

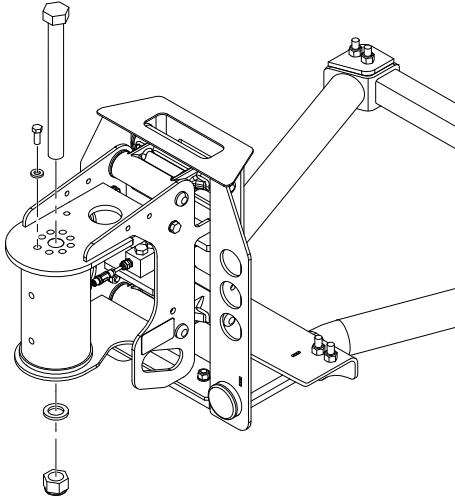
SECTION 4 - BOOM & PLATFORM

Support Installation

1. Using a suitable device, support the platform support and position it on the rotator.

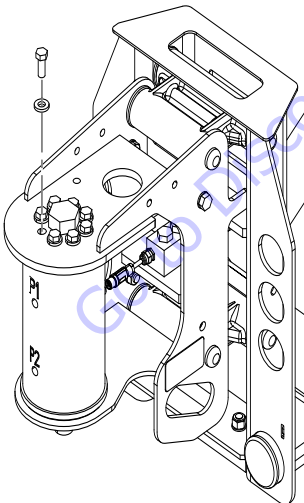
NOTE: The platform support weighs approximately 81.6 lb (57 kg).

2. Install the rotator center bolt and locknut.



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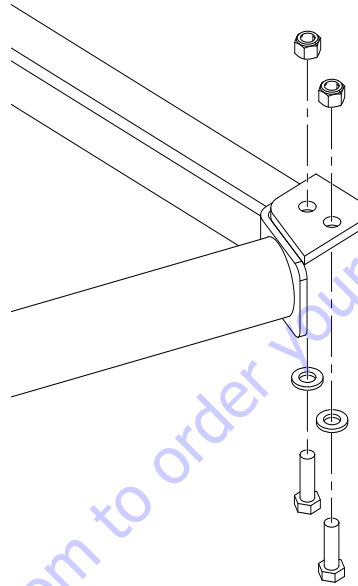
3. Apply Medium Strength Threadlocker Compound to the eight bolts securing the support to the rotator and install the bolts.



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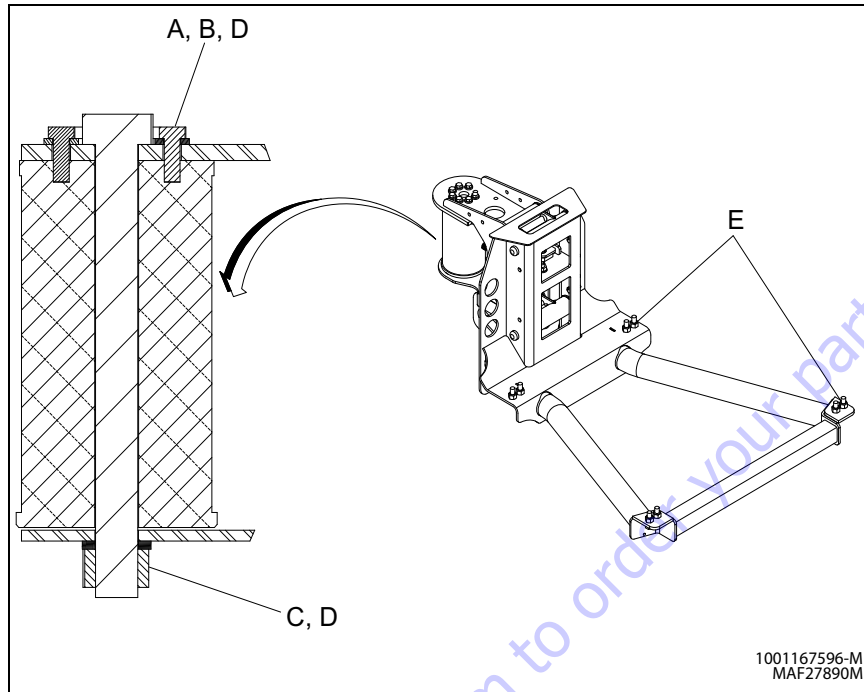
4. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 35 ft. lbs. (50 Nm).

5. Position the platform on the platform support and install the bolts securing the platform to the platform support.



MAF27870

6. Connect the electrical cables to the platform control console.



- A Torque to 35 ft. lbs. (50 Nm)
- B Medium Strength Threadlocking Compound
- C Torque to 586 ft. lbs. (795 Nm)
- D Check torque every 150 hours of operation
- E Torque to 65 ft. lbs (88 Nm)

Figure 4-1. Platform Support Torque Values

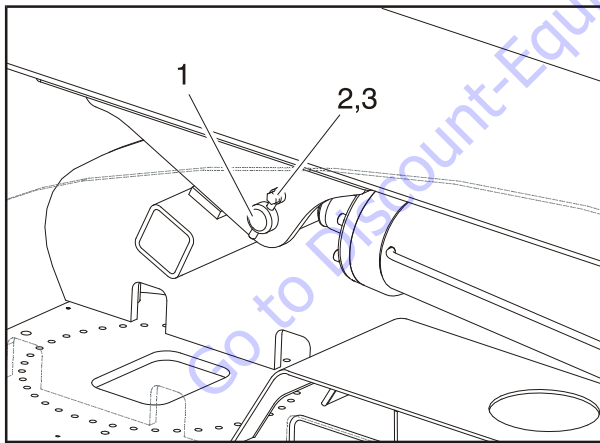
4.3 BOOM REMOVAL, DISASSEMBLY/ASSEMBLY, & CABLE REPLACEMENT

Removal

1. Place machine on firm, level ground.
2. Slightly elevate the boom and support the fly boom with a crane or an adequate lifting device capable of handling 6 - 7 tons.



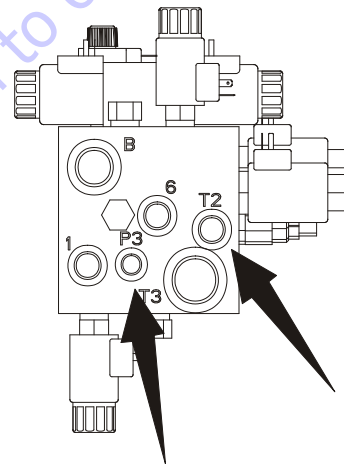
3. Place blocking under lift cylinder to hold it in place.
4. Remove lift cylinder pin securing the lift cylinder rod to the boom.



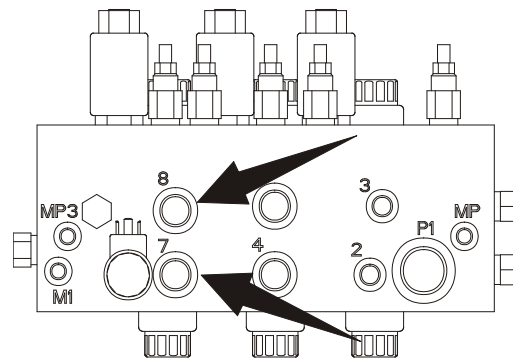
1. Pivot Pin
2. Bolt
3. Keeper Pin

5. Remove the boom end cover.

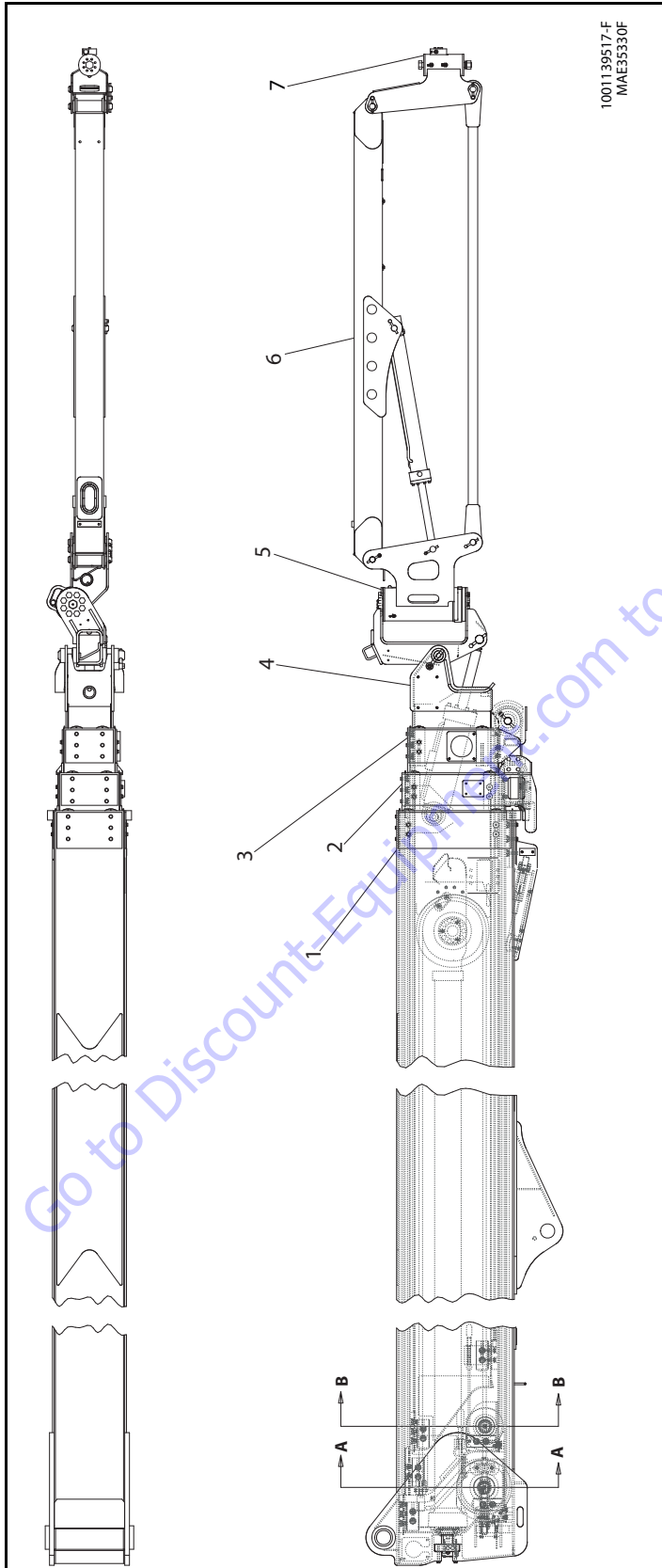
6. Tag and disconnect the telescope, tank, and pressure hoses as indicated below from the main valve and cap ends.



LEFT END VIEW



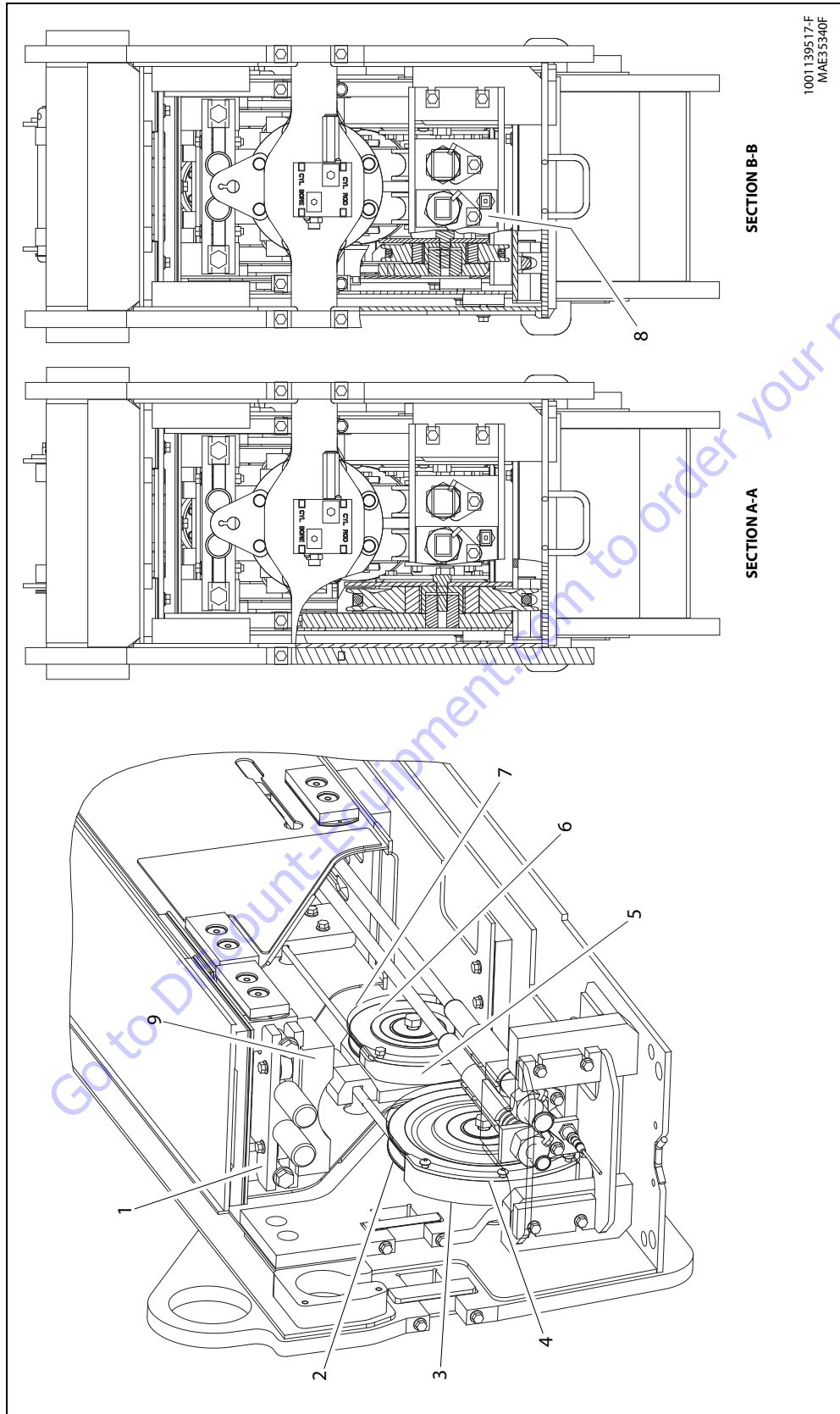
BOTTOM VIEW



1001139517-F
MAE35330F

- 1. Boom Base
- 2. Boom Inner Mid
- 3. Boom Outer Mid
- 4. Boom Fly
- 5. Jib Rotator
- 6. Jib Assembly
- 7. Platform Rotator

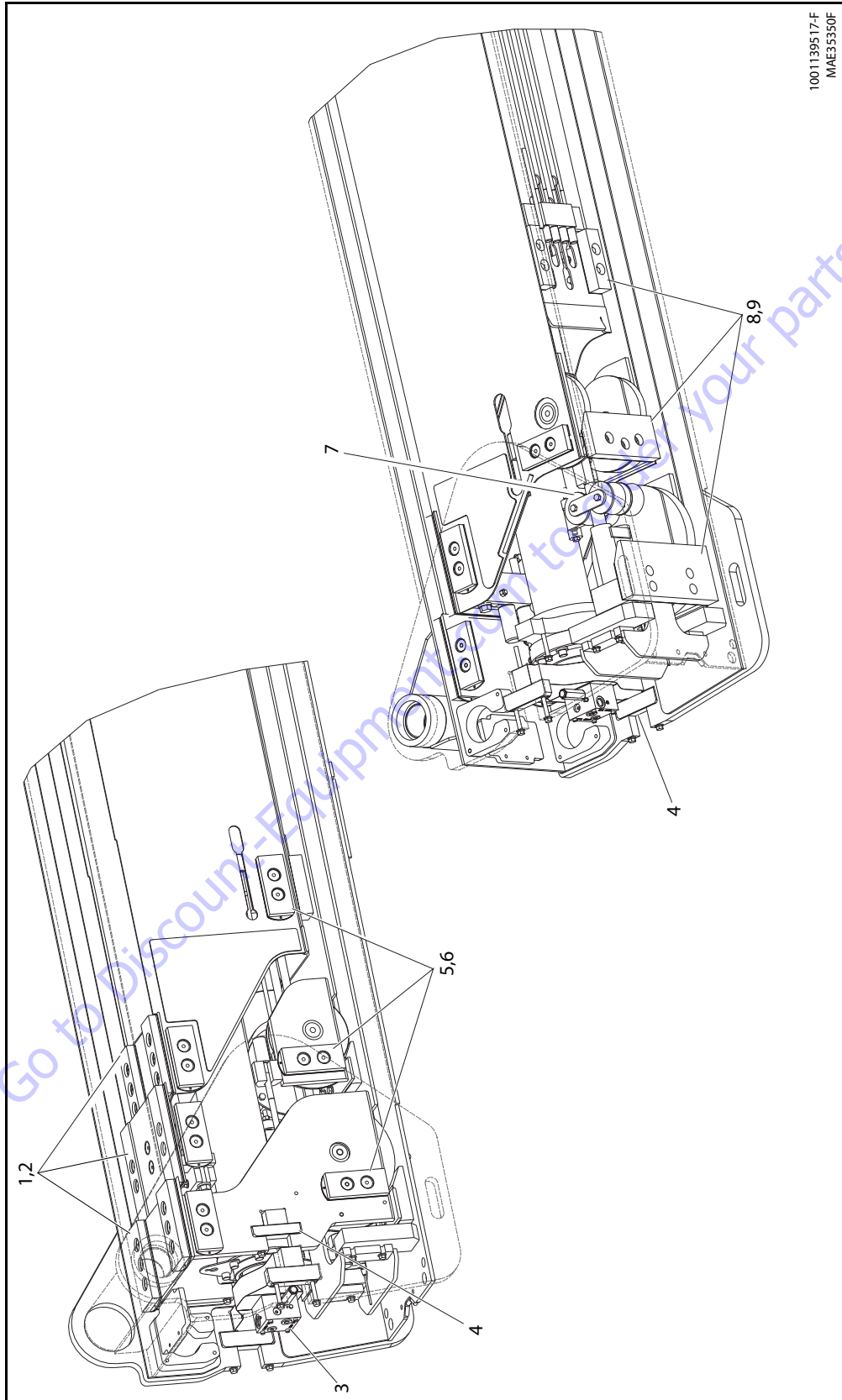
Figure 4-2. Boom Assembly - Sheet 1 of 7



1001.139517-F
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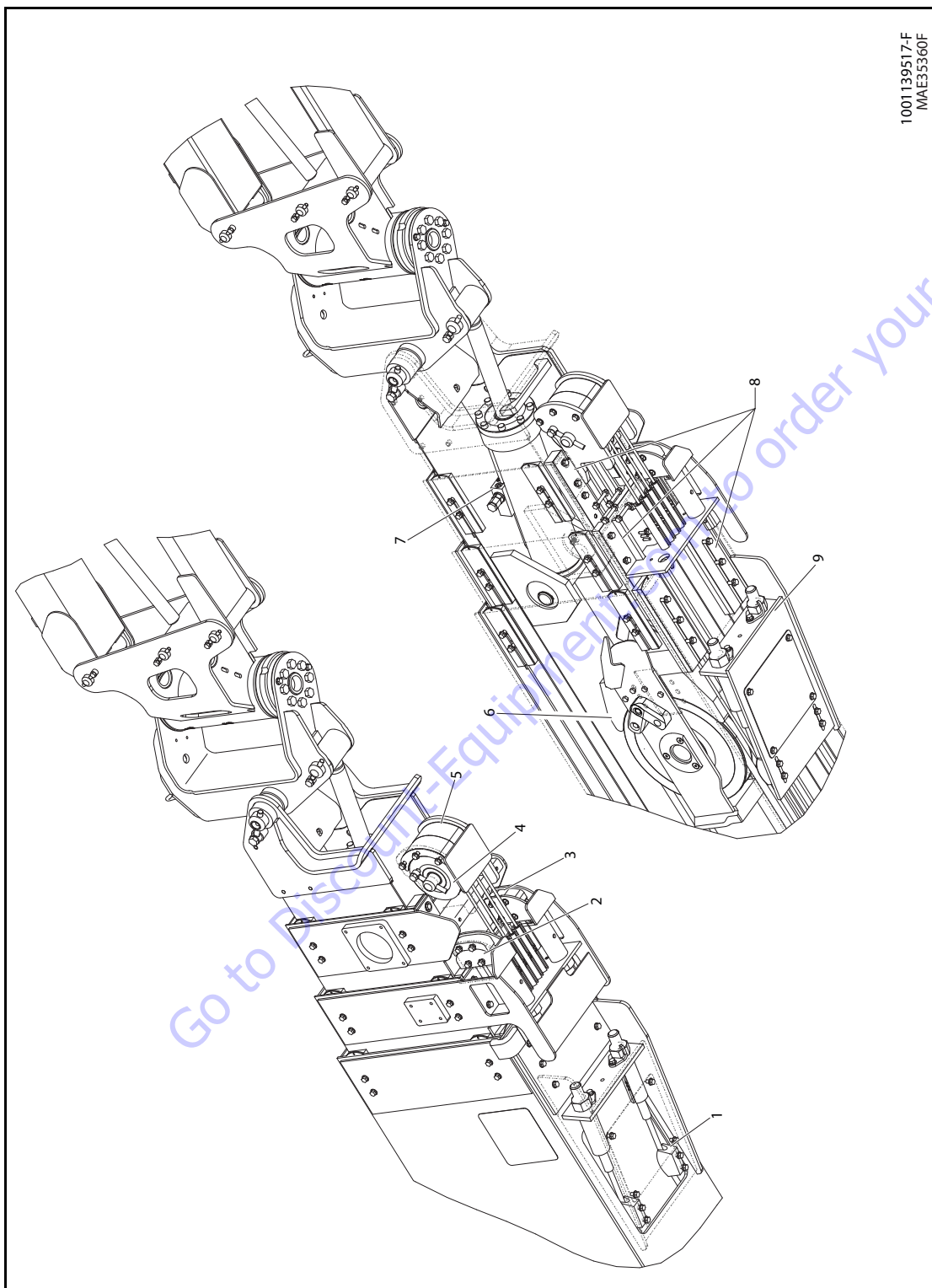
- 1. Outer Mid Extend Block
- 2. Outer Mid Retract Sheave
- 3. Rope Retainer Block
- 4. Retract Rope Retainer Plate
- 5. Rope Retainer Block
- 6. Fly Retract Sheave
- 7. Retract Rope Retainer Plate
- 8. Lock Plate
- 9. Tele Cylinder Wear Pad

Figure 4-3. Boom Assembly - Sheet 2 of 7



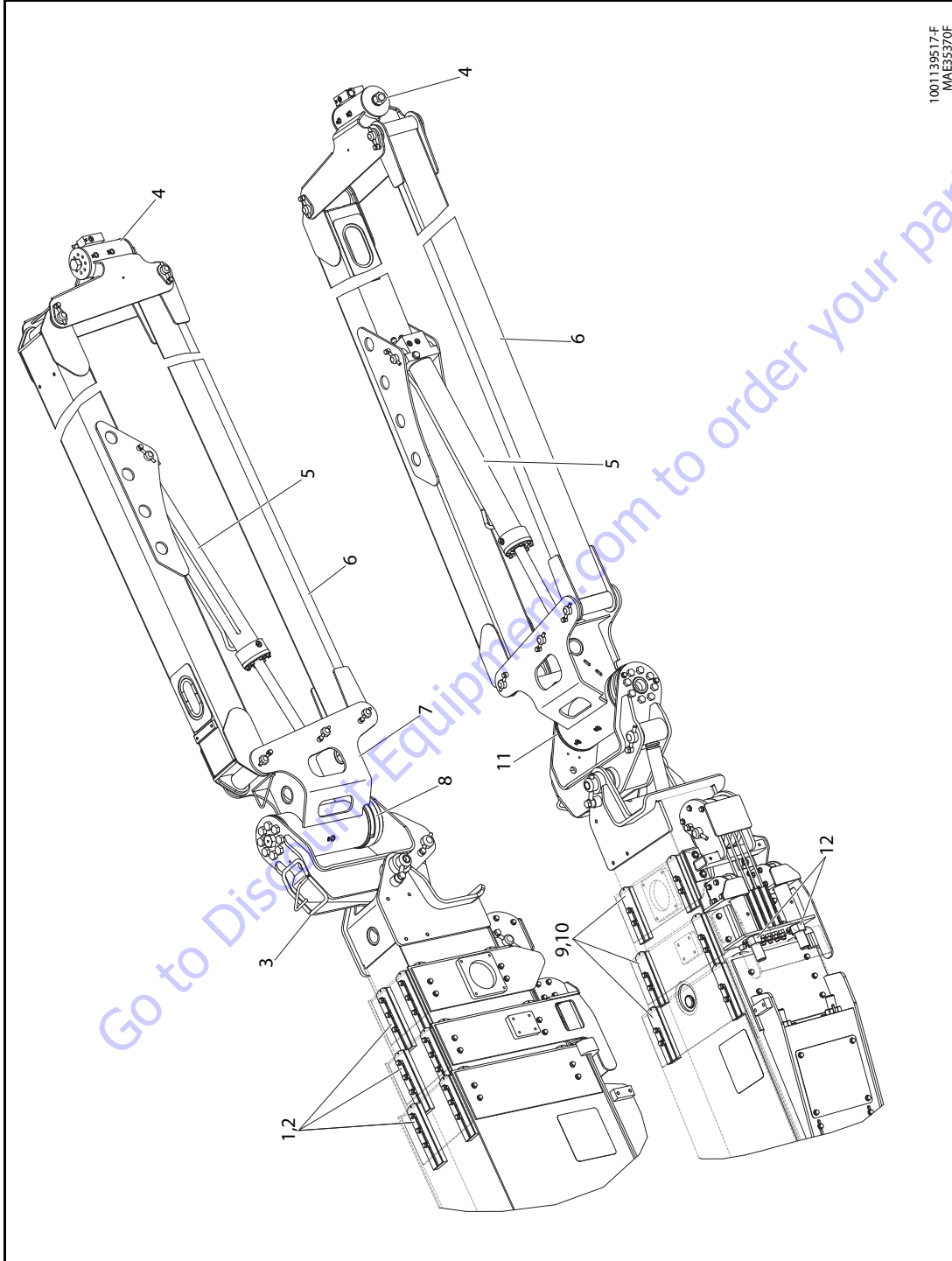
- | | |
|--------------------------|----------------------------------|
| 1. Upper Rear Wear Pad | 6. Shim |
| 2. Shim | 7. Tele Cylinder Pulley Assembly |
| 3. Telescope Cylinder | 8. Bottom Rear Wear Pad |
| 4. Trunnion Keeper Block | 9. Shim |
| 5. Lower Rear Wear Pad | |

Figure 4-4. Boom Assembly - Sheet 3 of 7



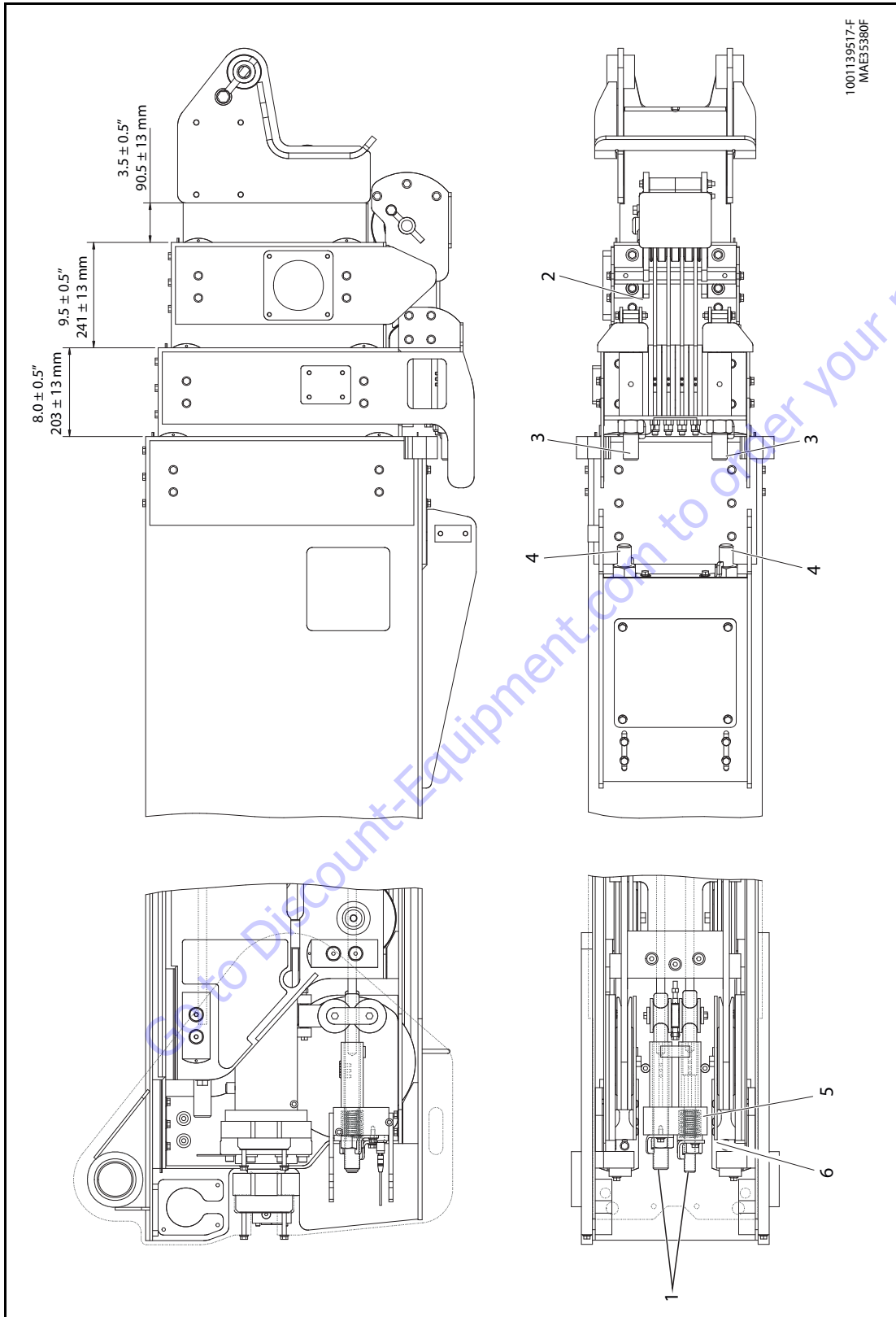
- | | |
|-------------------------|-------------------------|
| 1. Sheave Deflector | 6. Rope Retainer Block |
| 2. Sheave Deflector | 7. Level Cylinder |
| 3. Rope Retainer Block | 8. Front Lower Wear Pad |
| 4. Fly Extension Sheave | 9. Lock Plate |
| 5. Rope Retainer Block | |

Figure 4-5. Boom Assembly - Sheet 4 of 7



- | | |
|-------------------------|------------------------|
| 1. Front Upper Wear Pad | 7. Jib Rotator |
| 2. Shim | 8. Jib Rotator Cam |
| 3. Pivot Assembly | 9. Front Side Wear Pad |
| 4. Platform Rotator | 10. Shim |
| 5. Jib Cylinder | 11. Shim |
| 6. Lower Jib Link | 12. Lock Plate |

Figure 4-6. Boom Assembly - Sheet 5 of 7



- 1. Outer Mid Extend Rope
- 2. Fly Extend Rope
- 3. Fly Retract Rope
- 4. Outer Mid Retract Rope
- 5. Proximity Switch Spring
- 6. Switch Adjustment Block

Figure 4-7. Boom Assembly - Sheet 6 of 7

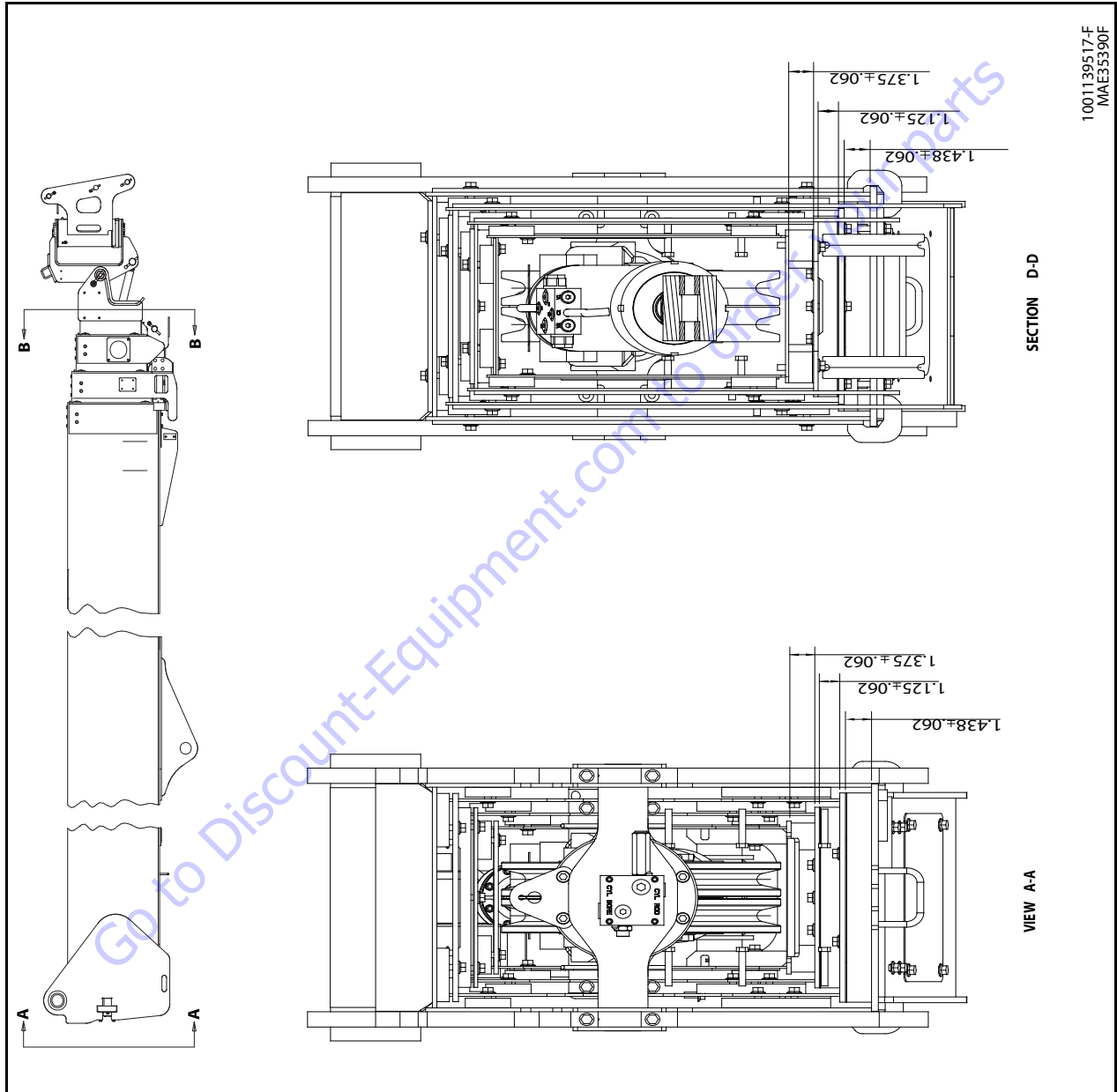


Figure 4-8. Boom Assembly - Sheet 7 of 7

SECTION 4 - BOOM & PLATFORM

7. Tag and disconnect the three electrical wires that run to the power track and the wire that goes to the proximity switch.



8. Unbolt the power track.
9. Remove the bolt securing the keeper pin and remove the keeper pin from boom pivot pin.
10. Using the lifting device, support the rear of the boom to remove the load from the pivot pin.



11. Remove the boom pivot pin.
12. Move all of the hydraulic hoses and electrical wires so they are free from chassis.

13. Using the lifting device, remove boom from chassis.



14. Place boom on saw horses or other adequate supports.

Disassembly

It is not necessary to completely remove the entire boom assembly from the machine to replace the cables. In the following procedure, the base boom section will remain on the machine.

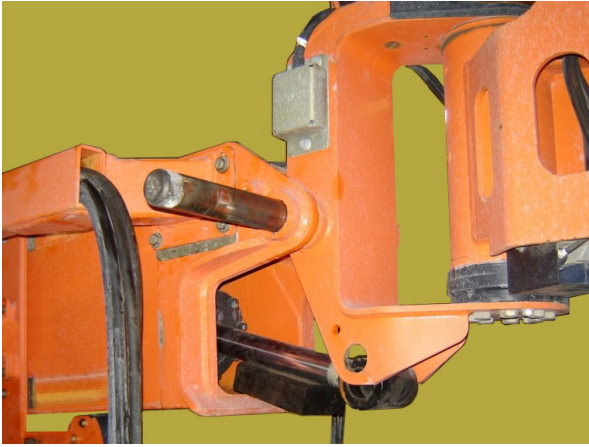
⚠ WARNING

NEVER HANDLE WIRE ROPE WITH BARE HANDS.

1. Position the boom so that it is horizontal. If the boom is below horizontal, ensure that the boom is not on the boom rest.
2. Use an adequate lifting device to support the weight of the jib and platform assembly.
3. Tag and disconnect the hoses and electrical harnesses that run to the platform. Cap or plug all openings.
4. Pull the hoses and harnesses through the jib and lay them off to the side of the boom.
5. Remove the bolt and keeper pin securing the platform level pivot pin and remove the pin.



- 6.** Remove the bolt and keeper pin securing the jib pivot pin and remove the pin.



- 9.** Pull the disconnected tube back to allow room to disconnect the lower tube.



- 7.** Remove the jib and platform assembly from the boom.

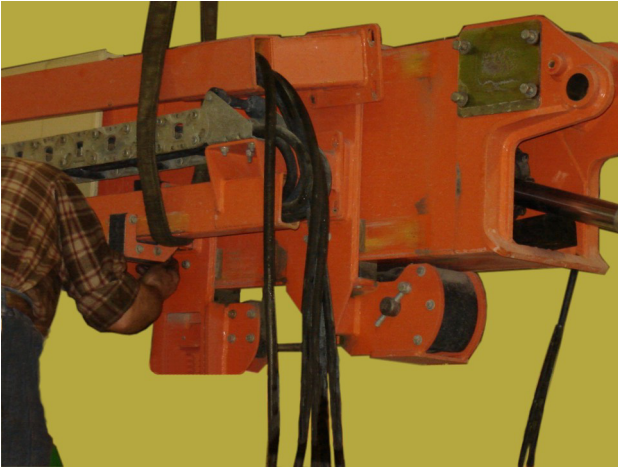


- 8.** Attach a lifting device to the powertrack for support and unbolt the upper powertrack tube from the fly boom.



SECTION 4 - BOOM & PLATFORM

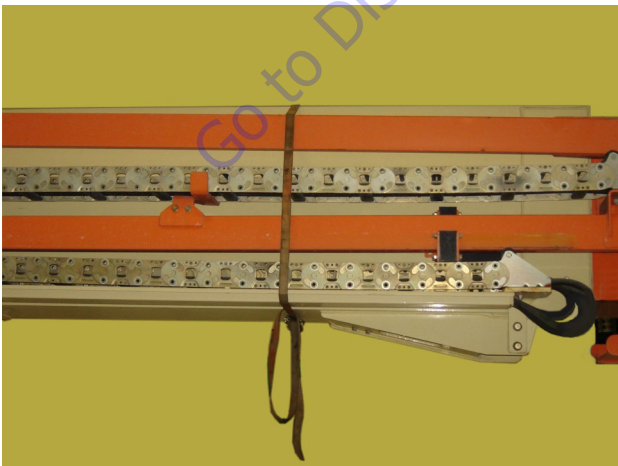
10. Unbolt the lower powertrack tube from the outer mid boom section and the mounting bracket from the inner mid boom section.



12. Remove the bolts securing the side wear pads to the front of the base boom and remove the pads and shims.



11. Attach a strap or other similar device around the powertrack and boom to keep the powertrack secure throughout the cable replacement procedure.



13. Remove the boom length plate.



- 14.** Remove the cover over the boom length limit switch at the front of the boom base section. Remove the switch.



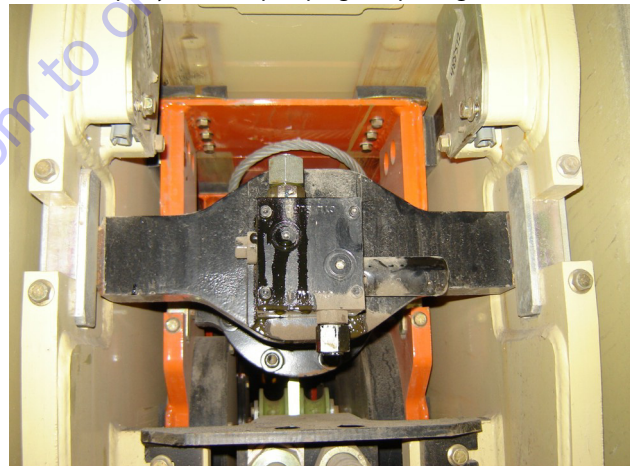
- 15.** Remove the rear boom cover.



- 16.** Tag and disconnect the wiring harness running to the boom length sensor. Remove all the bolts and washers securing the sensor, including those that secure the measuring cable to the telescope cylinder, and remove the length sensor.



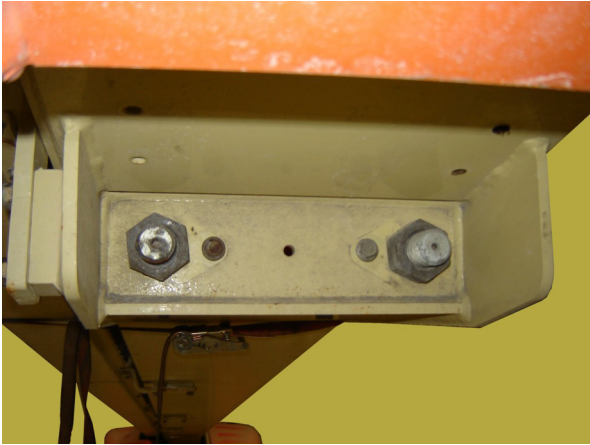
- 17.** Tag and disconnect the hydraulic hoses from the telescope cylinder. Cap or plug all openings.



- 18.** Remove the front side, top, and lower wear pads from the boom base section.

SECTION 4 - BOOM & PLATFORM

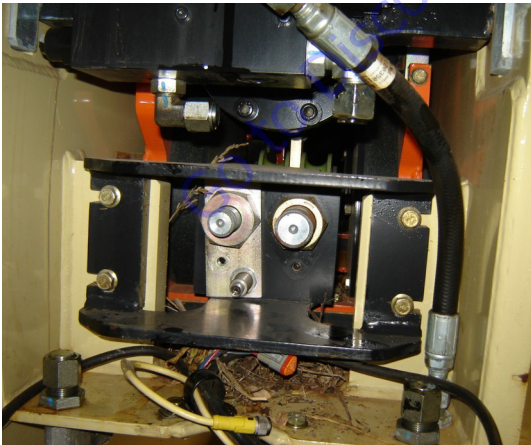
19. Remove the keepers for the outer mid retract cable adjustment nuts at the front of the boom base section.



20. Loosen and remove the outer mid retract cable adjustment nuts.



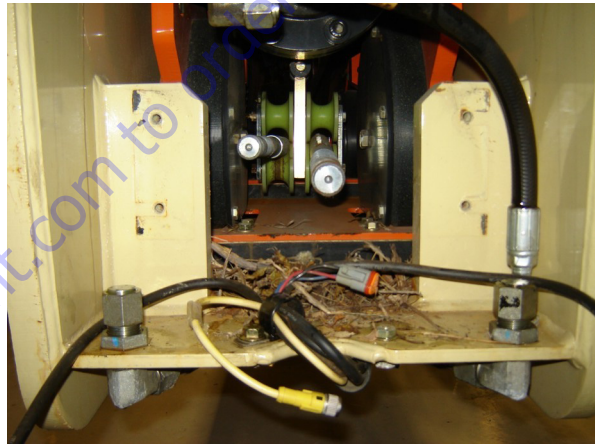
21. Remove the adjustment bolt keepers for the outer mid extend cable adjustment nuts at the rear of the boom.



22. Remove the adjustment nuts for the for the outer mid extend cables along with the Broken Cable proximity switch, spring, and adjustment plate.



23. Remove the cable mounting plate.



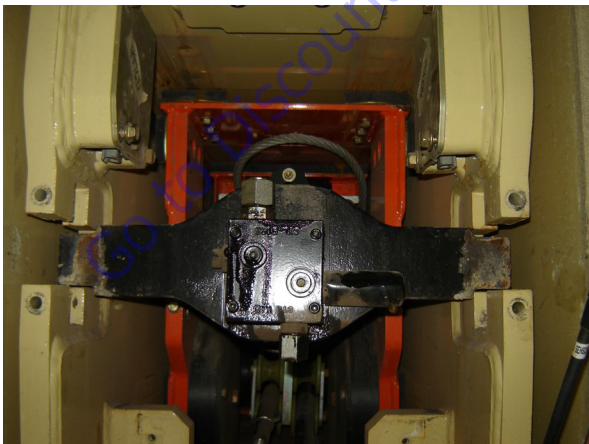
- 24.** Remove the cover plate from the bottom of the boom and remove the sheave blocks.



- 26.** Remove the outer mid retract cables from the attachment fixtures at the front of the boom base section.



- 25.** Remove the trunnion blocks that secure the telescope cylinder rod to the boom base section.

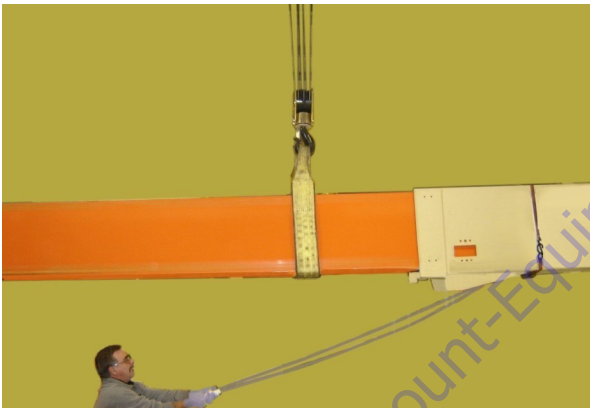
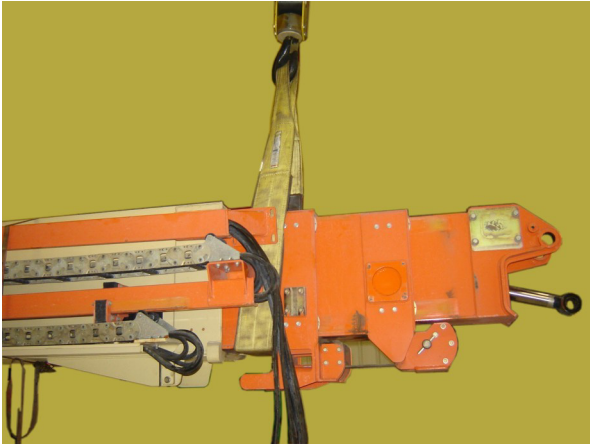


- 27.** Attach an auxiliary hydraulic power source to the telescope cylinder and extend the cylinder rod enough to turn the trunnion in a vertical position.



SECTION 4 - BOOM & PLATFORM

- 28.** Pull the inner mid, outer mid, and fly boom sections out of the base boom section. Use additional lifting devices and reposition any lifting straps as necessary as the sections are withdrawn. It will be helpful during this step to pull the outer mid retract cable out from the front of the base section as the other sections are being pulled out. This will prevent the cables from tangling as the sections are withdrawn.



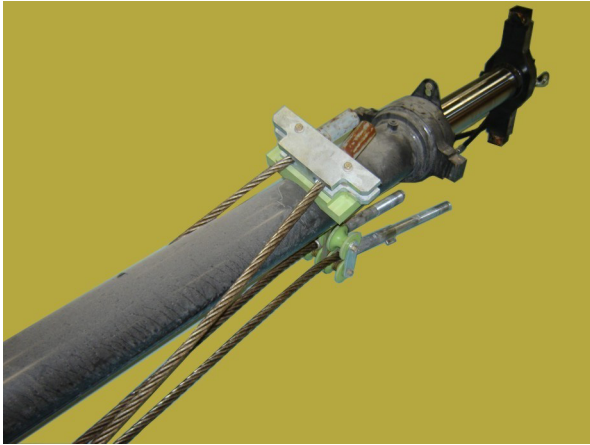
- 29.** Remove the trunnion blocks that secure the telescope cylinder barrel to the inner mid boom section.



- 30.** Attach a lifting device to the telescope cylinder and pull the cylinder, along with the outer mid extend cables out of the inner mid boom section. Reposition the lifting device as necessary to balance the cylinder.



- 31.** Remove the hardware attaching the outer mid extend block and remove the block and outer mid extend cables.



- 32.** Remove the cable retainer plate, cable retainer block, bushing, and sheave.



- 33.** Remove the rear bottom wear pad.

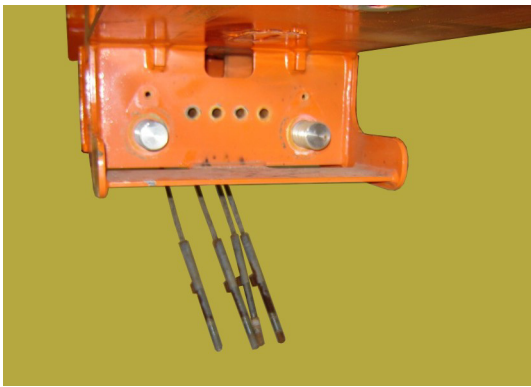


- 34.** Remove the lock plates from the fly boom retract cable adjustment nuts and remove the adjustment nuts from the fly boom retract cables and from the fly boom extend cables at the front of the inner mid boom section.



SECTION 4 - BOOM & PLATFORM

35. Pull the fly boom extend cables from their mounting receptacles.



36. Remove the top, side, and bottom wear pads from the front of the inner mid boom sections.



37. Attach a strap to pull the outer mid and fly boom sections out of the inner mid boom section. Secure the rear

of the inner mid boom section so it doesn't move as the other sections are withdrawn.

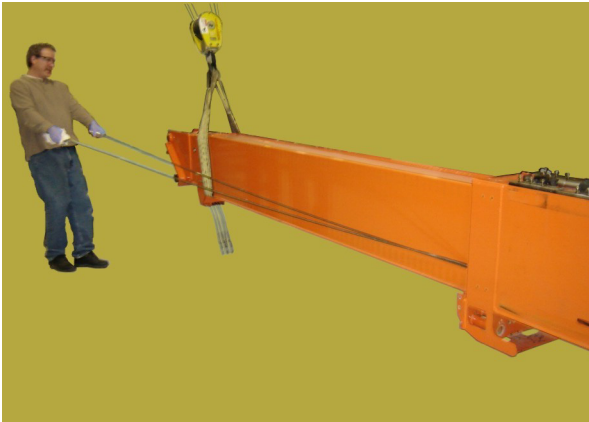


38. Pull the sections out enough to allow easy removal of the cable retainer blocks and sheave blocks for the fly boom retract cables at the front of the inner mid boom section.



NOTE: When pulling the outer mid and fly boom sections out of the inner mid boom section, make sure the outer mid retract cables do not catch at the rear of the boom section.

- 39.** Pull the sections the rest of the way out of the inner mid boom section, pulling the fly boom retract cables out at the same time.



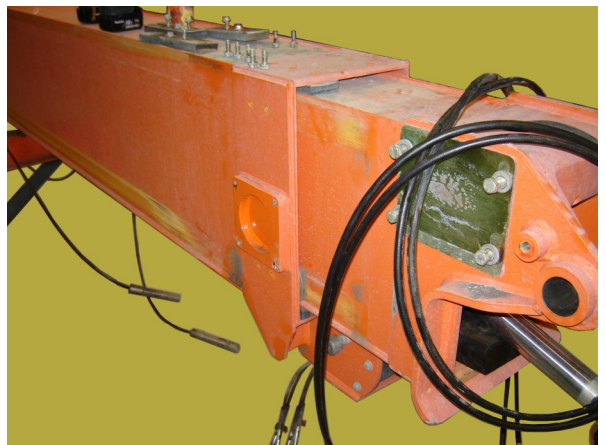
- 40.** Remove the outer mid retract cables from the rear of the inner mid boom section.



- 41.** Remove the cable retract retainer plates, cable retainer blocks, sheaves, and bushings from the rear of the outer mid boom section.



- 42.** Remove the front wear pads from the outer mid boom section.

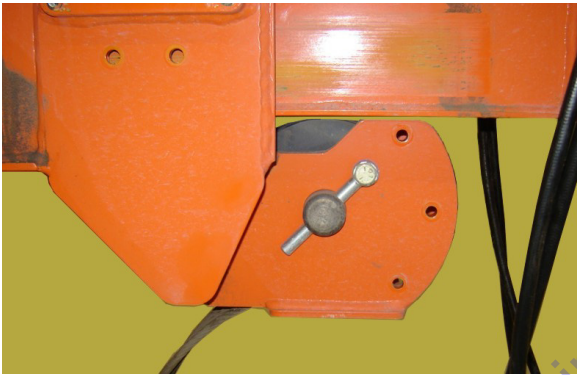


SECTION 4 - BOOM & PLATFORM

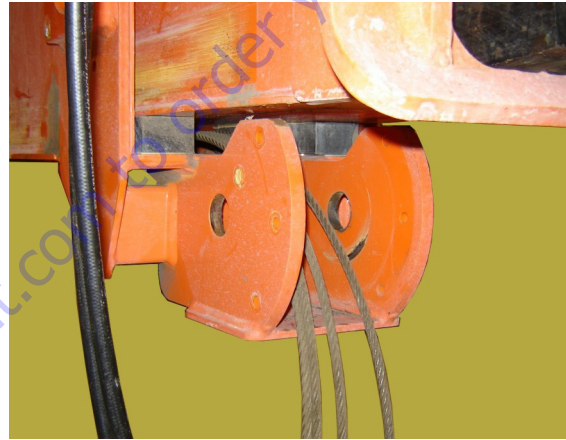
43. Remove the upper rear wear pads from the fly boom section.



44. Remove the cable retainer blocks and shims.



- ing bolt, keeper pin, pin, bushings, and sheave from the front of the outer mid boom section.



45. Pull the fly boom extend cables out enough to have clearance to remove the sheave, and remove the retain-

NOTE: When pulling the fly boom section out of the outer mid boom section, make sure the fly boom retract cables do not catch at the rear of the boom section.

- 46. Attach a lifting device to the fly boom section and pull the section and fly boom extend cables from the outer mid boom section. Secure the rear of the outer mid boom section so it doesn't move when the fly boom section is withdrawn.



- 47. Remove the tape from the fly boom section and remove the fly boom retract cables.



- 48. Remove the fly boom extend cables from the bottom of the fly boom section.



- 49. Thoroughly clean the boom sections.

Assembly

⚠ WARNING

NEVER HANDLE WIRE ROPE WITH BARE HANDS.

NOTE: Moderately apply Super Lube JLG Part No. 3020042 to all four inner surfaces of both ends of each boom section to a minimum depth of 3 to 4 feet (1 to 1.25 m). The fly boom section only needs Super Lube applied to the insertion end.

Super Lube is also to be moderately applied to all outer surfaces of interior wear pads after they are installed to the insertion end of boom sections. Care should be taken to avoid application on exposed painted surfaces of the fully extended boom. Refer to Section 1 - Remove the Platform Support. Refer to Section 4.2, Platform, Platform.

NOTICE

WIRE ROPE NUTS ARE CLOSE IN SIZE AND CAN BE SWITCHED. REFER TO THE JLG PARTS MANUAL. OUTER MID RETRACT NUTS, LOCATED ON BOTTOM OF BASE BOOM, WILL BE BLACK IN COLOR.

SECTION 4 - BOOM & PLATFORM

NOTICE

TAKE EXTRA CARE NOT TO CROSS ANY WIRE ROPES DURING THE ASSEMBLY PROCEDURE.

1. Install the fly extend wire rope button ends into the slots on the bottom of the fly boom section. Place tape over the wire ends to keep them in place during assembly.

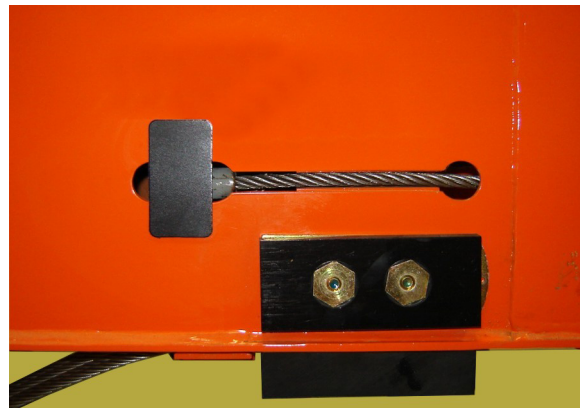


2. Fabricate a special fixture as shown below to keep four extend wire ropes from crossing over each other.



3. Install the fly retract wire rope button ends into the slots in the side of the fly boom, coil the remaining lengths of

wire rope and place them into the fly boom, tape the slots to keep the rope from jumping out.



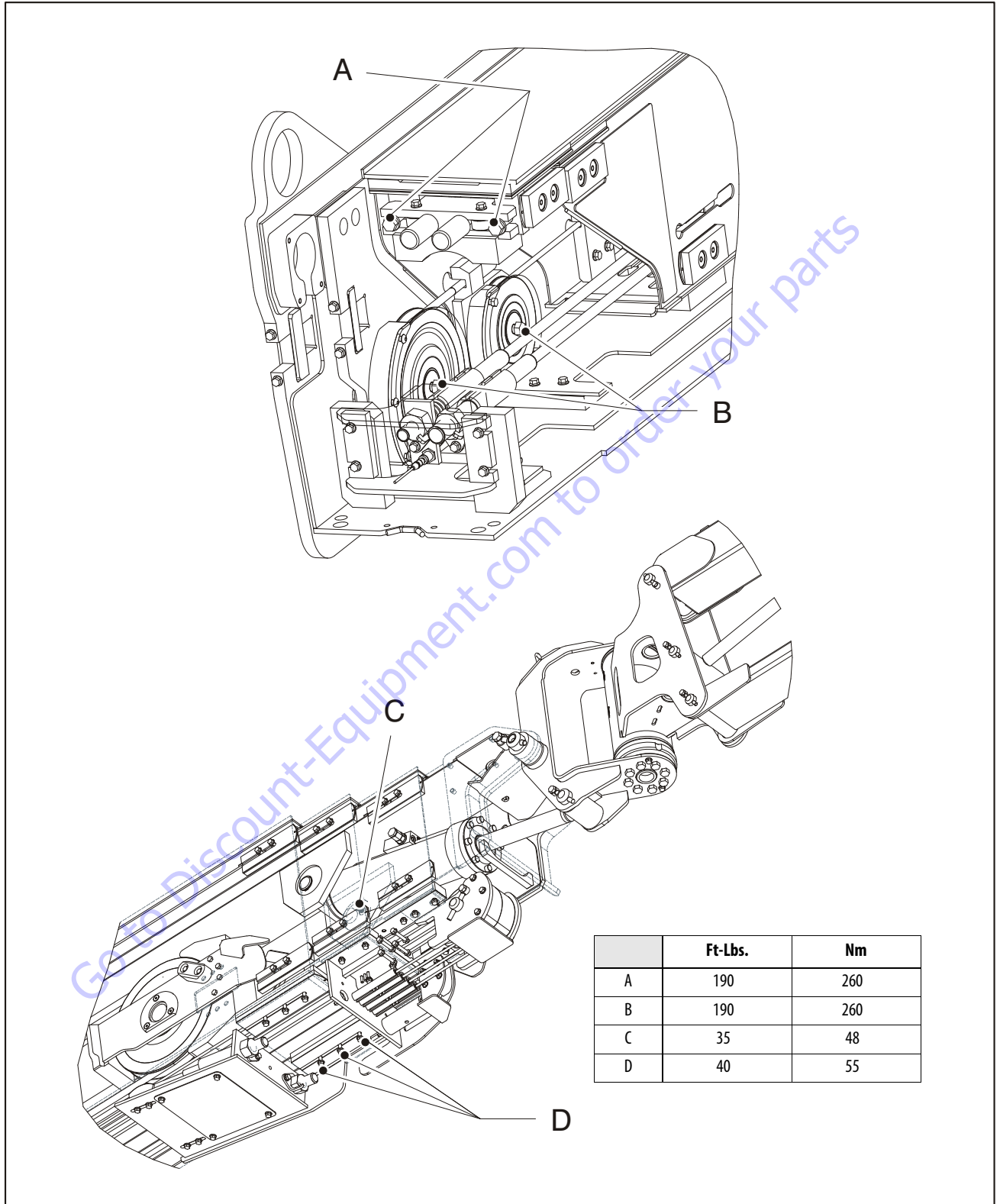


Figure 4-9. Boom Assembly Torque Values - Sheet 1 of 2

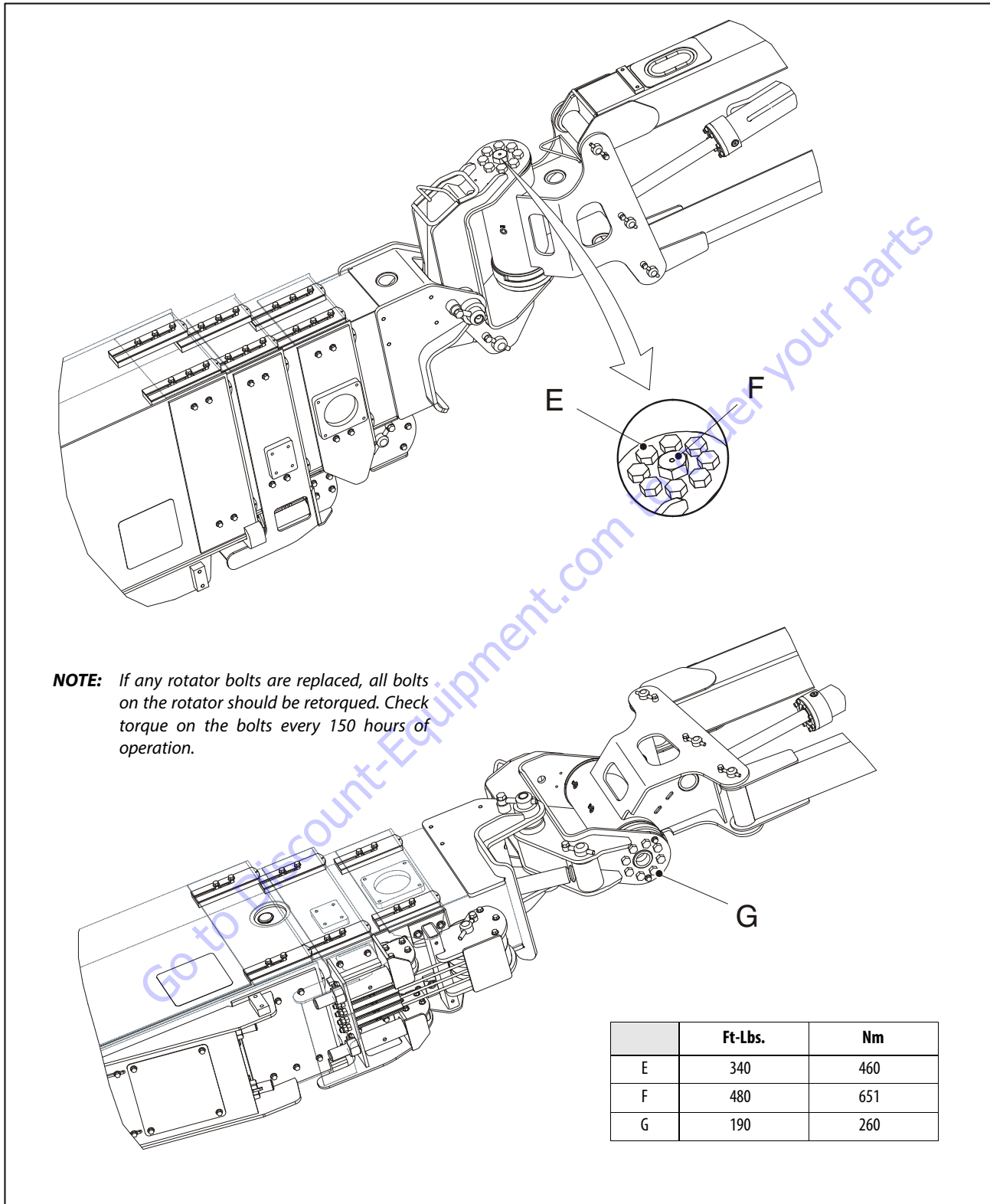
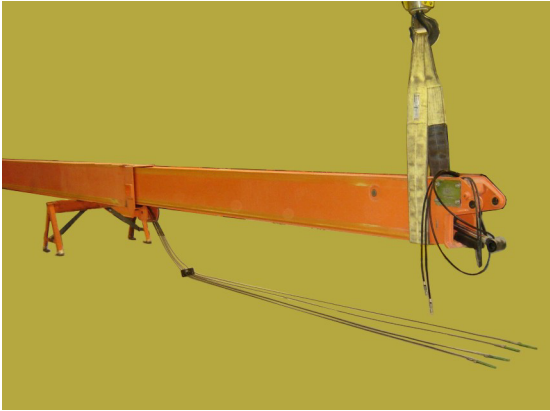


Figure 4-10. Boom Assembly Torque Values - Sheet 2 of 2

4. Install the fly boom section partially into the outer mid boom section.



NOTICE

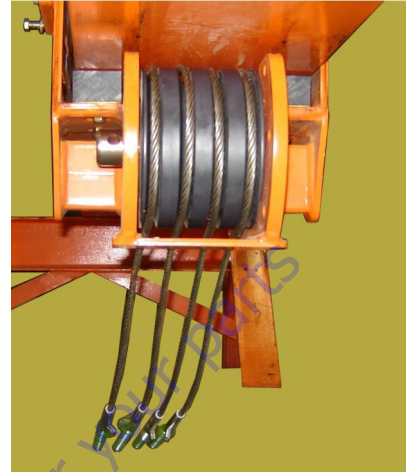
DO NOT ALLOW THE FLY BOOM TO REST ON THE FOUR EXTEND WIRE ROPES WHILE INSERTING IT INTO THE OUTER MID BOOM.

5. Apply Medium Strength Threadlocking Compound to the bolts and install the front lower wear pads and shims to the outer mid boom as marked during disassembly. Torque the bolts to 50 ft.lbs. (68 Nm).



6. Install the fly boom section most of the way into the outer mid boom section, leaving enough of the fly out so there is adequate slack in the fly boom extend cables to allow for installation of the front sheave.

7. Install the sheave, bushings, pin, keeper pin, and retaining bolt to the front of the outer mid boom section.



8. Install the cable retainer blocks and shims.



9. Apply Medium Strength Threadlocking Compound to the bolts and install the front upper, and side wear pads on the outer mid boom section as marked during disassembly. Torque the bolts to 50 ft.lbs. (68 Nm).



SECTION 4 - BOOM & PLATFORM

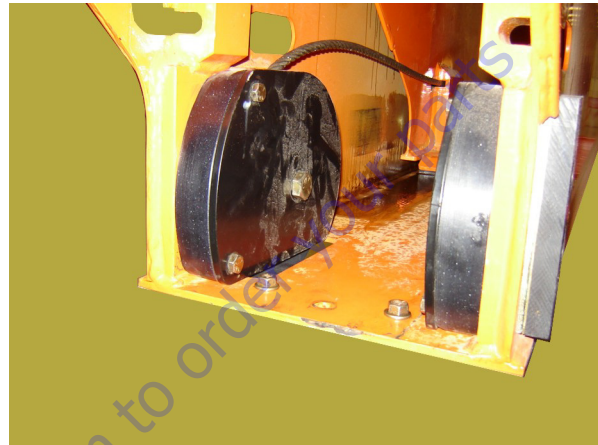
10. Apply Medium Strength Threadlocking Compound to the bolts and install the rear upper and side wear pads on the outer mid boom section as marked during disassembly. Torque the bolts to 50 ft.lbs. (68 Nm).



11. Uncoil the fly retract wire ropes from the fly boom. Route the threaded ends of the wire ropes through the holes in the outer mid boom plates at the retract sheave locations.



12. Apply a thin coat of moly paste lubricant to the inside diameter of the sheave composite bearings. Install the fly retract sheaves and bushings while guiding the wire ropes into the sheave grooves. Apply moly paste lubricant on the inside diameter of the sheave bushing cup. Ensure the sheaves move freely. Apply High Strength Threadlocking Compound to the sheave retaining bolts and torque to 165 ft.lbs. (224 Nm). Install the cable retract retainer plates and cable retainer blocks.



13. Apply Medium Strength Threadlocking Compound to the bolts and install the lower rear wear pad onto the outer mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).



14. Apply Medium Strength Threadlocking Compound to the bolts and install the side and upper wear pads on the rear of the inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).
15. Lubricate the wear surfaces on the inside of the inner mid boom section with Super Lube.

- 16.** Feed the fly boom retract cable into the inner mid boom section from the front.



- 17.** Using an adequate lifting device, align the outer mid boom section with the inner mid boom section.



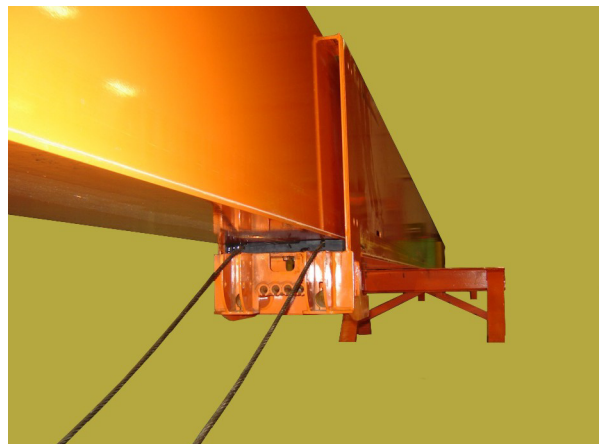
- 18.** Attach the fly boom retract cables in the inner mid boom section to the receptacles at the rear of the outer mid boom section.



- 19.** Put tape over the holes to keep the cable ends from jumping out.

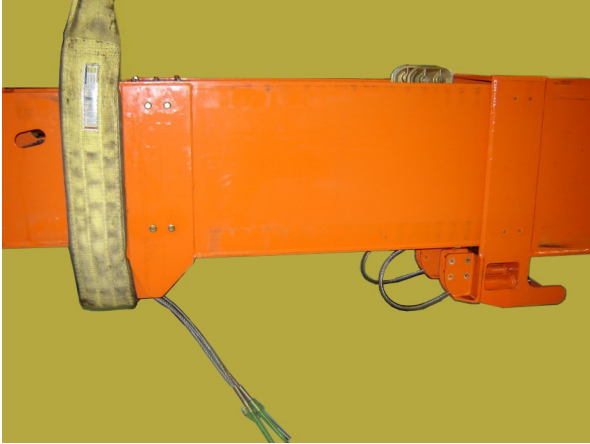


- 20.** Push the outer mid assembly part way into the inner mid boom section. Apply Medium Strength Threadlocking Compound to the bolts and install the front bottom wear pad into the inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).



SECTION 4 - BOOM & PLATFORM

21. Push the outer mid assembly into the inner mid while pulling the boom cables out the back fo the inner mid section at the same time. Leave 3 to 4 feet of the outer mid section sticking out of the inner mid section.



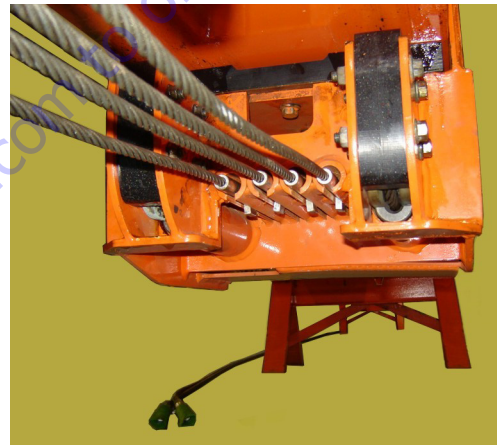
22. Push the retract cable ends into the mounting receptacles and install the cable sheaves and adjustment nuts.



23. Push the outer mid assembly almost completely into the inner mid boom section.



24. Install the cable retainer blocks over the fly boom retract cables and insert the fly boom extend cable into the mounting receptacles.



25. Apply Medium Strength Threadlocking Compound the bolts and install the side and top wear pads into the

inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).



and torque to 165 ft.lbs. (224 Nm). Install the cable retainer blocks and cable retainer plates.



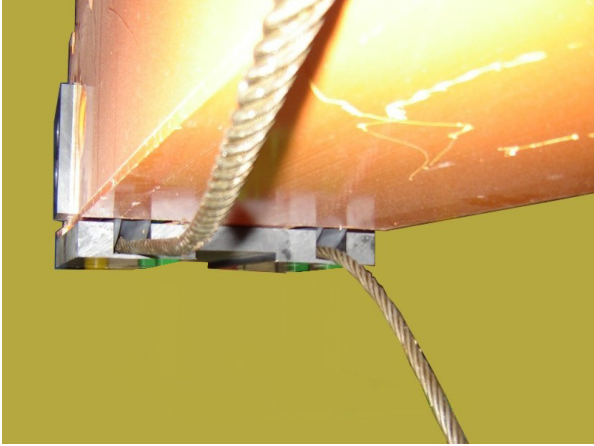
- 26.** Put moly paste on the sheave mounts at the rear of the inner mid boom section and install the sheaves.



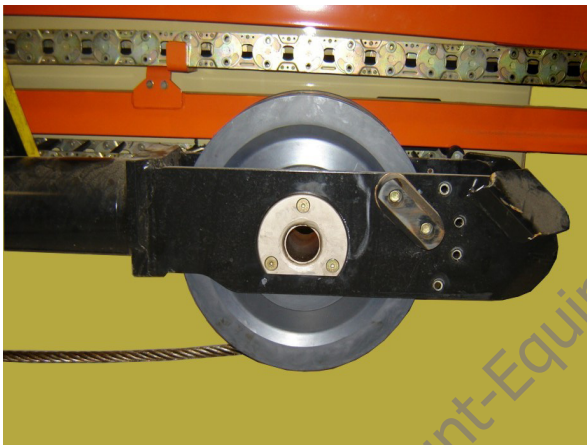
- 27.** Apply a thin coat of moly paste lubricant to the inside diameter of the sheave composite bearings. Install the retract sheaves and bushings while guiding the wire ropes into the sheave grooves. Apply moly paste lubricant on the inside diameter of the sheave bushing cup. Ensure the sheaves move freely. Apply High Strength Threadlocking Compound to the sheave retaining bolts

SECTION 4 - BOOM & PLATFORM

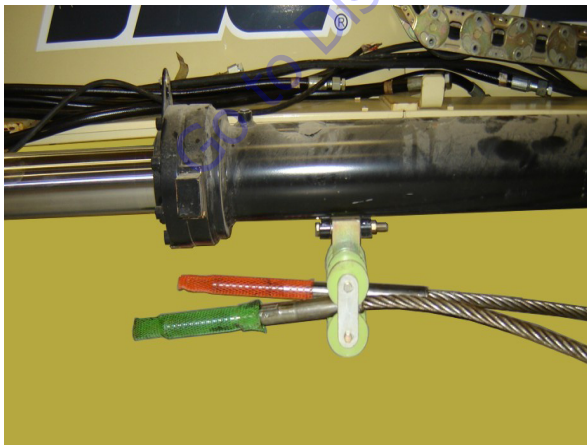
28. Apply Medium Strength Threadlocking Compound to the bolts and install the rear bottom wear pad on the rear of the inner mid boom section. Torque the bolts to 50 ft.lbs. (68 Nm).



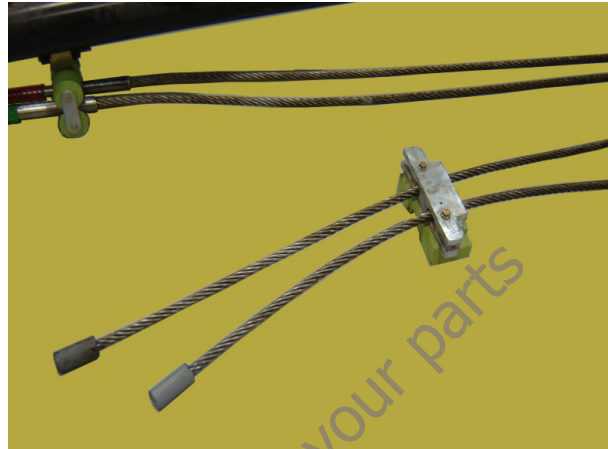
29. Install a new sheave on the telescope cylinder.



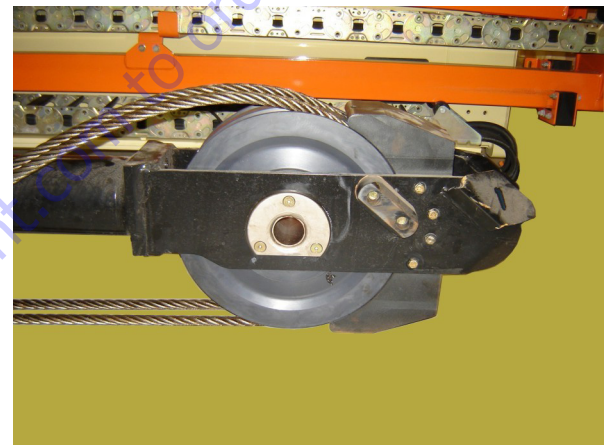
30. Install the outer mid extend cables into the cable pulley at the rod end of the telescope cylinder.



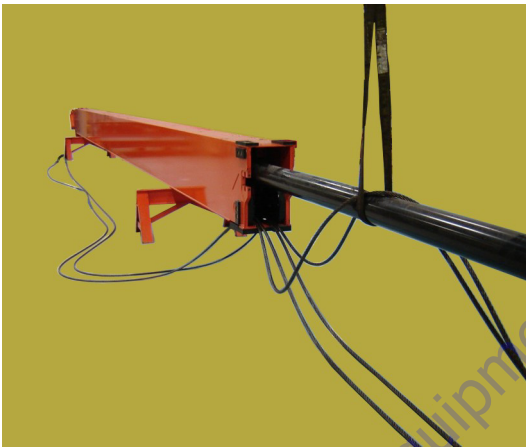
31. Install the other end of the outer mid extend cables into the cable guide block.



32. Route the cables around the sheave on the cylinder and install the cable retainer block.



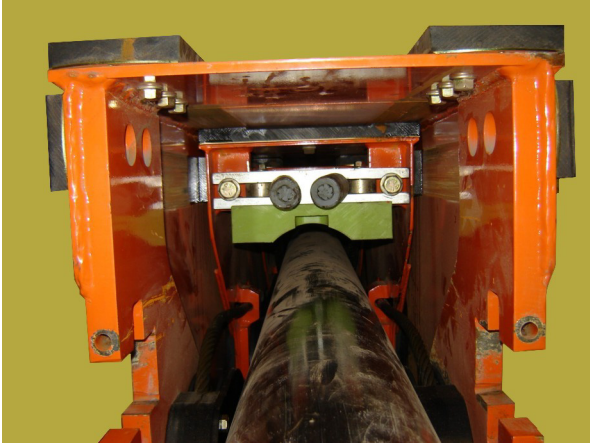
- 33.** Using an adequate lifting device, insert the cylinder and cables part way into the inner mid boom.



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SECTION 4 - BOOM & PLATFORM

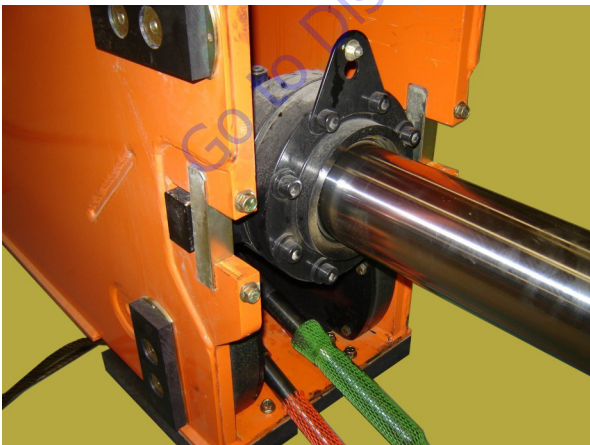
- 34.** Apply Medium Strength Threadlocking Compound to the bolts and attach the cable guide to the inner mid boom section with the mounting hardware. Torque the bolts to 165 ft.lbs. (224 Nm).



- 35.** Push the cylinder the rest of the way into the inner mid boom assembly.

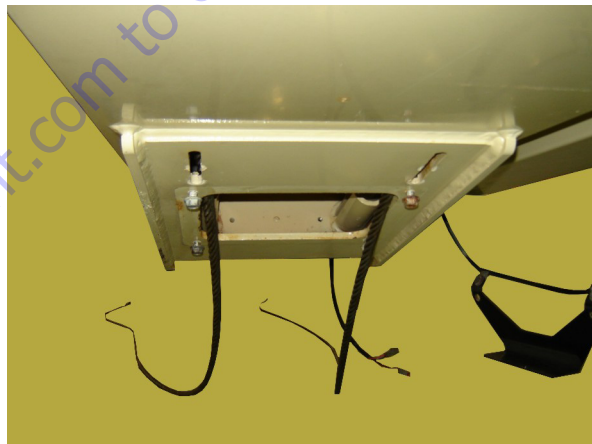


- 36.** Install the cylinder trunnion blocks and shims.

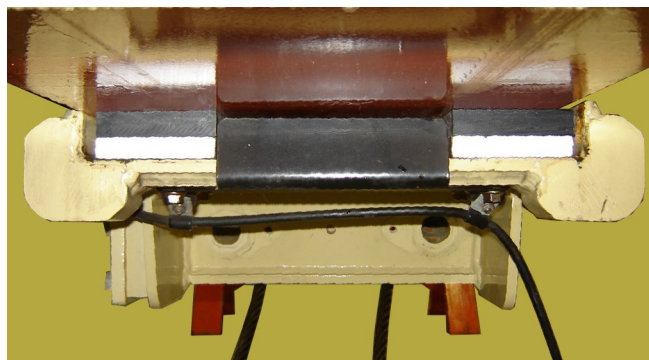


- 37.** Using Super Lube®, lubricate all wear surfaces on the inside of the boom base section and the outside of the inner mid boom section.

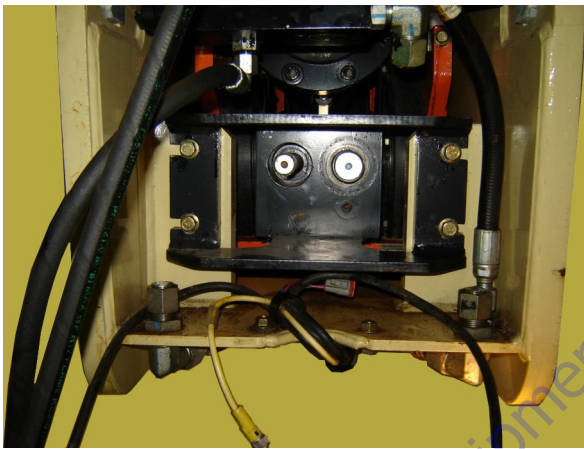
- 38.** Insert the inner mid boom section part way into the boom base section enough to be able to pull the outer mid retract cables out through the hole at the bottom front of the boom base section.



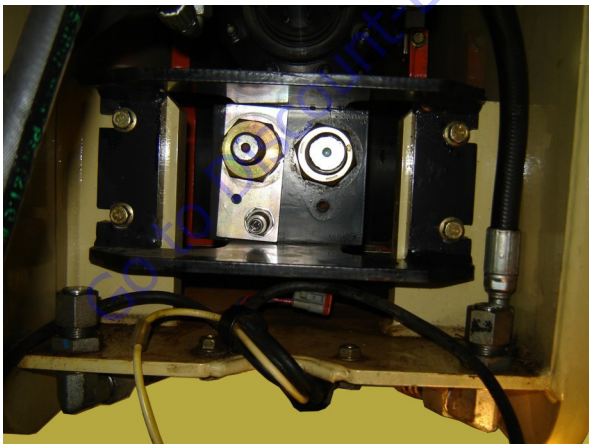
- 39.** Apply Medium Strength Threadlocking Compound to the bolts and install the front lower wear pads into the boom base section. Torque the bolts to 50 ft.lbs. (68 Nm).



- 40. Push the inner mid boom assembly the rest of the way into the boom base section, adjusting the lifting device as necessary to keep the weight balanced.
- 41. Apply Medium Strength Threadlocking Compound to the bolts and install the side and upper wear pads into the boom base section. Torque the bolts to 50 ft.lbs. (68 Nm).
- 42. Install the boom transport length sensor on the side of the boom base section.
- 43. Attach the powertrack tubes.
- 44. If necessary, attach a source of auxiliary hydraulic power and retract the boom enough to allow installation of the cable adjustment plate at the rear of the base boom section and install the plate.



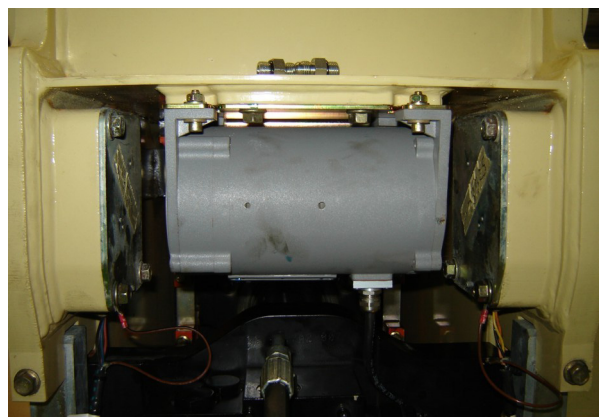
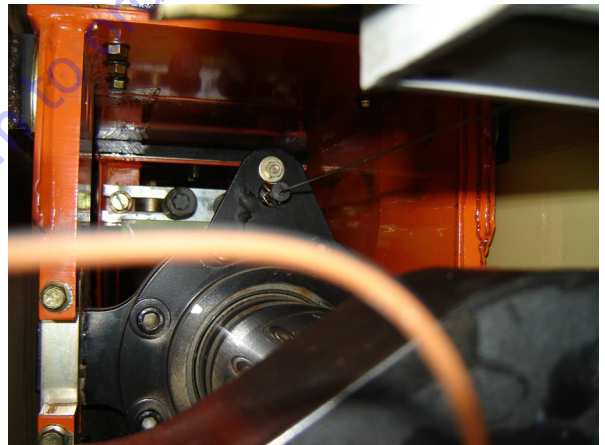
- 45. Install the broken cable sensor and the outer mid extend cable adjustment nuts.



- 46. Install the outer mid retract cable adjustment nuts at the front of the boom base section.



- 47. Install the boom length sensors and angle sensors as tagged during removal.



- 48. Connect the hydraulic hoses to the telescope cylinder as tagged during removal.
- 49. Adjust the boom cables. Refer to Section 4.13 - Wire Rope Tensioning Adjustment.
- 50. Perform a boom calibration as described in Section 6 under Calibrating the Boom Sensors.

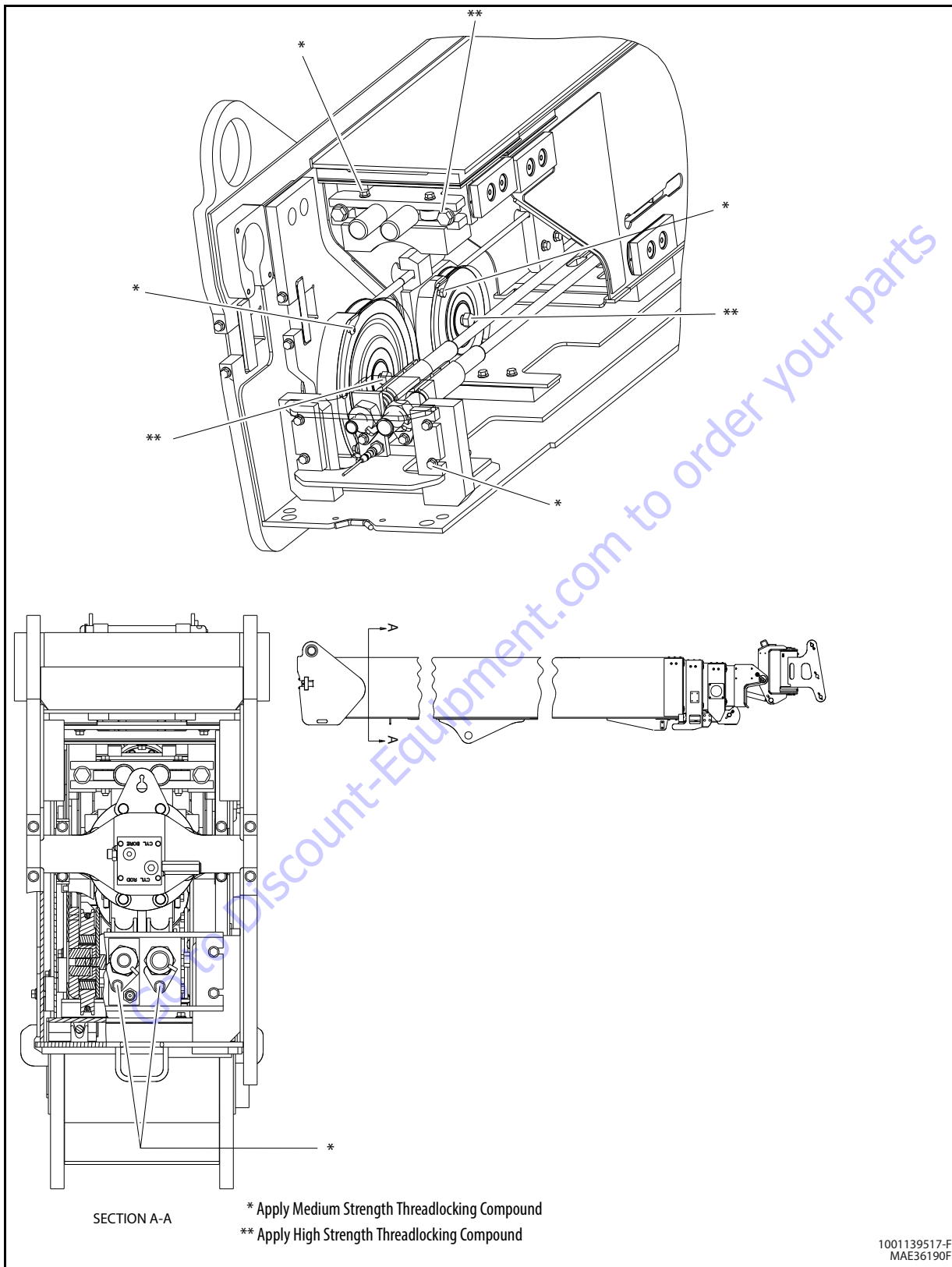


Figure 4-11. Locations for Threadlocker Application - Sheet 1 of 4

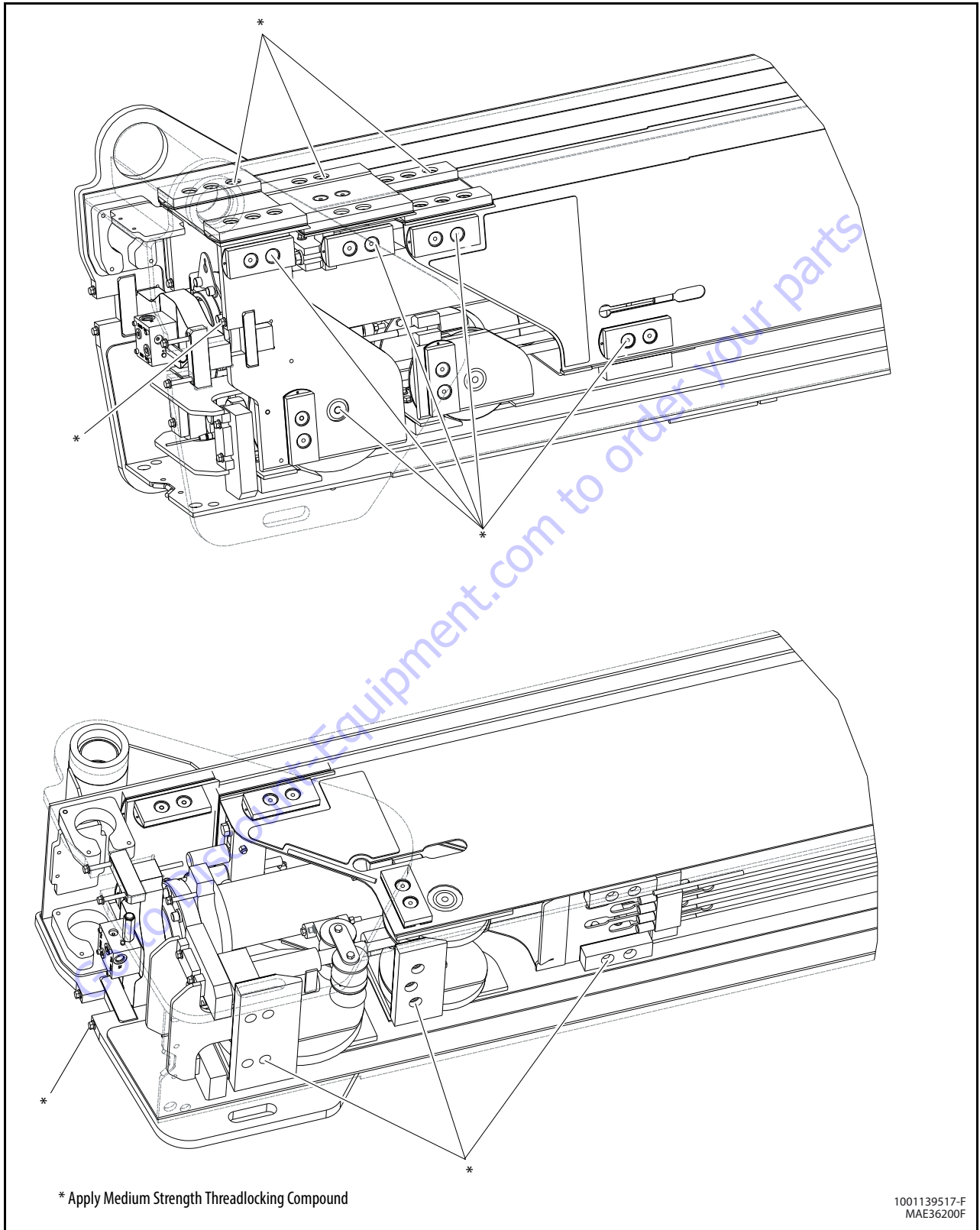


Figure 4-12. Locations for Threadlocker Application - Sheet 2 of 4

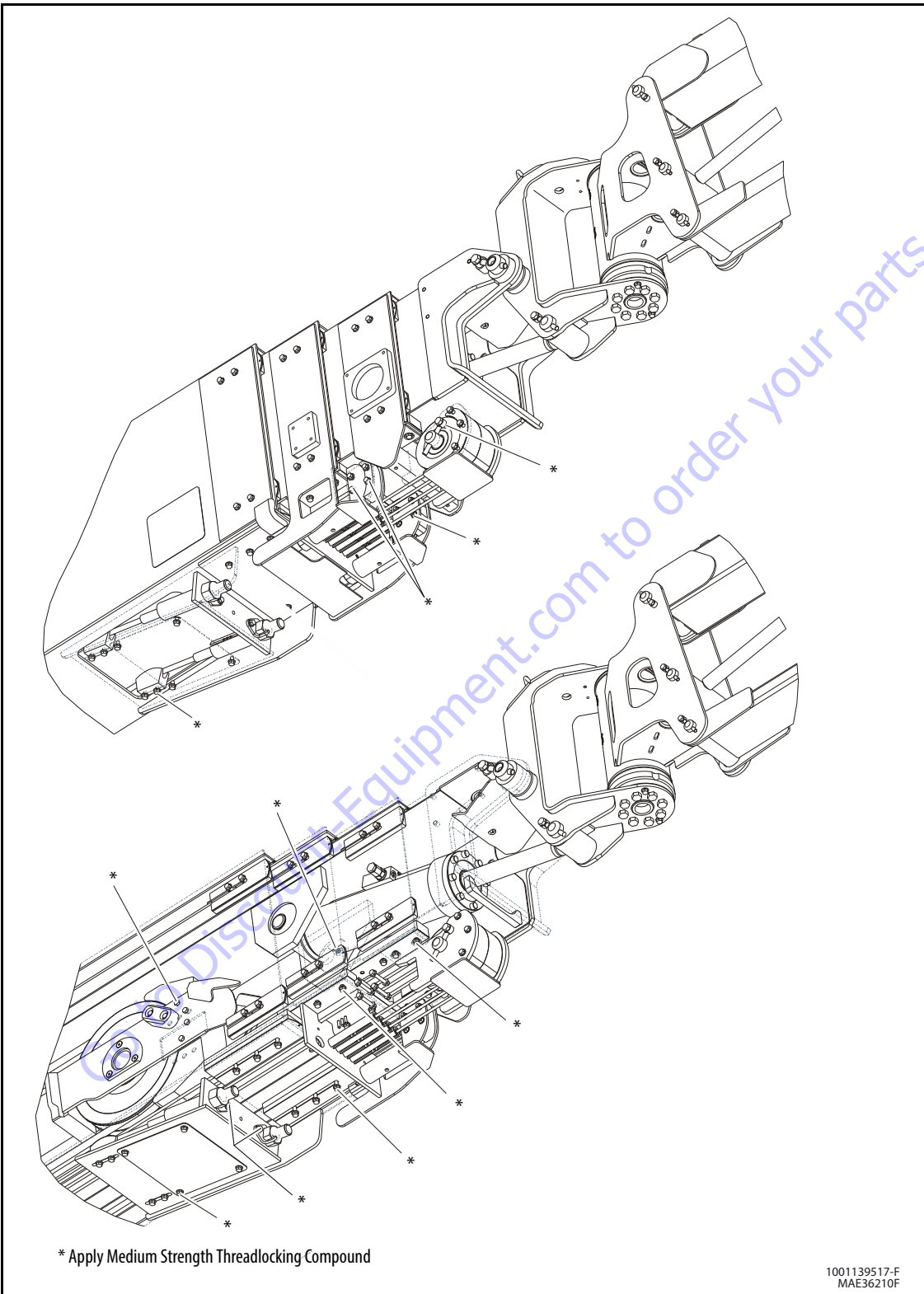


Figure 4-13. Locations for Threadlocker Application - Sheet 3 of 4

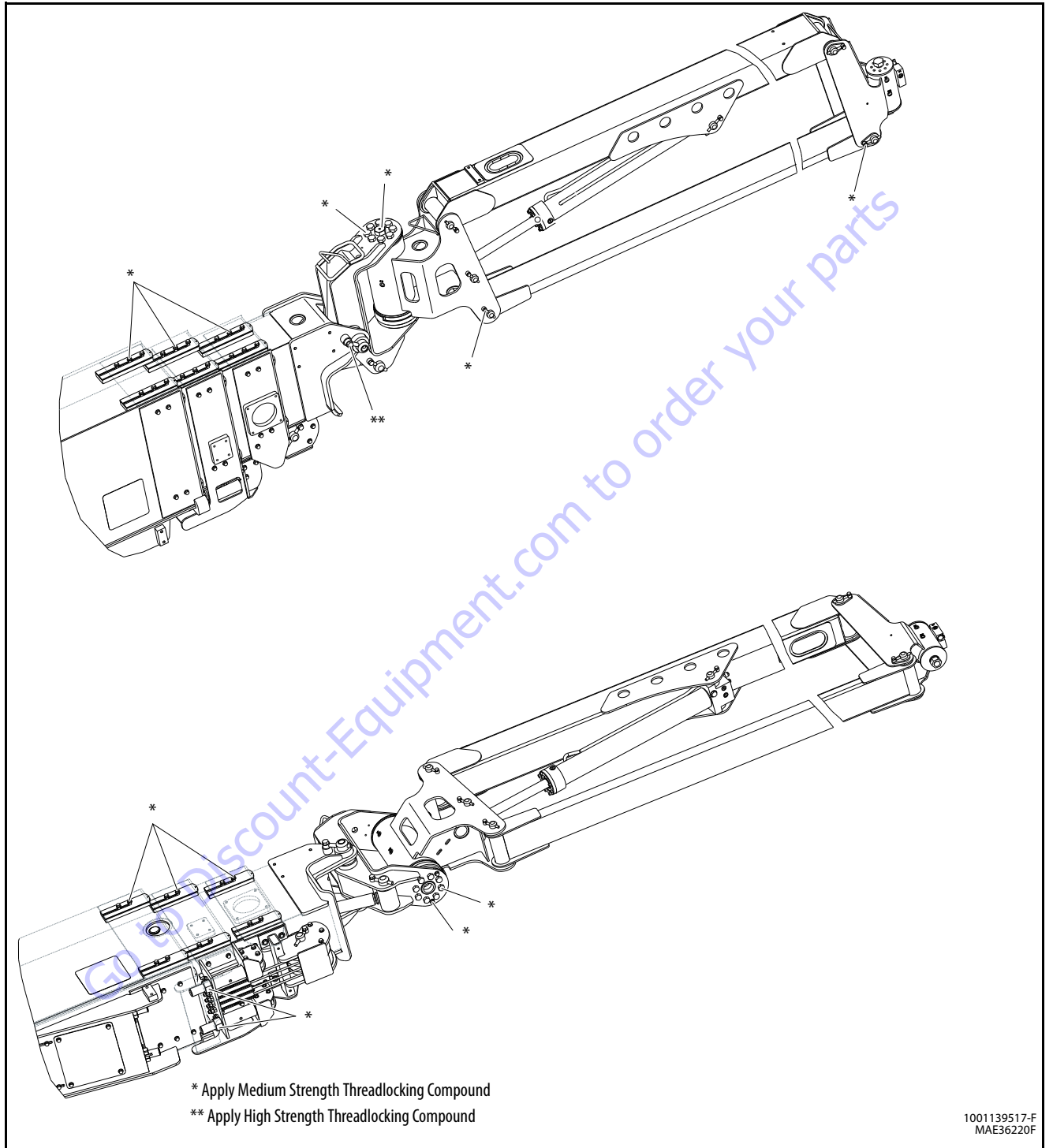


Figure 4-14. Locations for Threadlocker Application - Sheet 4 of 4

4.4 ROTATOR

Removal

1. Remove the Platform Support. Refer to Section 4.2, Platform, Platform.
2. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.

NOTE: The rotator approximately weighs 50 lb (23 kg).

3. Supporting the rotator and jib lift cylinder, remove hardware from pin (1). Using a suitable brass drift and hammer remove pin (1).
4. Remove the hardware from pin (2). Using a suitable brass drift and hammer, remove pin (2) and remove the rotator.

Installation

1. Supporting the rotator and jib lift cylinder, align rotator with jib lift cylinder and jib. Using a soft head mallet, install pin (1) to the jib assembly. Install hardware securing pin (1).

NOTE: The rotator approximately weighs 50 lb (23 kg).

2. Using a soft head mallet install pin (2) to jib assembly and install the rotator. Install hardware securing pin (2).
3. Install the platform and platform support. Refer Section 4.2, Platform.
4. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the rotator as tagged during removal.

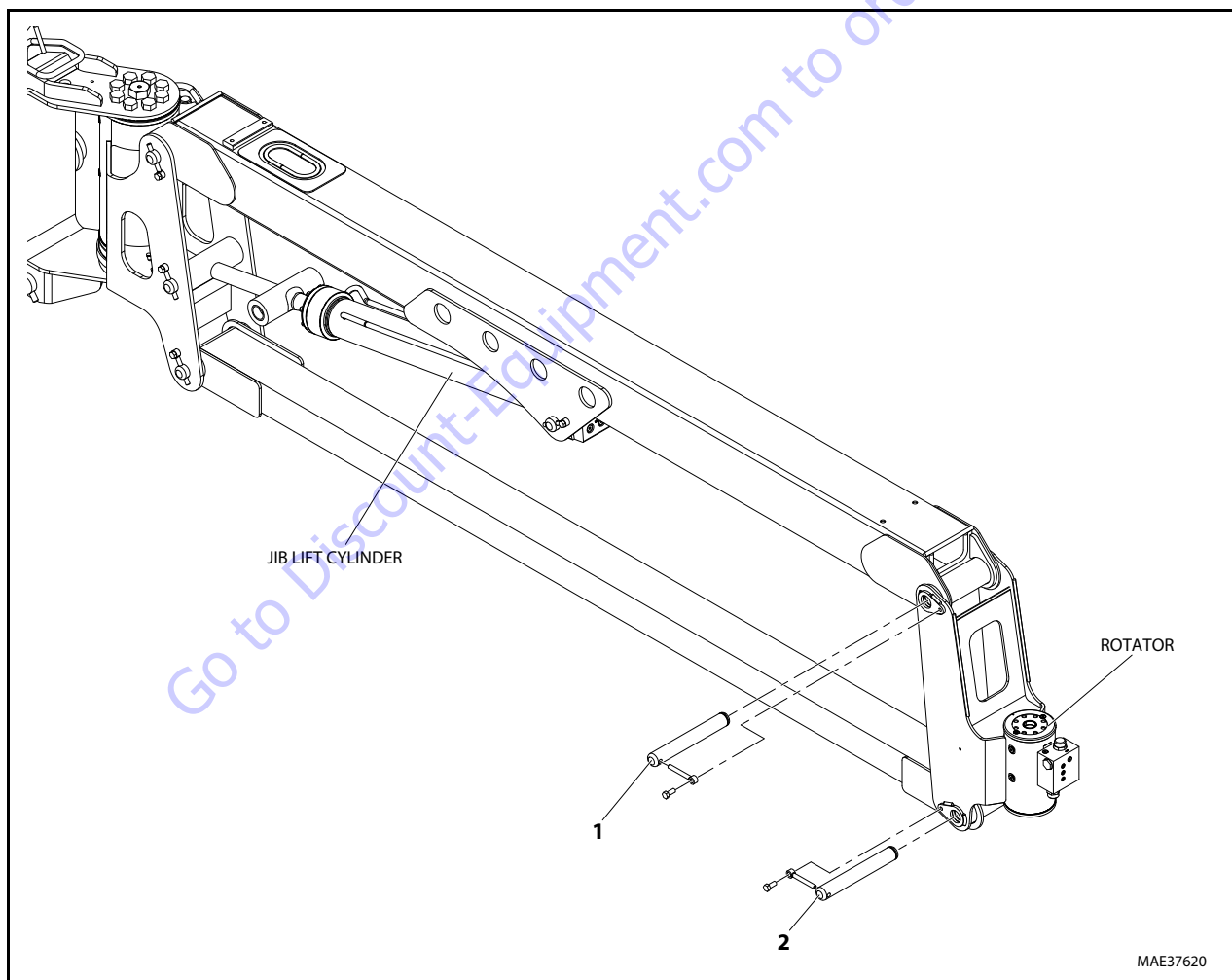


Figure 4-15. Platform Rotator Removal and Installation

4.5 BOOM LUBRICATION APPLICATION

This procedure applies to booms after assembly or during annual application using Super Lube® lubricant (JLG PN 3020042).

1. Position the boom on the boom rest using the 500 lb capacity setting.
2. Telescope main boom section as far as it will extend at this position, approximately 3 ft. (0.9 m).
3. From the front of the machine (boom pivot end), moderately apply lubricant to the interior surfaces of the base boom, inner mid boom, and outer mid boom. To prevent misdiagnosis of hydraulic leaks, take care to prevent excessive application of lubrication.
4. At the rear of the machine, apply lubricant to the side, top and bottom surfaces of the fly boom, outer mid, and inner mid specifically to wear pad contact paths. To prevent misdiagnosis of hydraulic leaks, take care to prevent excessive application of lubrication.
5. After application of the lubricant is complete, cycle the boom through its full range of travel 2 times.

4.6 BOOM SHIMMING PROCEDURE

1. Measure and record the dimension and direction of any sweep found in the fly boom section. Measure and record the inside width and inside height of the outer mid boom opening.

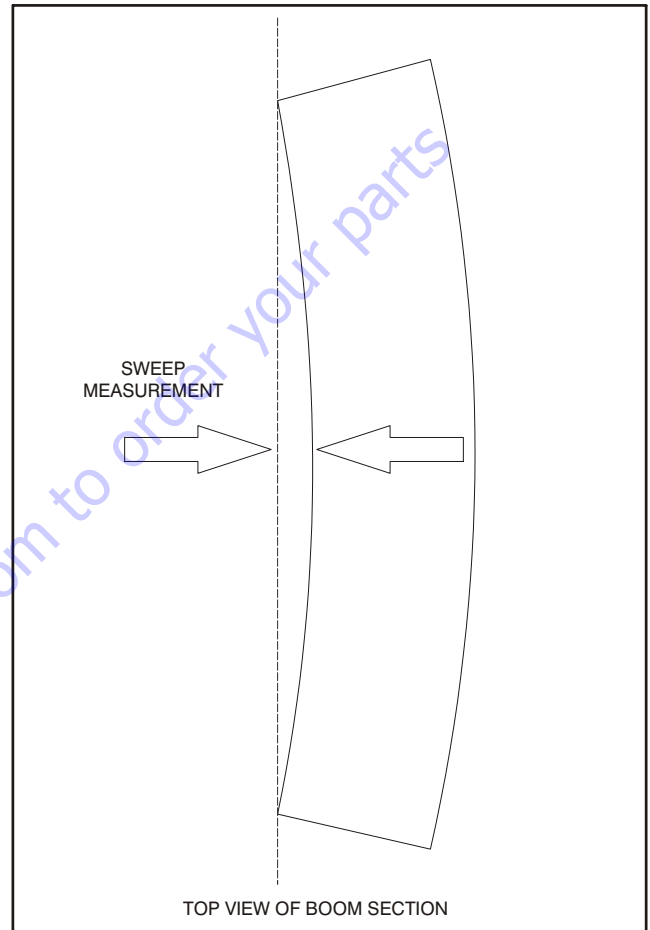


Figure 4-16. Measuring Boom Section Sweep

NOTE: Wear Pad bolt lengths should be flush to one thread below the surface of the insert. When installing wear pads in the following steps, the wear pad bolt lengths may need to be adjusted as shim thicknesses are adjusted.

2. Install the side wear pads on the fly boom sides. Shim as necessary to match the outer mid boom dimension recorded in step 1 $\pm 1/32''$ (± 0.8 mm). Shims should be divided as evenly as possible between the side pads unless corrections are needed to compensate for sweep recorded in step 1. If the sweep is to the left the internal side pads on the left should have more shims than the right side pads and vice versa.
3. Install the bottom wear pad(s) and shims if applicable on the fly boom.

4. Install the top wear pad(s) on the fly boom and shim as necessary to obtain 0 - 1/16" (0 - 1.6 mm) less than the corresponding dimension recorded in step 2.
5. Slide the fly into the outer mid boom leaving 2 - 6 feet (0.6-1.8 m) exposed.
6. Install the bottom wear pad(s) and shims if necessary into the end of the outer mid boom.
7. Temporarily insert the side pads on one side and slide the fly boom to that side. Insert the other side pads and using shims, measure how many will be required to fill the remaining space. Install the total amount of shims as evenly as possible between the two sides unless corrections are needed to compensate for out-of-square booms or for corrections due to sweep recorded in step 1. Care should be taken to keep the bottom pads evenly loaded while shimming the side pads.

NOTE: Do not install more shims than will fit because this may result in a boom being shimmed too tight. The use of pry bars or wedges should only be used to finish installing a shim that can be installed by hand more than 1/2 of its length.

8. Install the top wear pads and shims into the end of the outer mid boom leaving a gap of 0" to 1/16" between the top of the fly boom and inside of the outer mid boom.
9. Repeat steps 1-7 to install the fly/outer mid assembly into the inner mid boom.
10. Repeat steps 1-7 to assemble the fly/out mid/inner mid assembly into the base boom.
11. Complete the boom assembly. The boom should be functionally tested and evaluated for boom sweep. Boom sweep should be limited to no more than 5/16" (8 mm). If necessary, the boom may be re-shimmed by moving shims from one side to the other to further correct any remaining boom sweep. There may be some instances where no shims are used under a given side pad to pass the criteria for boom sweep at final inspection of machine.

4.7 JIB ROTATOR ORIENTATION

In order for the Jib Rotator to rotate properly, it must be installed with the timing marks running parallel to the flat rotator mounting plate as shown below.

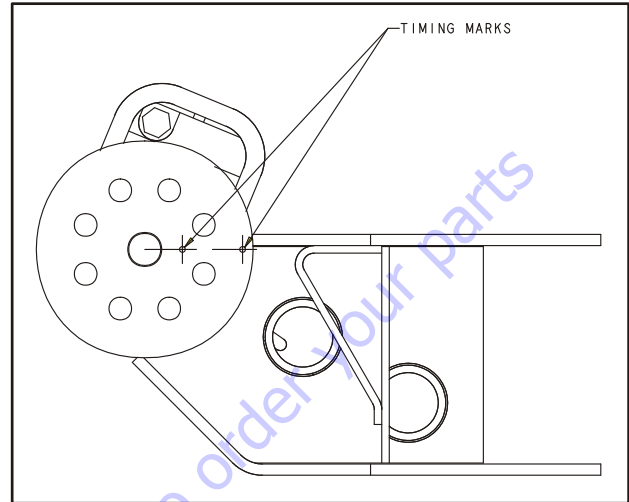


Figure 4-17. Jib Rotator Orientation

4.8 JIB LIFT END OF STROKE DAMPENING

The jib lift cylinder is constructed in a way that causes the jib lift cylinder oil flow to be restricted by an orifice while raising the jib within 5 degrees of maximum elevation. This restriction slows the jib lift speed while raising the jib. The oil flow is not restricted while lowering the jib and therefore the speed is not altered.

4.9 LOAD SENSING PIN REMOVAL AND INSTALLATION

1. Place the machine on a firm, level surface.

NOTE: Replacing the load sensing pin requires the boom sensors be re-calibrated. Make sure the machine is in an area where this can be accomplished after installation of the new pin.

2. Swing the engine tray out to gain access to the sensing pin and retaining pin.

NOTE: The lift cylinder weighs 787 lb (357 kg.)

3. Run a nylon strap capable of supporting the weight of the lift cylinder around the bottom of the cylinder. Lift up on the strap to relieve the weight of the lift cylinder on the load sensing pin.



4. Loosen and remove the bolt that secures the retaining pin and remove the retaining pin.



5. Disconnect the wiring harness from the strain relief connector at the opposite side of the load sensing pin.

6. Use the Load Pin Removal Tool (JLG PN 4846765) to prevent the pin from being damaged, and use a hammer to remove the pin. To make the tool refer to Figure 4-18., Load Pin Removal Tool, JLG PN 4846765. If the Load Pin Removal Tool is not available, use an arbor of the proper size (as shown below). If excessive force is necessary to move the pin, it may be necessary to carefully activate lift using the auxiliary power switch to relieve lift cylinder weight from the load sensing pin.



7. When installing a new pin, make sure all of the holes in the turntable and lift cylinder are aligned. If the new load sensing pin does not push 1/2 to 3/4 of the way in by hand, remove the pin and align the holes better. Also make sure the pin is installed with the strain relief connector opposing the pin orientation bar as shown. Refer to Figure 4-28., Pivot Pin Installation.



8. Using an oak block, carefully tap the pin until it is fully installed. Secure the pin in place with the retaining pin and retaining pin bolt.

NOTICE

DO NOT TAP ON THE CENTER OF THE PIVOT PIN.

9. Connect the wiring harness to the strain relief connector and re-calibrate the boom sensors.

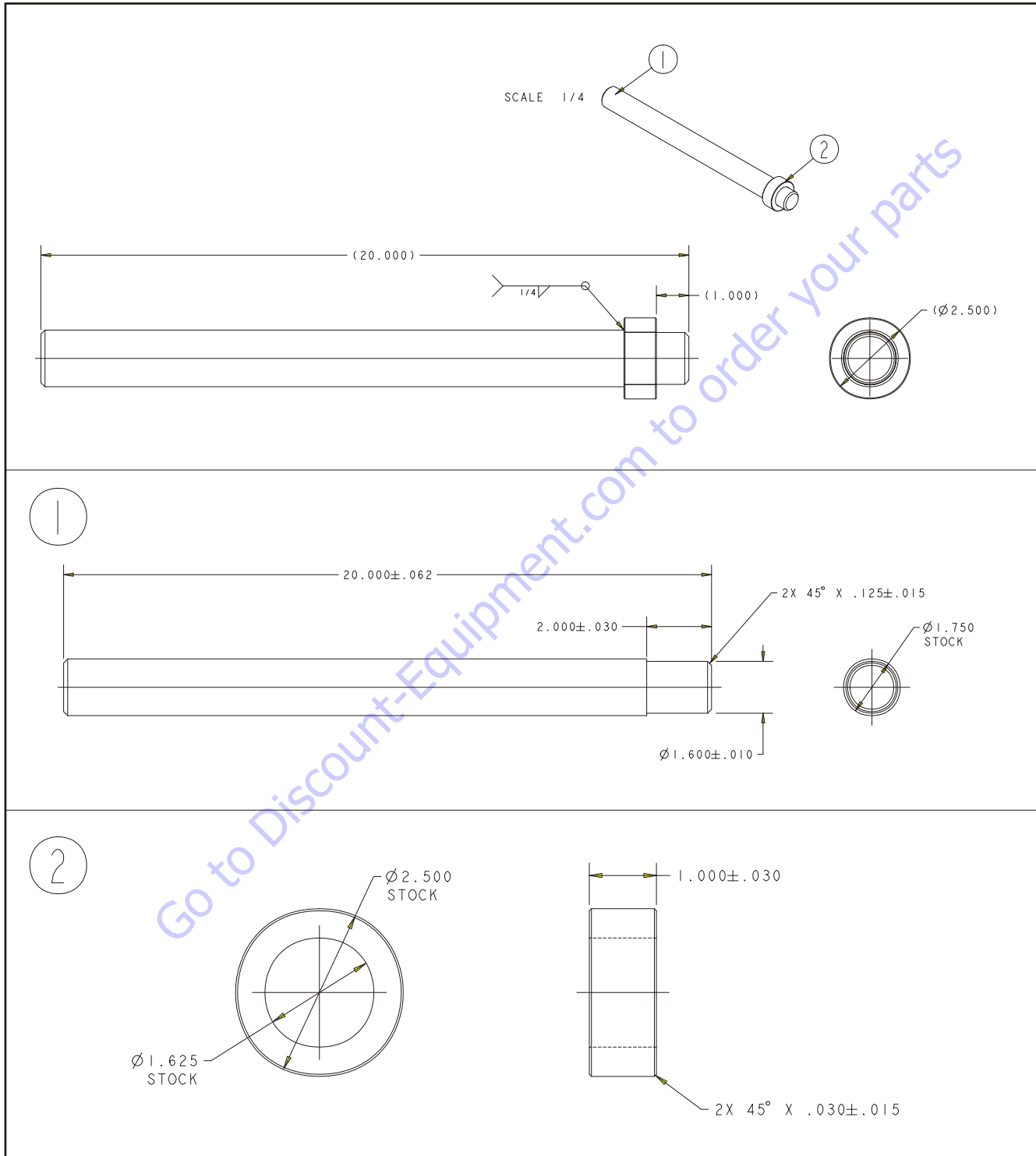


Figure 4-18. Load Pin Removal Tool, JLG PN 4846765

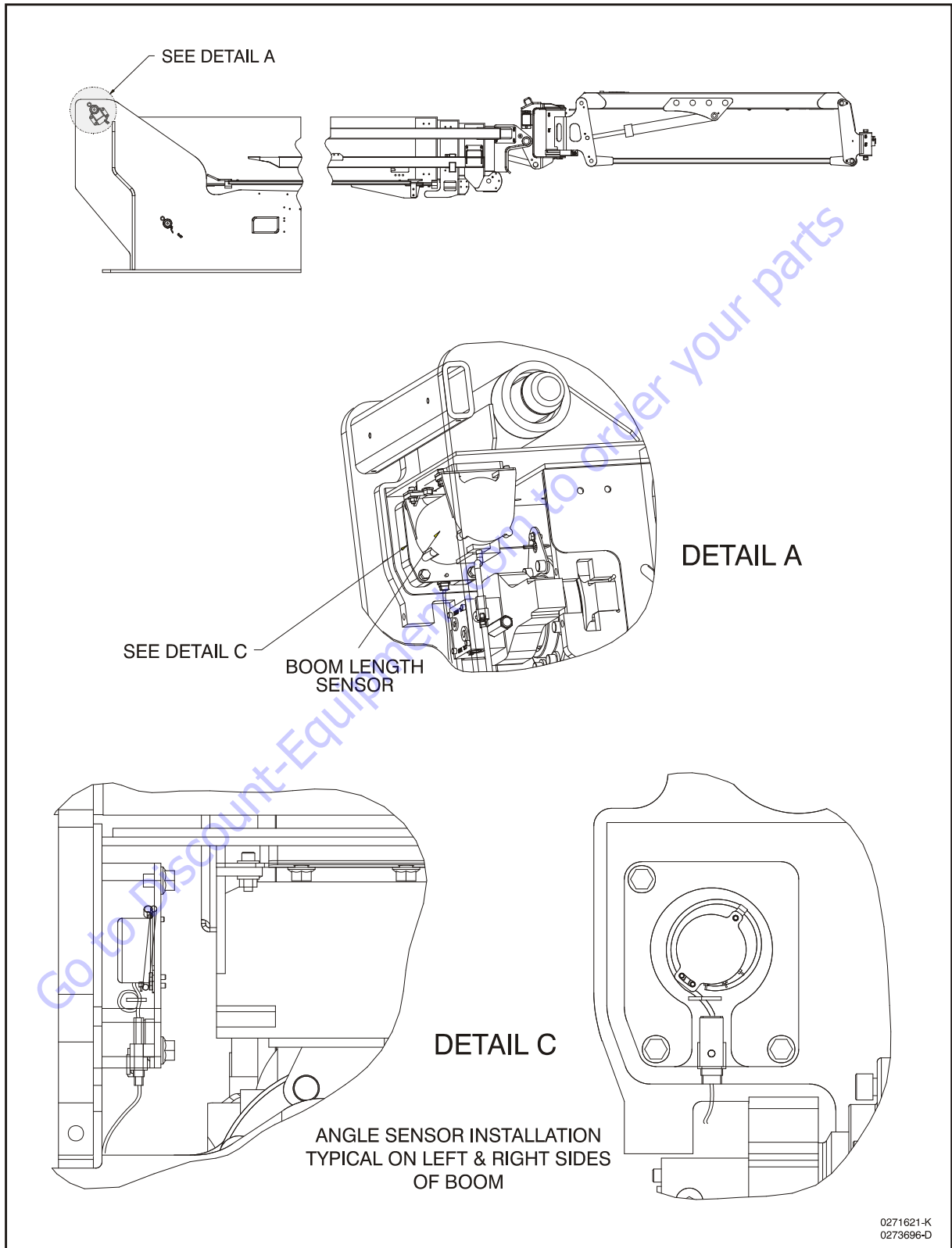
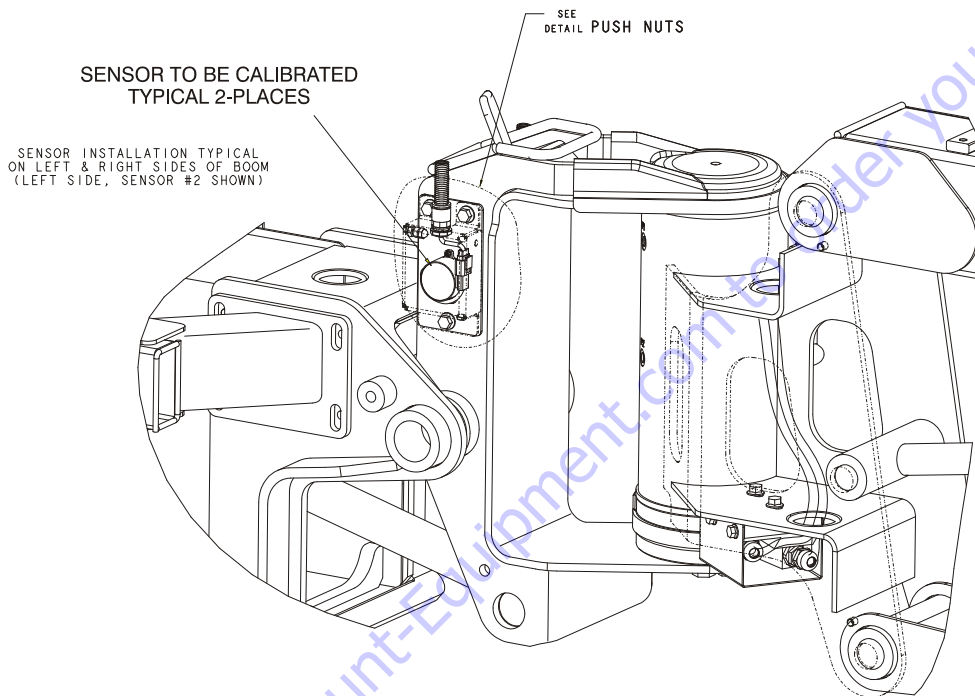
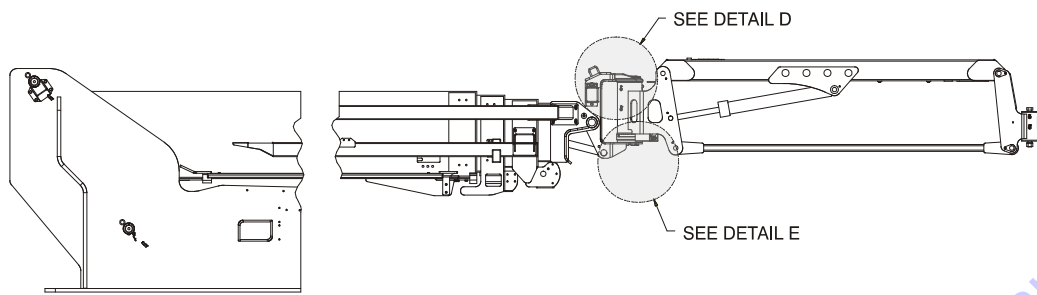


Figure 4-19. Boom/Jib Sensors and Switches Installation - Sheet 1 of 4

SECTION 4 - BOOM & PLATFORM



SENSOR #1			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	YELLOW	BLUE
PIN #3	GROUND	BLACK	BLACK

SENSOR #1			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	WHITE	BLUE
PIN #3	GROUND	BLACK	BLACK

SENSOR #2			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	ORANGE
PIN #2	PWM OUT	YELLOW	YELLOW
PIN #3	GROUND	BLACK	BLACK

SENSOR #2			
PIN #	DESC	SENSOR	HARNESS
PIN #1	POWER	RED	ORANGE
PIN #2	PWM OUT	WHITE	YELLOW
PIN #3	GROUND	BLACK	BLACK

PRIOR TO S/N 77470

S/N 77470 TO PRESENT

DETAIL D

0271621-K
0273696-D

Figure 4-20. Boom/Jib Sensors and Switches Installation - Sheet 2 of 4

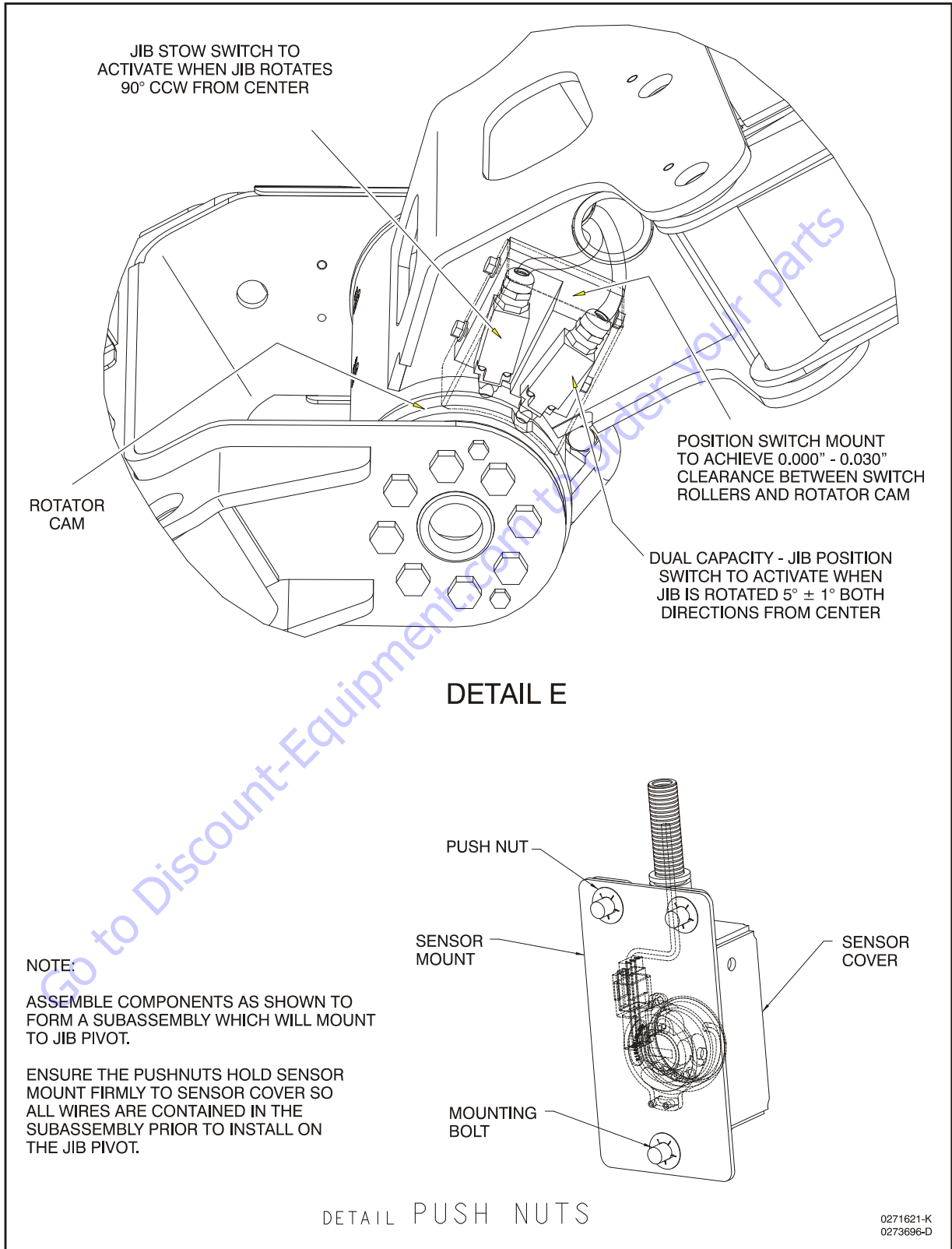


Figure 4-21. Boom/Jib Sensors and Switches Installation - Sheet 3 of 4

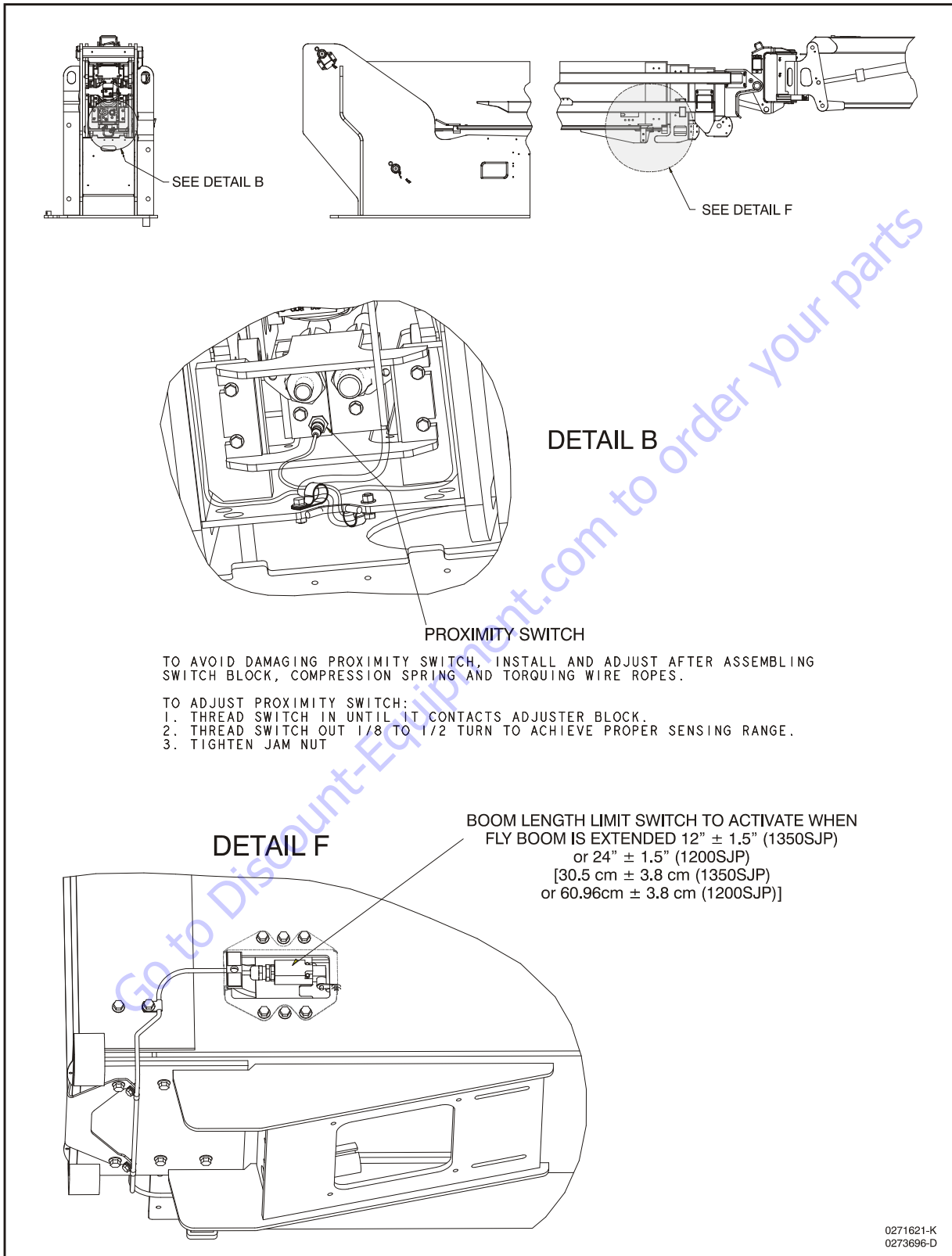


Figure 4-22. Boom/Jib Sensors and Switches Installation - Sheet 4 of 4

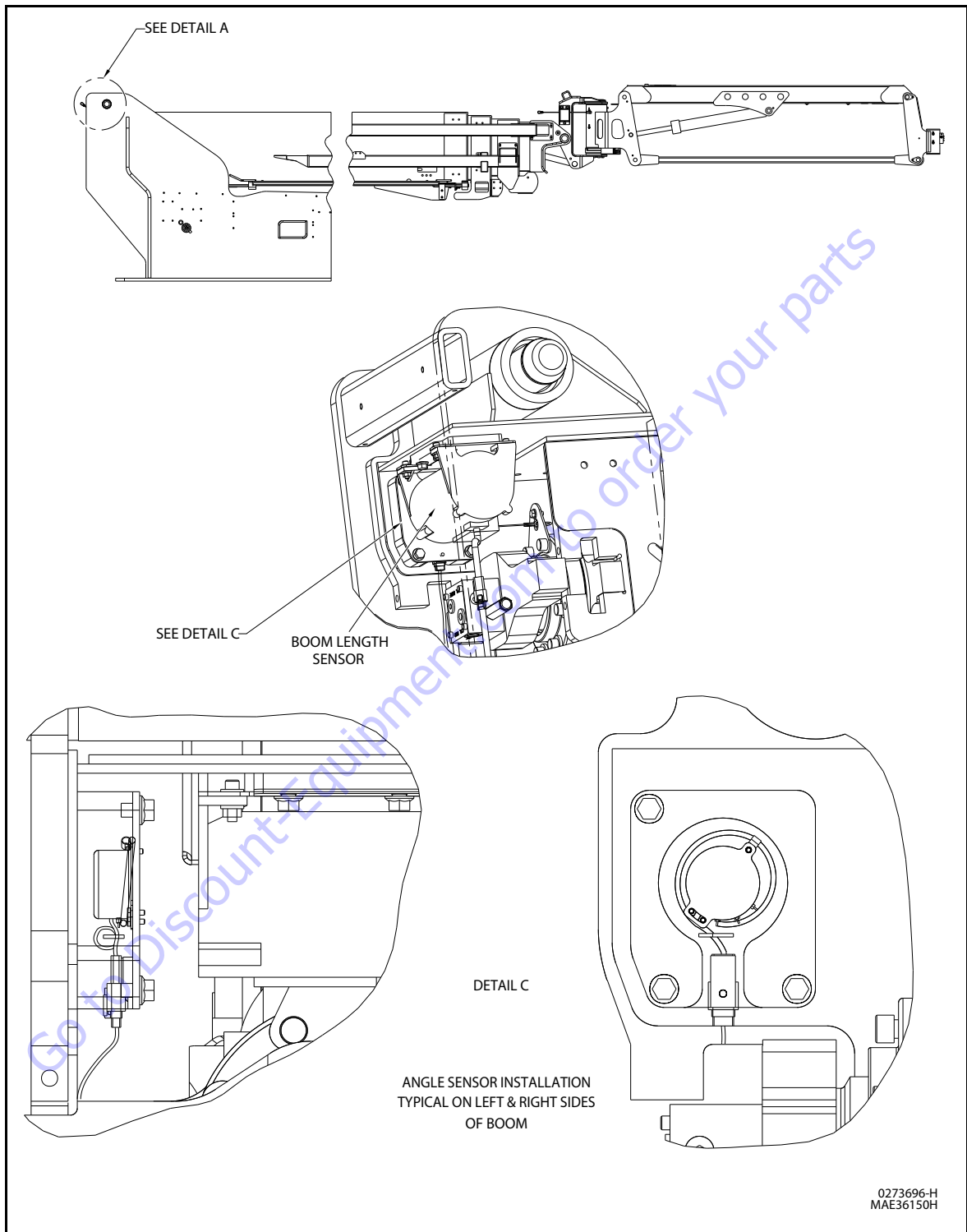


Figure 4-23. Boom/Jib Sensors and Switches Installation - Sheet 1 of 4

SECTION 4 - BOOM & PLATFORM

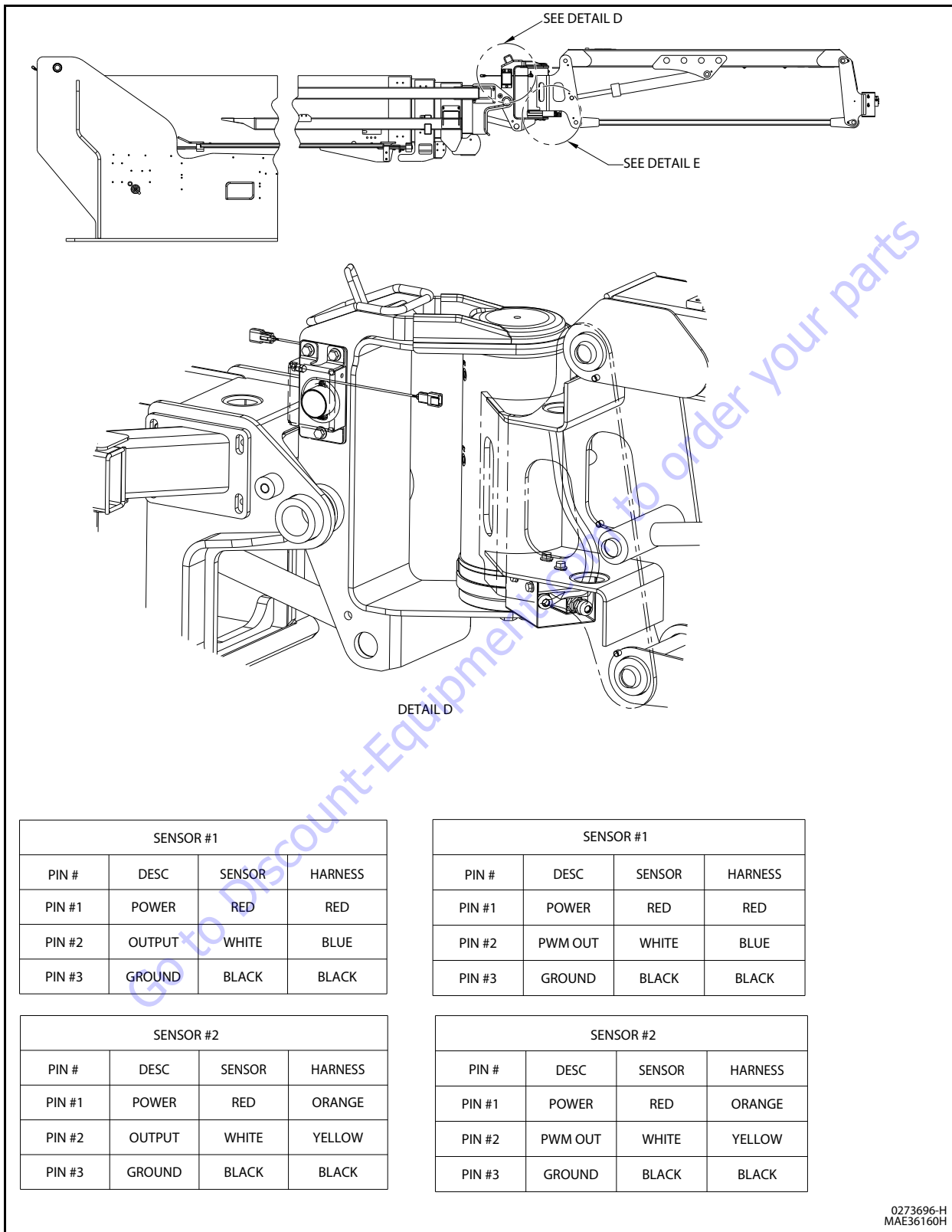


Figure 4-24. Boom/Jib Sensors and Switches Installation - Sheet 2 of 4

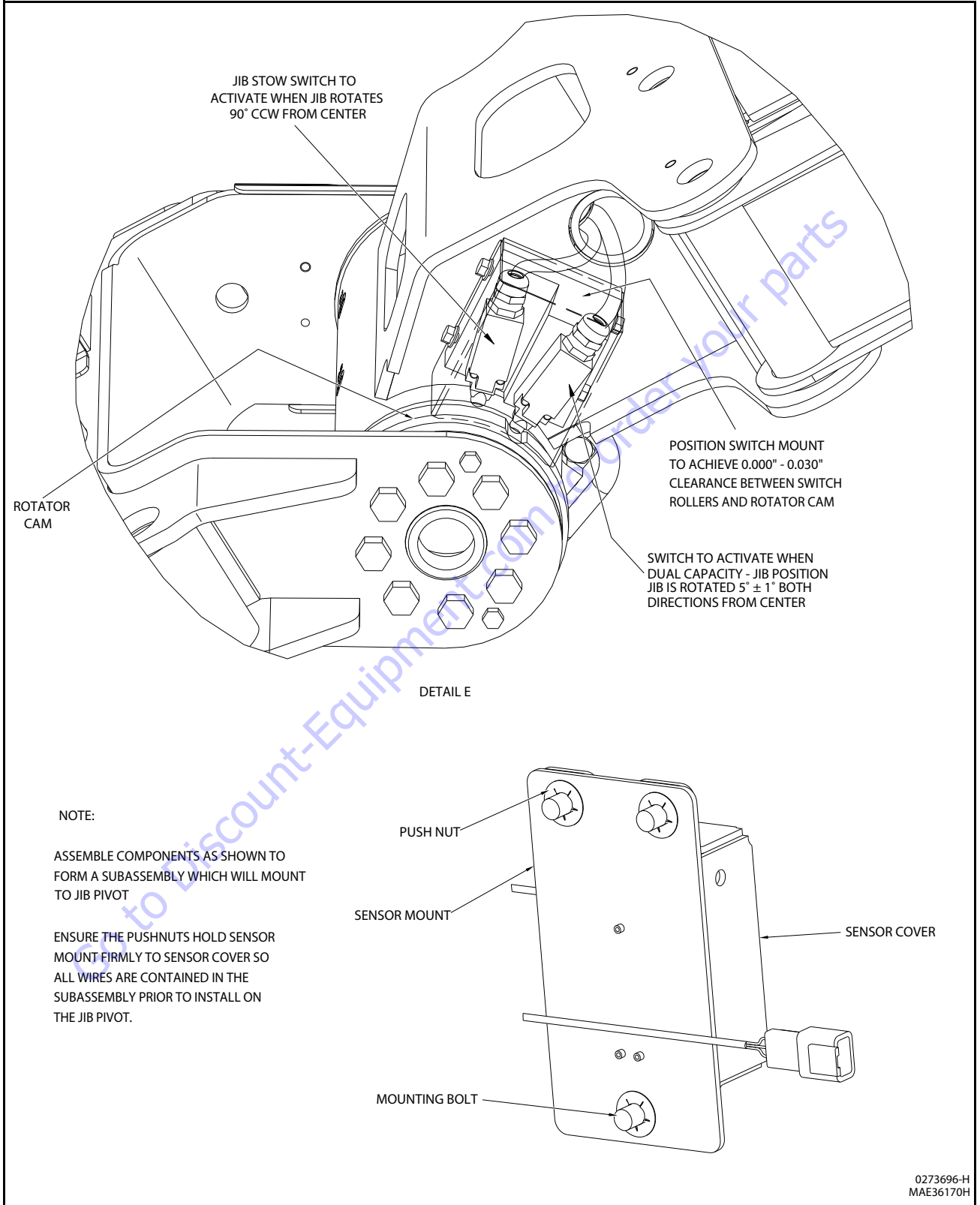


Figure 4-25. Boom/Jib Sensors and Switches Installation - Sheet 3 of 4

SECTION 4 - BOOM & PLATFORM

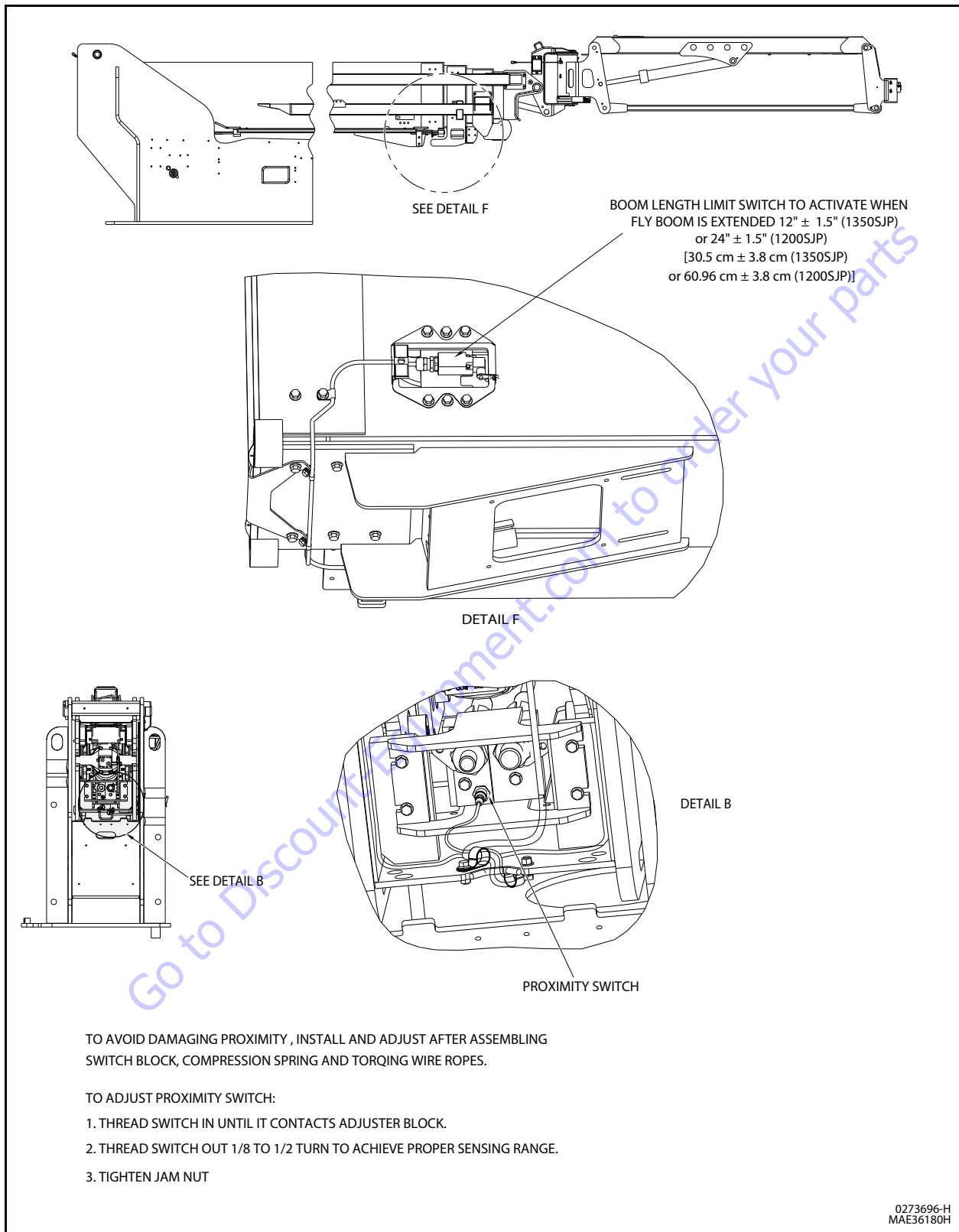
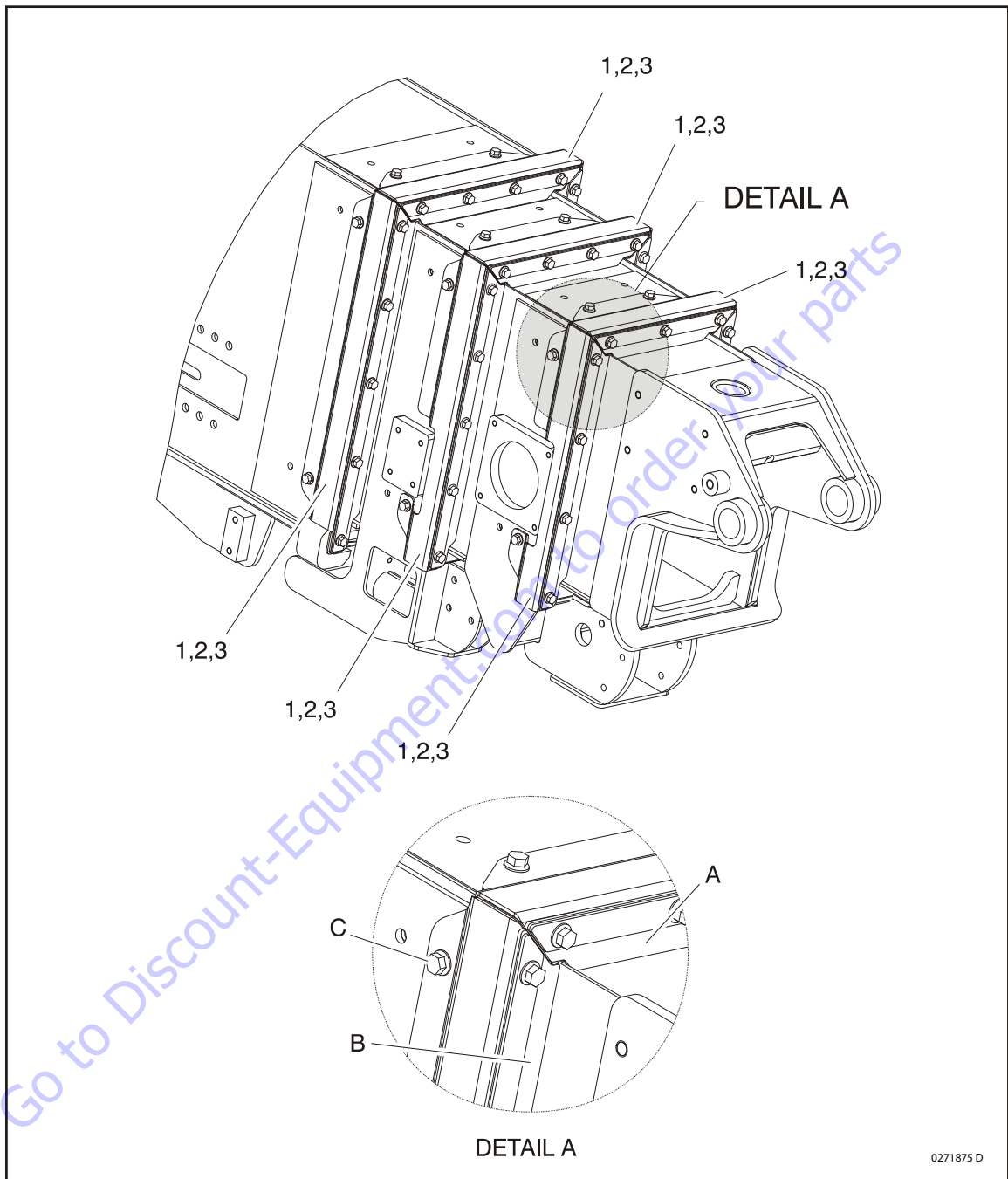


Figure 4-26. Boom/Jib Sensors and Switches Installation - Sheet 4 of 4



- 1. Bar
- 2. Blade
- 3. Mount
- A Adjust top blades 0.000 to 0.063" (0 to 1.6 mm) from top boom plate
- B Adjust side blades 0.000 to 0.063" (0 to 1.6 mm) from side boom plate
- C Apply Threadlocker PN 0100019 & torque to 50 ft.lbs. (70 Nm)

Figure 4-27. Boom Wiper Installation

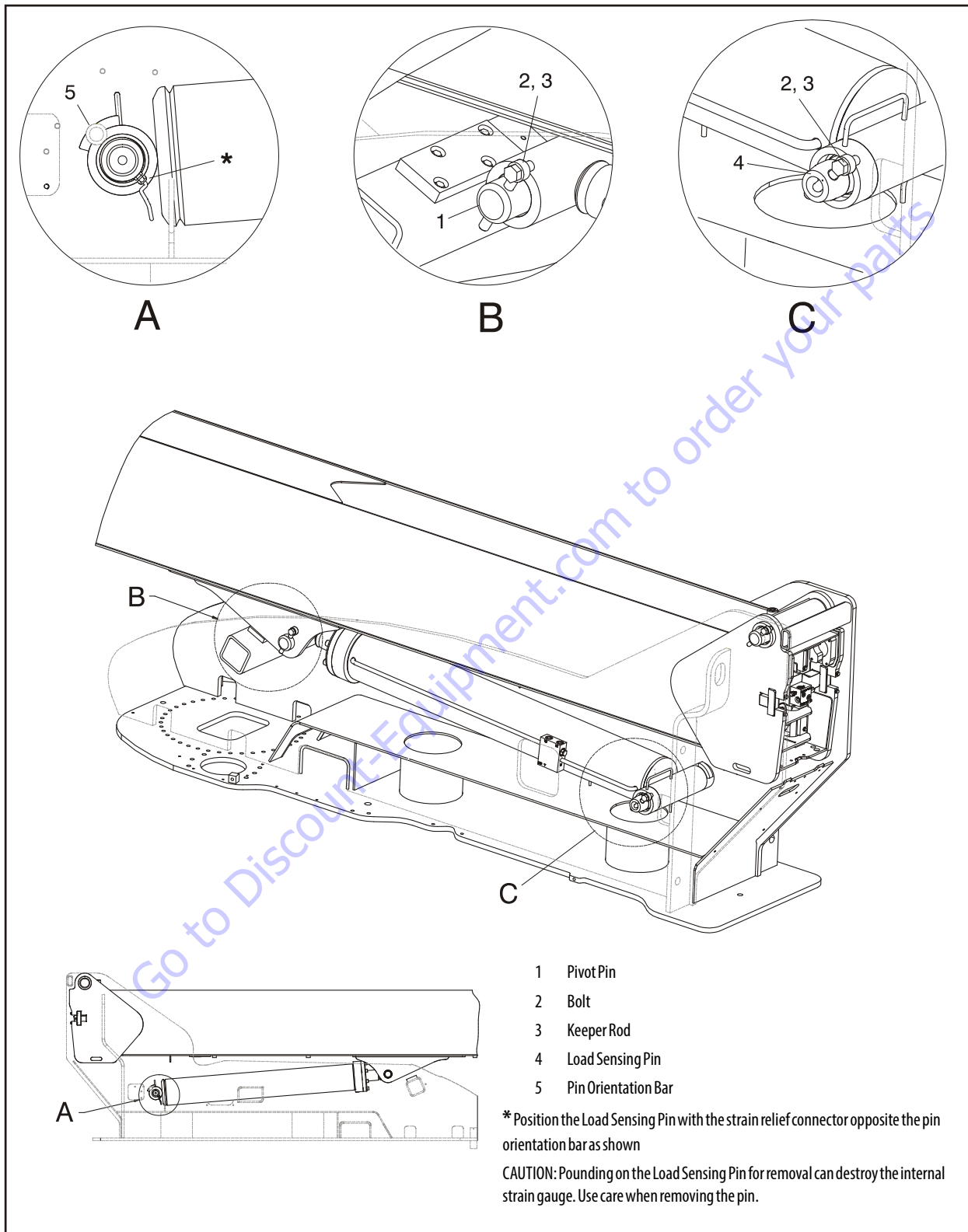
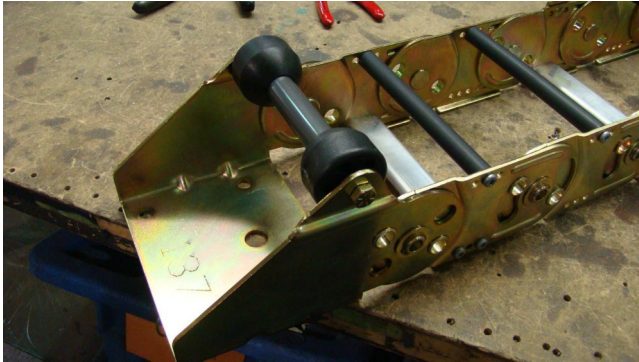


Figure 4-28. Pivot Pin Installation

4.10 POWERTRACK MAINTENANCE

One Piece Bracket Maintenance

1. Place the powertrack on a workbench.



2. Remove the screws from the bars on one side of the powertrack on the first link.



3. Remove the screws from the flat bar on the other side of the powertrack.



4. Pull up on the loose side of the round bar to allow the poly roller to slide off.

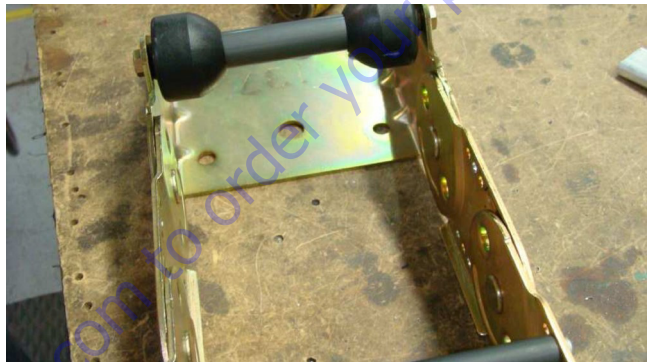
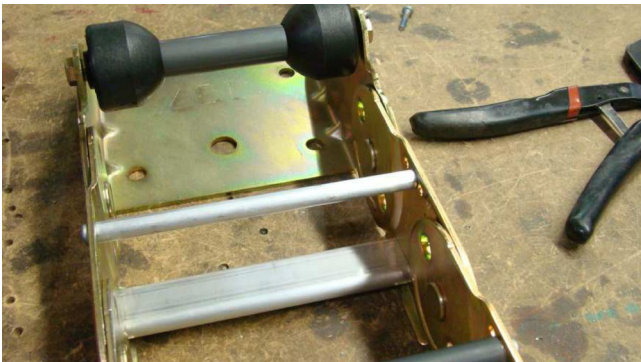
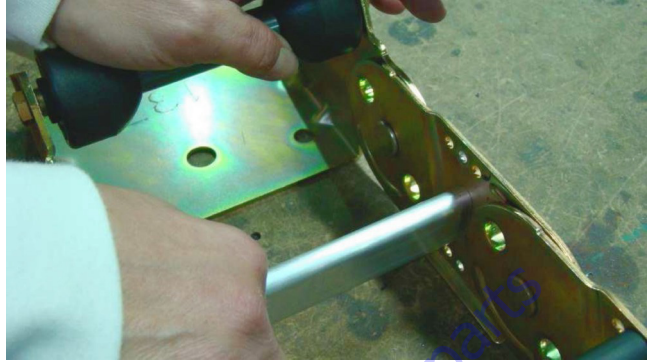


SECTION 4 - BOOM & PLATFORM

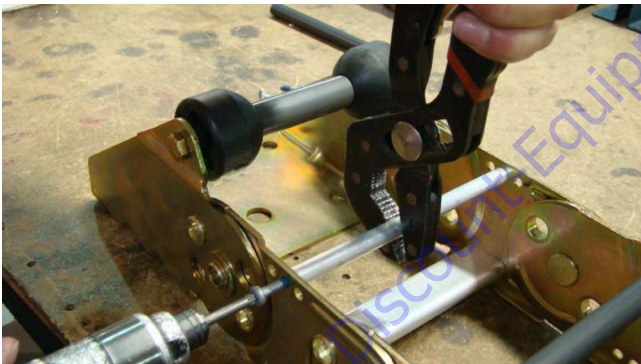
5. Slide the poly roller off of the round bar.



7. Slide the flat bar out.



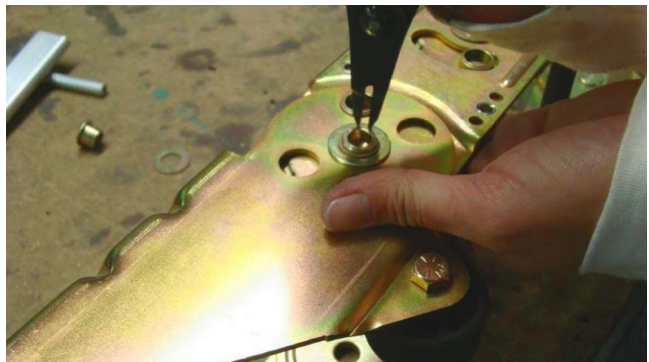
6. Hold the round bar to remove the other screw.



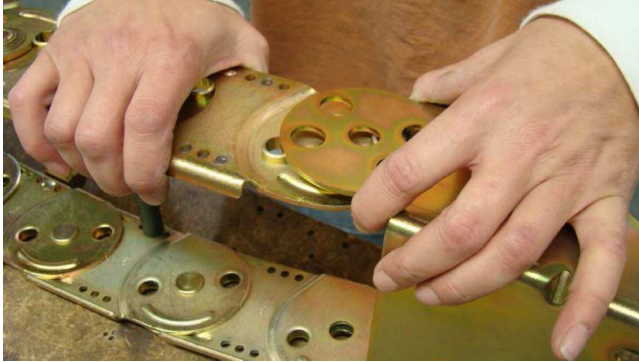
8. Remove the snap ring from one side of the bracket.



9. Remove the snap ring from the other side of the bracket.



10. Push down with slight pressure on the link and slide the bracket side up and over the extrusion on the link.



11. Repeat the previous step on the other side.

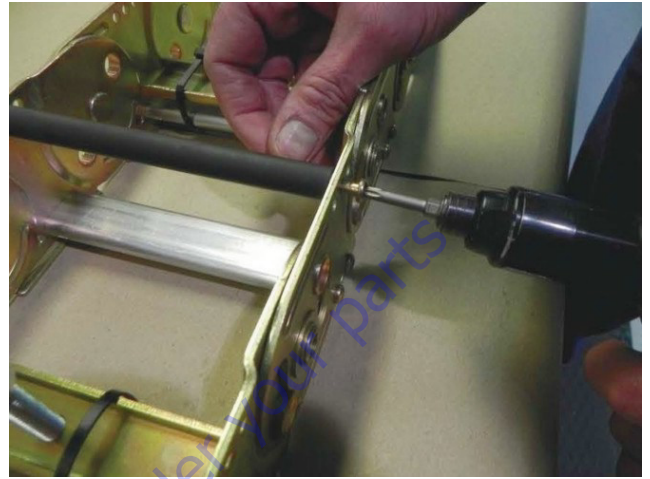


12. Slide the bracket off of the powertrack.

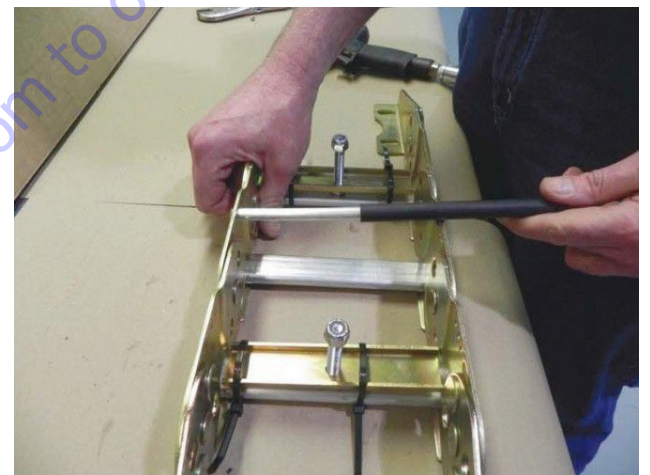


Two Piece Bracket Maintenance

1. Loosen the screw.



2. Slide the roller off the bar.

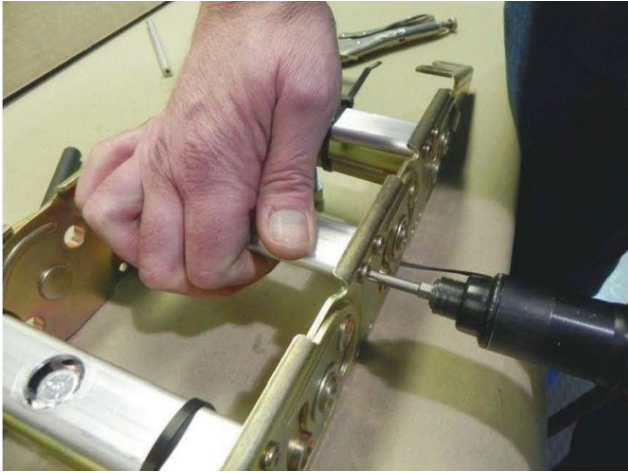


3. Hold the bar tightly and remove the other screw.



SECTION 4 - BOOM & PLATFORM

4. Hold the flat bar and remove the screws.



7. Slide the link out.



5. Remove the snap rings and pins.



6. Remove the screws from the bar. Remove the snap ring and pin.

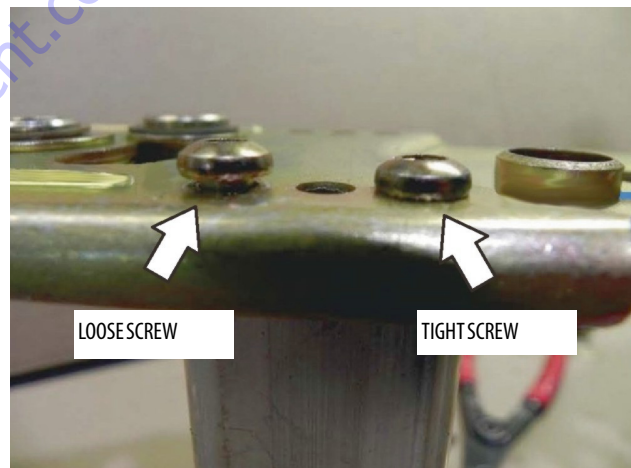


Snap Rings and Screws

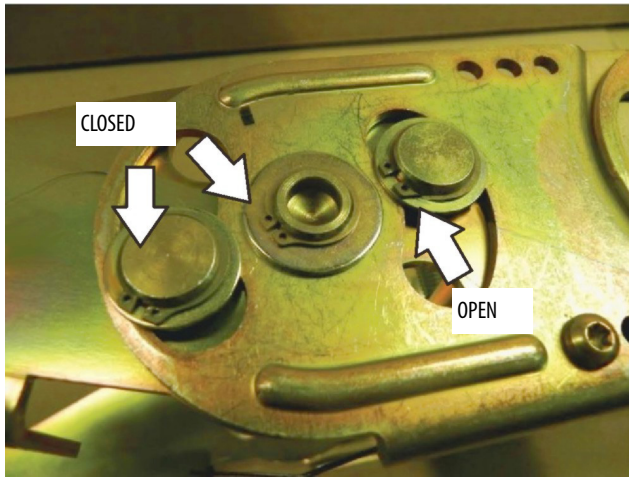
NOTICE

WHEN PERFORMING MAINTENANCE ON THE POWERTRACK, MAKE SURE TO DISCARD AND REPLACE ALL OLD SCREWS.

Make sure screws are tight and installed properly.



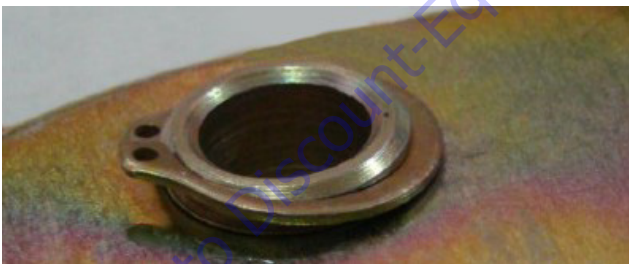
Make sure that all snap rings are closed and seated.



An open snap ring is shown below.



A snap ring that is not seated is shown below.



A seated and closed snap ring is shown below.



10-24 x 0.812 button torx socket head with blue locking patch:

- Tighten to 45-50 in.lbs. (5-5.6 Nm).
- Use T-25 torx bit.
- Do not reuse this screw. After removing replace with a new one.

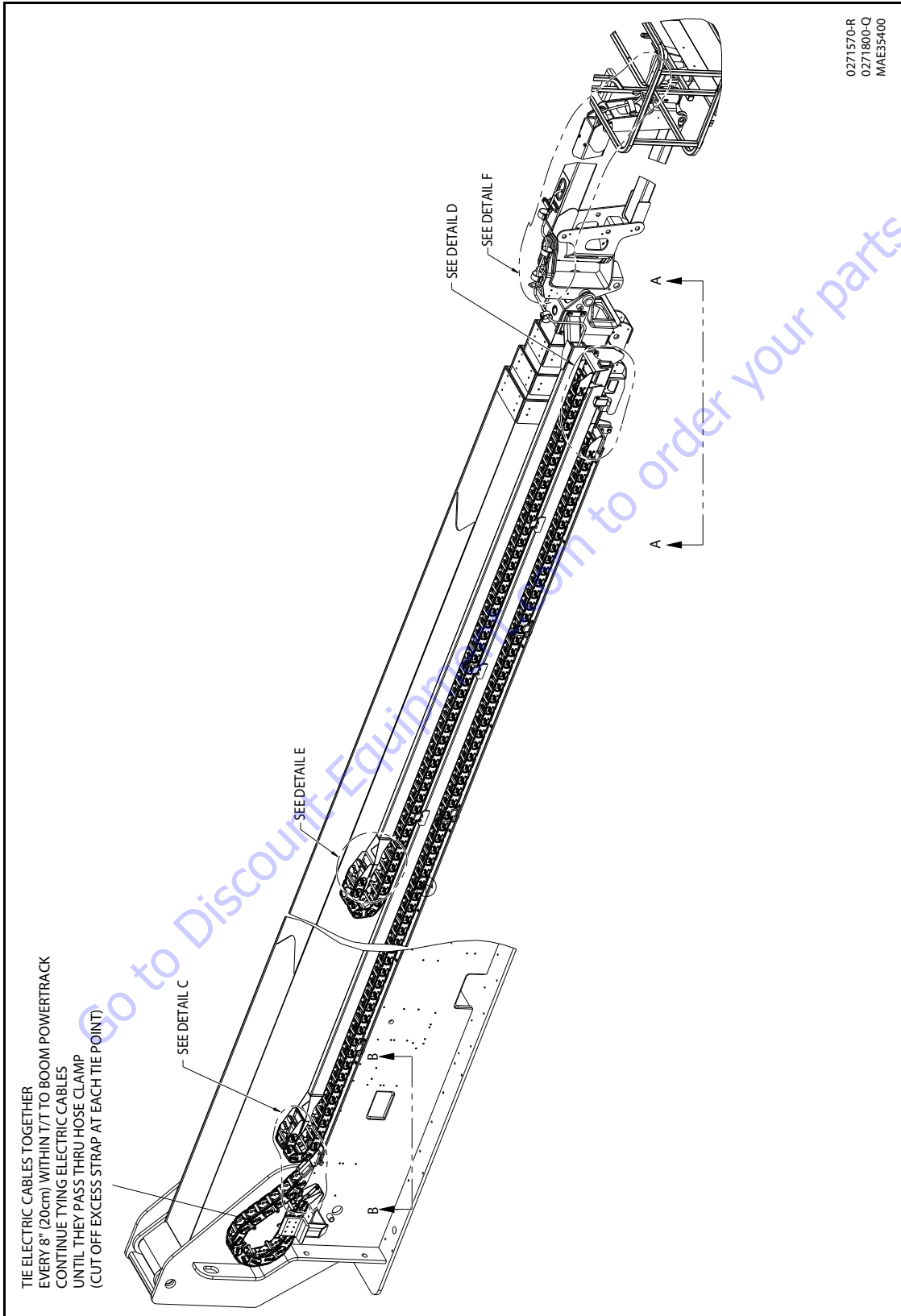


Figure 4-29. Powertrack Installation - Sheet 1 of 6

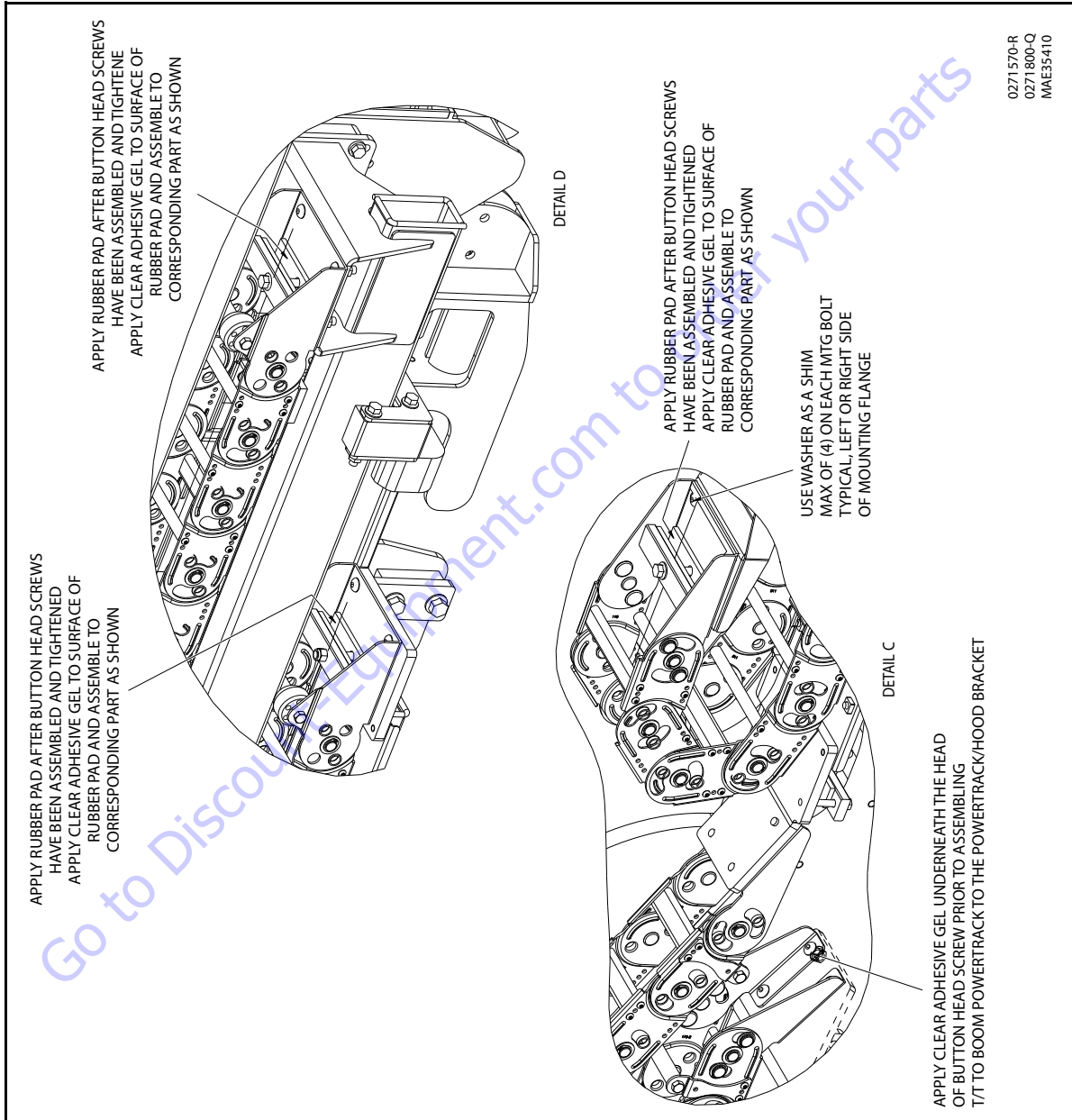


Figure 4-30. Powertrack Installation - Sheet 2 of 6

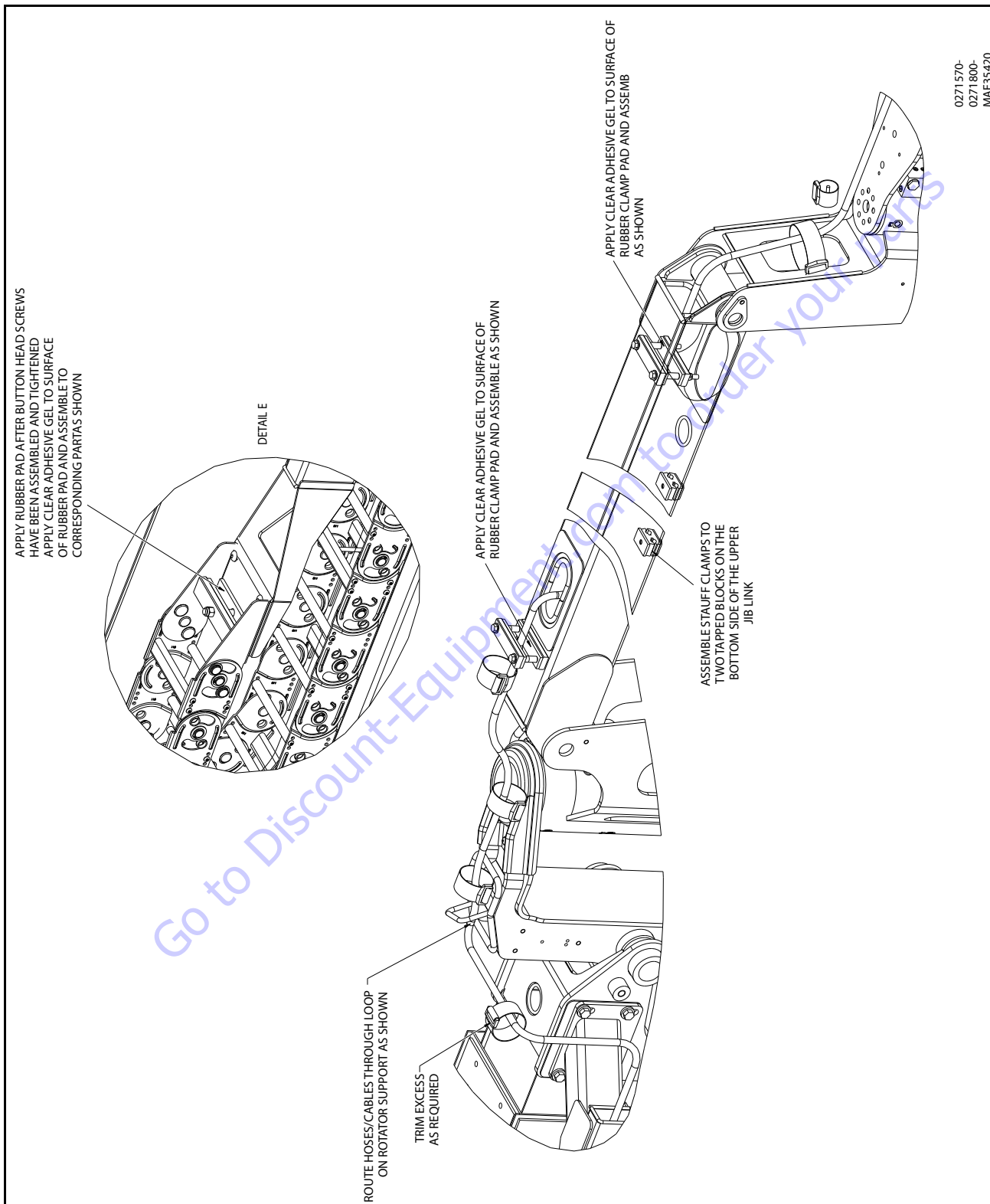


Figure 4-31. Powertrack Installation - Sheet 3 of 6

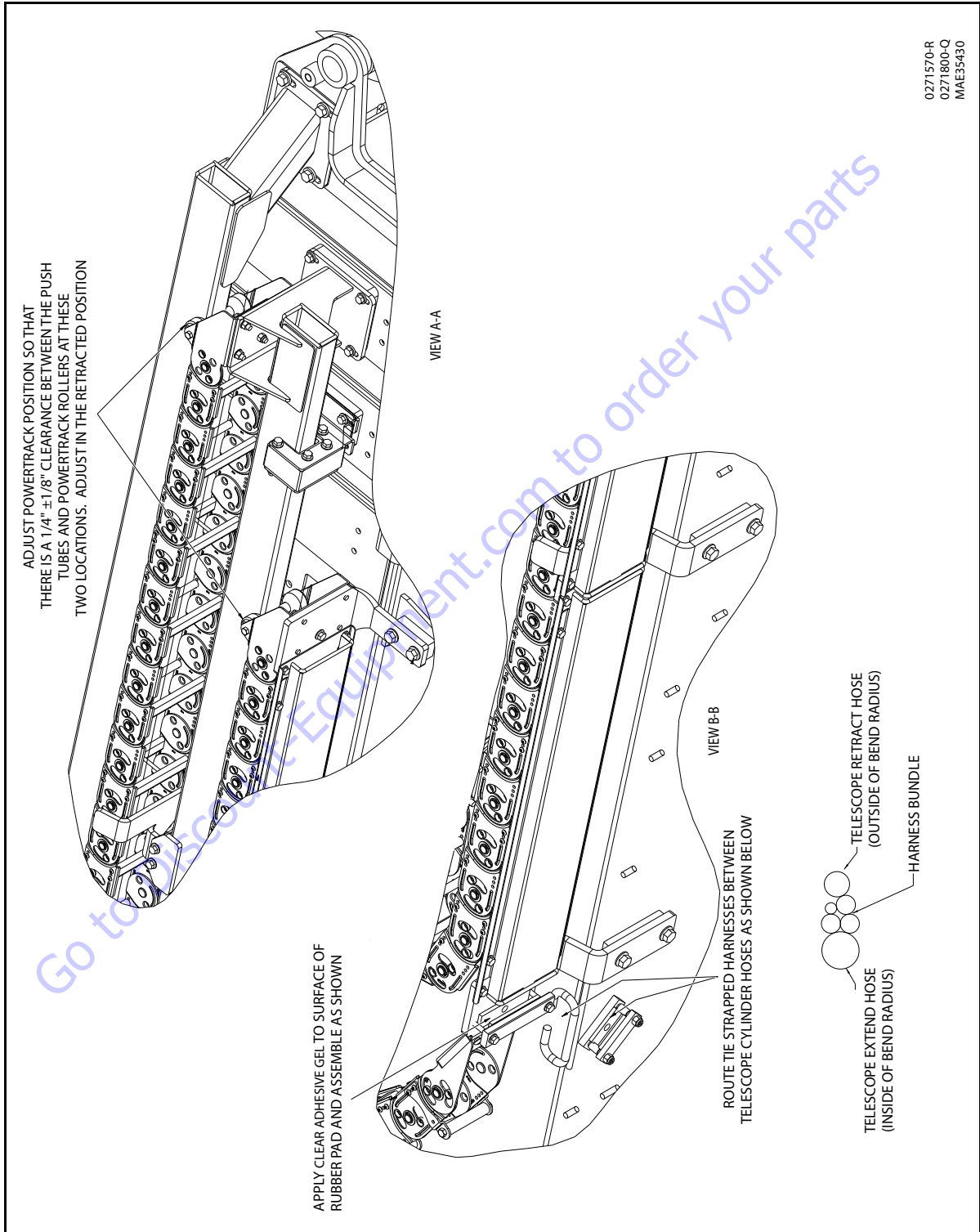


Figure 4-32. Powertrack Installation - Sheet 4 of 6

Table 4-2. Hose/Cable Pull Chart

LETTER	DESCRIPTION	DIM "X"	
		IN.	CM
P	LEVEL UP HOSE (PORT L1)	64	162.5
Q	LEVEL DOWN HOSE (PORT L2)	64	162.5
R	SWING RIGHT HOSE (PORT S1)	64	162.5
S	SWING LEFT HOSE (PORT S2)	64	162.5
T	JIB LIFT UP HOSE (PORT J1)	64	162.5
U	JIB LIFT DOWN HOSE (PORT J2)	64	162.5

NOTE: ALL CABLE HOSE LENGTHS TO BE ± 1" (2.5 cm)

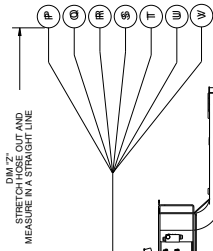
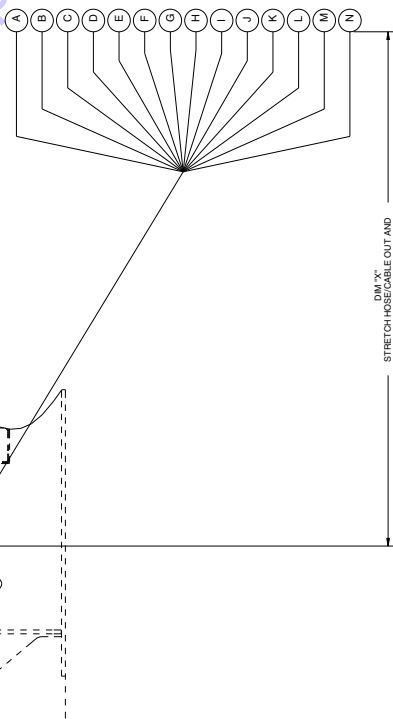


Table 4-1. Hose/Cable Pull Chart

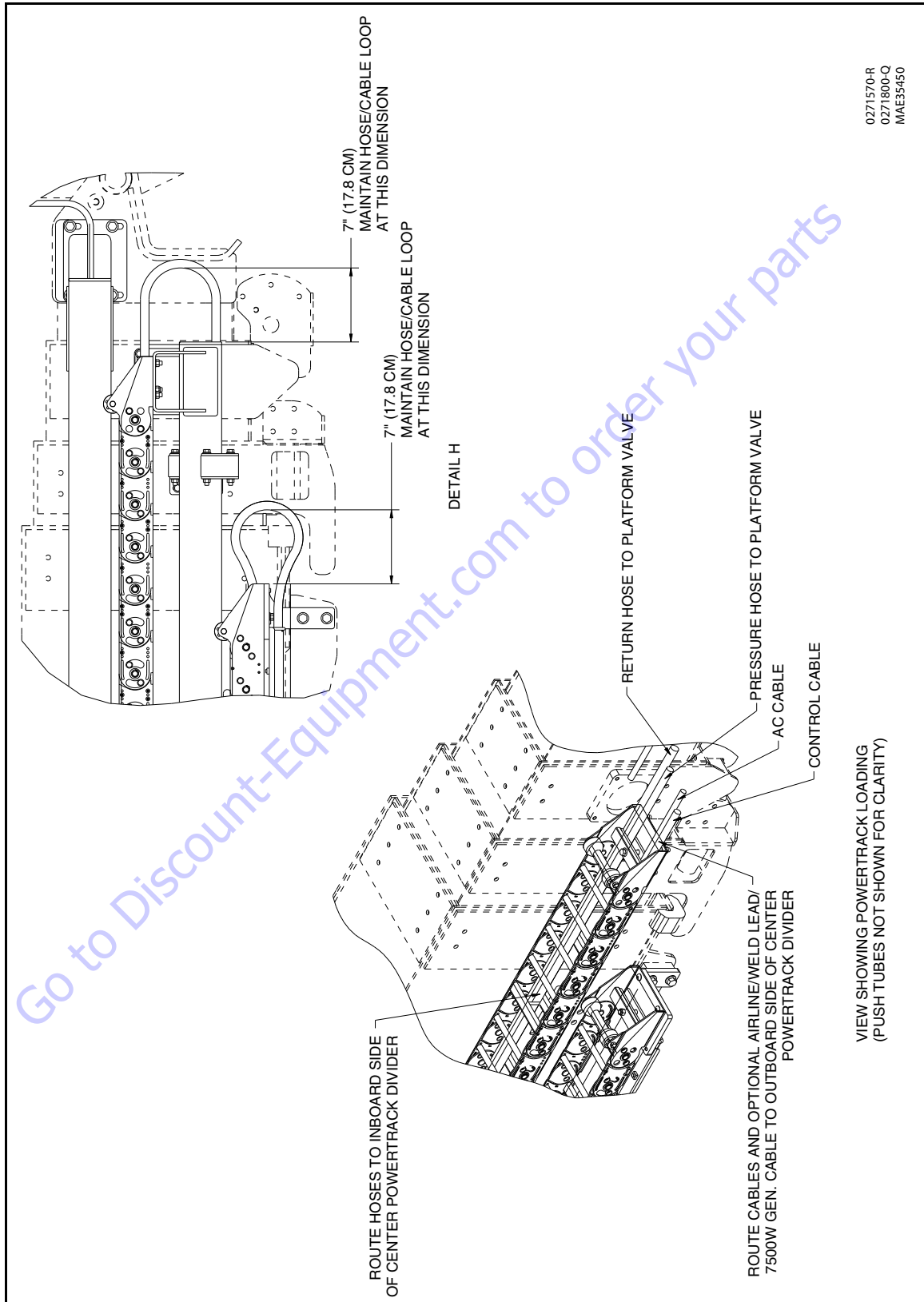
LETTER	DESCRIPTION	DIM "X"	
		FT. (IN.)	CM
A	HARNES, TRANSPORT LIMIT SWITCH (18/3 CABLE)	6 (72)	182.8
B	HARNES, BOOM ANGLE SENSOR (LEFT) (18/3 CABLE)	1.5 (18)	45.8
C	HARNES, BOOM ANGLE SENSOR (RIGHT) (18/3 CABLE)	1.5 (18)	45.8
D	HARNES, BOOM LENGTH SENSOR (18/3 CABLE)	1.5 (18)	45.8
E	BROKEN CABLE PROXIMITY SENSOR (YELLOW CABLE)	5 (60)	152.4
F	ACC CABLE (10/3)	13 (156)	396.2
G	CONTROL CABLE (18/8)	6 (72)	182.8
H	TELESCOPE EXTEND HOSE (5/8 10M3K)	7 (84)	213.3
I	TELESCOPE RETRACT HOSE (1/2 8M3K)	7 (84)	213.3
J	PRESSURE HOSE TO PLATFORM VALVE (3/8 6M4K)	6 (72)	182.8
K	RETURN HOSE TO PLATFORM VALVE (1/2 8M8K)	6 (72)	182.8
L	AIR LINE (1/2 8LO/A) OPTIONAL	10 (120)	304.8
M	WELD LEAD (3/0 CABLE) OPTIONAL	10 (120)	304.8
N	7500W GENERATOR (8/5 CABLE) OPTIONAL	10 (120)	304.8

NOTE: ALL CABLE HOSE LENGTHS TO BE ± 1" (2.5 cm)



0271570-R
0271800-Q
MAE35440

Figure 4-33. Powertrack Installation - Sheet 5 of 6



Go to Discount-Equipment.com to order your parts

Figure 4-34. Powertrack Installation - Sheet 6 of 6

4.11 HOSE ROUTING PROCEDURE

For proper hose routing and cable wrap placement and clamping, refer to Figure 4-29., Figure 4-30., Figure 4-31., Figure 4-32., Figure 4-33., and Figure 4-34. It is important to periodically inspect hoses, wraps and clamps for proper slack adjustments and clamping integrity (pull check). Any changes as a result of inspection should be verified by performing full strokes of boom functions especially lift, telescope, jib, and platform rotate.

4.12 WIRE ROPE

⚠ WARNING

IF DELAYED MOVEMENT IS DETECTED IN WIRE ROPE OPERATION, LOWER PLATFORM TO STOWED POSITION, SHUT DOWN MACHINE, AND HAVE WIRE ROPES INSPECTED/SERVICED BY A QUALIFIED JLG MECHANIC. LOOSE OR MISADJUSTED WIRE ROPES COULD RESULT IN SERIOUS INJURY OR DEATH.

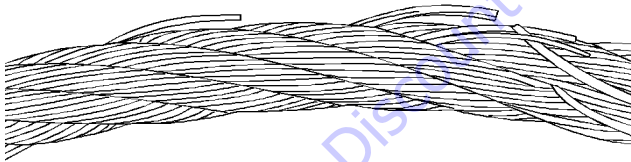
Each day before using the machine:

1. Raise the main boom to approximately horizontal.
2. Extend and retract the boom sections.
3. Check for delayed movement of the fly section, which indicates loose wire ropes.

Inspection

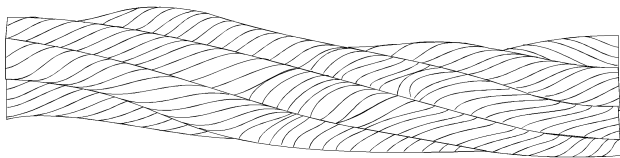
NOTE: *The pictures in this paragraph are just samples to show the replacement criteria of the rope.*

1. Inspect ropes for broken wires, particularly valley wire breaks and breaks at end terminations.



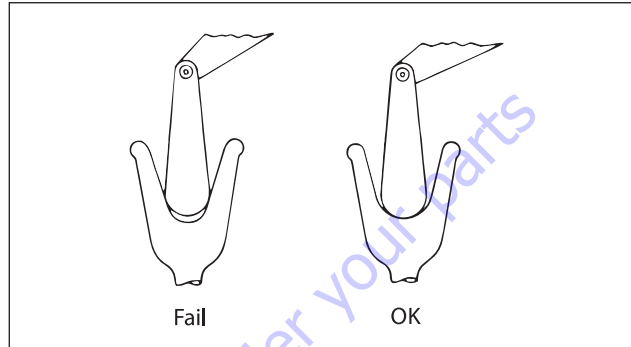
Flexing a wire rope can often expose broken wires hidden in valleys between strands.

2. Inspect ropes for corrosion.
3. Inspect ropes for kinks or abuse.



A kink is caused by pulling down a loop in a slack line during improper handling, installation, or operation.

4. Inspect sheaves for condition of bearings/pins. (See Dimension Of Sheaves for proper dimension.)
5. Inspect sheaves for condition of flanges. (See Dimension Of Sheaves for proper dimension.)
6. Inspect sheaves with a groove wearout gauge for excessive wear.



Observe the groove so that it may be clearly seen whether the contour of the gauge matches the contour of the bottom of the groove.

7. Ropes passing inspection should be lubricated with wire rope lubricant before reassembly.

Three Month Inspection

1. Remove boom covers and visually (with flashlight) inspect the ropes for rust, broken wires, frays, abuse, or any signs of abnormalities.
2. Check rope tension by deflecting the ropes by hand properly tensioned ropes should have little or no movement.

Additional Inspection Required If:

1. Machine is exposed to hostile environment or conditions.
2. Erratic boom operation or unusual noise exists.
3. Machine is idle for an extended period.
4. Boom is overloaded or sustained a shock load.
5. Boom exposed to electrical arc. Wires may be fused internally.

12 Year or 7000 Hour Replacement

1. Mandatory wire rope and sheave replacement.

Additional Replacement Criteria

1. Sheaves and wire rope must be replaced as sets.
2. Rusted or corroded wire ropes.
3. Kinked, "bird caged", or crushed ropes.
4. Ropes at end of adjustment range.
5. Sheaves failing wearout gage inspection.
6. Ropes with 6 total broken wires in one rope lay, 3 in one strand in one rope lay, 1 valley break, or 1 break at any end termination.

4.13 WIRE ROPE TENSIONING ADJUSTMENT

NOTICE

ANY TIME THE WIRE ROPE TENSIONING HAS BEEN ADJUSTED, BOOM CALIBRATION SHOULD BE PERFORMED IMMEDIATELY AFTERWARD.

Before adjusting wire rope tension, the boom sections must be in the proper position as shown in Figure 4-36., Wire Rope Tensioning. This is so the wire ropes are equalized on both sides of the sheaves and are seated properly in the sheave grooves. This is necessary for proper tensioning of the wire ropes.

This section covers the two major operations in tensioning the wire ropes which are as follows:

- Positioning the boom sections (so that proper tensioning can be achieved).
- Tensioning the wire rope.

Boom Section Re-Positioning

NOTE: Because the Outer Mid Boom is used to control the movement of the Fly Boom, any repositioning of the Outer Mid Boom section will also affect the position of the Fly Boom section. Correctly position the Outer Mid Boom before repositioning the Fly Boom.

NOTE: Use the Telescope function of the machine to position the boom sections. Do not use the wire rope adjustment nuts to position the booms. This may cause damage to the wire rope adjustment threads.

1. Ensure the machine is placed on firm, level ground.
2. Before making any adjustments, position the boom assembly in the fully retracted position.
3. Take preliminary measurements of the position of each boom section and compare them to Figure 4-36., Wire Rope Tensioning. If the measurements fall within the tolerances in the figure, proceed to Wire Rope Tensioning in this section.

NOTICE

PROPER BOOM POSITIONS DO NOT MEAN THAT THE WIRE ROPE TENSIONS ARE CORRECT.

If the measurements do not fall within the tolerances in Figure 4-36., Wire Rope Tensioning, adjust the booms using the re-positioning procedures that follow.

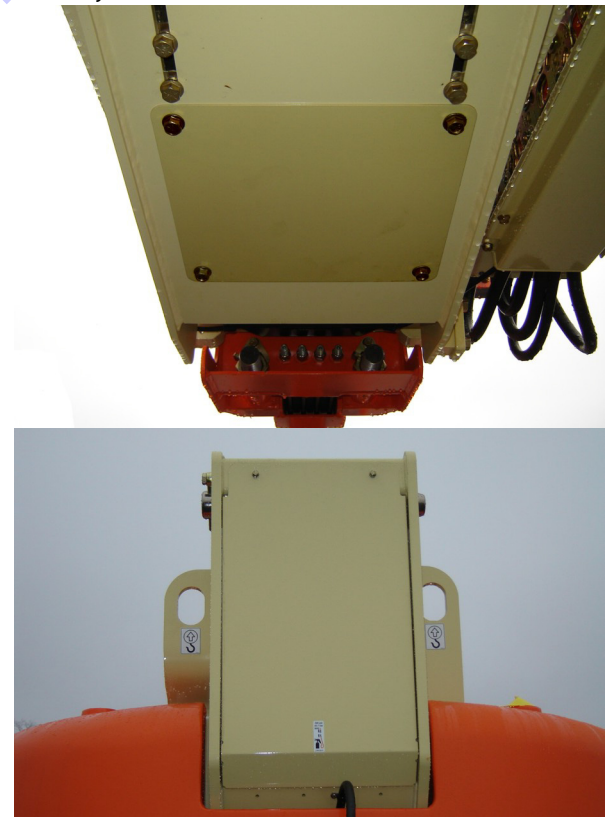
INNER MID BOOM SECTION REPOSITIONING

The inner mid section of the boom is positioned by the hydraulic cylinder. No adjustments can be made to this section. The wire ropes within the assembly only control the movement of the Outer Mid Boom and Fly Boom sections.

OUTER MID BOOM SECTION REPOSITIONING

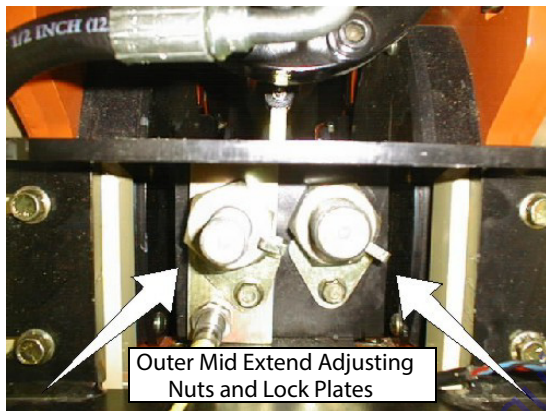
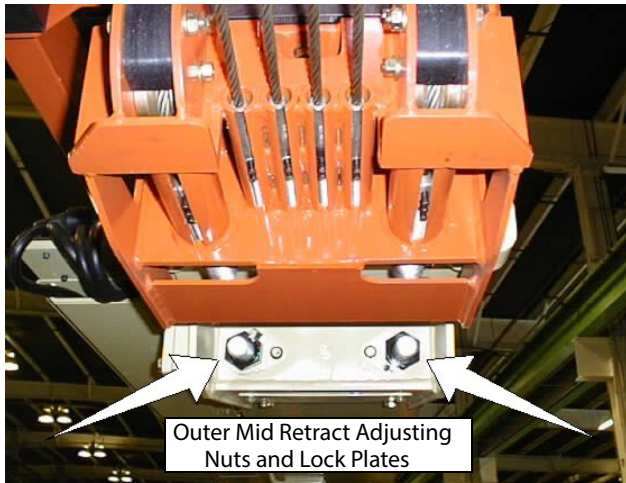
If the Outer Mid Boom falls within the dimension and tolerance of Figure 4-36., Wire Rope Tensioning, proceed to the Fly Boom Section Positioning procedure in this section. If the Outer Mid Boom section is outside of the tolerance as shown, perform the following procedure.

1. Extend the boom assembly so the platform moves 5 to 6 feet (1.5 to 1.8 m) from the fully retracted position.
2. Remove any covers necessary to access the wire rope adjustment nuts.



SECTION 4 - BOOM & PLATFORM

3. Remove the lock plates and nylon collar locknuts from the wire rope adjustment nuts.



4. If the Outer Mid Boom needs to be retracted:
 - a. Loosen the Outer Mid Boom Extend Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance.
 - b. Fully retract the boom.
 - c. To remove the slack caused by the previous step, tighten the Outer Mid Boom Extend Adjustment Nuts until they just contact the plate.
5. If the Outer Mid Boom needs to be extended out:
 - a. Loosen the Outer Mid Boom Retract Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance
 - b. Extend the boom 3-4 feet (1-1.5m).
 - c. To remove the slack caused by the previous step, tighten the Outer Mid Boom Retract Adjustment Nuts until they just contact the plate.
6. Fully retract the boom sections.
7. Verify that the exposed boom section dimensions meet the dimensions and tolerances of Figure 4-36., Wire Rope Tensioning.

- a. If the Outer Mid Boom still does not fall within the dimension and tolerance of Figure 4-36., repeat the Outer Mid Boom positioning procedure.
- b. If the Outer Mid Boom falls within the dimension and tolerance of Figure 4-36., proceed to the Fly Boom Section Positioning procedure in this section.

NOTE: Because the Outer Mid Boom is used to control the movement of the Fly Boom, any repositioning of the Outer Mid Boom Section will also affect the position of the Fly Boom section. After repositioning the Outer Mid Boom, always check the Fly Boom position per Figure 4-36.

FLY BOOM SECTION REPOSITIONING

If the Fly Boom section location and the Outer Mid Boom section location are both within the dimensions and tolerances in Figure 4-36., proceed to the Wire Rope Tensioning Procedure in this section.

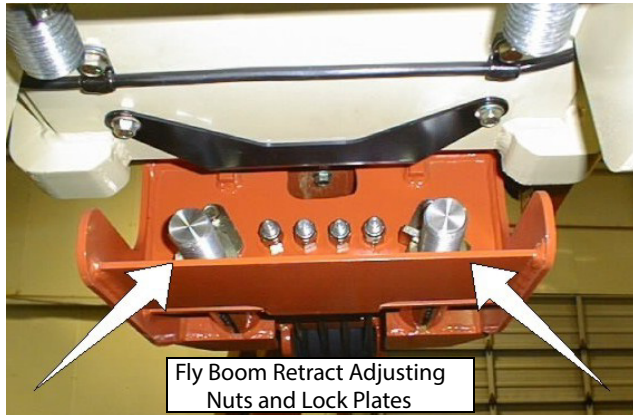
If the Fly Boom section is outside of the tolerance as shown in Figure 4-36. while the boom assembly is fully retracted, perform the following procedure:

1. Extend the boom assembly such that the platform moves 5 to 6 feet (1.5-1.8 m) from the fully retracted position.
2. Remove the lock plates and nylon collar locknuts from the wire rope adjustment nuts.
3. If the Fly Boom needs to be retracted farther in:
 - a. Loosen the Fly Boom Extend Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance.



- b. Fully retract the boom.
- c. To remove the slack caused by the previous step, tighten the Fly Boom Extend Adjustment Nuts until they just contact the plate.

4. If the Fly Boom needs extended:
 - a. Loosen the Fly Boom Retract Adjustment Nuts by an amount equal to twice the distance the boom needs to move to be in tolerance.



- b. Extend the boom 3-4 feet (1-1.5m).
 - c. To remove the slack caused by the previous step, tighten the Fly Boom Retract Adjustment Nuts until they just contact the plate.
 - d. Fully retract the boom sections.
5. Verify that the exposed boom section dimensions meet the dimensions and tolerances of Figure 4-36., Wire Rope Tensioning.
 - a. If the Fly Boom still does not fall within the dimension and tolerance of Figure 4-36., repeat the Fly Boom Section Repositioning procedure.
 - b. If the Fly Boom falls within the dimension and tolerance of Figure 4-36., proceed to the Wire Rope Tensioning Procedure.

Wire Rope Tensioning Procedure

NOTE: Verification of the rope tension should be determined by proper function of the boom assembly and by the dimensions and tolerances of Figure 4-36., Wire Rope Tensioning.

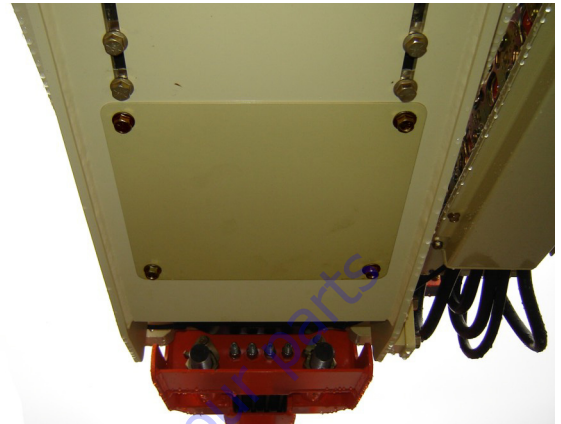
NOTICE

REPEAT WIRE ROPE TENSIONING PROCEDURE ONLY AS NECESSARY TO ACHIEVE PROPER TENSION.

NOTICE

IF THE BOOMS HAVE BEEN PROPERLY POSITIONED AND THERE IS NOT ENOUGH ADJUSTMENT REMAINING ON THE WIRE ROPES TO ACHIEVE TORQUE, THE SERVICE LIFE OF THE WIRE ROPES HAS BEEN CONSUMED. DO NOT PROCEED WITH THE REMAINDER OF THIS PROCEDURE. REPLACE THE WIRE ROPES AND SHEAVES.

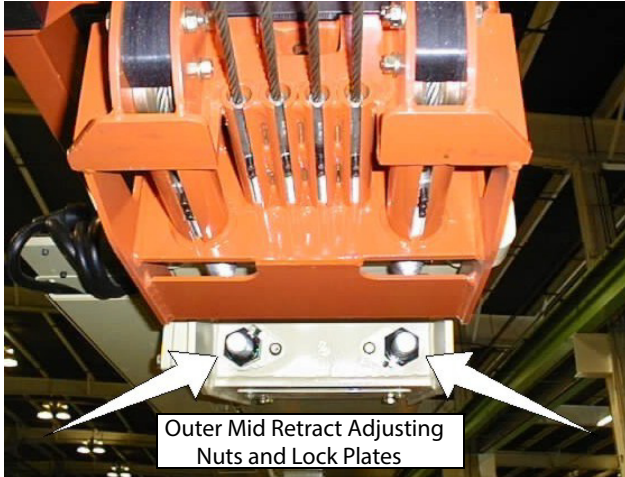
1. Remove any covers necessary to access the wire rope adjustment nuts.



2. If not already done, remove the lock plates and nylon collar locknuts from the wire rope adjustment nuts.
3. Position the boom so that it is horizontal within $\pm 5^\circ$. If the boom is below horizontal, ensure that the boom is not on the boom rest.
4. Extend the boom so the platform moves 5 to 6 feet (1.5-1.8 m) from the fully retracted position. This is done to position the boom so the ropes to be tensioned are not under load.
5. When extending the boom in the previous step, if the boom reaches the end of travel and then automatically retracts a small amount, the ropes may still be under load. If so, perform the following steps:
 - a. Note where the boom hits the end of stroke.
 - b. Retract 3-4 feet (1-1.3 m).
 - c. Extend the boom and stop just before the boom hits the end of stroke.

SECTION 4 - BOOM & PLATFORM

- Using tool JLG PN 4120043, torque the Outer Mid Boom Retract Adjustment Nuts to 80 ft-lb (108 Nm), alternating between the two ropes until both maintain the required torque.

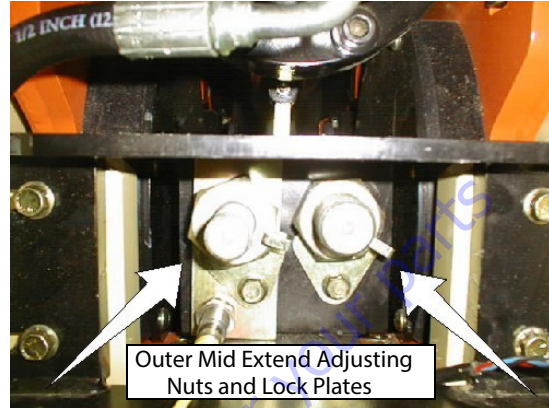


- Using tool JLG PN 4120043, torque the Fly Boom Retract Adjuster Nuts to 80 ft-lb (108 Nm), alternating between the two ropes until both maintain the required torque.



- Retract the boom 2-3 feet (0.6-1.0 m). Do not fully retract or bottom out the booms.

- Using tool JLG PN 4120043, torque the Outer Mid Boom Extend Adjustment Nuts to 80 ft-lb (108 Newton meters), alternating between the two ropes until both maintain the required torque.



- Using tool JLG PN 4120040, torque the Fly Extend Adjustment Nuts to 10 ft-lb (13.5 Nm), starting with the inside ropes and doing the outside ropes last. Refer to Figure 4-35., Torque Sequence for Fly Extend Rope. Alternate between the four ropes until all maintain the required torque.

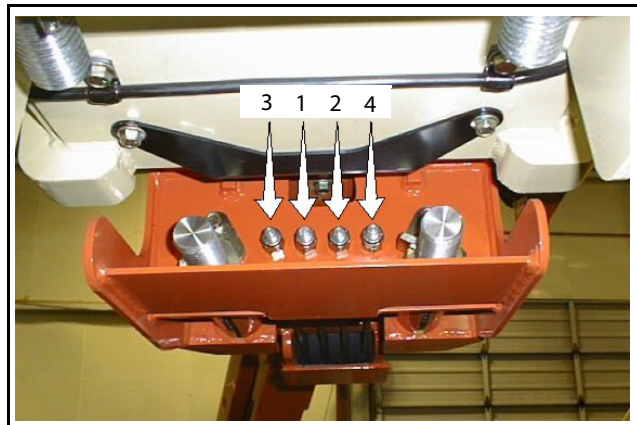


Figure 4-35. Torque Sequence for Fly Extend Rope

11. Repeat the following boom movement steps three times. This is to ensure that the wire rope tension has equalized on both sides of the sheaves and the ropes are seated properly in the sheave grooves.
 - a. Fully retract the boom.
 - b. Extend the boom such that the platform moves 5 to 6 feet (1.5-1.8 m) from fully retracted position.
12. Verify the Fly Boom and Outer Mid Boom Retract wire rope torques.
 - a. If the torque values are not correct, repeat the Wire Rope Tensioning procedure.
 - b. If the torque values are correct, proceed to the next step.
13. Retract the boom 2-3 feet (0.5-1 m). Do not fully retract or bottom out the boom.
14. Verify the Fly Boom and Outer Mid Boom Extend wire rope torques.
 - a. If the torque values are not correct, repeat the Wire Rope Tensioning procedure.
 - b. If the torque values are correct, proceed to the next step.
15. Check for proper function of the boom assembly. When properly torqued and positioned, all three moving boom sections will move simultaneously.
16. Install new nylon collar locknuts to the Fly Boom Extend wire rope fittings. Do not re-use the old nylon collar lock nuts. Torque the locknuts to 10 ft-lb (13.5 Nm)
17. Reinstall the lock plates to the remaining adjuster nuts.

18. Install all covers.



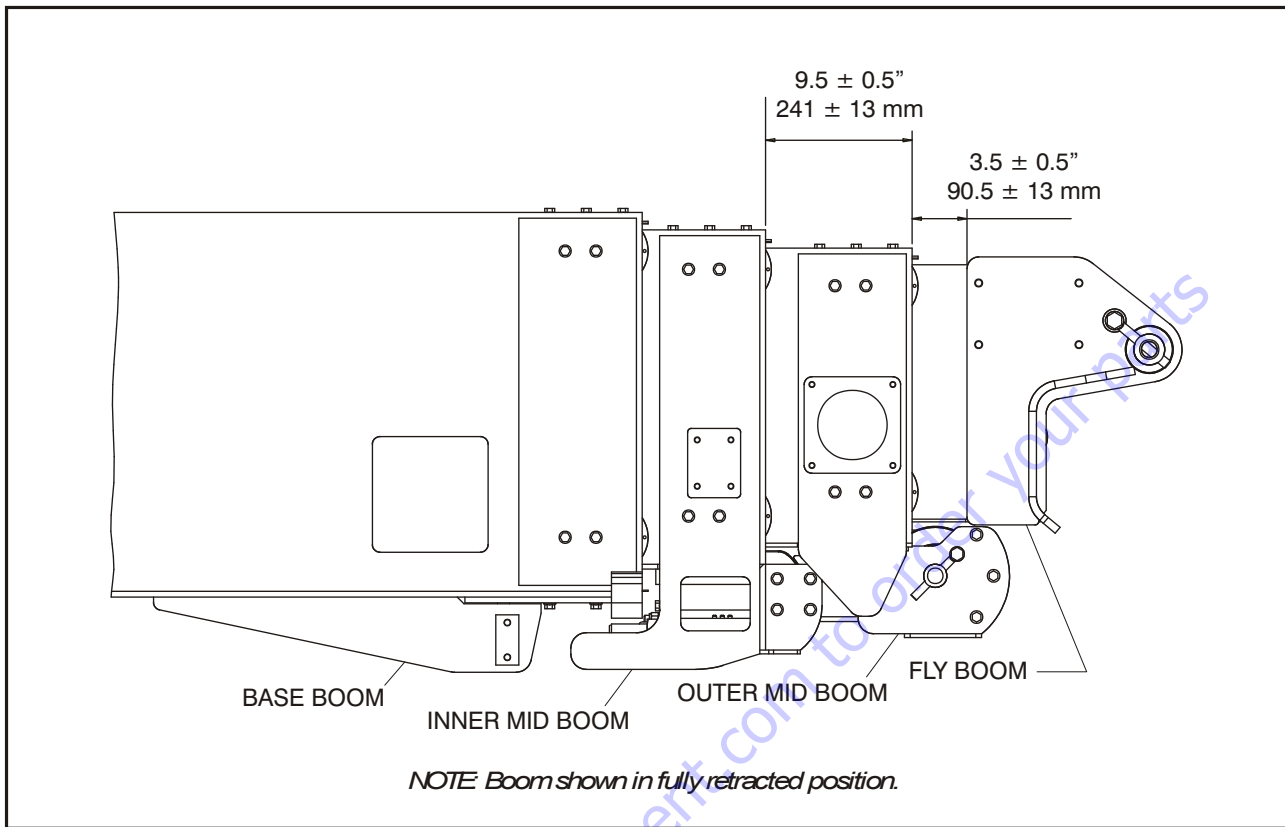


Figure 4-36. Wire Rope Tensioning

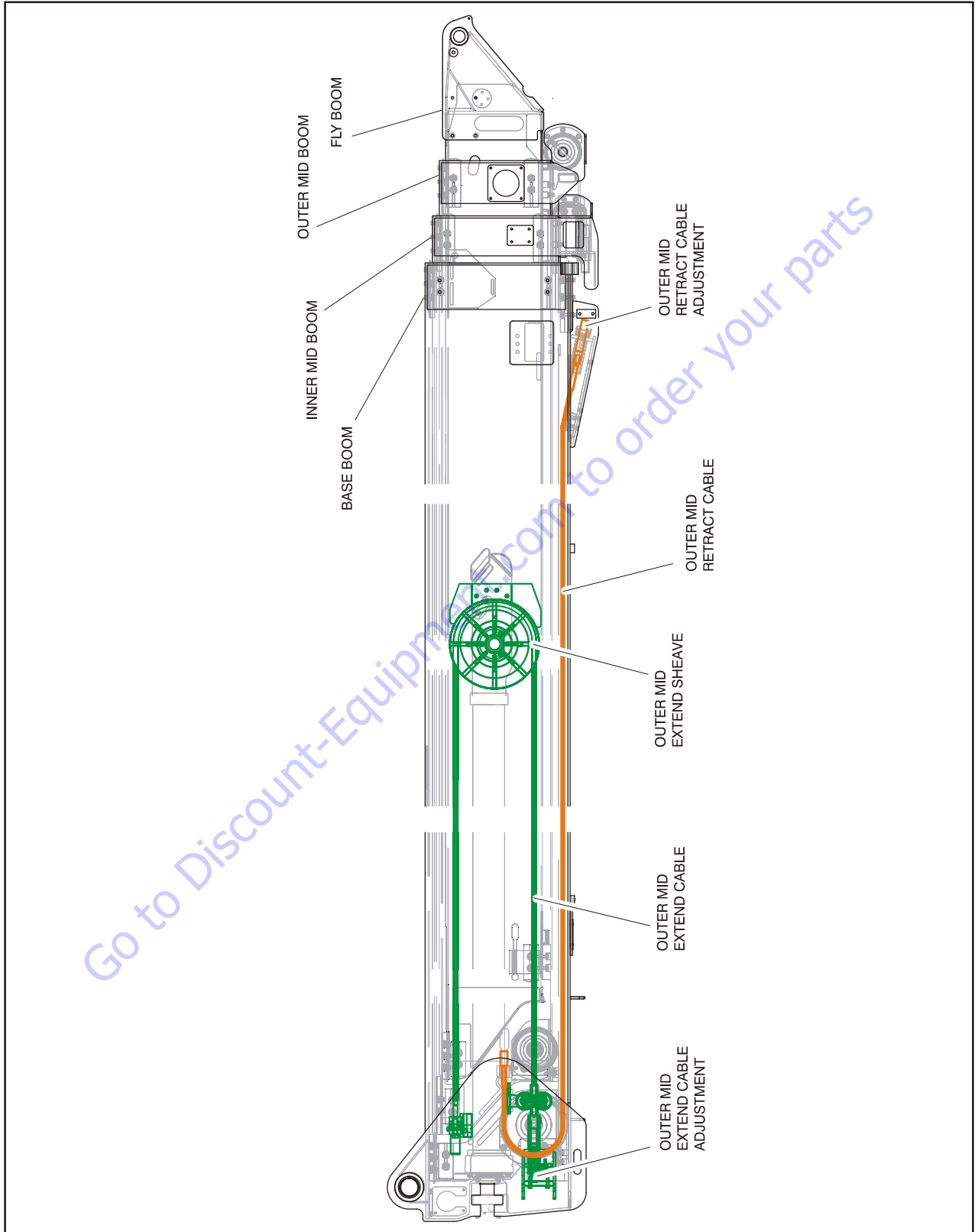


Figure 4-37. Outer Mid Boom Extend/Retract Cables

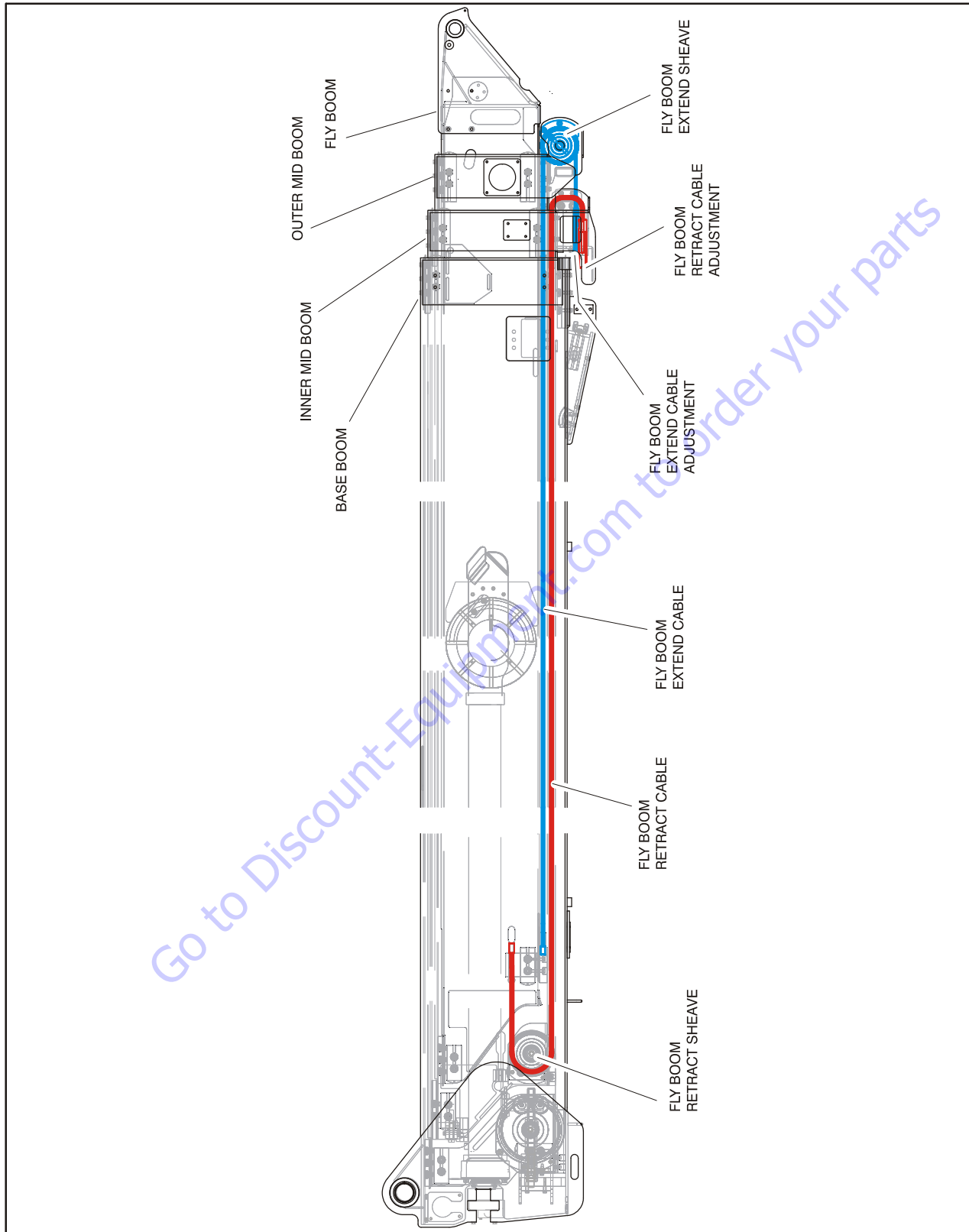
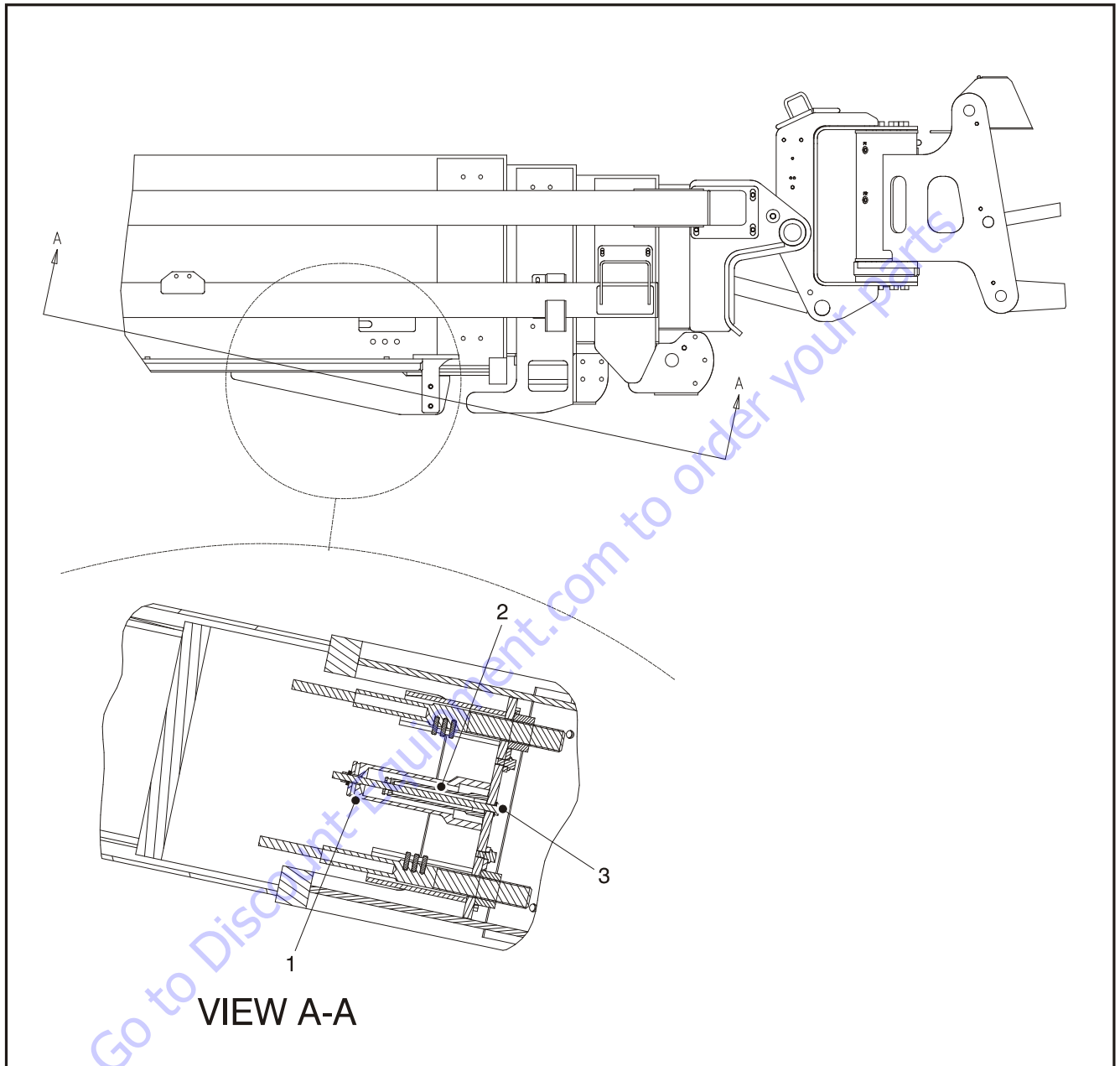


Figure 4-38. Fly Boom Extend/Retract Cables



- 1. 2" Socket
- 2. 3/4" Socket
- 3. Retaining Bolt

Figure 4-39. Wire Rope Adjustment Tools (Optional)

4.14 BROKEN BOOM CABLE PROXIMITY SWITCH

This system uses a proximity switch to detect excessive movement of the cable block. If movement is detected the Cable Break indicator will illuminate in the platform control panel. No restrictions are made to the functionality of the control system. It is the responsibility of the operator to take immediate action.

To avoid damaging the proximity switch, install and adjust after assembling the switch block, compression spring, and torquing the wire ropes.

Adjusting the Proximity Switch

1. Thread the switch in until it contacts the adjuster block.
2. Thread the switch out 1/8 to 1/2 turn to achieve proper sensing range.
3. Tighten the jam nut.

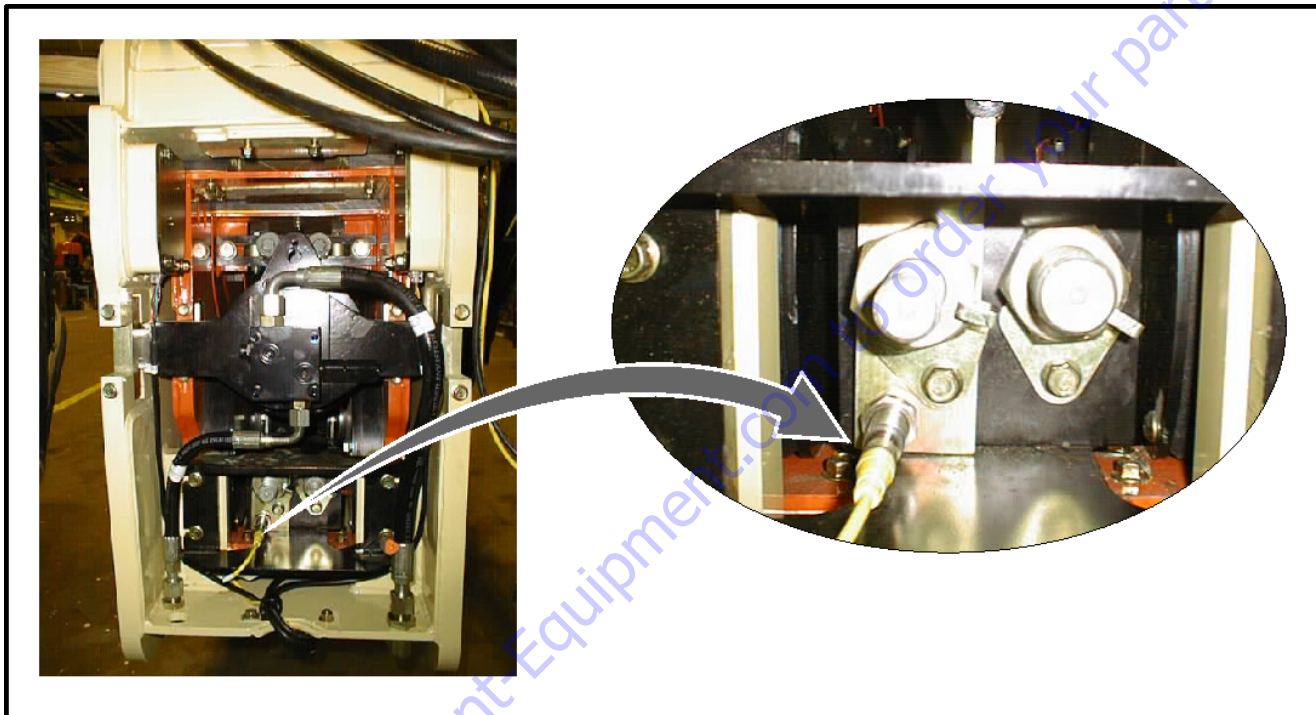


Figure 4-40. Broken Boom Cable Proximity Switch Location

4.15 ELECTRONIC PLATFORM LEVELING

NOTE: For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.

Description

Electronic platform leveling replaces the conventional hydraulic method of platform leveling.

To control electronic platform leveling the platform is equipped with a pair of tilt sensors, one primary and one secondary, mounted to the non-rotating portion of the platform rotator. The tilt sensors are monitored regularly and the platform level up and down valves are automatically controlled to maintain **set point** as the machine is operated.

PRIMARY AND SECONDARY TILT SENSOR INTERACTION

The secondary tilt sensor is used as a backup to the primary tilt sensor. Any time a tilt **set point** is reset, a value from each sensor shall be set.

If a fault occurs with the primary sensor, control will revert to the secondary sensor. (This is discussed in more detail in the error response section.)

Because of the mounting orientation of the tilt sensors, the primary tilt sensor will output ascending voltage values with increases in positive platform tilt angle. The backup or secondary tilt sensor will output descending voltage values with increases in positive platform angle.

PLATFORM VALVES

The platform specific valves are located in a manifold at the platform.

There are individual proportional control valves that control each of the four platform functions; Platform Level, Platform Rotate, Jib Lift, and Jib Swing.

There is also a Platform Dump Valve, located in the platform valve manifold, which is used to hydraulically isolate the control valves and to improve hydraulic response.

The Ground Module controls this valve to provide manual platform leveling in the event that the Platform Module is inoperable.

In ground mode, the platform dump valve is turned on whenever any platform or jib valve output is turned on. Whenever all platform and jib valves are turned off, the platform dump valve is turned off.

In platform mode, the platform dump valve is turned on whenever the footswitch is depressed.

Normal Operation**AUTOMATIC LEVELING**

Two tilt sensors, mounted on either side of the platform support, are used to measure the incline of the platform with respect to gravity and control the automatic leveling function, one is used as the primary sensor and one as a secondary back up sensor.

The level system shall assume a new **fixed set point** (fixed incline of the platform with respect to gravity) each time the control system is powered up (cycling of the EMS).

Automatic platform leveling only functions while operating drive, telescope, lift or swing. It does not operate while operating any other function (e.g. rotate, jib, or steer).

The proportional control for these valves varies. This is dependent on the tilt variance from target as well as on the impact coil temperature is having on the current to the valves.

If a command from the Platform Level Up and Down toggle switch on either the platform or the ground is received, automatic platform leveling will cease and the appropriate output will be commanded to turn on.

When the toggle switch is released, after ¼ second, the current filtered value of tilt angle will be taken as **the new set point**.

In order to obtain acceptable performance while performing all hydraulic functions, five sets of parameters are used. These "zones" allow compensation for differences in how the basket level changes when doing different functions. These zones are as follows:

1. Lift up
2. Lift down
3. Other boom functions
4. Drive
5. Auxiliary

The other boom functions zone includes Swing, Telescope, Jib swing (It is not necessary to level with jib lift, since the mechanical linkage keeps the basket level).

These zones are prioritized when multiple functions are active. The priorities are as follows.

1. Auxiliary power and any other function, zone = auxiliary power
2. Drive and any other function, zone = Drive
3. Lift up and any other function, zone = Lift up
4. Lift down and any other function, zone = Lift down
5. Other boom functions, zone = Other boom functions

During the power-up procedure, function enable, in both Platform and Ground Mode, is delayed during the 1.5 second startup lamp test. During this 1.5 second startup period, the basket level up valve will be energized at 100% duty cycle for 0.5 second, and then the basket level down valve energized at 100% duty cycle for 0.5 second. This will help to keep the valves from sticking.

PLATFORM LEVEL MANUAL OVERRIDE

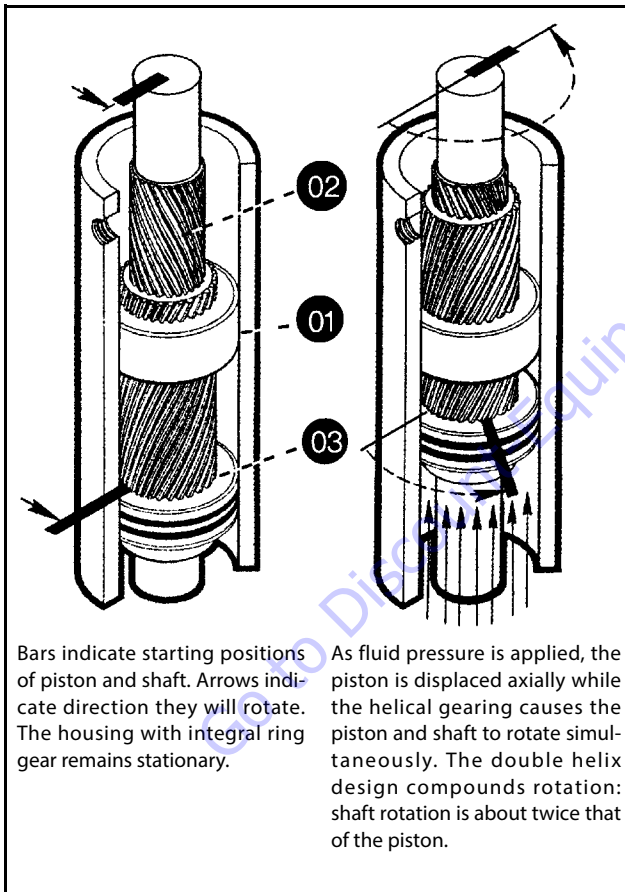
In addition to automatic leveling the operator is able to manually adjust the platform level position by means of the level override switches located at the platform and ground control positions (similar to a Master/Slave hydraulic system).

The level system assumes a **new set point** after a level override switch is operated. In other words the operator can chose a platform level incline other than level with gravity and the system will maintain this set point during automatic leveling.

4.16 ROTARY ACTUATOR

Theory of Operation

The L20 Series rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert linear piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear teeth (01) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (02), and the annular piston sleeve (03). Helical spline teeth machined on the shaft engage matching splines on the in- side diameter of the piston. The outside diameter of the piston carries a second set of splines, of opposite hand, which engage with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking the shaft in position.



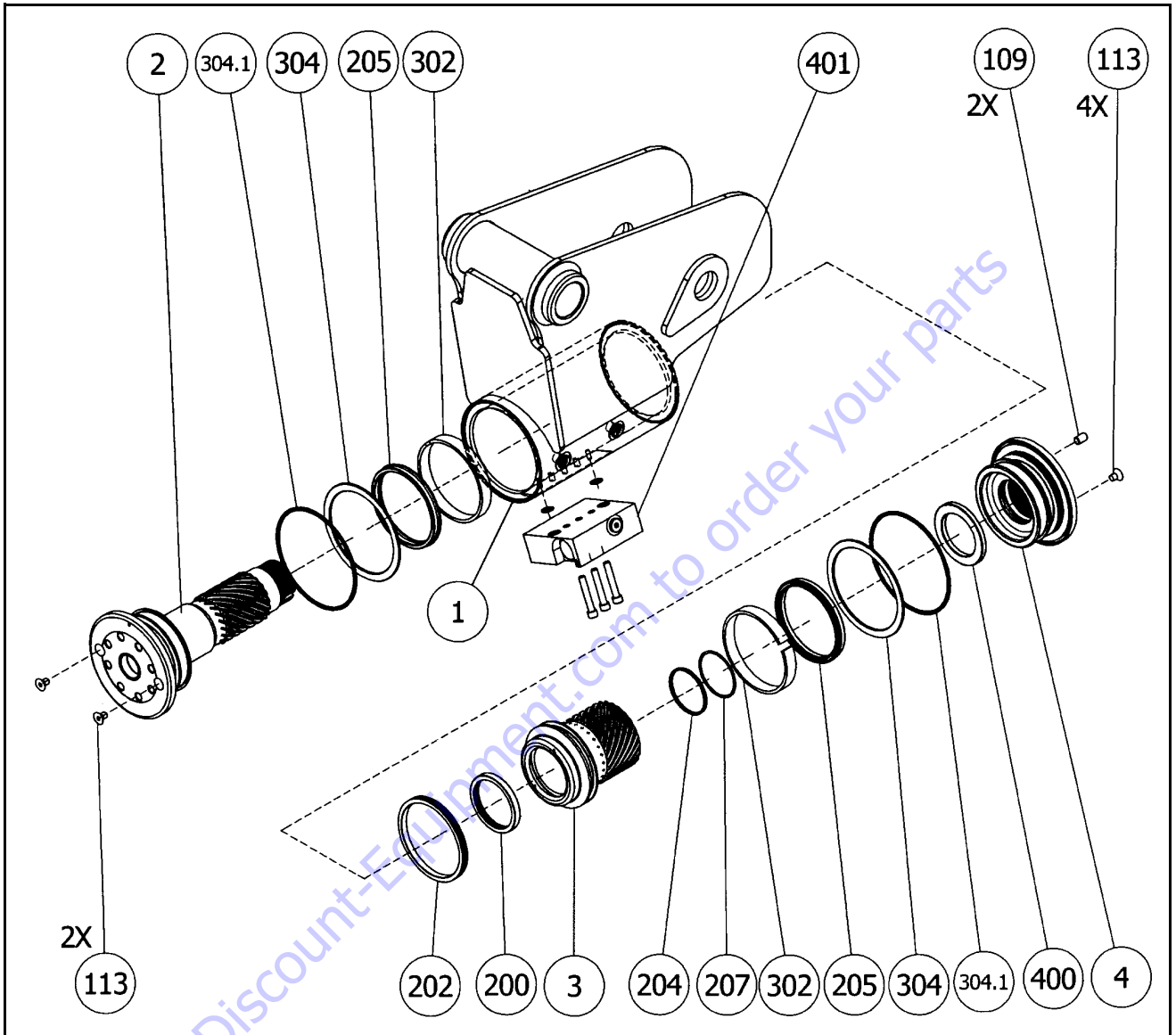
The shaft is supported radially by the large upper radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the upper and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

Required Tools

Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:



1. Flashlight - helps examine timing marks, component failure and overall condition.
2. Felt Marker - match mark the timing marks and outline troubled areas.
3. Allen wrench - removal of port plugs and set screws.
4. Box knife - removal of seals.
5. Seal tool - assembly and disassembly of seals and wear guides.
6. Pry bar - removal of end cap and manual rotation of shaft.
7. Rubber mallet- removal and installation of shaft and piston sleeve assembly.
8. Nylon drift - installation of piston sleeve
9. End cap dowel pins - removal and installation of end cap (sold with Helac seal kit).



PARTS

- 1. Housing
- 2. Shaft
- 3. Piston Sleeve
- 4. End Cap

HARDWARE

- 103.1. Screw
- 103.2. Washer
- 106.1. Port Plug
- 106.2. Port Plug
- 109. Lock Pin
- 113. Capscrew

SEALS

- 200. T-Seal
- 202. T-Seal
- 204. O-ring
- 205. Cup Seal
- 207. Backup Ring
- 304.1. Wiper Seal

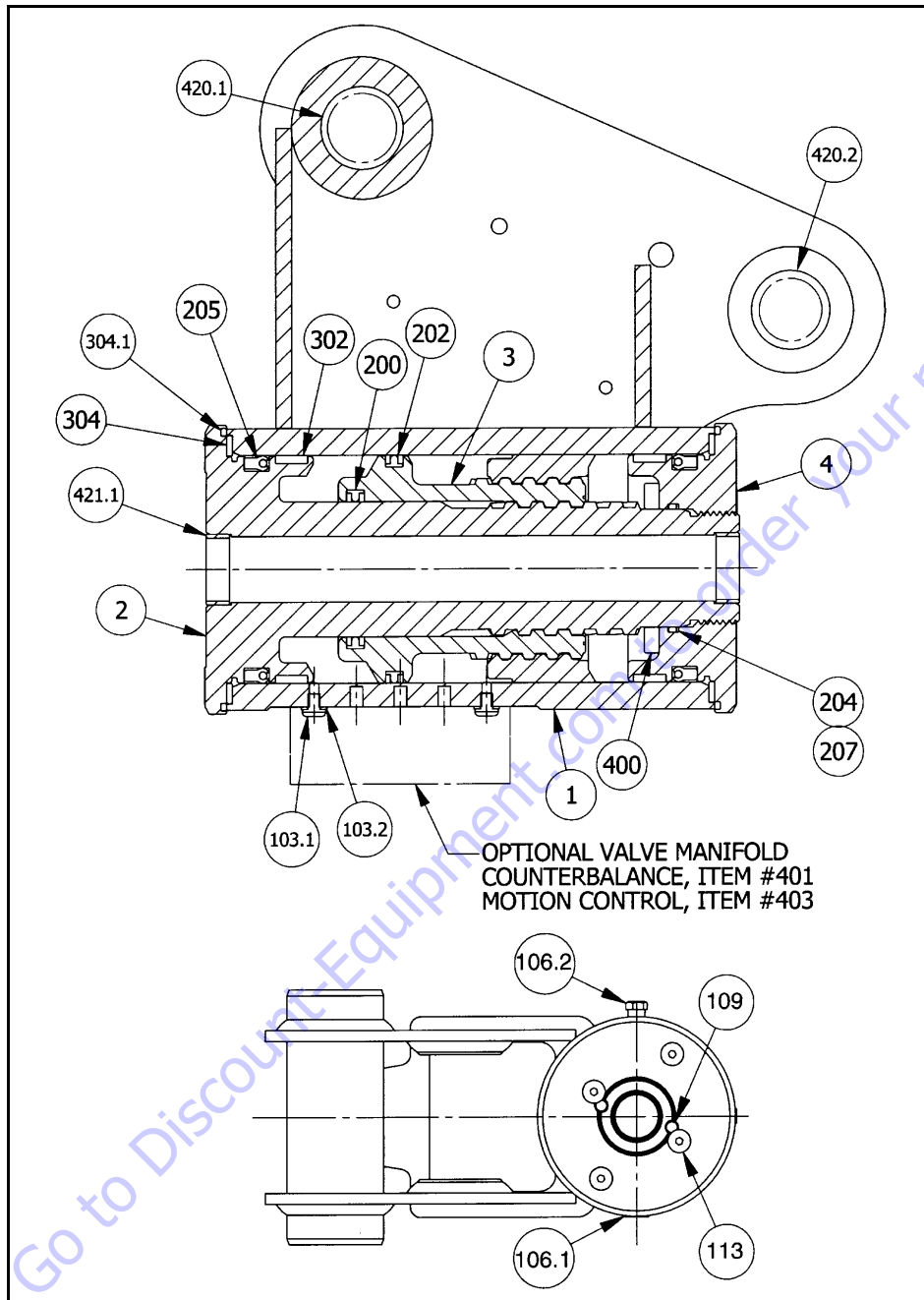
BEARINGS

- 302. Wear Guide
- 304. Thrust Washer

ACCESSORIES

- 400. Stop Tube
- 420.1 Bushing
- 420.2 Bushing
- 421.1 Bushing

Figure 4-41. Rotary Actuator - Exploded View

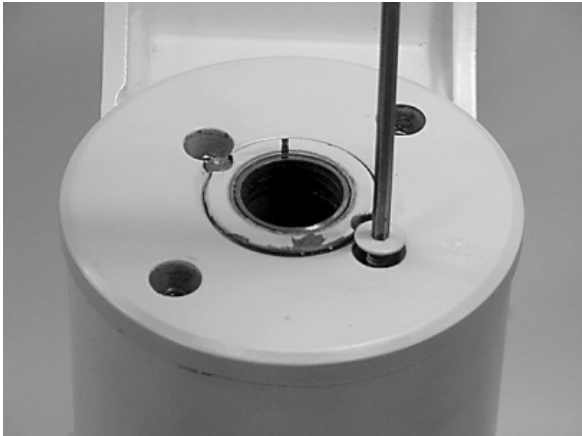


PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-42. Rotary Actuator - Assembly Drawing

Disassembly

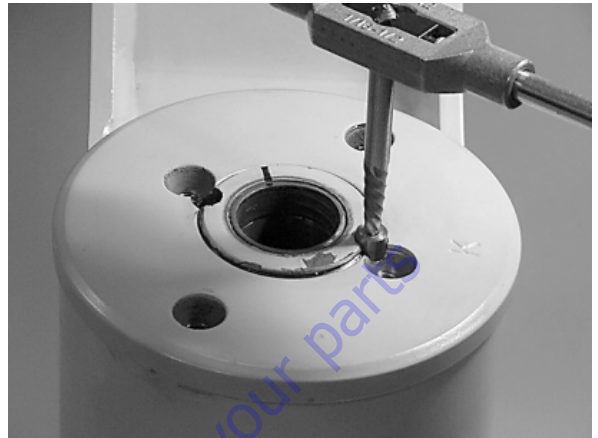
1. Remove the cap screws (113) over end cap lock pins (109).



2. Using a 1/8" (3.18mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16" (4.76mm).

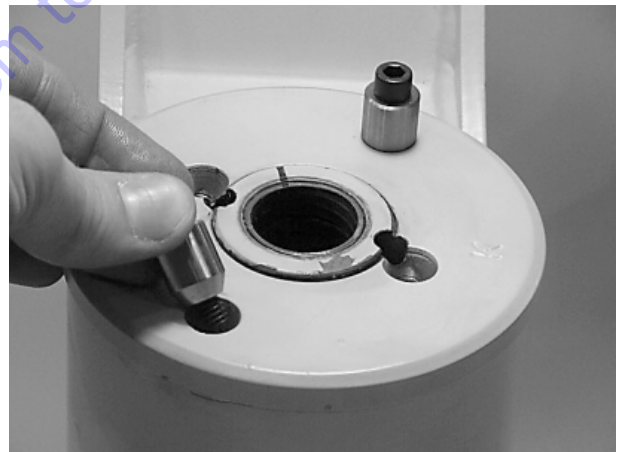


3. Remove the lock pins using an "Easy Out" (a size #2 is shown).



If the pin will not come out with the "Easy Out", use 5/16" drill bit to a depth of 1/2" (12.7mm) to drill out the entire pin.

4. Install the end cap (4) removal tools provided with the Helac seal kit.



5. Using a metal bar, or something similar, unscrew the end cap (4) by turning it counter clockwise.



SECTION 4 - BOOM & PLATFORM

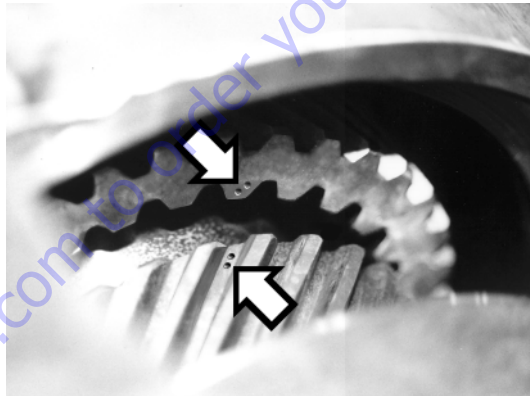
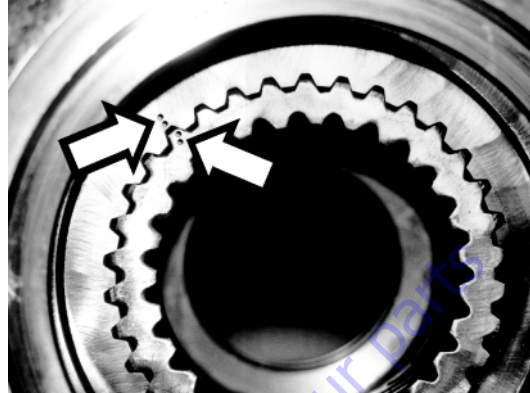
6. Remove the end cap (4) and set aside for later inspection.



7. Remove the stop tube if included. The stop tube is an available option to limit the rotation of the actuator.



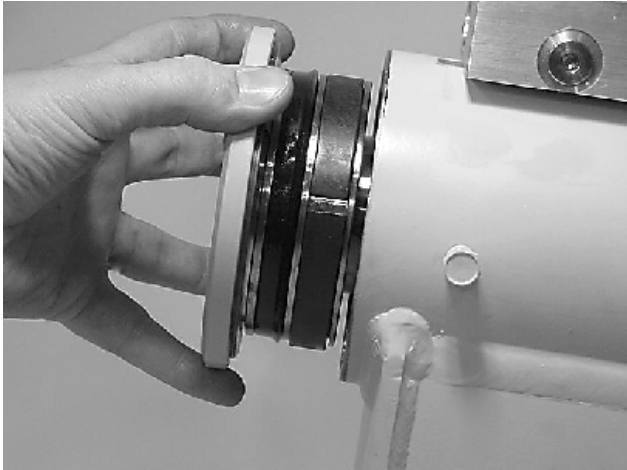
8. Every actuator has timing marks for proper engagement.



9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.



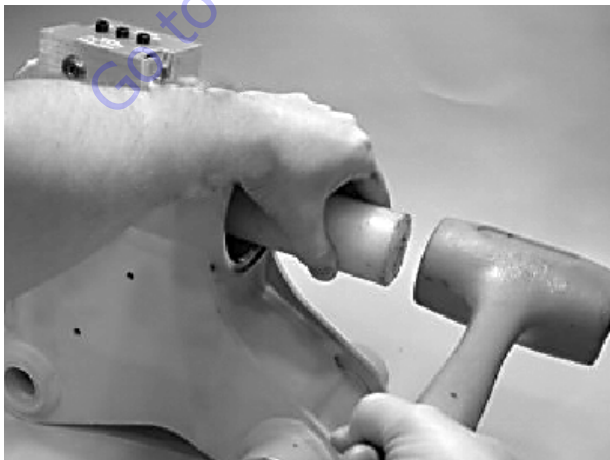
- 10.** Remove the shaft (2). It may be necessary to strike the threaded end of the shaft with a rubber mallet.



- 11.** Before removing the piston (3), mark the housing (1) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).



- 12.** To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.



- 13.** At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.



- 14.** Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

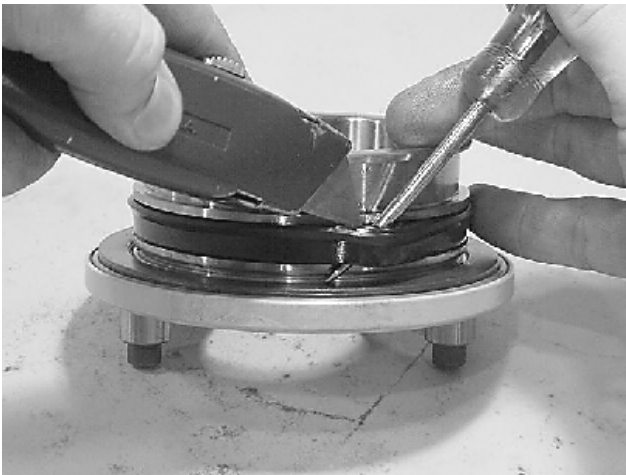


- 15.** Remove the wear guides (302) from the end cap (4) and shaft (2).



SECTION 4 - BOOM & PLATFORM

- 16.** To remove the main pressure seals (205), it is easiest to cut them using a sharp razor blade being careful not to damage the seal groove.



- 17.** Remove the thrust washers (304), from the end cap (4) and shaft (2).



- 18.** Remove the wiper seal (304.1) from its groove in the end cap (4) and shaft (2).



- 19.** Remove the piston O.D. seal (202).



- 20.** Remove the piston I.D. seal (200). You may now proceed to the inspection process.

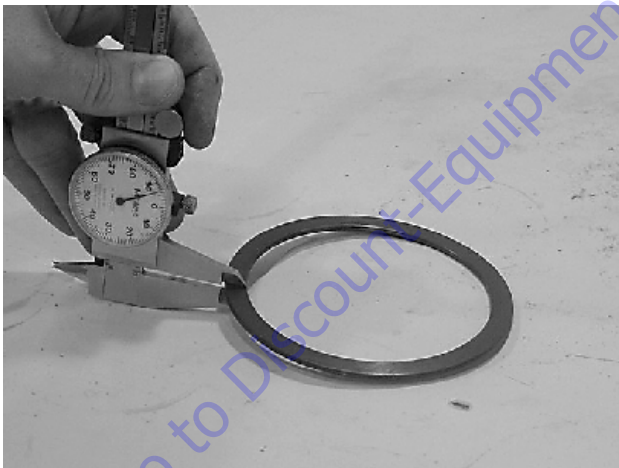


Inspection

1. Clean all parts in a solvent tank and dry with compressed air prior to inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore and gear teeth.



2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure its thickness to make sure it is within specifications (Not less than 0.092" or 2.34 mm).

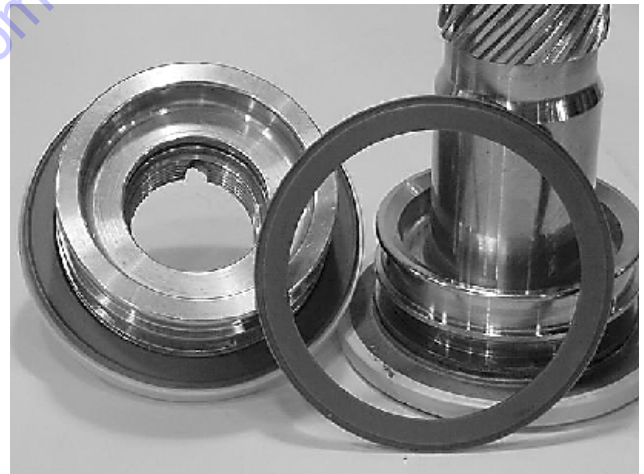


3. Inspect the wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).



Assembly

1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.

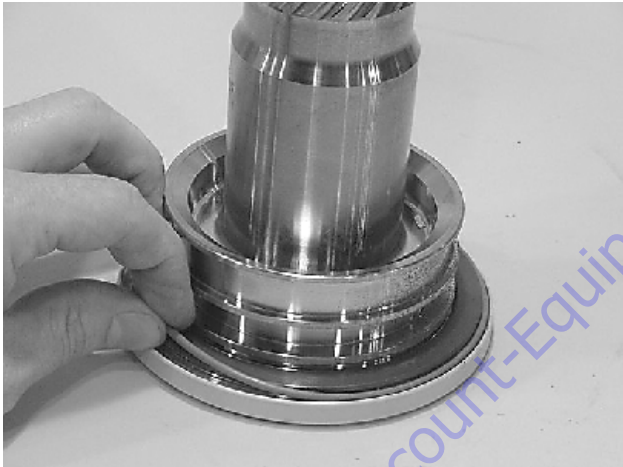


SECTION 4 - BOOM & PLATFORM

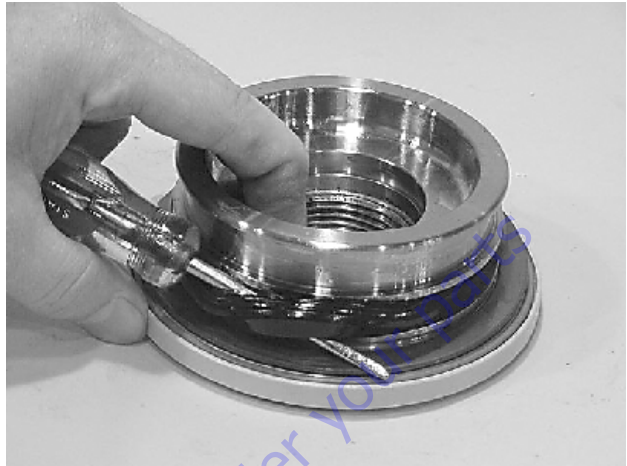
2. Install the thrust washer (304) onto shaft (2) and end cap (4).



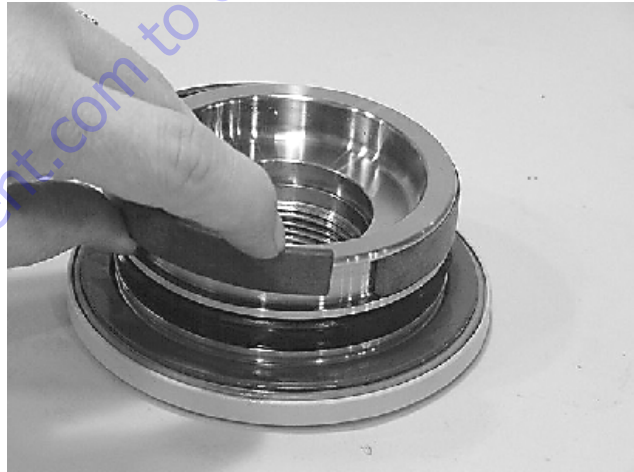
3. Install the wiper seal (304.1/green O-ring) into its groove on the shaft (2) and end cap (4) around the outside edge of the thrust washer (304).



4. Using a seal tool install the main pressure seal (205) onto shaft (2) and end cap (4). Use the seal tool in a circular motion.



5. Install the wear guide (302) on the end cap (4) and shaft (2).



6. Install the inner T-seal (200) into the piston (3) using a circular motion.

Install the outer T-seal (202) by stretching it around the groove in a circular motion.

Each T-seal has 2 Backup rings (see drawing for orientation).

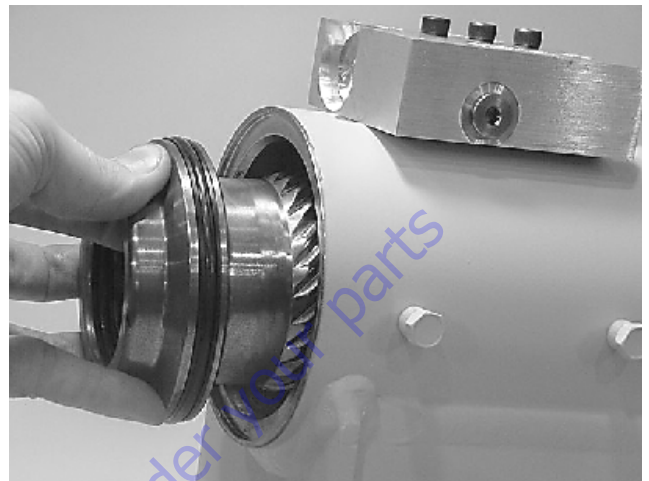


Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

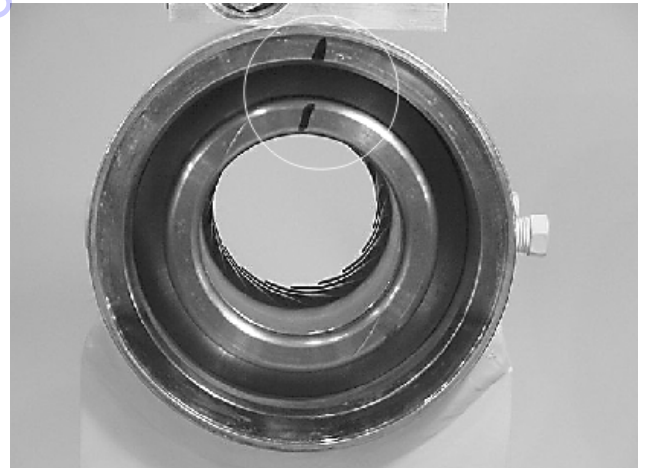
Repeat this step for the outer seal (202).



7. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.



8. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



SECTION 4 - BOOM & PLATFORM

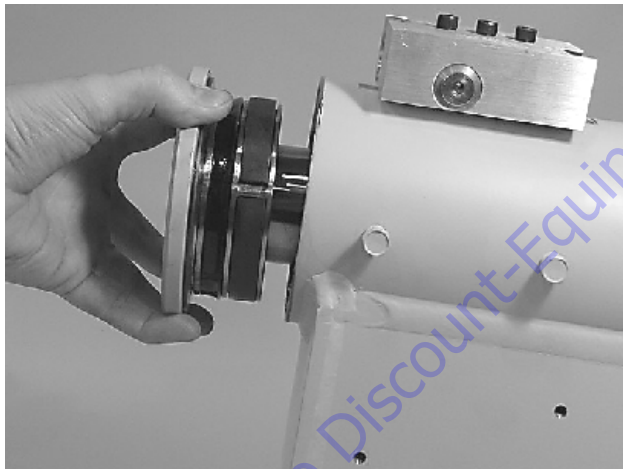
9. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.



11. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



10. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.

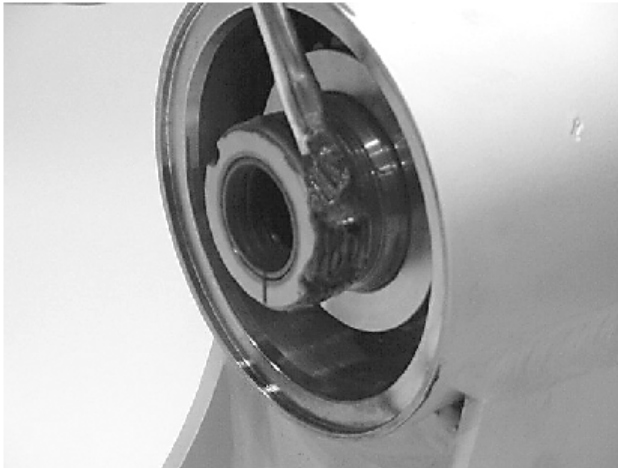


12. Install 2 bolts in the threaded holes in the flange. Using a bar, rotate the shaft in a clockwise direction until the wear guides are seated inside the housing bore.



13. Install the stop tube onto the shaft end. Stop tube is an available option to limit the rotation of an actuator.

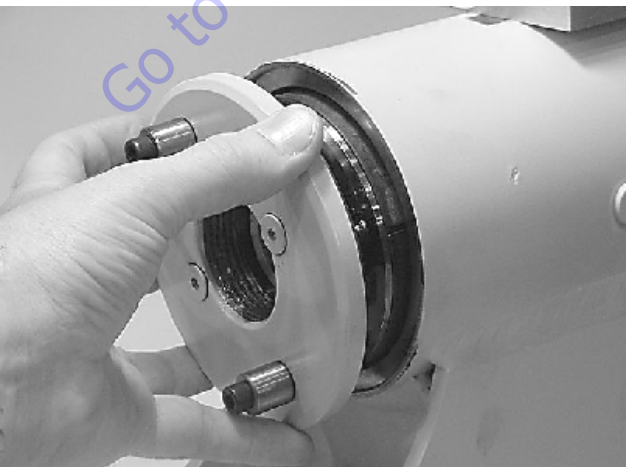
- 14.** Coat the threads on the end of the shaft with anti-seize grease to prevent galling.



- 15.** Install the O-ring (204) and Backup ring (207) into the inner seal groove on the end cap (4).



- 16.** Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide stays in place on the end cap as it is threaded into the housing (1).



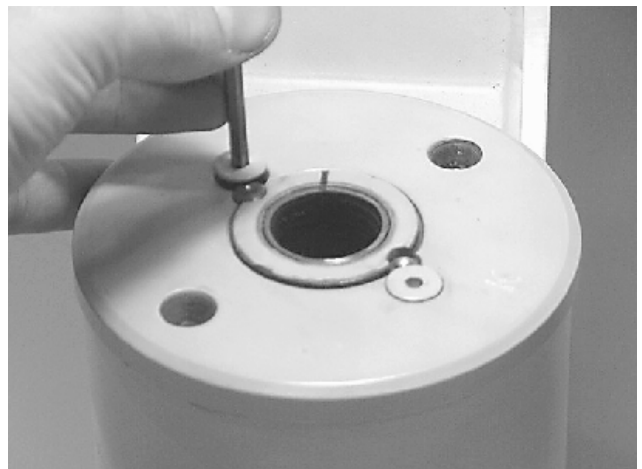
- 17.** Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



- 18.** Place the lock pins (109) provided in the Helac seal kit in the holes with the dimple side up. Then, using a punch, tap the lock pins to the bottom of the hole.



- 19.** Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.825 Nm).



Installing Counterbalance Valve

Refer to Figure 4-43., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Loctite.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Medium Strength Threadlocking Compound should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4-inch bolts 110 to 120 inch pounds (12.4 to 13.5 Nm). Do not torque over 125 inch pounds (14.1 Nm). Torque the 5/16-inch bolts 140 inch pounds (15.8 Nm). Do not torque over 145 inch pounds (16.3 Nm).

Testing the Actuator

If the equipment is available, the actuator should be tested on a hydraulic test bench. The breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 400 psi (28 bar). Cycle the actuator at least 25 times at 3000 psi (210 bar) pressure. After the 25 rotations, increase the pressure to 4500 psi (315 bar) to check for leaks and cracks. Perform the test again at the end of the rotation in the opposite direction.

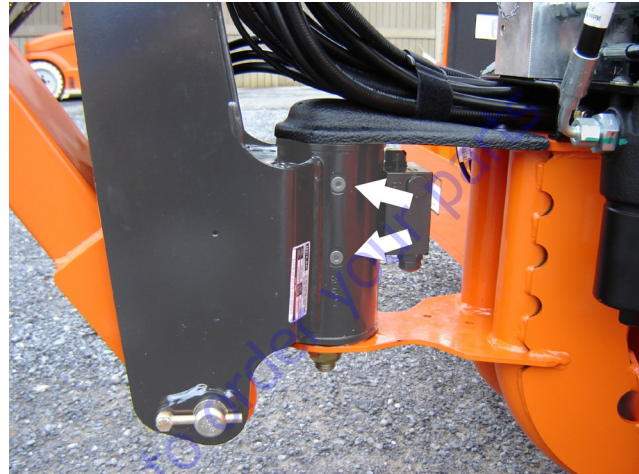
TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

If the actuator is equipped with with a counterbalance valve, plug the valve ports. Connect the hydraulic lines to the housing ports. Bleed all air from the actuator (see Installation and Bleeding) Rotate the shaft to the end of rotation at 3000 psi (210 bar) and maintain pressure. Remove the hydraulic line from the non-pressurized side.

Continuous oil flow from the open housing port indicates internal leakage across the piston. Replace the line and rotate the shaft to the end of rotation in the opposite direction. Repeat the test procedure outlined above for the other port. If there is an internal leak, disassemble, inspect and repair.

Bleeding After Installation

NOTE: Bleeding will be necessary if excessive backlash is displayed after the actuator is installed. To do this, bleeder valves must be installed in the actuator at the locations shown below. The following steps are recommended when a minimum of two gallons (8 liters) is purged.



1. Connect a 5 foot (1.5 m) long 3/16" inside diameter, 5/16" outside diameter clear vinyl drain tube to each of the two bleeder valves. Secure the tubes in place with hose clamps.
2. Place the end of the tubes in a clean 5 gallon (19 L) container to collect the purged oil. The oil can be returned to the reservoir when the procedure is complete.
3. Open both bleeder valves 1/4 turn. Using the hydraulic system, rotate the platform to the end of rotation and maintain hydraulic pressure. Oil with small air bubbles should be seen flowing through the tubes. Allow 1/2 gallon (2 L) of oil to be purged from the actuator.
4. Keep the bleeder valves open and rotate the platform in the opposite direction to the end of rotation. Maintain hydraulic pressure until an additional 1/2 gallon (2 L) of oil is pumped out.
5. Repeat steps 3 and 4. After the last 1/2 gallon (2 L) of oil is purged, close both bleed nipples before rotating away from the end of rotation.

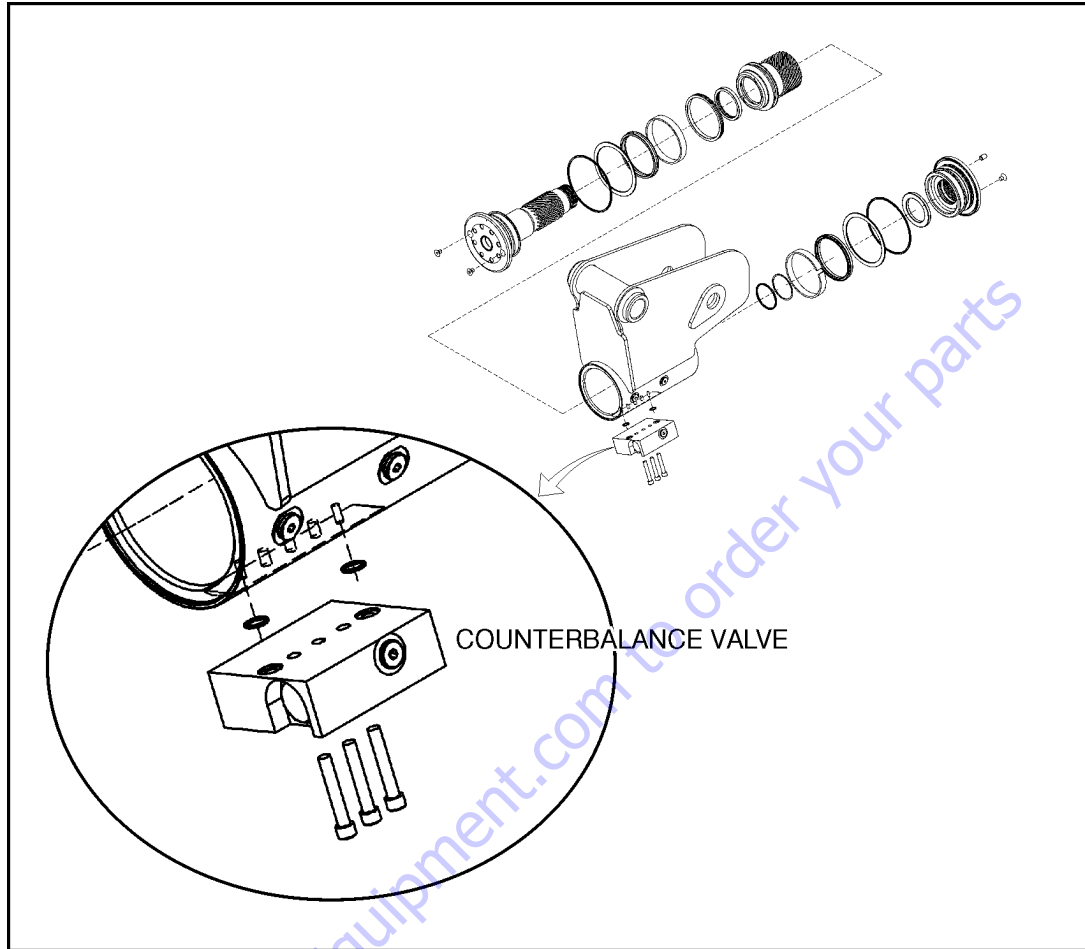


Figure 4-43. Rotator Counterbalance Valve

4.17 BOLT-ON EXTERNAL FALL ARREST

The bolt-on external fall arrest system is designed to provide a lanyard attach point while allowing the operator to access areas outside the platform. Exit/Enter the platform through the gate area only. The system is designed for use by one person.

Personnel must use fall protection at all times. A full body harness is required with lanyard not to exceed 6 ft. (1.8 M) in length, that limits the maximum arrest force to 900 lbs. (408 kg).

Bolt-On External Fall Arrest System capacity is 310 lb (140 kg) - one (1) person maximum.

Do not move the platform during use of the bolt-on external fall arrest system.

⚠ WARNING

DO NOT OPERATE ANY MACHINE FUNCTIONS WHILE OUTSIDE OF PLATFORM. BE CAREFUL WHEN ENTERING/EXITING THE PLATFORM AT ELEVATION.

⚠ WARNING

IF THE BOLT-ON EXTERNAL FALL ARREST SYSTEM IS USED TO ARREST A FALL OR IS OTHERWISE DAMAGED, THE ENTIRE SYSTEM MUST BE REPLACED AND THE PLATFORM FULLY INSPECTED BEFORE RETURNING TO SERVICE. REFER TO THE SERVICE MANUAL FOR REMOVAL AND INSTALLATION PROCEDURES.

THE BOLT-ON EXTERNAL FALL ARREST SYSTEM REQUIRES AN ANNUAL INSPECTION AND CERTIFICATION. THE ANNUAL INSPECTION AND CERTIFICATION MUST BE PERFORMED BY A QUALIFIED PERSON OTHER THAN THE USER.

Inspection Before Use

The bolt-on external fall arrest system must be inspected before each use of the mobile elevating work platform. Replace components if there are any signs of wear or damage.

Before each use, perform a visual inspection of the following components:

- Cable: Inspect cable for proper tension, broken strands, kinks, or any signs of corrosion.

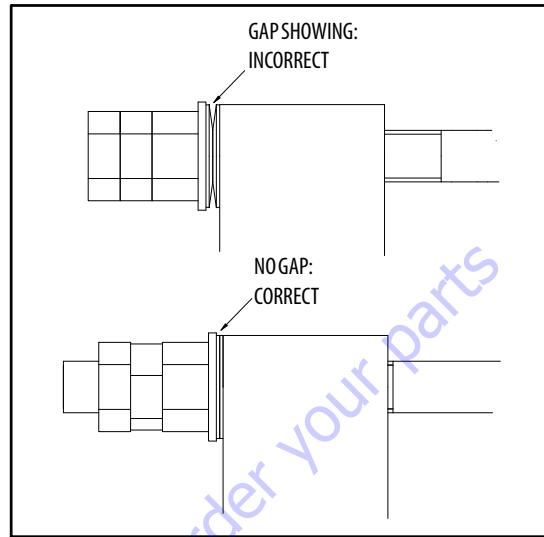
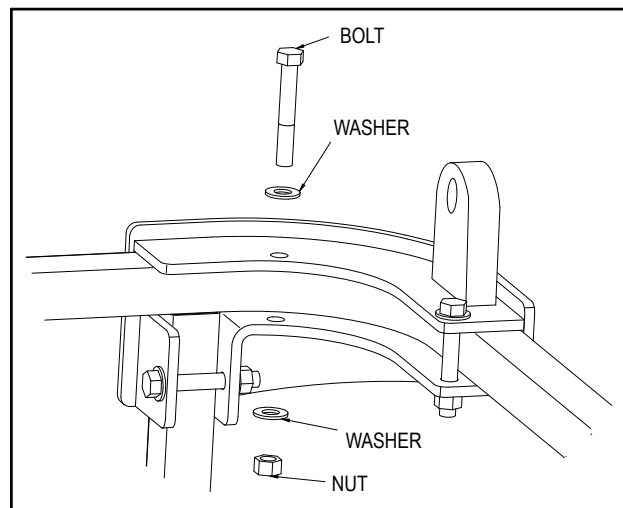


Figure 4-44. Bolt-On External Fall Arrest Cable Tension

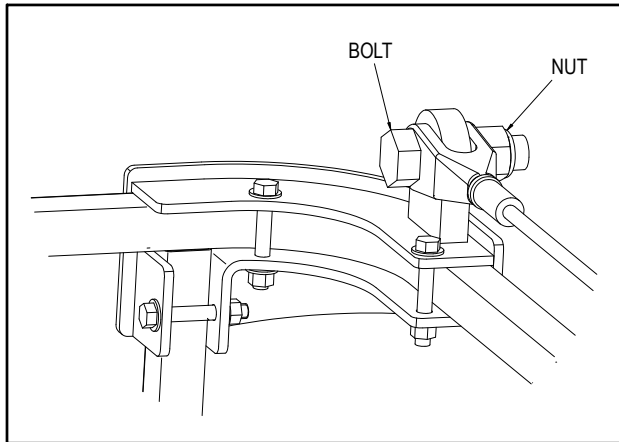
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are no missing components and hardware is properly tightened.
- Platform Rails: No visible damage is acceptable.

Installation

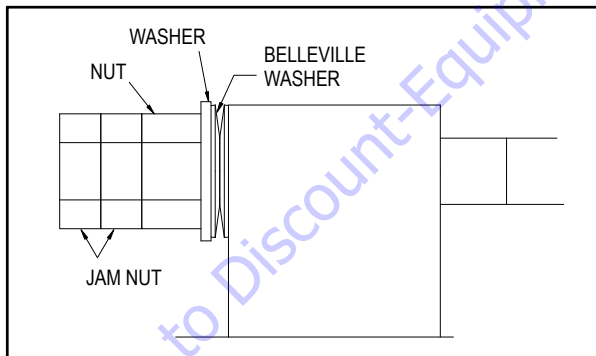
1. Install the retaining hardware (bolts, nuts, and washers) and secure the brackets to the platform rail. Tighten the nuts but do not torque them yet.



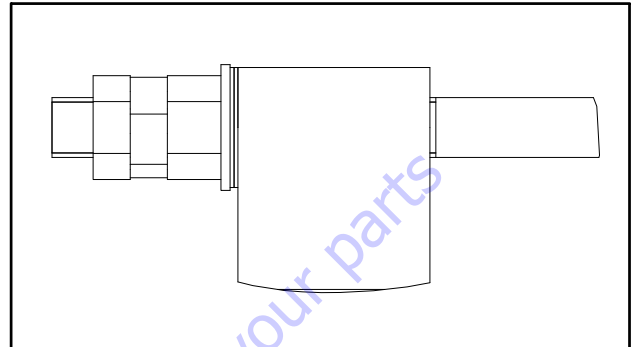
2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.



3. Install the Attachment Ring onto the cable.
4. Without twisting the fall arrest cable, pull it thru the left hand bracket and mark the top of the swaged cable end. Install the fall arrest cable through the left hand bracket and secure it using the belleville washers, washer, retaining nut, and jam nuts. Orient the hardware as shown below and with the belleville washers so the gap is present at the outside diameter of the washers. install the nuts onto the cable finger tight so the mark on the cable does not move.



5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is present at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



6. Tighten the first jam nut against the retaining nut to keep the nut from loosening. Tighten the remaining jam nut against the first jam nut.
7. Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).

SECTION 4 - BOOM & PLATFORM

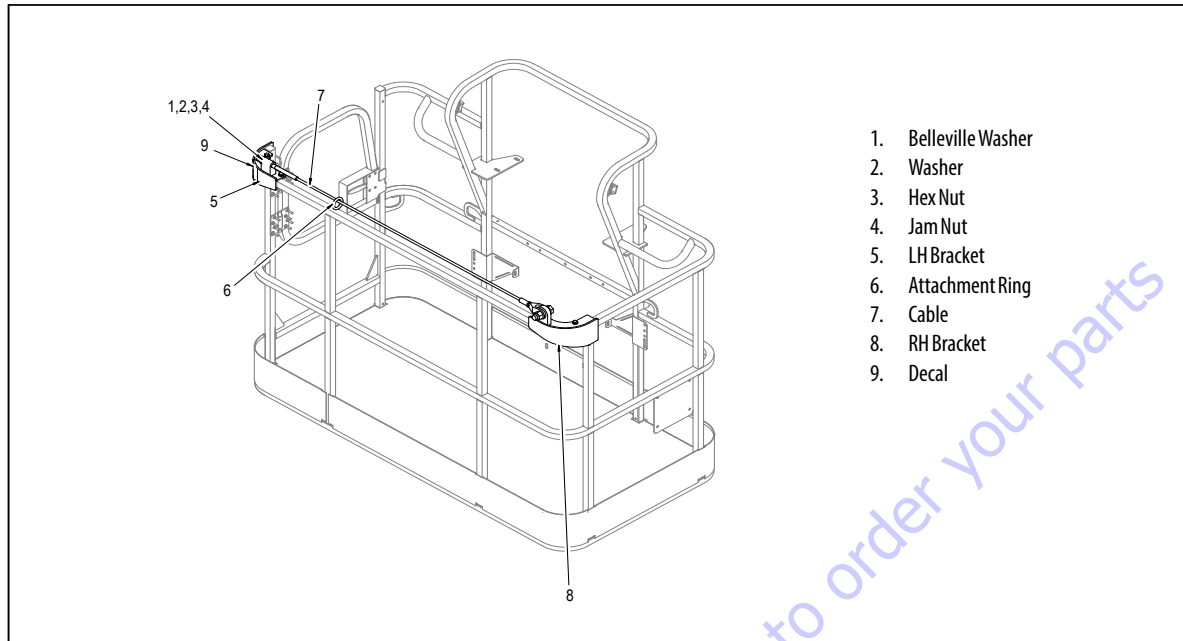


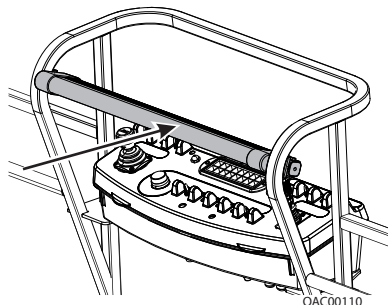
Figure 4-45. Bolt-On External Fall Arrest System

4.18 SKYGUARD

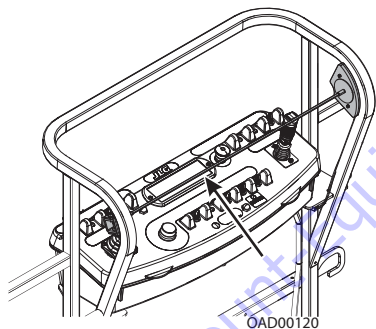
Operation

SkyGuard provides enhanced control panel protection. When the SkyGuard sensor is activated, functions in use at the time of actuation will reverse or cutout. The SkyGuard Function Table provides more details on these functions.

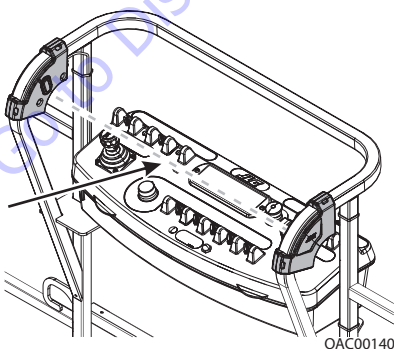
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

⚠ WARNING

THE MACHINE OPERATOR IS REQUIRED TO PERFORM A DAILY FUNCTION TEST TO ENSURE PROPER OPERATION OF THE SKYGUARD SYSTEM.

Function Test

SKYGUARD ONLY

Perform this function test if **SkyGuard only** is selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops then telescope in function operates for a short duration. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure normal operation available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

BOTH SKYGUARD AND SOFT TOUCH

Perform this procedure if both SkyGuard and Soft Touch are selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

NOTE: *Machine will treat Soft Touch/SkyGuard override switch as if it is a Soft Touch and SkyGuard switch.*

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure sure normal operation is available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

SOFT TOUCH ONLY

If **Soft Touch only** is selected in machine setup (refer to Table 6-2), machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

SKYGUARD NOT SELECTED IN MACHINE SETUP

If the SkyGuard system is installed on the machine, but no option is selected in the machine setup (refer to Table 6-2), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostics & Troubleshooting

If SkyGuard does not function when the sensor is engaged, first verify the configuration under the MACHINE SETUP: SKYGUARD OPTION menu using the hand-held Analyzer. Ensure the selected configuration matches the actual system installed on the machine. If not, select the correct configuration, then verify operation.

Additionally, use the handheld analyzer to navigate to the DIAGNOSTICS: FEATURES → SKYGUARD INPUTS menu to determine additional SkyGuard fault information.

Engage the SkyGuard sensor and observe the Analyzer to determine if the switch/relay closes.

If the status of the switch/relay remains OPEN while the SkyGuard sensor is actively engaged, it is possible the sensor has failed and should be replaced immediately.

If the status of the switch/relay remains CLOSED while the SkyGuard sensor is actively engaged, a power or ground wire may not be making good contact or may be loose or broken. Additionally, there is a low probability that both relays may have failed.

If the switch/relay status is in disagreement, then one may have failed or is not installed correctly. In this case, the machine will be inoperable.

FAULT CODES

Refer to Table 6-9 for more fault code information

- **0039** - SkyGuard switch activation fault
- **2563** - switch disagreement fault

Table 4-3. SkyGuard Function Table

Drive Forward	Drive Reverse	Steer	Swing	Boom Lift Up	Boom Lift Down	Boom Tele Out	Boom Tele In	Jib Lift	Jib Swing	Basket Level	Basket Rotate
R*/C**	R	C	R	R	R	R	C	C	C	C	C
R= Indicates Reversal is Activated											
C= Indicates Cutout is Activated											
* DOS (Drive Orientation System) Enabled											
** DOS Not Enabled, machine is driving straight without steering, and any other hydraulic function is active											
Note: If SkyGuard is enabled with the Soft Touch system, functions will cut out instead of reversing											

PARTS FINDER

**Search Website
by Part Number**



**Search Manual
Library For Parts
Manual & Lookup Part
Numbers – Purchase
or Request Quote**

A screenshot of the "Search Manuals" form. The form has a title "Search Manuals" and a subtitle "Please provide information to help us locate the manual and/or parts you need." Below the subtitle, there are several input fields: "Brand" (a dropdown menu), "Model Number" (a text field), "Serial Number" (a text field), "Year" (a dropdown menu), "Serial" (a text field), "Part Number" (a text field), "Part Name" (a text field), and "Quantity" (a text field). At the bottom of the form, there is a "Search" button.

**Can't Find Part or
Manual? Request Help
by Manufacturer,
Model & Description**

A screenshot of the "Parts Order Form". The form has a title "Parts Order Form" and a subtitle "Please fill in the information below." Below the subtitle, there are several input fields: "Manufacturer" (a dropdown menu), "Model" (a text field), "Description" (a text field), "Quantity" (a text field), "Part Number" (a text field), "Part Name" (a text field), "Part Description" (a text field), "Part Drawing" (a text field), "Part Photo" (a text field), "Part Video" (a text field), "Part Link" (a text field), "Part Source" (a text field), "Part Price" (a text field), "Part Cost" (a text field), "Part Profit" (a text field), "Part Margin" (a text field), "Part Tax" (a text field), "Part Shipping" (a text field), "Part Handling" (a text field), "Part Notes" (a text field), and "Part Comments" (a text field). At the bottom of the form, there is a "Submit" button.

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SECTION 5. BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

NOTE: All O-ring fittings must be pre-lubricated with hydraulic oil prior to assembly.

Cup and Brush

The following is needed to correctly oil the o-ring in this manner:

- A small container for hydraulic oil
- Small paint brush



1. Hold the fitting in one hand while using the brush with the other hand to dip into the container. Remove excess hydraulic oil from the brush so an even film of oil is applied on the o-ring.



2. Holding the fitting over the hydraulic oil container, brush an even film of oil around the entire o-ring in the fitting, making sure the entire o-ring is completely saturated.



3. Turn the o-ring on the other side of the fitting and repeat the previous step, ensuring the entire o-ring is coated with hydraulic oil.



Dip Method

NOTE: This method works best with Face Seal o-rings, but will work for all o-ring fitting types.

The following is needed to correctly oil the o-ring in this manner:

- A small leak proof container
 - Sponge cut to fit inside the container
 - A small amount of hydraulic oil to saturate the sponge.
1. Place the sponge inside the container and add hydraulic oil to the sponge until it is fully saturated.
 2. Dip the fitting into the sponge using firm pressure. Upon lifting the fitting, a small droplet will form and drip from the bottom of the fitting. This should signify an even coating of oil on the fitting.



3. O-ring Boss type fittings will require more pressure in able to immerse more of the fitting into the saturated sponge. This will also cause more oil to be dispersed from the sponge.



Spray Method

This method requires a pump or trigger spray bottle.

1. Fill the spray bottle with hydraulic oil.
2. Hold the fitting over a suitable catch can.
3. Spray the entire o-ring surface with a medium coat of oil.



Brush-on Method

This method requires a sealed bottle brush.

1. Fill the bottle with hydraulic oil.
2. Using slight pressure to the body of the spray bottle, invert the bottle so the brush end is in the downward position.
3. Brush hydraulic oil on the entire o-ring, applying an even coat of oil.



5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

Tapered Thread Types

NPTF = national tapered fuel (Dry Seal) per SAE J476/J512

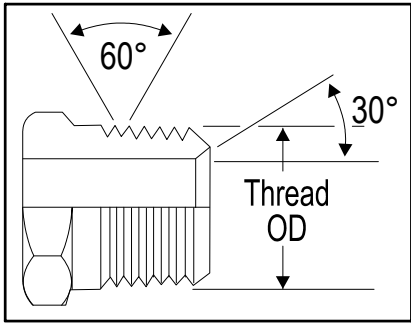


Figure 5-1. NPTF Thread

BSPT = British standard pipe tapered per ISO7-1

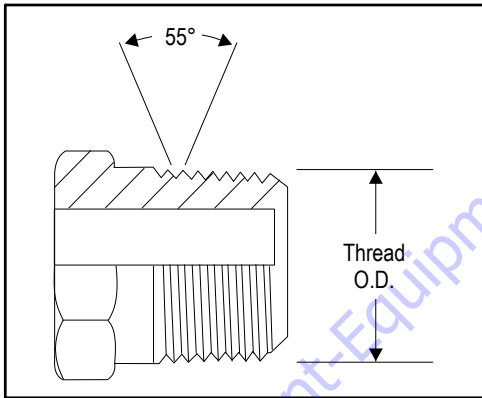


Figure 5-2. BSPT Thread

Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

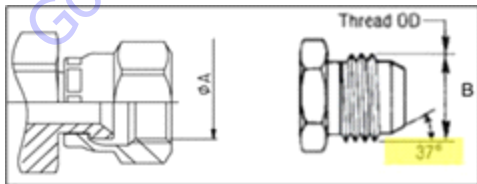


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

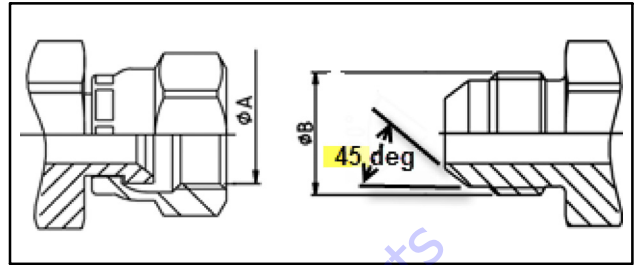


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

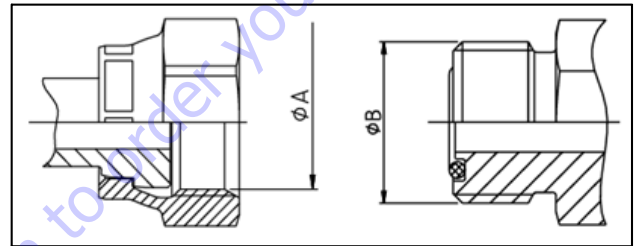


Figure 5-5. ORFS Thread

MBTL = metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353

MBTS = metric flareless bite type fitting, pressure rating S (high) per ISO 8434, DIN 2353

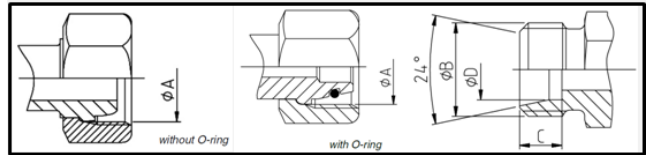


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

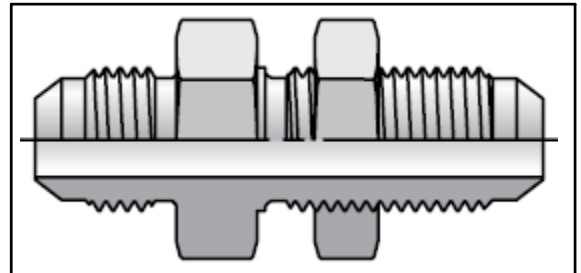


Figure 5-7. Bulkhead Thread

Straight Thread Types, Port Connections

ORB = o-ring boss per SAE J1926, ISO 11926

MPP = metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN 3852

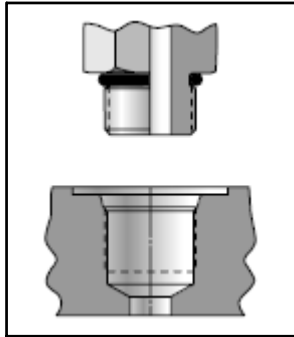


Figure 5-8. ORB-MPP Thread

MFF = metric flat face port per ISO 9974-1

BSPB = British standard parallel pipe per ISO 1179-1, DIN 3852-2

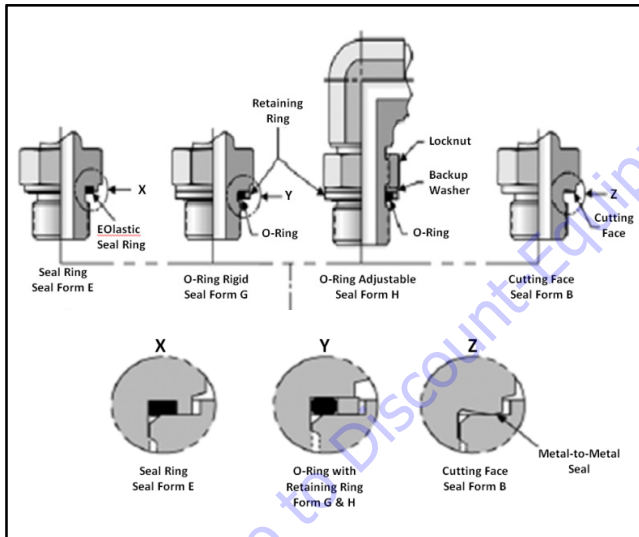


Figure 5-9. MFF-BSPB Thread

Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

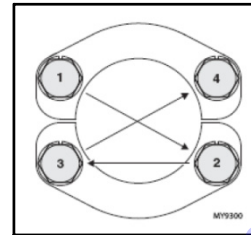


Figure 5-10. ORB-MPP Thread

Tightening Methods

Torque = Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight = The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 3 ft-lbs [4 N-m] Also referred to as 'Hand Tight.'

TFFT = Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR = Flats from Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of 'flats'. A 'flat' is one side of the hexagonal tube nut and equates to 1/6 of a turn. Also referred to as the 'Flats Method.'

Assembly And Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed. Refer to the Figures and Tables in this section.

GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.
3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
 - a. Avoid using dirty or oily rags when handling fittings.
 - b. If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before re-installing.
 - c. Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
 - d. Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
 - e. Sealant should only be applied to the male threads.
 - f. Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
 - g. When replacing or installing an O-ring, care is to be taken while transferring the O-ring over the threads as it may become nicked or torn. When replacing an O-ring on a fitting, the use of a thread protector is recommended.
 - h. When installing fittings with O-rings, lubrication shall be used to prevent scuffing or tearing of the O-ring. See O-ring Installation (Replacement) in this section.

4. Take care to identify the material of parts to apply the correct torque values.
 - a. Verify the material designation in the table headings.
 - b. If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows: Aluminum and Brass- reduce steel values by 35%; Stainless Steel- Use the upper limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.

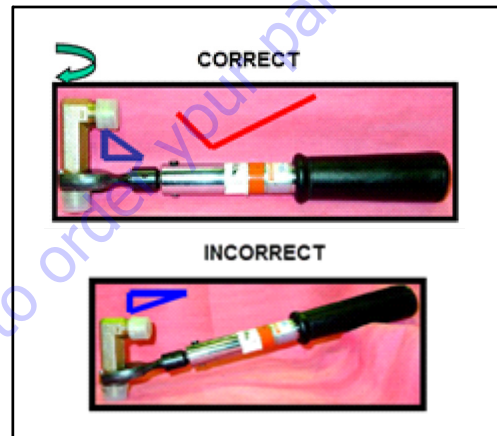


Figure 5-11. Torque Wrench Angle

6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection

Assembly Instructions for American Standard Pipe Thread Tapered (NPTF) Connections.

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as High Temperature high thread sealant with PTFE, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

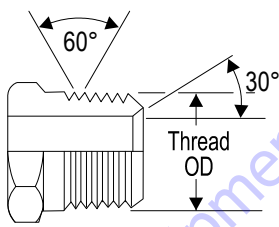
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-1, NPTF Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: TFFT values provided in Table 5-1, NPTF Pipe Thread are applicable for the following material configurations:

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-1. NPTF Pipe Thread



ØA dimension is measured on the 4th pitch of the thread

TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size	ØA*		
		(UNF)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-27	0.40	10.24	2 to 3
	4	1/4-18	0.54	13.61	2 to 3
	6	3/8-18	0.67	17.05	2 to 3
	8	1/2-14	0.84	21.22	2 to 3
	12	3/4-14	1.05	26.56	2 to 3
	16	1-11 1/2	1.31	33.22	1.5 to 2.5
	20	1 1/4-11 1/2	1.65	41.98	1.5 to 2.5
	24	1 1/2-11 1/2	1.89	48.05	1.5 to 2.5
	32	2-11 1/2	2.37	60.09	1.5 to 2.5

* ØA thread dimension for reference only.
 ** See FFWR and TFFT Methods subsection for TFFT procedure requirements.

Assembly Instructions for British Standard Pipe Thread Tapered (BSPT) Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as High Temperature high thread sealant with PTFE, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

5. Rotate male fitting the number of turns per Table 5-2, BSPT Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: TFFT values provided in Table 5-2, BSPT Pipe Thread are applicable for the following material configurations:

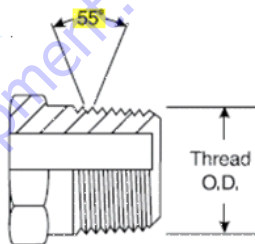
- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

Table 5-2. BSPT Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
MATERIAL	Dash Size	Thread Size	ØA*		
		(BSPT)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-28	0.38	9.73	2 to 3
	4	1/4-19	0.52	13.16	2 to 3
	6	3/8-19	0.66	16.66	2 to 3
	8	1/2-14	0.83	20.96	2 to 3
	12	3/4-14	1.04	26.44	2 to 3
	16	1-11	1.31	33.25	1.5 to 2.5
	20	1 1/4-11	1.65	41.91	1.5 to 2.5
	24	1 1/2-11	1.88	47.80	1.5 to 2.5
	32	2-11	2.35	59.61	1.5 to 2.5

* ØA thread dimension for reference only.
 ** See Appendix B for TFFT procedure requirements.

Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting and start threads by hand.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Torque assembly to value listed in Table Table 5-3, 37° Flare (JIC)Thread - Steel or Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

NOTE: *Torque values provided in Table Table 5-3, 37° Flare (JIC)Thread - Steel and Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-3. 37° Flare (JIC) Thread - Steel

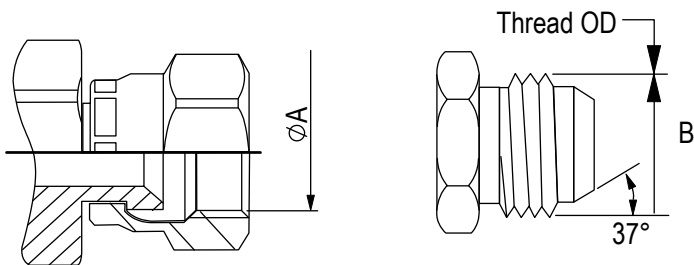
Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
32	2 1/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1	

* ØA and ØB thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-4. 37° Flare (JIC) Thread - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
			(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	11/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	13/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	15/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	15/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	17/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
32	2 1/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1	

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting.
3. Tighten fitting by hand until hand tight.

CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

Torque fitting to value listed in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass while using the Double Wrench Method outlined in this section. Refer to FFWR and TFFT Methods for procedure requirements if using the TFFT method.

NOTE: *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

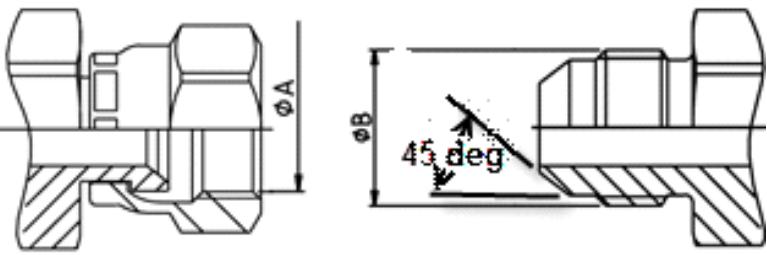
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS

mating components.

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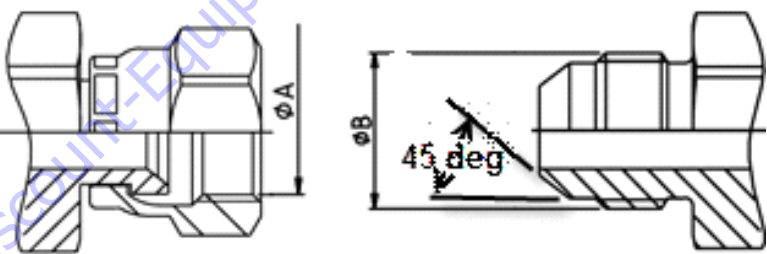
Table 5-5. 45° Flare (SAE) - Steel



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size (UNF)	ØA*		ØB*		[Ft-Lb]			[N-m]		
			(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	1 1/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125

* ØA and ØB thread dimensions for reference only.
 ** See FFWR and TFFT Methods for FFWR procedure requirements.

Table 5-6. 45° Flare (SAE) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size (UNF)	ØA*		ØB*		[Ft-Lb]			[N-m]		
			(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	1 1/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83

* ØA and ØB thread dimensions for reference only.
 ** See FFWR and TFFT Methods for TFFT procedure requirements.

Assembly Instructions for O-Ring Face Seal (ORFS) Fittings

1. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).
2. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the O-ring. Hand thread the nut onto the fitting body.

5. Torque nut to value listed in Table 5-7, O-ring Face Seal (ORFS) - Steel or Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass while using the Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

NOTE: *Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

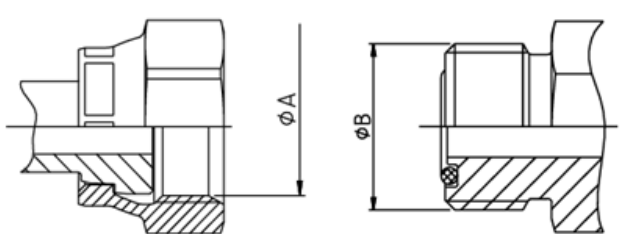
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or

BRASS mating components

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Table 5-7. O-ring Face Seal (ORFS) - Steel



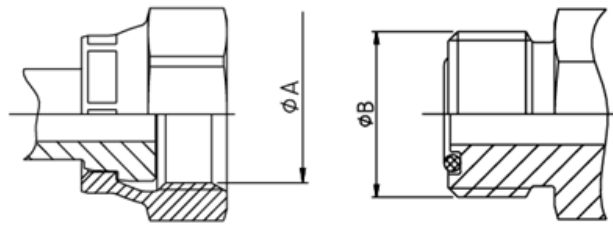
TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	1 1/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
32	2 1/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4	

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

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Table 5-8. O-ring Face Seal (ORFS) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

⚠ CAUTION

A NON-SQUARE TUBE END CAN CAUSE IMPROPERLY SEATED FITTINGS AND LEAKAGE.

1. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary replace fitting or tube.
2. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
3. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
4. Push the tube end into the coupling body.
5. Slide collet into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in Table Table 5-9, DIN 24°Cone (MBTL & MBTS) while using the Double Wrench Method. The tube must not turn with the nut.

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SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-9. DIN 24° Cone (MBTL & MBTS)

TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)							
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Wrench Resistance (F.F.W.R)**	
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	[Ft-Lb]			[N-m]				
								Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12x1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in this service manual.						1.5 to 1.75	
		8	M14x1.5	12.50	14.00	7.00	8.20							1.5 to 1.75	
		10	M16x1.5	14.50	16.00	7.00	10.20							1.5 to 1.75	
		12	M18x1.5	16.50	18.00	7.00	12.20							1.5 to 1.75	
		15	M22x1.5	20.50	22.00	7.00	15.20							1.5 to 1.75	
		18	M26x1.5	24.50	26.00	7.50	18.20							1.5 to 1.75	
		22	M30x2	27.90	30.00	7.50	22.20							1.5 to 1.75	
		28	M36x2	33.90	36.00	7.50	28.20							1.5 to 1.75	
		35	M45x2	42.90	45.00	10.50	35.30							1.5 to 1.75	
		42	M52x2	49.90	52.00	11.00	42.30							1.5 to 1.75	
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Wrench Resistance (F.F.W.R)**
			(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	[Ft-Lb]			[N-m]			
									Min	Nom	Max	Min	Nom	Max	
		DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14x1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in this service manual.						1.5 to 1.75
			8	M16x1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
			10	M18x1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
			12	M20x1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
			14	M22x1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
			16	M24x1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
			20	M30x2	27.90	30.00	10.50	20.20							1.5 to 1.75
25	M36x2		33.90	36.00	12.00	25.20	1.5 to 1.75								
30	M42x2	39.90	42.00	13.50	30.20	1.5 to 1.75									
38	M52x2	49.90	52.00	16.00	38.30	1.5 to 1.75									

* ØA, ØB, C, & ØD thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

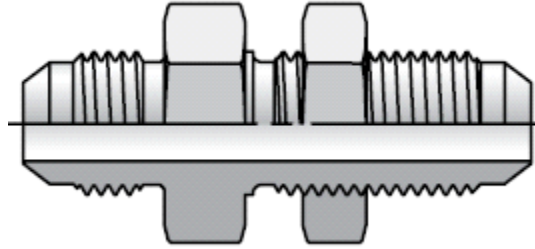
Assembly Instructions for Bulkhead (BH) Fittings

1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand thread the locknut onto the bulkhead end of the fitting body.
5. Torque nut onto fitting per Table 5-10 and Table 5-11 while using the Double Wrench Method.

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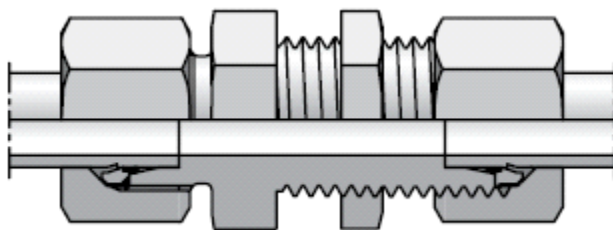
Table 5-10. Bulkhead Fittings (BH) - INCH



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors						
MATERIAL	TYPE	Dash Size	Thread Size	Torque						
				[Ft-Lb]			[N-m]			
			(UNF)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23	
		6	11/16-16	25	27	28	34	37	38	
		8	13/16-16	55	58	61	75	79	83	
		10	1-14	85	90	94	115	122	127	
		12	13/16-12	135	142	149	183	193	202	
		14	15/16-12	170	179	187	230	243	254	
		16	17/16-12	200	210	220	271	285	298	
		20	111/16-12	245	258	270	332	350	366	
	24	2-12	270	284	297	366	385	403		
	37° FLARE (JIC) BULKHEAD FITTING	TYPE	Dash Size	Thread Size	Torque					
					[Ft-Lb]			[N-m]		
		(UNF)	Min	Nom	Max	Min	Nom	Max		
		3	3/8-24	8	9	9	11	12	12	
		4	7/16-20	13	14	14	18	19	19	
		5	1/2-20	20	21	22	27	28	30	
		6	9/16-18	25	27	28	34	37	38	
		8	3/4-16	50	53	55	68	72	75	
		10	7/8-14	85	90	94	115	122	127	
		12	11/16-12	135	142	149	183	193	202	
		14	13/16-12	170	179	187	230	243	254	
16		15/16-12	200	210	220	271	285	298		
20	15/8-12	245	258	270	332	350	366			
24	17/8-12	270	284	297	366	385	403			
32	2 1/2-12	310	326	341	420	442	462			

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Table 5-11. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12x1.5	14	15	16	19	20	22
		8	M14x1.5	17	18	19	23	24	26
		10	M16x1.5	22	23	24	30	31	33
		12	M18x1.5	35	37	39	47	50	53
		15	M22x1.5	44	47	50	60	64	68
		18	M26x1.5	70	75	80	95	102	108
		22	M30x2	115	120	125	156	163	169
		28	M36x2	150	157	164	203	213	222
		35	M45x2	155	162	169	210	220	229
		42	M52x2	220	230	240	298	312	325
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	Connecting Tube O.D.	Thread M Size	Torque					
		(mm)	(metric)	[Ft-Lb]			[N-m]		
				Min	Nom	Max	Min	Nom	Max
		6	M14x1.5	17	15	16	23	20	22
		8	M16x1.5	22	18	19	30	24	26
		10	M18x1.5	35	23	24	47	31	33
		12	M20x1.5	40	35	37	54	47	50
		14	M22x1.5	44	47	50	60	64	68
		16	M24x1.5	70	75	80	95	102	108
		20	M30x2	115	120	125	156	163	169
25	M36x2	150	157	164	203	213	222		
30	M42x2	155	162	169	210	220	229		
38	M52x2	220	230	240	298	312	325		

Assembly Instructions for O-Ring Boss (ORB)

Fittings

1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).

⚠ CAUTION

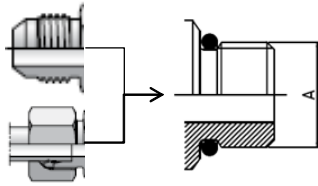
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.

6. Torque the fitting or nut to value listed in Table 5-12 thru Table 5-17 while using the Double Wrench Method.
 - a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
 - b. Torque values provided in Table 5-12 thru Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
 - STEEL fittings with ALUMINUM or BRASS mating components
 - ALUMINUM or BRASS fittings with STEEL mating components
 - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

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Table 5-12. O-ring Boss (ORB) - Table 1 of 6



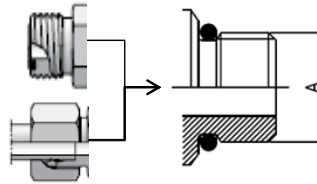
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

* ØA Thread OD dimension for reference only.

** Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

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Table 5-13. O-ring Boss (ORB) - Table 2 of 6



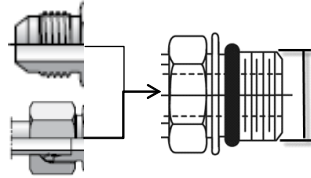
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

* ØA Thread OD dimension for reference only.

** Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

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Table 5-14. O-ring Boss (ORB) - Table 3 of 6



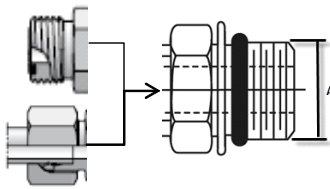
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	7	7
	3	3/8-24	0.37	9.52	(100)	(105)	(110)	11	12	12
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	21	22	23	28	30	31
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

* ØA Thread OD dimension for reference only.

** Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-15. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

* ØA Thread OD dimension for reference only.

** Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-16. O-ring Boss (ORB) - Table 5 of 6



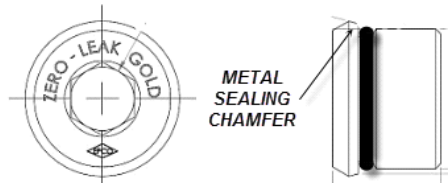
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

* ØA Thread OD dimension for reference only.

***Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-17. O-ring Boss (ORB) - Table 6 of 6



TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
32	2 1/2-12	2.50	63.50							
TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
32	2 1/2-12	2.50	63.50							

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.

6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, or Table 5-23 while using the Double Wrench Method.
 - a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
 - b. Torque values provided in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
 - STEEL fittings with ALUMINUM or BRASS mating components
 - ALUMINUM or BRASS fittings with STEEL mating components
 - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

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SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
	(metric)	(mm)	[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

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Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size (metric)	Connecting Tube O.D. (mm)	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-20. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
	(metric)	(mm)	[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size (metric)	Connecting Tube O.D. (mm)	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

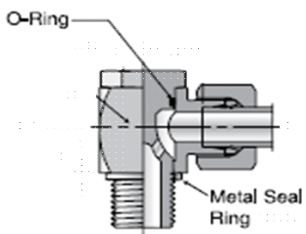
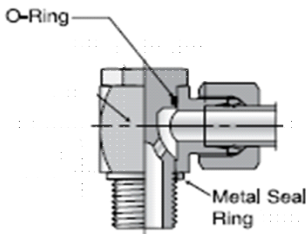
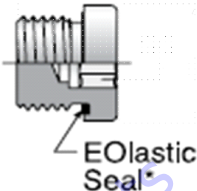
SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3

TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-23. Metric Flat Face Port (MFF) - S Series - Table 3 of 3

																													
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end									HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end									FORM E (EOASTIC SEALING RING) HOLLOW HEX PLUGS								
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque									Torque									Torque								
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]											
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max									
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--									
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--									
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--									
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--									
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88									
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--									
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--									
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--									
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--									
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--									
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--									
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--									
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--									
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--									
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57									
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--									
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--									
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--									
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--									
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--									

Assembly Instructions for Metric ISO 6149 (MPP) Port Assembly Stud Ends

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.

6. Torque the fitting or nut to value listed in Table 5-24 while using the Double Wrench Method.
 - a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
 - b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
 - STEEL fittings with ALUMINUM or BRASS mating components
 - ALUMINUM or BRASS fittings with STEEL mating components
 - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

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Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)

TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351	
M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366	
M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462	
M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301	
M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359	

Assembly instructions for Adjustable Port End (BSPP) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.

6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, or Table 5-30 while using the Double Wrench Method.
 - a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
 - b. Torque values provided in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, and Table 5-30 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
 - STEEL fittings with ALUMINUM or BRASS mating components
 - ALUMINUM or BRASS fittings with STEEL mating components
 - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

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Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3

TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B**(CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

* Typical for JLG Straight Male Stud Fittings
 ** Non typical for JLG Straight Male Stud Fittings, reference only.
 *** Typical for JLG Adjustable Fittings

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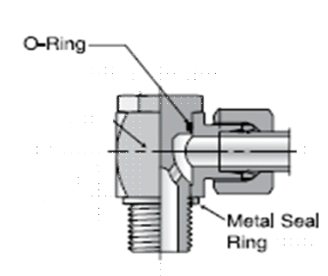
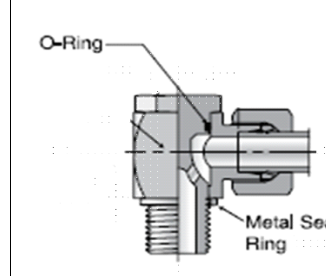
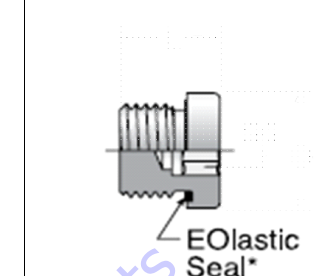
Table 5-26. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3

TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end											
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque									Torque								
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]								
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max						
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19						
	G1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39						
	G1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39						
	G3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77						
	G1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99						
	G1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99						
	G3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198						
	G1A	28	229	241	252	310	327	342	229	241	252	310	327	342						
	G1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495						
	G1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594						
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12						
	G1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26						
	G1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26						
	G3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50						
	G1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64						
	G1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64						
	G3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129						
	G1A	28	149	157	164	202	213	222	149	157	164	202	213	222						
	G1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321						
	G1-1/2A	42	259	272	285	351	369	386	259	272	285	351	369	386						

* Typical for JLG Straight Male Stud Fittings
 ** Non typical for JLG Straight Male Stud Fittings, reference only.
 *** Typical for JLG Adjustable Fittings

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Table 5-27. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3

																												
TYPE/FITTING IDENTIFICATION		BANJO FITTINGS with L series DIN (MBTL) opposite end									HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end									FORM E (EOlastic SEALING RING) HOLLOW HEX PLUGS								
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque													
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]										
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max								
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15								
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33								
	G 1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33								
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65								
	G 1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88								
	G 1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88								
	G 3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153								
	G 1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221								
	G 1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450								
	G 1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495								
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9								
	G 1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22								
	G 1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22								
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42								
	G 1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57								
	G 1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57								
	G 3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99								
	G 1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144								
	G 1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321								
	G 1-1/2A	42	--	--	--	--	--	--	335	352	369	454	477	500	216	227	237	293	308	321								

* Typical for JLG Straight Male Stud Fittings
 ** Non typical for JLG Straight Male Stud Fittings, reference only.
 *** Typical for JLG Adjustable Fittings

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-28. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3

TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61
	G3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500

* Typical for JLG Straight Male Stud Fittings
 ** Non typical for JLG Straight Male Stud Fittings, reference only.
 *** Typical for JLG Adjustable Fittings

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-29. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3

TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-30. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G 1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G 1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G 1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G 1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G 1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						

Note: BSPP O-ring only style (ISO 228-1) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), but is not interchangeable. Not typically used on JLG machines.

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

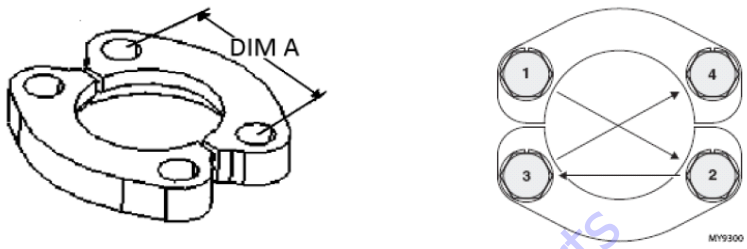
**Assembly Instructions for Flange Connections:
(FL61 and FL62)**

1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. See Figure for O-ring installation instructions.
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Position flange and clamp halves.
5. Place lock washers on bolt and bolt through clamp halves.
6. Tighten all bolts by hand.
7. Torque bolts in diagonal sequence in two or more increments to the torque listed on Table Table 5-31 and Table 5-32.

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SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-31. Flange Code (FL61 & FL62) -Inch Fasteners

																		
TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)												
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
		(in)	(mm)	(in)	(mm)		[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
							Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
		(in)	(mm)	(in)	(mm)		[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
							Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495

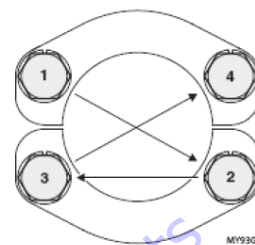
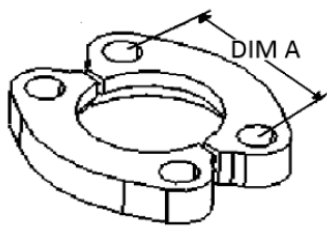
* A dimension for reference only.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

Table 5-32. Flange Code (FL61 & FL62) - Metric Fasteners

TYPE/FITTING IDENTIFICATION							STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)											
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size (Metric)	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
		(in)	(mm)	(in)	(mm)		[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
							Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
	12	0.75	19	1.88	47.75	M8x1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8x1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10x1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14x2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16x2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20x2.5	--	--	--	--	--	--	406	426	446	550	578	605

* A dimension for reference only.



MY9300

Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one Backup wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections,

the 'layline' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5-12. for double wrench method requirements.

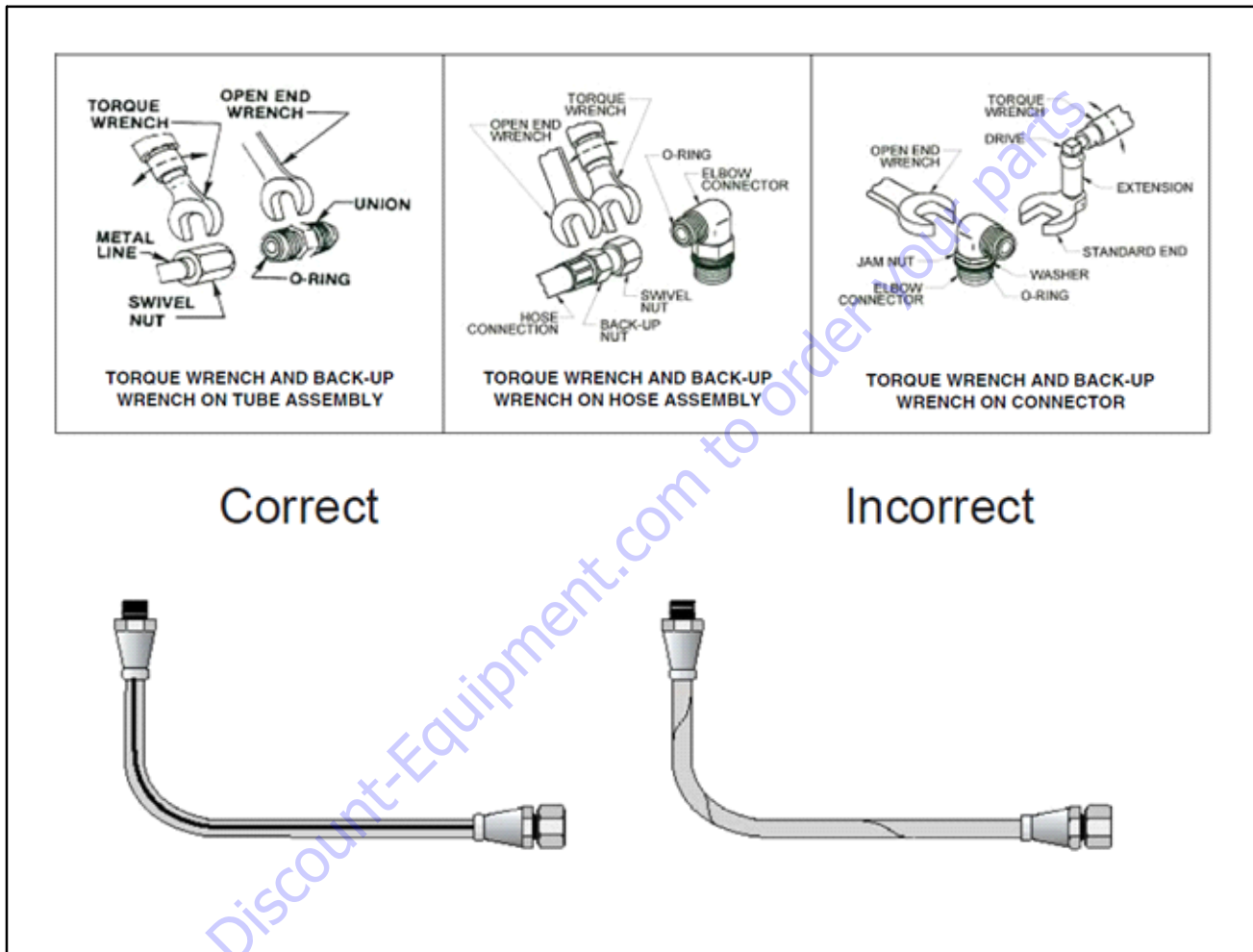


Figure 5-12. Double Wrench Method

FFWR and TFFT Methods

FFWR (FLATS FROM WRENCH RESISTANCE METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter. See Figure B.1.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten as shown in Figure B.1. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. See Figure 5-13.

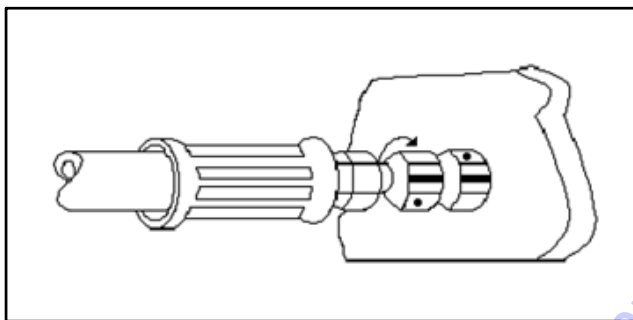


Figure 5-13. FFWR Method

TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

1. Lubricate the o-ring with a light coat of hydraulic oil.
2. Position #1 – The o-ring should be located in the groove adjacent to the face of the Backup washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
3. Position #2 – Position the locknut to just touch the Backup washer as shown. The locknut in this position will eliminate potential back up washer damage during the next step.
4. Position #3 – Install the connector into the straight thread box port until the metal Backup washer contacts the face of the port as shown.
5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.
7. Visually inspect, where possible, the joint to ensure the o-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

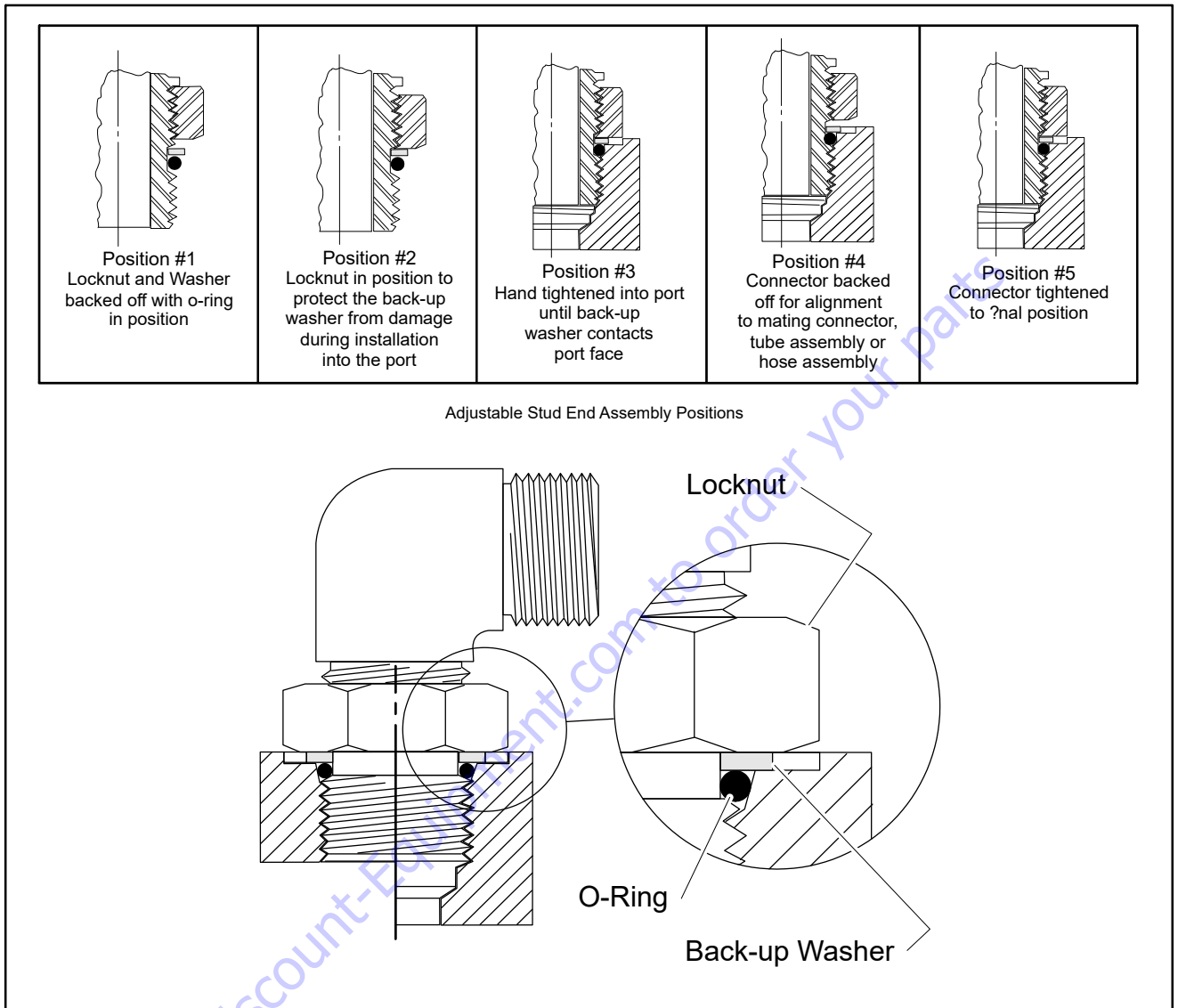


Figure 5-14. Adjustable Stud End Assembly

O-ring Installation (Replacement)

Care must be taken when installing O-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged O-ring could lead to leakage problems.

1. Inspect O-ring for tears or nicks. If any are found replace O-ring.
2. Ensure proper O-ring to be installed. Many O-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing O-rings on fittings.
4. In ORB; ensure O-ring is properly seated in groove. On straight threads, ensure O-ring is seated all the way past the threads prior to installation.
5. Inspect O-ring for any visible nicks or tears. Replace if found.

5.3 CYLINDER REPAIR

NOTE: The following are general procedures that apply to all of the cylinders on this machine. Procedures that apply to a specific cylinder will be so noted.

Disassembly

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

NOTICE

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

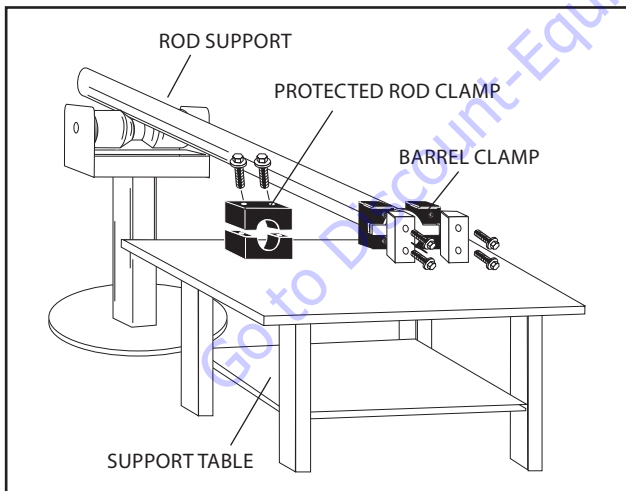


Figure 5-15. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the eight (8) cylinder head retainer cap screws, and remove cap screws from cylinder barrel.

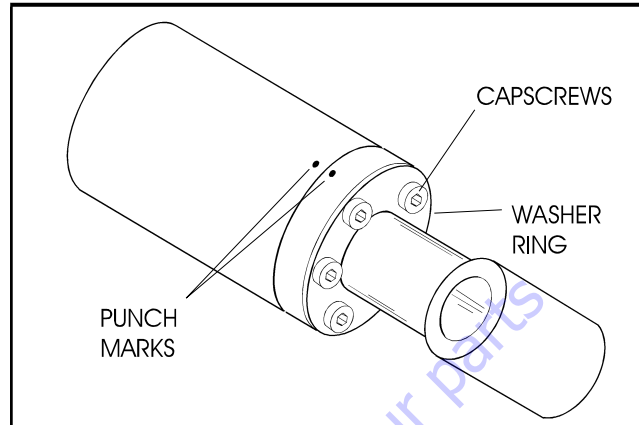


Figure 5-16. Cap Screw Removal

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

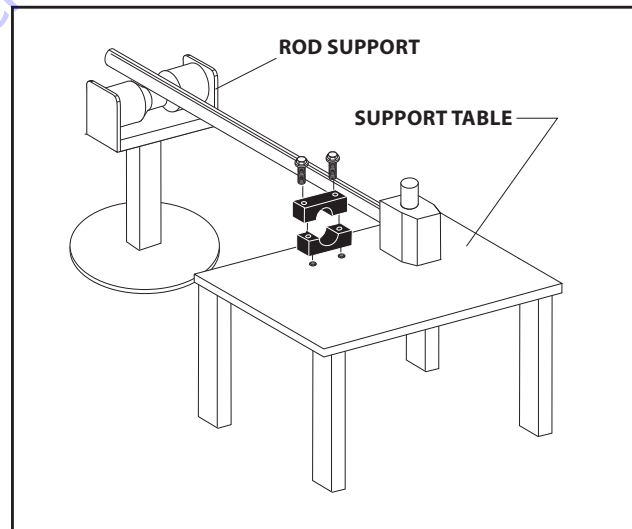
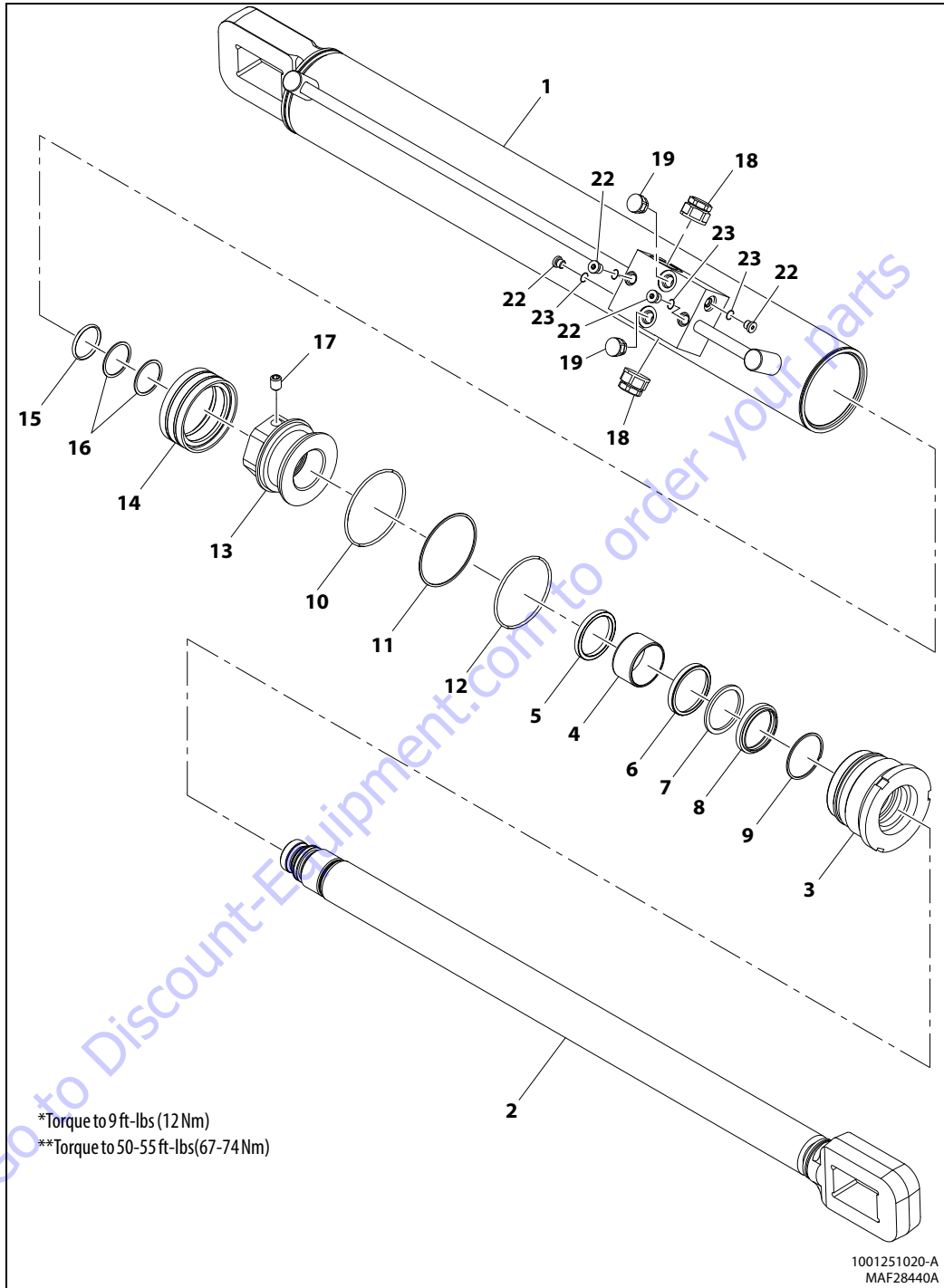
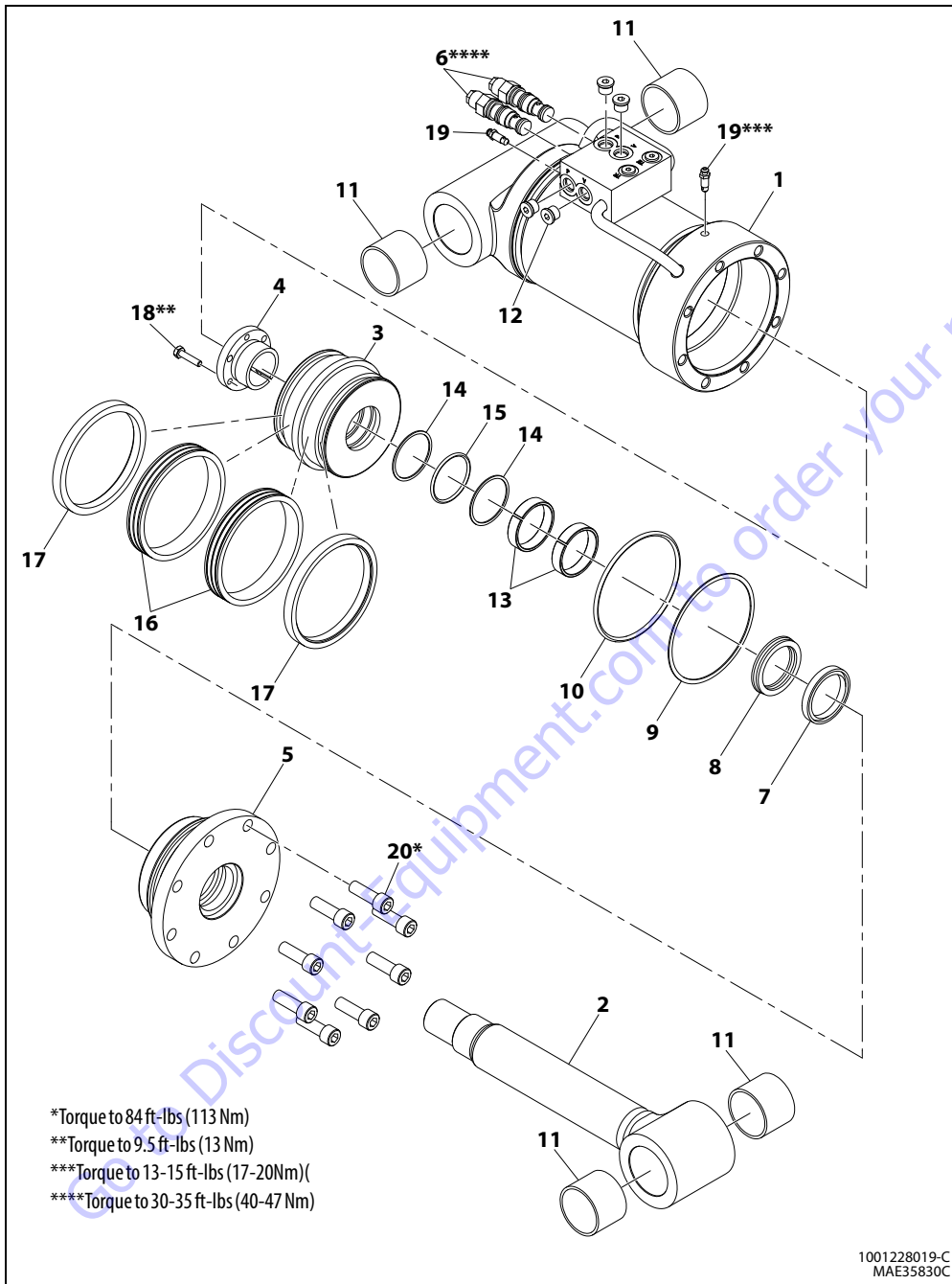


Figure 5-17. Cylinder Rod Support



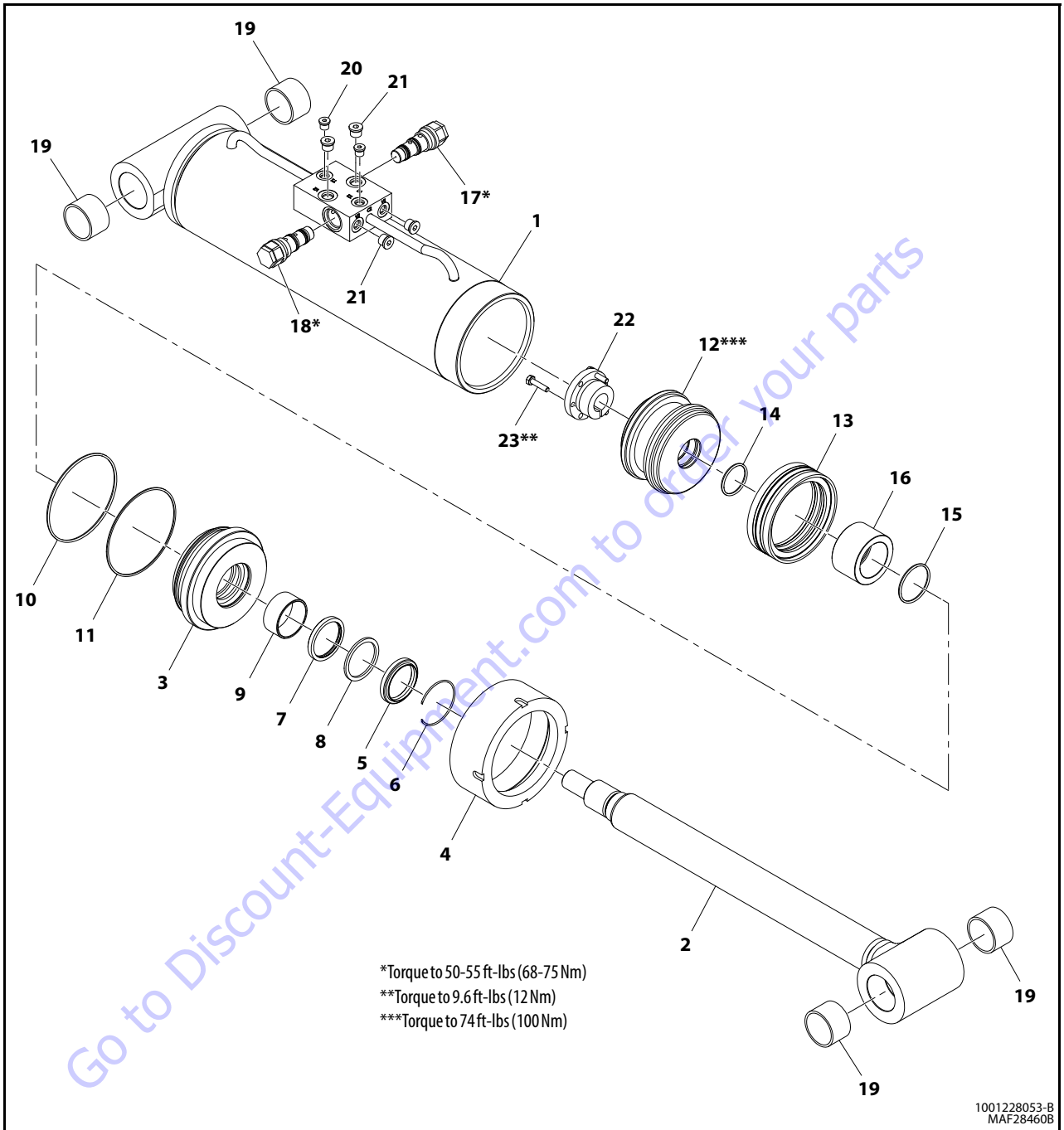
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|-------------------|-------------------|-----------------|--------------------------|------------|
| 1. Barrel | 6. U-Packing | 11. Backup Ring | 16. Backup Ring | 21. O-Ring |
| 2. Rod | 7. Backup Ring | 12. O-Ring | 17. SetScrew | 22. Plug |
| 3. Head | 8. Dust Wiper | 13. Piston | 18. Counterbalance Valve | 23. O-Ring |
| 4. Spacer | 9. Retaining Ring | 14. Piston Seal | 19. Dust Cap | |
| 5. Retaining Ring | 10. O-Ring | 15. O-Ring | 20. Plug | |

Figure 5-18. Axle Extension Cylinder



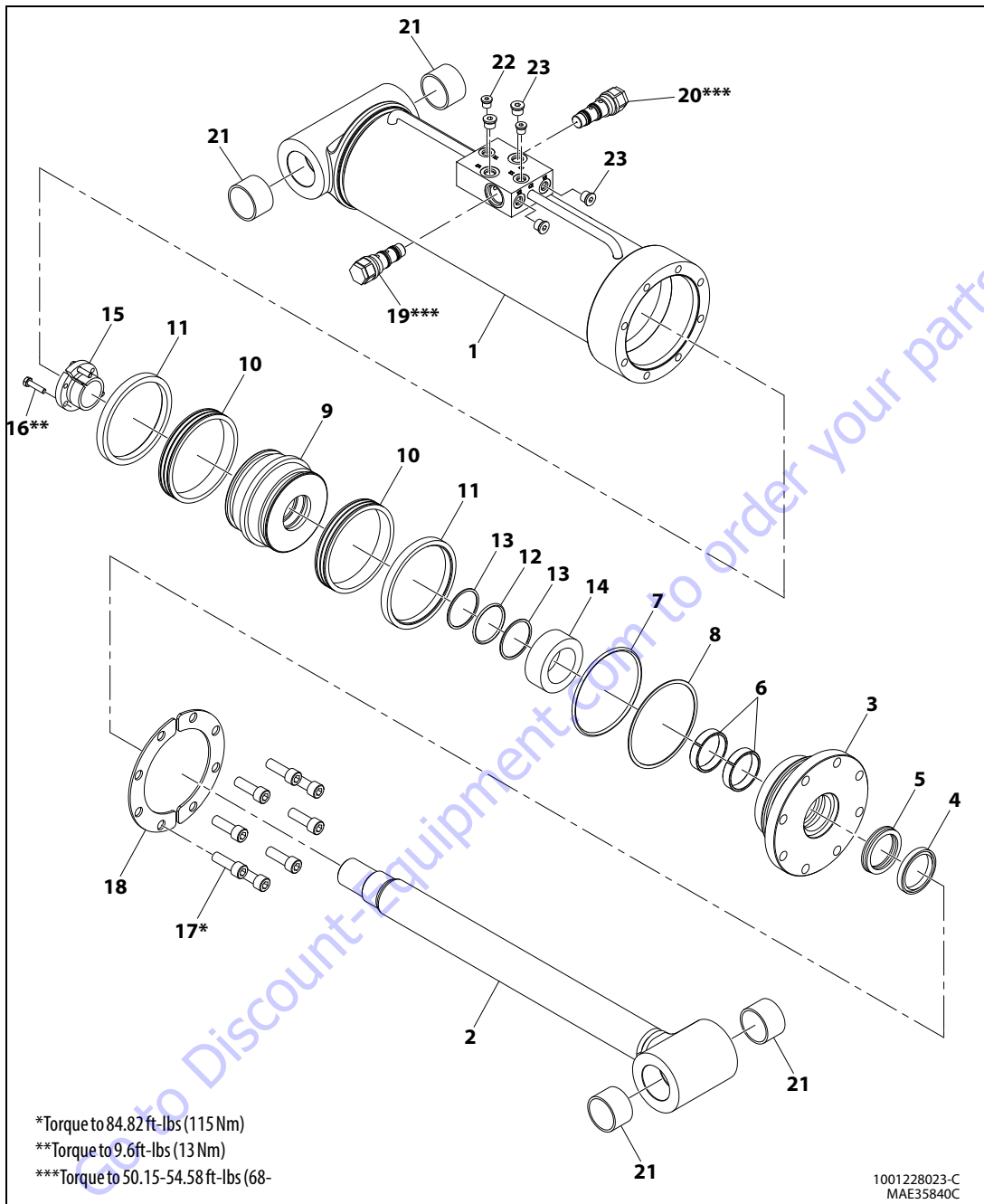
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|--------------------|-------------------------|-----------------|-------------------|
| 1. Barrel | 6. Counterbalance Valve | 11. Bushing | 16. Seal |
| 2. Rod | 7. Wiper | 12. O-ring Plug | 17. Lock Ring |
| 3. Piston | 8. Rod Seal | 13. Wear Ring | 18. Capscrew. |
| 4. Tapered Bushing | 9. Backup ring | 14. Backup ring | 19. Bleeder Valve |
| 5. Head | 10. O-ring | 15. O-ring | 20. Capscrew |

Figure 5-19. Axle Lockout Cylinder



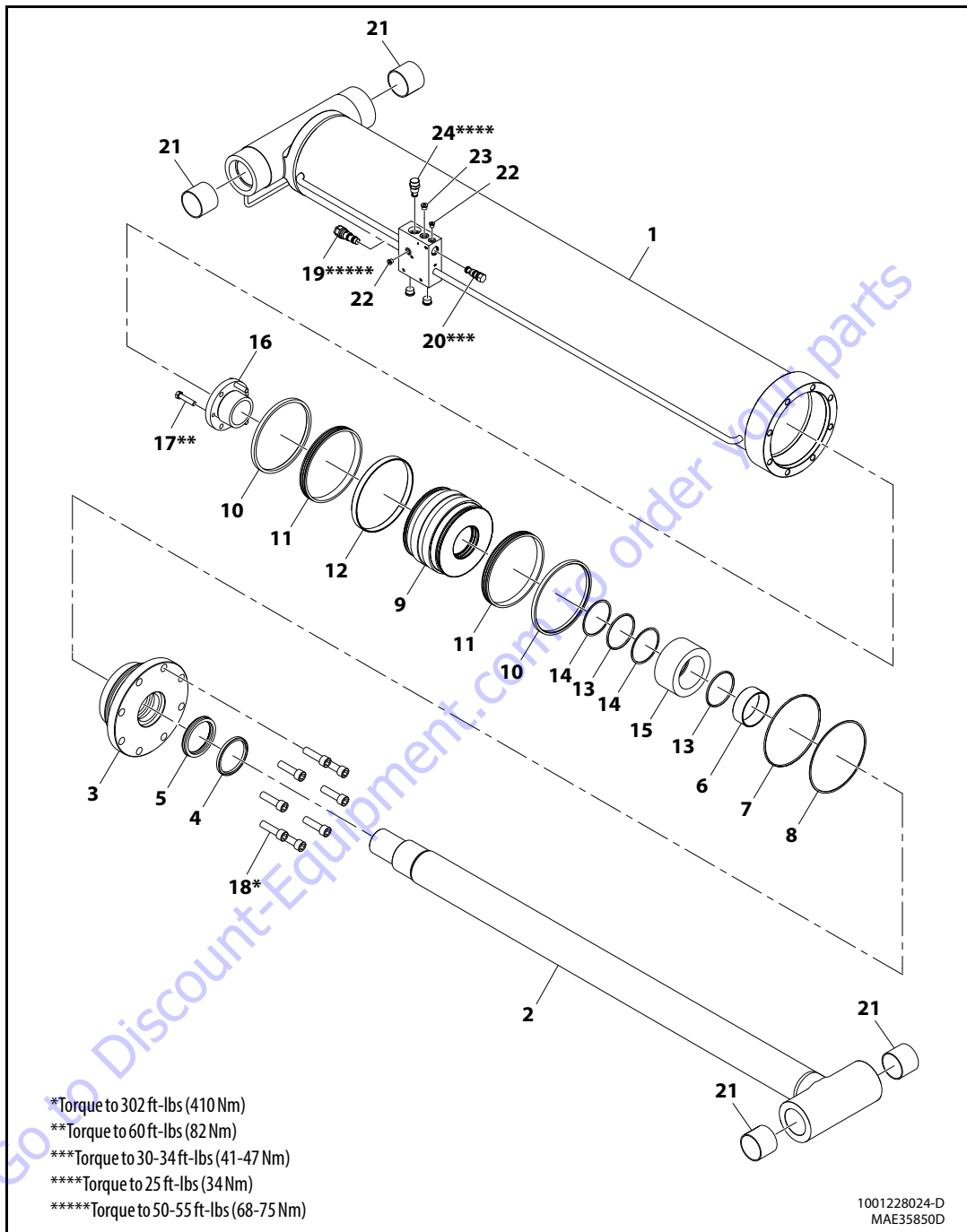
- | | | | |
|-----------------|-----------------|------------------------------------|---------------------|
| 1. Barrel | 7. Rod Seal | 13. Piston Seal | 19. Bushing |
| 2. Rod | 8. Backup Ring | 14. O-ring | 20. Plug |
| 3. Head | 9. Wear Ring | 15. O-ring | 21. Plug |
| 4. Cap Cylinder | 10. O-ring | 16. Spacer | 22. Tapered Bushing |
| 5. Wiper | 11. Backup Ring | 17. Holding Valve Cartridge | 23. Capscrew |
| 6. Retainer | 12. Piston | 18. Counterbalance Valve Cartridge | |

Figure 5-20. Platform Level Cylinder (With Cold Weather Plus Package)



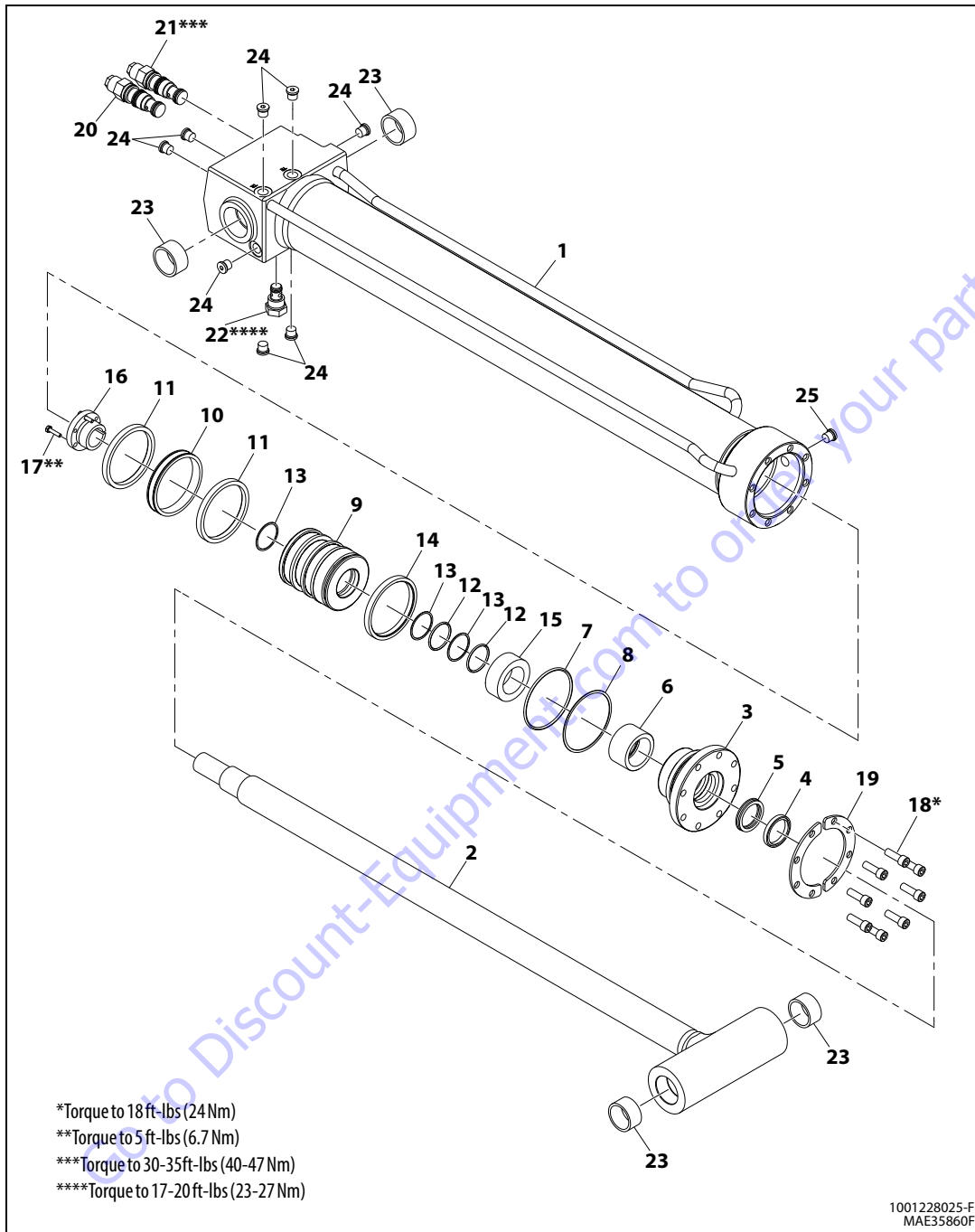
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|--------------|----------------|---------------------|--------------------------|
| 1. Barrel | 7. O-Ring | 13. Backup Ring | 19. Counterbalance valve |
| 2. Rod | 8. Backup Ring | 14. Spacer | 20. Cartridge Valve |
| 3. Head | 9. Piston | 15. Tapered Bushing | 21. Bushing |
| 4. Wiper | 10. Guide Ring | 16. Capscrew | 22. O-Ring |
| 5. Rod seal | 11. Lock Ring | 17. Capscrew | 23. O-Ring |
| 6. Wear Ring | 12. O-Ring | 18. Ring washer | |

Figure 5-21. Platform Level Cylinder (Without Cold Weather Plus Package)



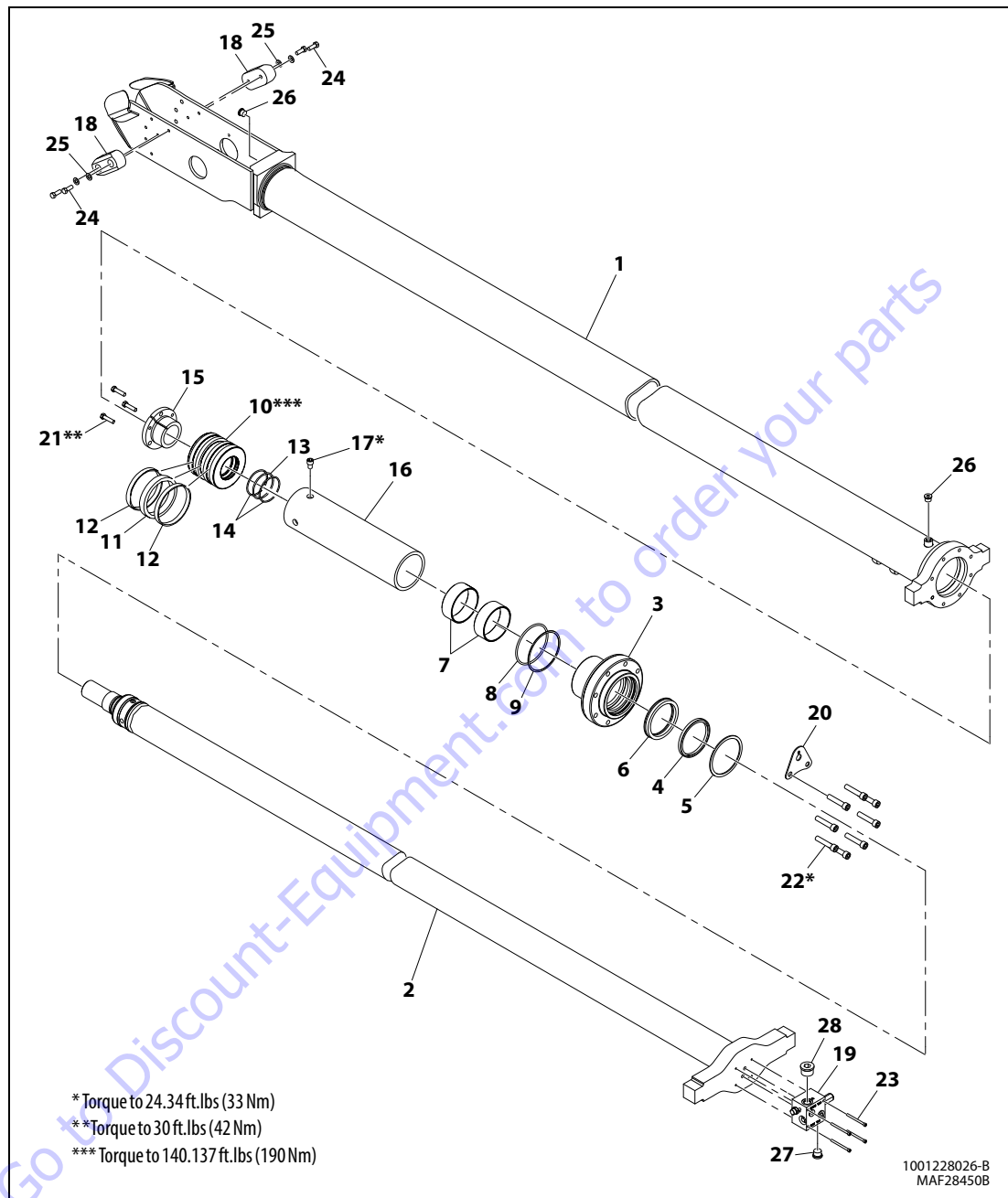
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|--------------|----------------|---------------------|------------------------------|
| 1. Barrel | 7. O-Ring | 13. O-Ring | 19. Holding Valve |
| 2. Rod | 8. Backup Ring | 14. Back Up Ring | 20. Check Valve |
| 3. Head | 9. Piston | 15. Spacer | 21. Bushing |
| 4. Wiper | 10. Lock Ring | 16. Tapered Bushing | 22. O-ring Plug |
| 5. Rod Seal | 11. Guide Ring | 17. Capscrew | 23. O-ring Plug |
| 6. Wear Ring | 12. Wear Ring | 18. Capscrew | 24. Pressure Regulator Valve |

Figure 5-22. Lift Cylinder



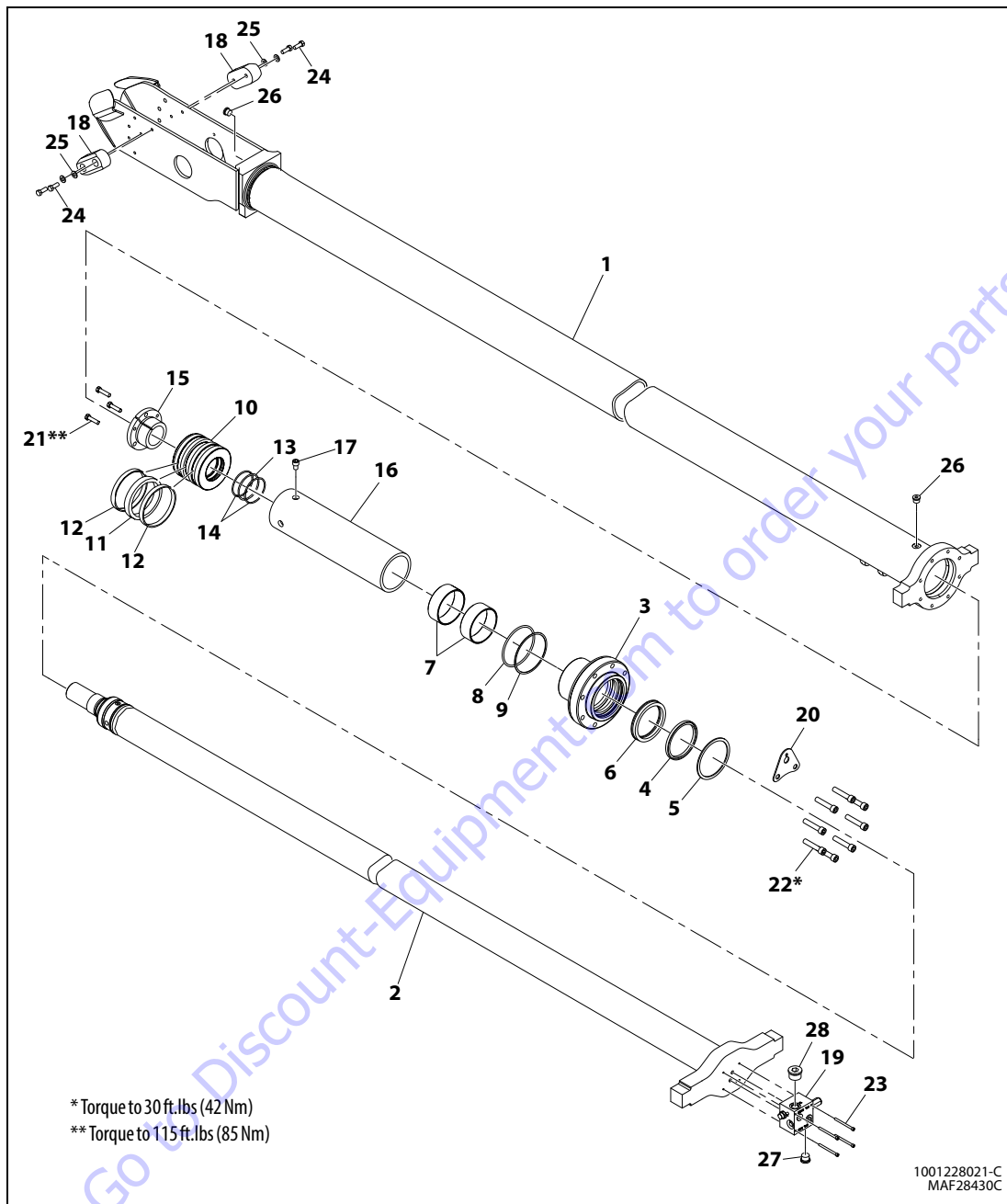
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|--------------|---------------|---------------------|--------------------------|------------|
| 1. Barrel | 7. O-Ring | 13. Backup Ring | 19. Ring Washer | 25. O-Ring |
| 2. Rod | 8. Backup Rig | 14. Seal | 20. Counterbalance valve | |
| 3. Head | 9. Piston | 15. Spacer | 21. Cartridge Valve | |
| 4. Rod Wiper | 10. Seal | 16. Tapered Bushing | 22. Cartridge Valve | |
| 5. Seal | 11. Wear Ring | 17. Capscrew | 23. Bushing | |
| 6. Wear Ring | 12. O-Ring | 18. Capscrew | 24. O-ring | |

Figure 5-23. Jib Cylinder



- | | | | |
|-------------------|-----------------|---------------------|--------------|
| 1. Barrel | 8. O-Ring | 15. Tapered Bushing | 22. Capscrew |
| 2. Rod | 9. Backup Ring | 16. Spacer | 23. Capscrew |
| 3. Head | 10. Piston | 17. Capscrew | 24. Bolt |
| 4. Wiper | 11. Seal | 18. Wear Pad | 25. Washer |
| 5. Retaining Ring | 12. Wear Ring | 19. Valve Assembly | 26. Plug |
| 6. Rodseal | 13. O-Ring | 20. Bracket | 27. Plug |
| 7. Wear Ring | 14. Backup Ring | 21. Capscrew | 28. Plug |

Figure 5-24. Telescope Cylinder - 1200SJP



- | | | | |
|-------------------|-----------------|---------------------|--------------|
| 1. Barrel | 8. O-Ring | 15. Tapered Bushing | 22. Capscrew |
| 2. Rod | 9. Backup Ring | 16. Spacer | 23. Capscrew |
| 3. Head | 10. Piston | 17. Capscrew | 24. Bolt |
| 4. Wiper | 11. Seal | 18. Wear Pad | 25. Washer |
| 5. Retaining Ring | 12. Wear Ring | 19. Valve Assembly | 26. O-Ring |
| 6. Rod seal | 13. O-Ring | 20. Bracket | 27. O-Ring |
| 7. Wear Ring | 14. Backup Ring | 21. Capscrew | 28. O-Ring |

Figure 5-25. Telescope Cylinder - 1350SJP

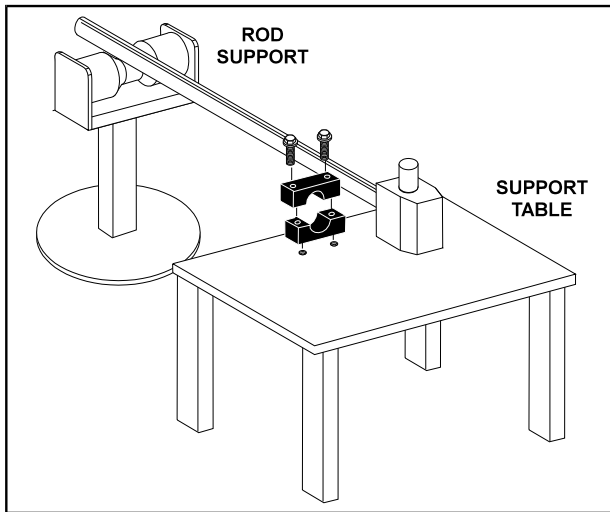


Figure 5-26. Cylinder Rod Support

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.
9. Insert the cap screw(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the cap screw(s) until the bushing is loose on the piston.
10. Remove the tapered bushing from the piston.

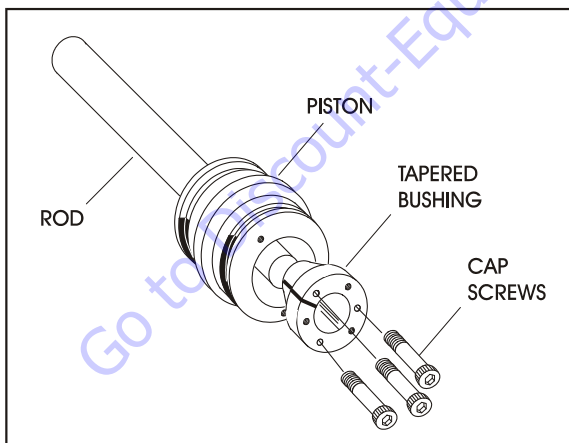


Figure 5-27. Tapered Bushing Removal

11. Screw the piston CCW, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.

14. Remove the rod from the holding fixture. Remove the cylinder head gland and retainer plate, if applicable. Discard the o-rings, Backup rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
 - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
 - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
 - c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.
 - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.

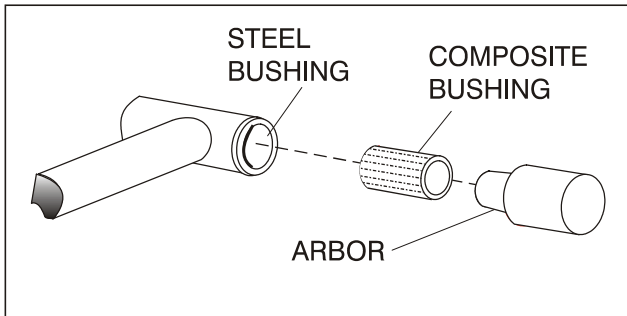


Figure 5-28. Composite Bearing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components prior to assembly.

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

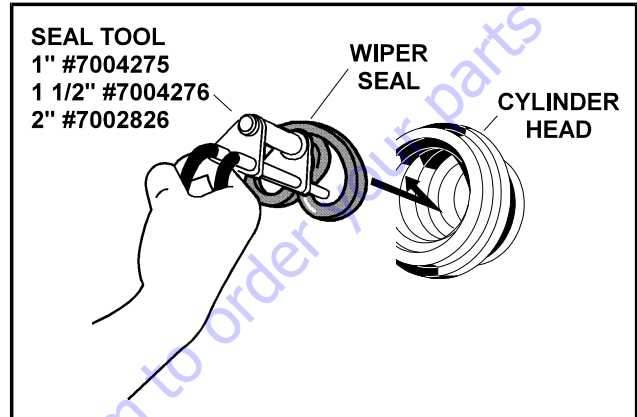


Figure 5-29. Rod Seal Installation

NOTICE

WHEN INSTALLING 'POLY-PAK' PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

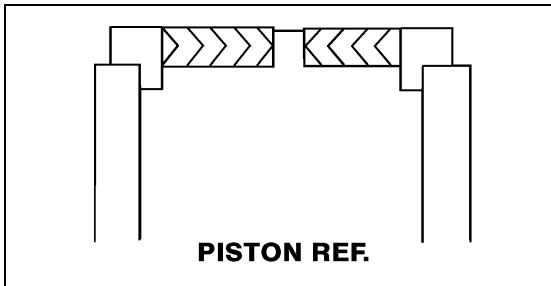


Figure 5-30. Poly-Pak Piston Seal Installation

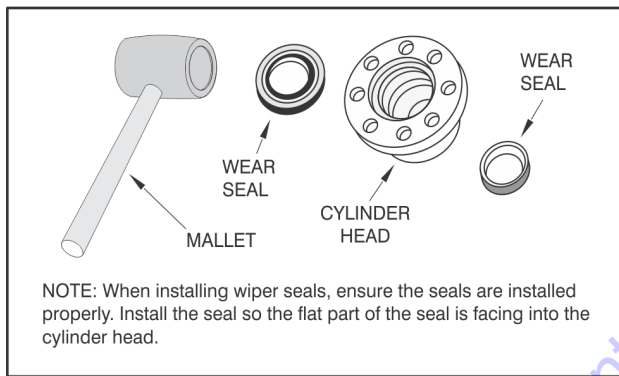


Figure 5-31. Wiper Seal Installation

3. Place a new O-ring and Backup seal in the applicable outside diameter groove of the cylinder head.

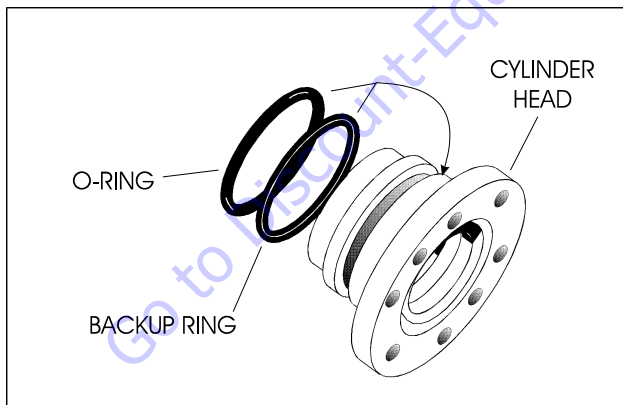


Figure 5-32. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the piston spacer on the rod.

NOTE: Main telescope cylinder piston has an o-ring installed inside the spacer.

6. If applicable, correctly place new o-ring in the inner piston diameter groove. (The backup ring side facing the O-ring is grooved.)
7. If applicable, correctly place new seals and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal.)

NOTE: The backup rings for the solid seal have a radius on one side. This side faces the solid seal. (See magnified insert in Figure 5-33.) The split of seals and backup rings are to be positioned so as not to be in alignment with each other.

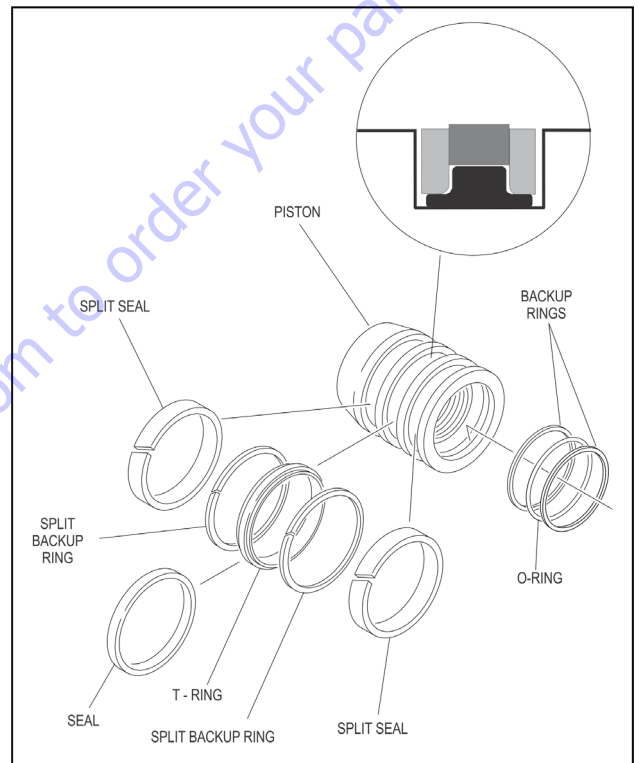


Figure 5-33. Piston Seal Kit Installation

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and Backup rings are not damaged or dislodged.
10. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: When installing the tapered bushing, piston and mating end of rod must be free of oil.

NOTICE

WHEN REBUILDING THE TELESCOPE, LIFT, JIB, LEVEL, AXLE LOCKOUT OR AXLE EXTENSION CYLINDERS, TIGHTEN SECURELY. (SEE TABLE 5-33)

11. Assemble the tapered bushing loosely into the piston and insert JLG capscrews (not vendor capscrews) through the drilled holes in the bushing and into the tapped holes in the piston.

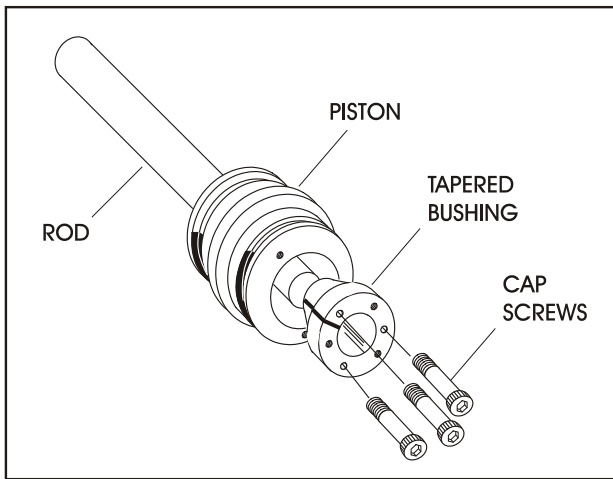


Figure 5-34. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to the specified torque value. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications).
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows:
 - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

- b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

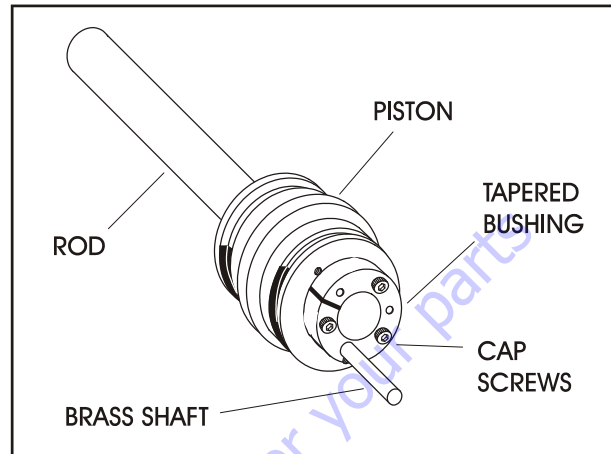


Figure 5-35. Seating the Tapered Bearing

14. Retorque the capscrews evenly and progressively in rotation to the specified torque value. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications).
15. Remove the cylinder rod from the holding fixture.
16. Place new guide locks and seals in the applicable outside diameter grooves of the cylinder piston. (See Figure 5-33., Piston Seal Kit Installation)
17. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

20. Secure the cylinder head gland using the washer ring and socket head bolts. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications and Table 5-34, Holding Valve Torque Specifications)

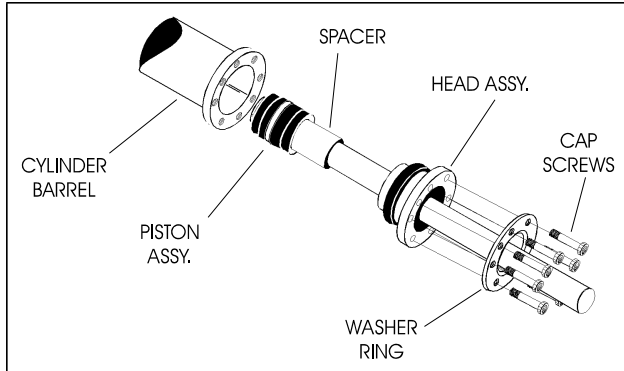


Figure 5-36. Rod Assembly Installation

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.
22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 5-34, Holding Valve Torque Specifications).

Table 5-33. Cylinder Head and Tapered Bushing Torque Specifications

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Tele Cylinder (1200SJP)	120 ft. lbs. (163 Nm)	30 ft. lbs. (40.5 Nm)
Tele Cylinder (1350SJP)	120 ft. lbs. (163 Nm)	45 ft. lbs. (63 Nm)
Level Cylinder	120 ft. lbs. (163 Nm)	9 ft. lbs. (12.6 Nm)
Jib Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Lift Cylinder	300 ft. lbs. (410 Nm)	120 ft. lbs. (168 Nm)
Axle Oscillation Cylinder	120 ft. lbs. (163 Nm)	9 ft. lbs. (12.6 Nm)
Axle Extend Cylinder	50 ft. lbs. (70 Nm)	9 ft. lbs. (12.6 Nm)

Table 5-34. Holding Valve Torque Specifications

Description	Torque Value
SUN - 7/8 HEX M20 X 1.5 THDS.	30-35 ft. lbs. (41-48 Nm)
SUN - 1 1/8 HEX 1-14 UNS THDS.	45-50 ft. lbs. (61-68 Nm)
SUN - 1 1/4 HEX M36 X 2 THDS.	150-160 ft. lbs. (204-217 Nm)
RACINE - 1 1/8 HEX 1 1/16 - 12 THDS.	50-55 ft. lbs. (68-75 Nm)
RACINE - 1 3/8 HEX 13/16 - 12 THDS.	75-80 ft. lbs. (102-109 Nm)
RACINE - 1 7/8 HEX 15/8 - 12 THDS.	100-110 ft. lbs. (136-149 Nm)

Steer Cylinder

DISASSEMBLY

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

NOTICE

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

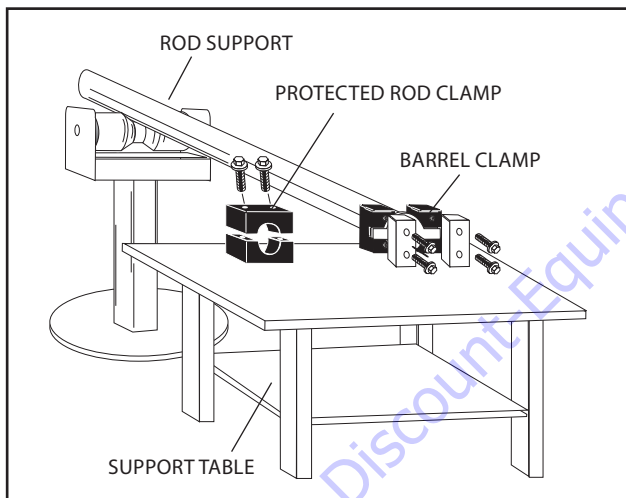


Figure 5-37. Cylinder Barrel Support

4. Mark cylinder cap and barrel with a center punch for easy realignment. Unscrew the cylinder cap from the barrel.
5. Using a hook spanner, loosen the cylinder cap on Barrel. Remove the cylinder head from the barrel and the rod.

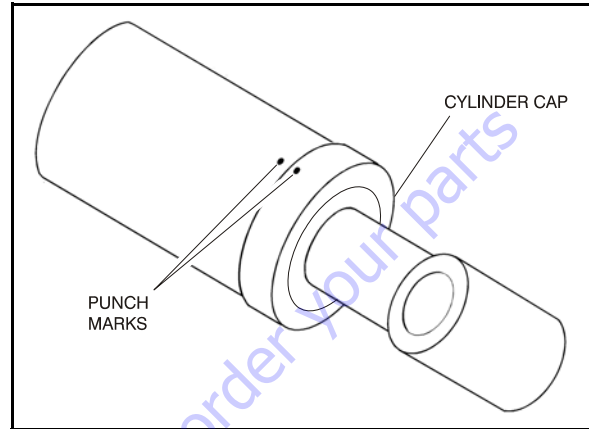


Figure 5-38. Cylinder Cap Removal

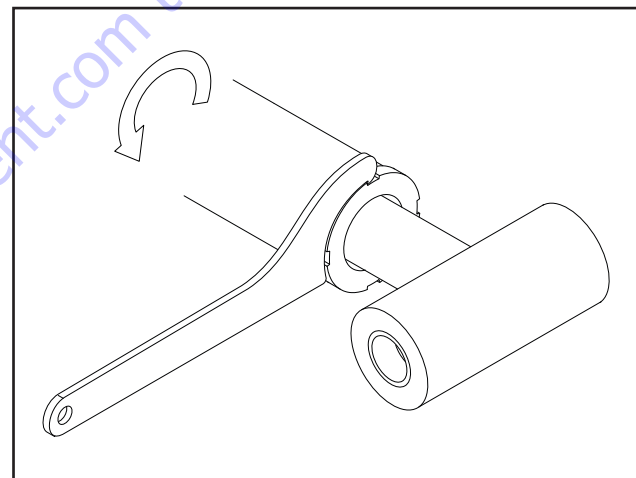
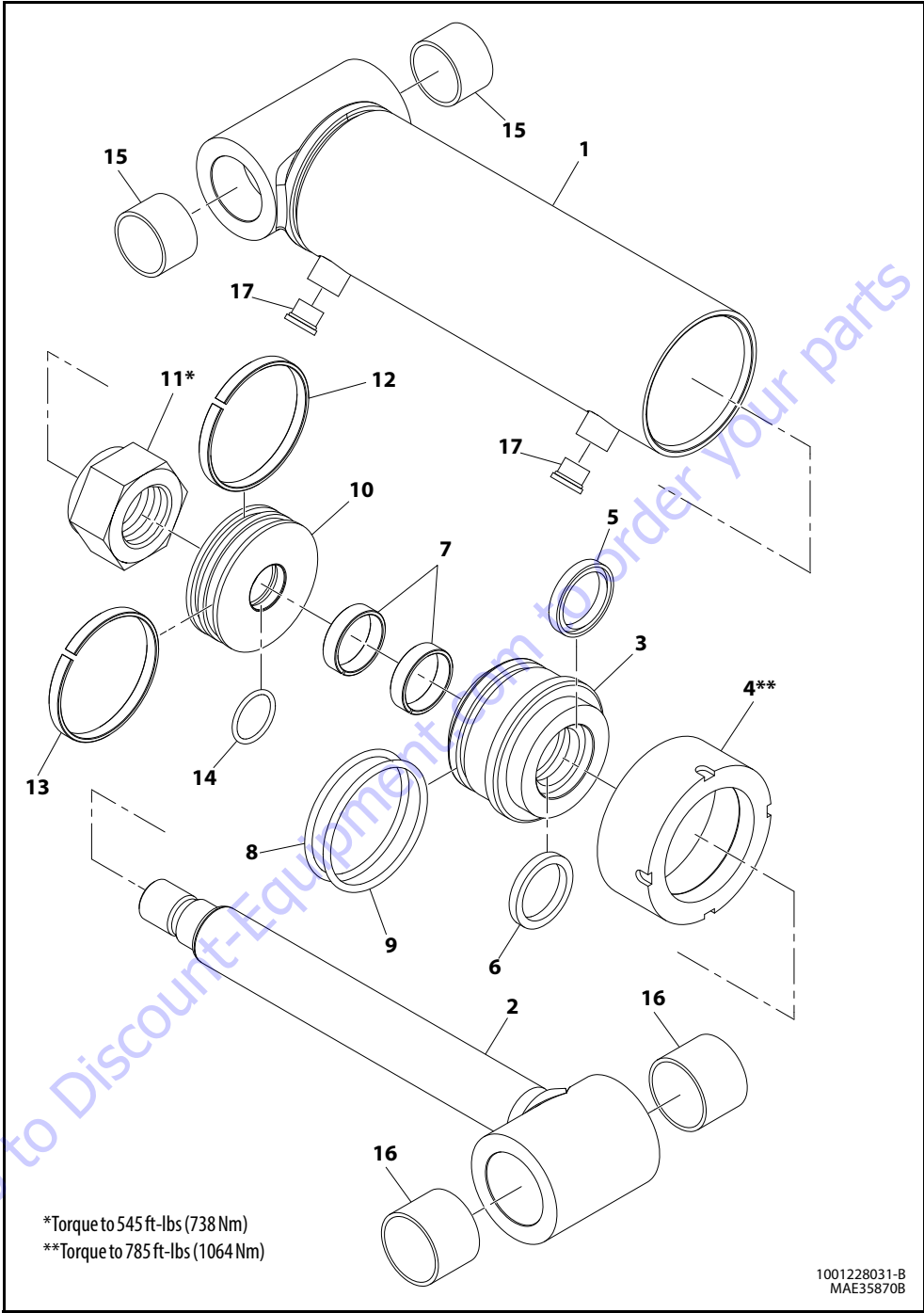


Figure 5-39. Cylinder Cap Removal

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.



- | | | | |
|-----------------|----------------|---------------|-------------|
| 1. Barrel | 6. Piston Seal | 11. Nut | 16. Bushing |
| 2. Rod | 7. Wear Ring | 12. Wiper | 17. Plug |
| 3. Head | 8. O-Ring | 13. Wear Ring | |
| 4. Cylinder Cap | 9. Backup Ring | 14. O-Ring | |
| 5. Wiper | 10. Piston | 15. Bushing | |

Figure 5-40. Steer Cylinder

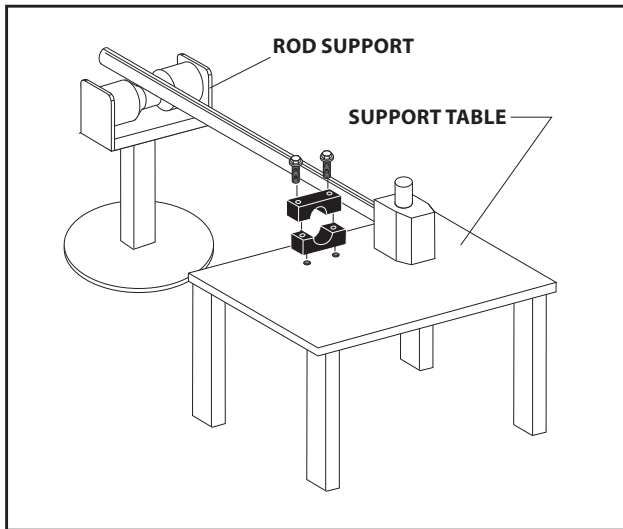


Figure 5-41. Cylinder Rod Support

8. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.
9. Loosen and remove the lock nut that secures the piston to the cylinder rod.
10. Remove the piston from the cylinder rod.
11. Remove and discard the piston o-rings, seal rings.
12. Remove the rod from the holding fixture. Remove the cylinder head. Discard all seals on the cylinder head.

Cleaning And Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.

9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
 - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
 - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
 - c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.
 - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.

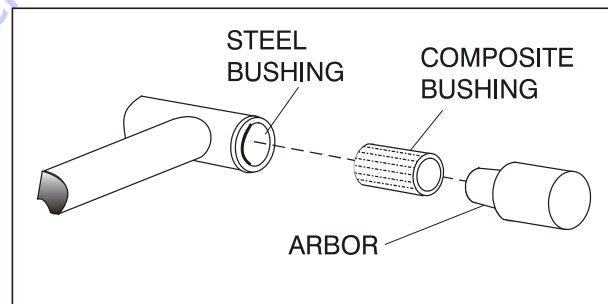


Figure 5-42. Composite Bearing Installation

14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

NOTE: Apply a light film of hydraulic oil to all components prior to assembly.

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

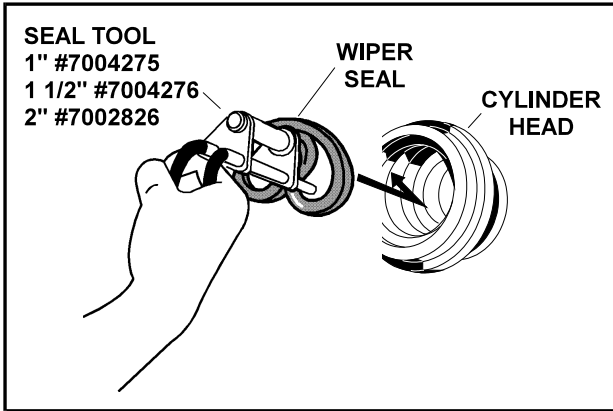


Figure 5-43. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

2. Use a soft mallet to tap a new wiper seal into the cylinder head gland groove. Install new wear rings into the cylinder head gland groove.

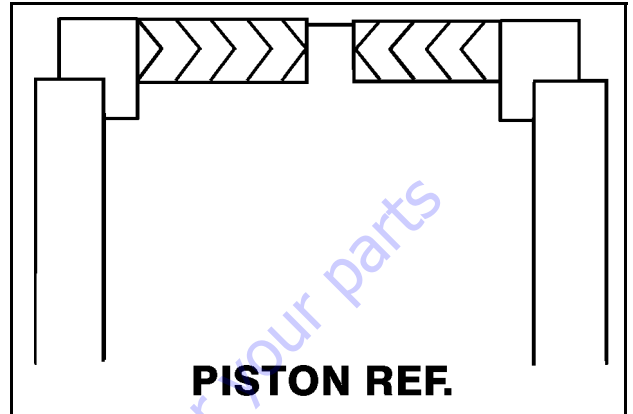


Figure 5-44. Poly-Pak Piston Seal Installation

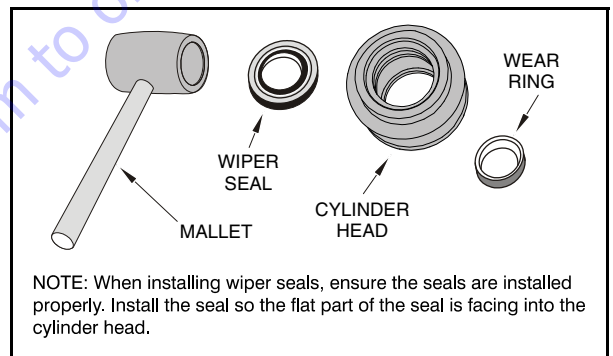


Figure 5-45. Wiper Seal Installation

3. Place a new O-ring and backup ring in the outside diameter groove of the cylinder head.

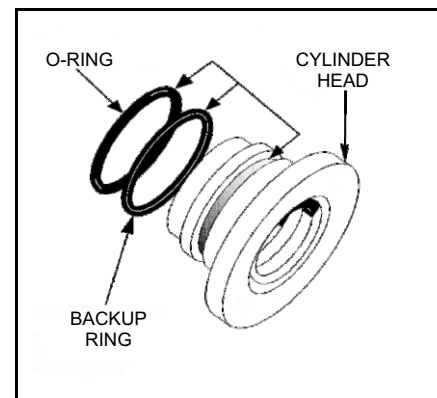


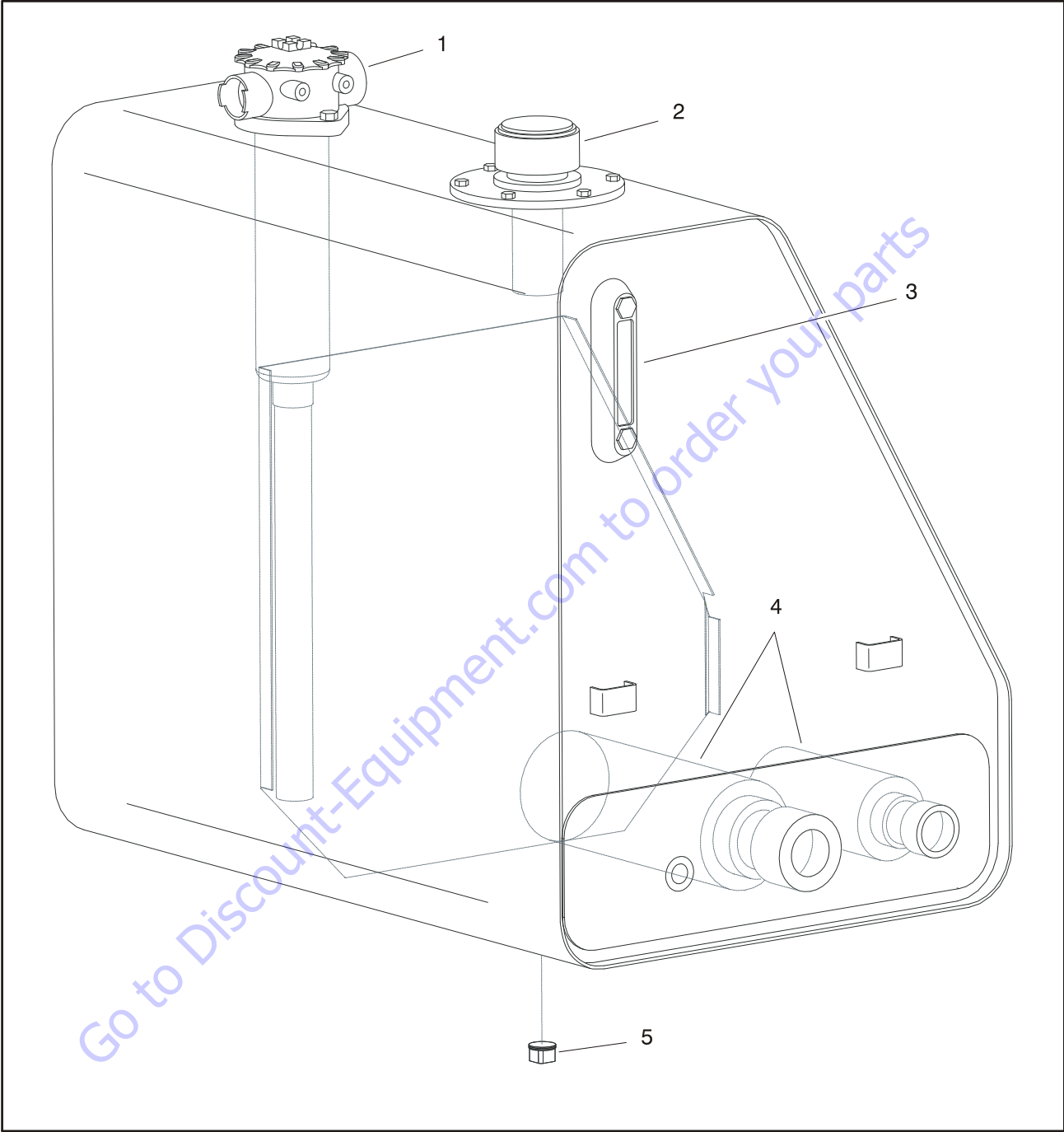
Figure 5-46. Installation of Head Seal Kit

4. Place the cylinder cap over the rod and carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end.
5. Place a new O-ring in the inner piston diameter groove.
6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
7. Install the piston on the cylinder rod hand tight, ensuring that the o-ring and Backup rings are not damaged or dislodged.
8. Place a new wear ring in the outer piston diameter grooves.
9. Carefully thread the lock nut onto the rod to secure the piston in place.
10. Remove the cylinder rod from the holding fixture.
11. Position the cylinder barrel in a suitable holding fixture.

NOTICE

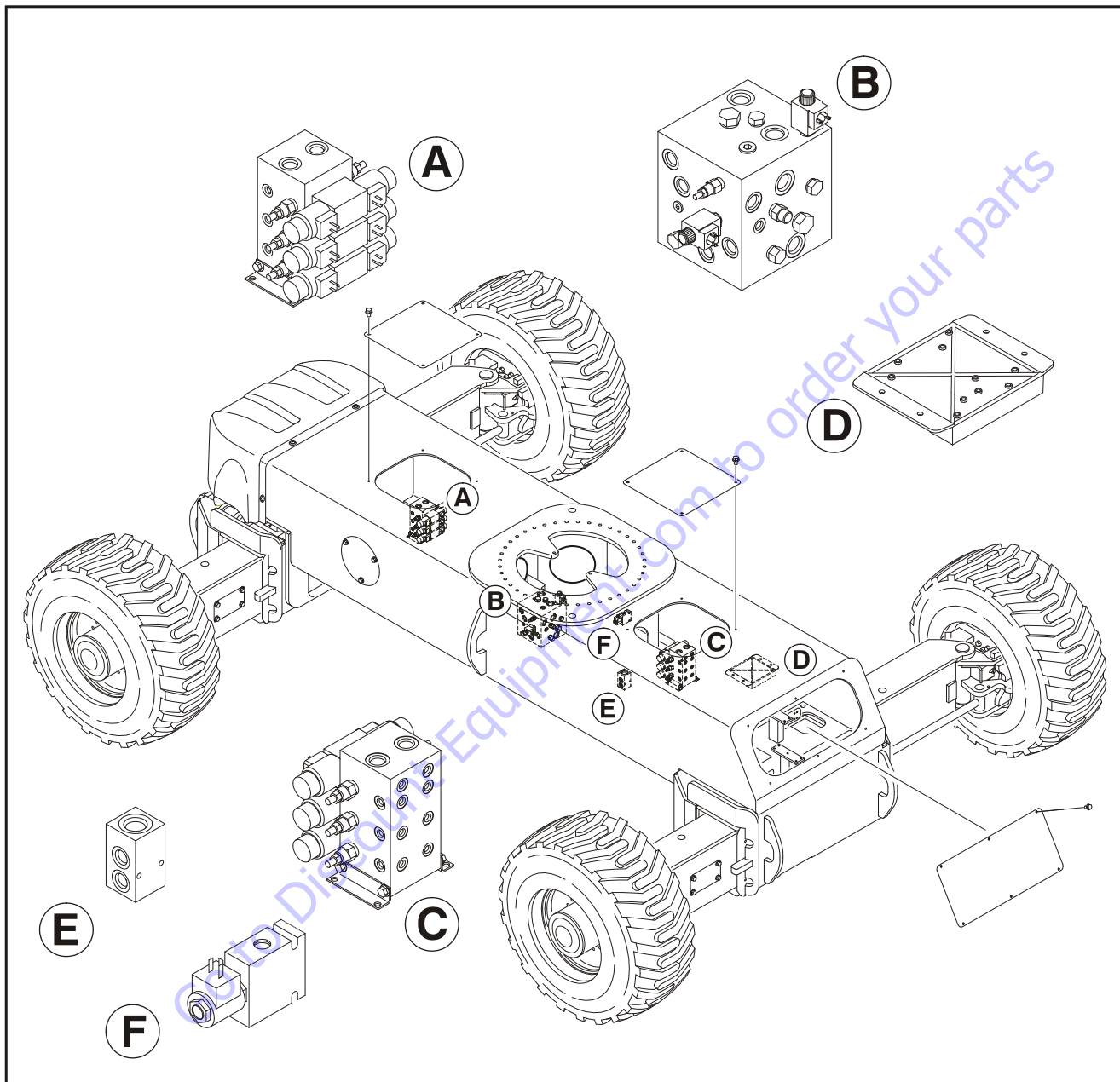
EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

12. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston seals are not damaged or dislodged.
13. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
14. Secure the cylinder head using Low Strength Thread-locking Compound and the cylinder cap.
15. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted).



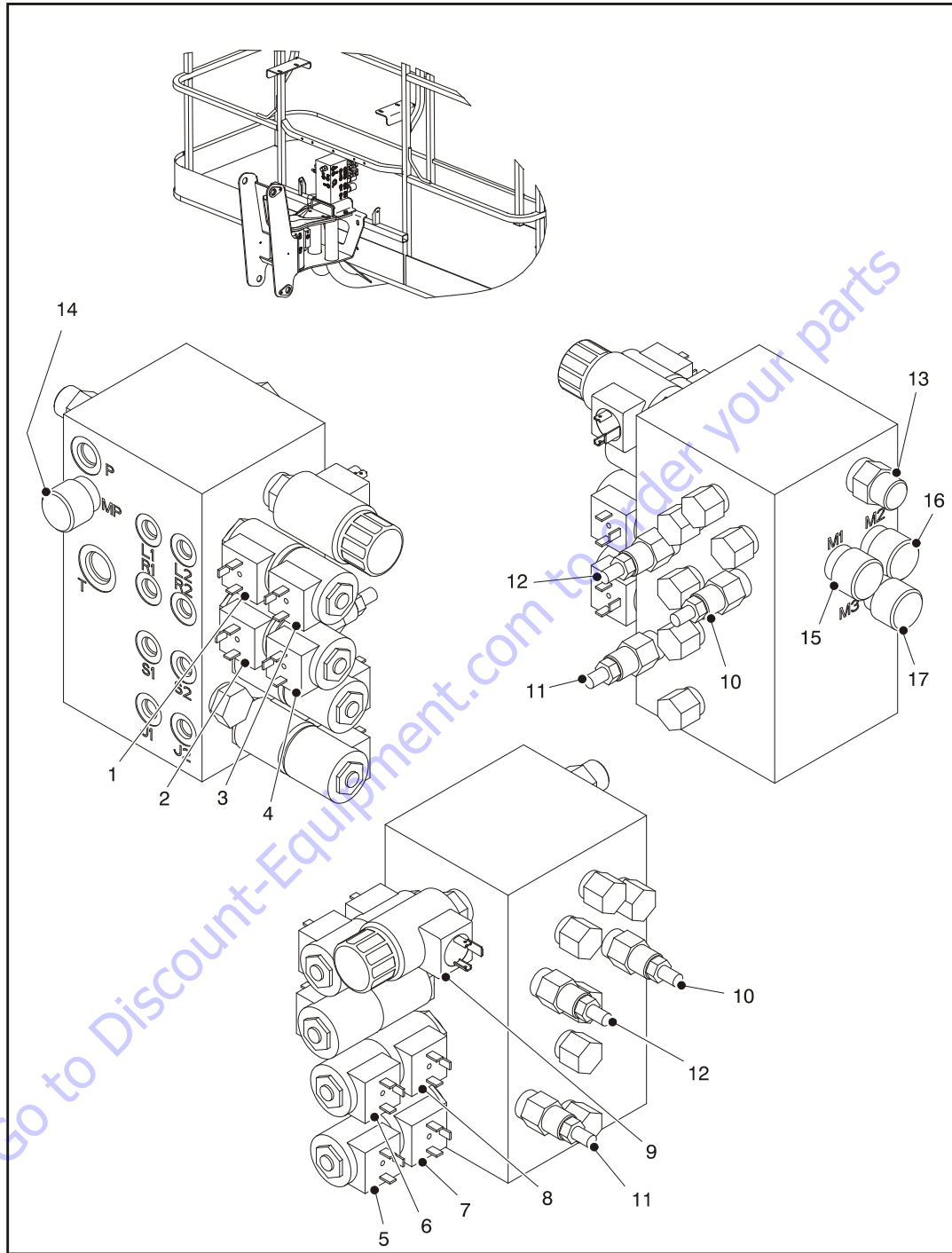
- 1. Return Filter
- 2. Vented Fill Cap
- 3. Sight/Temperature Gauge
- 4. Suction Strainer
- 5. Magnetic Drain Plug

Figure 5-47. Hydraulic Tank



- A. Front Steer Valve/Axle Extend
- B. Traction Valve
- C. Rear Steer Valve/Axle Extend
- D. Chassis Module Controller
- E. Junction Manifold Valve
- F. Axle Oscillation Valve

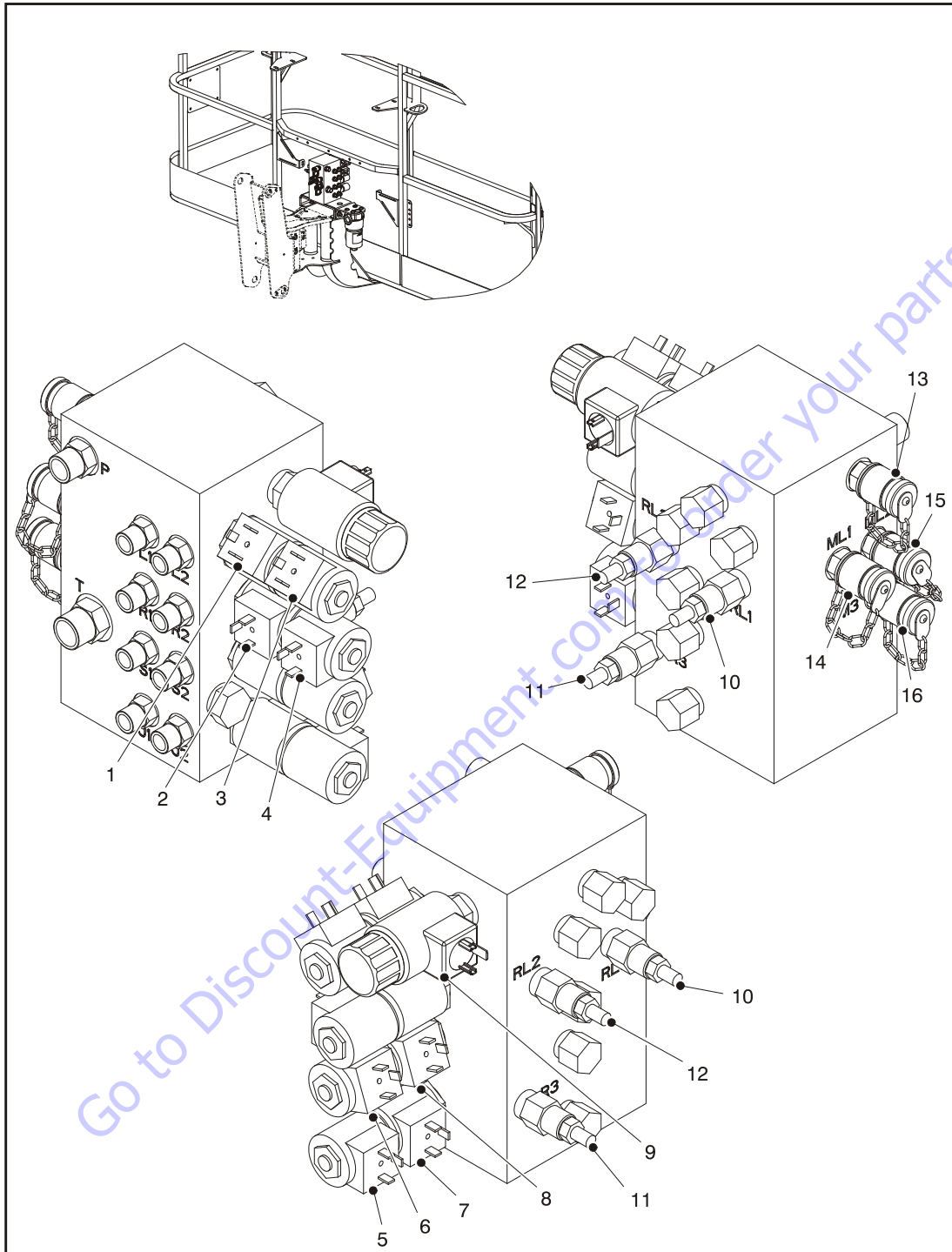
Figure 5-48. Chassis Control Valve Locations



- | | | | |
|-----------------|--------------------|------------------------|------------------------------|
| 1. Level Up | 6. Jib Swing Left | 10. Level Up Relief | 14. Main Pressure Check Port |
| 2. Rotate Right | 7. Jib Up | 11. Jib Up/Down Relief | 15. Level Up Test Port |
| 3. Level Down | 8. Jib Swing Right | 12. Level Down Relief | 16. Level Down Test Port |
| 4. Rotate Left | 9. Platform Dump | 13. Filter or Plug | 17. Jib Up/Down Test Port |
| 5. Jib Down | | | |

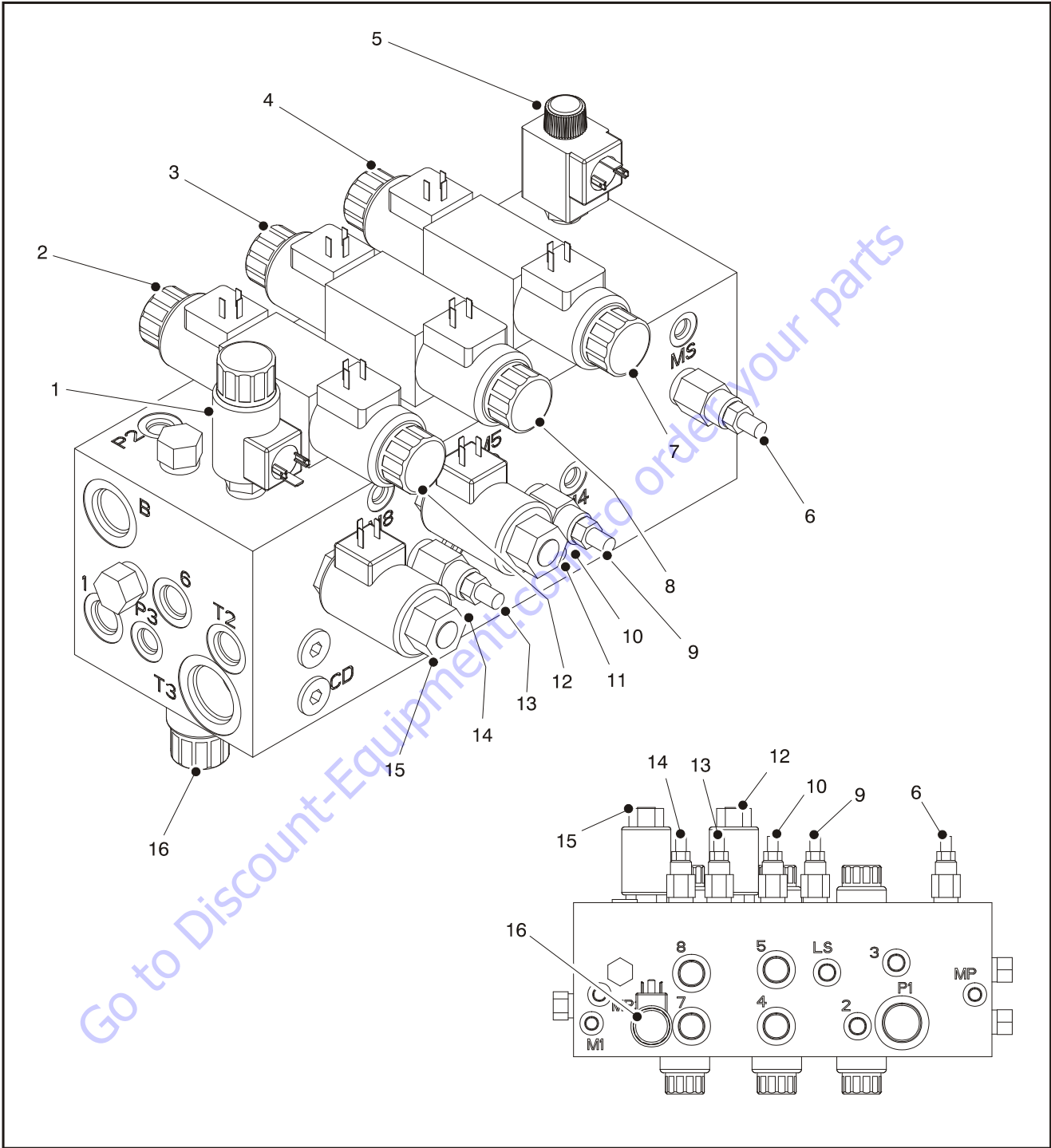
Figure 5-49. Platform Valve Identification - JLG PN 4641266

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS



- | | | | |
|-----------------|--------------------|------------------------|------------------------------|
| 1. Level Up | 5. Jib Down | 9. Platform Dump | 13. Main Pressure Check Port |
| 2. Rotate Right | 6. Jib Swing Left | 10. Level Up Relief | 14. Level Up Test Port |
| 3. Level Down | 7. Jib Up | 11. Jib Up/Down Relief | 15. Level Down Test Port |
| 4. Rotate Left | 8. Jib Swing Right | 12. Level Down Relief | 16. Jib Up/Down Test Port |

Figure 5-50. Platform Valve Identification - JLG PN 4641460



- | | | | |
|------------------|-----------------|----------------------|--------------------------|
| 1. Aux Lift Down | 5. Dump | 9. Lift Up Relief | 13. Tele Out Relief |
| 2. Tele Out | 6. Swing Relief | 10. Lift Down Relief | 14. Tele In Relief |
| 3. Lift Up | 7. Swing Left | 11. Lift Flow | 15. Tele Flow |
| 4. Swing Right | 8. Lift Down | 12. Tele In | 16. Lift Down/Aux Select |

Figure 5-51. Main Valve Identification

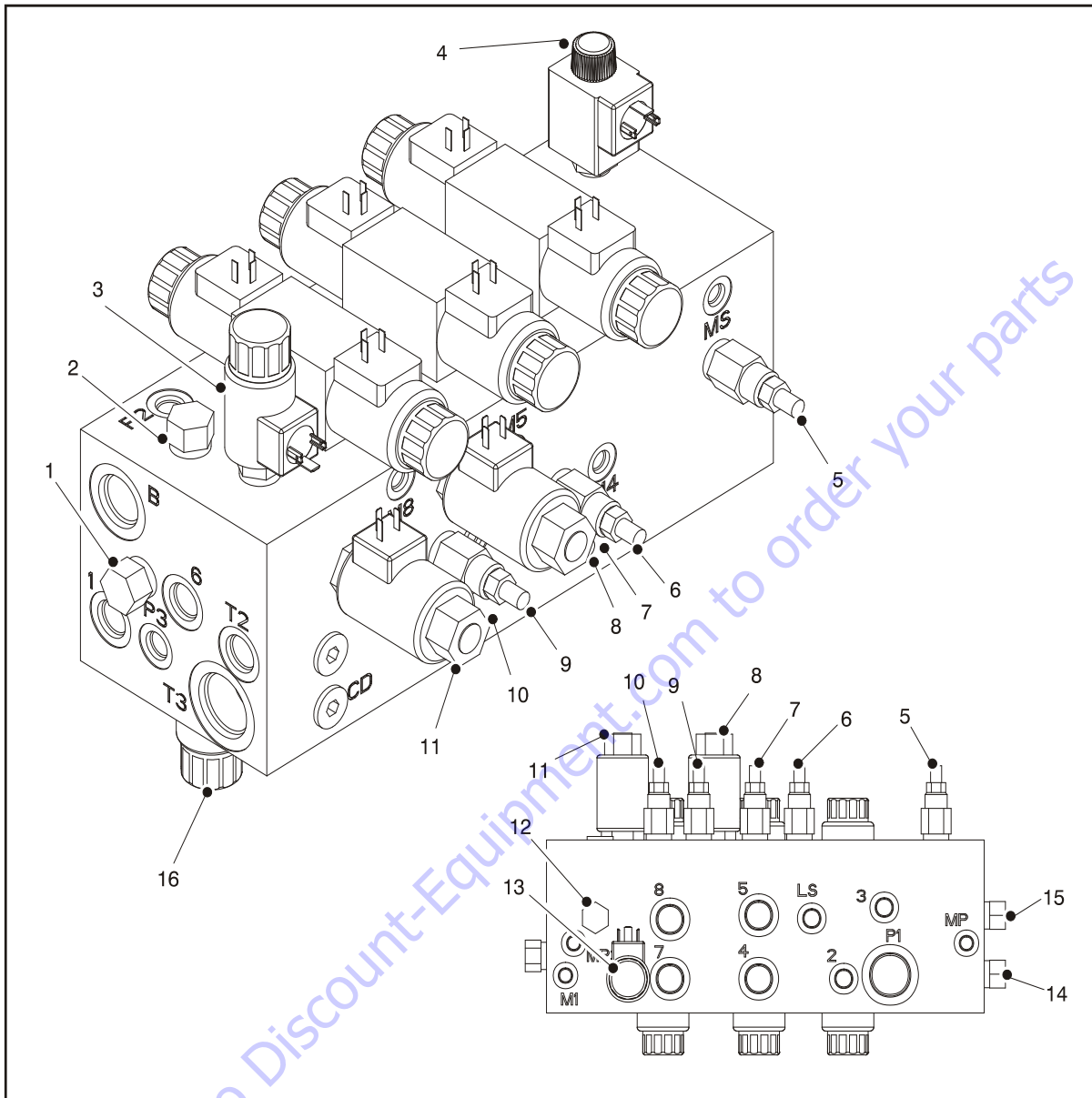


Table 5-35. Cartridge Torque Values

	Ft-Lbs.	Nm		Ft-Lbs.	Nm
1	25-30	33.9-40.6	9	30-35	40.6-47.4
2	25-30	33.9-40.6	10	30-35	40.6-47.4
3	30-35	40.6-47.4	11	30	40.6
4	30-35	40.6-47.4	12	30-35	40.6-47.4
5	30-35	40.6-47.4	13	30-35	40.6-47.4
6	30-35	40.6-47.4	14	30-35	40.6-47.5
7	30-35	40.6-47.4	15	30-35	40.6-47.5
8	30	40.6			

Figure 5-52. Main Valve Cartridge Torque Values

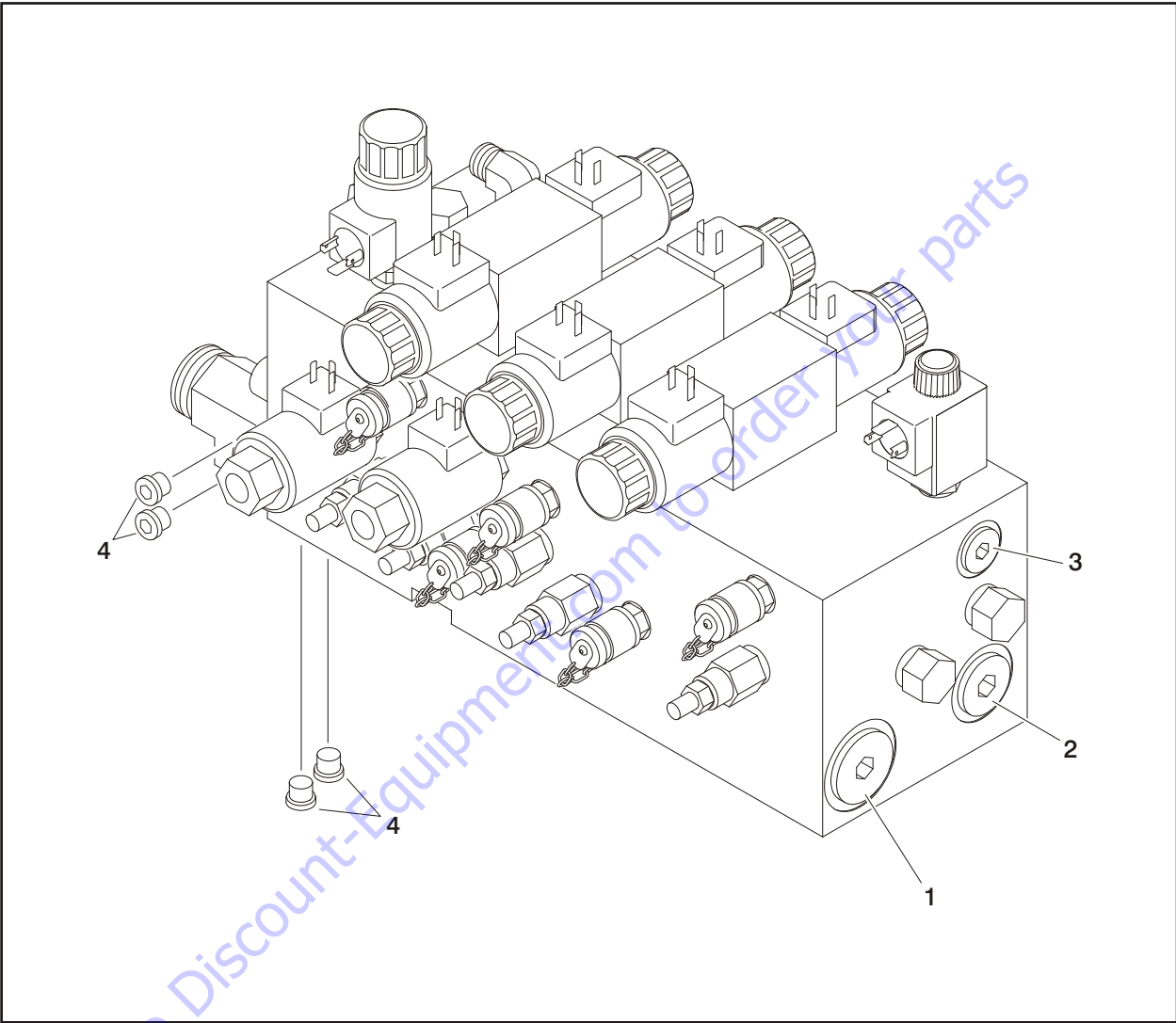


Table 5-36. Plug Torque Values

	Ft-Lbs.	Nm
1	115	156
2	100	135.5
3	40	54
4	13	17.5

Figure 5-58. Main Valve Plug Torque Values

5.4 HYDRAULIC TANK

The hydraulic tank has a capacity of 55 gallons (208 liters) and includes the hydraulic return filter and two suction strainers. It is normal for the oil level to appear low when the boom is raised and should only be checked with the machine on level ground and with the boom fully retracted and lowered. The hydraulic oil should be maintained at the full level as shown by the decal and hydraulic oil level gauge located on the side of the tank as shown in Figure 5-59., Hydraulic Oil Level Gauge. This decal shows the proper full level for both hot and cold oil. Do not fill the hydraulic tank past the appropriate full mark. Overfilling can cause the oil to overflow from the top of the hydraulic tank during emergency lowering operations.

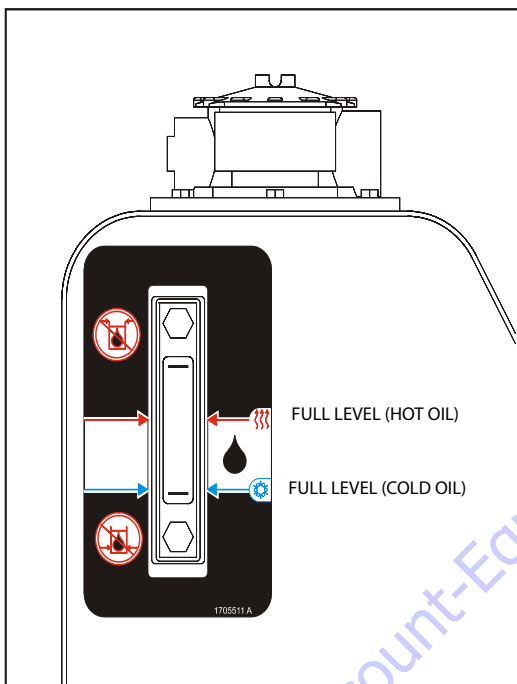


Figure 5-59. Hydraulic Oil Level Gauge

5.5 PRESSURE SETTING PROCEDURE

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within $\pm 5\%$ of specified pressures.

To ensure all pressures are set correctly, the following procedures must be followed in order.

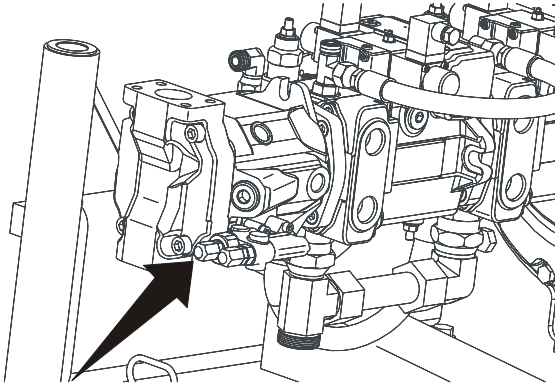
1. All applicable steps in Section 5.11, Drive & Function Pump Start Up Procedures must be followed.
2. Set up of the function pump.
3. Adjustments made at the main valve bank.
4. Adjustments made at the platform valve.

Set Up of the Function Pump

HIGH PRESSURE RELIEF - 3400 PSI (234.4 BAR)

1. Install a high pressure gauge at the MP port of the main valve block.
2. Using a screwdriver, remove the Din connector from the lift down coil.
3. Activate lift down. The gauge should read 3400 psi (234 bar).

4. To make an adjustment to this pressure, go back to the engine compartment to the function pump which is the back pump. The high pressure relief adjustment is the adjustment closest to the pump. Using a 17 mm wrench, remove the cover nut. Be careful not to lose the O-ring washer inside the cover nut.

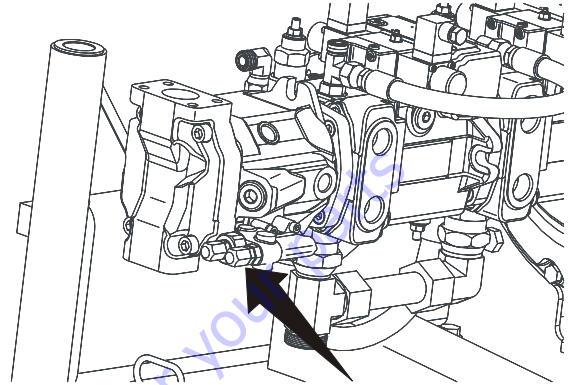


5. Loosen the jam nut at the setscrew with the 17 mm wrench. Using a 3 mm allen wrench, adjust clockwise to increase, or counterclockwise to decrease.
6. After adjusting the pressure, tighten the jam nut and the cover nut. This is the **maximum** relief pressure for all the functions governed by this pump.

STAND BY PRESSURE OR LOW PRESSURE RELIEF - 300 PSI (20.6 BAR)

1. Install a low pressure gauge at port MP of the main valve block capable of reading 300 psi (20.6 bar).
2. Start the engine, the gauge should read 300 psi (20.6 bar).

3. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. The stand by adjustment is the adjustment outside adjustment, closest to the turntable. Use the same tools that were used in the Hi pressure adjustment procedure.



Adjustments Made at the Main Valve Bank

LIFT UP - 2750 PSI (189.6 BAR)

1. Install a high pressure gauge at the M5 port of the main valve block. Plug and cap the hose on port 5.
2. Activate lift up. The gauge should read 2750 psi (189.6 Bar).
3. The adjustment cartridge is located below the M5 gauge port. Turn clockwise to increase, counterclockwise to decrease.

LIFT DOWN - 1500 PSI (103.4 BAR)

1. Install a high pressure gauge at the M4 port of the main valve block.
2. Activate lift down to the end of the stroke. The gauge should read 1500 psi (103.4 bar).
3. The adjustment cartridge is located to the left of the M4 gauge port. Turn clockwise to increase, counterclockwise to decrease.

SWING - 1500 PSI (103.4 BAR)

NOTE: Left and right are done with one adjustment.

1. Install a high pressure gauge at port MS.
2. Lock the turntable pin.
3. Activate swing, the gauge should read 1500 psi (103.4 Bar). The adjustment cartridge is located below the MS gauge port.
4. Turn clockwise to increase, counterclockwise to decrease.

TELESCOPE OUT - 3000 PSI (206.8 Bar)

1. Install a high pressure gauge at the M8 port of the main valve bank. Plug the telescope out hose either at the valve bank (port #8) or at the inlet of the telescope cylinder (V1).
2. Activate telescope out. The gauge should read 3000 psi (206.8 Bar).
3. The adjustment cartridge is located below the M8 gauge port. Turn clockwise to increase, counterclockwise to decrease.

TELESCOPE IN - 3200 PSI (220.6 BAR)

1. Install a high pressure gauge at the M7 port of the main valve block.
2. Activate Telescope In. The gauge should read 3200 psi (220.6 Bar).
3. The adjustment cartridge is located to the left of the M7 gauge port. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Frame Valve Bank

AXLE EXTEND AND RETRACT, FRONT AND REAR - 2500 PSI (172.3 BAR)

1. To extend the axles, drive the machine back and forth until extended. A machine that cannot be driven must be jacked up.
2. On both the front and rear frame valve banks, install a high pressure gauge on ports MA1 for extend and MA2 for retract. The gauge should read 2500 psi (172.3 Bar) in both directions.
3. The axle extend/retract cylinders are connected hydraulically in parallel. In order to get the correct pressure of the circuit being adjusted, unscrew the solenoid coil from the circuit not being adjusted and pull it away from the valve.
4. Turn clockwise to increase, counterclockwise to decrease.

STEERING, FRONT AND REAR

NOTE: The following procedure requires 2 people to perform. One is needed for verifying / adjusting pressure readings and wheel spindle alignment the other for operating the steer functions and using the Analyzer from the platform.

The Analyzer is required to perform the pressure check procedure through access of the calibration menu. The calibration menu will allow for extending and retracting the steer cylinders individually, verifying pressures, and proper steer sensor calibration. Verification of the steer sensor calibration will require one of two types of measuring methods; using a square and ruler or using string as explained in Section 6 - JLG Control System. The purpose of these measuring tools is to assure that the wheel spindle is aligned "straight" with the extended axle weldment.

1. Position the machine with both front and rear axles fully extended.
2. Install the Analyzer in the platform control box and scroll menu's to Access Level 2 and insert password (33271) to get into Access Level 1.



3. Scroll to the calibration mode. Once in the calibration mode, press "ENTER" and scroll to steer. Once in the steer calibration mode, the Analyzer is going to ask to calibrate the steer sensors, this is going to allow extending and retracting each steer cylinder individually during this process. The JLG control system will ask to calibrate the left front sensor, the left rear sensor, the right front sensor and finally the right rear sensor in that order. During this calibration mode each individual steer cylinder will be extended and retracted to verify correct pressures with the marked MS (Measure Steer) ports on the steer / axle valve that pertains to that steer cylinder. Refer to the Hydraulic Schematic in Section 7 - Schematics.

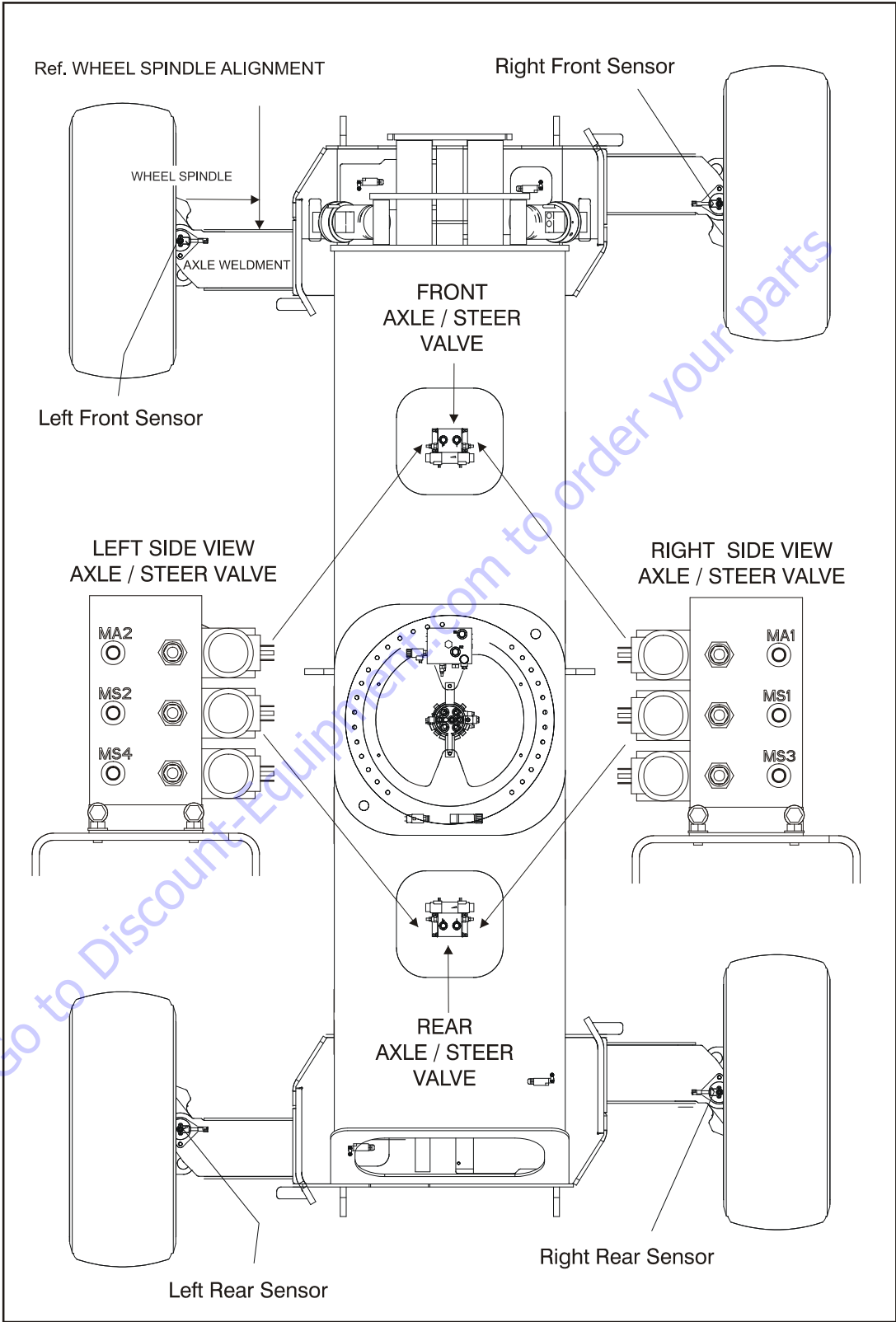
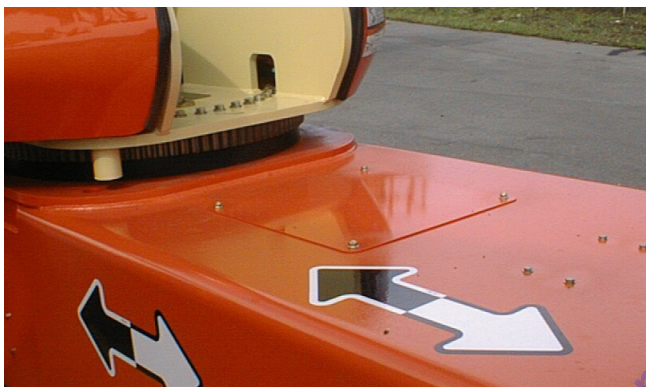


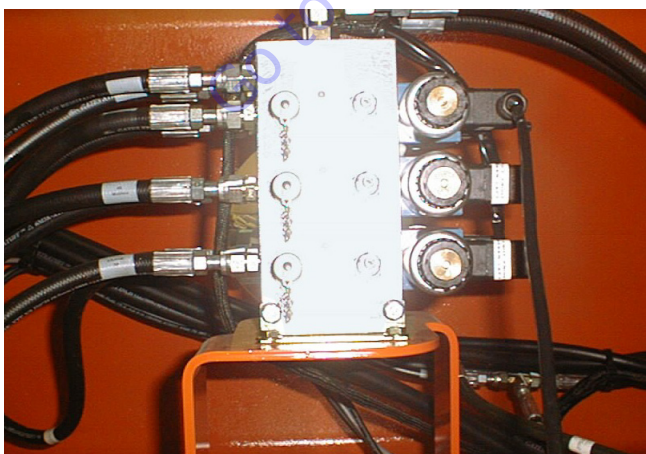
Figure 5-60. Steer Pressure Adjustments

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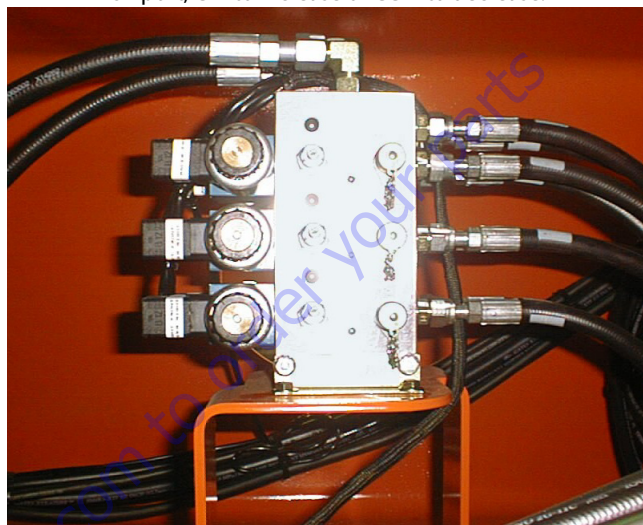
4. Remove the front circular steer/axle access covers at the front of the chassis, and the rear square cover at the top rear of the chassis to gain access to the axle/steer valves.



5. Install a pressure gauge at the front axle/steer valve at MS2 port. This should be located on the left side of the valve closest to the left front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully extended position and hold the switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (138 Bar). If the pressure is not 2000 psi (138 Bar) adjust relief valve mounted next to the MS2 port, CW to increase or CCW to decrease.

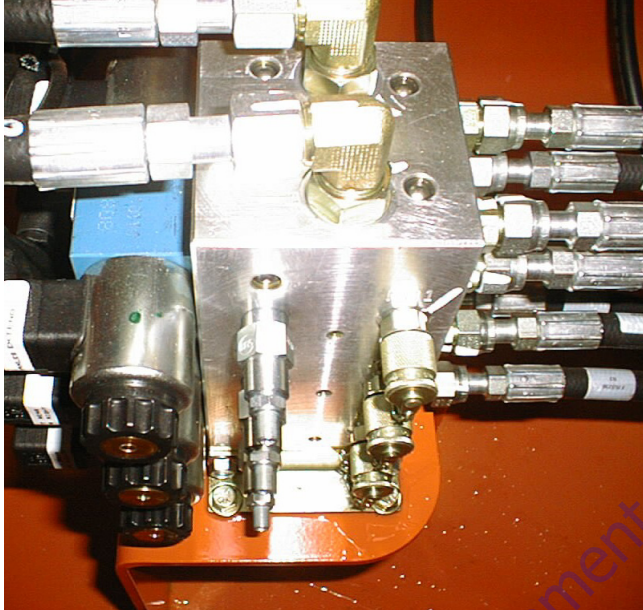


6. Remove the pressure gauge from MS2 port and install on the MS1 port, which is on the right side of the front axle/steer valve, closest to the right front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully retracted position and hold the switch for a few seconds after the rod has stopped. The MS1 port should read 2600 psi (179 Bar). If the pressure is not correct, adjust relief valve next to MS1 port, CW to increase or CCW to decrease.

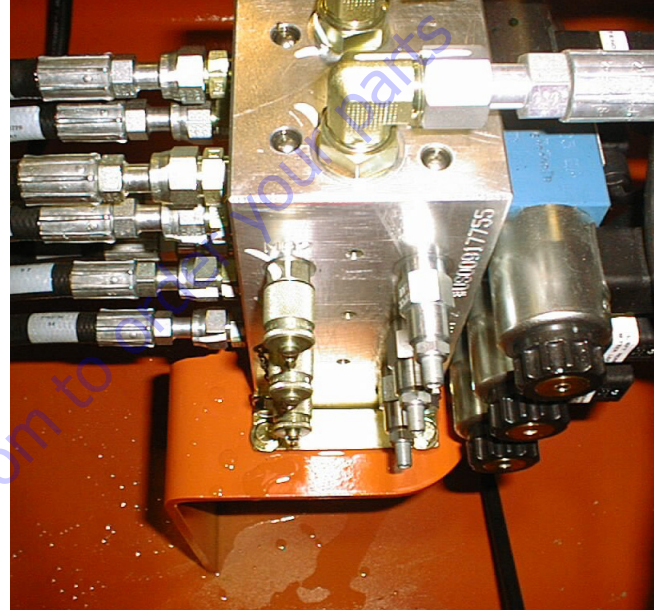


7. This step involves aligning the left front wheel spindle with the axle weldment. Position the left front wheel spindle "straight" using a square and rule or string for proper alignment (Refer to Section 6 - JLG Control System). Once the left front wheel spindle has been properly measured, press "ENTER" on the Analyzer. This is calibrating data to the JLG Control System that the left front steer sensor is centered.

8. Checking the left rear steer cylinder is identical to the procedure for left front steer cylinder, except now we are checking pressures at the rear axle/steer valve location. Install pressure gauge at MS1 port. This should be located on the left side of the valve closest to the left rear wheel spindle. MS1 port should read 2600 psi (179 Bar) when the left rear steer cylinder is activated with the rod in the fully retracted position. If the pressure is not 2600 psi (179 Bar) adjust relief valve mounted next to MS1 port CW to increase or CCW to decrease.



9. Remove the gauge from MS1 port and install on MS2 port, which is on the right side of the rear axle/steer valve, closest to the right rear wheel spindle. Position the steer switch to activate the left rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (179 Bar). If the pressure is not correct, adjust the relief valve mounted next to MS2 port CW to increase or CCW to decrease.



10. The next step is identical to the left front step mentioned above. Make sure the left rear wheel spindle is straight and press "ENTER" to accept the new calibration settings, now press "ESC" (escape) and scroll to the right front steer calibration step.
11. Checking the right front steer cylinder is identical to the procedure laid out for the left front steer cylinder, except the pressures are now checked at MS3 port of the front axle/steer valve. This should be at the right side of the valve closest to the right front wheel spindle. Install the gauge at MS3 port. Position the steer switch to activate the right front steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod has been fully retracted. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.
12. Remove the gauge from MS3 port and install on MS4 port, which is on the left side of the front axle/steer valve, closest to the left front wheel spindle. Position the steer switch to activate the right front steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar). If the pressure is not correct, adjust relief valve mounted next to the MS4 port CW to increase or CCW to decrease.
13. The next step is identical to the left front step mentioned above. Make sure the right front wheel spindle is straight and press "ENTER" to accept the new calibration settings. Scroll over to right rear steer calibration step.
14. Checking the right rear steer cylinder is identical to the procedure laid out for the left rear steer cylinder. Install gauge at MS4 port of the rear axle/steer valve. This should be at the right side of the valve closest to the right rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar). If the pressure is not correct, adjust relief valve next to the MS4 port CCW to increase or CCW to decrease.
15. Remove gauge from MS4 port and install on MS3 port, which is on the left side of the rear axle/steer valve, closest to the left rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod stops retracting. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.

16. The next step is identical to the left front step mentioned above, make sure the right rear wheel spindle is straight and press "ENTER" to accept the new calibration settings, now escape out of the calibration menu and remove the Analyzer and pressure gauge.

Adjustments Made at the Platform Valve Bank

PLATFORM LEVEL UP - 2500 PSI (172.3 BAR)

1. Install a high pressure gauge at the gauge port M1.
2. Activate level up to the end of stroke, it should read 2500 psi (172.3 Bar).
3. All the relief valves are located on the same face. The level up relief valve is located closest to the M1 gauge port. Turn clockwise to increase, counterclockwise to decrease.

PLATFORM LEVEL DOWN - 1500 PSI (103.4 BAR)

1. Install a high pressure gauge at gauge port M2.
2. Activate level down to the end of stroke, it should read 1500 psi (103.4 Bar).
3. The level down relief valve is located to the left of the level up relief valve. Turn clockwise to increase, counterclockwise to decrease.

ARTICULATING JIB UP AND DOWN - 2750 PSI (189.6 BAR)

1. Install a high pressure gauge on gauge port M3. The jib relief valve is located below the level down relief valve. Activate jib up or down, it should read 2750 psi (189.6 Bar). Turn clockwise to increase, counterclockwise to decrease.

5.6 DRIVE PUMPS (REXROTH)

Troubleshooting Procedure

To aid in troubleshooting, refer also to the pressure measuring port connections for test gauge installation information as shown on the hydraulic circuit diagram. Procedure assumes proper gauges are installed. (Minimum gauges required: (2) 0-6000 psi, (1) 0-3000 psi & (1) 0-1000 psi [(2) 0-415 bar, (1) 0-210 bar & (1) 0-70 bar]). This procedure was written to aid the troubleshooter in following a logical approach to a hydraulic system fault.

1. Transmission does not propel the machine, diesel engine running properly
 - a. Is there oil in the reservoir?
 - No** - Fill reservoir
 - Yes** - If yes, proceed to step 1.b
 - b. Is the pump input shaft connected to the engine flex plate or rear of forward pump?
 - No** - Connect pump input shaft
 - Yes** - If yes, proceed to step 1.c
 - c. Are the hydraulic hoses and tubing connected in accordance with the hydraulic circuit diagram?
 - No** - Correct the hoses/tubing
 - Yes** - If yes, proceed to step 1.d
 - d. Is the pump direction of rotation correct? (clockwise as looking at the shaft)
 - No** - Fit pump having the correct direction of rotation
 - Yes** - If yes, proceed to step 1.e
 - e. Are there "O"-rings missing from fittings (as example - suction leak), pinched hoses, broken tubing, etc?
 - No** - Proceed to step 1.f
 - Yes** - Repair damage or fault
 - f. Are the electrical connectors/wiring intact and secure to the pump control solenoids?
 - No** - Repair damage or fault
 - Yes** - If yes, proceed to step 1.g
 - g. Does the engine "labor" when attempting drive, are the brakes released?
 - No** - Proceed to step 1.h
 - Yes** - Check brake release circuit, measure pressure at port "MP" on Traction Control manifold
 - h. Are all four wheel drive planetary reduction gear-boxes engaged?
 - No** - Engage wheel drive(s)
 - Yes** - If yes, proceed to step 2.a
2. Transmission does not propel the machine, diesel engine running properly - Charge Pump/Relief Valve
 - a. Is there any charge pressure at port G or indicated by measuring pressure at Ma and Mb?
 - No** - Proceed to step 2.d
 - Yes** - Proceed to step 2.b
 - b. Is the charge pressure at least 500 psi while running at high engine speed?
 - No** - Proceed to step 2.c
 - Yes** - Proceed to step 3.a
 - c. Can the charge pressure be raised by removing dirt/debris from charge relief poppet or by adding or removing shims from the charge pressure relief valve mounted in the second pump of the triple?
 - No** - Proceed to step 2.d
 - Yes** - Adjust pressure to 500 psi +50 psi, -0 psi (34.4 bar +3.4 bar, -0 bar)

NOTE: The propulsion circuit uses a hot oil flushing valve to obtain brake release pressure. The hot oil flushing valve cartridge (#120) is mounted in the Traction Control Manifold. The flushing valve receives its oil from the "left side" wheel drive pump; the middle pump of the triple. With the engine running and propelling the machine forward or reverse, the "hot oil flushing valve" and the brake release pressure must be adjusted to 475 psi, +25 psi, -0 psi (32.7 bar, +1.7 bar, -0 bar), as set by adjusting pressure relief cartridge (#130). The brake release pressure must be 25 psi less than the charge pump pressure. Measure pressure at port "MP" using a 0-1000 psi (0 - 70 bar) pressure gauge.

- d. Is the transmission pumps suction hose pinched shut?
 - No** - Proceed to step 2e
 - Yes** - Repair damaged hose
- e. Is the charge pump suction pressure/vacuum within recommended limits? (0.8 bar absolute or 6.3 inches of mercury)
 - No** - Proceed to step 2.f
 - Yes** - Proceed to step 2.g
- f. Is the suction strainer inside the reservoir blocked, clogged, restricted?
 - No** - Proceed to step 2.g
 - Yes** - Repair/replace with a clean suction strainer
- g. Is the reservoir air breather blocked or restricted?
 - No** - Proceed to step 2.h
 - Yes** - Clean or replace air breather

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- h.** Remove charge pressure relief valve from the middle pump and inspect. Is it damaged?
No - Refit cartridge and proceed to step 2.i
Yes - Clean & inspect cartridge, poppet, springs, seals to determine cause of damage. Repair or fit a new cartridge and return to step 2.a
- i.** Remove and inspect charge pump assemblies. Are they damaged?
No - Proceed to step 2.j
Yes - Repair and/or replace damaged components and return to step 2.a
- j.** Is the charge pump installed for the clockwise rotation?
No - Refit charge pump. Return to step 2.a
Yes - With proper charge pressure and transmission still does not operate, proceed to step 3.a
- 3.** Transmission does not propel the machine, diesel engine running properly - Pump Control: (Insure Generator Drive option is not turned "on")
- a.** Are the electrical connectors & wiring connected properly to the pump control solenoids?
No - Connect an ammeter in series with solenoid wiring. Is a current of 400 mA to 1060 mA being applied. (Current signal varies with joystick position)
Yes - Proceed to step 3.b
- b.** Are all four of the two-speed motors, mounted in the wheel drive planetary reduction gearboxes, shifted to maximum displacement (high torque - low speed)?
No - Select maximum displacement
Yes - Proceed to step 3.c
- c.** Actuate the pump control in both directions. Do the pumps stroke? Do they go to full stroke?
No - Refer to the pump service manual and then proceed to step 3.d
Yes - Operate the transmission
- d.** Remove stroking orifices in X_1 and X_2 . Install pressure gauges in X_1 and X_2 (0-500 psi [0 - 35 bar]). Stroke the pump in both directions. Do the pressures at X_1 and X_2 alternate between 30 & 250 psi (2 & 17 bar)?
No - Remove the EP control module & replace it with a new unit. Repeat step 3.c
Yes - Proceed to step 3.e.
- e.** Is the pressure at port "R", case pressure, less than 15 psi (1 bar) gauge pressure?
No - Correct problem restricting case drain oil flow (oil cooler blockage, pinched hoses, etc)
Yes - Proceed to step 3.f
- f.** Stroke pump in both directions, while measuring pressure at Ma & Mb ports of the pump. Does any pressure greater than charge pressure alternate between ports Ma & Mb ?
No - Verify that loading the pump will cause system pressure to increase above charge pressure. Proceed to step 3.a
Yes - Proceed to step 3.g
- g.** Is it possible to adjust high pressure relief valves using 0-6000 psi (0 - 415 bar) gauges to monitor pressure at Ma & Mb ? (Refer to relief valve adjustment)
No - Replace high pressure relief valve and return to step 3.c
Yes - Adjust high pressure relief valves to 5000 psi +50 psi, -0 psi (344.7 bar +3.4 bar, -0 bar)
- h.** Actuate control in both directions. Does transmission operate?
No - Check that minimum displacement stops on the wheel drive motors are adjusted properly, check that the motors stroke between maximum to minimum.
Yes - Operate the transmission
- 4.** Transmission Drive is Sluggish or Erratic
- a.** Does the "EP" proportional pump control current vary with joystick movement?
No - Rectify the problem - broken wires, electrical connector, open solenoid coil, etc.
Yes - Proceed to step 4.b
- b.** Are all four (4) brakes fully released?
No - Check brake release pressure and insure each wheel receives correct release pressure.
Yes - Proceed to step 4.c
- c.** Are the pumps stroking time orifices installed tight and clean?
No - Remove the Plugs in ports X_1 and X_2 . Remove orifices with a 3mm allen wrench. Check that orifices are clean & re-install.
Yes - Proceed to step 4.d
- d.** Is an motor displacement stroking time orifice plugged or is the two-speed shift hose pinched?
Yes - Inspect and clean stroking orifice, check two-speed hose routing
- e.** Is a flow divider/combiner cartridge stuck in the Traction Control Manifold? Flow divider/combiner cartridge # 111 controls the right side wheels, # 112 controls the left side wheels. Also check to insure bypass orifices #151 (right side) and # 152 (left side) are not plugged.

5. Transmission Drives in one direction only

- a. Are electrical connections to pump control proportional solenoids correct, intact and without defects?
Yes - Proceed to step 5.b
No - Rectify the problem
- b. Check hot oil flushing valve cartridge #120 located in the Traction Control Manifold. Remove and inspect flushing valve cartridge for stuck spool or damaged cartridge "O"-ring seals & backup rings.
- c. Inspect "Make-Up" check valve cartridges, #190.1-190.4, installed in the Traction Control Manifold. Is a cartridge "stuck" open with debris or is an "O"-ring failed?
No - Proceed to step 5.d
Yes - Clean/repair or replace Make-Up check cartridge.
- d. Swap high pressure relief valves in the transmission. Does the transmission drive in the other direction?
No - Proceed to step 5.e
Yes - Repair/clean/adjust or replace high pressure relief valve on the non-driving side
- e. Replace "EP" control module. Does pump operate properly?
No - Replace or repair pump
Yes - Operate the transmission

6. Transmission Drives in Wrong Direction

- a. Check to see if electrical connectors or wiring have been swapped on the pump.
- b. Check to determine what end of the machine the boom is swung over.

7. Transmission Does Not Find or Hold Neutral

- a. Does pump remain in neutral with electrical connectors removed?
No - proceed to step 7.b
Yes - Check electrical system for signal problem
- b. With electrical connectors removed and machines wheels jacked off the ground and engine running, momentarily apply 12 volt DC signal (battery voltage) to a pump control solenoid. Does the pump return to neutral after the 12 volt signal is removed?
No - Apply 12 volts to opposite solenoid & recheck.
No - Replace pump control module, repeat step 7.a
Yes - Possibly dirt was dislodged from control module, re-check thoroughly to determine problem has definitely been resolved.
- c. Check mechanical centering of the pumps

8. Transmission Drives at a High Noise Level

- a. Are the wheel drive planetary reduction gearboxes filled to the correct level and do they have the proper lubricant?
No - Fill gearbox with correct grade of oil to the prescribed level.
Yes - Proceed to step 8.b
- b. Is the engine flex plate and drive coupling correctly installed and aligned with the transmission pump?
No - Install flex plate and bell housing per manufacturer's instructions
Yes - proceed to step 8.c
- c. Is a rigid item or object contacting the resilient mounted engine/pump assembly?
No - Proceed to step 8.d
Yes - Insure no item is contacting the unit, transmitting air borne noise.
- d. Is the suction pressure/vacuum at the charge pumps inlets within recommended limits?
No - Return to step 1.h
Yes - Proceed to step 8.e
- e. Is there air in the hydraulic fluid? This may be indicated by foaming or milky colored oil.
No - Proceed to step 8.f
Yes - Deaerate the oil and inspect system for cause of air induction. Check for loose or missing "O"-rings on face seal connections.

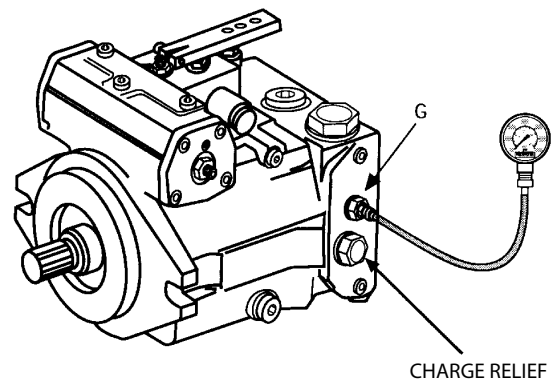
- f. Is a wheel drive hydraulic motor operating at excessive speed?
Yes - Check minimum displacement stop screw adjustments on the motors. Should be 0.433" or 11mm above the stop screw lock nut. Is one or more motors "stuck" at minimum displacement, check for plugged/blocked two-speed stroking orifice(s).
9. Transmission Operates at a Higher than Normal Temperature
- a. Is the reservoir temperature above 195°F (90.5° C)?
No - 195°F (90.5° C) is the upper limit. If temperature is over 195°F (90.5° C), the oil cooler may need to be cleaned.
Yes - Proceed to step 9.c
- b. Are the hydraulic motor(s) stalling (wheels not turning) intermittently?
No - Proceed to step 9.c
Yes - Hydraulic fluid is being heated through system pressure relief valves. Shut down system and rectify the cause of motor stall.
- c. Does oil temperature remain above 195°F (90.5° C), after cleaning the oil cooler?
No - Operate transmission. Check oil cooler more often.
Yes - Proceed to step 8.a
10. Transmission Operates at a Higher than Normal Temperature
- a. Check for differential temperature across the oil cooler. Is there a temperature difference?
No - Check to determine if the bypass check valve (10 psi [0.7 bar] crack pressure) is stuck open. Check to determine if the oil cooler is restricted internally, causing oil flow to pass across the bypass check valve.
Yes - Proceed to step 8.b

NOTE: Oil cooler flow is received from the transmission pumps cases, max. continuous pump case pressure is 15 psi gauge pressure. Higher pressure will prematurely damage pump shaft seals

- b. Disconnect pump case drain from oil cooler & check flow rate from charge pumps. Is the flow rate 3.8 GPM (14.4 LPM) with diesel idle speed of 1200 rpm?
No - Refer to charge pump removal & inspection procedure

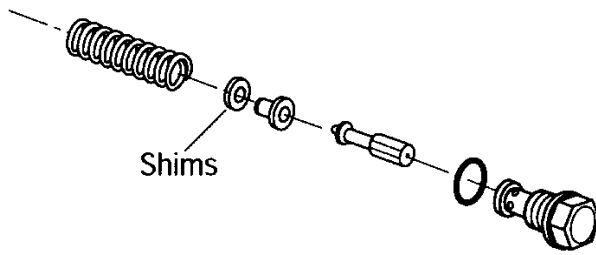
11. Transmission Pump(s) Do Not Develop Maximum Horsepower (Flow & Pressure)
- a. Does the charge pump pressure meet specification?
No - Return to step 2.a
Yes - Proceed to step 11.b
- b. Does the pump case pressure exceed 15 psi gauge pressure?
No - Proceed to step 11.c
Yes - Check case drain hoses, oil cooler, etc. for pinched or restricted oil flow
- c. Are the pump(s) high pressure cross port relief valves adjusted to the required pressure (5000 psi) so they do not bypass prematurely?
No - Inspect/clean/adjust and or replace valve cartridge
Yes - Replace the pump, after blocking the "A" & "B" ports, running the pump and measuring pressure developed at "A" & "B". This must be done to insure that flow & pressure loss is not elsewhere in the system. (motors, swivel coupling, etc)
- d. Is the diesel engine capable of developing horsepower at design rpm?
 Follow recommended troubleshooting procedures to insure the engine is developing full power at specified rpms.

Charge Pressure Relief Valve Adjustment



With a low pressure (0 – 1000 psi [0 - 70 bar]) pressure gauge tee'd into the "G" port or two (2) low pressure gauges installed into "Ma" and "Mb", run pump at engine idle speed. Do not place the pump on stroke – low pressure gauges installed in "Ma" & "Mb" will be damaged! Prior to adjusting pressure, insure charge pressure relief valve is clean of any dirt or debris. The charge pressure relief valve does not wear appreciably over time. If charge pressure was normal and then has decayed, check for other causes of low charge pressure. If pressure is low, remove relief valve and add shim(s). If pressure is high, remove relief valve and take out shim(s).

NOTE: Shim thickness 1 mm = 56 psi (3.86 bar). Shims are available in 0.3, 0.5, and 1.0 mm thickness.



Mechanical Centering of Pump

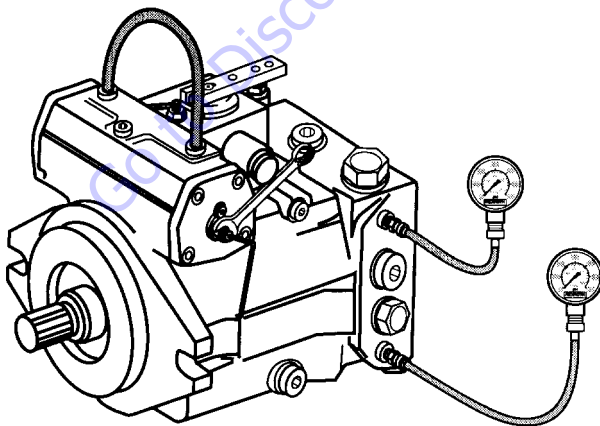
PREPARATION FOR ADJUSTMENT

The control piston has strong centering springs to ensure that once the pump is adjusted for the neutral position it will always return to neutral. If an adjustment is necessary follow the steps listed below.

To ensure there is equal pressure on both sides of the control module during the centering operation, it is necessary to connect the X₁ and X₂ ports together by means of hose or tubing. (No less than a 1/4 inch ID) The port sizes are:

Pump Size	Allen Wrench	Wrench
28	5 mm	17 mm

With pressure gages installed at M_A and M_B, and with A and B ports blocked (or motor stalled), and with the pump running, loosen the jam nut. Turn the mechanical centering adjusting screw until 1000 psi is read on M_A, or M_B then turn screw opposite direction until 1000 psi is read on other pressure port. Turn the screw back, splitting the distance between the previous two positions. This should be the neutral position. Pressure on M_A and M_B should be equal.

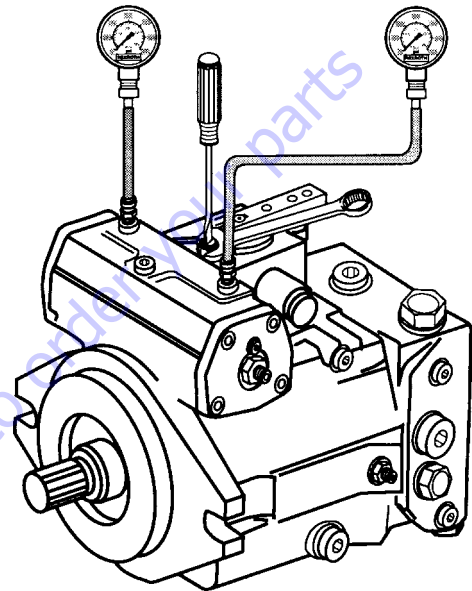


Tighten jam nut, stop the pump drive, remove the hose connecting ports X₁ and X₂.

Hydraulic Centering of Control Modules

PREPARATION FOR ADJUSTMENT

When control modules are exchanged or replaced, it is generally necessary to center the new module. This is done by running the pump with gauges installed at ports X₁, X₂, M_A, and M_B. Release the jam nut and turn the adjustment screw on top of the control module valve body.



The adjustment screw is an eccentric, therefore, turning more than 90° in either direction will have no further centering effect, and could cause damage to the eccentric pin.

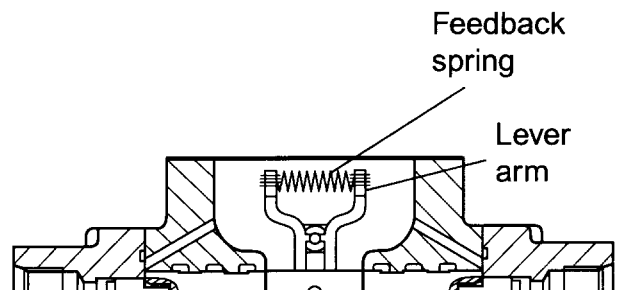
Pump Size	Tool Required	Wrench
28	Screwdriver	10 mm

CENTERING THE EP CONTROL MODULE

With no electrical signal to solenoids A and B, (remove both plug-in connectors), the EP control module is correctly adjusted when any or all of the following conditions exist:

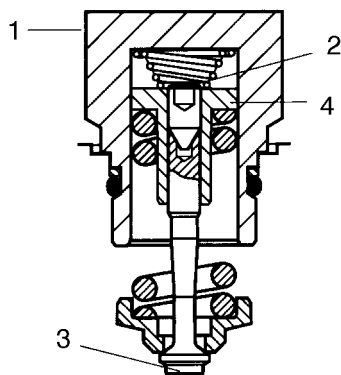
1. Approximately, when equal control pressures are obtained at control pressure ports X₁ and X₂.
2. The hydraulic motor does not turn when the brake is released.
3. Charge pressure is registered equally at ports M_A and M_B, when the flow output of the pump is deadheaded against a locked motor or a valve.

If difficulties are encountered in obtaining neutral position of the HD or EP control modules, check that the ends of the control spring are correctly located in the grooves near the end of the feedback lever arms.



High Pressure Relief Valve Adjustments

1. Remove relief valve cover from pump (ref. item 1).



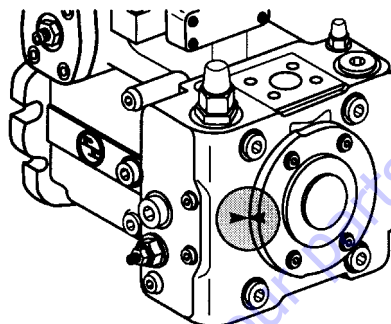
2. Loosen jam screw (ref. item 2).
3. Holding spring loading nut (ref. item 4) rotate valve spindle (ref. item 3). For high range relief valve, one turn equals approximately 630 psi (44 bar). For low range relief valve, one turn equals approximately 377 psi (26 bar).
4. After adjustment is completed torque jam screw (ref. item 2) to 5 ft.lb. (7 Nm).
5. Install relief valve assembly into pump, reinstall cover (ref. item 1) to proper torque.

Table 5-37. Torque Specs for Relief Valves into Port Block

Pump Size	Wrench Size	Torque
28	32 mm	66 ft.lb. (90 Nm)

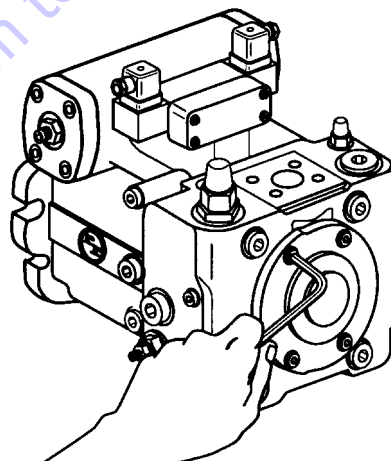
Removal and Inspection of Charge Pump

Before removing cap screws, mark the position of the charge pump housing and separator plate in relation to the port block.

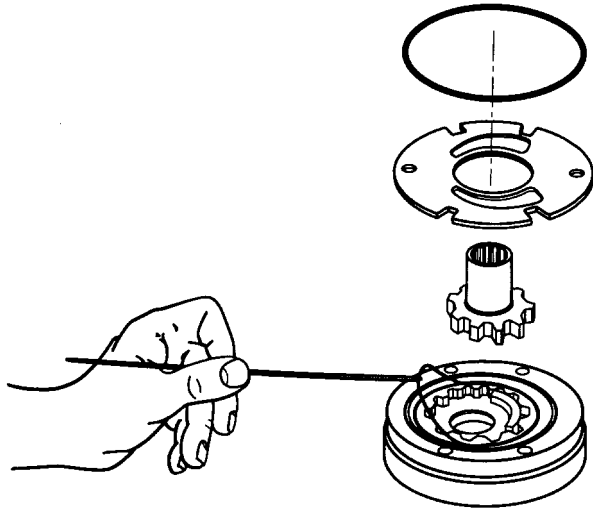


Loosen screws with metric allen wrench.

Pump Size	Allen Wrench
28	8 mm

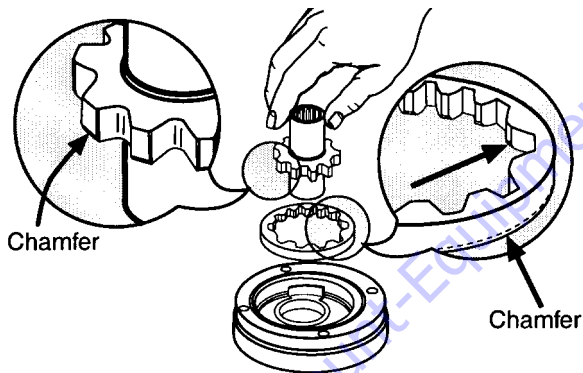


Remove charge pump housing and inspect for wear or damage to gear set and O-ring seals. Grease O-rings prior to reassembly. Make sure O-rings are completely seated in their grooves.



Withdraw pinion shaft and inspect gear teeth and bearing surfaces for abnormal wear.

When reassembling, make sure chamfer (on outer edge of driven gear and drive gear) is installed into housing per illustration.



Torque value for bolts when replacing charge pump.

Pump Size	Torque
28	18 ft.lb. (24 Nm)

NOTE: If serious wear or damage has occurred to one component, the complete charge pump assembly must be replaced because they are matched components.

Routine Maintenance

The Variable Displacement Hydrostatic Transmission Pumps are relatively maintenance free. Maintenance work is confined to the system, by way of maintaining hydraulic fluid condition, the "life blood" of the machine. Oil monitoring, changes and filter renewal promote system cleanliness. This will prevent premature breakdown and repairs. Under normal application conditions, the following maintenance intervals are suggested:

1. Renewal of Filter Elements
 - a. After commissioning or re-build.
 - b. At every 500 operating hours or when filter indicator shows a dirty element.
 - c. With the suction strainer, the strainer should be renewed as soon as charge pump inlet pressure is less than -3.2 psi, 6.3"Hg or 0.8 bar absolute.
 - d. Only JLG recommended filter elements are to be used. Paper elements cannot be cleaned; use throw-away cartridges.
2. Hydraulic Fluid Change
 - a. After 2000 operating hours (1st oil change)
 - b. Thereafter, every 2000 operating hours or annually, irrespective of operating hours achieved.
 - c. Oil change should be performed with the system in warm running condition. Before re-filling, the reservoir interior should be inspected and cleaned to remove any sludge.
 - d. Rags or threaded material must not be used.
 - e. This machine has been designed & manufactured to operate on an Exxon-Mobil Oil Co. hydraulic fluid, Mobilfluid #424, Product #52233-4. Consult JLG Industries prior to introducing any other type of fluid to prevent interaction or possible contamination.
 - f. The recommended interval between oil changes is based on various factors and should be carried out according to the degree of aging, contamination and water content.
 - g. Under application conditions with a heavy occurrence of dust or severe temperature fluctuations, the intervals between fluid maintenance should be shortened accordingly.

NOTICE

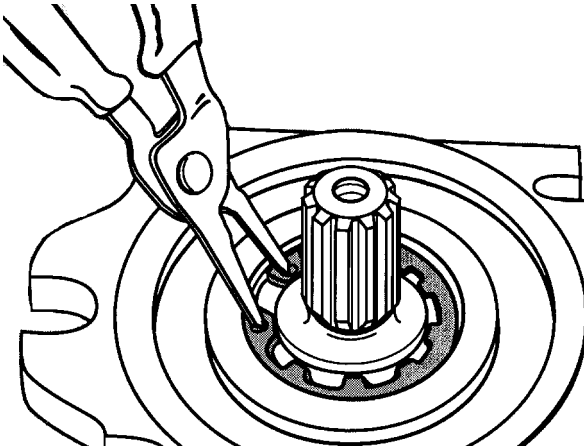
PRACTICAL EXPERIENCE SHOWS THAT MOST FLUID MAINTENANCE ERRORS OCCUR DURING AN OIL CHANGE DUE TO:

- **USE OF AN UNSUITABLE HYDRAULIC FLUID**
 - **USE OF OIL CONTAMINATED DUE TO POOR STORAGE PRACTICES**
 - **FAILURE TO CLEAN THE RESERVOIR**
 - **INADEQUATE CLEANLINESS WHEN FILLING THE RESERVOIR (DIRTY DRUMS, CONTAINERS, WATER, ETC)**
3. Leakage Inspection
 - a. After commissioning
 - b. The complete transmission drive system (pumps, motors, hosing, filters, valves, etc) should be checked for leakage at regular intervals.
 - c. Leaking joints & connections must only be tightened when pressureless.
 4. Cleanliness Inspection
 - a. The oil tank breather should be regularly cleaned of dirt and dust to prevent clogging. With each cylinder movement, gallons of oil pumped, an equal amount of air exchange occurs across the reservoir breather. A dirty or clogged breather will affect **all** machine functions!
 - b. The air/oil cooler surfaces and engine radiator should be cleaned at the same time.
 - c. If hose connections are disassembled, it is imperative that the utmost care be taken that no foreign bodies infiltrate the oil circuit. Catastrophic component failure may occur.

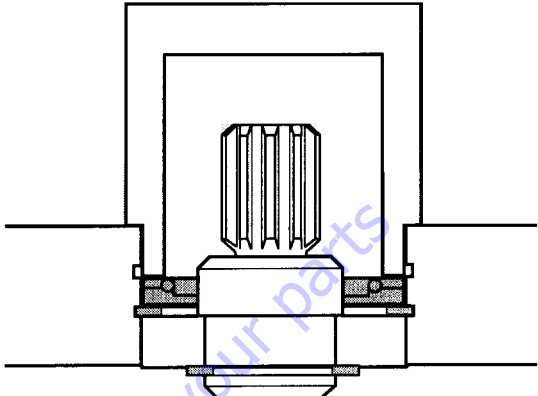
5. Oil Level Inspection
 - a. Inspect oil level in the reservoir daily.
 - b. If "topping off" is required, use only the same Mobil-fluid #424, Product #52233-4.
 - c. Do Not Mix Fluids.
6. Hydraulic Fluid - The "Life Blood" of the Machine
 - a. The type of hydraulic fluid supplied in the machine from the factory was selected after extensive testing and development. The fluid was selected to perform under "most" applications and conditions. Should this machine be in service for extended time periods at the extremes (hot or cold), JLG should be consulted for assistance in selection of the most suitable fluid type and grade for your application.
 - b. When operating at temperatures below 0°F, allow a warm-up period, if at all possible, to a temperature of 40°F.
 - c. When beginning motion of a "cold" machine, operate all functions at reduced speeds until the "cold" oil has circulated out of the drive loop.

Removal and Installation of Shaft Seal

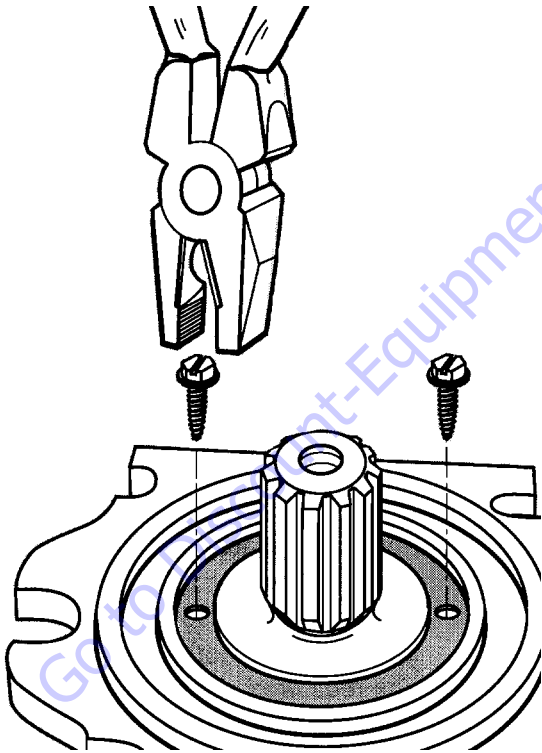
Remove the retaining ring with snap ring pliers.



Press in shaft seal with bushing to the stop. Then replace snap ring.



Screw in sheet metal screw into the holes fitted with rubber. Pull out shaft seal with pliers.



5.7 FUNCTION PUMP (REXROTH)

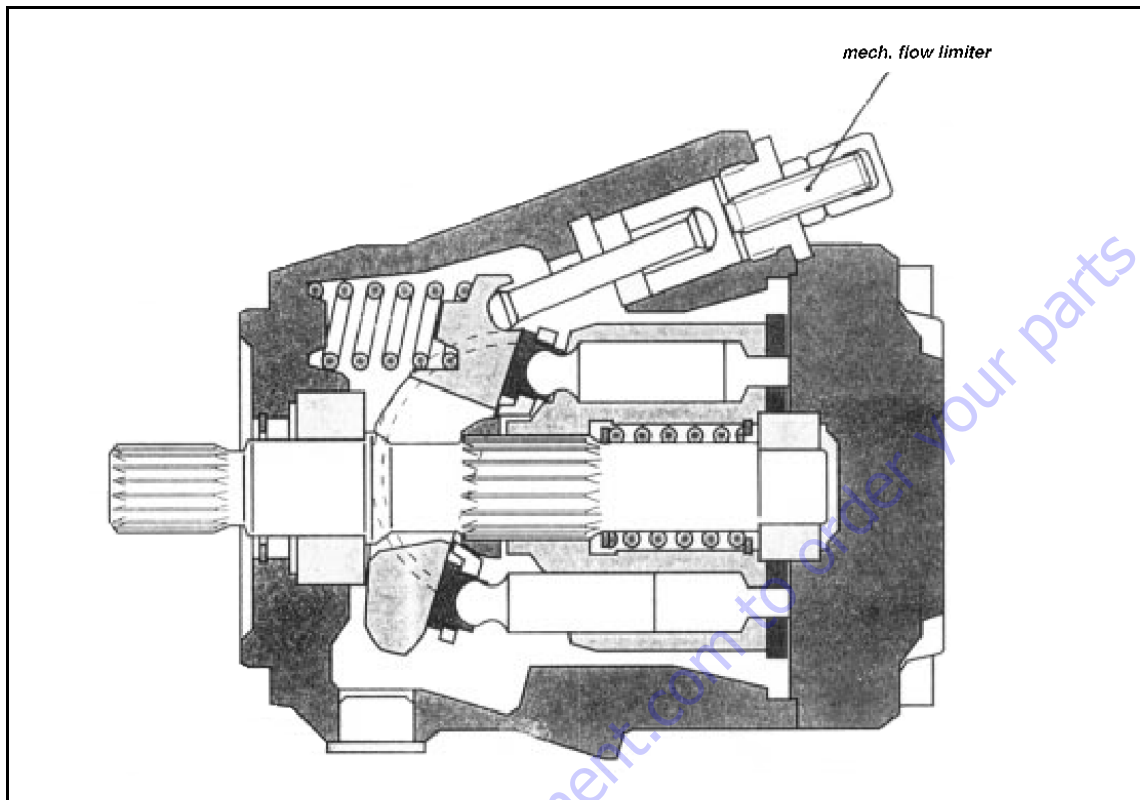
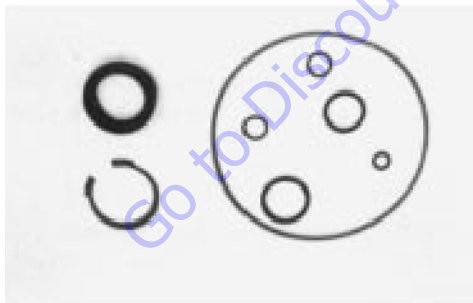


Figure 5-61. Function Pump - Sectional View

Spare Parts

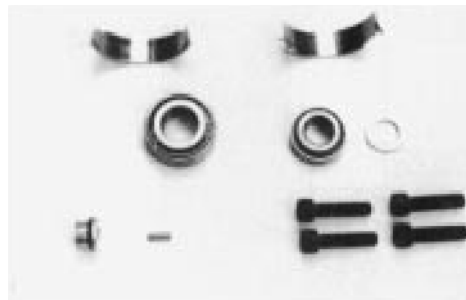
1. Sealing kit, existing spare parts: shaft sealing ring, o-rings, and a circlip.



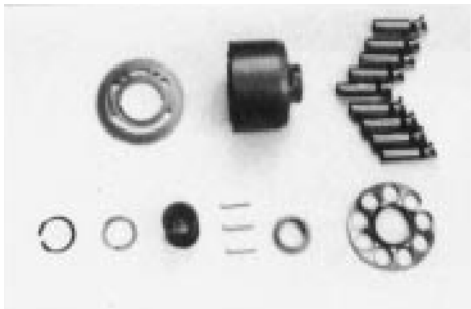
2. Drive Shaft



3. Bearing set, miscellaneous parts.



- 4. Rotary Group complete: 9 pistons, cylinder subassembly, valve plate, retaining plate, and retaining ball.



- 5. Swash Plate.



- 6. Parts of the control valve: control piston, piston rod, plug, spring stopper max flow, hex nut, and hex head nut.



- 7. DFR pilot valve.

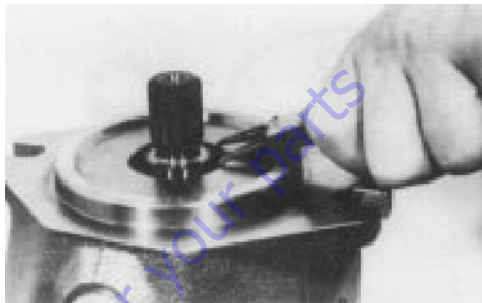


Sealing the Drive Shaft

NOTICE

BE VERY CAREFUL SO THE DRIVE SHAFT IS NOT DAMAGED DURING THE REMOVAL OF THE SHAFT SEALING RING.

- 1. Remove the snap ring.



- 2. Change the shaft seal and check its' sliding surface (drive shaft) and housing. Grease the sealing ring.



- 3. Be careful while you seal the drive shaft. Use an adhesive tape to prevent the shaft splines from damaging the seal.



SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

4. Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.



5. Assemble the snap ring.

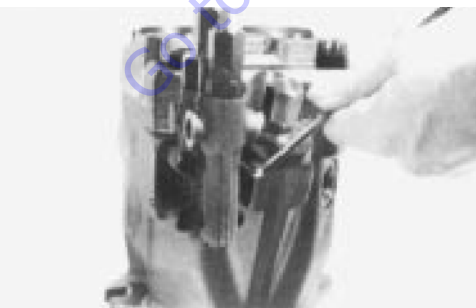


6. Assemble the snap ring in the correct position.



Disassembly and Assembly of the Complete Unit

1. Disassemble the pilot valve.



2. Mark the position of the port plate and remove the socket screw of the port plate.



3. Remove the port plate together with the valve plate (hold the valve plate so the plate can't fall down).



4. Remove the o-ring.



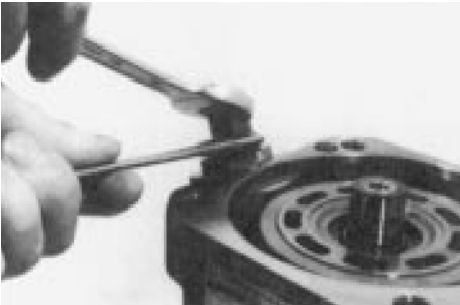
5. Disassemble the taper roller bearing (nearby port plate).



6. Remove the adjustment shim.



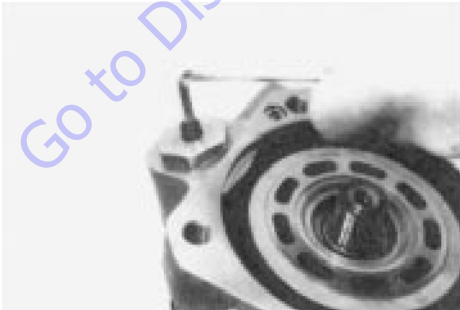
7. Unscrew the cap nut and remove it.



8. Loosen the fixing nut of the stopper max flow and disassemble it.



9. Turn in the stopper max flow to get swivel angle zero.



10. Disassemble the rotary group in horizontal position.



11. Disassemble the stopper max flow.



12. Remove the threaded pin.

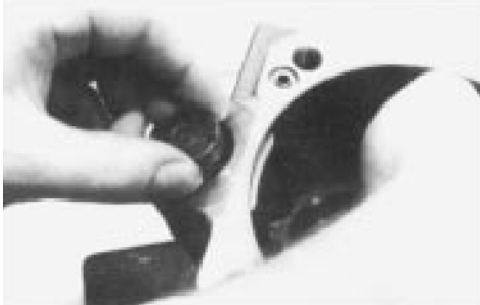


13. Disassemble the plug.



SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

14. Disassemble the control piston while moving the swash plate.



15. The swash plate must be lifted a little bit to disassemble the piston rod.



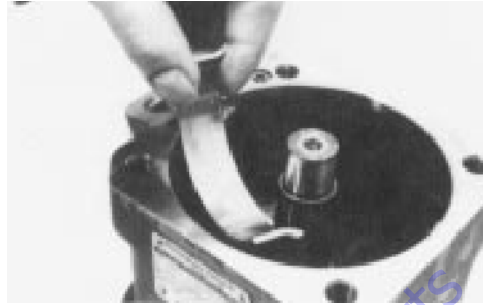
16. Remove the swash plate.



17. Remove the spring.



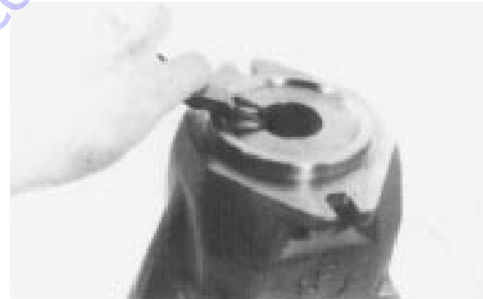
18. Remove both bearing shells.



19. Remove the drive shaft.



20. Disassemble the snap ring.



21. Disassemble the sealing ring.



22. The external front bearing ring is pulled out of the pump housing.



23. Remove the o-ring. Lifting of the valve plate isn't shown.



24. A bearing puller is used to disassemble the external bearing ring of the taper roller bearing inside the port plate. Take care of the surface of the port plate.



25. The spring has additional pretension while you disassemble the three pressure pins inside the cylinder.

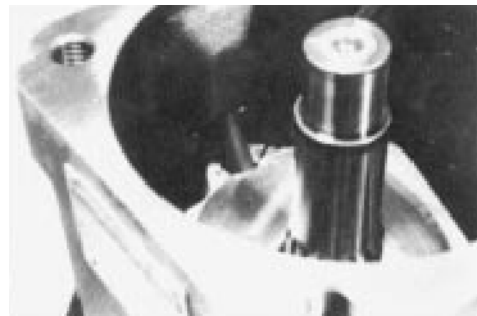


Assembly

1. Measurement of the taper roller bearing pretention.



2. Ensure there is a correct connection of the piston rod and the swash plate.



- 3. Pumps clockwise driven must have a position of the valve plate 4 degrees out of center in the same direction decentered like drive direction.



- 4. Pumps counterclockwise driven must have a position of the valve plate 4 degrees decentered in the ccw position.



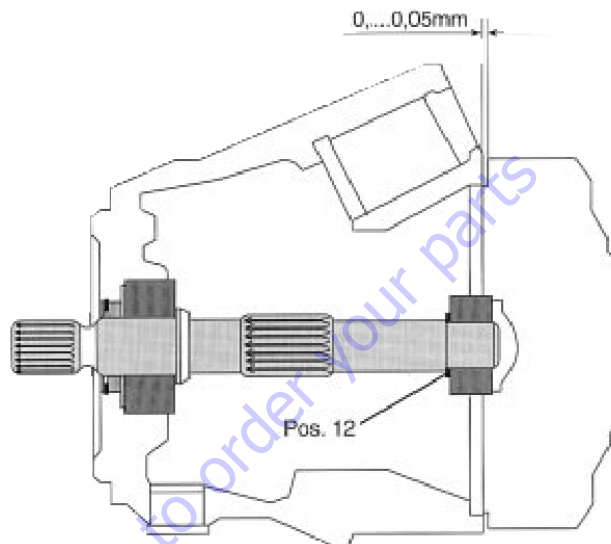
- 5. Note the correct position of the drilling that connects high pressure to the control valve. Check control valve drilling position at the pump housing and fit together.



Adjustments

TAPER ROLLER BEARING INITIAL TENSION

Cast Iron pump housing must have initial tension of the bearings: 0 to 0.05 mm.



MECHANICAL FLOW LIMITER

Differential volume if you are rotating the threaded pin - each rotation is approximately 3.1 cm³.

Tightening Torques

For break-off plugs, use High Strength Anaerobic Retaining Compound.

For all other parts, use Medium Strength Threadlocking Compound.

Table 5-38. Tightening Torques

	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M30
8.8	2.3	5.0	8.5	21	41	72	115	176	240	350	600	1220
10.9	3.2	7.2	12	29	58	100	165	250	350	490	840	1670
12.9	4.1	8.5	14.5	35	70	121	195	300	410	590	990	2000

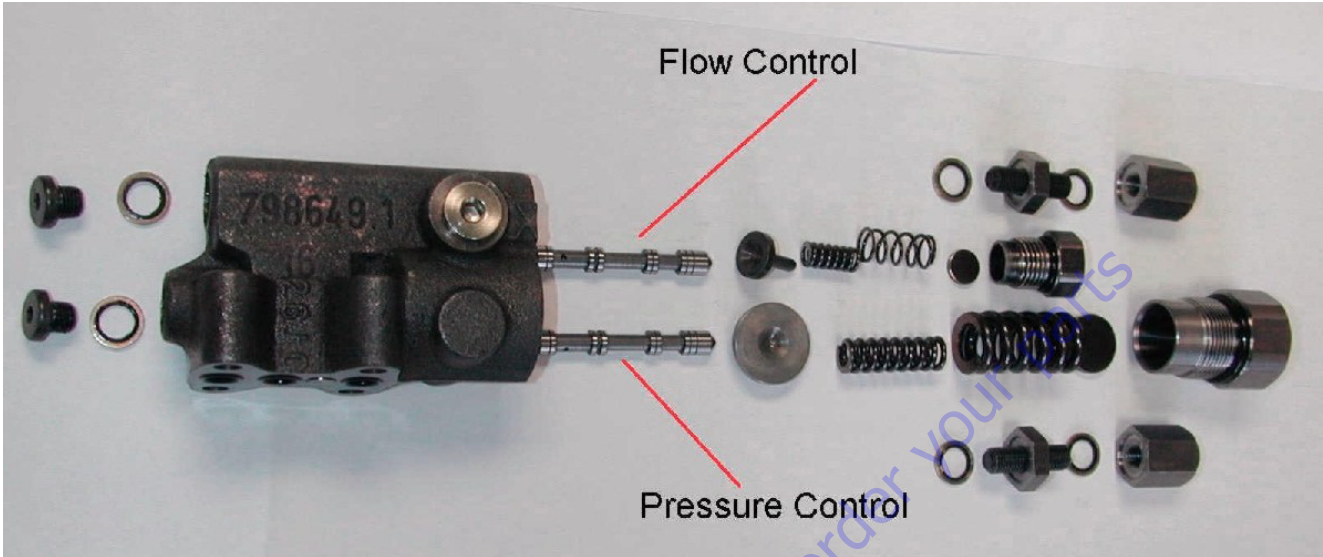


Figure 5-62. Function Pump, Pressure and Flow Control - Sheet 1

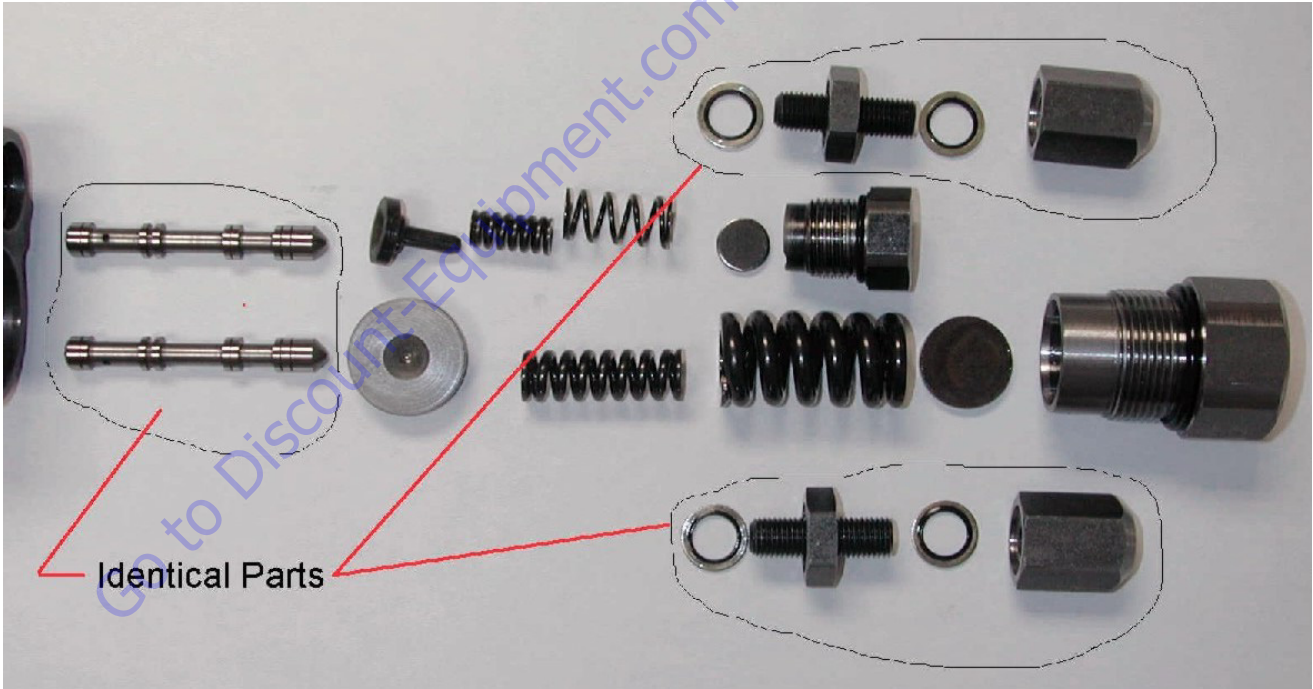


Figure 5-63. Function Pump, Pressure and Flow Control - Sheet 2



Figure 5-64. Function Pump, Pressure and Flow Control - Sheet 3

Pump Control Disassembly For Cleaning

NOTE: If the Function Pump does not perform correctly after following the pre-start start-up procedures, it is possible that a contaminate particle has lodged in the pump control preventing proper operation. The pump control's internal parts are not provided as spare parts due to the close tolerances required between the mating parts. However, the control can be disassembled, cleaned and placed back in service should the only problem prove to be contamination. Disassembly, inspection, cleaning and reassembly MUST BE done in a clean well-illuminated area.

Pump Control removal:

1. Disconnect plug the hose attached to the pump control Port "X".
2. Remove the four (4) socket head cap screws that attach the control to the pump. Insure that the three (3) "O"-rings are also removed with the control.

3. Hydraulic fluid may drip from the pump. Wiping the surface clean and installing some adhesive tape should prevent oil from seeping from the pump control.

4. Work on a clean, lint free area.

NOTE: The pump control can be equipped with either O-rings or a sealing plate. These components are NOT interchangeable.

5. Remove the three (3) "O"-rings (Parker # 2-011, Viton 90 shore)
6. Remove both the adjustment hex caps and bonded seal rings. (17 mm wrench)
7. Remove both the adjustment lock nuts and bonded seal rings. (17 mm wrench)
8. Remove both the adjusting screws. (3-mm Allen wrench)

9. Remove the spring cover hex cap for the "outer" flow regulation adjustment this requires a 19-mm wrench.
 10. Remove the spring disc.
 11. Remove the adjusting springs (two springs, one "nested" inside the other) and spring follower.
 12. The flow regulation spool should slide from the control housing, (a magnet should aid in removal). If it does not, remove the hollow hex head plug at the rear of the flow regulation spool and carefully push the spool from the housing - do not scratch/mar the spool's bore.
 13. Remove the spring cover hex cap for the "inner" pressure compensation adjustment - this requires a 30-mm wrench.
 14. Remove the spring disc.
 15. Remove the adjusting springs (two springs, one "nested" inside the other).
 16. Remove the spring follower.
 17. The pressure compensation spool should slide from the control housing, (a magnet should aid in removal). If it does not, remove the hollow hex head plug at the rear of the flow regulation spool and carefully push the spool from the housing - do not scratch/mar the spool's bore.
 18. The spools are identical.
 19. Wash the housing and all parts in a clean JLG approved solvent such as non-chlorinated brake cleaner, Stoddard solvent, etc.
 20. Blow off all the parts with clean, dry compressed air.
 21. Inspect the housing for contamination or plugged orifices. Clean orifices carefully with a dead soft steel wire to insure they are open. Inspect all parts for burrs, scoring, debris, etc.
- NOTE:** *On the mounting surface of the control housing, between the oil ports is what appears to be a slotted head screw. IT IS NOT A SCREW. This is a bleed orifice, which must be oriented to allow proper control operation. The slot in the head should be oriented to fall in-line with the oil ports, NOT PERPENDICULAR to the oil ports. If the slot is oriented perpendicular to the three ports, the pump pressure will not return from load pressure to stand-by pressure at the end of operating a function! The pump pressure will remain at the last highest pressure generated.)*
22. After all parts are clean and dry, lightly oil a control spool and install in its bore. The spool must slide smoothly and easily within the housing. If it does not, check for contamination. If contamination cannot be found check for "scoring" or "burring" of the control housing. If the spool does not slide smoothly & freely, the control must be replaced with a new unit.
 23. Lightly oil and check operation of the second spool. The spools are installed correctly when there "pointed" end faces the spring followers
 24. Re-assemble in reverse order.
 25. Bench set the pressure adjustments as described in "C. 4" of the Operating Instructions.
- NOTE:** *The pump control can be equipped with either O-rings or a sealing plate. These components are NOT interchangeable.*
26. Re-install on the Function Pump, insure the "O"-rings are installed properly and tighten the four (4) M6 socket head cap screws to 105 inch pounds.

5.8 DRIVE PUMPS (SAUER)

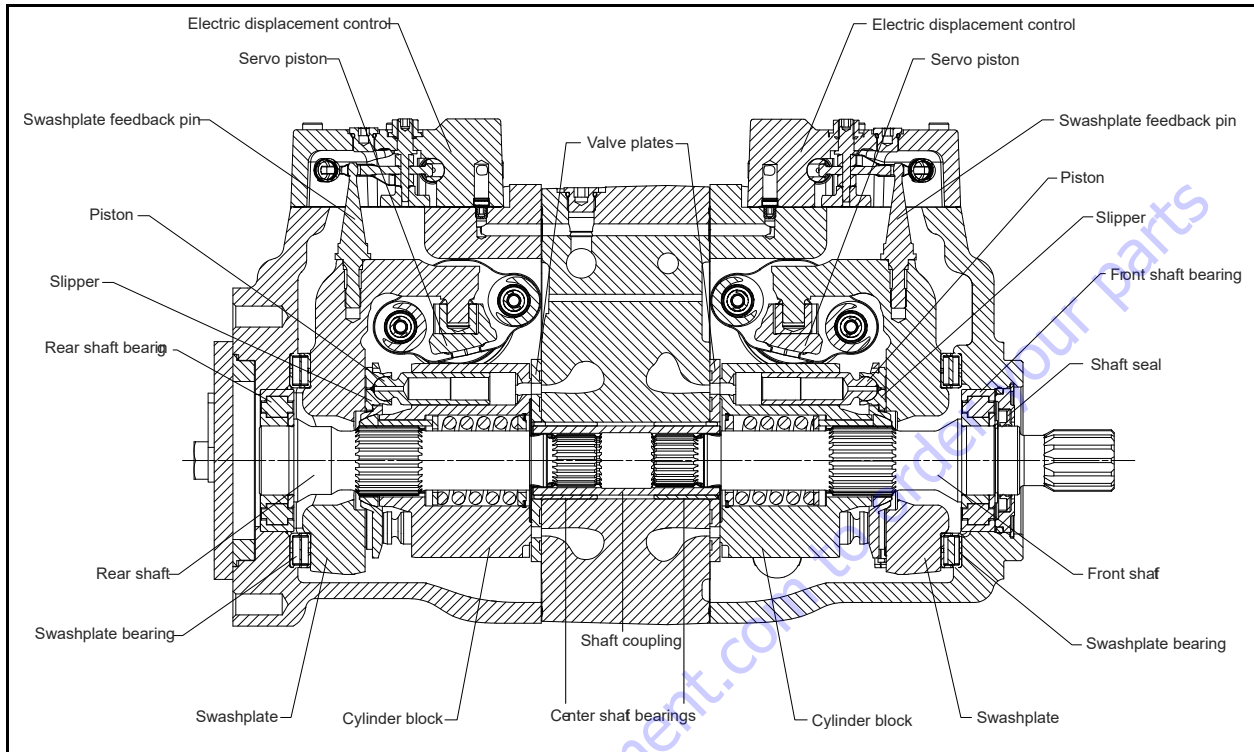


Figure 5-65. Piston Pump Cross Sectional View

Port Locations and Gauge Installation

Table 5-39. Port Information

Port identifier	Port size	Wrench size	Reading	Gauge size, bar [psi]
L1, L2, L3	11/16-12 UNF 2B	9/16 internal hex	Case drain	10 bar [100 psi]
MA, MB, MC, MD	9/16-18 UNF	1/4 internal hex	System pressure	600 bar [10,000 psi]
M3	9/16-18 UNF 2B	1/4 internal hex	Charge pressure	50 bar [1000 psi]
M4, M5	7/16-20 UNF 2B	3/16 internal hex	Servo pressure	50 bar [1000 psi]
X7	9/16-18 UNF 2B	1/4 internal hex	Brake pressure	50 bar [1000 psi]

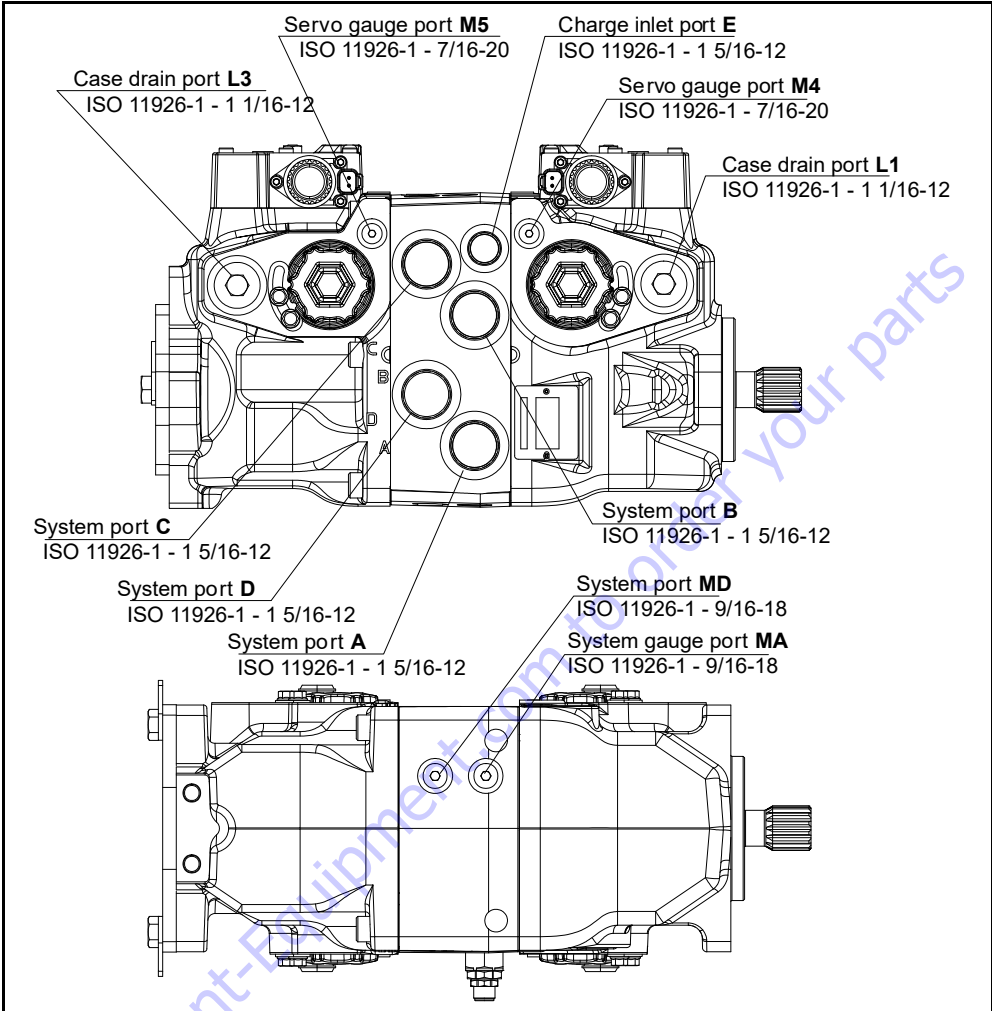


Figure 5-66. Port Locations - Sheet 1 of 2

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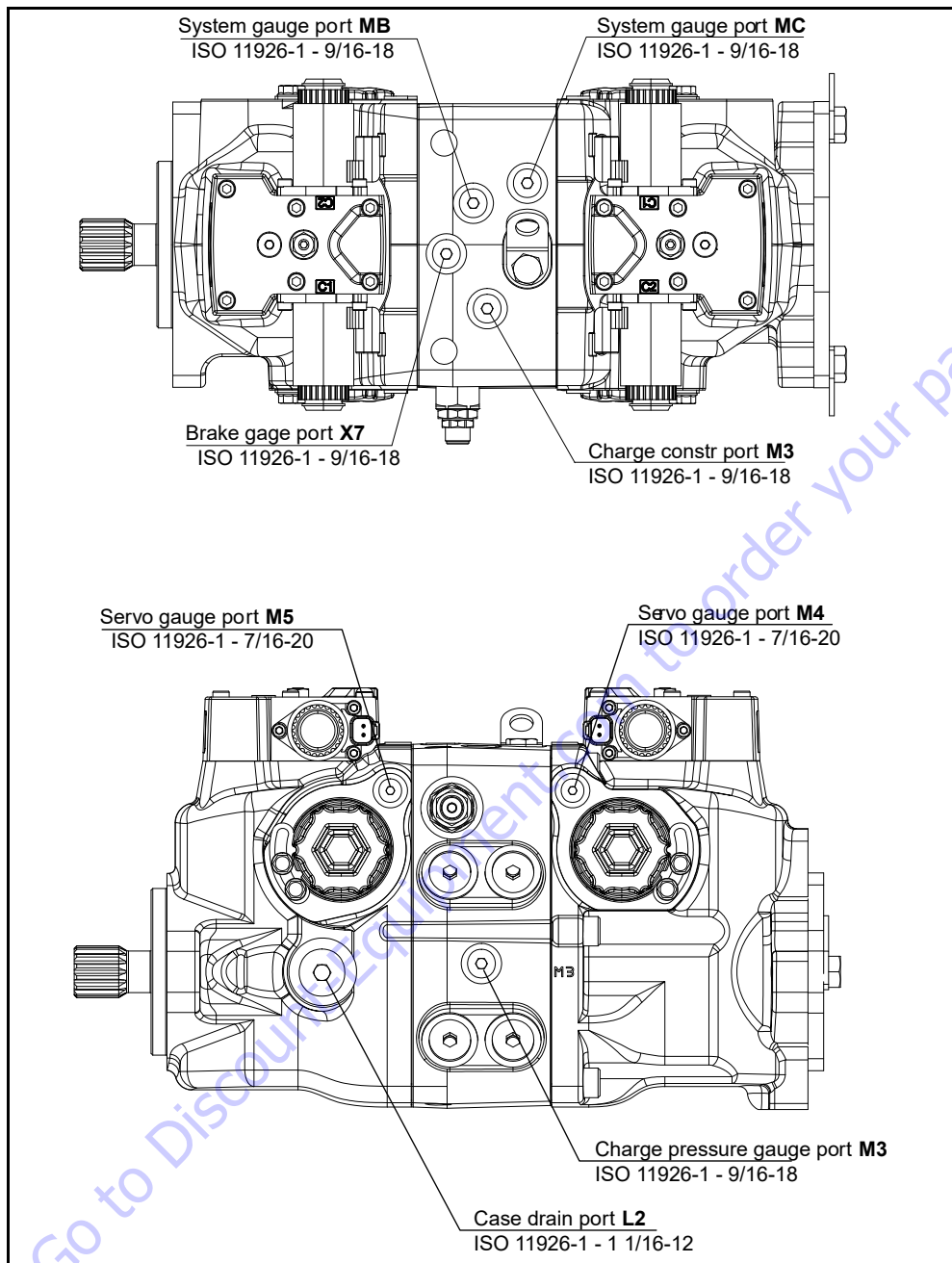


Figure 5-67. Port Locations - Sheet 2 of 2

Initial Startup Procedures

Follow this procedure when starting-up a new pump or when restarting a pump that has been removed. Ensure the pump is thoroughly tested on a test stand before installing.

Prior to installing the pump, inspect for damage that may have occurred during shipping.

1. Ensure that the machine hydraulic oil and system components (reservoir, hoses, valves, fittings, and heat exchanger) are clean and free of any foreign material.
2. Install new system filter element(s) if necessary. Check that inlet line fittings are properly tightened and free of air leaks.
3. Install the pump. Install a 50 bar [1000 psi] gauge in the charge pressure gauge port M3.
4. Fill the housing by adding filtered hydraulic fluid to the upper case drain port. If the controls are installed on top, open the construction plugs in the top of the controls to assist in air bleed.
5. Fill the reservoir with hydraulic fluid of the recommended type and viscosity. Use a 10-micron filler filter. Ensure construction plug is closed after filling is complete.
6. Disconnect the pump from all control input signals.

⚠ CAUTION

AFTER START-UP THE FLUID LEVEL IN THE RESERVOIR MAY DROP DUE TO SYSTEM COMPONENTS FILLING DAMAGE TO HYDRAULIC COMPONENTS MAY OCCUR IF THE FLUID SUPPLY RUNS OUT. ENSURE RESERVOIR REMAINS FULL OF FLUID DURING START-UP.

⚠ CAUTION

AIR ENTRAPMENT IN OIL UNDER HIGH PRESSURE MAY DAMAGE HYDRAULIC COMPONENTS. CHECK CAREFULLY FOR INLET LINE LEAKS.

⚠ CAUTION

DO NOT RUN AT MAXIMUM PRESSURE UNTIL SYSTEM IS FREE OF AIR AND FLUID HAS BEEN THOROUGHLY FILTERED.

7. Use a common method to disable the engine to prevent it from starting. Crank the starter for several seconds. Do not to exceed the engine manufacturer's recommendation. Wait 30 seconds and then crank the engine a second time as stated above. This operation helps remove air from the system lines. Refill the reservoir to recommended full oil level.
8. When the gauge begins to register charge pressure, enable and start engine. Let the engine run for a minimum of 30 seconds at low idle to allow the air to work itself out of the system. Check for leaks at all line connec-

tions and listen for cavitation. Check for proper fluid level in reservoir.

9. When adequate charge pressure is established (as shown in model code), increase engine speed to normal operating rpm to further purge residual air from the system.
10. Shut the off engine. Connect the pump control signal. Start the engine, checking to be certain the pump remains in neutral. Run the engine at normal operating speed and carefully check for forward and reverse control operation.
11. Continue to cycle between forward and reverse for at least five minutes to bleed all air and flush system contaminants out of the system loop.

NOTE: *Normal charge pressure fluctuation may occur during forward and reverse operation.*

12. Check that the reservoir is full. Remove charge pressure gauge and cap port. The pump is now ready for operation.

Troubleshooting

⚠ CAUTION

HIGH INLET VACUUM CAUSES CAVITATION WHICH CAN DAMAGE INTERNAL PUMP COMPONENTS.

⚠ WARNING

ESCAPING HYDRAULIC FLUID UNDER PRESSURE CAN HAVE SUFFICIENT FORCE TO PENETRATE YOUR SKIN CAUSING SERIOUS INJURY AND/OR INFECTION AND MAY BE HOT ENOUGH TO CAUSE BURNS. RELIEVE PRESSURE IN THE SYSTEM BEFORE REMOVING HOSES, FITTINGS, GAUGES, OR COMPONENTS. SEEK IMMEDIATE MEDICAL ATTENTION IF YOU ARE CUT OR BURNED BY HYDRAULIC FLUID.

⚠ CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND REINSTALLING SYSTEM COMPONENTS AND LINES

Table 5-40. Electrical Troubleshooting

Item	Description	Action
Control operates pump in one direction only	Control coil failure.	Measure resistance at coil pins. Resistance should be 14.2W (24V) or 3.66W (12V) at 20°C [70° F]. Replace coil.
No pump function	No power to controller.	Restore power to controller.
Erratic pump function	Electrical connection to pump is bad.	Disconnect connection, check wires, reconnect wires.
Erratic or no machine function	External controller malfunction or hydraulics system problem.	Verify external controller problem using spare controller. Replace controller. Check hydraulic system fluid level/pressures/filters/etc. Fix hydraulic system problems.

Table 5-41. Neutral Difficult or Impossible to Find

Item	Description	Action
Input to pump control	Input to control module is operating improperly.	Disconnect input and check to see if pump comes back to neutral. If Yes, input fault, replace/repair external controller. If No, go to next step.
Pump control neutral	Neutral set improperly.	Shunt servo gauge ports M4 and M5 together with external hose and see if pump comes back to neutral. If Yes: control neutral improperly set. If no: balance swashplate (see Mechanical neutral adjustment). If you still cannot set neutral, replace control.

Table 5-42. System Operating Hot

Item	Description	Action
Oil level in reservoir	Insufficient hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level.
Heat exchanger	Heat exchanger not sufficiently cooling the system.	Check air flow and input air temperature for heat exchanger. Clean, repair or replace heat exchanger.
Charge pressure	Low charge pressure will overwork system.	Measure charge pressure. Inspect and adjust or replace charge relief valve. Inspect charge pump. Repair or replace charge pump.
Charge pump inlet vacuum	High inlet vacuum will overwork system. A dirty filter will increase the inlet vacuum. Inadequate line size will restrict flow.	Check charge inlet vacuum. If high, inspect inlet filter and replace as necessary. Check for adequate line size, length or other restrictions.
System relief pressure settings	If the system relief valves are worn, contaminated, or valve settings are too low, the relief valves will be overworked.	Verify settings of high pressure relief valves and replace valves as necessary.
System pressure	Frequent or long term operation over system relief setting will create heat in system.	Measure system pressure. If pressure is too high, reduce loads.

Table 5-43. System Will not Operate

Item	Description	Action
Oil level in reservoir	Insufficient hydraulic fluid to supply system loop.	Fill reservoir to proper level.
Control orifices	Control orifices are blocked.	Clean control orifices.
Control screens	Control screens are blocked.	Clean or replace control screens.
Charge pressure with pump in neutral	Low charge pressure insufficient to recharge system loop.	Measure charge pressure with the pump in neutral. If pressure is low, go to next step.
Pump charge relief valve	A pump charge relief valve that is leaky, contaminated, or set too low will depressurize the system.	Adjust or replace pump charge relief valve as necessary.
Charge pump inlet filter	A clogged filter will under supply system loop.	Inspect filter and replace if necessary.
Charge pump	A malfunctioning charge pump will provide insufficient charge flow.	Repair or replace the charge pump.
System pressure	Low system pressure does not provide enough power to move load.	Measure system pressure. Continue to next step.
Charge check / HPRVs	Defective charge check / HPRVs cause system pressure to be low.	Repair or replace charge check / HPRVs.
Input to control	Input to control module is operating improperly.	Repair or replace control.
Optional control cutoff valve	Control cutoff valve coil not energized.	Ensure charge pressure to control via port X7. If none, confirm control cutoff valve coil is energized. If still no pressure, repair or replace control cutoff valve.

Table 5-44. System Noise or Vibration

Item	Description	Action
Reservoir oil level	Low oil level leads to cavitation.	Fill reservoir.
Aeration of the oil/pump inlet vacuum	Air in system decreases efficiency of units and controls. Air in system is indicated by excessive noise in pump, foaming in oil, and hot oil.	Find location where air is entering into the system and repair. Check that inlet line is not restricted and is proper size.
Cold oil	If oil is cold, it may be too viscous for proper function and pump cavitates.	Allow the oil to warm up to its normal operating temperature with engine at idle speed.
Pump inlet vacuum	High inlet vacuum causes noise/cavitation.	Check that inlet line is not restricted and is proper size. Check filter and bypass switch.
Shaft couplings	A loose input shaft to prime mover coupling will cause excessive noise.	Replace loose shaft coupling.
Shaft alignment	Misaligned input and prime mover shafts create noise.	Correct misalignment.
Charge/system relief valves	Unusual noise may indicate sticking valves. Possible contamination.	Clean/replace valves and test pump. May be a normal condition.

Table 5-45. Sluggish System Response

Item	Description	Action
Oil level in reservoir	Low oil level will cause sluggish response.	Fill reservoir.
Charge check/HPRVs	Incorrect pressure settings will affect system reaction time.	Replace charge check/HPRVs.
Low prime mover speed	Low engine speed will reduce system performance.	Adjust engine speed.
Charge and control pressures	Incorrect pressures will affect system performance.	Measure and adjust charge and control pressures.
Air in system	Air in system will produce sluggish system response.	Fill tank to proper level. Cycle system slowly for several minutes to remove air from system.
Contaminated control orifices	Control orifices are plugged.	Clean control orifices.
Contaminated control screens	Control screens are plugged.	Clean or replace control screens.
Pump inlet vacuum	Inlet vacuum is too high resulting in reduced system pressure.	Measure charge inlet vacuum. Inspect line for proper sizing. Replace filter. Confirm proper bypass operation.

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Adjustments

CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS AND VOID YOUR WARRANTY. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND REINSTALLING SYSTEM LINES

1. Thoroughly clean the outside of the pump.
2. If removing the pump, tag each hydraulic line. When you disconnect hydraulic lines, cap them and plug each open port to prevent contamination.
3. Ensure the surrounding area is clean and free of contaminants like dirt and grime.
4. Inspect the system for contamination.
5. Check the hydraulic fluid for signs of contamination: oil discoloration, foam in the oil, sludge, or metal particles.
6. If there are signs of contamination in the hydraulic fluid, replace all filters and drain the hydraulic system. Flush the lines and refill the reservoir with the correct filtered hydraulic fluid.
7. Before reinstalling the pump, test for leaks.

CHARGE PRESSURE RELIEF VALVE.

1. Install a 50 bar [1000 psi] pressure gauge in charge pressure gauge port M3. Install a 10 bar [100 psi] gauge at case pressure port L1, L2, or L3. Operate the system with the pump in neutral (zero displacement) when measuring charge pressure.
2. The table below shows the acceptable pump charge pressure range for some nominal charge relief valve settings (refer to model code located on serial number plate). These pressures assume 1800 min⁻¹ (rpm) pump speed and a reservoir temperature of 50°C [120°F], and are referenced to case pressure.

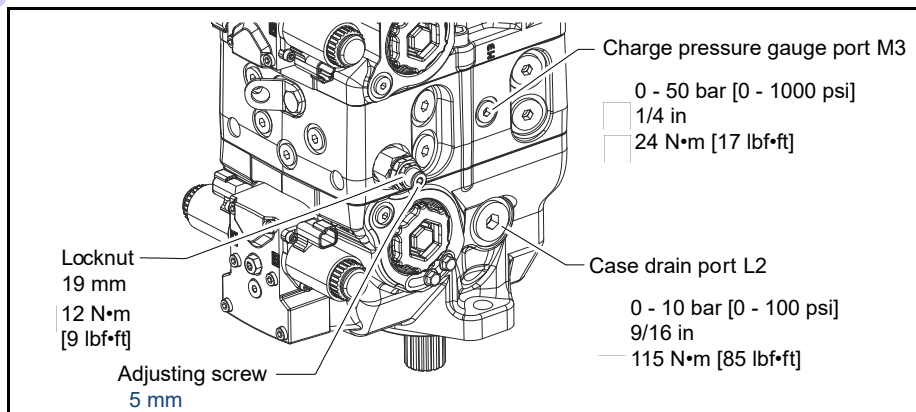


Figure 5-68. Charge Pressure Adjustment

NOTE: Listed pressures assume a pump speed of 1800 min⁻¹ (rpm) and charge flow of 26.5 l/min [7 US gal/min]. At higher pump speeds or higher charge flows the charge pressure will rise over the rated setting.

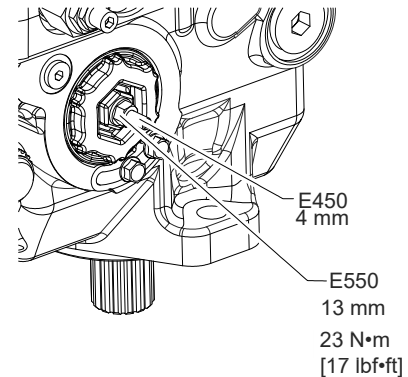
3. Loosen the locknut and rotate the adjusting screw clockwise to increase the setting; counterclockwise to decrease it. Subtract the case pressure reading to compute the actual charge pressure.

NOTE: Pressure change per turn is dependent on charge flow entering pump.

4. While holding the adjusting screw, torque locknut to 12 Nm [9 lbf•ft].
5. When you achieve the desired charge pressure setting, remove the gauges and plug the ports.

DISPLACEMENT LIMITER ADJUSTMENT

1. Mark servo cylinder location in case it rotates during displacement limiter adjustment.
2. Loosen the locknut (E550).



3. Rotate the adjusting screw (E450) based on the following table. Rotating the adjusting screw clockwise decreases the maximum displacement of the pump while rotating the adjusting screw counterclockwise increases the maximum displacement.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

- After establishing the desired maximum displacement setting, hold adjusting screw in place and tighten the locknut. Torque to 23 Nm [17 lbf·ft]. C

⚠ CAUTION

BE SURE SERVO CYLINDER DOES NOT ROTATE WHEN DISPLACEMENT LIMITER LOCKNUT (E550) IS TORQUED.

- One turn of the adjusting screw will change the maximum displacement approximately as follows.

Table 5-46. Displacement Limiter Adjustment Data

Displacement	Locknut wrench size and torque	Adjusting screw size	Approximate displacement change per revolution of adjusting screw
45	13 mm 23 Nm [17 lbf·ft]	4 mm internal hex	5.1 cc/turn

CONTROL NEUTRAL ADJUSTMENT

All functions of the Electric Displacement Control (EDC) are preset at the factory. Adjust the pump to neutral with the pump running on a test stand or on the vehicle/machine with the prime mover operating. If adjustment fails to give satisfactory results, you may need to replace the control or coils.

- Install a 50 bar [1000 psi] gauge in each of the two servo gauge ports (M4 and M5). Disconnect the external control input (electrical connections) from the control. Start the prime mover and operate at normal speed.
- Use a 4mm internal hex wrench to hold the neutral adjusting screw stationary while loosening the locknut with a 13mm wrench.

- Observe pressure gauges. If necessary, turn adjusting screw to reduce any pressure differential.

NOTE: Adjustment of the EDC is very sensitive. Be sure to hold the hex wrench steady while loosening the locknut. Total adjustment is less than 120 degrees.

- Rotate the neutral adjusting screw clockwise until the pressure increases on the gauge. Note the angular position of the wrench. Then rotate the neutral adjusting screw counterclockwise until the pressure increases by an equal amount on the other gauge. Again note the angular position of the wrench.

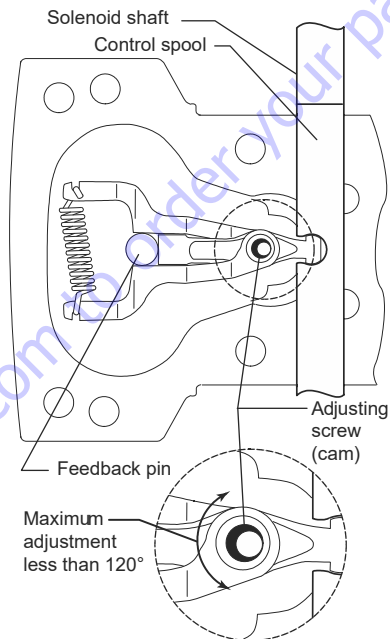


Illustration shows how eccentric cam on adjusting screw rotates to adjust neutral.

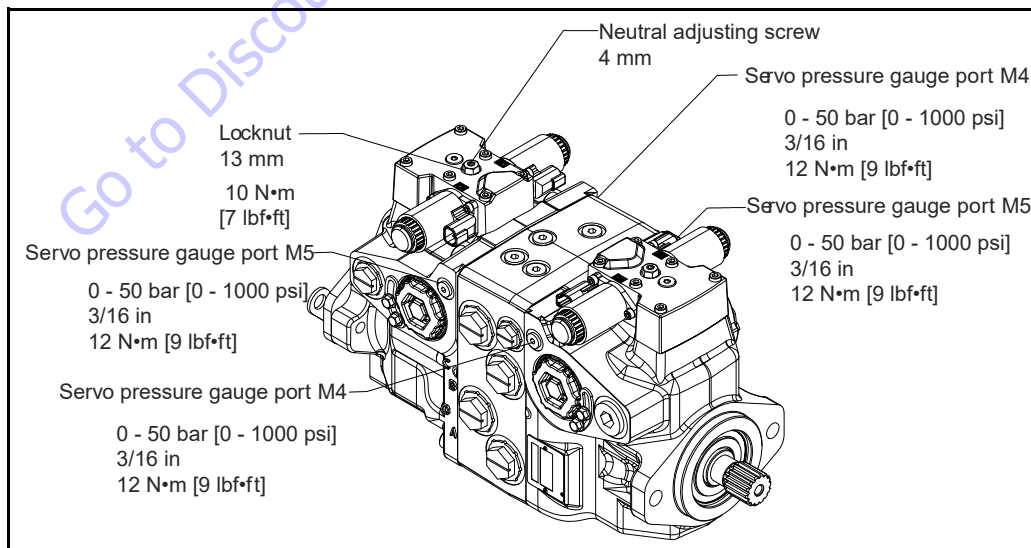


Figure 5-69. Control Neutral Adjustment

5. Rotate the neutral adjusting screw clockwise half the distance between the wrench positions noted above. The gauges should read the same pressure, indicating that the control is in its neutral position.
6. Hold the neutral adjusting screw stationary and tighten the lock nut. Torque to 10.Nm [7 lbft]. Do not over torque the nut.
7. When the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control input.

NOTE: A small pressure differential of 1.5 bar [22 psi] or less is acceptable. Zero differential is usually not possible.

MECHANICAL NEUTRAL ADJUSTMENT

Mechanical neutral is set with the pump running at 1800 min (rpm). To set neutral, you must stroke the pump in each direction.

This procedure details setting neutral for the entire pump, one side at a time. The procedure is the same for each side of each pump so you will need to repeat it four times to set mechanical neutral for both the front and rear sections. Alternate M4/M5 and MA/MB to zero out forward and reverse directions of the front unit, then move the gauges to M4/M5 of the rear unit and MC/MD (system gauge ports for the rear unit). Refer to the drawing that follows to identify all ports. The front and rear sections are basically mirror images of each other. The control solenoids C1 and C2 are marked on each control.

While performing this adjustment, you monitor the following pressures.:

- Servo pressure at M4 and M5
- System pressure at MA and MB or MC and MD
- Pressure differential between M4 and M5 (optional)
- Pressure differential between A and B or C and D (optional)

PUMP SETUP

1. Attach a 50 bar [1000 psi] gauge to each servo pressure port M4 and M5.
2. Attach a 600 bar [10 000 psi] gauge to each system pressure port (MA and MB for front pump, MC and MD for rear pump).
3. Remove servo cylinder locking screws (E350) and plates (E300) from both sides of the pump.
4. Disconnect the control solenoids from the vehicle wiring harness.
5. If using a PWM signal to set mechanical neutral, connect the control solenoids C1 and C2 to the signal source. Ensure the source supplies no current to the solenoids until required in the following procedure.

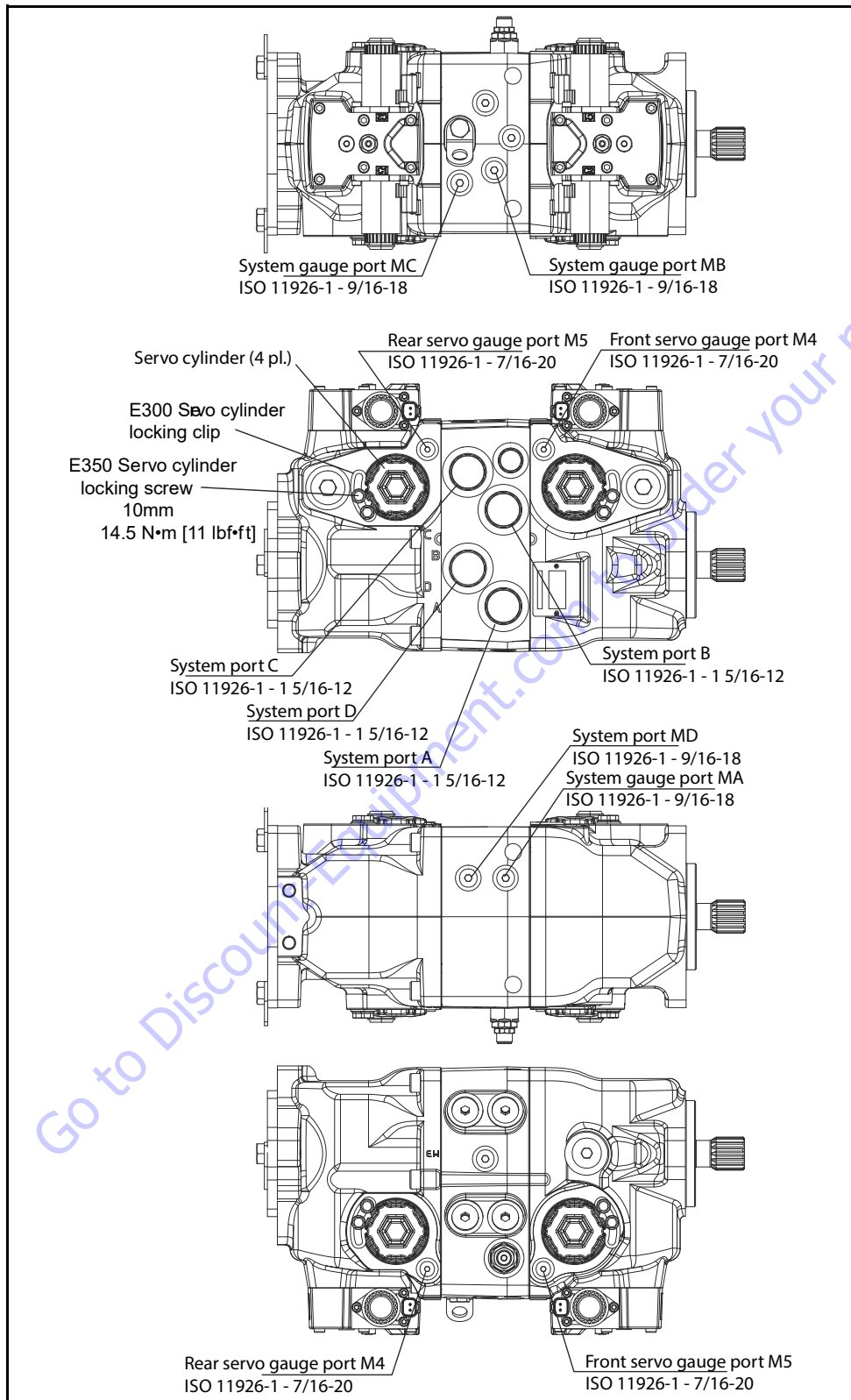


Figure 5-70. Servo and System Pressure Gauge Port Locations

SERVO ADJUSTMENT

6. Run prime mover at 1800 min (rpm).
7. If using a PWM signal, ensure the signal is off. Check the servo pressure gauges. Ensure the differential between M4 and M5 is less than 1.5 bar [22 psi].
8. Using a 3/4 in deep socket, unthread both servo cylinders 2-3 turns. This step ensures the servo cylinders have no contact with the servo piston.
9. Stroke the pump by turning the control eccentric screw (or supplying current to solenoid C1) until the servo pressure at port M4 is 1 to 2 bar [14 -29 psi] greater than at port M5 and the system pressure gauges indicate displacement. Pressure should be greater at port MA for clockwise rotation, or MB for counterclockwise rotation. This also indicates the servo piston is in contact with the servo cylinder on side M5.
10. Slowly thread the servo cylinder on the M5 side in until the system pressure differential starts to decrease. Maintain servo pressure differential between 1-2 bar [14-29 psi] during this step. Continue turning the servo cylinder in until the system pressure differential (between ports MA/MB or MC/MD) is less than 1.5 bar [22 psi]. This procedure sets the servo and swashplate to mechanical neutral on the M5 side.
11. To complete setting neutral, repeat steps 1-5 but stroke the pump in the opposite direction by turning the eccentric screw in the opposite direction, or by supplying current to solenoid C2. Reverse gauge locations (M4 for M5, MB for MA etc.) from those stated above since the pump is now stroking the other direction.
12. Set neutral for the rear pump by repeating steps 1-6 on the rear pump. Remember that the rear pump is a mirror image of the front pump and therefore the locations of the servo gauge ports (M4/M5) and the control solenoids (C1/C2) are opposite.
13. Remove all gauges and replace gauge port plugs.

Removing The Pump

Before working on the pump, thoroughly clean the outside. If the pump has an auxiliary pump attached, remove both pumps as a single unit. Tag and cap all hydraulic lines as you disconnect them, and plug all open ports to ensure that dirt and contamination do not get into the system.

⚠ CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND INSTALLING SYSTEM LINES.

1. Thoroughly clean all dirt and grime from the outside of the pump.
2. Tag, disconnect, and cap each hydraulic line connected to the pump. As hydraulic lines are disconnected, plug each open port, to ensure that dirt and contamination do not get into the pump.
3. Remove the pump and its auxiliary pump (if applicable) as a single unit.

NOTE: *Be careful, do not damage solenoids and electrical connections when using straps or chains to support the pump.*

Inspection

1. Ensure the work surface and surrounding area are clean and free of contaminants such as dirt and grime.
2. Inspect the system for contamination.
3. Look at the hydraulic fluid for signs of system contamination, oil discoloration, foam in the oil, sludge, or metal particles.

Replacement

1. Before replacing the pump, replace all filters and drain the hydraulic system. Flush the system lines and fill the reservoir with the correct, filtered hydraulic fluid.
2. Fill the pump with clean, filtered hydraulic fluid.
3. Attach the pump to the prime mover. Torque mounting screws according to the manufacturers recommendation.
4. Replace all hydraulic lines. Ensure the charge inlet line is filled with fluid.

Electric Control Module

REMOVAL

Refer to exploded diagram, next page.

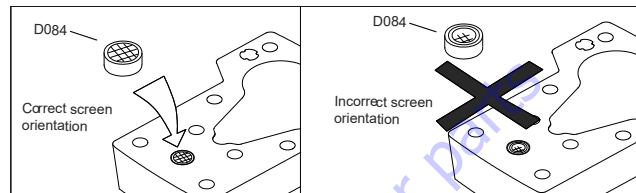
1. Using a 5 mm internal hex wrench, remove the six cap screws (D250).
2. Remove the control module and gasket (D150). Discard the gasket.
3. If necessary, remove orifices (F100) using a 3 mm internal hex wrench. Tag and number them for reinstallation.
4. Inspection
5. Inspect the machined surfaces on the control and top of the pump. If you find any nicks or scratches, replace the component.

NOTE: Remove plug on top of control to ensure the swashplate feedback pin is properly positioned in the center of the control module when installing control.

REASSEMBLY

NOTE: Ensure you install dowel pins (D300) in housing before installing control.

1. Install a new gasket (D150).
2. If you removed screen (D084), install a new one. Install with the mesh facing outward.



3. If previously removed, install orifices (F100) using a 3 mm internal hex wrench. Torque to 2.5 Nm [1.8 lbf·ft].
4. Install the control module and six cap screws (D250).
5. Using a 5 mm internal hex wrench, torque the cap screws (D250) to 13.5 Nm [10 lbf·ft].

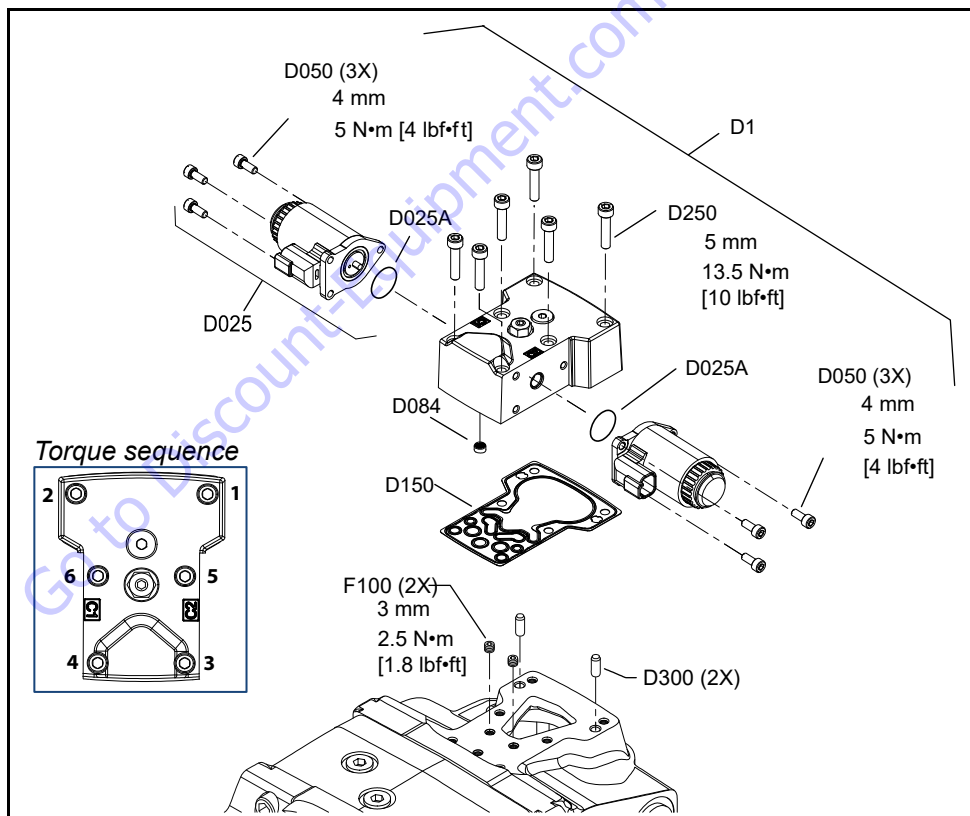


Figure 5-71. Control Module And Solenoid Removal/installation

CONTROL SOLENOIDS REMOVAL

1. Disconnect electrical connection and remove the three cap screws (D050) using a 4. mm internal hex wrench.
2. Remove the solenoid (D025) and O-ring (D025A). Discard the O-ring.
3. If necessary, remove the coil using a 12 point 26 mm socket.

CONTROL SOLENOIDS INSPECTION

1. Inspect the machined surface on the control. If you find any nicks or scratches, replace the component.

CONTROL SOLENOIDS REASSEMBLY

1. Lubricate new O-ring (D025A) using petroleum jelly and install.
2. Install solenoid with three cap screws (D050) using a 4 mm internal hex wrench. Torque screws to 5 Nm [4 lbft].
3. Install coil using a 12 point 26 mm socket. Torque coil nut to 5 Nm [3.7 lbft].
4. Reconnect electrical connections and test the pump for proper operation.

Shaft, Seal, and Bearing

The front pump input shaft assembly is serviceable without disassembling the pump, the rear shaft is not. Orient the pump on the work surface so the shaft is pointing to the side.

REMOVAL

1. Unwind the spiral ring (J300) from the housing to release the shaft/seal/bearing subassembly.
2. Pry on the lip of the seal carrier (J275) to remove it from the pump. Remove the seal carrier. Remove and discard O-ring (J260). Press the seal (J250) out of the carrier and discard.
3. Pull the shaft (J100) with bearing (J150) out of the pump. If necessary, tap lightly on the shaft to dislodge it from the cylinder block. C

CAUTION

DO NOT DAMAGE THE HOUSING BORE, SHAFT OR BEARING WHEN REMOVING THE SHAFT AND BEARING.

4. Remove the retaining ring (J200) using retaining ring pliers. Press the bearing off the shaft.

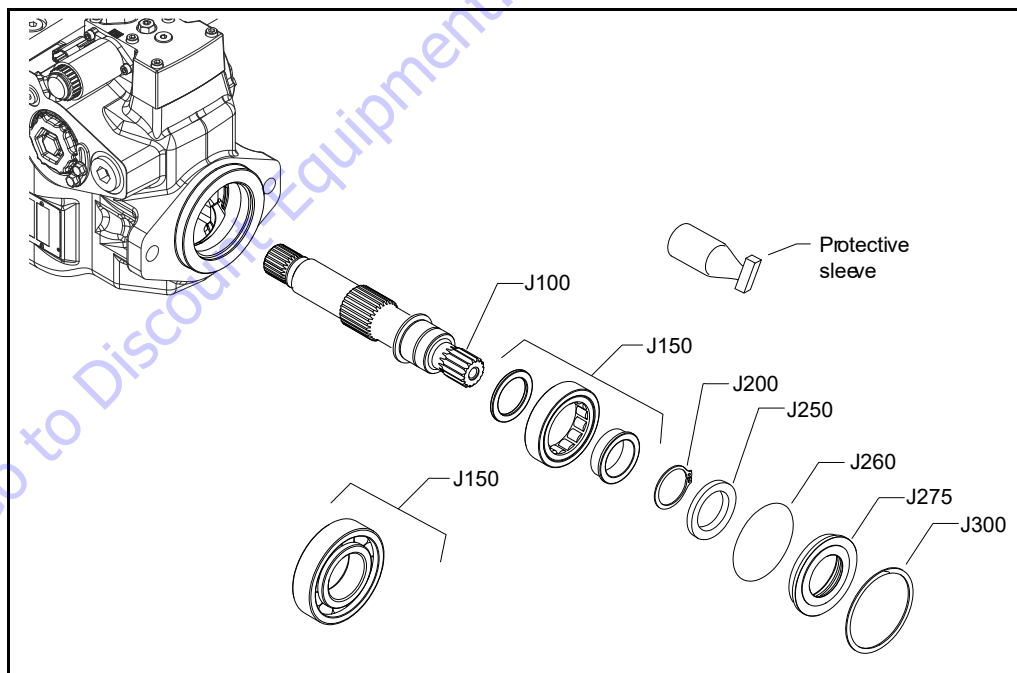


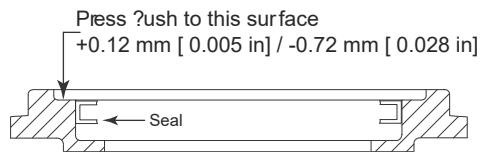
Figure 5-72. Shaft Assembly

INSPECTION

1. Inspect the shaft journals for wear, scratching, and pits. Check the splines for fretting; replace if damaged. Rotate the bearing, if it does not rotate smoothly, replace it.

REASSEMBLY

1. Press the bearing (J150) onto the shaft (J100) and replace the retaining ring (J200). Ensure the retaining ring diameter is less than 38.84 mm [1.53 in] when installed on the shaft.
2. Install the shaft/bearing assembly into the pump.
3. Lubricate and install a new O-ring (J260) onto seal carrier (J275). Press a new seal (J250) into the seal carrier. Press the seal until it is flush within +0.12 mm [0.005 in] or -0.72 mm [0.028 in] of the inside lip of the carrier: see illustration.



4. Cover the shaft with a protective sleeve while installing the seal carrier. Hand press the seal carrier into the housing. Ensure the seal carrier clears the spiral ring groove in the housing. Remove the protective sleeve.
5. Wind the spiral ring into the housing. Ensure the inside diameter of the spiral ring is greater than 68 mm [2.677 in] after installation.

Charge Pump

Position pump with front shaft pointing downward. Attach securely to a proper work stand. If an auxiliary pump is attached, remove auxiliary pump before servicing charge pump.

REMOVAL

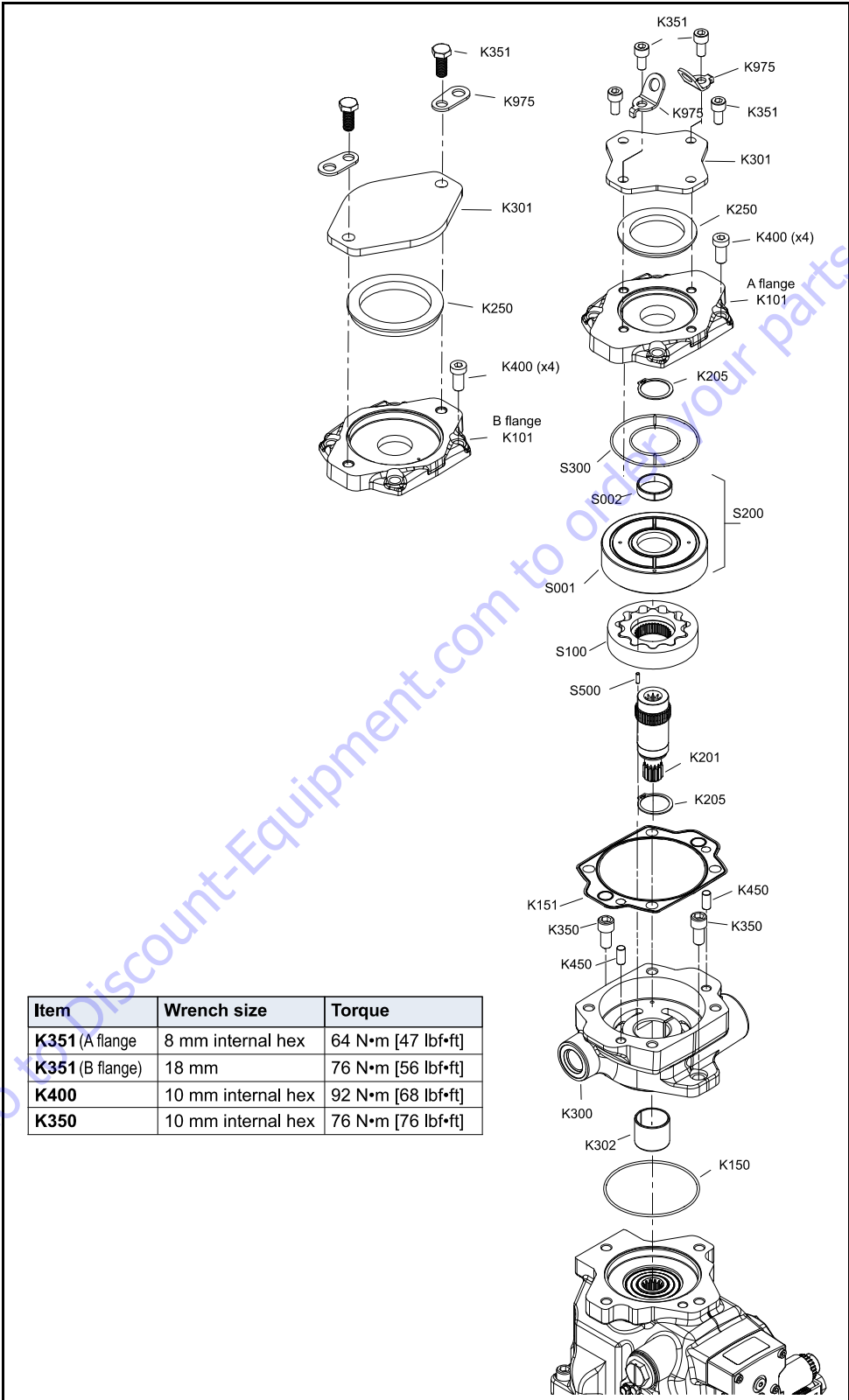
1. Remove screws (K351), and hangers (K975).
2. Remove running cover (K301). Remove and discard seal ring (K250).
3. Using a 10 mm internal hex, remove screws (K400). Remove cover (K101).
4. Remove charge pump assembly with shaft.

NOTE: Note position of alignment pin (S500) in housing. Alignment pin position will change for clockwise or counter-clockwise rotation.

5. Remove and discard seal (S300).
6. Using a snap ring pliers, remove two clips (K205).
7. Remove geroter cover (S200). Remove geroter assembly (S100).
8. Remove and discard gasket (K151). Remove alignment pins (K450).
9. If it is necessary to remove housing (K300), use a 10 mm internal hex to remove screws (K350).
10. Remove housing (K300).
11. Remove and discard seal (K150).

INSPECTION

1. Inspect all machined surfaces. If you find any nicks or scratches, replace the component.
2. Inspect geroter and cover for wear or damage. If wear or damage is found, replace geroter kit.
3. Inspect shaft for wear or damage. If found, replace shaft.
4. Inspect journal bearings in aux pad and housing. If worn or damaged, replace journal bearings or aux pad or housing assembly.

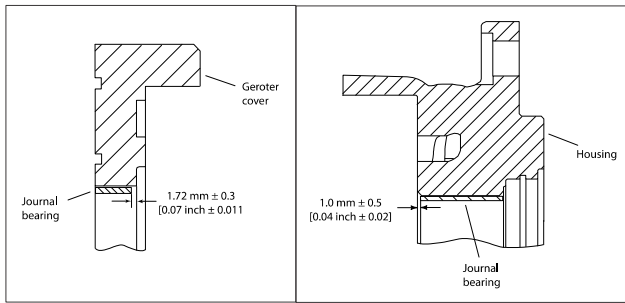


Item	Wrench size	Torque
K351 (A flange)	8 mm internal hex	64 N•m [47 lb•ft]
K351 (B flange)	18 mm	76 N•m [56 lb•ft]
K400	10 mm internal hex	92 N•m [68 lb•ft]
K350	10 mm internal hex	76 N•m [76 lb•ft]

Figure 5-73. Charge Pump

REPLACING CHARGE PUMP JOURNAL BEARINGS

Use a suitable press to remove and replace the journal bearings. Refer to the drawings below for installation dimensions.



ASSEMBLY

1. Lubricate and install new seal (K150).
2. Install housing (K300). Install screws (K350). Using a 10 mm internal hex, torque screws per listing in table.
3. Install alignment pins (K450). Install new gasket (K151).
4. Lubricate and reassemble charge pump assembly [shaft (K201), pin (S500), gerotor (S100), cover (S200), two clips (K205)].
5. Install charge pump assembly into housing in original position.
6. Lubricate and install seal (S300).
7. Install aux pad (K101).
8. Using a 10 mm internal hex, install screws (K400). Torque screws per listing in table.
9. Lubricate and install seal (K250). Install running cover (K301).

10. Install screws (K351) and brackets (K975). Torque screws per listing in the table.

Charge Check / HPRV

The high pressure relief and charge check valve assembly may be removed for cleaning and replacement of the O-rings. These valves are factory set and are not field adjustable. Refer to the pump model code for the factory setting when ordering replacements.

REMOVAL

1. Using an 8 mm internal hex wrench, remove the valve seat plugs (K007).
2. Carefully lift the valve (H002) and spring (H003) assemblies from the center section using a magnet.

INSPECTION

1. Inspect the valves and mating seats in the valve seat plugs (K007) for damage or foreign material.

REASSEMBLY

1. Lubricate and install new O-rings (K008, K010) and backup ring (K009) on valve seat plug (K007).
2. Verify that the conical springs (H003) are properly retained on the check relief valves (H002). Install the valve assemblies into the center section. Ensure each valve assembly moves freely in its bore.
3. Install the valve seat plugs into the center section and torque to 80 Nm [59.lbf·ft].
4. Operate machine through full range of controls to ensure proper operation. Check for leaks.

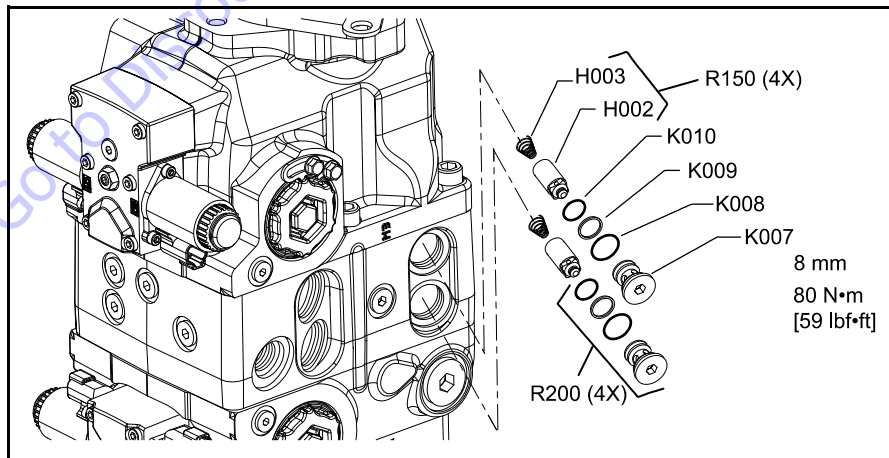


Figure 5-74. Charge Check / HPRV

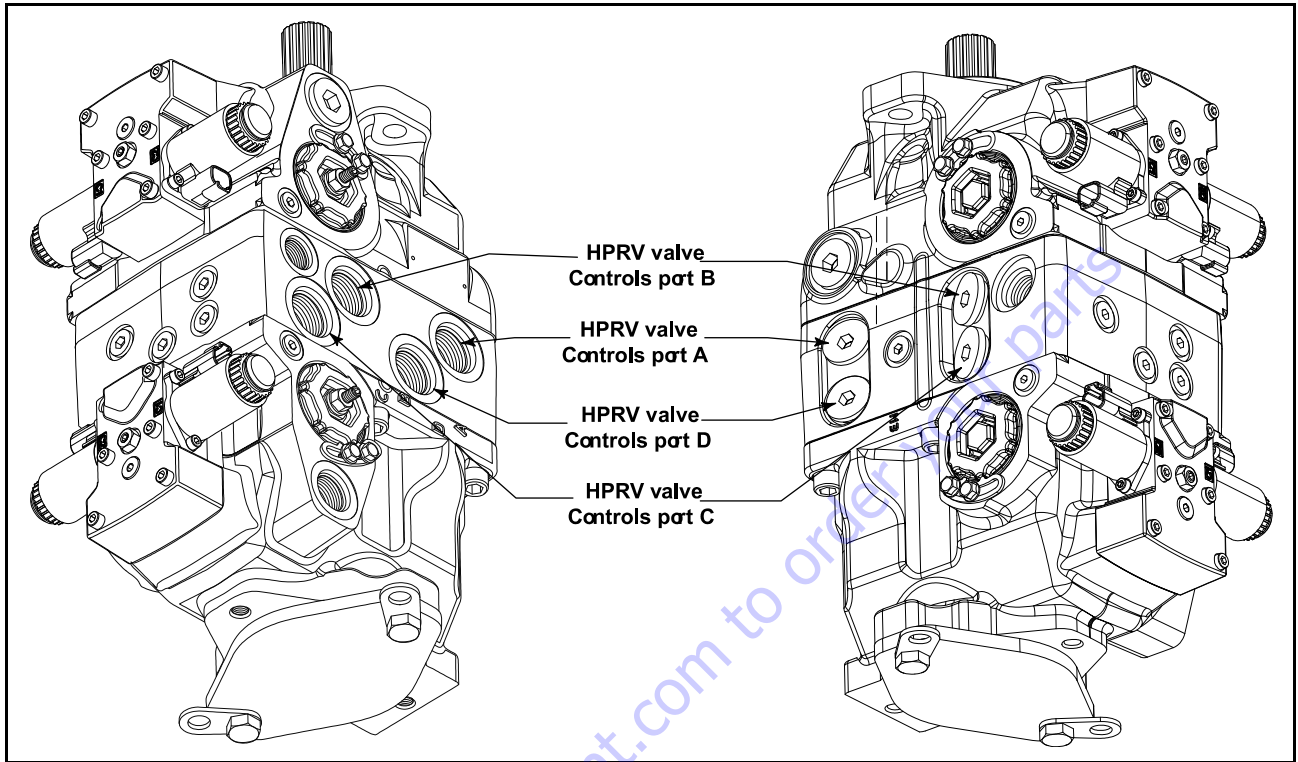


Figure 5-75. Charge Check / HPRV

Charge Pressure Relief Valve

Replace the charge pressure relief valve (V10-1) or (V10-2) as a complete unit. Do not attempt to repair the internal components of the valve.

REMOVAL

1. Using a 27 mm (V10-1) or a 1 in (V10-2) wrench, remove the charge pressure relief valve. Discard the O-rings (V10A).

INSPECTION

1. Inspect the sealing surfaces of the pump and charge pressure relief valve for nicks or scratches, replace components as necessary.

REASSEMBLY

1. Lubricate and install new O-rings (V10A).
2. Install the charge pressure relief valve (V10). Torque to 52 Nm [38 lbft].
3. Operate vehicle/machine through full range of controls to ensure proper operation.

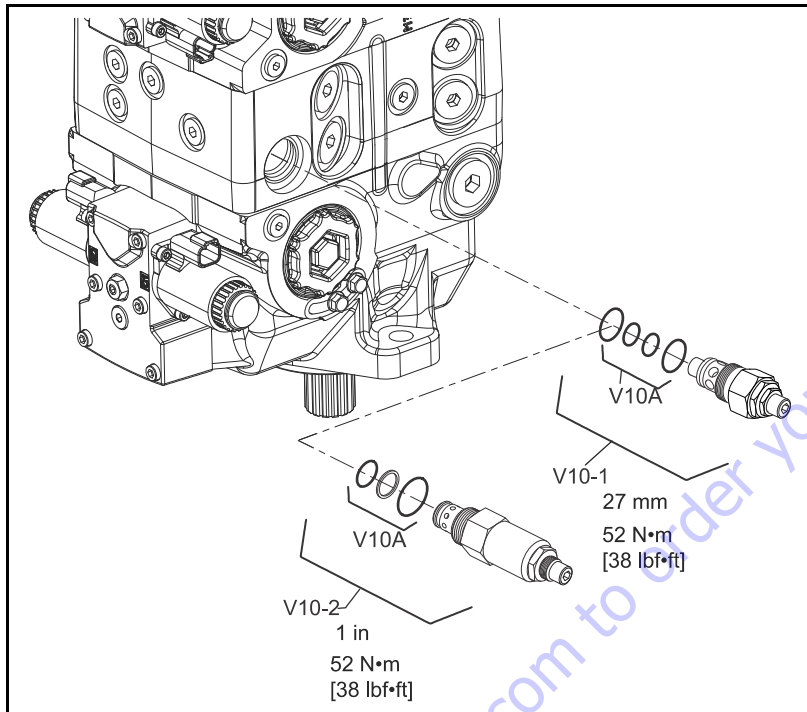


Figure 5-76. Charge Pressure Relief Valve

Control Cutoff Valve

Replace the control cutoff valve as a complete unit. Do not attempt to repair the internal components of the valve.

REMOVAL

1. Disconnect the coil from the vehicle/machine wire harness.
2. Using a 24 mm hex wrench, remove the control cutoff valve coil nut (G30). Remove the coil (G20).
3. Use a 1 1/16 in hex wrench to remove the control cutoff valve (G10). Remove and discard the O-rings and backup rings (G10A).

INSPECTION

1. Inspect the sealing surfaces of the pump and control cutoff valve for nicks or scratches. Replace components as necessary.

REASSEMBLY

1. Lubricate and install new O-rings (G10A) onto the valve.
2. Install the control cutoff valve (G10). Torque to 46 Nm [34 lbf·ft]. Slide the coil (G20) onto the valve.
3. Install the coil nut (G30). Torque to 9 Nm [7. lbf·ft]. Do not overtorque.
4. Operate vehicle/machine through full range of controls to ensure proper operation

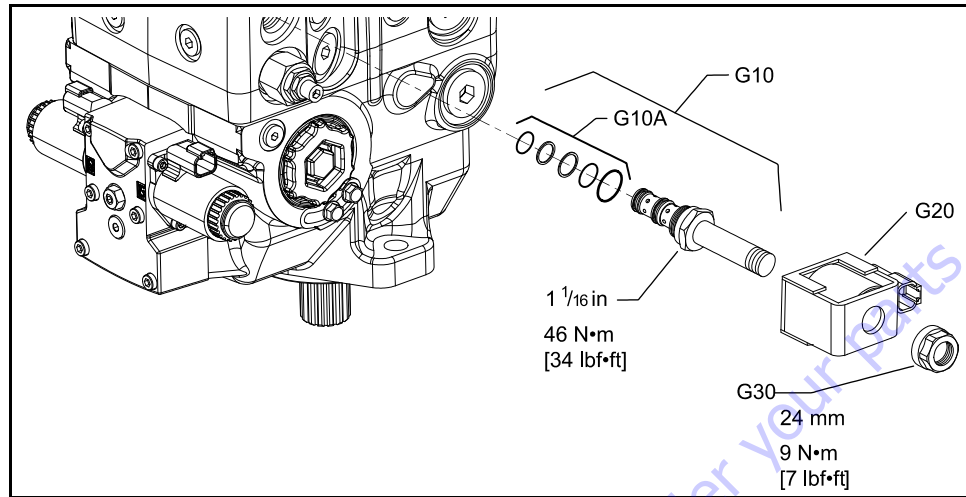


Figure 5-77. Control Cutoff Valve

Table 5-47. Fastener Size and Torque Chart

Item	Fastener	Wrench size	Torque
D015	Neutral adjust screw	4 mm internal hex	NA
D050	Control coil mounting screw	4 mm internal hex	8 Nm [5.9 lbf•ft]
D060	Neutral adjust locking nut	13 mm hex	10 Nm [7 lbf•ft]
D200	Swash plate feedback pin (not shown)	13 mm hex	25 Nm [18.4 lbf•ft]
D250	Electric control mounting screw	5 mm internal hex	13 Nm [9.5 lbf•ft]
E350	Servo cylinder locking screw	10 mm hex	14.5 Nm [11 lbf•ft]
G10	Control cutoff valve	1 1/16 in hex	45 Nm [33 lbf•ft]
G10B	Control cutoff valve coil nut	24 mm hex	9 Nm [7 lbf•ft]
K007	Charge check / HPRV	8 mm internal hex	80 Nm [60 lbf•ft]
K350	A pad cover mounting screw	17 mm hex	70 Nm [52 lbf•ft]
	B pad cover mounting screw	8 mm hex	111 Nm [82 lbf•ft]
V10-1	Charge relief valve	27 mm hex	52 Nm [38 lbf•ft]
V10-2	Charge relief valve	1 in hex	52 Nm [38 lbf•ft]

Table 5-48. Plug Size and Torque Chart

Item	O-ring plug	Wrench size	Torque
B015	7/16 - 20	3/16 internal hex	20 Nm [15 lbf•ft]
B020	1-1/16 - 12	9/16 internal hex	48 Nm [35 lbf•ft]
D065	7/16 - 20	3/16 internal hex	12 Nm [9 lbf•ft]
G250	9/16 - 18	1/4 internal hex (hardened plug)	45 Nm [33 lbf•ft]

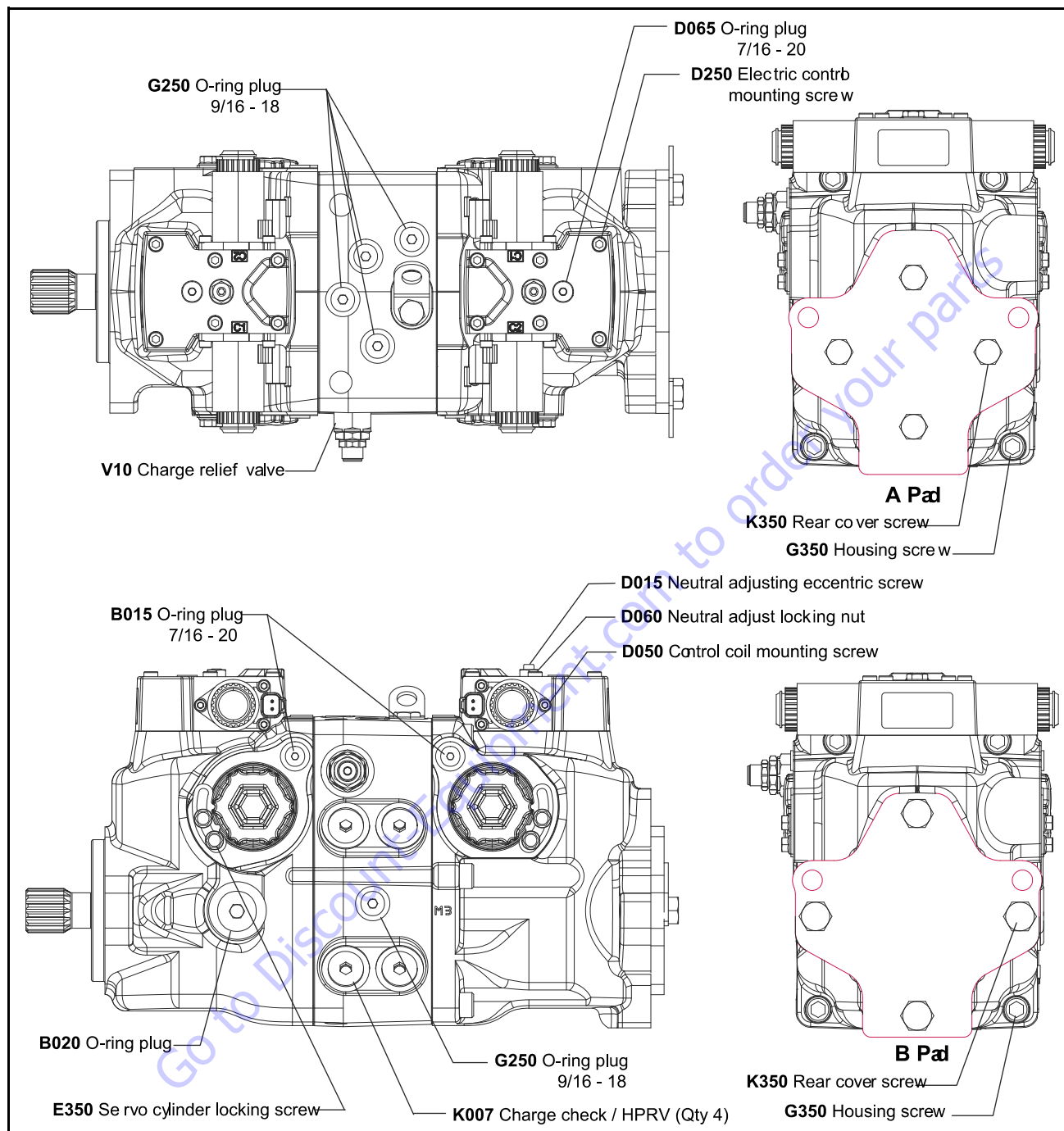
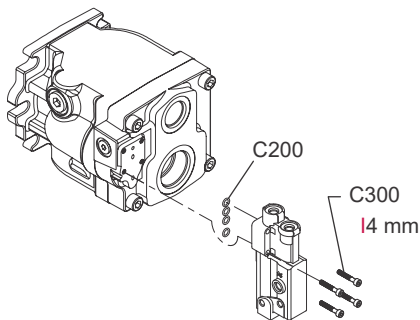


Figure 5-78. Fastener and Plug Locations

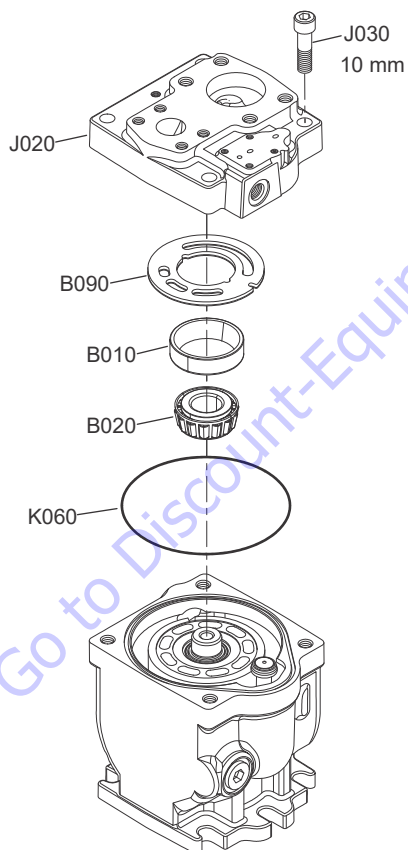
5.9 FUNCTION PUMP (SAUER)

Disassembly

1. Remove the control from the endcap by removing the 4 control bolts (C300), using a 4 mm internal hex wrench.

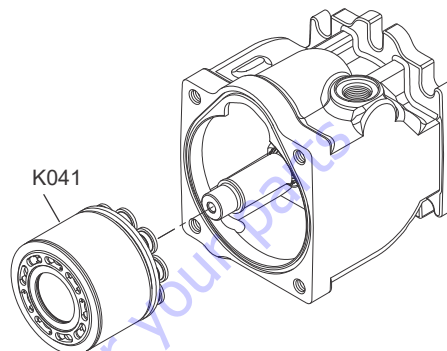


2. Remove and discard the 4 O-rings (C200).
3. Remove the 4 endcap screws (J030) using a 10 mm internal hex wrench.

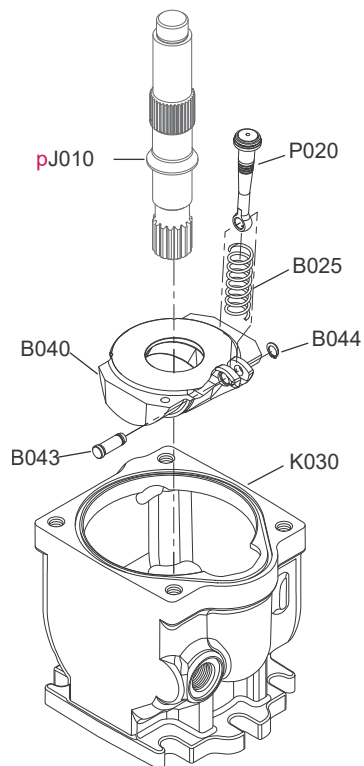


4. Carefully remove the endcap (J020). Prevent the valve (B090) plate from falling off.
5. Place the endcap and valve plate in a clean area, protecting them from contamination.

6. Remove the bearing cup (B010), bearing cone (B020) and housing O-ring (K060). Discard the O-ring.
7. Tilt the housing on its side to allow fluid to drain.
8. Remove the cylinder block kit while holding onto the front shaft.



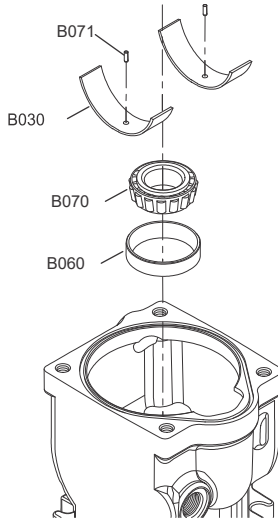
9. Set cylinder block on a clean dry surface.
10. Rotate pump back to a position so that the shaft is pointing down.
11. Pull the shaft (J010) from the shaft seal.



12. Compress the bias spring (B025) and rotate the servo piston assembly (P020) towards the swashplate (B040).
13. Lift the swashplate/servo piston assembly up at an angle and remove it from the housing.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

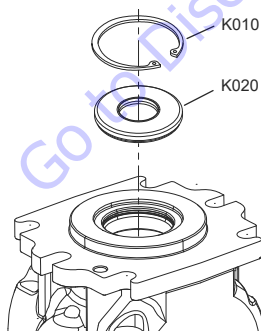
14. Remove the servo piston (P020) and bias spring (B025) from the swashplate by removing the clevis pin (B043) and snap ring (B044). Discard the snap ring.
15. Pull to remove the front tapered roller bearing cup (B060) and cone (B070).



16. Examine the cradle bearings (B030) to determine if they need replacement.

NOTE: Removing the pins (B071) will likely damage the cradle bearings, so make sure you have replacement bearings before you remove them.

17. If cradle bearings need replacing, remove the 2 pins (B071) holding the cradle bearings, and then remove the cradle bearings. Note the location and orientation of the bearings for re-installation.
18. Orient the housing with the flange facing up.
19. Using snap-ring pliers, remove the snap ring (K010).

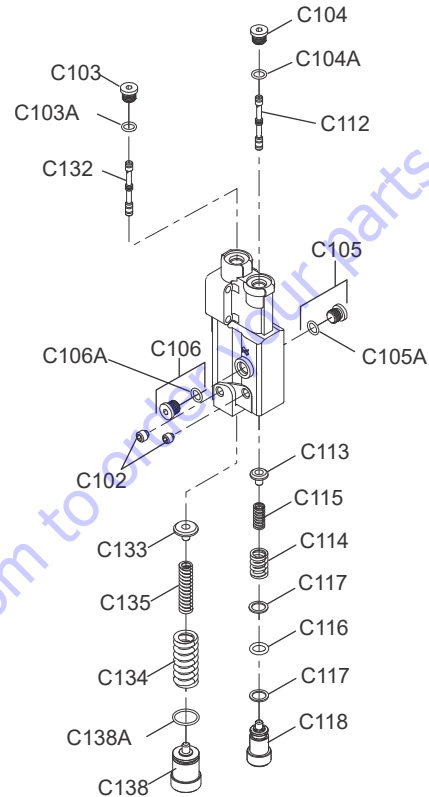


20. Carefully pry out the shaft seal (K020).

If you are unable to pull the shaft seal out, try to push the seal out by going through the inside of the housing.

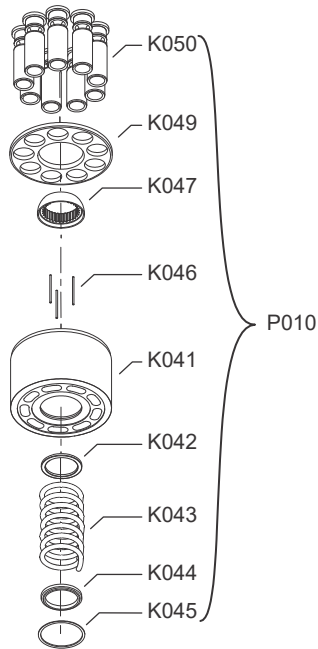
21. Remove the 4 plugs (C103, C104, C105, C106) and their O-rings (C103A, C104A, C105A, C106A). Discard the O-

rings. Remove the 2 set screws (C102). Remove the spools (C112, C132). Note which bore each spool came out of. Also note the orientation of each spool for reinsertion. There may be differences in reinserting into the same bore.



22. Remove the adjusting screw (C138) and the O-ring (C138A). Discard the O-ring. Remove the springs (C134, C135) and spring guide (C133).
23. Remove the adjusting screw (C118), O-ring (C116) and 2 backup rings (C117). Discard the O-ring and backup rings. Remove the springs (C114, C115) and spring guide (C113).
24. Pull to remove the slipper retainer (K049) with the pistons (K050) from the cylinder kit.

NOTE: The pistons are not selectively fitted, however units with high hourly usage may develop wear patterns. Number the pistons and bores for reassembly if they are to be reused.



- 25. Remove the ball guide (K047).
- 26. Remove the 3 pins (K046).

NOTE: Most repairs do not require block spring removal. Perform this procedure only if you suspect problems with the block spring.

- 27. Turn the block over. Using a press, apply pressure on the block spring washer (K044) to compress the block spring (K043). Compress the spring enough to safely remove the spiral retaining ring (K045). While maintaining pressure, unwind the spiral retaining ring. Carefully release the pressure and remove the outer block spring washer, block spring, and inner block spring washer (K042) from the cylinder block.

⚠ WARNING

RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 350 TO 400 N [80 TO 90.LBF]. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO REMOVE. THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING.RING IS REMOVED.

Inspection

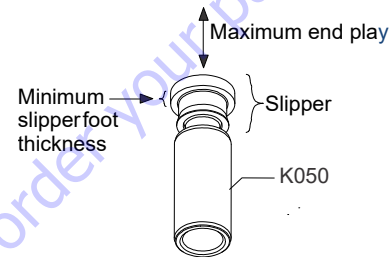
After disassembly, wash all parts (including the end-cap and housing) thoroughly with clean solvent and allow to air dry. Blow out oil passages in the housing and endcap with com-

pressed air. Conduct inspection in a clean area and keep all parts free from contamination. Clean and dry parts again after any rework or resurfacing.

PISTONS AND SLIPPERS

Inspect the pistons for damage and discoloration. Discolored pistons may indicate excessive heat; do not reuse.

Inspect the running surface of the slippers. Replace any piston assemblies with scored or excessively rounded slipper edges. Measure the slipper foot thickness. Replace any piston assemblies with excessively worn slippers. Check the slipper axial end-play. Replace any piston assemblies with excessive end-play.

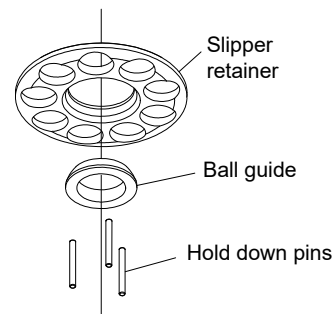


Minimum slipper foot thickness and maximum axial end-play are given in the table below.

JFrame	
Slipperfoot thickness	3.23 mm [0.127 in]
Piston/slipper end play	0.05 mm [0.002 in]

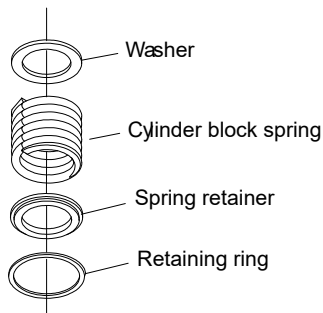
BALL GUIDE, SLIPPER RETAINER, AND HOLD-DOWN PINS

The ball guide should be free of nicks and scratches, and should not be excessively scored. Examine for discoloration that may indicate excessive heat or lack of lubrication. The slipper retainer should be flat, and slippers should fit in the retainer with minimal side play. Place the hold-down pins on a flat surface and roll them to make sure they are straight. Discard and replace any damaged parts.



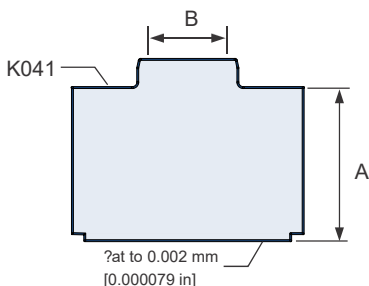
BLOCK SPRING, AND WASHERS

If cylinder kit was fully disassembled, visual inspection of the cylinder block, spring, and washers should indicate minimal wear. Replace if cracks or other damage is present.



CYLINDER BLOCK

Examine the running face of the cylinder block. The surface should be smooth and free of nicks and burrs. Ensure that no scratches or grooves exist; these may drastically reduce output flow.

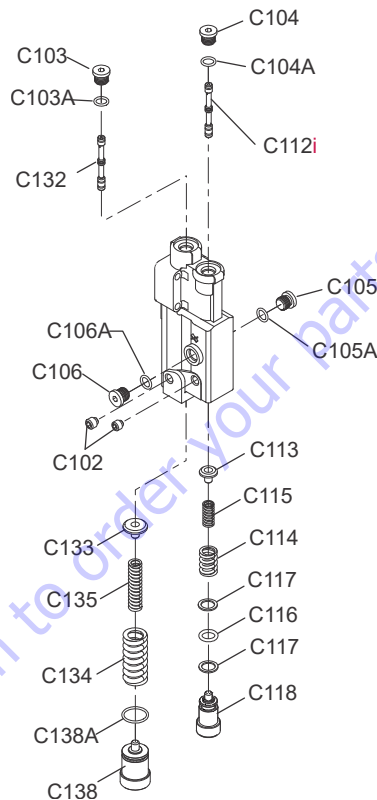


J Frame	45-60 cc	65-75 cc
Minimum cylinder block height (A)	62.25 mm [2.45 in]	
Maximum block bore diameter (B)	19.8 mm [0.785 in]	21.57 mm [0.85 in]

CONTROL

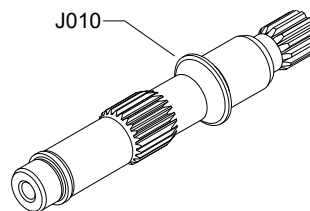
Carefully examine the plug(s) for signs of wear. Also check the small tip of the plug(s) for heavy wear and replace if necessary. Inspect each spool's springs to make sure they are intact. Check the inside and outside surfaces of the springs for wear and replace if necessary. Check the spool's outside diameter

for scratches and / or burrs. Clean and coat all spools, bores, and seals with a light coating of hydraulic oil.



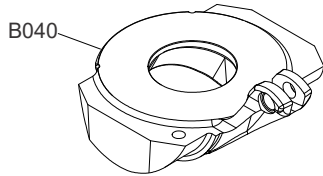
INPUT SHAFT

Check to see that the shaft (J010) and its splines are straight and free of damage or heavy wear. Inspect the shaft surface where it meets the shaft seal. Replace the shaft if a groove exists at the sealing land surface that may let dirt into or hydraulic fluid out of the unit. Clean the sealing area with a nonabrasive material if necessary. Lubricate the shaft with a light coat of hydraulic fluid.



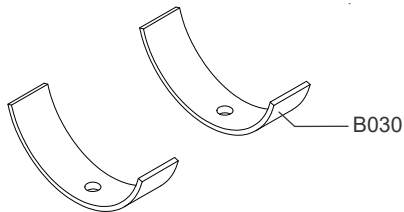
SWASHPLATE

Carefully inspect each surface of the swashplate for wear. All swashplate surfaces should be smooth. Inspect the swashplate's slipper running surface for damage and brass transfer. Excessive brass transfer from slippers may indicate that the slippers should be replaced. Finally, check the swashplate bearing journal for scratches. Replace swashplate if necessary.



JOURNAL BEARINGS

Inspect the journal bearings for damage or excessive wear. Replace journal bearings if scratched, warped, or excessively worn. The polymer wear layer must be smooth and intact.

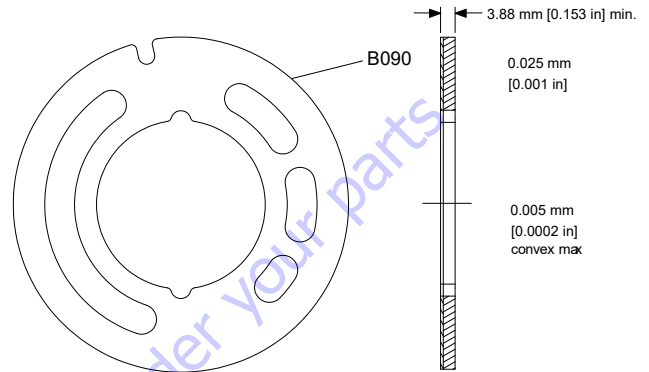


VALVE PLATE

Inspect the valve plate for scratches and grooves. Check the plate for evidence of any cavitation along the running face of the valve plate. If pitting from cavitation exists, replace the valve plate. Check for excess wear on the brass running face. If any discoloration or burn marks are observed, replace the valve plate.

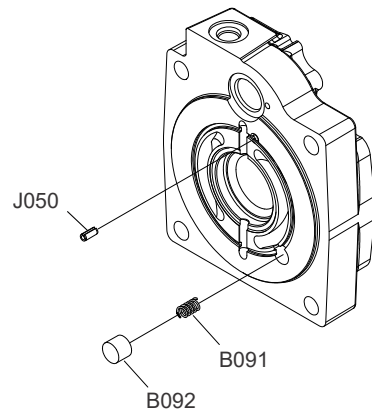
Run a fingernail or pencil tip across the diameter of the sealing land surface (see illustration). No deep or outstanding grooves should be felt, as these may decrease pump flow. Lap or replace if grooves or nicks are present. Inspect the mating surfaces of the endcap and valve plate for any possible contamination; even a few thousandths of an inch may affect pump operation.

Measure the thickness of the valve plate. Ensure that valve plate parallelism is equal to or less than 0.025 mm [0.001 in]. Appearance should be flat and smooth on both the running face and the bottom surface. The valve plate should be flat to 0.005 mm [0.0002 in] convex. A magnetic particle inspection is recommended to detect cracks. The valve plate must be replaced if any cracks exist.



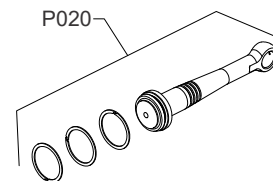
ENDCAP

Inspect the endcap. Remove the check valve (B092) to expose the spring (B091). Check and record orientation of the timing pin (J050). The split in the timing pin should be facing into or out of the slot in the valve plate. Inspect the check valve for wear on its sealing face and replace if necessary. Make sure the spring is undamaged. Replace any components if excess wear is present.



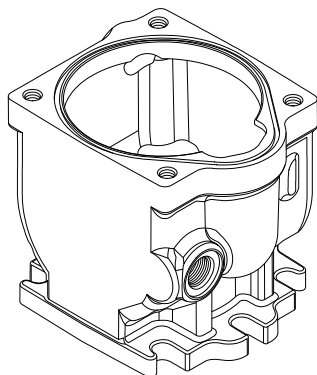
SERVO PISTON

Check the servo piston assembly (P020) for any obvious wear or damage. Check the corresponding endcap bore for galling or excessive wear. Discard the piston if damaged. Replace the servo piston-rings.



HOUSING

Inspect the housing to ensure that it is clean and free of foreign material. Inspect the swashplate bearing surfaces, and endcap mating surfaces.

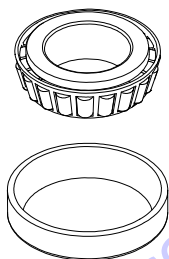


SHAFT BEARING KITS

The tapered roller bearing kit consists of a cup and cone. Make sure the cup and cone are free of excessive wear or contamination. Rotate the bearings to check for smoothness. If a contaminated bearing is suspected, clean with a solvent and lubricate with hydraulic fluid.

NOTE: Replace the bearing if the problem is not remedied by cleaning.

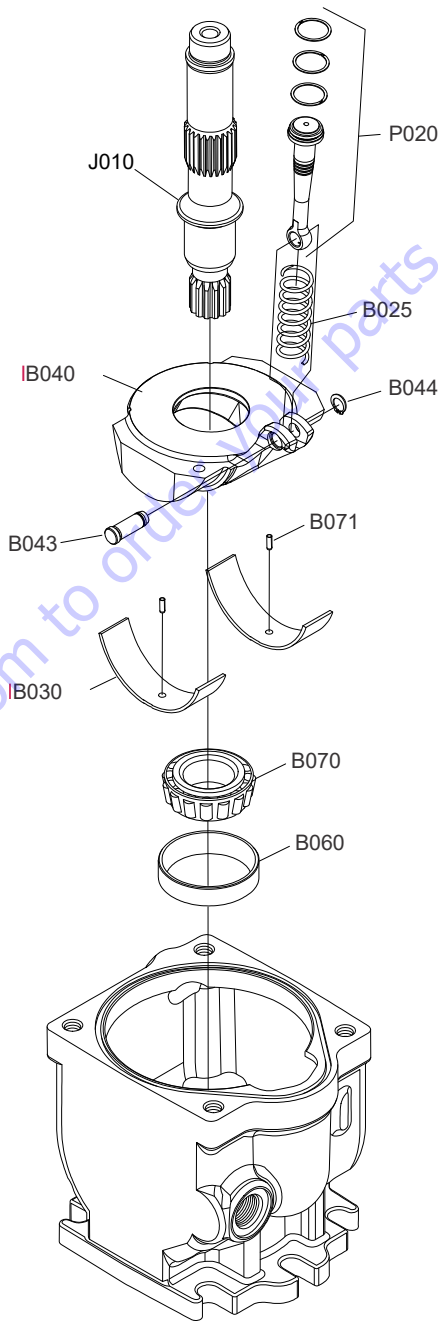
Inspect for uneven wear. If abnormal wear is found, replace the bearing kit.



Assembly

1. Coat the journal bearings (B030) with hydraulic fluid and install them into the pump housing. Punch in retaining pins (B071) a minimum of 0.5 mm [0.002 in] below the bearing surface.

NOTE: If journal bearings are reused, reinstall them in their original orientation and position.



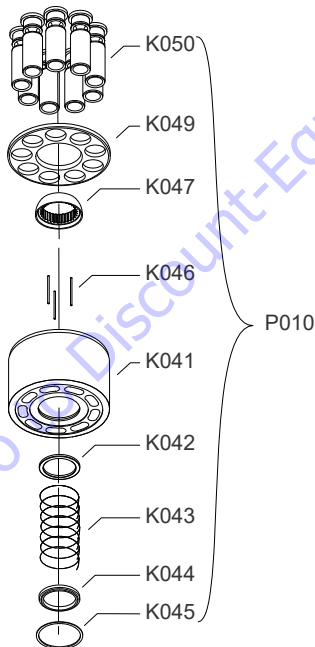
2. Reinstall shaft bearing cup (B060) and cone (B070). Before replacing the bias spring (B025), coat the curved surface of the swashplate with hydraulic fluid.

3. Reinstall the swashplate/servo piston/bias spring assembly in its original orientation in the housing. Rotate the servo piston perpendicular to the swashplate, and at the same time compress the bias spring to fit into housing pocket. Lubricate all sides of the servo piston and its respective bore liberally with hydraulic oil. Also, lubricate the flat face of the swashplate to prevent premature wear during start-up.
4. Insert the input shaft (J010) through the bearing into the housing. You may need to push on the servo piston to rotate the swashplate in order to put the shaft in properly.
5. Coat all parts with hydraulic fluid prior to reassembly.

⚠ WARNING

COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 350 TO 400 N [80 TO 90 LBF]. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS INSTALLED.

6. Install the inner block spring washer (K042), block spring (K043), and outer washer (K044) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (K045) into the groove in the cylinder block.

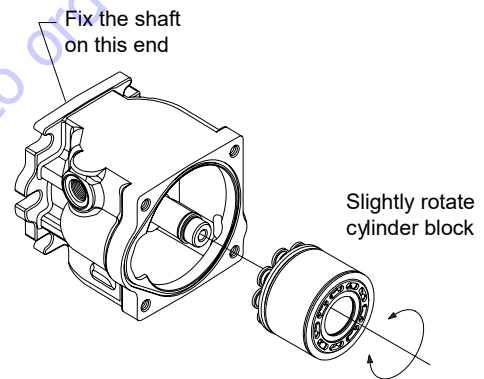


7. Turn the block over and install the hold-down pins (K046), and ball guide (K047) to the cylinder block.

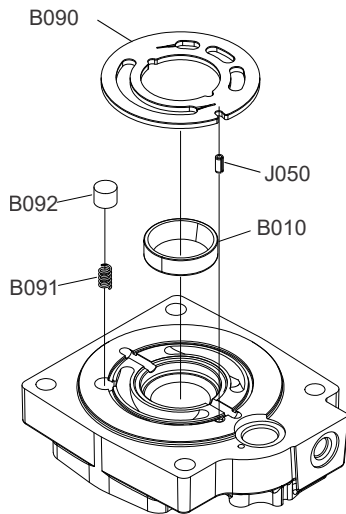
8. Install the pistons (K050) to the slipper retainer (K049). Install the piston/retainer assembly into the cylinder block. Ensure the concave surface of the retainer seats on the ball guide. If you're reusing the pistons, install them to the original block bores. Lubricate the pistons, slippers, retainer, and ball guide before assembly. Set the cylinder kit aside on a clean surface until needed.

NOTE: Be sure to install the slipper retainer so it mates correctly with the ball guide (concave side of the slipper retainer against the convex side of the ball guide).

9. Set the pump on its side. Secure the end of the shaft with one hand and keep it horizontal. Insert the cylinder kit onto the shaft. While holding the shaft still, slightly rotate the cylinder block kit to help start the shaft splines over the ball guide and align it with the block splines. When the cylinder block kit slides completely over the shaft splines, reposition the unit with the flange facing downward.

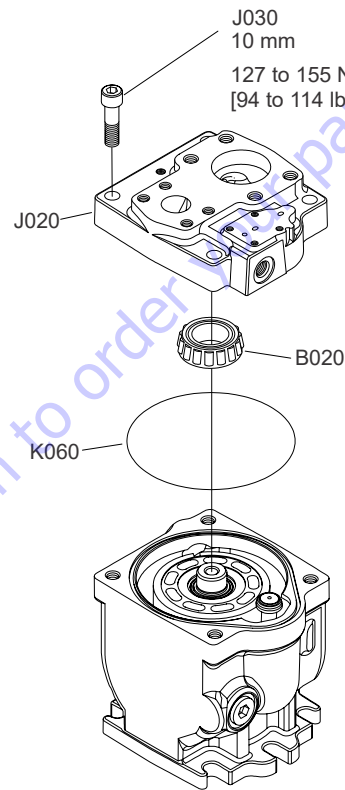


- 10.** Clean the valve plate (B090) and endcap. Install the timing pin (J050) in the endcap and verify that it is properly oriented with the split facing into or out of the slot in the valve plate. The timing pin should be installed to 3.61 ± 0.25 mm [0.141 ± 0.01 in] above the valve plate surface. Apply a liberal amount of assembly grease to the backside of the valve plate surface to hold it in position. Install the valve plate over the timing pin, check valve (B092), and bearing cup (B010).

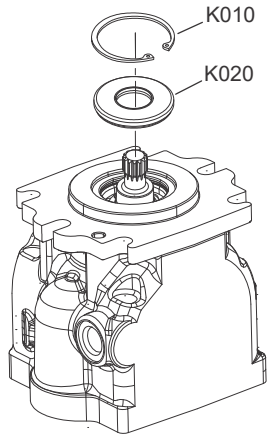


NOTE: To insure proper pump operation, it is extremely important to ensure that there is no contamination between the endcap and valve plate.

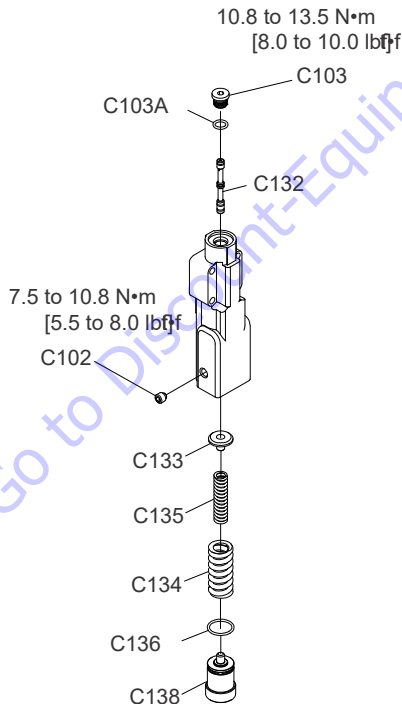
- 11.** Install the bearing cone (B020) onto the shaft. Using assembly grease to hold the seal (K060), install the endcap to the housing. Ensure that seals remain properly seated and are not pinched during assembly. With a 10 mm internal hex wrench, install and torque endcap screws at 127 to 155 Nm [94 to 114 lbf·ft], using the criss cross pattern. Retorque the first screw to ensure proper torque retention.



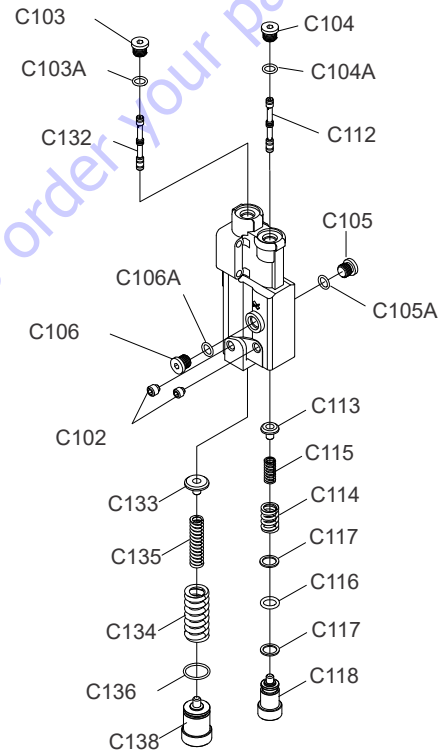
- 12.** Lubricate the lip of the new shaft seal (K020) with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation. Keeping the seal perpendicular to the shaft, press the new seal into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation. Using the appropriate snap ring pliers, install the seal retaining ring (K010). Remove the installation sleeve.



13. Clean all control parts and cover with a light coating of hydraulic fluid prior to reassembly.
14. Install the spherical end of the PC spool (C132) into the PC bore (refer to illustration). Install the PC plug (C103) using a new O-ring (C103A). Torque at 10.8 to 13.5 Nm [8.to.10.lbf]. Place the two PC springs (C134, C135) onto the PC spring guide (C133) and install into the PC bore. Place a new O-ring onto the PC plug and install it so that it sits one turn below the surface of the control housing. Install and tighten set screw (C102) at 7.5 to 10.8 Nm [5.5 to 8.0 lbf] to retain the adjusting plug.

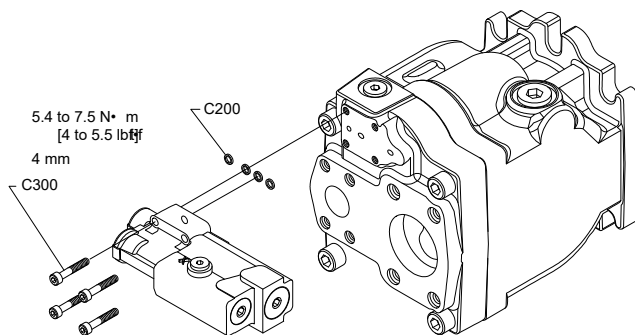


15. Hold the control in a horizontal position. Install the spherical end of the LS spool (C112) into the LS bore (see illustration). Using a new O-ring, install the LS plug (C104), torque at 10.8 to 13.5 Nm [8 to 10 lbf]. Place the 2 LS springs (C114, C115) onto the LS spring guide (C113) and install into the LS bore. Place a new O-ring (C116) and Backup rings (C117) onto the LS adjustment screw (C118). Install the LS plug assembly so that it sits one turn below the surface of the control housing. Install and tighten set screw (C102) at 7.5 to 10.8 Nm [5.5.to 8.0 lbf]. Also, install the plugs (C105, C106) with new O-rings. Torque the plugs at 10.8 to 13.5 Nm [8 to 10 lbf].



NOTE: PC and LS spools need to be adjusted to proper setting according to tag nomenclature.

16. Using petroleum jelly to retain them, install 4 new seal rings (C200) in the recesses on the control housing. Install the control assembly onto the endcap using the 4 screws (C300). Torque at 5.4 to 7.5 Nm [4.0 to 5.5 lbft] using a criss cross pattern and retorque the first screw to ensure proper torque retention.



5.10 GEAR PUMP (SAUER)

Disassembly

Prior to proceeding it may be necessary to prepare some sub-assemblies separately.

The details for preparing each subassembly are given in the following section.

Also, some general recommendations are given below.

CLEANLINESS

Cleanliness is a primary factor for reliable pump performance. Wash the outside of the pump thoroughly before disassembly and all pieces prior to assembly. Cleaning parts with clean shop solvent and air drying is usually adequate.

LUBRICATION OF MOVING PARTS

During assembly, it is imperative to provide lubrication with clean hydraulic oil to all the running parts of the pump.

It is also necessary to coat the seals with grease. The absence of lubrication during assembly can cause the unit to seize after a few minutes of running.

CARE OF SURFACE TREATMENT

Be careful when handling all the internal surfaces, especially bearings, gears, and body faces. Do not touch or score them with metal tools or cutting edges.

MARKING THE PARTS

Mark the parts before completely disassembling a pump. The marks allow components to be reassembled in the same relative position. This action should be applied to the body, bearings, and gears. Scribing, bluing, or using a felt tip pen to mark the outside of the body on the inlet side is suggested to indicate the relative position of the front flange and the rear cover to the body. Mark the bearing blocks also on the inlet side and the gears position relative to each other. DO NOT scribe internal surfaces.

PROCEDURE

1. Clamp the unit.

Clamp the unit in a vice from the flange side.

Make sure the vice jaws are clean and have smooth surfaces to prevent damage to the pump.



NOTE: Clamping the pump on the body is not recommended because serious damage to the surfaces, on which the ports are located, may occur.

2. Remove capscrews. (Except Units with 03 Flange).

Use a 17 mm socket wrench and loosen the four capscrews on the cover. Next completely unscrew the capscrews and remove them.

Inspect the threads of the capscrews for damage.

