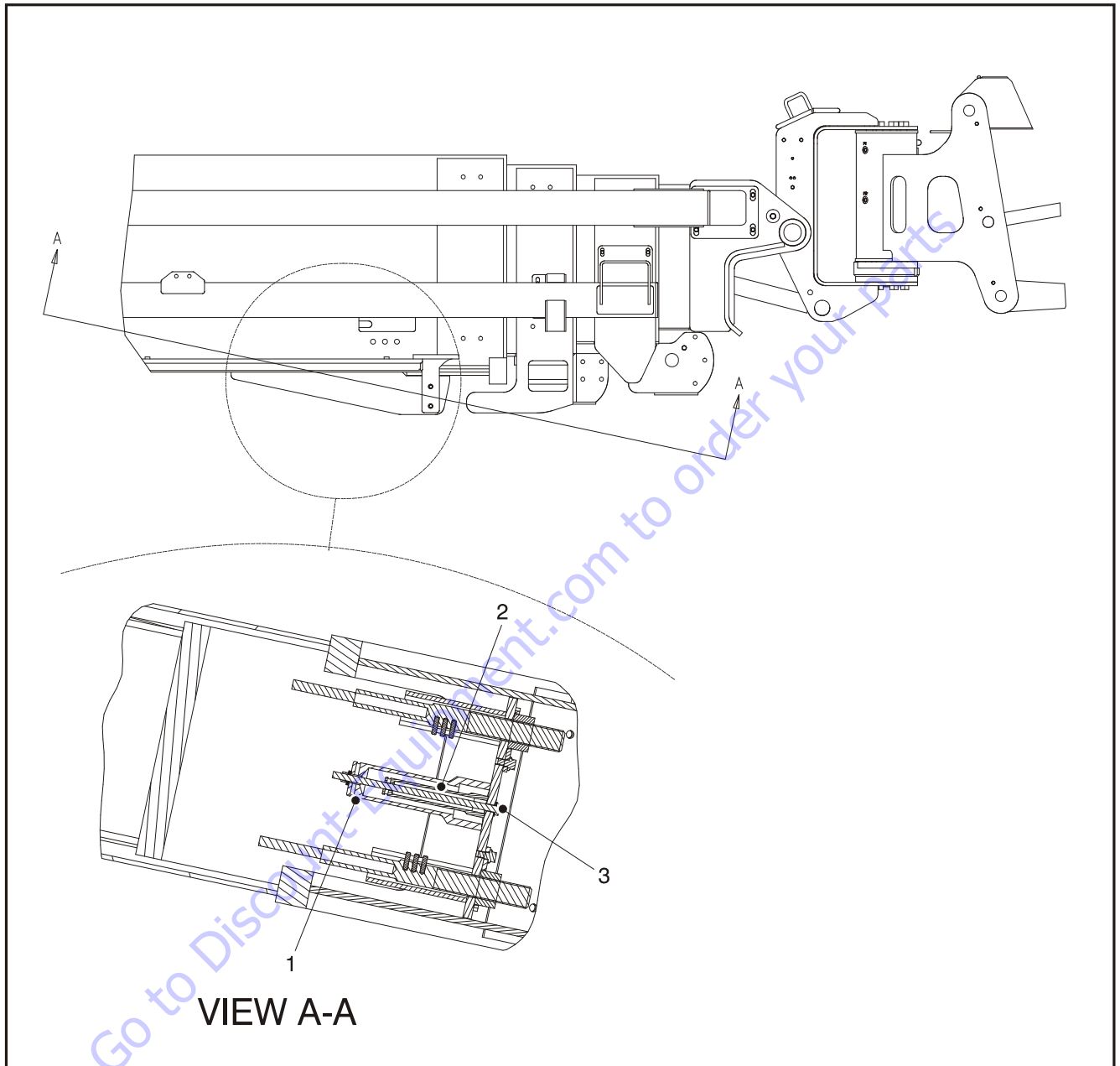


Figure 4-31. Fly Boom Extend/Retract Cables



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

Figure 4-32. Wire Rope Adjustment Tools (Optional)

#### 4.19 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.

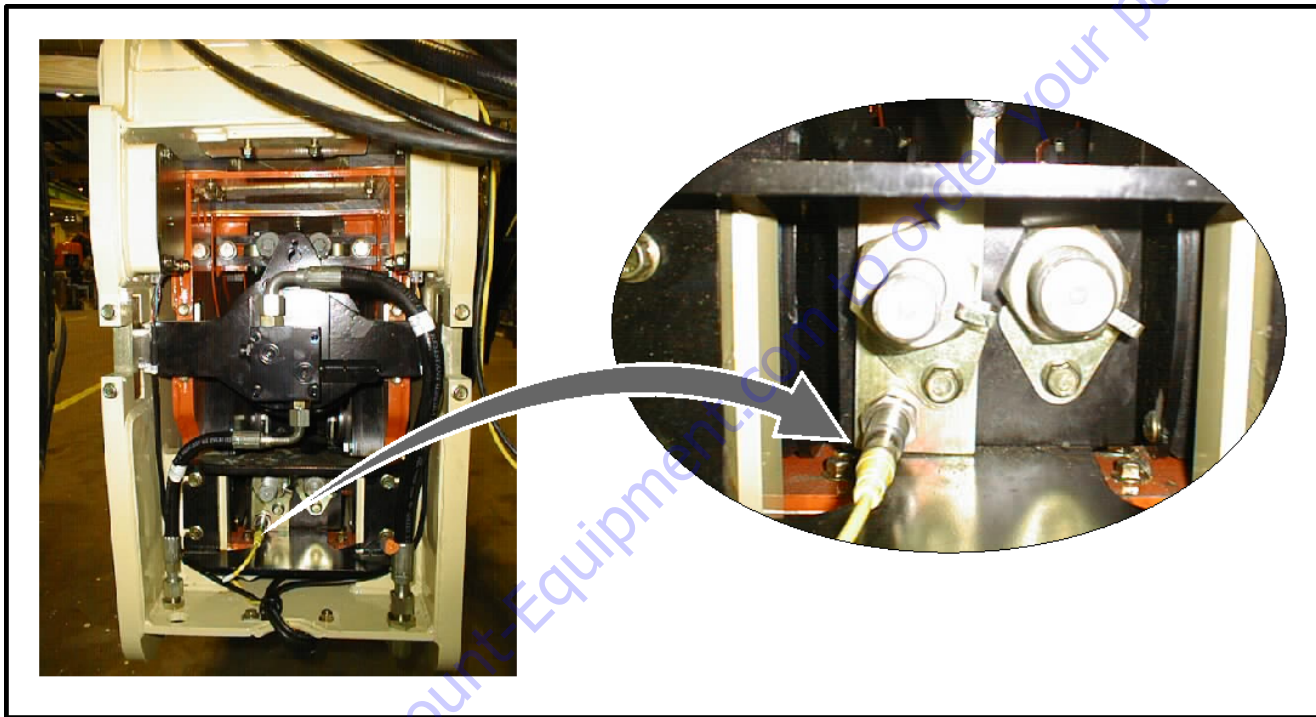


Figure 4-33. Broken Boom Cable Proximity Switch Location

#### 4.20 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 in Section 6 - JLG Control System.)

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 dependant 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.

## 4.21 ROTARY ACTUATOR

Each actuator is individually serial numbered. The serial number is a five or six digit number and must be provided before parts and/ or service issues can be addressed.

The serial number can be found on the Identification (ID) Tag that is affixed to all actuators. The tag is a thin, silver colored, plastic material with a self-adhesive backing. Information is imprinted in black. The tag is located either on the side plate or on the housing tube of the actuator.

Additionally, the serial number of the actuator is stamped onto the side plate or the housing tube. It may be necessary to remove paint to expose the serial number.

### Theory of Operation

The rotary actuator is a simple mechanism that uses Helac's sliding spline technology which converts axial piston motion into powerful shaft rotation. As seen in the illustration below left, each actuator is composed of a housing with an integral ring gear (1) and only two moving parts: the central shaft (2), and the annular piston sleeve (3). Note the actuator shaft features an integral mounting flange and bearing which are not shown in the illustration.

Helical spline teeth machined on the shaft engage matching splines on the inside diameter of the piston. The outside diameter of the piston carries a second set of splines, of opposite hand, which engage the matching splines of the housing's ring gear.

As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while, simultaneously, the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the housing, preventing piston movement and locking the shaft firmly in position.

The shaft is supported radially by the large upper radial bearing and the lower radial bearing (see drawings on pages 8 and 9). 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. Configurations of parts may be slightly different depending on model.

Many actuators are equipped with counterbalance valves, which performs four major functions.

- Protects the actuator in the event of overload
- Enables the actuator to hold position without drifting when external loads are applied
- Reduces hydraulic backlash by pressuring the hydraulic fluid
- Provides a constant controlled rate of rotation in over-center load conditions

Applying fluid pressure will displace the piston axially while the helical gearing causes the piston and shaft to rotate simultaneously. The double helix design compounds rotation: shaft rotation is about twice that of the piston. Applying pressure to the opposite port will return the piston and shaft to their original starting positions.

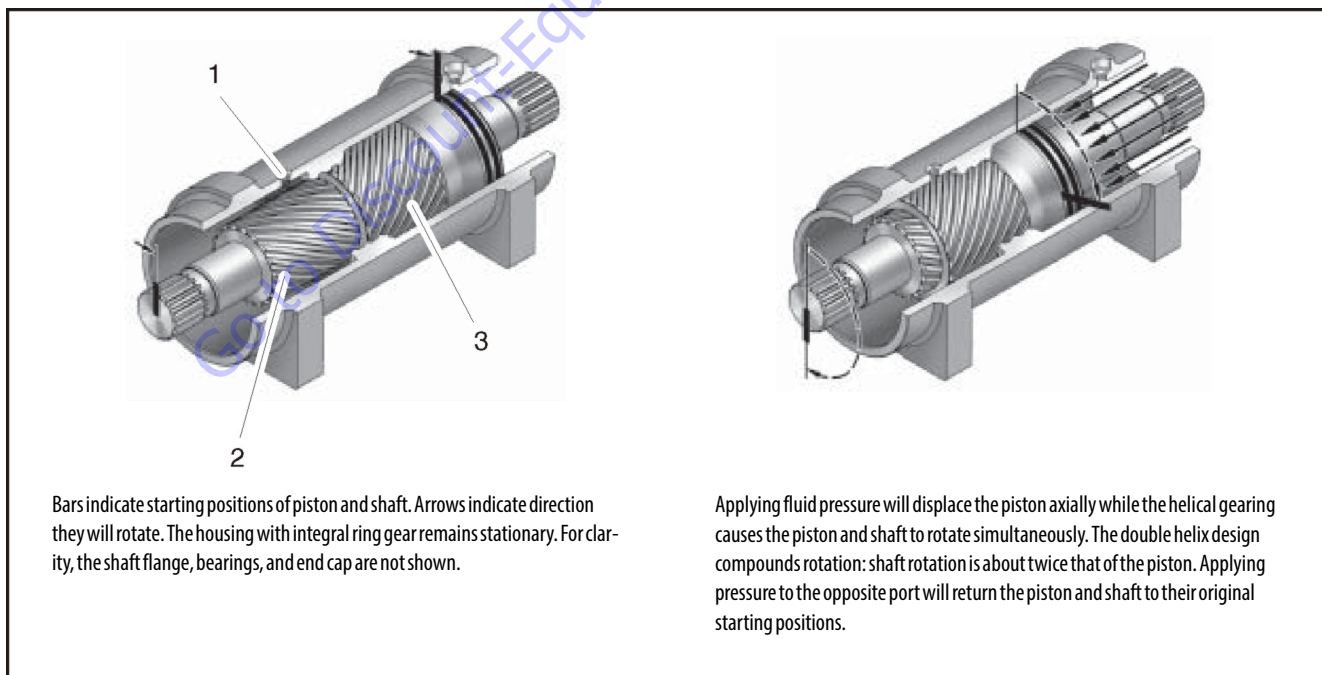


Figure 4-34. Actuator Theory of Operation

## Tools Required



Several basic tools are required for the disassembly and reassembly of the actuator. The tools and their intended functions are outlined below:

1. PIPE VISE
2. HEXWRENCH  
Removal and replacement of port plugs and set screws.
3. ASSORTED SCREWS
4. SAFETY GLASSES
5. END CAP REMOVAL TOOLS  
(provided with seal kit)
6. DRILL
7. FLASHLIGHT  
Helps in locating and examining timing marks, component failure and overall condition.
8. RUBBER MALLET  
Removal and installation of shaft and piston sleeve assembly.
9. PLASTIC MANDREL
10. PRY BAR  
Removal of end cap and manual rotation of shaft.
11. FELT MARKER  
Highlights timing marks and outlines troubled areas. Permanent ink is recommended.
12. T-HANDLE SCREW EXTRACTOR
13. HEX WRENCH SET  
Removal and replacement of port plugs and set screws (106,110).
14. SEAL TOOLS  
Removal and installation of seals and wear guides. Directions on making a seal tool are provided at bottom
15. PUNCH
16. DOWEL PINS  
Removal and installation of end cap.

### MAKING A SEAL TOOL



The seal tool is merely a customized standard flat head screwdriver.

1. Heat the flat end with a torch until it glows.
2. Secure the heated end of the screwdriver in a vise and bend the heated end to a slight radius.
3. Round off all sharp edges of the heated screwdriver to a polished finish. The tool may be modified slightly to your own personal preference.

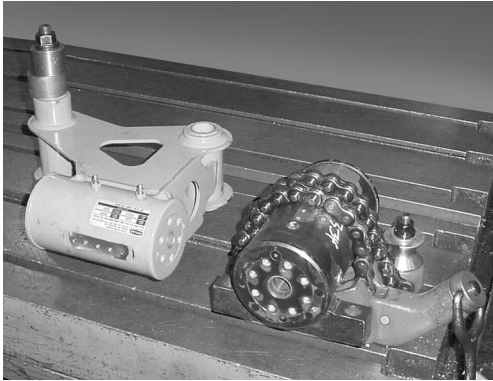
### **⚠ CAUTION**

**TO AVOID INJURY BE CAREFUL WHEN HANDLING THE SCREWDRIVER WHEN HOT.**

### Disassembly

Inspect the actuator for corrosion prior to disassembly. Severe corrosion can make it difficult to remove the lock pins (109) and unthread the end cap (04). If corrosion is evident, soak the lock pins and end cap with penetrating oil for several hours before disassembling.

Disassembly is easier if the actuator is firmly secured to a work bench. A pipe vise or mounting fixture works well for this purpose.



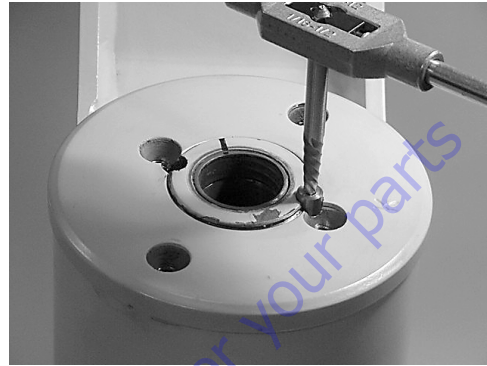
1. Remove port plugs (106.1) (106.2) and drain oil. Inspect oil for signs of contamination, i.e. water, metal shavings.



2. Remove the cap screws (113) that cover the end cap lock pins (109).
3. Using a 1/8" (3 mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16" (5 mm).

4. Remove the lock pins using a screw extracting tool such as an "Easy Out" (a size #2 is shown).

If the pin cannot be removed with the screw extractor, use a 5/16" bit to drill out the entire pin. Do not drill deeper than 1/2" (12.7 mm).

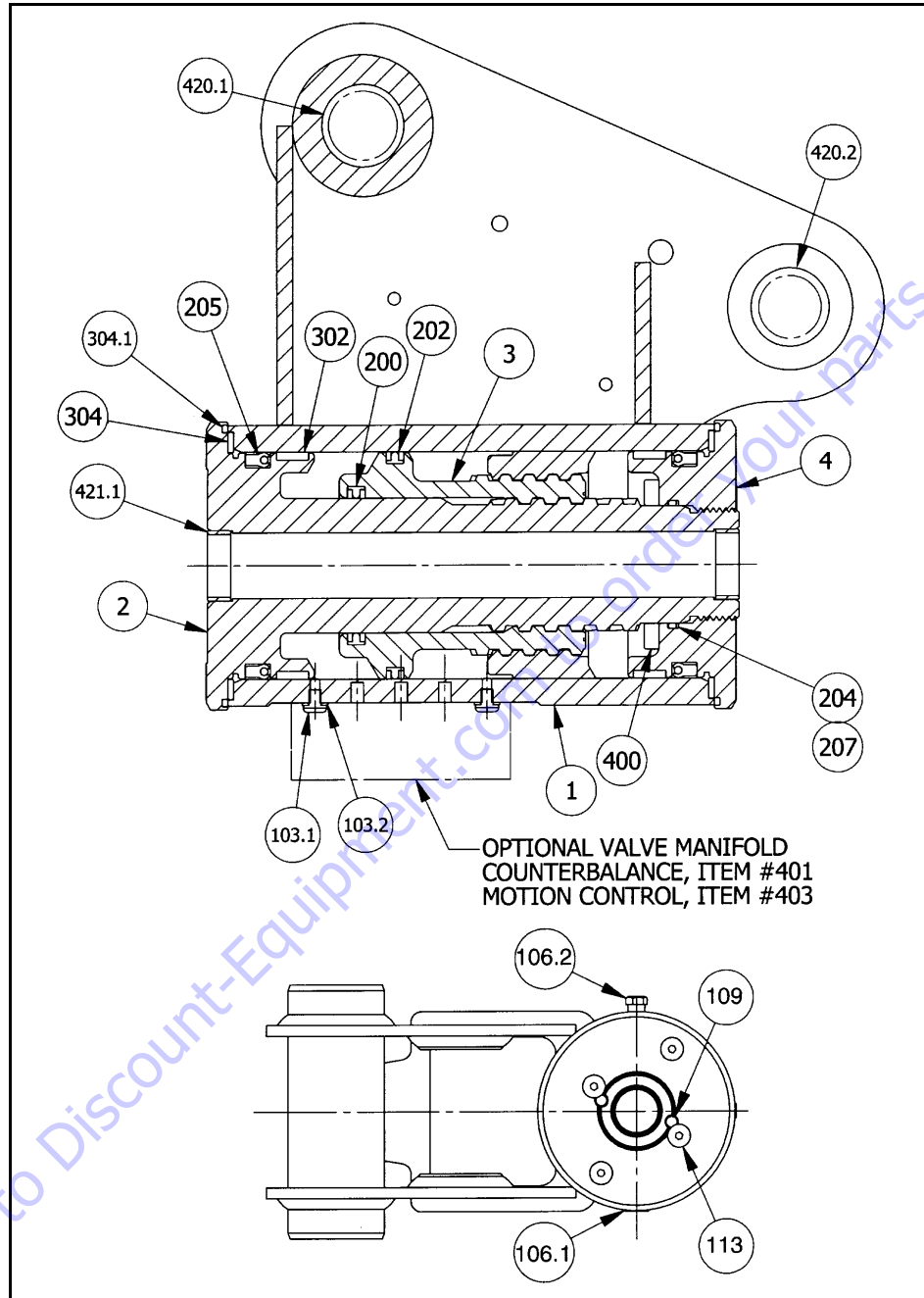


5. Install the end cap removal tools provided with the seal kit. (1/4-20)



6. Using a metal bar or similar tool, unthread the end cap (4) by turning it counterclockwise.

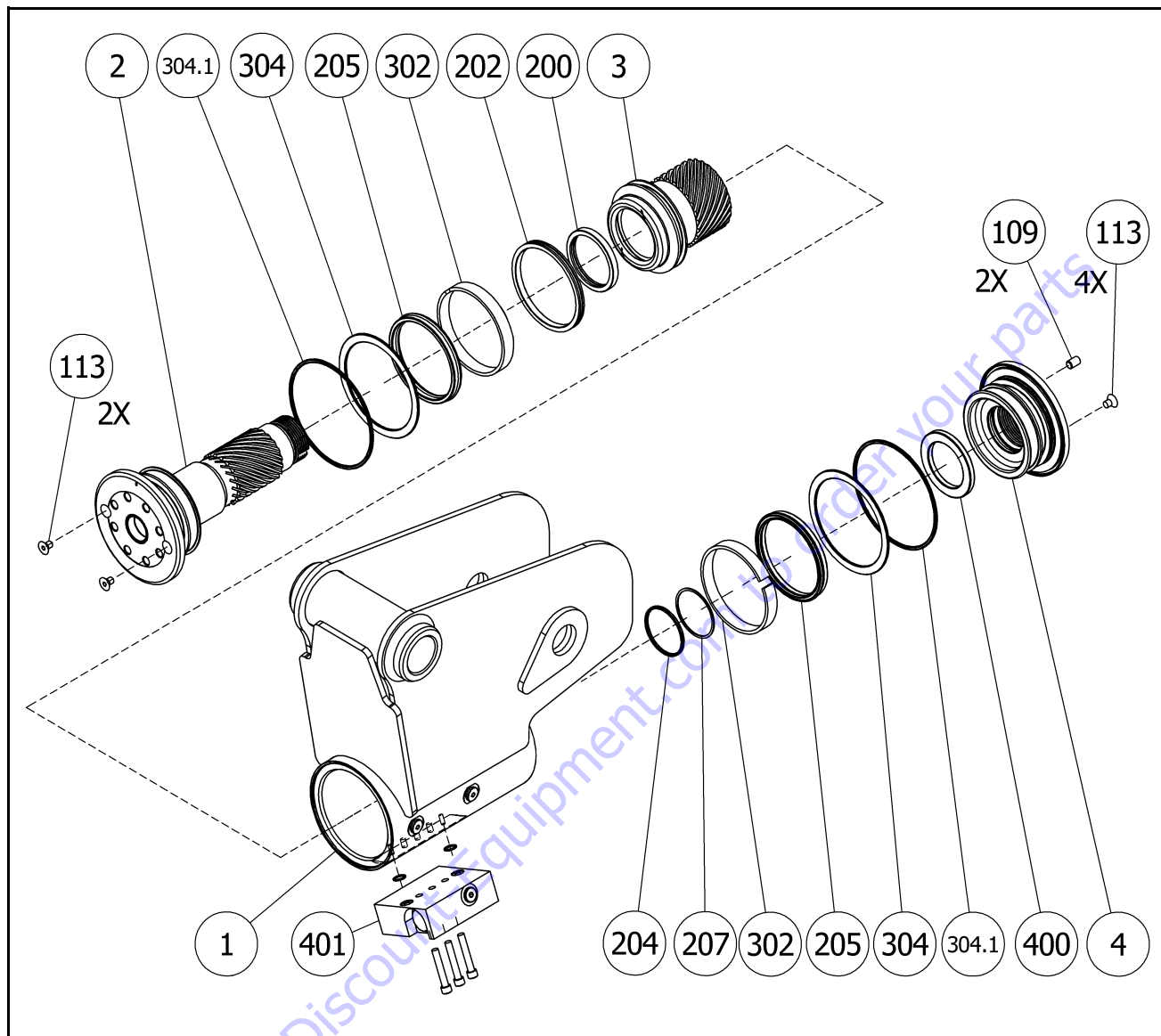




PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109.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

Figure 4-35. Rotary Actuator - Assembly Drawing





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. Exclusion Seal

BEARINGS

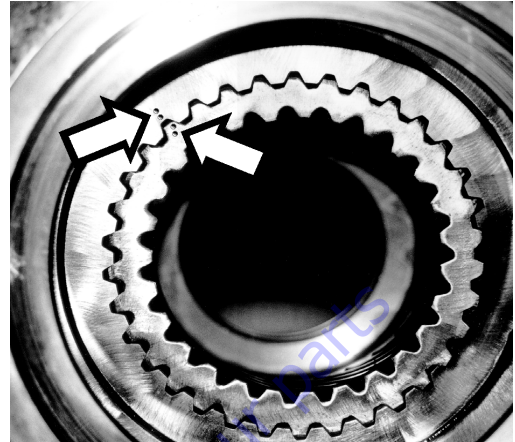
- 302. Wear Guide
- 304. Thrust Washer

ACCESSORIES

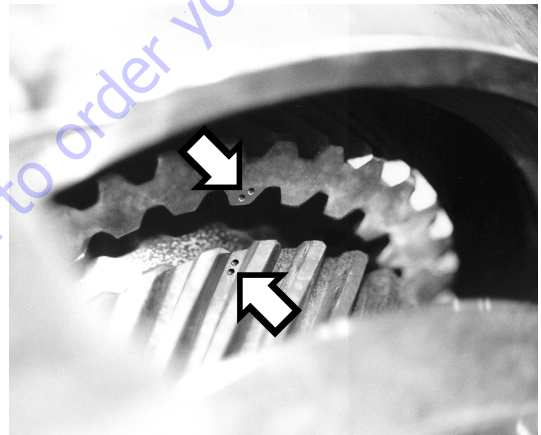
- 400. Stop Tube
- 401 Counterbalance Valve

Figure 4-36. Rotary Actuator - Exploded View

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



8. Remove the stop tube (400) if the actuator is equipped with one. The stop tube is an available option that limits the rotation of the actuator.



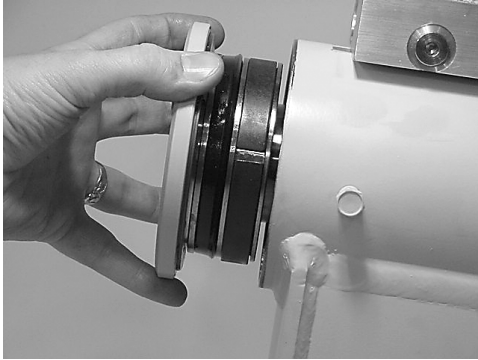
9. Every actuator has two sets of small punched timing marks that indicate timing between the gear sets. The location and appearance of the marks can vary slightly between models. One set indicates the timing between the piston sleeve (3) and the housing (1) (upper photo), the second set between the piston and the shaft (lower photo). To ensure correct rotation and accurate end positions, it is essential that the actuator be correctly timed when it is reassembled. The punched timing marks can be used, but it is easier to highlight punched marks with a marker before disassembly as outlined in the steps below.

10. Prior to removing the shaft (2), use a felt marker to clearly indicate the timing between shaft and piston sleeve (3). This will greatly simplify timing when the actuator is reassembled.

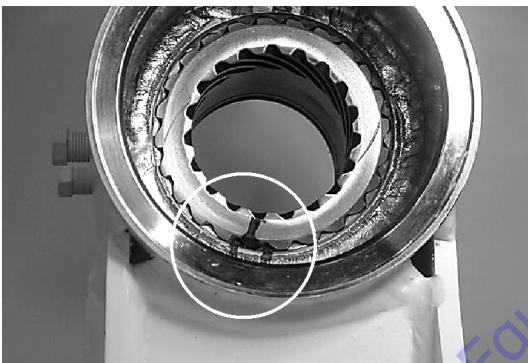


## SECTION 4 - BOOM & PLATFORM

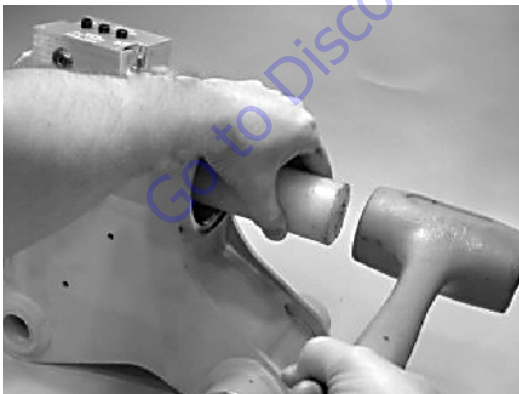
11. Remove the shaft (2) by rotating counterclockwise. As the shaft is rotated, it will disengage from the piston sleeve (3) and can be removed. It may be necessary to strike the threaded end of the shaft with a rubber mallet.



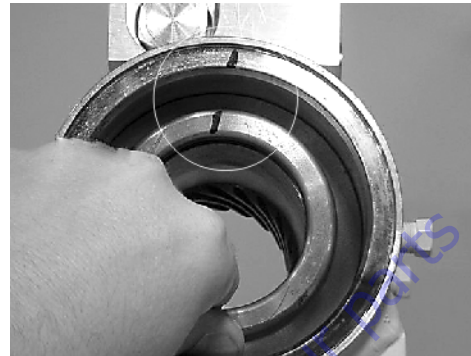
12. As in step 9, before removing the piston (3), mark the housing (1) ring gear in relation to the piston outside diameter gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).



13. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston and housing bore are not damaged.



14. 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.



15. Remove the O-ring (204) and backup ring (207) from end cap (4).



### NOTICE

**TO AVOID DAMAGE TO MACHINED PARTS CAREFULLY REMOVE SEALS USING REMOVAL TOOLS WITH ROUNDED EDGES.**

16. Remove the wear guide (302) from the end cap (4) and shaft (2).



17. Remove the main pressure seal (205).



18. Remove the thrust washer (304) from the end cap (4) and shaft (2).



19. Remove the O-ring (304.1) from its groove in the end cap (4) and shaft (2).



20. Remove the outside diameter piston seal (202) from the piston.



21. Remove the inside diameter piston seal (200).



### Inspection

#### **NOTICE**

**PRIOR TO ASSEMBLY OF ACTUATOR, THESE STEPS MUST BE CLOSELY FOLLOWED TO ENSURE PROPER OPERATION OF THE ACTUATOR.**

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

#### **NOTICE**

**SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.**

**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.



2. Coat the thrust washers (304) with a generous amount of Lithium grease. Install the thrust washer (304) onto shaft (2) and end cap (4).



3. Install the exclusion seal (304.1) into the appropriate grooves 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 O-ring (204) and back-up ring (207) into the inner seal groove on the end cap (4).



7. Install the inner T-seal (200) into the appropriate groove in the piston (3). Use a circular motion to ensure the seal is correctly seated in the groove. Install the outer T-seal (202) by stretching it around the groove in a circular motion.



Each T-seal has 2 back-up rings (see Assembly Drawing for orientation). Beginning with the inner seal (200) insert one end of backup ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

Insert the other back up ring in upper groove.

Repeat both of these steps for the outer seal (202).



8. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) contacts the inside housing bore.



9. Looking into the housing bore from the shaft flange end, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly align as shown. Using a rubber mallet, tap the piston into the housing until the gear teeth contact.

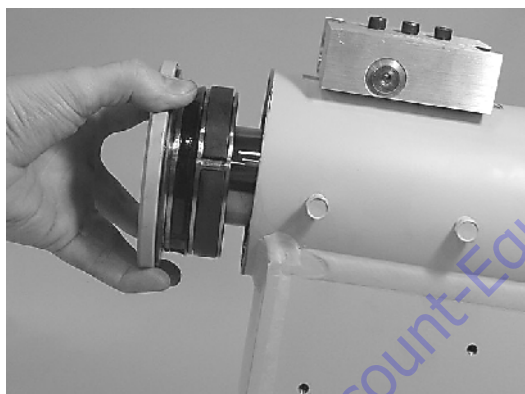


## SECTION 4 - BOOM & PLATFORM

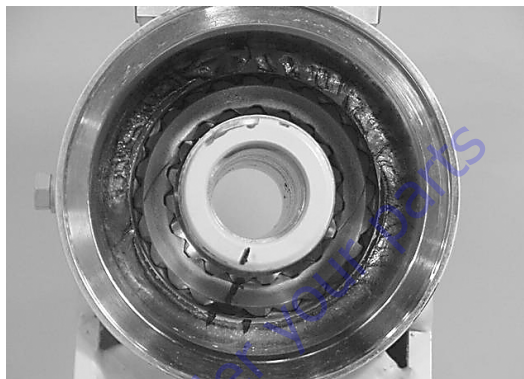
10. Looking into the bore from the opposite end of the housing (1) be sure the timing marks align correctly. Rotate the piston as necessary until aligned, then gently tap the piston (3) into the housing until the gear teeth mesh together. Tap the piston into the housing until it completely bottoms out against the ring gear.



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



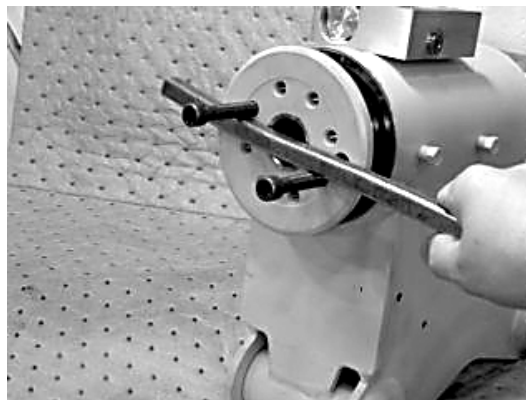
12. Looking at the actuator from the end opposite the shaft flange, use the existing timing marks to align the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). When the marks align, gently tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



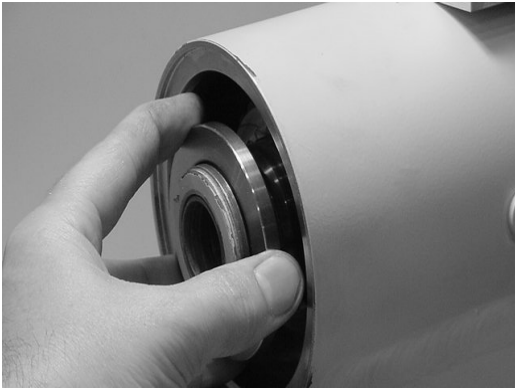
13. Install two bolts in the threaded holes in the flange. Using a metal bar, rotate the shaft in a clockwise direction until the wear guides are seated inside the housing bore.

### NOTICE

AS THE SHAFT IS ROTATED, BE CAREFUL NOT TO DISENGAGE THE PISTON AND HOUSING GEARING.



- 14.** Install the stop tube (400) onto the shaft end if necessary. Stop tubes are an available option to limit the rotation of an actuator.



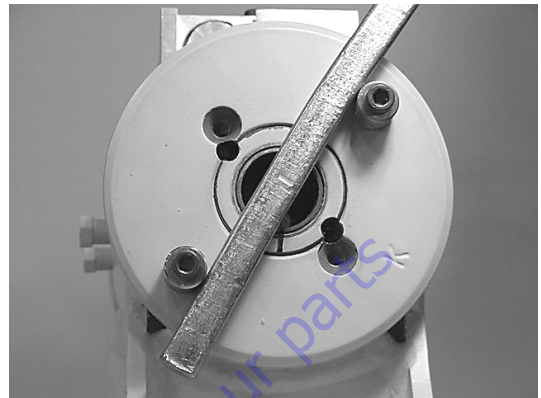
- 15.** Coat the threads on the end of the shaft with anti-seize grease to prevent galling.



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



- 17.** Tighten the end cap (4) using a metal bar. In most cases the original holes for the lock pins will align.



- 18.** Insert the lock pins (109) provided with the Helac seal kit into 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 to 25 in-lbs. (2.8 Nm).

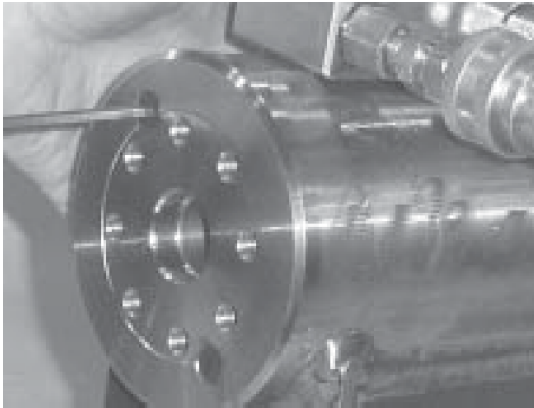




### Greasing Thrust Washers

1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

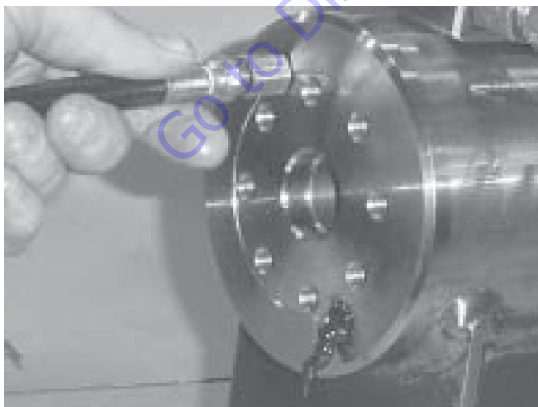
There are two grease ports located on both the shaft flange and the end cap. They are plugged with cap screws (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)



#### **NOTICE**

**IF A HYDRAULIC TEST BENCH IS NOT AVAILABLE, THE ACTUATOR CAN BE ROTATED BY HAND, OPEN THE PRESSURE PORTS AND USE A PRY BAR WITH CAP SCREWS INSERTED INTO THE SHAFT FLANGE TO TURN THE SHAFT IN THE DESIRED DIRECTION.**

Insert the tip of a grease gun into one port and apply grease to the shaft flange. Continue applying until grease flows from the opposite port. Cycle the actuator five times and apply grease again. Repeat this process on the end cap. Insert the cap screws into the grease ports and tighten to 25 in-lbs. (2.8 Nm).



### Installing Counterbalance Valve

Refer to Figure 4-37., 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. JLG Threadlocker PN 0100011 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 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.

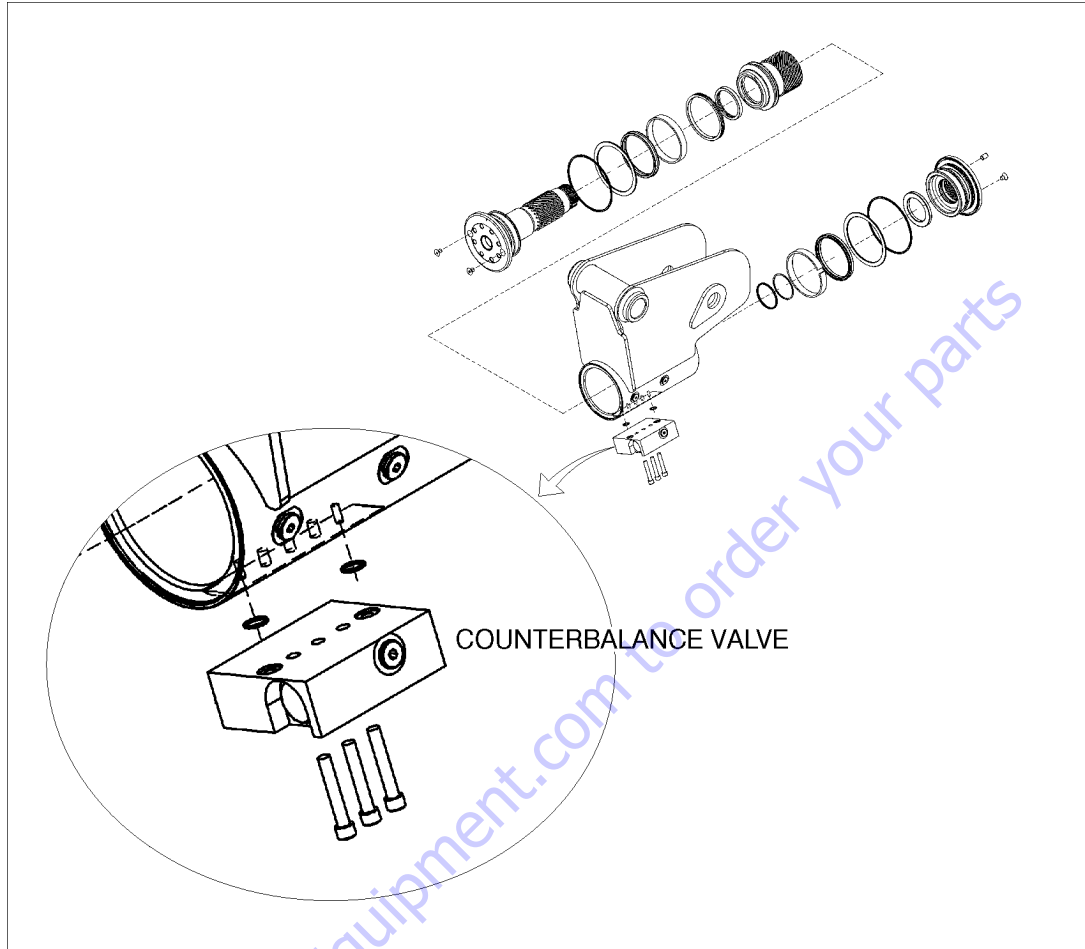


Figure 4-37. Rotator Counterbalance Valve

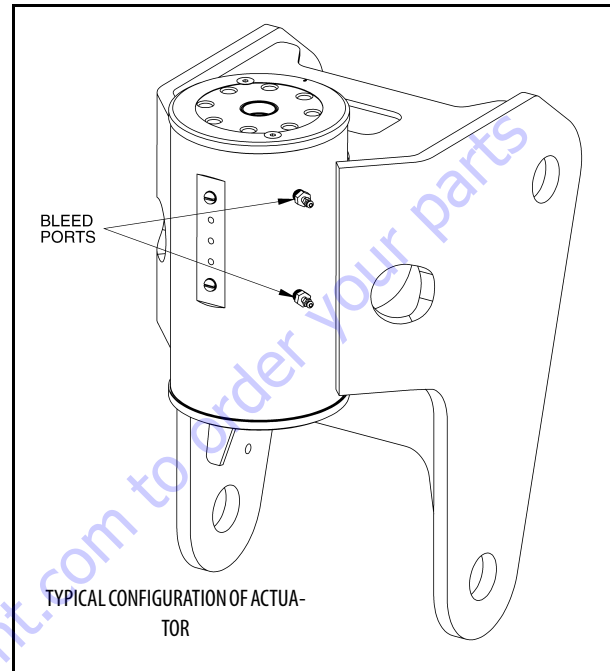
### Installation and Bleeding

After installation of the actuator on the equipment, it is important that all safety devices such as tie rods or safety cables are properly re-attached.

To purge air from the hydraulic lines, connect them together to create a closed loop and pump hydraulic fluid through them. Review the hydraulic schematic to determine which hydraulic lines to connect. The linear feet and inside diameter of the hydraulic supply lines together with pump capacity will determine the amount of pumping time required to fully purge the hydraulic system.

Bleeding may be necessary if excessive backlash is exhibited after the actuator is connected to the hydraulic system. The following steps are recommended when a minimum of two gallons (8 liters) is purged.

1. Connect a 3/16" inside diameter x 5/16" outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure them with hose clamps. Place the vinyl tubes in a clean 5-gallon container to collect the purged oil. The oil can be returned to the reservoir after this procedure is completed.



2. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate the platform to the end of rotation (either clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow a 1/2 gallon of fluid to be purged from the actuator.
3. Keep the fittings open and rotate the platform in the opposite direction to the end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.
4. Repeat steps 2 & 3. After the last 1/2 gallon is purged, close both bleed nipples before rotating away from the end position.

## Troubleshooting

**Table 4-1. Troubleshooting**

Problem	Cause	Solution
1. Shaft rotates slowly or not at all	a. Insufficient torque output  b. Low rate of fluid flow  c. Control or counterbalance valve has internal leak  d. Piston and/or shaft seal leak  e. Corrosion build-up on the thrust surfaces  f. Swollen seals and composite bearings caused by incompatible hydraulic fluid	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.  b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.  c. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.  d. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test as described in the Testing section on page 24 of this manual.  e. Re-build the actuator. Remove all rust then polish. Replacement parts may be needed.  f. Re-build the actuator. Use fluid that is compatible with seals and bearings.
2. Operation is erratic or not responsive	a. Air in actuator	a. Purge air from actuator. See bleeding procedures.
3. Shaft will not fully rotate	a. Twisted or chipped gear teeth  b. Port fittings are obstructing the piston	a. Check for gear binding. Actuator may not be able to be rebuilt and may need to be replaced. Damage could be a result of overload or shock.  b. Check thread length of port fittings. Fittings should during stroke not reach inside the housing bore.
4. Selected position cannot be maintained	a. Control or counterbalance valve has internal leak  b. Piston and/or shaft seal leak  c. Air in actuator	a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.  b. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test as described in the Testing section on page 24 of this manual.  c. Purge air from actuator. See bleeding procedures

### 4.22 JIB ROTATOR TORQUING PROCEDURE

See Figure 4-38., Jib Rotator Torque

1. Torque the center bolt to 350 ft.lbs. (475 Nm).
2. Torque the bottom bolts in a crossing star pattern to 170 ft.lbs. (230 Nm).
3. Torque the top bolts in a crossing star pattern to 300 ft.lbs. (410 Nm).
4. Torque the center bolt to a final torque of 700 ft.lbs. (950 Nm).

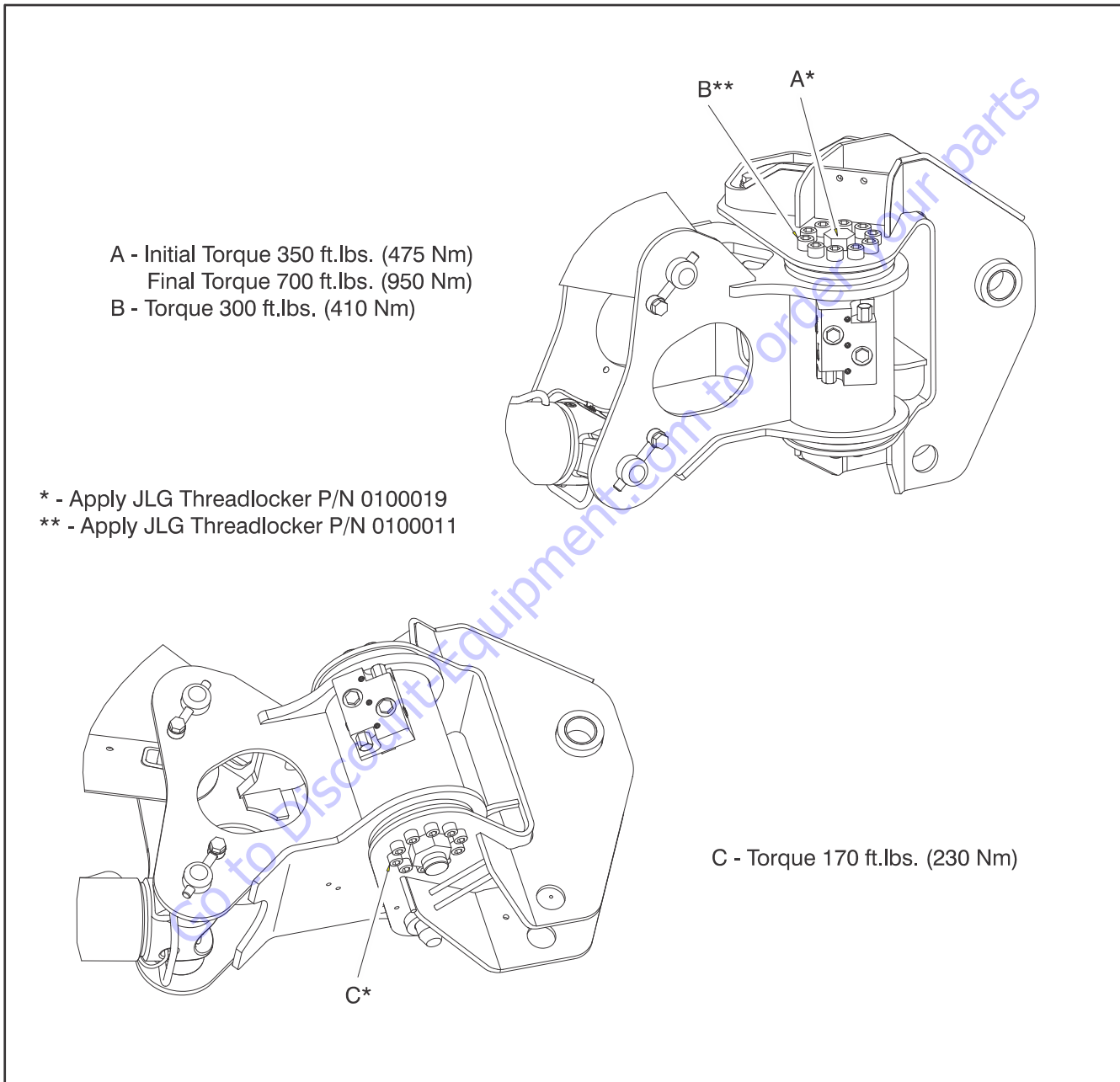
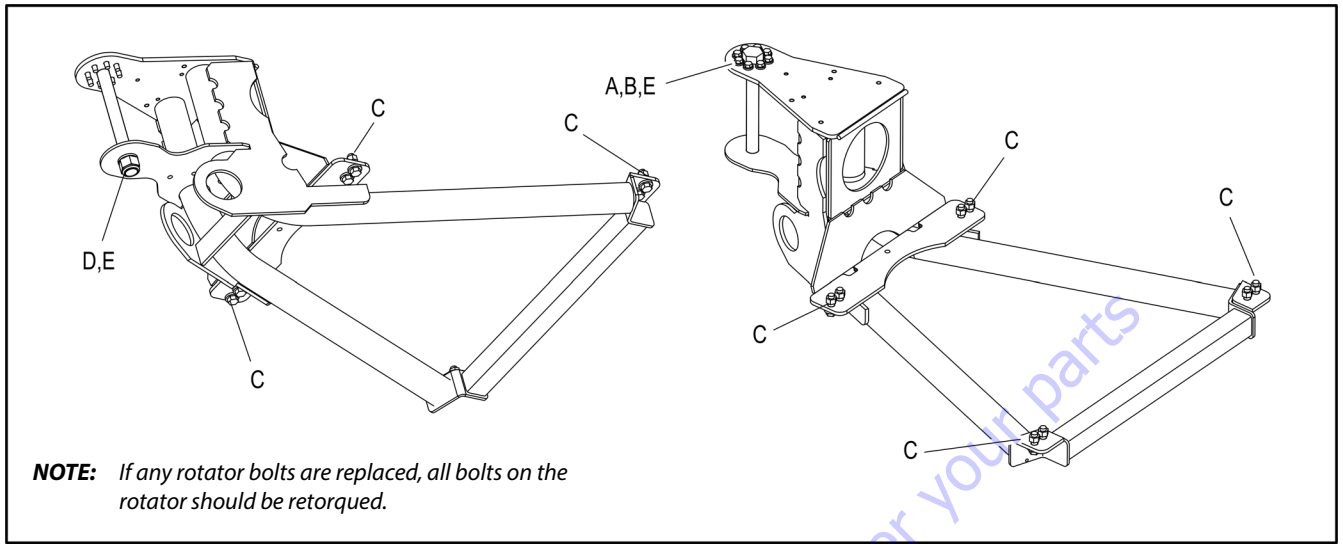


Figure 4-38. Jib Rotator Torque



- A Torque to 40 ft. lbs. (55 Nm)
- B JLG Threadlocker PN0100011
- C Torque 85 ft. lbs. (116 Nm)
- D Torque 586ft. lbs. (795 Nm)
- E Check torque every 150 hours of operation

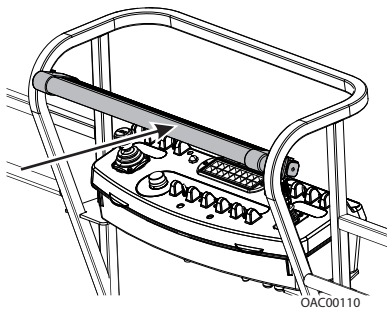
**Figure 4-39. Platform Support Torque Values**

## 4.23 SKYGUARD®

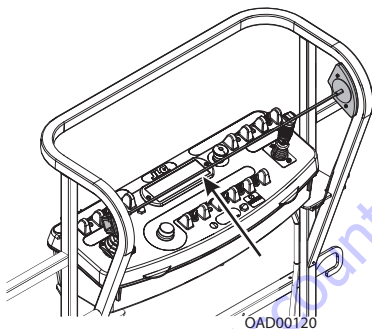
### Operation

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.

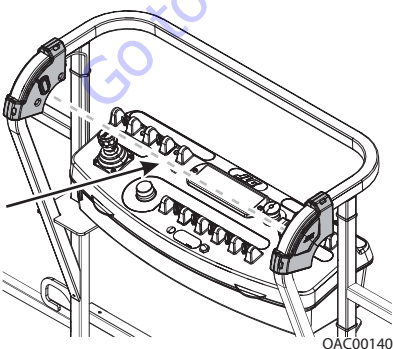
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

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 handheld 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 6-13 for more fault code information

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

**Table 4-2. 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	Jib Tele	Basket Level	Basket Rotate
R*/C**	R	C	R	R	R	R	C	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												
<b>Note:</b> If SkyGuard is enabled with the Soft Touch system, functions will cut out instead of reversing.												



### 4.24 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 aerial 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.

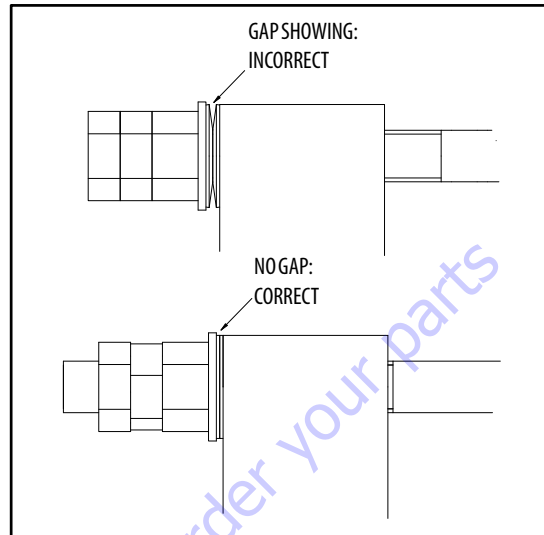
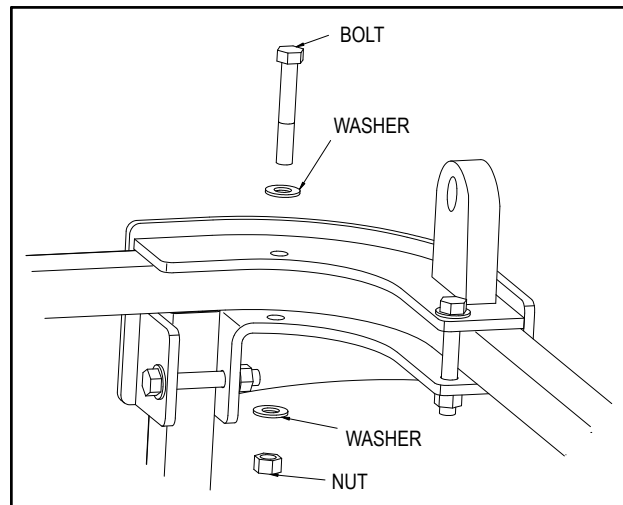


Figure 4-40. Bolt-On External Fall Arrest Cable Tension

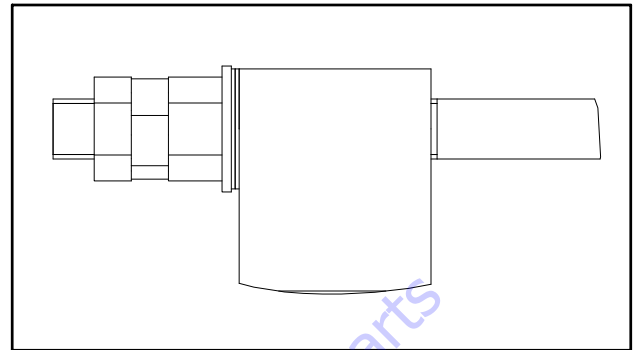
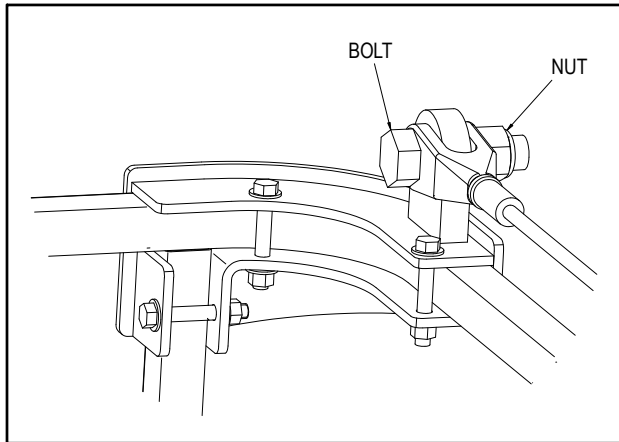
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are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

#### Installation

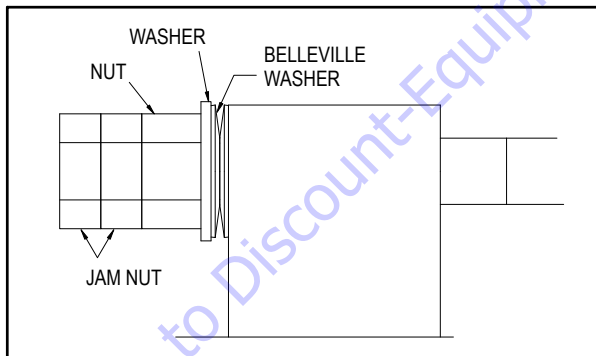
1. Install the retaining hardware (bolts, nuts, and washers) and secure the brackets to the platform rail. Tighten the nuts but do not torque them yet.



- 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.

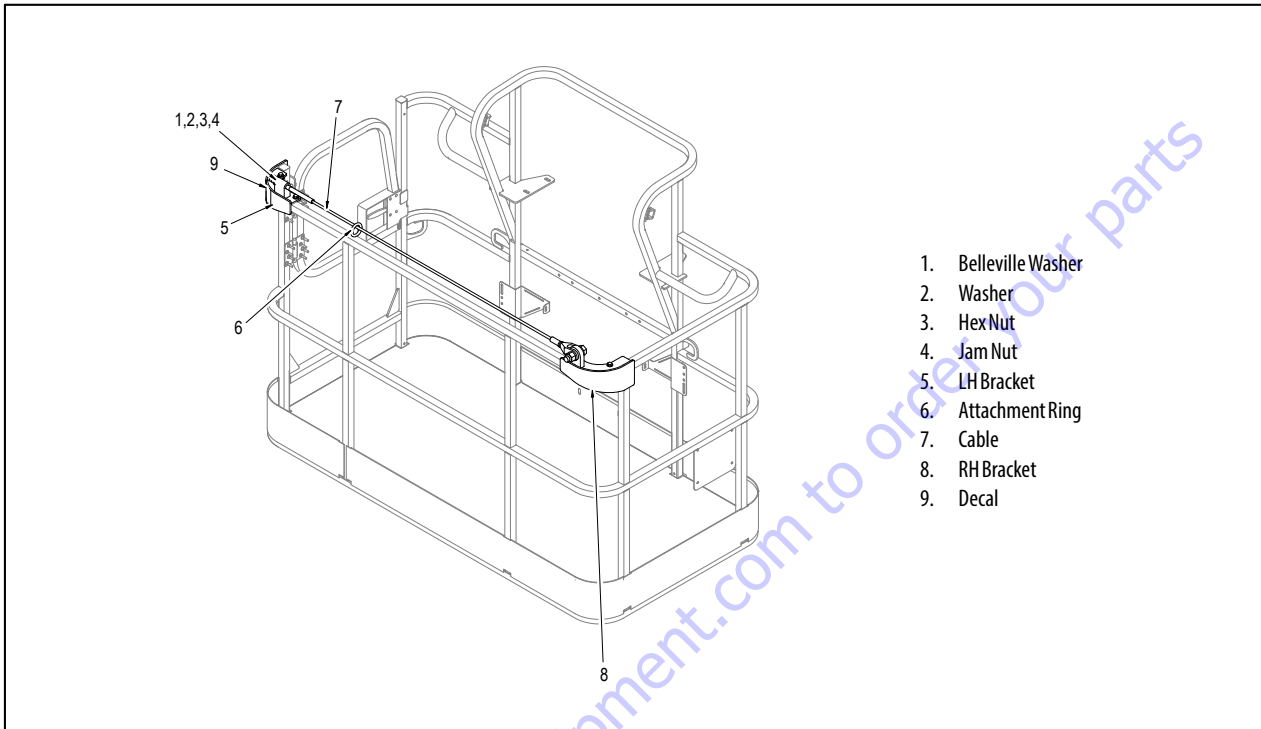


- Install the Attachment Ring onto the cable.
- Without twisting the fall arrest cable, pull it thru the left hand bracket and mark the top of the swaged cable end. Install the fall arrest cable through the left hand bracket and secure it using the belleville washers, washer, retaining nut, and jam nuts. 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.



- 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.

- 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.
- Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).



**Figure 4-41. Bolt-On External Fall Arrest System**

# PARTS FINDER

**Search Website  
by Part Number**



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

**Search Manuals**

Enter your model number or part number to search for parts.

\* Brand:

\* Model:

\* Serial:

\* Part Number:

\* Description:

\* Quantity:

\* Unit Price:

\* Tax:

\* Shipping:

\* Comments:

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

**Parts Order Form**

Please fill in the following information:

Name:

Address:

City:

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Zip:

Phone:

Fax:

E-mail:

Company:

Part Number:

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Quantity:

Unit Price:

Tax:

Shipping:

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We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

## 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.

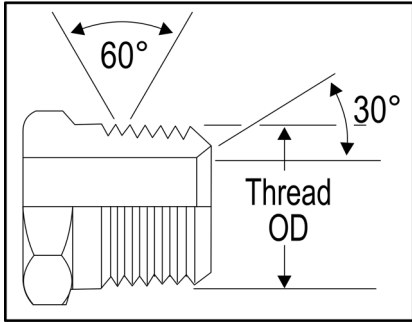
1. Fill the bottle with hydraulic oil.
2. Using slight pressure to the body of the spray bottle, invert the bottle so the brush end is in the downward position.
3. Brush hydraulic oil on the entire o-ring, applying an even coat of oil.



**5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION**

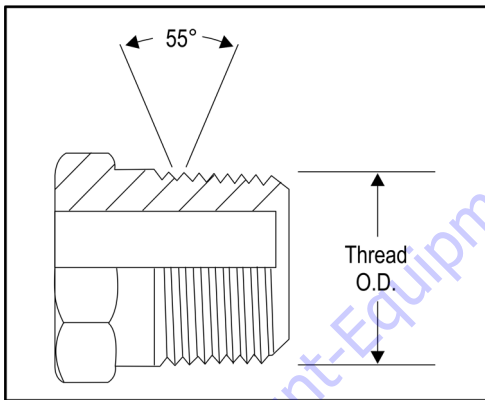
**Tapered Thread Types**

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



**Figure 5-1. NPTF Thread**

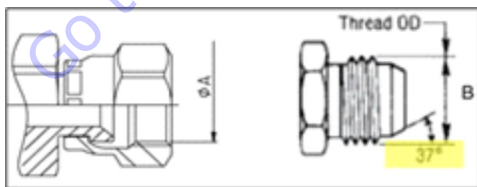
BSPT = British standard pipe tapered per ISO7-1



**Figure 5-2. BSPT Thread**

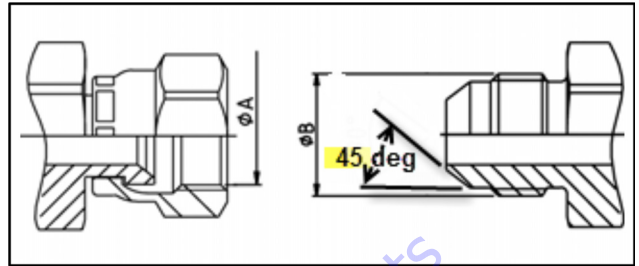
**Straight Thread Types, Tube and Hose Connections**

JIC = 37° flare per SAE J514



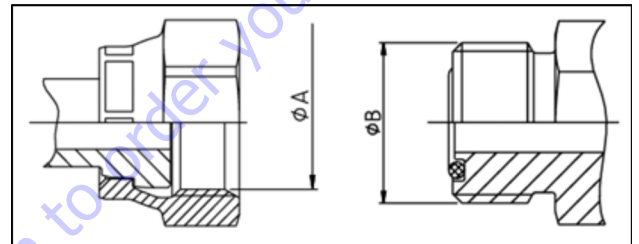
**Figure 5-3. JIC Thread**

SAE = 45° flare per SAE J512



**Figure 5-4. SAE Thread**

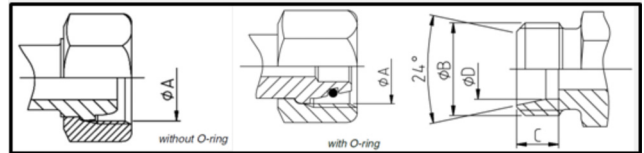
ORFS = o-ring face seal per SAE J1453



**Figure 5-5. ORFS Thread**

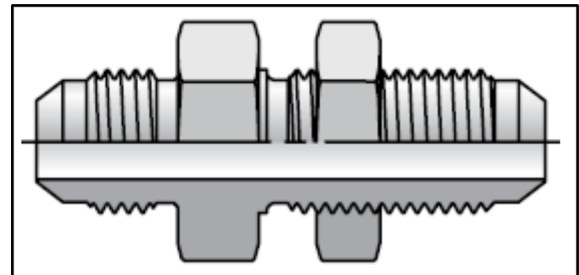
MBTL = metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353

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

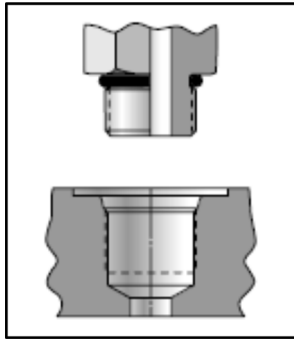


Figure 5-8. ORB-MPP Thread

MFF = metric flat face port per ISO 9974-1

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

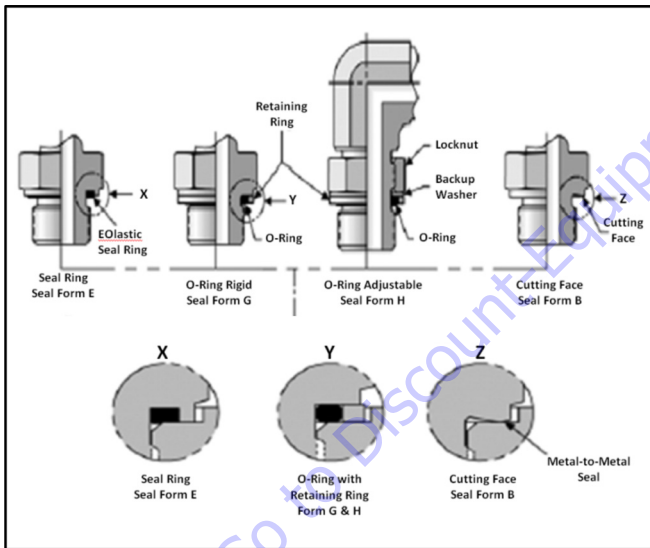


Figure 5-9. MFF-BSPB Thread

### Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

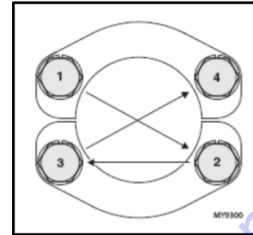


Figure 5-10. ORB-MPP Thread

### 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.
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 Loctite 567, 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.**

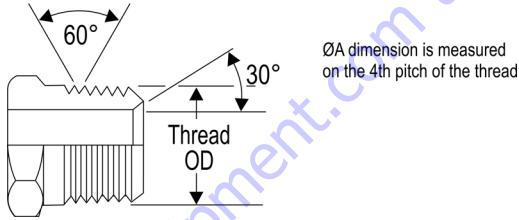
**NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.**

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**



TYPE/FITTING IDENTIFICATION					
Material	Dash Size	Thread Size	ØA*		Turns From Finger Tight (TFFT)**
		(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 Loctite 567, 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**

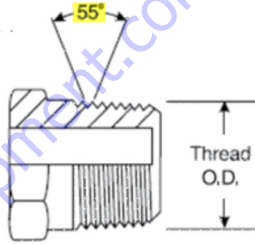
**TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.**

5. Rotate male fitting the number of turns per Table 5-2, 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.

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.

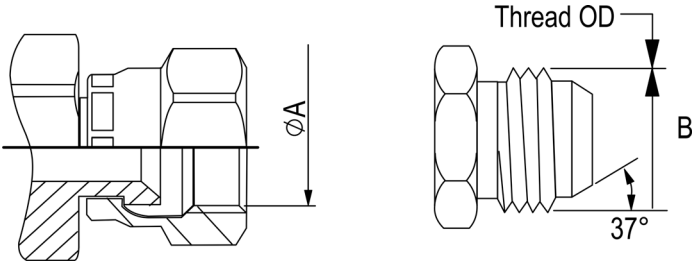
**NOTE:** *Torque values provided in Table Table 5-3, 37° Flare (JIC)Thread - Steel and Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

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.

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



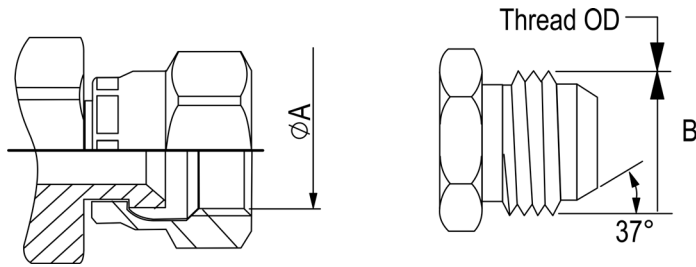
Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	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.

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**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 (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	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.*

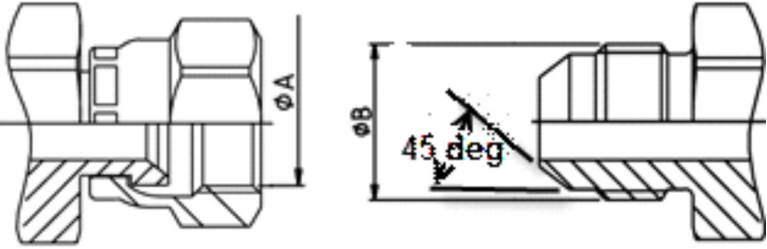
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- 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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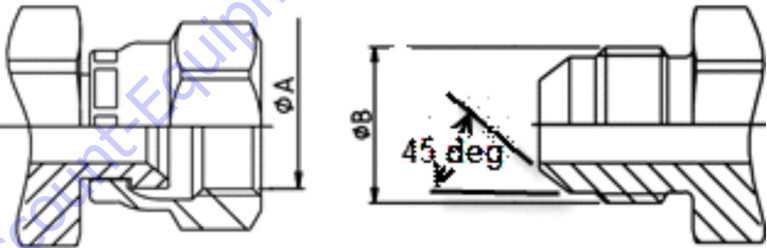
Table 5-5. 45° Flare (SAE) - Steel



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	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	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	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(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.

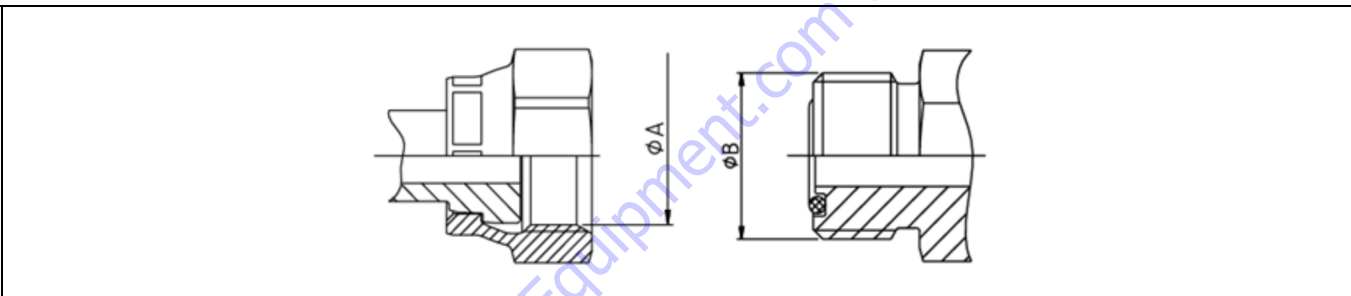
5. Torque nut to value listed in Table 5-7, O-ring Face Seal (ORFS) - Steel or Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass while using the Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

**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

**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 (UNF)	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
			(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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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 the						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 the						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.

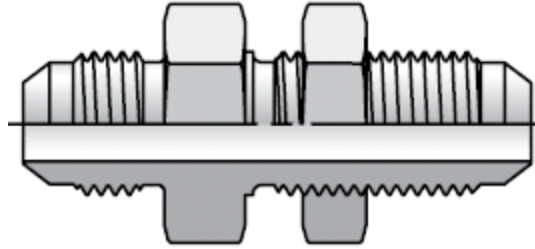
**Assembly Instructions for Bulkhead (BH) Fittings**

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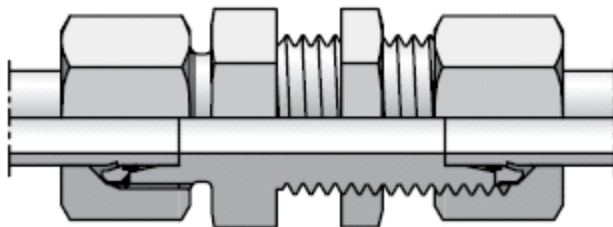
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Table 5-10. Bulkhead Fittings (BH) - INCH



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]			
						Min	Nom	Max	Min	Nom	Max
						3	3/8-24	8	9	9	11
			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				

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.**

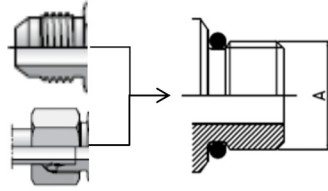
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.

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 counter bore of the port.



SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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



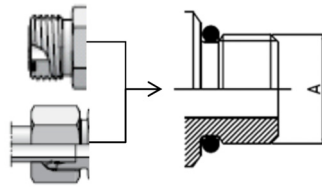
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(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.

**SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS**

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



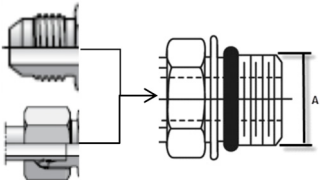
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	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.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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



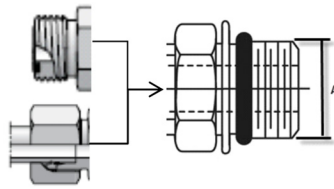
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	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



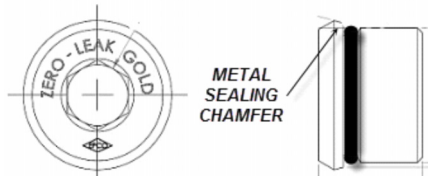
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	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 counter bore of the port.

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					
			[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	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



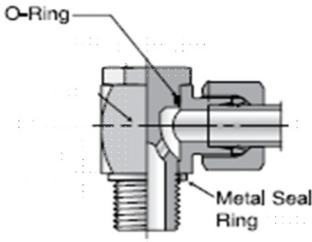
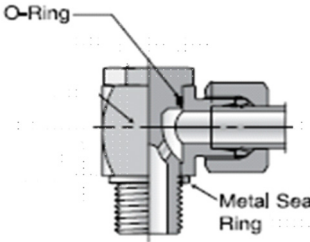
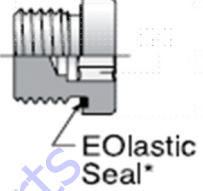
**SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS**

**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. (mm)	Torque						Torque						Torque							
	(metric)		[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

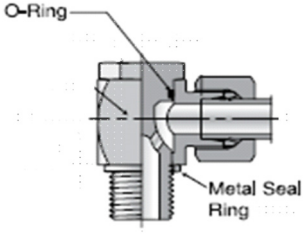
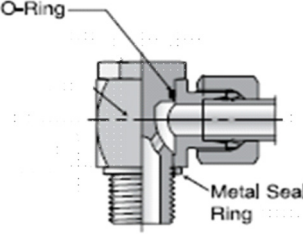
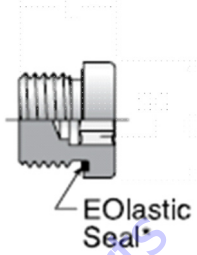
SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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) - L 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 (EOLASTIC 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**

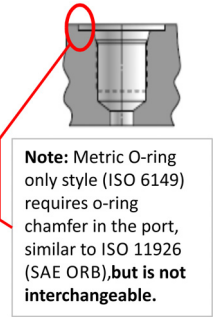
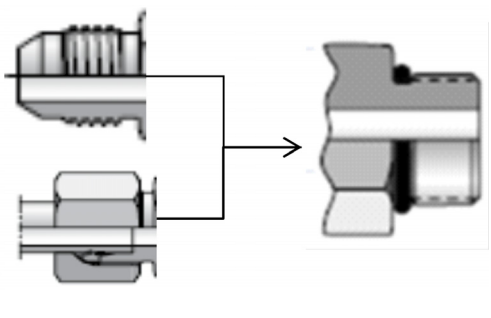
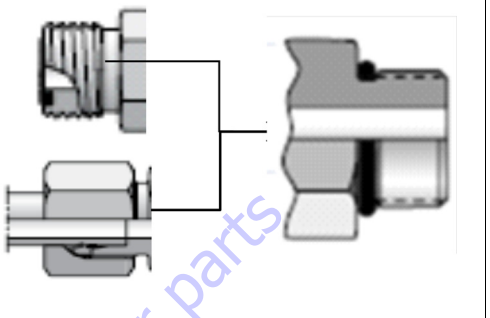
**CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

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 counter bore of the port.

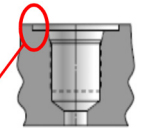
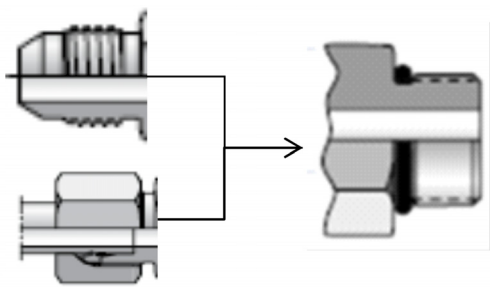
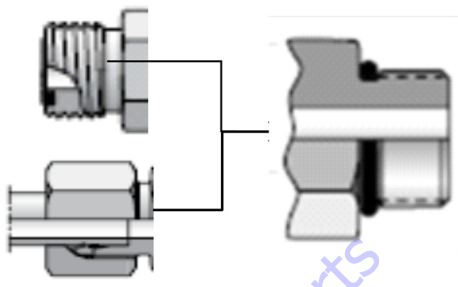
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Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)

														
<b>TYPE/FITTING IDENTIFICATION</b>			<b>STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end</b>						<b>STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end</b>					
<b>MATERIAL</b>	<b>Thread M Size</b>	<b>Connecting Tube O.D.</b>	<b>Torque</b>						<b>Torque</b>					
			<b>[Ft-Lb]</b>			<b>[N-m]</b>			<b>[Ft-Lb]</b>			<b>[N-m]</b>		
	<b>(metric)</b>	<b>(mm)</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>
<b>STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN- LUBRICATED THREADS</b>	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	

**SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS**

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

 <p><b>Note:</b> Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), but is not interchangeable.</p>														
<b>TYPE/FITTING IDENTIFICATION</b>			<b>STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end</b>						<b>STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end</b>					
<b>MATERIAL</b>	<b>Thread M Size</b>	<b>Connecting Tube O.D.</b>	<b>Torque</b>						<b>Torque</b>					
			<b>[Ft-Lb]</b>			<b>[N-m]</b>			<b>[Ft-Lb]</b>			<b>[N-m]</b>		
	<b>(metric)</b>	<b>(mm)</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>
<b>ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS</b>	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 counter bore of the port.

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	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

**SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS**

**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

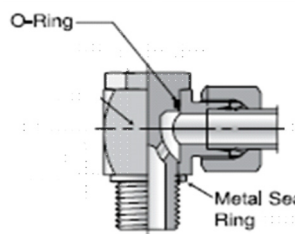
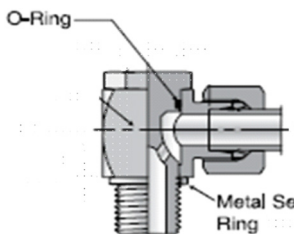
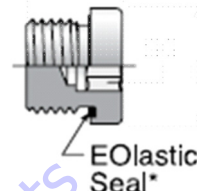
\* Typical for JLG Straight Male Stud Fittings

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

\*\*\* Typical for JLG Adjustable Fittings

SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15						
	G1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33						
	G1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33						
	G3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65						
	G1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88						
	G1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88						
	G3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153						
	G1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221						
	G1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450						
	G1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495						
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9						
	G1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22						
	G1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22						
	G3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42						
	G1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57						
	G1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57						
	G3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99						
	G1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144						
	G1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321						
	G1-1/2A	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	G 1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G 1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G 3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G 3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G 1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G 1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G 3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G 1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G 3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G 3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G 1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G 1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G 3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386

Diagram illustrating the Form E fitting configuration, showing a cutting face seal type 'B' and a metal-to-metal seal.

Diagram illustrating the Form G/H fitting configuration, showing O-ring with retaining ring types 'G' & 'H', O-ring rigid seal type 'G', O-ring adjustable seal type 'H', retaining ring, locknut, and back-up washer.

\* 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	G1/4A	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.					
	G1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	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.					
	G1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G1-1/2A	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.

Go to Discount-Equipment.com to order your parts

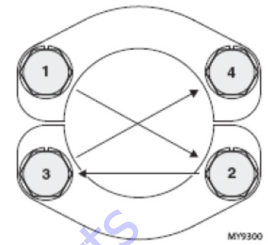
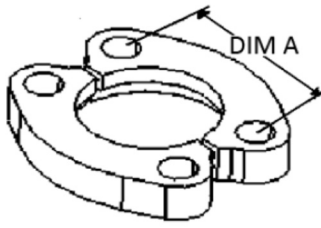


SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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
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.



M19300

**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.

**Double Wrench Method**

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one back-up 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.

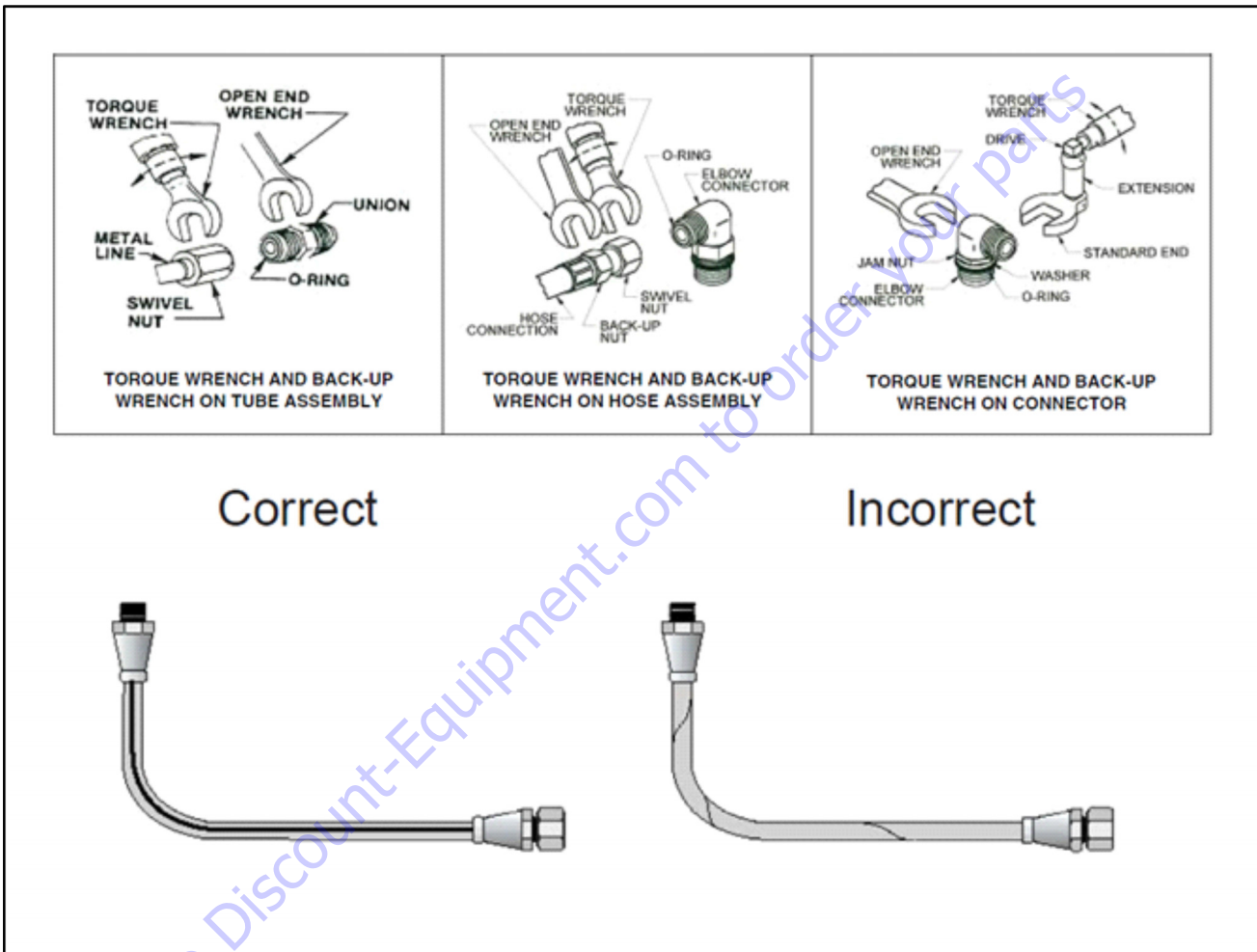


Figure 5-12. Double Wrench Method

## 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.

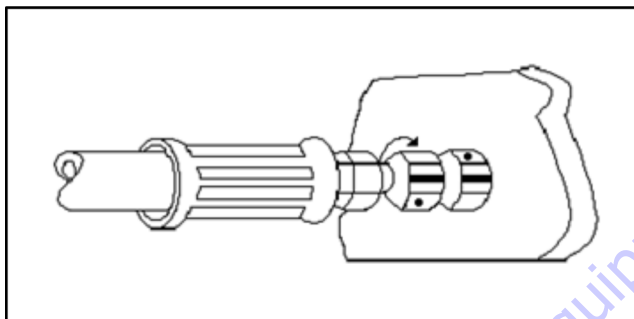


Figure 5-13. FFWR Method

### 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 back-up 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 back-up 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 back-up 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.

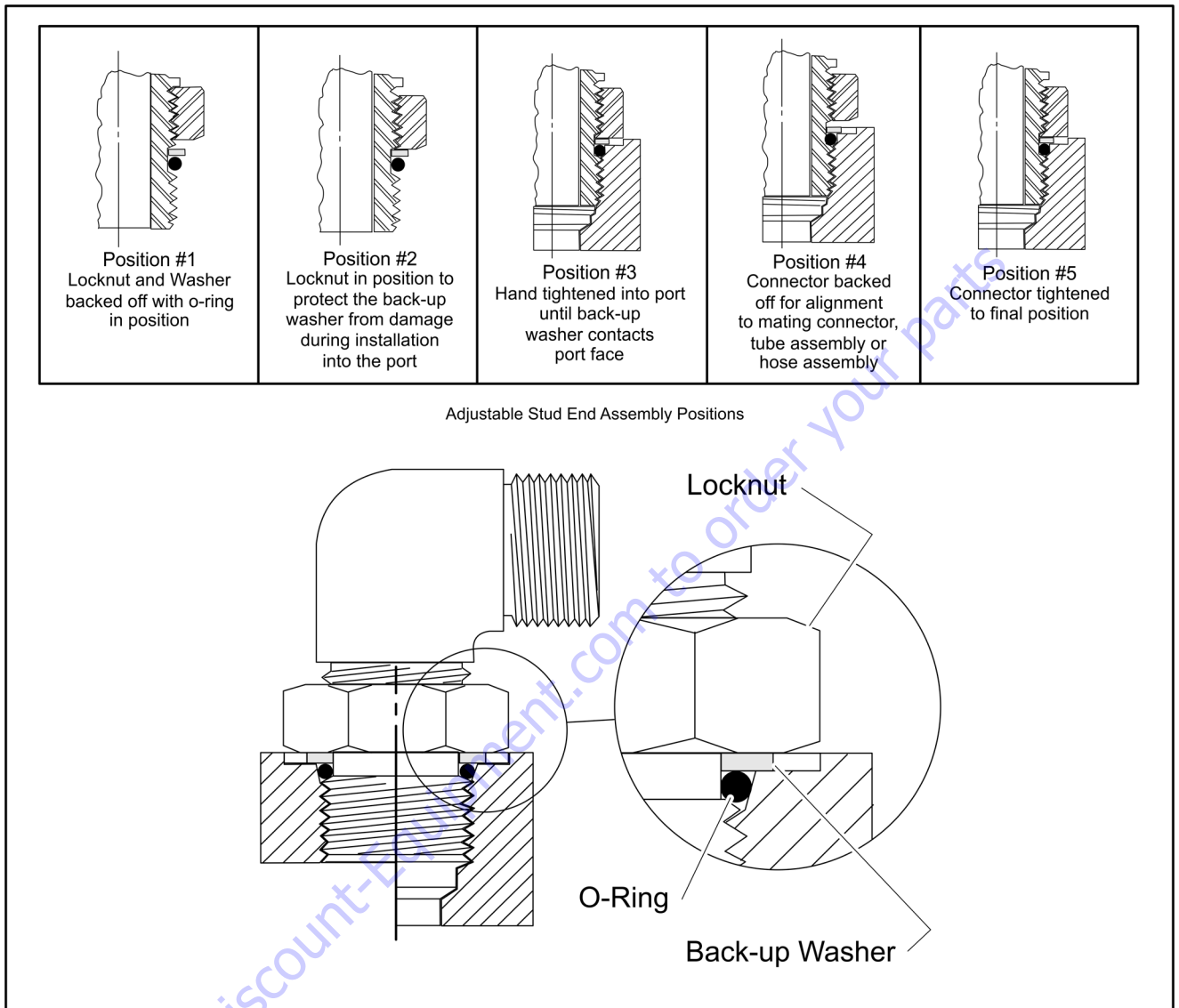


Figure 5-14. Adjustable Stud End Assembly

### 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 HYDRAULIC CYLINDERS

#### Axle Extension Cylinder

##### DISASSEMBLY

**NOTICE**

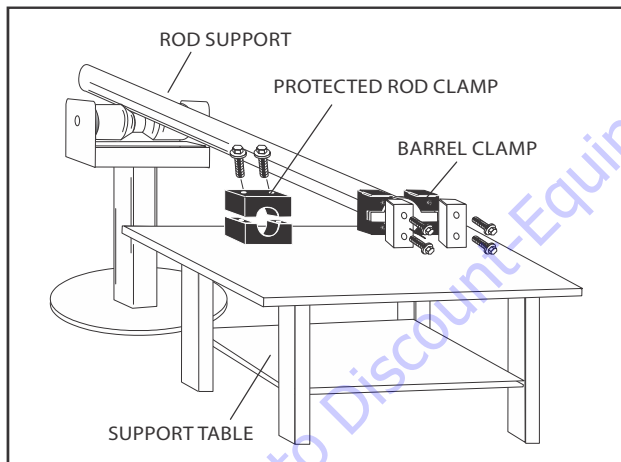
**DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.**

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

**NOTICE**

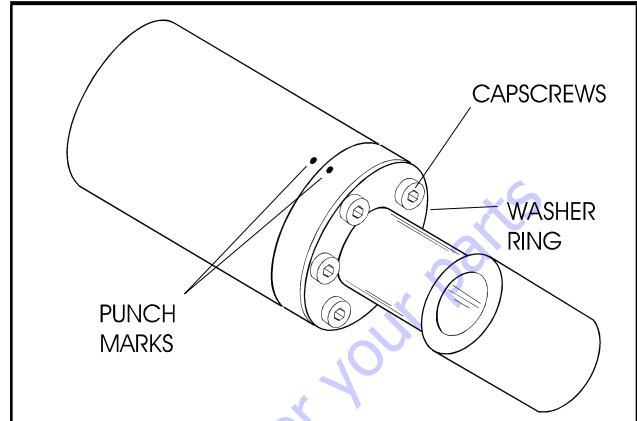
**DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.**

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. Remove the sequence valves from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.



**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 cylinder head retainer capscrews, and remove capscrews from cylinder barrel.



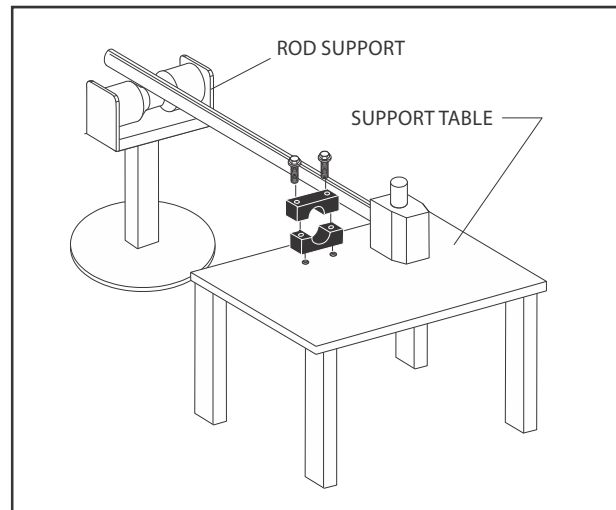
**Figure 5-16. Cap Screw Removal**

6. Attach a suitable pulling device to the cylinder rod end.

**NOTICE**

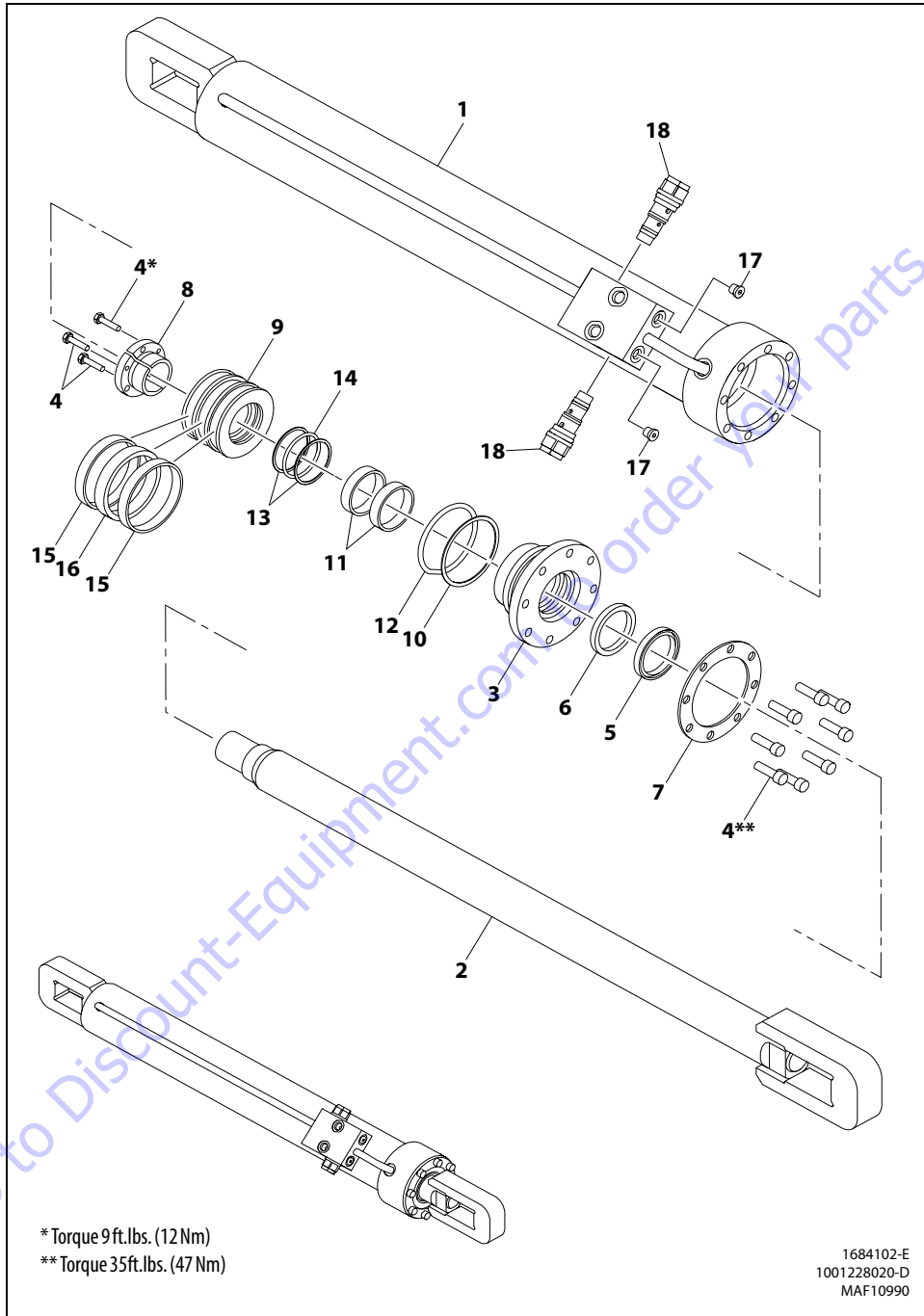
**EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.**

7. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.



**Figure 5-17. Cylinder Rod Support**

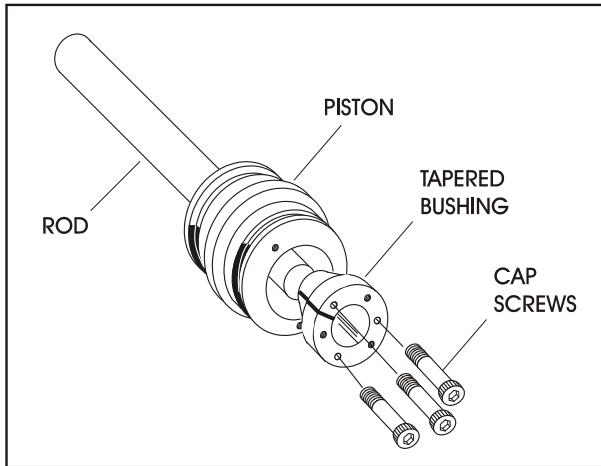
8. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.



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

Figure 5-18. Axle Extension Cylinder

9. Loosen and remove the capscrew which attach the tapered bushing to the piston.



**Figure 5-19. Tapered Bushing Removal**

10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose.
11. Remove the tapered bushing from the piston.
12. By hand, screw the piston counterclockwise and remove it from cylinder rod.
13. Remove and discard the piston o-rings, seal rings, and backup rings.
14. Remove the rod from the holding fixture. Remove the cylinder head gland and washer ring. 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.

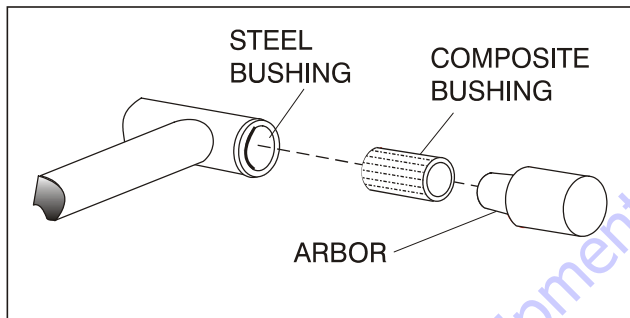


Figure 5-20. Composite Bearing Installation

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.

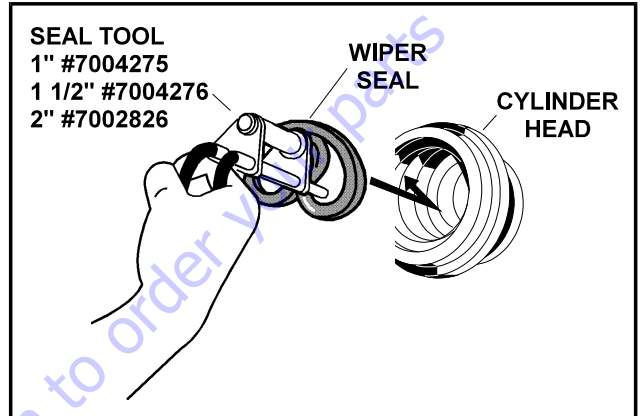


Figure 5-21. Rod Seal Installation

**NOTICE**

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

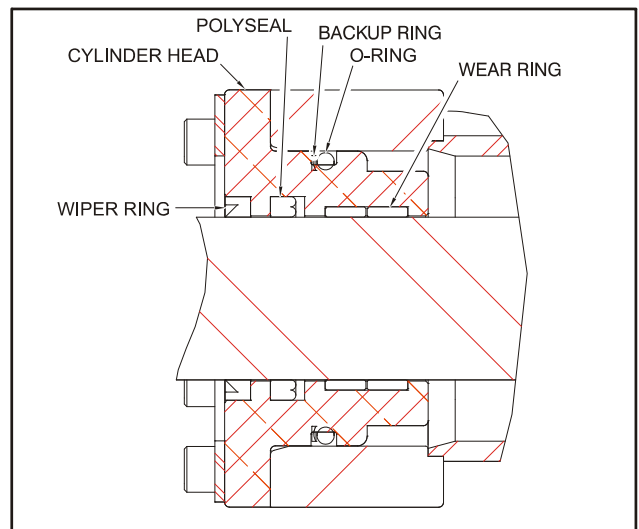


Figure 5-22. Cylinder Head Seal Installation

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

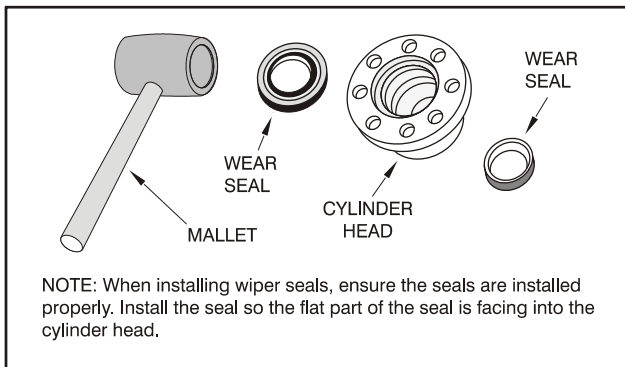


Figure 5-23. Wiper Seal Installation

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

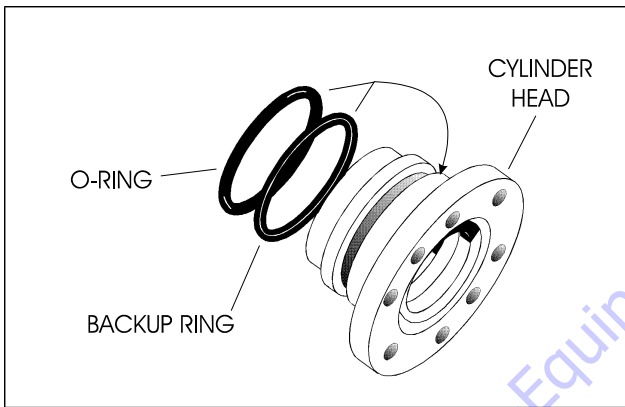


Figure 5-24. Installation of Head Seal Kit

- 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.
- Place a new O-ring and backup rings in the inner piston diameter groove.
- Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
- Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.

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

- Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

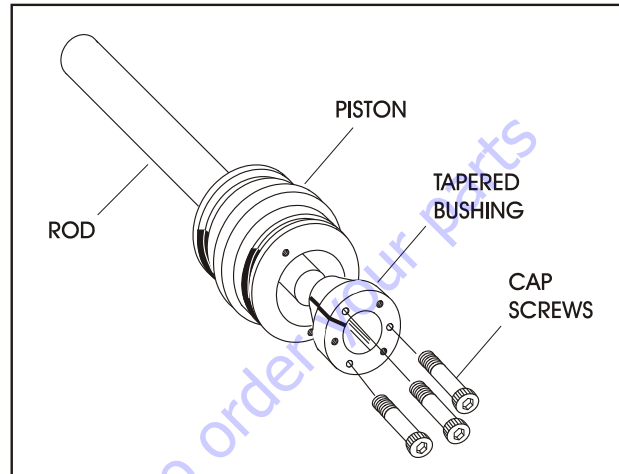


Figure 5-25. Tapered Bushing Installation

- Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).
- 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;
  - Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

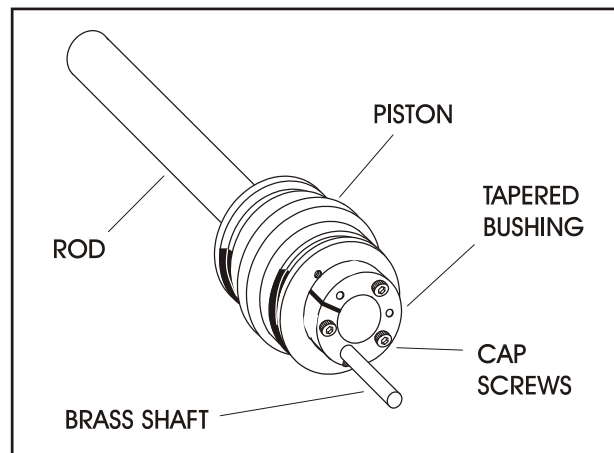


Figure 5-26. Seating the Tapered Bearing

- Retorque the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

12. Remove the cylinder rod from the holding fixture.
13. Place a new t-seal and wear rings in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

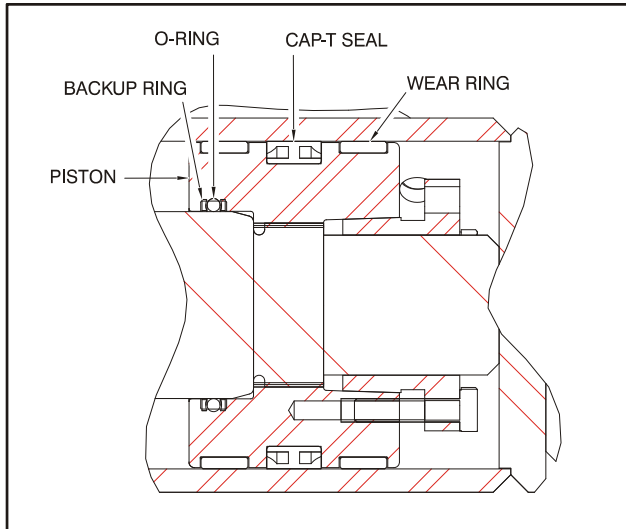


Figure 5-27. Piston Seal Kit Installation

14. 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.**

15. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston t-seal is not damaged or dislodged.
16. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

17. Secure the cylinder head gland using the washer ring, JLG Threadlocker PN 0100011 and socket head bolts. Torque to 35 ft.lbs. (47 Nm).

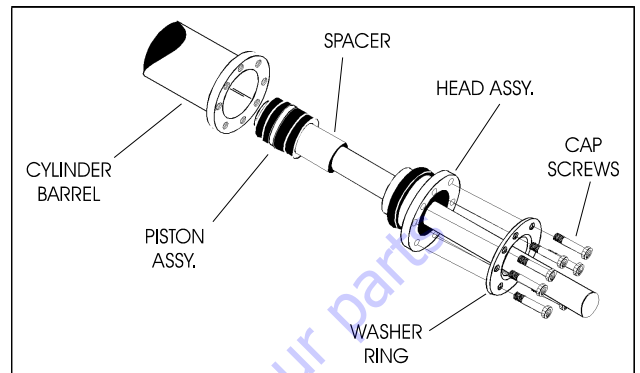


Figure 5-28. Rod Assembly Installation

18. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any valves.
19. Install the counterbalance valves in the rod port block.

## Axle Lockout 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. Remove the counterbalance valves from the cylinder port block. Discard o-rings.
4. If necessary, remove the bleeder valve.
5. Place the cylinder barrel into a suitable holding fixture.

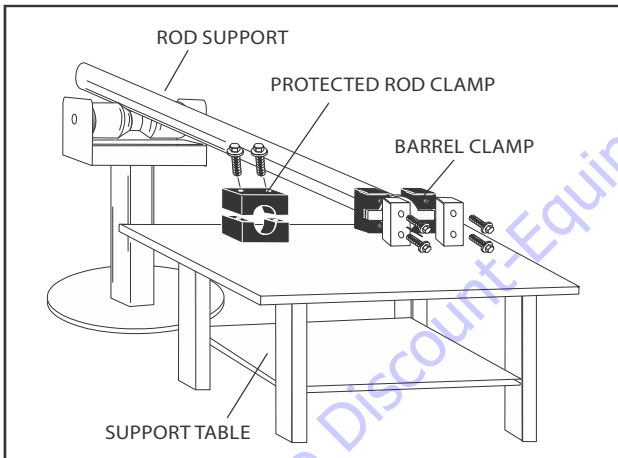


Figure 5-29. Cylinder Barrel Support

6. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

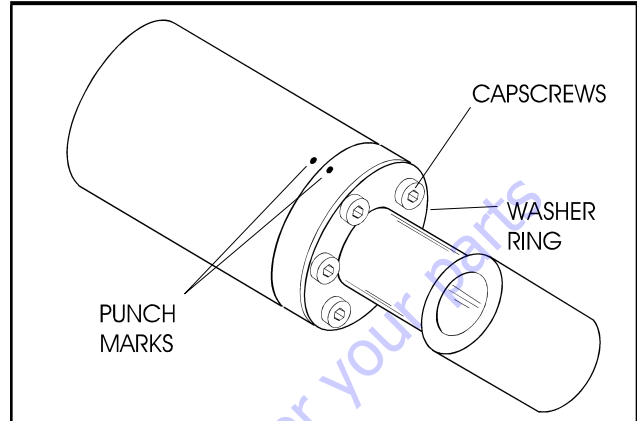


Figure 5-30. Cap Screw Removal

7. Attach a suitable pulling device to the cylinder rod end.

#### 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.

8. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.

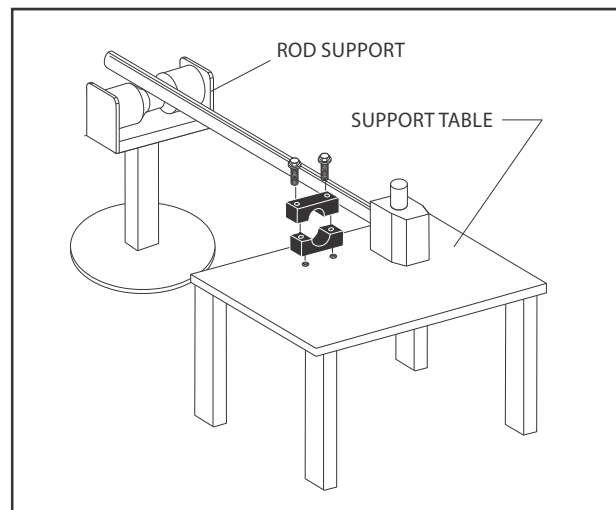
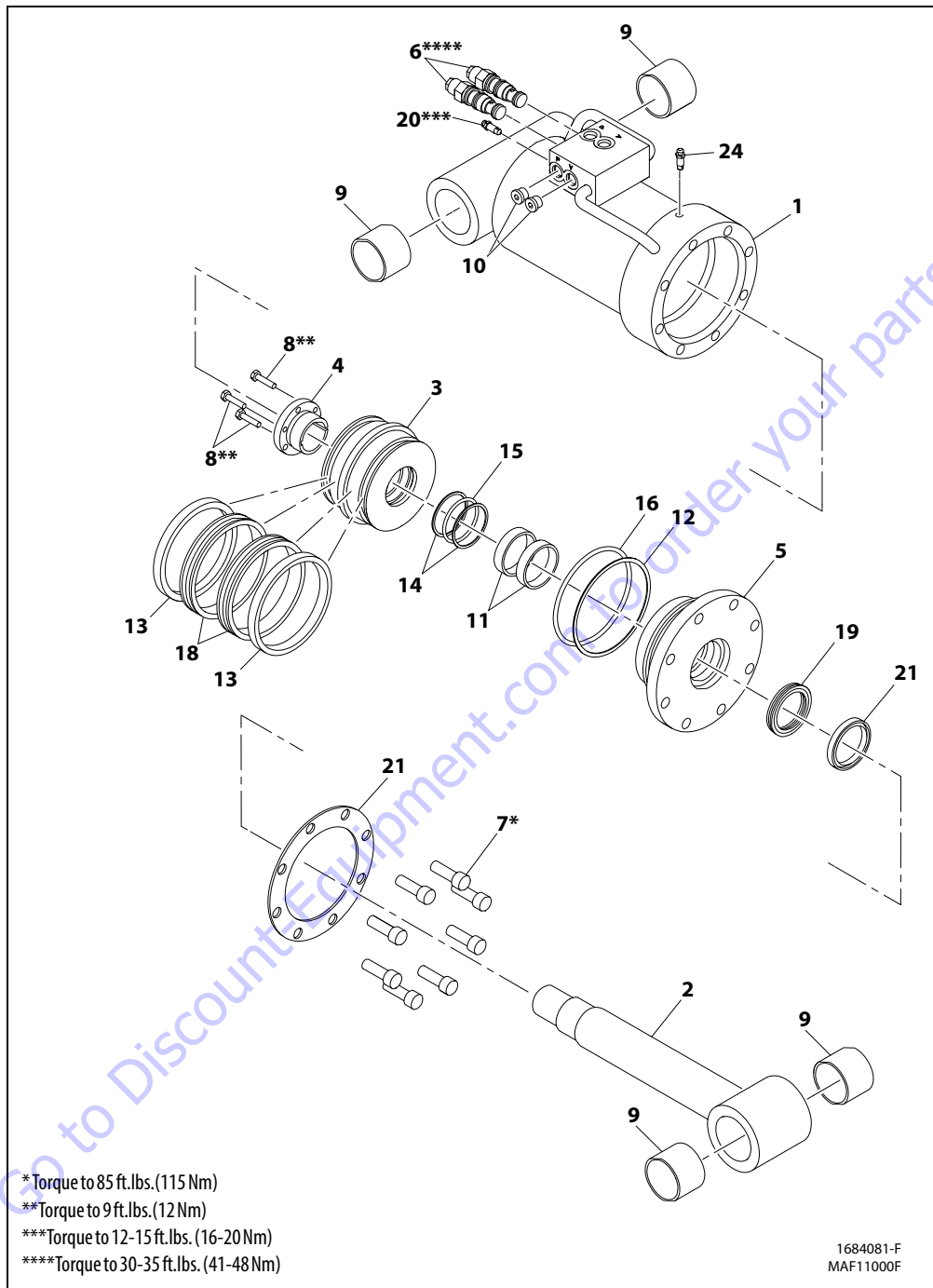
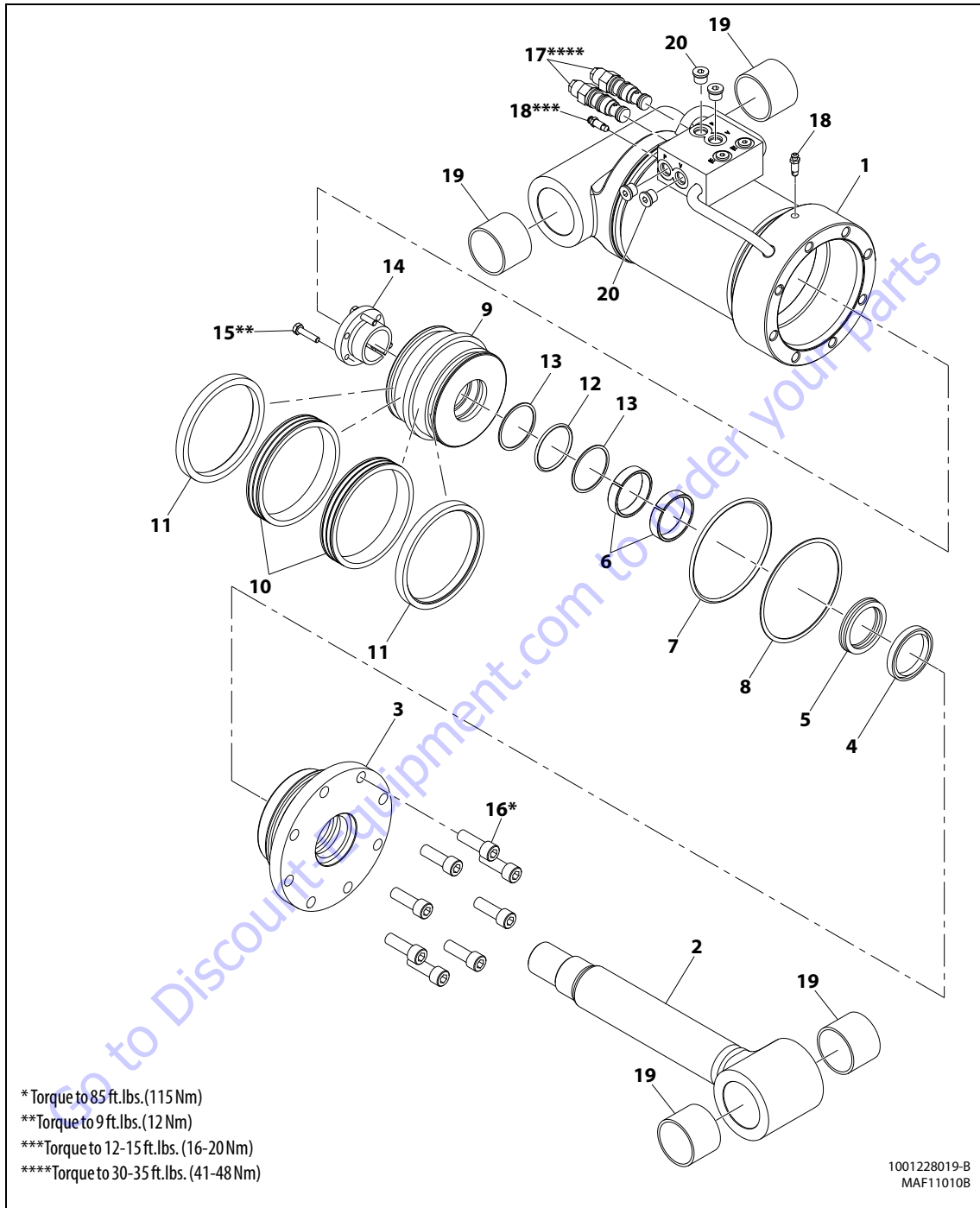


Figure 5-31. Cylinder Rod Support



- |            |                         |                 |                   |                 |
|------------|-------------------------|-----------------|-------------------|-----------------|
| 1. Barrel  | 6. Counterbalance Valve | 11. Wear Ring   | 16. O-ring        | 21. Washer Ring |
| 2. Rod     | 7. Capscrew             | 12. Backup Ring | 17. Wiper         |                 |
| 3. Piston  | 8. Bolt                 | 13. Lock Ring   | 18. Seal          |                 |
| 4. Bushing | 9. Bearing              | 14. Backup Ring | 19. Rod Seal      |                 |
| 5. Head    | 10. Plug                | 15. O-ring      | 20. Bleeder Valve |                 |

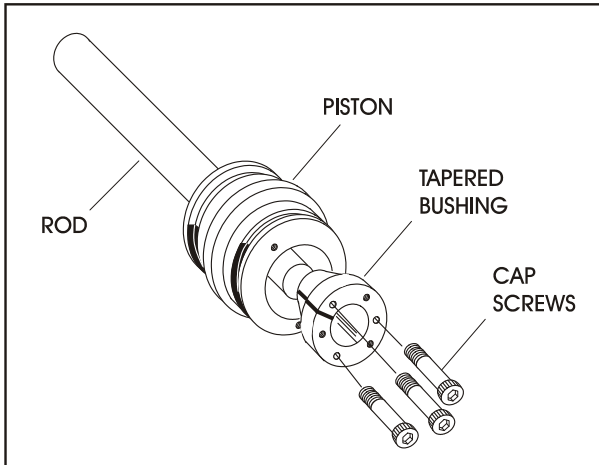
Figure 5-32. Axle Lockout Cylinder (SN 0300209000 through 0300239674)



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

Figure 5-33. Axle Lockout Cylinder (SN 0300239675 to Present)

9. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.
10. Loosen and remove the capscrews which attach the tapered bushing to the piston.



**Figure 5-34. Tapered Bushing Removal**

11. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose.
12. Remove the tapered bushing from the piston.
13. By hand, screw the piston counterclockwise and remove it from cylinder rod.
14. Remove and discard the piston o-rings, seal rings, and backup rings.
15. Remove the rod from the holding fixture. Remove the cylinder head gland and washer ring. 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.

## SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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.

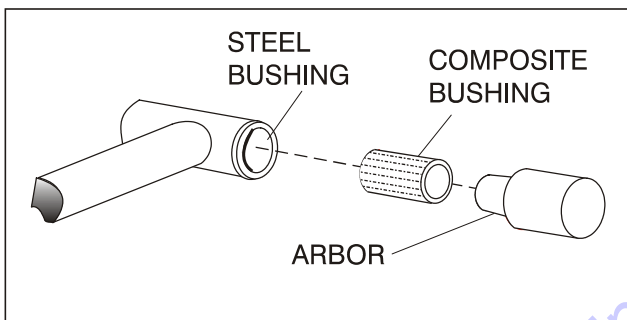


Figure 5-35. Composite Bearing Installation

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.

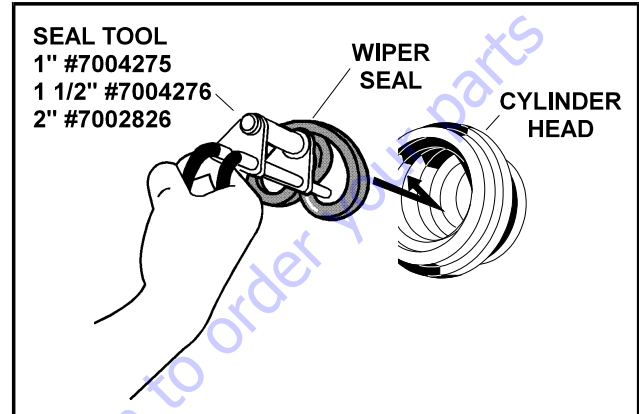


Figure 5-36. Rod Seal Installation

### NOTICE

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

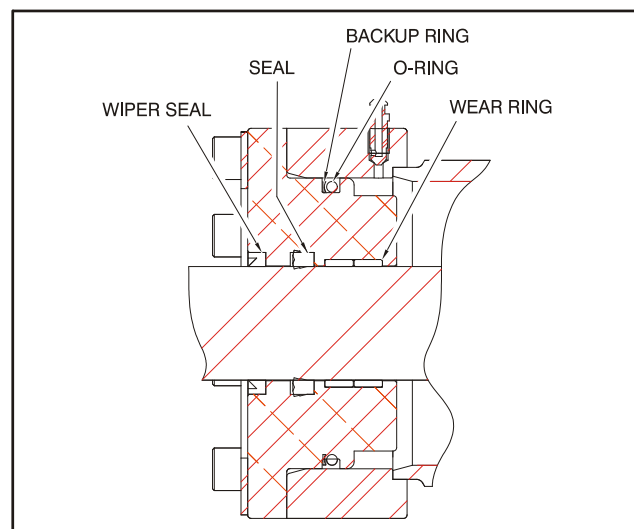


Figure 5-37. Cylinder Head Seal Installation



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

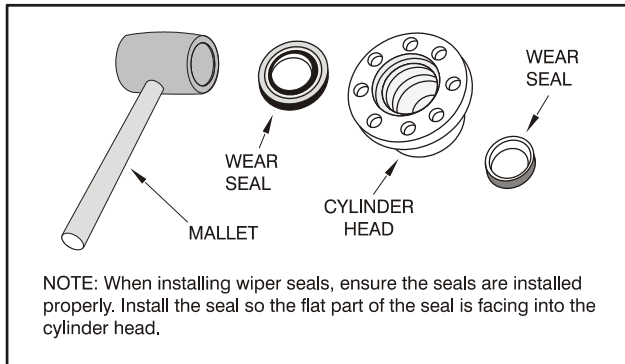


Figure 5-38. Wiper Seal Installation

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

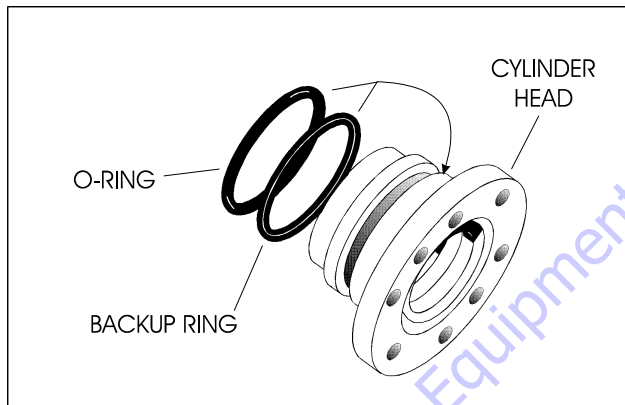


Figure 5-39. Installation of Head Seal Kit

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.
5. Place a new O-ring and backup rings 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. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.

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

8. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

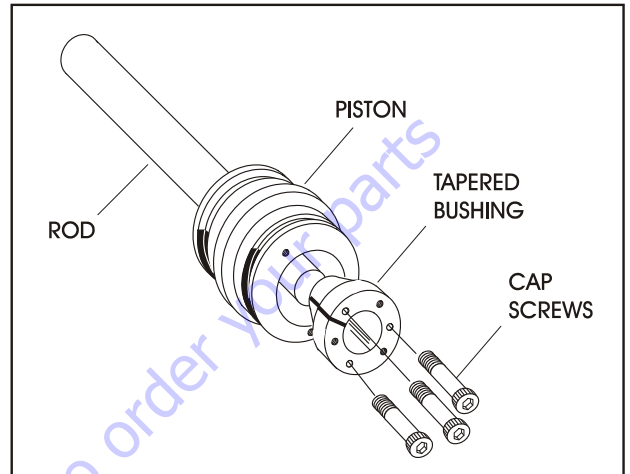


Figure 5-40. Tapered Bushing Installation

9. Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).
10. 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.

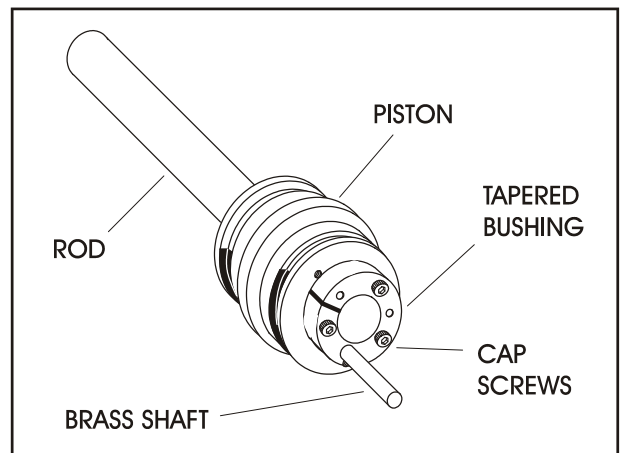


Figure 5-41. Seating the Tapered Bearing

11. Retorque the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

- Remove the cylinder rod from the holding fixture.

**NOTICE**

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

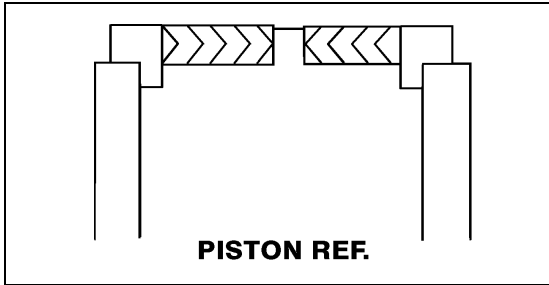


Figure 5-42. Hydrolock Piston Seal Installation

- Place new hydrolock seals in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

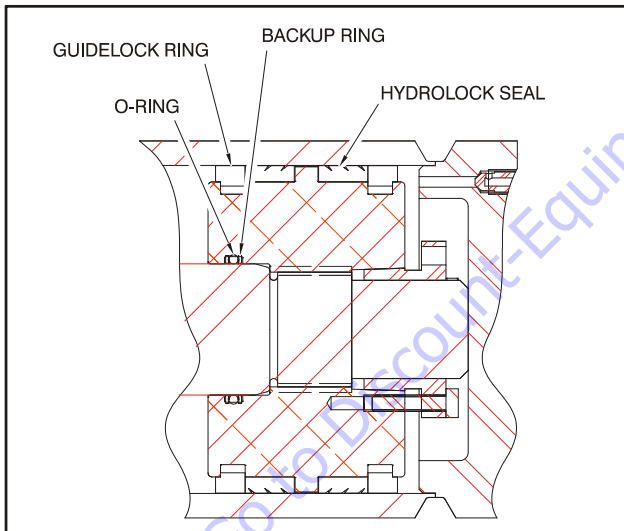


Figure 5-43. Piston Seal Installation

- 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.

- 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.
- Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
- Secure the cylinder head gland using the washer ring, JLG Threadlocker PN 0100011 and socket head bolts. Torque to 85 ft.lbs. (115 Nm).

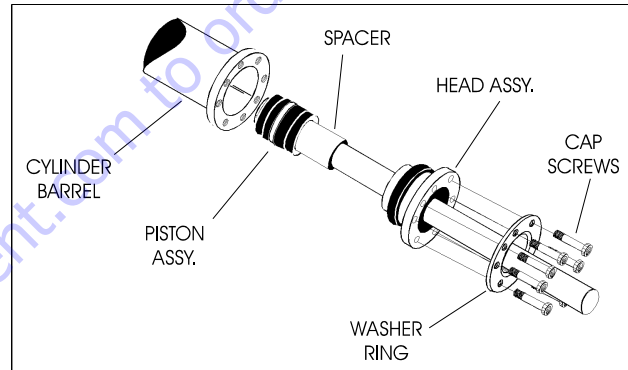


Figure 5-44. Rod Assembly Installation

- After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any valves.
- Install the counterbalance valves in the rod port block. Torque 30-35 ft.lbs. (41-48 Nm).
- If removed, install the bleeder valve. Torque 12 to 15 ft.lbs. (16 to 20 Nm).

**Jib Level Cylinder (SN 0300209000 through 0300239990)**

**DISASSEMBLY**

**NOTICE**

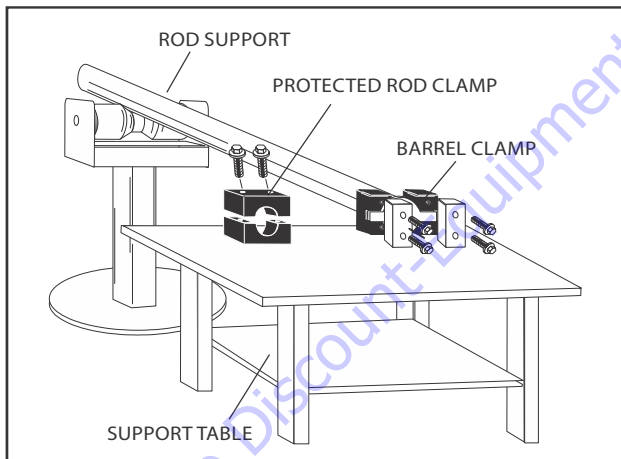
**DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.**

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

**NOTICE**

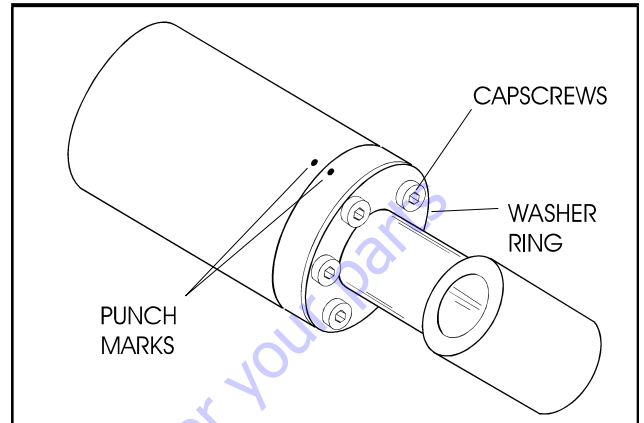
**DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.**

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. Remove the counterbalance valves from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.



**Figure 5-45. Cylinder Barrel Support**

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.



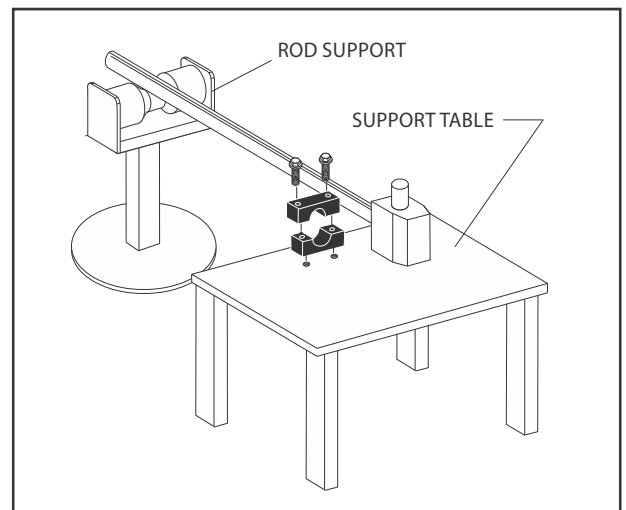
**Figure 5-46. Cap Screw Removal**

6. Attach a suitable pulling device to the cylinder rod end.

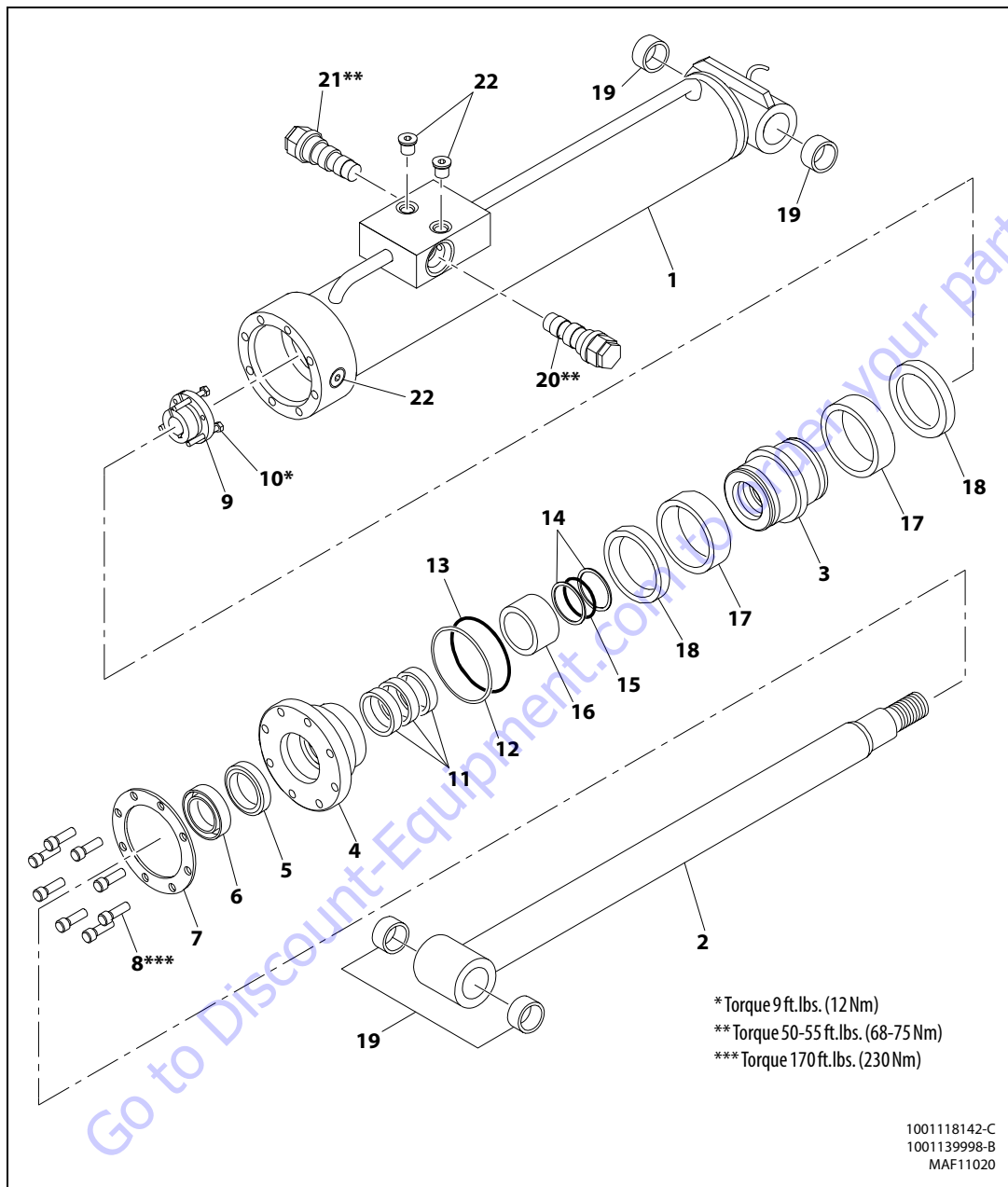
**NOTICE**

**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.**

7. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.



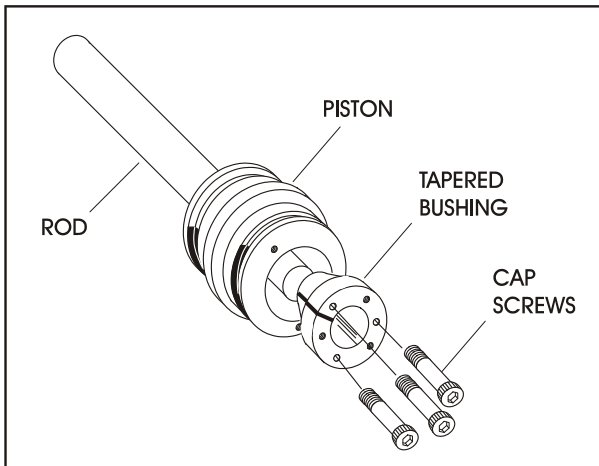
**Figure 5-47. Cylinder Rod Support**



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

Figure 5-48. Jib Level Cylinder

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 capscrews which attach the tapered bushing to the piston.



**Figure 5-49. Tapered Bushing Removal**

10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose.
11. Remove the tapered bushing from the piston.
12. By hand, screw the piston counterclockwise and remove it from cylinder rod.
13. Remove and discard the piston o-rings, seal rings, and backup rings.
14. Remove the piston spacer from the rod.
15. Remove the rod from the holding fixture. Remove the cylinder head gland and washer ring. 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.

## SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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.

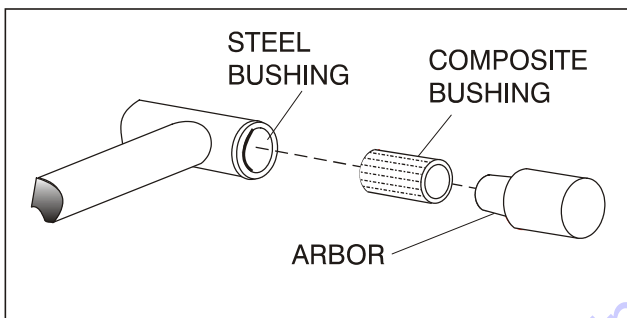


Figure 5-50. Composite Bearing Installation

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.

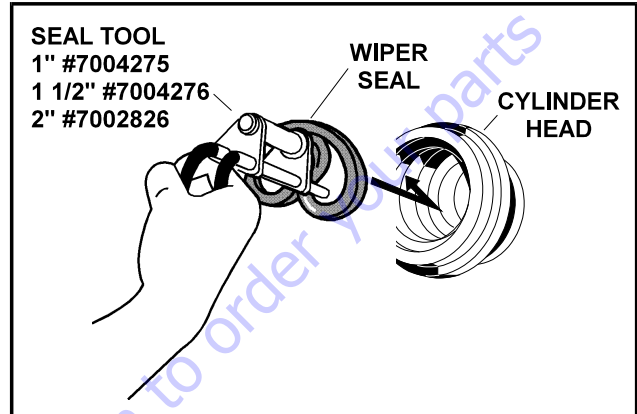


Figure 5-51. Rod Seal Installation

### NOTICE

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

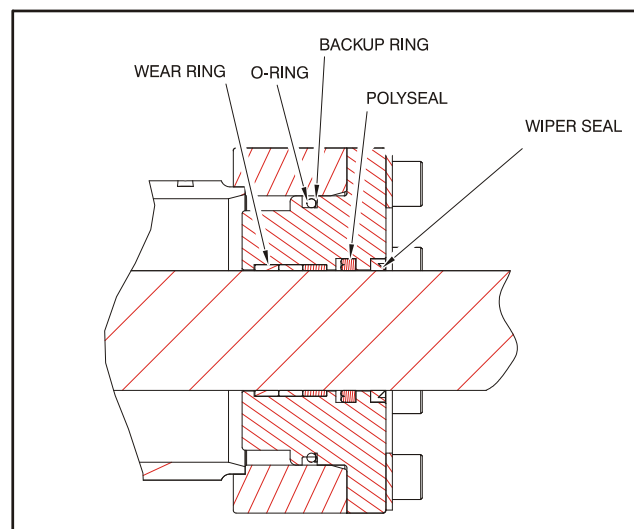


Figure 5-52. Cylinder Head Seal Installation

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

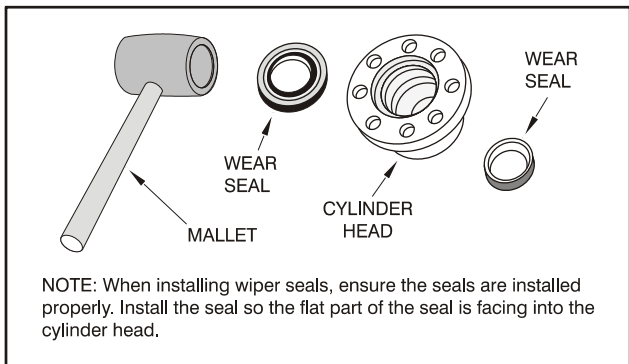


Figure 5-53. Wiper Seal Installation

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

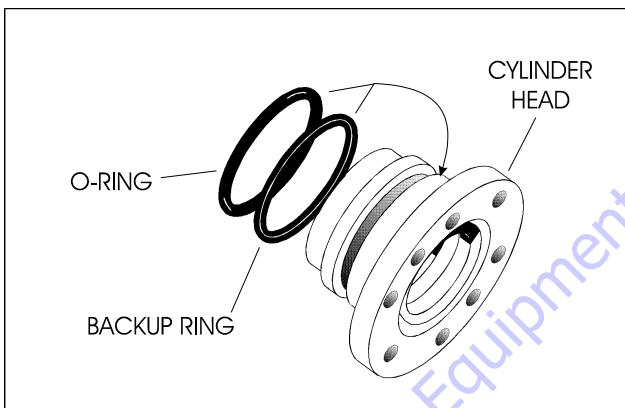


Figure 5-54. Installation of Head Seal Kit

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.
5. Push the spacer onto the rod.
6. Place a new O-ring and backup rings in the inner piston diameter groove.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.

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

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

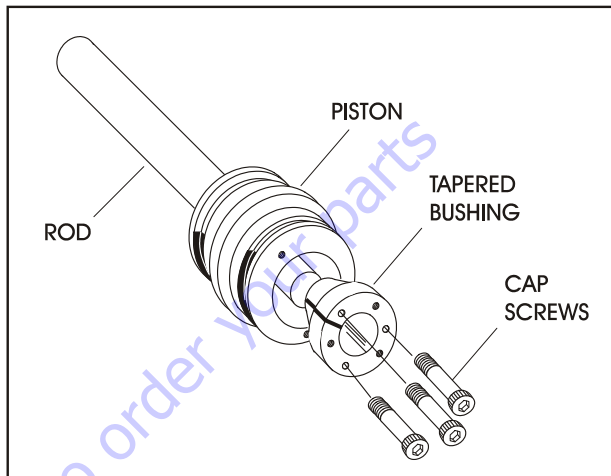


Figure 5-55. Tapered Bushing Installation

10. Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).
11. 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.

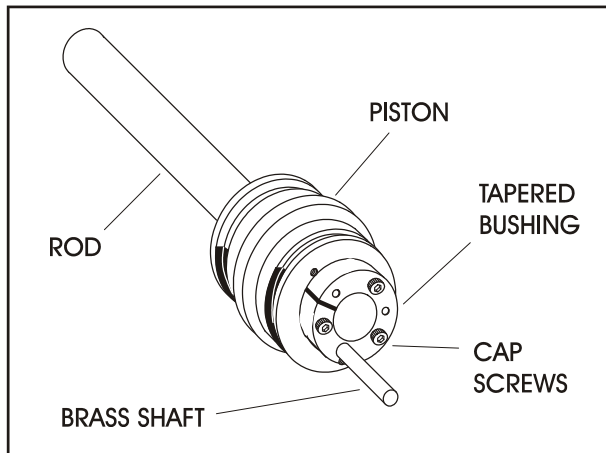


Figure 5-56. Seating the Tapered Bearing

12. Retorque the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

- Remove the cylinder rod from the holding fixture.

**NOTICE**

WHEN INSTALLING HYDROLOC PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

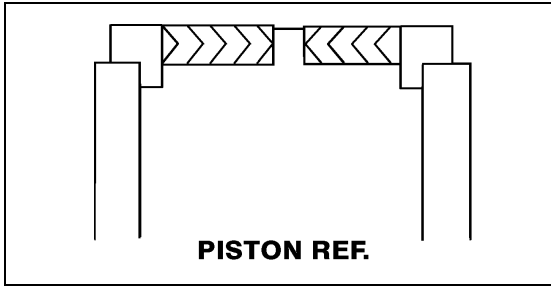


Figure 5-57. Hydrolock Piston Seal Installation

- Place new hydrolock seals in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

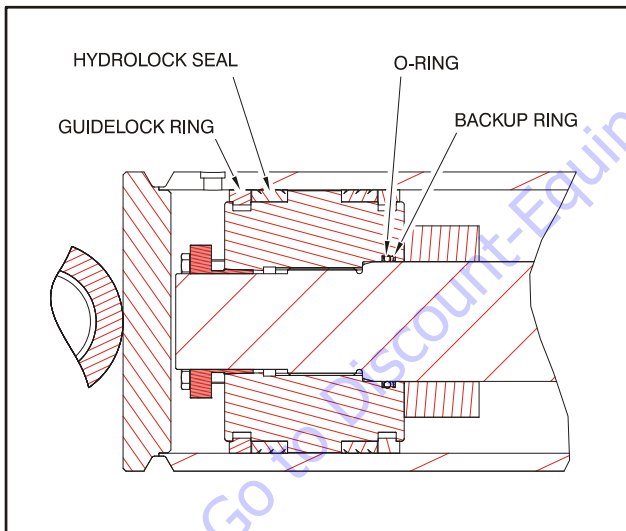


Figure 5-58. Piston Seal Installation

- 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.

- 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.
- Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
- Secure the cylinder head gland using the washer ring, JLG Threadlocker PN 0100011 and socket head bolts. Torque to 170 ft.lbs. (230 Nm).

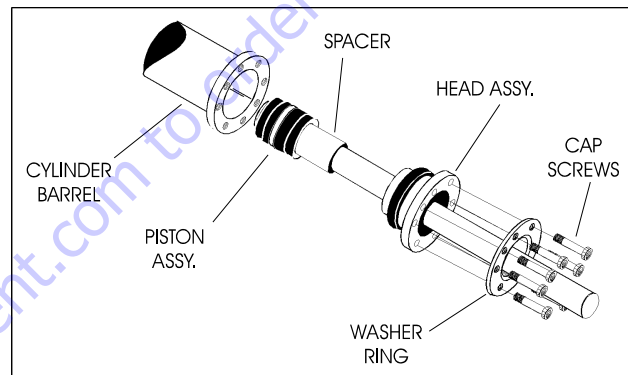


Figure 5-59. Rod Assembly Installation

- After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any valves.
- Install the counterbalance valves in the rod port block. Torque 50-55 ft.lbs. (68-75 Nm).



**Jib Level Cylinder (SN 0300239991 to Present)**

**DISASSEMBLY**

**NOTICE**

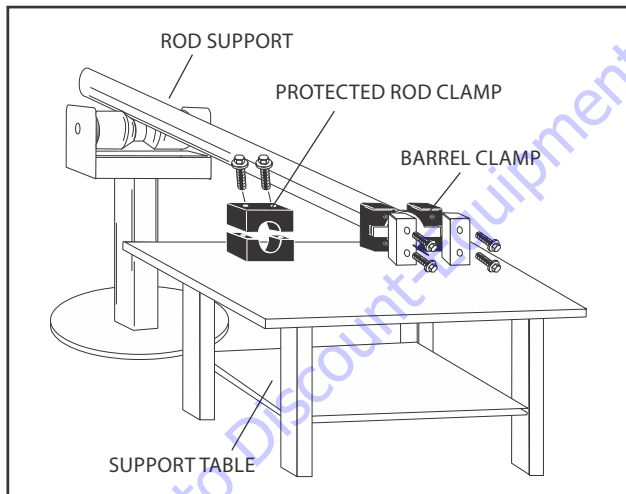
**DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.**

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

**NOTICE**

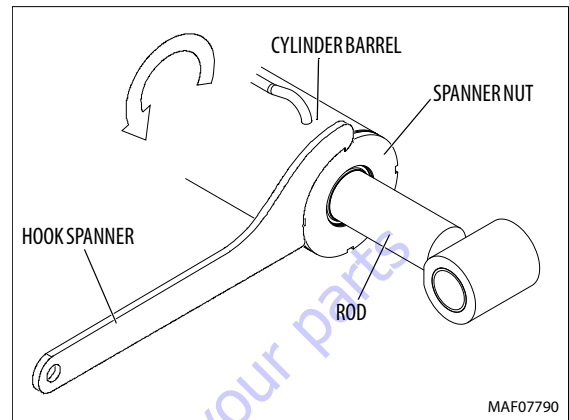
**DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.**

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. Remove the counterbalance valves from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.



**Figure 5-60. Cylinder Barrel Support**

5. Unscrew cylinder head with hook spanner wrench.



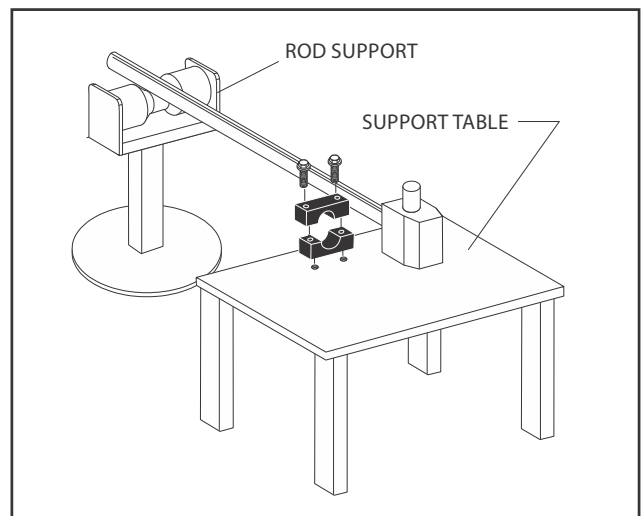
**Figure 5-61. Cylinder Head Removal**

6. Attach a suitable pulling device to the cylinder rod port-block end or cylinder rod end, as applicable.

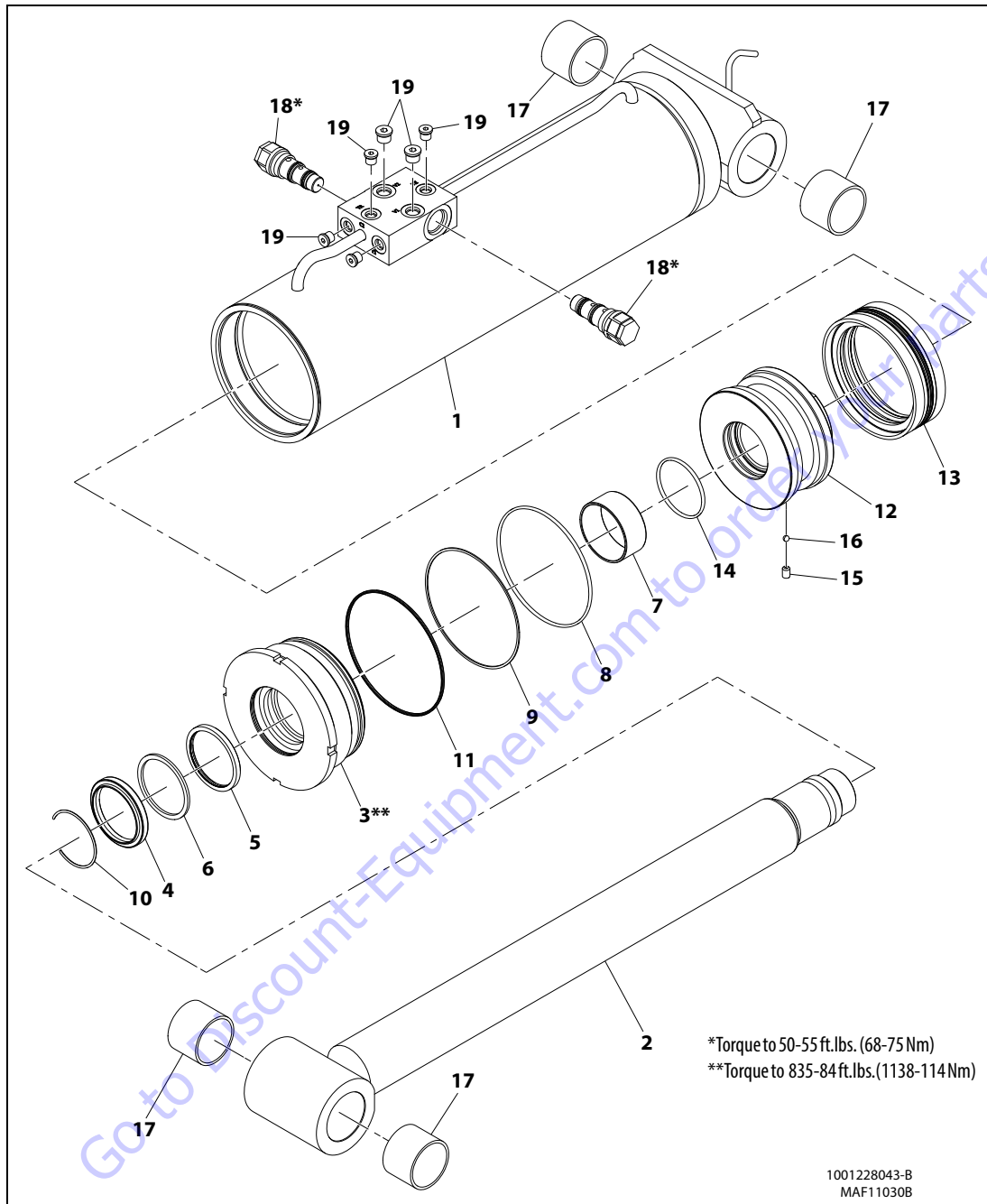
**NOTICE**

**PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.**

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



**Figure 5-62. Cylinder Rod Support**



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

Figure 5-63. Jib Level Cylinder

9. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
10. Loosen and remove the setscrew (16) and Steel ball (15) which attaches the piston to the rod.
11. Screw the piston (12) counterclockwise and remove the piston from cylinder rod (2).

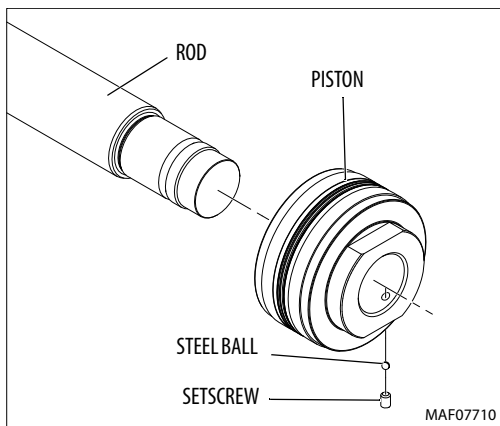


Figure 5-64. Piston Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

12. Remove and discard the piston seal (13) from outside grooves of piston (12).
13. Remove and discard the o-ring (14) from inside grooves of piston (12).

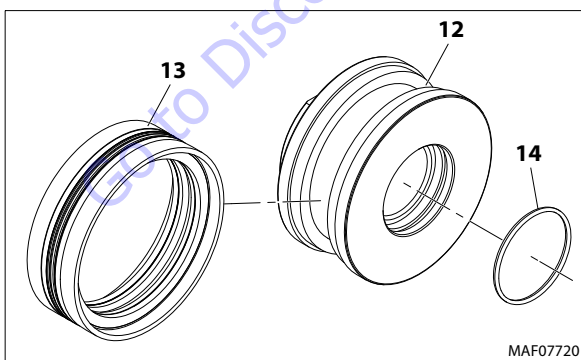


Figure 5-65. Piston Seal Disassembly

14. Remove rod from holding fixture and remove cylinder head (3).
15. Remove and discard wear ring (7), wiper seals (4), retainer ring (10), backup ring (6) and rod seal (5) from inside of cylinder head (3).
16. Remove and discard O-ring (8), backup ring (9) and O-ring (11) from outside grooves of cylinder head (3).

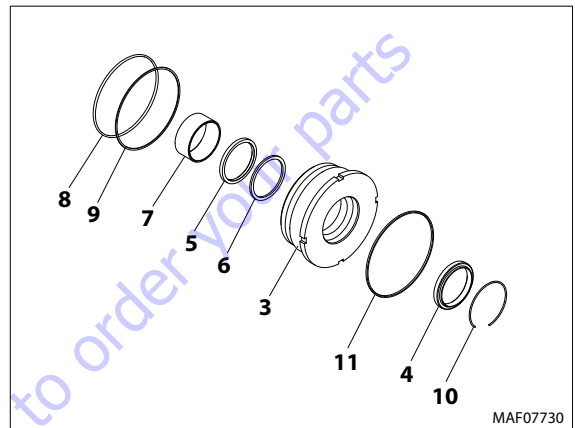
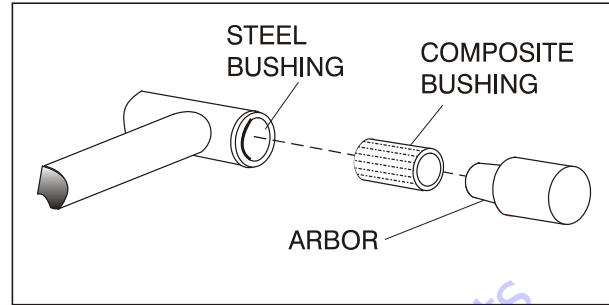


Figure 5-66. Cylinder Head Disassembly

**CLEANING AND INSPECTION**

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect 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, scoring, or 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 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, damage, ovality, and tapering. Replace as necessary.
13. 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. Press bushing in barrel or rod bushing with correct size arbor.



**Figure 5-67. Bushing Installation**

14. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. Inspect port block fittings and holding valves. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**NOTE:** Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

ASSEMBLY

**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

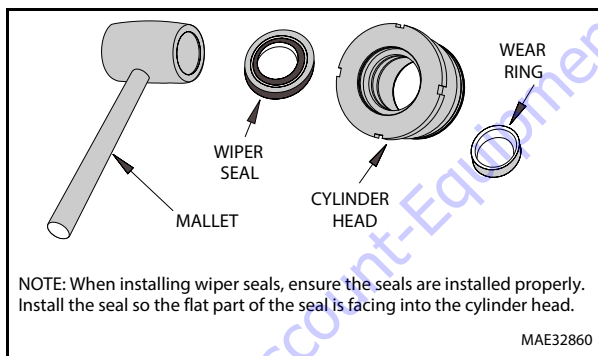
**NOTE:** Apply a light film of hydraulic oil to all components before assembly.

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

**NOTICE**

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

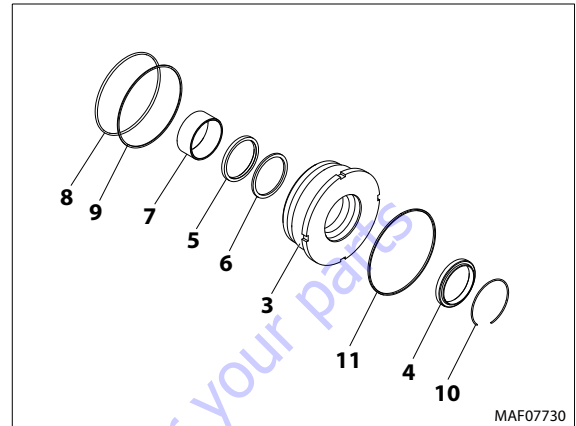
2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head groove. Install a new bearing into the applicable inside diameter of the cylinder head groove.



**Figure 5-68. Wiper Seal Installation**

3. Install wear ring (7), wiper seals (4), retainer ring (10), backup ring (6) and rod seal (5) in inside grooves of cylinder head (3).

4. Install o-ring (8), backup ring (9) and o-ring (11) in outside grooves of cylinder head (3).



**Figure 5-69. Cylinder Head Assembly**

5. Carefully install the cylinder head (3) on the rod (2), ensuring that the wiper seal (4), wear ring (7), backup rings (6), rod seal (5) and backup rings (9) are not damaged or dislodged. Push the head (3) along the rod (2) to the rod end, as applicable.
6. Using suitable protection, clamp the cylinder rod (2) in a vise or similar holding fixture as close to piston as possible.
7. Place new o-ring (14) in the inside diameter of the piston (12).
8. Carefully thread the piston (12) on the cylinder rod (2), ensuring that the o-ring (14) and seal (13) are not damaged or dislodged.
9. Install the setscrew (15) and ball (16) on the piston and attach the piston on the rod.
10. Remove the cylinder rod (2) from the holding fixture.

- Place new piston seal (13) in the outer diameter of piston (12) groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

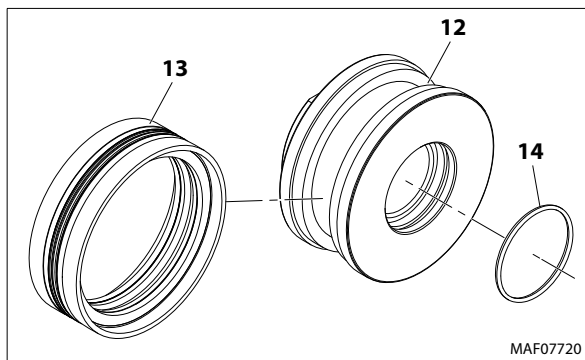


Figure 5-70. Piston Seal Installation

- After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any plugs.
- Install the plugs (19) in the cylinder ports.
- Install two counterbalance valves (3) with new O-rings in valve block. Torque to 50-55 ft-lb (68-75 Nm).

- 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.**

- With barrel clamped secured and adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and piston seal is not damaged or dislodged.
- Continue pushing the rod into the barrel until the cylinder head can be inserted into the barrel cylinder.
- Screw the cylinder head into the barrel using a hook spanner wrench. Torque to 835-84 ft.lbs (1138-114 Nm).

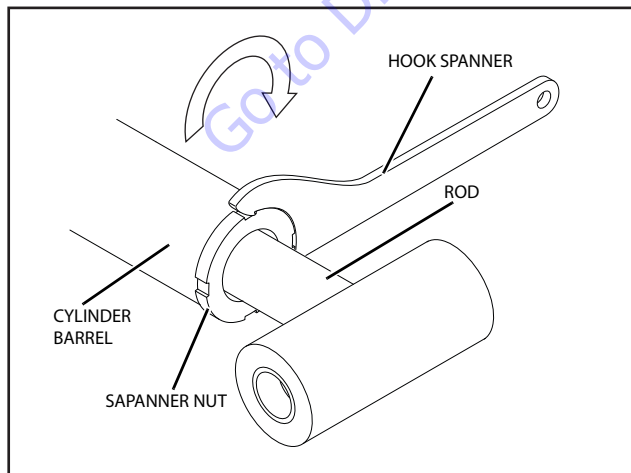


Figure 5-71. Cylinder Head Tightening

**Platform Level Cylinder (SN 0300209000 through 0300239674)**

**DISASSEMBLY**

**NOTICE**

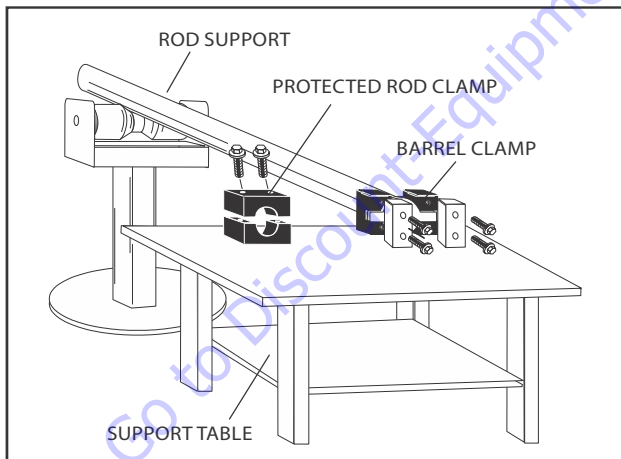
**DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.**

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. Remove the cylinder length sensor from the cylinder. See Section 5.4, Cylinder Length Sensor.
4. Remove the counterbalance valves from the cylinder port block. Discard o-rings.
5. Place the cylinder barrel into a suitable holding fixture.



**Figure 5-72. Cylinder Barrel Support**

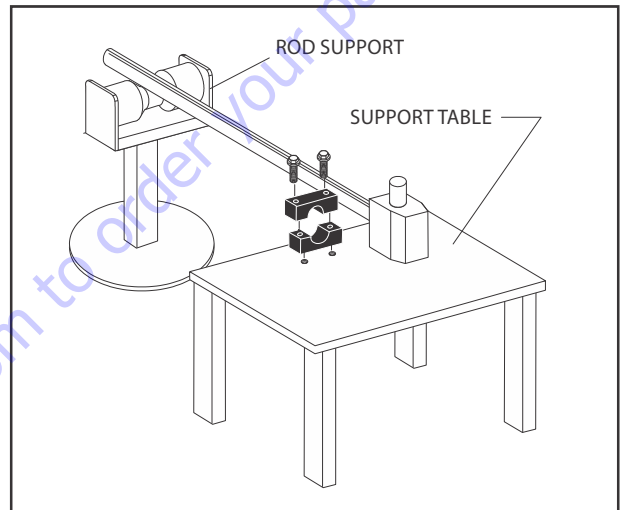
6. Remove the self-tapping screw from cylinder barrel.

7. Using a spanner wrench, unscrew the cylinder head from the barrel.
8. Attach a suitable pulling device to the cylinder rod end.

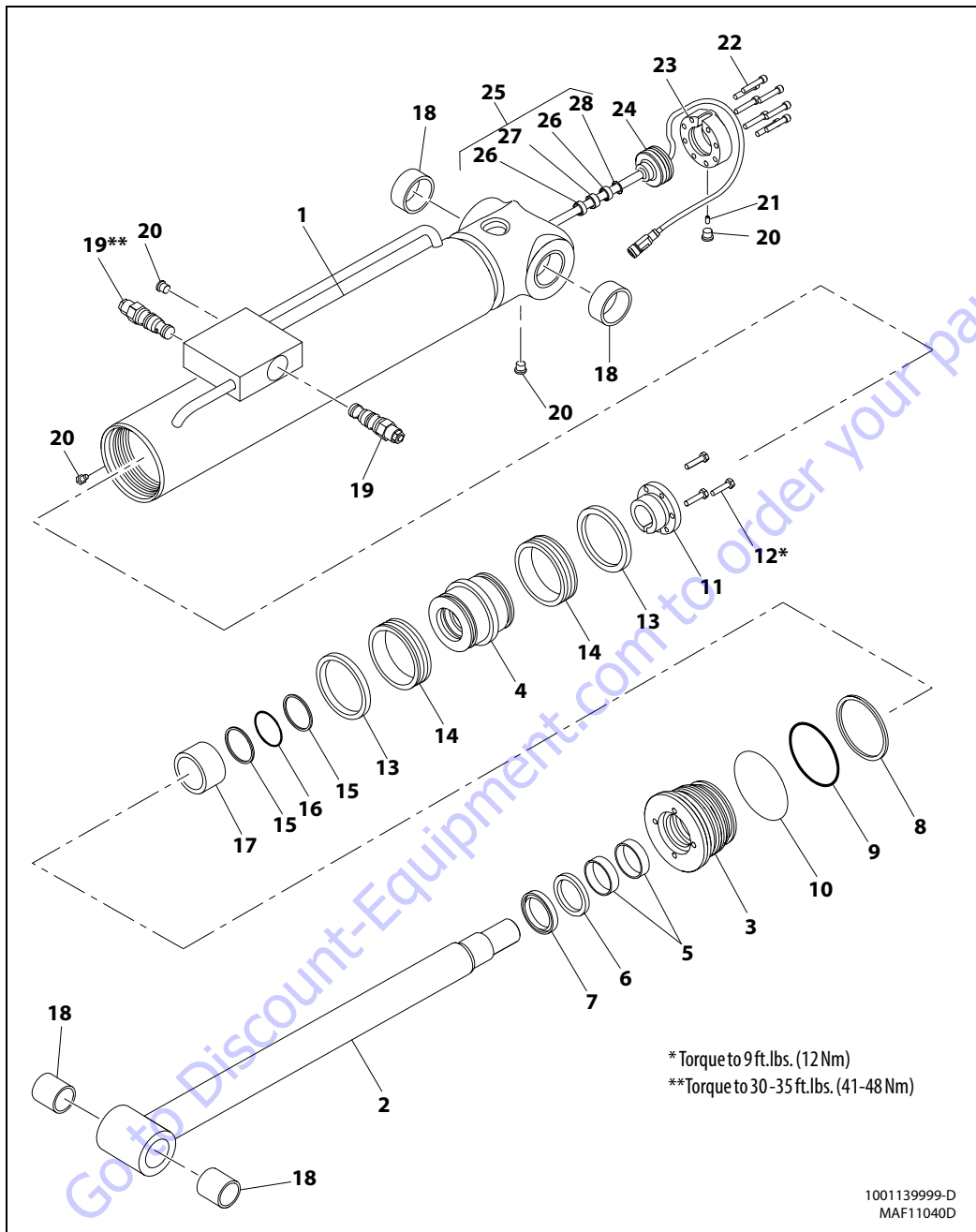
**NOTICE**

**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.**

9. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.



**Figure 5-73. Cylinder Rod Support**

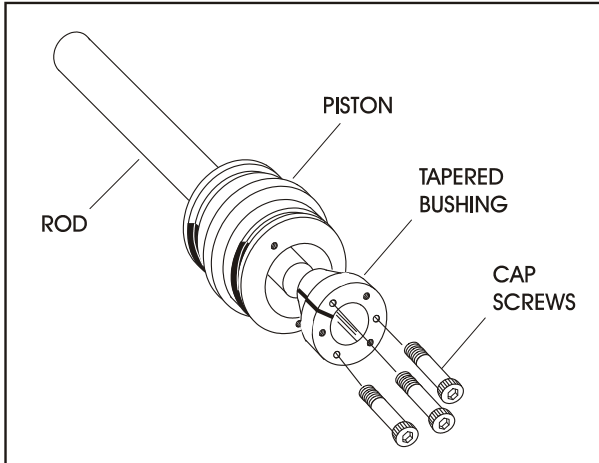


- |              |                     |                 |                            |                             |
|--------------|---------------------|-----------------|----------------------------|-----------------------------|
| 1. Barrel    | 7. Rod Wiper        | 13. Lock Ring   | 19. Counterbalance Valve   | 25. Sensor Magnet           |
| 2. Rod       | 8. Backup Ring      | 14. Seal        | 20. Plug                   | 26. Spacer Sleeve           |
| 3. Head      | 9. O-rings          | 15. Backup Ring | 21. Setscrew               | 27. Magnet Sensor           |
| 4. Piston    | 10. O-ring          | 16. O-ring      | 22. Capscrew               | 28. Internal Retaining Ring |
| 5. Wear Ring | 11. Tapered Bushing | 17. Spacer      | 23. Retainer cap           |                             |
| 6. Rod Seal  | 12. Bolt            | 18. Bushing     | 24. Cylinder length Sensor |                             |

Figure 5-74. Platform Level Cylinder



10. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.
11. Loosen and remove the capscrews which attach the tapered bushing to the piston.



**Figure 5-75. Tapered Bushing Removal**

12. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose.
13. Remove the tapered bushing from the piston.
14. By hand, screw the piston counterclockwise and remove it from cylinder rod.
15. Remove and discard the piston o-rings, seal rings, and backup rings.
16. Remove the piston spacer from the rod.
17. If necessary, remove the retaining ring, sensor magnet, and spacer sleeve from the cylinder rod.
18. Remove the rod from the holding fixture. Remove the cylinder head gland and 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.

## SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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.

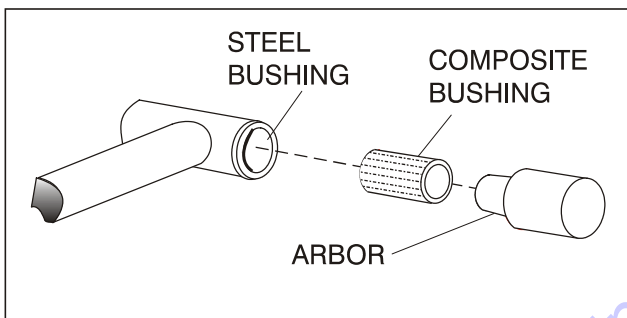


Figure 5-76. Composite Bearing Installation

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.

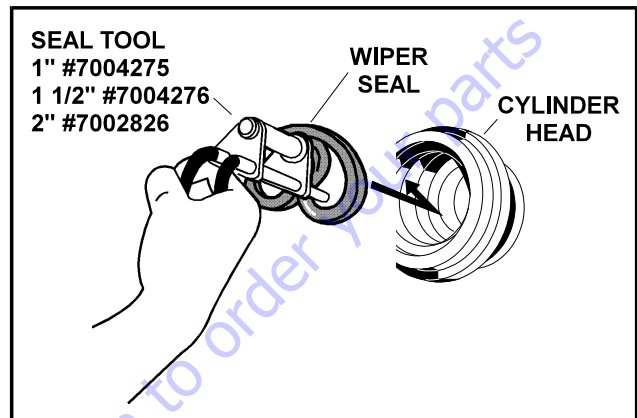


Figure 5-77. Rod Seal Installation

### NOTICE

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

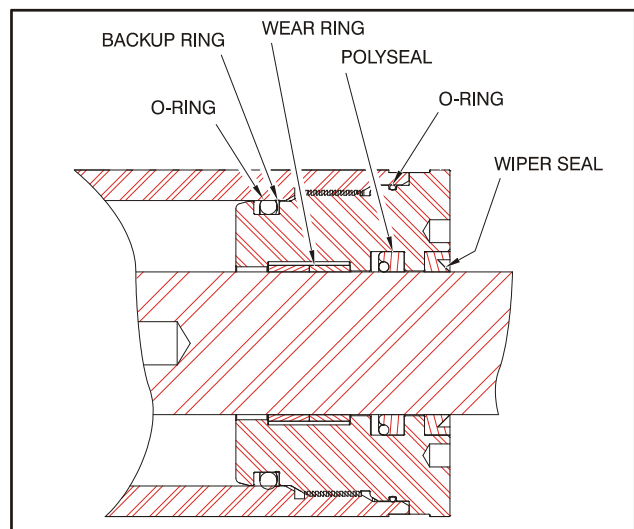


Figure 5-78. Cylinder Head Seal Installation

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

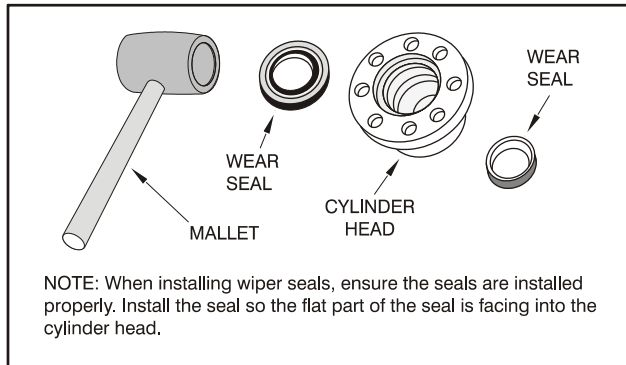


Figure 5-79. Wiper Seal Installation

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

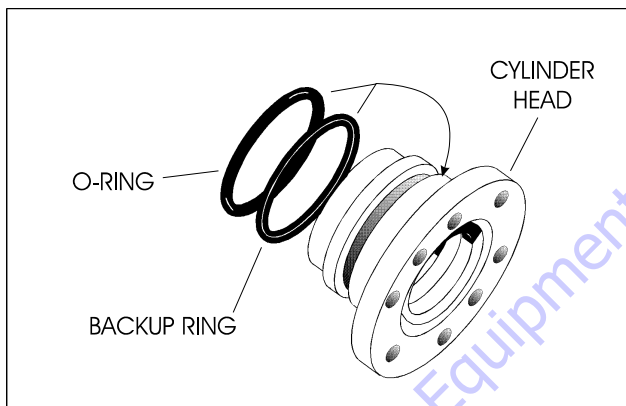


Figure 5-80. Installation of Head Seal Kit

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.
5. Push the spacer onto the rod.
6. Place a new O-ring and backup rings in the inner piston diameter groove.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.

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

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

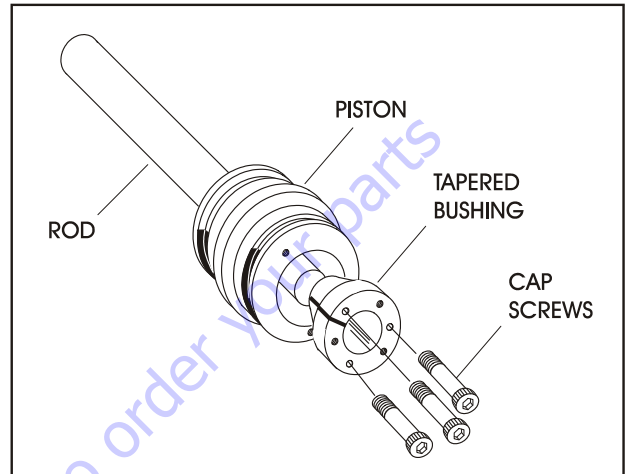


Figure 5-81. Tapered Bushing Installation

10. Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).
11. 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.

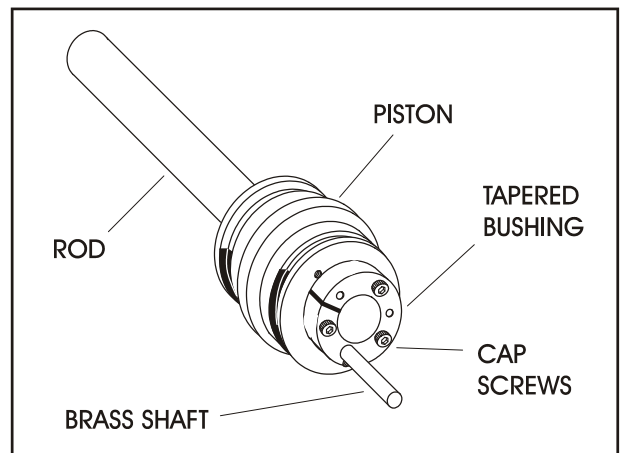


Figure 5-82. Seating the Tapered Bearing

12. Retorque the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

13. If removed, install the spacer sleeve, sensor magnet, and retaining ring.
14. Remove the cylinder rod from the holding fixture.

**NOTICE**

WHEN INSTALLING HYDROLOC PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

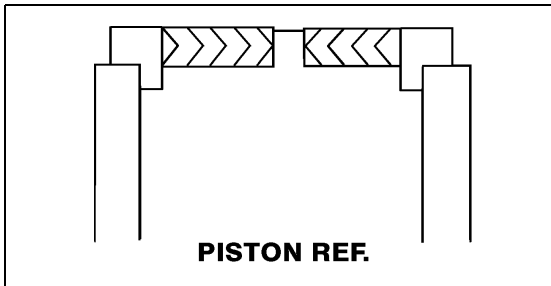


Figure 5-83. Hydrolock Piston Seal Installation

15. Place new hydrolock seals in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

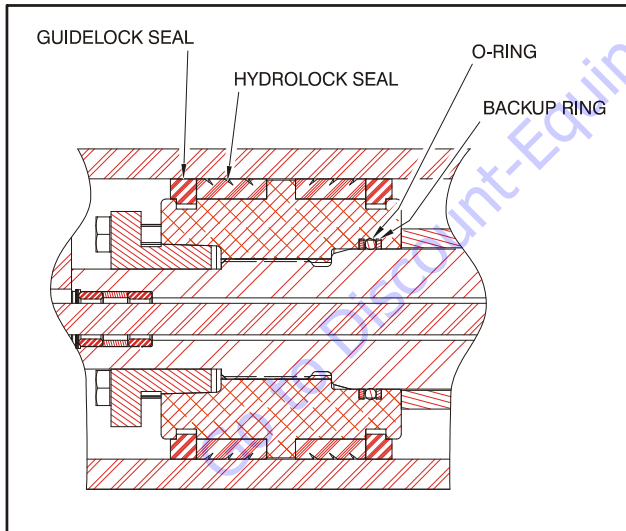


Figure 5-84. Piston Seal Installation

16. 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.

17. 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.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
19. Screw the cylinder head gland into the barrel using a spanner wrench.
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any valves.
21. Install the counterbalance valves in the rod port block. Torque 30 to 35 ft.lbs. (41-48 Nm).
22. Install the cylinder length sensor. See Section 5.4, Cylinder Length Sensor.

**Platform Level Cylinder (SN 0300239675 to Present)**

**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 cylinder port fitting.

**NOTICE**

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

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. Remove the cylinder length sensor from the cylinder. See Section 5.4, Cylinder Length Sensor.
4. Remove the counterbalance valves from the cylinder port block. Discard o-rings.
5. Place cylinder barrel in a suitable holding fixture.

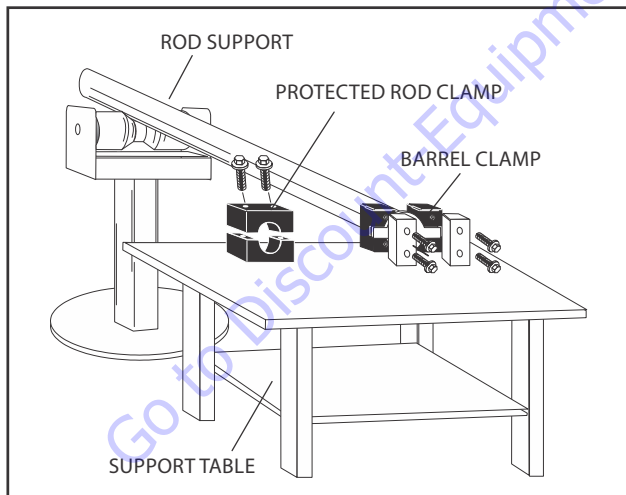


Figure 5-85. Cylinder Barrel Support

6. Unscrew cylinder head with hook spanner wrench.

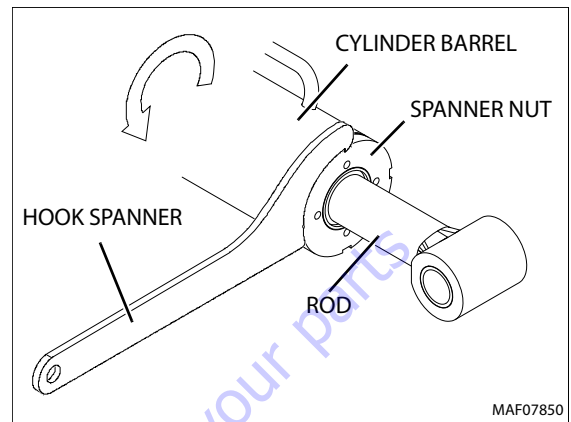


Figure 5-86. Cylinder Head Installation

7. Attach a suitable pulling device to the cylinder rod end.

**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.

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

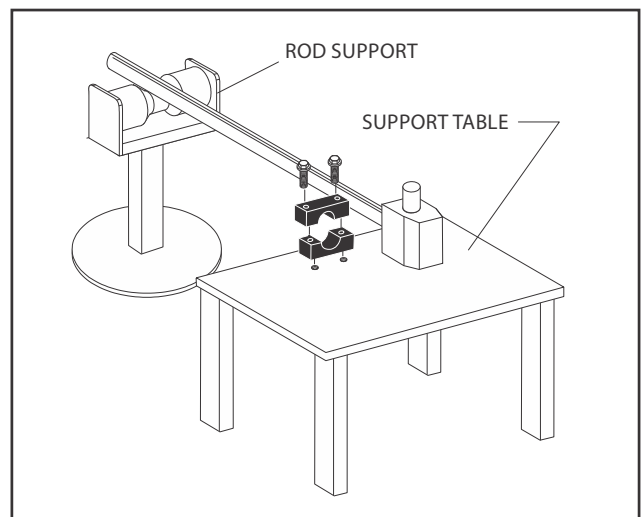
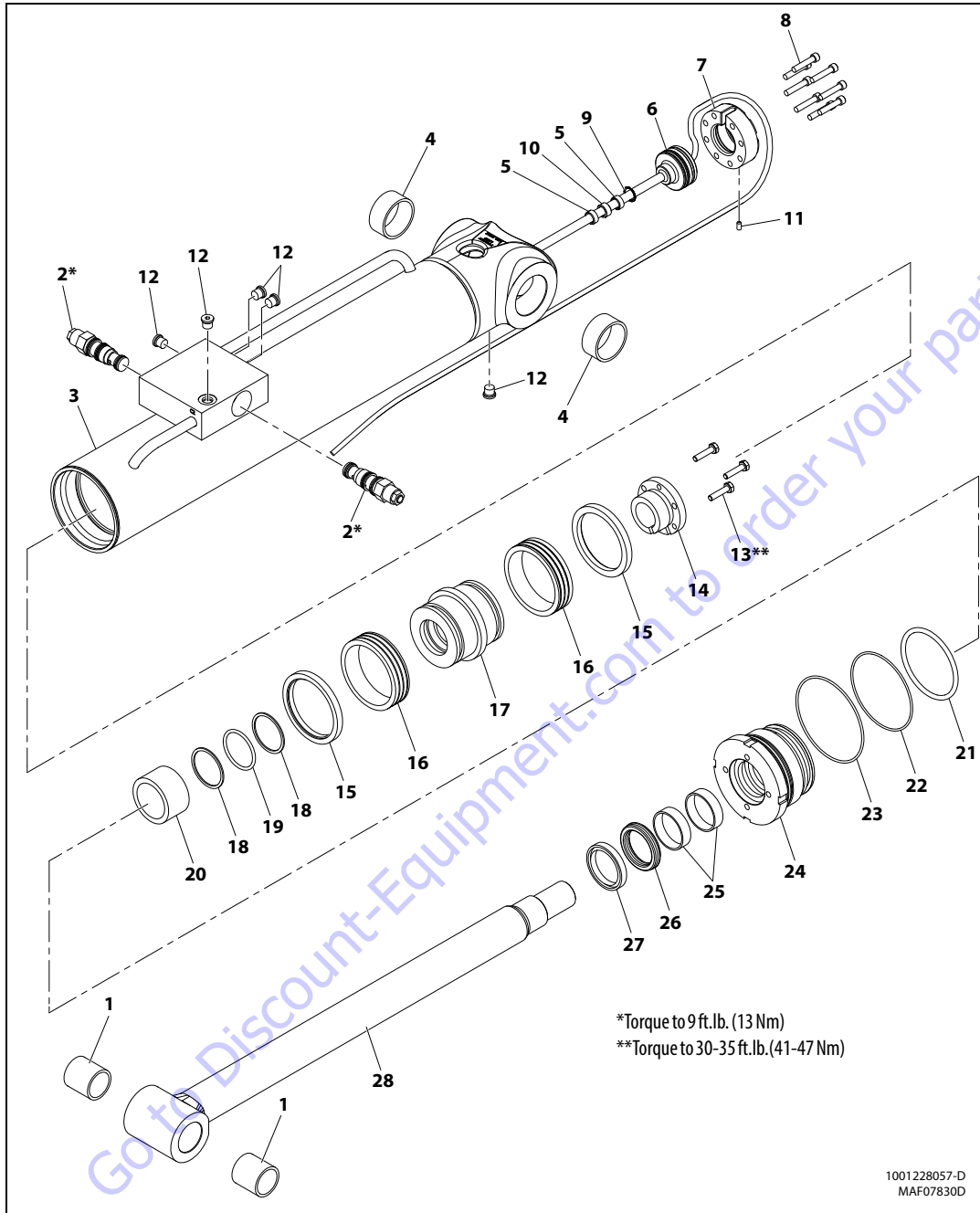


Figure 5-87. Cylinder Rod Support

**SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS**



- |                         |                   |                     |                 |                 |               |
|-------------------------|-------------------|---------------------|-----------------|-----------------|---------------|
| 1. Bushing              | 6. Length Sensor  | 11. Setscrew        | 16. Lock Ring   | 21. Backup Ring | 26. Seal      |
| 2. Counterbalance Valve | 7. Retainer Cap   | 12. Plug            | 17. Piston      | 22. O-Ring      | 27. Rod Wiper |
| 3. Barrel               | 8. Capscrew       | 13. Capscrew        | 18. Backup Ring | 23. O-Ring      | 28. Rod       |
| 4. Bushing              | 9. Retaining Ring | 14. Tapered Bushing | 19. O-Ring      | 24. Head        |               |
| 5. Spacer Sleeve        | 10. Sensor Magnet | 15. Guidelock Ring  | 20. Spacer      | 25. Wear Ring   |               |

**Figure 5-88. Platform Level Cylinder Assembly**

10. Loosen and remove Capscrews (13) from tapered bushing (14) and piston (17).
11. Insert capscrews (13) in threaded holes in outer piece of tapered bushing (14). Progressively tighten capscrews (13) until tapered bushing (14) is loose. Remove tapered bushing (14) from piston (17).

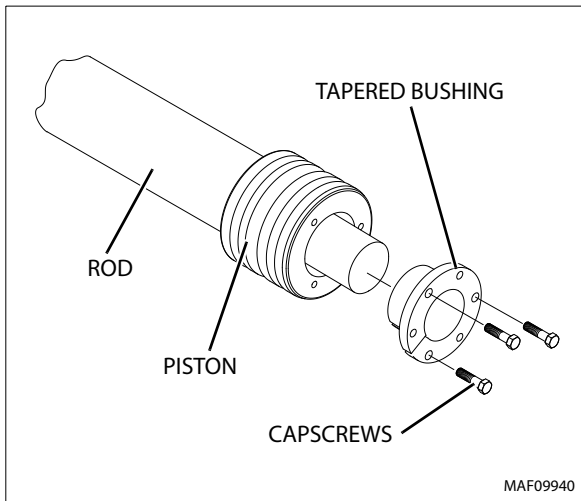


Figure 5-89. Tapered Bushing Removal

12. Screw piston (17) counter-clockwise by hand and remove from cylinder rod (28).

**NOTICE**

**REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.**

13. Remove and discard two guidelock ring (15), lock rings (16), backup rings (18), O-ring (19) from piston (17).
14. Remove piston spacer (20) from cylinder rod (28).

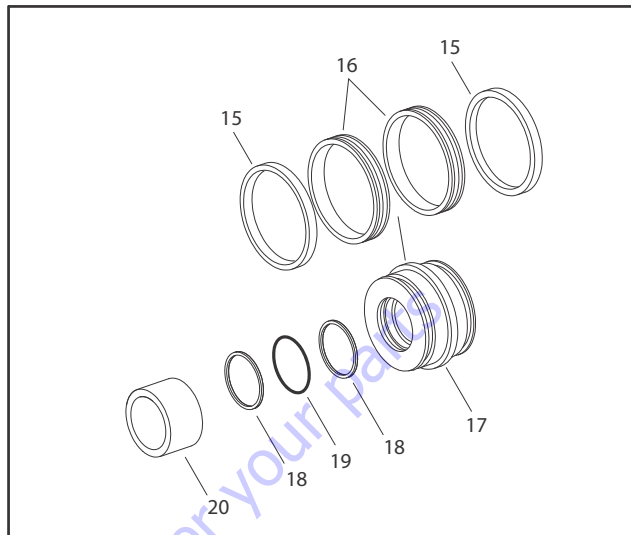


Figure 5-90. Piston Disassembly

15. Remove cylinder rod (28) from holding fixture. Remove cylinder head (24).
16. Remove and discard backup ring (21), O-ring (22), O-ring (23), rod wiper (27), seal (26), and two wear rings (25), from cylinder head (24).

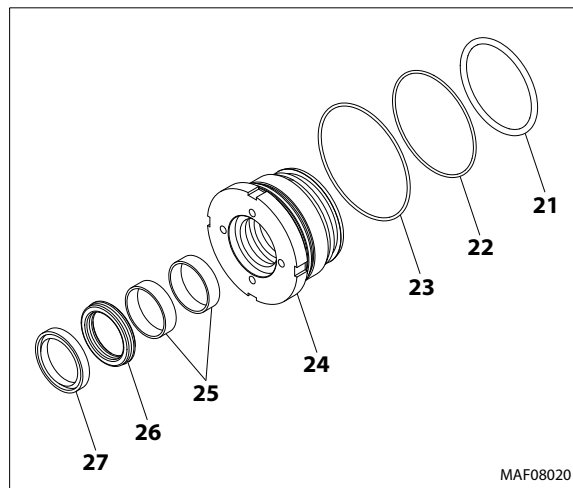
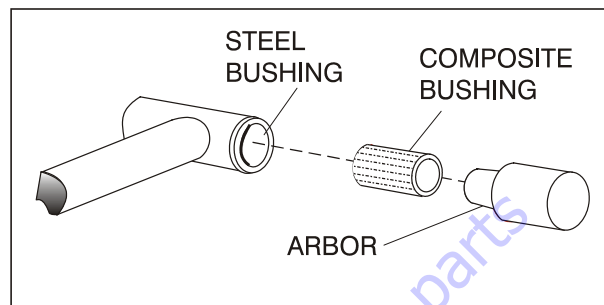


Figure 5-91. Cylinder Head Disassembly

### CLEANING AND INSPECTION

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect 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, scoring, or 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 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, damage, ovality, and tapering. Replace as necessary.
13. Inspect cylinder length sensor components for damage. Replace as needed.
14. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before installing bushings.
  - d. Press bushing into barrel or rod bushing with correct size arbor.

**NOTE:** Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.



**Figure 5-92. Composite Bushing Installation**

15. Inspect port block fittings and holding valve. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

### ASSEMBLY

**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

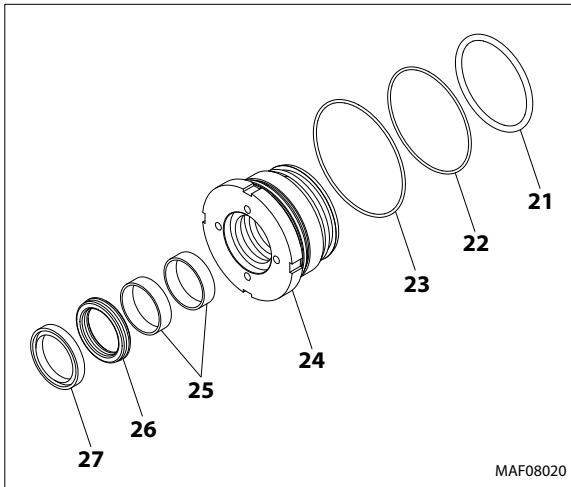
Apply a light film of hydraulic oil to all components before assembly.

### NOTICE

#### IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.

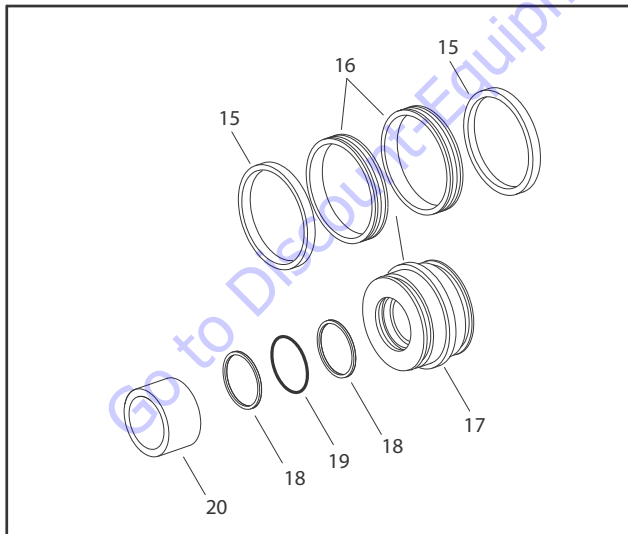
1. Install O-ring (23), O-ring (22), and backup ring (21) in outside diameter grooves of cylinder head (24).
2. Install two wear rings (25), seal (26), and rod wiper (27), into cylinder head (24).





**Figure 5-93. Cylinder Head Seal Kit Installation**

3. Install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Install piston spacer (20) on cylinder rod (28).
5. Install backup rings (18), O-ring (19) in inner diameter grooves of piston (17). Install two guidelock rings (15), lock rings (16) in outer grooves of piston (17).

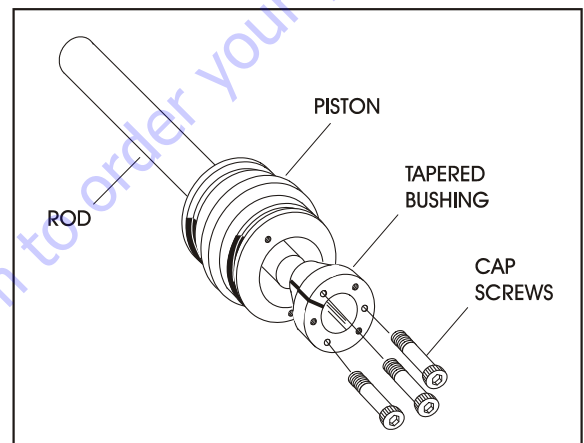


**Figure 5-94. Piston Seal Kit Installation**

6. Using suitable protection, clamp cylinder rod (28) in a vise or similar holding fixture as close to piston (17) as possible.
7. Thread piston (17) on cylinder rod (28) hand tight. Ensure O-ring and back-up rings are not damaged or dislodged.

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

8. Thread piston (17) on cylinder rod (28) until it aligns with spacer (20) end and install tapered bushing (14).
9. Apply JLG Threadlocker PN 0100011 or equivalent to tapered bushing cap screws (13) and assemble the tapered bushing (14) loosely into the piston (17). Insert cap screws (13) through the drilled holes in the tapered bushing (14) and into the tapped holes in the piston (17). Insert cap screws (13) through the drilled holes in the tapered bushing (14) and into the tapped holes in the piston (17).



**Figure 5-95. Tapered Bushing Installation**

10. Tighten the cap screws (13) evenly and progressively in rotation to 9 ft. lbs. (13 Nm).
11. 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 cap screws.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the cap screws.

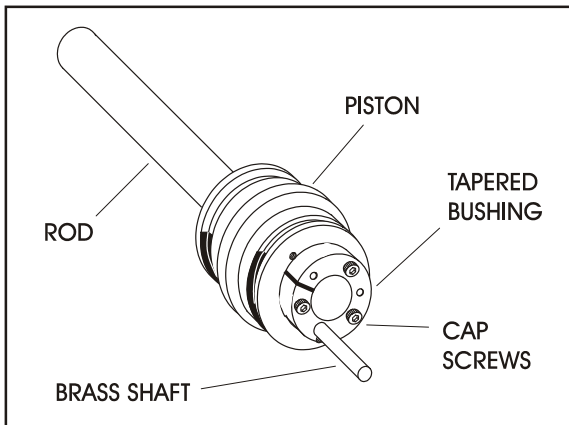


Figure 5-96. Seating the Tapered Bearing

12. Retorque the capscrews evenly and progressively in rotation to 9 ft. lbs. (13 Nm).
13. Install two counterbalance valves (2) with new O-rings in valve block. Torque to 30-35 ft-lb (41-47 Nm).
14. If removed, install the cylinder length sensor. See Section 5.4, Cylinder Length Sensor.

**NOTICE**

**INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD, AND PISTON.**

15. Clamp barrel (3) securely and support cylinder rod (28).
16. Insert piston (17) end into cylinder barrel (3). Do not damage or dislodge piston loading O-ring and seal ring.
17. Continue pushing cylinder rod (28) into cylinder barrel (3) until cylinder head (24) gland can be inserted into cylinder barrel (3).
18. Tighten cylinder head with hook spanner wrench.

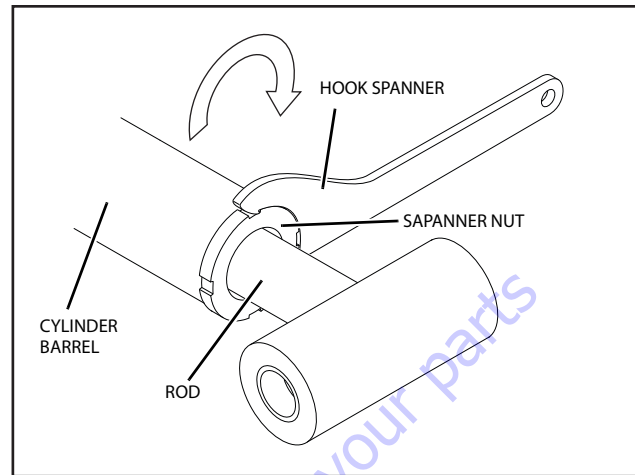


Figure 5-97. Cylinder Head Tightening

19. Install the plugs (12) in the cylinder ports.

**Boom Lift Cylinder (SN 0300209000 through 0300239990)**

**DISASSEMBLY**

**NOTICE**

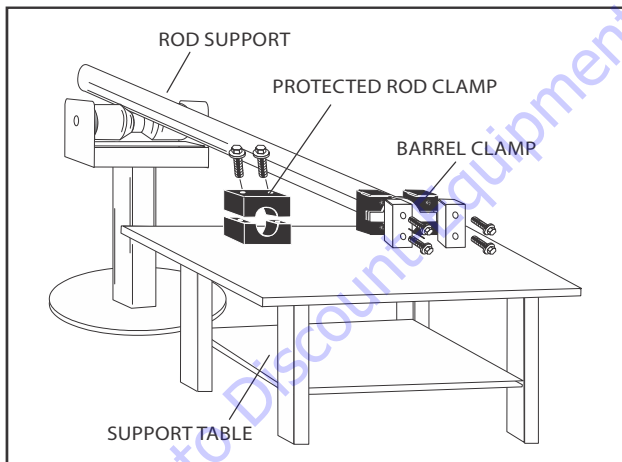
**DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.**

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

**NOTICE**

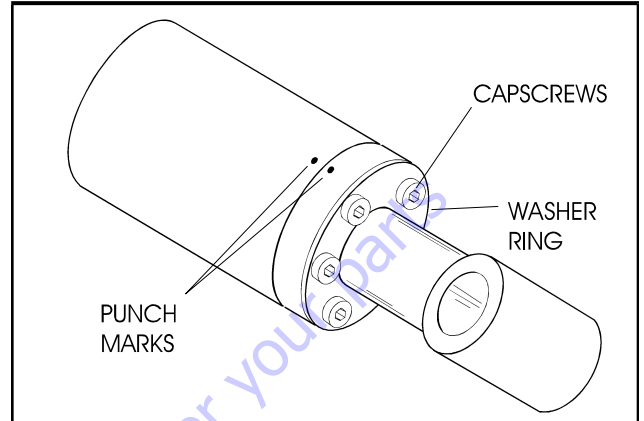
**DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.**

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. Remove the check valve, counterbalance valve, and pressure regulator valve from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.



**Figure 5-98. Cylinder Barrel Support**

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.



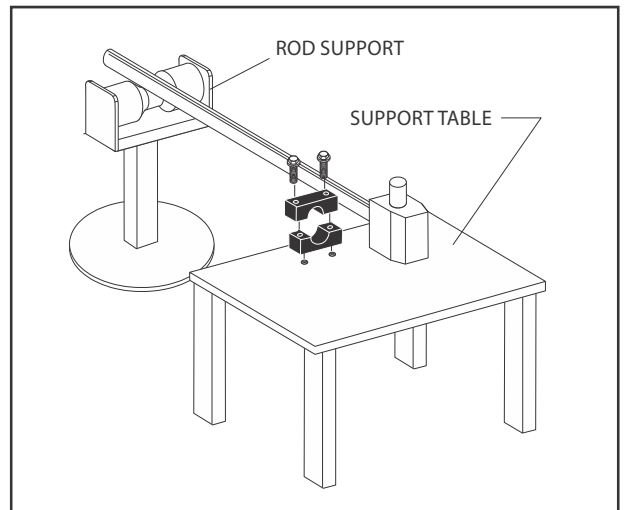
**Figure 5-99. Cap Screw Removal**

6. Attach a suitable pulling device to the cylinder rod end.

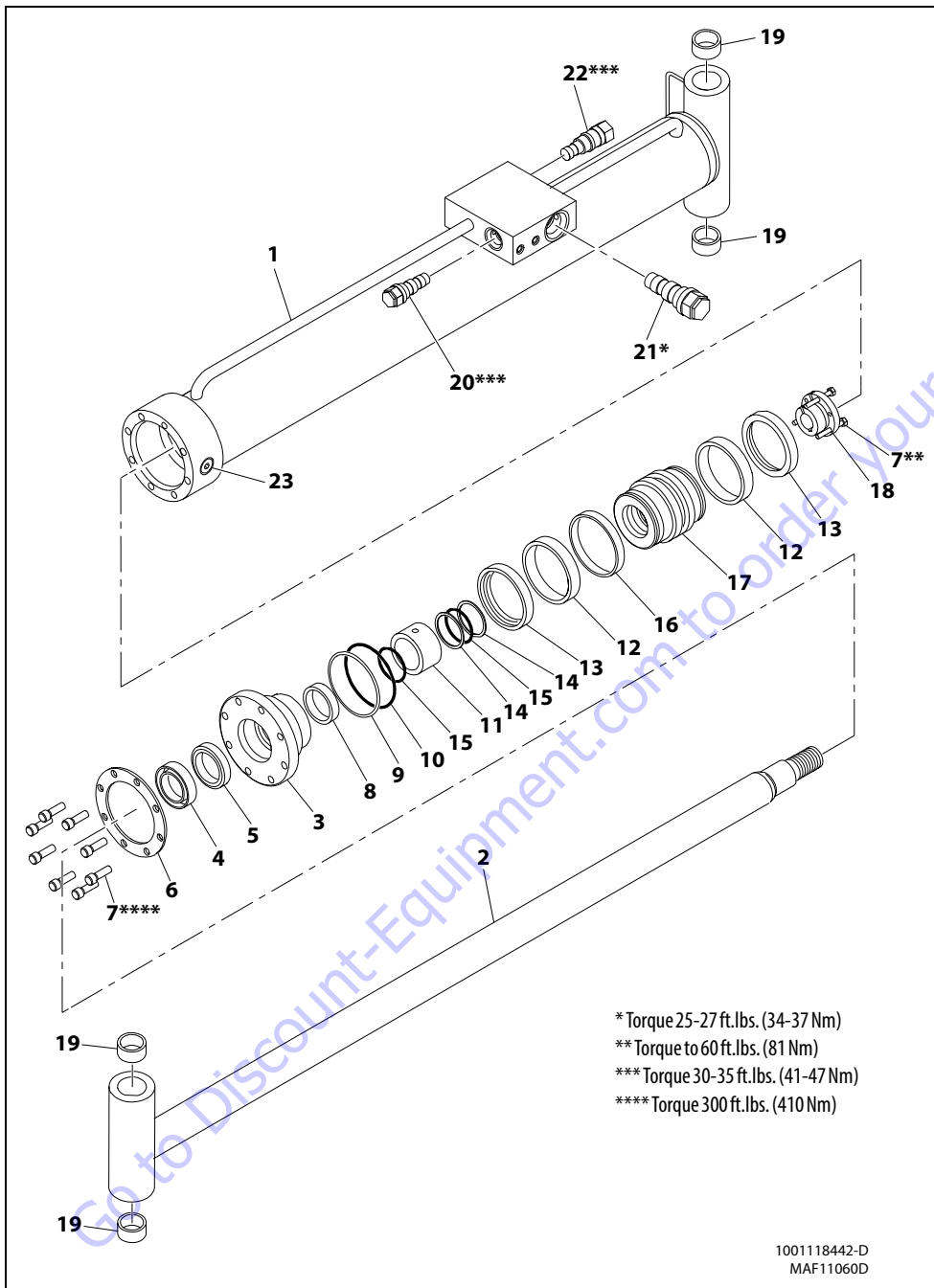
**NOTICE**

**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.**

7. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.



**Figure 5-100. Cylinder Rod Support**



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

Figure 5-101. Boom Lift Cylinder

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 capscrews which attach the tapered bushing to the piston.

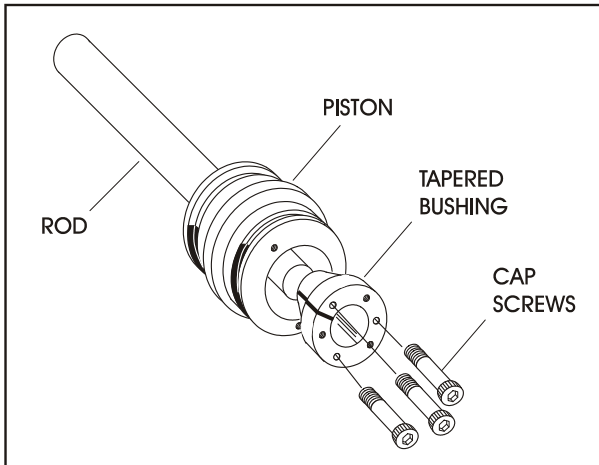


Figure 5-102. Tapered Bushing Removal

10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose.
11. Remove the tapered bushing from the piston.
12. By hand, screw the piston counterclockwise and remove it from cylinder rod.
13. Remove and discard the piston o-rings, seal rings, and backup rings.
14. Remove the piston spacer from the rod. Remove and discard the o-ring inside the piston spacer.
15. Remove the rod from the holding fixture. Remove the cylinder head gland and washer ring. Discard all seals on the cylinder head.

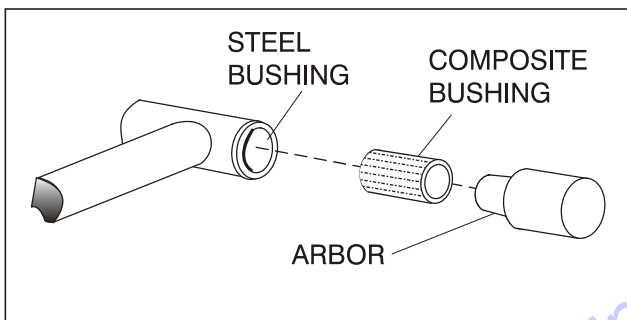
#### CLEANING AND INSPECTION

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.

## SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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 5-103. Composite Bearing Installation**

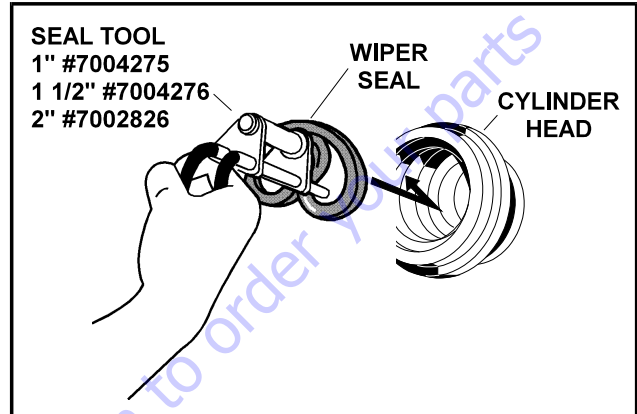
14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or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

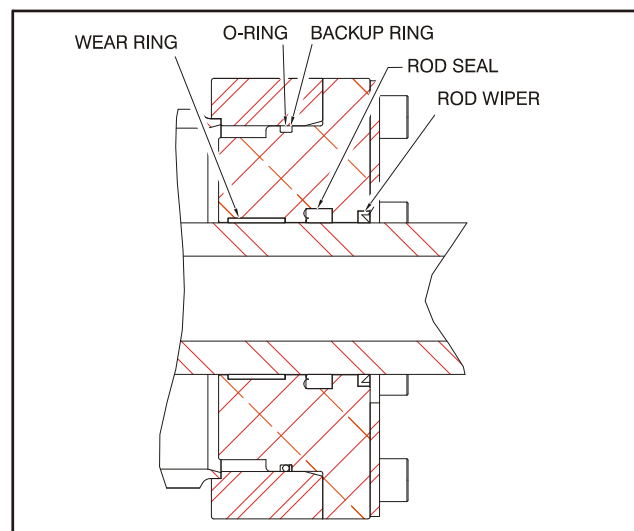
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-104. 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.**



**Figure 5-105. Cylinder Head Seal Installation**

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

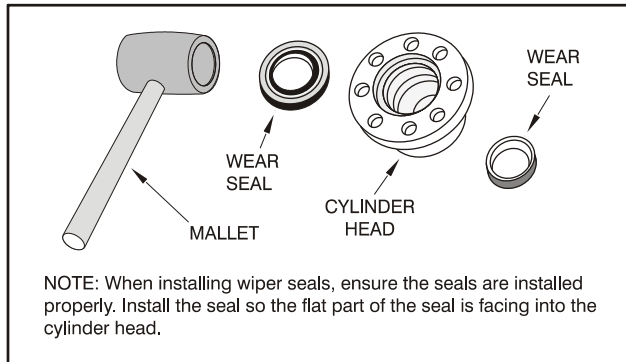


Figure 5-106. Wiper Seal Installation

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

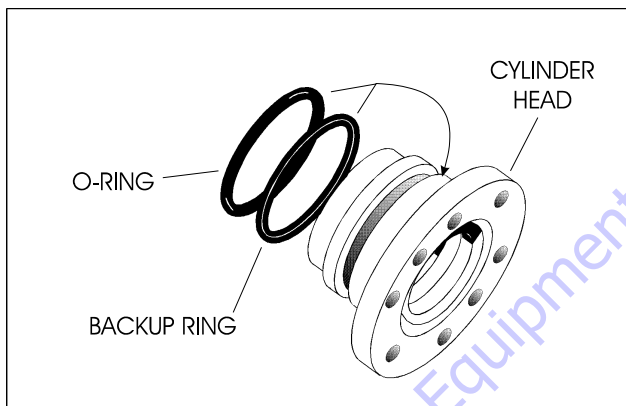


Figure 5-107. Installation of Head Seal Kit

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.
5. Place a new O-ring into the spacer and push the spacer onto the rod.
6. Place a new O-ring and backup rings in the inner piston diameter groove.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.

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

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

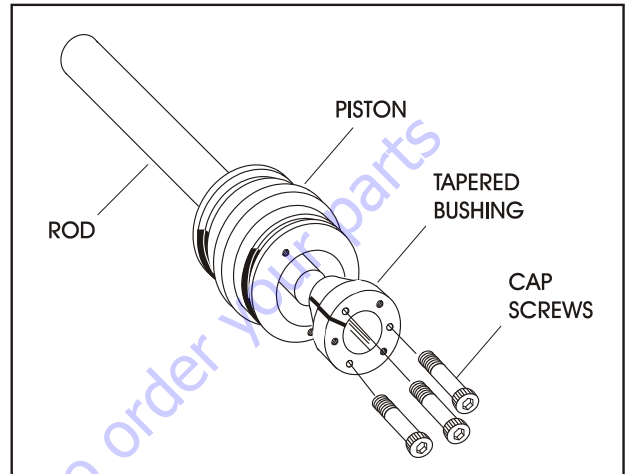


Figure 5-108. Tapered Bushing Installation

10. Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).
11. 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.

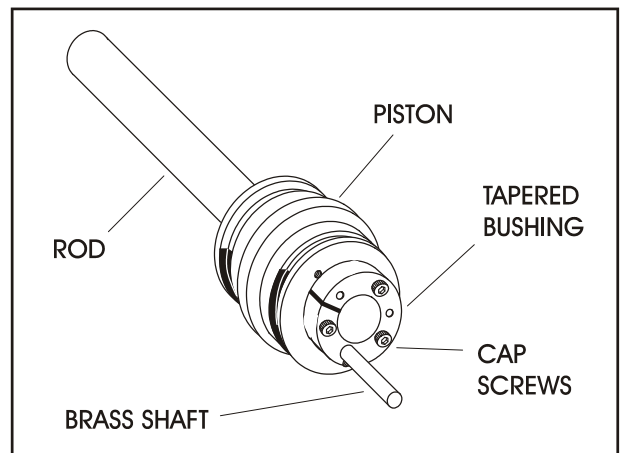


Figure 5-109. Seating the Tapered Bearing

12. Retorque the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

- Remove the cylinder rod from the holding fixture.

**NOTICE**

WHEN INSTALLING HYDROLOC PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

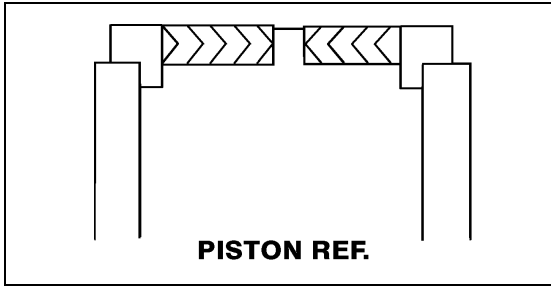


Figure 5-110. Hydrolock Piston Seal Installation

- Place new hydrolock seals in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

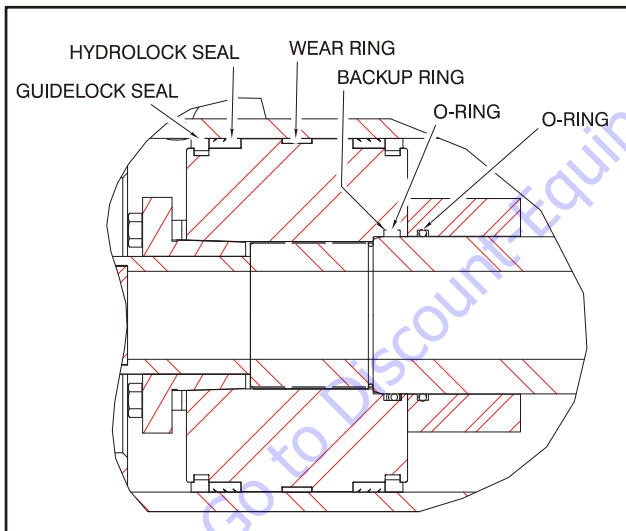


Figure 5-111. Piston Seal Installation

- 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.

- 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.
- Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
- Secure the cylinder head gland using the washer ring, JLG Threadlocker PN 0100011 and socket head bolts. Torque to 300 ft.lbs. (410 Nm).

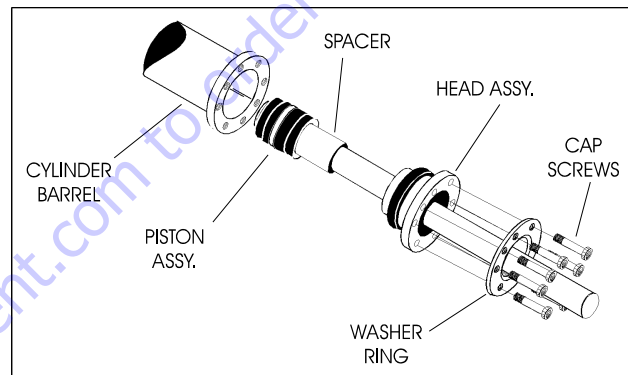


Figure 5-112. Rod Assembly Installation

- After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any valves.
- Install the check valve in the rod port block. Torque 30-35 ft.lbs. (41-47 Nm).
- Install the counterbalance valve in the rod port block. Torque 30-35 ft.lbs. (41-47 Nm).
- Install the pressure regulator valve in the rod port block. Torque 25-27 ft.lbs. (34-37 Nm).



**Boom Lift Cylinder (SN 0300239991 to Present)**

**DISASSEMBLY**

**NOTICE**

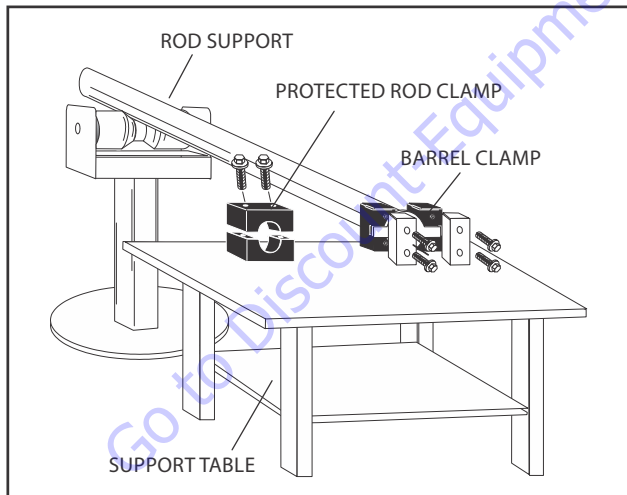
**CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.**

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

**WARNING**

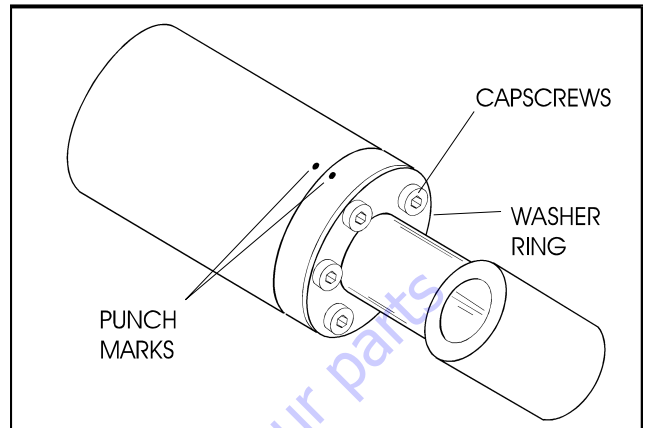
**DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.**

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. If applicable, remove cartridge-type counterbalance valve and fittings from cylinder port block. Discard Orings.
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 5-113. Cylinder Barrel Support**

5. Mark cylinder head and barrel with center punch marks for later realignment. Remove cylinder head cap screws

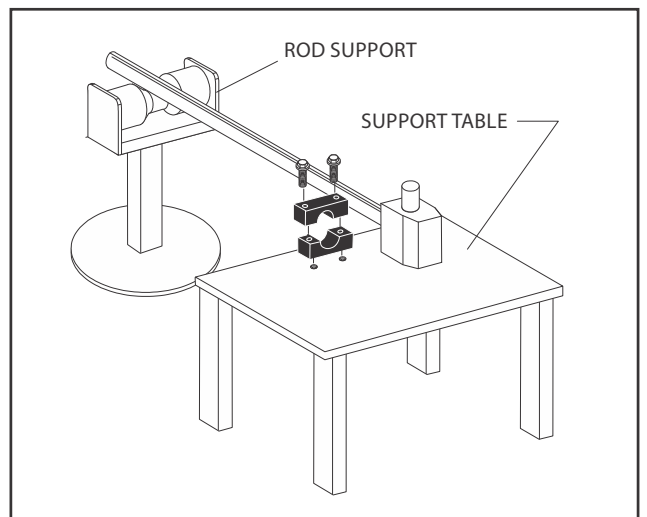


**Figure 5-114. Cap Screw Removal**

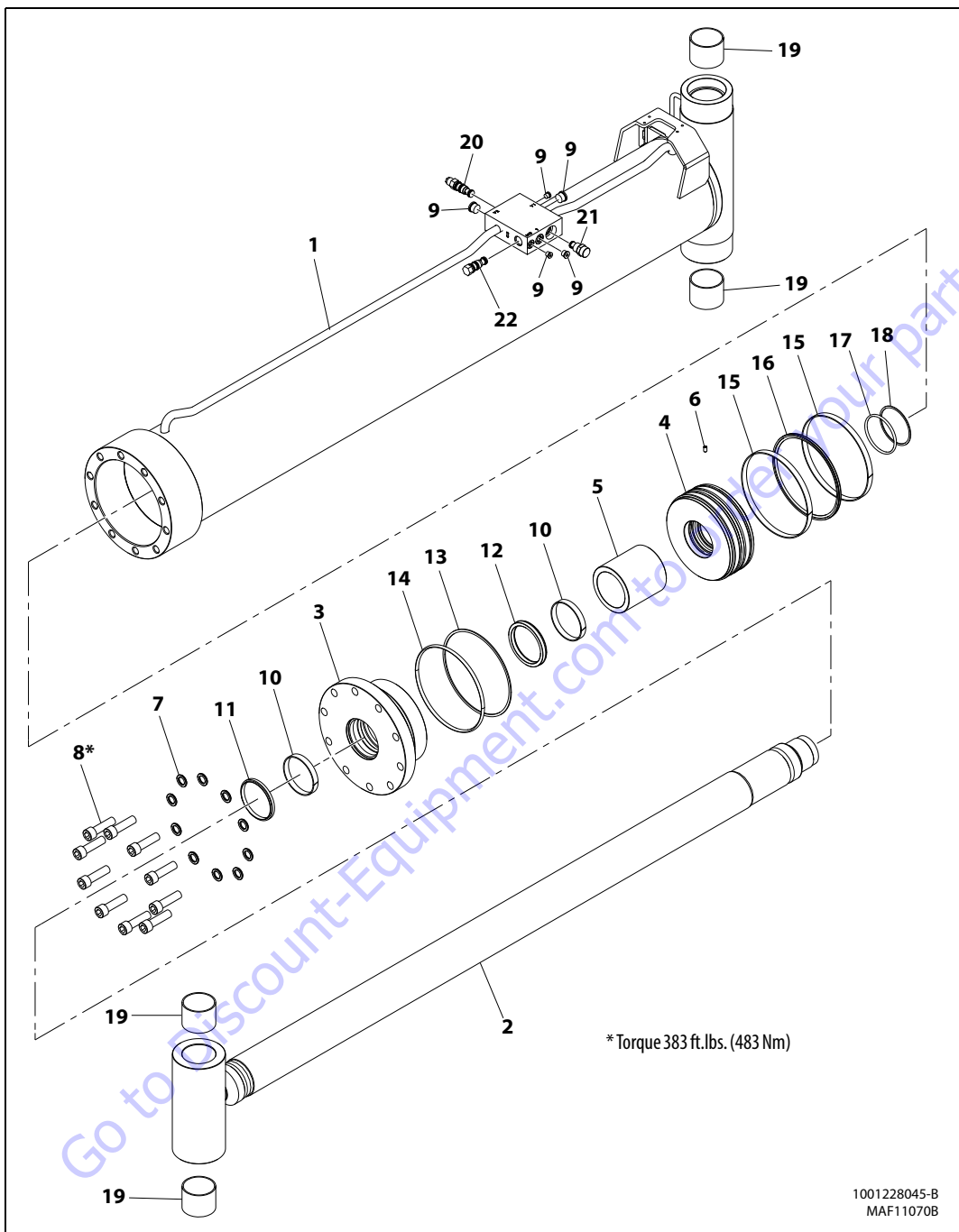
**NOTICE**

**PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.**

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



**Figure 5-115. Cylinder Rod Support**



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

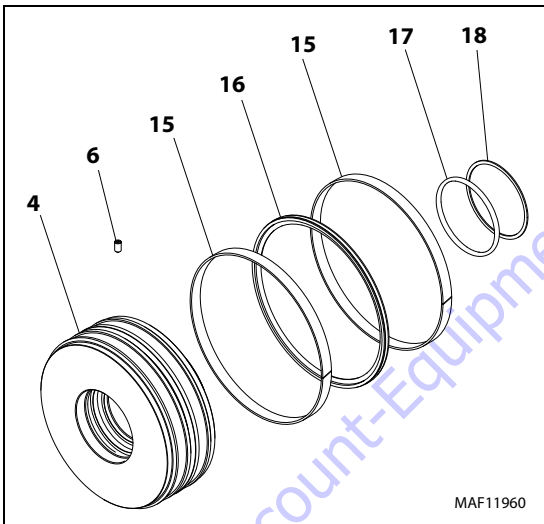
Figure 5-116. Boom Lift Cylinder

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Remove setscrews attaching piston to cylinder rod.
10. Screw the piston counterclockwise by hand and remove piston from cylinder rod.

**NOTICE**

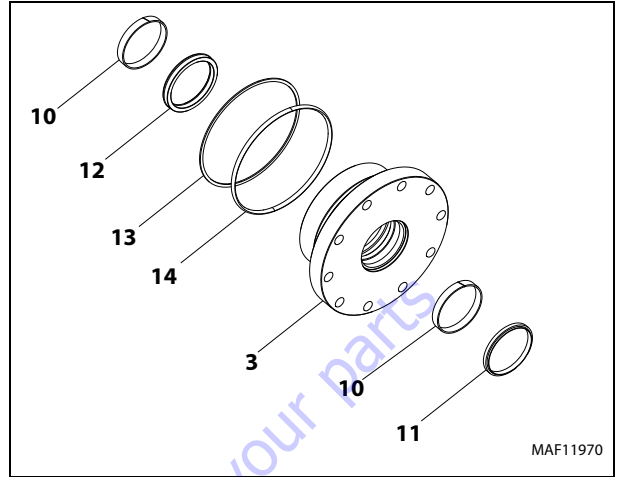
**REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.**

11. Remove and discard piston seal (16) and wear ring (15) from outside grooves of piston (4).
12. Remove spacer (5) from rod (2).
13. Remove and discard backup ring (17) and o-ring (18) from inside of piston (4).



**Figure 5-117. Piston Disassembly**

14. Remove rod (2) from holding fixture. Remove cylinder head (3) from rod (2).
15. Remove and discard wear ring (10), wiper (11) and rod seal (12) from inside of cylinder head (3).



**Figure 5-118. Cylinder Head Disassembly**

16. Remove and discard o-ring (13) and backup ring (14) from outside of cylinder head (3).

**CLEANING AND INSPECTION**

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect 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, scoring, or 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 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, damage, ovality, and tapering. Replace as necessary.

13. 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.

**NOTE:** Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

- d. Press bushing into barrel or rod bushing with correct size arbor.

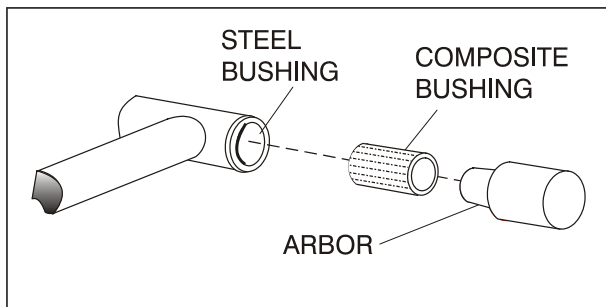


Figure 5-119. Bushing Installation

14. Inspect port block fittings and holding valves. Replace as necessary.
15. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**ASSEMBLY**

**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

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

**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

1. Install o-ring (13) and backup ring (14) on outside of cylinder head (3).
2. Install wear ring (10), wiper (11) and rod seal (12) in inside of cylinder head (3).

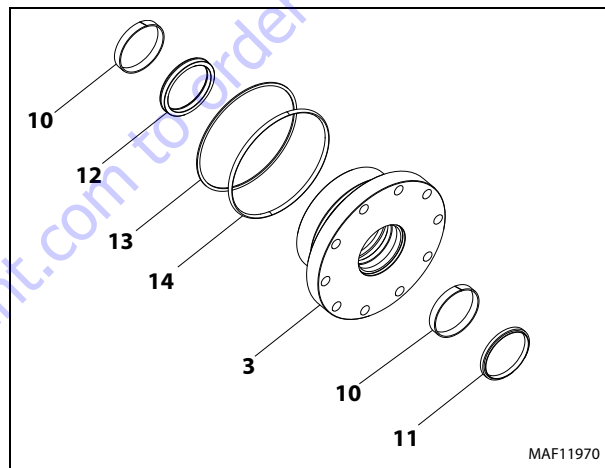
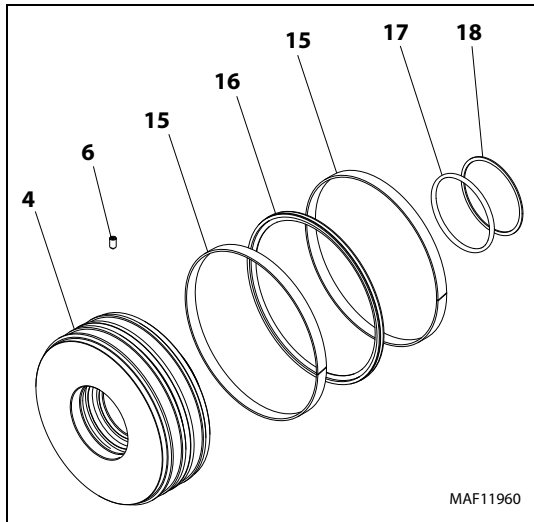


Figure 5-120. Cylinder Head Assembly

3. Carefully install cylinder head assembly (3) on rod (2). Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Install O-ring (18) and backup ring (17) into the spacer (5) and Carefully slide spacer (5) onto rod (2) with O-ring (18) end facing cylinder head. Ensure that O-ring not damage and dislodge.
5. Install wear ring (15) and piston seal (16) on outside of piston(4) groove.



**Figure 5-121. Piston Assembly**

6. Install the setscrew on the piston (10) and attach the piston (10) on the rod (2).
7. Position cylinder barrel (1) in a suitable holding fixture.

**NOTICE**

**INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD AND PISTON.**

8. Clamp barrel (1) securely and support rod (2). Insert piston (4) end in barrel. Do not damage or dislodge piston O-rings or seal rings.
9. Continue pushing rod in barrel until cylinder head (3) can be inserted in barrel.
10. Install cylinder head (3) until tight and marks made during disassembly are aligned.
11. Secure cylinder head assembly (3) to barrel (1) with cap screws (8). Torque to 356 ft-lb (483-Nm).

## Jib Lift 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. Remove the cylinder length sensor from the cylinder. See Section 5.4, Cylinder Length Sensor.
4. Remove the counterbalance valve and holding valve from the cylinder port block. Discard o-rings.
5. Place the cylinder barrel into a suitable holding fixture.

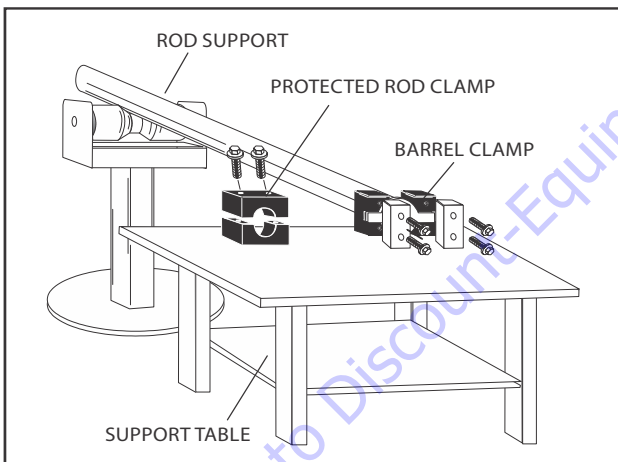


Figure 5-122. Cylinder Barrel Support

6. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

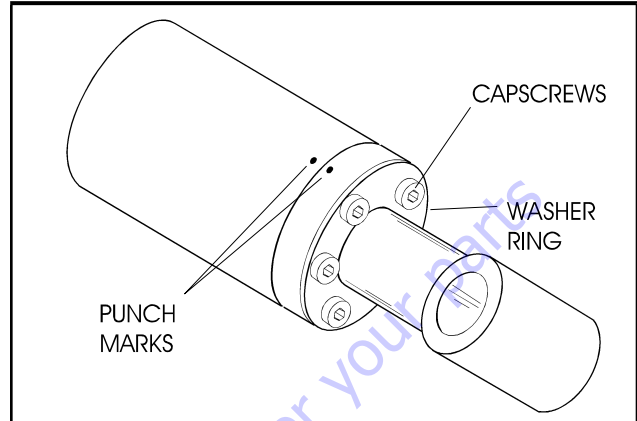


Figure 5-123. Cap Screw Removal

7. Attach a suitable pulling device to the cylinder rod end.

**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.**

8. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.

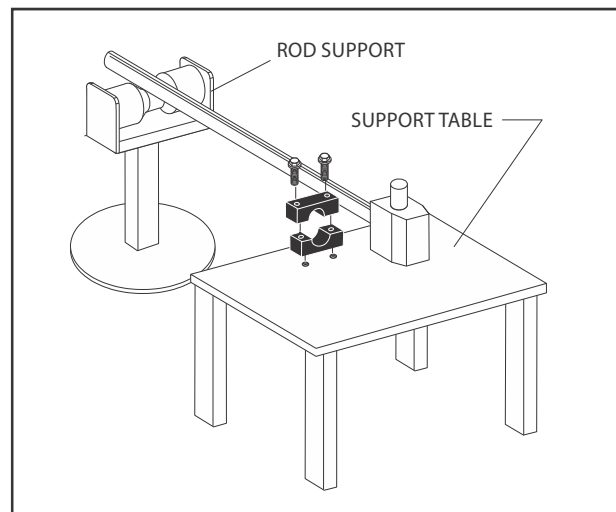
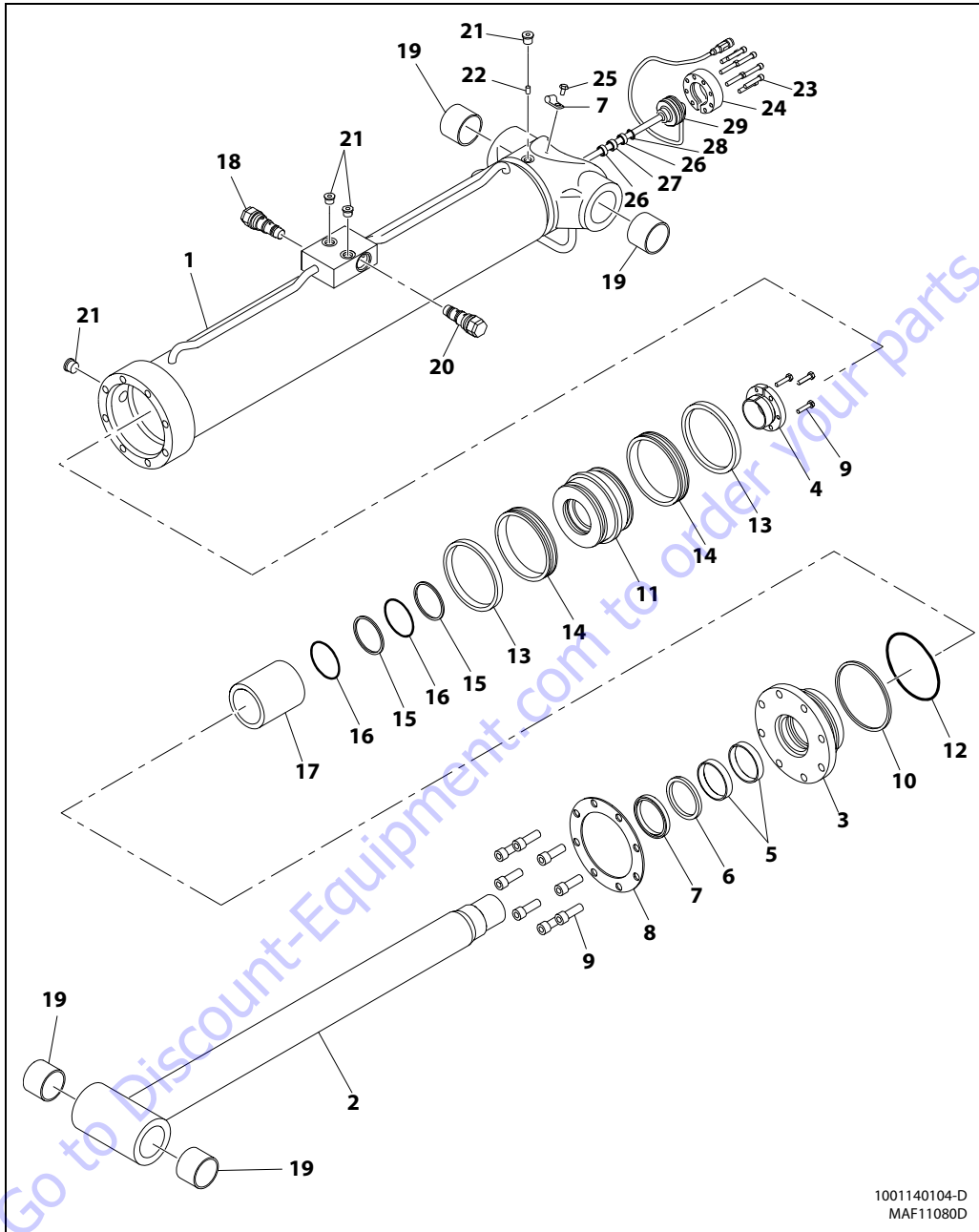
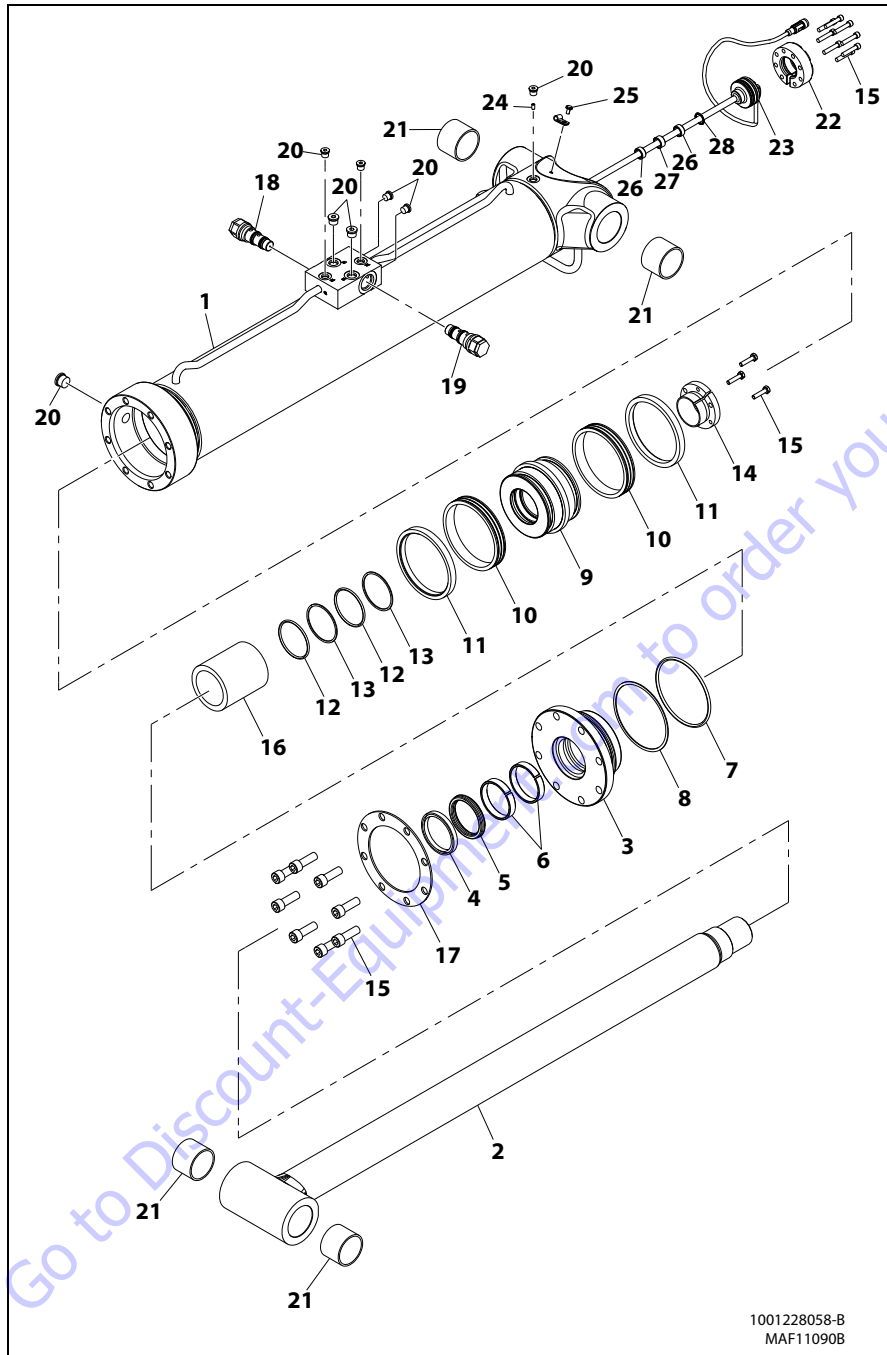


Figure 5-124. Cylinder Rod Support



- |                    |                   |                          |                   |                            |
|--------------------|-------------------|--------------------------|-------------------|----------------------------|
| 1. Barrel          | 8. Washer Ring    | 15. Backup Rings         | 22. Setscrew      | 29. Cylinder Length Sensor |
| 2. Rod             | 9. Capscrew       | 16. O-ring               | 23. Bolt          |                            |
| 3. Head            | 10. Backup Ring   | 17. Spacer               | 24. Retainer Cap  |                            |
| 4. Tapered Bushing | 11. Piston        | 18. Counterbalance Valve | 25. Screw         |                            |
| 5. Wear Ring       | 12. O-ring        | 19. Bushing              | 26. Sleeve Spacer |                            |
| 6. Rod Seal        | 13. Lock Ring     | 20. Holding valve        | 27. Magnet Sensor |                            |
| 7. Rod Wiper       | 14. Spacer Sleeve | 21. Plug                 | 28. Retainer Ring |                            |

Figure 5-125. Jib Lift Cylinder (SN 0300209000 through 0300239990)



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MAF11090B

- |              |                     |                           |                            |
|--------------|---------------------|---------------------------|----------------------------|
| 1. Barrel    | 8. Backup Ring      | 15. Capscrew              | 22. Retainer Cap           |
| 2. Rod       | 9. Piston           | 16. Spacer                | 23. Sensor Cylinder Length |
| 3. Head      | 10. Lock Ring       | 17. Washer Ring           | 24. Compound Locking       |
| 4. Wiper     | 11. Guide Ring      | 18. Counter Balance Valve | 25. Bolt                   |
| 5. Rod Seal  | 12. O-ring          | 19. Holding Valve         | 26. Sleeve Spacer          |
| 6. Wear Ring | 13. Backup Ring     | 20. Plug                  | 27. Magnet Sensor          |
| 7. O-ring    | 14. Tapered Bushing | 21. Bushing               | 28. Retainer Ring          |

Figure 5-126. Jib Lift Cylinder (SN 0300239991 to Present)



9. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.
10. Loosen and remove the capscrews which attach the tapered bushing to the piston.

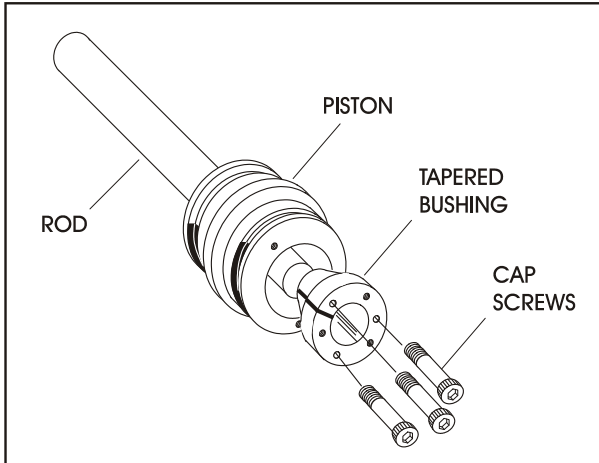


Figure 5-127. Tapered Bushing Removal

11. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose.
12. Remove the tapered bushing from the piston.
13. By hand, screw the piston counterclockwise and remove it from cylinder rod.
14. Remove and discard the piston o-rings, seal rings, and backup rings.
15. Remove the piston spacer from the rod. Remove and discard the o-ring inside the piston spacer.
16. If necessary, remove the retaining ring, sensor magnet, and spacer sleeve from the cylinder rod.
17. Remove the rod from the holding fixture. Remove the cylinder head gland and washer ring. Discard all seals on the cylinder head.

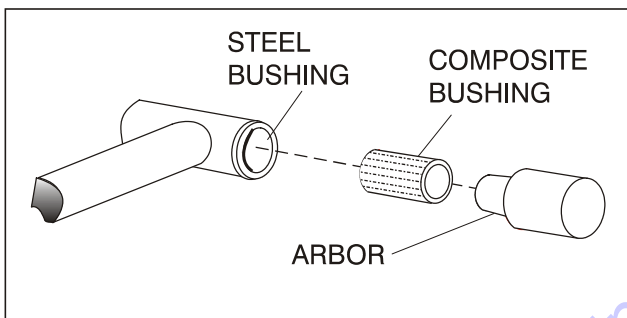
#### CLEANING AND INSPECTION

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.

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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 5-128. Composite Bearing Installation**

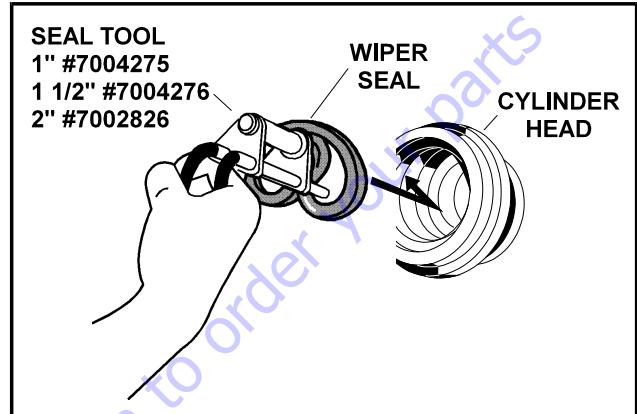
14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or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

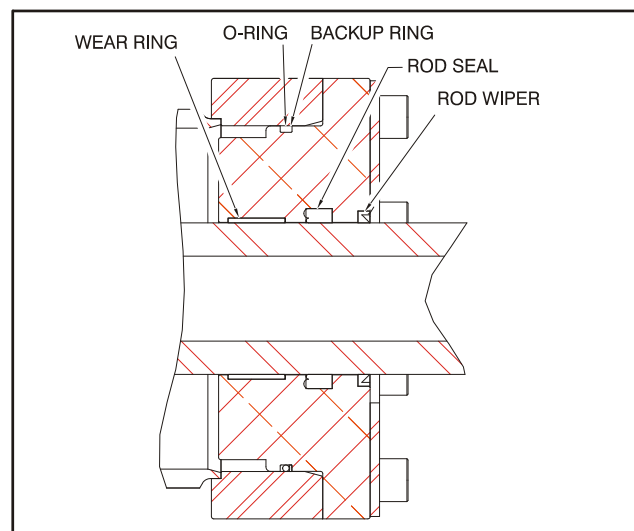
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-129. 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.**



**Figure 5-130. Cylinder Head Seal Installation**

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

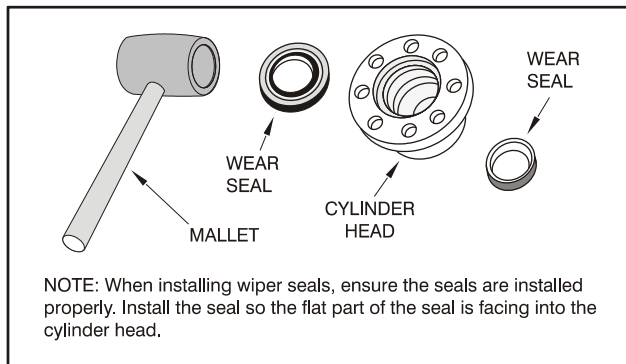


Figure 5-131. Wiper Seal Installation

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

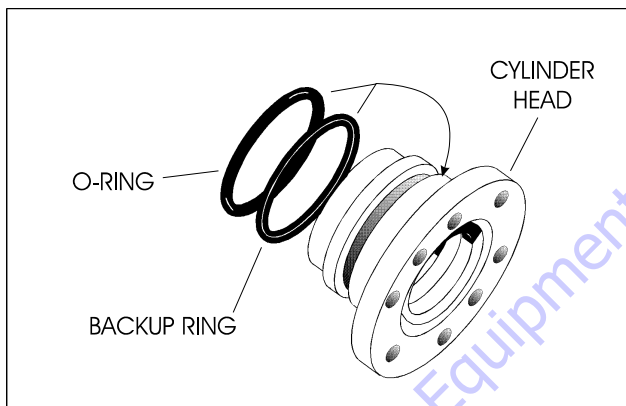


Figure 5-132. Installation of Head Seal Kit

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.
5. Place a new O-ring into the spacer and push the spacer onto the rod.
6. Place a new O-ring and backup rings in the inner piston diameter groove.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.

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

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

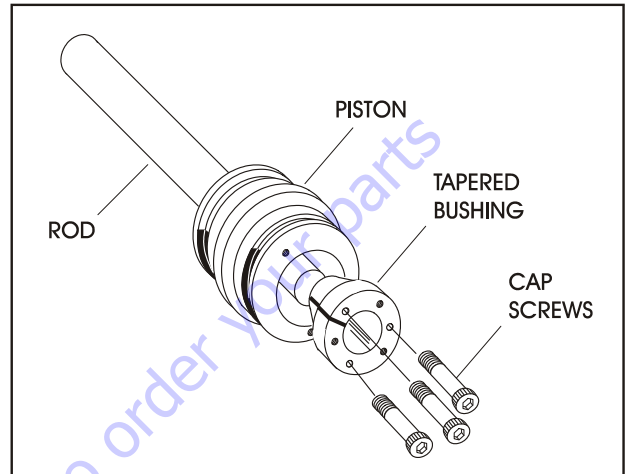


Figure 5-133. Tapered Bushing Installation

10. Tighten the capscrews evenly and progressively in rotation.
11. 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.

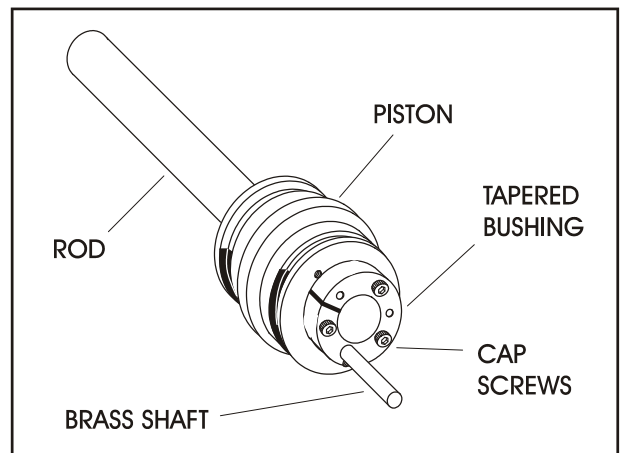


Figure 5-134. Seating the Tapered Bearing

12. Retorque the capscrews evenly and progressively in rotation.

- Remove the cylinder rod from the holding fixture.

**NOTICE**

WHEN INSTALLING HYDROLOC PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

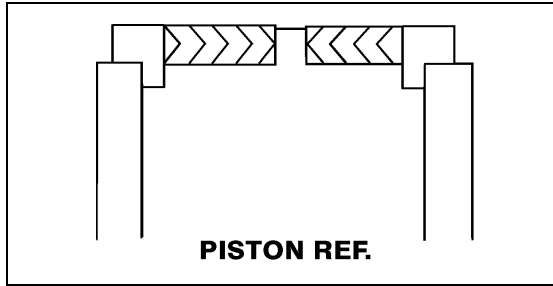


Figure 5-135. Hydrolock Piston Seal Installation

- Place new hydrolock seals in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

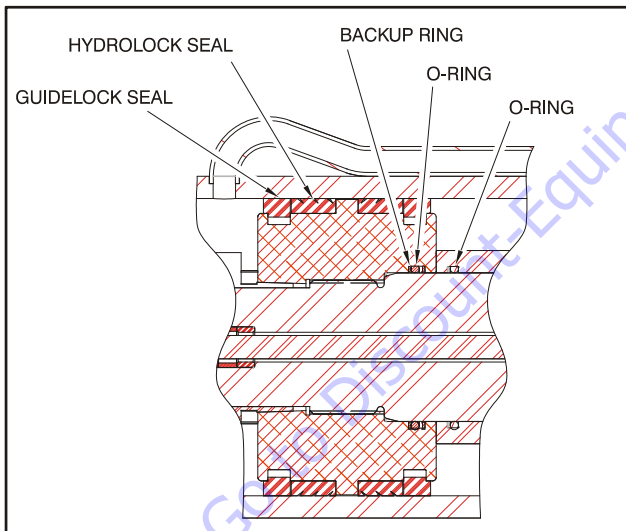


Figure 5-136. Piston Seal Installation

- 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.

- 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.
- Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
- Secure the cylinder head gland using the washer ring, JLG Threadlocker PN 0100011 and socket head bolts.

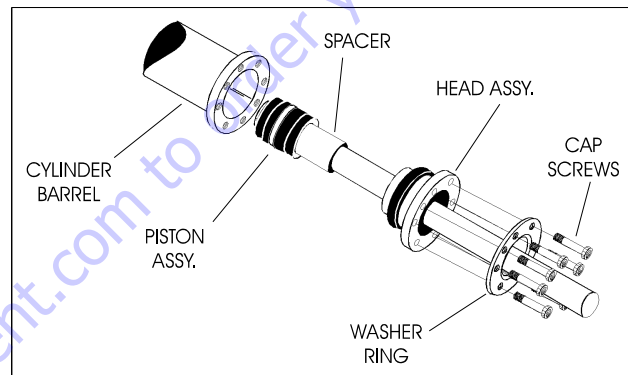


Figure 5-137. Rod Assembly Installation

- After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any valves.
- Install the holding valve and counterbalance valve in the rod port block.
- Install the cylinder length sensor. See Section 5.4, Cylinder Length Sensor.

## Jib Lock 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 the cylinder barrel into a suitable holding fixture.

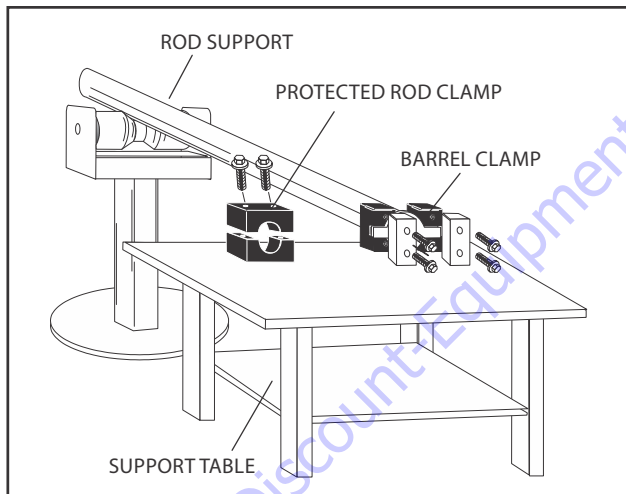


Figure 5-138. Cylinder Barrel support

4. Using a spanner wrench, unscrew the cylinder head from the barrel.

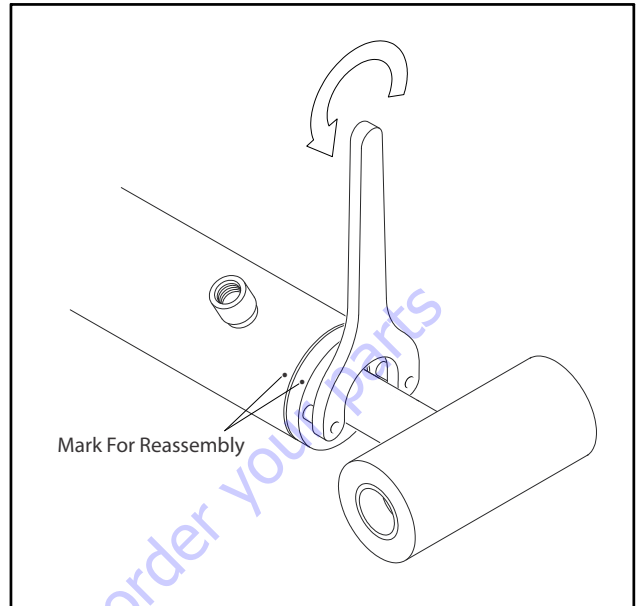


Figure 5-139. Cylinder Head Removal

5. Attach a suitable pulling device to the cylinder rod end.

**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.

7. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.

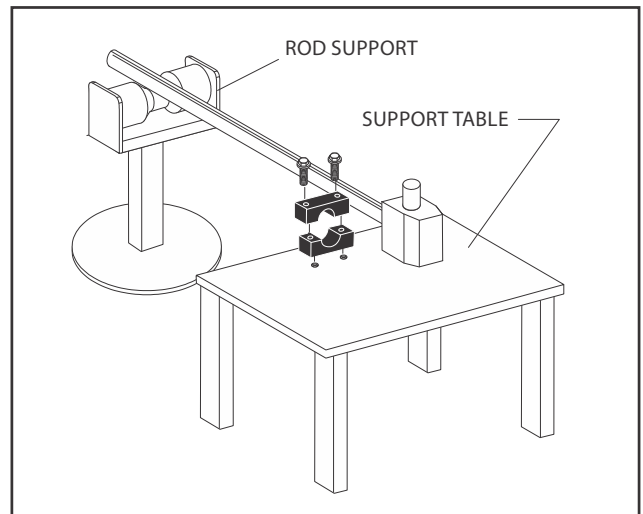


Figure 5-140. Cylinder Rod Support

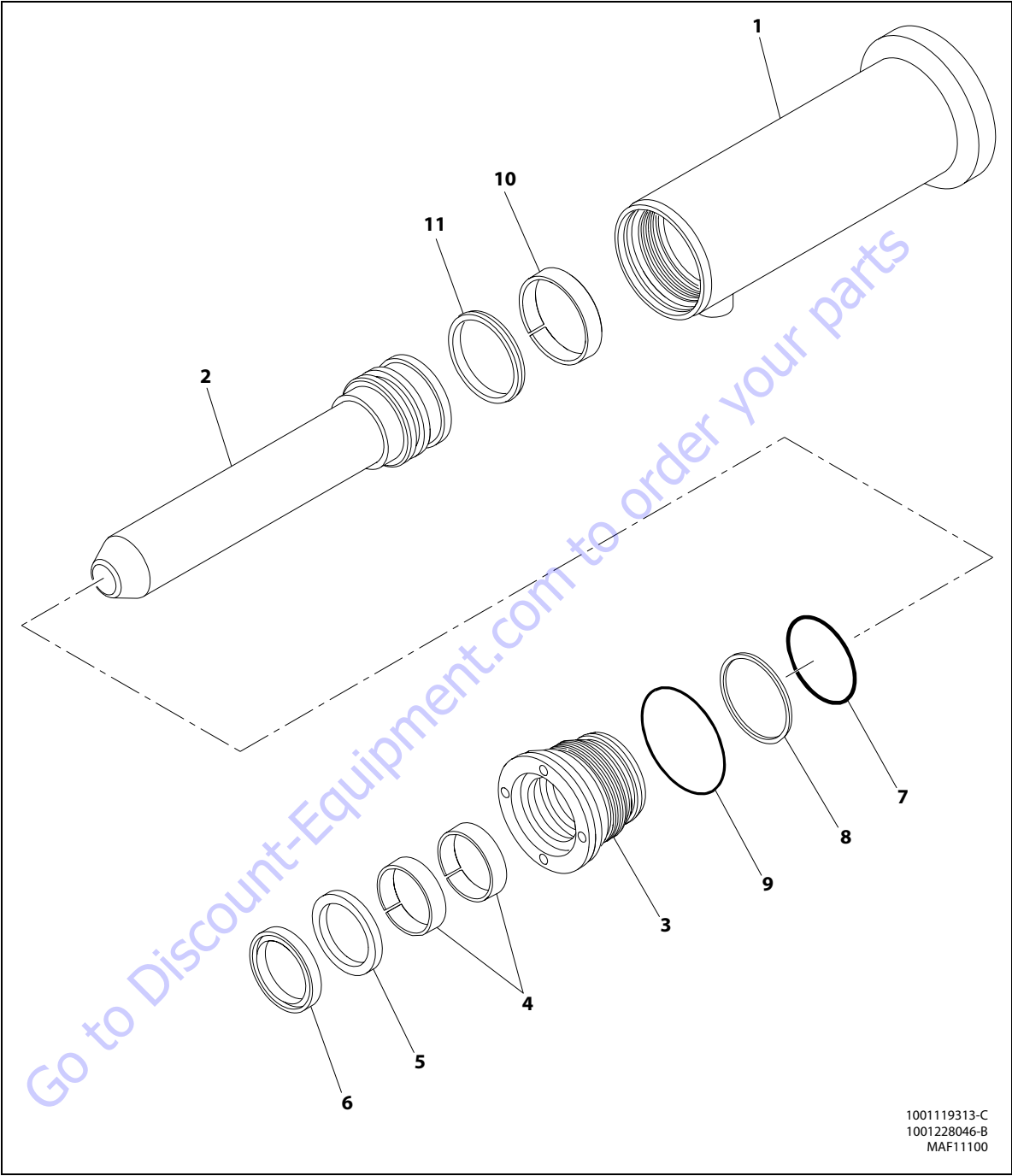
## SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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8. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.
9. Remove and discard the piston wear ring and t-seal.
10. Remove the rod from the holding fixture. Remove the cylinder head gland and 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 inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
4. Inspect threaded portion of barrel for damage. Dress threads as necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston and rod assembly as necessary.
6. Inspect seal and o-ring grooves on piston for burrs and sharp edges. Dress applicable surfaces as necessary.
7. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
8. Inspect threaded portion of head for damage. Dress threads as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
12. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.



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 1001228046-B  
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- |           |              |                |               |
|-----------|--------------|----------------|---------------|
| 1. Barrel | 4. Wear Ring | 7. O-ring      | 10. Wear Ring |
| 2. Rod    | 5. Seal      | 8. Backup Ring | 11. Seal      |
| 3. Head   | 6. Rod Wiper | 9. O-ring      |               |

Figure 5-141. Jib Lock Cylinder

## SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

### 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.

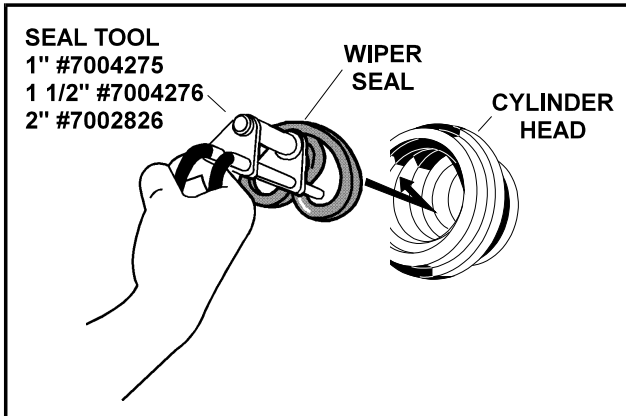


Figure 5-142. Rod Seal Installation

### NOTICE

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

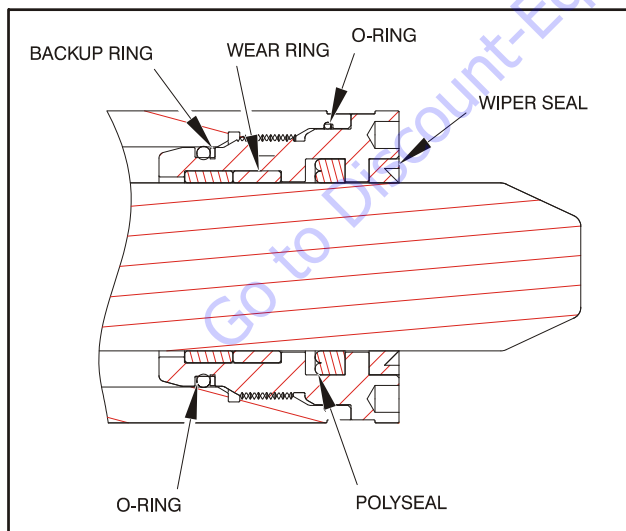


Figure 5-143. Cylinder Head Seal Installation

3. Place a new O-rings and backup ring in the outside diameter groove of the cylinder head and new wear rings and polyseal in the inside diameter grooves of the cylinder head.
4. 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 wear ring and t-seal in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

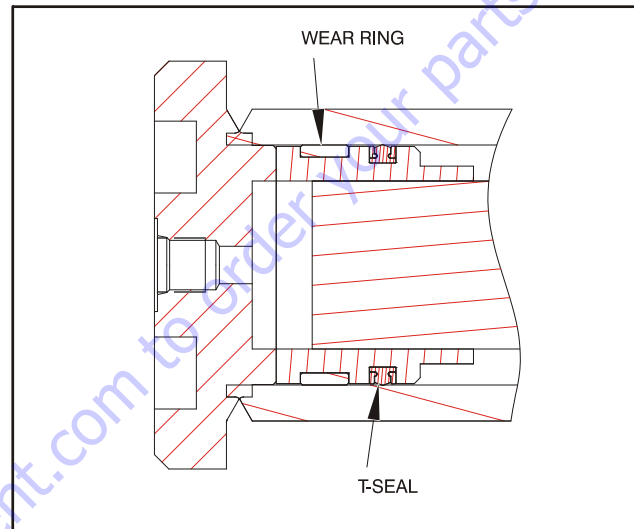


Figure 5-144. Piston Seal Installation

6. Position the cylinder barrel in a suitable holding fixture.

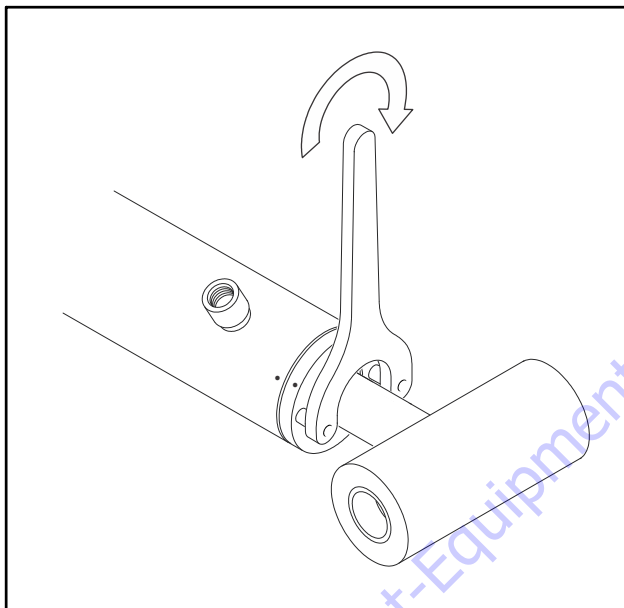
2. Use a soft mallet to tap a new wiper seal into the cylinder head gland groove. Install a new wear ring into the cylinder head gland groove.



**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.**

7. 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.
8. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.



**Figure 5-145. Cylinder Head Installation**

9. Apply anti-seize lubricant to the threads and screw the cylinder head gland into the barrel using a spanner wrench.

## 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 the cylinder barrel into a suitable holding fixture.

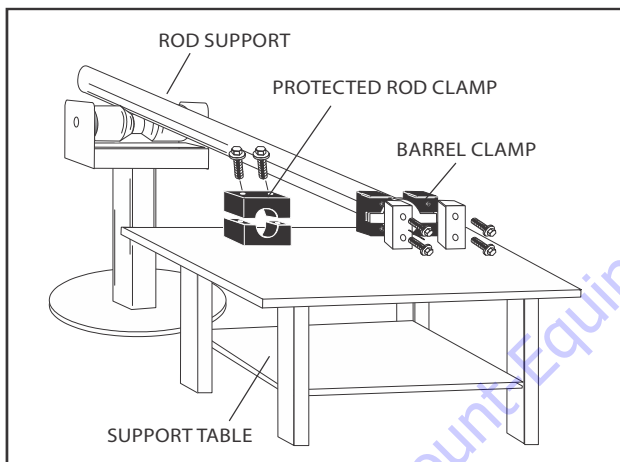


Figure 5-146. Cylinder Barrel Support

4. Mark cylinder cap and barrel with a center punch for easy realignment. Unscrew the cylinder cap from the barrel.

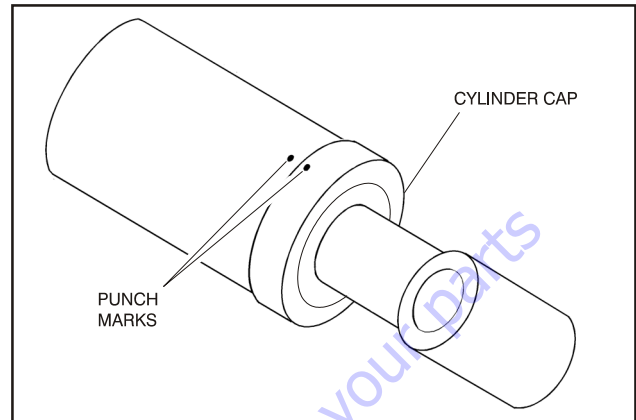


Figure 5-147. Cylinder Cap Removal

5. Attach a suitable pulling device to the cylinder rod end.

#### 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.

7. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.

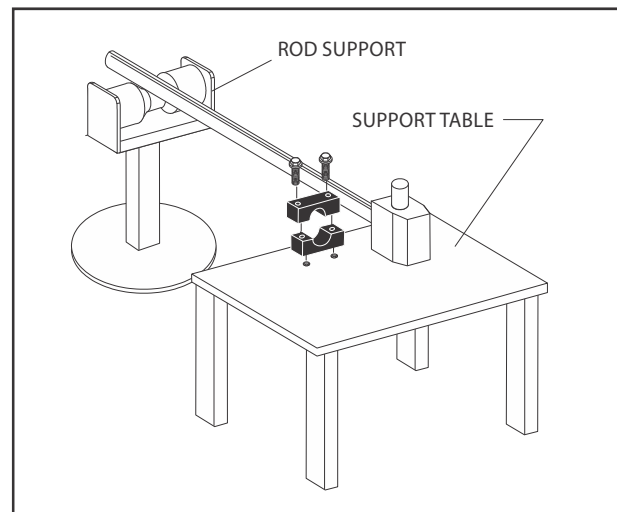
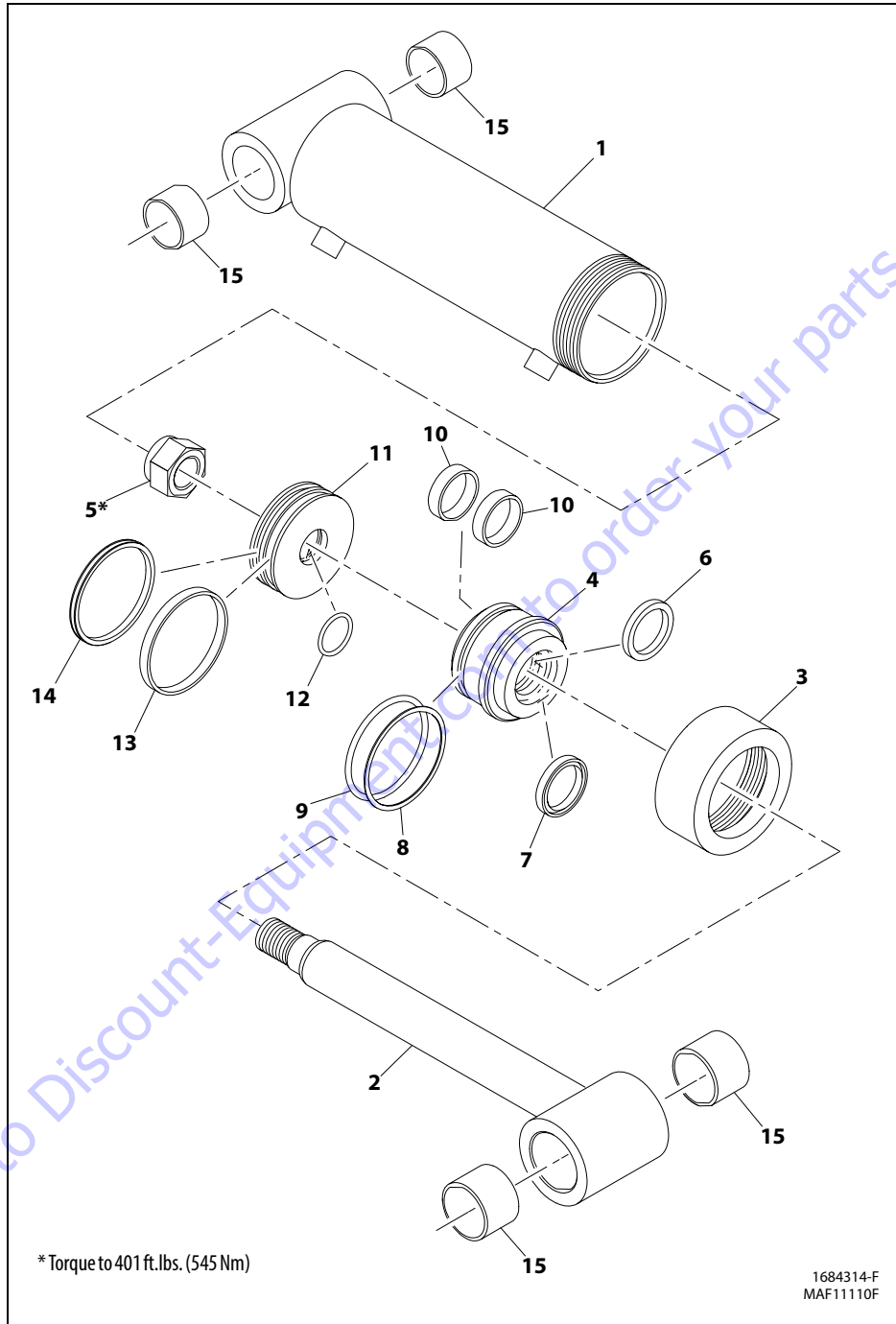
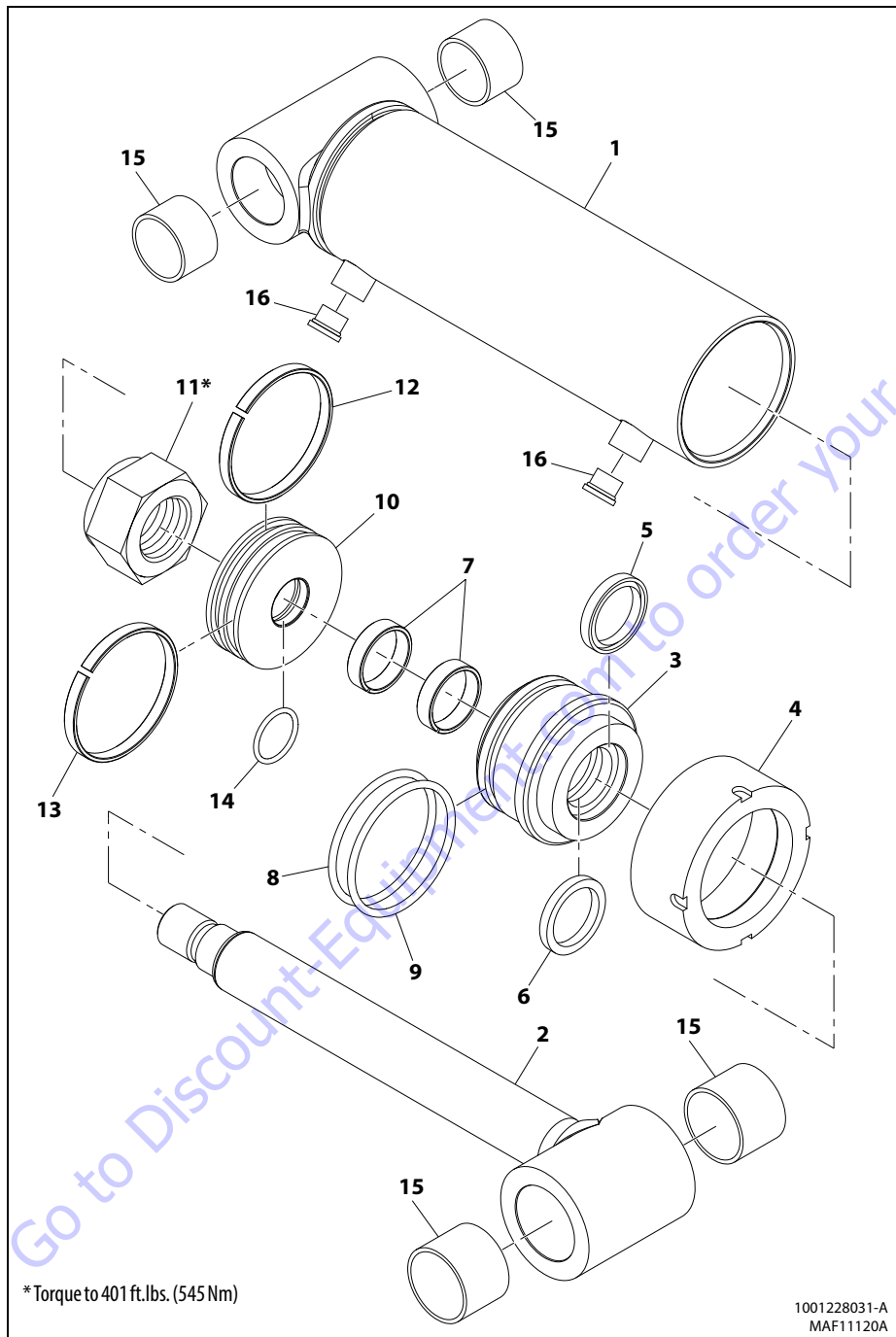


Figure 5-148. Cylinder Rod Support



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

Figure 5-149. Steer Cylinder (SN 0300209000 through 0300238017)



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

Figure 5-150. Steer Cylinder (SN 0300238018 to Present)

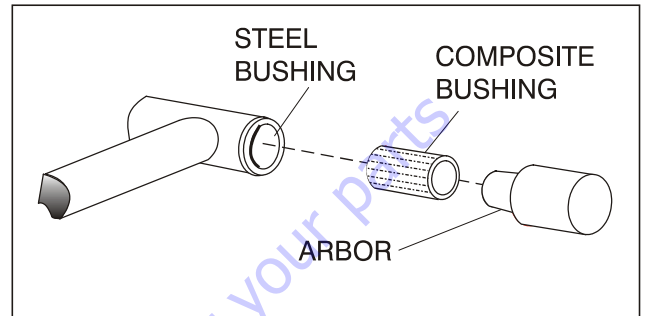
8. Using suitable protection, clamp the cylinder rod in a vise or holding fixture as close to the piston as possible.
9. Loosen and remove the lock nut that secures the piston to the cylinder rod.
10. Remove the piston from the cylinder rod.
11. Remove and discard the piston o-rings, seal rings, and t-seal.
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 5-151. Composite Bearing Installation**

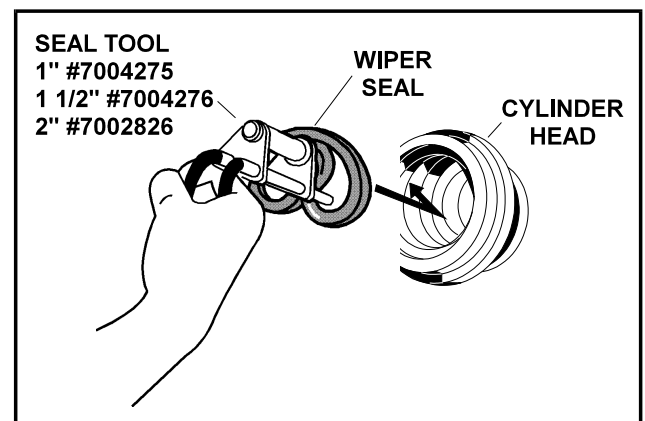
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

**ASSEMBLY**

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

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

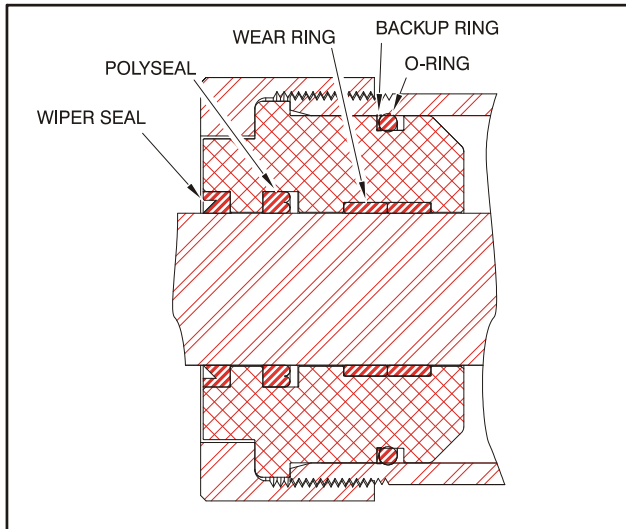
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-152. Rod Seal Installation**

**NOTICE**

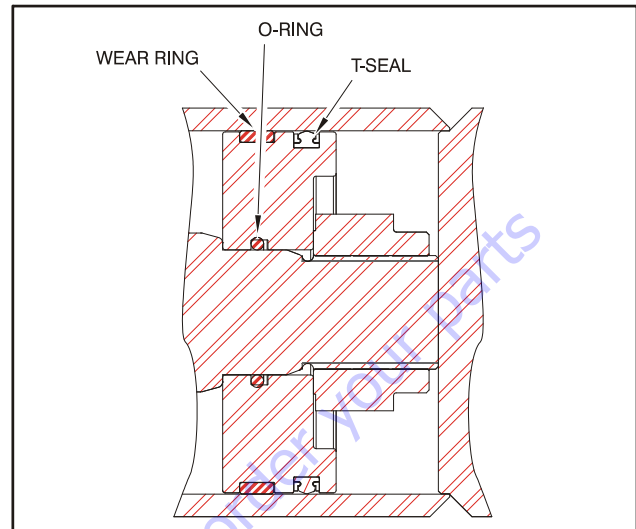
**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-153. Cylinder Head Seal Installation**

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.
3. Place a new O-ring and backup ring in the outside diameter groove of the cylinder head.
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 and backup rings 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 back-up rings are not damaged or dislodged.
8. Carefully thread the lock nut onto the rod to secure the piston in place. Torque to 401 ft.lbs. (545 Nm).
9. Remove the cylinder rod from the holding fixture.

10. Place a new wear ring and t-seal in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)



**Figure 5-154. Piston Seal Installation**

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 JLG Threadlocker PN 0100035 and the cylinder cap.
15. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted).

## Jib Telescope Cylinder

### CAUTION

**USE CARE IN REMOVAL OF ANY, AND ALL, COMPONENTS AS COUNTERBALANCE VALVES MAY RETAIN CONSIDERABLE PRESSURE WITHIN THE CYLINDER ASSEMBLY. USE EXTREME CARE REMOVING PLUGS, VALVES, AND/OR THE ROD ASSEMBLY TO ENSURE THE INTERNAL CYLINDER PRESSURE HAS BEEN RELIEVED.**

**NOTE:** *The jib telescope cylinder weighs approximately 130.5 lbs. (59.2 kg).*

### DISASSEMBLY

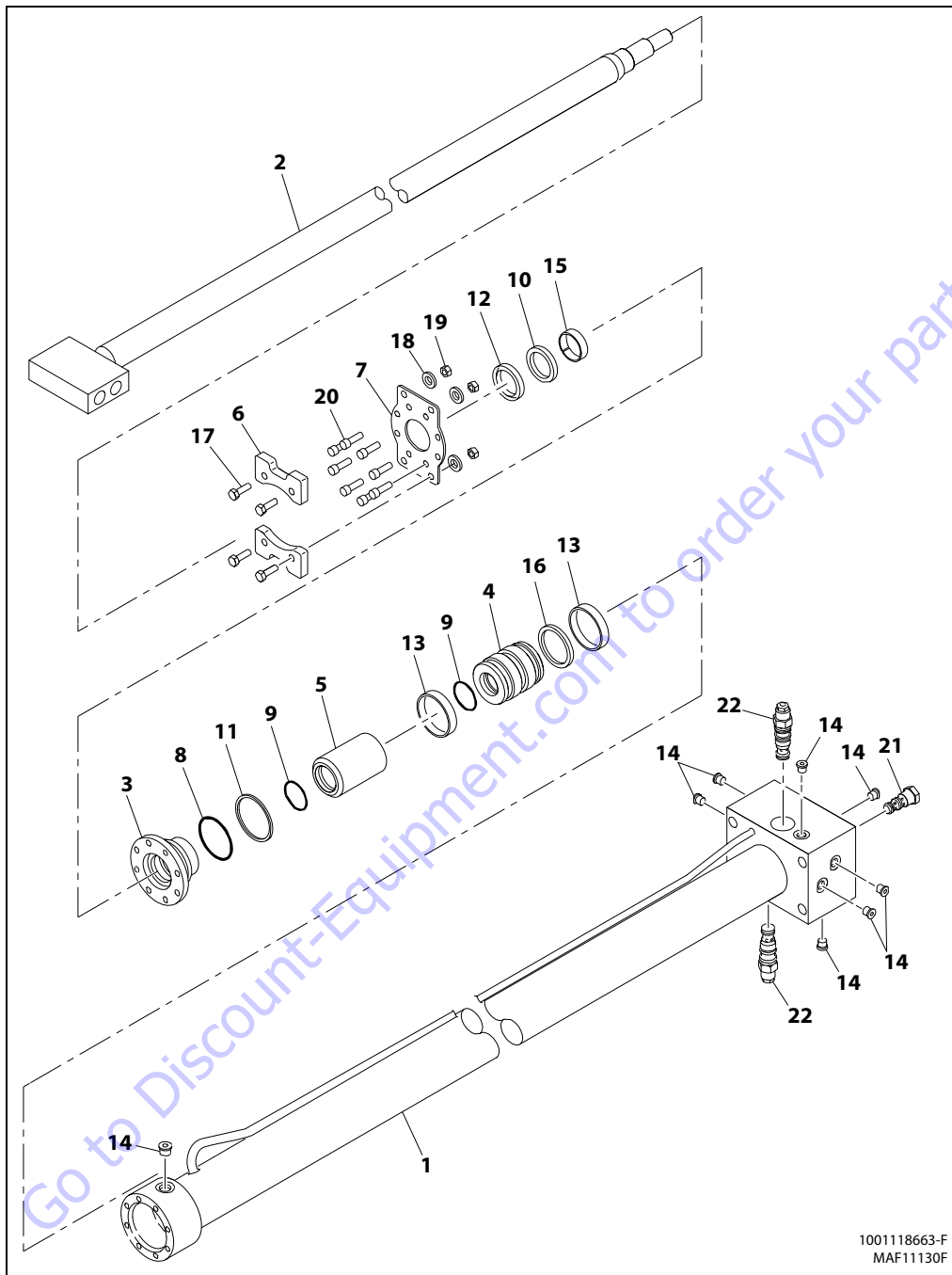
1. Retract cylinder and support equipment to allow for cylinder removal. Relieve system pressure to the cylinder. Clean any debris from around both ports and remove the hydraulic lines. Plug/cap both ports and remove cylinder from equipment.
2. The cylinder assembly should be secured in such a way as to prevent movement of the barrel assembly while removing the rod assembly. (Such as in a vise with pipe jaws.) Caution should be used to avoid damaging the rod surface and to avoid excessive deformation of the barrel, which could permanently damage the unit. Provisions must also be made to support the rod assembly during its removal.
3. Remove all dirt, grease, and other contaminants from around the ports and the head gland. Drain all oil from the unit. Extending and retracting the rod manually can help purge the bulk of remaining oil.
4. Mark the orientation of the rod, gland, pad support, and barrel with a permanent marker or paint pen. *Do not paint the chromed surface of the rod!* Remove the cap screws retaining the head gland from the cylinder assembly.

**NOTE:** *The threads are "locked" with a non-permanent thread adhesive during assembly; a quick tug on the wrench may be necessary to release the thread adhesive.*

5. Remove the rod assembly from the barrel using care not to damage the threads or any other components surface.
6. Clamp the rod mount and support the rod assembly with the chrome surface protected. Remove the piston assembly by unthreading the piston itself from the rod using a spanner wrench.

### INSPECTION

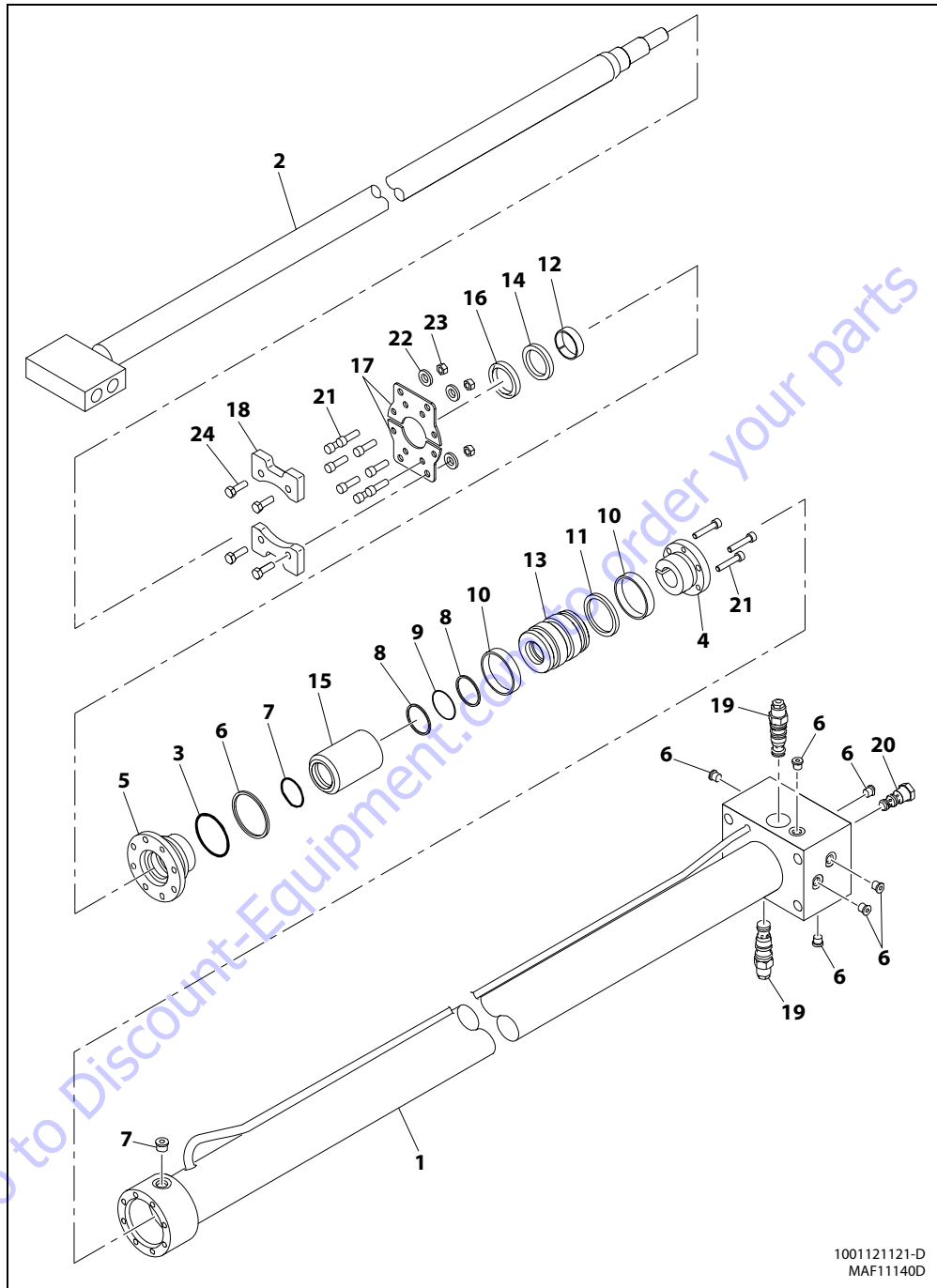
1. Inspect all seals, backup rings, wipers, and wear rings for tears, grooves, foreign matter, and excessive wear. Deep grooves may be an indication of damage to the barrel bore, rod chrome, or the presence of large particle contamination.
2. Remove the seals, backup rings, wipers, and wear rings using a soft metal tool (brass or aluminum) with rounded edges. Use care not to nick or score the surfaces of any component, especially the seal grooves.
3. Wipe all components clean with a lint-free cloth. Plug the barrel opening with a lint-free cloth. Remove any adhesive remnants from the head gland, barrel, rod, and piston threads (where applicable) using a soft wire brush. Use care not to scratch or otherwise damage the critical surfaces of any component including seal grooves, barrel bore, rod chrome, etc.
4. Inspect the piston and head gland for excessive wear, cracks, scoring, or any other damage. If wear is present on the O.D. of the piston or the I.D. of the head gland, check to ensure that the circularity of both dimensions are within 0.007". Beyond this limit the seal performance is compromised and the components must be replaced.
5. The stop tube should be inspected for cracking and excessive flaring of the ends.
6. Closely inspect the chrome surface of the rod. Any nicks, gouges, or scratches that penetrate the chrome plating or result in a sharp edge, which may damage seals, are cause for rod assembly replacement.
7. Flush the barrel and fluid tube (if equipped), drain, and wipe dry with a lint-free cloth. Closely inspect bore for nicks, gouges, or scratches. Replace barrel assembly if any of these are present.



- |             |                 |                  |                          |
|-------------|-----------------|------------------|--------------------------|
| 1. Barrel   | 7. Pad Support  | 13. Wear Ring    | 19. Nut                  |
| 2. Rod      | 8. O-ring       | 14. Plug         | 20. Capscrew             |
| 3. Head     | 9. O-ring       | 15. Wear Ring    | 21. Shuttle Valve        |
| 4. Piston   | 10. Rod Seal    | 16. Piston Seal  | 22. Counterbalance Valve |
| 5. Spacer   | 11. Backup Ring | 17. Capscrew     |                          |
| 6. Wear Pad | 12. Rod Wiper   | 18. Lock washers |                          |

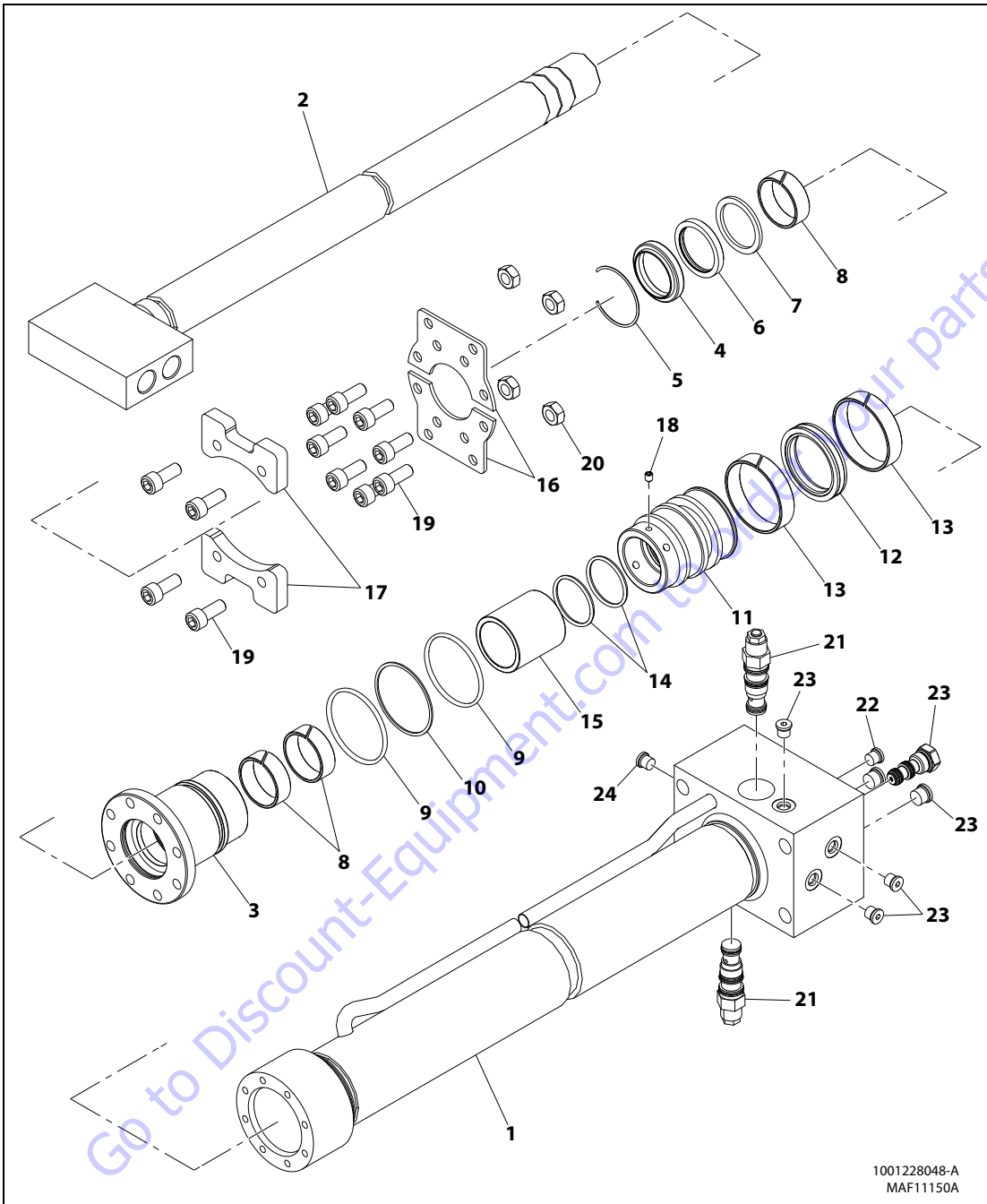
Figure 5-155. Jib Telescope Cylinder (SN 0300209000 through 0300213726)





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

Figure 5-156. Jib Telescope Cylinder (SN 0300213727 through 0300244704)



- |                   |                 |               |                          |
|-------------------|-----------------|---------------|--------------------------|
| 1. Barrel         | 7. Backup Ring  | 13. Wear Ring | 19. Capscrew             |
| 2. Rod            | 8. Wear Ring    | 14. O-ring    | 20. Nut                  |
| 3. Head           | 9. O-ring       | 15. Spacer    | 21. Counterbalance Valve |
| 4. Wiper          | 10. Backup Ring | 16. Plate     | 22. Shuttle valve        |
| 5. Retaining Ring | 11. Piston      | 17. Bracket   | 23. Plug                 |
| 6. Rod Seal       | 12. Piston Seal | 18. Setscrew  |                          |

Figure 5-157. Jib Telescope Cylinder (SN 0300244705 to Present)

### ASSEMBLY

**NOTE:** Refer to Figure 5-158. and Figure 5-159. provided at the end of this procedure for the proper seal locations and orientations. Improper seal orientation will compromise performance!

Inspect all components per above INSPECTION procedure. Clean all components with a lint-free cloth. The barrel should be flushed out and drained. Compressed air may be used to blow out the barrel bore and all ports. Lubricate all seals with hydraulic fluid prior to assembly.

#### HEAD GLAND ASSEMBLY

1. Install rod seal; refer to Seal Detail for proper orientation.
2. Install wear rings.
3. Press in the rod wiper using a soft metal (brass or aluminum) or nylon tool which contacts the wiper 360°. Make sure the wiper remains perpendicular to the bore at all times.
4. Install the backup ring and o-ring with the backup ring nearest the head gland flange.

#### PISTON ASSEMBLY

1. Install o-ring into groove in I.D. of piston.
2. Install one wear ring onto piston.
3. Install piston seal into central groove on piston O.D. A clean, small cross-section o-ring or a thin elastic band may be wrapped around seal to help stretch it over piston.
4. Install remaining wear ring.

#### ROD, GLAND, PISTON ASSEMBLY

1. Lubricate I.D. of head gland assembly with hydraulic fluid, and slide onto rod (rod wiper end first) using caution not to damage rod wiper or seal on rod end.
2. Slide stop tube (with o-ring) onto rod. Do not scratch rod chrome.
3. For pistons with threaded I.D., apply Loctite #7471 (Primer-T) to piston and rod threads. Allow primer to evaporate then apply two beads of Loctite #222 Thread Adhesive axially across the threads of the piston I.D.
4. Install piston assembly onto threaded end of rod. Tighten piston onto rod end to 100 ft.lbs. An optional method for tightening threaded piston is to turn until piston bottoms out; then set in place by hitting spanner wrench handle with a hammer; piston should rotate slightly while setting.

#### FINAL ASSEMBLY

1. Make sure all rags, etc. are removed from barrel bore. Lubricate barrel bore and piston assembly with hydraulic fluid. Avoid getting any oil in barrel threads.
2. Place pad support on rod assembly before installing into barrel. Use care to avoid damaging wear rings, seals, and rod chrome.
3. Align rod with barrel assembly. Insert piston into barrel opening. Use care to avoid damaging wear rings, seals, and piston surface on barrel.
4. Lubricate o-ring and backup on head gland using hydraulic fluid.
5. Align head gland with barrel assembly, position pad support over head gland (avoid damaging the o-ring and back-up with the pad support), and press head gland into barrel assembly.
6. Apply a bead of Loctite #222 Thread Adhesive axially cap screw threads.
7. Screw cap screws into head gland / barrel assembly.

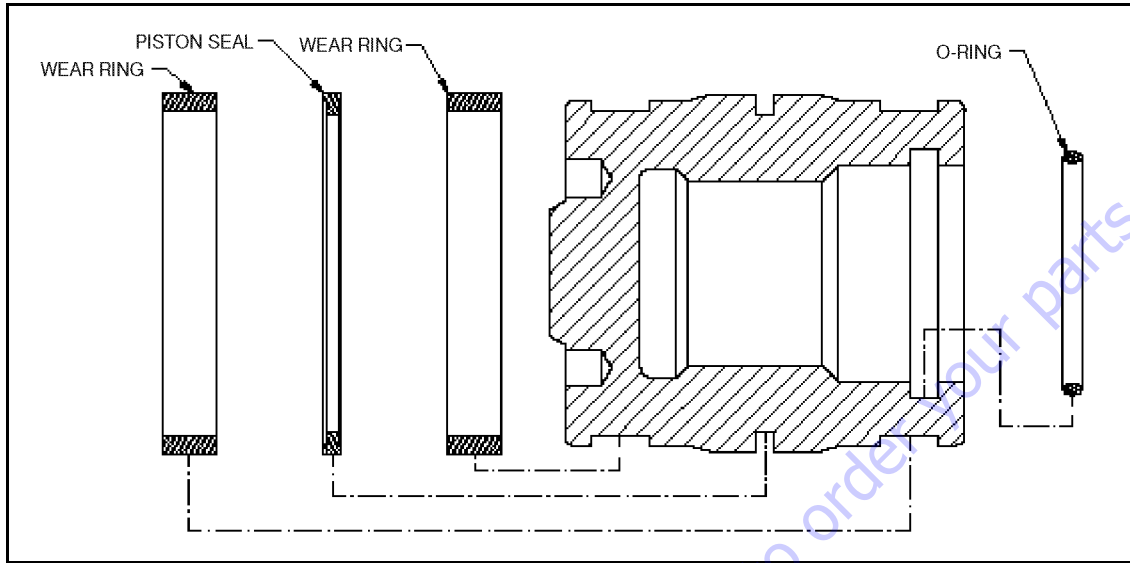


Figure 5-158. Jib Telescope Cylinder Head Gland Detail

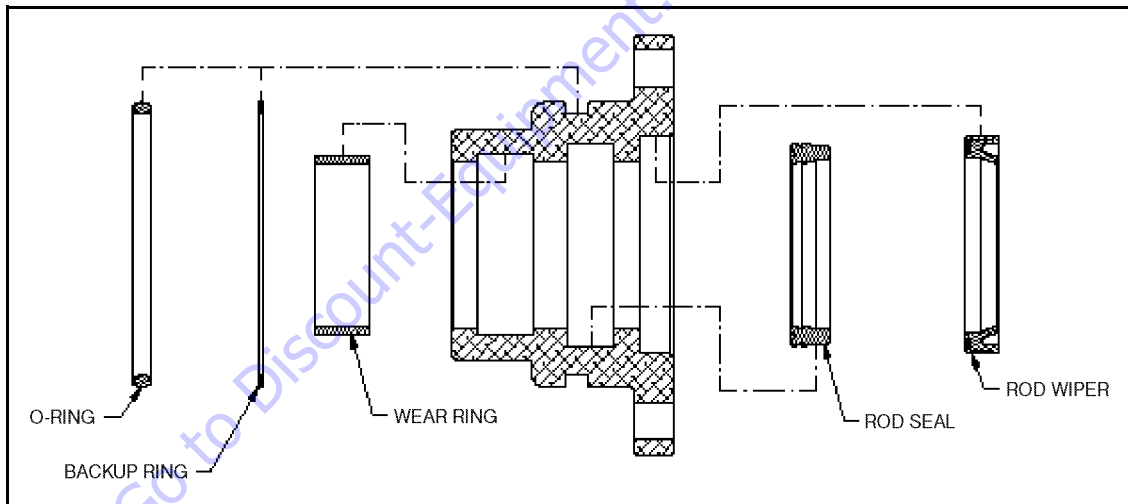


Figure 5-159. Jib Telescope Piston Detail

**Main Boom Telescope Cylinder (SN 0300209000 through 0300244704)**

**DISASSEMBLY**

**NOTICE**

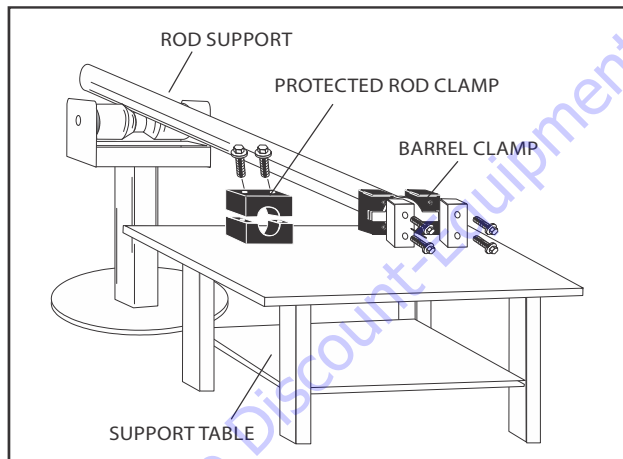
**DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.**

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

**NOTICE**

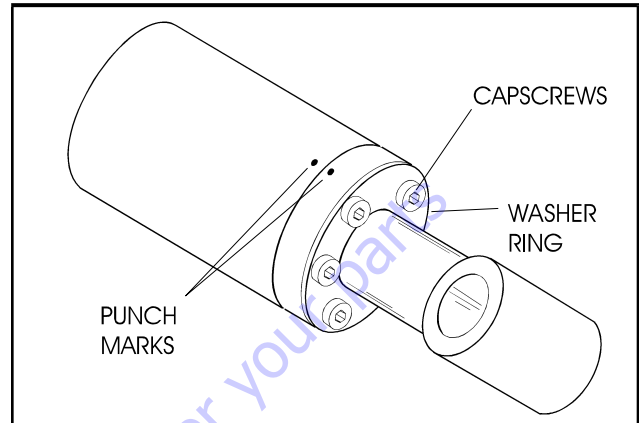
**DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.**

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. Remove the check valves, counterbalance valves, and relief valve from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.



**Figure 5-160. Cylinder Barrel Support**

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.



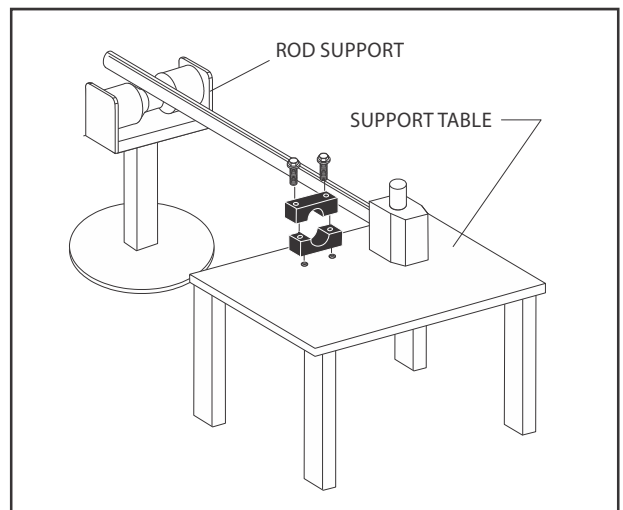
**Figure 5-161. Cap Screw Removal**

6. Attach a suitable pulling device to the cylinder rod end.

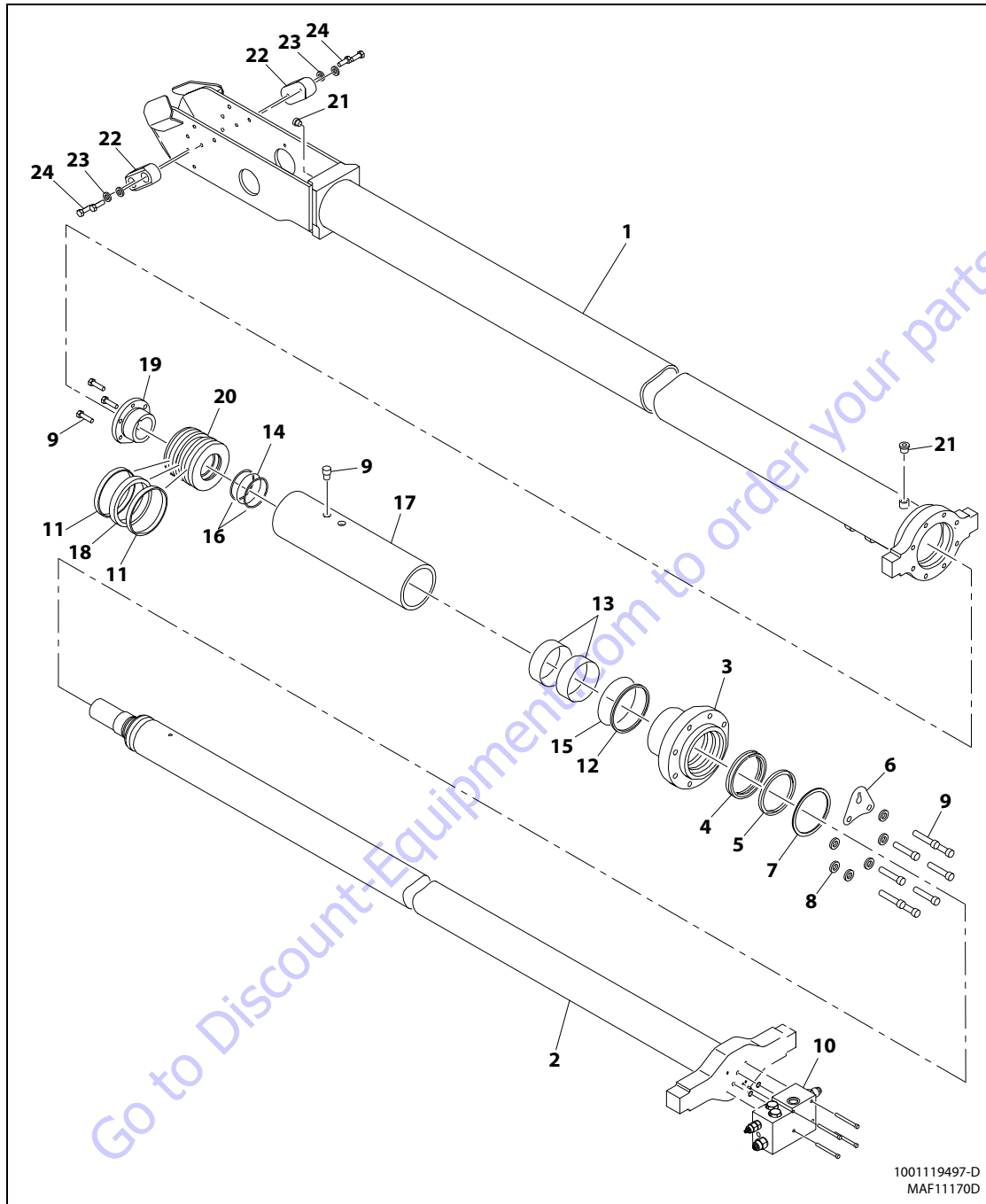
**NOTICE**

**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.**

7. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.



**Figure 5-162. Cylinder Rod Support**



1001119497-D  
MAF11170D

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

Figure 5-163. Boom Telescope Cylinder

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 capscrews which attach the tapered bushing to the piston.

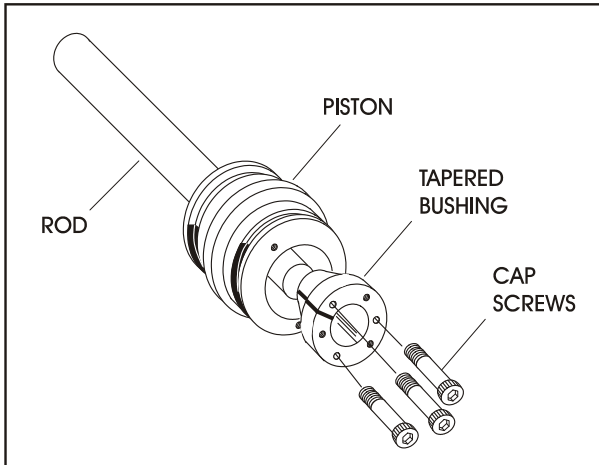


Figure 5-164. Tapered Bushing Removal

10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loose.
11. Remove the tapered bushing from the piston.
12. By hand, screw the piston counterclockwise and remove it from cylinder rod.
13. Remove and discard the piston o-rings, seal rings, and backup rings.
14. Remove the rod from the holding fixture. Remove the cylinder head gland and washer ring. Discard all seals on the cylinder head.

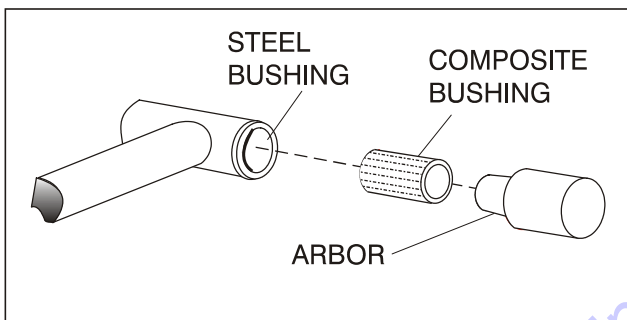
**CLEANING AND INSPECTION**

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.

## SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

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 5-165. Composite Bearing Installation**

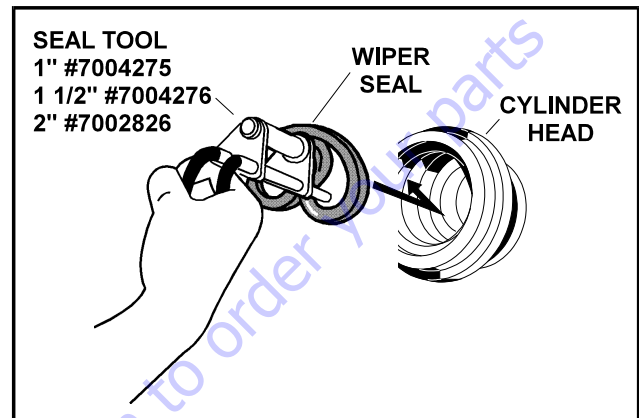
14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or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

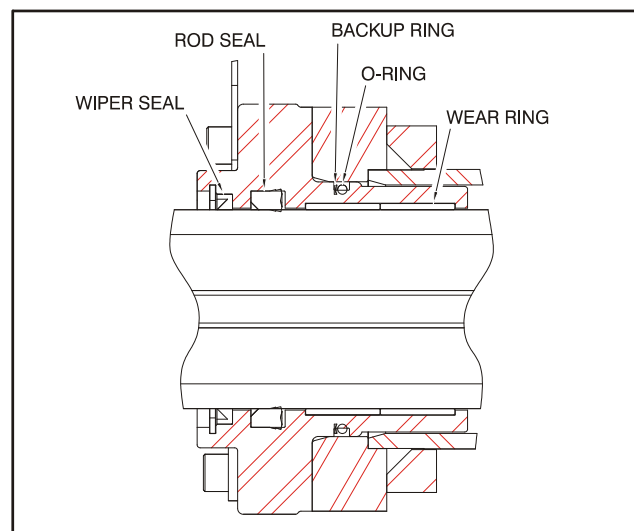
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-166. 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.**



**Figure 5-167. Cylinder Head Seal Installation**



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

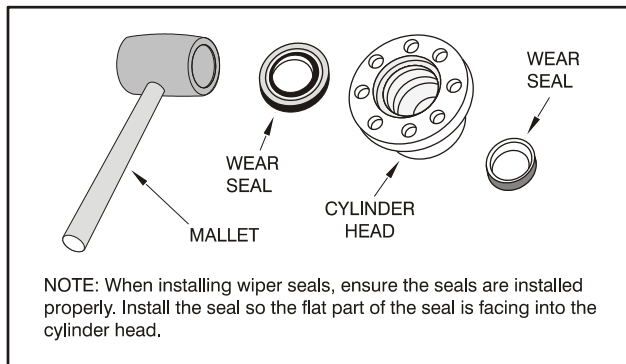


Figure 5-168. Wiper Seal Installation

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

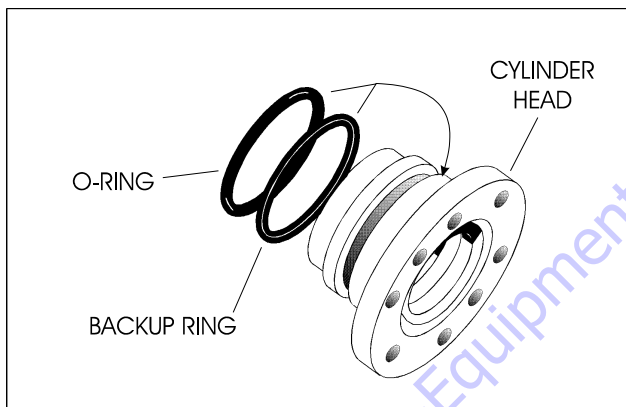


Figure 5-169. Installation of Head Seal Kit

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.
5. Push the spacer onto the rod.
6. Place a new O-ring and backup rings in the inner piston diameter groove.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston threads as possible.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.

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

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

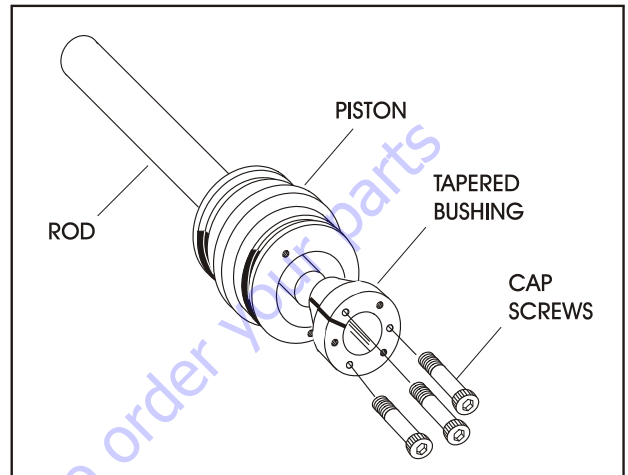


Figure 5-170. Tapered Bushing Installation

10. 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.

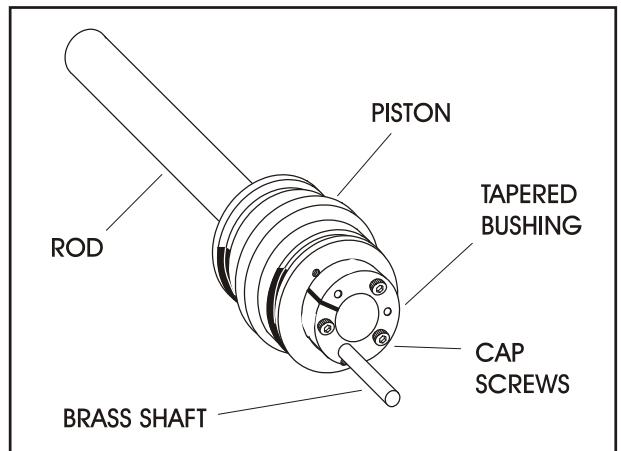


Figure 5-171. Seating the Tapered Bearing

11. Remove the cylinder rod from the holding fixture.

- Place a new t-seal and wear rings in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the seal.)

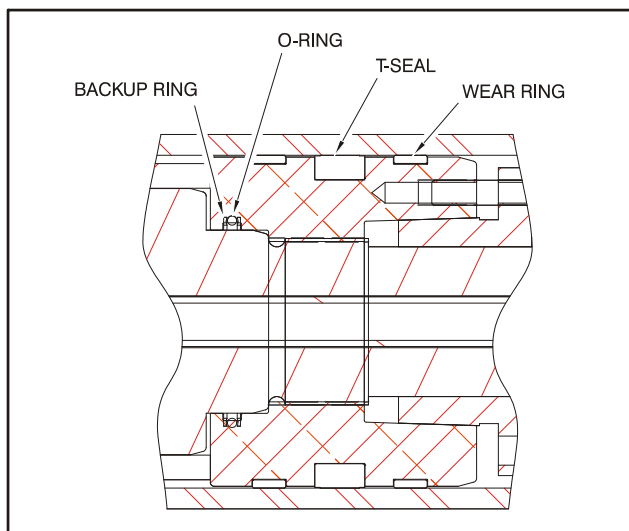


Figure 5-172. Piston Seal Installation

- 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.**

- 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.
- Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

- Secure the cylinder head gland using the washer ring, JLG Threadlocker PN 0100011 and socket head bolts.

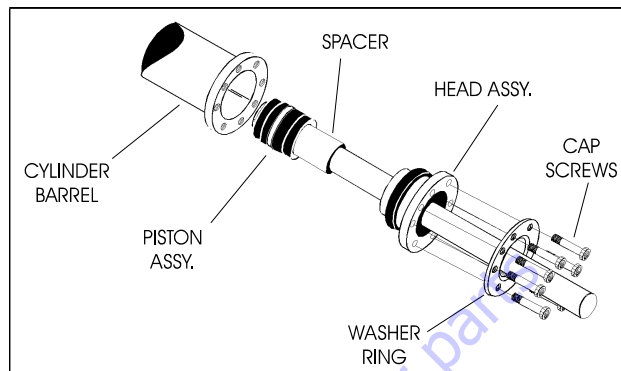


Figure 5-173. Rod Assembly Installation

- After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any valves.
- Install the check valves in the rod port block.
- Install the counterbalance valves in the rod port block.
- Install the relief valve in the rod port block.

## Main Boom Telescope Cylinder (SN 0300244705 to Present)

### 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. Remove the check valves, counterbalance valves, and relief valve from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

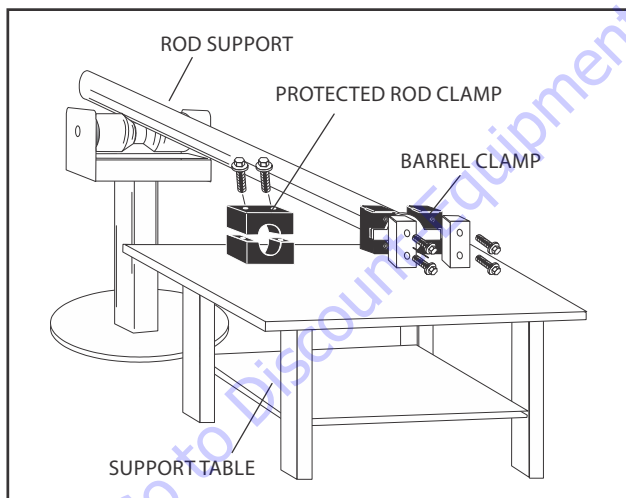


Figure 5-174. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

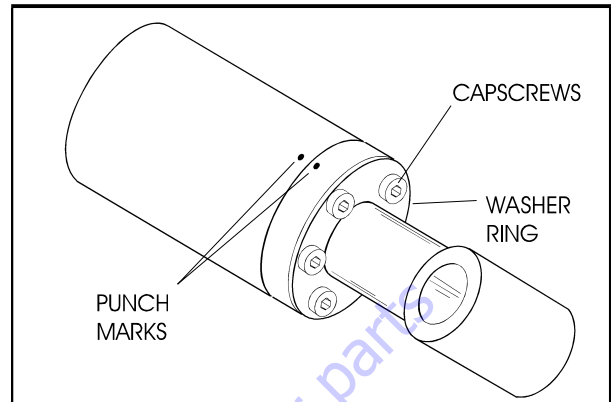


Figure 5-175. Cap Screw Removal

6. Attach a suitable pulling device to the cylinder rod end.

#### 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.

7. With the barrel clamped securely, carefully withdraw the complete rod assembly from the cylinder barrel.

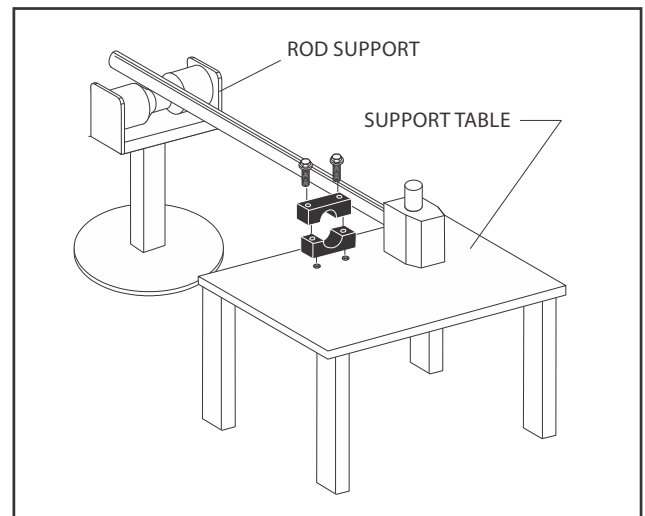
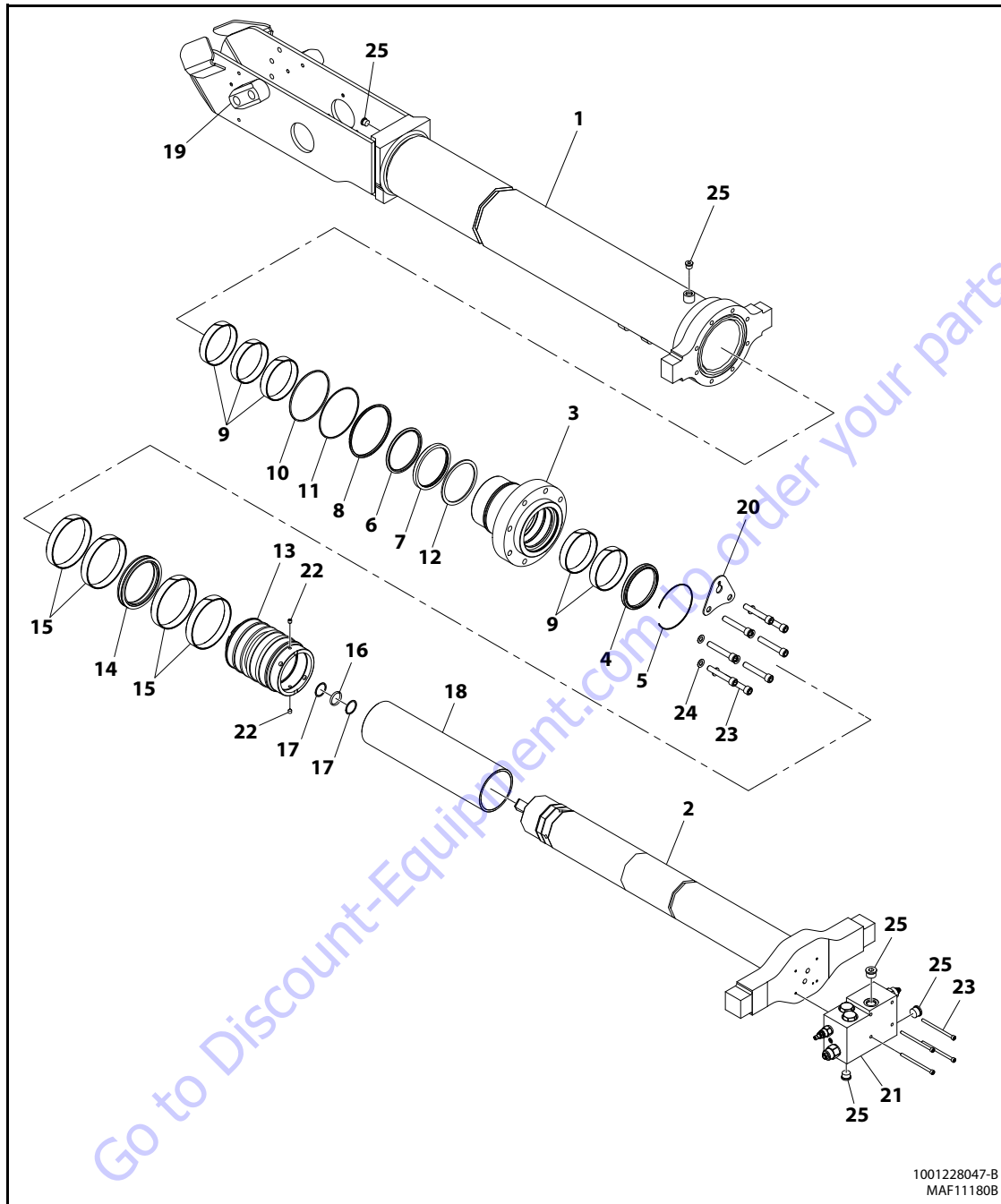


Figure 5-176. Cylinder Rod Support

8. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.



1001228047-B  
MAF11180B

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

Figure 5-177. Boom Telescope Cylinder

9. Loosen and remove the setscrew(22) which is attached to the piston assembly.
10. Screw the piston(13) counterclockwise and remove the piston from cylinder rod(2).

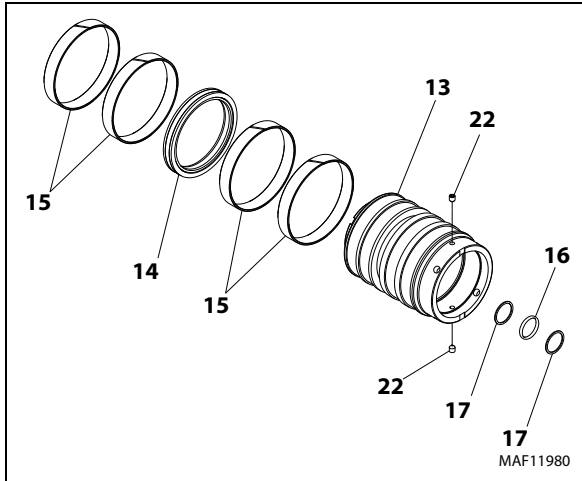


Figure 5-178. Piston Disassembly

11. Remove and discard o-ring (16) and backup ring (17) from inside of piston (13).
12. Remove and discard piston seal (14) and wear ring (15) from outside grooves of piston (13).
13. Remove spacer (18) from rod (2).

**NOTICE**

**REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.**

14. Remove and discard wear ring (9) and wiper (4) from inside of cylinder head (3).

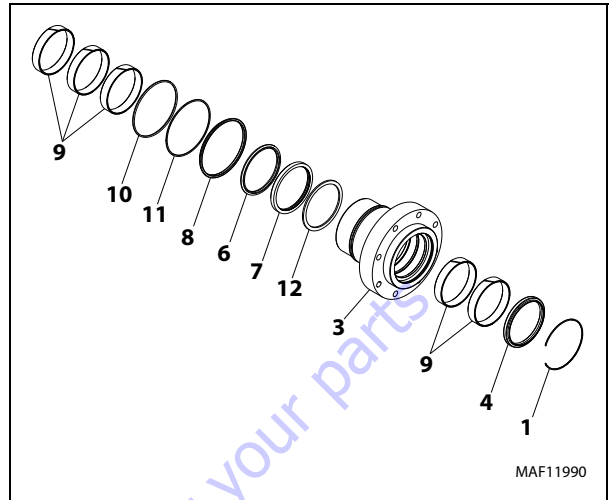


Figure 5-179. Cylinder Head Disassembly

15. Remove and discard retaining ring (5), rod seal (6), backup ring (7) and o-ring (12) from inside of cylinder head (3).
16. Remove and discard o-ring (10) and backup ring (11) from outside of cylinder head (3).

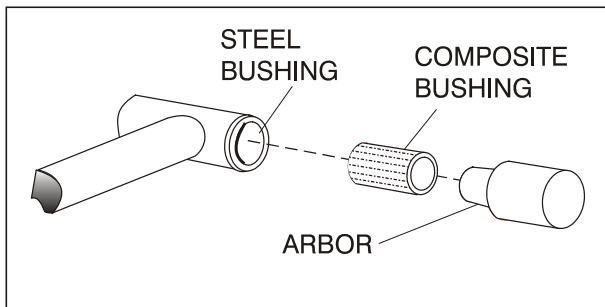
**CLEANING AND INSPECTION**

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect 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, scoring, or 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 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, damage, ovality, and tapering. Replace as necessary.
13. 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.

**NOTE:** Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

- d. Press bushing into barrel or rod bushing with correct size arbor.



**Figure 5-180. Bushing Installation**

14. Inspect port block fittings and holding valves. Replace as necessary.
15. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**ASSEMBLY**

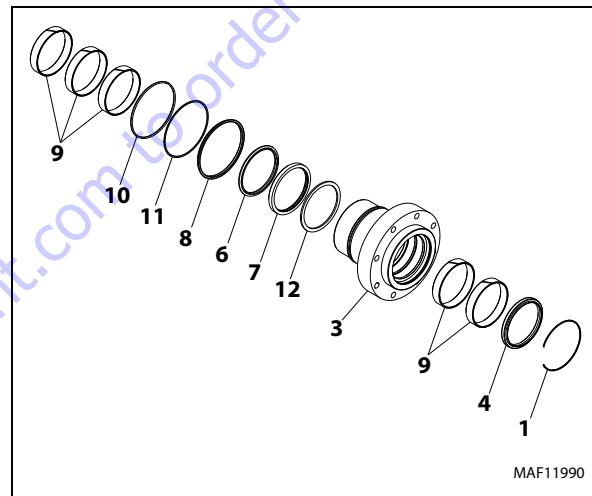
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

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

**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

1. Install rod seal (6), backup ring (7) and o-ring (12) inside the cylinder head (3).
2. Install wear ring (9), wiper (4) and retaining ring (5) inside the cylinder head (3).



**Figure 5-181. Cylinder Head Assembly**

3. Install o-ring (10) and backup ring(11) on outside grooves of the cylinder head (3).
4. Carefully slide the spacer (18) onto rod (2).
5. Install o-ring (16) and backup ring (17) inside the piston (13).
6. Install Piston seal (14) and wear ring (15) on outside grooves of the piston (13).
7. Using suitable protection, clamp cylinder rod (2) in a vise or similar holding fixture as close to piston as possible.

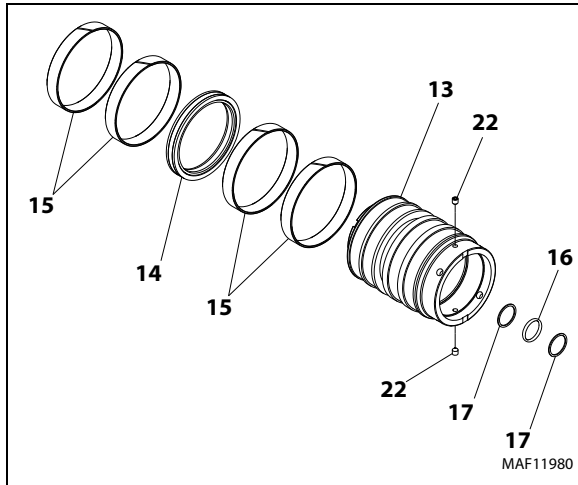


Figure 5-182. Piston Assembly

8. Carefully thread piston (13) on cylinder rod (2) hand tight. Do not damaged or dislodge O-ring and backup rings.
9. Install setscrew (22) on the piston (13) and attach piston (13) to the rod (2).
10. Position cylinder barrel (1) in a suitable holding fixture.

**NOTICE**

**INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD, AND PISTON.**

11. Continue pushing rod in barrel until cylinder head (3) can be inserted into the barrel.
12. Secure the cylinder head gland using the washer ring and socket head bolts.
13. 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.

## 5.4 CYLINDER LENGTH SENSOR

Both the jib lift cylinder and the platform level cylinder utilize a cylinder length sensor which communicates with the JLG control system. These sensors can be removed from without the cylinder being disassembled.

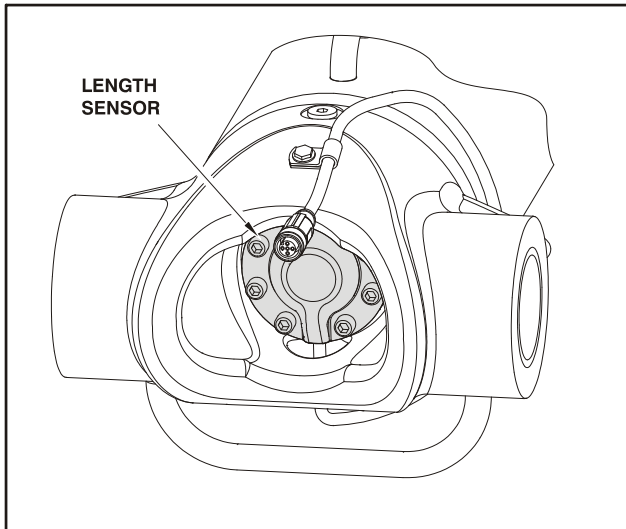


Figure 5-183. Cylinder Length Sensor

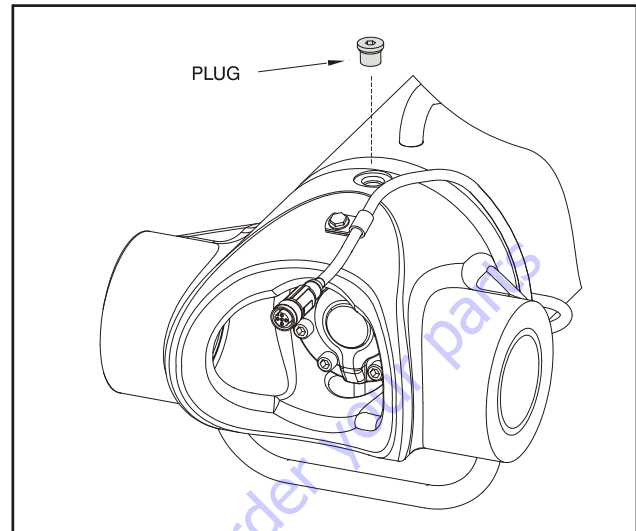
### Removal

1. Lower the platform to the ground or on suitable blocking.

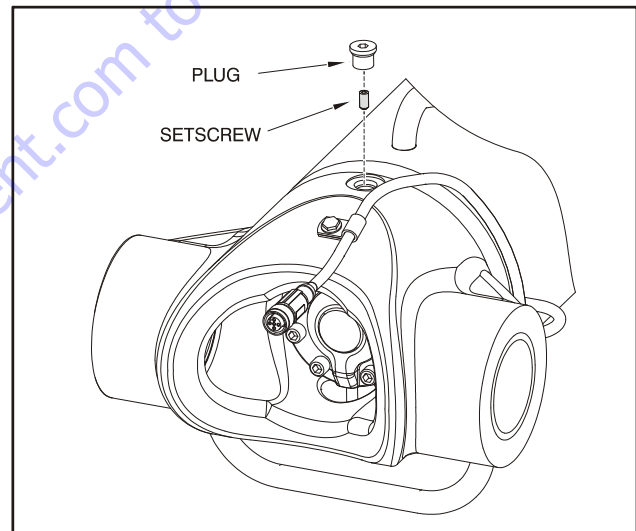
**NOTE:** The jib lift cylinder weighs approximately 186 lbs. (84 kg) and the platform level cylinder weighs approximately 76 lbs. (34 kg)

2. Support the weight of the jib cylinder and remove the bolt and keeper pin that secure the cylinder barrel retaining pin. Remove the pin.
3. Lower the cylinder to a horizontal position to gain access to the rear of the cylinder.
4. Place a catch pan under the cylinder to capture any oil that may drain out of the cylinder. If the cylinder is removed from the machine, drain the oil out of the cylinder.

5. Remove the plug that is over the setscrew that secures the sensor in place.



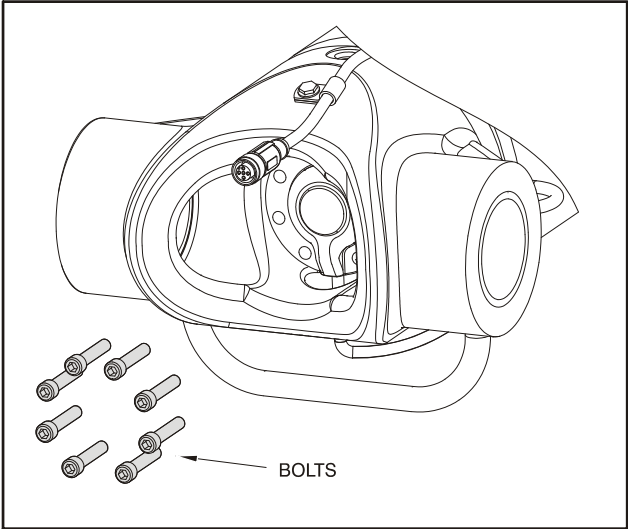
6. Using an allen wrench, remove the setscrew.



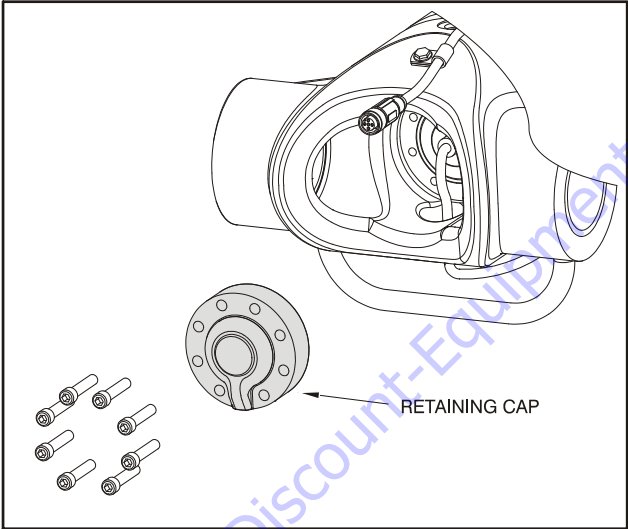
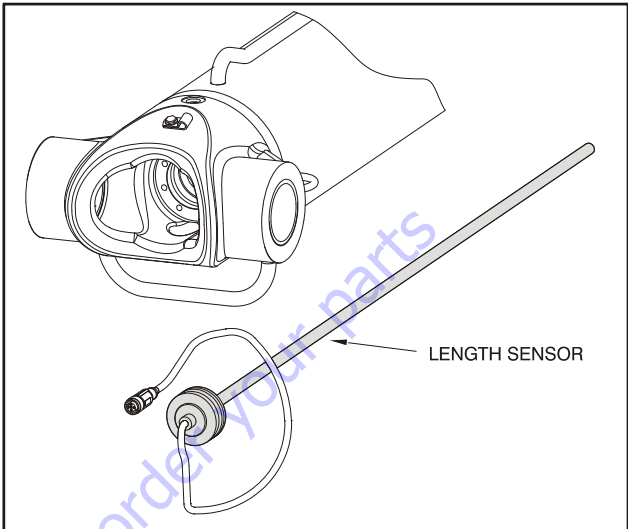


**SECTION 5 - BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS**

- 7. Using an allen wrench, remove the bolts securing the retaining cap and remove the cap.

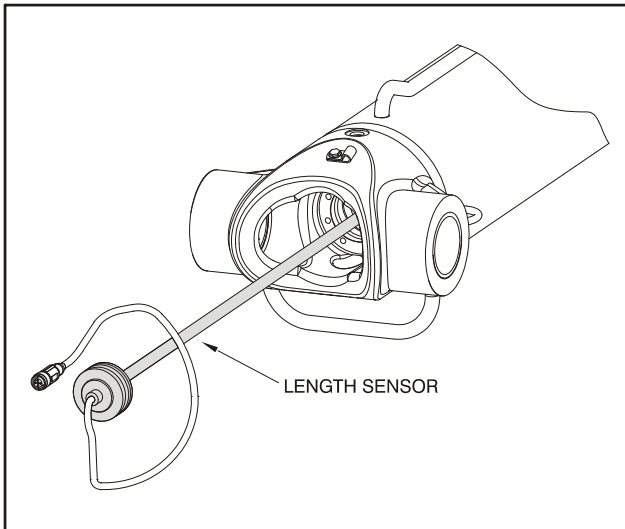


- 8. Pull sensor out of the cylinder. DO NOT use the wiring harness to pull the sensor out as this will cause damage to the wiring.

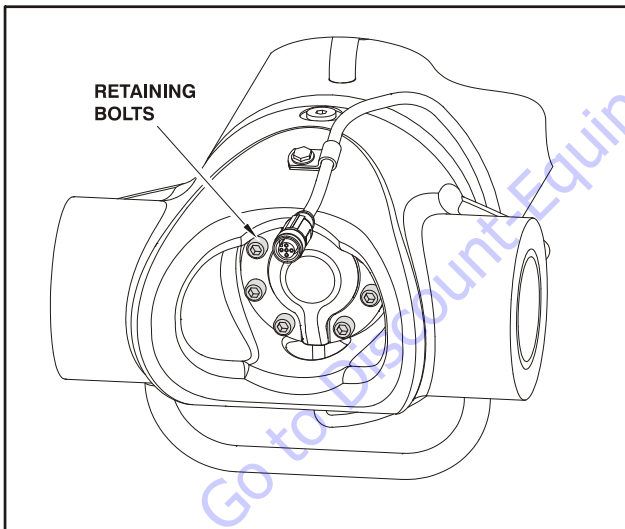


**Installation**

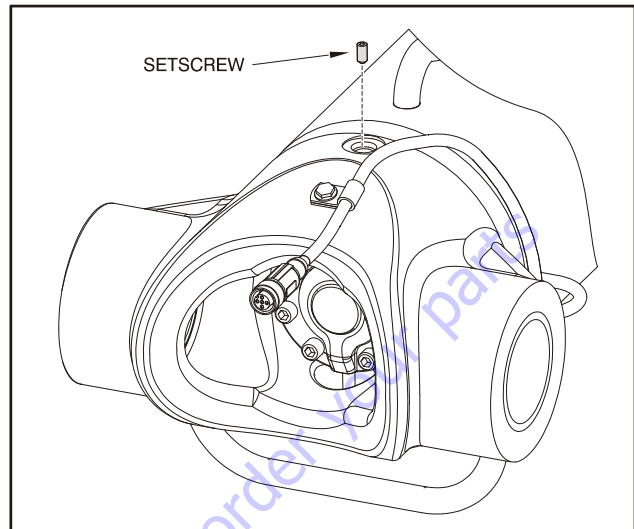
1. Carefully insert the sensor into the cylinder. It may be necessary to gently tap the end of the sensor to seat the o-ring into the sensor bore. **DO NOT** tap on the wiring harness.



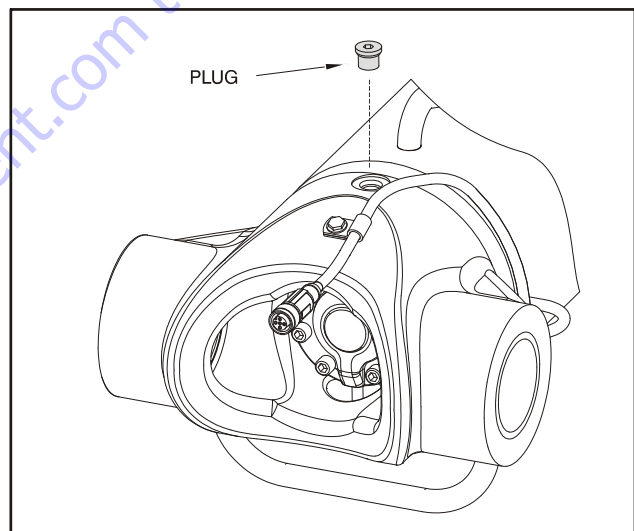
2. Install the cap and secure in place with the retaining bolts.



3. Apply lubricant JLG PN 3020039 to the setscrew and install the setscrew. Torque the setscrew to 4 in. lbs. (0.45 Nm).



4. Install the plug over the setscrew.



5. Raise the cylinder back in place and install the retaining pin.
6. Install the keeper pin and retaining bolt.
7. Check the cylinder for proper operation.

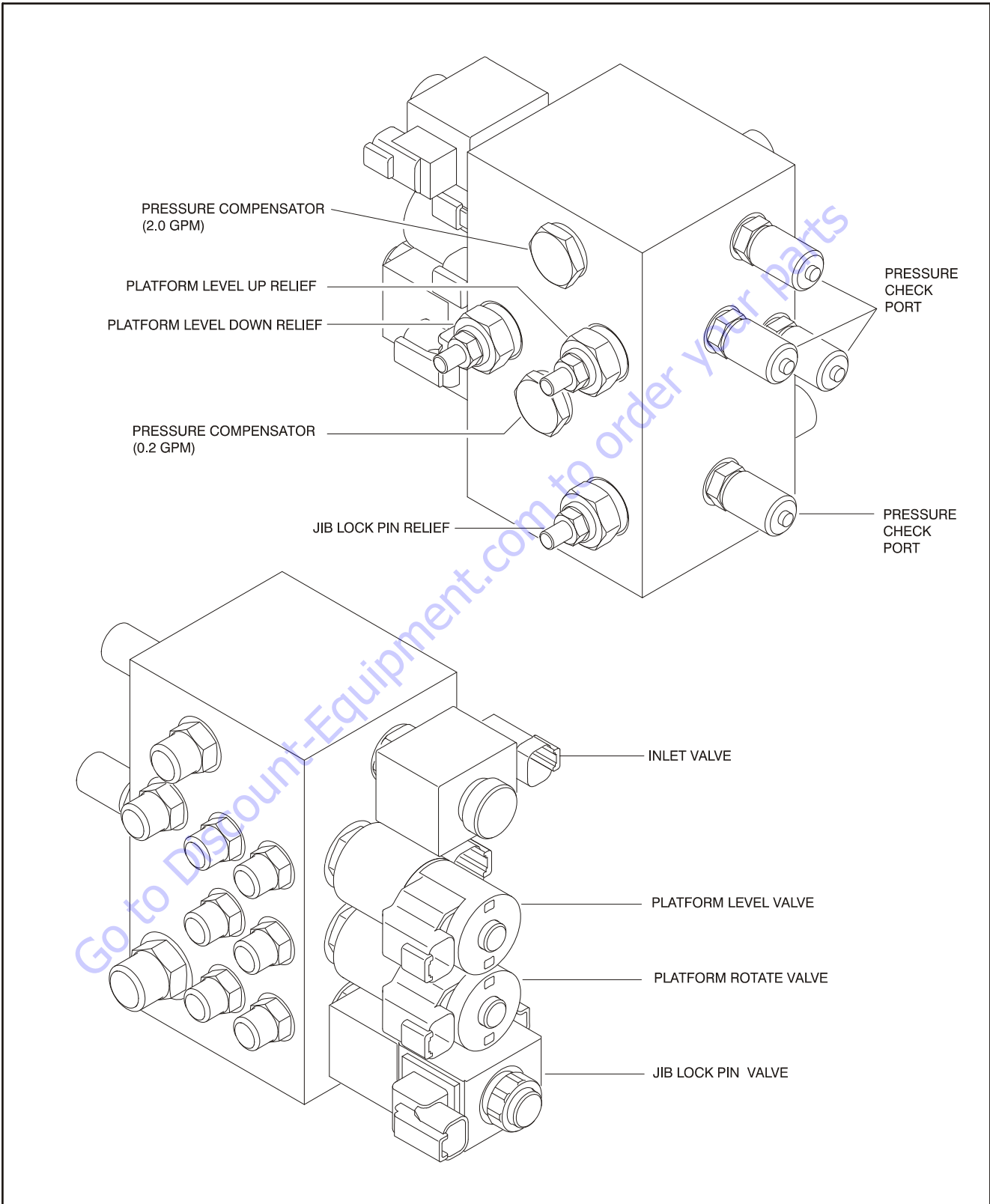


Figure 5-184. Platform Valve Identification

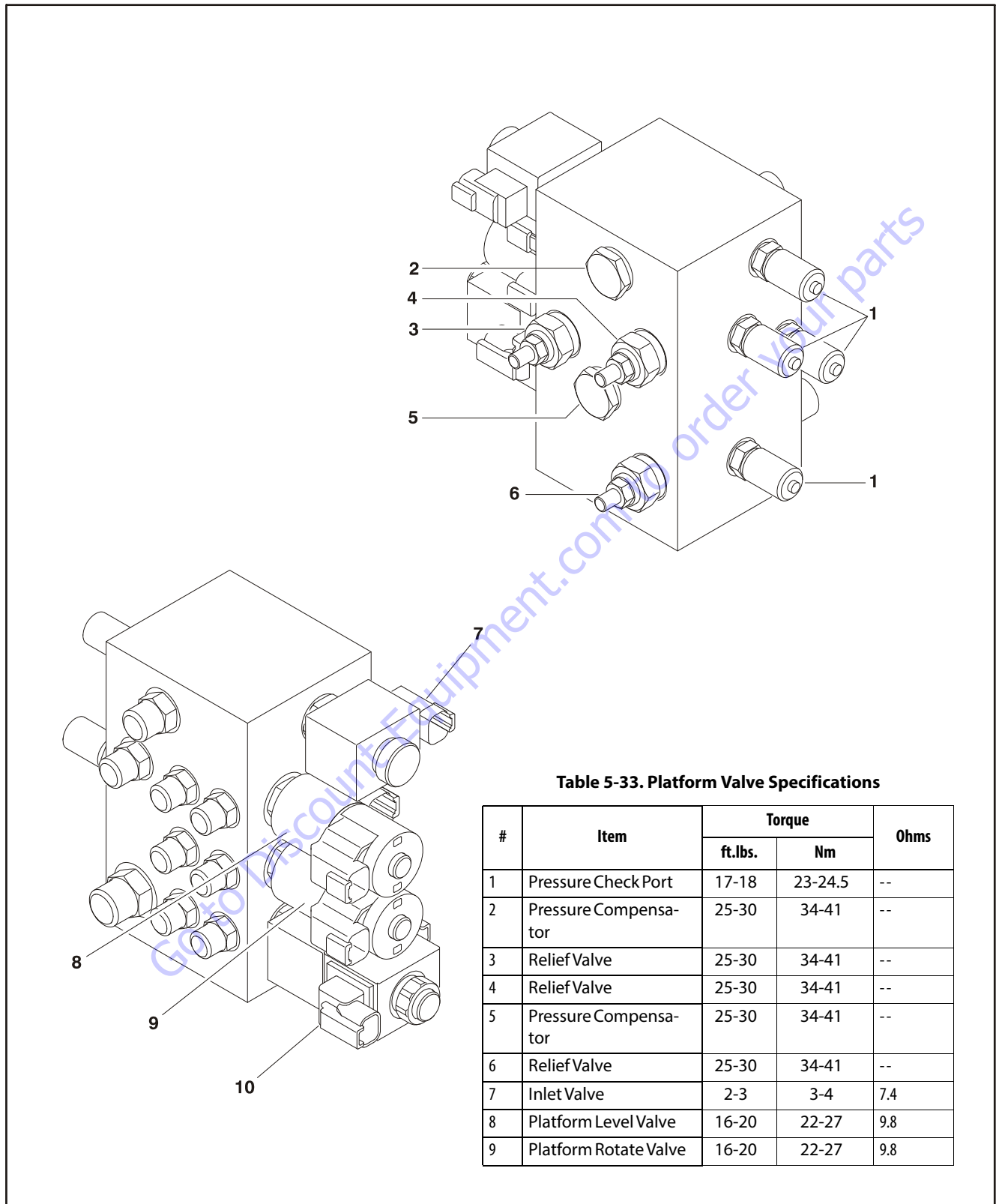


Figure 5-185. Platform Valve Torque and Resistance Specifications

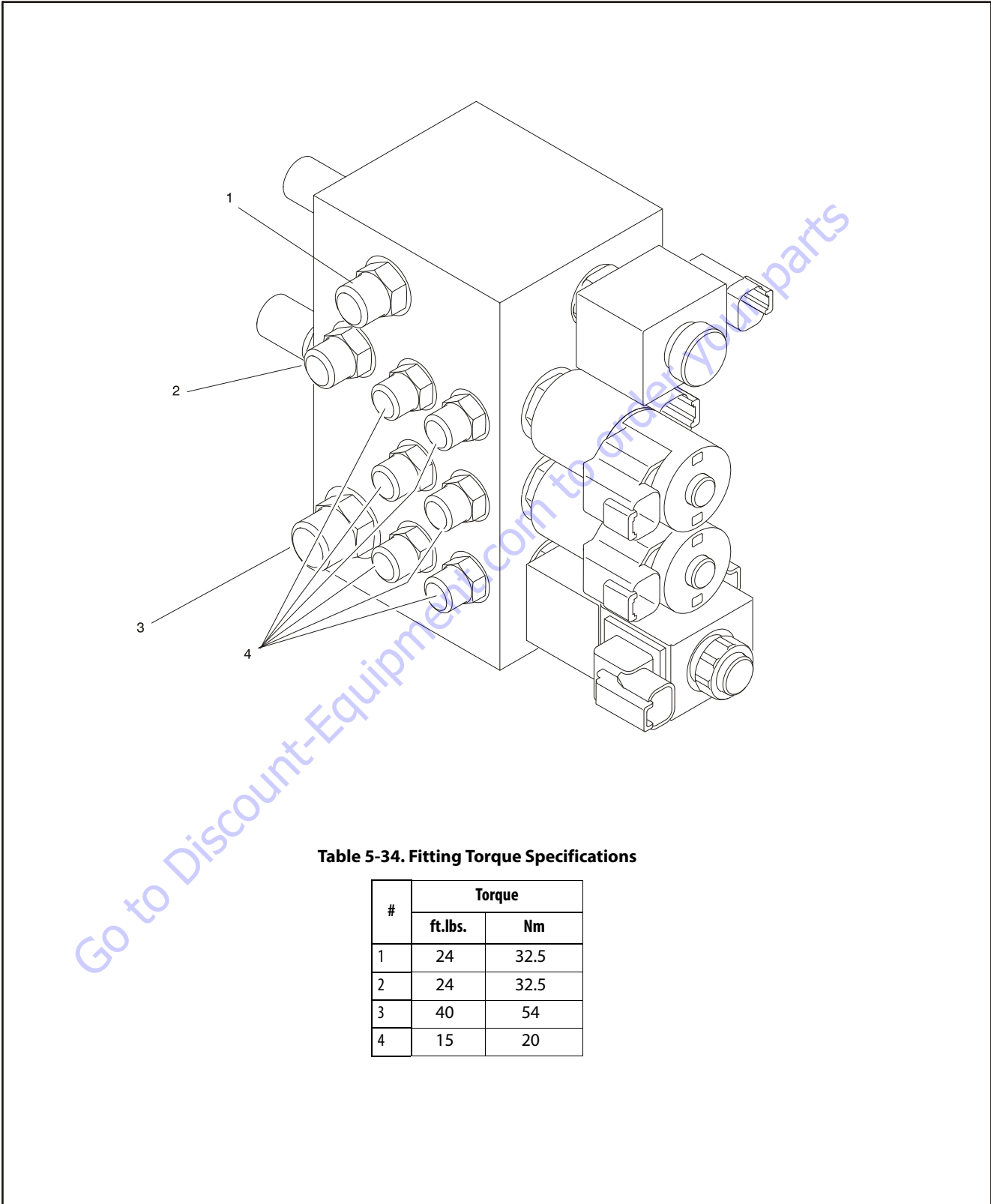


Table 5-34. Fitting Torque Specifications

#	Torque	
	ft.lbs.	Nm
1	24	32.5
2	24	32.5
3	40	54
4	15	20

Figure 5-186. Platform Valve Fitting Torque Specifications

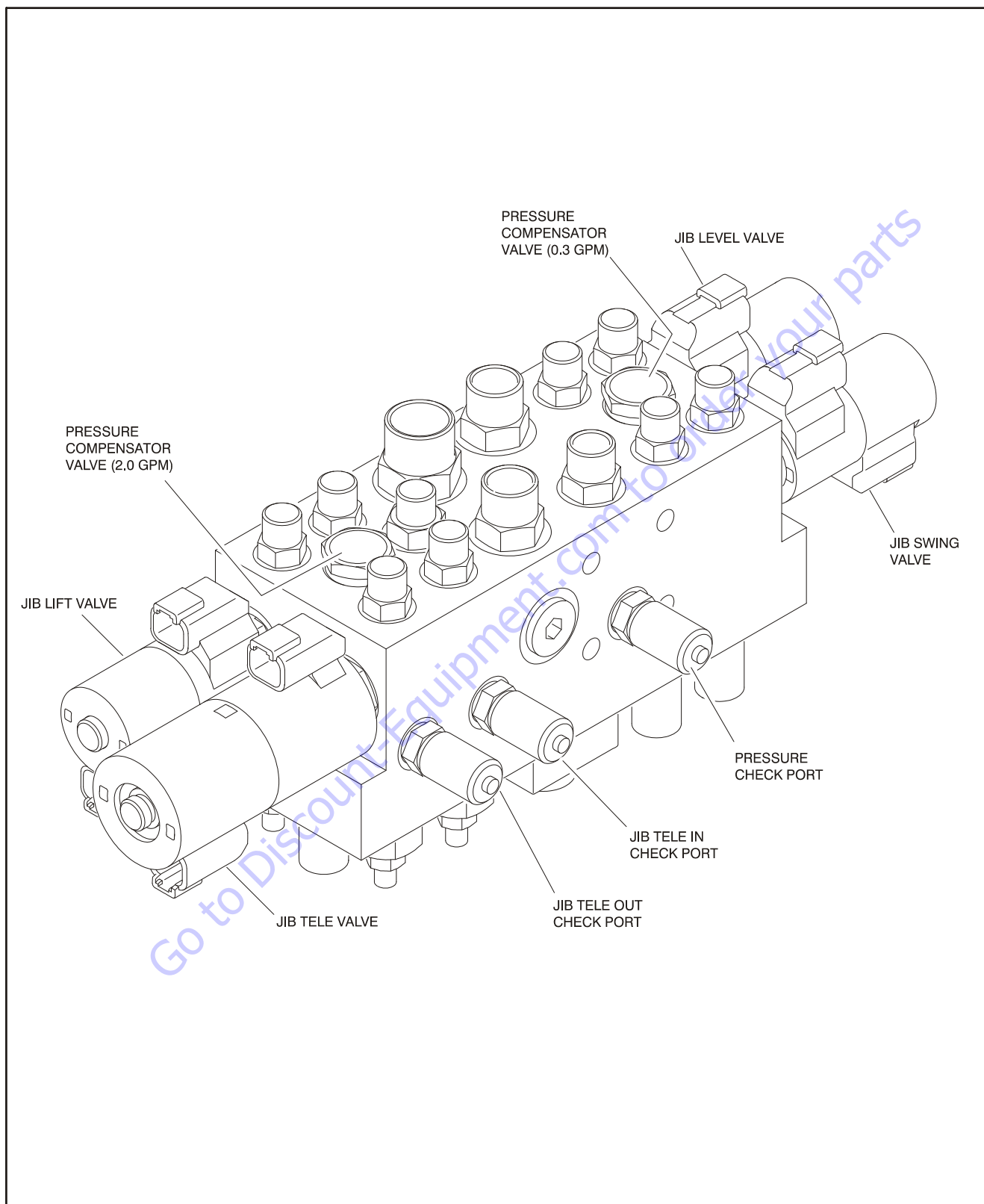


Figure 5-187. Jib Control Valve Identification - Sheet 1 of 2

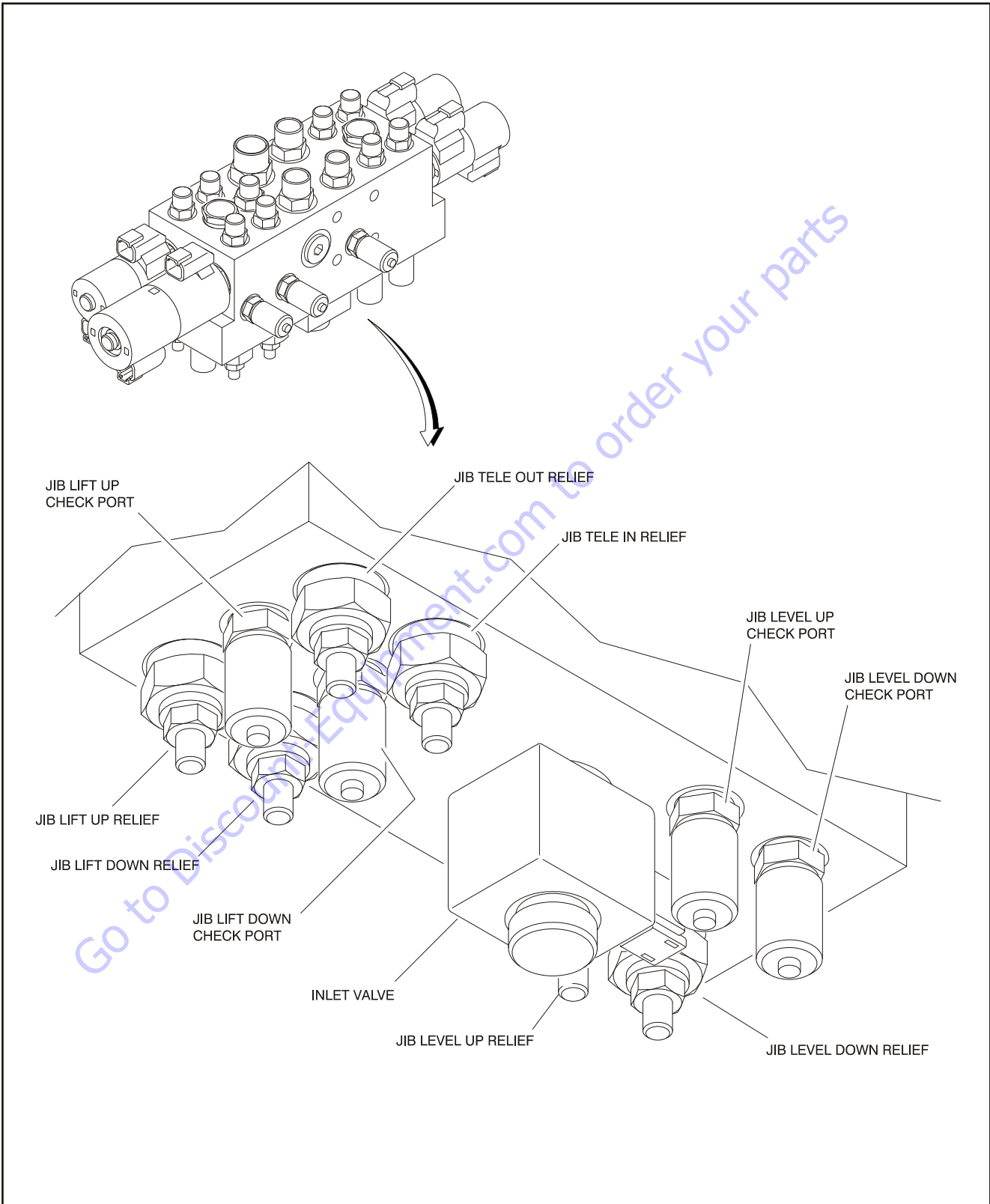


Figure 5-188. Jib Control Valve Identification - Sheet 2 of 2

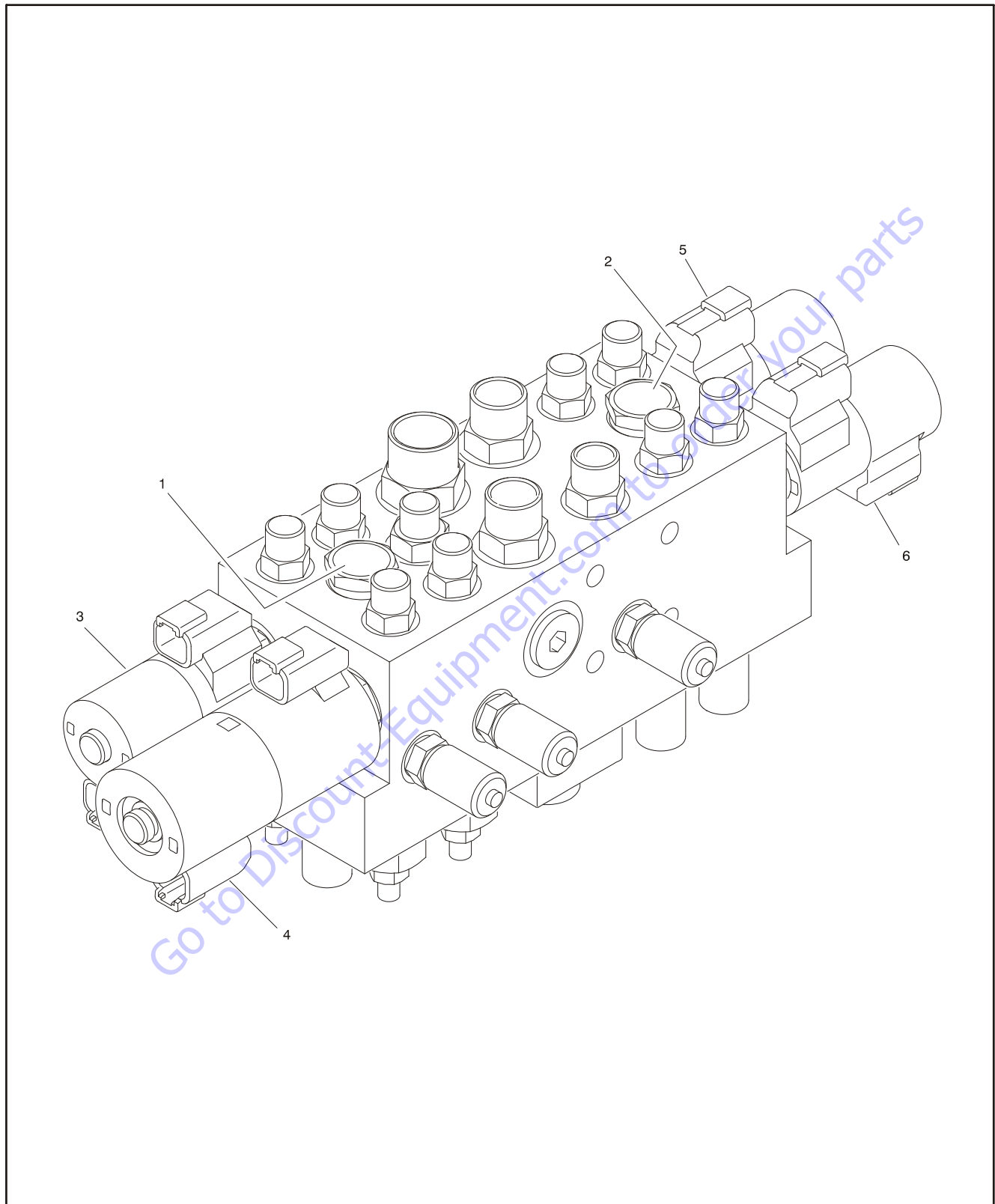


Figure 5-189. Jib Control Valve Torque and Resistance Specifications - Sheet 1 of 2



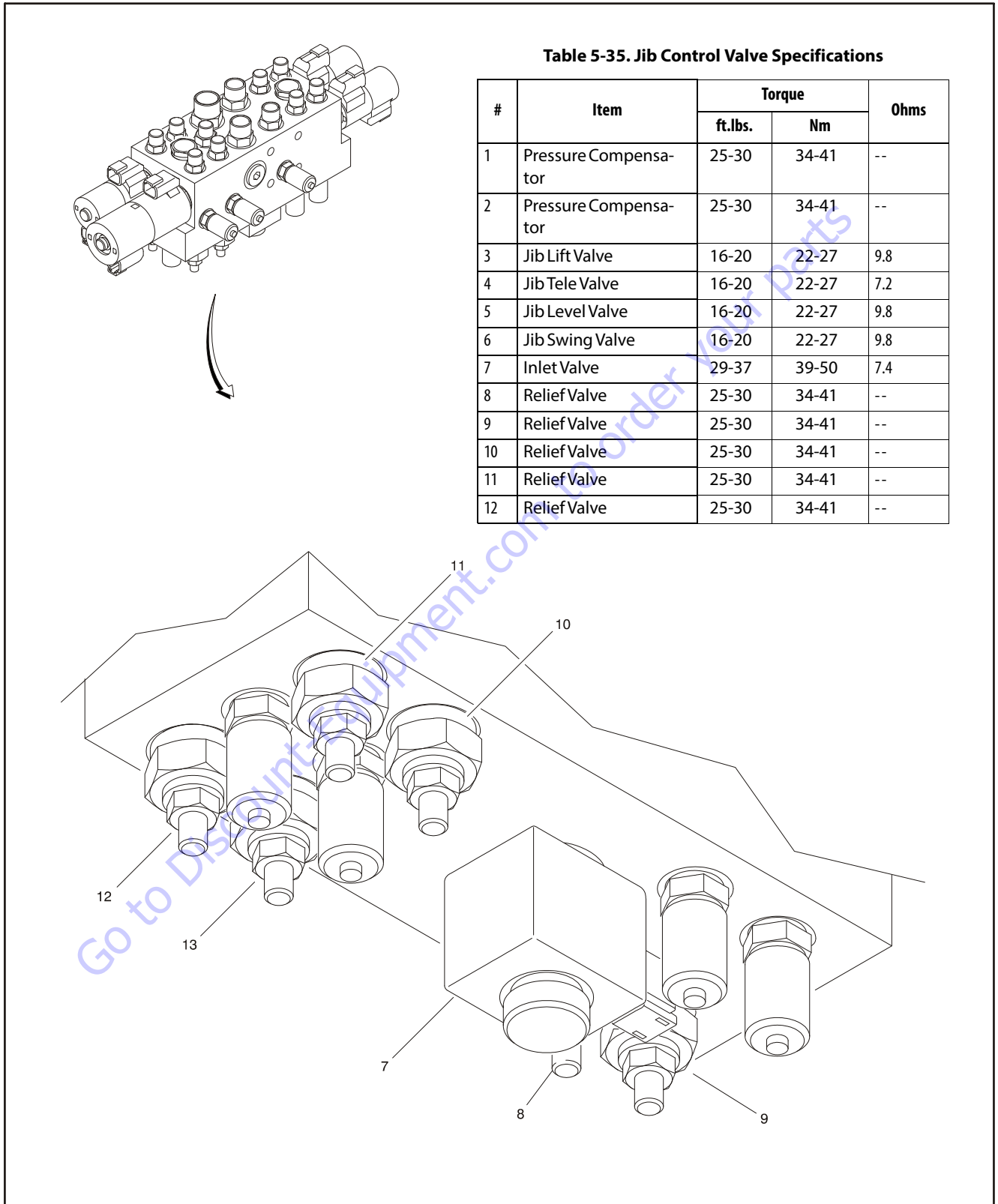
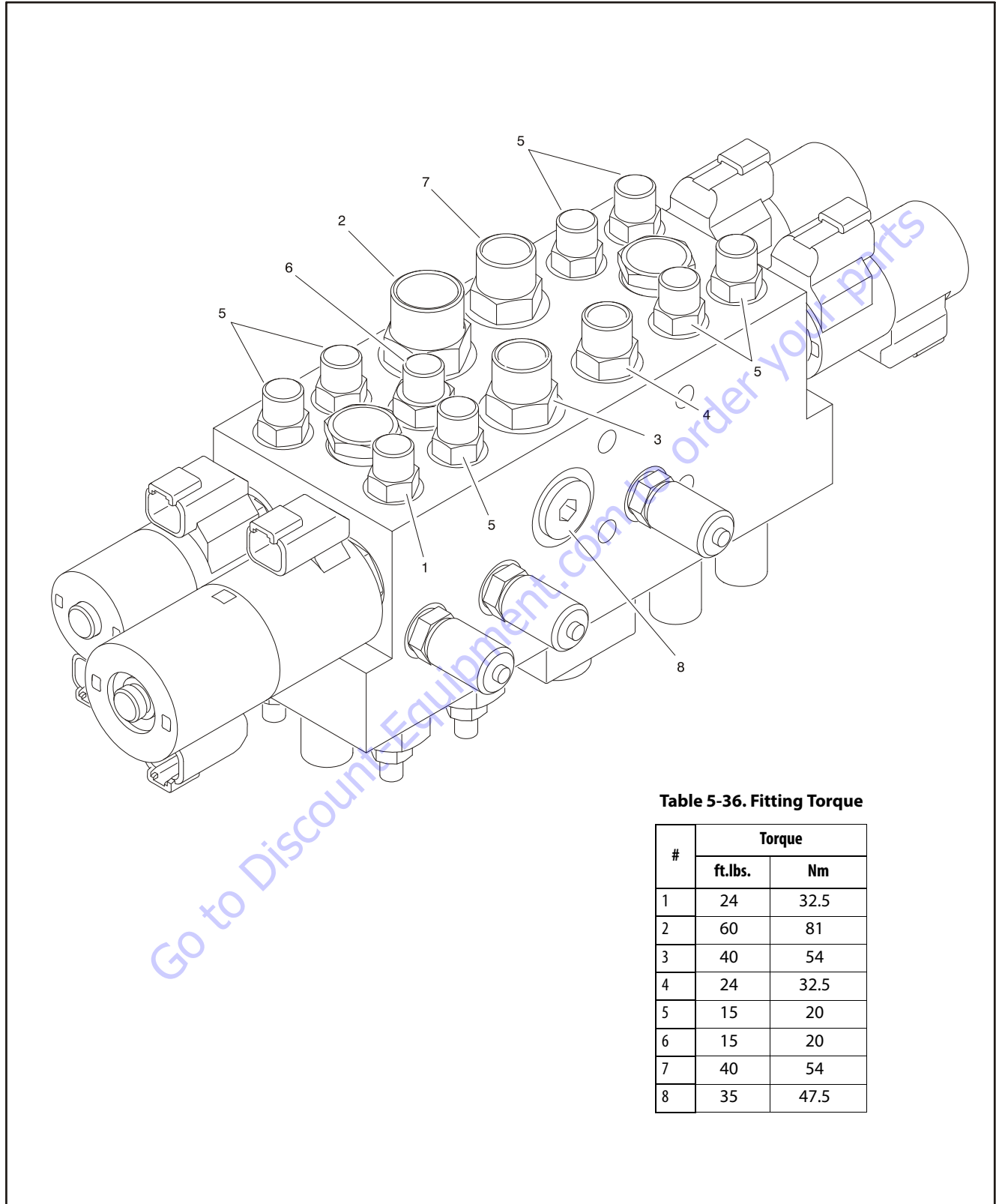


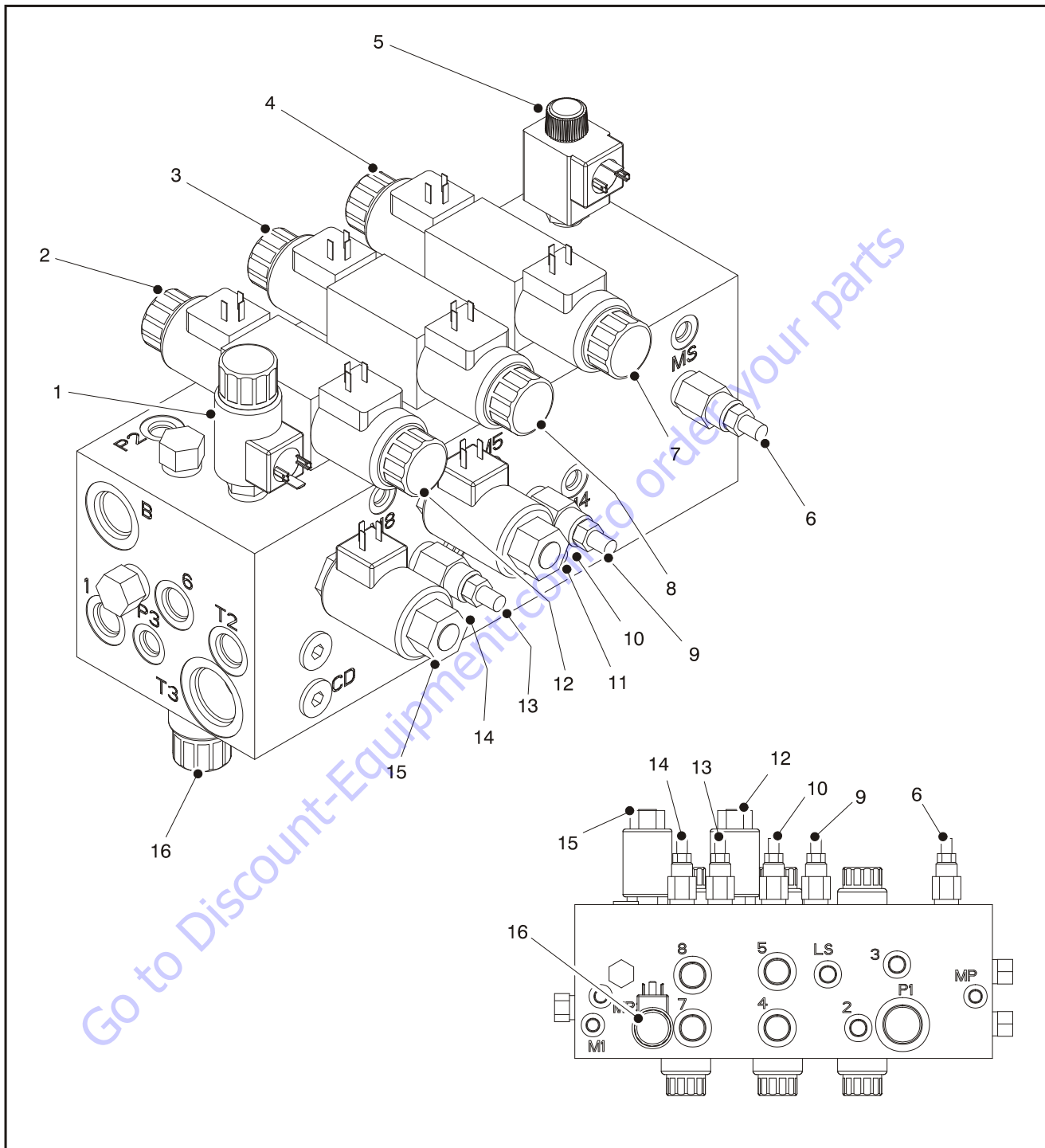
Figure 5-190. Jib Control Valve Torque and Resistance Specifications - Sheet 2 of 2



**Table 5-36. Fitting Torque**

#	Torque	
	ft.lbs.	Nm
1	24	32.5
2	60	81
3	40	54
4	24	32.5
5	15	20
6	15	20
7	40	54
8	35	47.5

**Figure 5-191. Jib Control Valve Fitting Torque Specifications**



- |                  |                 |                      |                          |
|------------------|-----------------|----------------------|--------------------------|
| 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 5-192. Main Valve Identification

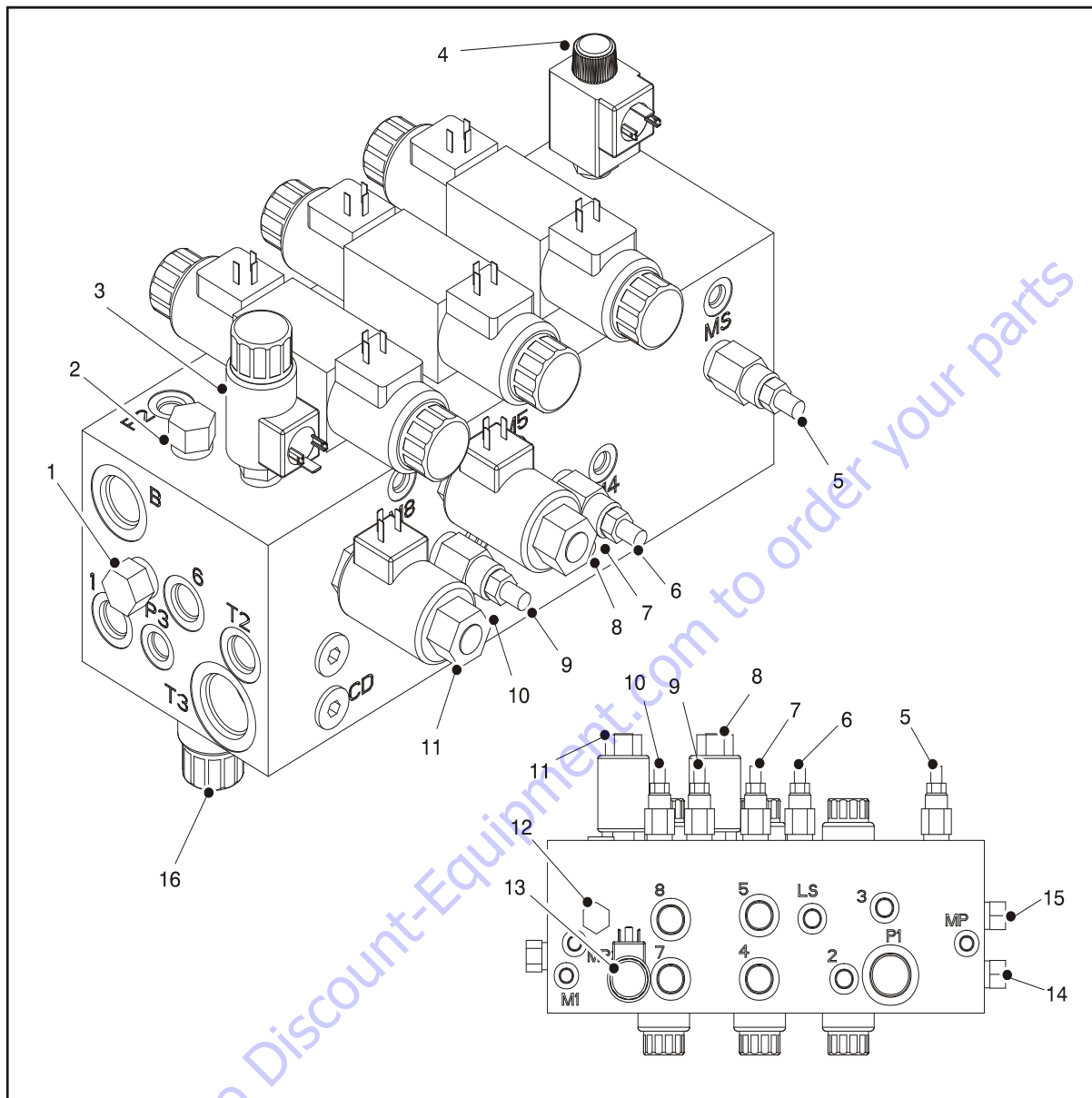


Table 5-37. Cartridge Torque Values

	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 5-193. Main Valve Cartridge Torque Values

## 5.5 OIL SAMPLING

See Figure 5-194., Oil Sampling Port.

This machine is equipped with an oil sampling valve to allow for verification of hydraulic oil condition.

### Procedure

1. Function the machine for approximately 15 minutes operating all functions.
2. Switch the select switch to the ground controls and start the engine.
3. Locate the oil sampling valve on the front of the main control valve.
4. Unscrew the knurled end which is attached to the chain.
5. Place a drip pan under the spout and push in for approximately 10 seconds. This should flush out the valve.
6. Open and place the sample bottle under the spout.
7. Push in on the end of the valve and fill up the bottle.
8. Cap the bottle immediately.
9. Thread the knurled cap back onto the valve.
10. The sample is complete.

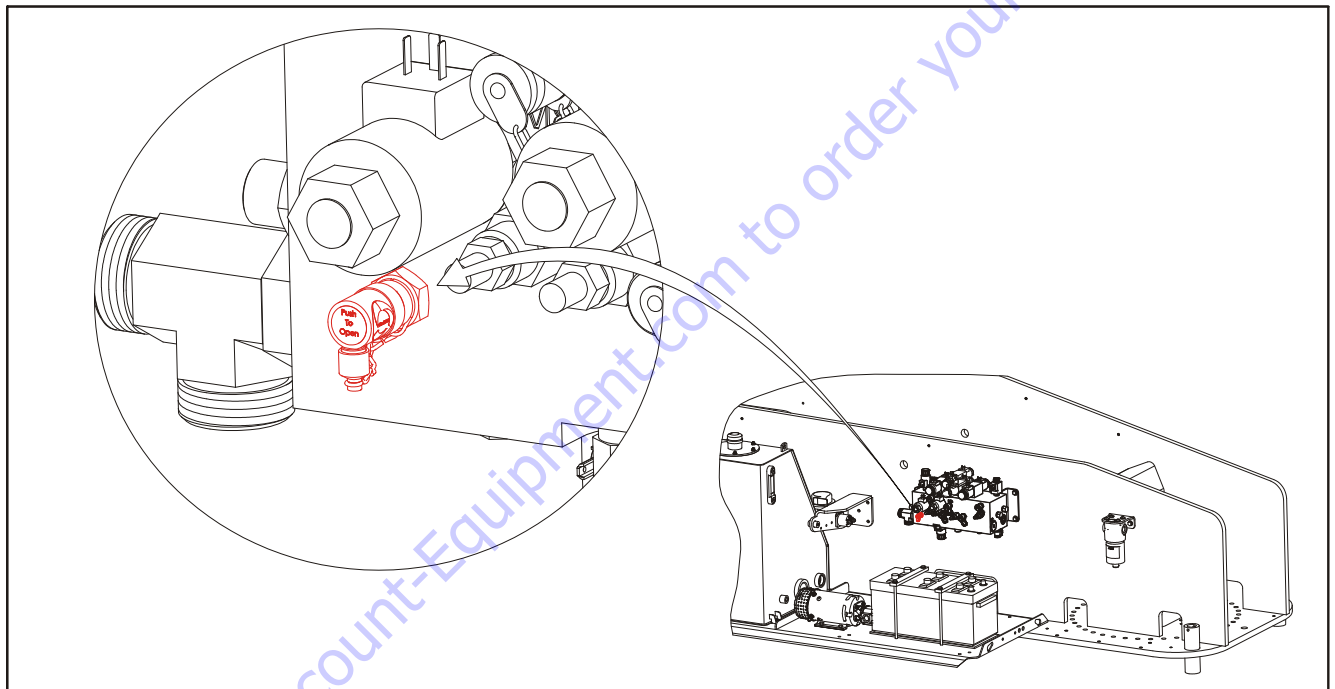


Figure 5-194. Oil Sampling Port