BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR THE MODELS

KST5XX-SR

SPRING RETURN SERIES

K-MASS COATED

PNEUMATIC ACTUATORS

PART NUMBER: 109735

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 KST5XX-SR "Scotch-Yoke" type pneumatic series actuators. When the actuator model number has "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.

1.2 The maximum recommended service interval for this series of actuators is five years. Storage time is counted as part of the service interval.

1.3 This procedure is written with the understanding that the actuator has been removed from the valve, the air or power gas has been removed from the power cylinders and all piping and accessories mounted on the actuator have been removed.

COMPLETE ACTUATOR REFURBISHMENT REQUIRES THAT THE ACTUATOR BE DISMOUNTED FROM THE VALVE

2.0 SUPPORT ITEMS AND TOOLS

2.1 Support Items - Service Kit, two each 1-8 UNC hex nuts, commercial leak testing solution, and non-hardening thread sealant.

2.2 Tools - All tools are American Standard inch. Two each medium standard screwdriver, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and a torque wrench (up to 5,000 in. lbs.). For recommended tool list refer to page 10 of 10.

3.0 BETTIS REFERENCE MATERIALS

3.1 Assembly Drawing 104824 * for ST5XX-SR (CW) actuator failing closed.

***** This drawing does not show the K-Mass coating and its related covers and hardware.

4.0 GENERAL

4.1 Numbers in parentheses, ( ), indicate the bubble number (reference number) used on the Bettis Assembly Drawing and actuator parts lists.

4.2 This procedure is written using the stop screw side of the housing (1-10) as a reference and this side will be considered the front side of the actuator. The housing cover (1-20) is considered the top of the actuator.

4.3 Mating parts should be marked for ease of reassembly, i.e. spring cartridge to housing and cylinder to housing.

4.4 When removing seals from seal groove, use a small standard screwdriver with the sharp edges rounded off or use a commercial seal removing tool.

4.5 Use a non-hardening thread sealant on all pipe threads. **CAUTION: Apply the thread sealant per the manufacture's instructions.**

4.6 Disassembly should be done in a clean area on a work bench.

4.7 Some components of this actuator are very heavy and will require a means of assistance.

4.8 Lubrication Requirements - Standard and high temperature service (-20º F to 350º F) use ESL-5 (Kronaplate 100). ESL-5 is contained in the Bettis Service Kit.

4.9 It is a good practice to operate the actuator with the nominal operating pressure (NOP), as listed on the actuator nametag or the pressure used by the customer to operate the actuator during normal operation, before starting the general disassembly of the actuator. Notate and record any abnormal symptoms such as jerky or erratic operation. Also note if the actuators spring rotates back to the full fail position. NOTE: Pressure is not to exceed the maximum operating pressure rating listed on the name tag.

5.0 GENERAL DISASSEMBLY

5.1 If not already removed disconnect all operating pressure from actuator power cylinder (2-10), allowing the spring to stroke. The spring will rotate the yoke to the fail position.

5.2 Remove any hardware attached K-Mass protection covers from the actuator.

5.3 Remove the latex caulking that covers the hardware on the housing cover.

5.4 Cut through the latex caulking that seals all joints where the actuator parts are disassembled.

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

6.0 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.

6.1 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.

6.2 Remove spring cartridge "pre-load" as follows: Apply nominal operating pressure to the pressure inlet port located in the cylinder end cap (2-30). Locate the stop screw (1-60) that is on the opposite side of the housing from the spring cylinder (4-10). Loosen jam nut (1-120). Unscrew the stop screw (1-60) until it runs into the inner end cap (2-40). Remove the pressure from the pressure inlet port.

6.3 Remove socket cap screw (4-60), lockwasher (4-50), and nut retainer (4-40) between large hex nut on outboard end of the spring cartridge (4-10).

6.4 Remove the hex cap screws (4-100) from the spring cartridge adapter plate (4-80).

6.5 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 the spring cartridge adapter plate (4-80). 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.

6.6 To keep from inadvertently pulling the tie bars back into the spring cartridge use two each one inch-8 UNC hex nuts and thread them on to the spring cartridge tie bars. Place the spring cartridge (4-10) to one side.

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

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

7.0 PRESSURE CYLINDER DISASSEMBLY

7.1 Remove breather assembly (610) from inner end cap (2-40).

7.2 Remove socket cap screw (2-120), lockwasher (2-110) and nut retainer (2-100) from the end of the outer end cap (2-30).

7.3 Remove hex nuts (2-90) from tie bars (2-60).

7.4 Remove outer end cap (2-30). The fit between the cylinder (2-10) and the outer end cap is very tight.

7.5 Pry inner end cap (2-40) away from the housing (1-10). Break the inner end cap free from the cylinder (2-10).

7.6 Remove the cylinder (2-10). When sliding the cylinder off of the piston, tilt the cylinder 15□ to 30□ degrees to the piston rod.

7.7 Unscrew and remove the tie bars (2-60) from the housing (1-10). Flats are provided on the outboard end of the tie bars for wrench placement. **CAUTION: DO NOT use a pipe wrench on the tie bars as it will mark the bar and may cause seal leakage.**

7.8 Remove the split ring retainer (2-80) and the split ring (2-70) from the outboard side of the piston (2-20). **CAUTION: Keep the split rings in matched sets.**

7.9 Remove the piston (2-20) from the piston rod (2-170). The piston will slide off of the piston rod.

7.10 Remove the piston rod o-ring seal (3-40) from the piston rod (2-170).

7.11 Remove the split ring retainer (2-80) and the split ring (2-70) from the inboard side of the piston. **CAUTION: Keep the split rings in matched sets.**

7.12 Slide the inner end cap (2-40) off the piston rod (2-170).

8.0 HOUSING DISASSEMBLY

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

8.2 Unscrew piston rod (2-170) from yoke pin nut (1-30) and remove. Flats are provided on the outboard end of the piston rod for wrench placement. **CAUTION: DO NOT use a pipe wrench on the piston rod as it will mark the rod and cause seal leakage.**

8.3 Remove rod bushing (2-50) and rod seal (3-70). The bushing will slide off of the end of the piston rod.

8.4 Remove position indicator pin (1-170).

8.5 Unscrew and remove hex cap screws (1-240) with gasket seals (3-100) from position indicator cover (1-210).

8.6 Remove position indicator cover (1-210).

8.7 Unscrew and remove set screw (1-180) from position indicator drive (1-230). NOTE: Mark the hole that the set screw (1-180) is removed from.

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

8.9 Remove the housing cover hex cap screws (1-90) and gasket seals (3-100).

8.10 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).

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

8.12 Remove the yoke pin (1-40).

8.13 Remove the yoke pin nut (1-30).

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

8.15 The yoke (1-160) can now be removed by lifting it from the housing.

8.16 Remove stop screws (1-60), stop nuts (1-120), countersunk washers (3-120) and thread seals (3-110).

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.

9.0 GENERAL REASSEMBLY

9.1 Remove and discard all old 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. Particular attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding motion. Sealing surfaces must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

9.4 All K-Mass coated parts should be inspected for damage to the coating. Replace or repair all K-Mass parts that are damaged.

9.5 Before installation coat all moving parts with lubricant. coat all seals with lubricant, before installing into seal grooves.

9.6 T-seal set installation - The T-seal is composed of one rubber seal and two split skive-cut back-up rings.

9.6.1 Install the T-seal into the seal groove.

9.6.2 Install a back-up ring on each side of the T-seal.

9.6.3 When installing the back-up rings, do not align the skive-cuts.

9.6.4 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.

9.7 Prime and apply master gasket (510) to all surfaces as indicated on the assembly drawing.

10.0 HOUSING REASSEMBLY

10.1 Coat one of the yoke o-ring seal (3-50) with lubricant and install into the housing (1-10).

10.2 If the yoke bushings (1-200) was removed then install one in the housing yoke bore and one in the housing cover yoke bore.

10.3 Inside the housing (1-10) apply lubricant to the tracks and yoke bore and arrange the housing with the yoke bore nearest you.

10.4 Apply lubricant to the slots in the upper/lower yoke arms and the lower bearing surface.

10.5 Install the yoke (1-160) into the housing (1-10) as follows: Arrange the yoke arms to approximately a 45º degree position in either direction and lower into the housing. NOTE: The hub with tapped holes faces up. Rotate the yoke back to approximately the mid-stroke (center) position.

10.6 Apply lubricant to all surfaces of two of the yoke rollers (1-50) and two roller spacers (1-110). Place one yoke roller in the track in the bottom of the housing and position it under the slot in the yoke arms. Place a roller spacer (1-110) on top of the bottom yoke roller (1-50). Place a second yoke roller on top of the roller spacer in the slot in the lower yoke arm. Place another 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.

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

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

10.9 Apply lubricant to all the surfaces of the two remaining yoke rollers (1-50) and two remaining roller spacers (1-110). Place one roller spacer on top of the yoke pin nut (1-30) then install the third yoke roller (1-50). Place the last roller spacer on top of the third yoke roller (1-50). Place the fourth and final yoke roller on to the yoke pin. The top roller will remain above the yoke arm and will engage the cover track when the cover is installed.

10.10 Apply Loctite - 242 to external threads on the piston rod (2-170). Lubricate the piston rod (2-170) and slide into the right side of the housing for fail close (CW) actuators or into the left side of the housing for fail open (CCW) actuators. Screw the piston rod into the yoke pin nut (1-30). (**DO NOT TIGHTEN**) Flats are provided on the outboard end of the piston rod. These flats should be used to put a wrench on to tighten the piston rod. **CAUTION: DO NOT use a pipe wrench on the piston rod, as it may cause seal leakage.**

10.11 Apply lubricant to the rod bushing (2-50), install it over the piston rod and slide it up into the housing.

10.12 Lubricate the push rod (4-20) and slide into the other side of the housing and screw into the yoke pin nut (1-30).

10.13 Place thread seals (3-110), countersunk washers (3-120) and jam nuts (1-120) on the stop screws (1-60). Install both assemblies into the housing.

10.14 Position the position indicator drive (1-230) onto the top of the yoke (1-160) with the slot positioned over the hole that was marked in step 8.6. Secure with the set screw (1-180).

10.15 Install the o-ring seal (3-150) over the position indicator drive shaft and down against the flat cover plate.

10.16 Place the housing cover gasket (3-20) on the housing (1-10).

10.17 Coat the remaining yoke o-ring seal (3-50) with lubricant and install into the housing cover (1-20).

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

10.19 Apply lubricant to the yoke upper bearing surface.

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

10.21 Install the cover screws (1-90) and seal gasket (3-100). **LEAVE FINGER TIGHT - DO NOT TIGHTEN**.

10.22 Do this step only if you have pulled the cover pins (1-130) or if you are replacing the cover pins. Drive the pins (1-130) thru the cover (1-20) and into the 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.

10.23 Tighten the cover screws (1-90) and torque to 21.5 foot pounds or 3.0 kilograms-meters.

10.24 Tighten the piston rod (2-170) to a torque of approximately 150 foot pounds or 20.7 kilogram-meters. Flats are provided on the outer end for wrenching purposes. **CAUTION: DO NOT USE A PIPE WRENCH OR SIMILAR TOOL TO TIGHTEN PISTON ROD.**

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

10.26 Install the o-ring seal (3-140) into the bottom seal groove inside the position indicator cover (1-210).

10.27 Install the wiper ring (3-160) into the top groove inside the position indicator cover (1-210).

10.28 Install the o-ring seal (3-170) into the bottom seal groove on the bottom of the position indicator cover (1-210).

10.29 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).

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

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

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

10.33 Rotate the yoke to a position that will leave a minimum of the piston rod (2-170) protruding from the actuator housing.

11.0 PRESSURE CYLINDER RE-ASSEMBLY

11.1 Coat the rod seal (3-70) with lubricant and install, lip first, into the recess provided in the inner end cap ((2-40).

11.2 Install one end cap o-ring seal (3-10) into the inner end cap (2-40).

11.3 Coat two tie bar o-ring seals (3-30) with lubricant and install into the inner end cap (2-40).

11.4 Slide the inner end cap (2-40) over the piston rod (2-170) and the rod bushing (2-50), protruding from the housing. Install with the large raised boss toward the housing (flat side outward). The pressure inlet port should be toward the top of the actuator.

11.5 Apply lubricant to the end cap o-ring seal (3-60) and install on the inner end cap (2-40).

11.6 Apply lubricant to two sets of piston tie bar T-seal components (3-80) and install into the piston internal seal groove. Refer to step 9.6 for proper installation instructions.

11.7 Coat the ends of the piston rod (2-170) with lubricant.

11.8 Apply lubricant to the piston o-ring (3-40) and place onto the piston rod (2-170).

11.9 Install a matched set of split rings (2-70) into the inner most groove in the piston rod and retain with one of the split ring retainers (2-80) retaining ring groove away from piston.

11.10 Slide the piston (2-20) onto the piston rod against the split ring (2-70). Ribbed section of piston should face away from housing.

11.11 Install a matched set of split rings (2-70) into the piston rod and retain with the split ring retainer (2-80). Split ring retainer groove to face away from the piston.

11.12 Coat the piston T seal components (3-90) with lubricant and install into the piston external seal groove. Refer to step 9.6 for proper "T" seal installation.

11.13 Apply lubricant to the threads and end of the tie bars (2-60), (end without wrench flat), and install by carefully inserting the tie bars through the piston (2-20) and then through the inner end cap (2-40) and screwing into the housing (1-10). Relubricate all exposed surfaces of piston rod (2-170) and tie bars (2-60).

CAUTION: Tighten the tie bars until the threads bottom out, then back out each tie bar one half-turn.

11.14 Apply a light coat of lubricant to the bore of the cylinder (2-10).

11.15 Slide the lubricated cylinder (2-10) over the piston (2-20) and onto the inner end cap (2-40). When sliding the cylinder over the piston seal tilt the cylinder 15□ to 30□ degrees to the piston rod.

CAUTION: Hammer on the end of the cylinder only with a non metallic object.

CAUTION: Make certain the back-up rings (components of the piston seal) are seated into the seal groove. Should the back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.

11.16 Apply lubricant to two end cap tie bars o-ring seals (3-30) and install into the outer end cap (2-30).

11.17 Apply lubricant to the outer end cap cylinder o-ring seal (3-60) and install onto outer end cap (2-30).

11.18 Install the outer end cap (2-30) onto the tie bars and into the end of the end of the cylinder (2-10). The pressure inlet port should be toward the top of the actuator.

11.19 Install the two tie bar hex nuts (2-90) on the tie bars (2-60), using them to draw all of the cylinder components into position. Torque alternately, in 50 ft. lb. increments until a final torque of 90 +/- 9 foot pounds has been achieved. **CAUTION: While the tie bar nuts are being tightened, do not allow the tie bars to turn.**

11.20 Install the nut retainer (2-100), securing in place with the retainer screw (2-120) and lockwasher (2-110). It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the nut retainer can be installed.

11.21 Apply ten psig pneumatic pressure to the breather port in the inner end cap (2-40) and stroke the actuator. Remove the air pressure from the breather port.

12.0 SPRING CARTRIDGE INSTALLATION

12.1 Install the end cap o-ring seal (3-10) into the spring cartridge adapter plate (4-80).

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

12.3 Retain the spring cartridge adapter plate with socket cap screws (4-90) and (4-110).

12.4 Install o-ring seal (3-190) into the spring cartridge adapter plate (4-80).

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

12.6 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).

12.7 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.

12.8 Unscrew and remove the spring cartridge tie bar nuts, countersunk washers (3-190) and thread seals (3-180).

12.9 Install new thread seals (3-210) and countersunk washers (3-220) on to the spring cartridge tie bars. Reistall the tie bars nuts and alternately tighten them in 50 foot pounds increments until the spring cartridge is firmly against the spring cartridge adapter plate and then tighten to 90 +/- 9 foot pounds.

12.10 Install nut retainer (4-40), lockwasher (4-50), and socket cap screw (4-60). It is necessary that the flats on the hex nuts be aligned and parallel before the nut retainer can be installed.

13.0 ACTUATOR TESTING

13.1 Leak Test - General - All areas, where leakage to atmosphere may occur, are to be checked using a leak testing solution.

13.2 All leak testing will use the nominal operating pressure (NOP) as listed on the actuator nametag.

13.3 Before testing for leaks, alternately apply and release NOP pressure 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 proper working attitude.

13.4 Leakage Test - Procedure - Apply NOP pressure to the pressure port in the outer end cap (2-30).

13.5 Apply a leak testing solution to the following areas:

13.5.1 Joint between the outer end cap (2-30) and the cylinder (2-10). Checks cylinder to end cap o-ring seals.

13.5.2 Around the tie bar nuts on the cylinder end cap (2-30). Checks tie bars to end cap o-ring seals.

13.5.3 The breather port hole in the inner end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.

13.6 Remove pressure from pressure inlet port in the outer end cap.

13.7 If excessive leakage across the piston is noted (generally a bubble which breaks three seconds or less after starting to form), the actuator must be disassembled and the cause of leakage must be determined and corrected.

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

14.0 RETURN TO SERVICE

14.1 Install breather assembly (610) in the inner end cap (2-40).

14.2 If supplied in the service kit, replace the software components of the snubber valve (1-190) and then install the snubber in the housing cover port.

14.3 Adjust both stop screws (1-60) back to settings recorded in step 5.5.

14.4 Tighten both stop nuts (1-120) securely, while holding stop screw (1-60).

14.5 All accessories, including solenoid valves, positioners, pressure switches, etc., should be hooked up and tested for proper operations and replaced, if found defective.

14.6 Using a tube of latex window caulk seal all joints that where removed or cut through or removed during disassembly.

KST5XX-SR

TOOL STYLE AND WRENCH SIZES

ITEM NO.	WRENCH SIZE	QTY	LOCATION	RECOMMENDED WRENCH STYLE
1-60	15/16"	2	Stop Screw	Open End Or Adjustable
1-90	9/16"	12	Cover Screws	Socket
1-120	1-7/8"	2	Stop Screw Nut	Box End (1)
1-190	7/8"	1	Snubber	Deep Socket
1-240	9/16"	6	Position Indicator Cover Screws	Socket
2-60	5/8"	2	Tie Bar Flats	Open End or Adjustable
2-90	1-5/8"	2	Power Cylinder Tie Bar Nuts	Crows Foot (1)
None	1-5/8"	2	Spring Cartridge Tie Bar Nuts	Crows Foot
2-120	3/16"	1	Outer End Cap (2-30) Nut Retainer	Allen
2-170	1-3/8"	1	Piston Rod Flat	Crows Foot (1)
4-20	(2)	1	SR Push Rod	Strap Wrench
4-60	3/16"	1	SR Nut Retainer Screw	Allen
4-90	1/2"	4	SR Adapter Plate Screws	Allen
4-100	15/16"	4	SR Adapter Plate Screws	Open End Or Adjustable
4-110	3/4"	2	SR Adapter Plate Screws	Allen

(1) No alternate style recommended

(2) Wrench placement not provided

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Released	August 18, 1992	A	COMPILED	O. Kalinec	August 18, 1992
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			APPROVED	M. R.	August 20, 1992

* **Signatures on file Waller, Texas**