

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY & REASSEMBLY

FOR MODELS

T3XX AND T4XX

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 074889

REVISION: "A"

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REPLACES: Service-013 (SE-013)

1.0 INTRODUCTION

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis T3XX and T4XX double acting 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 **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 well trained, equipped, prepared and competent personnel.

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.

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.

1.4 **BASIC SERVICE INFORMATION:** Complete actuator refurbishment will require the actuator to be dismantled from the valve or device it is operating.

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

1.6 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.

2.0 SUPPORT ITEMS AND TOOLS

2.1 Support Items - Service/Seal Kit, razor sharp cutting instrument, 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 Chart number 1 on page 12.

3.0 BETTIS REFERENCE MATERIALS

- 3.1 Actuator model T3XX series Assembly Drawing part number 036006.
- 3.2 Actuator model T4XX series Assembly Drawing part number 035934.
- 3.3 Actuator model T3XX Exploded Detail Drawing * part number 063367.
- 3.4 Actuator model T4XX Exploded Detail Drawing * part number 063370.

* Exploded Detail Drawings are contained in Bettis standard Service/Seal Kit.

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 parenthesis, (), indicate the bubble number (reference number) used on the Bettis Assembly Drawing, Exploded Detail Drawing, and actuator parts list.
- 4.3 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 and the housing cover as the top of the actuator.
- 4.4 Refer to actuator weights as listed in the following chart by actuator model (includes actuator models that have a -10 or -11 suffix at the end of the model number).

ACTUATOR MODEL	APPROXIMATE WEIGHT (POUNDS)**	ACTUATOR MODEL	APPROXIMATE WEIGHT (POUNDS)**
T310	186	T410	236
T312	220	T412	271
T316	265	T416	316
		T420	382
** Weights listed for each model are for a bare actuator without valve mounting bracket or mounted accessories.			

- 4.5 Mating parts should be marked for ease of reassembly, i.e. left and right stop screws and cylinder to housing.
- 4.6 When removing seals from seal groove, use a commercial seal removing tool or use a small standard screwdriver with the sharp edges rounded off.
- 4.7 Use a non-hardening thread sealant on all pipe threads. **CAUTION: Apply thread sealant per the manufacture's instructions.**
- 4.8 Disassembly should be done in a clean area on a work bench.

4.9 LUBRICATION REQUIREMENTS: Lubricants, other than those listed in steps 4.9.1 and 4.9.2, should not be used without prior written approval of Bettis Product Engineering.

4.9.1 Standard and high temperature service (-20°F to +350°F) use Bettis ESL-5, Kronaplate 100 lubricant. ESL-5 is contained in the Bettis Service/Seal Kit.

4.9.2 Low temperature service (-50°F to +150°F) use Kronaplate 50 lubricant. Kronaplate 50 is not contained in the Low Temperature Service/Seal Kit.

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

4.10 Before starting the general disassembly of the actuator, it is a good practice to operate the actuator with the pressure used by the customer to operate the actuator during normal operation. Notate and record any abnormal symptoms such as jerky or erratic operation.

5.0 GENERAL DISASSEMBLY

5.1 If not already removed disconnect all operating pressure from the actuator power cylinder (2-10).

5.2 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. NOTE: Stop screws will be removed later in this procedure.

5.3 Mark and record location of the pneumatic inlet ports on cylinder outer end cap (2-30) and inner end cap (2-40).

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

5.5 Remove socket cap screws (1-180) from position indicator (1-170) yoke weather cover (3-130) and remove position indicator/yoke weather cover.

6.0 PRESSURE CYLINDER DISASSEMBLY

6.1 Unscrew and remove socket head cap screw (2-120), lockwasher (2-110), and nut retainer (2-100).

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

6.3 Remove outer end cap (2-30). The fit between the cylinder (2-10) and the outer end cap is very tight. NOTE: Break the outer end cap free by tapping with a breaker bar on the lip provided on the end cap.

CAUTION: When separating cylinder (2-10) from outer end cap (2-30) do not damage o-ring groove.

6.4 Pry inner end cap (2-40) away from the housing (1-10). Break the inner end cap free from the cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap.

CAUTION: When separating cylinder (2-10) from inner end cap (2-40) do not damage o-ring groove.

6.5 Remove the cylinder (2-10). When sliding the cylinder off of the piston, tilt the cylinder at an angle to the piston rod, approximately 15° to 30° degrees.

6.6 Move the piston so that there is at least four to six inches of distance between inner end cap (2-40) and piston (2-20).

6.7 NOTE: Flats are provided on the outboard end of the tie bars for wrench placement. Unscrew the tie bars (2-60) from the housing (1-10).

CAUTION: Do not use a pipe wrench on the tie bars as it will mark the bar and cause seal leakage.

6.8 Pull the tie bars out of inner end cap (2-40) far enough to expose o-rings (3-30). Remove o-rings (3-30) from inboard end of tie bars.

6.9 Remove tie bars (2-60) by pulling them out of piston (2-20).

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

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

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

6.13 NOTE: Keep the split rings in matched sets. Remove inboard split ring retainer (2-80) and split ring (2-70) from piston rod (2-170).

6.14 Remove inner end cap (2-40) from piston rod (2-170).

7.0 BLIND END CAP REMOVAL

7.1 Remove hex cap screws (6-20) and seal gaskets (6-30).

7.2 Remove blind end cap (6-10) from housing (1-10).

8.0 HOUSING GROUP DISASSEMBLY

8.1 Unscrew piston rod (2-170) from yoke pin nut (1-30) and remove, including the rod bushing (2-50). NOTE: Removal of piston rod may require extra amount of torque for break out due to the use of Loctite - 242 during assembly. A new rod bushing is provided in the standard Bettis Service/Seal Kit.

CAUTION: Do not use a pipe wrench on the piston rods as it may mark the rod and cause seal leakage. Flats are provided on the outboard end of the piston rod for wrench placement.

8.2 Remove rod bushing (2-50) from the housing or the piston rod.

8.3 Remove cover screws (1-90) and gasket seals (3-100).

- 8.4 Remove housing cover (1-20). NOTE: The cover will have a very tight fit. It is not necessary to remove cover pins (1-130) from the cover.
- 8.5 Remove top two yoke rollers (1-50) from the top of yoke pin (1-40).
- 8.6 Remove yoke pin (1-40) from the yoke and yoke pin nut.
- 8.7 Remove yoke pin nut (1-30).
- 8.8 Remove lower two yoke rollers (1-50) from the housing.
- 8.9 Remove the yoke (1-160) by lifting it from the housing.

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.

- 8.10 Remove the stop screws (1-60), jam nut (1-120), and seal gasket (3-110). Be sure to mark or identify this stop screw as instructed in section 5.
- 8.11 It is not necessary to remove pipe plug (1-80) to service the actuator.

9.0 GENERAL RE-ASSEMBLY

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

- 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 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.

- 9.4 INSTALLATION LUBRICATION INSTRUCTIONS: Use the correct lubrication as defined in section 4.0 step 4.9.
 - 9.4.1 Before installation coat all moving parts with lubricant.
 - 9.4.2 Coat all seals with lubricant, before installing into grooves, also both sides of gaskets.
- 9.5 T-seal set installation - The T-seal is composed of one rubber seal and two split skive-cut back-up rings.
 - 9.5.1 Install the T-seal into the seal grooves.

- 9.5.2 Install a back-up ring on each side of the T-seal.
- 9.5.3 When installing the back-up rings, do not align the skive-cuts.
- 9.5.4 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.

10.0 CENTER HOUSING GROUP RE-ASSEMBLY

- 10.1 If removed install drain plug (1-80) in actuator housing (1-10).
- 10.2 If removed, install grease fitting (1-70) in actuator housing (1-10) and cover (1-20). The fitting in the housing is located on the bottom of the housing, next to the lower yoke bearing area. The fitting in the cover is located on top of the cover in the upper yoke bearing area. NOTE: Grease fittings are optional as of March, 1983.
- 10.3 Inside housing (1-10) apply lubricant to the tracks and yoke bore.
- 10.4 Coat one yoke oring seal (3-50) with lubricant and install into seal groove located in bottom area of housing (1-10).
- 10.5 Apply lubricant to the slots in the upper/lower yoke arms and the lower bearing surface.
- 10.6 Install yoke (1-160) into housing (1-10) as follows: Rotate yoke arms to approximately a 45° degree position in either direction and lower into the housing. NOTE: The yoke hub with tapped holes faces up. Rotate the yoke arms back to approximately mid-stroke (center) position.
- 10.7 Apply lubricant to the surfaces of all four yoke pin rollers (1-50).
- 10.8 Place one yoke roller (1-50) in the track in the bottom of the housing and position it under the slot in the yoke arms.
- 10.9 Place a second yoke roller on top of the first yoke roller in the slot in the lower yoke arm and align the holes in the yoke rollers.
- 10.10 Coat the upper and lower surfaces of 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.
- 10.11 Lubricate the yoke pin (1-40) and insert through the yoke pin nut (1-30) and the two yoke rollers (1-50).
- 10.12 Install the third yoke pin roller over the yoke pin in the slot in the upper yoke arm and now install the fourth and last remaining yoke roller on top of the yoke roller you just installed in the upper yoke arm slot. The top roller will remain partially above the upper yoke arm and will engage the cover track when cover is installed.

CAUTION: If cycle speed of the actuator is two seconds or faster, apply Loctite 242 to external threads of piston rod (2-170). NOTE: Loctite cure time is 10 - 30 minutes.

- 10.13 Apply lubricant to piston rod (2-170) and rod bushing (2-50). Install rod bushing over the piston rod. NOTE: A new rod bushing is provided in the standard Bettis Service/Seal Kit.
- 10.14 Install piston rod (2-170) with rod bushing (2-50) into right side of housing. Slide rod bushing along the piston rod and into housing counter bore. Screw piston rod into yoke pin nut (1-30). NOTE: Do not torque tighten piston rod until the housing cover is installed later in this procedure.
- 10.15 Place jam nuts (1-120) and new gaskets (3-110) on stop screws (1-60). Install the pre-assembled stop screws into the housing.
- 10.16 Place housing cover gasket (3-20) on housing (1-10).
- 10.17 Coat remaining o-ring seal (3-50) with lubricant and install into cover (1-20).
- 10.18 Apply lubricant to the yoke bore and track in housing cover (1-20).
- 10.19 Apply lubricant to upper bearing surface of yoke (1-160).
- 10.20 Install cover (1-20), being careful not to damage gasket (3-20) or o-ring seal (3-50).
- 10.21 Install cover screws (1-90) and new seal gaskets (3-100). NOTE: Leave cover screws loose, do not tighten.
- 10.22 Do this step only if you have pulled cover pins (1-130) or if you are replacing the cover pins. NOTE: The cover pins (1-130) are grooved at one end, tapering to a smooth diameter at the other end.
 - 10.22.1 Install four cover pins smooth end first into housing cover (1-20).
 - 10.22.2 Drive four cover pins (1-130) through cover (1-20) and into housing (1-10) until each pin is flush with the cover.
- 10.23 Tighten cover screws (1-90).
- 10.24 Tighten piston rod (2-170) to a torque of 150 ± 7 foot pounds. NOTE: 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 Rotate yoke to a position that will leave a minimum of piston rod (2-170) protruding from actuator housing.

11.0 BLIND END CAP RE-ASSEMBLY

- 11.1 Apply a light coating of lubricant to left end of housing (1-10).
- 11.2 Coat one end cap gasket (3-10) with lubricant on both sides and install onto lubricated housing end.

- 11.3 Install blind end cap (6-10) onto left end of housing and retain using hex cap screws (6-20) and seal gaskets (6-30). Torque to 126 foot pounds.

12.0 PRESSURE CYLINDER RE-ASSEMBLY

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

CAUTION: Install rod seal (3-70) with the energizer ring facing outboard side (away from housing).

- 12.2 Apply lubricant to end cap gasket (3-10) and install over piston rod (2-170) and rod bushing (2-50).

- 12.3 Install inner end cap (2-40) over piston rod (2-170) and rod bushing (2-50). NOTE: Install inner end cap with large raised boss toward the housing (flat side outward). End cap pressure inlet port should be toward the top of actuator.

- 12.4 Apply lubricant to o-ring seal (3-60) and install into outer diameter seal groove on inner end cap (2-40).

- 12.5 Apply lubricant to two sets of piston tie bar T-seal components (3-80) and install into piston internal seal groove. Refer to step 9.5 for proper T-seal installation instructions.

- 12.6 Apply lubricant to threads and outboard end of piston rod (2-170).

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

- 12.8 Install matched set of split rings (2-70) into inner most groove on piston rod and retain with retaining ring (2-80).

- 12.9 Install piston (2-20) onto piston rod (2-170) and up against split rings (2-70).

- 12.10 Install matched set of split rings (2-70) onto piston rod and retain with retaining ring (2-80).

- 12.11 Apply lubricant to threads and end of tie bars (2-60), end without wrench flat.

- 12.12 Install two tie bars (2-60) by carefully inserting through piston (2-20). NOTE: Install tie bars far enough through piston to expose inboard o-ring seal groove.

- 12.13 Apply lubricant to two o-ring seals (3-30) and install into exposed seal groove on inboard end of tie bars.

- 12.14 Insert tie bars through the inner end cap (2-40) and screw into the housing (1-10).

CAUTION: Tighten the tie bars until the threads bottom out, then back out each tie bar one-half (1/2) turn.

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

- 12.16 Apply lubricant to piston T-seal components (3-90) and install into piston outer diameter seal groove. Refer to step 9.5 for proper T-seal installation instructions.

CAUTION: If needed when installing cylinder (2-10), hammer on end of cylinder only with a non metallic object.

CAUTION: Make certain back-up rings, components of piston T-seal (3-90), are seated into piston external seal groove. Should back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.

- 12.17 Install end of cylinder (2-10) over piston (2-20) and onto inner end cap (2-40). When installing cylinder over the piston seal, tilt cylinder 15° to 30° degrees to piston rod (2-170).
- 12.18 Apply lubricant to two o-ring seals (3-30) and install into seal groove on outboard end of tie bars (2-60).
- 12.19 Apply lubricant to o-ring seal (3-60) and install into outer diameter seal groove on outer end cap (2-30).
- 12.20 Install outer end cap (2-30) onto tie bars and into end of cylinder (2-10). NOTE: Make certain that outer end cap inlet port(s) are toward top of actuator.
- 12.21 Install two tie bar nuts (2-90) onto tie bars (2-60), using them to draw all of the cylinder components into position. Torque alternately, until a final torque of 65 ± 7 foot pounds has been achieved. NOTE: It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the nut retainer can be installed.

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

- 12.22 Install nut retainer (2-100), securing in place with retainer screw (2-120) and lockwasher (2-110).

12.23 POSITION INDICATOR INSTALLATION:

12.23.1 Rotate the yoke to full clockwise (CW) position (as shown on the assembly drawing).

12.23.2 Position yoke weather cover (3-130) /position indicator (1-170) on the yoke with pointer facing the front and perpendicular to piston rod (2-170).

12.23.3 Secure position indicator with socket head cap screws (1-180).

13.0 ACTUATOR TESTING

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

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

- 13.3 All leak testing will use 65 psig pressure. NOTE: When testing the actuator use a proper adjusted regulator to apply pressure to the actuator.
- 13.4 Before testing for leaks, alternately apply and release 65 psi pressure to the each side of the piston to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.
- 13.5 Apply 65 psig pressure to the pressure port in the outer end cap (2-30).
- 13.6 Apply a leak testing solution to the following areas:
- 13.6.1 Joint between outer end cap (2-30) and cylinder (2-10). Checks cylinder to end cap o-ring seal.
 - 13.6.2 Around tie bar nuts (2-90) on the cylinder outer end cap (2-30). Checks tie bars to outer end cap o-ring seals.
 - 13.6.3 The pressure inlet port in inner end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
 - 13.6.4 Remove pressure from pressure inlet port in the outer end cap.
- 13.7 Apply 65 psig pressure to the pressure port in inner end cap (2-40).
- 13.8 Apply a leak testing solution to the following areas:
- 13.8.1 Joint between inner end cap (2-40) and cylinder (2-10). Checks cylinder to inner end cap o-ring seal.
 - 13.8.2 Around the joint of inner end cap (2-40) and housing (1-10). Checks tie bars to inner end cap o-ring seals and the inner end cap to housing gasket seal (3-10).
 - 13.8.3 The snubber valve port hole in housing cover (1-20). Checks the rod seal and tie bars to end cap o-ring seals.
 - 13.8.4 Remove pressure from pressure inlet port in the inner end cap.
- 13.9 If an actuator was disassembled and repaired, the above leakage test must be performed again.

14.0 RETURN TO SERVICE

- 14.1 Replace software components of snubber (1-190) and then install snubber (1-190) in the housing cover port.
- 14.2 Adjust both stop screws (1-60) back to settings recorded in section 5 under General Disassembly.
- 14.3 Tighten both jam nuts (1-120) securely, while holding stop screws (1-60).
- 14.4 After the actuator is installed on the valve all accessories should be hooked up and tested for proper operations and replaced, if found defective.

CHART NO. 2 - TOOL STYLE AND WRENCH SIZES

ITEM NO.	WRENCH SIZE	LOCATION	RECOMMENDED WRENCH STYLE
1-60	1/2"	Stop Screw	Open End or Adjustable
1-80	9/16"	Housing Drain Plug	Open End or Adjustable
1-90	1/2"	T3 Cover Screws	Socket
1-90	9/16"	T4 Cover Screws	Socket
1-120	1-5/16"	Stop Screw Nut	Box End (1)
1-180	3/16"	Weather Cover Screws	Allen
1-190	7/8"	Snubber Valve	Deep Socket
2-60	1/2"	Tie Bar Flats	Open End or Adjustable
2-90	1-7/16"	Tie Bar Nuts	Deep Socket
2-120	3/16"	Nut Retainer	Allen
2-170	1-1/4"	Piston Rod Flats	Crows Foot (1)
6-20	1-7/16"	Blind End Cap Screw	Socket
(1) No alternate style tool recommended			

<u>ECN</u>	<u>DATE</u>	<u>REV</u>	<u>BY *</u>	<u>DATE</u>
Released	July, 1994	A	Bill Cornelius	8 July 1994
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