BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY & REASSEMBLY

FOR MODELS

ST50X-SR

SPRING RETURN SERIES

HYDRAULIC ACTUATORS

PART NUMBER: 111566

REVISION: "A"

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1.0 INTRODUCTION

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis ST50X-SR Spring Return Hydraulic series actuators. When the model number has a "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.

1.2 **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.

1.3 **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

1.4 **BASIC SERVICE INFORMATION: Complete actuator refurbishment requires the actuator be dismounted from the valve or device it is operating.**

1.5 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.

1.6 This procedure is applicable with the understanding that all electrical power and hydraulic pressure has been removed from the actuator, allowing the spring to stroke and rotate the actuator to its fail position. 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.

2.0 SUPPORT ITEMS AND TOOLS

2.1 Support Items - Service Kit and non-hardening thread sealant.

2.2 Tools - All tools are Imperial. Two each medium screwdrivers, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and torque wrench (up to 5,000 inch pounds). For recommended tool list refer to the following Tool Chart.

TOOL STYLE AND WRENCH SIZES

ITEM NO.	WRENCH SIZE		ITEM QTY	DESCRIPTION	RECOMMENDED WRENCH STYLE
	INCH	MM			
1-60	15/16 SQ	23.8 SQ	2	Stop Screw	Open End or Adjustable
1-80	7/16 SQ	11.11 SQ	2	Housing Drain Plug	Open End or Adjustable
1-90	9/16"	14.28	12	Cover Screws	Socket
1-120	2	50.8	2	Stop Screw Nut	Box End **(1)**
1-180	3/16	4.76	1	Socket Set Screw	Allen
1-190	7/8	22.22	2	Snubber Valve	Deep Socket
1-240	9/16	14.28	6	Hex Cap Screws	Socket
2-80	½"	12.7	1	Piston Rod	Male Square Drive
2-90	9/32	7.14	2	Pipe Plug	Open End or Adjustable
2-100	13/32	10.32	2	1/8" Bleed Valve	Open End or Box **(1)**
2-110	¾	19.05	4	Socket Cap Screw	Allen
2-120	¾	19.05	4	Socket Cap Screw	Allen
2-140	¾	19.05	2	Socket Cap Screw	Allen
2-150	5/8	15.87	3	Pipe Plug (BSPP)	Open End or Adjustable
2-150	7/8	22.22	2	O-Ring Plug (SAE)	Open End or Adjustable
6-20	1-1/2	38.1	2	Hex Cap Screws	Socket
6-50	3/16	4.76	1	Socket Cap Screw	Allen

(1) No alternate style tool recommended or wrench placement not provided.

3.0 BETTIS REFERENCE MATERIALS

3.1 Assembly Drawing 104958 for ST50X-SR spring return series hydraulic actuators.

4.0 GENERAL DETAILS

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 Bettis Assembly Drawing and Actuator Parts Lists.

4.3 This procedure is written using the following references:

4.3.1 Stop screw side of housing (1-10) will be considered the front of the actuator.

4.3.2 Housing cover (1-20) will be the top of the actuator.

4.4 To help at re-assembly mark or tag all mating surfaces. Make reference marks at the hydraulic cylinder/housing interface to ensure that the assembly are correctly returned to its original location.

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

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

CAUTION: Apply the thread sealant per the manufacture's instructions.

4.7 Disassembly of actuator should be done in a clean area on a work bench.

4.8 Some components of this actuator are very heavy and will require a means of assistance. For actuator approximate weight refer to the following listed weights.

ACTUATOR MODEL (1) (2)	APPROXIMATE WEIGHT (POUNDS) (2)							
	SR1		SR2		SR3		SR4	
	LBS	KG	LBS	KG	LBS	KG	LBS	KG
ST503.5-SR	N/A	N/A	1120	508	920	417	941	427
ST504.0-SR	1380	626	1131	513	931	931	952	432
ST505.0-SR	1431	649	1182	536	982	982	1003	455
ST506.0-SR	1467	666	1218	553	1018	462	1039	472

NOTES: **(1)** Includes both fail clockwise (CW) and fail counter-clockwise (CCW) actuator models.
(2) Weights listed for each actuator model are for bare actuators without accessories or valve mounting brackets.

4.9 LUBRICATION REQUIREMENTS - HOUSING AND SPRING CARTRIDGE:

NOTE: Lubricants, other than listed in step 4.9.1 should not be used without prior written approval of Bettis Product Engineering.

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

4.10 FLUID REQUIREMENTS: For use in the hydraulic power cylinder (2-10). The following listed fluids are recommended fluids only and does not limit the use of other hydraulic fluids compatible with supplied seals and coatings.

4.10.1 Standard Temperature Service (-20º F to +200º F) use Dexron Automatic Transmission Fluid.

4.10.2 High Temperature Service (0º F to +350º F) use Dexron Automatic Transmission Fluid.

4.10.3 Low temperature service (-40º F to +150º F) use Exxon Univis J13 Hydraulic Fluid.

5.0 SPRING CARTRIDGE REMOVAL

WARNING: Under no circumstances should the spring cartridge be cut open as the spring is pre-loaded with the end caps and cylinder welded around the loaded spring.

CAUTION: Due to the weight and size of the spring cartridge, support equipment will be required when removing the spring cartridge from the actuator housing.

5.1 When the spring cartridge is installed on the actuator the spring is under compression. Do not remove the spring cartridge until the actuator has the "pre-load" removed.

5.2 Remove spring cartridge stop screw "pre-load" as follows: Using a suitable hydraulic power source apply pressure to the pressure inlet port located in outer end of cylinder (2-10).

NOTE: If hydraulic pressure is not available to apply to the pressure inlet port of cylinder assembly (2-10) then manually perform the following steps.

5.3 Mark the stop screws (1-60) left and right. The setting of the stop screws (1-60) should be checked and setting recorded before stop screws are loosened or removed.

5.4 Refer to assembly drawing page 2 of 2 Detail "A". Locate stop screws (1-60) and loosen jam nuts (1-120) and remove stop screws (1-60) from front of housing (1-10).

5.5 Remove hydraulic pressure from pressure inlet port of cylinder assembly (2-10).

5.6 Remove socket screw (4-60), lockwasher (4-50) and nut retainer (4-40) from the end of spring cartridge (4-10).

WARNING: Use suitable lifting equipment to support the spring cartridge (4-10).

5.7 Loosen the two large hex nuts on the outboard end of the spring cartridge (4-10). Unscrew the tie bars until the spring cartridge is free from housing (1-10). Flats are provided on the outboard end of the tie bars for wrench placement. Care should be taken so that the tie bars are not pulled back into the spring cartridge. Place the spring cartridge to one side.

NOTE: To keep from inadvertently pulling the tie bars back into the spring cartridge use 7/8 inch 9 UNC hex nuts and screw them on to the spring cartridge tie bars.

5.8 Unscrew and remove push rod (4-20) from yoke pin nut (1-30).

5.9 Remove the hex cap screws (4-100) from the inboard side of spring cartridge adapter plate (4-80).

5.10 Remove socket cap screws (4-90) and (4-110) from the spring adapter plate (4-80).

5.11 Remove the spring cartridge adapter plate (4-80).

6.0 HYDRAULIC POWER CYLINDER REMOVAL

WARNING: Ensure that all operating pressure is removed from the hydraulic cylinder.

CAUTION: Using some means to contain hydraulic fluid as the tubing (piping) is disconnected from the hydraulic power cylinder (2-10).

6.1 Scribe or mark the following items:

6.1.1 adapter plate (2-130) to the cylinder adapter (2-20).

6.1.2 Cylinder adapter (2-20) to the flange of cylinder assembly (2-10).

6.2 Record the orientation and location of bleed valves (2-100), pipe plugs (2-90), and pressure ports in cylinder assembly (2-10).

6.3 Drain hydraulic fluid from cylinder assembly (2-10) by opening bleed valves (2-100) and then removing cylinder drain pipe plugs (2-90). One drain plug is located on outboard end of cylinder and the other on the inboard end of cylinder.

6.4 Using a 1/2 inch (12.7 mm) square drive extension through the outer end of cylinder assembly (2-10), unscrew the piston rod (2-80) from the yoke pin nut (1-30).

WARNING: Use suitable lifting equipment to support the cylinder assembly (2-10).

NOTE: Around the large flange of the cylinder assembly (2-10) are four socket cap screws (2-110) and four socket cap screws (2-120). To identify the four socket cap screws (2-120), use the top of the cylinder flange as a starting point, going clockwise around the cylinder flange to one o'clock, four o'clock, seven o'clock and ten o'clock these screws will be item (2-120).

6.5 Remove four socket cap screws (2-120).

7.6 As the socket cap screws (2-120) are removed, the cylinder assembly can be removed from cylinder adapter (2-130).

6.7 Remove cylinder assembly (2-10) to a clean area for disassembly. See section 7.0 for hydraulic cylinder assembly dismantling procedure.

7.0 HYDRAULIC POWER CYLINDER ASSEMBLY DISASSEMBLY

CAUTION: Using some means to contain hydraulic fluid as the tubing (piping) is disconnected from the hydraulic power cylinder (2-10).

7.1 Drain any residual hydraulic fluid from cylinder assembly (2-10) by opening bleed valves (2-100) and then removing cylinder pipe plugs (2-90).

NOTE: Actuators manufactured after 1995 will not be shipped with cylinder bleed valves (2-100). Instead of one bleed valve (2-100) and one pipe plug (2-90) on each end of cylinder (2-10) there will be two pipe plugs (2-90) on each end of cylinder (2-10).

7.2 Remove four socket cap screws (2-110) from cylinder assembly (2-10).

7.3 Remove cylinder inner end cap (2-20) from cylinder assembly (2-10).

7.4 Refer to assembly drawing page 2 of 2 Detail "C". Carefully remove piston rod (2-80) and piston (2-30) from cylinder assembly (2-10).

7.5 Refer to assembly drawing page 2 of 2 Detail "C". Remove split ring retainer (2-70) and split rings (2-60) from the outboard side of piston (2-30).

7.6 Remove piston (2-30) from piston rod (2-80).

7.7 Remove inboard split ring retainer (2-70) and split rings (2-60).

7.8 Refer to assembly drawing page 2 of 2 Detail "B". Remove retaining ring (2-50) from inner end cap (2-20).

7.9 Refer to assembly drawing page 2 of 2 Detail "B". Remove rod bushing (2-40) from inner end cap (2-20).

8.0 HOUSING DISASSEMBLY

NOTE: Review and complete Section 5 prior to commencing with the following steps.

8.1 Remove two socket cap screws from adapter plate (2-130).

8.2 Remove adapter plate (2-130) from end of housing (1-10).

8.3 Remove snubber valve (1-190) from housing cover (1-20).

8.4 Remove snubber valve (1-190) from lower left front of housing (1-10).

8.5 Refer to assembly drawing page 2 of 2 section A-A. Remove position indicator pin (1-170) from position indicator drive (1-230).

8.6 Refer to assembly drawing page 2 of 2 section A-A and Detail “D”. Unscrew and remove hex cap screws (1-240) with gasket seals (3-100) from position indicator cover (1-210).

8.7 Refer to assembly drawing page 2 of 2 section A-A. Remove position indicator cover (1-210).

8.8 Refer to assembly drawing page 2 of 2 detail "D". NOTE: Record the orientation of the position indicator drive (1-230) relative to the top of yoke (1-160). Mark the hole that set screw (1-180) is removed from. Unscrew and remove set screw (1-180) from position indicator drive (1-230).

8.9 Remove position indicator drive (1-230) from the top of the yoke (1-160).

8.10 Remove hex cap screws (1-90) with gasket seals (3-100) from housing cover (1-20).

8.11 Remove the housing cover (1-20). NOTE: The cover will have a very tight fit. It is not necessary to remove cover pins (1-130).

8.12 Remove the top two yoke rollers (1-50) and roller spacer (1-110) from the top of the yoke pin (1-40).

8.13 Remove yoke pin (1-40) from yoke arms and yoke pin nut (1-30).

8.14 Remove yoke pin nut (1-30) from between the arms of yoke (1-160).

8.15 Remove the lower two yoke rollers (1-50) and roller spacers (1-110) from the bottom of the yoke and housing.

8.16 Yoke (1-160) can now be removed by lifting it from inside housing (1-10).

8.17 It is not necessary to remove the yoke bushings (1-200) from the housing (1-10) or the housing cover (1-20) unless these items are being replaced due damage or wear.

8.18 It is not necessary to remove the pipe plugs (1-80), to service the actuator.

9.0 GENERAL REASSEMBLY

CAUTION: Only new seals that are still within the seal's expectant shelf life should be install back into actuator being refurbished.

9.1 Remove and discard all seals and gaskets.

9.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.

9.3 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 and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

CAUTION: Actuator parts that reflect any of the characteristics listed in step 9.3 may require replacement with new parts.

9.4 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 will be assembled using lubricant as identified in step 4.9. The parts and seals used in the cylinder assembly (2-10) will be assembled using the hydraulic fluid identified in step 4.10.

9.5 Prime and apply master gasket to all surfaces as indicated on the assembly drawing. Master Gasket should be applied per the manufacture instructions. In general a small continuous bead of sealant should be applied to one of the jointing surfaces. This sealant bead should be applied as close to the edge of jointing surfaces. This sealant bead should also be applied around any unsealed passages that passes through either surfaces to the atmosphere.

10.0 HOUSING REASSEMBLY

CAUTION: Use the lubricants as referenced in Section 4 step 4.9 on all moving parts and seals in the housing assembly.

10.1 If removed install drain plugs (1-80).

10.2 Coat one o-ring seal (3-50) with lubricant and install into the seal groove located in the yoke bore in the bottom area of housing (1-10).

10.3 If yoke bushings (1-200) have been moved then install a new bushing into the yoke bore of housing (1-10) and a new yoke bushing (1-200) into the yoke bore of housing cover (1-20). NOTE: Install yoke bushings (1-200) without any lubricant.

10.4 Inside housing (1-10) apply lubricant to the tracks and yoke bore. Arrange or position housing (1-10) with the yoke bore nearest the worker.

10.5 Apply lubricant to slots in the upper and lower arms of yoke (1-160).

10.6 Apply lubricant to lower bearing surface of yoke (1-160) and install yoke (1-160) into housing (1-10) as follows:

10.6.1 Position arms of yoke (1-160) to approximately 45° degree position in either direction.

10.6.2 Install yoke (1-160) into housing (1-10). NOTE: The yoke hub with tapped holes faces up.

10.6.3 Rotate the yoke arms back to approximately mid-stroke (center) position.

10.7 Apply lubricant to all surfaces of two yoke rollers (1-50) and two roller spacers (1-110).

10.8 Refer to assembly drawing page 2 of 2 Section A-A and detail "D". Install one yoke roller (1-50) into the track in bottom of housing (1-10) and position it under the slot in the arms of yoke (1-160).

10.9 Place one roller spacer (1-110) on top of lower yoke roller (1-50).

10.10 Place a second yoke roller (1-50) on top of roller spacer (1-110) in the slot in the lower arm of yoke (1-160).

10.11 Place a second roller spacer (1-110) on to of the second yoke roller (1-50) and align the holes in the roller spacer and the yoke rollers.

10.12 Coat upper and lower surfaces of yoke pin nut (1-30) with lubricant and install into position between the arms of yoke (1-160) and parallel to the track in the bottom of housing (1-10). Align the yoke pin hole with yoke rollers (1-50) and roller spacers (1-110).

10.13 Lubricate yoke pin (1-40) and insert through yoke pin nut (1-30), two yoke rollers (1-50) and two roller spacers (1-110).

10.14 Apply lubricant to all surfaces of the two remaining yoke rollers (1-50) and two remaining roller spacers (1-110).

10.15 Refer to assembly drawing page 2 of 2 Section A-A and detail "D". Place one roller spacer (1-110) over yoke pin (1-40) and on top of yoke pin nut (1-30).

10.16 Install third yoke roller (1-50) over yoke pin (1-40) and on top of roller spacer (1-110).

10.17 Place the last roller spacer (1-110) over yoke pin (1-40) and on top of third yoke roller (1-50).

10.18 Place the fourth and final yoke roller (1-50) over the yoke pin (1-40) and on top of roller spacer (1-110).

NOTE: The top roller will remain above the yoke arm and will engage the track in housing cover (1-20) when the housing cover is installed.

10.19 Refer to assembly drawing page 2 of 2 detail "A". Place thread seals (3-110), countersunk washers (3-120) and jam nuts (1-120) onto stop screws (1-60).

10.20 Install the two assembled stop screws (1-60) into the front areas of housing (1-10), making sure the stop screws marked in Section 5 step 5.3 are installed into the same stop screw holes as they where removed from.

10.21 Place position indicator drive (1-230) onto top of yoke (1-160) with the slot positioned over the hole that was marked in Section 8 step 8.8.

10.22 Install set screw (1-180) through position indicator drive (1-230) and into the top of yoke (1-160).

10.23 Prepare the mounting surfaces of adapter plate (2-130) and right end of housing (1-10) per master gasket instructions (reference step 9.5 under General Reassembly).

10.24 Install o-ring seal (3-10) into adapter plate (2-130).

10.25 Install adapter plate (2-130) on to the right end of housing (1-10) for fail clockwise actuators or into left end of housing (1-10) for fail counter-clockwise actuators.

10.26 Install and tighten socket cap screws (2-140) through adapter plate (2-130) and into right end of housing (1-10) for fail clockwise actuators or into left end of housing (1-10) for fail counter-clockwise actuators.

10.27 Apply Loctite - 242 to external threads on the push rod (4-20). NOTE: The cure time for Loctite 242 is 10 to 30 minutes.

10.28 Lubricate the push rod (4-20) and install into the left side of the housing for fail clockwise (CW) actuators or into the right side of the housing for fail counter-clockwise (CCW) actuators. Screw the push rod into the yoke pin nut (1-30).

10.29 Tighten the push rod (4-20) securely with a strap wrench.

10.30 Refer to assembly drawing page 2 of 2 detail "D". Install o-ring seal (3-150) over the position indicator drive shaft and down against the flat of the position indicator drive (1-230).

10.31 Coat the remaining yoke o-ring seal (3-50) with lubricant and install into the seal groove located in the yoke bore in the housing cover (1-20).

10.32 Apply lubricant to the yoke bore and the track in housing cover (1-20).

10.33 Apply lubricant to the yoke upper bearing surface.

10.34 Prepare the mounting surfaces of housing cover (1-20) and housing (1-10) per master gasket instructions (reference step 9.5 under General Reassembly).

10.35 Place housing cover gasket (3-20) on the top of housing (1-10).

10.36 Install housing cover (1-20) being careful not to damage the cover gasket (3-20) or yoke o-ring seal (3-50).

10.37 Install new seal gaskets (3-100) on to cover screws (3-90).

10.38 Install cover screws (1-90) with seal gasket (3-100). NOTE: Leave finger tight - do not tighten.

10.39 Do this step only if you have pulled cover pins (1-130) or if you are replacing the cover pins. Drive the pins (1-130) through cover (1-20) and into housing (1-10) until the pin is flush with the cover. NOTE: The pins are deeply grooved at one end, tapering to a smooth diameter at the other end. The pin should be installed smooth end first.

10.40 Torque tighten cover screws (1-90) to a lubricated torque of 16 foot pounds (21.7 n-m) ±5 % percent.

10.41 Refer to assembly drawing page 2 of 2 detail "D". Install o-ring seal (3-140) into the lower seal groove inside position indicator cover (1-210).

10.42 Refer to assembly drawing page 2 of 2 detail "D". Install wiper ring (3-160) into the upper groove inside position indicator cover (1-210).

10.43 Prepare the mounting surfaces of position indicator cover (1-210) and top area of housing (1-10) per master gasket instructions (reference step 9.5 under General Reassembly).

10.44 Refer to assembly drawing page 2 of 2 detail "D". Install o-ring seal (3-170) into the lower seal groove on the bottom area of position indicator cover (1-210).

10.45 Install the position indicator cover (1-210), being careful not to damage the o-ring seals (3-140), (3-170) and wiper ring (3-160).

10.46 Install new gasket seals (3-100) on to hex cap screws (1-240).

10.47 Install and tighten the position indicator cover hex screws (1-240).

10.48 Install position indicator pointer (1-170) into the taped hole in the position indicator drive assembly (1-230).

10.49 Replace the software components of two snubber valves (1-190) and install as follows:

10.49.1 Install one snubber valve (1-190) into the top of housing cover (1-20).

10.49.2 Install the second snubber valve (1-190) into the left front of housing (1-10).

11.0 HYDRAULIC POWER CYLINDER ASSEMBLY REASSEMBLY

NOTE: Where the procedure indicates to "coat or apply fluid", use hydraulic fluid for lubricating the part being installed.

11.1 Refer to assembly drawing page 2 of 2 detail "C". Apply fluid to o-ring seal (3-40) and install onto piston rod (2-80).

11.2 Install a set of matched split rings (2-60) into the inboard groove of piston rod (2-80) and retain with retaining ring (2-70).

11.3 Install piston (2-30) onto piston rod (2-80) and over the split rings installed in step 11.2.

11.4 Install a set of split rings (2-60) into the outboard groove and retain with retaining ring (2-70).

11.5 Apply fluid and install two Polypak seals (3-90) into outer diameter seal grooves in piston (2-30). Verify that the two Polypak seals are both facing outward and are back to back.

11.6 Install two back-up rings (3-200) into outer diameter seal grooves in piston (2-30). NOTE: The two back-up rings will be back to back (refer to assembly drawing page 2 of 2, Detail “C”).

11.7 Refer to assembly drawing page 2 of 2, Detail “C”. Install two piston wear rings (3-80) into the outer diameter grooves provided on piston (2-30).

11.8 Apply fluid to the cylinder wall of cylinder assembly (2-10) and then carefully insert the piston assembly into the cylinder assembly.

11.9 Refer to assembly drawing page 2 of 2 Detail "B". Apply fluid and install two Polypak seals (3-70). Install one Polypak seal, lip first, into the recess provided in inner end cap (2-20).

11.10 Install the second Polypak (3-70) into seal groove located on the outer diameter of rod bushing (2-40), with the Polypak lip facing short side of rod bushing (2-40).

NOTE: Verify that both Polypak seals (3-70) have their lips facing outward and are back to back.

11.11 Refer to assembly drawing page 2 of 2 Detail "B". Apply fluid to three o-ring seals (3-60), (3-180) and (3-230), install the three o-rings into the inner end cap (2-30) as follows:

11.11.1 Install o-ring (3-180) into the outer diameter seal groove of cylinder adapter (2-20).

11.11.2 Install o-ring seal (3-230) into the seal groove located in the inboard side of cylinder adapter (2-20).

11.11.2 Install o-ring seal (3-60) into the seal groove located in the outboard side of cylinder adapter (2-20).

11.12 Install rod bushing (2-40) into inner end cap (2-20).

11.13 Retain rod bushing (2-40) in cylinder adapter (2-20) with retaining ring (2-50).

11.14 Prepare the mounting surface of the cylinder assembly flange and both mounting surfaces of inner end cap (2-20) per master gasket instructions (reference step 9.5 under General Reassembly).

11.15 Install four stat-o-seals (3-240) onto four socket cap screws (2-110).

11.16 Aligning the marks, as recorded in section 6 step 6.1.2, carefully install inner end cap (2-20) over piston rod (2-80) and into open end of cylinder assembly (2-10).

11.17 Install four socket cap screws (2-110), with stat-o-seals (3-210), through the flange of cylinder assembly (2-10) and screw into cylinder adapter (2-20).

11.18 Torque tighten the four socket cap screws (2-110), with stat-o-seals (3-240) to 240 foot pounds (325.2 n-m) lubricated.

11.19 If removed apply pipe dope on bleed valves (2-100) and install into cylinder assembly (2-10).

11.20 Apply pipe dope on pipe plugs (2-90) and install into cylinder assembly (2-10).

NOTE: Bettis does not require any special hydraulic fluid cleaning standard for this assembled cylinder assembly. If required by the customer's facility, flush the assembled hydraulic cylinder assembly to meet that facilities standard. Seal all port openings after flushing.

12.0 HYDRAULIC POWER CYLINDER ASSEMBLY REPLACEMENT

NOTE: Ensure that the previously marked housing positions of the hydraulic cylinder assembly are observed when replacing the hydraulic cylinder assembly.

12.1 Apply Loctite - 242 to external threads on the piston rod (2-80). NOTE: Loctite cure time is ten to thirty minutes.

NOTE: Refer to section 6 step 6.1 for correct location and orientation for the assembled cylinder assembly.

12.2 Carefully install piston rod (2-80) through cylinder adapter (2-130) and bring cylinder assembly (2-10), with inner end cap (2-20), up to cylinder adapter (2-130). Align the four cylinder assembly flange "through holes" with the tapped holes in cylinder adapter (2-130).

12.3 Install four stat-o-seals (3-240) on to four socket cap screws (2-120).

12.4 Install four socket cap screws (2-120) with stat-o-seals (3-240) through the flange cylinder assembly (2-10), through cylinder adapter (2-20) and screw into adapter plate (2-130).

12.5 Torque tighten socket cap screws (2-120) to 150 foot pounds (203.2 n-m) lubricated.

12.6 Torque tighten socket cap screws (2-110) to 240 foot pounds (325.2 n-m) lubricated.

12.7 Using a 1/2 inch (12.7 mm) square drive extension through the SAE or BSPP port in the outer end of cylinder assembly (2-10), screw piston rod (2-80) into yoke pin nut (1-30).

12.8 Torque tighten piston rod (2-80) to 150 foot pounds (203.2 n-m) lubricated.

NOTE: If the actuator is not being placed in service immediately then seal all opening ad ports in the assembled cylinder assembly.

13.0 SPRING CARTRIDGE INSTALLATION

13.1 Prepare the mounting surface of the SR adapter plate (4-80), inboard end of spring cartridge (4-10) and spring cartridge side of the housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).

13.2 Refer to assembly drawing page 2 of 2 Detail "A". Install the end cap o-ring seal (3-10) into the spring cartridge adapter plate (4-80).

13.3 Install the spring cartridge adapter plate (4-80) over the push rod (4-20) and up against the housing (1-10).

13.4 Retain the spring cartridge adapter plate with socket cap screws (4-90).

13.5 Refer to assembly drawing page 2 of 2 Detail "A". Install o-ring seal (3-190) into the spring cartridge adapter plate (4-80).

13.6 Remove the nuts, installed at step 6.6, from the spring cartridge tie bars.

13.7 Place the spring cartridge (4-10) on to the push rod (4-20) and align the spring cartridge tie bars with the holes in the spring cartridge adapter plate (4-80).

13.8 Screw the tie bars into the spring cartridge adapter plate (4-80). Tighten the tie bars until the threads bottom out, then back the tie bars back out one half turn.

13.9 Refer to assembly drawing page 2 of 2 Detail "A". Install hex cap screws (4-100) thru the spring cartridge adapter plate (4-80) and screw them into the SR cartridge (4-10).

13.10 Unscrew and remove the spring cartridge tie bar nuts, countersunk washer's (3-220) and thread seals (3-210).

13.11 Install new thread seals (3-210) and countersunk washers (3-220) on to the spring cartridge tie bars.

CAUTION: While the tie bar nuts are being tightened, do not allow the tie bars to turn.

13.12 Reinstall the tie bars nuts and alternately tighten them in 50 foot pounds (67.75 n-m) increments until the spring cartridge is firmly against the spring cartridge adapter plate and then tighten to 90 foot pounds (122 n-m) ±10 percent lubricated.

NOTE: It is necessary that the flats on the SR tie bar hex nuts be aligned and parallel before the nut retainer (4-40) can be installed.

13.13 Install lockwasher (4-50) onto socket cap screw (4-60).

13.14 Install nut retainer (4-40) onto outer end of SR cartridge (4-10) between SR tie bar nut flats.

13.15 Install and tighten socket cap screw (4-60) with lockwasher (4-50).

14.0 RETURN TO SERVICE

14.1 After the actuator is mounted on the valve all accessories should be hooked up and tested for proper operations and replaced, if found defective.

14.2 The actuator is ready to return to service.

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