

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR MODEL

STR10XX-M4

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 111586

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 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 which 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 a customers plant safety or work procedures. If a conflict arises between this procedure and the customers 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.

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. 2 page 18.

3.0 REFERENCE BETTIS MATERIALS

- 3.1 Assembly Drawing 104838 for STR10XX-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. 1 on page 17.
- 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 (-20°F to +350°F) use Bettis, Kronaplate 100 lubricant. This lubricant is furnished in the Bettis Service/Seal Kit.
 - 4.8.2 Low temperature service (-50°F to +150°F) 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 (-20°F to +350°F) use Dextron II Automatic Transmission fluid.

4.9.2 Low temperature service (50°F to +150°F) 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).

NOTE: Stop screw (2-130) has a 1/2" Square X 7/8" deep female hole in its outboard end.

5.2 Go through the hole vacated by pipe plug (2-150), using a 1/2 inch square drive extension to hold stop screw (2-130) in place, remove stop screw nut (2-140). Mark or identify this stop screw.

NOTE: Stop screw (3-110) has a 1/2" Square X 7/8" deep female hole in its outboard end.

5.3 Go through the hole vacated by 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 Measure and record the exposed length of power cylinder stop screw (2-130) and blind end cap stop screw.

5.5 Remove the snubber valve (1-230) from the housing cover (1-130).

5.6 Mark and record location of the hydraulic inlet ports on outer end cap (3-30) and inner end cap (3-40).

CAUTION: The bleed valves (3-150) are 1/8 npt and are made out of brass. Use only the correct size wrench. Refer to tool list at the end of this procedure for recommended wrench style and correct wrench size. Do not use pliers or other style adjustable wrench for bleed valve removal or adjustment.

5.7 Drain the hydraulic fluid from cylinder (3-10) by opening bleed valves (3-150) and then removing cylinder pipe plugs (3-140).

5.8 If the M4 package is remote mounted then disregard the rest of this step. Remove the cylinder mounted M4 Hydraulic Control package from cylinder (3-10) by loosening the nuts/lockwashers on the mounting bracket u-bolts and then slide the M4/bracket assembly off of the end of cylinder (3-10).

NOTE: Before removing the hydraulic cylinder mounted M4 package mark and record the package orientation.

CAUTION: Plug the 3/8" NPT ports in the M4 as foreign material may enter the system and cause the package to malfunction.

6.0 PNEUMATIC PRESSURE CYLINDER DISASSEMBLY

6.1 Remove two 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).

6.2 The fit between cylinder (2-10) and outer end cap (2-30) is very tight. Separate outer end cap (2-30) from cylinder (2-10) 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.

CAUTION: When separating cylinder (2-10) from outer end cap (2-30) and inner end cap (2-40) do not damage outer diameter o-ring seal groove.

6.3 Pry inner end cap (2-40) away from housing (1-10).

6.4 Separate inner end cap (2-40) from cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap.

NOTE: Fit between cylinder (2-10) and inner end cap (3-40) is very tight.

6.5 Remove cylinder (2-10) from inner end cap (2-40).

NOTE: When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to piston rod (2-70).

6.6 Unscrew and remove tie bars (2-60) from housing (1-10).

NOTE: Flats on outboard end of tie bars are provided for wrench placement.

6.7 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).

NOTE: Keep split rings (2-80) in matched sets.

6.8 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).

6.9 FABRICATED PISTON DISASSEMBLY: Refer to assembly drawing sheet 2 of 2 Detail "B".

6.9.1 Remove retaining rings (2-230) from piston (2-20).

6.9.2 Remove piston bushing (2-220) from piston (2-20).

NOTE: Piston bushing (2-220) should be replaced each time the actuator is refurbished. The Bettis Service Kit should contain new piston bushings.

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

NOTE: Keep split rings (2-80) in matched sets.

- 6.11 Refer to assembly drawing page 2 of 2 Detail "B". Remove o-ring seal (5-20) from piston rod (2-70).
- 6.12 Remove inner end cap (2-40) off piston rod (2-70).
- 6.13 Unscrew and remove piston rod (2-70) from yoke pin nut (1-110). NOTE: A 1/2" inch recessed square is provided on the outboard end of the piston rod for wrenching purposes.
- 6.14 Refer to assembly drawing page 2 of 2 Detail "D". Remove rod bushing (2-50) and rod seal (5-60).

7.0 HYDRAULIC CONTROL CYLINDER DISASSEMBLY

- 7.1 Remove two tie bar nuts (3-100), from the outboard side of outer end cap (3-30).
- 7.2 The fit between cylinder (3-10) and outer end cap (3-30) is very tight. Separate outer end cap (3-30) from cylinder (3-10) by tapping with a breaker bar on lip provided on the end cap. Remove outer end cap (3-30) from cylinder (3-10). NOTE: Stop screw (3-110) may remain in outer end cap.

CAUTION: When separating cylinder (3-10) from outer end cap (3-30) and inner end cap (3-40) do not damage outer diameter o-ring seal groove.

- 7.3 Pry inner end cap (3-40) away from housing (1-10).
- 7.4 Separate inner end cap (3-40) from cylinder (3-10) by tapping with a breaker bar on the lip provided on the end cap.

NOTE: Fit between cylinder (3-10) and inner end cap (3-40) is very tight.

- 7.5 Remove cylinder (3-10) from inner end cap (3-40).

NOTE: When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to piston rod (3-70).

- 7.6 Unscrew and remove tie bars (3-60) from housing (1-10).

NOTE: Flats on outboard end of tie bars are provided for wrench placement.

- 7.7 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).

NOTE: Keep MX split rings (3-80) in matched sets.

- 7.8 Remove piston (3-20) off of piston rod (3-70).
- 7.9 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).

NOTE: Keep MX split rings (3-80) in matched sets.

- 7.10 Refer to assembly drawing page 2 of 2 Detail "B". Remove o-ring seal (6-20) from piston rod (3-70).
- 7.11 Remove inner end cap (3-40) off piston rod (3-70).
- 7.12 Unscrew and remove piston rod (3-70) from yoke pin nut (1-110).

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.

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

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 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 Unscrew and remove set screw (1-250) from position indicator drive assembly (1-260).

NOTE: Mark the hole that the set screw (1-250) is removed from.

- 8.5 Remove position indicator drive assembly (1-260) from the top of yoke (1-30).
- 8.6 Unscrew and remove sixteen socket cap screws (1-60) from upper yoke/segmented retaining rings (1-50).
- 8.7 Remove upper segmented retaining rings (1-50).
- 8.8 Remove forty cover screws (1-150) and gasket seals (4-50).

NOTE: The eight cover screws (1-150), that stick up and have hex nut (1-240) on them, are not to be removed.

- 8.9 To help in removing housing cover (1-130) loosen eight hex nuts (1-240). Alternately rotate eight raised cover screws (1-150) clockwise until the cover is clear of cover pins (1-140).
- 8.10 Remove 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 Refer to assembly drawing page 2 of 2 detail "J". Position housing (1-10) in such a manner so as to allow the lower yoke bushing (1-20) to be removed.

- 8.14 Unscrew and remove sixteen socket cap screws (1-60) from four lower yoke/segmented retaining rings (1-50).
- 8.15 Remove lower segmented retaining rings (1-50).
- 8.16 Remove lower yoke bushing (1-20).
- 8.17 Remove yoke pin (1-120).
- 8.18 Remove two short yoke rollers (1-90) and one long yoke roller (1-100).
- 8.19 Remove four shoulder bolts (1-80), two bolts from each of two rails (1-70).
- 8.20 Remove rails (1-70) from housing (1-10).
- 8.21 Remove yoke pin nut (1-110) from yoke (1-30).
- 8.22 Remove yoke (1-30) from housing (1-10).
- 8.23 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 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 installed 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 and power cylinder 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. Master Gasket should be applied per the manufactures instructions. A continuous small 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 pipe plugs (1-190) and four 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 yoke bore in housing (1-10).
- 10.3 Install o-ring seals (4-10) and (4-20) into lower yoke bushing (1-20).
- 10.4 Install lower yoke bushing (1-20) into housing (1-10).
- 10.5 Install four segment retaining rings (1-50) into the lower yoke bushing and retain with sixteen socket cap screws (1-60).
- 10.6 Apply lubricant to yoke (1-30) in the lower trunion area and the lower yoke arm slot.
- 10.7 Install yoke (1-30) into lower yoke bushing. NOTE: Yoke hub with tapped holes faces up. Rotate yoke to mid-stroke position.
- 10.8 Apply lubricant to all surfaces of two short yoke rollers (1-90) and one long yoke roller (1-100). Install one short roller (1-90) into the slot of bottom yoke arm.
- 10.9 Apply lubricant to two rails (1-70). Install inner rail (1-70) by inserting rail into housing (1-10) between arms of yoke (1-30). Retain inner rail (1-70) with two shoulder bolts (1-80). 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, For cylinder (2-10) side of housing (1-10) use two adapter pieces (see Drawing B-64899) as temporary replacements. Retain inner rail (1-70) with two shoulder bolts (1-80).
- 10.10 Apply lubricant to the upper and lower surfaces of yoke pin nut (1-110).
- 10.11 Install yoke pin nut between upper and lower yoke arms. NOTE: Arrange yoke pin nut to be parallel to rail (1-70).
- 10.12 Install long yoke roller (1-100) into slot of yoke pin nut (1-110). Align hole of long roller with hole in short roller (1-90).

10.13 Apply lubricant to yoke pin (1-120) and install into long yoke roller (1-100) and short yoke roller (1-90).

10.14 Install final short yoke roller (1-90).

10.15 Install outer rail (1-70) with two shoulder bolts (1-80).

NOTE: Use rail alignment tool (see Drawing B-64899) to support rail until tie bars are installed. Do not tighten the shoulder bolts.

10.16 Apply lubricant to rod bushing (2-50) and install into the right side of housing (1-10).

10.17 Apply lubricant to rod bushing (3-50) and install into left side of housing (1-10).

10.18 Install piston rods (2-70) and (3-70) into yoke pin nut (1-110). NOTE: Do not tighten either piston rod.

NOTE: For wrenching purposes piston rod will be equipped with flats on its outboard end or a 1/2 inch female square.

10.19 Remove temporary adapter pieces one at a time and install tie bars (2-60) into the right side of housing (1-10) with the tipped end of the tie bar being inserted into rail (1-70).

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

10.20 Remove temporary adapter pieces one at a time and install tie bars (3-60) into the right side of housing (1-10) with the tipped end of the tie bar being inserted into rail (1-70).

10.21 After both tie bars sets are installed then tighten all four shoulder bolts (1-80).

10.22 Torque tighten piston rod (2-70) to 166 foot pounds lubricated.

NOTE: For wrenching purposes piston rod will be equipped with flats on its outboard end or a 1/2 inch female square.

10.22 Torque tighten piston rod (3-70) to 166 foot pounds lubricated.

10.24 Install position indicator drive assembly (1-260) onto top of yoke (1-30) with the slot positioned over hole that was marked in section 8 step 8.4.

10.25 Install set screw (1-250) through position indicator drive assembly (1-260) and into top of yoke (1-30).

10.26 Install o-ring seal (4-80) over the position indicator drive assembly shaft and down against the flat plate.

11.0 POWER CYLINDER RE-ASSEMBLY

11.1 Prepare mounting surfaces of inner end cap (2-40) and end cap side of 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 o-ring seal (4-40) into inner end cap (2-40).
- 11.3 Refer to assembly drawing page 2 of 2, Detail "D". Install rod seal (5-50) into recess (counter bore) provided in inner end cap (2-40).

CAUTION: Install rod seal (5-50) with energizer ring facing outboard side (away from housing).

- 11.4 Refer to assembly drawing page 2 of 2, Detail "E". Install two o-ring seals (5-10) into inner end cap (2-40).
- 11.5 Install inner end cap (2-40) by sliding over piston rod (2-70), tie bars (2-60), and rod bushing (2-50). Exercise extreme care during installation in order to prevent damage to rod seal (5-50).

NOTE: Pressure port should be above actuator centerline.

- 11.6 Install o-ring seal (5-30) into outer diameter seal groove of 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 piston rod (2-70) with lubricant. Install a matched set of split rings (2-80) into the inner most groove in piston rod (2-70) and retain with retaining ring (2-90).
- 11.8 Install o-ring seal (5-20) onto the o-ring groove in the piston rod (2-70).
- 11.9 Install two o-ring seals (5-10) into inner diameter seal grooves in piston (2-20). Refer to step 11.10 for assembling fabricated piston equipped with piston bushings (2-220).
- 11.10 FABRICATED PISTON REASSEMBLY: Refer to assembly drawing sheet 2 of 2, alternate Detail "B".
- 11.10.1 Install o-ring seals (5-90) into the outer diameter seal groove on piston bushings (2-220).
- 11.10.2 Install o-ring seals (5-10) into the inner diameter seal groove in piston bushing (2-220).
- 11.10.3 Install piston bushing (2-220) into piston (2-20).

CAUTION: The piston bushings (2-220) should be replaced each time the actuator is refurbished. NOTE: The Bettis Service Kit should contain new piston bushings.

- 11.10.4 Install retaining rings (2-230) into piston (2-20).
- 11.11 Install piston (2-20) onto piston rod (2-70) and up against the split ring installed in step 11.7.

NOTE: When installing cast pistons be sure to install with ribbed section of piston is facing away from the housing (1-10). When installing fabricated pistons, 24" inch diameter and larger, make certain that the smaller diameter piston plate is facing away from housing (1-10).

- 11.12 Refer to assembly drawing page 2 of 2 Detail "B". Install a matched set of split rings (2-80) and a ring retainer (2-90).
- 11.13 Refer to assembly drawing page 2 of 2 Detail "C". Install piston T-seal (5-40) into the outer diameter seal groove on piston (2-20).
- 11.14 Apply lubricant to the bore of 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 -10) cap (2-40). To facilitate installation tilt Cylinder (2-10) approximately 15° to 30° degrees across piston (2-20).
- 11.16 If removed, install stop screw (2-130) into outer end cap (2-30).
- 11.17 Refer to assembly drawing page 2 of 2 Detail "A". Install two o-ring seals (5-10) into the inner diameter seal grooves in outer end cap (3-30).
- 11.18 Refer to assembly drawing page 2 of 2 Detail "C". Install o-ring seal (5-30) into the outer diameter seal groove of outer end cap (2-30).
- 11.19 Install outer end cap (2-30) onto tie bars (2-60) and into cylinder (2-10). Install with the raised boss away from the cylinder and the inlet port above the centerline of the actuator.
- 11.20 Install two tie bar nuts (2-100) onto tie bars (2-60).

CAUTION: While tie bar nuts (2-100) are being tightened, do not allow the tie bars to turn.

- 11.21 Torque tighten two tie bar nuts (2-100) to 150 ±15 foot pounds lubricated.

12.0 HYDRAULIC CONTROL CYLINDER RE-ASSEMBLY

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

CAUTION: Use hydraulic fluid listed in section 4 step 4.9 as the assembly lubricant for section 12.

- 12.2 Refer to assembly drawing page 2 of 2, Detail "E". Install o-ring seal (4-40) into inner end cap (3-40).
- 12.3 Refer to assembly drawing page 2 of 2, Detail "D". Install MX rod seal (6-50) into recess (counter bore) provided in inner end cap (3-40).

CAUTION: Install MX rod seal (6-50) with energizer ring facing outboard side (away from housing).

12.4 Refer to assembly drawing page 2 of 2, Detail "E". Install two MX o-ring seals (6-10) into inner end cap (3-40).

12.5 Install inner end cap (3-40) by sliding over piston rod (3-70) and MX rod bushing (3-50). Exercise extreme care during installation in order to prevent damage to the MX rod seal (6-50).

NOTE: Refer to section 5 step 5.6 for location of the end cap pressure port.

12.6 Install MX o-ring seal (6-30) into outer diameter seal groove 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 piston rod (3-70) with lubricant. Install a matched set of MX split rings (3-80) into the inner most groove in piston (3-70) rod and retain with MX retaining ring (3-90).

12.8 Install MX o-ring seal (6-20) onto the o-ring groove in piston rod (3-70).

12.9 Install two MX o-ring seals (6-10) into inner diameter seal grooves in piston (3-20).

12.10 Install piston (3-20) onto piston rod (3-70) and up against the split ring installed in step 12.7.

12.11 Refer to assembly drawing page 2 of 2 Detail "B". Install a matched set of MX split rings (3-80) and a MX ring retainer (3-90).

12.12 Refer to assembly drawing page 2 of 2 Detail "F". Install piston T-seal (6-40) into the outer diameter seal groove on piston (3-20).

12.13 Apply lubricant to the bore of 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.

12.14 Install cylinder (3-10) over piston (3-20) and onto inner end cap (3-40). To facilitate installation tilt cylinder (3-10) approximately 15° to 30° degrees across piston (3-20).

12.15 If removed, install stop screw (3-110) into outer end cap (3-30).

12.16 Install two o-ring seals (6-10) into the inner diameter seal groove in outer end cap (3-30).

12.17 Refer to assembly drawing page 2 of 2 Detail "F". Install o-ring seal (6-30) into the outer diameter seal groove of outer end cap (3-30).

12.18 Install outer end cap (3-30) onto tie bars (3-60) and into cylinder (3-10).

NOTE: Refer to section 5 step 5.6 for location of outer end cap (3-30) pressure inlet port.

12.19 Install two tie bar nuts (3-100) onto tie bars (3-60).

CAUTION: While tie bar nuts (3-100) are being tightened, do not allow the tie bars to turn.

12.20 Torque tighten two tie bar nuts (3-100) to 150 ±15 foot pounds lubricated.

12.21 Install two pipe plugs (3-140) into cylinder (3-10). Refer to section 4 step 4.5 for pipe plug seal requirements.

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 o-ring seals (4-10) and (4-20) into upper yoke bushing (1-40).

13.3 Install the upper yoke bushing (1-40) into the housing cover (1-130).

13.4 Install four segment retaining rings (1-50) into the upper yoke bushing and retain in cover (1-130) with sixteen socket cap screws (1-60).

13.5 Remove fifty two screws (1-150) and replace gasket seals (4-50) with new gasket seals.

13.6 Prepare the mounting surfaces of housing (1-10) and cover (1-130) per master gasket instructions (reference step 9.6 under General Reassembly).

13.7 Install gasket (4-30) onto housing (1-10).

13.8 Install cover (1-130) onto housing (1-10).

13.9 Install screws (1-150), with new gasket seals (4-50), back into cover (1-130). Tighten all screws (1-150), with the exception of eight screws (1-150) that have hex nuts (1-240).

13.10 Make sure that eight screws (1-150) with hex nuts (1-240) are not contacting housing (1-10). Tighten eight hex nuts (1-240).

13.11 Tighten 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".

13.12 Install o-ring seal (4-70) into the bottom seal groove inside position indicator cover (1-270).

13.13 Install wiper ring (4-60) into the top seal groove inside position indicator cover (1-270).

13.14 Prepare mounting surfaces of position indicator cover (1-270) and cover (1-130) per master gasket instructions (reference step 8.6 under General Reassembly).

- 13.15 Install o-ring seal (4-90) into the bottom seal groove on the bottom of position indicator cover (1-270).
- 13.16 Install position indicator cover (1-270), being careful not to damage o-ring seals (4-90), (4-70), and wiper ring (4-60).
- 13.17 Install new gasket seals (4-100) on to hex head screws (1-280).
- 13.18 Install and tighten screws (1-280) with gasket seals (4-100).
- 13.19 Install position indicator pointer (1-290) into the taped hole in position indicator drive assembly (1-260).
- 13.20 Adjust stop screw (2-130) back to setting recorded in section 5.
- 13.21 Apply lubricant to o-ring seal (5-20) and install into stop nut (2-140).
- NOTE: Make certain that stop screw (2-130) does not change its setting while installing stop nut (2-140).
- 13.22 Install stop nut (2-140) on to stop screw (2-130). NOTE: Do not tighten stop nut (2-140).
- 13.23 Go through pipe plug (2-150) hole, and using a 1/2 inch square drive extension to hold stop screw (2-130) in place, tighten stop screw nut (2-140).
- 13.24 Adjust stop screw (3-110) back to setting recorded in section 5.
- 13.25 Apply lubricant to o-ring seal (6-20) and install into stop nut (3-120).
- NOTE: Make certain that stop screw (3-110) does not change its setting while installing stop nut (3-120).
- 13.26 Install stop nut (3-120) on to stop screw (3-110). NOTE: Do not tighten stop nut (3-120).
- 13.27 Go through pipe plug (3-130) hole, and using a 1/2 inch square drive extension to hold stop screw (3-110) in place, tighten stop screw nut (3-120).

14.0 ACTUATOR TESTING

- 14.1 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.
- 14.2 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.

- 14.3 All leak testing will use 65 psig pressure. NOTE: When testing the actuator use a proper adjusted regulator to apply pressure to the actuator.
- 14.4 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.

- 14.5 Apply 65 psig pressure to the pressure port in inner end cap (2-40).
- 14.6 Apply a commercial leak testing solution to the following areas:
- 14.6.1 Joint between inner end cap (2-40) and cylinder (2-10). This checks cylinder to inner end cap o-ring seal.
 - 14.6.2 The inlet port hole in outer end cap (2-30). This checks piston to cylinder (2-10) "T" seal (5-40), o-ring seals (5-10) and (5-20).
 - 14.6.3 The snubber valve (1-230) port hole in cover (1-130). This checks the o-ring seals that seals tie bars to inner end cap. Also checks rod seal (5-60) that seals piston rod to inner end cap.
 - 14.6.4 Remove pressure from inner end cap (2-40) pressure inlet port.
- 14.7 Apply 65 psig pressure to the pressure port in outer end cap (2-30) and allow the actuator to stabilize.
- 14.8 Apply a commercial leak testing solution to the following areas:
- 14.8.1 Joint between outer end cap (2-30) and cylinder (2-10). This checks cylinder to inner end cap o-ring seal.
 - 14.8.2 Joints around tie bar nuts (2-100), stop nut (2-140) and stop nut pipe plug (2-150).
 - 14.8.3 Remove pressure from outer end cap (2-30) pressure inlet port.
- 14.9 If an actuator was disassembled and repaired, the above leakage test must be performed again.

15.0 M4 HYDRAULIC CONTROL PACKAGE INSTALLATION

CAUTION: The M4 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 on the hydraulic cylinder (3-10).

NOTE: Refer to section 5 step 5.8 for M4 hydraulic control package orientation.

- 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 (3-10).
 - 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 clockwise (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 counter clockwise (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 90°, clockwise and counter clockwise, using M4 hydraulic control package.

16.0 RETURN TO SERVICE

- 16.1 Replace the software components of the snubber valve (1-230). Install snubber valve (1-230) into cover (1-130).
- 16.2 The actuator is ready to return to service.

CHART NO. 1 - ACTUATOR WEIGHTS

ACTUATOR MODEL	WEIGHT (1)	ACTUATOR MODEL	WEIGHT (1)
STR1010-M4	2403	STR1020-M4	2652
STR1012-M4	2473	STR1024-M4	2962
STR1016-M4	2531	STR1028-M4	3521

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

CHART NO. 2 - 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
----	-	-	Hydraulic Control Package	Open end or adjustable

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

ECN	DATE	REV	BY *	DATE
Released	May, 1995	A	COMPILED Bill Cornelius	23 may 1995
			CHECKED Bill Cornelius	23 may 1995
			APPROVED Robert McEver	23 may 1995

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