- Inspect all wires and harnesses for proper connections and routing; bent or broken connector pins; burned, chafed, or pinched wires; and corrosion. Verify that harness grounds are clean and tight.
- Inspect engine control module (ECM), sensors, and actuators for physical damage.
- Inspect ECM grounds for cleanliness, tightness, and proper location.
- Inspect fuel system for adequate fuel level, and fuel quality (concerns such as proper octane, contamination, winter/summer blend).
- Inspect intake air system and air filter for restrictions.
- Inspect battery condition and starter current draw.

If no evidence of a problem is found after visual/physical engine check has been performed, proceed to MIL DTC retrieval procedure.

EFI Diagnostics

The EFI diagnostics are designed to assist in locating a faulty circuit or component. When a malfunction is detected by the Engine Control Module (ECM), a diagnostic trouble code (DTC) is set and will be displayed on the JLG Control System Analyzer. Refer to Section 6 - JLG Control System.

CLEARING TROUBLE CODES

To clear the trouble codes from the ECM, the electrical current running to the ECM must be shut off. To do this, disconnect the negative terminal from the battery for a period of approximately 15 minutes.

ECM and Sensors

CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence. The CKP sensor initiates the reference pulses which the ECM uses to calculate RPM and crankshaft position.

CAMSHAFT POSITION (CMP) SENSOR AND SIGNAL

The camshaft position (CMP) sensor sends a CMP signal to the ECM. The ECM uses this signal as a "sync pulse" to trigger the injectors in the proper sequence. The ECM uses the CMP signal to indicate the position of the #1 piston during its power stroke. The CMP uses a Hall Effect sensor to measure piston position. This allows the ECM to calculate true sequential fuel injection (SFI) mode of operation. If the ECM detects an incorrect CMP signal while the engine is running, DTC 53 will set. If the CMP signal is lost while the engine is running, the fuel injection system will shift to a calculated sequential fuel injection mode based on the last fuel injection pulse, and the engine will continue to nun. As long as the fault is present, the engine can be restarted. It will run in the previously established injection sequence.

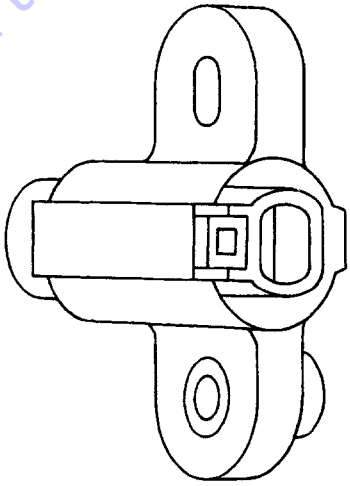


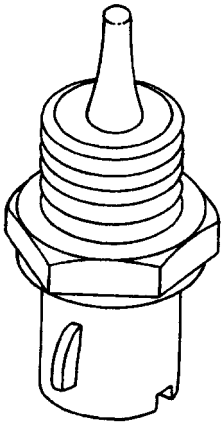
Table 3-15. ECM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description
11	All Systems OK
12	Throttle Position (TP) Sensor Low Voltage
14	Manifold Absolute Pressure (MAP) Low Voltage
15	Under Minimum Map Sensor Temperature
21	Overspeed
22	Throttle Position (TP) Sensor High Voltage
23	Over maximum throttle
24	Manifold Absolute Pressure (MAP) High Voltage
25	Over Maximum Map Sensor Temperature
26	Over maximum initial Throttle Position Sensor Voltage
31	Fuel Pump Low Voltage
32	Heated Oxygen Sensor (HO2S) Low Voltage
33	Engine Coolant Temperature (ECT) Sensor High Voltage
35	Intake Air Temperature (IAT) Sensor High Voltage
41	Fuel Pump High Voltage
42	Heated Oxygen Sensor (HO2S) High Voltage
43	Engine Coolant Temperature (ECT) Sensor Low Voltage
45	Intake Air Temperature (IAT) Sensor Low Voltage
51	Low Oil Pressure
52	Crankshaft Position (CKP) Sensor Extra/Missing Pulses
53	Camshaft Position Sensor (CMP) Sensor Illegal Pattern
54	Engine Control Module (ECM) Fault Illegal Operation
55	Engine Control Module (ECM) Fault Illegal Interruption
56	Engine Control Module (ECM) Fault COP (Computer Operating Properly) Failure
61	System Voltage Low
62	System Voltage High

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The engine coolant temperature (ECT) sensor is a Thermistor (a resistor which changes value based on temperature), mounted in the engine coolant stream. Low coolant temperature produces a high resistance of 100,000 ohms at -40°C (-40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The ECM supplies a 5-volt signal to the ECT sensor through resistors in the ECM and measures the voltage. The signal voltage will be high when the engine is cold and low when the engine is hot. By measuring the voltage, the ECM calculates the engine coolant temperature. Engine coolant temperature affects most of the systems that the ECM controls.

After engine start-up, the temperature should rise steadily to about 85°C (185°F). it then stabilizes when the thermostat opens. If the engine has not been run for several hours (overnight), the engine coolant temperature and intake air temperature displays should be close to each other. A fault in the engine coolant sensor circuit will set DTC 33 or DTC 43.



ELECTRICALLY ERASABLE PROGRAMMABLE READ ONLY MEMORY (EEPROM)

The Electrically Erasable Programmable Read Only Memory (EEPROM) is a permanent memory chip that is located within the ECM. The EEPROM contains the pro-gram and the calibration information that the ECM needs to control engine operations. If the ECM is replaced, the new ECM will need to be programmed. An IBM-compatible computer and software containing the correct program and calibration for the application are required to program the ECM.

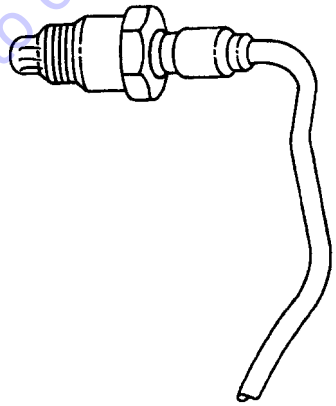
HEATED OXYGEN SENSOR

The heated oxygen sensor is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust gas. The oxygen present in the exhaust gas reacts with the sensor to produce a voltage output. This voltage should constantly fluctuate from approximately 100 mV to 900 mV. The heated oxygen sensor voltage can be monitored on an IBM PC-compatible computer with diagnostic software. By monitoring the voltage output of the oxygen sensor, the ECM calculates the pulse width command for the injectors to produce the proper combustion chamber mixture.

Low HO2S voltage indicates a lean mixture which will result in a rich command to compensate.

High HO2S voltage indicates a rich mixture which will result in a lean command to compensate.

A constant voltage below 200 mV for 10 consecutive seconds will set OTC 32. A constant voltage above 650 mV for 10 consecutive seconds will set OTC 42.



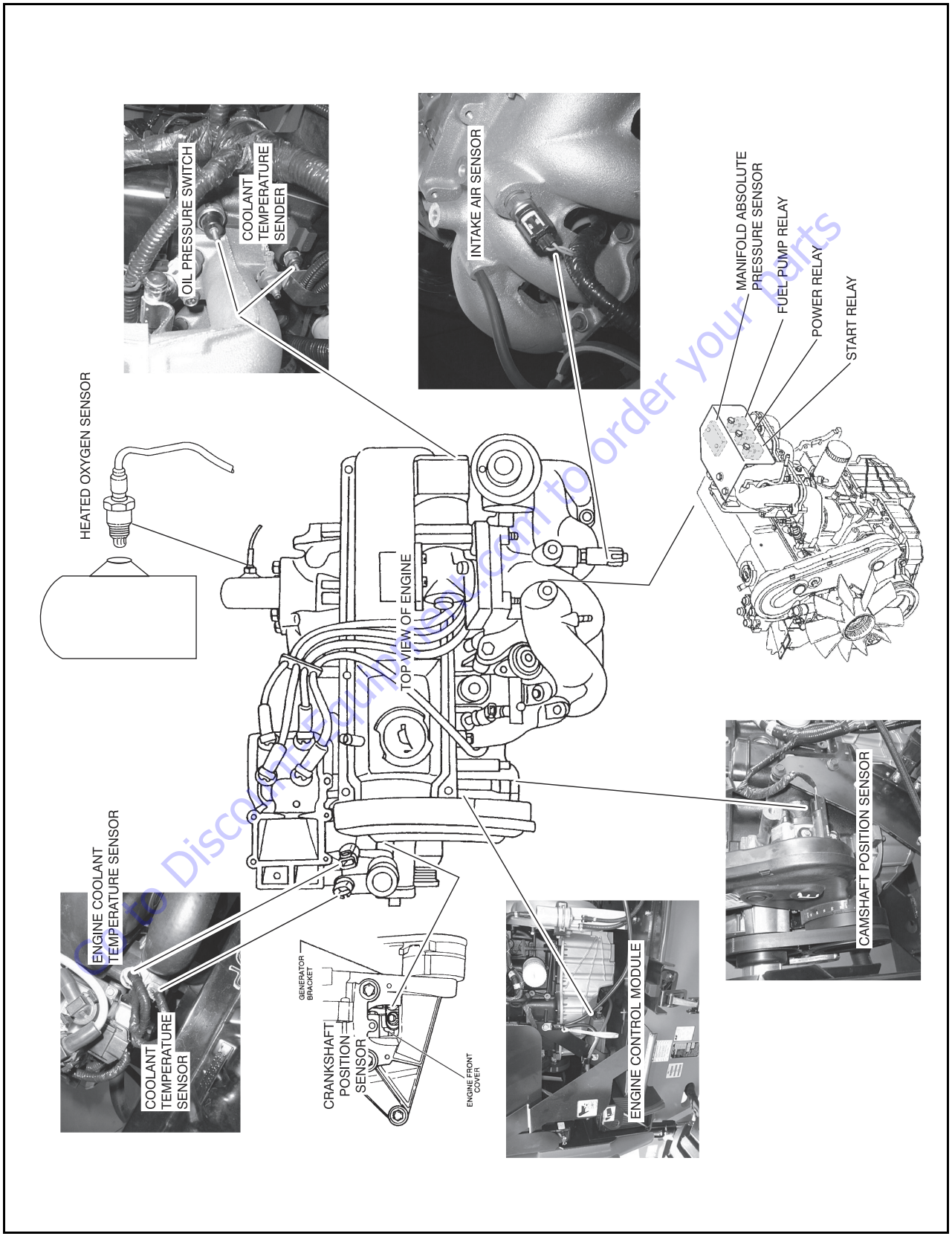
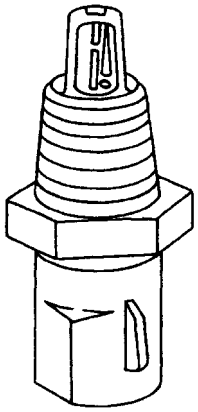


Figure 3-97. EFI Component Location

INTAKE AIR TEMPERATURE (IAT) SENSOR

The Intake Air Temperature (IAT) sensor is a thermistor which changes its resistance based on the temperature of air entering the engine. Low temperature produces a high resistance of 100,000 ohms at -40°C (-40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The ECM supplies a 5-volt signal to the sensor through a resistor in the ECM and monitors the signal voltage. The signal voltage will be high when the incoming air is cold and low when the incoming air is hot. By measuring the voltage, the ECM calculates the incoming air temperature. The IAT sensor signal is used to adjust spark timing according to the incoming air density. An IBM PC-compatible computer with diagnostic soft-ware can be used to display the temperature of the air entering the engine. The temperature should read close to the ambient air temperature when the engine is cold, and rise as engine compartment temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor temperature and engine coolant temperature should read close to each other. A failure in the IAT sensor circuit will set DTC 35 or DTC 45.



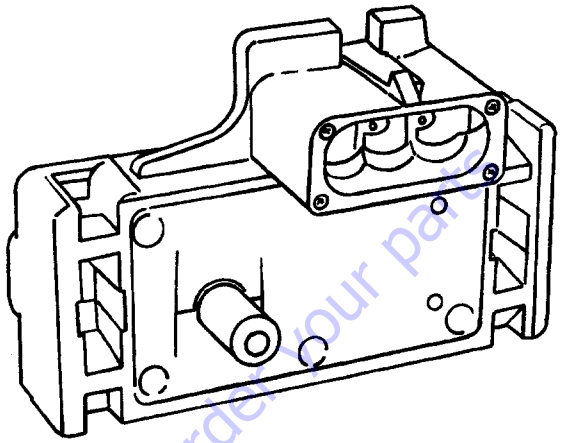
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor responds to changes in intake manifold pressure (vacuum). The MAP sensor signal voltage to the ECM varies from below 2 volts at idle (high vacuum) to above 4 volts with the ignition ON, engine not running or at wide-open throttle (low vacuum).

The MAP sensor is used to determine the following:

- Engine vacuum level for engine control purposes.
- Barometric pressure (BARO).

If the ECM detects a voltage that is significantly lower than the estimated MAP value for 2 or more consecutive seconds, DTC 14 will be set. A signal voltage significantly higher than the estimated MAP value for 2 or more consecutive seconds will set DTC 24.



ENGINE CONTROL MODULE (ECM)

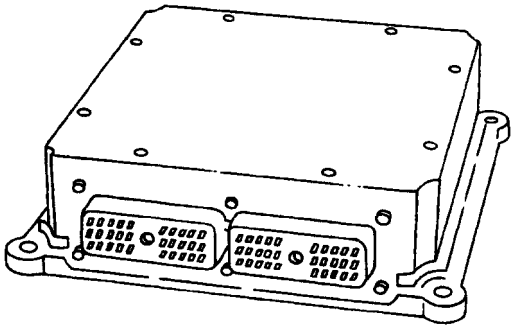
The ECM controls the following:

- Fuel metering system
- Ignition timing
- On-board diagnostics for engine functions

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect engine performance. The ECM performs the diagnostic function of the system. It can recognize operational problems, alert the operator through the Malfunction Indicator Lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the problem areas to aid the technician in making repairs.

The ECM supplies either 5 or 12 volts to power various sensors or switches. The power is supplied through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter with at least 10 meg ohms input impedance is required to ensure accurate voltage readings. The ECM controls output circuits such as the fuel injectors, electronic governor, etc., by control ling the ground or the power feed circuit through transistors or other solid state devices.

The ECM is designed to maintain exhaust emission levels to government mandated standards while providing excellent operation and fuel efficiency. The ECM monitors numerous engine functions via electronic sensors such as the throttle position (TP) sensor and the heated oxygen sensor (HO2S).



ECM INPUTS/OUTPUTS

Inputs - Operating Conditions

- Engine Coolant Temperature
- Crankshaft Position
- Exhaust Oxygen Content
- Manifold Absolute Pressure
- Battery Voltage
- Throttle Position
- Fuel Pump Voltage
- Intake Air Temperature
- Camshaft Position

Outputs - System Controlled

- Fuel Control
- Idle Air Control
- Electric Fuel Pump
- Diagnostics:
  - Malfunction Indicator Lamp
  - Data Link Connector (DLC)

ECM SERVICE PRECAUTIONS

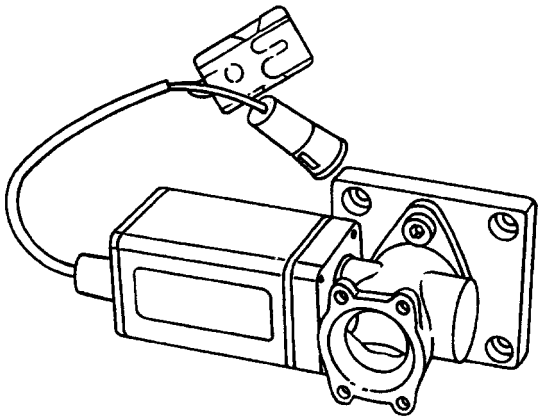
The ECM is designed to withstand normal current draws associated with engine operation. When servicing the ECM, observe the following guidelines:

- Do not overload any circuit.
- Do not probe wires for testing. This can cause a voltage drop that would be critical to the operation of the ECM.
- When testing for opens and shorts, do not ground or apply voltage to any of the ECM's circuits unless instructed to do so.
- When measuring voltages, use only a digital voltmeter with an input impedance of at least 10 megohms.
- Do not jump start with more than 12 volts. This could cause damage to the electronic components.
- Do not employ any non-standard practices such as charging the battery with an arc welder.
- Take proper precautions to avoid static damage to the ECM. Refer to “Electrostatic Discharge Damage” for more information.

THROTTLE POSITION (TP) SENSOR

The Throttle Position (TP) sensor is a potentiometer connected to the throttle shaft on the throttle body which is built into the electronic governor. The ECM monitors the voltage on the signal line and calculates throttle position. As the throttle valve angle is changed, the TP sensor signal also changes. At a closed throttle position, the output of the TP sensor is low. As the throttle valve opens, the output increases so that at wide open throttle (WOT), the output voltage should be above 4 volts.

The ECM calculates fuel delivery based on throttle valve angle (operator demand). A broken or loose TP sensor may cause intermittent bursts of fuel from an injector and unstable idle because the ECM thinks the throttle is moving. A hard failure in the TP sensor 5-Volt reference or signal circuits for greater than 2 consecutive seconds will set either a DTC 12 or DTC 22. A hard failure with the TP sensor ground circuit for more than two consecutive seconds may set DTC 22. If either DTC 12 or DTC 22 are set, the throttle will be forced to a 6% (idle) position.



USE OF CIRCUIT TESTING TOOLS

Do not use a test light to diagnose the engine electrical systems unless specifically instructed by the diagnostic procedures. A test light can put an excessive load on an ECM circuit and result in component damage. For volt-age measurements, use only a digital voltmeter with an input impedance of at least 10 megohms.

ELECTROSTATIC DISCHARGE DAMAGE

Electronic components used in the ECM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, It takes as much as 4000 volts for a person to feel the spark of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

An example of charging by friction is a person sliding across a seat.

Charge by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore it is important to-use care when handling and testing electronic components.

To prevent possible electrostatic discharge damage, follow these guidelines:

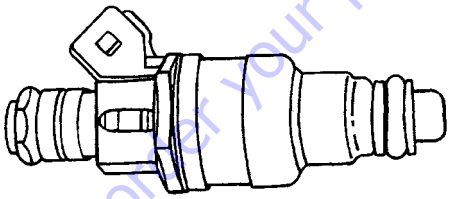
- Do not touch the ECM connector pins or soldered components on the ECM board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the equipment.
- If the part has been handled while sliding across a seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.

Fuel System

FUEL INJECTOR

The Electronic Fuel Injection (EFI) fuel injector is a solenoid-operated device controlled by the ECM. The ECM energizes the solenoid, which opens a valve to allow fuel delivery.
The fuel is injected under pressure in a conical spray pattern at the opening of the intake valve. Excess fuel not used by the injectors passes through the fuel pressure regulator before being returned to the fuel tank.

A fuel injector which is stuck partly open will cause a loss of fuel pressure after the engine is shut down, causing long crank times.



FUEL METERING SYSTEM COMPONENTS

The fuel metering system is made up of the following parts:

- The fuel injectors
- The fuel rail
- The fuel pressure regulator/filter assembly
- The electronic governor
- The ECM
- The crankshaft position (CKP) sensor
- The camshaft position (CMP) sensor
- The fuel pump
- The fuel pump relay

BASIC SYSTEM OPERATION

The fuel metering system starts with the fuel in the fuel tank. The fuel is drawn up to the fuel pump through a pre-filter. The electric fuel pump then delivers the fuel to the fuel rail through an inane fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A fuel pressure regulator in the fuel filter assembly keeps fuel available to the fuel injectors at a constant pressure. A return line delivers unused fuel back to the tank.

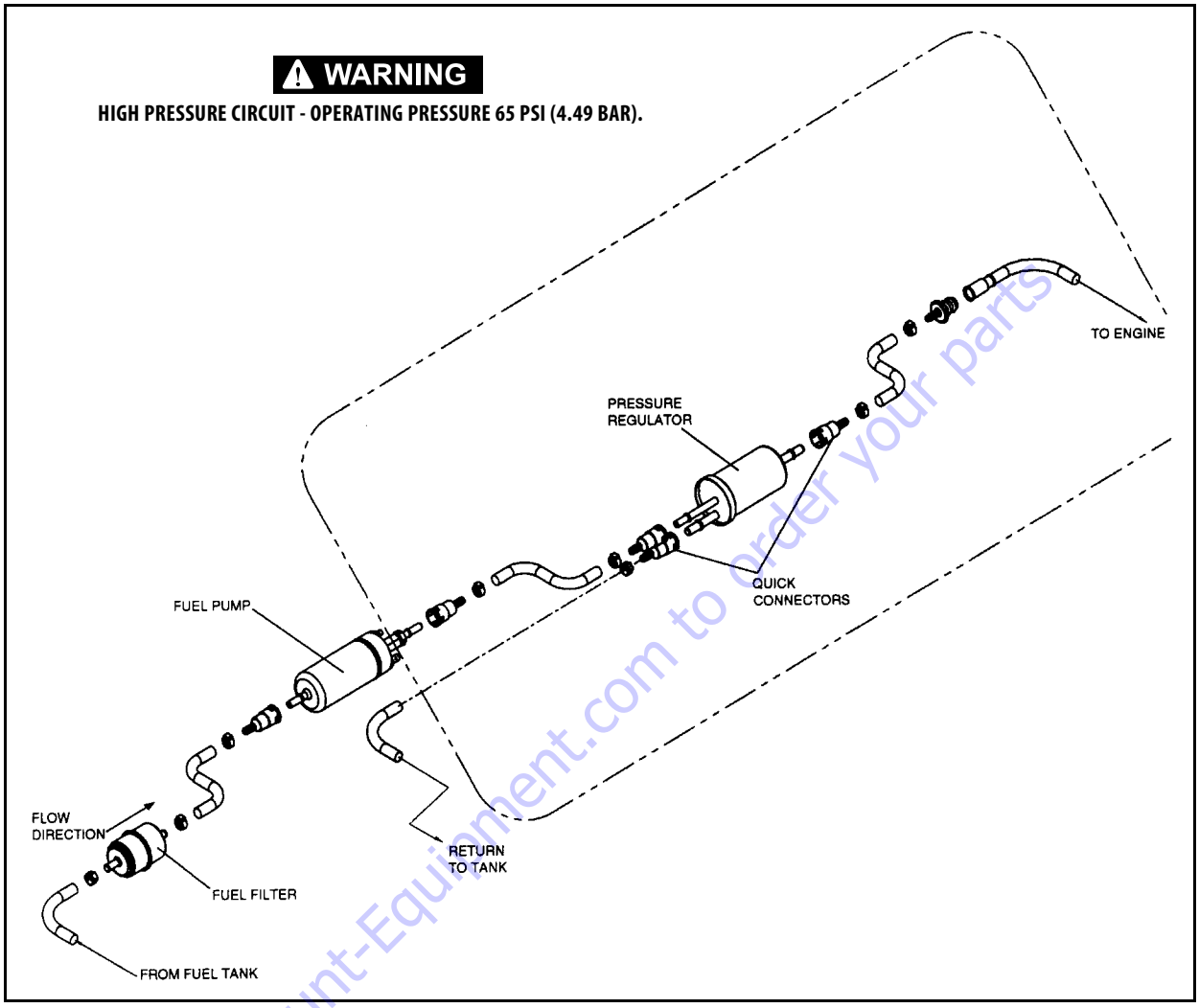


Figure 3-98. Typical Fuel System

FUEL METERING SYSTEM PURPOSE

The basic function of the air/fuel metering system is to control the air/fuel delivery to the engine. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each intake valve.

The main control sensor is the heated oxygen sensor (H02S) located in the exhaust system. The H02S tells the ECM how much oxygen is in the exhaust gas. The ECM changes the air/fuel ratio to the engine by control-ling the amount of time that the fuel injector is "ON." The best mixture to minimize exhaust emissions is 14.7 parts of air to 1 part of gasoline by weight, which provides the most efficient combustion. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.

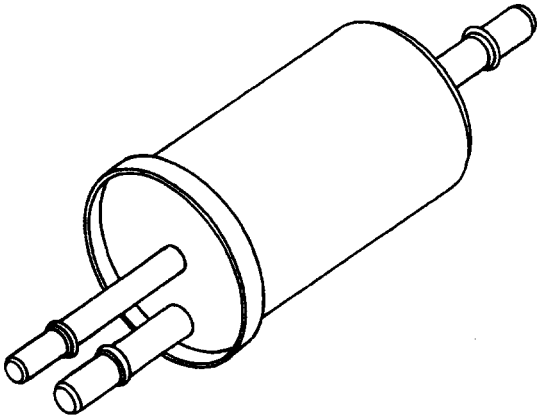
The ECM monitors signals from several sensors in order to determine the fuel needs of the engine. Fuel is delivered under one of several conditions called "modes." All modes are controlled by the ECM. Refer to "Open Loop and Closed Loop Operation" for more information.

FUEL PRESSURE REGULATOR

The fuel pressure regulator is a relief valve mounted in the fuel filter. It provides a constant fuel pressure of 441 kPa (64 psi).

If the pressure is too low, poor performance and a DTC 32 will set. If the pressure is too high, excessive odor and/or a DTC 42 will result.

When replacing the fuel filter, be sure to use an identical filter/regulator assembly. A standard fuel filter does not regulate pressure and could cause engine problems or component damage.



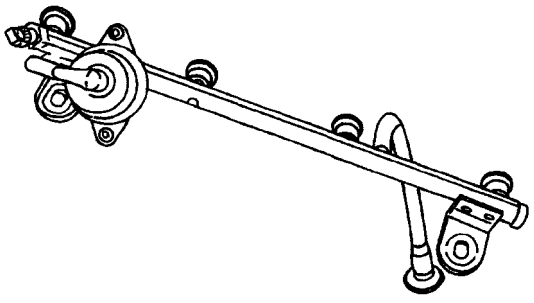
FUEL PUMP ELECTRICAL CIRCUIT

When the key is first turned "ON," the ECM energizes the fuel pump relay for two seconds to build up the fuel pressure quickly. If the engine is not started within two seconds, the ECM shuts the fuel pump off and waits until the engine is cranked. When the engine is cranked and crankshaft position signal has been detected by the SECM, the ECM supplies 12 volts to the fuel pump relay to energize the electric fuel pump.

An inoperative fuel pump will cause a "no-start" condition. A fuel pump which does not provide enough pressure will result in poor performance.

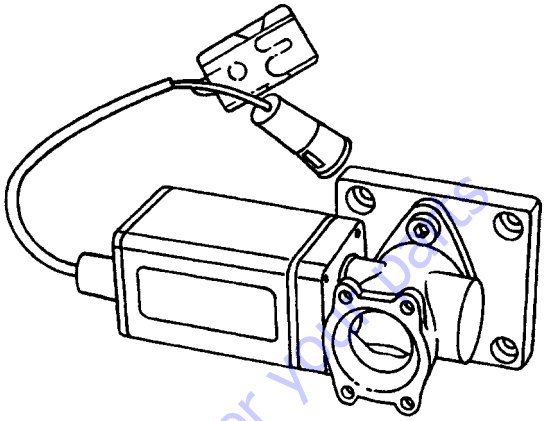
FUEL RAIL

The fuel rail is mounted to the top of the engine and distributes fuel to the individual injectors. Fuel is delivered to the fuel inlet tube of the fuel rail by the fuel lines.



ELECTRONIC GOVERNOR AND THROTTLE BODY

In the 2.5L EFI industrial engine, throttle control is achieved by using an electronic governor which is controlled by the engine control module (ECM).



The electronic governor consists of a throttle body, an electronically-actuated throttle plate, and a built-in throttle position (TP) sensor. There are two pigtails that exit the governor body. The 3-wire pigtail connects the TP sensor to the ECM. Refer to "Throttle Position (TP) Sensor" for more information.

The 2-wire pigtail carries the throttle signal from the ECM to the governor. Desired engine speeds are stored in the configuration program for each specific application, and can be changed with the ECM calibration software. When an engine speed is selected with the toggle switch, the ECM sends the appropriate signal to the governor. This is a pulse-width modulated (PWM) signal which cannot be read with conventional diagnostic tools such as a voltmeter. A 12-volt signal is pulsed on and off at a high rate of speed. The width of the "on" pulse determines the amount of throttle opening. The ECM sends a signal with the appropriate pulse width to the governor based on the operator's choice of switch settings.

The electronic governor also acts as an idle air control (IAC) valve. Changes in engine load are detected by the ECM by comparing manifold absolute pressure (MAP) with throttle position. When the ECM detects a change in engine load, it can adjust idle speed by changing the PWM signal to the governor.

OPEN LOOP AND CLOSED LOOP OPERATION

The ECM will operate in the following two modes:

- Open loop
- Closed loop

When the engine is first started, the system is in “open loop” operation. In open loop, the ECM ignores the signal from the heated oxygen sensor (HO2S). It uses a pre-programmed routine to calculate the air/fuel ratio based on inputs from the TP, ECT, and MAP sensors.

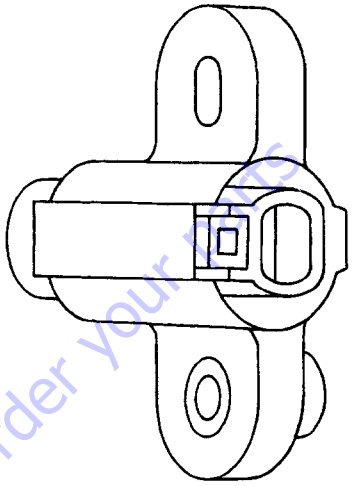
The system remains in open loop until the following conditions are met:

- The HO2S has a varying voltage output showing that it is hot enough to operate properly (this depends on temperature).
- The ECT has reached 160°F (71°C).
- Seven minutes has elapsed since starting the engine.

After these conditions are met, the engine is said to be operating in “closed loop.” In closed loop, The ECM continuously adjusts the air/fuel ratio by responding to signals from the HO2S (except at wide-open throttle). When the HO2S reports a lean condition (low sensor signal voltage), the ECM responds by increasing the “on” time of the fuel injectors, thus enriching the mixture. When the HO2S reports a rich condition (high) sensor signal Voltages the ECM responds by reducing the “on” time of the fuel injectors, thus leaning out the mixture.

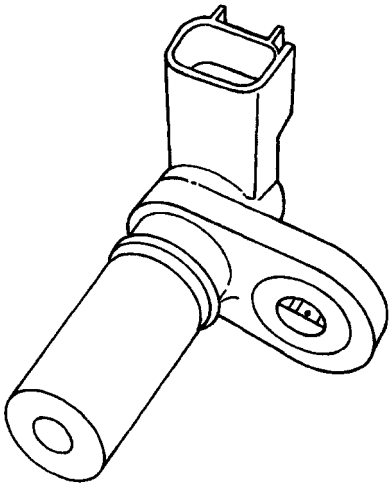
CAMSHAFT POSITION (CMP) SENSOR

The CMP sensor uses a variable reactor sensor to detect camshaft position. The CMP signal is created as piston #1 is a predetermined number of degrees after top dead center on the power stroke.



CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence. The sensor initiates the reference pulses which the ECM uses to calculate RPM and crank-shaft position.



ELECTRONIC IGNITION

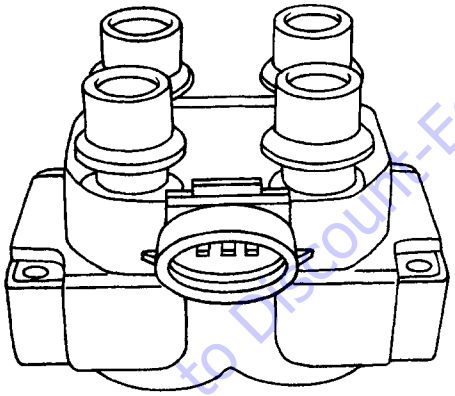
The electronic ignition system controls fuel combustion by providing a spark to ignite the compressed air/fuel w mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the ECM controls the spark advance of the ignition system. Electronic ignition has the following advantages over a mechanical distributor system:

- No moving parts
- Less maintenance
- Remote mounting capability
- No mechanical load on the engine
- More coil cool down time between firing events
- Elimination of mechanical timing adjustments
- Increased available ignition coil saturation time

IGNITION COIL

The electronic ignition system uses a coil pack with one ignition coil for each two cylinders in the engine. Each cylinder is paired with its opposing cylinder in the firing order, so that one cylinder on compression fires simultaneously with the opposing cylinder on exhaust. The spark that occurs in the cylinder on the exhaust stroke is referred to as a "waste spark".

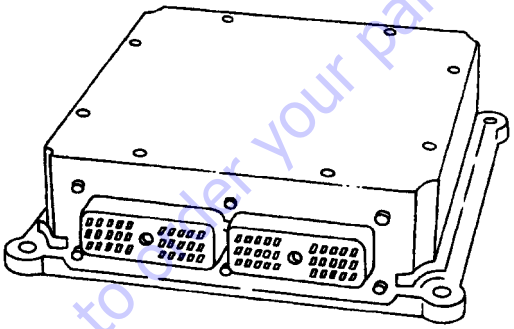
The primary coils in the coil pack are triggered by the "Ignition Coil Feed #1" and "Ignition Coil Feed #2" Signals from the ECM.



ENGINE CONTROL MODULE (ECM)

The ECM is responsible for maintaining proper spark and fuel injection timing for all operating conditions. To provide optimum operation and emissions, the ECM monitors the input signals from the following components in order to calculate spark timing:

- Engine coolant temperature (ECT) sensor
- Intake air temperature (IAT) sensor
- Throttle position sensor
- Crankshaft position sensor



3.25 FORD LPG SYSTEM

NOTE: *+20° F (-6.6° C) is the low temperature limit for LP gas, for both starting and operation. This applies to all LP gas powered engines.*

Description

The LPG system starts at the tank. The liquid propane exits the tank, flows through the fuel lock off solenoid, flows through the regulator (regulator converts the liquid to a vapor), flows through the megajector, flows through the mixer and into the engine.

Regulator

The regulator accepts LPG liquid at tank pressure (min = 30 psi; max = 312 psi [min = 207 kPa; max = 2151 kPa]) and reduces it to a regulator outlet pressure of 1.5-2.5 inches (3.8-6.3 cm) of H_2O at idle flow (approx. 750 RPM / no load). This regulator must have engine coolant flowing through it whenever the engine is running.

Megajector

The megajector is an electronic pressure regulator. This electronic regulator outputs a specific pressure needed at the mixer to maintain the desired air to fuel ratio. The megajector accepts LPG vapor at the regulator outlet pressure (1.5-2.5 inches [3.8-6.3 cm] of H_2O) and reduces it to a pressure value commanded by the EPM. The pressure command is sent by the EPM over the CAN link via the megajector harness. The megajector outlet pressure has units of inches of H_2O. The megajector outlet pressure is defined as the difference between the megajector outlet gas pressure and the balance line pressure (usually at or near barometric pressure depending on air intake restriction). The megajector outlet pressure can vary between -1.00 to -5.00 inches (-2.5 to -12.7 cm) of H_2O depending on the speed and load of the engine. The megajector must be mounted per the 2.5L 2004 Emission Installation Instructions. Torque mounting bolts to a maximum of 60 in. lbs. (7 Nm).

Mixer

The mixer accepts LPG vapor at the megajector outlet pressure (-1.00 to -5.00 inches [-2.5 to -12.7 cm] of H_2O) and mixes it with clean air. This mixture is then sucked into the engine via the actuator.

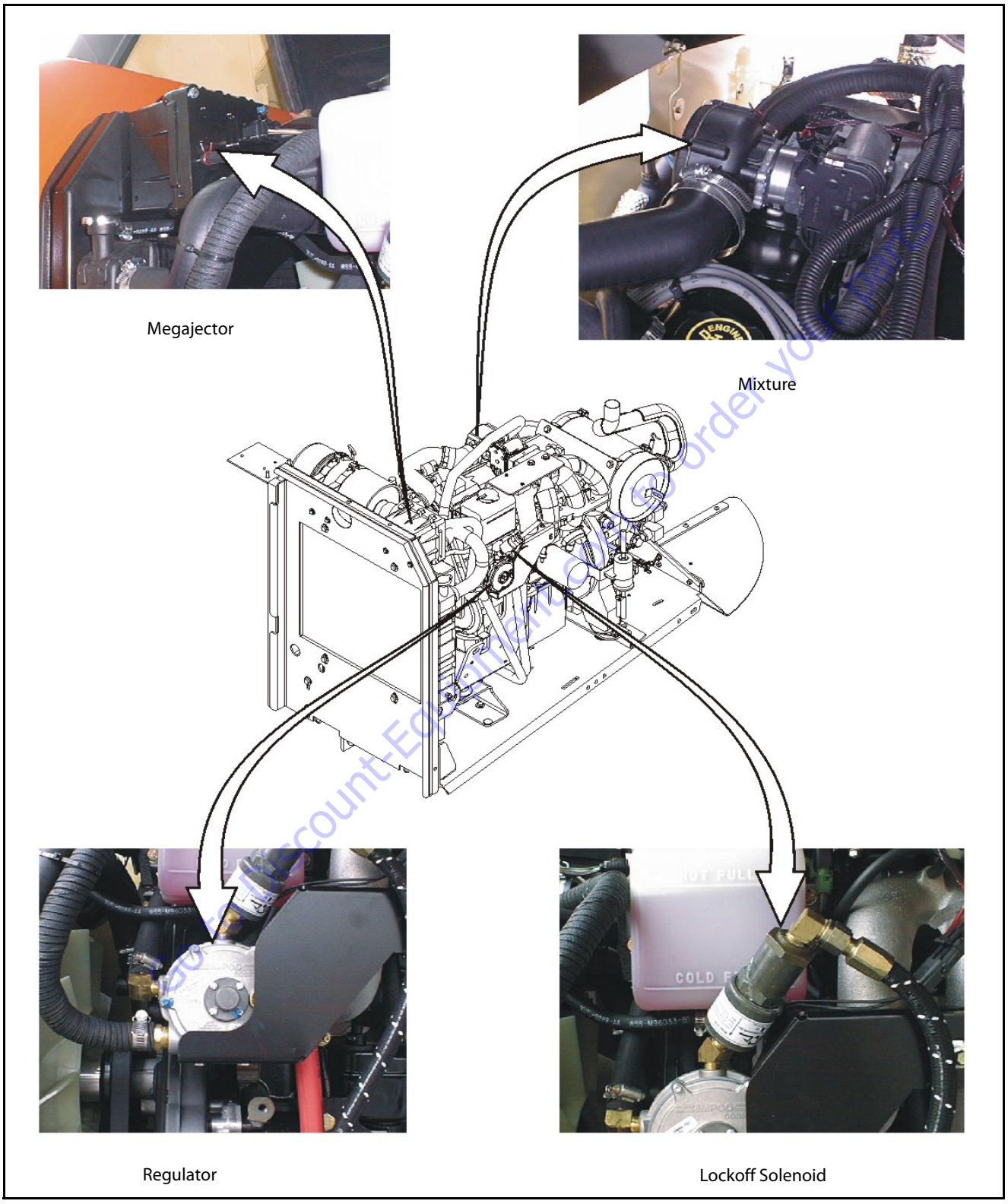


Figure 3-99. Ford LPG System

Lock off Solenoid

The lock off solenoid is used to reduce the possibility of backfires. The EPM controls the opening and closing of the lock off so that as a shutdown is commanded, the lock off is closed, but the ignition system continues to operate to burn off unburned fuel in the manifold. This will cause longer than usual start times, because the manifold must fill up with fuel again before the engine will fire. This will also cause the engine to run for one to two seconds after ignition is turned off.

Megajector Diagnostic Code Descriptions

The following diagnostic codes are specific to the megajector. They will be displayed on the analyzer if the JLG Control System senses a fault dealing with the megajector. Refer to Section 6 - JLG Control System for more information concerning the Control System.

DTC 353 - Megajector delivery pressure higher than expected. This code will set if the difference between the Megajector actual pressure and the Megajector commanded pressure is greater than 4.00 in. (10.1 cm) of H_2O.

a. **Fuel Supply** - Check fuel supply pressure at the megajector inlet fitting. Fuel supply pressure on LPG applications should be between 3-5 in. (7.6-12.7 cm) H_2O.

b. **Lockoff Solenoid** - Check the lockoff to make sure it is sealing when closed. If it is not completely sealing, it could allow pressure creep in the fuel system.

c. **Reference Line** - Make sure the reference line is in place between the Megajector and the carburetor balance port. Make sure the hose is not kinked or restricted in any way and has no holes in it.

d. **Regulator** - Observe the regulator with the engine running to see if it is icing up. If it's icing up, refer to Engine Cooling System below.

e. **Engine Cooling System** - Make sure the engine cooling system is operating properly and there are no air locks in the system. Make sure the engine is operating at the proper temperature. Check the coolant hoses at the regulator and make sure they are both warm to verify proper coolant circulation.

If the fuel system is operating properly, the Megajector has an internal failure and must be replaced.

DTC 354 - Megajector delivery pressure lower than expected. This code will set if the difference between the Megajector actual pressure and the Megajector commanded pressure is less than 4.00 inches (10.1 cm) of H_2O.

a. **Fuel Supply** - Check fuel supply pressure at the megajector inlet fitting. Fuel supply pressure on LPG applications should be between 3-5 in. (7.6-12.7 cm) H_2O.

b. **Fuel System Hoses** - Make sure all fuel system hoses are in good condition. They should be clamped tight, free from kinks with no cuts, pinches, etc.

c. **Lockoff Solenoid** - Check the lock off to make sure it is opening properly. If it is not opening completely, it could cause low fuel pressure.

d. **Reference Line** - Make sure the reference line is in place between the Megajector and the carburetor balance port. Make sure the hose is not kinked or restricted in any way and has no holes in it.

e. **Regulator** - Observe the regulator with the engine running to see if it is icing up. If it's icing up, refer to Engine Cooling System below.

f. **Engine Cooling System** - Make sure the engine cooling system is operating properly and there are no air locks in the system. Make sure the engine is operating at the proper temperature. Check the coolant hoses at the regulator and make sure they are both warm to verify proper coolant circulation.

If the fuel system is operating properly, the Megajector has an internal failure and must be replaced.

DTC 355 - Megajector comm. lost. This codes will set if the communication (CAN link) between the Megajector and the EPM is not present.

a. **CAN Circuits** - Check CAN circuits for continuity and shorts to power or ground and for proper connections.

If the CAN circuits are ok and all wiring connections are good, the Megajector has an internal failure and must be replaced.

DTC 361 - Megajector voltage supply high.

a. **Voltage** - Check battery voltage. If the voltage at the battery is greater than 18 volts, either the charging system or the megajector is faulty.

DTC 362 - Megajector voltage supply low.

a. Voltage - Check battery voltage. If the voltage at the battery is less than 9.5 volts:

The battery is faulty

or

The charging system is faulty

or

The Megajector is faulty.

DTC 363 - Megajector Internal Actuator Fault Detection.

a. **Connections** - Check power, ground, and CAN circuits at the Megajector in addition to all electrical connections. Repair as necessary and retest.

b. **Megajector** - Megajector has an internal failure. Contact JLG Industries for further assistance.

DTC 364 - Megajector Internal Circuitry Fault Detection.

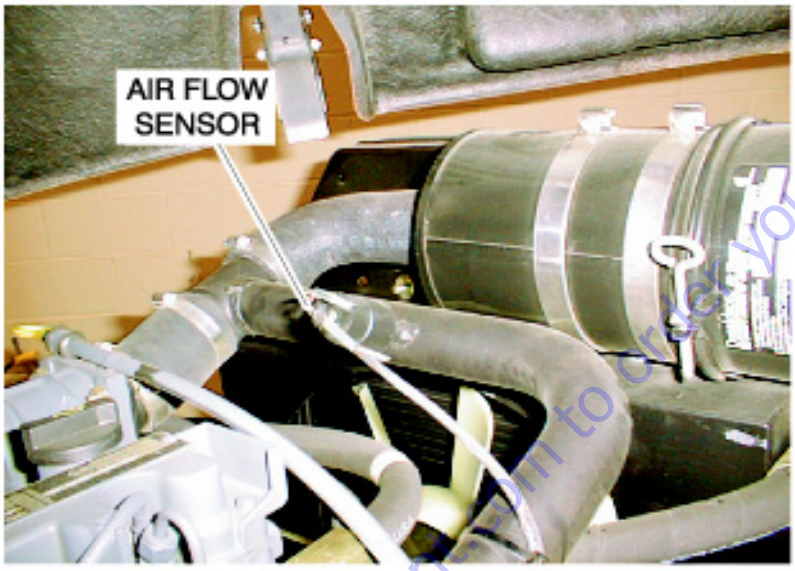
a. Connections - Check power, ground, and CAN circuits at the Megajector in addition to all electrical connections. Repair as necessary and retest.

b. Megajector - Megajector has an internal failure. Contact JLG Industries for further assistance.

DTC 365 - Megajector Internal Comm Fault Detection.

a. Connections - Check power, ground, and CAN circuits at the Megajector in addition to all electrical connections. Repair as necessary and retest.

Megajector - Megajector has an internal failure. Contact JLG Industries for further assistance.



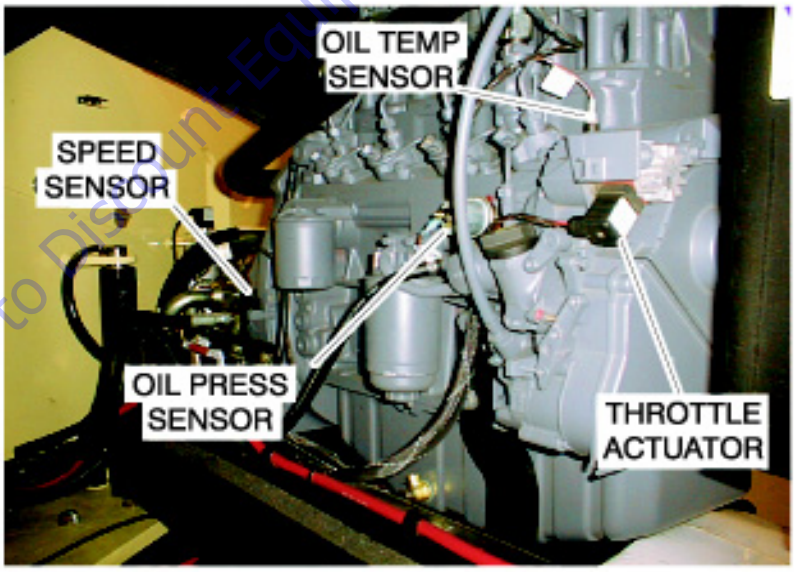


Figure 3-100. Deutz Sensors for JLG Control System

3.26 DEUTZ EMR 2

The EMR2 consists of the sensors, the control unit and the actuator. Engine-side controls as well as the JLG Control System are connected by means of separate cable harnesses to the EMR control unit.

The sensors attached to the engine provide the electronics in the control unit with all the relevant physical parameters In accordance with the information of the current condition of the engine and the preconditions (throttle position etc.), the EMR2 controls an actuator that operates the control rod of the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

The exact position of the regulating rod is reported back and, if necessary, is corrected, by means of the control rod travel sensor, situated together with the rotation magnets in a housing of the actuator.

The EMR2 is equipped with safety devices and measures in the hardware and software in order to ensure emergency running (Limp home) functions.

In order to switch the engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A strong spring in the actuator presses the control rod in the de-energized condition into the zero position. As a redundancy measure, an additional solenoid serves for switching off and this, independently of the actuator, also moves the control rod in the de-energized condition into the zero position.

After the programming, that is carried out over the ISO9141 interface, the EMR2 possesses a motor-specific data set and this is then fixedly assigned to the engine. Included in this are the various application cases as well as the customer's wishes regarding a particular scope of function.

Each EMR2 module is matched by serial number to the engine. Modules cannot be swapped between engines.

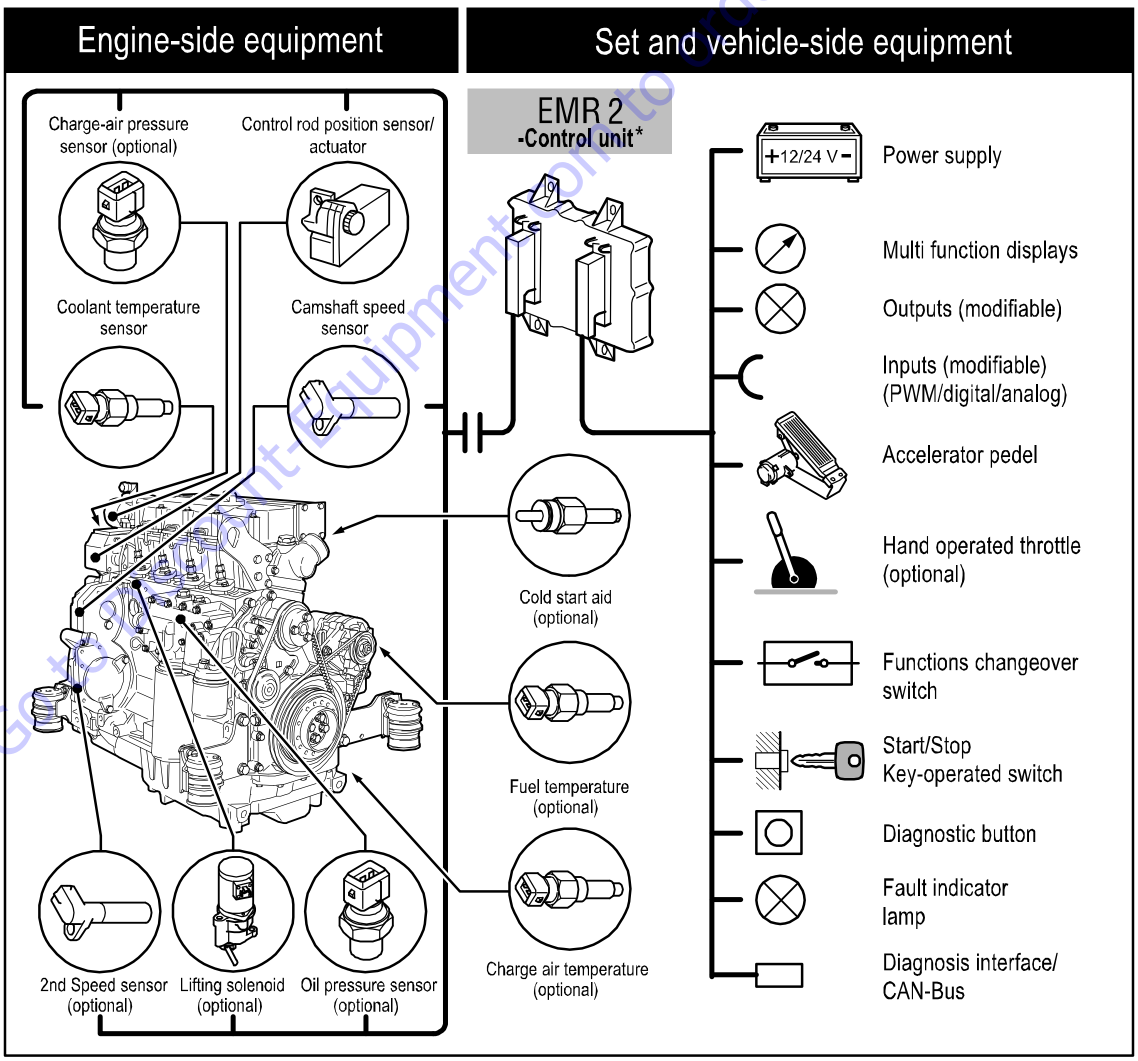


Figure 3-101. EMR 2 Engine Side Equipment

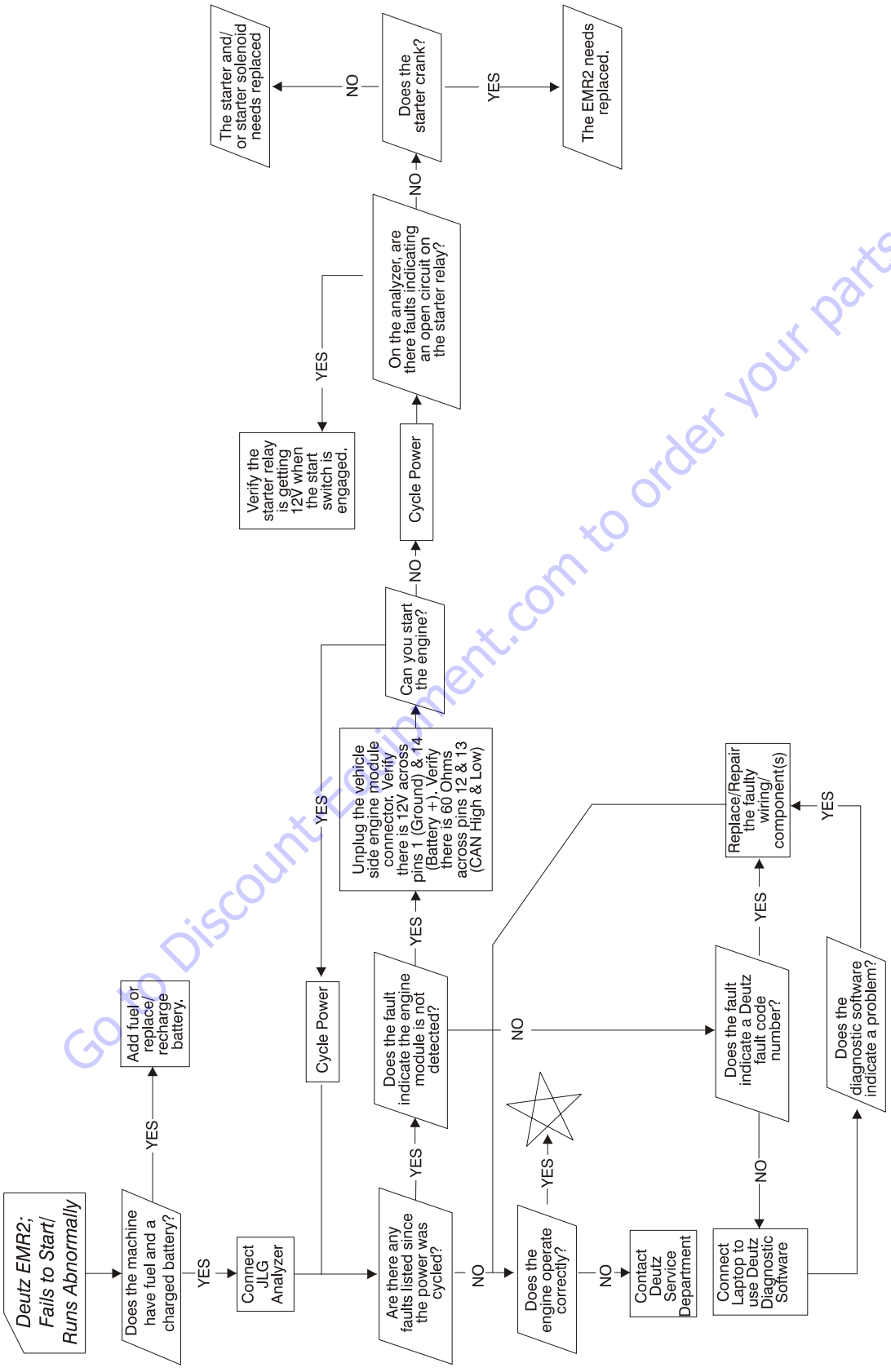


Figure 3-102. Deutz EMR 2 Troubleshooting Flow Chart

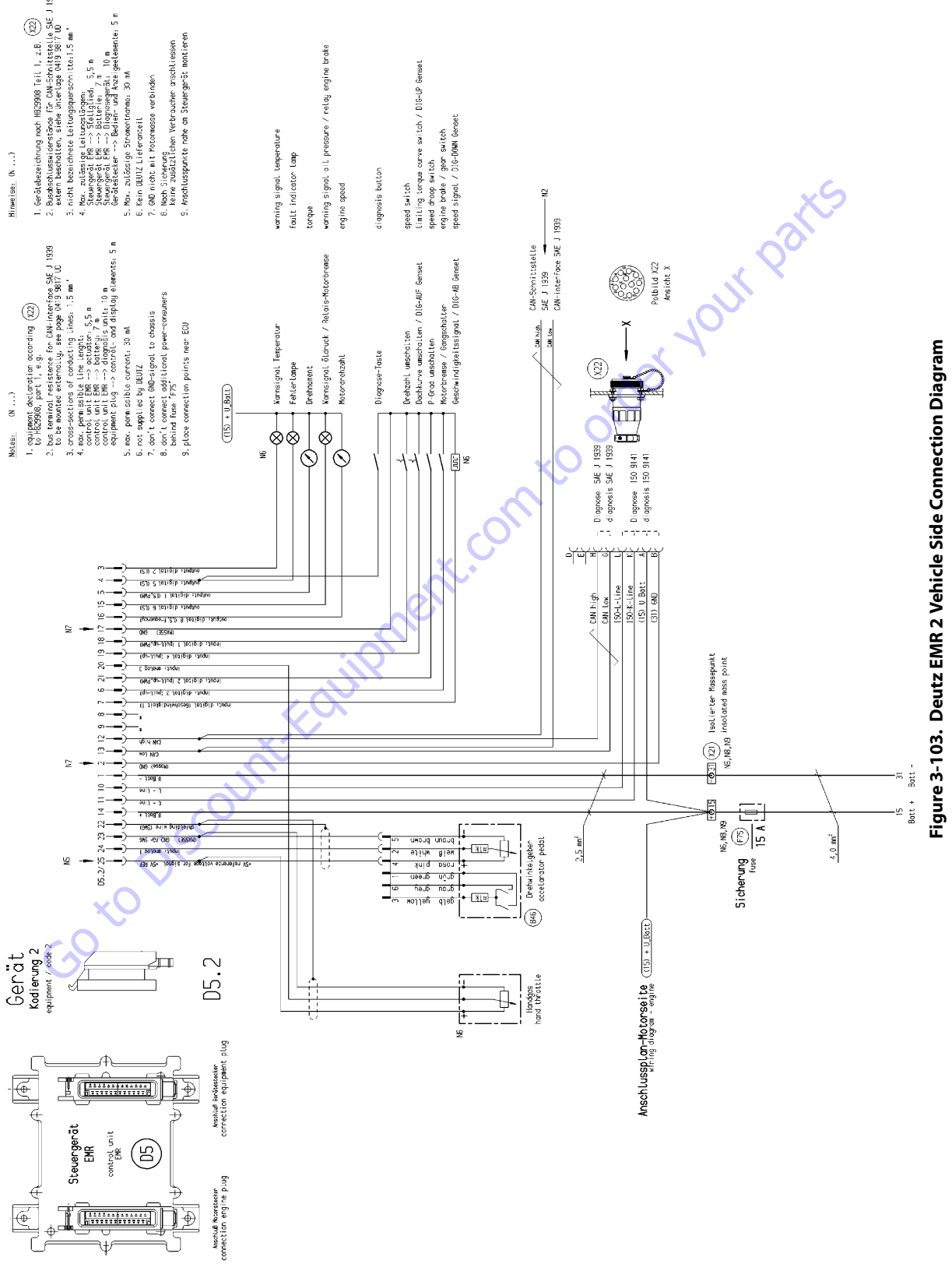


Figure 3-103. Deutz EMR 2 Vehicle Side Connection Diagram

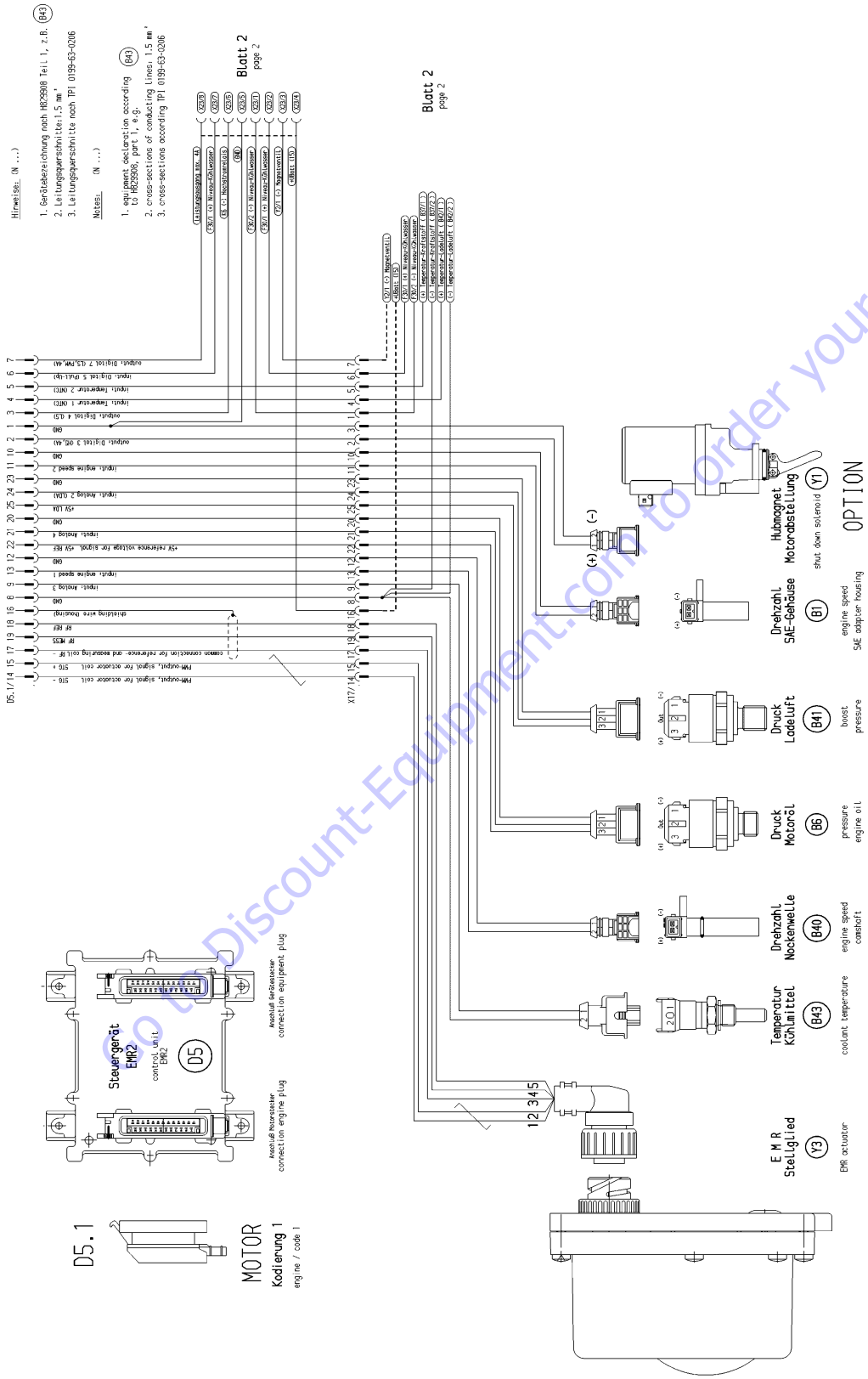


Figure 3-104. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

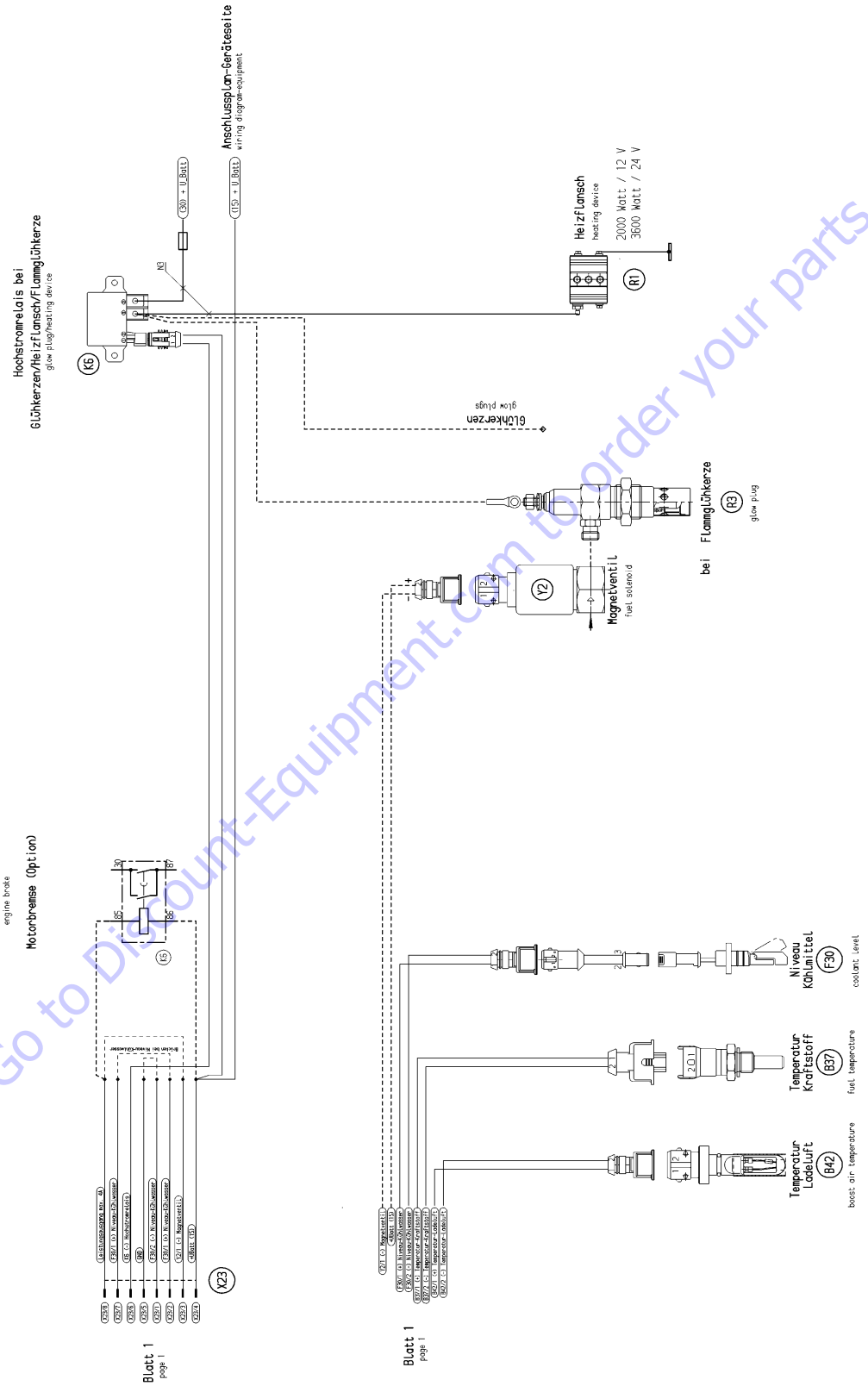
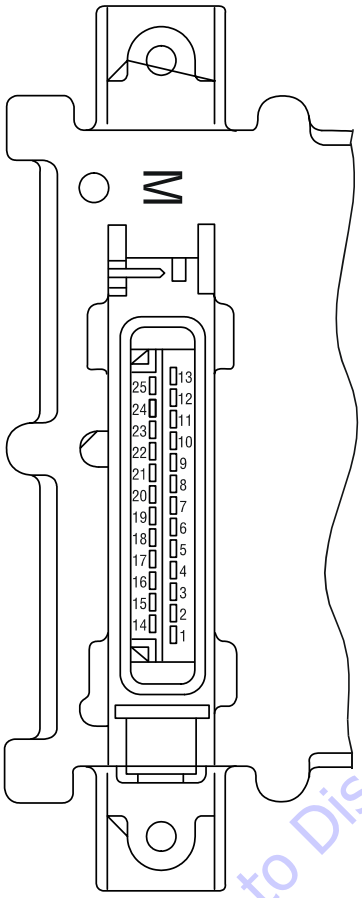


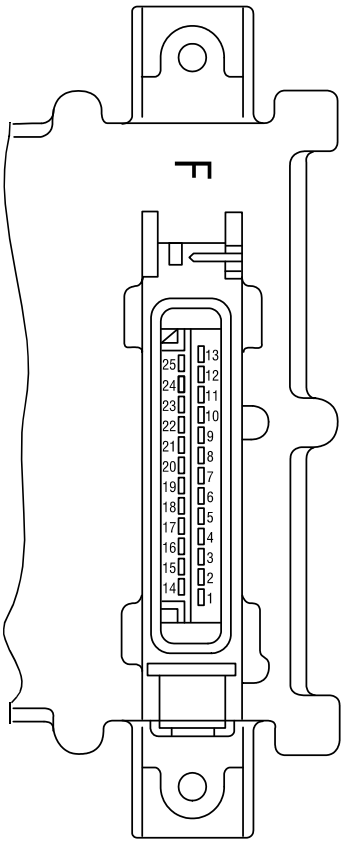
Figure 3-105. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid 1)
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature 2)
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant level / oil level
7	Output: PWM2/digital 6	
8	GND	Reference potential for analog signal at pin 9
9	Input: analog 7	Analog input for Coolant temperature sensor (NTC)
10	GND	Reference potential for analog signal at pin 11
11	Multi-function input: speed 2/DigIn 2	Digital input second engine speed (crankshaft) (optional) and speed signal (optional)
12	GND	Reference potential for analog signal at pin 13
13	Input: speed 1	Digital input first engine speed (camshaft)
14	STG -	PWM output, signal for actuator coil
15	STG +	PWM output, signal for actuator coil
16	Screen	Screening regulating rod travel sensor (for lines 17, 18, 19)
17	RF -	General connection for reference and measuring coil
18	RF REF	Analog input, reference signal of the reference coil
19	RF MESS	Analog input, measuring signal of the measuring coil
20	GND	Reference potential for signal at pin 21
21	Input: analog 4/digital 9	Analog input 4 (sensor signal oil pressure sensor) or digital input 9
22	+5 V REF	+5 V Reference voltage for signal at pin 21 (max. 15 mA)
23	GND	Reference potential for signal at pin 24
24	Input: analog 2/digital 7	Analog input 2 (sensor signal charge air) or digital input 7
25	+5 V LDA	+5 V Reference potential for signal at pin 24 (max. 15 mA)

1) For continuous power: < 4 A
2) Corresponds to special function"fuel temperature compensation at the EMR (0211 2571)

Figure 3-106. EMR 2 Engine Plug Pin Identification



Pin-No.	Designation	Description
1	U Batt -	Negative pole at battery (clamp 31)
2	GND	Reference potential for signal
3	Output: digital 2	PWM or digital output, various functions
4	Input / output: DigInOut	Fault lamp and diagnostic button
5	Output: PWM 1/Dig 1	PWM or digital output, various functions
6	Multi-function input: DigIn 3	Genset applications/gear shift/motor brake
7	Input: digital 10/velocity	Speed signal (tacho input)
8	NC	Not occupied
9	NC	Not occupied
10	L-line	Serial ISO 9141 interface
11	K-line	Serial ISO 9141 interface
12	CAN high	Interface for CAN-Bus
13	CAN low	Interface for CAN-Bus
14	U Batt +	Positive pole for battery (clamp 15)
15	Output: digital 5	Digital output, various functions
16	Output: digital 7/Frequency	Frequency, PWM or digital output, various functions
17	Ground	Reference potential for signal at pins 18, 19 and 21
18	Input: digital 1 / PWM 1	PWM 1 or digital input 1, various functions
19	Multi-function input: DigIn 4	Performance curve switching/genset applications
20	Multi-function input: digital 8 / analog 3	Hand hand throttle/genset applications, Digital (8) or analog input (3)
21	Input: digital 2 / PWM 2	PWM 2 or digital input 2, various functions
22	Screen	Screening (e.g. for lines hand throttle or PWG)
23	GND	Reference potential for signal at pin 24
24	Input: analog 1 / digital 6	Analog input 1 (pedal value sensor, PWG) or digital input 6
25	+5 V REF	+5 V Reference voltage for signal at pin 24

Figure 3-107. EMR 2 Vehicle Plug Pin Identification

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Zero error display	-	No faults	524287	31	No **active** faults present		
Revolutions / speed acquisition	01	Speed sensor 1	190	8	Sensor failure. Distance from gear too far. Additional fault impulses. Cable joint interrupted.	Governor in emergency operation (if sensor 2 available). Emergency switch-off (if sensor 2 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
						Governor in emergency operation (with sensor 1) Emergency switch-off (if sensor 1 not available or failed).	
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e.	Engine stop.	Check parameter (21). Check speed settings.
					Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.		
Sensors	07	Charge air pressure	102	2	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor, the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2			
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-108. EMR2 Fault Codes - Sheet 1 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault warning	30	Oil pressure warning	100	1	Oil pressure below speed-dependent warning line characteristic	Fault message (disappears when oil pressure is again above recovery limit). After a delay time - fill limitation.	Check engine (oil level, oil pump). Check oil pressure sensor and cable. Check oil pressure warning line characteristic.
	31	Coolant temperature warning	110	0	Coolant temperature has exceeded warning level.	Fault message (disappears when coolant temperature again drops below recovery level). After a delay time - fill limitation.	Check coolant. Check coolant temperature sensor and cable.
	32	Charge air temperature warning	105	0	Charge air temperature has exceeded warning level.	Fault message (disappears when charge air temperature gain drops below recovery level). After a delay time - fill limitation.	Check charge air. Check charge air-temperature sensor and cable.
	34	Coolant level warning	111	1	Switch input “Low coolant level” is active.	Fault message.	Check coolant level. Check coolant level sensor and cable.
	35	Speed warning (with thrust mode operation).	SID 190	14	revolutions was/is above (top) revolution speed limit. “Thrust mode” function is active.		Check parameters. Check speed settings.
					Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator. Check speed sensor (impulses on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.		
	36	Fuel temperature warning	174	0	Fuel-temperature has exceeded warning level.	Fault message (disappears when fuel temperature again drops below recovery level).	Check fuel. Check fuel temperature sensor and cable.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-109. EMR2 Fault Codes - Sheet 2 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault, switch-off	42	Charge air temperature switch-off	105	0	Charge air temperature has exceeded switch-off limit.	Emergency stop	Check charge air. Check charge air-temperature sensor and cable. Check switch-off limit.
	44	Coolant level switch-off	111	1	Switch input “Low coolant level” is active.	Emergency stop. Start lock.	Check coolant level. Check coolant level sensor and cable.
Actuator	50	Feedback	SID 24	12	Actuator not connected. Fault in actuator confirmation.	Emergency switch-off. Actuator cannot be operated.	Check actuator, replace if required. Check cable, check fault limits for “Confirmation”.
	52	Reference feedback	SID 24	13			Check actuator, replace if required. Check cable, check fault limits for “Rifeness confirmation”.
	53	Control travel difference	SID 23	7	Injection pump/actuator jammed or not connected. Difference between nominal/actual control travel is > 10 % of the overall control path.	Fault message (disappears when difference is < 10 %).	Check actuator/actuator rods / injection pump, replace if required. Check actuator cable.
	59	Auto calibration BOSCH-EDC pumps faulty operation	SID 23	13	No automatic actuator equalization possible. Incorrect input of the actuator reference values.	Engine stop / start lock. Governor cannot be taken into use. EDC actuator calibration required.	Check actuator and replaced if required. Check feedback cable. Check fault limits and reference values of the feedback. Program the fault limits for feedback, save values. Switch ignition off and on again.Check again. If faulty, inform DEUTZ-Service and carry out automatic equalization again. Set fault limits again.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-110. EMR2 Fault Codes - Sheet 3 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Hardware inputs/ outputs	60	Digital output 3 (Switch-off solenoid, pin M 2)	SID 51	2	Fault (short circuit / cable break) at digital output.	Driver level is switched off.	Check cable of digital output (cable break or short circuit).
	62	Digital output 6, pin M 7	SID 60	2		Fault message.	
	63	Excess voltage switch-off solenoid	SID 51	6			
	67	Error Hand Setp1	91	11			
	68	Error CAN Setp1	898	2			
Communi-cation	70	CAN-Bus controller	SID 231	12	CAN-controller for CAN-bus is faulty. Fault removal despite re-initialising continuously not possible	Application-dependent.	Check CAN connection, terminating resistor (see Chapter 12.4), Check control unit.
	71	CAN interface SAE J 1939	SID 231	9	Overflow in input buffer or a transmission cannot be placed on the bus.		
	74	Cable break, short circuit or bus-error	SID 231	14			Check CAN connection, cable connection. Check sensor and replace if required.
Memory	76	Parameter programming (write EEPROM)	SID 253	12	Fault in parameter programming in the governor fixed value memory.	Emergency switch-off. engine cannot be started.	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service
	77	Cyclic program test	SID 240	12	Constant monitoring of program memory shows error (so-called “Flash-test”).		
	78	Cyclic RAM test	SID 254	2	Constant monitoring of working memory shows error.		Note values of parameters (3895 and 3896). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-111. EMR2 Fault Codes - Sheet 4 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Control unit hardware	80	Power supply (Actuator)	SID 254	2	Power supply for actuator not in the permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	83	Reference voltage 1	SID 254	2	Reference voltage for actuator not in the permissible range.	Fault message (disappears when power again in the normal range). Auxiliary value 5 V	Check voltage supply. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	84	Reference voltage 2	SID 254	2			
	85	Reference voltage 4	SID 254	2			
	86	Internal temperature	171	12	Internal temperature for control unit not in permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	87	Atmospheric pressure	108	12	Atmospheric pressure not in permissible range.	Fault message (disappears when power again in normal range). Atmospheric pressure monitoring function de-activated.	
Program logic	90	Parameter fault (EEPROM retrieval or checksum faulty).	SID 253	2	No data found or checksum of data is faulty (note: fault only occurs during setting of parameter / saving or reset.).	Engine cannot be started.	Check data for correct settings. Save parameters. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	93	Stack overflow	SID 240	2	Internal calculation fault (so-called “Stack overflow” fault).	Emergency switch-off. Engine cannot be started.	Note parameters (3897 and 3898). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	94	Internal fault	SID 254	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-112. EMR2 Fault Codes - Sheet 5 of 5

3.27 GM ENGINE GENERAL MAINTENANCE

Maintenance of the Drive Belt

The serpentine drive belt utilizes a spring loaded tensioner which keeps the belt properly adjusted. The drive belt is an integral part of the cooling and charging systems and should be inspected frequently.

When inspecting the belts check for:

- Cracks or breaks
- Chunking of the belt
- Splits
- Material hanging from the belt
- Glazing and hardening
- Damaged or improperly aligned pulleys
- Improperly performing tensioner

Check the belt tensioner by pressing down on the midway point of the longest stretch between pulleys. The belt should not depress beyond 1/2 in. (13 mm). If the depression is more than allowable adjust the tension.

NOTICE

THE ENGINE MANUFACTURER DOES NOT RECOMMEND THE USE OF "BELT DRESSING" OR "ANTI SLIPPING AGENTS" ON THE DRIVE BELT.

Engine Electrical System Maintenance

The engine electrical system incorporates computers and microprocessors to control the engine ignition, fuel control, and emissions. Due to the sensitivity of the computers to good electrical connections periodic inspection of the electrical wiring is necessary. When inspecting the electrical system use the following:

- Check and clean the battery terminal connections and ensure the connections are tight.
- Check the battery for any cracks or damage to the case.
- Check the Positive and Negative battery cables for any corrosion build up, rubbing or chafing, check connection on the chassis to ensure they are tight.
- Check the entire engine wire harness for rubbing chafing, cuts or damaged connections, repair if necessary.
- Check all wire harness connectors to ensure they are fully seated and locked.
- Check ignition coil and spark plug cables for hardening, cracking, chafing, separation, split boot covers and proper fit.
- Replace spark plugs at the proper intervals as prescribed in the engine manufacturer's manual.
- Check to make sure all electrical components are fitted securely.
- Check the ground and platform control stations to ensure all warning indicator lights are functioning.

Checking/Filling Engine Oil Level

NOTICE

AN OVERFILLED CRANKCASE (OIL LEVEL OVER THE SPECIFIED FULL MARK) CAN CAUSE AN OIL LEAK, A FLUCTUATION OR DROP IN THE OIL PRESSURE, AND ROCKER ARM "CLATTER" IN THE ENGINE.

NOTICE

CARE MUST BE TAKEN WHEN CHECKING THE ENGINE OIL LEVEL. OIL LEVEL MUST BE MAINTAINED BETWEEN THE "ADD" MARK AND "FULL" MARK ON THE DIPSTICK.

To ensure that you are not getting a false reading, make sure the following steps are taken to before check the oil level.

1. Stop the engine if in use.
2. Allow sufficient time (approximately 5 minutes) for the oil to drain back into the oil pan.
3. Remove the dipstick. Wipe with a clean cloth or paper towel and reinstall. Push the dipstick all the way into the dipstick tube.
4. Remove the dipstick and note the oil level.
5. Oil level must be between the "FULL" and "ADD" marks.

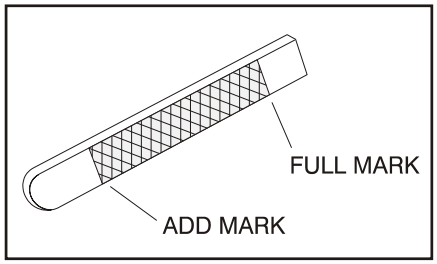


Figure 3-113. Engine Oil Dip Stick

6. If the oil level is below the "ADD" mark, proceed to Step 7 and 8 and reinstall the dipstick into the dipstick tube.
7. Remove the oil filter cap from the valve rocker arm cover.
8. Add the required amount of oil to bring the level up to but not over "FULL" mark on the dipstick.
9. Reinstall the oil fill cap to the valve rocker cover and wipe away any excess oil.

Changing The Engine Oil

NOTICE

WHEN CHANGING THE OIL, ALWAYS CHANGE THE OIL FILTER. CHANGE OIL WHEN THE ENGINE IS WARM FROM OPERATION AS THE OILS WILL FLOW FREELY AND CARRY AWAY MORE IMPURITIES.

To change the oil use the following steps:

1. Start the engine and run until it reaches normal operating temperature.
2. Stop the engine.
3. Remove the drain plug and allow the oil to drain.
4. Remove and discard the oil filter and its sealing ring.
5. Coat the sealing ring on the filter with clean engine oil and wipe the sealing surface on the filter mounting surface to remove any dust, dirt and debris. Tighten the filter securely (follow the filter manufacturers instructions). Do not over tighten.
6. Check the sealing ring on drain plug for any damage, replace if necessary, wipe the plug with a clean rag, and wipe the sealing surface on the pan and reinstall the pan plug. Do not over tighten.
7. Fill the crankcase with oil.
8. Start the engine and check for oil leaks.
9. Stop the engine and check the oil level to ensure the oil level is at "FULL".
10. Dispose of the oil and filter in a safe manner.

Coolant Fill Procedure - Dual Fuel Engine

NOTICE

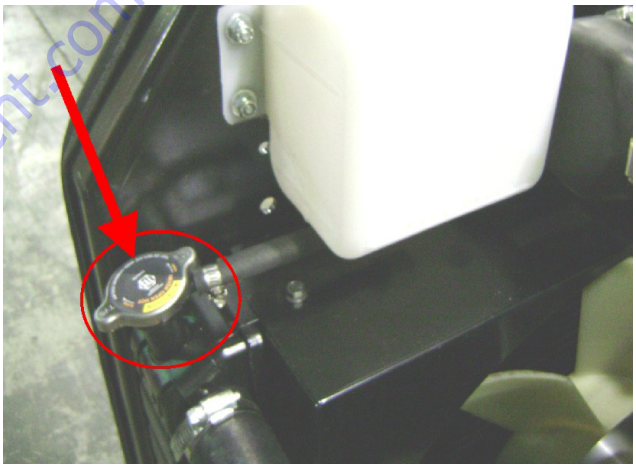
DAMAGE TO THE ENGINE COULD OCCUR IF NOT PROPERLY FILLED WITH COOLANT. LPG FUELED ENGINES ARE MOST PRONE TO CREATING AN AIR LOCK DURING A COOLANT FILL OPERATION DUE TO THE ELECTRONIC PRESSURE REGULATOR (EPR) BEING THE HIGHEST POINT IN THE COOLING SYSTEM. AN EPR THAT APPEARS TO HAVE FROST FORMING ON IT IS A SIGN THAT THE ENGINE COOLING SYSTEM CONTAINS AIR. THE APPEARANCE AND TEMPERATURE OF THE EPR SHOULD BE MONITORED DURING THE COOLANT FILL OPERATION. A WARM EPR IS AN INDICATION THAT THE COOLING SYSTEM IS PROPERLY FILLED AND FUNCTIONING.

⚠ CAUTION

MAKE SURE ENGINE IS COOL BEFORE PERFORMING ANY MAINTENANCE WORK.

1. Loosen the worm gear clamp on the coolant line running into the EPR as shown below and remove the hose from the EPR. Place a rag under the hose to prevent coolant from running onto the engine/machine.

2. Remove the radiator cap. Fill the radiator with coolant until coolant starts to appear from the previously removed hose at the EPR. Reinstall the hose back onto the EPR and continue to fill radiator with coolant.



3. With the radiator cap still removed, start the engine and run until the thermostat opens. The thermostat opens at 170° F (77° C), which can be checked using the JLG handheld analyzer.

NOTICE

WHILE ENGINE IS RUNNING, AIR AND/OR STEAM MAY BE PRESENT COMING FROM THE RADIATOR. THIS IS NORMAL.

4. After running the engine for 5 minutes after it has reached operating temperature, shut the engine off and continue to step 5.

⚠ CAUTION

WITH THE ENGINE RUNNING OR WHEN SHUTTING OFF THE ENGINE, SOME HEATED COOLANT MAY SPILL OUT DUE TO AIR "BURPING" OUT OF THE SYSTEM WITH THE RADIATOR CAP OFF.

5. Next, verify that the 2 coolant hoses on the EPR are warm. If they are not warm repeat step 3 and 4, otherwise continue to step 6.

NOTICE

A PROPERLY PURGED COOLING SYSTEM WILL YIELD A WARM UPPER RADIATOR HOSE AND A WARM EPR HOSE. IF THE UPPER RADIATOR HOSE AND/OR EPR HOSE ARE NOT WARM TO THE TOUCH AFTER THE ENGINE HAS RUN FOR 5-8 MINUTES AFTER REACHING OPERATING TEMPERATURE, THE SYSTEM MAY STILL CONTAIN AIR. IT MAY BE NECESSARY TO REPEAT THE ABOVE STEPS.

6. Fill radiator with coolant as needed and install the radiator cap. Next, remove the cap off the coolant recovery bottle and fill just below the HOT FULL line and reinstall the caps.

3.28 GM ENGINE DUAL FUEL SYSTEM

The Dual Fuel system allows the operator to operate the vehicle on either gasoline or LPG by positioning a selector switch in the operator's platform. When the operator places the selector switch in the gasoline mode the gasoline fuel pump is energized. While in the gasoline mode the LPG fuel lock-off is isolated and will not energize. In addition the gasoline injector circuit is enabled and injector pulses are provided to each injector and the ECM calibration for gasoline is also enabled. When the operator selects the LPG mode the Low Pressure LPG lock-off is energized and fuel from the LPG tank flows to the Electronic Pressure Regulator (EPR). The EPR receives an electronic signal to position the secondary lever for the start or run positions and when the engine begins to crank the mixer air valve will rise and fuel will begin flowing to engine. During this mode the gasoline fuel pump is isolated and will not be activated. The primary components of the gasoline dual fuel system are the gasoline tank, electric fuel pump and filter, fuel supply line, injector rail and injectors and the fuel pressure regulator. The primary components of the LPG dual fuel system are the LPG fuel tank, in-fuel filter, LPG Low Pressure lock-off, Electronic Pressure Regulator (EPR) and the fuel mixer module. The LPG fuel system operates at pressures which range from 14.0 inches (355.60 mm) of water column up to 312 psi (21.5 bar).

Components which are shared by both systems include the Electronic Throttle Control and the ECM. The ECM contains a dual calibration; one controls the gasoline fuel system during gasoline operation and one controls the LPG fuel system during LPG operation.

Fuel Filter

Propane fuel like all other motor fuels is subject to contamination from outside sources. Refueling of the equipment's tank and removal of the tank from the equipment can inadvertently introduce dirt and other foreign matter into the fuel system. It is therefore necessary to filter the fuel prior to entering the fuel system components downstream of the tank. An inline fuel filter has been installed in the fuel system to remove the dirt and foreign matter from the fuel. The inline filter is replaceable as a unit only. Maintenance of the filter is critical to proper operation of the fuel system and should be replaced as Section 1. In severe operating condition more frequent replacement of the filter may be necessary.

Electric Lock Off

The Electric Lock Off device is an integrated assembly. When energized the solenoid opens the valve and allows the Propane fuel to flow through the device. The valve opens during cranking and run cycles of the engine. The lock off supply voltage is controlled by the engine control module (ECM).

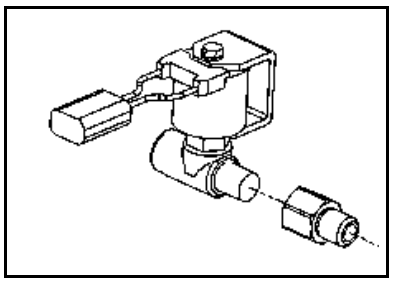
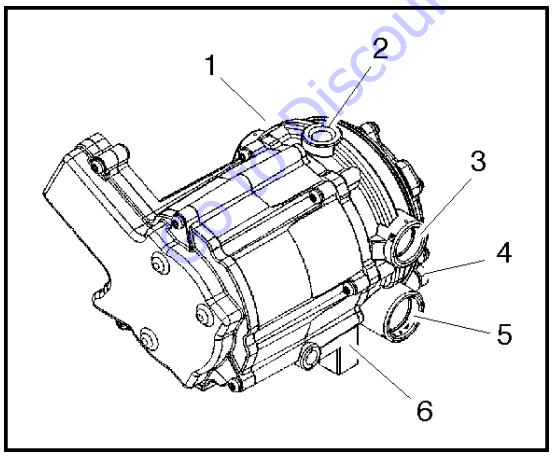


Figure 3-114. Electric Fuel Lock Off

EPR Assembly

The EPR assembly is a combination Low Pressure Regulator and a Voice Coil Assembly. The Voice coil is an electronic actuator which is controlled by an internal microprocessor. The microprocessor provides output data to the ECM and receives input data over a CAN BUS connection. The internal microprocessor receives electrical signals from the Fuel Pressure Sensor FPS and the Fuel Temperature Pressure FTP and communicates the data to the ECM. The ECM uses the FPS and FTP data to calculate the location of the secondary lever in the LPR and sends that data back to the EPR via the CAN BUS. The internal microprocessor in the EPR will then output a signal, which causes the voice coil to move and position the secondary lever to the correct location.



1. Pressure Regulator Section
2. Fuel Inlet
3. Coolant Passage
4. Primary Test Port
5. Secondary Test Port
6. Voice Coil Section

Figure 3-115. EPR Assembly

Low Pressure Regulator (LPR)

The LPR is a combination vaporizer, pressure regulating device. The LPR is a negative pressure, two stage regulator that is normally closed when the engine is not running. When the engine is cranking or running, a partial vacuum is created in the fuel line which connects the regulator to the mixer. This partial vacuum opens the regulator permitting fuel to flow to the mixer.

Propane fuel enters the primary port of the LPR and passes through the primary jet and into the primary/ exchanger chamber. As the propane passes through the heat exchanger the fuel expands and creates pressure inside the chamber. The pressure rises as the fuel expands when the pressure rises above 1.5 psi (10.34 kpa), sufficient pressure is exerted on the primary diaphragm to cause the diaphragm plate to pivot and press against the primary valve pin thus closing off the flow of fuel. This action causes the flow of fuel into the regulator to be regulated.

When the engine is cranking, sufficient vacuum will be introduced into the secondary chamber from the mixer drawing the secondary diaphragm down onto the spring loaded lever and opening the secondary valve allowing vaporized fuel to pass to the mixer. This mechanical action in conjunction with the EPR reactions causes the downward action on the secondary lever causing it to open wider allowing more fuel to flow to the mixer.

NOTICE

THE VOICE COIL SECTION OF THE EPR ASSEMBLY IS AN EMISSIONS CONTROL DEVICE AND CANNOT BE REBUILT. IF THE COIL ASSEMBLY FAILS TO OPERATE PROPERLY, REPLACE IT WITH AN OEM REPLACEMENT PART ONLY.

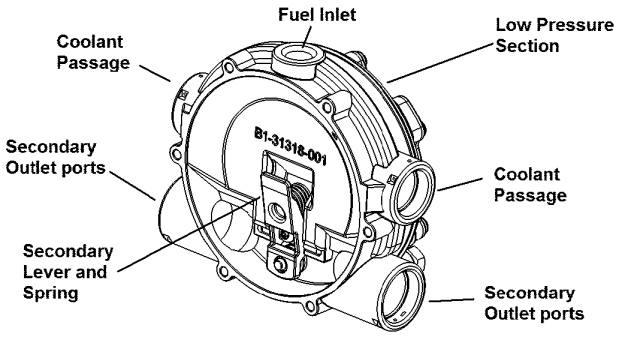


Figure 3-116. Low Pressure Regulators

Air Fuel Mixer

The air valve mixer is an air-fuel metering device and is completely self-contained. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted in the air stream ahead of the throttle control device.

When the engine begins to crank, it draws in air with the air valve covering the inlet, negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber through 4 vacuum ports in the air valve assembly. A pressure/force imbalance begins to build across the air valve diaphragm between the air valve vacuum chamber and the atmospheric pressure below the diaphragm. The air valve vacuum spring is calibrated to generate from 4.0 in. (101.6 mm) of water column at start to as high as 14.0 inches (355.60 mm) of water column at full throttle. The vacuum being created is referred to as Air Valve Vacuum (AVV). As the air valve vacuum reaches 4.0 in. (101.6mm) of water column, the air valve begins to lift against the air valve spring. The amount of AVV generated is a direct result of the throttle position. At low engine speed the air valve vacuum is low and the air valve position is low thus creating a small venturi for the fuel to flow. As the engine speed increase the AVV increases and the air valve is lifted higher thus creating a much larger venturi. This air valve vacuum is communicated from the mixer venture to the LPR secondary chamber via the low pressure fuel supply hose. As the AVV increases in the secondary chamber the secondary diaphragm is drawn further down forcing the secondary valve lever to open wider.

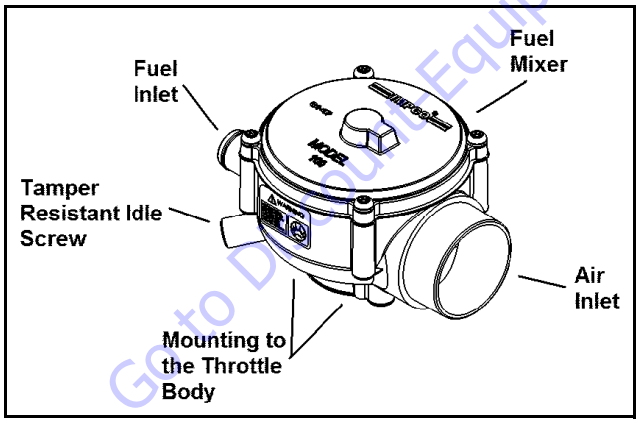


Figure 3-117. Air Fuel Mixer

Electronic Throttle Control (ETC)

Engine speed and load control is maintained by an ETC device. Speed and load control are determined by the ECM. Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine. The Electronic Throttle Control device or "throttle body assembly" is connected to the intake manifold of the engine. The electronic throttle control device utilizes an electric motor connected to the throttle shaft. When the engine is running electrical signals are sent from the equipment controls to the engine ECM when the operator depresses an equipment function switch. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel flow to the engine.

The electronic throttle control device also incorporates two internal Throttle Position Sensors (TPS) which provide output signals to the ECM as to the location of the throttle shaft and blade. The TPS information is used by the ECM to correct speed and load control as well as emission control.

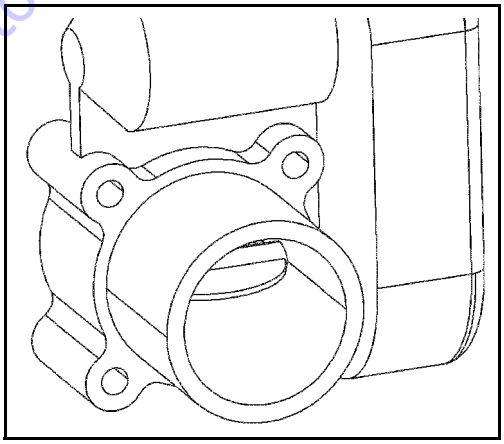


Figure 3-118. ETC throttle control device

Engine Control Module

To obtain maximum effect from the catalyst and accurate control of the air fuel ratio the emission certified engine is equipped with an onboard computer or Engine Control Unit (ECM). The ECM is a 32 bit controller which receives input data from sensors fitted to the engine and fuel system and then outputs various signals to control engine operation.

One specific function of the controller is to maintain "closed loop fuel control". Closed loop fuel control is accomplished when the exhaust gas oxygen sensor (HEGO) mounted in the exhaust system sends a voltage signal to the controller. The controller then calculates any correction that may need to be made to the air fuel ratio. The controller then outputs signals to the EPR to correct the amount of fuel being supplied to the mixer. At the same time the ECM may correct the throttle blade position to correct speed and load of the engine.

The controller also performs diagnostic functions on the fuel system and notifies the operator of malfunctions by turning on a Malfunction Indicator Light (MIL) mounted in the Ground Control Station and the Platform Control Station. Malfunctions in the system are identified by a Diagnostic Code number. In addition to notifying the operator of the malfunction in the system the controller also stores the information about the malfunction in its memory.

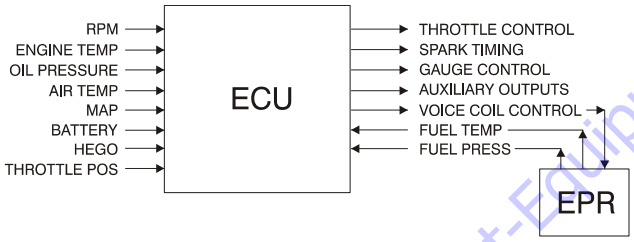


Figure 3-119. LPG Engine Control Unit (ECM)

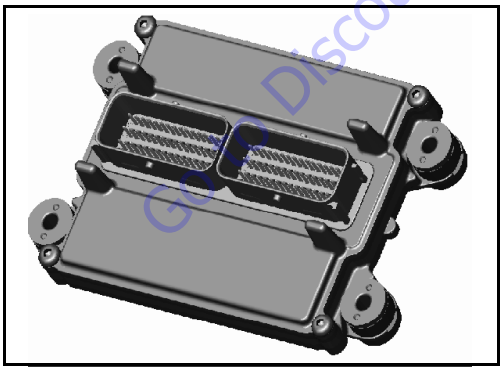


Figure 3-120. ECM Assembly

Heated Exhaust Gas Oxygen Sensor

There are two Heated Exhaust Gas Oxygen Sensors (HEGO). The first HEGO is mounted in the exhaust system downstream of the engine. It is used to measure the amount of oxygen present in the exhaust stream and communicate that to the ECM via an electrical signal. The amount of oxygen present in the exhaust stream indicates whether the fuel/air ratio is too rich or too lean. If the HEGO sensor signal indicates that the exhaust stream is too rich the ECM will decrease or lean the fuel mixture during engine operation, if the mixture is too lean the ECM will richen the mixture. The ECM continuously monitors the HEGO sensor output. If a rich or lean condition is present for an extended period of time, and the ECM cannot correct the condition, the ECM will set a diagnostic code and turn on the MIL light in control box.

The second HEGO is mounted in the exhaust system after the muffler. It measures the amount of oxygen in the exhaust system after the catalyst treatment has been completed in the muffler. If the ECM detects that the catalytic action in the muffler is not sufficient and fuel correction cannot correct the malfunction the MIL light is illuminated in the control box and a DTC code will stored in the computer.

NOTICE

THE HEATED EXHAUST GAS OXYGEN SENSOR IS AN EMISSION CONTROL DEVICE. IF THE HEGO FAILS TO OPERATE, REPLACE IT WITH AN OEM REPLACEMENT PART. THE HEGO SENSOR IS SENSITIVE TO SILICONE OR SILICONE BASED PRODUCTS AND CAN BECOME CONTAMINATED. AVOID USING SILICONE SEALERS OR HOSES TREATED WITH SILICONE LUBRICANTS IN THE AIR STREAM OR FUEL LINES.

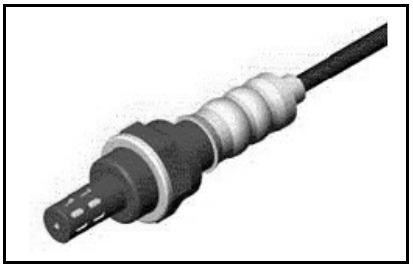


Figure 3-121. Heated Exhaust Gas Oxygen Sensor

Gasoline Multi Point Fuel Injection System (MPFI)

The primary components of the Gasoline Multi Point Fuel Injection (MPFI) fuel system are the fuel tank, electric fuel pump, fuel pressure and temperature sensor manifold, fuel filter and fuel rail.

Gasoline Fuel Pump

The Gasoline is stored as a liquid in the fuel tank and in drawn into the fuel system by an electric fuel pump. The fuel pump will receive a signal from the ECM to prime the fuel system for approximately 2 seconds prior to start. Priming of the fuel system provides for a quicker start, when the engine begins to crank.

Gasoline Pressure And Temperature Sensor Manifold

This engine is equipped with a fuel injector rail that does not have a pressure regulator or a return circuit to the fuel tank. Fuel pressure for this engine is regulated by the engine's ECM. The ECM receive fuel pressure and temperature feedback from the gasoline fuel sensor manifold and uses this information to control the ground side of the fuel pump. Fuel pressure is regulated by the ECM pulse width modulating (PWM) the fuel pump. The fuel pressure and temperature sensor manifold has a return or "bleed" circuit that connects back to the fuel tank. This circuit is used to bleed off any vapor that develops in the line and return a small amount of fuel to the tank. The fuel comes from the fuel tank and passes through the fuel pump. Fuel exits the fuel pump, passes through the filter and then enters the fuel pressure and temperature manifold assembly. Fuel flows through the feed circuit and is delivered to the fuel injector rail. Fuel that enters the bleed circuits through they bypass valve in the manifold is returned to the fuel tank.

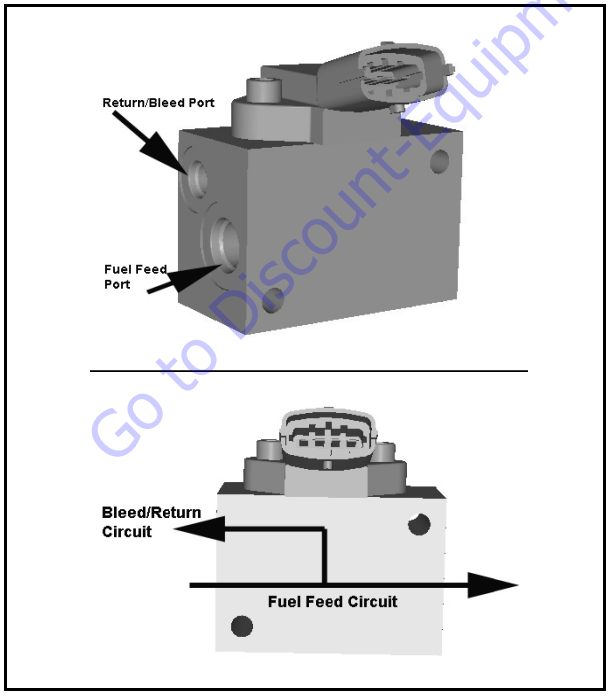


Figure 3-122. Gasoline Fuel Pressure and Temperature Manifold Assembly

Fuel Filter

After the fuel is drawn into the fuel pump, the fuel flows through the gasoline fuel filter. The fuel filter will trap small particles as the fuel passes through the filter to remove debris and prevents the fuel pressure and temperature manifold and fuel injectors from becoming damaged. Maintenance of the fuel filter is required as indicated in Section 1.

Fuel Injector Rail

Fuel flows from the fuel pressure and temperature manifold assembly to the fuel rails where the fuel is delivered to the fuel injectors. The fuel rail also contains a Schrader valve which is utilized to test the regulated pressure of the fuel system.

Fuel Injector

The fuel supply is maintained on the top of the injector from the injector rail. The injector is fed a "pulse" signal through the wire harness which causes the injector to open. During regular operating conditions the ECM controls the opening and duration of opening of the injector. During lower RPM operation the injector signals or "pulses" are less frequent then when the engine is operating at higher RPMs. The engine has been calibrated to deliver the precise amount of fuel for optimum performance and emission control.

3.29 GM ENGINE FUEL SYSTEM REPAIR

Propane Fuel System Pressure Relief

⚠ CAUTION

THE PROPANE FUEL SYSTEM OPERATES AT PRESSURES UP TO 312 PSI (21.5 BAR). TO MINIMIZE THE RISK OF FIRE AND PERSONAL INJURY, RELIEVE THE PROPANE FUEL SYSTEM PRESSURE (WHERE APPLICABLE) BEFORE SERVICING THE PROPANE FUEL SYSTEM COMPONENTS.

To relieve propane fuel system pressure:

1. Close the manual shut-off valve on the propane fuel tank.
2. Start and run the vehicle until the engine stalls.
3. Turn the ignition switch OFF.

NOTICE

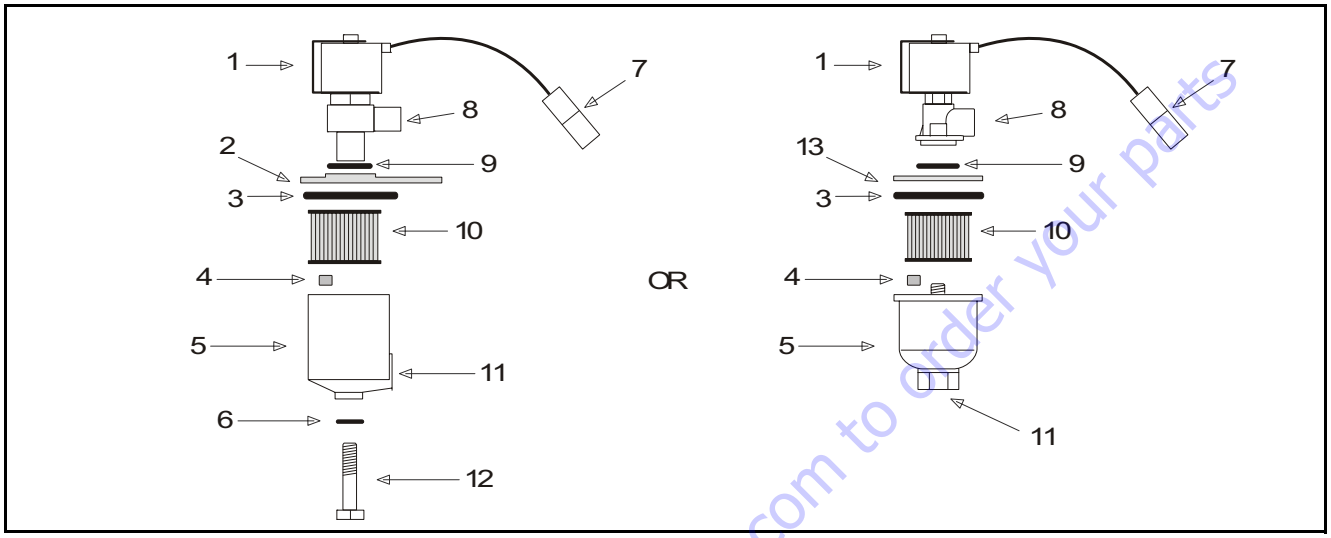
RESIDUAL VAPOR PRESSURE WILL BE PRESENT IN THE FUEL SYSTEM. ENSURE THE WORK AREA IS WELL VENTILATED BEFORE DISCONNECTING ANY FUEL LINE.

Propane Fuel System Leak Test

⚠ CAUTION

NEVER USE AN OPEN FLAME OF ANY TYPE TO CHECK FOR PROPANE FUEL SYSTEM LEAKS.

Always inspect the propane fuel system for leaks after performing service. Check for leaks at the fittings of the serviced or replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector.



7. Electric Lock Off Solenoid
8. Mounting Plate
9. Housing Seal
10. Filter Magnet
11. Filter Housing
12. Seal
13. Electrical Connector
14. Fuel Outlet
15. O-ring
16. Filter
17. Fuel Inlet
18. Retaining Bolt
19. Ring

Figure 3-123. Filter Lock Assembly

REMOVAL

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief".
2. Disconnect the negative battery cable.
3. Slowly loosen the Filter housing retaining bolt and remove it.
4. Pull the filter housing from the Electric lock off assembly.
5. Remove the filter from the housing.
6. Locate Filter magnet and remove it.
7. Remove and discard the housing seal.
8. If equipped, remove and discard the retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

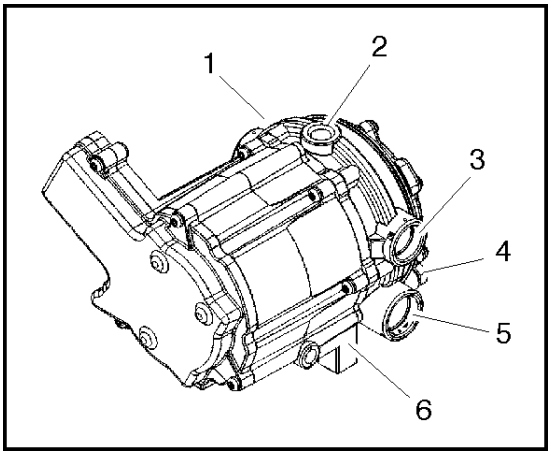
INSTALLATION

NOTICE

BE SURE TO REINSTALL THE FILTER MAGNET INTO THE HOUSING BEFORE INSTALLING NEW SEAL.

1. Install the mounting plate to lock off O-ring seal.
2. If equipped, install the retaining bolt seal.
3. Install the housing seal.
4. Drop the magnet into the bottom of the filter housing.
5. Install the filter into the housing.
6. If equipped, install the retaining bolt into the filter housing.
7. Install the filter up to the bottom of the electric lock off.
8. Tighten the filter retaining bolt to 106 in. lbs. (12 Nm).
9. Open manual shut-off valve. Start the vehicle and leak check the propane fuel system at each serviced fitting Refer to Propane Fuel System Leak Test.

Electronic Pressure Regulator (EPR) Assembly Replacement



1. Pressure Regulator Section
2. Fuel Inlet
3. Coolant Passage
4. Primary Test Port
5. Secondary Test Port
6. Voice Coil Section

Figure 3-124. EPR Assembly

The EPR assembly is a made up of two separate components. The Voice Coil Section is not serviceable and can only be replaced as an assembly. The pressure regulator section is serviceable and will be detailed in this section.

REMOVAL

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief".
2. Disconnect the negative battery cable.
3. Slowly remove the fuel inlet fitting at the Electric Lock Off.

NOTE: *Residual vapor pressure will be present in the fuel system.*

4. Disconnect the electrical connector to the Electric Lock off.
5. Remove the Electric Lock Off from the regulator.
6. Remove the lock pin from the vapor fitting on the regulator housing and remove the fitting and hose and retain the pin.
7. Remove the lock pin from the pressure sensor on the regulator housing and remove the Sensor and retain the pin.
8. Using a clamp pliers pinch off the hoses on the coolant lines to the regulator.
9. Remove the lock pin from both the water fittings on the regulator housing and remove the fittings and hoses and retain the pin.
10. Disconnect the EPR electrical connector.
11. Remove the (3) three nuts from the EPR isolators and the EPR mounting bracket.
12. Remove the EPR from the bracket.
13. Remove the (3) three mounting isolators.

INSTALLATION

NOTICE

DO NOT USE TEFLON TAPE ON ANY FUEL FITTING. USE A LIQUID PIPE THREAD SEALANT WHEN INSTALLING FITTINGS.

CHECK ALL THE O-RINGS ON THE VAPOR AND WATER FITTINGS FOR ANY DAMAGE REPLACE IF NECESSARY.

LUBE ALL THE O-RINGS WITH AN O-RING LUBE BEFORE INSTALLING.

1. Install the three (3) rubber isolators to the bottom of the EPR.
2. Install the EPR assembly to the bracket and tighten the retaining nuts.

NOTE: *Do not over tighten the isolators and cause a separation of the isolators.*

3. Install the fuel temperature sensor into the regulator opening and lock in place with the locking pin, connect the electrical connector.
4. Insert the fuel vapor line and fitting into the regulator port and lock in place with the locking pin.
5. Install both the water hoses and fittings into the regulator and lock in place with the locking pin remove the clamp pliers from the hoses.
6. Install the electric lock off into the regulator inlet and tighten into proper location, connect the electrical connector.
7. Connect the fuel supply line and tighten until fully seated.
8. Connect the EPR electrical connector.
9. Open the manual valve.
10. Start the vehicle and leak check the propane fuel system at each serviced fitting Refer to Propane Fuel System Leak Test.

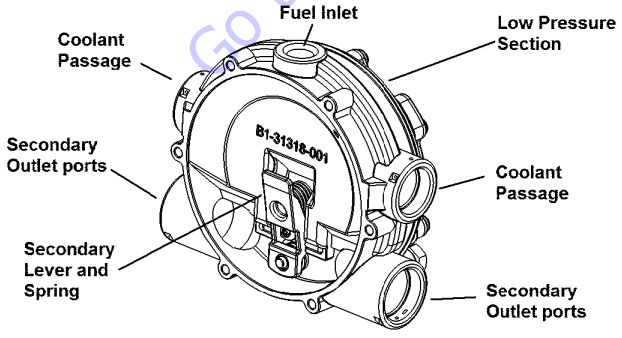


Figure 3-125. Pressure Regulator Section

PRESSURE REGULATOR SECTION REMOVAL

1. Remove the EPR refer to EPR Removal Procedure.
2. Remove the six (6) regulator to voice coil screws using the special tool and separate the regulator from the actuator.

NOTICE

DO NOT REMOVE THE SECONDARY DIAPHRAGM RETAINING PLATE AND DIAPHRAGM THIS WILL VOID THE WARRANTY OF THE ACTUATOR SECTION.

PRESSURE REGULATOR SECTION INSTALLATION

1. Install the regulator to the actuator section using the six (6) retaining screws and tighten 70 in. lbs. (8 Nm).
2. Install the EPR refer to EPR Installation.

Temperature Manifold Absolute Pressure (TMAP) Sensor

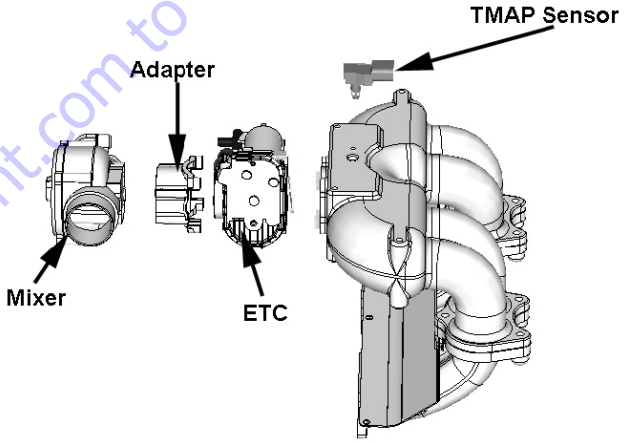


Figure 3-126. (TMAP) Sensor & Electronic Throttle Control (ETC)

REMOVAL

1. Disconnect the TMAP electrical connector.
2. Remove the two retaining bolts.
3. Remove the TMAP.

INSTALLATION

NOTE: *Apply a small amount of O-ring lubricant before installation.*

1. Install in the TMAP.
2. Tighten retaining bolts to 62 in. lbs. (7 Nm).
3. Start the vehicle and check for proper operation.

Electronic Throttle Control Replacement

See Figure 3-126.

REMOVAL

1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Release the hose clamp on the vapor fuel line and remove the vapor hose.
4. Disconnect the TMAP electrical connector.
5. Disconnect the electronic throttle control connector.
6. Remove the manifold to throttle body adapter bolts and remove the throttle body mixer assembly.
7. Pull the throttle body assembly from the adapter.
8. Remove electronic throttle control device.
9. Remove the O-rings gasket and discard.

INSTALLATION

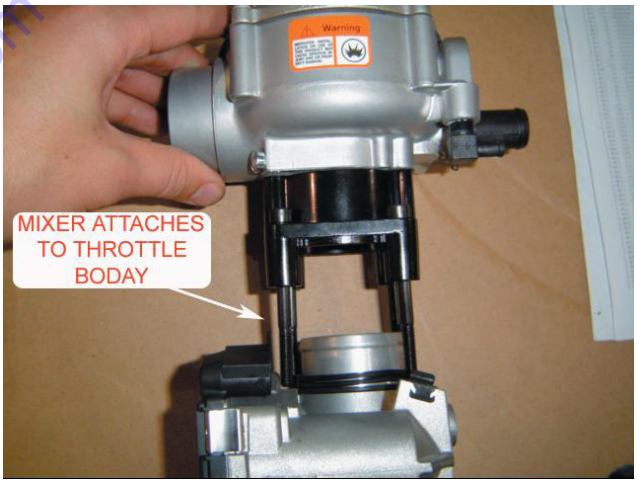
NOTICE

LIGHTLY LUBRICATE BOTH THROTTLE CONTROL DEVICE TO ADAPTER O-RINGS.

1. Install the O-ring on throttle body. Press it down to the bottom of the surface.

2. Install the two quad seals. Install one seal at a time to ensure the seal does not roll. The seal must sit flat on the throttle body.

3. Attach mixer and throttle body together. The two parts do not bolt together; they will be secured when you mount it on the intake. Notice the orientation of the air inlet and throttle body cover.



4. Place gasket on intake manifold and attach mixer/ throttle assembly to manifold.

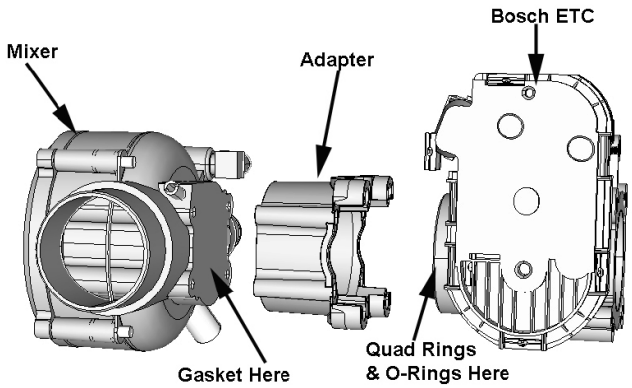


Figure 3-127. Mixer Assembly

Mixer Replacement

See Figure 3-127.

REMOVAL

1. Remove the Throttle control device Refer to Electronic Throttle Body Replacement.
2. Remove the four (4) bolts to the throttle control device to mixer adapter bolts.
3. Remove and discard the mixer to adapter gasket.

INSTALLATION

NOTICE

COVER THROTTLE BODY ADAPTER OPENING TO PREVENT DEBRIS FROM ENTERING ENGINE UNTIL REASSEMBLY.

1. Install Mixer to adapter gasket onto the mixer.
2. Install the mixer to the throttle control device to mixer adapter and secure with the 4 retaining screws. Tighten 80 in. lbs. (9 Nm).
3. Install Throttle body. Refer to Electronic Throttle Control Device Replacement.
4. Start the engine and leak check all fittings and connections.

Coolant Hose Replacement

REMOVAL

1. Drain the coolant.
2. Using hose clamp pliers, disconnect both hose clamps on each hose.
3. Remove the hose from each of the fittings.

INSTALLATION

NOTE: *Use hose material and lengths specified by JLG.*

1. Install the hose clamps to each hose and set the clamp back on each hose to make installation easier.
2. Fit the hose to the fittings.
3. Secure by positioning each of the clamps.

Vapor Hose Replacement

REMOVAL

1. Using hose clamp pliers disconnect both hose clamps.
2. Remove the vapor hose from each fitting.

INSTALLATION

NOTICE

THE VAPOR SUPPLY HOSE IS SPECIFICALLY DESIGNED, DO NOT USE HOSE MATERIAL OR LENGTH OTHER THAN JLG SPECIFIED PARTS.

1. Install hose clamps and set back on each hose.
2. Reinstall the vapor hose to each fitting.
3. Reset clamps.
4. Start engine and check for leaks.

Engine Control Module Replacement

REMOVAL

1. Disconnect Negative battery cable.
2. Remove controller from mounting bracket.
3. Push connector lock back to unlock connector.
4. Unplug controller and remove.

INSTALLATION

NOTICE

THE CONTROLLER IS CALIBRATED FOR EACH ENGINE VERIFY YOU HAVE THE CORRECT CONTROLLER

1. Plug connector into controller.
2. Push lock into place.
3. Mount controller into mounting bracket.
4. Reconnect the battery cable.
5. Start engine.
6. Check for any DTC codes and clear.
7. Verify engine is in closed loop and no warning lights are illuminated.

Heated Exhaust Gas Oxygen Sensor Replacement

REMOVAL

1. Disconnect Negative battery cable.
2. Disconnect the O2 sensor electrical connector.
3. Using an O2 Sensor socket, remove the O2 Sensor and discard.

INSTALLATION

NOTICE

BEFORE INSTALL THE O2 SENSOR LUBRICATE THREADS WITH ANTI-SEIZE COMPOUND GM P/N 5613695 OR EQUIVALENT. AVOID GETTING COMPOUND ON THE SENSOR TIP.

1. Install O2 sensor. Tighten to 30 ft. lbs. (41 Nm).
2. Start engine.
3. Check for any DTC codes and clear.
4. Verify engine is in closed loop and no warning lights are illuminated.

3.30 LP GAS FITTING INSPECTION

NOTICE

USE ALL APPLICABLE SAFETY PRECAUTIONS WHILE WORKING ON, UNDER, OR AROUND ANY MACHINERY.

⚠ CAUTION

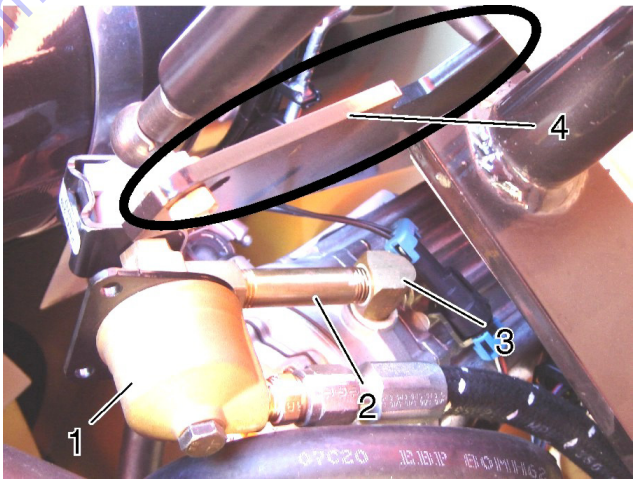
DO NOT SMOKE DURING THIS PROCEDURE.

1. Position the machine on a firm, level surface in a well-ventilated area free from any heat sources.
2. Lower the platform to the stowed position.
3. Depress the Emergency Stop button at the ground control panel and remove the key from the key switch.

⚠ CAUTION

ENSURE THE ENGINE IS COOL PRIOR TO PERFORMING THIS INSPECTION.

4. Locate the 2-1/2 in. (62.7 mm) straight fitting between the LP gas lockoff valve and the LP gas mixer. Refer to Figure 3-128., LP Gas Fitting Components.



1. LP Gas Lockoff Valve
2. 1/4 in. NPT x 2-1/2 in. Straight Fitting
3. 1/4in. NPT x 1/4in. SPT x 90 Degree Elbow
4. Hood Mounting Bracket

Figure 3-128. LP Gas Fitting Components

5. Refer to Figure 3-128., LP Gas Fitting Components and ensure that the hood-mounting bracket does not interfere with the 1/4 in. NPT X 2-1/2 in. straight tube fitting (JLG P/N 70001531).

6. Refer to Figure 3-129., Hood Mounting Bracket Clearance. If adequate clearance **DOES EXIST** between the straight tube fitting and the hood-mounting bracket, proceed to Step 10. If adequate clearance **DOES NOT EXIST** between the straight tube fitting and the hood-mounting bracket, proceed to Step 7.

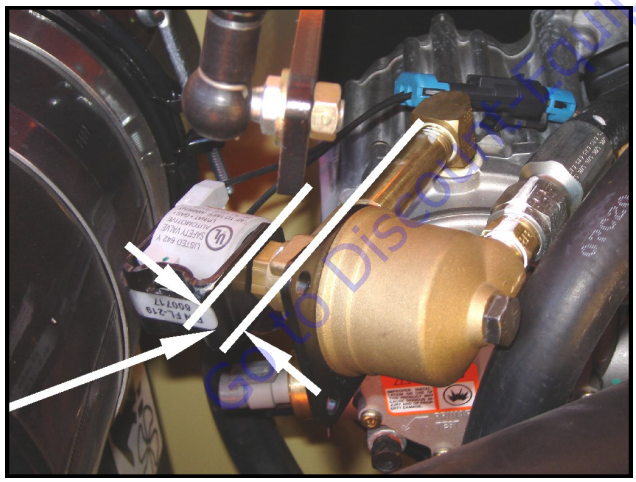
NOTICE

ENSURE THE LP GAS SUPPLY AT THE LP TANK IS CLOSED OFF PRIOR TO PROCEEDING.

7. As necessary, disassemble the LP gas system between the lock-off valve and the LP mixer to allow for reorientation of the 1/4 in. NPT X 1/4 in. SPT X 90 degree elbow (JLG P/N 70001307).

8. Properly clean all old thread sealant from the LP gas fittings.

9. Apply Permatex Thread Sealant (Permatex P/N 56525) to the LP gas fittings. Reassemble, allowing for proper clearance of the hood-mounting bracket and the LP gas system that was disassembled in Step 7. Refer to Figure 3-129., Hood Mounting Bracket Clearance for proper clearance. Properly tighten all LP gas connections.



Make sure there is a minimum of 0.5 in. (13 mm) clearance between the hood mounting bracket and the straight tube fitting.

Figure 3-129. Hood Mounting Bracket Clearance

10. Check the LP system for evidence of leaks. If any leaks are detected, properly repair them prior to returning the unit to service.

3.31 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

Fuel System Description

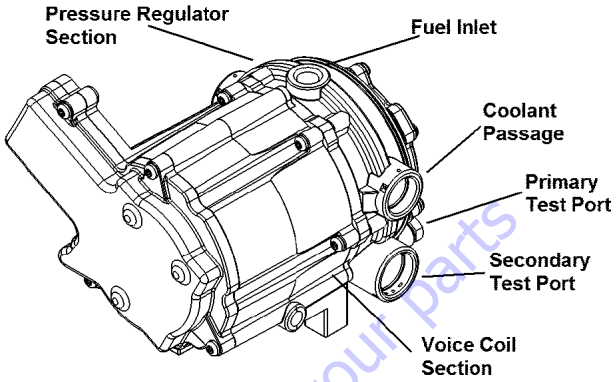


Figure 3-130. EPR Assembly

To maintain fuel and emission control on the LPG fuel system the Engine Control Units (ECM) relies on numerous engine sensor and output data from the Electronic Pressure Regulator (EPR). The ECM will then determine the target fuel calibration and command the EPR to reposition the voice coil to the proper position which, subsequently reposition the secondary lever of the pressure regulator to maintain proper control. The EPR and ECM will continue to communicate back and forth during normal operation.

In the event that the EPR fails to communicate or the Communications Area Network (CAN) cable fails to transmit data the regulator will operate in an open loop configuration. As the air valve vacuum in the mixer venturi is communicated to the secondary chamber of the regulator the secondary diaphragm will be drawn in a downwards motion. This downward motion will cause the secondary lever to open thus allowing more fuel to enter the mixer.

In the (LPR) the fuel is vaporized and the pressure reduced in two stages. The first stage reduces the pressure to approximately 1.0-3.0 psi (6.8-20.6 kPa). The second stage reduces the pressure to approximately negative 1.5 in. (38.1 mm) of water column.

The fuel is then drawn from the secondary chamber of the LPR by the vacuum generated by air flowing through the mixer. This vacuum signal is also used to generate lift for the mixer air valve. This vacuum signal is most commonly referred to as air valve vacuum. In the mixer, the fuel mixes with the air entering the engine. This air/ fuel mixture is then drawn into the engine for combustion.

Diagnostic Aids

This procedure is intended to diagnose a vehicle operating on LPG. If the vehicle will not continue to run on LPG, refer to Hard Start for preliminary checks. Before proceeding with this procedure, verify that the vehicle has a sufficient quantity of fuel and that liquid fuel is being delivered to the LPR. Also, ensure that the manual shut off valve on the LPG tank is fully opened and that the excess flow valve has not been activated.

TOOLS REQUIRED:

- 7/16 Open end wrench (for test port plugs).
- DVOM (GM J 39200, Fluke 88 or equivalent).
- 12 volt test light.

DIAGNOSTIC SCAN TOOL

- Diagnostic Display tool.

PRESSURE GAUGES

- IMPCO ITK-2 Test kit.
- Water Column Gauge / Manometer (GM 7333-6 or equivalent).
- 0-10 PSI (0-0.69 BAR) Gauge.

TEST DESCRIPTION.

The numbers below refer to step numbers on the diagnostic table.

5. This step determines if the LPR requires replacement.

6. This step determines if the problems are in the mechanical side of the Pressure Regulator or the Electronic Voice Coil.

10. This step determines if the Mixer requires replacement.

14. This step determines if the Lock Off requires replacement.

17. This step determines if the Fuel Filter requires replacement.

Table 3-16. LPG Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
1	Were you referred to this procedure by a DTC diagnostic chart?	--	Go to Step 3	Go to Step 2
2	Perform the On Board Diagnostic (OBD) System Check. Are any DTCs present in the ECM?	--	Go to the applicable DTC Table	Go to Step 3
3	Verify that the LPG fuel tank has a minimum of 1/4 tank of fuel, that the manual valve is open and the tank quick connect is fully engaged Does the vehicle have fuel?	--	Go to Step 4	--
4	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Start the engine and allow it to reach operating temperature. Does the engine start and run?	--	Go to Step 5	Go to Step 8
5	With the engine idling, observe the pressure reading for the LPR secondary pressure. Does the fuel pressure fluctuate rhythmically OUTSIDE the specified range?	-0.5″ to -2.5″ w.c	Go to Step 25	Go to Step 6
6	1. Disconnect the EPR electrical connectors. NOTE: This action will cause a DTC to be set by the ECM 2. With the engine idling observe the pressure reading on the secondary test port. Is the fuel pressure WITHIN the specified range?	-0.5″ to -2.5″ w.c	Go to Fuel Control System Diagnosis	Go to Step 7
7	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the fuel hose connection between the LPR and mixer assembly for damage or leakage. 3. Inspect any vacuum hoses for leaks Was a problem found and corrected?	--	Go to Step 26	Go to Step 22
8	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR secondary pressure. Does the fuel pressure indicate a vacuum is present?	--	Go to Step 12	Go to Step 9
9	1. Remove Air induction hose to the mixer 2. Observe the air valve for movement while the engine is cranking. Note: Movement of the air valve will be minimal at cranking speeds. Does the air valve move when the engine is cranked?	--	Go to Step 11	Go to Step 10
10	1. Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses from the mixer for proper connection and condition. Was a problem found and repaired?	--	Go to Step 26	Go to Step 24
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	--	Go to Step 26	Go to Step 12
12	1. Connect a 0-10 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is the fuel pressure ABOVE the specified value?	1-3 PSI	Go to Step 22	Go to Step 13
13	1. Turn OFF the ignition. 2. Disconnect the LPL connector. 3. Install a test light between the pins of the LPL connector. 4. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 14	Go to Step 16
14	Using a DVOM, check the resistance of the low pressure lock-off (LPL). Is the resistance within the specified range?	12W - 16W	Go to Step 15	Go to Step 23

Table 3-16. LPG Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
15	1. Turn the ignition OFF. 2. Close the manual shut-off valve on the LPG tank. CAUTION: When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area. 3. Loosen the fuel inlet hose fitting at the inlet of the LPL. Was fuel present when the fitting was loosened?	--	Go to Step 23	Go to Step 17
16	1. Turn OFF the ignition. 2. Connect the test light to chassis ground and probe pin A of the LPL connector. 3. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 20	Go to Step 21
17	1. Remove the LPG fuel filter / LPL. 2. Remove the filter from the LPL. 3. Empty the contents of the inlet side of the LPG fuel filter onto a clean surface. 4. Inspect the contents of the LPG fuel filter for an excessive amount of foreign material or water. If necessary, locate and repair the source of contamination. 5. Verify the LPG fuel filter is not restricted or plugged. Was a problem found?	--	Go to Step 19	Go to Step 18
18	The fuel supply system or hoses are plugged or restricted, locate and repair the problem. Is the action complete?	--	Go to Step 26	--
19	Replace the fuel filter. Refer to Fuel Filter Replacement. Is the action complete?	--	Go to Step 26	--
20	Repair the open in the lock-off ground circuit. Is the action complete?	--	Go to Step 26	--
21	Repair the open in the lock-off power circuit. Is the action complete?	--	Go to Step 26	--
22	Replace the low pressure regulator (LPR). Refer to Low Pressure Regulator Replacement. Is the action complete?	--	Go to Step 26	--
23	Replace the lock-off. Refer to Lock-off Replacement. Is the action complete?	--	Go to Step 26	--
24	Replace the mixer assembly. Refer to Fuel Mixer Replacement. Is the action complete?	--	Go to Step 26	--
25	The fuel supply system is operating normally, if a failure of the control solenoids is suspected. Refer to Fuel Control System Diagnosis. 1. Install the test plug in the LPR secondary chamber. 2. If you were sent to this routine by another diagnostic chart, return to the previous diagnostic procedure. Is the action complete?	--	System OK	--
26	1. Disconnect all test equipment 2. Install the primary and secondary test port plugs. 3. Start the engine. 4. Using SNOOP or equivalent, leak check the test port plugs. Is the action complete?	--	System OK	--

Table 3-17. Symptom Diagnosis

Checks	Action
Important Preliminary Checks	
Before Using This Section	Before using this section, you should have performed On Board Diagnostic Check and determined that: 1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly. 2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL. Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks that may save valuable time.
LPG Fuel System Check	1. Verify the customer complaint. 2. Locate the correct symptom table. 3. Check the items indicated under that symptom. 4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich. IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.
Visual and Physical Checks	[2] Check all ECM system fuses and circuit breakers. [2] Check the ECM ground for being clean, tight and in its proper location. [2] Check the vacuum hoses for splits, kinks and proper connections. [2] Check thoroughly for any type of leak or restriction. [2] Check for air leaks at all the mounting areas of the intake manifold sealing surfaces. [2] Check for proper installation of the mixer module assembly. [2] Check for air leaks at the mixer assembly. [2] Check the ignition wires for the following conditions: - Cracking - Hardness - Proper routing - Carbon tracking [2] Check the wiring for the following items: - Proper connections, pinches or cuts. [2] The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.
Intermittent	
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	[2] Refer to Important Preliminary Checks. [2] Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	[2] Faulty electrical connections or wiring can cause most intermittent problems. [2] Check the suspected circuit for the following conditions: - Faulty fuse or circuit breaker - Connectors poorly mated - Terminals not fully seated in the connector (backed out) - Terminals not properly formed or damaged - Terminal to wires poorly connected - Terminal tension insufficient. [2] Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension. [2] Checking for poor terminal to wire connections requires removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.

Table 3-17. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no DTC(s): [2] A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. [2] The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. [2] The ignition secondary voltage shorted to a ground. [2] The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. [2] The Control Module grounds.
Loss of DTC Memory	To check for the loss of the DTC Memory: 1. Disconnect the TMAP sensor. 2. Idle the engine until the Malfunction Indicator Lamp illuminates. The ECM should store a TMAP DTC. The TMAP DTC should remain in the memory when the ignition is turned OFF. If the TMAP DTC does not store and remain, the ECM is faulty
Additional Checks	
No Start	
DEFINITION: The engine cranks OK[22] but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	If a scan tool is available: [2] Check for proper communication with both the ECM. [2] Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. [2] Check battery power, ignition power and ground circuits to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity for each circuit.
Sensor Checks	[2] Check the TMAP sensor. [2] Check the Magnetic pickup sensor (RPM).
Fuel System Checks	**Important:** A closed LPG manual fuel shut off valve will create a no start condition. [2] Check for air intake system leakage between the mixer and the throttle body. [2] Verify proper operation of the low pressure lock-off solenoids. [2] Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis. [2] Check for proper mixer air valve operation.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. [2] Check for the proper ignition voltage output with J 26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS). [2] Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits [2] Check for bare or shorted ignition wires. [2] Check for loose ignition coil connections at the coil.
Engine Mechanical Checks	**Important:** The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. [2] Check for the following: - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes

Table 3-17. Symptom Diagnosis

Checks	Action
Exhaust System Checks	[2] Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes. - Inspect the muffler for signs of heat distress or for possible internal failure. [2] Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis.
Hard Start	
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	[2] Refer to Important Preliminary Checks. [2] Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	[2] Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to DTC 111. [2] Check the Crankshaft Position (CKP) sensor. [2] Check the Throttle position (TPS) sensor.
Fuel System Checks	Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. [2] Verify the excess flow valve in the LPG manual shut-off valve is not tripped. [2] Check mixer module assembly for proper installation and leakage. [2] Verify proper operation of the low pressure lock-off solenoids. [2] Verify proper operation of the EPR. [2] Check for air intake system leakage between the mixer and the throttle body. [2] Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. [2] Check for the proper ignition voltage output with J 26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS). [2] Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits [2] Check for bare or shorted ignition wires. [2] Check for moisture in the distributor cap if applicable. [2] Check for loose ignition coil connections. Important: 1. If the engine starts but then immediately stalls, Check the Crankshaft Position (CKP). 2. Check for improper gap, debris or faulty connections.
Engine Mechanical Checks	Important: The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. [2] Check for the following: - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes [2] Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	[2] Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes. - Inspect the muffler for signs of heat distress or for possible internal failure. [2] Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual.

Table 3-17. Symptom Diagnosis

Checks	Action
Additional Checks	[2]
Cuts Out, Misses	
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	[2] Refer to Important Preliminary Checks.
Ignition System Checks	[2] Start the engine. [2] Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. [2] Check for proper ignition output voltage with spark tester J 26792. [2] Check for a cylinder misfire. [2] Verify that the spark plugs are correct for use with LPG (R42LTS). [2] Remove the spark plugs in these cylinders and check for the following conditions: [2] Insulation cracks [2] Wear [2] Improper gap [2] Burned electrodes [2] Heavy deposits [2] Visually/Physically inspect the secondary ignition for the following: [2] Ignition wires for arcing, cross-firing and proper routing [2] Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	[2] Perform a cylinder compression check. [2] Check the engine for the following: - Improper valve timing - Bent push rods - Worn rocker arms - Worn camshaft lobes - Broken or weak valve springs [2] Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	[2] Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. [2] Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). [2] EMI on the reference circuit can cause a missing condition. [2] Monitoring the engine RPM with a scan tool can detect an EMI. [2] A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. [2] If the problem exists, check the routing of the secondary wires and the ground circuit.
Hesitation, Sag, Stumble	
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	[2] Check the fuel pressure. Refer to LPG Fuel System Diagnosis. [2] Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. [2] Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. [2] Check LPL electrical connection. [2] Check the mixer air valve for sticking or binding. [2] Check the mixer module assembly for proper installation and leakage. [2] Check the EPR electrical connections.

Table 3-17. Symptom Diagnosis

Checks	Action
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly. [2] Check for the proper ignition voltage output with J 26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS). [2] Check for faulty spark plug wires. [2] Check for fouled spark plugs.
Additional Check	[2] Check for manifold vacuum or air induction system leaks. [2] Check the generator output voltage.
Backfire	
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	[2] Refer to Important Preliminary Checks.
Ignition System Checks	Important! LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire. [2] Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent. [2] Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. [2] Check the connection at each ignition coil. [2] Check for deteriorated spark plug wire insulation. [2] Check the spark plugs. The correct spark plugs for LPG are (R42LTS) [2] Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits
Engine Mechanical Check	Important! The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system. [2] Check the engine for the following: - Improper valve timing - Engine compression - Manifold vacuum leaks - Intake manifold gaskets - Sticking or leaking valves - Exhaust system leakage [2] Check the intake and exhaust system for casting flash or other restrictions.
Fuel System Checks	[2] Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.
Lack of Power, Sluggishness, or Sponginess	
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	[2] Refer to Important Preliminary Checks. [2] Refer to the LPG Fuel system OBD System Check. [2] Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics. [2] Remove the air filter and check for dirt or restriction. [2] Check the vehicle transmission Refer to the OEM transmission diagnostics.

Table 3-17. Symptom Diagnosis

Checks	Action
Fuel System Checks	[2] Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG Fuel System Diagnosis. [2] Check for the proper ignition output voltage with the spark tester J 26792 or the equivalent. [2] Check for proper installation of the mixer module assembly. [2] Check all air inlet ducts for condition and proper installation. [2] Check for fuel leaks between the LPR and the mixer. [2] Verify that the LPG tank manual shut-off valve is fully open. [2] Verify that liquid fuel (not vapor) is being delivered to the LPR.
Sensor Checks	[2] Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. [2] Check for proper operation of the TPS sensor.
Exhaust System Checks	[2] Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes. - Inspect the muffler for signs of heat distress or for possible internal failure. - Check for possible plugged catalytic converter.
Engine Mechanical Check	Check the engine for the following: [2] Engine compression. [2] Valve timing. [2] Improper or worn camshaft. Refer to Engine Mechanical in the Service Manual.
Additional Check	[2] Check the ECM grounds for being clean, tight, and in their proper locations. [2] Check the generator output voltage. [2] If all procedures have been completed and no malfunction has been found, review and inspect the following items: [2] Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. [2] Check the scan tool data.
Poor Fuel Economy	
DEFINITION: Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an by refueling records.	
Preliminary Checks	[2] Refer to Important Preliminary Checks. [2] Check the air cleaner element (filter) for dirt or being plugged. [2] Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections. [2] Check the operators driving habits for the following items: - Is there excessive idling or stop and go driving? - Are the tires at the correct air pressure? - Are excessively heavy loads being carried? - Is their often rapid acceleration? [2] Suggest to the owner to fill the fuel tank and to recheck the fuel economy. [2] Suggest that a different operator use the equipment and record the results.
Fuel System Checks	[2] Check the LPR fuel pressure. Refer to LPG Fuel System Diagnosis. [2] Check the fuel system for leakage.
Sensor Checks	[2] Check the Temperature Manifold Absolute Pressure (TMAP) sensor.
Ignition System Checks	[2] Verify that the spark plugs are correct for use with LPG (R42LTS). [2] Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits [2] Check the ignition wires for the following items: - Cracking - Hardness - Proper connections
Cooling System Checks	[2] Check the engine thermostat for always being open or for the wrong heat range.

Table 3-17. Symptom Diagnosis

Checks	Action
Additional Check	[2] Check the transmission shift pattern. Refer to the OEM Transmission Controls section the Service Manual. [2] Check for dragging brakes.
Rough, Unstable, or Incorrect Idle, Stalling	
DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Check	Refer to Important Preliminary Checks.
Sensor Checks	[2] Check for silicon contamination from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe drive-ability problem. [2] Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: [2] Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	[2] Check for rich or lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. [2] Check for a sticking mixer air valve. [2] Verify proper operation of the EPR. [2] Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. [2] Check the LPR fuel pressure. Refer to the LPG Fuel System Diagnosis. [2] Check mixer module assembly for proper installation and connection.
Ignition System Checks	[2] Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS). [2] Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Blistered insulators - Heavy deposits [2] Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	**Important:** The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. [2] Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. [2] Check the ECM grounds for being clean, tight, and in their proper locations. [2] Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.
Engine Mechanical Check	[2] Check the engine for the following: - Broken motor mounts - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes
Surges/Chuggles	
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.	
Preliminary Checks	Refer to Important Preliminary Checks.
Sensor Checks	[2] Check Heated Exhaust Gas Oxygen Sensor (HEGO) performance.

Table 3-17. Symptom Diagnosis

Checks	Action
Fuel System Checks	[2] Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. [2] Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. [2] Verify proper fuel control solenoid operation. [2] Verify that the LPG manual shut-off valve is fully open. [2] Check the in-line fuel filter for restrictions.
Ignition System Checks	[2] Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS). [2] Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits - Check the Crankshaft Position (CKP) sensor.
Additional Check	[2] Check the ECM grounds for being clean, tight, and in their proper locations. [2] Check the generator output voltage. [2] Check the vacuum hoses for kinks or leaks. [2] Check Transmission

Table 3-18. DTC to SPN/FMI Cross Reference Chart

DTC	Description	SPN Code	FMI Code
16	Crank Never Synced at Start	636	8
91	Fuel Pump Low Voltage	94	4
92	Fuel Pump High Voltage	94	3
107	MAP Low Voltage	106	4
108	MAP High Pressure	106	16
111	IAT Higher Than Expected 1	105	15
112	IAT Low Voltage	105	4
113	IAT High Voltage	105	3
116	ECT Higher Than Expected 1	110	15
117	ECT Low Voltage	110	4
118	ECT High Voltage	110	3
121	TPS 1 Lower Than TPS 2	51	1
122	TPS 1 Signal Voltage Low	51	4
123	TPS 1 Signal Voltage High	51	3
127	IAT Higher Than Expected 2	105	0
129	BP Low Pressure	108	1
134	EGO 1 Open/Inactive	724	10
154	EGO 2 Open/Inactive	520208	10
171	Adaptive Learn High Gasoline	520200	0
172	Adaptive Learn Low Gasoline	520200	1
182	Fuel Temp Gasoline Low Voltage	174	4
183	Fuel Temp Gasoline High Voltage	174	3
187	Fuel Temp LPG Low Voltage	520240	4
188	Fuel Temp LPG High Voltage	520240	3
217	ECT Higher Than Expected 2	110	0
219	Max Govern Speed Override	515	15
221	TPS 2 Signal Voltage Low	51	0
222	TPS 2 Signal Low Voltage	520251	4
223	TPS 2 Signal High Voltage	520251	3
261	Injector Driver 1 Open	651	5
262	Injector Driver 1 Shorted	651	6

DTC	Description	SPN Code	FMI Code
264	Injector Driver 2 Open	652	5
265	Injector Driver 2 Shorted	652	6
267	Injector Driver 3 Open	652	5
268	Injector Driver 3 Shorted	653	6
270	Injector Driver 4 Open	654	5
271	Injector Driver 4 Shorted	654	6
336	Crank Sync Noise	636	2
337	Crank Loss	636	4
341	Cam Sync Noise	723	2
342	Cam Sensor Loss	723	4
420	Gasoline Cat Monitor	520211	10
524	Oil Pressure Low	100	1
562	System Voltage Low	168	17
563	System Voltage High	168	15
601	Flash Checksum Invalid	628	13
604	RAM Failure	630	12
606	COP Failure	629	31
642	External 5V Reference Low	1079	4
643	External 5V Reference High	1079	3
685	Power Relay Open	1485	5
686	Power Relay Shorted	1485	4
687	Power Relay Short to Power	1485	3
1111	Fuel Rev Limit	515	16
1112	Spark Rev Limit	515	0
1151	Closed Loop Multiplier High LPG	520206	0
1152	Closed Loop Multiplier Low LPG	520206	1
1155	Closed Loop Multiplier High Gasoline	520204	0
1156	Closed Loop Multiplier Low Gasoline	520204	1
1161	Adaptive Learn High LPG	520202	0
1162	Adaptive Learn Low LPG	520202	1
1165	LPG Cat Monitor	520213	10

DTC	Description	SPN Code	FMI Code
1171	LPG Pressure Higher Than Expected	520260	0
1172	LPG Pressure Lower Than Expected	520260	1
1173	EPR Comm Lost	520260	31
1174	EPR Voltage Supply High	520260	3
1175	EPR Voltage Supply Low	520260	4
1176	EPR Internal Actuator Fault	520260	122
1177	EPR Internal Circuitry Fault	520260	12
1178	EPR Internal Comm Fault	520260	12
1612	RTI 1 loss	629	31
1613	RTI 2 Loss	629	31
1614	RTI 3 Loss	629	31
1615	A/D Loss	629	31
1616	Invalid Interrupt	629	31
1625	Shutdown Request	1384	31
1626	CAN Tx Failure	639	12
1627	CAN Rx Failure	639	12
1628	CAN Address Conflict Failure	639	13
1629	Loss of TSC 1	639	31
2111	Unable to Reach Lower TPS	51	7
2112	Unable to Reach Higher TPS	51	
2135	TPS 1/2 Simultaneous Voltages	51	31
2229	BP Pressure High	108	0

PARTS FINDER

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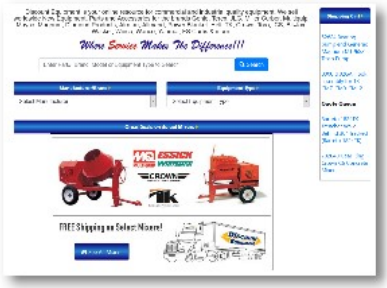

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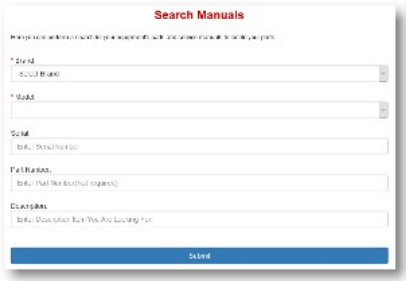

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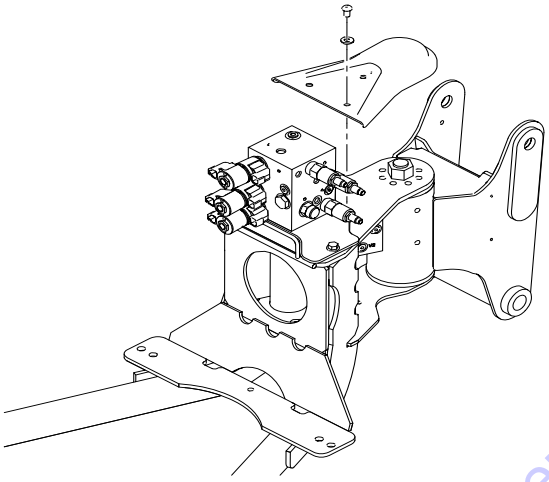
SECTION 4. BOOM & PLATFORM

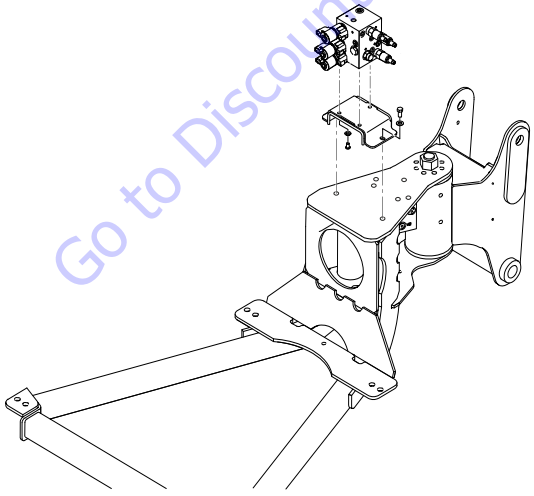
4.1 PLATFORM

Platform Valve Removal

1. Tag and disconnect the hydraulic lines from the platform control valve. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Remove hardware securing cover from the platform support. Remove cover.

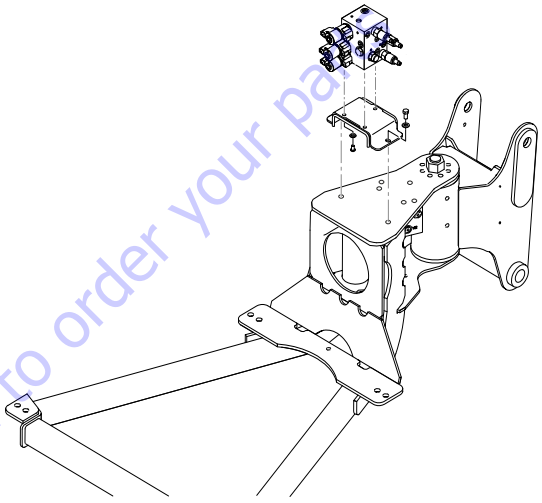


3. Remove hardware securing the mounting bracket to the platform support. Take out the mounting bracket along with platform control valve.
4. Remove hardware securing the platform control valve to the mounting bracket. Remove platform control valve.

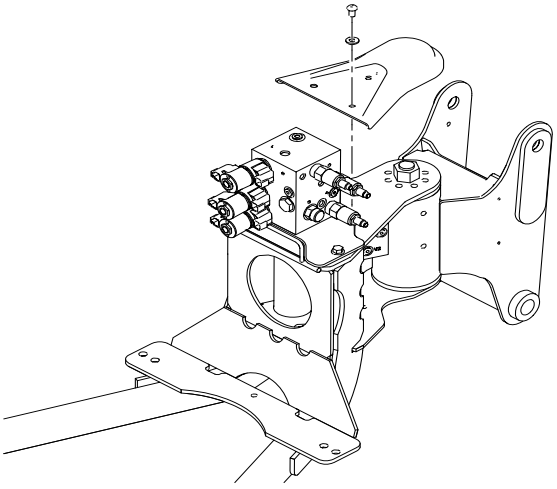


Platform Valve Installation

1. Install platform control valve onto the mounting bracket and secure using hardware.
2. Install the mounting bracket onto the platform support and secure using hardware.



3. Install cover onto the platform support securing the hardware.



4. Remove tag and reconnect the hydraulic lines to the platform control valve.

Support Removal

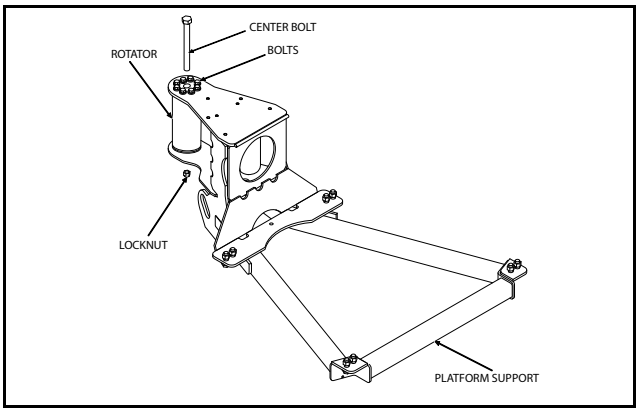
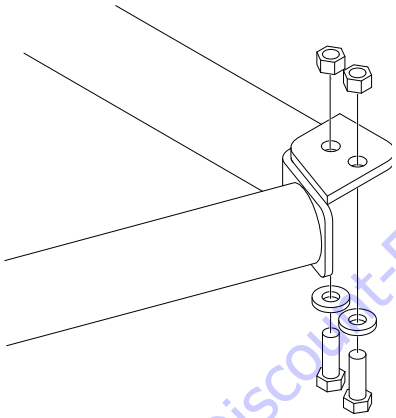


Figure 4-1. Location of Components Platform Support

1. Disconnect electrical cables from control console.
2. Remove the bolts securing the platform to the platform support, then remove the platform.

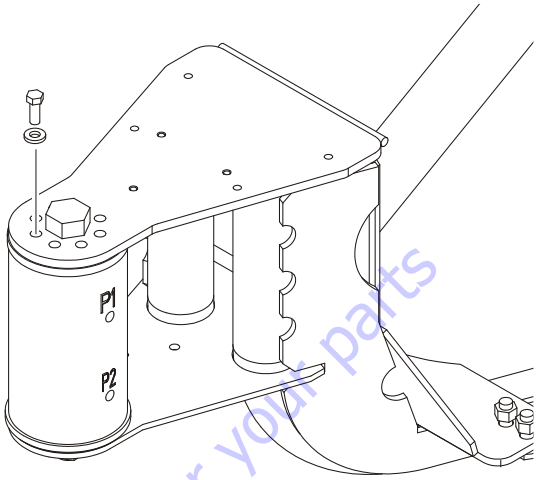
NOTE: *The Platform Weighs approximately 220 lbs. (100 kg).*



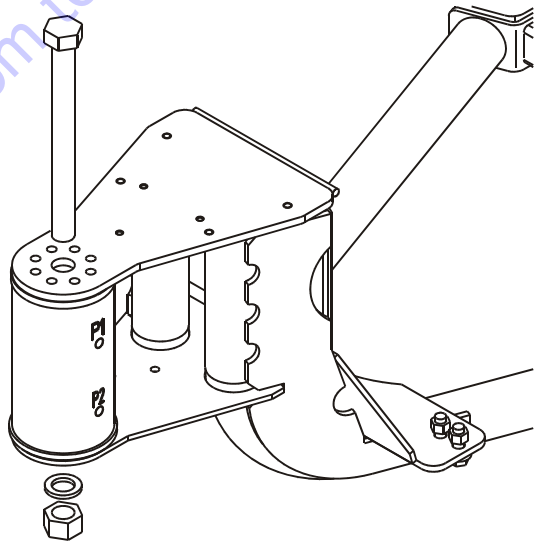
3. Using a suitable device, support the platform support.

NOTE: *The platform support weighs approximately 77 lbs. (35 kg).*

4. Remove the bolts and locknuts securing the support to the rotator.



5. Using a suitable brass drift and hammer, remove the rotator center bolt, then remove the support from the rotator.

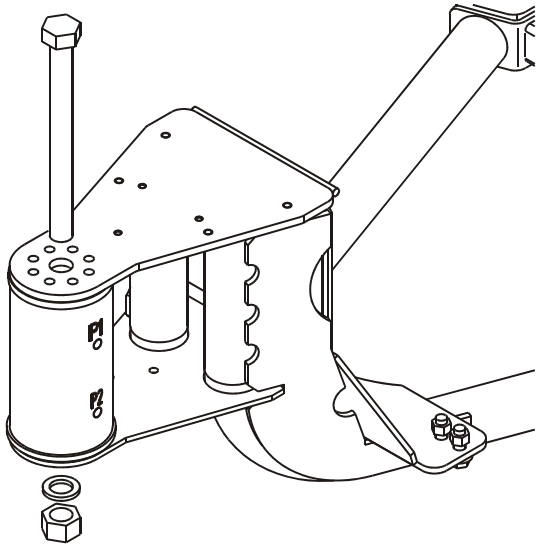


Support Installation

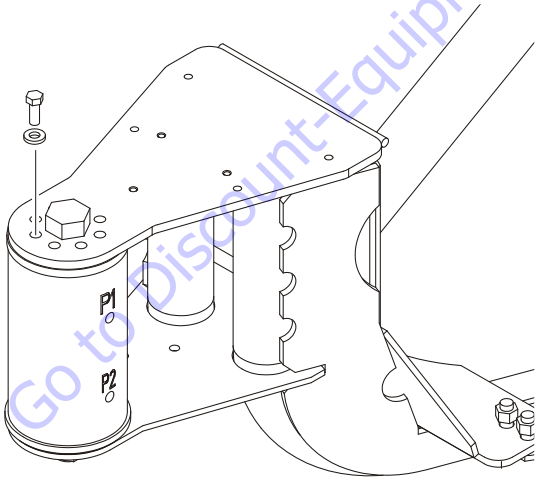
1. Using a suitable device, support the platform support and position it on the rotator.

NOTE: *The platform support weighs approximately 77 lbs. (35 kg).*

2. Install the rotator center bolt.

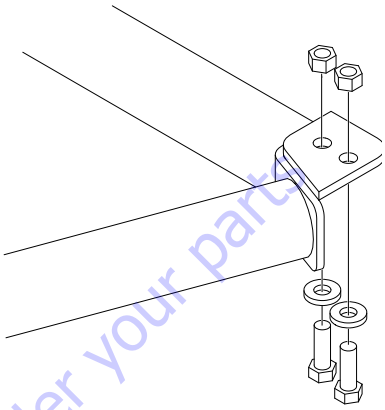


3. Apply JLG Threadlocker P/N 0100011 to the eight bolts and locknuts securing the support to the rotator and install the bolts and locknuts.

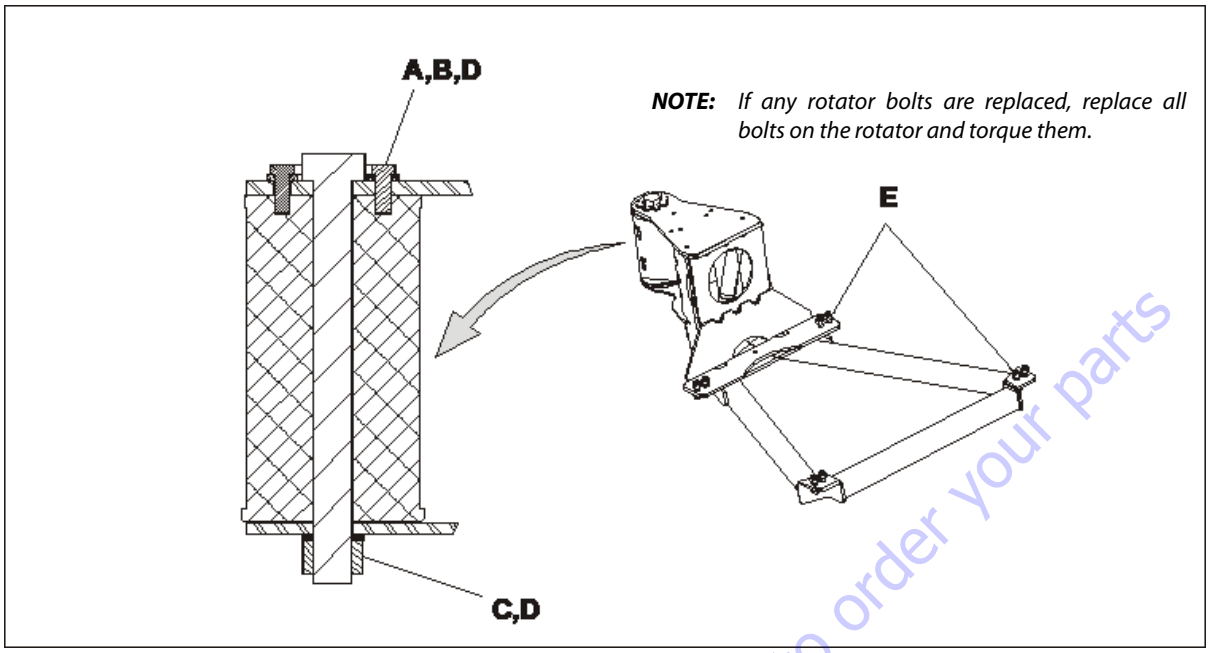


4. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).

5. Position the platform on the platform support and install the bolts securing the platform to the platform support. Torque the bolts to 105 ft. lbs. (145 Nm).



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



A	Torque to 40 ft.lbs. (55 Nm)
B	JLG Thread locker (#0100011)
C	Torque to 586 ft. lbs. (795 Nm)
D	Check torque every 150 hours of operation
E	Torque to 105 ft. lbs. (145 Nm)

Figure 4-2. Platform Support Torque Values

4.2 ROTATOR AND SLAVE CYLINDER

Removal

600A

1. Tag and disconnect hydraulic lines from the rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Supporting the rotator, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1 from the fly boom.
3. Remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the fly boom and remove the rotator.
4. Supporting the slave cylinder, remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the fly boom.
5. Tag and disconnect hydraulic lines from the slave leveling cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.

600AJ

1. Tag and disconnect hydraulic lines from the rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Supporting the rotator, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1 from the jib assembly.
3. Remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the jib assembly and remove the rotator.
4. Telescope the fly section out approximately 20 in. (50.8 cm) to gain access to the slave leveling cylinder.
5. Remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the jib assembly.
6. Supporting the slave cylinder, remove the hardware from pin #4. Using a suitable brass drift and hammer remove pin #4 from the fly boom.
7. Tag and disconnect hydraulic lines from the slave leveling cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.

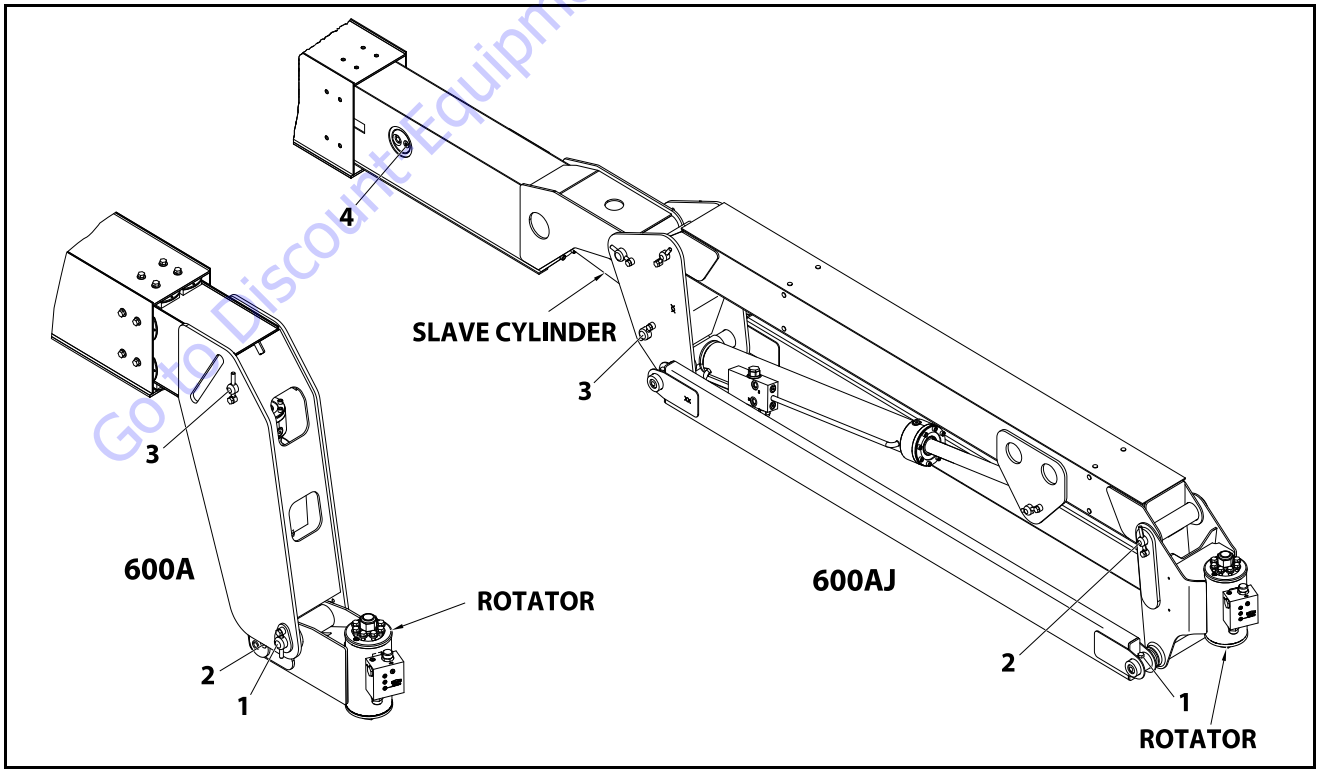


Figure 4-3. Removal of Components - Rotator and Leveling Cylinder

Installation

600A

1. Support the slave cylinder. Using a suitable brass drift and hammer, install pin #3 to the fly boom.
2. Support the rotator. Using a suitable brass drift and hammer, install pin #2 to the fly boom and install the rotator.
3. Using a suitable brass drift and hammer, install pin #1 to the rotator.
4. Remove tag and reconnect the hydraulic lines to the rotator and the slave cylinder.

600AJ

1. Telescope the fly section out approximately 20 in. (50.8 cm) to gain access to the slave leveling cylinder.
2. Support the slave cylinder. Using a suitable brass drift and hammer, install pin #4 to the fly boom.
3. Using a suitable brass drift and hammer, install pin #3 to the jib assembly.
4. Support the rotator. Using a suitable brass drift and hammer, install pin #2 to the fly boom and install the rotator.
5. Using a suitable brass drift and hammer, install pin #1 to the rotator.
6. Remove tag and reconnect the hydraulic lines to the rotator and the slave cylinder.

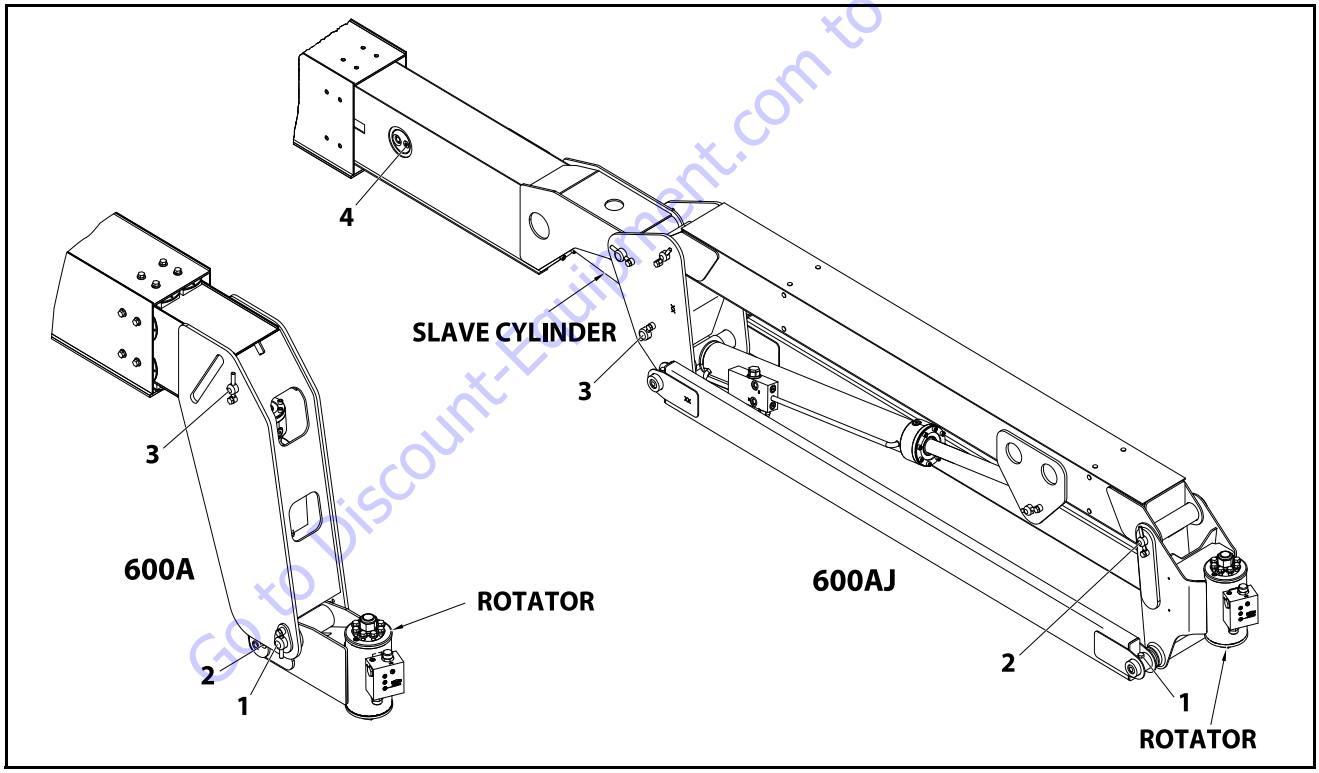


Figure 4-4. Installation of Components - Rotator and Leveling Cylinder

4.3 MAIN BOOM POWERTRACK

Removal

1. Disconnect wiring harness connectors located in tower upright.

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 collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect dual capacity indicator limit switch from side of boom section (600A only).
4. Remove hydraulic lines and electrical cables from Powertrack.
5. Using suitable lifting equipment, adequately support Powertrack weight along entire length.
6. Remove bolt #1 securing the push tube on the fly boom section.
7. Remove bolt #2 securing the push tube on the mid boom section.
8. With Powertrack supported and using all applicable safety precautions, remove bolts #3, #4 and #5 securing rail to the base boom section. Remove Powertrack from boom section.

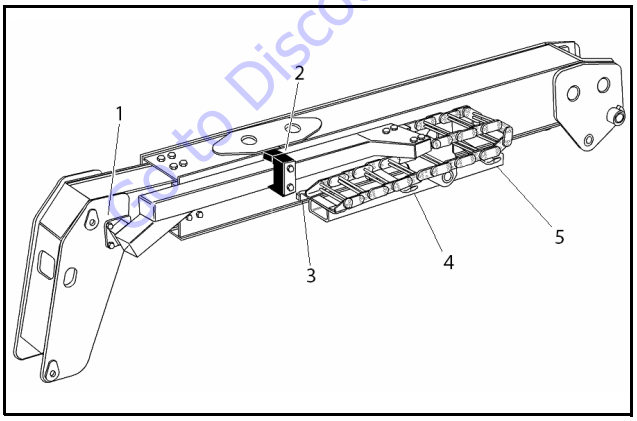


Figure 4-5. Main Boom Powertrack Components

Installation

1. Using suitable lifting equipment, adequately support the Powertrack weight along entire length.
2. With powertrack supported and using all applicable safety precautions, install bolts #3 securing rail to the base boom.
3. Install bolts #2 that attaches rail to the push tube on the main boom section.
4. Install bolts #1 securing the push tube on the fly boom section.
5. Remove tag and reconnect all hydraulic lines and electrical cable from powertrack.
6. Reconnect dual capacity indicator limit switch from side of boom section (600A only).
7. Remove tag and reconnect hydraulic lines from connectors at boom assembly.

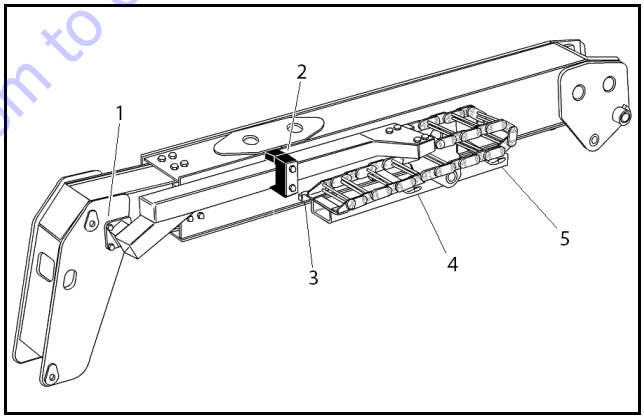


Figure 4-6. Main Boom Powertrack Components

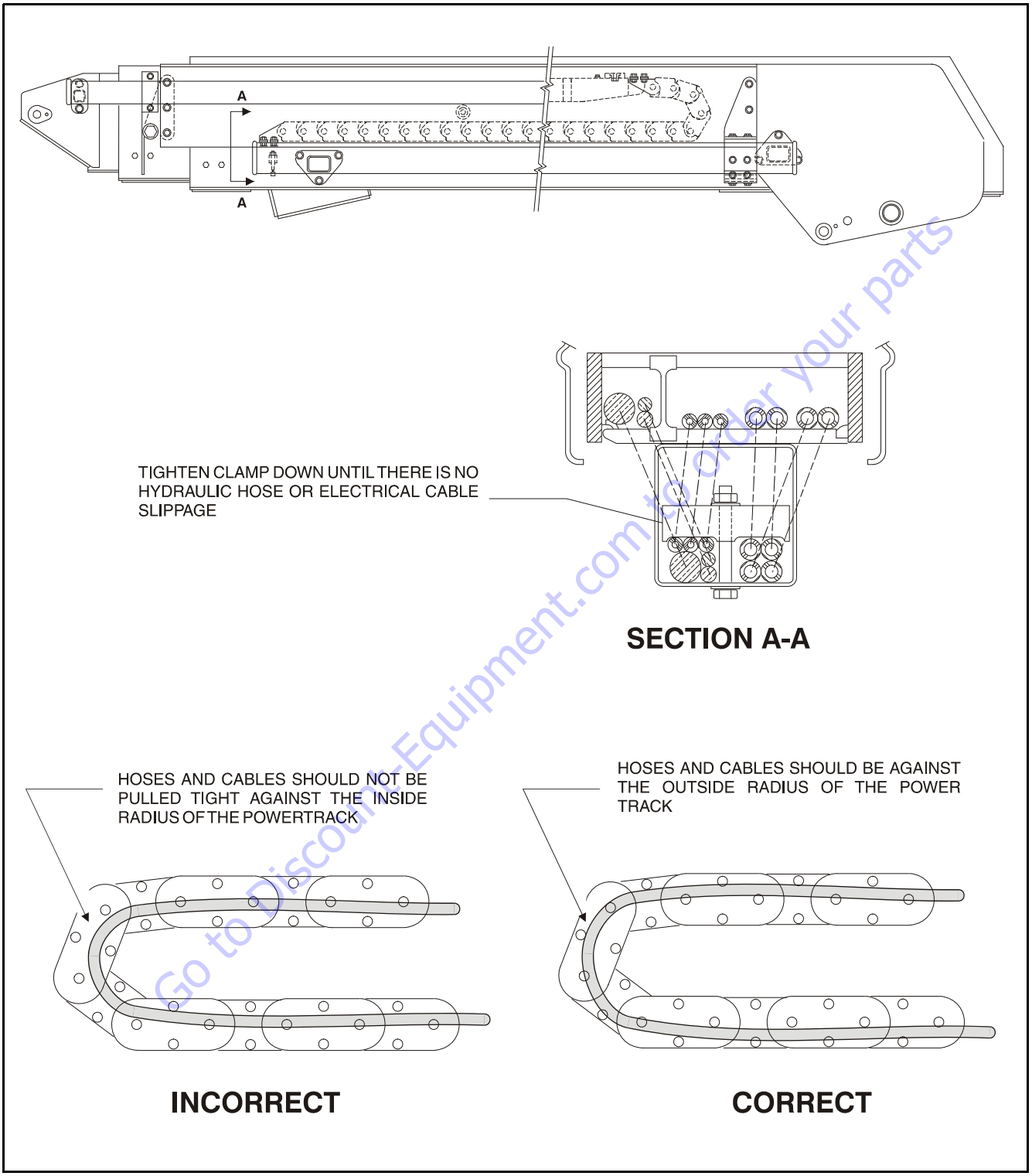


Figure 4-7. Boom Powertrack Installation

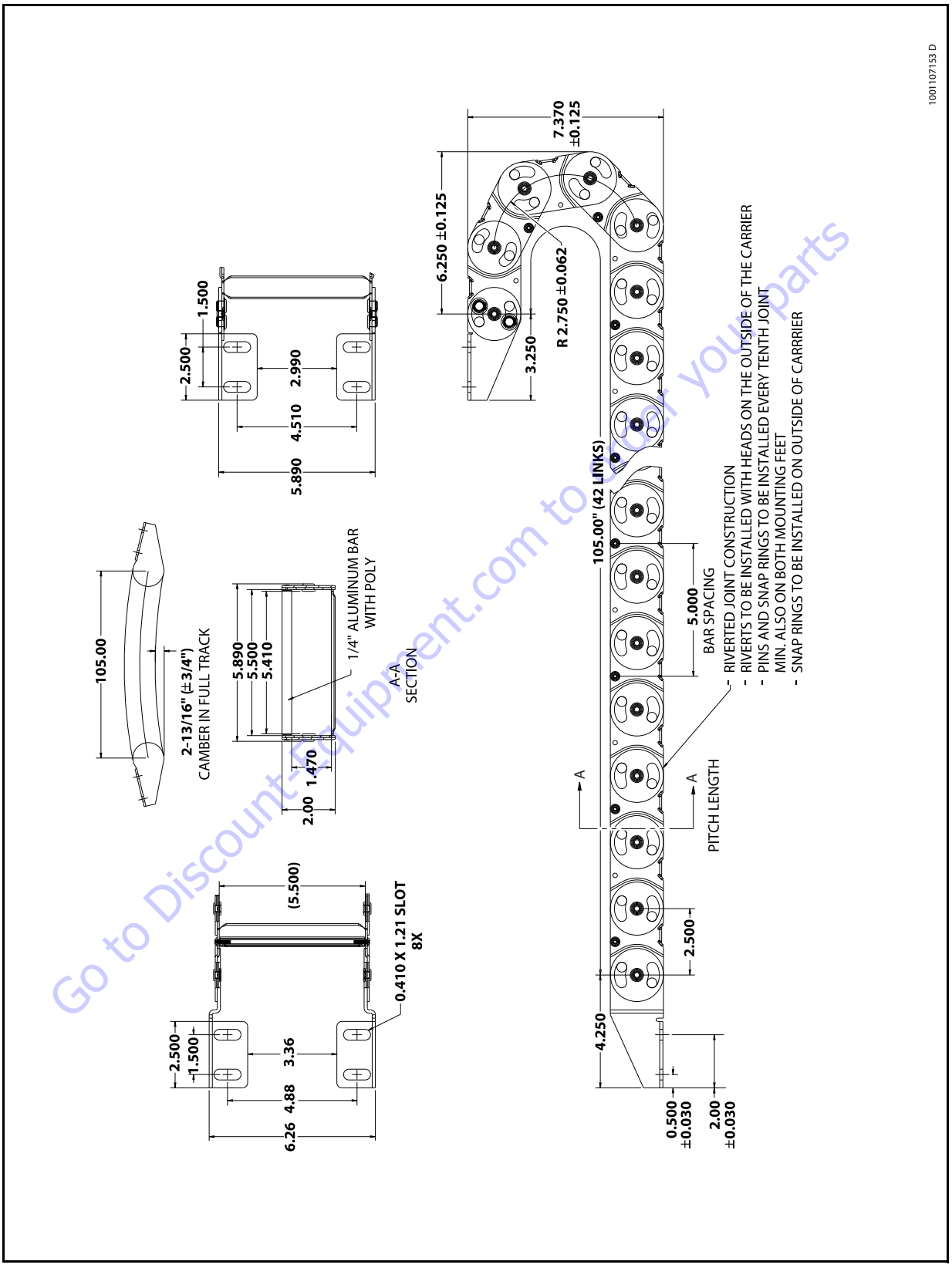


Figure 4-8. Powertrack Installation Main Boom - USA Build Machine (600A)

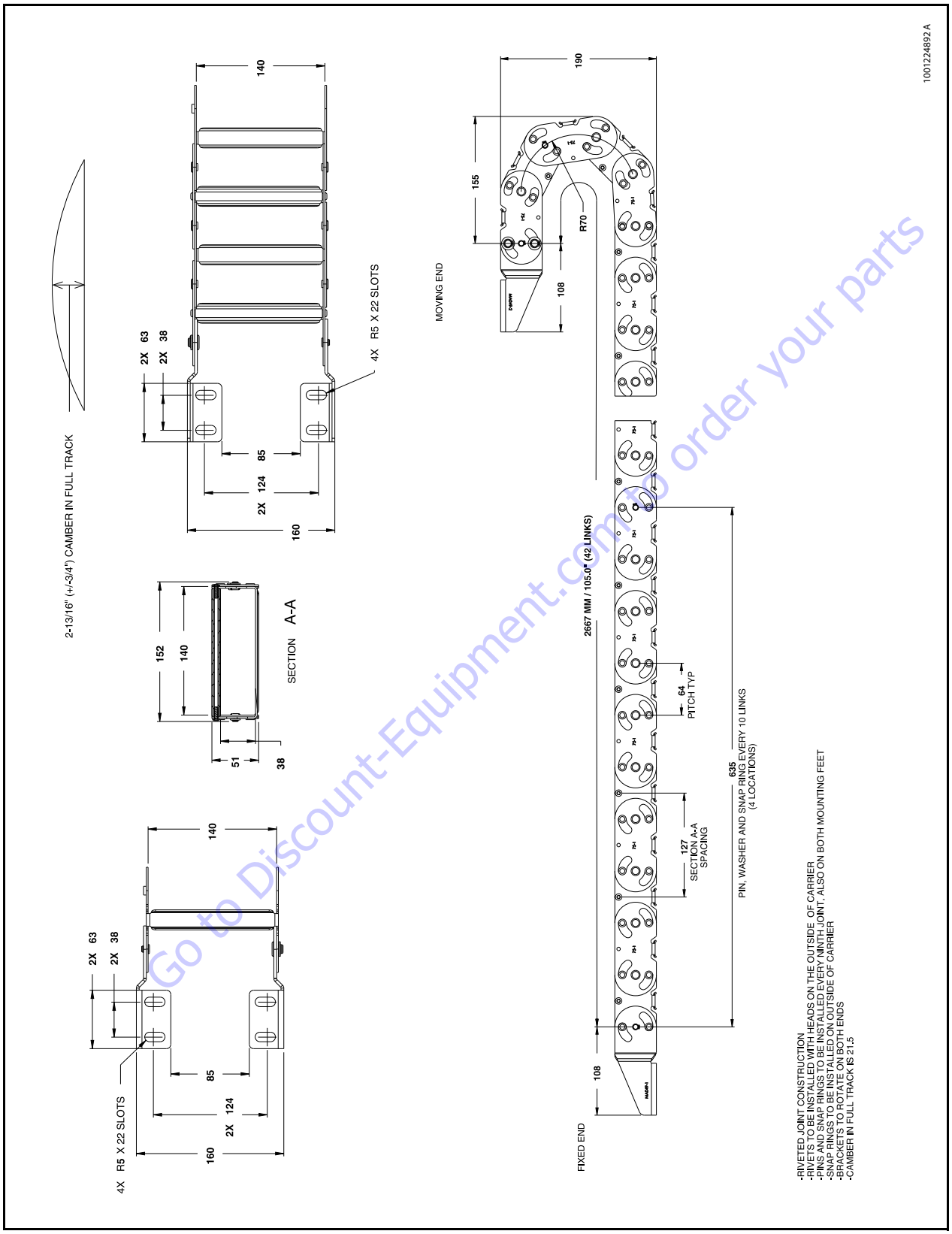


Figure 4-9. Powertrack Installation Main Boom - China Build Machine (600A)

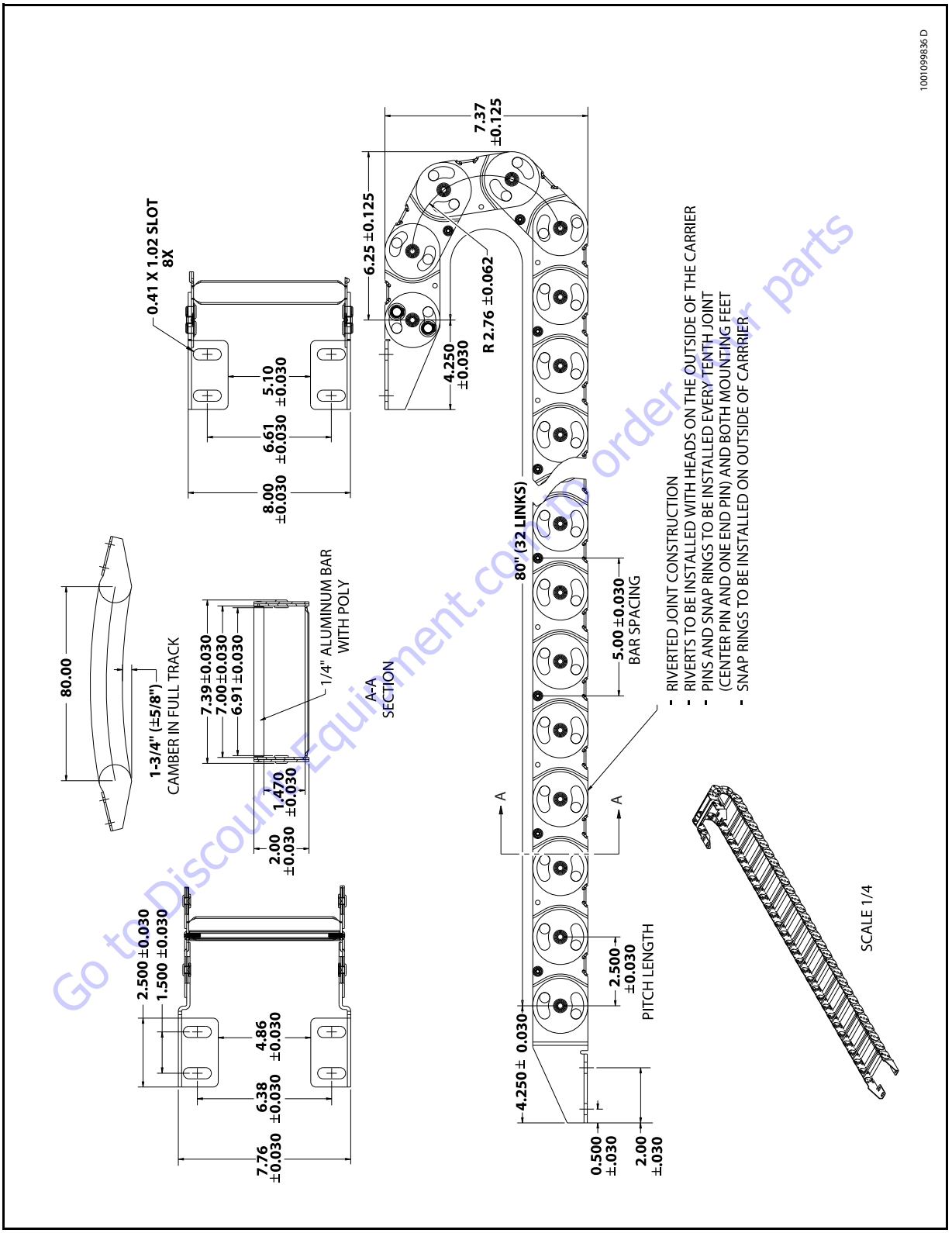


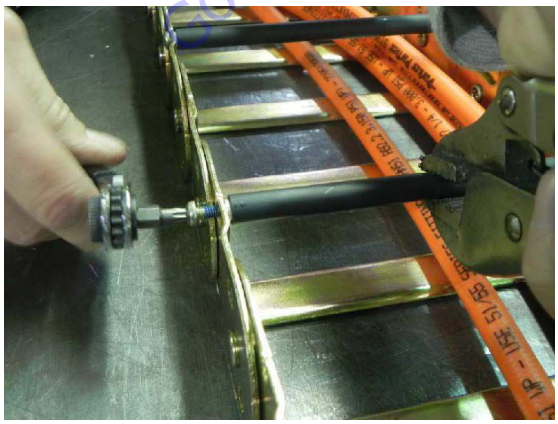
Figure 4-10. Powertrack Installation Main Boom (600AJ)

4.4 MAIN BOOM POWERTRACK MAINTENANCE

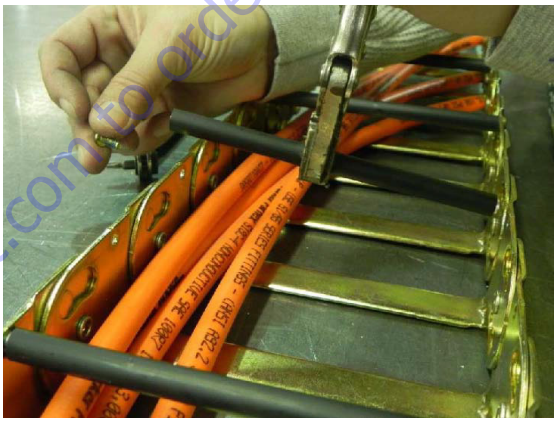
Round Bar/Poly Bar Removal

NOTE: *Hoses shown in track are used for examples only. Actual hose/cable package may be different.*

1. Clamp the bar and poly roller tightly so they don't spin when removing the screw. Use a small ¼ in. ratchet and T-20 Torx bit remove the 8-32 X 0.500 screw from one side.

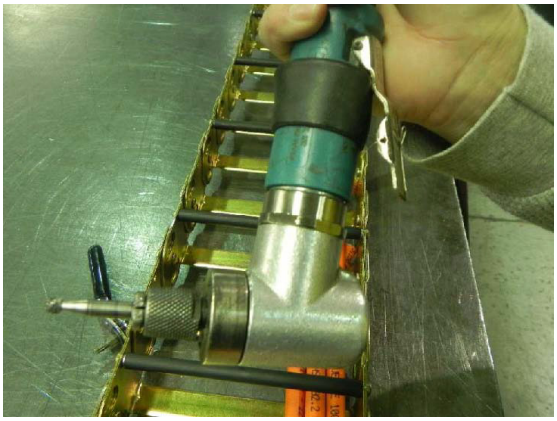


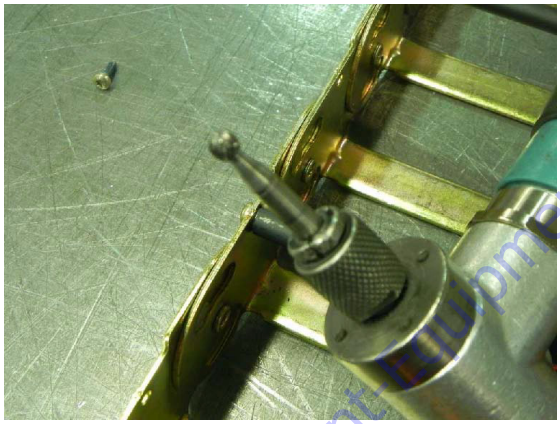
2. Repeat step 1 and remove the screw from other side of track. Remove bar/poly roller from the track.



Remove link

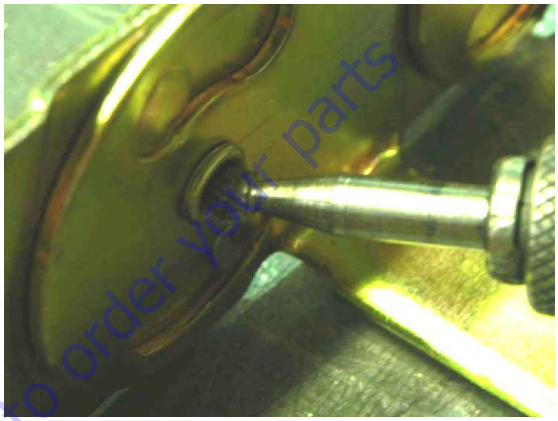
1. To remove the links, the rivets holding the links together must be removed. The following will show one way this can be done. Use a right angle die grinder with a ¼ in. ball double cut bur.

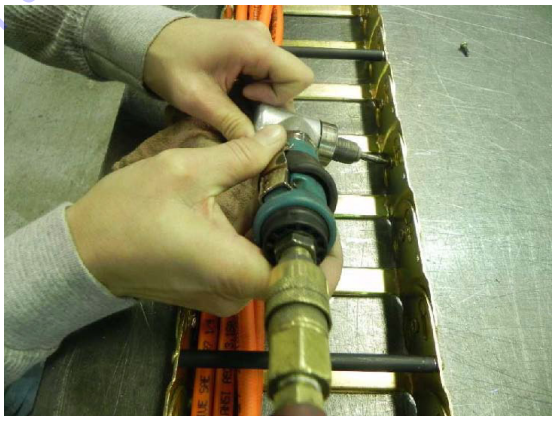




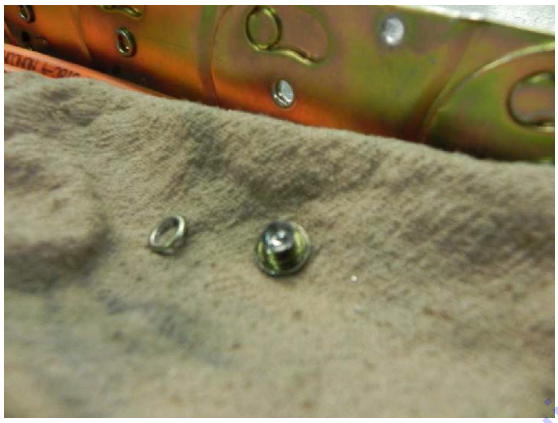
2. Insert the tool into the rolled over end of the rivet as shown. Grind out the middle of the rivet until the rolled over part of the rivet falls off. Repeat this step for all rivets that must be removed.

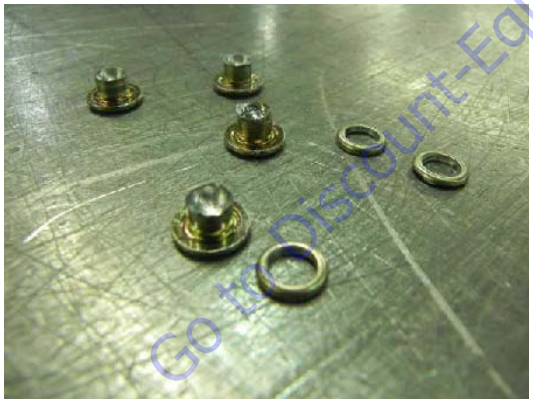
NOTE: *Protect the cables/hoses during this process by moving them out of the way. Cover them with a rag or towell to prevent any debris from getting on them.*





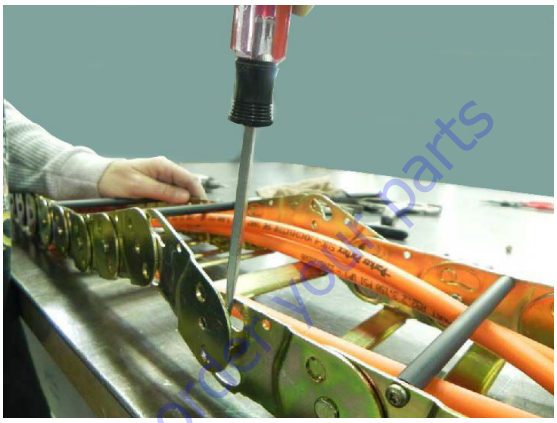
3. After grinding, it is sometimes necessary to use a center punch to punch out the rivet from the link.





4. Use as flat head screwdriver between the links, twist the screwdriver and pull the links apart.

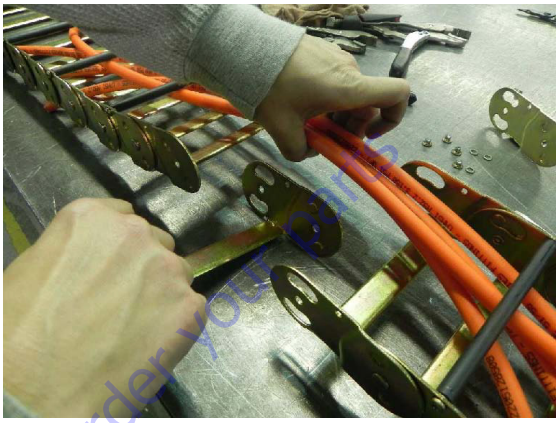
NOTE: *It may be necessary to loosen the fixed end brackets from the machine in order to twist and pull the track section enough to disconnect the links.*



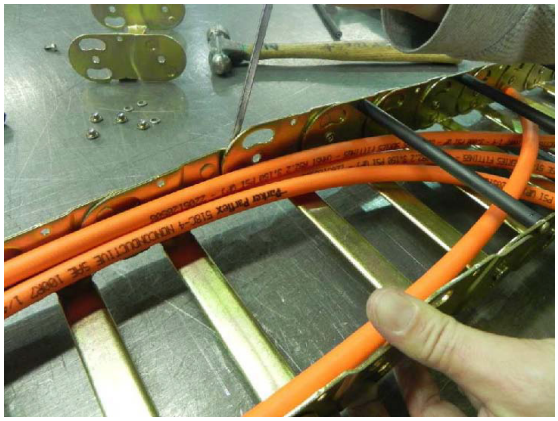
5. Use a screwdriver to remove link from other section of track.

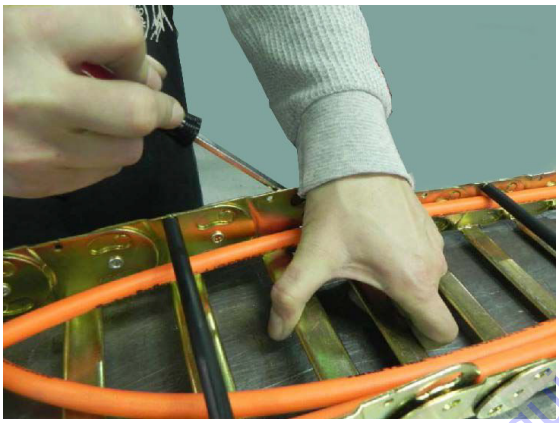
Install new link

1. To install new link, squeeze the peanut cut out end of the new link into the half-shear (female) end of the track section.

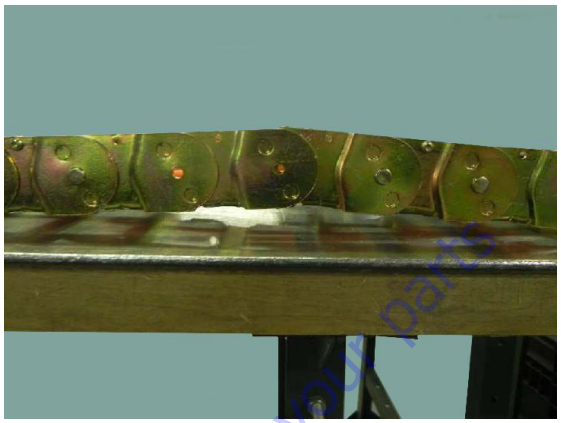


2. Use a screwdriver, to spread apart the half-shear (female) end of the new link and slide the peanut end of the track section into it.

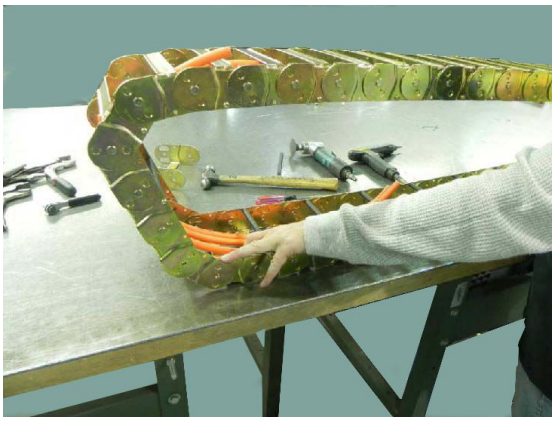




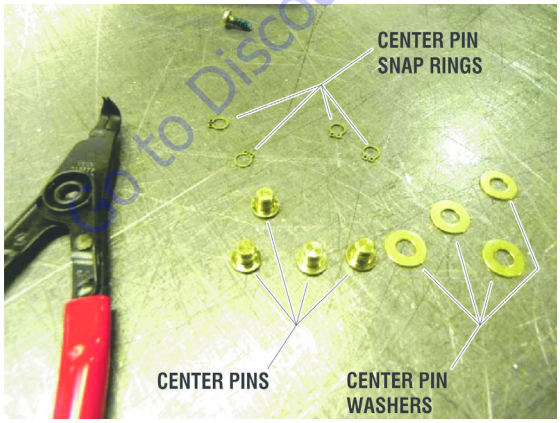
3. After the new link is installed in the track, the round half-shears will not fit properly in the peanut cut outs fit.



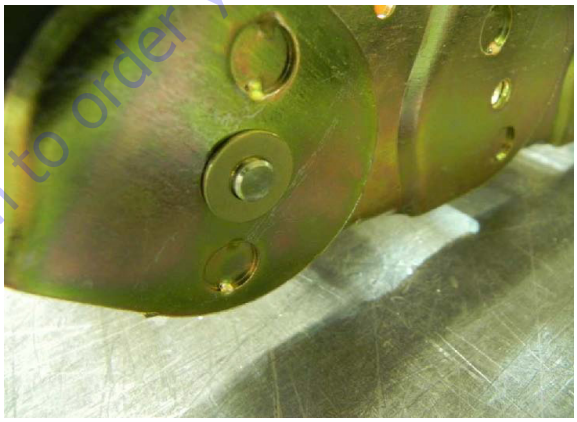
4. To position the new connection in the curve of the track, pull the moving end out over the track. In this position the round half-shears will rotate into the peanut cut outs.



5. The below parts will be used to connect the new link to the track.

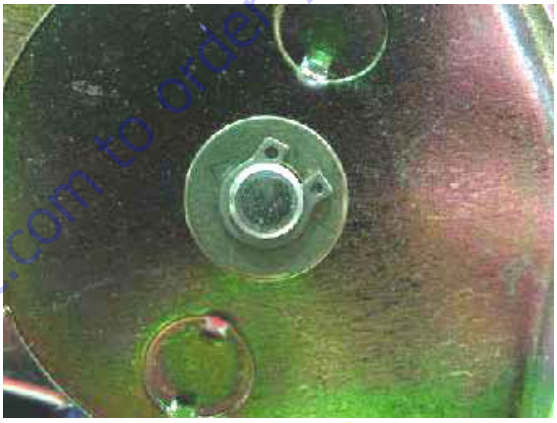


6. Push the pin through center hole then slide the washer on pin.



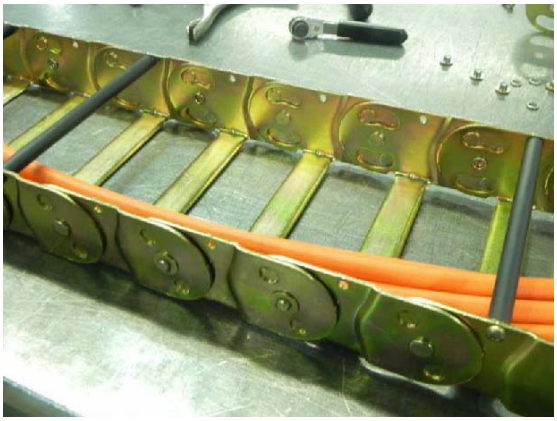
7. Install snap ring in groove on pin. Repeat these pin installation steps for all center holes that had the rivets removed.

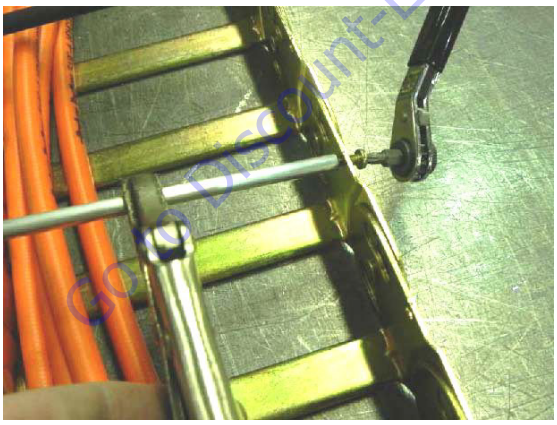
NOTE: *When installing snap rings make sure they are seated in the pin groove and closed properly.*



Installing a New Bar/Poly Roller

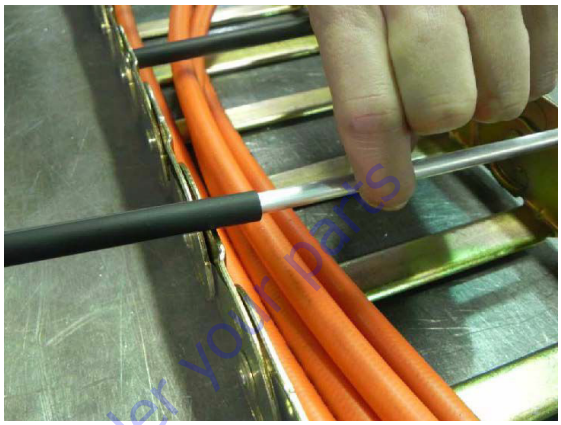
1. Hold new aluminum round bar tightly. Install new 8-32 X 0.500 self threading Torx head screw into one end.



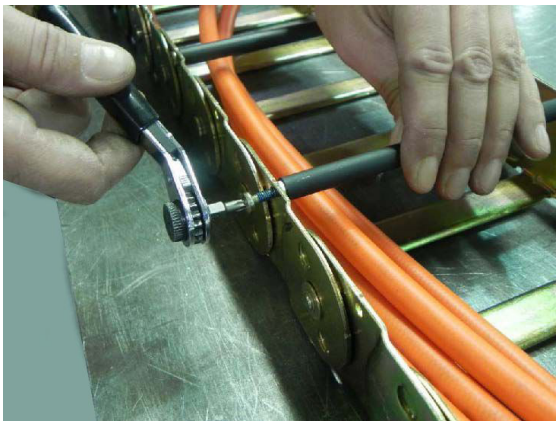


NOTE: *Maximum tightening torque is 18-20 in.lbs. (2-2.3 Nm).*

2. Pull other end of round bar and slide new poly roller onto bar.

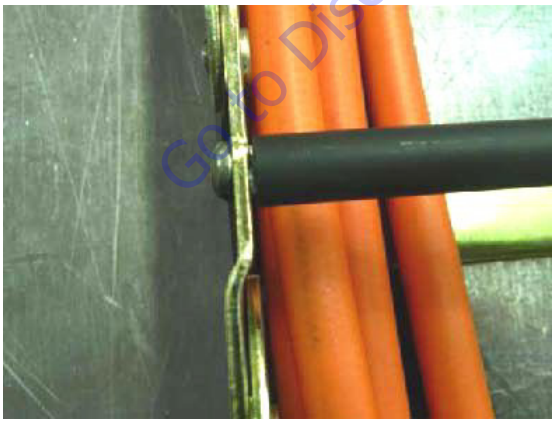


3. Install new 8-32 X 0.500 self threading screw on other side.



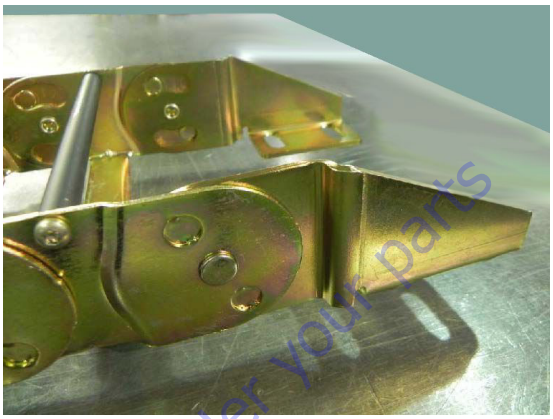
NOTE: *When tightening screws make sure screw head is seated against link with no space in between link and underside of screw head.*

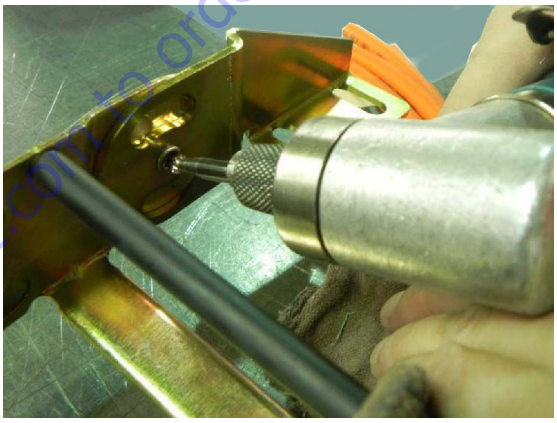
NOTE: *Maximum tightening torque is 18-20 in.lbs. (2-2.3 Nm).*



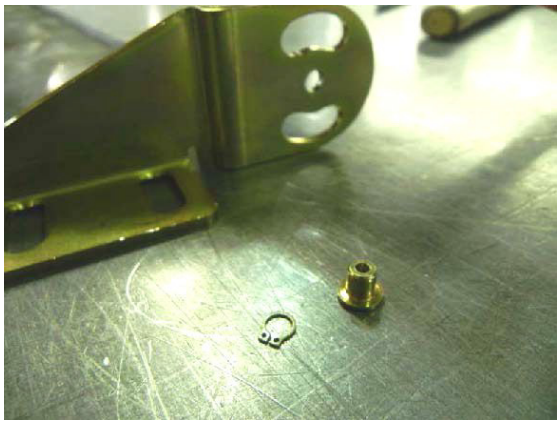
Replacing Fixed End Bracket

1. To remove the fixed end bracket rivets, use step 1, 2 and 3 of Remove link.





2. The below parts will be used to install fixed end bracket.

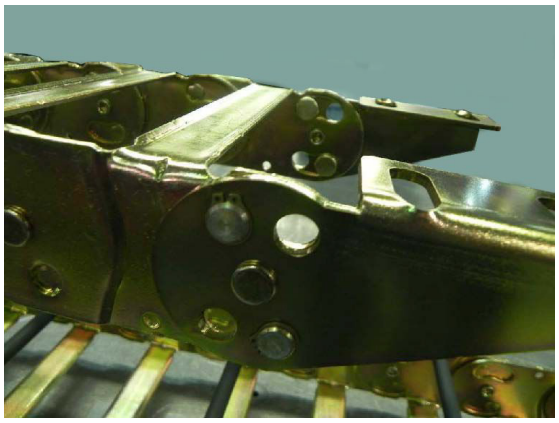


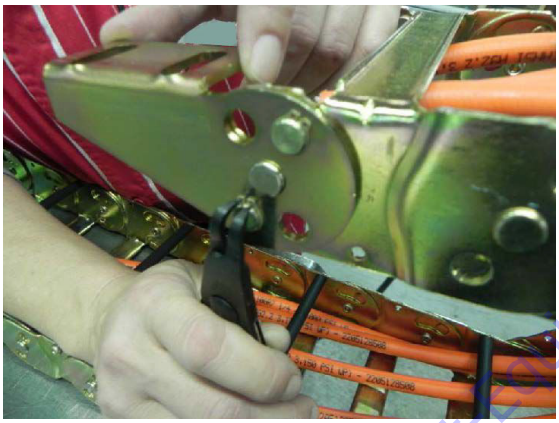
3. To install fixed end bracket, take new bracket and install bracket center pin and snap ring. Repeat on other bracket as well, if replacing.

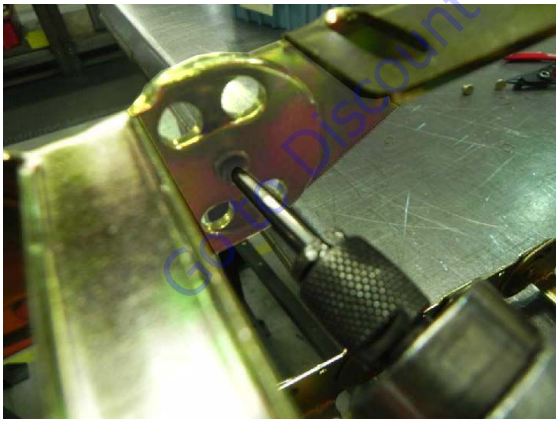
NOTE: *When installing snap ring make sure they are seated in pin groove and closed properly.*

Replacing Moving End Bracket

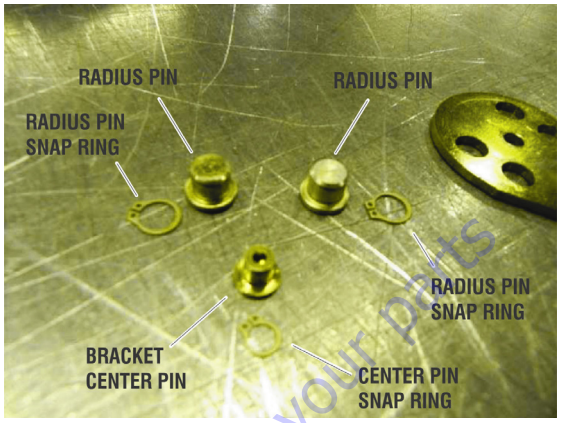
1. Remove existing pins and center rivet. To remove rivet use step 1, 2 and 3 of Remove link. Repeat on other bracket as well, if replacing.



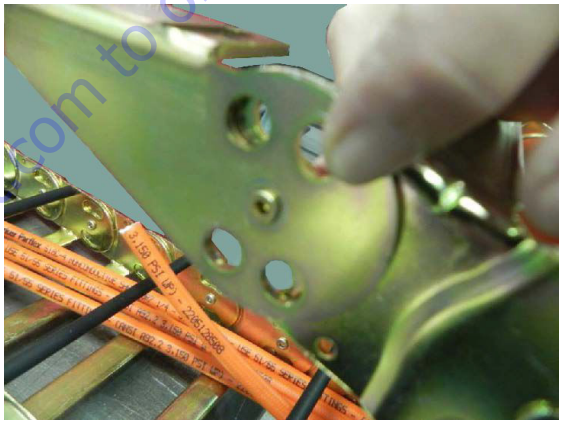




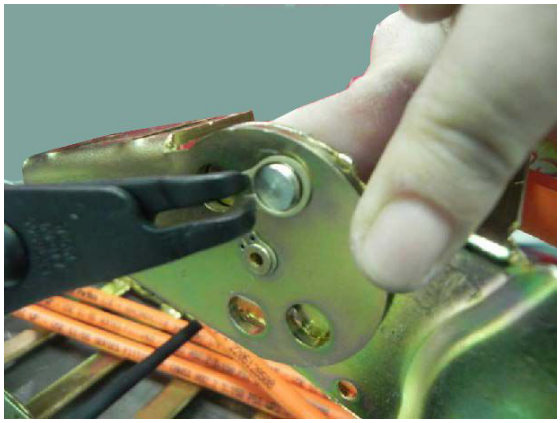
2. The below parts will be used to install Moving end bracket.



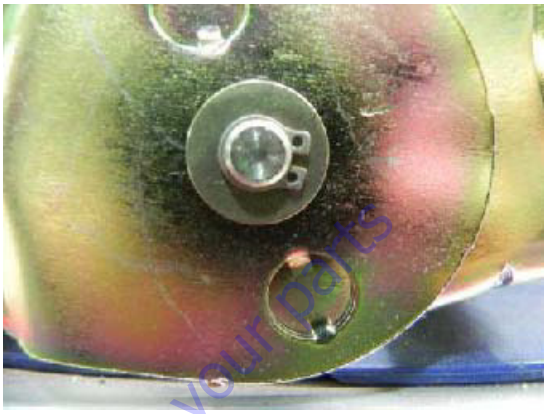
3. To install moving end bracket, take new bracket and install center pin with snap ring.

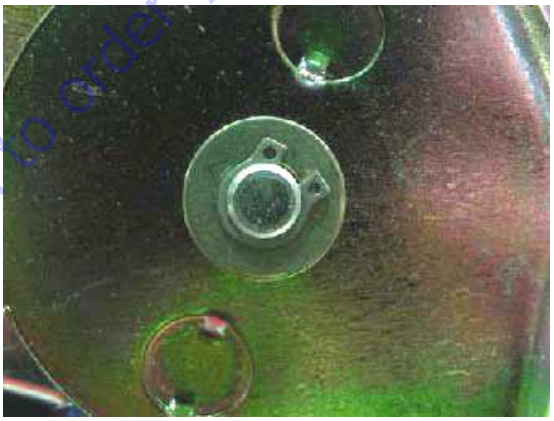


4. Install radius pins into their original location and install snap rings. Repeat with other moving end as well, if applicable.

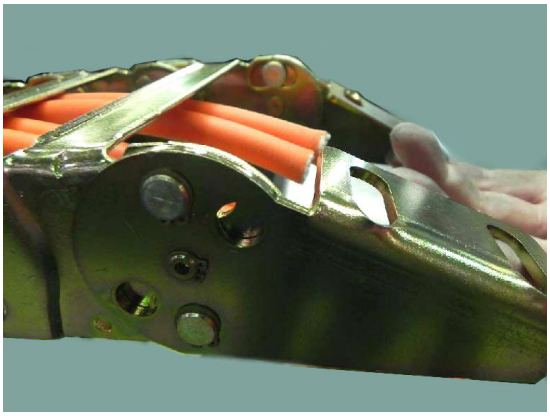


NOTE: *When installing snap ring make sure they are seated in pin groove and closed properly.*





5. Make sure that both brackets rotate correctly, when completed.



4.5 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.

4.6 MAIN BOOM ASSEMBLY

Removal

1. Using a suitable lifting equipment, adequately support boom assembly weight along entire length.

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 telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

3. Use adequate support for the main boom lift cylinder.

4. Using a suitable brass drift and hammer, remove hardware secured to the main boom lift cylinder rod end pin #1 to the base boom section. Remove the main boom lift cylinder pin from base boom. Retract the main boom lift cylinder by using the auxiliary power switch.

NOTE: *The main boom lift cylinder weighs approximately 165.5 lbs. (75.1 kg).*

5. Use adequate support for the master cylinder.

6. Using a suitable brass drift and hammer, remove hardware securing the master cylinder rod end pin #2 to the base boom section. Remove the master cylinder pin from base boom. Retract the master cylinder by using the auxiliary power switch.

NOTE: *The master cylinder weighs approximately 53.4 lbs. (24.2 kg).*

NOTE: *When installing the master cylinder rod end pin, insert the keeper hardware pin to prevent the pin from inserting too far.*

7. Remove the bolt and keeper pin securing the boom pivot pin #3 to the upright. Using a suitable brass drift and hammer, remove the pivot pin from upright.

8. Using all applicable safety precautions, carefully lift boom assembly clear of upright and lower to ground or suitably supported work surface.

NOTE: *The main boom alone weighs approximately 1662.3 lbs. (754 kg). Including the slave cylinder, rotator, and platform support the assembly weighs approximately 1797 lbs. (815 kg).*

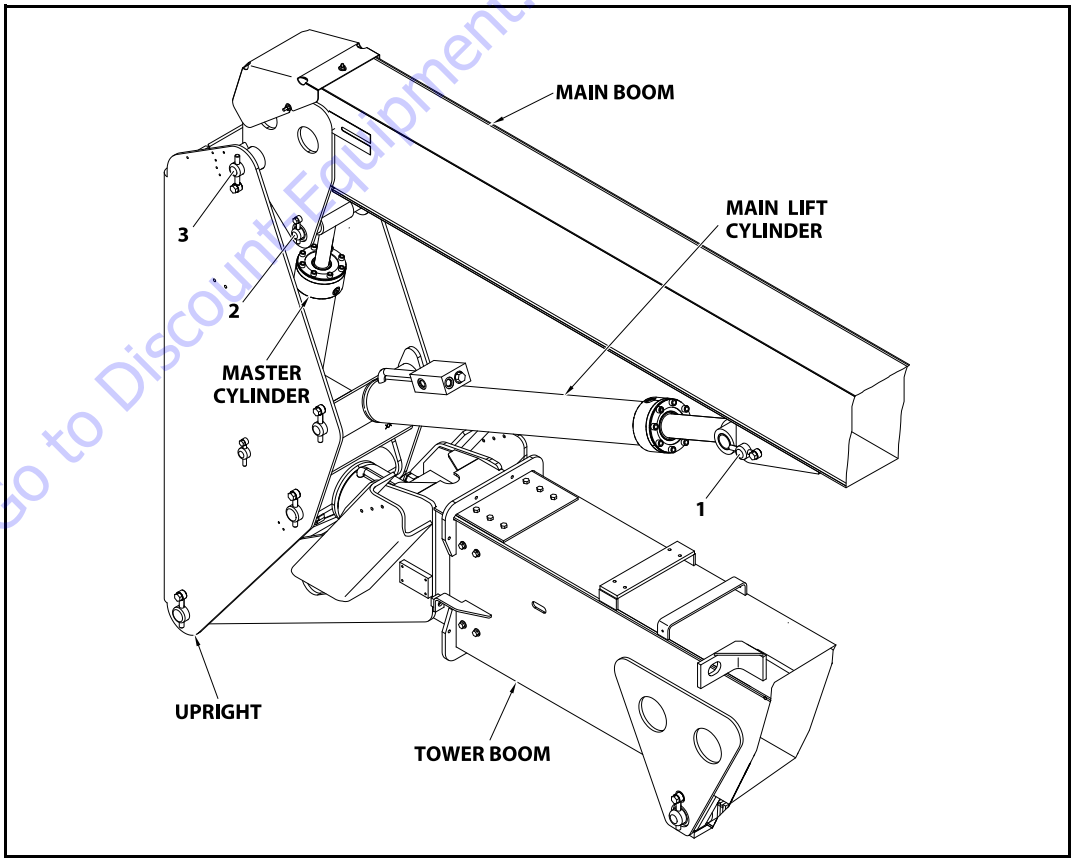


Figure 4-11. Removal - Main Boom

Disassembly

1. Remove hardware securing telescope cylinder to aft end of the base boom section.
2. Remove hardware which secures the wear pads to the base boom section; remove the wear pads from the top, sides and bottom of the base boom section.
3. Using overhead crane or suitable lifting device, remove fly boom assembly from base section.
4. Remove hardware from the telescope cylinder pin. Using a suitable brass drift and hammer remove the cylinder pin from fly boom section.
5. Pull the telescope cylinder partially from aft end of the fly boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
6. Carefully remove the telescope cylinder and place telescope cylinder on a suitable trestle.

NOTE: *The Main Boom Telescope Cylinder can be removed without disassembling the main boom by disconnecting hydraulic lines, top attaching pin of main boom lift cylinder and telescope cylinders as directed above, and pulling out the telescope cylinder from the rear, thru the access plate opening of the upright.*

7. Remove hardware which secures the wear pads to the aft end of fly boom section; remove the wear pads from the top, sides and bottom of the fly boom section.

Inspection

NOTE: *When inspecting pins and bearings, refer to Section 2, Pins and Composite Bearing Repair Guidelines.*

1. Inspect main boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins if necessary.
2. Inspect telescope cylinder attach point for scoring, tapering and ovality. Replace pins if necessary.
3. Inspect main boom lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins if necessary.
4. Inspect inner diameter of boom pivot bearing for scoring, distortion, wear, or other damage. Replace bearing if necessary.
5. Inspect all wear pads for excessive wear or other damages. Replace pads when worn to within 1/8 in. (3.2 mm) of threaded insert.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace if necessary.
7. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections if necessary.

Assembly

NOTE: *When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.*

1. Measure inside dimensions of the base section to determine the number of shims required for proper fit.
2. Install side, top and bottom wear pads to the aft end of fly section; shim evenly to the measurements of the inside of base boom section.

NOTICE

WHEN ASSEMBLING BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS AND OTHER OBSTRUCTIONS.

3. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the fly boom section.
4. Slide telescope cylinder into the aft end of fly boom section. Align attachment holes in fly boom section with hole in rod end of telescope cylinder.
5. Install telescope cylinder pin and secure with mounting hardware.
6. Secure the sling and lifting device at the fly boom assembly approximate center of gravity.
7. Slide fly boom assembly into the base boom section. Shim boom, if necessary, for a total of 1/16 in. (1.6 mm) clearance.
8. Install wear pads into the forward position of the base boom section. Shim boom, if necessary, for a total of 2/10 in. (5.1 mm) clearance.
9. Align the cylinder with the slots at aft end of base boom section, then secure cylinder with mounting hardware.

Installation

1. Using all applicable safety precautions, carefully lift boom assembly to align the pivot holes in the boom with those of the upright.

NOTE: *The main boom alone weighs approximately 1662.3 lbs. (754 kg). Including the slave cylinder, rotator, and platform support the assembly weighs approximately 1797 lbs. (815 kg).*

2. Using a suitable brass drift and hammer, install the pivot pin into the upright. Install the bolt and keeper pin securing the boom pivot pin #3 to the upright.

3. Using an adequate supporting device, align the master cylinder with the mounting holes on the boom and upright.

4. Extend the master cylinder by using the auxiliary power switch. Install the master cylinder rod end pin #2 into the base boom. Using a suitable brass drift and hammer, install mounting hardware secured to the master cylinder rod end pin into the base boom section.

NOTE: *The master cylinder weighs approximately 53.4 lbs. (24.2 kg).*

NOTE: *When installing the master cylinder rod end pin, insert the keeper hardware pin to prevent the pin from inserting too far.*

5. Connect hydraulic lines to the master cylinder as tagged during removal.

6. Using an adequate supporting device, align the main boom lift cylinder with the mounting holes on the boom section.

7. Extend the main boom lift cylinder by using the auxiliary power switch. Using a suitable brass drift and hammer, install hardware secured to the main boom lift cylinder rod end pin #1 into the base boom section.

8. Remove cap and tag. Reconnect hydraulic lines from telescope cylinder.

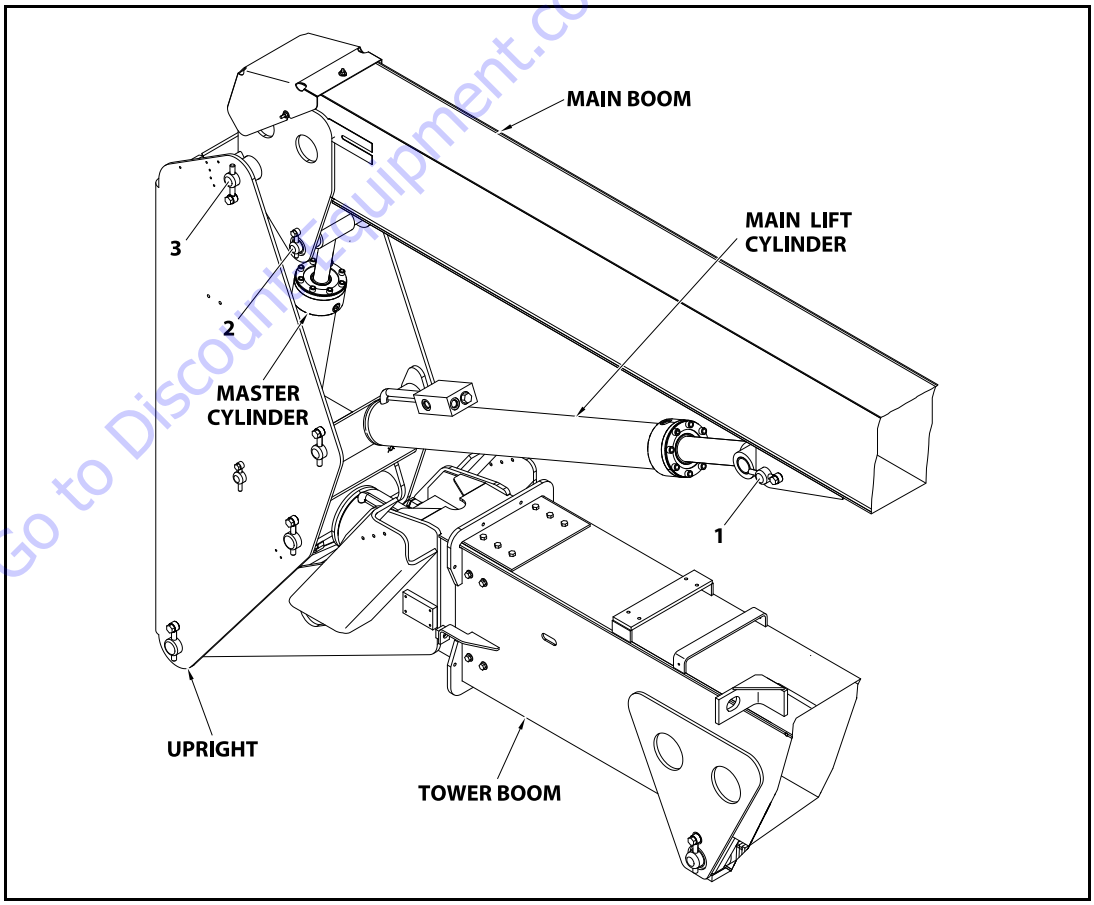


Figure 4-12. Installation - Main Boom

4.7 UPRIGHT

Removal

NOTICE

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

1. Tag and disconnect hydraulic lines to the main boom lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Using suitable lifting device, support the main boom lift cylinder.
3. Remove mounting hardware from main boom lift cylinder barrel end. Using a suitable brass drift and hammer, remove pin #1 from Upright and remove Main Boom Lift Cylinder.
4. Disconnect wiring harness from the horizontal limit switch and dual capacity limit switch.
5. Tag and disconnect hydraulic lines from the master cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
6. Using suitable lifting device, support the master cylinder.
7. Remove mounting hardware from master cylinder barrel end. Using a suitable brass drift and hammer, remove pin #2 from Upright and remove master cylinder.
8. Disconnect the Upright Level Cylinder as follows:
   a. Using a suitable lifting device, support the Upright.
   b. Remove mounting hardware securing hose bracket in upright and remove the hose bracket.
   c. Remove mounting hardware securing the upright level cylinder to the upright. Using a suitable brass drift and hammer, remove pin #3 from upright and disconnect the upright level cylinder from the upright.
9. Remove mounting hardware from the Upright Pivot Pin. Using a suitable brass drift and hammer, remove pin #4 from tower boom assembly and remove the upright from the machine.

NOTE: *Steps 10 through 13 are only necessary if the upright level cylinder is to be removed.*

10. With upright removed, override tower telescope limit switch and extend the tower boom to gain access to the upright level cylinder rod end attach pin.
11. Tag and disconnect hydraulic lines from the upright lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
12. Using an overhead crane or suitable lifting device, support the upright lift cylinder, remove mounting hardware from the rod end of the upright lift cylinder and remove the pin.
13. Carefully remove the upright lift cylinder and place on a suitable work surface.

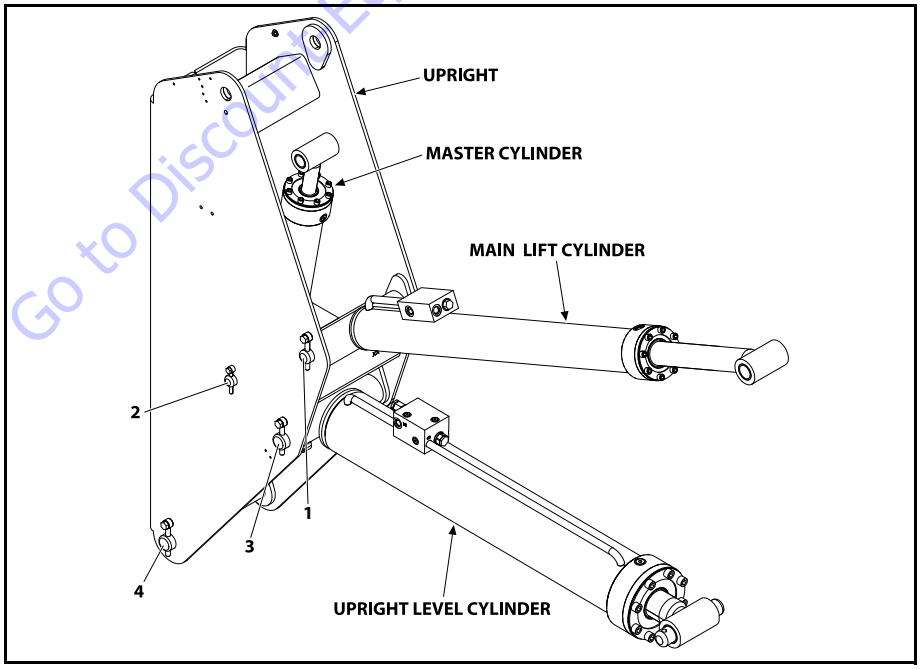


Figure 4-13. Removal - Upright

Installation

NOTE: *Steps 1 through 4 are only necessary if the upright level cylinder is to be removed.*

1. Using a suitable lifting device, carefully install the upright lift cylinder into place in the tower boom.
2. Install the pin and mounting hardware at the rod end of the upright lift cylinder.
3. Connect the hydraulic lines to the upright lift cylinder as tagged during removal.
4. Override the tower telescope limit switch and retract the tower boom.
5. Using an adequate lifting device, install the upright into position. Install pin #4 into the tower boom assembly and secure it in place with the mounting hardware.
6. Connect the Upright Level Cylinder as follows:
   a. Align the holes of the cylinder and upright for pin #3, install the pin into the upright and connect the upright level cylinder to the upright. Install the mounting hardware securing the pin.
   b. Install the hose bracket and secure in place with the mounting hardware.
7. Connect wiring harness to horizontal limit switch and dual capacity limit switch.
8. Align the holes of the master cylinder and upright for pin #2 and install the pin. Secure the pin in place with the mounting hardware.
9. Connect the hydraulic lines to the master cylinder as tagged during removal.
10. Align the holes of the main boom lift cylinder and upright for pin #1 and install the pin. Secure the pin in place with the mounting hardware.
11. Connect the hydraulic lines to the main boom lift cylinder as tagged during removal.

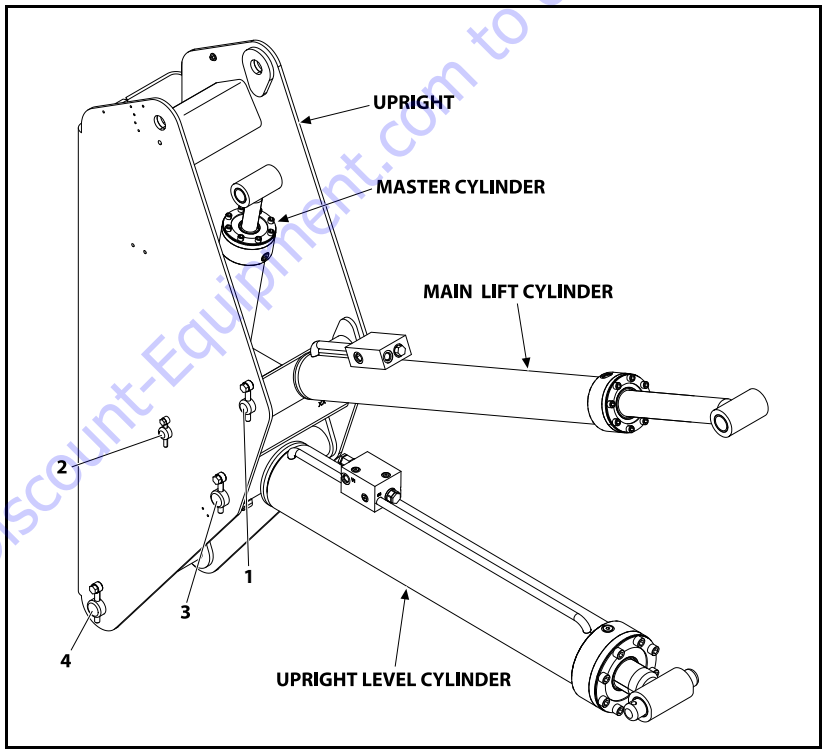


Figure 4-14. Installation - Upright

4.8 TOWER BOOM ASSEMBLY

Removal

NOTICE

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

1. Using an overhead crane or suitable lifting device, support the entire Tower Boom Assembly and separately support the tower lift cylinder.
2. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect wiring harness from the ground control box.
4. Remove mounting hardware from tower lift cylinder rod end. Using suitable brass drift and hammer, remove the tower lift cylinder pin #1 from the tower boom assembly.
5. Remove mounting hardware from the tower boom pivot pin. Using a suitable brass drift and hammer, remove pin #2 from turntable assembly.
6. Using all applicable safety precautions, carefully lift the Tower Boom Assembly clear of turntable and lower to ground or a suitable supported work surface.

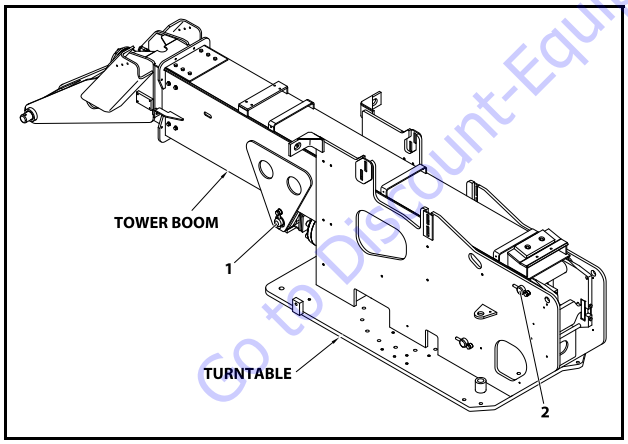


Figure 4-15. Removal - Tower Boom

Disassembly

1. Remove brackets securing hoses and wiring harnesses to push tubes and top of tower boom assembly.
2. Mark all hoses and wiring harnesses at bracket on rear end of tower base boom section for future assembly. Remove hoses and wiring harness from tower boom powertrack.
3. Remove mounting hardware which secures the push tubes to the tower fly boom section.
4. Remove mounting hardware which secures the push tubes to the powertrack, then remove push tubes.
5. Remove mounting hardware which secures the powertrack to the cover plate, then remove powertrack.
6. Remove mounting hardware which secures the cover plate to the top of the tower base section, then remove cover plate.
7. Remove mounting hardware from tower boom telescope cylinder barrel end.
8. Remove mounting hardware which secures the wear pads to front of tower base boom section; remove the wear pads from the top, sides and bottom of the tower base boom.
9. Using an overhead crane or suitable lifting device, remove fly assembly from base section.
10. Remove mounting hardware which secures the tower telescope cylinder to the fly section. Using a suitable brass drift and hammer, remove the pin from the fly boom section.
11. Remove mounting hardware which secures the wear pads to aft end of tower fly boom section; remove the wear pads from the top, sides and bottom of the fly boom.
12. Remove mounting hardware which secures the upright leveling cylinder to the fly section. Using a suitable brass drift and hammer, remove the pin from the fly boom section.
13. Remove hardware which secures the wear pads to the front end of fly tower boom section; remove the wear pads from the top, sides and bottom of the fly boom section.

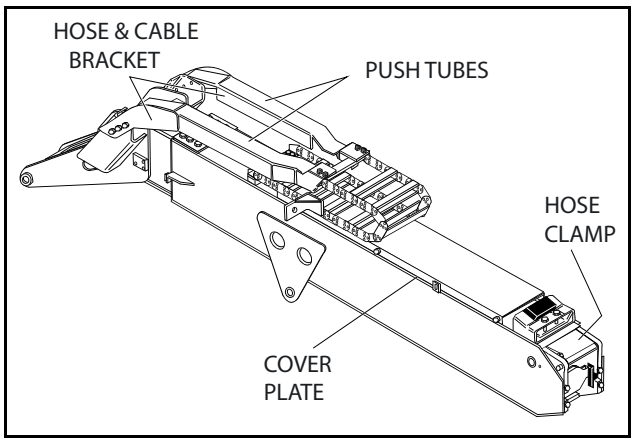


Figure 4-16. Location Of Components - Tower Boom

Inspection

NOTE: *Refer to Section 2, Pins and Composite Bearing Repair Guidelines.*

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

Assembly

NOTE: *When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.*

1. Measure inside dimensions of the tower base section to determine the number of shims required for proper fit.
2. Install side, top, and bottom wear pads to the front end of tower fly section; shim evenly to the measurements of the inside of the base boom section.

NOTICE

WHEN ASSEMBLING TOWER BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS AND OTHER OBSTRUCTIONS.

3. Align upright leveling cylinder with attach holes in tower fly boom. Using a soft head mallet, install the cylinder pin into tower fly boom and secure with mounting hardware.
4. Install side, top, and bottom wear pads to the aft end of tower fly section; shim evenly to the measurements of the inside of the base boom section.
5. Align tower telescope cylinder with attach holes in tower fly boom. Using a soft head mallet, install the cylinder pin into tower fly boom and secure with mounting hardware.
6. Secure the sling and lifting device at the tower fly boom assembly's approximate center of gravity.
7. Slide tower fly boom assembly into the tower base boom section. Shim boom, if necessary, for a total of 1/16 in. (1.6 mm) clearance.
8. Install wear pads into the forward position of the tower base boom section. Shim boom, if necessary, for a total of 2/10 in. (5.1 mm) clearance.
9. Align the telescope cylinder with the slots at the aft end of tower base boom section, then secure cylinder with mounting hardware.
10. Install cover plate to attach point on the tower base boom section, then secure with mounting hardware.
11. Install powertrack to attach point on the cover plate, then secure with mounting hardware.
12. Attach push tubes to the powertrack and attach point on the tower fly boom section; with mounting hardware.
13. Properly route the hoses and wiring harnesses through bracket at aft end of tower base boom section.
14. Pull hoses and wiring harnesses through hose bracket to the mark on hoses and harnesses from previous disassembly and clamp for proper length.
15. Route hoses and harnesses through powertrack, push tubes, then through holes in side of tower fly boom nose. Secure hoses and harnesses with hoses brackets.

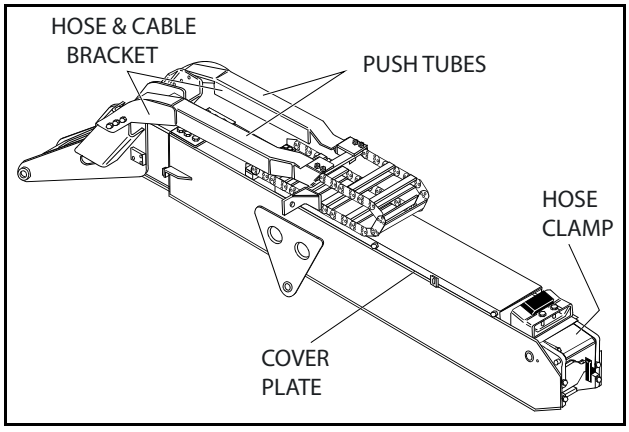


Figure 4-17. Location Of Components - Tower Boom

Installation

1. Using a suitable lifting device, position tower boom assembly on turntable so that the pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin #2, ensuring that location of hole in pin is aligned with attach point on turntable.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
4. Using all applicable safety precautions, operate lifting device in order to position tower boom lift cylinder so that holes in the cylinder rod end and boom structure are aligned. Insert the lift cylinder pin #1, ensuring that location of hole in pin is aligned with attach point on boom.
5. Connect all wiring connectors to the correct connectors.
6. Connect all hydraulic lines of boom assembly.

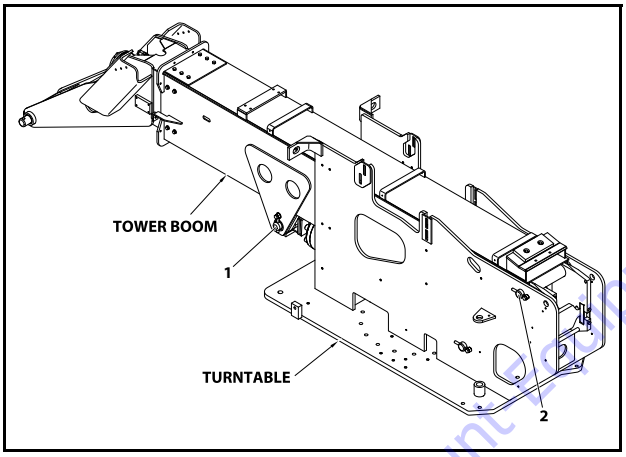
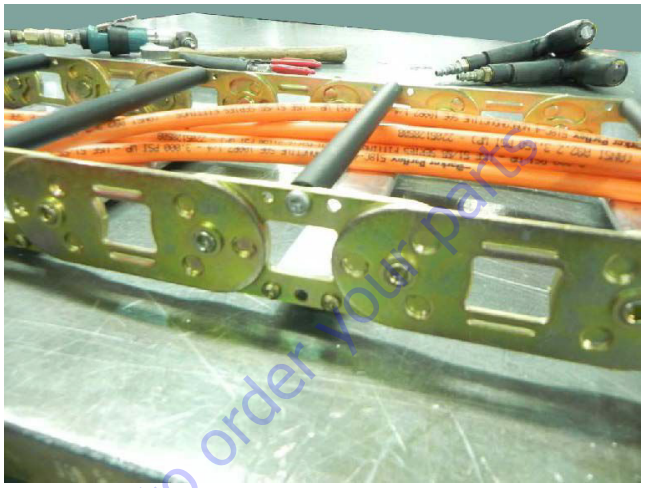


Figure 4-18. Installation - Tower Boom

4.9 TOWER BOOM POWERTRACK MAINTENANCE

Flat Bar Removal

NOTE: *Hoses shown in the Powertrack are for example only. Actual hose and cable arrangements will be different.*

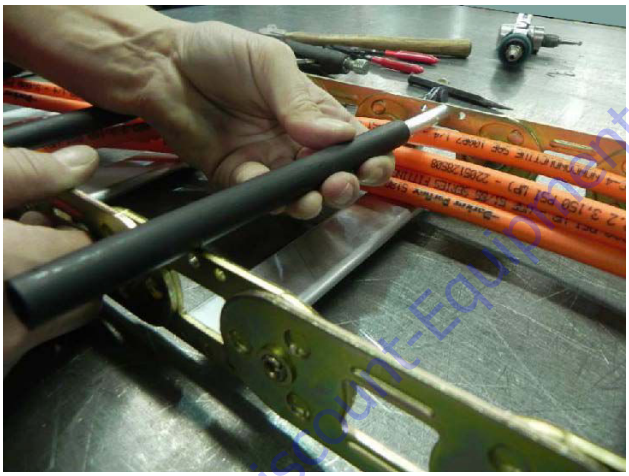


1. Use a small ¼ in. ratchet and a T-20 Torx bit. Remove the 8-32 x 0.500 screws from both sides. (If the track also has a flat bar on the inside of the track instead of round bar/poly, perform the same step to remove it.).

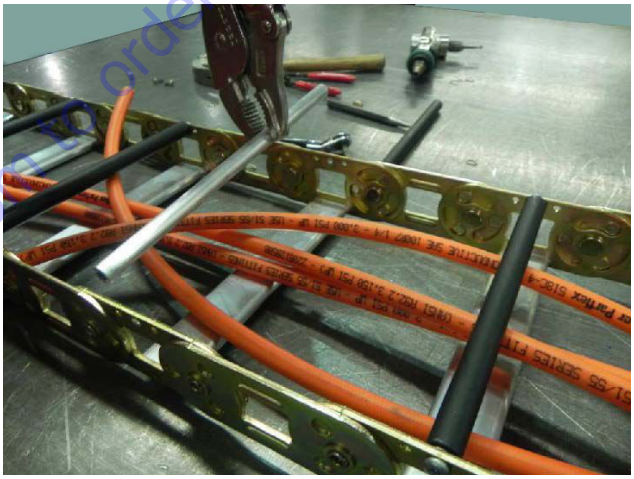
Round Bar/Poly Bar Removal

1. Use a small ¼ in. ratchet with a T-25 Torx bit. Remove the 10-24 x 0.812 screw. (If the bar spins then grip the bar and poly tightly with a vise-grip).

2. Lift up one end of the bar and slide the poly roller off.

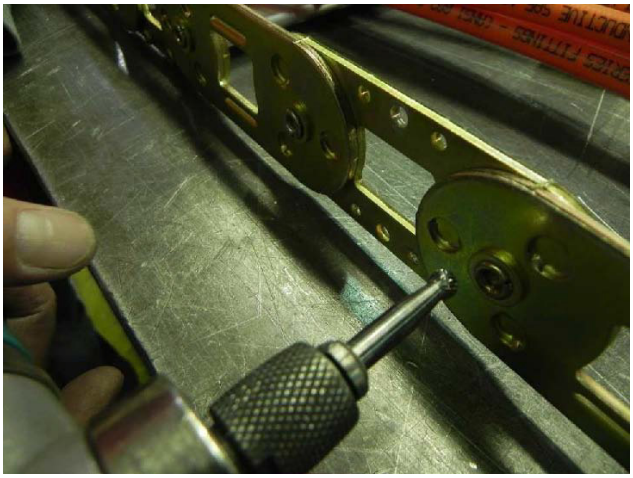


3. While gripping the bar tightly, remove the other 10-24 x 0.812 screw.



Removing and Installing Links

1. To remove the links, the rivets holding the links together must be removed. The following will show one way this can be done. Use a right angle die grinder with a ¼ in. ball double cut bur.

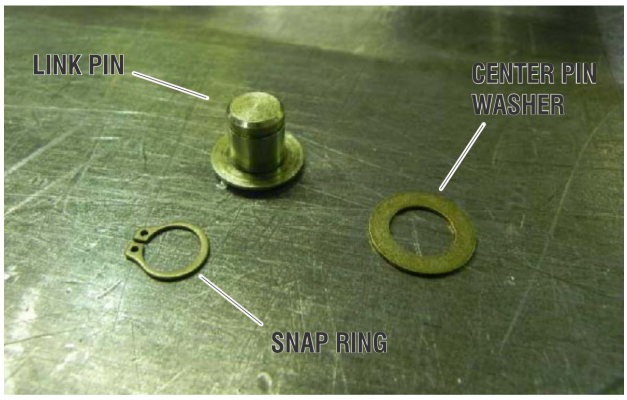


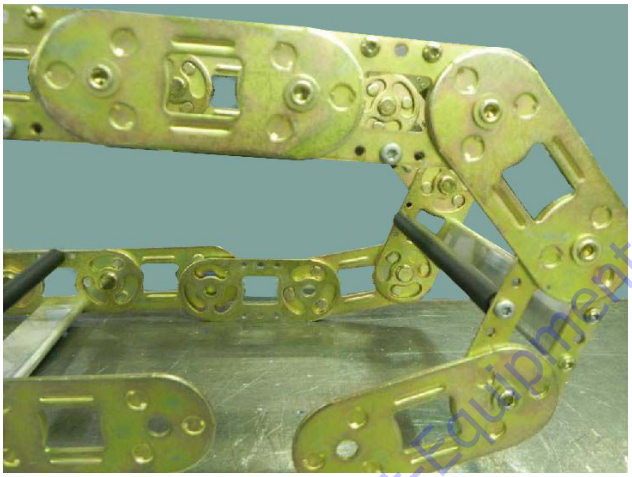
2. Insert the tool into the rolled over end of the rivet as shown. Grind out the middle of the rivet until the rolled over part of the rivet falls off. Repeat this step for all rivets that must be removed.

NOTE: *Protect the cables/hoses during this process by moving them away from the grinding area. Cover with a rag to prevent any debris from getting on them.*

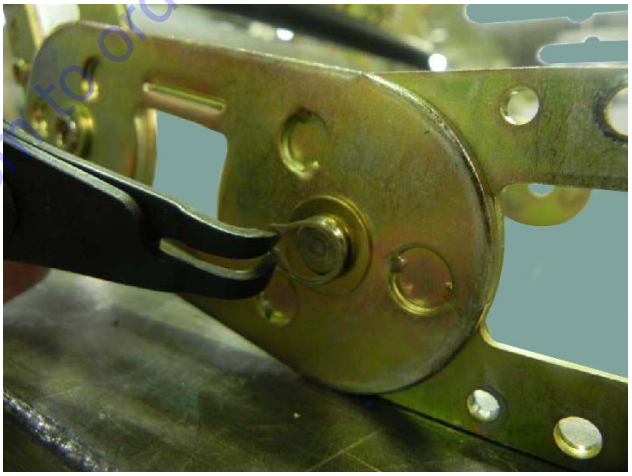
3. After grinding, it is sometimes necessary to use a center punch to punch out the rivet from the link.

4. To install new links, extend the main moving end over the lower part of the track so the new connection point is in the curved part of the track. This will allow the round half-shears to be rotated in a way they will fit into the peanut-shaped cut-outs.

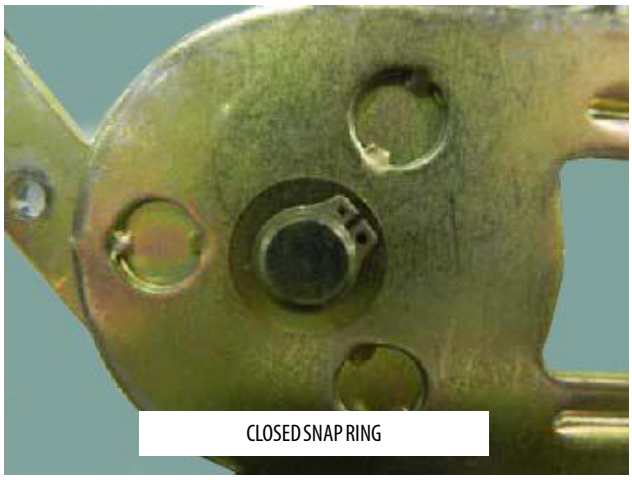




5. Install the pin into the center hole, then slide the washer over the pin. Install the snap ring into the groove in the pin.

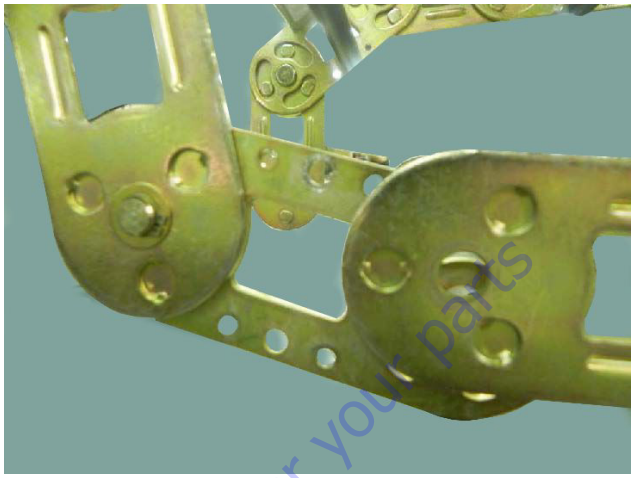


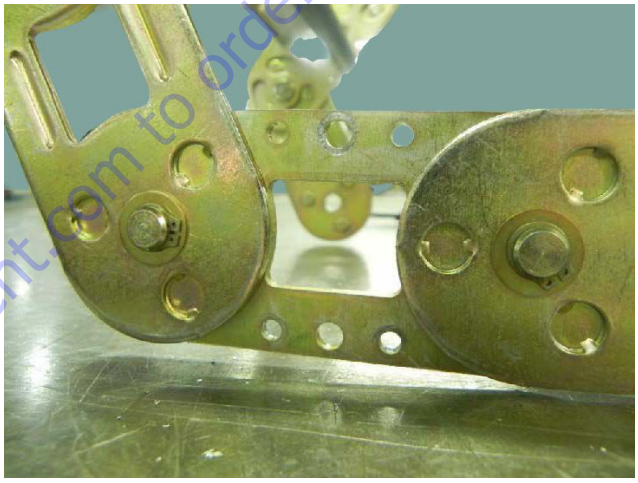
NOTE: *When installing snap rings make sure they are seated in the pin groove and closed properly.*


CLOSED SNAP RING


SNAP RING NOT CLOSED PROPERLY

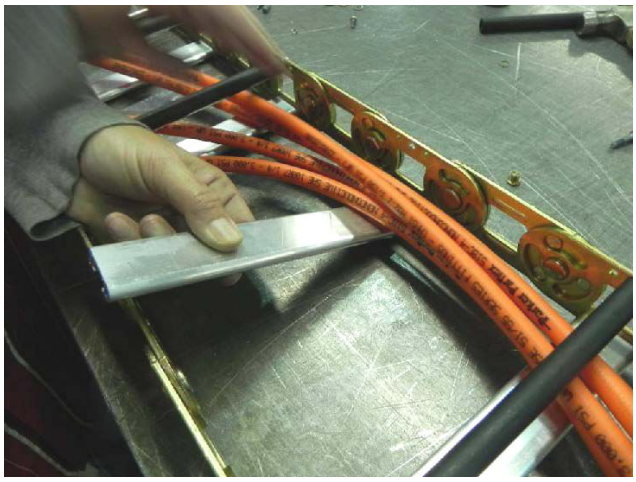
6. Install more pins, washers, and snap rings into all the links where a rivet was removed.

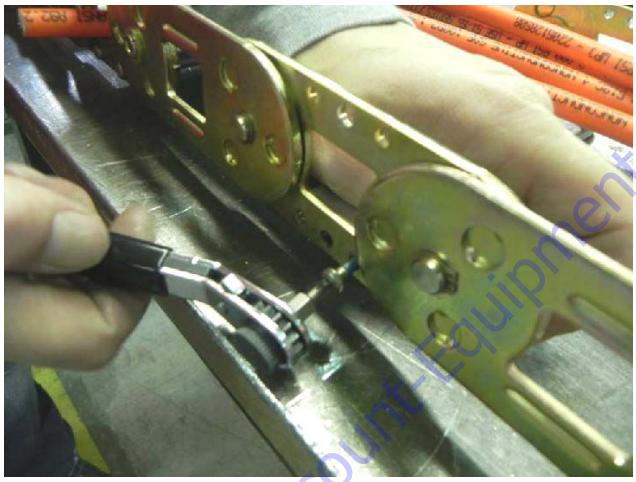




Installing a New Flat Bar

1. While holding the flat bar, install new 8-32 x 0.500 self threading torx screws into both holes on each side of track.

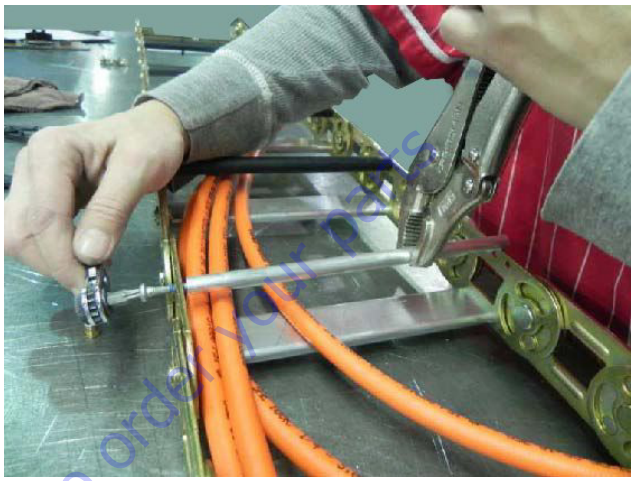




NOTE: *Maximum tightening torque for the 8-32 screw is 18-20 in. lbs. (2-2.2 Nm).*

Installing a New Round Bar/Poly Roller

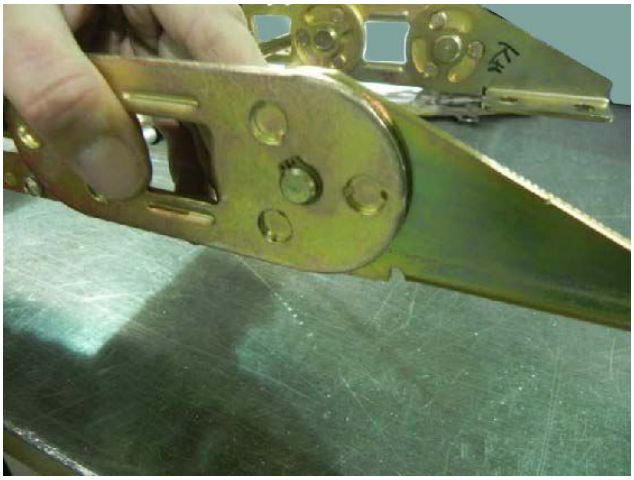
1. While tightly holding the round bar, install the new 10-24 x 0.812 self threading torx screw. Next lift up the other end and slide a new poly roller on. Install another 10-24 x 0.812 screw on the other side.

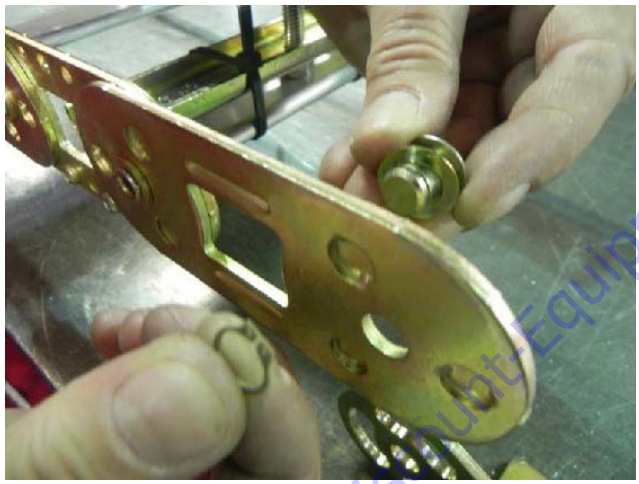


NOTE: *Maximum tightening torque for the 10-24 screw is 45-50 in. lbs. (5-5.6 Nm).*

Replacing a Fixed End Bracket

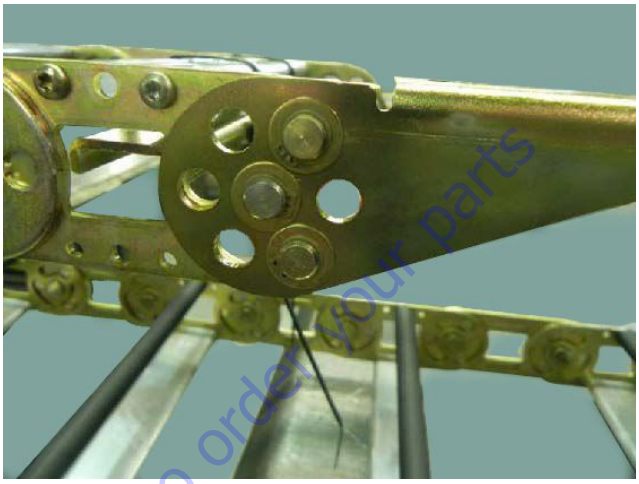
1. Remove the bracket by removing the center pin, washer and snap ring. Install a new bracket then reinstall the pin, washer and new snap ring. After installing the new bracket make sure that it rotates correctly.

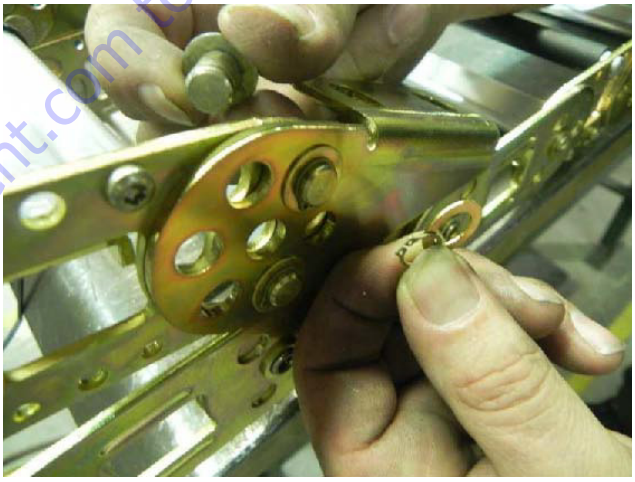




Replacing a Moving End Bracket

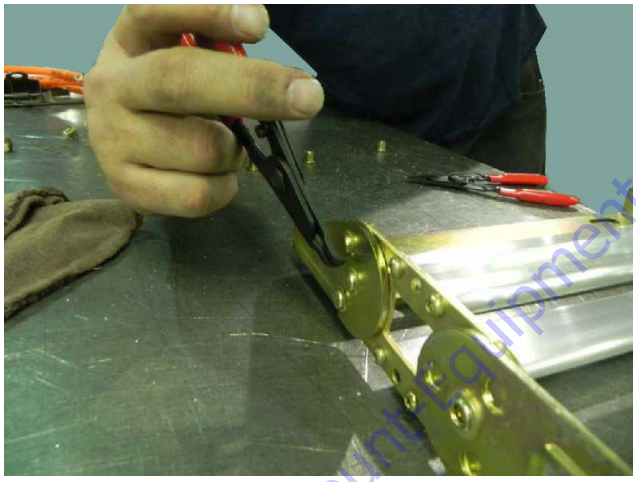
1. Remove bracket by removing all pins, washers and snap rings. Replace with a new bracket and reinstall the pins, washers and new snap rings. After installation of the new bracket, make sure that it rotates correctly.

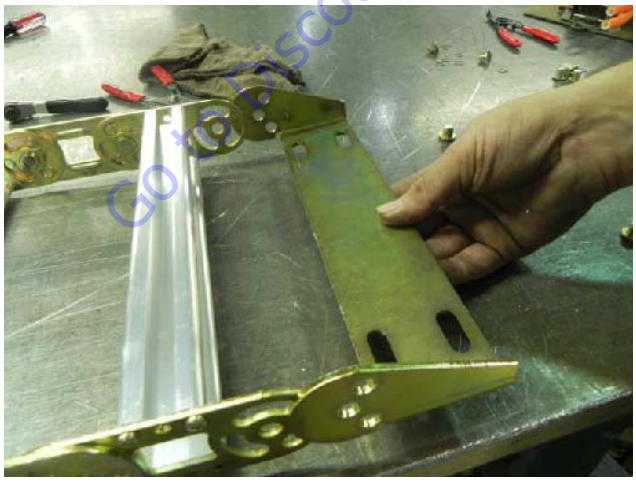




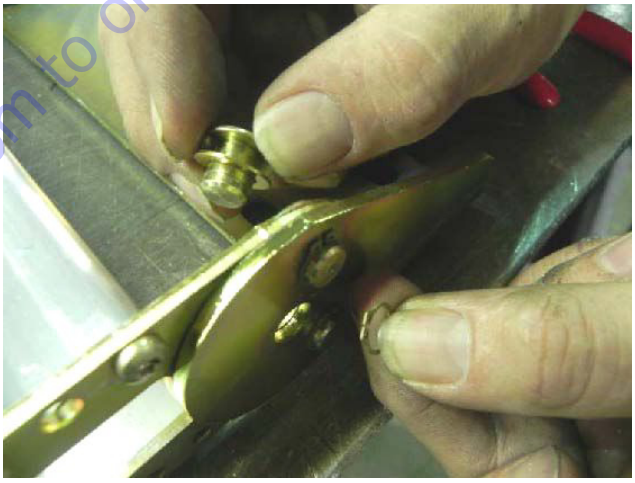
Replacing a One Piece Bracket

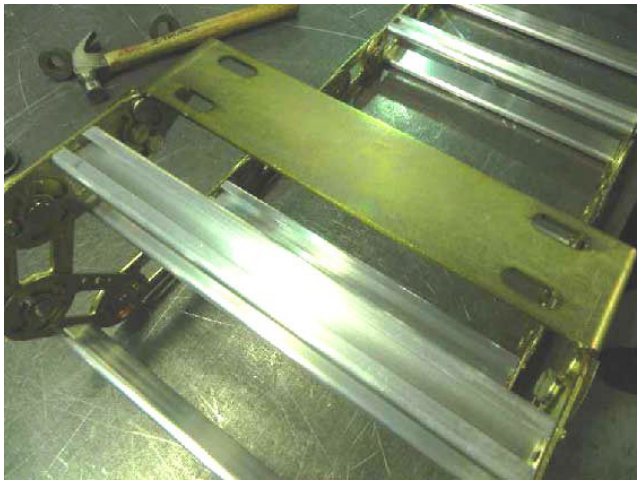
1. Remove all pins, washers and snap rings and slide the bracket off of the links.





2. To install a new bracket, slide the bracket over the links and reinstall the pins, washers and new snap rings. After installation of the new bracket make sure that it rotates correctly.





4.10 UPRIGHT MONITORING SYSTEM

The UMS provides a visual and audible warning to the operator when the limits of the upright assembly alignment have been reached. In addition, the UMS will not allow the tower boom to be lowered when the upright assembly is misaligned in a direction oriented away from the work platform.

Re-Synchronizing Upright

A pull type control valve allows the operator to adjust the upright level cylinder if the upright is not 90° (vertical) relative to the chassis (Refer to Figure 4-19.). This valve is located in the tank compartment area.

Perform the following steps with the aid of an assistant:

1. Turn the key switch to the ground control position.
2. Start the engine.
3. Pull and hold the red re-level knob located next to the main control valve. Refer to Figure 4-19.
4. Raise the tower boom 6 feet (1.8 m).
5. Release the red re-level knob.
6. Lower the tower boom fully and continue to hold down the switch to Tower Down for an additional 20 seconds.
7. Repeat steps 3 thru 6 as necessary until the upright is 90° (vertical) relative to the chassis.

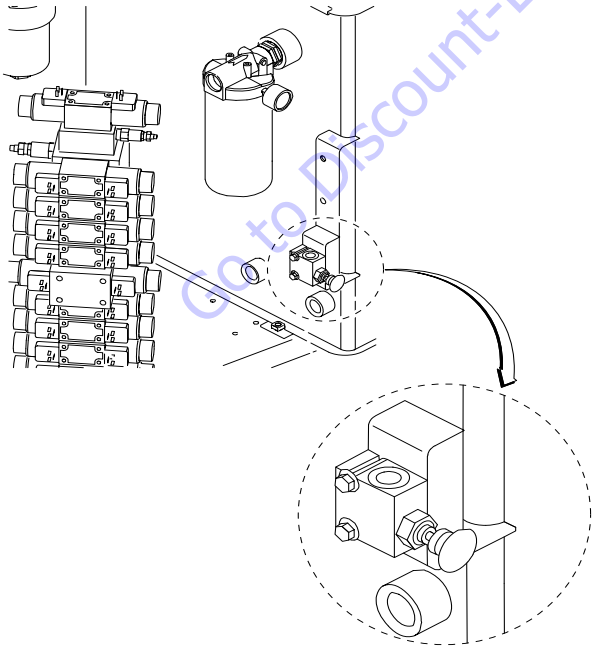


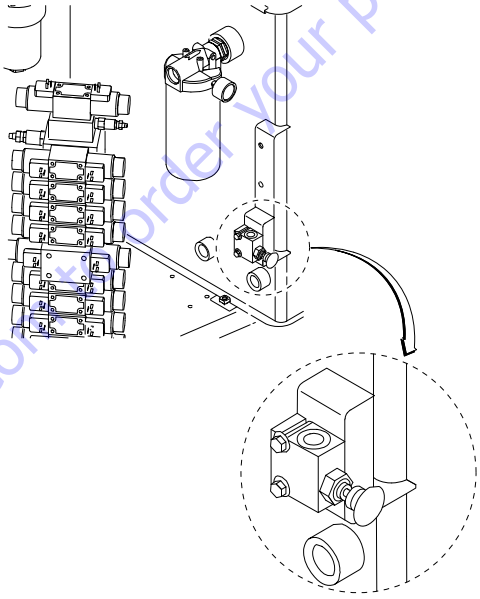
Figure 4-19. Releveling Valve

Tower Out of Sync

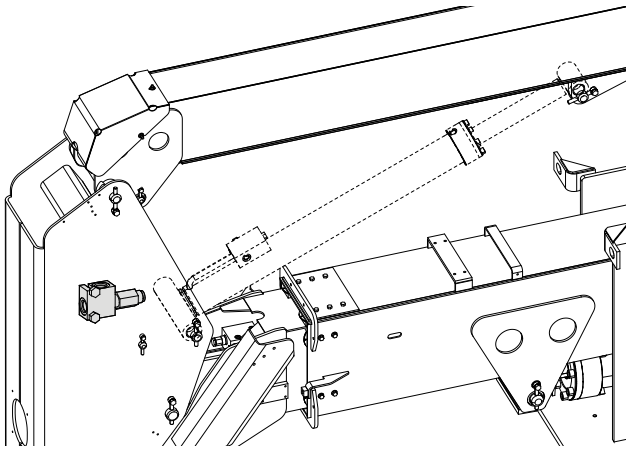
Tower is out of sync backwards, upright leaning toward the platform.

When towering down the upright cylinder bottoms out before the lower lift. Problems that could cause this are:

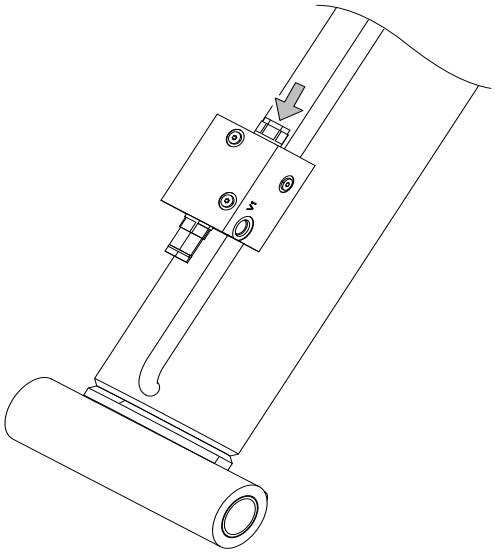
1. The re-leveling valve (red knob on the oil tank P/N: 4640866), this is a poppet valve that could be leaking fluid out of the closed loop. Manually opening the valve and flushing it can eliminate any contaminate on the seat. The seat could also be damaged, so replacing the cartridge might be necessary.



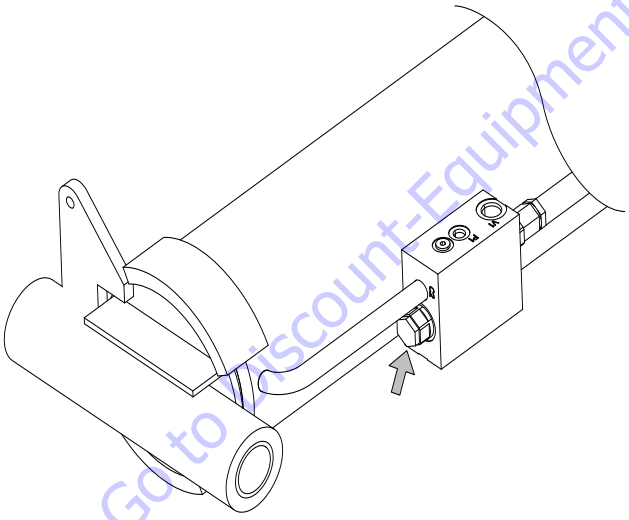
2. A relief valve is located in the upright. This relief valve could be leaking backwards out of the loop. Replace the cartridge. They are pre-set.



3. The counterbalance valve in the piston end of the upright level cylinder. There could be a leak path from the valve port to the pilot port. Replace the counterbalance valve.



4. The counterbalance valve in the rod end of the lower lift cylinder. There could be a leak path from the valve port to the pilot port. Replace the counterbalance valve.

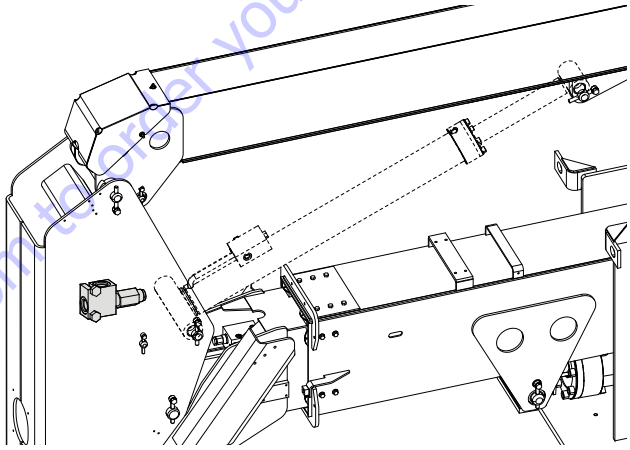


5. The packing on either the upright or lower cylinder can cause this. Do cylinder tests to determine if either cylinder needs new packing.

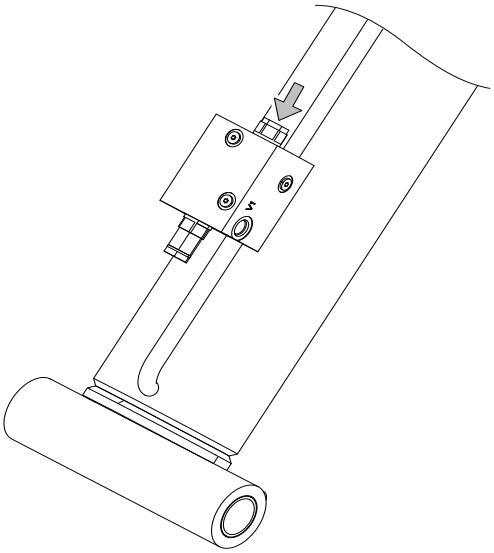
Tower is out of sync forwards, upright leaning toward the steer axle.

When towering down, the lower lift cylinder bottoms out before the upright level cylinder. This is caused by too much oil between the two cylinders. Problems that could cause this are:

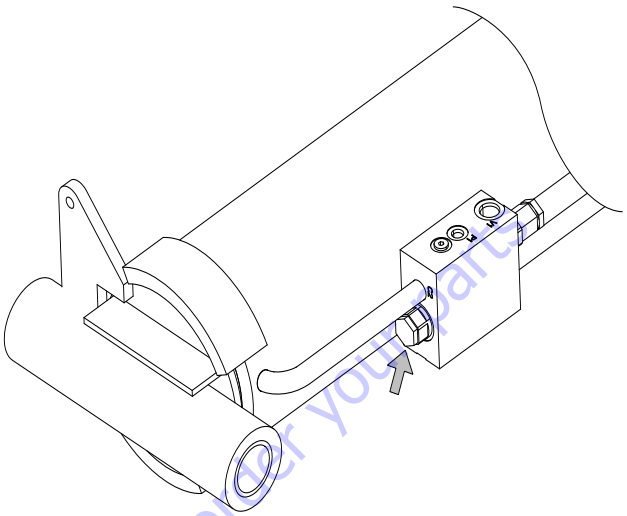
1. The relief valve located in the upright (P/N: 4640929). If this valve is set too low or has contaminate in it causing it to leak prematurely, when lifting down oil can pass through it causing the volume to grow between the cylinders. Flush the valve out and reinstall it, or replace the cartridge. The cartridge pressure is pre-set so no adjustment can be made.



2. The counterbalance valve in the piston end of the upright level cylinder. There could be a leak path from the pilot port to the valve port. Replace the counterbalance valve.



3. The counterbalance valve in the rod end of the lower lift cylinder. There could be a leak path from the pilot port to the valve port. Replace the counterbalance valve.



4. The packing on the lower lift cylinder can cause this. Do a cylinder test to check this out. Refer to Section 2.4, Cylinder Drift Test.

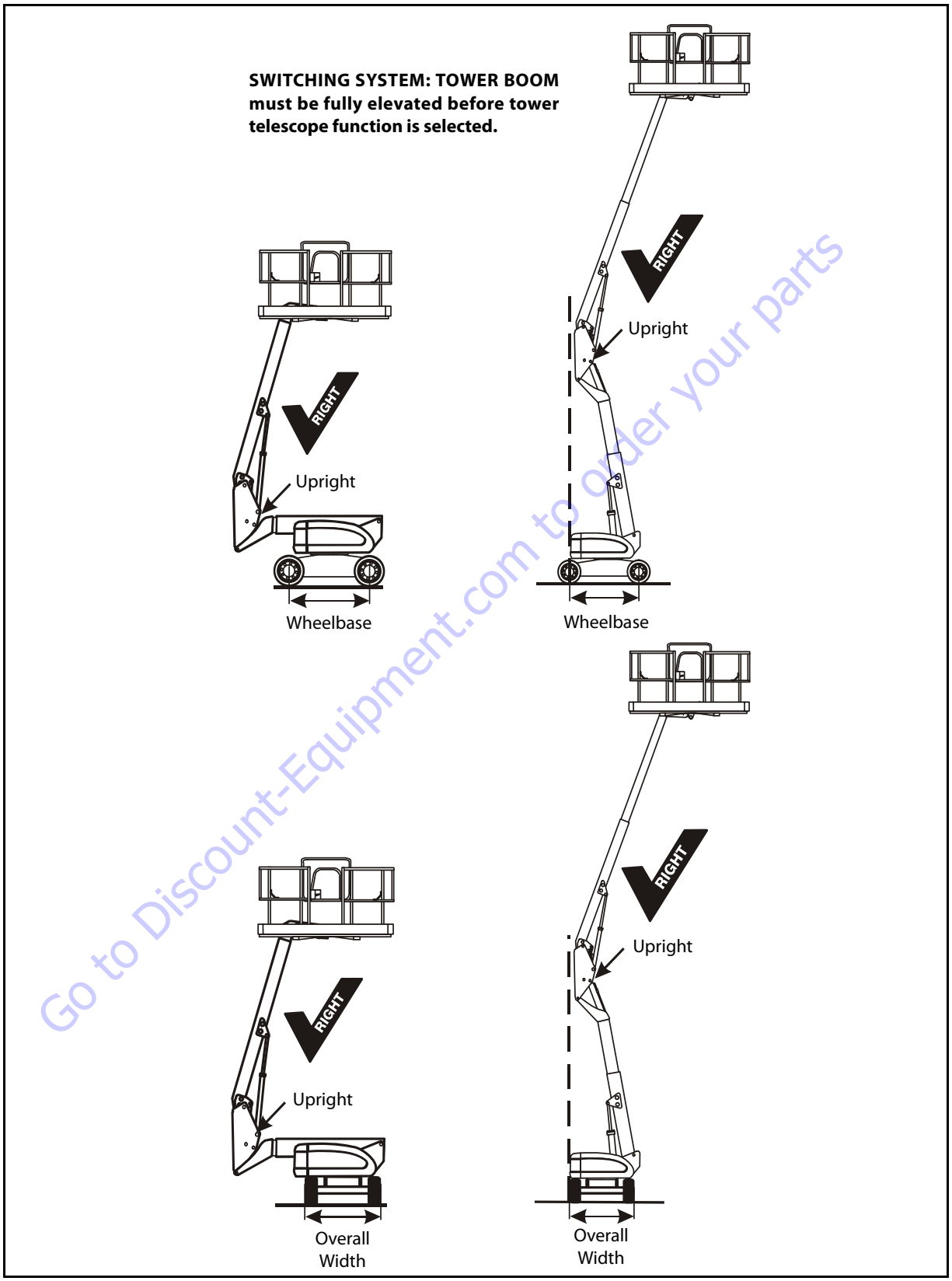


Figure 4-20. Boom Upright Positioning - Sheet 1 of 2

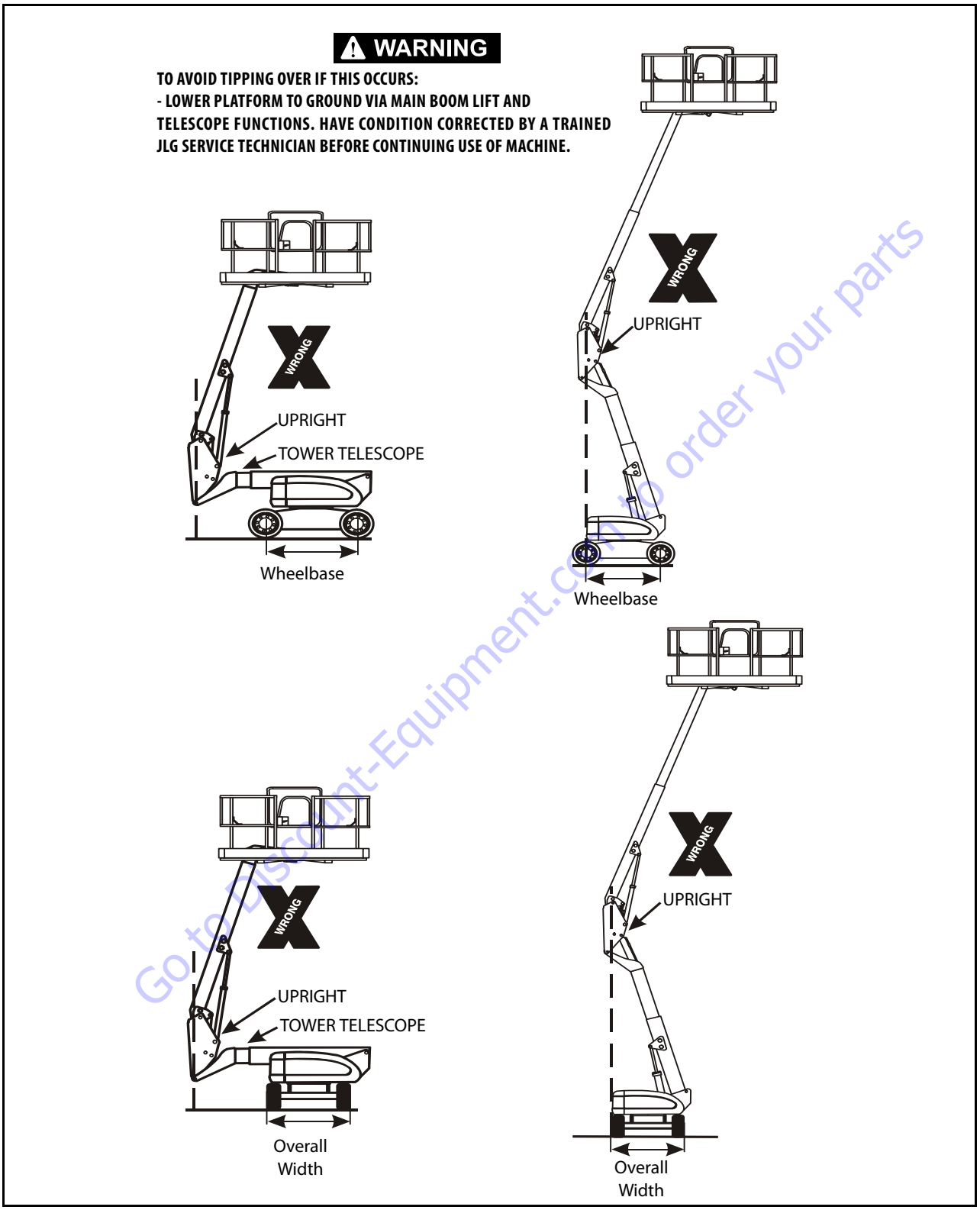


Figure 4-21. Boom Upright Positioning - Sheet 2 of 2

4.11 JIB

NOTE: *Using a suitable lifting device, support the jib.*

Removal

1. For platform and support removal see Section 4.1 - Platform.
2. Position the jib boom level with the ground.
3. Remove mounting hardware from slave leveling cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin from jib boom.
4. Remove mounting hardware from jib boom pivot pin #2. Using a suitable brass drift and hammer, remove the pivot pin from boom assembly.

Disassembly

1. Remove mounting hardware from jib boom pivot pins #3 and #4. Using a suitable brass drift and hammer, remove the pins from jib boom pivot weldment.
2. Remove mounting hardware from rotator support pins #5 and #6. Using a suitable brass drift and hammer, remove the pins from rotator support.
3. Remove mounting hardware from lift cylinder pin #7. Using a suitable brass drift and hammer, remove the cylinder pin from jib boom.

Inspection

NOTE: *When inspecting pins and bearings Refer to Section 2.5, Pins and Composite Bearing Repair Guidelines.*

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

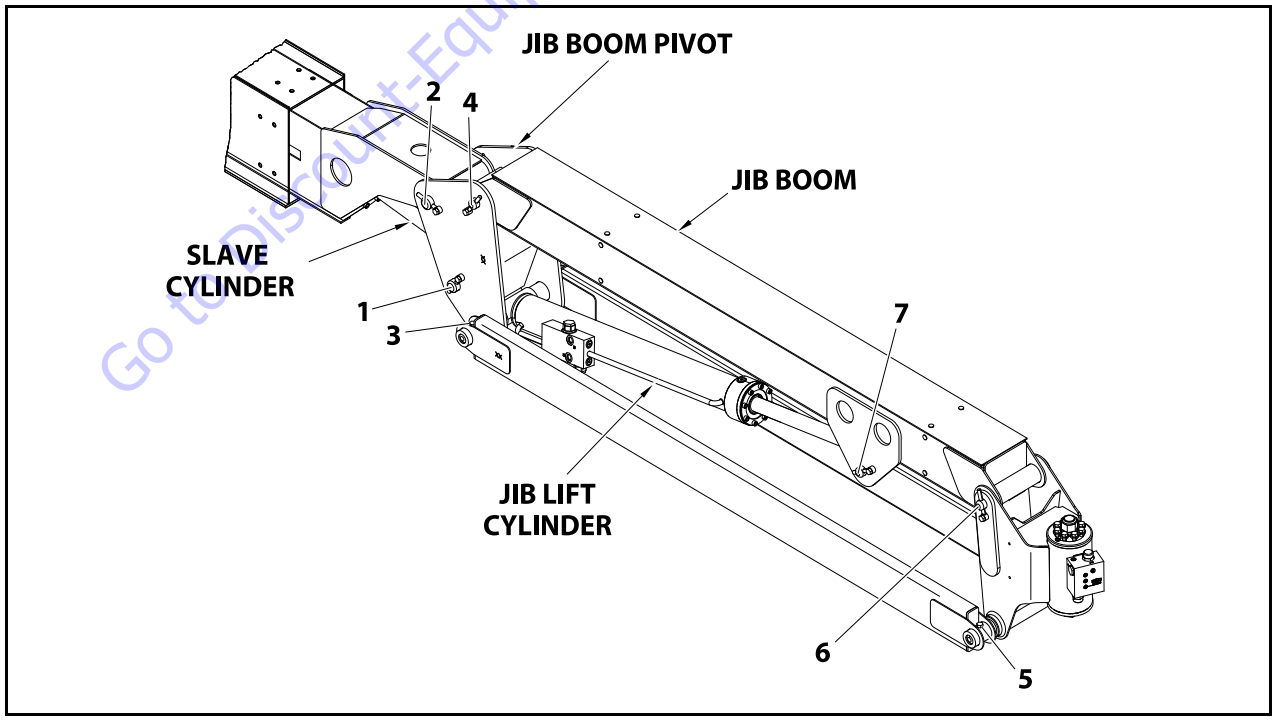


Figure 4-22. Removal and Installation - Jib

Assembly

1. Align lift cylinder with attach holes in jib boom. Using a soft head mallet, install cylinder pin #7 into jib boom and secure with mounting hardware.
2. Align rotator support with attach hole in jib boom. Using a soft head mallet, install rotator support pin #6 into jib boom and secure with mounting hardware.
3. Align bottom tubes with attach holes in rotator support. Using a soft head mallet, install rotator support pin #5 into jib boom and secure with mounting hardware.
4. Align jib boom with attach hole in jib boom pivot weldment. Using a soft head mallet, install rotator support pin #4 into jib boom and secure with mounting hardware.
5. Align bottom tubes with attach holes in jib boom pivot weldment. Using a soft head mallet, install rotator support pin #3 into jib boom pivot weldment and secure with mounting hardware.

Installation

1. Align jib boom pivot weldment with attach holes in fly boom assembly. Using a soft head mallet, install pivot pin #2 into fly boom assembly and secure with mounting hardware.
2. Align the slave leveling cylinder with attach holes in jib boom pivot weldment. Using a soft head mallet, install slave leveling cylinder pin #1 into jib boom pivot weldment and secure with mounting hardware.

4.12 SEQUENCE FOR HOSE REPLACEMENT IN THE TOWER BOOM

1. Remove the tower boom front cover bolts, exposing the Powertrack.
2. Remove bolts to disconnect the top bar of the Powertrack
3. Pull the Powertrack out of base boom. (as far as hoses will allow)
4. At left side rear of upright, remove access cover plate (4) bolts. (others if necessary)
5. Remove access cover plate, (4) bolts, from bottom front of fly boom.
6. Cut cable ties that attach hose to be replaced.
7. Disconnect hose that is to be replaced, and cap the male fitting.
8. Attach the new hose to the end of the hose to be replaced.
9. Pull these lines thru the upright and out the bottom, then feed back into the fly boom.
10. At the Powertrack, in front of the tower boom, open the Powertrack links to expose the hose to be replaced.
11. Pull hose to be replaced, attached to the new hose, thru the fly boom and thru the Powertrack links.
12. Disconnect new hose from the replaced hose and connect to fitting where the damaged hose was connected.
13. Roll Powertrack back into base, and attach the top bar of the Powertrack (2) bolts to the inside top of the fly boom section.
14. Check for leaks and hardware tightened securely.
15. Replace access cover plates and front cover.

4.13 LIMIT SWITCHES AND CAM VALVE ADJUSTMENT

Adjust switches and cam valve as shown in figure Figure 4-23., Boom Limit Switches Adjustment.

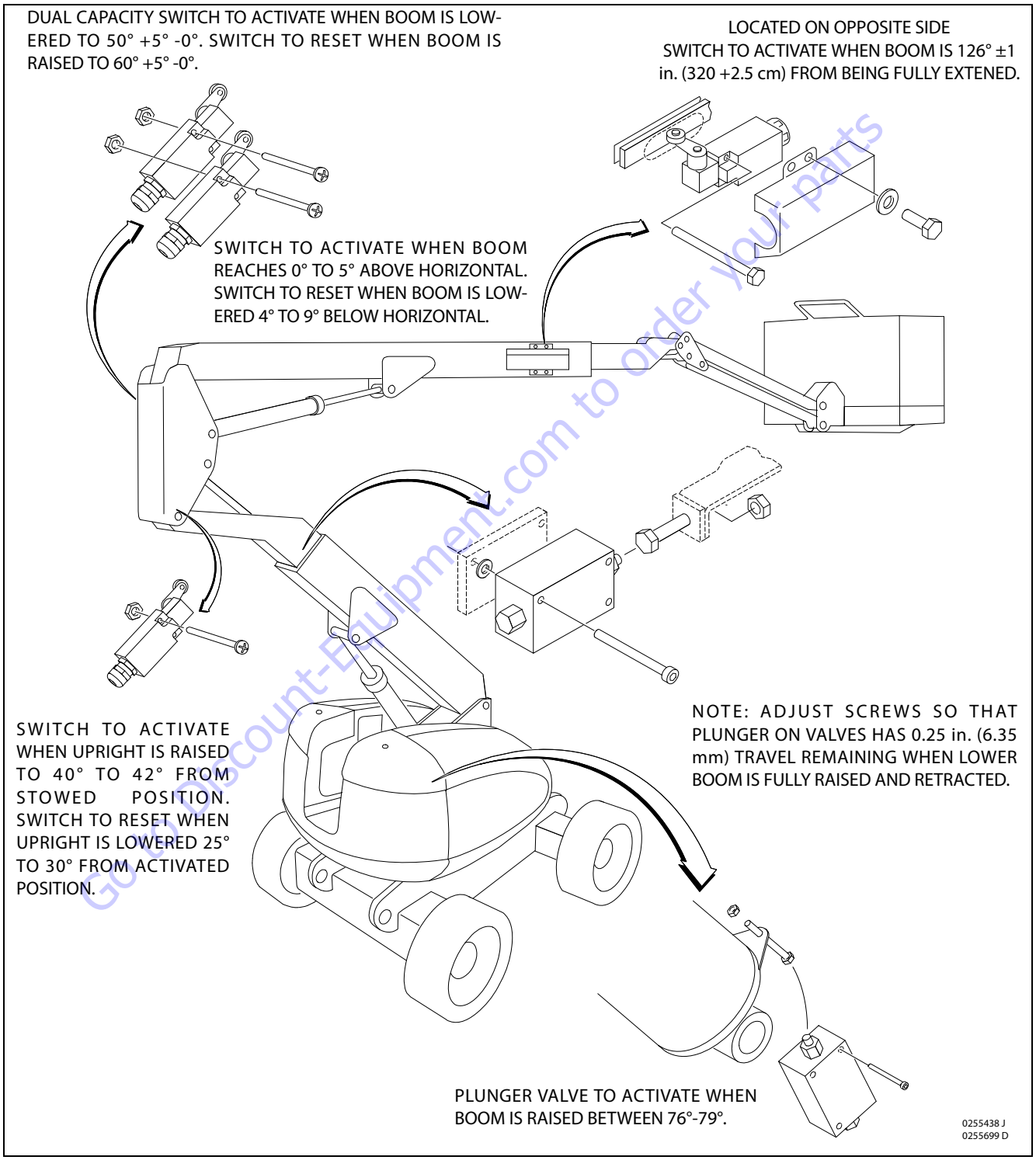
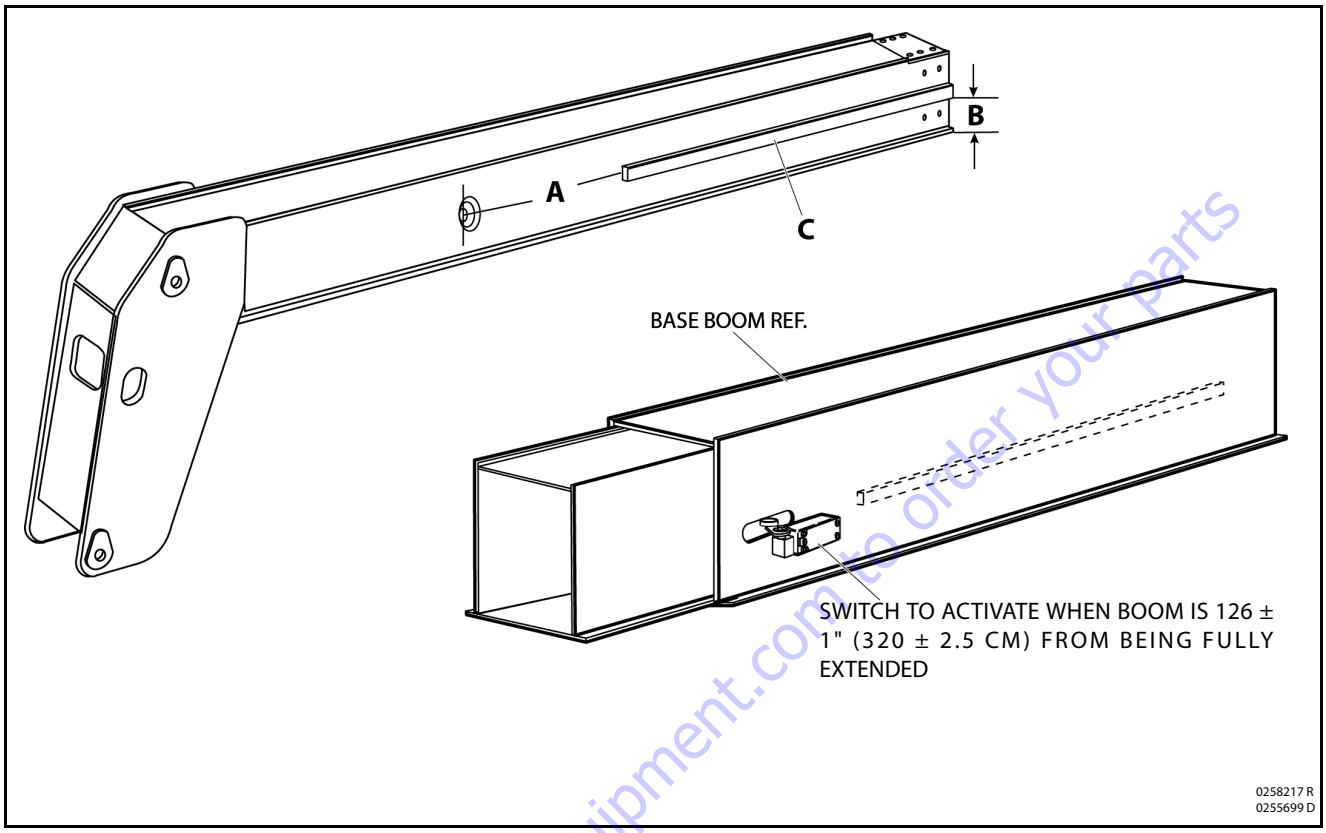


Figure 4-23. Boom Limit Switches Adjustment



A	B	C
70.3125"	3.343"	117.5"
178.593 cm	8.5 cm	298.45 cm

Figure 4-24. Fiberglass Bar Installation

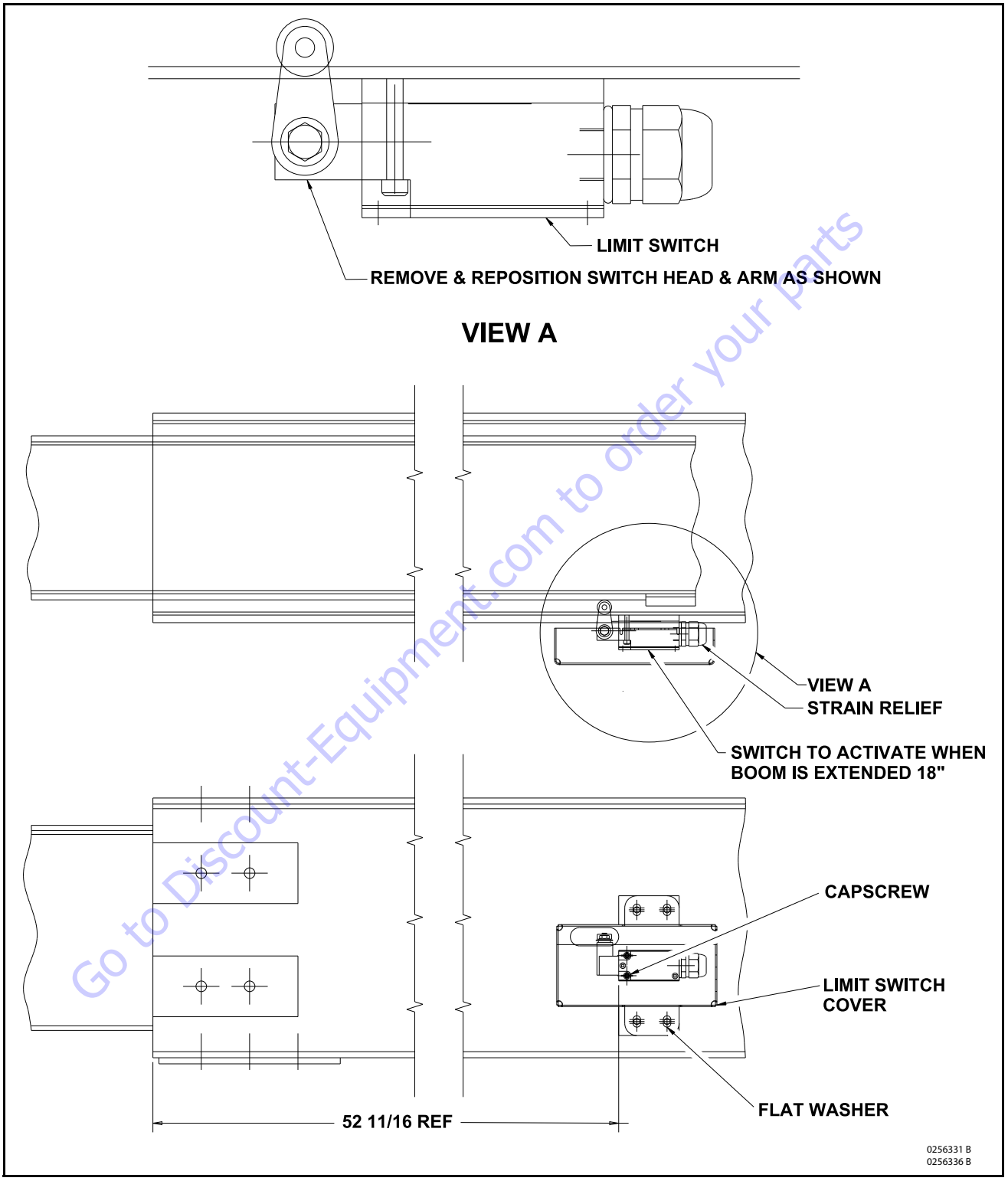


Figure 4-25. Transportation Switch Installation (CE only) - Sheet 1 of 2

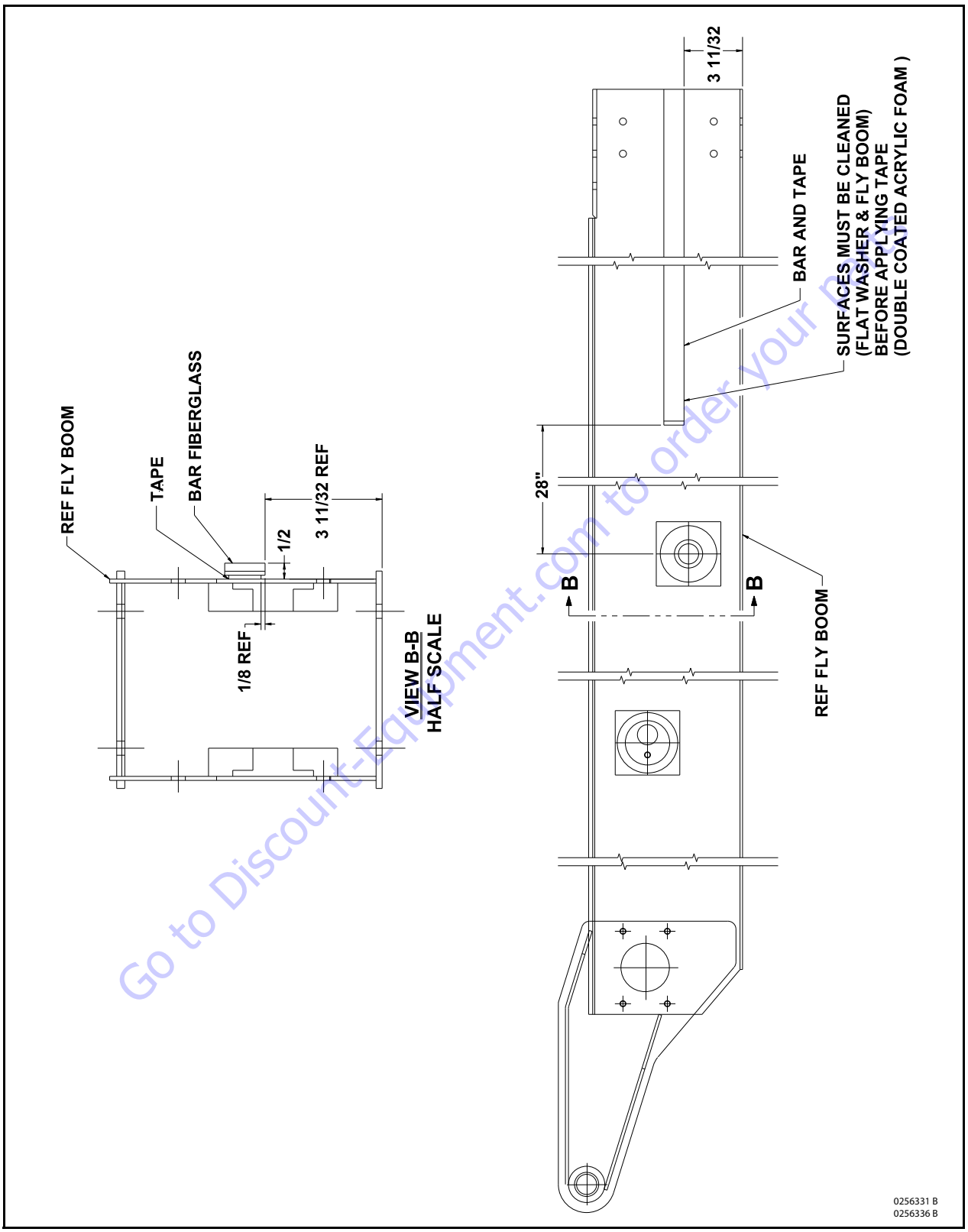


Figure 4-26. Transportation Switch Installation (CE only) - Sheet 2 of 2

4.14 BOOM VALVE ADJUSTMENT

Adjust the screws so the plunger on the valves has 0.250 in. (6.35 mm) travel remaining when the lower boom is fully raised and retracted.

Tower Boom

1. Shim up wear pads until 1/32 in. (0.8 mm) clearance to adjacent surface.
2. When adjusting wear pads, removing or adding shims, bolt length must also be changed.
   a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.

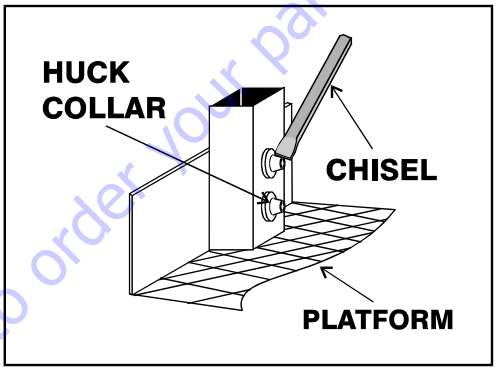
Main Boom

1. Shim up wear pads to within 1/32 in. (0.8 mm) clearance between wear pad and adjacent surface.
2. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
   a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and Sheaves and wire rope must be replaced as sets.

4.15 PLATFORM

The platform is made up of five sections: floor, right side, left side, back (console box mounting.) and gate. The sections are secured with huck magna grip fastener and collars. Replace damaged platform sections as follows:

1. Support the huck collar with a sledge hammer or other suitable support.
2. Using a hammer and chisel, remove the collar from the fastener as shown in the diagram below.

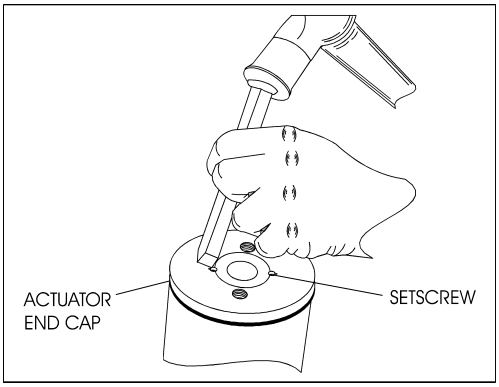


3. When installing new section of platform replace huck fasteners with 1/4 x 20 NC x 2 1/4" grade 5 bolts, flatwashers and locknuts.
4. When installing a new gate to platform, replace rivets with 1/4 x 20 NC x 2 “grade 5 bolts, flatwashers and locknuts.

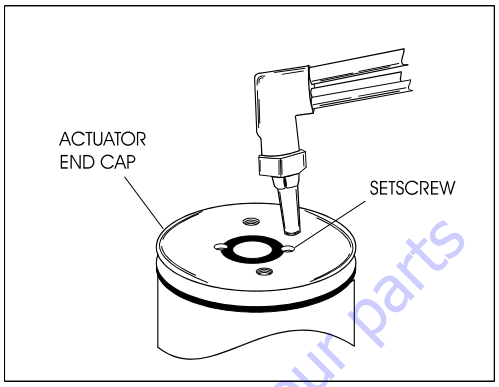
4.16 ROTATOR - (PRIOR TO SN 0300132474)

Disassembly

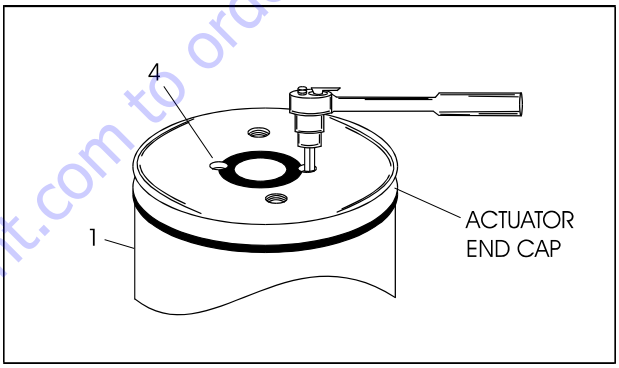
1. Place actuator on a clean workbench.
2. Remove all hydraulic fittings.
3. Using a suitable hammer and chisel remove the portion of end cap securing setscrew.

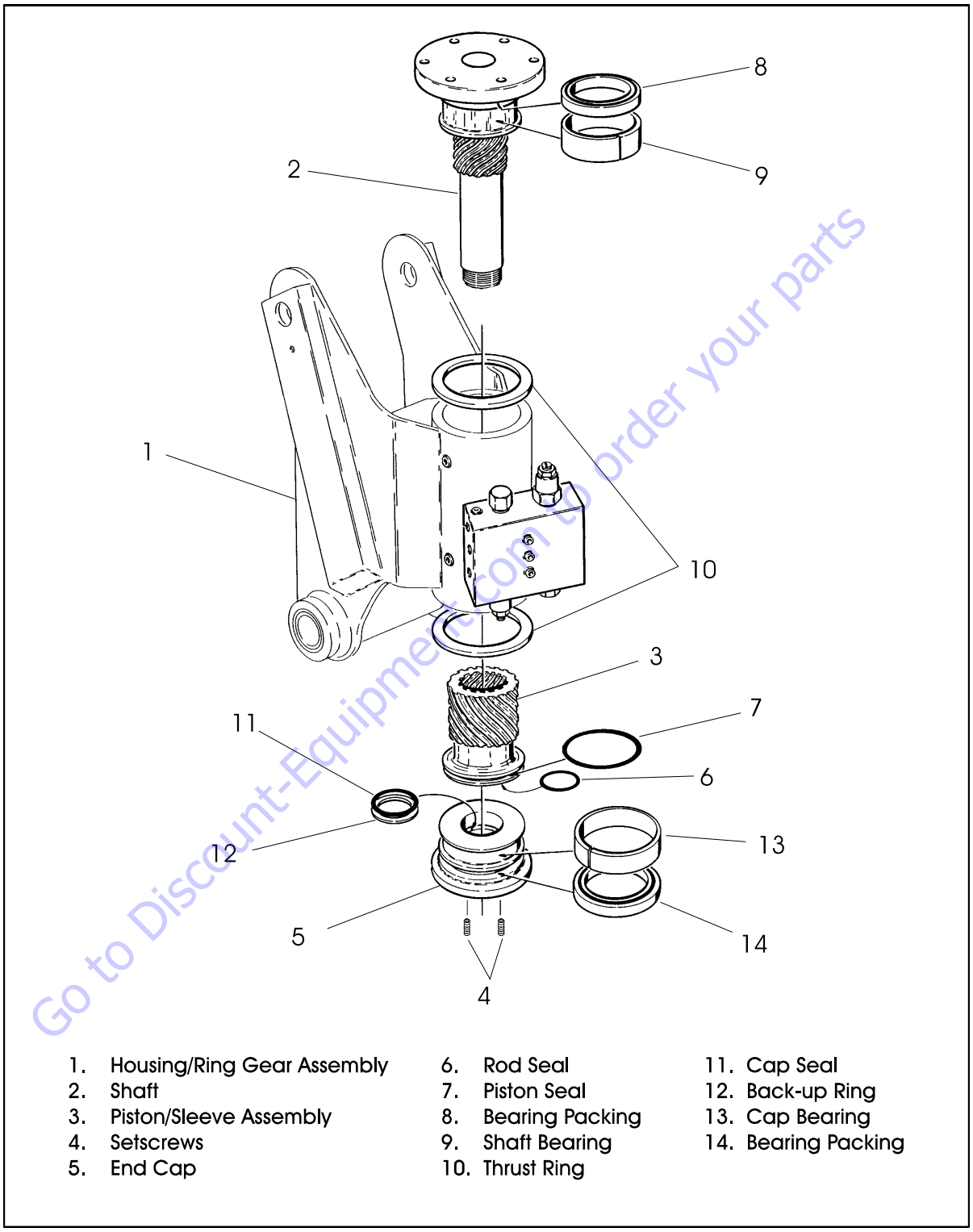


4. Using a torch, apply heat to the setscrews on the bottom of actuator.



5. Remove the two (2) setscrew (4) from bottom of actuator (1). Discard setscrew.

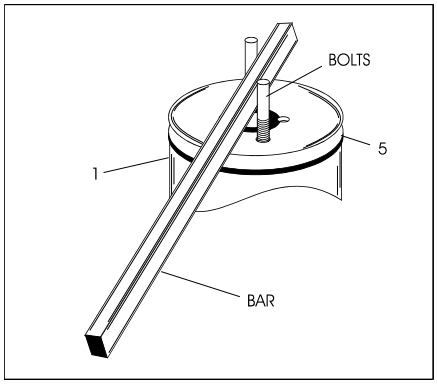




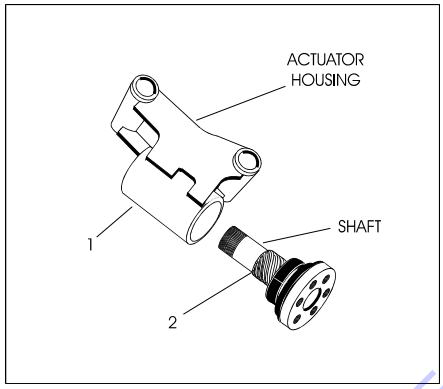
1. Housing/Ring Gear Assembly
2. Shaft
3. Piston/Sleeve Assembly
4. Setscrews
5. End Cap
6. Rod Seal
7. Piston Seal
8. Bearing Packing
9. Shaft Bearing
10. Thrust Ring
11. Cap Seal
12. Back-up Ring
13. Cap Bearing
14. Bearing Packing

Figure 4-27. Rotator Assembly

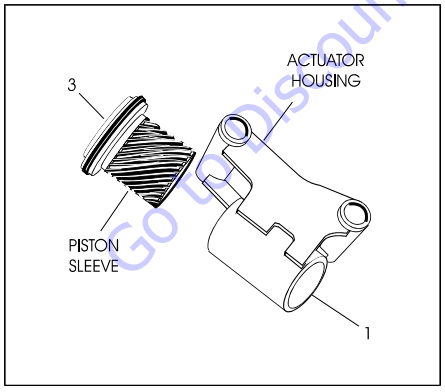
6. Place two (2) 3/8"x16NC bolts in threaded holes in bottom of the actuator. Using a suitable bar, unscrew the end cap (5). Remove the end cap from actuator (1).



7. Remove the shaft (2) from piston sleeve (3) and the actuator housing (1).



8. Remove piston sleeve (3) from housing (1).



9. Remove all seals and bearings from grooves. Discard seals.

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.

NOTE: *A small amount of wear in the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about 0.005 in. per mating set. After long service, a backlash of about 0.015 per set may still be acceptable in most cases, depending on the required accuracy of the application.*

3. Check the ring gear for wear and weld damage to the pins.
4. Inspect the cylinder bore for wear and scratches.

Assembly

NOTE: *Lubricate all seals and o-rings with clean hydraulic oil prior to assembly.*

1. Install new seal (7) and bearing (6) on the piston sleeve (3).

NOTE: *Apply a coat of grease to the thrust ring before sliding onto the shaft.*

2. Install new seal (8), thrust ring (10) and bearing (9) on shaft (2).

NOTE: *Apply a coat of grease to the thrust ring before sliding onto the end cap.*

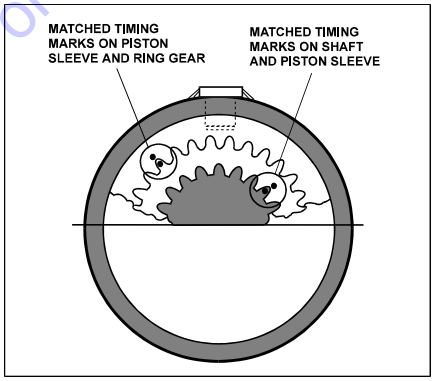
3. Install new seals (11), backup ring (12), cap bearing (13), bearing packing (14) and thrust ring (10) on end cap (5).
4. Place the actuator in the vertical position, install the piston sleeve (3) in timed relation to the housing (1).

⚠ CAUTION

DO NOT MISALIGN THE SLEEVE TOO MUCH ANY ONE WAY, AS IT WILL MARK THE CYLINDER BORE.

NOTE: *The timing marks (the small punch marks on the face of each gear), must be aligned for proper shaft orientation. (See Actuator Timing.)*

5. Install the shaft (2) into housing (1) by aligning the proper punched timing marks (See Actuator Timing).
6. Temporarily tape the threaded portion of the shaft will help installation past the shaft seals (masking tape).
7. The end cap (5) is torqued to 40 - 50 ft. lbs. (54 - 68 Nm), such that the actuator begins rotation at approximately 100 psi (6.895 Bar) pressure.
8. The end cap must be secured against the shaft by installing axial set screws (4).



4.17 ROTATOR ASSEMBLY

Theory of Operation

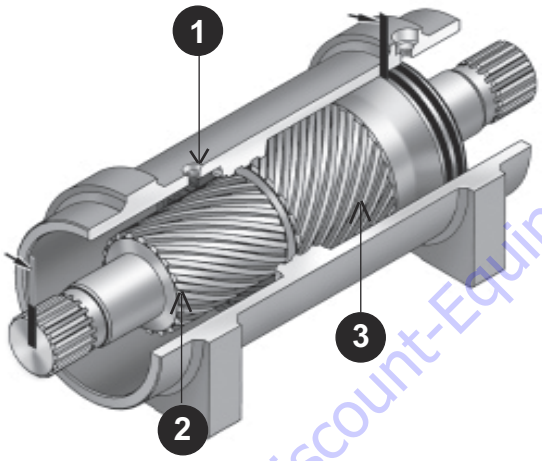
The rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert axial piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear ring (1) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (2), and the annular piston sleeve (3). 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 with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing similar to the operation of a hydraulic cylinder while the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the housing, preventing piston movement and locking the shaft in position.

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

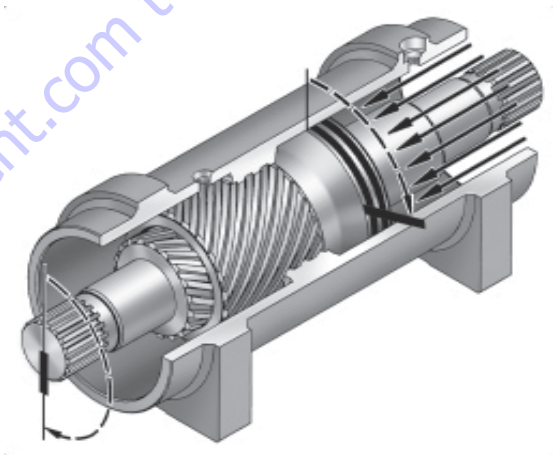
The actuators are equipped with factory installed counterbalance valves, which performs four major functions.

- 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



Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.



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

Required Tools

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

1. PIPE VISE
2. HEX WRENCH - Removal and replacement of port plugs and setscrews.
3. ASSORTED SCREWS
4. SAFETY GLASSES
5. END CAP REMOVAL TOOLS (provided with Helac seal kit).
6. DRILL
7. FLASHLIGHT - Helps to locate and examine 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 the timing marks and outline troubled areas.
12. T-HANDLE SCREW EXTRACTOR
13. HEX WRENCH SET - Removal and replacement of port plugs and setscrews (106 &110).
14. SEAL TOOLS - Removal and installation of seals and wear guides. Directions to make a seal tool are provided below Making a Seal Tool
15. PUNCH
16. DOWEL PINS - Removal and installation of end cap.

Making a Seal Tool

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

⚠ CAUTION

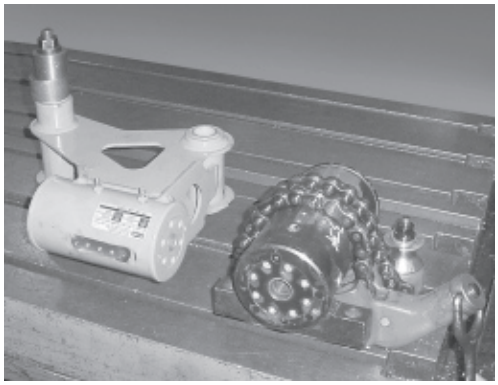
TO AVOID INJURY BE CAREFUL WHILE HANDLING THE HOT SCREWDRIVER.

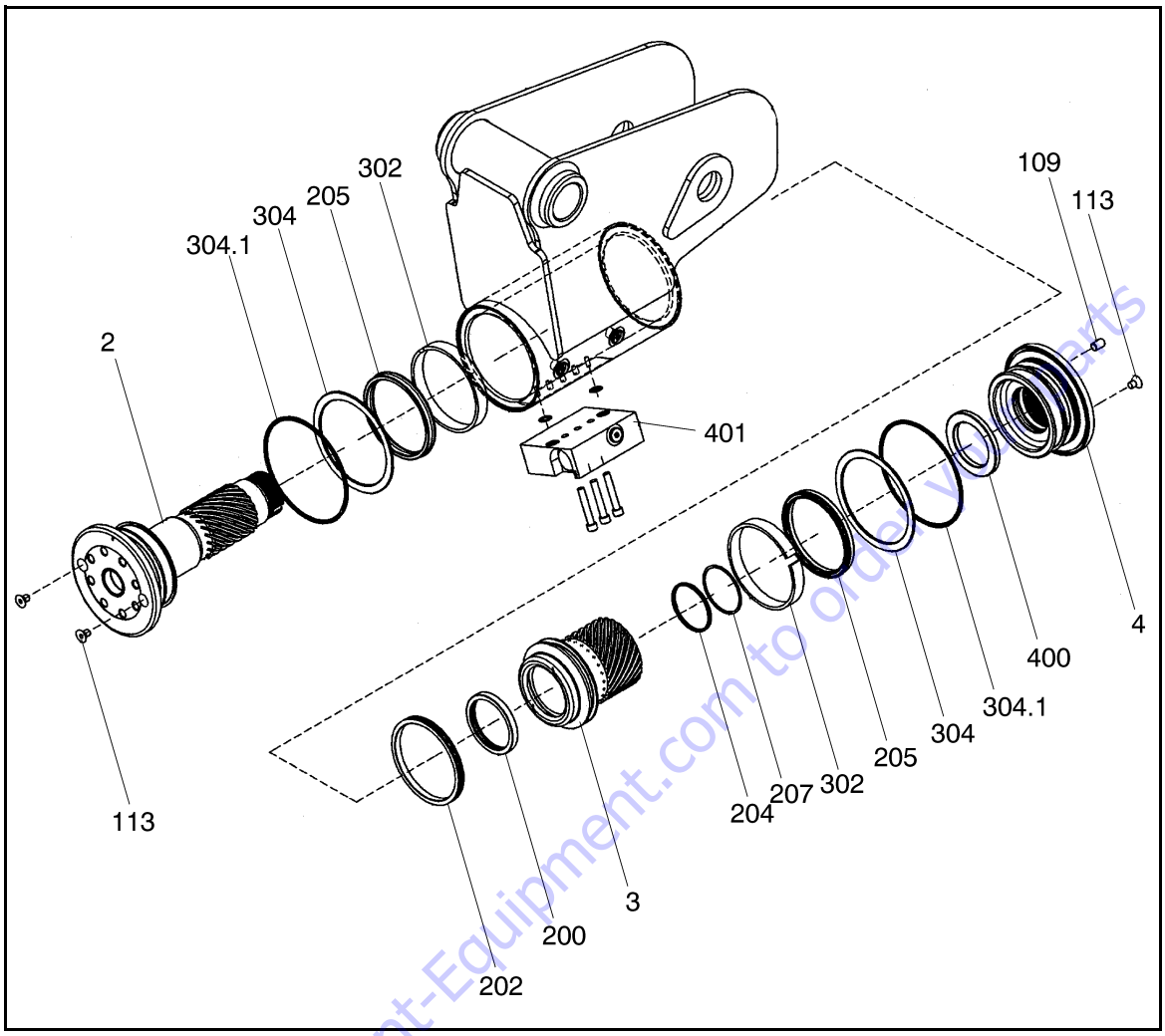
1. Heat the flat end with a torch until it glows.
2. Secure the heated end of the screwdriver in a vise and bend the heated end to a slight radius.
3. Round off all sharp edges of the heated to a polished finish. The tool may be modified slightly to your own personal preference.To avoid injury be careful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

Before 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 disassembly.

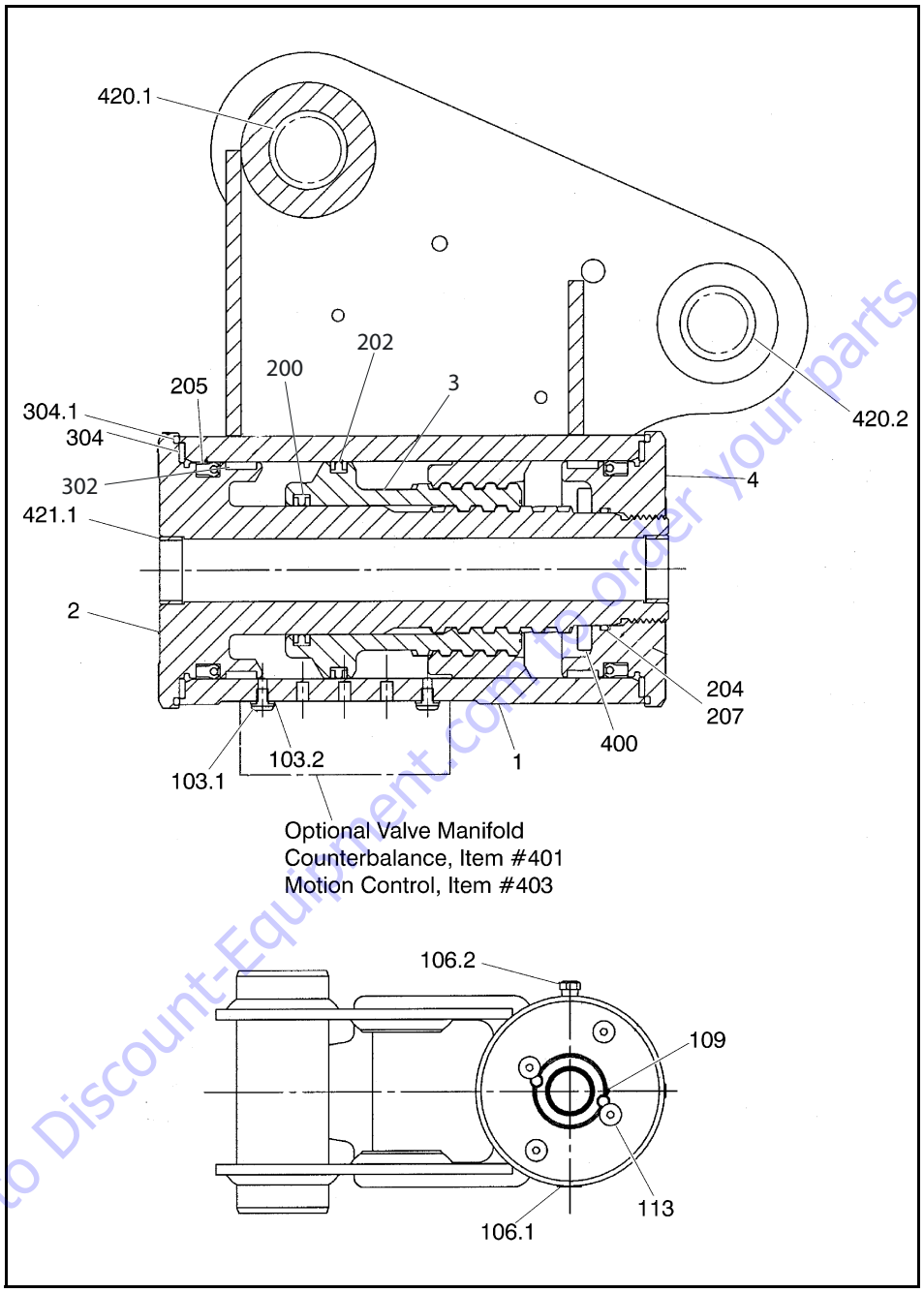
Disassembly is considerably easier if the actuator is firmly secured to the work bench. A pipe vise or mounting fixture work well.





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 4-28. Rotator - Exploded View



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

Figure 4-29. Rotator - Assembly Drawing

Disassembly

⚠ CAUTION

TO AVOID INJURY OR DAMAGE TO PRODUCT: SECURE PRODUCT TO SLOTTED TABLE OR VISE.

⚠ CAUTION

SPRAYING FLUIDS. CONTENT UNDER PRESSURE. WEAR APPROVED EYE PROTECTION. USE CAUTION WHEN REMOVING PORT PLUGS AND FITTINGS.

NOTICE

MAKE SURE WORK AREA IS CLEAN.

1. Remove port plugs (106.1 & 106.2) and drain oil. Inspect oil for signs of contamination, i.e. water, metal shavings.
2. Remove the cap screws (113) over end cap lock pins (109).

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

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

NOTE: *If the pin will not come out with the "Easy Out", use 5/1 6 in. drill bit to a depth of 1/2 in. (12.7 mm) to drill out the entire pin. Do not drill deeper than 1/2 in. (12.7 mm).*

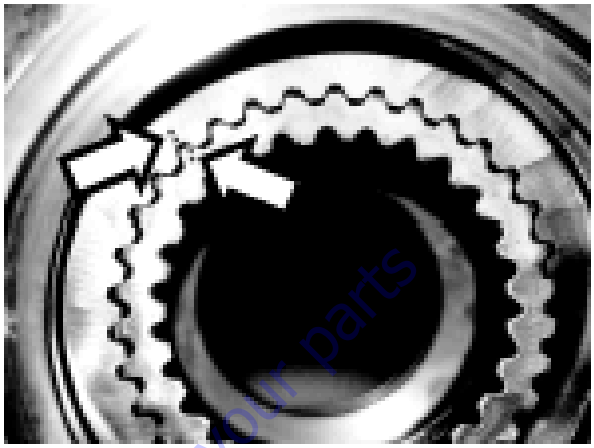
5. Install the end cap (4) removal tools provided with the Helac seal kit.

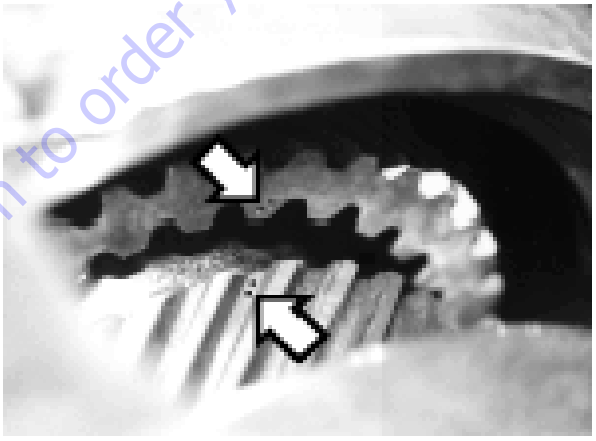
6. Using a metal bar, or similar tool, unscrew the end cap (4) by turning it counter clockwise.

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

8. Remove the stop tube if equipped with one. The stop tube is an available option to limit the rotation of the actuator.

9. Every actuator has timing marks for proper engagement.



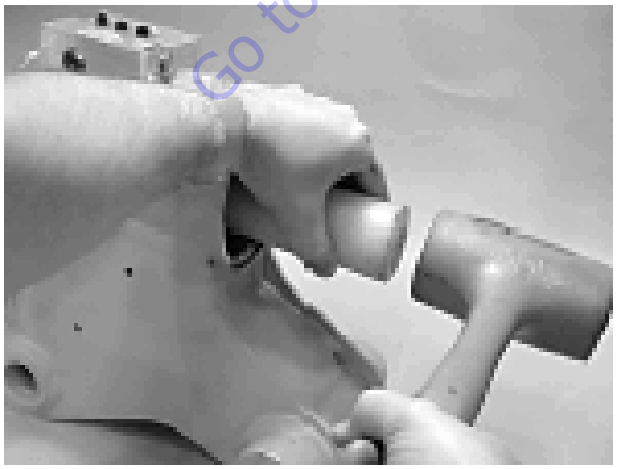


10. Prior to removing the shaft (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.

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

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

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

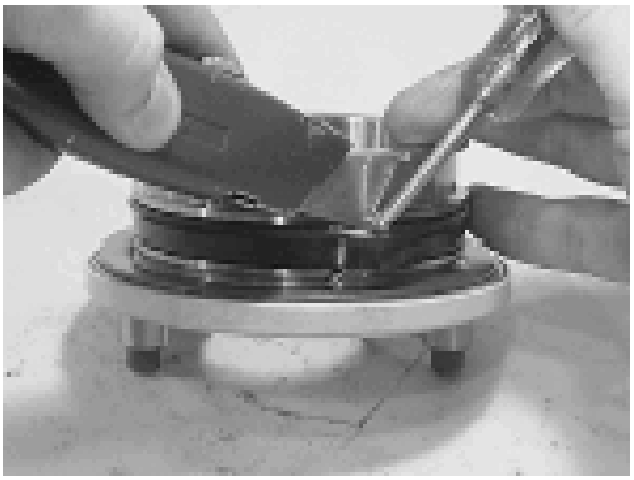


14. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.

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

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

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



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

19. Remove the wiper seal (304.1) from it's groove in the end cap (4) and shaft (2).

20. Remove the piston O.D. seal (202) from the piston.

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

Inspection

NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

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

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

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

Assembly

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

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

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

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

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

6. Install the O-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).

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

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

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

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

   Repeat this step for the outer seal (202).

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

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

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

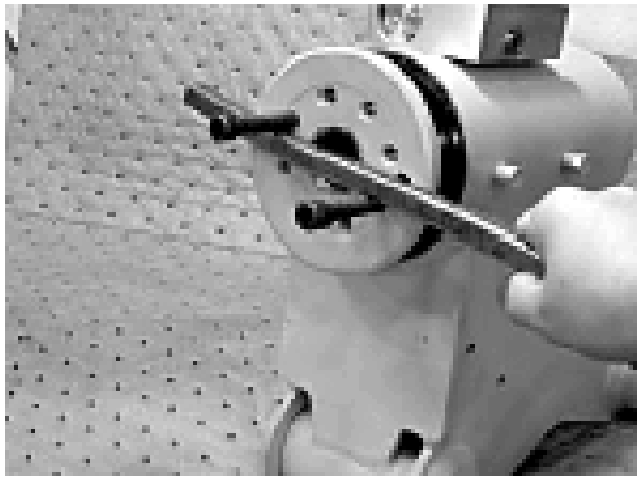
11. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.

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

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

NOTICE

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



14. Install the stop tube (400) onto the shaft end, if equipped. Stop tube is 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) end. 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). In most cases the original holes for the lock pins will line up.

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

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

Installing Counterbalance Valve

Refer to Figure 4-30., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old JLG Threadlocker P/N 0100011.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. JLG Threadlocker P/N 0100011 should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4 in. bolts 110-120 in. lbs. (12.4-13.5 Nm). Do not torque over 125 in. lbs. (14.1 Nm). Torque the 5/16 in. bolts to 140 in. lbs. (15.8 Nm). Do not torque over 145 in. lbs. (16.3 Nm).
5. Make sure the valve is seated against the housing valve flat. If it is raised up on any side or corner, remove the valve to determine what the obstruction is. If possible, test this using a hydraulic hand pump or electric test.

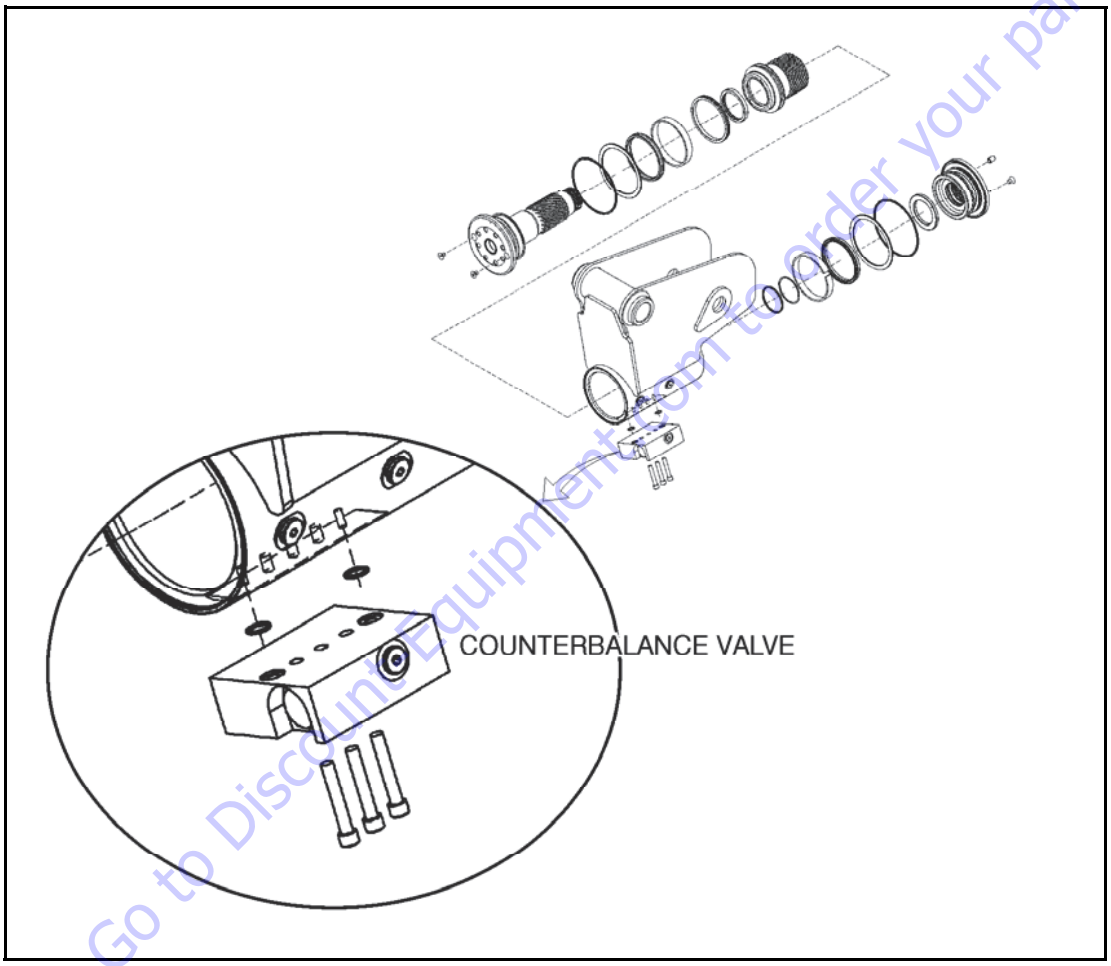


Figure 4-30. Rotator Counterbalance Valve

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.

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

NOTICE

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

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

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.

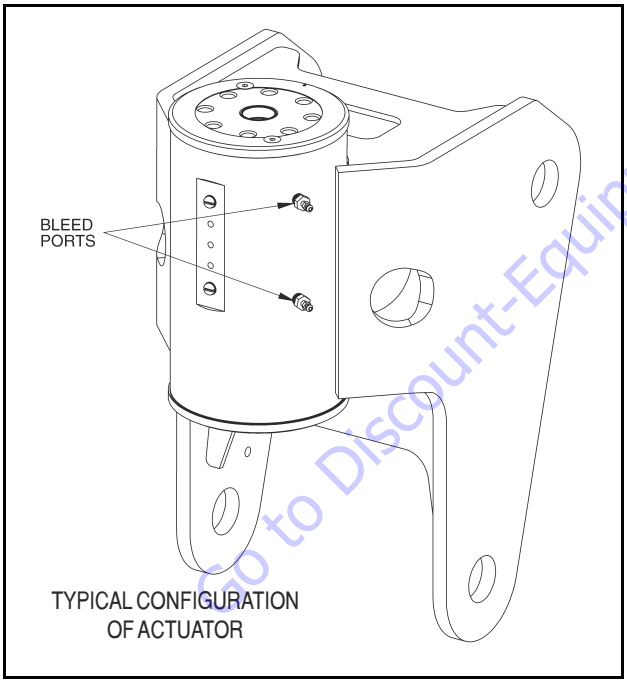
Installation and Bleeding

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 in. inside diameter x 5/16 in. 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.

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.
	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 (Standard actuators only)	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 overload conditions	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 during stroke	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.
	c. Air in actuator	c. Purge air from actuator. See bleeding procedures

4.18 FOOT SWITCH ADJUSTMENT

Adjust so that functions will operate when pedal is at center of travel. If switch operates within last 1/4 in. (6.35 mm) of travel, top or bottom, it should be adjusted.

4.19 BOOM SYNCHRONIZING PROCEDURE

NOTE: *If the Lower Boom assembly does not fully lower:*

1. Remove all personnel from the platform.
2. Pull the red knob located under the manual descent control valve.
3. From Ground Control, activate the lift control switch, raise Lower Boom 6 feet (1.83 m).
4. After raising Lower Boom, release the red knob.
5. Activate Lower Boom Down, fully lower boom.
6. Repeat step 1 thru 5 if necessary.

4.20 SKYGUARD

Operation

Skyguard is used to provide enhanced control panel protection. When the SkyGuard sensor is activated, functions that were in use at the time of actuation will reverse or cutout. The table below outlines these functions.

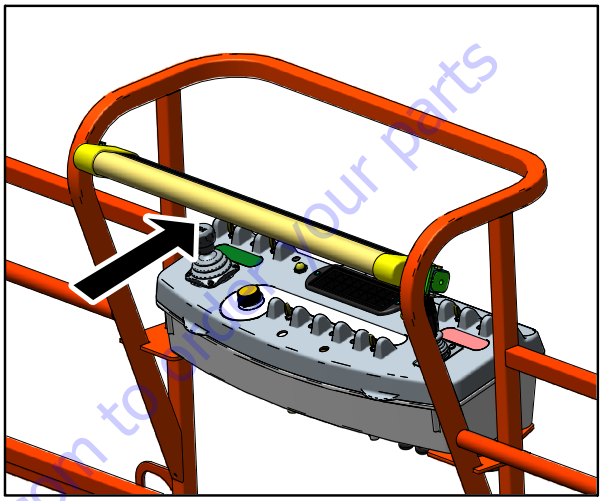


Figure 4-31. Skyguard

Functional Test

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "SKYGUARD" IS SELECTED IN MACHINE SET UP.

In Platform Mode:

1. In an area free of obstructions, from the platform controls test the SkyGuard feature by operating the telescope out functions and engaging (and holding) the SkyGuard sensor. Telescope function will be stopped and telescope in function will be activated for a short duration. Soft touch indicator light will flash at 3HZ, horn will be turned on, until the SkyGuard sensor and footswitch is disengaged.

2. With SkyGuard sensor engaged, press and hold the yellow "Override Soft Touch" button and then operate a function switch or joystick to check if the operation can be resumed.

3. Disengage the SkyGuard sensor, release controls, recycle the foot switch, make sure normal operation available.

In Ground Mode:

Operation will be allowed regardless of SkyGuard sensor activation.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "BOTH" IS SELECTED.
In Platform Mode:

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

1. In an area free of obstructions, from platform controls test the SkyGuard feature by operating the telescopic out functions and engaging the SkyGuard sensor, telescopic out function will be stopped, soft touch indicator light will flash at 3HZ, the horn will be turned on until the SkyGuard sensor and footswitch is disengaged.
2. With SkyGuard sensor engaged, press and hold the yellow "Override Soft Touch" button and then operate a function switch or joystick to check if the operation can be resumed.
3. Disengage the SkyGuard sensor, release controls, recycle the foot switch, make sure normal operation is available.

In Ground Mode:

Operation will be allowed regardless of SkyGuard switch activation.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "SOFT TOUCH" IS SELECTED.
Machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "NONE" IS SELECTED.
Skyguard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostic & Troubleshooting

If you are experiencing a problem that is not described here, see your authorized dealer for service.

1. Check the configuration under the menu "MACHINE SETUP → STOUCH/SKYGUARD" according to the actual system installed on machine. Make sure recommended configuration described is selected.

If SkyGuard Does Not Function with sensor engaged.

⚠ CAUTION

AUTHORIZED TECHNICIAN OR OPERATOR IS REQUIRED TO CONDUCT AN OPERATION CHECK OF SKYGUARD SENSOR DAILY.

Help menu or diagnostics menu is to be used to collect the fault information.

Depending on configurations, diagnostics menu will read:

Diagnostics->System->Skyguard switch

Diagnostics->System->STOUCH OR SG

Pressing to engage the SkyGuard sensor will change the switch or relay to open/close status.

If the switch status stays in "Open" while the actual SkyGuard sensor is pressed, then the SkyGuard sensor may have failed, it needs to be changed immediately.

2. **If machine operation is not available:**

Help menu or diagnostics menu is to be used to collect the fault information.
Depending on configuration, diagnostics menu will read:

Diagnostics->System->Skyguard switch

Diagnostics->System->STOUCH OR SG

Pressing to engage the SkyGuard sensor will change the switch or relay to open/close status.

If the switch status states “Closed” regardless of sensor activation status:

Power or ground wire is not making good contact and/ or may be loose or broken.

Both relays failed (low probability).

If the switch status is in disagreement, then one relay may have failed or one relay isn't inserted into the holder correctly. This may also be noticed since machine will not be able to be operated.

Switch disagreement fault (2563) and SkyGuard switch activation fault (0039) will be shown under Help menu.

Table 4-2. SkyGuard Function Table

Main Lift	Main Tele In	Main Tele Out	Swing	Drive Forward		Drive Reverse		Tower Lift Up	Tower Lift Down	Platform Level	Platform Rotate	Jib Lift
				DOS Enabled	DOS Not Enabled	DOS Enabled	DOS Not Enabled					
R	C	R	R	R	C*	R	R	R	C	C	C	C
R = Indicates Reversal is Activated												
C = Indicates Cutout is Activated												
* Disregard when boom is in line and driving forward with or without steering and no other function active.												
NOTE: *When Soft Touch is enabled with SkyGuard all functions are cut out only.*												

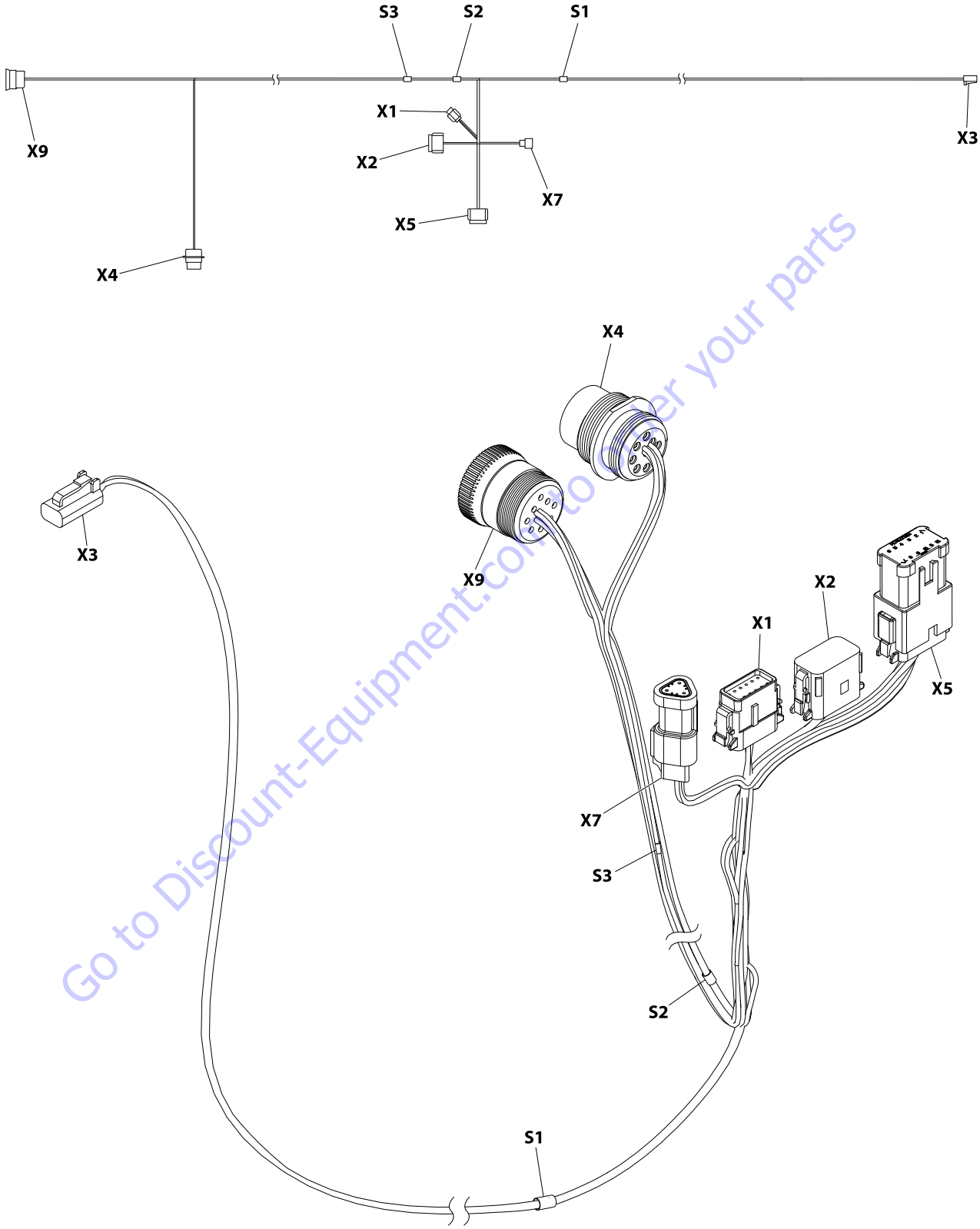
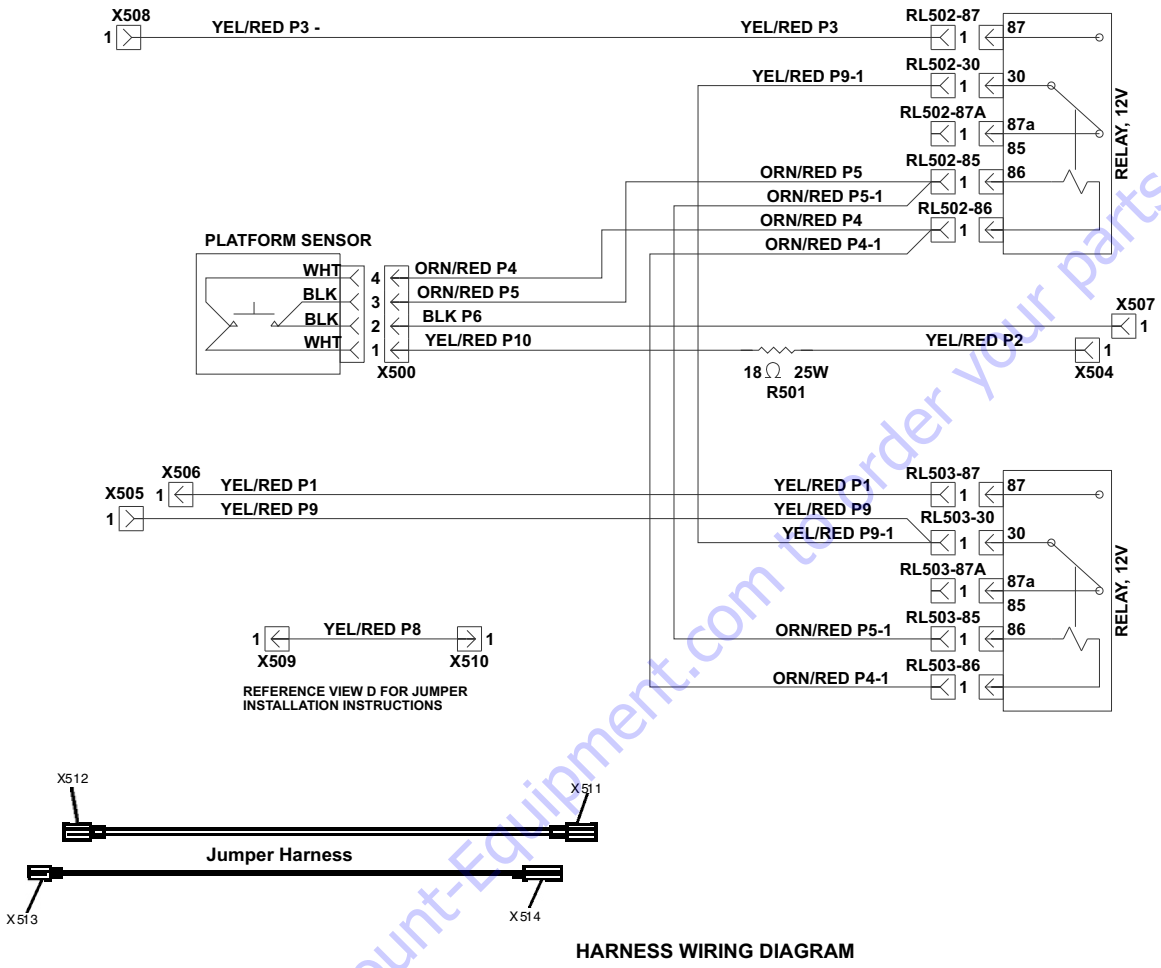


Figure 4-32. SkyGuard Harness



HARNESS WIRING DIAGRAM

Figure 4-33. SkyGuard Harness Wiring Diagram

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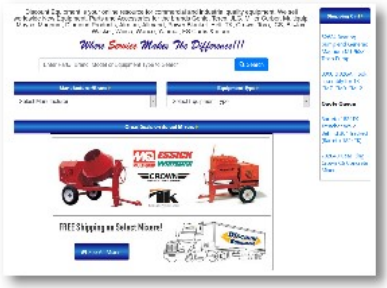

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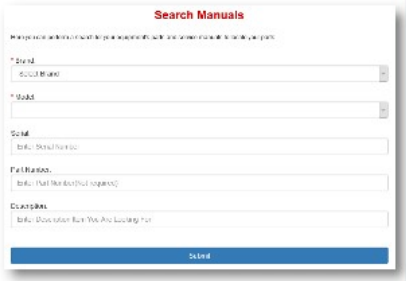

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SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

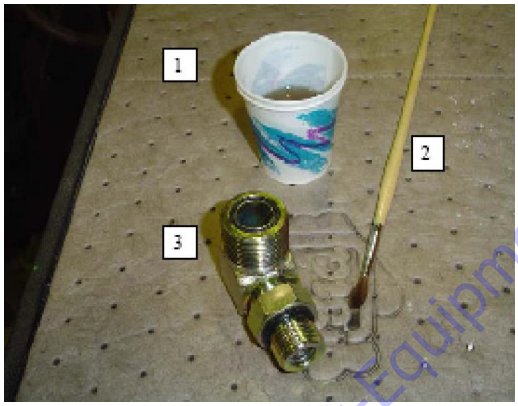
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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.

Dip Method

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

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

- A small leak proof container
- Sponge cut to fit inside the container
- A small amount of hydraulic oil to saturate the sponge.

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

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

Spray Method

This method requires a pump or trigger spray bottle.

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

Brush-on Method

This method requires a sealed bottle brush.

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

5.2 CYLINDERS - THEORY OF OPERATION

Systems Incorporating Double Acting Cylinders

Cylinders are of the double acting type, a double acting cylinder is one that requires oil flow to operate the cylinder rod in both directions. Directing oil (by actuating the corresponding control valve to the piston side of the cylinder) forces the piston to travel toward the rod end of the barrel, extending the cylinder rod (piston attached to rod). When the oil flow is stopped, movement of rod will stop. By directing oil to the rod side of the cylinder, the piston will be forced in the opposite direction and the cylinder rod will retract. Systems incorporating double acting cylinders are as follows:

- Tower Lift
- Tower Telescope
- Slave Level/Main Level
- Main Lift
- Main Telescope
- Master Level/Upright Level
- Jib Boom Lift
- Steer and Axle lockout

Systems Incorporating Holding Valves

Holding valves are used in the - Tower Lift, Tower Telescope, Upright Level, Lockout, Jib Boom Lift, Main Lift/Slave Level and Main Telescope circuits to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its related control valve.

5.3 CYLINDER CHECKING PROCEDURE

NOTE: *Cylinder check must be performed every time a system component is replaced or when an improper system operation is suspected.*

Cylinders Without Counterbalance Valves - Master Cylinder and Steer Cylinder

1. Using all applicable safety precautions, activate engine and fully extend cylinder to be checked. Shut down engine.
2. Carefully disconnect hydraulic hoses from retract port of cylinder. There will be some initial weeping of hydraulic fluid which can be caught in a suitable container. After the initial discharge, there should be no further drainage from the retract port.
3. Activate engine and extend cylinder.
4. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to port and retract cylinder. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repair must be made.
5. With cylinder fully retracted, shut down engine and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate engine and retract cylinder. Check extend port for leakage.
7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, than activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.

Cylinders With Single Counterbalance Valve

Main Lift Cylinder

NOTICE

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

1. Using all applicable safety precautions, activate hydraulic system.

⚠ WARNING

WHEN WORKING ON THE MAIN LIFT CYLINDER, RAISE THE BOOM TO HORIZONTAL AND PLACE A BOOM PROP APPROXIMATELY 1 INCH (2.54 CM) BELOW THE MAIN BOOM. DO NOT WORK ON THE CYLINDER WITHOUT A SUITABLE PROP IN PLACE.

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with bang-bang or proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.
3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the counterbalance valve is defective and must be replaced.
4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.
5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.
6. If used, remove lifting device from upright or remove prop from below main boom, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

Cylinders With Dual Counterbalance Valves

Jib Boom Lift, and Slave), Slave Level, Tower Lift, Upright level, Main Telescope and Tower Telescope.

NOTICE

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

1. Using all applicable safety precautions, activate hydraulic system.

⚠ WARNING

IF WORKING ON THE TOWER BOOM LIFT CYLINDER, RAISE TOWER BOOM HALFWAY, FULLY ELEVATE MAIN BOOM WITH TELESCOPE CYLINDER FULLY RETRACTED AND ATTACH AN OVERHEAD CRANE TO THE UPRIGHT FOR SUPPORT, LEAVING APPROXIMATELY 1 INCH (2.54 CM) OF SLACK IN CHAIN OR SLING FOR TEST PURPOSES. IF WORKING ON THE UPRIGHT LEVEL, RAISE THE TOWER BOOM HALFWAY, THEN RAISE MAIN BOOM TO HORIZONTAL AND POSITION A SUITABLE BOOM PROP APPROXIMATELY 1 INCH (2.54 CM) BELOW MAIN BOOM. IF WORKING ON THE PLATFORM LEVEL CYLINDER, STROKE PLATFORM LEVEL CYLINDER FORWARD UNTIL PLATFORM SITS AT A 45 DEGREES ANGLE. HYDRAULIC CYLINDERS

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with bang-bang or proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.
3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the counterbalance valve is defective and must be replaced.
4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.
5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.
6. If used, remove lifting device from upright or remove prop from below main boom, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

5.4 HYDRAULIC CYLINDERS

Axle Lockout Cylinder (USA Built Machines SN 0300087000 through 0300089731)

DISASSEMBLY

NOTICE

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

⚠ WARNING

ROD CAN FALL OUT OF BARREL AND CAUSE INJURY OR DAMAGE TO THE EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE ROD TO FALL OUT OF BARREL.

1. Open bleeder valve. Rotate rod and remove from barrel.
2. Remove two wear rings, wiper seal and rod seal from grooves of barrel bore. Do not scratch barrel bore.
3. Remove counterbalance valve.

CLEANING AND INSPECTION

1. Inspect bore and rod for scoring, pitting, or excessive wear.
2. Remove minor surface blemishes with wet sandpaper. Pitting requires replacement of barrel and rod.
3. Clean all parts with approved solvent and dry with compressed air.

ASSEMBLY

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

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

NOTICE

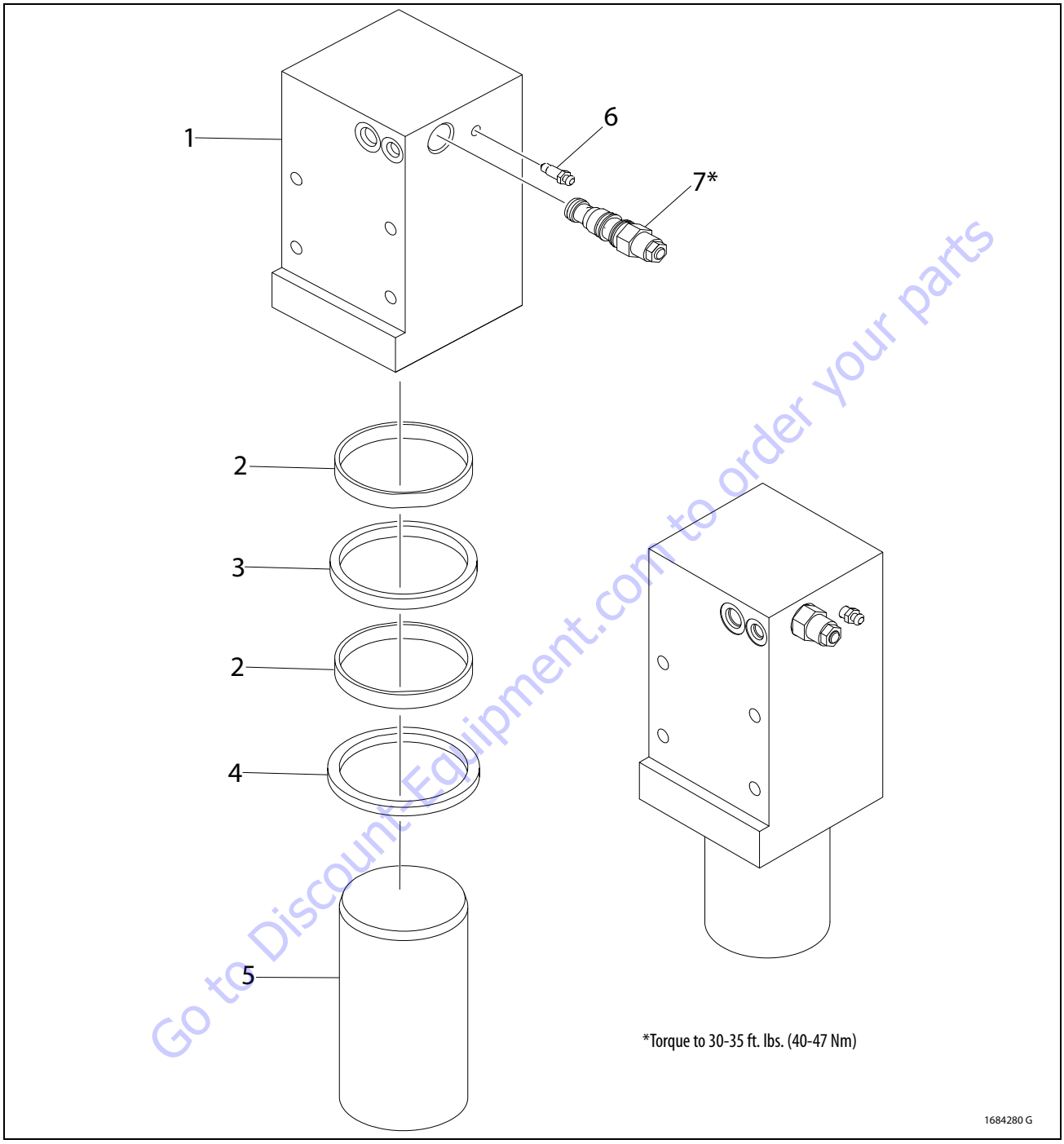
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

1. Install two new wear rings, wiper seal and rod seal in barrel bore grooves. Make sure they are not twisted.
2. Lubricate rod bore with clean hydraulic fluid.

NOTICE

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

3. Insert and push the rod into top of barrel bore, rotate to install the rod into barrel bore.
4. Install counterbalance valve. Torque to 30-35 ft. lbs. (40-47 Nm).
5. Bleed system.



1. Barrel
2. Wear Ring
3. Rod Seal
4. Wiper Seal
5. Rod
6. Bleeder Valve
7. Counterbalance Valve

Figure 5-1. Axle Lockout Cylinder (USA Built Machines SN 0300087000 through 0300089731)

Axle Lockout Cylinder (USA Built Machines SN 0300089732 through 0300177361 and China Built Machines SN B300000100 to Present)

DISASSEMBLY

NOTICE

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

⚠ WARNING

ROD CAN FALL OUT OF BARREL AND CAUSE INJURY OR DAMAGE TO THE EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE ROD TO FALL OUT OF BARREL.

1. Remove plug and pilot piston from the barrel.
2. Open bleeder valve. Rotate rod and remove from barrel.
3. Remove two wear rings, wiper seal and rod seal from grooves of barrel bore. Do not scratch barrel bore.
4. Remove counterbalance valve.

CLEANING AND INSPECTION

1. Inspect bore and rod for scoring, pitting, or excessive wear.
2. Remove minor surface blemishes with wet sandpaper. Pitting requires replacement of barrel and rod.
3. Clean all parts with approved solvent and dry with compressed air.

ASSEMBLY

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

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

NOTICE

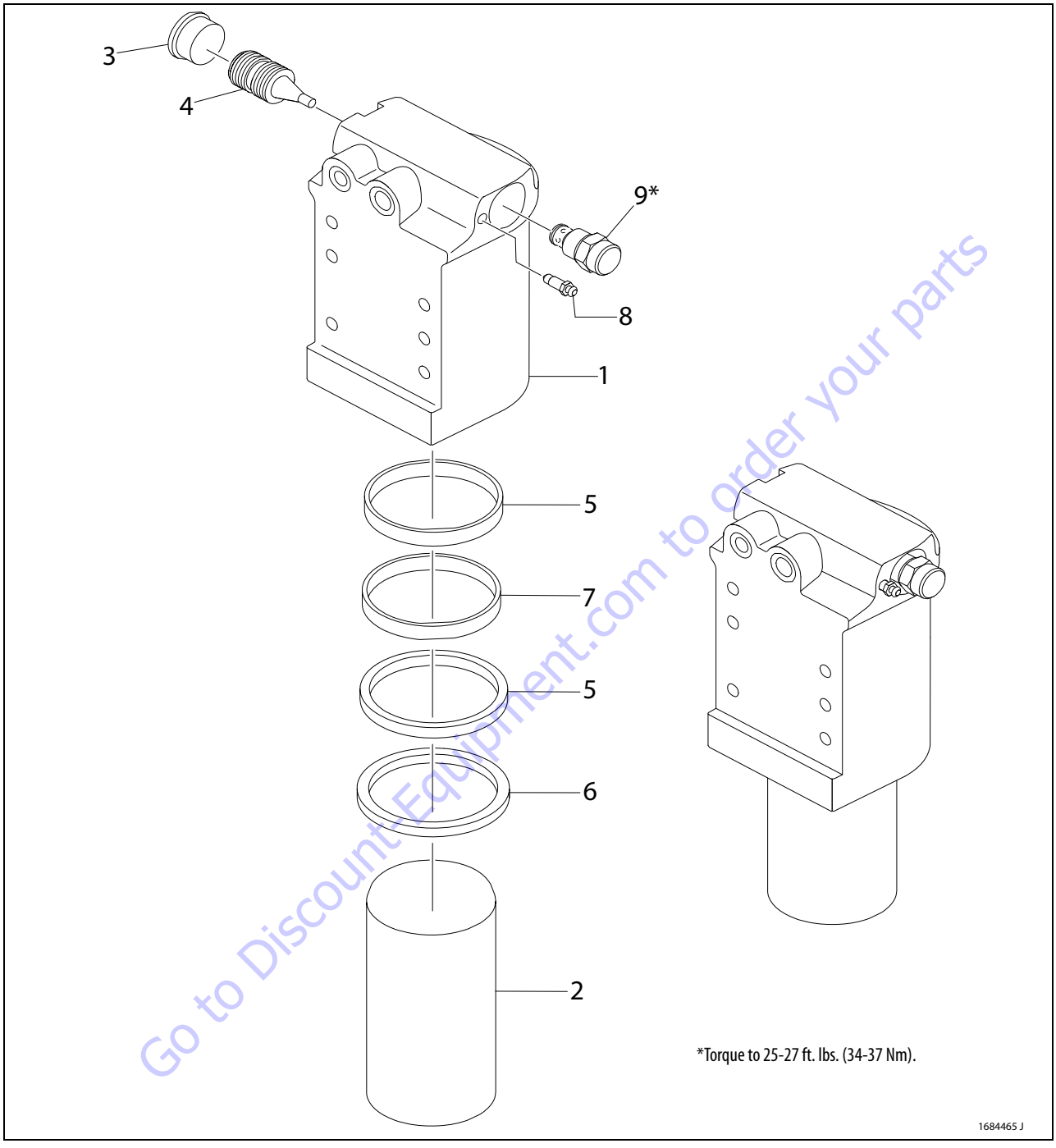
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

1. Install two new wear rings, wiper seal and rod seal in barrel bore grooves. Make sure they are not twisted.
2. Lubricate rod bore with clean hydraulic fluid.

NOTICE

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

3. Insert and push the rod into top of barrel bore, rotate to install the rod into barrel bore.
4. Install counterbalance valve. Torque to 25-27 ft. lbs. (34-37 Nm).
5. Install plug and pilot piston into the barrel.
6. Bleed system.



1. Barrel
2. Rod
3. Plug
4. Pilot Piston
5. Wear Ring
6. Wiper Seal
7. Rod Seal
8. Bleeder Valve
9. Counterbalance Valve

Figure 5-2. Axle Lockout Cylinder (USA Built Machines SN 0300089732 through 0300177361 and China Built Machines SN B300000100 to Present)

Platform Level Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove counterbalance valves and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

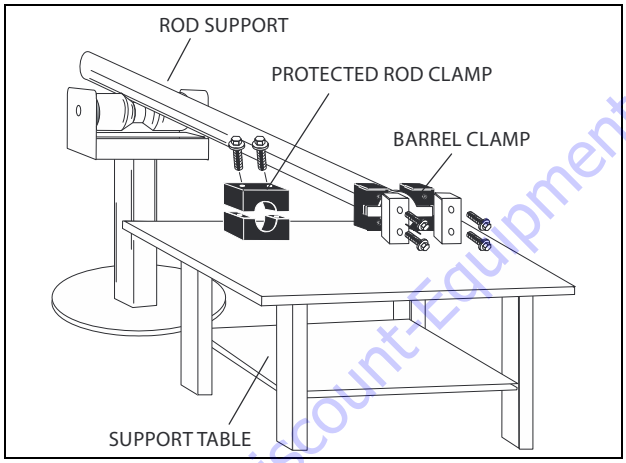


Figure 5-3. Cylinder Barrel Support

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

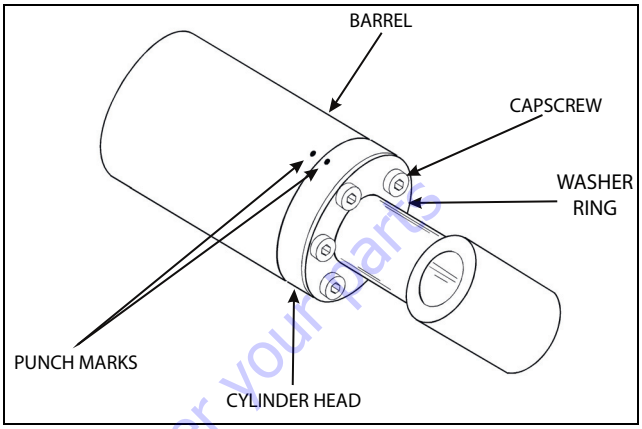


Figure 5-4. Capscrew Removal

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

NOTICE

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

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

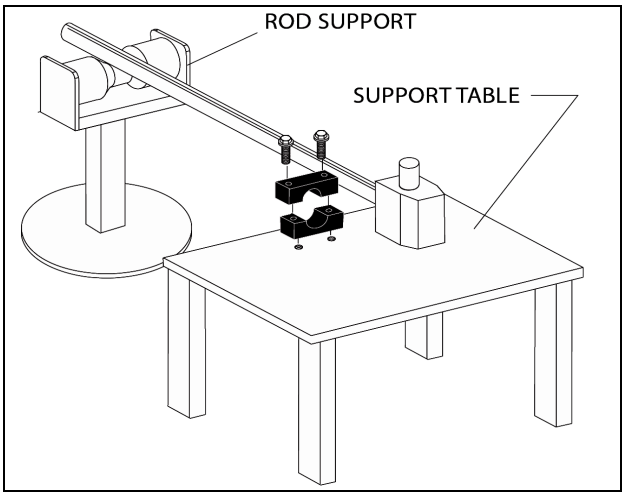
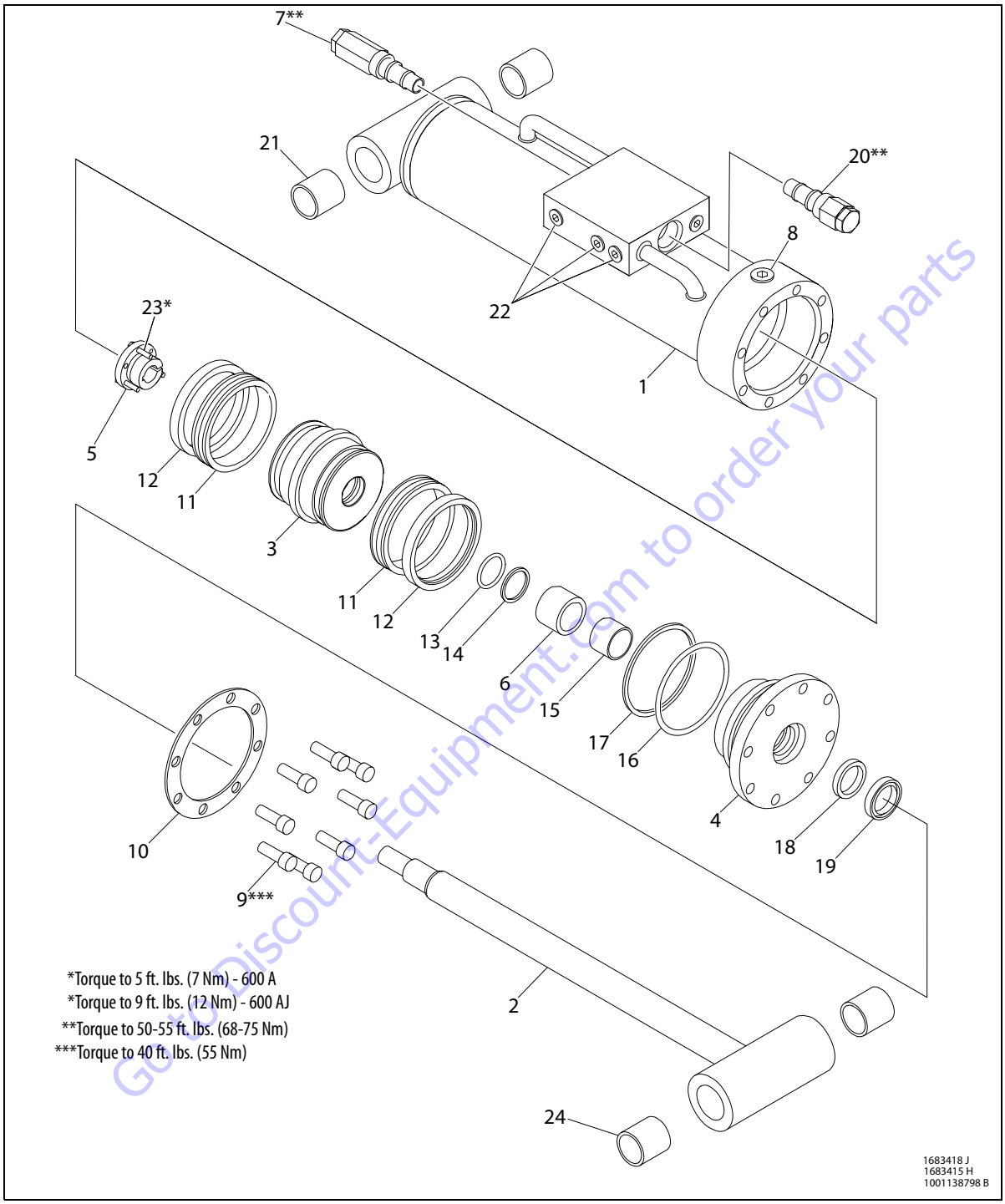


Figure 5-5. Cylinder Rod Support



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

Figure 5-6. Platform Level Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled hole.
10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

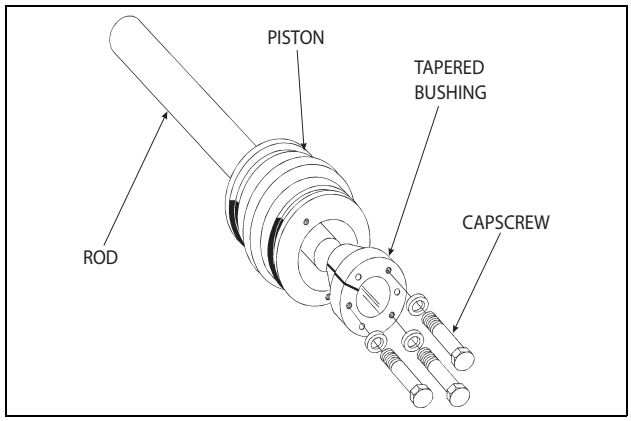


Figure 5-7. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-ring, backup ring, hydrolock seals and guidelock rings.
14. Remove piston spacer from the rod.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, rod seal, wear ring and wiper seal.

CLEANING AND INSPECTION

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

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

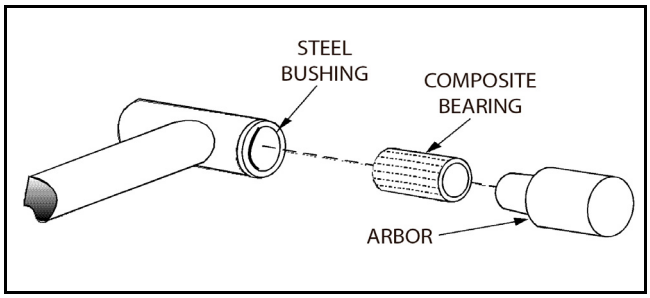


Figure 5-8. Composite Bearing Installation

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

ASSEMBLY

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

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

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

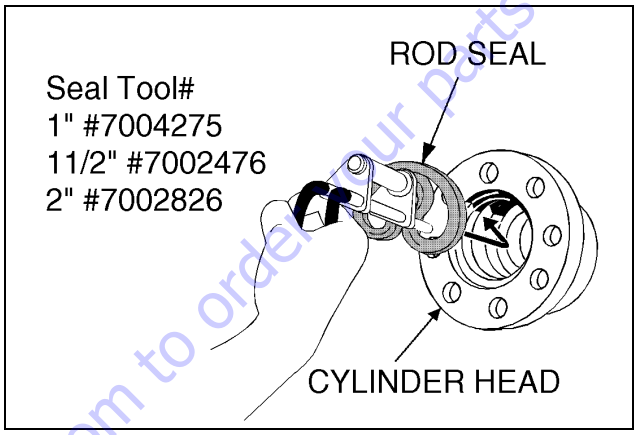


Figure 5-9. Rod Seal Installation

NOTICE

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

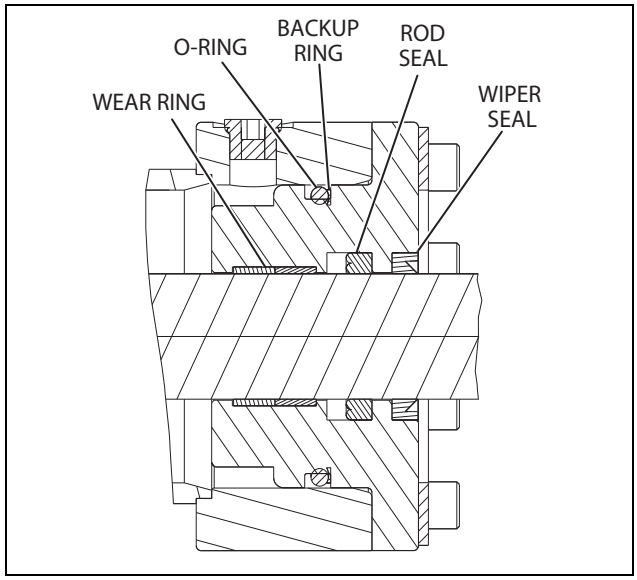


Figure 5-10. Cylinder Head Seal Installation - 600A

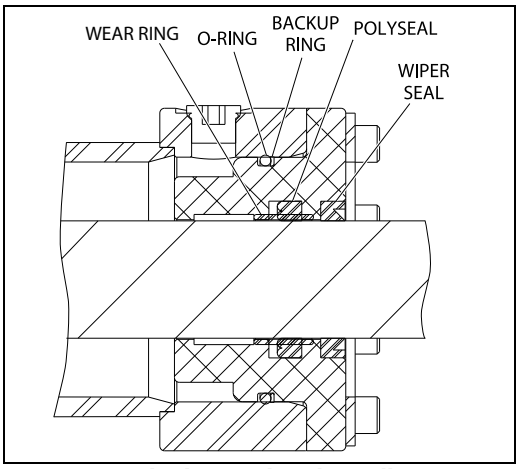


Figure 5-11. Cylinder Head Seal Installation - 600AJ

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

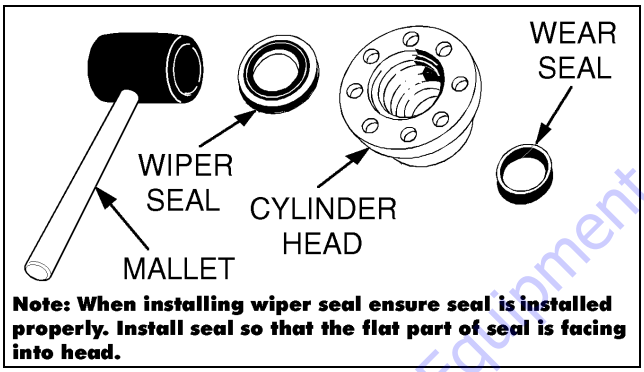


Figure 5-12. Wiper Seal Installation

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

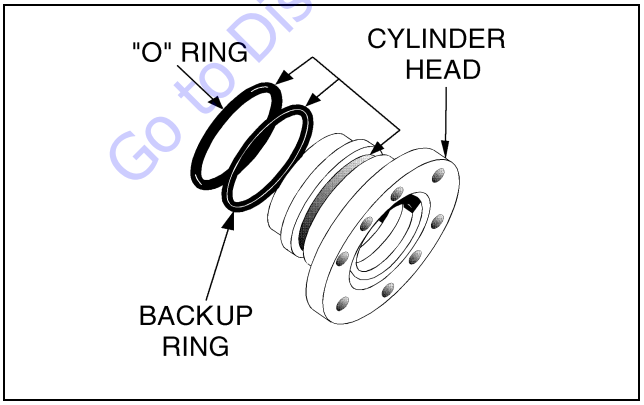


Figure 5-13. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the piston spacer on rod.
6. Using suitable support, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
7. Place a new o-ring and backup ring in the inner piston diameter groove.
8. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring and backup ring are not damaged or dislodged.
9. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

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

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

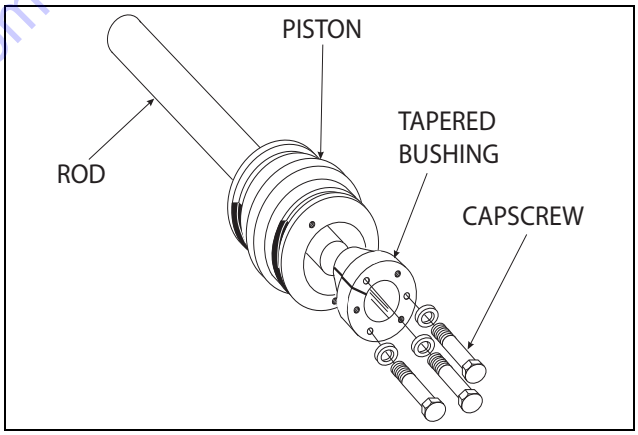


Figure 5-14. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm) for 600A and 9 ft. lbs. (12 Nm) for 600AJ.

12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

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

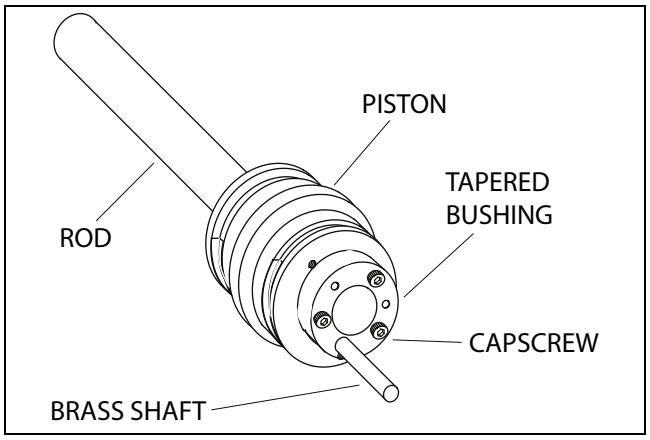


Figure 5-15. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 5 ft. lbs. (9 Nm) for 600A and 9 ft. lbs. (12 Nm) for 600AJ.

14. Remove the cylinder rod from the holding fixture.

NOTICE

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

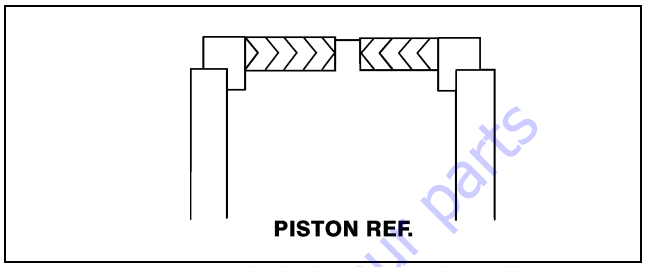


Figure 5-16. Hydrolock Piston Seal Installation

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

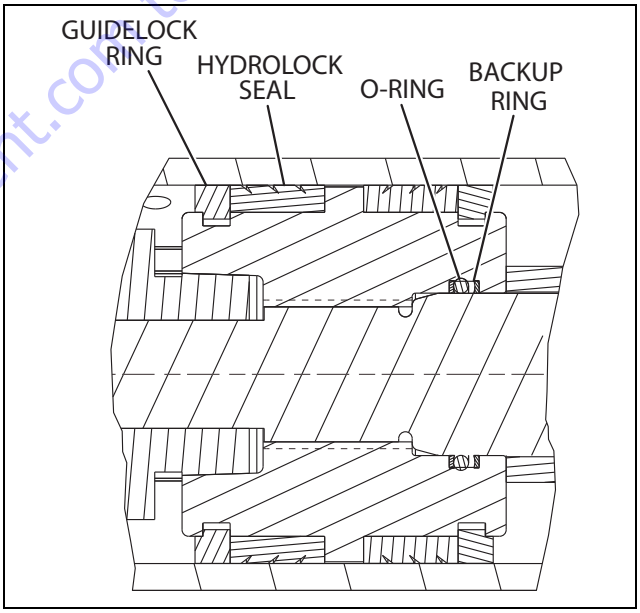


Figure 5-17. Piston Seal Kit Installation

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

NOTICE

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

17. With barrel clamped securely and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading guidelock rings and hydrolock seals are not damaged or dislodged.

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

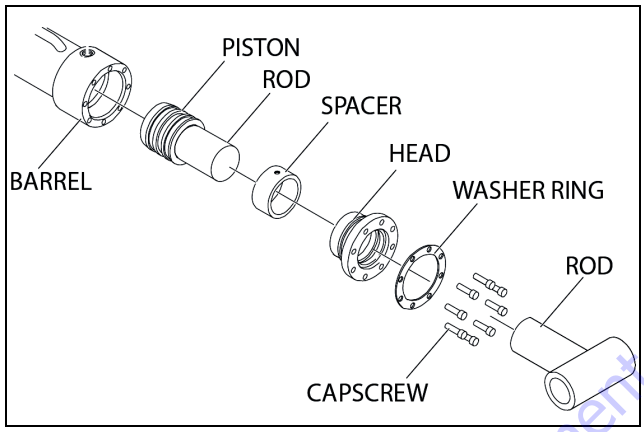


Figure 5-18. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head capscrews and secure the cylinder head gland using the washer ring and capscrews. Torque bolts to 40 ft. lbs. (55 Nm).

20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.

21. If applicable, install the cartridge-type holding valves and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Upright Level Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the counterbalance valves and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

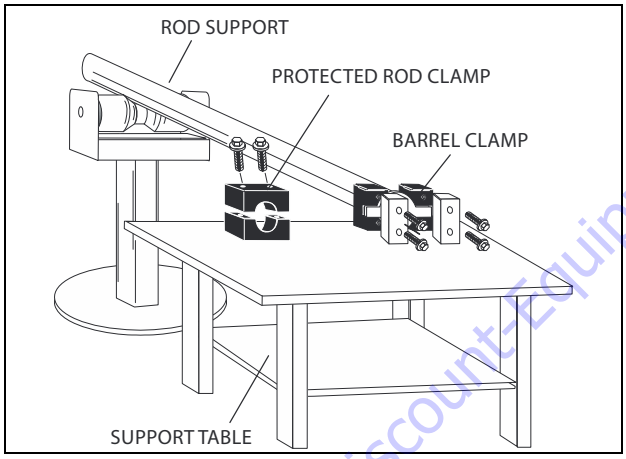


Figure 5-19. Cylinder Barrel Support

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

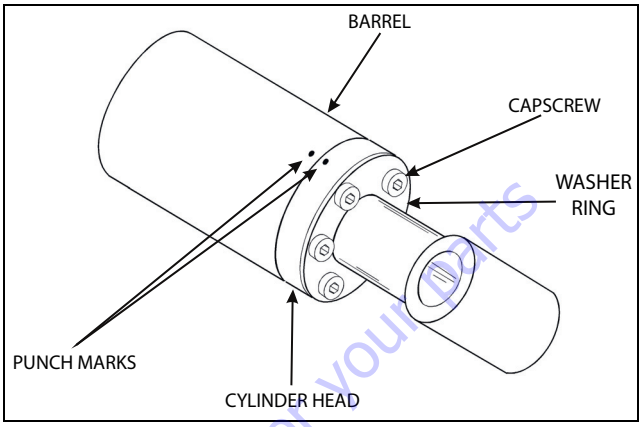


Figure 5-20. Capscrew Removal

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

NOTICE

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

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

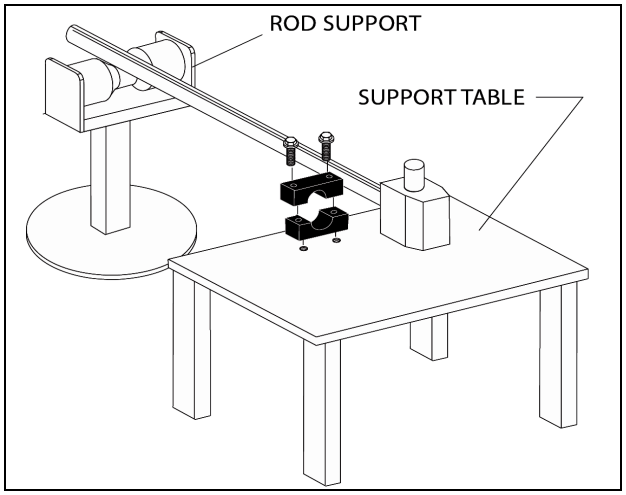
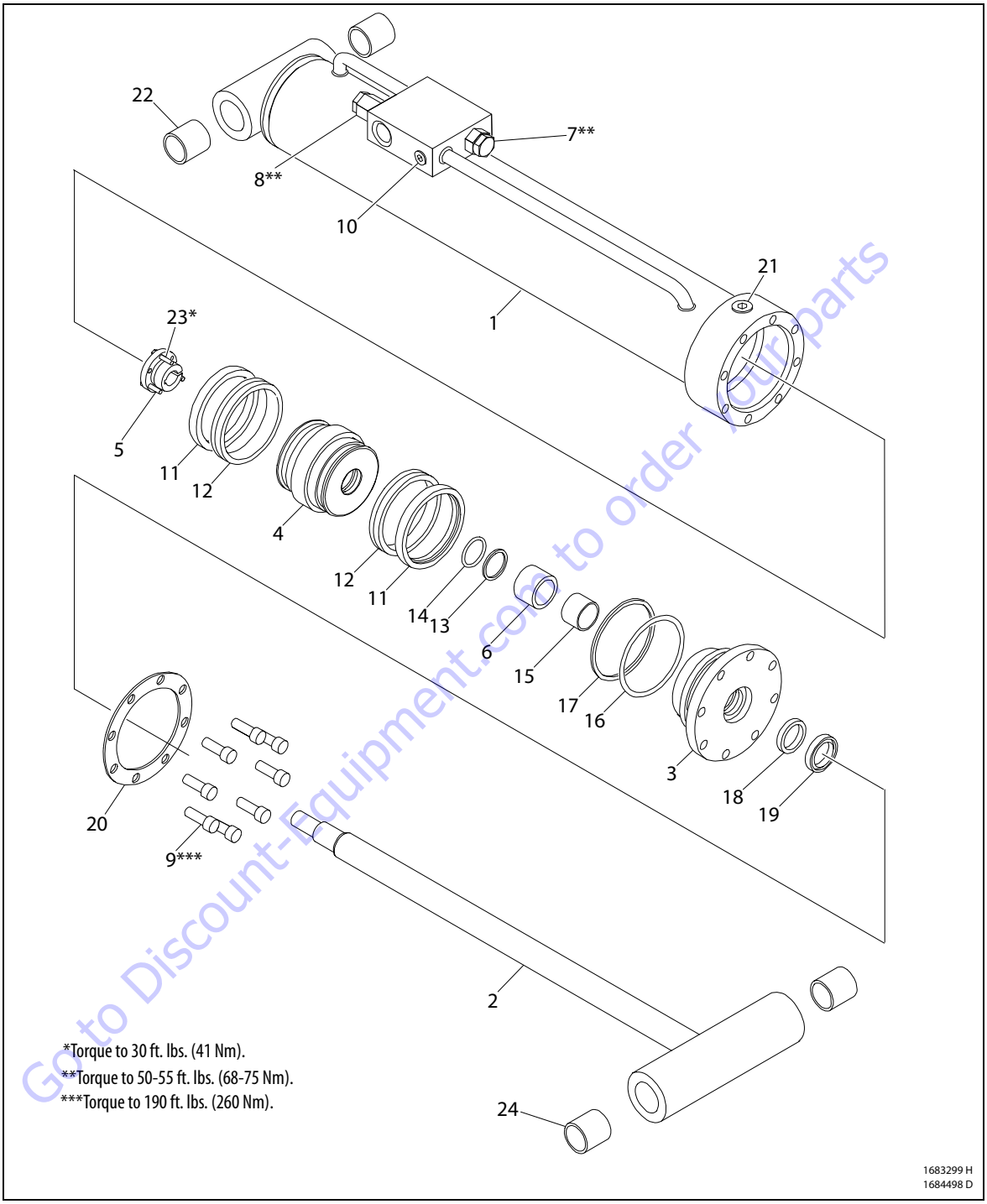


Figure 5-21. Cylinder Rod Support



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

Figure 5-22. Upright Level Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled holes.
10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

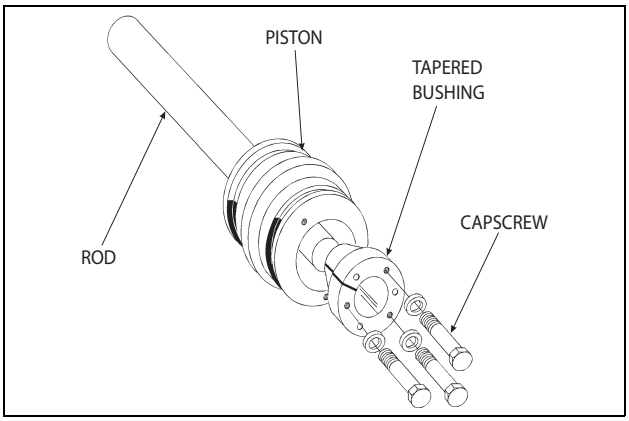


Figure 5-23. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-ring, backup ring, hydrolock seals and guidelock rings.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, rod seal, and wiper seal.

CLEANING AND INSPECTION

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

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

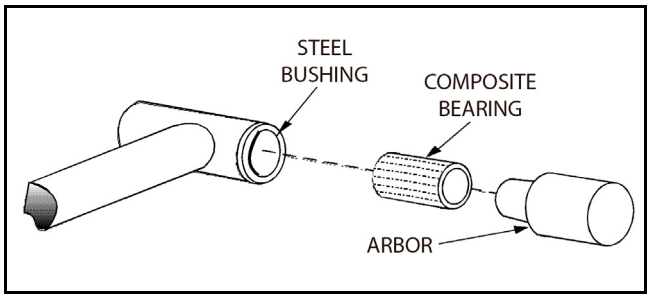


Figure 5-24. Composite Bearing Installation

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

ASSEMBLY

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

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

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

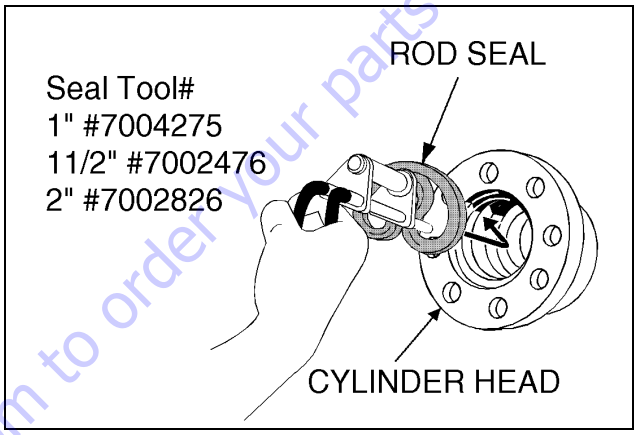


Figure 5-25. Rod Seal Installation

NOTICE

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

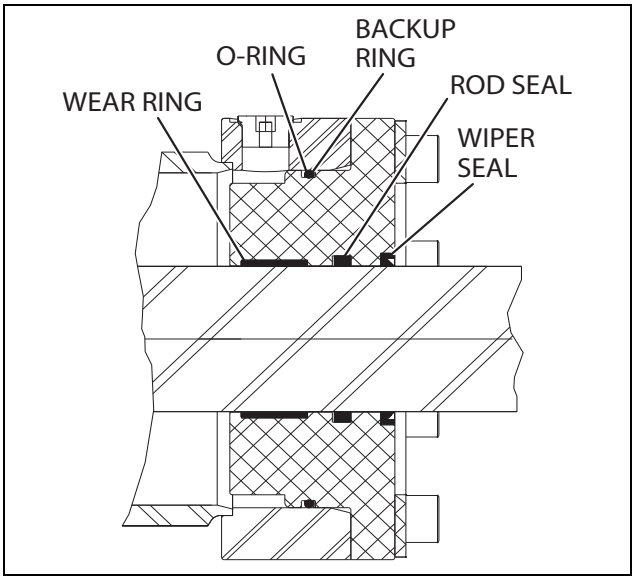


Figure 5-26. Cylinder Head Seal Installation

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

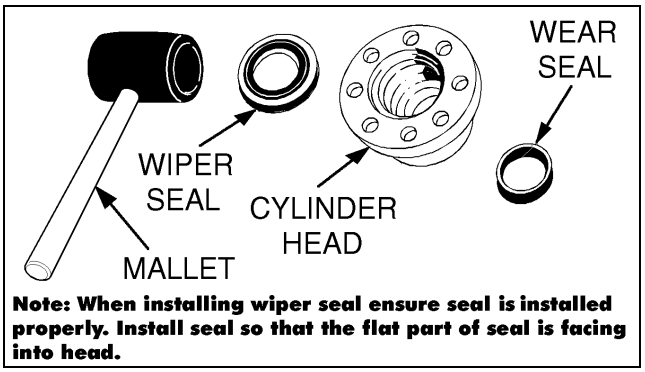


Figure 5-27. Wiper Seal Installation

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

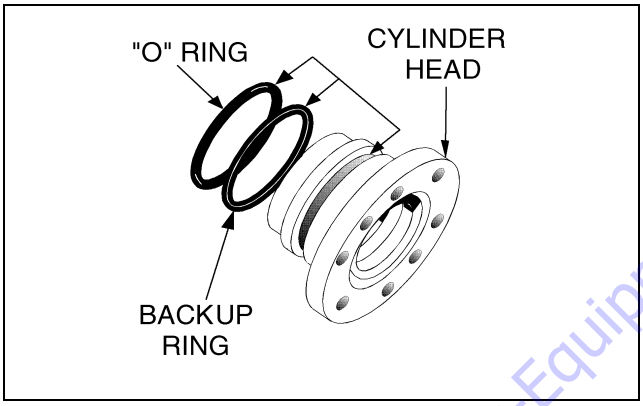


Figure 5-28. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seal are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the piston spacer on the rod.
6. Using suitable support, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
7. Place a new o-ring and backup ring in the inner piston diameter groove.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup ring are not damaged or dislodged.
9. Thread piston onto rod and install the tapered bushing.

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

10. Install the bolt in tapered bushing.
11. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

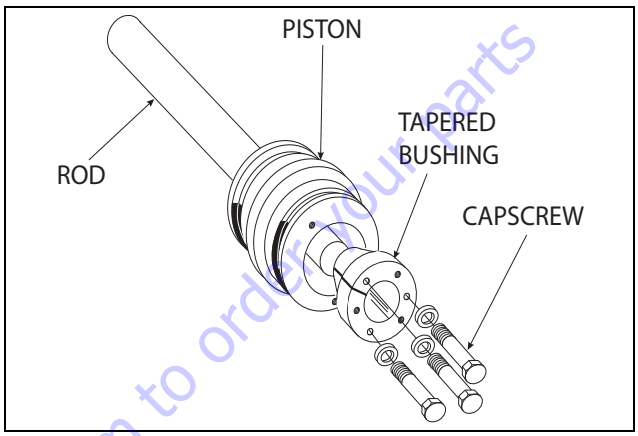


Figure 5-29. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to 30 ft. lbs. (41 Nm).
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

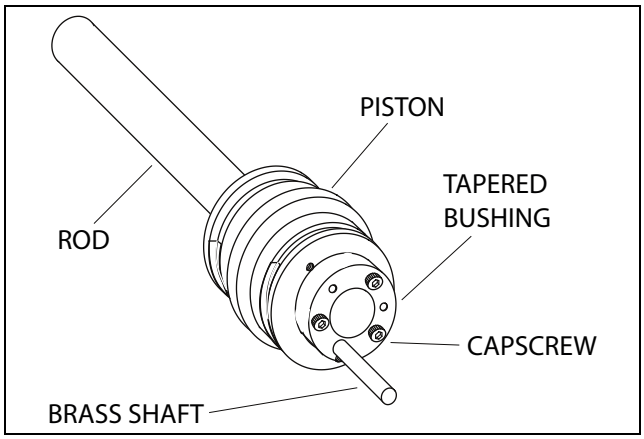


Figure 5-30. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation to 30 ft. lbs. (41 Nm).

15. Remove the cylinder rod from the holding fixture.

NOTICE

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

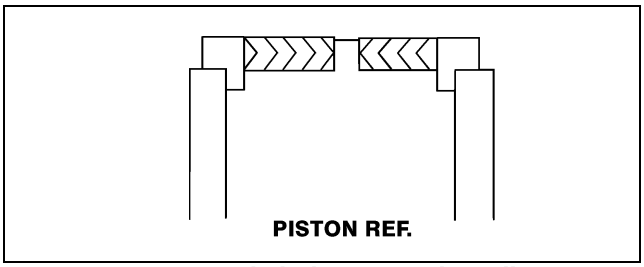


Figure 5-31. Hydrolock Piston Seal Installation

16. Place new hydrolock seals and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

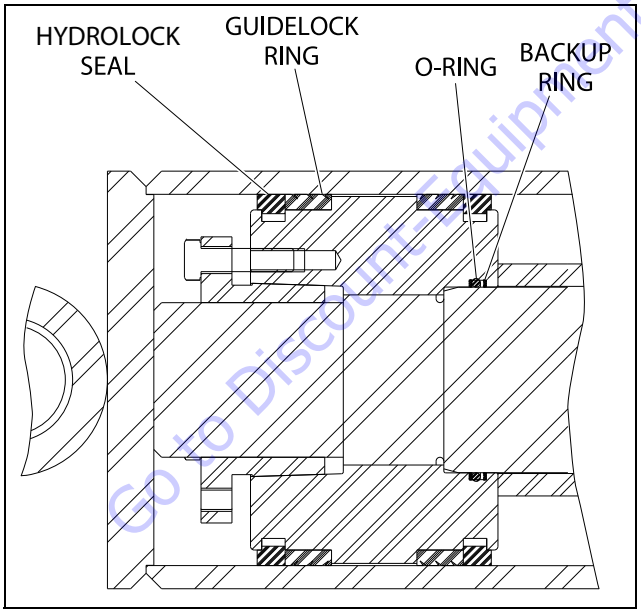


Figure 5-32. Piston Seal Kit Installation

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

NOTICE

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

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals and guidelock rings are not damaged or dislodged.

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

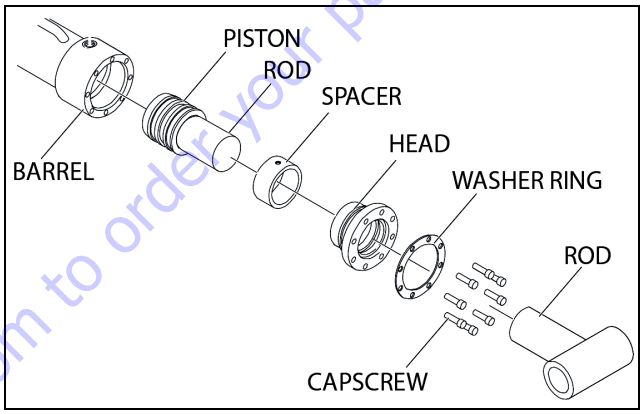


Figure 5-33. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 190 ft. lbs. (260 Nm).

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Jib Lift Cylinder (600AJ Only)

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the counterbalance holding valves and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

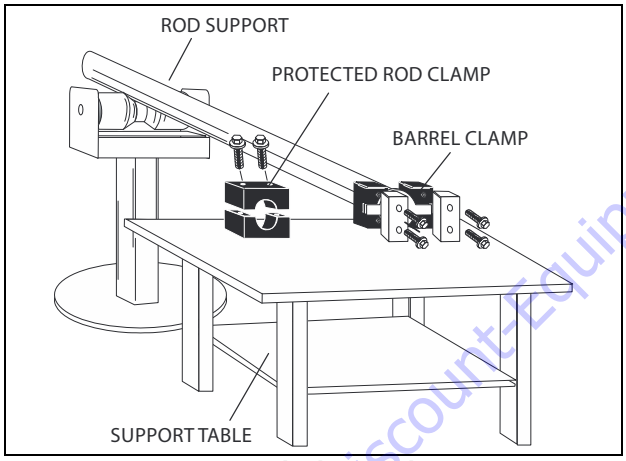


Figure 5-34. Cylinder Barrel Support

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

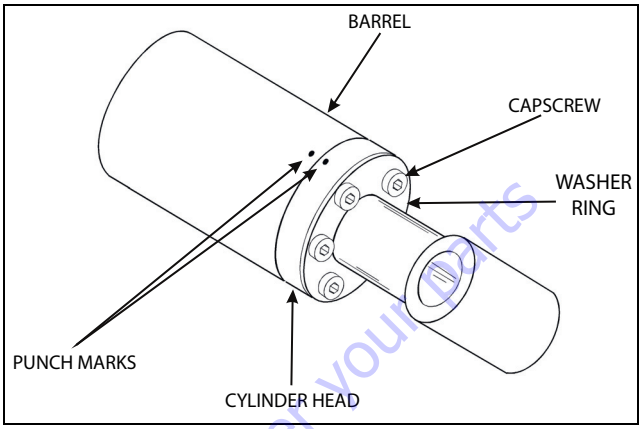


Figure 5-35. Capscrew Removal

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

NOTICE

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

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

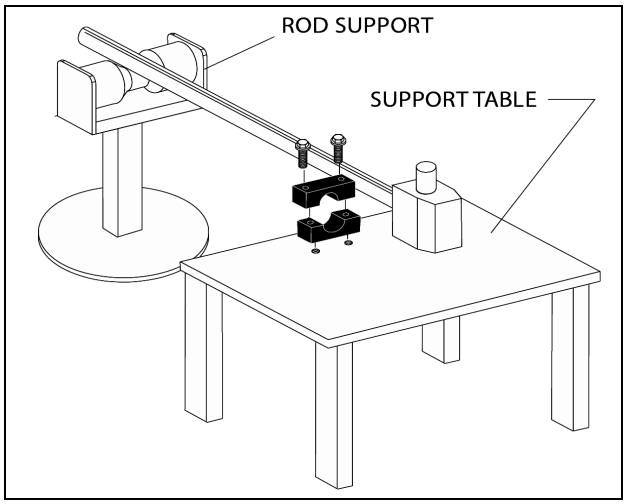
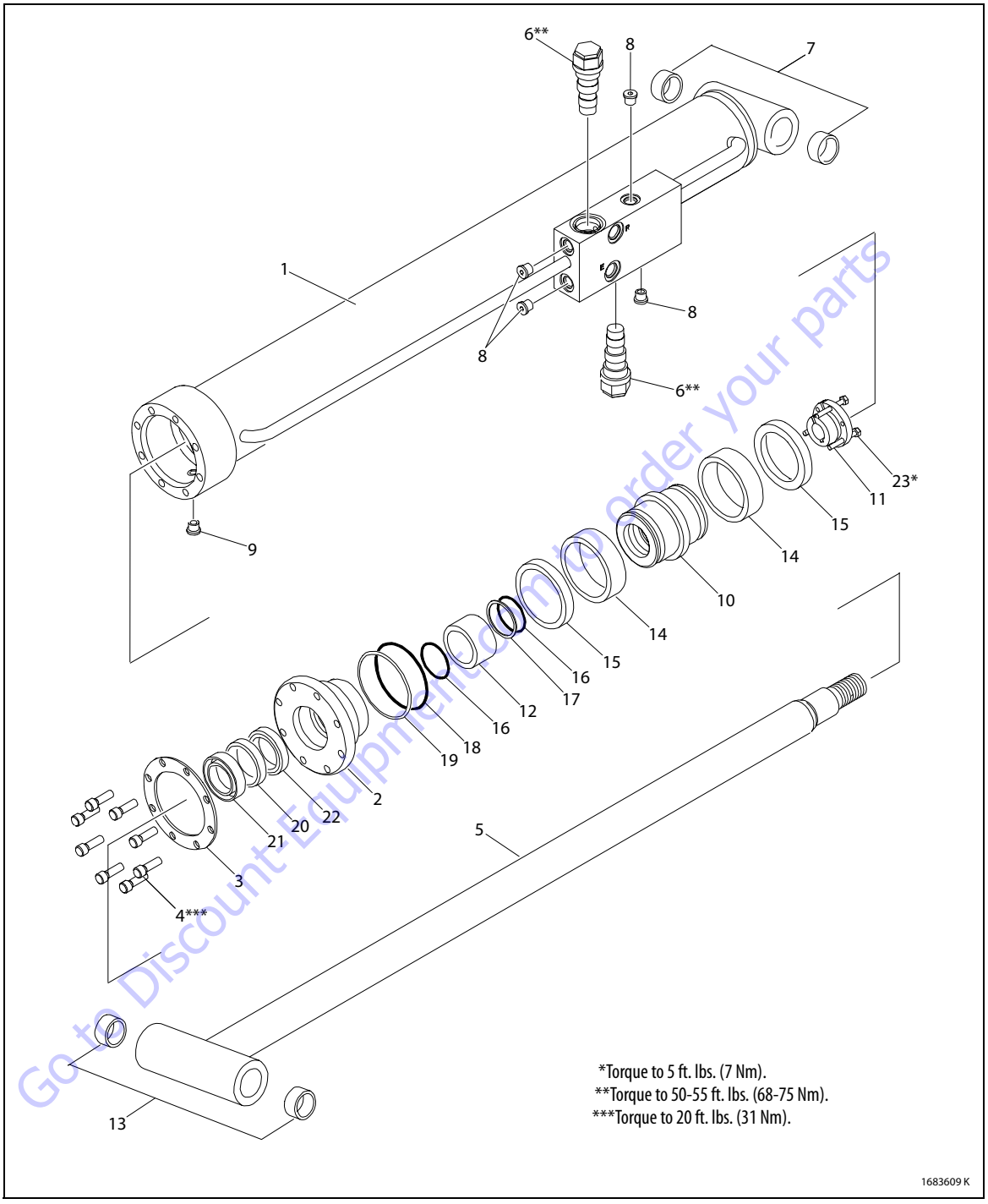


Figure 5-36. Cylinder Rod Support



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

Figure 5-37. Jib Lift Cylinder (600AJ only)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled holes.
10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

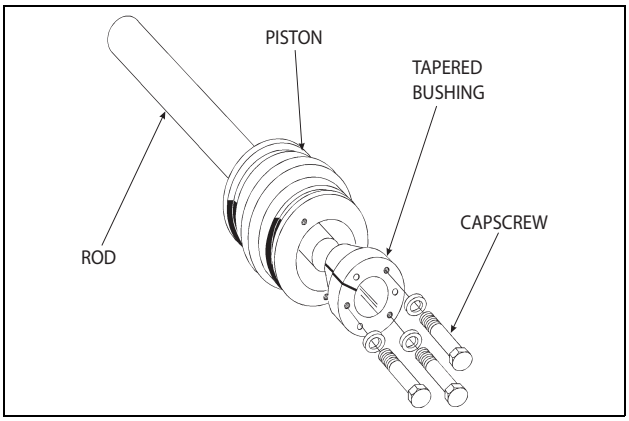


Figure 5-38. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the o-rings, backup ring, hydrolock seals and guidelock rings.
14. Remove piston spacer from the rod.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup ring, rod seal, wiper seal and wear ring.

CLEANING AND INSPECTION

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

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

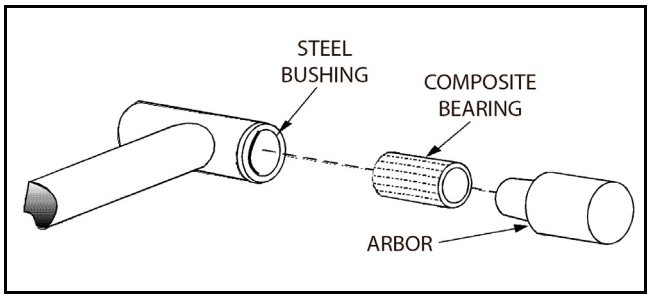


Figure 5-39. Composite Bearing Installation

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

ASSEMBLY

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

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

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

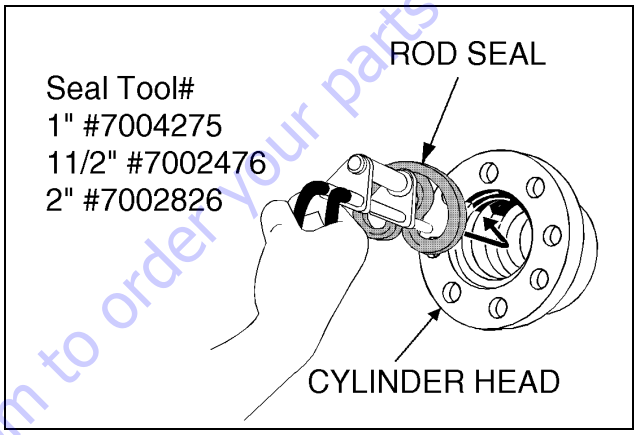


Figure 5-40. Rod Seal Installation

NOTICE

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

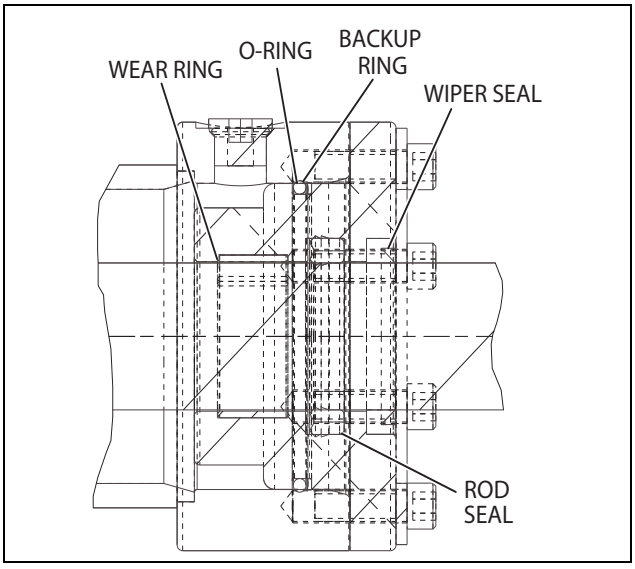


Figure 5-41. Cylinder Head Seal Installation

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

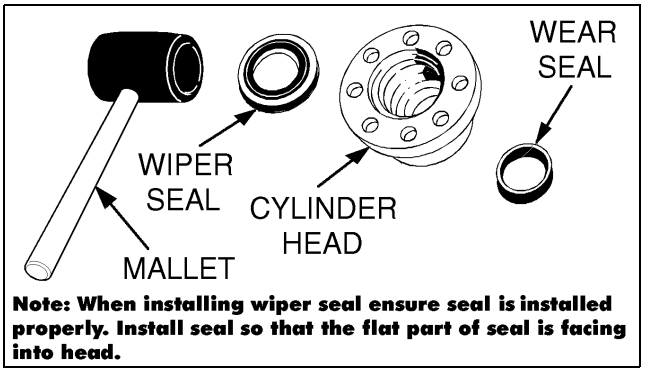


Figure 5-42. Wiper Seal Installation

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

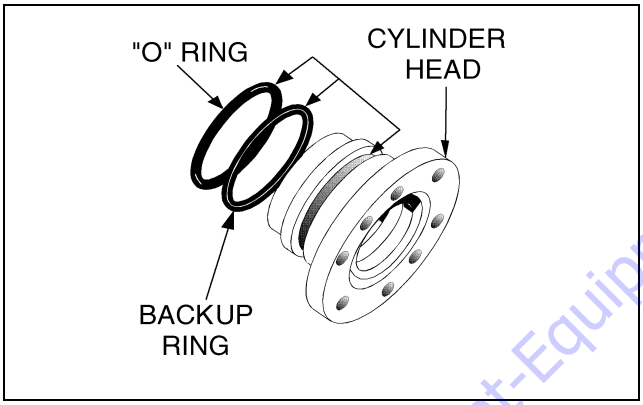


Figure 5-43. Installation of Head Seal Kit

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

5. Install o-ring and carefully slide the piston spacer on the rod.

6. Using suitable support, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

7. Place a new o-ring and backup ring in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

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

10. Install the bolts in tapered bushing.

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

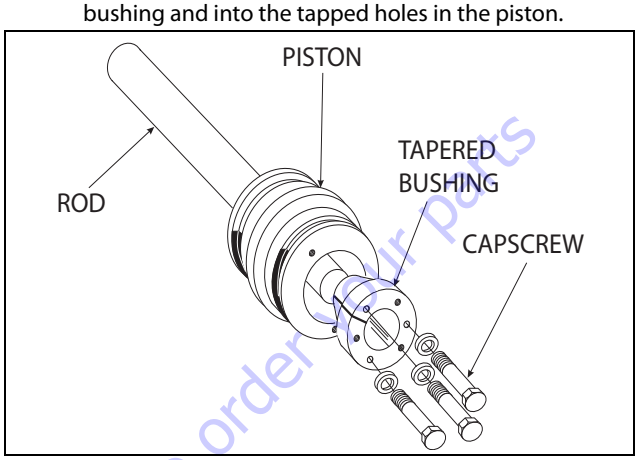


Figure 5-44. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm).

13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

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

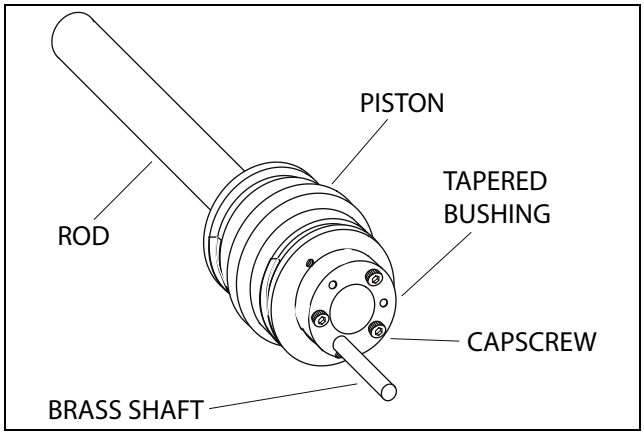


Figure 5-45. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm).

15. Remove the cylinder rod from the holding fixture.

NOTICE

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

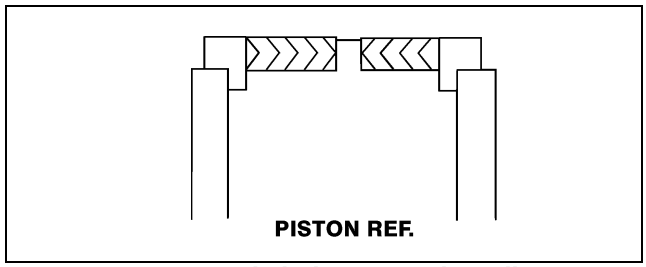


Figure 5-46. Hydrolock Piston Seal Installation

16. Place new hydrolock seals and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

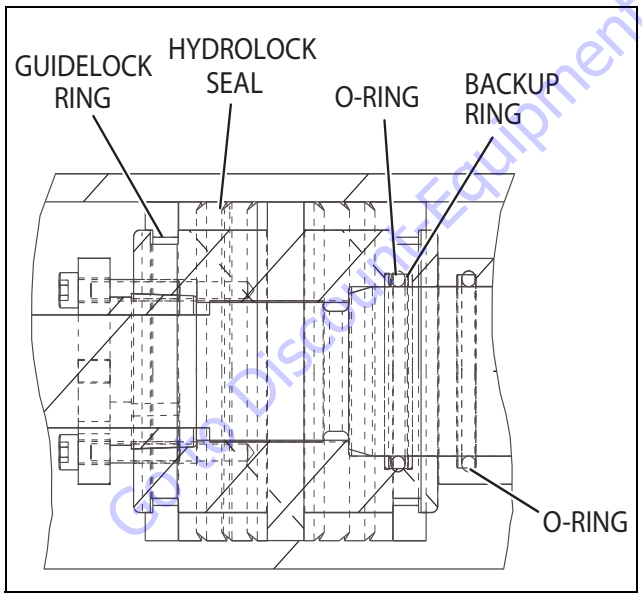


Figure 5-47. Piston Seal Kit Installation

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

NOTICE

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

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals and guidelock rings are not damaged or dislodged.

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

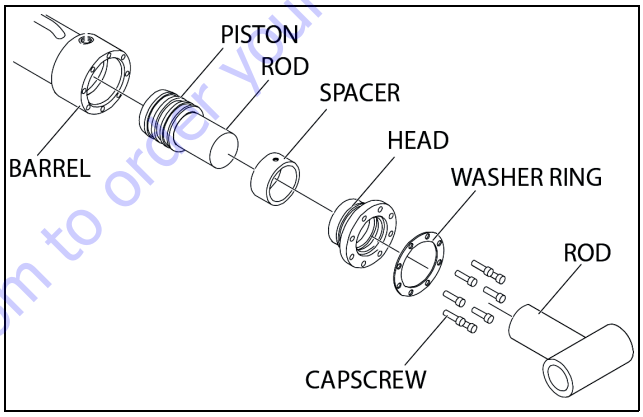


Figure 5-48. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and capscrews. Torque bolts to 20 ft. lbs. (27 Nm).

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.

22. If applicable, install the cartridge-type holding valves and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Main Boom Lift Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the counterbalance valves and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

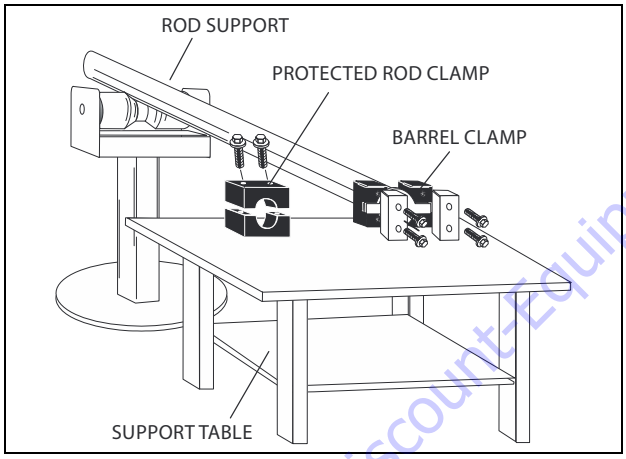


Figure 5-49. Cylinder Barrel Support

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

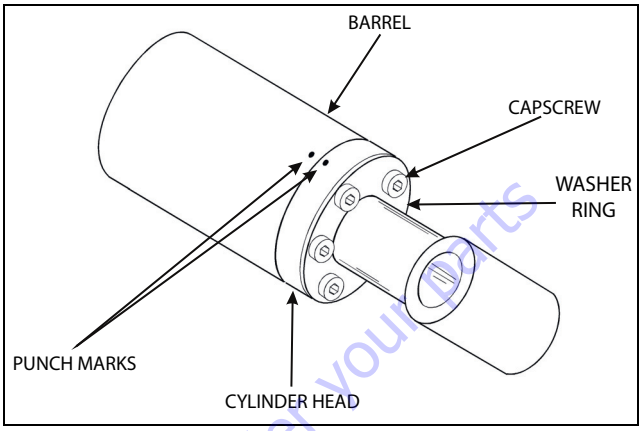


Figure 5-50. Capscrew Removal

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

NOTICE

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

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

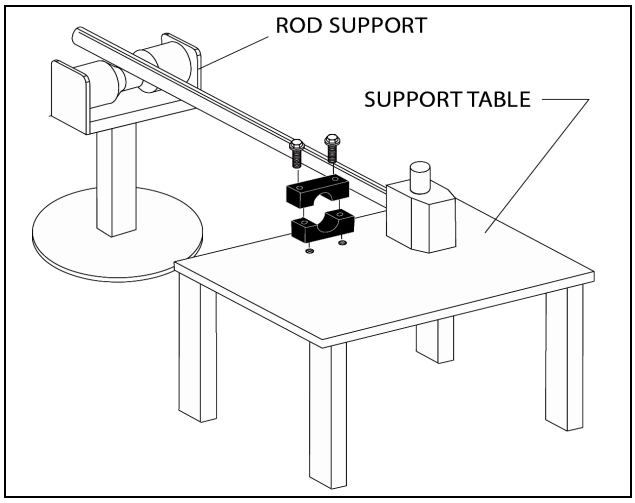
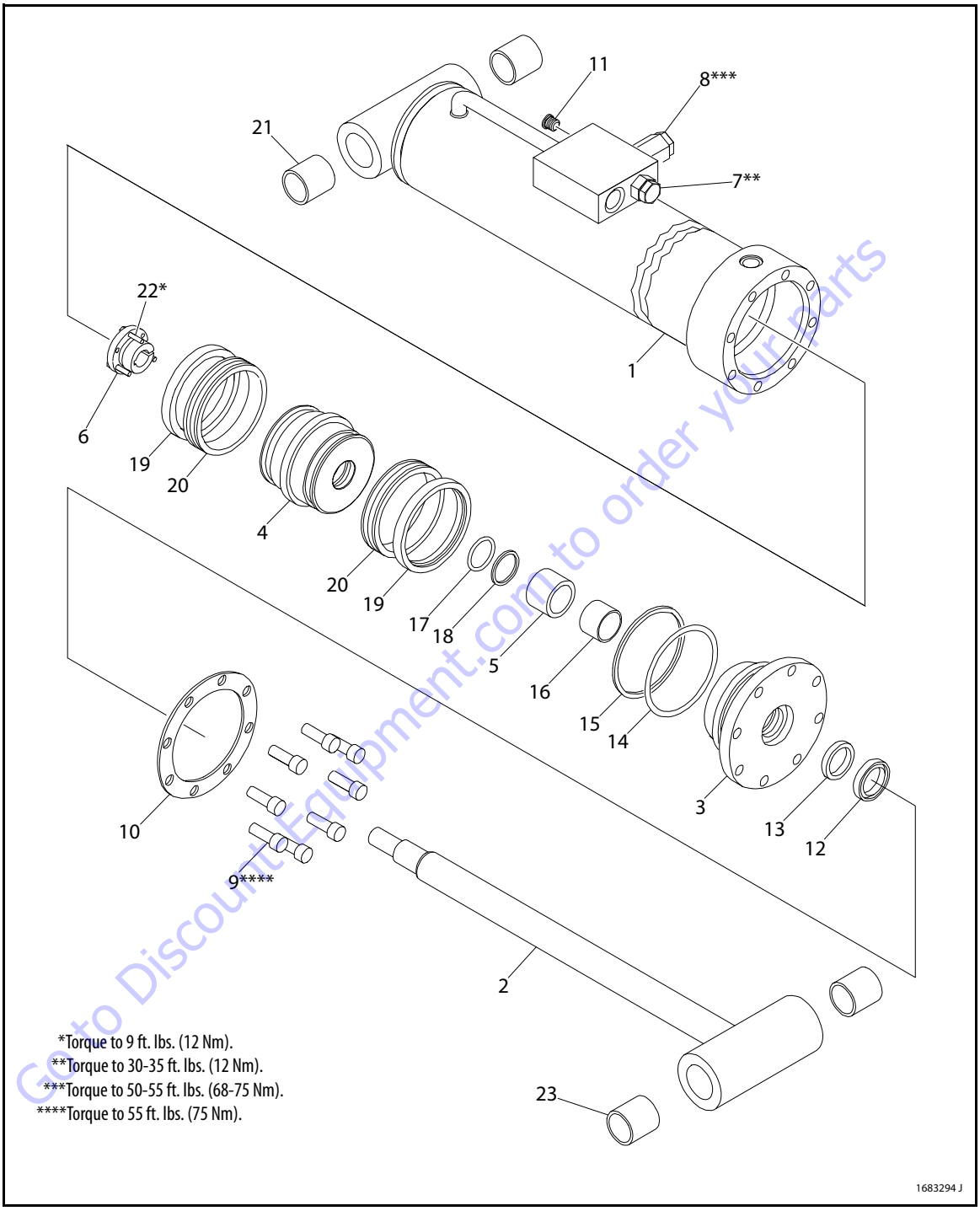


Figure 5-51. Cylinder Rod Support



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

Figure 5-52. Main Boom Lift Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled holes.
10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

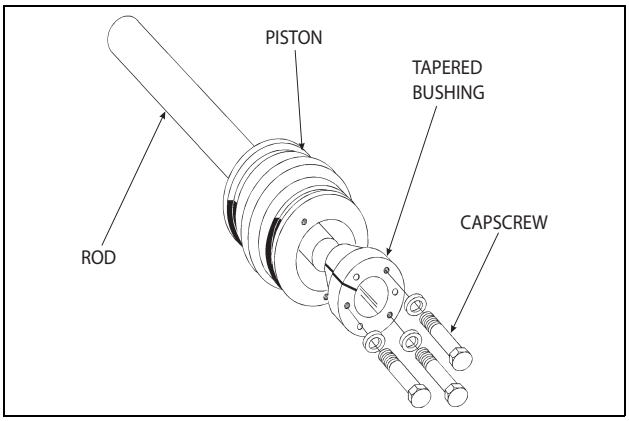


Figure 5-53. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-ring, backup ring, hydrolock seals and guidelock rings.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, rod seals, wear ring and wiper seal.

CLEANING AND INSPECTION

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

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

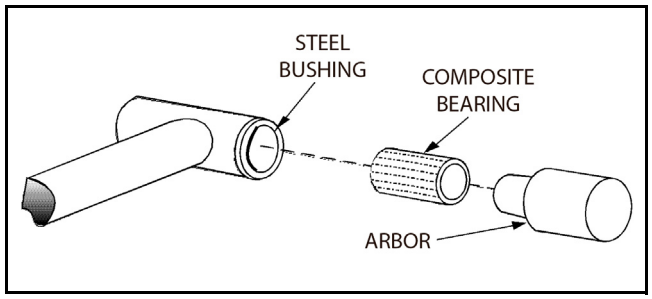


Figure 5-54. Composite Bearing Installation

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

ASSEMBLY

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

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

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

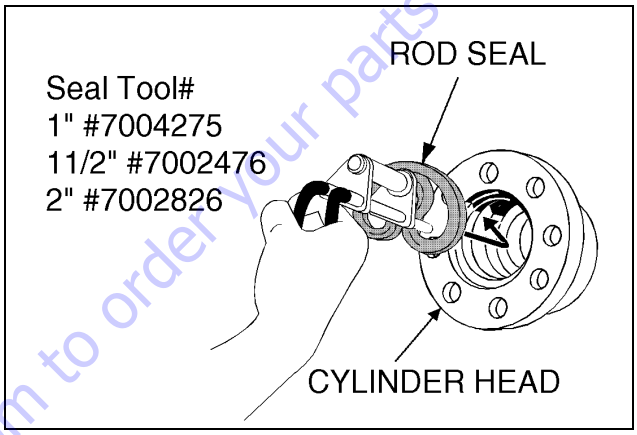


Figure 5-55. Rod Seal Installation

NOTICE

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

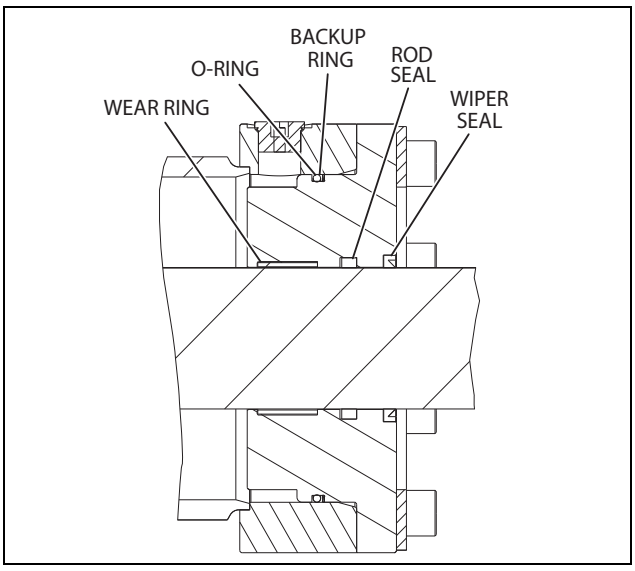


Figure 5-56. Cylinder Head Seal Installation

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

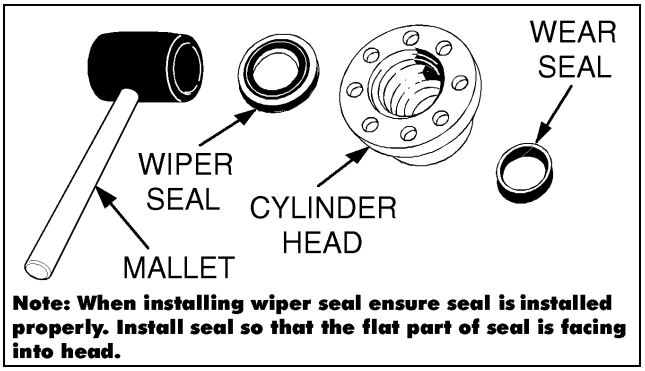


Figure 5-57. Wiper Seal Installation

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

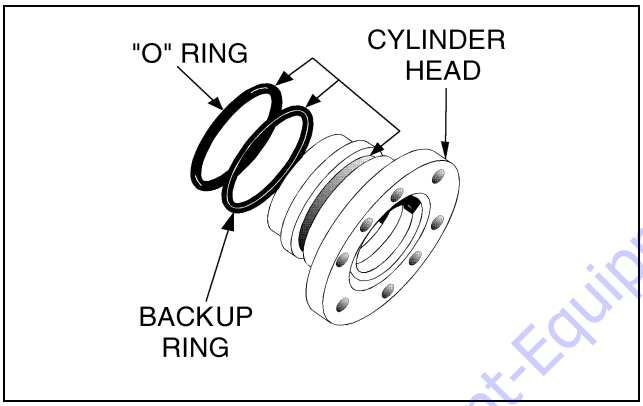


Figure 5-58. Installation of Head Seal Kit

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

5. Carefully slide the piston spacer on the rod.

6. Using suitable support, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

7. Place a new o-ring and backup rings in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. Thread piston onto rod hand tight and install the tapered bushing.

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

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

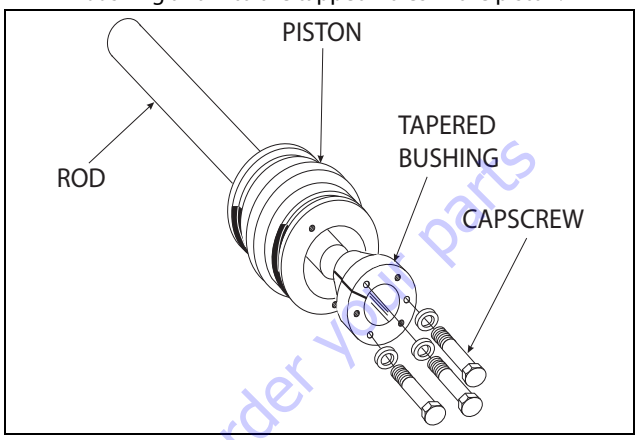


Figure 5-59. Tapered Bushing Installation

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

12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

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

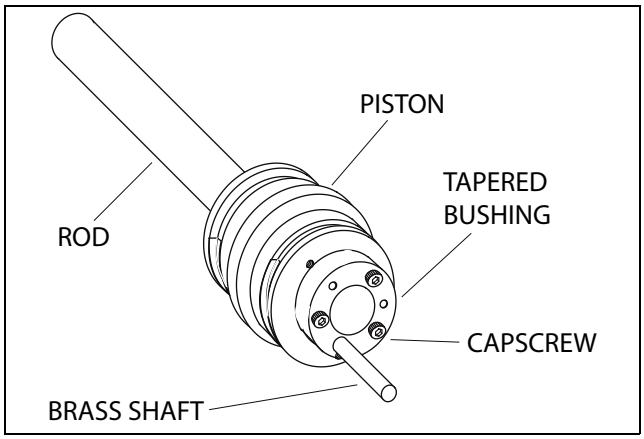


Figure 5-60. Seating the Tapered Bearing

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

14. Remove the cylinder rod from the holding fixture.

NOTICE

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

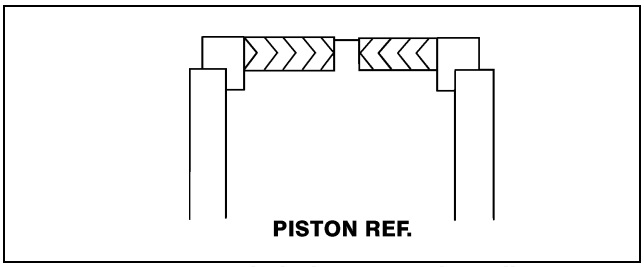


Figure 5-61. Hydrolock Piston Seal Installation

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

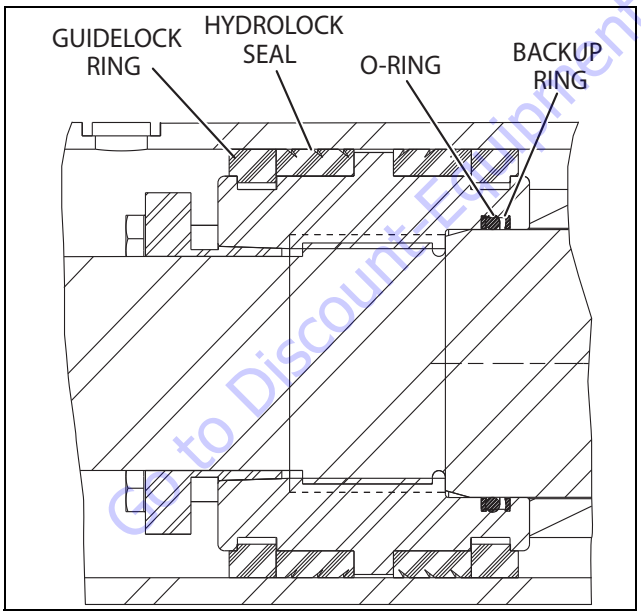


Figure 5-62. Piston Seal Kit Installation

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

NOTICE

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

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals and guidelock rings are not damaged or dislodged.

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

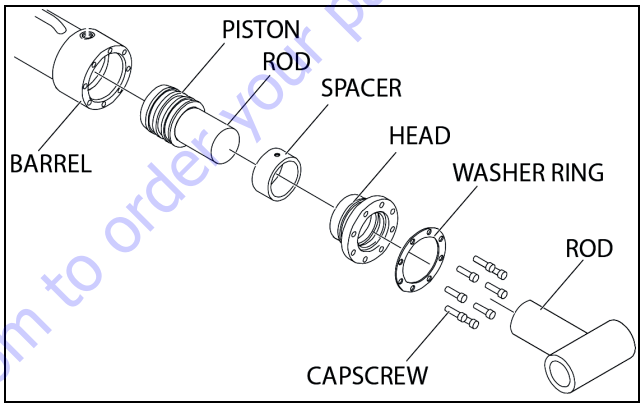


Figure 5-63. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 55 ft. lbs. (75 Nm).

20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.

21. Install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Tower Boom Lift Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the counterbalance valves and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

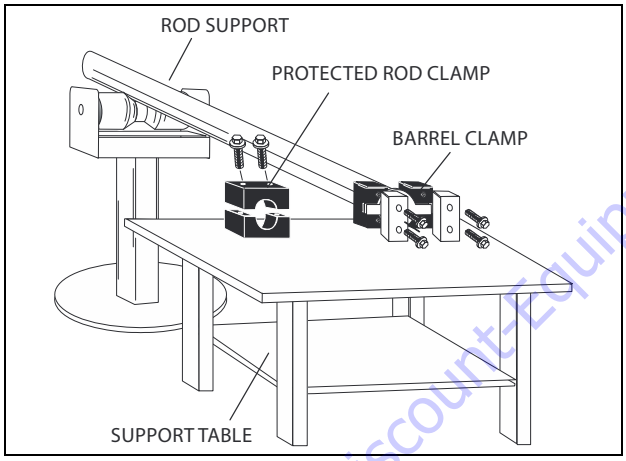


Figure 5-64. Cylinder Barrel Support

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

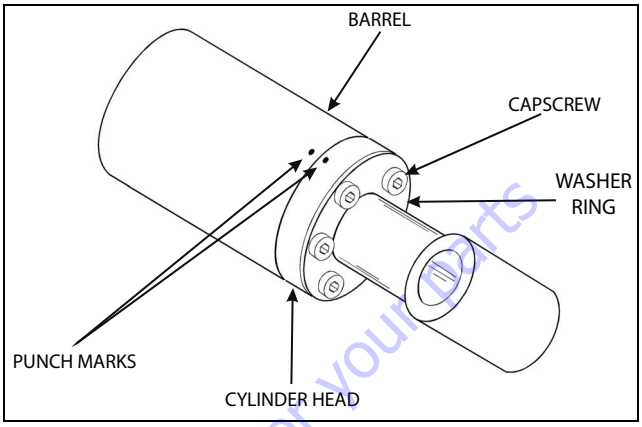


Figure 5-65. Capscrew Removal

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

NOTICE

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

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

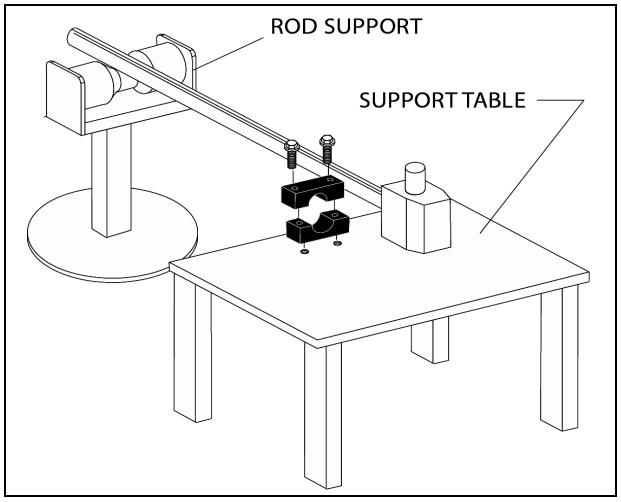
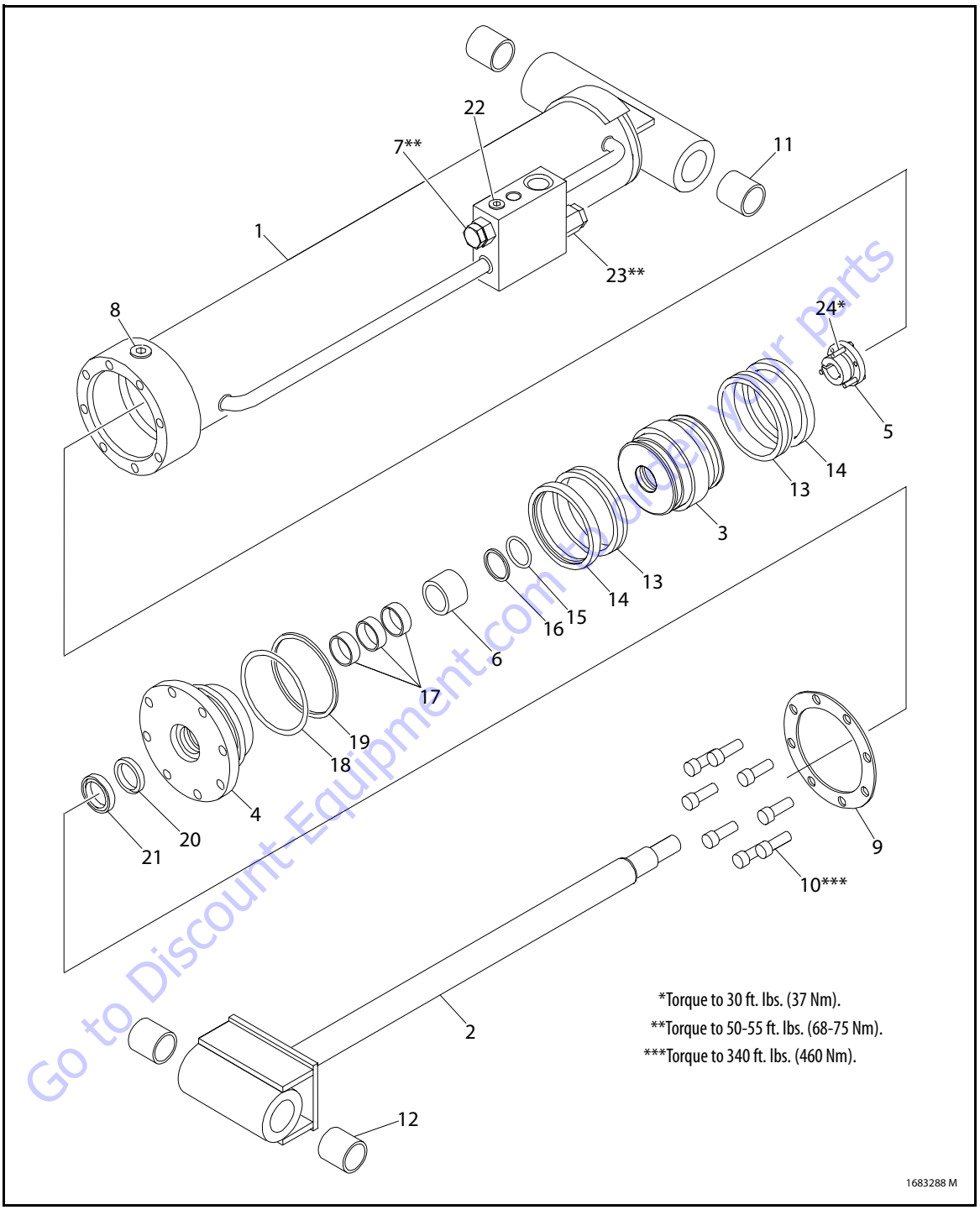


Figure 5-66. Cylinder Rod Support



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

Figure 5-67. Tower Boom Lift Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled holes.
10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

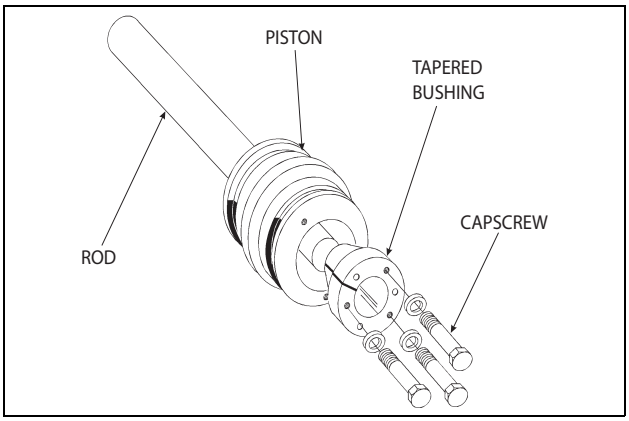


Figure 5-68. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-rings, backup ring, hydrolock seals and guidelock rings.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, rod seal, wiper seal and wear rings.

CLEANING AND INSPECTION

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

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

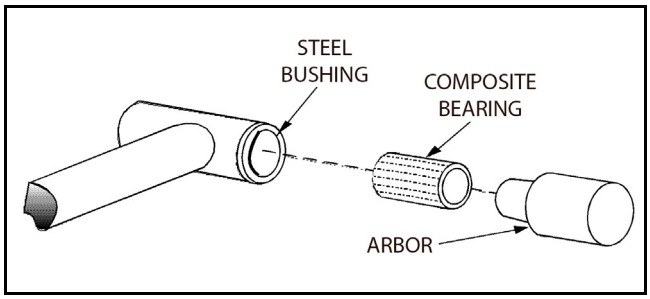


Figure 5-69. Composite Bearing Installation

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

ASSEMBLY

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

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

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

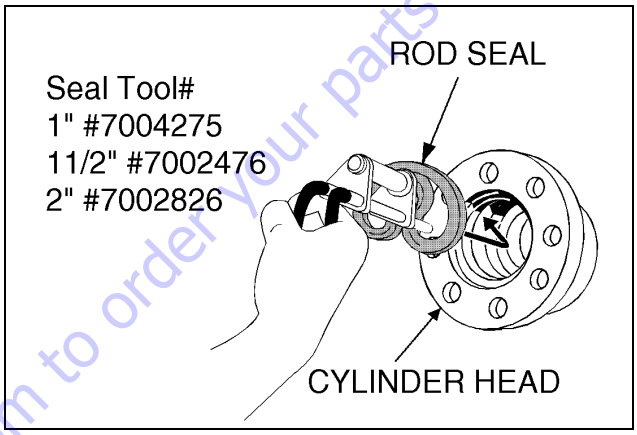


Figure 5-70. Rod Seal Installation

NOTICE

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

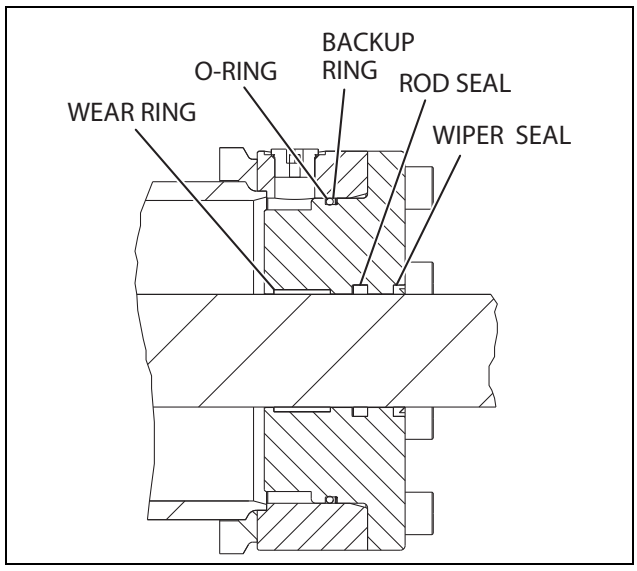


Figure 5-71. Cylinder Head Seal Installation

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

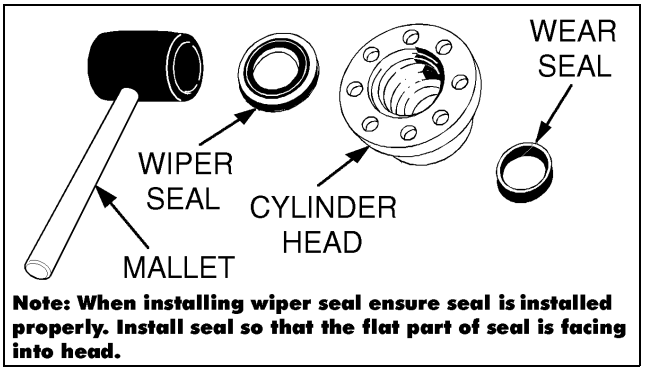


Figure 5-72. Wiper Seal Installation

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

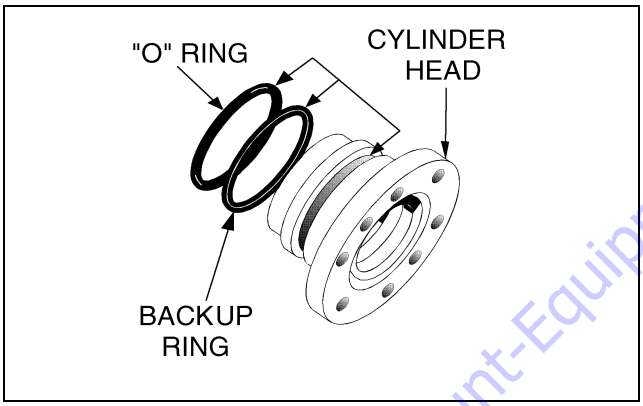


Figure 5-73. Installation of Head Seal Kit

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

5. Install tube spacer onto the rod.

6. Using suitable support, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

7. Place a new o-ring and backup ring in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup ring are not damaged or dislodged.

9. Thread piston onto rod hand tight and install the tapered bushing.

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

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

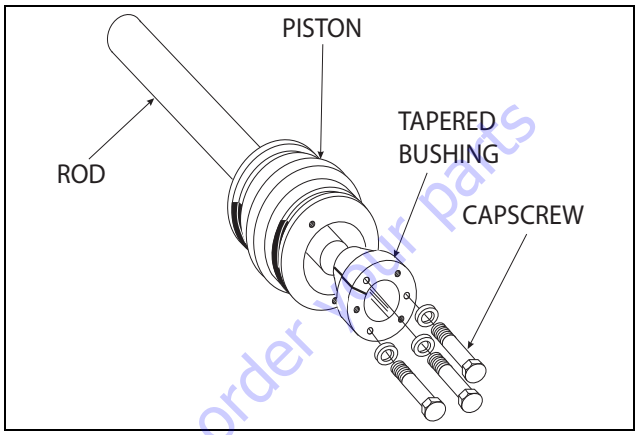


Figure 5-74. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 30 ft. lbs. (41 Nm).

12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

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

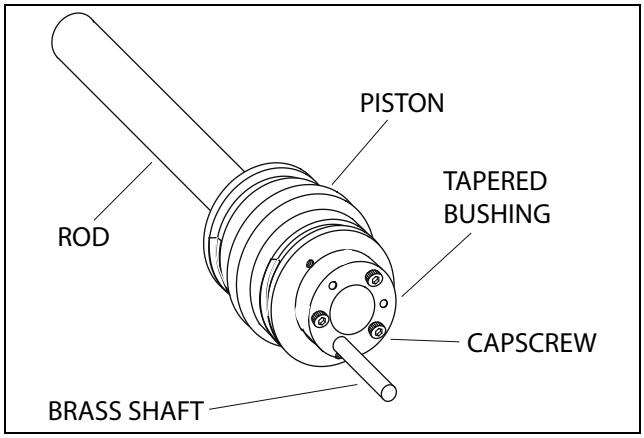


Figure 5-75. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 30 ft. lbs. (41 Nm).

14. Remove the cylinder rod from the holding fixture.

NOTICE

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

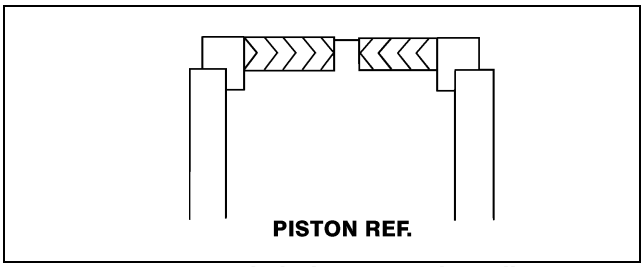


Figure 5-76. Hydrolock Piston Seal Installation

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

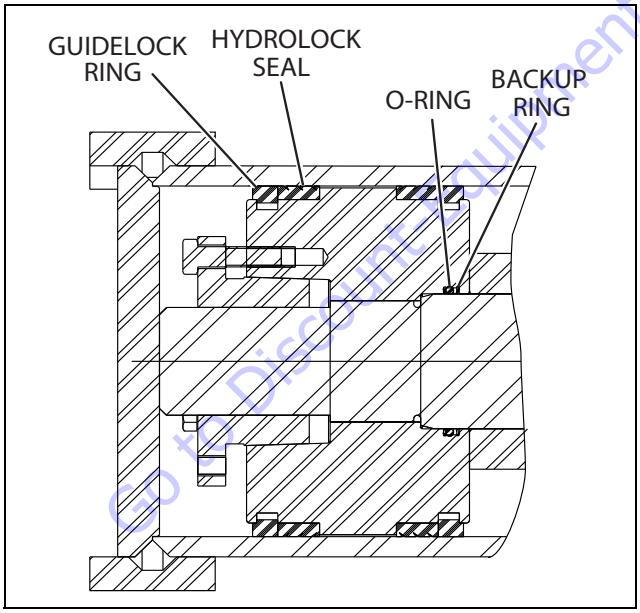


Figure 5-77. Piston Seal Kit Installation

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

NOTICE

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

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals and guidelock rings are not damaged or dislodged.

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

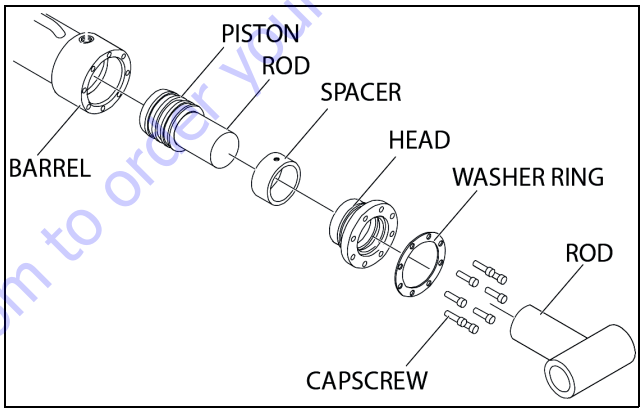


Figure 5-78. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 340 ft. lbs. (460 Nm).

20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.

21. Install the cartridge-type holding valves, o-ring plugs, and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Master Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

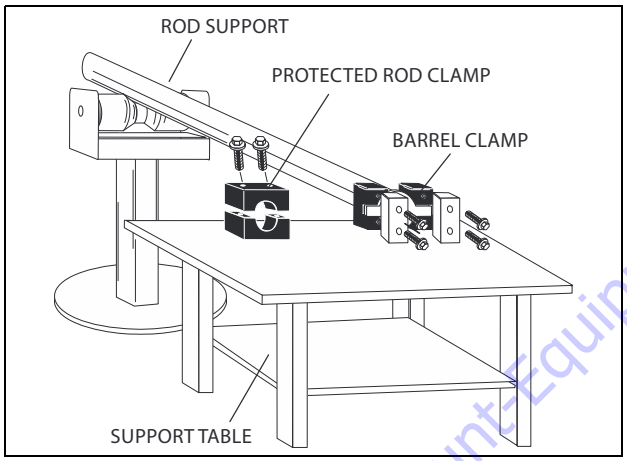


Figure 5-79. Cylinder Barrel Support

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

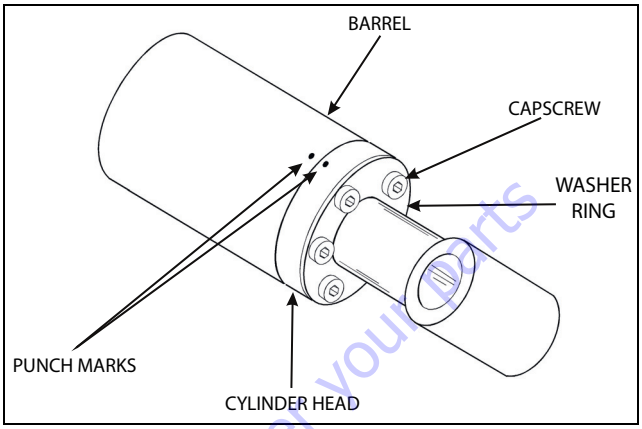


Figure 5-80. Capscrew Removal

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

NOTICE

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

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

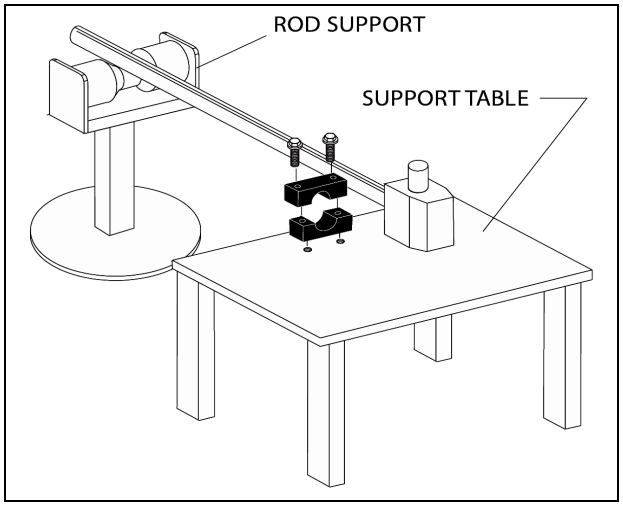
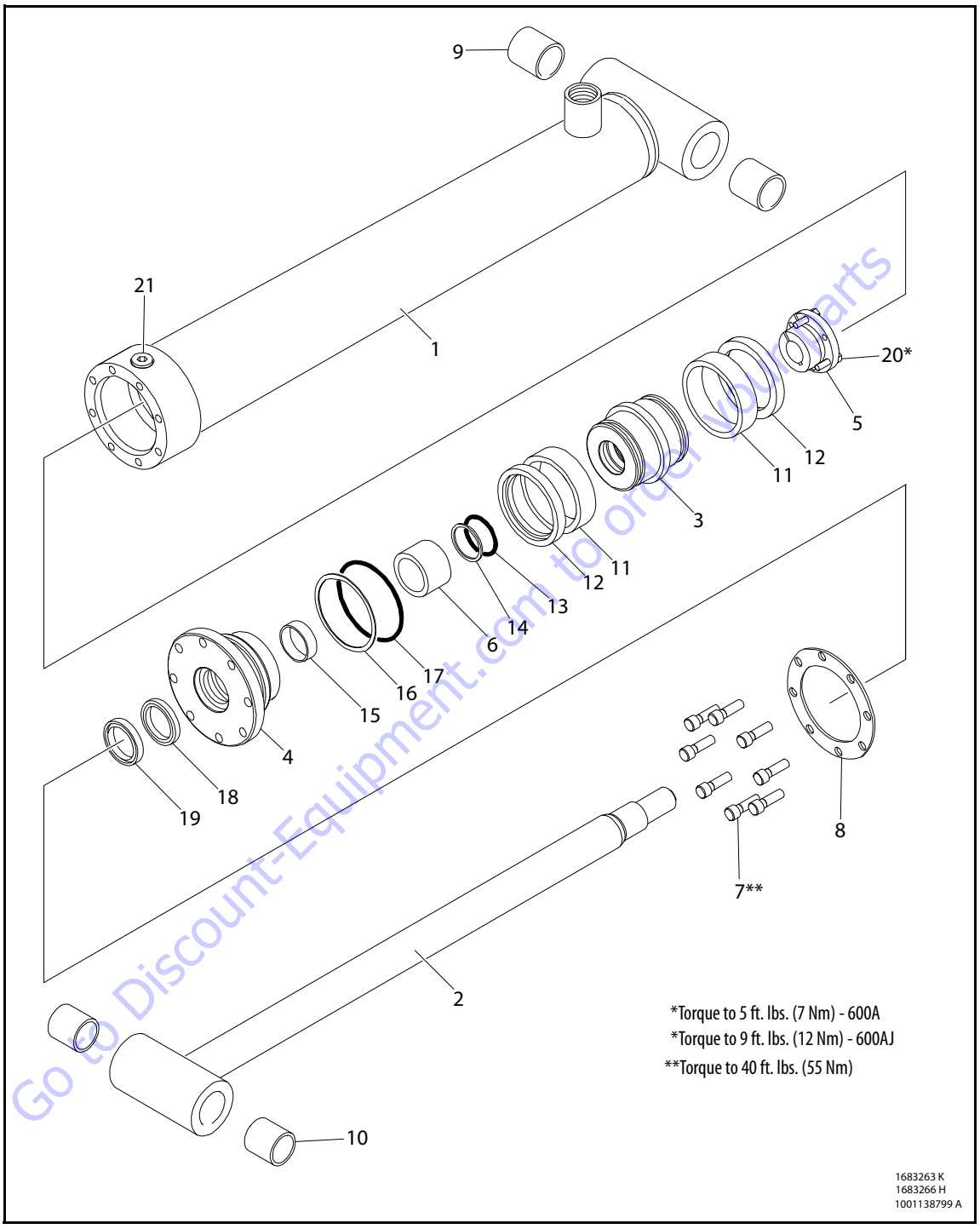


Figure 5-81. Cylinder Rod Support



1. Barrel
2. Rod
3. Piston
4. Head
5. Tapered Bushing
6. Spacer
7. Capscrew
8. Washer Ring
9. Bushing
10. Bushing
11. Hydrolock Seal
12. Guidelock Ring
13. O-ring
14. Backup Ring
15. Wear Ring
16. O-ring
17. Backup Ring
18. Rod Seal
19. Wiper Seal
20. Capscrew
21. Plug

Figure 5-82. Master Cylinder

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove capscrews from drilled holes.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

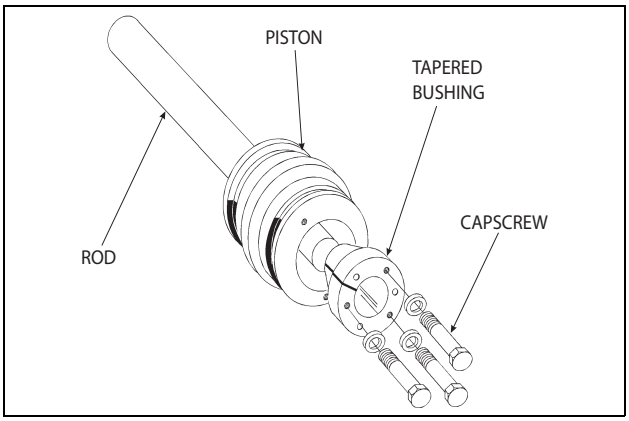


Figure 5-83. Tapered Bushing Removal

11. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
12. Remove and discard the piston o-ring, backup ring, hydrolock seals and guidelock rings. Remove spacer from the piston rod.
13. Remove the rod from the holding fixture. Remove capscrews and washer ring. Remove the cylinder head gland. Discard the o-rings, backup ring, rod seal, wiper seal and wear ring.

CLEANING AND INSPECTION

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

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

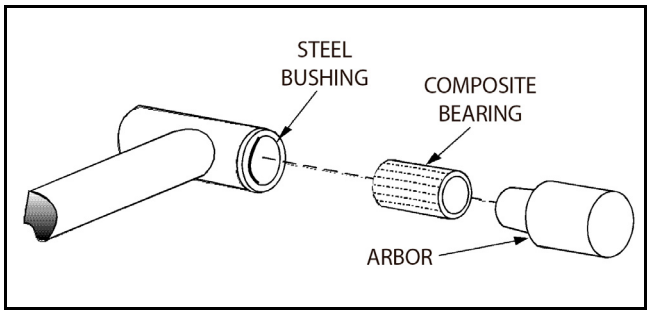


Figure 5-84. Composite Bearing Installation

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

ASSEMBLY

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

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

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

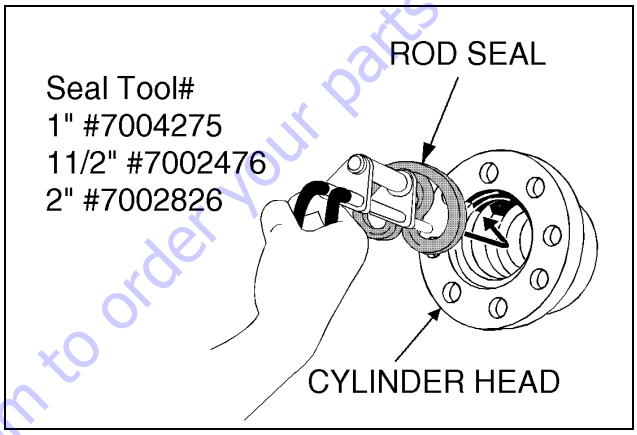


Figure 5-85. Rod Seal Installation

NOTICE

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

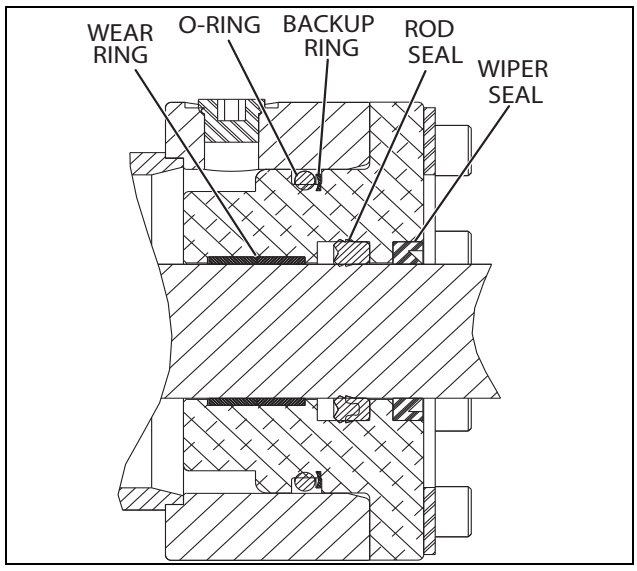


Figure 5-86. Cylinder Head Seal Installation

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

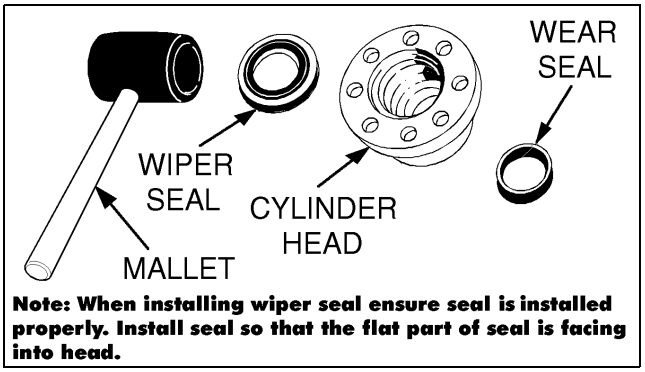


Figure 5-87. Wiper Seal Installation

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

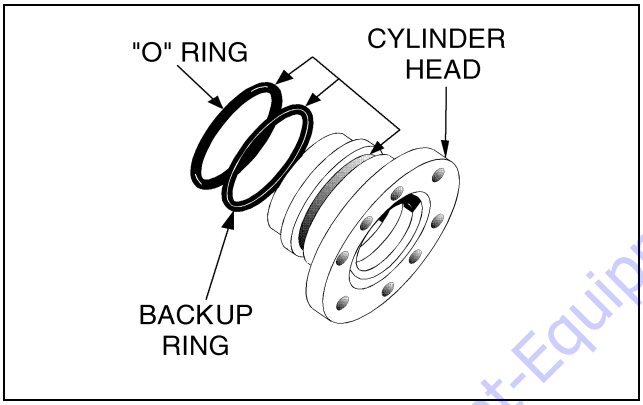


Figure 5-88. Installation of Head Seal Kit

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

5. Carefully slide the piston spacer on the rod.

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

7. Place a new o-ring and backup rings in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

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

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

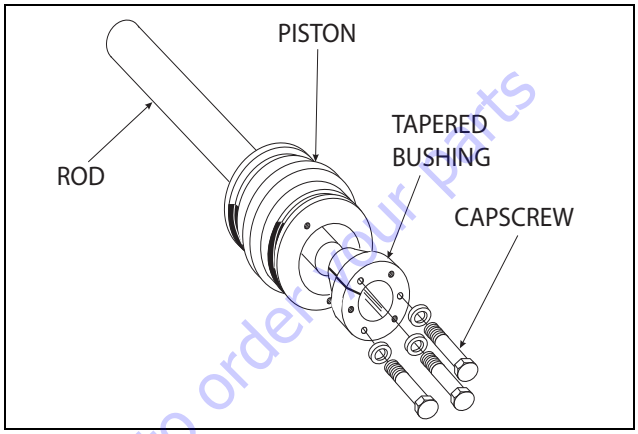


Figure 5-89. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm) for 600A and 9 ft. lbs. (12 Nm) for 600AJ.

12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

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

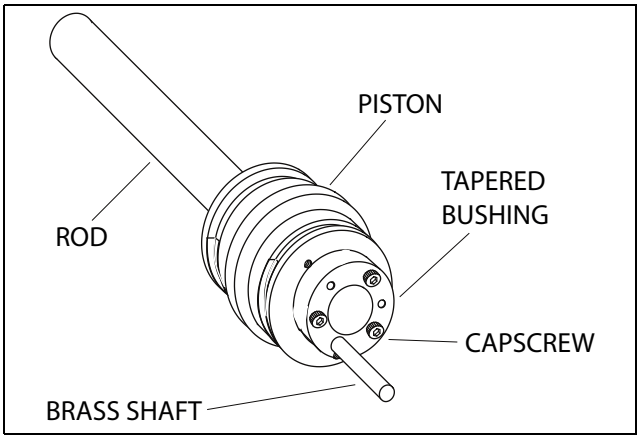


Figure 5-90. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm) for 600A and 9 ft. lbs. (12 Nm) for 600AJ.

14. Remove the cylinder rod from the holding fixture.

NOTICE

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

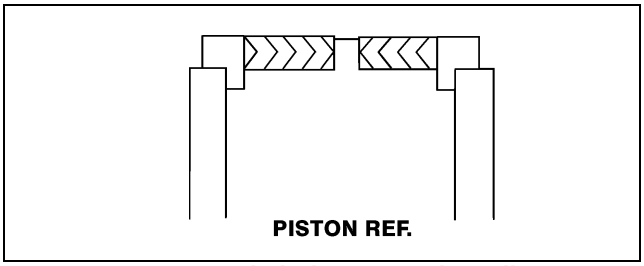


Figure 5-91. Hydrolock Piston Seal Installation

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

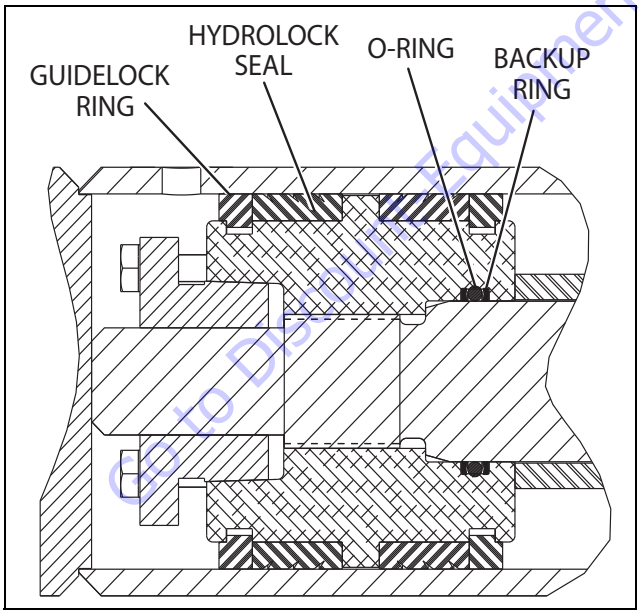


Figure 5-92. Piston Seal Kit Installation

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

NOTICE

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

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals and guidelock rings are not damaged or dislodged.

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

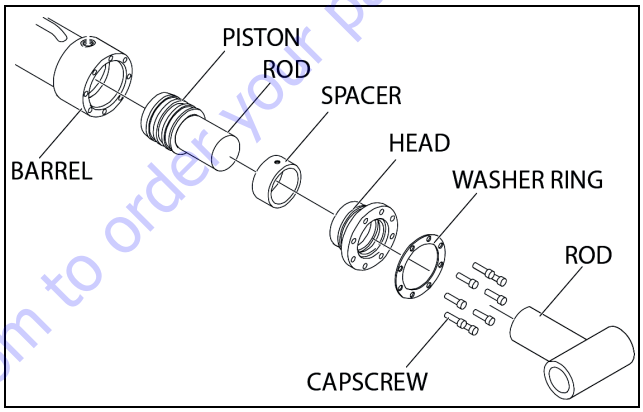


Figure 5-93. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 40 ft. lbs. (55 Nm).

20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves, If applicable.

Steer Cylinder (USA Built Machines SN 0300087000 through 0300142624)

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

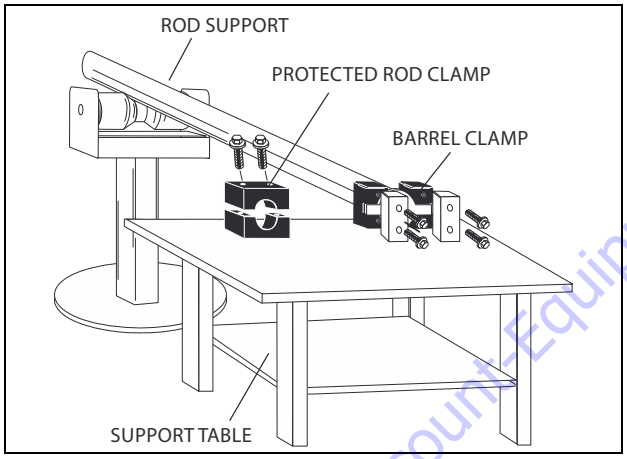


Figure 5-94. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

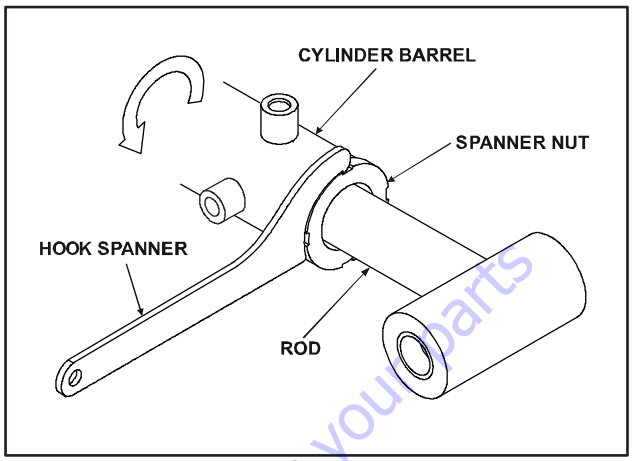


Figure 5-95. Spanner Nut Removal

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

NOTICE

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

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

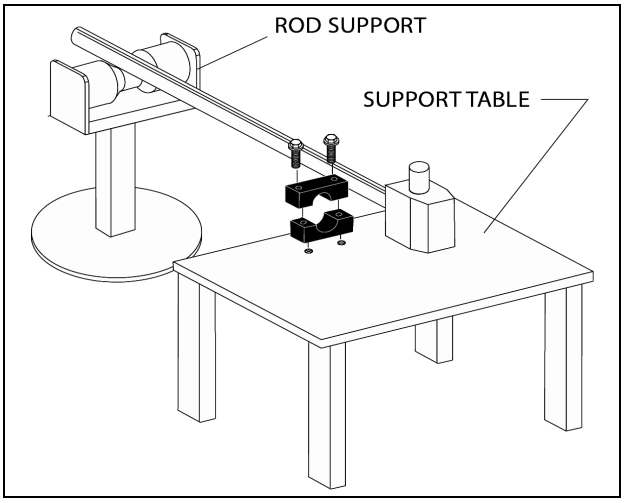
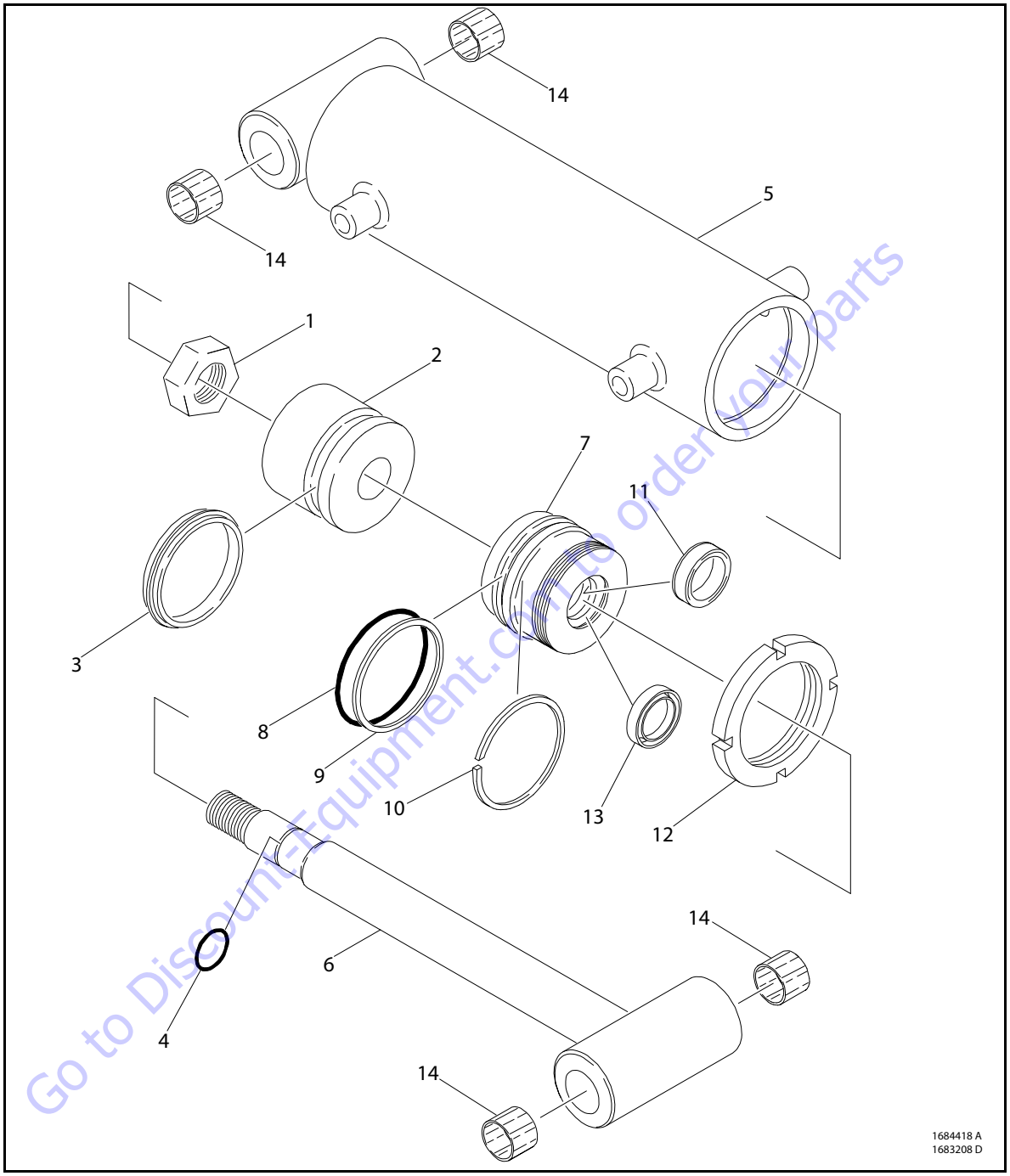


Figure 5-96. Cylinder Rod Support



1. Locknut
2. Piston
3. Seal
4. O-ring
5. Barrel
6. Rod
7. Guide
8. O-ring
9. Backup Ring
10. Retaining Ring
11. Rod Seal
12. Spanner Nut
13. Wiper Seal
14. Bushing

Figure 5-97. Steer Cylinder USA Built Machines (SN 0300087000 through 0300142624)

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove Locknut from the piston rod.
9. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
10. Remove and discard the piston seal.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, rod seal, and wiper seal.

CLEANING AND INSPECTION

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

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

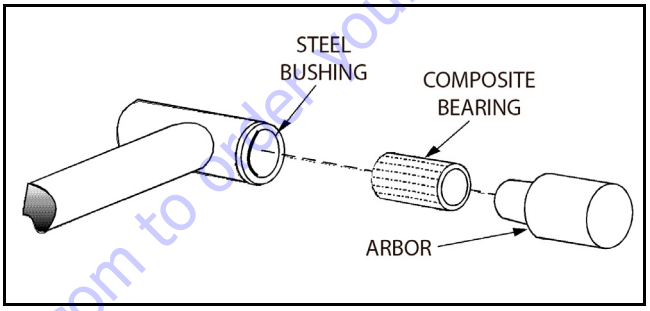


Figure 5-98. Composite Bearing Installation

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

ASSEMBLY

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

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

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

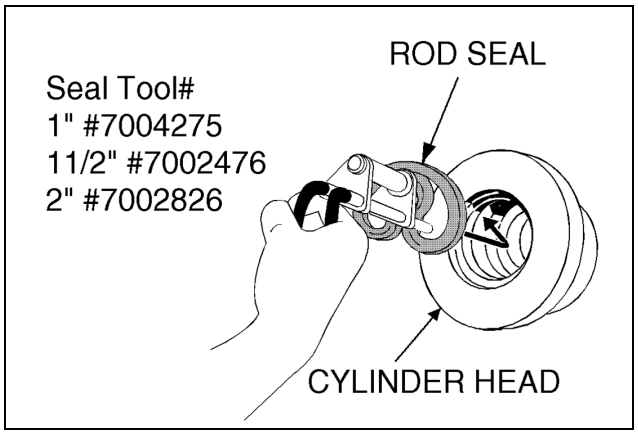


Figure 5-99. Rod Seal Installation

NOTICE

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

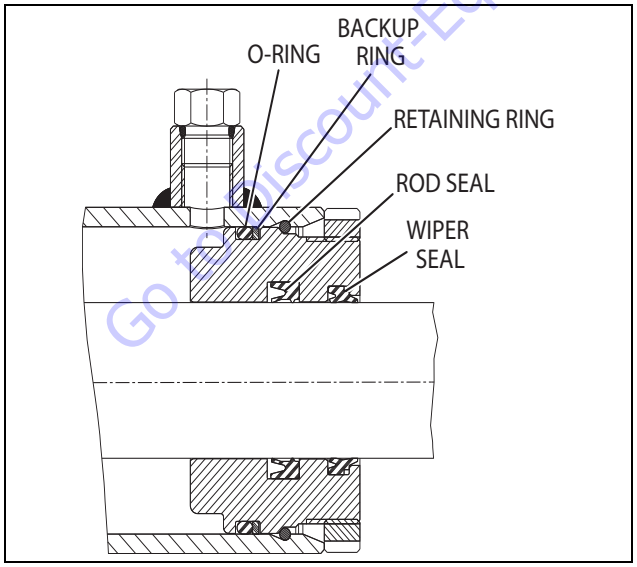


Figure 5-100. Cylinder Head Seal Installation

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

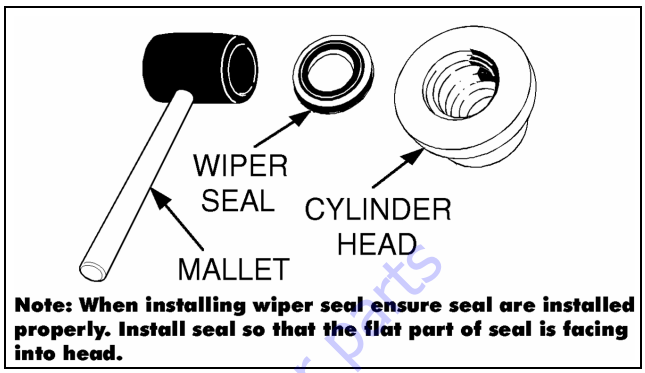


Figure 5-101. Wiper Seal Installation

3. Place a new o-ring, backup ring and retainer ring in the applicable outside diameter groove of the cylinder head.

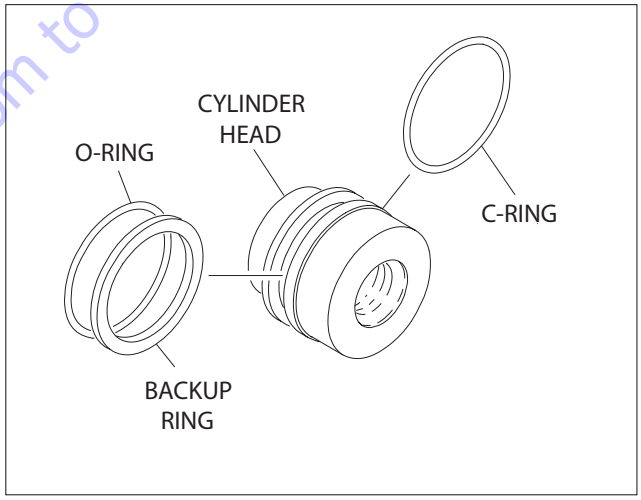


Figure 5-102. Installation of Head Seal Kit

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

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

6. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

7. Install locknut onto the piston rod.

8. Remove the cylinder rod from the holding fixture.

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

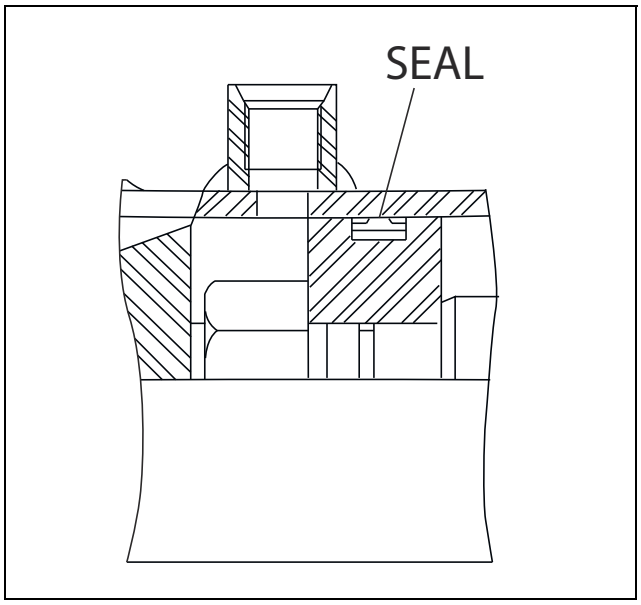


Figure 5-103. Piston Seal Kit Installation

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

NOTICE

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

11. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

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

13. Secure spanner nut into the cylinder barrel. Torque nut to 325-390 ft. lbs. (441-529 Nm).

14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves, if applicable.

Steer Cylinder (USA Built Machines SN 0300142625 through 0300177361 & China Built Machines SN B300000100 to Present)

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

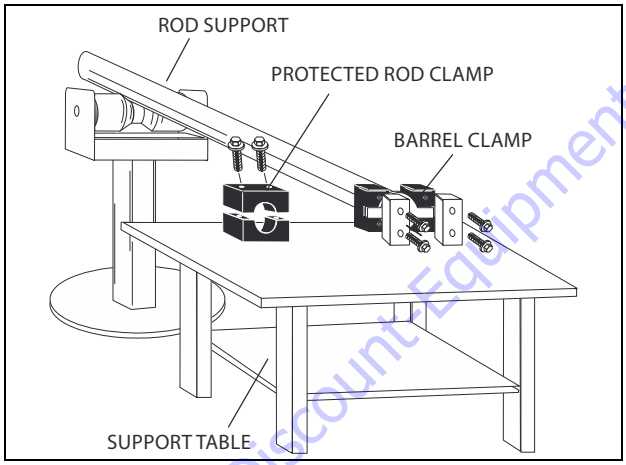


Figure 5-104. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

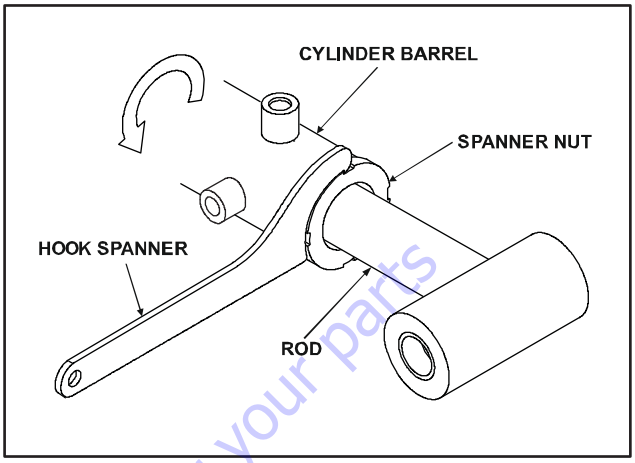


Figure 5-105. Spanner Nut Removal

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

NOTICE

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

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

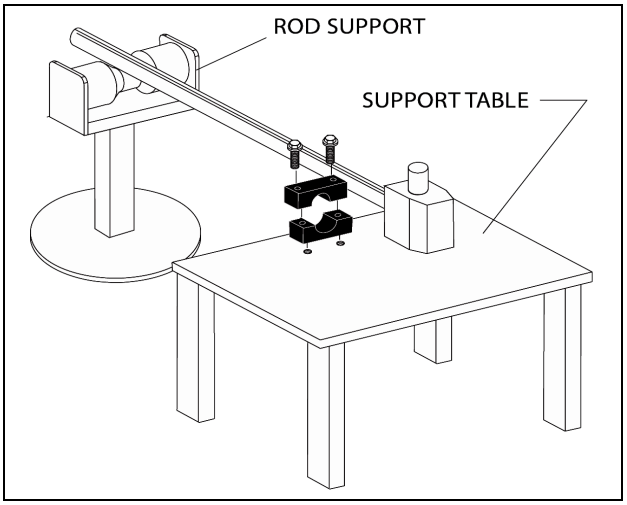
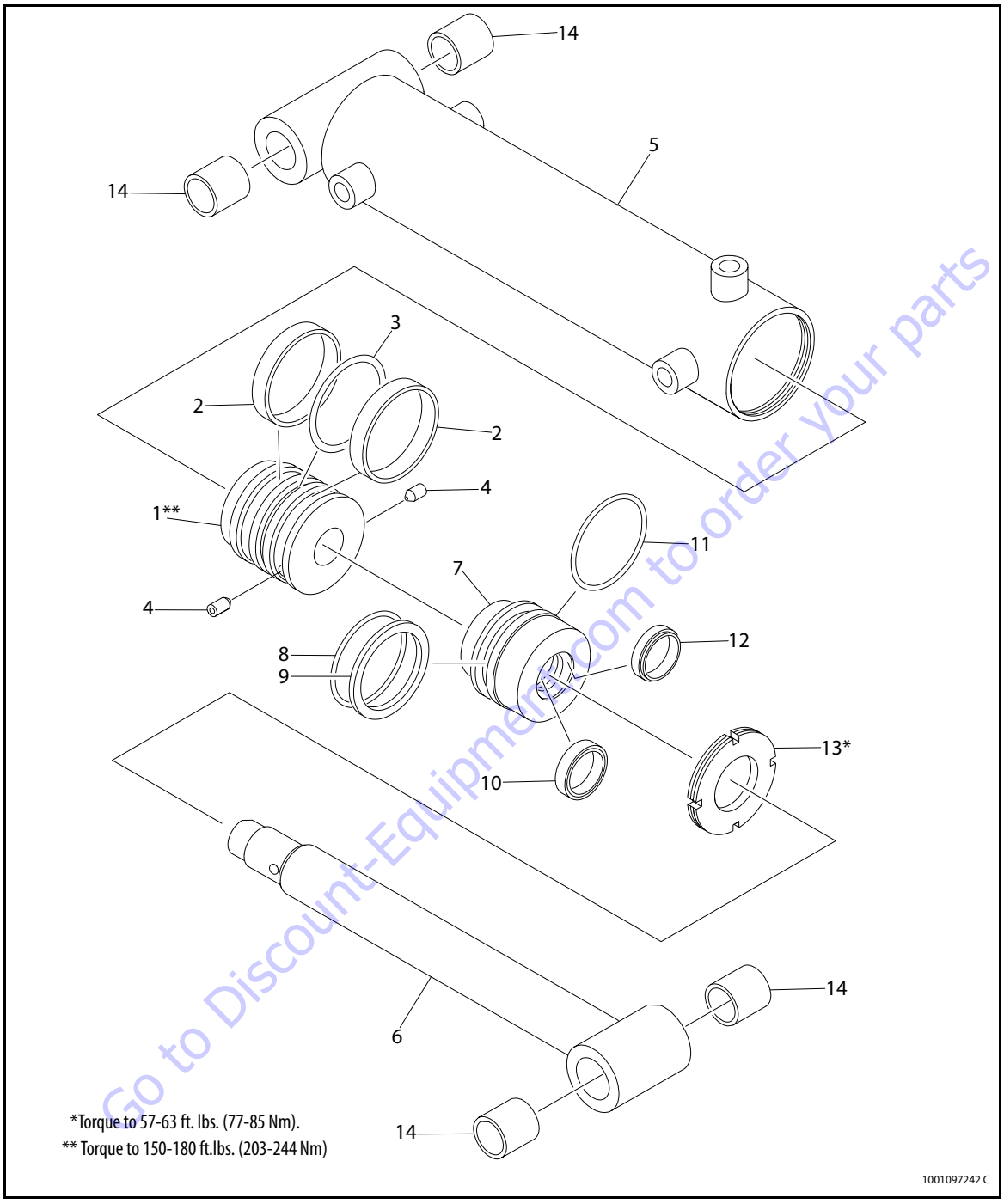


Figure 5-106. Cylinder Rod Support



1. Piston
2. Seal
3. O-ring
4. Setscrew
5. Barrel
6. Rod
7. Head
8. O-ring
9. Backup Ring
10. Rod Seal
11. C-ring
12. Wiper Seal
13. Spanner Nut
14. Bushing

Figure 5-107. Steer Cylinder (USA Built Machines SN 0300142625 through 0300177361 & China Built Machines SN B300000100 to Present)

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove the setscrews from the piston.
9. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
10. Remove and discard the piston seal and wear rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, rod seal, and wiper seal.

CLEANING AND INSPECTION

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

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

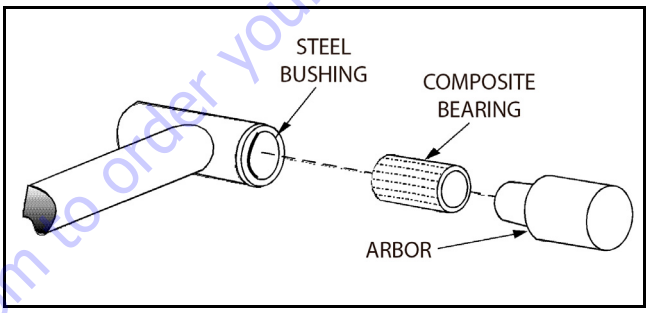


Figure 5-108. Composite Bearing Installation

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

ASSEMBLY

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

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

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

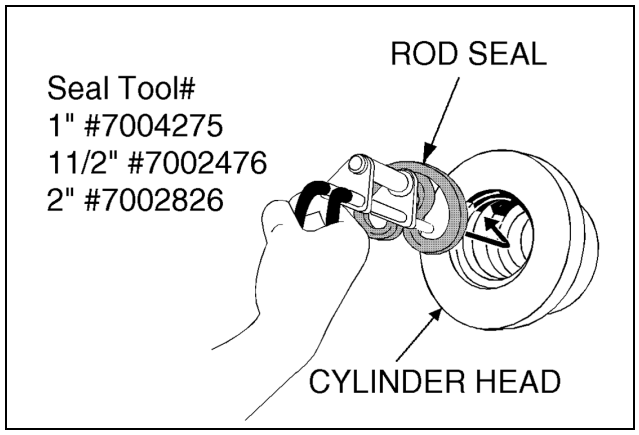


Figure 5-109. Rod Seal Installation

NOTICE

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

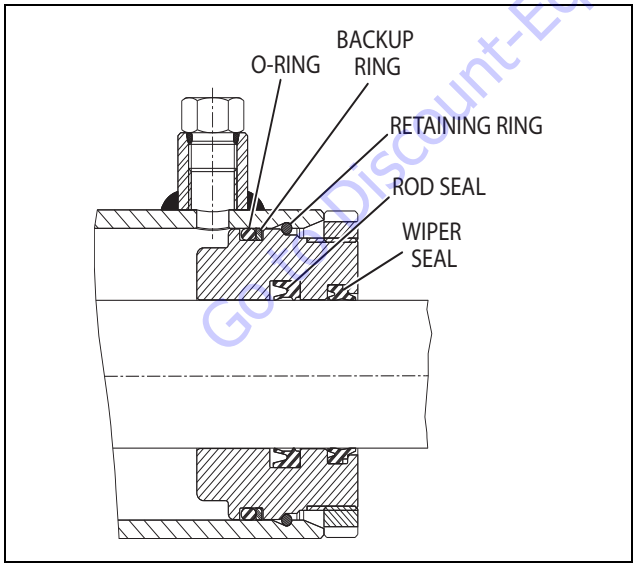


Figure 5-110. Cylinder Head Seal Installation

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

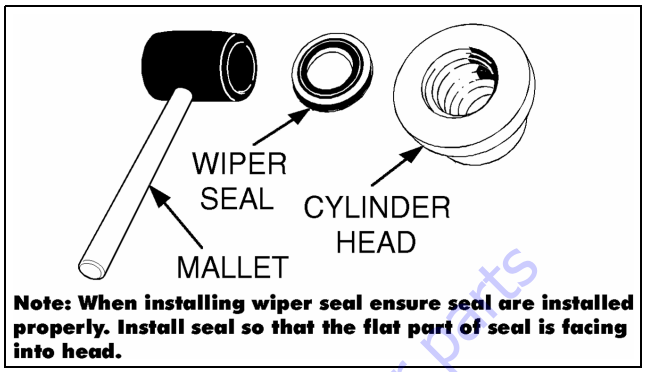


Figure 5-111. Wiper Seal Installation

3. Place a new o-ring, backup ring and c-ring in the applicable outside diameter groove of the cylinder head.

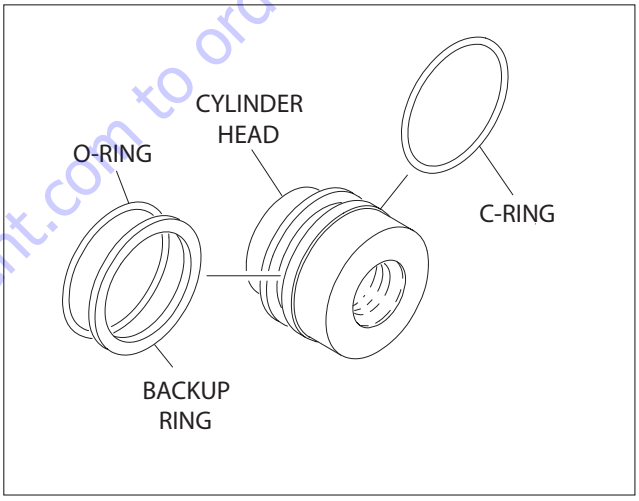


Figure 5-112. Installation of Head Seal Kit

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod and torque to 150-180 ft.lbs. (204-244 Nm), ensuring that the o-ring and backup rings are not damaged or dislodged.
7. Install the setscrews on the piston.
8. Remove the cylinder rod from the holding fixture.

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

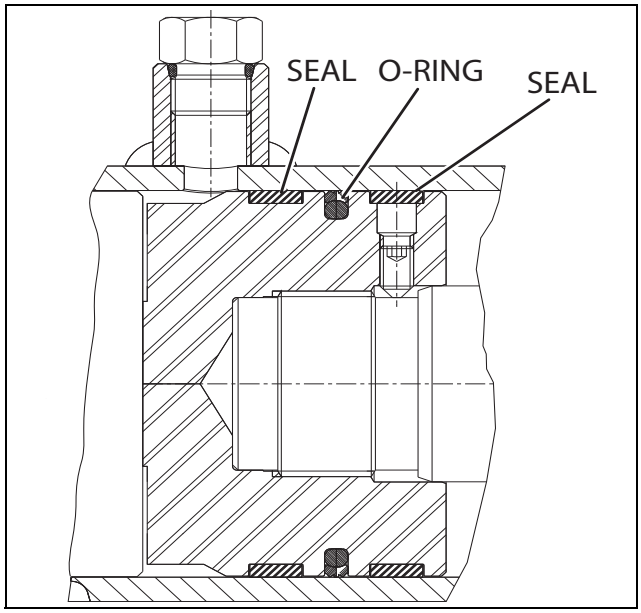


Figure 5-113. Piston Seal Kit Installation

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

NOTICE

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

11. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

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

13. Secure spanner nut into the cylinder barrel. Torque nut to 57-63 ft. lbs. (77-85 Nm).

14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves, if applicable.

Main Boom Telescope Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove capscrews and valve assembly from the barrel end. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

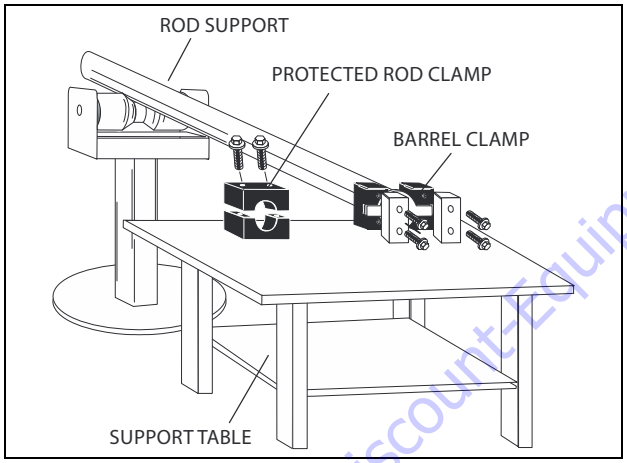


Figure 5-114. Cylinder Barrel Support

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

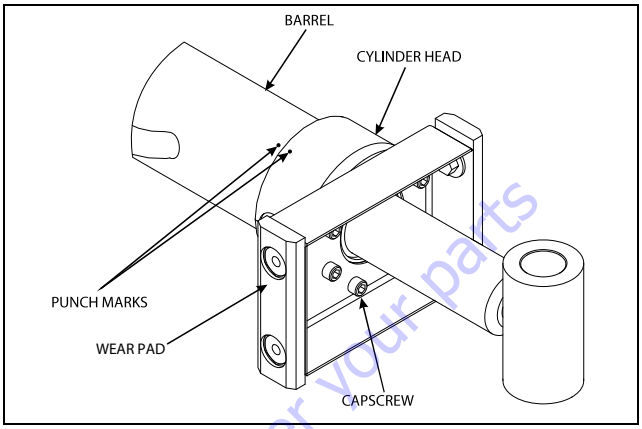


Figure 5-115. Capscrew Removal

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

NOTICE

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

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

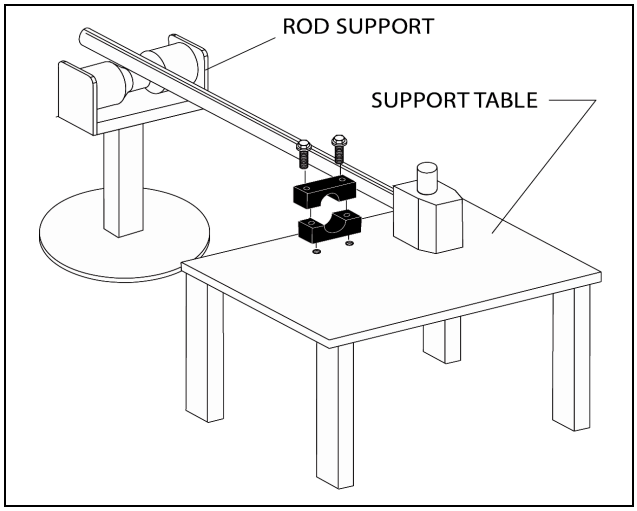
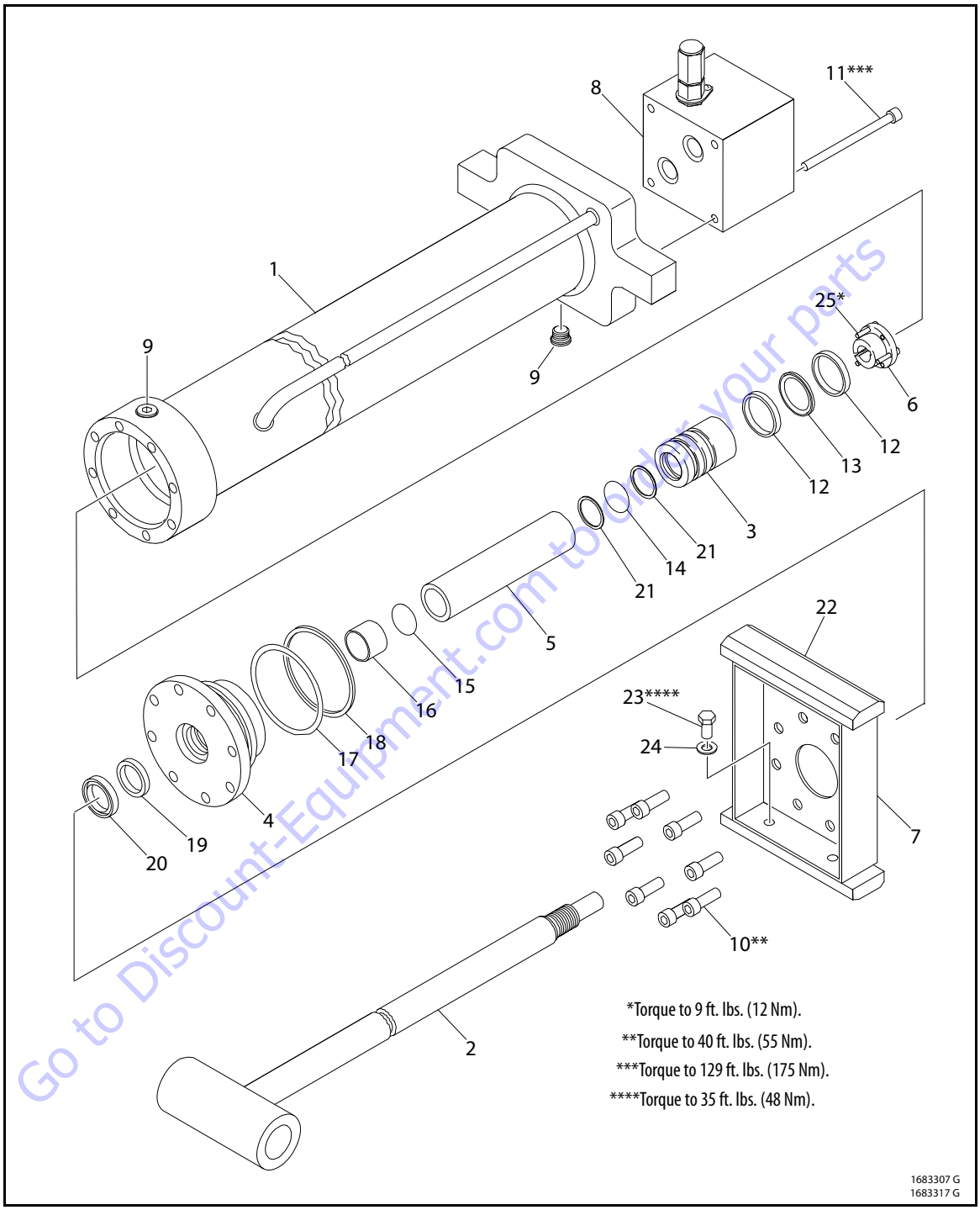


Figure 5-116. Cylinder Rod Support



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

Figure 5-117. Main Boom Telescopic Cylinder

8. Using suitable support, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled holes.
10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

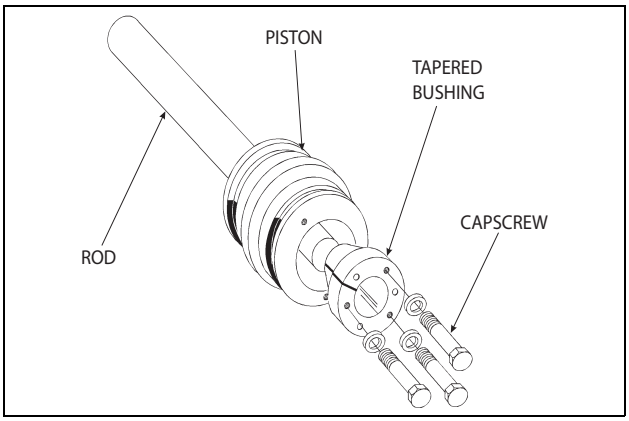


Figure 5-118. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-ring, seal ring, wear rings and backup rings.
14. Remove piston spacer and o-ring from rod.
15. Remove capscrews to remove plate and wear pads.
16. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, rod seal, wear ring and wiper seal.

CLEANING AND INSPECTION

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

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

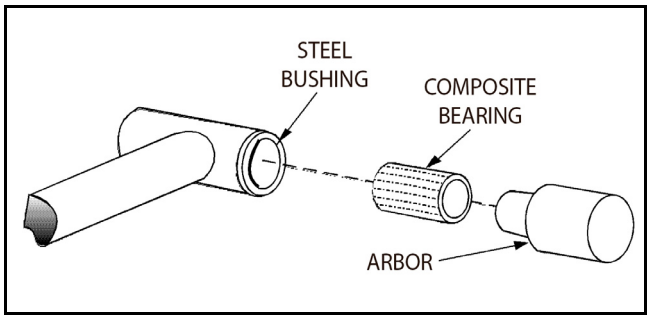


Figure 5-119. Composite Bearing Installation

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

ASSEMBLY

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

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

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

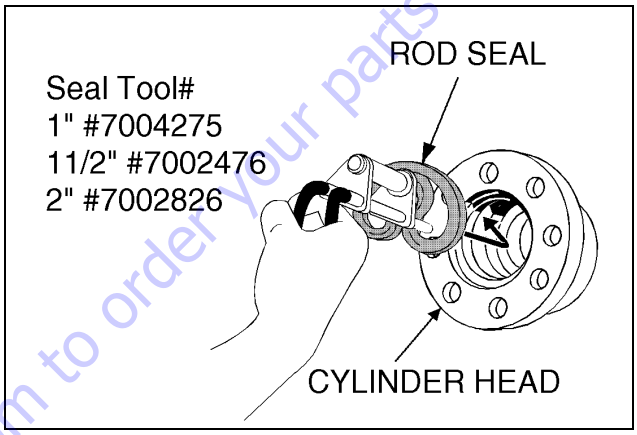


Figure 5-120. Rod Seal Installation

NOTICE

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

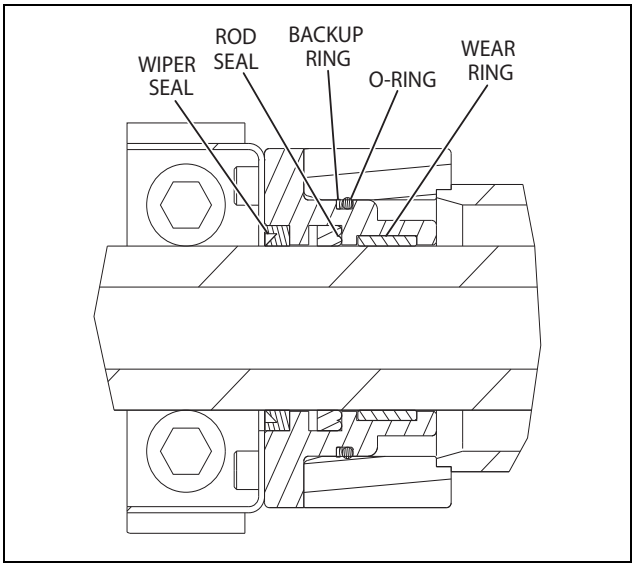


Figure 5-121. Cylinder Head Seal Installation

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

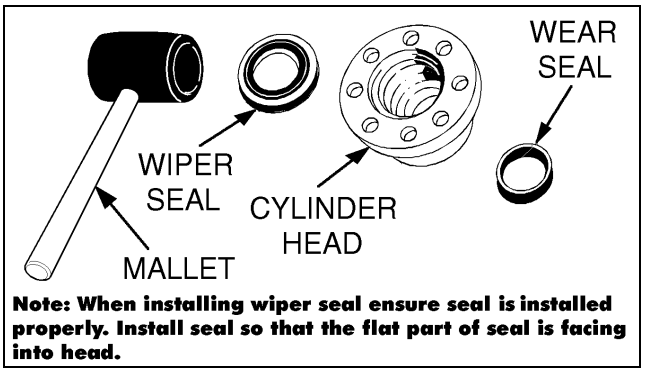


Figure 5-122. Wiper Seal Installation

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

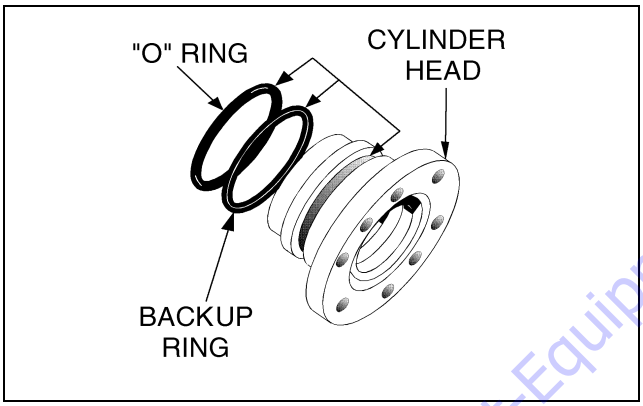


Figure 5-123. Installation of Head Seal Kit

4. Install plate on to the rod. Use capscrews to attach wear pads on the plate.

5. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

6. Install o-rings inside grooves of the piston spacer. Carefully slide the spacer on the rod.

7. Using suitable support, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

8. Place a new o-ring and backup rings in the inner piston diameter groove.

9. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

10. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

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

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

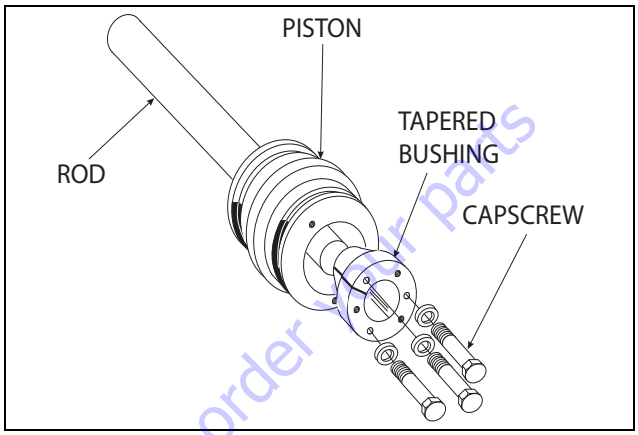


Figure 5-124. Tapered Bushing Installation

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

13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

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

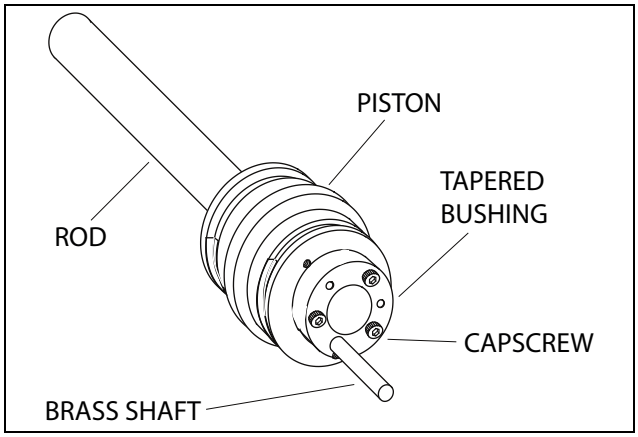


Figure 5-125. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation to 9 ft. lbs. (12 Nm).
15. Remove the cylinder rod from the holding fixture.
16. Place new seal and wear rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

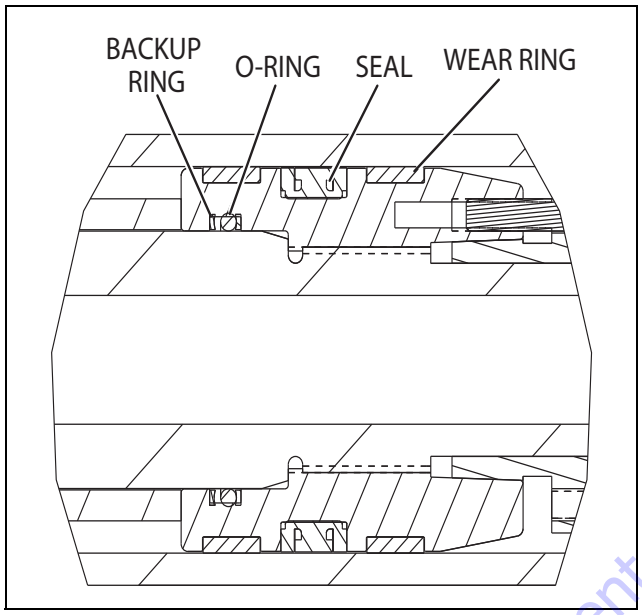


Figure 5-126. Piston Seal Kit Installation

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

NOTICE

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

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

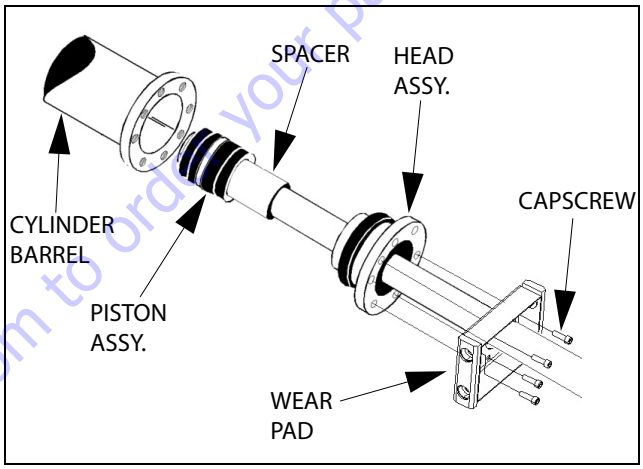


Figure 5-127. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the wear pad mounting plate, wear pads. Torque bolts to 40 ft. lbs. (55 Nm).
21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.
22. Install the valve assembly. Torque capscrew to 9 ft. lbs. (12 Nm).

Tower Boom Telescope Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the counterbalance valves and O-ring plugs from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

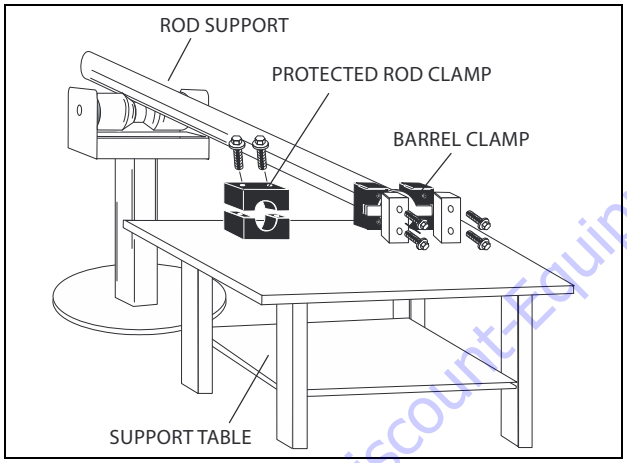


Figure 5-128. Cylinder Barrel Support

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

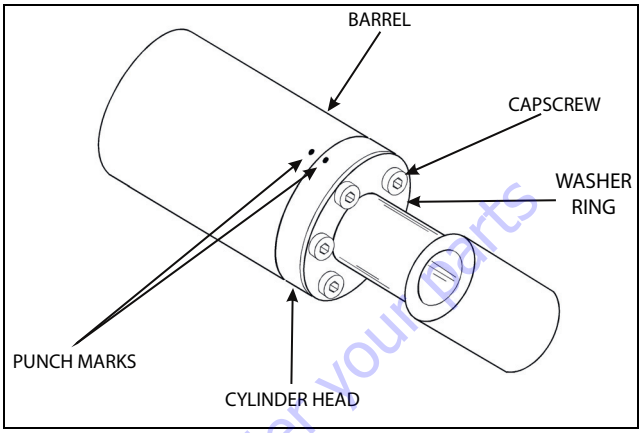


Figure 5-129. Capscrew Removal

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

NOTICE

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

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

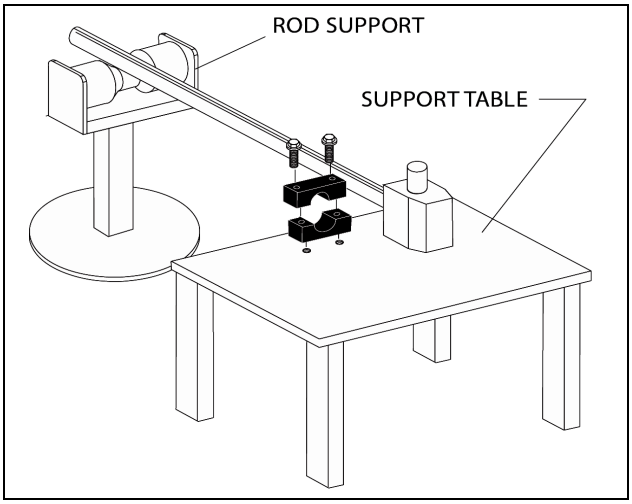
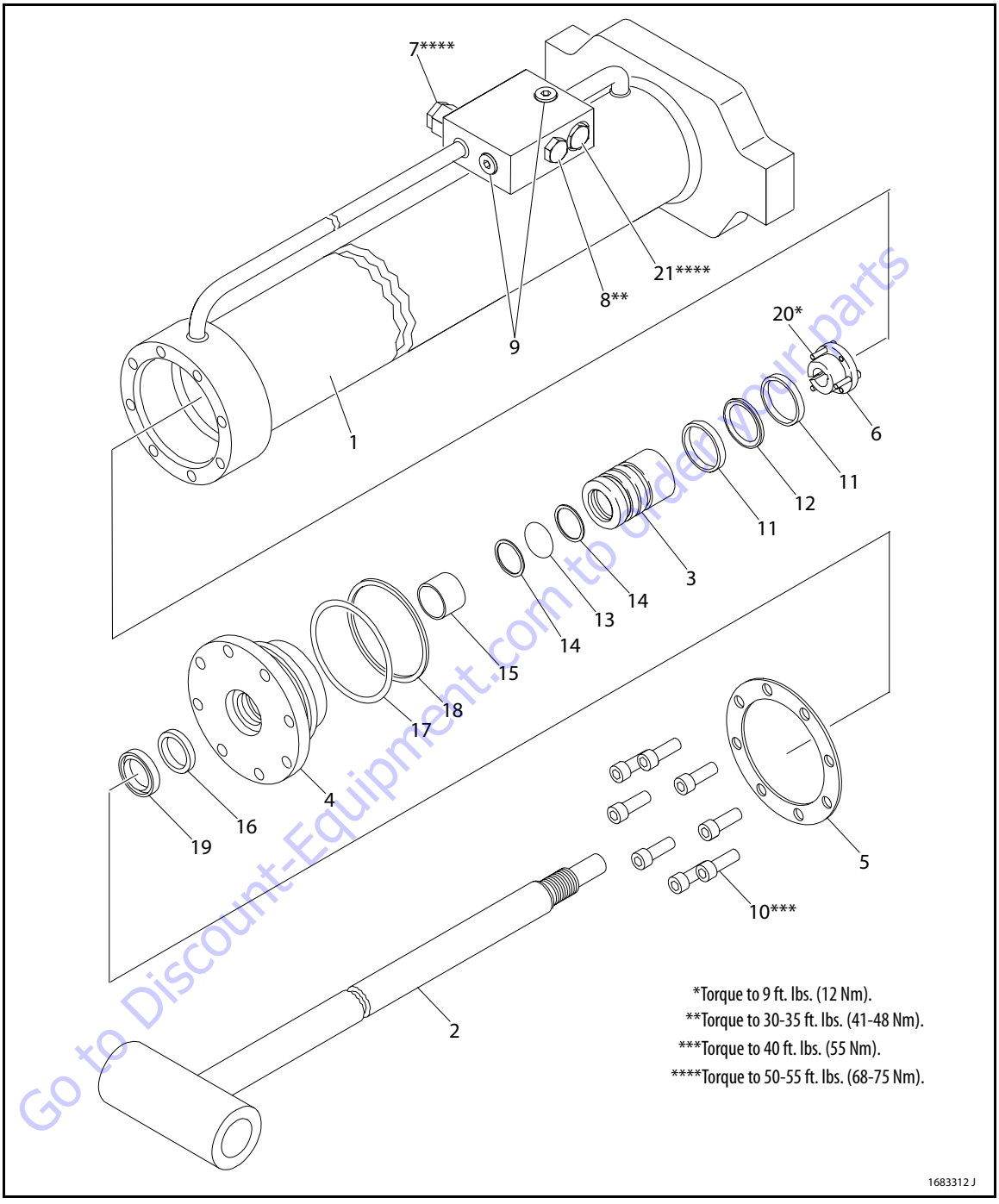


Figure 5-130. Cylinder Rod Support



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

Figure 5-131. Tower Boom Telescopic Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled holes.
10. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

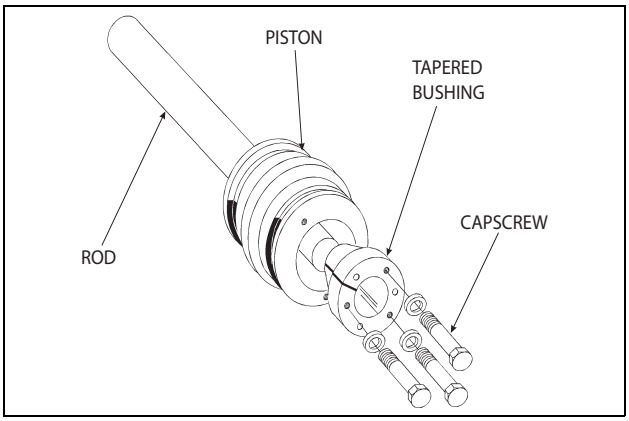


Figure 5-132. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-ring, backup ring, wear rings and T-seal.
14. Remove the rod from the holding fixture. Remove capscrews, target plate and washer ring. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, and wiper seals.

CLEANING AND INSPECTION

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

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

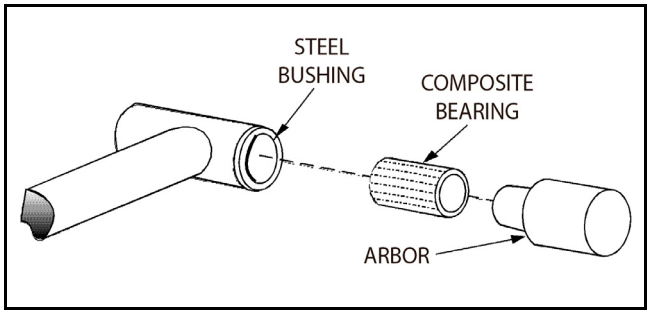


Figure 5-133. Composite Bearing Installation

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

ASSEMBLY

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

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

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

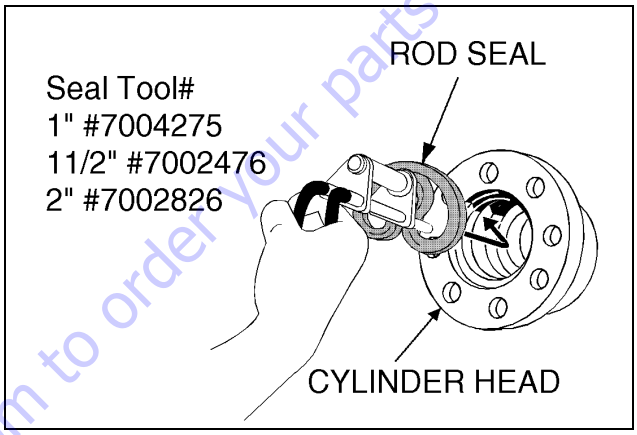


Figure 5-134. Rod Seal Installation

NOTICE

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

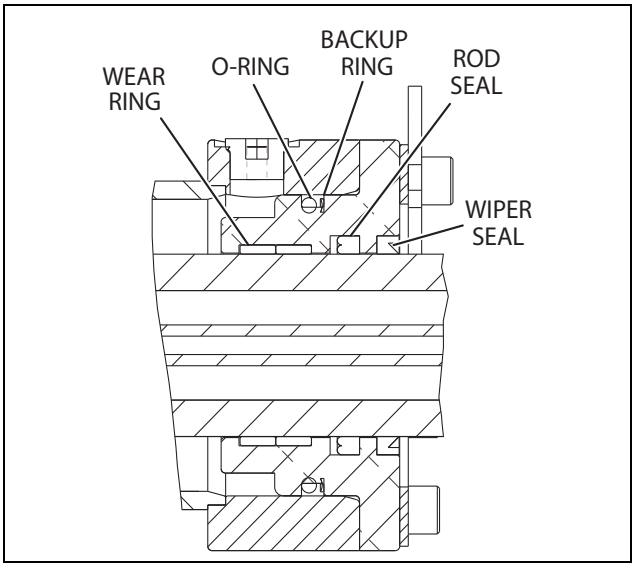


Figure 5-135. Cylinder Head Seal Installation