3.22 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-74., Counterweight Bolt Torque.

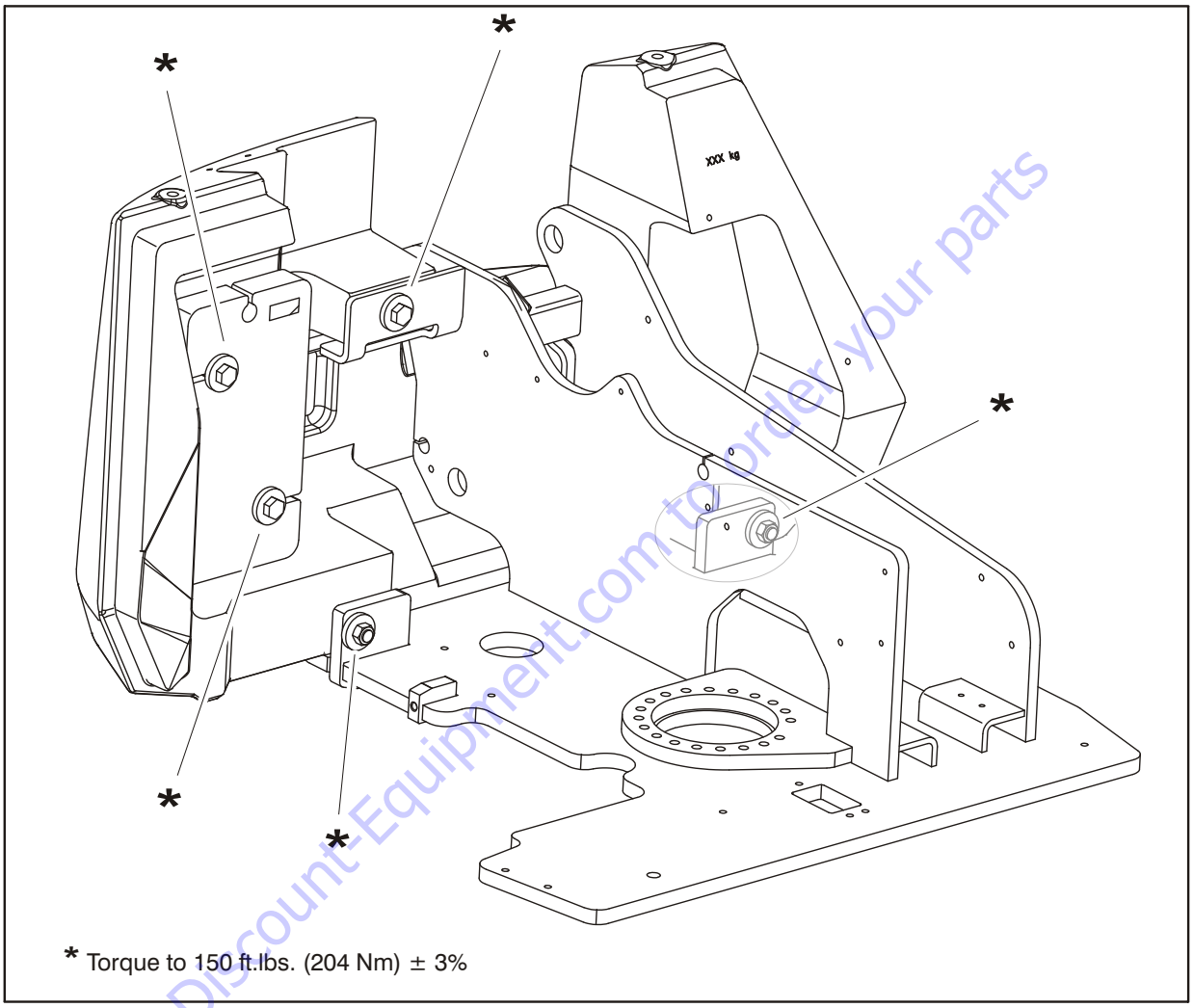

Figure 3-74. Counterweight Bolt Torque

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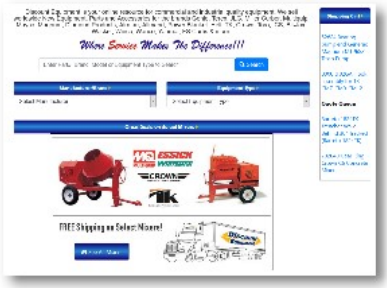

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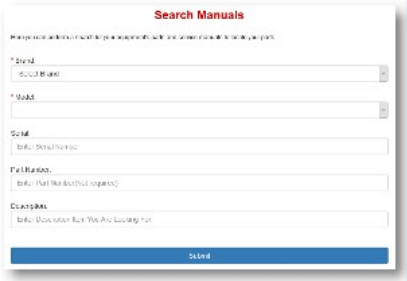

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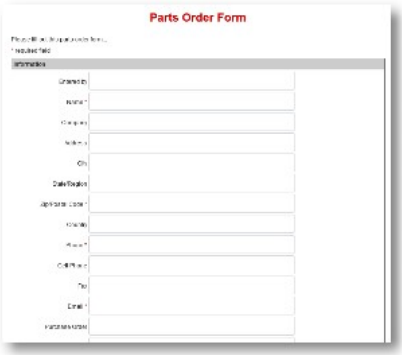

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SECTION 4. BOOM & PLATFORM

4.1 PLATFORM CONTROL ENABLE SYSTEM

The platform controls use a time dependent enable circuit to limit the time availability of "live" or enabled controls. When the footswitch is depressed, the controls are enabled and the operator has 7 seconds to operate any control. The controls will remain enabled as long as the operator continues to use any function and will remain enabled 7 seconds after the last function has been used. While the controls are "live", the enabled light will be illuminated in the platform display panel. When the time limit has been reached, the enabled light will turn off and the controls will be disabled. To continue use of the machine the controls must be re-enabled to start the timer system over again. This is done by releasing all functions, then releasing and re-depressing the footswitch.

4.2 PLATFORM LOAD SENSING SYSTEM

The Platform Load Sensing System (LSS) consists of 1 load cell and 2 linkages mounted to the platform rotator and platform support. The load cell includes a sealed circuit and is connected directly to a CAN-based platform control panel within the platform box. This system measures the weight in the platform. When the capacity is exceeded, or when there is a fault in the system, the platform overload indicator will flash, the platform alarm will sound at the standard JLG duty cycle of 5sec on / 2sec off and all platform controls (except emergency descent) will be disabled.

4.3 GROUND CONTROL KEYSWITCH SYSTEM

The ground control keyswitch is used for selecting the active control of the machine between the platform or ground control stations and as another shut off switch for machine power. On the standard keyswitch, the key is removable only in the off position. This allows the ground control station to have ultimate priority over the platform control.

4.4 FUNCTION SPEED CONTROL SYSTEM

The platform controls for the platform rotate, platform level, jib lift, telescope, and tower lift functions are controlled through a common variable speed control knob. This knob provides a common control signal allowing a smooth ramp up, controlled maximum output speed, and ramp down. Each function has its own personality settings allowing the characteristics of each function to be modified using the standard analyzer. Not all functions will respond the same to the changes in the function speed knob position.

4.5 JIB LIFT END OF STROKE DAMPENING

The Jib Lift cylinder is constructed in a way that causes the Jib Lift cylinder oil flow to be restricted by an orifice while lowering the jib near the end of stroke at minimum elevation. This flow restriction reduces the speed of this function just before bottoming out the cylinder.

4.6 EMERGENCY DECENT SYSTEM

The emergency descent system allows the boom and jib to be lowered in the event of primary power (engine power) loss. This system uses electrically powered solenoid valves and the force of gravity to lower the booms and jib. The following functions are included in this system and will operate normally if the engine is not running and the “auxiliary power” switch has been activated.

- Main Lift Down

- Tower Lift Down

- Jib Down

Additionally, the jib can be raised by the use of a manual hand pump located between the hydraulic tank and ground control station. See the instructions at that location. Also, the turntable can be swung manually by using a wrench to turn the swing motor shaft.

4.7 TRANSPORT POSITION SENSING SYSTEM

The transport position sensing system uses the two main boom angle switches (mounted on the upper upright at the lift cylinder pivot bushing) and the tower boom angle switch (mounted between the turntable sides at the lower boom link pivot bushing) to sense when the boom is in the position associated with high speed travel. These switches are normally closed and unactuated when in the transport position. Above transport angle is recognized when the main boom travels from the stowed position to 1° below horizontal to 3° above horizontal (it resets at 1° to 4° below horizontal) or when the tower boom is sensed to be more than 2° to 5° above horizontal (it resets at 1° below horizontal to 5° above horizontal). The main boom may be telescoped to any position, and the articulating jib may be in any position without changing the transport state.

This system is used to control the following systems:

- Above Elevation - Drive Speed Cutback System

Drive/Steer - Boom Function Interlock System (CE Only)

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4.8 PLATFORM

Platform/Support Removal

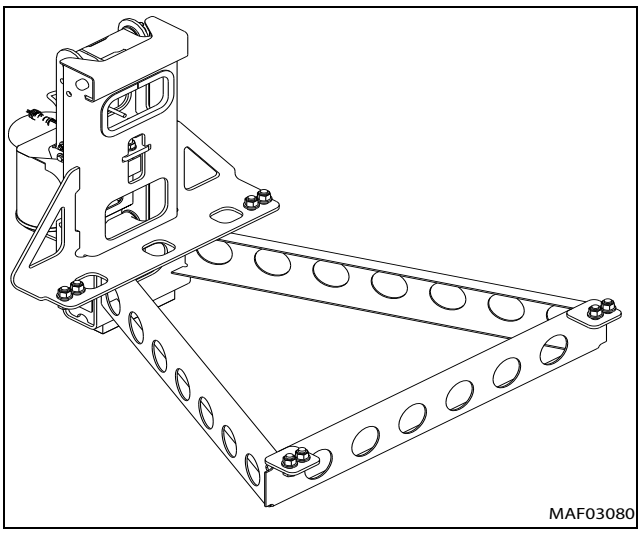
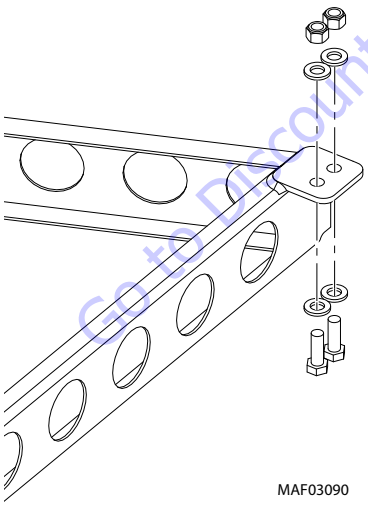
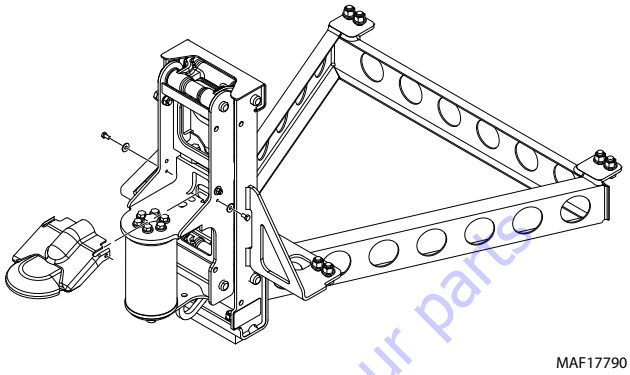


Figure 4-1. Location of Components Platform Support

1. Disconnect electrical cable from control console.
2. Tag and disconnect the hydraulic lines from the rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove the bolts securing the platform to the platform support, then remove the platform.

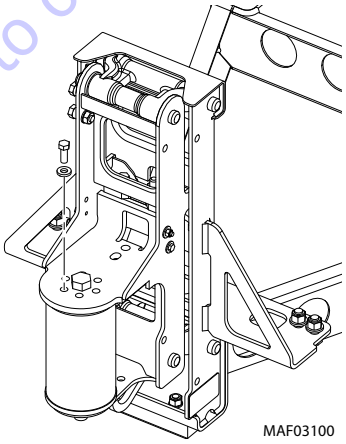


4. Using a suitable device, support the platform support.
5. Remove the bolts and washers securing the platform support cover to the platform support. Remove platform support cover.

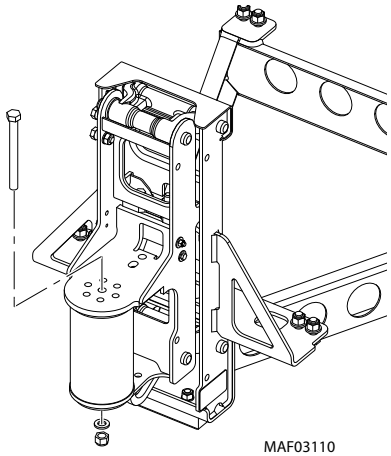


NOTE: *The platform support weighs approximately 42 lb (19 kg).*

6. Remove the bolts and washers securing the support to the rotator.



7. Using a suitable brass drift and hammer, remove the center bolt and locknut.



8. Remove the platform support from rotator.

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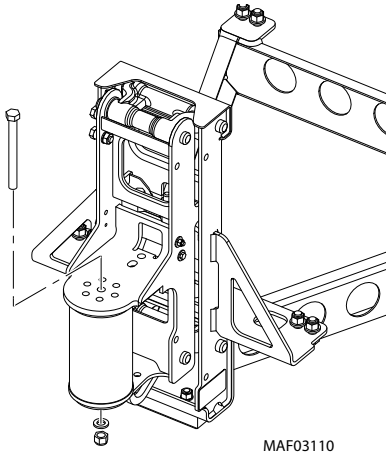
Support Installation

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

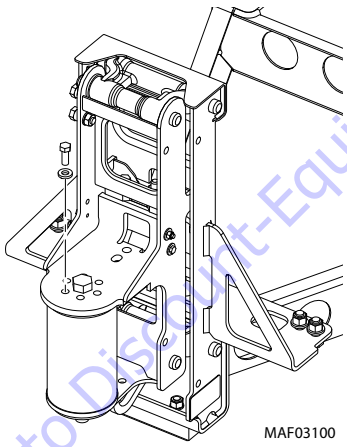
NOTE: *The platform support weighs approximately 42 lb (19 kg).*

2. Install the rotator center bolt and locknut.



MAF03110

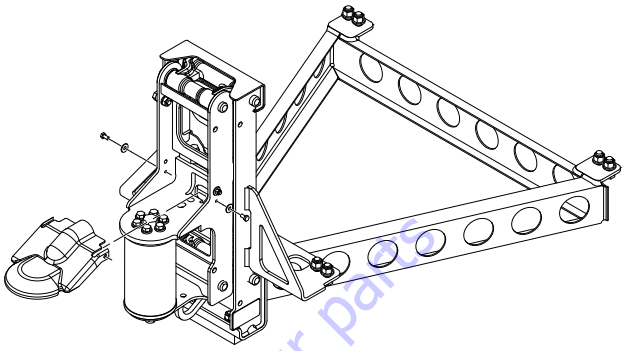
3. Apply Medium Strength Threadlocking Compound to the eight bolts securing the support to the rotator and install the bolts.



MAF03100

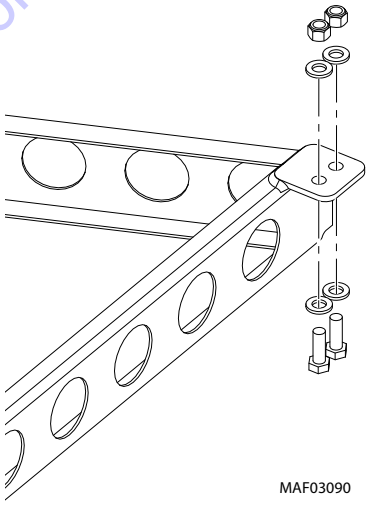
4. Torque the nut on the rotator center bolt and the retaining bolts. See Figure 4-2.

5. Apply Medium Strength Threadlocking Compound to the bolts and washers securing platform support cover to the platform support.



MAF17790

6. Position the platform on the platform support and install the bolts securing the platform to the platform support. See Figure 4-2.



MAF03090

7. Remove tag and reconnect the hydraulic lines to the rotator.

8. Connect the electrical harness to the platform control console.

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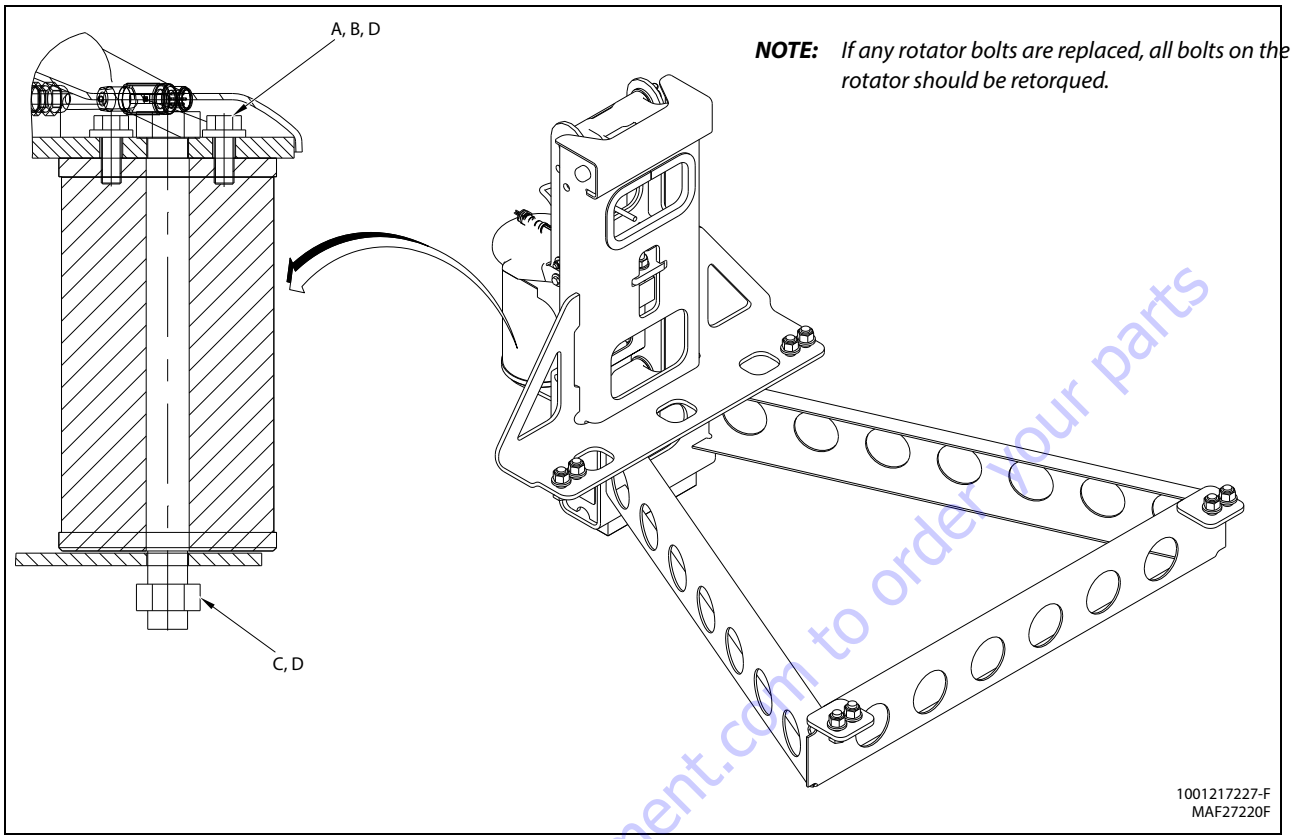

A Torque to 40 ft.lbs. (55 Nm)
B Medium Strength Threadlocking Compound
C Torque 250-270 ft. lbs. (340-365 Nm)
D Check torque every 150 hours of operation

Figure 4-2. Platform Support Torque Values

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4.9 MAIN BOOM POWERTRACK

Removal

1. Disconnect wiring harness connectors located in turntable.

NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove hydraulic lines and electrical cables from Powertrack.

NOTE: *The powertrack weighs approximately 7 lb (3.2 kg).*

4. Using suitable lifting device, adequately support Powertrack weight along entire length.
5. Remove hardware #1 securing the powertrack on the tube carrier.
6. Remove bolt #2 securing the powertrack on the base boom section. Remove the powertrack assembly.

Installation

1. Using suitable lifting device, adequately support the powertrack weight along entire length.

NOTE: *The powertrack weighs approximately 7 lb (3.2 kg).*

2. With powertrack supported and using all applicable safety precautions, install hardware #2 securing rail to the base boom.
3. Install hardware #1 to tube carrier.
4. Remove tag and reconnect all hydraulic lines and electrical cable from powertrack.
5. Remove tag and reconnect hydraulic lines from connectors at boom assembly.

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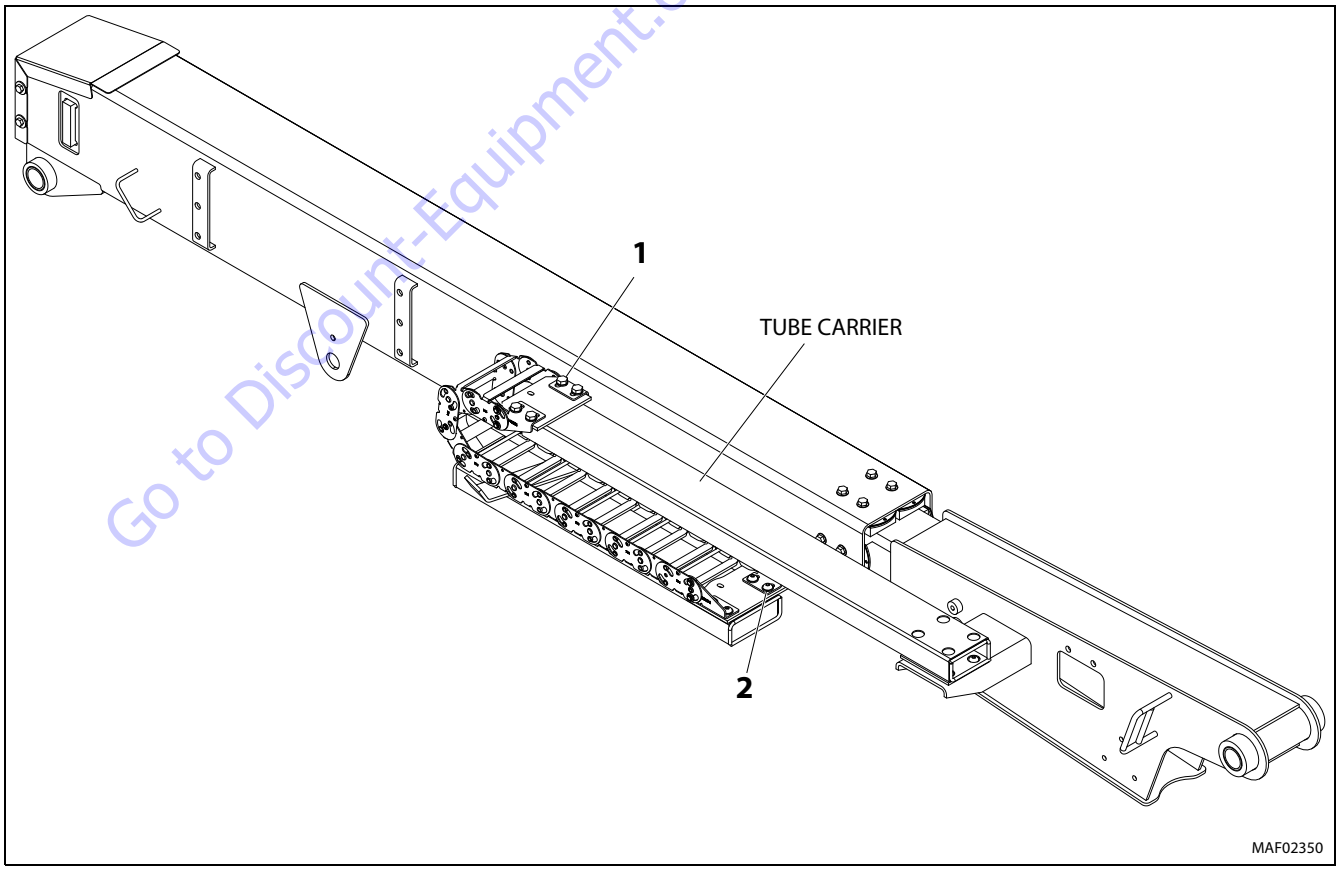


Figure 4-3. Location of Components - Powertrack

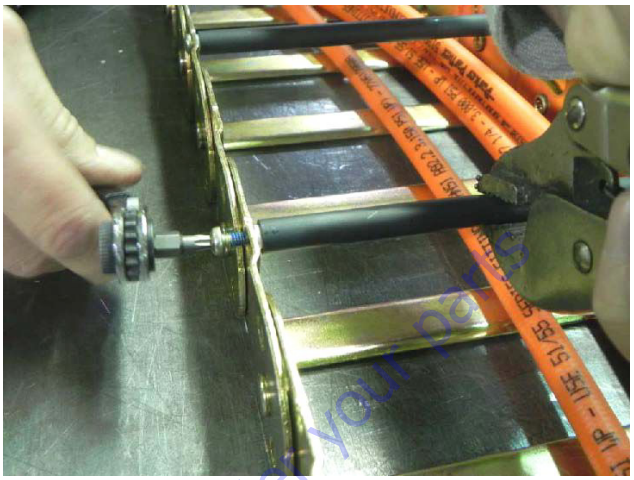
4.10 POWERTRACK MAINTENANCE

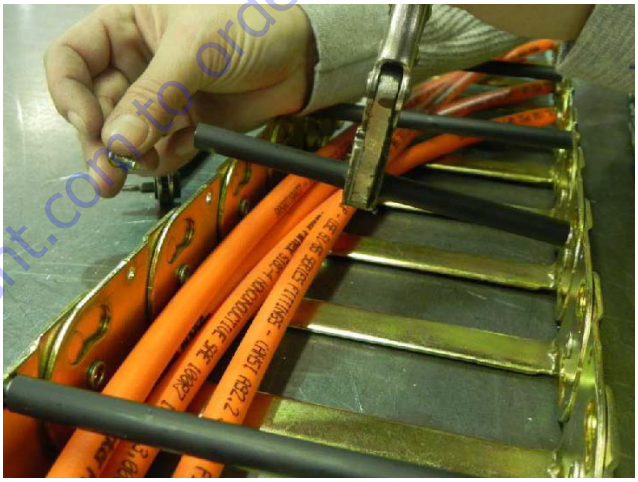
Remove Link

NOTE: *Hoses shown in powertrack are for example only. Actual hose and cable arrangements are different.*

1. Clamp bar and poly roller tightly so they do not spin when removing screw. With a small 1/4 in. ratchet and a T-20 torx bit, remove 8-32 x 0.500 screw from one side.

2. Repeat step 1 and remove screw from other side of track. Remove bar/poly roller from powertrack.





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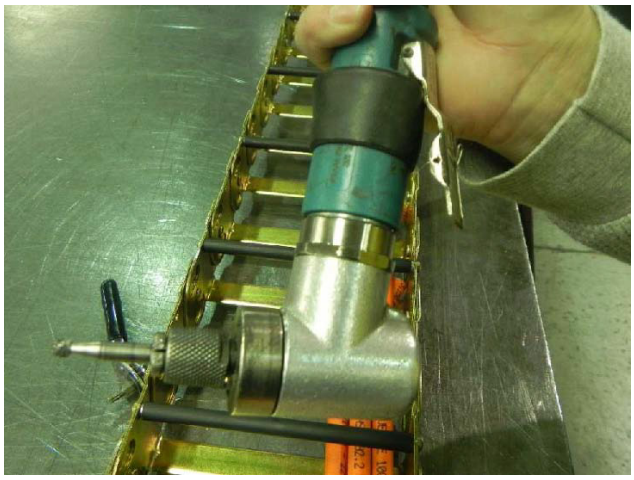
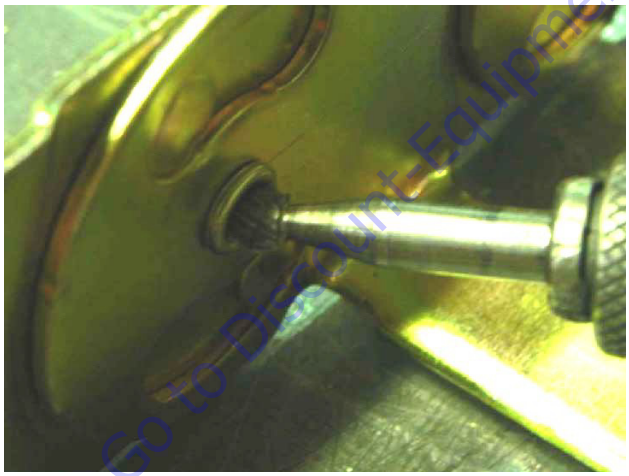
NOTICE

REPOSITION CABLES/HOSES AND KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

3. To remove a link, rivets holding links together must be removed. Use a right-angle pneumatic die grinder with a 1/4 in. ball double cut bur attachment.

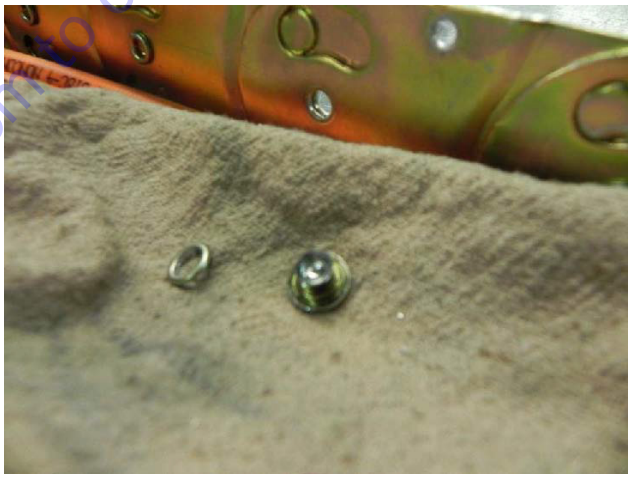


4. Insert tool into rolled over end of rivet. Grind out middle of rivet until rolled over part of rivet falls off. Repeat for all rivets to be removed.



5. After grinding it may be necessary to use a center punch with a hammer to remove rivet.

NOTE: *It may be necessary to loosen fixed end brackets from machine to move track section enough to disconnect links.*



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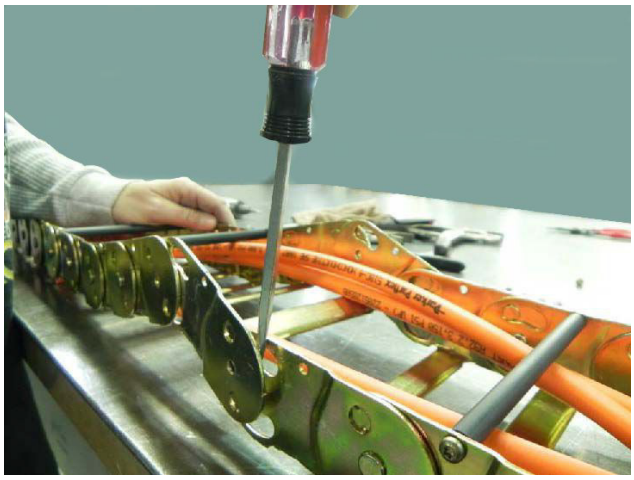
6. Insert flat head screwdriver between links. Twist and pull links apart.



7. Remove link from other section of powertrack using screwdriver.

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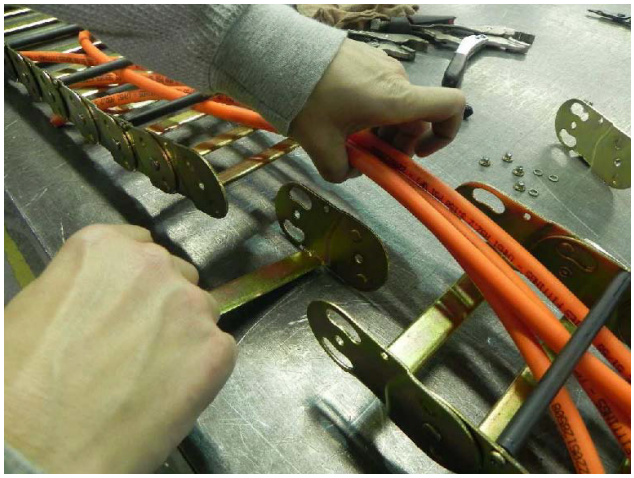
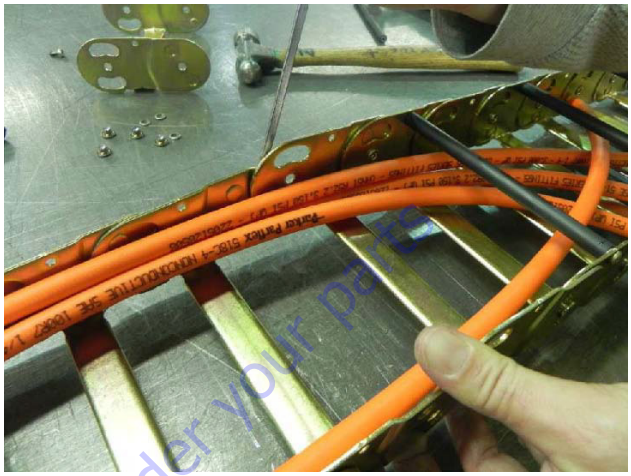
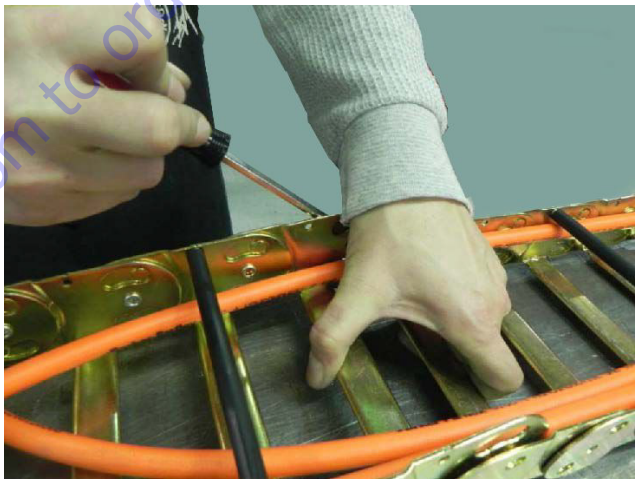
Install New Link

1. Squeeze cut-out end of new link into half-shear (female) end of track section.

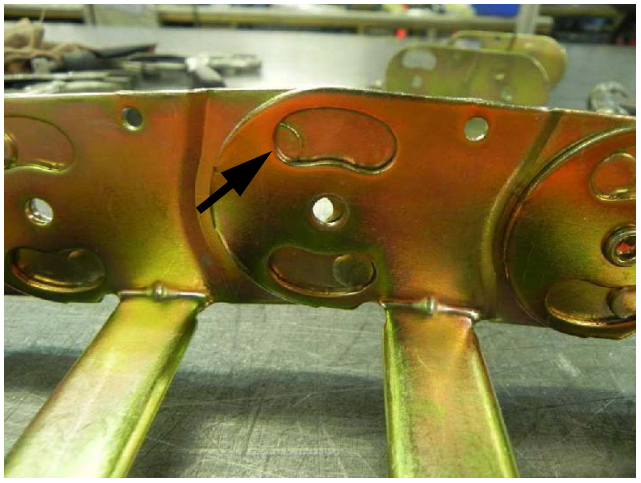


2. Spread half-shear (female) end of new link and slide cut-out end of track section into it. Use a screwdriver if necessary.





3. After new link is installed round half-shears do not fit properly in cut-outs.



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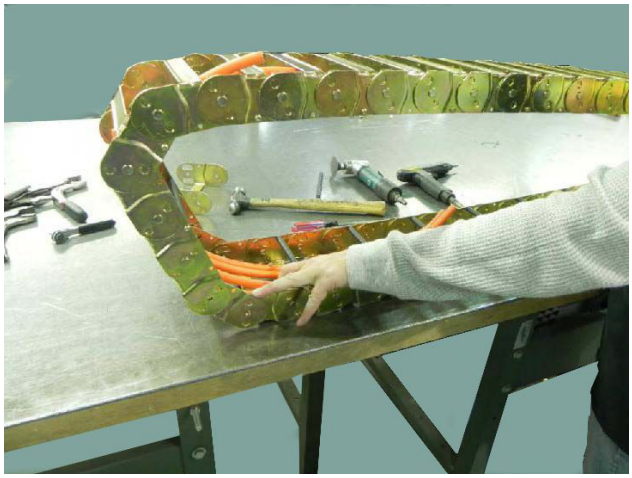
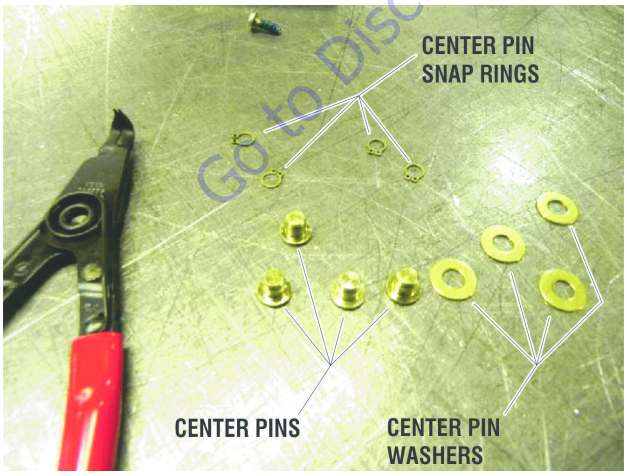
4. Pull moving end over track so new connection is positioned in curve of powertrack. Round half-shears will rotate into cut-outs.



5. Parts shown below connect new link to powertrack.



6. Push pin through center hole then slide washer on pin.

7. Install snap ring in groove on pin. Repeat pin installation steps for all center holes with rivets removed.

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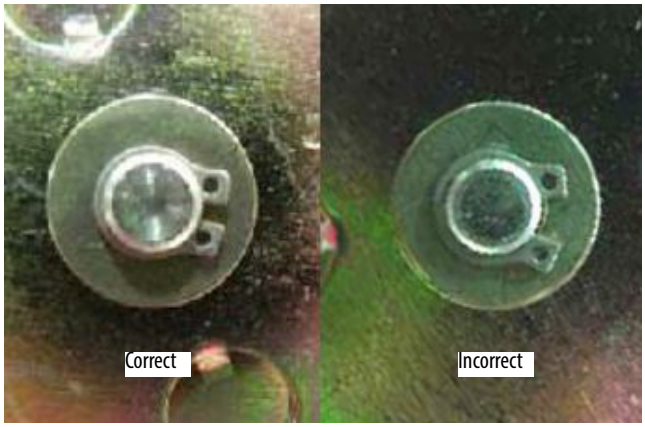
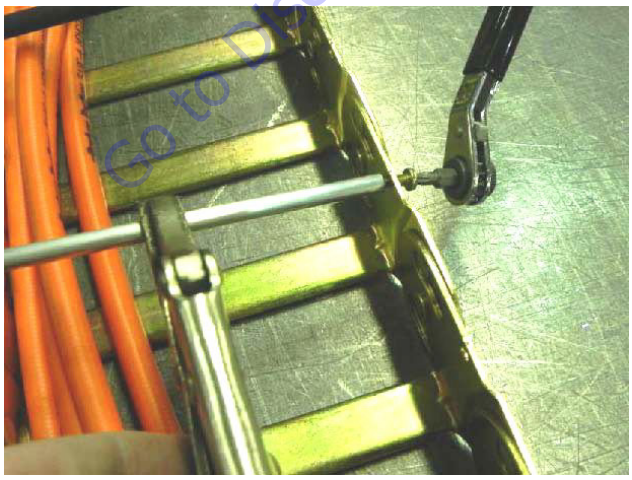
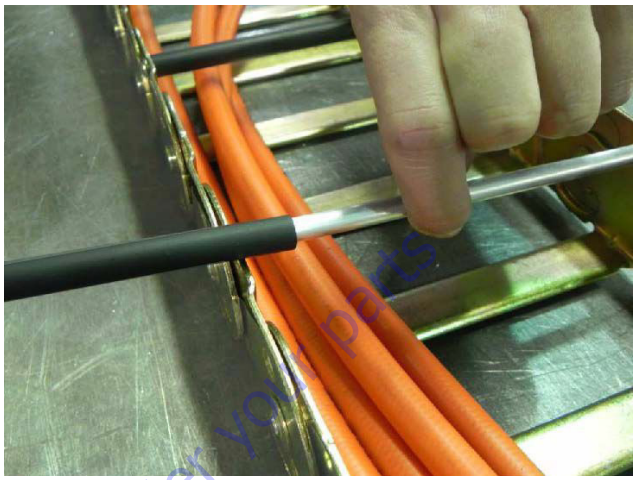
NOTE: *Make sure snap rings are seated in pin groove and closed properly.*



8. Install new 8-32 x 0.500 self-threading torx head screw in end of new aluminum round bar. Torque to 18-20 in. lbs. (2-2.25 Nm).



9. Pull up on other end of round bar and slide new poly roller on bar.



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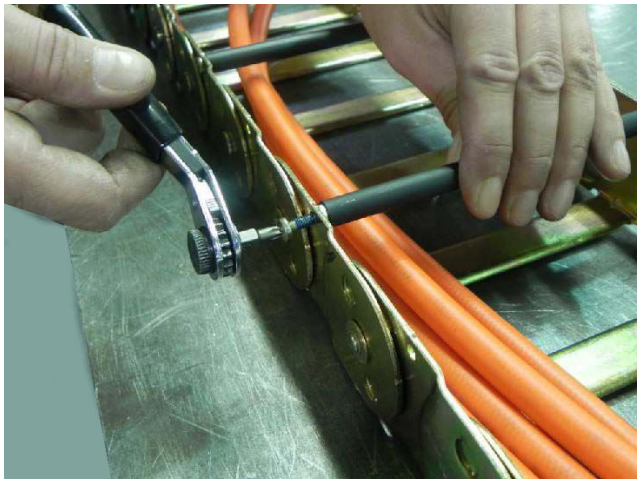
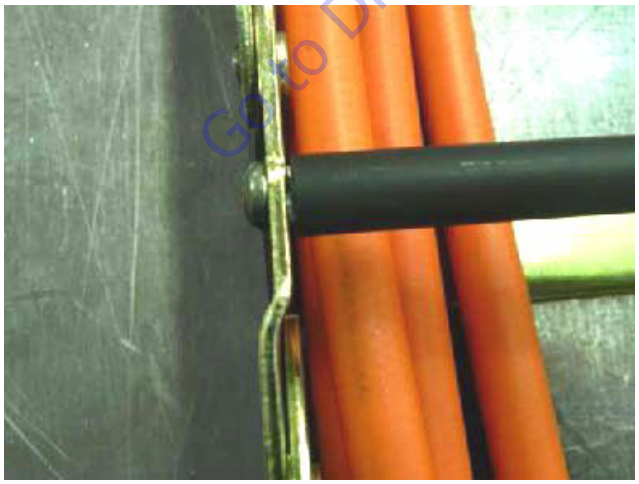
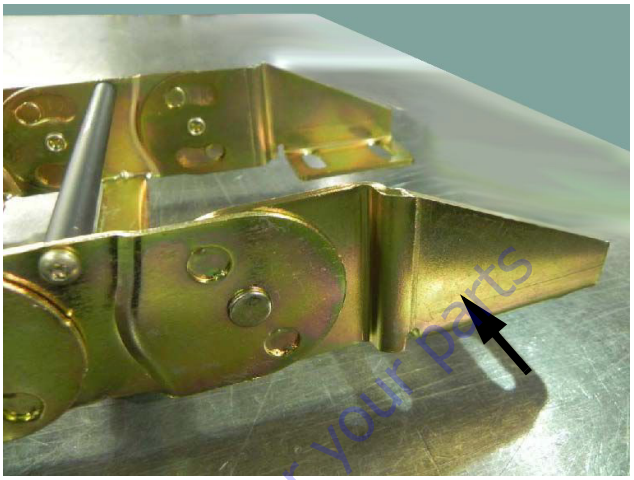
10. Install new 8-32 x 0.500 self threading screw on other side. Torque to 18-20 in. lbs. (2-2.25 Nm).



NOTE: *When tightening screws make sure screw head is seated against link with no space in between link and underside of screw head.*



Replace Fixed End Brackets



NOTICE

REPOSITION CABLES/HOSES AND KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

1. Remove rivets as shown in link removal instructions on page 4-7.

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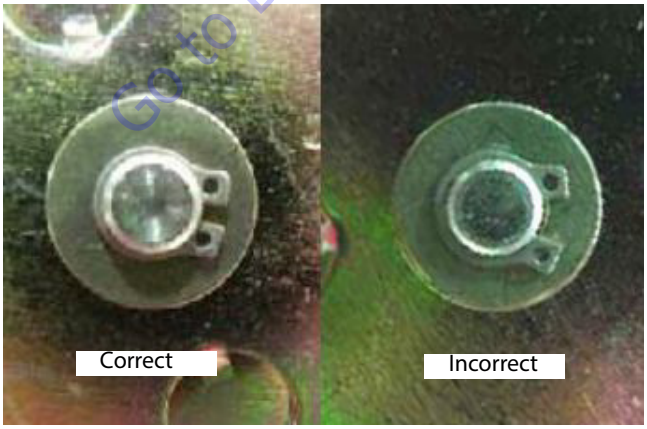
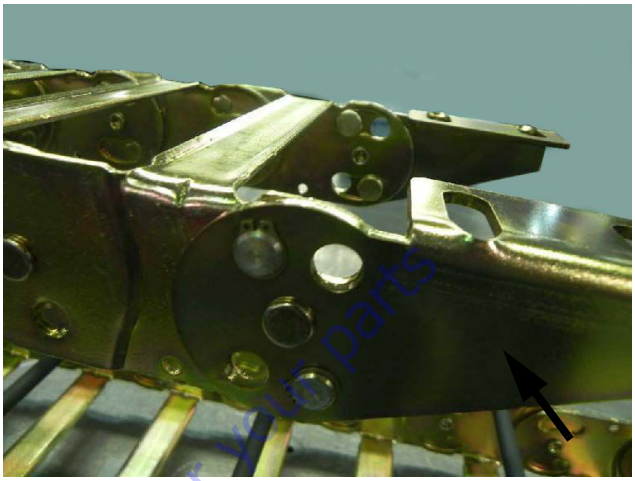
2. Parts used: Bracket Center Pin and Center Pin Snap Ring.

3. Take new bracket and install bracket center pin and snap ring. Repeat on other bracket if replacing it.

NOTE: *When installing snap rings make sure they are seated in pin groove and closed properly.*



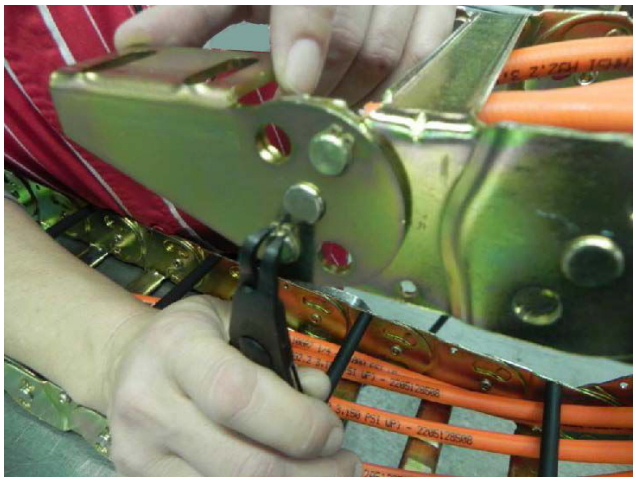
Replace Moving End Brackets



NOTICE

REPOSITION CABLES/HOSES AND KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

1. Remove existing pins and center rivet. Remove rivet as shown in link removal instructions on page 4-2. Repeat on other bracket if replacing it.



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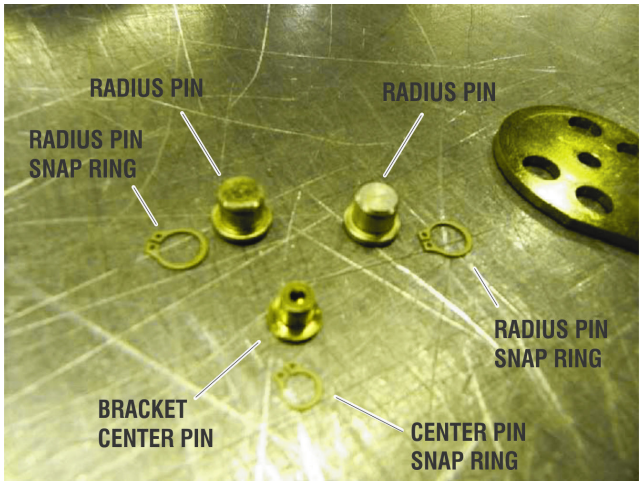
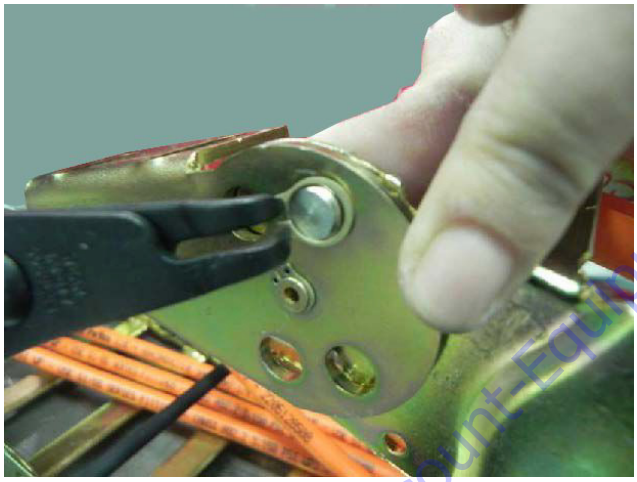
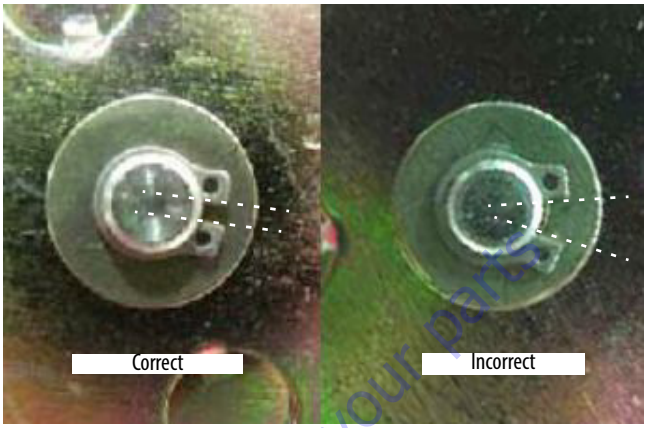
2. Install center pin with snap ring in new bracket.



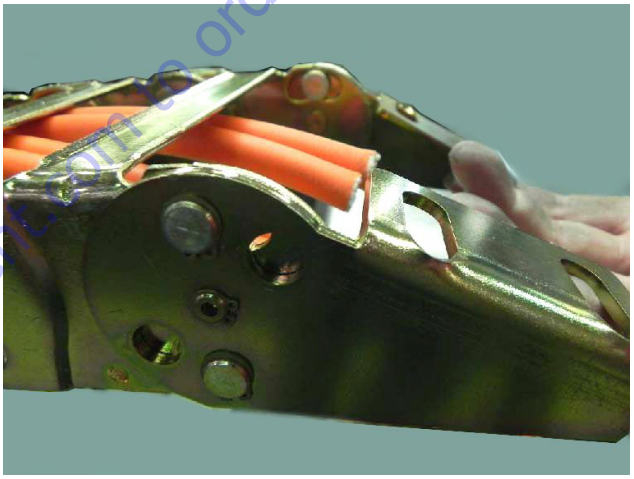
3. Install radius pins and snap rings in original locations. Repeat with other moving end if replacing it.



NOTE: *When installing snap rings make sure they are seated in pin groove and closed properly.*



4. Make sure both brackets rotate correctly.



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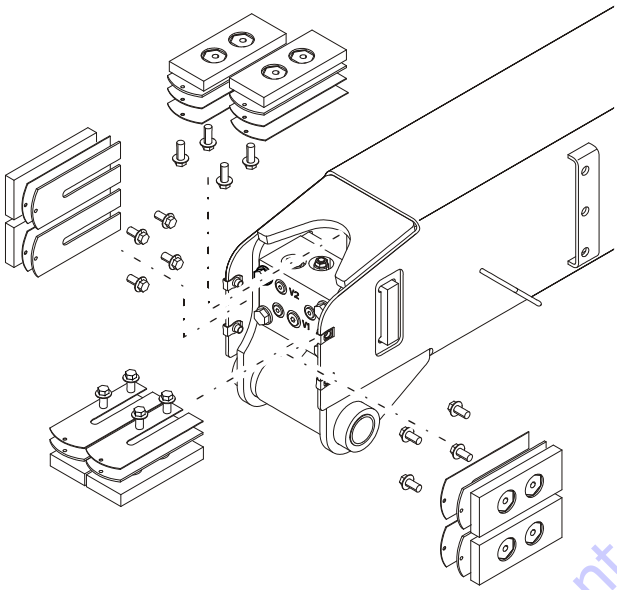
4.11 BOOM MAINTENANCE

Disassembly of the Main Boom

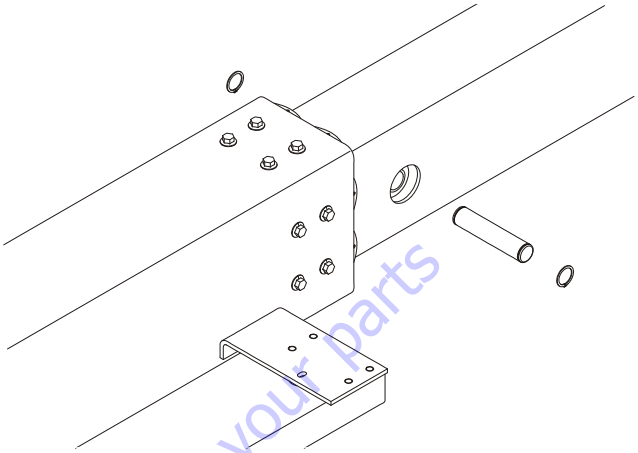
1. Loosen the wear pad retaining bolts at the rear of fly boom section and remove the shims and wear pads noting the location and amount of shims to aid in reassembly.



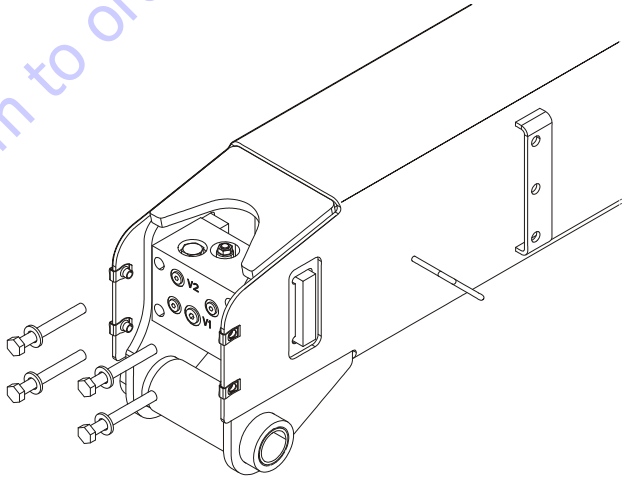
2. Using a portable power source, attach hose to telescope cylinder port block. Using all applicable safety precautions, activate hydraulic system and extend cylinder to gain access to cylinder rod retaining pin. Shut down the portable power source.
3. Carefully disconnect hydraulic hose from retract port of cylinder. There will be initial weeping of hydraulic fluid which can be caught in a suitable container. After initial discharge, there should be no further leakage from the retract port. Cap or plug all openings.

NOTE: *When removing the retaining pin from the rod end of the telescope cylinder, make sure the cylinder is properly supported.*

4. Remove the retaining ring and pin securing the telescope cylinder rod end to the fly boom section.



5. Remove the bolts and washers securing telescope cylinder to the rear of the base boom section.



NOTE: *The telescope cylinder weighs approximately 53 lb (24 kg).*

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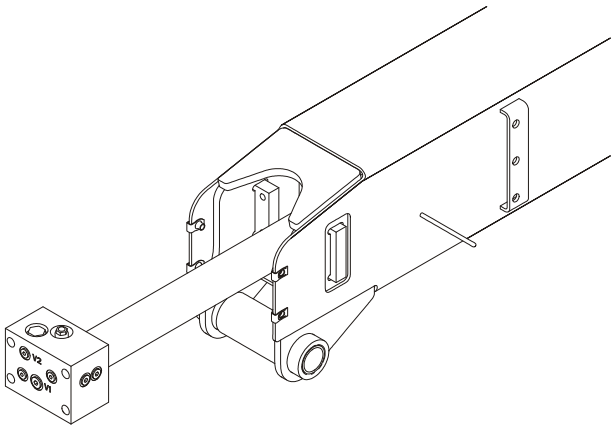
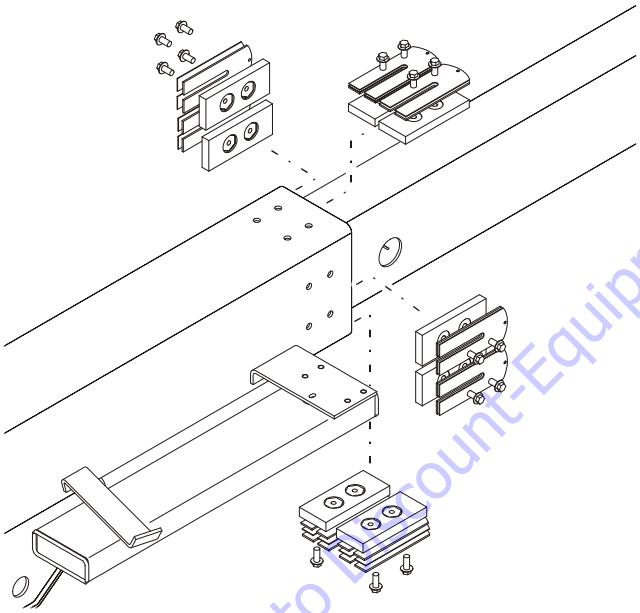
6. Using a suitable lifting device, remove telescope cylinder from the rear of the boom sections.



7. Remove hardware securing the front wear pads on base boom section, remove wear pads and shims, noting the location and amount of shims to aid in reassembly.



NOTE: *The fly boom section weighs approximately 188 lb (85 kg).*

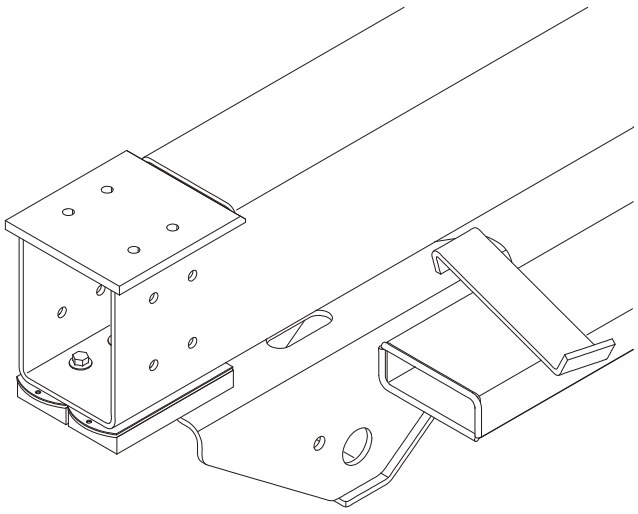
8. Using a suitable lifting device, remove fly boom from boom section.

Inspection

1. Inspect all boom pivot pins for wear, scoring or other damage, and for tapering or ovality. Replace pins as necessary.
2. Inspect lift cylinder pins for wear, scoring or other damage, and for tapering or ovality. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
3. Inspect telescope cylinder rod attach pin for wear, scoring or other damage. Replace pin as necessary.
4. Inspect inner diameter of boom pivot bushings for scoring, distortion, wear or other damage. Replace bushings as necessary.
5. Inspect wear pads for wear.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly of the Main Boom

1. Using Medium Strength Threadlocking Compound or equivalent, install the bottom wear pads and shims as noted during disassembly on the rear of the fly section. Torque the retaining bolts to 40 ft.lbs. (55 Nm). Install the rest of the wear pads on the rear of the fly section but do not install the shims or torque them at this time.



2. Using an adequate lifting device, slide the fly boom section into the base boom section. Install the remaining shims on the rear of the fly section as noted during disassembly and torque the retaining bolts to 40 ft.lbs. (55 Nm). Pull the fly section out of the base section enough to install the pin that secures the telescope cylinder rod to the fly boom section.

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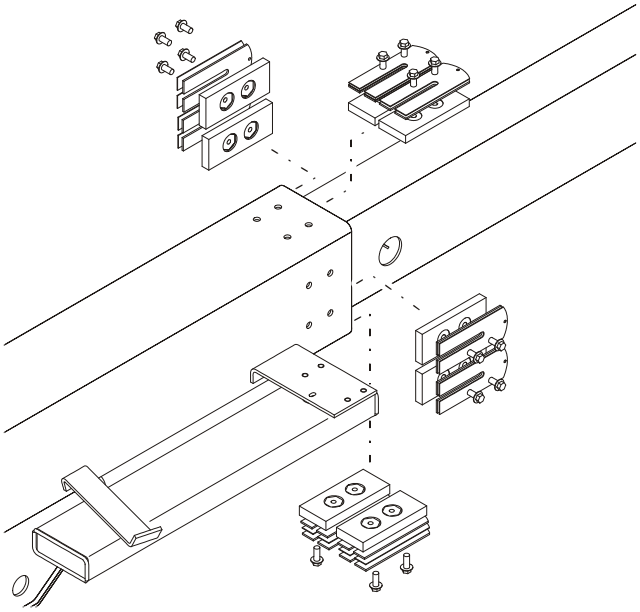
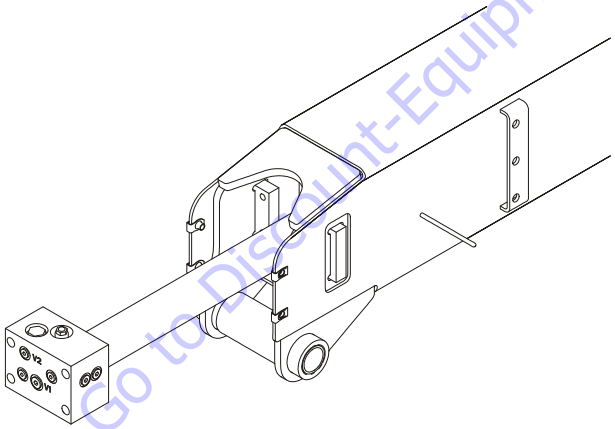
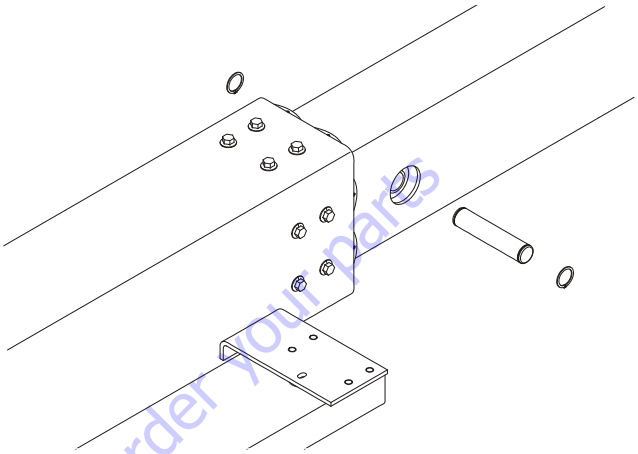
3. Using Medium Strength Threadlocking Compound or equivalent, install the front wear pads and shims as noted during disassembly on the base boom section. Torque the retaining bolts to 40 ft.lbs. (55 Nm).



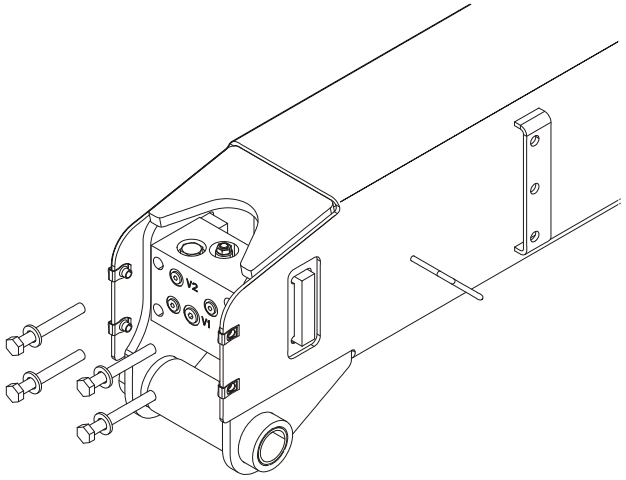
4. Using an adequate lifting device, install the telescope cylinder into the boom assembly. It will aid assembly if the cylinder is extended to enable connection to the fly boom section.



5. Align the telescope cylinder rod end with the corresponding hole in the fly boom section. If necessary, attach a portable power supply to the cylinder to extend or retract the cylinder for alignment. Install the retaining pin and secure it in place with the retaining ring.



6. Using Medium Strength Threadlocking Compound or equivalent, secure the rear of the telescope cylinder to the base boom section with the attaching bolts and washers. Torque the bolts 95 ft.lbs. (129 Nm).



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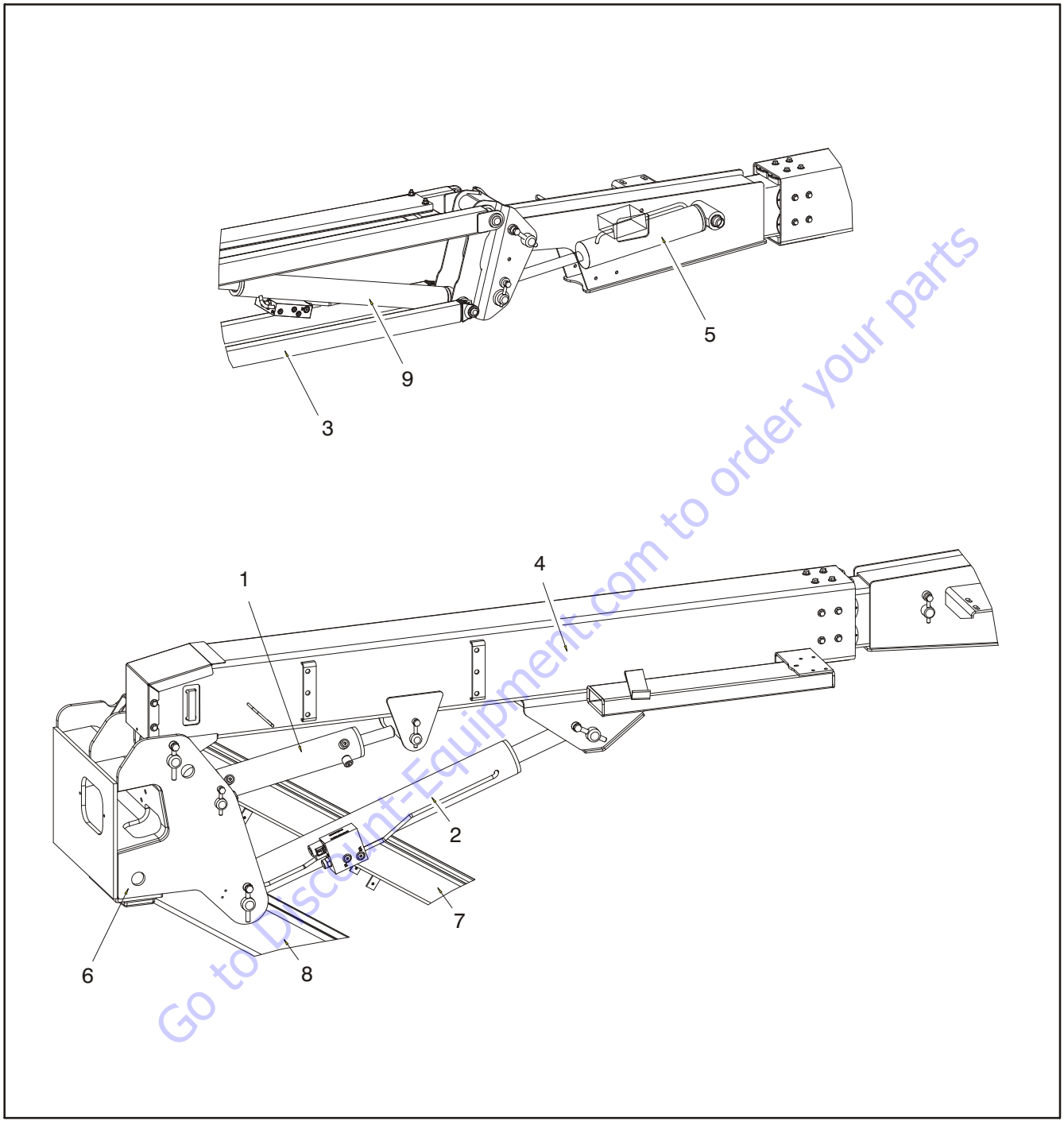

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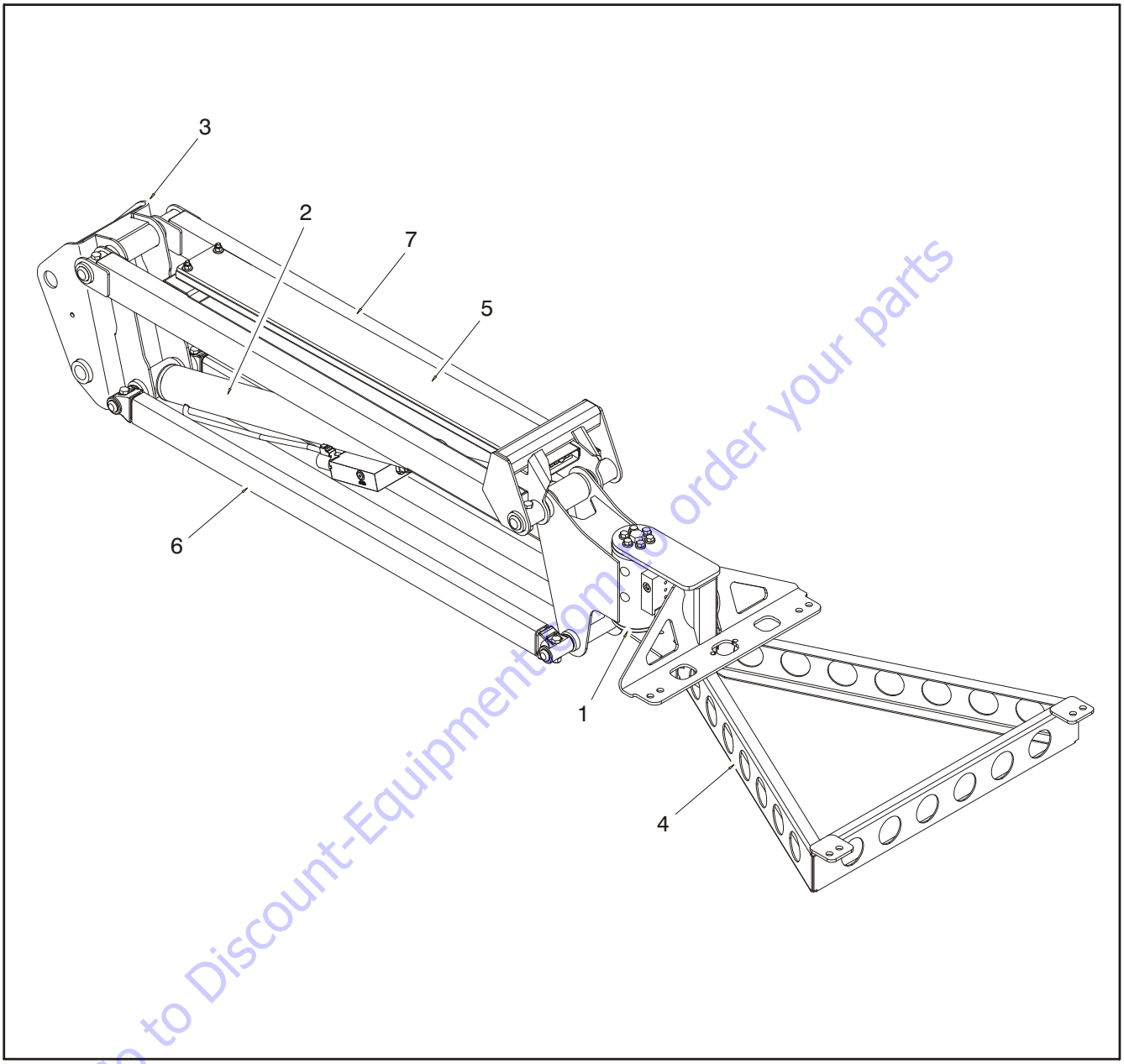
1. Master Cylinder
2. Upper Lift Cylinder
3. Jib
4. Main Boom
5. Level Cylinder
6. Upper Upright
7. Mid Boom Link
8. Mid Boom
9. Jib Cylinder

Figure 4-4. Main Boom Assembly



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1. Rotator
2. Jib Cylinder
3. Jib Pivot
4. Platform Support
5. Hose Carrier
6. Lower Jib Link
7. Upper Jib Link

Figure 4-5. Jib/ Platform Support

4.12 BOOM CLEANLINESS GUIDELINES

The following are guidelines for internal boom cleanliness for machines that are used in excessively dirty environments.

1. JLG recommends the use of the JLG Hostile Environment Package if available to keep the internal portions of a boom cleaner and to help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.

2. JLG recommends that you follow all guidelines for servicing your equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to the proper operation of the machine. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.

3. Debris and foreign matter inside of the boom can cause premature failure of components and should be removed. Methods to remove debris should always be done using all applicable safety precautions outlined in the JLG Service & Maintenance Manuals.

4. The first attempt to remove debris from inside the boom must be to utilize pressurized air to blow the debris toward the nearest exiting point from the boom. Make sure that all debris is removed before operating the machine.

5. If pressurized air cannot dislodge the debris, then water with mild solvents applied via a pressure washer can be used. Again the method is to wash the debris toward the nearest exiting point from the boom. Make sure that all debris is removed, that no “puddling” of water has occurred, and that the boom internal components are dry prior to operating the machine. Make sure you comply with all federal and local laws for disposing of the wash water and debris.

6. If neither pressurized air nor washing of the boom dislodges and removes the debris, then disassemble the boom in accordance to the instructions outlined in the JLG Service & Maintenance Manual to remove the debris.

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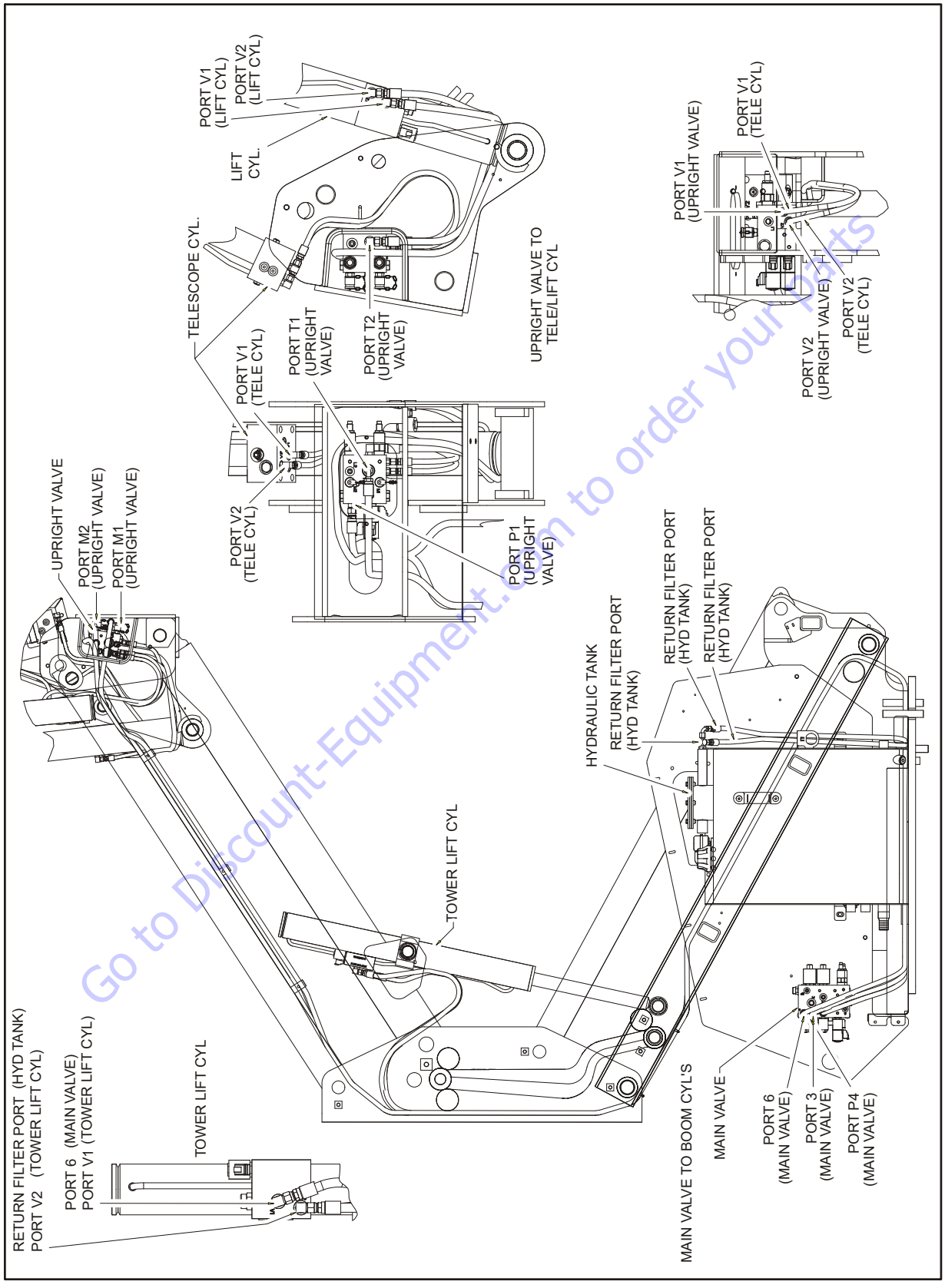

Figure 4-6. Boom Hydraulic Lines - Sheet 1 of 2

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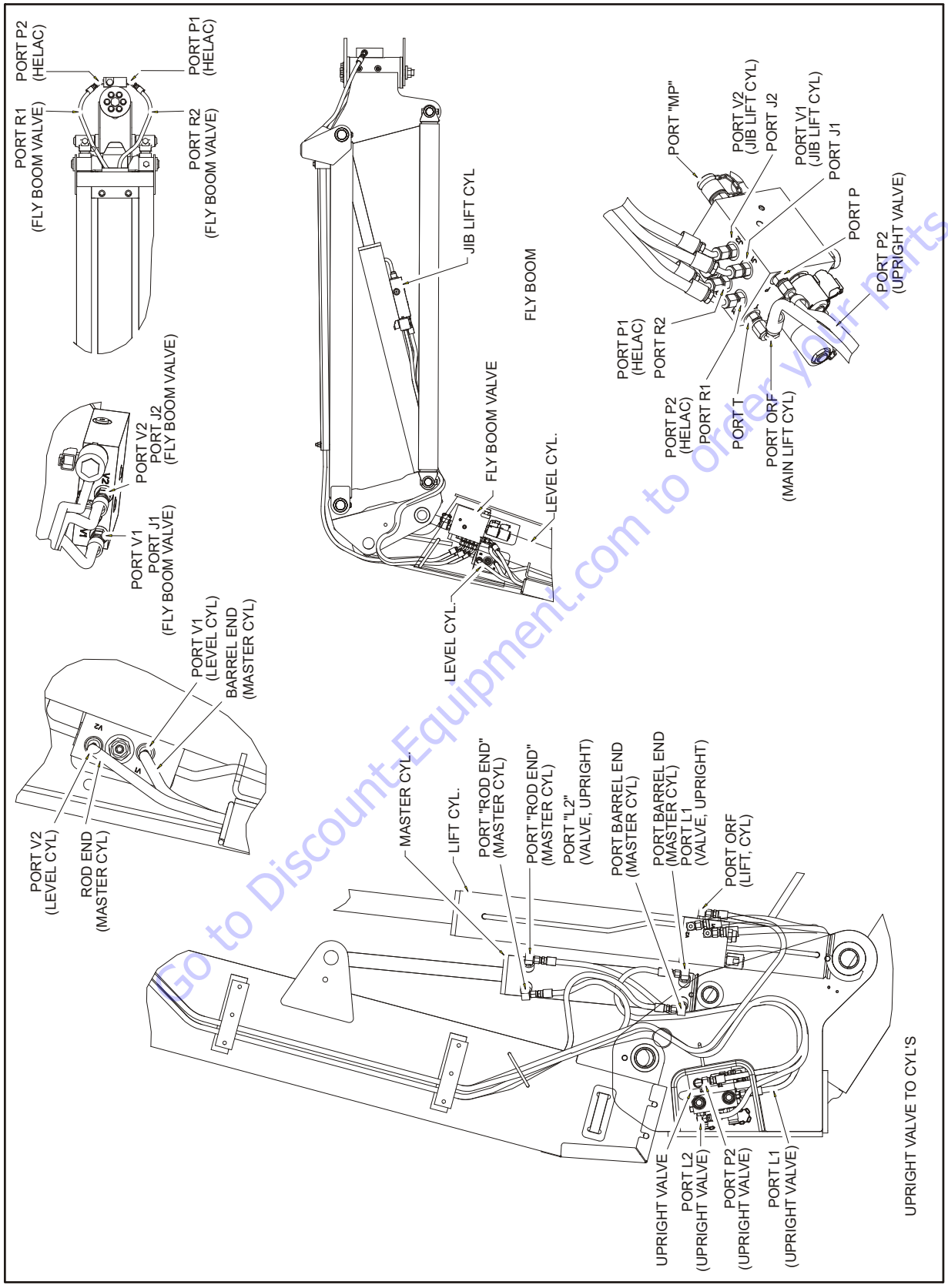

Figure 4-7. Boom Hydraulic Lines - Sheet 2 of 2

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4.13 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.

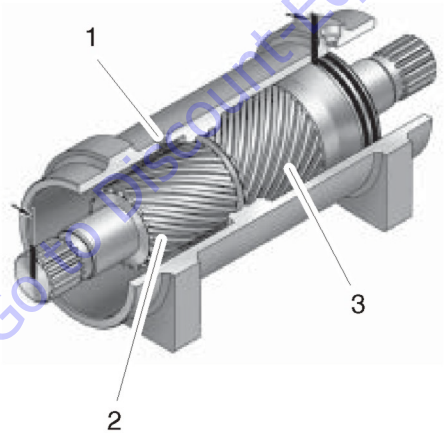
As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while, simultaneously, the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the housing, preventing piston movement and locking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

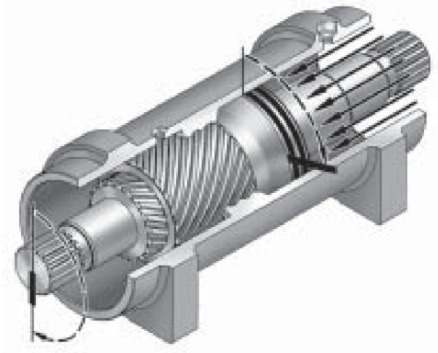
Many actuators are equipped with counterbalance valves, which performs four major functions.

- 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.



Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary. For clarity, the shaft flange, bearings, and end cap are not shown.



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 4-8. Actuator Theory of Operation

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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.
15. PUNCH
16. DOWEL PINS
    Removal and installation of end cap.

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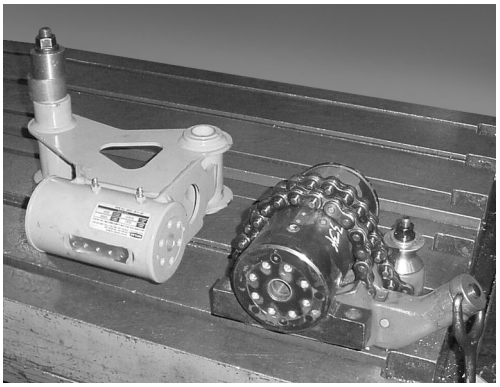
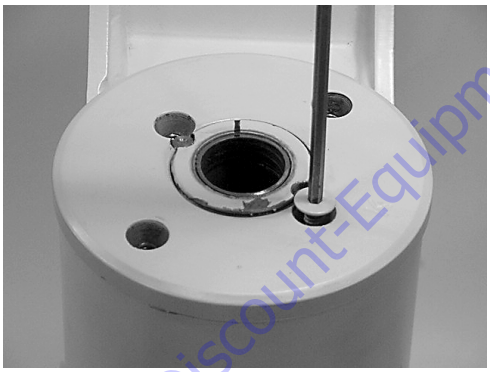
Disassembly

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.

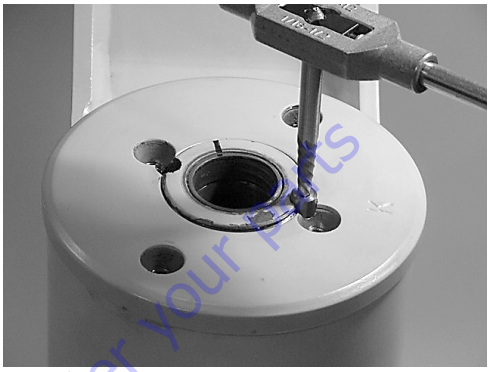


1. Remove port plugs (106.1) (106.2) and drain oil. Inspect oil for signs of contamination, i.e. water, metal shavings.

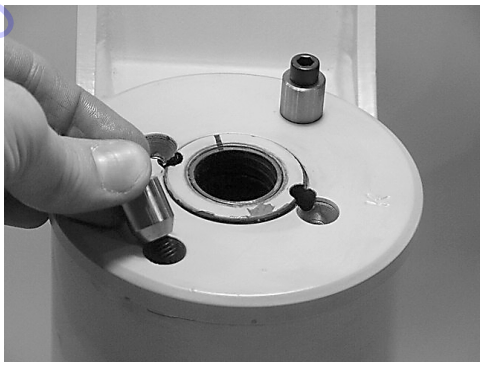


2. Remove the capscrews (113) that cover the end cap lock pins (109).
3. Using a 1/8" (3 mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16" (5 mm).
4. Remove the lock pins using a screw extracting tool such as an "Easy Out" (a size #2 is shown).

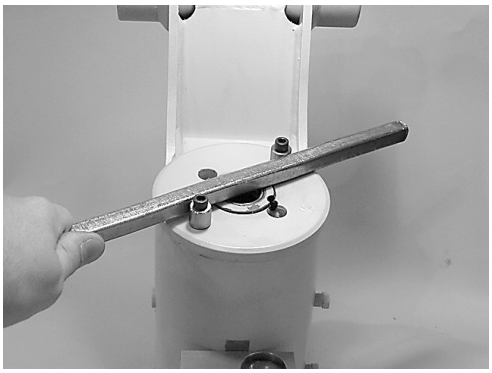
   If the pin cannot be removed with the screw extractor, use a 5/16" bit to drill out the entire pin. Do not drill deeper than 1/2" (12.7 mm).



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.



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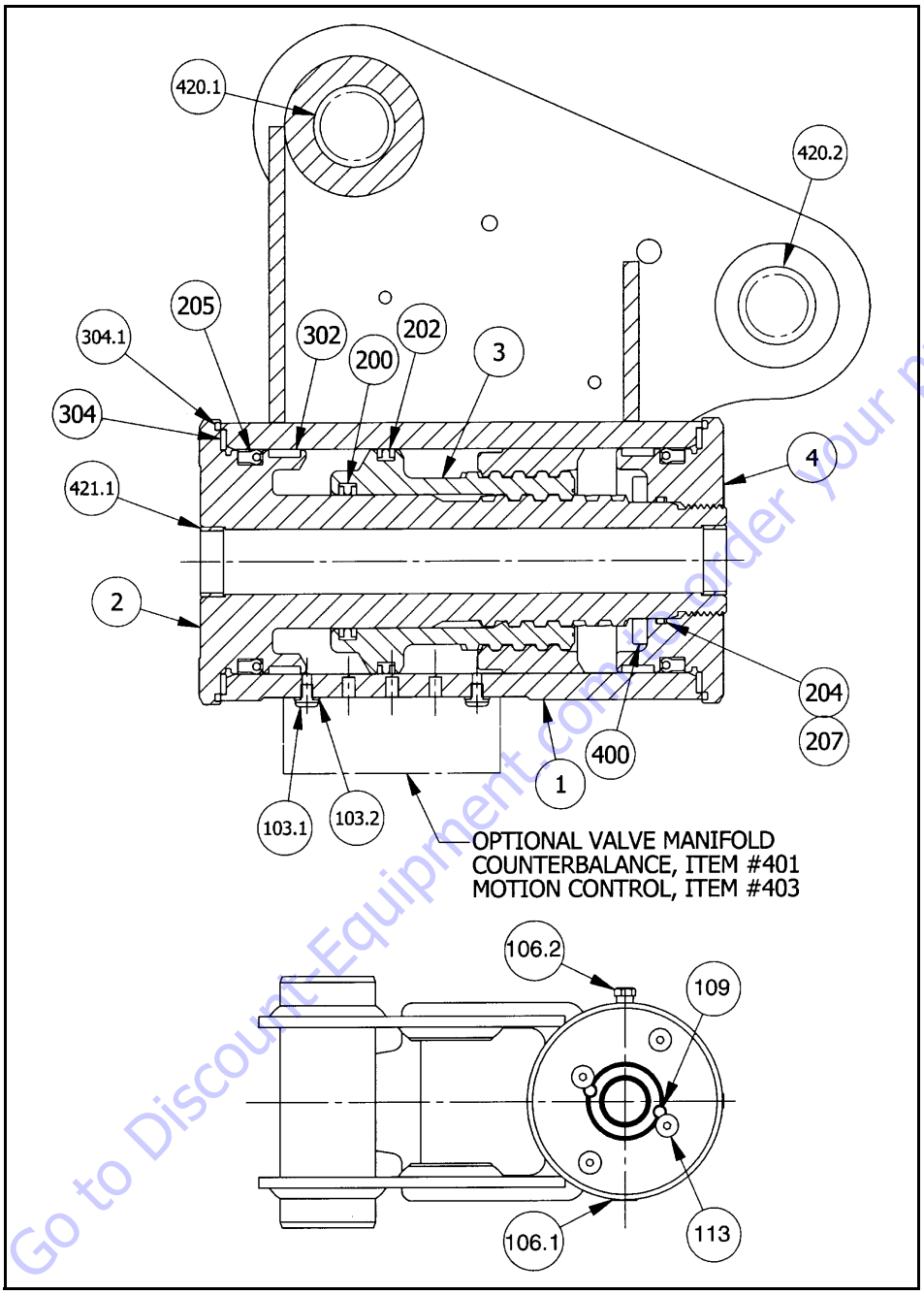

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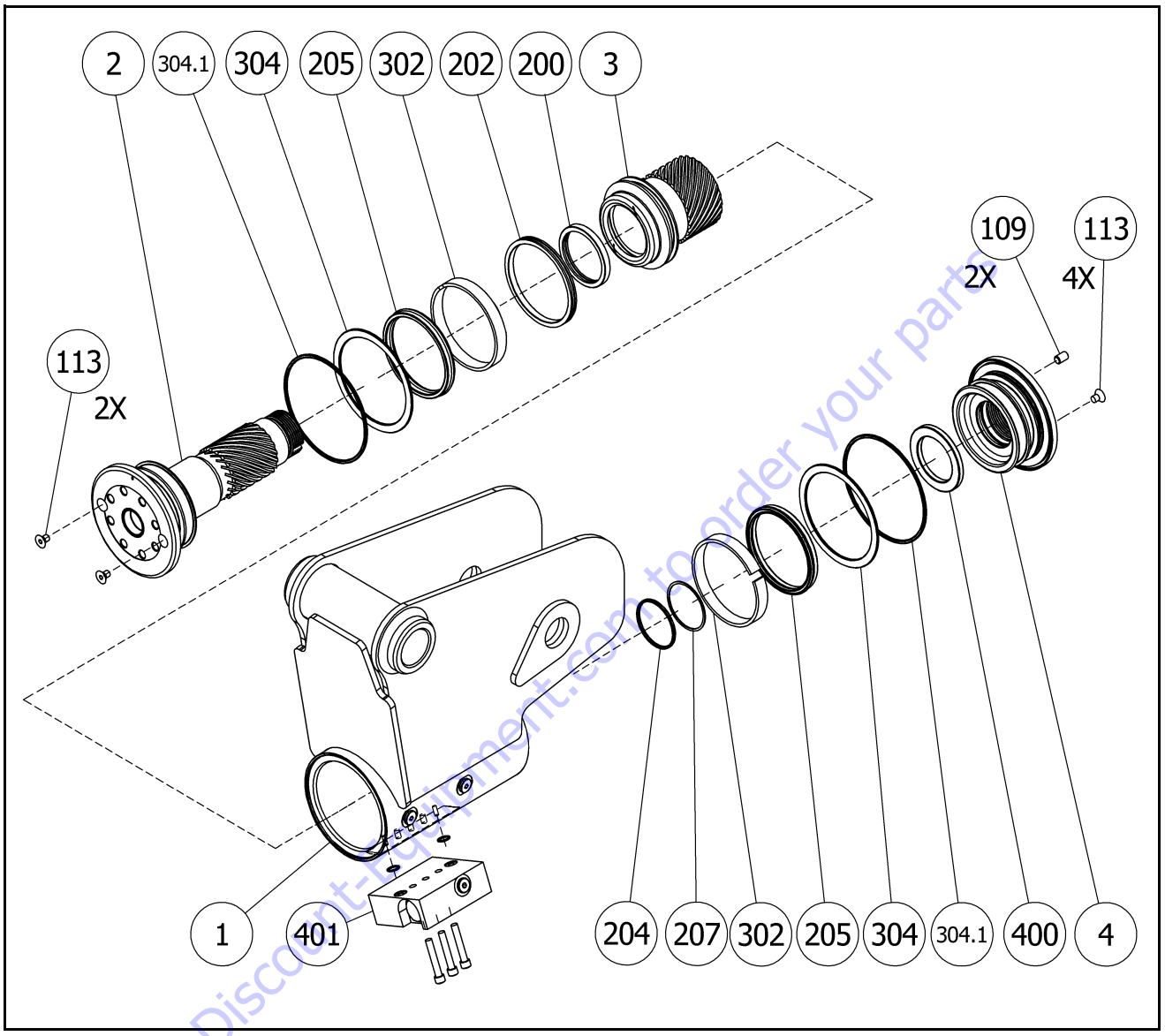
PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109.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

Figure 4-9. Rotary Actuator - Assembly Drawing



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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

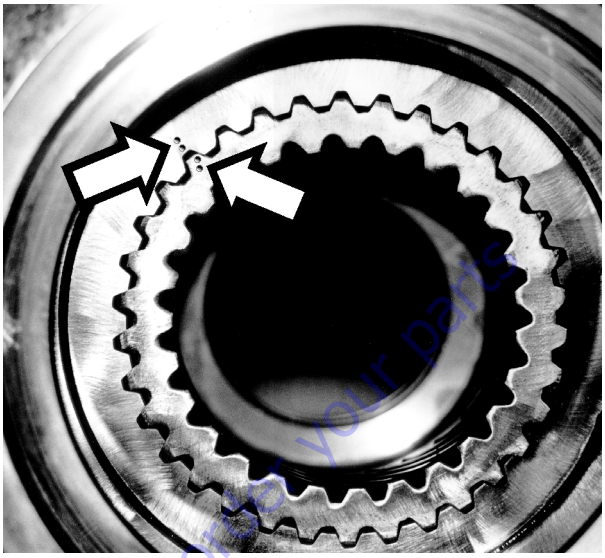
ACCESSORIES
400. Stop Tube
401 Counterbalance Valve

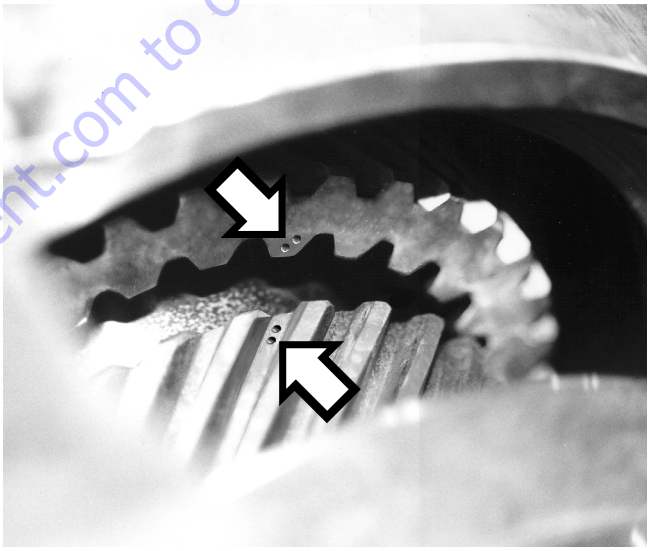
Figure 4-10. Rotary Actuator - Exploded View

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.

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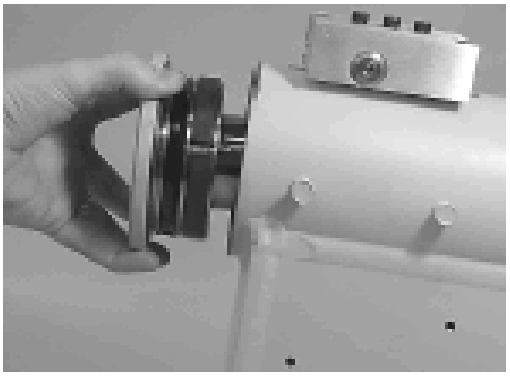
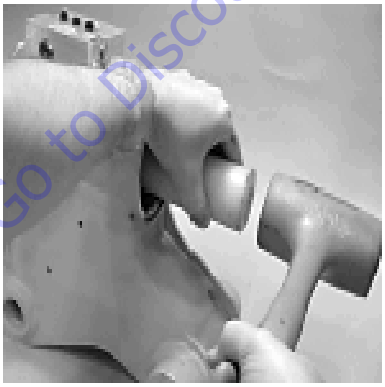
11. Remove the shaft (2) by rotating counterclockwise. As the shaft is rotated, it will disengage from the piston sleeve (3) and can be removed. It may be necessary to strike the threaded end of the shaft with a rubber mallet.



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.



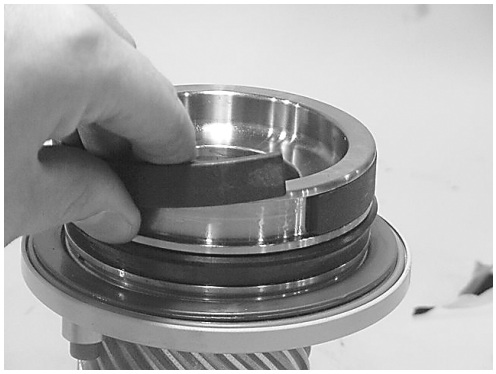
14. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.

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).



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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.

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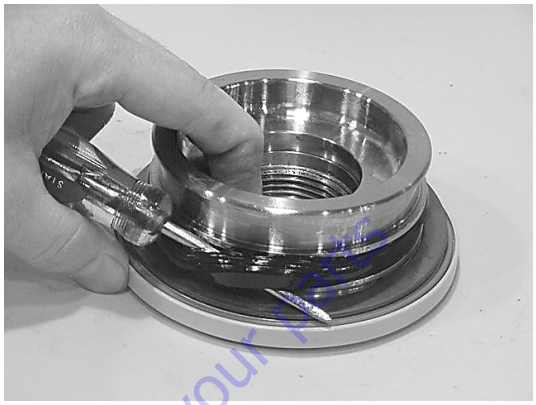
Assembly

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 backup ring (207) into the inner seal groove on the end cap (4).

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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.

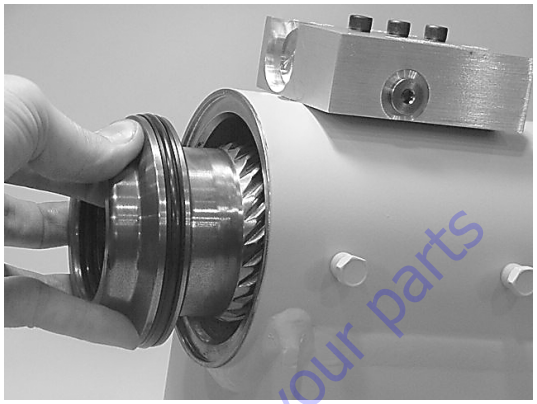
   Install the outer T-seal (202) by stretching it around the groove in a circular motion.

   Each T-seal has 2 backup 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 backup 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.

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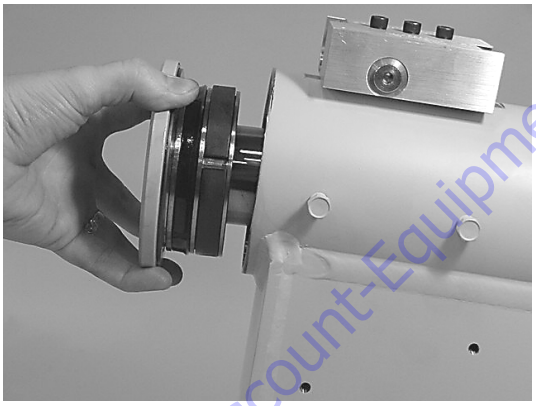
10. Looking into the bore from the opposite end of the housing (1) be sure the timing marks align correctly. Rotate the piston as necessary until aligned, then gently tap the piston (3) into the housing until the gear teeth mesh together. Tap the piston into the housing until it completely bottoms out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

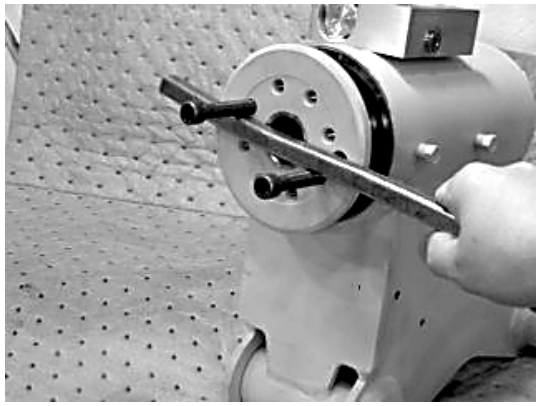


12. Looking at the actuator from the end opposite the shaft flange, use the existing timing marks to align the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). When the marks align, gently tap the flange end of the shaft with a rubber mallet until the gear teeth engage.

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.



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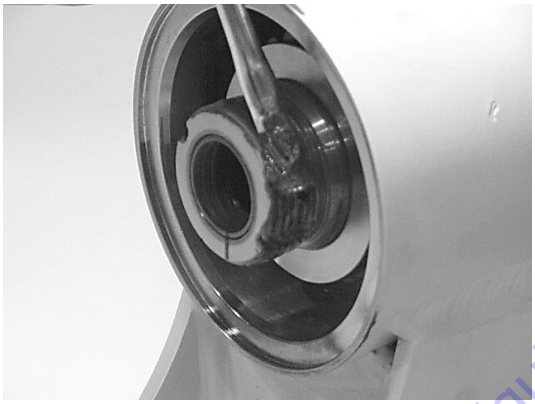
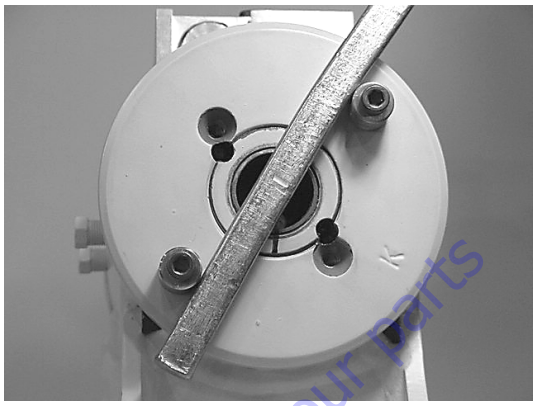
14. Install the stop tube (400) onto the shaft end if necessary. Stop tubes are an available option to limit the rotation of an actuator.

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



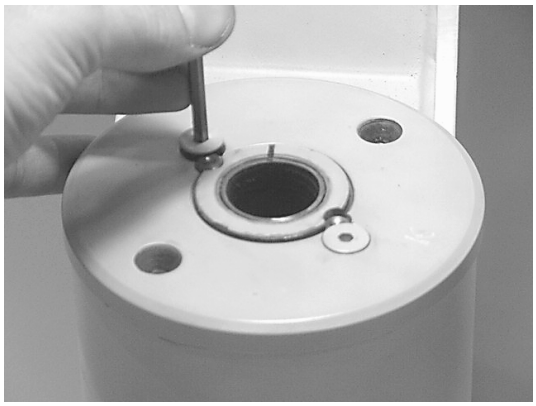
16. Thread the end cap (4) onto the shaft (2). Make sure the wear guide remains in place on the end cap as it is threaded into the housing (1).

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).



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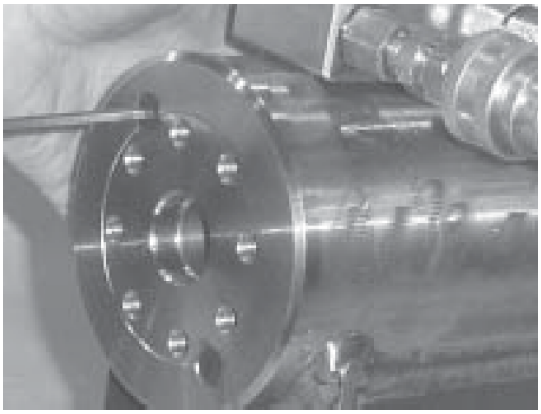
Greasing Thrust Washers

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

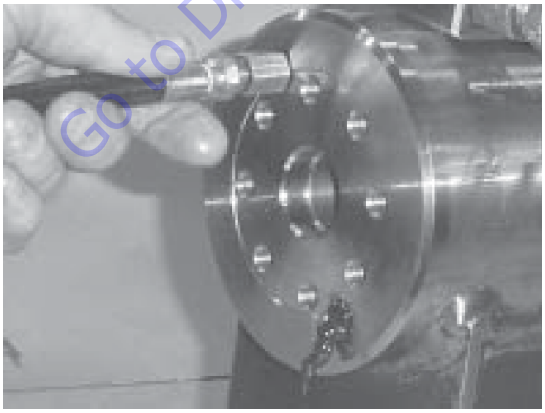
   There are two grease ports located on both the shaft flange and the end cap. They are plugged with capscrews (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)



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 CAPSCREWS 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 capscrews into the grease ports and tighten to 25 in-lbs. (2.8 Nm).



Installing Counterbalance Valve

Refer to Figure 4-11., Rotator Counterbalance Valve.

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

Testing the Actuator

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

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

If the actuator is equipped with 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.

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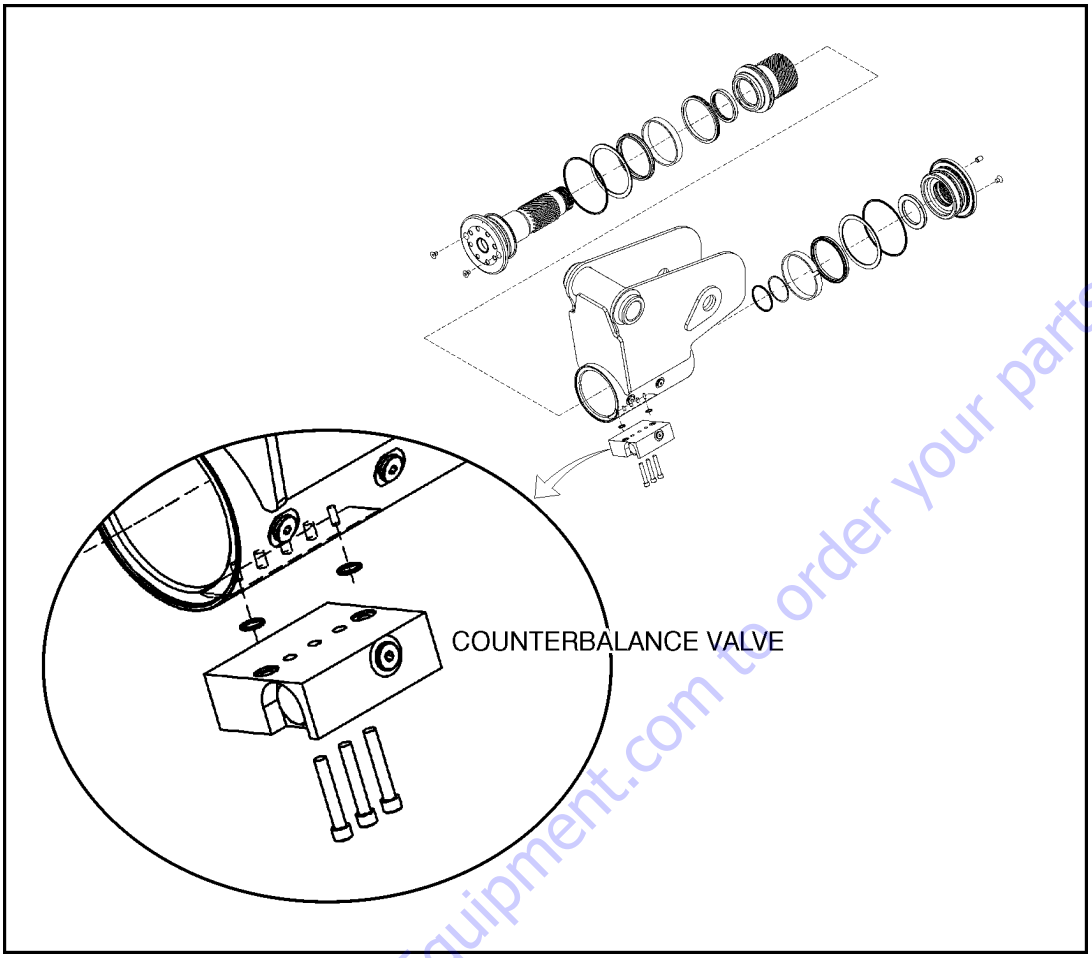

Figure 4-11. Rotator Counterbalance Valve

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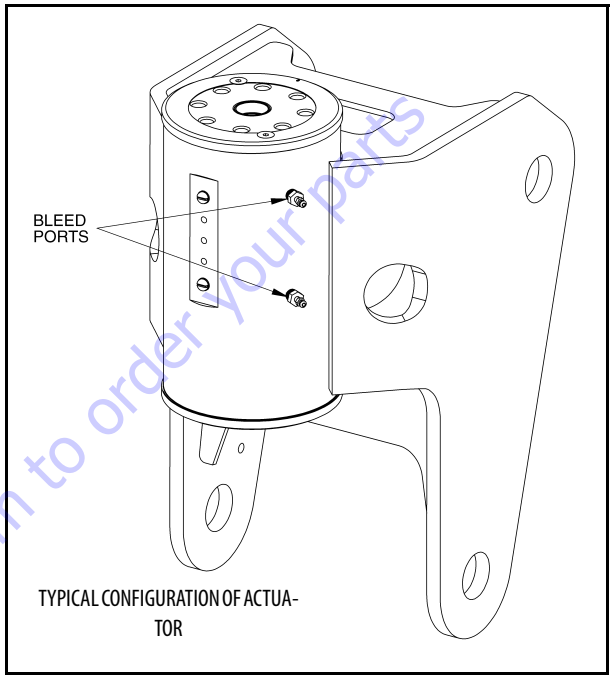
Installation and Bleeding

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

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.



TYPICAL CONFIGURATION OF ACTUATOR

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.

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Troubleshooting

Table 4-1. Troubleshooting

Problem	Cause	Solution
1. Shaft rotates slowly or not at all	a. Insufficient torque output	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.
	b. Low rate of fluid flow	b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.
	c. Control or counterbalance valve has internal leak	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. Piston and/or shaft seal leak	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. Corrosion build-up on the thrust surfaces	e. Re-build the actuator. Remove all rust then polish. Replacement parts may be needed.
	f. Swollen seals and composite bearings caused by incompatible hydraulic fluid	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	a. Check for gear binding. Actuator may not be able to be re-built and may need to be replaced. Damage could be a result of overload or shock.
	b. Port fittings are obstructing the piston	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	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. Piston and/or shaft seal leak	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. Air in actuator	c. Purge air from actuator. See bleeding procedures

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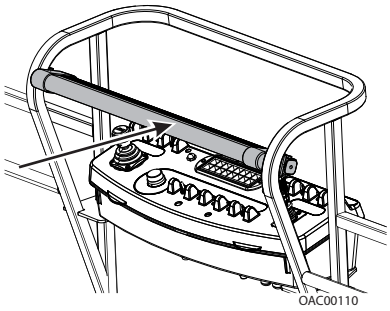
4.14 SKYGUARD®

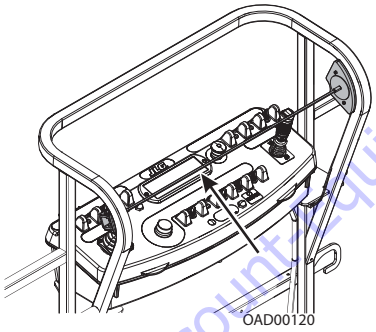
Operation

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

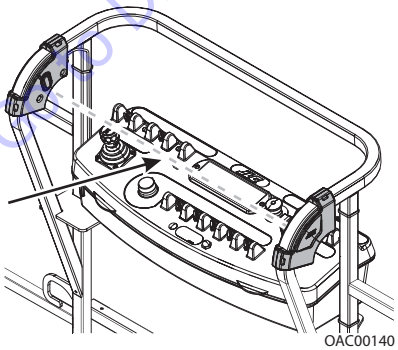
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

⚠ WARNING

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

Function Test

SKYGUARD ONLY

Perform this function test if **SkyGuard only** is selected in machine setup (refer to Table 6-7).

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.

SOFT TOUCH ONLY

If **Soft Touch only** is selected in machine setup (refer to Table 6-7), 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 6-7), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

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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 6-15 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	Tower Lift Up	Tower Lift Down	Boom Lift Up	Boom Lift Down	Boom Tele Out	Boom Tele In	Jib Lift	Basket Level	Basket Rotate
R*/C**	R	C	R	R	C	R	R	R	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												

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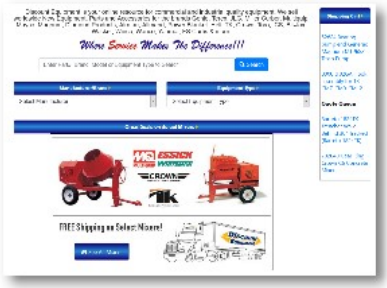

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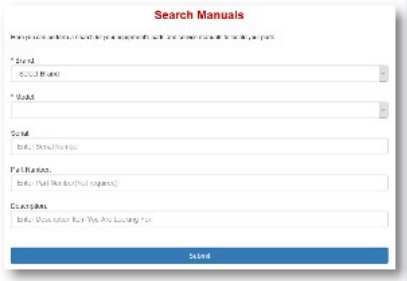

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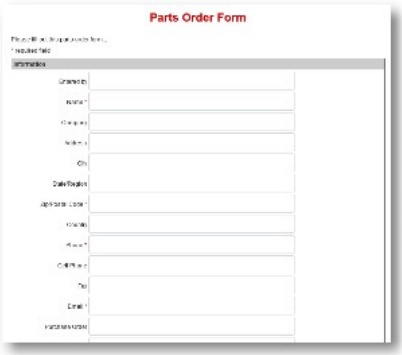

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SECTION 5. BASIC HYDRAULIC INFORMATION & SCHEMATICS

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.

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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.

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5.2 HYDRAULIC CYLINDERS

Holding (counterbalance) valves are used in the Lift, Level, Jib, Telescope, and Axle Lockout circuits to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its' related holding valve.

NOTE: *The steer cylinder weighs approximately 37.2 lb (16.9 kg).*

NOTE: *The tower lift cylinder weighs approximately 76 lb (34.5 kg).*

NOTE: *The upper lift cylinder weighs approximately 97 lb (44 kg).*

NOTE: *The master cylinder weighs approximately 35.3 lb (16 kg).*

NOTE: *The level cylinder weighs approximately 37.4 lb (17 kg).*

NOTE: *The jib lift cylinder weighs approximately 55 lb (25 kg).*

NOTE: *The telescope cylinder weighs approximately 52.7 lb (23.9 kg).*

NOTE: *The axle oscillation lockout cylinder weighs approximately 26.2 lb (11.9 kg).*

Disassembly and Assembly Instructions

1. Make sure the work surface is large enough for the entire cylinder and clean and free of dirt. Ensure the cylinder can be secured firmly in place during disassembly.
2. Prepare all the necessary tools and replacement parts. Refer to Table 5-1, Required Tools.

General Information

1. Clean any burrs or contamination from the surface of the cylinder before disassembly.
2. Handle every part with care. Each part is precision made and hitting parts together or letting them fall could damage the machined surfaces.
3. Do not twist or strike parts to get them apart. This will damage the part and/or threads, resulting in leakage and poor function.
4. Do not let the cylinder in a disassembled condition for a long period of time. It only takes a short period of time for the parts to rust.

Standard of Maintenance

Parts and seals should be replaced according to the conditions as follows.

1. Bushings - 1/4 of the bushing is worn off.
2. Seal and Slide Ring - Replace during disassembly.
3. Pin Bushing - When it is worn down.
4. Rod - Bent or warped more than 0.5mm/1m.

Inspection After Assembly

Operation Inspection Without Load	There is no problem when fully extended 5 times without load						
Dimension	Check the retracted length and stroke						
Inspection of the Surface	When each of the cylinders are pressurized with test pressure on the piston end, it should not be loose and have no change in pressure or external leakage						
Inspection of external leakage	Check the oil leakage at the rod area. Refer to Figure 5-1., Acceptable Oil Leakage on Cylinder Rod.						
Inspection of internal leakage	Leakage Unit: ml/ 10 minutes						
	Bore (mm)	Leakage (ml)	Bore (mm)	Leakage (ml)	Bore (mm)	Leakage (ml)	Remark
	32	0.4	100	4	160	10	
	40	0.6	125	5.6	180	12.6	
	50	1	140	6	200	15.6	
	63	1.6			220	20	
	80	2.3			250	22	

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Check the oil leakage status on the rod surface with a flow of 20cc - 40cc. Oil leakage in an amount as shown in example A is unacceptable. Examples B-G are acceptable.

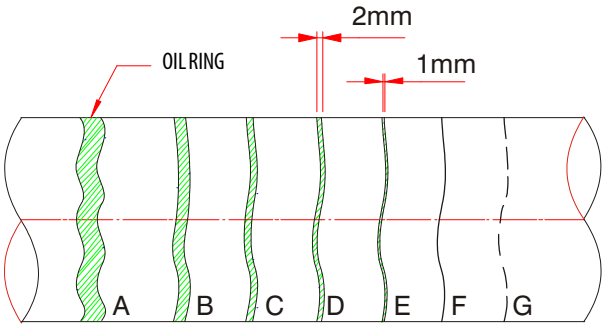

Figure 5-1. Acceptable Oil Leakage on Cylinder Rod

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Table 5-1. Required Tools

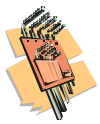
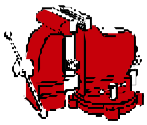
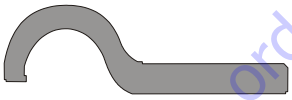
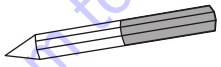
Item No.	Description	Quantity
1	Flat-head Screwdriver 	1
2	Allen Wrench Set 	1 Set
3	Vise 	1
4	Spanner Wrench 	1 Set
5	Punch 	1
6	Torque Wrench 	1 Set
7	Plastic Hammer 	1
8	Crescent Wrench 	1
9	Hera (Seal Disassembly)  	

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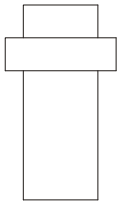
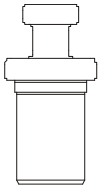
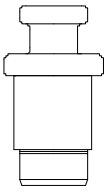
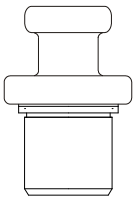
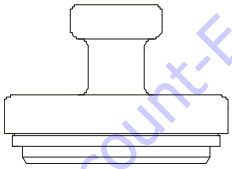
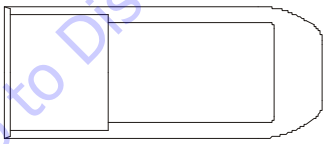
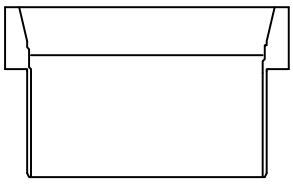
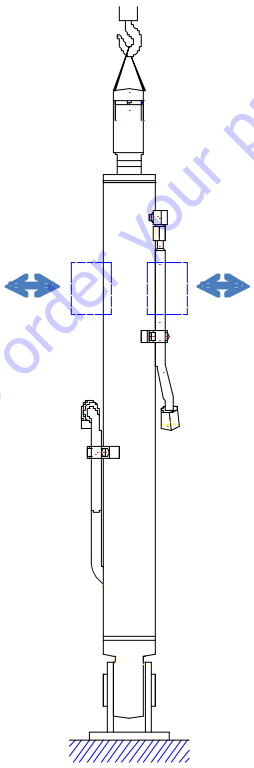
Table 5-2. Special Tools

Name of Tool	Description
Bushing for Disassembly	
Bushing for Press	
MRP Bearing Disassembly	
MRP Bearing Press	
Dust Wiper Press/ Dust Wiper Insert	
Gland Seal Protection (Gland Guide Jig)	
Piston Seal Protection (Piston Guide Jig)	

Disassembly Procedure

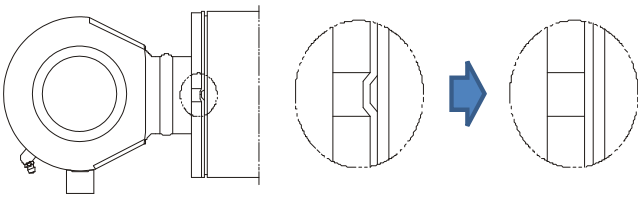
1. Remove the oil from the cylinder.

2. Fix the cylinder in a vertical or horizontal position. Vertical position is convenient for disassembly and assembly. Fix the base by inserting the pin not to be rotated. Remove any hoses, valves, or fittings that may be in the way.



3. Unscrew the cylinder Head

   Glands that are threaded into the barrel are locked in place with caulking. Using a spanner wrench, unscrew the gland from the barrel. (It is easier to do this with rod pulled out 5cm from the gland). If there is no caulking, continue with the disassembly process.



4. Remove the Rod assembly

   a. Check if the cap or plug has been removed from the cylinder ports.

   b. Place a suitable container under the cylinder to catch any oil coming out of the cylinder.

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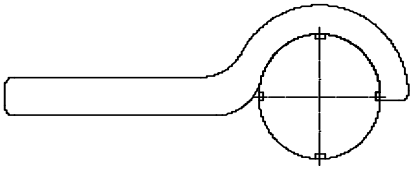
c. After the Rod assembly is pulled from the barrel, unscrew the head using a spanner wrench.



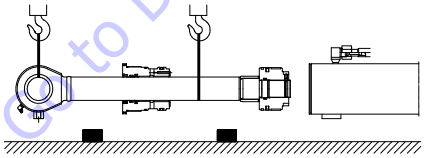
d. After disassembling the rod assembly, place it on a support.

⚠ CAUTION

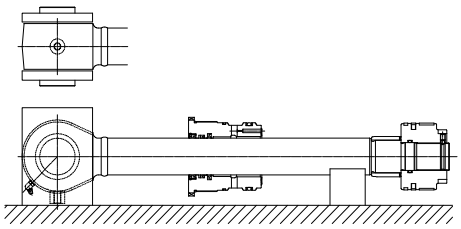
IF THE CYLINDER IS AT A VERTICAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; WHEN THE HEAD IS UNSCREWED AND THE ROD ASSEMBLY IS PULLED FROM THE BARREL, THERE IS A SPACE BETWEEN THE HEAD AND PISTON. IT IS POSSIBLE FOR THE HEAD TO SUDDENLY SLIDE DOWN, POSSIBLY CAUSING INJURY. TO PREVENT THIS, THE HEAD SHOULD BE PUSHED AGAINST THE PISTON BEFORE PROCEEDING.

⚠ CAUTION

IF A CYLINDER IS AT A HORIZONTAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; IT IS POSSIBLE FOR THE ROD TO FALL AND BE DAMAGED WHEN REMOVED FROM THE BARREL IF NOT PROPERLY SUPPORTED. PLACE SUPPORT UNDER THE BARREL AS SHOWN BELOW.

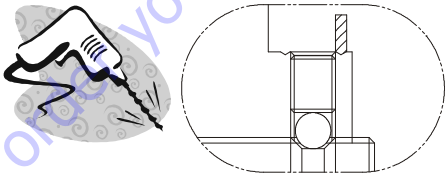


5. Place the Rod assembly on blocking as shown below. Use the pin hole to keep it from rotating.



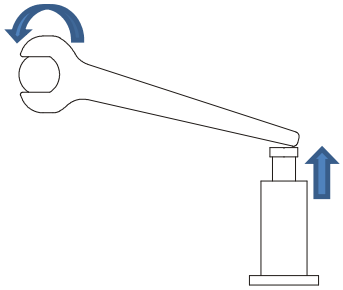
6. Unscrew the Piston Nut.

a. Unscrew the set screw. Caulking is used to lock the setscrew so grind the caulking area and then unscrew the set screw.



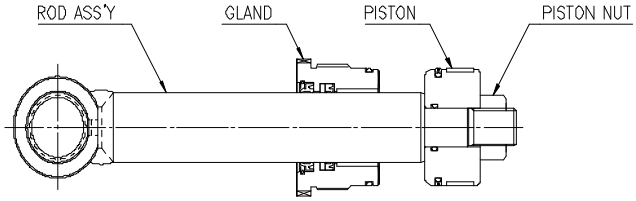
b. Remove the steel ball

c. Unscrew the piston nut. The piston nut is secured with a torque specified in Table 5-3, Piston Nut Torque. 1.5 x this torque is needed to remove the nut. If the stronger torque is needed, use a power wrench operated by a hydraulic unit



NOTE: *If it is not a set screw type, continue with the disassembly of the piston nut.*

7. Remove the PISTON NUT, PISTON and GLAND in sequence.



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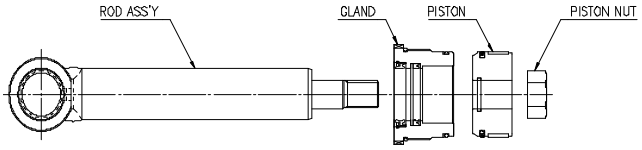
8. Piston nut, piston, gland disassembly.

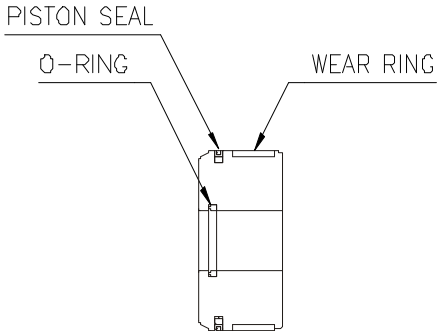


a. Unscrew the Piston Nut.

b. Take the piston apart by sliding off the rod in the direction of the rod threads.

c. Take the gland apart by sliding off the rod in the direction of the rod threads.

9. Take apart piston seals.



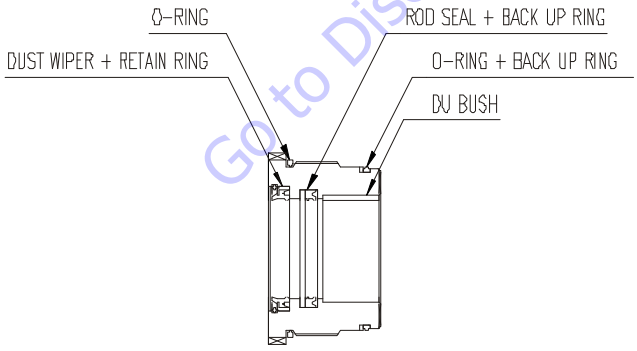
a. The wear ring is easily taken apart by hand.

b. The piston seal is a two piece seal; the ring at the outer side is easily removed. Remove the ring inside of the piston seal.

c. Remove the o-ring.

NOTE: *All seals must be discarded after removal. They can not be reused.*

10. Remove the gland seal.

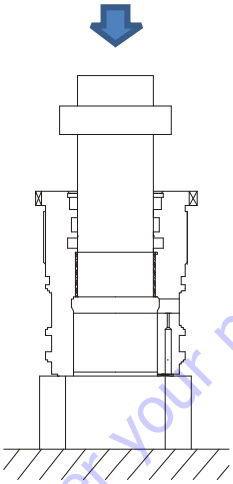


a. Remove the rod seal and backup ring.

b. Remove the retaining ring with a flat-head screwdriver prior to removing the dust wiper and remove the dust wiper.

c. Remove the o-ring and backup ring.

d. The du bushing is pressed in and must be removed by using a tool as shown below.



NOTICE

DISCARD ALL SEALS AFTER REMOVAL AND REPLACE THEM WITH NEW ONES FOR ASSEMBLY.

11. MRP BEARING DISASSEMBLY

To remove the MRP bearing, break it into pieces.

12. WASHING AND STORAGE

All removed parts should be washed with cleaning solution and then coated with light oil to prevent rust. If the cylinder is not to be reassembled right away, store the parts and put a covering over them.

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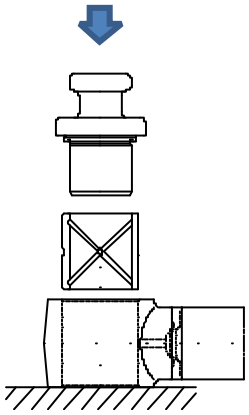
Assembly

⚠ CAUTION

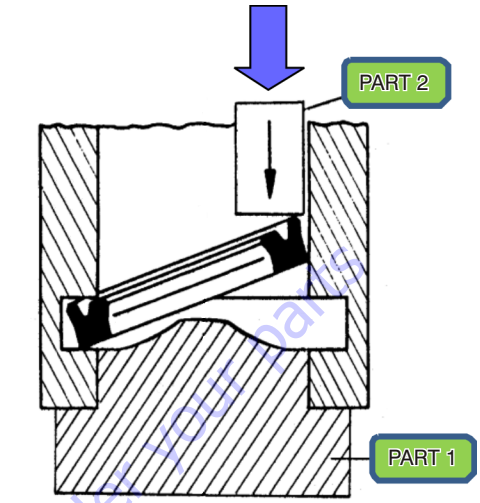
TAKE CARE NOT TO LET ANY PAINT CHIPS OR DIRT FALL INSIDE THE CYLINDER. THIS COULD CAUSE LEAKAGE.

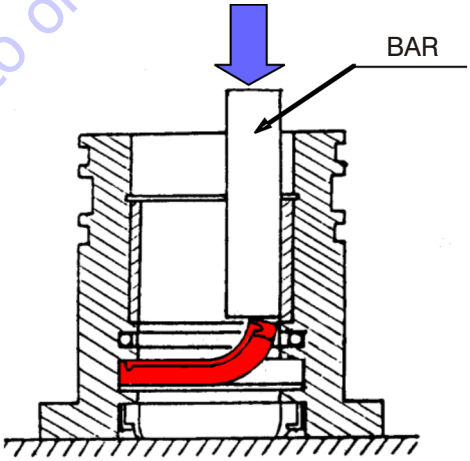
1. Pin bushing assembly

   Coat the opening with oil to aid in assembly and press the bushing into the rod as shown below.



2. Gland seal assemblies
   a. Coat the opening with oil to aid in assembly and press the bushing into place with the proper tool.
   b. Rod seal assembly (Keep the right direction and do not make damage to seal)





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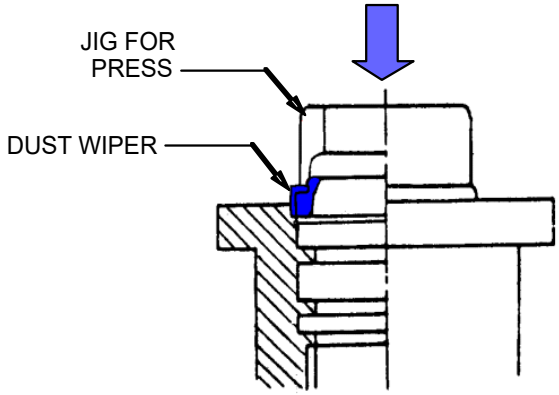
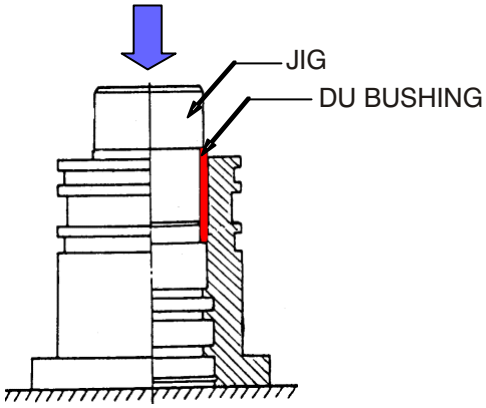
c. Install du bushing assembly and dust wiper assembly as shown below.





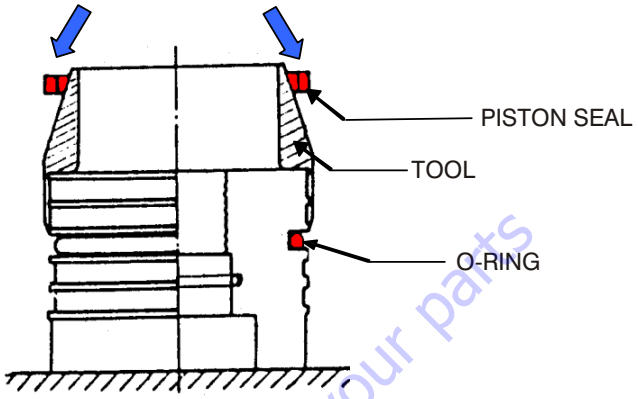
d. Assemble backup ring, o-ring (Check the sequence of backup ring, o-ring.)

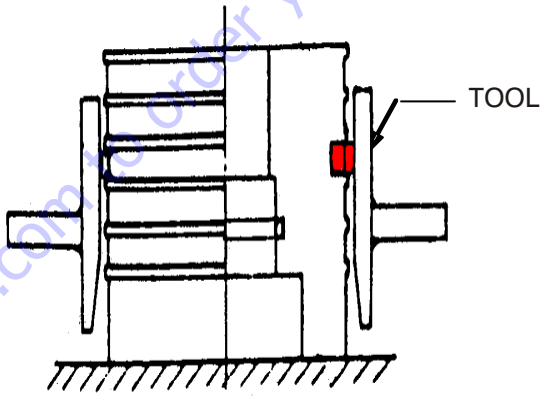
3. Piston Seal Assembly

a. Assembly the seal assembly.

b. Install the o-ring into the groove.

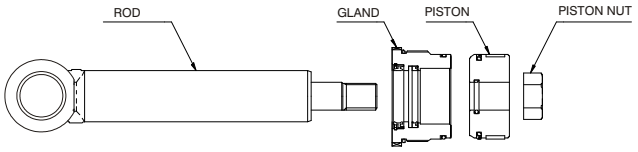
c. Using a proper tool, press the piston seal onto the piston. When installing the piston seal, it is stretched while passing over the head.





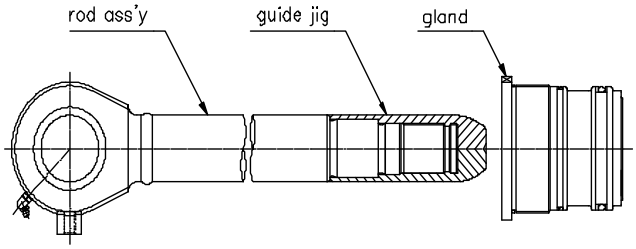
d. Install the wear ring assembly by spreading it apart.

4. Rod assembly



a. Secure the rod assembly.

b. Install the Head onto the rod assembly. Take care as not to damage the lip of the dust wiper and rod seal.



c. Assemble Piston.

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d. Torque the Piston nut as specified in Table 5-3, Piston Nut Torque. Lack of the torque can result in internal leakage, the piston coming unscrewed, and thread damage. If overtorqued, the piston surface which meets the rod will be damaged.

Table 5-3. Piston Nut Torque

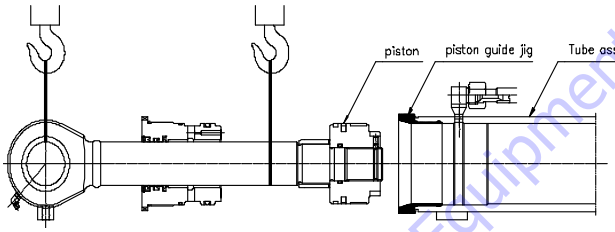
CYLINDER	PISTON
STEERING	NA
TOWER LIFT	267 ft.lbs.
UPPER LIFT	528 ft.lbs.
MASTER	267 ft.lbs.
LEVEL	267 ft.lbs.
JIB	267 ft.lbs.
TELESCOPE	267 ft.lbs.
RAM LOCK	NA

5. Assemble the rod assembly.

a. Secure the barrel at a vertical or horizontal position.

b. Insert the assembly into the barrel.

c. When piston is inserted to the barrel take care as to not damage the seal rings.

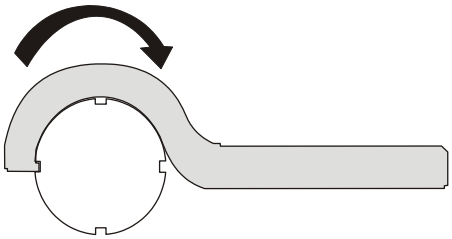


6. Gland assembly.

Install the gland using a spanner wrench as shown below

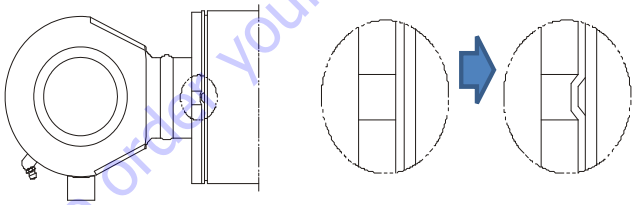
Table 5-4. Gland Torque

CYLINDER	GLAND
STEERING	397 ft.lbs.
TOWER LIFT	463 ft.lbs.
UPPER LIFT	550 ft.lbs.
MASTER	463 ft.lbs.
LEVEL	463 ft.lbs.
JIB	405 ft.lbs.
TELESCOPE	318 ft.lbs.
RAM LOCK	NA



7. Caulking.

Caulk at the machined area of the cylinder barrel end so that it locks the cylinder head in place and it does not unscrew from the barrel. If there is no caulking hole, caulking is not necessary.



8. Test operation.

a. Install the cylinder on a machine. Fill the cylinder with oil and then have the cylinder slowly operated a minimum of 8 cycles. If it is operated too fast in the beginning, cavitation will result. It is important to make sure all air is cycled from the cylinder.

b. Grease the end of the pin.

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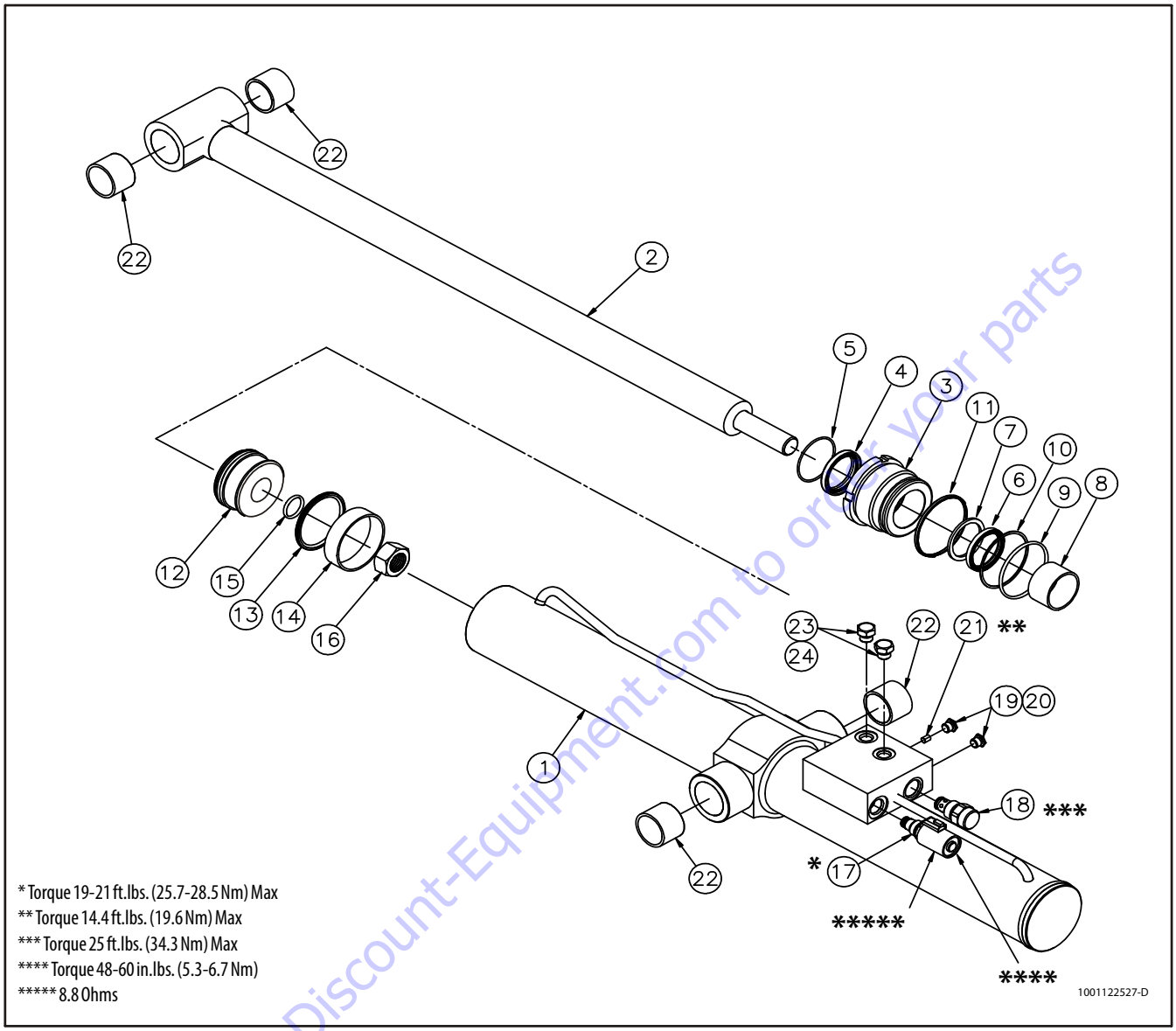

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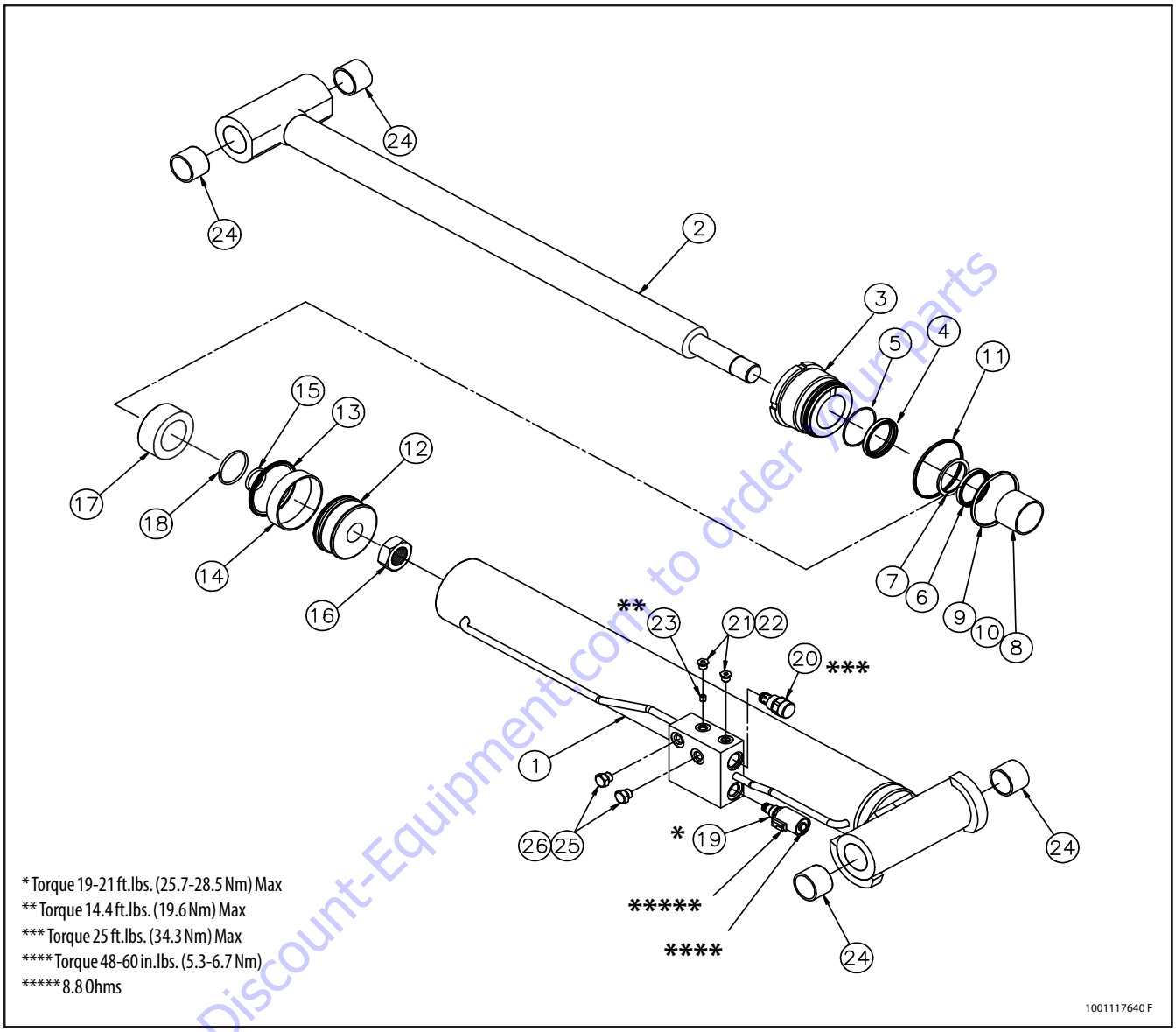
1.	Tube	6.	Rod Seal	11.	O-ring	16.	Nut	21.	Orifice
2.	Rod	7.	Backup Ring	12.	Piston	17.	Poppet Valve	22.	MPR Bearing
3.	Gland	8.	Dry Bearing	13.	Piston Seal	18.	Check Valve	23.	Plug
4.	Dust Wiper	9.	O-ring	14.	Wear Ring	19.	Plug	24.	O-ring
5.	Retaining Ring	10.	Backup Ring	15.	O-ring	20.	O-ring		

Figure 5-2. Tower Lift Cylinder



1. Tube
2. Rod
3. Gland
4. Dust Wiper
5. Retaining Ring
6. Rod Seal
7. Backup Ring
8. Dry Bearing
9. O-ring
10. Backup Ring
11. O-ring
12. Piston
13. Piston Seal
14. Wear Ring
15. O-ring
16. Nut
17. Spacer
18. O-ring
19. Poppet Valve
20. Check Valve
21. Plug
22. O-ring
23. Orifice
24. MPR Bearing
25. Plug
26. O-ring

Figure 5-3. Upper Lift Cylinder

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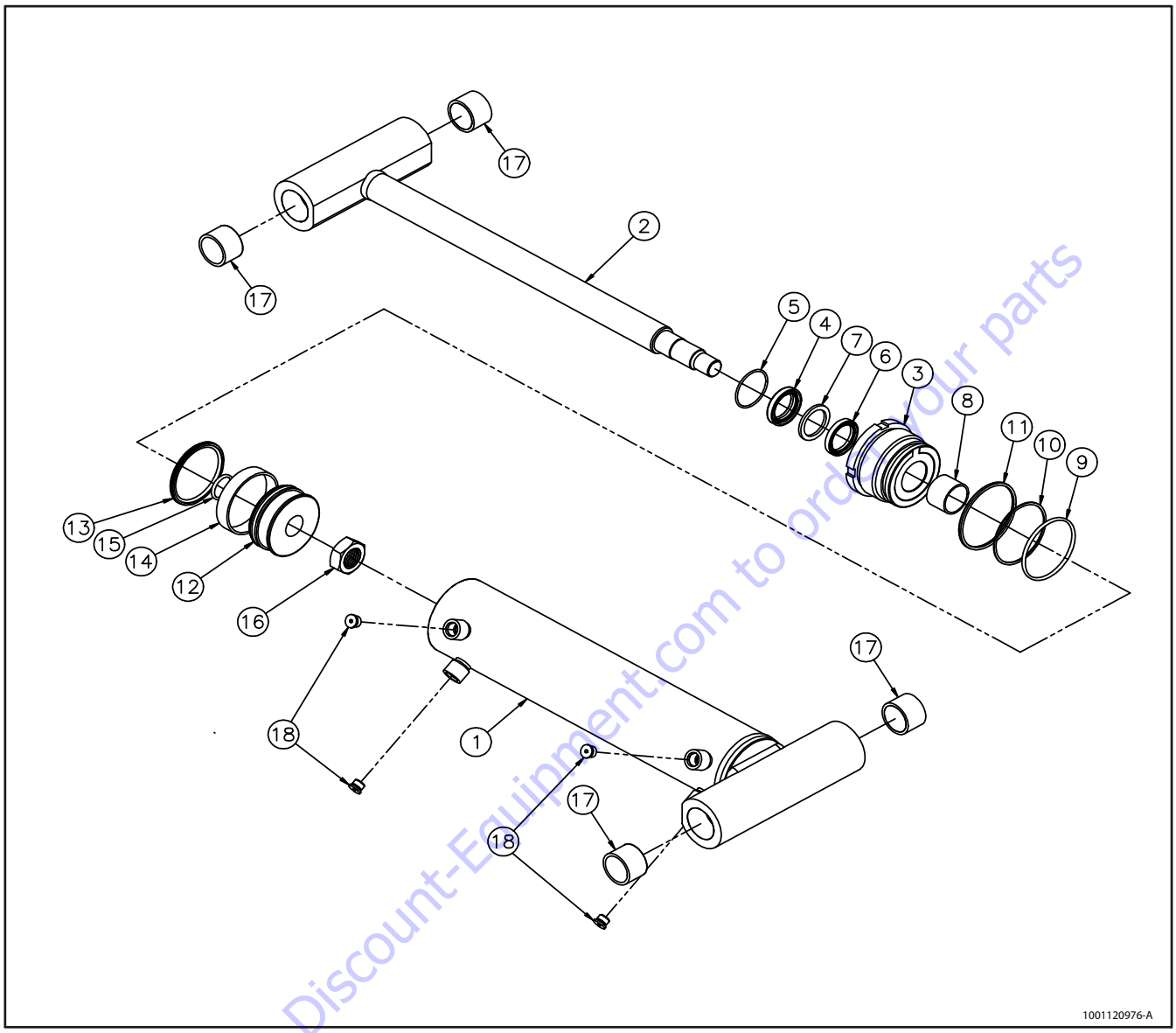

1. Tube
2. Rod
3. Gland
4. Dust Wiper
5. Retaining Ring
6. Rod Seal
7. Backup Ring
8. Dry Bearing
9. O-ring
10. Backup Ring
11. O-ring
12. Piston
13. Piston Seal
14. Wear Ring
15. O-ring
16. Nut
17. MRP Bearing
18. Plug

Figure 5-4. Master Cylinder

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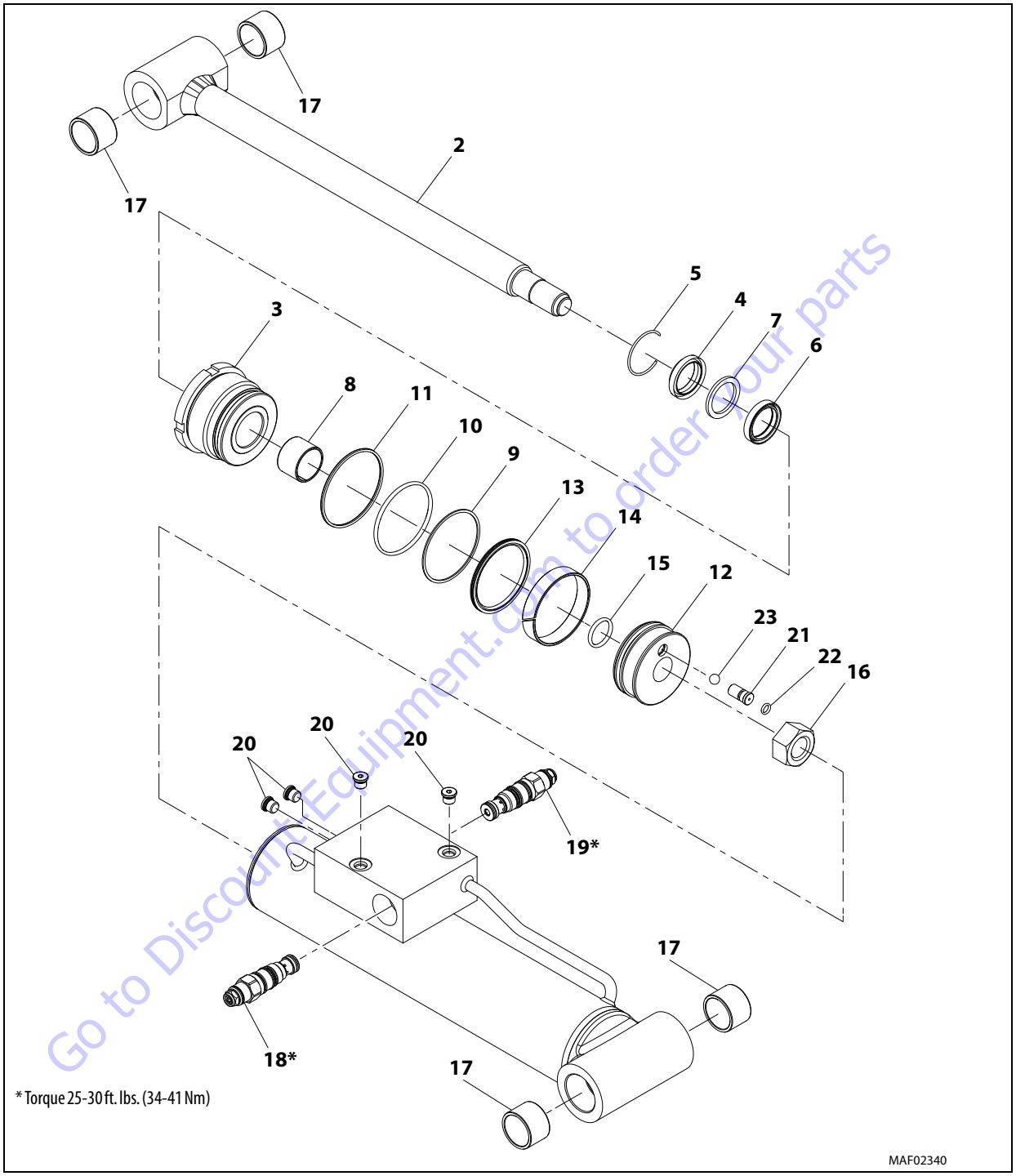

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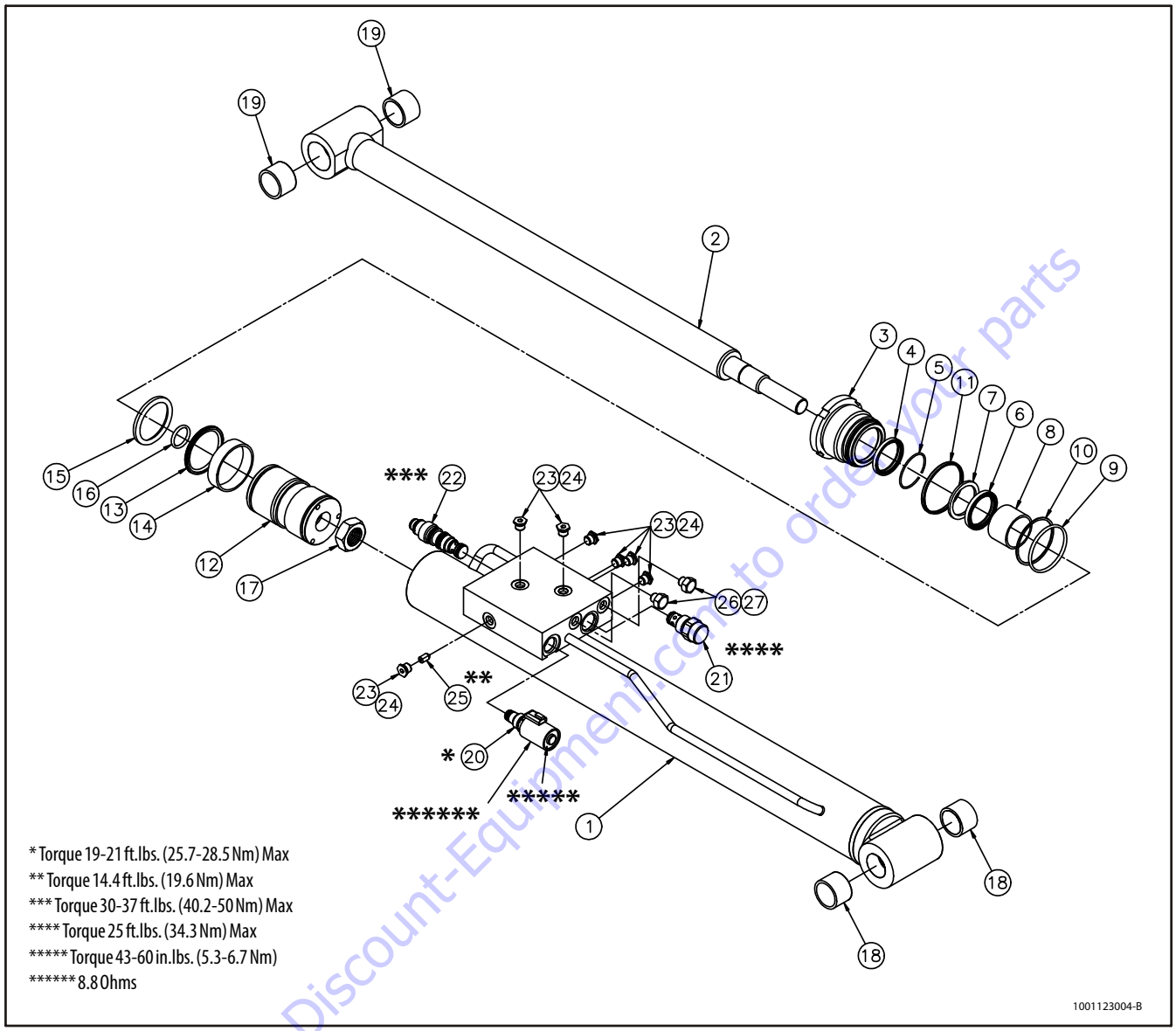
1. Barrel
2. Rod
3. Cylinder Head
4. Wiper Seal
5. Retaining Ring
6. Rod Seal
7. Backup Ring
8. Bearing
9. O-Ring
10. Backup Ring
11. O-Ring
12. Piston
13. Piston Seal
14. Wear Ring
15. Wear Ring
16. Nut
17. Bushing
18. Cartridge Valve
19. Cartridge Valve
20. Plug
21. Valve Seat
22. O-Ring
23. Steel Ball

Figure 5-5. Platform Level Cylinder



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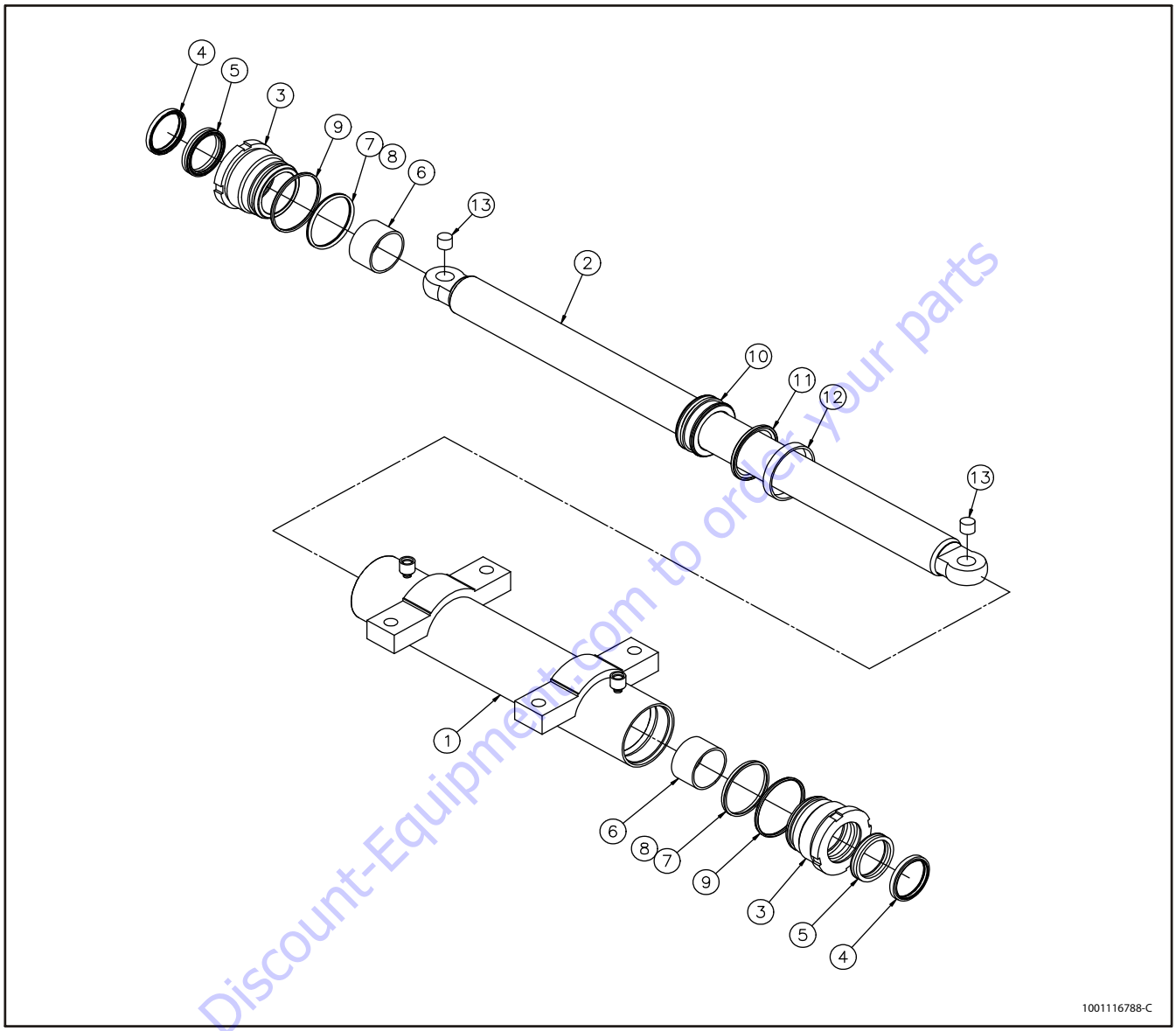
1. Tube
2. Rod
3. Gland
4. Dust Wiper
5. Retaining Ring
6. Rod Seal
7. Backup Ring
8. Dry Bearing
9. O-ring
10. Backup Ring
11. O-ring
12. Piston
13. Piston Seal
14. Wear Ring
15. O-ring
16. Piston Ring
17. Hex Nut
18. MRP Bearing
19. MRP Bearing
20. Poppet Valve
21. Check Valve
22. Counterbalance Valve
23. Plug
24. O-ring
25. Orifice
26. Plug
27. O-ring

Figure 5-6. Jib Cylinder



1. Tube
2. Rod
3. Piston
4. Gland
5. Dust Wiper
6. Rod Seal
7. Dry Bearing
8. O-ring
9. Backup Ring
10. O-ring
11. Wear Ring
12. Piston Seal
13. MRP Bearing

Figure 5-7. Steer Cylinder

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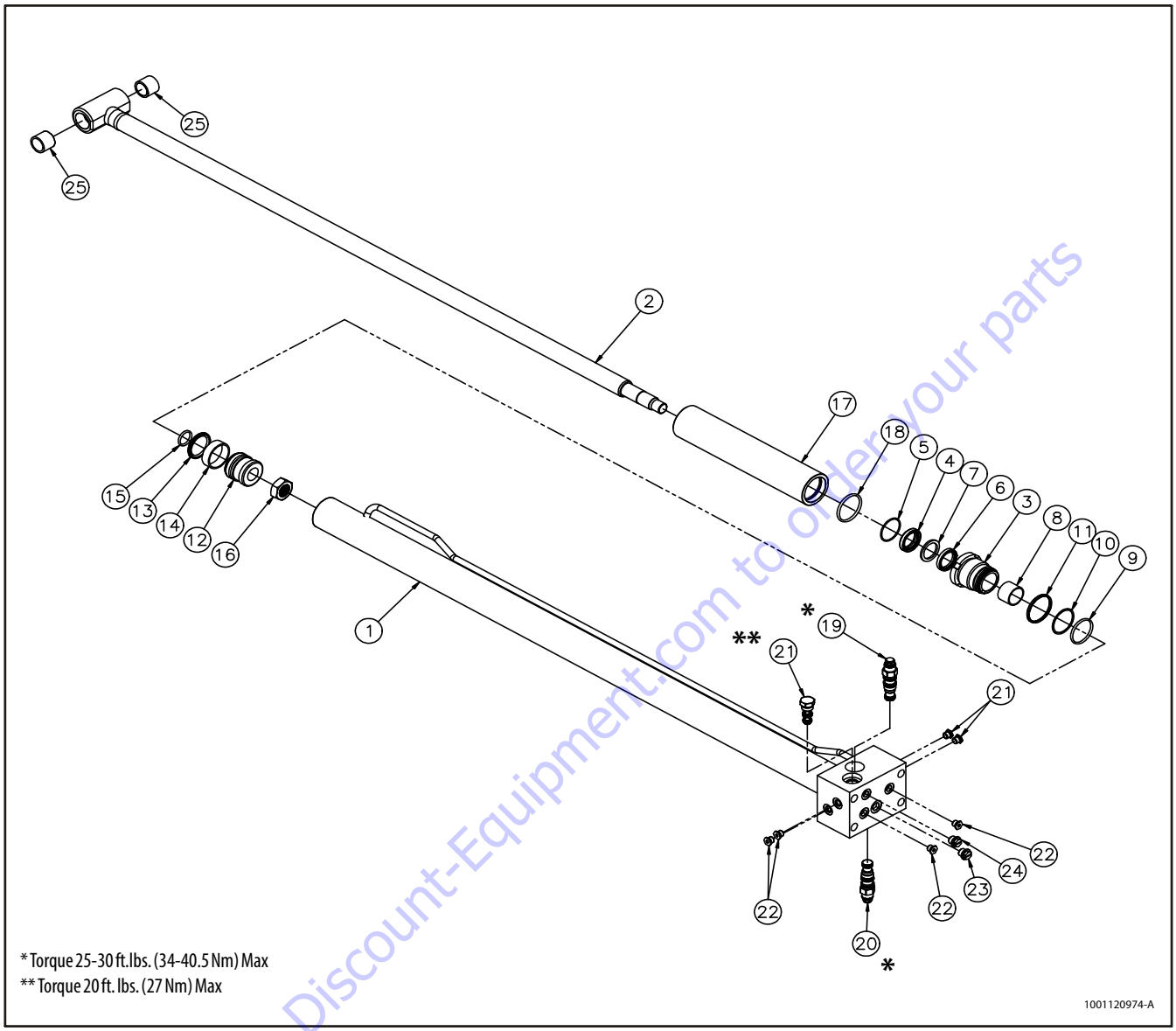

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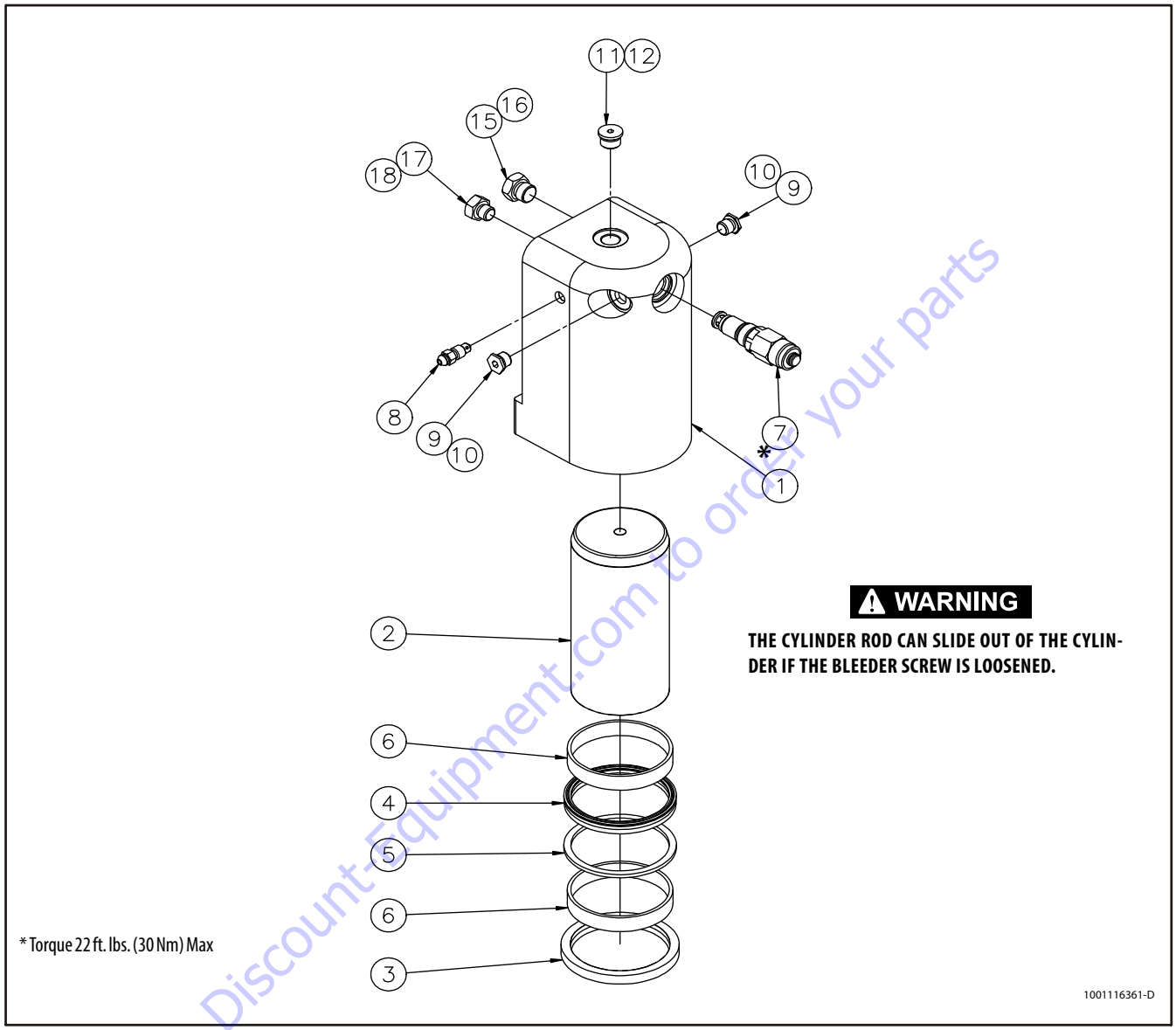
1. Tube Assembly	6. Rod Seal	11. O-ring	16. Hex Nut	21. Load Shuttle Valve
2. Rod	7. Backup Ring	12. Piston	17. Spacer	22. Plug
3. Gland	8. Dry Bearing	13. Piston Seal	18. O-ring	23. Plug
4. Dust Wiper	9. O-ring	14. Wear Ring	19. Counterbalance Valve	24. Plug
5. Retaining Ring	10. Backup Ring	15. O-ring	20. Counterbalance Valve	25. MRP Bearing

Figure 5-8. Telescope Cylinder



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1. Body
2. Rod
3. Dust Wiper
4. Rod Seal
5. Backup Ring
6. Wear Ring
7. Counterbalance Valve
8. Bleeder
9. Plug
10. O-ring
11. Plug
12. O-ring
13. Not Used
14. Not Used
15. Plug
16. O-ring
17. Plug
18. O-ring

Figure 5-9. Axle Lockout Cylinder

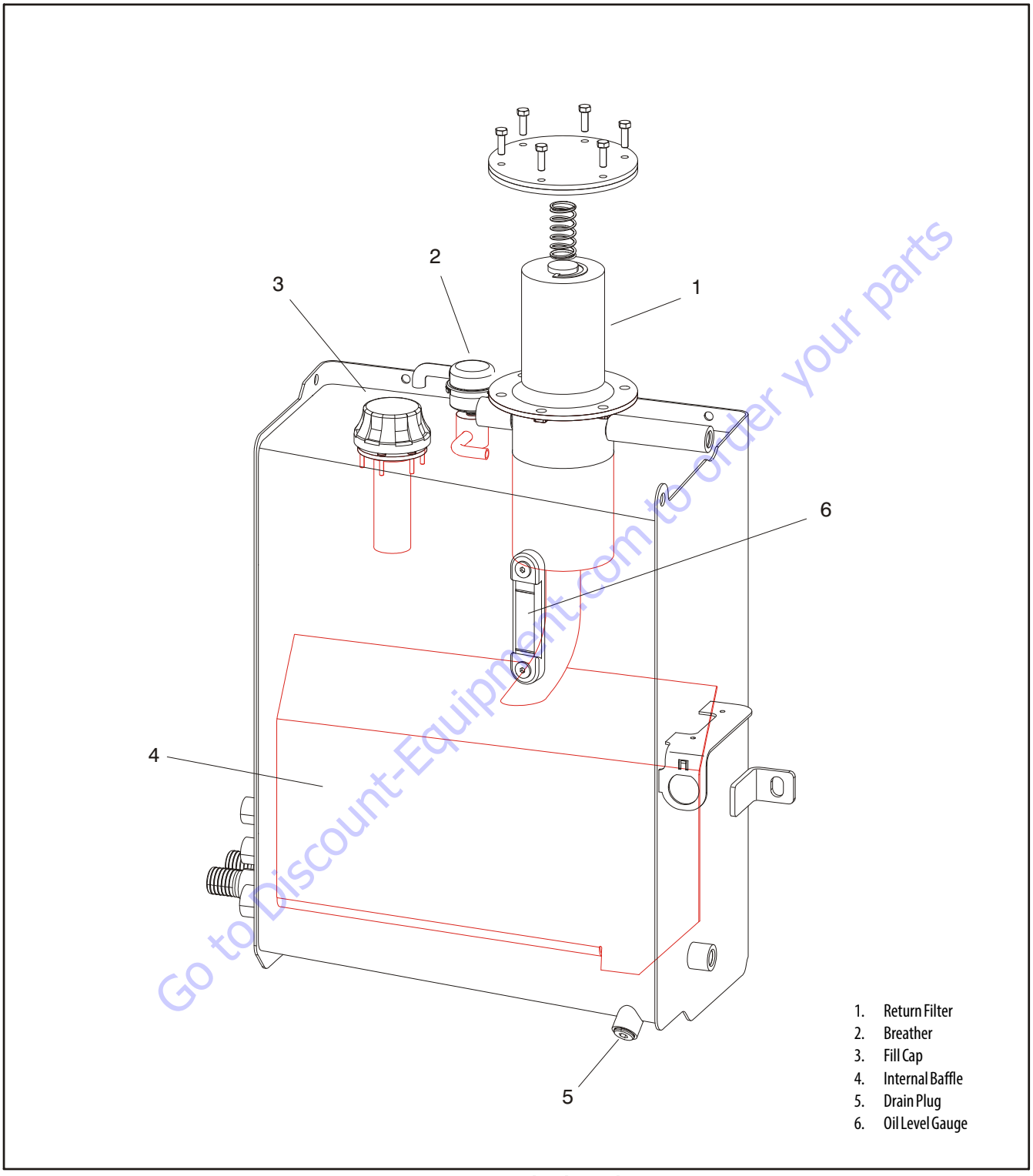

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Figure 5-10. Hydraulic Tank

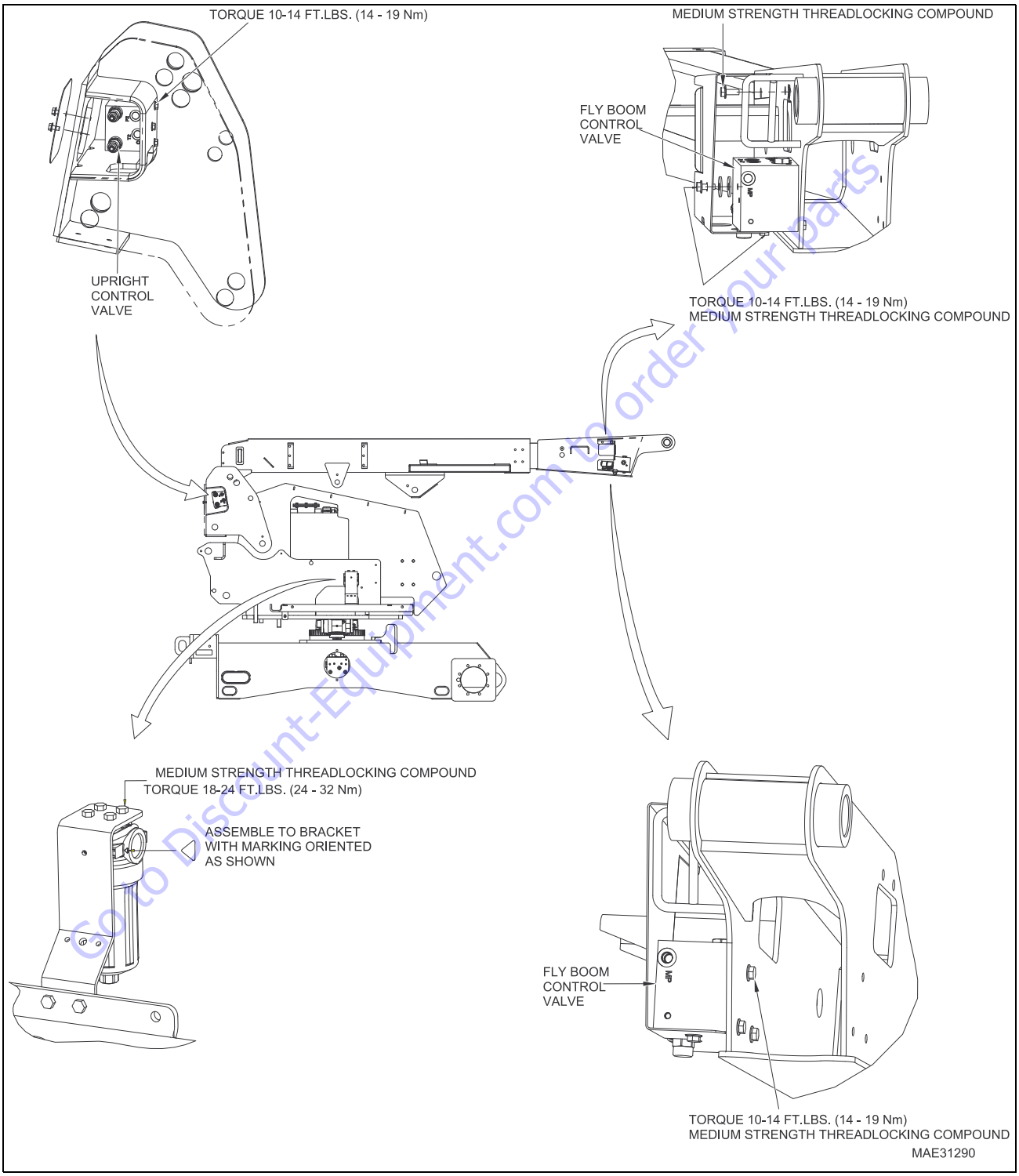

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Figure 5-11. Valve Installation - Sheet 1 of 2

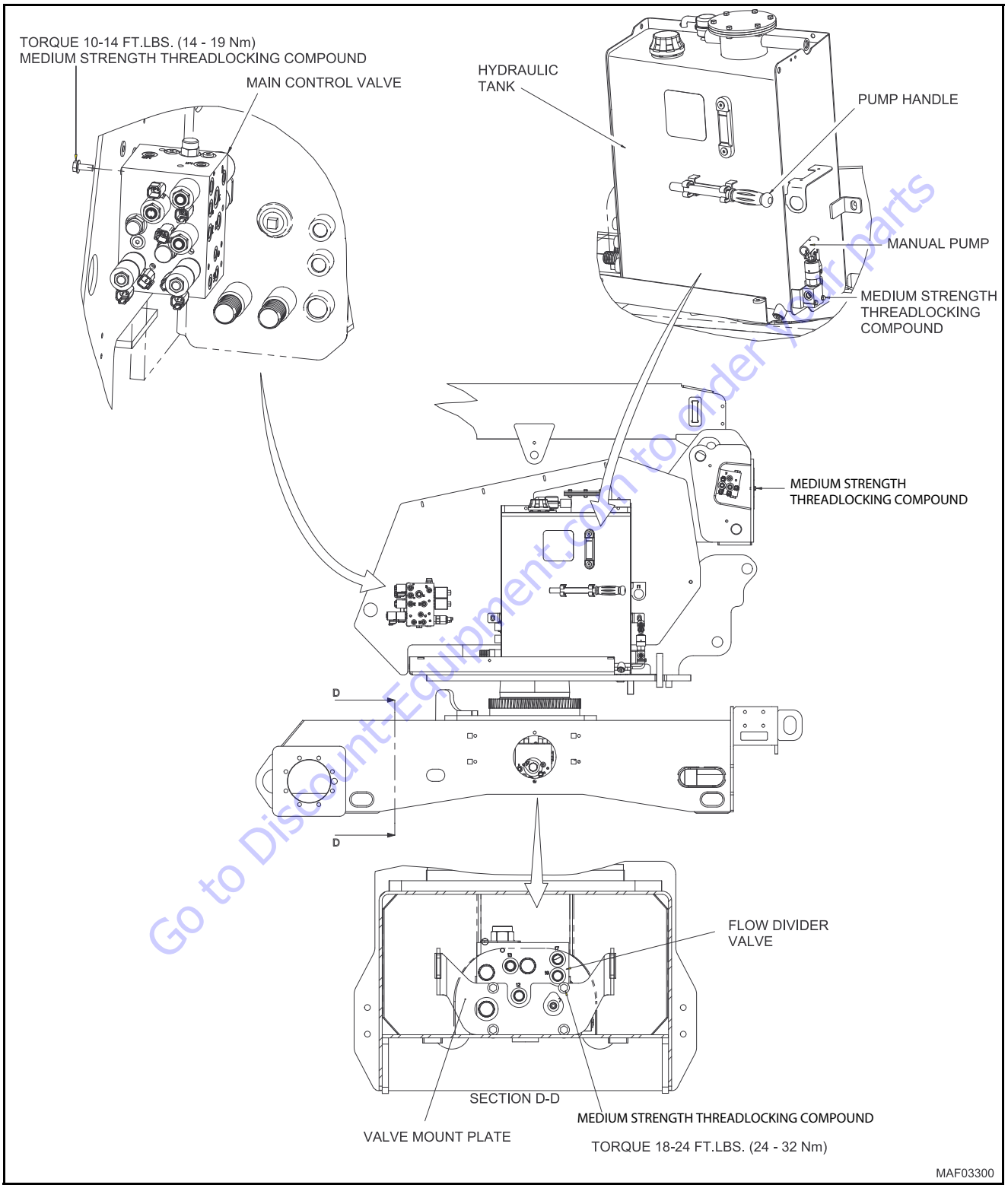

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Figure 5-12. Valve Installation - Sheet 2 of 2

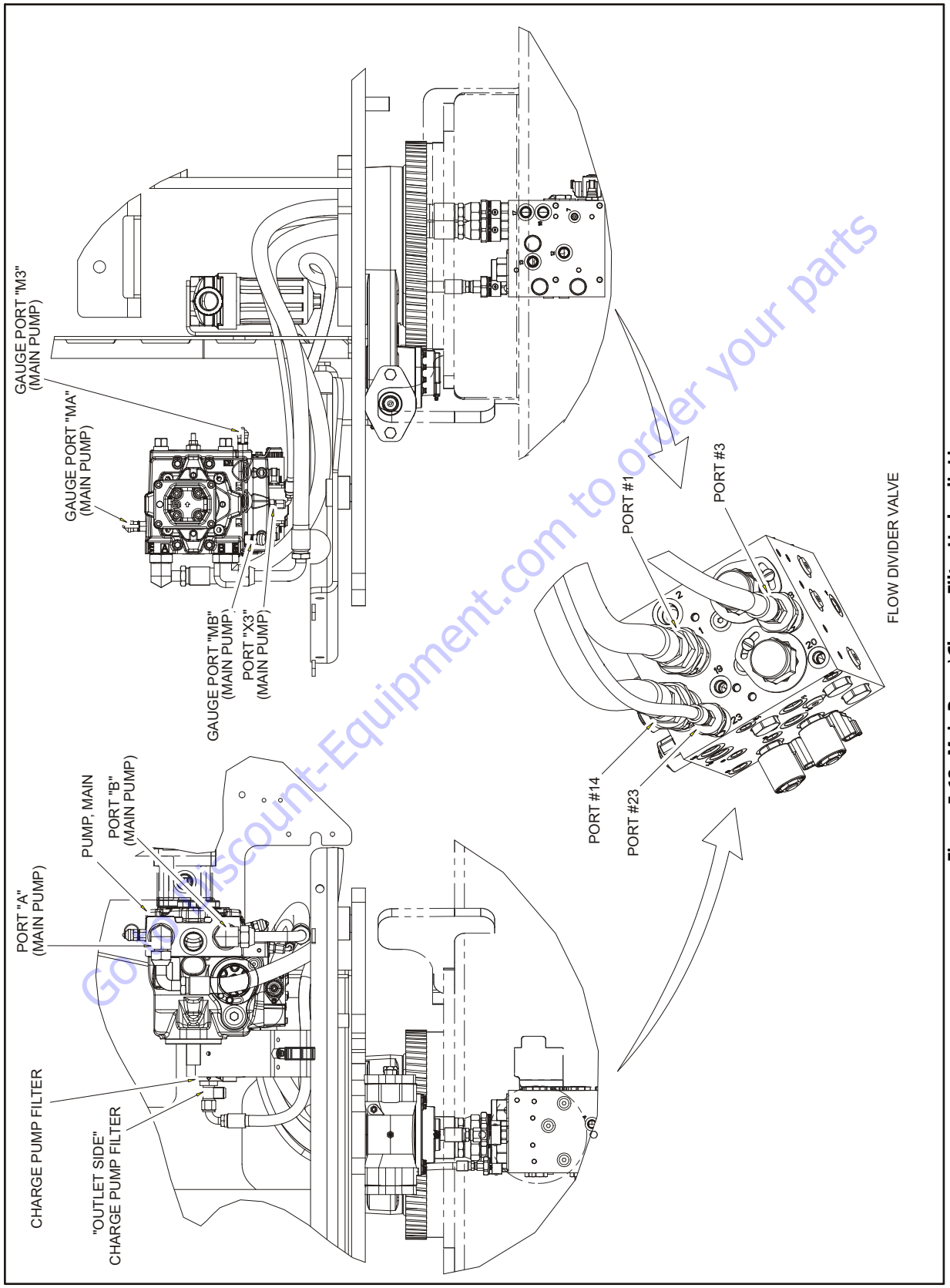

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Figure 5-13. Main Pump\Charge Filter Hydraulic Lines

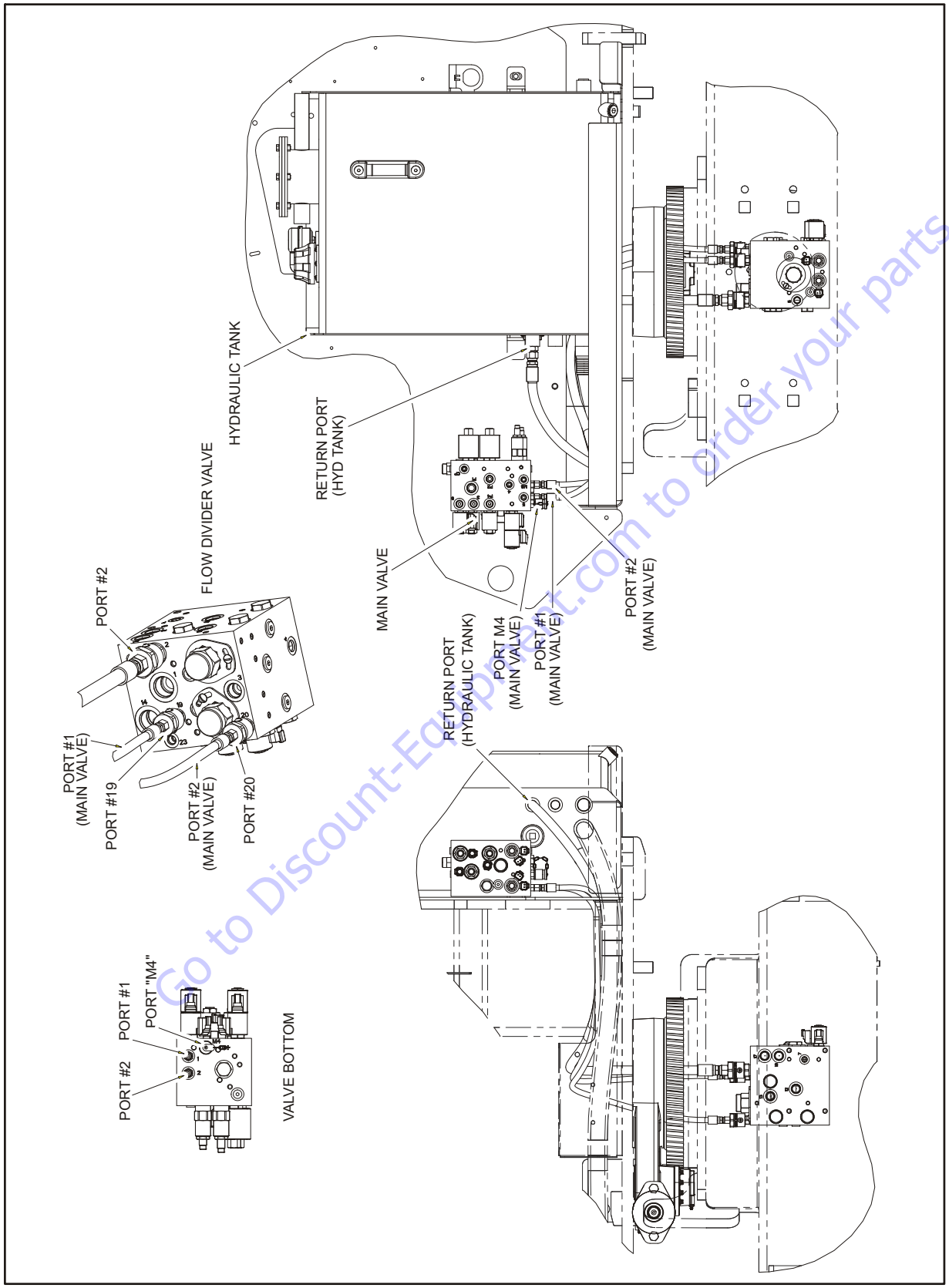

Figure 5-14. Main Pump\Main Valve Hydraulic Lines

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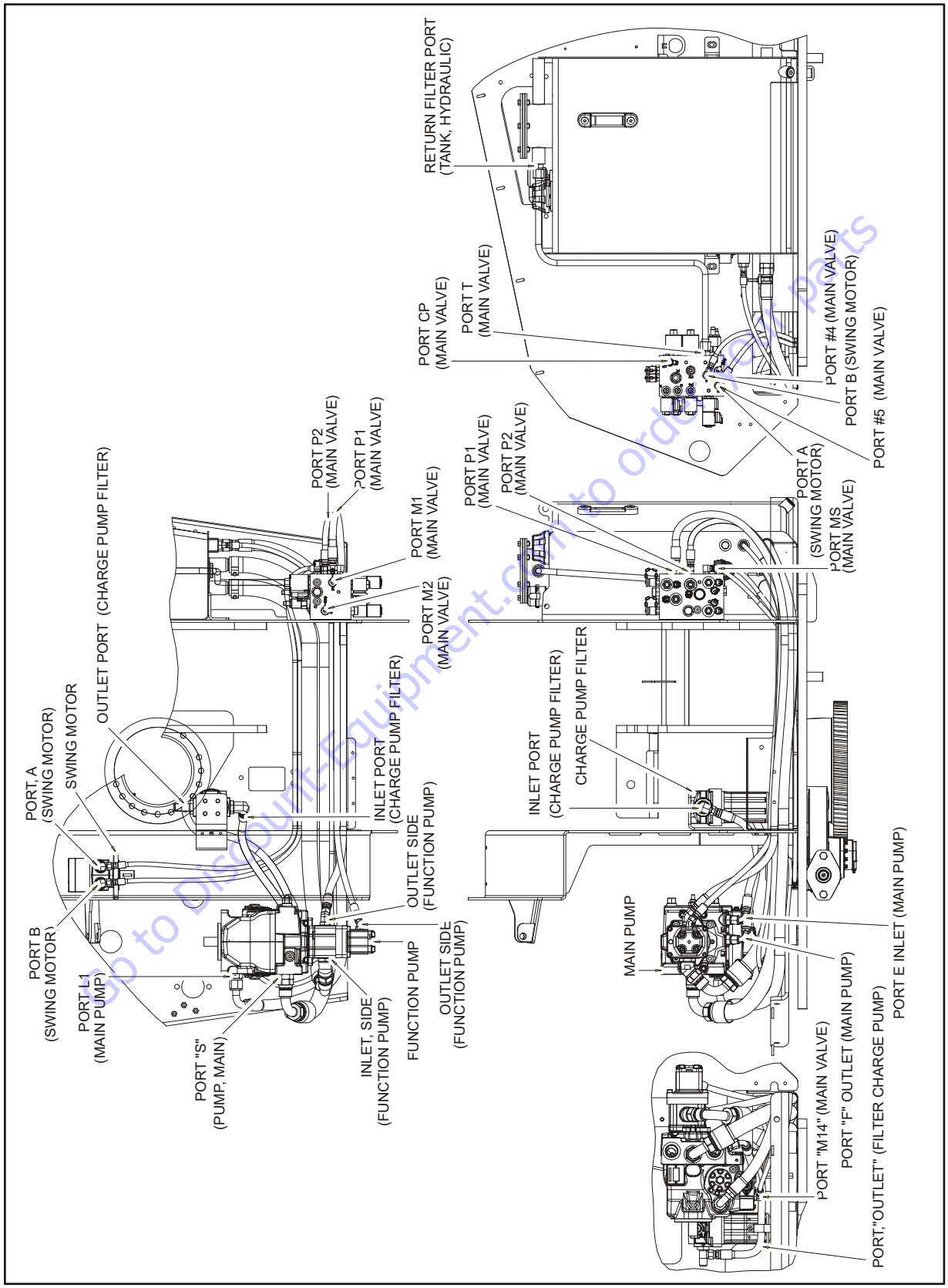

Figure 5-15. Drive Pump to Main Valve/Tank Hydraulic Lines

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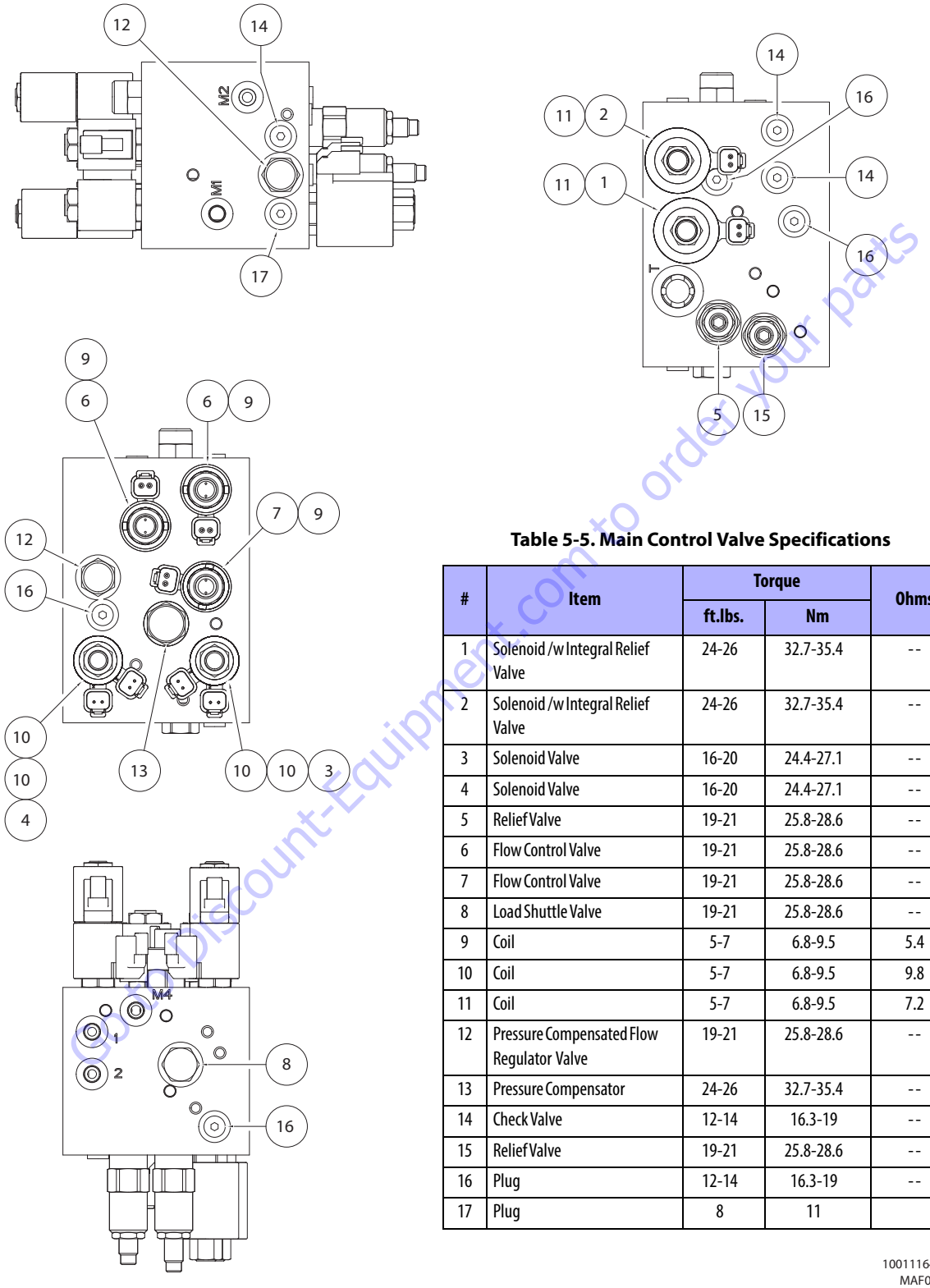

Table 5-5. Main Control Valve Specifications

#	Item	Torque		Ohms
		ft.lbs.	Nm	
1	Solenoid /w Integral Relief Valve	24-26	32.7-35.4	--
2	Solenoid /w Integral Relief Valve	24-26	32.7-35.4	--
3	Solenoid Valve	16-20	24.4-27.1	--
4	Solenoid Valve	16-20	24.4-27.1	--
5	Relief Valve	19-21	25.8-28.6	--
6	Flow Control Valve	19-21	25.8-28.6	--
7	Flow Control Valve	19-21	25.8-28.6	--
8	Load Shuttle Valve	19-21	25.8-28.6	--
9	Coil	5-7	6.8-9.5	5.4
10	Coil	5-7	6.8-9.5	9.8
11	Coil	5-7	6.8-9.5	7.2
12	Pressure Compensated Flow Regulator Valve	19-21	25.8-28.6	--
13	Pressure Compensator	24-26	32.7-35.4	--
14	Check Valve	12-14	16.3-19	--
15	Relief Valve	19-21	25.8-28.6	--
16	Plug	12-14	16.3-19	--
17	Plug	8	11	

1001116487-J
MAF03330

Figure 5-16. Main Control Valve Torque Specifications

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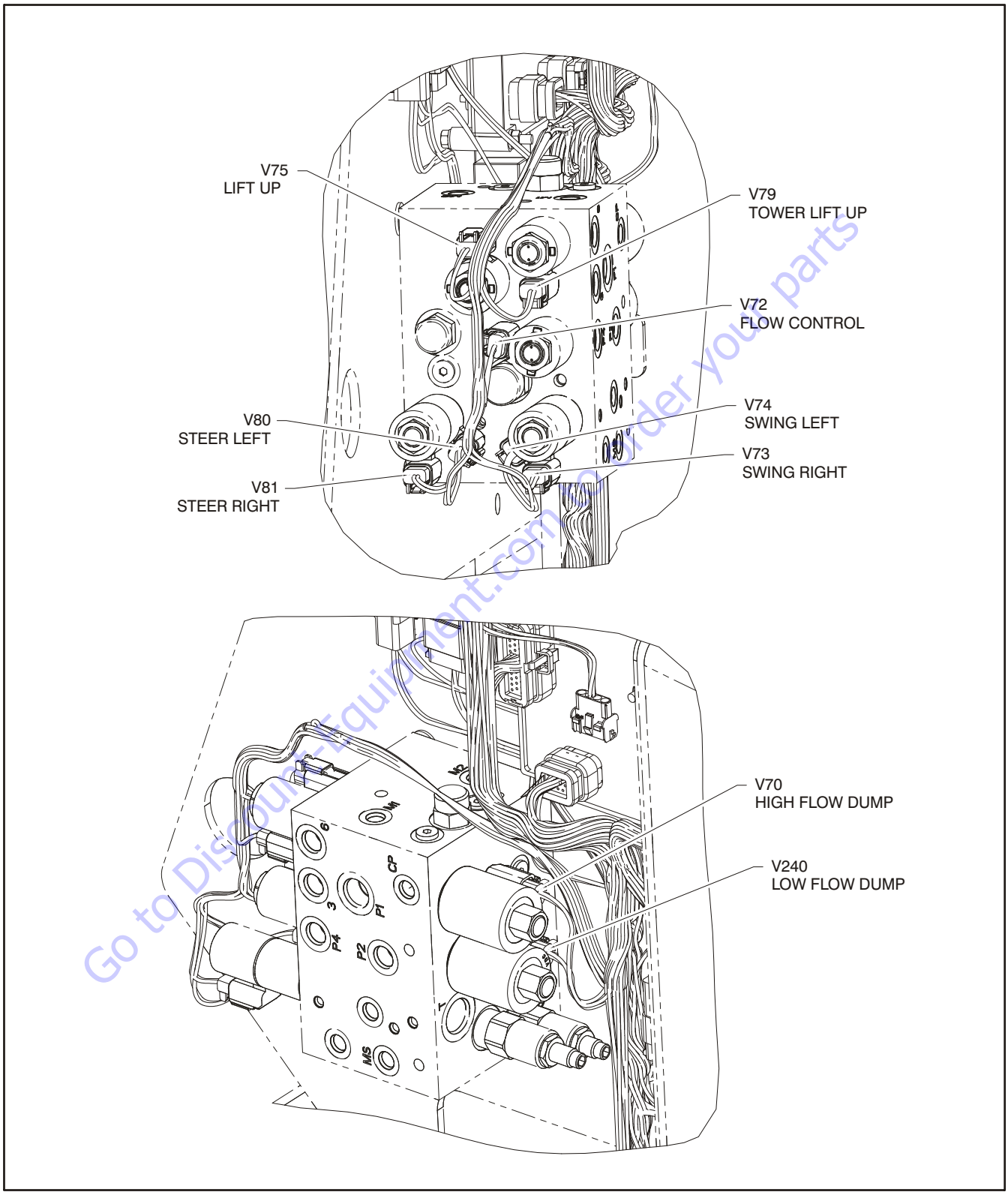

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Figure 5-17. Main Control Valve Identification

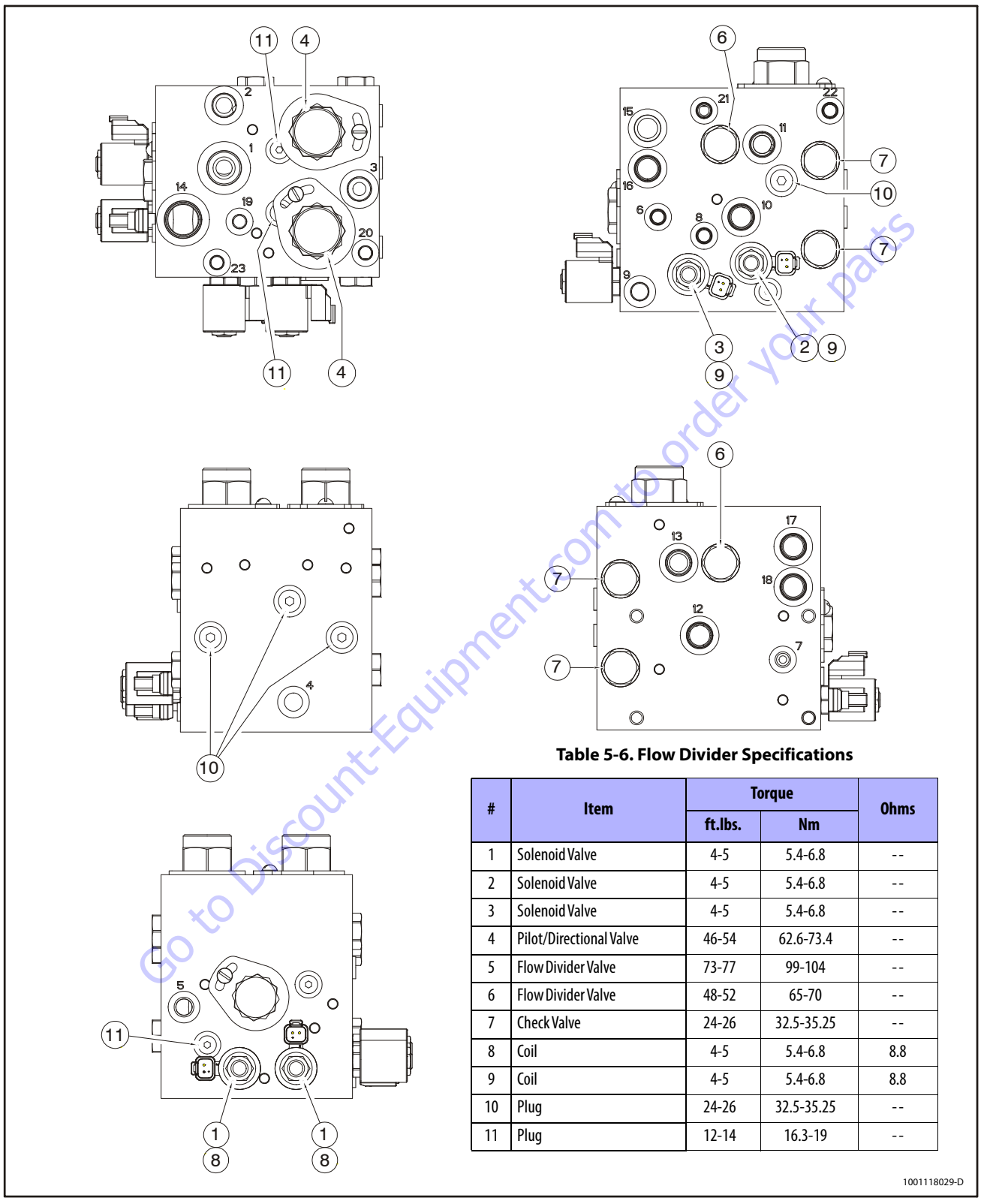

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Table 5-6. Flow Divider Specifications

#	Item	Torque		Ohms
		ft.lbs.	Nm	
1	Solenoid Valve	4-5	5.4-6.8	--
2	Solenoid Valve	4-5	5.4-6.8	--
3	Solenoid Valve	4-5	5.4-6.8	--
4	Pilot/Directional Valve	46-54	62.6-73.4	--
5	Flow Divider Valve	73-77	99-104	--
6	Flow Divider Valve	48-52	65-70	--
7	Check Valve	24-26	32.5-35.25	--
8	Coil	4-5	5.4-6.8	8.8
9	Coil	4-5	5.4-6.8	8.8
10	Plug	24-26	32.5-35.25	--
11	Plug	12-14	16.3-19	--

Figure 5-18. Flow Divider Valve Torque Specifications

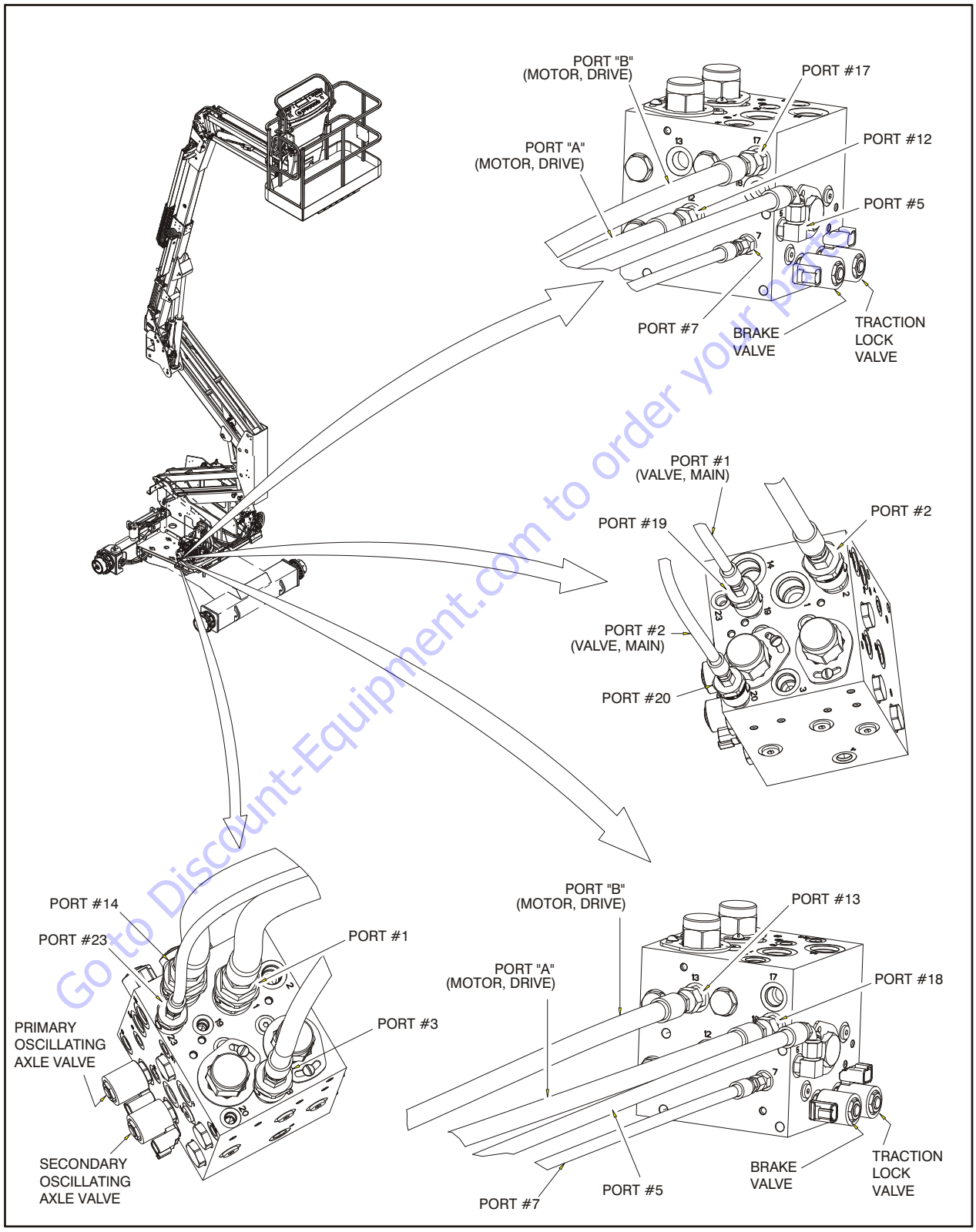

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Figure 5-19. Flow Divider Valve Identification - Sheet 1 of 3

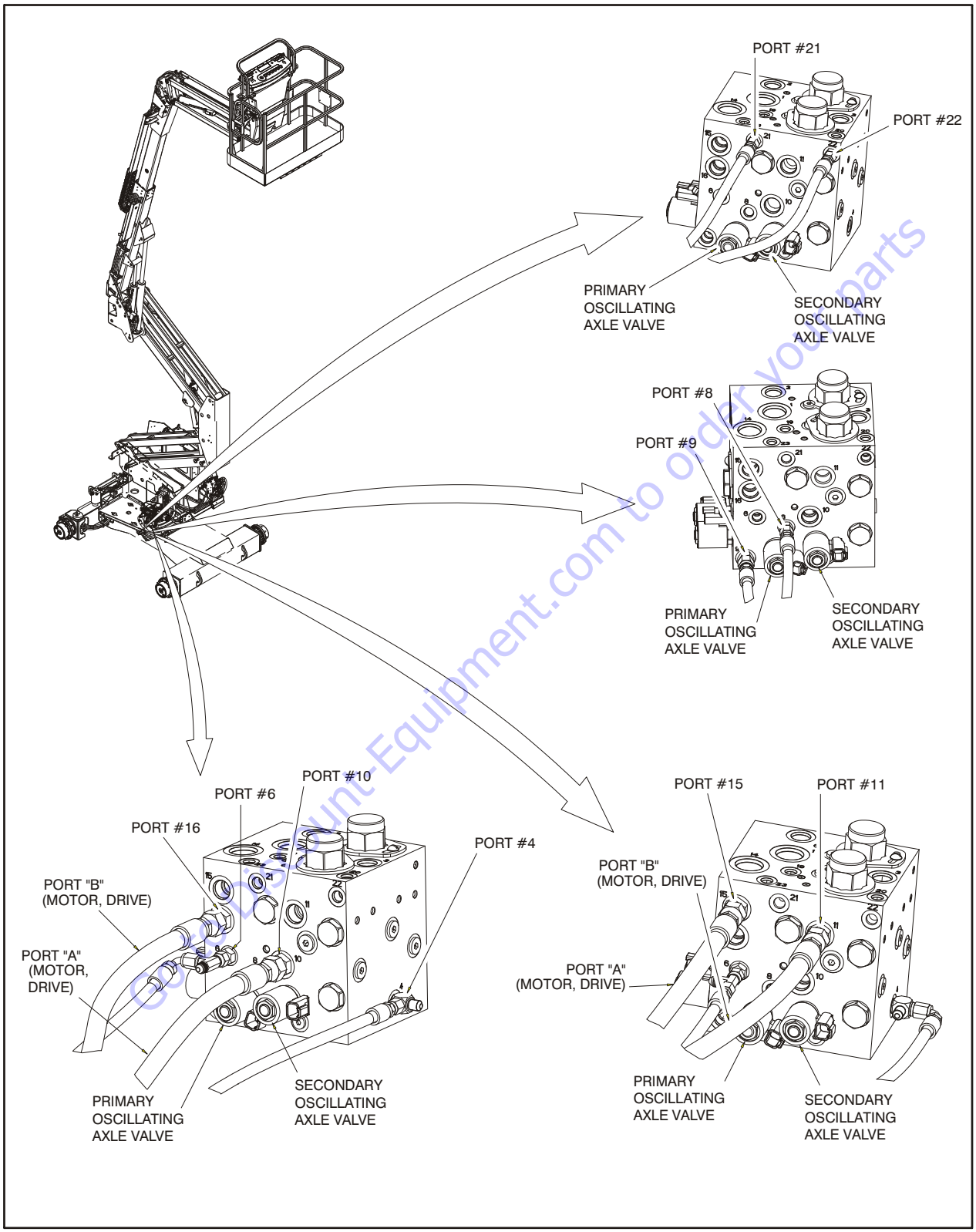

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Figure 5-20. Flow Divider Valve Identification - Sheet 2 of 3

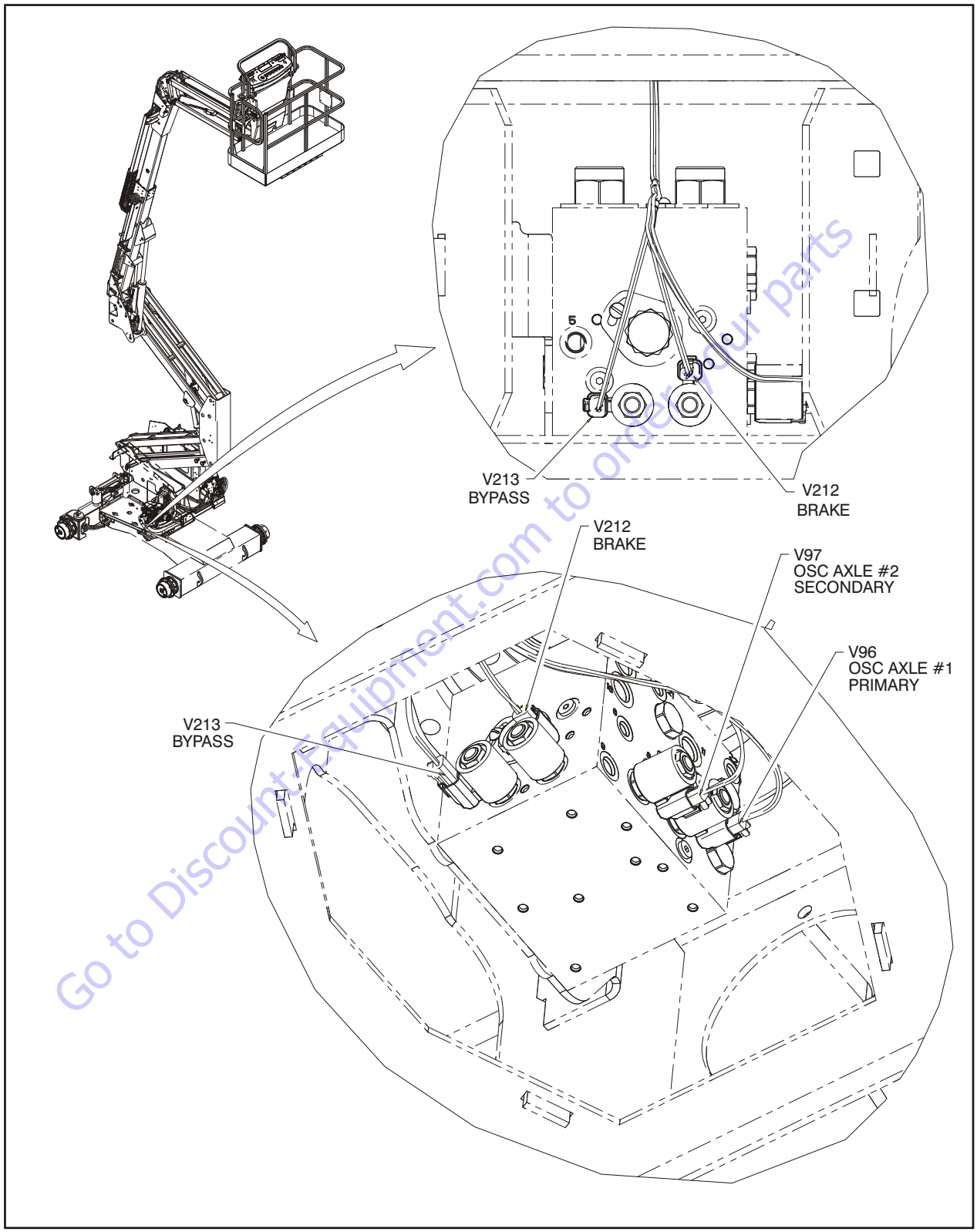

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Figure 5-21. Flow Divider Valve Identification - Sheet 3 of 3

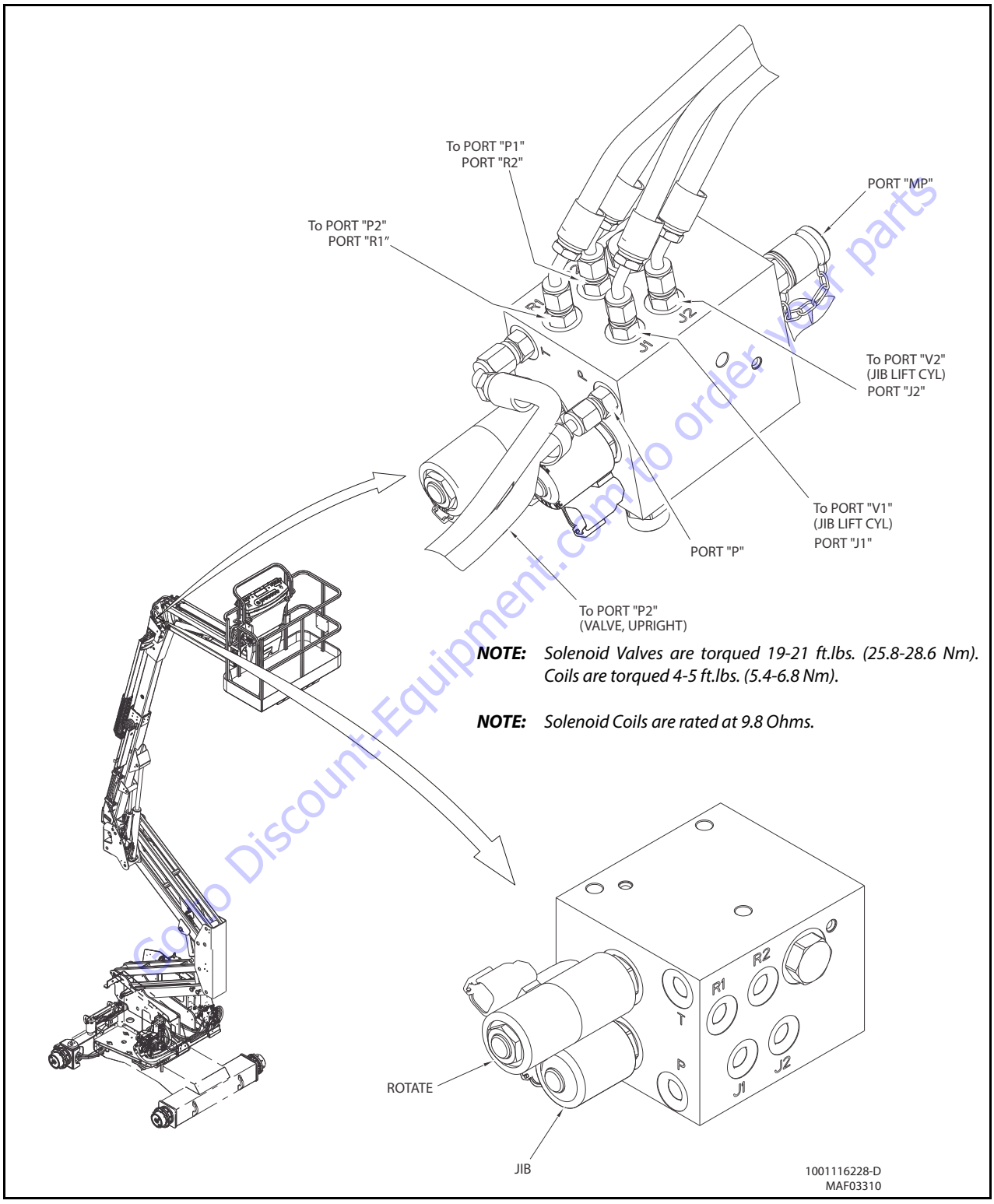

Figure 5-22. Fly Boom Control Valve Identification

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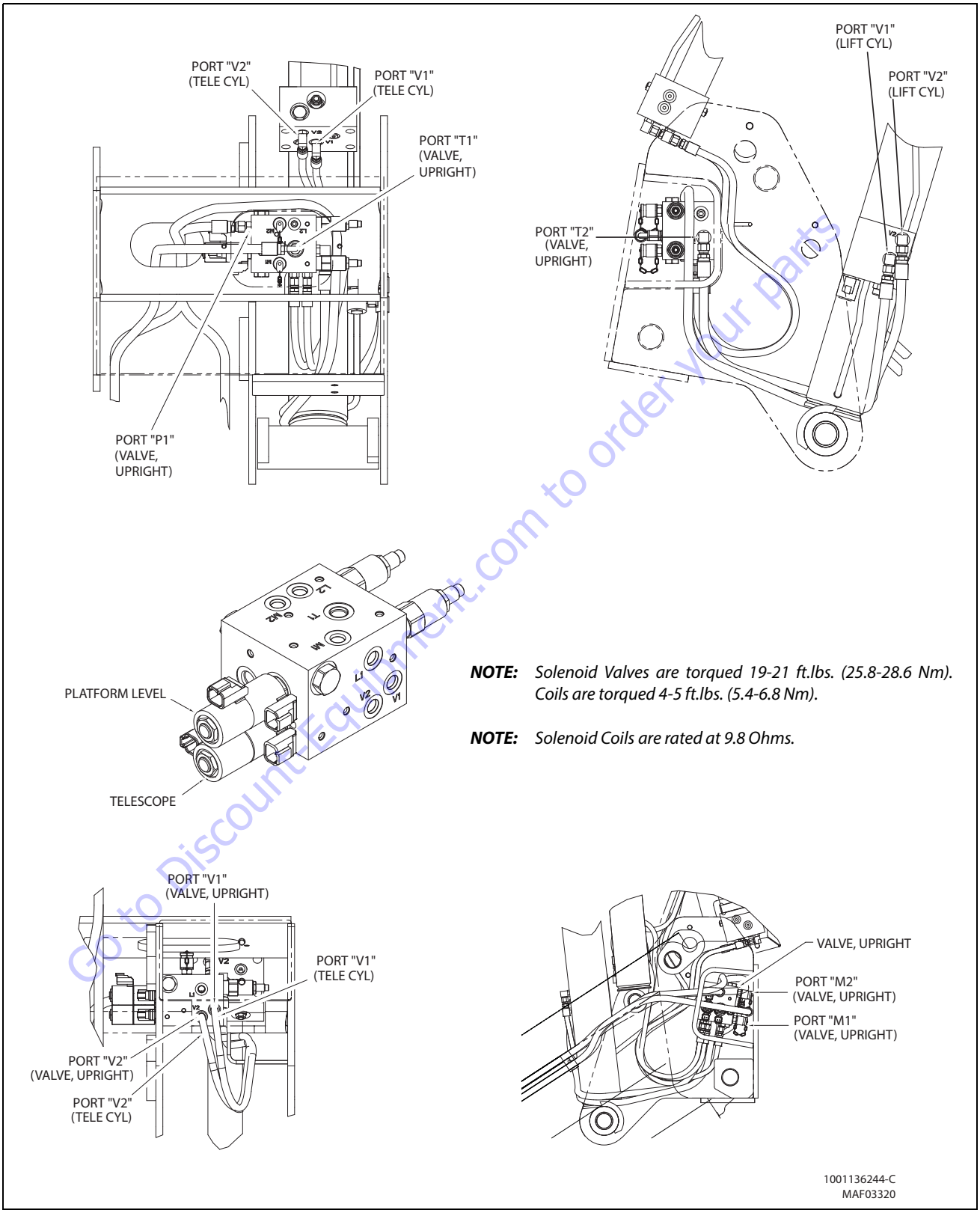

NOTE: *Solenoid Valves are torqued 19-21 ft.lbs. (25.8-28.6 Nm). Coils are torqued 4-5 ft.lbs. (5.4-6.8 Nm).*

NOTE: *Solenoid Coils are rated at 9.8 Ohms.*

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Figure 5-23. Upright Control Valve Identification

5.3 DRIVE PUMP

Description

Sauer-Danfoss H1 tandem closed circuit piston pumps convert input torque to hydraulic power.The tandem design powers two independent drive trains for dual-path propel applications.The two-piece input shaft transmits rotational force to the cylinder block. A splined coupling connects the front and rear shafts. Bearings at the front, rear, and center of the pump support the shaft. Splines connect each shaft to a cylinder block. A lip-seal at the front end of the pump prevents leakage where the shaft exits the pump housing.The spinning cylinder block contains nine reciprocating pistons. Each piston has a brass slipper connected at one end by a ball joint. The block spring, ball guide, and slipper retainer hold the slippers to the swash plate. The reciprocating movement of the pistons occurs as the slippers slide against the inclined swashplates during rotation.Via the valve plates, one half of each cylinder block is connected to port A or C and the other half to port B or D. Front and rear sections have independent porting in the center section. As each piston cycles in and out of its bore, fluid is drawn from one port and displaced to the other thereby imparting hydraulic power into the system. A small amount of fluid is allowed to flow from the cylinder block/valve plate and slipper/swashplate interfaces for lubrication and cooling.Case drain ports return this fluid to the reservoir. An external charge pump (not shown) provides clean, cool fluid to makeup this lubricating flow and to maintain minimum loop pressure.

The angle of each swashplate controls the volume and direction of fluid displaced into the system.The servo pistons control the angle of the swashplates. Each pump control, by varying the pressure at the servo pistons, controls each piston's position. An electric signal to the control coils transmits the command from the operator to the pump. Mechanical feedback of the swashplate position to the control through the feedback pins allows for very precise displacement control and increases overall system stability. Non-feedback control options do not use the mechanical feedback link.

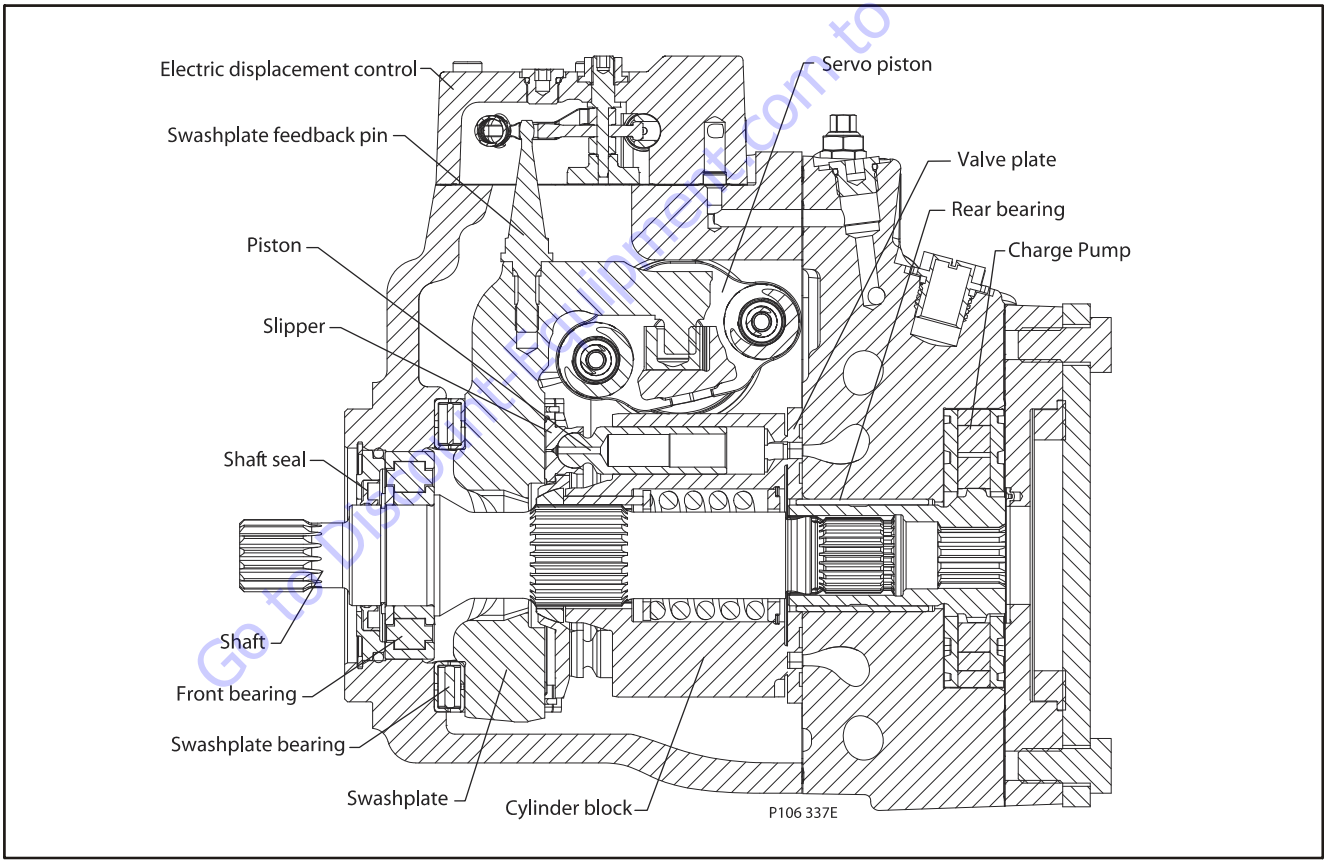

Figure 5-24. Drive Pump - Cross Sectional View

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The System Circuit

THE BASIC CLOSED CIRCUIT

Hydraulic lines connect the main ports of the pump to the main ports of the motor. Fluid flows in either direction from the pump to the motor and back. Either of the hydraulic lines can be under high pressure. In pumping mode the position of the pump swashplate determines which line is high pressure as well as the direction of fluid flow.

CASE DRAIN AND HEAT EXCHANGER

The pump and motor require case drain lines to remove hot fluid from the system.The pump and motor drain from the top-most port to ensure the cases remain full of fluid.The motor case drain can connect to the lower drain port on the pump housing or it can tee into the case drain line upstream of the heat exchanger. A heat exchanger with bypass valve cools the case drain fluid before it returns to the reservoir.

High Pressure Relief Valve (HPRV) and Charge Check

All H1 pumps have a combination high pressure relief and charge check valve. The high-pressure relief function is a dissipative (heat generating) pressure control valve for the purpose of limiting excessive system pressures. The charge check function replenishes the low-pressure side of the working loop with charge oil. Each side of the transmission loop has a dedicated non-adjustable, factory-set HPRV valve. When system pressure exceeds the factory setting, oil is passed from the high pressure system loop into the charge gallery, and into the low pressure system loop via the charge check.

The pump may have different pressure settings at each system port. When an HPRV valve is used in conjunction with a pressure limiter, the HPRV valve is always factory set above the setting of the pressure limiter. The system pressure shown in the order code for pumps with only HPRV is the HPRV setting.The system pressure shown in the order code for pumps with pressure limiter and HPRV, is the pressure limiter setting.

NOTE: *HPRVs are set at low flow condition. Any application or operating condition which leads to elevated HPRV flow will cause a pressure rise with flow above the valve setting.*

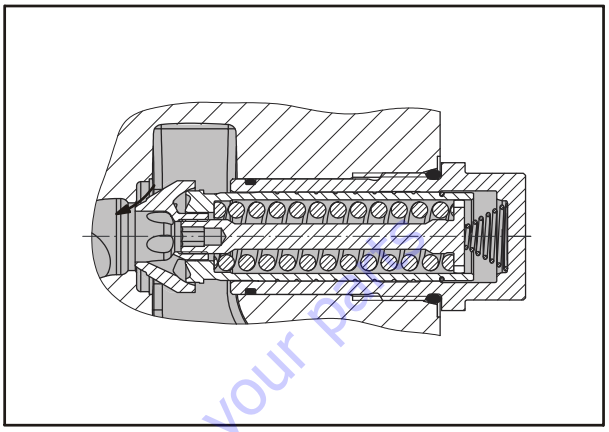

Figure 5-25. High Pressure Relief and Charge Check Valve with Bypass Valve in charging mode

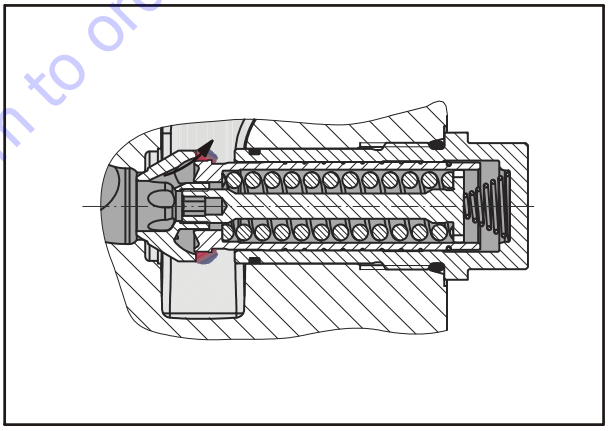

Figure 5-26. High Pressure Relief and Charge Check Valve with Bypass Valve in relief mode

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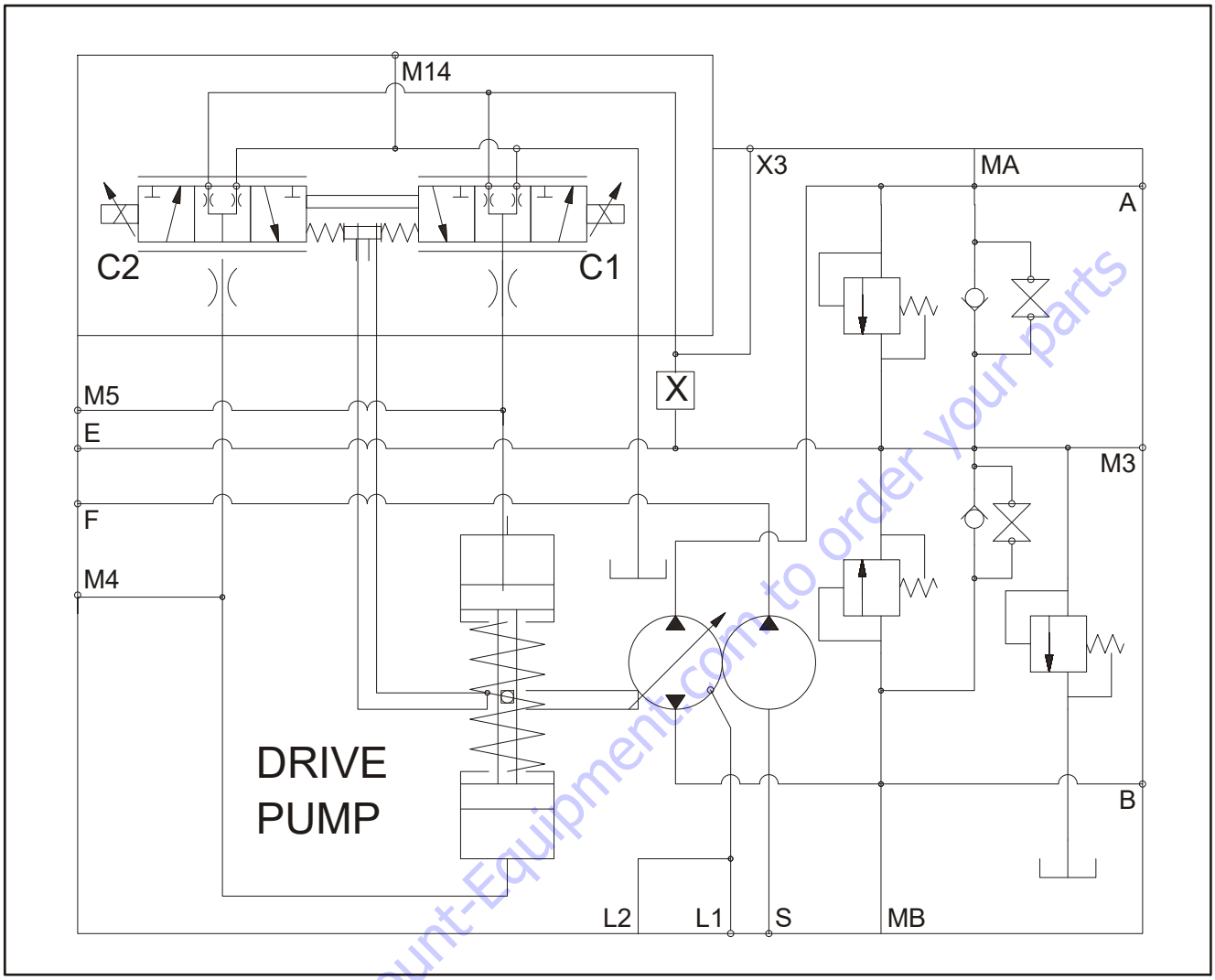

Figure 5-27. Drive Pump Hydraulic Schematic

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Charge Pressure Relief Valve

The charge pressure relief valve maintains charge pressure at a designated level above case pressure.The charge pressure relief valve is a direct acting poppet valve that opens and discharges fluid to the pump case when pressure exceeds a designated level. This level is nominally set with the pump running at 1800 min^{-1} (rpm). For external charge flow, the CPRV is set with a flow of 30 l/min [8 US gal/min]. In forward or reverse, charge pressure will be slightly lower than in neutral position. The model code of the pump specifies the charge relief setting.

Typically charge pressure increases from 1.2-1.5 bar per 10 l/min [17.4-21.8 psi per 2.64 US gal/min].

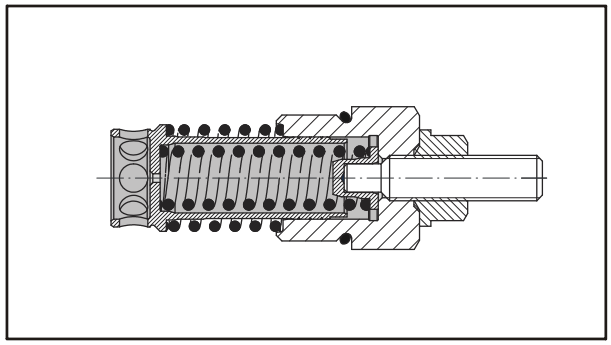

Figure 5-28. Charge pressure relief valve

Electrical Displacement Control (EDC)

EDC PRINCIPLE

The Electrical Displacement Control (EDC) consists of proportional solenoids on each side of a three-position, four-way porting spool. The proportional solenoid applies a force to the spool, which ports hydraulic fluid to either side of the servo piston. Differential pressure across the servo piston rotates the swashplate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

EDC OPERATION

H1 EDC's are current driven controls requiring a Pulse Width Modulated (PWM) signal. Pulse width modulation allows more precise control of current to the solenoids. The PWM signal causes the solenoid pin to push against the porting spool, which pressurizes one end of the servo piston, while draining the other. Pressure differential across the servo piston moves the swashplate. A swashplate feedback link, opposing control links, and a linear spring provide swashplate position force feedback to the solenoid. The control system reaches equilibrium when the position of the swashplate spring feedback force exactly balances the input command solenoid force from the operator. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position of the swashplate.

The EDC incorporates a positive neutral dead-band as a result of the control spool porting, spring preload from the servo piston assembly, and the linear control spring. Once the neutral threshold current is reached, the swashplate position becomes directly proportional to the control current.To minimize the effect of the control neutral deadband, we recommended the transmission controller or operator input device incorporate a jump up current.

NOTE: *The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.*

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When the control input signal is either lost or removed, or if there is a loss of charge pressure, the spring-loaded servo piston automatically returns the pump to neutral position.

The EDC is a displacement (flow) control. Pump swashplate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

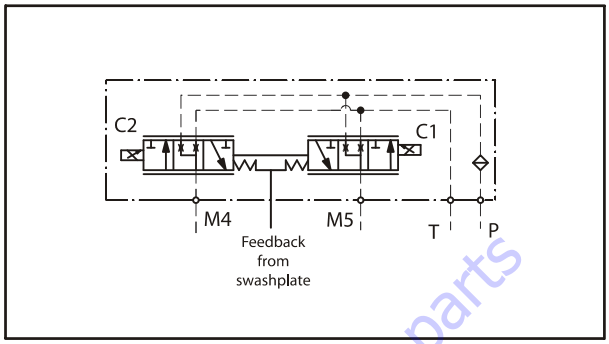

Figure 5-29. EDC-Schematic Diagram

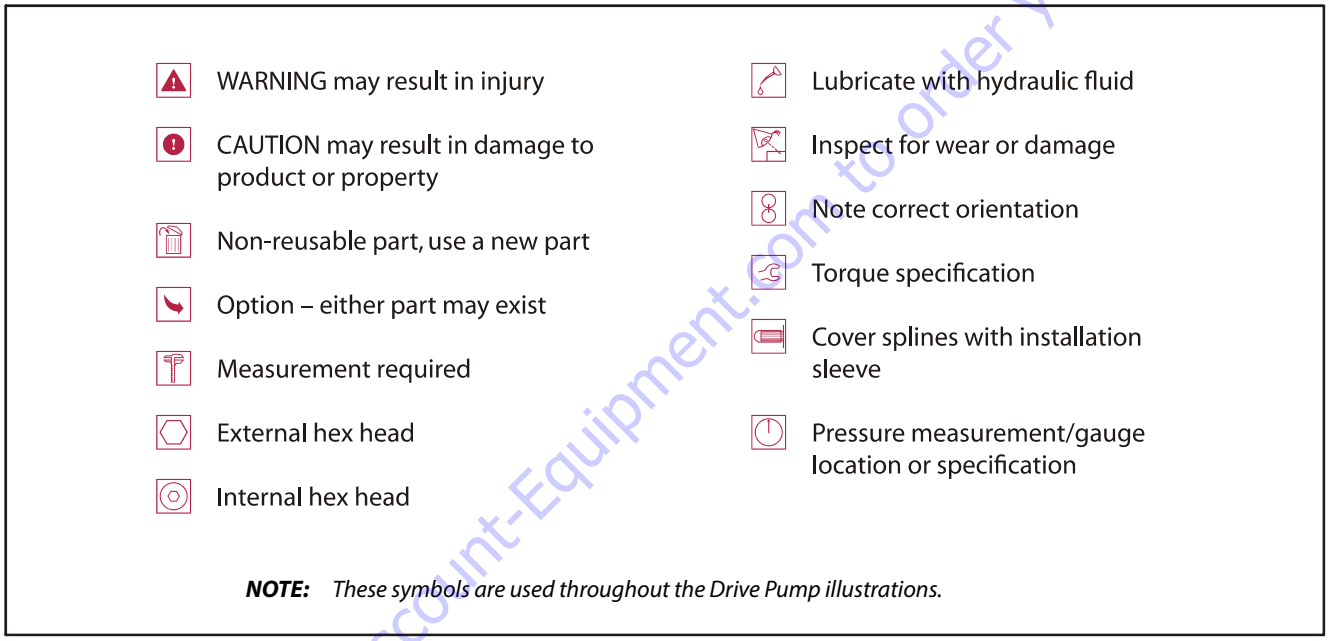

Figure 5-30. Symbol Chart

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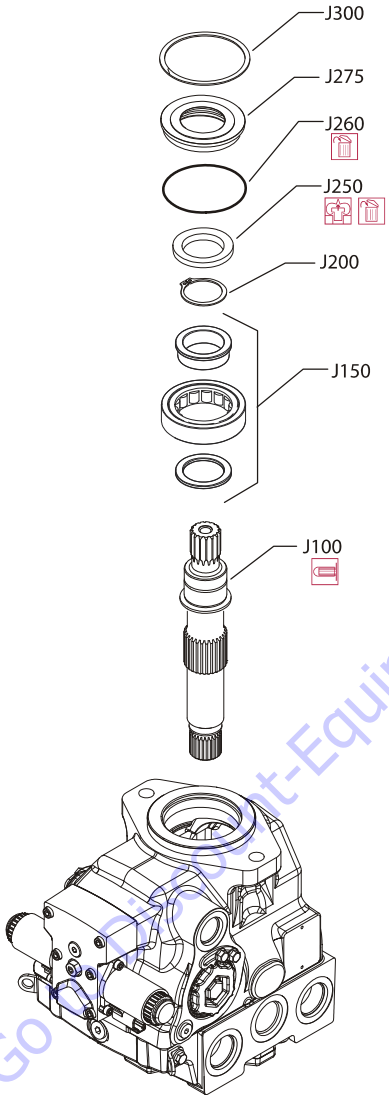
Disassembly

SHAFT SEAL REMOVAL

1. Orient pump with the shaft pointing up.
2. Remove the spiral ring (J300) from the front housing to release the shaft seal carrier (J275).



3. Pry on the lip of the seal carrier to remove it from the pump.
4. Remove and discard the O-ring (J260) and seal (J250) from the seal carrier.

INPUT SHAFT

1. Pull the shaft with bearing out of the pump. If necessary, tap lightly on the shaft to dislodge it from the internal pump components.

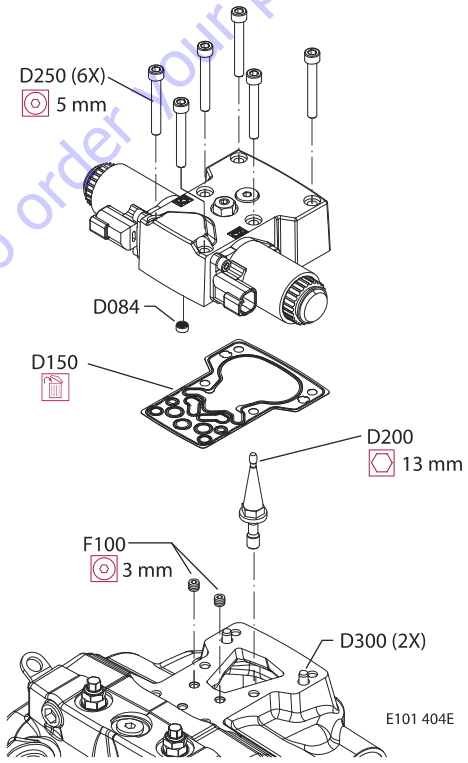
⚠ CAUTION

DO NOT DAMAGE THE HOUSING BORE, SHAFT OR BEARING WHEN REMOVING THE SHAFT AND SHAFT SEAL.

2. Remove the snap ring (J200) using snap ring pliers.
3. Use an adequate press to remove the bearing from the shaft.

EDC CONTROL REMOVAL

1. Remove control screws (D250) using a 5 mm internal hex wrench. Remove the control from the pump.



2. Remove and discard the gasket (D150).
3. Using a 13 mm deep well socket wrench, remove feedback pin (D200) from top of swash plate.
4. If necessary, remove the screen (D084).

⚠ CAUTION

SCREEN (D084) MAY BE LOOSE AND FALL OUT OF CONTROL. TAKE CAUTION NOT TO LOSE IT.

5. If necessary, remove orifices (F100) using a 3 mm internal hex wrench.

NOTICE

DOWEL PINS (D300) ARE A PRESS FIT AND WILL REMAIN IN HOUSING.

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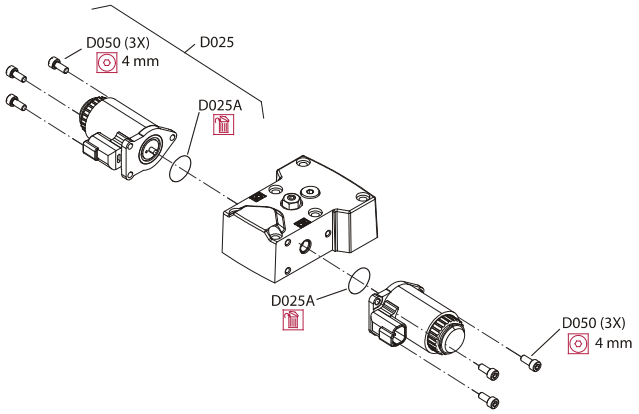
EDC CONTROL DISASSEMBLY

NOTICE

IT IS NOT NECESSARY TO REMOVE SOLENOIDS (D025) UNLESS YOU ARE REPLACING THEM.

1. Use a 4 mm internal hex wrench to remove capscrews (D050).



NOTICE

IF YOU SUSPECT A COIL MALFUNCTION, REMOVE THE COIL. REMOVE THE PLASTIC NUT WITH A 26 MM 12 POINT SOCKET. INSTALL A NEW COIL. TORQUE NUT TO 5 NM [3.7 FT.LBS.].

2. Remove solenoids (D025). Remove and discard O-rings (D025A).

NOTICE

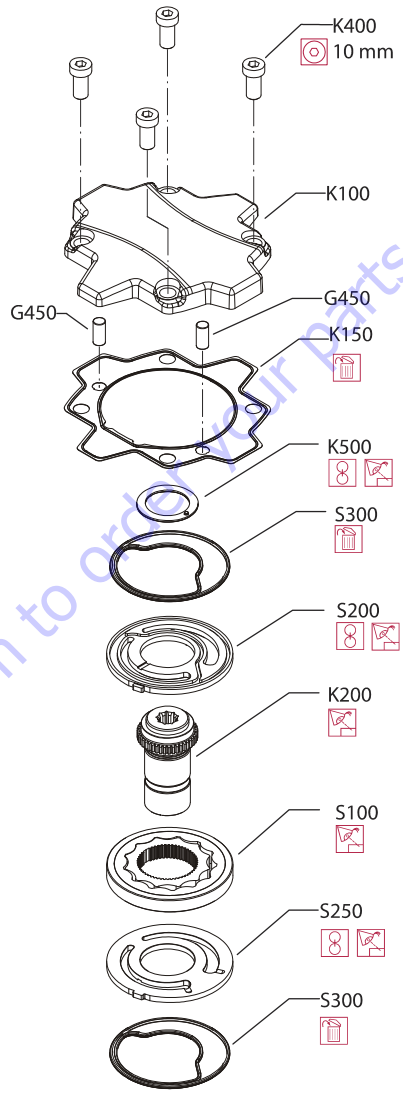
DO NOT DISASSEMBLE INTERNAL PARTS OF CONTROL. INTERNAL PARTS ARE NOT AVAILABLE SEPARATELY. CONTROL IS SOLD AS A COMPLETE UNIT ONLY.

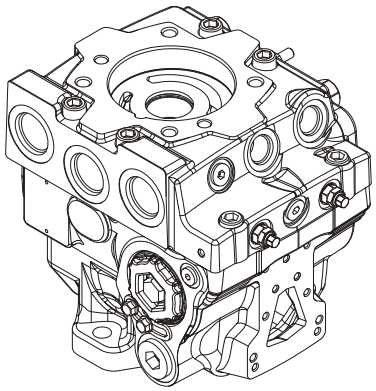
AUXILIARY PAD OR END COVER REMOVAL

NOTICE

REMOVE AUXILIARY PUMP, IF PRESENT.

1. Position pump so end cover (K100) or auxiliary pad is on top.





2. Remove end cover/auxiliary pad screws (K400) using an 8 mm internal hex wrench.

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NOTICE

ALIGNMENT PINS (G450) ARE IN END COVER. THEY MAY DISLODGE DURING DISASSEMBLY.

3. Remove and discard gasket (K150).
4. Remove thrust washer (K500). Note thrust washer orientation.
5. Remove pressure balance plate (S200) and seal (S300). Note plate orientation. Discard seal (S300).
6. Remove coupling (K200).

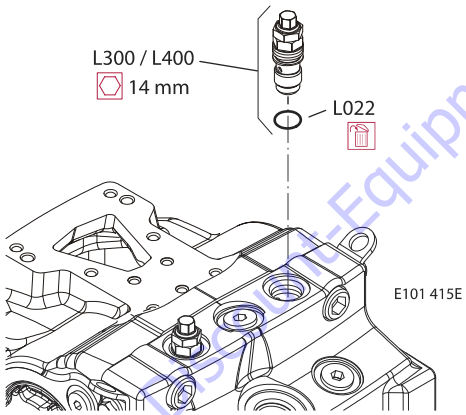
CHARGE PUMP REMOVAL

1. Remove charge pump outer ring (S150),and gearset(S100).
2. Remove valve plate (S250) with seal (S300). Discard seal (S300).

NOTE: *If charge pump requires replacement, replace as a kit. Kit includes (S300), (S250), (S100), and(S200).*

PRESSURE LIMITER REMOVAL

1. Using a 14 mm wrench, remove pressure limiter cartridges (L300) and (L400).



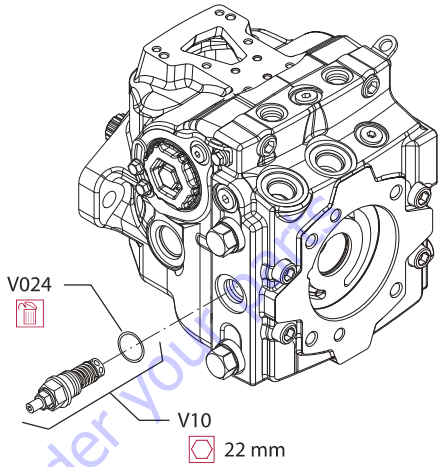
NOTE: *Pressure limiter (L300 / L400) is available as complete unit only. Seal (L022) is available separately.*

2. Remove and discard O-ring (L022).

NOTE: *Right and left pressure settings are different. Tag each valve for later re-assembly*

CHARGE PRESSURE RELIEF VALVE REMOVAL

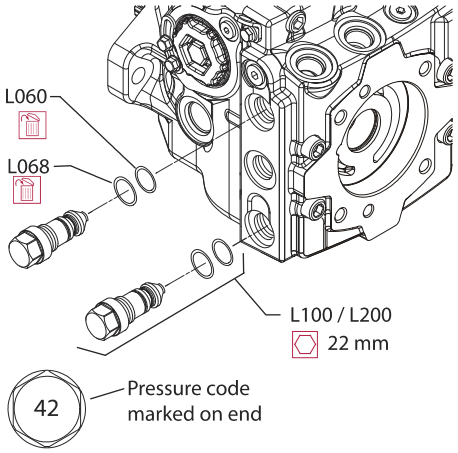
Using a 22 mm wrench, remove the charge pressure relief valve (VI0). Discard O-ring (V024).



NOTE: *Charge pressure relief valve (VI0) is available as complete unit only. Seal (V024) is available separately.*

HIGH PRESSURE RELIEF VALVE REMOVAL

Using a 22 mm wrench, remove the HPRV valves (LI00 / L200). Discard O-rings (L060) and seals (L068).



NOTE: *HPRV valves may not have the same pressure setting. Tag each valve for reassembly.*

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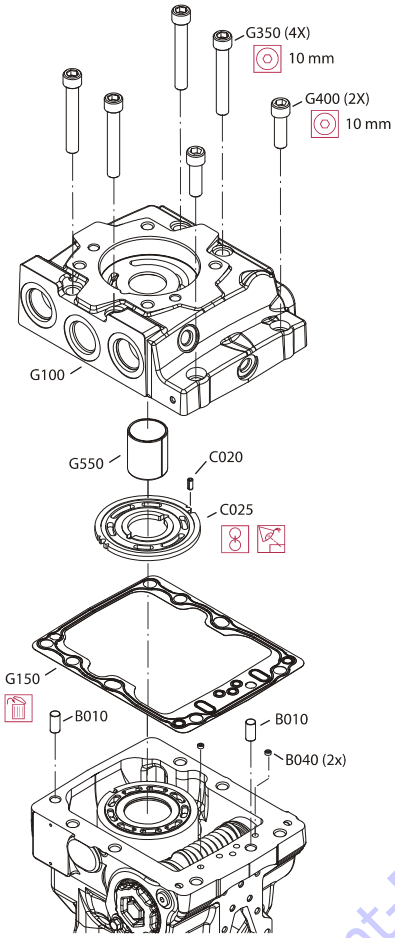
ENDCAP REMOVAL

1. Remove two endcap screws (G400) using a 10 mm internal hex wrench.



2. Remove four endcap screws (G350) using a 10 mm internal hex wrench.
3. Carefully remove the endcap (G100) and valveplate (C025). Valveplate may be stuck to endcap. Alignment pin (C020) may remain in endcap.

NOTICE

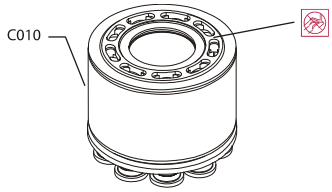
NOTE VALVE PLATE ORIENTATION FOR PROPER REASSEMBLY.

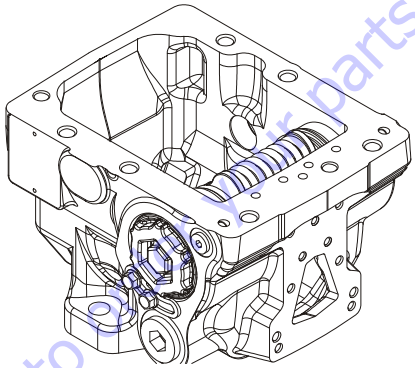
4. Place the endcap and valve plate in a clean area, protecting them from contamination.
5. Remove and discard gasket (G150).
6. If necessary, remove bushing (G550) using a suitable puller.
7. Remove locating pins (B010).

NOTE: *If necessary, use a hook to remove screens (B040) and discard.*

CYLINDER BLOCK KIT REMOVAL

1. Remove cylinder block assembly (C010).





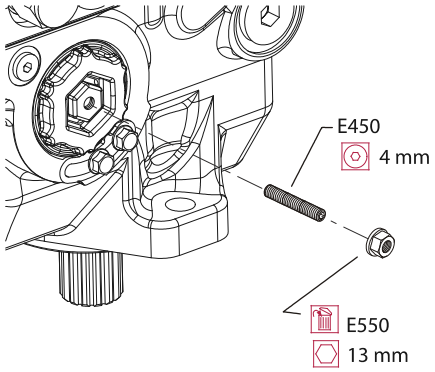
2. Set cylinder block and components on a clean dry surface.

CAUTION

DO NOT SCRATCH THE RUNNING SURFACES OF THE CYLINDER BLOCK OR SLIPPERS. SCRATCHES IN THESE SURFACES CAN LEAD TO POOR PERFORMANCE OR PUMP FAILURE.

SERVO SLEEVE REMOVAL

1. If equipped, remove and discard locking nut (E550) and remove displacement limiter screw (E450).



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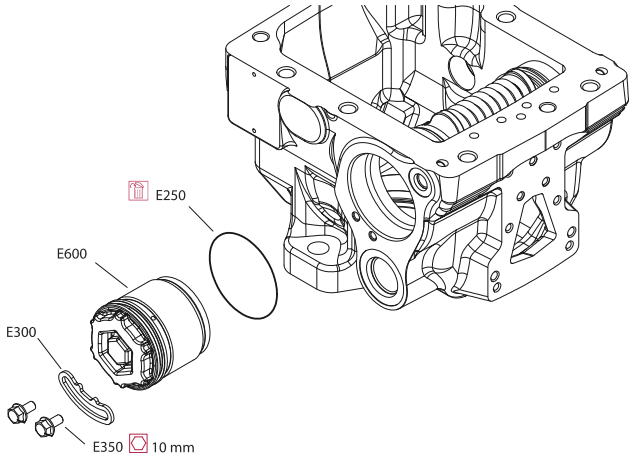
2. Remove the locking screws (E350) with a 10 mm hex wrench. Remove the locking plates (E300).



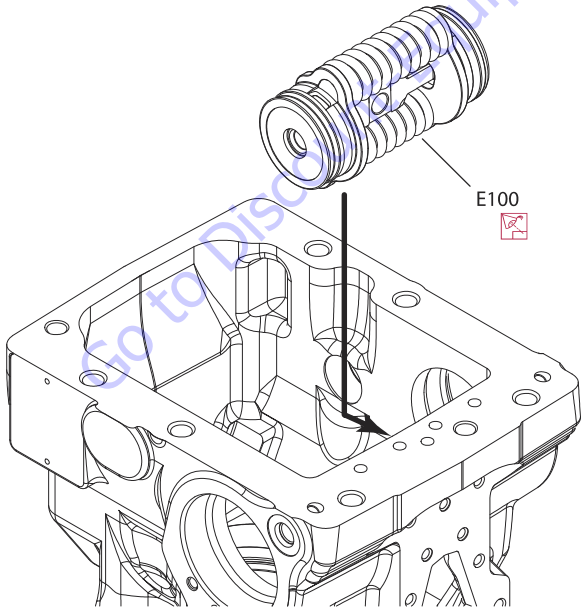
3. Using a 3/4 in.deep socket, unthread the servo sleeves (E600) from each side of the pump. Servo piston will be loose after servo cylinders are removed. Discard O-rings (E250).

⚠ CAUTION

DO NOT ALLOW LOOSE SERVO PISTON TO DAMAGE INTERNAL MACHINED SURFACES OF PUMP.

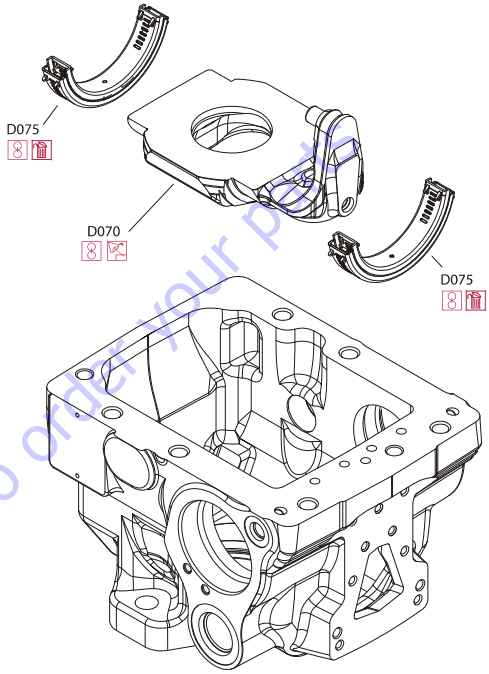
SERVO PISTON REMOVAL

Tilt swashplate up to disengage servo arm from piston. Remove the servo piston assembly (E100).



SWASHPLATE AND SWASHPLATE BEARING REMOVAL

1. Lift the swashplate (D070) out by grasping the swashplate pin. Swashplate bearings (D075) will remain on the swash plate.



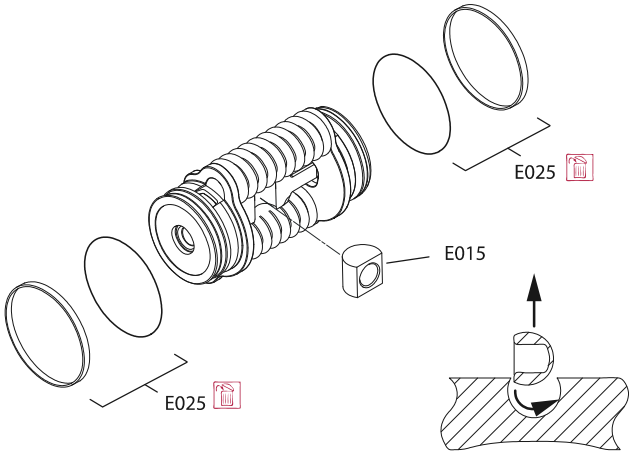
2. Remove bearings (D075) by sliding them from the swashplate and discard them.

NOTICE

DO NOT REUSE SWASHPLATE BEARINGS.

SERVO PISTON DISASSEMBLY

1. Remove and discard seals (E025).



2. Remove slider block (EO 15).

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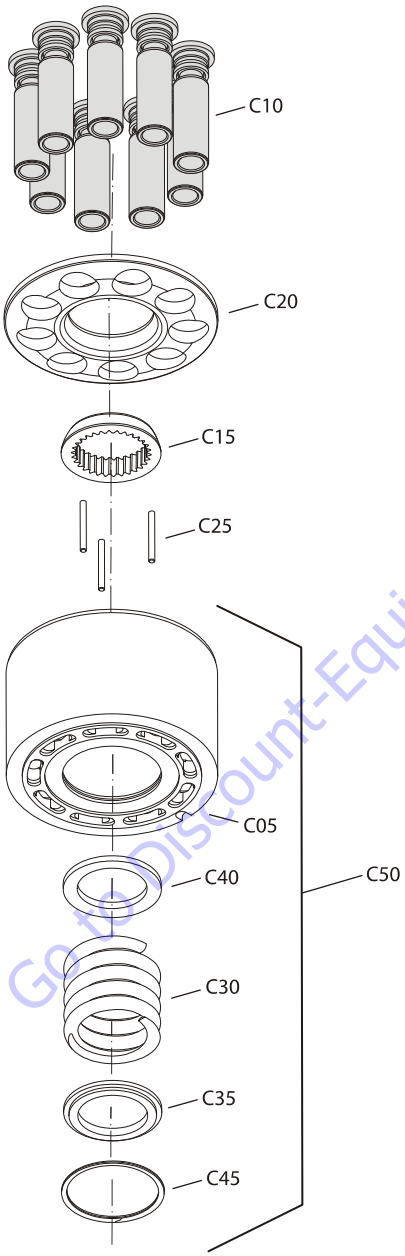
NOTE: *Servo (E100) is available as an assembly only. Seals (E025) and slider block (E015) are available as repair items.*

CYLINDER KIT

1. Pull to remove the slipper retainer (C20) with the pistons (C10) from the cylinder kit.

NOTE: *The pistons are not selectively fitted, however units with high hourly usage may develop wear patterns. Number the pistons and bores for reassembly if they are to be reused.*



2. Remove the ball guide (C15).
3. Remove the three pins (C25).

BLOCK SPRING REMOVAL

NOTE: *Most repairs do not require block spring removal. Perform the following only if you suspect problems with the block spring.*

1. Turn the block over. Using a press, apply pressure on the block spring washer (C35) to compress the block spring (C30). Compress the spring enough to safely remove the spiral retaining ring (C45).While maintaining pressure, unwind the spiral retaining ring. Carefully release the pressure and remove the outer block spring washer, block spring, and inner block spring washer (C40) from the cylinder block.

⚠ WARNING

RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 350 TO 400 N [80 TO 90 LBF]. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT.

ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO REMOVE THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS REMOVED.

Inspection

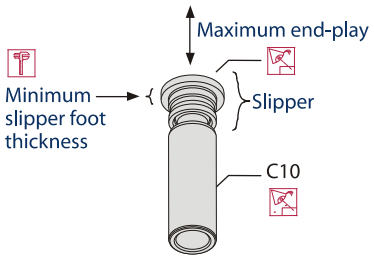
OVERVIEW

After disassembly, wash all parts (including the end-cap and housing) thoroughly with clean solvent and allow to air dry. Blow out oil passages in the housing and endcap with compressed air. Conduct inspection in a clean area and keep all parts free from contamination. Clean and dry parts again after any rework or resurfacing.

PISTONS AND SLIPPERS

Inspect the pistons for damage and discoloration. Discolored pistons may indicate excessive heat; do not reuse.

Inspect the running surface of the slippers. Replace any piston assemblies with scored or excessively rounded slipper edges. Replace any piston assemblies with excessively worn slippers. Check the slipper axial end-play. Replace any piston assemblies with excessive end-play.



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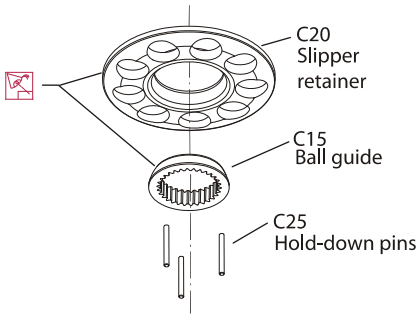
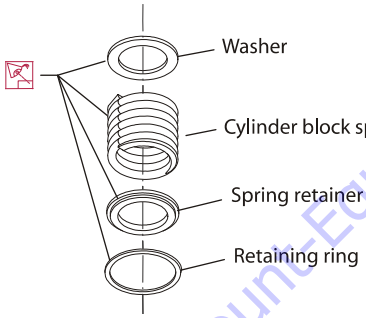
BALL GUIDE, SLIPPER RETAINER, AND HOLD-DOWN PINS

Ensure ball guide is free of nicks and scratches, and not scored. Examine for discoloration that may indicate excessive heat or lack of lubrication.The slipper retainer should be flat, and slippers should fit in the retainer with minimal side play. Place the hold-down pins on a flat surface and roll them to make sure they are straight. Discard and replace any damaged parts.



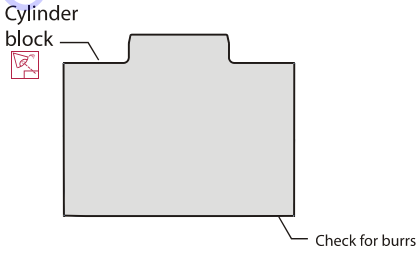
BLOCK SPRING, AND WASHERS

If cylinder kit was fully disassembled, visual inspection of the cylinder block, spring, and washers should indicate minimal wear. Replace if cracks or other damage are present.



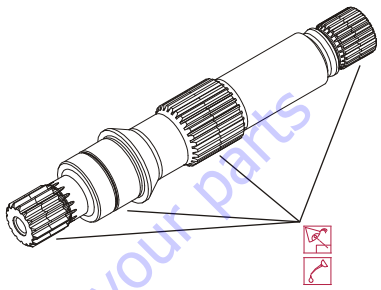
CYLINDER BLOCK

Examine the running face of the cylinder block. The surface should be smooth and free of nicks and burrs. Ensure that no scratches or grooves exist; these may drastically reduce output flow.



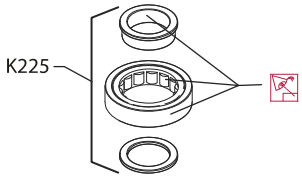
SHAFT

Check to see that the shaft and its splines are straight and free of damage or heavy wear. Inspect the shaft surface where it meets the shaft seal. Replace the shaft if a groove exists at the sealing land surface where it meets the shaft seal. Clean the sealing area with a nonabrasive material if necessary. Lubricate the shaft with a light coat of hydraulic fluid before reassembly.



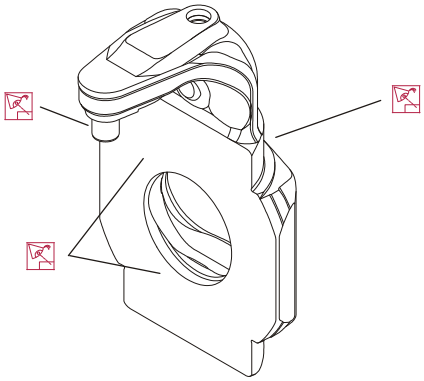
SHAFT BEARING

Clean bearing with a solvent and lubricate with hydraulic fluid. Inspect for wear, or pitting. Rotate the bearing in your hand. Replace if it does not rotate smoothly.



SWASHPLATE

Carefully inspect each machined surface of the swashplate for wear. Ensure all swashplate surfaces are smooth. Inspect the swashplate's slipper running surface for flatness and brass transfer. Excessive brass transfer from slippers may indicate you should replace the slippers. Check the journals for scratches. Replace swashplate if necessary.



VALVE PLATE

Inspect the valve plate for scratches and grooves. Check the plate for pitting along the running face. If pitting from cavitation exists, replace the valve plate. Check for excess wear on the brass running face. If you observe any discoloration or burn marks, replace the valve plate.

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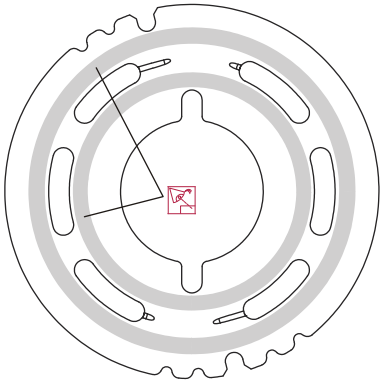
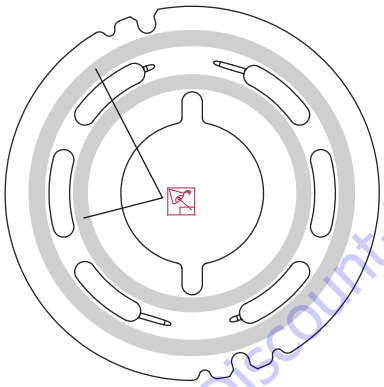
Run a fingernail or pencil tip across the diameter of the sealing land surface (see illustration).You should feel no deep or outstanding grooves.These may decrease pump flow. Lap or replace if grooves or nicks are present. Inspect the mating surfaces of the endcap and valve plate for any possible contamination; even a few thousandths of an inch may affect pump operation.

Ensure plate appears flat and smooth on both the running face and the bottom surface. Perform a magnetic particle inspection to detect cracks. Replace if any cracks exist.

Counterclockwise valveplate

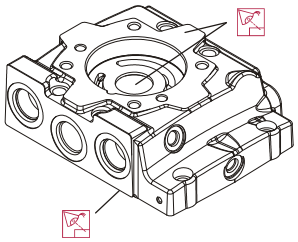


Clockwise valveplate



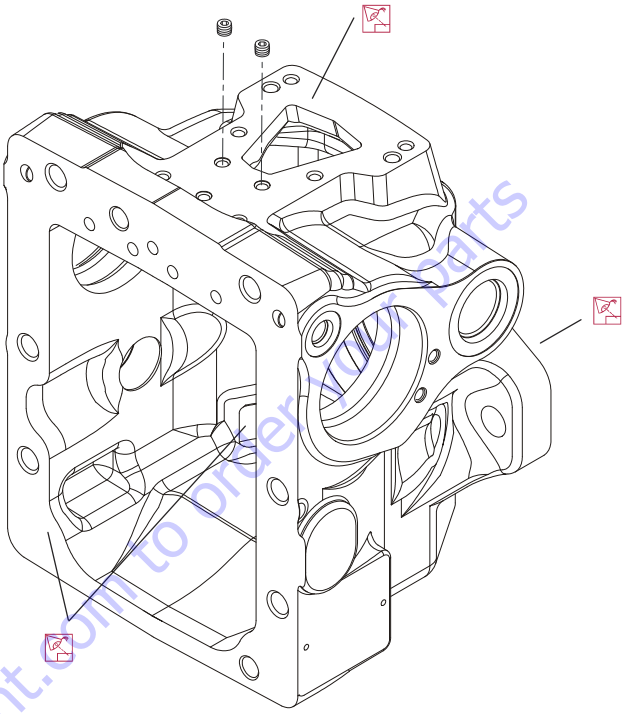
ENDCAP

Inspect the endcap. Inspect all machined surfaces for scratches or pits. Carefully check the bearing surface for wear. Inspect valve seats carefully for wear or cracks. Replace if damaged.



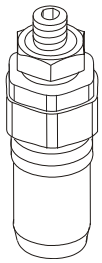
HOUSING

Inspect the housing to ensure that it is clean and free of foreign material. Inspect the swashplate bearing surfaces, and endcap and control mating surfaces.



PRESSURE LIMITER

Pressure limiter valves are available as complete units only. If you suspect valve malfunction, replace the valve(s) and test pump operation. Replace O-rings before reassembly.



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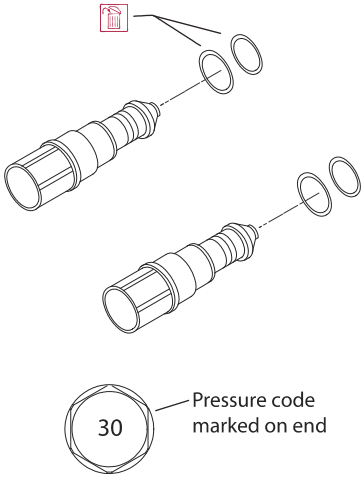
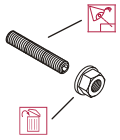
HPRV VALVE

HPRV valves are available as complete units only. If you suspect valve malfunction, replace the valve(s) and test pump operation. Replace O-rings before reassembly.



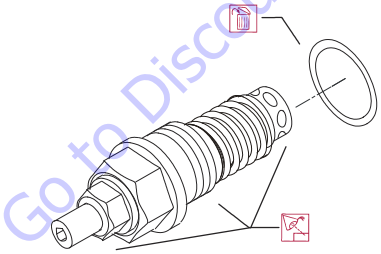
OPTIONAL DISPLACEMENT LIMITER

Inspect the displacement limiter screw threads. Ensure that the screw is not bent. Replace the seal/nut.



CHARGE PRESSURE RELIEF VALVE

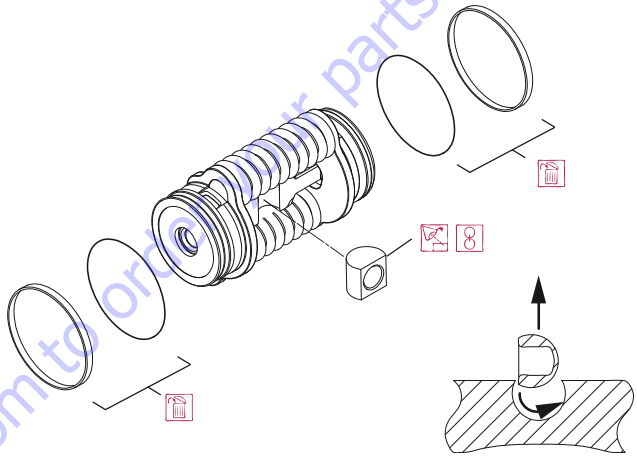
Charge pressure relief valve is available as a complete unit only. If you suspect valve malfunction, replace the valve and test pump operation. Replace O-rings before assembly.



SERVO PISTON ASSEMBLY

NOTE: *Do not disassemble servo piston assembly. Replacement servo piston assembly is available as a complete unit only.*

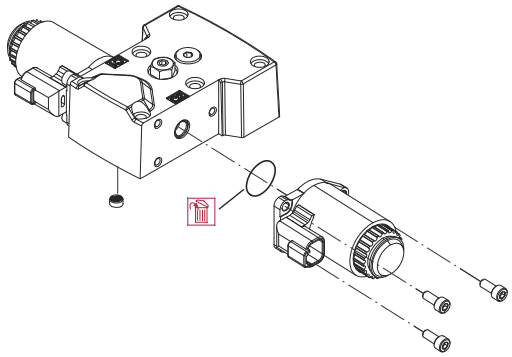
Inspect slider block for wear or damage. Replace if necessary. Inspect springs for warping or cracking. Replace entire assembly if springs are damaged. Inspect servo piston for wear, cracks, or damage. Replace entire assembly if servo piston is damaged.



CONTROL

NOTE: *If you suspect a coil malfunction, remove the coil by removing the plastic nut with a 26 mm 12 point socket. Install a new coil. Torque nut to 5 Nm [3.7 ft.lbs.].*

Inspect sealing surfaces of control. If you find nicks or scratches that may allow fluid leakage, replace control. Inspect feedback spring and linkage. Control is available as a complete unit only. If you suspect control operation problems, replace control with a new unit and test pump. If necessary, you may remove and clean the control orifices. Use a 3 mm internal hex. wrench Torque to 2.5 Nm [1.8 lb.ft.]. Remove and replace the screen if contaminated. Screen is not serviceable.



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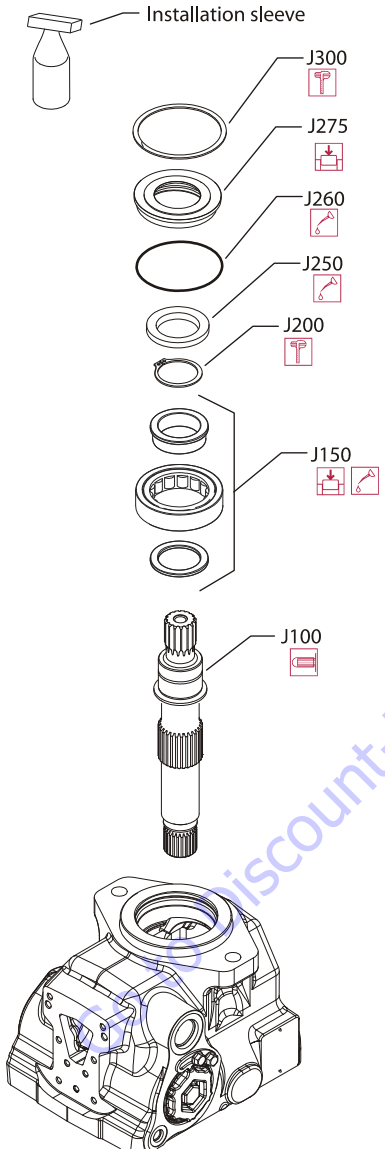
Assembly

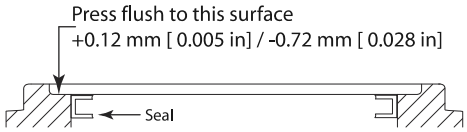
SHAFT AND SEAL INSTALLATION

1. Orient pump with the mounting flange pointing up.
2. Using an adequate press, press the bearing (J150) onto the shaft (J100) and install the retaining ring (J200). Ensure the retaining ring diameter is less than 38.84 mm [1.53 in] once installed on the shaft.



3. Lubricate and install a new O-ring (J260) onto seal carrier (J275). Press a new seal (J250) into the seal carrier so the solid side of the seal is against the shoulder of the seal carrier.

NOTE: *Seal does not need to be flush with surface of seal carrier. Top of seal may be 0.12 mm [0.005 in] above surface or 0.72 mm [0.028 in] below surface of seal carrier.*



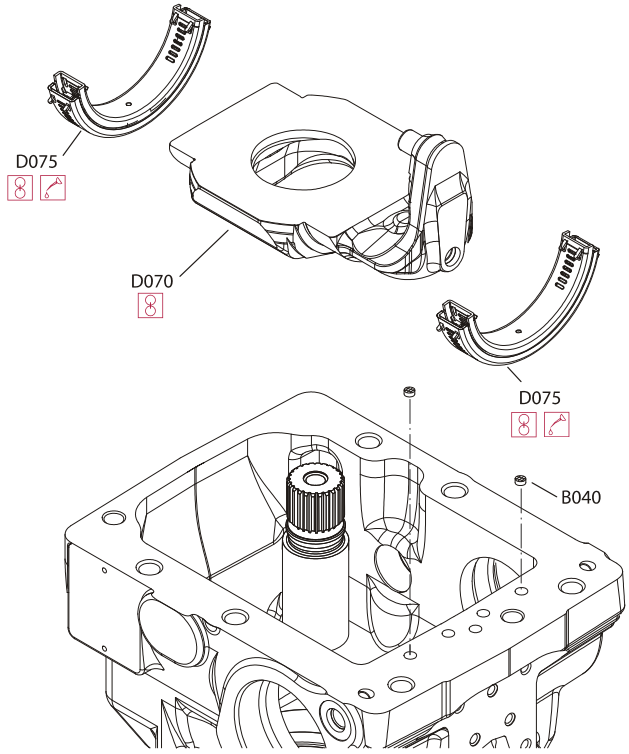
4. Install the shaft assembly into the front housing. Cover the shaft with an installation sleeve to protect it during installation of the seal carrier.
5. Hand press the seal carrier (J275) into the housing. Ensure the seal carrier clears the spiral ring groove in the housing. Remove protective cover from shaft end.
6. Install the spiral ring (J300) into the housing. The inside diameter of the ring must be at least 68 mm [2.677 in] after installation.

SWASHPLATE BEARINGS AND SWASHPLATE INSTALLATION

1. Position housing with front flange pointing down.

NOTE: *Always replace swashplate bearings (D075).*

2. Coat swashplate bearings (D075) with hydraulic fluid and install them onto the swashplate (D070). The inner race of the swashplate bearing clips onto the swashplate.



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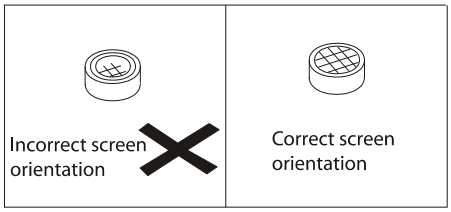
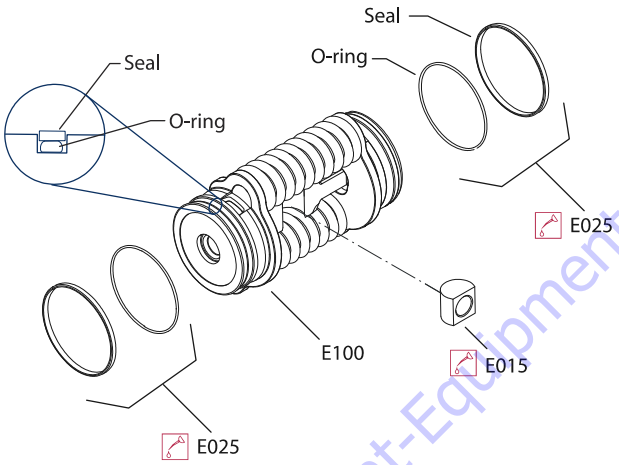
3. Install the swashplate and bearings into the housing. Ensure swashplate is in neutral position.
4. If removed, install new filter screens (B040) into housing. Install screens in same orientation as when removed.

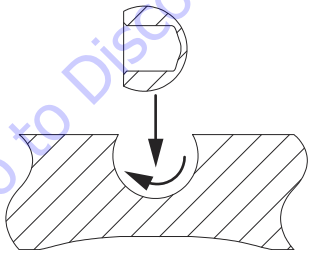


SERVO PISTON REASSEMBLY

1. Lubricate and install new piston seals and O-rings (E025). Stretch O-rings onto servo piston, then install piston seals outboard of the O-rings. Allow seals to relax before installing servo piston. Use the servo cylinder to resize the seals before installing servo piston.

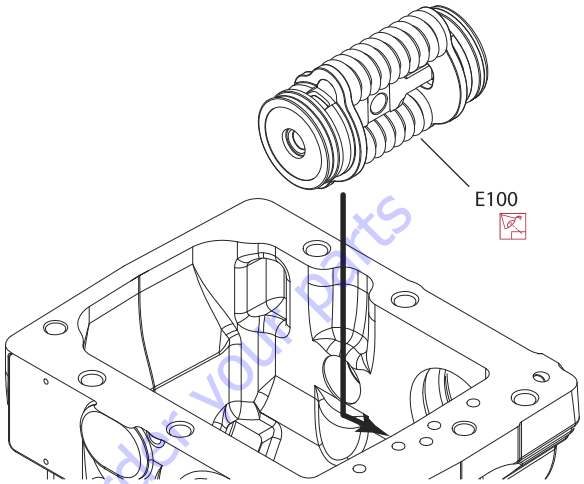


2. Lubricate and install slider block (EOT 5).



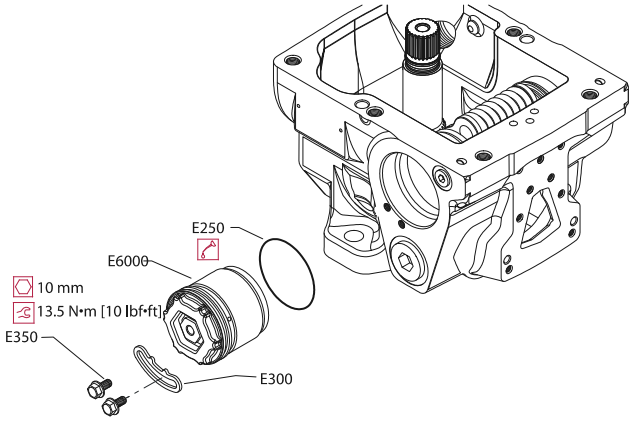
SERVO PISTON INSTALLATION

Install servo piston assembly (E100). Ensure swashplate pin fits properly in servo slider block (EOT5).



SERVO CYLINDER INSTALLATION

1. Lubricate new O-rings (E250) and install on each servo cylinder.



2. While holding the servo piston in place, thread servo cylinders into housing using a 3/4 in socket. Thread cylinders equal distance in each side of pump until each cylinder contacts servo cylinder. Do not compress servo piston spring.

⚠ CAUTION

DO NOT ALLOW LOOSE SERVO PISTON TO DAMAGE INTERNAL MACHINED SURFACES OF PUMP.

DO NOT DAMAGE SEALS WHEN INSTALLING SERVO CYLINDERS.

3. Install locking plates (E300). Using a 10 mm wrench, install locking plate screws (E350). Torque screws to 13.2-16.1 Nm [9.7-11.9 lb.ft.].

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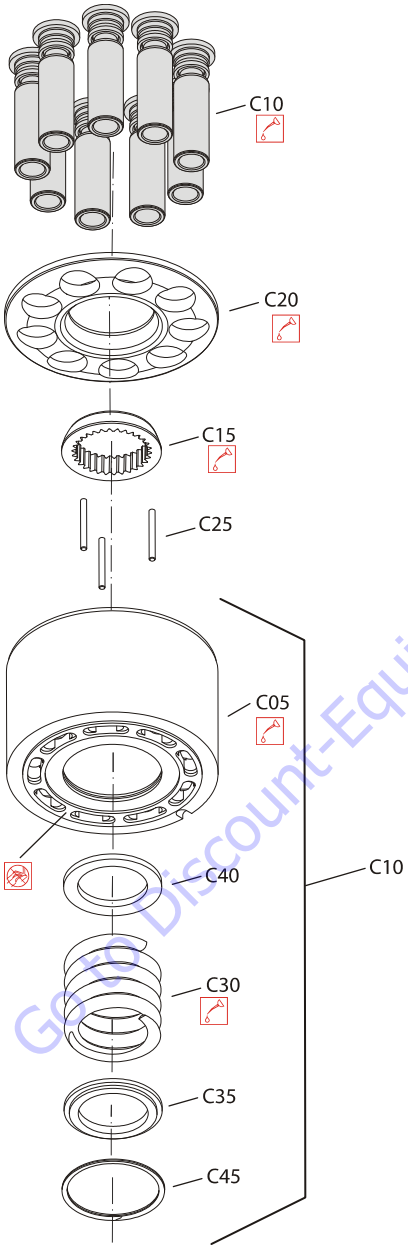
NOTE: *After pump assembly is complete, mount pump on test stand. Perform mechanical neutral adjustment and control neutral adjustment. Refer to HI Closed Circuit Axial Piston Pumps 078/147/165 Service Manual 520L0848 for adjustment procedures.*

CYLINDER KIT REASSEMBLY

1. Coat all parts with hydraulic fluid prior to reassembly.



2. Install the inner block spring washer (C40), block spring (C30), and outer washer (C35) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (C45) into the groove in the cylinder block.

⚠ WARNING

RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 350 TO 400 N [80 TO 90 LB.F.]. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS INSTALLED.

3. Turn the block over and install the hold-down pins (C25) and ball guide (C15) into the cylinder block.

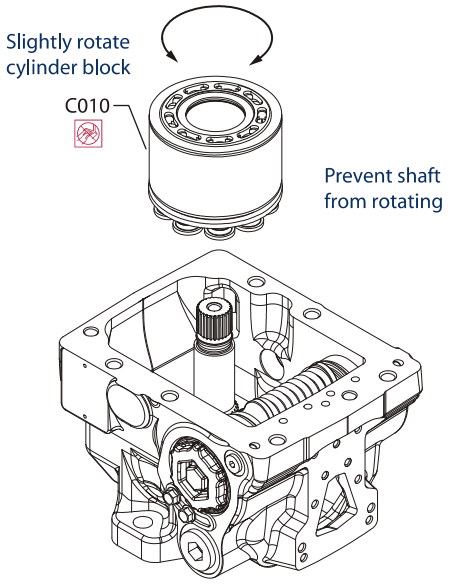
4. Insert the pistons (C10) into the slipper retainer (C20). Install the piston/retainer assembly into the cylinder block. Ensure the concave surface of the retainer seats on the ball guide. If you are reusing the pistons, install them to the original block bores. Lubricate the pistons, slippers, retainer, and ball guide before assembly. Set the cylinder kit aside on a clean surface until needed.

NOTE: *Be sure to install the slipper retainer (C20) so it mates correctly with the ball guide (C15) (concave side of the slipper retainer against the convex side of the ball guide).*

CYLINDER KIT INSTALLATION

1. Position pump with shaft pointing down.

2. Insert the cylinder block kit onto the shaft. While holding the shaft, slightly rotate the cylinder block kit to help start the shaft splines over the ball guide and align it with the block splines.



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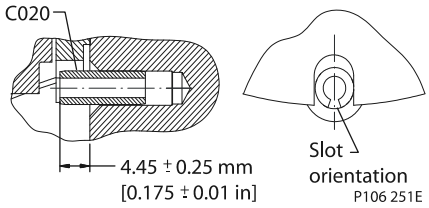
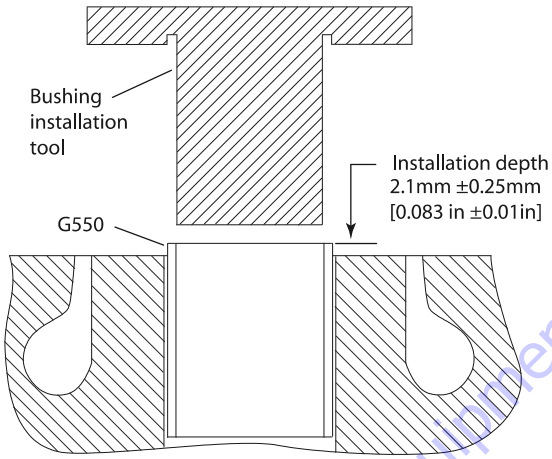
TIMING PIN AND ENDCAP BUSHING INSTALLATION

1. Install timing pin (C020) in endcap as shown. Orient slot away from valve plate. Install the alignment pins (B010) in housing. Measure pin insertion depth to verify proper pin insertion.



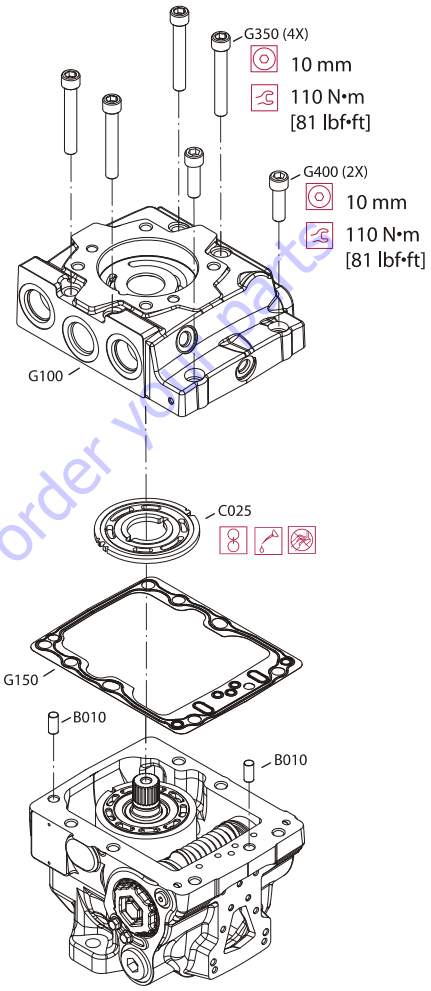
2. Orient endcap bushing slots towards top or bottom of endcap. Lubricate and press the bushings (G550) into the end cap to depth shown below.



NOTE: *Ensure that bushing is properly installed. Improper installation resulting in improper depth or misalignment will result in premature bushing and charge pump failure.*

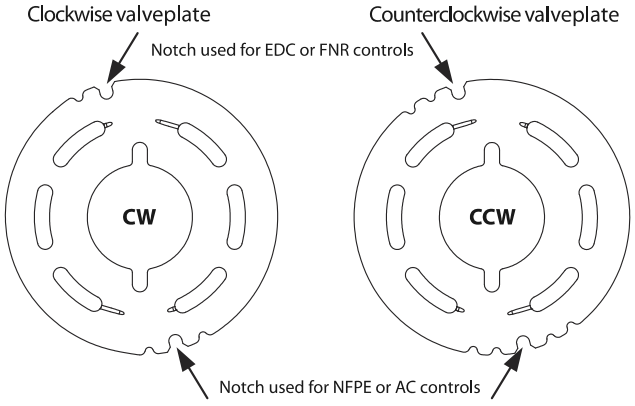
VALVE PLATE AND ENDCAP INSTALLATION

1. Install the alignment pins (B010) in housing.



2. Clean the valve plate (C025) and endcap(G100).

3. Apply a liberal amount of assembly grease to the backside of the valve plate surface to hold it in place and position on endcap in original position.



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NOTE: *For proper pump operation, it is extremely important to ensure that there is no contamination between the end cap and valve plate.*

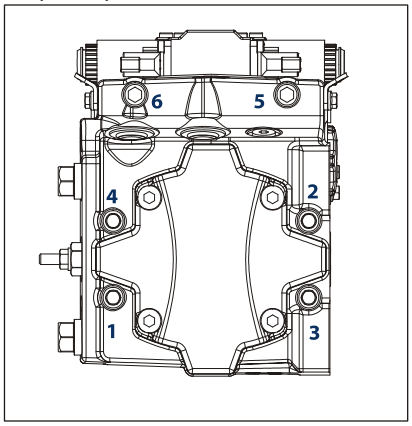
4. Install new gasket (G150).

NOTE: *Do not bend or warp the gasket in an attempt to straighten it.This may damage the embossing which is not visible under the rubber coating.*

5. Using a 10 mm internal hex wrench install endcap with capscrews (G350) and (G400).

6. Torque capscrews (G350) and (G400) to 110 Nm [81 lb.ft.].

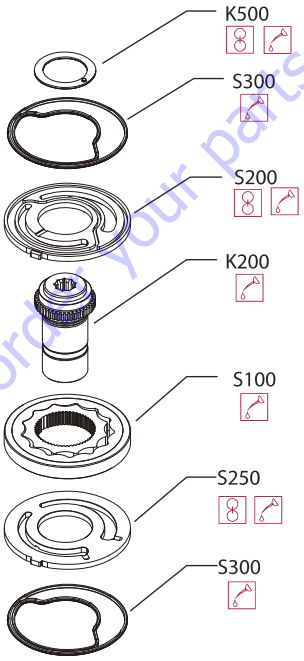
7. Use torque sequence shown below.

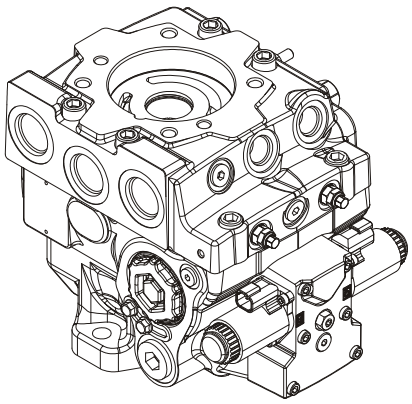


CHARGE PUMP INSTALLATION

NOTE: *Charge pump components are available as a complete kit only. Kit includes (S300), (S250), (SI 00), (SI 50), and (S200).*

1. Install new seal (S300) to valve plate (S250). Lubricate valve plate (S250) and install in same orientation as when it was removed.





2. Lubricate and install outer ring (S150) and charge pump gear set (S100). Lubricate and install coupling (K200).

3. Lubricate and install pressure-balance plate (S200) in same orientation as when it was removed. Install new outer seal (S300).

4. Lubricate and install thrust washer (K500) in same orientation as when it was removed.

NOTE: *Bump on thrust washer fits into hole in cover.*

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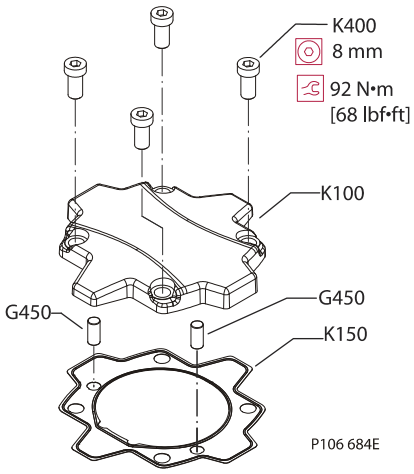
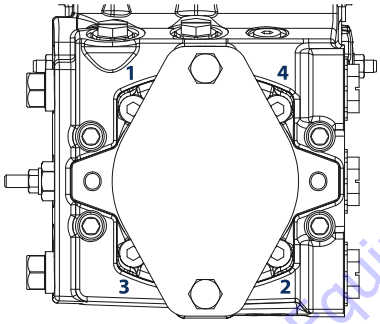
END COVER INSTALLATION

1. Install alignment pins (G450). Install gasket (K150).

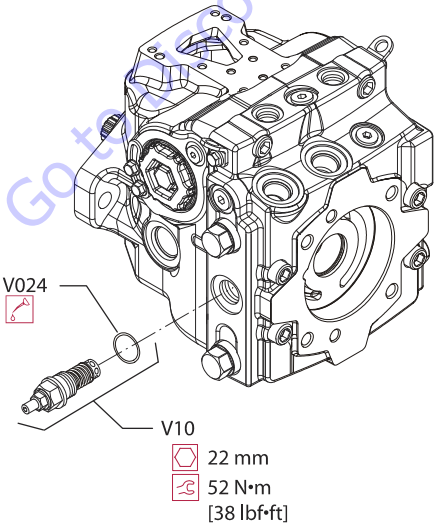


2. Install end cover with capscrews (K400) using an 10 mm internal hex wrench. Torque to 92 Nm [68 lb.ft.]. Follow torque sequence below.



CHARGE PRESSURE RELIEF VALVE INSTALLATION

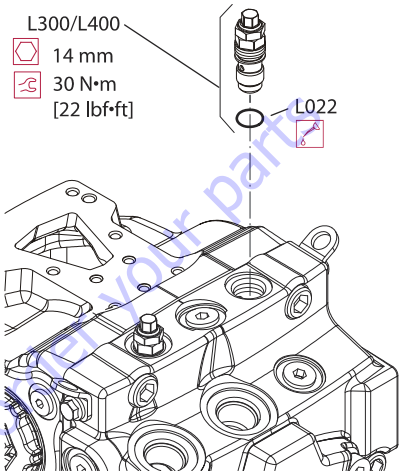
1. Install new O-ring (V024).



2. Using a 22 mm wrench, install the charge pressure relief valve (VI0).
3. Torque to 52 Nm [38 lb.ft.].

PRESSURE LIMITER INSTALLATION

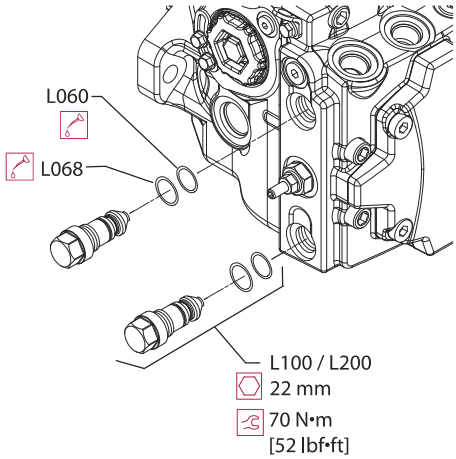
1. Lubricate and install O-rings (L022).



2. Using a 14 mm wrench, install pressure limiter cartridges (L300) and (L400).
3. Torque to 30 Nm [22 lb.ft.].

HPRV VALVE INSTALLATION

1. Replace and lubricate O-rings (L060) and backup rings (L068) before reassembly.



2. Using a 22 mm wrench, install HPRV valves (L100) and (L200).
3. Torque to 70 Nm [52 lb.ft.].

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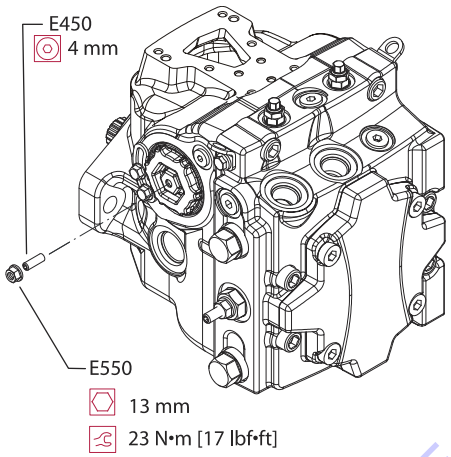
OPTIONAL DISPLACEMENT LIMITER INSTALLATION

NOTE: *Set the approximate displacement limiter depth. See the table below for displacement change per turn. Run screw in until it contacts the servo piston, then back out the appropriate number of turns.*

Table 5-7. Displacement Limiter Adjustment Data

Locknut wrench size and torque	Adjusting screw size	Approximate displacement change per revolution of adjusting screw
13 mm 23 Nm [17 ft.lbs.]	4 mm internal hex	5.1 cm^3 [0.31 in^3]

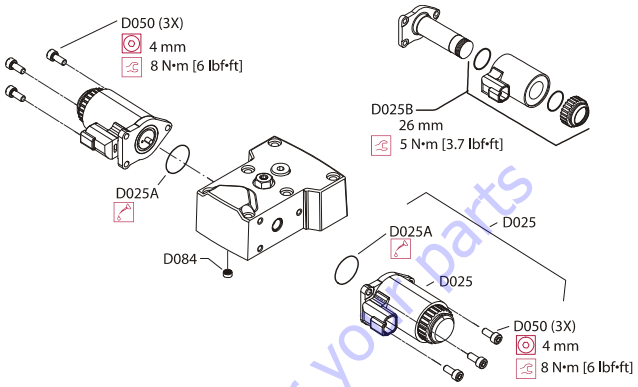
1. Thread displacement limiter adjusting screw (E450) into servo sleeve.



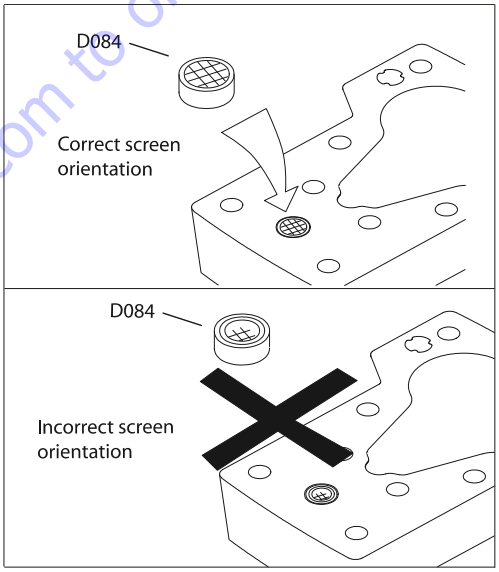
2. Thread a new locking nut onto adjustment screw.Torque to 23 Nm [17 ft.lbs.] using a 13mm hex wrench.

EDC CONTROL ASSEMBLY

1. Install new O-rings (D025A) into solenoids (D025), and attach solenoids with capscrews (D050) using 4 mm internal hex wrench. Torque to 8 Nm [6 ft.lbs.].



2. Replace screen (D084) if removed. Drawing shows proper screen orientation.



NOTE: *If you suspect coil malfunction, remove the coil (D025B) by removing the plastic nut with a 26 mm 12 point socket. Install a new coil and torque the nut to 5 Nm [3.7 ft.lbs.].*

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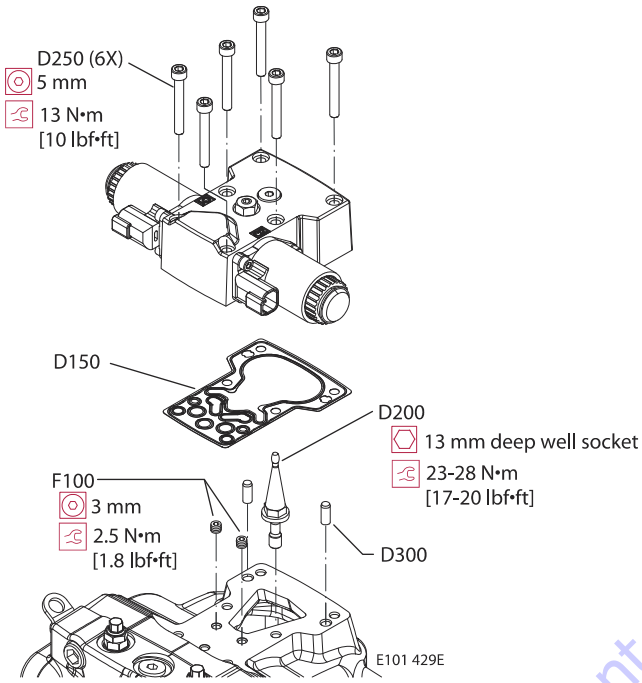
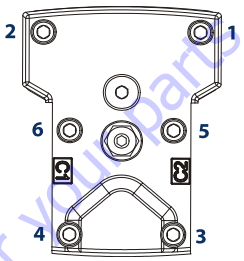
EDC CONTROL INSTALLATION

1. Use a 13 mm deep well socket to install feedback pin in swashplate. Torque to 23-28 Nm [17-20 ft.lbs.]. Do not overtorque.



NOTE: *If orifices (F100) were removed, reinstall using a 3 mm internal hex wrench.Torque to 2.5 Nm [1.8 ft.lbs.].*

2. Install dowel pins (D300).
3. Install new gasket (D150).
4. Position control on pump housing. Remove plug on top of control to visually ensure that feedback pin on swash-plate is engaged properly in control arms.
5. Using a 5 mm internal hex wrench, fasten control to pump with hex screws (D250). Torque screws to 13 Nm [10 ft.lbs.]. Follow torque sequence shown.



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Port Locations and Gauge Installation

PORT LOCATIONS AND GAUGE INSTALLATION

The following table and drawing show the port locations and gauge sizes needed. When testing system pressures, calibrate pressure gauges frequently to ensure accuracy. Use snubbers to protect gauges.

Table 5-8. Port information

Port identifier	Port size	Wrench size	Pressure obtained	Gauge size, bar [psi]
L1,L2	1 1/16-12 UNF28	9/16 internal hex	Case drain	10bar[100psi]
MA, MB	9/16-18 UNF	1/4 internal hex	System pressure	600 bar [10,000 psi]
M3	9/16-18 UNF 2B	1/4 internal hex	Charge pressure	50 bar [1000 psi]
M4,M5	7/16-20 UNF 2B	3/16 internal hex	Servo pressure	50 bar [1000 psi]

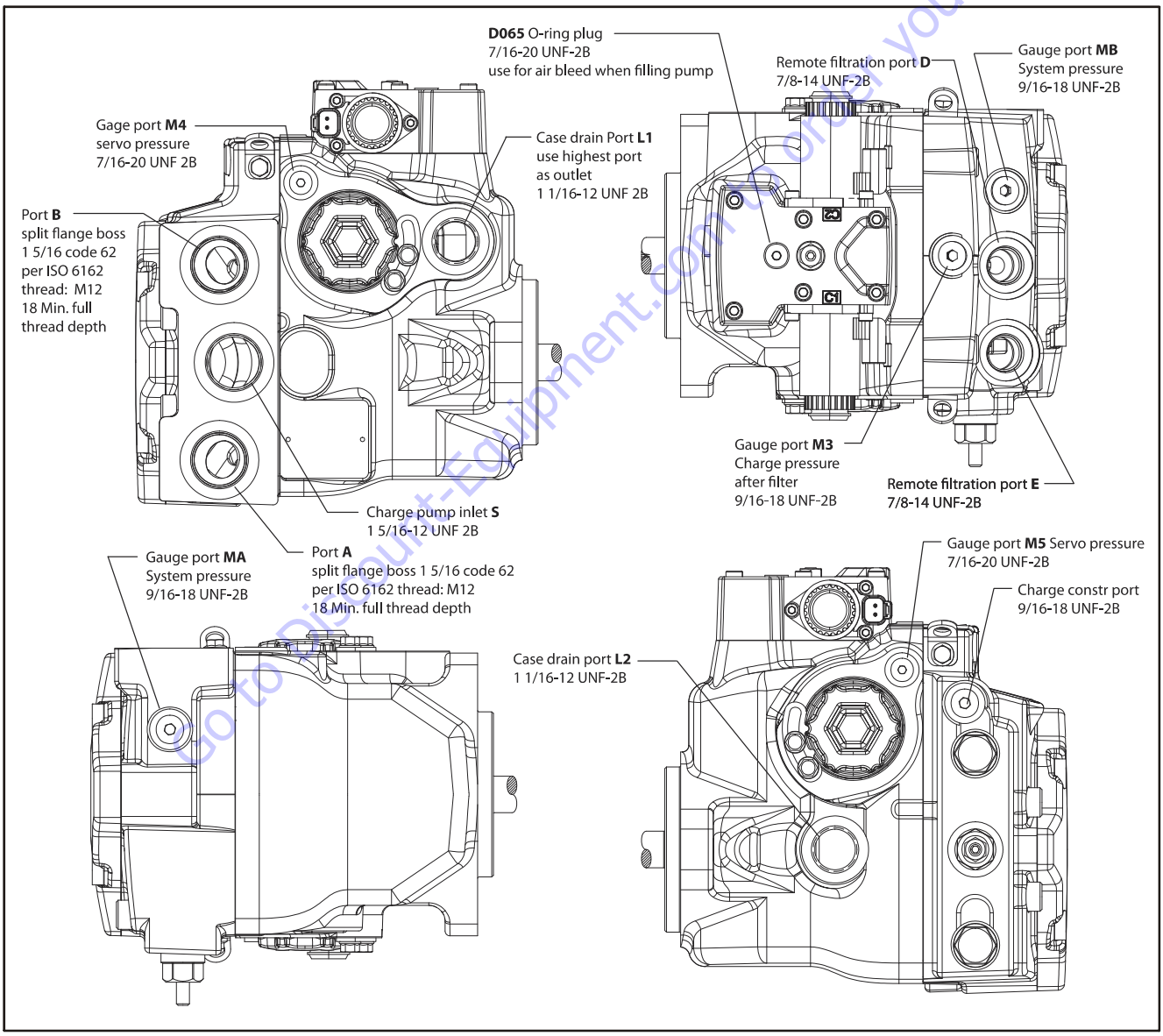

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Figure 5-31. Port Locations

Fastener Size and Torque Chart

Item	Fastener	Wrench size	Torque
D015	Neutral adjust screw	4 mm internal hex	NA
D050	Coil mounting bolt	4 mm internal hex	8 Nm [9 ft.lbs.]
D060	Neutral adjust locking nut	13 mm	10 Nm [7 ft.lbs.]
D250	Electric control mounting bolt	5 mm internal hex	13 Nm [10 ft.lbs.]
E350	Servo cylinder locking bolt	Servo cylinder locking bolt	14.5 Nm [11 ft.lbs.]
K350Apad	Shipping cover mounting bolt	17mm	48 Nm [35 ft.lbs.]
K350 Bpad	Shipping cover mounting bolt	18mm	77 Nm [58 ft.lbs.]
K400	Rear cover/aux pad mounting bolt	8 mm internal hex	92 Nm [68 ft.lbs.]
L010	Pressure limiter adjust screw	8 mm	NA
L300/L400	Pressure limiter cartridge	14mm	30 Nm [22 ft.lbs.]
L024	Pressure limiter locking nut	14mm	20 Nm [15 ft.lbs.]
L100/L200	High pressure relief valve	22 mm	70 Nm [52 ft.lbs.]
V10	Charge pressure cartridge	22 mm	52 Nm [38 ft.lbs.]
V020	Charge pressure adjusting screw	4 mm internal hex	NA
V022	Charge pressure locking nut	13mm	12 Nm[9 ft.lbs.]

Plug Size and Torque Chart

Item	O-ring plug	Wrench size	Torque
B015	7/16-20	3/16 in internal hex	19 Nm [14 ft.lbs.]
B020	1-1/16- 12	9/16 in internal hex	49 Nm [36 ft.lbs.]
D065	7/16-20	3/16 in internal hex	19 Nm [14 ft.lbs.]
G250	9/16-18	7 mm internal hex	22-26 Nm [16-20 ft.lbs.]
G300/G302	9/16-18 UNF	1/4 in internal hex	42 Nm [30 ft.lbs.]

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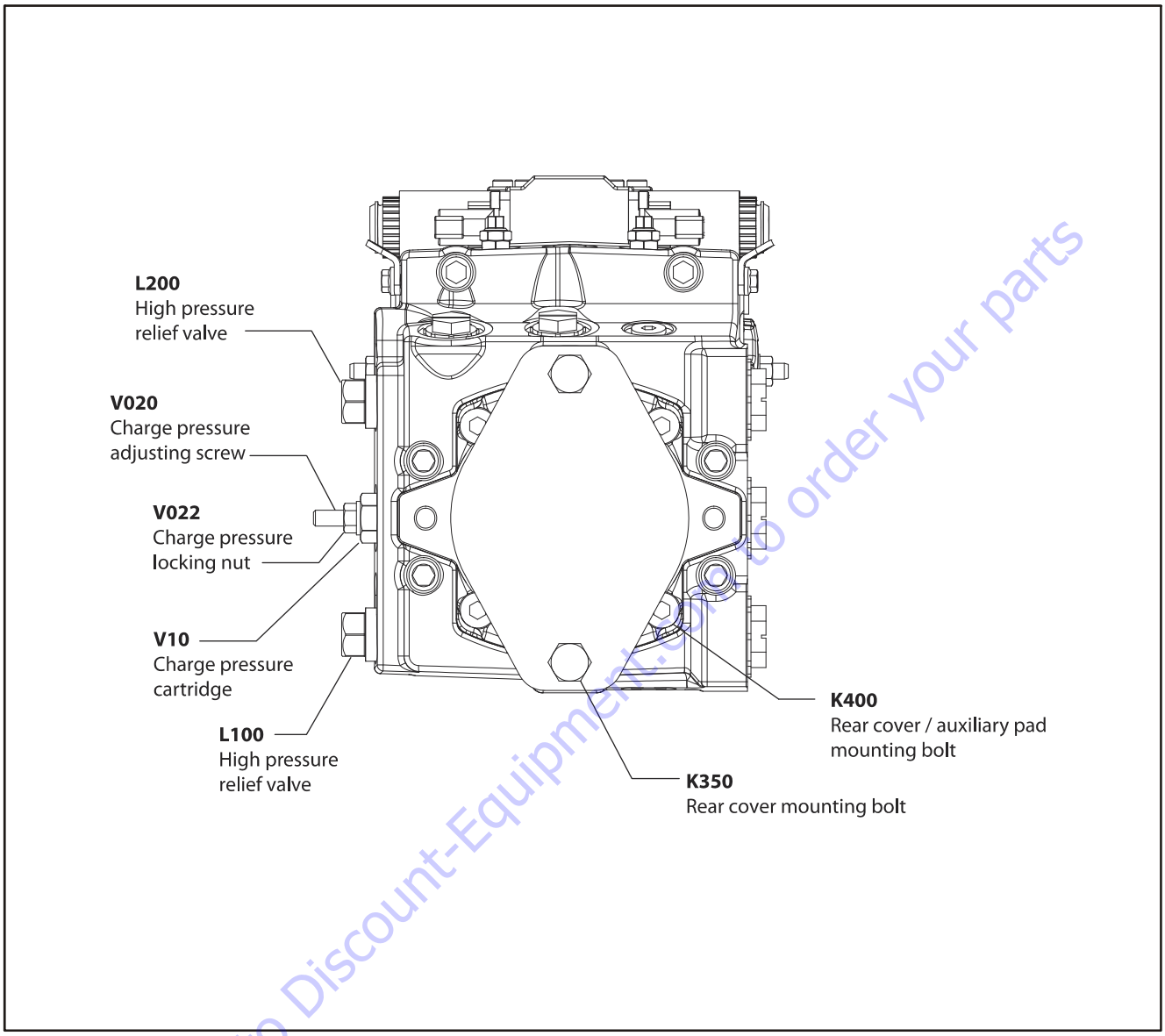

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Figure 5-32. Fasteners and Plugs - Sheet 1 of 2

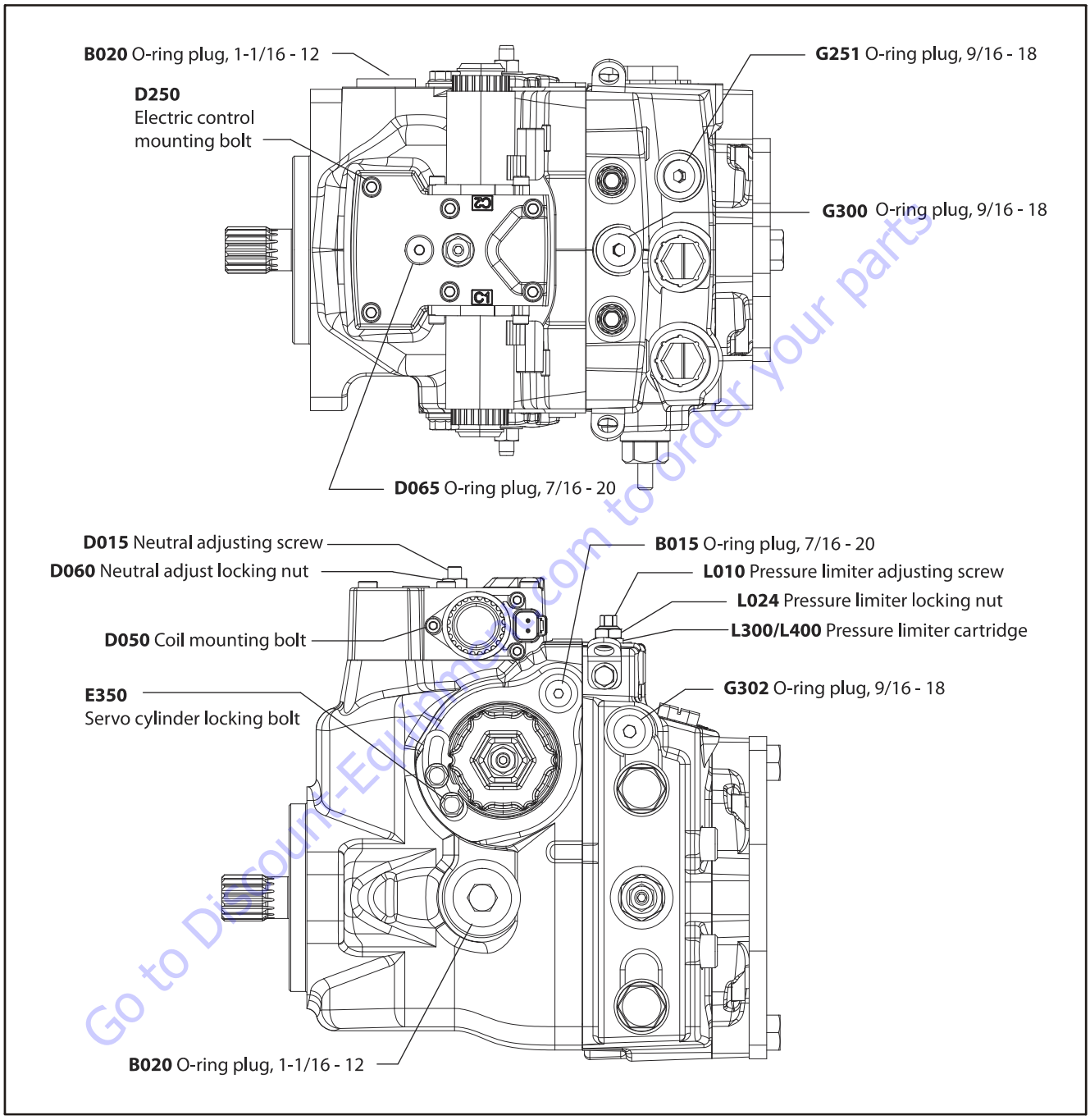

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Figure 5-33. Fasteners and Plugs - Sheet 2 of 2

Initial Startup Procedures

GENERAL

Follow this procedure when starting-up a new pump installation or when restarting an installation in which the pump has been removed and re-installed on a machine. Ensure pump has been thoroughly tested on a test stand before installing on a machine.

⚠ WARNING

UNINTENDED MOVEMENT OF THE MACHINE OR MECHANISM MAY CAUSE INJURY TO THE TECHNICIAN OR BYSTANDERS. TO PROTECT AGAINST UNINTENDED MOVEMENT, SECURE THE MACHINE OR DISABLE/ DISCONNECT THE MECHANISM WHILE SERVICING.

PRE-FILL PROCEDURE

The case of the pump MUST be pre-filled before starting the engine. Failure to do so can cause premature failure of the pump.

1. Fill the hydraulic reservoir.
2. Locate the L2 case port on the pump. It is located on the back side facing the turntable side plate. Using a 9/16" allen wrench, remove the O-ring plug.
3. When hydraulic oil starts to flow out of this port for approximately 30 to 40 seconds, install the O-ring plug.

START-UP PROCEDURE

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

1. Ensure that the machine hydraulic oil and system components (reservoir, hoses, valves, fittings, and heat exchanger) are clean and free of any foreign material.
2. Install new system filter element(s) if necessary. Check that inlet line fittings are properly tightened and there are no air leaks.
3. Install the pump. Install a 50 bar [1000 psi] gauge in the charge pressure gauge port M3.
4. Fill the housing by adding filtered oil in the upper case drain port. If the control is installed on top, open the construction plug in the top of the control to assist in air bleed.
5. Fill the reservoir with hydraulic fluid of the recommended type and viscosity. Use a 10-micron filler filter. Fill inlet line from reservoir to pump. Ensure construction plug in control is closed after filling.
6. Disconnect the pump from all control input signals.
7. Close construction plug removed in step 4.

⚠ CAUTION

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

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

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

8. Use a common method to disable the engine to prevent it from starting. Crank the starter for several seconds. Do not to exceed the engine manufacturer's recommendation. Wait 30 seconds and then crank the engine a second time as stated above. This operation helps remove air from the system lines. Refill the reservoir to recommended full oil level.
9. When the gauge begins to register charge pressure, enable, and start engine. Let the engine run for a minimum of 30 seconds at low idle to allow the air to work itself out of the system. Check for leaks at all line connections and listen for cavitation. Check for proper fluid level in reservoir.
10. When adequate charge pressure is established (as shown in model code), increase engine speed to normal operating rpm to further purge residual air from the system.
11. Shut off engine. Connect pump control signal. Start engine, checking to be certain pump remains in neutral. Run engine at normal operating speed and carefully check for forward and reverse control operation.
12. Continue to cycle between forward and reverse for at least five minutes to bleed all air and flush system contaminants out of loop.

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

13. Check that the reservoir is full. Remove charge pressure gauge.The pump is now ready for operation.

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Troubleshooting

This section provides general steps to follow if you observe undesirable system conditions. Follow the steps listed until you solve the problem. Some of the items are system specific. We reference the section in this manual if more information is available. Always observe the safety precautions listed in the Introduction section and precautions related to your specific equipment.

PRECAUTIONS

⚠ CAUTION

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

⚠ WARNING

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

⚠ WARNING

UNINTENDED MOVEMENT OF THE MACHINE OR MECHANISM MAY CAUSE INJURY TO THE TECHNICIAN OR BYSTANDERS. TO PROTECT AGAINST UNINTENDED MOVEMENT, SECURE THE MACHINE OR DISABLE/ DISCONNECT THE MECHANISM WHILE SERVICING.

⚠ CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS AND VOID THE MANUFACTURER'S WARRANTY. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND REINSTALLING SYSTEM COMPONENTS AND LINES.

⚠ WARNING

HYDRAULIC FLUID CONTAINS HAZARDOUS MATERIAL. AVOID CONTACT WITH HYDRAULIC FLUID. ALWAYS DISPOSE OF USED HYDRAULIC FLUID ACCORDING TO STATE, AND FEDERAL ENVIRONMENTAL REGULATIONS.

Table 5-9. Electrical Troubleshooting

Item	Description	Action
Control operates pump in one direction only.	Control coil failure	Measure resistance at coil pins. Resistance should be 14.20 Ohm (24V) or 3.66 Ohm (12V) at 20×C [70×F]. Replace coil.
No pump function	No power to controller	Restore power to controller.
Erratic pump function	Electrical connection to pump is bad	Disconnect connection, check wires, reconnect wires.
Filter bypass indicator switch	Filter switch may be bad	Check/replace filter switch. Add gauge to filter bypass port to verify proper fluid flow and verify switch operation by measuring resistance, open resistance=>510 Ohm, closed resistance<=1220hm

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Table 5-10. System Operating Hot

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

Table 5-11. System Noise Or Vibration

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

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Table 5-12. Neutral Difficult or Impossible to Find

Item	Description	Action
Input to pump control	Input to control module is operating improperly	Disconnect input and check to see if pump comes back to neutral. If Yes, input fault, replace/repair external controller. If No, go to next step.
Pump control neutral	Neutral set improperly	Shunt servo gauge ports M4 and M5 together with external hose and see if pump comes back to neutral. If Yes: control neutral improperly set (see page 35). If no: balance swashplate (see Mechanical neutral adjustment, page 37). If you still cannot set neutral, replace control.

Table 5-13. Sluggish System Response

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

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Pump Adjustment

Read through the entire topic before beginning a service activity. Refer to Figure 5-31., Port Locations, for location of gauge ports and suggested gauge size.

⚠ CAUTION

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

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

CHARGE PRESSURE RELIEF VALVE ADJUSTMENT

NOTE: *Ensure charge pressure is properly set before checking pressure limiter.*

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

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

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

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

4. While holding the adjusting screw, torque locknut to 17 Nm [13 lb.ft.].
5. When you achieve the desired charge pressure setting, remove the gauges and plug the ports.

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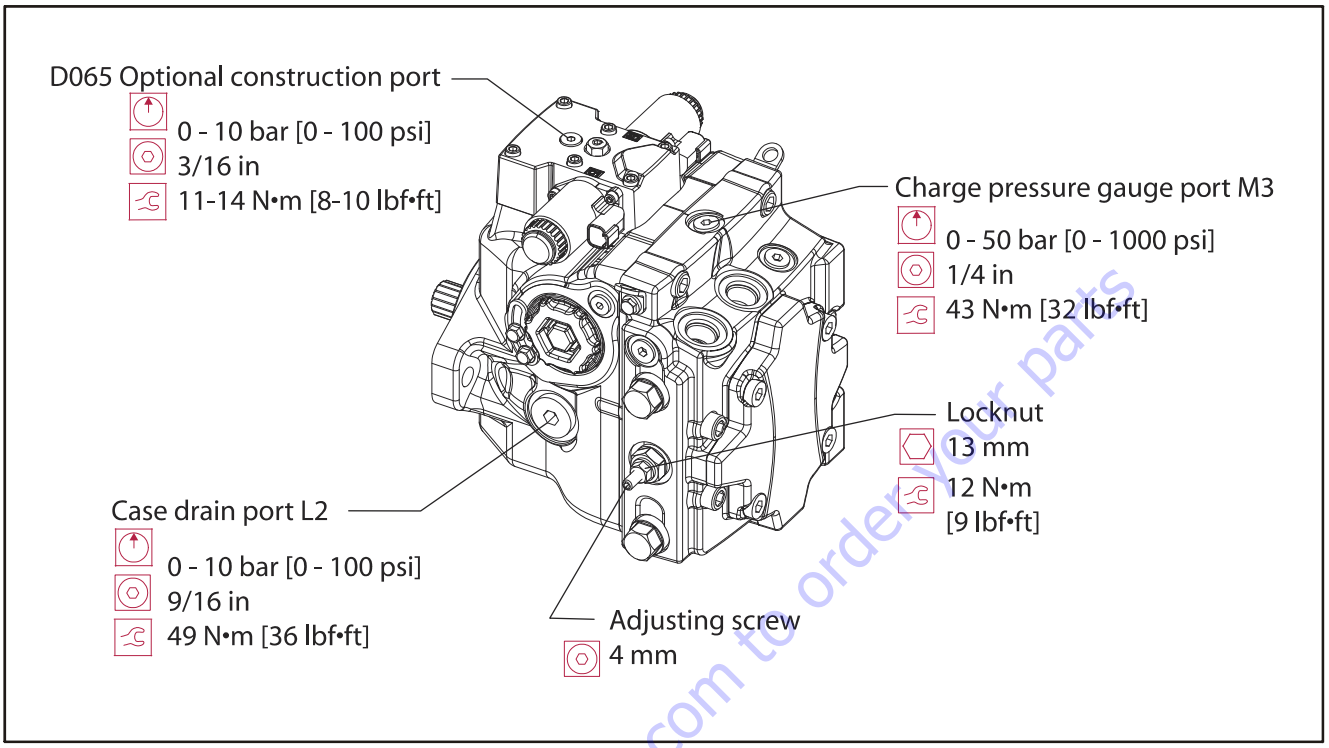

Figure 5-34. Charge Pressure Adjustment

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PRESSURE LIMITER ADJUSTMENT

Lock motor output shaft to adjust the pressure limiter setting. Lock the vehicle's brakes or rigidly fix the work function so it cannot rotate.

NOTE: *Ensure charge pressure is properly set before checking pressure limiter.*

NOTE: *If you change pressure limiter settings, you must also change the HPRV valve to maintain proper PL function. Refer to the table for corresponding settings.*

1. Install 600 bar [10,000 psi] pressure gauges in the high pressure gauge ports (MA and MB). Install a 50 bar [1000 psi] pressure gauge in the charge pressure gauge port (M3).

NOTE: *The model code on the serial plate gives the factory setting of the PL (Pressure Limiter).The PL setting is referenced to charge pressure. Subtract charge pressure from system pressure gauge readings to compute the effective PL setting.*

2. Start the prime mover and operate at normal speed.
3. Use a 17mm wrench to loosen the locking nut (L024).
4. Activate the control input until pressure in the high side of the system loop stops rising. This pressure is the PL setting.
5. Return the pump to neutral and adjust the PL setting using an internal hex wrench. Wrench size is in the diagram on the previous page. Turn the adjusting screw clockwise to increase the PL setting, counterclockwise to decrease it.The adjustment is very sensitive. Change per turn is approximately 150 bar [2176 psi].

NOTE: *Change per turn is 150 bar/rev [2176 psi/rev].*

6. Repeat steps four and five until you reach the desired PL setting. After adjustment, torque the locknut (L024) to 12 Nm [9 ft.lbs.]. Do not over torque.
7. Shut down the prime mover. Remove gauges and replace plugs.

Table 5-14. Pressure Limiter Settings

Pressure limiter setting	HPRV setting
150	200
180	230
200	250
230	280
250	300
280	330
300	350
330	380

Table 5-14. Pressure Limiter Settings

Pressure limiter setting	HPRV setting
350	400
380	420
400	450
410	
420	
430	480
440	
450	
460	510
470	
480	

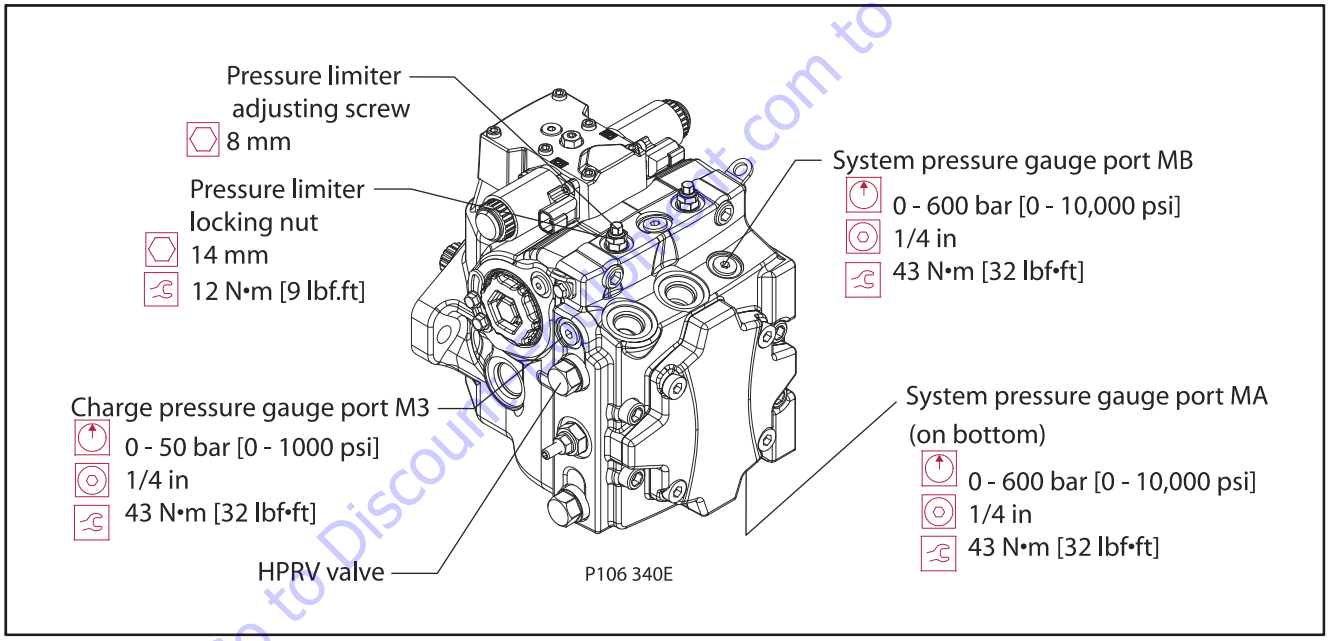

Figure 5-35. Pressure Limiter Adjustment

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Displacement Limiter Adjustment

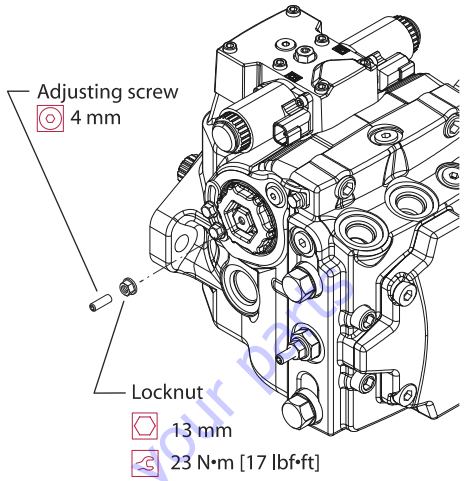
If your pump has displacement limiters, you will find them on either servo cover. You can limit forward and reverse displacement independently.

NOTE: *Displacement limiters are not pre-set by the factory. We install them as far as possible without contacting the servo piston. Limiting displacement requires clockwise adjustment of the limiting screw.*

⚠ CAUTION

BEFORE ADJUSTING THE DISPLACEMENT LIMITER, MARK THE POSITION OF THE SERVO CYLINDER. BE SURE THE SERVO CYLINDER DOES NOT TURN WHEN SETTING THE DISPLACEMENT LIMITER LOCKNUT.

1. Loosen the locking nut.



2. Rotate the adjusting screw to achieve the desired maximum displacement. Set the adjusting screw against the servo piston by feel before counting turns. Refer to the table below for change per turn. Clockwise rotation decreases displacement, counterclockwise rotation increases it. Adjustment is possible from zero to maximum.
3. After establishing the desired maximum displacement setting, hold the adjusting screw while torquing the locknut to the value in the table below.
4. Test operation of the vehicle/ machine to verify proper maximum speed of vehicle/work function.

Table 5-15. Displacement Limiter Adjustment Data

Displacement	Locknut wrench size and torque	Adjusting Screw Size	approximate displacement change per revolution of adjusting screw
45	13 mm 23Nm[17lb.ft.]	4 mm internal hex	5.1 cm3 [0.31 in3]
53	13 mm 23Nm [17 lb.ft.]	4 mm internal hex	6.0 cm3 [0.37 in3]

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Control Neutral Adjustment

NOTICE

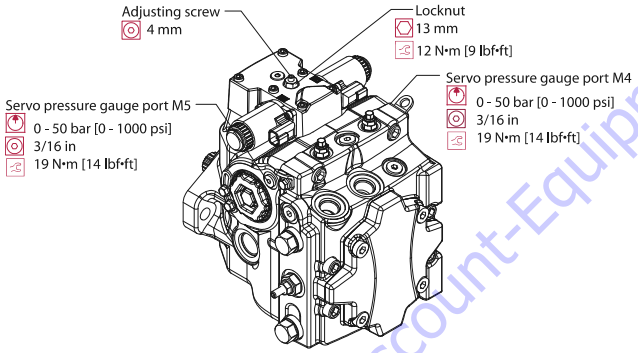
ADJUSTMENT OF THE EDC IS VERY SENSITIVE. BE SURE TO HOLD THE HEX WRENCH STEADY WHILE LOOSENING THE LOCKNUT. TOTAL ADJUSTMENT IS LESS THAN 120 DEGREES.

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

⚠ WARNING

UNINTENDED MOVEMENT OF THE MACHINE OR MECHANISM MAY CAUSE INJURY TO THE TECHNICIAN OR BYSTANDERS. TO PROTECT AGAINST UNINTENDED MOVEMENT, SECURE THE MACHINE OR DISABLE/ DISCONNECT THE MECHANISM WHILE SERVICING.

1. Install a 50 bar [1000 psi] gauge in each of the two servo gauge ports (M4and M5). Disconnect the external control input (electrical connections) from the control. Start the prime mover and operate at normal speed.



2. Use a 4mm internal hex wrench to hold the neutral adjusting screw (D015) stationary while loosening the locknut (D060) with a 13mm wrench.

3. Observe pressure gauges. If necessary, turn adjusting screw (D015) to reduce any pressure differential.

4. Rotate the neutral adjusting screw (D015) clockwise until the pressure increases on the gauge. Note the angular position of the wrench. Then rotate the neutral adjusting screw counterclockwise until the pressure increases by an equal amount on the other gauge. Again note the angular position of the wrench.

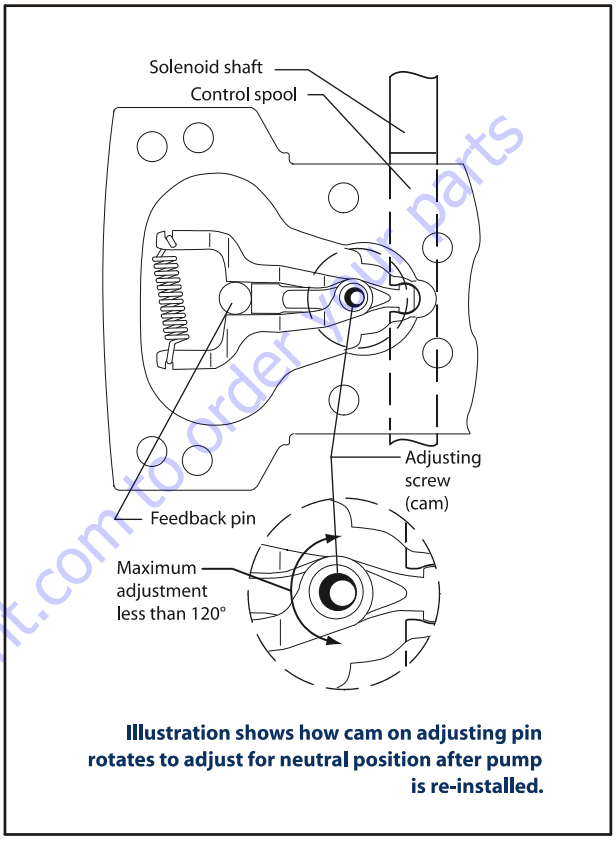


Figure 5-36. Neutral Adjustment (EDC) - Bottom View

5. Rotate the neutral adjusting screw clockwise half the distance between the wrench positions noted above. The gauges should read the same pressure, indicating that the control is in its neutral position.

6. Hold the neutral adjusting screw stationary and tighten the lock nut (D060).Torque to 10 Nm [7 lb.ft.]. Do not over torque the nut.

7. When the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control input.

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

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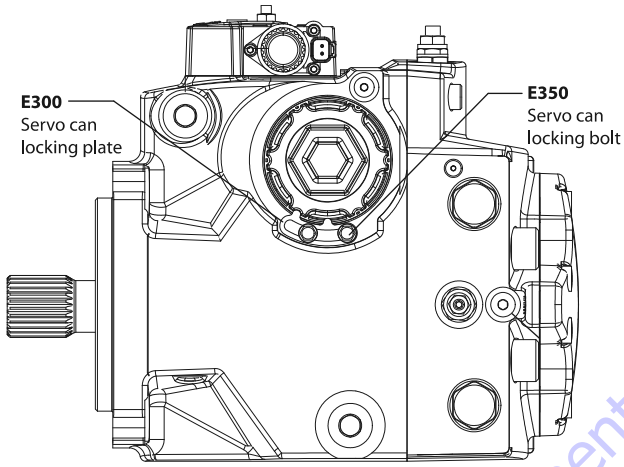
Mechanical Neutral Adjustment

SERVO ADJUSTMENT

1. Run prime mover at 1800 min rpm.
2. If using a PWM signal, ensure the signal is off. Check the servo pressure gauges. Ensure the differential between M4 and M5 is less than 1.5 bar [22 psi].
3. Using a 3/4 in hex deep socket, unthread both servo cylinders 2-3 turns.This step ensures the servo cylinders have no contact with the servo piston.



4. Stroke the pump by turning the control eccentric screw (or supplying current to solenoid C1) until the servo pressure at port M4 is 1 to 2 bar [14- 29 psi] greater than at port M5 and the system pressure gauges indicate displacement. Pressure should be greater at port MA for clockwise rotation, or MB for counterclockwise rotation. This also indicates the servo piston is in contact with the servo cylinder on side M5.
5. Slowly thread the servo cylinder on the M5 side in until the system pressure differential starts to decrease. Maintain servo pressure differential between 1-2 bar [14-29 psi] during this step. Continue turning the servo cylinder in until the system pressure differential (between ports MA/MB) is less than 1.5 bar [22 psi]. This procedure sets the servo and swashplate to mechanical neutral on the M5 side.
6. To complete setting neutral, repeat steps 1-5 but stroke the pump in the opposite direction by turning the eccentric screw in the opposite direction, or by supplying current to solenoid C2. Reverse gauge locations (M4 for M5, MB for MA) from those stated above since the pump is now stroking the other direction.
7. Remove all gauges and replace gauge port plugs. You can find wrench sizes and plug torques in the Plug size and torque chart.

SERVO ADJUSTMENT SIDE M4

1. Run prime mover at 1800 rpm.
2. If using a PWM signal to set mechanical neutral, start with the electronic control testing tool off (no current to either solenoid). Check to be sure the servo pressure differential is less than 1.5 bar [22 psi]. Reference Control Neutral Adjustment.
3. Turn neutral adjust excenter screw (or supply current to solenoid C2) until the servo pressure at port M5 is 1 - 2 bar [14- 29 psi] greater than at port M4.
4. The system pressure differential must be greater than zero and the pressure at port A (B for clockwise rotation) must be greater than the pressure at port B (A for clockwise rotation). This step ensures the servo is in contact with the servo cylinder on side M4.
5. Slowly turn in the servo cylinder on the M4 side until the system pressure differential starts to decrease. The servo pressure differential must be maintained between 1-2 bar [14-29 psi] during this step. Continue turning in the servo cylinder until the system pressure differential is less than 1.5 bar [22 psi]. This procedure sets the servo and swashplate to mechanical neutral.

VERIFY NEUTRAL SETTING

1. If using a PWM signal to set mechanical neutral, check that servo pressure differential is less than 1.5 bar [22 psi]. Refer to Control Neutral Adjustment.
2. To verify mechanical neutral, provide current to solenoid C1,or turn neutral adjust excenter screw, until the servo pressure differential is 3 bar [43 psi]. The system pressure differential must be below 1.5 bar [22 psi]. Repeat test on solenoid C2 side.
3. The current required to set the servo pressure differential to 3 bar [43 psi] should be the same for each solenoid. Refer to TS-392.
4. If using neutral adjust excenter screw to set mechanical neutral, reset control neutral.

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Removing the Pump

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

⚠ CAUTION

CONTAMINATION CAN DAMAGE INTERNAL COMPONENTS AND VOID THE MANUFACTURER'S WARRANTY. TAKE PRECAUTIONS TO ENSURE SYSTEM CLEANLINESS WHEN REMOVING AND INSTALLING SYSTEM LINES.

DISASSEMBLY, INSPECTION, ASSEMBLY

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

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

4. Ensure the work surface and surrounding area are clean and free of contaminants such as dirt and grime.
5. Inspect the system for contamination.
6. Look at the hydraulic fluid for signs of system contamination, oil discoloration, foam in the oil, sludge, or metal particles.
7. Before replacing the pump, replace all filters and drain the hydraulic system. Flush the system lines and fill the reservoir with the correct, filtered hydraulic fluid.
8. Fill the pump with clean, filtered hydraulic fluid.
9. Attach the pump to the prime mover. Torque mounting screws according to the manufacturers recommendation.
10. Replace all hydraulic lines. Ensure the charge inlet line is filled with fluid.

Electric Control Module

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

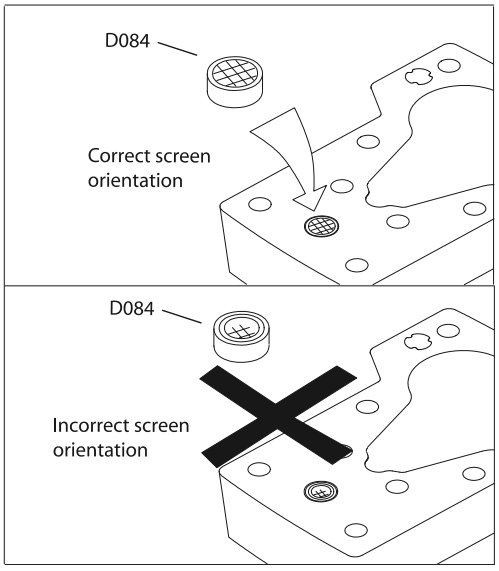
REMOVAL, INSPECTION, REASSEMBLY

Refer to Figure 5-37., Control Module Removal/Installation.

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

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

5. Install a new gasket (D150).
6. If you removed screen (D084), install a new one. Install with the mesh facing outward (see drawing).



7. If previously removed, install orifices (F100) using a 3 mm internal hex wrench. Torque to 2.5 Nm [1.8 lb.ft.].
8. Install the control module and six capscrews (D250).
9. Using a 5 mm internal hex wrench, torque the capscrews (D250) to 13.5 Nm [10 lb.ft.].

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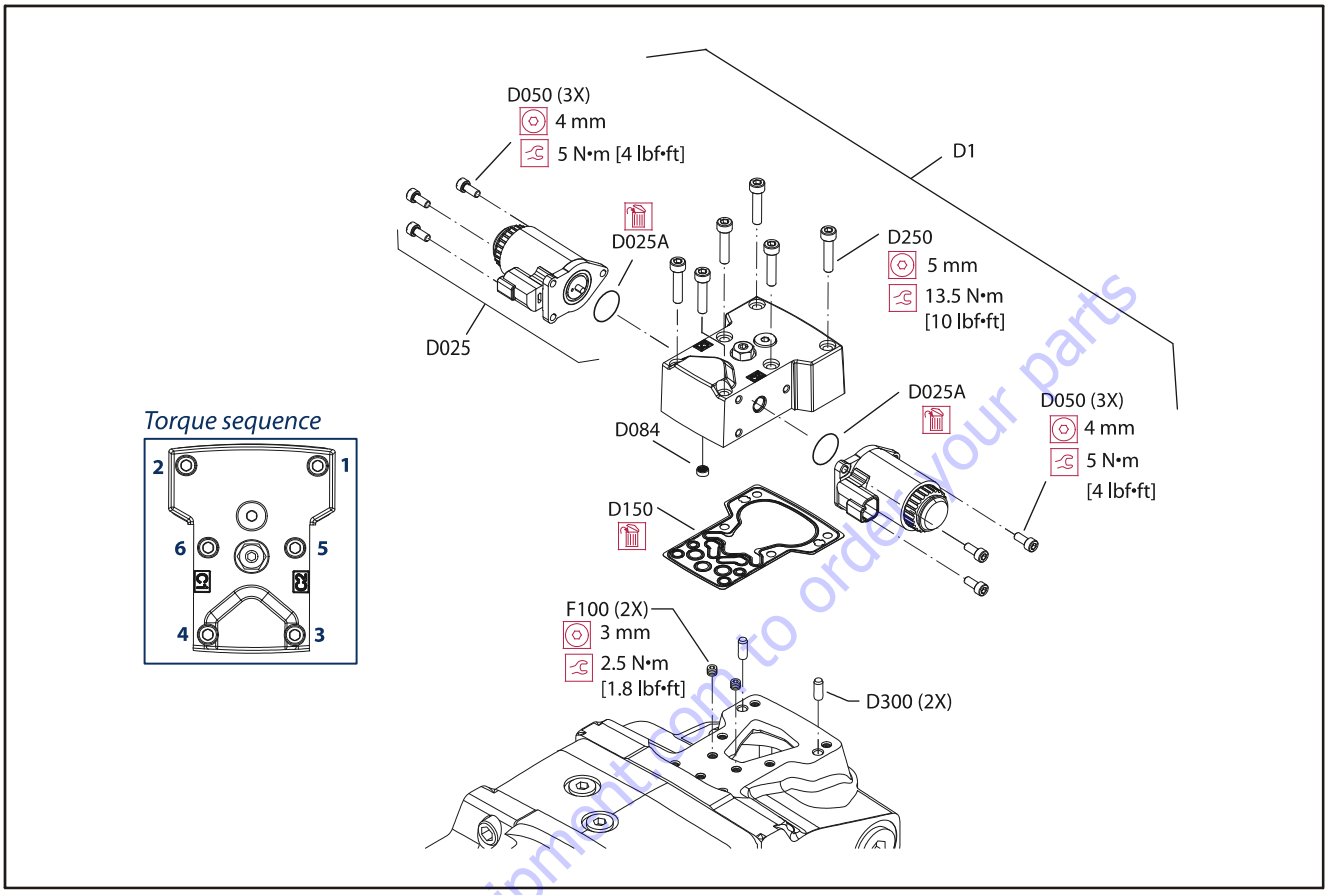

Figure 5-37. Control Module Removal/Installation

Control Solenoids

REMOVAL, INSPECTION, REASSEMBLY

1. Disconnect electrical connection and remove the three capscrews (D050) using a 4 mm internal hex wrench.
2. Remove the solenoid (D025) and O-ring (D025A). Discard the O-ring.
3. If necessary, remove the coil using a 12 point 26 mm socket.
4. Inspect the machined surface on the control. If you find any nicks or scratches, replace the component.
5. Lubricate new O-ring (D025A) using petroleum jelly and install.
6. Install solenoid with three capscrews (D050) using a 4 mm internal hex wrench. Torque screws to 5 Nm [4 lb.ft.].
7. Install coil using a 12 point 26 mm socket. Torque coil nut to 5 Nm [3.7 ft.lbs.].
8. Reconnect electrical connections and test the pump for proper operation.

Shaft Seal, Roller Bearing and Shaft Replacement

⚠ CAUTION

DO NOT DAMAGE THE HOUSING BORE, SHAFT OR BEARING WHEN REMOVING THE SHAFT AND SHAFT SEAL.

The shaft assembly is serviceable without disassembling the pump. Orient the pump on the work surface so the shaft is pointing to the side.

REMOVAL, INSPECTION, ASSEMBLY

1. Unwind the spiral ring (J300) from the housing to release the shaft/seal/bearing subassembly.
2. Pry on the lip of the seal carrier (J275) to dislodge it from the pump. Remove the seal carrier. Remove and discard O-ring (J260). Press the seal (J250) out of the carrier and discard.

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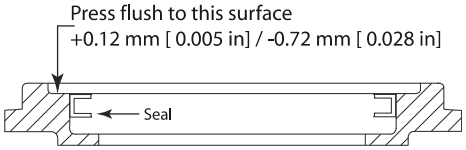
3. Pull the shaft (J100) with bearing (J150) out of the pump. If necessary, tap lightly on the shaft to dislodge it from the cylinder block. C
4. Remove the retaining ring (J200) using retaining ring pliers. Press the bearing off the shaft.
5. Inspect the shaft journals for wear, scratching, and pits. Check the splines for fretting; replace if damaged. Rotate the bearing, if it does not rotate smoothly, replace it.
6. Press the bearing (J150) onto the shaft (J100) and replace the retaining ring (J200). Ensure the retaining ring diameter is less than 38.84 mm [1.53 in] when installed on the shaft.
7. Install the shaft/bearing assembly into the pump.
8. Lubricate and install a new O-ring (J260) onto seal carrier (J275). Press a new seal (J250) into the seal carrier. Press the seal until it is flush within +0.12mm [0.005 in] or -0.72 mm [0.0028 in] of the inside lip of the carrier as shown below.



9. Cover the shaft with a protective sleeve while installing the seal carrier. Hand press the seal carrier into the housing. Ensure the seal carrier clears the spiral ring groove in the housing. Remove the protective sleeve.
10. Wind the spiral ring into the housing. Ensure the inside diameter of the spiral ring is greater than 68 mm [2.677 in] after installation.

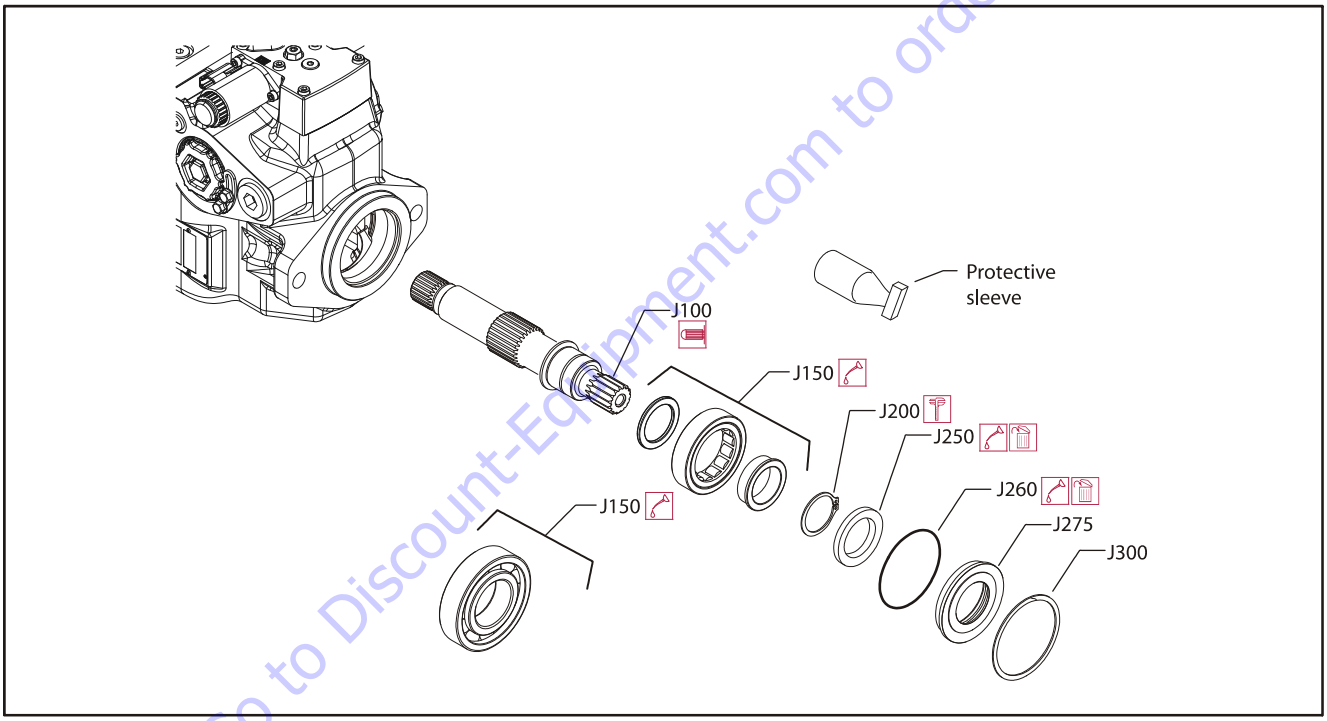


Figure 5-38. Shaft assembly

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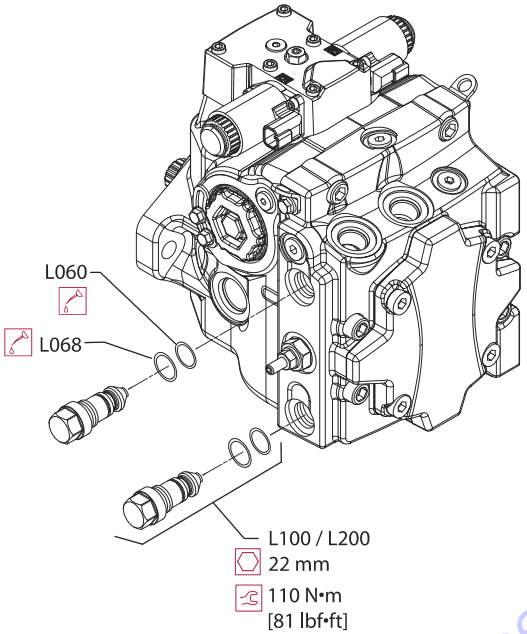
Charge Check / HPRV

REMOVAL, INSPECTION, ASSEMBLY

1. Using a hex wrench shown in the table below, remove the HPRVs (L1 50). Remove and discard the O-rings (L060) and backup rings (L068).



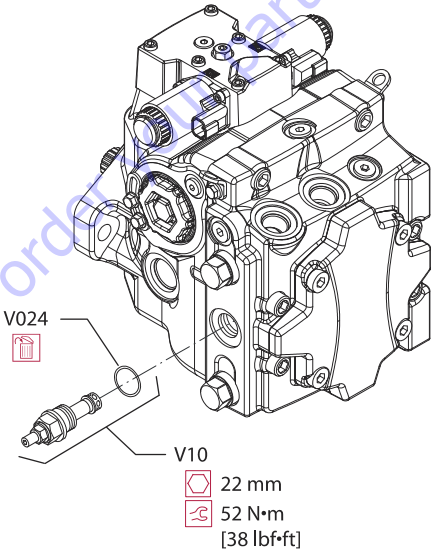
2. Inspect the sealing surfaces in the pump for nicks or scratches. Check the valves for damage. Replace any damaged components.
3. Lubricate and install new backup rings (L068) and O-rings (L060).
4. Install HPRVs. Torque to the value in the table below.
5. Operate the vehicle/machine through full range of controls to ensure proper operation. Check for leaks.

Charge Pressure Relief Valve

Replace the charge pressure relief valve (V010) as a complete unit. Do not attempt to repair the internal components of the valve. Torque to 52 Nm [38 lb.ft.]. See Charge Pressure Relief Valve Adjustment for adjustment instructions.

REMOVAL, INSPECTION, ASSEMBLY

1. Using a 22 mm wrench, remove the charge pressure relief valve (V010). Discard seal (V024).



2. Inspect the sealing surfaces of the pump for nicks or scratches.
3. Lubricate and install new seal (V024).
4. Install the charge pressure relief valve. Torque to 52 Nm [38 lb.ft.].
5. Operate vehicle/machine through full range of controls to ensure proper operation.

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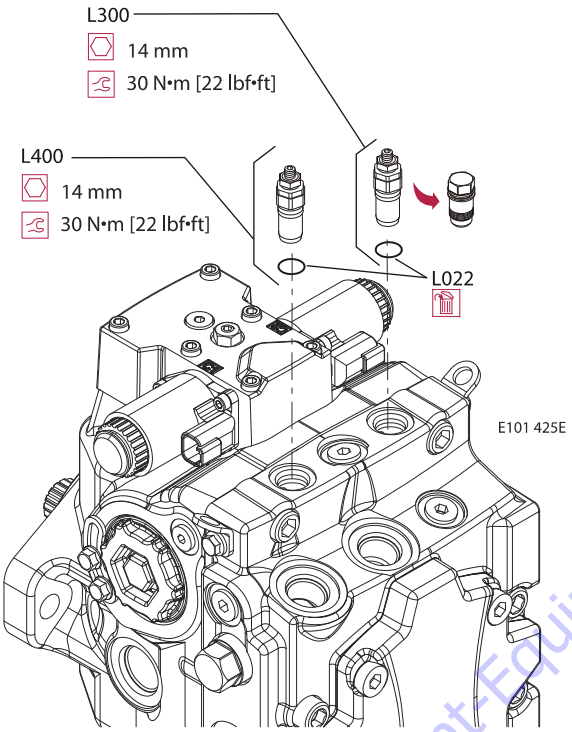
Pressure Limiter Valve Replacement

Replace the pressure limiter valve as a complete unit. Do not attempt to repair individual components. See Pressure limiter adjustment for adjustment instructions.

REMOVAL, INSPECTION, ASSEMBLY

1. Using a 14 mm wrench, remove the pressure limiter valve (L100). Discard O-ring.



2. Inspect the sealing surfaces of the pump for nicks or scratches.
3. Install new O-ring. Lubricate O-ring with petroleum jelly.
4. Replace pressure limiter valve. Torque to 30 Nm [22 lb.ft.].
5. Operate pump at full range of controls to ensure proper machine operation. Pressure limiter is available as complete unit only. O-ring is available separately.

5.4 GEAR PUMP

Disassembly

Prior to proceeding with disassembly, it may be necessary to prepare some subassemblies separately.

The details for preparing each subassembly are given in the following section.

Also, some general recommendations are given below.

CLEANLINESS

Cleanliness is a primary factor for reliable pump performance. Wash the outside of the pump thoroughly before disassembly and all pieces prior to assembly. Cleaning parts with clean shop solvent and air drying is usually adequate.

LUBRICATION OF MOVING PARTS

During assembly, it is imperative to provide lubrication with clean hydraulic oil to all the running parts of the pump.

It is also necessary to coat the seals with grease. The absence of lubrication during assembly can cause the unit to seize after a few minutes of running.

CARE OF SURFACE TREATMENT

Be careful when handling all the internal surfaces, especially bearings, gears, and body faces. Do not touch or score them with metal tools or cutting edges.

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MARKING THE PARTS

Mark the parts before completely disassembling a pump. The marks allow components to be reassembled in the same relative position. This action should be applied to the body, bearings, and gears. Scribing, bluing, or using a felt tip pen to mark the outside of the body on the inlet side is suggested to indicate the relative position of the front flange and the rear cover to the body. Mark the bearing blocks also on the inlet side and the gears position relative to each other. DO NOT scribe internal surfaces.

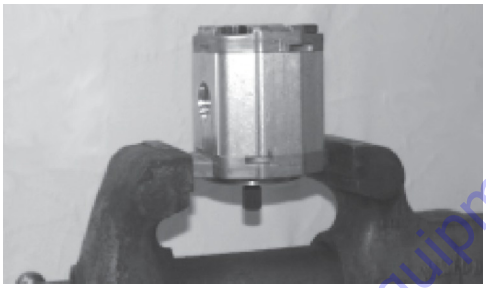
PROCEDURE

1. Clamp the unit.

   Clamp the unit in a vice from the flange side.

   Make sure the vice jaws are clean and have smooth surfaces to prevent damage to the pump.

   Clamping the pump on the body is not recommended because serious damage to the surfaces, on which the ports are located, may occur.



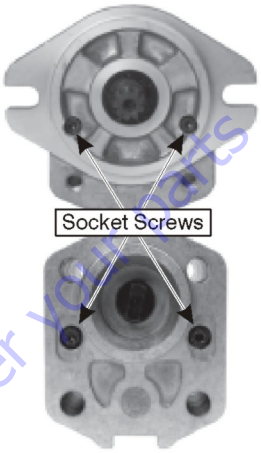
2. Remove capscrews.

   Use a 17 mm socket wrench and loosen the four capscrews on the cover. Next completely unscrew the capscrews and remove them.

   Inspect the threads of the capscrews for damage.

3. Remove socket head capscrews.

   Using a 4 mm internal hex wrench, loosen and remove the two small socket screws placed in the center of the cover. Repeat the same operation for the corresponding screws on the rear flange.



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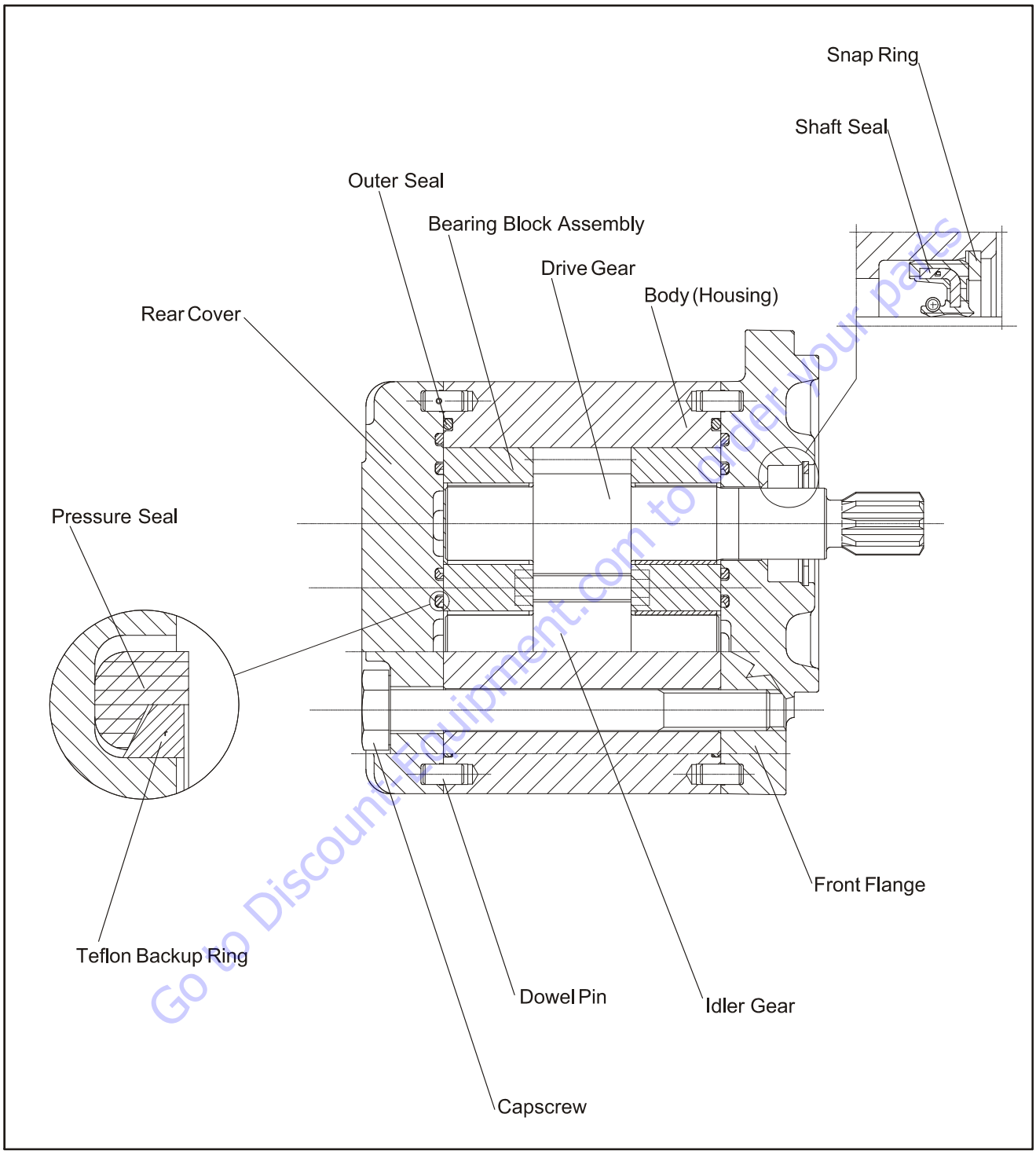

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Figure 5-39. Gear Pump Cutaway

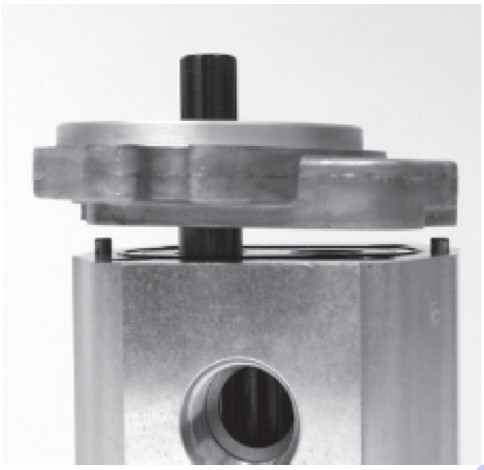
4. Remove front flange.

   Place the pump on the table and slowly remove the front flange.

   Be careful not to damage the shaft seal when removing the flange. Avoid contact of the shaft seal lips with keyway edges (in tapered and parallel shafts) or splined shaft teeth.

   Inspect the front flange and seal area.

   Clean with shop solvent, dry, and set aside.



5. Remove rear cover.

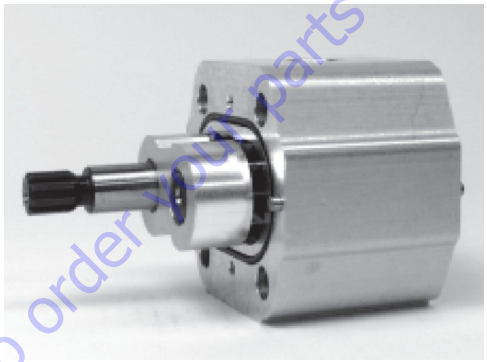
   Clean with shop solvent, dry, and set aside.

   Visually inspect rear cover and seal area.

6. Remove bearing blocks and gears.

   Place the pump on its side and carefully remove the bearing block and gear set. To accomplish this, hold the pump body and push with your fingers on the rear bearing block.

   Mark the relative positions of the gear mesh (drive gear tooth to idler gear tooth) and the bearing blocks to the body so they can be reassembled in the same position.



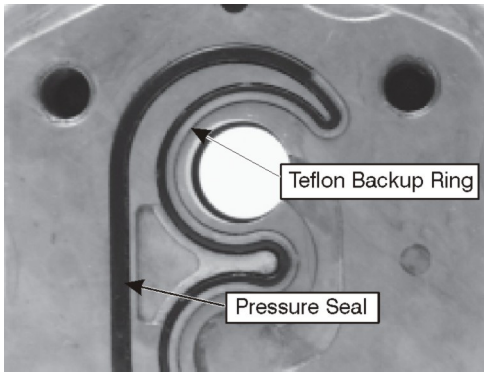
7. Remove pressure seals.

   Check the seal quality. Replacement is recommended whenever there are burrs, evidence of extrusion, or marks caused by overheating. If the seals need to be replaced, carefully remove them from the flange cover, beginning with the backup ring and then the pressure seal.

NOTICE

IMPORTANT: DO NOT USE TOOLS WITH SHARP EDGES TO REMOVE THE SEALS, AS DAMAGE TO THE COVER CAN RESULT.

After removal, dispose of damaged seals.



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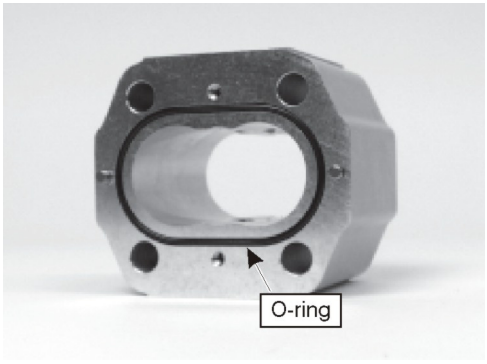
8. Remove Outer O-Ring Seal

Check the quality of this seal. If necessary, replace it. Follow the same removal recommendations given in step 7.}

After removal, discard the damaged seal.

NOTICE

DO NOT USE TOOLS WITH SHARP EDGES TO REMOVE THE SEALS, AS DAMAGE TO THE COVER CAN RESULT.



9. Remove the snap ring.

Place the flange on the work surface. Using internal snap ring pliers, remove the snap ring.

10. Remove the shaft seal.

Check the shaft seal quality and remove if necessary.

To remove, pry the bottom of the shaft seal and force it out while rotating the flange to lift it out evenly.

Do not use the flange pilot to gain leverage, damage may result. Use a plastic rod or wooden dowel as a fulcrum.

After removal, dispose of damaged seal.

ASSEMBLY

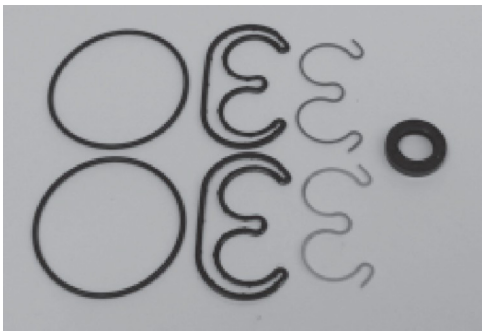
1. Prepare the seals.

Have the entire seal kit available.

Lightly coat all seals with seal grease. The grease is needed to adhere the seals to their grooves.

NOTICE

DO NOT INSTALL DRY SEALS.



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2. Install shaft seal into front flange.

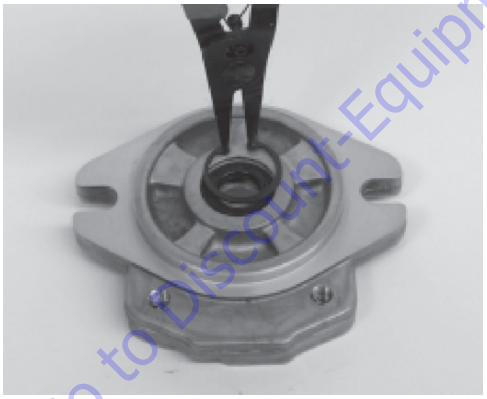
Prepare the flange and shaft seal by lightly.

lubricating with grease.

Seat the seal in the flange by hand. Then, using the shaft seal installation tool (shown on page 52), press the seal until the tool stops on the flange. This will insure the seal is inserted to the proper depth.

3. Install snap ring.

Install the snap ring using internal snap ring pliers. Ensure the snap ring fits securely in its groove. This is necessary to retain the shaft seal.

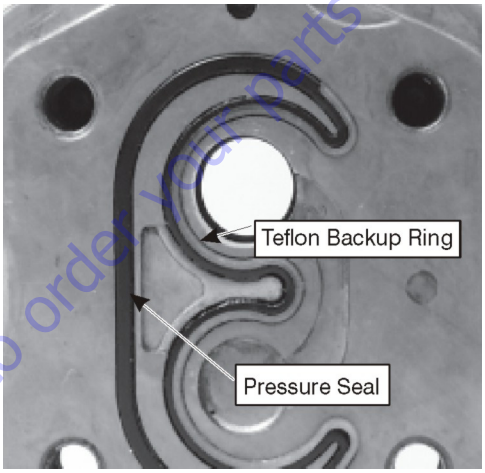


4. Install pressure seals.

Prepare the pressure seals by lightly lubricating them with grease.

Install pressure seals into the grooves on the front flange and rear cover. Then install the teflon backup ring.

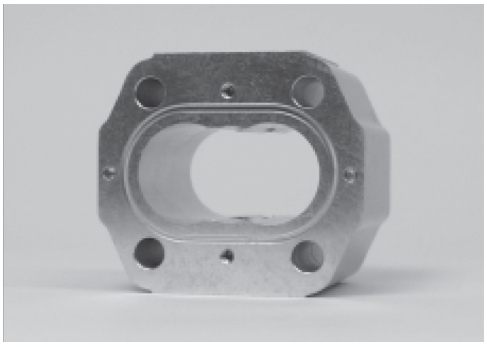
Ensure that the seals are located in the grooves, as shown.



5. Prepare the body.

Clean the body.

Inspect the internal and mating surfaces. Ensure the surfaces are free of burrs and scratches. Check both the bearing block mating surface and the cut-in path. The cut-in path should be no deeper than 0.1 mm (0.004 in).



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6. Install outer seal.

   Prepare the outer seal by lightly lubricating with grease.

   Install outer seals in the grooves on both sides of the body.

7. Prepare the gears.

⚠ CAUTION

THE GEAR SURFACES ARE SUPERFINISHED. RESIDUE ON HANDS AND FINGERS MAY BE CORROSIVE TO THIS SURFACE. DO NOT TOUCH.

   Carefully clean the two gears. If the gears are new, wash them with shop solvent to remove any anticorrosive grease on the surfaces.

   Inspect the journals and the flat faces on the top and bottom of the gears. Ensure these surfaces are free from burrs or scratches. If scratches or burrs are found, clean them with a flat stone and/or very fine emery paper. Rewash the gears after this operation.

8. Prepare the bearing blocks.

   Clean the two bearing blocks.

   Inspect the flat surfaces of the bearing blocks for burrs or scratches on the edges. If necessary, remove burrs with very fine emery paper. Then rewash the bearings.

   Inspect the DU™ bushings for wear. There should be no bronze showing.

   Using clean hydraulic oil, lubricate the internal and external surfaces of the bearing blocks.

9. Assemble the bearing blocks and gears.

   Lubricate the journals and the gear faces.

   Assemble the bearing blocks and gears. Ensure that the recessed bearing faces are installed adjacent to the gear faces. Align all assembly marks made during disassembly. Ensure the front and rear bearing blocks occupy the same location with respect to the housing as before disassembly. Ensure that the relative position of the gear mesh is maintained as before disassembly. Misalignment of the gear teeth may increase operating noise.

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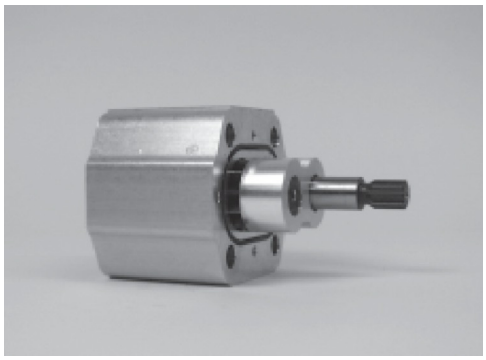
10. Install the gear block assembly.

Install the bearing block and gear assembly into the body cavity. Align the assembly marks to ensure that the gear block assembly is installed with the same orientation as before disassembly.



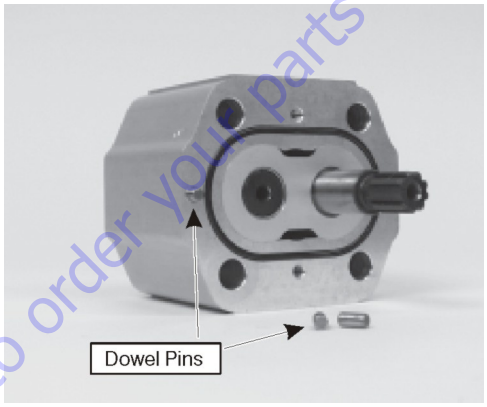
11. Clean the mating surfaces.

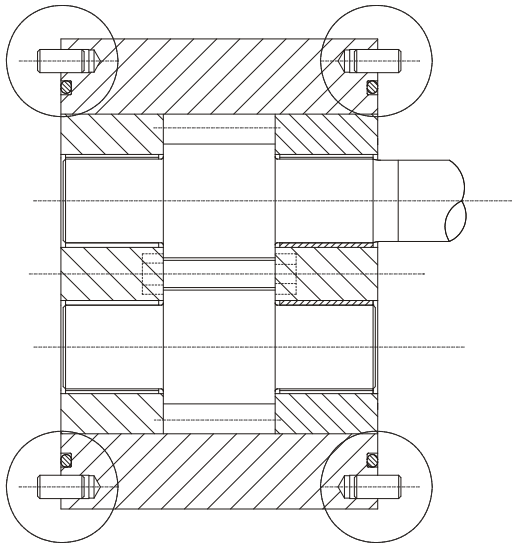
Remove any excess lubrication and grease from the mating surfaces of the pump body. Ensure that these surfaces are dry and free of contamination before moving on to the next step.

12. Install the dowel pins.

Install four 5 mm dowel pins into the proper cavities on both sides of the body (refer to the illustration below). Swab the pins with assembly grease or petroleum jelly to retain them during assembly.

Do not install dowel pins to the rear cover or flange, as one of them may drop inside the pump during assembly.





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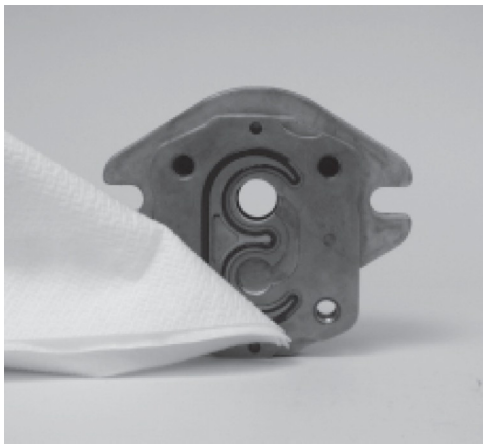
13. Clean the mating surfaces.

Remove any excess lubrication and grease from the mating surfaces of the front flange and rear cover. Ensure that these surfaces are dry and free of contamination before moving on to the next step.

Ensure the pressure seals are seated properly after this operation.

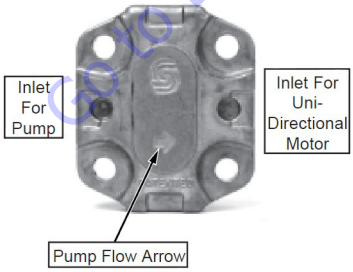


14. Install Rear Cover.

Mount the cover on the body. Ensure the arrow on the back is oriented properly. The arrow should be:

- In the same direction as the flow if the unit is a pump.
- Against the direction of the flow if the unit is a unidirectional motor.
- If the unit is a bidirectional motor the arrow does not appear on the cover.

Ensure that all the pressure seals stay in place during this operation.



15. Prepare pump for front flange assembly.

Place the pump with the rear cover downwards.

Ensure that the assembly marks on the bearing block / body are properly aligned.

16. Install the front flange.

Install a protective sleeve over the shaft. The sleeve is used to protect the shaft seal from damage by the shaft splines / keyway during front flange assembly.

Install the flange onto the body, then remove the protective sleeve.

Ensure that the seals remain seated in their grooves during this operation.

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17. Torque sequence.

Install capscrews. While observing the torque sequence shown, pre tighten the capscrews. Then, using a torque wrench, tighten them to the proper torque.

Torque 44-54 Nm (32-40 ft.lbs.).

18. Install socket head capscrews.

Using a 4 mm internal hex wrench, install the socket head capscrews to the front flange and rear cover.

Torque 2.5-3.4 Nm (22-30 ft.lbs.).

If used, install new o-ring to flange pilot.

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Troubleshooting

Low or No Flow From Gear Pump		
Item	Description	Action
1. Check oil level in reservoir.	Insufficient oil to supply gear pump.	Fill reservoir to proper level.
2. Check input spline condition.	Input shaft broken or stripped.	Repair or replace gear pump.
3. Check pressure at pump inlet. Recommended inlet pressure: 0.8 to 3.0 bar absolute. 0.6 Minimum at cold start.	Clogged suction filter or inlet screen.	Replace filter or clean suction screen.
4. Check condition of gear faces and bearing blocks.	Scored bearing block and gear faces will reduce pump efficiency.	Repair or replace gear pump.
5. Check bushings.	Overpressure of gear pump will cause idler gear bushing to fail.	Repair or replace gear pump.

Excessive Noise		
Item	Description	Action
1. Check oil level in reservoir.	Excessive air will cause cavitation sound.	Fill reservoir to proper level.
2. Check inlet line for leaks.	Excessive air will cause cavitation sound.	Repair inlet line.
3. Check pressure at pump inlet. Recommended inlet pressure: 0.8 to 3.0 bar absolute. 0.6 Minimum at cold start.	Lower than normal inlet pressure causes excessive pump noise.	Return inlet pressure to recommended levels.

External Leakage		
Item	Description	Action
1. Check for pinched o-rings or backup ring seal.	Pinched seal will allow leakage.	Replace pinched seal.
2. Check pressure seals.	Damage to pressure seals is typically caused by reduced "stack-up" in the pump assembly. This may be due to under-torqued assembly fasteners, or more commonly is attributed to excessive wear on the bearing blocks. Reduced "stack-up" will affect seal efficiency possibly to the point of seal extrusion.	Inspect condition of bearing blocks. If they are found to be worn, repair or replace the pump. If bearing blocks are not worn, replace pressure seals and re-torque pump assembly fasteners.

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5.5 PRESSURE SETTING PROCEDURE

1. P1 Main relief valve

   This is a solenoid valve and relief valve all in one. The relief portion is pre-set and non adjustable. The cartridge is located on the "T" port face of the valve block. This cartridge is the solenoid valve located at the top on that face. To check, install a pressure gauge at port "M1". Activate lower lift up. At the end of stroke, the pressure read should be 2500 psi, +/- 150 psi. If the boom cannot be raised to full extension, remove the hose from port "#6". Plug and cap. This is non adjustable, so if the setting is not correct the valve cartridge will need replaced.

2. P2 Main relief valve

   This is a solenoid valve and relief valve all in one. The relief portion is pre-set and non adjustable. The cartridge is located on the tank port face of the valve block. This cartridge is the solenoid valve located just above the "T" port. To check, install a pressure gauge at port "M2". Activate telescope in, or remove the hose from port "P4". Plug and cap. The pressure read should be 3000 psi, +/- 150. This is non adjustable, so if the setting is not correct the valve cartridge will need replaced.

3. Swing relief valve

   The swing relief valve is adjustable and is located on the "T" port face of the valve block. The relief valve is located right next to the "T" port. To check, install a pressure gauge at port "MS". Activate swing until the turn-table is bottomed out at the stop. You can also remove the hose from port "5", plug and cap. Activate swing right. You should read 1000 psi +/-100. To increase, turn clockwise. To decrease, turn counterclockwise.

4. Steer relief valve

   The steer relief valve is adjustable and is located on the "T" port face of the valve block. The steer relief valve is located right next to the swing relief valve. To check, install a pressure gauge at port "M2". Activate steer right. You should read 2500 psi +/-100. To increase, turn clockwise. To decrease, turn counterclockwise.

5. Platform level up relief valve

   This relief valve is adjustable and is located on the valve manifold inside the tower upright boom. Install a pressure gauge at port "M1" of this valve. Remove the hose from port L1 located on the bottom of the valve. Plug and cap. The relief valve is located above port "T2". Activate level up. The pressure read should be 2800 psi +/-100. To increase, turn clockwise. To decrease, turn counterclockwise. Re-hose port L1.

6. Platform level down relief valve

   This relief valve is adjustable and is located on the valve manifold inside the tower upright boom. Install a pressure gauge at port "M2" of this valve. The relief valve is located above port "P2". Activate level down. The pressure read should be 1400 psi +/-100. To increase, turn clockwise. To decrease, turn counterclockwise.

5.6 OIL SAMPLING

See Figure 5-40., 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.

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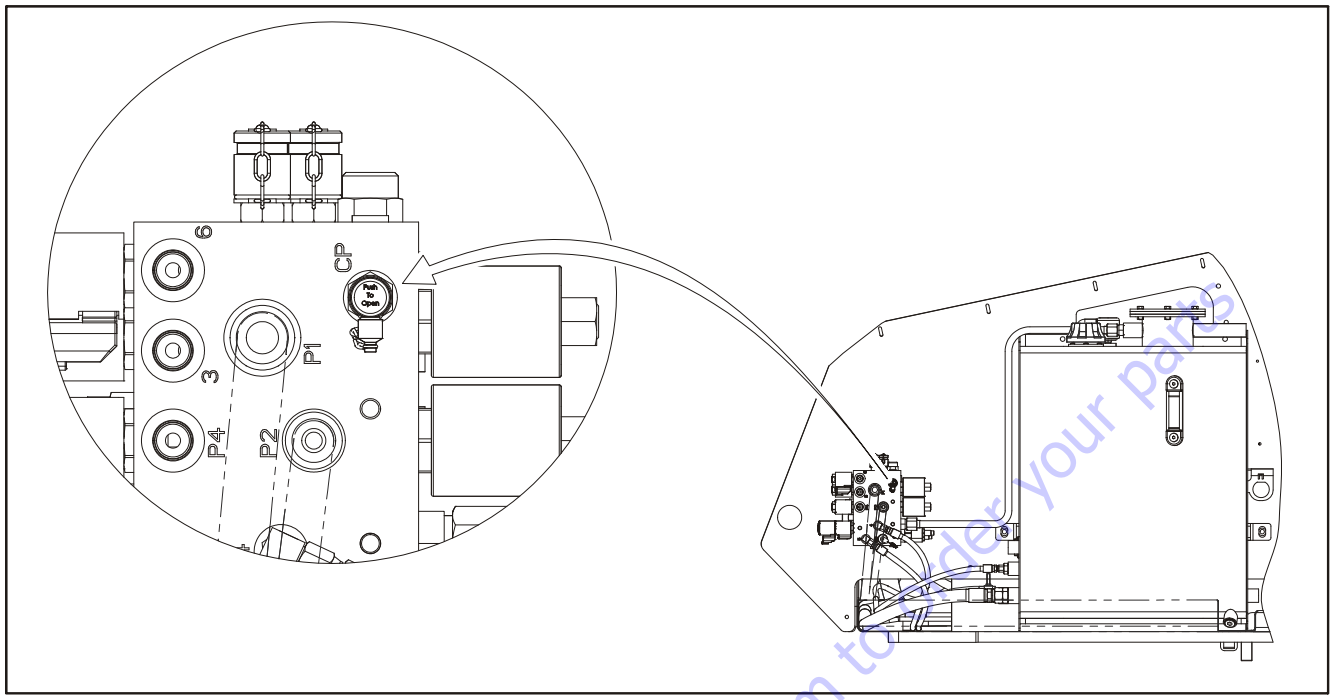

Figure 5-40. Oil Sampling Port

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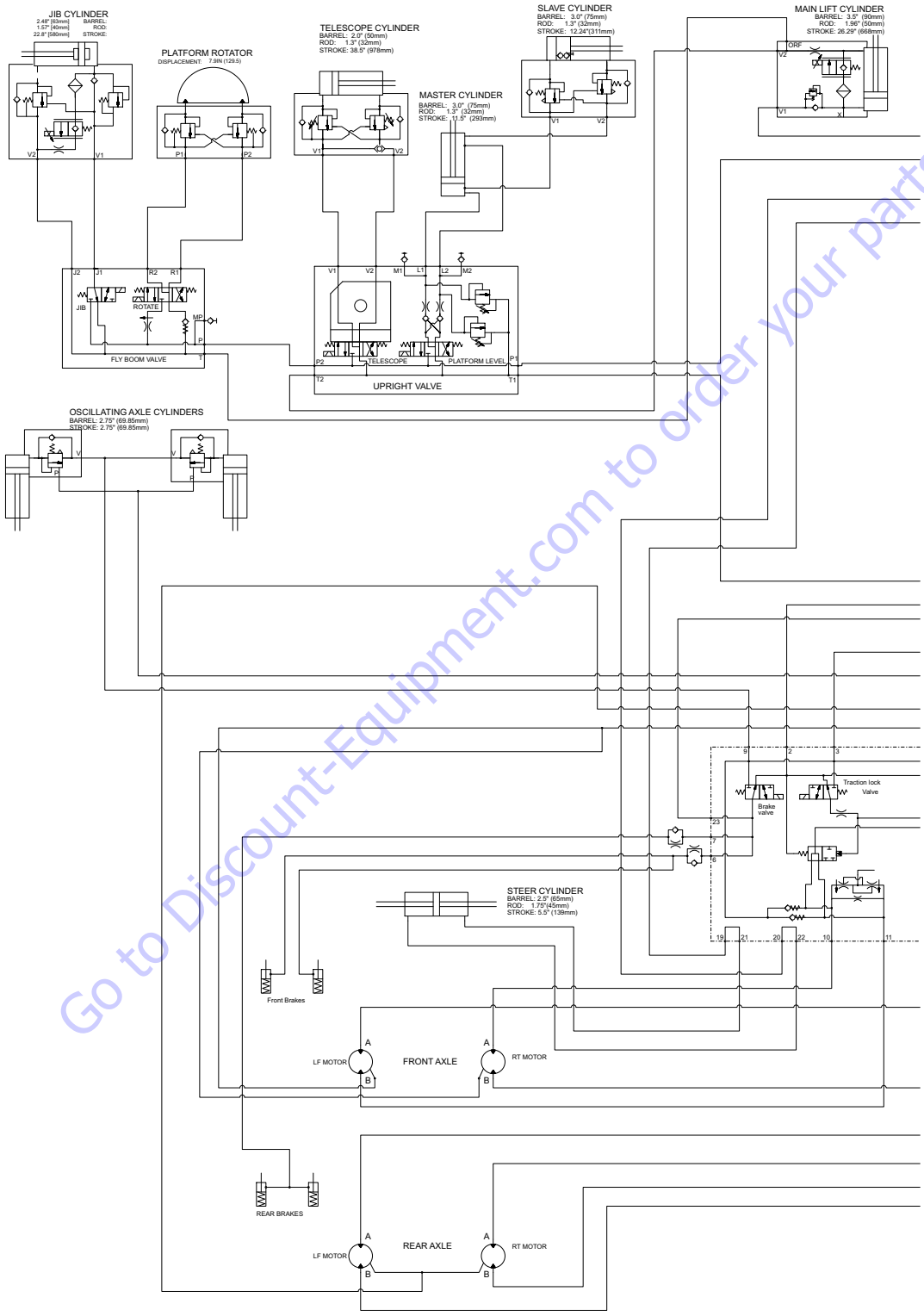
5.7 HYDRAULIC SCHEMATIC



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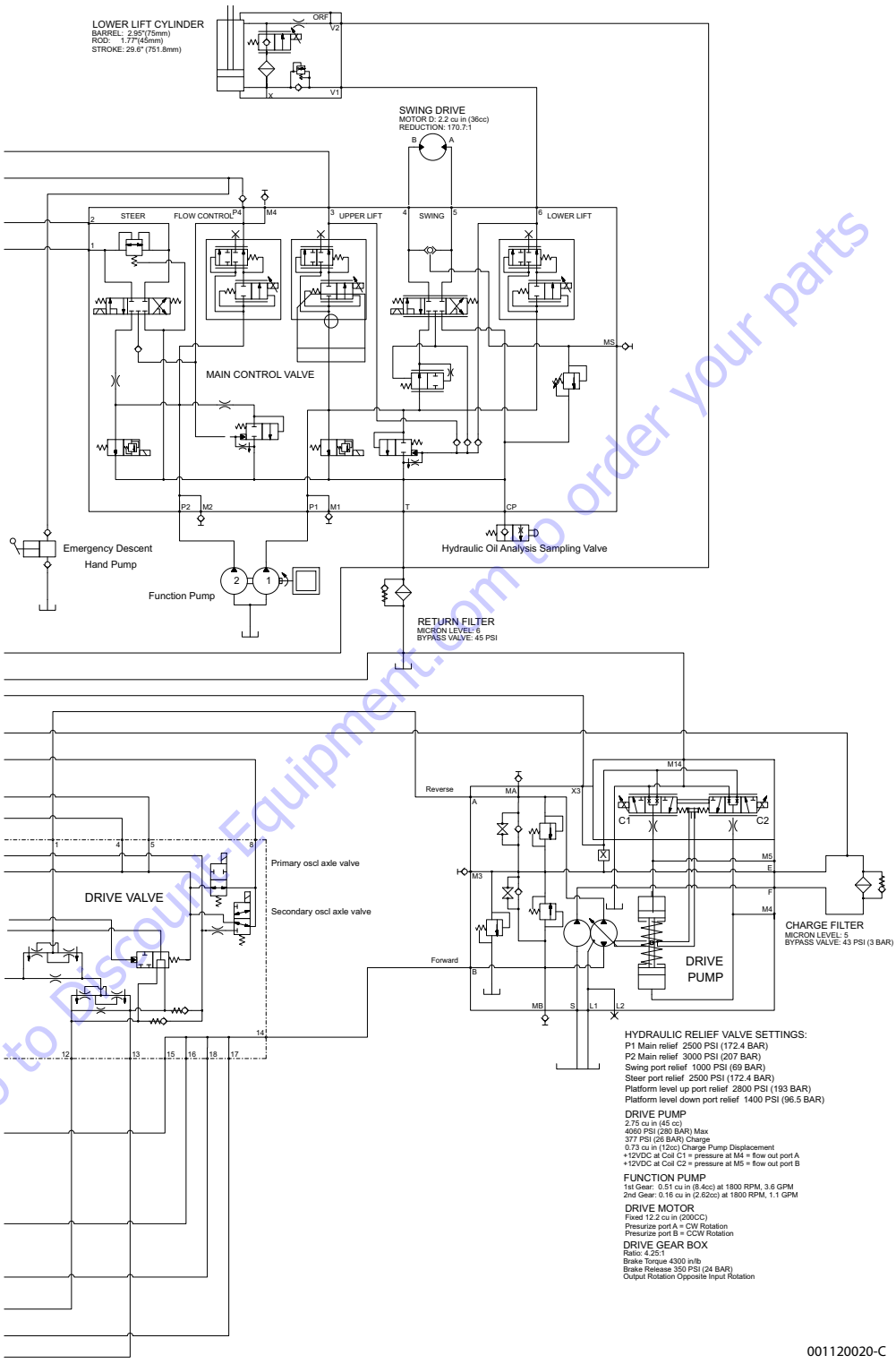

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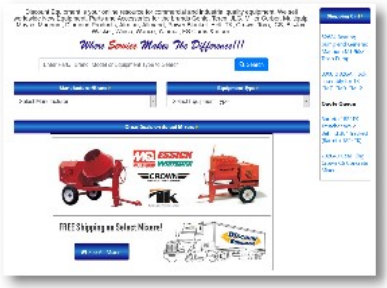

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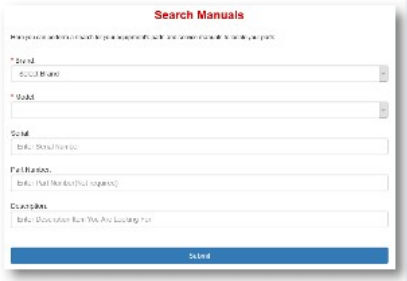

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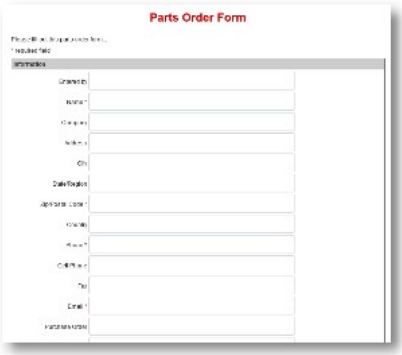

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SECTION 6. JLG CONTROL SYSTEM

6.1 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

Introduction

NOTICE

WHEN INSTALLING A NEW POWER MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

NOTICE

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based motor control unit installed on the boom lift.

The JLG Control System provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep and max.-speed for all boom, drive, and steering functions.

The upper lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The controller will control current output, as programmed for smooth operation and maximum cycle time. Speeds for all boom functions can also be adjusted via the Personalities menu on the Analyzer.

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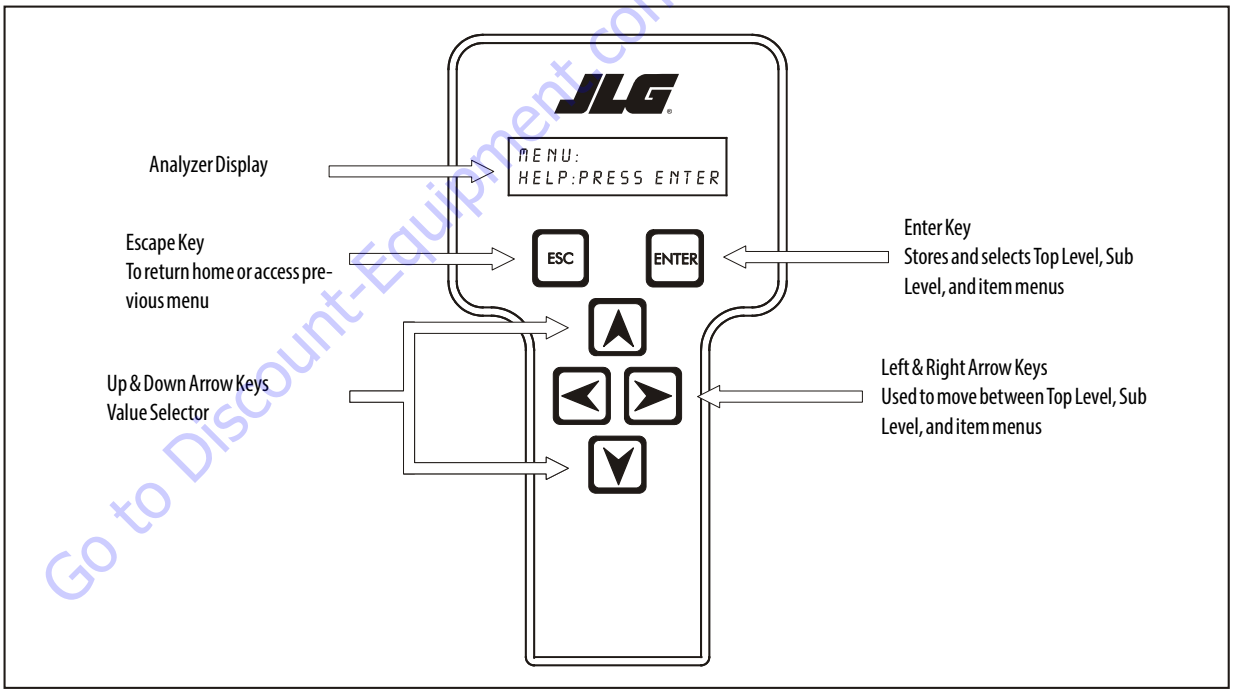

Figure 6-1. Hand Held Analyzer

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a beacon light, function cutout, and ground alarm. These options may be added later but some must be programmed into the controller when installed.

The Control System may be accessed by using a custom designed, hand held analyzer (Analyzer Kit, JLG PN 2901443 or separately, Analyzer, JLG PN 1600244 & Cable, JLG PN 1600633) which will display two lines of information at a time, by scrolling through the program.

NOTE: *Each module has a label with the JLG part number and a serial number which contains a date code.*

6.2 ANALYZER MENU STRUCTURE

There are seven levels within the Analyzer menu structure and they are as follows;

1. **HELP: PRESS ENTER**
   This is the default menu that appears at power up of the Analyzer. This menu displays the current Help (fault) message. This is intended to quickly guide the technician in the event of a fault in the JLG Control System. This menu also displays functional interlocks. Pressing ENTER shows Logged Help which is a record of the last 25 Help (fault) messages. Editing of information in this menu is not possible.

2. **DIAGNOSTICS**
   This menu provides real-time status information about the control system as a diagnostic aid.

3. **SYSTEM TEST**
   This menu is used to activate and then interact with the Control System's self-test functionality. Starting the System Test will cause the functionality of each device to be tested. Outputs are energized to detect short or open circuit conditions and digital inputs are stimulated to simulate switching conditions. Editing of information in this menu is not possible.

4. **ACCESS LEVEL**
   This menu allows the technician to navigate between access levels; Operator Access or Service Access. To enter the Service access level, a five-digit code must be entered. Powering down returns the Analyzer to Operator Access.

5. **PERSONALITIES**
   This menu contains performance settings specific to the machine. These settings are necessary to maintain functions such as solenoid breakpoints and joystick engagement percentages and are organized in an outline format (see Figure 6-13., Analyzer Flow chart (Version P2.14) - Sheet 5 of 8). These settings can be modified in the Service access level.

6. **MACHINE SETUP**
   This menu contains machine configuration information for the JLG Control System. Selections in this menu can change interlock functionality and cause some Personality and Machine Setup entries to be visible or hidden. These settings can be modified in the Service access level.

7. **CALIBRATIONS**
   This menu allows the operator to interact with the sensors on the machine. These settings can be modified in the Service access level.

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6.3 USING THE HAND HELD ANALYZER

To Connect the JLG Control System Analyzer

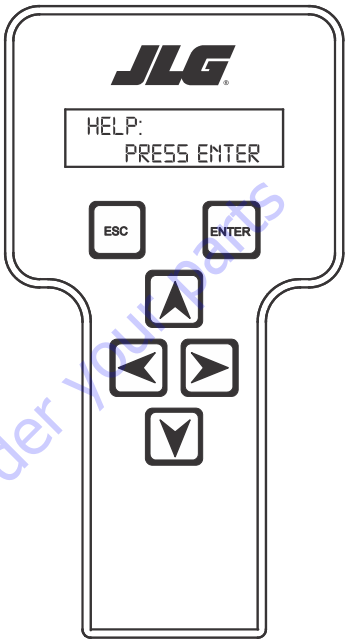
1. Connect the four pin end of the cable supplied with the analyzer, to the motor controller module located in the platform box or at the power module and connect the remaining end of the cable to the analyzer.

NOTE: *The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.*

2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.

Using the Analyzer

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

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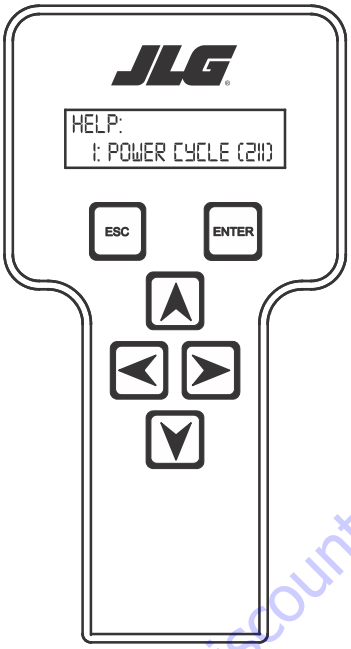
The top level menus are as follows:

HELP
DIAGNOSTICS
SYSTEM TEST
OPERATOR ACCESS
PERSONALITIES
MACHINE SETUP
CALIBRATIONS (Service Access only)

If you press **ENTER**, at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK.** If powered up at the ground station, the display will read: **GROUND OK.**

If **ENTER** is pressed again, the display moves to the following display:



LOG (211)
1: POWER CYCLE

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC.** two times. **POWER CYCLE (211)** indicates a power up.

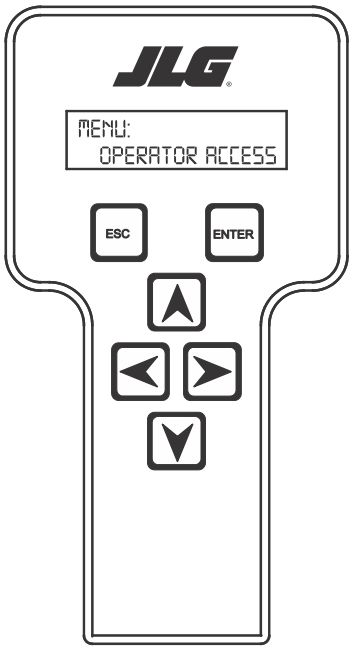
When a top level menu is selected, a new set of menu items may be offered: for example:

SYSTEM
DATALOG
VERSIONS
ENGINE
OPER CONTROLS

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in Operator Access level. Remember, you may always cancel a selected menu item by pressing the **ESC.** key.

Changing the Access Level of the Hand Held Analyzer

When the analyzer is first connected, you will be in Operator Access level which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **OPERATOR ACCESS** level menu. For example:



ACCESS LEVEL:
CODE 00000

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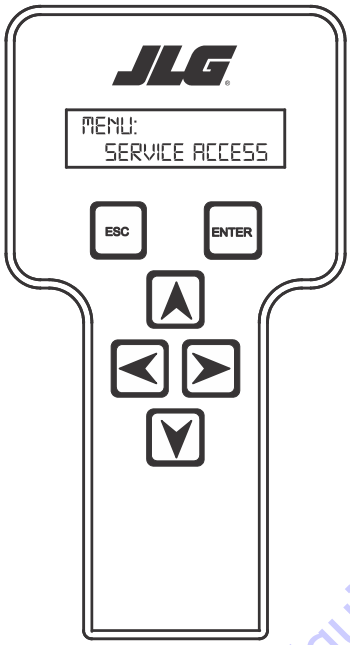
Press **ENTER** to select the **ACCESS LEVEL** menu.

Using the **UP** or **DOWN** arrow keys, enter the first digit of the password, 3.

Then using the **RIGHT** arrow key, position the cursor to the right one space to enter the second digit of the password.

Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

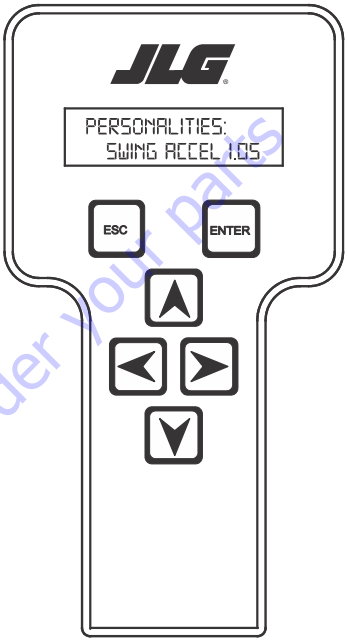


MENU:
SERVICE ACCESS

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

Adjusting Parameters Using the Hand Held Analyzer

Once you have gained Service Access, and a personality item is selected, press the UP or DOWN arrow keys to adjust its value, for example:



SWING:
ACCEL 1.0s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at Service Access.

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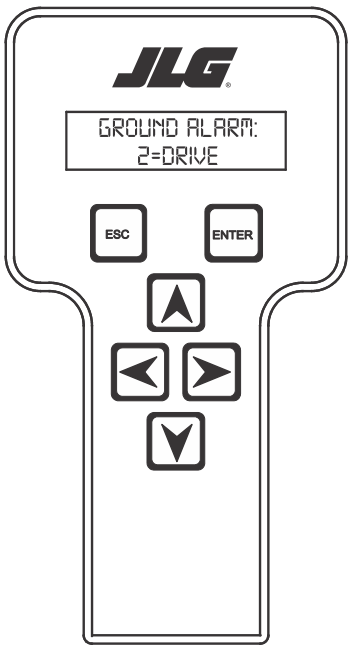
Machine Setup

When a machine digit item is selected, press the UP or DOWN arrow keys to adjust its value, for example:



GROUND ALARM:
2 = DRIVE

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when driving. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

NOTE: *Refer to Table 6-6, Machine Model Adjustment for the recommended factory settings.*

NOTE: *Password 33271 will give you Service Access, which will permit you to change all machine personality settings.*

There are two settings that JLG strongly recommends that you do not change. These settings are so noted below:

DRIVE MT ELEV MAX (Driving with engine at Max Torque and machine at maximum elevation)
DRIVE ME ELEV MAX (Driving with engine at Mid Engine and machine at maximum elevation)

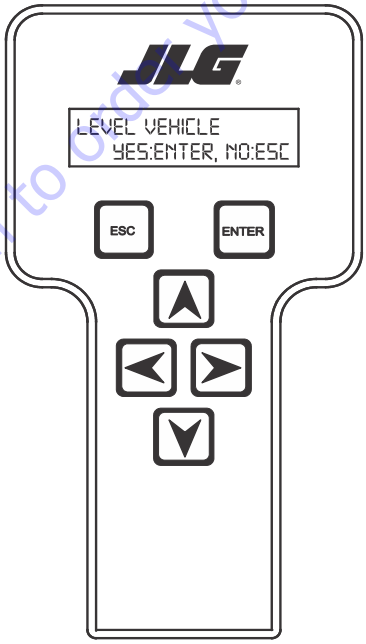
⚠ WARNING

CHANGING THESE SETTINGS COULD ADVERSELY AFFECT THE STABILITY OF YOUR MACHINE.

Level Vehicle Description

⚠ WARNING

DO NOT LEVEL VEHICLE EXCEPT ON A LEVEL SURFACE.



LEVEL VEHICLE
YES:ENTER, NO:ESC

Not available in Operator Access ENTER confirms that vehicle is currently level, and zeroes the tilt sensor measurements.

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Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
ACCEL	ACCELERATE
ACT	ACTIVE
A/D	ANALOG DIGITAL CONVERTER COUNT
AMB.	AMBIENT
ANG	ANGLE
AUX	AUXILIARY
BCS	BOOM CONTROL SYSTEM
BM	BOOM LENGTH ANGLE MODULE
BLAM	BOOM LENGTH ANGLE MODULE
BR	BROKEN
BSK	BASKET
CAL	CALIBRATION
CL	CLOSED
CM	CHASSIS MODULE
CNTL	CONTROL
CNTRL	CONTROL
C/O	CUT OUT
CONT(S)	CONTRACTOR(S)
COOR	COORDINATED
CRK PT	CRACK POINT
CRP	CREEP
CUT	CUTOUT
CYL	CYLINDER
DECEL	DECELERATE
D	DOWN
DN	DOWN
DWN	DOWN
DEG.	DEGREE
DOS	DRIVE ORIENTATION SYSTEM
DRV	DRIVE
E	ERROR
E&T	ELEVATED & TILTED
ELEV	ELEVATION
ENG	ENGINE
EXT	EXTEND
F	FRONT
FL	FLOW
FNT	FRONT
FOR	FORWARD
FWD	FORWARD
FSW	FOOT SWITCH
FUNC	FUNCTION
G	GROUND

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
mA	MA FOR MILLIAMPERES
mA/s	MILLIAMPERES PER SECOND
NO	NORMALLY OPEN or NO
NC	NORMALLY CLOSED
O	OUT
O/C	OPEN CIRCUIT
OP	OPEN
O/R	OVERRIDE or OUTRIGGER
O//R	OVERRIDE
OSC	OSCILLATING
OVRD	OVERRIDE
P	PLATFORM
P	PRESSURE
PCV	PROPORTIONAL CONTROL VALVE
PLAT	PLATFORM
PLT	PLATFORM
PM	PLATFORM MODULE
POT	POTENTIOMETER
PRES	PRESSURE
PRS	PRESSURE
PT	POINT
R	REAR or RIGHT
REV	REVERSE or REVISION
RET	RETRACT

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Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
ROT.	ROTATE
RT	RIGHT
S/C	SHORT CIRCUIT
SEL	SELECTOR
SN	SERIAL NUMBER
SPD	SPEED
STOW	STOWED
STOWD	STOWED
SW	SWITCH or SOFTWARE
TELE	TELESCOPE
TEMP	TEMPERATURE
TORQ.	TORQUE
TRN	TRANSPORT
T/T	TURNTABLE
T	TOWER
TURNTBL	TURNTABLE
TWR	TOWER
U	UPPER or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

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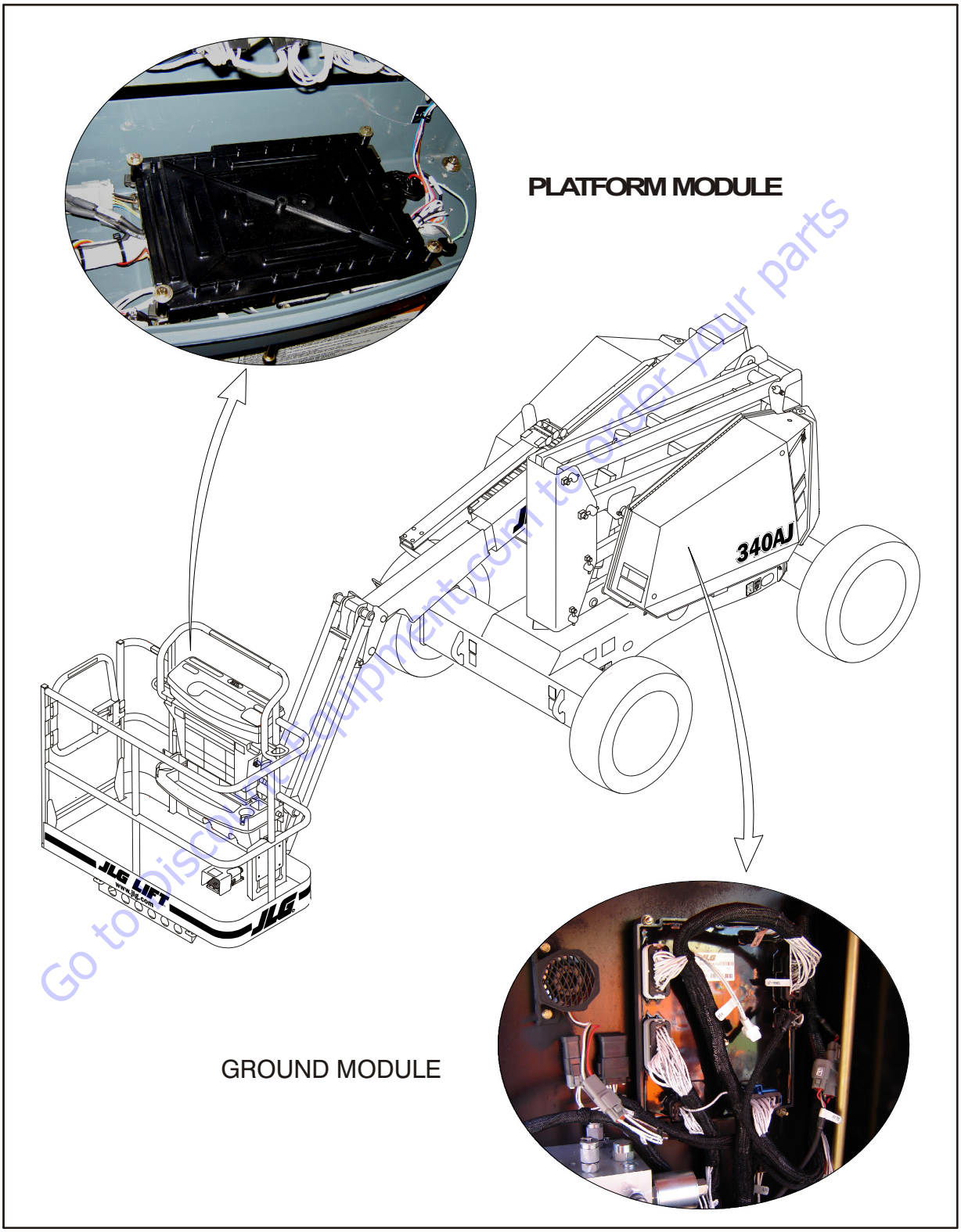

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Figure 6-2. Control Module Location

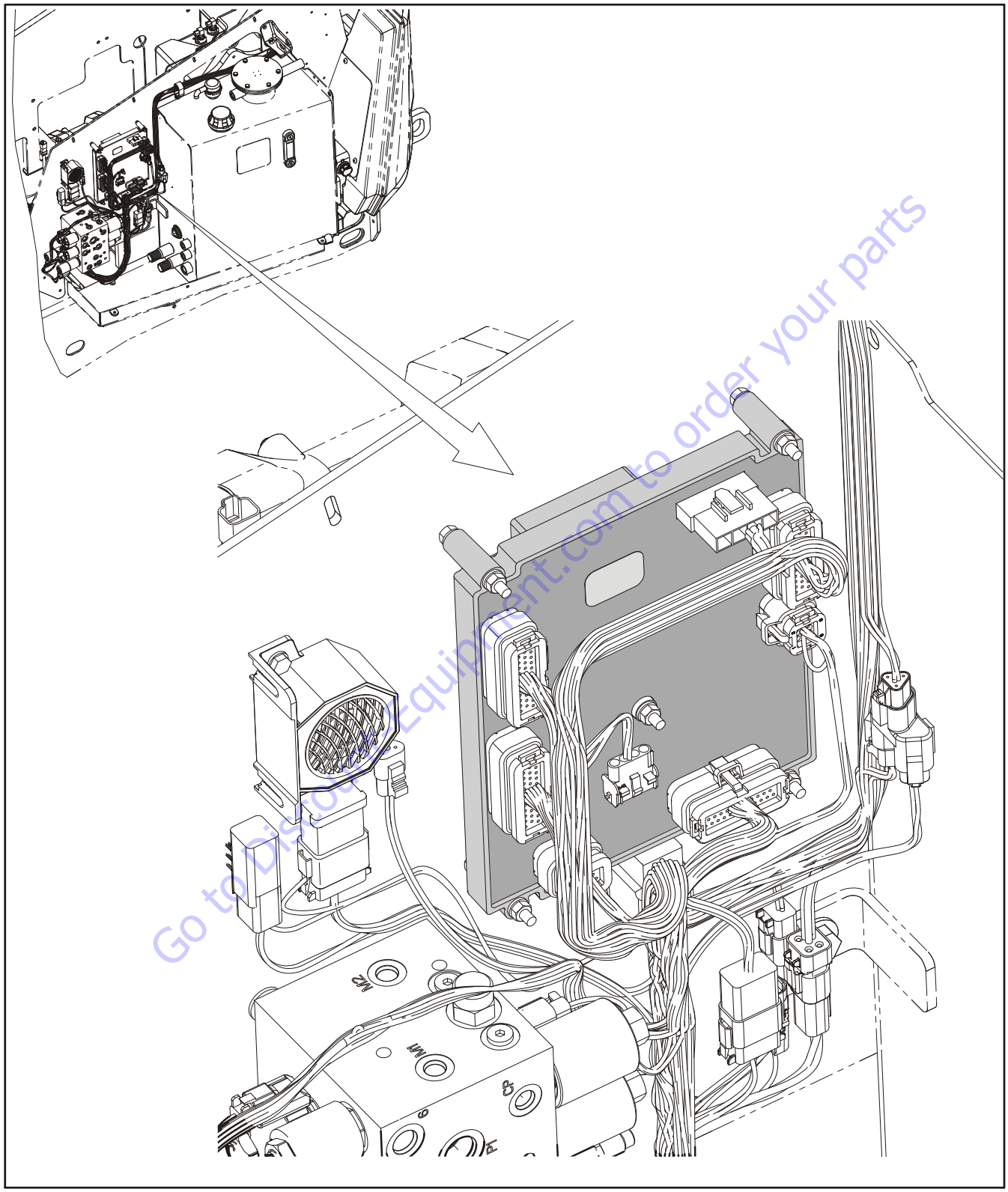

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Figure 6-3. Ground Module - Sheet 1 of 4

Connector	Pin	Function	Type	
J1 (Natural)	1	PROPORTIONAL FUEL RACK ACTUATOR	DIGITAL	OUTPUT
	2	ENGINE THROTTLE ARM ACTUATOR	DIGITAL	OUTPUT
	3	DRIVE FORWARD VALVE	DIGITAL	OUTPUT
	4	UNUSED (GROUND)	GROUND	INPUT
	5	UNUSED (GROUND)	GROUND	INPUT
	6	DRIVE REVERSE VALVE	DIGITAL	OUTPUT
	7	OSCILLATING AXLE POWER	DIGITAL	OUTPUT
	8	UNUSED (GROUND)	GROUND	INPUT
	9	MSSO SWTICH GROUND	GROUND	INPUT
	10	UNUSED (ECU POWER)	DIGITAL	OUTPUT
	11	START RELAY	DIGITAL	OUTPUT
	12	ENGINE GLOW PLUG RELAY	DIGITAL	OUTPUT
	13	APU ENABLE RELAY	DIGITAL	OUTPUT
	14	ENGINE COOLANT TEMPERATURE SENSOR	ANALOG	INPUT
	15	ENGINE OIL PRESSURE SENSOR	ANALOG	INPUT
	16	ENGINE SPEED SINGAL	FREQUENCY	INPUT
	17	ENGINE SPEED GROUND	GROUND	INPUT
	18	ENGINE GROUND	GROUND	INPUT
	19	2WD VALVE GROUND	GROUND	INPUT
	20	TRACTION LOCK / 2WD VALVE	DIGITAL	OUTPUT
	21	UNUSED (TOWER ELEVATION SWITCH #2)	DIGITAL	INPUT
	22	GENERATOR ENABLE RELAY	DIGITAL	OUTPUT
	23	BRAKE VALVE	DIGITAL	OUTPUT
	24	UNUSED	N/C	N/C
	25	UNUSED (RESERVED FOR RS-485 HIGH)	SERIAL	I/O
	26	UNUSED (RESERVED FOR RS-485 LOW)	SERIAL	I/O
	27	BRAKE VALVE GROUND	GROUND	INPUT
	28	ANALYZER POWER	VOLTAGE	OUTPUT
	29	ANALYZER RS-232 RX	SERIAL	INPUT
	30	ANALYZER RS-232 TX	SERIAL	OUTPUT
	31	ANALYZER GROUND	GROUND	INPUT
	32	ALTERNATOR EXCITATION	DIGITAL	OUTPUT
	33	UNUSED (GROUND)	GROUND	INPUT
	34	UNUSED (TELESCOPE RETRACT SWTICH #2)	DIGITAL	INPUT
	35	UNUSED (CAPACITY LENGTH SWTICH #2)	DIGITAL	INPUT

Connector	Pin	Function	Type	
J2 (Gray)	1	STEER DUMP VALVE	DIGITAL	OUTPUT
	2	GROUND ALARM	DIGITAL	OUTPUT
	3	UNUSED (TOWER TELESCOPE IN VALVE)	DIGITAL	OUTPUT
	4	TELESCOPE IN VALVE	DIGITAL	OUTPUT
	5	PLATFORM LEVEL UP VALVE	DIGITAL	OUTPUT
	6	FUEL SENSOR GROUND	GROUND	INPUT
	7	PLATFORM LEVEL DOWN VALVE	DIGITAL	OUTPUT
	8	FRONT RIGHT STEER VALVE	DIGITAL	OUTPUT
	9	TOWER LIFT DOWN / TELESCOPE IN VALVE	DIGITAL	OUTPUT
	10	PLATFORM ROTATE LEFT VALVE	DIGITAL	OUTPUT
	11	LIFT UP VALVE	DIGITAL	OUTPUT
	12	JIB LIFT UP VALVE	DIGITAL	OUTPUT
	13	MAIN DUMP VALVE	DIGITAL	OUTPUT
	14	PLATFORM LEVEL / PLATFORM ROTATE / TELESCOPE VALVES GROUND	GROUND	INPUT
	15	UNUSED (TOWER TELESCOPE OUT VALVE)	DIGITAL	OUTPUT
	16	TELESCOPE OUT / TELESCOPE OUT DUMP VALVE	DIGITAL	OUTPUT
	17	TELESCOPE OUT DUMP VALVE GROUND	GROUND	INPUT
	18	STEER DUMP VALVE GROUND	GROUND	INPUT
	19	FRONT LEFT STEER VALVE	DIGITAL	OUTPUT
	20	TOWER LIFT UP / TELESCOPE OUT VALVE	DIGITAL	OUTPUT
	21	PLATFORM ROTATE RIGHT VALVE	DIGITAL	OUTPUT
	22	LIFT DOWN VALVE	DIGITAL	OUTPUT
	23	JIB LIFT DOWN VALVE	DIGITAL	OUTPUT
	24	UNUSED (CONFIGURATION #2)	DIGITAL	INPUT
	25	FUEL SENSOR SINGAL	ANALOG	INPUT
	26	HEAD / TAIL LIGHT ENABLE RELAY	DIGITAL	OUTPUT
	27	GROUND ALARM / HORN OUTPUT	DIGITAL	OUTPUT
	28	STEER VALVE GROUND	GROUND	INPUT
	29	GROUND ALARM GROUND	GROUND	INPUT
	30	MAIN DUMP VALVE GROUND	GROUND	INPUT
	31	FLOW CONTROL VALVE	DIGITAL	OUTPUT
	32	UNUSED (REAR STEER RIGHT VALVE)	DIGITAL	OUTPUT
	33	UNUSED (REAR STEER LEFT VALVE)	DIGITAL	OUTPUT
	34	SWING LEFT VALVE	DIGITAL	OUTPUT
	35	SWING RIGHT VALVE	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
J3 (Black)	1	DRIVE CURRENT FEEDBACK	GROUND	INPUT
	2	THROTTLE ACTUATOR CURRENT FEEDBACK	GROUND	INPUT
	3	UNUSED (CABLE BRAKE SWITCH GROUND)	GROUND	INPUT
	4	SWING CURRENT FEEDBACK	GROUND	INPUT
	5	TOWER / TELESCOPE CURRENT FEEDBACK	GROUND	INPUT
	6	FLOW CONTROL VALVE CURRENT FEEDBACK	GROUND	INPUT
	7	GROUND ALARM POWER	VBAT	OUTPUT
	8	UNUSED (CABLE BRAKE SWITCH)	DIGITAL	INPUT
	9	CRIBBING ENABLE SWITCH	DIGITAL	INPUT
	10	UNUSED (INPUT)	DIGITAL	INPUT
	11	CONFIGURATION #1	DIGITAL	INPUT
	12	UNUSED (+5 VOLTS)	VOLTAGE	OUTPUT
	13	UNUSED (INPUT)	ANALOG	INPUT
	14	LIFT CURRENT FEEDBACK	GROUND	INPUT

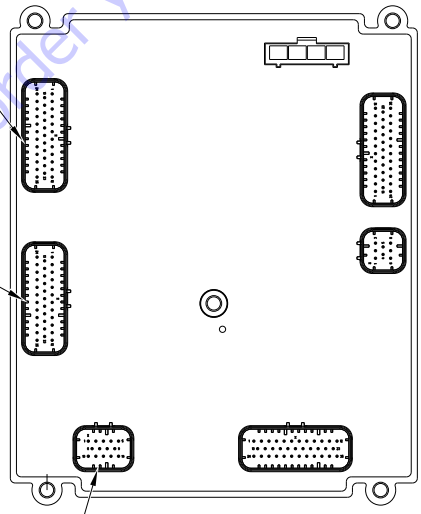

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Figure 6-4. Ground Module - Sheet 2 of 4