

Bettis Disassembly and Reassembly

For Models HD732-S Double-Acting Series Hydraulic Actuators

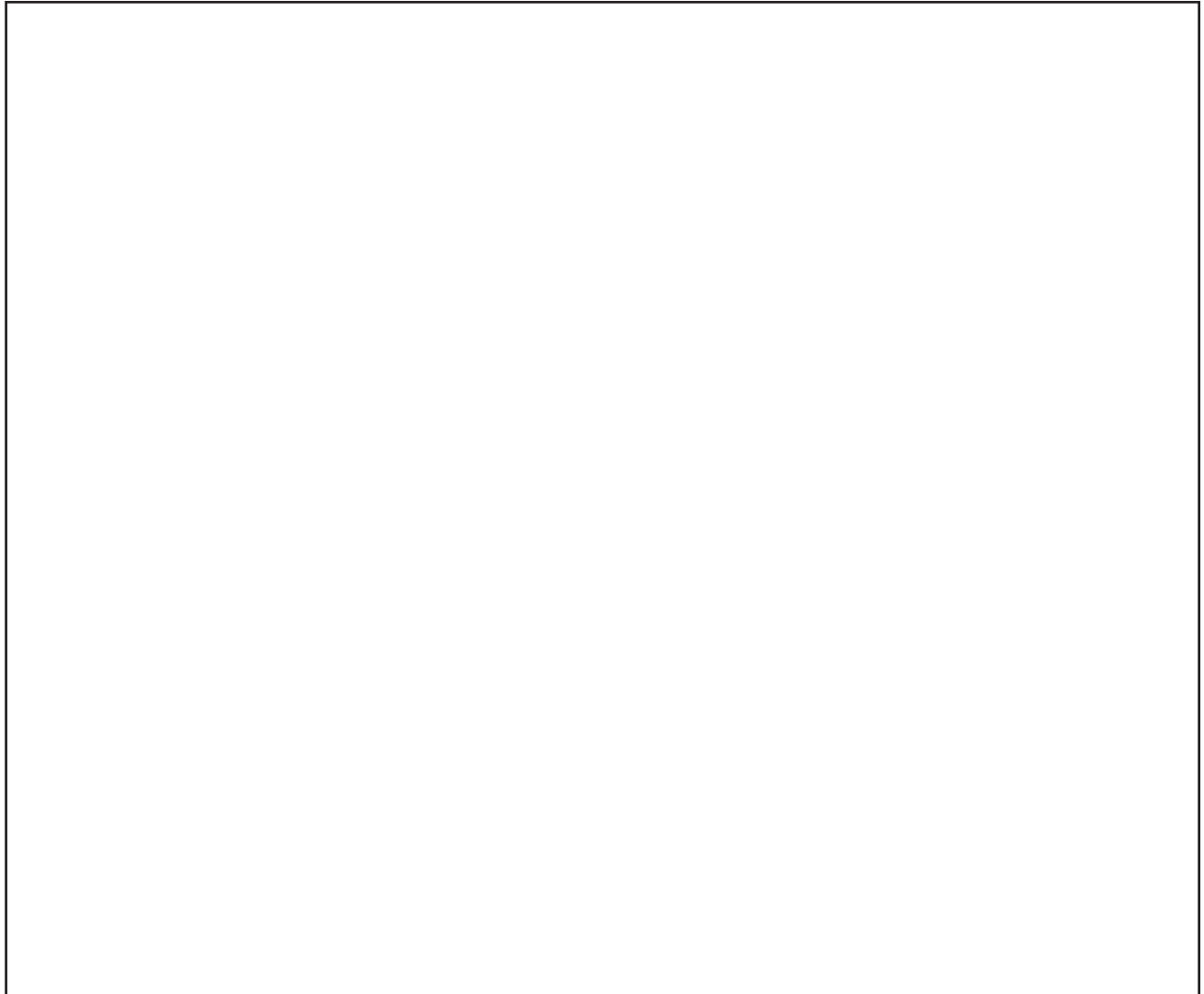


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Section 1: Introduction

1. This service procedure is offered as a guide to enable general maintenance to be performed on Bettis, HD732-S, HD732 M3-S, and HD732 M3HW-S hydraulic series actuators.
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.

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.

NOTE:

This product is only intended for use in large-scale fixed installations excluded from the scope of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 2).

4. **BASIC SERVICE INFORMATION:** Complete actuator refurbishment requires the actuator be dismantled from the valve or device it is operating.
5. The maximum recommended service interval for this actuator series is five years. Storage time is counted as part of the service interval.
6. This procedure is applicable with the understanding that all electrical power and hydraulic 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.

Section 2: Support Items and Tools

2.1 Support Items

Service/Seal Kit, 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 2,000 inch-pounds). For recommended tool list, refer to Page 17.

Section 3: Bettis Reference Materials

1. Assembly Drawing Part Number 036278* .
2. Exploded Detail Drawing 063356* for HD732 actuators.
3. Exploded Detail Drawing 068112* for HD732 M3 and HD732 M3HW actuators.

* The drawings called out in the above Steps 1 through 3 are for pneumatic operated actuators and will not call out the bleed valves (2-120) or the drain pipe plugs (2-130) that are located in the cylinder adapters (2-30) or in the cylinders (3)/(3-10).

Section 4: General

1. This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.
2. Numbers in parentheses(), indicate the bubble number (reference number) used on the GH-Bettis Assembly Drawing, Exploded Detail Drawing, and actuator Part List.
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) will be the top of the actuator.
4. Refer to Table 1 for approximate actuator weights.
5. To help in correct reassembly; that is, with power cylinder on same end of housing as was, cylinder to cylinder adapter, cylinder adapter to housing, right and left stop screws, and others, mark or tag for ease of reassembly, also mark mating surfaces.
6. When removing seals from seal grooves, use a commercial seal removing tool or use a small screwdriver with the sharp edges rounded off.
7. Use a non-hardening thread sealant on all pipe threads.

NOTE:

Apply the thread sealant per the manufacturer's instructions.

8. Disassembly of actuator should be done in a clean area on a work bench.
9. LUBRICATION REQUIREMENTS:
For use in housing (1-10) area of the actuator. Lubricants, other than those listed in following steps A and B, should not be used without prior written approval of Bettis Product Engineering.
 - a. Standard and high temperature service (-20°F to +350°F) use Bettis ESL 5 (Kronaplate 100). ESL 5 is contained in the Bettis Service/Seal Kit.
 - b. Low temperature service (-50°F to +150°F) use Kronaplate 50. Kronaplate 50 is not contained in the Low Temperature Service/Seal Kit.
10. FLUID REQUIREMENTS:
For use in power cylinders (3) or (3-10). The following listed fluids are recommended fluids only and does not limit the use of other hydraulic fluids compatible with supplied seals and coatings.
 - a. Standard and high temperature service (-20°F to +350°F) use Dexron II or Shell Tellus T-32 Automatic Transmission Fluid.
 - b. Low temperature service (-50°F to +150°F) use Exxon Univis J13 or HVI 13 Hydraulic Fluid.

Section 5: General Disassembly

1. If not already done, remove all operating pressure from actuator cylinder (3) or cylinder assemblies M3 (3-10).
2. If the actuator is equipped with a M3 jackscrew, make sure that the jackscrew (3-20) does not engage the piston rod (2-10).
3. Actuators equipped with M3HW jackscrew with handwheel option, remove hex nut (8-30), lock washer (8-20), and handwheel (8-10).
4. Mark stop screws (1-60) left and right. Measure and record the exposed length of the right and left stop screws (1-60). The stop screws will be removed later in this procedure.
5. Identify each cylinder adapter (2-30) left or right and record the inlet port locations in cylinder adapters (2-30).
6. Remove the socket cap screws (1-120) from position indicator (1-110), yoke weather cover (6-110), and remove position indicator/yoke weather cover.
7. Remove snubber (1-130) from the housing (1-10).
8. On cylinders (3) or (3-10) and cylinder adapters (2-30), open bleed valves (2-120).

⚠ CAUTION: USE PROPER WRENCH STYLE AND SIZE

The bleed valves are 1/8 NPT and are made out of brass. Use only the correct size wrench. Refer to Table 2 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.

9. Drain the hydraulic fluid from cylinders (3) or (3-10) and cylinders adapters (2-30) by removing pipe plugs (2-130).

Section 6: Pressure Cylinder Disassembly

1. The following steps may be performed on one cylinder and then on the other cylinder or simultaneously on both cylinders.
2. Secure the chain wrench around cylinder (3) or cylinder assembly M3 (3-10) as close to the welded end cap as possible. Using the mallet, break the cylinder loose and then, remove the cylinder by rotating in a counterclockwise direction. When setting the cylinder aside, care should be taken to protect the chamfered edge and cylinder threads.
3. Unscrew and remove piston hex lock nut (2-70).
4. Remove piston (2-20) from piston rod (2-10).
5. Unscrew and remove four cylinder adapter ferry screws (2-90) and gasket seals (6-80) from cylinder adapter (2-30).
6. Remove cylinder adapter (2-30), taking care not to scratch piston rod (2-10) or disengage rod bushings (2-40).
7. It is not necessary to disassemble M3 Jackscrew (3-20) from cylinder assembly M3 (3-10) unless it needs maintenance or when replacing nut seal (3-30). For disassembly of the M3 or M3HW jackscrew, refer to Section 13, "*M3 Jackscrew Disassembly*".

Section 7: Housing Group Disassembly

1. Remove cover screw (1-30) and gasket seals (6-80).
2. Remove housing cover (1-20).

NOTE:

Housing cover has a tight fit and will require the use of two pry bars or screw drivers to assist in removal.

3. Move the yoke arms to the center position.
4. Remove upper yoke roller (1-50).
5. Remove yoke pin (1-40).
6. Holding rod bushing (2-40) in place, remove piston rod (2-10).
7. Remove both rod bushings (2-40) from housing (1-10).
8. Remove yoke (1-140) from housing (1-10).
9. Remove lower yoke roller (1-50).
10. Remove stop screws (1-60), jam nuts (1-70), and gasket seals (6-90). Be sure to identify the stop screws.
11. It is not necessary to remove housing pipe plug (1-100) or cylinder adapter pipe plug (2-110).

Section 8: General Reassembly

⚠ CAUTION: INSTALL ONLY NEW SEALS INTO ACTUATOR

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

1. Remove and discard all seals and gaskets.
2. All parts should be cleaned to remove all dirt and other foreign material prior to inspection.
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 and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

⚠ CAUTION: REPLACE NEW PARTS ACCORDINGLY

Actuator parts that reflect any of the above listed characteristics must be replaced with new parts.

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 will be assembled using lubricant as identified in Section 4, Step 9. The parts and seals used in cylinder (3) or cylinder assembly M3 (3-10) will be assembled using the hydraulic fluid identified in Section 4, Step 10.

5. Low Temperature or trim 11 T-Seal Set installation - The T-Seal is composed of one rubber seal and two split skive cut back up rings.
 - a. Install the T-Seal into the seal groove.
 - b. Install a backup ring on each side of the T-Seal.
 - c. When installing the backup rings, do not align the skive cuts.
 - d. If the backup rings are too long and the rings overlap beyond the skive cuts, then the rings must be trimmed with a razor sharp instrument.

Section 9: Center Housing Group Reassembly

1. If removed, install a pipe plug (1-100) into the drain port of housing (1-10).
2. Coat one O-ring seals (6-20) with lubricant and install into the housing (1-10).
3. Apply lubricant to the yoke bore in housing (1-10), raised ribs in the bottom of the housing.
4. Lubricate yoke (1-140) with a generous amount of lubricant to all bearing surfaces and yoke slots in the upper and lower arms.
5. Install yoke (1-140) into housing (1-10).

NOTE:

The wide yoke arm should be installed toward the top of the housing.

6. Coat one yoke roller (1-50) with lubricant and place into the lower yoke arm slot nearest the cylindrical portion of the yoke.
7. Coat rod bushings (2-40) with lubricant and install into both sides of housing (1-10).
8. Apply a light coat of lubricant to piston rod (2-10) and install through bushings (2-40) in housing (1-10).
9. Coat yoke pin (1-40) with lubricant and install through piston rod (2-10) into lower yoke roller (1-50).
10. Coat the remaining yoke roller (1-50) with lubricant and install over the yoke pin and into the slot in the upper yoke arm.
11. Install gasket seals (6-90) and jam nuts (1-70) onto stop screws (1-60).
12. Install stop screws (1-60) with gasket seals (6-90) and jam nuts (1-70) into housing (1-10) in the position as recorded in Section 5, Step 4.
13. Install stop screws (1-60), gasket seals (6-90), and jam nuts (1-70).
14. Coat the remaining yoke O-ring seal (6-20) with lubricant and install into the housing cover (1-20).
15. Coat the yoke bore in the housing cover (1-20) with lubricant.
16. Install the housing cover gasket (6-60) onto the top of housing (1-10).
17. Install the housing cover (1-20) onto the housing (1-10).
18. Install gasket seals (6-80) onto four cover screws (1-30).
19. Retain housing cover (1-20) with four cover screws (1-30) and gasket seals (6-80).

Section 10: Pressure Cylinder Reassembly

NOTE:

Seals and parts being used in the assembly of cylinders (3) or (3-10) should use hydraulic fluid as the assembly lubricant. Where Section 10 indicates to "coat or apply fluid", use hydraulic fluid for lubricating the part being installed.

1. The following steps may be performed on one cylinder and then on the other cylinder or simultaneously on both cylinders.
2. Coat the piston rod seal (6-30) with fluid and install, lip first, into the cylinder adapter (2-30).

⚠ CAUTION: ALIGN ENERGIZER RING PROPERLY

The energizer ring of the rod seal (6-30) must face the cylinder adapter (piston side).

3. Install the adapter gasket (6-70) over the piston rod (2-10), rod bushing (2-40) and up against the housing (1-10).
4. Install the cylinder adapter (2-30) over the end of the piston rod (2-10).

⚠ CAUTION: DO NOT SCRATCH PISTON ROD

Care should be taken to not scratch or damage the piston rod when installing the cylinder adapter.

5. Arrange the position of the cylinder adapter (2-30) per the identification recorded in Section 6, Step 5, and retain with the cylinder adapter ferry screws (2-90) and gasket seals (6-80).
 6. If removed, install a pipe plug (2-110) into the cylinder adapter (2-30) pressure port location as recorded in Section 6.
 7. Coat the cylinder adapter O-ring seal (6-40) with fluid and install into the cylinder adapter (2-30) in the groove at the inner end of the threads.
 8. Coat the O-ring seal (6-50) with fluid and install onto the piston rod (2-10).
-

NOTE:

The O-ring should be installed against the shoulder of the piston rod.

9. **PISTON SEAL INSTALLATION:**
Standard and High Temperature Actuators:
 - a. Coat piston seal grooves with fluid.
 - b. Coat one piston U-Cup seal (6-10) with fluid and install into piston seal groove with the lip of the seal pointing outward toward the side of piston (2-20).
 - c. Coat the second U-Cup seal (6-10) with fluid and install into remaining piston seal groove with lip of the seal pointing outward toward the side of piston (2 20).

Low Temperature Actuators:

- a. Coat piston seal grooves with fluid.
 - b. Apply fluid to piston T-Seal (6-10). Seal is composed of rubber seal and two back up rings. The rings serve as anti-extrusion backups.
 - c. Install T-Seal (6-10) into piston seal groove - outboard side of piston (2-20).
 - d. Install backup ring on each side of T-Seal.
10. Install piston (2-20) onto piston rod (2-10).

NOTE:

One side of piston (2-20) has a raised boss in the center that is counter bored to accept the O-ring installed in Section 10, Step 8. The counter bore side of the piston should be installed against the shoulder of piston rod (2-10) and over O-ring seal (6-50).

11. Install hex lock nut (2-70) onto piston rod (2-10). Torque the hex lock nut (2-70) to approximately 146 foot-pounds.

NOTE:

When installing hex lock nut (2-70), the Teflon insert should rest up against piston (2-20).

12. For actuators equipped with a M3 jackscrew, refer to Section 14 for reassembling the M3 into cylinder (3-10).
13. Apply a thin coating of fluid to the bore of the cylinder (3) or cylinder assembly M3 (3-10).
14. Install the cylinder (3) or cylinder assembly M3 (3-10) over the piston (2-20).

⚠ CAUTION: DO NOT DAMAGE PISTON CUP SEAL LIP

Exercise care to prevent damage to the piston cup seal lip during cylinder installation. It is necessary to depress the seal lip while working the cylinder over it.

15. Rotating the cylinder clockwise, screw the cylinder (3) or cylinder assembly M3 (3-10) into the cylinder adapter and tighten with the chain wrench.

⚠ CAUTION: SECURE CHAIN WRENCH PROPERLY

When using the chain wrench on the cylinder, it should be secured as close to the welded end cap as possible.

16. Install pipe plugs (2-130) into cylinder adapters (2-30) and cylinders (3) or (3-10).
17. Close bleed valves (2-120) in cylinders adapters (2-30) and cylinders (3) or (3-10).

Section 11: Actuator Testing

1. All areas, where leakage to atmosphere may occur, are to be checked using a leak testing solution. 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.
2. Before leak testing may be accomplished, it will be necessary to provide a piping system whereby pressure may be applied simultaneously to all common pressure ports.
3. All leak testing will use 65 psig pneumatic pressure.
4. Before testing for leaks, alternately apply and release the 65 psig pressure to each side of the pistons to stroke the actuator fully in each direction. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.
5. Simultaneously apply 65 psig pressure to the pressure ports in the end of the right side cylinder (3) or cylinder assembly M3 (3-10) and in the left side cylinder adapter (2-30).
6. Apply leak testing solution to the following areas:
 - a. The pressure inlet port in the left side cylinder adapter (2-30), checks piston to cylinder and piston to piston rod seals.
 - b. The pressure inlet port hole in the end of the right side cylinder, checks the piston to cylinder wall and piston to piston rod seals.
 - c. The threaded joint between the right side cylinder and right side cylinder adapter (2-30), checks the cylinder to cylinder adapter O-ring seal.
 - d. The joint between the right side cylinder adapter and the housing.
 - e. The snubber port hole located in the housing, checks the cylinder adapter to piston rod seal.
7. Remove pressure from the pressure ports in the end of the right side cylinder (3) or cylinder assembly M3 (3-10) and in the left side cylinder adapter (2-30).
8. Simultaneously apply 65 psig pressure to the pressure ports in the end of the left side cylinder (3) or cylinder assembly M3 (3-10) and in the right side cylinder adapter (2-30).
9. Apply leak testing solution to the following areas:
 - a. The pressure inlet port in the left side cylinder adapter (2-30), checks piston to cylinder and piston to piston rod seals.

- b. The pressure inlet port hole in the end of the right side cylinder, checks the piston to cylinder wall and piston to piston rod seals.
 - c. The threaded joint between the right side cylinder and right side cylinder adapter (2-30), checks the cylinder to cylinder adapter O-ring seal.
 - d. The joint between the right side cylinder adapter and the housing.
 - e. The snubber port hole located in the housing, checks the cylinder adapter to piston rod seal.
10. Remove pressure from the pressure ports in the end of the right side cylinder (3) or cylinder assembly M3 (3-10) and in the left side cylinder adapter (2-30).
11. If an actuator was disassembled and repaired, the above leakage test must be performed again.

Section 12: Return to Service

1. Replace the software components of the snubber (1-130) and then install the snubber into the housing (1-10).
2. Adjust both stop screws (1-60) back to settings recorded in Section 5 under General Disassembly.
3. Tighten both jam nut (1-70) securely, while holding stop screws (1-60).
4. Rotate the yoke to the full clockwise (CW) position. Position the yoke weather cover (6-110) and position indicator (1-110) on the yoke (1-140) with the pointer facing the piston rod and perpendicular to the cylinder assemblies.
5. Install and tighten yoke position indicator/yoke weather cover screws (1-120).

NOTE:

These screws will need to be rechecked for tightness after the actuator has been cycled.

6. For actuators equipped with a M3 jackscrew and require an optional handwheel, install the handwheel using the following procedure:
 - a. Place the handwheel (8-10) onto the M3 and over the pinned nut (the handwheel hub has a cast hexagon hole that fits over the pinned nut).
 - b. Place lock washer (8-20) onto M3 up against handwheel hub.
 - c. Place hex nut (8-30) onto M3 and thread up against lock washer, torque to 250 foot-pounds.
7. The actuator is now ready for returning to service.

Section 13: M3 Jackscrew Disassembly

1. With the cylinder (3-10) on a work bench, lubricate jackscrew assembly (3-20) threads with lubricant.
2. Using a 3/16 inch pin punch, drive out and remove the spiral pin from the outboard slotted nut.
3. Remove the slotted nut from the jackscrew assembly (3-20).
4. Loosen and remove the jam nut (3-30) from the jackscrew assembly (3-20).
5. Screw the jackscrew assembly (3-20) into the cylinder (3-10) until it is disengaged from the cylinder end cap.
6. Remove the jackscrew assembly (3-20) from the open end of the cylinder (3-10).

Section 14: M3 Jackscrew Reassembly

1. Apply a light coating of lubricant to the threads of jackscrew assembly (3-20).
2. Insert the jackscrew assembly (3-20) through the open end of cylinder (3-10). Screw the jackscrew into the cylinder end cap until the end of the assembly protrudes out of the end cap of the cylinder.
3. Turn the jackscrew until the M3 retainer comes into contact with the inside of the cylinder end cap.
4. Install seal nut (3-30) onto the jackscrew assembly (3-20). Screw the seal nut until it is up against the cylinder end cap.
5. Screw the slotted nut onto the outboard end of the jackscrew stud until one of the slots in the nut is aligned with the cross drilled "through hole" in the stud

NOTE:

The nut slots will be facing toward the cylinder end cap.

⚠ CAUTION: ALIGN SLOT AND CROSS DRILLED HOLE

When aligning the slot and the cross drilled hole, make certain that the back of the slot is at least one thread from being aligned with the hole.

6. Insert the spiral pin through the slotted nut and through the jackscrew stud making sure that equal amounts of the spiral pin is exposed on both sides of the slotted nut and the jackscrew stud.
7. Turn nut seal until fully tight against end cap.
8. If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, lubricant may be left on jackscrew to provide additional corrosion protection.

Table 1. Tool Style and Wrench Sizes

Actuator Model	Approximate Weight [Pounds]
732-S	207
732 M3-S	217
732 M3HW-S	227

Table 2. Tool Style and Wrench Sizes

Item No.	Wrench Size	Quantity	Description	Recommended Wrench Style
1-30	3/4"	4	Cover screws	Socket
1-60	7/8"	2	Stop screw	Open end or adjustable
1-70	1-5/16"	2	Stop screw nut	Open end or adjustable
1-100	7/16"	1	Pipe plug	Open end
1-120	3/16"	4	Weather cover screws	Allen
1-130	7/8"	1	Snubber Valve	Deep socket
2-70	1-5/8"	2	Piston rod locknut	Socket
2-90	1/2"	8	Cylinder adapter screws	12 Point socket ⁽¹⁾
2-110	7/16"	2	Pipe plugs	Open end
2-120	9/32"	4	1/8 NPT drain plug	Open end or adjustable
2-130	13/32"	4	Bleed valves	Open end or box
3	⁽¹⁾	1	Cylinder	Chain ⁽²⁾
3-10	⁽¹⁾	1	Cylinder with M3	Chain ⁽²⁾
3-30	1-13/16"	1	M3 seal nut	Open end or adjustable
8 30	1-11/16"	1	M3 Handwheel jam nut	Open end or adjustable

(1) No alternate style recommended.

(2) Bettis recommends a short handle chain wrench with a 40" chain.

Section 15: Document Revision

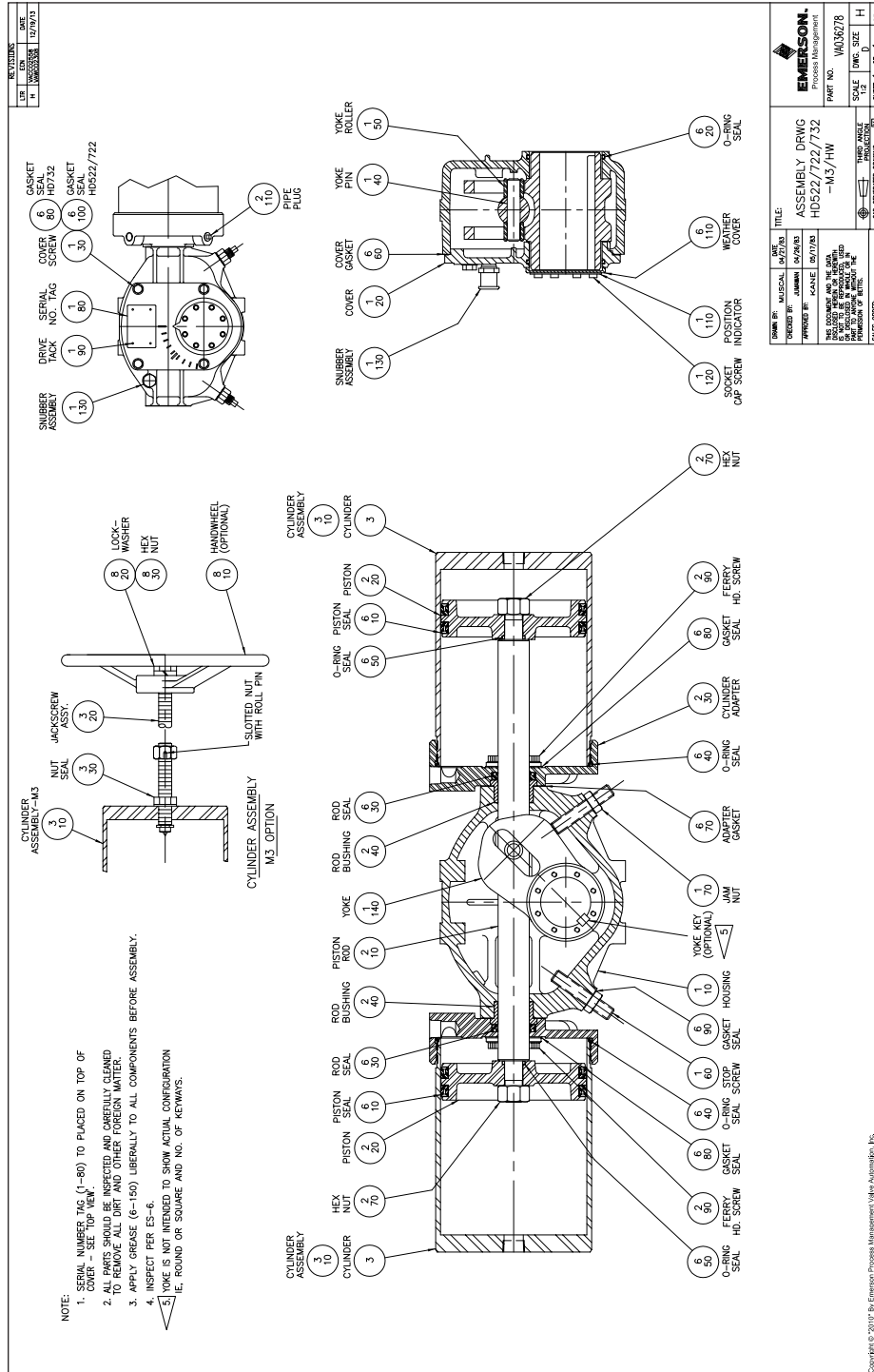
Table 3. Revision Overview

ECN	DATE	REV		BY *	DATE
Released	October 1994	A	COMPILED	Colby	22 June 2006
19110	July 2006	B	CHECKED	John R	22 June 2006
			APPROVED	David McGee	18 July 2006

* Signatures on file Waller, Texas

Appendix A: List of Drawings

A.1 Part No. VA036278, HD522/722/732-M3/HW, Assembly Drawing



World Area Configuration Centers (WACC) offer sales support, service, inventory and commissioning to our global customers. Choose the WACC or sales office nearest you:

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