

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

301 SERIES

SPRING RETURN

RACK & PINION

PNEUMATIC ACTUATORS*

*** INCLUDES OBSOLETE 701 SERIES**

SPRING RETURN ACTUATORS

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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 301-SRXX 301-SRXX-M3, 301-SRXX-M3HW, and 301-180-SRXX Rack and Pinion Spring Return series pneumatic actuators. NOTE: This procedure is for all revisions of model 301 actuators, i.e. 301 basic model (no revision letter), 301A, 301B, 301C and 301D.
- 1.2 The maximum recommended service interval for this actuator series is five years. Storage time is counted as part of the service interval.

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

2.0 BASIC TOOLS

All tools are American Standard inch. Large adjustable wrench, snap ring pliers, chain wrench, Allen wrench set, rubber or leather mallet, non-corrosive commercial leak testing solution, and non-hardening thread sealant.

3.0 BETTIS REFERENCE MATERIALS

- 3.1 301-SRXX Assembly Drawing 035801 page 1 of 2 for fail closed actuators.
- 3.2 301-SRXX Exploded Detail Drawing 035801 page 2 of 2.
- 3.3 301-SRXX Assembly Drawing 072239 for fail open actuators.
- 3.4 301-SRXX-M3 Assembly Drawing 035803 page 1 of 2 for fail closed actuators.
- 3.5 301-SRXX-M3 Exploded Detail Drawing 035803 page 2 of 2.

4.0 GENERAL INFORMATION

- 4.1 Numbers in parentheses (), indicate the bubble number (reference number) used on the Bettis Assembly Drawing, Exploded Detail Drawing, and actuator Parts List.
- 4.2 Mating parts should be marked for ease of reassembly, i.e. cylinder to housing, right and left stop screws, etc.
- 4.3 When removing seals from seal grooves, use a small screwdriver with the sharp edges rounded off or use a commercial seal removing tool.
- 4.4 Use a non-hardening thread sealant on all pipe threads.
- 4.5 Disassembly of actuator should be done in a clean area on a work bench.

4.6 LUBRICATION REQUIREMENTS.

4.6.1 Standard and high temperature service (-20° F to +350° F) use Bettis ESL-5 Kronaplate 100 lubricant.

4.6.2 Low temperature service (-50° F to +150° F) use Kronaplate 50 lubricant.

5.0 GENERAL DISASSEMBLY

- 5.1 Remove all operating pressure from actuator cylinder (3) or cylinder assembly M3 (3-10) allowing the spring to stroke. The spring will rotate the yoke to the fail position.
- 5.2 Remove all piping and accessories mounted on actuator.
- 5.3 When actuator is equipped with a M3 or M3HW jackscrew make sure that jackscrew assembly (3-20) is not engaging piston and gear rack (2-10).
- 5.4 Actuators equipped with M3HW jackscrew with handwheel (8), remove hex nut from end of jackscrew. Unscrew and remove the handwheel (8).
- 5.5 The setting of stop screw (2-20) and (2-30) should be checked and settings recorded before stop screws are loosened or removed. If the actuator is a M3 jackscrew actuator then item (2-20) will be replaced by jackscrew assembly (3-20).
- 5.6 Remove actuator from valve and valve mounting bracket.
- 5.7 Remove breather (2-50) from housing (1-10).

6.0 SPRING CYLINDER REMOVAL

- 6.1 When the spring cartridge is installed on the actuator the spring is under compression. DO NOT remove the spring cartridge until the actuator has the "pre-load" removed.
- 6.2 Spring cartridge "preload". For standard actuators use step 6.2.1 for "preload" removal. For actuators equipped with M3 or M3HW use step 6.2.2 for "preload" removal.
 - 6.2.1 Standard actuator "pre-load" removal.
 - 6.2.1.1 Loosen the stop screw seal nut (2-40).
 - 6.2.1.2 Unscrew and remove the stop screw (2-20).
 - 6.2.2 M3 or M3HW actuator "pre-load" removal.
 - 6.2.2.1 Loosen the seal nut (3-30).
 - 6.2.2.2 Thread the jackscrew out until the flat washer (2-70) is up against the end cap of cylinder (3-10). Actuators manufactured before 1982 may not have a flat washer (2-70) and a spiral pin (2-60).

- 6.3 WARNING: Under no circumstances should the spring cartridge be cut apart, as the spring is preloaded and the spring cartridge welded together.
- 6.4 Secure the chain wrench around the spring cylinder (4) as close to the welded end cap as possible. Using the mallet, break the cylinder loose sufficiently so that it can be removed.
- 6.5 Due to added weight and the nature of a preloaded assembly, caution should be exercised when handling the spring cartridge cylinder (4). The spring cartridge (5) is unattached and is only contained by the spring cylinder (4).
- 6.6 Remove the cylinder (4) and when setting the spring cylinder (4) aside, care should be taken to protect the chamfered edge and cylinder threads.
- 6.7 The stop screw (2-30) and seal nut (2-40) need not be removed for general actuator maintenance.

7.0 PRESSURE CYLINDER DISASSEMBLY

- 7.1 Secure the chain wrench around the cylinder (3) or cylinder assembly M3 (3-10) as close to the welded end cap as possible. Using the mallet, break the cylinder loose sufficiently so it can be removed.
- 7.2 Remove the cylinder and when setting the cylinder aside, care should be taken to protect the chamfered edge and cylinder threads.
- 7.3 For actuators equipped with M3 or M3HW jackscrew override, the following steps will be used for disassembly of the M3 from cylinder assembly M3 (3-10).
 - 7.3.1 With the cylinder assembly M3 (3-10) on a work bench, lubricate jackscrew assembly (3-20) threads with lubricant.
 - 7.3.2 Loosen and thread nut seal (3-30) all the way back to the welded nut.
 - 7.3.3 Thread the jackscrew assembly (3-20) into the cylinder assembly M3 (3-10) until the spiral pin (2-60) and flat washer (2-70) are exposed.
 - 7.3.4 Using a 3/16 inch pin punch, drive out and remove pin (2-60).
 - 7.3.5 Remove flat washer (2-70).
 - 7.3.6 Thread the jackscrew assembly (3-20) out and remove.
 - 7.3.7 Remove nut seal (3-30).

8.0 HOUSING DISASSEMBLY

- 8.1 Remove piston seal (6-20) from piston and gear rack (2-10).
- 8.2 Loosen set screw (1-70) and remove the position indicator (1-60).

- 8.3 Remove snap ring (1-30) from torque plug (1-20).
- 8.4 Grasp actuator housing (1-10) and turn unit upside down (square stem down). By slowly pushing down on housing, the torque plug (1-20) should slide out approximately 2.00 inches (50mm).
- 8.5 Remove the torque plug (1-20) from housing.
- 8.6 Remove o-ring seals (6-30) and (6-40) from the torque plug.
- 8.7 Remove piston and gear rack (2-10) from housing (1-10).
- 8.8 Remove cylinder o-ring seals (6-10) from housing (1-10). The seals are located in each end of the housing.

9.0 PRE-ASSEMBLY NOTES

- 9.1 Remove all old seals taking care not to scratch or damage seal grooves.
- 9.2 Before starting the assembly of an actuator, all parts should be thoroughly cleaned, inspected, and de-burred. Particular attention should be directed to threads, sealing surfaces, and areas that will be subjected to sliding motion.
- 9.3 Coat all seals with lubricant before installing into the seal grooves.

10.0 HOUSING REASSEMBLY

- 10.1 Coat the threads in the housing (1-10) with lubricant.
- 10.2 Coat the cylinder seals (6-10) with lubricant and install into the grooves provided at the end of the threaded portion in each end of the actuator housing (1-10).
- 10.3 Coat the torque plug bores in the housing with lubricant and arrange the housing with the large torque plug bore down and the hole for the breather (2-50) facing away.
- 10.4 Coat all of the teeth on the piston and gear rack (2-10) with lubricant except for the space between the two center teeth. This will provide a visual alignment for later use.
- 10.5 Piston and gear rack (2-10) installation. For actuators failing close or clockwise use step 10.5.1 for installation. For actuators failing counterclockwise use step 10.5.2 for installation.
 - 10.5.1 Fail Close (CW) - Place the piston and gear rack (2-10) into the housing (1-10) with the gear tooth side of the rack on the side of the housing with the hole for the breather (2-50). Lengthwise, center the rack inside the housing.
 - 10.5.2 Fail Open (CCW) - Place the piston gear rack (2-10) into the housing (1-10) with the gear tooth side of the rack on the opposite side of the housing that has the hole for the breather (2-50). Lengthwise, center the rack inside the housing.

- 10.6 Coat the lower torque plug o-ring seal (6-40) with lubricant and install into the bottom groove on the torque plug (1-20).
- 10.7 Coat the upper torque plug o-ring seal (6-30) with lubricant and install into the upper groove on the torque plug (1-20).
- 10.8 TORQUE PLUG ALIGNMENT AND LUBRICATION. (Refer to Figures 1A, 1B and 1C, mid-stroke positions).
 - 10.8.1 Figure 1A 301 - 90° degree Actuator

Coat all of the torque plug gear teeth with lubricant except for one tooth that corresponds with the centerline of one of the flats on top of the torque plug. Figure 1A shows one face of torque plug is parallel to actuator centerline.
 - 10.8.2 Figures 1B & 1C 301 - 135/180° degree Actuator

Coat all of the torque plug gear teeth with lubricant except for one tooth that corresponds with one of the corners on top of the torque plug. Figures 1B and 1C show corners of stem are on centerline of actuator.
- 10.9 Pick up housing, containing the piston and gear rack, and set it down over the torque plug (1-20). Engage the non-lubricated gear tooth on the torque plug with the non-lubricated space on the piston and gear rack. Again, refer to Figures 1A, 1B or 1C (mid-stroke position) for piston/torque plug alignment.
- 10.10 Install the retaining ring (1-30) into the groove at the top of the torque plug.
- 10.11 Coat the piston seal (6-20) with lubricant and install into the groove provided on the piston. Install piston u-cup seal with the lip of the seal pointing away from the housing.

11.0 PRESSURE CYLINDER REASSEMBLY

- 11.1 The following reassembly instructions are for the assembly of the standard Bettis actuator. When the torque plug (1-20) is in vertical position and the breather port in housing facing away, the spring cartridge is on the left side of the housing and the air cylinder is on the right.
- 11.2 For actuators equipped with M3 jackscrew overrides, pre-assemble the M3 into cylinder assembly M3 (3-10) using the following procedure. Reference Figure 2.
 - 11.2.1 If removed, install nut seal (3-30) onto jackscrew assembly (3-20) with the Teflon side facing away from the welded nut.
 - 11.2.2 Thread the nut seal until it is up against the welded nut.
 - 11.2.3 Apply a generous coating of lubricant to the M3 threads (3-20).

- 11.2.4 Thread the jackscrew assembly (3-20) into the cylinder end cap. Turn the jackscrew until the end of the assembly protrudes out of the threaded end of the cylinder.
- 11.2.5 Install flat washer (2-70) and spiral pin (2-60) as shown on assembly drawing.
- 11.2.6 Turn the jackscrew until the flat washer (2-70) just comes into contact with the cylinder end cap.
- 11.2.7 If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, lubricant may be left on jackscrew to provide additional corrosion protection.
- 11.3 Apply a thin coating of lubricant to the bore of the cylinder (3) or cylinder assembly M3 (3-10).
- 11.4 Install the cylinder (3) or cylinder assembly M3 (3-10) over the piston, screwing into the housing (1-10). Tighten with a chain wrench. Exercise caution to prevent pinching of the piston cup seal lip during installation. It is necessary to depress the seal lip while working the cylinder over it. The chain wrench should be secured as close to the welded end cap as possible.

12.0 SPRING CYLINDER REASSEMBLY

- 12.1 Rotate the torque plug clockwise by pushing the exposed end of the piston and gear rack (2-10) into the housing.
- 12.2 Very lightly coat the cylinder threads and the cylinder bore with lubricant.
- 12.3 Coat the outside of the spring with lubricant and insert the spring cartridge assembly (5) into the spring cylinder (4). The end of the spring cartridge assembly, having a deep hole in the center, should be inserted into the cylinder first.
- 12.4 Install the spring cylinder (4), containing spring cartridge assembly (5), into the end of the housing (1-10) and then thread the spring cylinder into the housing.
- 12.5 Tighten the spring cylinder (4) using a "chain wrench" secured as close to the welded end cap as possible. When the cylinder cannot be turned any further with the wrench, rap the handle of the wrench with a mallet, this will tighten the cylinder sufficiently.
- 12.6 Install the hollow (pressure port) stop screw (2-20) and stop screw nut (2-40) into the air cylinder (3). If the actuator is an M3 jackscrew unit then the M3 replaces the stop screw (2-20).
- 12.7 If removed, install the solid stop screw (2-30) and nut (2-40) into the end of the spring cylinder (4).
- 12.8 Adjust both of the stop screws (2-20) or jackscrew (3-20) and (2-30) back to settings recorded in step 5.5 under General Disassembly. Tighten both of the stop screw seal nuts securely, while holding the stop screws.

13.0 ACTUATOR TESTING

13.1 Leakage Test - General

13.1.1 All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.

13.1.2 All leak testing will use the nominal operating pressure (NOP) as listed on the actuator name tag or the normal customer supply pressure.

13.2 Before testing for leak, alternately apply and release NOP pressure to the pressure side of the piston gear rack to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their proper working attitude.

13.3 Leakage Test - Procedure

13.3.1 Apply NOP pressure to the pressure port in the end of cylinder (3) or cylinder assembly M3 (3-10).

13.3.2 Apply leak testing solution to the following areas:

13.3.2.1 The breather port hole in the housing checks the piston seal to cylinder wall.

13.3.2.2 Cylinder stop screw seal nut.

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

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

14.0 RETURN TO SERVICE

14.1 Install breather (2-50) in the housing (1-10).

14.2 Install position indicator (1-60) and tighten socket set screw (1-70). Refer to Figure 3 for proper; installation position.

14.3 Reinstall actuator to valve mounting bracket and valve.

14.4 Reinstall any piping and accessories that were removed.

14.5 For actuators equipped with an M3 jackscrew override and which require an optional handwheel, install the handwheel using the following procedure.

14.5.1 Thread the handwheel (8) onto the jackscrew assembly (3-20). Thread the handwheel up against the fixed nut.

- 14.5.2 Place hex nut onto M3 and thread up against handwheel.
- 14.6 All accessories, including solenoid valves, positioners, pressure switches, etc., should be hooked up and tested for proper operations and replaced, if found defective.
- 14.7 Refer to General Operating and Maintenance Instructions for Bettis Rotary Series Valve Actuators (part number 074650) for actuator start-up procedures.

CHART 1

PRESSURE REQUIREMENT & LIMITATIONS FOR MODELS

301-SR & 301-180-SR

<u>ACTUATOR MODEL (*)</u>	NOMINAL OPERATING PRESSURE <u>(NOP)</u>	MAXIMUM OPERATING PRESSURE <u>(MOP)</u>	MAXIMUM HYDROSTATIC TEST PRESSURE	MAXIMUM AIR ASSIST PRESSURE <u>(MAAP)</u>	COLUMN B SPRING SELECTION <u>PRESSURE</u>
301-SR40	50	275	300	226	31
301-SR80	90	300	300	202	60
301-SR125	125	300	300	179	90
301-SR250	175	300	300	111	175
301-180-SR80	80	300	300	205	60

* Includes actuator models that have M3 and M3HW included in their model numbers, i.e. 301-SR80-M3 or 301-SR250-M3HW

301 (90° ACTUATOR)
INITIAL ASSEMBLY POSITION

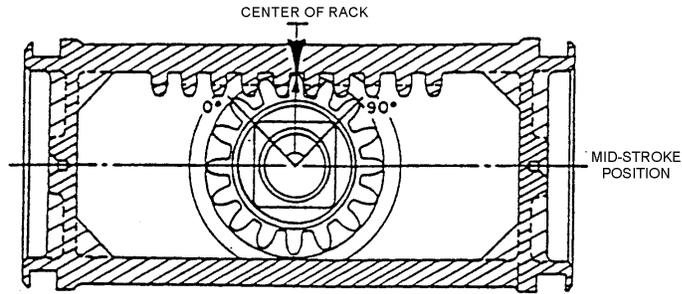


FIGURE 1A

301 (135° ACTUATOR)
INITIAL ASSEMBLY POSITION
CENTER OF RACK

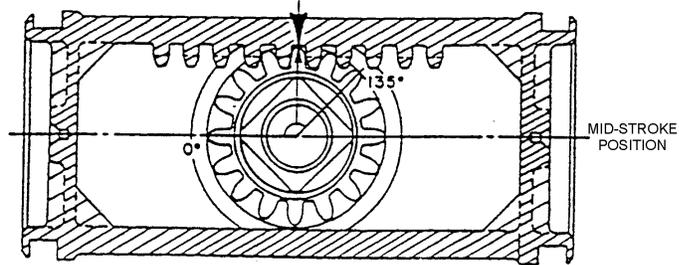


FIGURE 1B

301 (180° ACTUATOR)
INITIAL ASSEMBLY POSITION
CENTER OF RACK

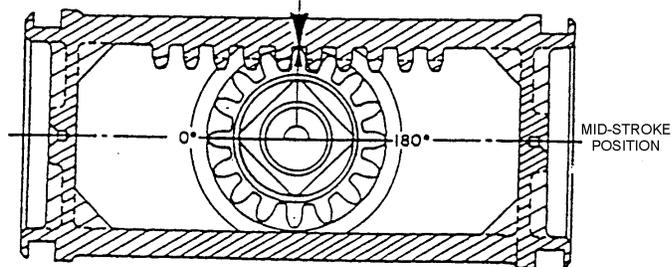
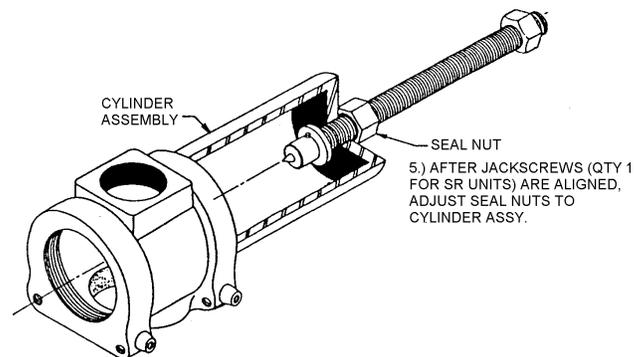
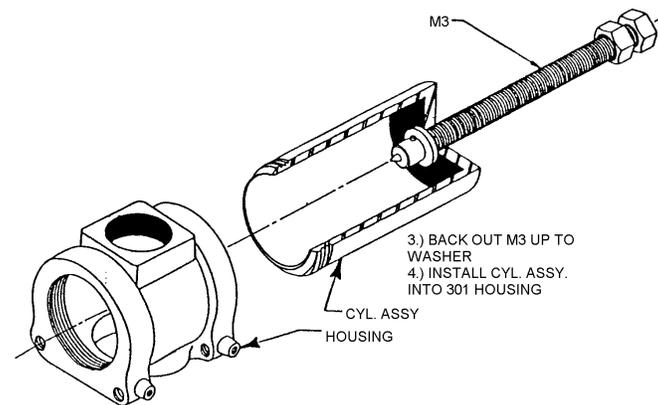
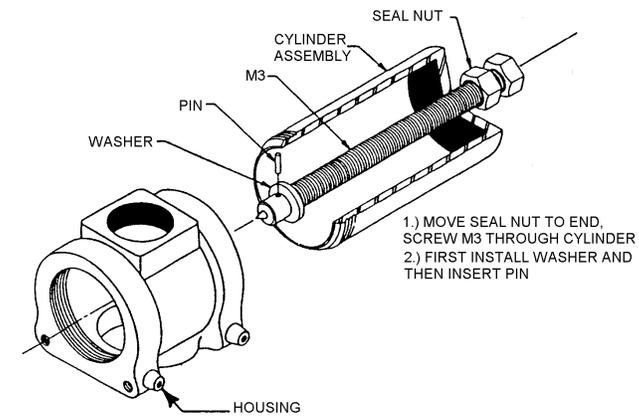


FIGURE 1C

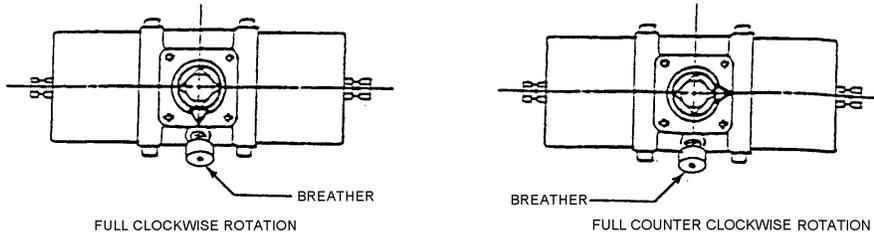
FIGURE 1A, 1B & 1C - MID STROKE RACK POSITION



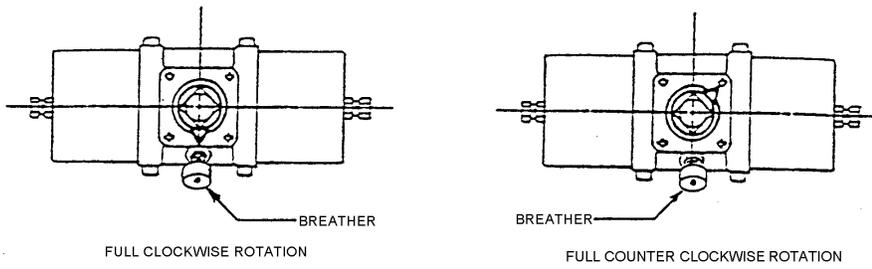
INTERNAL HOUSING COMPONENTS DELETED FOR CLARITY.

FIGURE 2 - M3 ASSEMBLY EXPLODED DRAWING

301-SRXX SPRING RETURN ACTUATORS



301-135-SRXX SPRING RETURN ACTUATORS



301-180-SRXX SPRING RETURN ACTUATORS

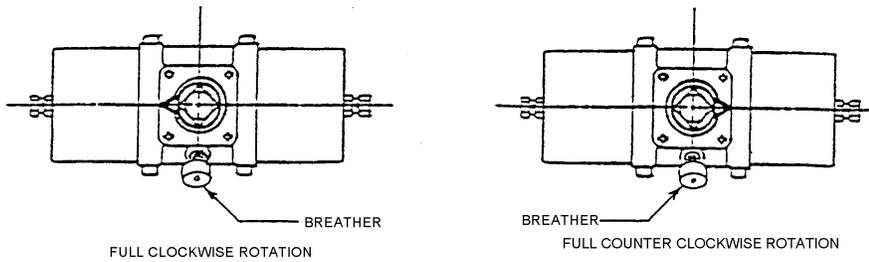


FIGURE 3 - 301-SR SERIES ACTUATOR POSITION INDICATOR