Technical Repair Guidelines for Limitorque Gear Operator Models HBC 0-10

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Technical Report

Technical Repair Guidelines for Limitorque Gear Operator Models HBC 0 through 10

This technical repair guide (TRG) for Limitorque gear operator models HBC-0 through HBC-10 is the fourth in a series of documents devoted to the comprehensive maintenance and repair of Limitorque valve actuators. This guide provides instructions for engineering, operations, and maintenance personnel on the repair, maintenance, and operation of Limitorque HBC gear operators and their accessories.

INTEREST CATEGORIES

Maintenance practices
Nuclear plant operations and maintenance
Engineering and technical support

KEYWORDS

Maintenance
Valves
Valve actuators
Maintainability
Motor-operated valves

BACKGROUND HBC gear operators are generally used on butterfly, ball, plug, or other quarter-turn valves. These units are generally installed in conjunction with electric motor-operated valve actuators. Although simple in operation, they can be misused or damaged. Because of manufacturing changes in HBCs and their spur gear adapters, a need exists for guidance on maintenance, repair, and refurbishment.

OBJECTIVE To provide instruction on operating, maintaining, and repairing Limitorque HBC actuators and their accessories.

APPROACH This guide is similar in format to the SMB series guides for Limitorque models SMB-000 (EPRI report NP-6229D), SMB-00 (report NP-6631D), and SMB-0-4 (report NP-7214). The Nuclear Maintenance Applications Center (NMAC) reviewed and collected available industry data on the repair and maintenance of Limitorque valve actuators. A draft of this guide was then sent to a group of utility maintenance personnel, Institute of Nuclear Power Operations (INPO), and NRC for review. This final publication incorporates resolution of their comments and some additional information on spare parts and certain recommended modifications received from the manufacturer.

RESULTS This guide reviews the general design and operation of the two basic HBC styles and their spur reduction gear adapters. It presents design changes, improvements, and preventive maintenance techniques. Failure mechanisms and causes are also reviewed in detail. The guide provides instructions for gear operator disassembly, inspection/repair, and reassembly procedures. Spare parts handling and storage requirements are discussed, and a listing of HBC parts is included.

EPRI PERSPECTIVE Proper valve operation provides economic benefits and reduces equipment out-of-service rates and maintenance costs. This guide reviews both proper and improper actuator operation and provides suggestions for improved maintenance.

This document is a guide and is not intended for verbatim compliances. It has been prepared to assist with the maintenance of motor-operated valves in nuclear power plants. However, the information and guidance in it can be used on any manually or motor-operated Limitorque HBC application. The material presented in this guide

also can be used in training operators and maintenance personnel in actuator operation.

This publication does not supersede the manufacturers' technical instructions but only elaborates on them to enhance the repair and maintenance capability of utility personnel. Related research includes EPRI reports NP-6229D, NP-6631D, and NP-7214.

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Abstract

This technical repair guide (TRG) for Limitorque valve gear operator models HBC-0 through HBC-10, is fourth in a series of documents devoted to the comprehensive maintenance and repair of Limitorque HBC actuators. This guide provides instructions for engineering, operations, and maintenance personnel on the repair, maintenance, and operation of Limitorque HBC gear operators and their accessories.

The guide reviews the general design and operation of the two HBC styles and their spur reduction gear adapters. It presents design changes, improvements, and preventive maintenance techniques. The guide also provides instructions for gear operator disassembly, inspection/repair, and reassembly procedure. Spare parts handling and storage requirements are discussed and a listing of HBC parts is included.

This document has been prepared to assist with the maintenance of motor operated valves in nuclear power plants. However, the information and guidance in it can be used on any manually or motor operated Limitorque HBC application. The material presented in this guide can also be used for training operators and maintenance personnel in actuator operation. This publication does not supersede the manufacturers' technical instructions but only elaborates on them to enhance the repair and maintenance capability of utility personnel.

Acknowledgements

This document was created with the help and input from many organizations, mostly utilities, where practical valve maintenance experience exists. Utilities, vendors, and service organizations provided procedures, reports and comments used m the guide's preparation. Special appreciation is given to the persons who reviewed this guide. All of them have an extensive working knowledge of valves and actuators. They are responsible for establishing the guide's scope and contents. However, most importantly, they performed the reviews ensuring the accuracy and quality.

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Introduction

Selected valves in nuclear power plants are equipped with motor actuators which are installed for both remote operation and high speed valve operation. Their proper maintenance and repair have a major impact on power plant operation. Proper valve operation provides economic benefits and reduces equipment out-of-service rates and maintenance costs. This technical repair guide (TRG) for Limitorque gear operator models HBC-0 through HBC-10 is the fourth in a series of documents devoted to the comprehensive maintenance and repair of Limitorque valve actuators. It provides instructions for engineering, operations, and maintenance personnel on the repair, maintenance, and operation of Limitorque HBC gear operators and their accessories.

This guide has been prepared to assist with the maintenance of motor operated valves in nuclear power plants. However, the information and guidance in it can be used on any manually or motor operated Limitorque HBC application. This includes fossil and hydro power stations, water plants, petrochemical plants, and process industries. The material presented in this document can also be used for training operators and maintenance personnel in actuator operation.

The guide provides general descriptions of HBC gearboxes and their operation. The process of interaction among the parts that make the mechanisms work is explained and illustrations are provided. Other sections of the guide include information on HBC unit application, design change and modifications, the four types of mechanical stops associated with HBC actuators, general name plate data, valve problems and operability, environmental qualification, general precautions, interchangeability, preventive maintenance inspection guidelines, and failure modes.

Root cause and corrective action guidelines are included in Section 13 of this document. These guidelines serve as a tool for determining failures, their causes, and the required corrective maintenance needed. Section 14 provides predictive maintenance guidelines which can be used to establish the need or to alter the time interval for preventive maintenance.

Section 15 of this guide provides general guidance for complete HBC gear actuator disassembly, inspection/repair, and reassembly. Steps are listed sequentially, illustrations are provided, and clearly marked notes give additional guidance. Material and equipment requirements are clearly defined.

The Spur and Bevel Gear Attachment chapter gives a comprehensive explanation of total spur and bevel gear disassembly. It provides separate sections, parts lists, and illustrations for single spur gear, double spur gear, triple spur gear, and bevel gear assembly and disassembly.

The final chapters of the guide include discussions of preoperational/post maintenance testing, spare parts handling and storage requirements, and HBC parts.

The Appendices augment other chapters of this guide by providing a discussion on pipe plug additions on spur gear attachments, HBC angular displacement tolerances, and lubrication amounts.

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1.0 General Descriptions

Refer to Figure 1-1.

The Limitorque HBC gearbox is primarily used for actuation of butterfly, ball, and other quarter turn valves, but may be used with dampers and other equipment which require only 90 degrees or less of operation. HBC-0 through 6 gearboxes are also available with 360 degrees of operation. Segmental gears are available for applications other than 90 or 360 degrees.

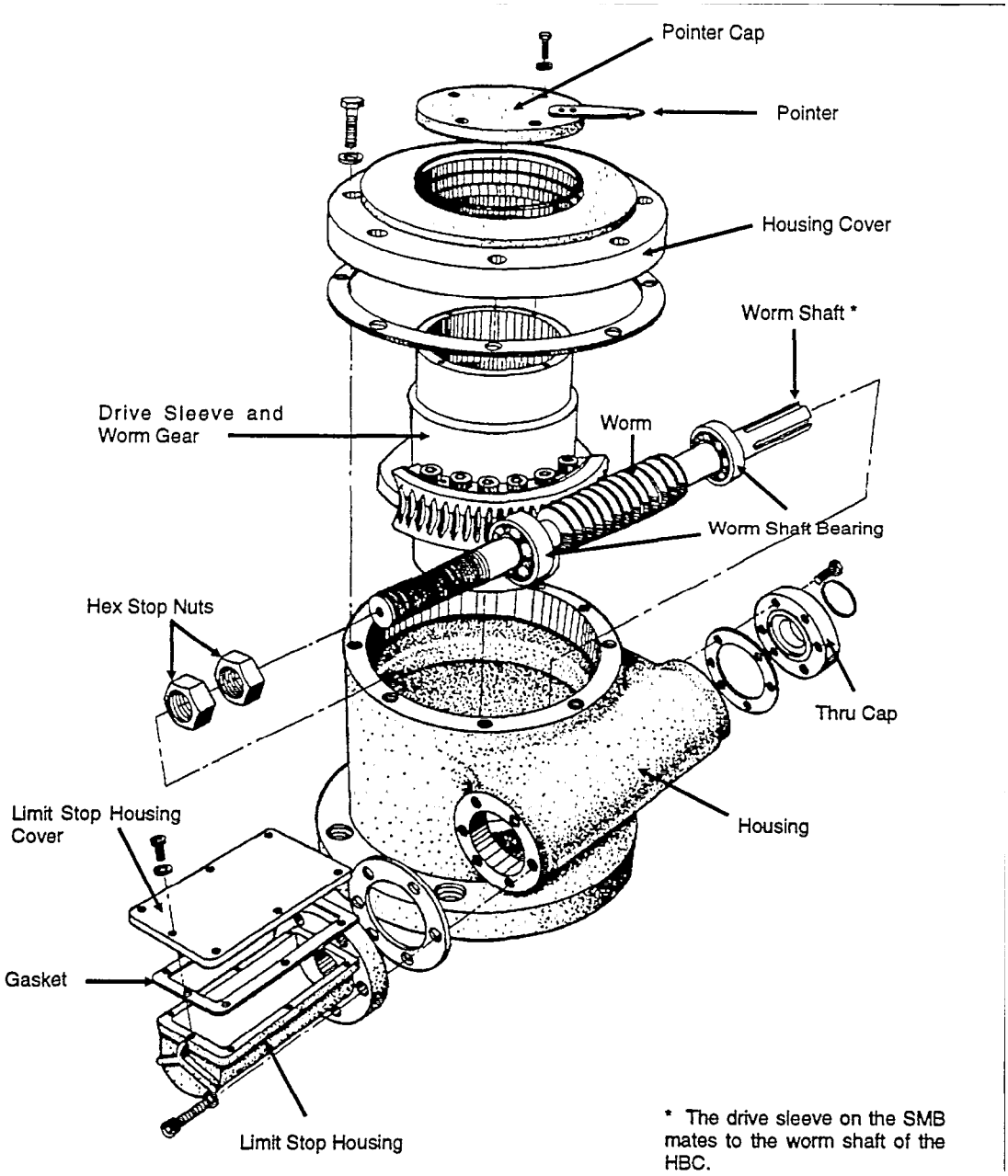


Figure 1-1

Typical HBC Actuator

The HBC gearbox may be driven either directly by a handwheel, by an actuator such as a Limitorque SMB-000 through SMB-5 unit, and manually or by motor through spur or bevel gearboxes described later.

The HBC gearboxes differ in construction depending on size and application. Sizes HBC-0 through HBC-3 are normally found with two traveling hex nuts or a single key nut being used as stops. In addition to traveling hex nuts or a key stop nut, a manual unit may be fitted with input shaft AWWA (American Water Works Association) stops which can be set very accurately.

HBC-4 through HBC-10 units have setscrew type travel stops. These stops are for over travel only and not for normal or routine travel limiting.

Manually operated gear boxes consist of two types - bevel and spur gear. Bevel drives have 2.86:1 reduction. Spur gear reduction ranges from 2.86:1 to 38.90:1. Most gear ratios in the HBC are self locking.

Manual stops are not normally designed to have Limitorque or other actuators torque out against them. Travel of most quarter turn valves is controlled based on position open and closed, although some are designed for torque control closure.

Spur gearboxes may be found attached to the Limitorque or other motor actuators behind the handwheel to assist in manual operation. In other instances the valve or HBC gearbox may be driven through a spur or bevel type gearbox.

2.0 Theory of Operation

2.1 HBC-0 through HBC-3

Refer to Figure 2-1.

The following steps describe the operation of the HBC-0 through 3 gearboxes by explaining the process of interaction among the parts that make the mechanism work:

1. The input power source is attached to the thru cap (4) and delivers power to the worm shaft (6).

2. The worm shaft (6) rotates and causes the drive sleeve and worm gear (5) to rotate.

3. Power out is via the saline adapter (7), which transfers power from the drive sleeve and worm gear (5) to the valve stem in the saline adapter. The output end of the housing (1) is attached to a valve, or other driven equipment.

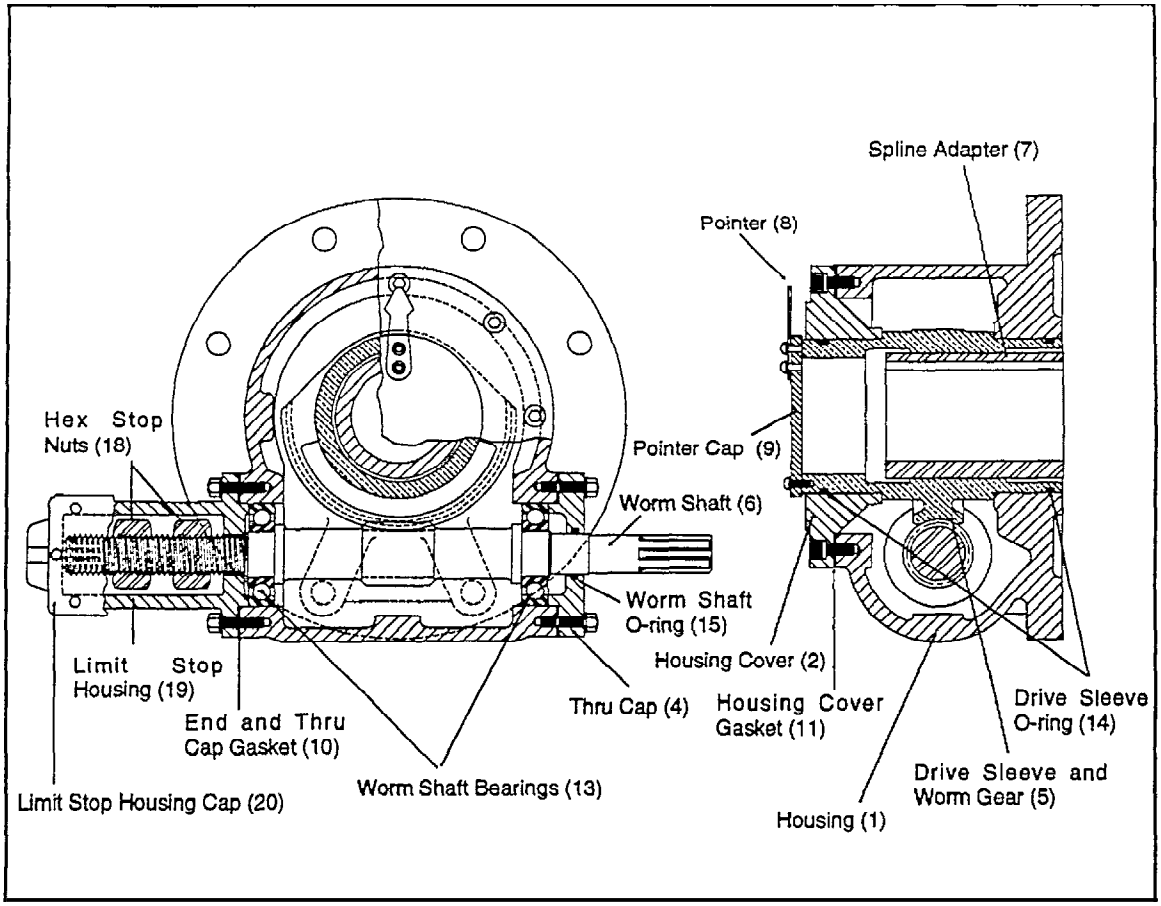


Figure 2 -1

HBC-0 through HBC-3

4. The pointer (8) is attached to the pointer cap (9) which is attached to the drive sleeve and worm gear (5). The pointer rotates with the drive sleeve and gives a visual indication of the position.

5. The worm shaft bearings (13) support and fix the position of the worm shaft (6).

6. The limit stop housing (19) locates the position of one worm shaft bearing (13) and provides stops for the hex stop nuts (18). The thru cap (4) locates the position of the other worm shaft bearing.

7. The hex stop nuts (18) are on a threaded portion of the worm shaft (6), and are prevented from rotating by the limit stop housing cap (20) which fits on the hex stop nut flats. The nuts travel backward and forward during shaft rotation.

8. The hex stop nuts (18) are positioned to jam into the limit stop housing (19) after a set amount of actuator travel - normally, one nut just after valve full open and one just after valve full close. The limit stop housing cap (20) must be removed for stop nut travel setting.

9. The drive sleeve and worm gear (5) sits on a shoulder inside the housing (1).

10. The housing cover (2) sits on a shoulder on the drive sleeve and worm gear (5). This positions the drive sleeve inside the housing.

11. The drive sleeve O-rings (14) provide seals for the drive sleeve.

12. Worm shaft O-ring (15) provides a seal for the worm shaft.

13. The end and thru cap gaskets (10) and the housing cover gasket (11) provide the remainder of seals for the HBC unit.

14. The end and thru cap gaskets (10) set the worm shaft bearing (13) preload, and the housing cover gasket (11) sets the drive sleeve preload.

2.2 HBC-4 through HBC-10

NOTE: Models HBC-8 and HBC-9 do not exist.

Refer to Figure 2-2.

Operation of the HBC-4 through HBC-10 is the same as for the HBC-0 through HBC-3 with the following exceptions:

- Stop screws (17) are long set screws. They contact the drive sleeve and worm gear assembly (6) to limit actuator or valve overtravel. (Overtravel should only occur if controls are improperly set and a control circuit failure happens, or manual operation causes excessive travel.)

- Drive sleeve bushings (12) in the housing (1) and housing cover (2) (except HBC-10) are used as drive sleeve bearing surfaces.

- Worm shafts (6) on HBC-7 and HBC-10 actuators use tapered roller bearings.

- Drive sleeves on HBC-10 actuators use tapered roller bearings.

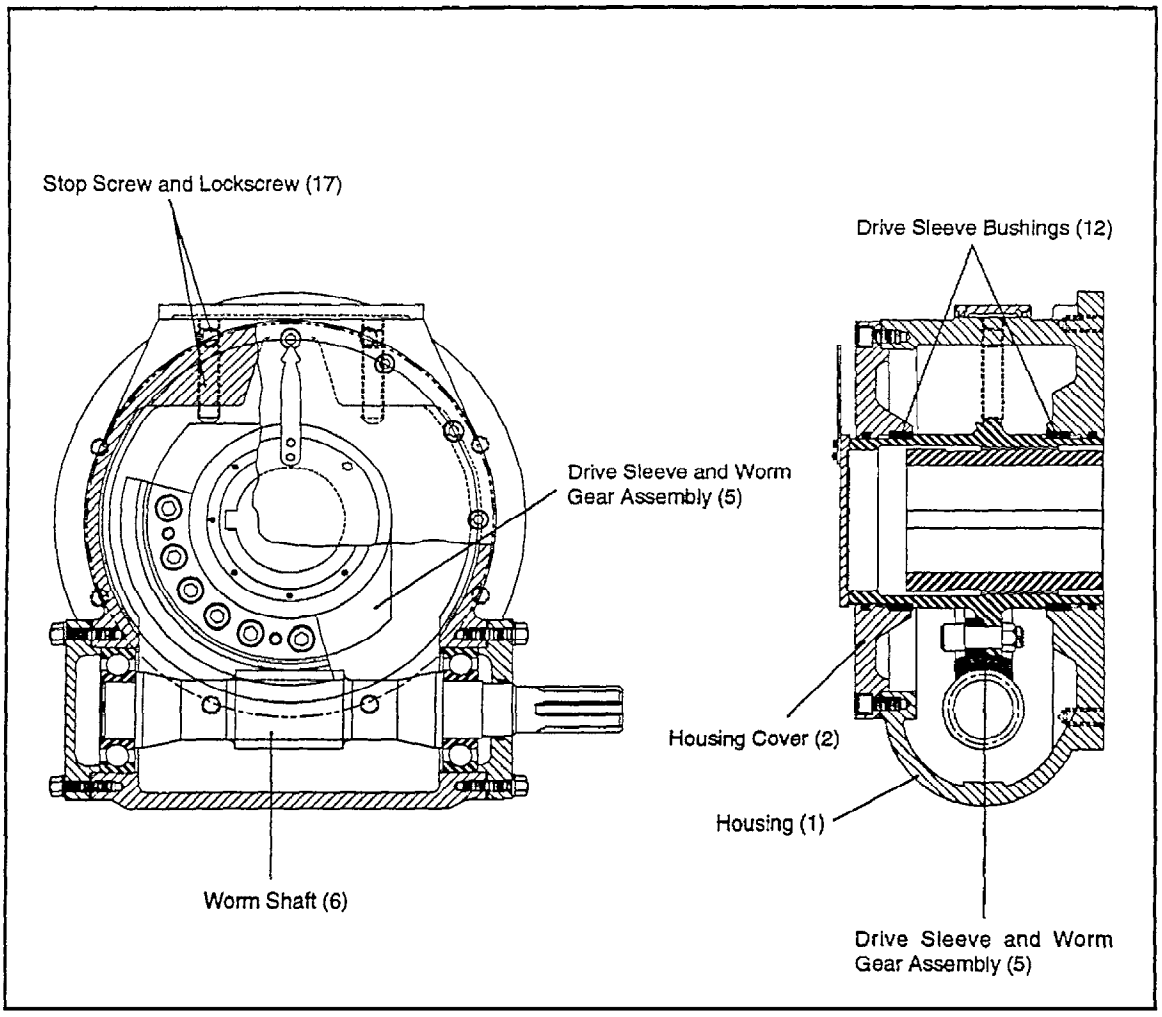


Figure 2 - 2

Typical for HBC-4 through HBC-10

2.3 Spur and Bevel Gears

2.3.1 Spur Gears

A Single Reduction

Refer to Figure 2-3.

- Gear reduction is 2.86:1.
- Input is through 1st input shaft and pinion (3).
- Pinion (3) meshes with idler (4).
- Idler (4) meshes with 1st set output gear (5).
- Output is through shaft keyed or splined to 1st set output gear (5).
- 1st set housing adapter (1) is attached to driven device.

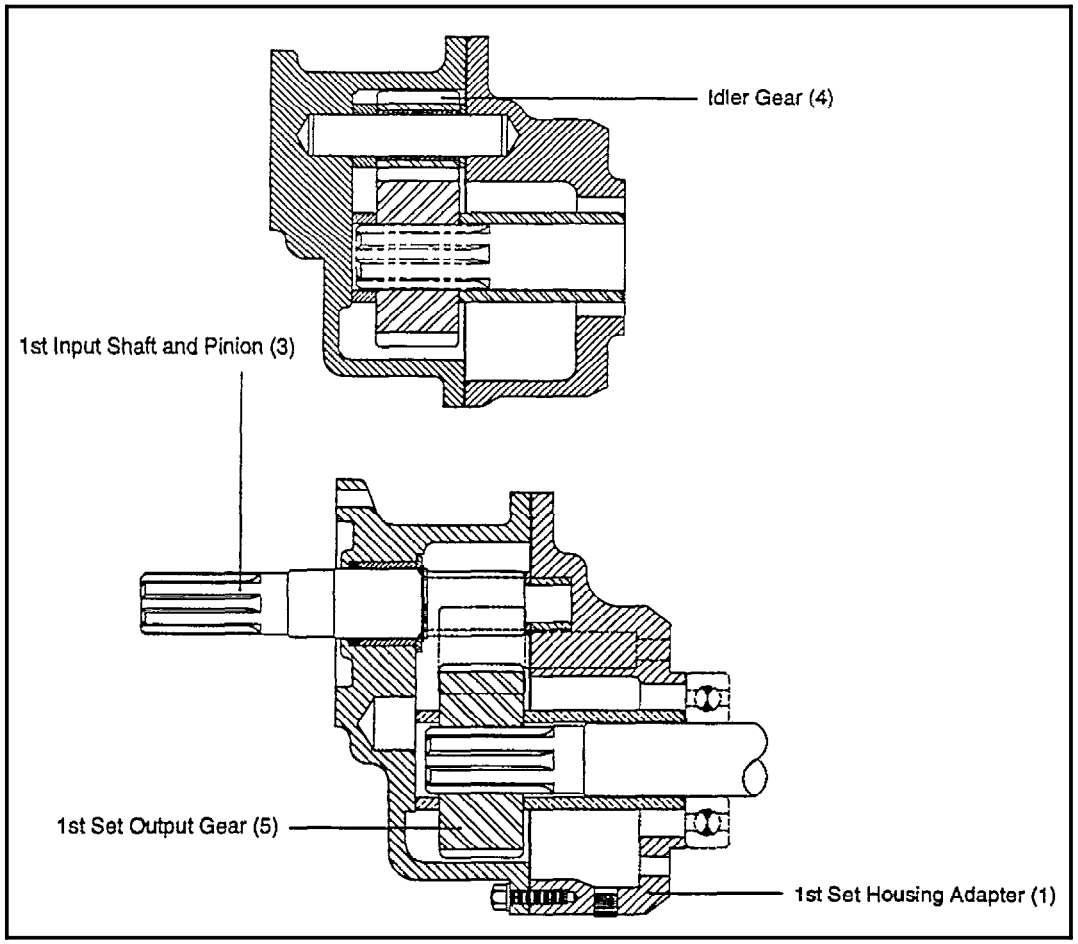


Figure 2 - 3

Single Reduction Ratio 2.86:1

B. Double Reduction

Refer to Figure 2-4.

- Gear reduction is 12.00:1.
- Input is through 1st input shaft and pinion (3).
- Pinion (3) meshes with 1st set output gear (5) (first reduction), which is on same shaft as intermediate shaft and pinion (22).
- Intermediate shaft and pinion (22), mesh with 2nd set output gear (23) (second reduction).
- Output is through shaft keyed or splined to 2nd set output gear (23).
- 2nd set housing (19) is attached to driven device.

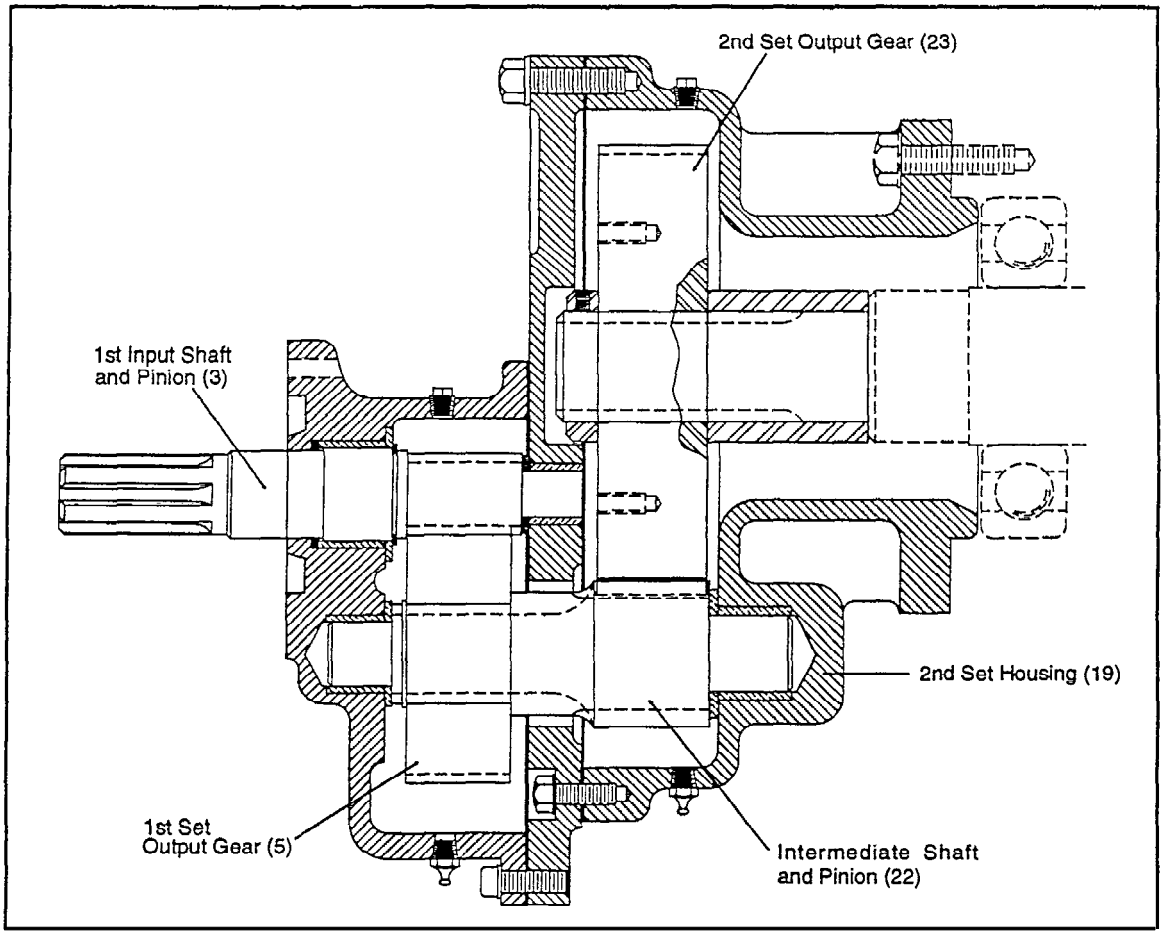


Figure 2 - 4

Double Reduction Ratio 12.00:1

C. Triple Reduction

Refer to Figure 2-5.

- Gear reduction is 38.90:1.
- Input is through 1st input shaft and pinion (3).
- 1st input shaft and pinion (3) mesh with 1st set output gear (5) (1st reduction).
- Gear on same shaft as 1st set output gear (5) meshes with 2nd set output gear (23) (2nd reduction).
- Gear on same shaft as 2nd set output gear (23) meshes with 3rd output gear (34) (3rd reduction).
- Output is through shaft keyed or splined to 3rd output gear (34).
- 3rd set housing (31) is attached to driven device.

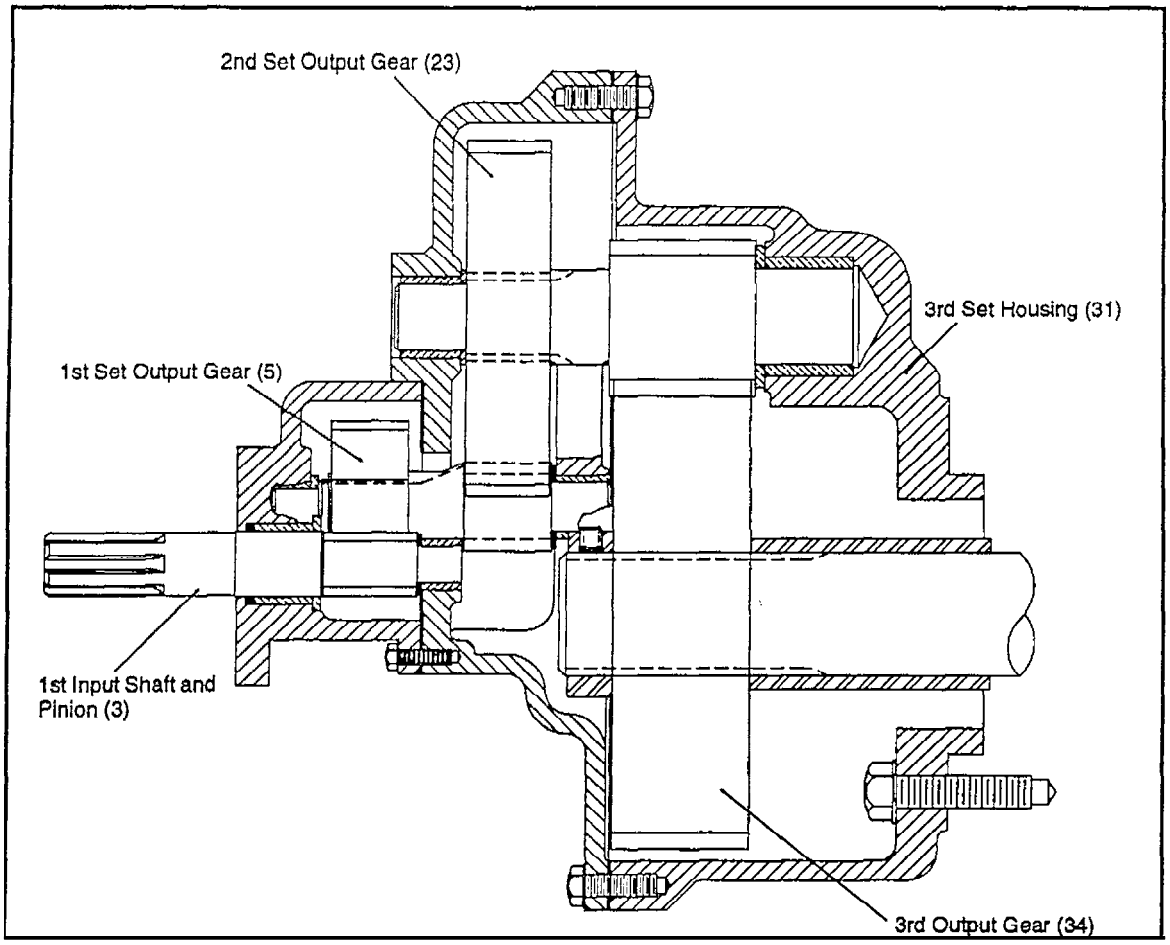


Figure 2 - 5

Triple Reduction Ratio 38.90:1

2.3.2 Bevel Gear

Refer to Figure 2-6.

- Gear reduction is 2.86:1.
- Input is through bevel pinion and shaft (44).
- Bevel pinion meshes with bevel gear (45).
- Output is through shaft keyed or splined to bevel gear (45).
- 1st set housing adapter (1) is attached to driven device.
- Bevel pinion and shaft (44) is supported by pinion shaft bearing (46) and pinion shaft bushing (47).
- Bevel pinion and shaft (44) is positioned by pinion shaft bearing (46) on shaft shoulder, and bevel pinion retaining ring (48).

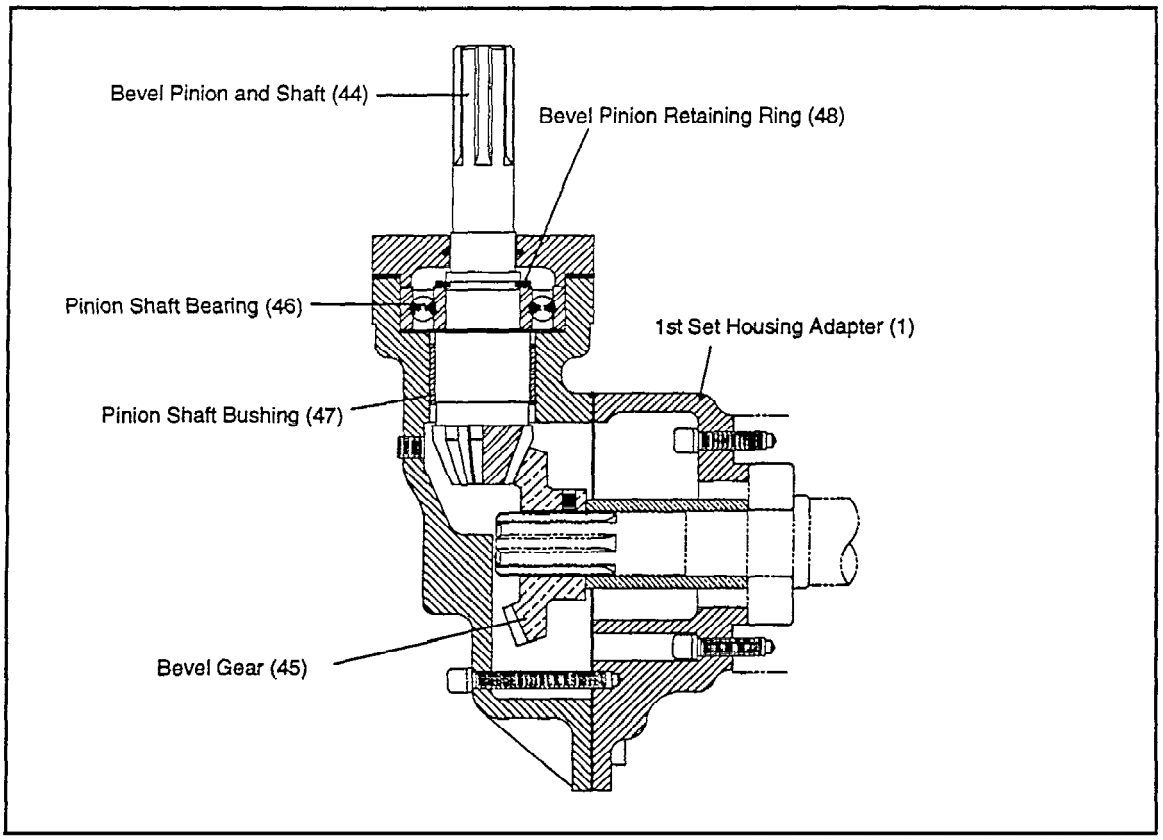


Figure 2 - 6

Bevel Gear Reduction Ratio 2.86:1

3.0 Application

HBC units are used for any valve or device which requires 90 degree rotational movement. In power plants they are normally found on butterfly, ball, and plug valves.

The HBC units can be driven directly by a handwheel, a motor actuator or other means, either directly or through spur or bevel gear attachments.

The HBC units provide additional gear reduction, 90 degree operation, and prevent valve self closure or opening due to pressure or flow induced forces.

Some HBC units can be provided with 360 degrees of rotation.

Input is through a worm to a worm gear on the drive sleeve. Output is from the drive sleeve, normally through an adapter, then into the valve shaft.

Valve position indication is provided by an arrow on top of the HBC unit. The valve position indications are not exact. The valve may be open without the pointer being centered on the indicator. The pointer does not have to be at the end of the label for the valve to be full open or closed.

Spur and bevel gearboxes are used to provide a mechanical advantage when torque requirements for handwheel drive are excessive. Spur gearboxes may be located on Limitorque motor actuators between the handwheel and motor actuator. In other cases they may be found attached to and operating the HBC gearboxes or rotary turn valves directly. Whereas the bevel gearboxes may only be used for driving the HBC gearboxes or rotary turn valves directly.

4.0 Design Change and Modification History

In 1988 Limitorque started building HBC actuators with pipe plugs installed in the housing for lubricant sampling, visual inspection and lubricant addition. Actuators built prior to this time require that the housing cover be removed for grease checking and addition.

See the Limitorque Maintenance Bulletin 92-1 for instructions on pipe plug addition to the housing for pre-88 actuators. See Appendix A for housing cover installation information.

See Appendix A for information on adding pipe plugs to spur gearboxes for grease addition and checking purposes.

Slight changes in spur reduction gear construction have also occurred. New and old unit parts may not be interchangeable.

5.0 Mechanical Stops

There are four types of mechanical stops associated with HBC actuators. Hex, key, AWWA and stop screws are described m the following sections.

5.1 Hex Nut Stops

Refer to Figure 5-1.

Hex nut stops will be found on most HBC-0 through HBC-3 size actuators. This type uses two hex stop nuts (18) which are prevented from rotating by the limit stop housing cap (20). The nuts move forward and backward on the threaded portion of the worm shaft and run into the ends of the limit stop housing (19) where they jam, preventing further rotation if overtravel occurs.

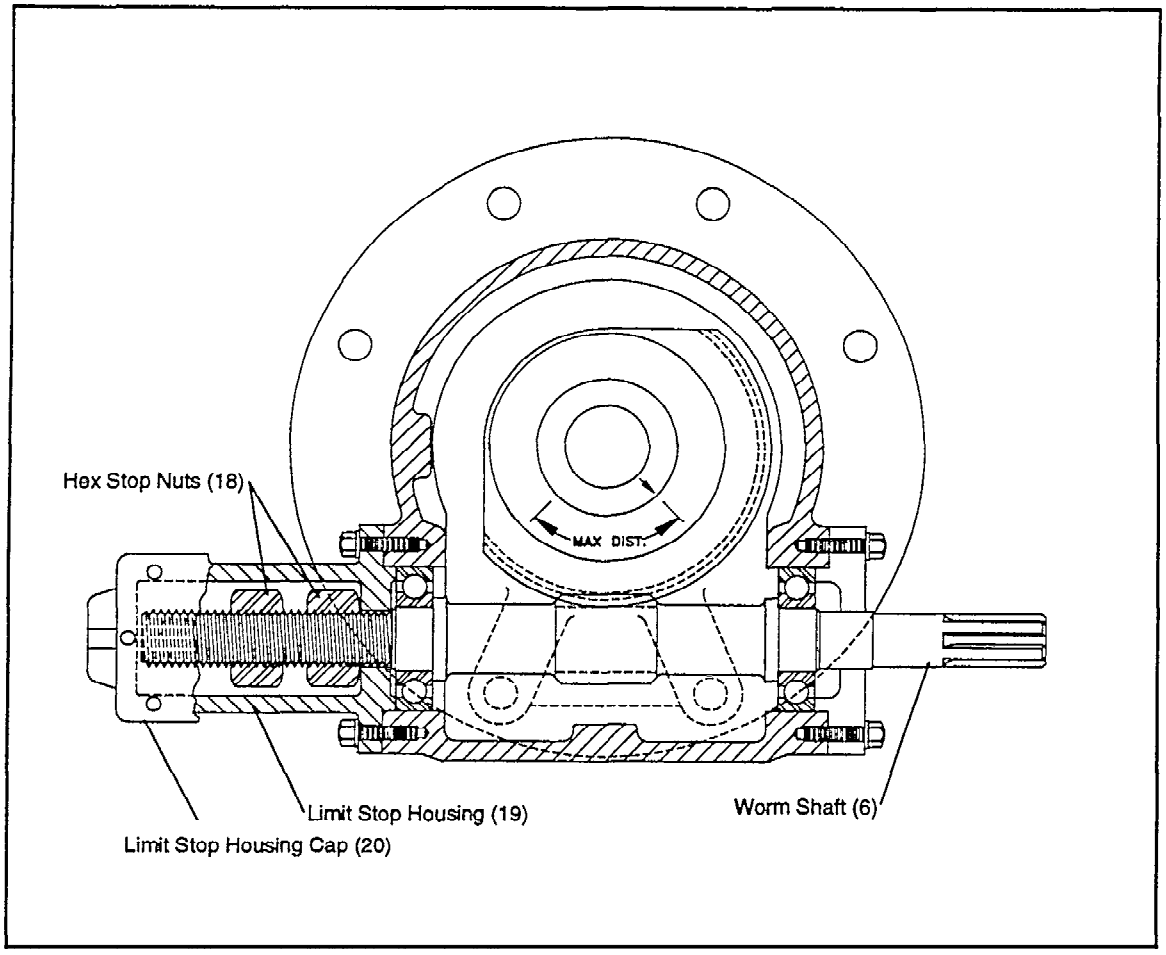


Figure 5 -1

Hex Nut Stop

5.2 Key Nut

Refer to Figure 5-2.

Key nut stops can be found on some HBC-0 through HBC-3 size actuators. This type uses one key nut which is prevented from rotating inside the limit stop housing. The key nut moves forward and backward on the threaded portion of the worm shaft where it is limited to 90 degrees of valve travel by the length of the limit stop housing and length of the threaded portion of the worm shaft.

The key nut will jam into the ends of the limit stop housing, preventing further rotation if overtravel occurs.

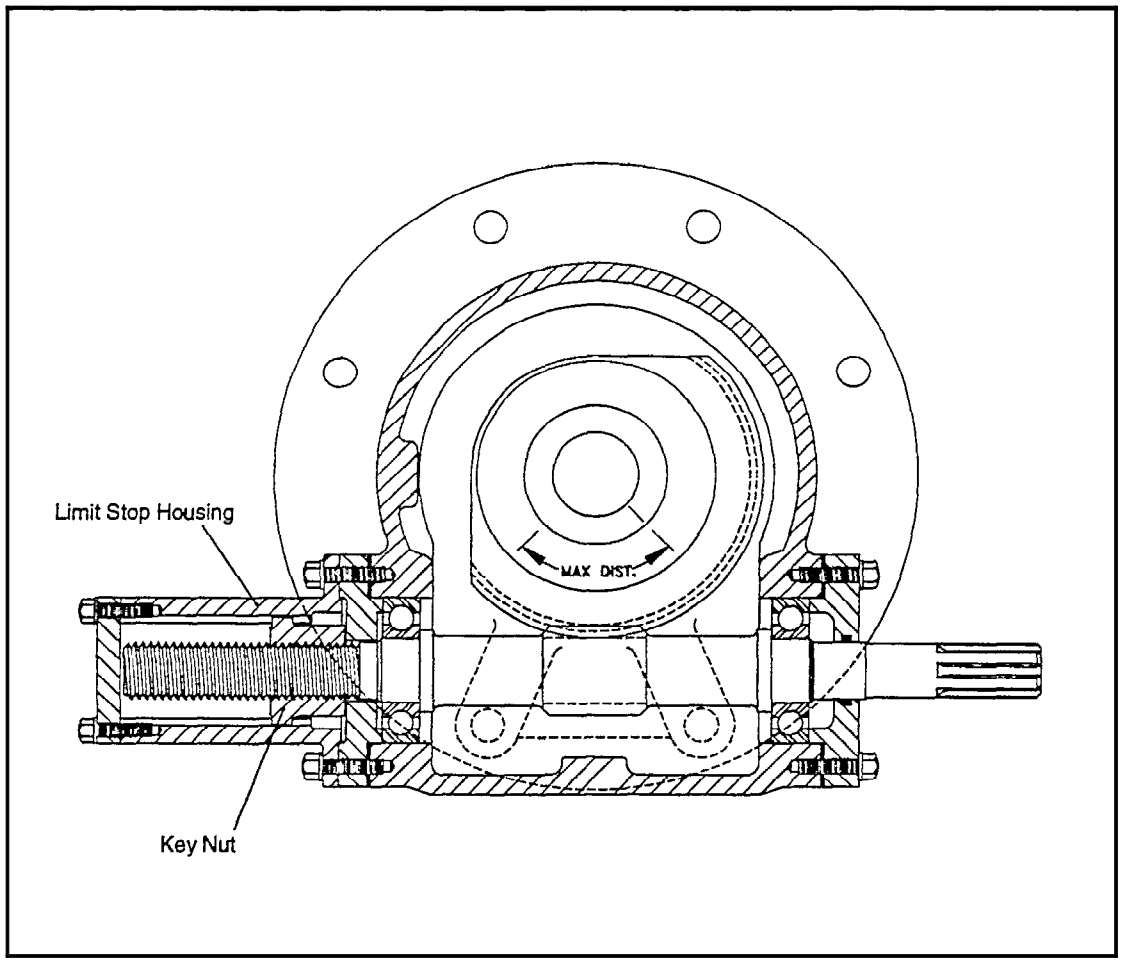


Figure 5 - 2

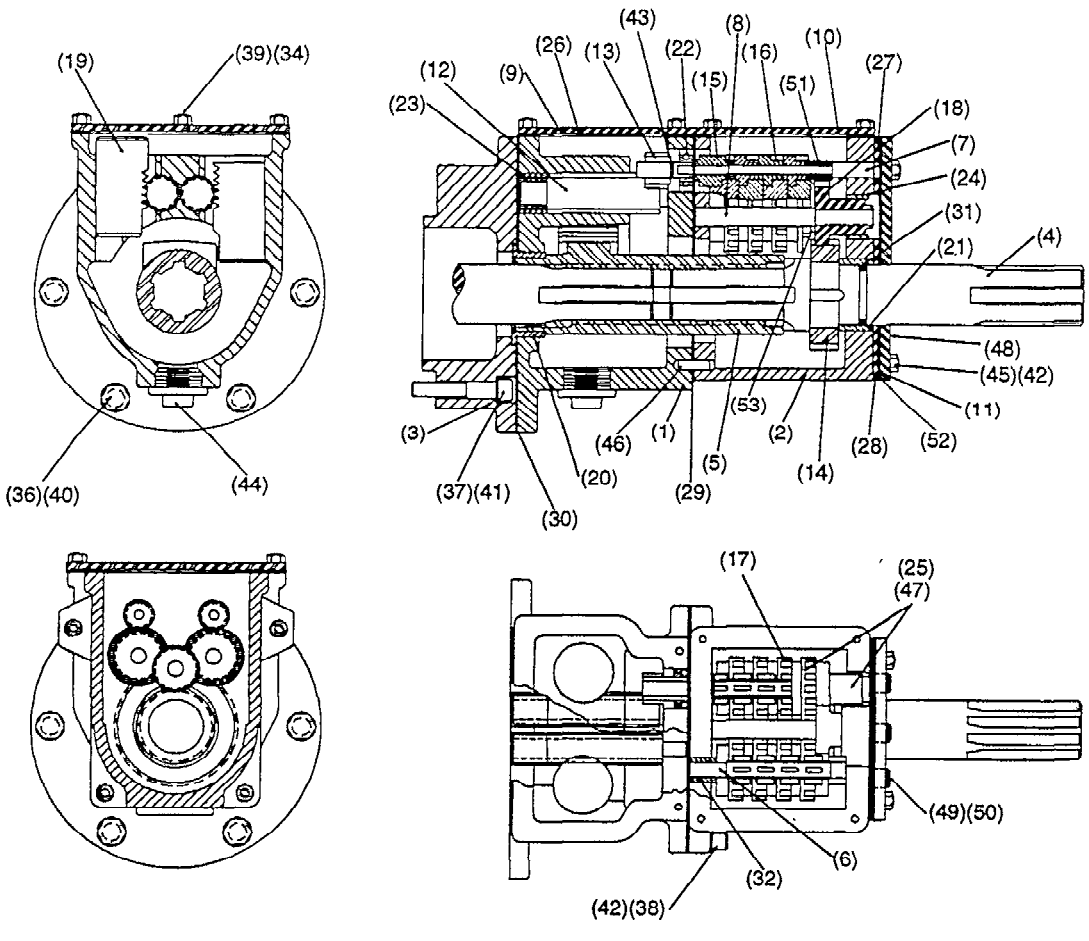
Key Nut Stop

5.3 AWWA (American Water Works Association)

Refer to Figure 5-3.

AWWA stops are found on the input shaft of their associated pieces of equipment. Very accurate settings can be made using this type of stop. When a setting is reached, a rack is driven downward where a lug splined to the input shaft strikes it, preventing further input shaft and output rotation. The normal stop used by the associated HBC actuator will probably still be installed.

The AWWA stop gearing is similar to the gearing found in the electrical limit switch gearbox of Limitorque motor driven actuators.



***Refer to Table 5-1 on page 5-4 for Parts List.**

Figure 5 - 3

AWWA Stop

Table 5-1			
Parts List for Figure 5-3			
Pc. No.	Description	Pc. No.	Description
1	Limit Stop Housing	27	Gear Frame Cover Gasket
2	Gear Frame	28	Thru Cap Gasket
3	Limit Stop Housing Adapter	29	Housing Gasket
4	Input Shaft	30	Adapter Gasket
5	Splined-Lug Sleeve	31	O-ring
6	Intermediate Gear Shaft	32	Bushing
7	Intermediate Pinion Shaft	34	Cap Screw Rd. Hd. #10-32 x 1/2" Lg.
8	Intermediate Drive Shaft	36	Cap Screw Hex Hd 5/16-18 x 1" Lg.
9	Cover (Limit Stop Housing)	37	Cap Screw Soc. Hd 3/8-16 x 1 1/2" Lg.
10	Housing) (Gear Frame	38	Cap Screw Soc. Hd 1/4-20 x 3/4" Lg.
11	Gear Frame Thru Cap	39	Lockwasher #10
12	Rack Pinion	40	Lockwasher 5/16"
13	Pinion	41	Lockwasher 3/8"
14	Input Gear	42	Lockwasher 1/4"
15	Intermediate Stem Pinion	43	Roll Pin 1/8" Dia. x 5/8" Lg.
16	Intermediate Pinion	44	1" -20 Drain Plug
17	Intermediate Gear	45	Cap Screw Rd. Hd. 1/4-20 x 1/2" Lg.
18	Idler Gear	46	Dowel Pin 1/4" Dia. x 5/8" Lg.
19	Rack	47	Input Pinion - Gear Assembly
20	Flanged Bushing	48	Gear Frame Retaining Pl
21	Input Shaft Bushing	49	1/4-20 x 7/16 Lg. Soc. Hd. Cap Scr.
22	Intermediate Stem Pinion	50	1/4 Lockwasher Hi-Collar
23	Rack Pinion Bearing	51	Pinion Spacer
24	Bushing	52	Gasket-Thru Cap
25	Input Pinion	53	Idle Gear Spacer
26	Housing Cover Gasket		

5.4 Stop Screws

Refer to Figure 5-4.

Long set screw type stop screws (17) are screwed through the body of the HBC actuator and extend inside. If overtravel occurs the stop screws contact the drive sleeve and worm gear assembly (5), limiting further overtravel. This type stop, with some differences, depending on HBC size, is found m HBC-4 through HBC-10 actuators.

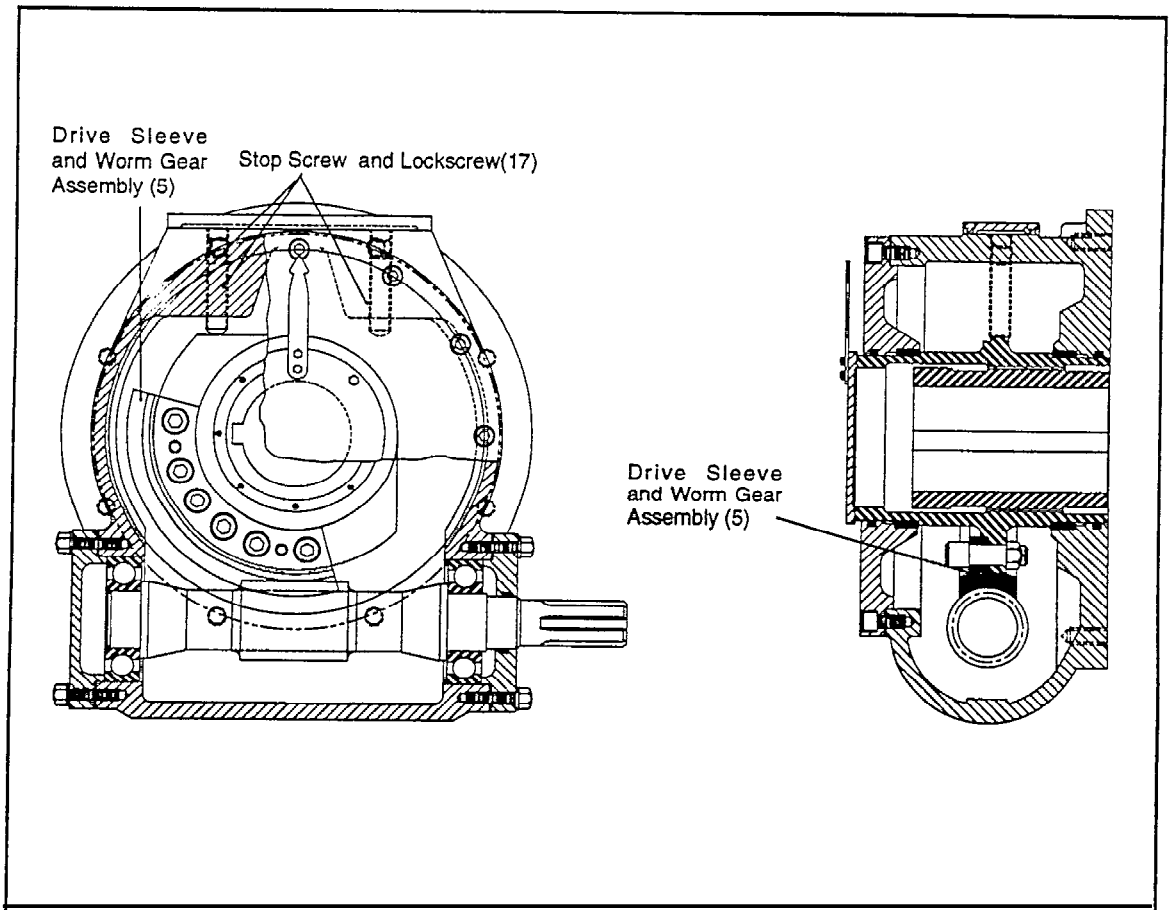


Figure 5 - 4

Stop Screws

6.0 General Nameplate Data

The Limitorque Corporation maintains records of all the actuators and gearboxes it has produced. These records are organized by the following four major categories found on the nameplate.

Type: Limitorque model number is the generic category in which the actuator belongs (e.g. HBC).

Size: The size of the actuator/gearbox is provided numerically (0, 1, 2 etc.).

Order: Limitorque purchase order number. This number is a reference that enables Limitorque Corporation to locate records and other design information regarding a particular actuator/gearbox. This number is not necessarily unique to a single actuator/gearbox. Actuators/gearboxes that have the same order number (including the suffix) should be of identical design and construction when delivered from Limitorque.

Serial Number: The serial number of the actuator is a unique number. Serial numbers are useful since they may be used by Limitorque Corporation for determining when a design change takes place, e.g., when the original type of lubricant was changed, grease plugs added.

Valve: The valve number may also be on the nameplate if designated by the utility or valve vendor documentation.

7.0 Valve Problems and Operability

Some valve problems which may affect operation of the HBC actuator are:

1. Sticking shaft or bushing

   - When shafts do not rotate freely in their bushings, an added load is placed on the HBC actuator. This problem may be caused by, but not limited to, improper assembly, improper materials, or improper usage.

     - As an example of improper material, a brass bushing might be mistakenly used instead of a polymer bushing such as Teflon.

     - For an example of improper use, see item 6 below.

2. Worn shaft or bushing

   - Over time, bushings and shafts become worn, allowing parts to become misaligned or drag.

3. Damaged shaft or bushing

   - If the shaft becomes bent or misaligned, or if the bushing is damaged drag will occur.

4. Debris in the valve

   - If debris becomes lodged in the valve, extreme operational difficulty may occur. Clams and other mollusks may be an especially difficult problem in some areas.

5. Damaged or sticking seating surface

   - If seating cannot be accomplished properly, leakage will occur. If a rubber type seat is being used and the rubber becomes loose, dragging and leakage may occur. Sticking of seating surfaces has caused operational problems.

6. Misuse of valve

   - If a butterfly valve is being used as a throttling valve where flow is excessive, vibration may cause damage to valve internals. Erosion of disc and seat is also likely.

8.0 Environmental Qualification Summary

Lubricants and seals are the only environmental concerns associated with HBC actuators and spur/bevel gearboxes.

8.1 O-Rings and Quad Rings

O-rings and quad ring seals that are used in the actuators and gearboxes are either Buna-N or Viton. Buna-N O-rings are qualified by Limitorque's outside containment reports, whereas the Viton O-rings were used by Limitorque for inside containment testing. Both the Buna-N and the Viton O-rings are black; but when purchased through Limitorque Corporation, the Viton O-rings generally have a small colored dot. This colored dot will fade with use.

8.2 Lubricants

Exxon Nebula EP-0 and EP-1 greases are the standard inside containment gear case lubricants currently qualified for use by Limitorque. HBC actuators are shipped with Exxon Nebula EP-0. Care should be taken to ensure greases from different manufacturers or with different bases are not mixed.

Appendix C shows the approximate amount of grease required for various sizes of HBC operators.

9.0 General Precautions

The following general precautions should be observed when operating or performing preventive maintenance on HBC actuators and bevel/spur gearboxes.

DO NOT attempt to disassemble any actuator or gearbox while it is under load.

DO NOT expose gears and lubricant when the surrounding environment contains excessive moisture, grit, dust, metal grindings, etc.

If working on equipment that is attached to an electrical drive, ensure that the circuit is deenergized before performing maintenance.

Ensure that adequate ventilation is available when opening the gear cases and when using a cleaning solvent.

> *NOTE: Refer to Limitorque Maintenance Update 92-1 for instructions concerning addition of grease inspection plugs to the HBC actuators.*

When obtaining grease samples, do not use hard steel tools such as screwdrivers or punches. A plastic straw, Ty-rap, clear plastic tubing, or dowel rod may be used.

Surgeon's gloves may be used to reduce personnel exposure to greases and solvents. Surgeon's gloves provide improvement over standard anti-C gloves for parts handling.

All loose parts should be controlled to prevent loss and damage.

Matchmarking of components prior to disassembly reduces the potential for errors during reassembly.

Ensure that different types of greases are not mixed if grease is added during post maintenance.

For actuators on valves which are torque closed by an actuator, ensure that the actuator as placed in a non-torqued condition prior to HBC maintenance.

> *CAUTION: Serious system and equipment damage can occur if an actuator is removed from a butterfly type valve in a system which has flow through it due to the possibility of extremely rapid valve closing and associated high pressure. Valve gagging is not recommended for this type valve due to the large shaft forces being generated and the small shaft diameter available for purchase.*

10.0 Interchangeability

HBC actuators are available with several different gearsets for each size. Some actuators may have been ordered with special attachments or construction.

To ensure that the proper parts are used when maintaining HBC actuators and spur/bevel gearboxes, it is advisable to call Limitorque with nameplate data for both old and replacement units for confirmation. If nameplate data is not available, the following items should be confirmed as a minimum:

- Units are the same physical size.
- Gear ratios are the same. Output shaft rotates the same amount for equal input shaft rotation for both old and replacement units. The number of sector gear teeth are the same on the old and new units or parts.
- Units will bolt-up correctly to both input and output devices.
- Stem and/or shaft adapters will work properly with the replacement unit.
- Keys and keyways are both the same size, shape, and configuration.

NOTE: The direction of rotation can be changed in the field with no added parts by swapping the end and thru caps and inserting the input shaft from the opposite end.

- Direction of rotation is the same for both units.

11.0 Preventive Maintenance Inspection Guidelines

Preventive maintenance is to be performed periodically; the time interval depends on the frequency and type of operation, working environment, and utility experience. The following preventive maintenance inspection guidelines aid in identifying equipment degradation.

NOTE: For more information concerning Preventive Maintenance, see "Technical Repair Guidelines for the Limitorque SMB-000 Actuator", Chapter 10 Preventive Maintenance Inspection Guidelines" (NP-6229).

1. A thorough visual inspection of the actuators and gearboxes is recommended. Any visible leaks, physical damage or other abnormalities is cause for investigation and possible corrective maintenance.

NOTE: If HBC actuators do not have grease inspection plugs, see Limitorque Maintenance Update 92-1 for housing installation instructions. See Appendix A for housing cover installation requirements. Installation requires partial disassembly.

2. It is recommended that grease samples be taken at regular intervals as determined by plant experience.

NOTE: If an actuator and its associated HBC gearbox are both regreased at the same time, grease samples from the main gearbox of the actuator may be considered as being representative of the grease in the HBC gearbox, provided there are no indications of gearbox grease deterioration or gearbox problems.

NOTE: For information concerning grease evaluation see Technical Repair Guidelines for the Limitorque Model SMB-000 Valve Actuators Chapter 13 Predictive Maintenance Guidelines".

3. If actuators and/or gearboxes have a manual drive, operate them fully if possible. Operation should be smooth with no binding, chattering, grinding, squeaking, or other noises indicating problems.

4. If manual driving is not possible, electrically operate the equipment through a full cycle if possible. Observe the operation.

5. Operation should be smooth with no vibration, chattering, squeaking, or grinding noises occurring.

6. If problems are encountered with the operation, further investigation should be initiated.

12.0 HBC Failure Modes

Some HBC actuator failure modes are categorized below. These failure modes have been obtained from NRC IE Notices, Bulletins, and Circulars, plant work orders, maintenance experiences and other miscellaneous sources. These failure modes are provided to assist in actuator troubleshooting and in the development of effective preventive and corrective maintenance programs. Once the failure mode has been determined, Chapter 13 may be used to assist in determining the root cause of the failure and the corrective action required.

1. HBC actuator fails to operate (no output movement).

   - If the actuator size is HBC-0 through HBC-3, the unit may have rotated past the mesh point of the worm/wormgear due to improper stop setting and/or improper match between the actuator and valve before installation.

   - Failure of teeth on the worm and/or wormgear on all sizes is also possible.

   - The HBC actuator must be position matched to its valve before installation i.e.: both in mid position, same end position, etc.

   - Failure of gears can be caused by extended operation with poor lubricant, excessive force caused by the use of valve handle extension bars (cheater bar) on the handwheel, or undersizing of the HBC actuator.

2. HBC unit is hard to operate.

   - This problem can be caused by the lack of lubrication, bad bearings, damaged gears or improper gaskets.

3. HBC unit will operate part way in one direction but will drive past the normal valve closed position in other direction.

   - This type of failure can occur if the actuator is not properly aligned with the valve disc at installation or if the stops are improperly set.

4. HBC unit is bound up and will not rotate in either direction.

   - Refer to Number 2.

5. The valve leaks and the HBC unit cannot be driven any farther towards closed direction.

   - Refer to Number 3.

6. Spur or bevel gearbox is hard to turn.

- Insufficient lubrication, improper gaskets, wrong thickness thrust washers, gear teeth failure, or improper assembly can cause this type failure.

7. Spur or bevel gearbox has no output when the input shaft is rotated.

   - Stripped gears are a probable cause. This can be caused by cheater bars being used on the handwheel.

   - Improper assembly.

   - HBC actuator housing cracked or end cap forced (broken) off. Excessive handwheel forces, improper set up, or improper operation can cause enough force to damage the HBC housing and/or associated components.

8. HBC actuator drive sleeve rotates m wrong direction.

   - Worm shaft was installed backwards in housing during reassembly.

   - Input to actuator will be from opposite side of housing if orientation is unchanged.

9. In HBC-4 through HBC-10 actuators, insufficient clearance between drive sleeve and stops after setting of stops, which allows contact between the drive sleeve and stop(s) during operation, causing possible overloading and

   - This condition is caused by the long set screw type stop rotating further into the gearbox after the locking set screw is run into the back of the stop, before locking is accomplished. The stop screw housing thread is a "clearance" thread which does not provide resistance to set screw rotation. The normal fix for this problem is to use a stop screw with a Nylock patch. This prevents the stop from rotating further into the gearbox when the locking set screw is run into the back of the stop.

13.0 Root Cause and Corrective Action Guidelines

With HBC actuators, spur and bevel gearboxes, failure normally requires disassembly and repair before being returned to service. There are few factors and conditions which can lead to inoperability of the HBC actuator and gearboxes. The following guideline is provided as a tool to assist in determining failures or their causes.

No guideline can be all inclusive. Proper training and experience is necessary for analyzing failures.

> *NOTE: The discussions on troubleshooting and repair assume the HBC actuator can be driven by a handwheel or some other suitable method. The handwheel may be on an SMB actuator. The hand wheel may also directly drive the HBC actuator by the input shaft or drive the HBC actuator through a bevel or spur gearbox attached to the input shaft.*

The following occurrences may be reported as failures of HBC actuators and gearboxes.

- HBC actuator fails to operate (no output movement).
- HBC actuator is hard to operate.
- HBC actuator will operate part way in one direction but will drive past the normal valve closed position in the other direction.
- HBC actuator is bound and will not rotate in either direction.
- The valve leaks and the HBC actuator cannot be driven any farther towards the closed position.
- The spur or bevel gearbox is hard to turn or the handwheel turns with no output.

The following data can be collected to help determine the cause of failure:

- Observations of the personnel involved.
- Preoperational/post-maintenance testing failure analysis discussion.
- Safety class and category of the HBC actuator.
- Type of lubricant in the HBC actuator.
- Date that the lubricant was last checked or changed.
- Pertinent environmental conditions (temperature, vibration, etc.).

- Operating frequency.
- Date and conditions under which the valve was last operated. (flow, pressure, temperature et.)
- History of failures.
- Recently performed maintenance.

This data and the troubleshooting guidelines can be used to assist in the determination of the root cause failure of the equipment and the required corrective maintenance.

13.1 HBC Actuator Has No Output

The following steps may be used to determine cause when the HBC actuator has no output when the input shaft has input.

If disassembly and reassembly are required, locate the instructions in proper chapter in this manual.

1. Rotate the HBC actuator input shaft while viewing the pointer on the HBC actuator.
2. If there is no corresponding drive sleeve movement when the worm is rotated, the worm/wormgear has become separated probably due to one of the following:
   - The wormgear has rotated past the point of worm contact (HBC-0 through HBC-3 only).
   - Teeth are broken on the worm and/or wormgear.
   - Worm is broken.
3. Place the HBC actuator in position for partial disassembly to determine the cause of failure.
4. Remove the pointer cap.
5. Remove the housing cover.
6. Inspect for the following
   - Broken teeth on the worm and wormgear.
   - If it is an HBC-0 through HBC-3 check to see if the wormgear has rotated out of contact with the worm.
   - Broken worm.

7. If teeth and/or worm are broken, disassemble as required, replace broken components, and reassemble.

8. If the drive sleeve and wormgear have rotated out of mesh with the worm (HBC-0 through HBC-3 only) check for the following:

   - Improper set up when the HBC actuator was last installed.
   - The HBC actuator is improperly matched to the valve.
   - Hex stop nuts are incorrectly set.
   - Missing hex stop nut(s).

9. If the actuator was not matched properly with the valve, it will have to be removed, positioned correctly, and reinstalled.

10. If the hex stop nut(s) was missing, replace and reset.

11. If the hex stop nuts were improperly set, reset.

13.2 HBC Actuator is Hard to Operate

1. If the actuator is mounted on a valve, eliminate the valve as a cause of the problem if possible. This may require HBC removal from the valve with minimal disassembly, then operating the HBC unit alone after removal.

2. If the actuator is still hard to operate, causes may be as follows:

   - Hard grease.
   - Incorrect gasket thickness.
   - Damaged components.

3. Incorrect gasket thickness can be checked by loosening the end cap and housing cover bolts slightly while checking the operation of the actuator. If thin gaskets are found, replace with gaskets of proper size.

4. To check grease in the main housing, the housing cover must be removed if the actuator has not been modified by the addition of grease plugs. End cap(s) may be removed and the bearings checked. Also check the condition of the worm/wormgear while the housing cover is off.

5. Replace damaged components if required.

13.3 HBC Actuator Will Operate Part Way In One Direction But Will Drive Past the Normal Valve Closed Position in the Other Direction

NOTE: All HBC actuators may not have the index mark on top of the d rive sleeve. If the index mark is not there, the housing cover may have to be removed.

NOTE: Most, but not all, butterfly type valves have a line or some other marking on either the driven or undriven end of the shaft which indicates the valve position. If an indicator mark is not present, it is recommended that one be added when appropriate.

1. Remove the pointer cover from the HBC actuator and by use of the index mark on top of the drive sleeve and the position of the housing cover fastener heads, place the actuator either in mid or full open/full close position.

2. Check the valve position against the HBC actuator position.

3. If the valve is not in the same position as the actuator, the actuator was not installed properly. Remove the HBC actuator, realign the actuator to valve adapter, if required, re-adjust the actuator and reinstall.

4. If the valve and actuator are lined up, check the stops. If the stops are improperly set, reset them.

13.4 HBC Actuator is Bound Up and Will Not Rotate Either Direction

1. If the valve cannot be dismissed as part of the problem, the HBC actuator or adapter will have to be removed.

2. Loosen the fasteners on the housing cover, end cap and thru cap.

3. Attempt to drive the HBC actuator.

4. If the problem can be located, repair it.

5. If the HBC actuator does not loosen, remove the pointer cap and housing cover. Remove grease as required.

6. Attempt to rotate the worm/wormgear, the problem should be evident.

7. Repair.

8. Brass and soft metal components that interface with hardened or forged steel components under heavy load conditions are almost always the components that indicate signs of wear or failure.

   The only brass component normally found in an HBC actuator is the worm gear.

13.5 Spur or Bevel Gearbox is Hard to Turn or the Handwheel Turns With No Output

1. If the gearbox is hard to turn, check the condition of the grease.

   - To check grease in the spur gearboxes, if grease plugs have not been installed as shown in Appendix A, it is necessary to remove the handwheel or other input device, then remove the first set housing.

   - To check grease in the bevel gearboxes, remove the grease fitting on top of the housing.

2. If the grease is hard, disassemble the gearbox, clean, relubricate and reinstall.

   Brass and soft metal components in the gearbox which might fail are:

   - Thrust bearing

   - Bearings

   - Bushings

   Failure of these components is normally caused by pieces of gears after gear failure.

3. If the handwheel turns with no output from the gearbox, disassemble and repair.

NOTE: Stripped gears are possible when input force is excessive. This condition may be accompanied by a grinding noise.

13.6 Lubricant Failure

Actuator and gearbox failure can occur due to improper lubricants or mixed lubricants being used. Never mix lubricants from different manufacturers, or those with different bases.

If possible, include HBC actuators and spur and bevel gearboxes m your grease sampling program. Use plant experience and guidelines to determine proper frequency.

NOTE: If an actuator and its associated HBC gearbox are both regreased at the same time, grease samples from the main gearbox of the actuator may be considered as being representative of the grease in the HBC gearbox, provided there are no indications of gearbox grease deterioration or problems with the gearbox. This is a conservative approach as long as the HBC gearbox as not overloaded, since the gearbox contains a large amount of grease and the worm operates so slowly.

NOTE: HBC actuators built prior to 1988 did not have pipe plugs installed. See Limitorque Maintenance Bulletin 92-1 for installation instructions for the older ver- sions. See Appendix A for information on installation of the pipe plugs in the housing cover as an alternate location.

14.0 Predictive Maintenance Guidelines

NOTE: For added information on predictive maintenance see the "Technical Repair Guidelines for the Limitorque Model SMB-OOO Valve Actuator" Chapter 13 "Predictive Maintenance Guidelines"

Predictive maintenance may be performed periodically with the time interval depending on the frequency of operation, working environment, severity of usage, and plant experience. Results of predictive maintenance may be used to establish the need or to alter the time interval for preventive maintenance.

1. If the HBC operator is being used with a motor actuator, a diagnostic program such as VOTES or MOVATS may show the abnormalities of the HBC actuator on the current, power, or other relevant traces.

2. Routine visual inspections are recommended. Check for damage and grease leakage.

3. Grease sampling for the HBC actuators and spur/bevel gearboxes IS an excellent practice for predictive maintenance. If the HBC actuators do not have pipe plugs installed, see the Limitorque Maintenance Update 92-1 for pipe plug installation in the housing. An approved alternate location is the housing cover. See Appendix A for information. Without pipe plugs, partial disassembly is required for sampling. Spur gearboxes require partial disassembly for grease sampling unless fitted with grease flush ports. For guidance on installation of ports, see Appending A of this manual.

4. If a spur or bevel gearbox is installed, operate the valve or equipment fully if possible. The gearbox should operate quietly and smoothly.

5. Refer to the reference listed in the note for grease evaluation.

15.0 Disassembly, Inspection / Repair, and Reassembly

NOTE: There are no HBC-8 or HBC-9 actuators.

NOTE: Thread-locking compound may be used for additional fastener and key security. Limitorque uses Loctite 242. One or two drops of Loctite is enough.

NOTE: Asterisked steps identify subjective or quantitative acceptance criteria. Ensure that the site requirements concerning data recording are met when implementing on-site procedures.

NOTE: The phrase "blocked/safety tagged is used in various places in this section. This phrase means the equipment has been placed in a ready-for-maintenance condition according to plant procedures. This condition is called Cleared/tagged out" at some plants. In some cases equipment can still be energized during performance of the maintenance activity.

NOTE: All piece numbers except numbers for HBC-10 are taken from Limitorque Type HBC Instruction and Maintenance Manual (Bulletin HBCI - 90). Piece numbers for HBC-10 are taken from Drawing 01440-01984.

15.1 Total HBC Gear Actuator Disassembly Guidelines

This general guidance IS for complete SC GEAR ACTUATOR disassembly and re-assembly. Disassembly of some subassemblies is not recommended unless needed. Label all parts or store them in a labeled container as they are removed to prevent loss.

NOTE: Spur and bevel gearboxes may be mounted either directly on valves or on manual HBC actuators. Spur gearboxes may also be mounted on Limitorque motor actuators directly behind the hand wheel

NOTE: Ensure that the equipment is Blocked Safety tagged and the crew has Operation's permission before starting any work.

NOTE: Some repairs on HBC actuators and spur and bevel gearboxes may be performed while they are still installed. This procedure is written for complete teardown and rebuild.

1. Determine the required work support equipment needed (e.g., temporary lighting, scaffolding).

2. Determine and position suitable rigging, including transport equipment needed, if removing the HBC actuator to a separate rebuild area.

3. Remove external connections (e.g., supports, etc.) as required.

NOTE: Spur and bevel gearboxes generally must be disassembled for removal from associated equipment.

4. Remove the type SMB Limitorque Actuator from the type HBC actuator using the proper procedure, if required.

5. Remove the HBC actuator from the valve.

6. Move to the rebuild area, if required.

7. Disassemble the HBC actuator. Disassemble the spur or bevel gearbox, if used.

8. Clean and inspect all parts.

9. Replace or repair the parts as necessary.

NOTE: Hand pack all bearings with grease before reassembly. Do not depend on the actuator or gearbox fill to grease the bearings.

NOTE: When returning worn parts to service, carefully evaluate and document their condition. They should be serviceable to the next scheduled maintenance inspection. This helps prevent unanticipated corrective maintenance.

10. Reassemble the actuator (and gearbox if used).

11. Preinstall the HBC actuator on the valve.

12. Reinstall the SMB actuator if required.

13. Reinstall the external connections, if required.

14. Perform the required adjustments, post-maintenance testing, and any required work.

15. Remove temporary work support equipment.

15.2 Notes and Precautions

NOTE: When replacing parts affecting the worm-to-worm gear alignment (e.g., drive sleeve, housing, worm, worm gear) or when the worm gear mesh is suspect, a blue check should be performed.

NOTE: All parts, lubricants, fluids and cleaners should be approved for use on the site. Inclusion of the site material code numbers in site procedures material lists is recommended. All this material and equipment will not be required for every job. Experience will provide guidance on what is actually required.

NOTE: Viton O-rings and quad rings are identified with a red paint dot. With time this dot may fade to a pinkish or orangish color.

PRECAUTION: On larger actuators, parts can be very heavy. are should be taken in selecting work tables and equipment to ensure the weight can be properly supported.

15.3 Material Requirements

- Tags and/or containers for parts
- Penetrating oil
- Disassembly table/platform
- Solvent container
- Anti-seize compound
- Cleaning solvent
- Clean lint-free cloths

- Emery cloth
- Metal scouring pads
- Brushes (soft-bristle, stainless steel or bronze)
- Seal and gasket replacement kit (if required)
- Thread-locking compound

NOTE: Limitorque Maintenance Update 92-1 lists information concerning non-asbestos gasket material.

- Gasket material, 1/32" thickness (also 1/64" and 1/16" if required)
- Parings for worm shaft and drive sleeve
- Bags or containers for grease removal
- Replacement grease

15.4 Equipment Requirements

- Bronze drift pin or soft metal punches
- Hammer (lead, wood, leather, or phenolic)
- Long and short hex key wrench set (ball driver and t-handle wrench sets are useful)
- Honing stone
- File set
- Feeler gauges
- Cold chisel, diamond point (alternate: prick punch)
- Drill bits (set)
- Electric hand drill
- Scribe or pin punch
- Small retaining ring pliers (external and internal)
- Bearing puller (alternate: arbor press, for bearing removal/installation)

- Inside micrometers (0 to 3 inch)
- Outside micrometers (0 to 1 inch, 0 to 3 inch)
- Small magnet
- Vernier caliper (0 to 3 inch)
- Brass rod 1/2 inch x 12 inch
- Thin 8-inch slot screwdriver
- Combination wrench set
- Large slot screwdriver
- Strap wrench
- Rigging equipment, as required
- Housing cover rigging lift adapter
- Scraper

15.5 HBC Gear Actuator Removal

Refer to the proper section of this manual for HBC drawing.

NOTE: By match marking pieces of the gear actuator before removing and d wring tear down, then assembling and installing with the match marked pieces matched, the actuator and valve should be properly matched after installation.

1. Establish a work area.
2. Set up scaffolding and temporary lighting as required.

NOTE: See EPRI SMB-000, SMB-00, or SMB-0 through 4 manual, as appropriate, for Limitorque actuator removal procedure if needed.

3. Determine the rigging and transport equipment needed.
4. Remove lifting or transportation interferences.
5. Verify special tool availability.

NOTE: Due to the operational characteristics of the quarter turn valve, proper orientation of the HBC actuator with the valve d wring installation will be much easier if the valve is placed in the full open or full closed position before HBC removal.

6. Ensure that the valve is m the fully open or fully closed position.

7. Record the valve position.

   *Valve Position _____

   Ensure that the valve position can be determined after HBC removal by use of other appropriate means.

NOTE: Ensure the HBC and valve mounting flanges are match marked before HBC removal.

NOTE: The pointer (8) can be oriented in several different directions on the drive sleeve and worm gear fix).

8. Using a center punch, match mark the pointer cap to drive sleeve location, and pointer cap to housing cover location.

9. Remove the fasteners and washers holding the pointer cap (9) in position. Refer to Figure 15-1.

10. Remove the pointer cap (9) and wipe clean.

11. Examine pointer cap (9) for any unacceptable damage or wear.

12. Using a center punch, match mark the splined shaft adapter (7) and the drive sleeve and worm gear (5).

13. Using a center punch, match mark the splined shaft adapter (7) to the valve shaft.

14. Using a felt marker, match mark the top of the drive sleeve and worm gear (5) to the housing cover (2) location.

15. Using a center punch, match mark the housing cover (2) to housing (1) location.

16. Remove the SMB actuator from the HBC actuator, if required. If a spur gear attachment is between the SMB actuator and HBC actuator, it must also be removed.

17. For HBC-10 only, the following items must be removed and match marked m the following order:

    - Pointer
    - Dial cover
    - Housing cover thru cap
    - Indicator pedestal

    After removal and match marking of the above, the HBC actuator to valve stem adapter may be match marked to the drive sleeve and worm gear (5) and valve stem.

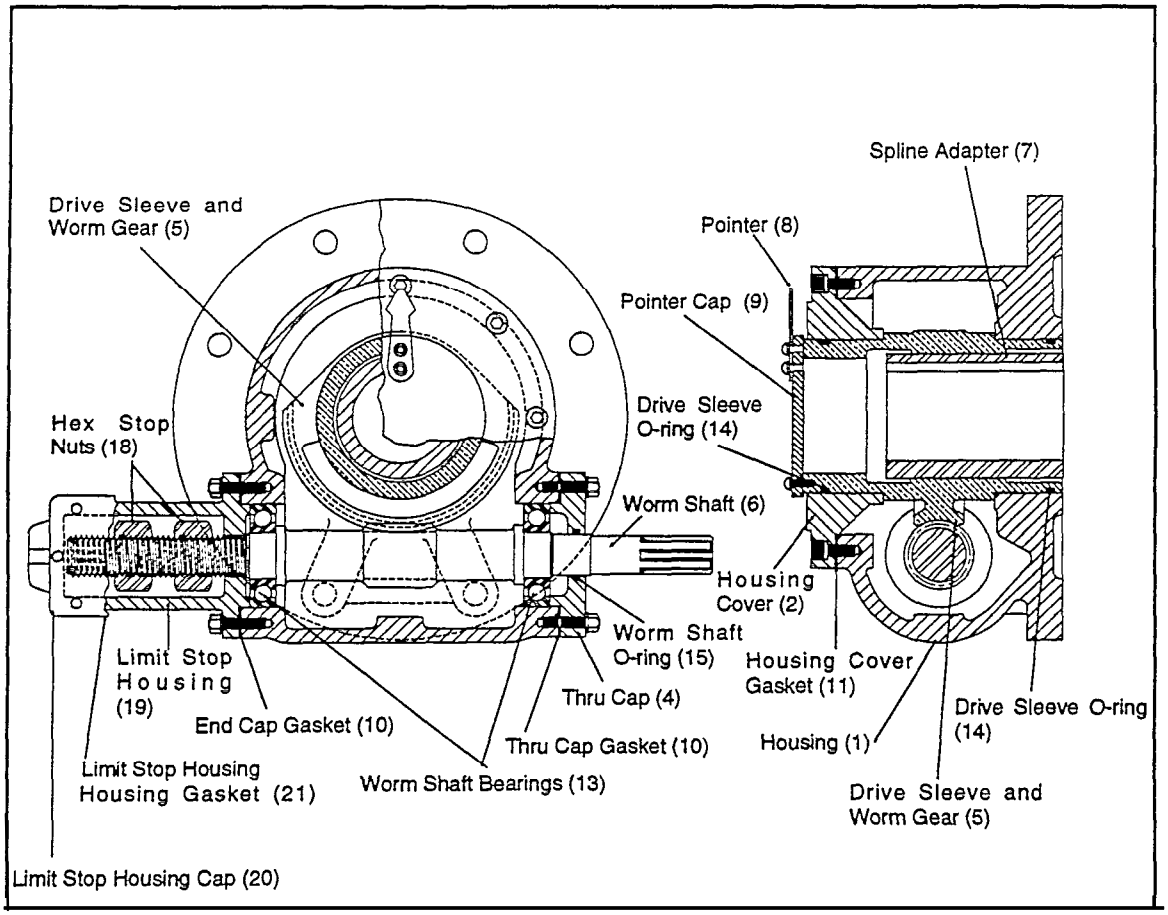


Figure 15-1
HBC-O through HBC-3

18. Remove any adapter plates which may be mounted to the valve stem which prevent HBC removal.

19. Install the lifting equipment and take up the slack.

20. Remove the key from the valve adapter and store, if used.

21. Carefully remove the HBC actuator to valve mounting fasteners and store.

22. Carefully remove the HBC actuator from the valve stem.

23. Transport the actuator to designated work area, if required.

15.6 Disassembly of HBC-0 through HBC-3 Gear Actuator

Refer to Figure 15-1.

NOTE: All parts should be inspected, properly tagged, and stored after removal.

1. Remove the limit stop housing cap (20) and the limit stop housing gasket (21).

2. Using the splined end, rotate the worm shaft (6) clockwise until the drive sleeve stops turning. This separates the worm shaft (6) from the drive sleeve and worm gear (5).

3. Remove the pointer cap (9) (if required), housing cover (2) and housing cover gasket(11). Record gasket thickness.

   *Gasket Thickness _____

4. Remove as much grease as possible using spatulas, scrapers, or other appropriate instruments and dispose per plant procedures.

5. Remove the hex stop nuts (18) and limit stop housing (19) with the end cap gasket (10). The limit stop housing (19) has to be removed with hex stop nuts (18) due to the hex stop nuts not having room to come off the worm shaft (6) while the limit stop housing (19) is still installed. Rotation of the worm shaft (6) or stop nuts IS required to disengage the hex stop nuts (18) from the threaded portion of the worm shaft (6). Record gasket thickness.

   *Gasket Thickness _____

6. Match mark the thru cap (4) to the housing (1). This ensures proper assembly since the worm shaft can be installed in either direction through the housing (1) to change worm shaft rotation for open and closed.

7. Remove the thru cap (4) with the thru cap gasket (10). Record gasket thickness.

   *Gasket Thickness _____

8. Remove the worm shaft O-ring (15) from the thru cap (4).

9. Remove the worm shaft (6) by pulling from the housing (1).

   It will be necessary to rotate slightly, or cock the drive sleeve and worm gear (5) away from the worm shaft (6) to allow the bearing to clear.

   It IS not necessary to remove the worm shaft bearings (13) from the worm shaft (6).

10. Remove the drive sleeve and worm gear (5) from the housing (1).

11. Remove the remainder of the grease and dispose per plant procedures.

12. Remove the drive sleeve O-rings (14).

13. Clean the interior of housing with approved solvent and wipes or by solvent immersion.

14. Clean all gasketed surfaces.

15. Clean and inspect all parts for wear and damage. Record findings.

15.7 Disassembly of HBC-4 Through HBC-6 Gear Actuator

Refer to Figure 15-2.

NOTE: All parts should be properly stored after removal.

NOTE: Stop screws on HBC-6 gear actuators have a pivoting cap on the end instead of being solid like HBC-4 and 5 units.

1. Remove the stop screw cover (16).

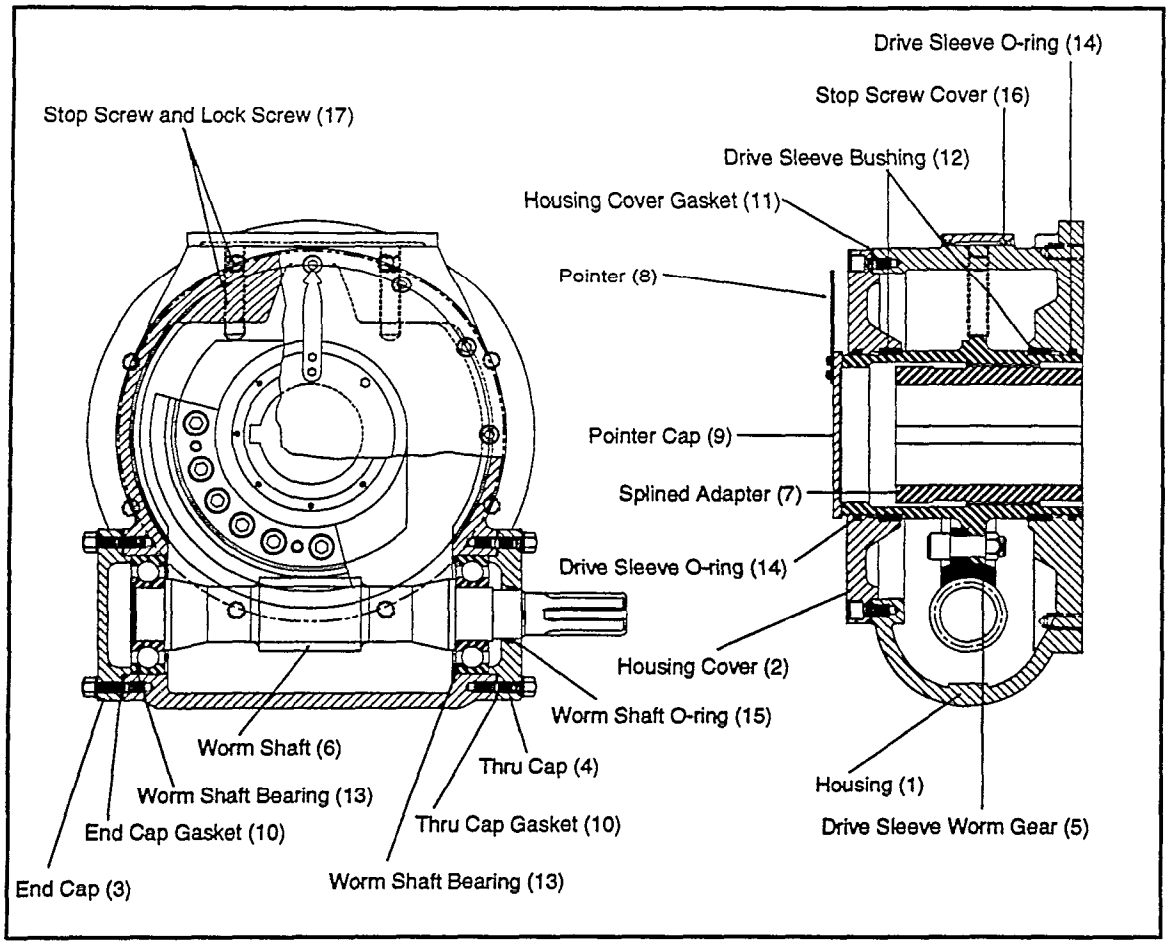


Figure 15 - 2
HBC-4 through HBC-6

2. Remove the stop screws and lock screws (17).

NOTE: It is not possible to run the worm shaft off the worm gear. The drive sleeve will strike the housing first.

3. Using the splined end, rotate the worm shaft (6) m a clockwise direction until the worm shaft can no longer be turned.

4. Match mark the end cap (3) and thru cap (4) to the HBC housing (1).

6. Remove the end cap (3) and thru cap (4) with gaskets (10). Record gasket thickness.

*Gasket Thickness - End Cap _____

*Gasket Thickness - Thru Cap _____

6. Remove the worm shaft O-ring (15) from the thru cap (4).

7. Remove the pointer cap (9), if required, and the housing cover (2) with the housing cover gasket (11). Record gasket thickness.

*Gasket Thickness _____

8. Mechanically remove as much grease as possible and place it in a proper container.

CAUTION: Do not allow the worm shaft to drop abruptly as the shaft bearing clears the actuator housing during Step 9.

9. Remove the worm shaft(6) from the housing (1).

Rotate the worm shaft (6) by hand, such that it emerges through the end cap opening until the worm shaft bearing (13) at that end of the shaft just clears the housing (1). Allow the end of the worm shaft (6) to drop when the bearing clears the opening and leave the shaft in this position in the housing (1).

10. Lift and remove the drive sleeve and worm gear assembly (5) from the actuator housing (1).

11. Slide the worm shaft (6) and worm shaft bearings (13) out of the actuator housing (1).

NOTE: The worm may need to be supported by slings and a hoist when removing and installing.

12. Remove the remainder of the grease m the housing and dispose per plant procedures.

13. Remove the drive sleeve O-rings (14).

14. Clean the housing (1) with solvent and wipes.

15. Clean all gasketed surfaces.

15.8 Disassembling HBC-7 Actuator

Refer to Figure 15-3.

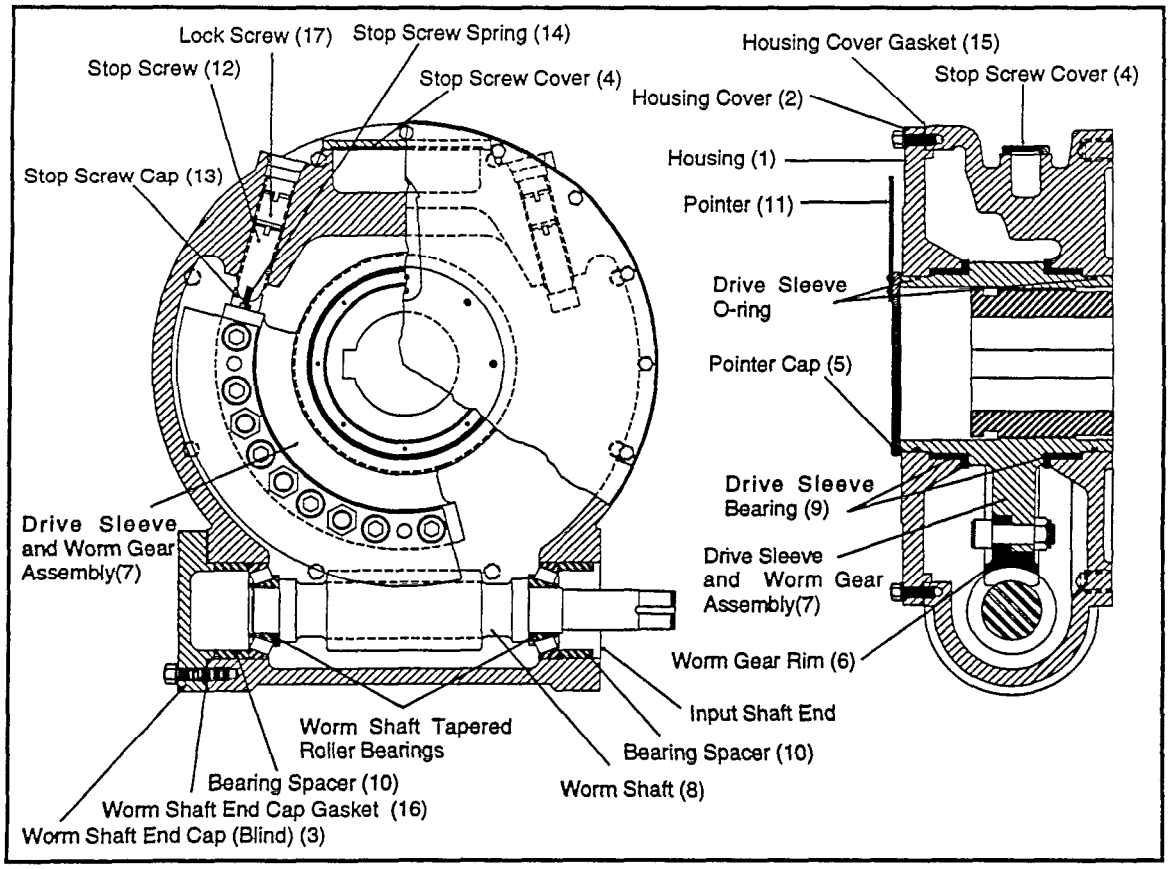


Figure 15 - 3

HBC-7

1. There are several differences between HBC-4 through 6 actuators and HBC-7 actuators. They are:

    - HBC-7 actuators have tapered roller bearings on the worm shaft (8) with bearing spacers (10) between the bearings and end cap (3) and the thru cap. The thru cap is not shown. It is on the splined (input end) of the worm shaft.

    - The stop screw (12) has a stop screw cap (13) with a stop screw spring (14).

    - The stop screw cover (4) does not cover the stop screws (12). They are located on each side of the cover.

NOTE: All parts should be properly stored after removal.

2. Remove the two lock screws (17) and stop screws (12). Count number of turns on each lock screw as it is removed and identify location.

    *Lock screw #1- Number of turns _____

    *Lock screw #2- Number of turns _____

NOTE: It as not possible to run the worm shaft off the worm gear. The drive sleeve will strike the housing first.

3. Match mark the housing cover (2) to the HBC housing (1).

4. Remove the cap screws and lock washers from the housing cover (2) and remove the cover.

5. Remove the housing cover gasket (15) and measure the thickness. Record gasket thickness.

    *Gasket Thickness _____

6. Scoop out and discard as much grease as possible from the inside of the actuator housing.

7. Match mark the worm shaft end cap (3) to the HBC housing (1).

8. Remove the fasteners holding the end caps (3) in place.

9. Remove the worm shaft end caps (3).

10. Remove the worm shaft end cap gaskets (16) and measure the thickness. Record gasket thickness.

    *Gasket Thickness - Blind End Cap _____

    *Gasket Thickness - End Cap _____

11. Rotate the worm shaft (8) to position the drive sleeve and worm gear (7) to the approximate mid point.

12. Remove the bearing spacer (10) from the input shaft end.

NOTE: This is one method for removal. Other suitable methods may be used.

NOTE: A nominal 5 inch brass spacer and all thread fasteners will speed the process of bearing spacer removal.

i. Place a brass spacer between the worm shaft end cap (3) and the end of the worm shaft (8).

CAUTION: Do not allow the drive sleeve (worm gear) to contact the housing while removing the bearing spacer.

ii. Using fasteners with adequate thread engagement, temporarily install the worm shaft end cap (3). By tightening each fastener approximately 1/2 turn in a criss cross fashion, the bearing spacer (10) on the input shaft end will be pushed out of the housing.

NOTE: Use a thicker brass spacer and repeat the procedure if the bearing spacer (10) as not removed when all fastener threads have been taken up.

iii. Continue until the bearing spacer (10) is forced from the input shaft end.

CAUTION: Be cautious while letting the worm shaft drop when sliding the weight off the bearings. The use of slings and a hoist is recommended.

13. While rotating the worm shaft, carefully slide the shaft toward the input shaft end until the bearing on the opposite end slides into the housing (1).

14. Remove the tapered roller bearing from the worm shaft (8) on the worm shaft end cap (3) end of the worm shaft (8) by the use of a long drift on the inner bearing race and a dead blow hammer. Rotate the worm shaft (8) while removing the tapered roller bearing.

CAUTION: The worm shaft is heavy. Slings and a hoist are recommended for support.

15. Once the bearing is removed, remove the worm shaft (8) from the HBC actuator by rotating and carefully sliding it out of the housing (1).

16. Mechanically remove as much grease as possible and dispose per plant procedures.

17. Remove the drive sleeve and worm gear (7) from the housing (1).

18. Remove the remainder of the grease in the housing and dispose per plant procedures..

19. Remove the drive sleeve O-rings.

20. Clean the housing with solvent and wipes.

21. Clean all gasketed surfaces.

15.9 Disassembly of HBC-10 Gearbox

Refer to Figure 15-4.

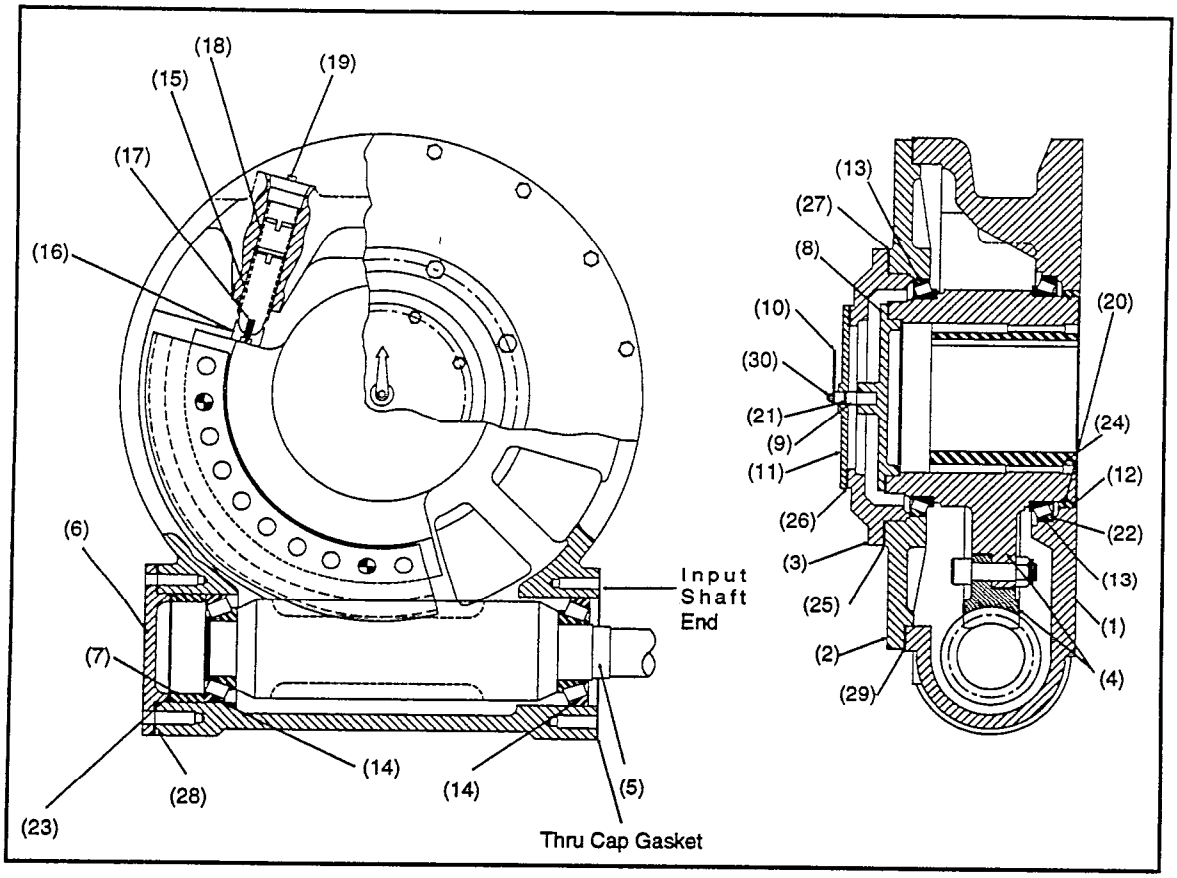


Figure 15-4

HBC-10

*See Table 15-1 on page 15-17 for parts list.

Table 15-1	
Parts List for Figure 15-4	
Part Number	Description
1	Housing
2	Housing Cover
3	Housing Cover Thru Cap
4	Drive Sleeve and Worm Gear Assembly
5	Worm Shaft
6	Worm Shaft End Cap
7	Bearing Cap
8	Indicator Pedestal
9	Indicator Shaft
10	Pointer
11	Dial Cover
12	Drive Sleeve Retaining Ring
13	Drive Sleeve Bearing
14	Worm Shaft Bearing (Tapered Roller Bearing)
15	Stop Screw
16	Stop Screw Head
17	Stop Screw Spring
18	Lock Screw
19	2" Standard Pipe Plug
20	Drive Sleeve O-ring
21	Indicator Shaft O-ring
22	Drive Sleeve Bearing Shim
23	Worm Shaft Bearing Shim Set
24	Spline Adapter
25	Housing Cover Thru Cap Gasket
26	Dial Cover Gasket
27	Pedestal Gasket
28	End Cap Gasket
29	Housing Cover Gasket
30	Hex Nut

1. There are several differences between HBC-4 through 6 actuators and HBC-10 actuators. They are:

   - HBC-10 actuators have tapered roller bearings (14) on the worm shaft (5), with a bearing spacer (7) on the worm shaft end cap end.
   - The stop screw (15) has a stop screw head (16) with a stop screw spring (17).
   - Pipe plugs (19) are used for stop screw covers.
   - The drive sleeve (4) uses tapered roller bearings.
   - The housing cover (2) has a housing cover thru cap (3) which has a dial cover (11) mounted to it.
   - The dial cover has an indicator shaft (9) through it with a pointer (10) attached.

NOTE: All parts should be properly stored after removal.

2. In order to remove the stop screws (15):

   i. First remove the two pipe plugs (19),

   ii. then, remove the two lock screws (18), and

   iii. finally, remove the two stop screws (15). Count the turns as they are removed. Identify the screws and record the results.

   *Screw #1 turns _____

   *Screw #2 turns _____

NOTE: It as not possible to run the worm shaft (5) off the worm gear. The d rive sleeve will strike the housing first.

3. Match mark the housing cover (2) to the HBC housing (1).

4. Match mark the housing cover thru cap (3) to the housing cover (2).

5. Match mark the pointer (10) to dial cover (11) position.

6. Remove the pointer (10) by removing the hex nut (30) and lifting pointer off the indicator shaft (9).

7. Remove the dial cover (11) with the dial cover gasket (26), taking care not to damage the O-ring (21) on the indicator shaft (9).

8. Remove the O-ring (21) from the indicator shaft (9).

9. Remove the housing cover thru cap (3) with the housing cover thru cap gasket (25).

10. Match mark the indicator pedestal (8) to drive sleeve (4) position.

11. Remove the indicator pedestal (8) with the pedestal gasket (27) from the

12. Remove the housing cover (2) with the housing cover gasket (29). Record

*Gasket Thickness _____

13. Scoop out and discard as much grease as possible from the inside of the

14. Match mark the worm shaft end cap (6) to the HBC housing (1).

15. Rotate the worm shaft (5) to position the drive sleeve and worm gear (4) to

16. Remove the fasteners holding the worm shaft end cap (6) and the thru cap

17. Remove the worm shaft end caps (6) and worm shaft bearing shim set (23).

18. Remove the end cap gaskets (28) and measure the thickness. Record gasket

*Gasket Thickness - Blind End Cap _____

*Gasket Thickness - Thru Cap _____

NOTE: This is one method for worm shaft removal. Other suitable methods may be used.

CAUTION: The worm shaft is heavy. Use appropriate lifting equipment for support.

19. Using appropriate support and lifting equipment, move the worm shaft (5) out of the input shaft end far enough to expose the bearing on the blind cap end.

20. Remove the tapered roller bearing (14) from the worm shaft (5) on the worm shaft end cap end of the worm shaft by use of a long drift on the inner bearing race and a dead blow hammer. Rotate the worm shaft while removing the bearing.

21. Once the tapered roller bearing is removed, remove the worm shaft (5) by

22. Mechanically remove as much grease as possible and dispose per plant

23. Remove the drive sleeve and worm gear (4) from the housing.

24. Remove the remainder of the grease from the housing and dispose per plant

25. Remove the drive sleeve O-ring (20).

15.10 Cleaning, Inspection and Repair

1. Mechanically remove as much of the remaining grease as possible from parts.

2. Clean all parts with site approved solvent.

3. Inspect all parts for wear, abrasion, breakage and deterioration. Pay partitular attention to the worm to see if it is a picking" up brass. This is an indication of wear. Replace as necessary.

NOTE: Pay particular attention to housing cracking at the end cap end of housing.

4. If replacing the housing cover and end cap/thru cap gasket(s), ensure that the bearing preload is correct by rotating the worm shaft and the drive sleeve after tightening the fasteners.

   If the preload is too great (bearing tight), add approximately 0.005" to gasket thickness.

   Continue to add thickness in approximate .005" increments until the preload is acceptable.

NOTE: HBC4 through 10 only. If the worm gear has to be removed /replaced, it has tapered holes which fit onto tapered dowel pins located on the drive sleeve. Ensure that the worm gear as positioned properly before replacement.

5. If the drive sleeve, worm or worm gear is replaced, perform a blue check of the worm/worm gear after reassembly to ensure the correct worm\worm gear alignment.

6. Wipe parts, as appropriate, listed below with wiping cloths. Examine these parts for cuts, nicks, tears, etc. Replace any defective parts.

   - End cap gasket
   - Thru cap gasket
   - Housing cover gasket
   - Worm shaft O-ring
   - Drive sleeve O-rings

7. Clean the parts listed below, as appropriate, with wiping cloths and solvent, followed by air drying. Examine all the parts for wear, damage or other deterioration.

   - Housing cover
   - Pointer cap
   - End cap
   - Thru cap

- Drive sleeve and worm gear assembly
- Worm shaft
- Stop screw cover
- Stop screws and lock screws
- All threaded fasteners
- Upper and lower drive sleeve bushings
- Indicator pedestal (HBC-10)
- Indicator shaft (HBC-10)
- Dial cover (HBC-10)
- Housing cover thru cap (HBC-10)
- Upper and lower drive sleeve bearings (HBC-10)
- Worm shaft tapered roller bearings (HBC-7 and HBC-10)

8. Examine the worm shaft bearings on both ends of the worm shaft for evidence of rusting, flat spots, flaking, rough movement or excessive movement between inner and outer races. If the results of this examination or of the worm shaft examination are unsatisfactory, replace the bearings using Steps 9 and 10.

9. Using a bearing puller, pull the worm shaft bearing(s) off the worm shaft. Discard the faulty part(s). It is recommended that both worm shaft bearings be replaced at the same time.

NOTE: Bearings for HBC-0 through 5 actuators should be pressed onto the worm shaft and bearings for HBC-6 through 10 actuators should be heated to 160 degrees Fahrenheit in an induction heater prior to installation on the worm shaft (and drive sleeve on HBC-10) when possible. Use of refrigerators or dry ice may be appropriate for bearing outer races d wring replacement. Alternate means may be used to fit bearings if necessary. Use of a tempil stick to monitor bearing temperature may be used.

NOTE: Do not place the bearing on the HBC-7 and 10 worm shaft end cap end opposite the input shaft end before assembling the HBC unit.

10. Use the applicable method to install the new (or serviceable original) worm shaft tapered roller bearings on to the new (or serviceable original) worm shaft.

NOTE: If the drive sleeve bushings require replacement, replace using Steps 11, 12 and 13. HBC-10 actuator drive sleeves have tapered roller bearings.

NOTE: HBC-10 units have shim(s) underneath the drive sleeve lower bearing outer race. Shim(s) must be replaced underneath the outer race if the drive sleeve bearings are replaced. Old shim(s) may be reused if they are not damaged.

11. Remove the defective drive sleeve bushing(s) (also HBC-10 bearing outer races and HBC-7 worm shaft bearing outer races) by either cutting, grinding or drilling through the ring in one or more locations until the ring (or race) can be readily removed from the HBC housing.

12. Install the new drive sleeve bushing(s) by carefully tapping in place with a soft faced mallet. Tap equally around the periphery of the ring to ensure that it goes onto its seating lip evenly without cocking.

13. Install the HBC-10 drive sleeve bearing outer races and the HBC-7 worm shaft bearing outer races by cooling and shrinking the races before installation, if required.

15.11 Reassembly and Installation of Limitorque Actuation

NOTE: All parts are to be visually clean (free from dirt, grease, etc.) and dry prior to assembly.

NOTE All fasteners, gaskets, O-rings, joints, and all moving parts should be lubricated with a thin film of lubricant prior to assembly.

NOTE: All bearings are to be packed with grease before installation.

15.11.1 HBC-O Through HBC-3 Reassembly and Installation

NOTE: Line up the match marks when reassembling

Refer to Figure 15-5.

NOTE: Replace any gaskets that are stiff or damaged.

1. Replace the drive sleeve O-ring (14) after coating with a thin film of grease.

2. Coat the worm shaft O-ring (15) with a thin film of grease and install in the thru cap.

   - Coat the drive sleeve bearing surfaces with a thin film of grease before installation.

3. Install the drive sleeve and worm gear assembly (5) in the housing (1).

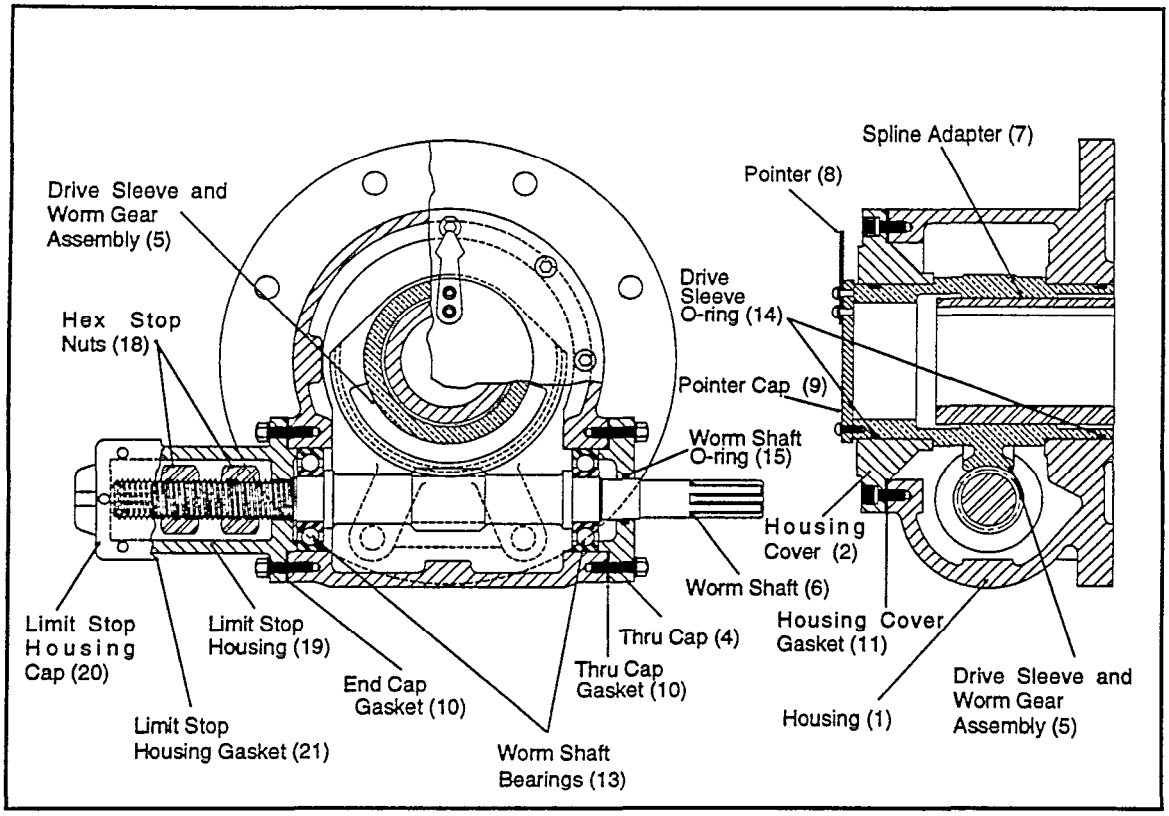


Figure 15 - 5
HBC-0 through HBC-3

4. Pack the worm shaft bearings (13) with a site approved lubricant.

5. Coat the worm (6) with a site approved lubricant.

NOTE: It is easier to install the worm shaft in the housing if the d rive sleeve and worm gear assembly (5) is moved to one side. The drive sleeve and worm gear assembly (5) can be rotated with a strap wrench.

6. Install the worm shaft in the housing.

See Section 15.6 Step 5 for recorded gasket thickness

NOTE:After both the limit stop housing (19) and thru cap fad are installed, rotate the worm shaft (6) to ensure that the gaskets are the correct thickness. The worm shaft (6) should rotate freely without binding.

7. Install the limit stop housing (19) with the end cap gasket (10) together with the hex stop nuts (18).

8. Install the thru cap (4) with the thru cap gasket (10) and worm shaft O-ring (15).

See Section 15.6 Step 7 for recorded gasket thickness

9. Engage the worm/worm gear if it is not engaged. Rotate the drive sleeve with a strap wrench if required.

10. Add a site approved lubricant to the housing. Ensure that an adequate amount IS added to keep the worm/worm gear interface covered during operation. (See Appendix C for approximate amount of grease required.)

    - Coat the housing cover (2) bearing surface and O-ring with a thin film of grease.

    - See Section 15.6 Step 3 for gasket thickness.

11. Install the housing cover (2) with the housing cover gasket (11), aligning the match marks with the housing (1).

12. Rotate the worm shaft (6) to ensure that the housing cover gasket (11) is the proper thickness and that the housing cover (2) is not binding the drive sleeve and worm gear assembly.

13. To set up the gear box, do the following:

    Refer to Figure 15-6, bolts "C" and "D", and the index mark on top of the drive sleeve and worm gear assembly (5).

> *NOTE: Using a cold chisel on top of the drive sleeve, mark the mid point of the worm sector gear, if it is not marked.*

14. Bolts "C" and "D" indicate the approximate 90 degree movement limit of the drive sleeve and worm gear assembly (5).

15. The index mark on top of the drive sleeve and worm gear assembly (5) indicates mid position of the worm gear.

16. Place your fingers on the hex stop nuts (18) to prevent their rotation.

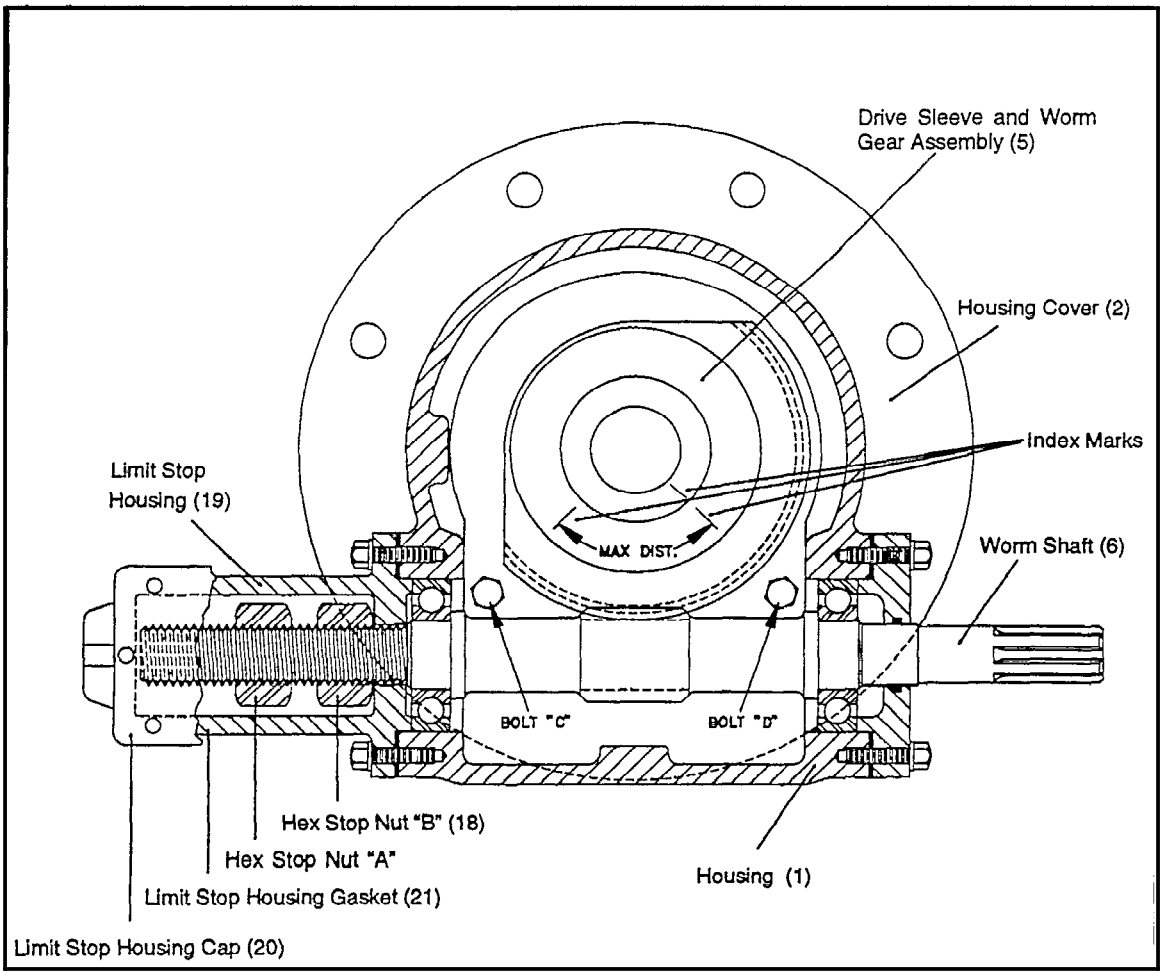


Figure 15 - 6

HBC-0-3 with Bolts "C" and "D" Shown

17. Rotate the worm shaft (6) m both directions to determine which direction the hex stop nuts will move with the worm shaft rotation.

18. Remove your fingers from the hex stop nuts (18).

19. Rotate the worm shaft (6) until the index mark on the drive sleeve and worm gear assembly (5) is pointing at one of the 90 degree housing (1) indicator bolts ("C" or"D").

20. Run the hex nuts (18) to the correct end of the limit stop housing and back off three flats. If the flat of the hex stop nut against the housing is not facing upwards, back off the hex stop nut until the flat is facing upwards. Rotate the other hex stop nut until the flat is facing upwards.

21. Install the limit stop housing cap (20), with two fasteners finger tight (enough to keep the hex stop nuts (18) from rotating).

22. Rotate the worm shaft in the opposite direction until the index mark on the drive sleeve and worm gear assembly (5) is pointing at the other 90 degree housing cover (2) mounting bolt.

NOTE: Do not allow the first hex stop nut, which has already been set, to rotate while setting the second hex stop nut.

NOTE: If the salve is torque closing, the close hex stop nut may be set next to the open nut.

23. Remove the limit stop housing cap (20) and run the other hex stop nut (18) into the end of the limit stop housing (19) toward which it was moving and back off three flats. If the flat is not facing upwards after running into the end of the housing, back off the hex stop nut until the flat is facing upwards.

24. Install the limit stop housing cap (20) with all fasteners and gasket (21).

NOTE: Step 25 begins the installation procedures for the Limitorque actuator and continues through Step 36.

NOTE: Steps 25 through 27 need only be performed if the drive sleeve and worm gear or spline adapter was replaced.

Refer to Figures 15-5 and 15-6.

25. Observe the mark on the end of the valve shaft which indicates the position of the valve disc. If mark is not visible, the valve disc position may be obtained from vendor drawing.

NOTE: Full stroke rotation of the index mark on the drive sleeve should not move past the corresponding travel limit index marks on the housing cover in order to avoid disengaging the worm gear segment. Should the housing cover index marks be missing or not visible, the two housing cover bolts "C" and "D" can be used for alignment.

26. Observe the mark on the end of the valve shaft to determine whether the valve disc is m the open or closed position.

27. Using the index mark on top of the drive sleeve and fasteners "C" and "D", turn the worm shaft (6) until the index mark points to one of the fasteners corresponding to the position of the valve disc observed in Step 25.

28. Turn the worm shaft (6) in a direction counter to that turned in Step 27 and observe that the orientation of the index mark and fasteners corresponds with the rotation of the valve disc.

29. Ensure that the index mark on the drive sleeve (center line of gear segment) IS at the valve full open/closed position.

30. Mount the HBC actuator on the valve aligning match marks made in Section 15.5 Step 13 if the drive sleeve was not replaced. If the drive sleeve was replaced, align the match marks on the HBC and the valve mounting flanges.

31. Position spline adapter (7) flush with the end of the valve stem.

32. Position shaft key 1/16" below the face of the spline adapter, if required.

33. Stake the edges of the spline adapter and valve shaft around the end of the keyway using a center punch to prevent the key from slipping past the flush position, if required.

34. Lubricate the mounting bolts with anti-seize, if required.

35. Install bolts, holding actuator on valve, and tighten finger tight.

36. Torque the valve mounting bolts to the proper value, using the proper sequence.

15.11.1.1 Setting Position Limit Stops

Refer to Figures 15-6 and 15-6.

1. Turn the input shaft of the HBC actuator to fully close the valve.

NOTE: Ensure that the valve is fulled closed by observation of the shaft end markings or review of the shaft key position in the vendor drawing.

NOTE:lf hex stop nut "A" or "B" hits the housing before the valve is tightly closed, back off the hex nut until the valve is tight. Adjust the correct hex stop nut depending on direction of rotation of the worm shaft.

2. Remove the limit stop housing cap (20).

3. Run hex stop nut "B" (18) hand tight against the housing (1) then back off the hex nut three flats so that one of the flats is on top facing the limit stop housing cap (20).

4. Install the limit stop housing cap (20) with a minimum of two fasteners.

5. Turn the input shaft of the HBC actuator to fully open the valve.

6. Ensure that the valve is fully open by observation of the shaft end markings or review of the shaft key position in the vendor drawing.

7. Remove the limit stop housing cap (20).

8. Run hex stop nut "A" (18) hand tight against the end of the limit stop housing (19) then back off the stop nut three flats so that one of the flats of the hex nut is on top facing the limit stop housing cap (20).

9. Install limit stop housing cap (20) complete with gasket.

10. Install the pointer cap (9) on the HBC actuator drive sleeve, aligning match marks.

11. Lubricate fasteners holding pointer cap (9) in position with anti-seize, if required.

12. Install the pointer cap fasteners and washers and tighten.

15.11.1.2 Setting AWWA Type Stops

Refer to Figures 15-7 and 15-8.

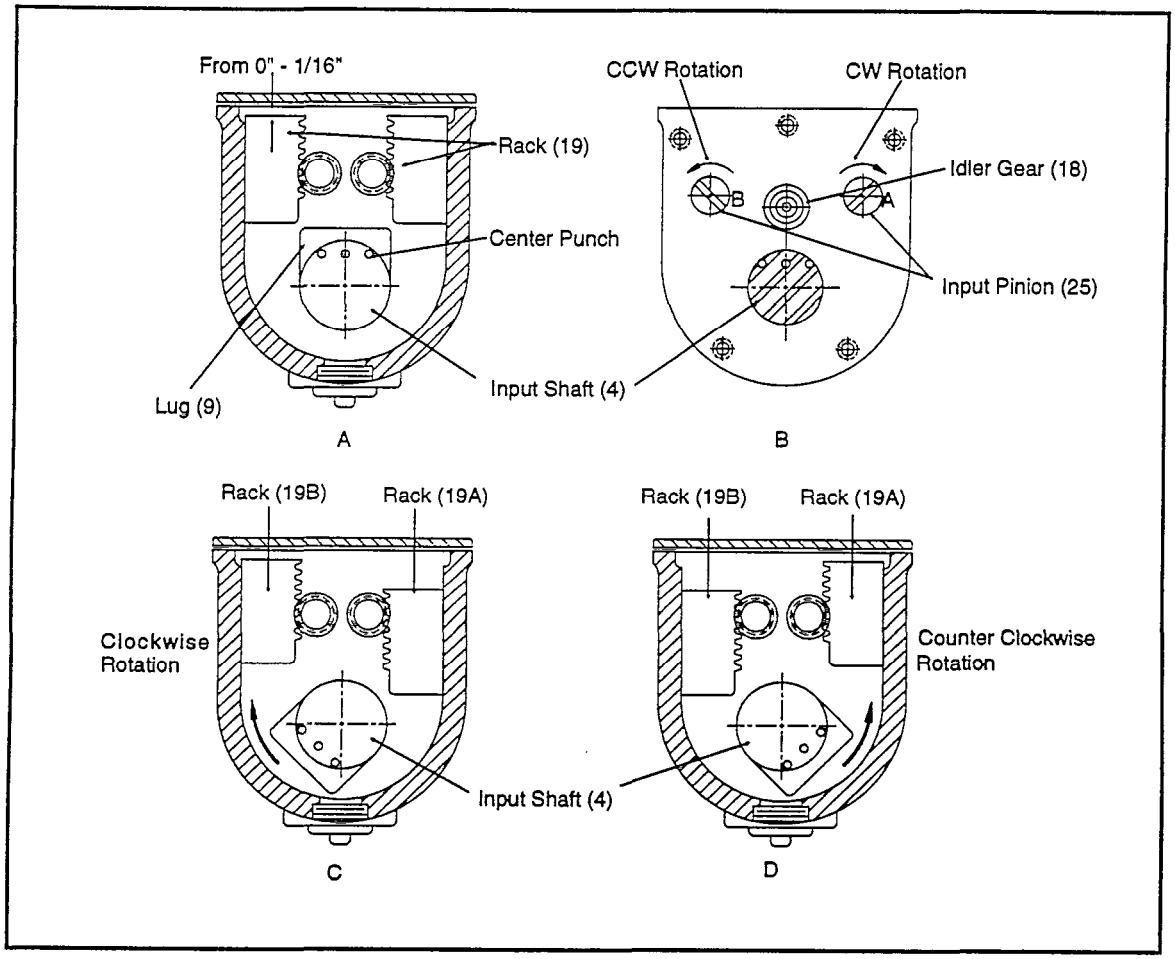


Figure 15 - 7

AWWA Input Shaft Stop

1. AWWA type stops are mounted directly on the equipment input shafts and operate similarly to the limit switch on a Limitorque SMB motor actuator.

2. When an AWWA stop is used, the standard limit stop used with the device on which it is mounted is also used.

3. To set the stops, the following procedure may be used.

   Remove the cover plates (9), (10) and (11).

   Refer to Figure 15-7-A. Both racks (19) should be in the up position as shown.

NOTE: There are three center punch marks on the end of the input shaft. The three marks indicate the position of the lug which impacts the racks (19) when they are in the lowered position.

NOTE: The following steps assume that CW (clockwise) rotation of the hand-wheel closes the valve.

- With the input shaft m the position shown in Figure 15-7-B, grasp the idler gear (18) and pull it backwards, disengaging it from the input pinion-gear assembly (47).

NOTE: Refer to Figure 15-7-B. Input pinions (25) rotate in the same direction as the hand wheel. CCW for counterclockwise hand wheel rotation and CW for clockwise handwheel rotation.

- Rotate the handwheel with the input shaft in the clockwise direction until the valve reaches its maximum amount of travel (normally closed).

- Rotate the input shaft to the position shown in Figure 15-7-C.

- Grasp and pull the idler gear (18). Hold it out of engagement with the input pinion-gear assembly (47).

NOTE: If the rack (19A) (Figure 15-7-C), moves downward during hand wheel rotation, rotate the hand wheel backwards slightly to cause the rack to lift. Using a screwdriver, rotate the input pinion (25A) (Figure 15-7-B) in CW handwheel rotation in the CCW direction approximately 50 turns. Repeat if the rack drops again before the valve reaches the required position.

- While holding the idler gear (18) out of engagement, rotate the handwheel until the valve reaches the closed, or required position.

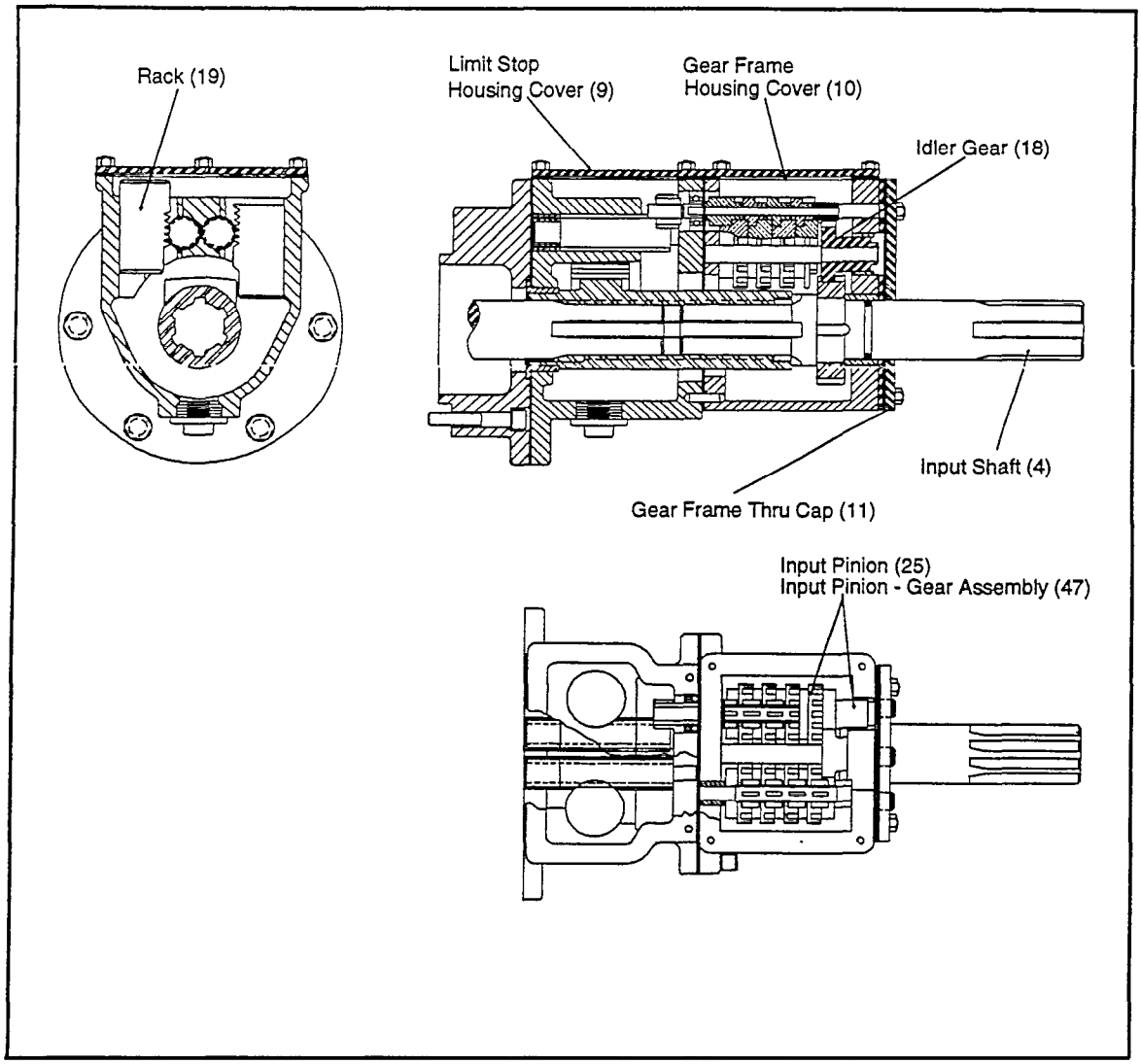


Figure 15 - 8

AWWA Input Shaft Stop

Using a screwdriver or suitable instrument, rotate input pinion (25A) (Figure 15-7-B) in CW direction until the rack (19A) (Figure 15-7-D) moves fully downward. Do not rotate the input pinion farther

Push the idler gear (18) back into engagement, rotate the handwheel clockwise to ensure that the lug hits the rack and prevents further handwheel rotation.

15.11.1.3 Setting Opening Stop

NOTE: The idler gear must remain engaged d bring opening travel.

1. Rotate the handwheel with the input shaft in the counterclockwise direction until the valve reaches desired location (normally open).

NOTE: If the rack (19B) (Figure 15-7-C) moves downward during handwheel rotation, rotate the handwheel backwards slightly to cause the rack to lift. Pull the idler gear (18) out of engagement. Using a screwdriver or suitable instrument, rotate the input pinion (25B) (Figure 15-7-B) in the CW direction approximately 50 turns. Push the idler gear (18) back into engagement. Repeat if the rack drops again before the valve reaches its required position.

3. Grasp and pull the idler gear (18). Hold it out of engagement with the input pinions-gear assembly (47).

4. Using a screwdriver or suitable instrument, rotate the input pinion (25B) (Figure 15-7-B) in the CCW direction until the rack (19B) (Figure 15-7-D) moves fully downward. Do not rotate the input pinion farther.

5. Push the idler gear (18) back into engagement, rotate the handwheel counterclockwise to ensure that the lug hits the rack and prevents further handwheel rotation.

6. Replace the cover plates (9), (10) and (11), along with the proper gaskets and fasteners. Replace the gaskets if damaged.

7. Fully close and open the valve to ensure that the stops are properly set.

15.11.1.4 Setting Key Nut Type Stop

NOTE: This type stop may be found on HBC-0 through HBC-3 units.

Refer to Figure 15-9.

This stop uses one nut with grooves in the outer perimeter that mate with grooves in the limit stop housing which prevent the nut from rotating. The length of nut travel is limited to 90 degrees of valve travel by the length of the limit stop housing and threaded shaft.

NOTE: Steps 1 through 7 are for actuators which have the key nut stop moving toward the adapter cap on closing. For actuators which have the key nut stop moving toward the end cap on closing, perform Steps 1 and 2, then perform Steps 8 through 12.

1. Remove the end cap (3) and limit stop housing (19).

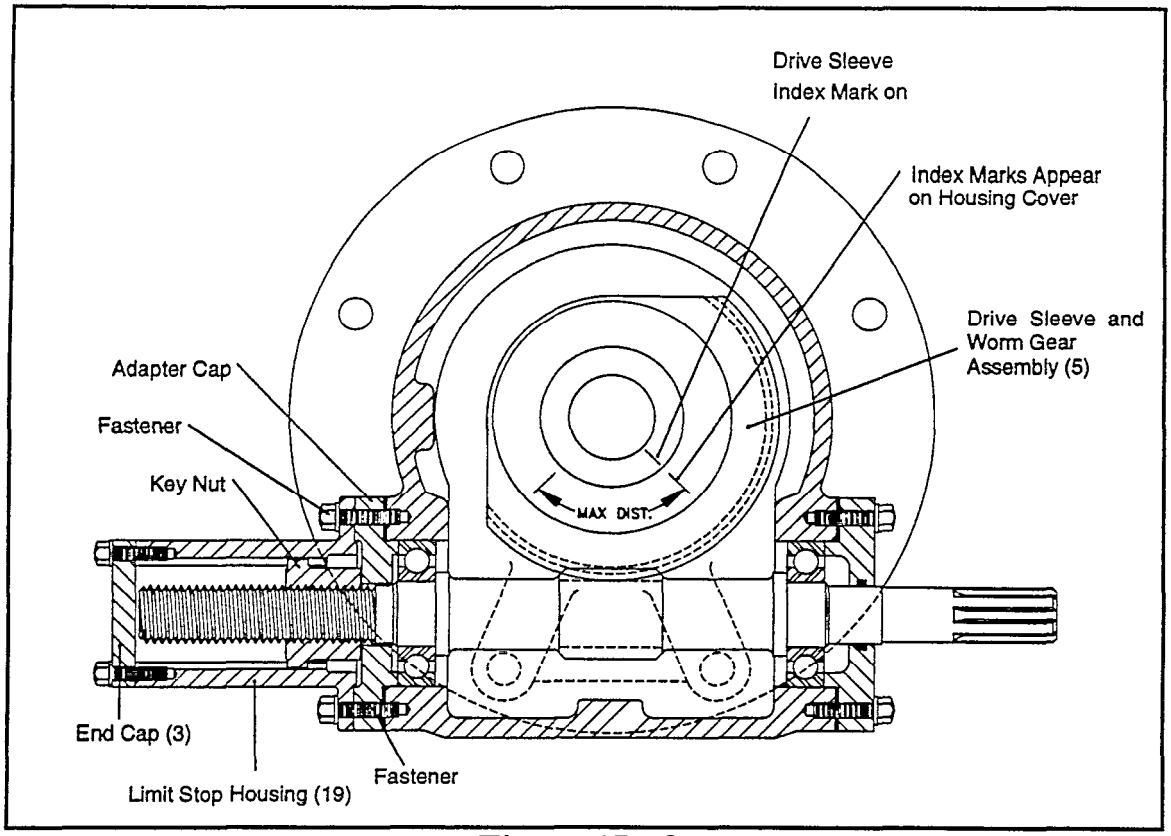


Figure 15 - 9

HBC-O through 3 with Key Nut Stop

2. Fully close the valve. Verify the valve is fully closed by marks or keyway on the valve shaft end, or other appropriate means.

3. Run the key nut hand tight against the adapter cap face.

4. Place the limit stop housing (19) over the key nut and rotate it to line up the nearest set of holes in the adapter cap.

5. Insert the fasteners through the limit stop housing (19) and adapter cap.

6. Tighten the fasteners.

7. Assemble and fasten the end cap (3) to the limit stop housing (19).

NOTE: If the key not goes toward the end cap on closing, do the following:

8. Place the limit stop housing (19) in position and rotate it to move the key nut flush with the end of the limit stop housing (19).

9. Insert the fasteners through the limit stop housing (19) and adapter cap.

10. Tighten the fasteners.

11. Assemble and fasten the end cap (3) to the limit stop housing (19).

12. Open and close the valve to ensure proper operation.

15.11 .2 HBC-4 Through HBC-6 Reassembly and Installation

NOTE: Align the match marks during reassembly.

Refer to Figure 15-10.

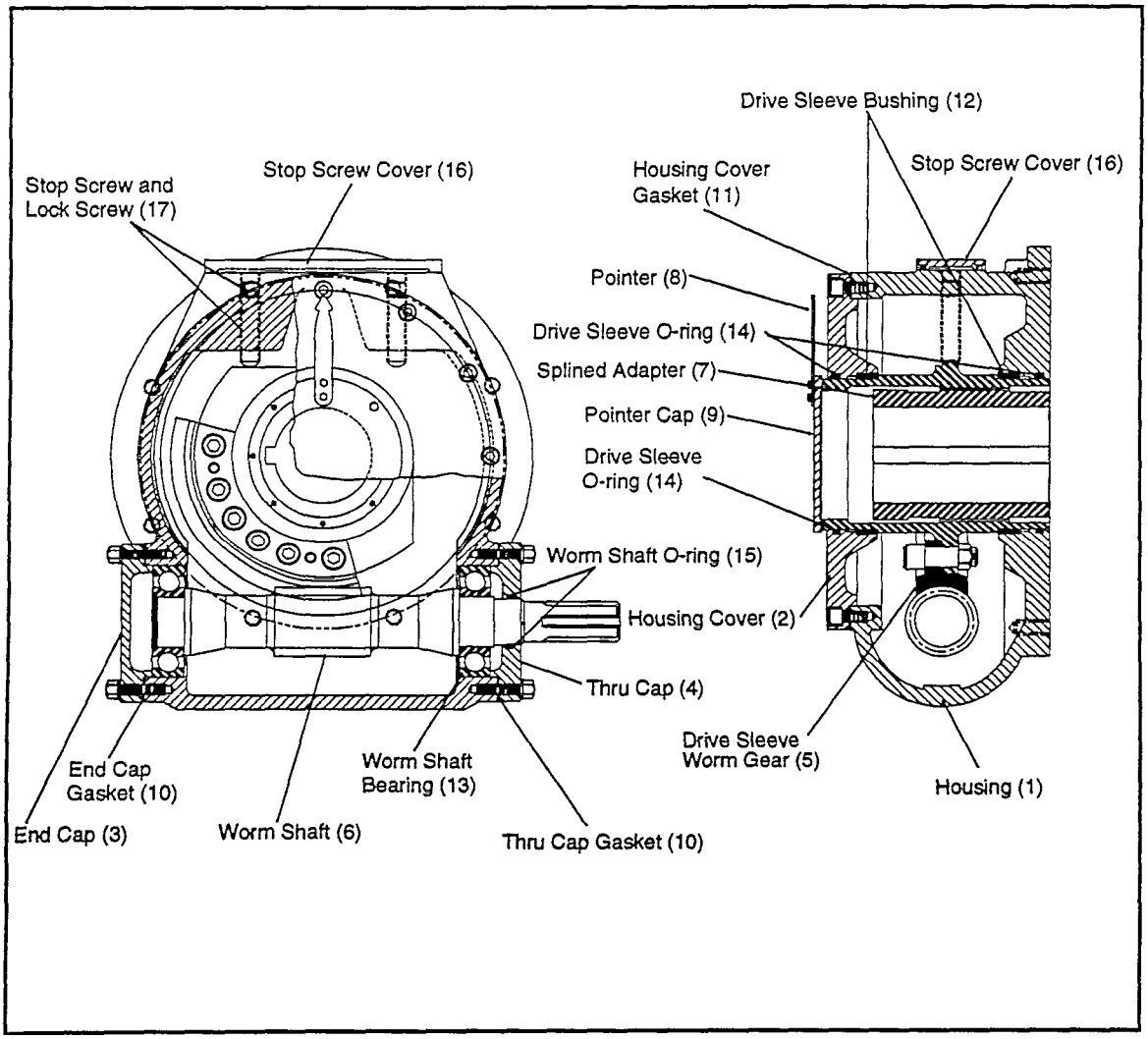


Figure 15 -10

HBCZ through HBC-6

NOTE: Replace any gaskets that are stiff or damaged.

1. Coat the O-rings with a thin film of grease.

2. Replace the drive sleeve O-rings (14).

3. Coat the worm shaft (6) with a thin film of grease.

4. Install the worm shaft (6) in the housing (1), leaving the worm shaft (6) resting on the housing (1) with the inside worm shaft bearing (13) laying in the housing just in front of its housing opening.

5. Install the drive sleeve and worm gear assembly (5) in the housing (1).

6. Complete the installation of the worm shaft (6) into the housing (1).

NOTE: After both the end cap (3) and thru cap (4) are installed, rotate the worm shaft (6) to ensure that the end cap and thru cap gaskets (10) are the correct thickness. The worm shaft (6) should rotate freely without binding

7. See Section 15.7 Step 5 for old gasket thickness.

8. Install the end cap (3) with the end cap gasket (10) on the housing (1).

9. Coat the worm shaft O-ring (15) with a thin film of grease and install it in the thru cap (4).

10. Install the thru cap (4) with the thru cap gasket (10) on the housing (1).

11. Rotate the worm shaft (6) until the worm is approximately in the drive sleeve and worm gear (5) mid position.

12. Install the stop screws (17). Tighten them slightly at this tlme.

NOTE: If the housing or drive sleeve has been replaced, the reference marks Match marks) made in Section 15.5 Steps 8, 12, 13 and 14 will be erroneous and should be disregarded.

13. Temporarily install the pointer cap (9) in position on top of the drive sleeve and worm gear (5).

14. Install the pointer cap fasteners finger tight.

15. Rotate the worm shaft (6) by hand until the flat on one side of the drive sleeve and worm gear (5) just touches the housing. Using a site approved marker, mark the pointer (8) location on the outside of the housing.

16. Rotate the worm shaft (6) by hand, in the opposite direction from Step 15 until the opposite drive sleeve flat just touches the housing. Use a site approved marker to mark the pointer (8) location on the outside of the housing.

NOTE: The markings applied in Steps 15 and 16 denote the maximum allowable total travel of the actuator.

NOTE: Ninety degree travel on the actuator drive sleeve and worm gear (5) is defined as opposing flat sides of the drive sleeve being at once parallel and perpendicular to the worm shaft. See Figure 15-10.

17. Rotate the worm shaft (6) by hand until the drive sleeve flat currently touching the housing is parallel to the worm shaft (6) and the opposite flat is perpendicular to the shaft.

18. Insert one stop screw (17) into its hole adjacent to the drive sleeve flat which is parallel to the worm shaft (6). Thread the stop screw inward until it protrudes from the housing inner wall and just touches the drive sleeve flat.

19. Using a site approved marker, mark the pointer (8) location on the outside of the housing.

20. Rotate the worm shaft (6) until the alternate flats of the drive sleeve and worm gear (5) are parallel and perpendicular, and the opposite flat is now parallel to the worm shaft.

21. Insert the second stop screw (17) into its hole adjacent to the drive sleeve flat which is parallel to the worm shaft (6). Thread the stop screw inward until it protrudes from the housing inner wall and just touches the drive sleeve flat.

22. Using a site approved marker, mark the pointer (8) location on the outside of the housing.

NOTE: The reworkings applied in Steps 19 and 22 denote the 90 degree travel of the actuator.

23. Fill the Limitorque actuator housing with site approved lubricant, leaving an approximate one inch space between the lubricant and the housing cover

for grease expansion. (See Appendix C for approximate amount of grease required.)

NOTE: If the housing (1) housing cover (2) drive sleeve and worm gear (5) or d rive sleeve bushing (12) was replaced d bring previous steps, proceed to Step 24. If the housing cover gasket (11) was replaced and none of the other above mentioned parts were replaced, proceed to Step 25. If the original gasket (11) is to be reused and no other parts mentioned above were substituted, proceed to Step 26.

24. Temporarily install the housing cover (2) on the housing and tighten the fasteners snug tight. Measure the clearance between the housing (1) and the housing cover (2). Add 10% to the measurement taken and use the closest nominal gasket thickness.

25. Measure the replacement housing cover gasket (11) to ensure that it is the same thickness, nominally, as the original gasket measurement determined in Section 16.7 Step 7.

26. Install the housing cover gasket (11) on the actuator housing.

27. Install the housing cover (2) on the actuator housing.

28. Coat the housing cover fasteners with anti-seize, if required.

29. Install the housing cover fasteners and tighten.

30. Using a site approved marker, transfer the 90 degree travel marks made in Steps 19 and 22, from the side of the housing to the housing cover (2).

31. Using a center punch, transfer the maximum allowable total travel marks, made in Steps 15 and 16 from the side of the housing to the housing cover (2).

32. Place the actuator in the same position (i.e., open or closed) as the valve position recorded in Section 15.5 Step 7.

NOTE: The splined shaft adapter should be a press fit to avoid splined adapter movement in the HBC drive sleeve.

33. If the splined shaft adapter (7) was removed from the valve in previous steps, replace it by pressing the shaft adapter on the valve shaft and positioning it flush with the end of the valve stem.

NOTE: If the drive sleeve (S), spline adapter (7), or actuator housing cover was replaced, specific alignment marks may not be available.

34. If removed, insert the spline adapter key into the adapter/valve stem keyway, and position slightly below (approximately 1/16") the face of the spline adapter (7).

35. Apply anti-seize, if required, to the splines of the splined shaft adapter (7).

36. Mount the HBC actuator on the valve and align the actuator and valve mounting flange match marks and appropriate full open/close match marks, if available.

NOTE: If actuator housing mounting bolt holes do not align with the valve yoke mounting holes, perform the following Steps 37 and 38.

37. Rotate the worm shaft (6) so as to move the housing away from the stop that the drive sleeve is close to, and attempt to align bolt holes.

CAUTION: The housing can only be cranked away an amount equal to the difference in allowable travel. This amount is the distance between the maximum allowable total travel and the 90 degree travel marks. Exceeding the distance will prevent the actuator from reaching a complete 90 degree travel.

38. If the actuator housing shifts in the wrong direction or if more travel is required for alignment than the distance between total travel and 90 degree travel marks, the actuator must be removed, rotated a slight amount and reinstalled on the spline adapter (7). The spline tooth spacing in degrees is shown on the a "HBC Angular Displacement Tolerances" Table in Appendix A.

39. When the actuator mounting bolt holes are aligned, lubricate the bolts with anti-seize, if required.

40. Install the actuator mounting bolts and tighten finger tight.

41. Torque mounting bolts using proper values and proper sequence.

15.11.2.1 Setting Position Limit Stops

1. Screw the stop screw (17) which is closest to contacting the drive sleeve flat inward, while counting the number of turns, until the end touches the drive sleeve.

2. Screw the opposite stop screw (17) outward the same number of turns as the first screw was turned inward m Step 1.

3. Back out both stop screws (17) by:

NOTE: This is only a recommended amount. Site procedures may state different amounts.

- 1/2 turn each for "limit seated valves".
- 4 turns each for "torque seated valves".

4. Install the pointer cap (9) in the same position as Section 15.11.2 Step 13 with match marks from Section 15.5 Step 8 aligned.

5. Lubricate the pointer cap fasteners with anti-seize, if required.

6. Install the pointer cap fasteners and washers and tighten.

NOTE: The position of the pointer (8) now indicates the new full travel mark in one direction.

7. Using a site approved marker, mark the new full travel position on the housing, as indicated by the pointer (8) position.

8. Measure the distance between the new reference mark made in Step 7 and the old full travel (90 degree) travel reference mark, made in Section 15.11.2, Step 19 or 22.

9. Use the distance measured in Step 8 and establish the new full travel (90 degree) mark at the opposite end of actuator travel by measuring the same distance from the old reference mark made in Section 15.11.2, Step 19 or 22. Using a site approved marker, mark the new reference point.

10. Verify that the new travel point is not beyond the maximum allowable travel point.

11. Install a Limitorque SMB, or other type actuator, if used.

CAUTION: Due to the large gear ratios on SMB/SB and HBC combinations, the actuator or salve can easily be damaged by excessive force on the actuator handwheel. Do not attempt to rotate past the open position as indicated by resistance to movement and pointer indication. Use caution when going closed into the seat.

CAUTION: Use extreme caution when installing the lock screw to prevent it from turning the stop screw. A slight resistance will be felt when the lock screw contacts the stop screw.

12. Install the two stop screw lock screws (17) and tighten.
13. Install the stop screw cover (16) on the actuator housing.
14. Lubricate the stop screw cover fasteners with anti-seize, if required.
15. Install the stop screw cover fasteners and washers and tighten.

NOTE The pointer cap is removed so the end of the value shaft can be viewed.

16. Remove the fasteners and washers holding the pointer cap (9) in place.
17. Remove the pointer cap (9).
18. Cycle the actuator to both full open and full closed positions. Ensure that the valve fully opens and closes by observation of the shaft end markings or review of the shaft key position in the vendor drawing.
19. Install the pointer cap (9) on the housing (1).
20. Install the pointer cap fasteners and washers and tighten.

15.11.3 HBC-7 Reassembly and Installation

NOTE: Align the match marks during reassembly.

Refer to Figure 15-11.

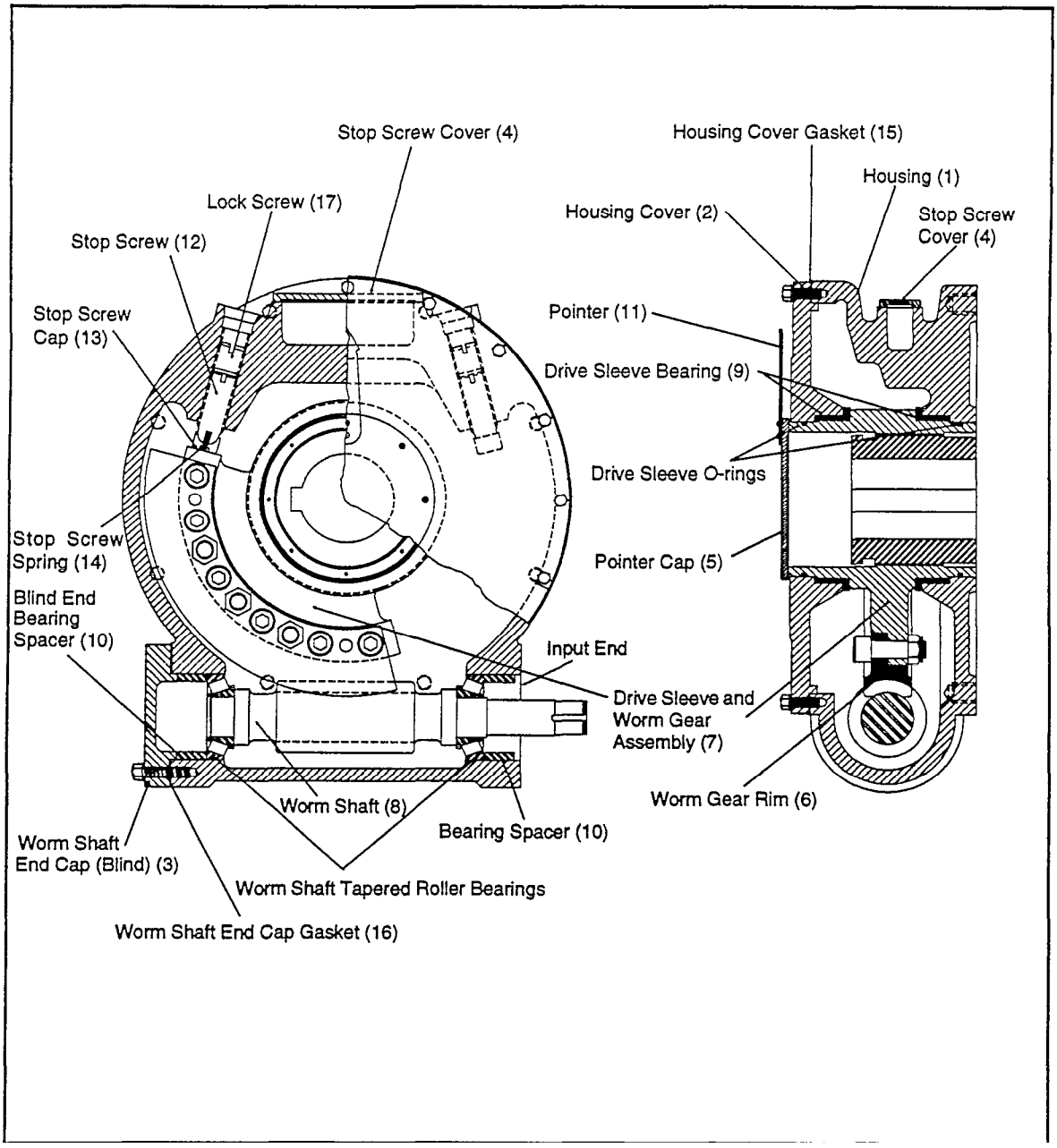


Figure 16 -11

HBC-7

NOTE: Replace any gaskets that are stiff or damaged.

1. Coat the drive sleeve O-rings with a thin film of grease.
2. Install the drive sleeve O-rings on the drive sleeve (7).
3. Install the drive sleeve (7) in the housing (1).
4. Pack the worm shaft tapered roller bearings with a site approved lubricant.
5. Coat the worm shaft (8) with a site approved lubricant.
6. Install the tapered bearing on the worm shaft thru cap end.
7. Install the worm shaft (8) in the housing (1).
8. Install the worm shaft end cap (3) with the worm shaft end cap gasket (16) in the housing (1).

NOTE: The following is one method of installing the worm shaft end cap end tapered roller bearing on the worm shaft. Other appropriate methods may be used.

9. Start the tapered roller bearing on the worm shafts end cap end of the worm shaft (8).
10. Install the tapered roller bearing against the worm shaft end cap end bearing spacer (10).

WARNING: Do not allow the drive sleeve to contact the housing while installing the tapered roller bearing.

NOTE: Rotate the worm shaft after each hammerblow to tighten the worm shaft against the tapered roller bearing and move the worm shaft threads against the opposite side of the threads on the worm gear (7). This prevents the threads being driven against each other.

11. Using a dead blow hammer, drive the worm shaft end (8) through the tapered roller bearing on the worm shaft end cap end.

12. Install the bearing spacer (10) in the input shaft end of the housing (1), around the worm shaft (8).

13. Install the thru cap (not shown) with the thru cap gasket on the input shaft end of the housing (1).

14. Using a chisel or punch, establish a reference mark for worm gear midpoint on top of the drive sleeve if it is not there. The indicator mark can be used with housing cover mounting bolts spaced 90 degrees apart as a reference to indicate drive sleeve travel limits.

15. Temporarily install the pointer cap (5) in position on top of the drive sleeve (7).

16. Install the pointer cap fasteners finger tight.

17. Rotate the worm shaft (8) until the flat on one side of the drive sleeve (7) just touches the housing. Using a site approved marker, mark the pointer (11) location on the outside of the housing.

18. Rotate the worm shaft (8) in the opposite direction from Step 17 until the opposite drive sleeve flat just touches the housing. Using a site approved marker, mark the pointer (8) location on the outside of the housing.

NOTE: The markings applied in Steps 17 and 18 denote the maximum allowable total travel of the actuator.

NOTE:Ninety degree travel on the actuator drive sleeve (7) is defined as opposing flat side of the drive sleeve being at once parallel and perpendicular to the worm shaft (8). See Figure 15-10.

19. Rotate the worm shaft (8) until the drive sleeve flat currently touching the housing is parallel to the worm shaft (8) and the opposite flat is perpendicular to the shaft.

20. Insert one stop screw (12) into its hole adjacent to the drive sleeve flat which is parallel to the worm shaft (8). Thread the stop screw inward until it just touches the drive sleeve flat.

21. Using a site approved marker, mark the pointer (11) location on the outside of the housing.

22. Rotate the worm shaft (8) until the alternate flats of the drive sleeve (7) are parallel and perpendicular, and the opposite flat is now parallel to the worm shaft.

23. Insert the second stop screw (12) into its hole adjacent to the drive sleeve flat which is parallel to the worm shaft (8). Thread the stop screw inward until it protrudes from the housing inner wall and just touches the drive sleeve flat.

24. Using a site approved marker, mark the pointer (11) location on the outside of the housing.

NOTE: The markings applied in Steps 21 and 24 denote the 90 degree travel of the actuator.

26. Fill the Limitorque actuator housing with site approved lubricant, leaving an approximate one inch space between the lubricant and the housing cover for grease expansion. (See Appendix C for approximate amount of grease required.)

NOTE: If the housing (1), housing cover (2), drive sleeve assembly (7), or drive sleeve bearing (9) was replaced during previous steps, proceed to Step 26. If the housing cover gasket (15) was replaced and none of the other above mentioned parts were replaced, proceed to Step 27. If the original gasket (15) is to be reused and no other parts mentioned above were substituted, proceed to Step 28.

26. Temporarily install the housing cover (2) on the housing and tighten the fasteners snug tight. Measure the clearance between the housing (1) and the housing cover (2). Add 10% to the measurement taken and use the closest nominal gasket thickness.

27. Measure the replacement housing cover gasket (15) to ensure that it is the same thickness, nominally, as the original gasket measurement determined in Section 15.8 Step 5.

28. Install the housing cover gasket (15) on the actuator housing.

29. Install the housing cover (2) on the actuator housing.

30. Coat the housing cover fasteners with anti-seize, if required.

31. Install the housing cover fasteners and tighten.

32. Using a site approved marker, transfer the 90 degree travel marks, made in Steps 21 and 24, from the side of the housing to the housing cover (2).

33. Using a center punch, transfer the maximum allowable total travel marks, made in Steps 17 and 18 from the side of the housing to the housing cover (2).

34. Place the actuator in the same position (i.e., open or closed) as the valve position recorded in Section 15.5 Step 7.

NOTE: The shaft adapter should be a press fit to avoid adapter movement in the HBC drive sleeve.

36. If the shaft adapter was removed from the valve in previous steps, replace it by pressing the shaft adapter on the valve shaft and positioning it flush with the end of the valve stem.

NOTE: If the drive sleeve (5), shaft adapter, or actuator housing cover was replaced, specific aligned marks may not be available.

36. If removed, insert the shaft adapter key into the adapter/valve stem keyway, and position slightly below (approximately 1/16") the face of the spline adapter (7).

37. Apply anti-seize, if required, to the surface and keyway of the shaft adapter.

38. Mount the HBC actuator on the valve and align the actuator and valve mounting flange match marks and appropriate full open/close match marks, if available.

NOTE: If the actuator housing mounting bolt holes do not align with the valve yoke mounting holes, perform the following Steps 39 and 40.

39. Rotate the worm shaft (6) so as to move the housing away from the stop that the drive sleeve is close to, and attempt to align the bolt holes.

CAUTION: The housing can only be cranked away an amount equal to the difference in allowable travel. This amount is the distance between the maximum allowable total travel and the 90 degree travel marks. Exceeding the distance will prevent the actuator from reaching a complete 90 degree travel.

40. If the actuator housing shifts in the wrong direction or if more travel is required for alignment than the distance between total travel and 90 degree travel marks, the actuator must be removed, and the adapter repositioned on the valve shaft such that the actuator can be installed in its normal position and provide a full open/close movement to the valve.

41. When the actuator mounting bolt holes are aligned, lubricate the bolts with anti-seize, if required.

42. Install the actuator mounting bolts and tighten finger tight.

43. Torque the mounting bolts using proper values and proper sequence.

15.11.3.1 Setting Position Limit Stops

1. Screw the stop screw (12) which is closest to contacting the drive sleeve flat inward, while counting the number of turns, until the end touches the drive sleeve.

2. Screw the opposite stop screws (12) outward the same number of turns as the first screw was turned inward in Step 1.

3. Back out both stop screws (12):

NOTE: This is one recommended amount. Site procedures may state different amounts.

- 1/2 turn each for "limit seated valves".
- 4 turns each for "torque seated valves".

4. Install the pointer cap (5) in the same position as Section 15.11.3 Step 15 with match marks from Section 15.5 Step 8 aligned.

5. Lubricate the pointer cap fasteners with anti-seize, if required.

6. Install the pointer cap fasteners and washers and tighten.

NOTE: The position of the pointer (11) now indicates the new full travel mark in one direction.

7. Using a site approved marker, mark the new full travel position on the housing, as indicated by the pointer (11) position.

8. Measure the distance between the new reference mark made in Step 7 and the old full travel (90 degree) travel reference mark, made in Section 15.11.3, Step 21 or 24.

9. Use the distance measured in Step 8 and establish the new full travel (90 degree) mark at the opposite end of actuator travel by measuring the same distance from the old reference mark made in SEction 15.11.3, Step 21 or 24. Using a site approved marker, mark the new reference point.

10. Verify that the new travel point is not beyond the maximum allowable travel point.

11. Install a Limitorque SMB, or other type actuator, if used.

CAUTION: Due to the large gear ratios on SMB/SB, or other type, and HBC combinations, the actuator or valve can easily be damaged by excessive force on the actuator handwheel. Do not attempt to rotate past the open position as indicated by resistance to movement and pointer indication. Use caution when going closed into the seat.

CAUTION: Use extreme caution when installing the lock screw to prevent it from turning the stop screw. A slight resistance will be felt when the lock screw contacts the stop screw.

12. Install the two stop screw lock screws and tighten.

13. Install the two stop screw covers/plugs on the actuator housing, use anti-seize if required.

NOTE: The pointer cap is removed so the end of the valve shaft can be viewed.

14. Remove the fasteners and washers holding the pointer cap (5) in place.

15. Remove the pointer cap (5).

16. Cycle the actuator to both full open and full closed positions. Ensure that the valve fully opens and closes by observation of the shaft end markings or review of the shaft key position in the vendor drawing.

17. Install the pointer cap (5) on the housing.

18. Install the pointer cap fasteners and washers and tighten.

15.11.4 HBC-10 Reassembly

NOTE: Line up the match marks during reassembly.

Refer to Figure 15-12.

NOTE: Replace any gaskets that are stiff or damaged.

1. Coat the drive sleeve O-ring (20) with a thin film of grease.
2. Install the O-ring (20) on the drive sleeve (4).

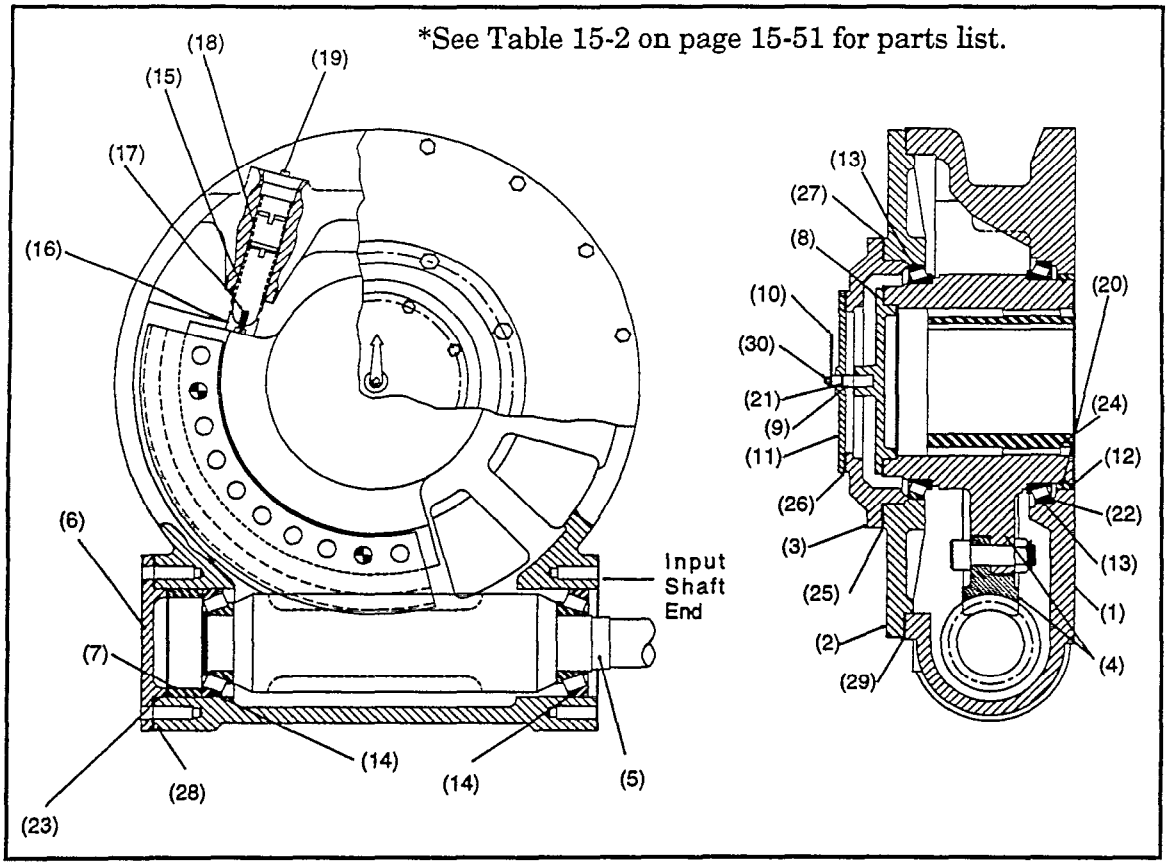


Figure 15 - 12
HBC-10

Table 15-2	
Parts List for Figure 15-12	
Part Number	Description
1	Housing
2	Housing Cover
3	Housing Cover Thru Cap
4	Drive Sleeve and Worm Gear Assembly
5	Worm Shaft
6	Worm Shaft End Cap
7	Bearing Cap
8	Indicator Pedestal
9	Indicator Shaft
10	Pointer
11	Dial Cover
12	Drive Sleeve Retaining Ring
13	Drive Sleeve Bearing
14	Worm Shaft Bearing (Tapered Roller Bearing)
15	Stop Screw
16	Stop Screw Head
17	Stop Screw Spring
18	Lock Screw
19	2" Standard Pipe Plug
20	Drive Sleeve O-ring
21	Indicator Shaft O-ring
22	Drive Sleeve Bearing Shim
23	Worm Shaft Bearing Shim Set
24	Spline Adapter
25	Housing Cover Thru Cap Gasket
26	Dial Cover Gasket
27	Pedestal Gasket
28	End Cap Gasket
29	Housing Cover Gasket
30	Hex Nut

3. Pack the drive sleeve bearings (13) with a site approved lubricant.

4. Install the drive sleeve (4) in the housing (1) with the midpoint of the worm gear (4) rim aligned with the center point on the housing (1) (midpoint between the worm shaft tapered roller bearing centers). Using a center punch, mark this point on the housing. Also mark center point of worm gear rim on top of the drive sleeve (4).

5. Pack the worm shaft tapered roller bearings (14) with a site approved lubricant.

6. Coat the worm shaft (5) with a site approved lubricant.

7. Install the tapered bearing on the worm shaft thru cap end.

8. Install the worm shaft (5) in the housing (1).

9. Install the worm shaft end cap (6) with the end cap gasket (28) and worm shaft bearing shim set (23) in the housing (1).

NOTE: The following is one method of installing the worm shaft end cap end tapered roller bearing on the worm shaft. Other appropriate methods may be used.

10. Start the tapered roller bearing (14) on the worm shaft end cap end of the worm shaft (5).

11. Install the tapered roller bearing (14) against the worm shaft end cap end bearing spacer (7).

CAUTION: Do not allow the drive sleeve to contact housing while installing bearing.

CAUTION: Rotate the worm shaft after each hammerblow to tighten the worm shaft against the tapered roller bearing and move the worm shaft threads against the opposite side of the threads on the worm gear. This prevents the threads from being driven against each other.

12. Using a dead blow hammer, drive the worm shaft end (5) through the tapered roller bearing (14) on the worm shaft end cap end.

13. Install the thru cap (not shown) with the thru cap gasket on the input end of the housing (1).

    Rotate the worm shaft (5) to ensure that the gaskets are properly sized. If the worm shaft bearings are too tight, add approximately .005" to the thru cap gasket. Continue adding approximately .005" increments until the worm shaft (5) turns with appropriate feel.

14. Temporarily install the indicator pedestal (8) in position on top of the drive sleeve (7), matching match marks.

15. Temporarily install the indicator shaft (9), pointer (10) with hex nut (3) on the indicator pedestal (8), using match marks.

16. Rotate the worm shaft (5) until the flat on one side of the drive sleeve (4) just touches the housing. Using a site approved marker, mark the pointer (10) location on the outside of the housing.

17. Rotate the worm shaft (5), in the opposite direction from Step 16 until the opposite drive sleeve flat just touches the housing. Using a site approved marker, mark the pointer (10) location on the outside of the housing.

NOTE: The markings applied to Steps 16 and 17 denote the maximum allowable total travel of the actuator.

18. Rotate the worm shaft (5) until the center point on the worm gear rim lines up with the first 90 degree mark.

19. Insert one stop screw (15) into its hole adjacent to the drive sleeve flat which is most parallel to the worm shaft (5). Thread the stop screw inward until it just touches the drive sleeve flat.

20. Using a site approved marker, mark the pointer (10) location on the outside of the housing.

21. Rotate the worm shaft (5) until the center point on the worm gear rim lines up with the other 90 degree mark.

22. Insert the second stop screw (15) into its hole adjacent to the drive sleeve flat which is most parallel to the worm shaft (5). Thread the stop screw inward until it just touches the drive sleeve flat.

23. Using a site approved marker, mark the pointer (10) location on the outside of the housing.

NOTE: The markings applied in Steps 20 and 23 denote the 90 degree travel of the actuator.

24. Remove the indicator shaft (9) with pointer (10) from the indicator pedestal (8).

25. Remove the indicator pedestal (8) from the drive sleeve (4).

26. Fill the HBC actuator housing with site approved lubricant, leaving an approximate one inch space between the lubricant and the housing cover for grease expansion. (See Appendix C for approximate amount of grease required.)

NOTE: If the housing (1), housing cover (2), drive sleeve assembly (4), or drive sleeve bearing (13) was replaced during previous steps, proceed to Step 27. If the housing cover gasket (29) was replaced and none of the other above mentioned parts were replaced proceed to Step 28. If the original gasket (29) as to be reused and no other parts mentioned above were substituted, proceed to Step 29.

27. Temporarily install the housing cover (2) on the housing and tighten the fasteners snug tight. Measure the clearance between the housing (1) and the housing cover (2). Add 10% to the measurement taken and use the closest nominal gasket thickness.

28. Measure the replacement housing cover gasket (29) to ensure that it is the same thickness, nominally as the original gasket measurement determined in Section 15.9 Step 12.

29. Install the housing cover gasket (29) on the actuator housing.

30. Install the housing cover (2) on the actuator housing.

31. Coat the housing cover fasteners with anti-seize, if required.

32. Install the housing cover fasteners and tighten.

33. Using a site approved marker, transfer the 90 degree travel marks, made in Steps 20 and 23, from the side of the housing to the housing cover (2).

34. Using a center punch, transfer the maximum allowable total travel marks, made in Steps 16 and 17 from the side of the housing to the housing cover (2).

35. Place the actuator in the same position (i.e., open or closed) as the valve position recorded in Section 15.11.4 Step 15.

NOTE: The shaft adapter should be a press fit to avoid adapter movement in the HBC drive sleeve.

36. If the shaft adapter was removed from the valve in previous steps, replace it by pressing the shaft adapter on the valve shaft and positioning it flush with the end of the valve stem.

NOTE: If the drive sleeve (4), shaft adapter, or actuator housing cover was replaced, specific alignment marks may not be available.

37. If removed, insert the shaft adapter key into the adapter/valve stem keyway, and position slightly below (approximately 1/16") the face of the spline adapter (24).

38. Apply anti-seize, if required, to the surface and keyway of the shaft adapter.

39. Mount the HBC actuator on the valve and align the actuator and valve mounting flange match marks and appropriate full open/close match marks, if available.

NOTE: If the actuator housing mounting bolt holes do not align with the valve yoke mounting holes, perform the following Steps 40 and 41.

40. Rotate the worm shaft (5) so as to move the housing away from the stop that the drive sleeve is close to, and attempt to align the bolt holes.

CAUTION: The housing can only be cranked away an amount equal to the difference in allowable travel. This amount is the distance between the maximum allowable total travel and the 90 degree travel marks. Exceeding the distance will prevent the actuator from reaching a complete 90 degree travel.

41. If the actuator housing shifts in the wrong direction or if more travel is required for alignment than the distance between total travel and 90 degree travel marks, the actuator must be removed, and the adapter repositioned on the valve shaft such that the actuator can be installed in its normal position and provide a full open/close movement to the valve.

42. When the actuator mounting bolt holes are aligned, lubricate the bolts with anti-seize, if required.

43. Install the actuator mounting bolts and tighten finger tight.

44. Torque the mounting bolts using proper values and proper sequence.

45. Install the indicator pedestal (8) with indicator shaft (9), using match marks.

46. Install indicator pedestal fasteners with anti-seize, if required.

47. Install the thru cap (3).

48. Install the thru cap fasteners with anti-seize, if required.

15.11.4.1 Setting Position Limit Stops

1. Screw the stop screw (15) which is closest to contacting the drive sleeve flat inward, while counting the number of turns, until the end touches the drive sleeve.

2. Screw the opposite stop screws (15) outward the same number of turns as the first screw was turned inward in Step 1.

3. Back out both stop screws (15):

NOTE: This is one recommended amount. Site procedures may state different amounts.

- 1/2 turn each for "limit seated valves".
- 4 turns each for "torque seated valves".

4. Install the dial cover (11) using match marks.

5. Install the dial cover fasteners with anti-seize, if required.

6. Install the pointer (10) with hex nut and lock washer(30).

NOTE: The position of the pointer (10) now indicates the new full travel mark in one direction.

7. Using a site approved marker, mark the new full travel position on the housing, as indicated by the pointer (10) position.

8. Measure the distance between the new reference mark made in Step 7 and the old full travel (90 degree) travel reference mark, made in Section 15.11.4, Step 20 or 23.

9. Use the distance measured in Step 8 and establish the new full travel (90 degree) mark at the opposite end of actuator travel by measuring the same distance from the old reference mark made in Section 15.11.4, Step 20 or 23. Using a site approved marker, mark the new reference point.

10. Verify that the new travel point is not beyond the maximum allowable travel point.

11. Install a Limitorque SMB, or other type actuator, if used.

CAUTION: Due to the large gear ratios on SMB/SB, or other type, and HBC combinations, the actuator or valve can easily be damaged by excessive force on the actuator handwheel. Do not attempt to rotate past the open position as indicated by resistance to movement and pointer indication. Use caution when going closed into the seat.

CAUTION: Use extreme caution when installing the lock screw to prevent it from turning the stop screw. A slight resistance will be felt when the lock screw contacts the stop screw.

12. Install the two stop screw lock screws (18) with anti-seize, if required, and tighten.

13. Install the two pipe plugs (19) with anti-seize, if required, and tighten.

14. Cycle the actuator to both full open and full closed positions. Ensure that the valve fully opens and closes by observation of the shaft end marking or keyway position on the valve drawing.

NOTE: If observation of the keyway end in the HBC actuator as required, remove hex nut (30) and lock washer, pointer (10), thru cap (3), and indicator pedestal (8).

15. Replace above items in opposite order of removal, ensuring match marks are aligned.

16.0 Spur and Bevel Gear Attachments

16.1 Total Spur and Bevel Gear Disassembly and Assembly

NOTE: Generally, spur and bevel gearboxes must be disassembled before they can be removed from the equipment they are driving.

NOTE: This procedure is for complete disassembly. If complete disassembly is not required, disregard appropriate steps.

1. Removal of blind bushings.

   There are blind bushings in some of the spur gear cases which cannot be removed using a standard puller. One easy way to remove these bushings is:

   - Hold the gear case so the open end of the bushing is facing upward.
   - Pack grease down through the bushing and fill the cavity and bushing. Leave enough space in the bushing to insert the end of the original shaft.
   - Insert the shaft which was in the bushing back into it.
   - Using a dead blow hammer, or other suitable instrument, tap the end of the shaft.
   - The hydraulic force generated by tapping the shaft and displacing the grease will force the bushing out of the case.

16.2 Single Reduction Spur Gear Disassembly (Ratio 2.86:1)

Refer to Figure 16-1.

1. Remove the handwheel from the 1st input shaft and pinion (3).

2. Remove the cap screws, 1st set housing (2), and 1st set housing gasket (9). Record gasket thickness.

   *Gasket Thickness _____

3. Remove the 1st input shaft and pinion (3).

4. Remove the input shaft quad ring (16), 1st set housing bearing (13), 1st housing adapter bearing (14), input shaft thrust bearings (10 and 11), and input shaft retaining ring (17).

5. Remove the idler gear spacer (8) and idler shaft pin (18).

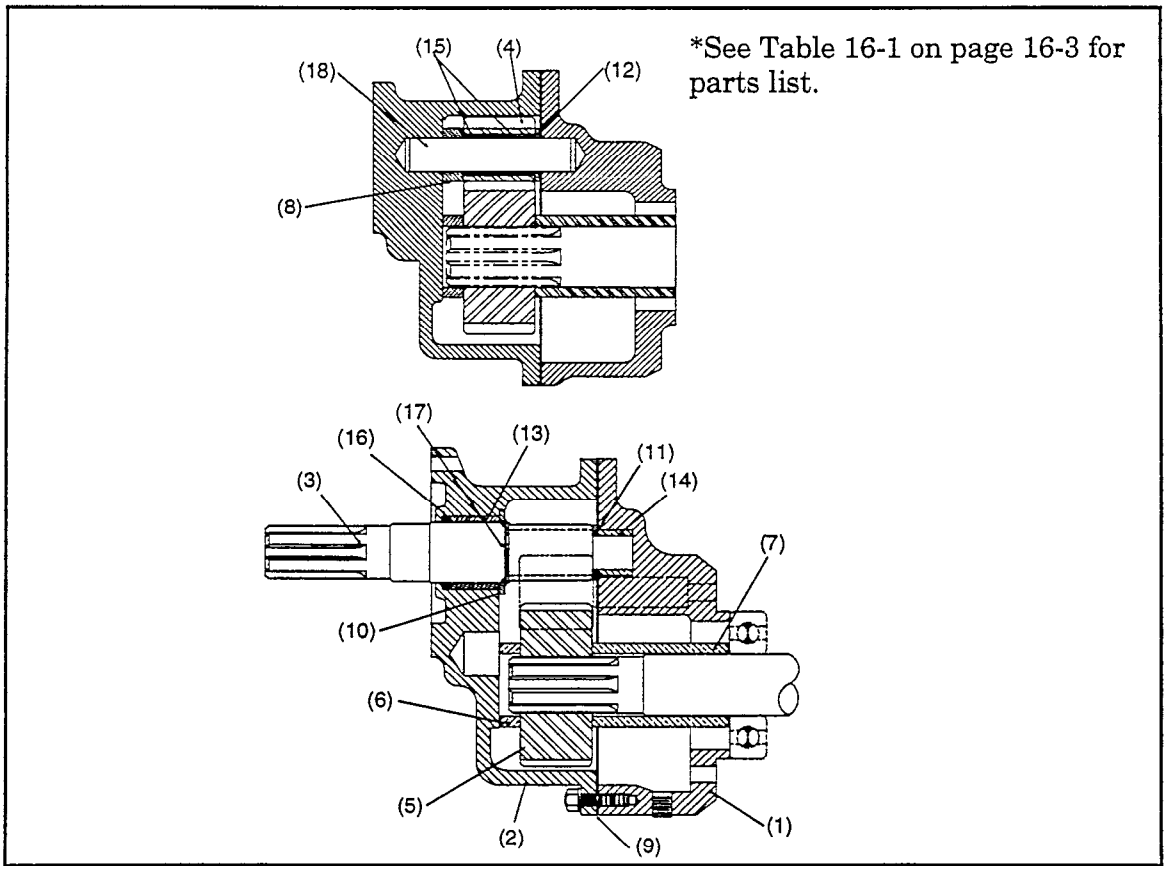


Figure 16 -1

Single Reduction Spur Gear

6. Remove the idler gear bearing (15) and idler gear thrust bearing (12).

7. Remove the 1st set collar (6).

8. Remove the 1st set output gear (5) and 1st set output gear spacer (7).

9. Remove the cap screws and 1st set housing adapter (1).

10. Clean and inspect all parts.

11. Replace/repair parts as required.

12. Identify and store parts until required for reassembly.

Table 16-1

Parts List for Figure 16-1

Part Number	Description
1	1st Set Housing Adapter
2	1st Set Housing
3	1st Input Shaft and Pinion
4	Idler Gear
5	1st Set Output Gear
6	1st Set Collar
7	1st Set Output Gear Spacer
8	Idler Gear Spacer
9	1st Set Housing Gasket
10	Thrust Bearing Input Shaft
11	Thrust Bearing Input Shaft
12	Thrust Bearing Idler Gear
13	Bearing 1st Set Housing
14	Bearing 1st Housing Adapter
15	Bearing Idler Gear
16	Quad Ring Input Shaft
17	Retaining Ring Input Shaft
18	Idler Shaft Pin

16.3 Double Reduction Spur Gear Disassembly (Ratio 12.0:1)

Refer to Figure 16-2.

1. Remove the handwheel from the 1st input shaft and pinion (3).

2. Remove the capscrews, 1st set housing (2), and 1st set housing gasket (9). Record gasket thickness.

   *Gasket Thickness _____

3. Remove the input shaft quad ring (16), 1st set housing bearing (13), 1st set housing adapter bearing (14), input shaft thrust bearings (10 and 11) and input shaft retaining ring (17).

4. Remove the capscrews, 2nd set housing adapter (20) and 2nd set housing gasket (21). Record gasket thickness.

   *Gasket Thickness _____

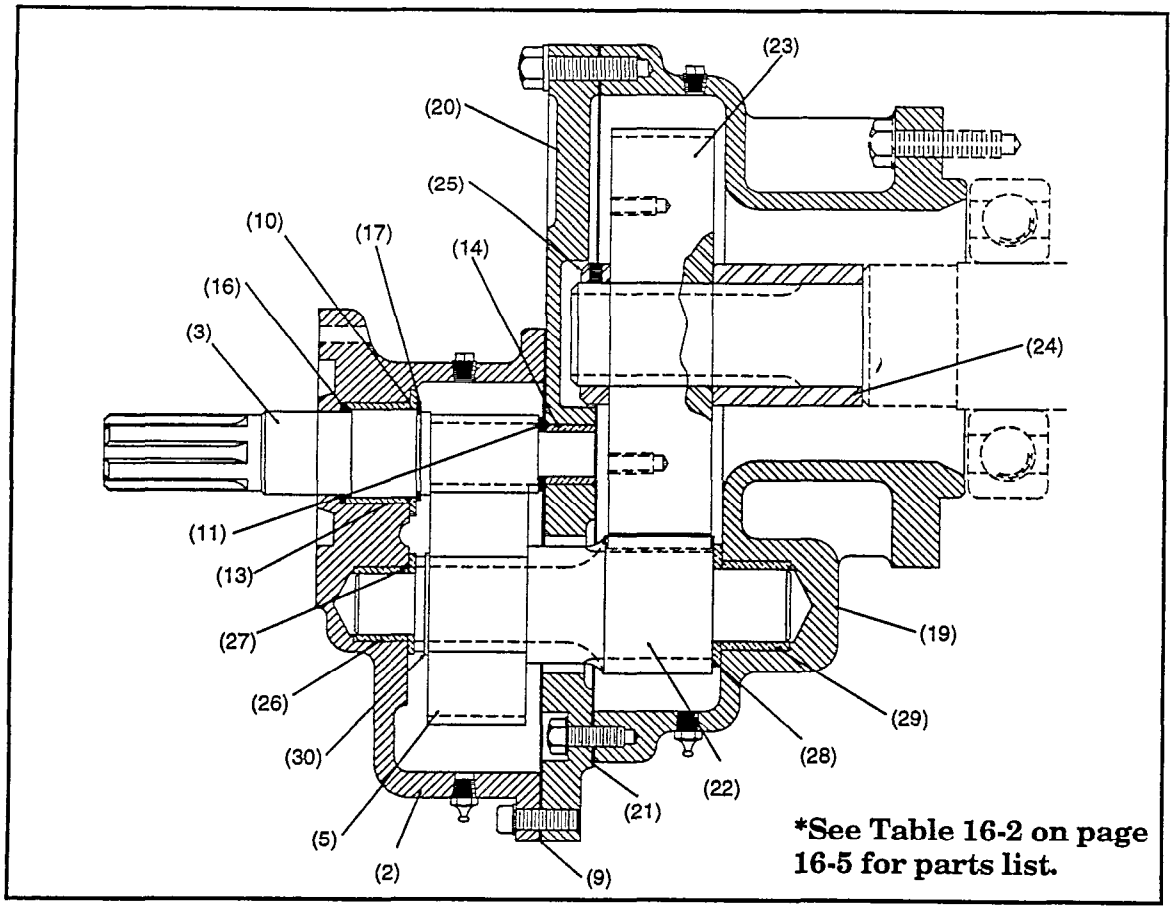


Figure 16 - 2

Double Reduction Spur Gear

5. Remove the intermediate shaft and pinion (22).

6. Remove intermediate shaft retaining ring (30), bearing intermediate shaft (26), bearing 2nd set housing (29), and thrust bearings intermediate shaft (27 and 28).

7. Remove the 2nd set output gear collar (25).

8. Remove the 2nd set output gear (23), and 2nd set output shaft spacer (24).

9. Remove the capscrews and 2nd set housing (19).

10. Clean and inspect all parts.

11. Replace/repair parts as required.

12. Identify and store parts until required for reassembly.

Table 16-2

Parts List for Figure 16-2

Part Number	Description
2	1st Set Housing
3	1st Input Shaft and Pinion
5	1st Set Output Gear
9	1st Set Housing Gasket
10	Thrust Bearing Input Shaft
11	Thrust Bearing Input Shaft
13	Bearing 1st Set Housing
14	Bearing 1st Housing Adapter
16	Quad Ring Input Shaft
17	Retaining Ring Input Shaft
19	2nd Set Housing
20	2nd Set Housing Adapter
21	2nd Housing Gasket
22	Intermediate Shaft and Pinion
23	2nd Set Output Gear
24	2nd Set Output Shaft Spacer
25	Collar Output Gear 2nd Set
26	Bearing Intermediate Shaft
27	Thrust Bearing Intermediate Shaft
28	Thrust Bearing Intermediate Shaft
29	Bearing 2nd Set Housing
30	Intermediate Shaft Retaining Ring

16.4 Triple Reduction Spur Gear Disassembly (Ratio 38.90:1)

Refer to Figure 16-3.

1. Remove the handwheel from the 1st input shaft and pinion (3).

2. Remove the capscrews, 1st set housing (2), and 1st set housing gasket (9). Record gasket thickness.

   *Gasket Thickness _____

3. Remove the 1st input shaft and pinion (3).

4. Remove the input shaft quad ring (16), 1st set housing bearing (13), 1st housing adapter bearing (14), input shaft thrust bearings (10 and 11) and input shaft retaining ring (17).

5. Remove the intermediate shaft and pinion (22).

6. Remove the bearing intermediate shaft (26), 2nd set housing bearing (29), intermediate shaft thrust bearings (27 and 28), and intermediate shaft retaining ring (30).

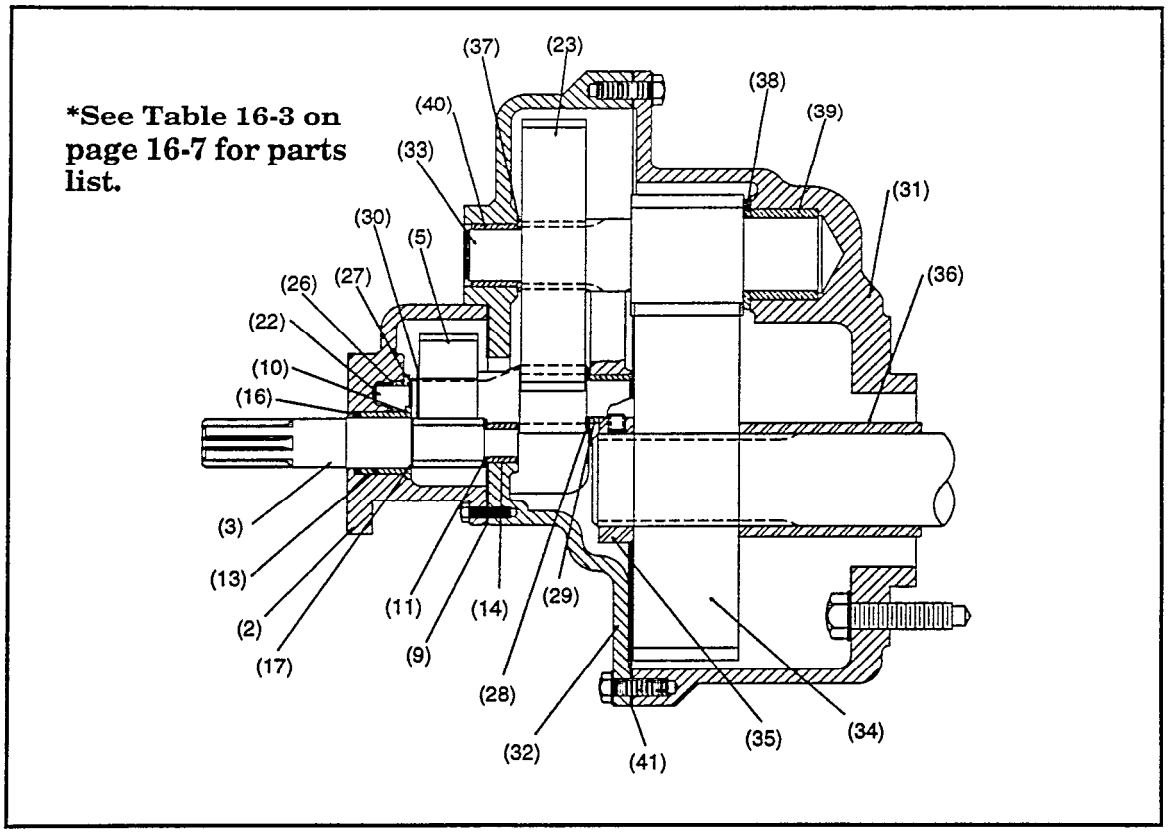


Figure 16 - 3

Triple Reduction Spur Gear

7. Remove the capscrews, 3rd set housing adapter (32), and 3rd set housing gasket (41). Record gasket thickness.

   *Gasket Thickness _____

8. Remove the intermediate shaft and output pinion (33).

9. Remove the 3rd set housing bearing (39), 3rd set housing adapter bearing (40), output pinion and shaft thrust bearings (37 and 38) and 2nd set output gear (23).

Table 16-3

Parts List for Figure 16-3

Part Number	Description
2	1st Set Housing
3	1st Input Shaft and Pinion
5	1st Set Output Gear
9	1st Set Housing Gasket
10	Thrust Bearing Input Shaft
11	Thrust Bearing Input Shaft
13	Bearing 1st Set Housing
14	Bearing 1st Housing Adapter
16	Quad Ring Input Shaft
17	Retaining Ring Input Shaft
22	Intermediate Shaft and Pinion
23	2nd Set Output Gear
26	Bearing Intermediate Shaft
27	Thrust Bearing Intermediate Shaft
28	Thrust Bearing Intermediate Shaft
29	Bearing 2nd Set Housing
30	Intermediate Shaft Retaining Ring
31	3rd Set Housing
32	3rd Set Housing Adapter
33	Intermediate Shaft and Output Pinion
34	3rd Output Gear
35	Collar Output Gear 3rd Set
36	3rd Set Output Shaft Spacer
37	Thrust Bearing Output Pinion and Shaft
38	Thrust Bearing Output Pinion and Shaft
39	Bearing 3rd Set Housing
40	Bearing 3rd Set Housing Adapter
41	3rd Set Housing Gasket

10. Remove the 3rd set output gear collar (35).
11. Remove the 3rd output gear (34) and 3rd set output shaft spacer (36).
12. Remove the capscrews and 3rd set housing (31).
13. Clean and inspect all parts.
14. Replace/repair parts as required.
15. Identify and store parts until required for reassembly.

16.5 Bevel Gear Disassembly (Ratio 2.86:1)

Refer to Figure 16-4.

1. Remove the handwheel from the bevel pinion and shaft (44).
2. Remove the bevel gear housing cap (43).
3. Remove the bevel gear cap O-ring (49).
4. Remove the bevel gear cap gasket (50) and pinion shaft cap shim (52). Record gasket thickness.

   *Gasket Thickness _____

5. Remove the bevel pinion and shaft (44).

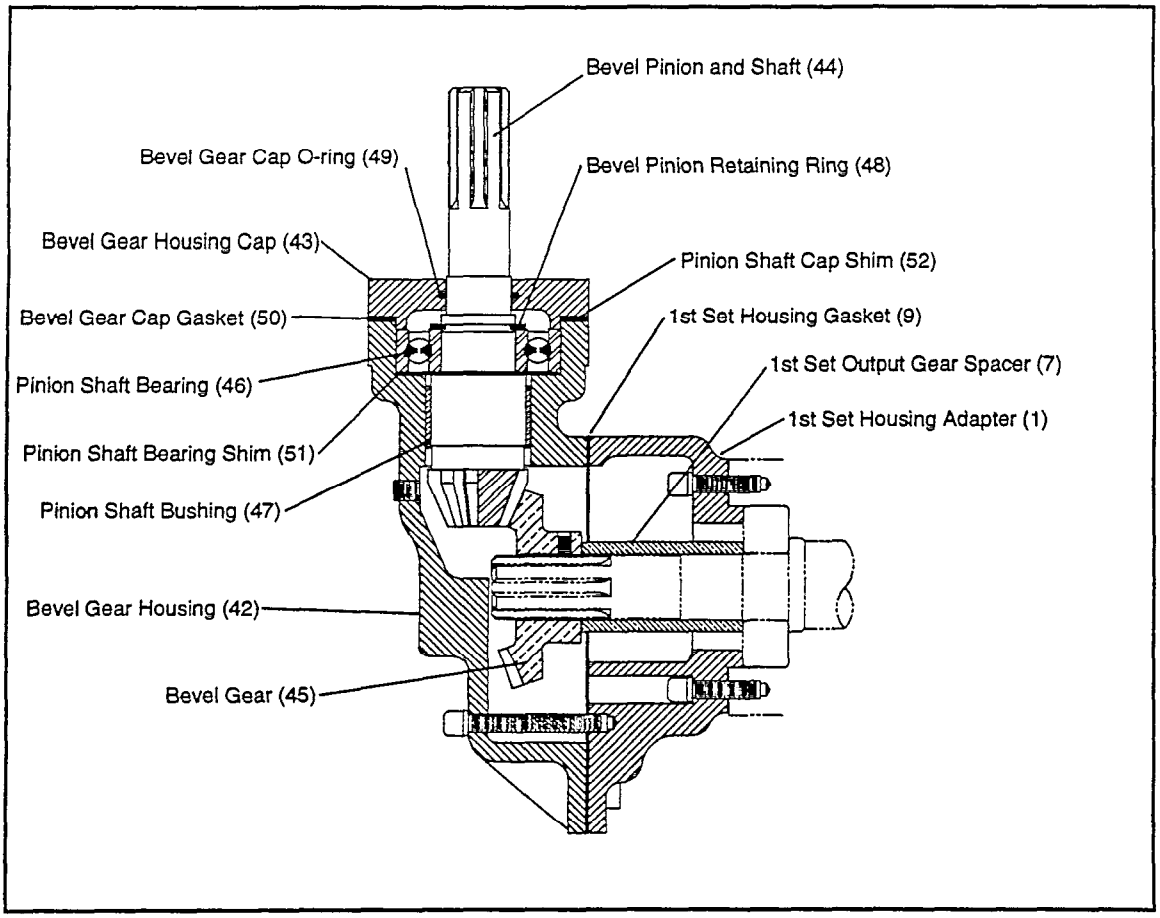


Figure 16 - 4

Bevel Gear Reduction

6. Remove the bevel pinion retaining ring (48), pinion shaft bearing (46) and pinion shaft bushing (47).

7. Remove the pinion shaft bearing shim (51).

8. Remove the capscrews, bevel gear housing (42) and 1st set housing gasket (9). Record gasket thickness.

   *Gasket Thickness _____

9. Loosen the set screw and remove the bevel gear (45).

10. Remove the 1st set output gear spacer (7).

11. Remove the capscrews and 1st set housing adapter (1).

16.6 Single Reduction Spur Gear Assembly

Refer to Figure 16-1.

NOTE: This assembly is based on complete disassembly. If the actuator was not completely disassembled, perform the assembly using only the appropriate steps.

NOTE: Gears, shafts, and bearings shall be packed with site specified grease prior to installation.

NOTE: The gears, shafts, and bearings shall be packed with site approved grease before assembly.

1. Install the 1st set housing adapter (1).

2. Install the capscrews and tighten them securely.

3. Install the 1st set output gear spacer (7) with the 1st set output gear (5).

4. Install the 1st set collar (6).

5. Install the idler gear bearings (15) with the idler gear thrust bearing (12) on the idler shaft pin (18).

6. Install the idler gear spacer (8) on the idler shaft pin (18).

7. Install the idler shaft pin (18).

8. Place the input shaft retaining ring (17) on the 1st input shaft and pinion (3).

9. Place the input shaft thrust bearings (10 and 11) with the 1st set housing bearing (13) and 1st housing adapter bearing (14) on the 1st input shaft and pinion (3).

10. Install the input shaft quad ring (16) on the 1st input shaft and pinion (3).

11. Install the 1st input shaft and pinion (3).

NOTE: See Section 16.2 Step 2 for gasket thickness.

12. Install the 1st set housing (2) with the 1st set housing gasket (9).

13. Install the capscrews and tighten them securely.

14. Install the handwheel on the 1st input shaft and pinion (3).

15. Lubricate the attachment with a site approved lubricant.

16.7 Double Reduction Spur Gear Assembly

Refer to Figure 16-2.

NOTE- The gears, shafts, and bearings shall be packed with site specified grease prior to installation.

WARNING: If modifications such as pipe plugs and internal holes have not been added to the gearbox lubrication must be done during reassembly as each section is completed. (See Appendix A for information on modification.)

1. Install the 2nd set housing (19).

2. Install the setscrews and tighten them securely.

3. Install the 2nd set output shaft spacer (24) and 2nd set output gear (23).

4. Install the 2nd set output gear collar (25).

5. Install the intermediate shaft retaining ring (30) on the intermediate shaft and pinion (22).

6. Place the intermediate shaft thrust bearings (27 and 28), intermediate shaft bearing (26) and 2nd set housing bearing (29) on the intermediate shaft and pinion (22).

7. Install the intermediate shaft and pinion (22).

NOTE: See Section 16.3 Step 4 for gasket thickness.

8. Install the 2nd set housing adapter (20) with the 2nd housing gasket (21).

9. Install the capscrews and tighten them securely.

10. Place the retaining ring input shaft (17) on the 1st input shaft and pinion (3).

11. Place the input shaft thrust bearings (10 and 11), with the 1st set housing bearing (13) and 1st housing adapter bearing (14) on the 1st input shaft and pinion (3).

12. Install the 1st input shaft and pinion (3).

13. Install the 1st set housing (2) with the 1st set housing gasket (9).

14. Install the capscrews and tighten them securely.

15. Lubricate the attachment with site approved lubricant.

16. Install the handwheel on the 1st input shaft and pinion (3).

16.8 Triple Reduction Spur Gear Assembly

Refer to Figure 16-3.

WARNING: If modifications such as pipe plugs and internal holes hare not been added to the gearbox, lubrication must be done during reassembly as each section is completed.

1. Install the 3rd set housing (31).
2. Install the capscrews and tighten them securely.
3. Install the 3rd set output shaft spacer (36) and 3rd output gear (34).
4. Install the 3rd set output gear collar (35).
5. Place the thrust bearings output pin and shaft (37 and 38) on the intermediate shaft and output pinion (33).
6. Place the 3rd set housing bearing (39) and 3rd set housing adapter bearing (40) on the intermediate shaft and output pinion (33).
7. Install the intermediate shaft and output pinion (33) and 2nd set output gear (23).

NOTE: See Section 16.4 Step 7 for gasket thickness.

8. Install the 3rd set housing gasket (41) and 3rd set housing adapter (32).
9. Install the capscrews and tighten them securely.
10. Install the intermediate shaft retaining ring (30) on the intermediate shaft and pinion (22).
11. Place the thrust bearings intermediate shaft (27 and 28), bearing intermediate shaft (26) and bearing 2nd set housing (29) on the intermediate shaft and pinion (22).
12. Install the intermediate shaft and pinion (22).
13. Place the retaining ring input shaft (17) on 1st input shaft and pinion (3).

14. Install the thrust bearings input shaft (10 and 11), bearing 1st set housing (13) and bearing 1st housing adapter (14) on the 1st input shaft and pinion (3).

15. Install the 1st input shaft and pinion (3).

16. Install the input shaft quad ring (16) into the 1st set housing (2).

NOTE: See Section 16.4 Step 2 for gasket thickness.

17. Install the 1st set housing gasket (9) with the 1st set housing (2).

18. Install the capscrews and tighten them securely.

19. Install the handwheel on the 1st input shaft and pinion (3).

20. Ensure that lubrication has been performed using the site approved lubricant.

16.9 Bevel Gear Assembly

Refer to Figure 16-4.

NOTE: The gears, shafts and bearings shall be packed with site approved grease before assembly.

1. Install the 1st set housing adapter (1).

2. Install the capscrews and tighten them securely.

3. Install the 1st set output gear spacer (7).

4. Install the bevel gear (45). Ensure that the set screw is tightened securely.

NOTE: See Section 16.5 Step 8 for gasket thickness.

5. Install the bevel gear housing (42) with the 1st set housing gasket (9).

6. Install the capscrews and tighten them securely.

7. Rotate the bevel gear (45). If it is tight, add gasket thickness until the gear rotates freely.

8. Place the pinion shaft bushing (47) on the bevel pinion and shaft (44).

9. Place the pinion shaft bearing (46) and the bevel pinion retaining ring (48) on the bevel pinion and shaft (44).

10. Place the pinion shaft bearing shim (51) in the bevel gear housing (42).

11. Ensure that the pinion shaft bearing (46) is packed with a site approved grease.

12. Install the bevel pinion and shaft (44).

NOTE: See Section 16.5 Step 4 for gasket thickness.

13. Install the pinion shaft cap shim (52) with the bevel gear cap gasket (50).

14. Place the bevel gear cap O-ring (49) in the bevel gear housing cap (43).

15. Install the bevel gear housing cap (43).

16. Lubricate the bevel gear with a site approved lubricant.

17. Install the handwheel on the bevel pinion and shaft (44).

18. Rotate the handwheel. It should rotate smoothly with little drag.

17.0 Preoperational/Post Maintenance Testing

The following are methods by which post-maintenance testing can be performed to ensure that HBC gearboxes have been restored to proper operating condition before being approved for unrestricted use:

1. Visually check that there are no leaking gaskets or seals.

2. Ensure that the boltup/connection to driver and driven unit is correct.

3. Operate the actuator/gearbox through full cycle:

   - Ensure that the actuator/gearbox operates smoothly with no binding.

   - Ensure that there are no vibrations, squeaks, chattering, squeals or grinding noise.

18.0 Spare Parts Handling and Storage Requirements

Spare parts must be handled and stored properly if they are to be of use when needed. The parts are expensive and lead times are generally long when ordering replacements.

The following guidelines can help in keeping spare parts in good condition.

18.1 Storage Locations

Store in an environmentally controlled area with a low moisture environment and minimal temperature fluctuations.

Keep parts plainly marked to assist in locating and for ready access for inspection.

Store actuators and gearboxes so that their full weight is supported. This helps prevent component distortion.

Periodically rotate the input shafts of spare actuators and gearboxes. This may require a strap wrench or other assistance.

18.2 Periodic Maintenance While in Storage

Ensure all covers, caps, and plugs remain intact.

Keep storage area clean.

Periodically check for damage and oil weepage.

18.3 Spare Parts Ordering Guidelines

Typically, the following information is required when ordering spare parts:

- Equipment nameplate data
  - Type
  - Size
  - Serial Number
  - Order Number
  - Gear Ratio
- Safety related or commercial class.

Certificate of compliance required.

Any special packaging and/or identification required.

Limitorque customer service may be contacted for assistance as required.

18.4 Material Receipt

The following checks may be performed upon receipt of material.

- Check for damage to cartons by crushing, fire, water, etc.
- Compare vendor shipping documents with purchase order for variances. Ensure that any required certificate of compliances are included.
- Ensure that required tagging and packaging is in accordance with purchase order.
- Ensure that correct number of items and proper item have been shipped.
- Check items for the following:

  Bent

  Cracked

  Deformed

  Casting defects

  Missing items from complete assemblies

18.5 Used Parts

Ensure damaged parts are properly disposed of and do not get into spare parts inventory.

Treat salvaged parts as new parts. Maintain traceability as required.

18.6 Spare Parts Inventory

Listed in Chapter 19 are HBC and spur/bevel gearbox part numbers and item numbers for all actuators and gearboxes with the exception of part numbers for the HBC-10 actuator. Limitorque may be contacted for this information as needed. This parts list is believed to be accurate as of date of this publication. However, users are requested to confirm the part numbers before placing any order.

18.7. Spare Parts Ordering Guidelines

The following factors should be considered in determining inventory levels. Some parts may require inventory levels higher or lower than the industry norms based on individual plant experience.

> *NOTE: The cause of part usage higher than industry norms should be investigated. It may indicate other problems.*

- Plant experience with the part.
- Industry experience with the part.
- Vendor recommendations based on past spare parts order history.
- Number of gear operators of a particular model/size in use.
- Delay between order and receipt of parts.
- Common part usage in several size operators.
- Potential common part usage in non-safety, safety, non-environmentally and environmentally qualified among the various model and sizes.
- Planned upgrades or modifications involving part replacement.
- Industry testing or inspection requirements potentially increasing part usage.
- Planned overhauls, increasing preventive maintenance activities.

19.0 HBC Parts

NOTE: There are no HBC-8 and HBC-9 gearboxes.

Listed are HBC part numbers and item numbers for all HBC operators and spur/bevel gearboxes with the exception of part numbers for the HBC-10 operator. Limitorque may be contacted for this information.

Sites should establish their own spare parts list. This may be done by considering the following, plus any other pertinent information.

- Past parts usage history
- Frequency of operation
- Operational environment (hot, wet, etc.)
- Severity of operation (heavily loaded, lightly loaded)
- Spare parts lead time
- Safety related application
- Post maintenance findings

Table 19-1		
HBC-0 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003-0021-4
2	Housing Cover	60-103-0049-2
4	Thru Cap W.S.	60-120-0042-1
4A	Hex Head Cap Screw	HB1-5/16 - 18 x 20
5	Drive Sleeve and Worm Gear Assembly	
	71:1, 90 Degrees	60-214-0053-2
	71:1, 360 Degrees	60-214-0131-2
	32:1, 90 Degrees	60-214-0174-2
	32:1, 360 Degrees	60-214-0176-2
6	Worm Shaft	Per Order
7	Splined Adapter	Per Order
8	Pointer	60-564-0009-1
9	Pointer Cap	60-138-0024-1
10	End and Thru Cap Gasket	60-654-0263-1
11	Housing Cover Gasket	60-654-0264-1
13	Worm Shaft Bearing	CC1-6206
14	Drive Sleeve O-ring	CM2-334-V14A
15	Worm Shaft O-ring	CM2-216-V14A
18	Hex Stop Nut	HP-1-1-8
19	Limit Stop Housing	60-014-0017-3
19A	Socket Head Cap Screw	HC1-5/16 - 18 x 16
20	Limit Stop Housing Stop Cap	60-117-0086-1
21	Limit Stop Housing Cover Gasket	60-654-0091-1

Table 19-2		
HBC-1 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003-0023-4
2	Housing Cover	60-103-0051-2
4	Thru Cap W.S.	60-123-0045-1
4A	Hex Head Cap Screw	HB1-3/8 - 16 x 24
5	Drive Sleeve and Worm Gear Assembly	
	70:1, 90 Degrees	60-214-0056-3
	70:1, 360 Degrees	60-214-0027-3
	35:1, 90 Degrees	60-214-0144-3
	35:1, 360 Degrees	60-214-0158-3
6	Worm Shaft	Per Order
7	Splined Adapter	Per Order
8	Pointer	60-564-0009-1
9	Pointer Cap	60-138-0025-1
10	End and Thru Cap Gasket	60-654-0260-1
11	Housing Cover Gasket	60-654-0262-1
13	Worm Shaft Bearing	CC1-6307
14	Drive Sleeve O-ring	CM2-339-V14A
15	Worm Shaft O-ring	CM2-219-V14A
18	Hex Stop Nut	HP-1-1 1/4-7
19	Limit Stop Housing	60-014-0007-3
19A	Socket Head Cap Screw	HC1-3/8 - 16 x 20
20	Limit Stop Housing Stop Cap	60-117-0041-1
21	Limit Stop Housing Cover Gasket	60-654-0243-1

Table 19-3		
HBC-2 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003-0022-4
2	Housing Cover	60-103-0050-3
4	Thru Cap W.S.	60-123-0045-1
4A	Hex Head Cap Screw	HB1-3/8 - 1 16x 24
5	Drive Sleeve and Worm Gear Assembly	
	70:1, 90 Degrees	60-214-0055-3
	70:1, 360 Degrees	60-214-0122-3
	41:1, 90 Degrees	60-214-0440-3
	41:1, 360 Degrees	60-214-0441-3
6	Worm Shaft	Per Order
7	Splined Adapter	Per Order
8	Pointer	60-564-0009-1
9	Pointer Cap	60-138-0026-1
10	End and Thru Cap Gasket	60-654-0260-1
11	Housing Cover Gasket	60-654-0264-1
13	Worm Shaft Bearing	CC1-6307
14	Drive Sleeve O-ring	CM2-348-V14A
15	Worm Shaft O-ring	CM2-219-V14A
18	Hex Stop Nut	HPl-l 1/4-7
19	Limit Stop Housing	60-014-0007-3
19A	Socket Head Cap Screw	HC1-3/8 - 16 x 20
20	Limit Stop Housing Stop Cap	60-117-0041-3
21	Limit Stop Housing Cover Gasket	60-654-0243-1

Table 19-4		
HBC-3 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003-0025-3
2	Housing Cover	60-103-0044-3
4	Thru Cap W.S.	60-123-0045-1
4A	Hex Head Cap Screw	HB1-3/8 - 1 16 x 24
5	Drive Sleeve and Worm Gear Assembly	
	70:1, 90 Degrees	9300-12
	70:1, 360 Degrees	9300-16
	41:1, 90 Degrees	9300-21
	41:1, 360 Degrees	9300-25
6	Worm Shaft	Per Order
7	Splined Adapter	Per Order
8	Pointer	60-564-0009-1
9	Pointer Cap	60-138-0027-1
10	End and Thru Cap Gasket	60-654-0260-1
11	Housing Cover Gasket	60-654-0265-1
12	Drive Sleeve Bushing	60-675-0006-1
13	Worm Shaft Bearing	CC1-6307
14	Drive Sleeve O-ring	CM2-435-V14A
15	Worm Shaft O-ring	CM2-219-V14A
18	Hex Stop Nut	HP1-1 1/4-7
19	Limit Stop Housing	60-014-0007-3
19A	Socket Head Cap Screw	HC1-3/8 - 16 x 20
20	Limit Stop Housing Stop Cap	60-117-0041-1
21	Limit Stop Housing Cover Gasket	60-654-0243-1

Table 19-5		
HBC-4 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003 -0026-4
2	Housing Cover	60-103-0045-3
3	End Cap W.S.	60-117-0060-1
3 A	Hex Head Cap Screw	HB1-1/2 - 1 13 x 32
4	Thru Cap W.S.	60-120-0041-1
4 A	Hex Head Cap Screw	HB1-1/2 - 1 13 x 32
5	Drive Sleeve and Worm Gear Assembly	
	60:1, 90 Degrees	8201-102
	60:1, 360 Degrees	8201-103
	39:1, 90 Degrees	8201-104
	39:1, 360 Degrees	8201-105
6	Worm Shaft	Per Order
7	Splined Adapter	Per Order
8	Pointer	60-564-0009-1
9	Pointer Cap	60-138-0028-1
10	End and Thru Cap Gasket	60-654-0054-1
11	Housing Cover Gasket	60-654-0055-1
12	Drive Sleeve Bushing	60-676-0007-1
13	Worm Shaft Bearing	CC1-6312
14	Drive Sleeve O-ring	CM2-440-V14A
15	Worm Shaft O-ring	CM2-331-V14A
16	Stop Screw Cover	60-117-0066-1
17	Stop Screw and Lockscrew (2)	60-525-0045-1
	Socket Head Set Screw	H71-7/8 - 9 x 12

Table 19-6		
HBC-5 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003-0027-4
2	Housing Cover	60-103-0046-3
3	End Cap W.S.	60-117-0060-1
3 A	Hex Head Cap Screw	HB1-1/2 - 13 x 32
4	Thru Cap W.S.	60-120-0041-1
4 A	Hex Head Cap Screw	HB1-1/2-1 13 x 32
5	Drive Sleeve and Worm Gear Assembly	
	65:1, 90 Degrees	8301-048
	65:1, 360 Degrees	8301-049
	63:1, 90 Degrees	8301-052
	63:1, 360 Degrees	8301-053
	42:1, 90 Degrees	8301-050
	42:1, 360 Degrees	8301-051
6	Worm Shaft	Per Order
7	Splined Adapter	Per Order
8	Pointer	60-564-0041-1
9	Pointer Cap	60-138-0029-1
10	End and Thru Cap Gasket	60-654-0054-1
11	Housing Cover Gasket	60-654-0056-1
12	Drive Sleeve Bushing	60-676-0008-1
13	Worm Shaft Bearing	CC1-6312
14	Drive Sleeve O-ring	CM2-447-V14A
15	Worm O-ring	CM2-331-V14A
16	Stop Screw Cover	60-117-0066-1
17	Stop Screw and Lockscrew (2)	60-525-0046-1
	Socket Head Set Screw	H73-1-12

Table 19-7		
HBC-6 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003-0028-4
2	Housing Cover	60-103-0047-3
3	End Cap W.S.	60-117-0061-1
3 A	Hex Head Cap Screw	HB1-3/4 - 10 x 44
4	Thru Cap W.S.	60-120-0040-1
4 A	Hex Head Cap Screw	HB1-3/4 - 1 10 x 44
5	Drive Sleeve and Worm Gear Assembly	
	66:1, 90 Degrees	8401-085
	66:1, 360 Degrees	8401-086
	45:1, 90 Degrees	8401-087
	45:1, 360 Degrees	8401-088
6	Worm Shaft	Per Order
7	Splined Adapter	Per Order
8	Pointer	60-564-0010-1
9	Pointer Cap	60-138-0030-2
10	End and Thru Cap Gasket	60-654-0058-1
11	Housing Cover Gasket	60-654-0057-1
12	Drive Sleeve Bushing	60-676-0009-1
13	Worm Shaft Bearing	CB1-78551
	Worm Shaft Bearing	CA-1-78250
14	Drive Sleeve O-ring	CM2-451-V14A
15	Worm Shaft O-ring	CM2-333-V14A
16	Stop Screw Cover	60-117-0067-1
17	Stop Screw & Lockscrew Group (90 Degrees Only)	60-525-0046-1

Table 19-8		
HBC-7 Parts List		
Piece No.	Description	Part No.
1	Housing	60-003-0131-4
2	Housing Cover	60-103-0048-3
3	End Cap W.S.	60-123-0118-1
3 A	Hex Head Cap Screw	HB1-7/8 - 9 x 48
5	Drive Sleeve and Worm Gear Assembly	Per Order
6	Worm Shaft	Per Order
8	Pointer	60-564-0010-1
9	Pointer Cap	60-138-0031-2
10	End and Thru Cap Gasket	60-654-0060-1
11	Housing Cover Gasket	60-654-0061-1
12	Drive Sleeve Bushing	60-676-0010-1
13	Worm Shaft Bearing	CB1-JHM522610
14	Drive Sleeve O-ring	CM1-452-B46A
16	Stop Screw Cover	60-117-0066-1
17	Stop Screw & Lockscrew Group (90 Degrees Only)	8501-043

NOTE: The piece numbers on this HBC-7 parts list and the piece numbers on Figures 15-3 and 15-11 are not the same because Limitorque used different piece numbers on its parts list and drawing. The piece numbers on the figures in this guide were taken from Limitorque drawing number 01-440-0118-4. The piece numbers used on these drawings are listed on the table below.

Table 19-9			
Part Numbers from Limitorque Drawing Number 01-440-0118-4			
1	Housing	9	Drive Sleeve Bearing
2	Housing Cover	10	Bearing Spacer
3	W. S. End Cap (Blind)	11	Pointer
4	Stop Screw Cover	12	Stop Screw
5	Pointer Cap	13	Stop Screw Cap
6	Worm Gear Rim	14	Stop Screw Spring
7	Drive Sleeve	15	Housing Cover Gasket
8	Worm Shaft	16	W. S. End Cap Gasket

Table 19-10		
HBC-10 Parts List (For Part Number, consult Factory)		
Piece No.	Description	Where Used
1	Housing	
2	Housing Cover	
3	Thru Cap (Housing Cover)	
4	Worm Gear Rim	
4	Drive Sleeve	
5	Worm Shaft	
6	Worm Shaft End Cap	
8	Indicator Pedestal	
9	Indicator Shaft	
10	Pointer	
11	Dial Cover	
12	Drive Sleeve Seal Retaining Ring	
13	Drive Sleeve Bearings	
14	Worm Shaft Bearings	
15	Stop Screw	
16	Stop Screw Head	
17	Stop Screw Spring	
18	2"-4 1/2 x 2" lg. St. Screw Flt. Pt.	
19	2" Std. Pipe Plug	
20	Drive Sleeve O-ring	4
21	Indicator Shaft 0-ring	9
22	Drive Sleeve Bearing Shim	1
23	Worm Shaft Bearing Shim Set	7/5
24	Spline Adapter	4
25	Housing Cover Thru Cap Gasket	3/2
26	Dial Cover Gasket	3/11
27	Pedestal Gasket	4/8
28	Worm Shaft End Cap Gasket	1/6
29	Housing Cover Gasket	1/2
30	1/2-13 Hex Nut and Lock Washer	9
	5/8- 11 x 3" Hex Head Cap Screw and Lockwasher	1/2
	5/8- 11x2 3/4" Long Hex Head Cap Screw & L.W.	
	3/8- 16x1 1/4" Long Hex Head Cap Screw & L.W.	3/11 and 4/8
	3/4- 10x3 1/4" Long Soc Head Cap Screw & L.W.	1/6
	1" - 8 x 4 1/2 Long Socket Head Cap Screw	4
	1" - 8 Nuts - Flexloc	4
	1" Dia x 3 1/4 Long Dowel Pin	4
	1/2 -13 x 3/8 Long Set Screws	1/2

Table 19-11			
Spur and Bevel Gear Attachments Parts List			
Piece No.	Qty.	Description	Part No.
1	1	1st Set Housing Adapter	60-006-0026-3
2	1	1st Set Housing	60-106-0016-3
3	1	1st Input Shaft and Pinion	60-322-0019-2
4	1	Idler Gear	60-426-0067-1
5	1	1st Set Output Gear	60-426-0068-1
6	1	1st Set Collar	60-551-0032-1
7	1	1st Set Output Gear Spacer	60-551-0033-1
8	1	Idler Gear Spacer	60-551-0031-1
9	1	1st Set Housing Gasket	60-654-1024-2
10	1	Thrust Bearing (Input Shaft)	CE2-TT-1900
11	1	Thrust Bearing (Input Shaft)	CE2-TT-1205
12	1	Thrust Bearing (Idler Gear)	CE2-TT-1205
13	1	Bearing (1st Set Housing)	CE2-AA-1608-10
14	1	Bearing (1st Housing Adapter)	CF2-AA-1043-6
15	2	Bearing (Idler Gear)	CF2-AA-1043-6
16	1	Quad Ring (Input Shaft)	CN1-Q4221-366Y
17	1	Retaining Ring (Input Shaft)	CG1-5100-137
18	1	Idler Shaft Pin	JC1-3/4 X 56
19	1	2nd Set Housing	60-106-0019-4
20	1	2nd Set Housing Adapter	60-117-0051-3
21	1	2nd Set Housing Gasket	60-654-1029-3
22	1	Intermediate Shaft and Pinion	60-322-0022-2
23	1	2nd Set Output Gear	60-426-0079-2
24	1	2nd Set Output Shaft Spacer	60-551-0034-1
25	1	Collar Output Gear 2nd Set	60-553-0019-1
26	1	Bearing (Intermediate Shaft)	CF2-AA-1043-6
27	1	Thrust Bearing (Intermediate Shaft)	CE2-TT-1205-1
28	1	Thrust Bearing (Intermediate Shaft)	CE2-TT-1502
29	1	Bearing (2nd Set Housing)	CF2-AA-1204-7
30	1	Intermediate Shaft Retaining Ring	CG1-5100-125
31	1	3rd Set Housing	60-006-0108-4
32	1	3rd Set Housing Adapter	60-156-0052-4
33	1	Intermediate Shaft and Output Pinion	60-322-0067-2
34	1	3rd Output Gear	60-426-0078-2
35	1	Collar Output Gear 3rd Set	60-559-0049-01
36	1	Output Shaft Spacer 3rd Set	60-551-0038-1
37	1	Thrust Bearing (Output Pin and Shaft)	CE2-1T-1900

Table 19-11			
Spur and Bevel Gear Attachments Parts List (continued)			
Piece No.	Qty.	Description	Part No.
38	1	Thrust Bearing (Output Pin and Shaft)	CE2-TT-3001-3
39	1	Bearing (3rd Set Housing)	CF2-AA-2304
40	1	Bearing (3rd Set Housing Adapter)	CF2-AA-1608-10
41	1	3rd Set Housing Gasket	60-654-1037-2
42	1	Bevel Gear Housing	60-006-0032-3
43	1	Bevel gear Housing Cap	60-123-0027-1
44	1	Bevel Pinion and Shaft	60-427-0027-2
45	1	Bevel Gear	60-429-0018-2
46	1	Pinion Shaft Bearing	CC1-6307
47	1	Pinion Shaft Bushing	CF2-AA-2001-3
48	1	Bevel Pinion Retaining Ring	CG1-5160-137
49	1	Bevel Gear Cap O-ring	CM1-219-B46A
50	1	Bevel Gear Cap Gasket	60-654-1038-1
51	1	Pinion Shaft Bearing Shim Set	60-660-0035-1
52	1	Pinion Shaft Cap Shim	60-660-0036-1

Table 19-12	
One Set Spur Gear Attachment Parts List	
Piece No.	Description
1	1st Set Housing Adapter
2	1st Set Housing
3	1st Input Shaft and Pinion
4	Idler Gear
5	1st Set Output Gear
6	1st Set Collar
7	1st Set Output Gear Spacer
8	Idler Gear Spacer
9	1st Set Housing Gasket
10	Input Shaft Thrust Bearing
11	Input Shaft Thrust Bearing
12	Idler Gear Thrust Bearing
13	2nd Set Housing Bearing
14	1st Housing Adapter Bearing
15	Idler Gear Bearing
16	Input Shaft Quad Ring
17	Input Shaft Retaining Ring
18	Idler Shaft Pin

Table 19-13	
Two Sets Spur Gear Attachment Parts List	
Piece No.	Description
2	1st Set Housing
3	1st Input Shaft and Pinion
5	1st Set Output Gear
9	1st Set Housing Gasket
10	Input Shaft Thrust Bearing
11	Input Shaft Thrust Bearing
13	2nd Set Housing Bearing
14	1st Housing Adapter Bearing
16	Input Shaft Quad Ring
17	Input Shaft Retaining Ring
19	2nd Set Housing
20	2nd Set Housing Adapter
21	2nd Set Housing Gasket
22	Intermediate Shaft and Pinion
23	2nd Set Output Gear
24	2nd Set Output Shaft Spacer
25	2nd Set Output Gear Collar
26	Intermediate Shaft Bearing
27	Intermediate Shaft Thrust Bearing
28	Intermediate Shaft Thrust Bearing
29	2nd Set Housing Bearing
30	Intermediate Shaft Retaining Ring

Table 19-14	
Three Sets Spur Gear Attachment Parts List	
Piece No.	Description
2	1st Set Housing
3	1st Input Shaft and Pinion
5	1st Set Output Gear
9	1st Set Housing Gasket
10	Input Shaft Thrust Bearing
11	Input Shaft Thrust Bearing
13	2nd Set Housing Bearing
14	1st Housing Adapter Bearing
16	Input Shaft Quad Ring
17	Input Shaft Retaining Ring
22	Intermediate Shaft and Pinion
23	2nd Set Output Gear
26	Intermediate Shaft Bearing
27	Intermediate Shaft Thrust Bearing
28	Intermediate Shaft Thrust Bearing
29	2nd Set Housing Bearing
30	Intermediate Shaft Retaining Ring
31	3rd Set Housing
32	3rd Set Housing Adapter
33	Intermediate Shaft and Output Pinion
34	3rd Output Gear
35	3rd Set Output Gear Collar
36	3rd Set Output Shaft Spacer
37	Output Pin and Shaft Thrust Bearing
38	Output Pin and Shaft Thrust Bearing
39	3rd Set Housing Bearing
40	3rd Set Housing Adapter Bearing
41	3rd Set Housing Gasket

20.0 References

1. Limitorque Maintenance Update 92-1.

2. NMAC Lubrication Guide. (NP-4916R1)

3. NRC IE Information Notice No. 83-02: Limitorque HBC-0, HBC-1, HBC-2, and HBC-3 Gearheads.

4. Limitorque Type HBC Instruction and Maintenance Manual, Bulletin HBCI - 90.

5. Clarification of Information Related to the Environmental Qualification of Limitorque Motorized Valve Operators, by Nuclear Utility Group on Equipment Qualification, April, 1986.

6. Limitorque Valve Controls, Manual Type HBC. Bulletin 15-73.

Appendix A Pipe Plug Addition on Spur Gear Attachment

Limitorque HBC actuators built prior to 1988 did not contain a pipe plug for inspection or grease addition. The housing covers on these actuators had to be removed for checking grease level or condition. Appendix A provides step by step instructions for installing pipe plugs on the reduction gear housing. In addition to the main housing, housing cover is also an acceptable location for the installation of a pipe plug. These recommendations are based on the Limitorque Maintenance Bulletin 92-1.

A.1 For Single Reduction Spur Gear

Refer to Figure A-1.

1. Disassemble and clean the single reduction gearbox.

NOTE: The housing must be deburred and cleaned before reassembly.

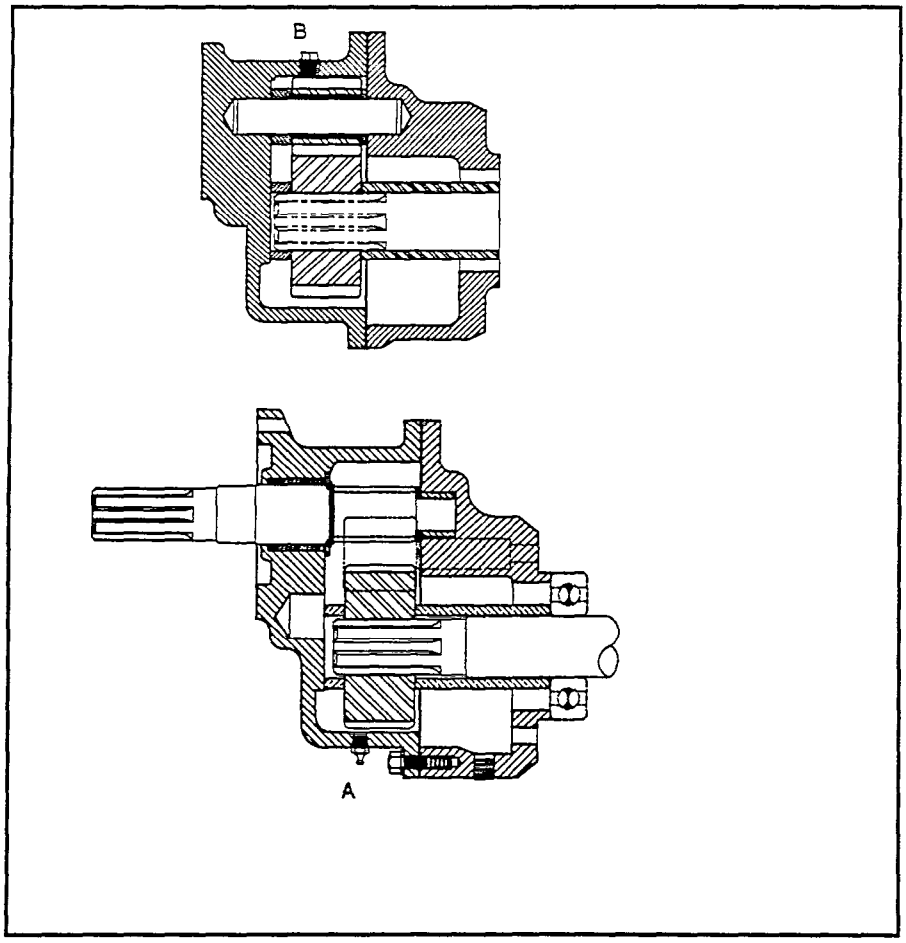


Figure A - 1

Single Reduction Set Pipe Plug & Grease Fitting

2. Add a grease fitting and plug at the following location.

   - Add a 1/8" grease fitting at Point A, the low point of the first set housing, below the 1st set output gear.

   - Add a 1/8" plug at Point B, the high point of the first set housing, above the idler gear.

3. After reassembly, the housing may be filled with grease through the bottom openings, while using the upper openings as sight windows. Do not overfill. Leave some air space for thermal expansion.

A.2 For Double Reduction Spur Gear

Refer to Figure A-2.

1. Disassemble and clean the double reduction gearbox.

NOTE: The housing must be deburred and cleaned before reassembly.

2. Add grease fittings and plugs at the following locations.

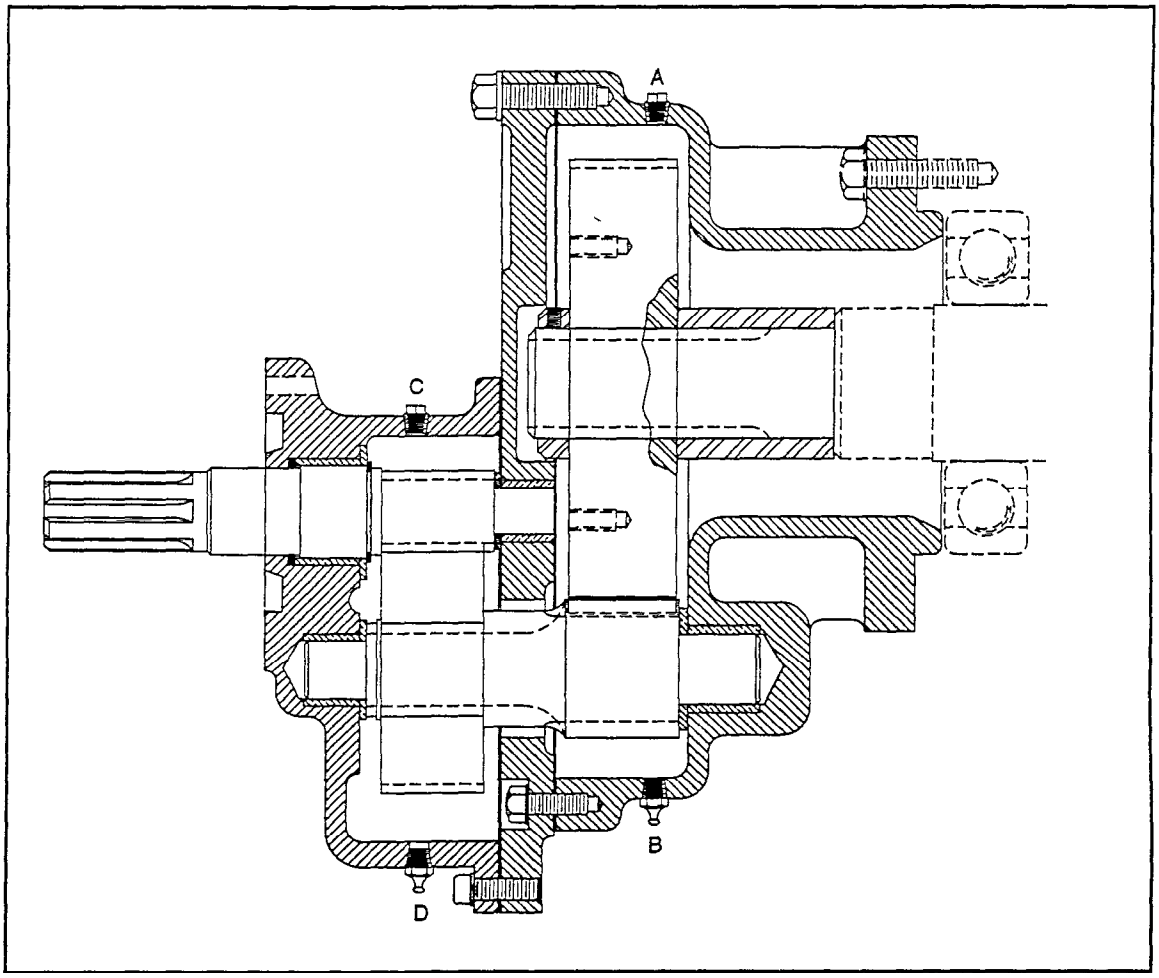
   - Add a 1/8" plug at Point A, the high point section of the second set housing, above the second set output gear.

   - Add a 1/8" grease fitting at Point B, the low point section of the second set housing, directly opposite the high point plug.

   - Add a 1/8" plug at Point C, the high point section of the first set housing, close to the retaining ring input shaft.

   - Add a 1/8" grease fitting at Point D, the low point section of the first set housing close, to the first set output gear.

3. After reassembly, the housing may be filled with grease through the bottom openings, while using the upper openings as sight windows. Do not overfill. Leave some air space for thermal expansion.



A - 2

Double Reduction Set Pipe Plug & Grease Fittings

A.3 For Triple Reduction Spur Gear

Refer to Figure A-3.

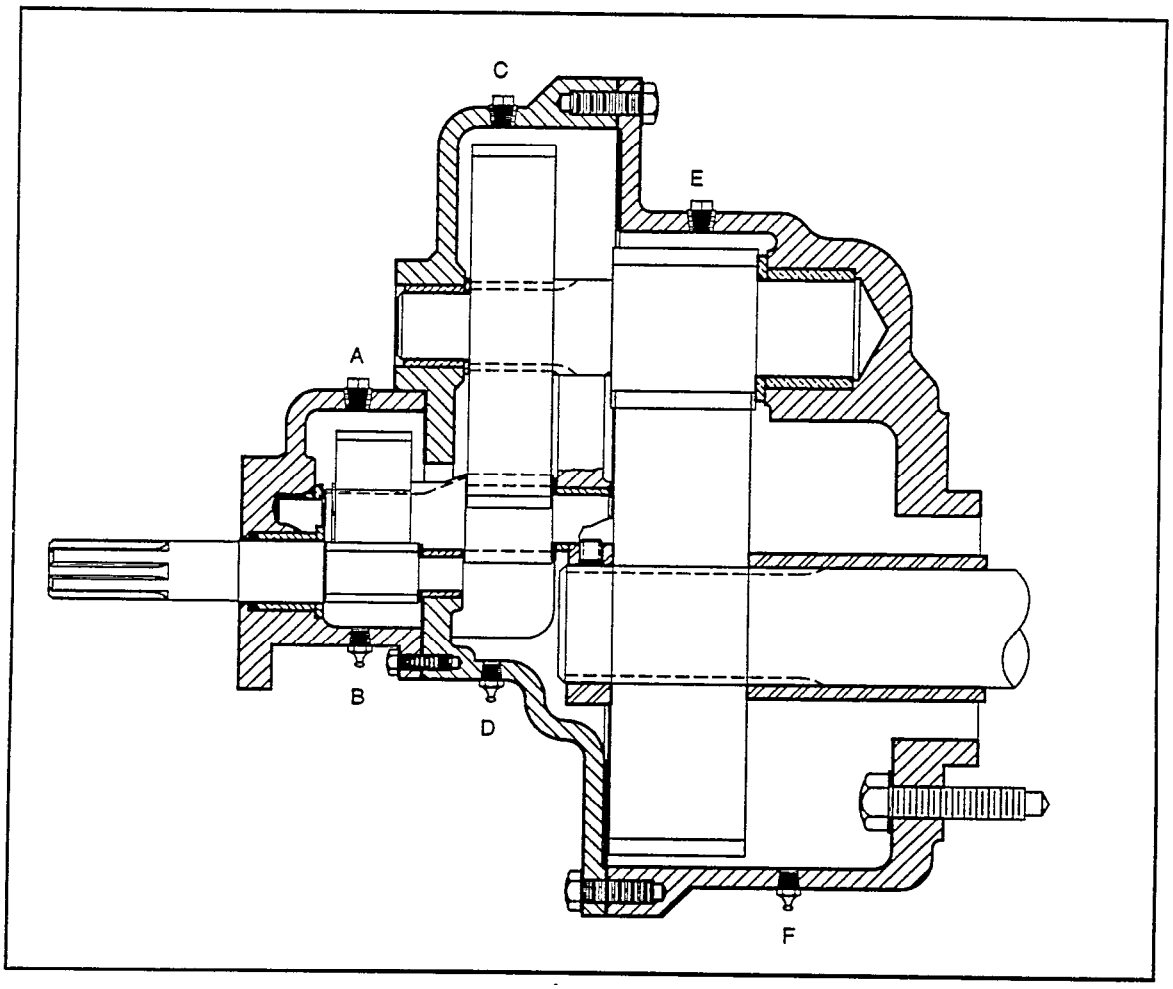
1. Disassemble and clean the triple reduction gearbox.

NOTE: The housing must be deburred and cleaned before reassembly.

2. Add grease fittings and plugs at the following locations.

   - Add a 1/8" plug at Point A, the high point section of the first set housing, above the first set output gear.
   - Add a 1/8" grease fitting at Point B, the low point section of the first set housing, below the first input pinion.
   - Add a 1/8" plug at Point C, the high point section of the 3rd set housing adapter, above the 2nd set output gear.
   - Add a 1/8" grease fitting at Point D, the low point section of the 3rd set housing adapter, below the intermediate pinion gear.
   - Add a 1/8" plug at Point E, the high point of the 3rd set housing, above the intermediate output pinion.
   - Add a 1/8" grease fitting at Point F. the low point of the 3rd set housing, below the 3rd output gear.

3. After reassembly, the housing may be filled with grease through the bottom openings, while using the upper openings as sight windows. Do not overfill. Leave some air space for thermal expansion.



A - 3

Triple Reduction Set Pipe Plug & Grease Fittings

A.4 Pipe Plug Addition to HBC Housing Cover

In addition to the HBC housing placement of the pipe plug given in Limitorque Maintenance Bulletin 92-1, the housing cover is an acceptable alternate location for the pipe plug as long as the following concerns are met.

- The pipe plug does not interfere with operation of the HBC gearbox.
- The worm and worm gear interface is covered with grease during operation.
- There is an approximate one inch space left between the grease and the housing cover for grease expansion.

Appendix B HBC Angular Displacement Tolerances

Refer to Figure B-1 and the following table.

Table B-1

HBC Angular Displacement Tolerances

Unit Size	Angular Displacement Stop	Angular Displacement Gear	Spline Tooth Space in Degrees
HBC-0	* 105°	170° Gear Segment	9.00°
HBC-1	* 114°	170° Gear Segment	6.42°
HBC-2	* 114°	170° Gear Segment	4.50°
HBC-3	* 114°	*** 170° Gear Segment	3.46°
HBC-4	** ± 7°	± 7°	3.00°
HBC-5	** ± 6.75°	± 6.75°	2.14°
HBC-6	** ± 9°	± 9°	1.80°
HBC-7	** ± 9°	± 9°	N/A
HBC-10	± 10°	± 10°	N/A

*Stops used on HBC-0 through HBC-3 actuators incorporate standard hex nuts. The tolerance listed is ±.031" from basic size on the thickness. The data shown above is based the maximum thickness of both nuts.

** Displacement is based on 45° travel on either side of the gear centerline.

*** Units with a serial number less than S/N 365365 have 110° gear segments.

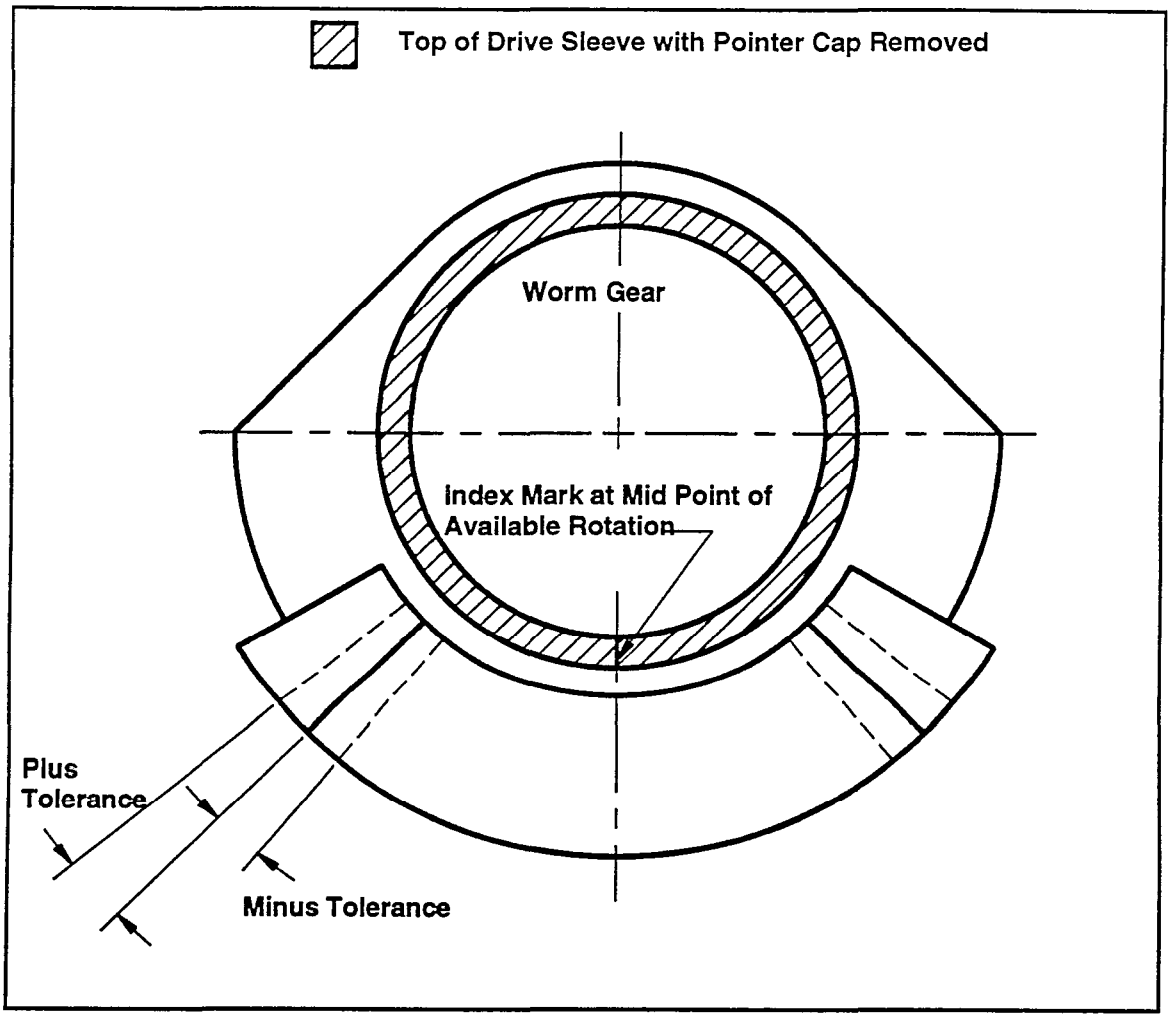


Figure B - 1

Angular Displacement Tolerances

Appendix C Approximate Amount of Lubricant

Approximately 1/2 gallon of lubricant should be sufficient for all spur/bevel gearboxes. Use personal judgment after viewing the gearbox.

The following table lists approximate amounts of lubricant required for HBC actuators.

Table C-1
Amount of Lubricant

Unit Size	Approx. Gallon	Approx. Lbs.
HBC-0	.20	1.5
HBC-1	.35	3.0
HBC-2	.50	4.0
HBC-3	1.40	12.0
HBC-4	3.50	30.0
HBC-5	5.20	45.0
HBC-6	9.25	80.0
HBC-7	14.5	125.0
HBC-10	26.0	225.0

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