

GH-BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR THE MODELS

ST5XX

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 111577

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 GH-Bettis ST5XX "Scotch-Yoke" type pneumatic series actuators. When the actuator model number has "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.
- 1.2 **SAFETY STATEMENT:** Products supplied by GH-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 GH-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 DISMOUNTED FROM THE VALVE OR DEVICE IT IS OPERATING.**
- 1.5 The maximum recommended service interval for this actuator series is five years. Storage time is counted as part of the service interval.
- 1.6 This procedure is applicable with the understanding that all electrical power and pneumatic pressure has been removed from the actuator. Also, it is understood that the actuator has been removed from the valve as well as all piping and accessories that are mounted on the actuator have been removed.

2.0 SUPPORT ITEMS AND TOOLS

- 2.1 Support Items - Service/Seal Kit, razor sharp cutting instrument, commercial leak testing solution, and non-hardening thread sealant.
- 2.2 Tools - All tools are American Standard inch. Two each medium standard screwdriver, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and a torque wrench (up to 5,000 in.lbs.). For recommended tool list refer to Chart Number 2 page 10.

3.0 REFERENCE GH BETTIS MATERIALS

- 3.1 Assembly Drawing part number 104514.

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 GH-Bettis Assembly Drawing and actuator parts lists.
- 4.3 This procedure is written using the stop screw side of the housing (1-10) as a reference and this side will be considered the front side of the actuator. The housing cover (1-20) is considered the top of the actuator.
- 4.4 Mating parts should be marked for ease of reassembly.
- 4.5 When removing seals from seal groove, use a commercial seal removing tool or use a small standard screwdriver with the sharp edges rounded off.
- 4.6 Use a non-hardening thread sealant on all pipe threads. **CAUTION: Apply the thread sealant per the manufacture's instructions.**
- 4.7 Disassembly should be done in a clean area on a work bench.
- 4.8 Some components of this actuator are very heavy and will require a means of assistance. Refer to Chart Number 1 on page 10 for approximate weights of ST5XX series actuators.
- 4.9 Lubrication Requirements
- 4.9.1 Standard and high temperature service (-20°F to 350°F) use ESL-5 lubricant. ESL-5 is contained in the GH Bettis Service/Seal Kit.
- 4.9.2 Low temperature service (-50°F to 150°F) use Kronaplate 50. This lubricant is not contained in the Low Temperature Service/Seal Kit.
- 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. **NOTE: Pressure is not to exceed the maximum operating pressure rating listed on the name tag.**

5.0 GENERAL DISASSEMBLY

- 5.1 If not already removed disconnect all operating pressure from actuator power cylinder (2-10).
- 5.2 Mark the stop screws (1-60) left and right. The setting of the stop screw (1-60) should be checked and setting recorded before stop screws are loosened or removed.

6.0 BLIND END CAP REMOVAL

- 6.1 Remove socket cap screw (6-50), lockwasher (6-40), and nut retainer (6-30) between large hex cap screws on outboard end of the housing (1-10).
- 6.2 Remove the hex cap screws (6-20) from the blind end cap (6-10).
- 6.3 Remove the blind end cap (6-10).

7.0 PRESSURE CYLINDER DISASSEMBLY

- 7.1 Remove socket cap screw (2-120), lockwasher (2-110) and nut retainer (2-100) from the end of the outer end cap (2-30).
- 7.2 Remove hex nuts (2-90) from tie bars (2-60).

- 7.3 Remove outer end cap (2-30). The fit between the cylinder (2-10) and the outer end cap is very tight. Break the outer end cap free by tapping with a breaker bar on the lip provided on the end cap. **CAUTION: Do not damage o-ring groove on end cap.**
- 7.4 Pry inner end cap (2-40) away from the housing (1-10). Break the inner end cap free from the cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap. **CAUTION: Do not damage o-ring groove on end cap.**
- 7.5 Remove the cylinder (2-10). **NOTE: When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to the piston rod.**
- 7.6 Unscrew and remove the tie bars (2-60) from the housing (1-10). Flats are provided on the outboard end of the tie bars for wrench placement. **CAUTION: Do not use a pipe wrench on the tie bars as it will mark the bar and may cause seal leakage.**
- 7.7 Remove the split ring retainer (2-80) and the split ring (2-70) from the outboard side of the piston (2-20). **NOTE: Keep the split rings in matched sets.**
- 7.8 Remove the piston (2-20) from the piston rod (2-170). The piston will slide off of the piston rod. Refer to step 7.12 for 24" piston tie bar bushing (2-180) disassembly.
- 7.9 Remove the piston rod o-ring seal (3-40) from the piston rod (2-170).
- 7.10 Remove the split ring retainer (2-80) and the split ring (2-70) from the inboard side of the piston. **NOTE: Keep the split rings in matched sets.**
- 7.11 Slide the inner end cap (2-40) off the piston rod (2-170).
- 7.12 Fabricated 24" piston disassembly (refer to assembly drawing detail "B").
- 7.12.1 Remove the retaining rings (2-190) from the piston.
- 7.12.2 Remove the piston tie bar bushings (2-180) from the piston. The piston bushing should be replaced each time the actuator is refurbished (refer to section 1 for recommend service interval). **NOTE: The GH-Bettis Service Kit should contain a new piston bushing.**

8.0 HOUSING GROUP DISASSEMBLY

- 8.1 Unscrew and remove the snubber valves (1-190) from the housing cover and the housing.
- 8.2 Unscrew piston rod (2-170) from yoke pin nut (1-30) and remove. Flats are provided on the outboard end of the piston rod for wrench placement. **NOTE: Removal of piston rod may require extra amount of torque for break out due to the use of Loctite - 242 during assembly. CAUTION: Do not use a pipe wrench on the piston rod as it will mark the rod and cause seal leakage.**
- 8.3 Remove rod bushing (2-50) from the housing or the piston rod.
- 8.4 Remove position indicator pin (1-170).
- 8.5 Unscrew and remove hex cap screws (1-240) with gasket seals (3-100) from position indicator cover (1-210).
- 8.6 Remove position indicator cover (1-210).

- 8.7 Unscrew and remove set screw (1-180) from position indicator drive (1-230). **NOTE: Mark the hole that the set screw (1-180) is removed from.**
- 8.8 Remove position indicator drive (1-230) from the top of the yoke (1-160).
- 8.9 Remove the housing cover hex cap screws (1-90) and gasket seals (3-100).
- 8.10 Remove the housing cover (1-20). **NOTE: The cover will have a very tight fit. It is not necessary to remove cover pins (1-130).**
- 8.11 Remove the top two yoke rollers (1-50) and roller spacer (1-110) from the top of the yoke pin (1-40).
- 8.12 Remove the yoke pin (1-40).
- 8.13 Remove the yoke pin nut (1-30).
- 8.14 Remove the lower two yoke rollers (1-50) and roller spacers (1-110) from the bottom of the yoke and housing.
- 8.15 The yoke (1-160) can now be removed by lifting it from the housing.
- 8.16 Remove the stop screws (1-60), stop nuts (1-120), countersunk washers (3-120) and thread seals (3-110).
- 8.17 It is not necessary to remove the yoke bushings (1-200) from the housing (1-10) or the housing cover (1-20) unless these items are being replaced due damage or wear. It is not necessary to remove the pipe plugs (1-80), to service the actuator.

9.0 GENERAL RE-ASSEMBLY

- 9.1 Remove and discard all old seals and gaskets.
- 9.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.
- 9.3 All parts should be thoroughly inspected. Particular attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding motion. Sealing surfaces must be free of deep scratches, pitting, corrosion and blistering or flaking coating.
- 9.4 Before installation coat all moving parts with lubricant. Coat all seals with lubricant, before installing into seal grooves.
- 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 groove.
 - 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 5 on the assembly drawing).

10.0 CENTER HOUSING GROUP RE-ASSEMBLY

- 10.1 If removed install drain plugs (1-80).
- 10.2 Coat one of the yoke o-ring seal (3-50) with lubricant and install into the housing (1-10).
- 10.3 If the yoke bushings (1-200) was removed then install one in the housing yoke bore and one in the housing cover yoke bore.
- 10.4 Inside the housing (1-10) apply lubricant to the tracks and yoke bore and arrange the housing with the yoke bore nearest you.
- 10.5 Apply lubricant to the slots in the upper/lower yoke arms and the lower bearing surface.
- 10.6 Install the yoke (1-160) into the housing (1-10) as follows: Arrange the yoke arms to approximately a 45° degree position in either direction and lower into the housing. **NOTE: The hub with tapped holes faces up.** Rotate the yoke back to approximately the mid-stroke (center) position.
- 10.7 Apply lubricant to all surfaces of two of the yoke rollers (1-50) and two roller spacers (1-110). Place one yoke roller in the track in the bottom of the housing and position it under the slot in the yoke arms. Place a roller spacer (1-110) on top of the bottom yoke roller (1-50). Place a second yoke roller on top of the roller spacer in the slot in the lower yoke arm. Place another roller spacer (1-110) on to of the second yoke roller (1-50) and align the holes in the roller spacer and the yoke rollers.
- 10.8 Coat the upper and lower surfaces of the yoke pin nut (1-30) with lubricant and insert into position between the yoke arms, parallel to the track in the housing. Align the yoke pin hole with the yoke rollers (1-50) and roller spacers (1-110).
- 10.9 Lubricate the yoke pin (1-40) and insert through the yoke pin nut (1-30), the two yoke rollers (1-50) and the two roller spacers (1-110).
- 10.10 Apply lubricant to all the surfaces of the two remaining yoke rollers (1-50) and two remaining roller spacers (1-110). Place one roller spacer on top of the yoke pin nut (1-30) then install the third yoke roller (1-50). Place the last roller spacer on top of the third yoke roller (1-50). Place the fourth and final yoke roller on to the yoke pin. The top roller will remain above the yoke arm and will engage the cover track when the cover is installed.
- 10.11 Apply loctite - 242 to external threads on the piston rod (2-170). **NOTE: loctite cure time is 10 - 30 minutes.** Lubricate the piston rod (2-170) and slide into the right side of the housing. Screw the piston rod into the yoke pin nut (1-30). **(DO NOT TIGHTEN)** Flats are provided on the outboard end of the piston rod. These flats should be used to put a wrench on to tighten the piston rod. **CAUTION: DO NOT use a pipe wrench on the piston rod, as it may cause seal leakage.**
- 10.12 Apply lubricant to the rod bushing (2-50), install it over the piston rod and slide it up into the housing.
- 10.13 Place thread seals (3-110), countersunk washers (3-120) and jam nuts (1-120) on the stop screws (1-60). Install both assemblies into the housing.
- 10.14 Position the position indicator drive (1-230) onto the top of the yoke (1-160) with the slot positioned over the hole that was marked in section 8. Secure with the set screw (1-180).

- 10.15 Install the o-ring seal (3-150) over the position indicator drive shaft and down against the flat cover plate.
- 10.16 Coat the remaining yoke o-ring seal (3-50) with lubricant and install into the housing cover (1-20).
- 10.17 Apply lubricant to the yoke bore and the track in the housing cover (1-20).
- 10.18 Apply lubricant to the yoke upper bearing surface.
- 10.19 Prepare the mounting surfaces of the housing cover (1-20) and the housing (1-10) per master gasket instructions (reference note 5 on the assembly drawing).
- 10.20 Place the housing cover gasket (3-20) on the housing (1-10).
- 10.21 Install the housing cover (1-20) being careful not to damage the cover gasket (3-20) or yoke o-ring seal (3-50). **NOTE: If the housing cover does not want to go down against the housing then the cover may be hanging on the top yoke roller.**
- 10.22 Install the cover screws (1-90) and seal gasket (3-100). **NOTE: Leave finger tight - do not tighten.**
- 10.23 Do this step only if you have pulled the cover pins (1-130) or if you are replacing the cover pins. Drive the pins (1-130) through the cover (1-20) and into the housing (1-10) until the pin is flush with the cover. **NOTE: The pins are deeply grooved at one end, tapering to a smooth diameter at the other end. The pin should be installed smooth end first.**
- 10.24 Tighten the cover screws (1-90) and torque to 16 foot pounds ± 5 % percent.
- 10.25 Tighten the piston rod (2-170) to a torque of approximately 150 foot pounds ± 5 % percent. Flats are provided on the outer end for wrenching purposes. **CAUTION: Do not use a pipe wrench or similar tool to tighten piston rod.**
- 10.26 Install the o-ring seal (3-140) into the bottom seal groove inside the position indicator cover (1-210).
- 10.27 Install the wiper ring (3-160) into the top groove inside the position indicator cover (1-210).
- 10.28 Install the o-ring seal (3-170) into the bottom seal groove on the bottom of the position indicator cover (1-210).
- 10.29 Install the position indicator cover (1-210), being careful not to damage the o-ring seals (3-140), (3-170) and wiper ring (3-160).
- 10.30 Install new gasket seals (3-100) on to hex cap screws (1-240).
- 10.31 Install and tighten the position indicator cover hex screws (1-240).
- 10.32 Install the position indicator pointer (1-170) into the taped hole in the position indicator drive assembly (1-230).
- 10.33 Rotate the yoke to a position that will leave a minimum of the piston rod (2-170) protruding from the actuator housing.

11.0 PRESSURE CYLINDER RE-ASSEMBLY

- 11.1 Coat the rod seal (3-70) with lubricant and install, lip first, into the recess provided in the inner end cap (2-40). **CAUTION: Install with energizer ring facing outboard side (away from housing).**

- 11.2 Install one end cap o-ring seal (3-10) into the inner end cap (2-40).
- 11.3 Coat two tie bar o-ring seals (3-30) with lubricant and install into the inner end cap (2-40).
- 11.4 Prepare the mounting surfaces of the inner end cap (2-40) and inner end cap side of the housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).
- 11.5 Slide the inner end cap (2-40) over the piston rod (2-170) and the rod bushing (2-50), protruding from the housing. Install with the large raised boss toward the housing (flat side outward). The pressure inlet port should be toward the top of the actuator.
- 11.6 Apply lubricant to the end cap o-ring seal (3-60) and install on the inner end cap (2-40).
- 11.7 Apply lubricant to two sets of piston tie bar T-seal components (3-80) and install into the piston internal seal groove. Refer to section 9 for proper T-seal installation instructions. Refer to the next step for 24" piston bushing (2-180) reassembly.
- 11.8 Fabricated 24"piston reassembly (refer to assembly drawing detail "B").
 - 11.8.1 Install the o-ring seals (3-35) into the O.D. groove on piston tie bar bushings (2-180).
 - 11.8.2 Install the rod T-seals (3-80) into the I.D. groove in the piston bushing (2-180).
 - 11.8.3 Install the piston bushings (2-180) into the piston.
 - 11.8.4 Install the retaining rings (2-190) into the piston.
- 11.9 Coat the ends of the piston rod (2-170) with lubricant.
- 11.10 Apply lubricant to the piston o-ring (3-40) and place onto the piston rod (2-170).
- 11.11 Install a matched set of split rings (2-70) into the inner most groove in the piston rod and retain with one of the split ring retainers (2-80).
- 11.12 Slide the piston (2-20) onto the piston rod against the split ring (2-70). When installing cast pistons install with ribbed section of piston facing away from housing. **CAUTION: When installing 24" inch diameter, or larger, pistons make certain that the smaller diameter plate faces the outer end cap (2-30).**
- 11.13 Install a matched set of split rings (2-70) into the piston rod and retain with the split ring retainer (2-80).
- 11.14 Coat the piston T seal components (3-90) with lubricant and install into the piston external seal groove. Refer to section 9 for proper "T" seal installation instructions.
- 11.15 Apply lubricant to the threads and end of the tie bars (2-60), (end without wrench flat), and install by carefully inserting the tie bars through the piston (2-20) and then through the inner end cap (2-40) and screwing into the housing (1-10). Lubricate all exposed surfaces of piston rod (2-170) and tie bars (2-60). **CAUTION: Tighten the tie bars until the threads bottom out, then back out each tie bar one-half (1/2) turn.**
- 11.16 Apply a light coat of lubricant to the bore of the cylinder (2-10).

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

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

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

- 11.18 Apply lubricant to two end cap tie bars o-ring seals (3-30) and install into the outer end cap (2-30).
- 11.19 Apply lubricant to the outer end cap cylinder o-ring seal (3-60) and install onto outer end cap (2-30).
- 11.20 Install the outer end cap (2-30) onto the tie bars and into the end of the end of the cylinder (2-10).
NOTE: The pressure inlet port should be toward the top of the actuator.
- 11.21 Install the two tie bar hex nuts (2-90) on the tie bars (2-60), using them to draw all of the cylinder components into position. Torque alternately, in 50 ft. lb. increments until a final torque of 90 ±9 foot pounds has been achieved. **CAUTION: While the tie bar nuts are being tightened, do not allow the tie bars to turn.**
- 11.22 Install the nut retainer (2-100), securing in place with the retainer screw (2-120) and lockwasher (2-110). It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the nut retainer can be installed.

12.0 BLIND END CAP INSTALLATION

- 12.1 Install o-ring seal (3-10) into the seal groove of blind end cap (6-10).
- 12.2 Install thread seals (3-180) and countersunk washers (3-190) on to the hex cap screws (6-20).
- 12.3 Prepare the mounting surfaces of the blind end cap (6-10) and blind end cap side of the housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).
- 12.4 Install the blind end cap (6-10) onto the housing (1-10) and retain with hex cap screws (6-20).
- 12.5 Install nut retainer (6-30), lockwasher (6-40), and socket cap screw (6-50). It is necessary that the flats on the hex cap screws (6-20) be aligned and parallel before the nut retainer can be installed.

13.0 ACTUATOR TESTING

- 13.1 All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.
- 13.2 All leak testing will use 65 psig pressure.
- 13.3 If excessive leakage across the piston is noted (generally a bubble which breaks three seconds or less after starting to form), the actuator must be disassembled and the cause of leakage must be determined and corrected.
- 13.4 Before testing for leaks, alternately apply and release 65 psi pressure to the each side of the piston to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.
- 13.5 Apply 65 psig pressure to the pressure port in the outer end cap (2-30).

- 13.6 Apply a leak testing solution to the following areas:
- 13.6.1 Joint between the outer end cap (2-30) and the cylinder (2-10). Checks cylinder to end cap o-ring seal.
 - 13.6.2 Around the tie bar nuts (2-90) on the cylinder outer end cap (2-30). Checks tie bars to outer end cap o-ring seals.
 - 13.6.3 The pressure inlet port in the inner end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
 - 13.6.4 Remove pressure from pressure inlet port in the outer end cap.
- 13.7 Apply 65 psig pressure to the pressure port in the inner end cap (2-40).
- 13.8 Apply a leak testing solution to the following areas:
- 13.8.1 Joint between the inner end cap (2-40) and the cylinder (2-10). Checks cylinder to inner end cap o-ring seal.
 - 13.8.2 Around the joint of inner end cap (2-40) and the housing (1-10). Checks tie bars to end cap o-ring seals and the inner end cap to housing o-ring seal.
 - 13.8.3 The snubber valve port hole in the housing cover (1-20). Checks the rod seal and the tie bars to end cap o-ring seals.
 - 13.8.4 Remove pressure from pressure inlet port in the inner end cap.
- 13.9 If an actuator was disassembled and repaired, the above leakage test must be performed again.

14.0 RETURN TO SERVICE

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

CHART NO. 1 - ACTUATOR WEIGHTS

<u>ACTUATOR MODEL</u>	<u>APPROXIMATE WEIGHT (POUNDS) **</u>
ST510	456
ST512	495
ST516	569
ST520	692
ST524	987

** Weights listed for each model are for bare actuators without valve mounting brackets and accessories.

CHART NO. 2 - TOOL STYLE AND WRENCH SIZES

<u>ITEM NO.</u>	<u>WRENCH SIZE</u>	<u>QTY</u>	<u>LOCATION</u>	<u>RECOMMENDED WRENCH STYLE</u>
1-60	15/16"	2	Stop Screw	Open End or adjustable
1-90	9/16"	12	Cover screws	Socket
1-120	1-7/8"	2	Stop screw nut	Box End (1)
1-190	7/8"	1	Snubber	Deep Socket
1-240	9/16"	6	Cover screws	Socket
2-60	5/8"	2	Tie bar flats	Open End or adjustable
2-90	1-5/8"	2	Tie bar nuts	Crows Foot (1)
2-120	3/16"	1	Nut retainer screw	Allen
2-170	1-3/8"	1	Piston rod flat	Crows Foot (1)
6-20	1-5/8"	2	Blind end cap screws	Open End or adjustable
6-50	3/16"	1	Nut retainer screw	Allen

(1) No alternate style recommended

<u>ECN</u>	<u>DATE</u>	<u>REV</u>	<u>BY *</u>	<u>DATE</u>
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* Signatures on file Bettis Actuator & Controls, Waller, Texas