

**BETTIS**

**SERVICE INSTRUCTIONS**

**DISASSEMBLY AND REASSEMBLY**

**FOR "B" AND "C" MODEL**

**HD733-SR SERIES**

**SPRING RETURN**

**PNEUMATIC ACTUATORS**

PART NUMBER: 074945

REVISION: "A"

Date: 5 May 2000

## CONTENTS

SECTION	DESCRIPTION	PAGE
1.0	Introduction .....	2
2.0	Definitions .....	2
3.0	Safety .....	2
4.0	Basic Service Information .....	3
5.0	Support Items And Tools .....	3
6.0	Bettis Reference Materials .....	4
7.0	Lubrication Requirements .....	4
8.0	General Disassembly .....	4
9.0	Spring Cylinder Removal .....	6
10.0	Pressure Cylinder Disassembly .....	6
11.0	Housing Disassembly .....	7
12.0	General Reassembly .....	8
13.0	Housing Reassembly .....	8
14.0	Pressure Cylinder Reassembly .....	9
15.0	Spring Cylinder Reassembly .....	13
16.0	Actuator Testing .....	14
17.0	Return To Service .....	16
18.0	M3 Jackscrew Disassembly .....	16
19.0	M3 Jackscrews Pre-Assembly .....	17
20.0	Information Notes .....	19
21.0	HD733-SR Generic Parts List .....	21
22.0	Figure 1 – HD733-SR Exploded Drawing .....	23
23.0	Figure 2 – HD733-SR-M3 Exploded Drawing .....	24

## 1.0 INTRODUCTION

- 1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis "B" & "C" model HD733-SR, HD733-SR-M3, and HD733-SR-M3HW pneumatic actuators. When the actuator model number has "X" in it or a "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.
- 1.2 The HD733-SR actuator series went out of production in the early 1970's. The Service Kit is a generic kit that fits all HD733 double acting and HD733-SR series actuators (models "Basic", "A", "B" and "C"). Because the kit fits so many different model actuators there will be extra seals, gaskets and hardware items in the kit. NOTE: Refer to page 20 for a generic parts list for HD733-SR actuators.

## 2.0 DEFINITIONS

- WARNING:** If not observed, user incurs a high risk of severe damage to actuator and/or fatal injury to personnel.
- CAUTION:** If not observed, user may incur damage to actuator and/or injury to personnel.
- NOTE:** Advisory and information comments provided to assist maintenance personnel to carry out maintenance procedures.
- SR:** Spring Cartridge.
- J:** Jackscrew Manual overrides. The "J" in the model number has been changed to M3 or to M3HW (HW indicates an 8" inch or 18" inch handwheel attached to the outboard end of the jackscrew). Refer to Section 20 steps 20.10 and 20.11 for more information on M3 and M3HW jackscrews.

## 3.0 SAFETY

- 3.1 SAFETY STATEMENT: Products supplied by Bettis, in its "as shipped" condition, are intrinsically safe if the instructions contained within this Service Instruction are strictly adhered to and executed by a well trained, equipped, prepared and competent technician.

**WARNING:** For the protection of personnel working on Bettis actuators, this procedure should be reviewed and implemented for safe disassembly and reassembly. Close attention should be noted to the WARNINGS, CAUTIONS and NOTES contained in this procedure.

**WARNING:** This procedure should not supersede or replace any customer's plant safety or work procedures. If a conflict arises between this procedure and the customer's procedures the differences should be resolved in writing between an authorized customers representative and an authorized Bettis representative.

**WARNING:** It is possible, that the actuator may contain a dangerous gas (Sour gas/H<sub>2</sub>S, Oxygen, Nitrogen, etc.) or liquid (Chlorine, Condensates, etc.). Ensure that all proper measures have been taken to prevent dangerous exposure or release of these types of residues before commencing any work.

#### **4.0 BASICE SERVICE INFORMATION**

- 4.1 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.
- 4.2 Numbers in parentheses, ( ) indicate the bubble number (reference number) used on the Exploded Detail Drawing.
- 4.3 Complete actuator refurbishment requires the actuator be dismantled from the valve or device it is operating.
- 4.4 Normal recommended service interval for this actuator series is five years to maximum total life cycle.

NOTE: Storage time is counted as part of the service interval.

- 4.5 This procedure is applicable with the understanding that all electrical power and pneumatic pressure has been removed from the actuator. Also, it is understood that the actuator has been removed from the valve as well as all piping and accessories that are mounted on the actuator have been removed.

#### **5.0 SUPPORT ITEMS AND TOOLS**

- 5.1 Support Items - Service Kit, commercial leak testing solution, and non-hardening thread sealant.
- 5.2 Tools - All tools are American Standard inch. Two each medium screwdrivers, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and a torque wrench (up to 2,000 inch pounds). For recommended tool list refer to the following table.

ITEM NO.	WRENCH SIZE	QTY	DESCRIPTION OR LOCATION	RECOMMENDED WRENCH STYLE
-	3/16"	4	Weather cover screws	Allen
9	<b>(1)</b>	1	Outer cylinder	Chain
11	7/8"	2	Stop Screw	Open end or adjustable
12	1-5/16"	2	Stop screw nut	Open end or adjustable
13	1-5/8"	1	Lok nut	Socket or adjustable
19	3/4"	4	Cover screws	Socket
21	3/8"	8	Cylinder adapter screws	Allen/socket <b>(3)</b>
22	7/8"	1	Snubber valve	Deep Socket
23	7/16"	1	Pipe plug	Open end or adjustable
28	<b>(1) (2)</b>	1	Inner cylinder	Chain
31	1-3/4"	1	Piston rod adapter	Open end or adjustable
33	1-1/4"	1	Lok nut	Socket or adjustable
38	<b>(1)</b>	1	SR cylinder	Chain
39	11/16"	2	Breather <b>(4)</b>	Open end
3-30	1-13/16"	1	M3 seal nut	Open end or adjustable
-	1-11/16"	1	M3HW hex nut	Open end or socket
NOTES: (1) Bettis recommends a short handled Chain Wrench with a 40" inch chain. (2) Two chain wrenches will be needed to remove item number 28. (3) Refer to Section 20 step 20.8. (4) Refer to Section 20 step 20.5.				

## 6.0 BETTIS REFERENCE MATERIALS

- 6.1 Exploded drawing, Section 22.0 Figure Number 1, for HD733-SR fail clockwise (CW).
- 6.2 Exploded drawing, Section 13.0 Figure Number 2, for HD733-SR-M3 fail clockwise (CW).

## 7.0 LUBRICATION REQUIREMENTS

- 7.1 All temperature services (-50°F to +350°F) / (-45.5°C to 176.6°C) use Bettis ESL-4,5 & 10 lubricant. This lubricant is contained in the Bettis Service Kit.

NOTE: Lubricant other than that listed in Section 7 step 7.1 should not be used without prior written approval of Bettis Product Engineering.

## 8.0 GENERAL DISASSEMBLY

- 8.1 This procedure is written using the stop screw side of the housing (1) as a reference and this side will be considered the front side of the actuator and the housing cover as the top of the actuator.
- 8.2 To help in correct re-assembly; that is, with spring on same end of housing as was, mark right or left and mark mating surfaces.

8.3 When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp edges rounded off.

8.4 Use a non-hardening thread sealant on all pipe threads.

**CAUTION: Apply the thread sealant per the manufacture instructions.**

8.5 Disassembly of actuator should be done in a clean area on a workbench.

**CAUTION: Pressure applied to the actuator is not to exceed the maximum operating pressure rating listed on the actuator name tag.**

8.6 Before starting the general disassembly of the actuator, it is a good practice to operate the actuator with the pressure supplied by the customer to operate the actuator during normal operation. Notate and record any abnormal symptoms such as jerky or erratic operation. Also note, when operating pressure is removed from the air cylinders and exhausted, that the spring rotates the actuator back to it's fail position.

NOTE: When all pneumatic pressure is removed from the pressure inlet ports it will allow the spring cartridge (30) to rotate the actuator to its fail position.

8.7 If not already done remove all operating pressure from actuator cylinder (9), outer body (29) and cylinder adapter (8) located on spring cylinder (29) side of housing (1).

8.8 If the actuator is equipped with an M3 jackscrew make sure that the jackscrew does not engage piston rod (30).

8.9 Actuators equipped with M3HW jackscrew with handwheel option, remove hex nut, lockwasher, and handwheel. Refer to step number 20.10 for information on non-removable handwheel.

8.10 Remove three breathers (39). One is located in the end of spring cylinder (38), one in the port of cylinder adapter (8) and the final breather in outer body (29). Refer to step number 20.5 for additional information.

8.11 Mark stop screws (1-60) left and right. Measure and record the exposed length of the right and left stop screws (11). The stop screws will be removed later in this procedure.

8.12 Mark all the pressure ports on the cylinder adapted (8) and the outer body (29) in such a manner as to be able to reassemble the actuator with the ports in the correct location.

## 9.0 SPRING CYLINDER REMOVAL

**WARNING:** When cylinder assembly (38) is installed on the actuator, the spring cartridge is under compression. Do not remove cylinder assembly (38) until the actuator has the "pre-load" removed.

9.1 Remove spring cylinder "pre-load" as follows: To move the actuator load off of the stop screw, simultaneous apply sufficient pneumatic pressure to the pressure inlet ports located in the SR cylinder adapter (8), outer body (29), and outer cylinder (9).

9.2 Loosen the two jam nuts (12).

9.3 Unscrew and remove two stop screws (11) from the front of housing.

9.4 Remove pressure from the pressure inlet ports.

**CAUTION:** Due to the weight and nature of a spring cartridge pre-loaded assembly, caution should be exercised when handling the spring cartridge (37). The spring cartridge (37) is unattached and is only contained by the cylinder assembly (38).

9.5 Secure the chain wrench around spring cylinder (38) as close to the welded end cap as possible. Using a mallet, break the cylinder loose and then remove the cylinder by rotating in a counter clockwise direction.

NOTE: When setting the cylinder assembly (38) aside, care should be taken to protect the chamfered edge and cylinder threads.

9.6 Carefully remove spring cartridge (37) from cylinder assembly (38) by slightly tilting open end of cylinder down.

**WARNING:** Under no circumstances should the spring cartridge (37) be cut apart, as the spring is pre-loaded and the spring cartridge welded together.

9.7 Unscrew and remove standard hex lock nut (13) from piston rod (6).

NOTE: Refer to step 20.3 for additional information concerning different piston configurations.

9.8 Remove piston (7) or (40) from piston rod (6).

## 10.0 PRESSURE CYLINDER DISASSEMBLY

NOTE: When disassembling the tandem (double) cylinder side of the actuator you will need to hold the assembly with a chain wrench while rotating the part you are removing with a second chain wrench.

10.1 Secure a chain wrench around outer cylinder (9)/(3-10), as close to the welded end cap as possible and a second chain wrench around outer body (29). Using a mallet, break cylinder loose and then remove the cylinder by rotating in a counter clockwise direction.

NOTE: When setting cylinder aside, care should be taken to protect the chamfered edge and cylinder threads.

- 10.2 Unscrew and remove hex lock nut (33). NOTE: Some models will have a lockwasher with a standard hex jam nut.
- 10.3 Remove outer piston (32) from outer piston rod (30).
- 10.4 Secure a chain wrench around outer body (29) and a second chain wrench around inner cylinder (28). Using a mallet, break outer body loose, remove outer body by rotating in a counter clockwise direction.
- 10.5 Secure a chain wrench around inner cylinder (28). Using a mallet, break inner cylinder loose, remove inner cylinder by rotating in a counter clockwise direction.
- 10.6 Remove outer piston rod (30) and piston rod adapter (31) from piston rod (6).
- 10.7 Remove inner piston (7) from piston rod (6).
- 10.8 Unscrew and remove four cylinder adapter screws (21) and gasket seals (24) from both cylinder adapters (8). Refer to Section 20 step 20.8 for information regarding lockwashers and gasket seal use with cylinder adapter screws.
- 10.9 Remove inner cylinder adapter (8), taking care not to scratch piston rod (6) or disengage rod bushing (10).
- 10.10 For actuators equipped with M3 or M3HW jackscrew override, it is not necessary to disassemble the M3 Jackscrew from cylinder assembly -M3. If the M3 stud or nut seal needs replacement then refer to Section 18.0, M3 Jackscrew Disassembly.
- 10.11 It is not necessary to remove pipe plugs from cylinder adapters (8).

## **11.0 HOUSING DISASSEMBLY**

- 11.1 Remove the socket cap screws from the position indicator and yoke weather cover. Remove the position indicator and yoke weather cover. Refer to step 20.4 for information regarding early model actuators and the use of a weather cover under the position indicator.
- 11.2 Remove the snubber (22) from the top of housing (1).
- 11.3 Remove cover screws (19) and seal gaskets. NOTE: Refer to step 20.7 for additional information.
- 11.4 Remove housing cover (3) from housing (1). NOTE: Housing cover (3) has a tight fit and will require the use of two pry bars or screw drivers to assist in removal.
- 11.5 Rotate the yoke arms to center position.
- 11.6 Remove upper yoke roller (5).



- 11.7 Remove yoke pin (4).
- 11.8 Holding the rod bushing (10) in place, pull piston rod (6) out through rod bushings (10).
- 11.9 Remove yoke (2) from the housing cavity.

**CAUTION:** The yoke/housing bearing area must be lubricated and inspected to extend service life and prevent degradation of torque output. This can only be accomplished by removing the yoke from the housing which requires removing the actuator from the valve.

- 11.10 Remove lower yoke roller (5).
- 11.11 Remove both rod bushings (10) from housing (1).
- 11.12 It is not necessary to remove housing pipe plug (23) or cylinder adapter pipe plug.

## 12.0 GENERAL REASSEMBLY

**CAUTION:** Only new seals, that are still within the seals expectant shelf life, should be installed into actuator being refurbished.

- 12.1 Remove and discard all seals and gaskets.
- 12.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.
- 12.3 All parts should be thoroughly inspected for excessive wear, stress cracking, galling and pitting. Attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding or rotating motion. Sealing surfaces of the cylinder, tie bars and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

**CAUTION:** Actuator parts that reflect any of the above listed characteristics must be replaced with new parts.

- 12.4 Before installation coat all moving parts with a complete film of lubricant. Coat all seals with a complete film of lubricant, before installing into seal grooves. NOTE: The parts and seals used in the actuator housing assembly, power cylinder and spring cartridge will be assembled using lubricant as identified in step 7.1.

## 13.0 HOUSING REASSEMBLY

- 13.1 If removed, install a pipe plug (23) into the drain port of the housing (1).
- 13.2 Install one of the yoke o-ring seal's (15) into the groove in the housing bore. Refer to Section 20 step 20.1 for "B" model yoke o-ring information.
- 13.3 Apply lubricant to the yoke bore in the housing and arrange the housing so that the yoke bore is nearest to you. Lubricate the raised ribs in the bottom of the housing.

- 13.4 Apply a generous amount of lubricant to slots in the upper and lower arms of yoke (2).
- 13.5 Coat the bearing surfaces of yoke (2) with lubricant and install into the housing. The wide yoke arm should be installed toward the top of the housing.
- 13.6 Coat two rod bushings (10) with lubricant and install into both sides of the housing (1).
- 13.7 Coat one of the yoke rollers (5) with lubricant and place into the lower yoke arm slot nearest the cylindrical portion of the yoke.
- 13.8 Apply lubricant to piston rod (6) and install through rod bushings (10) in housing (1).
- 13.9 Coat yoke pin (4) with lubricant and install through piston rod (6) into lower yoke roller (5).
- 13.10 Coat remaining yoke roller (5) with lubricant and install over yoke pin (4) and into slot in the upper yoke arm.
- 13.11 Coat the yoke bore in cover (3) with lubricant.
- 13.12 Install remaining o-ring seal (15) into housing cover (3). Refer to Section 20 step 20.1 for "B" model yoke o-ring information.
- 13.13 Install cover gasket (18) onto housing (1).
- 13.14 Install eight gasket seals (80) on to cover screws (3).
- 13.15 Install housing cover (3) onto housing (1).
- 13.16 Install four cover screws (19) with gasket seals (80) through housing cover (3) and screw into housing (1). NOTE: Refer to Section 20 step 20.8 for information when gasket seals have not been in prior use for this location.

#### **14.0 PNEUMATIC CYLINDER REASSEMBLY**

NOTE: The parts and seals used in the actuator cylinder assembly (9) will be assembled using lubricant as identified in step 7.1.

- 14.1 Coat piston rod seal (27) with lubricant and install, lip first, into cylinder adapter (8). Refer to Section 20 step 20.2 for information pertaining too early model actuator rod seal configurations.

**CAUTION: Energizer ring (O-ring) of rod seal (27) must face into cylinder adapter or when cylinder is installed on the actuator the rod seal o-ring will be facing towards piston (32).**

- 14.2 Install cylinder adapter gasket (20) as follows:
  - 14.2.1 Onto the left end of housing (1) for fail clockwise actuators.
  - 14.2.2 Onto the right end of housing (1) for fail counter clockwise actuators.

- 14.3 Install gasket seals onto cylinder adapter screws (21). NOTE: Refer to Section 20 step 20.8 for information pertaining to the use of lockwashers.

**CAUTION: Care should be taken not to scratch the piston rod when installing the cylinder adapter (8).**

- 14.4 Install cylinder adapter (8) over the end of piston rod (6) as follows:

NOTE: Arrange cylinder adapter (8) with the pressure inlet port in the same position as recorded in Section 8 step 8.6. The location of the port may be different on your actuator depending on customer, plumbing, and accessory requirements.

14.4.1 Onto the left end of housing (1) for fail clockwise actuators.

14.4.2 Onto the right end of housing (1) for fail counter clockwise actuators.

- 14.5 Install and tighten ferris cap screws (21) with gasket seals (24) through cylinder adapter (8) and into housing (1).

- 14.6 If removed, install a pipe plug into the cylinder adapter pressure port in the same position as recorded in Section 8 step 8.6.

- 14.7 Coat o-ring seal (17) with lubricant and install into cylinder adapter (8). NOTE: Install o-ring into the groove at inner end of the cylinder adapter inner diameter threads.

- 14.8 Install o-ring seal (26) onto piston rod (6). NOTE: The o-ring should be installed against the shoulder of the piston rod.

- 14.9 Install piston (7) onto piston rod (6). NOTE: One side of piston (7) has a raised boss in the center that is counter bored to accept the o-ring installed in step 14.7. The counter bore side of the piston should be installed against the shoulder of piston rod (6) and over o-ring seal (26).

- 14.10 Retain piston (7) with piston rod adapter (31).

- 14.11 Torque tighten piston rod adapter (31) to 146 foot pounds (198 N-m).

- 14.12 Piston Seal Installation

14.12.1 Standard and High Temperature actuators:

14.12.1.1 Coat piston outer diameter seal grooves with lubricant.

14.12.1.2 Coat two u-cup seal (14) with lubricant.

14.12.1.3 Install one u-cup seal into outermost piston seal groove. The lip of the cup seal should point outward toward the side of the piston.

## 14.12.2 Low Temp Actuators:

- 14.12.2.1 Coat piston outer diameter seal grooves with lubricant.
- 14.12.2.2 Apply lubricant to one T-seal. T-Seal is composed of rubber seal and two skive-cut back-up rings.
- 14.12.2.3 Install T-seal set into piston outboard seal groove.
- 14.12.2.4 Install a back-up ring on each side of the T-seal. NOTE: When installing the back-up rings, do not align the skive-cuts.

NOTE: If the back-up rings are too long and the rings overlap beyond the skive-cuts, then the rings must be trimmed with a razor sharp instrument.

- 14.13 Install outer piston rod (30) into piston rod adapter (31).
- 14.14 Apply a light coating of lubricant to the inner cylinder threads and the entire bore of the inner cylinder (28).
- 14.15 Install inner cylinder (28) over piston (7). Rotate the cylinder clockwise and screw into the cylinder adapter. Tighten with a chain wrench.

**CAUTION: Exercise caution during cylinder installation to prevent pinching lip of the u-cup seal during installation. It is necessary to depress the seal lip while working the cylinder over it.**

- 14.16 Install rod seal (34) into the inner diameter seal groove of outer body (29). NOTE: For actuators that are equipped with one inch O.D. piston rod use step 14.17 for rod seal installation.
- 14.17 Coat the Polypak seal (34), Service Kit item number (105), with lubricant and install lip facing toward the housing (1) and into the outer body (29).

**CAUTION: For the one inch O. D. piston rod the energizer ring of rod seal (34) must be install such that when outer body (29) is installed on the inner cylinder the rod seal will face the inner piston (7). This caution is only for Polypak seals installed per step 14.20.**

- 14.18 Install outer body o-ring seals (17) into both sides of outer body (29). NOTE: Install o-rings into the grooves at inner end of the outer body inner diameter threads.
- 14.19 Install the outer body (29) over the outer piston rod (30), screwing onto the inner cylinder threads. NOTE: Make sure that the energizer ring of the outer rod seal (34) is facing the inner piston (7) and that the ports are in the same location as marked or recorded in Section 8 step 8.6. Tighten outer body with a chain wrench.
- 14.20 Install o-ring seal (35) onto the outer piston rod (30). NOTE: The o-ring should be installed against the shoulder of the piston rod. Refer to Section 20 step 20.12 pertaining to different size outer piston rods used in HD733-SR series actuators.

- 14.21 Install outer piston (32) onto outer piston rod (30). NOTE: One side of outer piston (32) has a raised boss in the center that is counter bored to accept the o-ring installed in step 14.16. The counter bore side of the piston should be installed against the shoulder of piston rod (30) and over o-ring seal (35).
- 11.22 Retain outer piston (32) with hex jam nut (33). Torque tighten hex jam nut (33) to 146 foot pounds (198 N-m).
- 14.23 Piston Seal Installation
- 14.23.1 Standard and High Temperature actuators:
- 14.23.1.1 Coat outer piston seal grooves with lubricant.
- 14.23.1.2 Coat one u-cup seal (14) with lubricant.
- 14.23.1.3 Install one u-cup seal into outermost piston seal groove. The lip of the cup seal should point outward toward the side of the piston.
- 14.23.2 Low Temp Actuators:
- 14.23.2.1 Coat outer piston seal grooves with lubricant.
- 14.23.2.2 Apply lubricant to one T-seal. T-Seal is composed of rubber seal and two skive-cut back-up rings.
- 14.23.2.3 Install T-seal set into piston outboard seal groove.
- 14.23.2.4 Install a back-up ring on each side of the T-seal. NOTE: When installing the back-up rings, do not align the skive-cuts.
- NOTE: If the back-up rings are too long and the rings overlap beyond the skive-cuts, then the rings must be trimmed with a razor sharp instrument.
- 14.24 For actuators equipped with a M3 jackscrew, and if the M3 was removed then refer to paragraph 19.0 for reassembling the M3 into outer cylinder (3-10).
- 14.25 Apply a coating of lubricant to the outer cylinder outer diameter threads and the entire bore of outer cylinder (9) or (3-10).
- 14.26 Install outer cylinder (9) or (3-10) over outer piston (32). Rotate the outer cylinder clockwise and screw into outer body (29). Tighten with a chain wrench.

**CAUTION:** Exercise caution during cylinder installation to prevent pinching lip of the u-cup seal during installation. It is necessary to depress the seal lip while working the cylinder over it.

## 15.0 SPRING CYLINDER REASSEMBLY

15.1 Coat one piston rod seal (16) with lubricant and install, lip first, into the cylinder adapter (8).

**CAUTION:** The energizer ring of rod seal (27) must face the cylinder adapter, piston side.

15.2 Install one cylinder adapter gasket (21) over the piston rod bushing on the right side of the housing for clockwise actuators or on the left side of the housing for counterclockwise actuators.

**CAUTION:** Care should be taken not to scratch the piston rod when installing the cylinder adapter.

15.3 Install cylinder adapter (20) over the end of piston rod (6) and retain with screws (21) and gasket seals (24). Arrange the cylinder adapter with the pressure inlet port in the same position as recorded in Section 8 step 8.6. The location of the port may be different on your actuator depending on customer, plumbing, and accessory requirements.

15.4 If removed, install a pipe plug into the cylinder adapter pressure port in the same position as recorded in step 8.6.

15.5 Install one o-ring seal (17) into cylinder adapter (8). NOTE: Install o-ring into the groove at the inner end of the cylinder adapter inner diameter threads.

15.6 Install one o-ring seal (26) onto piston rod (6). NOTE: The o-ring should be installed against the shoulder of the piston rod.

15.7 Install piston (7) or (40) onto piston rod (6). NOTE: One side of piston (7) or (40) has a raised boss in the center that is counter bored to accept the o-ring installed in step 15.6. The counter bore side of the piston should be installed against the shoulder of piston rod (6) and over o-ring seal (26).

15.8 Retain piston (7) or (40) with hex lock nut (13). Torque tighten hex nut (13) to 146 foot pounds (198 N-m).

15.9 Piston Seal Installation:

15.9.1 Standard and High Temperature actuators:

15.9.1.1 Coat piston seal grooves with lubricant.

15.9.1.2 Coat one u-cup seal (14) with lubricant.

15.9.1.3 Install one u-cup seal into the innermost piston groove.  
The lip of the cup seal should point outward toward the side of the piston.

15.9.2 Low Temp Actuators:

15.9.2.1 Coat piston seal grooves with lubricant.

15.9.2.2 Apply lubricant to one T-seal. T-Seal is composed of rubber seal and two skive-cut back-up rings.

15.9.2.3 Install T-seal set into piston outboard seal groove.

15.9.2.4 Install a back-up ring on each side of the T-seal. NOTE: When installing the back-up rings, do not align the skive-cuts.

NOTE: If the back-up rings are too long and the rings overlap beyond the skive-cuts, then the rings must be trimmed with a razor sharp instrument.

15.10 Push the piston in towards the housing as far as it will go.

15.11 Coat the cylinder threads and the cylinder bore with lubricant.

15.12 Coat the outside of the spring with lubricant and insert the spring cartridge assembly (37) into the cylinder assembly (38).

NOTE: One end of the spring cartridge assembly has a flat face with a deep hole in it, this end should be inserted into the cylinder first.

15.13 Install the spring cylinder, containing the spring cartridge, over the piston and screw into the cylinder adapter (8). Tighten with a chain wrench.

15.14 Position Indicator Installation:

15.14.1 For spring to close actuators (clockwise), rotate the yoke to the full clockwise (CW) position. Position the yoke weather cover and position indicator on the yoke (2) with the pointer pointing to the piston rod and perpendicular to the cylinder assemblies.

15.14.2 For spring to open actuators (counterclockwise) rotate the yoke to full counterclockwise (CCW) position. Position the yoke weather cover and position indicator on the yoke with the pointer to the air cylinders (28), (9) or (3-10) and parallel to the piston rod (6).

15.14.3 Install and tighten yoke position indicator/yoke weather cover screws.

NOTE: These screws will require rechecking for tightness after the actuator has been cycled and tested.

15.15 Install the stop screws (11), stop screw gasket seals (25) and stop screw jam nuts (12).

## 16.0 **ACTUATOR TESTING**

16.1 All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution. A small amount of leakage may be tolerated. Generally, a small bubble, which breaks about three seconds after starting to form, is considered acceptable.

**WARNING: Pressure applied to the actuator is not to exceed the maximum operating pressure rating listed on the actuator name tag.**

16.2 Unless otherwise listed all leak testing will use the nominal operating pressure (NOP) as listed on the actuator name tag or the pressure used by the customer to operate actuator during normal operation.

**CAUTION: Test the actuator using a properly adjusted self relieving regulator, with gauge.**

16.3 Prior to testing for leaks, alternately apply and release pressure, as defined in step 16.2, to the pressure side of both pistons. Allow each application of pressure to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.

NOTE: Before leak testing may be accomplished, it will be necessary to provide a piping system whereby pressure may be applied simultaneously to all common pressure ports.

16.4 Before testing for leaks, alternately apply and release pressure, as defined in step 16.3, to the pressure side of the pistons to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.

16.5 Simultaneously apply pressure, as defined in step 16.3, to pressure inlet port in the end of cylinder (9), outer body (29), and to the SR cylinder adapter (8).

16.6 Apply leak testing solution to the following areas:

16.6.1 The breather port hole in the side of outer body (29), checks the outer piston to the outer cylinder and outer piston to outer piston rod seals

16.6.2 The breather port in the inner cylinder adapter (8). Checks the inner piston to inner cylinder and inner piston to piston rod seals.

16.6.3 The breather port hole in the end of the SR cylinder (38). Checks the SR piston to SR cylinder wall and SR piston to piston rod seals.

16.6.4 The joint between the inner cylinder (28) and the outer body (29). Checks the inner cylinder to outer body o-ring seal.

16.6.5 The threaded joint between the SR cylinder (38) and SR cylinder adapter (8). Checks the cylinder to cylinder adapter o-ring seal.

16.6.6 The joint between the SR cylinder adapter and the housing.

16.6.7 The snubber porthole located in the housing, checks the cylinder adapter to piston rod seal.

16.7 Remove pressure from the pressure inlet ports.

16.8 If an actuator was disassembled and repaired, the above leakage test must be performed again.



## **17.0 RETURN TO SERVICE**

- 17.1 Install breathers (39) in the end of the spring cylinder (38), into the inner cylinder adapter (8) of inner cylinder (28) and into the side of the outer body (29). NOTE: Refer to Section 20 step 20.5 for information when a snubber valve was used in place of a breather.
- 17.2 If supplied in the service kit, replace the software components of the snubber (22) and then install the snubber into the housing.
- 17.3 Adjust both stop screws (11) back to settings recorded in step 8.5 under General Disassembly.
- 17.4 Tighten both of the jam nuts (12) securely, while holding stop screws (11).
- 17.5 Re-install any piping and accessories that were removed.
- 17.6 All accessories should be hooked up and tested for proper operations and replaced, if found defective.

## **18.0 M3 JACKSCREW DISASSEMBLY**

NOTE: If the age of the actuator is unknown or if the M3 jackscrew has been replaced at some unknown point in time, then review all of Section 18 for a M3 jackscrew description that is installed on the actuator being disassembled.

- 18.1 Disassembly of M3 Jackscrews manufactured before July 1978.
  - 18.1.1 With the cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.
  - 18.1.2 Loosen nut seal (3-30).
  - 18.1.3 Remove jackscrew assembly (3-20) by rotating counter clockwise.
  - 18.1.4 Remove seal nut (3-30) from the jackscrew stud.
- 18.2 Disassembly of M3 Jackscrews manufactured July 1978 thru February 1982.
  - 18.2.1 With the cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.
  - 18.2.2 Loosen and unscrew nut seal (3-30) all the way back to the welded nut.
  - 18.2.3 Rotate jackscrew assembly (3-20) clockwise, into cylinder (3-10), until retaining screw is exposed.
  - 18.2.4 Remove the retaining screw from jackscrew assembly (3-20).
  - 18.2.5 Remove jackscrew assembly (3-20) by rotating counter clockwise.

18.2.6 Remove seal nut (3-30) from the jackscrew stud.

18.3 Disassembly of M3 Jackscrews manufactured March 1982 through December 1990.

18.3.1 With the cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.

18.3.2 Loosen and unscrew nut seal (3-30) all the way back to the welded nut.

18.3.3 Rotate jackscrew assembly (3-20) clockwise, into cylinder (3-10), until the pin and washer are exposed.

18.3.4 Using a 3/16 inch pin punch, drive out and remove the pin.

18.3.5 Remove the washer.

18.3.7 Remove seal nut (3-30) from the jackscrew stud.

18.4 Disassembly of M3 Jackscrews manufactured after December 1990.

18.4.1 With the cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.

18.4.2 Using a 3/16 inch pin punch, drive out and remove the spiral pin from slotted nut located on outboard end of jackscrew assembly (3-20).

18.4.3 Remove the slotted nut from the jackscrew assembly (3-20).

18.4.4 Loosen and screw seal nut (3-30) off of the jackscrew assembly (3-20).

18.4.5 Screw the jackscrew assembly (3-20) into the cylinder (3-10) until it is disengaged from the cylinder end cap.

18.4.6 Remove the jackscrew assembly (3-20) from the open end of the cylinder (3-10).

## **19.0 M3 JACKSCREW REASSEMBLY**

NOTE: If the age of the actuator is unknown or if the M3 jackscrew has been replaced at some unknown point in time, then review all of Section 19 for a M3 jackscrew description that is installed on the actuator being reassembled.

19.1 Reassembly of M3 Jackscrews manufactured before July 1978.

19.1.1 If removed, install nut seal (3-30) onto jackscrew assembly (3-20) with nylon seal insert facing away from the retaining nut.

19.1.2 Screw the nut seal until it is up against the retaining nut.

- 19.1.3 Apply a generous coating of lubricant to the jackscrew threads.
  - 19.1.4 Screw the jackscrew assembly (3-20) into the cylinder end cap. Turn the jackscrew until the end of the assembly protrudes just out of the cylinder end cap.
  - 19.1.5 Turn nut seal (3-30) until fully tight against end cap.
  - 19.1.6 If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, grease may be left on jackscrew to provide additional corrosion protection.
- 19.2 Reassembly of M3 Jackscrews manufactured July 1978 through February 1982.
- 19.2.1 If removed, install nut seal (3-30) onto jackscrew assembly (3-20) with nylon seal insert facing away from the retaining nut.
  - 19.2.2 Turn the nut seal until it is up against the retaining nut.
  - 19.2.3 Apply a generous coating of lubricant to jackscrew threads.
  - 19.2.4 Screw jackscrew assembly (3-20) into the cylinder end cap. Turn the jackscrew until the end of the assembly protrudes out of threaded end of the cylinder.
  - 19.2.5 Retain the jackscrew stud in the cylinder, by screwing a hex head screw into the threaded hole in the turndown area of the jackscrew stud.
  - 19.2.6 Rotate jackscrew counter clockwise until retaining screw just comes into contact with cylinder.
  - 19.2.7 Turn nut seal (3-30) until fully tight against end cap.
  - 19.2.8 If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, grease may be left on jackscrew to provide additional corrosion protection.
- 19.3 Reassembly of M3 Jackscrews manufactured March 1982 through December 1990.
- 19.3.1 If removed, install seal nut (3-30) onto jackscrew assembly (3-30) with nylon seal insert facing away from the welded nut.
  - 19.3.2 Screw the nut seal until it is up against the retaining nut.
  - 19.3.3 Apply a generous coating of lubricant to the M3 threads.
  - 19.3.4 Screw the jackscrew assembly (3-20) into the cylinder end cap. Turn the jackscrew until the end of the assembly protrudes out of the threaded end of the cylinder.
  - 19.3.5 Install a washer and pin onto the turndown end of the M3.
  - 19.3.6 Turn the jackscrew until the washer just comes into contact with the cylinder end cap.

- 19.3.7 Turn nut seal until fully tight against end cap.
- 19.3.8 If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, grease may be left on jackscrew to provide additional corrosion protection.
- 19.4 Reassembly of M3 jackscrew manufactured after December 1990.
- 19.4.1 Apply a light coating of lubricant to the threads of jackscrew assembly (3-20).
- 19.4.2 Insert jackscrew assembly (3-20) through the threaded end of cylinder (3-10). Screw the jackscrew into the cylinder end cap until the end of the assembly protrudes out of the end cap of the cylinder.
- 19.4.3 Turn the jackscrew until the welded nut comes into contact with the inside of the cylinders end cap.
- 19.4.4 Install seal nut (3-30) onto the jackscrew assembly (3-20). Turn the seal nut until it is up against the cylinder end cap.
- 19.4.5 Screw slotted nut onto outboard end of jackscrew stud with slot facing toward cylinder end cap. Screw the nut until one of the slots in the nut is aligned with cross drilled "through hole" in the stud.
- CAUTION: When aligning the slot and the cross drilled hole make certain that the back of the slot is at least one thread from being aligned with the hole.**
- 19.4.6 Insert spirol pin through slotted nut and jackscrew stud making sure that equal amounts of the spirol pin is exposed on both sides of slotted nut and jackscrew stud.
- 19.4.7 Turn nut seal (3-30) until fully tight against end cap.
- 19.4.8 If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, lubricant may be left on jackscrew to provide additional corrosion protection.

## 20.0 INFORMATION NOTES

- 20.1 On HD733B-SR models the yoke o-ring grooves are in the yoke journals. On the HD733C-SR models the yoke o-ring grooves will be in the housing cover and in the housing. Both "B" and "C" model o-ring seals are provided in Bettis standard Service Kit.
- 20.2 These actuators were originally shipped with a rod seal and an anti-extrusion seal. This combination is replaced with the current Polypak seal. The dimensional stack of the rod seal and the anti-extrusion seal is greater than the rod seal provided in the current Service Kit. This dimensional difference does not affect the ability of the current Polypak seal to provide sealing in this application.

- 20.3 Early 1970's model actuators may have a single seal groove piston as the SR cylinder piston.
- 20.4 Early model actuators, manufactured prior to 1979, may not have a position indicator or a weather cover. These items may be added to your actuator.
- 20.5 Most early model actuators used a snubber valve instead of a breather for items (39). For most applications it is recommended that the snubber valves for items (39) be replaced with a Bettis part number 029198.
- 20.6 Early model actuators used nylon "Zytel 101" stop screw seal (25). For most applications the nylon seal is replaced with a wrought copper alloy (ASTM B-152 C11000) gasket seal.
- 20.7 Early model actuators did not use any gasket seal washers on the cover screws (19). The current Service kits provide wrought copper alloy (ASTM B-152 C11000) gasket seal washers. If the cover screws are long enough, then for most applications, Bettis would recommend that gasket seals be installed on actuator cover screws (19).
- 20.8 Early model actuators used lockwashers (24) on the cylinder adapter retaining screws (21). During the early 1970's the lockwashers (24) were replaced with wrought copper alloy (ASTM B-152 C11000) gasket seal washers. The current Service kits provide these wrought copper alloy washers and for most applications Bettis would recommend that they be used in place of the original lockwashers.
- 20.9 All asbestos has been eliminated from the gasket material used in Bettis Actuators. The current gasket material used is Non Asbestos Synthetic Fiber.
- 20.10 All jackscrew handwheel assemblies manufactured prior to January, 1981 had non-replaceable handwheel. This style M3 jackscrew with handwheel was a weldment and the handwheel is not removable or replaceable as an option. NOTE: When replacing this style M3HW it will require a complete new M3 stud and handwheel option.
- 20.11 The replacement M3 jackscrews manufactured since July of 1978 have been of a design that allowed the M3 stud to be captivated in the actuator cylinder. All previous M3 stud designs manufactured prior to January 1991 are replaced with the current M3 jackscrew.
- 20.12 733-SR actuators are supplied with a one and one half inch or a one inch outer piston rod (30). To accommodate these different sizes the Service Kit is supplied with two sizes of outer piston rod seal (34) and piston o-ring seal (35).

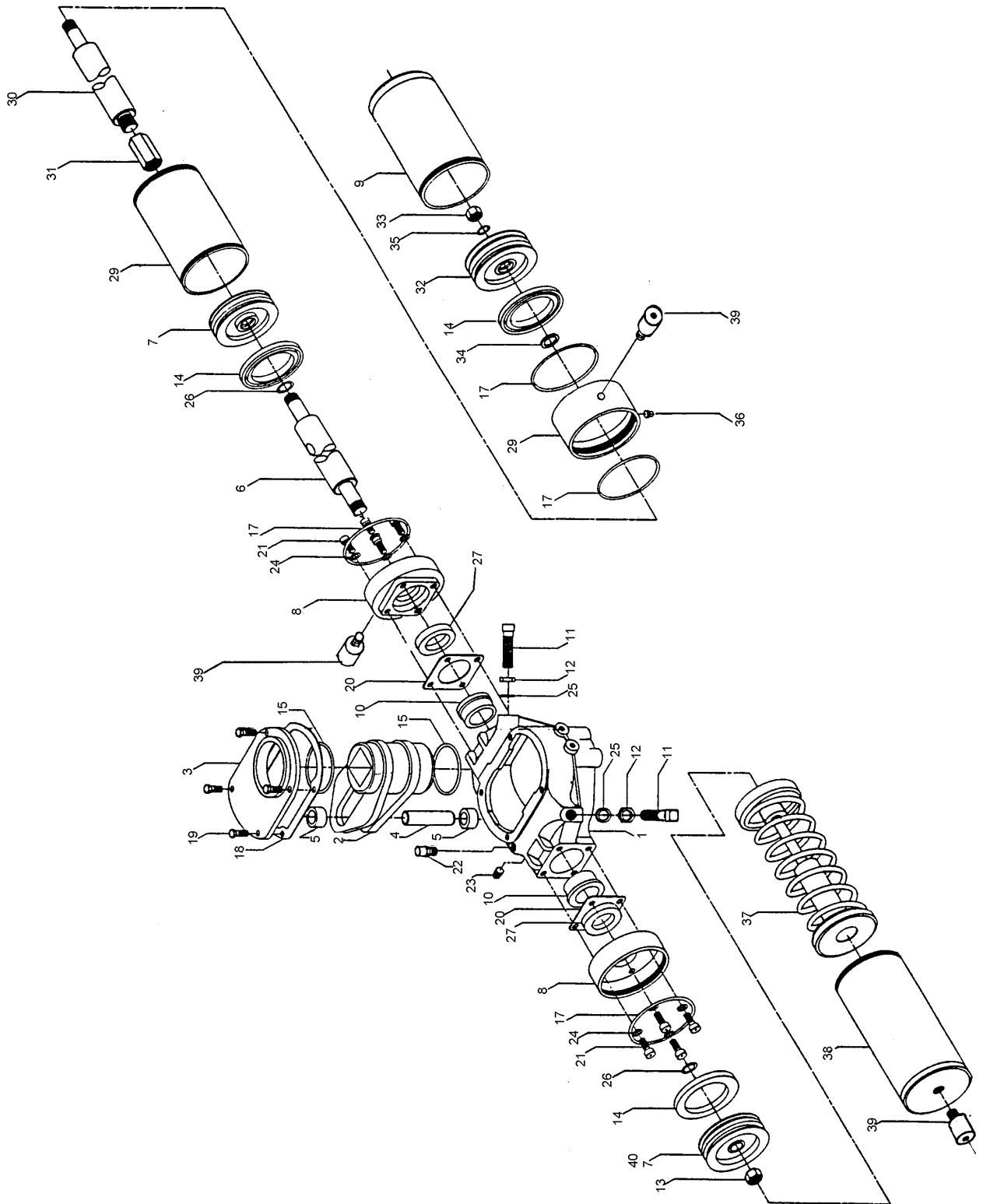
**21.0 HD733-SR GENERIC PARTS LIST** - Part numbers listed in this generic part number list may not be the part number required to replace parts in the actuator being repaired. For correct parts replacement provide the actuator model number and serial number.

Item No.	Part Number	Quantity	Description
1	011328	1	Housing
2	011329	1	Yoke <b>(3)</b>
3	011330	1	Housing Cover
4	071107-002	1	Yoke Pin
5	071136-002	2	Yoke Pin Roller
6	071178-005	1	Piston Rod
7	110415-002	1	Piston
8	072817-002	2	Cylinder Adapter
9	110238-005	1	Cylinder
10	009096	2	Rod Bushing
11	016364	2	Stop Screw
12	011335	2	Jam Nut
13	008388	2	Piston Nut
14	10 <b>(6)</b>	3	Piston Seal, U-Cup
15	20 <b>(6)</b>	2	O-Ring Seal
17	40 <b>(6)</b>	4	O-Ring Seal
18	50 <b>(6)</b>	1	Cover Gasket
19	004684	4	Cover Screw
20	60 <b>(6)</b>	2	Cylinder Adapter Gasket
21	004670	8	Cylinder Adapter Screw
22	011967	4	Snubber Valve
23	003727	1	Pipe Plug
24	85 <b>(6)</b>	8	Adapter Seal Gasket
25	80 <b>(6)</b>	2	Gasket Seal
26	90 <b>(6)</b>	2	O-Ring Seal
28	111633-005	1	Inner Cylinder
29	011759	1	Outer Body, for 1.5" O.D. Piston Rod
	011759	1	Outer Body, for 1" O.D. Piston Rod <b>(2)</b>
30	012961	1	Outer Piston Rod, 1.5" O.D.
	009050	1	Outer Piston Rod, 1" O.D.
31	012938	1	Piston Rod Adapter, for 1.5" O.D. Piston Rod
	009092	1	Piston Rod Adapter, for 1" O.D. Piston Rod
32	110414-002	1	Outer Piston, for 1.5" O.D. Piston Rod
	004824	1	Outer Piston, for 1" O.D. Piston Rod
33	009045	1	Outer Piston Nut, for 1.5" O.D. Piston Rod
	009013	1	Outer Piston Nut, for 1" O.D. Piston Rod
34	100 <b>(6)</b>	1	Outer Rod Seal, for 1.5" O.D. Piston Rod
	105 <b>(6)</b>	2	Outer Rod Seal, for 1" O.D. Piston Rod
35	110 <b>(6)</b>	1	Outer Piston O-Ring Seal, for 1.5" O.D. Piston Rod
	115 <b>(6)</b>	1	Outer Piston O-Ring Seal, for 1" O.D. Piston Rod
36	013243	2	Outer Body Port Plug

Item No.	Part Number	Quantity	Description
37		1	Spring Cartridge Assembly <b>(3)</b>
38		1	Spring Cylinder <b>(3)</b>
39	029198 <b>(4)</b>	3	Breather
40	003780	1	Spring Piston, Single Seal Groove <b>(5)</b>
	110415-002	1	Spring Piston, Double Seal Groove <b>(5)</b>
NOTES: (2) Items not longer available. (3) When this item is replaced the serial number from the actuator will be required. (4) For replacement information refer to Section 20, step 20.5. (5) For information refer to Section 20, step 20.3. (6) Number represents item number in Service Kit.			

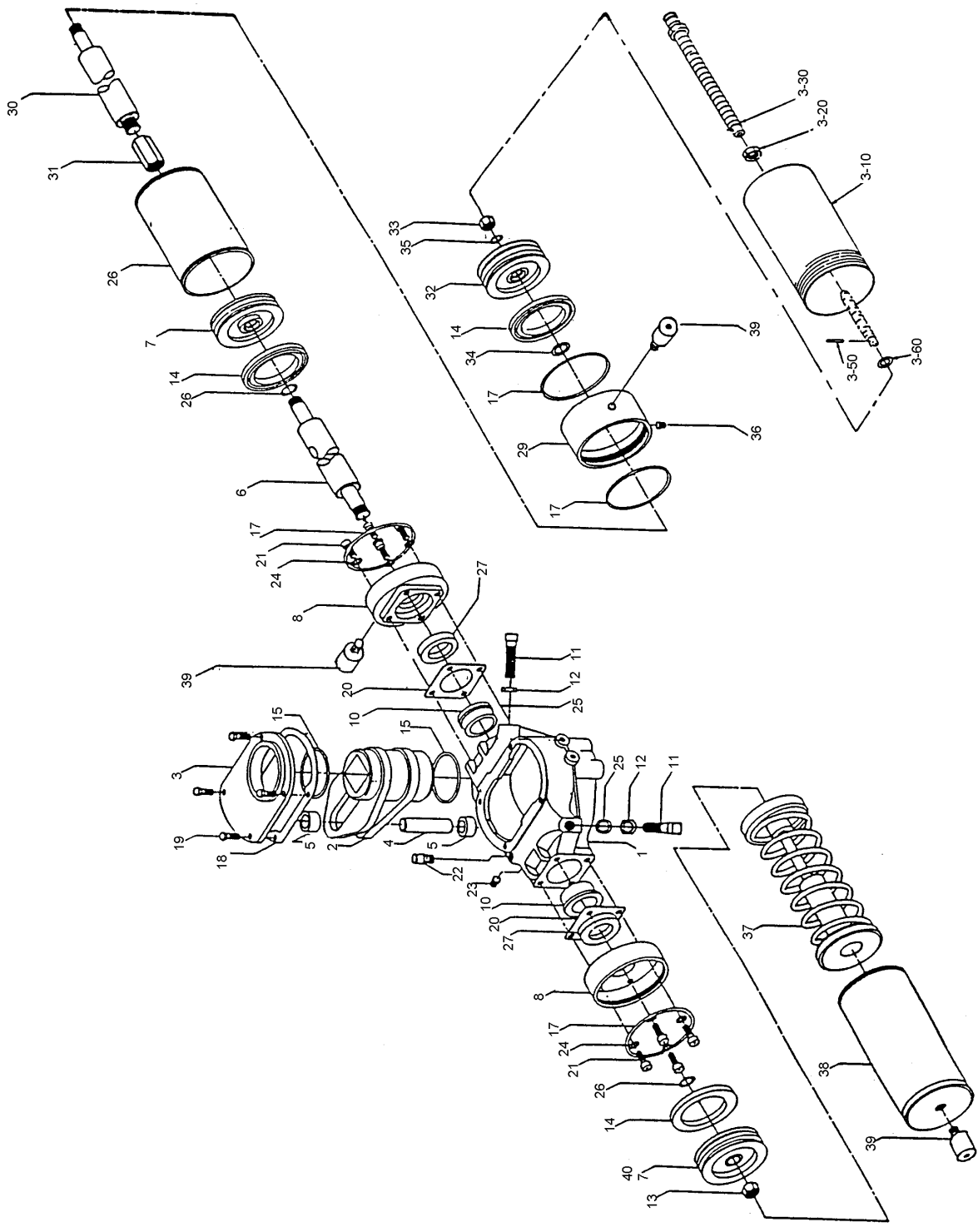
ECN	DATE	REV	BY *	DATE	
Released	May 2000	A	COMPILED	Bill Cornelius	11 May 2000
			CHECKED	Bill Cornelius	11 May 2000
			APPROVED	Robert McEver	11 May 2000

\* Signatures on file Bettis Actuator & Controls, Waller, Texas



**22.0 - FIGURE 1 - HD733-SR SPRING RETURN ACTUATOR**





**23.0 - FIGURE 2 - HD733-SR-M3 SPRING RETURN ACTUATOR**

**World Area Configuration Centers (WACC) offer sales support, service, inventory and commissioning to our global customers. Choose the WACC or sales office nearest you:**

***NORTH & SOUTH AMERICA***

19200 Northwest Freeway  
Houston, TX 77065  
USA  
T +1 281 477 4100  
F +1 281 477 2809

Av. Hollingsworth,  
325, Iporanga Sorocaba  
SP 18087-105  
Brazil  
T +55 15 3238 3788  
F +55 15 3228 3300

***ASIA PACIFIC***

No. 9 Gul Road  
#01-02 Singapore 629361  
T +65 6501 4600  
F +65 6268 0028

No.1 Lai Yuan Road  
Wuqing Development Area  
Tianjin 301700  
P.R.China  
T +86 22 8212 3300  
F +86 22 8212 3308

***MIDDLE EAST & AFRICA***

P. O. Box 17033  
Dubai  
United Arab Emirates  
T +971 4 811 8100  
F +971 4 886 5465

P. O. Box 10305  
Jubail 31961  
Saudi Arabia  
T +966 3 340 8650  
F +966 3 340 8790

24 Angus Crescent  
Longmeadow Business Estate  
East P.O. Box 6908; Greenstone  
1616 Modderfontein, Extension 5  
South Africa  
T +27 11 451 3700  
F +27 11 451 3800

***EUROPE***

Berenyi u. 72- 100  
Videoton Industry Park,  
Building #230  
Székesfehérvár 8000  
Hungary  
T +36 22 530 950  
F +36 22 543 700

For complete list of sales and manufacturing sites, please visit  
[www.emersonprocess.com/valveautomationlocations](http://www.emersonprocess.com/valveautomationlocations)  
Or contact us at [info.valveautomation@emerson.com](mailto:info.valveautomation@emerson.com)

[www.emersonprocess.com/bettis](http://www.emersonprocess.com/bettis)

©2016 Emerson Process Management. All rights reserved.

The Emerson logo is a trademark and service mark of Emerson Electric Co. Bettis is a mark of one of the Emerson Process Management family of companies. All other marks are property of their respective owners.

The contents of this publication are presented for information purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. All sales are governed by our terms and conditions, which are available on request. We reserve the right to modify or improve the designs or specifications of our products at any time without notice.

**BETTIS™**



**EMERSON™**  
Process Management