



# Hydraguide™ Hydrostatic Steering System

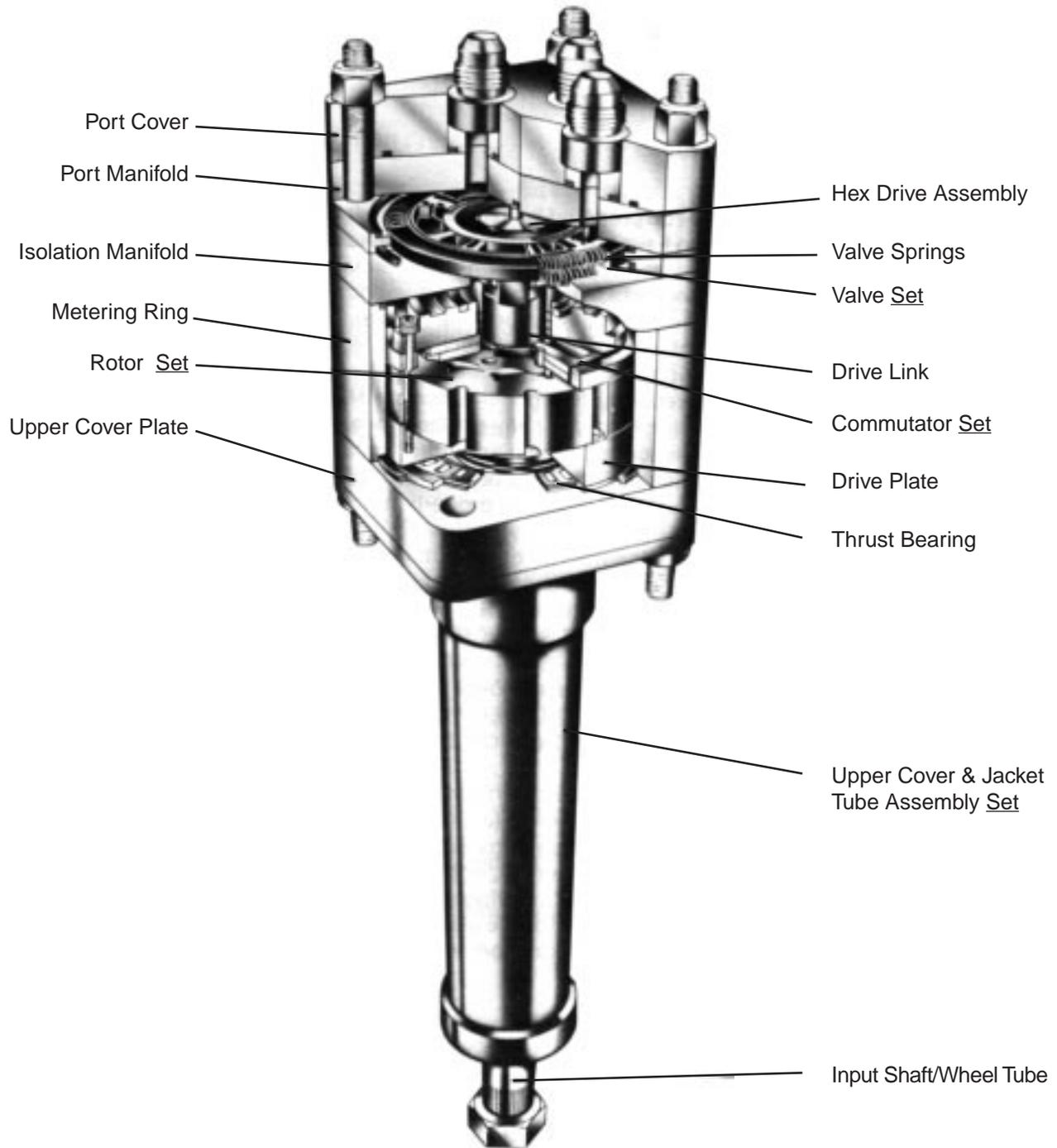
HGF Series Service Procedure

Service Manual 2753



Hydraulic Pump/Motor Division

# HGF Design Features Illustration



# Hydraguide™

## HGF Design Features

The model HGF Hydraguide™ power steering unit is Ross' most recent addition to its series of hydrostatic steering products. The HGF combines several advanced features designed to meet industry's needs for improved steering of its construction, industrial, and agricultural vehicles.

- An ultra compact and light weight package designed for easy installation with fluid connections at the lower end of unit.
- An open center fast response rotary plate type valve (spring centered) with options of open or closed cylinder ports and "power beyond".
- Small eccentric rotor set provides smooth operation.
- Lower optional noise levels.
- Column (jacket tube) and input shaft/wheel tube integral to unit for improved column/unit alignment. Lengths tailored to user requirements.

For operation, the HGF system requires the following components:

- an engine-driven pump,
- a relief valve,
- a cylinder or cylinders,
- a reservoir and filter,
- suitable fluid lines or hoses, and
- the HGF hydrostatic unit.

The driver has power steering control at all times, so long as system components work together, system integrity is maintained, and adequate fluid is present. If there is a failure in the high-pressure circuit, a loss of power steering will result. The HGF, however, is designed to have some manual steering capability, depending on the installation. If you can't manually steer the vehicle without using extraordinary measures, such as leaving your seat, or pushing with your legs, don't try it. Some vehicles may be impossible to steer manually because of their weight and size. Repair the failure in the power circuit.

**WARNING: SUCH EXTRAORDINARY MEASURES SHOULD NOT BE USED IN ATTEMPTING TO MANUALLY STEER THE VEHICLE, AS THEY MAY GENERATE FORCES IN EXCESS OF 125 FT. LBS. (169 N m), THEREBY DAMAGING THE UNIT INTERNALLY, WHICH COULD RESULT IN A COMPLETE LOSS OF STEERING.**

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

## Definitions

**NOTE:** A NOTE provides key information to make a procedure easier or quicker to complete.

**CAUTION:** A CAUTION refers to procedures that must be followed to avoid damaging the HGF or other system components.

<p><b>WARNING:</b> A WARNING REFERS TO PROCEDURES THAT MUST BE FOLLOWED FOR THE SAFETY OF THE VEHICLE DRIVER AND THE PERSON INSPECTING OR REPAIRING THE HGF.</p>
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## Disclaimer

This Service Manual has been prepared by Ross for reference and use by mechanics who have been trained to repair and service steering components and systems on commercial and non-commercial vehicles. Ross has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the techniques and tools required for maintaining, repairing and servicing the complete line of Ross HGF "Hydraguide" Hydrostatic Steering Units. However, despite the care and effort taken in preparing this general Service Manual, Ross makes no warranties that (a) the Service Manual or any explanations, illustrations, information, techniques or tools described herein are either accurate, complete or correct as applied to a specific HGF steering unit, or (b) any repairs or service of a particular HGF steering unit will result in a properly functioning steering unit.

If inspection or testing reveals evidence of abnormal wear or damage to the HGF steering unit or if you encounter circumstances not covered in the Manual, STOP—CONSULT THE VEHICLE MANUFACTURER'S SERVICE MANUAL AND WARRANTY. DO NOT TRY TO REPAIR OR SERVICE AN HGF STEERING UNIT WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL EQUIPMENT REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO ORIGINAL EQUIPMENT SPECIFICATIONS FOR THE HGF STEERING UNIT.

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular HGF steering unit to (a) inspect the steering unit for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the vehicle, or the safe operation of the vehicle, and (c) fully inspect and test the HGF steering unit and the vehicle steering system to insure that the repair or service of the steering unit has been properly performed and that the steering unit and system will function properly.

## Introduction

### Service Manual for Model HGF

This service manual has one purpose: to guide you in maintaining, troubleshooting, and servicing the HGF Hydraguide power steering valve.

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

The next section of this manual, Design and Operation, treats the major parts of the HGF 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 HGF from the vehicle. If you must service the HGF, the checklists will help you to determine where the problem may be.

The three-column format of the Disassembly and Inspection, and Assembly sections will make it easier for you to service the HGF. 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 fold-out page with an HGF Hydraguide exploded assembly view 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 and assembly 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 and assembly procedures.

As you gain experience in servicing the HGF, you may find that some information in this manual could be clearer or 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 HGF should be a safe and productive procedure, in order for the unit to deliver the reliable, long-life operation engineered into it.

## HGF: Design and Operation

(See HGF Design Features and Design Illustration)

Satisfactory performance of the overall hydraulic system requires a well-engineered installation. The hydraulics must meet the design features of the vehicle and contribute to the operation for which the vehicle was built. Make no changes to the steering system without first consulting qualified factory service personnel. Ross Gear extends engineering advice and welcomes requests for assistance.

Engineering contacts can provide information on such hydraulic components as pumps, cylinders, and fluid lines. The HGF control unit works best with a balanced-area cylinder design.

### HGF: Design

The HGF Hydraguide unit consists of a fluid control valve section and a fluid metering section. These are hydraulically and mechanically interconnected inside the unit.

### Control Valve Section: Operation

The HGF Hydraguide uses a servo-reactive (feedback control) valve which is centered by two sets of three coil springs. The valve regulates pressure and directs pump flow to the steering cylinder or cylinders. The valve is of the open-center type: when in the neutral position, it allows fluid to flow from the pump to the pressure port, through the HGF unit to the return port, and back to the reservoir.

The valve is available in open- or closed-cylinder

configurations, each of which brings its own advantages to bear in the hydraulic system.

**Open Cylinder:** cylinder ports are open to the metering pump, allowing road or ground reaction to rotate and recenter the valve, as the vehicle's steering geometry provides recentering forces. When the driver completes a turn, the steering will recenter, as happens, for example, in most automobile power steering systems.

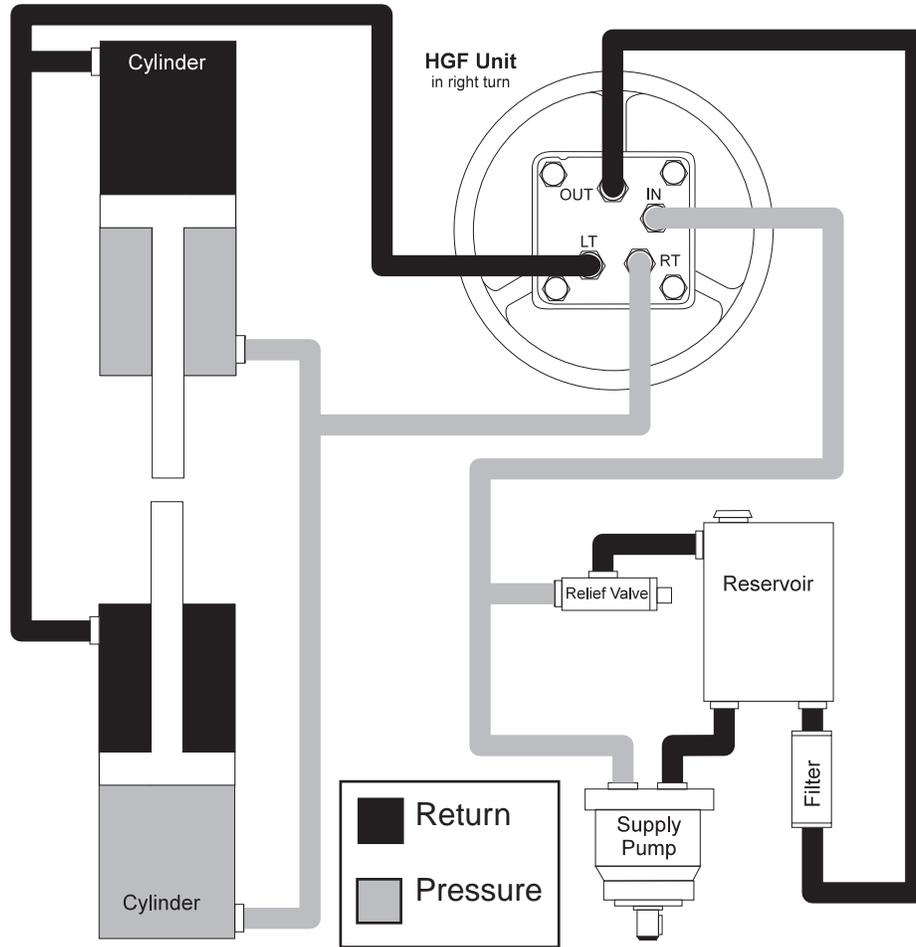
**Closed Cylinder:** cylinder ports are blocked to the metering pump, preventing road or ground reaction from rotating and recentering the valve. The driver must steer to "straight ahead" or another position. This design is useful in a vehicle which must remain turned while the driver takes his hands off the steering wheel to operate other controls.

### Metering Section: Operation

The metering section performs three functions:

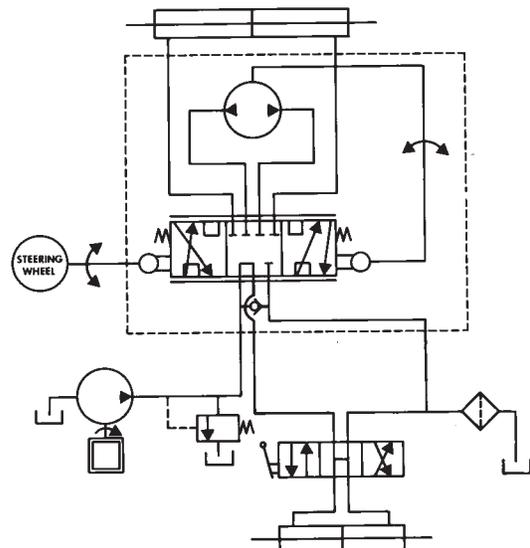
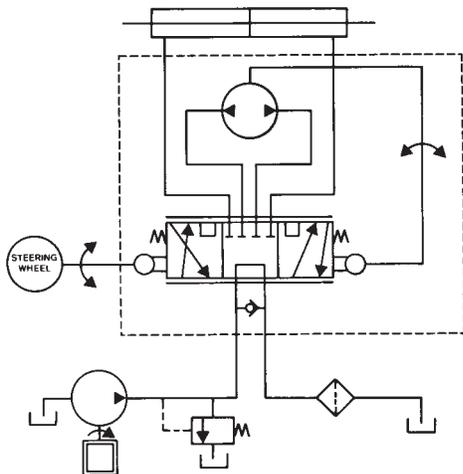
- It meters (measures) fluid to the cylinder or cylinders:
- It maintains the ratio of hand wheel turns to the direction of the steered wheels; and
- It acts as a pump for manual steering in the event high-pressure fluid does not reach the HGF unit.

# HGF Hydraguide™ Steering system



**OPEN CENTER  
HYDRAGUIDE™ STEERING**

**POWER BEYOND  
HYDRAGUIDE™ STEERING**



## Troubleshooting Guide

**NOTE:** Before troubleshooting a steering problem, check service literature published by the vehicle and component manufacturers. Follow their instructions, if given, for checking any component but the HGF Hydraguide unit.

### Preparation

Make your troubleshooting easier by preparing as follows:

- work in a clean, well-lighted place;
- have proper tools and materials nearby;
- have a space set aside where you can lay components, parts, and tools; and
- have an adequate supply of clean petroleum-based solvent.

**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.**

### Preliminary Checks

For all their complexity, hydraulic systems are often trouble-free. The steering problem an operator complains of could be caused by something other than the hydraulic components.

Thus, once you have determined the problem and test driven the vehicle (if possible), start with the easy-to-check items.

On some vehicles, the conditions of the tires, especially on the steered wheels, may affect steering. Make sure pressures are at manufacturer's specifications. Make sure tires are balanced and that they show no signs of damage or severe wear. Check that they are mounted properly.

Check steering and front end linkage. Broken, loose, or binding parts could cause certain steering problems.

See if something in the steering column is loose or binding.

If belts are present, check all of them. A tight belt could also be glazed and a slipping belt doesn't always squeal.

In addition, the following could also contribute to a steering problem:

- an overloaded vehicle;
- parts damaged from impact not properly repaired, or that should have been replaced; and
- improper replacement parts.

### Hydraulic Components

If you think the problem is caused by a hydraulic component, start by checking the easy-to-reach items.

Check all hoses and lines for cracks, hardening, or other signs of wear. Reroute any usable hoses that are kinked, severely bent, or that rest against hot engine parts. Look for leaks, especially at couplings. Replace any hoses or lines that don't meet system flow and pressure ratings.

Next, go to the reservoir and filter or filters. Check fluid level and look for air bubbles. Examine the filter; if it's clogged, follow manufacturer's instructions for cleaning or replacing it. A filter with a minimum 25 micron filtration is recommended for the HGF system.

Visually check other components to see if they are loosely mounted, show signs of leaks, or other damage or wear.

It may be necessary that you perform hydraulic tests on the pump and other hydraulic components. To do so, consult the manuals published by the vehicle or component manufacturers.

# Troubleshooting Checklists

## 1. NOISE

### **NORMAL NOISE**

- A low hissing from the HGF control valve section during a turn
- A noise from the system relief valve when it is actuated
- Pump growl from some types of power steering pumps

### **ABNORMAL NOISE**

- A squealing noise during a turn may indicate that the belt or belts should be tightened or replaced
- A clicking noise during a turn may indicate that some component is loose and shifting under load.

## II. POSSIBLE STEERING PROBLEMS AND CAUSES

### **STEERING WANDER**

- Different size tires
- Tire pressure incorrect or unequal left to right
- Loose or worn steering linkage parts
- Improperly adjusted or worn wheel bearings
- In some vehicles, front end out of alignment

### **NO RECOVERY FOR OPEN-CYLINDER UNIT**

- Tire pressure low
- Steering linkage parts binding
- Tight front axle kingpins
- Steering column binding or misaligned

### **SHIMMY**

- Improperly mounted tire or wheel
- Components in steering linkage loose, worn, or out of adjustment
- Wheels or brake drums out of balance
- Wheel bearings improperly adjusted
- Air in the hydraulic system

### **HIGH STEERING EFFORT IN ONE DIRECTION**

- Vehicle overloaded
- Low hydraulic system pressure
- Excessive system heat causing HGF plate valve to stick. See checklist under Excessive Heat.

### **HIGH STEERING EFFORT IN BOTH DIRECTIONS**

- Different size tires
- Vehicle overloaded
- Low hydraulic fluid level
- Low flow or pressure from pump
- Components in steering linkage binding
- Restriction in fluid return line, or line too small

### **LOST MOTION (LASH) AT THE STEERING WHEEL**

- Steering wheel loose on column
- Components in steering linkage loose or worn
- HGF unit loose at mounting
- Air in hydraulic system

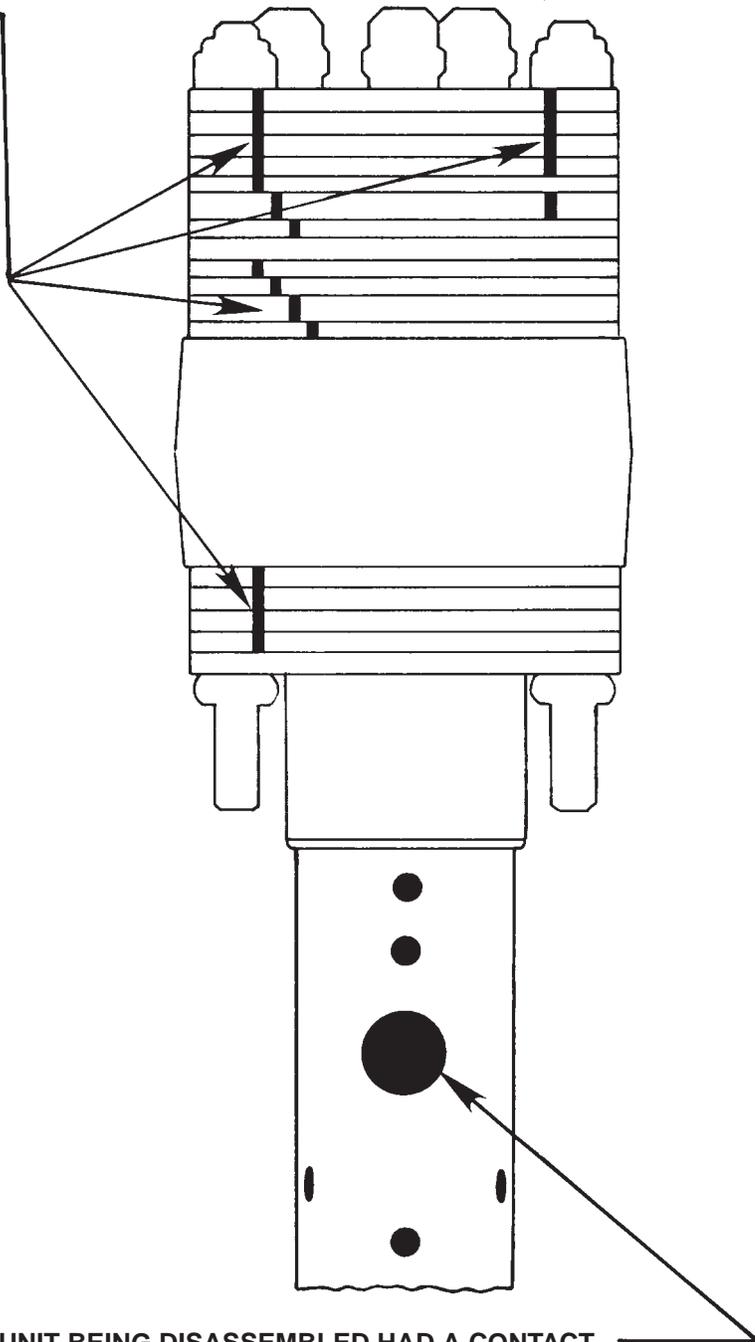
### **EXCESSIVE HEAT [200° F MAXIMUM (93.3°)]**

- Undersized replacement hose or line
- Kinked or severely bent hose or line
- Restricted oil coolers
- Restricted recentering of HGF unit
- Excessive fluid flow

**WARNING: IF THE HYDRAULIC SYSTEM FLUID BECOMES OVERHEATED [IN EXCESS OF 200°F (93.3° C)], SEALS IN THE SYSTEM CAN SHRINK, HARDEN, OR CRACK, THUS LOSING THEIR SEALING ABILITY.**

## HGF COMPONENT ALIGNMENT GROOVE ILLUSTRATION

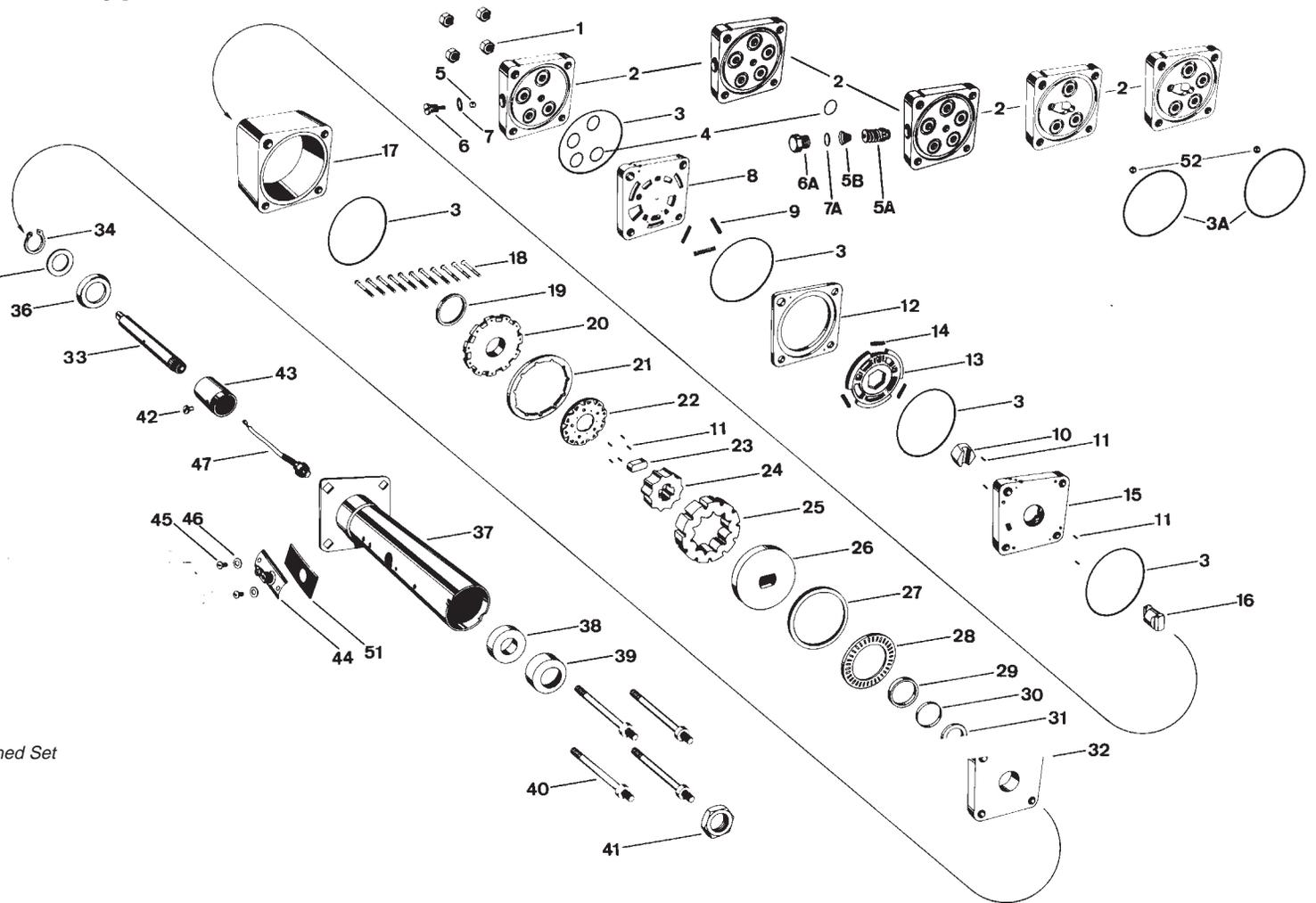
COMPONENTS OF THE HGF UNIT WITH ALIGNMENT GROOVES MUST BE ASSEMBLED SO THAT THEIR ALIGNMENT GROOVES ARE POSITIONED AS ILLUSTRATED FOR THE UNIT TO FUNCTION CORRECTLY



IF THE HGF UNIT BEING DISASSEMBLED HAD A CONTACT BRUSH ASSEMBLY, NOTE THE RADIAL POSITION OF IT'S HOLE RELATIVE TO ALIGNMENT GROOVED SIDE OF THE UNIT BEFORE DISASSEMBLY AND REASSEMBLE IN THE SAME RADIAL POSITION.

# HGF Exploded Assembly View-Typical

Item Number	Description
1	Nut 5/16 UNF 24 (4)
2	Port Cover
3	Seal Ring (5)
3A	Seal Ring (White)
4	O'Ring (3), (4) or (5)
5	Ball-7/32 inch (6mm) dia.
5A	Relief valve cartridge
5B	Coil spring
6	Plug
6A	Hex plug
7	O'Ring, Plug & O'Ring assy.
7A	O'Ring
8	Port Manifold
9	Spring, 3/4 inch (19mm) (3)
10	Hex Drive assy.
11	Alignment Pin (Needle Brg.) (9)
12	Valve Ring
13	Valve Plate } <i>Matched Set</i>
14	Spring, 1/2 inch (13mm) (3)
15	Isolation Manifold
16	Drive Link
17	Metering Ring
18	Screw, Hex Socket Hd (11)
19	Seal, Commutator
20	Commutator Cover
21	Commutator Ring
22	Commutator
23	Spacer-Drive Link
24	Rotor
25	Stator } <i>Rotor Assy-Matched Set</i>
26	Drive Plate
27	Spacer-Thrust Bearing
28	Thrust Bearing
29	Face Seal
31	Seal Spacer
32	Upper Cover Plate
33	Input Shaft/Wheel Tube
34	Retaining Ring
35	Washer-Retaining Plate
36	Retaining Plate } <i>Matched Set</i>
37	Upper Cover & Jacket Assy } <i>Matched Set</i>
38	Bushing
39	Seal
40	Special Bolt, 5/16 24UNF-2A
41	Nut
42	Screw
43	Contact Ring Assy.
44	Contact Brush Assy.
45	Screw & Lock Washer
46	Washer [for 1-3/4 inch (45mm)
Jacket]	
47	Horn Wire Cable Assy.
51	Spacer [for 1-1/2 inch (38 mm)
Jacket]	
52	Ball 9/32 inch (22mm)



Items # 44, 45, 46, 51 are not part of HGF service assembly unit. They must be purchased as separate items of order.

## Use with HGF Assembly View—Typical

<b>1</b> Nut 5/16 UNF (4) G103025	<b>2-8</b> Port Cover & Port Mainfold Kits HGF 016015 X1(5 line) HGF 016016X1 (4 line)			<b>3</b> Seal Ring 032755 (5)	<b>3A</b> Seal Ring (White) 032832		
<b>4</b> "O"Ring (5) 032758	<b>5</b> Ball 7/32 dia. G453569	<b>6-7</b> Plug and "O" Ring 415585-A1	<b>9 &amp; 14</b> Spring Kit 401443X1 (3) 401443 (3) 401608	<b>10</b> Hex Drive Assy HGF 013001 A1	<b>11</b> Alignment Pin 040147 X1		
<b>12-13</b> Valve Ring-Valve Plate Matched Set HGF 014000 A1		<b>15</b> Isolation Manifold HGF 015000	<b>16</b> Drive Link HGF 013002	<b>19</b> Seal Commutator 032724			
<b>20</b> Commutator Cover HGF 014001	<b>21-22</b> Commutator-Commutator Ring HGF 014002 A1		<b>26</b> Drive Plate HGF 013000	<b>27</b> Spacer Thrust Bearing 4773000			
<b>28</b> Thrust Bearing 069020	<b>29</b> Face Seal 032763	<b>30</b> Back-up Ring 032770	<b>31</b> Seal Spacer 477297	<b>32</b> Upper Cover Plate HGF 016012			
Seal Kit SK 000097	<b>3</b> 032755 (5)	<b>3A</b> 032832	<b>4</b> 032758 (5)	<b>7</b> 032645	<b>7A</b> 032750	<b>19</b> 032724	<b>29</b> 478046
<b>34</b> Retaining Rings 401465	<b>35</b> Washer 028493	<b>38</b> Bushing 063042	<b>39</b> Seal Dust 402405	All other column parts per specification.			
Items %	17	18 (11)	24-25	23	40(4)		
HGF 08	Metering Ring HGF019007	Screw Hex 0213470100	Rotor Assy. HGF087000	Spacer Drive Link 4773010022	Special Bolt 0213810406		
10	HGF019008	0123480112	HGF107000	4773010034	0213810406		
12	HGF019009	0213470125	HGF127000	4773010047	0213810431		
16	HGF019010	0213470150	HGF167000	4773010072	0213810456		
20	HGF019011	0123470175	HGF207000	4773010097	0213810481		

## Tools Materials Required for Servicing

HGF Service Manual  
 HGF service ass'y fixture (See Figure 1)  
 Clean, petroleum-based solvent  
 Vise  
 Pliers  
 Screw driver  
 Blunt ended punch  
 6 pieces of .007 inch (.18 mm) shim stock, approximately  
 .5 inch (13 mm) wide x 1.5 inch (38 mm) long.  
 External retaining ring pliers  
 Tape, plastic electrical  
 Breaker bar  
 Sockets: 1/2, 7/8 inch  
 3/32 inch Allen wrench socket  
 T-30 Torq socket  
 Slot type screw driver socket  
 5/16-24 UNF hex nut (4) required  
 3/4 inch (19 mm) to 7/8 inch (22 mm) bearing puller  
 Clean grease  
 Light weight oil  
 Torque wrenches: 11–13 in. lb. & 25–35 ft.lb. or Newton Meter  
 Feeler gauge .003 in. (.08 mm) or .005 in. (.13 mm)  
 (See disassembly procedure #37)  
 Electrical continuity checking device

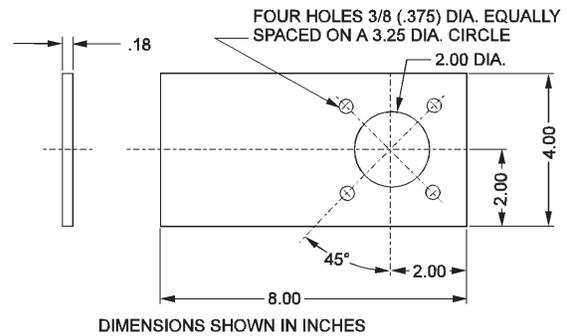


Figure 1

CONVERSIONS	
INCHES	mm
0.18	4.6
0.375	9.5
2.0	51.0
3.25	82.6
4.0	101.6
8.0	203.2

## Torque Chart

Part Name	Exploded View Item Number	Torque
Socket Head Cap Screws	18	11-13 in.-lbs. (1.24-1.47 N m)
Plug and O-Ring Ass'y	6, 7	8-12 ft.-lbs. (11-16 N m)
Plug and O-Ring Ass'y	6A, 7A	25-35 ft.-lbs. (34-48 N m)
Hex Nut 5/16-24	1	18-22 ft.-lbs. (25-30 N m)
Jam Nut 5/8-18	41	25-30 ft.-lbs. (34-41 N m)
Jam Nut 13/16-20 UNEF	41	30-40 ft.-lbs. (41-55 N m)

# HGF: Disassembly and Inspection

## Preparation before disassembly

Before you disassemble the HGF Hydraguide unit or any of its parts, read this entire manual. It provides important information on parts and procedures you will need to know to service the HGF.

When disassembling any of the parts, use a clean work bench. Wash all parts in clean petroleum based solvent and blow them dry. Keep each part separate to avoid nicks and burrs.

**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.**

**WARNING: REMOVE STEERING WHEEL WITH A STEERING WHEEL PULLER AFTER REMOVING WHEEL NUT. DO NOT LOOSEN WITH HAMMER, AS THIS COULD DAMAGE UNIT INTERNALLY.**

Before you disconnect any hoses, clean off all outside dirt from around the fittings. Plug the port holes and hoses immediately after you disconnect the hoses and before you remove the HGF from the vehicle. This is to prevent foreign matter from entering the HGF and damaging it when you clean and reassemble it.

Remove any contact brush cover (49) contact brush cover seal (48) and related screw and lock washers (50), and disconnect any horn wire connection to the HGF unit. Next, remove nuts from the mounting bolts, blow the unit dry and place it on a work bench.

Components throughout this assembly are stacked on four bolts and held in alignment with alignment pins designed to be a slip fit into the components. Use the minimum force necessary and maximum care to separate or assemble the components.

The HGF Hydraguide unit has several components that are of brazed laminate construction, plates and parts bonded together permanently to form an integral component that is not subject to disassembly for service. Disassemble the HGF unit only to the extent shown in this manual.

**CAUTION: Do not force or abuse closely fitted parts, or you may damage them. Use only genuine Ross or OEM approved service parts.**

The components, required to service an HGF unit and their service part numbers are available from authorized OEM parts distributors or other authorized HGF distributors.

### Remove contact brush assembly & related components

1. Remove screw and lock washers (45) and contact brush assemblies (44) and washers (46) or spacer (51) from the upper cover and jacket tube assembly (37) if the HGF unit is so equipped. See FIGURE 2.



Figure 2

**Place HGF unit in service fixture**

2. To avoid distorting or damaging the HGF unit, do not clamp it directly into a vise. Clamp a service assembly fixture described in FIGURE 1 securely in a vise, See FIGURE 3, and place the HGF unit, input shaft/wheel tube first, into the service assembly fixture. Attach the unit to the fixture with four 5/16-24 UNF nuts. See FIGURE 4.

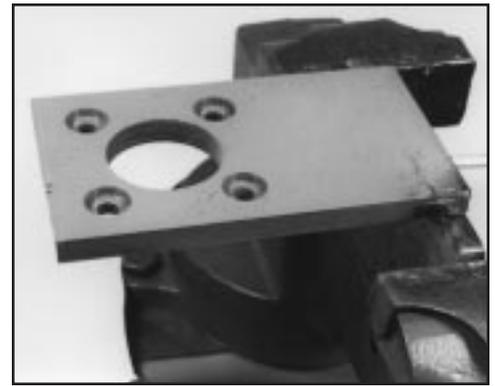


Figure 3

**NOTE**

NOTE: Before beginning the disassembly of HGF unit, study the relative positions of the alignment grooves on the side of the components in the assembly. Also, note the jacket tube contact brush cover hole radial position relative to the side of the unit with the alignment grooves. The relative alignment groove positions on the components and the jacket tube contact brush cover hole positions must be maintained at reassembly. Refer to the alignment groove graphic on fold-out.

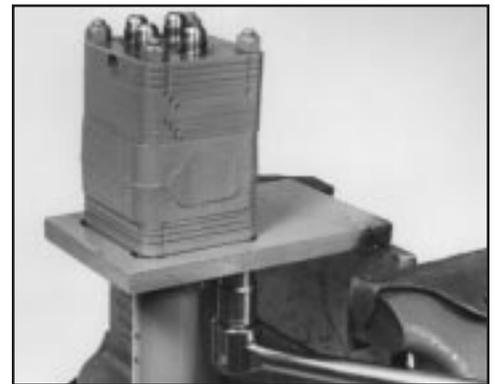


Figure 4

**Loosen plug assembly**

3. Loosen plug (6) or hex plug (6A) assembly in the port cover (2) for disassembly after the port cover is removed from the unit. Use an appropriate type screwdriver, T-30 Torx driver or 7/8 inch hex socket. See FIGURE 5.



Figure 5

**Remove port cover nuts**

4. Remove the four retaining nuts (1) from the port cover (2) assembly. Be careful not to damage the protruding ports. See FIGURE 6. Replace any nut that has damaged threads or hex.



Figure 6

**Remove port cover**

- 5. Grasp the port cover (2) assembly and lift it from the unit. Discard three, four, or five seal rings (4) and seal ring (3) or if included white seal ring (3A). See FIGURE 7. Remove loose check ball (52) from top of port manifold (8) if included.



Figure 7

**Remove plug**

- 6. If included, remove the loosened plug (6) and o-ring (7) assembly from the port cover. Be ready to catch the steel check ball (5) as it falls from its cavity. Discard o-ring (7). See FIGURE 8.



Figure 8

**Remove hex cap & relief valve cartridge & spring assy.**

- 6A. If included, removed the loosened hex plug (6A) and o-ring (7A) from the port cover (2). Discard o-ring. Remove relief valve cartridge (5A) and spring (5B) assembly. A bent or lost spring (5B) can be serviced separately. See FIGURE 8A. Do not try to disassemble relief valve cartridge (5A).

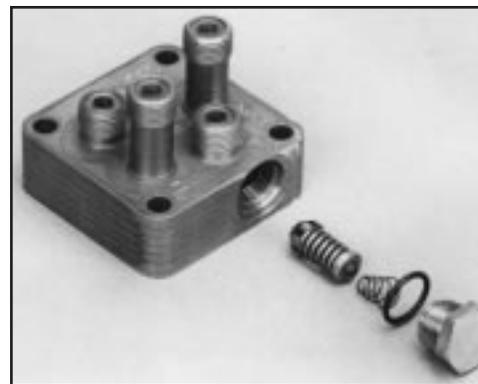


Figure 8A

**Inspect port cover**

- 7. Inspect the port cover (2) for port fitting sealing surface scratches and thread damage. Replace port cover, if these conditions are evident.

**Remove port manifold**

- 8. Carefully lift the port manifold (8) (3 plates bonded together) from the unit. See FIGURE 9.

**NOTE**

NOTE: Be prepared to catch three springs (9) which may become disengaged when removing the port manifold.

**Remove springs**

- 9. Remove three springs (9) from the port manifold (8).

**NOTE**

NOTE: The unit has two different length spring sets. The set you have just removed from the port manifold are three-quarter inch (19 mm) long. Keep this set of three springs separate from the next set of three springs to be removed.

**Inspect springs**

- 10. Inspect the springs for bent or distorted coils. If a spring is broken or deformed, all six springs in the unit should be replaced.



Figure 9

**Inspect port manifold**

11. Inspect the ground surfaces of the port manifold (8). You should notice a "normal" polished pattern due to the rotation of the valve plate (13) and hex drive assembly (10). All edges should be sharp and free of nicks and burrs. The surfaces of the port manifold should be free of scratches or scoring. If any of these wear conditions exist, replace the port manifold.



Figure 10

**CAUTION**

**CAUTION: Many components in the unit have finely ground surfaces. Be careful not to nick or scratch these surfaces.**

**Remove valve ring**

12. Remove the valve ring (12), discard the two seal rings (3). See FIGURES 10 and 11. The valve ring should be free of nicks and scoring.



Figure 11

**Remove valve plate**

13. Remove the valve plate (13) by lifting it from the isolation manifold (15).

**Inspect valve plate**

14. Inspect the slot edges and ground surfaces. If the valve plate (13) shows nicks or scoring or the edges are not sharp, it must be replaced. See FIGURE 12.



Figure 12

**NOTE**

NOTE: The valve ring (12) and valve plate (13) are a matched set and must be replaced as a set.

**Remove springs**

15. Remove three springs (14) from the isolation manifold (15) pockets. See FIGURE 13.

**NOTE**

NOTE: The unit has two different length spring sets. The set you have just removed from the isolation manifold is one-half inch (13 mm) long. Keep this spring set separate from the set removed from the port manifold (8).



Figure 13

### Inspect springs

16. Inspect the springs (14), for bent or distorted coils. If a spring is broken or deformed, all six springs in the unit must be replaced. See FIGURE 14.

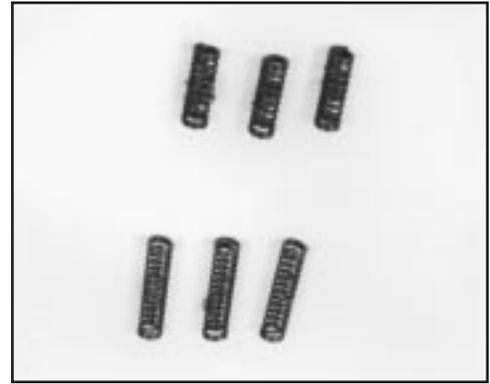


Figure 14

### Remove hex drive assembly

17. Remove hex drive assembly (10) from drive link (16). See FIGURE 15.



Figure 15

### Inspect hex drive assembly

18. The pin in the hex drive assembly (10) should not show wear and must be firmly pressed in place. The sides of the hex and the slot should not have grooves or scoring. If the hex drive assembly (10) shows signs of this type of wear, it must be replaced.

### Remove alignment pins

19. Remove the two alignment pins (11) that align the port manifold (8), valve ring (12) and isolation manifold (15). See FIGURE 16.

### NOTE

NOTE: A service kit of nine alignment pins (11) is available for servicing the unit.

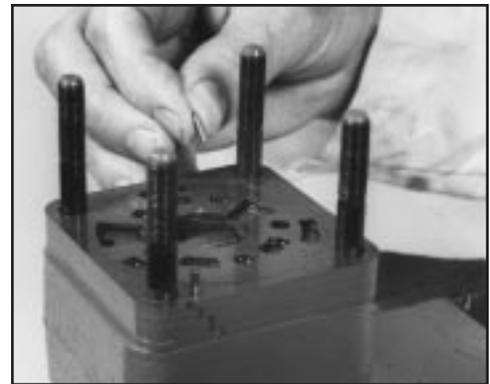


Figure 16

### Remove isolation manifold

20. Remove the isolation manifold (15), (four plates bonded together). See FIGURE 17.



Figure 17

**Inspect isolation manifold**

- 21. Inspect the ground surfaces of the isolation manifold (15). You should notice a "normal" polished pattern due to the rotation of the valve plate (13) and on the opposite side a "normal" polished pattern due to the action of the commutator cover (20) and commutator seal (19). The holes and edges should be free of nicks. The manifold surfaces should be free of nicks or scoring. If the manifold has developed any of these conditions, it must be replaced.

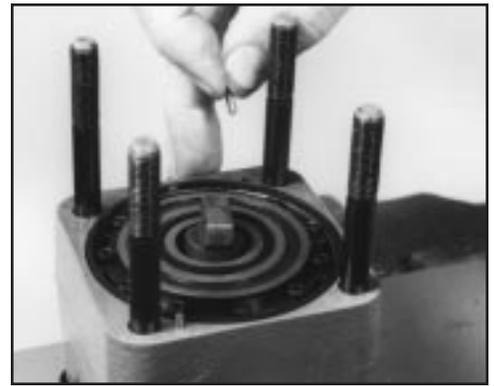


Figure 18

**Remove alignment pins**

- 22. Remove the two isolation manifold-metering ring alignment pins (11). See FIGURE 18.
- 23. Remove the drive link (16) from the unit. See FIGURE 19.



Figure 19

**Inspect drive link**

- 24. Inspect each end of the drive link (16). The four crowned contact surfaces should not be worn or scored. Replace if wear or scoring is evident.



Figure 20

**Remove & inspect metering ring**

- 25. Remove the metering ring (17) and discard the two seal rings (3). See FIGURE 20. If the metering ring bore is scored, it should be replaced.

**Remove metering package**

- 26. The "metering package" components are held together with eleven hex. socket head screws. Lift the metering package from the assembly, and place it on a clean surface. See FIGURE 21.



Figure 21

**CAUTION**

**CAUTION: Do not clamp the metering package in vise, as this could damage the components.**

**Remove commutator seal**

27. Remove and discard the commutator seal (19) from the commutator cover (20). See FIGURE 22.

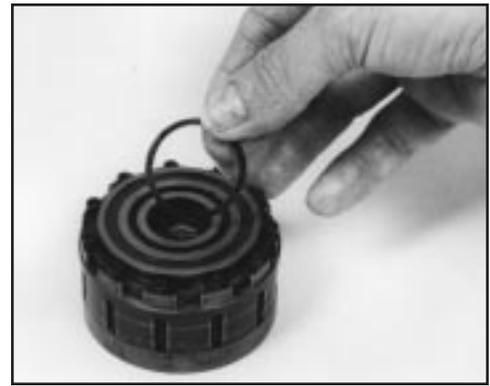


Figure 22

**Remove cap screws**

28. Remove the eleven hex. socket head screws (18), that hold the metering package together. See FIGURE 23. Use a 3/32 inch Allen wrench. Inspect screws for thread and socket damage and replace as required.



Figure 23

**Remove commutator cover**

29. Lift the commutator cover (20) from the metering package.

**Inspect commutator cover**

30. Inspect the ground surfaces of the commutator cover (20). You should notice a "normal" polished pattern due to the rotation of the commutator (22). If the cover has nicks, burrs, or scoring, it must be replaced. See FIGURE 24.

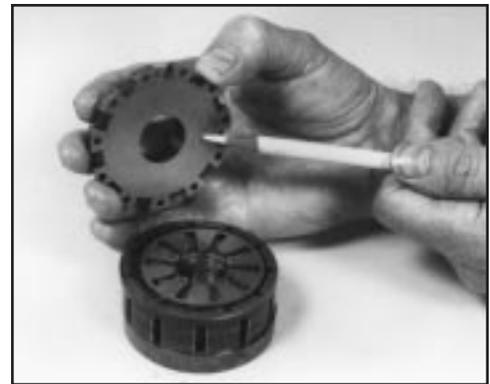


Figure 24

**Remove commutator ring**

31. Remove commutator ring (21). See FIGURE 25. Inspect for cracks, burrs, and scoring.

**CAUTION**

**CAUTION: Handle commutator ring with care, as it is easily broken.**



Figure 25

**Remove commutator**

32. Remove the commutator (22) from the rotor (24). See FIGURE 26.

**CAUTION**

**CAUTION: Five alignment pins (11) connect the commutator to the rotor with a slip fit. Care and minimum force should be used to separate the two components.**

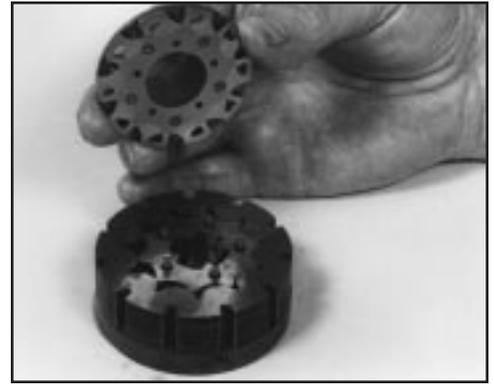


Figure 26

**Remove alignment pins**

33. Remove the five alignment pins (11). See FIGURE 27.

**Remove & inspect drive link spacer**

34. Remove drive link spacer (23). See FIGURE 28. Replace it, if it is grooved or worn.

**Inspect commutator**

35. The commutator (22) is made up of two round plates pinned and bonded together as a permanent assembly and is not subject to further disassembly. Inspect the ground surfaces of the commutator. The holes and edges should be free of nicks. The ground surfaces should be free of scoring. The edges should be sharp.

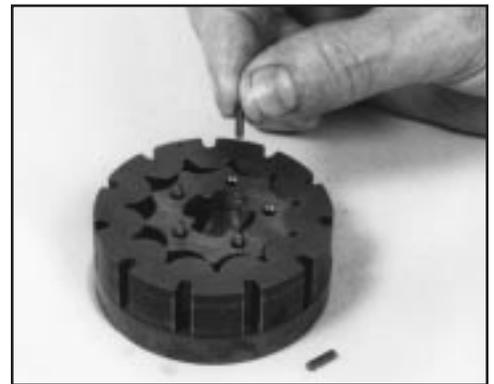


Figure 27

**NOTE**

**NOTE:** The commutator (22) and commutator ring (21) are a matched set. If either is worn or damaged, you must replace the set.

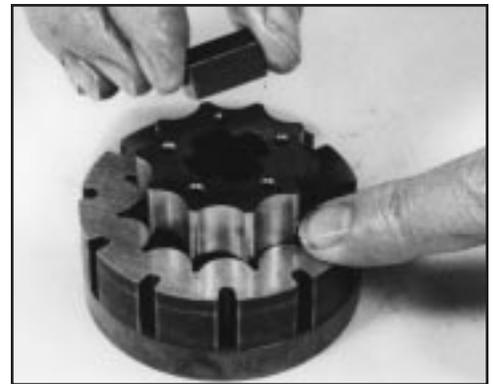


Figure 28

**Inspect rotor set**

36. With the rotor set (24, 25) lying on the drive plate (26), the rotor (24) should rotate and orbit freely within the stator (25). The commutator side of the stator face must be free of grooves or scoring.

**NOTE**

**NOTE:** The rotor (24) and stator (25) are a matched set. You must replace them as a matched set, if either is worn or damaged.

**Check rotor to stator  
"tip" clearance**

37. Check the rotor (24) lobe "tip" to stator (25) lobe "tip" clearance, using the appropriate feeler gage. See FIGURE 29. The rotor lobe, directly across from the rotor lobe tip being gaged, (see pointer FIGURE 29) must be centered between stator lobes during the gaging process. A rotor and stator that is .75 inches (19 mm) or less in height has a maximum allowable "tip" clearance of .003 inches (.08 mm). A rotor and stator that is 1.00 inch (25.4 mm) or more in height, has a maximum allowable "tip" clearance of .005 inches (.13 mm). A rotor and stator that exceeds the maximum allowable "tip" clearance, must be replaced.

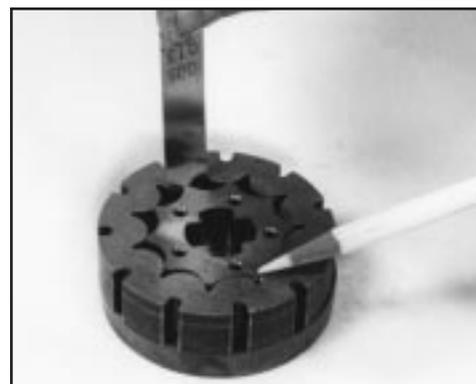


Figure 29

**Remove rotor set**

38. Remove the rotor set (24, 25), from the drive plate (26). The drive plate side of the rotor set also must be free of grooves or scoring.

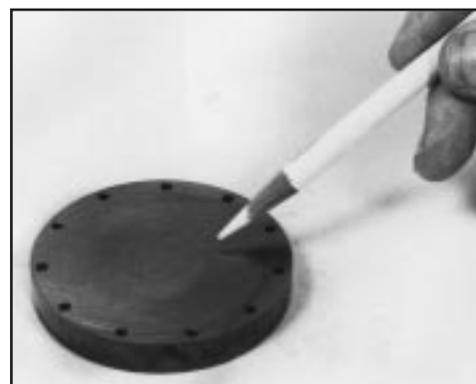


Figure 30

**NOTE**

NOTE: Handle the rotor set carefully to avoid nicks and scratches.

**Inspect drive plate**

39. The rotor side of the drive plate (26) should show the "normal" spiral pattern due to rotor movement. Inspect the thrust bearing side of the plate for brinelling (dents) or spalling (flaking). The flat sides of the input shaft engagement hole should not be grooved or worn. If any of these conditions are present, the drive plate (26) must be replaced. See FIGURES 30 and 31.

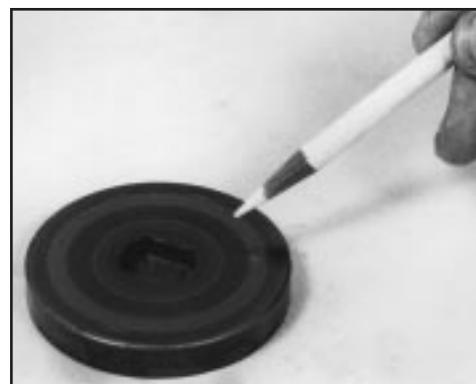


Figure 31

**CAUTION**

**CAUTION: Protect seal surface from damage.**

**Remove face seal and spacer**

40. Remove face seal (29) and face seal spacer (31) from upper cover plate (32). See FIGURE 32. Discard the face seal (29). **Retain metal spacer (31).**



Figure 32

**NOTE**

NOTE: Back up ring (30) may be an integral part of face seal (29) on some HGF units. Old style seal may have back-up ring; remove and discard.

**Remove thrust bearing & spacer**

41. Note position of bearing spacer undercut (groove-side down). Remove thrust bearing (28) and bearing spacer (27) from upper cover plate (32). See FIGURE 33.

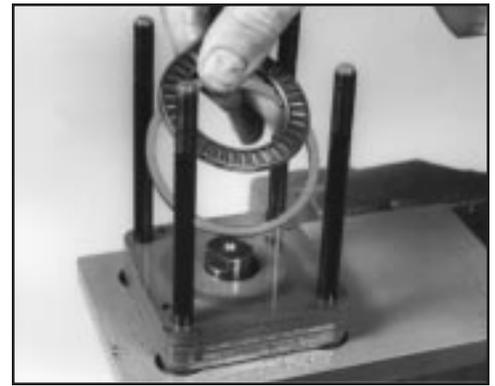


Figure 33

**Inspect bearing and spacers**

42. Inspect the thrust bearing (28) for brinelling (dents) or spalling (flaking), if either exists, or if one of more of the rolls is lost or broken, replace the bearing assembly. See FIGURE 33. Replace seal spacer (31) or bearing spacer (27) if worn or broken.

**CAUTION**

**CAUTION: The thrust bearing assembly (28) will have 16 or 17 rolls evenly spaced in a roller cage that can hold 32 or 34 rolls or the thrust bearing will have a full complement of 32 or 34 rolls. The bearing assembly with 32 or 34 rolls should not be replaced with a bearing assembly that has 16 or 17 rolls.**

**NOTE**

**NOTE:** For reassembly purposes, note the radial position of the alignment grooved edge of the upper cover plate (32) relative to the jacket tube contact brush hole if the unit is so equipped.



Figure 34

**Remove and inspect upper cover plate**

43. Remove the upper cover plate (32) (four plates bonded together). Inspect the upper cover plate. You should notice some polishing due to the action of the seal. The plate should be free of brinelling (dents) or spalling (flaking). If it is damaged, the upper cover plate must be replaced. See FIGURE 34.

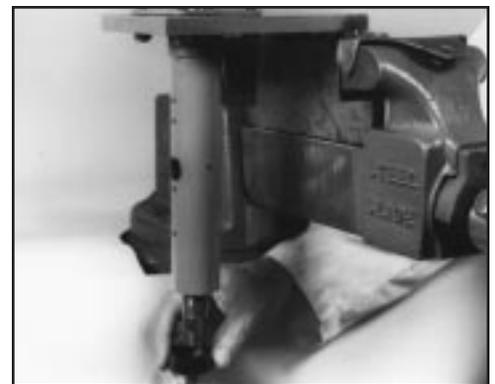


Figure 35

**CAUTION**

**CAUTION: Protect seal area.**

**Remove dirt and water seal**

44. Slide the seal (39) from the jacket tube. If the seal is worn or damaged, it must be replaced. See FIGURE 35.

**Remove input shaft/wheel tube**

45. Remove the input shaft/wheel tube (33) assembly, sliding it out of the upper cover end of the assembly. See FIGURE 36.



Figure 36

**NOTE**

**NOTE:** If the input shaft/wheel tube assembly has 7/8 serrations or contact ring assembly (43), the washer (35) and retaining plate (36) will be removed with input shaft/wheel tube assembly.

**Inspect input shaft/wheel tube sub-assembly**

46. Inspect the input shaft/wheel tube (33) and sub-assembly components as assembled. Inspect input shaft/wheel tube for worn or damaged serrations, wheel nut threads, bearing diameter, and flats on the lower end. Inspect the other components of the sub-assembly for wear damage. If the sub-assembly includes horn cable assembly(ies), check its electrical functions with an appropriate continuity checking device. If this sub-assembly passes inspection, set it aside, and go to disassembly procedure number 50. If it does not pass inspection, continue with disassembly procedure number 47.

**NOTE**

NOTE: There must be electrical continuity (connection) from the upper terminal of horn cable assembly (47) to the contact ring of the contact ring assembly (43). There must not be any electrical continuity (connection) from horn cable assembly terminal or contact ring assembly to the input shaft/wheel tube (33) or other components.

**Remove retaining ring**

47. Using appropriate external retaining ring pliers, remove the retaining ring (34) from the input shaft/wheel tube (33). See FIGURE 37. Discard, if deformed or broken.

**Remove retaining plate**

48. Remove washer (35) and retaining plate (36) from input shaft/wheel tube (33) or upper cover and jacket assembly (37). Discard, if deformed or damaged. See FIGURE 38.

**NOTE**

NOTE: Retaining plate (36) cannot be serviced separately, but is a part of an upper cover and jacket tube assembly service kit.

**Remove horn cable and contact ring assemblies**

49. Remove tape, horn cable assembly (47), screw (42), and contact ring assembly (43) from input shaft/wheel tube (33) if the unit is so equipped. Replace broken or electrically defective components. See FIGURES 39 and 40.



Figure 37



Figure 38



Figure 39



Figure 40

**NOTE**

NOTE: The relative positioning of the contact ring(s) (43) should be noted before removal for reassembly purposes.

**Remove upper cover and jacket tube assembly**

- 50. Remove the upper cover and jacket tube assembly (37) and lay the assembly on the bench. See FIGURE 41.

**Inspect upper cover and jacket tube assembly**

- 51. The jacket tube has been pressed into and welded to the upper cover plate support tube such that the retainer plate (36) is flush with the upper cover plate surface when seated against the jacket tube. Any signs of looseness or movement of jacket tube in the upper cover support tube will require replacement of upper cover and jacket tube assembly (37), retainer plate (36) and bushing (38) as a set. A loose or worn input shaft/wheel tube bushing (38) in the upper cover and jacket tube assembly can be serviced separately.

**Remove worn bushing**

- 52. If the bushing (38) is to be replaced, place the upper cover and jacket tube assembly (37) in a vise with the vise jaws clamping firmly on the jacket tube without deforming the jacket tube. Using an appropriate type of pliers, "uncrimp" or relieve the two crimped areas on the bushing end of the jacket tube. Remove the bushing using a bearing or seal type puller and discard the bushing. Set the upper cover and jacket tube aside to await assembly. See FIGURES 42, 43.

**Remove and inspect bolts**

- 53. Remove the nuts holding the four bolts (40) to the fixtures and remove the bolts. Bolts with the square shoulder or the threads damaged such that the nuts cannot be properly torqued must be replaced. See FIGURE 44.

**WARNING**

**WARNING: USE ONLY GENUINE OEM APPROVED REPLACEMENT PARTS. THE USE OF IMPROPER PARTS COULD CAUSE A LOSS OF STEERING WHICH COULD LEAD TO AN ACCIDENT.**

The HGF disassembly is complete.



Figure 41



Figure 42



Figure 43



Figure 44

## HGF: Assembly

### Replace gaskets, seals and O-Rings

Replace all seals and "O" rings with new ones each time you assemble the HGF unit. Be sure the seal and "O" rings remain seated correctly when components are assembled. See FIGURE 45.

### NOTE

NOTE: A seal kit with all required seals except the column and jacket seal is available for service. The seal (39) is available separately.

### Clean and dry parts

Before you reassemble the HGF, wash all parts in clean petroleum based solvent. Blow them dry with compressed air.

### 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.

### Place bolts into fixture

1. Place four bolts (40) into fixture with shortest threaded end of bolts through the fixture holes. Secure bolts to fixture with four 5/16 24 UNF nuts. Tighten nuts to secure assembly to fixture but loose enough to turn bolts and facilitate stacking of components. See FIGURE 46.

### Assemble new bushing

2. If the bushing (38) was removed from the upper cover and jacket tube (37) for replacement, press a new bushing (38) into the upper end of the jacket tube with the end of the bushing that has recesses toward the jacket tube. This may be done using an arbor press or clamping on the jacket tube per disassembly step 52 and using the wood handle end of a hammer. The bushing must be seated firmly in the jacket tube and below the end of the jacket tube. "Crimp" the end of the jacket tube over the bushing in two places approximately 90° away from the original crimped areas, using pliers and/or a blunt ended punch. See FIGURES 47 and 48.

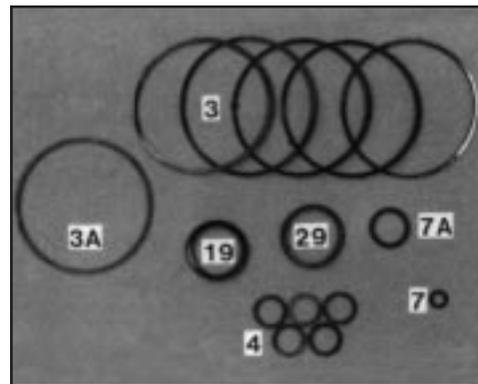


Figure 45



Figure 46



Figure 47



Figure 48

**Stack upper cover and jacket tube assembly**

3. Apply clean grease to bushing (38) and stack upper cover and jacket tube assembly (37) on the four bolts (40) with the jacket tube pointing down through the hole in the fixture. Make sure the square shoulder of the bolts engage the square holes in the upper cover. See FIGURE 49.

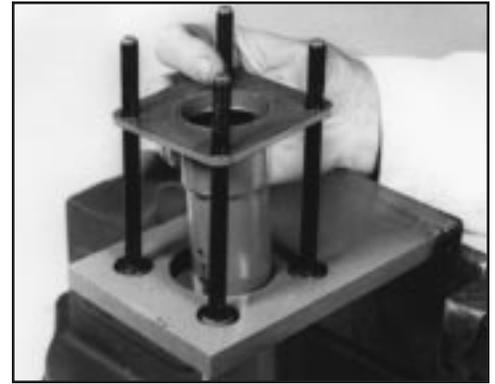


Figure 49

**NOTE**

NOTE: If contact ring assemblies and horn wires are not required, go to assembly Step 6.

**Install contact ring assembly**

4. Install the contact ring assembly(ies) (43), if required, onto the input shaft/wheel tube (33) into the same position as before disassembly. See FIGURE 50.



Figure 50

**Install horn cable assembly**

5. Insert horn cable assembly (47) spade terminal end first into the steering wheel end of the input shaft/wheel tube (33) so that it exits from the horn cable outlet hole. Push the horn cable spade terminal onto the contact ring (43) terminal connector. Be sure it is a good, firm connection. Position the horn cable protector sleeve so that it protects the horn cable from any sharp corner where it exits the horn cable outlet hole. Position and fasten the contact ring assembly (43) with screw (42). Use about 1 1/2 turns of tape around the input shaft/wheel tube, horn cable and contact ring to hold the horn cable in place. See FIGURE 51. Check for electrical continuity (connection) required from horn cable assembly (47) upper terminal to contact ring of contact ring assembly (43). There must not be electrical continuity (connection) from upper horn cable terminal or contact ring to input shaft/wheel tube (33). Also, see FIGURES 99 and 100.



Figure 51

**CAUTION**

**CAUTION: Failure to check the electrical functions of the input shaft/wheel tube, horn cable assembly before it is assembled into the HGF unit, would require another complete disassembly of the unit if proved electrically defective after the HGF unit is assembled.**

**Install retaining plate and washer**

6. Apply small amount of grease to the recessed face of retainer plate (36) and to washer (35). If the input shaft/wheel tube (33) is 3/4 inch (19 mm) diameter with no contact ring assembly (43), place the retainer plate into the upper cover and jacket assembly (37) with recessed retainer face out. Place washer (35) against recessed face of retainer plate.



Figure 52

**Install retaining ring**

If input shaft/wheel tube (33) is 7/8 inch (22 mm) diameter on the hand wheel end or has a contact ring assembly (43), slide the retainer plate (36) then the washer (35) onto the retaining ring groove end of the input shaft/wheel tube, past the ring groove. The recessed face of the retaining plate must be toward the washer. See FIGURE 52.



Figure 53

**Install retaining ring**

7. Install retaining ring (34) onto input shaft/wheel tube (33) using the appropriate external retaining ring pliers. See FIGURE 53.

**Install input shaft/wheel tube**

8. Slide input shaft/wheel tube (33) assembly into upper cover end of upper cover and jacket tube assembly (37) and through the bushing (38) until the retaining ring (34) bottoms against washer (35) which bottoms against retainer plate's (36) recessed face and the retainer plate seats against the end of jacket tube. See FIGURES 54 & 55.



Figure 54

**Install upper cover plate**

9. Assemble the upper cover plate (32) over the four bolts (40) and input shaft/wheel tube (33) onto the upper cover and jacket tube assembly (37) with the highly polished surface up and the edge with the alignment groove in the same position relative to the jacket tube contact brush cover hole as noted before disassembly. See FIGURE 55. (Reference alignment groove graphic--fold-out page.)



Figure 55

**Grease upper cover plate face**

10. Apply clean grease to the face of the upper cover plate (32), to the drive plate end of the input shaft/wheel tube (33) and to the face seal (29). See FIGURE 56.

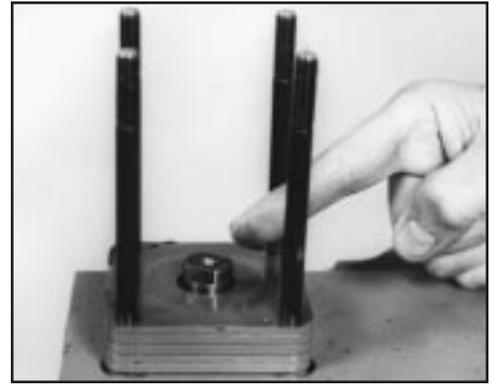


Figure 56

**Install face seal**

11. Install face seal and spacer (31) assembly over end of input shaft/wheel tube (33) onto upper cover plate (32). See FIGURE 57.

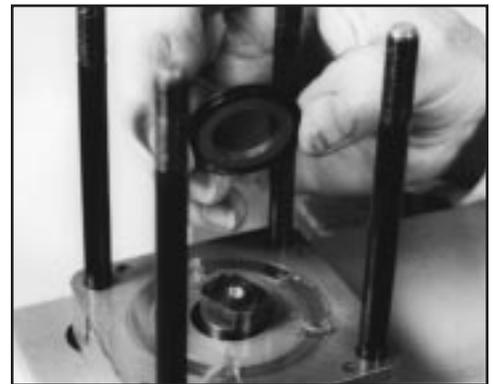


Figure 57

**Assemble metering package**

12. Place the drive plate (26) on a clean lint-free surface with the eleven tapped holes facing up. Place the rotor set (24,25) on top of the drive plate with the five pin holes facing up. Rotate the stator (25) until the eleven hex. socket head screw relief slots are aligned with the tapped holes in the drive plate. See FIGURE 58.

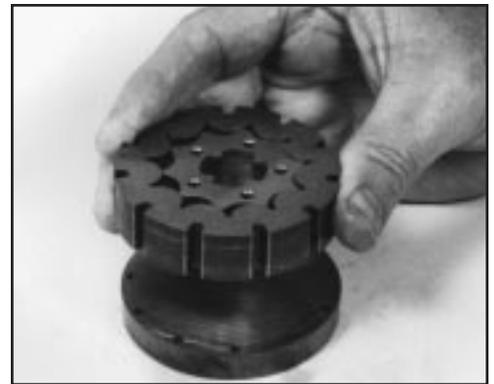


Figure 58

### Install spacer

13. Apply a small amount of clean grease to spacer (23) and insert it into the drive slot in the rotor (24). See FIGURE 59. The grease will aid in retaining the spacer during other assembly procedures.

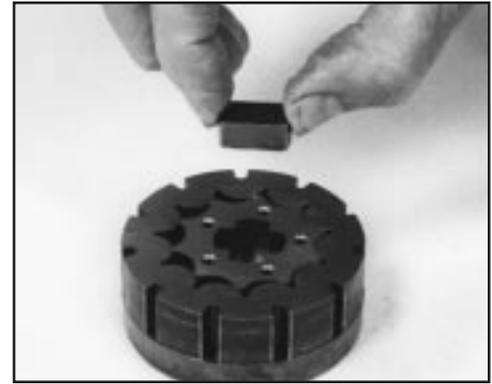


Figure 59



Figure 60

### Install commutator

14. Place the commutator (22) on top of the rotor (24). Be sure the correct surface, shown in FIGURE 60, is toward the rotor. Align the five holes and press the five alignment pins (11) in place. See FIGURE 61.

### CAUTION

**CAUTION: Make sure the five alignment pins are pressed below the surface of the commutator (22).**

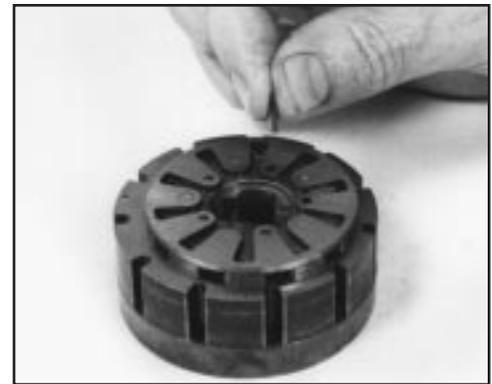


Figure 61

### Lubricate the commutator

15. Place a few drops of oil into each recess in the commutator (22). See FIGURE 62.

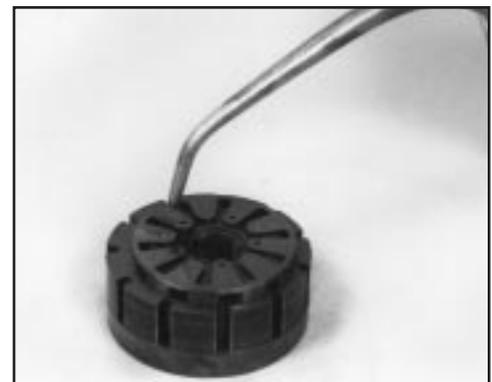


Figure 62

### Install commutator ring

16. Place commutator ring (21) either side up on top of stator (25). Align commutator ring screw recesses with stator screw slots. See FIGURE 63.



Figure 63

### Install commutator cover

17. Place commutator cover (20) on top of commutator ring (21) with flat surface toward commutator. Align screw holes in cover, with screw holes in drive plate (26). See FIGURE 64.



Figure 64

### Install cap screws

18. Screw the eleven hex. socket head cap screws (18) loosely into metering package. See FIGURE 65.

### NOTE

NOTE: The commutator ring (21) must be concentric with drive plate (26) within .005 inch (.127 mm) total indicator reading after tightening the eleven hex. socket head cap screws (18). The next two procedures are a method of achieving the concentricity.



Figure 65

### Align commutator ring concentrically with drive plate

19. Place the metering ring (17) on a hard flat surface. Place the assembled metering package into the metering ring with the commutator cover (20) down, such that the drive plate is partially out of the metering ring. (A suitable wood block under the metering package will hold it in this position.) See FIGURE 66.



Figure 66

Place one piece of .007 inch (.18 mm) shim stock approximately .5 inch (13 mm) wide x 1.5 inch (38 mm) long between the metering ring and drive plate in three places approximately equal distance around the outside diameter of the drive plate. Place another piece of the .007 inch (.18 mm) shim stock between the drive plate and each of the three pieces of shim stock already in place. Lift the metering ring and metering package and remove the wood block. Push the metering package and shims into the metering ring until the drive plate and shims are at least flush with the metering ring. See FIGURE 67.



Figure 67

**Tighten hex socket head cap screws**

20. Reverse the metering ring (17) and metering package as a unit on the flat surface. Push down on the metering package until the drive plate is on the flat surface. Be sure the cap screws (18) are loose enough to allow the commutator ring (21) and drive plate (26) to align themselves concentrically in the metering ring bore. Gradually tighten the eleven cap screws, following the sequence shown in FIGURE 70, at least twice until a final torque of 11-13 inch pounds (1.24 to 1.47 N m) is reached.) See FIGURES 68 and 69. Remove the metering package and shims from the metering ring. Discard the shims.



Figure 68

**WARNING**

**WARNING: USE CARE AND EYE PROTECTION WHILE ADDING AND REMOVING SHIMS FROM METERING RING AS THE SHIMS WILL BE UNDER SPRING TENSION AND COULD FLY INTO THE AIR CAUSING INJURY.**

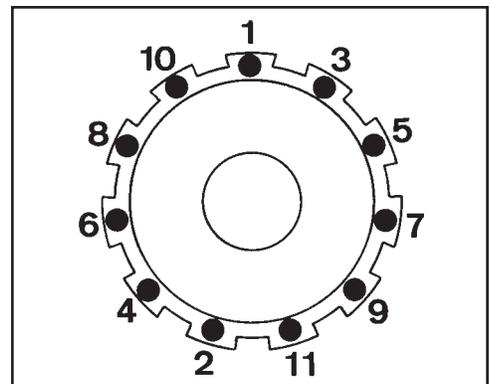


Figure 69

**Install drive link**

21. Insert large tang of the drive link (16) into the slot in the rotor (24). See FIGURE 70.

**CAUTION**

**CAUTION: An incorrect (reversed) assembly of the drive link will prohibit the assembly of the hex drive (10) in step 35.**



Figure 70

### Check rotor movement

22. Grasp the drive link (16) and rotate the metering package by hand to make sure the parts do not bind. The rotor (24) should orbit inside the stator (25). If they bind, disassemble the metering package, correct the cause, and repeat the assembly and concentricity procedures. See FIGURE 71.



Figure 71

### Install metering ring

23. Apply clean grease to the metering ring seal ring (3). Position the seal ring in the metering ring seal groove opposite to the end with the alignment pin holes. Stack the metering ring (17) into place, over the four bolts (40), with the seal ring towards the upper cover plate (32), and an alignment pin hole on the metering ring in line with and on the same side as the alignment groove on the side of the upper cover plate. See FIGURE 72. This is required so that the other components can be aligned correctly.



Figure 72

### CAUTION

**CAUTION: Be sure the seal ring (3) does not slip from position.**

### Install bearing spacer

24. Place the bearing spacer (27) onto the face of the upper cover plate (32). Position of undercut is down. See FIGURE 73.

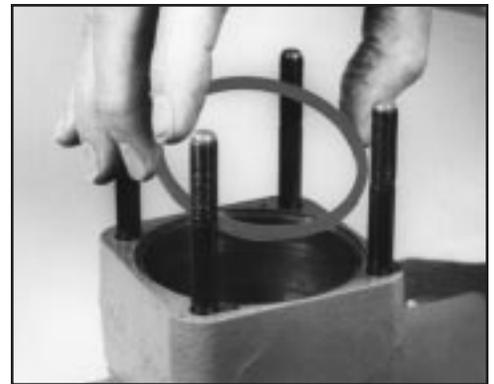


Figure 73

### Install bearing

25. Lightly grease roller thrust bearing (28), and place it on the upper cover plate (32), inside the bearing spacer (27). See FIGURE 74.



Figure 74

**Install metering package**

26. Inspect the exposed face of the drive plate (26) making sure it is clean and lint free. Apply a small amount of clean grease on the drive plate. Place the "metering package", drive plate side first, into the metering ring (17). Revolve the input shaft (33) or metering package until the hole in the drive plate (26) engages the end of the input shaft and the drive plate is seated on the thrust bearing (28). When properly seated, the metering package will be below the surface of the metering ring. See FIGURES 75 and 76.



Figure 75



Figure 76

**Install commutator seal**

27. Grease the new commutator seal (19) and place it into the commutator cover (20) seal groove. The rubber portion (the softer side) of the seal with the yellow mark must be placed into the seal groove. See FIGURE 77.

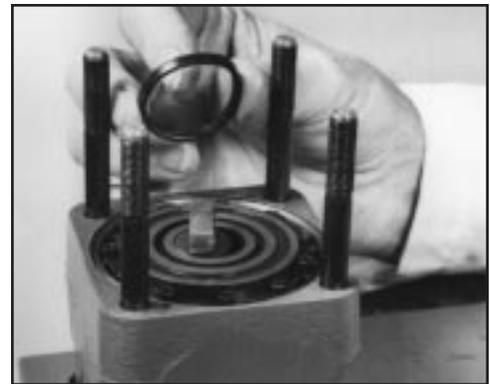


Figure 77

**Install metering ring seal ring**

28. Apply clean grease to the metering ring seal ring (3). Place the seal ring into the metering ring seal ring groove. See FIGURE 78.

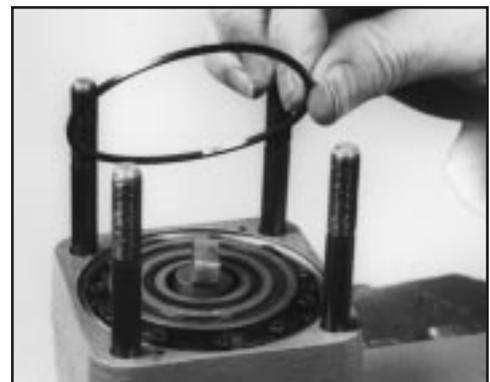


Figure 78

**Install alignment pins**

29. Place two alignment pins (11) into the metering ring (17). See FIGURE 79.

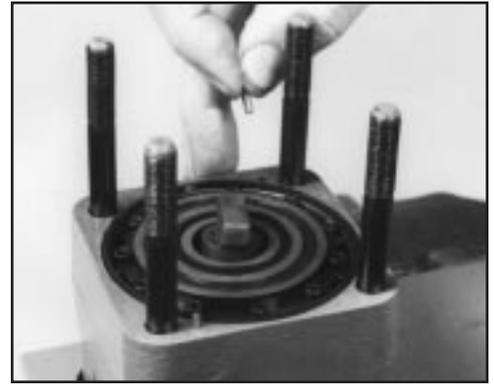


Figure 79

**Install isolation manifold**

30. Stack the isolation manifold (15) (4 plates bonded together) onto the metering ring (17), aligning the grooves on the side of the manifold with the grooves on the side of the upper cover plate (32) and the alignment pin holes with the alignment pins in the metering ring. The isolation manifold surface without the recessed slots must be placed toward the metering ring. See FIGURE 80.

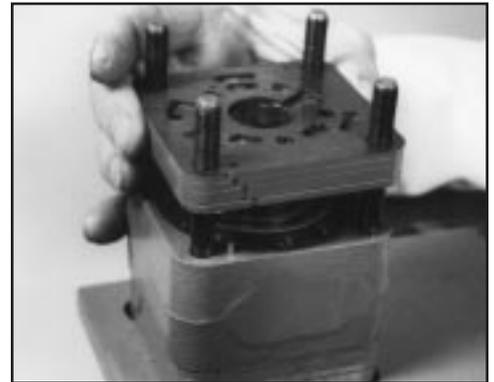


Figure 80

**Install two alignment pins**

31. Install two alignment pins (11) into the isolation manifold (15). See FIGURE 81.



Figure 81

**Install 1/2 inch springs**

32. Place the three 1/2 inch (13 mm) springs (14) into the spring pockets of the isolation manifold (15). See FIGURE 82.

**NOTE**

NOTE: Two different length springs are used in the unit. Be sure to use the 1/2 inch (13 mm) length springs (14) during this part of the assembly.



Figure 82

### Install valve ring

33. Apply clean grease to a seal ring (3) and place it in the valve ring (12) recess that will face down when installed. Install the valve ring over the bolts and alignment pins with seal ring facing the isolation manifold (15). See FIGURE 83.

### CAUTION

**CAUTION: Be sure seal ring is seated correctly after valve ring is assembled.**

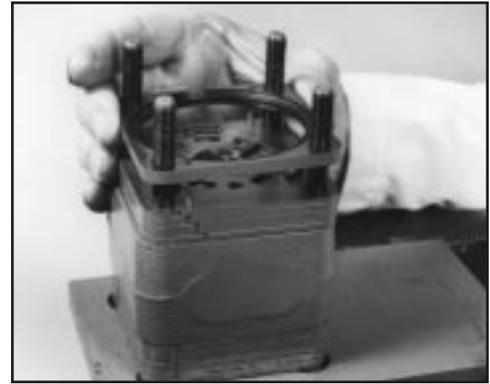


Figure 83

### Install hex drive assembly

34. Place hex drive assembly (10), pin side up, through the hole in the isolation manifold (15). The slot in the hex drive must be engaged with the small tang of the drive link (16). Turn the input shaft/wheel tube to assist the engagement. See FIGURE 84.

### NOTE

**NOTE:** If hex drive does not readily assemble on drive link, see CAUTION note after assembly step 22.



Figure 84

### Install valve plate

35. To install the valve plate (13) correctly, first carefully study FIGURES 85 and 86 for positioning of the valve plate (13) spring slots and its other cavities in relation to the spring and spring recesses on the isolation manifold (15). Be sure to use the alignment grooves on the side of the isolation manifold for orientation. Place the valve plate (13) with the surface that reads "shaft side" down over the hex drive assembly (10) aligning the three spring slots centrally over the three springs placed in the spring recesses of the isolation manifold (15). The valve plate spring slot with the small cavity and then the words "port side" centrally below it as pointed to in FIGURE 85, must be placed over the spring and spring recess in the isolation manifold at the top (at 12 o'clock) as shown in FIGURES 85 and 86. Adjust the valve plate position radially to centralize the spring slots over the springs and the spring recesses in the isolation manifold.

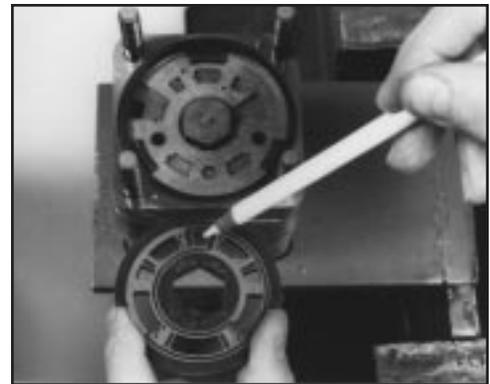


Figure 85



Figure 86

**CAUTION**

**CAUTION:** The unit will not function if the valve plate is not positioned on the isolation manifold exactly as shown in FIGURE 86. If the valve plate spring slots, isolation manifold spring recesses and springs are not centrally aligned in this step, the springs could be damaged when the port manifold is placed on the assembly.

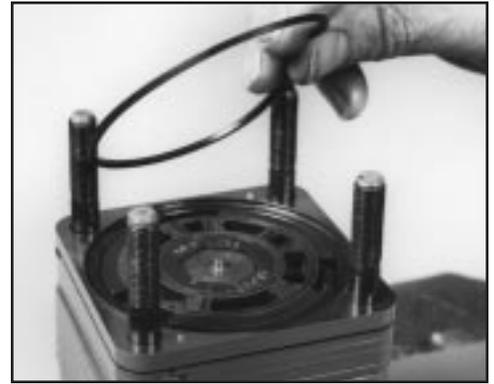


Figure 87

**Install valve ring seal ring**

36. Apply clean grease to the valve ring seal ring (3). Install seal ring in the valve ring (12). See FIGURE 87.

**Install 3/4 inch springs**

37. Place port manifold (8) valve side up on a clean surface. Install three 3/4 inch (19 mm) springs (9) into the spring pockets. See FIGURE 88.

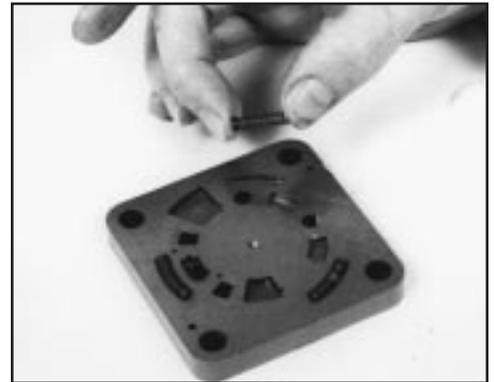


Figure 88

**Install port manifold**

38. Apply a few drops of oil to the valve plate (13). Align the grooves on the side of the port manifold (8) with the grooves on the side of the isolation manifold (15) and assemble the port manifold with the springs toward the valve plate (13). Be careful not to pinch a spring during installation. The two alignment pins (11), in the valve plate, will engage the holes in the port manifold. The pin on the hex. drive assembly (10) must engage the center hole in the port manifold. See FIGURE 89.



Figure 89

**Install check ball**

39. Install new "O" ring (7) on plug (6), insert check ball (5) into check ball hole in port cover (2). Be sure ball (5) is seated in bottom of check ball hole. Turn plug assembly (6, 7), into port cover (2) until ball (5) is retained. See FIGURE 90.



Figure 90

**Install relief valve cartridge and spring assy. and hex plug**

40. If required, place new O-Ring (7A) onto hex plug (6A). Apply clean grease to the O-Ring. Place the rounded nose of the relief valve, cartridge assembly (5A) into its bore in the port cover (2). Place the small end of coil spring (5B) on the small pin on the back of the relief valve cartridge assembly so it is held in place. Install the hex plug so the valve cartridge and coil spring fit into the bore in the hex plug. See FIGURE 8A. Tighten the hex plug to 25-35 ft. lbs.



Figure 91

**Place seals on port cover**

41. Apply clean grease to the three, four or five O-Rings (4), and seal ring (3) or white seal ring (3A) as required. Place the new O-Rings (4) and seal ring (3) or (3A) into their proper location in the port cover (2). See FIGURE 91.



Figure 92

**CAUTION**

**CAUTION: If white seal ring (3A) was removed from port cover (2), a new white seal ring must be assembled into the port cover. The seal ring (3A) and seal ring (3) are not interchangeable.**

**Install check ball**

- 41A. If a check ball (52) was removed from unit, place it in hole in the port manifold (8).



Figure 93

**Install port cover**

42. Align a groove on the side of the port cover (2) with the grooves on the side of the port manifold (8) and place the port cover (2) into position. See FIGURE 92.

**Install nuts**

43. Install nuts (1) onto bolts (40). Tighten each one gradually until resistance is felt. Torque to 18-22 ft. lbs. (24-30 N m) in sequence shown. See FIGURES 93 and 94. Torque plug (6) to 8-12 ft. lbs. (11-16 N m). See FIGURE 95.

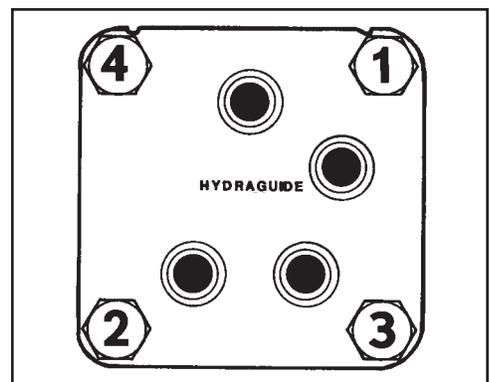


Figure 94

**Install dirt and water seal**

- 44. Apply a small amount of clean grease on the lip of the seal (39). Install the seal onto the jacket tube and input shaft/wheel tube. See FIGURE 96.



Figure 95

**Make final assembly check and remove unit from fixture**

- 45. Make final check of the relative groove positions on the side of the unit using the component alignment groove graphic on page 9B (fold-out) for comparison. Disassemble and correct any misassembly. Remove the four nuts holding the unit to the fixture and remove the unit. Make sure shaft rotates by hand. See FIGURE 97.



Figure 96

**Assemble contact brush and related parts**

- 46. Place HGF unit on a clean working surface. If required, assemble spacer (51) [for 1 1/2 inch (38 mm) jacket tube only], contact brush assembly (44) washer (46) [for 1 3/4 inch (44 mm) jacket only] and screw and lock washers (45). See FIGURES 98, 99, and 100. Check for the required electrical continuity (connection) from the horn cable assembly (47) upper terminal to the contact brush (44) terminal as the input shaft/wheel tube is rotated. There must not be any electrical continuity (connection) from the upper horn cable terminal or contact brush terminal to any other exposed part of the HGF unit, including the body of the contact brush.



Figure 97



Figure 98

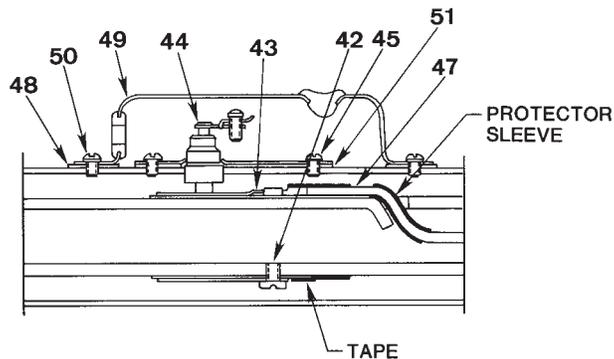
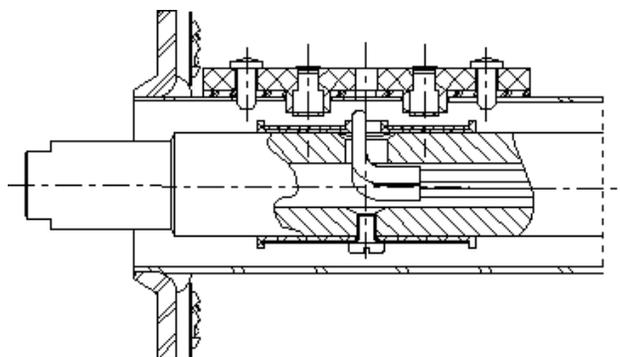


Figure 99  
TYPICAL

7/8" (22 mm) Input Shaft/Wheel Tube  
1 1/2" (38 mm) Jacket Tube



New Horn Contact Design

7/8" (22 mm) Input Shaft/Wheel Tube  
1 1/2" (38 mm) Jacket Tube

THIS COMPLETES THE ASSEMBLY OF HGF UNIT WITH THE EXCEPTION OF WHEEL NUT (41), CONTACT BRUSH COVER SEAL (48), CONTACT BRUSH COVER (49), AND RELATED SCREW AND LOCK WASHERS (50) WHICH MUST AWAIT INSTALLATION OF STEERING WHEEL AND ELECTRICAL SOURCE CONNECTION. REF. FIGURES 99 AND 100.

**CAUTION: IF THE INSTALLATION APPLICATION HAS A JACKET TUBE (COLUMN) SUPPORT CLAMP, IT IS EXTREMELY IMPORTANT THAT THE UPPER COVER AND JACKET TUBE ASSEMBLY ALIGN WITH THIS CLAMP IN THE FREE STATE. IF MISALIGNMENT IS EVIDENT, THE HGF UNIT MUST BE SHIMMED AT THE MOUNTING SURFACE TO ELIMINATE THIS MISALIGNMENT, OR DAMAGE TO THE HGF UNIT MAY RESULT.**

## Hydraulic Fluid

Keep the steering system filled with one of the following:

- Automatic Transmission Fluid Type "F"
- Automatic Transmission Fluid Dexron II
- Hydraulic fluid as recommended by the vehicle manufacturer

**WARNING:** MAINTAIN THE PROPER FLUID LEVEL IN THE SYSTEM RESERVOIR. DO NOT MIX OIL TYPES. A MIXTURE OF OIL TYPES OR AN UNAPPROVED OIL, COULD DETERIORATE THE SEALS, CAUSING LEAKAGE THAT WOULD CREATE A LOSS OF POWER STEERING, COMPLETELY DRAIN OLD OIL FROM THE SYSTEM BEFORE CHANGING TO ANOTHER FLUID. IT IS SUGGESTED ALSO THAT YOU FLUSH THE SYSTEM WITH CLEAN OIL.

## Filling and Air Bleeding the System

**NOTE:** For steps 1 and 2, do not turn the steering wheel.

1. Fill the reservoir nearly full. Crank the engine for 10 seconds without, if possible, allowing the engine to start. If the engine does start, shut it off immediately. Do this procedure 3 times, each time checking and refilling the reservoir.

**CAUTION:** Do not allow fluid to drop significantly or to run out of the reservoir. This will 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.

NOTE: For step 3, have someone turn the steering wheel while you check the reservoir.

3. Start the engine. Steer the vehicle from full left to full right several times, all the while adding fluid. When you are finished, add fluid to the fill line in reservoir.

## Tips for Maintaining the Hydrostatic Steering System

- Top up fluid level in reservoir as necessary.
- Maintain correctly inflated tires.
- Always use a puller to remove the steering wheel. Do not use a hammer, torch, or crow bar.
- Investigate and correct immediately any play, rattle, shimmy, or other unusual occurrence in the steering system.
- Remove cause of steering column misalignment.
- Encourage all drivers or operators to report any malfunction or accident that may have damaged a steering system part.
- 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 part.
- Prevent dirt or other foreign matter from entering the hydraulic system. Clean off around filler caps before checking oil level.
- Investigate and correct any external leak in the steering system, no matter how minor the leak.
- Comply with manufacturer's specifications for cleaning or replacing the filter.

### **WARNINGS for Proper Steering System Operation**

WARNING: DO NOT WELD, BRAZE, OR SOLDER ANY STEERING SYSTEM COMPONENT.

WARNING: MAXIMUM OPERATING PRESSURE MUST NOT EXCEED VEHICLE MANUFACTURER'S RECOMMENDED PUMP PRESSURE CAPACITY.

WARNING: ALWAYS CAREFULLY INSPECT ANY STEERING SYSTEM COMPONENT THAT MAY HAVE BEEN STRUCK OR DAMAGED DURING OPERATION OR IN AN ACCIDENT. REPLACE ANY COMPONENT THAT IS DAMAGED OR THAT IS QUESTIONABLE.

Ross extends close technical cooperation and assistance. If steering problems occur which you cannot solve, please contact our Ross Field Service Department. Our phone number and address are on the back cover of this manual

## Notes

## HGF Series Service Procedure



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