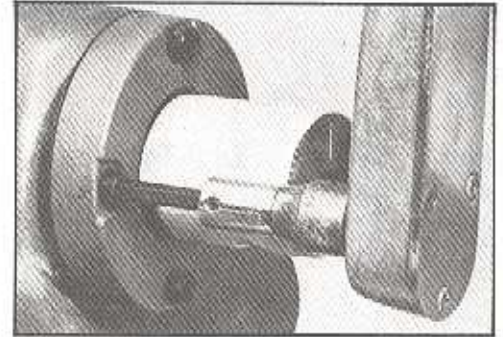


Figure 174

**assemble
sector shaft
protector seal**

63. Remove tape from the sector shaft serrations. Add more of the special grease to the cupped side of seal (53) and assemble over sector shaft (46) and trunnion cover (52). SEE FIGURE 175.



Figure 175

**assemble worm
shaft protector
seal**

64. Add the special grease to cupped side of protector seal (1) and assemble seal over worm shaft (25B) and upper cover (7). SEE FIGURE 176.



Figure 176

This completes assembly of the HF64 steering gear. Before you install the gear onto the vehicle, make final adjustments described on page 52. 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 (25B) until the timing mark on the end of sector shaft (46) is perpendicular to the worm shaft. SEE FIGURE 177. A 12 point 3/4 or 13/16 inch box end or socket required.

NOTE

NOTE: Worm, valve thrust bearing preload adjustment was accomplished in assembly procedure 11, page 38.

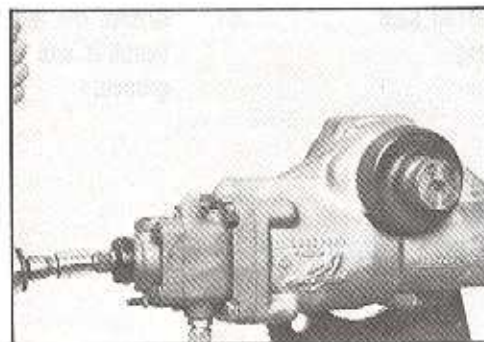


Figure 177

tighten adjusting screw

2. Tighten sector shaft adjusting screw (45) to provide 15-20 inch lbs. (1.7-2.3 N m) of torque required to rotate the worm shaft (25B) through 90° each side of center. SEE FIGURE 178.

NOTE

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

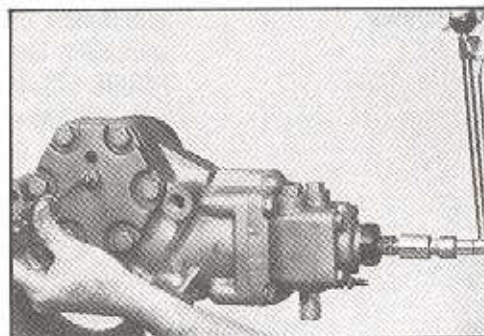


Figure 178

loosen adjusting screw and note torque

3. Loosen sector shaft adjusting screw (45) one turn and note maximum torque required to rotate the worm shaft (25B) through 180° each side of center.

adjust adjusting screw

4. Adjust sector shaft adjusting screw (45) to increase maximum torque noted in procedure #3 by 2 to 4 inch lbs. (.23 to .45 N m). Torque jam nut (37) 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 HF64 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 (HF64 on "HYDRAULIC FLUID" and "FILLING AND AIR BLEEDING THE SYSTEM" which also includes instructions for adjustment of the adjustable poppet valves.

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 TSAE 30

MOBILSAE 10W30

ASHLANDSAE 10W40

UNIONSAE 10W40

TEXACOSAE 10W40

MOBILSAE 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.

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 1750 PSI (120.7 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.



TRW Automotive
Commercial Steering Systems
800 Heath Street
Lafayette, IN 47904
Tel 765.423.5377
Fax 765.429.1868
<http://www.trw.com/commercialsteering>