

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR MODELS

STR102XX-M4

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 111589

REVISION: "A"

RELEASE DATE: April, 1994

1.0 **INTRODUCTION**

- 1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis STR10XX-M4 double Acting Series pneumatic actuators with M4 hydraulic speed control package. 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.

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 requires the actuator 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 does not include M4 Disassembly and Reassembly Instruction. Bettis does not recommend periodic maintenance for the M4 itself. The M4 needs only to be serviced when it malfunctions. Complete M4 refurbishment should be done by Bettis.
- 1.7 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 - Seal/Service Kit, Rail Alignment tool, razor sharp cutting instrument, commercial leak testing solution and non-hardening thread sealant.
- 2.2 Tools: All tools are American Standard inch. Large adjustable wrench, two (2) large screwdrivers, allen wrench set, set of open/box-end wrenches, rubber or leather mallet, torque wrench (up to 5,000 in.lbs.), breaker bar, 1/2" drive socket set. For itemized wrench size list and recommended wrench style refer to Chart No. 1 page 17.

3.0 **BETTIS REFERENCE MATERIALS**

- 3.1 Assembly Drawing 107277 for STR102XX-MX double acting actuators.
- 3.2 Rail alignment tool drawing part number B-064899.

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 List.
- 4.3 As referenced in this procedure the front of the actuator is: Yoke bore nearest workman. The top of the actuator will be the housing cover.
- 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 **CAUTION: Apply the thread sealant per the manufacture's instructions.** Use a non-hardening thread sealant on all pipe threads.
- 4.6 Disassembly should be done in a clean area near a work bench.
- 4.7 Some components of this actuator are very heavy and will require a means of assistance. For actuator approximate weight refer to Chart No. 2 on page 18.
- 4.8 **LUBRICATION REQUIREMENTS:** For use in all areas of actuator except in M4 Hydraulic Control package (8) and hydraulic cylinder (3-160). Lubricants, other than those listed in steps 4.8.1 and 4.8.2, should not be supplied without prior written approval of Bettis Product Engineering.
 - 4.8.1 Standard and high temperature service (-200F to +3500F) use Bettis, Kronaplate 100 lubricant. This lubricant is furnished in the Bettis Service/Seal Kit.
 - 4.8.2 Low temperature service (-500F to +1500F) use Kronaplate 50. This lubricant is not furnished in the Service/Seal Kit.
- 4.9 **FLUID REQUIREMENTS:** For use in the M4 Hydraulic Speed Control Package (8) and the hydraulic cylinder (3-160). Fluids, 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 (-200F to +3500F) use Dextron II Automatic Transmission fluid.
 - 4.9.2 Low temperature service (-500F to +1500F) use Exxon Univis J13 Hydraulic Fluid.

CAUTION: Pressure is not to exceed the maximum operating pressure rating listed on the 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 Remove pipe plugs (2-150) and (3-130) from stop screw nuts (2-140) and (3-120).
- 5.2 Go through the hole made by removing pipe plug (2-150), using a 1/2 inch square drive extension to hold the stop screw (2-130) in place, remove stop screw nut (2-140). Mark or identify this stop screw and, measure and record it's exposed length.
- 5.3 Go through the hole made by removing pipe plug (3-130), using a 1/2 inch square drive extension to hold the stop screw (3-110) in place, remove stop screw nut (3-120). Mark or identify this stop screw left and, measure and record it's exposed length.
- 5.4 Remove the snubber valve (1-230) from the housing cover (1-130).
- 5.5 Mark and record location of the hydraulic inlet ports on the hydraulic cylinder outer end cap (3-190) and inner end cap (3-180).
- 5.6 Drain the hydraulic fluid from Hydraulic Cylinder (3-160) by opening the bleed valves (3-150) and then removing the cylinder drain pipe plugs (3-140). One is located on outboard end of hydraulic cylinder and the other on the inboard end of hydraulic cylinder.
- 5.7 **CAUTION: Plug the 3/8" NPT ports in the M4 as foreign material may enter the system and cause the package to malfunction.** If the M4 is mounted on the actuator then remove the M4 control package from hydraulic cylinder (3-160).

6.0 PNEUMATIC PRESSURE CYLINDER DISASSEMBLY

- 6.1 Remove two in number tie bar hex nuts (2-100), thread seals (5-60) and counter sunk washers (5-70), from the outboard side of outer end cap (2-30). NOTE: The thread seals (5-60) and counter sunk washers (5-70) may have been provided on your actuator. These items have been eliminated on current model actuators and need not used when rebuilding the actuator.
- 6.2 **CAUTION: Do not damage o-ring groove when removing end cap.** The fit between the cylinder and the outer end cap is very tight. Break the end cap free by tapping with a breaker bar on lip provided on the end cap. Remove outer end cap (2-30) from cylinder (2-10). NOTE: Stop screw (2-130) may remain in outer end cap.
- 6.3 Pry inner end cap (2-40) from housing, using a breaker bar. Pry cylinder (2-10) from inner end cap (2-40).
- 6.4 NOTE: When sliding the cylinder off, tilt the cylinder 150 to 300 degrees with respect to actuator centerline to help facilitate removal. Remove cylinder (2-10) from the inner end cap (2-40).

- 6.5 NOTE: Flats on outboard end of tie bars are provided for wrench placement. Unscrew and remove tie bars (2-60) from housing (1-10).
- 6.6 NOTE: Keep the split rings in matched sets. Refer to assembly drawing page 2 of 2 Detail "B". Remove split rings (2-80) and split ring retainer (2-90) from the outboard end of piston rod (2-70).
- 6.7 Remove piston (2-20) off of piston rod (2-70). Refer to step 6.8 for disassembly of fabricated pistons equipped with piston bushings (2-220).
- 6.8 FABRICATED PISTON DISASSEMBLY: Refer to assembly drawing sheet 2 of 2 Detail "B".
- 6.8.1 Remove the retaining rings (2-230) from the piston.
- 6.8.2 Remove the piston bushing (2-220) from the piston. NOTE: The Bettis Service Kit should contain new piston bushings.
- 6.9 NOTE: Keep the split rings in matched sets. Remove second set of split rings (2-80) and split ring retainer (2-90).
- 6.10 Refer to assembly drawing page 2 of 2 Detail "B". Remove o-ring seal (5-20) and slide inner end cap (2-40) off piston rod (2-70).
- 6.11 **CAUTION: Do not use pipe wrench on the piston rod (2-70).** NOTE: A 1/2" inch recessed square is provided on the outboard end of the piston rod for wrenching purposes. Unscrew and remove piston rod (2-70) from yoke pin nut (1-110).
- 6.12 Refer to assembly drawing page 2 of 2 Detail "D". Remove rod bushing (2-50) and rod seal (5-60).

7.0 PNEUMATIC AND HYDRAULIC CONTROL CYLINDER DISASSEMBLY

- 7.1 Remove two in number MX tie bar nuts (3-100), from the outboard side of outer end cap (3-190).
- 7.2 **CAUTION: Do not damage o-ring groove when removing end cap.** Remove outer end cap (3-190) from the cylinder (3-160). The fit between the cylinder and the outer end cap is very tight. Break the end cap free by tapping with a breaker bar on lip provided on the end cap. NOTE: Stop screw (3-110) may remain in outer end cap.
- 7.3 Pry hydraulic cylinder inner end cap (3-180) away from the pneumatic cylinder outer end cap (3-30). Break the hydraulic cylinder inner end cap free from the hydraulic cylinder (3-160) by tapping with a breaker bar on the lip provided on the end cap.
- 7.4 NOTE: When sliding the cylinder off of the piston, tilt the cylinder 150 to 300 degrees to the piston rod (3-70). Remove the hydraulic cylinder (3-160).
- 7.5 NOTE: Keep the split rings in matched sets. Refer to assembly drawing page 2 of 2 Detail "B". Remove the MX split ring (3-80) and MX split ring retainer (3-90) from outboard end of piston rod (3-70).

- 7.6 Remove hydraulic piston (3-170) off of piston rod (3-70) and tie bars (3-60).
- 7.7 NOTE: Keep the split rings in matched sets. Refer to assembly drawing page 2 of 2 Detail "B". Remove second set of MX split rings (3-80) and MX split ring retainer (3-90).
- 7.8 Refer to assembly drawing page 2 of 2 Detail "B". Remove o-ring seal (6-20) and slide hydraulic cylinder inner end cap (3-180) off piston rod (3-70) and tie bars (3-60).
- 7.9 Refer to assembly drawing page 2 of 2 Detail "G". Remove the rod bushing (3-200) from the pneumatic outer end cap (3-30).
- 7.10 NOTE: Do not damage o-ring groove when removing the end cap. Remove the pneumatic outer end cap (3-30). The fit between the cylinder (3-10) and this end cap is very tight. Break the end cap free by tapping with a breaker bar on the lip provided on the end cap.
- 7.11 Pry the pneumatic inner end cap (3-40) away from the housing (1-10). Break this end cap free from the cylinder (3-10) by tapping with a breaker bar on the lip provided on the end cap.
- 7.12 NOTE: When sliding the cylinder off of the piston, tilt the cylinder 150 to 300 degrees to the piston rod (3-70). Remove the pneumatic cylinder (3-10).
- 7.13 **CAUTION: Do not use pipe wrench for this step.** NOTE: Flats on outboard end of tie bars are provided for wrench placement. Remove tie bars (3-60) from housing (1-10).
- 7.14 NOTE: Keep the split rings in matched sets. Refer to assembly drawing page 2 of 2 Detail "B". Remove a third set of MX split ring retainer (3-90) and the MX split rings (3-80) from the outboard side of the piston (3-20).
- 7.15 Remove the piston (3-20) from the piston rod (3-70). The piston will slide off of the piston rod (3-70).
- 7.16 FABRICATED PISTON DISASSEMBLY: Refer to assembly drawing sheet 2 of 2 alternate Detail "B".
 - 7.16.1 Remove the retaining rings (2-230) from the piston.
 - 7.16.2 Remove the piston bushing (2-220) from the piston. NOTE: The Bettis Service Kit should contain new piston bushings.
- 7.17 Refer to assembly drawing page 2 of 2 Detail "B". Remove the MX o-ring seal (6-20).
- 7.18 NOTE: Keep the split rings in matched sets. Refer to assembly drawing page 2 of 2 Detail "B". Remove the fourth and final set of MX split ring retainer (3-90) and the MX split ring (3-80) from the piston rod (3-70).
- 7.19 Slide the inner end cap (3-40) off piston rod (3-70).
- 7.20 **CAUTION: Do not use pipe wrench for this step.** NOTE: Some actuators have Flats on the outboard end of the piston rod while most actuators will utilize a 1/2 female square for wrenching purposes. Remove piston rod (3-70) from yoke pin nut (1-110).

- 7.21 Refer to assembly drawing page 2 of 2 Detail "D". Remove MX rod bushing (3-50) and rod seal (6-50).

8.0 HOUSING GROUP DISASSEMBLY

- 8.1 Remove position indicator pin (1-290) from the position indicator drive assembly (1-260).
- 8.2 Unscrew and remove eight in number hex cap screws (1-280) with gasket seals (4-100) from position indicator cover (1-270).
- 8.3 Remove position indicator cover (1-270).
- 8.4 NOTE: Mark the hole that the set screw (1-250) is removed from. Unscrew and remove set screw (1-250) from position indicator drive assembly (1-260).
- 8.5 Remove position indicator drive assembly (1-260) from the top of the yoke (1-30).
- 8.6 Unscrew and remove sixteen in number socket cap screws (1-60) from upper yoke/segmented retaining rings (1-50).
- 8.7 Remove upper segmented retaining rings (1-50).
- 8.8 NOTE: The eight cover screws (1-150), that stick up and have hex nut (1-240) on them, are not to be removed. Remove forty in number cover screws (1-150) and gasket seals (4-50).
- 8.9 To help in removing the housing cover (1-130) loosen the eight hex nuts (1-240). Alternately rotate the eight raised cover screws (1-150) clockwise until the cover is clear of the cover pins (1-140).
- 8.10 Remove the cover (1-130).
- 8.11 Cover pins (1-140) should not be removed unless damaged.
- 8.12 Remove upper yoke bushing (1-40).
- 8.13 Position the housing in such a manner so as to allow the lower yoke bushing (1-20) to be removed (refer to assembly drawing page 2 of 2 detail "J").
- 8.14 Unscrew and remove sixteen in number socket cap screws (1-60) from four in number lower yoke/segmented retaining rings (1-50).
- 8.15 Remove the lower segmented retaining rings (1-50).
- 8.16 Remove lower yoke bushing (1-20).
- 8.17 Remove the yoke pin (1-120).
- 8.18 Remove two in number short yoke rollers (1-90) and one long yoke roller (1-100).
- 8.19 Remove the four in number shoulder bolts (1-80), two bolts from each of two rails (1-70). Remove the rails (1-70) from the housing (1-10).

- 8.20 Remove the yoke pin nut (1-110) from the yoke (1-30).
- 8.21 Remove the yoke (1-30) from the housing (1-10).
- 8.22 The following items need not be removed for standard actuator refurbishment: Lifting lugs (1-160), lock-washer (1-180), hex head screws (1-170), pipe plugs (1-190) and four in number pipe plugs (1-220).

9.0 **GENERAL RE-ASSEMBLY**

- 9.1 Remove and discard all seals and gaskets.

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

- 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 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 4.8. The parts and seals used in the hydraulic cylinder assembly will be assembled using the hydraulic fluid identified in step 4.9.**
- 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.
- 9.6 Prime and apply master gasket (510) to all surfaces as indicated on the assembly drawing (reference note flag number 5). Master Gasket should be applied per the manufactures 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 GROUP RE-ASSEMBLY

- 10.1 If removed, install four in number pipe plugs (1-190) and four in number pipe plugs (1-220).
- 10.2 Refer to assembly drawing sheet 2 of 2 Detail "J". Apply lubricant to lower yoke bushing (1-20) and the yoke bore area in the housing.
- 10.3 Install o-ring seals (4-10) and (4-20) into the lower yoke bushing (1-20).
- 10.4 Install lower yoke bushing (1-20) into the housing (1-10).
- 10.5 Install the segment retaining rings (1-50) into the lower yoke bushing and retain with the socket cap screws (1-60).
- 10.6 Apply lubricant to the yoke (1-30) journal and in the lower yoke arm area slots.
- 10.7 Install yoke (1-30) into lower yoke bushing the yoke hub with tapped holes faces up). Rotate yoke to mid-stroke position.
- 10.8 Apply lubricant to all surfaces of yoke rollers (1-90) and (1-100). Install one short roller (1-90) into slot of bottom yoke arm.
- 10.9 Apply lubricant to two in number rails (1-70). NOTE: Do not tighten the shoulder bolts at this point. Tie bars with "tipped" ends will be added later to support rail. Until that time, an adapter piece (see Drawing B64899) may be used as temporary replacements. Install inner rail (1-70) by inserting rail into the housing between yoke arms. Retain the inner rail with two in number shoulder bolts (1-80).
- 10.10 Apply lubricant to the upper and lower surfaces of yoke pin nut (1-110) and install between the yoke arms and parallel to rail inside housing.
- 10.11 Install second yoke roller (1-100) into slot of the yoke pin nut (1-110). Align holes of both rollers.
- 10.12 Apply lubricant to yoke pin (1-120) and install into middle and bottom yoke rollers.
- 10.13 Install the final short yoke roller (1-90).
- 10.14 NOTE: Do not tighten the shoulder bolts.. Use rail alignment tool to support rail until tie bars are installed. Install outer rail (1-70) with two in number shoulder bolts (1-80).
- 10.15 Apply lubricant to the rod bushing (2-50) and install into the right hand side of housing (1-10).
- 10.16 NOTE: Do not tighten either piston rod. Install piston rods (2-70) and (3-70) into yoke pin nut (1-110).
- 10.17 Remove temporary adapter pieces one at a time and install tie bars (2-60) into the side of the housing with the tipped end of the tie bar being inserted into the rail (1-70). **CAUTION: Tighten the tie bars until threads bottom out, then back out one half-turn.**

- 10.18 After both tie bars sets are installed then tighten all four shoulder bolts (1-80).
- 10.19 Torque tighten the piston rod (2-70) to 166 foot pounds lubricated. Flats are provided on the outer end for wrenching purposes. Torque tighten the piston rod (3-70) to 166 foot pounds lubricated.
- 10.20 Position the position indicator drive assembly (1-260) onto the top of yoke (1-30) with the slot positioned over hole that was marked in section 8. Secure with the set screw (1-250).
- 10.21 Install the o-ring seal (4-80) over the position indicator drive assembly shaft and down against the flat cover plate.

11.0 POWER CYLINDER RE-ASSEMBLY

- 11.1 Prepare the mounting surfaces of the inner end cap (2-40) and end cap side of the housing (1-10) per master gasket instructions (reference step 9.6 under General Reassembly).
- 11.2 Refer to assembly drawing page 2 of 2, Detail "E". Install the end cap o-ring seal (4-40) into the inner end cap (2-40).
- 11.3 **CAUTION: Install with energizer ring facing outboard side (away from housing).** Refer to assembly drawing page 2 of 2, Detail "D". Install the rod seal (5-50) into recess (counter bore) provided in inner end cap (2-40).
- 11.4 Refer to assembly drawing page 2 of 2, Detail "E". Install o-ring seals (5-10) into inner end cap (2-40).
- 11.5 Install inner end cap (2-40) by sliding over piston rod , tie bar and rod bushing. Pressure port should be above actuator centerline. Exercise extreme care during installation in order to prevent damage to the rod seal (5-50).
- 11.6 Install o-ring seal (5-30) on the O.D. of the inner end cap (2-40).

NOTE: For steps 11.7, 11.8, and 11.9 refer to assembly drawing page 2 of 2, Detail "B".

- 11.7 Coat the grooves on the piston rod (2-70) with lubricant. Install a set of split rings (2-80) into the inner most groove in the piston rod and retain with retaining ring (2-90).
- 11.8 Install o-ring seal (5-20) onto the o-ring groove in the piston rod.
- 11.9 Install two o-ring seals (5-10) into the tie bar bores in a piston (2-20). Refer to step 11.10 for piston bushing (2-220) reassembly.
- 11.10 FABRICATED PISTON REASSEMBLY: Refer to assembly drawing sheet 2 of 2, alternate Detail "B".
 - 11.10.1 Install the o-ring seals (5-90) into the O.D. groove on piston bushings (2-220).
 - 11.10.2 Install the o-ring seals (5-10) into the I.D. groove in the piston bushing (2-220).
 - 11.10.3 Install the piston bushing (2-220) into the piston.

CAUTION: The piston bushings should be replaced each time the actuator has its five year refurbishment. **NOTE:** The Bettis Service Kit should contain new piston bushings.

11.10.4 Install the retaining rings (2-230) into the piston.

11.11 Install one of the pistons (2-20) onto piston rod (2-70) and up against the split ring installed in step 11.7.

11.12 Refer to assembly drawing page 2 of 2 Detail "B". Install second set of split rings (2-80) and ring retainer (2-90).

11.13 Install piston T-seals (5-40) into the O.D. groove on piston (2-20) that was installed in step 11.11.

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

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

CAUTION: If needed, when installing the cylinder, hammer on the end of the cylinder only with a non metallic object.

11.15 Install cylinder (2-10) over piston (2-20) and onto inner end cap (2-40). Cylinder will have to be tilted approximately 150 to 300 degrees across piston to facilitate installation.

11.16 Install stop screw (2-130) into outer end cap (2-30). Back stop screw as far out as possible.

11.17 Refer to assembly drawing page 2 of 2 Detail "A". Install o-ring seals (5-10) in the outer end cap tie bar holes.

11.18 Install o-ring seal (5-30) onto outer end cap (2-30).

11.19 Install outer end cap (2-30) onto tie bars and into the cylinder (2-10).

11.20 **NOTE:** While the nuts are being tightened, do not allow the tie bars to turn. Install the two tie bar nuts (2-100) onto the tie bars (2-60).

12.0 PNEUMATIC AND HYDRAULIC CONTROL CYLINDER RE-ASSEMBLY

12.1 Prepare the mounting surfaces of the inner end cap (3-40) and end cap side of the housing (1-10) per master gasket instructions (reference step 9.6 under General Reassembly).

12.2 Refer to assembly drawing page 2 of 2, Detail "E". Install the end cap o-ring seal (4-40) into the inner end cap (3-40).

12.3 Refer to assembly drawing page 2 of 2, Detail "D". Install the MX rod seal (6-50) into recess (counter bore) provided in inner end cap (3-40). Install with energizer ring facing outboard side (away from housing).

- 12.4 Refer to assembly drawing page 2 of 2, Detail "E". Install the MX o-ring seals (6-10) into the inner end cap (3-40).
- 12.5 NOTE: The pressure port should be positioned above the actuator centerline. Exercise extreme care during installation in order to prevent damage to the MX rod seal (6-50). Install inner end cap (3-40) by sliding over piston rod (3-70) and MX rod bushing (3-50).
- 12.6 Install MX o-ring seal (6-30) on the outer diameter of inner end cap (3-40).

NOTE: For steps 12.7, 12.8, and 12.9 refer to assembly drawing page 2 of 2, Detail "B".

- 12.7 Coat the grooves on the piston rod (3-70) with lubricant. Refer to assembly drawing page 2 of 2, Detail "B". Install a matched set of MX split rings (3-80) into the inner most groove in the piston rod and retain with a MX retaining ring (3-90).
- 12.8 Install MX o-ring seal (6-20) onto the o-ring groove in the piston rod (3-70).
- 12.9 Install two MX o-ring seals (6-10) into the tie bar bores of piston (3-20). Refer to step 12.10 for piston bushing (2-220) reassembly.
- 12.10 FABRICATED PISTON REASSEMBLY: Refer to assembly drawing sheet 2 of 2, alternate Detail "B".
- 12.10.1 Install the o-ring seals (6-110) into the O.D. groove on piston bushings (3-220).
- 12.10.2 Install the o-ring seals (6-10) into the I.D. groove in the piston bushing (3-220).
- 12.10.3 Install the piston bushing (3-220) into the piston (3-20).

CAUTION: The piston bushings should be replaced each time the actuator has its five year refurbishment. **NOTE:** The Bettis Service Kit should contain new piston bushings.

- 12.10.4 Install the retaining rings (3-230) into the piston.
- 12.11 Install piston (3-20) onto piston rod (3-70) and up against the split ring installed in step 12.7.
- 12.12 Refer to assembly drawing page 2 of 2 Detail "B". Install set of matched MX split rings (3-80) and MX ring retainer (3-90).
- 12.13 Refer to assembly drawing page 2 of 2 Detail "C". Install the MX piston T-seals (6-40) into the outer diameter groove on the piston (3-20).
- 12.14 Apply lubricant to the bore of the cylinder (3-10).

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

CAUTION: If needed, when installing the cylinder, hammer on the end of the cylinder only with a non metallic object.

- 12.15 Slide cylinder (3-10) over piston and onto the inner end cap. Cylinder will have to be tilted approximately 150 to 300 degrees across piston to facilitate installation.
- 12.16 Install two end cap tie bar MX o-ring seals (6-10) into the pneumatic cylinder outer end cap (3-30).
- 12.17 Refer to assembly drawing page 2 of 2 Detail "C". Install the pneumatic cylinder outer end cap MX o-ring seal (6-30) onto the pneumatic cylinder outer end cap (3-30).
- 12.18 Install the pneumatic cylinder outer end cap (3-30) onto the tie bars and into the end of pneumatic cylinder (3-10). Install with the raised boss away from the cylinder and the inlet port above the centerline of the actuator.

NOTE: For steps 12.19, 12.20, and 12.21 refer to assembly drawing page 2 of 2, Detail "G".

- 12.19 **CAUTION: The energizer ring of rod seal (6-50) must be facing into the end cap recess.** Install rod seal (6-50), lip first, into the recess provided in the pneumatic cylinder outer end cap (3-30).
- 12.20 Apply lubricant to rod bushing (3-200) and install it up into the pneumatic cylinder outer end cap (2-30).
- 12.21 **CAUTION: The energizer ring of rod seal (6-50) must be facing into the end cap recess.** Install the rod seal (6-50), lip first, into the recess provided in the hydraulic cylinder inner end cap (3-180).
- 12.22 Refer to assembly drawing page 2 of 2 Detail "F". Install end cap o-ring seal (6-80) onto the inner end cap (3-180).
- 12.23 Prepare the mounting surfaces of the outer end cap (3-30) and inner end cap (3-180) per master gasket instructions (reference step 9.6 under General Reassembly).
- 12.24 Apply lubricant to the o-ring seal (6-100) and install into the seal groove in the hydraulic cylinder inner end cap (3-180).

CAUTION: Use hydraulic fluid as the lubricant for steps 12.25 Through 12.39.

- 12.25 Refer to assembly drawing page 2 of 2 Detail "G". Lubricate two tie bar o-ring seals (6-10) with hydraulic fluid and install into the hydraulic cylinder inner end cap (3-180).
- 12.26 NOTE: The pressure inlet port should be installed in the position recorded in section 5. Slide the hydraulic cylinder inner end cap (3-180) over the tie bars (3-60), piston rod (3-70) and rod bushing (3-200).

NOTE: For steps 12.27, 12.28, and 12.29 refer to assembly drawing page 2 of 2, Detail "B".

- 12.27 Coat the outboard end grooves on the piston rod (3-70) with hydraulic fluid. Install matched set of MX split rings (3-80) into the inner most groove in the piston rod and retain with a MX retaining ring (3-90).
- 12.28 Install MX o-ring seal (6-20) onto the o-ring groove in the piston rod (3-70).
- 12.29 Refer to assembly drawing page 2 of 2 Detail "B". Lubricate two MX o-ring seals (6-10) with hydraulic fluid and install into the tie bar bores of piston (3-170).
- 12.30 Install piston (3-170) onto piston rod (3-70) and up against the split ring installed in step 12.27.
- 12.31 Refer to assembly drawing page 2 of 2, Detail "B". Install final set of matched MX split rings (3-80) and MX ring retainer (3-90) onto the piston rod (3-70).
- 12.32 Install the MX piston T-seal (6-90) into the outer diameter groove on the piston (3-170).
- 12.33 Apply hydraulic fluid to the bore of the cylinder (3-160).

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

CAUTION: If needed, when installing the cylinder, hammer on the end of the cylinder only with a non metallic object.

- 12.34 Slide cylinder (3-160) over piston (3-170) and onto the inner end cap (3-180). Cylinder will have to be tilted approximately 15^o to 30^o across piston to facilitate installation.
- 12.35 Install two end cap tie bar MX o-ring seals (6-10) into the hydraulic cylinder outer end cap (3-190).
- 12.36 Refer to assembly drawing page 2 of 2, Detail "F". Install the hydraulic cylinder outer end cap MX o-ring seal (6-80) onto the hydraulic cylinder outer end cap (3-190).
- 12.37 Install stop screw (3-110) onto outer end cap (3-190).
- 12.38 Install the hydraulic cylinder outer end cap (3-190) onto the tie bars and into the end of hydraulic cylinder (3-160).
- 12.39 NOTE: While the nuts are being tightened, do not allow the tie bars to turn. Install the tie bar nuts (2-100) with thread seals (5-60) and countersunk washer (5-70) onto the tie bars (2-60). Torque the tie bar nuts to 150 ±15 foot pounds.

13.0 HOUSING COVER INSTALLATION

- 13.1 Apply lubricant to the upper yoke bushing (1-40).

NOTE: For steps 13.2, 13.3, and 13.4 refer to assembly drawing page 2 of 2, Detail "H".

- 13.2 Install the remaining o-ring seals (4-10) and (4-20) into the upper yoke bushing (1-40).
- 13.3 Install the upper yoke bushing (1-40) into the housing cover (1-130).
- 13.4 Install the remaining segmented retaining rings (1-50) into the upper yoke bushing and retain with socket cap screws (1-60).
- 13.5 Remove all housing cover screws (1-150) and replace the gasket seals (4-50) with new seals.
- 13.6 Prepare the mounting surfaces of the housing (1-10) and housing cover (1-130) per master gasket instructions (reference step 9.6 under General Reassembly).
- 13.7 Install the housing cover gasket (4-30) onto the housing (1-10).
- 13.8 Install the housing cover (1-130) onto the housing (1-10).
- 13.9 Install the housing cover screws (1-150), with the new gasket seals (4-50), back into the housing cover. Tighten all cover screws but the eight cover screws that have hex nuts (1-240).
- 13.10 Tighten the eight hex nuts (1-240).

NOTE: For steps 13.10, 13.11, and 13.12 refer to assembly drawing page 2 of 2, Detail "H".

- 13.11 Install the o-ring seal (4-70) into the bottom seal groove inside the position indicator cover (1-270).
- 13.12 Install the wiper ring (4-60) into the top seal groove inside the position indicator cover (1-270).
- 13.13 Install the o-ring seal (4-90) into the bottom seal groove on the bottom of the position indicator cover (1-270).
- 13.14 Refer to assembly drawing page 2 of 2, Detail "H" and Section A-A. Install the position indicator cover (1-270), being careful not to damage the o-ring seals (4-90), (4-70) and wiper ring (4-60).
- 13.15 Install new gasket seals (4-100) on to hex head screws (1-280).
- 13.16 Refer to assembly drawing page 2 of 2, Section A-A. Install and tighten the position indicator cover screws (1-280).
- 13.17 Refer to assembly drawing page 2 of 2, Section A-A. Install the position indicator pointer (1-290) into the taped hole in the position indicator drive assembly (1-260).

14.0 ACTUATOR TESTING

- 14.1 Leakage Test - All areas where leakage to atmosphere may occur are to be checked, using a commercial leak testing solution.
- 14.2 Apply air pressure (65 psig) to one side of the piston and allow the unit to stabilize. If any leakage to atmosphere is noted, the actuator must be disassembled and the cause of leakage must be determined and corrected.
- 14.3 If excessive leakage across the piston is noted, generally a bubble which breaks three seconds or less after starting to form, cycle the actuator five times to allow the seals to seek their proper working attitude and retest. If excessive leakage across the piston remains, the unit must be disassembled and the cause of leakage must be determined and corrected.
- 14.4 Repeat the above procedure for the opposite side of the piston.
- 14.5 If an actuator was disassembled and repaired, the above leakage test must be performed again.

15.0 M4 HYDRAULIC CONTROL PACKAGE INSTALLATION

CAUTION: The unit must be mounted with reservoir upright with the pump shaft horizontal.

CAUTION: Do not use teflon tape to seal hydraulic system threads.

- 15.1 If the M4 Control Package is not remote mounted then re-install the M4 control package (8) on the hydraulic cylinder (3-160).
- 15.2 NOTE: Recommend that a non hardening thread sealant, compatible with petroleum base hydraulic fluid be used in this system. Hook up piping from the M4 hydraulic control block to cylinder ports.
- 15.3 M4 Refilling Instructions Refilling of the M4 hydraulic control system and actuator cylinder is best accomplished using a pressure pump. Put the actuator in the closed position (CW) and proceed using the following steps.
 - 15.3.1 Remove the breather from the reservoir.
 - 15.3.2 Attach the pump discharge line to reservoir breather port.
 - 15.3.3 Open both speed control valves.
 - 15.3.4 Open the two bleed valves (3-150), located at each end of hydraulic cylinder (3-160).
 - 15.3.5 Slowly pump hydraulic fluid into the reservoir. Approximately three to five PSI will be required. As the hydraulic fluid passes through the M4 control block into the cylinder, air will be displaced.

- 15.3.6 Close each bleed valve (3-150) when the air has been displaced and hydraulic fluid appears.
 - 15.3.7 Remove pump discharge line from reservoir breather port.
 - 15.3.8 Adjust fluid level to 1½" (40mm) from top of reservoir with actuator in open (CCW) position.
 - 15.3.9 Re-install breather removed, in step 15.3.1.
- 15.4 Alternate Refilling Instructions Refilling the M4 hydraulic control system, during field service, often must be done without the use of a pressure pump. Proceed as follows:
- 15.4.1 Put the actuator in the closed position (CW).
 - 15.4.2 Remove the breather from the reservoir.
 - 15.4.3 Fill the reservoir approximately three-fourths (3/4) full.
 - 15.4.4 Open both speed control valves.
 - 15.4.5 Open the bleed valve (3-150) on the outboard end of the hydraulic cylinder only.
 - 15.4.6 Rotate the handle slowly, clockwise, until all air has escaped from the system.
 - 15.4.7 Close the bleed valve opened in step 15.4.5. During the fill procedure, it is important that the lowest level be not less than approximately one-fourth (¼) of the reservoir volume at any time.
 - 15.4.8 Open the bleed valve (3-150) on the inboard end of the hydraulic cylinder.
 - 15.4.9 Rotate the handle slowly, counterclockwise, until all air has escaped from the system.
 - 15.4.10 Close the bleed valve opened in step 15.4.8. During the fill procedure, the piston will not move. This may be determined by observing the position indicator pin (1-290) on the actuator.
 - 15.4.11 Adjust fluid level to 1-1/2" (40mm) from top of reservoir with actuator in open (CCW) positions.
 - 15.4.12 Re-install breather removed in step 15.4.2.
- 15.5 Additional M4 Instructions These steps are to be performed to insure air is removed from the system (most likely air in pump) and to test the operation of M4 hydraulic control system.
- 15.5.1 Turn M4 crank arm CW. The actuator should move clockwise as well. Adjust outboard bleed valve (3-150) to remove air from system.
 - 15.5.2 Turn M4 crank arm CCW. The actuator will move counterclockwise. Adjust inboard bleed valves to remove air from system.

15.5.3 With bleed valves closed, stroke actuator full 900, CW and CCW, using M4 override.

16.0 RETURN TO SERVICE

- 16.1 Replace the software components of the snubber valve (1-230). If removed, install the snubber valve (1-230) in the housing cover.
- 16.2 Adjust stop screws (2-130) and (3-110) back to settings recorded in section 5.
- 16.3 Install oring seals (5-20) and (6-20) into the stop nuts (2-140) and (3-120). Tighten both stop nuts securely.
- 16.4 The actuator is ready to return to service.

CHART NO. 1 - TOOL STYLE AND WRENCH SIZES

ITEM NO.	WRENCH SIZE	ITEM QTY	LOCATION OR DESCRIPTION	RECOMMENDED WRENCH STYLE
1-60	3/16"	32	Segmented retainer	Hex socket or allen
1-80	5/8"	4	Rail shoulder bolts	Hex socket
1-150	3/4"	52	Cover Screws	Socket
1-170	1-1/8"	16	Lifting lugs hex screws	Socket
1-190	7/16" Sq.	4	3/8" NPT pipe plug	Open end or adjustable
1-220	9/16" Sq.	4	1/2" NPT pipe plug	Open end or adjustable
1-230	7/8"	1	Snubber Valve	Deep socket
1-240	3/4"	8	Cover screws lifting nut	Open end
1-250	1/4"	1	Position Indicator drive	Allen
1-280	9/16"	8	Position Indicator cover	Socket
2-60	3/4"	2	Tie bar flats	Open end or adjustable
2-70	1/2" Sq.	1	Piston rod	Square drive (1)
2-100	2-3/16"	2	Tie bar nuts	Crows foot (1)
2-130	1-1/4"	1	Stop screw flats	Open end or adjustable
	1/2" Sq.	1	Stop screw recess	Square drive (1)
2-140	2-3/4"	1	Stop nut	Open end or adjustable
2-150	9/16" Sq.	1	1/2" NPT drain plug	Open end or adjustable
3-60	3/4"	2	Tie bar flats	Open end or adjustable
3-70	1-3/4" Sq.	1	Piston rod flats	Crow foot (1)
3-100	2-3/16"	2	Tie bar nuts	Crows foot (1)
3-110	1-1/4"	1	Stop Screw flats	Open end or adjustable
	1/2" Sq.	1	Stop screw recess	Square drive (1)
3-120	2-3/4"	1	Stop nut	Open end or adjustable
3-130	9/16" Sq.	1	1/2" NPT drain plug	Open end or adjustable
3-140	13/32"	2	1/8 NPT bleed valve	box or open end
3-150	9/32" Sq.	1	1/8 NPT pipe plug	Open end or adjustable
8	-	-	M4B Hydraulic Control Package	Open end set or adjustable

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

CHART NO. 2 - ACTUATOR WEIGHTS

ACTUATOR MODEL	WEIGHT (1)	ACTUATOR MODEL	WEIGHT (1)
STR10212-M4	2551	STR10220-M4	2891
STR10216-M4	2680	STR10224-M4	3641

NOTES: (1) Weights listed for each actuator model are for bare actuators without accessories or valve mounting brackets.

ECN	DATE	REV	BY *	DATE
Released	April, 1994	A	COMPILED BC	7 April 1994
			CHECKED BJ	7 April 1994
			APPROVED RMM	7 April 1994

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