An Oshkosh Corporation Company

Service and Maintenance Manual

Models
800S
860SJ

P/N - 3121139

November 16, 2012

ANSI

CE

An Oshkosh Corporation Company

SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the aerial platform. It is of utmost importance that maintenance personnel pay strict attention to these warnings and precautions to avoid possible injury to themselves or others, or damage to the equipment. A maintenance program must be followed to ensure that the machine is safe to operate.

⚠ WARNING

MODIFICATION OR ALTERATION OF AN AERIAL WORK PLATFORM SHALL BE MADE ONLY WITH WRITTEN PERMISSION FROM THE MANUFACTURER.

The specific precautions to be observed during maintenance are inserted at the appropriate point in the manual. These precautions are, for the most part, those that apply when servicing hydraulic and larger machine component parts.

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

⚠ WARNING

SINCE THE MACHINE MANUFACTURER HAS NO DIRECT CONTROL OVER THE FIELD INSPECTION AND MAINTENANCE, SAFETY IN THIS AREA IS THE RESPONSIBILITY OF THE OWNER/OPERATOR.

B HYDRAULIC SYSTEM SAFETY

It should be noted that the machines hydraulic systems operate at extremely high potentially dangerous pressures. Every effort should be made to relieve any system pressure prior to disconnecting or removing any portion of the system.

Relieve system pressure by cycling the applicable control several times with the engine stopped and ignition on, to direct any line pressure back into the reservoir. Pressure feed lines to system components can then be disconnected with minimal fluid loss.

C MAINTENANCE

⚠ DANGER

FAILURE TO COMPLY WITH SAFETY PRECAUTIONS LISTED IN THIS SECTION COULD RESULT IN MACHINE DAMAGE, PERSONNEL INJURY OR DEATH AND IS A SAFETY VIOLATION.

- ENSURE REPLACEMENT PARTS OR COMPONENTS ARE IDENTICAL OR EQUIVALENT TO ORIGINAL PARTS OR COMPONENTS.
- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICEMANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTED-DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

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SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Table 1-1. Operating Specifications

Maximum Work Load (Capacity) Unrestricted: Restricted	 500 lb (230 kg) Refer to Capacity Decals on machine for restricted platform capacities
Maximum Capacity - Dual Rating 800S 860SJ	 1000 lb. (450 kg) 750 lb. (340 kg)
Maximum Travel Grade (Gradeability)* 2WD 4WD	 30% 45%
Maximum Travel Grade (Side Slope)*	5°
Maximum Vertical Platform Height:	800S - 80 ft. (24.3 m) 860SJ - 86 ft. (26.2 m)
Maximum Horizontal Platform Reach 800S 860SJ	 71 ft. (21.6 m) 75 ft. (22.9 m)
Turning Radius (outside)	22 ft. 6 in. (6.8 m)
Turning Radius (inside)	12 ft. (3.6 m)
Maximum Drive Speed:	3.5 mph (1.5 m/s)
Max. Hydraulic System Pressure	4500 psi (310 Bar)
Maximum Wind Speed	28 mph (12.5 m/s)
Maximum Manual Force	400 N
Electrical System Voltage	12 Volts
Gross Machine Weight (Platform Empty) 800S 860SJ	 34,700 lbs. (15,740 kg) 37,900 lbs. (17,191 kg)

* With boom in stowed position

1.2 SPECIFICATIONS AND PERFORMANCE DATA

Table 1-2. Specifications and Performance Data

Swing	360°
Tail Swing	4'8" (1.42 m)
Platforms	36" x 72" (0.91m x 1.83m) 36" x 96" (0.91m x 2.44m)
Overall Width	8' 2" (2.5 m)
Stowed Height 800S 860SJ	 9' 10.6" (3.01 m) 10' (3.04 m)
Stowed Length 800S 860SJ	 37' 3.25" (11.4 m) 40' (12.2 m)
Wheel base	10' (3.04 m)
Ground Clearance	15.625" (0.4 m)
Drive Speed Stowed 2WD Stowed 4WD Elevated	 3.0 mph (5.5 kph) 3.5 mph (5.6 kph) 0.75 mph (1.2 kph)
Ground Bearing Pressure - 800S 15-625 15-625FF 41/18LLx22.5	 72 psi (5.0 kgm/cm^2) 79 psi (5.5 kgm/cm^2) 68 psi (4.8 kgm/cm^2)
Ground Bearing Pressure - 860SJ 15-625 15-625FF 41/18LLx22.5	 81 psi (5.7 kgm/cm^2) 92 psi (6.5 kgm/cm^2) 79 psi (5.5 kgm/cm^2)
Max. Tire Load - 800S 15-625 15-625FF 41/18LLx22.5	 16,900 lbs. (7665 kg) 17,200 lbs. (7802 kg) 17,300 lbs. (7850 kg)
Max. Tire Load - 860SJ 15-625 15-625FF 41/18LLx22.5	 19,800 lbs. (8981 kg) 20,100 lbs. (9117 kg) 20,200 lbs. (9163 kg)

1.3 CAPACITIES

Table 1-3. Capacities

Fuel Tank	Approx. 31 gallons (117 liters)
Hydraulic Tank	Approx. 47.8 gallons (181 liters)
Engine Oil Capacity	
Ford	4.5 Quarts (4.25 L) w/Filter
Deutz	
Cooling System	5 Quarts (4.5 L)
Crankcase	11 Quarts (10.5 L) w/Filter
Total Capacity	16 Quarts (15 L)
Caterpillar	10.6 quarts (10 L)
GM	4.5 Quarts (4.25 L) w/Filter

1.4 COMPONENT DATA

Engine Data

Table 1-4. Ford LRG-425 Specifications

Type	Water-cooled
Fuel	Gasoline
Oil Capacity	4.5 Quarts (4.25 L) w/Filter
Idle RPM	1000
Low RPM	1800
High RPM	2800
Alternator	95 Amp, Belt Drive
Fuel Consumption	
Low RPM	3.45 GPH (13.06 lph)
High RPM	4.60 GPH (17.41 lph)
Horsepower	74 @ 3000 RPM, full load
Cooling System	16 Quarts (15.14 L)
Spark Plug	AWSF-52-C
Spark Plug Gap	0.044 in. (1.117 mm)

Table 1-5. Deutz F4M2011 Specifications

Type	Liquid Cooled (Oil)
Fuel	Diesel
Oil Capacity	
Cooling System	5 Quarts (4.5 L)
Crankcase	11 Quarts (10.5 L) w/Filter
Total Capacity	16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2800
Alternator	55 Amp, belt drive
Fuel Consumption	
Low RPM	1.90 GPH (7.19 lph)
High RPM	2.50 GPH (9.46 lph)
Horsepower	66 @ 3000 RPM, full load

Table 1-6. Deutz D2011L04 Specifications

Type	Liquid Cooled (Oil)
Fuel	Diesel
Oil Capacity	
Cooling System	5 Quarts (4.5 L)
Crankcase	11 Quarts (10.5 L) w/Filter
Total Capacity	16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2600
Alternator	55 Amp, belt drive
Fuel Consumption	
Low RPM	1.90 GPH (7.19 lph)
High RPM	2.50 GPH (9.46 lph)
Battery	1000 Cold Cranking Amps, 210 minutes Reserve Capacity, 12 VDC
Horsepower	64 @ 2600 RPM, full load

Table 1-7. Caterpillar 3044C/ Caterpillar 3.4

Type	Four Stroke Cycle
Cylinders	4 in-line
Bore	3.70 inch (94 mm)
Stroke	4.72 inch (120 mm)
Aspiration	turbocharged
Compression ratio	19:1
Displacement	203 in^3 (3.33 L)
Firing Order	1-3-4-2
Rotation (viewed from flywheel)	Counterclockwise
Oil Capacity (w/filter)	10.6 quarts (10 L)
Cooling System (Engine Only)	5.8 quarts (5.5 L)
Idle RPM	1000
Low RPM	1800
High RPM - 3044C	2600
High RPM - 3.4	2500
Alternator	60 Amp, belt drive

Table 1-8. GM 3.0L

Fuel	Gasoline or Gasoline/LP Gas
No. of Cylinders	4
BHP Gasoline LP	 83 hp @ 3000 rpm 75 hp @ 3000 rpm
Bore	4.0 in. (101.6 mm)
Stroke	3.6 in. (91.44 mm)
Displacement	181 cu.in. (3.0 L, 2966 cc)
Oil Capacity w/filter	4.5 qts. (4.25 L)
Minimum Oil Pressure at idle Hot	 6 psi (0.4 Bar) @ 1000 rpm 18 psi (1.2 Bar) @ 2000 rpm
Compression Ratio	9.2:1
Firing Order	1-3-4-2
Max. RPM	2800

Battery

Table 1-9. Battery Specifications

Voltage	12 Volt
Type	31-5
Cold Cranking Amps	1000 CCA @ 0° F (-18° C)
Reserve Capacity	210 Minutes @ 80° F (27° C)

1.5 TIRES

Table 1-10. Tire Specifications

Size	Type	Ply Rating	Load Range	Weight (Tire & Wheel)
15 - 625	Pneumatic 95 psi (6.5 Bar)	16	H	269 lbs. (122 kg)
15 - 625	Foam-Filled	16	H	544 lbs. (247 kg)
18 - 625	Pneumatic 85 psi (6.5 Bar)	16	H	288 lbs. (131 kg)
18 - 625	Foam-Filled	16	H	601 lbs. (273 kg)
41/ 18LL x 22.5	Foam-Filled	16	H	724 lbs. (329 kg)

1.6 FUNCTION SPEEDS

Table 1-11. Function Speeds (In Seconds)

Function	800S	860SJ
Lift Up	59-75	56-73
Lift Down	57-75	56-75
Swing Right & Left*	110-135	110-135
Telescope Out	59-65	56-65
Telescope In	45-57	44-60
Platform Rotate Right & Left**	18-30	18-30
Jib Up	N/A	33-47
Jib Down	N/A	29-39
Drive (Forward)	33-45	33-45
Drive (Reverse)	33-45	33-45
Drive (Elevated)	46-75	46-75
*Max 10% Difference Between Left & Right **Max 15% Difference Between Left & Right		

Machine Orientation When Doing Speed Tests

Lift: Telescope Retracted. Lift Up, Record Time, Lift Down, Record Time.

Swing: Boom at Full Elevation. Telescope Retracted. Swing the Turntable 360 degrees, Record Time. Swing the Opposite Direction, Record Time.

Telescope: Boom at Full Elevation; Telescope Retracted; Telescope Out, Record Time. Telescope In, Record Time.

Drive (Forward/Reverse): Test should be done on a smooth level surface. Drive Select Switch should be set to High Engine. Results should be recorded for a 200 ft. course. Drive Forward, Record Time. Drive Reverse, Record Time.

Drive (Elevated): Test should be done on a smooth level surface. Drive Select Switch should be set to High Engine. Results should be recorded for a 50 ft. course. Drive Forward, Record Time. Drive Reverse, Record Time.

Platform Rotate: Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

Articulating Jib: Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
3. The platform speed knob control must be at full speed (turned clockwise completely).
4. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).
5. Some flow control functions may not work with the speed knob clicked into the creep position.

1.7 TORQUE REQUIREMENTS

Table 1-12. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Wheel Lugs	300 ft. lbs. (407 Nm)	150
Swing Bearing Bolts	190 ft. lbs. (258 Nm)	50/600*
Starter Solenoid Contacts Coil	 95 in. lbs. (9.5 Nm) 40 in. lbs. (4 Nm)	 As required
*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter. (See Swing Bearing in Section 3.)		
NOTE: *When maintenance becomes necessary or a fastener has loosened, refer to the Torque Chart to determine proper torque value.*		

1.8 LUBRICATION

Hydraulic Oil

Table 1-13. Hydraulic Oil

Hydraulic System Operating Temperature Range	S.A.E. Viscosity Grade
+0° to + 180° F (-18° to +83° C)	10W
+0° to + 210° F (-18° to +99° C)	10W-20, 10W30
+50° to + 210° F (+10° to +99° C	20W-20

NOTE: *Hydraulic oils must have anti-wear qualities at least to API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service. JLG Industries recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity index of 152.*

NOTE: *When temperatures remain consistently below 20 degrees F. (-7 degrees C.), JLG Industries recommends the use of Mobil DTE13.*

Aside from JLG recommendations, it is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. If use of hydraulic oil other than Mobilfluid 424 is desired, contact JLG Industries for proper recommendations.

Table 1-14. Mobilfluid 424 Specs

SAE Grade	10W30
Gravity, API	29.0
Density, Lb/Gal. 60°F	7.35
Pour Point, Max	-46°F (-43°C)
Flash Point, Min.	442°F (228°C)
Viscosity	
Brookfield, cP at -18°C	2700
at 40° C	55 cSt
at 100° C	9.3 cSt
Viscosity Index	152

Table 1-15. Mobil DTE 13M Specs

ISO Viscosity Grade	#32
Specific Gravity	0.877
Pour Point, Max	-40°F (-40°C)
Flash Point, Min.	330°F (166°C)
Viscosity	
at 40° C	33cSt
at 100° C	6.6 cSt
at 100° F	169 SUS
at 210° F	48 SUS
cp at -20° F	6,200
Viscosity Index	140

Table 1-16. Mobil EAL 224H Specs

Type	Synthetic Biodegradable
ISO Viscosity Grade	32/46
Specific Gravity	.922
Pour Point, Max	-25°F (-32°C)
Flash Point, Min.	428°F (220°C)
Operating Temp.	0 to 180°F (-17 to 162°C)
Weight	**7.64 lb. per gal. (0.9 kg per liter)**
Viscosity	
at 40° C	37 cSt
at 100° C	8.4 cSt
Viscosity Index	213
NOTE: *Must be stored above 32°F (14°C)*	

Table 1-17. UCon Hydrolube HP-5046

Type	Synthetic Biodegradable
Specific Gravity	1.082
Pour Point, Max	-58°F (-50°C)
pH	9.1
Viscosity	
at 0° C (32° F)	340 cSt (1600SUS)
at 40° C (104° F)	46 cSt (215SUS)
at 65° C (150° F)	22 cSt (106SUS)
Viscosity Index	170

1.9 PRESSURE SETTINGS

Table 1-18. Pressure Settings

Telescope Out	2500 psi (172 Bar)
Swing, Left & Right	1700 psi (117 Bar)
Steer	2500 psi (172 Bar)
Platform Level Up	2600 psi (179 Bar)
Platform Level Down	1800 psi (124 Bar)
Jib, Up & Down	1700 psi (117 Bar)

1.10 MAJOR COMPONENT WEIGHTS

Table 1-19. Component Weights

Component	Pounds	Kilograms
Turntable (no other components included)	3700	1678
Counterweight (800S)	7000	3175
Counterweight (860SJ)	8750	3969
Upright	1050	476
Tower	685	311
Fly Boom (SJ)	472	214
Fly Boom (S)	490	222
Mid Boom (SJ)	750	340
Mid Boom (S)	740	336
Base Boom (SJ)	1400	635
Base Boom (S)	1410	640
Boom Assembly	3337	1514
Telescope Cylinder (800S)	590	268
Telescope Cylinder (860SJ)	570	259
Slave Cylinder	73	33
Torque Hub (2WD)	218	99
Tire & Wheel (pneu)	269	122
Tire & Wheel (FF)	544	247

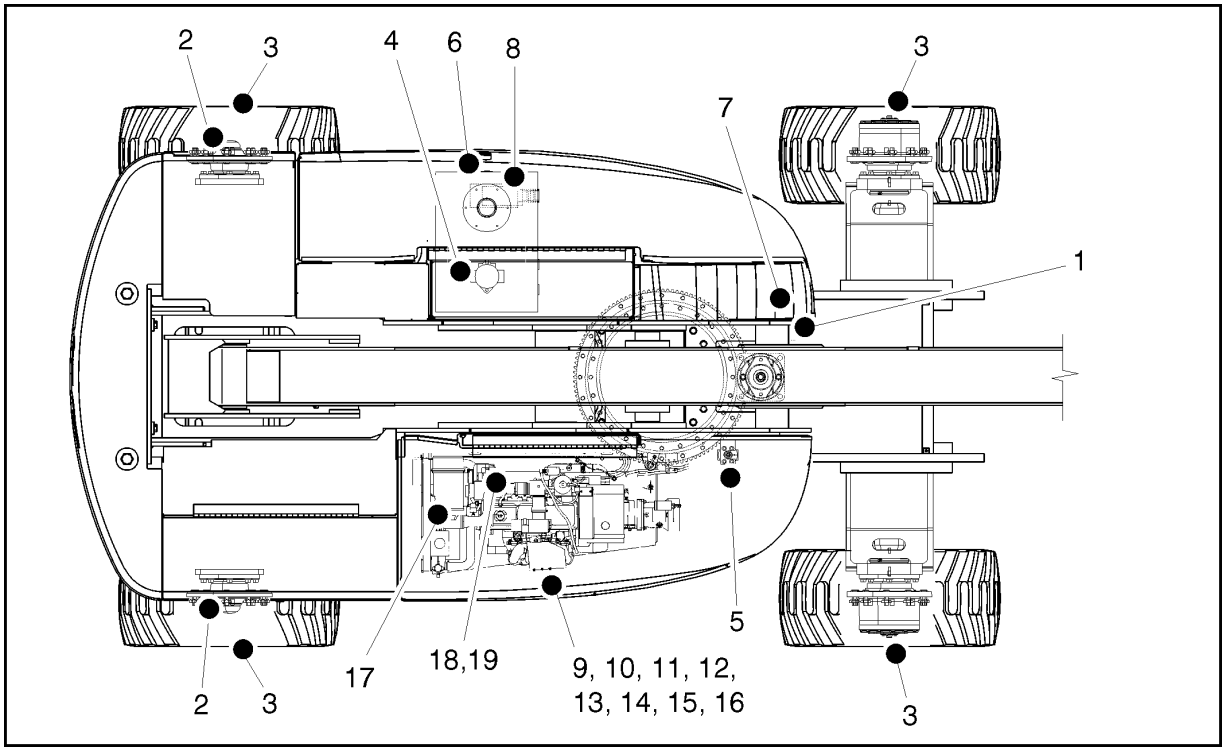


Figure 1-1. Operator Maintenance and Lubrication Diagram

1.11 OPERATOR MAINTENANCE

NOTE: *The following numbers correspond to those in Figure 1-1., Operator Maintenance and Lubrication Diagram.*

Table 1-20. Lubrication Specifications

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350° F (177° C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
HO	Hydraulic Oil. API service classification GL-3, e.g. Mobilfluid 424.
EO	Engine (crankcase) Oil. Gas - API SF, SH, SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C.

NOTICE

LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

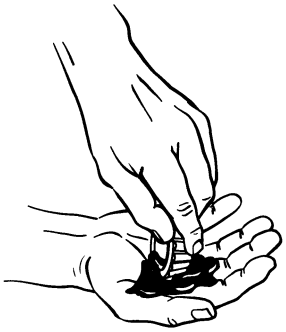
NOTE: *It is recommended as a good practice to replace all filters at the same time.*

1.Swing Bearing - Internal Ball Bearing



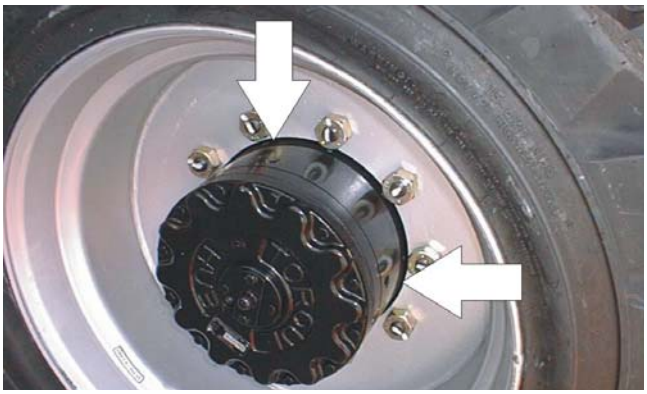
Lube Point(s) - 1 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
Comments - Remote Access

2. Wheel Bearings



Lube Point(s) - Repack
Capacity - A/R
Lube - MPG
Interval - Every 2 years or 1200 hours of operation

3. Wheel Drive Hub



Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (0.5 L) - 1/2 Full
Lube - EPGL
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation
Comments - Place Fill port at 12 o'clock position and Check port at 3 o'clock position. Pour lubricant into fill port until it just starts to flow out of check port.

4. Hydraulic Return Filter



Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

5. Hydraulic Charge Filter



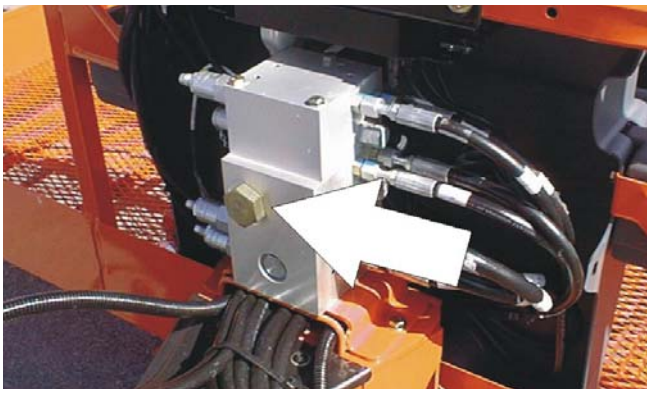
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

6. Hydraulic Tank



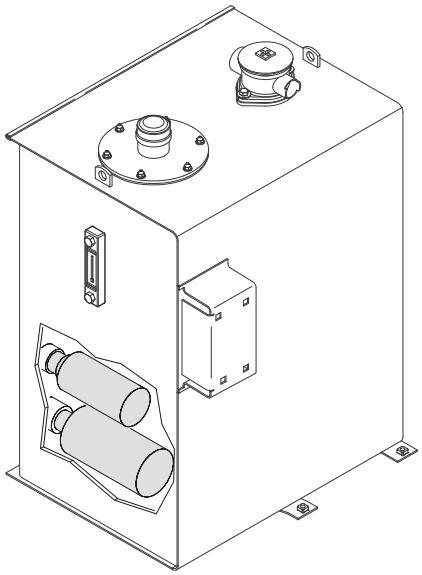
Lube Point(s) - Fill Cap
Capacity - 116 liters Tank 124 liters System
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

7. Platform Filter



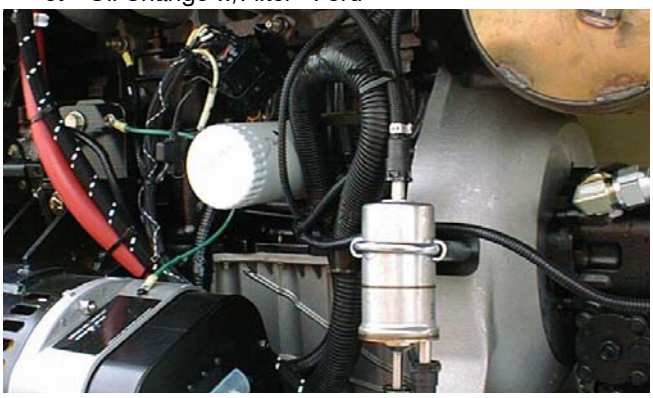
Interval - Change as necessary

8. Suction Strainers



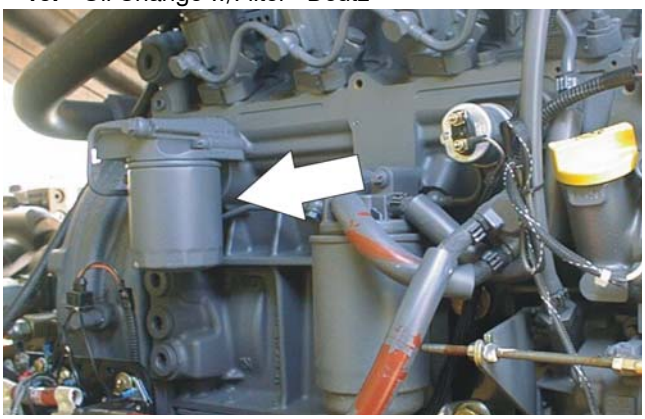
Lube Point(s) - 2
Interval - Every 2 years or 1200 hours of operation, remove and clean at time of hydraulic oil change.

9. Oil Change w/Filter - Ford



Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 4.5 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

10. Oil Change w/Filter - Deutz



Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 11 Quarts(10.5 L) Crankcase;
Lube - EO
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

11. Oil Change w/Filter - Caterpillar

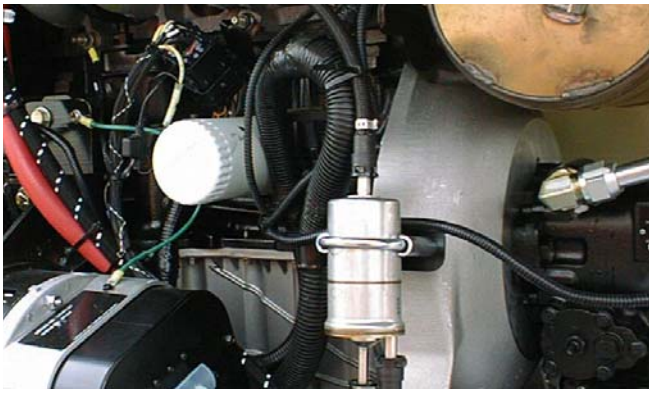
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 10.6 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

12. Oil Change w/Filter - GM



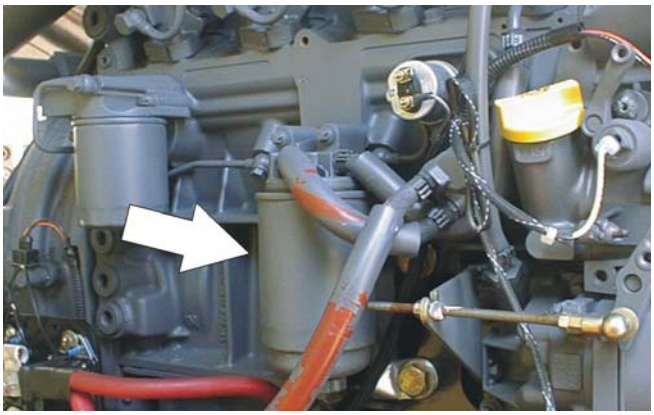
Lube Point(s) - Fill Cap/Spin-on Element
(JLG P/N 7027965)
Capacity - 4.5 qt. (4.25 L) w/filter
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

13. Fuel Filter - Ford



Lube Point(s) - Replaceable Element
Interval - Every Year or 1200 hours of operation

14. Fuel Filter - Deutz



Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation

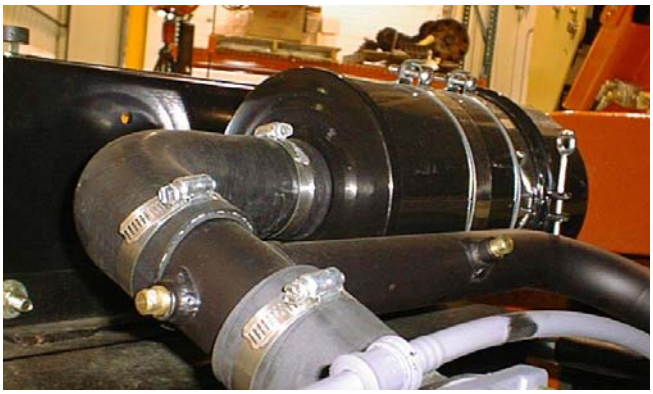
15. Fuel Filter - Caterpillar

Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation

16. Fuel Filter (Gasoline) - GM

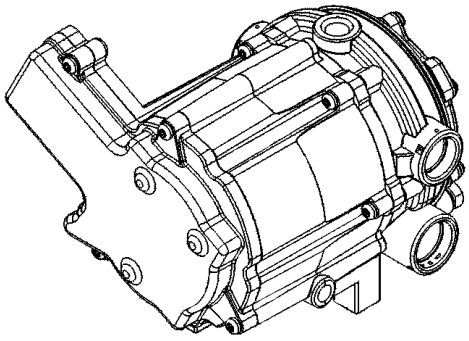
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation

17. Air Filter



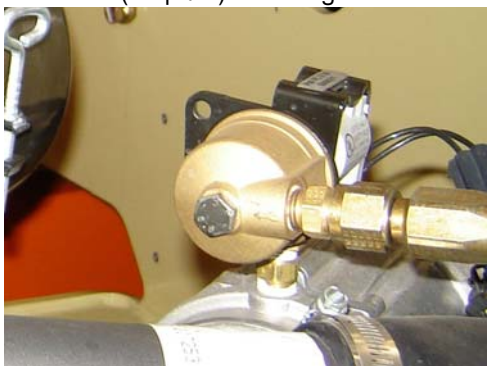
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator

18. Electronic Pressure Regulator (LP only)



Interval - 3 Months or 150 hours of operation
Comments - Drain oil build up. Refer to Draining Oil Build Up From The Propane Regulator

19. Fuel Filter (Propane) - GM Engine



Interval - 3 Months or 150 hours of operation
Comments - Replace filter. Refer to Propane Fuel Filter Replacement

Draining Oil Build Up From The Propane Regulator

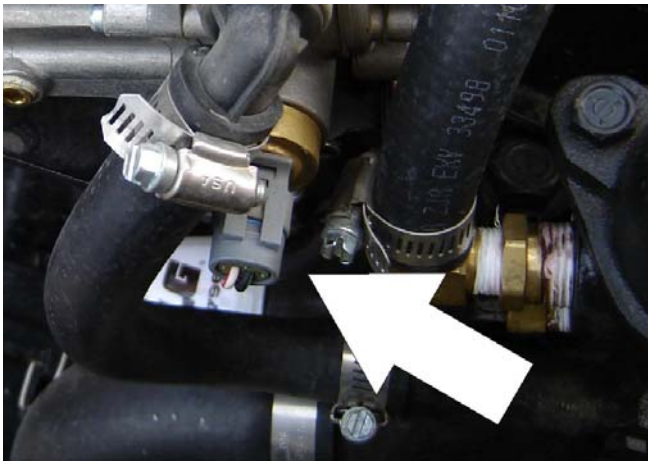
During the course of normal operation oils may build inside the primary and secondary chambers of the propane pressure regulator. These oils may be a result of poor fuel quality, contamination of the fuel supply chain, or regional variation in the make up of the fuel. If the build up of the oil is significant this can effect the operation of the fuel control system. Refer to Section 1.11, Operator Maintenance for maintenance intervals. More frequent draining may be required if the fuel supply has been contaminated.

NOTICE

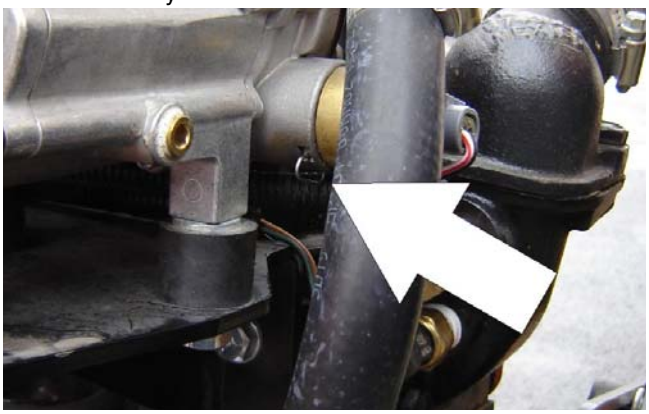
FOR BEST RESULTS WARM THE ENGINE TO OPERATING TEMPERATURE BEFORE DRAINING. THIS WILL ALLOW THE OILS TO BE LIQUID AND FLOW FREELY FROM THE REGULATOR.

1. Move the equipment to a well ventilated area. Ensure there are no external ignition sources.
2. Start the engine and bring to operating temperature.
3. With the engine running, close the manual tank valve and run the engine out of fuel.
4. Push in the Emergency Switch once the engine stops.

5. Disconnect the electrical connection to the LPG fuel temperature sensor in the auxiliary fuel port of the EPR.



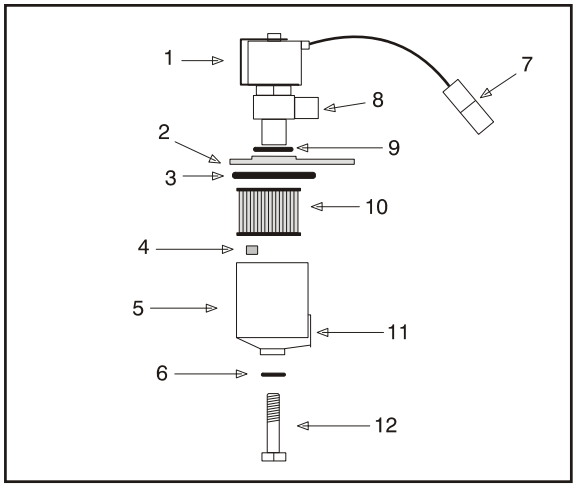
6. Remove the retainer clip for the LPG fuel temperature sensor and remove the sensor from the regulator body.



NOTE: *Have a small container ready to collect oil that will drain freely from the regulator at this point.*

7. Once all of the oil has been drained, reinstall the LPG fuel temperature sensor and reconnect the electrical connector.
8. Open the fuel tank manual valve.
9. Start the engine and verify all connections are secure.
10. Dispose of any drained oil in a safe and proper fashion.

Propane Fuel Filter Replacement



1. Electric Lock Off Solenoid
2. Mounting Plate
3. Housing Seal
4. Filter Magnet
5. Filter Housing
6. Seal
7. Electrical Connector
8. Fuel Outlet
9. O-ring
10. Filter
11. Fuel Inlet
12. Retaining Bolt

Figure 1-2. 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. Locate Filter magnet and remove it.
6. Remove the filter from the housing.
7. Remove and discard the housing seal.
8. 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. 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. 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.

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.

⚠ CAUTION

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

1.12 SERIAL NUMBER LOCATION

A serial number plate is affixed to the left rear side of the frame. If the serial number plate is damaged or missing, the machine serial number is stamped on the left side of the frame.

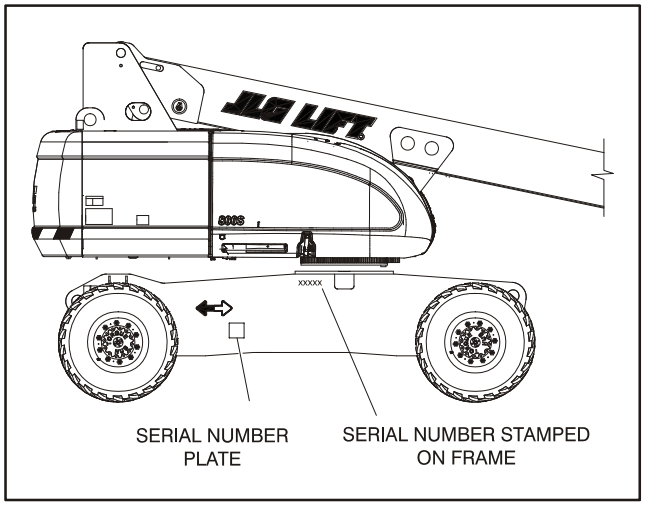


Figure 1-3. Serial Number Locations

VALUES FOR ZINC PLATED / YELLOW CHROMATE FASTENERS ONLY													
SAE GRADE 5 BOLTS & GRADE 2 NUTS													
SIZE	TPI	BOLT DIA	TENSILE STRESS AREA	CLAMP LOAD	TORQUE (DRY OR LOCTITE 263)		TORQUE (LUB)		TORQUE (LOCTITE 262)		TORQUE (LOCTITE) (242 OR 271)	
		IN	SQ IN	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	8	[.9]	6	[.7]				
	48	0.1120	0.00661	420	9	[1.0]	7	[.8]				
6	32	0.1380	0.00909	580	16	[1.8]	12	[1.4]				
	40	0.1380	0.01015	610	18	[2.0]	13	[1.5]				
8	32	0.1640	0.01400	900	30	[3.5]	22	[2.5]				
	36	0.1640	0.01474	940	31	[4]	23	[2.6]				
10	24	0.1900	0.01750	1120	43	[5]	32	[3.5]				
	32	0.1900	0.02000	1285	49	[5.5]	36	[4]				
1/4	20	0.2500	0.0318	2020	96	[11]	75	[9]			105	[12]
	28	0.2500	0.0364	2320	120	[14]	86	[10]			135	[15]
		IN	SQ IN	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	17	[23]	13	[18]	16	[22]	19	[26]
	24	0.3125	0.0580	3700	19	[26]	14	[19]	17	[23]	21	[29]
3/8	16	0.3750	0.0775	4940	30	[41]	23	[31]	28	[38]	35	[47]
	24	0.3750	0.0878	5600	35	[47]	25	[34]	32	[43]	40	[54]
7/16	14	0.4375	0.1063	6800	50	[68]	35	[47]	45	[61]	55	[75]
	20	0.4375	0.1187	7550	55	[75]	40	[54]	50	[68]	60	[81]
1/2	13	0.5000	0.1419	9050	75	[102]	55	[75]	68	[92]	85	[115]
	20	0.5000	0.1599	10700	90	[122]	65	[88]	80	[108]	100	[136]
9/16	12	0.5625	0.1820	11600	110	[149]	80	[108]	98	[133]	120	[163]
	18	0.5625	0.2030	12950	120	[163]	90	[122]	109	[148]	135	[183]
5/8	11	0.6250	0.2260	14400	150	[203]	110	[149]	135	[183]	165	[224]
	18	0.6250	0.2560	16300	170	[230]	130	[176]	153	[207]	190	[258]
3/4	10	0.7500	0.3340	21300	260	[353]	200	[271]	240	[325]	285	[386]
	16	0.7500	0.3730	23800	300	[407]	220	[298]	268	[363]	330	[447]
7/8	9	0.8750	0.4620	29400	430	[583]	320	[434]	386	[523]	475	[644]
	14	0.8750	0.5090	32400	470	[637]	350	[475]	425	[576]	520	[705]
1	8	1.0000	0.6060	38600	640	[868]	480	[651]	579	[785]	675	[915]
	12	1.0000	0.6630	42200	700	[949]	530	[719]	633	[858]	735	[997]
1 1/8	7	1.1250	0.7630	42300	800	[1085]	600	[813]	714	[968]	840	[1139]
	12	1.1250	0.8560	47500	880	[1193]	660	[895]	802	[1087]	925	[1254]
1 1/4	7	1.2500	0.9690	53800	1120	[1518]	840	[1139]	1009	[1368]	1175	[1593]
	12	1.2500	1.0730	59600	1240	[1681]	920	[1247]	1118	[1516]	1300	[1763]
1 3/8	6	1.3750	1.1550	64100	1460	[1979]	1100	[1491]	1322	[1792]	1525	[2068]
	12	1.3750	1.3150	73000	1680	[2278]	1260	[1708]	1506	[2042]	1750	[2373]
1 1/2	6	1.5000	1.4050	78000	1940	[2630]	1460	[1979]	1755	[2379]	2025	[2746]
	12	1.5000	1.5800	87700	2200	[2983]	1640	[2224]	1974	[2676]	2300	[3118]

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NOTE: THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS



SAE GRADE 5 SAE GRADE 8

Figure 1-4. Torque Chart (SAE Fasteners - Sheet 1 of 3)

				VALUES FOR ZINC PLATED / YELLOW CHROMATE FASTENERS ONLY				
				SAE GRADE 8 BOLTS & GRADE 8 NUTS, & SOCKET HEAD CAP SCREWS #6 THRU 1/4				
SIZE	TPI	BOLT DIA	TENSILE STRESS AREA	CLAMP LOAD	TORQUE (DRY OR LOCTITE 263)	TORQUE (LUB)	TORQUE (LOCTITE 262)	TORQUE (LOCTITE) (242 OR 271)
		IN	SQ IN	LB	IN-LB [N.m]	IN-LB [N.m]	IN-LB [N.m]	IN-LB [N.m]
4	40	0.1120	0.00604	540	12 [1.4]	9 [1.0]		
	48	0.1120	0.00661	600	13 [1.5]	10 [1.1]		
6	32	0.1380	0.00909	820	23 [2.6]	17 [1.9]		
	40	0.1380	0.01015	920	25 [2.8]	19 [2.2]		
8	32	0.1640	0.01400	1260	41 [4.5]	31 [3.5]		
	36	0.1640	0.01474	1320	43 [5]	32 [4]		
10	24	0.1900	0.01750	1580	60 [7]	45 [5]		
	32	0.1900	0.02000	1800	68 [8]	51 [6]		
1/4	20	0.2500	0.0318	2860	144 [16]	108 [12]		160 [18]
	28	0.2500	0.0364	3280	168 [19]	120 [14]		185 [21]
		IN	SQ IN	LB	FT-LB [N.m]	FT-LB [N.m]	FT-LB [N.m]	FT-LB [N.m]
5/16	18	0.3125	0.0524	4720	25 [34]	18 [24]	22 [30]	30 [41]
	24	0.3125	0.0580	5220	25 [34]	20 [27]	25 [34]	30 [41]
3/8	16	0.3750	0.0775	7000	45 [61]	35 [47]	40 [54]	50 [68]
	24	0.3750	0.0878	7900	50 [68]	35 [47]	45 [61]	55 [75]
7/16	14	0.4375	0.1063	9550	70 [95]	55 [75]	63 [85]	80 [108]
	20	0.4375	0.1187	10700	80 [108]	60 [81]	70 [95]	90 [122]
1/2	13	0.5000	0.1419	12750	110 [149]	80 [108]	96 [130]	120 [163]
	20	0.5000	0.1599	14400	120 [163]	90 [122]	108 [146]	135 [183]
9/16	12	0.5625	0.1820	16400	150 [203]	110 [149]	139 [188]	165 [224]
	18	0.5625	0.2030	18250	170 [230]	130 [176]	154 [209]	190 [258]
5/8	11	0.6250	0.2260	20350	220 [298]	170 [230]	180 [244]	240 [325]
	18	0.6250	0.2560	23000	240 [325]	180 [244]	204 [277]	265 [359]
3/4	10	0.7500	0.3340	30100	380 [515]	280 [380]	301 [408]	420 [569]
	16	0.7500	0.3730	33600	420 [569]	320 [434]	336 [456]	465 [630]
7/8	9	0.8750	0.4620	41600	600 [813]	460 [624]	485 [658]	660 [895]
	14	0.8750	0.5090	45800	660 [895]	500 [678]	534 [724]	725 [983]
1	8	1.0000	0.6060	51500	900 [1220]	680 [922]	687 [931]	990 [1342]
	12	1.0000	0.6630	59700	1000 [1356]	740 [1003]	796 [1079]	1100 [1491]
1 1/8	7	1.1250	0.7630	68700	1280 [1735]	960 [1302]	1030 [1396]	1400 [1898]
	12	1.1250	0.8560	77000	1440 [1952]	1080 [1464]	1155 [1607]	1575 [2135]
1 1/4	7	1.2500	0.9690	87200	1820 [2468]	1360 [1844]	1453 [1970]	2000 [2712]
	12	1.2500	1.0730	96600	2000 [2712]	1500 [2034]	1610 [2183]	2200 [2983]
1 3/8	6	1.3750	1.1550	104000	2380 [3227]	1780 [2413]	1907 [2586]	2625 [3559]
	12	1.3750	1.3150	118100	2720 [3688]	2040 [2765]	2165 [2935]	3000 [4067]
1 1/2	6	1.5000	1.4050	126500	3160 [4284]	2360 [3200]	2530 [3430]	3475 [4711]
	12	1.5000	1.5800	142200	3560 [4827]	2660 [3606]	2844 [3856]	3925 [5322]

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NOTE: THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS



SAE GRADE 5 SAE GRADE 8

Figure 1-5. Torque Chart (SAE Fasteners - Sheet 2 of 3)

				JLG SPECIFICATION #4150701- MAGNI 565			
				SOCKET HEAD CAP SCREWS 5/16 & ABOVE			
SIZE	TPI	BOLT DIA	TENSILE STRESS AREA	CLAMP LOAD	TORQUE	TORQUE (LOCTITE 262)	TORQUE (LOCTITE) (242 OR 271)
		IN	SQ IN	LB	IN-LB [N.m]	IN-LB [N.m]	IN-LB [N.m]
4	40	0.1120	0.00604				
	48	0.1120	0.00661				
6	32	0.1380	0.00909				
	40	0.1380	0.01015				
8	32	0.1640	0.01400				
	36	0.1640	0.01474				
10	24	0.1900	0.01750				
	32	0.1900	0.02000				
1/4	20	0.2500	0.0318	2860	108 [12]		160 [18]
	28	0.2500	0.0364	3280	120 [14]		185 [21]
		IN	SQ IN	LB	FT-LB [N.m]	FT-LB [N.m]	FT-LB [N.m]
5/16	18	0.3125	0.0524	4720	18 [24]	22 [30]	30 [41]
	24	0.3125	0.0580	5220	20 [27]	25 [34]	30 [41]
3/8	16	0.3750	0.0775	7000	35 [47]	40 [54]	50 [68]
	24	0.3750	0.0878	7900	35 [47]	45 [61]	55 [75]
7/16	14	0.4375	0.1063	9550	55 [75]	63 [85]	80 [108]
	20	0.4375	0.1187	10700	60 [81]	70 [95]	90 [122]
1/2	13	0.5000	0.1419	12750	80 [108]	96 [130]	120 [163]
	20	0.5000	0.1599	14400	90 [122]	108 [146]	135 [183]
9/16	12	0.5625	0.1820	16400	110 [149]	139 [188]	165 [224]
	18	0.5625	0.2030	18250	130 [176]	154 [209]	190 [258]
5/8	11	0.6250	0.2260	20350	170 [230]	180 [244]	240 [325]
	18	0.6250	0.2560	23000	180 [244]	204 [277]	265 [359]
3/4	10	0.7500	0.3340	30100	280 [380]	301 [408]	420 [569]
	16	0.7500	0.3730	33600	320 [434]	336 [456]	465 [630]
7/8	9	0.8750	0.4620	41600	460 [624]	485 [658]	660 [895]
	14	0.8750	0.5090	45800	500 [678]	534 [724]	725 [983]
1	8	1.0000	0.6060	51500	680 [922]	687 [931]	990 [1342]
	12	1.0000	0.6630	59700	740 [1003]	796 [1079]	1100 [1491]
1 1/8	7	1.1250	0.7630	68700	960 [1302]	1030 [1396]	1400 [1898]
	12	1.1250	0.8560	77000	1080 [1464]	1155 [1607]	1575 [2135]
1 1/4	7	1.2500	0.9690	87200	1360 [1844]	1453 [1970]	2000 [2712]
	12	1.2500	1.0730	96600	1500 [2034]	1610 [2183]	2200 [2983]
1 3/8	6	1.3750	1.1550	104000	1780 [2413]	1907 [2586]	2625 [3559]
	12	1.3750	1.3150	118100	2040 [2765]	2165 [2935]	3000 [4067]
1 1/2	6	1.5000	1.4050	126500	2360 [3200]	2530 [3430]	3475 [4711]
	12	1.5000	1.5800	142200	2660 [3606]	2844 [3856]	3925 [5322]

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NOTE: THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS



SAE GRADE 5 SAE GRADE 8

Figure 1-6. Torque Chart (SAE Fasteners - Sheet 3 of 3)

			VALUES FOR ZINC PLATED / YELLOW CHROMATE FASTENERS ONLY				
			CLASS 8.8 METRIC BOLTS CLASS 8 METRIC NUTS				
SIZE	PITCH	TENSILE STRESS AREA	CLAMP LOAD	TORQUE (DRY OR LOCTITE 263)	TORQUE (LUB)	TORQUE (LOCTITE 262)	TORQUE (LOCTITE) (242 OR 271)
		sq mm	KN	N.m	N.m	N.m	N.m
3	.5	5.03	2.19	1.3	1.0	1.2	1.4
3.5	.6	6.78	2.95	2.1	1.6	1.9	2.3
4	.7	8.78	3.82	3.1	2.3	2.8	3.4
5	.8	14.2	6.18	6.2	4.6	5.6	6.8
6	1	20.1	8.74	11	7.9	9.4	12
7	1	28.9	12.6	18	13	16	19
8	1.25	36.6	15.9	25	19	23	28
10	1.5	58.0	25.2	50	38	45	55
12	1.75	84.3	36.7	88	66	79	97
14	2	115	50.0	140	105	126	154
16	2	157	68.3	219	164	197	241
18	2.5	192	83.5	301	226	271	331
20	2.5	245	106.5	426	320	383	469
22	2.5	303	132.0	581	436	523	639
24	3	353	153.5	737	553	663	811
27	3	459	199.5	1080	810	970	1130
30	3.5	561	244.0	1460	1100	1320	1530
33	3.5	694	302.0	1990	1490	1790	2090
36	4	817	355.5	2560	1920	2300	2690
42	4.5	1120	487.0	4090	3070	3680	4290

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NOTE: THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS



METRIC CLASS 8.8



METRIC CLASS 10.9

Figure 1-7. Torque Chart (METRIC Fasteners - Sheet 1 of 3)

			VALUES FOR ZINC PLATED / YELLOW CHROMATE FASTENERS ONLY CLASS 10.9 METRIC BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3-M5				
SIZE	PITCH	TENSILE STRESS AREA	CLAMP LOAD	TORQUE (DRY OR LOCTITE 263)	TORQUE (LUB)	TORQUE (LOCTITE 262)	TORQUE (LOCTITE) (242 OR 271)
		sq mm	KN	N.m	N.m	N.m	N.m
3	.5	5.03	3.13	1.9	1.4	1.5	2.1
3.5	.6	6.78	4.22	3.0	2.2	2.4	3.3
4	.7	8.78	5.47	4.4	3.3	3.5	4.8
5	.8	14.2	8.85	8.9	6.6	7.1	9.7
6	1	20.1	12.5	15	11	12	17
7	1	28.9	18.0	25	19	20	28
8	1.25	36.6	22.8	37	27	29	40
10	1.5	58.0	36.1	72	54	58	79
12	1.75	84.3	52.5	126	95	101	139
14	2	115	71.6	200	150	160	220
16	2	157	97.8	313	235	250	344
18	2.5	192	119.5	430	323	344	473
20	2.5	245	152.5	610	458	488	671
22	2.5	303	189.0	832	624	665	915
24	3	353	220.0	1060	792	845	1170
27	3	459	286.0	1540	1160	1240	1690
30	3.5	561	349.5	2100	1570	1680	2310
33	3.5	694	432.5	2600	2140	2280	2860
36	4	817	509.0	3660	2750	2930	4020
42	4.5	1120	698.0	5860	4400	4690	6440

5000059_H

NOTE: THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS



Figure 1-8. Torque Chart (METRIC Fasteners - Sheet 2 of 3))

			JLG SPECIFICATION #4150701- MAGNI 565 CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE			
SIZE	PITCH	TENSILE STRESS AREA	CLAMP LOAD	TORQUE	TORQUE (LOCTITE 262)	TORQUE (LOCTITE) (242 OR 271)
		sq mm	KN	N.m	N.m	N.m
3	.5	5.03			1.5	2.1
3.5	.6	6.78			2.4	3.3
4	.7	8.78			3.5	4.8
5	.8	14.2			7.1	9.7
6	1	20.1	12.5	11	12	17
7	1	28.9	18.0	19	20	28
8	1.25	36.6	22.8	27	29	40
10	1.5	58.0	36.1	54	58	79
12	1.75	84.3	52.5	95	101	139
14	2	115	71.6	150	160	220
16	2	157	97.8	235	250	344
18	2.5	192	119.5	323	344	473
20	2.5	245	152.5	458	488	671
22	2.5	303	189.0	624	665	915
24	3	353	220.0	792	845	1170
27	3	459	286.0	1160	1240	1690
30	3.5	561	349.5	1570	1680	2310
33	3.5	694	432.5	2140	2280	2860
36	4	817	509.0	2750	2930	4020
42	4.5	1120	698.0	4400	4690	6440

NOTE: THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS

5000059_H



METRIC CLASS 8.8



METRIC CLASS 10.9

Figure 1-9. Torque Chart (METRIC Fasteners - Sheet 3 of 3)

SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

This section provides the necessary information needed by those personnel that are responsible to place the machine in operation readiness and maintain its safe operating condition. For maximum service life and safe operation, ensure that all the necessary inspections and maintenance have been completed before placing the machine into service.

Preparation, Inspection, and Maintenance

It is important to establish and conform to a comprehensive inspection and preventive maintenance program. The following table outlines the periodic machine inspections and maintenance recommended by JLG Industries, Inc. Consult your national, regional, or local regulations for further requirements for aerial work platforms. The frequency of inspections and maintenance must be increased as environment, severity and frequency of usage requires.

Pre-Start Inspection

It is the User's or Operator's primary responsibility to perform a Pre-Start Inspection of the machine prior to use daily or at each change of operator. Reference the Operator's and Safety Manual for completion procedures for the Pre-Start Inspection. The Operator and Safety Manual must be read in its entirety and understood prior to performing the Pre-Start Inspection.

Pre-Delivery Inspection and Frequent Inspection

The Pre-Delivery Inspection and Frequent Inspection shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

The Pre-Delivery Inspection and Frequent Inspection procedures are performed in the same manner, but at different times. The Pre-Delivery Inspection shall be performed prior to each sale, lease, or rental delivery. The Frequent Inspection shall be accomplished for each machine in service for 3 months or 150 hours (whichever comes first); out of service for a period of more than 3 months; or when purchased used. The frequency of this inspection must be increased as environment, severity and frequency of usage requires.

Reference the JLG Pre-Delivery and Frequent Inspection Form and the Inspection and Preventative Maintenance Schedule for items requiring inspection during the performance of these inspections. Reference the appropriate areas of this manual for servicing and maintenance procedures.

Annual Machine Inspection

The Annual Machine Inspection must be performed by a Factory-Certified Service Technician on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries, Inc. recognizes a Factory-Certified Service Technician as a person who has successfully completed the JLG Service Training School for the subject JLG product model. Reference the machine Service and Maintenance Manual and appropriate JLG inspection form for performance of this inspection.

Reference the JLG Annual Machine Inspection Form and the Inspection and Preventative Maintenance Schedule for items requiring inspection during the performance of this inspection. Reference the appropriate areas of this manual for servicing and maintenance procedures.

For the purpose of receiving safety-related bulletins, it is important that JLG Industries, Inc. has updated ownership information for each machine. When performing each Annual Machine Inspection, notify JLG Industries, Inc. of the current machine ownership.

Preventative Maintenance

In conjunction with the specified inspections, maintenance shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

Reference the Preventative Maintenance Schedule and the appropriate areas of this manual for servicing and maintenance procedures. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.

Table 2-1. Inspection and Maintenance

Type	Frequency	Primary Responsibility	Service Qualification	Reference
Pre-Start Inspection	Prior to use each day; or At each Operator change.	User or Operator	User or Operator	Operation and Safety Manual
Pre-Delivery Inspection	Prior to each sale, lease, or rental delivery.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Frequent Inspection	In service for 3 months or 150 hours, whichever comes first; or Out of service for a period of more than 3 months; or purchased used.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Annual Machine Inspection	Annually, no later than 13 months from the date of the prior inspection.	Owner, Dealer, or User	Factory-Trained Service Technician (Recommended)	Service and Maintenance Manual and applicable JLG inspection form.
Preventative Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

2.2 SERVICE AND GUIDELINES

General

The following information is provided to assist you in the use and application of servicing and maintenance procedures contained in this book.

Safety and Workmanship

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.
2. At any time when air, fuel, or oil lines are disconnected, clear adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent entry of foreign matter.
3. Clean and inspect all parts during servicing or maintenance, and assure that all passages and openings are unobstructed. Cover all parts to keep them clean. Be sure all parts are clean before they are installed. New parts should remain in their containers until they are ready to be used.

Components Removal and Installation

1. Use adjustable lifting devices, whenever possible, if mechanical assistance is required. All slings (chains, cables, etc.) should be parallel to each other and as near perpendicular as possible to top of part being lifted.
2. Should it be necessary to remove a component on an angle, keep in mind that the capacity of an eyebolt or similar bracket lessens, as the angle between the supporting structure and the component becomes less than 90 degrees.
3. If a part resists removal, check to see whether all nuts, bolts, cables, brackets, wiring, etc., have been removed and that no adjacent parts are interfering.

Component Disassembly and Reassembly

When disassembling or reassembling a component, complete the procedural steps in sequence. Do not partially disassemble or assemble one part, then start on another. Always recheck your work to assure that nothing has been overlooked. Do not make any adjustments, other than those recommended, without obtaining proper approval.

Pressure-Fit Parts

When assembling pressure-fit parts, use an anti-seize or molybdenum disulfide base compound to lubricate the mating surface.

Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used but do not spin the bearing.
2. Discard bearings if the races and balls (or rollers) are pitted, scored, or burned.
3. If bearing is found to be serviceable, apply a light coat of oil and wrap it in clean (waxed) paper. Do not unwrap reusable or new bearings until they are ready to install.
4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

Gaskets

Check that holes in gaskets align with openings in the mating parts. If it becomes necessary to hand-fabricate a gasket, use gasket material or stock of equivalent material and thickness. Be sure to cut holes in the right location, as blank gaskets can cause serious system damage.

Bolt Usage and Torque Application

NOTICE

SELF LOCKING FASTENERS, SUCH AS NYLON INSERT AND THREAD DEFORMING LOCKNUTS, ARE NOT INTENDED TO BE REINSTALLED AFTER REMOVAL.

1. Always use new replacement hardware when installing locking fasteners. Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.
2. Unless specific torque requirements are given within the text, standard torque values should be used on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart Section 1.)

Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines and electrical wiring, as well as their receptacles, when disconnecting or removing them from the unit. This will assure that they are correctly reinstalled.

Hydraulic System

1. Keep the system clean. If evidence of metal or rubber particles are found in the hydraulic system, drain and flush the entire system.
2. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components, as required, to aid assembly.

Lubrication

Service applicable components with the amount, type, and grade of lubricant recommended in this manual, at the specified intervals. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

Battery

Clean battery, using a non-metallic brush and a solution of baking soda and water. Rinse with clean water. After cleaning, thoroughly dry battery and coat terminals with an anti corrosion compound.

Lubrication and Servicing

Components and assemblies requiring lubrication and servicing are shown in the Lubrication Chart in Section 1.

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.
2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.
3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, the system must be drained, flushed, and refilled with clean oil.
4. It is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

NOTE: *Metal particles may appear in the oil or filters of new machines due to the wear-in of meshing components.*

Hydraulic Oil

Refer to Section 1 for recommendations for viscosity ranges.

Changing Hydraulic Oil

1. Filter elements must be changed after the first 50 hours of operation and every 300 hours (unless specified otherwise) thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils. JLG Industries recommends changing the hydraulic oil annually.
2. Use every precaution to keep the hydraulic oil clean. If the oil must be poured from the original container into another, be sure to clean all possible contaminants from the service container. Always clean the mesh element of the filter and replace the cartridge any time the system oil is changed.
3. While the unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a functional check of each system, before placing the machine back in service.

Lubrication Specifications

Specified lubricants, as recommended by the component manufacturers, are always the best choice, however, multi-purpose greases usually have the qualities which meet a variety of single purpose grease requirements. Should any question arise, regarding the use of greases in maintenance stock, consult your local supplier for evaluation. Refer to Section 1 for an explanation of the lubricant key designations appearing in the Lubrication Chart.

2.4 CYLINDER DRIFT TEST

Maximum acceptable cylinder drift is to be measured using the following methods.

Platform Drift

Measure the drift of the platform to the ground. Lower booms (if equipped) slightly elevated, upper boom fully extended with the rated load in the platform and power off. Maximum allowable drift is 2 inches (5 cm) in 10 minutes. If the machine does not pass this test, proceed with the following.

Cylinder Drift

Table 2-2. Cylinder Drift

Cylinder Bore Diameter		Max. Acceptable Drift in 10 Minutes	
inches	mm	inches	mm
3	76.2	0.026	0.66
3.5	89	0.019	0.48
4	101.6	0.015	0.38
5	127	0.009	0.22
6	152.4	0.006	0.15
7	177.8	0.005	0.13
8	203.2	0.0038	0.10
9	228.6	0.0030	0.08

Drift is to be measured at the cylinder rod with a calibrated dial indicator. The cylinder oil must be at ambient temperature and temperature stabilized.

The cylinder must have the normal load, which is the normal platform load applied.

If the cylinder passes this test, it is acceptable.

NOTE: *This information is based on 6 drops per minute cylinder leakage.*

2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

1. Pinned joints should be disassembled and inspected if the following occurs:
   - **a.** Excessive sloppiness in joints.
   - **b.** Noise originating from the joint during operation.
2. Filament wound bearings should be replaced if any of the following is observed:
   - **a.** Frayed or separated fibers on the liner surface.
   - **b.** Cracked or damaged liner backing.
   - **c.** Bearings that have moved or spun in their housing.
   - **d.** Debris embedded in liner surface.
3. Pins should be replaced if any of the following is observed (pin should be properly cleaned prior to inspection):
   - **a.** Detectable wear in the bearing area.
   - **b.** Flaking, pealing, scoring, or scratches on the pin surface.
   - **c.** Rusting of the pin in the bearing area.
4. Re-assembly of pinned joints using filament wound bearings.
   - **a.** Housing should be blown out to remove all dirt and debris...bearings and bearing housings must be free of all contamination.
   - **b.** Bearing / pins should be cleaned with a solvent to remove all grease and oil...filament wound bearing are a dry joint and should not be lubricated.
   - **c.** Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the bearing during installation and operation.

2.6 WELDING ON JLG EQUIPMENT

NOTE: *This instruction applies to repairs, or modifications to the machine and to welding performed from the machine on an external structure, or component,*

Do the Following When Welding on JLG Equipment

- Disconnect the battery.
- Disconnect the moment pin connection (where fitted)
- Ground only to structure being welded.

Do NOT Do the Following When Welding on JLG Equipment

- Ground on frame and weld on any other area than the chassis.
- Ground on turntable and weld on any other area than the turntable.
- Ground on the platform/support and weld on any other area than the platform/support.
- Ground on a specific boom section and weld on any other area than that specific boom section.
- Allow pins, wear pads, wire ropes, bearings, gearing, seals, valves, electrical wiring, or hoses to be between the grounding position and the welded area.

NOTICE

FAILURE TO COMPLY WITH THE ABOVE REQUIREMENTS MAY RESULT IN COMPONENT DAMAGE (I.E. ELECTRONIC MODULES, SWING BEARING, COLLECTOR RING, BOOM WIRE ROPES ETC.)

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Boom Assembly	9					
Boom Weldments				1,2,4	1,2,4	
Hose/Cable Carrier Installations				1,2,9,12	1,2,9,12	
Pivot Pins and Pin Retainers				1,2	1,2	
Sheaves, Sheave Pins				1,2	1,2	
Bearings				1,2	1,2	
Wear Pads				1,2	1,2	
Covers or Shields				1,2	1,2	
Extend/Retract Chain or Cable Systems				1,2,3	1,2,3	
Platform Assembly	9					
Platform	1,2				1,2	
Railing	1,2			1	1,2	
Gate			5	1	1,5	
Floor	1,2			1	1,2	
Rotator		9,5		15		
Lanyard Anchorage Point	2			1,2,10	1,2,10	
Turntable Assembly	9					
Swing Bearing or Worm Gear				1,2,14	1,2,3,13,14	
Oil Coupling		9				
Swing Drive System				11	11	
Turntable Lock				1,2,5	1,2,5	
Hood, Hood Props, Hood Latches				5	1,2,5	
Chassis Assembly	9					
Tires	1	16,17		16,17,18	16,17,18	
Wheel Nuts/Bolts	1	15		15	15	
Wheel Bearings						14,24
Oscillating Axle/Lockout Cylinder Systems					5,8	
Outrigger or Extendable Axle Systems				5,8	5,8	
Steer Components						
Drive Motors						
Torque Hubs				11	11	
Functions/Controls	9					
Platform Controls	5	5		6	6	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Ground Controls	5	5		6	6	
Function Control Locks, Guards, or Detents	1,5	1,5		5	5	
Footswitch	1,5			5	5	
Emergency Stop Switches (Ground & Platform)	5			5	5	
Function Limit or Cutout Switch Systems				5	5	
Capacity Indicator					5	
Drive Brakes				5		
Swing Brakes				5		
Boom Synchronization/Sequencing Systems					5	
Manual Descent or Auxiliary Power				5	5	
Power System	9					
Engine Idle, Throttle, and RPM				3	3	
Engine Fluids (Oil, Coolant, Fuel)	11	9,11		11	11	
Air/Fuel Filter		1,7		7	7	
Exhaust System			1,9	9	9	
Batteries	5	1,9			19	
Battery Fluid		11		11	11	
Battery Charger		5			5	
Fuel Reservoir, Cap, and Breather	11,9		2	1,5	1,5	
Hydraulic/Electric System	9					
Hydraulic Pumps		1,9		1,2,9		
Hydraulic Cylinders		1,9,7	2	1,2,9	1,2,9	
Cylinder Attachment Pins and Pin Retainers		1,9		1,2	1,2	
Hydraulic Hoses, Lines, and Fittings		1,9	12	1,2,9,12	1,2,9,12	
Hydraulic Reservoir, Cap, and Breather	11	1,9	2	1,5	1,5	24
Hydraulic Filter		1,9		7	7	
Hydraulic Fluid	11			7,11	7,11	
Electrical Connections		1		20	20	
Instruments, Gauges, Switches, Lights, Horn		1			5,23	
General						
Operators and Safety Manuals in Storage Box	21			21	21	
ANSI and EMI Manuals/Handbooks Installed					21	
Capacity Decals Installed, Secure, Legible	21			21	21	
All Decals/Placards Installed, Secure, Legible	21			21	21	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Walk-Around Inspection Performed	21					
Annual Machine Inspection Due				21		
No Unauthorized Modifications or Additions				21	21	
All Relevant Safety Publications Incorporated				21	21	
General Structural Condition and Welds				2,4	2,4	
All Fasteners, Pins, Shields, and Covers				1,2	1,2	
Grease and Lubricate to Specifications				22	22	
Function Test of All Systems	21			21	21, 22	
Paint and Appearance				7	7	
Stamp Inspection Date on Frame					22	
Notify JLG of Machine Ownership					22	

Footnotes:

[1] Prior to use each day; or at each Operator change

[2] Prior to each sale, lease, or delivery

[3] In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used

[4] Annually, no later than 13 months from the date of the prior inspection

Performance Codes:
1 - Check for proper and secure installation
2 - Visual inspection for damage, cracks, distortion or excessive wear
3 - Check for proper adjustment
4 - Check for cracked or broken welds
5 - Operates Properly
6 - Returns to neutral or "off" position when released
7 - Clean and free of debris
8 - Interlocks function properly
9 - Check for signs of leakage
10 - Decals installed and legible
11 - Check for proper fluid level
12 - Check for chafing and proper routing
13 - Check for proper tolerances
14 - Properly lubricated
15 - Torqued to proper specification
16 - No gouges, excessive wear, or cords showing
17 - Properly inflated and seated around rim
18 - Proper and authorized components
19 - Fully charged
20 - No loose connections, corrosion, or abrasions
21 - Verify
22 - Perform
23 - Sealed Properly
24 - Drain, Clean, Refill

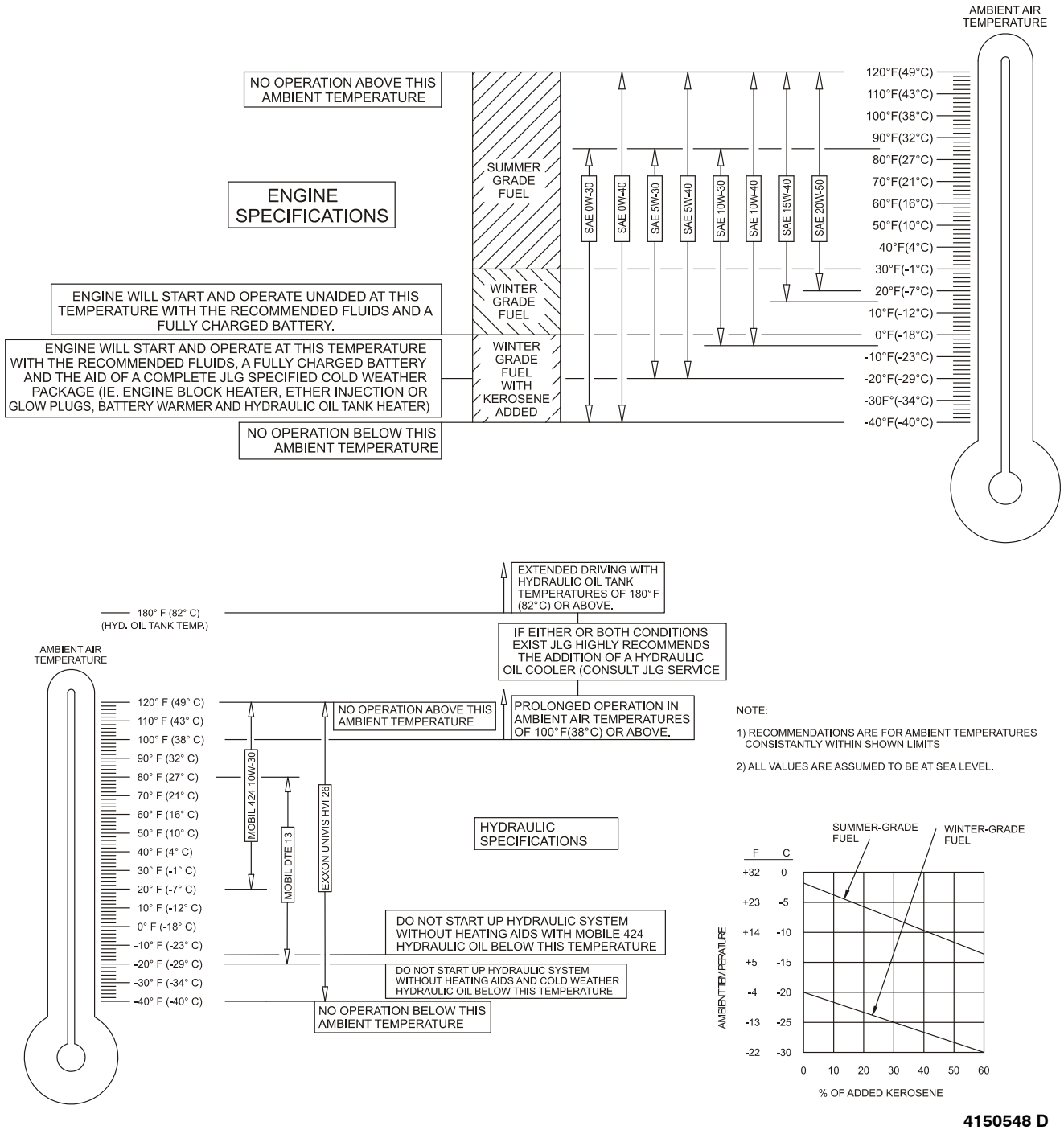


Figure 2-1. Engine Operating Temperature Specifications - Deutz

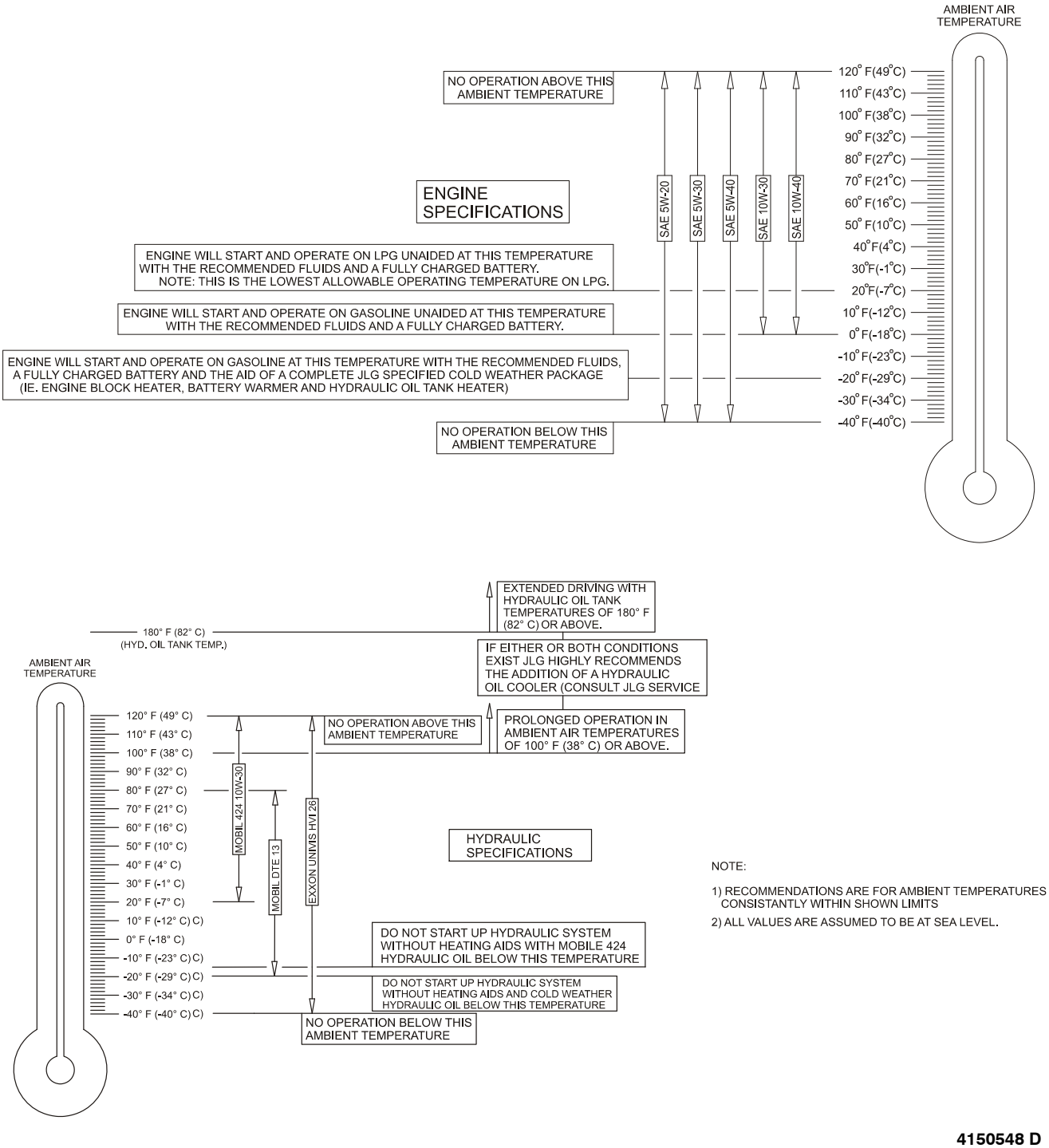


Figure 2-2. Engine Operating Temperature Specifications - Ford

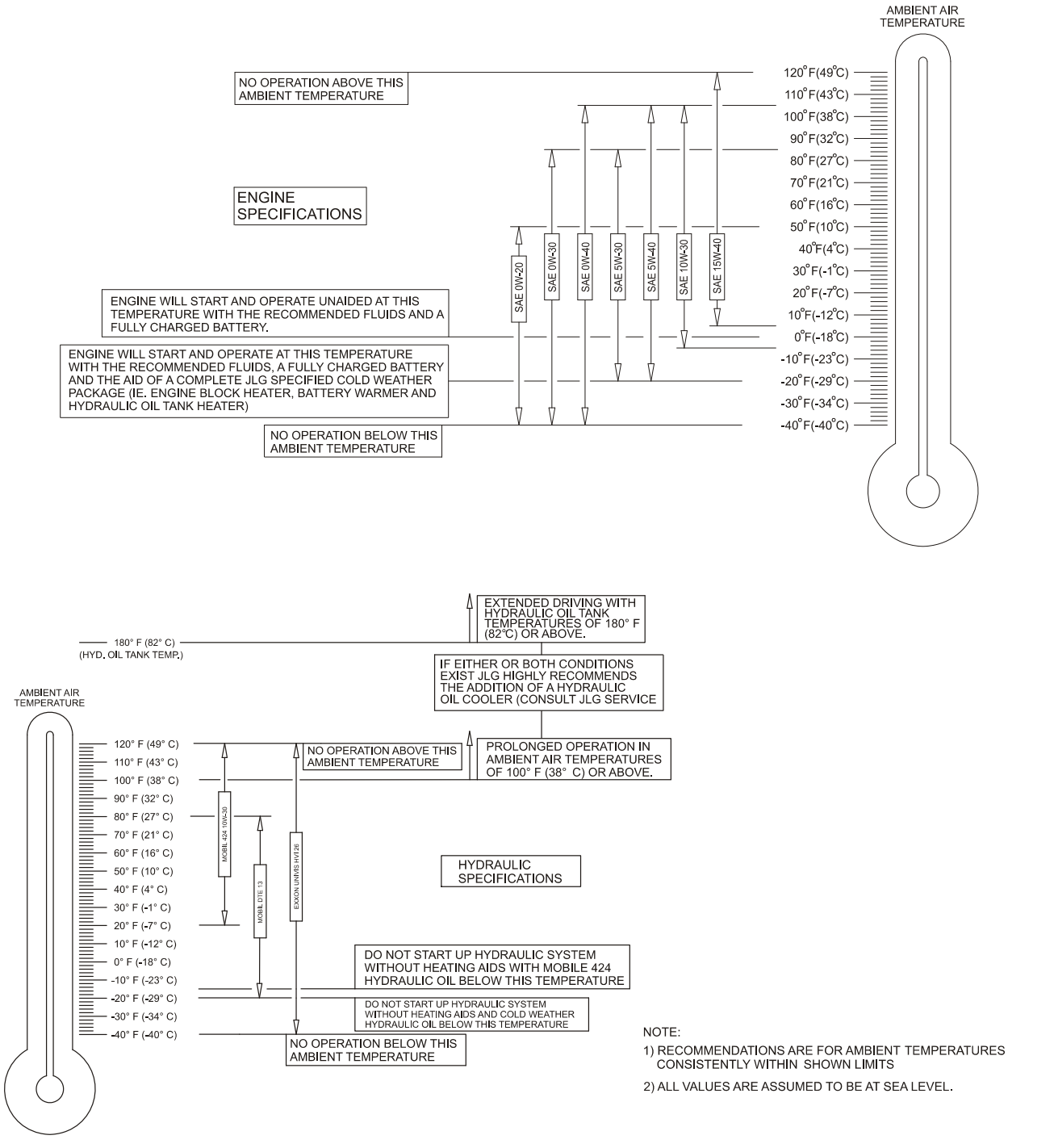


Figure 2-3. Engine Operating Temperature Specifications - Caterpillar

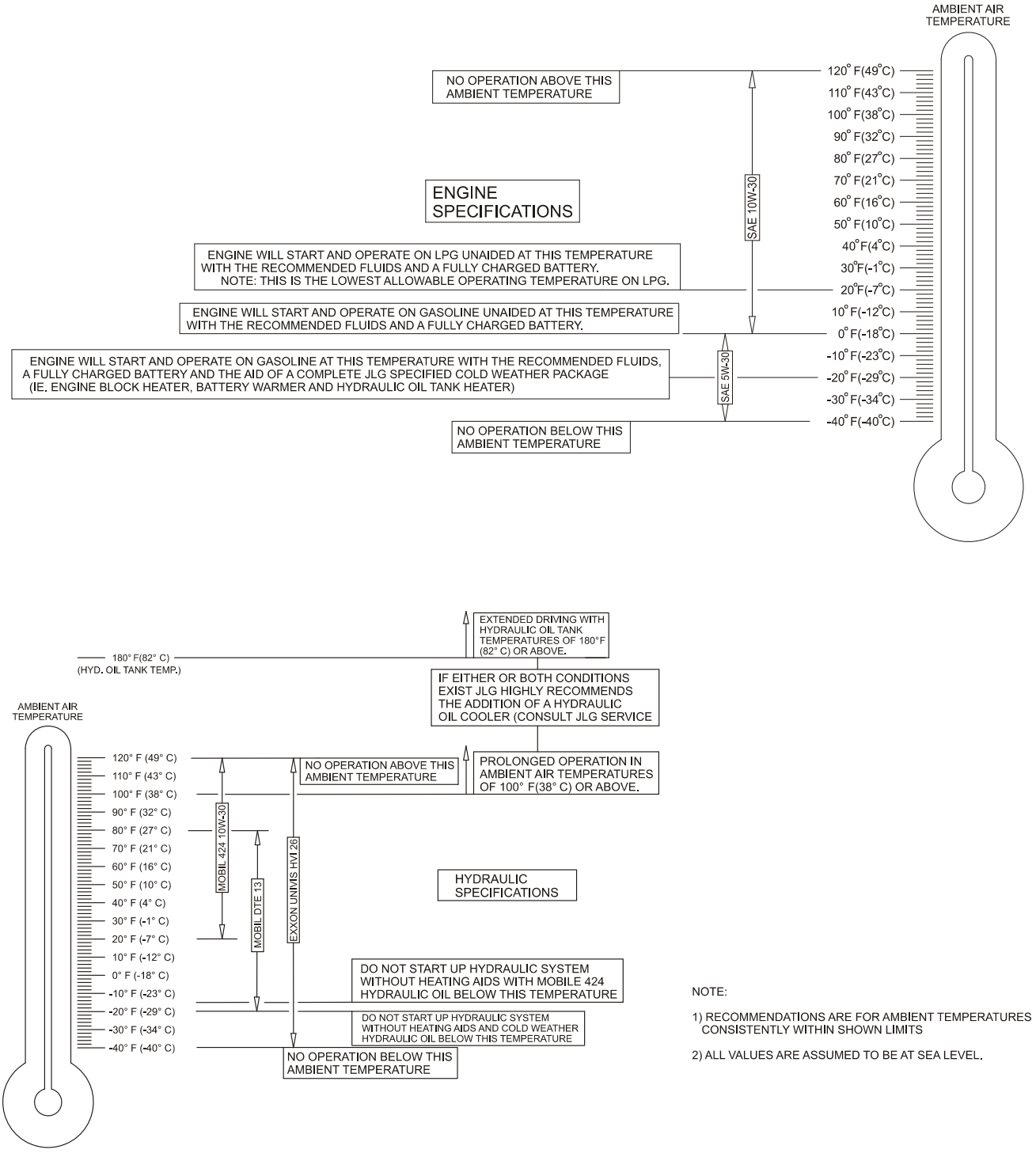


Figure 2-4. Engine Operating Temperature Specifications - GM

SECTION 3. CHASSIS & TURNTABLE

3.1 TIRES & WHEELS

Tire Inflation

The air pressure for pneumatic tires must be equal to the air pressure that is stenciled on the side of the JLG product or rim decal for safe and proper operational characteristics.

Tire Damage

For pneumatic tires, JLG Industries, Inc. recommends that when any cut, rip, or tear is discovered that exposes sidewall or tread area cords in the tire, measures must be taken to remove the JLG product from service immediately. Arrangements must be made for replacement of the tire or tire assembly.

For polyurethane foam filled tires, JLG Industries, Inc. recommends that when any of the following are discovered, measures must be taken to remove the JLG product from service immediately and arrangements must be made for replacement of the tire or tire assembly.

- a smooth, even cut through the cord plies which exceeds 3 inches (7.5 cm) in total length
- any tears or rips (ragged edges) in the cord plies which exceeds 1 inch (2.5 cm) in any direction
- any punctures which exceed 1 inch in diameter
- any damage to the bead area cords of the tire

If a tire is damaged but is within the above noted criteria, the tire must be inspected on a daily basis to insure the damage has not propagated beyond the allowable criteria.

Tire Replacement

JLG recommends a replacement tire be the same size, ply and brand as originally installed on the machine. Please refer to the JLG Parts Manual for the part number of the approved tires for a particular machine model. If not using a JLG approved replacement tire, we recommend that replacement tires have the following characteristics:

- Equal or greater ply/load rating and size of original
- Tire tread contact width equal or greater than original
- Wheel diameter, width, and offset dimensions equal to the original

Unless specifically approved by JLG Industries Inc. do not replace a foam filled or ballast filled tire assembly with a pneumatic tire. When selecting and installing a replacement tire, ensure that all tires are inflated to the pressure recommended by JLG. Due to size variations between tire brands, both tires on the same axle should be the same.

Wheel Replacement

The rims installed on each product model have been designed for stability requirements which consist of track width, tire pressure, and load capacity. Size changes such as rim width, center piece location, larger or smaller diameter, etc., without written factory recommendations, may result in an unsafe condition regarding stability.

Wheel Installation

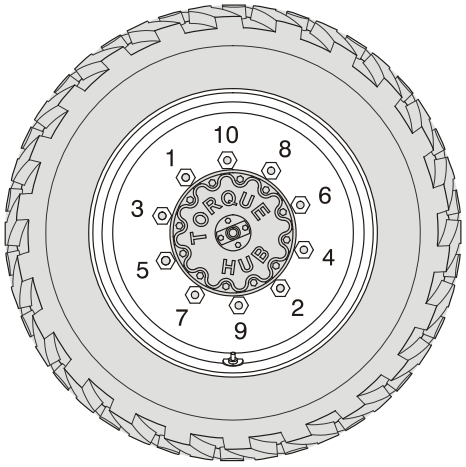
It is extremely important to apply and maintain proper wheel mounting torque.

⚠ WARNING

WHEEL NUTS MUST BE INSTALLED AND MAINTAINED AT THE PROPER TORQUE TO PREVENT LOOSE WHEELS, BROKEN STUDS, AND POSSIBLE DANGEROUS SEPARATION OF WHEEL FROM THE AXLE. BE SURE TO USE ONLY THE NUTS MATCHED TO THE CONE ANGLE OF THE WHEEL.

Tighten the lug nuts to the proper torque to prevent wheels from coming loose. Use a torque wrench to tighten the fasteners. If you do not have a torque wrench, tighten the fasteners with a lug wrench, then immediately have a service garage or dealer tighten the lug nuts to the proper torque. Over-tightening will result in breaking the studs or permanently deforming the mounting stud holes in the wheels. The proper procedure for attaching wheels is as follows:

1. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.
2. Tighten nuts in the following sequence:



3. The tightening of the nuts should be done in stages. Following the recommended sequence, tighten nuts per wheel torque chart.

Table 3-1. Wheel Torque Chart

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
70 ft. lbs. (95 Nm)	170 ft. lbs. (225 Nm)	300 ft. lbs. (405 Nm)

4. Wheel nuts should be torqued after first 50 hours of operation and after each wheel removal. Check torque every 3 months or 150 hours of operation.

3.2 WHEEL DRIVE ASSEMBLY, 2WD

Removal and Disassembly

NOTE: *The drive motor and/or drive brake can be removed through the axle flange as part of the wheel drive assembly or they can be removed separately through the bottom of the frame while leaving the torque hub bolted to the axle.*

1. Use a jack to lift the frame enough so the tire and wheel assembly is off of the ground. Place blocking strong enough to support the weight of the machine under the frame and remove the jack.

NOTE: *The pneumatic tire & wheel assembly weighs approximately 269 lbs. (122 kg). The foam-filled tire & wheel assembly weighs approximately 544 lbs. (247.25 kg).*

2. Remove the tire and wheel assembly.
3. Through the access holes in the axle, tag and disconnect the hydraulic lines running to the drive motor and drive brake. Cap or plug all openings to ensure no dirt enters the hydraulic system.

NOTE: *The torque hub, drive brake, and drive motor assembly weighs approximately 275 lbs. (125 kg).*

4. Use a supporting device capable of handling the weight of the torque hub, drive brake, and drive motor and unbolt the torque hub from the frame. Remove the entire assembly from the machine.
5. Remove the nuts and washers that secure the drive motor to the torque hub and drive brake and remove the drive motor. Remove and discard the o-ring between the drive motor and drive brake.
6. Remove the drive brake from the torque hub. Remove and discard the o-ring between the drive brake and torque hub.
7. If necessary, remove the studs from the torque hub.

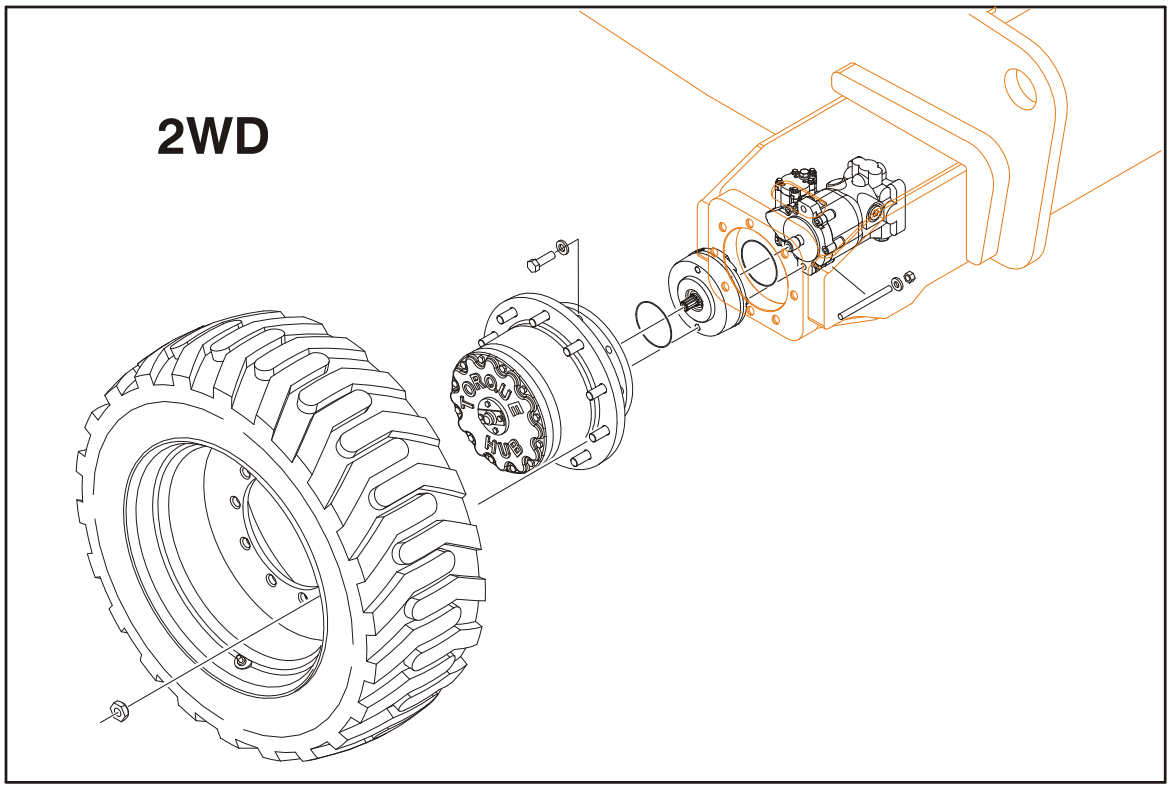
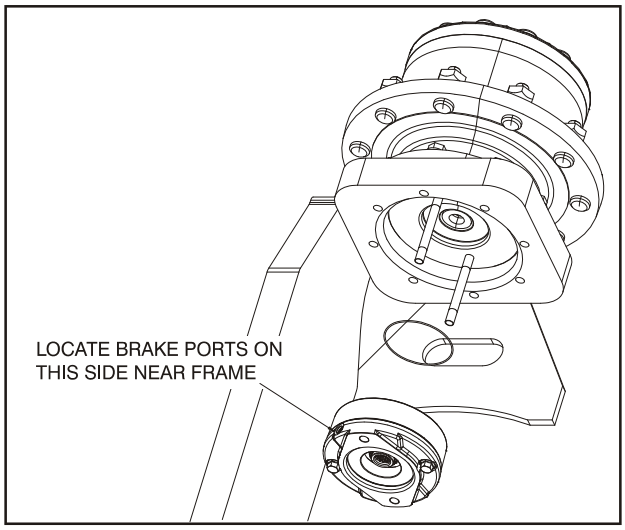


Figure 3-1. Torque Hub Installation - 2WD

Assembly and Installation

1. If re-installing the old studs or installing new ones, coat the threads of the studs with Loctite #242 before screwing them into the torque hub.
2. Install a new o-ring between the drive brake and torque hub and slide the drive brake over the studs with the brake port positioned as shown.

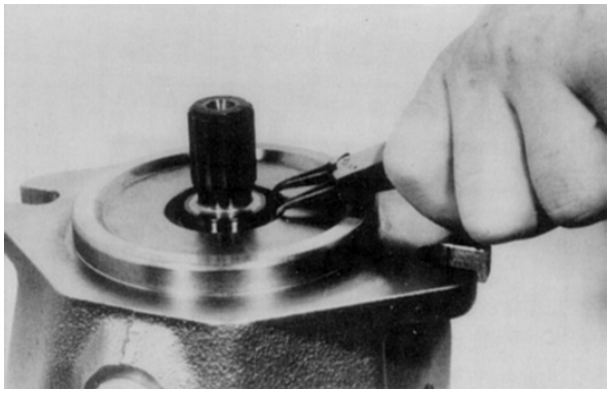


3. Install a new o-ring between the drive brake and drive motor and slide the drive motor over the studs. Install the washers and nuts to secure the assembly together and torque the nuts to 75 ft. lbs. (102 Nm).
4. Place the torque hub flange against the mounting flange on the axle and fasten it in place with the bolts and washers. Torque the bolts to 220 ft. lbs. (298 Nm).
5. Install the tire and wheel assembly.

3.3 DRIVE MOTOR - 2WD (PRIOR TO S/N 83331)

Replacing the Drive Shaft Seal

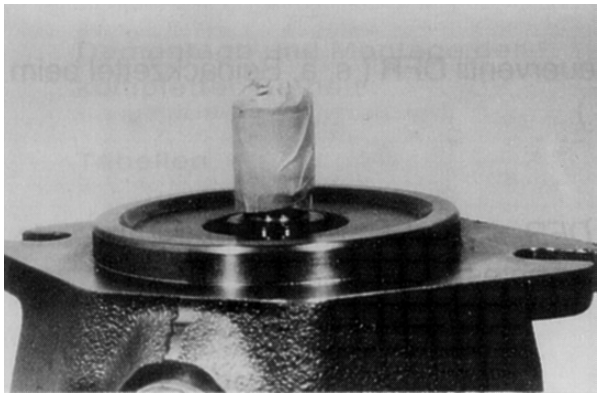
1. Remove snap ring.



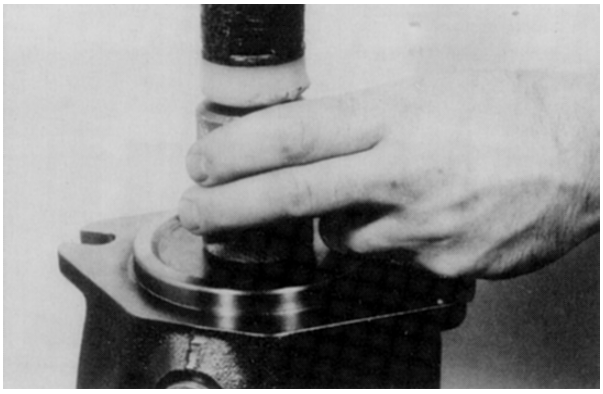
2. Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.



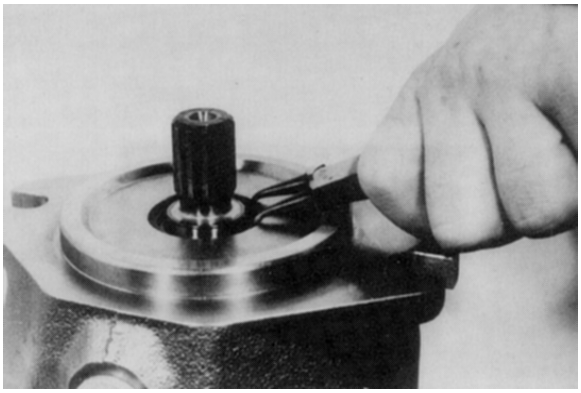
3. Be careful while you seal the drive shaft, use an adhesive tape.



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



5. Assemble the snap ring.



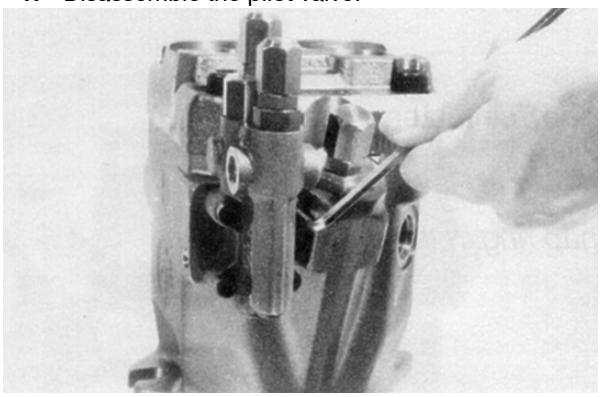
6. Assemble the snap ring in the correct position.



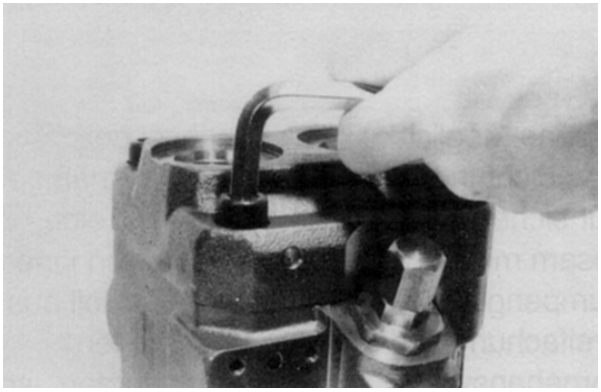
NOTE: *This description shows how to change the drive shaft sealing ring but isn't the way of serial assembly. the sealing ring is assembled together with the taper roller bearing from inside the pump housing normally to get a secure condition. If you decide to repair the pump in the shown way be very careful while handling so that the drive shaft will not be damaged during disassembly of the shaft sealing ring.*

Disassembly

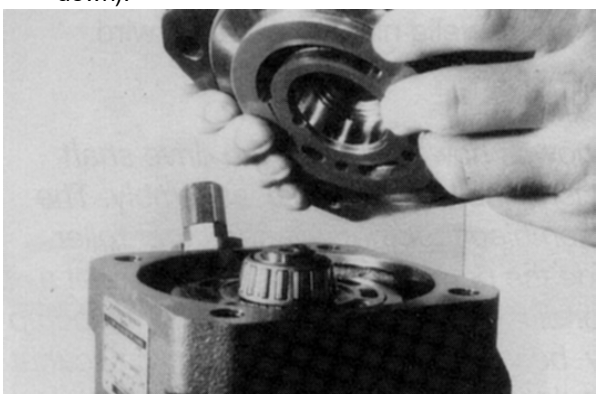
1. Disassemble the pilot valve.



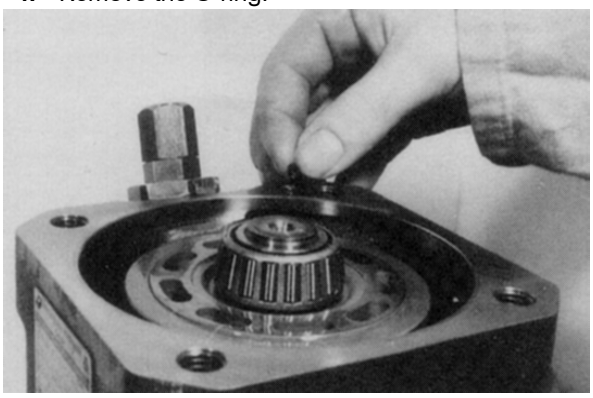
2. Mark the position of the port plate and remove the socket screw of the port plate.



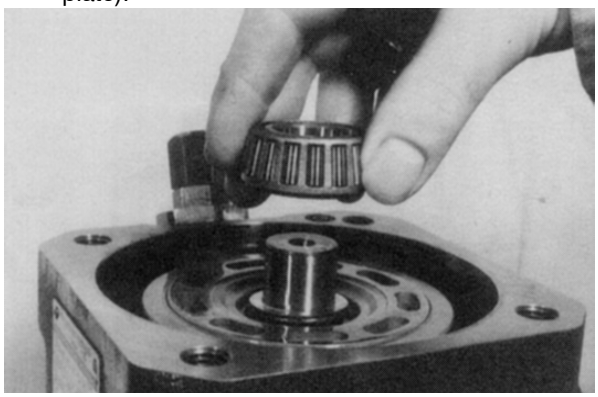
3. Remove the port plate together with the valve plate (hold the valve plate so that the plate can't fall down).



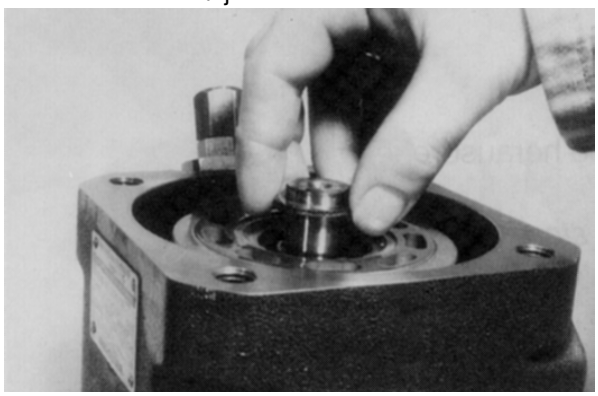
4. Remove the O-ring.



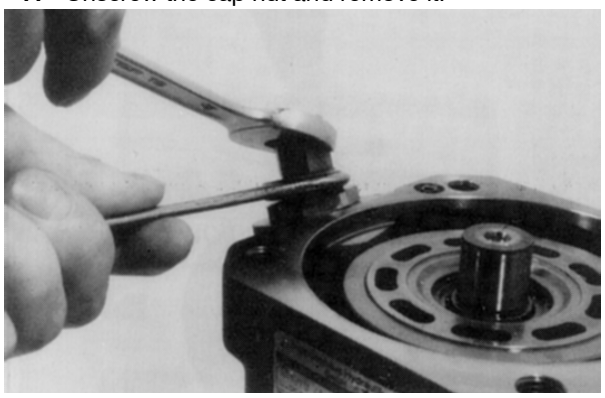
5. Disassemble the taper roller bearing (near by port plate).



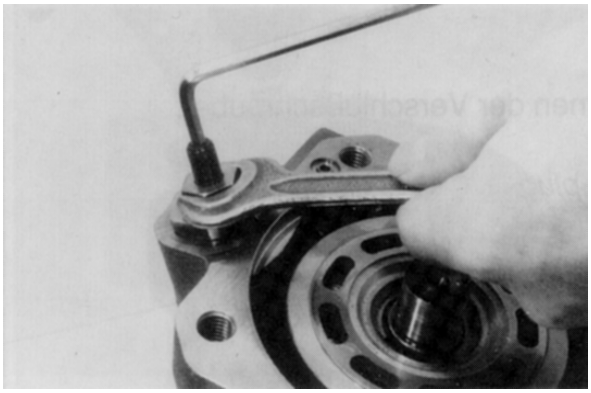
6. Remove the adjustment shim.



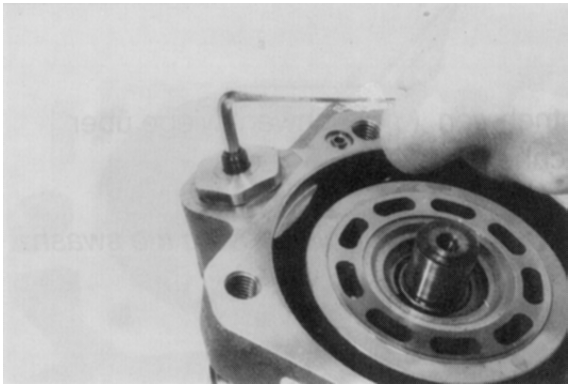
7. Unscrew the cap nut and remove it.



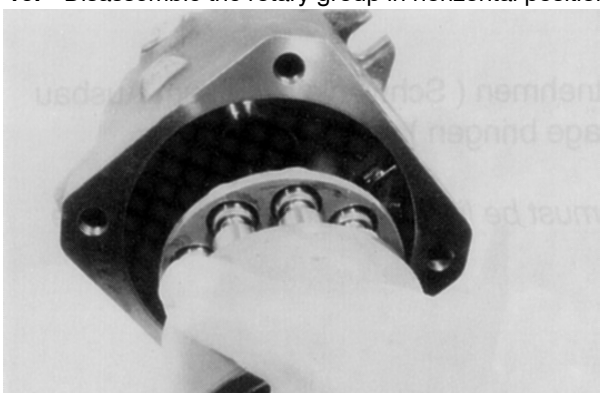
8. Loosen the fixing nut of the stopper max flow and disassemble it.



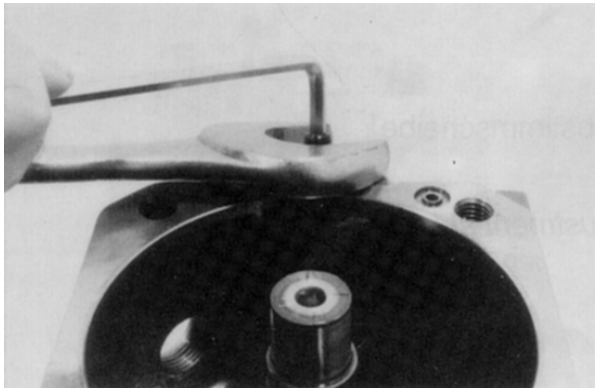
9. Turn in the stopper max flow to get swivel angle zero.



10. Disassemble the rotary group in horizontal position.



11. Disassemble the stopper - max flow.



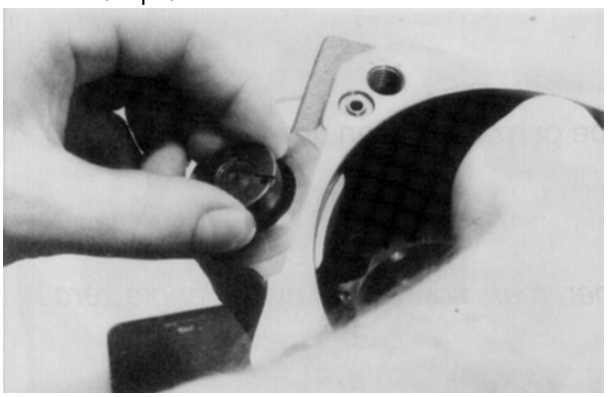
12. Remove the threaded pin (stopper - max flow).



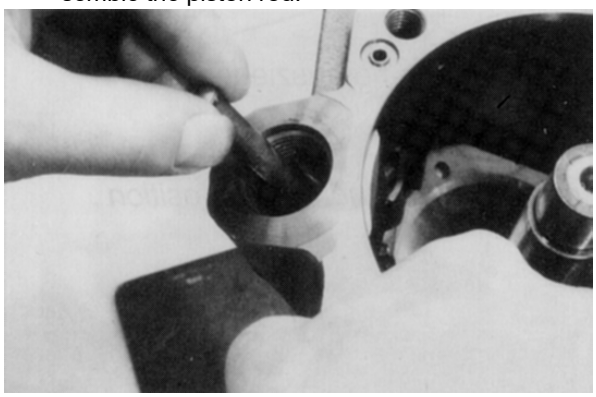
13. Disassemble the plug.



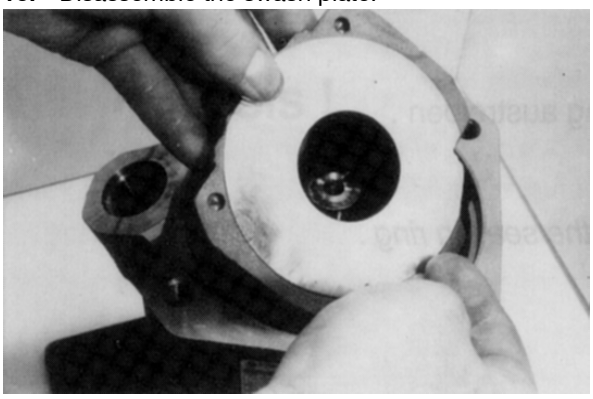
14. Disassemble the control plate while moving the swash plate.



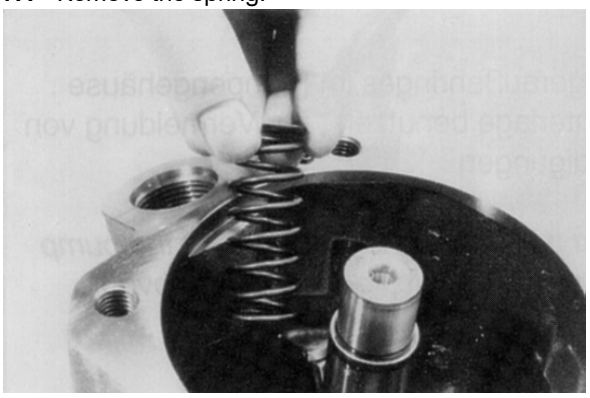
15. The swash plate must be lifted a little bit to disassemble the piston rod.



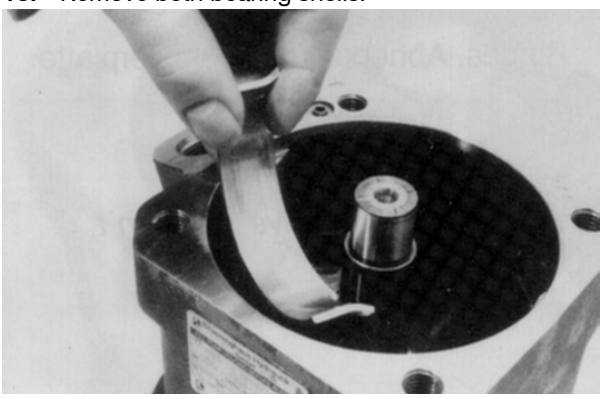
16. Disassemble the swash plate.



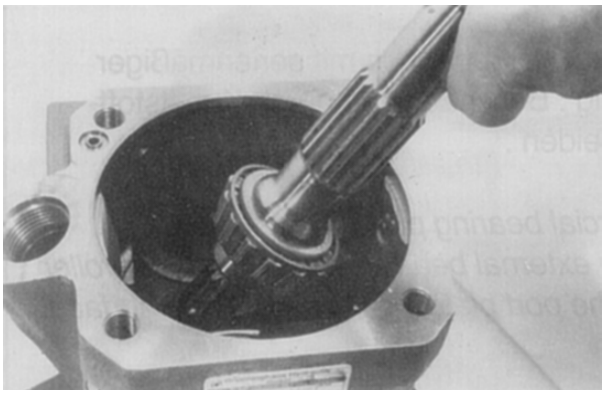
17. Remove the spring.



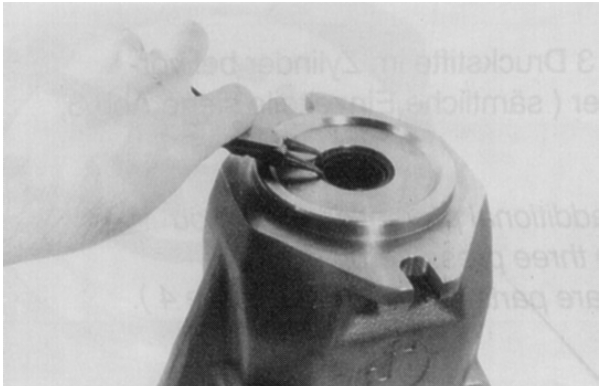
18. Remove both bearing shells.



19. Remove the drive shaft.



20. Disassemble the snap ring.



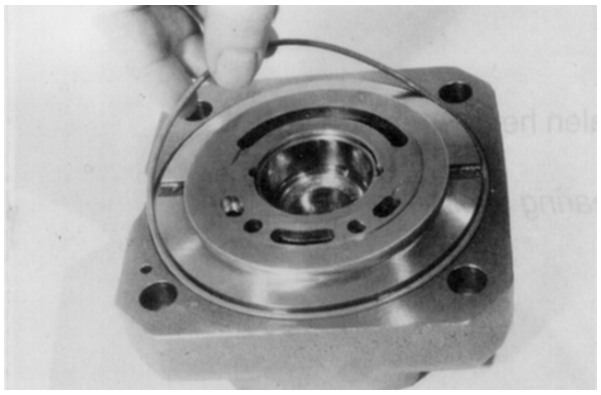
21. Disassemble the sealing ring.



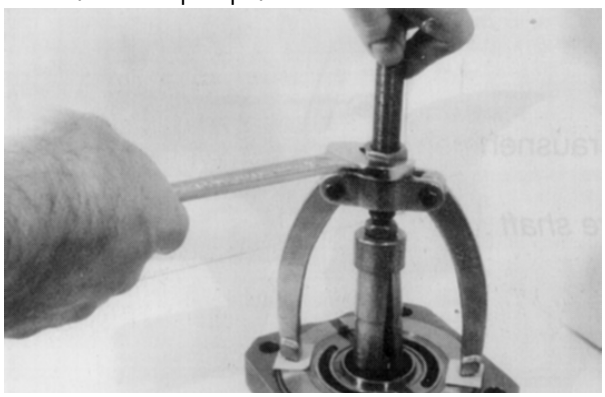
22. The external front bearing ring is pulled out of the pump housing.



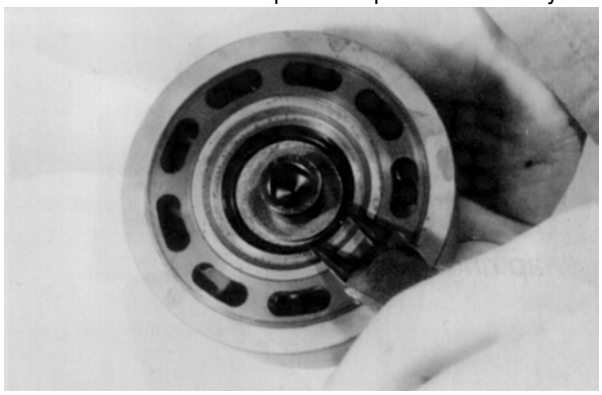
23. Remove the O-ring. Lifting of the valve plate isn't shown.



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

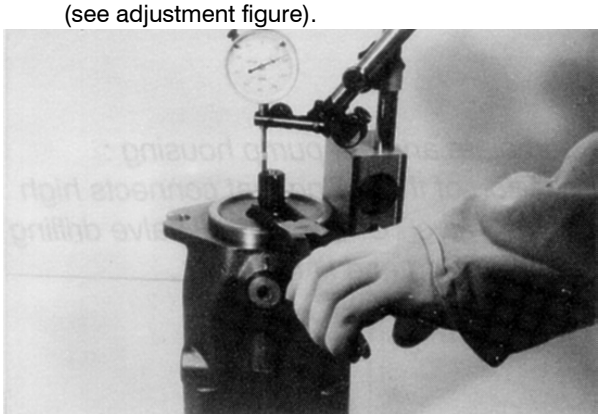


25. The spring has additional pretension while you disassemble the three pressure pins inside the cylinder.

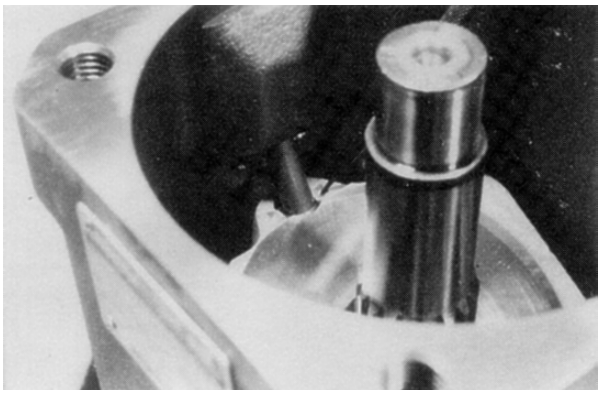


Assembly

1. Assemble the variable displacement pump in reverse order.
2. Measurement of the taper roller bearing pretension (see adjustment figure).

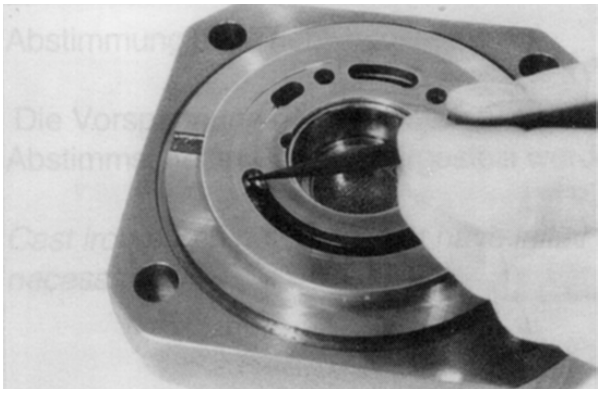


NOTE: *There is a correct connection of the piston rod and swash plate.*

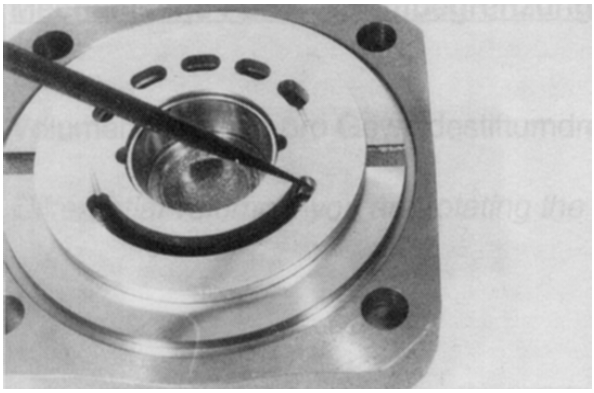


3. Pumps clockwise driven must have a position of the valve plate 4° out of center in the same direction decentered like drive direction.

NOTE: *Spare parts exist as clockwise and counter-clockwise valve plates.*

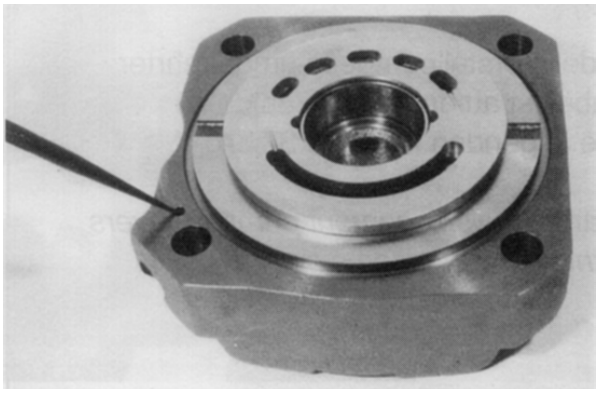


4. Pumps anti-clockwise driven must have a position of the valve plate 4° decentered in counter-clockwise position.

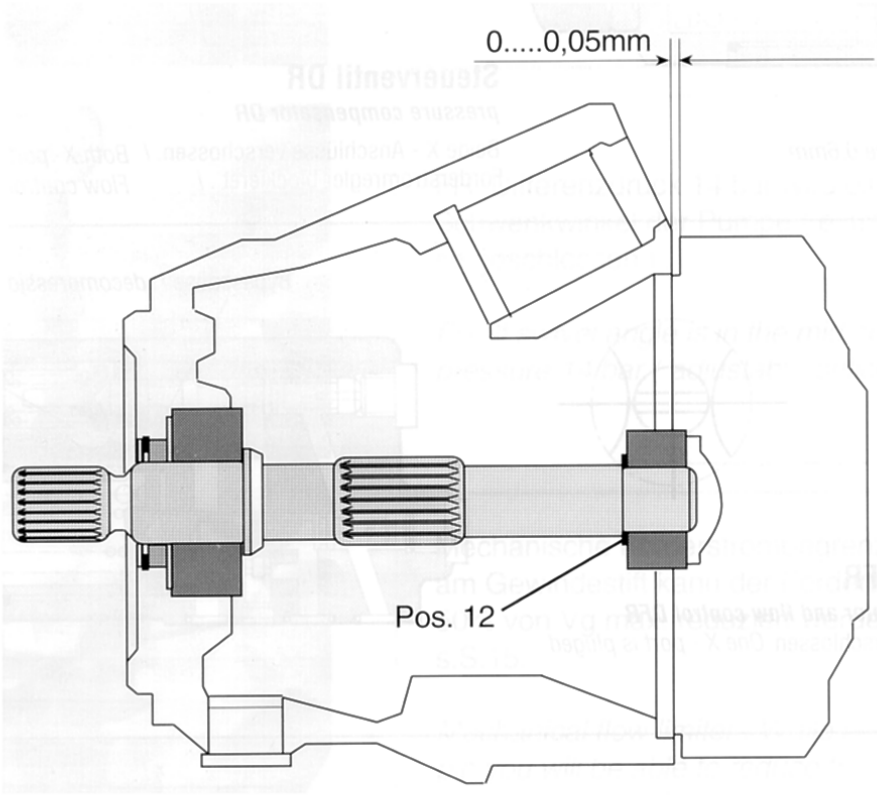


5. Assembly of the port plate and pump housing:

NOTE: *The correct position of the drilling that connects high pressure to the control valve. Check control valve drilling position at the pump housing and fit together.*



Taper roller bearing initial tension



Cast iron pump housing must have initial tension of the bearings : 0.....0,05 mm , grind Pos. 12 if necessary.

Figure 3-2. Bearing Tension

3.4 DRIVE MOTOR (S/N 83331 TO PRESENT)

Description

The drive motors are low to medium power, two-position axial piston motors incorporating an integral servo piston. They are designed for operation in both open and closed circuit applications. The standard control is a direct acting single line hydraulic control. The integral servo piston controls motor displacement.

The motors are spring biased to maximum displacement and hydraulically shifted to minimum displacement. Minimum and maximum displacement can be set with fixed internal stops. The large diameter servo piston allows smooth acceleration and deceleration with relatively large circuit orificing.

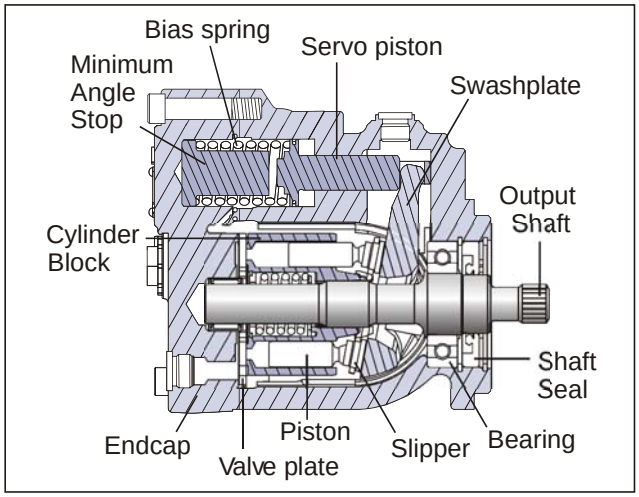
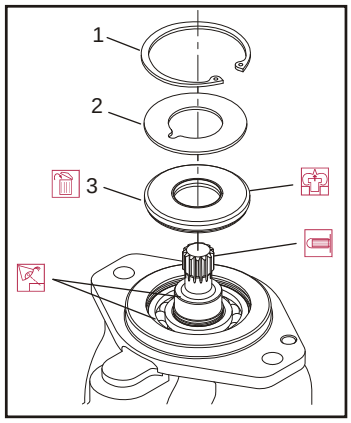


Figure 3-3. Drive Motor Cross Section

Shaft Seal Replacement

REMOVAL

1. Remove the snap ring (1) retaining the shaft seal and support washer.



1. Snap Ring
2. Support Washer
3. Shaft Seal

Figure 3-4. Removing the Shaft Seal

2. Remove the support washer (2).
3. Carefully pry out the shaft seal (3).

   To avoid damaging the shaft during removal, install a large sheet metal screw into the chuck of a slide hammer. Drive the screw into the seal surface and use the slide hammer to pull the seal.
4. Discard the seal.

INSPECT THE COMPONENTS

Inspect the new seal, the motor housing seal bore, and the sealing area on the shaft for rust, wear, and contamination. Polish the shaft and clean the housing if necessary.

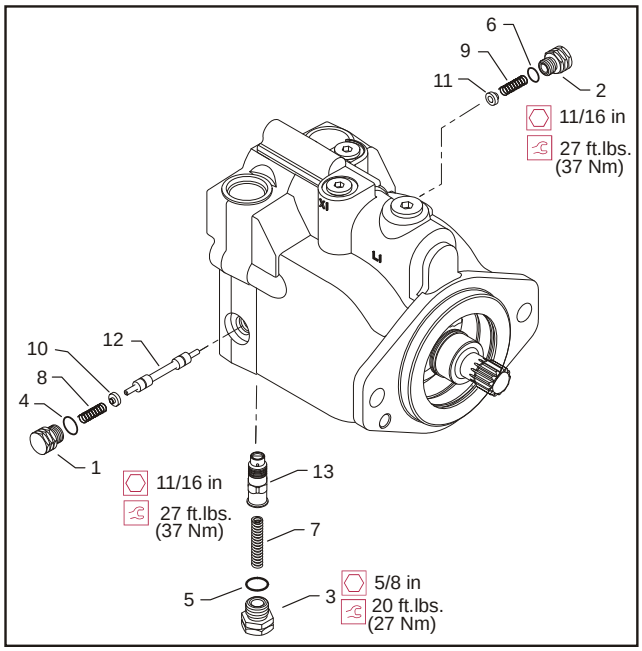
INSTALLATION

1. Cover the shaft splines with an installation sleeve to protect the shaft seal during installation.
2. Install a new shaft seal with the cupped side facing the motor. Press seal into housing until it bottoms out. Press evenly to avoid binding and damaging the seal.
3. Install seal support washer.
4. Install snap ring.
5. Remove the installation sleeve.

Loop Flushing Valve

REMOVAL

1. Using a 11/16 in internal hex wrench remove plug (1) and (2).



1. Plug
2. Plug
3. Plug
4. O-ring
5. O-ring
6. O-ring
7. Spring
8. Spring
9. Spring
10. Washer
11. Washer
12. Shift Spool
13. Orifice Poppet

Figure 3-5. Loop Flushing Spool

2. Using a 1/4 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).

INSPECT THE COMPONENTS

Inspect new O-rings and the sealing area for rust, wear, or contamination. Also check springs and poppet for wear.

INSTALLATION

1. Install orifice poppet (13).
2. Install shift spool (12).
3. Install spring retaining washers onto springs (10 and 11).
4. Carefully install centering springs (7, 8, and 9).
5. Install new O-rings (6, 4, and 5).
6. Using a 1/4 in hex wrench torque plug (3) to 20 ft. lbs. (27 Nm).
7. Using a 11/16 in internal hex, torque plugs (2 and 1) to 27 ft.lbs. (37 Nm).

Troubleshooting

Table 3-2. Excessive Noise and/or Vibration

Item	Description	Action
Check oil level in reservoir and oil supply to the motor.	Insufficient hydraulic fluid could lead to cavitation that would cause system noise.	Fill the reservoir to the proper level and ensure that oil supply to the motor is adequate and the lines are unobstructed.
Check for air in the system.	Air trapped within the system lines, or the motor itself, could result in cavitation that would cause system noise.	Ensure that all of the system lines and components are purged of air.
Inspect the output shaft couplings.	A loose or incorrect shaft coupling will produce vibrations that could result in system noise.	Ensure that the correct coupling is used and that it fits properly onto the shaft.
Inspect the output shaft alignment.	Misaligned shafts create excessive frictional vibration that could result in system noise.	Ensure that the shafts are properly aligned.
Hydraulic oil viscosity above limits.	Viscosity above acceptable limits will result in cavitation that would lead to system noise.	Replace hydraulic oil with appropriate fluid for operating conditions.

Table 3-3. System Operating Hot

Item	Description	Action
Check oil level in reservoir and oil supply to the pump.	Insufficient amount of hydraulic fluid will not meet the cooling demands of the system.	Fill the reservoir to the proper level.
Inspect the heat exchanger, (if so equipped).	If the heat exchanger fails, or becomes obstructed, it may not meet the cooling demands of the system.	Ensure that heat exchanger is receiving adequate air flow and that the heat exchanger is in good operating condition. Repair or replace as necessary.
Check the system relief valves.	If a system relief valve becomes unseated for an extended period of time or fails for any other reason, the system could become overheated.	Repair or replace any malfunctioning relief valves as applicable and verify that the loads on the machine are not excessive.

Table 3-4. Won't Shift or Slow to Start

Item	Description	Action
Check the signal line to the servo control port.	Obstructed or restricted flow through the servo control signal lines could result in slow shift or no shift conditions within the motor.	Ensure that the signal lines are not obstructed or restricted and that signal pressure is adequate to shift the motor.
Check that the correct supply and drain orifices are properly installed, and are not obstructed.	Supply and drain orifices determine the shift rate of the motor. The smaller the orifice, the longer the time it takes to shift the motor. Obstruction will also increase shift times.	Ensure that the proper control orifices are installed in the motor and verify that they are not obstructed. Clean or replace as necessary.

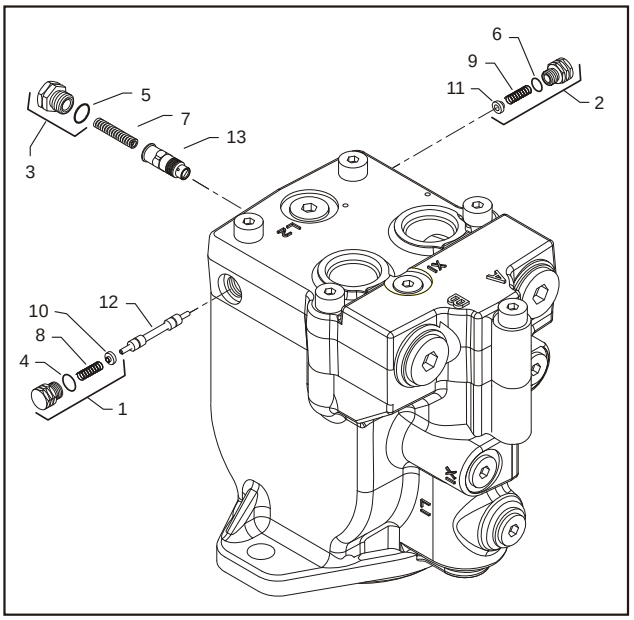
Disassembly

NOTE: *Removal of the endcap voids warranty.*

During assembly, coat all moving parts with a film of clean hydraulic oil. This assures that these parts will be lubricated during start-up.

Replace all O-Rings and gaskets.

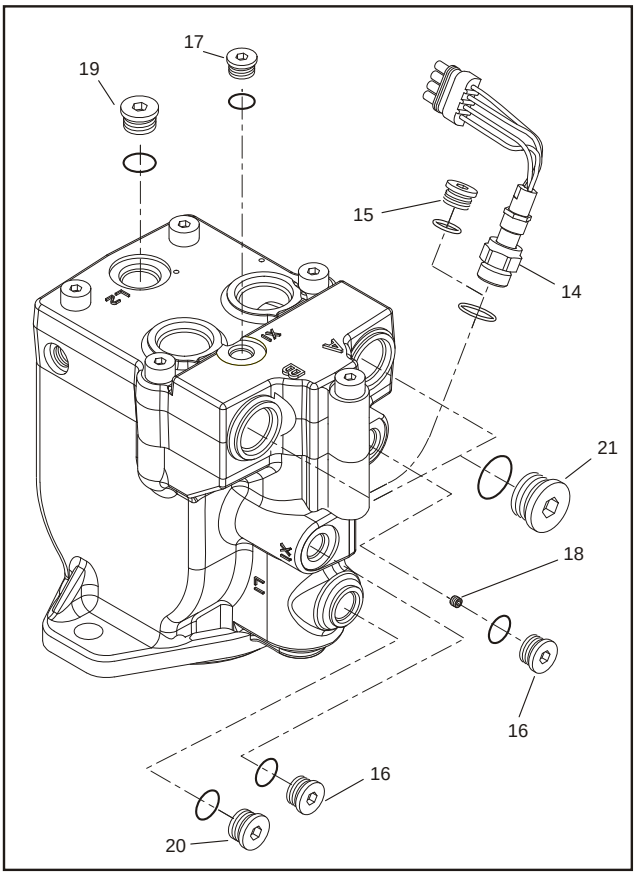
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



1. Plug
2. Plug
3. Plug
4. O-ring
5. O-ring
6. O-ring
7. Spring
8. Spring
9. Spring
10. Washer
11. Washer
12. Shift Spool
13. Orifice Poppet

Figure 3-6. Loop Flushing Spool

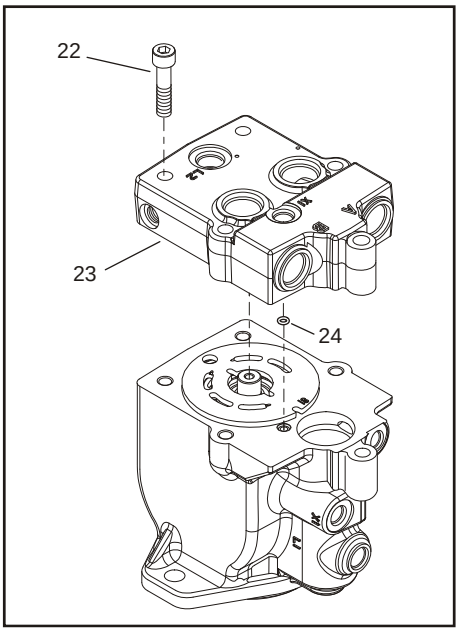
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



14. Lock Nut
15. O-ring Plug
16. Control Line Plug
17. Control Line Plug
18. Cavity Plug
19. Drain Plug
20. Drain Plug
21. Work Port Plug

Figure 3-7. Plugs, Fittings, and Speed Sensor

8. Remove all fittings from the unit. Discard any O-rings on the fittings.
9. Using an 11/16 inch hex wrench, loosen the speed sensor lock nut (14) if equipped. Then remove the speed sensor using a Vi inch hex wrench. Units without speed sensor have an O-ring plug (15) installed in that location; remove it with a Va inch internal hex wrench.
10. Using a 1/4 inch internal hex wrench, remove control line plugs (16, 17). Discard O-rings. Using a 3 mm hex wrench, remove cavity plug (18, if equipped with two-line control) from X2 cavity.
11. Using a 5/16 inch internal hex wrench, remove drain plugs (19, 20). Discard O-rings.
12. Using a 9/16 inch internal hex wrench, remove work port plugs (21, if equipped with axial ports). Discard O-rings.



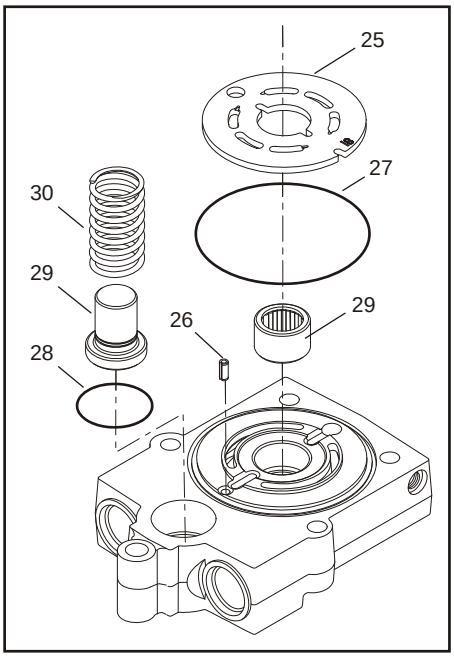
22. Screw
23. End Cap
24. O-ring

Figure 3-8. End Cap

13. Using an 8 mm internal hex wrench, remove the endcap screws (22).

14. Remove the endcap (23). Remove O-ring (24) from the housing or endcap.

When the endcap screws are removed, pressure from the servo spring will cause the endcap to bind on the shaft. Press down on the portion of the end-cap covering the servo piston and hold the endcap level while removing.



25. Valve Plate
26. End Cap
27. O-ring
28. O-ring
29. Angle Stop
30. Servo Spring

Figure 3-9. Valve Plate & Rear Shaft Bearing

NOTICE

TAKE CARE NOT TO SCRATCH THE SURFACE OF THE VALVE PLATE.

15. Remove the valve plate (25) and timing pin (26) from the endcap.

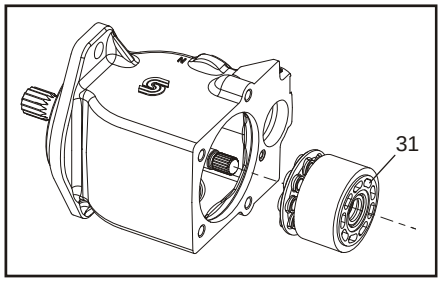
Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.

16. Remove and discard the O-rings (27, 28).

17. Remove the rear shaft bearing (29) from the endcap with a bearing puller.

The bearing may be difficult to remove with a puller. Try this as an alternative: Pack the bearing cavity with heavy grease. After the shaft is removed, insert it into the bearing cavity and tap lightly with a soft mallet on the splined end. The grease will force the bearing out. Use caution not to drive the bearing past the rear shaft journal as the bearing may become trapped on the shaft and damaged.

18. Remove minimum angle stop (29) and servo spring (30) from the housing.



31. Cylinder Kit Assembly

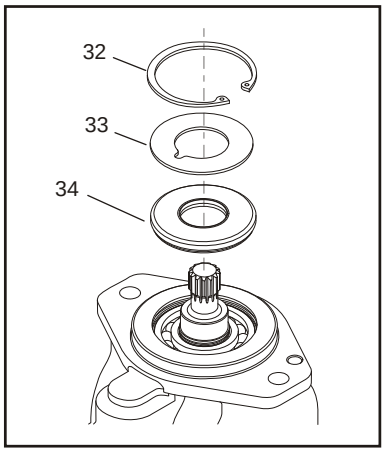
Figure 3-10. Cylinder Kit

19. Turn the housing on its side and remove the cylinder kit assembly (31). Set the assembly aside, being careful not to scratch the running surface.

NOTE: *Grooves on the surface of the cylinder kit identify its displacement:*

Table 3-5. Displacement Identifiers

# of Grooves	Frame L	Frame K
1	25	38
2	30	45
3	35	--

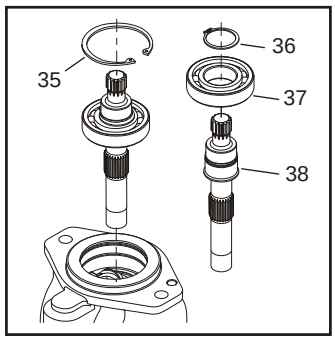


32. Snap Ring
33. Support Washer
34. Shaft Seal

Figure 3-11. Shaft Seal

20. Turn the housing over and remove the snap ring (32) retaining the shaft seal and support washer. Remove the support washer (33) and carefully pry out the shaft seal (34). Discard the seal.

To avoid damaging the shaft during seal removal, install a large sheet metal screw into the chuck of a slide hammer. Drive the screw into the seal surface and use the slide hammer to pull the seal.

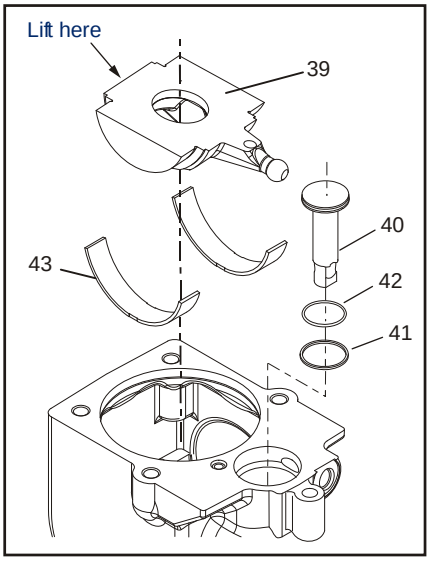


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

Figure 3-12. Shaft & Front Bearing

21. Remove the inner snap ring (35) and the shaft / bearing assembly.

22. Remove the snap-ring (36) retaining the shaft front bearing. Pull the bearing (37) off of the shaft (38).



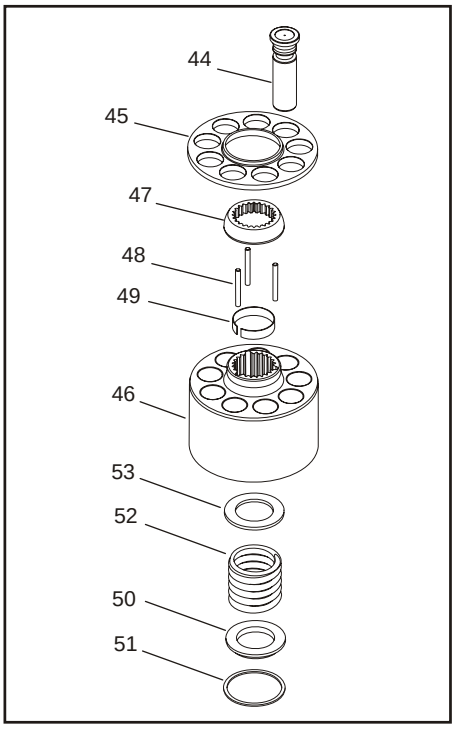
39. Swashplate
40. Servo Piston
41. Piston Seal
42. O-ring
43. Journal Bearings

Figure 3-13. Swash Plate & Servo Piston

23. Turn housing over and remove the swashplate (39) by lifting on the end opposite the servo lever.

24. Remove the servo piston (40). Remove the piston seal (41) and O-ring (42) from the servo piston. Discard the seal and O-ring.

25. Remove the journal bearings (43) from the housing. If the bearings are to be reused, note the location and orientation of each bearing for reassembly.



44. Piston
45. Slipper Retainer
46. Cylinder Block
47. Ball Guide
48. Holddown Pins
49. Retaining Ring
50. Block Spring Washer
51. Spiral Retaining Ring
52. Block Spring
53. Inner Block Spring Washer

Figure 3-14. Cylinder Kit Disassembly

26. Remove pistons (44) and slipper retainer (45) from the cylinder block (46).

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

27. Remove the ball guide (47), hold-down pins (48), and retaining ring (49) from the cylinder block.

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

⚠ CAUTION

RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES FORCE OF ABOUT 80 TO 90 LBF (350 TO 400 N). USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO REMOVE THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS REMOVED.

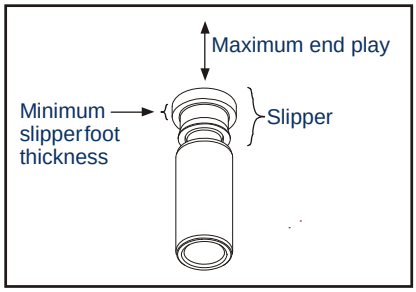
28. Turn the block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress the spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release the pressure and remove the outer block spring washer (50), block spring (52), and inner block spring washer (53) from the cylinder block.

Inspection

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

PISTON

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



SLIPPERS

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

Minimum slipper foot thickness and maximum axial end-play are given in the table below.

Table 3-6. Slipper Foot Thickness & End Play

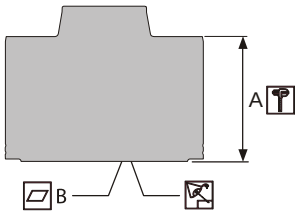
Measurement		L Frame	K Frame
Slipper Foot Thickness	mm (in.)	2.71 (0.11)	4.07 (0.16)
Piston/Slipper End Play		0.15 (0.006)	

CYLINDER BLOCK

Measure the cylinder block height. Replace blocks worn beyond the minimum height specification. Inspect the running surface of the cylinder block. Replace or resurface worn or scratched blocks. Blocks may be resurfaced to the specifications shown in the drawing, provided resurfacing will not reduce the block height below the minimum specification. Table 3-7, Cylinder Block Measurements.

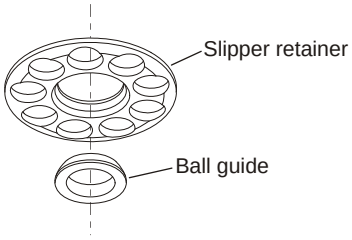
Table 3-7. Cylinder Block Measurements

Measurement	L25	L30	L35	K38	K45
Minimum Cylinder Block Height (A)	50.8 (2.00)	50.8 (2.00)	50.8 (2.00)	54.4 (2.14)	54.4 (2.14)
Cylinder Block Surface Flatness	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)



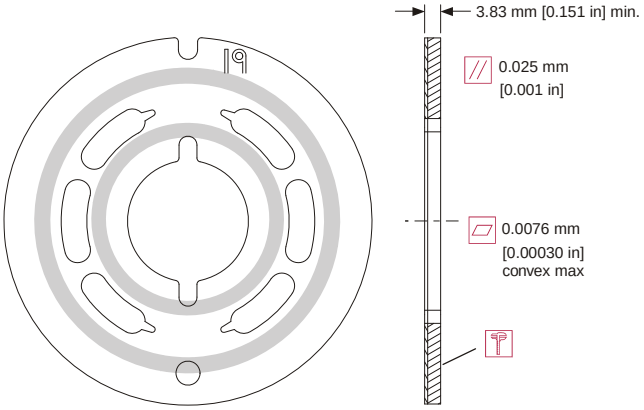
BALL GUIDE AND SLIPPER RETAINER

Inspect the ball guide and slipper retainer for damage, discoloration, or excessive wear. A discolored ball guide or slipper retainer indicates excessive heat. Do not reuse.



VALVE PLATE

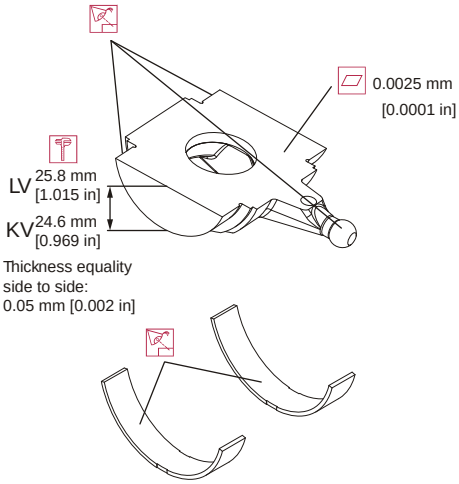
The condition of the valve plate is critical to the efficiency of the motor. Inspect the valve plate surfaces carefully for excessive wear, grooves, or scratches. Replace or resurface grooved or scratched valve plates. Measure the valve plate thickness and replace if worn beyond the minimum specification. Valve plates may be resurfaced to the specifications shown in the drawing, provided resurfacing will not reduce the thickness below the minimum specification.



SWASHPLATE AND JOURNAL BEARINGS

Inspect the running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable providing the surface condition meets specifications shown. Measure the swashplate thickness from the journals to the running face. Replace swashplate if damaged or worn beyond minimum specification.

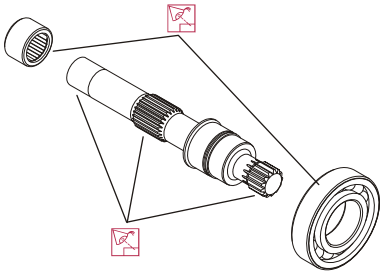
Replace swashplate if the difference in thickness from one side to the other exceeds specification.



Inspect the journal bearings for damage or excessive wear. Replace journal bearings if scratched, warped, or excessively worn. The polymer wear layer must be smooth and intact.

SHAFT BEARINGS

Inspect bearings for excessive wear or contamination. Rotate the bearings while feeling for uneven movement. Bearings should spin smoothly and freely. Replace bearings that appear worn or do not rotate smoothly.

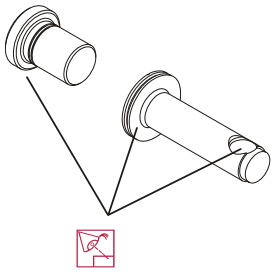


SHAFT

Inspect the motor shaft. Look for damage or excessive wear on the output and block splines. Inspect the bearing surfaces and sealing surface. Replace shafts with damaged or excessively worn splines, bearing surfaces, or sealing surfaces.

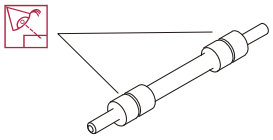
SERVO PISTON AND MINIMUM ANGLE STOP

Inspect the minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace if necessary.



LOOP FLUSHING SPOOL

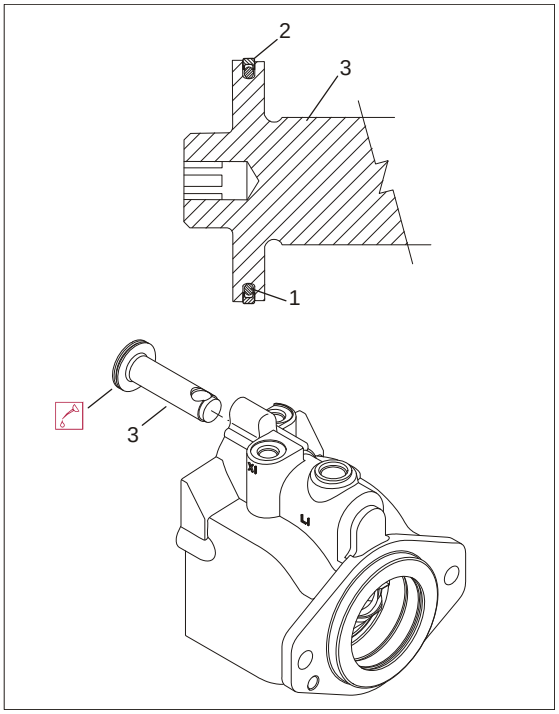
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



Assembly

1. Install new O-ring (1) and piston seal (2) to the servo piston (3). Install the piston seal over the O-ring.

   Installing the piston seal stretches it, making it difficult to install the servo piston in its bore. Allow 30 minutes for the seal to relax after installation. To speed up seal relaxation, compress the seal by installing the piston head into the servo cavity in the end-cap and let it stand for at least five minutes.



1. O-ring
2. Piston Seal
3. Servo Piston

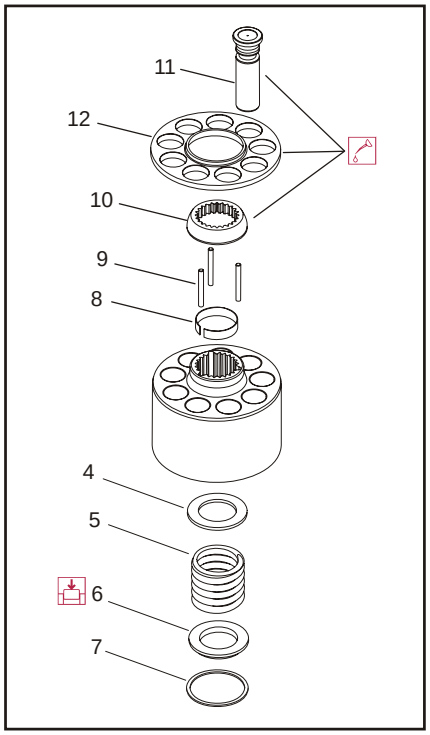
Figure 3-15. Servo Piston

2. After piston seal has relaxed, lubricate and install servo piston into the housing bore. Align the piston with the ball socket facing the inside of the housing.

⚠ CAUTION

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

3. Install the inner block spring washer (4), block spring (5), and outer washer (6) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (7) into the groove in the cylinder block.



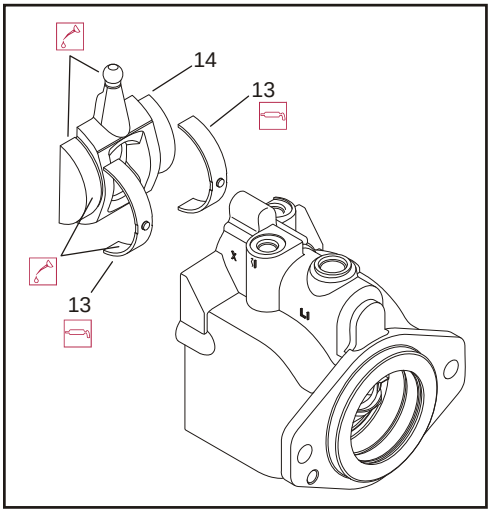
4. Block Spring Washer
5. Block Spring
6. Outer Washer
7. Spiral Retaining Ring
8. Retaining Ring
9. Holddown Pins
10. Ball Guide
11. Piston
12. Slipper Retainer

Figure 3-16. Cylinder Kit Assembly

4. Turn the block over and install the retaining ring (8), hold-down pins (9), and ball guide (10) to the cylinder block.

5. Install the pistons (11) to the slipper retainer (12). Install the piston/retainer assembly into the cylinder block. Ensure the concave surface of the retainer seats on the ball guide. If you're reusing the pistons, install them to the original block bores. Lubricate the pistons, slippers, retainer, and ball guide before assembly. Set the cylinder kit aside on a clean surface until needed.

6. Install the journal bearings (13) into the housing seats. Use assembly grease to keep the bearings seated during assembly. Ensure the locating nubs drop into the cavities in the seats. If you're reusing the bearings, install them in the original location and orientation. Lubricate the journal bearings.

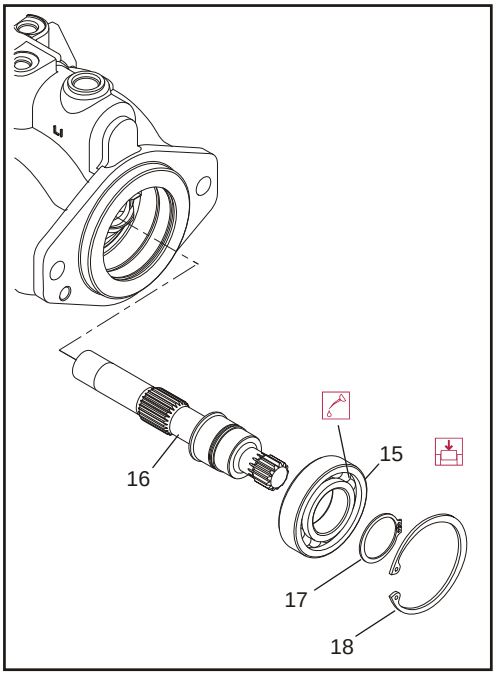


13. Journal Bearings
14. Swash Plate

Figure 3-17. Swash Plate and Journal Bearing

7. Install the swashplate (14) into the housing. Tilt the swashplate and guide the servo lever ball into its socket in the servo piston rod. Ensure the swashplate seats into the journal bearings and moves freely. Lubricate the running surface of the swashplate.

8. Press front shaft bearing (15) onto shaft (16). Press bearing onto shaft with lettering facing out. Lubricate bearing rollers. Install snap-ring (17) onto shaft.

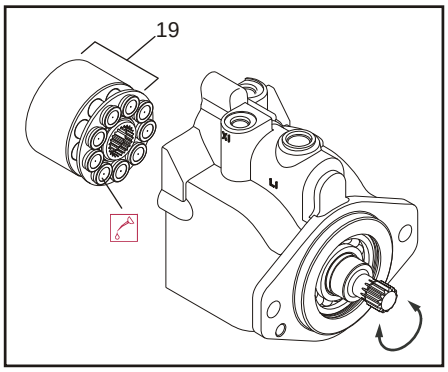


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-18. Shaft and Front Bearing

9. While holding the swashplate in place, turn the housing on its side. Install the install shaft/bearing assembly into housing from the flange end. Install the snap-ring (18).

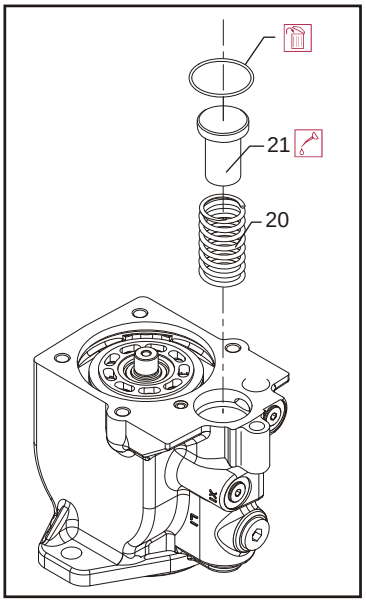
10. Verify swashplate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swashplate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder kit, swashplate, journal bearings, and servo piston are all secure and properly installed.



19. Cylinder Kit

Figure 3-19. Cylinder Kit Installation

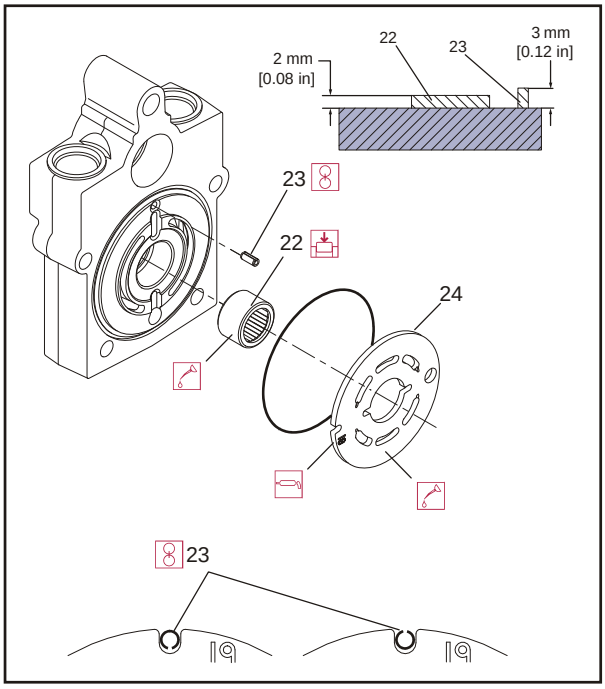
11. Lubricate and install the servo spring (20), and minimum angle stop (21) into the housing bore.



20. Servo Spring
21. Minimum Angle Stop

Figure 3-20. Servo Spring and Minimum Angle Stop

12. Press the rear shaft bearing (22) into the endcap. Install the bearing with letters facing out. Press until bearing surface is 0.08 ±0.01 in (2 ±0.25 mm) above endcap surface.



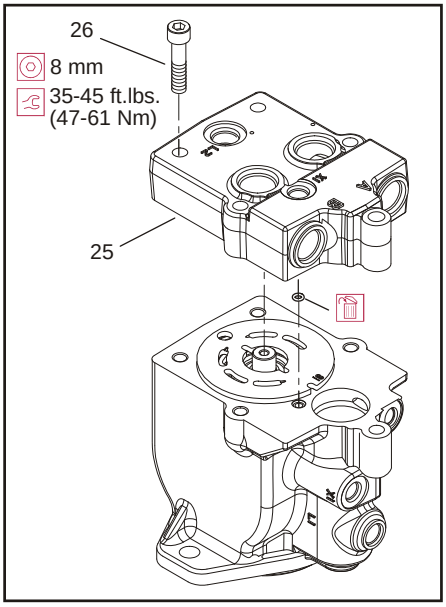
22. Rear Shaft Bearing
23. Timing Pin
24. Valve Plate

Figure 3-21. Valve Plate and Rear Bearing

13. Install timing pin (23) into its bore in the endcap. Install the pin with its groove facing toward or away from the shaft. Press the pin until the end protrudes 0.12 ±0.01 in (3 ±0.25 mm) above endcap surface.

14. Install the valve plate (24) onto the endcap. Install the valve plate with the yellow surface toward the cylinder block. Align the slot in the valve plate with the timing pin. Apply a liberal coat of assembly grease to the endcap side of the valve plate to keep it in place during installation.

15. Install the endcap (25) onto the housing with the endcap screws (26). Check to ensure the endcap will properly seat onto the housing without interference. Improper assembly of the internal components may prevent the endcap from seating properly. Ensure the O-rings seat properly when installing the endcap.



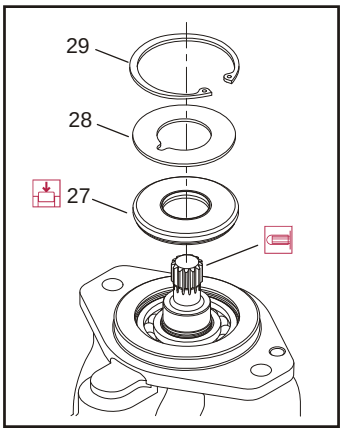
25. End Cap
26. Screw

Figure 3-22. End Cap

16. Using an 8 mm internal hex wrench, tighten the endcap screws. Tighten the screws in opposite corners slowly and evenly to compress the servo spring and properly seat the endcap. Torque endcap screws 35-45 ft.lbs. (47-61 Nm).

17. Before installing the shaft seal, ensure the shaft turns smoothly with less than 120 in.lbs. (13.5 Nm) of force. If the shaft does not turn smoothly within the specified maximum force, disassemble and check the unit.

18. Cover shaft splines with an installation sleeve. Install a new shaft seal (27) with the cup side facing the motor. Press seal into housing until it bottoms out. Press evenly to avoid binding and damaging the seal. Install seal support washer (28) and snap ring (29).



27. Shaft Seal
28. Seal Support Washer
29. Snap Ring

Figure 3-23. Shaft Seal

19. Install remaining plugs and fittings to the housing. Refer to the drawing below for wrench sizes and installation torques.

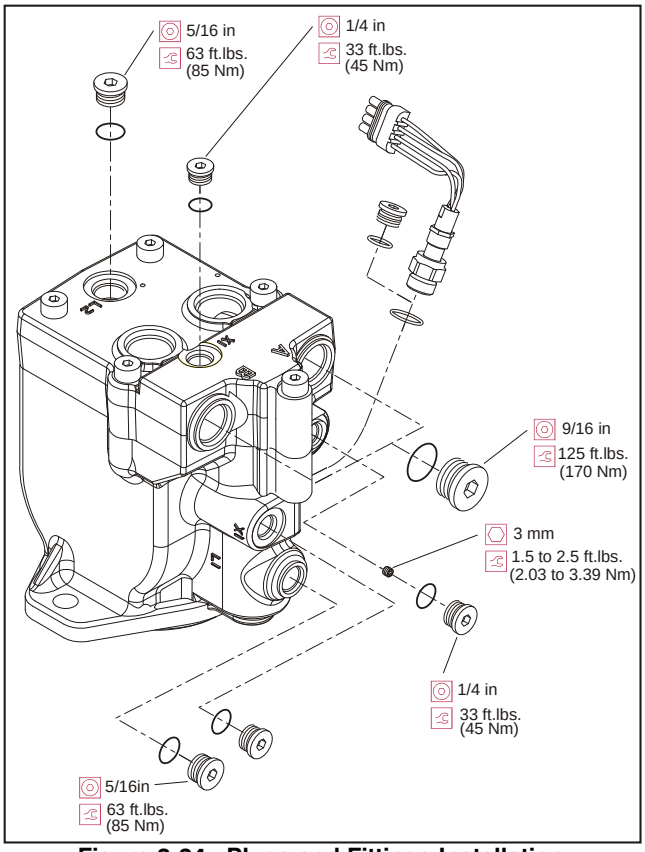
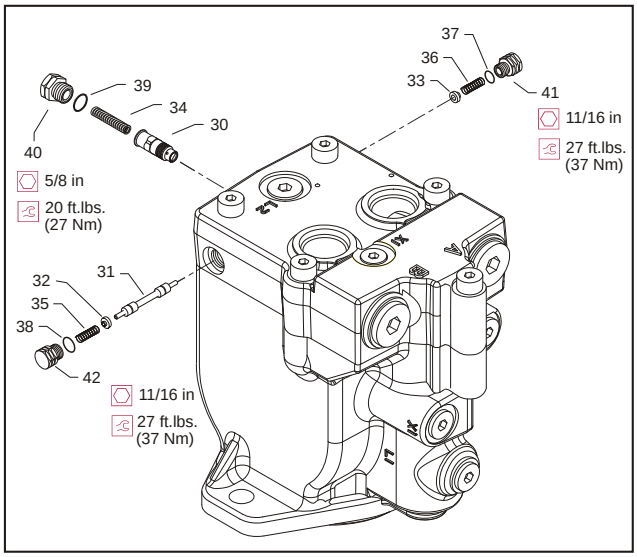


Figure 3-24. Plugs and Fittings Installation

20. Install orifice poppet (30).



30. Orifice Poppet	34. Spring	37. O-ring	40. Plug
31. Shift Spool	35. Spring	38. O-ring	41. Plug
32. Spring	36. Spring	39. O-ring	42. Plug
33. Spring			

Figure 3-25. Loop Flushing Spool

21. Install shift spool (31).

22. Install spring retaining washers onto springs (32 and 33).

23. Carefully install centering springs (34, 35, and 36).

24. Install new O-rings (37, 38, and 39).

25. Using a 5/8 in wrench torque plug (40) to 20 ft.lbs. (27 Nm).

26. Using a 11/16 in wrench, torque plugs (41 and 42) to 27 ft.lbs. (37 Nm).

Initial Start-up Procedures

Follow this procedure when starting-up a new motor or when installing a motor that has been removed.

Prior to installing the motor, inspect for damage incurred during shipping. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

1. Fill the reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.

2. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.

3. Fill the pump and motor housing with clean hydraulic fluid. Pour filtered oil directly into the upper most case drain port.

4. To ensure the pump and motor stay filled with oil, install case drain lines into the upper most case drain ports.

5. Install a 0 to 500 psi (0 to 35 bar) gauge in the charge pressure gauge port of the pump to monitor system pressure during start up.

6. While watching the pressure gauge, run the engine at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shut down the prime mover, determine cause, and take corrective action.

7. Operate the hydraulic system for at least fifteen minutes under light load conditions.

8. Check and adjust control settings as necessary after installation.

9. Shut down the prime mover and remove the pressure gauge. Replace plug at the charge pressure gauge port.

10. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The motor is now ready for operation.

3.5 TORQUE HUB

Disassembly

1. Position hub over suitable container and remove drain plugs (10) from unit. Allow oil to completely drain, then replace drain plugs.
2. Remove eight bolts (41) and four shoulder bolts (42) securing cover assembly to hub (7). Remove cover assembly (23) and discard o-ring seal (22).
3. Lift carrier assembly and top thrust washer and thrust bearing(39, 40) from hub. Thrust washer may stick inside cover.
4. Pry ring gear (21) loose from hub and remove it. Remove o-ring seal (22) from hub counter bore and discard it.
5. Remove input gear (37) and thrust spacer (36) from input shaft assembly and remove input shaft assembly from hub.
6. Lift internal gear (12) and thrust washer and thrust bearing (39, 40) from hub. Thrust washer may stick to bottom of carrier.
7. Remove retaining ring (9) from spindle (1) and discard; lift hub from spindle.

⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL.

8. Remove inside bearing cone (6) and bearing shim (8).
9. If necessary, pry seal (2) out of hub using screwdriver or pry bar. With seal removed, outside bearing cone (4) can be removed.
10. If necessary, remove inner and outer bearing cones (3, 5) using a suitable slide hammer puller.

NOTICE

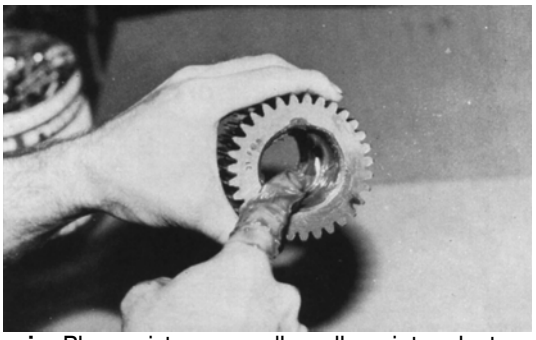
WHEN REBUILDING TORQUE HUB, REMOVE AND REPLACE ALL O-RINGS AND RETAINING RINGS.

Cleaning and Inspection

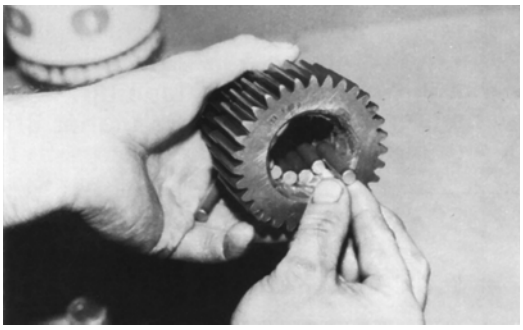
1. Thoroughly clean all parts in an approved cleaning solvent.
2. Inspect bearing cups and cones for damage, pitting, corrosion, or excessive wear. If necessary, replace bearings as a complete set ensuring that they remain covered until use.
3. Inspect bearing mounting surfaces on spindle, hub, input shaft and carrier. Replace components as necessary.
4. Inspect all geared components for chipped or broken teeth and for excessive or uneven wear patterns.
5. Inspect carrier for damage, especially in anti-roll pin and planet shaft hole areas.
6. Inspect all planet shafts for scoring or other damage.
7. Inspect all threaded components for damage including stretching, thread deformation, or twisting.
8. Inspect seal mounting area in hub for burrs or sharp edges. Dress applicable surfaces or replace components as necessary.
9. Inspect cover for cracks or other damage, and o-ring sealing area for burrs or sharp edges. Dress applicable surfaces or replace cover as necessary.

Repair

1. Cover Assembly.
   - **a.** Remove two bolts (25) securing disconnect cap (26) to cover (23) and remove cap.
   - **b.** Remove two bolts (25) securing cover cap (24) to cover and remove cap.
   - **c.** Remove disconnect rod (27) from cap and remove o-rings (28, 29) from cover cap. Discard o-rings.
   - **d.** If necessary, remove pipe plug (30) from cover.
   - **e.** Clean and inspect parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
   - **f.** If removed, screw pipe plug into cover.
   - **g.** Slip o-ring (29) over cover cap and against face.
   - **h.** Place o-ring (28) into cover cap internal groove. Disconnect rod may be used to push o-ring into groove.
   - **i.** Place cover cap into cover with large hole located over pipe plug. Secure cover cap to cover with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).
   - **j.** Place disconnect cap over cover cap with nipple facing out and secure with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).
   - **k.** Turn cover over and push disconnect rod into cover cap. Rod will be held in place by friction from o-ring.
2. Carrier Assembly.
   - **a.** Drive anti-roll pin (19) into planet shaft (17) using a suitable punch.
   - **b.** Using a suitable press, press planet shaft from carrier (13). After planet shaft is removed, drive anti-roll pin from shaft.
   - **c.** Remove cluster gear (18) and thrust washers (14) from carriers.
   - **d.** Remove sixteen needle rollers (15) from cluster gear bore.
   - **e.** Remove spacer (16) from cluster gear bore and remove second set of sixteen needle rollers (15).
   - **f.** Repeat steps (a) through (e) for remaining two cluster gears.
   - **g.** Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
   - **h.** Apply a coat of grease or petroleum jelly to cluster gear bore.



- **i.** Place sixteen needle rollers into cluster gear bore.



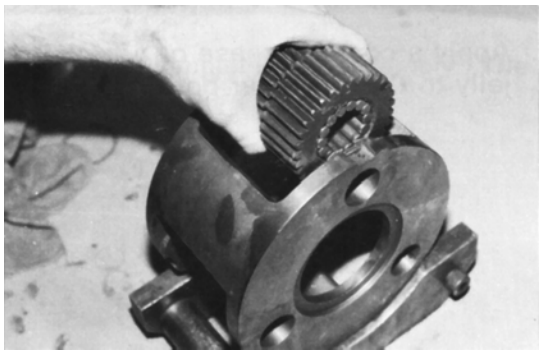
- **j.** Place spacer into opposite side of cluster gear and against needle rollers.



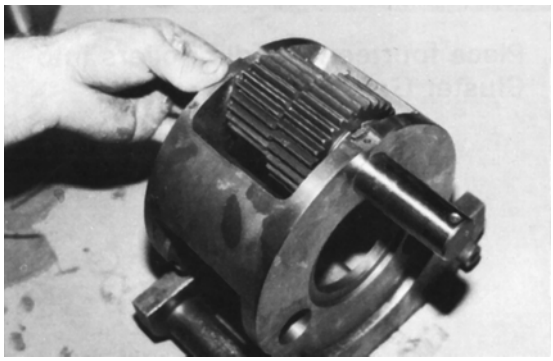
- **k.** Place second set of sixteen needle rollers into cluster gear.
- **l.** Apply grease or petroleum jelly to tang side of two thrust washers. Place thrust washers against bosses in carrier with washer tang fitting into slot in carrier outside diameter.



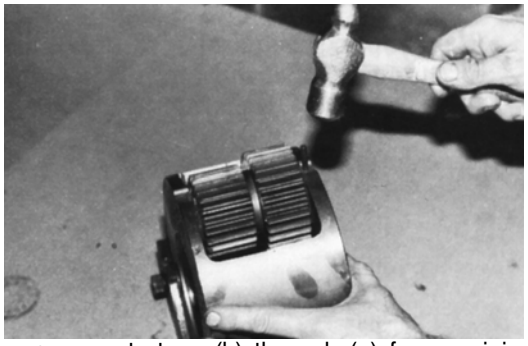
m. While keeping thrust washers in place, slide cluster gear into carrier with larger gear on side with small pin hole.



n. Line up cluster gear and thrust washers with hole in carrier and slide planet shaft through. Ensure chamfered side of hole in planet shaft is lined up with pin hole in carrier.



o. Drive anti-roll pin flush into carrier hole, locking planet shaft into place.



p. repeat steps (h) through (o) for remaining two cluster gears.

3. Input Shaft Assembly.

⚠ CAUTION

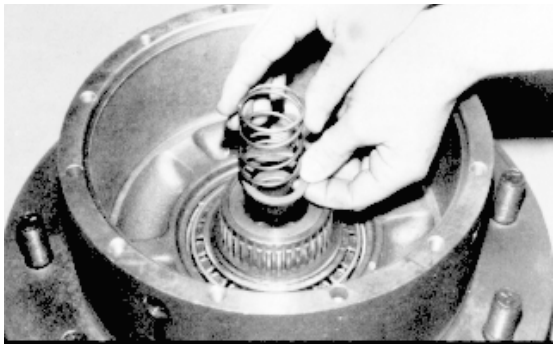
EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL AND INSTALLATION

a. Carefully remove retaining ring (33) from counterbore in the spindle (1) and discard retaining ring.

b. Remove two spacers (31) and spring (32) from input shaft.

c. Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.

d. Place washer (31), spring (32), and washer (31), in that order, onto input shaft.



Install retaining ring into input shaft groove to secure spacers and spring to shaft.

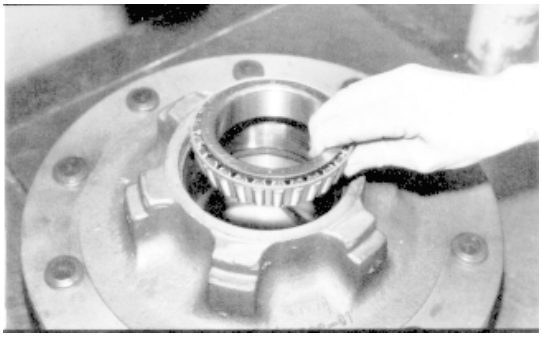


Assembly

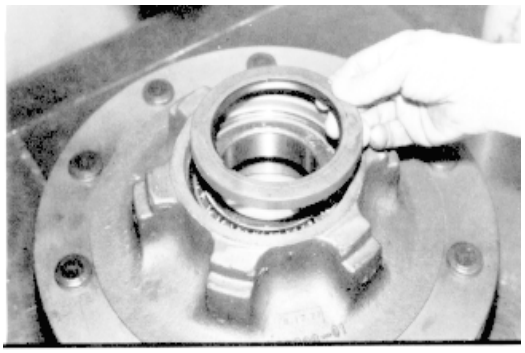
1. Using a suitable press, press new bearing cups (3, 5), with large inside diameters facing out, into hub (7) counter bores.



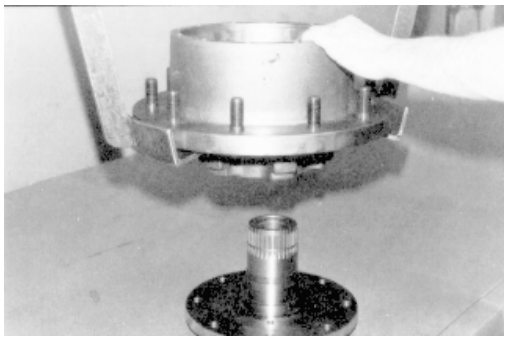
2. Place bearing cone (4) into bearing cup (3) in small end of hub.



3. Press new seal (2) into hub counter bore with flat metal side facing in. Use a flat object to ensure that seal is pressed evenly and is flush with hub face.



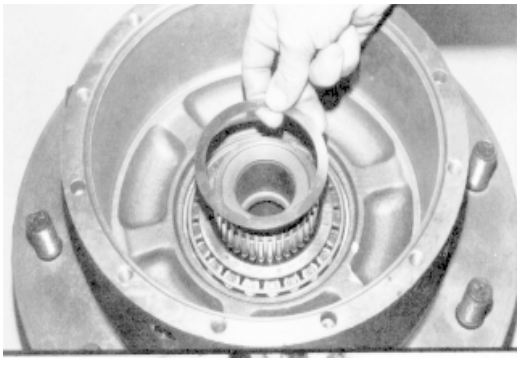
4. Lower hub onto spindle (1) with large open end up.



5. Place bearing cone (6) over end of spindle and into bearing cup.



6. Place bearing shim (8) over end of spindle and against bearing cone.



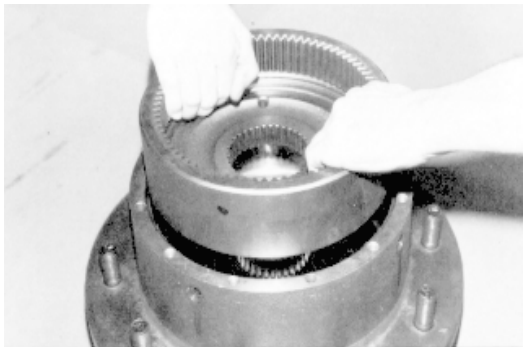
⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING INSTALLATION.

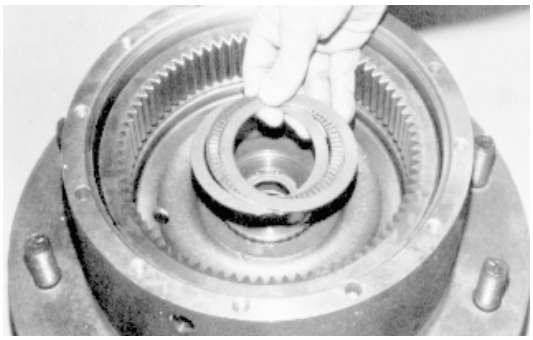
7. Install new retaining ring (9) completely into spindle groove and against bearing shim. Ensure retaining ring is entirely in groove.



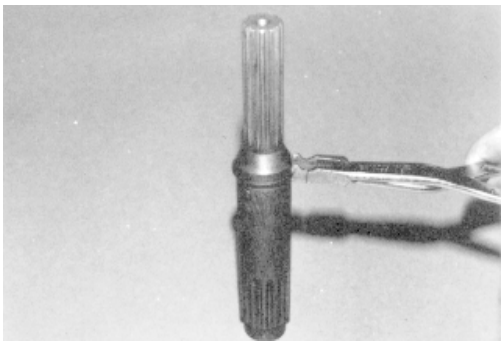
8. Place internal gear (12) onto end of spindle.



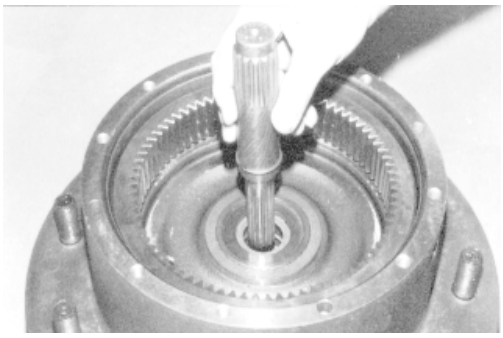
9. Install thrust washers and thrust bearing (39, 40) on the portion of the spindle which extends into the internal gear.



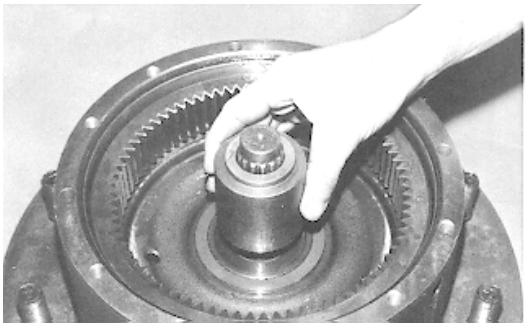
10. Install retaining ring (34) into input shaft retaining ring groove.



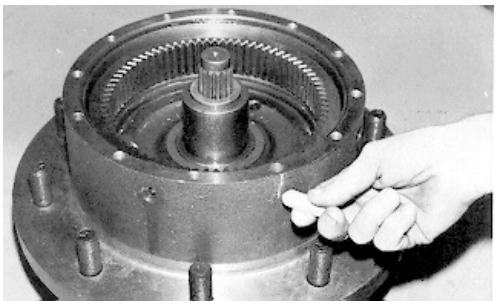
11. Place input shaft assembly (35) into spindle bore with unsplined end facing out.



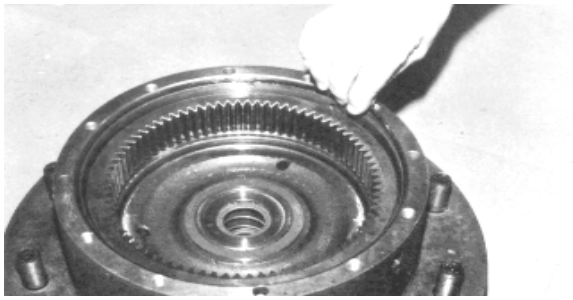
12. Place thrust spacer (36) over input shaft (35) with counter bore side facing spindle.



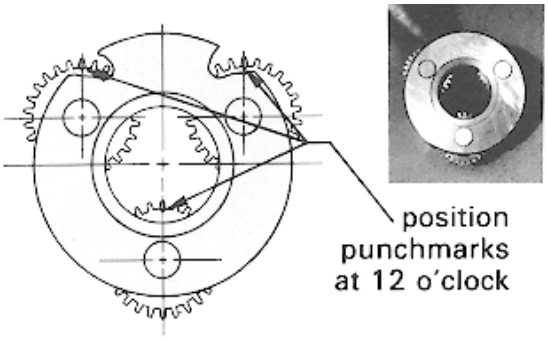
13. Locate the four counter reamed holes in the face of the hub, mark them for later identification.



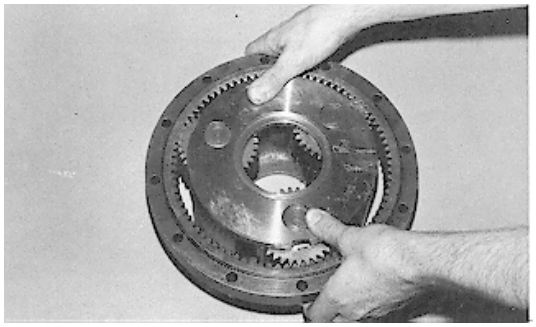
14. Place o-ring (22) into hub counter bore. Use petroleum or grease to hold o-ring in place. Slight stretching of o-ring may be necessary to insure proper seating.



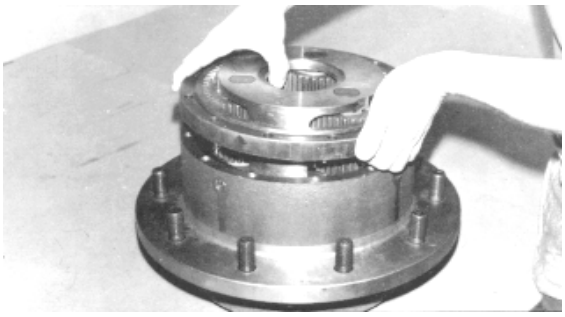
15. Place carrier assembly on a flat surface with large gears up and positioned as shown. Find punch marked tooth on each large gear and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under carrier on upper two gears.



16. With shoulder side of ring gear (21) facing down, place ring gear over (into mesh with) large gears. Ensure punch marks remain in correct location during ring gear installation.

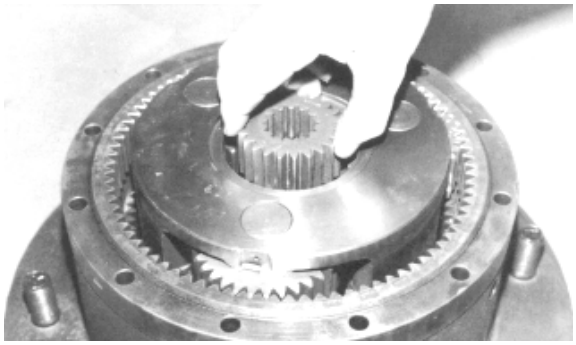


17. While holding ring gear, input gear, and cluster gears in mesh, place small side of cluster gears into mesh with internal gear. On ring gear, locate hole marked 'X' over one of counter bored holes in hub.

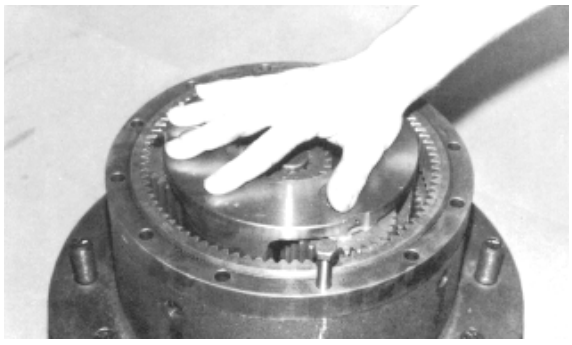


NOTE: *If gears do not mesh easily or carrier assembly does not rotate freely, then remove carrier and ring gear and check cluster gear timing.*

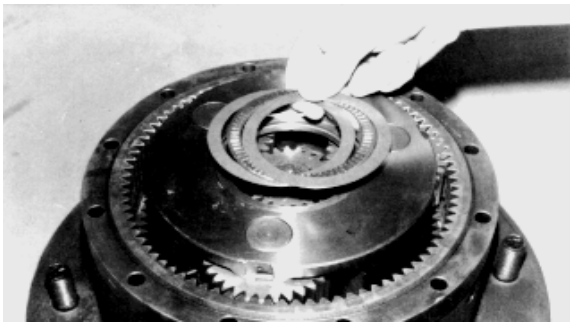
18. Install input gear (37) into carrier, meshing with large diameter cluster gears (18). Counter bore in bore of input gear must be to outside of carrier assembly.



19. After inserting at least one shoulder bolt in the proper location, rotate the carrier. Check freedom of rotation and timing.



20. Install thrust washers and thrust bearing (39, 40) into carrier counter bore.



21. Place o-ring (22) into cover assembly counter bore. Use petroleum jelly or grease to hold o-ring in place.

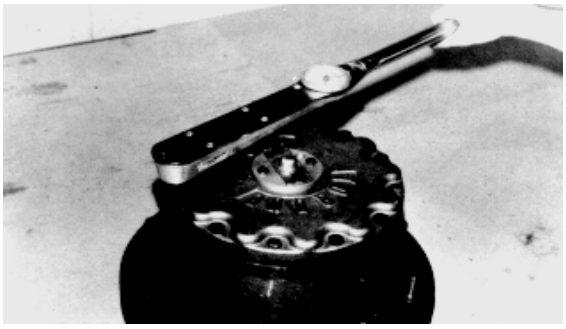


22. Place cover assembly over ring gear with oil level check plug in cover located approximately 90 degrees from oil fill plug in hub.

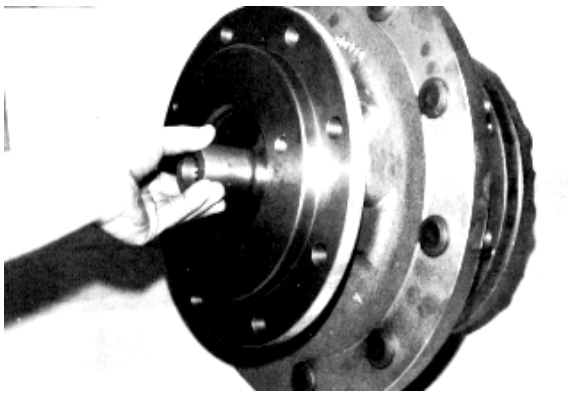
23. Locate four shoulder bolts (42), 90 degrees apart into counter bored holes in hub marked in step (13). Torque shoulder bolts to 47 ft. lbs. (64 Nm).



24. Install bolts (41) in remaining holes. Torque bolts to 47 ft. lbs. (64 Nm).



25. Place coupling (1) into spindle and onto input shaft.



26. Fill hub one-half full of EPGL 90 lubricant before operation.

1. Spindle
2. Seal
3. Bearing Cup
4. Bearing Cone
5. Bearing Cup
6. Bearing Cone
7. Hub
8. Spacer
9. Retaining Ring
10. Plug
11. Wheel Bolt
12. Internal Gear
13. Carrier
14. Thrust Washer
15. Needle Roller
16. Spacer
17. Piston Shaft
18. Cluster Gear
19. Roll Pin
20. Not Used
21. Cluster Gear
22. O-ring
23. Cover
24. Cover Cap
25. Bolt
26. Disconnect Cap
27. Disconnect Rod
28. O-ring
29. O-ring
30. Pipe Plug
31. Washer
32. Spring
33. Retaining Ring
34. Retaining Ring
35. Input Shaft
36. Thrust Spacer
37. Input Gear
38. Not Used
39. Thrust Washer
40. Thrust Bearing
41. Bolt
42. Shoulder Bolt
43. Coupling

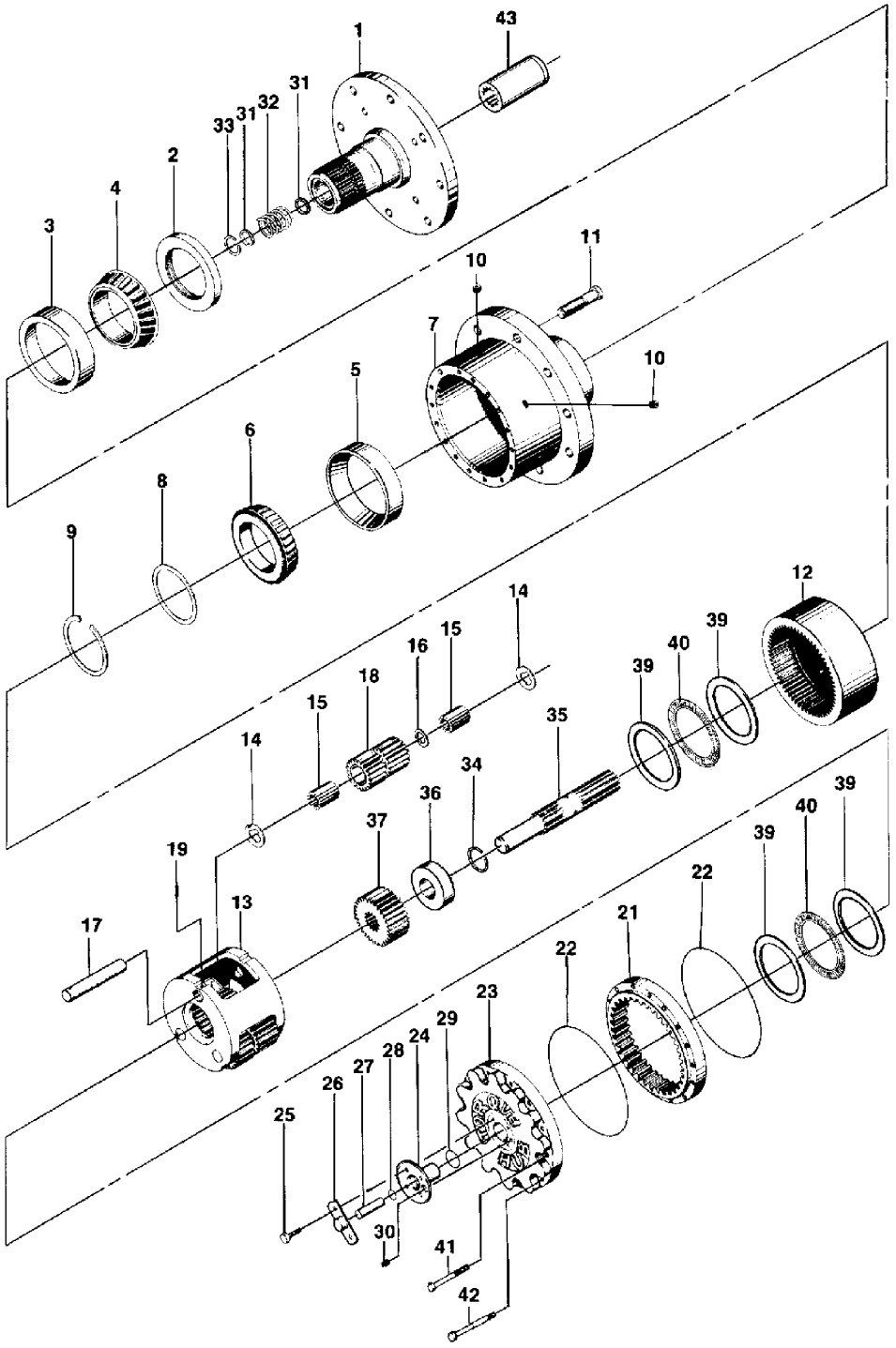


Figure 3-26. Torque Hub Drive (Fairfield)

3.6 WHEEL DRIVE ASSEMBLY, 4WD

Removal and Disassembly

NOTE: *The drive motor can be removed through the axle flange as part of the wheel drive assembly or they can be removed separately through the bottom of the frame while leaving the torque hub bolted to the axle.*

1. Use a jack to lift the frame enough so the tire and wheel assembly is off of the ground. Place blocking strong enough to support the weight of the machine under the frame and remove the jack.

NOTE: *The pneumatic tire & wheel assembly weighs approximately 269 lbs. (122 kg). The foam-filled tire & wheel assembly weighs approximately 544 lbs. (247.25 kg).*

2. Remove the tire and wheel assembly.
3. Through the access holes in the axle, tag and disconnect the hydraulic lines running to the drive motor. Cap or plug all openings to ensure no dirt enters the hydraulic system.

NOTE: *The torque hub and drive motor assembly weighs approximately 270 lbs. (122 kg).*

4. Use a supporting device capable of handling the weight of the torque hub and drive motor and unbolt the torque hub from the frame. Remove the entire assembly from the machine.
5. Remove the bolts and washers that secure the drive motor to the torque hub and remove the drive motor. Remove and discard the o-ring between the drive motor and torque hub.

Assembly and Installation

1. Install a new o-ring between the drive motor and torque hub. Install the bolts and washers to secure them together and torque to 110 ft. lbs. (149 Nm).
2. Place the torque hub flange against the mounting flange on the axle and fasten it in place with the bolts and washers. Torque the bolts to 220 ft. lbs. (298 Nm).
3. Install the tire and wheel assembly.

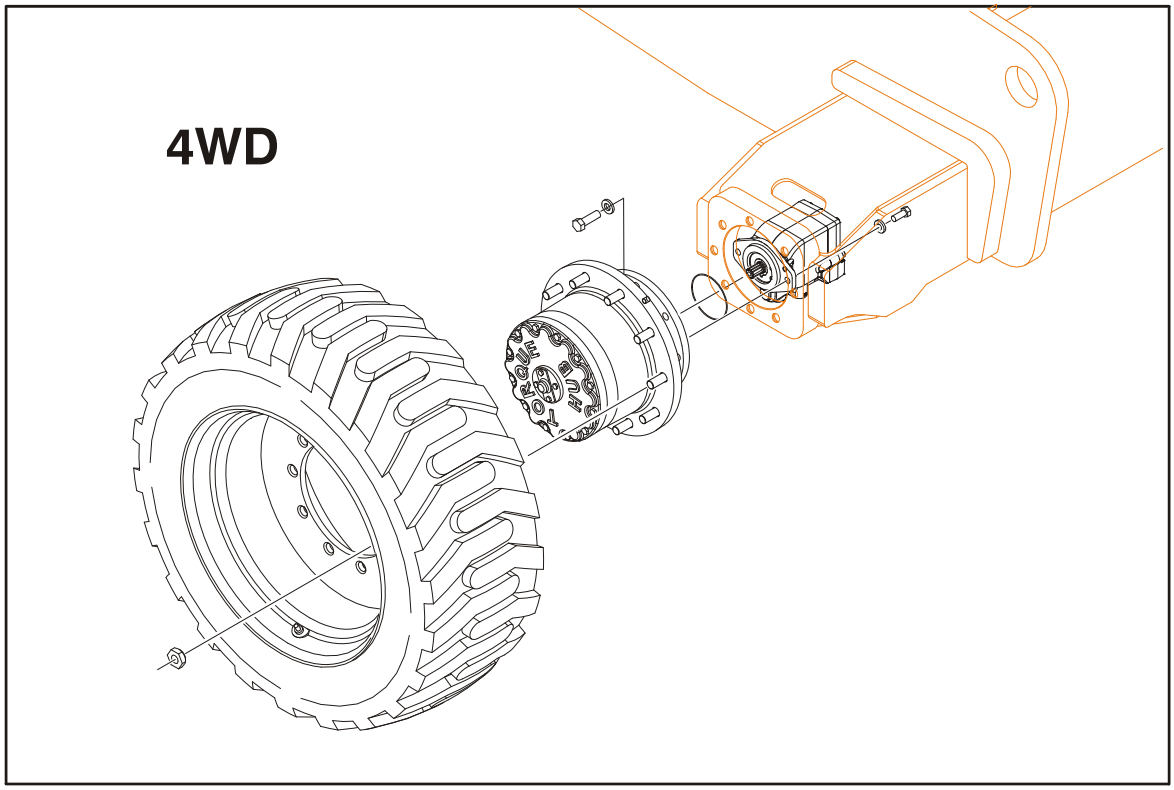


Figure 3-27. Torque Hub Installation - 4WD

3.7 TORQUE HUB (4WD MACHINES W/ INTEGRAL BRAKE)

Roll, Leak and Brake Testing

Torque-Hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears, bearings and seals are working properly. The following information briefly outlines what to look for when performing these tests.

NOTE: *The brake must be released before performing the roll test. This can be accomplished by either pressurizing the brake using the Brake Leak Test procedure below or by tightening the bolts into the piston through the end plate (See Brake Disassembly Procedure)*

NOTE: *Bolts must be removed while performing brake release test*

THE ROLL TEST

The purpose of the roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for improper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

THE LEAK TEST (MAIN UNIT)

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your leak checking fitting starts to fall after the unit has been pressurized and allowed to equalize. Leaks will most likely occur at the pipe plugs, the main seal or wherever o-rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where the o-rings or gaskets meet on the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, o-ring or gasket, the part must be replaced, and the unit rechecked. Leak test at 10 psi for 20 minutes.

THE BRAKE TEST

Input Brake - 1,850 in-lb (208 Nm) Static,
225 psi (15.5 bar) Full Release
3000 psi (207 bar) maximum o-ring check.

If brake does not release at these pressure values, brake has to be inspected, repaired or replaced.

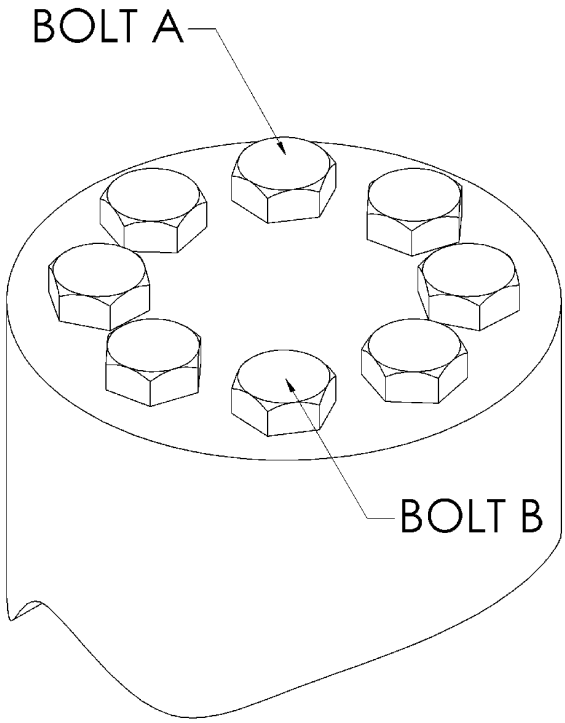
NOTE: *Failure to perform this test may result in damaged or ineffective brake parts.*

Tightening and Torquing Bolts

If an air impact wrench is used to tighten bolts, extreme care should be taken to ensure that the bolts are not tightened beyond their specified torque.

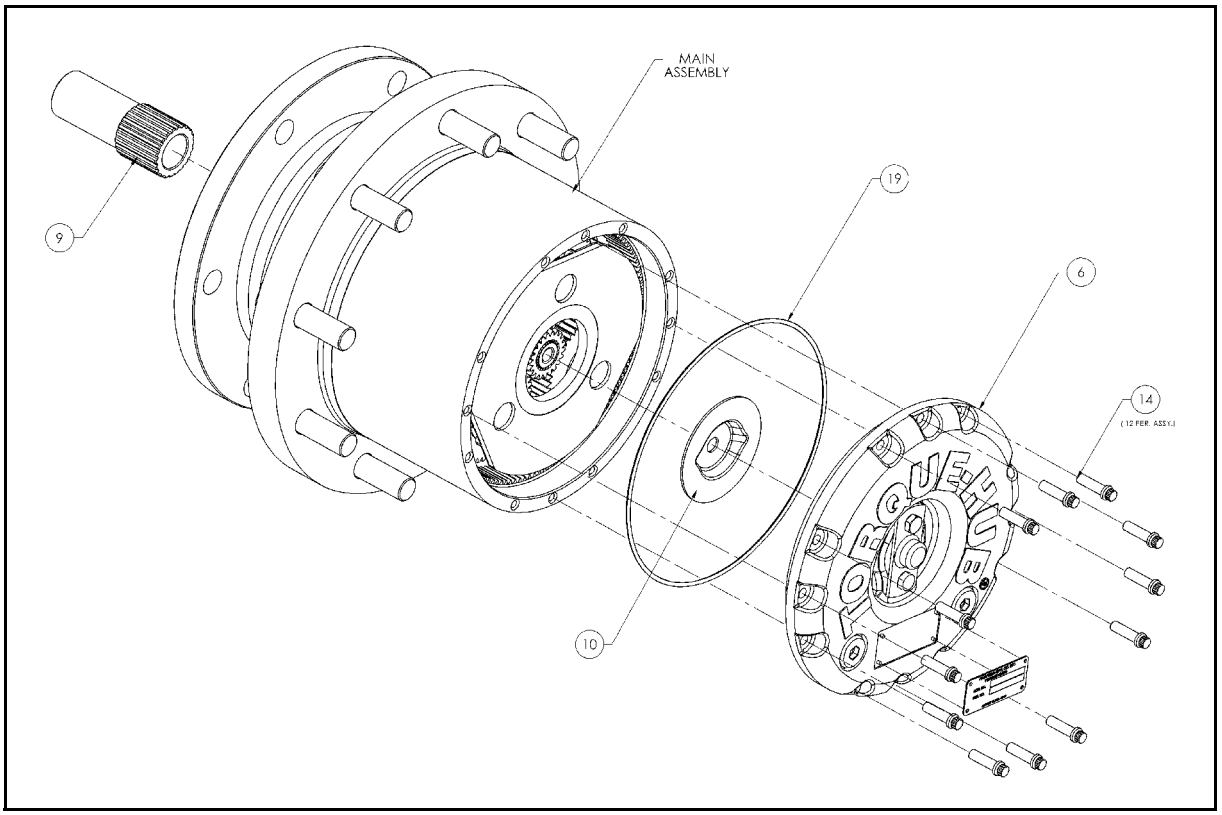
The following steps describe how to tighten and torque bolts or socket head cap screws in a bolt circle.

1. Tighten (but do not torque) bolt “A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt "A".
5. Using the same sequence, crisscross around the bolt circle and apply an equal torque to the remaining bolts.



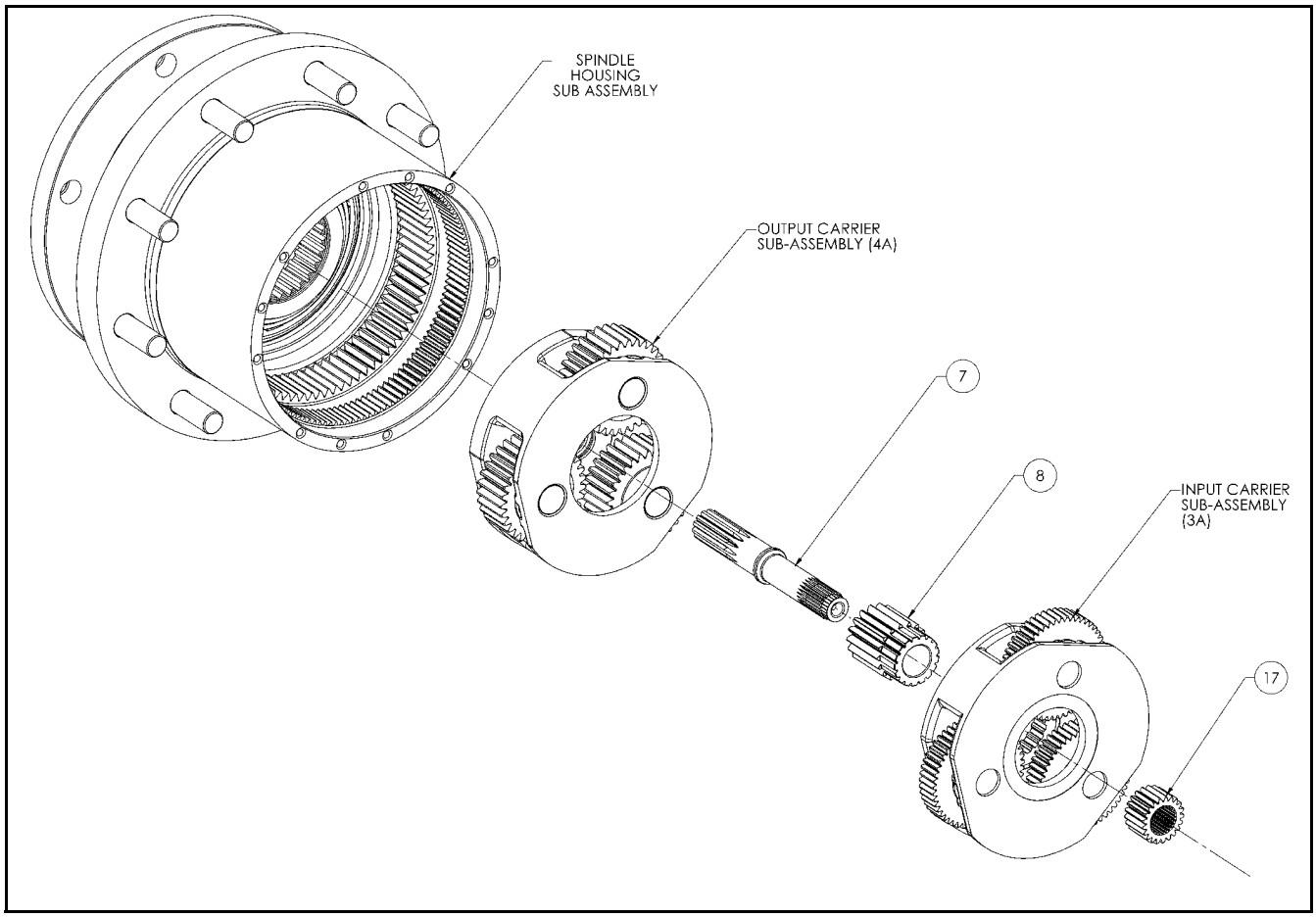
Main Disassembly

1. Perform Roll Check, Leak Check and Brake Check if applicable prior to disassembling the unit.
2. Drain oil from unit. Note the condition and volume of the oil.
3. Remove Input Coupling (9) from Spindle (1A) end of unit.
4. Remove Cover Bolts (14) and remove Cover (6).
5. Remove O-ring (19) and Thrust Spacer (10) from the Cover (6).
6. Remove Input Sun Gear (17) from Input Carrier Sub-Assembly (3A).
7. Remove Input Carrier Sub-Assembly (3A) from Housing (1E).
8. Remove Output Sun Gear (8) from Output Carrier Sub-Assembly (4A).
9. Remove Input Shaft (7) from Output Carrier Sub-Assembly (4A).
10. Remove Output Carrier Sub-Assembly (4A) from Housing (1E).



6. Cover
9. Input Coupling
10. Thrust Spacer
14. Cover Bolts
19. O-ring

Figure 3-28. Main Disassembly Drawing 1

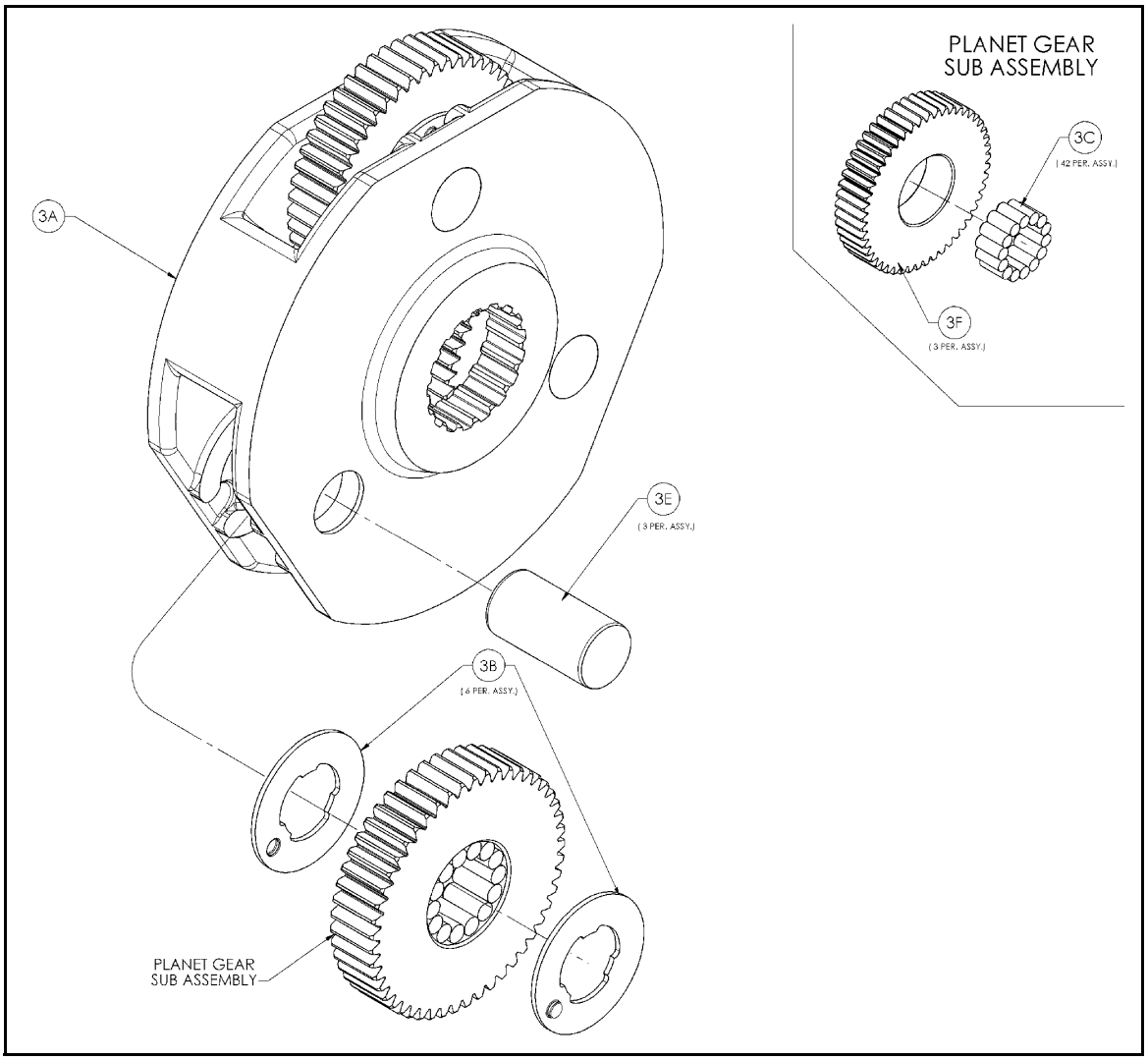


7. Input Shaft
8. Output Sun Gear
17. Input Sun Gear

Figure 3-29. Main Disassembly Drawing 2

Input Carrier Disassembly

1. Place the Carrier (3A) on a press with the spline end up and drive the Planet Shaft (3E) out of the Carrier (3A).
2. Slide the Planet Gear (3F) and the two Thrust Washers (3B) out of the Carrier (3A).
3. Remove the 14 needle Bearings (3C) from the bore of the Planet Gear (3F).
4. Repeat steps 1 through 3 for each of the two remaining planet gears.



3A. Carrier
3B. Thrust Washers
3C. Needle Bearings
3E. Planet Shaft
3F. Planet Gear

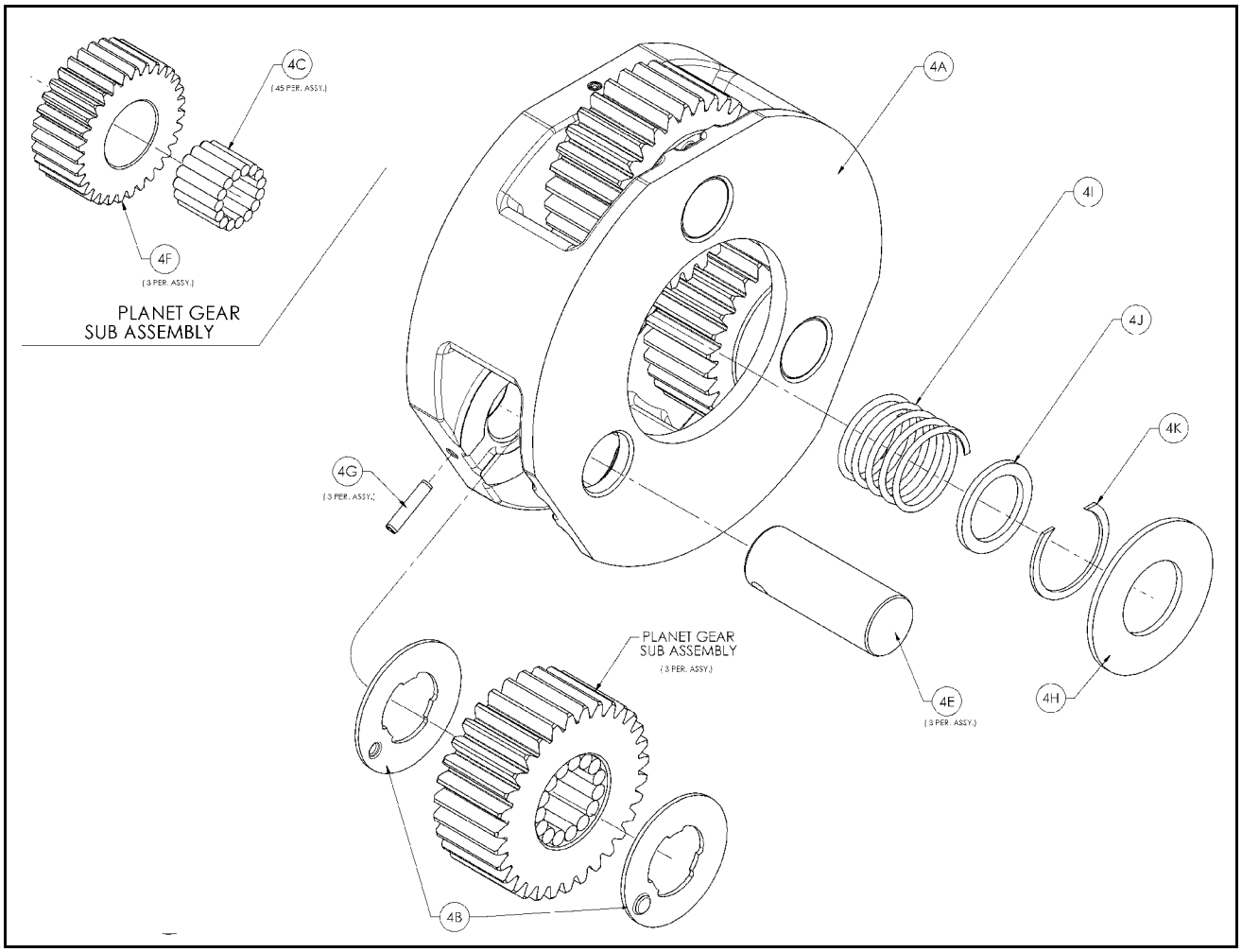
Figure 3-30. Input Carrier Disassembly

Output Carrier Disassembly

1. Using a small diameter punch, Drive the Roll Pin (4G) which holds the Planet Shaft (4E) in the Carrier (4A) down into the Planet Shaft (4E) until it bottoms.

NOTE: *Make sure that the Roll Pin has bottomed. Otherwise, damage to the carrier could occur when the Planet Shaft is removed.*

2. Remove the Planet Shaft (4E) from the Carrier (4A). Use a small punch to remove the Roll Pin (4G) from the Planet Shaft (4E).
3. Slide the Planet Gear (4F) and the two Thrust Washers (4B) out of the Carrier (4A).
4. Remove the 15 needle Bearings (4C) from the bore of the Planet Gear (4F).
5. Repeat steps 1 through 4 for each of the two remaining planet gears.
6. Remove the Thrust Washer (4H) from the Carrier (4A).
7. Using retaining ring pliers, remove the Retaining Ring (4K) from the Carrier (4A) and pull the Thrust Washer (4J) and Spring (4I) out of the Carrier (4A).



4A.	Carrier	4G.	Roll Pin
4B.	Thrust Washers	4H.	Thrust Washer
4C.	Needle Bearings	4I.	Spring
4E.	Planet Shaft	4J.	Thrust Washer
4F.	Planet Gear	4K.	Retaining Ring

Figure 3-31. Output Carrier Disassembly

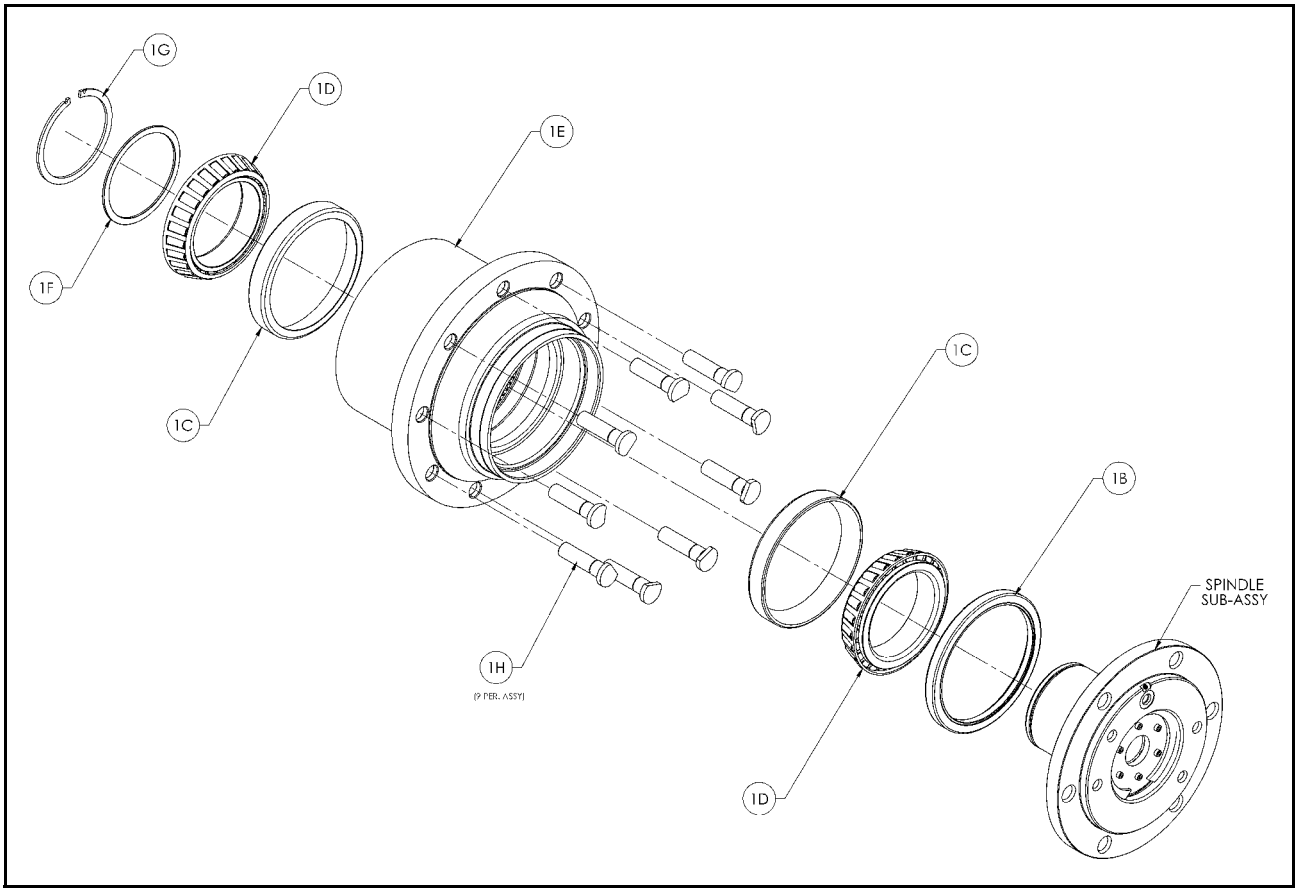
Housing-Spindle Disassembly

1. Place unit on bench with Spindle (1A) end down.

⚠ CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING THE NEXT STEP IN THIS PROCEDURE.

2. Using retaining ring pliers, remove Retaining Ring (1G) from the groove in Spindle (1A).
3. Remove Bearing Spacer (1F) from top of Bearing Cone (1D).
4. While supporting the unit on Housing (1E) flange, press Spindle (1A) out of Housing (1E). The Seal (1B) and "B" position Bearing Cone (1D) should come out of Housing (1E) with Spindle (1A).
5. Remove "A" position Bearing Cone (1D) from Bearing Cup (1D) in Housing (1E).
6. Lift Housing (1E) off of Spindle (1A).
7. If necessary, press Studs (1N) out of Housing (1E). Locate Housing (1E) on Seal (1B) end.
8. Remove "B" position Bearing Cone (1D) from Spindle (1A).
9. Remove Seal (1B) from the Spindle (1A).
10. Using a soft steel rod, knock both Bearing Cups (1C) out of Housing (1E)



1B. Seal
1C. Bearing Cups
1D. Bearing Cone
1E. Housing
1F. Bearing Spacer
1G. Retaining Ring
1H. Wheel Stud

Figure 3-32. Housing-Spindle Disassembly

Spindle-Brake Disassembly

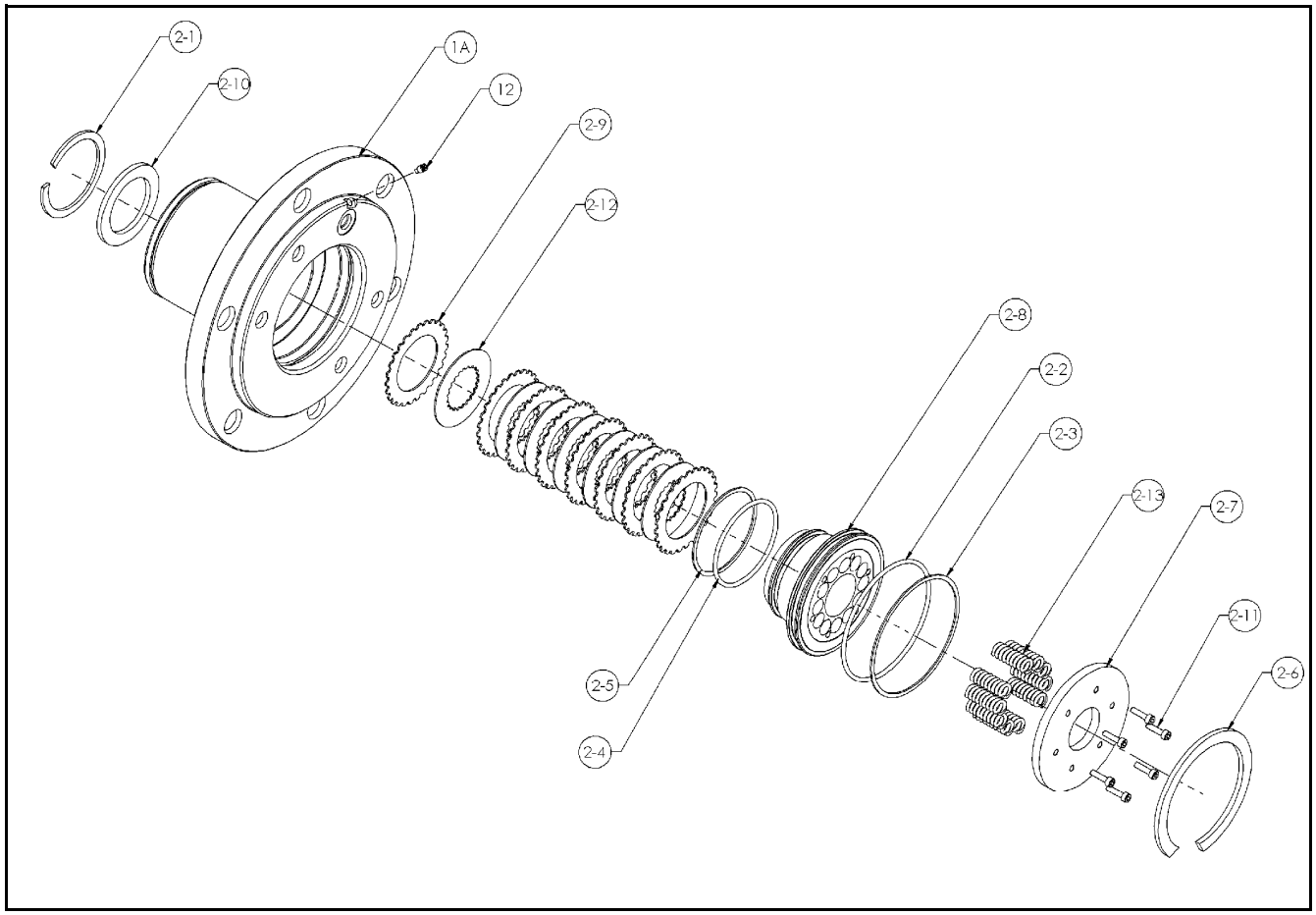
NOTE: *This procedure applies only to units with integral input brake (2).*

NOTE: *For this procedure, use the Brake Assembly Drawing, which will show the proper balloon numbers for the individual brake components. In the following instructions, if the number has a "-" between two numbers, it refers to the Brake Assembly Drawing only and NOT the Torque Hub Assembly Drawing.*

NOTE: *The Pressure Plug (12) requires a special tool for installation. It is not recommended to remove this plug unless it is leaking. The plug is called a Koenig Expander. The installation tool is not supplied by Fairfield manufacturing, but can be supplied by the manufacturer of the Koenig Expander, Sherex Industries, or one of their distributors.*

⚠ CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING STEPS 1-3 IN THIS PROCEDURE.



1-A. Spindle
12. Pressure Plug
2-1. Internal Circlip
2-2. O-ring
2-3. Back-up Ring
2-4. O-ring
2-5. Back-up Ring
2-6. Internal Circlip
2-7. End Plate
2-8. Piston
2-9. Stator
2-10. Spacer
2-11. Capscrew
2-12. Rotor
2-13. Compression Spring

Figure 3-33. Spindle Brake Disassembly

1. Compress the Compression Springs (2-13) by installing a minimum of three M4 x 16mm Socket Head Cap Screws (2-11) equally spaced through End Plate (2-7) and into Piston (2-8) and tightening incrementally until spring force has been taken off of the Retaining Ring (2-6).
2. Using a small pry bar or screwdriver, pry one end of the Retaining Ring (2-6) out of the groove in Spindle (1A), then, using pliers, pull Retaining Ring (2-6) the rest of the way out of the groove.
3. Back Socket Head Cap Screws (2-11) incrementally out of Piston (2-8) until spring force is relieved from the End Plate (2-7).
4. Remove Socket Head Cap Screws (2-11) and End Plate (2-7) from brake cavity in Spindle.
5. Remove Compression Springs (2-13) from Piston (2-8).

⚠ CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING THE NEXT STEP IN THIS PROCEDURE.

6. Using an air hose, slowly and carefully pressurize the brake port in the Spindle (1A) until the Piston (2-8) comes out of piston bore of Spindle (1A), Then pull the Piston (2-8) the rest of the way out of the Spindle (1A) by hand.
7. Remove Backup Rings (2-3) & (2-5) and O-rings (2-2) & (2-4) from Piston (2-8).
8. Remove Rotors (2-12) and Stators (2-9) from Spindle (1A).

⚠ CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING THE NEXT STEP IN THIS PROCEDURE.

9. Invert Spindle (1A) and, using retaining ring pliers, remove Retaining Ring (2-1).
10. Remove Spacer (2-10) from Spindle.

Input Carrier Sub-Assembly

1. Apply a liberal coat of grease to the bore of one Input Planet Gear (3F).
2. Line the inside of the Planet Gear (3F) with 14 Needle Rollers (3C).

NOTE: *The last roller installed must be installed end wise. That is, the end of the last roller must be placed in between the ends of the two rollers that form the space, and then slid, parallel to the other rollers, into place.*

3. Set Carrier (3A) in an upright position.
4. Insert a Planet Shaft (3E) into the planet shaft hole in the end of the Carrier (3A) opposite the splined end.
5. Place one Thrust Washer (3B) onto the end of Planet Shaft (3E). Make sure the flat faces towards the inside of the carrier and make sure the button fits in the pocket inside the Carrier (3A).
6. Place one more Thrust Washer (3B) into the Carrier (3A). Align the Thrust Washer (3B) in the same manner described in Step 5.

NOTE: *Some grease may need to be applied to the Thrust Washers (3B) to hold them in place while installing the planet gear. Instead of using grease, the washers could be inserted from the ID of the carrier for the buttons to fit into pockets of the carrier.*

7. Following the thrust washers, place Planet Gear (3F) with needle rollers, into the Carrier (3A) between the Thrust Washers (3B).
8. Push the Planet Shaft (3E) through the Planet Gear (3F) and the other Thrust Washer (3B) until it touches the other side of the Carrier (3A).

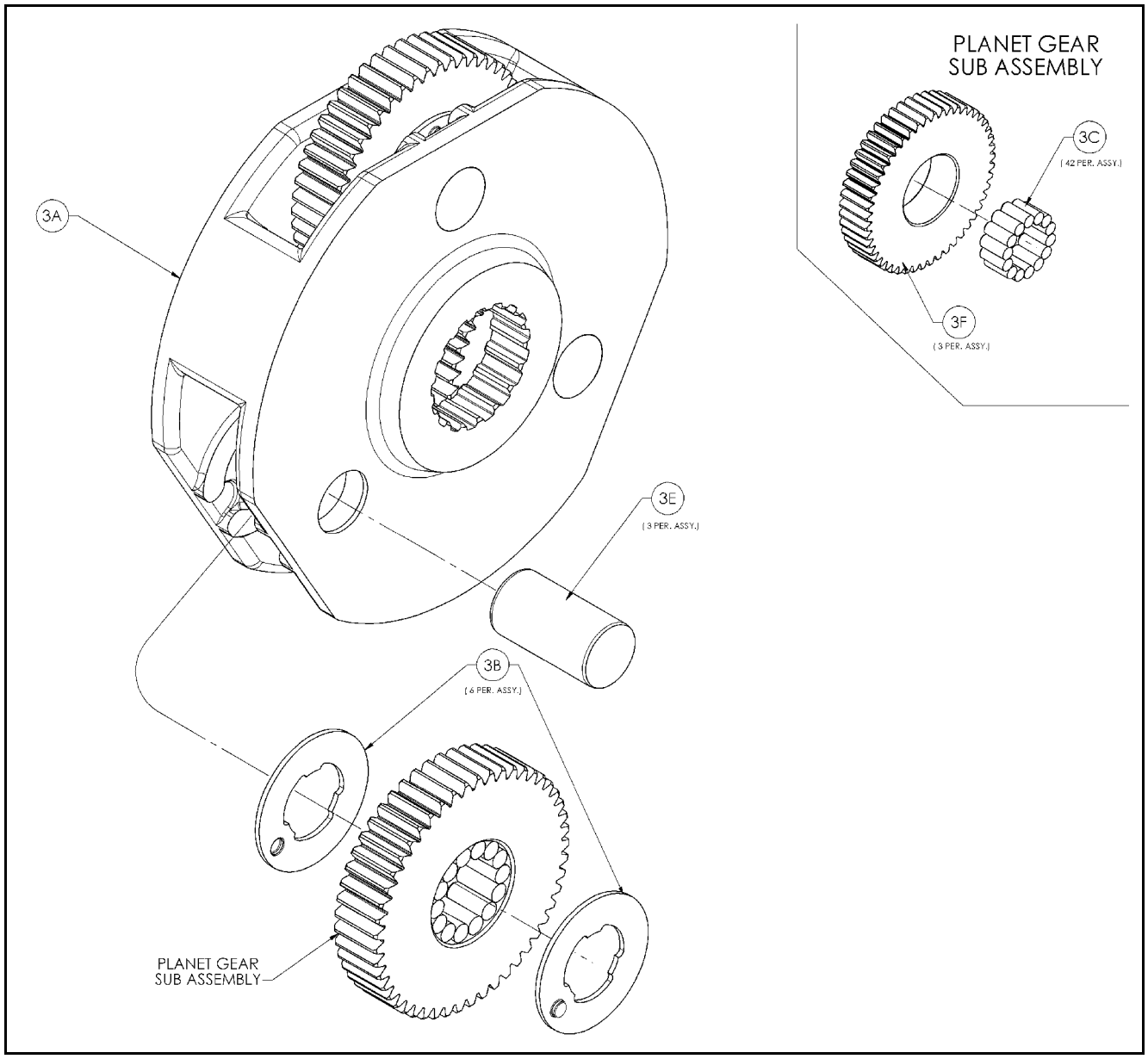
⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

9. Press the Planet Shaft (3E) until it is pressed to the appropriate depth.

NOTE: *If planet shaft locating tooling is not available, press lightly on Planet Shaft (3E) and make sure not to press Planet Shaft (3E) through the small shoulder in Carrier (3A). This shoulder is intended to keep the planet pin from working loose in that direction during proper operation of the unit. It is **NOT** intended to keep the planet pin from being pressed through the carrier.*

10. On the side of the Carrier (3A) where the Planet Shaft (3E) was inserted, stake the Carrier (3A) in 3 places using a punch and a hammer around the Planet Shaft (3E) to assure the shaft stays in place during operation of the unit.
11. Repeat Steps 1 through 10 for the installation of the two remaining Planet Gears (3F).



3A. Carrier
3B. Thrust Washers
3C. Needle Bearings
3E. Planet Shaft
3F. Planet Gear

Figure 3-34. Input Carrier Sub-Assembly

Output Carrier Sub-Assembly

1. Place Spring (4I) into the deep counterbore of the Output Carrier (4A).
2. Place Washer (4J) on top of Spring (4I).

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

3. With Retaining Ring (4K) installed on snap ring pliers, place on top of Washer (4J) and compress Spring (4I) until Retaining Ring (4K) is seated completely in groove.
4. Apply a liberal coat of grease to the bore of one Output Planet Gear (4F).
5. Line the inside of the Planet Gear (4F) with 15 Needle Rollers (4C).

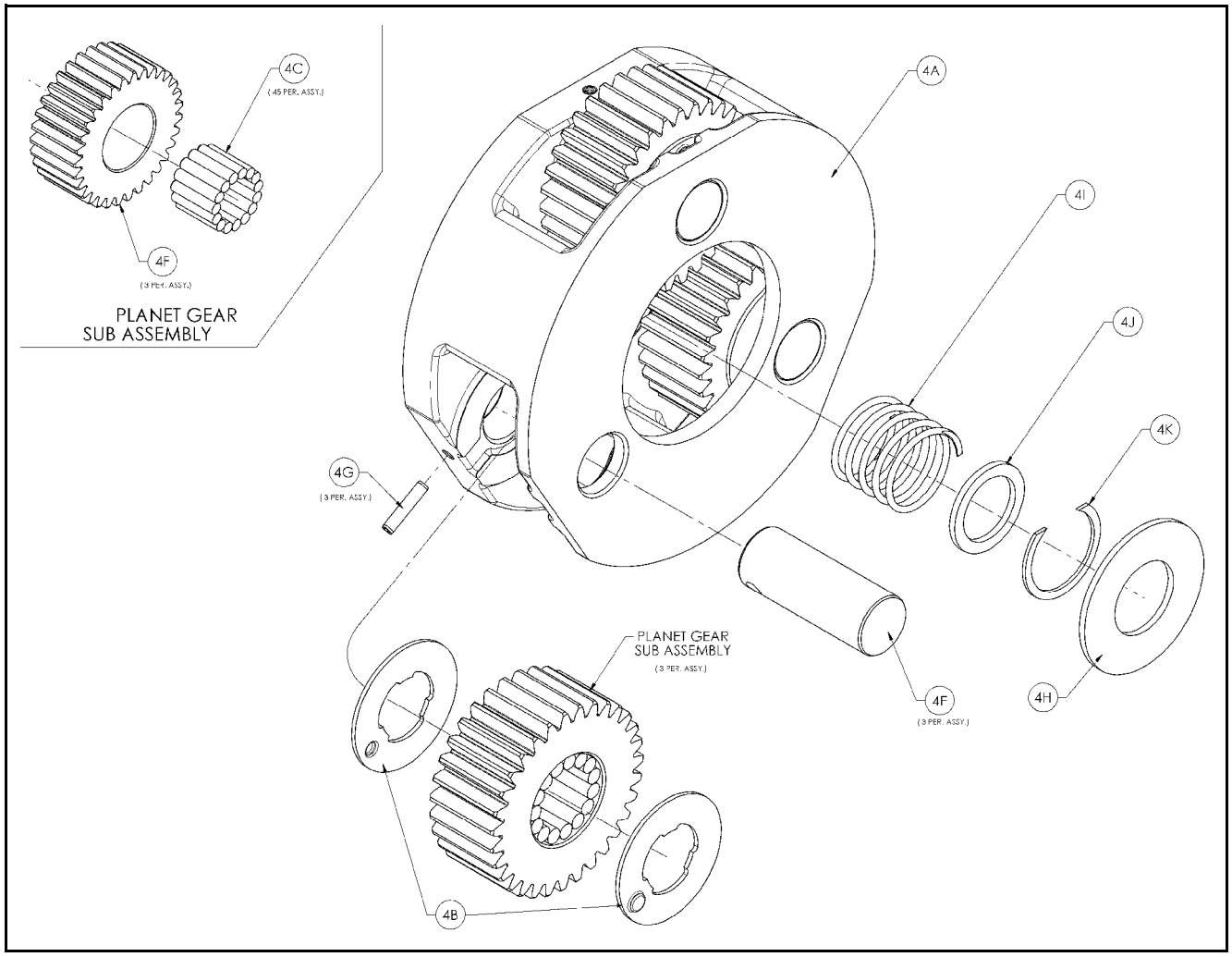
NOTE: *The last roller installed must be installed end wise. That is, the end of the last roller must be placed in between the ends of the two rollers that form the space, and then slid, parallel to the other rollers, into place.*

6. Place Thrust Washer (4H) into the shallow counterbore of the Output Carrier (4A).
7. Set Carrier (4A) in an upright position.
8. Insert a Planet Shaft (4E) into one of the planet shaft holes on the Carrier (4A). The end of the planet shaft that does **NOT** have the roll pin hole should be inserted in the carrier **FIRST**.
9. Place one Thrust Washer (4B) onto the end of Planet Shaft (4E). Make sure the flat faces towards the inside of the carrier and make sure the button fits in the pocket inside the Carrier (4A).
10. Following the thrust washer, place Planet Gear (4F) with needle rollers, onto Planet Shaft (4E).
11. Following the planet gear, place one more Thrust Washer (4B) onto Planet Shaft (4E). Align the Thrust Washer (4B) in the same manner described in Step 6.
12. Now insert Planet Shaft (4E) through the opposite planet shaft hole on Carrier (4A). Use an alignment punch or similar tool to align the roll pin holes on Carrier (4A) and Planet Shaft (4E).

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

13. Drive Roll Pin (4G) down into the aligned roll pin holes. Pin should be flush with OD of carrier.
14. Repeat Steps 4,5, & 8-13 for the installation of the two remaining Planet Gears (4F).



4A. Output Carrier
4B. Thrust Washer
4C. Needle Rollers
4E. Planet Shaft
4F. Planet Gear
4G. Roll Pin
4H. Thrust Washer
4I. Spring
4J. Washer
4K. Retaining Ring

Figure 3-35. Input Carrier Sub-Assembly

Spindle-Brake Sub-Assembly

NOTE: *This procedure applies only to units with integral input brake (2).*

NOTE: *For this procedure, use the Brake Assembly Drawing (Figure 3-36.), which will show the proper balloon numbers for the individual brake components. In the following instructions, if the number has a "-" between two numbers, it refers to the Brake Assembly Drawing only and NOT the Torque Hub Assembly Drawing.*

NOTE: *The Pressure Plug (12) requires a special tool for installation. It is not recommended to remove this plug unless it is leaking. The plug is called a Koenig Expander. The installation tool is not supplied by Fairfield manufacturing, but can be supplied by the manufacturer of the Koenig Expander, Sherex Industries, or one of their distributors.*

1. Install Pressure Plug (12) into Spindle (1A) using following procedure:

- Clean hole in spindle using appropriate Loctite spray
- Dip collar of plug in Loctite 290 or 680 (keep unplugged portion of hole free of Loctite)
- Using appropriate tool, install plug flush with surface of spindle

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

2. Place Spindle (1A) such that the splined end is facing down. Using appropriate tool (See back of manual), install Retaining Ring (2-1) into the spindle groove within the splines.
3. Place Washer (2-10) on top of Retaining Ring (2-1).
4. Place Stator (2-9) on top of Washer (2-10).
5. Place Rotor (2-12) on top of Stator (2-9).
6. Repeat steps 3 & 4 until there are a total of 8 Stators (2-9) and 7 Rotors (2-12) installed.
7. Place Piston (2-8) such that the smaller O.D. end is facing upward.
8. Grease the large Backup Ring (2-3) and install in the large-diameter groove at the bottom of the Piston (2-8).
9. Grease the large O-Ring (2-2) and install in the large-diameter groove at the bottom of the Piston (2-8), on top of the large Backup Ring (2-3).
10. Grease the small O-Ring (2-5) and install in the small-diameter groove near the top of the Piston (2-8). Make sure the O-Ring is seated on the bottom of the groove.
11. Grease the small Backup Ring (2-4) and install in the small-diameter groove near the top of the Piston (2-8), on top of the small O-Ring (2-5).

NOTE: *If piston comes pre-assembled with shipping bolts (2-11), skip to Step 15.*

12. Insert Piston (2-8) into Spindle (1A) until it contacts the Stator (2-9).
13. Insert the appropriate number of Springs (2-13) into Piston (2-8) counterbore. Use the brake spring chart below and a bill of materials for your particular model number to determine the number of springs.

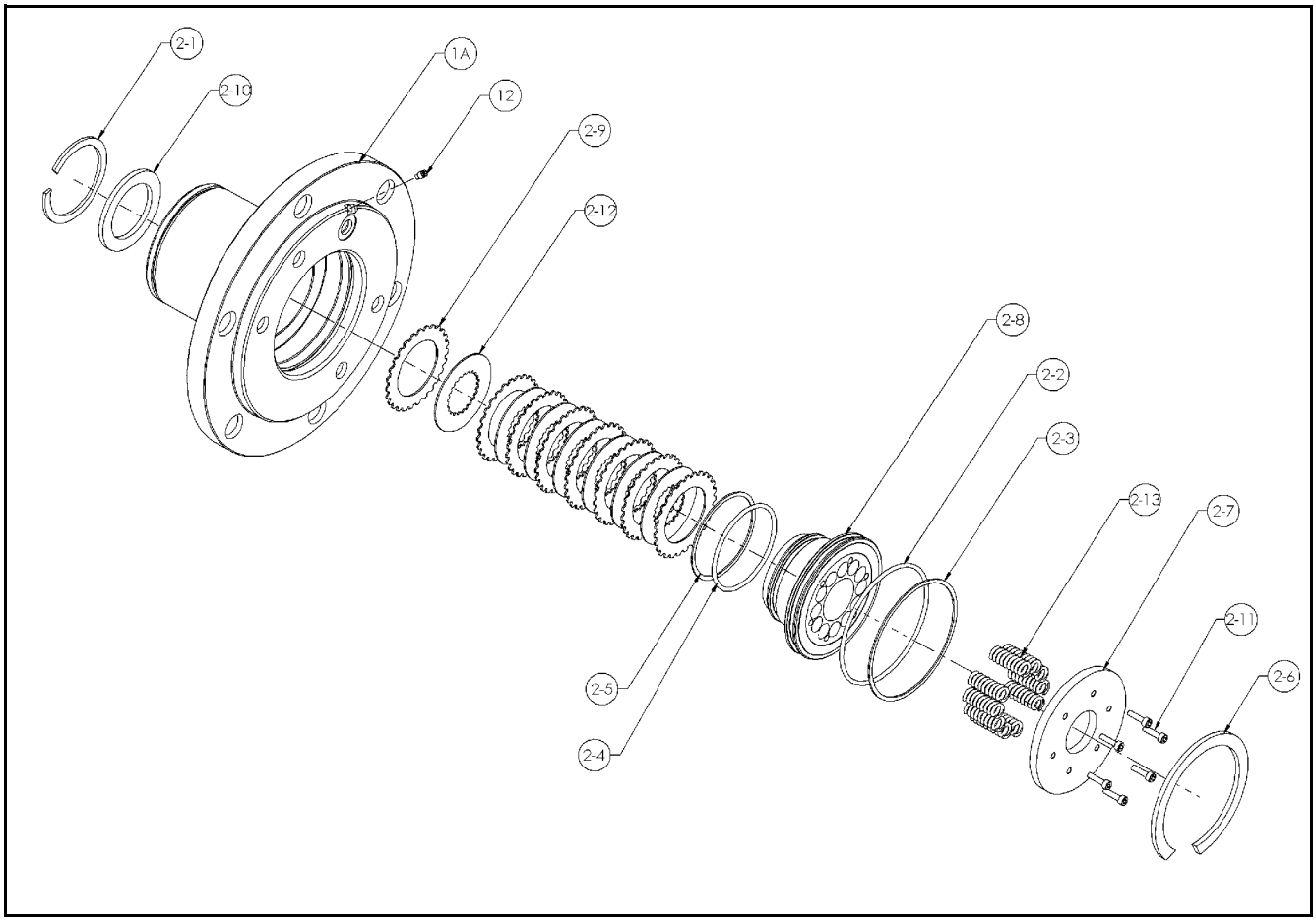
BRAKE CODE	BRAKE P/N	NUMBER OF SPRINGS
A	902337	12
B	902341	10
C	902342	8
D	902343	6
E	902345	9

14. Place Pressure Plate (2-7) on top of Springs (2-13).

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT TWO STEPS.

15. Using snap ring pliers, install Retaining Ring (2-6) into groove in Spindle (1A) and on top of Pressure Plate (2-7). Make sure that Retaining Ring (2-6) is seated properly in the groove.
16. Remove Shipping Bolts (2-11) in brake pressure plate to release springs in brake. Before removing bolts, use the Coupling (9) (See Assembly Drawing at back of manual) to center and align the Brake Rotors (2-12) with the Spindle (1A).



1-A. Spindle
12. Pressure Plug
2-1. Internal Circlip
2-2. O-ring
2-3. Back-up Ring
2-4. O-ring
2-5. Back-up Ring
2-6. Internal Circlip
2-7. End Plate
2-8. Piston
2-9. Stator
2-10. Spacer
2-11. Capscrew
2-12. Rotor
2-13. Compression Spring

Figure 3-36. Spindle Brake Sub-Assembly

Housing-Spindle Sub-Assembly

NOTE: *Spray a light film of oil on all component parts during assembly.*

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE ENTIRE HOUSING-SPINDLE SUBASSEMBLY.

1. Press Bearing Cup (1C), position A, into Housing (1E) using appropriate pressing tool (See back of manual).
2. Turn Housing (1E) over and place into pressing base. Press nine Studs (1H) into Housing (1E).

NOTE: *Use enough pressure to press in studs. Don t use excessively high pressure to press in studs or Housing may crack. Make sure head of stud contacts face of flange on Housing.*

NOTE: *Spray a generous amount of oil on bearings during installation.*

3. Press Bearing Cup (1C), position "B", into Housing (1E) using “B” Bearing Cone pressing tool (see back of manual).
4. Place Bearing Cone (1D), into Bearing Cup (1C), position "B".
5. Grease Seal (1B) lip and press seal into Housing (1E) using seal pressing tool (see back of manual) until seal is flush with end of Housing.
6. Turn Housing (1E) over and lower onto Spindle (1A).
7. Install Bearing Cone (1D) into Bearing Cup (1C), position "A". and lightly press on Bearing Cup using the “A” Bearing Cone pressing tool (see back of manual) while rotating Housing (1E) in both directions to seat bearings.
8. Place Bearing Spacer (1F) on top of Bearing Cone (1D).
9. Using retaining ring pliers, install Retaining Ring (1G) into Spindle (1A) groove. Make sure ring is completely seated in groove.

NOTE: *Extra bearing pre-load caused by pressing “A” Bearing Cone (1D) must be removed. This should be done by placing a flat piece of steel or a pressing tool on the end of the spindle, and then lightly striking the tool with a piece of barstock. This should be adequate to remove any additional bearing pre-load.*

DW2B Integral Brake Check

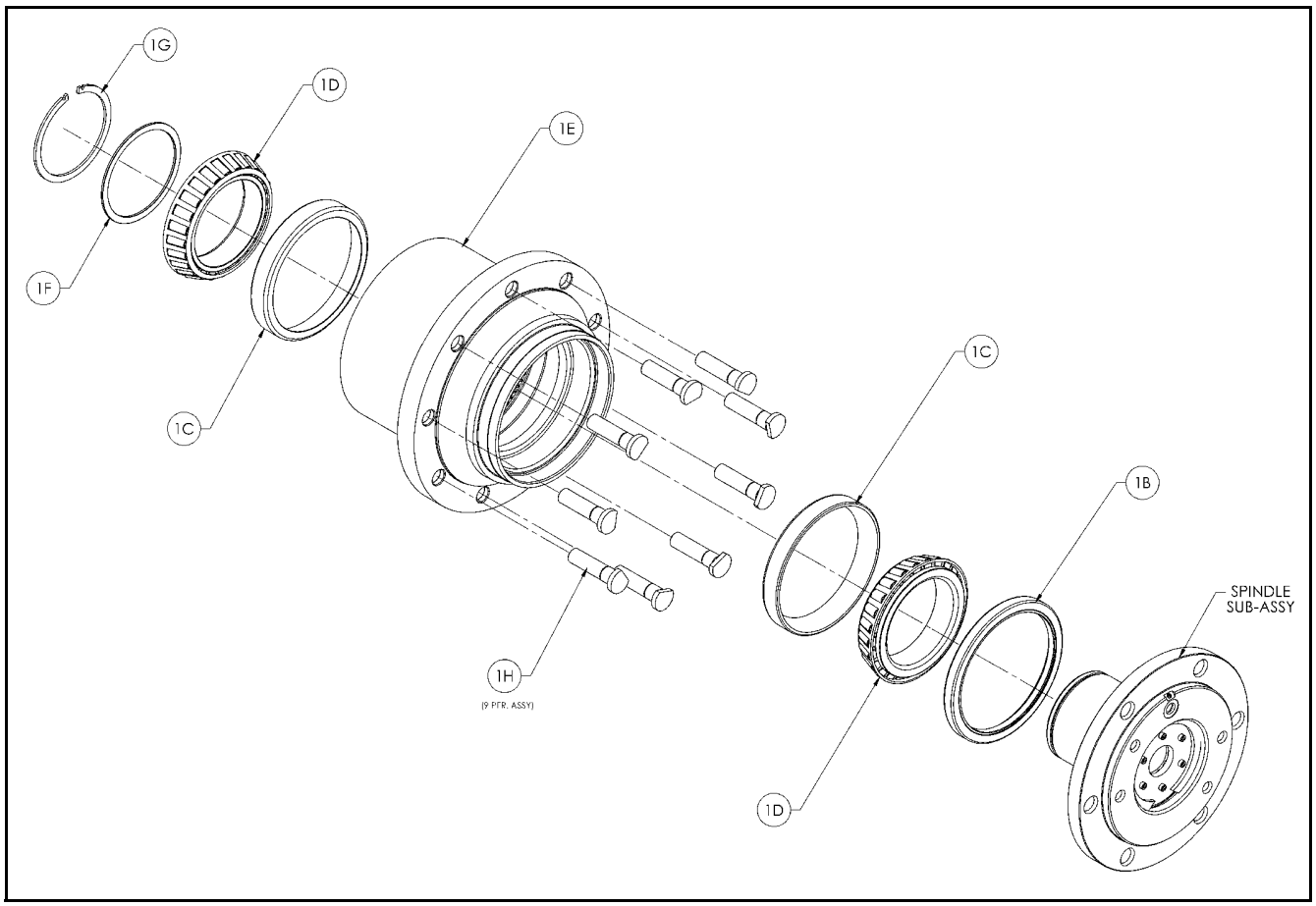
1. Using appropriate fittings, connect hydraulic line from hand pump to brake port.
2. Check to see that brake is set by trying to rotate Input Shaft (7). This can be accomplished by installing an appropriate tool (any tool that can locate on the splines of the Input Coupling (9), such as a mating splined shaft) into Input Coupling (9)
3. Bleed brake. Increase hydraulic pressure gradually while trying to rotate the input until brake just starts to release. Note this pressure. Make sure the pressure falls into the appropriate range below.

BRAKE CODE	BRAKE P/N	JUST RELEASE PRESSURE RANGE (psi)
A	902337	185-230
B	902341	155-192
C	902342	125-155
D	902343	93-115
E	902345	132-172

4. Increase pressure to 3,000 psi and hold for 30 seconds to check for leaks. Repair leaks if necessary.

NOTE: *Make sure that brake re-engages when pressure is released.*

NOTE: *When done, make sure Input Coupling (9) is centered in Spindle (1A) to make installation of motor possible without release of brake.*



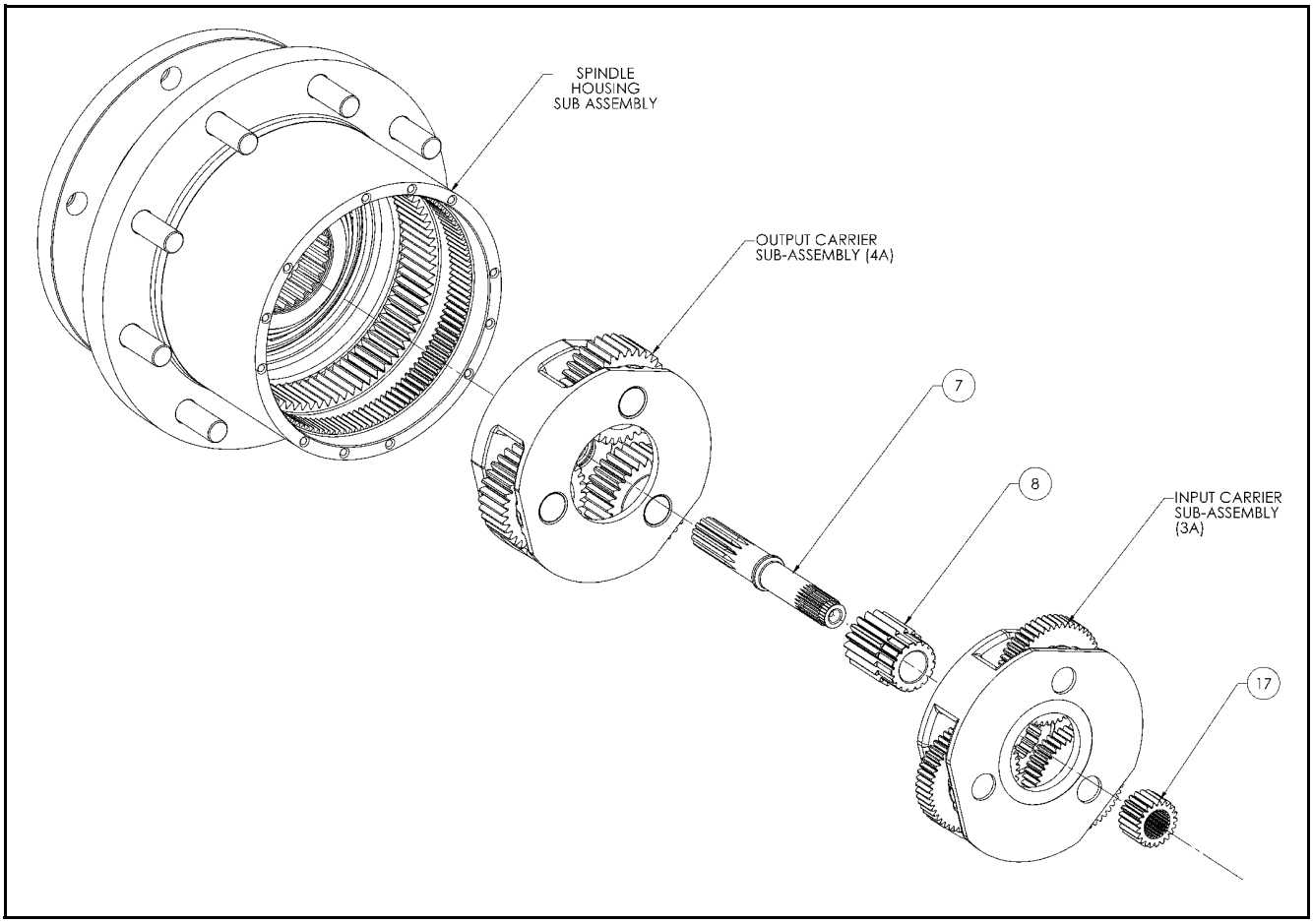
1B. Seal
1C. Bearing Cups
1D. Bearing Cone
1E. Housing
1F. Bearing Spacer
1G. Retaining Ring
1H. Wheel Stud

Figure 3-37. Housing-Spindle Disassembly

Main Assembly

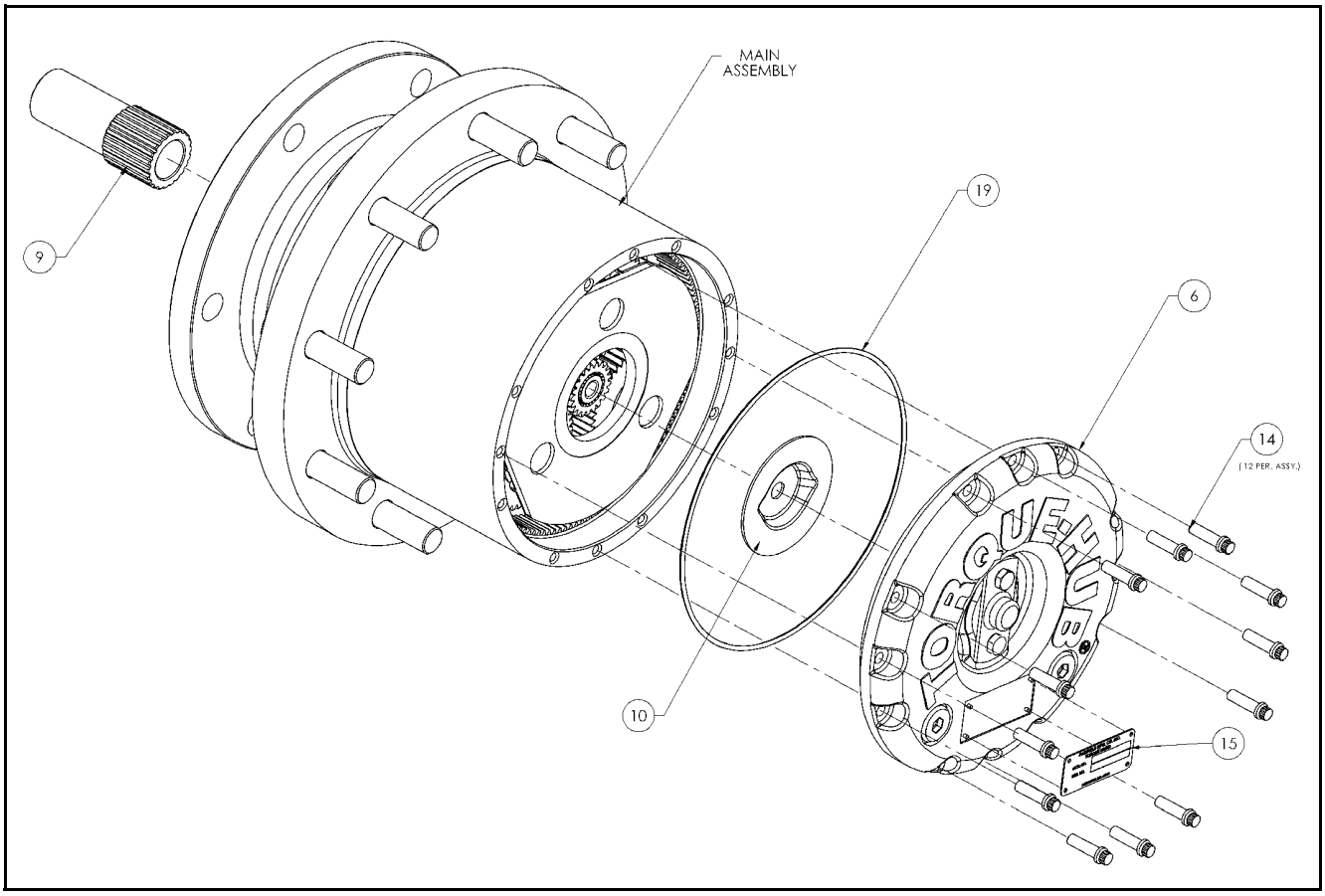
NOTE: *All components should receive a generous amount of lubricant oil as they are being assembled.*

1. Place Housing-Spindle Sub-Assembly on the bench with Spindle (1A) side down.
2. Place Output Carrier Sub-Assembly into Housing (1E) and onto Spindle (1A).
3. Insert the larger diameter splined end of Input Shaft (7) through bore of Output Carrier Sub Assembly (4A) until shoulder of Input Shaft (7) contacts Thrust Washer (4J) (See assembly drawing at back of manual).
4. With the modified spline end facing up, place the Output Sun Gear (8) into mesh with the planet gears from the Output Carrier Sub-Assembly (4A).
5. Place Input Carrier Sub-Assembly (3A) onto Output Sun Gear (8) splines.
6. Grease O-Ring (19) and insert into groove in Cover Sub-Assembly (6).
7. Install Cover Sub-Assembly (6) onto Housing (1E) and install twelve Bolts (14) into Cover (6). Torque bolts to 70-80 in-lbs.
8. Attach ID Tag (15) onto unit. If Cover has knobs as part of the cover, peen the top of each knob to form a head to hold on the Tag. If the cover has no such knobs, use drive screws.
9. Check disconnect, roll and leak check unit, leak check brake, check brake release pressure.



7. Input Shaft
8. Output Sun Gear
17. Input Sun Gear

Figure 3-38. Main Assembly Drawing1



6. Cover
9. Input Coupling
10. Thrust Spacer
14. Cover Bolts
19. O-ring

Figure 3-39. Main Assembly Drawing 2

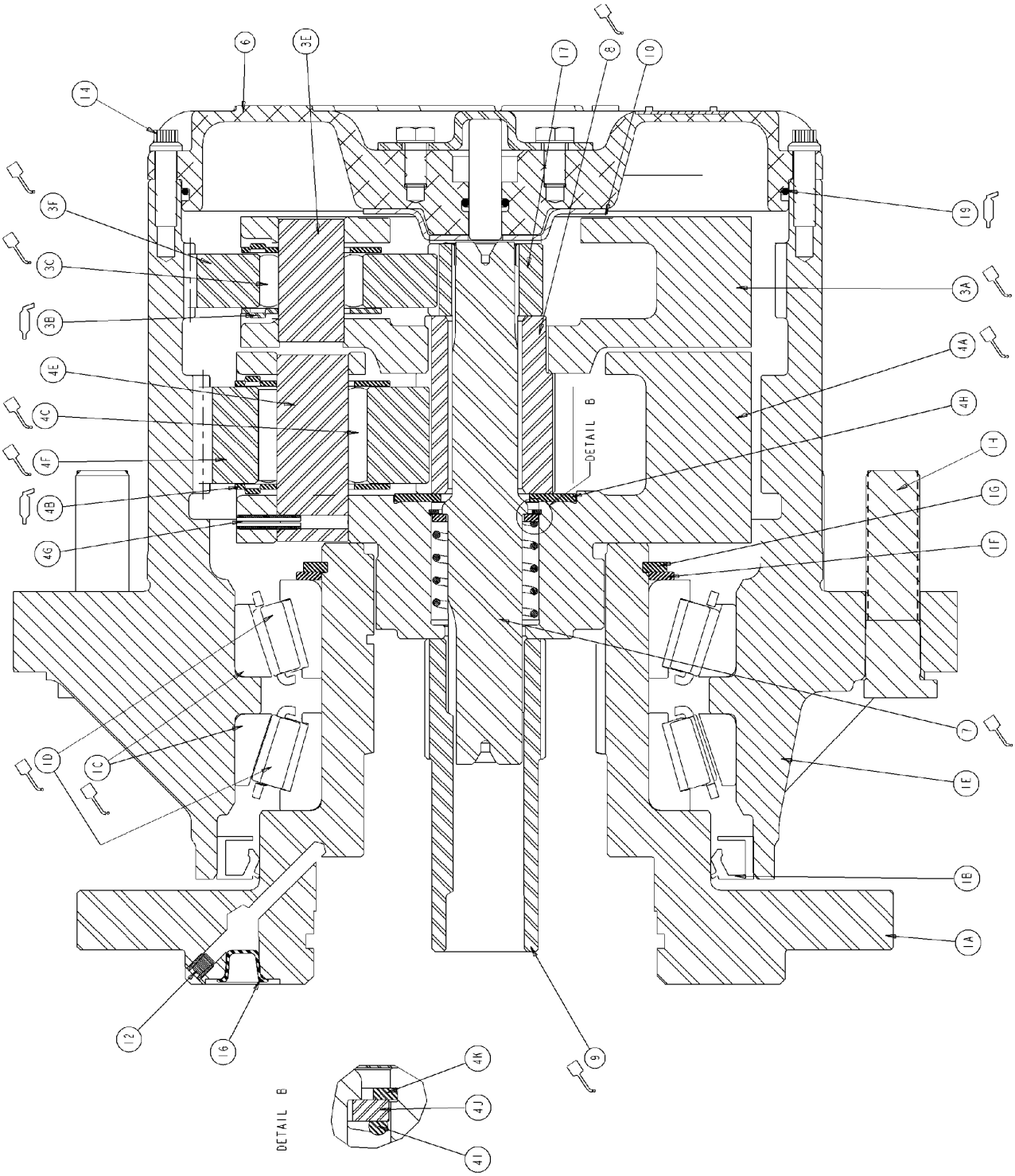


Figure 3-40. Assembly Drawing - Without Integral Input Brake - Sheet 1 of 2

1A	Spindle	4E	Planet Shaft
1G	Retaining Ring - Ext	4C	Needle Bearing
12	Pressure Plug	4I	Spring
16	O-ring Pipe Plug	4K	Retaining Ring - Int
1F	Thrust Washer	4G	Roll Pin
1E	Housing/Ring Gear	4B	Thrust Washer
1N	Stud	4H	Thrust Washer
1C	Tapered Bearing - Cup	4J	Thrust Washer
1D	Tapered Bearing - Cone	17	Sun Gear
1B	Lip Seal	8	Sun Gear
3A	Carrier	7	Input Shaft
3F	Planet Gear	9	Coupling
3E	Planet Shaft	6	Cover Subassembly
3C	Needle Bearing	10	Thrust Spacer
3B	Thrust Washer	15	Id Plate
4A	Carrier	14	12 Pt Flange Bolt
4F	Planet Gear	19	O-ring

Figure 3-41. Assembly Drawing - Without Integral Input Brake - Sheet 2 of 2

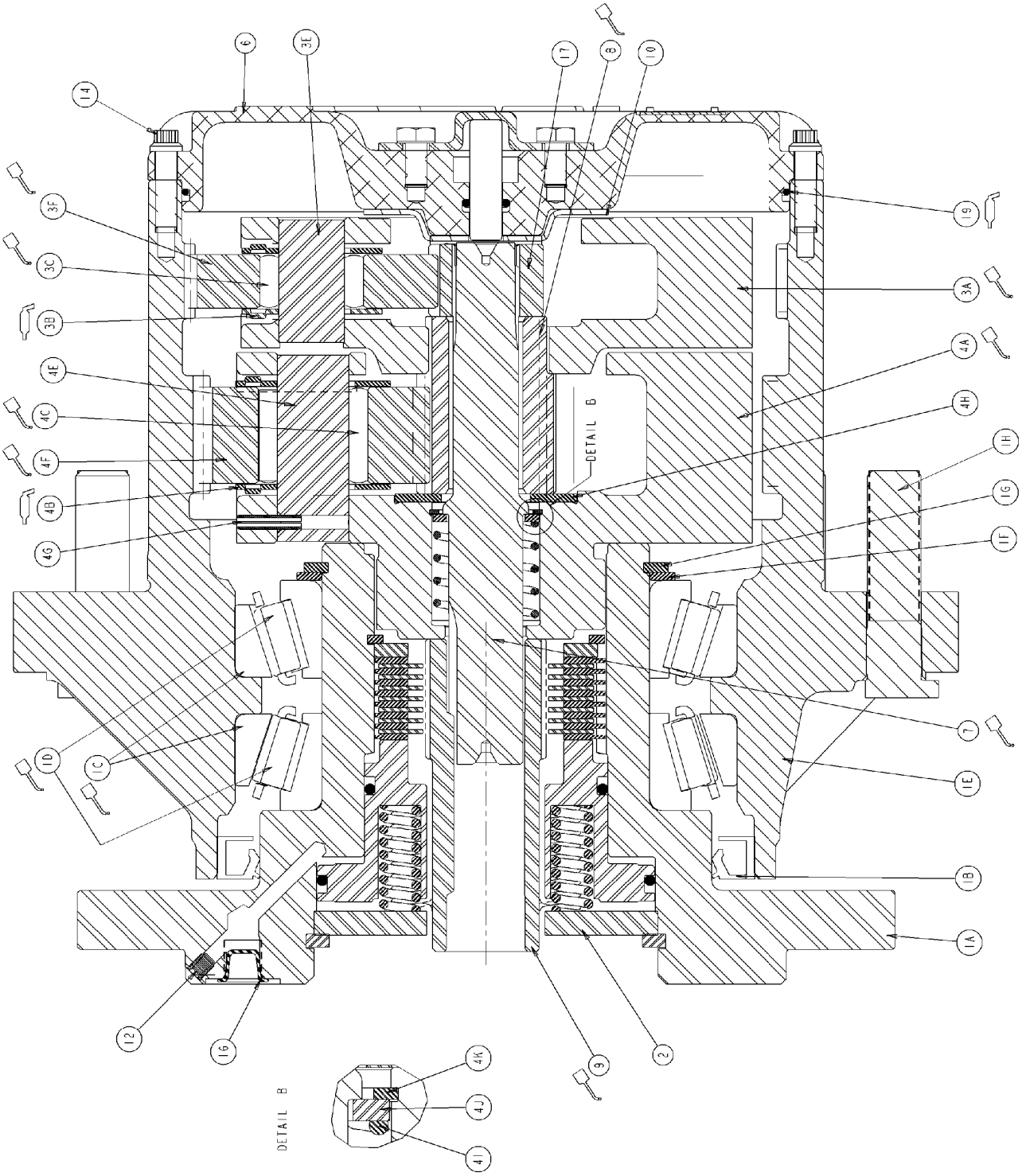


Figure 3-42. Assembly Drawing - With Integral Input Brake - Sheet 1 of 2

1A	Spindle	4E	Planet Shaft
2	Input Brake	4C	Needle Bearing
1G	Retaining Ring - Ext	4I	Spring
12	Pressure Plug	4K	Retaining Ring - Int
16	O-ring Pipe Plug	4G	Roll Pin
1F	Thrust Washer	4B	Thrust Washer
1E	Housing/ring Gear	4H	Thrust Washer
1N	Stud	4J	Thrust Washer
1C	Tapered Bearing - Cup	17	Sun Gear
1D	Tapered Bearing - Cone	8	Sun Gear
1B	Lip Seal	7	Input Shaft
3A	Carrier	9	Coupling
3F	Planet Gear	6	Cover Subassembly
3E	Planet Shaft	10	Thrust Spacer
3C	Needle Bearing	15	Id Plate
3B	Thrust Washer	14	12 Pt Flange Bolt
4A	Carrier	19	O-ring
4F	Planet Gear		

Figure 3-43. Assembly Drawing - With Integral Input Brake - Sheet 2 of 2

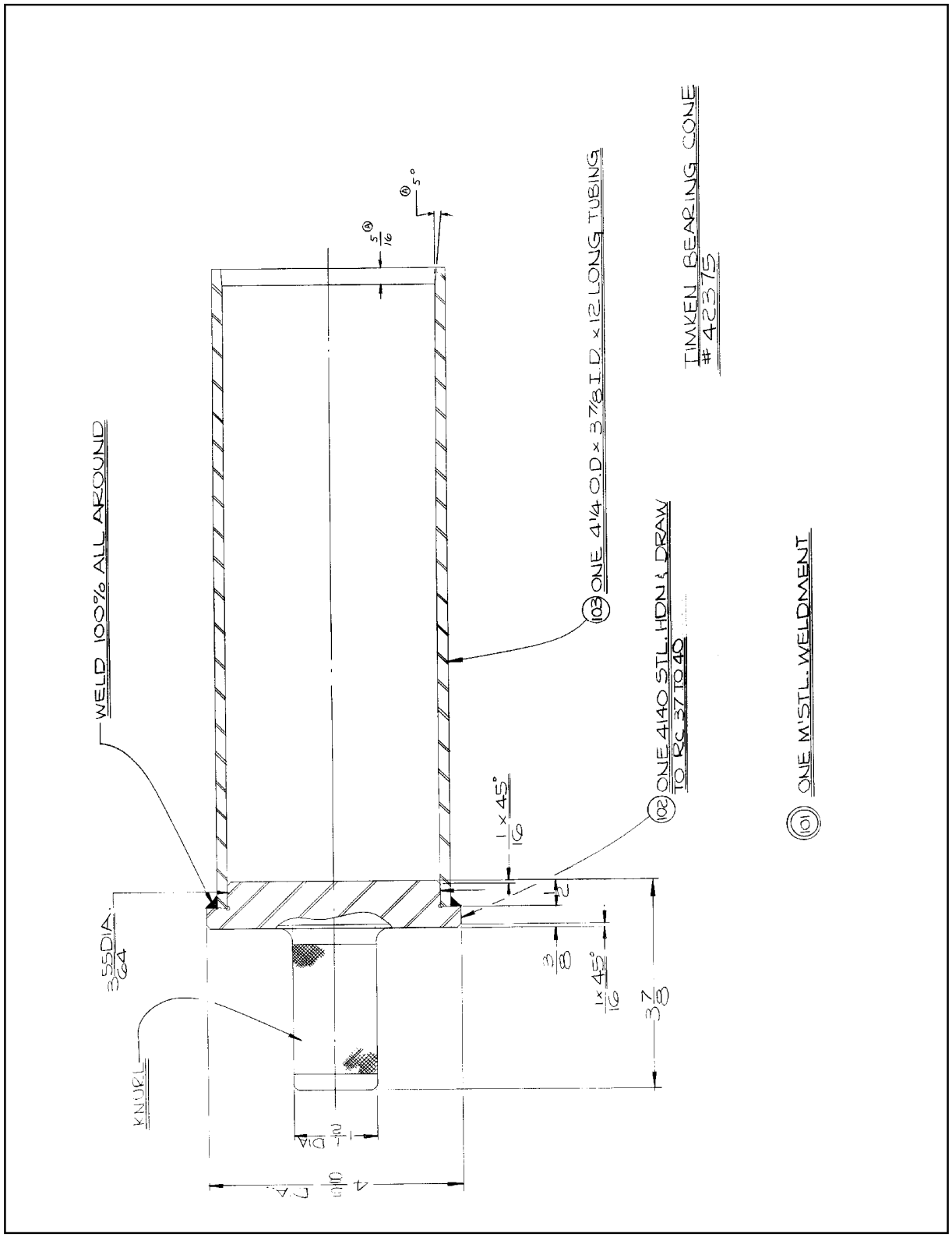


Figure 3-44. Assembly Tools - Bearing Cone Pressing - "B" Bearing

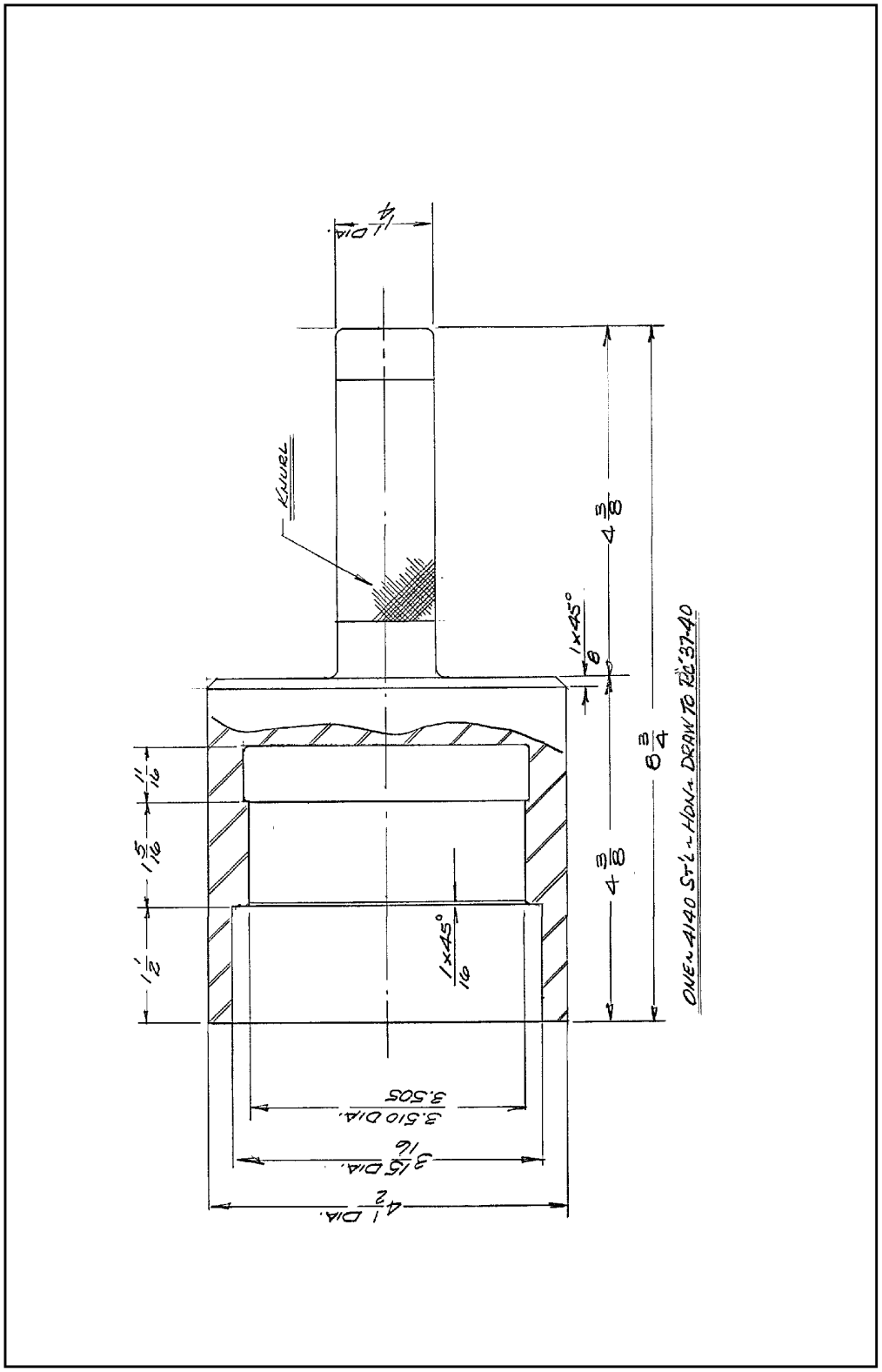


Figure 3-45. Assembly Tools - Bearing Cone Pressing - "A" Bearing

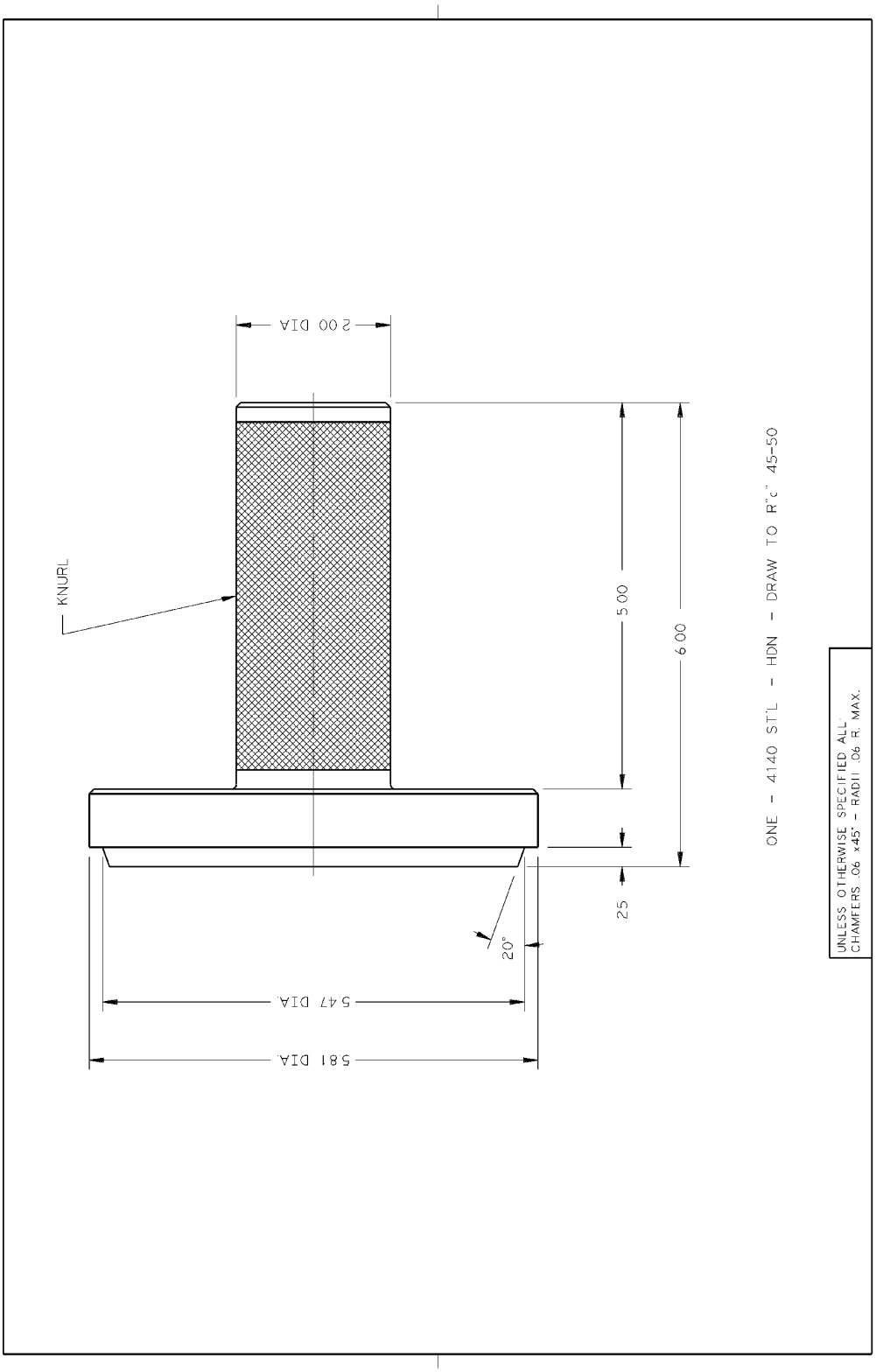


Figure 3-46. Assembly Tools - Bearing Cup Pressing - "A" & "B" Bearings

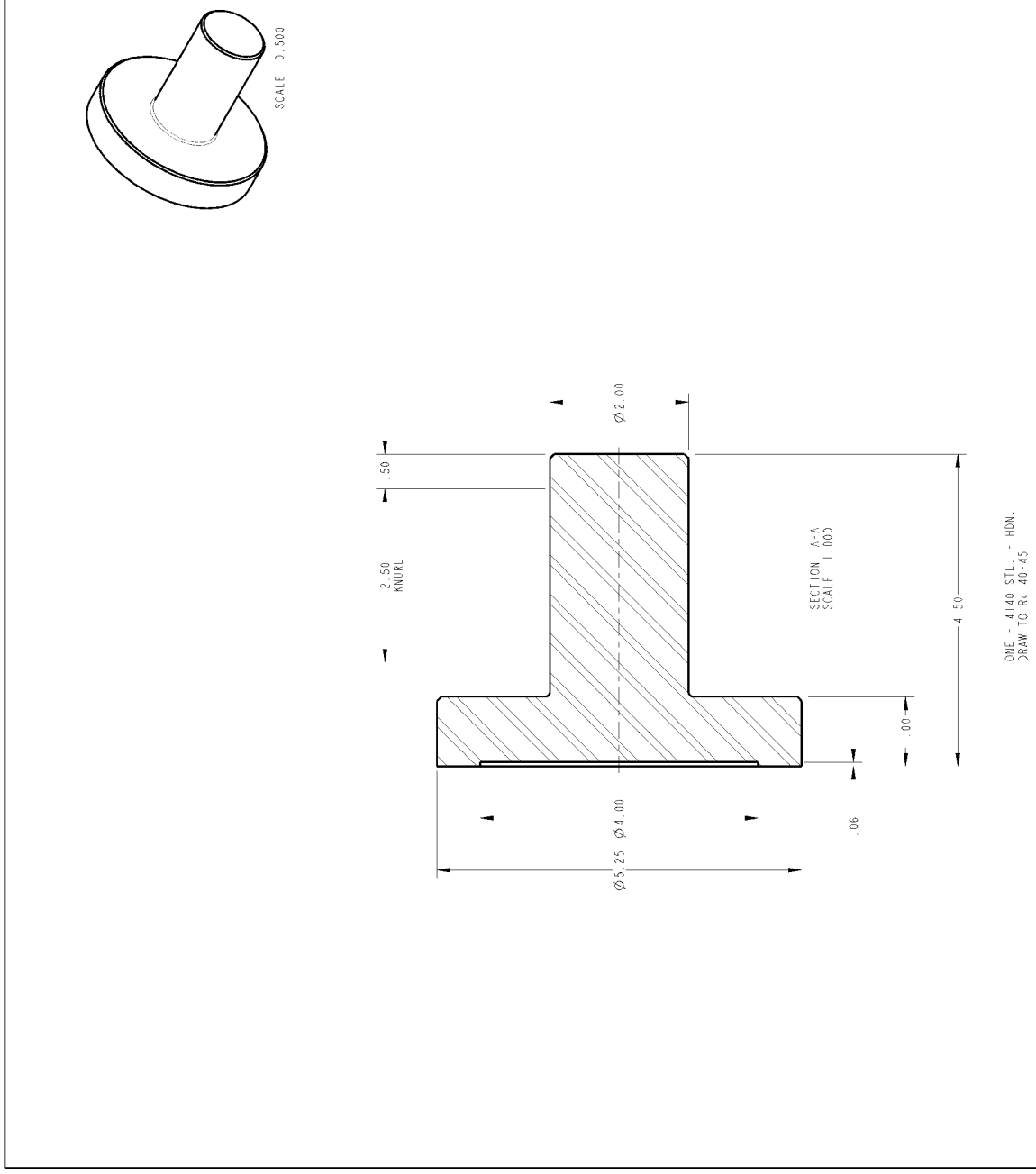


Figure 3-47. Assembly Tools - Seal Pressing

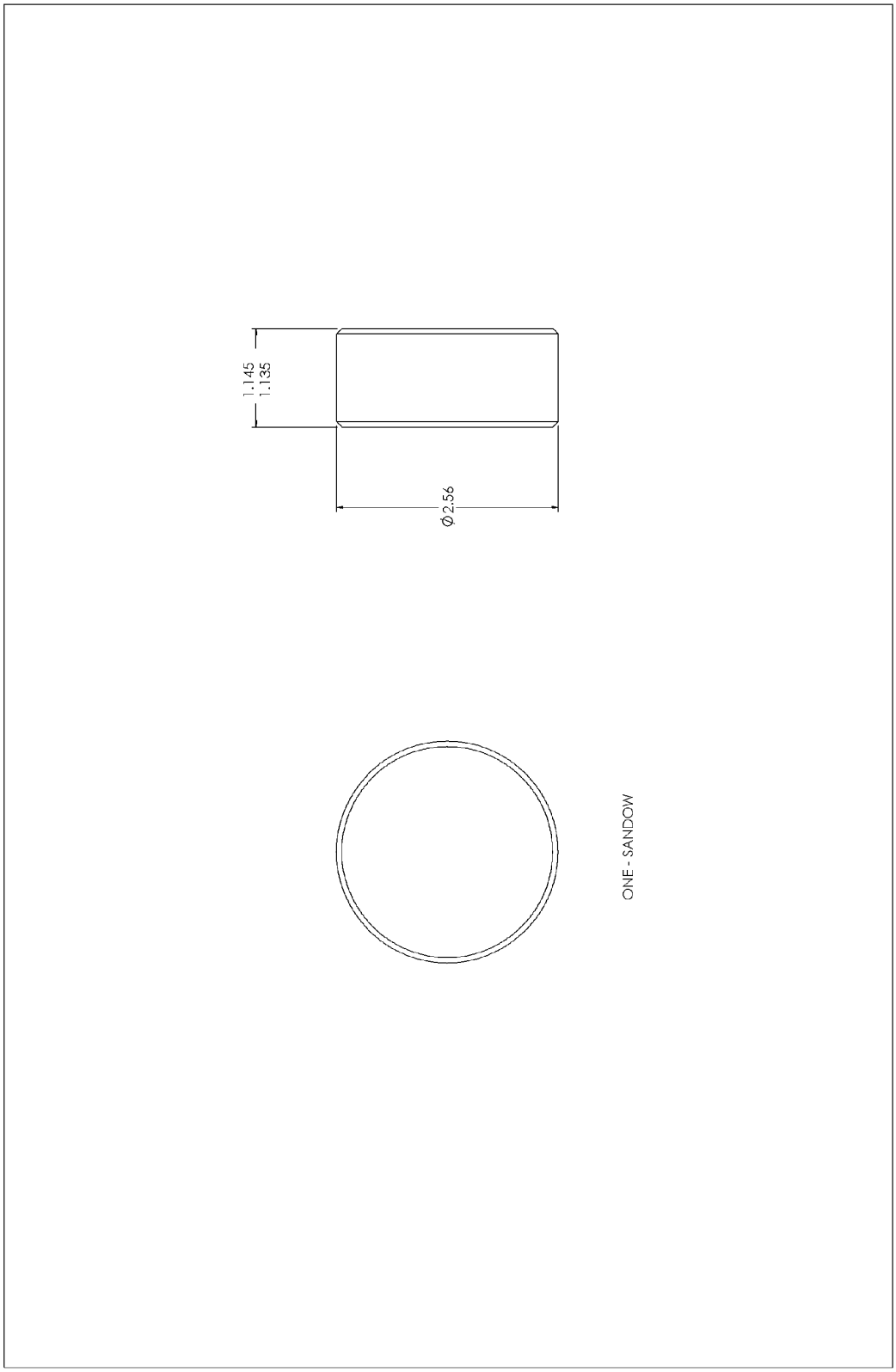


Figure 3-48. Assembly Tools - Spacer - Brake Disc Installation

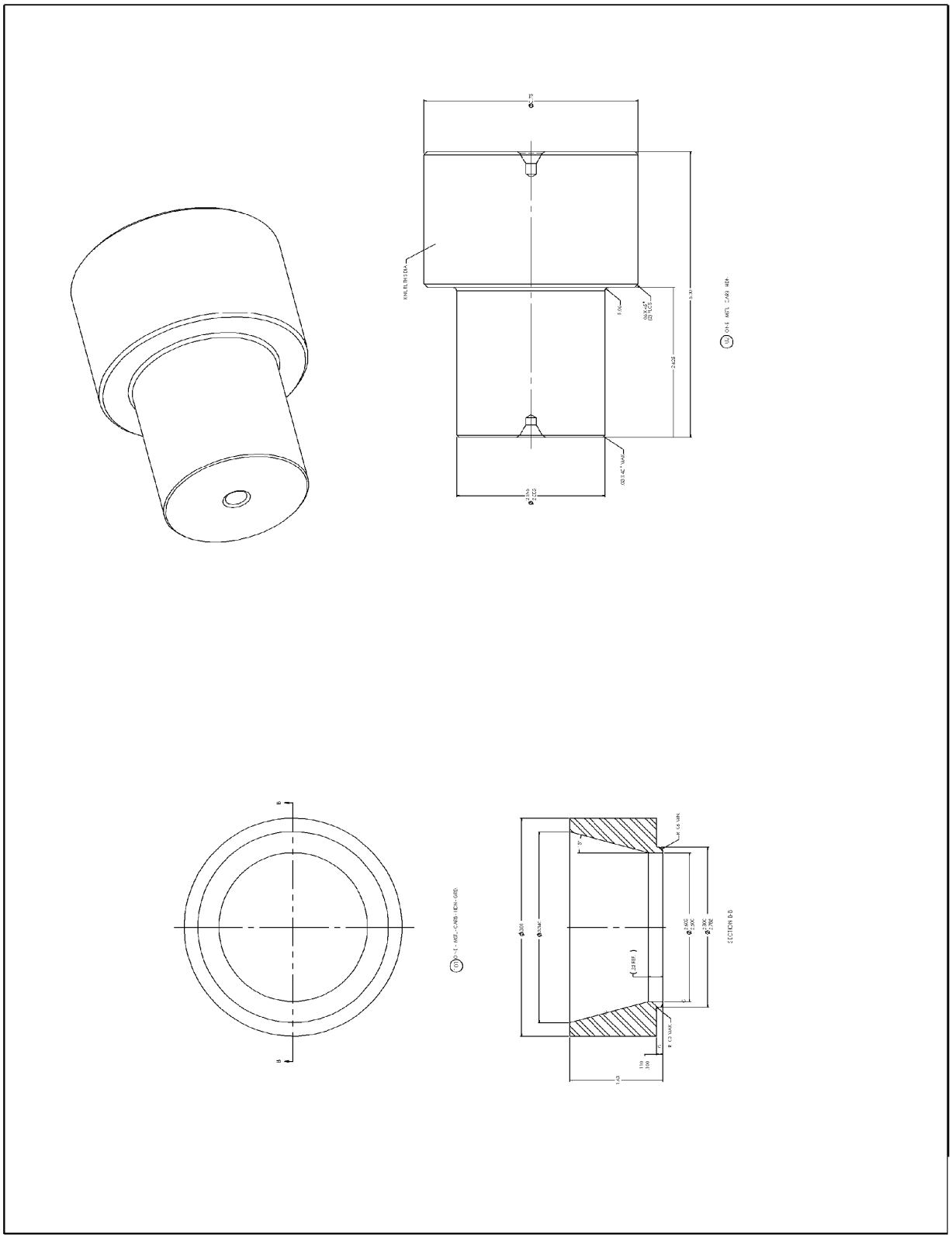


Figure 3-49. Assembly Tools - Brake Retaining Ring Installation

3.8 DRIVE BRAKE, 2WD - MICO (PRIOR TO S/N 83331)

Disassembly

1. Remove pressure plate (3) from cover plate (16) by removing cap screws (1) and washers (2).

⚠ CAUTION

PRESSURE PLATE IS UNDER SPRING TENSION OF APPROXIMATELY 907 KGF (2000 IBS). THE TWO CAP SCREWS MUST BE LOOSENED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE, 1361 KGF (3000 IBS) MINIMUM, THE PRESSURE PLATE CAN BE HELD IN POSITION WHILE REMOVING THE CAP SCREWS. COVER PLATE (16) MUST BE SUPPORTED AS SHOWN IN FIGURE 3-50.

2. Remove case seal (4) from cover plate (16).
3. Remove piston (7) from pressure plate (3).
4. Remove O-ring (5), back-up ring (6), O-ring (8) and back-up ring (9) from piston (7).
5. Remove stator disc (11), rotor disc (12) and return plate (13) from cover (16).

NOTE: *Not all models use the same number of springs or spring pattern.*

6. Remove dowel pins (15) and springs (14) from cover plate (16). Record this information for assembly purposes.
7. Remove retaining ring (19) from cover plate (16).
8. Remove shaft (10) by pressing or using a soft mallet on male end of shaft (10).

NOTE: *Cover plate (16) must be supported as shown in FIGURE 3-50.*

9. Remove retaining ring (20) from cover plate (16) and press out oil seal (17) and bearing (18) if required.

NOTE: *Cover plate (16) must be supported as indicated in Figure 3-50.*

Assembly

LUBRICATE ALL RUBBER COMPONENTS FROM REPAIR KIT WITH CLEAN TYPE FLUID USED IN THE SYSTEM.

1. Use an alkaline wash to clean parts before assembly.
2. Press oil seal (17) into cover plate (16) until it is flush with bearing shoulder. Note direction of seal.
3. Press bearing (18) into position until it bottoms out on borestep.

NOTE: *Cover plate (16) must be supported as indicated in Figure 1.*

4. Install retaining ring (20) in cover plate (16).
5. Press shaft (10) into bearing (18) until it bottoms on shoulder.

NOTE: *Bearing (18) inner race and cover plate (16) must be supported as indicated in Figure 1 during this operation.*

6. Install retaining ring (19) on shaft (10).
7. Insert dowel pins (15) and springs (14) in cover plate (16).

NOTE: *Be sure to use the same number of springs and spring pattern as recorded during disassembly.*

8. Position return plate (13) on springs (14).

NOTE: *Discs (11 & 12) and return plate (13) must remain dry during installation. No oil residue must be allowed to contaminate disc surfaces.*

9. Install rotor disc (12) and stator disc (13).
10. Install o-ring (5), back-up ring (6), O-ring (8) and back-up ring (9) on piston (7). Note order of O-rings and back-up rings. Insert piston (7) into pressure plate (3).

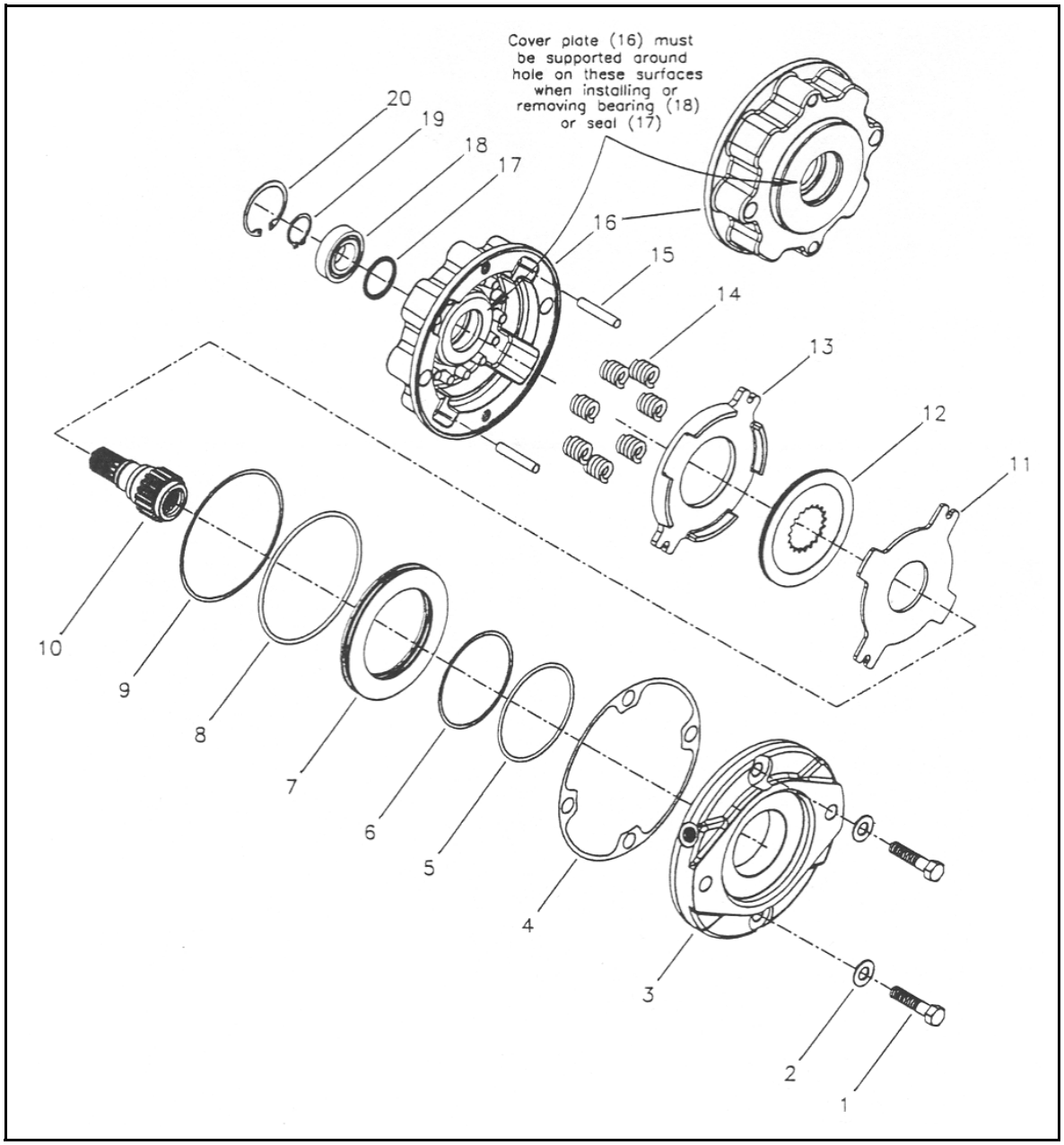
NOTE: *Be careful not to shear o-rings or back-up rings. Be careful not to scratch or mar piston.*

11. Install new case seal (4) in cover plate (16).
12. Position pressure plate (3) on cover plate (16) aligning dowel pins (15) with holes in pressure plate.
13. Install cap screws (1) and washers (2) and tighten evenly to draw pressure plate (3) to cover plate (16). Torque cap screws 65.1-67.8 N-m (48-50 lb-ft).

NOTE: *A hydraulic press will simplify installation of pressure plate on cover. Clamp pressure plate in position while tightening the cap screws. Cover plate (16) must be supported as indicated in Figure 3-50.*

⚠ CAUTION

IF HYDROSTATIC BENCH TESTING IS PERFORMED ON THE BRAKE ASSEMBLY, RELEASE PRESSURE MUST NOT EXCEED 134.5 BAR (500 PSI).



1. Capscrew
2. Washer
3. Pressure Plate
4. Case Seal
5. O-ring
6. Backup Ring
7. Piston
8. O-ring
9. Backup Ring
10. Shaft
11. Stator Disc
12. Rotor Disc
13. Return Plate
14. Springs
15. Dowel Pin
16. Cover Plate
17. Oil Seal
18. Bearing
19. Retaining Ring
20. Retaining Ring

Figure 3-50. Drive Brake, 2WD - Mico (Prior to S/N 83331)

Bleeding

1. Install brake in system and connect pressure lines.
2. Bleed pressure release section of brake by pressurizing side inlet port and allowing air to escape from top port. Pressure should not exceed 6.9 bar (100 psi) during bleeding.
3. Apply sufficient pressure to release brake and check for proper operation in system.

Table 3-8. Troubleshooting

PROBLEM	CAUSE	EXPLANATION	ACTION
Brake slips	Excessive pressure in hydraulic system	If there is back pressure in the actuation line of the brake, holding torque will be reduced.	Check filters, hose size, restrictions in other hydraulic components.
	Oil in brake if designed for dry use	Wet linings generate 67% of the dry torque rating. If the brake has oil in it, check the type of oil hydraulic or gearbox. 1 . Gearbox oil 2. Hydraulic oil	Replace oil seal in brake. Check motor seal Check piston seals ***NOTE:*** *Internal components will need to be inspected, cleaned and replaced as required.*
	Disc plates worn	The thickness of the disc stack sets the torque level. A thin stack reduces torque.	Check disc thickness.
	Springs broken or have taken a permanent set	Broken or set springs can cause reduced torque - a rare occurrence.	Check release pressure. (See spring replacement).
Brake drags or runs hot	Low actuation pressure	The brake should be pressurized to minimum of 1.38 bar (20 psi) over the full release pressure under normal operating conditions. Lower pressures will cause the brake to drag thus generating heat.	Place pressure gauge in bleed port & check pressure with system on.
	Bearing failure	If the bearing should fail, a large amount of drag can be generated.	Replace bearing.
Brake will not release	Stuck or clogged valve	Brakes are designed to come on when system pressure drops below stated release pressure. If pressure cannot get to brake, the brake will not release.	Place pressure gauge in bleed port - check for adequate pressure. Replace inoperative line or component.
	Bad o-rings	If release piston will not hold pressure, brake will not release.	Replace o-rings.
	Discs frozen	These brakes are designed for only limited dynamic braking. A severe emergency stop or prolonged reduced release pressure operation may result in this type of damage.	Replace disc stack.

3.9 RE-ALIGNING TORQUE HUB INPUT COUPLING

The following procedure applies to torque hubs with integral brakes.

Equipment Required

1. Hydraulic power supply (hand pump) capable of producing 200 psi (13.8 bar).
2. Hydraulic fittings to adapt hydraulic supply to brake release port on hub.

Procedure

1. Using appropriate fittings, connect a line from the hydraulic power supply to the brake port.
2. Pressurize the brake release port 155 to 200 psi (10.6 to 13.8 bar) to release the brake.
3. Verify that the brake is released by rotating the input coupling or hub spindle.
4. Once the brake is released, the input coupling will be free to re-align with the drive motor.
5. Install the drive motor on the hub, then release the hydraulic pressure at the brake release port. The coupling will remain in position.
6. Disconnect the hydraulic power supply and reconnect the line going into the brake release port.

3.10 OSCILLATING AXLE BLEEDING PROCEDURE AND LOCKOUT TEST

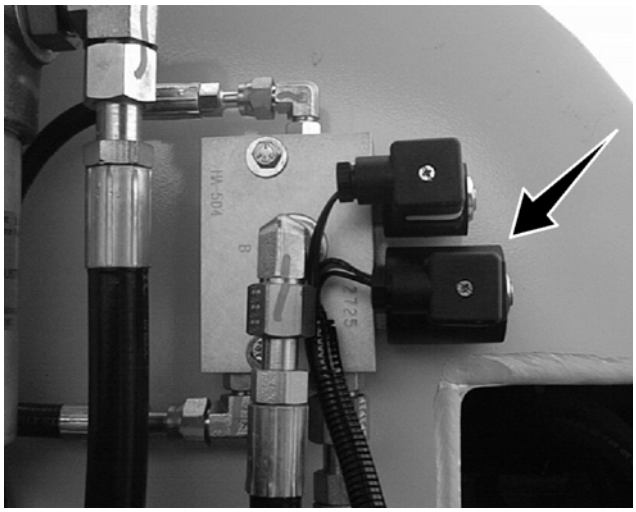
Lockout Cylinder Bleeding

NOTICE

ENSURE PLATFORM IS FULLY LOWERED AND BOOM IS CENTERED OVER REAR AXLE PRIOR TO BEGINNING BLEEDING PROCEDURE.

ENSURE MACHINE IS ON A LEVEL SURFACE AND REAR WHEELS ARE BLOCKED, BRAKE WIRE IS DISCONNECTED.

1. Make sure machine is on a level surface.
2. Center boom over rear axle to make sure the cam valve in the rotary coupling is depressed.
3. Place chocks under the tires to ensure the machine does not move. Disable the machine brakes by disconnecting the brake solenoid on the dual select valve.



4. Use suitable containers to catch any excess hydraulic fluid. Place the containers under each lockout cylinder.
5. Open one bleeder screws at a time.
6. Start the engine, position drive control lever on the main hydraulic pump forward or reverse.
7. Close bleeder screws when all air is dissipated (bled).
8. Reconnect the brake solenoid and remove the wheel chocks.
9. Perform oscillating axle lockout test.
10. If necessary, repeat steps 1 thru 7.

Oscillating Axle Lockout Test

NOTICE

LOCKOUT SYSTEM TEST MUST BE PERFORMED QUARTERLY, ANY TIME A SYSTEM COMPONENT IS REPLACED, OR WHEN IMPROPER SYSTEM OPERATION IS SUSPECTED.

NOTE: *Ensure boom is fully retracted, lowered, and centered between drive wheels prior to beginning lockout cylinder test.*

1. Place a 6 inch (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, activate machine hydraulic system.
3. Place FUNCTION SPEED CONTROL and DRIVE SPEED/TORQUE SELECT control switches to their respective LOW positions.
4. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
5. Carefully activate SWING control lever and position boom over right side of machine.
6. With boom over right side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.
7. Have an assistant check to see that left front wheel remains locked in position off of ground.
8. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground, it may be necessary activate DRIVE to release cylinders.
9. Place the 6 inch (15.2 cm) high block with ascension ramp in front of right front wheel.
10. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.
11. Carefully activate SWING control lever and position boom over left side of machine.
12. With boom over left side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.
13. Have an assistant check to see that right front wheel remains locked in position off of ground.
14. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground, it may be necessary activate DRIVE to release cylinders.
15. If lockout cylinders do not function properly, have qualified personnel correct the malfunction prior to any further operation.

3.11 SWING DRIVE HUB

Disassembly

1. Loosen all 12 cover bolts (12)&(13) and drain the oil from the unit.
2. Remove the 12 cover bolts (12)& (13) and lift off the cover (6). Remove and discard the O-ring (5) from the counterbore of the cover (6).
3. Remove the input gear (8) and thrust washer (10).
4. Lift out the carrier assembly (3) and top thrust washer (11). The thrust washer (11) may stick to the inside of the carrier (3).
5. Remove the input thrust spacer (9).
6. Lift out the internal gear (2) and thrust washer (11). The thrust washer (11) may stick to the under side of the carrier (3).
7. Remove the retaining ring (1I) from the output shaft (1A) and discard.

⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING (1I) REMOVAL.

8. Remove bearing shim (1H) from the output shaft (1A).
9. The output shaft (1A) may now be pressed out of the hub (1G).
10. THe bearing cups (1C)&(1E) will remain in hub (1G) as will bearing cone (1F). Bearing cone (1D) will remain on the same output shaft (1A). The seal (1B) will be automatically removed during this procedure.

NOTE: *If bearing replacement is necessary, the bearing cups can be removed with a slide hammer puller driven out with a punch.*

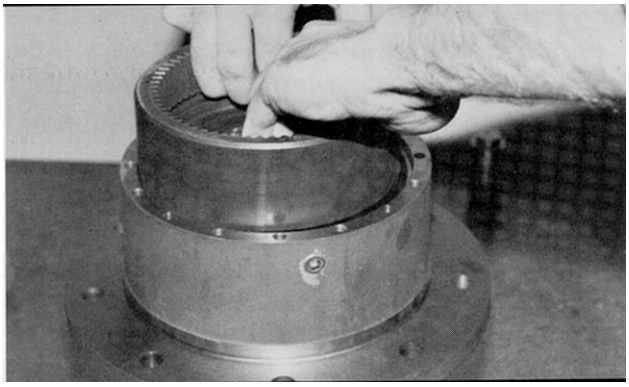
11. To remove the cluster gears (3F) from the carrier (3A), drive the anti-roll pin (3G) into the planet shaft (3E) may now be tapped out of the carrier. After planet shaft (3E) has been removed the roll pin (3G) can be driven out.
12. The cluster gear (3F) can now be removed from the carrier (3A). THe thrust washers (3B) will be removed with the cluster gear (3F).
13. The needle rollers (3C) and spacer (3D) are now removed from the cluster gear (3F).

NOTICE

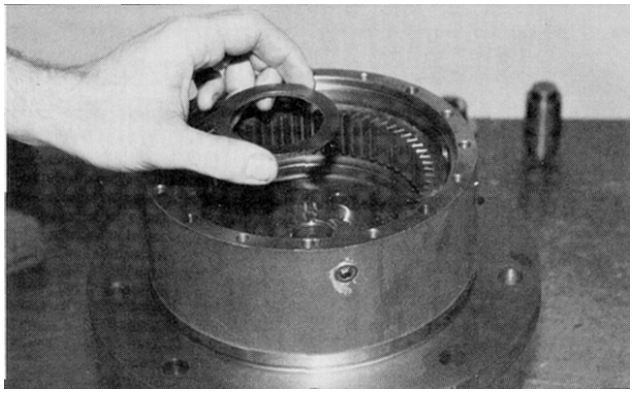
WHEN REBUILDING OR REPAIRING THE UNIT, THE RETAINING RING (1I), O-RINGS (5) AND SEAL (1B) SHOULD ALWAYS BE REPLACED.

Main Assembly Procedure

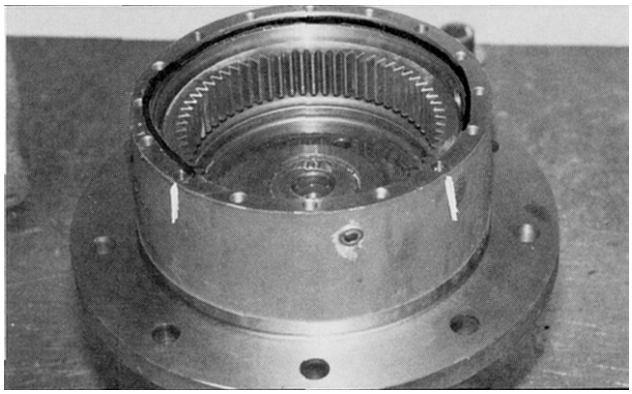
1. With the hub shaft sub-assembly resting on the shaft (1A) install internal gear (2). The spline of the internal gear (2) bore will mesh the spline of the output shaft (1A).



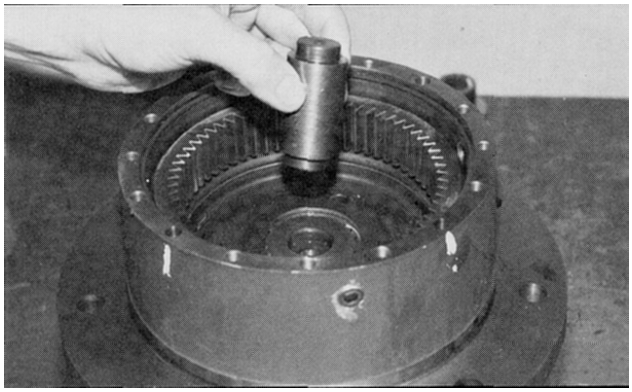
2. Thrust washer (11) is installed on the face of the output shaft (1A). Sufficient grease or petroleum jelly should be used to hold thrust washer in place.



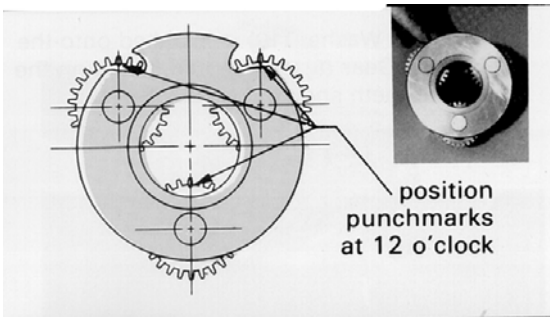
3. Place O-ring (5) into hub counterbore. Use petroleum jelly to hold O-ring in place. Also at this time locate and mark the 4 counter beamed holes in the face of the hub (1G). This is for identification later in the assembly.



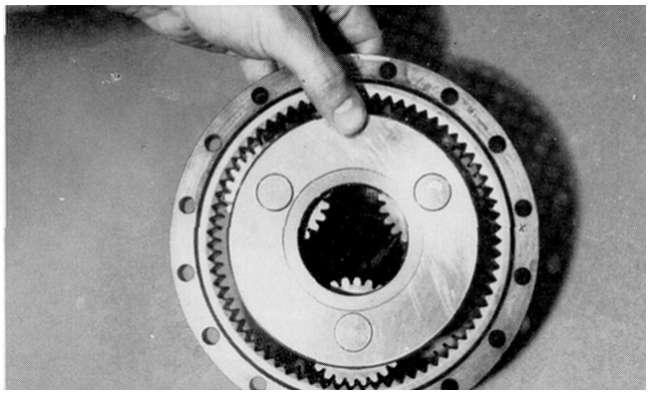
4. Thrust spacer (9) is installed into the bore of the output shaft (1A). This should be a slip fit and thrust spaces should rotate in this location.



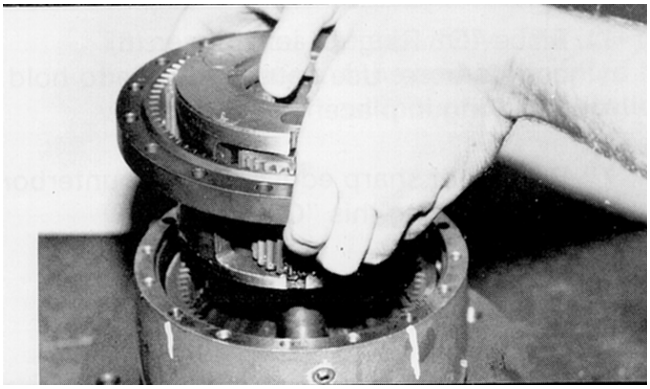
5. Place carrier assembly (3) on a flat surface with the large gears (3F) up and positioned as shown. Find the punch marked tooth on each large gear (3F) and locate at 12 0'clock (straight-up) from each planet pin. Marked tooth will be located just under the carrier (3A) on upper two gears (3F).



6. With shoulder side of ring gear (4) facing down, place ring gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during ring gear installation. The side of the ring gear with an x stamped on it should be up.

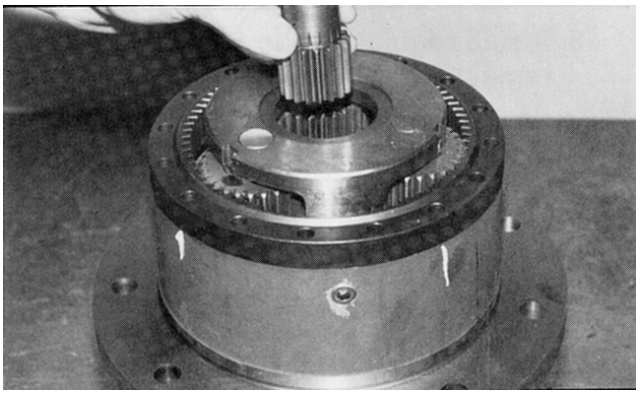


7. While holding ring gear (4) and cluster gears (3F) in mesh, place small side of cluster gears (3F) into mesh with the internal gear (2) and input gear (13). On the ring gear locate the hole marked "x" over one of the marked counterbore holes (step 3) in hub (1G).

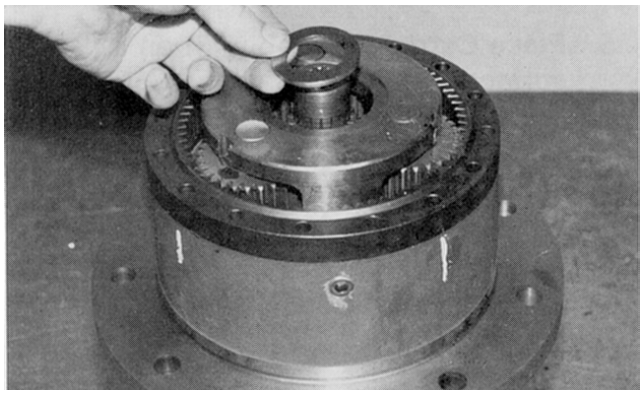


NOTE: *If gears do not mesh easily or carrier assembly does not rotate freely, then remove the carrier and ring gear and check the cluster gear timing.*

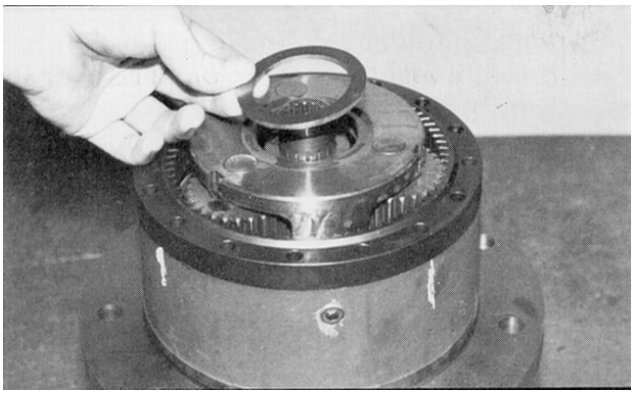
8. Input gear (8) is installed, meshing with teeth of the large diameter cluster gear (3F). The counterbore on the input gear (8) locates on the shoulder of the thrust spacer (9). This is to be a slip fit and operate freely.



9. Thrust washer (10) is installed onto the input gear (8) and should locate on the gear teeth shoulder.



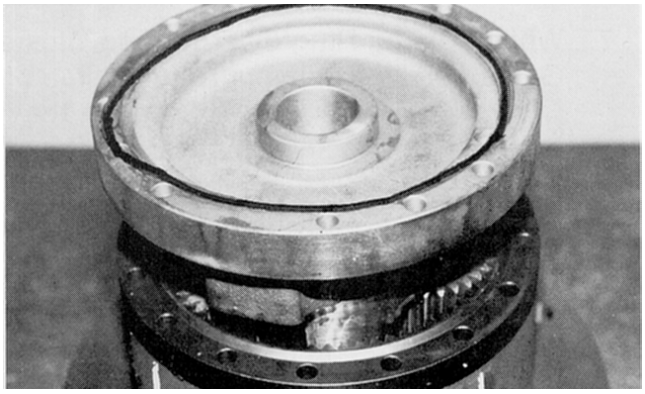
10. Thrust washer (11) is installed into the counterbore of the carrier (3).



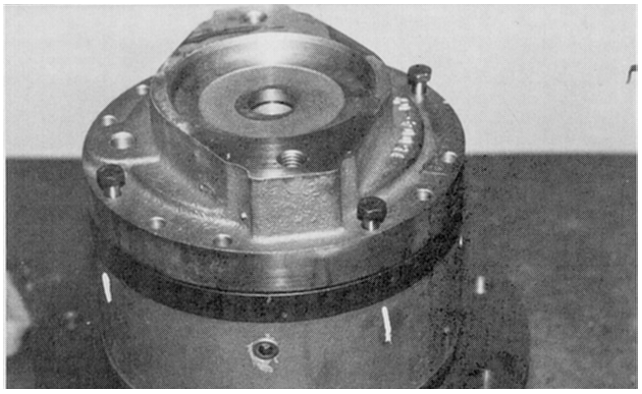
11. Place O-ring (5) into cover (6) counterbore. Use petroleum jelly to hold O-ring in place.

⚠ CAUTION

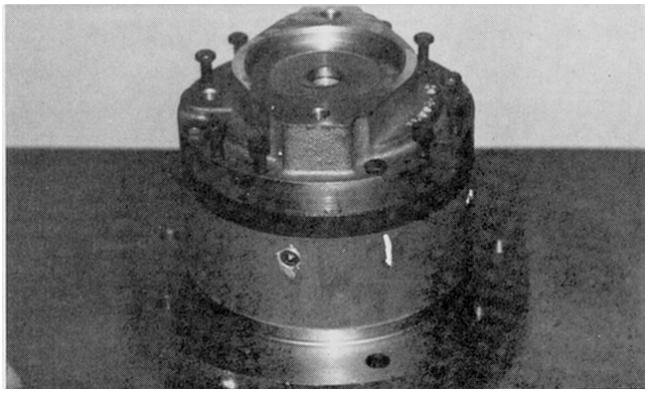
BEWARE OF SHARP EDGES OF THE COUNTERBORE WHILE SEATING THIS O-RING.



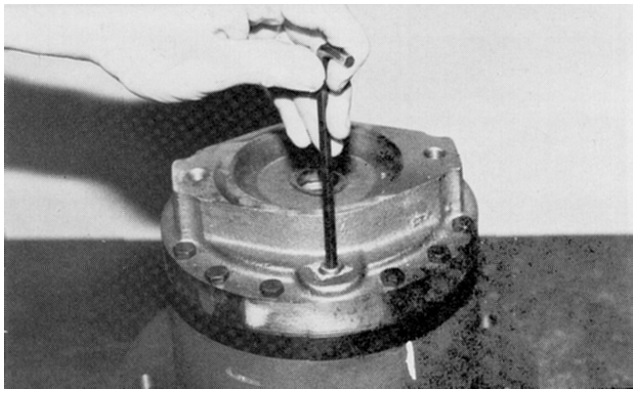
12. THe cover (6) is now installed on this assembly. Taking care to correctly align pipe plug hole (20) with those in the hub (1J), usually 90° to one another. Locate the 4 counterbore holes in hub (1G) (marked in step 3) and install 4 shoulder bolts (13). A slight tap with a hammer may be necessary to align shoulder bolt with hub (1G) counterbore.



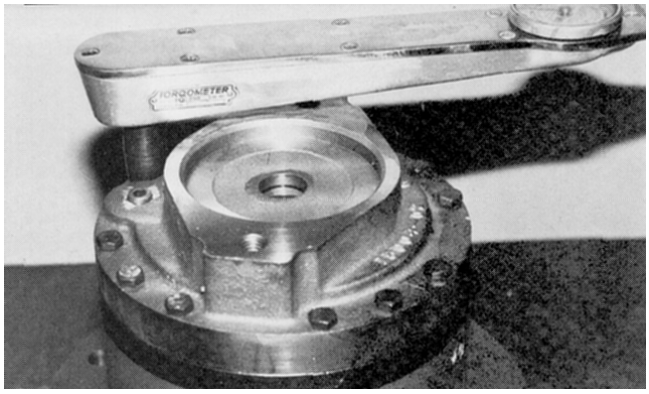
13. Install regular grade 8 bolts (12) into remaining holes.



14. Pipe plugs (20) are to be installed into cover (6) using a lubricant of some sort.



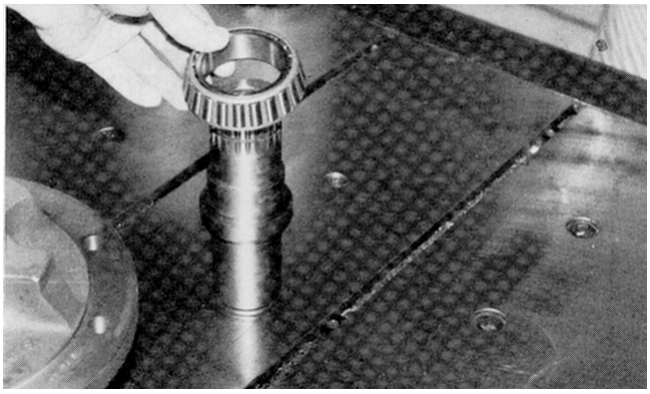
15. Torque shoulder bolts (13) to 23-27 ft./lbs. and regular grade 8 bolts (12) to 23-27 ft./lbs,



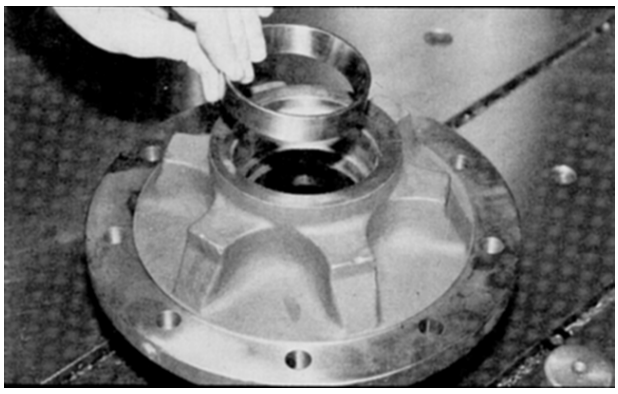
This completes the assembly. THe unit must be filled one-half full of EP 90 lubricant before operation if the unit is mounted horizontally, and completely filled if mounted vertically. In vertical mounting application case oil circulation is recommended.

Hub Shaft Sub-Assembly

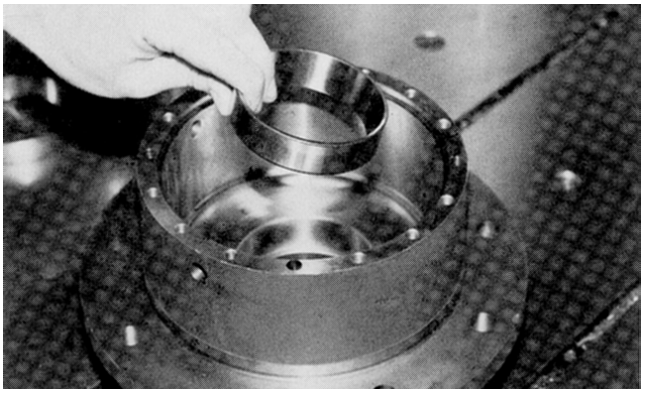
1. Press bearing cone (1D) onto shaft (1A).



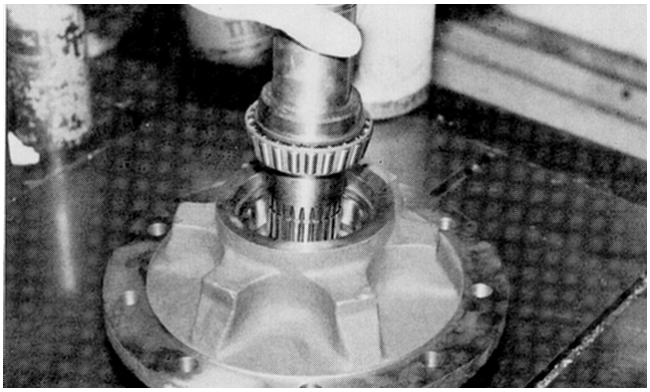
2. Press bearing cup (1C) into hub (1G) taking care to insure cup start square with the bore of the hub.



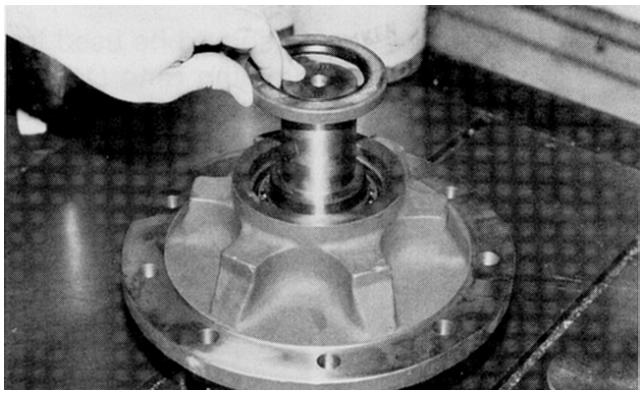
3. Invert hub (1G) and press bearing cup (1E) into inter counterbore of hub (1G).



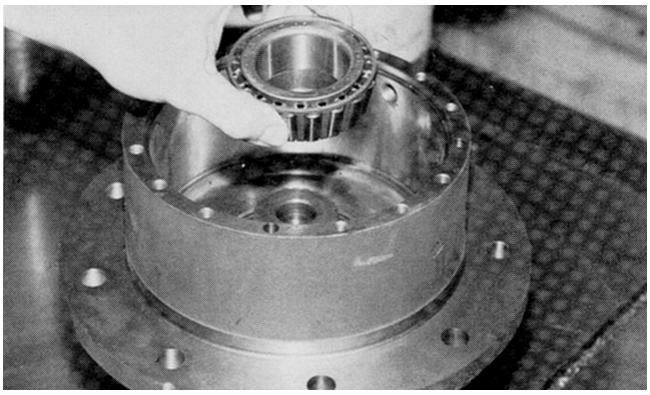
4. Returning the hub (1G) to locate on the large diameter end, the output shaft (1A) is carefully installed into the hub (1G).



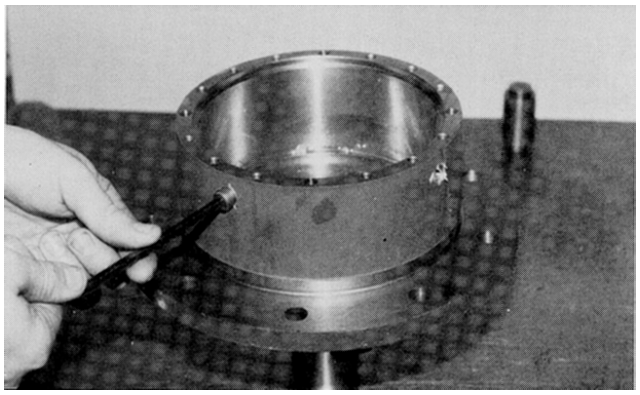
5. The shaft seal (1B) is installed over the output shaft (1A) and into the counterbore of the hub (1G). Care should be taken to insure the seal (1B) is being correctly installed (smooth face up and located just flush with the counterbore face).



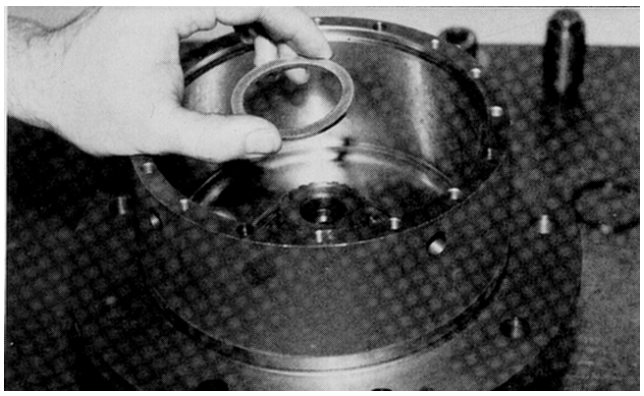
6. The bearing cone (1F) is an interference fit and has to be pressed or tapped on.



7. Pipe plugs (1J & 1K) should be checked and/ or installed at this time in the assembly.



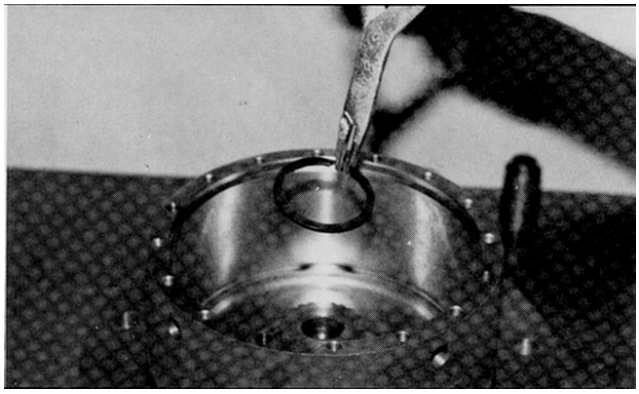
8. Bearing spacer (1H) is installed around the output shaft (1A) and locates on bearing cone (1F).



9. Retaining ring (1I) installed into groove provided in the output shaft (1A). This retaining ring (1I) should never be reused in a repair or rebuild.

⚠ CAUTION

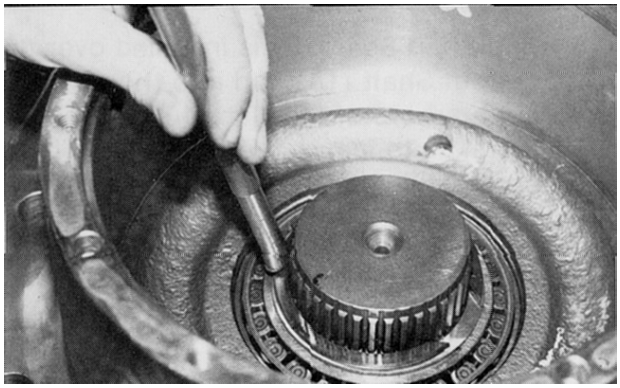
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.



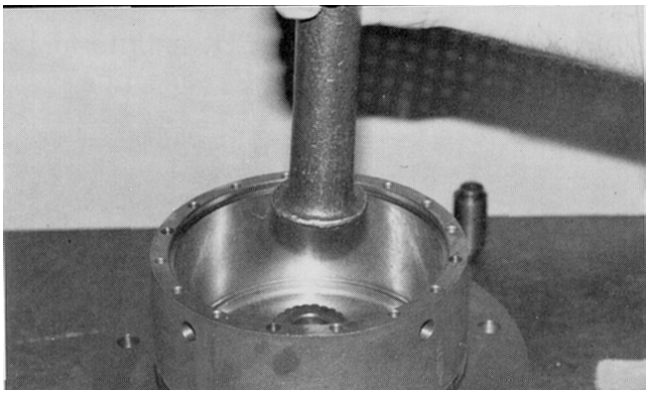
10. A soft metal punch should be used to insure that this retaining ring (1I) is completely seated in the groove of the output shaft (1A).

⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.



11. Upon completion of step 10, rap the internal end of the output shaft (1A) twice with a piece of soft metal rod. This will release the preload which was on the bearings.



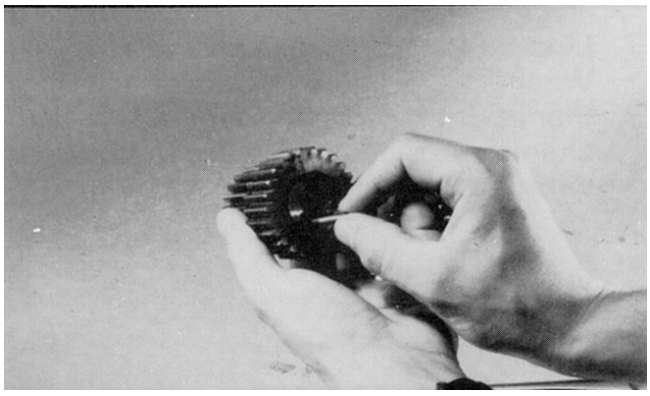
This completes the hub shaft sub-assembly —items (1A) through (1J). If this assembly is not going to be used right away, it should be oiled and covered to help prevent rusting,

Carrier Sub-Assembly

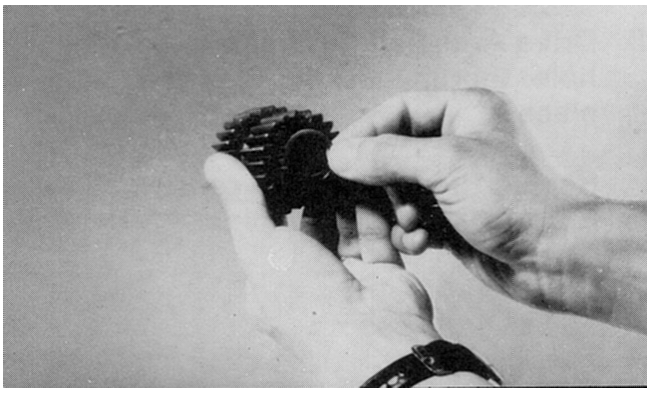
1. Apply a coat of grease or petroleum jelly to cluster gear bore.



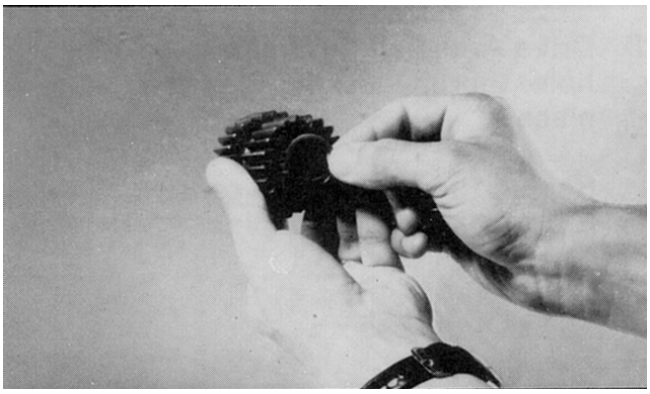
2. Place sixteen needle rollers into cluster gear bore.



3. Place spacer washer into opposite side of cluster gear and against needle rollers.

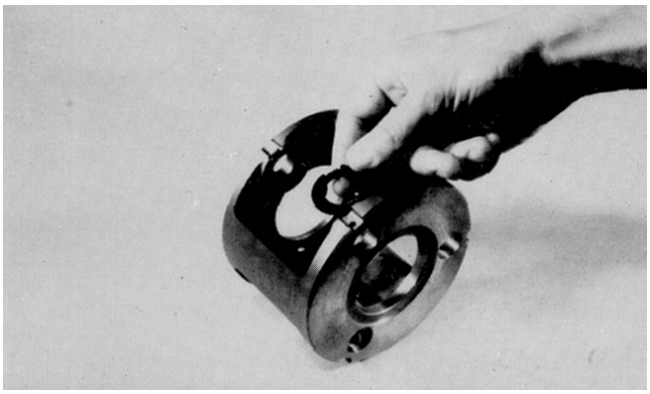


4. Place second set of sixteen needle rollers into cluster gear.

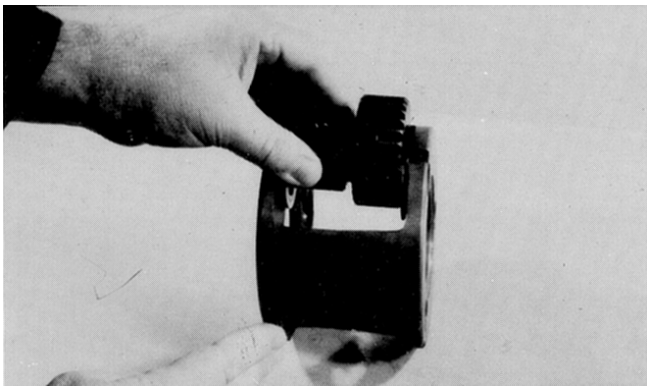


5. Apply grease or petroleum jelly to the tang side of two thrust washers. Place thrust washers against bosses in carrier with washer tang fitting into slot in carrier outside diameter.

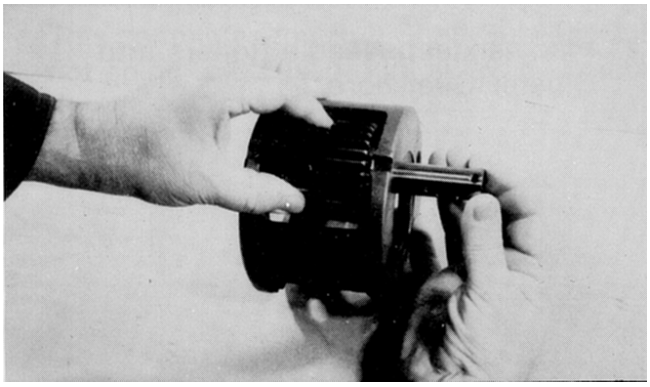
NOTE: *Some old style carriers will not have slots and tangs should be located inside boss relief.*



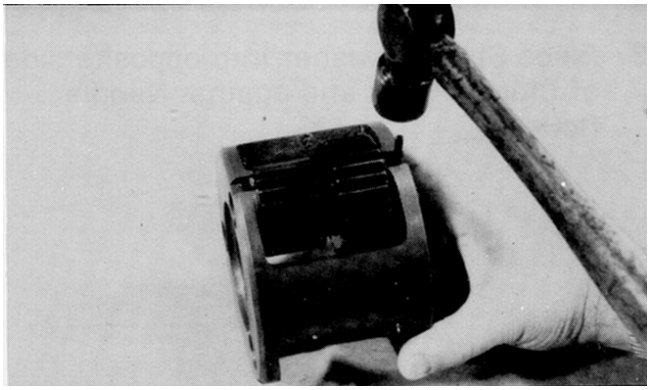
6. While keeping thrust washers in place, slide cluster gear into carrier with the larger gear on the side with the small pin hole.



7. Line up cluster gear and thrust washer with hole in carrier and slide planet shaft through. Line up chamfered side of hole in planet shaft with pin hole in carrier.



8. Drive anti-roll pin flush into carrier hole, thereby locking planet shaft into place.
   Repeat these steps for remaining two cluster gears to complete carrier assembly.



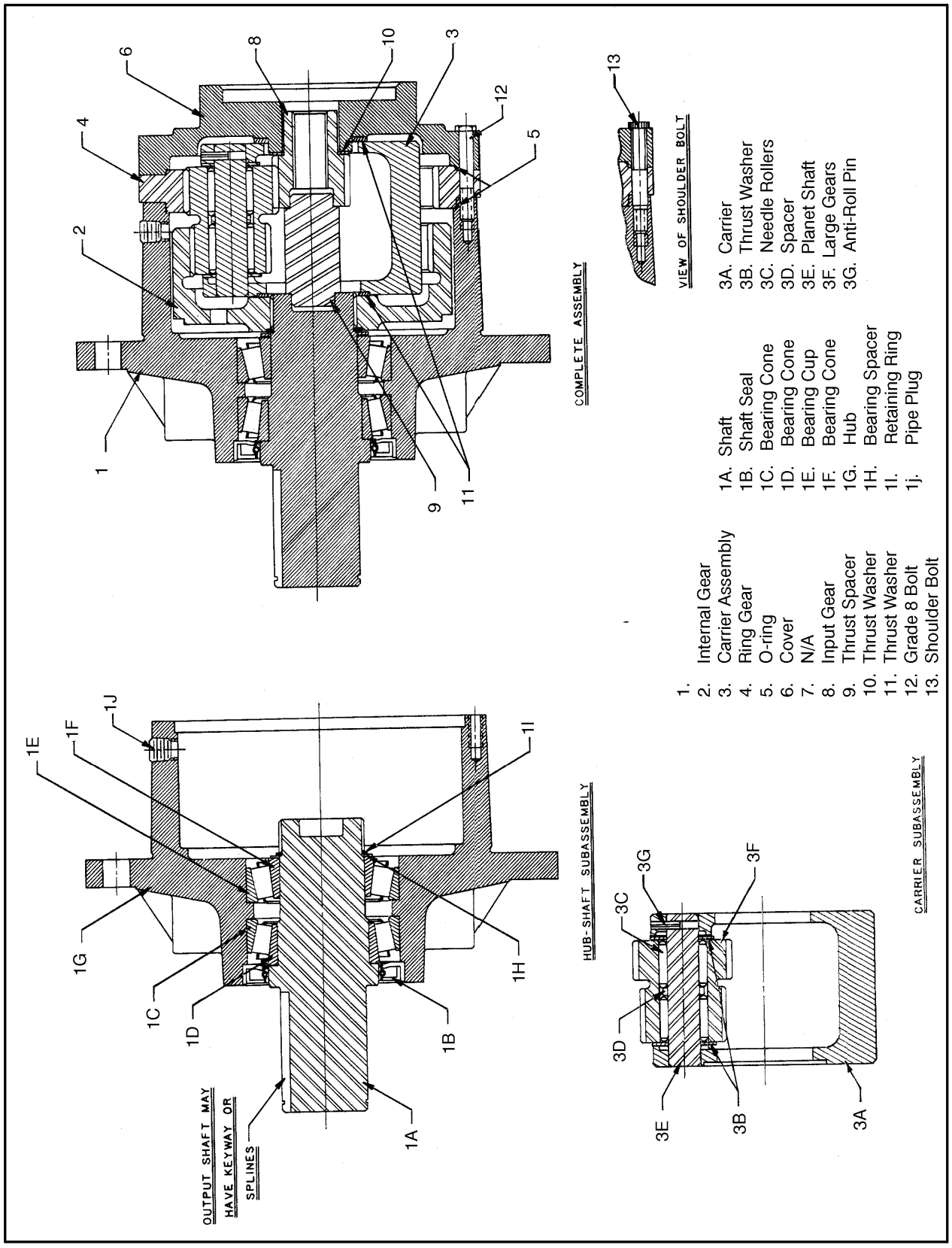


Figure 3-51. Swing Drive Hub (Fairfield)

3.12 SWING BRAKE - MICO (PRIOR TO S/N 66417)

Disassembly

1. Remove pressure plate (3) from cover plate (16) by removing cap screws (1) and washers (2).

⚠ CAUTION

PRESSURE PLATE IS UNDER SPRING TENSION OF APPROXIMATELY 907 KGF (2000 IBS). THE TWO CAP SCREWS MUST BE LOOSENED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE, 1361 KGF (3000 IBS) MINIMUM, THE PRESSURE PLATE CAN BE HELD IN POSITION WHILE REMOVING THE CAP SCREWS. COVER PLATE (16) MUST BE SUPPORTED AS SHOWN IN FIGURE 3-50.

2. Remove case seal (4) from cover plate (16).
3. Remove piston (7) from pressure plate (3).
4. Remove O-ring (5), back-up ring (6), O-ring (8) and back-up ring (9) from piston (7).
5. Remove stator disc (11), rotor disc (12) and return plate (13) from cover (16).

NOTE: *Not all models use the same number of springs or spring pattern.*

6. Remove dowel pins (15) and springs (14) from cover plate (16). Record this information for assembly purposes.
7. Remove retaining ring (19) from cover plate (16).
8. Remove shaft (10) by pressing or using a soft mallet on male end of shaft (10).

NOTE: *Cover plate (16) must be supported as shown in FIGURE 3-50.*

9. Remove retaining ring (20) from cover plate (16) and press out oil seal (17) and bearing (18) if required.

NOTE: *Cover plate (16) must be supported as indicated in Figure 3-50.*

Assembly

LUBRICATE ALL RUBBER COMPONENTS FROM REPAIR KIT WITH CLEAN TYPE FLUID USED IN THE SYSTEM.

1. Use an alkaline wash to clean parts before assembly.
2. Press oil seal (17) into cover plate (16) until it is flush with bearing shoulder. Note direction of seal.
3. Press bearing (18) into position until it bottoms out on borestep.

NOTE: *Cover plate (16) must be supported as indicated in Figure 1.*

4. Install retaining ring (20) in cover plate (16).
5. Press shaft (10) into bearing (18) until it bottoms on shoulder.

NOTE: *Bearing (18) inner race and cover plate (16) must be supported as indicated in Figure 1 during this operation.*

6. Install retaining ring (19) on shaft (10).
7. Insert dowel pins (15) and springs (14) in cover plate (16).

NOTE: *Be sure to use the same number of springs and spring pattern as recorded during disassembly.*

8. Position return plate (13) on springs (14).

NOTE: *Discs (11 & 12) and return plate (13) must remain dry during installation. No oil residue must be allowed to contaminate disc surfaces.*

9. Install rotor disc (12) and stator disc (13).
10. Install o-ring (5), back-up ring (6), O-ring (8) and back-up ring (9) on piston (7). Note order of O-rings and back-up rings. Insert piston (7) into pressure plate (3).

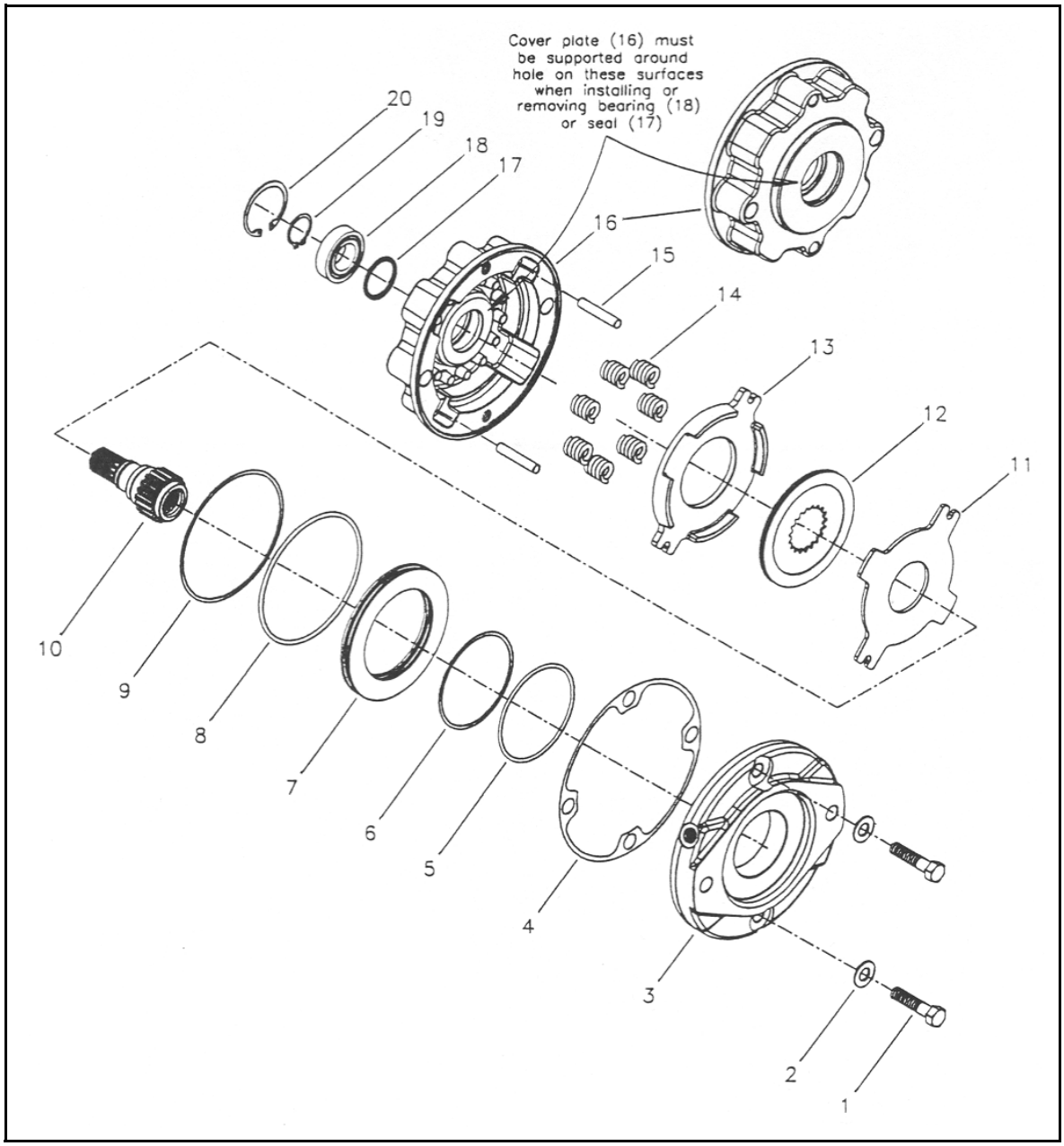
NOTE: *Be careful not to shear o-rings or back-up rings. Be careful not to scratch or mar piston.*

11. Install new case seal (4) in cover plate (16).
12. Position pressure plate (3) on cover plate (16) aligning dowel pins (15) with holes in pressure plate.
13. Install cap screws (1) and washers (2) and tighten evenly to draw pressure plate (3) to cover plate (16). Torque cap screws 65.1-67.8 N-m (48-50 lb-ft).

NOTE: *A hydraulic press will simplify installation of pressure plate on cover. Clamp pressure plate in position while tightening the cap screws. Cover plate (16) must be supported as indicated in Figure 3-50.*

⚠ CAUTION

IF HYDROSTATIC BENCH TESTING IS PERFORMED ON THE BRAKE ASSEMBLY, RELEASE PRESSURE MUST NOT EXCEED 134.5 BAR (500 PSI).



1. Capscrew
2. Washer
3. Pressure Plate
4. Case Seal
5. O-ring
6. Backup Ring
7. Piston
8. O-ring
9. Backup Ring
10. Shaft
11. Stator Disc
12. Rotor Disc
13. Return Plate
14. Springs
15. Dowel Pin
16. Cover Plate
17. Oil Seal
18. Bearing
19. Retaining Ring
20. Retaining Ring

Figure 3-52. Swing Brake - Mico (Prior to S/N 66417)

Bleeding

1. Install brake in system and connect pressure lines.
2. Bleed pressure release section of brake by pressurizing side inlet port and allowing air to escape from top port. Pressure should not exceed 6.9 bar (100 psi) during bleeding.
3. Apply sufficient pressure to release brake and check for proper operation in system.

Table 3-9. Troubleshooting

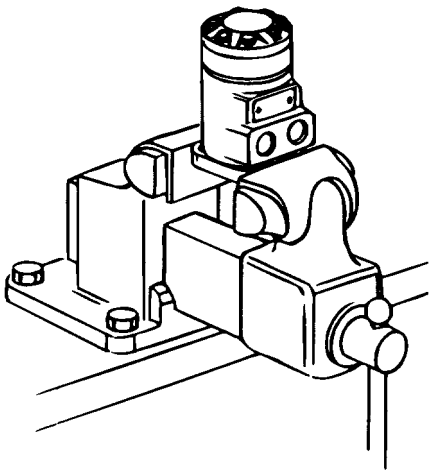
PROBLEM	CAUSE	EXPLANATION	ACTION
Brake slips	Excessive pressure in hydraulic system	If there is back pressure in the actuation line of the brake, holding torque will be reduced.	Check filters, hose size, restrictions in other hydraulic components.
	Oil in brake if designed for dry use	Wet linings generate 67% of the dry torque rating. If the brake has oil in it, check the type of oil hydraulic or gearbox. 1 . Gearbox oil 2. Hydraulic oil	Replace oil seal in brake. Check motor seal Check piston seals ***NOTE:*** *Internal components will need to be inspected, cleaned and replaced as required.*
	Disc plates worn	The thickness of the disc stack sets the torque level. A thin stack reduces torque.	Check disc thickness.
	Springs broken or have taken a permanent set	Broken or set springs can cause reduced torque - a rare occurrence.	Check release pressure. (See spring replacement).
Brake drags or runs hot	Low actuation pressure	The brake should be pressurized to minimum of 1.38 bar (20 psi) over the full release pressure under normal operating conditions. Lower pressures will cause the brake to drag thus generating heat.	Place pressure gauge in bleed port & check pressure with system on.
	Bearing failure	If the bearing should fail, a large amount of drag can be generated.	Replace bearing.
Brake will not release	Stuck or clogged valve	Brakes are designed to come on when system pressure drops below stated release pressure. If pressure cannot get to brake, the brake will not release.	Place pressure gauge in bleed port - check for adequate pressure. Replace inoperative line or component.
	Bad o-rings	If release piston will not hold pressure, brake will not release.	Replace o-rings.
	Discs frozen	These brakes are designed for only limited dynamic braking. A severe emergency stop or prolonged reduced release pressure operation may result in this type of damage.	Replace disc stack.

3.13 SWING MOTOR (PRIOR TO S/N 66417)

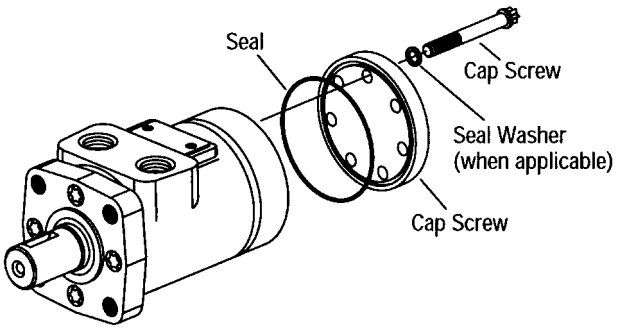
Disassembly

Cleanliness is extremely important when repairing these motors. Work in a clean area. Before disconnecting lines, clean port area of motor. Remove key when used. Check shaft and key slot. Remove burrs, nicks and sharp edges. Before disassembly, drain oil from motor. Then plug ports and thoroughly clean exterior of motor.

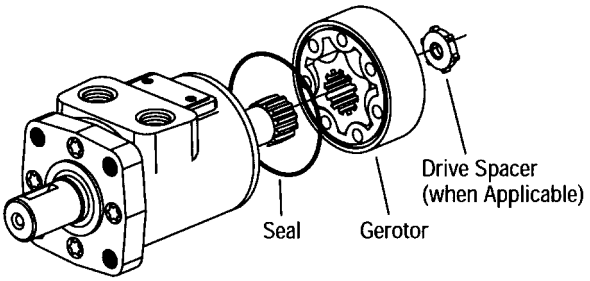
Although not all drawings show motor in a vise, we recommend that you keep the motor in a vise during disassembly. Follow the clamping procedures explained throughout the manual.



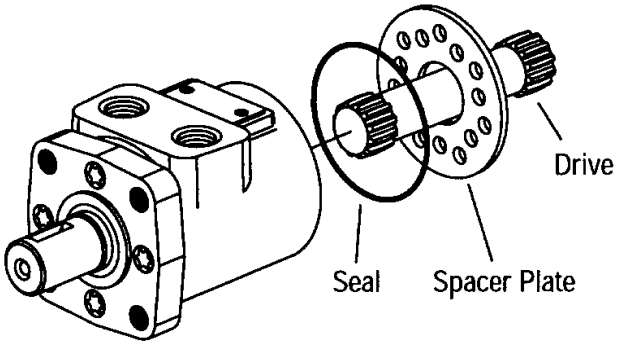
1. Place motor in vice and clamp across edge of flange with output shaft down. When clamping, use protective device on vice such as special soft jaws, pieces of hard rubber or board.



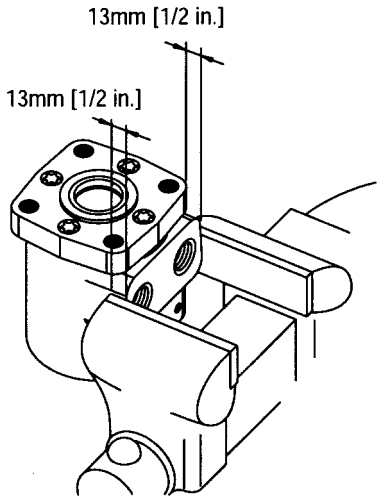
2. remove cap screws and seal washers.
3. Remove end cap.
4. Remove seal from end cap.



5. Remove gerotor.
6. Remove seal from gerotor.
7. Remove drive spacer if applicable.



8. Remove drive.
9. Remove spacer plate.
10. Remove seal from housing.
11. Remove output shaft from housing.
12. Remove needle thrust bearing from shaft or housing.



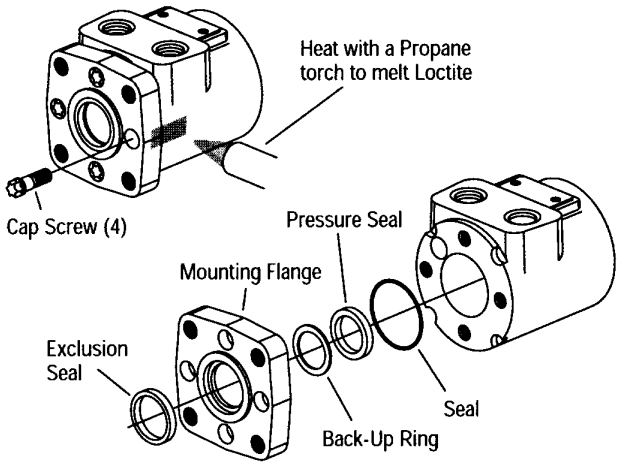
13. Reposition motor in vise. Clamp across ports as shown above. Do not clamp side of housing. Excessive clamping pressure on side of housing causes distortion.

14. Remove cap screws from mounting flange. These screws are assembled with Loctite to hold them in place.

The screws will require 35-45 Nm (300 - 400 in/lbs) of torque to break loose and 11 Nm (100 in/lbs) torque to remove. Do not use impact wrench on screws that have been secured with Loctite. This could result in rounded heads or broken sockets.

NOTE: *If torque higher than given above is required to break screws loose, apply heat according to following instructions.*

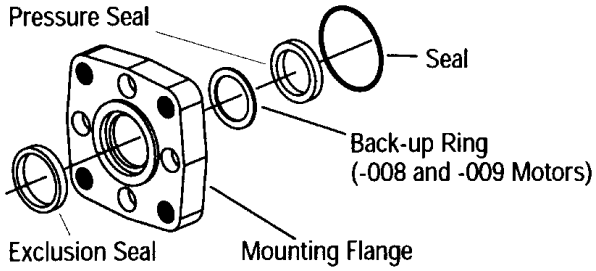
NOTE: *When heated, Loctite partially melts. This reduces the torque required to remove screw. Use small flame propane torch to heat small area of housing where screw enters (see figure below). Be careful not to overheat housing and damage motor. Gradually apply torque to screw with socket wrench as heat is applied for 8 to 10 seconds. As soon as screw breaks loose, remove heat from housing. Continue turning screw until it is completely removed.*



15. Carefully remove flange from housing.

NOTICE

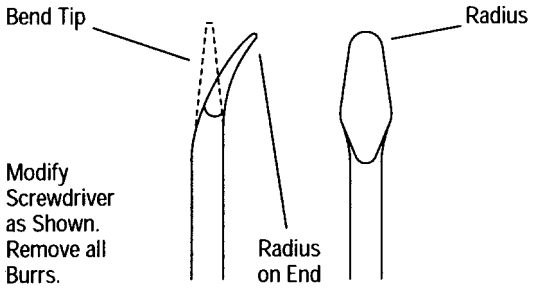
SOME MOTORS MAY HAVE A QUAD SEAL AND BACK-UP RING IN PLACE OF THE PRESSURE SEAL. THE QUAD SEAL AND BACK-UP RING ARE NO LONGER AVAILABLE AND ARE REPLACED BY THE PRESSURE SEAL. THEY ARE INTERCHANGEABLE, BUT SOME PRECAUTIONS MUST BE TAKEN TO INSURE PROPER INSTALLATION. FOLLOW THE REASSEMBLY INSTRUCTIONS.

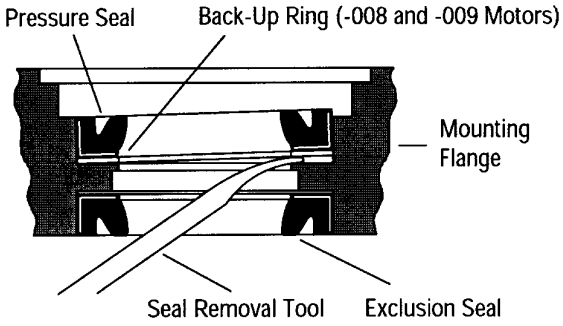


16. Exclusion seal, back-up ring, pressure seal and seal will come off with flange. Use seal removal tool as shown to remove exclusion and pressure seals.

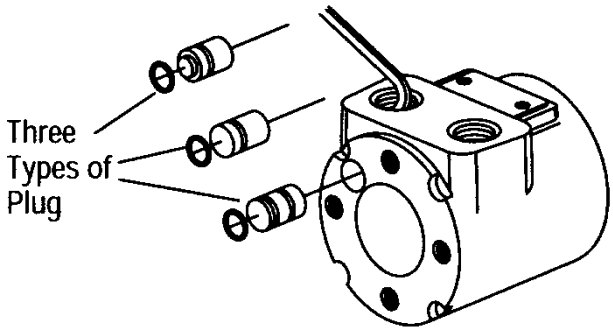
NOTICE

BE CAREFUL NOT TO SCRATCH SEAL CAVITY O.D. THIS COULD CREATE A LEAK PATH.





Work from outer side for both (either) Seals.



17. A metal plug, with seal, plugs a machining hole in the housing. It is not necessary to remove plug and replace seal unless leakage occurs around plug. To remove plug, insert 5 mm (.187 in.) hex key through port opening and push it out. The 009 plug is not interchangeable with 007 and 008 plugs.

Inspection and Cleaning

Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage or damage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe parts with cloth or paper towel because lint or other matter could get into the hydraulic system and cause damage.

Check around key slot and chamfered area of shaft for burrs, nicks or sharp edges that could damage seals during reassembly. Remove nicks or burrs with hard smooth stone (such as an Arkansas stone). Do not file or grind motor parts.

NOTE: *Lubricate all seals with petroleum jelly. Use new seals when reassembling motor.*

NOTICE

DO NOT STRETCH SEALS BEFORE INSTALLING THEM.

Cleanliness is extremely important in the successful application of Loctite. Before Loctite can be applied, the parts should be cleaned as follow:

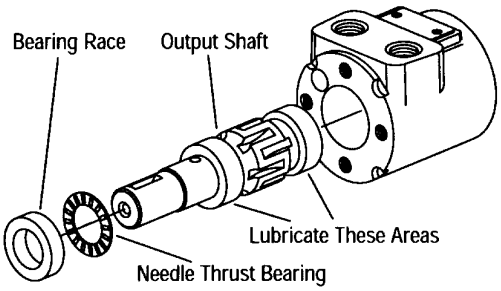
NOTE: *Fully cured Loctite resists most solvents, oils, gasoline and kerosene and is not affected by cleaning operations. It is not necessary to remove cured Loctite that is securely bonded in tapped holes; however, any loose particles of cured Loctite should be removed.*

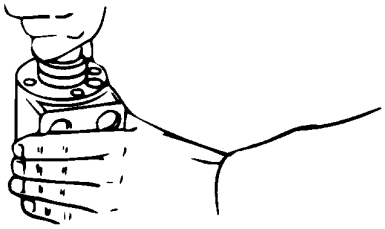
- **a.** Wash the housing with solvent to remove oil, grease and debris. Pay particular attention to four tapped holes on flanged end.
- **b.** Blow dry with compressed air. Clean and dry tapped holes.
- **c.** Wire brush screw threads to remove cured Loctite and other debris. Discard any screws that have damaged threads or rounded heads.
- **d.** Wash screws with non-petroleum base solvent. Blow dry with compressed air.

Assembly

SHAFT END

1. If you remove plug and seal, lubricate seal and install on plug. Some plugs have two o-ring grooves but require only one o-ring. Install o-ring in groove closest to end of plug. Push plug into housing. Be careful not to damage seal.



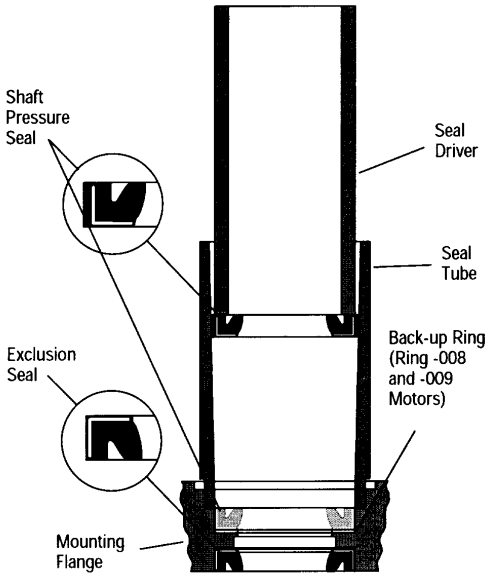


2. Lubricate output shaft with hydraulic oil, then install shaft in housing.

NOTICE

DO NOT PERMIT OIL TO GET INTO THE FOUR TAPPED HOLES.

3. Install needle thrust bearing, then bearing race on shaft. Pull shaft partially out of housing. Push all three parts in housing together. The bearing race must rotate freely when in position.



Seal Installation Tool
No. 600470 (007 Motors)
No. 600523 (008, 009 Motors)

4. Install exclusion seal in flange. Carefully press exclusion seal into place.
5. Visually check seal seat in mounting flange for scratches or other marks that might damage the pressure seal. Check for cracks in flange that could cause leakage.
6. Lubricate I.D. of seal tube and O.D. of shaft pressure seal with light film of petroleum jelly. Align small I.D. end of seal tube with seal seat in mounting flange. Install back-up ring and pressure seal in tube with lip seal face up. Insert seal driver in tube and firmly push seal seat with a rotating action.

NOTICE

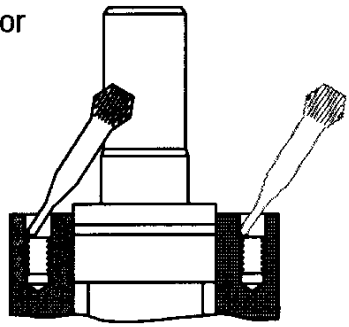
AFTER INSTALLING SEAL IN FLANGE, EXAMINE SEAL CONDITION. IF DAMAGED OR IMPROPERLY INSTALLED, YOU MUST REPLACE IT BEFORE CONTINUING WITH REASSEMBLY.

7. Install 49 mm (1.937 in.) I.D. seal in flange.
8. It is recommended to apply a light coat of Loctite Primer NF in tapped holes of housing. Allow primer to dry for at least 1 minute. Do not force dry with air jet; the primer will blow away.

   Use of primer is optional. With primer, curing time is approximately 15 minutes. Without primer curing time is approximately 6 hours.

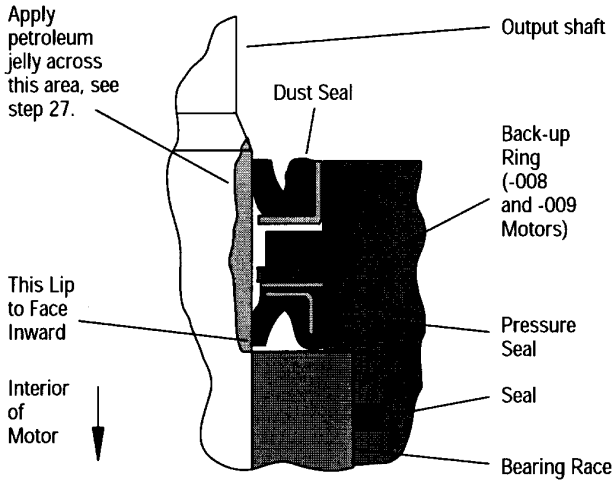
Place tip of applicator at top of threaded portion.

Apply 3 or 4 drops in each hole.



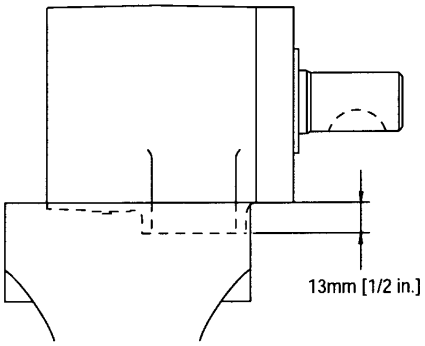
9. Apply 3 or 4 drops of Loctite sealant at top of threads for each of the four holes in housing. Do not allow parts with Loctite applied to come on contact with metal parts other than those for assembly.Wipe off excess Loctite from housing face, using a non petroleum base solvent.

   Do not apply Loctite to threads more than 15 minutes before installing screws. If housing stands for more than 15 minutes, repeat application. No additional cleaning or removal of previously applied Loctite is necessary.



10. Before installing flange and seal assembly over shaft, place protective sleeve or bullet over shaft. Then lubricate space between exclusion seal and pressure seal, as well as lips of both seals.

Install flange. Rotate flange slowly while pushing down over shaft. Be careful not to invert or damage seals.



11. After removing bullet, clamp motor in vise as shown above. Make sure shaft cannot fall out. Install dry screws and alternately torque them immediately to 250 in/lbs (28 Nm). If you use primer, allow to cure 10 to 15 minutes. Without primer, allow 6 hours curing time before subjecting to high torque reversals. On all other applications, you can run motor immediately.
If you use new screws, make sure they are correct length: 22 mm (.875 in.) under head length. See parts book for correct part number.

GEROTOR END

1. Reposition motor with gerotor end up, then clamp across ports. Do not clamp on side of housing.

NOTICE

TO AID INSTALLATION OF SEALS, APPLY LIGHT COAT OF CLEAN PETROLEUM JELLY TO SEALS. DO NOT STRETCH SEALS BEFORE INSTALLING THEM IN GROOVE.

2. Pour approximately 35 cc of clean hydraulic oil in output shaft cavity.

3. Install 73 mm (2.875 in.) I.D. seal in housing seal groove. Avoid twisting seal.

Timing Procedure

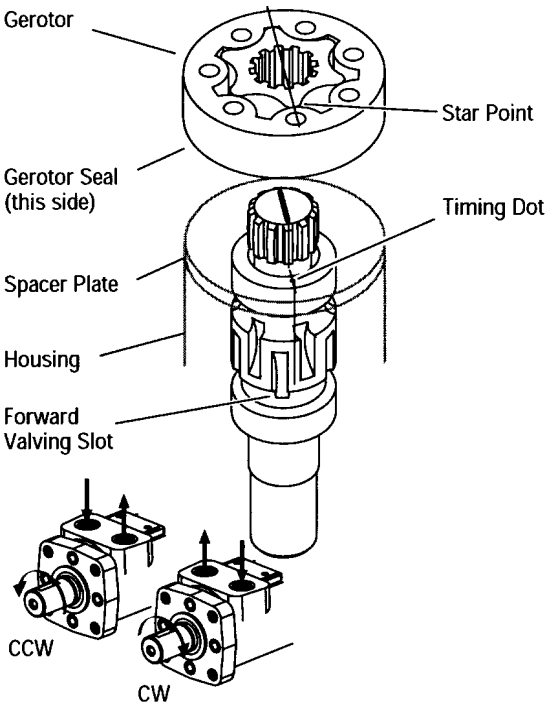
a. Install drive. Use felt tip marker to mark or drive tooth. Align this tooth with timing dot on shaft.

NOTE: *If drive is not symmetrical, install larger splined end into shaft.*

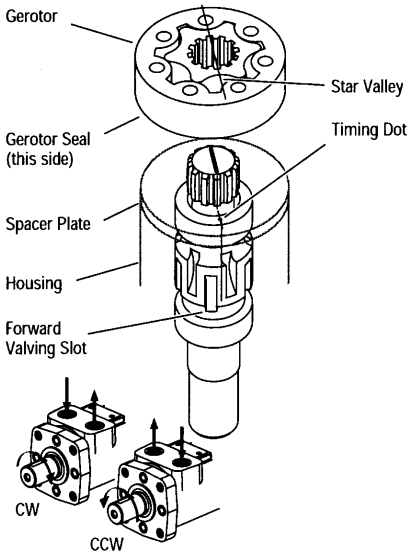
b. Install spacer plate.

c. Install 73 mm (2.875 in) I.D. seal in gerotor seal groove. Carefully place gerotor on spacer plate, seal side toward spacer plate.

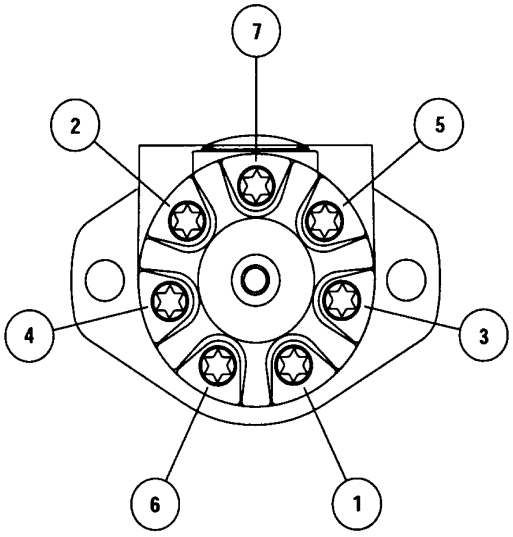
Standard rotation align any star point with tooth marked on drive (see figure below).



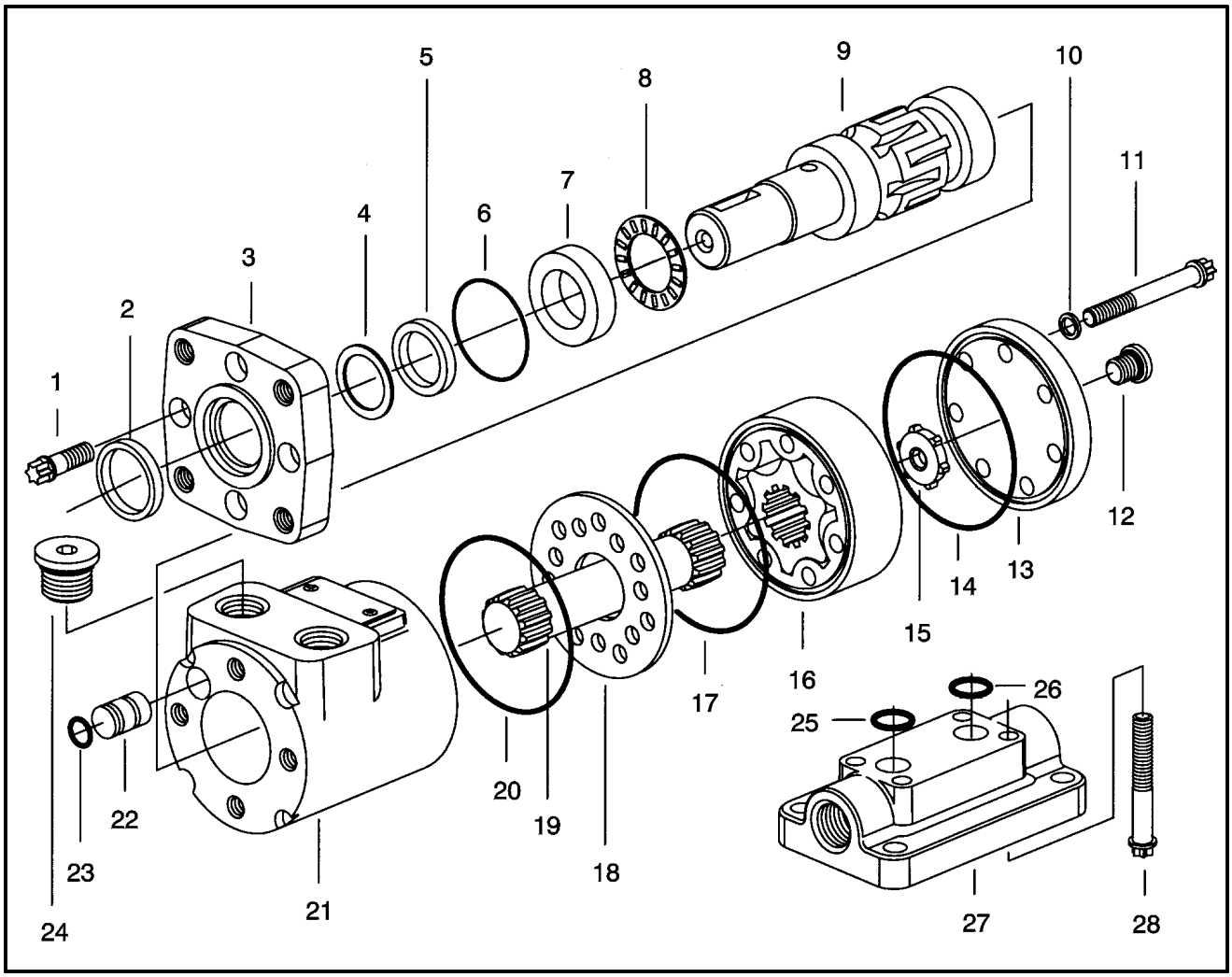
Reverse rotation align any star valley with marked tooth (see figure below).



1. Rotate gerotor to line up with bolt holes. Be careful not to disengage star from drive or disturb gerotor seal.
2. Install drive spacer if applicable.
3. Install 73 mm (2.875 in.) seal in end cap. Carefully place end cap on gerotor.



4. Install cap screws and seal washers (if applicable) in end cap. Pre-tighten screws to 7.4 Nm (40 in/lbs). Make sure seal washers are properly seated. Then torque screws to 27 - 28 Nm (235 - 250 in/lbs) in sequence, as shown above.



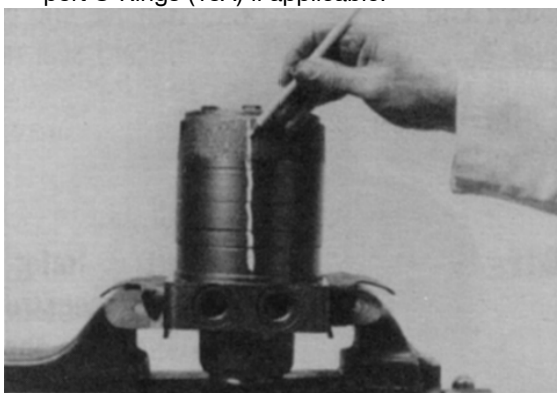
1. Capscrew
2. Exclusion Seal
3. Mounting Flange
4. Backup Ring (-008, -009 Motors)
5. Pressure Seal
6. Seal
7. Bearing Race
8. Needle Bearing Thrust
9. Output Shaft
10. Seal Washer (When Applicable)
11. Capscrew
12. Plug/O-ring S/A
13. End Cap
14. Seal
15. Drive Spacer (When Applicable)
16. Geroter
17. Seal
18. Spacer Plate
19. Drive
20. Seal
21. Housing
22. Plug
23. Seal
24. Plug/O-ring S/A (End Ported Motors)
25. O-ring
26. O-ring
27. Optional - Base Block Mounting Kit
28. Capscrew

Figure 3-53. Swing Motor

3.14 SWING MOTOR (S/N 66417 TO PRESENT)

Disassembly and inspection

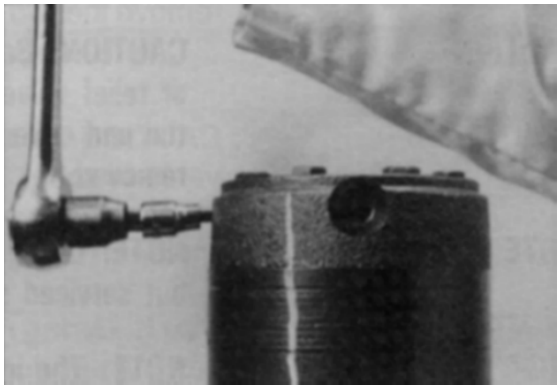
1. Place the Torqlink™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

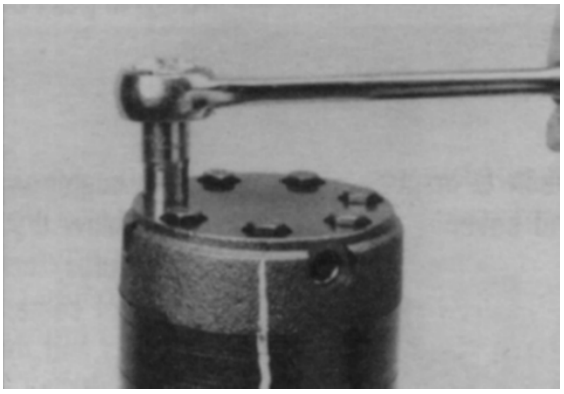


⚠ CAUTION

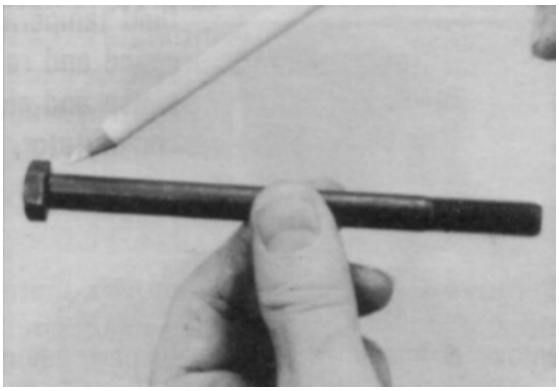
IFTHETORQLINK™ IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DISLODGED DURINGTHE SERVICE PROCEDURES, CAUSING INJURY.

2. Scribe an alignment mark down and across the Torqlink™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 inch Allen wrench or 1 inch hex socket required.

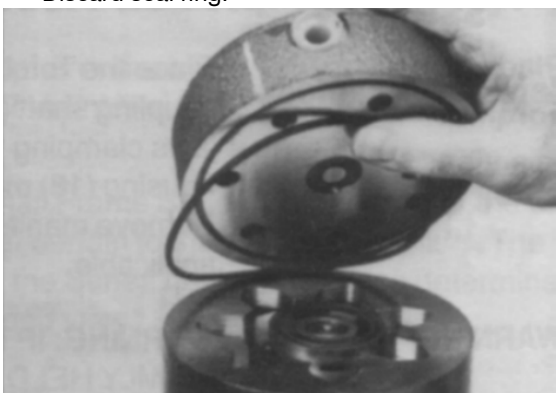




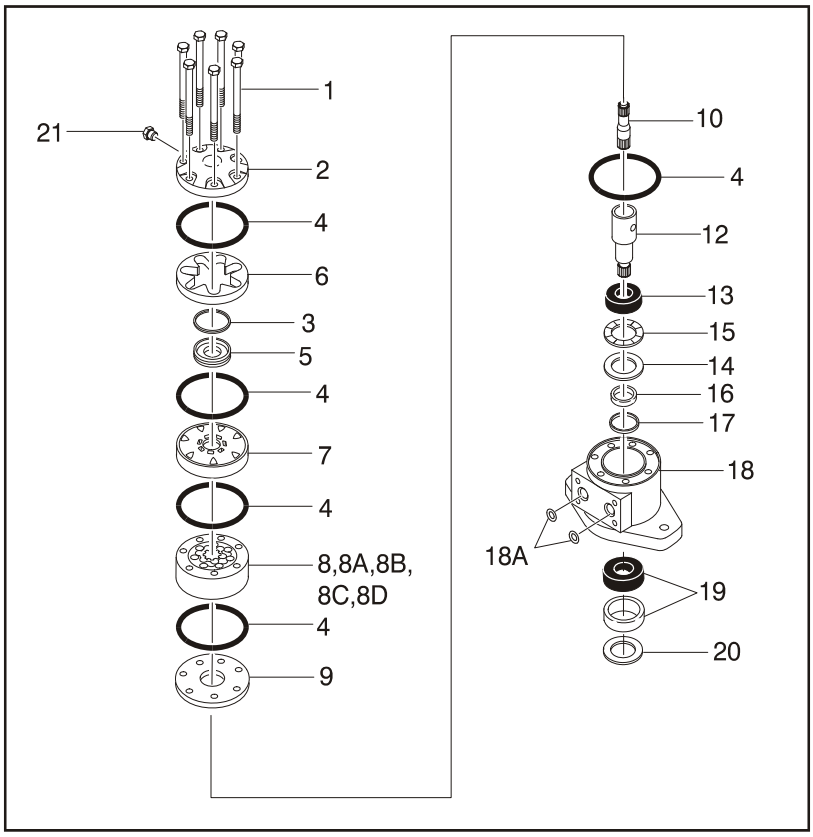
3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 inch size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.



4. Remove end cover assembly (2) and seal ring (4). Discard seal ring.



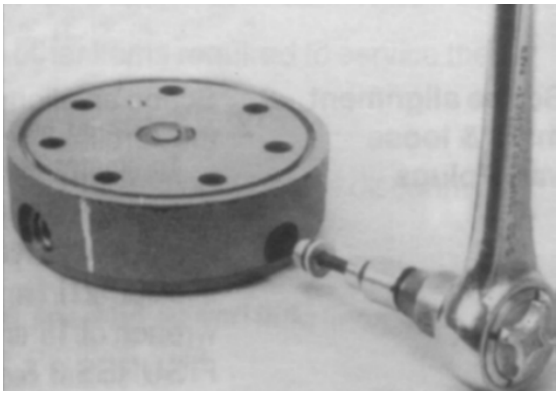
NOTE: *Refer to the appropriate "alternate cover construction" on the exploded view to determine the end cover construction being serviced.*



1. Special Bolts
2. End Cover
3. Seal Ring-Commutator
4. Seal Ring
5. Commutator Ring
6. Commutator Ring
7. Manifold
8. Rotor Set
8A. Rotor
8B. Stator or Stator Vane
8C. Vane
8D. Stator Half
9. Wear Plate
10. Drive Link
12. Coupling Shaft
13. Bearing/Bushing, Inner
14. Thrust Washer
15. Thrust Bearing
16. Seal
17. Back-up Washer
18. Housing
18A. O-Ring
19. Bearing/Bushing, Outer
20. Dirt & Water Seal
21. Plug

Figure 3-54. Swing Drive Motor

5. If the end cover (2) is equipped with shuttle valve components, remove the two previously loosened plugs (21).

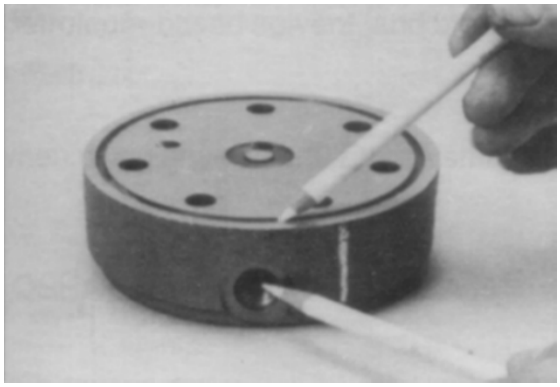


NOTICE

BE READY TO CATCH THE SHUTTLE VALVE OR RELIEF VALVE COMPONENTS THAT WILL FALL OUT OF THE END COVER VALVE CAVITY WHEN THE PLUGS ARE REMOVED.

NOTE: *The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.*

6. Thoroughly wash end cover (2) in proper solvent and blow dry. Be sure the end cover valve apertures, including the internal orifice plug, are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary.



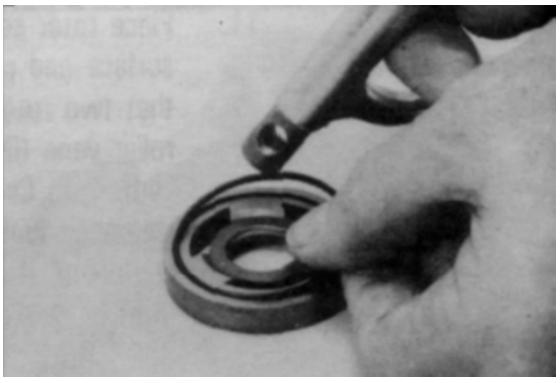
NOTE: *A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.*

7. Remove commutator ring (6). Inspect commutator ring for cracks, or burrs.



8. Remove commutator (5) and seal ring (3) Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator and commutator ring as a matched set.



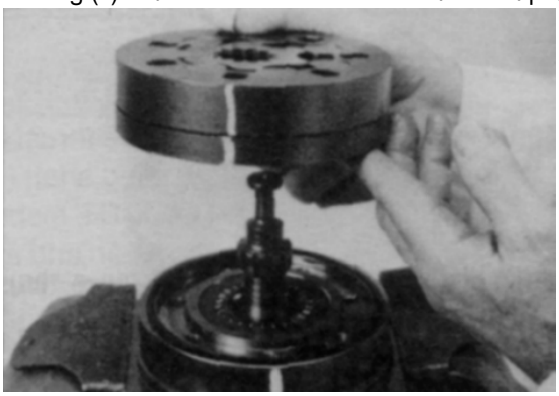


9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.

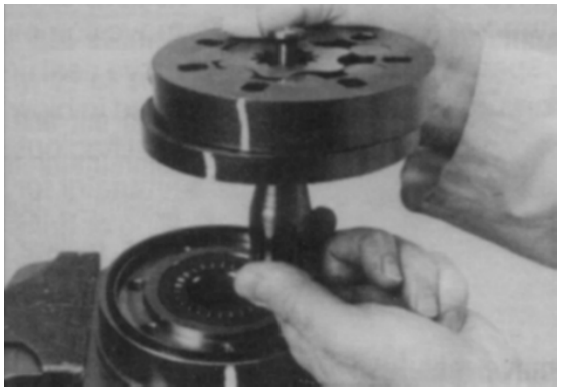


NOTE: *The manifold is constructed of plates bonded together to form an integral component not subject tofurtherdisassemblyforservice.Compare configuration of both sides oft hem an if old to ensure that same surface is reassembled against the rotor set.*

10. Remove rotor set (8) and warplane (9), together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wearplate.You may have to shift the rotor set on the warplane to work the drive link out of the rotor (8A) and warplane. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the warplane for cracks, brinelling, or scoring. Discard seal ring (4) that is between the rotor set and wearplate.



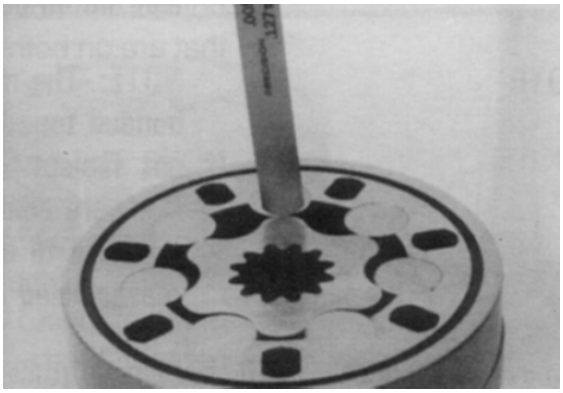
NOTE: *The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqlink™ will ensure correct reassembly of rotor into stator and rotor set intoTorqlink™.Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set andTorqlink™.*



NOTE: *Series TG Torqlinks™ may have a rotor set with two stator halves (8B) with a seal ring (4) between them and two sets of seven vanes (8C). Discard seal ring only if stator halves become disassembled during the service procedures.*

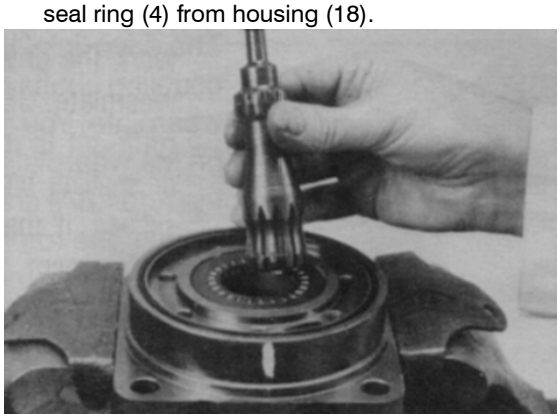
NOTE: *A polished pattern on the wear plate from rotor rotation is normal.*

11. Place rotor set (8) and wear plate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180 degrees apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is more than 0.005 inches (0.13 mm) of clearance, replace rotor set.



NOTE: *If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.*

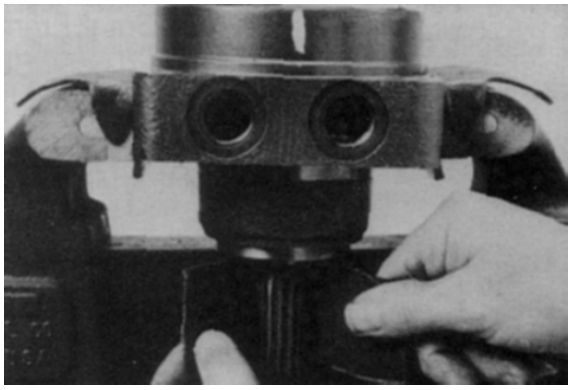
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).



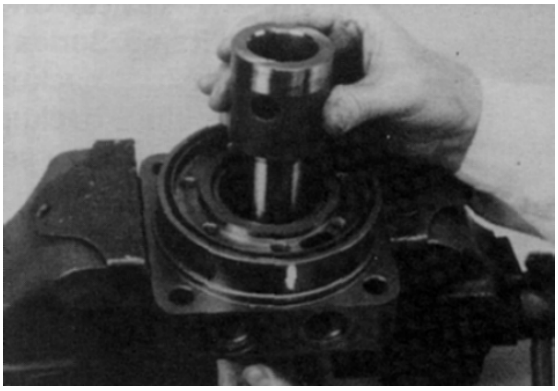
13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.

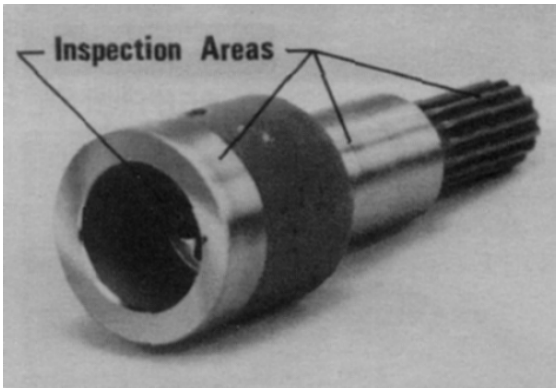


14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used.



15. Remove coupling shaft (12), by pushing on the output end of shaft. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. Replace coupling shaft if any of these conditions exist.





NOTE: *Minor shaft wear in seal area is permissible. If wear exceeds 0.020 inches (0.51 mm) diametrically, replace coupling shaft.*

NOTE: *A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.*

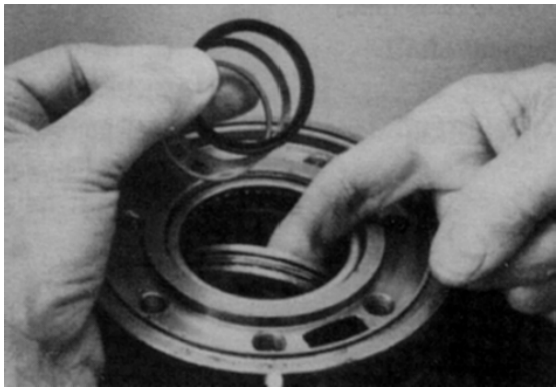
16. Remove and discard seal ring (4) from housing (18).

17. Remove thrust bearing (15) and thrust washer (14) Inspect for wear, brinelling, corrosion and a full complement of retained rollers.

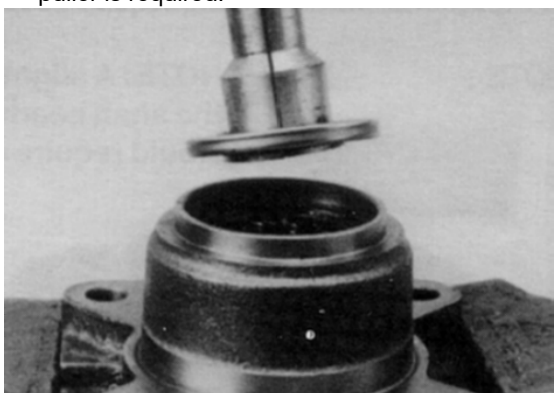


18. Remove seal (16) and back up washer (17) from Small Frame, housing (18). Discard both.

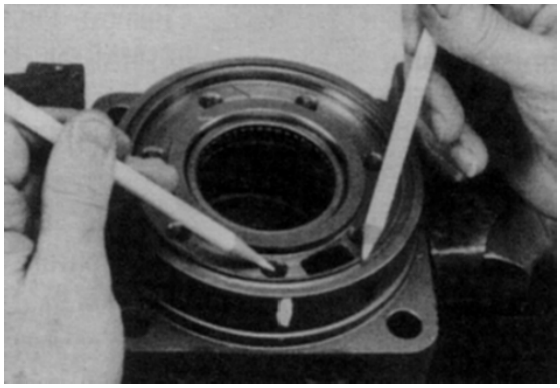




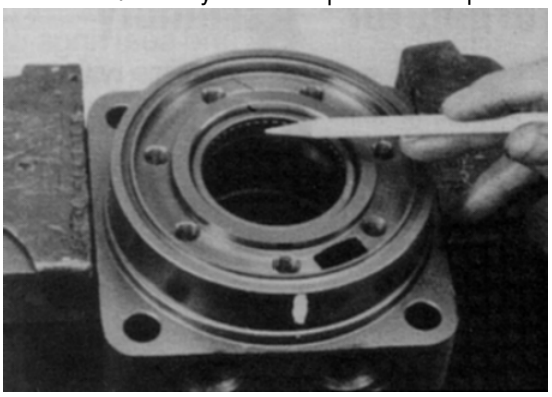
19. Remove housing (18) from vise, invert it and remove and discard seal (20). A blind hole bearing or seal puller is required.

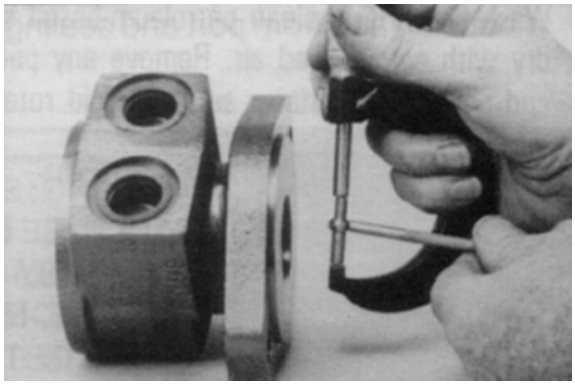


20. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly.

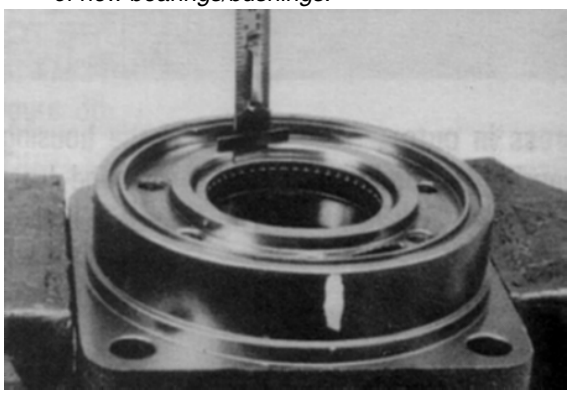


21. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion. The bushing (19) or (13) to coupling shaft diameter clearance must not exceed 0.010 inch (0.025 mm). A bearing, bushing, or thrust washer that does not pass inspection must be replaced. If the housing has passed this inspection the disassembly of the Torqlink™ is completed.

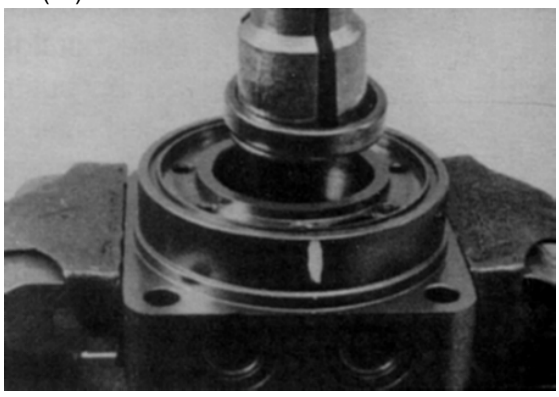


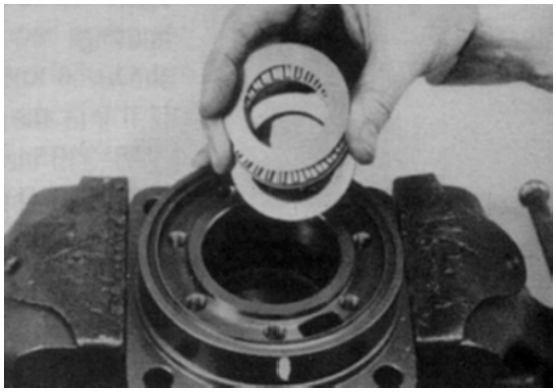


NOTE: *The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counter bore should be measured and noted before removing the bearings/bushings. This will facilitate the correct reassembly of new bearings/bushings.*



22. If the bearings, bushing or thrust washers must be replaced use a suitable size bearing puller to remove bearing/bushings (19) and (13) from housing (18) without damaging the housing. Remove thrust washers (14) and thrust bearing (15) if they were previously retained in the housing by bearing (13).





Assembly

Replace all seals and seal rings with new ones each time you reassemble the Torqlink™ unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly.

NOTE: *Individual seals and seal rings as well as a complete seal kit are available. The parts should be available through most OEM parts distributors or Parker approved Torqlink™ distributors. (Contact your local dealer for availability).*

NOTE: *Unless otherwise indicated, do not oil or grease parts before assembly.*

Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing areas.

⚠ WARNING

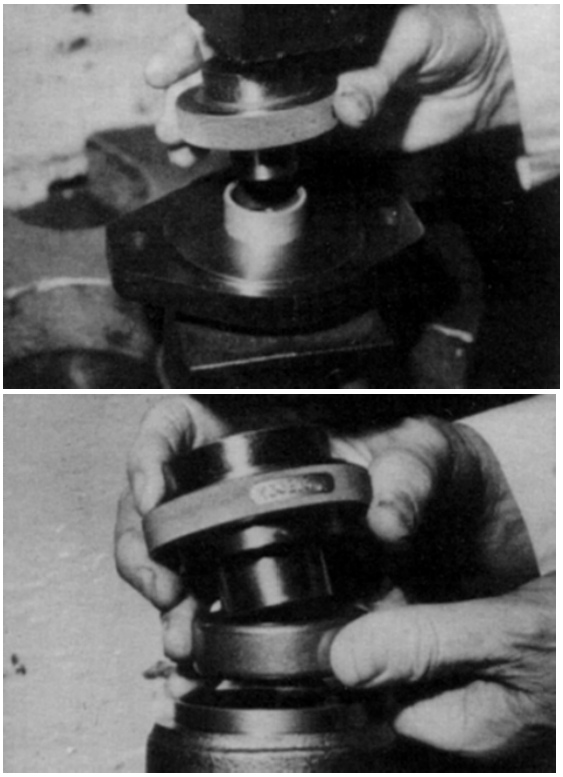
SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

⚠ CAUTION

WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

1. If the housing (18) bearing components were removed for replacement, thoroughly coat and pack a **new** outer bearing/bushing (19) with clean corrosion resistant grease recommended in the material section. Press the new bearing/bushing into the counterbore at the mounting flange end of the housing, using the appropriate sized bearing mandrel, which will control the bearing/ bushing depth.

   Torqlink™ housings require the use of bearing mandrel to press bearing/ bushing (19) into the housing to a required depth of 0.151/0.161 inches (3.84/4.09 mm) from the end of the bearing counterbore.



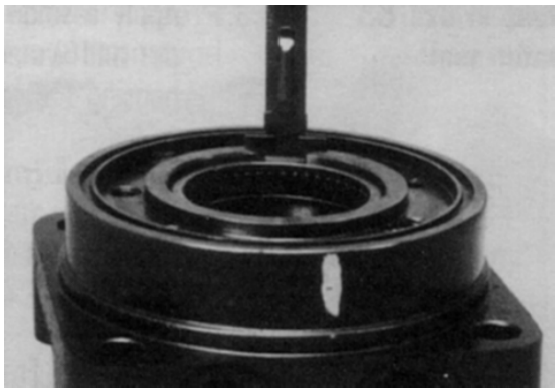
NOTE: *Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.*

NOTICE

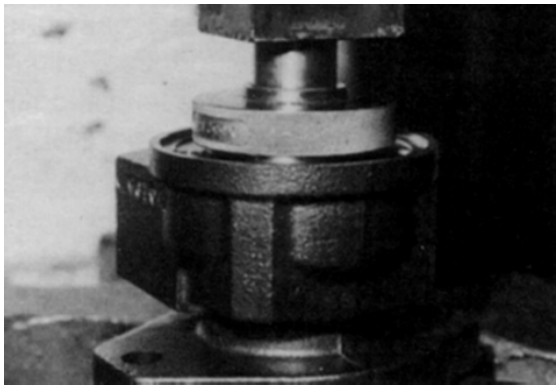
IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT COMPONENTS WHEN ASSEMBLED.

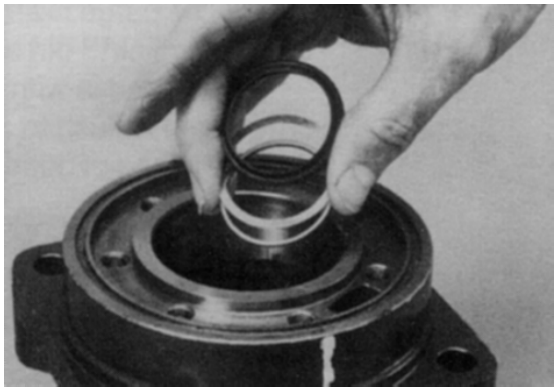
NOTICE

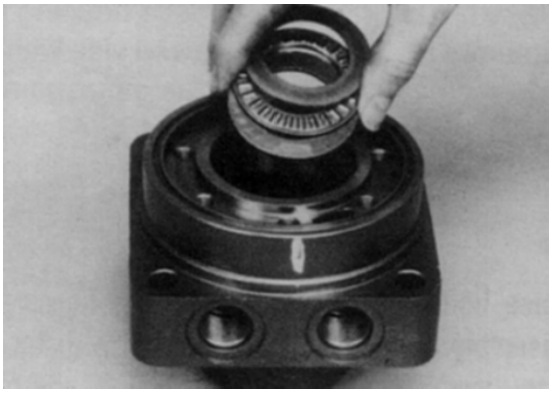
BECAUSE THE BEARING/BUSHINGS (13) AND (19) HAVE A PRESS FIT INTO THE HOUSING THEY MUST BE DISCARDED WHEN REMOVED. THEY MUST NOT BE REUSED.

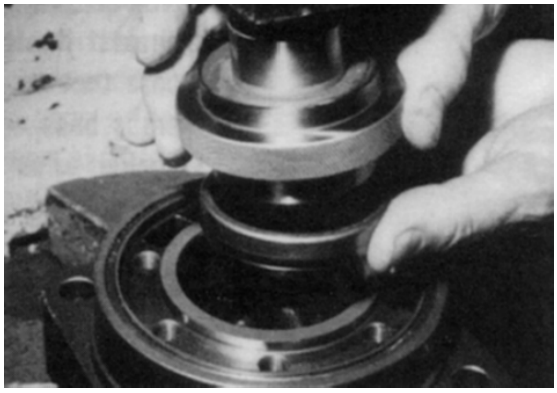


2. The Torqlink™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 inch (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing (19).



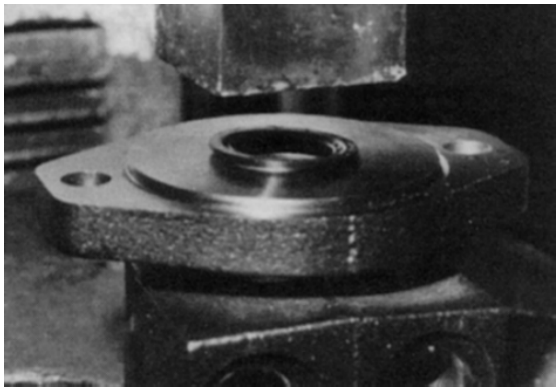


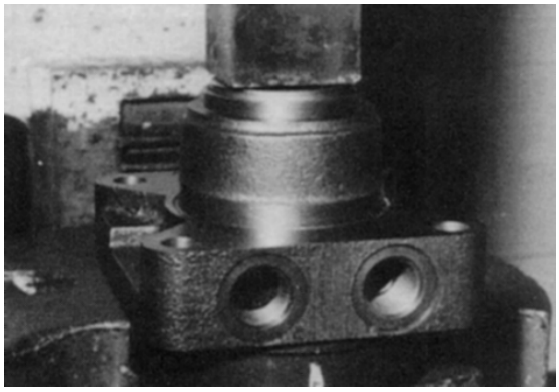




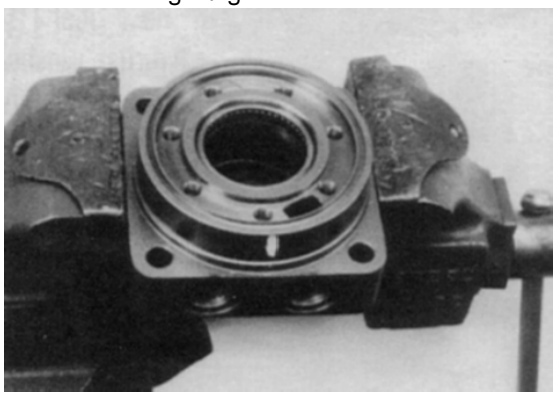
3. Press a **new** dirt and water seal (20) into the housing (18) outer bearing counterbore.

   The Torqlink™ dirt and water seal (20) must be pressed in until its' flange is flush against the housing.

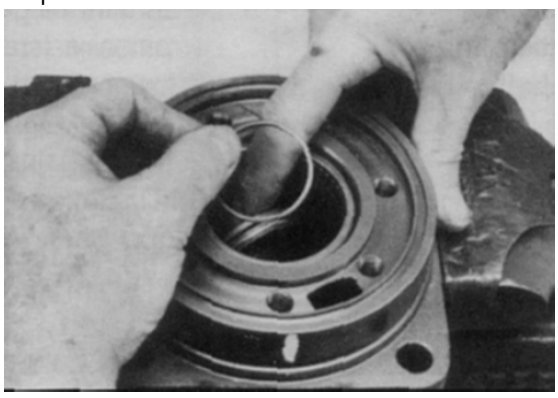




4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



5. On the Torqlinks™ assemble a **new** backup washer (17) and **new** seal (16) with the seal lip facing toward the inside of Torqlink™, into their respective counterbores in housing (18) if they were not assembled in procedure 2.

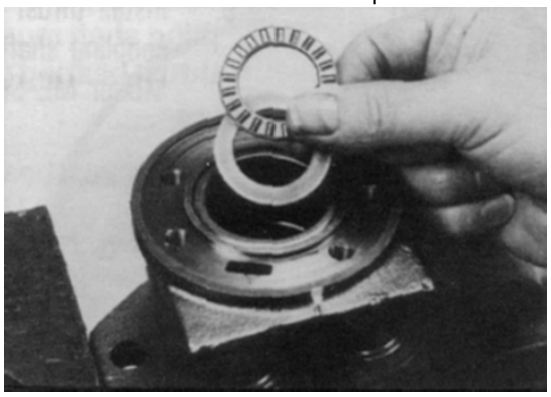




NOTICE

ORIGINAL DESIGN LARGE FRAME, TF & TG TORQLINKS™ THAT DO NOT HAVE BACKUP WASHER (25) WHEN DISASSEMBLED MUST BE ASSEMBLED WITH A NEW BACKUP WASHER (17), NEW BACKUP WASHER (25), AND NEW SEAL (16).

6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Torqlink™.

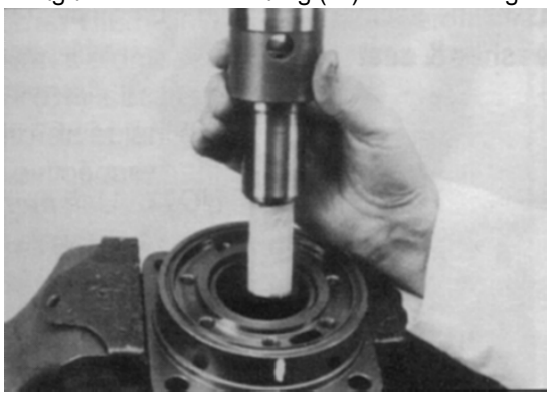


NOTE: *Torqlinks™ require one thrust washer (14) with thrust bearing (15).The coupling shaft will be seated directly against the thrust washer.*

7. Apply masking tape around splines or keyway on shaft (12) to prevent damage to seal.



8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in the housings.



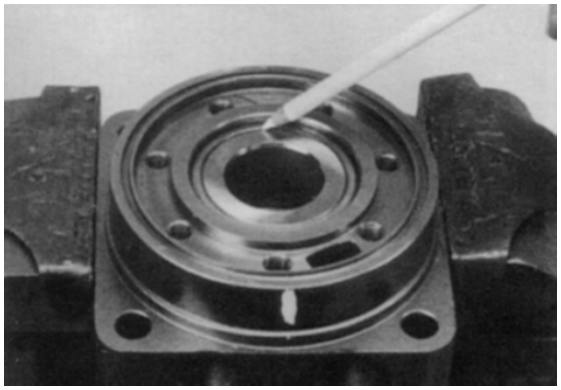
NOTICE

THE OUTER BEARING (19) IS NOT LUBRICATED BY THE SYSTEM'S HYDRAULIC FLUID. BE SURE IT IS THOROUGHLY PACKED WITH THE RECOMMENDED GREASE, PARKER GEAR GREASE SPECIFICATION #045236, E/M LUBRICANT #K-70M.

NOTE: *Mobil Mobilith SHC ® 460*

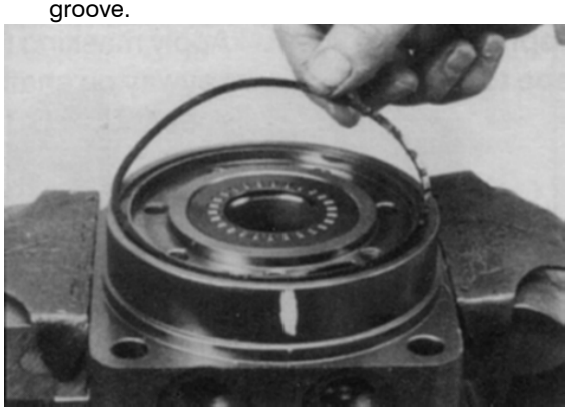
NOTE: *A 102Tube (P/N 406010) is included in each seal kit.*

NOTE: *The coupling shaft (12) will be flush or just below the housing wear plate surface on Torqlinks™ when properly seated. The coupling shaft must rotate smoothly on the thrust bearing package.*





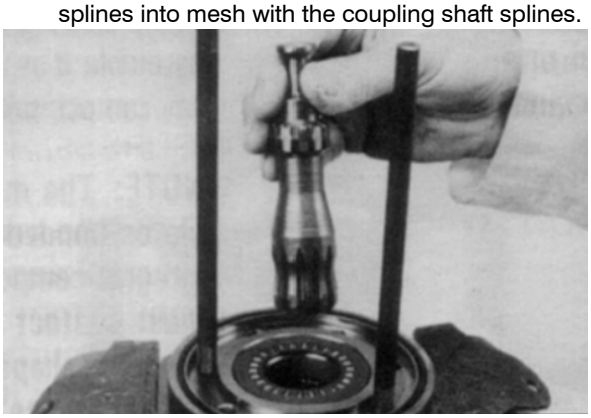
9. Apply a small amount of clean grease to a **new** seal ring (4) and insert it into the housing (18) seal ring groove.



NOTE: *One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures.The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A*

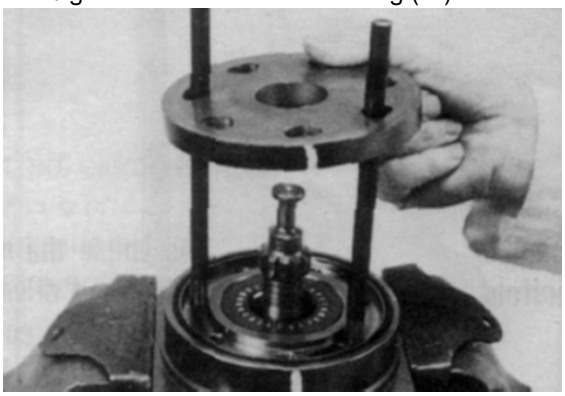
bolts as required that are over 0.5 inch (12.7 mm) longer than the bolts (1) used in the Torqlink™.

10. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines.

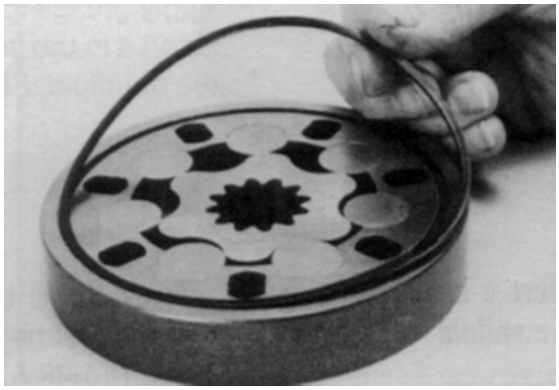


NOTE: *Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.*

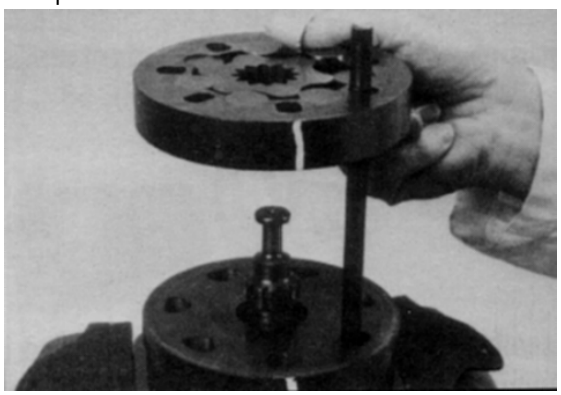
11. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



12. Apply a small amount of clean grease to a new seal ring (4) and assemble it into the seal ring groove on the wear plate side of the rotor set stator (8B).



13. Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines.

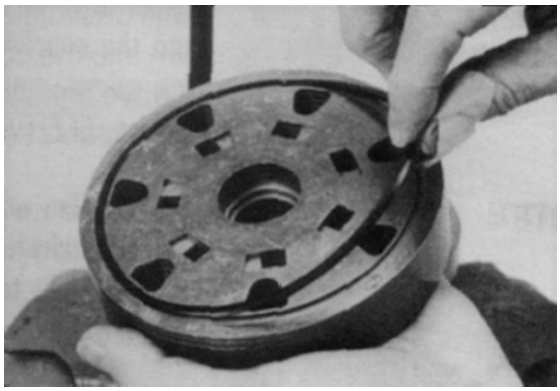


NOTE: *It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.*

NOTE: *If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure."*

NOTE: *The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down.The rotor set seal ring groove faces toward the wear plate (9).*

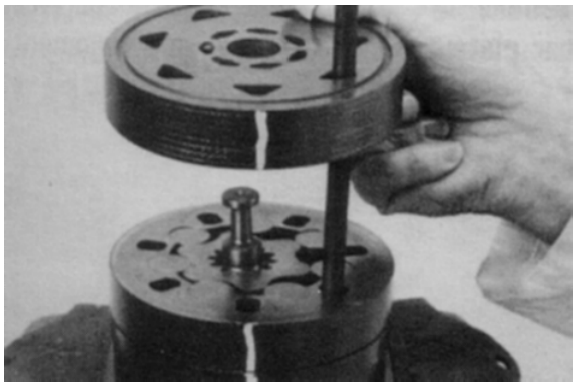
14. Apply clean grease to a **new** seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7).



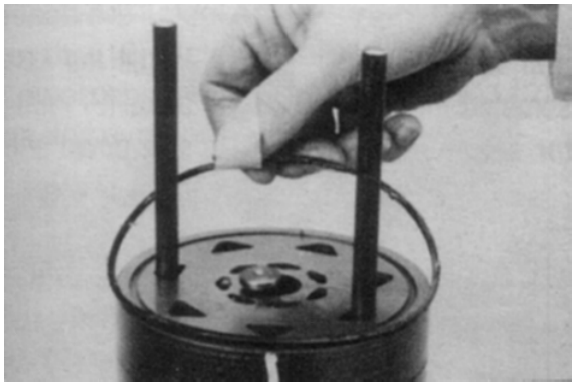
NOTE: *The manifold (7) is made up of several plates bonded together permanently to form an integral component.The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter.The polished impression left on the*

manifold by the rotor set is another indication of which surface must contact the rotor set.

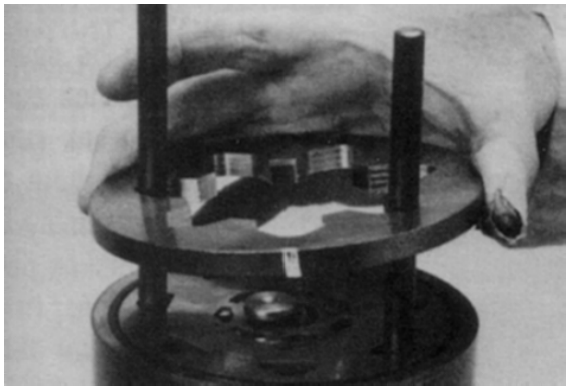
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



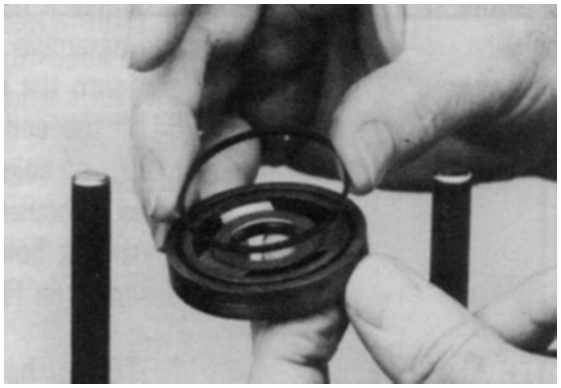
16. Apply grease to a **new** seal ring (4) and insert it in the seal ring groove exposed on the manifold.

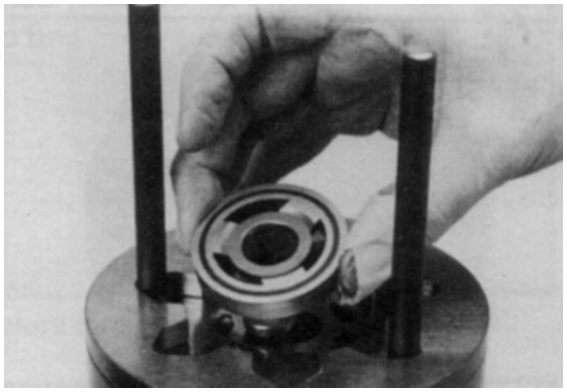


17. Assemble the commutator ring (6) over alignment studs onto the manifold.



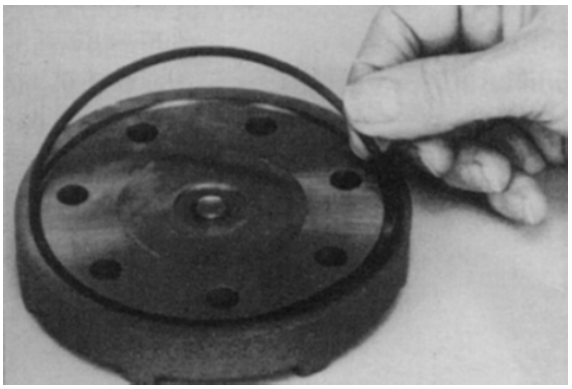
18. Assemble a **new** seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.

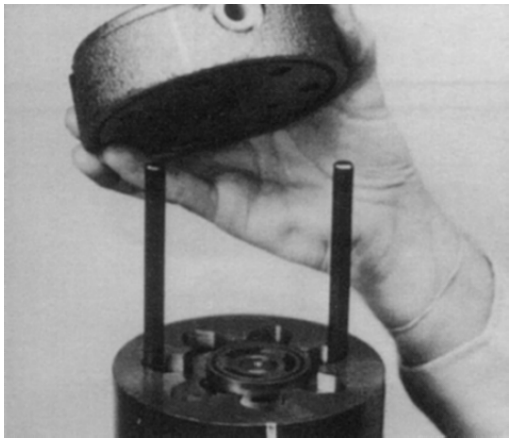


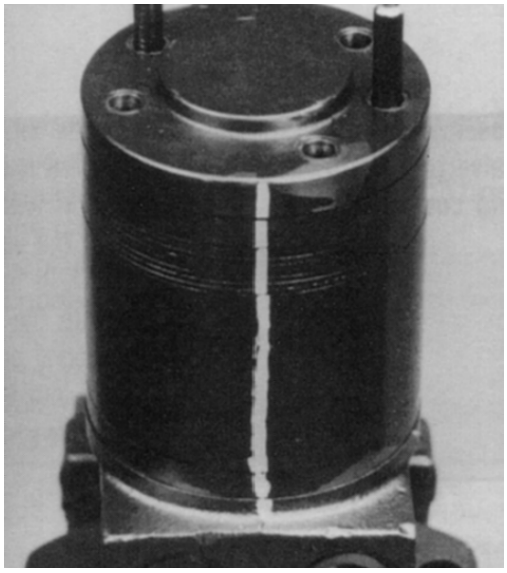


19. If shuttle valve components items #21, were removed from the end cover (2) turn a plug (21), loosely into one end of the valve cavity in the end cover. A 3/16 inch Allen wrench is required.

20. Assemble a **new** seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18).The correct 5 bolt end cover bolt hole relationship to housing port bosses.

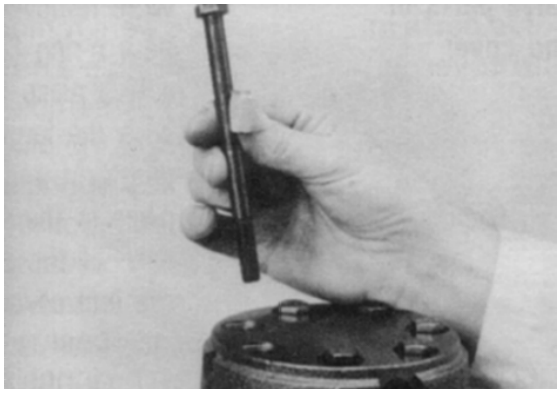


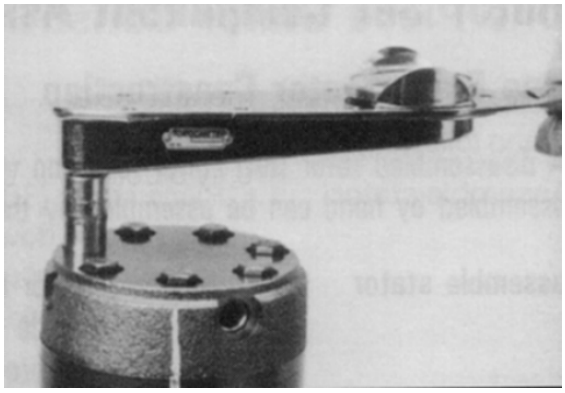


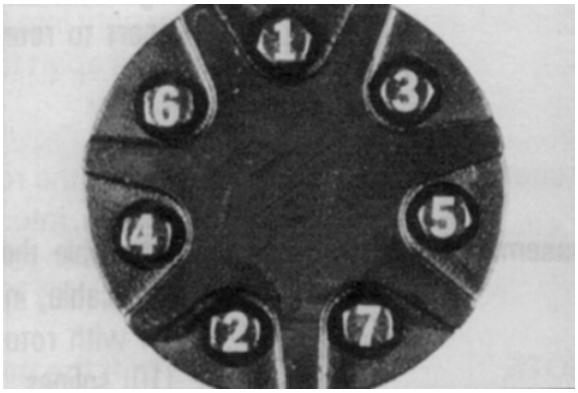


NOTE: *If the end cover has a valve (24) or has five bolt holes, use the line you previously scribed on the cover to radially align the end cover into its original position.*

21. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 22-26 ft. lbs. 45-55 ft. lbs.(61-75 N m) for the seven 3/8-24 threaded bolts.



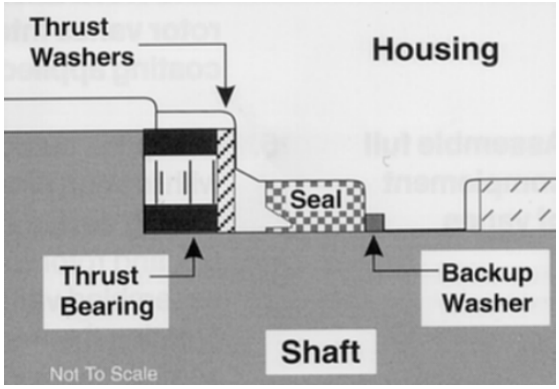




NOTE: *The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.*

22. Torque the two shuttle valve plug assemblies (21) in end cover assembly to 9-12 ft. lbs. (12-16 N m) if cover is so equipped.

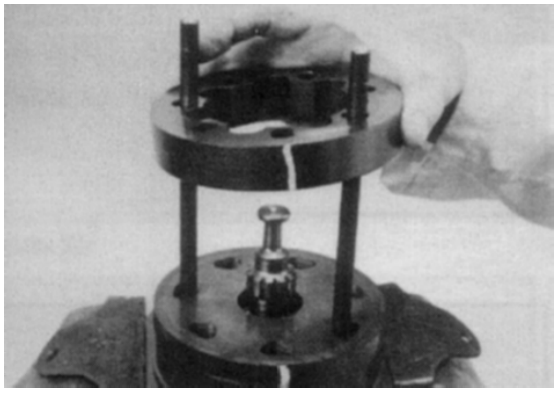
    Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs.(61-75 N m) if cover is so equipped.



One Piece Stator Construction

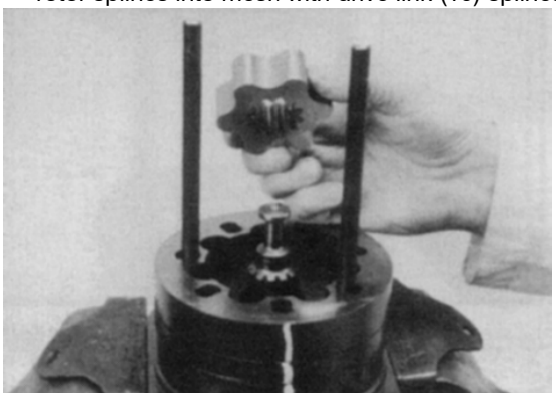
A disassembled rotor (8A) stator (8B) and vanes (8C) that cannot be readily assembled by hand can be assembled by the following procedures.

1. Place stator (8B) onto wear plate (9) with seal ring (4) side down, after following Torqlink™ assembly procedures 1 through 13. Be sure the seal ring is in place.



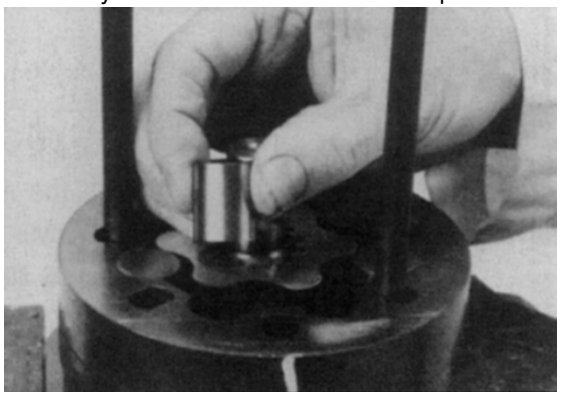
2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.



NOTE: *If the manifold side of the rotor was etched during Torqlink disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.*

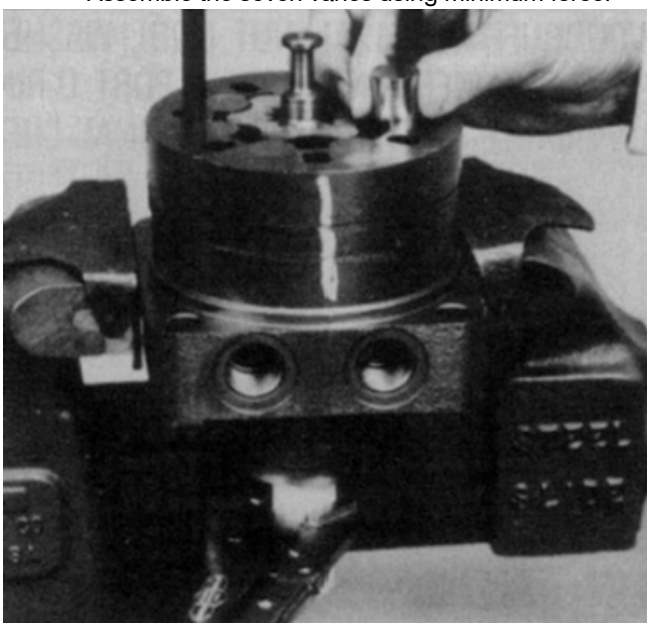
4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.



NOTICE

EXCESSIVE FORCE USED TO PUSH THE ROTOR VANES INTO PLACE COULD SHEAR OFF THE COATING APPLIED TO THE STATOR VANE POCKETS.

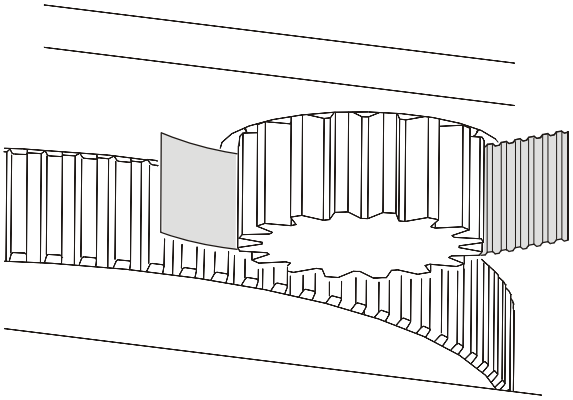
5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.



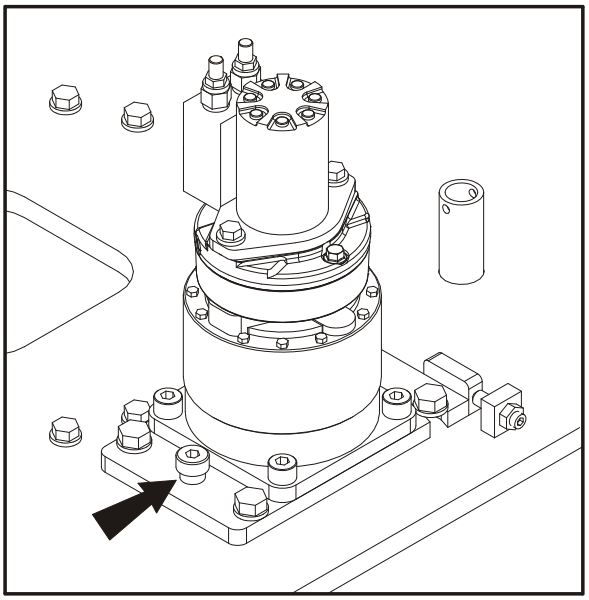
6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

3.15 PROCEDURE FOR SETTING GEAR BACKLASH

1. Set backlash to 0.008 to 0.012" (0.203 to 0.304 mm) using the following procedure.
2. Place shim (JLG p/n 4071009) between pinion and bearing on the bearing high spot.

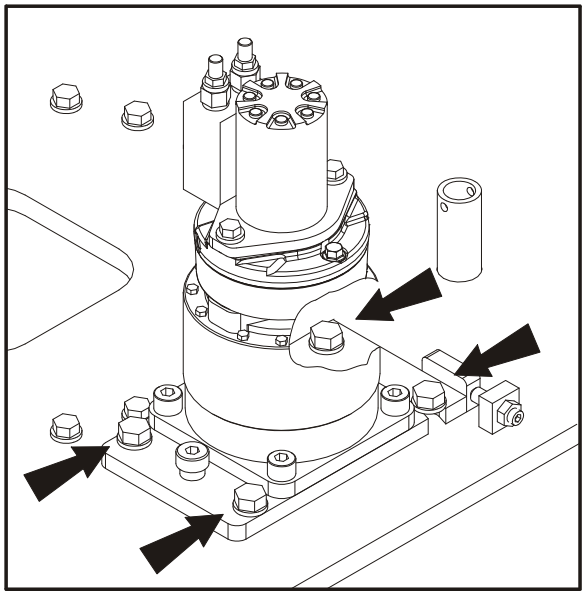


3. Apply Loctite #271 to the shoulder screw (shown below) and torque to 420 foot-pounds (569 Nm.

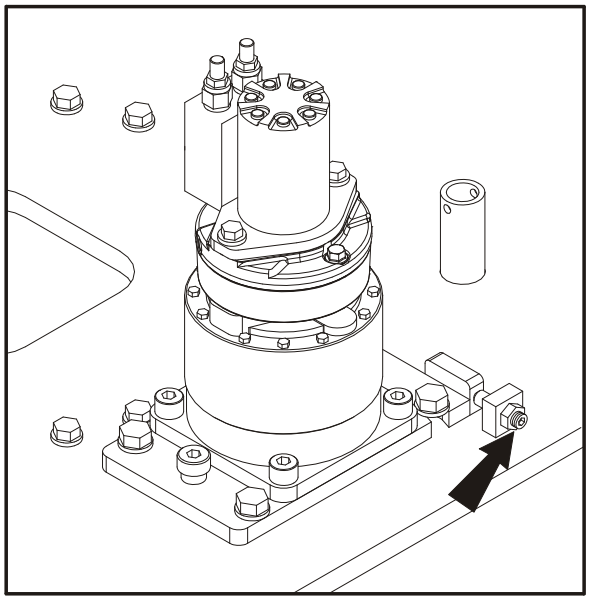


4. Remove the turntable lock pin.

5. Apply Loctite #271 to the capscrews (shown below) and pre-torque to 30 foot-pounds (42 Nm.

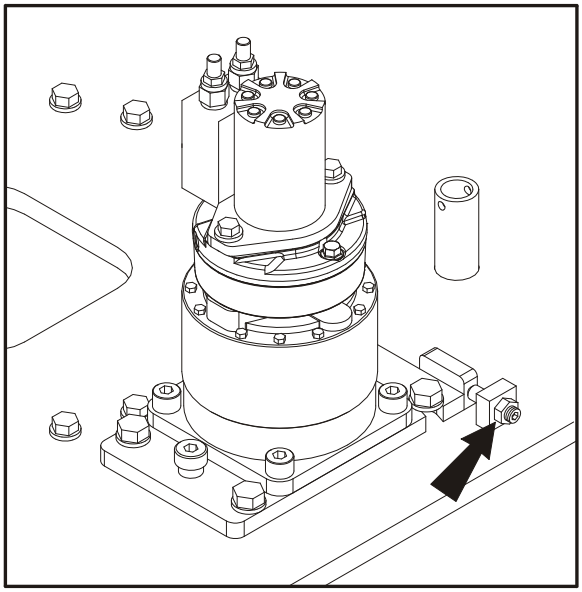


6. Tighten the setscrew (shown below) until the pinion is completely snug against the shim and bearing and then back off the setscrew.



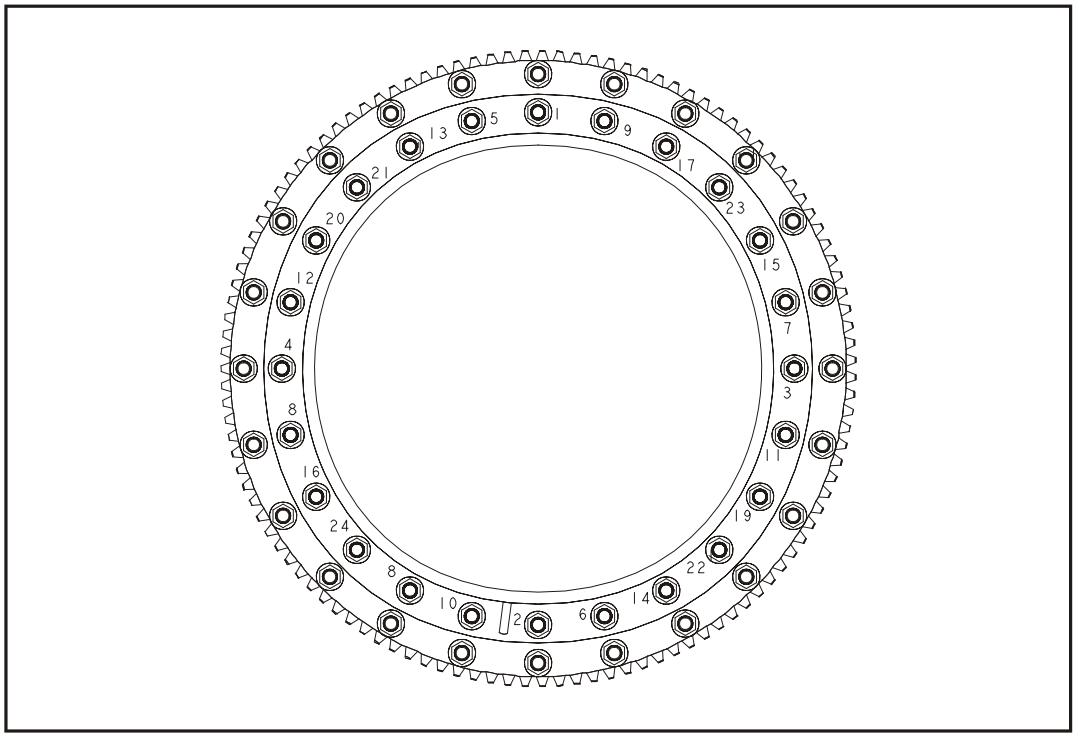
7. Apply Loctite #271 to the setscrew and torque to 50 foot-pounds (68 Nm).

8. Apply Loctite #271 to the jam nut (shown below) and tighten.



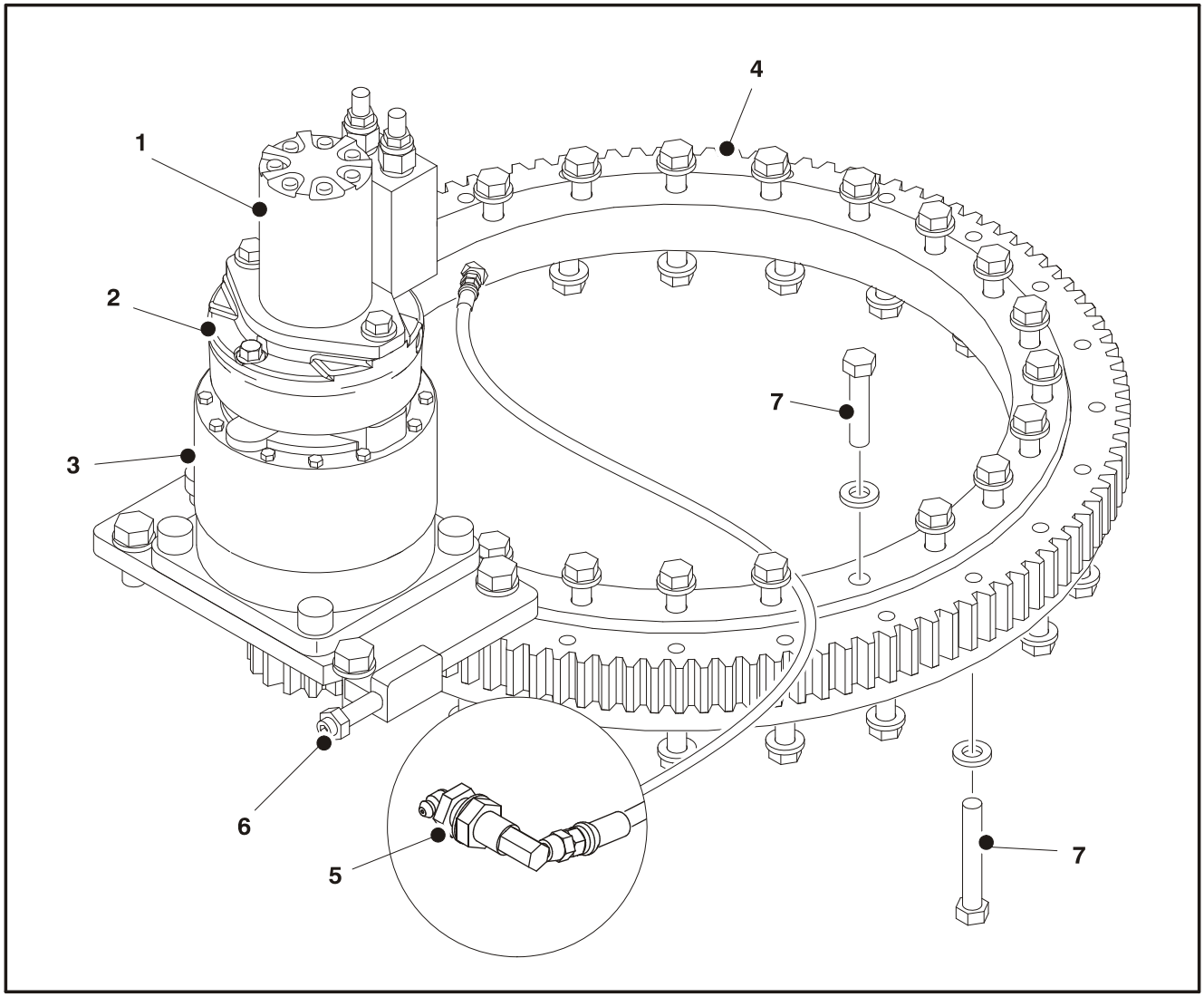
9. Torque the capscrews shown in step 5 to 420 foot-pounds (569 Nm).

10. Remove shim and discard.



NOTE: *Swing Bearing Torque Sequence is typical for both inner and outer races.*

Figure 3-55. Swing Bearing Torque Sequence



1. Swing Motor
2. Swing Brake
3. Swing Drive
4. Swing Bearing
5. Remote Lube Fitting
6. Backlash Adjuster
7. Bearing Bolt

Figure 3-56. Swing Drive and Turntable Bearing

3.16 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

NOTE: *This check is designed to replace the existing bearing bolt torque checks on JLG Lifts in service. This check must be performed after the first 50 hours of machine operation and every 600 hours of machine operation thereafter. If during this check any bolts are found to be missing or loose, replace missing or loose bolts with new bolts and torque to the value specified in the torque chart, after lubricating the bolt threads with loctite #271. After replacing and retorquing bolt or bolts recheck all existing bolts for looseness.*

1. Check the frame to bearing attach bolts as follows:
   - **a.** Elevate the fully extended main boom to horizontal. (See Figure 3-57.)
   - **b.** At the positions indicated on Figure 3-57., try to insert a 0.0015 feeler gauge between the bolt and hardened washer at the arrow indicated position.
   - **c.** Ensure that the.0015” feeler gauge will not penetrate under the bolt head to the bolt shank.
   - **d.** Swing the turntable 90 degrees, and check some selected bolts at the new position.
   - **e.** Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.
2. Check the turntable to bearing Attach bolts as follows:
   - **a.** Elevate the fully retracted main boom to full elevation.
   - **b.** At the position indicated on Figure 3-59.. try to insert the 0.0015” feeler gauge between the bolt head and hardened washer at the arrow indicated position.
   - **c.** Lower the boom to horizontal and fully extend the boom.
   - **d.** At the position indicated on Figure 3-58., try and insert the 0.0015” feeler gauge between the bolt head and hardened washer at the arrow indicated position.

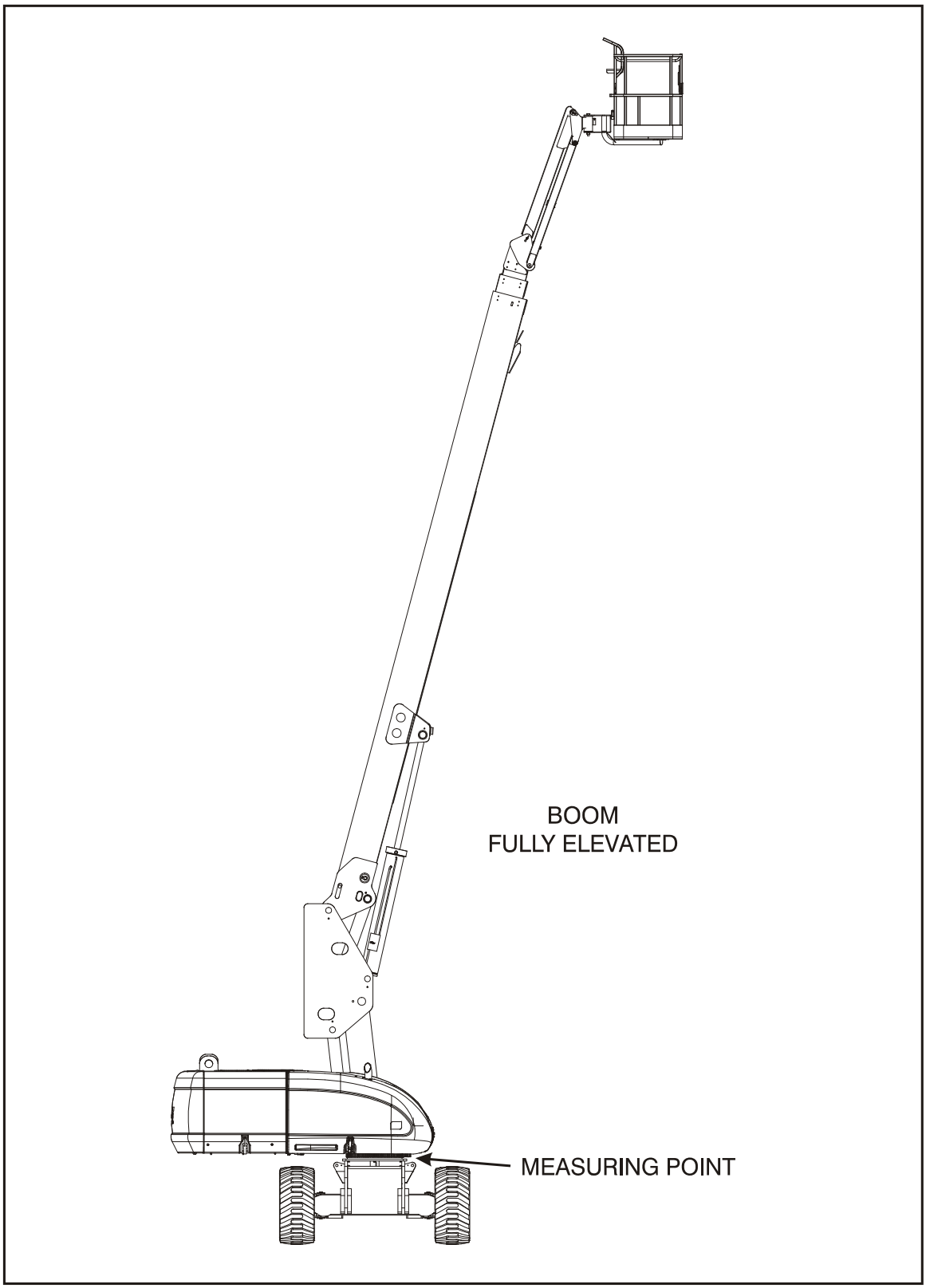


Figure 3-57. Swing Bearing Tolerance Boom Placement. (Sheet 1 of 2)

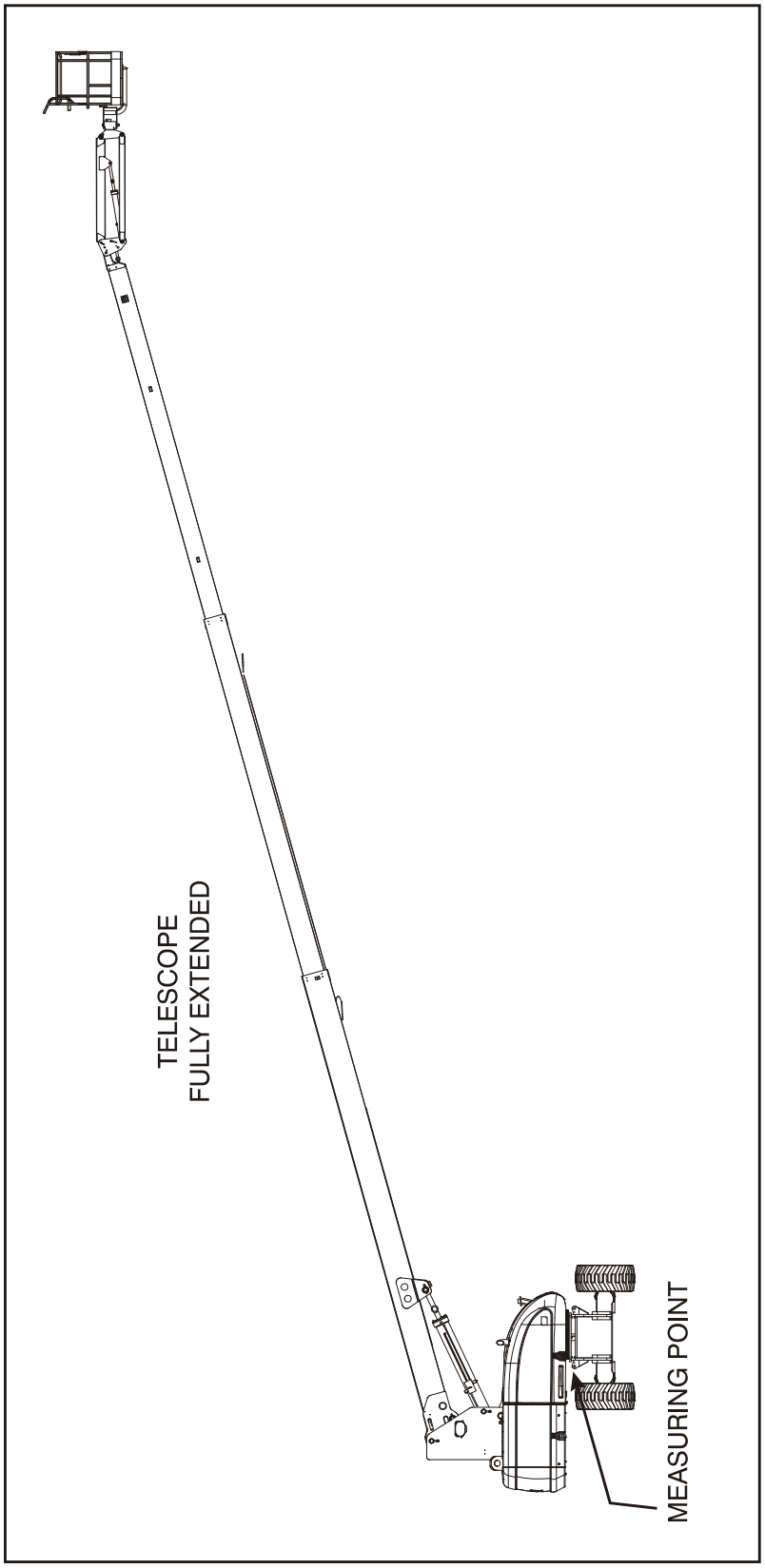


Figure 3-58. Swing Bearing Tolerance Boom Placement.(Sheet 2 of 2)

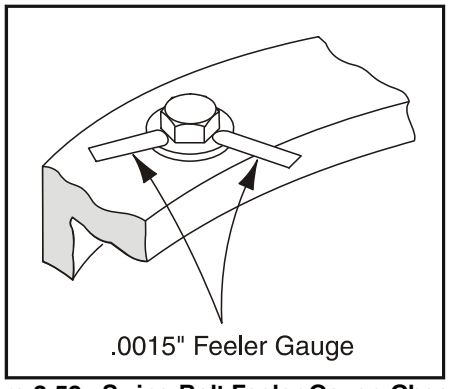


Figure 3-59. Swing Bolt Feeler Gauge Check.

Wear Tolerance

1. From the underside of the machine, at rear center, with the main boom fully elevated and fully retracted, and tower boom stowed, as shown in Figure 3-57., Swing Bearing Tolerance Boom Placement. (Sheet 1 of 2), using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-60., Swing Bearing Tolerance Measuring Point.
2. At the same point, with the main boom at horizontal and fully extended, and the tower boom fully elevated and fully retracted as shown in Figure 3-58., Swing Bearing Tolerance Boom Placement.(Sheet 2 of 2). Using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-60., Swing Bearing Tolerance Measuring Point.
3. If a difference greater than 0.079 in. (2.00 mm) is determined, the swing bearing should be replaced.
4. If a difference less than 0.079 in. (2.00 mm) is determined, and any of the following conditions exist, the bearing should be removed, disassembled, and inspected for the following:
   - **a.** Metal particles in the grease.
   - **b.** Increased drive power required.
   - **c.** Noise.
   - **d.** Rough rotation.
5. If bearing inspection shows no defects, reassemble and return to service.

NOTICE

THE SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON AN AERIAL LIFT. IT IS HERE THAT THE STRESSES OF LIFTING ARE CONCENTRATED, AT THE CENTER OF ROTATION. BECAUSE OF THIS, PROPER MAINTENANCE OF THE SWING BEARING BOLTS IS A MUST FOR SAFE OPERATION.

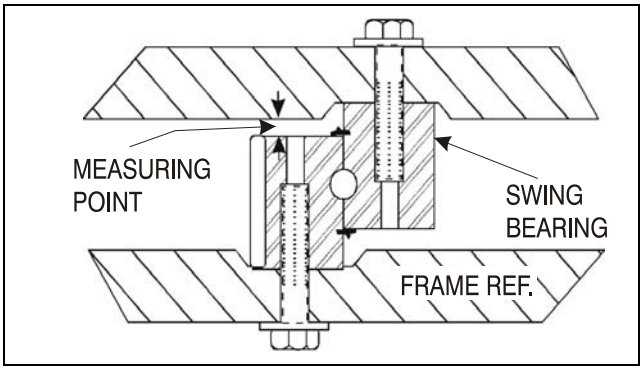


Figure 3-60. Swing Bearing Tolerance Measuring Point.

Swing Bearing Removal

1. From Ground Control station, operate the boom adequately to provide access to frame opening to rotary coupling.

⚠ WARNING

NEVER WORK BENEATH THE BOOM WITHOUT FIRST ENGAGING BOOM SAFETY PROP OR PROVIDING ADEQUATE OVERHEAD SLING SUPPORT AND/OR BLOCKING.

2. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.
3. From inside turntable, remove mounting hardware which attach rotary coupling retaining yoke brackets to turntable.

NOTICE

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

4. Tag and disconnect the hydraulic lines from the fittings on the top of the rotary coupling. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.
5. Attach suitable overhead lifting equipment to the base of the turntable weldment.
6. Use a suitable tool to scribe a line on the inner race of the swing bearing and on the underside of the turntable. This will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the turntable to the bearing inner race. Discard the bolts.
7. Use the lifting equipment to carefully lift the complete turntable assembly from the bearing. Ensure that no damage occurs to the turntable, bearing or frame-mounted components.

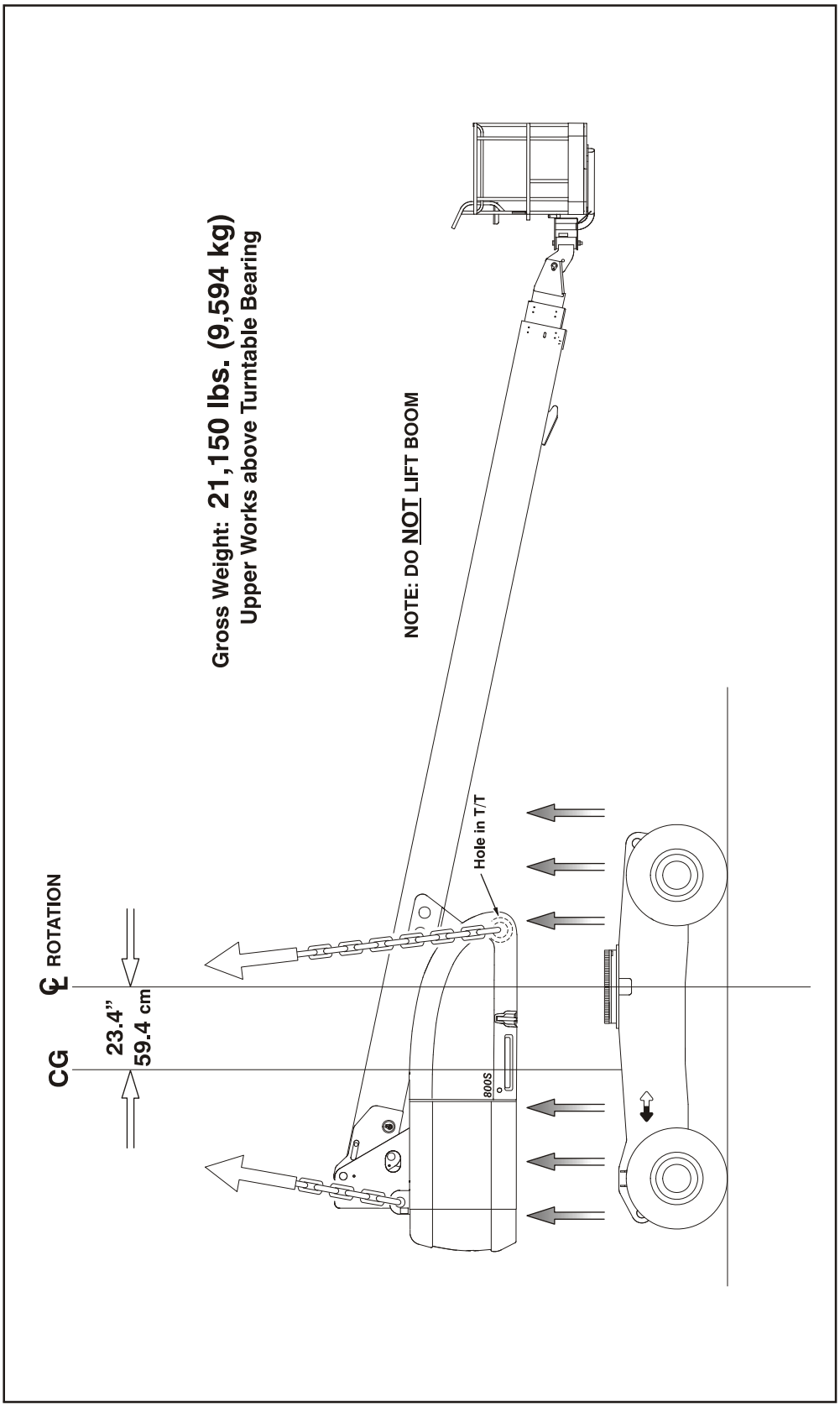


Figure 3-61. Swing Bearing Removal - 800S

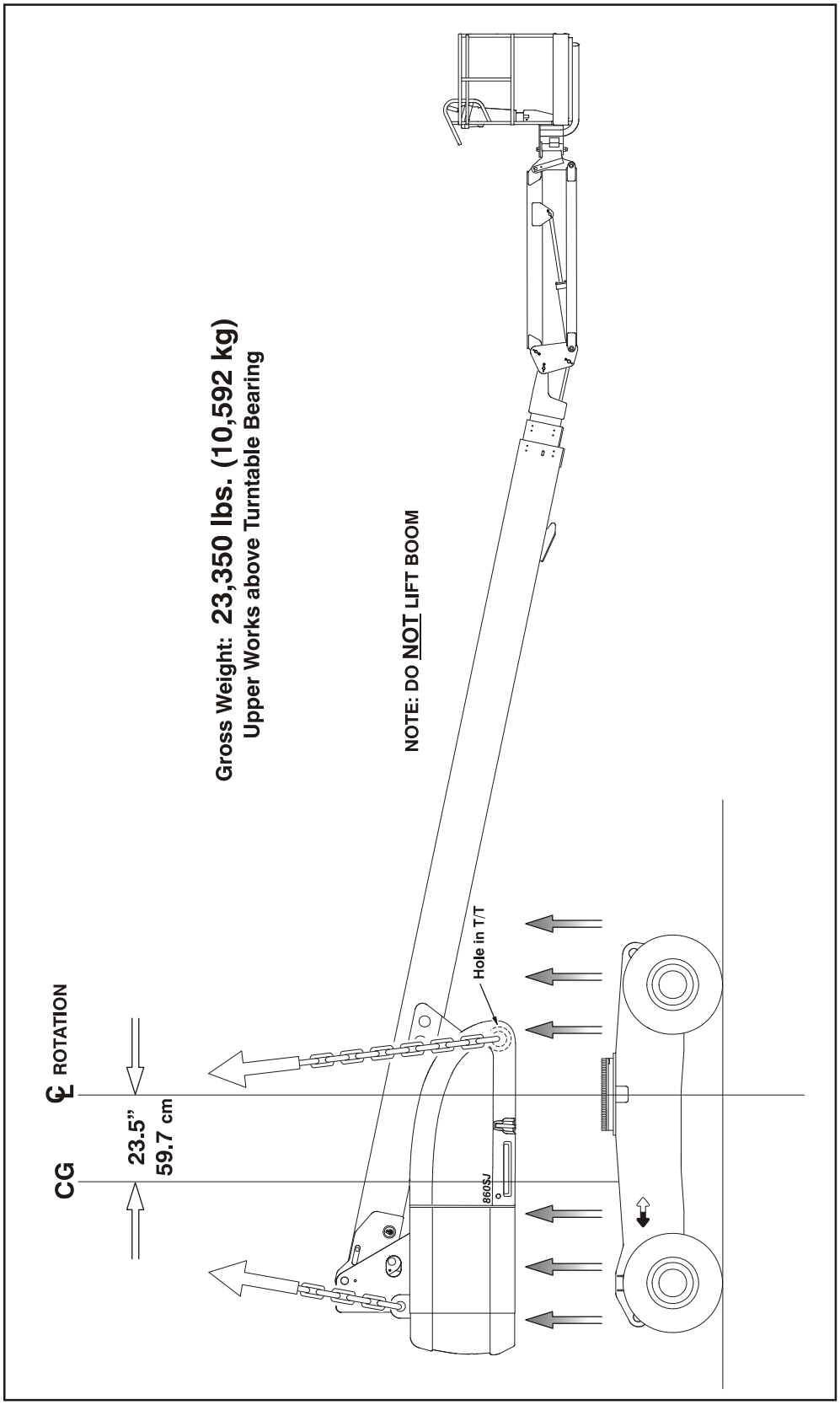


Figure 3-62. Swing Bearing Removal - 860SJ

8. Carefully place the turntable on a suitably supported trestle.
9. Use a suitable tool to scribe a line on the outer race of the swing bearing and the frame. This line will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing from the frame, then move the bearing to a clean, suitably supported work area.

Swing Bearing Installation

1. Using suitable lifting equipment, carefully lower the swing bearing into position on the frame. Ensure the scribed line of the outer race of the bearing aligns with the scribed line on the frame. If a new swing bearing is used, ensure that the spot with minimum gear backlash (marked with yellow paint) is towards the centerline of the swing drive (as close as the bolt pattern will allow).

⚠ CAUTION

JLG INDUSTRIES RECOMMENDS THAT ALL REMOVED BEARING BOLTS BE DISCARDED AND REPLACED WITH NEW BOLTS. SINCE THE SWING BEARING IS THE ONLY STRUCTURAL LINK BETWEEN THE FRAME AND TURNTABLE, IT IS IMPERATIVE THAT SUCH REPLACEMENT HARDWARE MEETS JLG SPECIFICATIONS. USE OF GENUINE JLG HARDWARE IS HIGHLY RECOMMENDED.

2. Apply a light coating of Loctite #271 to the new bearing bolts, and loosely install the bolts and washers through the frame and outer race of bearing.

NOTICE

IF COMPRESSED AIR OR ELECTRICALLY OPERATED IMPACT WRENCH IS USED FOR TIGHTENING THE BEARING ATTACHMENT BOLTS, THE TORQUE SETTING ACCURACY OF THE TOOL SHOULD BE CHECKED PRIOR TO USE.

3. Refer to the Torque Sequence diagram as shown in Figure 3-55., Swing Bearing Torque Sequence. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of Loctite #271 to the new bearing bolts, and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to a torque of 190 Ft. lbs. (258 Nm) w/Loctite.
4. Remove the lifting equipment from the bearing.
5. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.
6. Carefully lower the turntable onto the swing bearing, ensuring that the scribed line of the inner race of the bearing aligns with scribed line on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the turntable.
7. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of Loctite #271 to the new bearing bolts, and install the bolts and washers through the turntable and inner race of the bearing.
8. Following the Torque Sequence diagram shown in Figure 3-55., Swing Bearing Torque Sequence, tighten the bolts to a torque of 190 Ft. lbs. (258 Nm) w/Loctite.
9. Remove the lifting equipment.
10. Install the rotary coupling retaining yoke brackets, apply a light coating of Loctite #242 to the attaching bolts and secure the yoke to the turntable with the mounting hardware.
11. Connect the hydraulic lines to the rotary coupling as tagged prior to removal.
12. At ground control station, use boom lift control to lower boom to stowed position.
13. Using all applicable safety precautions, activate the hydraulic system and check the swing system for proper and safe operation.

Swing Bearing Torque Values

1. Outer Race - 190 ft. lbs. (258 Nm) w/Loctite.
2. Inner Race - 190 ft. lbs. (258 Nm) w/Loctite.
3. See Swing Bearing Torquing Sequence.

⚠ WARNING

CHECK THE INNER AND OUTER SWING BEARING BOLTS FOR MISSING OR LOOSENESS AFTER FIRST 50 HOURS OF OPERATION, AND EVERY 600 HOURS THEREAFTER.

3.17 ROTARY COUPLING

Use the following procedure to install the seal kit.

1. If not already removed, remove the axle oscillation valve from the cylinder barrel. The spool of the valve protrudes into the barrel and will damage the spool and seals if left in place.
2. Remove snap ring (7) from end.
3. Remove thrust ring (3) from the same end.
4. Remove center body (1) from housing (3).
5. Cut off old seals (2,4,5).
6. Assemble lip seals (2) in direction shown in Figure 3-63., Rotary Coupling Seal Installation.
7. Reassemble O-ring (4).
8. Heat cap seals (5) in hydraulic oil for 5 minutes at 300° F (149° C).
9. Assemble cap seals over O-rings
10. Reinsert center body into housing (lube with hydraulic oil).
11. Replace thrust ring and snap ring.

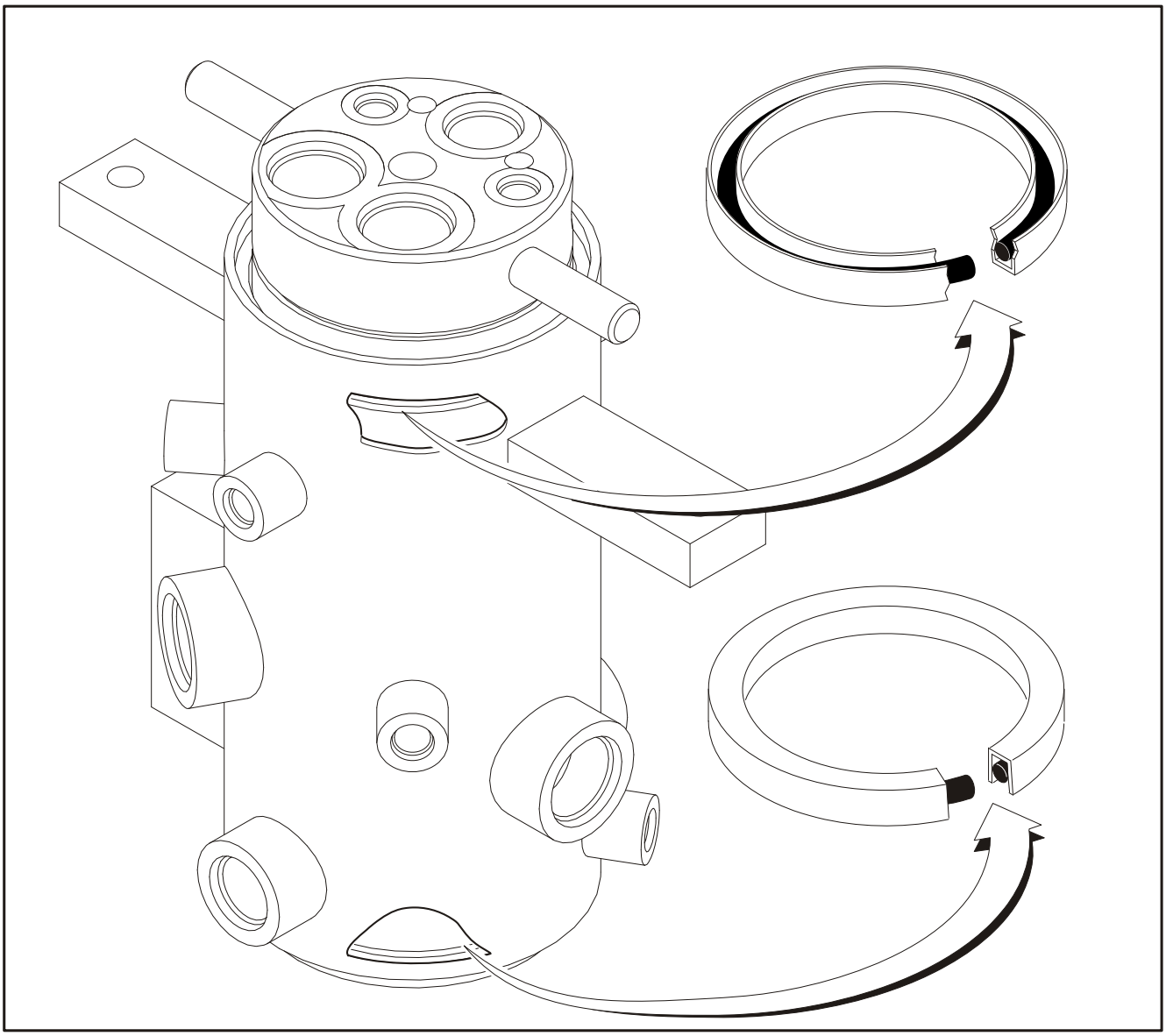
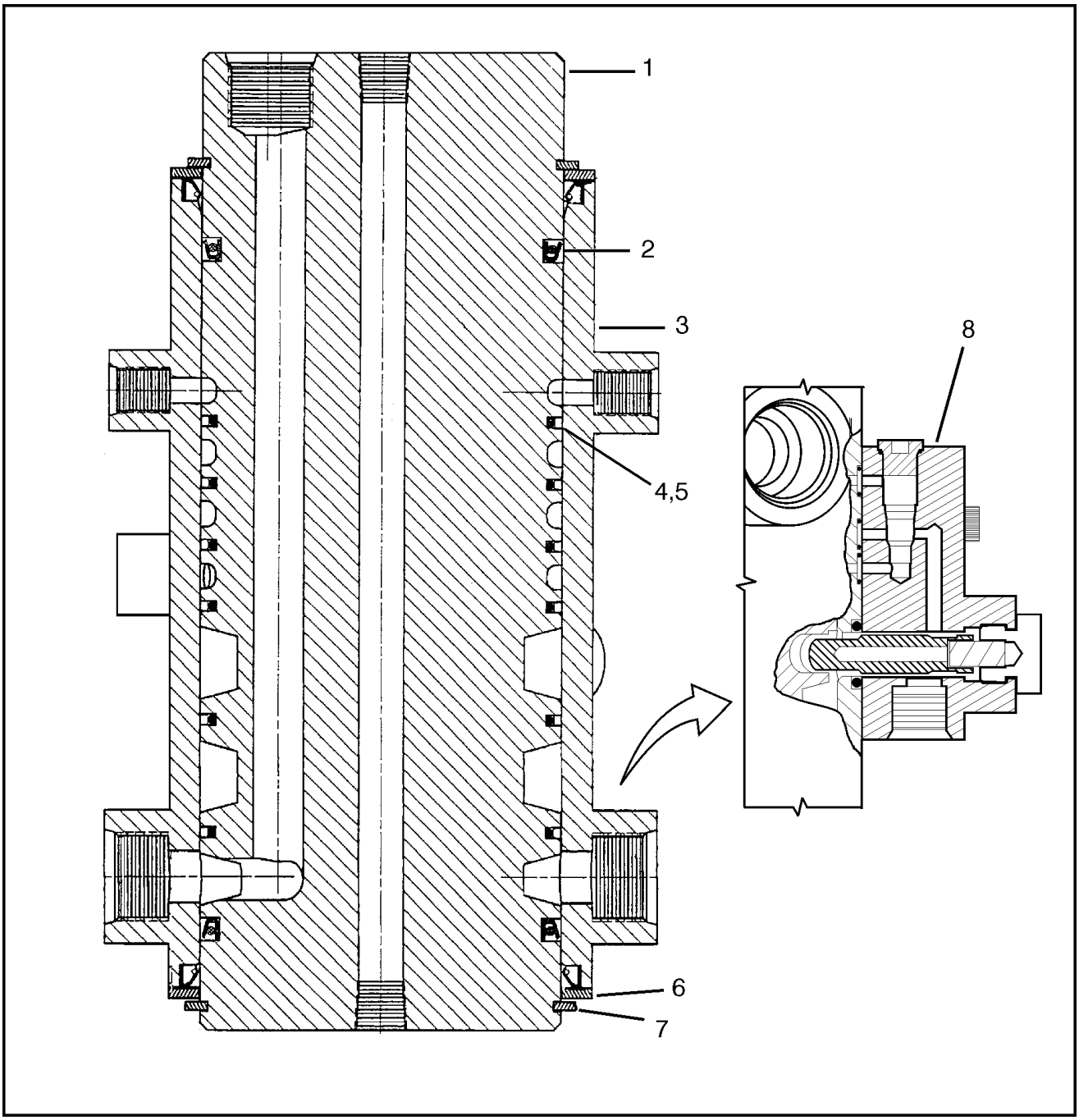


Figure 3-63. Rotary Coupling Seal Installation



1. Center Body
2. Seal
3. Housing
4. O-ring
5. Seal
6. Thrust Ring
7. Snap Ring
8. Valve Block (Axle Oscillation)

Figure 3-64. Rotary Coupling Cutaway

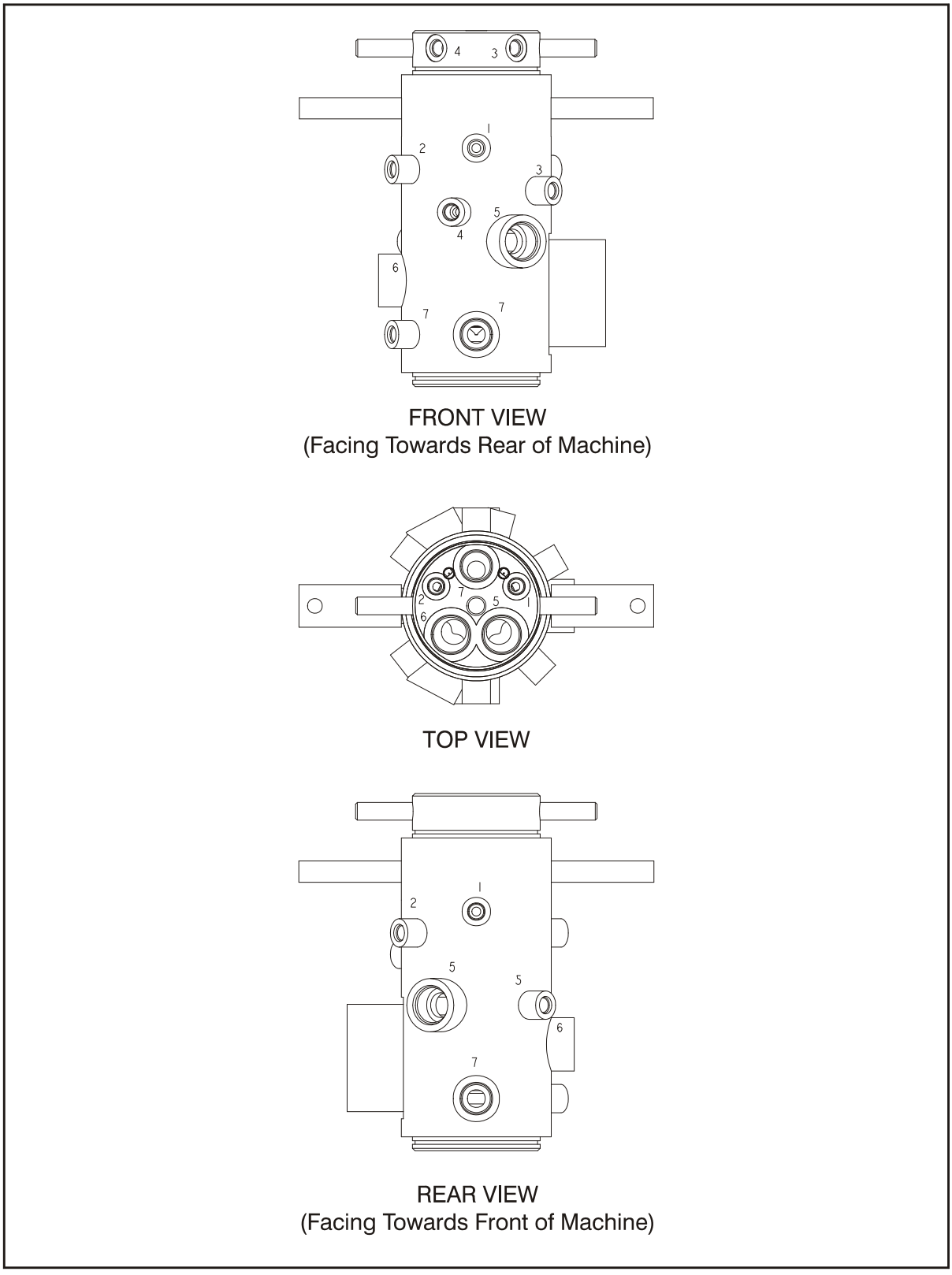


Figure 3-65. Rotary Coupling Port Location

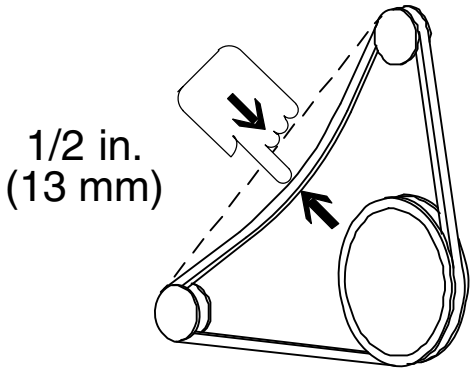
Table 3-10. Coupling Port Information Table

Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	2	-6	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (138)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	3	2-16, 1-6	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	2	-12	Drain	250 (17)	375 (26)

3.18 GENERATOR

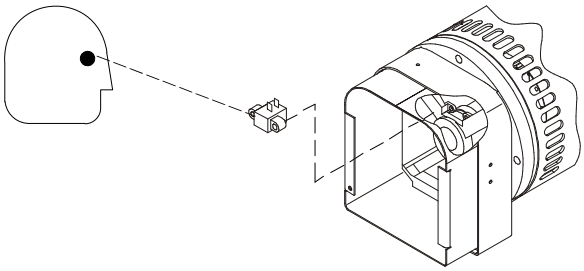
Every 250 hours

Every 250 hours of operation, check the drive belt for proper tension.

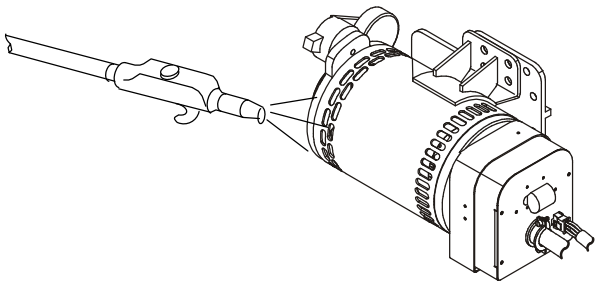


Every 500 hours

Every 500 hours of operation, service the generator brushes and slip rings. Hostile environments may require more frequent service.



Every 500 hours of service, blow out the inside of the generator. If operating in a hostile environment, clean monthly.

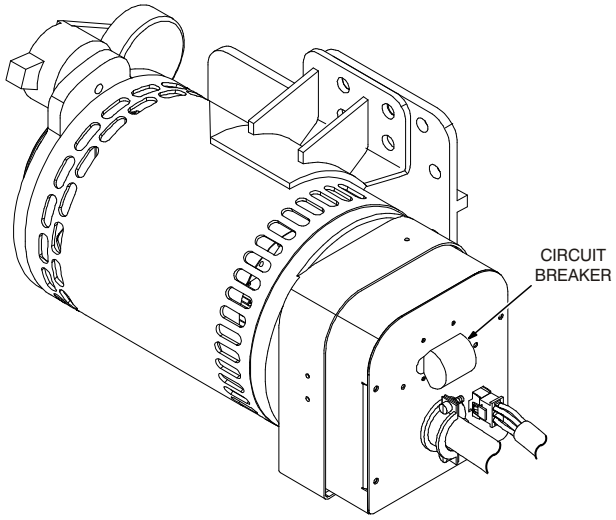


Overload Protection

⚠ CAUTION

STOP THE ENGINE WHENEVER CHECKING OR INSPECTING THE CIRCUIT BREAKER.

The circuit breaker protects the generator windings from overload. If the circuit breaker opens, generator output stops. If the circuit breaker continues to open, check for faulty equipment connected to the platform receptacles.



Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

Refer to Figure 3-66., Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings.

INSPECTING BRUSH POSITION

Inspect brush alignment with slip rings. View alignment through the air vents in the stator barrel. The brushes must ride completely on the slip rings.

INSPECTING BRUSHES

Remove the end panel. Inspect the wires. Remove the brush holder assembly. Pull the brushes from the holders.

Replace the brushes if damaged, or if the brush is at or near minimum length.

CLEANING SLIP RINGS

Visually inspect the slip rings. Under normal use, the rings turn dark brown.

If the slip rings are corroded or their surface is uneven, remove the belt to turn the shaft by hand for cleaning.

Clean the rings with 220 grit emery paper. Remove as little material as possible. If the rings are deeply pitted and do not clean up, consult generator factory service.

Reinstall the belt, brush holder assembly, and end panel.

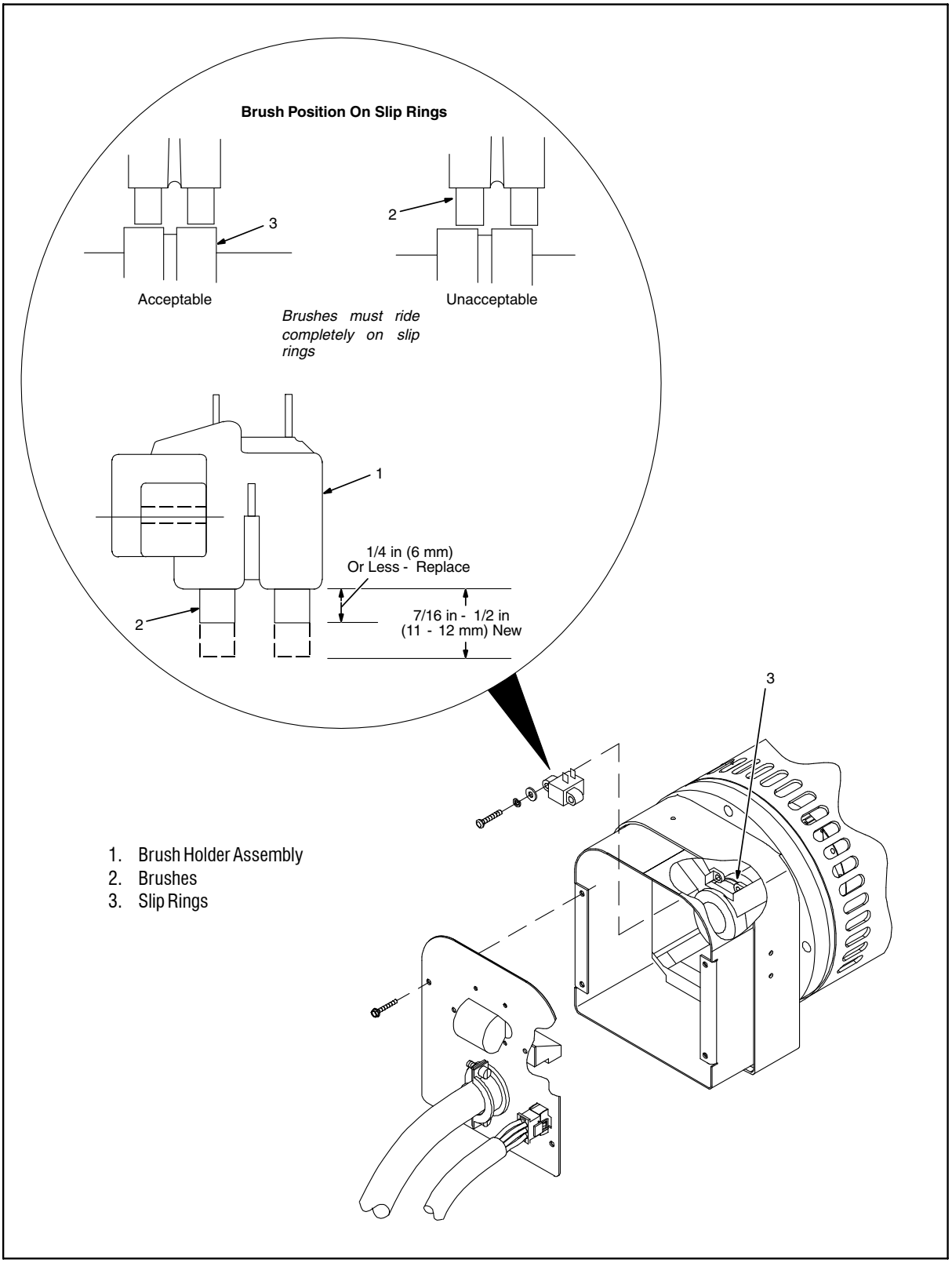


Figure 3-66. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

3.19 FORD EFI ENGINE

Performing Diagnostics

1. Verify the complaint and determine if it is a deviation from normal operation.
2. Once the complaint has been verified, preliminary checks can be done. Conduct a thorough visual inspection, be alert for unusual sounds or odors, and gather diagnostic trouble code information.
3. Perform a system check that will verify the proper operation of the system in question and check for recent information updates.
4. If a diagnostic trouble code (DTC) is stored, contact a JLG distributor to make an effective repair.
5. If no DTC is stored, select the symptom from the symptom tables and follow the diagnostic path or suggestions to complete the repair.
6. After the repair has been made and validated for proper operation, the old part should be momentarily re-installed to verify that it was indeed the source of the problem.

If no matching symptom is available, analyze the complaint and develop a plan for diagnostics utilizing the wiring diagrams, technical assistance, and repair history.

Intermittent conditions may be resolved by using a check sheet to pinpoint the circuit or electrical system component. Some diagnostic charts contain Diagnostic Aids which give additional information about a system. Be sure to use all of the information that is available to you.

VISUAL/PHYSICAL ENGINE INSPECTION CHECK

Perform a careful visual and physical engine inspection before performing any diagnostic procedure. Perform all necessary repairs before proceeding with additional diagnosis, this can often lead to repairing a problem without performing unnecessary steps. Use the following guidelines when performing a visual/physical inspection check:

- Inspect engine for modifications or aftermarket equipment that can contribute to the symptom; verify that all electrical and mechanical loads or accessory equipment is "OFF" or disconnected before performing diagnosis.
- Inspect engine fluids for correct levels and evidence of leaks.
- Inspect vacuum hoses for damage, leaks, cracks, kinks and improper routing, inspect intake manifold sealing surface for a possible vacuum leak.
- Inspect PCV valve for proper installation and operation.
- 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.

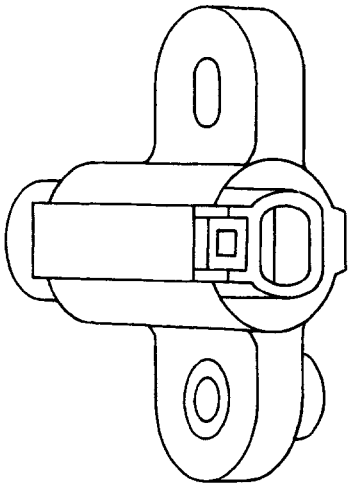


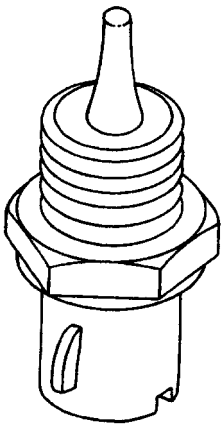
Table 3-11. ECM Diagnostic Trouble Codes

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 g 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 program 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.

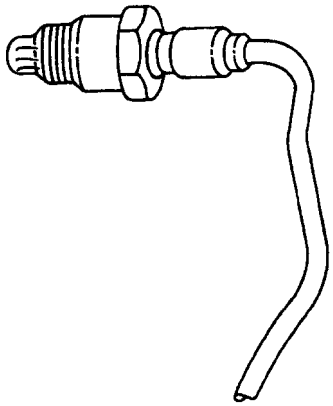
HEATED OXYGEN SENSOR

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 out-put 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.



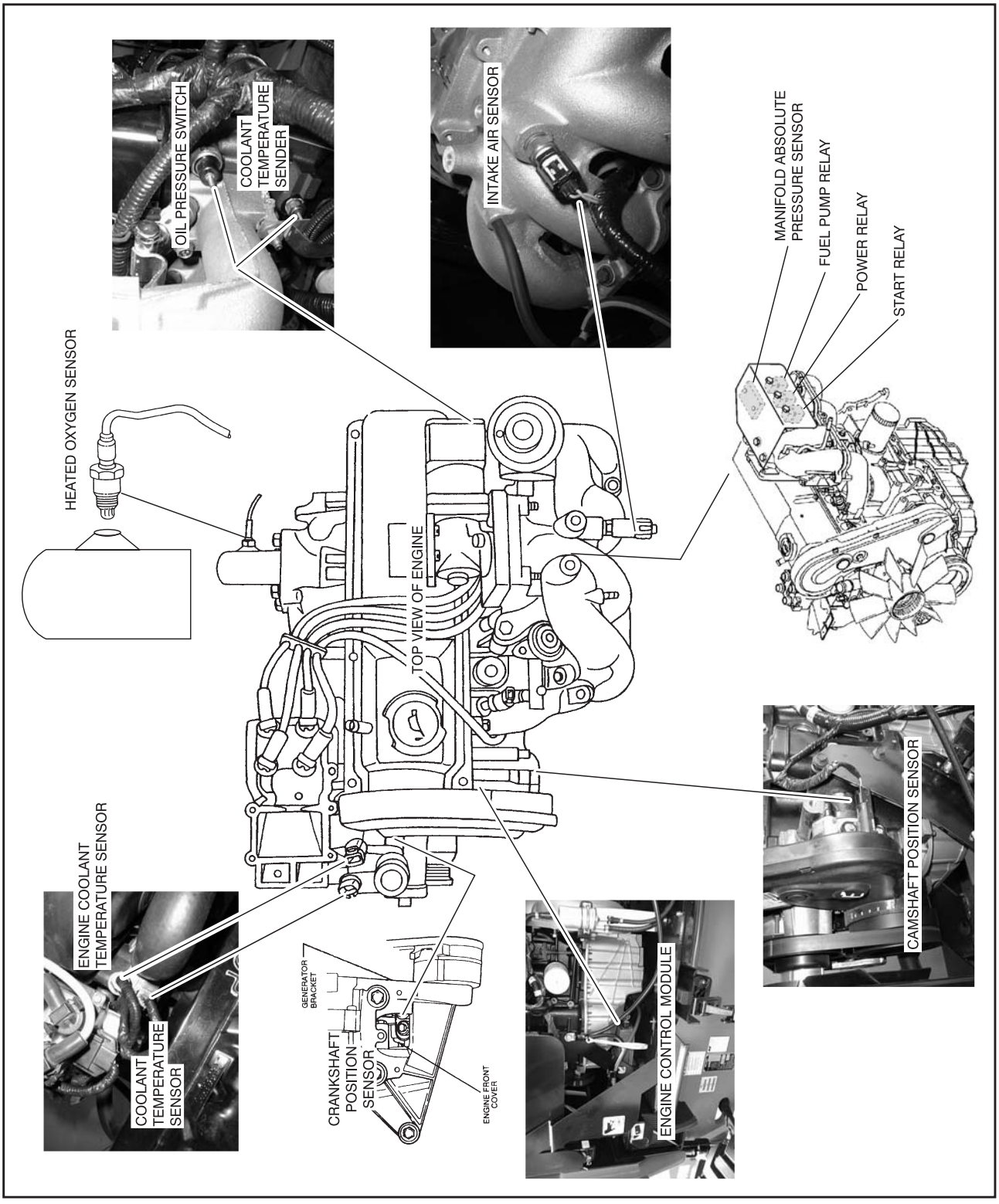
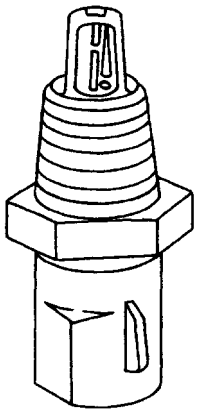


Figure 3-67. EFI Component Location

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.



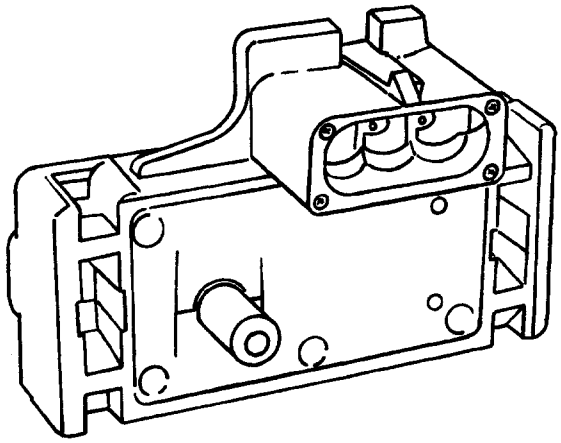
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

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)

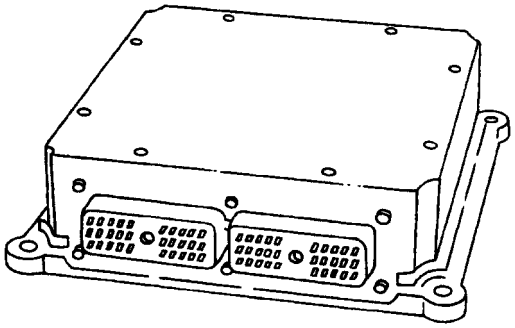
The ECM controls the following:

- 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 huh 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

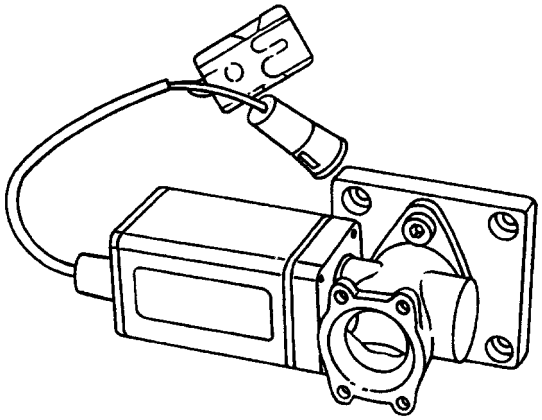
The ECM is designed to withstand normal current draws associated with engine operation. When servicing the ECM, observe the following guidelines:

- 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 voltage 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.

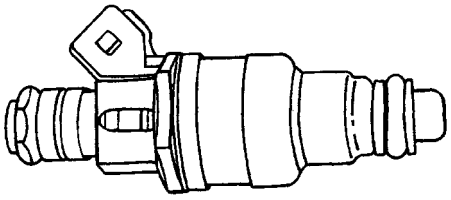
Fuel System

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 prefilter. 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.

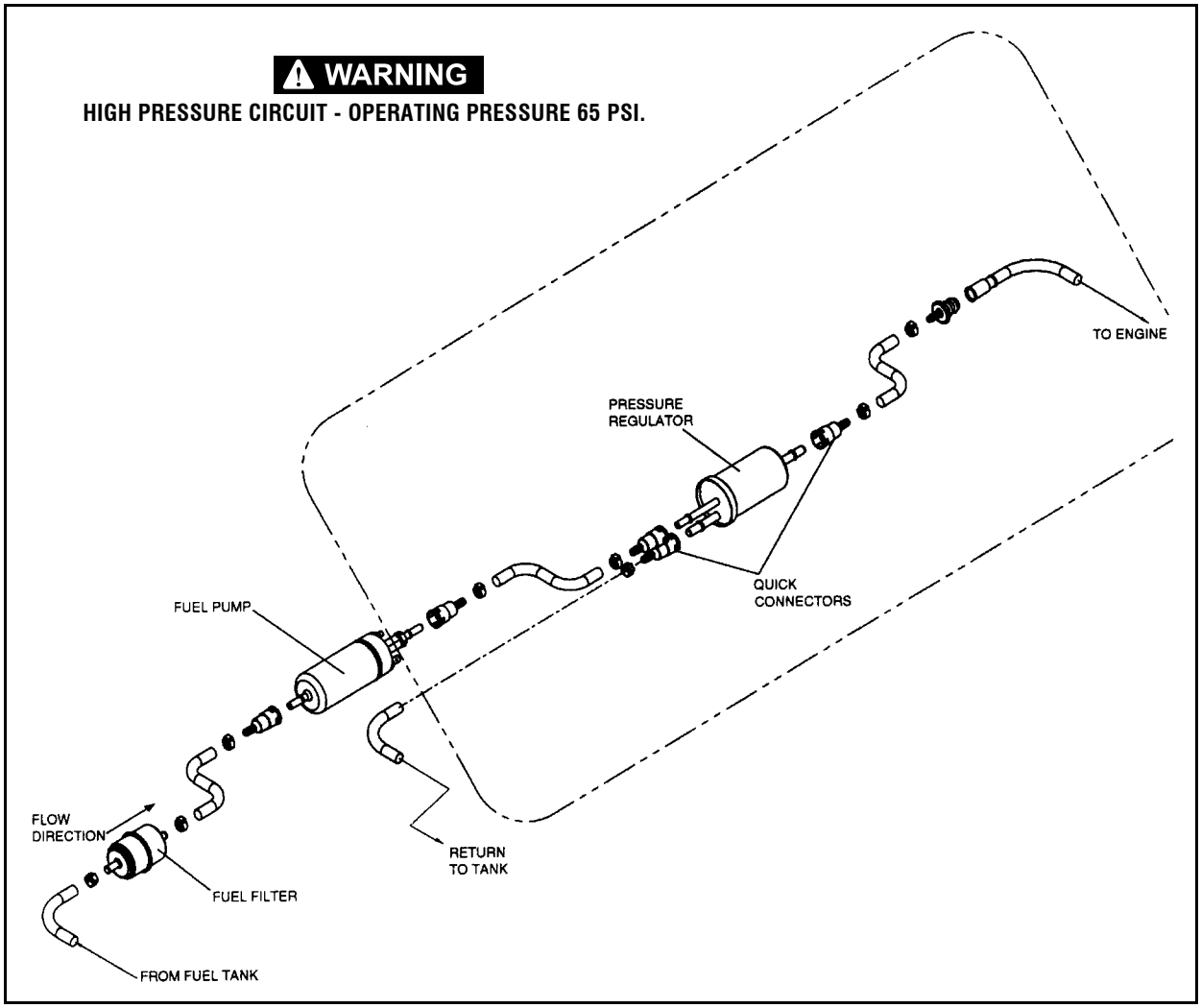


Figure 3-68. Typical Fuel System

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.

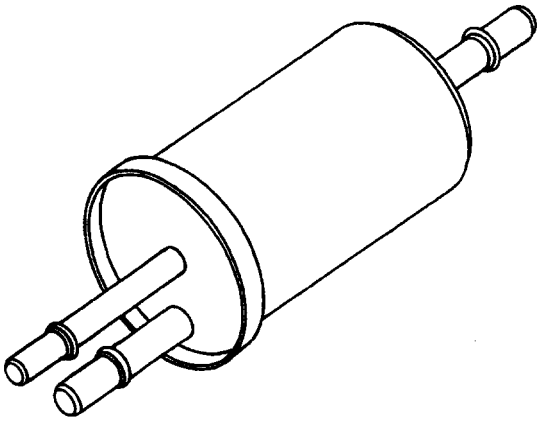
The ECM monitors signals from several sensors in order to determine the fuel needs of the engine. Fuel is delivered under one of several conditions called "modes." All modes are controlled by the ECM. Refer to "Open Loop and Closed Loop Operation" for more information.

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.



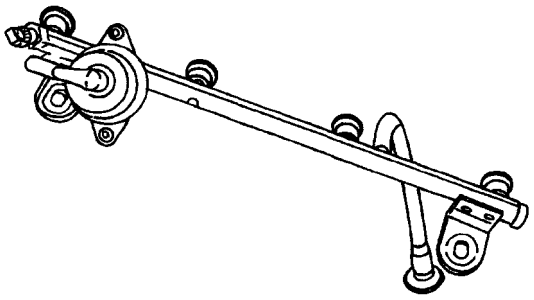
FUEL PUMP ELECTRICAL CIRCUIT

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.

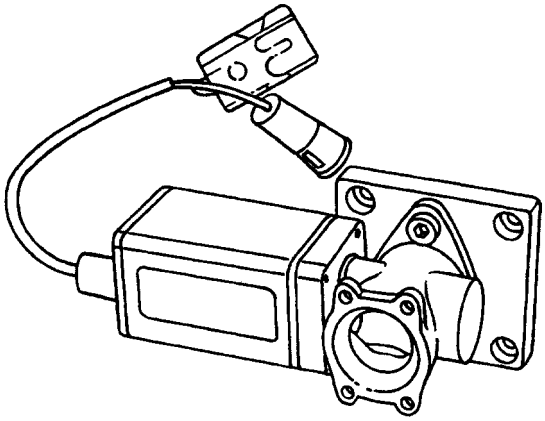
FUEL RAIL

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.

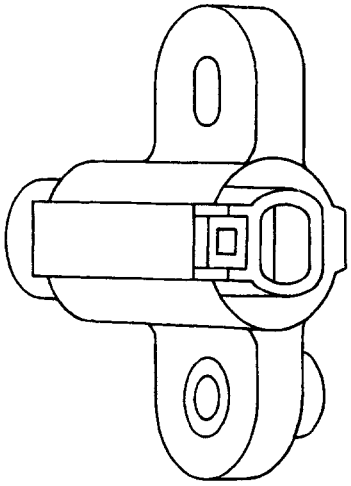
The system remains in open loop until the following conditions are met:

- 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.

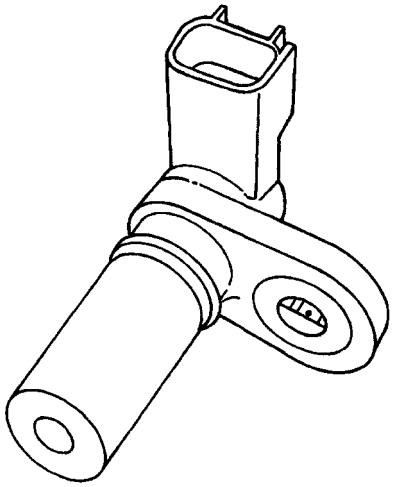
CAMSHAFT POSITION (CMP) SENSOR

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 crankshaft position.



ELECTRONIC IGNITION

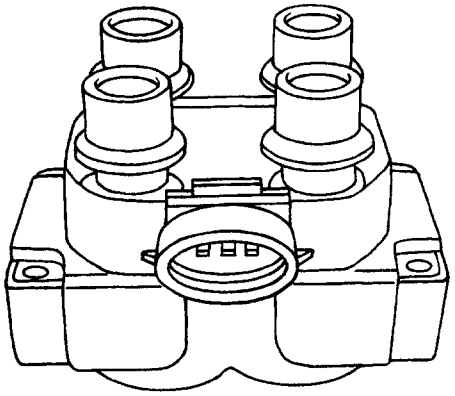
The electronic ignition system controls fuel combustion by providing a spark to ignite the compressed air/fuel w mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the ECM controls the spark advance of the ignition system. Electronic ignition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

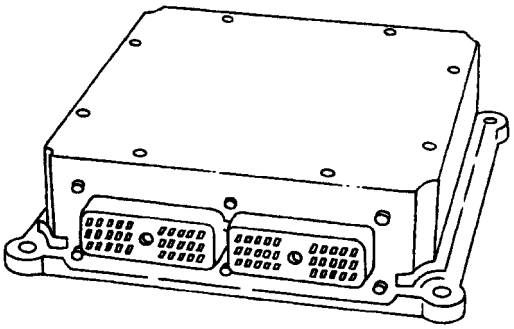
The primary coils in the coil pack are triggered by the "Ignition Coil Feed #1" and "Ignition Coil Feed #2" Signals from the ECM.



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



3.20 DEUTZ EMR 2 (S/N 85332 TO PRESENT)

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.

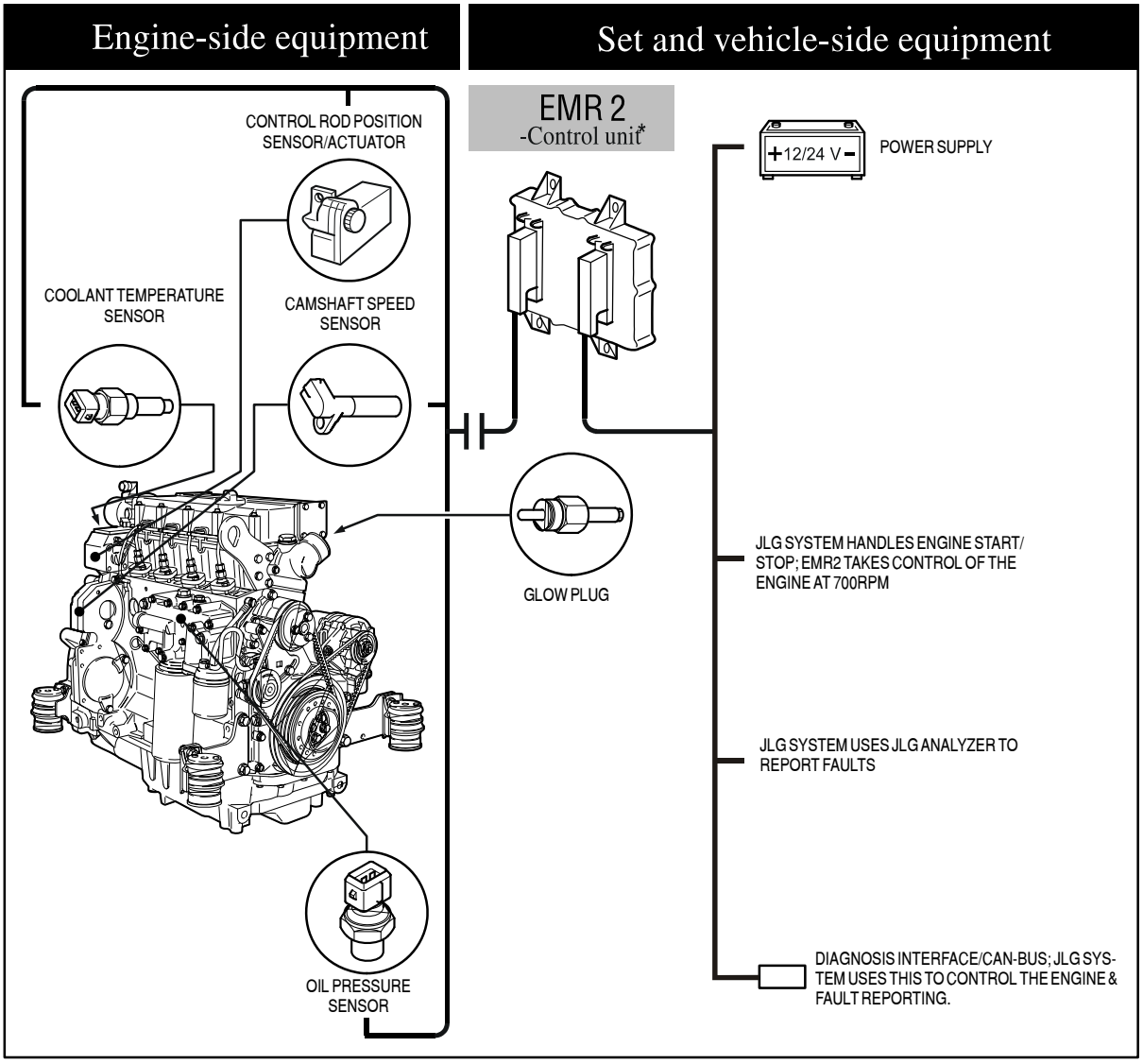


Figure 3-69. EMR 2 Engine Side Equipment

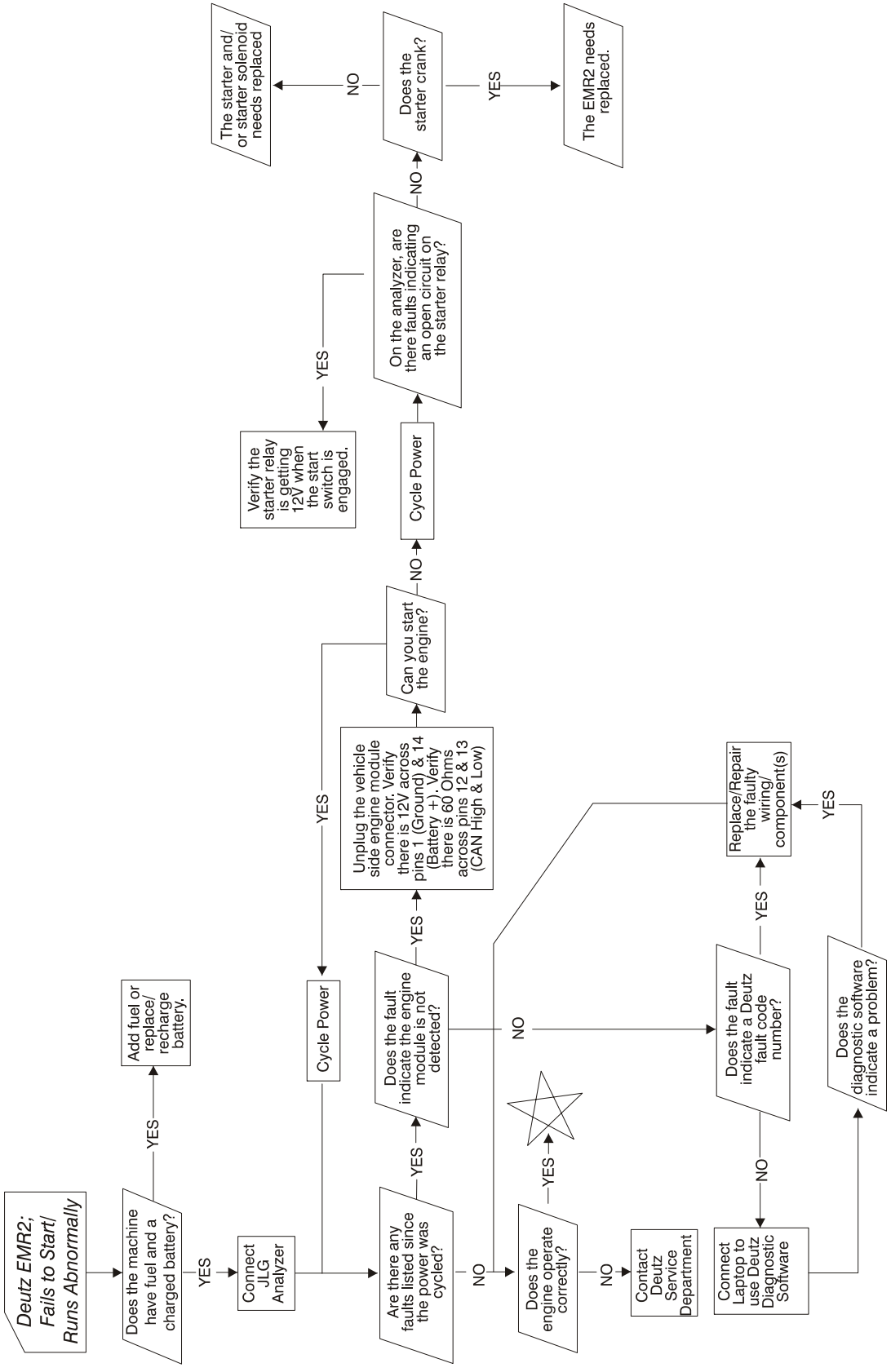


Figure 3-70. Deutz EMR 2 Troubleshooting Flow Chart

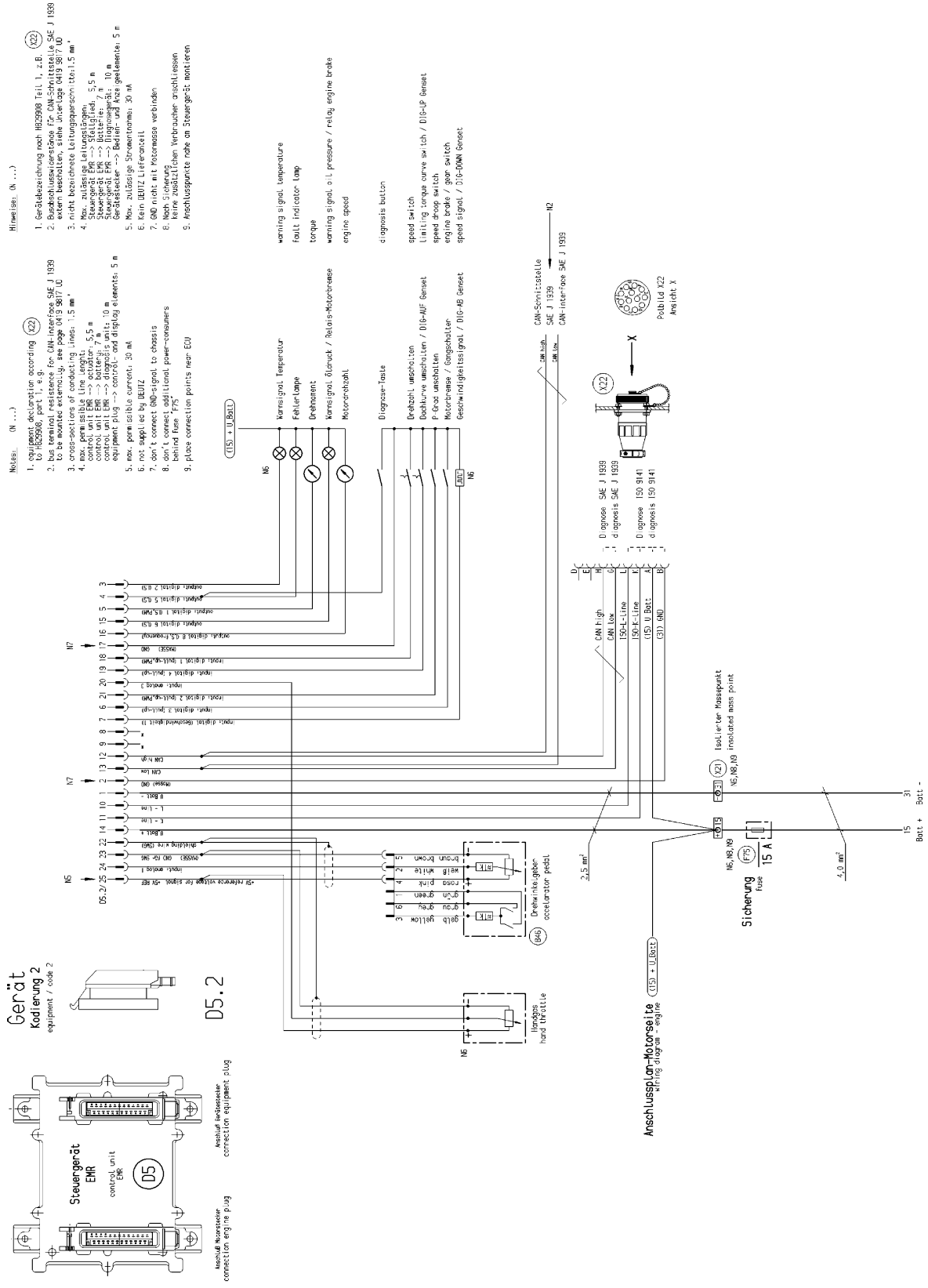


Figure 3-71. Deutz EMR 2 Vehicle Side Connection Diagram

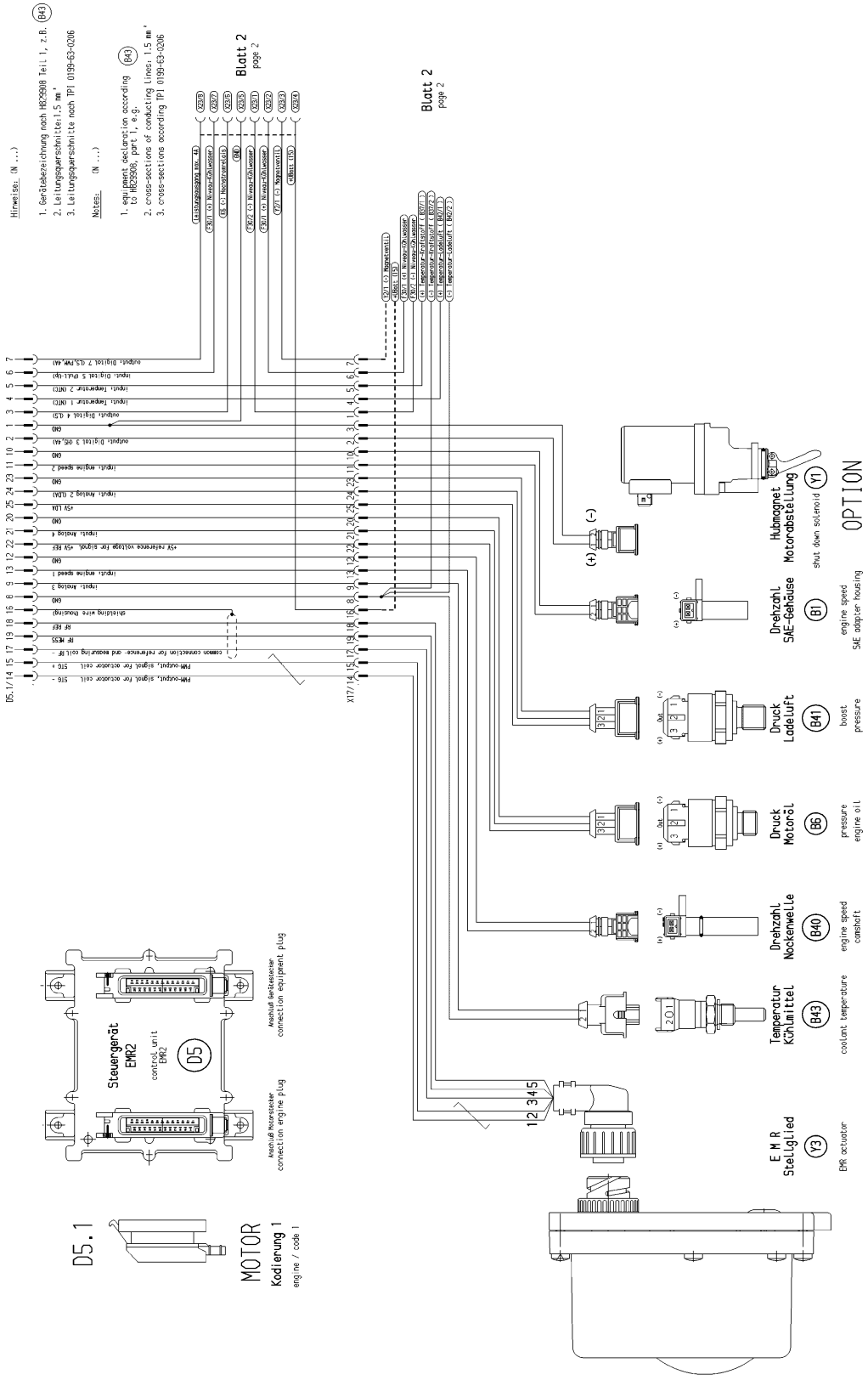


Figure 3-72. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

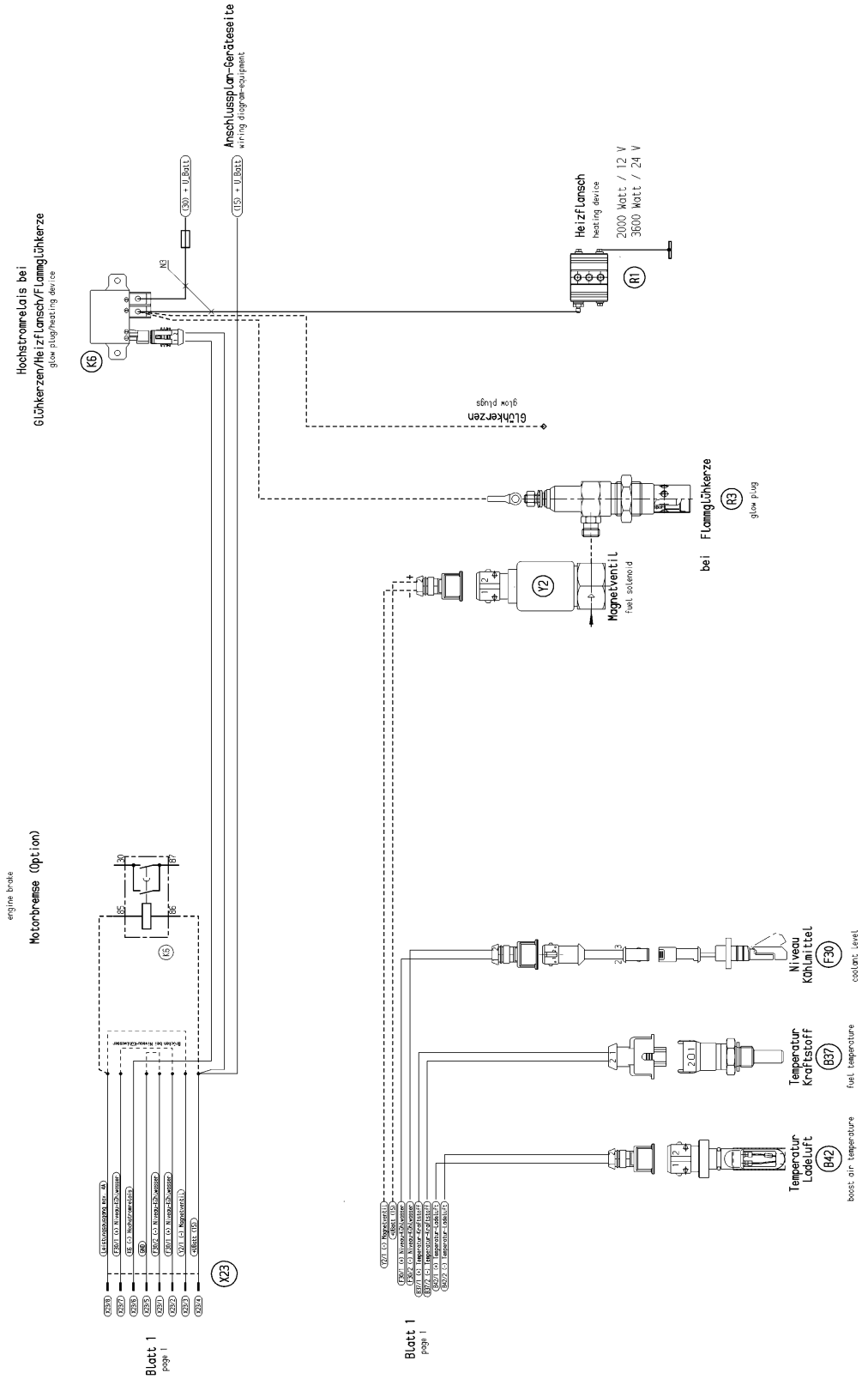
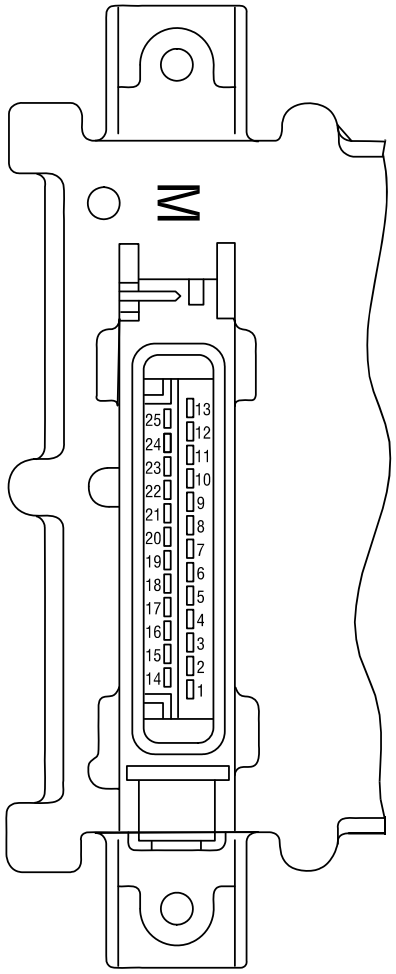


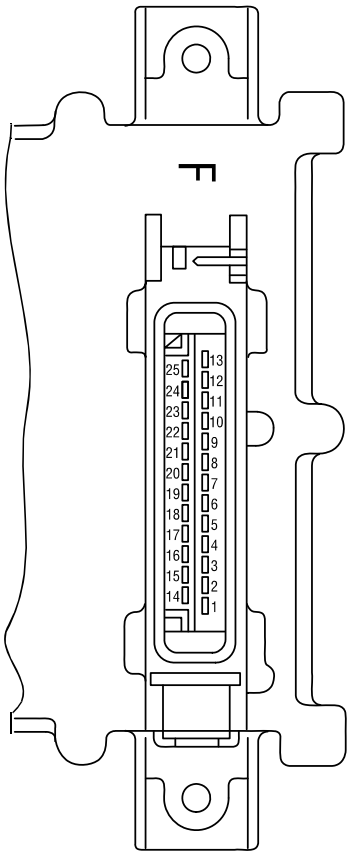
Figure 3-73. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



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 3-74. 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 3-75. 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 3-76. 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 3-77. 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 3-78. 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 3-79. 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 3-80. EMR2 Fault Codes - Sheet 5 of 5

3.21 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 inch (13mm). 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 insure 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 insure 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 insure 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 insure 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.

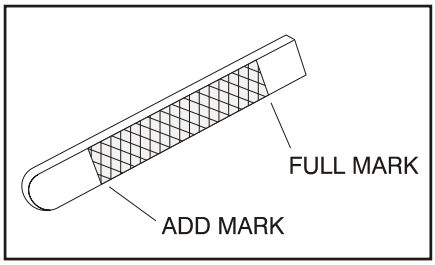


Figure 3-81. Engine Oil Dip Stick

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 insure 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.



3.22 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).

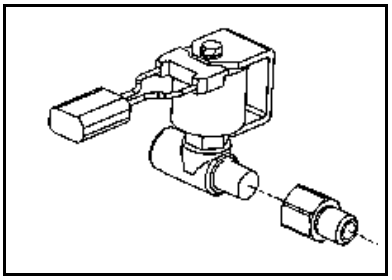
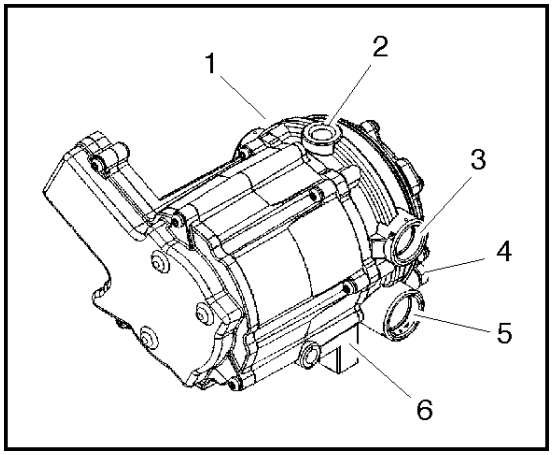


Figure 3-82. Electric Fuel Lock Off

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 3-83. 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.

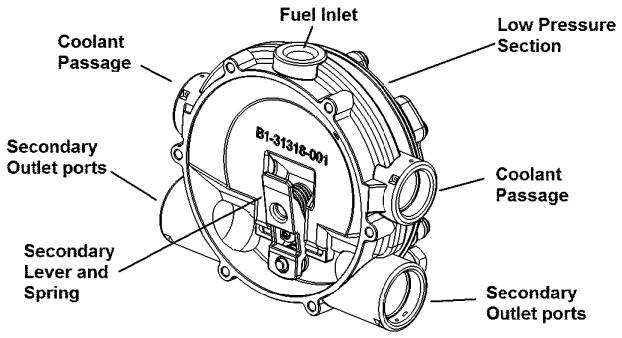


Figure 3-84. Low Pressure Regulators

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 inches (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 inches (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.

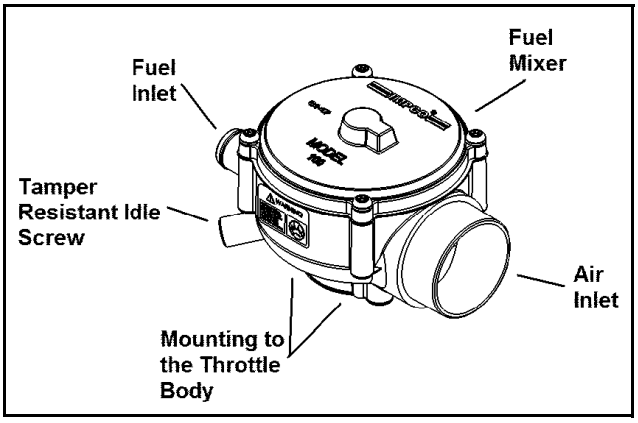


Figure 3-85. Air Fuel Mixer

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.

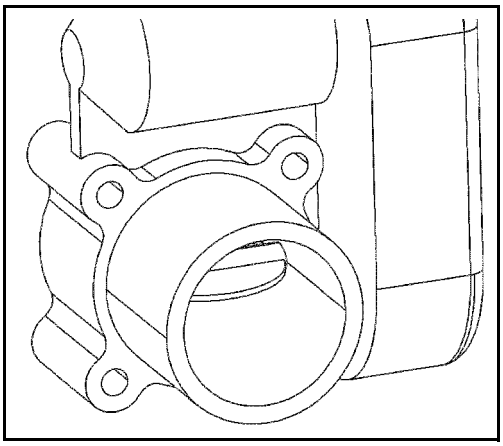


Figure 3-86. ETC throttle control device

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.

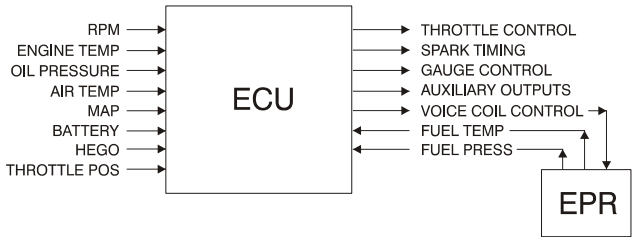


Figure 3-87. LPG Engine Control Unit (ECM)

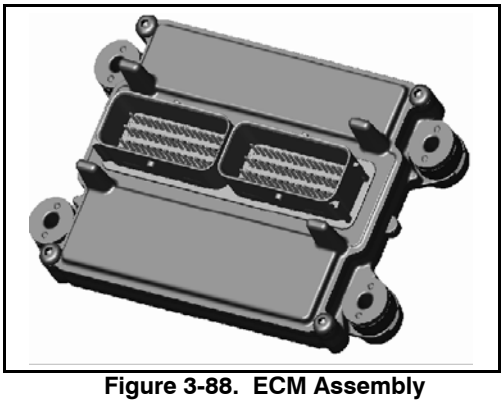


Figure 3-88. ECM Assembly

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.

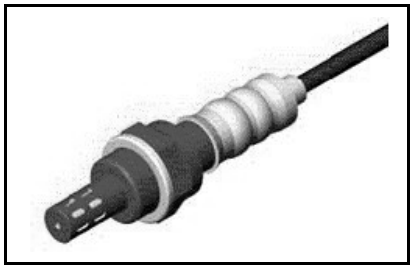


Figure 3-89. Heated Exhaust Gas Oxygen Sensor (HEGO)

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.

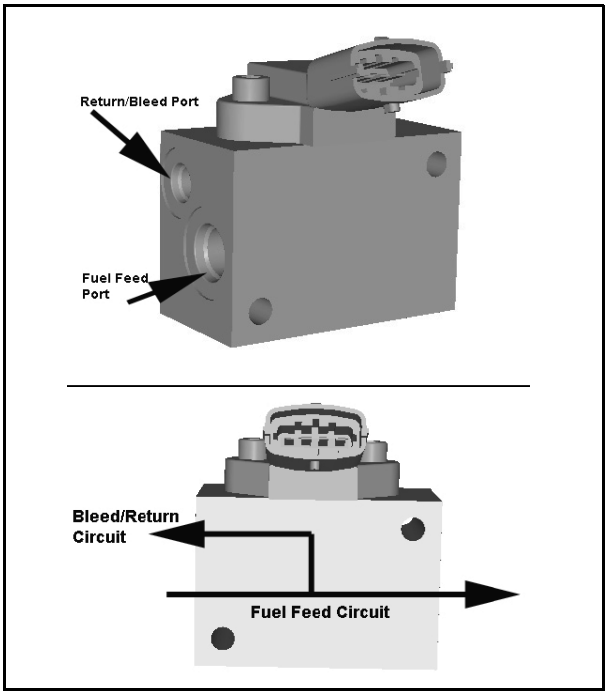


Figure 3-90. Gasoline Fuel Pressure and Temperature Manifold Assembly

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.

3.23 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.

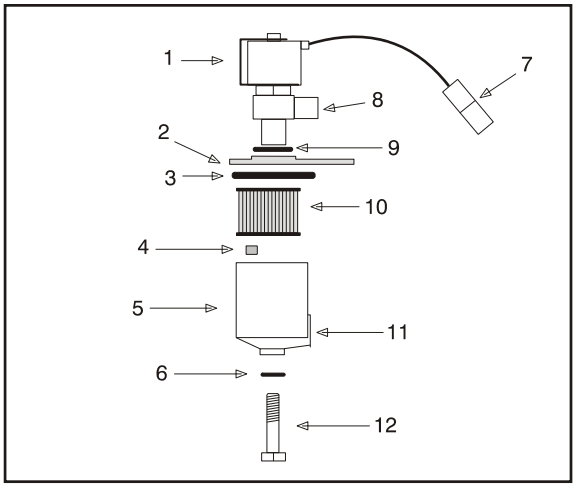
Propane Fuel System Leak Test

⚠ 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.

Propane Fuel Filter Replacement



1. Electric Lock Off Solenoid
2. Mounting Plate
3. Housing Seal
4. Filter Magnet
5. Filter Housing
6. Seal
7. Electrical Connector
8. Fuel Outlet
9. O-ring
10. Filter
11. Fuel Inlet
12. Retaining Bolt

Figure 3-91. 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. Locate Filter magnet and remove it.
6. Remove the filter from the housing.
7. Remove and discard the housing seal.
8. Remove and discard the retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

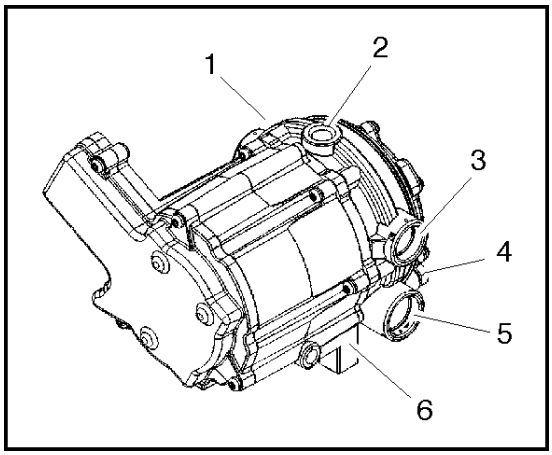
INSTALLATION

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. 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. 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 3-92. 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.

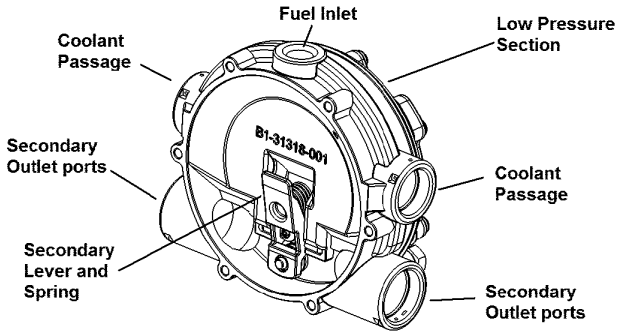


Figure 3-93. Pressure Regulator Section

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

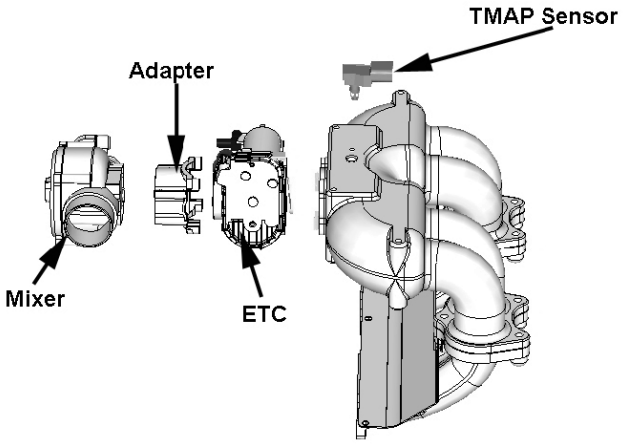


Figure 3-94. (TMAP) Sensor & Electronic Throttle Control (ETC)

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 lb-in (7 Nm).
3. Start the vehicle and check for proper operation.

Electronic Throttle Control Replacement

See Figure 3-94.

REMOVAL

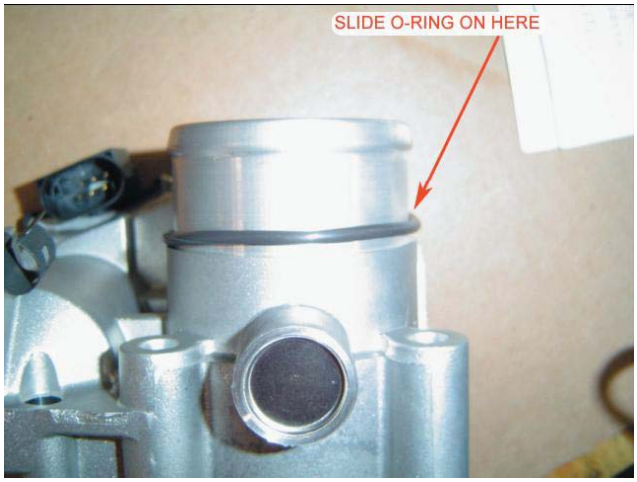
1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Release the hose clamp on the vapor fuel line and remove the vapor hose.
4. Disconnect the TMAP electrical connector.
5. Disconnect the electronic throttle control connector.
6. Remove the manifold to throttle body adapter bolts 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.

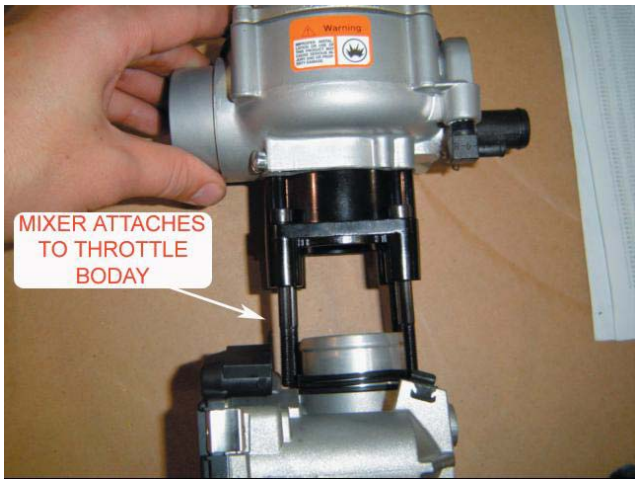
1. Install the O-ring on throttle body. Press it down to the bottom of the surface.



2. Install the two quad seals. Install one seal at a time to insure 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.

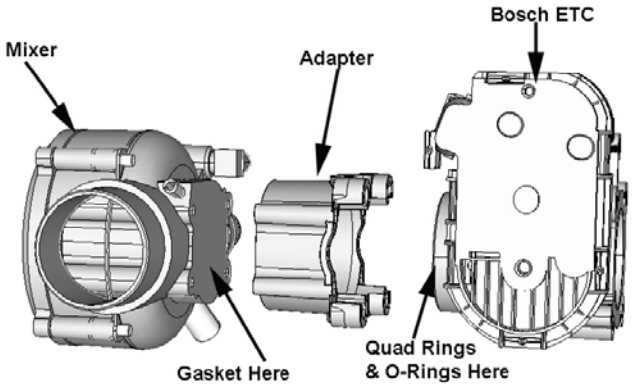


Figure 3-95. Mixer Assembly

Mixer Replacement

See Figure 3-95.

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 lb-in (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 lb-ft (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.

3.24 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

Fuel System Description

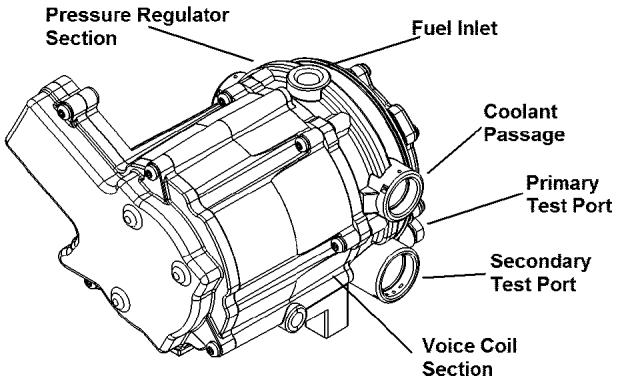


Figure 3-96. EPR Assembly

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 in 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 to 3.0 psi (6.8 to 20.6 kPa). The second stage reduces the pressure to approximately negative 1.5" 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 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 3-12. LPF 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?	- -	Gotothe 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?	-1.0" to -2.0" 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?	-1.0" to -2.0" 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

Table 3-12. LPF Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
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
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	--

Table 3-12. LPF Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
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 3-13. 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	□ Check all ECM system fuses and circuit breakers. □ Check the ECM ground for being clean, tight and in its proper location. □ Check the vacuum hoses for splits, kinks and proper connections. □ Check thoroughly for any type of leak or restriction. □ Check for air leaks at all the mounting areas of the intake manifold sealing surfaces. □ Check for proper installation of the mixer module assembly. □ Check for air leaks at the mixer assembly. □ Check the ignition wires for the following conditions: - Cracking - Hardness - Proper routing - Carbon tracking □ Check the wiring for the following items: - Proper connections, pinches or cuts. □ 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	□ Refer to Important Preliminary Checks. □ 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	□ Faulty electrical connections or wiring can cause most intermittent problems. □ 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. □ 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. □ 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 3-13. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no DTC(s): □ 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. □ The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. □ The ignition secondary voltage shorted to a ground. □ The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. □ 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□ □but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	If a scan tool is available: □ Check for proper communication with both the ECM □ Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. □ 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	□ Check the TMAP sensor. □ Check the Magnetic pickup sensor (RPM).
Fuel System Checks	**Important:** A closed LPG manual fuel shut off valve will create a no start condition. □ Check for air intake system leakage between the mixer and the throttle body. □ Verify proper operation of the low pressure lock-off solenoids. □ Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis. □ 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. □ Check for the proper ignition voltage output with J 26792 or the equivalent. □ Verify that the spark plugs are correct for use with LPG (R42LTS) □ Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits □ Check for bare or shorted ignition wires. □ 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. □ 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 3-13. Symptom Diagnosis

Checks	Action
Exhaust System Checks	□ 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. 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	□ Refer to Important Preliminary Checks. □ Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	□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 □ Check the Crankshaft Position (CKP) sensor. □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. □ Verify the excess flow valve in the LPG manual shut-off valve is not tripped. □ Check mixer module assembly for proper installation and leakage. □ Verify proper operation of the low pressure lock-off solenoids. □ Verify proper operation of the EPR □ Check for air intake system leakage between the mixer and the throttle body. □ 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. □ Check for the proper ignition voltage output with J 26792 or the equivalent. □ Verify that the spark plugs are correct for use with LPG (R42LTS) □ Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits □ Check for bare or shorted ignition wires. □ Check for moisture in the distributor cap if applicable. □ 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. □ Check for the following: - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes. □ Check the intake and exhaust manifolds for casting flash.

Table 3-13. Symptom Diagnosis

Checks	Action
Exhaust System Checks	□ 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. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual
Additional Checks	□
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	□ Refer to Important Preliminary Checks.
Ignition System Checks	□ Start the engine. □ Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. □ Check for proper ignition output voltage with spark tester J 26792. □ Check for a cylinder misfire. □ Verify that the spark plugs are correct for use with LPG (R42LTS) □ Remove the spark plugs in these cylinders and check for the following conditions: □ Insulation cracks □ Wear □ Improper gap □ Burned electrodes □ Heavy deposits □ Visually/Physically inspect the secondary ignition for the following: □ Ignition wires for arcing, cross-firing and proper routing □ Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	□ Perform a cylinder compression check. □ Check the engine for the following: - Improper valve timing - Bent pushrods - Worn rocker arms - Worn camshaft lobes. - Broken or weak valve springs. □ Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	□ Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. □ Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). □ EMI on the reference circuit can cause a missing condition. □ Monitoring the engine RPM with a scan tool can detect an EMI. □ A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. □ If the problem exists, check the routing of the secondary wires and the ground circuit.

Table 3-13. Symptom Diagnosis

Checks	Action
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	□ Check the fuel pressure. Refer to LPG Fuel System Diagnosis. □ 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. □ Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. □ Check LPL electrical connection □ Check the mixer air valve for sticking or binding. □ Check the mixer module assembly for proper installation and leakage. □ Check the EPR electrical connections.
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. □ Check for the proper ignition voltage output with J 26792 or the equivalent. □ Verify that the spark plugs are correct for use with LPG (R42LTS) □ Check for faulty spark plug wires □ Check for fouled spark plugs.
Additional Check	□ Check for manifold vacuum or air induction system leaks □ 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	□ 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.** □ Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent. □ 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. □ Check the connection at each ignition coil. □ Check for deteriorated spark plug wire insulation. □ Check the spark plugs. The correct spark plugs for LPG are (R42LTS) □ 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. □ Check the engine for the following: - Improper valve timing - Engine compression - Manifold vacuum leaks - Intake manifold gaskets - Sticking or leaking valves - Exhaust system leakage □ Check the intake and exhaust system for casting flash or other restrictions.
Fuel System Checks	□ Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.

Table 3-13. Symptom Diagnosis

Checks	Action
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	□ Refer to Important Preliminary Checks. □ Refer to the LPG Fuel system OBD System Check □ 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 □ Remove the air filter and check for dirt or restriction. □ Check the vehicle transmission Refer to the OEM transmission diagnostics.
Fuel System Checks	□ Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG Fuel System Diagnosis. □ Check for the proper ignition output voltage with the spark tester J 26792 or the equivalent. □ Check for proper installation of the mixer module assembly. □ Check all air inlet ducts for condition and proper installation. □ Check for fuel leaks between the LPR and the mixer. □ Verify that the LPG tank manual shut-off valve is fully open. □ Verify that liquid fuel (not vapor) is being delivered to the LPR.
Sensor Checks	□ Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. □ Check for proper operation of the TPS sensor.
Exhaust System Checks	□ 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: □ Engine compression □ Valve timing □ Improper or worn camshaft. Refer to Engine Mechanical in the Service Manual.
Additional Check	□ Check the ECM grounds for being clean, tight, and in their proper locations. □ Check the generator output voltage. □ If all procedures have been completed and no malfunction has been found, review and inspect the following items: □ Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. □ 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	□ Refer to Important Preliminary Checks. □ Check the air cleaner element (filter) for dirt or being plugged. □ Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections. □ 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? □ Suggest to the owner to fill the fuel tank and to recheck the fuel economy. □ Suggest that a different operator use the equipment and record the results.
Fuel System Checks	□ Check the LPR fuel pressure. Refer to LPG Fuel System Diagnosis. □ Check the fuel system for leakage.
Sensor Checks	□ Check the Temperature Manifold Absolute Pressure (TMAP) sensor.

Table 3-13. Symptom Diagnosis

Checks	Action
Ignition System Checks	□ Verify that the spark plugs are correct for use with LPG (R42LTS) □ 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 ignition wires for the following items: - Cracking - Hardness - Proper connections
Cooling System Checks	□ Check the engine thermostat for always being open or for the wrong heat range
Additional Check	□ Check the transmission shift pattern. Refer to the OEM Transmission Controls section the Service Manual. □ 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	□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 driveability problem. □Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: □Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	□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. □Check for a sticking mixer air valve. □Verify proper operation of the EPR. □Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. □Check the LPR fuel pressure. Refer to the LPG Fuel System Diagnosis. □Check mixer module assembly for proper installation and connection.
Ignition System Checks	□Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. □ Verify that the spark plugs are correct for use with LPG (R42LTS) □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 □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. □Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. □Check the ECM grounds for being clean, tight, and in their proper locations. □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.

Table 3-13. Symptom Diagnosis

Checks	Action
Engine Mechanical Check	□ 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	□ Check Heated Exhaust Gas Oxygen Sensor (HEGO) performance.
Fuel System Checks	□ 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. □ Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. □ Verify proper fuel control solenoid operation. □ Verify that the LPG manual shut-off valve is fully open. □ Check the in-line fuel filter for restrictions.
Ignition System Checks	□ Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. □ Verify that the spark plugs are correct for use with LPG (R42LTS) □ 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	□ Check the ECM grounds for being clean, tight, and in their proper locations. □ Check the generator output voltage. □ Check the vacuum hoses for kinks or leaks. □ Check Transmission

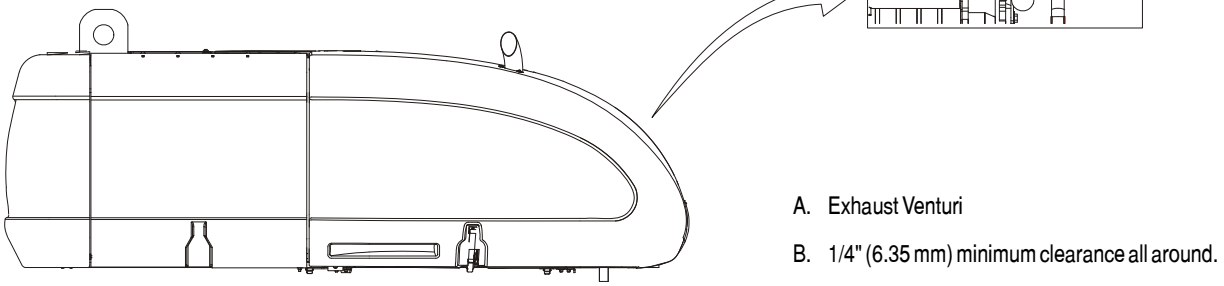
Table 3-14. DTC to SPN/FMI Cross Reference Chart

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
264	Injector Driver 2 Open	652	5
265	Injector Driver 2 Shorted	652	6
267	Injector Driver 3 Open	653	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

Table 3-14. DTC to SPN/FMI Cross Reference Chart

DTC	Description	SPN Code	FMI Code
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
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	12
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

NOTE: *The outlet pipe must be centered within 1/4" (6.35 mm) minimum clearance to the exhaust venturi all around the venturi's perimeter. If the exhaust pipe touches the venturi, it will transfer heat and melt the hood. If the exhaust pipe is not centered, adjust the muffler or outlet as needed to achieve the necessary clearance.*



A. Exhaust Venturi

B. 1/4" (6.35 mm) minimum clearance all around.

C. 3/4" (19.05 mm) minimum engagement

D. Exhaust Pipe Outlet

Figure 3-97. Exhaust Venturi Adjustment

NOTES:

SECTION 4. BOOM & PLATFORM

4.1 BOOM MAINTENANCE

Removal

1. Remove the platform/support as follows:
   a. Disconnect electrical cable from control console.
   b. Remove the eight (8) bolts securing the platform to the platform support, then remove the platform.
   c. Using an overhead crane or suitable lifting device, strap support the platform support.
   d. Remove the six (6) bolts and locknuts securing the support to the rotator.
   e. Using a suitable brass drift and hammer, remove the rotator shaft, then remove the support from the rotator.

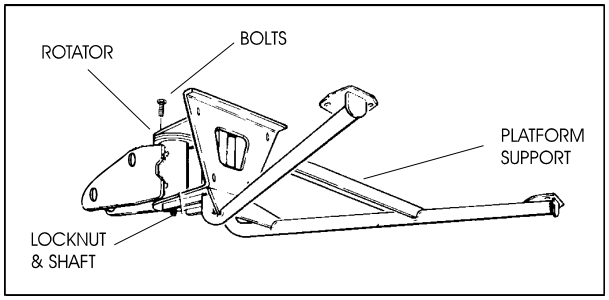


Figure 4-1. Location of Components - Platform Support

2. Remove the rotator and slave level cylinder from the fly boom as follows:
   a. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
   b. Remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1 from the fly boom.
   c. Supporting the rotator, remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the fly boom and remove the rotator.
   d. Telescope the fly section out approximately 20 inches (50.8 cm) to gain access to the leveling cylinder.
   e. Supporting the cylinder, remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the fly boom.
   f. Tag and disconnect hydraulic lines to the leveling cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the leveling cylinder.

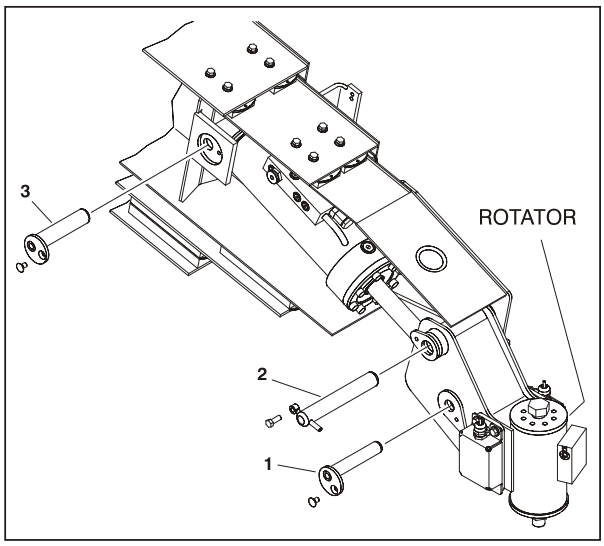


Figure 4-2. Location of Components - Rotator and Leveling Cylinder

3. Remove the powertrack from the boom as follows:
   a. Disconnect wiring harness from ground control box.

NOTICE

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

   b. Tag and disconnect hydraulic lines from boom to control valve. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
   c. Disconnect the dual capacity indicator limit switch from side of boom section.
   d. Remove hydraulic lines and electrical cables from powertrack.
   e. Using a suitable lifting equipment, adequately support powertrack weight along entire length.
   f. Remove bolts #1 securing the push tube on the fly boom section.
   g. Remove bolts #2 securing the push tube on the mid boom section.

h. With powertrack support and using all applicable safety precautions, remove bolts #3 and #4 securing rail to the base boom section. Remove powertrack from boom section.

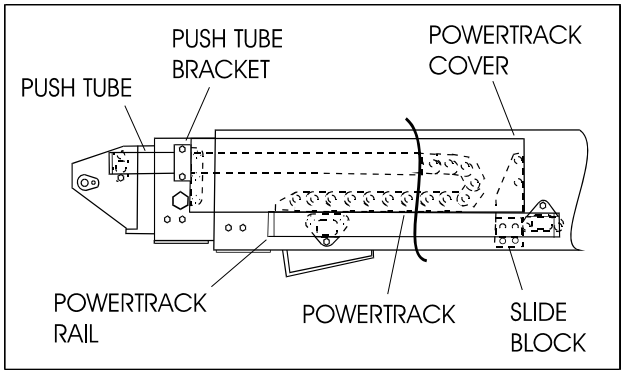


Figure 4-3. Location of Components - Boom Powertrack

4. Remove boom assembly from machine as follows:

a. Using 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.

b. Tag and disconnect hydraulic lines from telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

c. Remove hardware securing the lift cylinder rod end to the base boom section.

d. Using a suitable brass drift and hammer, remove the lift cylinder pin from the base boom.

e. Remove hardware securing the master cylinder rod end to the base boom section.

f. Using a suitable brass drift and hammer, remove the master cylinder pin from the base boom.

g. Remove hardware securing the boom pivot pin to the turntable upright.

h. Using a suitable brass drift and hammer, remove the pivot pin from the turntable upright.

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

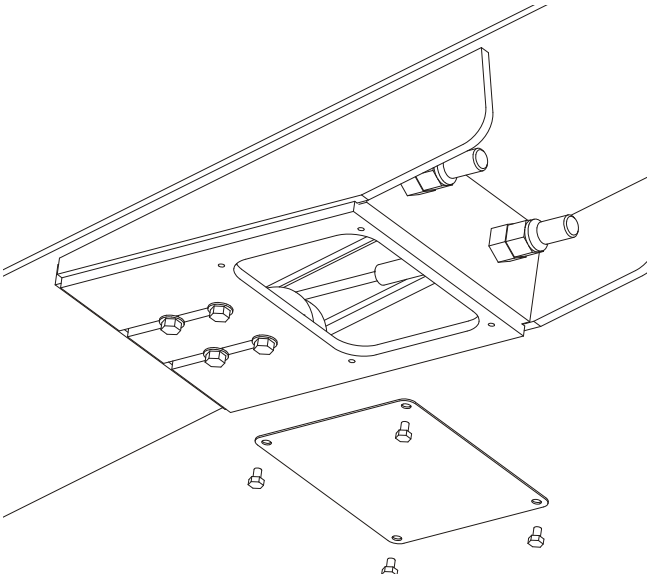
Boom Disassembly

NOTE: *The following procedure assumes the boom is removed from the machine.*

1. Extend the boom approximately 2 feet (0.6 m). This will enable access to the bolts that secure the cable mount block to the boom fly section.

2. Remove hardware securing the telescope cylinder.

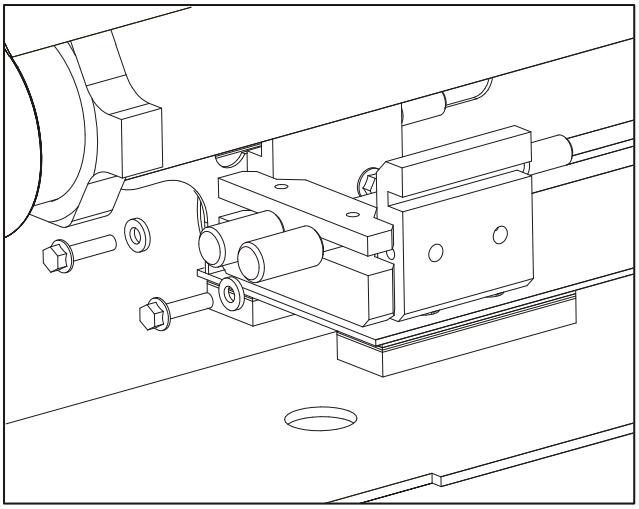
3. Remove hardware securing the cover plate on the bottom front of the base boom section.



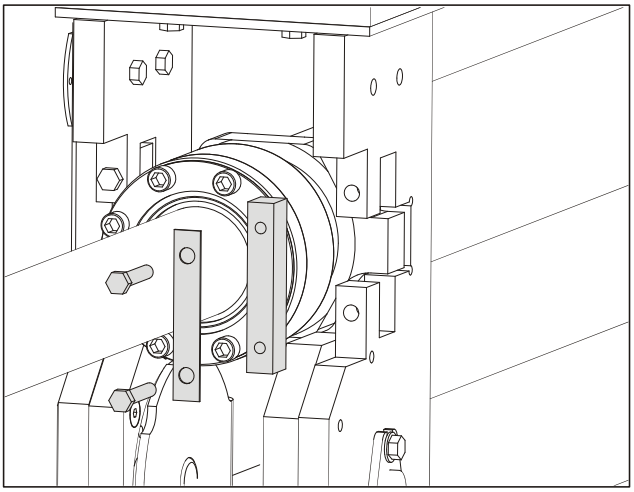
NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

4. Clamp both threaded ends of wire rope to prevent rotation. Note: Do not clamp on threads. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

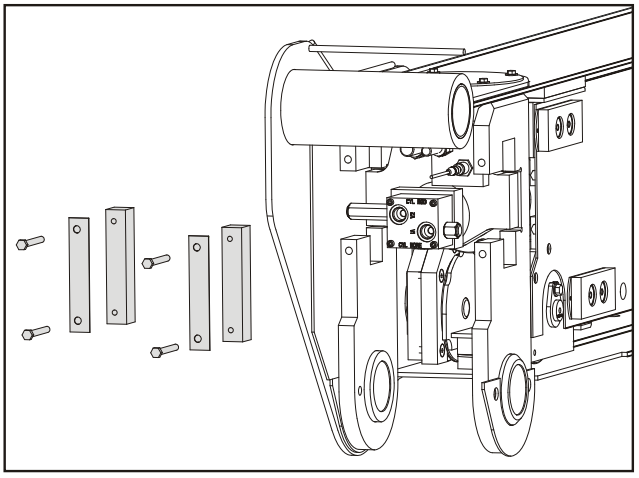
5. Using a 3/8 drive extension approximately 4 feet (1.2 m) long, remove the bolts and washers securing the cable mount block to the boom fly section.



6. Remove the four bolts, shims, and attachment blocks that secure the telescope cylinder barrel to the boom mid section.



7. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the boom base section.

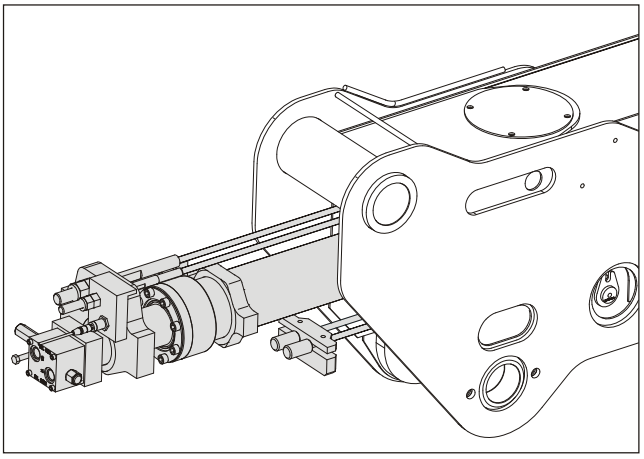


NOTICE

WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY FROM THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The telescope cylinder weighs approximately 600 lbs. (275 kg).*

8. Using overhead cranes or other suitable lifting/supporting devices, carefully pull the telescope cylinder out from the back of the boom. At the same time, also pull the cable mount block out so the extension cables come out with the telescope cylinder and do not bind. The lifting/supporting devices will have to be repositioned to support the weight of the cylinder as it is drawn out of the boom.



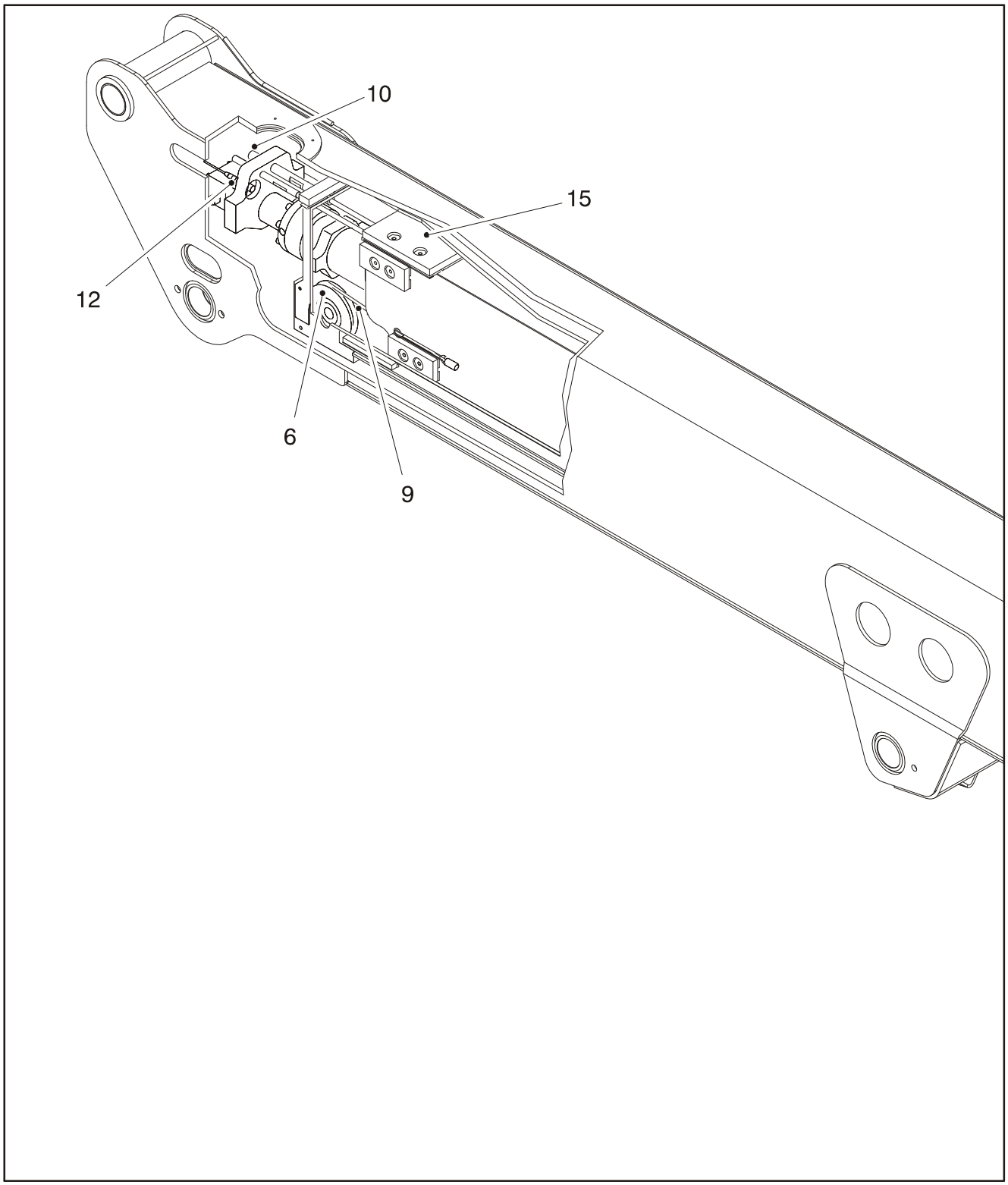


Figure 4-4. Boom Assembly Cutaway - Sheet 1 of 2

1. Base Boom
2. Mid Boom
3. Fly Boom
4. Telescope Cylinder
5. Extend Sheave
6. Retract Sheave
7. Sheave Block
8. Extend Cable
9. Retract Cable
10. Extend Cable Adjustment
11. Retract Cable Adjustment
12. Proximity Switch
13. Wear Pad
14. Shims
15. Wear Pad

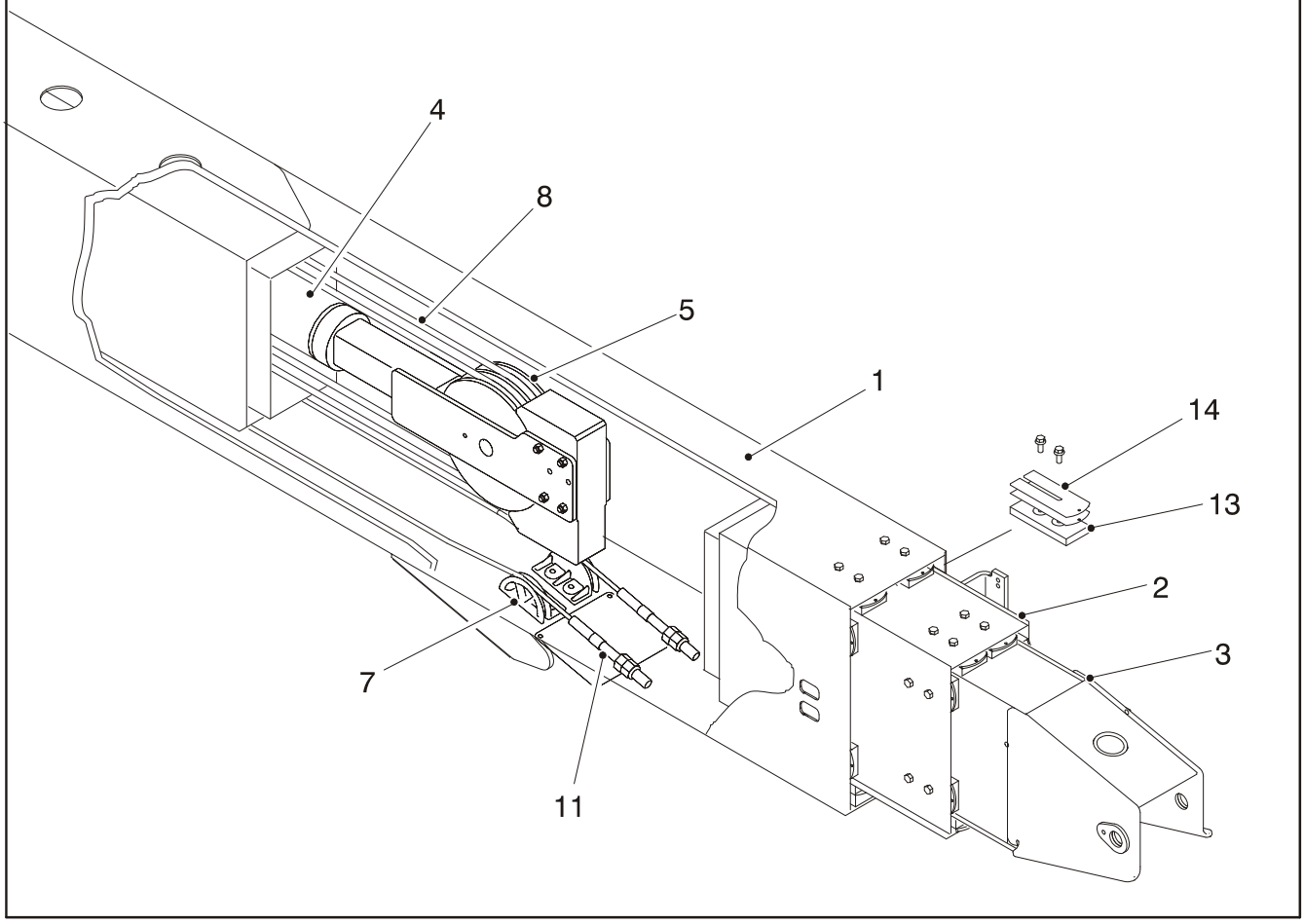
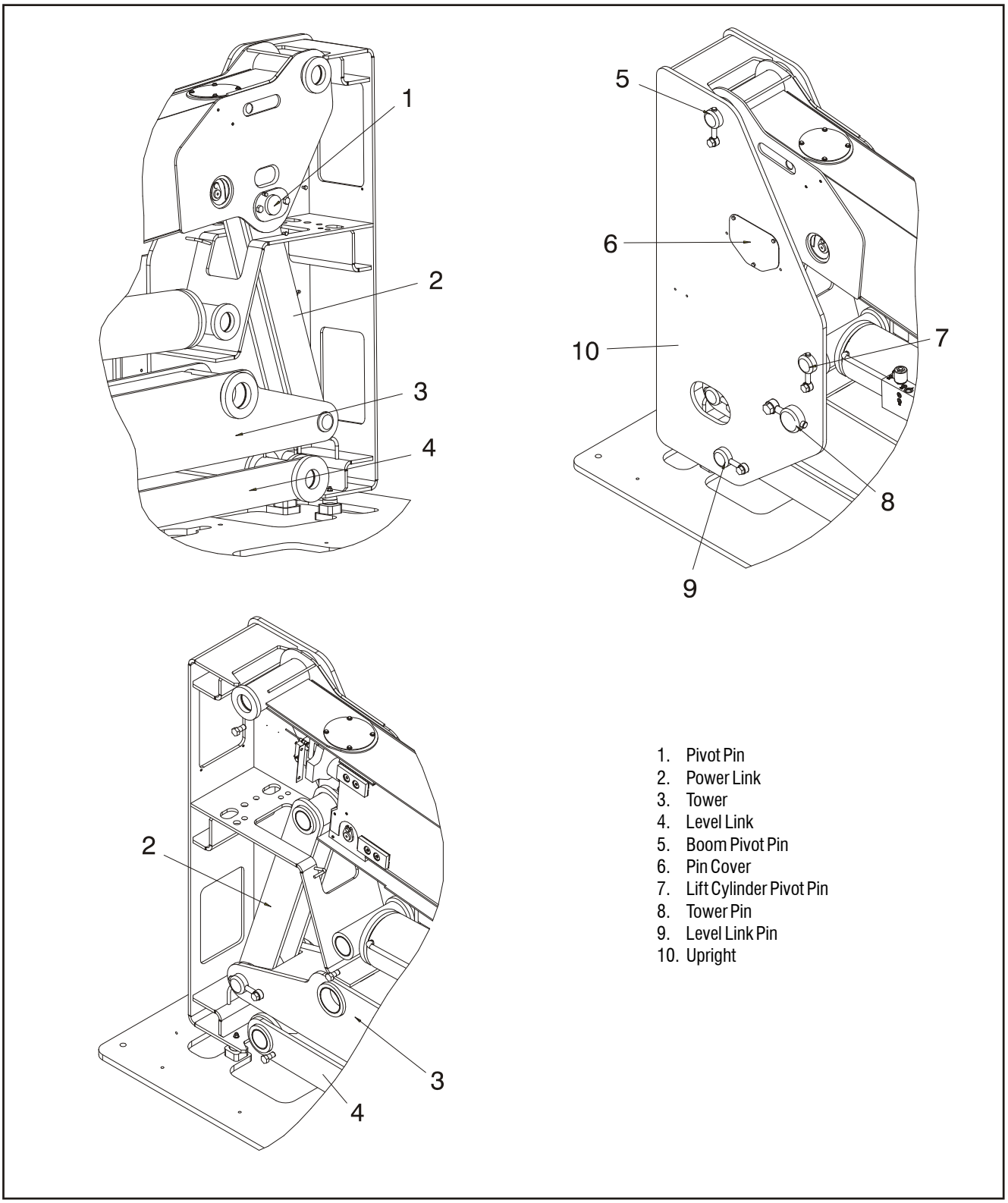


Figure 4-5. Boom Assembly Cutaway - Sheet 2 of 2



1. Pivot Pin
2. Power Link
3. Tower
4. Level Link
5. Boom Pivot Pin
6. Pin Cover
7. Lift Cylinder Pivot Pin
8. Tower Pin
9. Level Link Pin
10. Upright

Figure 4-6. Boom Components - Sheet 1 of 2

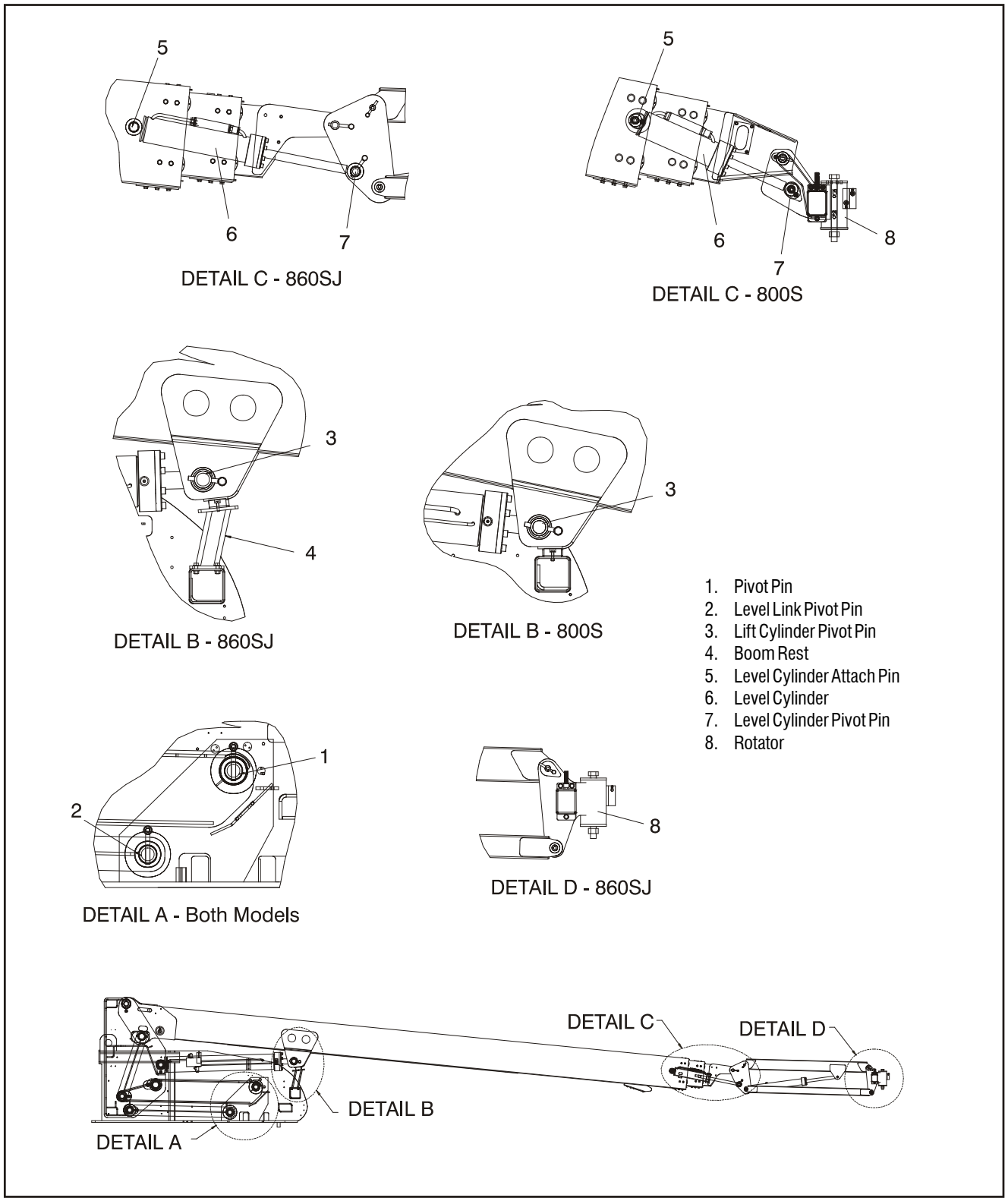


Figure 4-6. Boom Components - Sheet 2 of 2

8. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.
   a. Remove hardware from the wear pads; remove wear pads from cylinder.
   b. Remove hardware from the wire rope guard; remove guard from cylinder.
   c. Remove hardware from the sheave pin; remove pin and sheave from cylinder.

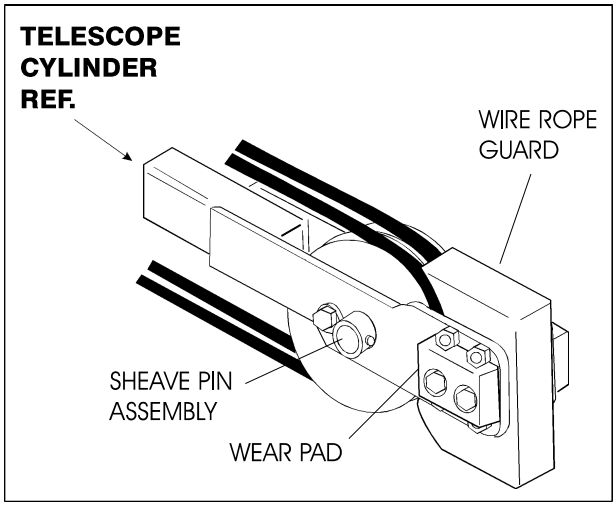


Figure 4-6. Disassembly of Sheave Assembly

9. Remove hardware which secures the wear pads to the front of base boom section; remove wear pads from the top, sides and bottom of the base boom section.
10. Using an overhead crane or suitable lifting device, remove mid and fly boom sections from base section. Note: When removing mid and fly boom sections from base boom section, retract wire rope must be dragged along with boom sections.
11. Remove hardware which secures the wear pads to the rear end of mid boom section; remove the wear pads from the top, sides and bottom of the mid boom section.
12. Remove hardware which secures the sheave guards and sheave assemblies to mid boom section, remove sheave assemblies from mid boom section.
13. Remove hardware which secures the wear pads to the front of mid boom section; remove wear pads from the top, sides and bottom of the mid boom section.
14. Using an overhead crane or suitable lifting device, remove fly boom section from mid section. Note: When removing fly boom section from mid boom section, retract wire rope must be dragged along with fly boom section.
15. Remove hardware which secures the wear pads to the rear end of fly boom section; remove wear pads from the top, sides and bottom of the fly boom section.
16. When removing wire rope from fly boom section, push the cable into fly boom. Route wire rope back through holes in the side of the fly boom section.

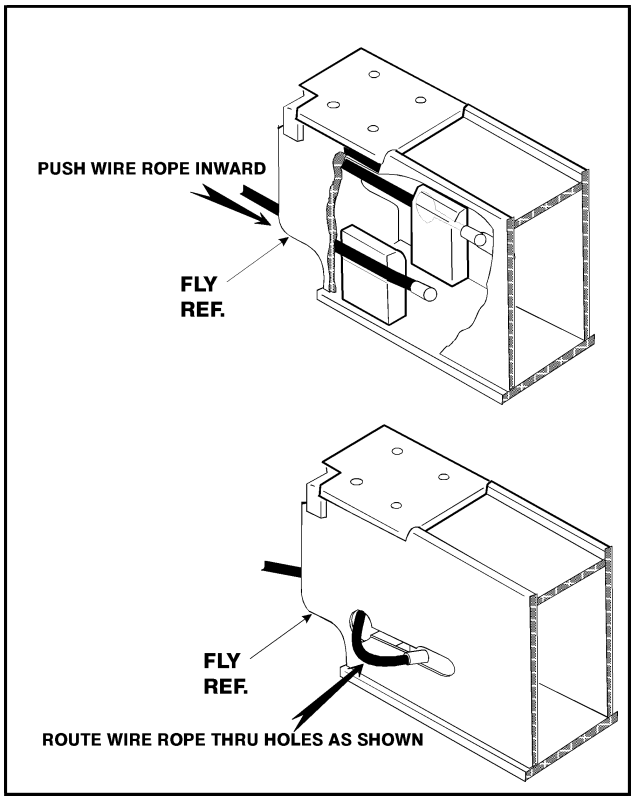


Figure 4-7. Disassembly Wire Rope Routing Procedure

Inspection

NOTE: *When inspecting pins and bearings Refer to the guidelines established in Section 2 - General.*

1. Inspect all sheaves (extend and retract wire ropes and telescope cylinder) for excessive groove wear, burrs or other damage. Replace sheaves as necessary.

NOTE: *To check the size, contour and amount of wear, a groove gauge is used. Replace the sheave if worn as shown in the following drawing.*

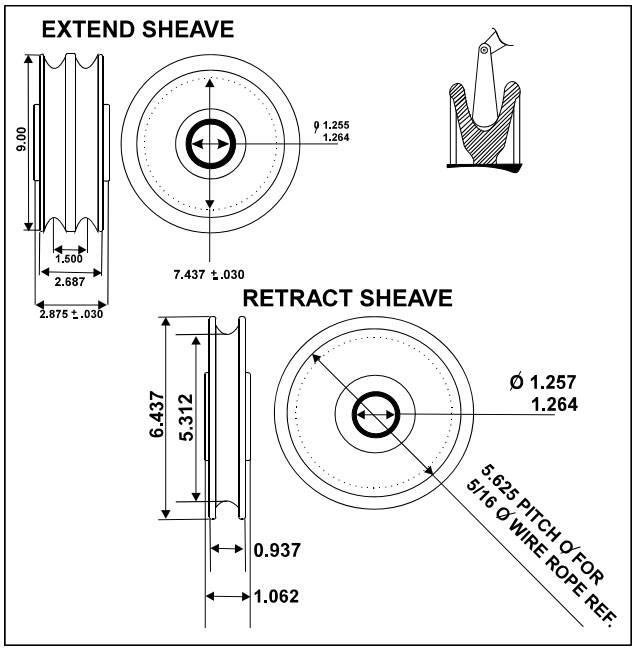


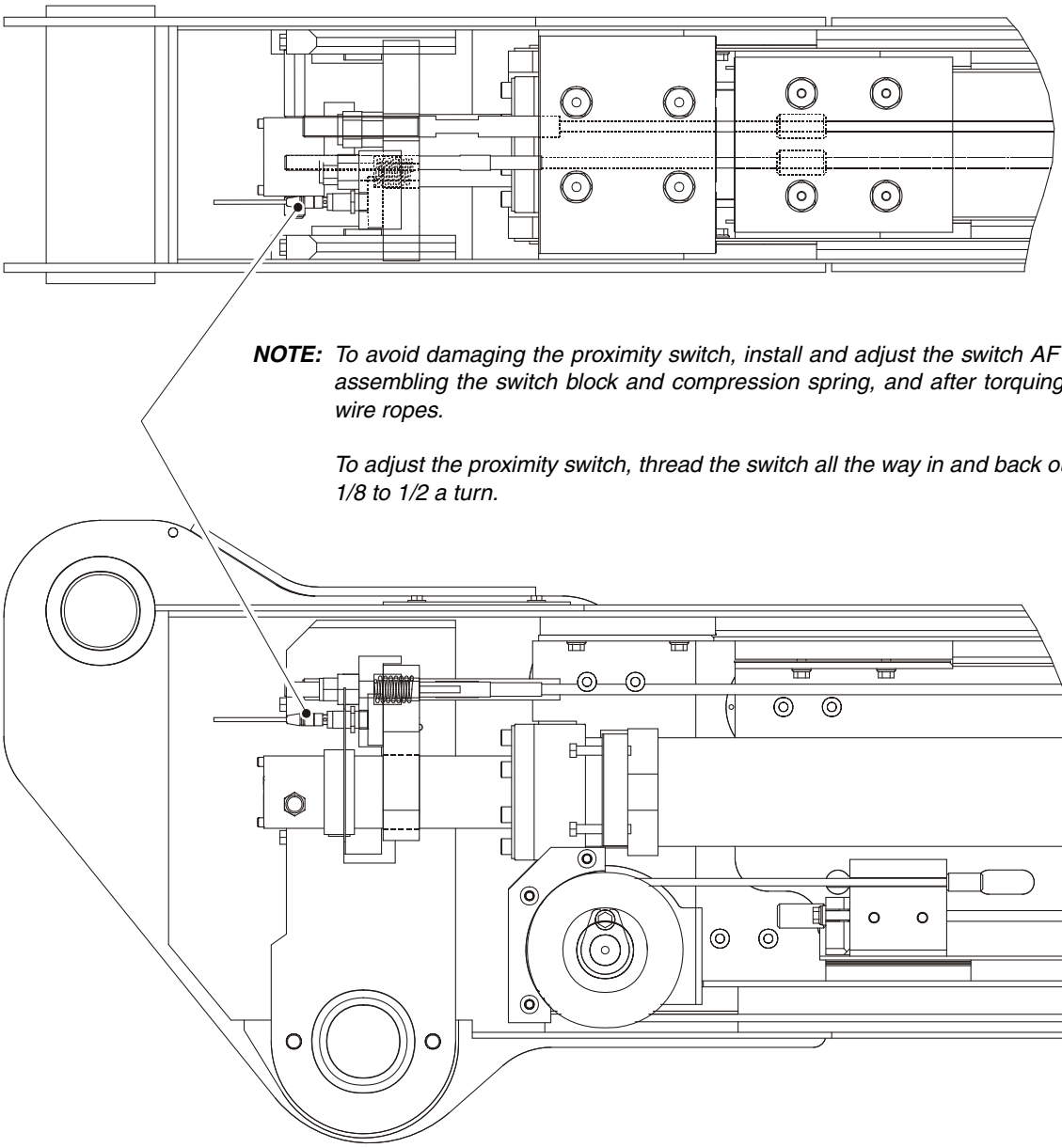
Figure 4-8. Dimension of Sheaves When New

2. Inspect extend and retract wire rope sheave bearings for wear, scoring, or other damage, and for ovality.
3. Inspect extend wire rope and retract wire rope sheave pins for scoring, tapering and ovality. Replace pins as necessary.
4. Inspect telescope cylinder sheave pin for scoring, tapering and ovality. Replace pins as necessary.
5. Inspect boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
6. Inspect telescope cylinder attach point for scoring, tapering and ovality. Replace pins as necessary.
7. Inspect upper lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
8. Inspect inner diameter of boom pivot bushing for scoring, distortion, wear, or other damage. Replace bearing as necessary.
9. Inspect all wear pads for excessive wear or other damage. Replace pads when worn to within 1/8 inch (3.2 mm) of threaded insert.
10. Inspect extend and retract wire rope attach point components for cracks, stretching, distortion, or other damage. Replace components as necessary.
11. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
12. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as 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 and mid sections to determine the number of shims required for proper lift.
2. Measure inside dimensions of the mid section to determine the number of shims required for proper lift.
3. Install side, top and bottom wear pads to the rear end of fly section; shim evenly to the measurements of the inside of mid section.



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

To adjust the proximity switch, thread the switch all the way in and back out 1/8 to 1/2 a turn.

Figure 4-9. Proximity Switch Adjustment

4. Install retract wire ropes into rear end of fly section, route wire ropes thru holes in side of fly boom section and pull into slot.

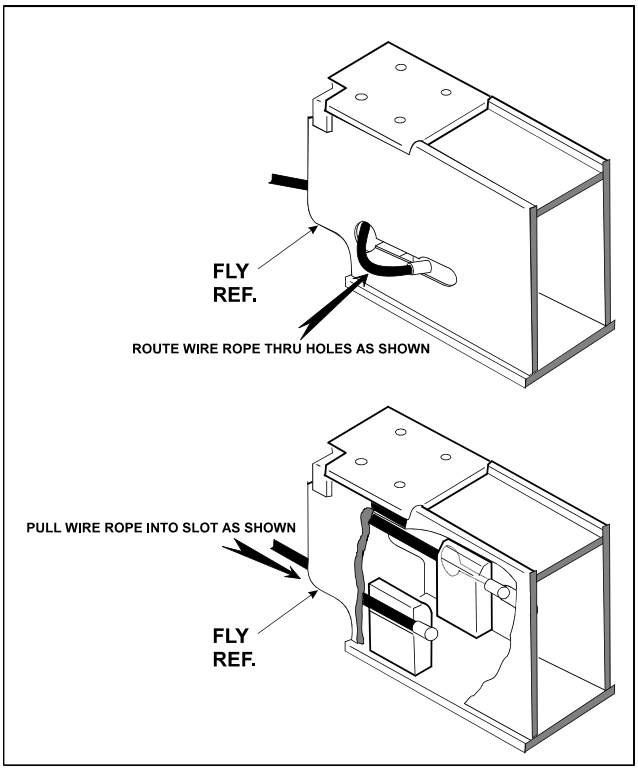


Figure 4-10. Routing Installation of Retract Wire Ropes

5. Install side, top and bottom wear pads to the rear end of mid section; shim evenly to the measurements of the inside of mid section.

NOTICE

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

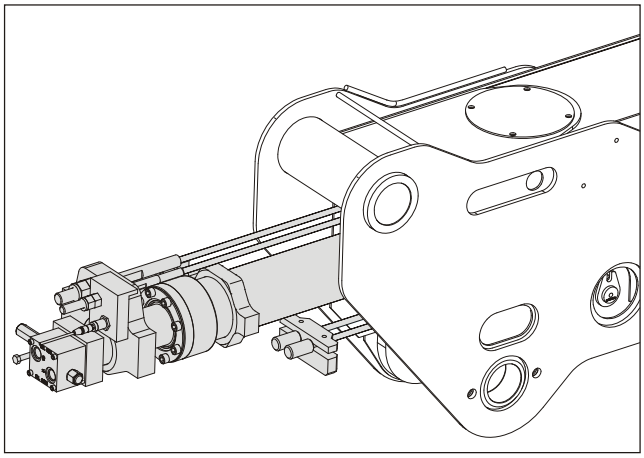
6. Shim the insides of the boom sections for a total of 1/16 inch (0.062) clearance (if the action is centered, there will be 1/32 clearance on each side).
7. Slide fly boom section into the mid boom section. Shim boom, if necessary, for a total of 1/16 inch (0.062) clearance.
8. Install wear pads into the forward position of the mid boom section. Shim boom, if necessary, for a total of 2/10 inch (0.20) clearance.
9. Properly position the retraction wire rope sheaves assemblies at the rear end of the mid boom section; ensure all sheave-to-mounting block attachment holes align. Install the sheave pins and secure them with mounting hardware. Position retract wire ropes onto the sheaves.
10. Install sheave guards to rear end of mid boom section and secure with mounting hardware.
11. Slide mid boom section into the base boom section. Allow the retraction wire ropes to trail between the bottom surfaces of boom sections. Shim boom, if necessary, for a total of 1/16 inch (0.062) clearance.
12. Install wear pads into the forward position of the base boom section. Shim boom, if necessary, for a total of 2/10 inch (0.20) clearance.
13. Install sheave block to bottom of base boom section and adjust block so that retract wire ropes do not come into contact with boom surfaces.
14. Install wire rope threaded ends thru attachment holes in the bottom of base boom section. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.
15. Pull the boom sections out to approximately where they were extended to for telescope cylinder removal.
16. Install a new extend sheave on the end of the telescope cylinder.
17. Route new extend cables around the telescope cylinder. Loosely fasten the threaded end of the cables to the rod end of the telescope cylinder with the adjusting nuts and lock nuts. Install the opposite end of the cables in the cable mount block.
18. Use tape or tie straps to fasten the cables to the telescope cylinder assembly. It is important that the tape or straps be strong enough to hold the cable in place yet weak enough to break and fall away when the cables are adjusted.

NOTICE

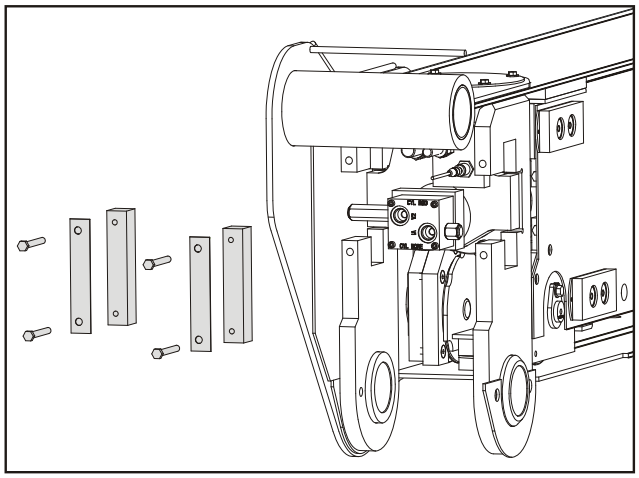
WHEN PUSHING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The telescope cylinder weighs approximately 600 lbs. (275 kg).*

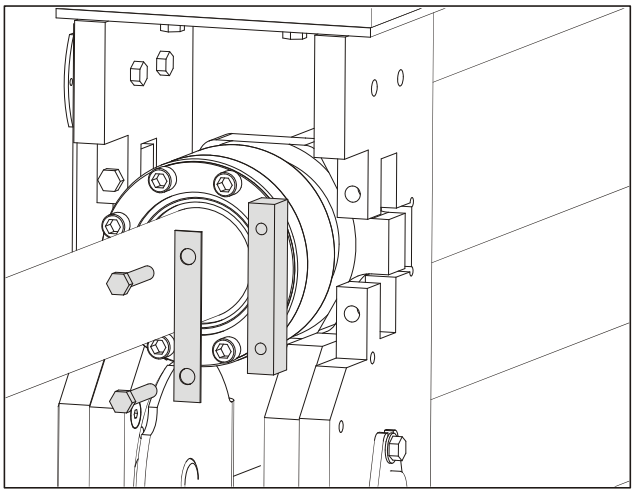
19. Using adequate lifting equipment, carefully push the telescope cylinder assembly and cables back into the boom.



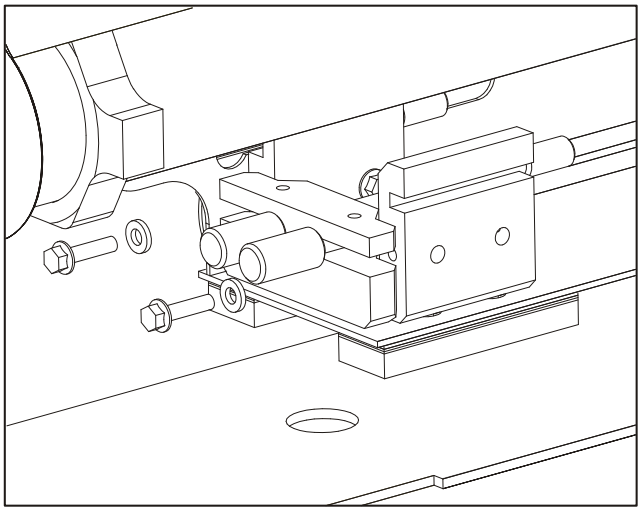
20. Apply Loctite #242 to the bolts and fasten the telescope cylinder rod to the boom base section with the bolts, shims, mounting blocks.



21. Apply Loctite #242 to the bolts and fasten the telescope cylinder barrel to the boom mid section with the bolts, shims, mounting blocks.



22. Using a 3/8 drive extension approximately 4 feet (1.2 m) long, install the bolts and washers securing the cable mount block to the boom fly section. Tape the bolts to the socket at the end of the extension to prevent it from coming out of the socket before it engages the mounting threads.



23. Connect all the hydraulic lines to the cylinder as tagged during the removal procedure.

24. Adjust the boom cables as outlined under Section 4.3, Boom Rope Torquing Procedures.

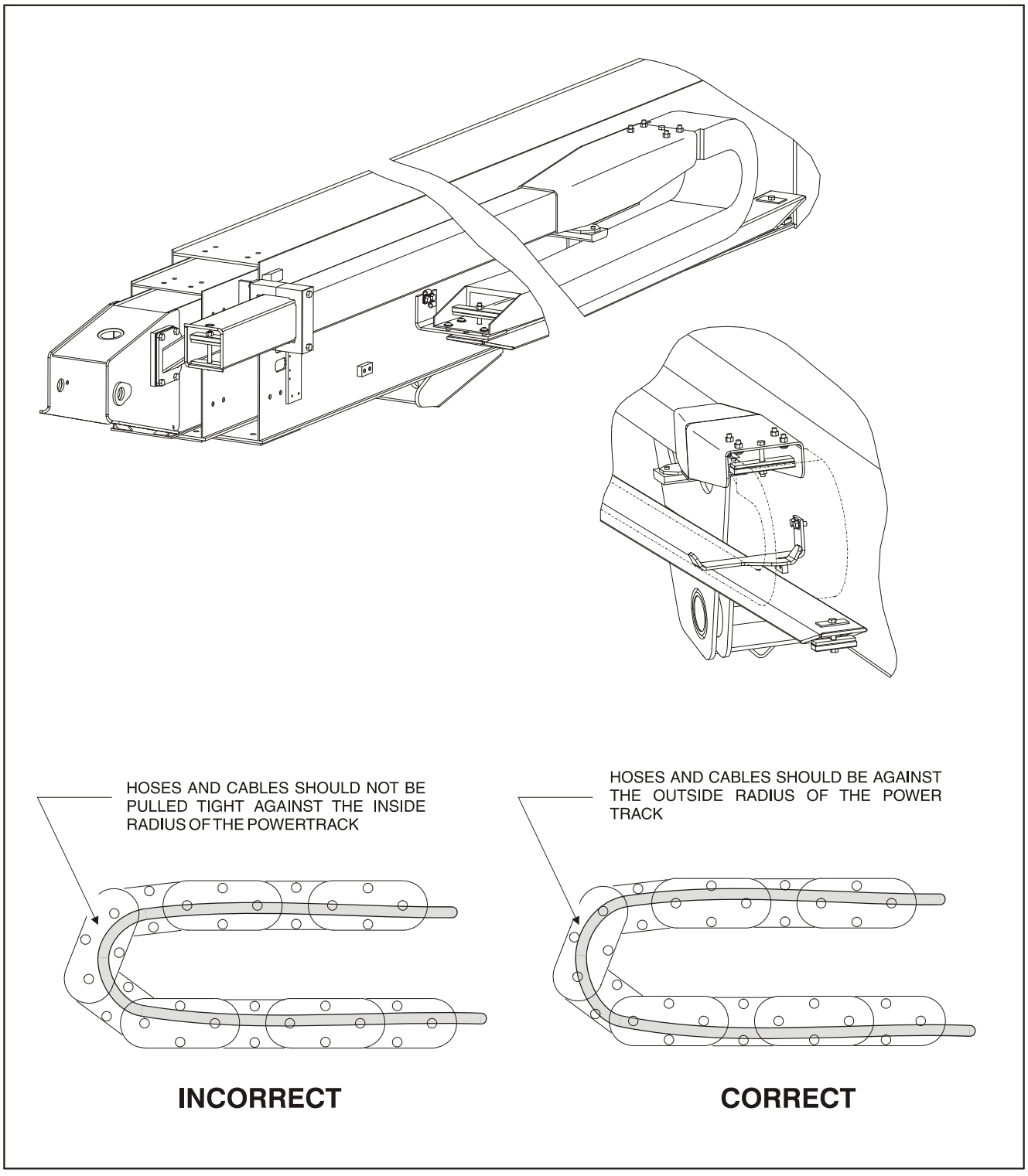


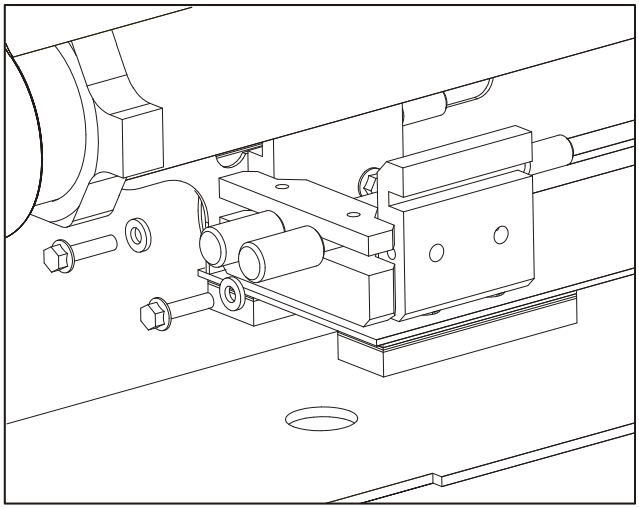
Figure 4-11. Boom Powertrack Installation

Installation

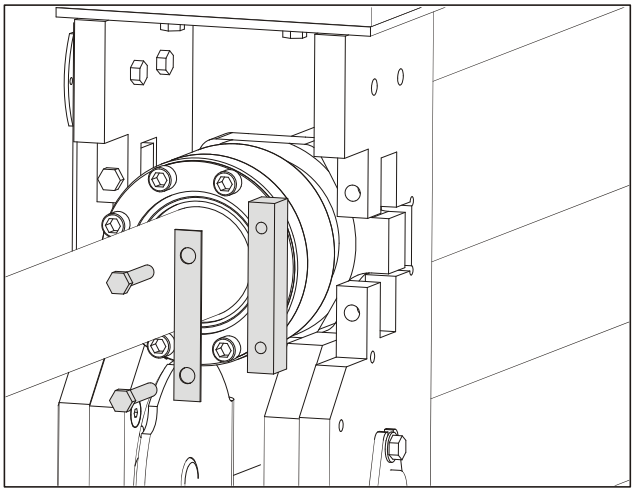
1. Using a suitable lifting device, position boom assembly on upright so that the pivot holes in both boom and upright are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on upright.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
4. Connect all wiring to the ground control box.
5. Connect all hydraulic lines running along side of boom assembly.
6. Using all applicable safety precautions, operate lifting device in order to position boom lift cylinder so that holes in the cylinder rod end and boom structure are aligned. Insert the lift cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
7. Align holes in boom structure with hole in master cylinder. Insert the master cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
8. Adjust retract and extend cables to the proper torque. Refer to Section 4.3, Boom Rope Torquing Procedures.
9. Using all applicable safety precautions, operate machine systems and raise and extend boom fully, noting the performance of the extension cycle.
10. Retract and lower boom, noting the performance of the retraction cycle.

Telescope Cylinder/Boom Cable Removal

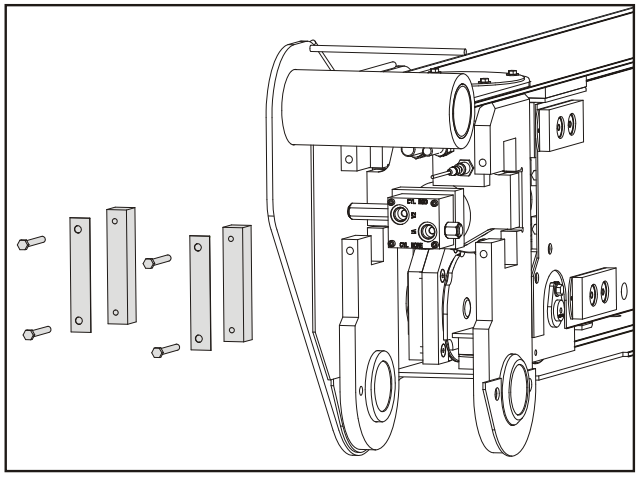
1. Make sure the machine is on a firm, level surface.
2. Raise the boom to a horizontal position.
3. Extend the boom approximately 2 feet (0.6 m). This will enable access to the bolts that secure the cable mount block to the boom fly section.
4. Tag and disconnect all hydraulic hoses running to the telescope cylinder. Cap or plug all openings to prevent any foreign matter from entering the hydraulic system.
5. Using a 3/8 drive extension approximately 4 feet (1.2 m) long, remove the bolts and washers securing the cable mount block to the boom fly section.



6. Remove the four bolts, shims, and attachment blocks that secure the telescope cylinder barrel to the boom mid section.



7. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the boom base section.

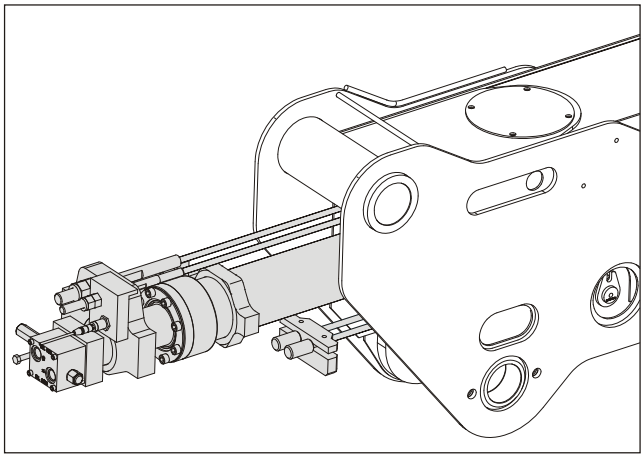


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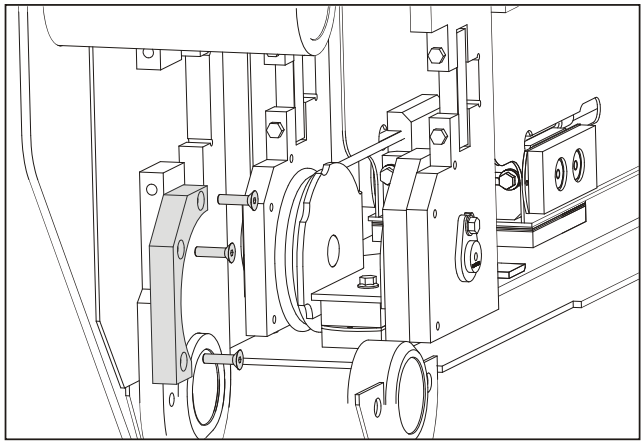
NOTE: *The telescope cylinder weighs approximately 600 lbs. (275 kg).*

8. Using overhead cranes or other suitable lifting/supporting devices, carefully pull the telescope cylinder out from the back of the boom. At the same time, also pull the cable mount block out so the extension cables come out with the telescope cylinder and do not bind. The lifting/supporting devices will have to be repositioned to support the weight of the cylinder as it is drawn out of the boom.

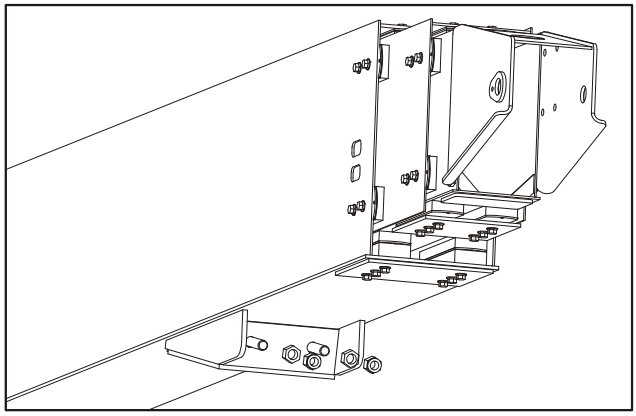


9. Push the boom fly sections back in to gain access to the boom retraction cable.

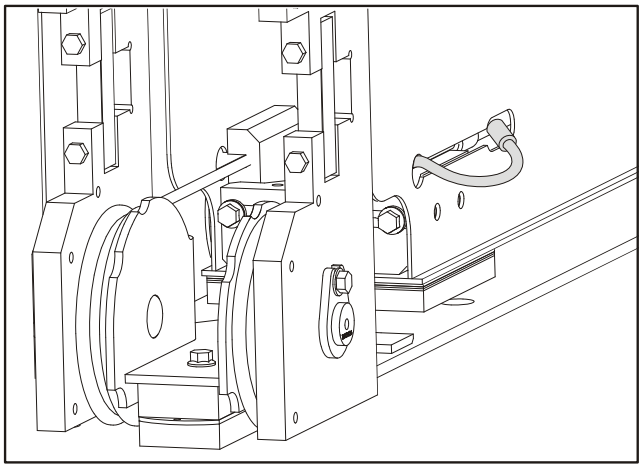
10. Remove the screws securing the sheave guards to the boom mid section and remove the sheave guards.



11. Remove the adjusting nuts and lock nuts from the opposite end of the retraction cables at the front of the boom base section. To aid in installing new retraction cables, fasten a length of tie wire as long as the retraction cables to the ends of the cables.



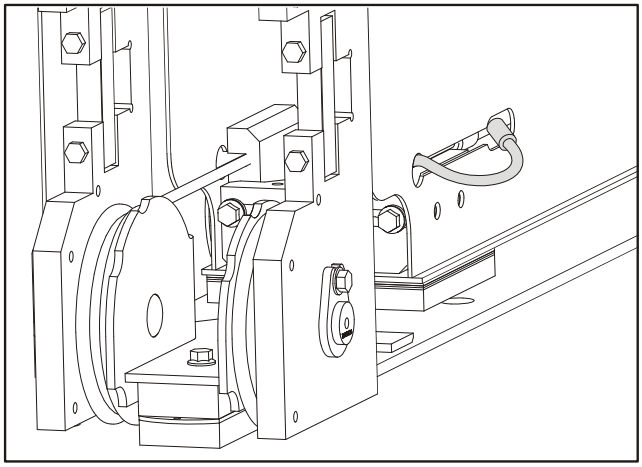
12. Twist the ends of the retraction cables to remove the ends of the cables from the slots in the side of the boom fly section.



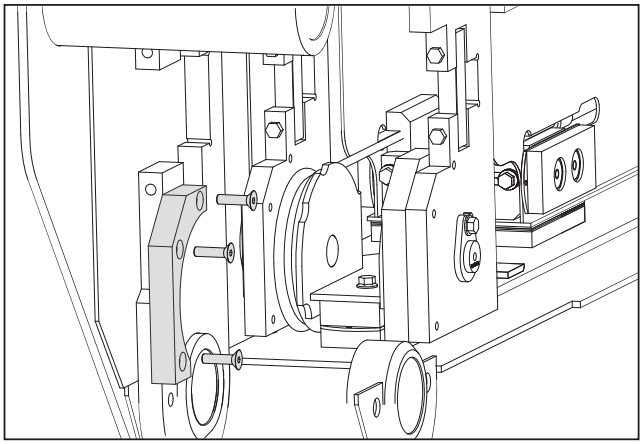
13. From the rear of the boom, pull out the boom retraction cables.

Telescope Cylinder/Boom Cable Installation

1. Attach the threaded end of the new retraction cables to the tie wires used in the removal procedure.
2. From the front of the boom, pull the retraction cables through the boom and through the attachment holes in the bottom of the boom base section. Loosely install the adjustment nuts and jam nuts.
3. Install new retract sheaves, then route the opposite end of the retraction cables around the sheaves. Push the ends of the cables through the slots in the side of the boom fly section.



4. Install the sheave guards and secure them in place with the retaining screws.



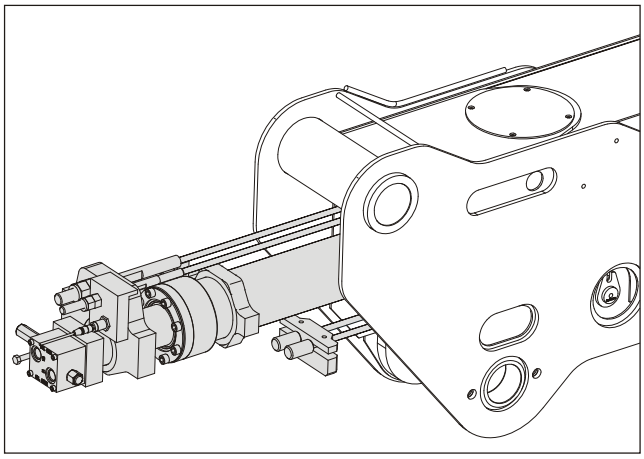
5. Pull the boom sections out to approximately where they were extended to for telescope cylinder removal.
6. Install a new extend sheave on the end of the telescope cylinder.
7. Route new extend cables around the telescope cylinder. Loosely fasten the threaded end of the cables to the rod end of the telescope cylinder with the adjusting nuts and lock nuts. Install the opposite end of the cables in the cable mount block.
8. Use tape or tie straps to fasten the cables to the telescope cylinder assembly. It is important that the tape or straps be strong enough to hold the cable in place yet weak enough to break and fall away when the cables are adjusted.

NOTICE

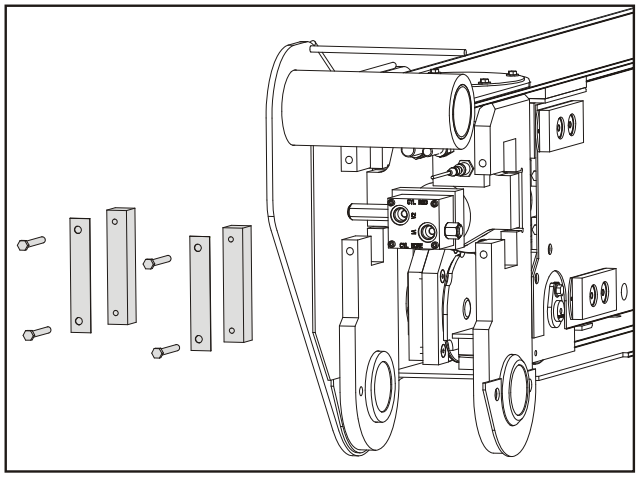
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NOTE: *The telescope cylinder weighs approximately 600 lbs. (275 kg).*

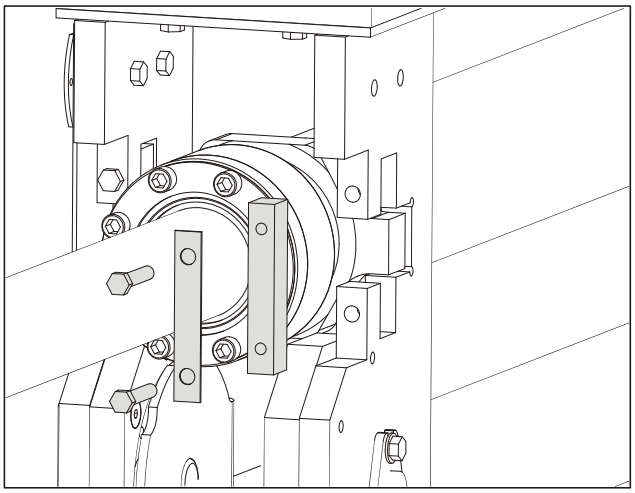
9. Using adequate lifting equipment, carefully push the telescope cylinder assembly and cables back into the boom.



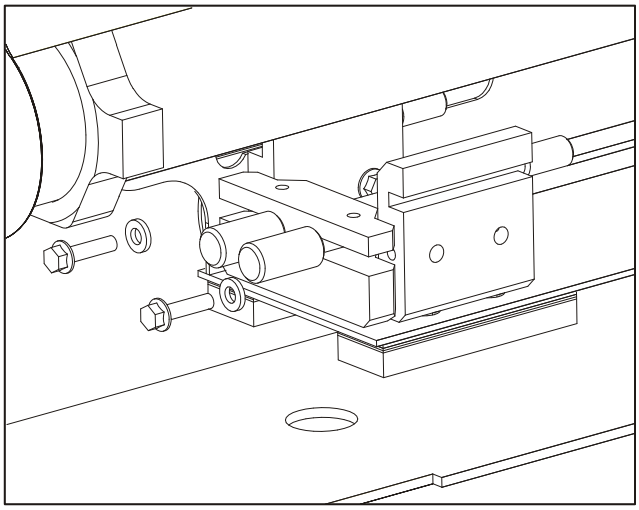
10. Apply Loctite #242 to the bolts and fasten the telescope cylinder rod to the boom base section with the bolts, shims, mounting blocks.



11. Apply Loctite #242 to the bolts and fasten the telescope cylinder barrel to the boom mid section with the bolts, shims, mounting blocks.



12. Using a 3/8 drive extension approximately 4 feet (1.2 m) long, install the bolts and washers securing the cable mount block to the boom fly section. Tape the bolts to the socket at the end of the extension to prevent it from coming out of the socket before it engages the mounting threads.



13. Connect all the hydraulic lines to the cylinder as tagged during the removal procedure.

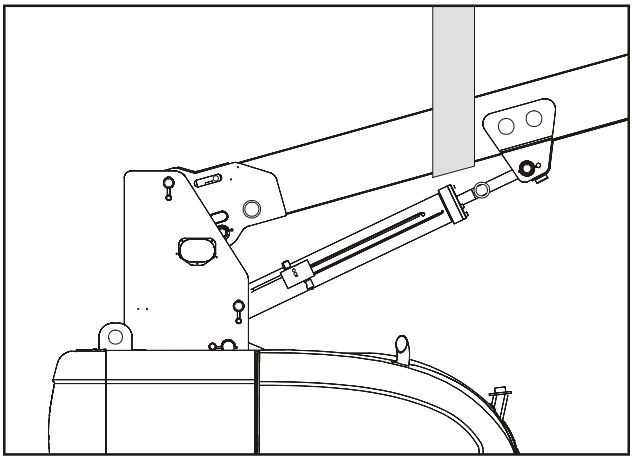
14. Adjust the boom cables as outlined under Section 4.3, Boom Rope Torquing Procedures.

15. Run the boom through all lift and telescope functions and check for proper operation or any leakage.

Lift Cylinder Removal

1. Elevate the boom enough to gain access to the lift cylinder lower pivot pin.
2. Use an adequate supporting device to support the weight of the boom and associated components as shown below.

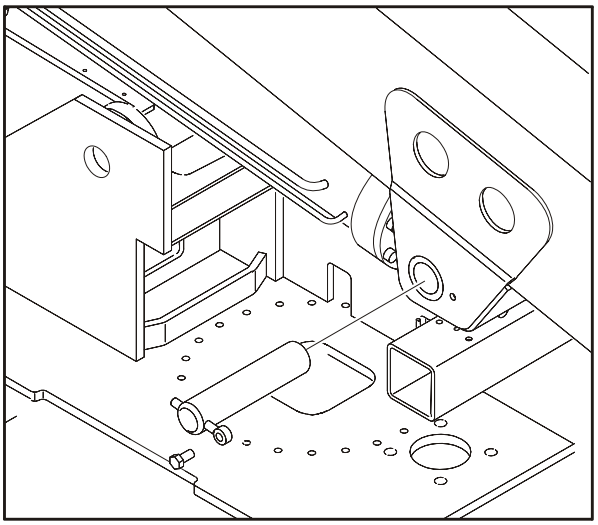
NOTE: *The supporting device must be able to support approximately 5350 pounds (2430 kg).*



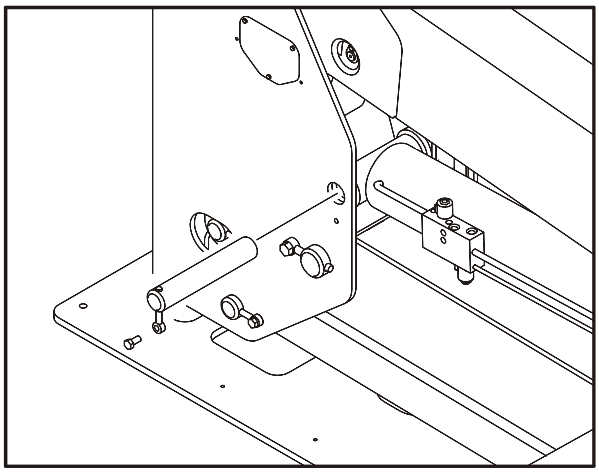
3. Tag and disconnect the hydraulic hoses from the lift cylinder.
4. Use an adequate lifting device to support the lift cylinder.

NOTE: *The lift cylinder weighs approximately 618 pounds (280 kg).*

5. Remove the bolt and keeper pin securing the upper lift cylinder pivot pin and remove the pivot pin.



6. Remove the bolt and keeper pin securing the lower lift cylinder pivot pin and remove the pivot pin.



7. Using the lifting device, slide the lift cylinder back enough to allow the cylinder end to clear the attachment point on the boom.
8. Slide the lift cylinder sideways enough to remove it from the machine.

Lift Cylinder Installation

1. Using an adequate lifting device, position the lift cylinder in the machine in the same manner that it was removed.
2. Install the lower pivot pin and secure it in place with the keeper pin and bolt.
3. Connect the hydraulic lines to the cylinder as tagged during removal.
4. Extend the cylinder rod until it aligns with the attachment point on the boom. Take care not to extend the cylinder rod too far.
5. Install the upper lift cylinder pivot pin and secure it in place with the keeper pin and bolt.
6. Remove the supporting device and function check the boom to make sure the lift cylinder operates properly and there are no leaks.

4.2 WIRE ROPE

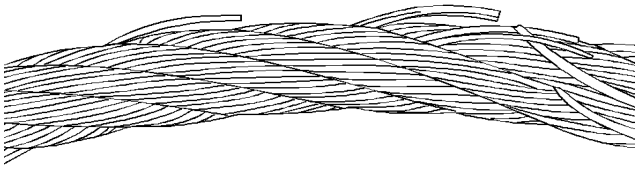
Each day before using the machine:

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

Inspection

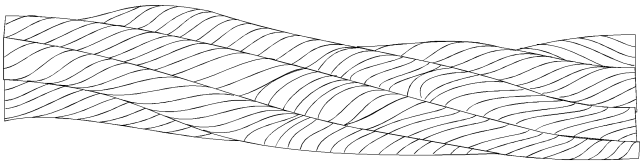
NOTE: *The pictures in this paragraph are just samples to show the replacement criteria of the rope.*

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



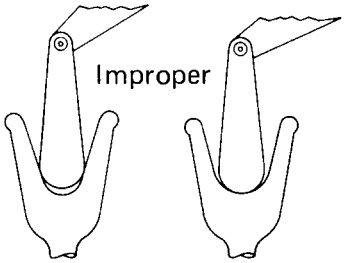
Flexing a wire rope can often expose broken wires hidden in valleys between strands.

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



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

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



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

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

Three Month Inspection

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

Seven Year Inspection

1. Mandatory wire rope and sheave replacement.

   Additional inspection required if:

   a. Machine is exposed to hostile environment or conditions.
   b. Erratic boom operation or unusual noise exists.
   c. Machine is idle for an extended period.
   d. Boom is overloaded or sustained a shock load.
   e. Boom exposed to electrical arc...wires may be fused internally.

Replacement Criteria

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

4.3 BOOM ROPE TORQUING PROCEDURES

Torque Procedures

1. Position boom in fully down and fully retracted position.
2. Clamp both threaded ends of wire rope to prevent rotation.

NOTE: *Do not clamp on threads.*

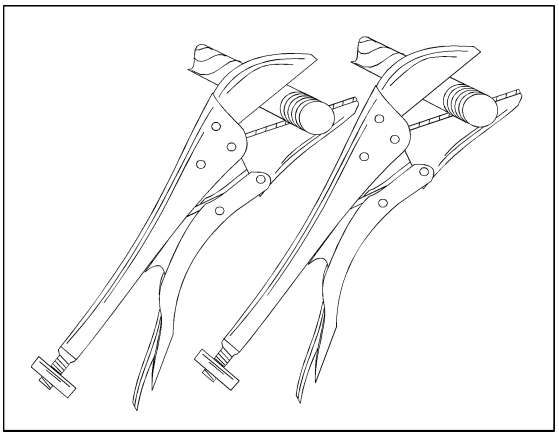


Figure 4-12. Clamping Wire Ropes

3. Install adjusting nuts (or remove nylon collar locknuts if re-adjusting) to both retract and extend wire ropes.
4. Torque retract adjusting nuts (platform end) to 15 ft. lbs. (20 Nm) alternating between the two wire ropes and keeping approximately the same amount of thread beyond the adjusting nut.

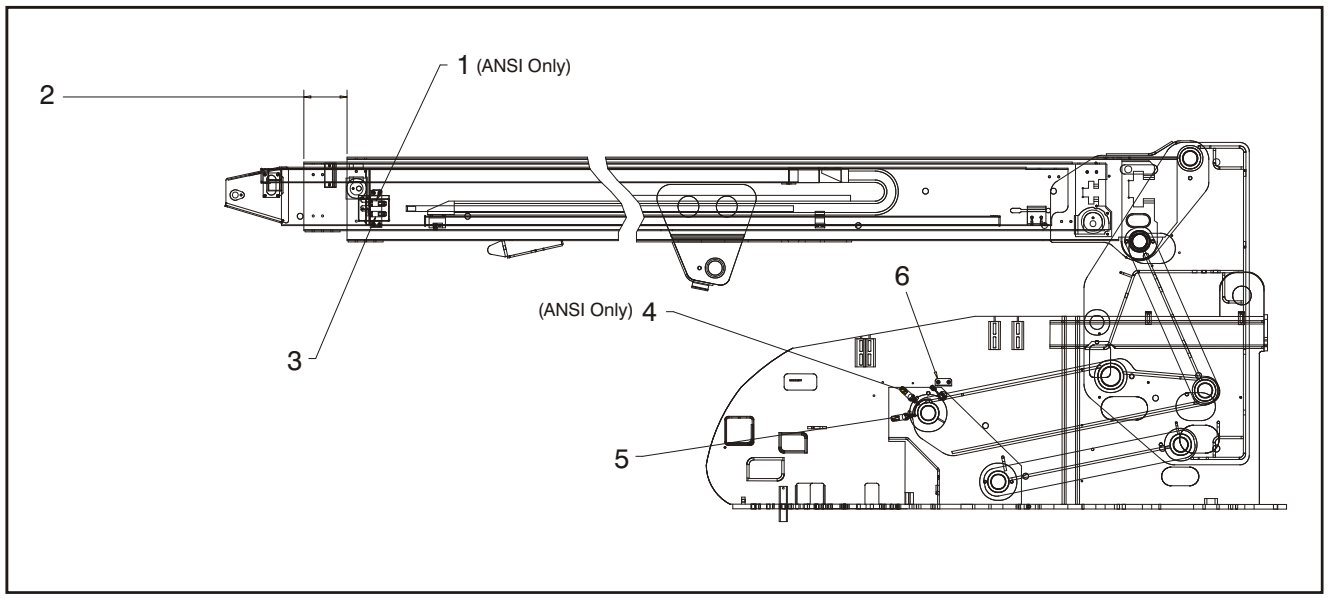
NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

5. Repeat the torque procedure in step #4 to the extend wire ropes (turntable end).
6. Extend the boom 2 - 3 feet using the telescope function. Repeat step #4.
7. Retract the boom 1 - 2 feet using the telescope function. Do not bottom out telescope cylinder. Repeat step #5.
8. Extend the boom approximately 2 - 3 feet again and check torque on the retract wire ropes.
9. Retract the boom without bottoming out telescope cylinder and check torque on the extend wire ropes.

NOTE: *Step #8 and #9 may need to be repeated to equalize the torque on all 4 wire ropes.*

10. After all wire ropes have been properly torqued, install nylon collar locknuts. Remove all clamping devices and install all covers and guards. Check the boom for proper function.

4.4 ELEVATION & CAPACITY SWITCHES - 800S



1	Boom Capacity Length Switch to trip boom when it's 216" ± 1" (5486mm ± 25mm) from fully extended
2	150.75" ± 1" (3829mm ± 25mm) position of boom sections to Trip Capacity Length Switch (ANSI Only) 18.25" ± 1" (463.5mm ± 25mm) position of boom sections to trip Transport Length Switch
3	Boom Transport Length Switch to trip when boom is 18" ± 1" from fully retracted
4	Boom Capacity Angle Switch to trip when upper boom is 50° to 55° above horizontal. 52° is the preferred trip angle Boom Capacity Angle Switch to reset when upper boom is 59° to 64° above horizontal. 61° is the preferred reset angle
5	Boom Elevation Switch to trip when upper boom is 7° to 12° above horizontal. 9° is the preferred trip angle Boom Elevation Switch to reset when upper boom is 3° below horizontal to 2° above horizontal. 0° is the preferred reset angle
6	End of Stroke Switch should trip when boom is 5° from end of extended cylinder stroke

Figure 4-13. Elevation, Dual Capacity and Transport Switch Information - 800S

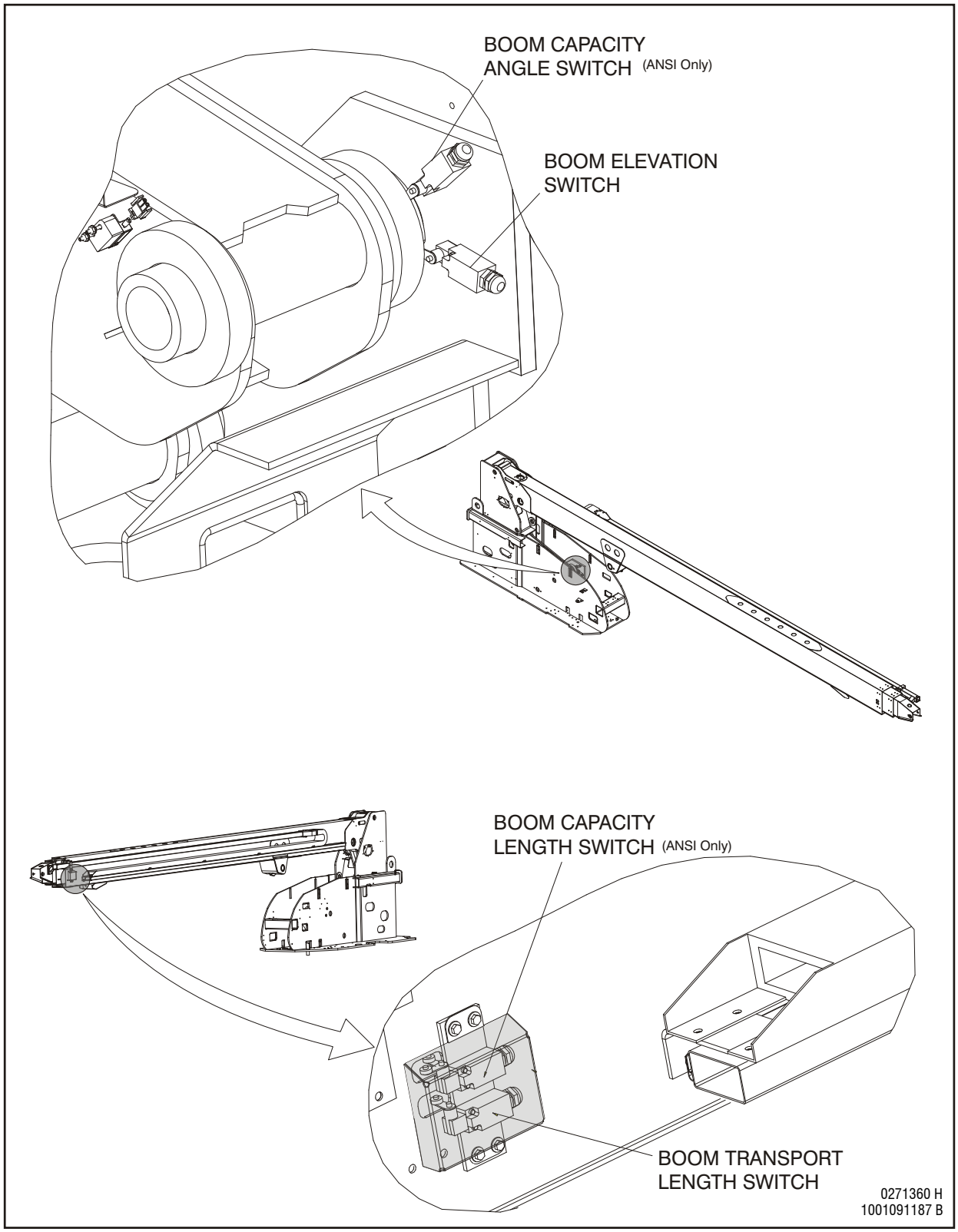
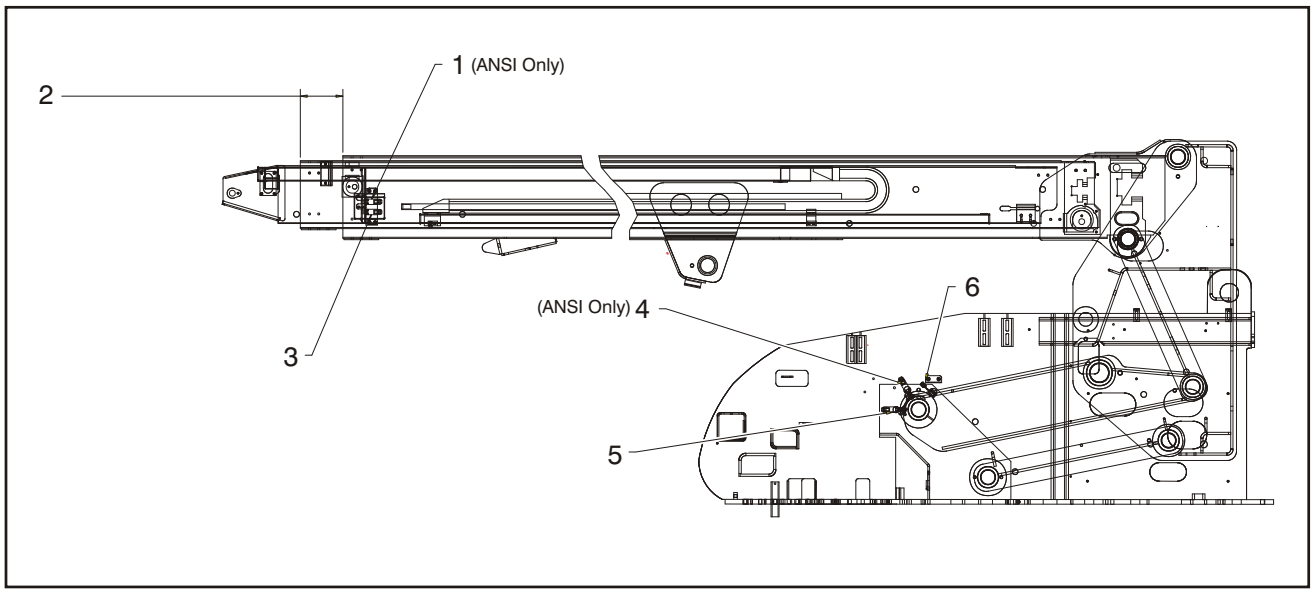


Figure 4-14. Elevation, Dual Capacity and Transport Switch Installation - 800S

4.5 ELEVATION, DUAL CAPACITY, & TRANSPORT SWITCH - 860SJ



1	Boom Capacity Length Switch to trip boom when it's 180" ± 1" (4572mm ± 25mm) from fully extended
2	160.25" ± 1" (4070mm ± 25mm) position of boom sections to Trip Capacity Length Switch (ANSI Only) 18.25" ± 1" (463.5mm ± 25mm) position of boom sections to trip Transport Length Switch
3	Boom Transport Length Switch to trip when boom is 18" ± 1" from fully retracted
4	Boom Capacity Angle Switch to trip when upper boom is 44° to 49° above horizontal. 46° is the preferred trip angle Boom Capacity Angle Switch to reset when upper boom is 52° to 57° above horizontal. 55° is the preferred reset angle
5	Boom Elevation Switch to trip when upper boom is 9° to 14° above horizontal. 12° is the preferred trip angle Boom Elevation Switch to reset when upper boom is 1° below horizontal to 4° above horizontal. 2° is the preferred reset angle
6	End of Stroke Switch should trip when boom is 5° from end of extended cylinder stroke

Figure 4-15. Elevation, Dual Capacity, and Transport Switch Information - 860S

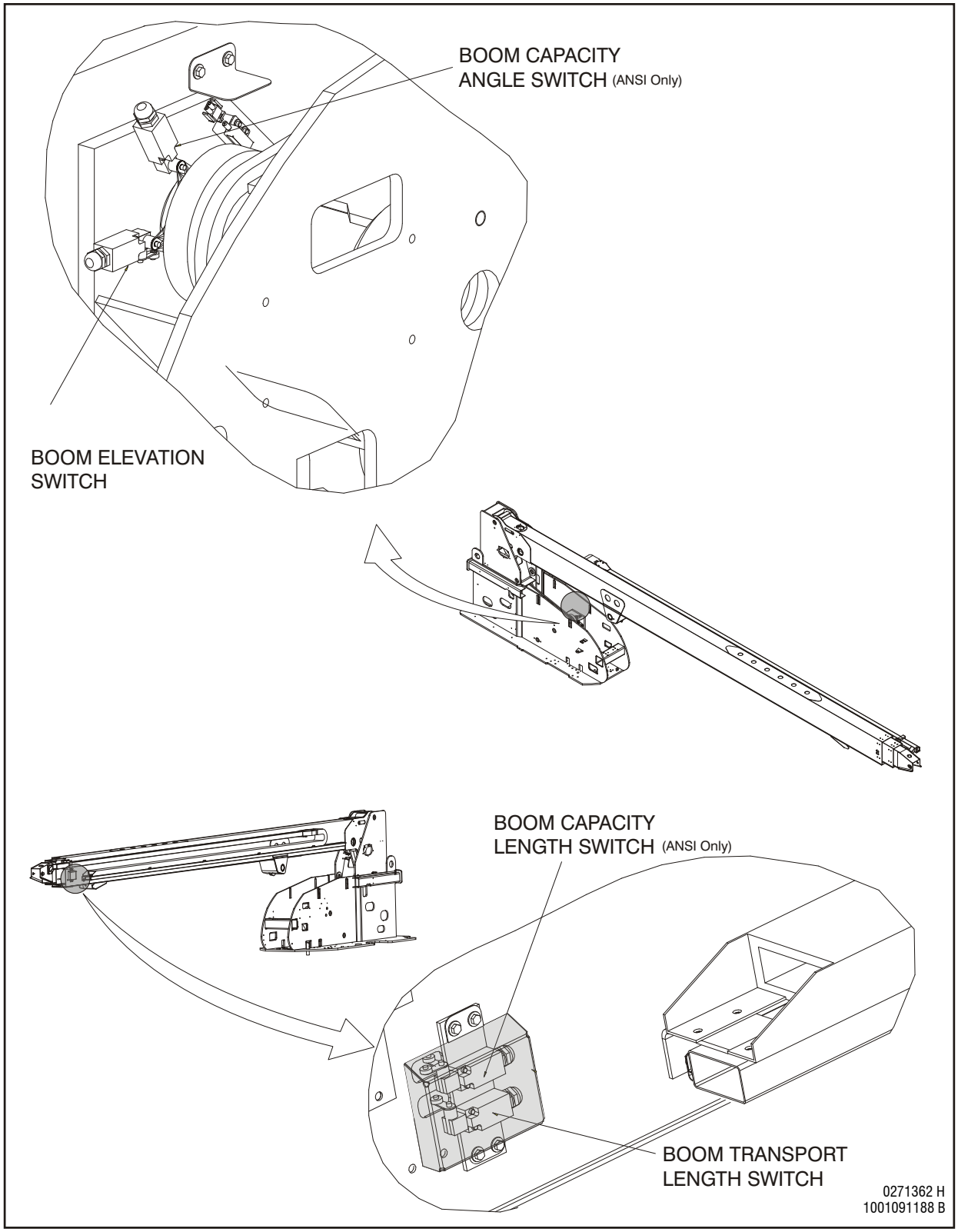


Figure 4-16. Elevation, Dual Capacity, and Transport Switch Installation - 860S

4.6 ELECTRONIC PLATFORM LEVELING

Description

Electronic platform leveling replaces the conventional hydraulic method of platform leveling. The term "platform leveling" does not refer to the system maintaining the platform at level (or 0°) with respect to gravity, but instead refers to the controls automatically maintaining the platform within several degrees of a preset angle.

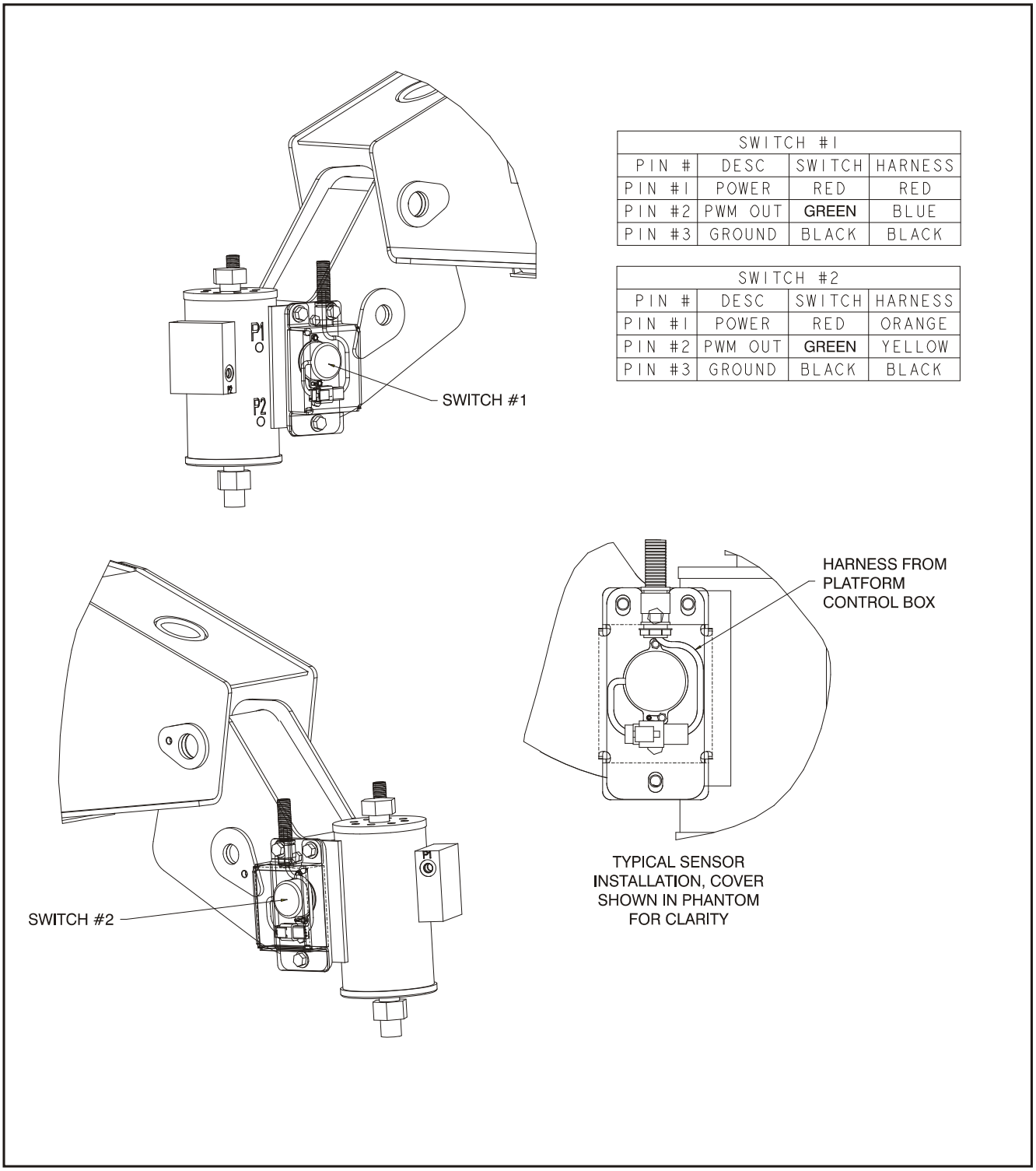
To control electronic platform leveling the platform is equipped with a pair of tilt sensors, one primary and one secondary, mounted to the non-rotating portion of the platform rotator, level up and level down valves that are used to provide proportional hydraulic flow for each directional function, and a control module that interprets the sensor readings and actuates the leveling valves.

PRIMARY AND SECONDARY TILT SENSOR INTERACTION

Two tilt sensors, mounted on each side of the platform support, are used to measure the incline of the platform with respect to gravity and control the automatic platform angle control function. The right one (as viewed from standing in the platform) is used as the primary sensor and the left one as a secondary back up sensor.

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

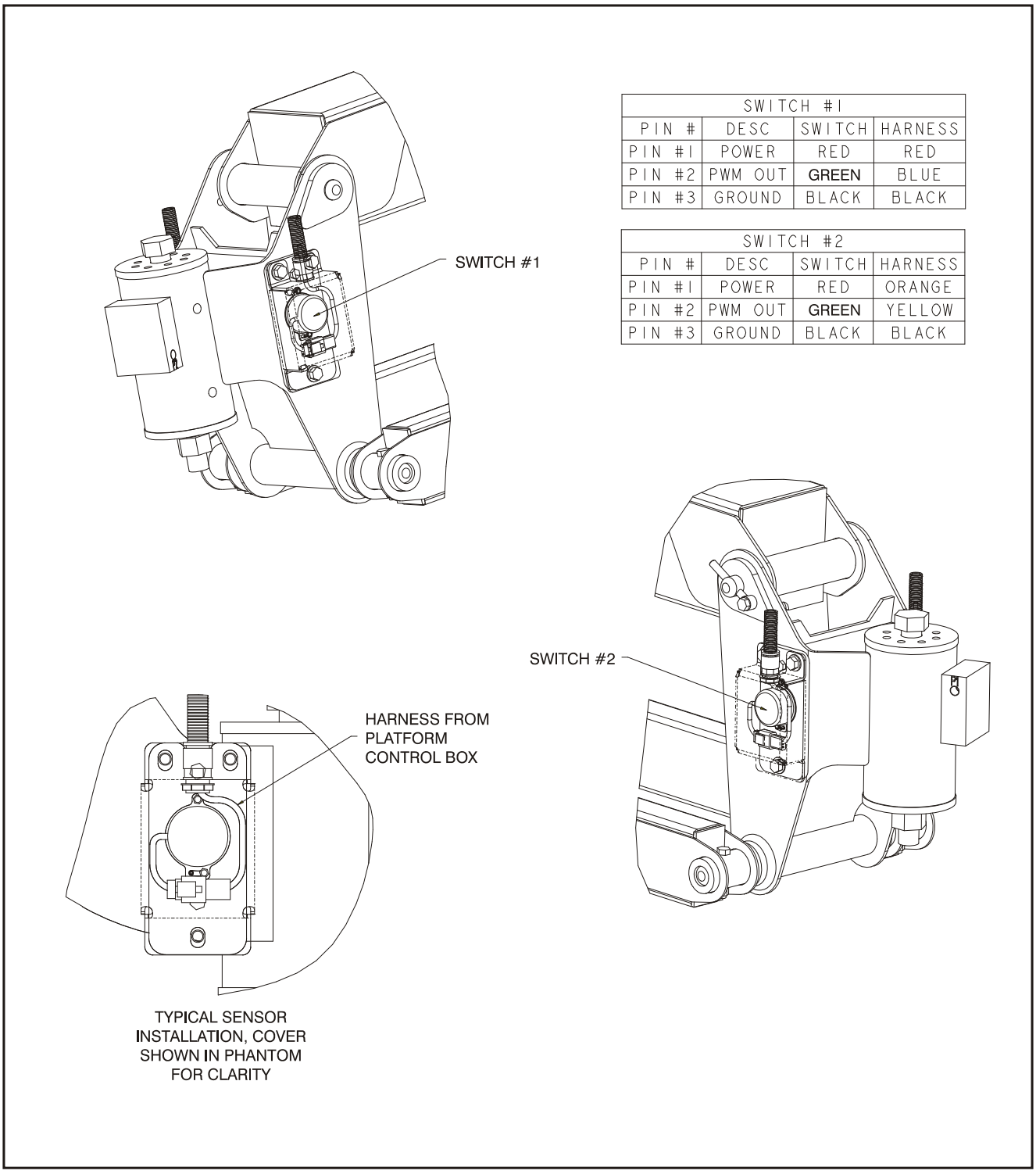
Because of the mounting orientation of the tilt sensors, the primary tilt sensor will output ascending voltage values with increases in positive platform tilt angle. The backup or secondary tilt sensor will output descending voltage values with increases in positive platform angle.



SWITCH #1			
PIN #	DESC	SWITCH	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	GREEN	BLUE
PIN #3	GROUND	BLACK	BLACK

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

Figure 4-17. Level Switches - 800S



SWITCH #1			
PIN #	DESC	SWITCH	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	GREEN	BLUE
PIN #3	GROUND	BLACK	BLACK

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

Figure 4-18. Level Switches - 860SJ

PLATFORM VALVES

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

There are six valves that control various platform functions. Two control Platform Level up and down for the leveling function, two are used to rotate the platform, and two to control jib up and down.

All platform valves are Pulse Width Modulated (PWM'd). PWM is a method of setting the voltage across a valve, and therefore the flow through it, by varying the On/Off duty cycle of the control module output. PWMing permits proportional flow control.

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

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

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

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

Normal Operation

AUTOMATIC PLATFORM ANGLE CONTROL

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

Automatic platform angle control only functions while operating drive, telescope, lift or swing. It does not adjust the platform angle while operating any other function (e.g. rotate, jib, or steer). Furthermore, machines equipped with control system software P5.0 and later, automatic platform angle control for drive and swing may be disabled by using the analyzer. For this case, the platform angle setpoint is taken when the joystick moves from a non-leveling function (drive/swing) to a leveling function (lift/tele).

The machine controls attempt to maintain the angle of the platform to setpoint by providing a command proportional to the angular error from setpoint. Since the sensors used to measure the platform angle are fluid-filled, gravity-based sensors, reading the sensors in real time would cause constant correction of the platform position due to machine vibration and inertial changes of the boom. Therefore, the sensor readings are averaged over time, or filtered, in order to achieve a more uniform reading. This filtering has the advantage of providing smoother operation, but has the disadvantage of causing a lag (or sluggishness) in the system response. This lag may cause the platform to be several degrees from setpoint.

In order to provide a better system response, the controls also compute the rate of angular change of the platform position and set the leveling valve positions to achieve a matching velocity. The measured velocity is the average platform speed over the last 0.5 seconds. The desired valve command is computed by comparing the measured velocity to the desired velocity and setting the valve opening to correspond to the required amount of make-up angle. The amount the valve opens when making an automatic correction is proportional to and directly affected by:

- Crackpoint setting
- Velocity error (proportional factor)
- Sum of velocity errors over time (integral factor)

These three factors are summed together with appropriate gain factors to compute the resulting current to the valves. The operator does not have control over the latter two factors, but can affect the resulting current by adjusting the crackpoint. Increasing the crackpoint makes the valve current higher, resulting in quicker more aggressive control and larger amounts of overshoot. Decreasing the crackpoint will result in smoother operation but may not permit enough platform velocity to keep up with the boom (i.e., may get platform timeout alarms) in some multi-function operations. The platform controls are set up to provide smooth leveling operations for the majority of conditions and will perform best for steady operator command, as opposed to command values for function, that change frequently.

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

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

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

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

1. Auxiliary power and any other function, zone = auxiliary power
2. Drive and any other function, zone = Drive

3. Lift up and any other function, zone = Lift up
4. Lift down and any other function, zone = Lift down
5. Other boom functions, zone = Other boom functions

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

PLATFORM LEVEL MANUAL OVERRIDE

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

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

The duty cycle of the output shall be scaled from the pump potentiometer. When the toggle switch is released, after one second, the current filtered value of tilt angle will be taken as **the new set point**.

In other words the operator can chose a platform level incline other than level with gravity and the system will maintain the chosen platform angle within several degrees of setpoint.

Platform Leveling Fault

The JLG Control System takes a snapshot of the two sensor values and records the difference once on each power up. The Control system allows a ±5 degree difference from those values. For example, if Sensor 1 is at 5 degrees and Sensor 2 is at 11 degrees, the difference is 6 degrees and the DTC is triggered when the sensors are 1 degree (or less) apart or 11 degrees (or more) apart.

If a fault occurs in the platform leveling system the following will occur:

1. Automatic platform angle control will stop and the platform dump valve will be disabled (level, rotate, and jib functions disabled). The exception is when there is a fault in only one sensor automatic platform angle control will remain active as the control system will use the other sensor to control leveling.
2. The level system fault lamp will flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position see below).

To reset the fault the emergency stop switch should be recycled.

NOTICE

IF THE LEVEL SYSTEM FAULT INDICATOR REMAINS ILLUMINATED, RETURN THE PLATFORM TO THE STOWED POSITION, SHUT DOWN THE MACHINE, AND REPAIR THE LEVELING SYSTEM.

ERROR RESPONSE

If basket level varies from the current **setpoint** by ± 5.5° for more than 2 seconds for large variations from setpoint when the platform is not in the transport position, the controls assume the system is not properly set up or has degraded and initiate a fault.

When the unit is in the transport position and driving and the current setpoint varies by ± 5.5° for more than 10 seconds the events 1,2,3 & 4 above will occur. (note function speeds will operate normally). Since the control system can not anticipate all conditions under which a machine is to be operated, these parameters have been chosen to provide reasonable performance and safe operation. If an error occurs, cycling the EMS will clear the fault. The operator should evaluate the operating situation and assess his machine to determine the source of the fault.

VALVE DRIVER ERRORS

There are three possible level valve driver errors, short to battery, short to ground, and open circuit.

1. In the case of a **short to ground or an open circuit**, the platform valve cannot be turned on and the following will occur:
   - **a.** All interactions with platform leveling shall cease
   - **b.** The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   - **c.** The platform alarm will sound.
   - **d.** A system fault will be logged.
   - **e.** All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).
2. In the case of a **short to battery** on one of the platform leveling valves, the valve cannot be turned off and the following will occur:
   - **a.** The platform dump valve will be turned off to prevent unintended tilting of the platform.
   - **b.** All interactions with platform leveling shall cease.
   - **c.** The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   - **d.** The platform alarm will sound.
   - **e.** A system fault will be logged.
   - **f.** All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position)
3. In the case of a **short to battery on the platform dump valve**, the valve cannot be turned off. The controllability of the platform leveling function will be impaired and the following will occur:
   - **a.** All interactions with platform leveling shall cease.
   - **b.** The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   - **c.** The platform alarm will sound.
   - **d.** A system fault will be logged.
   - **e.** All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).

Lift, swing, drive and telescope will continue to operate

In each of the cases above it shall be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

TILT SENSOR ERRORS

If the secondary tilt sensor is faulty, the control system will continue to utilize information from the primary sensor.

If the primary sensor is faulty, the control system will switch to the backup sensor for control.

In both cases above the following will occur:

1. The Electronic Leveling System Fault Lamp will flash (to indicate that there is a leveling fault).
2. The platform alarm will sound.
3. A system fault will be logged.
4. All function speeds (lift, swing, telescope, jib and drive) will be placed in creep mode (except when the platform is in the transport position).
5. Automatic platform angle control remains active.

Lift, swing, drive and telescope will continue to operate.

In each of the cases above it will be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

When both sensors appear to be working but have measurements that disagree by ±5.5º The following will occur:

1. All interactions with platform leveling shall cease.
2. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position)

At this point, the operator must use the level up and down toggle switch to manually level during descent. It shall be necessary to re-cycle the EMS to clear the fault.

CAN Errors

The Ground Module has two direct outputs dedicated to overriding the Platform Module's control of the leveling valves. The EPBC Ground Module "Platform Level Up/ Down" outputs are used to control the platform level up and down valves.

When in ground mode, if the Ground Module reads a platform leveling switch command, the switch command is communicated over CAN to the Platform Module where it is handled normally.

If Ground Module determines that CAN communication is inoperable, it turns on the platform control valve and the appropriate platform leveling override outputs while the switch is engaged.

If the Platform Module is still running when CAN is down nothing will operate when in platform mode. When the operator switches to ground mode, the platform will not control any of its valve outputs and a CAN error message is signaled.

Replacing the Level Sensors

Earlier generations of this machine had three different generations of level sensors that were used on this machine. JLG P/N 4360503, P/N 4360528, and P/N 4360544. P/N 4360528 and 4360544 supersede P/N 4360503. If one of the 4360503 sensors fail, BOTH sensors must be replaced with two P/N 4360544 sensors. 4360503 Sensors can be identified by the code SSY0185-13 which is printed on the sensor. Otherwise, single 4360528 or 4360544 9999sensors may be replaced.

Additional Platform and Jib Valves

The high side drivers for the platform left and right and the jib up and down valves are be located in the Platform Module and are PWM'd. The control for these functions are the same as currently implemented for the EPBC except that the flow through the valves is individually controllable instead of controlled by single the flow control valve. The individually controlled duty cycle will be the same as would otherwise have been commanded to the flow control valve.

Only one platform or jib function is allowed at one time to limit the amount of current draw, minimizing the voltage drop on the supply to the PM.

The function is enabled first shall remain active until it is released. Any other function commanded while another function is active is ignored.

If only one other function is commanded when the active function is released, the other function will be activated.

If more than one function is commanded when the active function is released, only one function shall be activated.

Platform Leveling Calibration Procedure

STEP 1: SETTING THE PLATFORM VALVE MINIMUMS

1. Put machine into "Ground Mode".
2. Start machine and plug in Analyzer.
3. Go to the "Access Level 2" screen.
4. Enter "33271" to get into Access Level 1 mode.
5. Go to the "Personalities" menu and adjust the following personalities. Refer to the Personality Ranges/ Defaults table in Section 6 - JLG Control System for proper setting values.

   Basket Level Up Min
   Basket Level Up Max
   Basket Level Down Max
   Jib Up Min
   Jib Down Min
6. Recycle EMS.

STEP 2: CALIBRATING THE PLATFORM LEVEL SENSORS (FOR PLATFORM SOFTWARE PRIOR TO VERSION P3.4)

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Manually level the platform with the switch on the MTB.
4. Go to the “Access Level 2” screen.
5. Enter “33271” to get into Access Level 1 mode.
6. Go to the “Calibrations” menu and hit ENTER.
7. Use RIGHT ARROW go to “Plat. Leveling” screen.
8. Hit ENTER. “Calibrate?” prompt should appear.
9. Hit ENTER again to calibrate level sensors.
10. When calibration has been successful “Cal. Complete” should appear.
11. Cycle power to the machine.

STEP 3: BLEEDING THE PLATFORM VALVES

Start up the machine and exercise the following platform functions (from the ground) eight (8) to ten (10) times for 5 seconds in each direction.

Basket Rotate
Basket Level
Jib U/D (if configured)

STEP 4: CALIBRATING THE PLATFORM LEVEL UP AND DOWN VALVE CRACKPOINTS

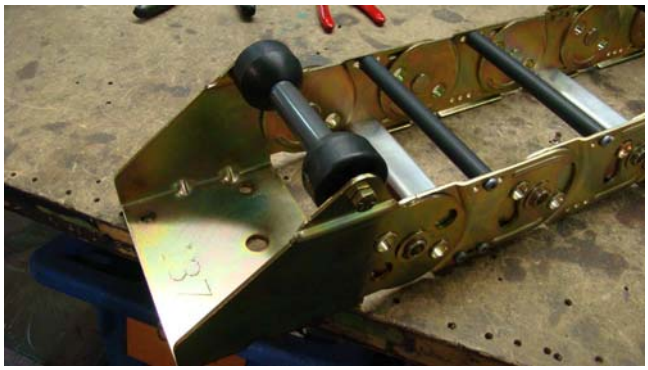
NOTE: *Since the valve position which allows minimum oil flow (crackpoint) is dependent on the oil pressure, verify the proper stand-by pressure as outlined in Section 5.3 prior to setting the crackpoints.*

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Go to the “Access Level 2” screen.
4. Enter “33271” to get into Access Level 1 mode.
5. Go to the “Calibrations” menu and hit ENTER.
6. Go to the “Basket U Crkpt” Screen. Hit ENTER.
7. “Calibrate?” prompt should appear. Hit ENTER again.
8. You will hear engine go to 1800 rpm.
9. Using UP ARROW, increase the value until you see the basket up movement. (Typically from 275 – 425).
10. Hit ENTER again. “Cal. Complete” message should appear
11. Engine should again return to idle.
12. Hit ESC should return to “Basket U Crkpt” screen.
13. Hit RIGHT ARROW to get to the “Basket D Crkpt” screen. Hit ENTER.
14. “Calibrate?” prompt should appear. Hit ENTER again.
15. You will hear engine go to 1800 rpm.
16. Using UP ARROW, increase the value until you see the basket down movement. (Typically from 275 – 425).
17. Hit ENTER again. “Cal. Complete” message should appear.
18. Engine should again return to idle.
19. Hit ESC to exit.
20. Cycle power to the machine.
21. The preceding steps will provide acceptable crackpoint settings for the majority of machines. However, if the operator can feel small jolts in the platform from the valve opening during a leveling operation, the crackpoint is likely too high for this machine. A high crackpoint may also lead to "over-leveling", causing the platform to drift beyond the set point. An example of this would be the platform tilting too far backwards during a Lift Up operation. Therefore, use the following guidelines to evaluate whether further crackpoint adjustment is required.
    a. Telescope the machine halfway.
    b. Perform Lift Up. If the basket leans backward (over compensates), the Level Down crackpoint is too high. If the basket leans forward or a BASKET LEVELING SYSTEM TIMEOUT fault occurs, the Level Down crackpoint is too low.
    c. Perform Lift Down. If the basket leans forward (over compensates), the Level Up crackpoint is too high. If the basket leans backwards or the Tilt Cutout Alarm comes on, the Level Up crackpoint is too low.

4.7 POWERTRACK MAINTENANCE

One Piece Bracket Maintenance

1. Place the powertrack on a workbench.



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





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

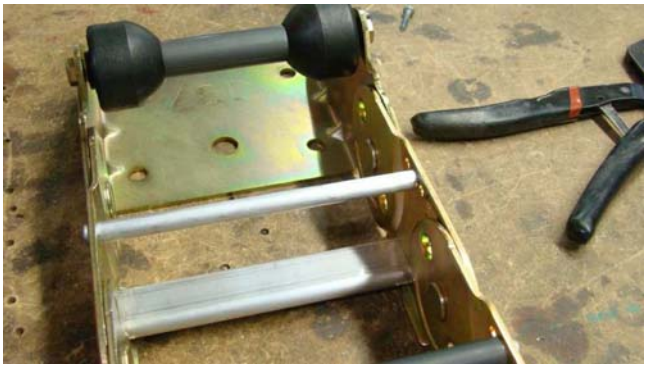


4. Pull up on the loose side of the round bar to allow the poly roller to slide off.

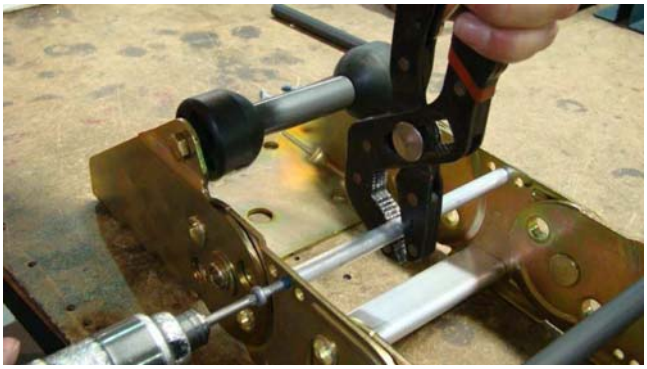


5. Slide the poly roller off of the round bar.

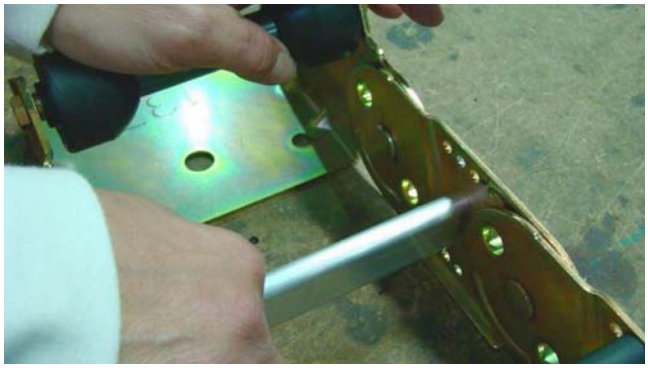


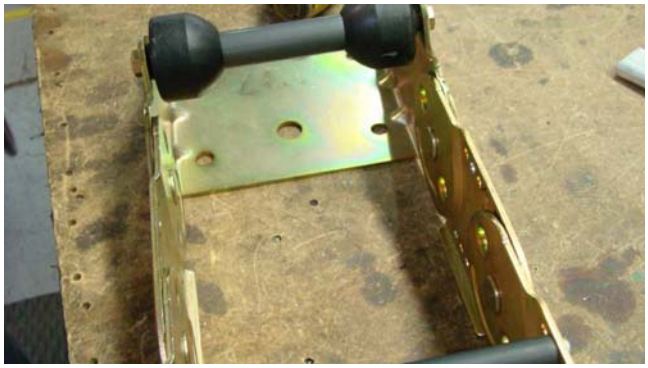


6. Hold the round bar to remove the other screw.



7. Slide the flat bar out.





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



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



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



11. Repeat the previous step on the other side.

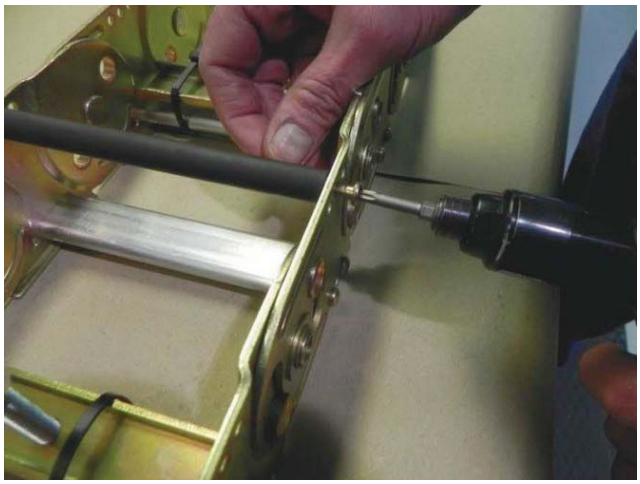


12. Slide the bracket off of the powertrack.

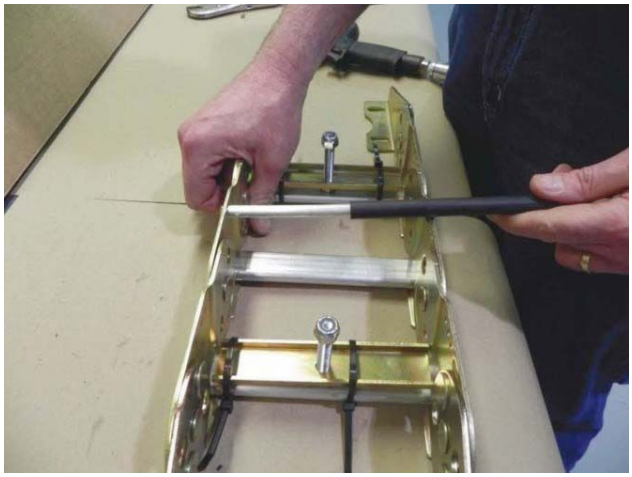


Two Piece Bracket Maintenance

1. Loosen the screw.



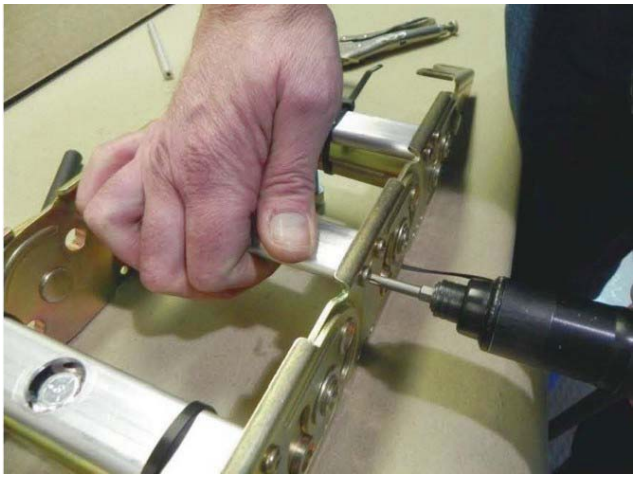
2. Slide the roller off the bar.



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



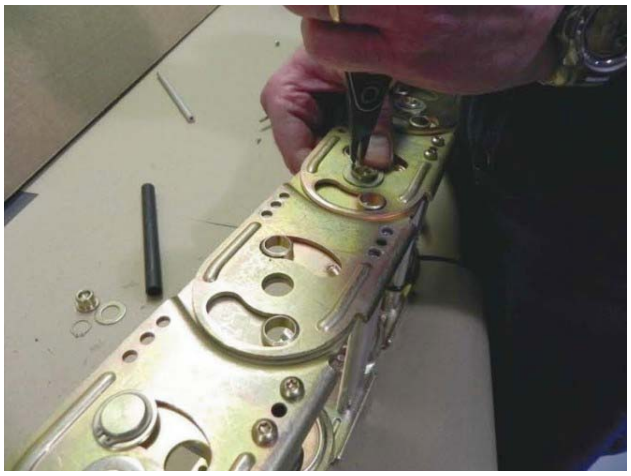
4. Hold the flat bar and remove the screws.



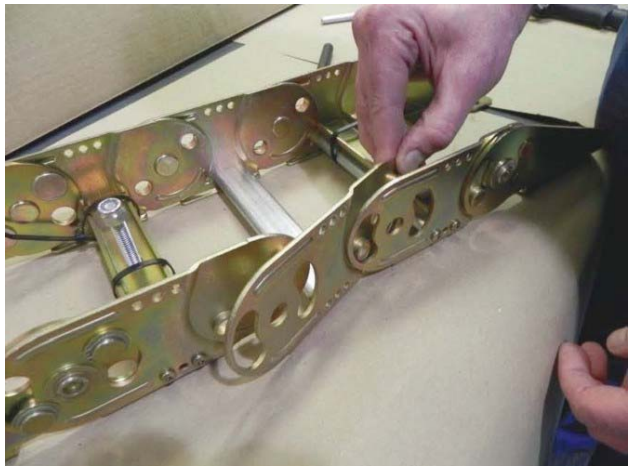
5. Remove the snap rings and pins.



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



7. Slide the link out.

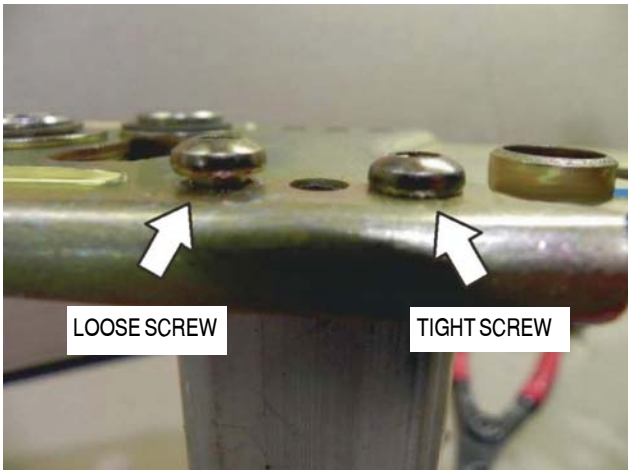


Snap Rings and Screws

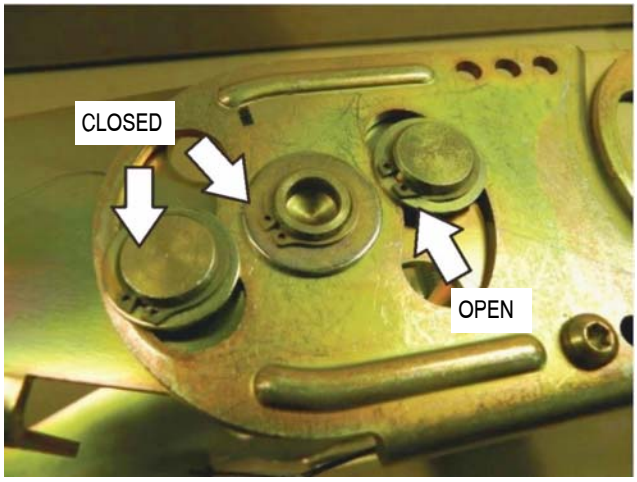
NOTICE

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

Make sure screws are tight and installed properly.



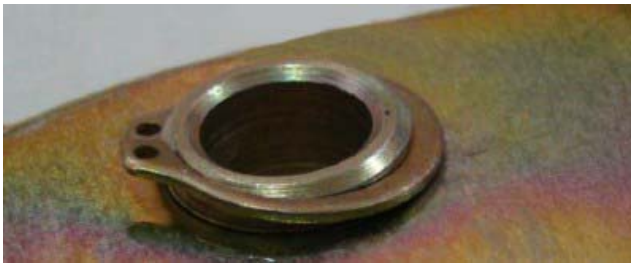
Make sure that all snap rings are closed and seated.



An open snap ring is shown below.



A snap ring that is not seated is shown below.



A seated and closed snap ring is shown below.



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

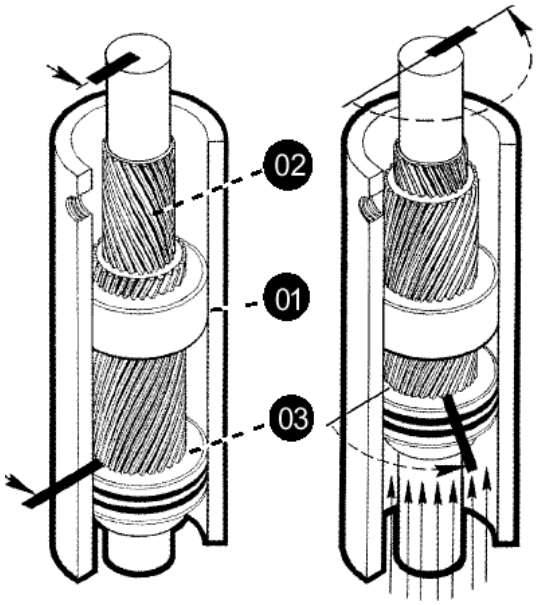
- Tighten to 45-50 in.lbs. (5-5.6 Nm).
- Use T-25 torx bit.
- Do not reuse this screw. After removing replace with a new one.

4.8 HELAC ROTARY ACTUATOR

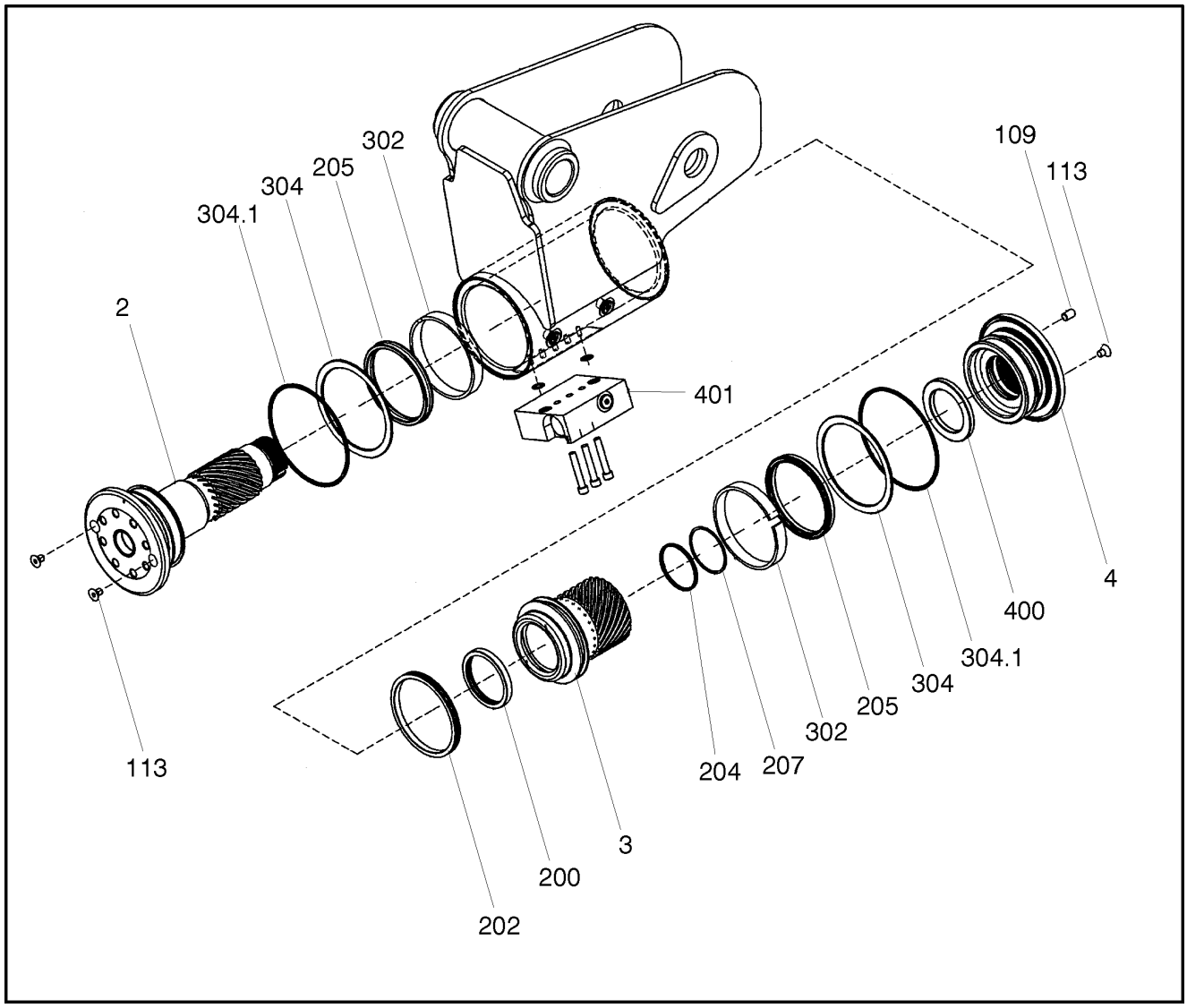
Theory of Operation

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

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

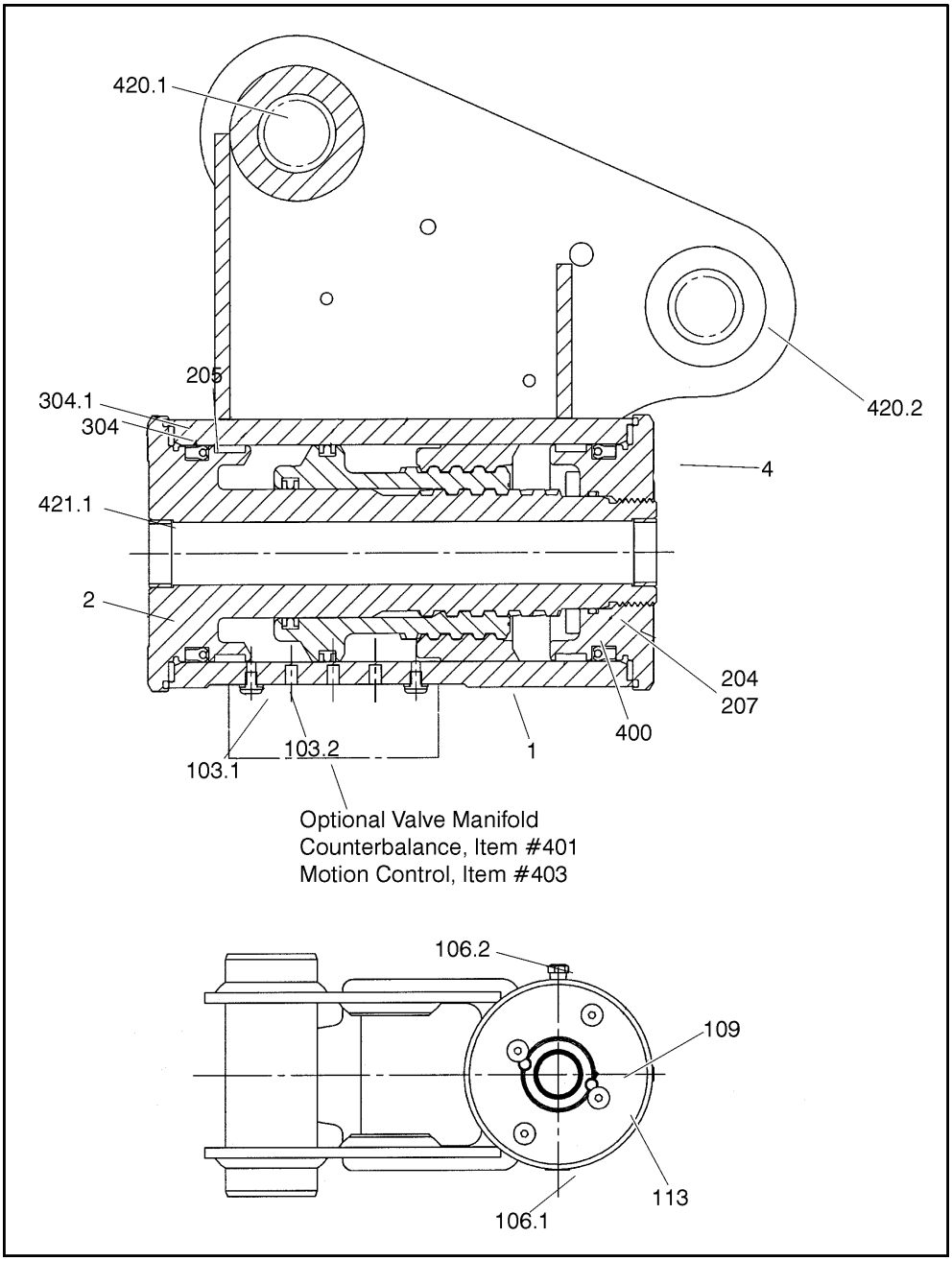


NOTE: *Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.*
As fluid pressure is applied, the piston is displaced axially while the helical gearing causes the piston and shaft to rotate simultaneously. The double helix design compounds rotation: shaft rotation is about twice that of the piston.



1. Housing
2. Shaft
3. Piston Sleeve
4. End Cap
109. Lock Pin
113. Cap Screw
200. T-Seal
202. T-Seal
204. O-ring
205. Cup Seal
207. Backup Ring
302. Wear Guide
304. Thrust Washer
304.1 Wiper Seal
401. Counterbalance Valve
400. Stop Tube

Figure 4-19. Rotary Actuator (Exploded View)



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

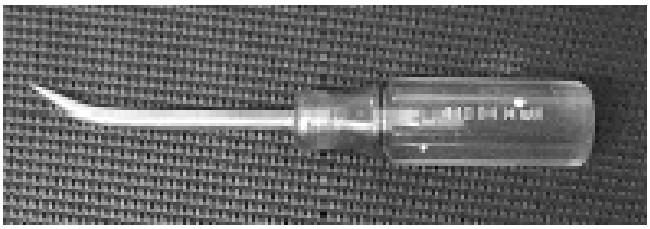
Figure 4-20. Rotary Actuator (Cutaway View)

Tools Required for Assembly/Disassembly

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

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





The seal tool is merely a customized standard flat head-screwdriver. To make this tool you will need to heat the flat end with a torch. Secure the heated end of the screwdriver in a vice and physically bend the heated end to a slight radius. Once the radius is achieved round off all sharp edges of the heated end by using a grinder. There may be some slight modifications for your own personal preference.

Disassembly



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



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



3. Remove the lock pins using an “Easy Out” (a size #2 is shown). If the pin will not come out with the “Easy Out”, use 5/16” drill bit to a depth of 1/2” (12.7mm) to drill out the entire pin.



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



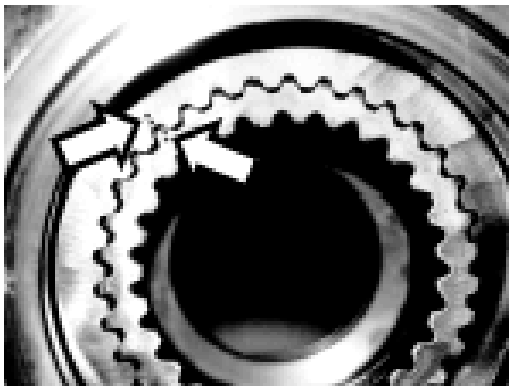
5. Using a metal bar, or something similar, unscrew the end cap (4) by turning it counter clockwise.

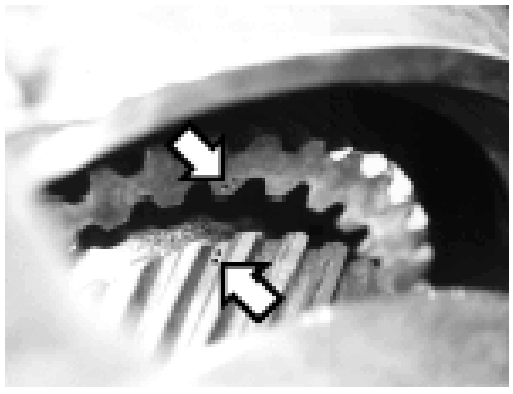


6. Remove the end cap (4) and set aside for later inspection.



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





8. Every actuator has timing marks for proper engagement.



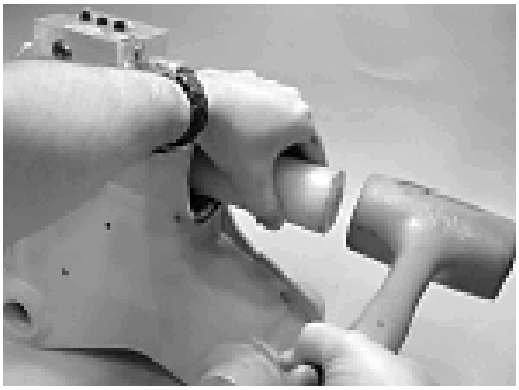
9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.



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



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



12. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is no damaged.



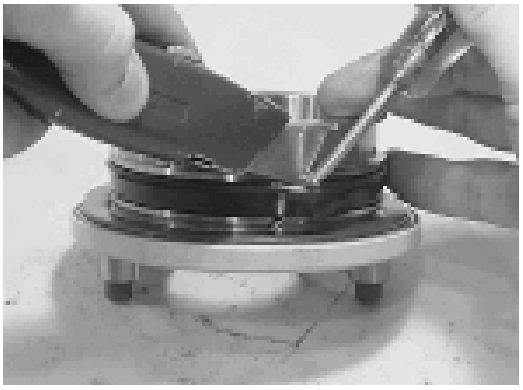
13. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.



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



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



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



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



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



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

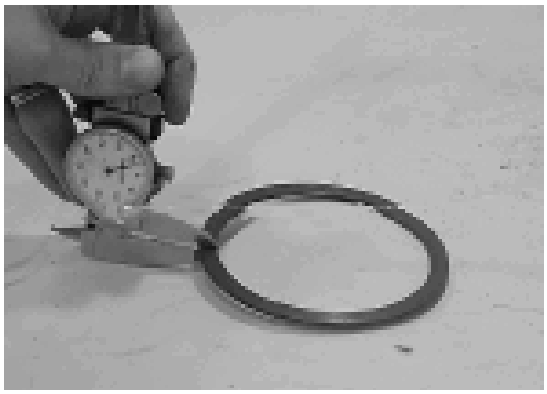


20. Remove the piston I.D. seal (200). You may now proceed to the inspection process.

Inspection



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



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



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

Assembly



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



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



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



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



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



6. Install the inner T-seal (200) into the piston (3) using a circular motion. Install the outer T-seal (202) by stretching it around the groove in a circular motion. Each T-seal has 2 back-up rings (see drawing for orientation).



Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly. Repeat this step for the outer seal (202).



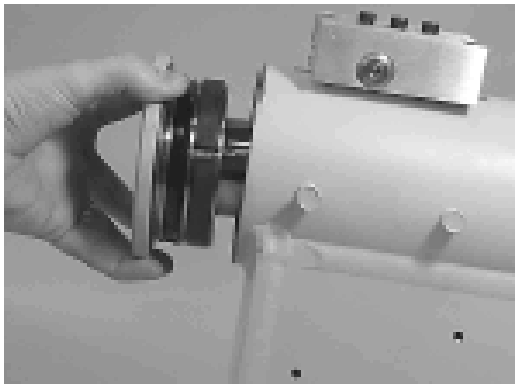
7. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.



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



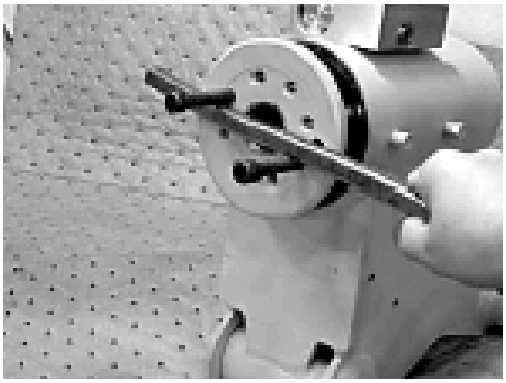
9. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.



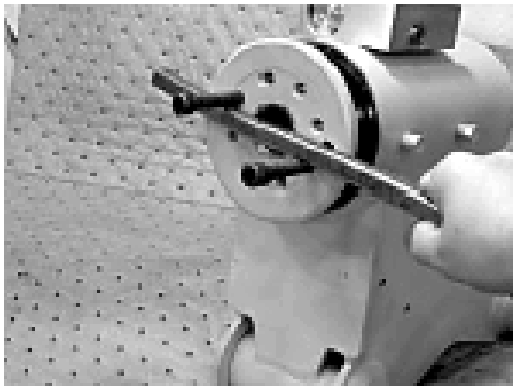
10. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.



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



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



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



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



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



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



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



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



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

Installing Counterbalance Valve

Refer to Figure 4-21., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Loctite.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Loctite #242 should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4-inch bolts 110 to 120 inch pounds (12.4 to 13.5 Nm). Do not torque over 125 inch pounds (14.1 Nm). Torque the 5/16-inch bolts 140 inch pounds (15.8 Nm). Do not torque over 145 inch pounds (16.3 Nm).

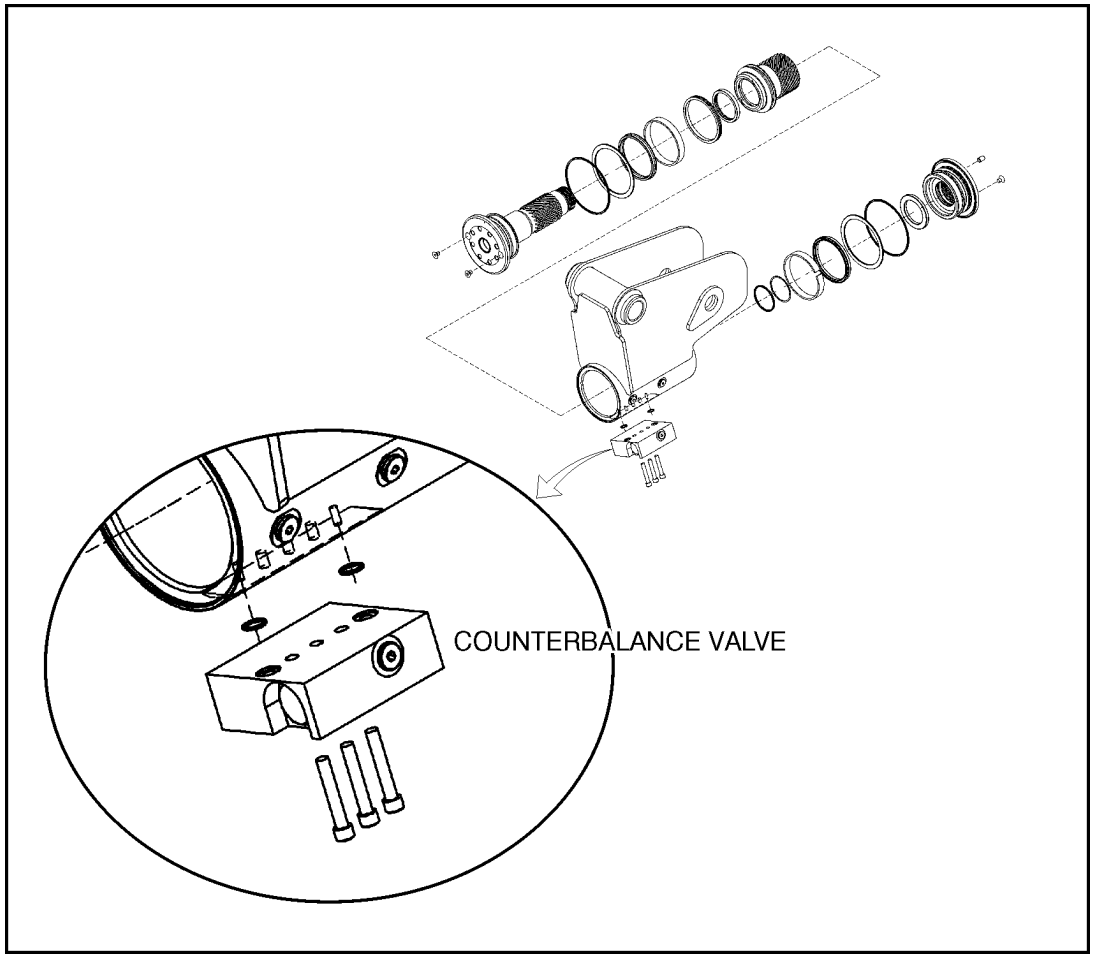


Figure 4-21. Rotator Counterbalance Valve

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.

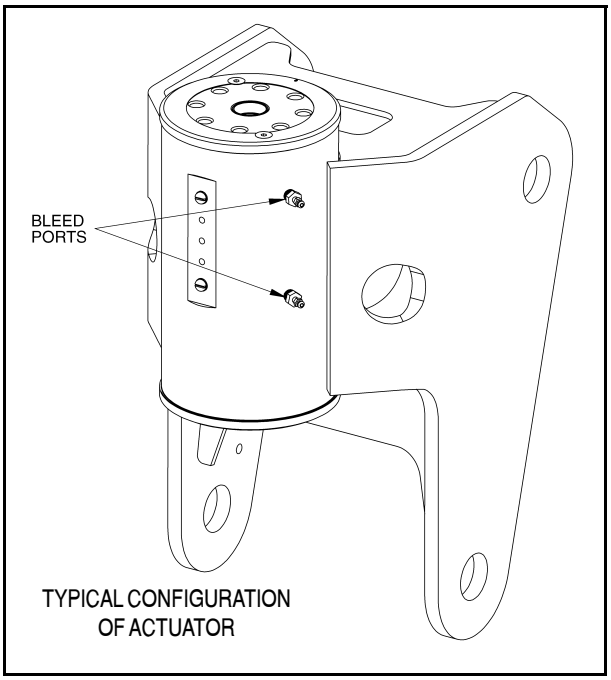
Installation and Bleeding

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



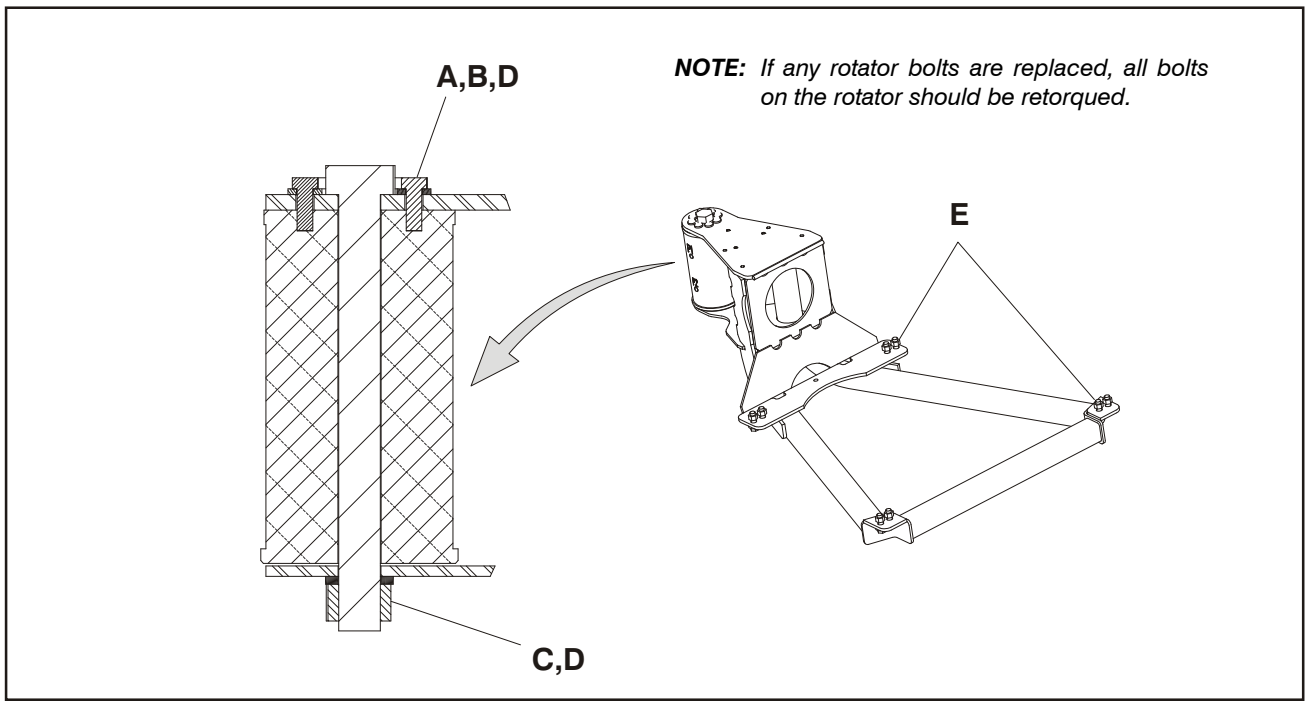
TYPICAL CONFIGURATION
OF ACTUATOR

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

Troubleshooting

Table 4-1. Troubleshooting

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



A Torque to 50 ft.lbs. (68 Nm)
B Loctite #242
C Torque to 480 ft. lbs. (650 Nm)
D Check torque every 150 hours of operation
E Torque to 85 ft. lbs. (115 Nm)

Figure 4-22. Platform Support Torque Values

4.9 LOAD SENSING DEVICE

Calibrating the Load Sensor

NOTE: *Refer to Section 6 - JLG Control System.*

1. Place the boom in the following position.
   - **a.** Boom - Stowed
   - **b.** Telescope - In
   - **c.** Jib - 0 Degrees
   - **d.** Swing - 0 Degrees
   - **e.** Basket Level - 0 Degrees
   - **f.** Basket Rotate - 0 Degrees
   - **g.** Weight in Basket - 0
   - **h.** Machine parked on firm, level surface
2. Activate both emergency stop switches and turn the key switch to the platform position.
3. Remove all loads from the platform, including the operator.
4. Turn P1 clockwise (in) until the potentiometer begins to click.
5. Plug the analyzer into the port in the platform.
6. Select Access Level from Main Menu.
7. Enter 33271.
8. Select Machine Set-Up>Load Cell>1 Warn Only.
9. Select Machine Diagnostics>System Load Cell on the Analyzer.
10. Adjust P2 until the Load = 0%.
11. Place 525 lbs. (238 kg) in the center of the basket.
12. Adjust P1 until the Load = 100%
13. Verify that the overload indicator lights continuously and the alarm sounds continuously during an overload condition.
14. Remove the weight from the platform.
15. Adjust P2 until the Load = 0%.
16. Place 525 lbs. (238 kg) in the center of the basket.

17. Adjust P1 until the Load = 100%
18. Remove the weight from the basket.
19. Seal the potentiometers with fingernail polish.

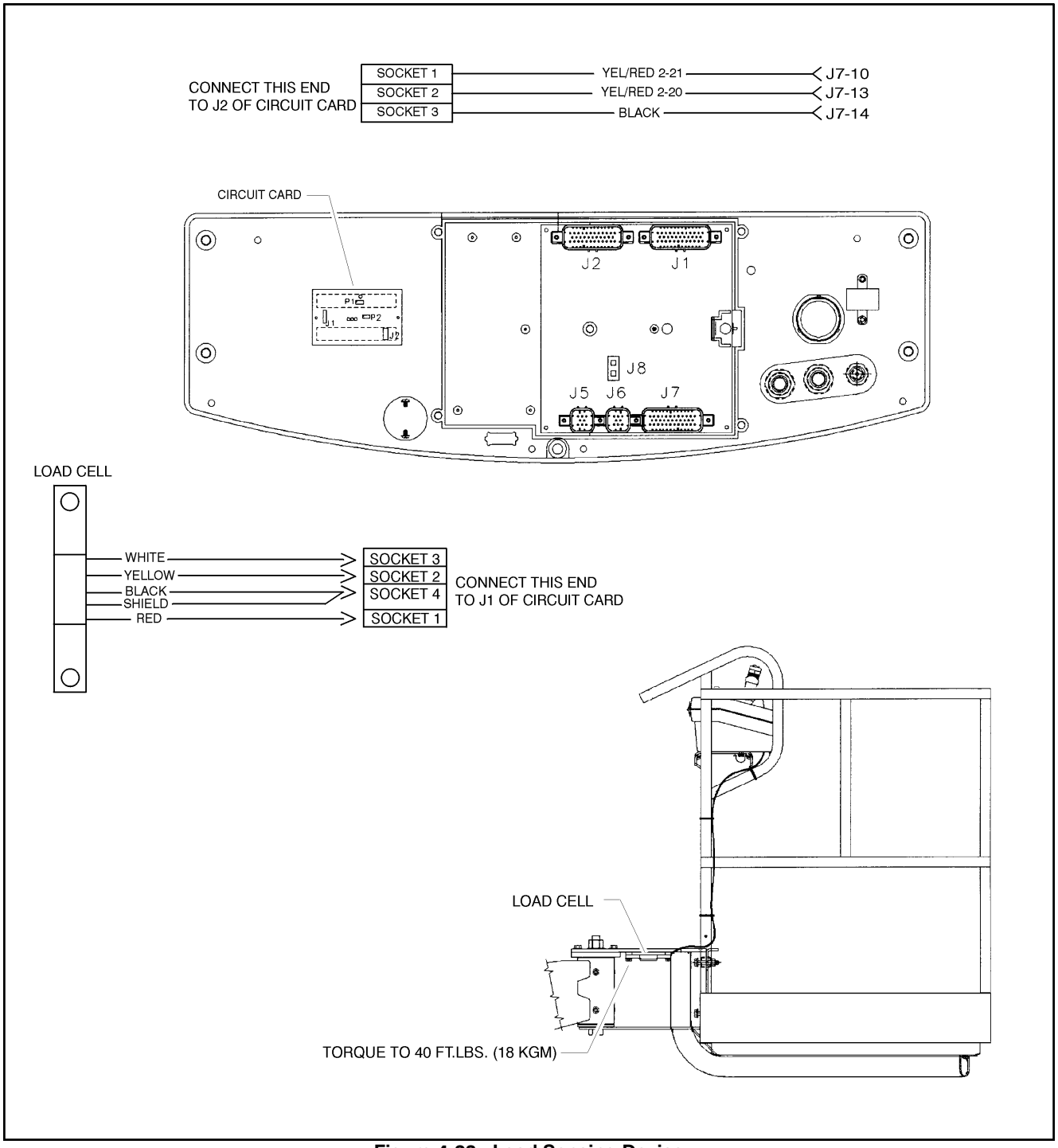


Figure 4-23. Load Sensing Device

NOTES:

SECTION 5. HYDRAULICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

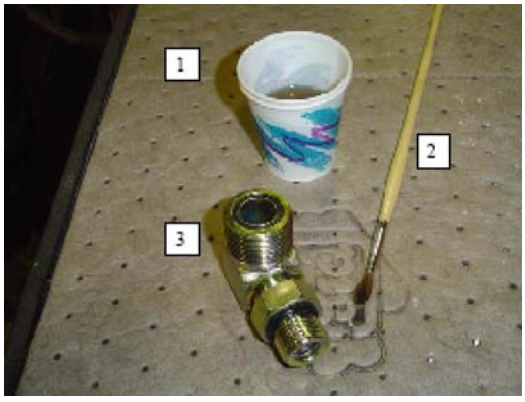
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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 CYLINDER REPAIR

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

Disassembly

NOTICE

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

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

⚠ 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 cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture. Tap around the outside of the cylinder head retainer with a suitable hammer to shatter the loctite seal.

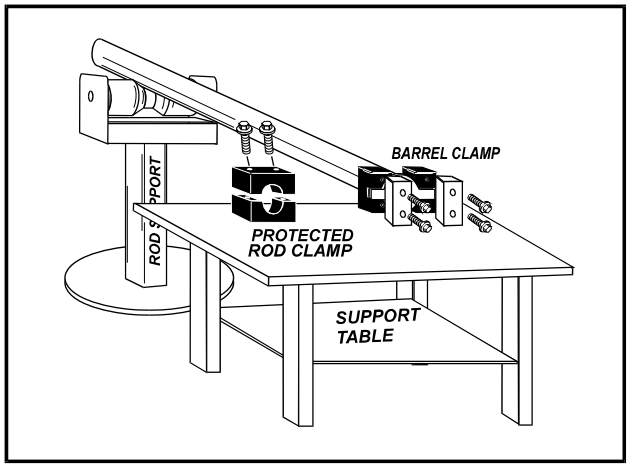


Figure 5-1. Cylinder Barrel Support

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

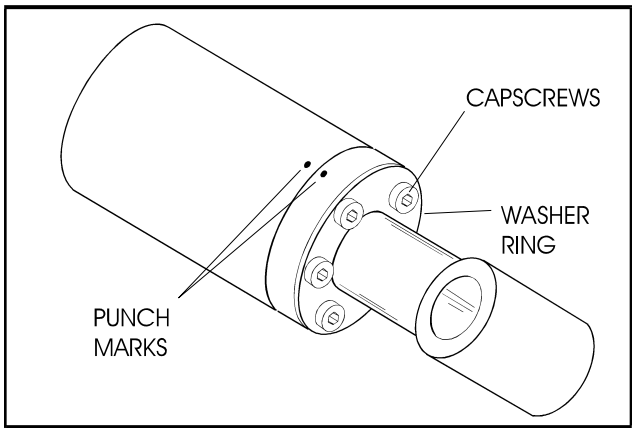
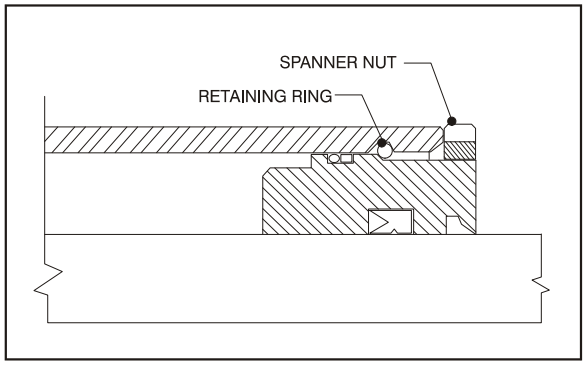


Figure 5-2. Cap Screw Removal

NOTE: *Steps 6 and 7 apply only to the steer cylinder.*

6. Using a spanner wrench, loosen the spanner nut retainer, and remove spanner nut from cylinder barrel.
7. Being careful not to mar the surface of the rod, use a punch or wooden dowel and hammer to drive the rod guide about one inch down into the cylinder bore. Using a screw driver, carefully push one end of the round retaining ring back towards the inside of the cylinder and then slip the screwdriver tip under that end. Pull the ring out of the groove toward the wall mouth. Once one end of the retaining ring is free from the groove, the remainder can be easily pried free using ones fingers or pliers.



8. 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.

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

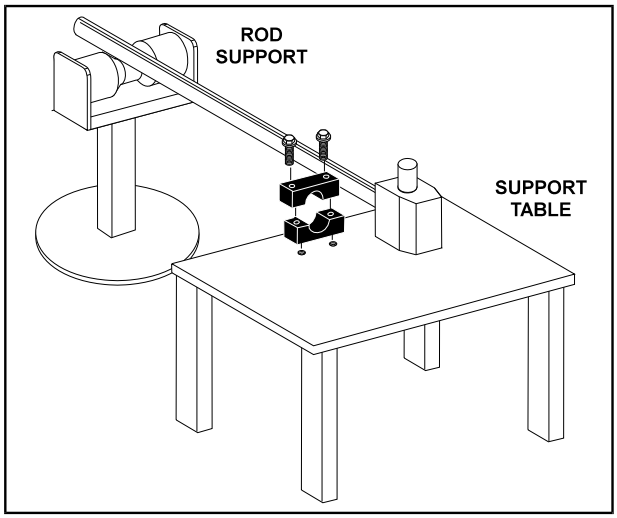


Figure 5-3. Cylinder Rod Support

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

NOTE: *Step 11 applies only to the steer cylinder.*

11. Loosen and remove nut which attaches the piston to the rod, and remove the piston.

12. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.

13. Insert the cap screw(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the cap screw(s) until the bushing is loose on the piston.

14. Remove the bushing from the piston.

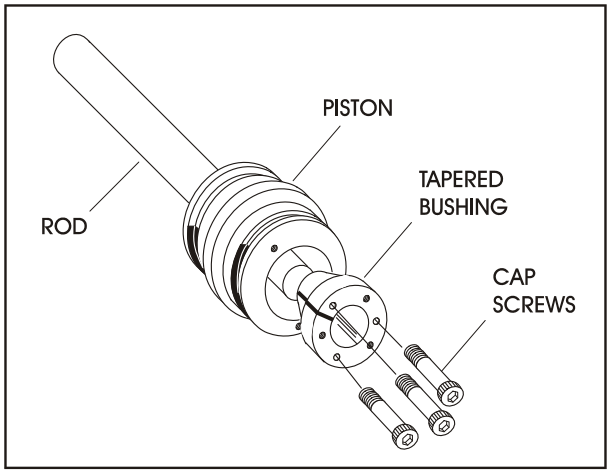


Figure 5-4. Tapered Bushing Removal

15. Screw the piston CCW, by hand, and remove the piston from cylinder rod.

16. Remove and discard the piston o-rings, seal rings, and backup rings.

17. Remove piston spacer, if applicable, from the rod.

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

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.

2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.

3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.

4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.

5. Inspect threaded portion of barrel for damage. Dress threads as necessary.

6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.

7. Inspect threaded portion of piston for damage. Dress threads as necessary.

8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.

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

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

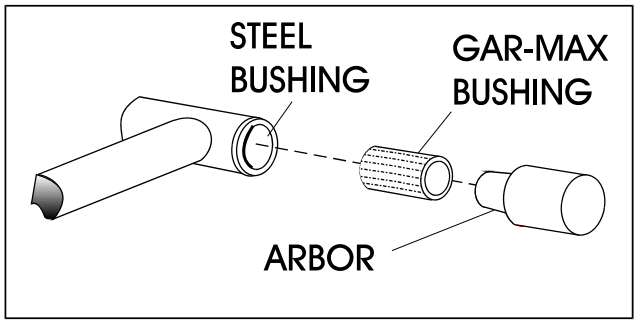


Figure 5-5. Gar-Max Bearing Installation

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

Assembly

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

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

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

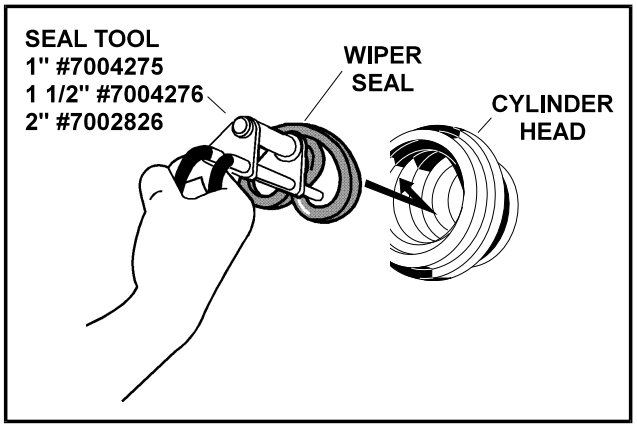


Figure 5-6. Rod Seal Installation

NOTICE

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

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

wear ring into the applicable cylinder head gland groove.

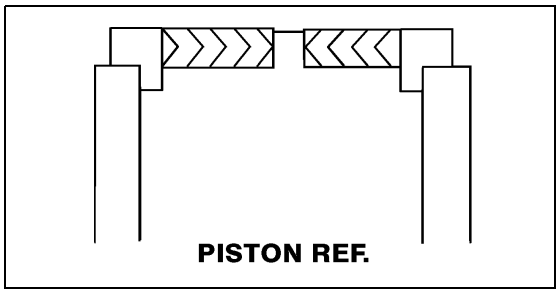


Figure 5-7. Poly-Pak Piston Seal Installation

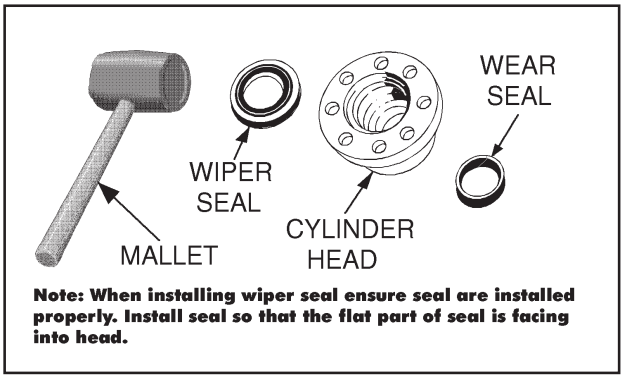


Figure 5-8. Wiper Seal Installation

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

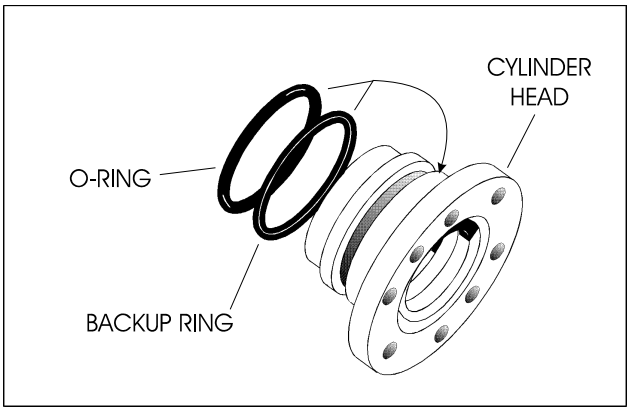


Figure 5-9. Installation of Head Seal Kit

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

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

6. If applicable, correctly place a new o-ring and back-up rings in the inner piston diameter groove.

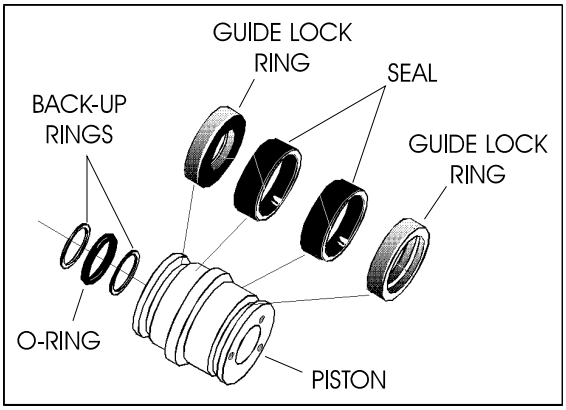


Figure 5-10. Piston Seal Kit Installation

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
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.*

NOTICE

WHEN REBUILDING THE MASTER, SLAVE, LIFT, AXLE LOCKOUT, OR TELESCOPE CYLINDERS, APPLY LOCTITE #242 TO TAPERED BUSHING BOLTS, THEN TIGHTEN SECURELY. (SEE TABLE 2-1 AND 2-3. TORQUE SPECIFICATIONS).

10. Install the bolts in tapered bushing using loctite #242. (See Table 2-1 and 2-3. Torque Specifications.)

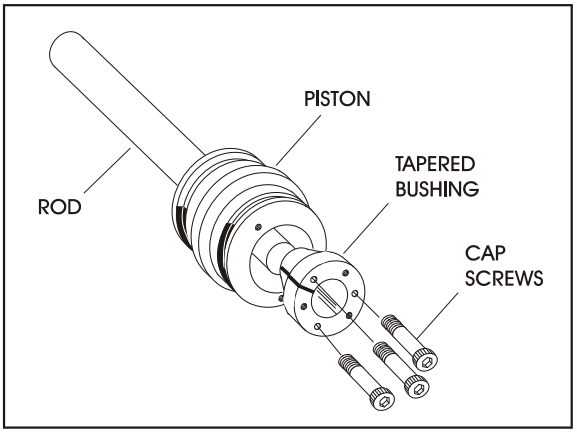


Figure 5-11. Tapered Bushing Installation

11. Remove the cylinder rod from the holding fixture.
12. Place new guide locks and seals in the applicable outside diameter grooves of the cylinder piston. (See Figure 2-28. Piston Seal Kit Installation.)
13. 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.

14. 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.
15. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
16. Secure the cylinder head gland using the washer ring and socket head bolts. (See Table 2-1 and 2-3. Torque Specifications.)

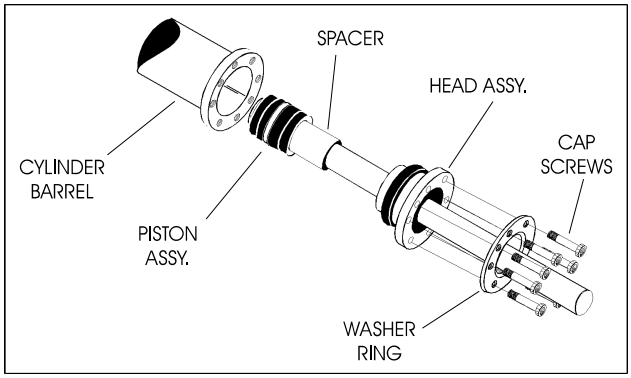


Figure 5-12. Rod Assembly Installation

17. 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.
18. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 2-2. Holding Valve Torque Specifications).

Table 5-1. Cylinder Head and Tapered Bushing Torque Specifications

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Lift Cylinder 800S & 860SJ	420 ft. lbs. (569 Nm)	45 ft. lbs. (61 Nm)
Telescope Cylinder 800S & 860SJ	80 ft. lbs. (108 Nm	9 ft. lbs. (12.2 Nm)
Jib Cylinder 800S & 860SJ	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Level Cylinder 800S & 860SJ	80 ft. lbs. (108 Nm)	9 ft. lbs. (12.2 Nm)
Lockout Cylinder 800S & 860SJ	80 ft.lbs. (108 Nm)	9 ft. lbs. (12.2 Nm)

Table 5-2. Holding Valve Torque Specifications

Description	Torque Value
SUN - 7/8 HEX M20 X 1.5 THDS.	30-35 ft. lbs. (41-48 Nm)
SUN - 1 1/8 HEX 1 -14 UNS THDS.	45-50 ft. lbs. (61-68 Nm)
SUN - 1 1/4 HEX M36 X 2 THDS.	150-160 ft. lbs. (204-217 Nm)
RACINE - 1 1/8 HEX 1 1/16 - 12 THDS.	50-55 ft. lbs. (68-75 Nm)
RACINE - 1 3/8 HEX 1 3/16 - 12 THDS.	75-80 ft. lbs. (102-109 Nm)
RACINE - 1 7/8 HEX 1 5/8 - 12 THDS.	100-110 ft. lbs. (136-149 Nm)

NOTICE

IF THE CYLINDER IS TO BE TESTED PRIOR TO INSTALLATION ON THE MACHINE, EXTREME CARE SHOULD BE USED TO INSURE THAT THE OUTER END OF THE ROD IS SUPPORTED. USE EITHER A TRAVELING OVERHEAD HOIST, FORK-LIFT, OR OTHER MEANS TO SUPPORT THE OVERHANGING WEIGHT OF THE EXTENDING ROD.

Steer Cylinder Seal Repair Instructions

1. The cylinder should be disassembled in a clean environment to prevent dirt or other contamination from entering the interior of the cylinder. Clean any accumulated dirt or debris from the port openings and guide area. Remove the port plugs and drain oil from the cylinder. Do not reinstall the port plugs at this time. No special tools are required for disassembly, but snap ring pliers would ease removal of the snap ring that retains the rod guide. Items that should be at hand are a vise, Flat punch, hammer, rubber hammer, clean oil, and a wrench for removal of the piston nut. A piston ring compressor is suggested for resizing new teflon piston seals used in some cylinders.
2. Secure in vise at approximately the mid-point of the cylinder wall. Do not tighten vise excessively, the wall may be distorted.
3. If the steer cylinder has a retaining plate on front of the rod guide, remove the cap screws and dismount the retaining plate. Remove the retaining ring with snap ring pliers. If the steer cylinder has an external spiral retaining ring ahead of the rod guide internal retaining ring, carefully remove both rings.
4. Pull the rod vigorously outward and allow the piston to bump the rod guide. The momentum of the rod should be sufficient to pull the rod guide an piston from the cylinder barrel. Be careful not to mar the chromed surface rod.

NOTE: *The piston seal and rod guide static seal will likely be cut on removal from the barrel. This is normal and cannot be avoided on disassembly.*

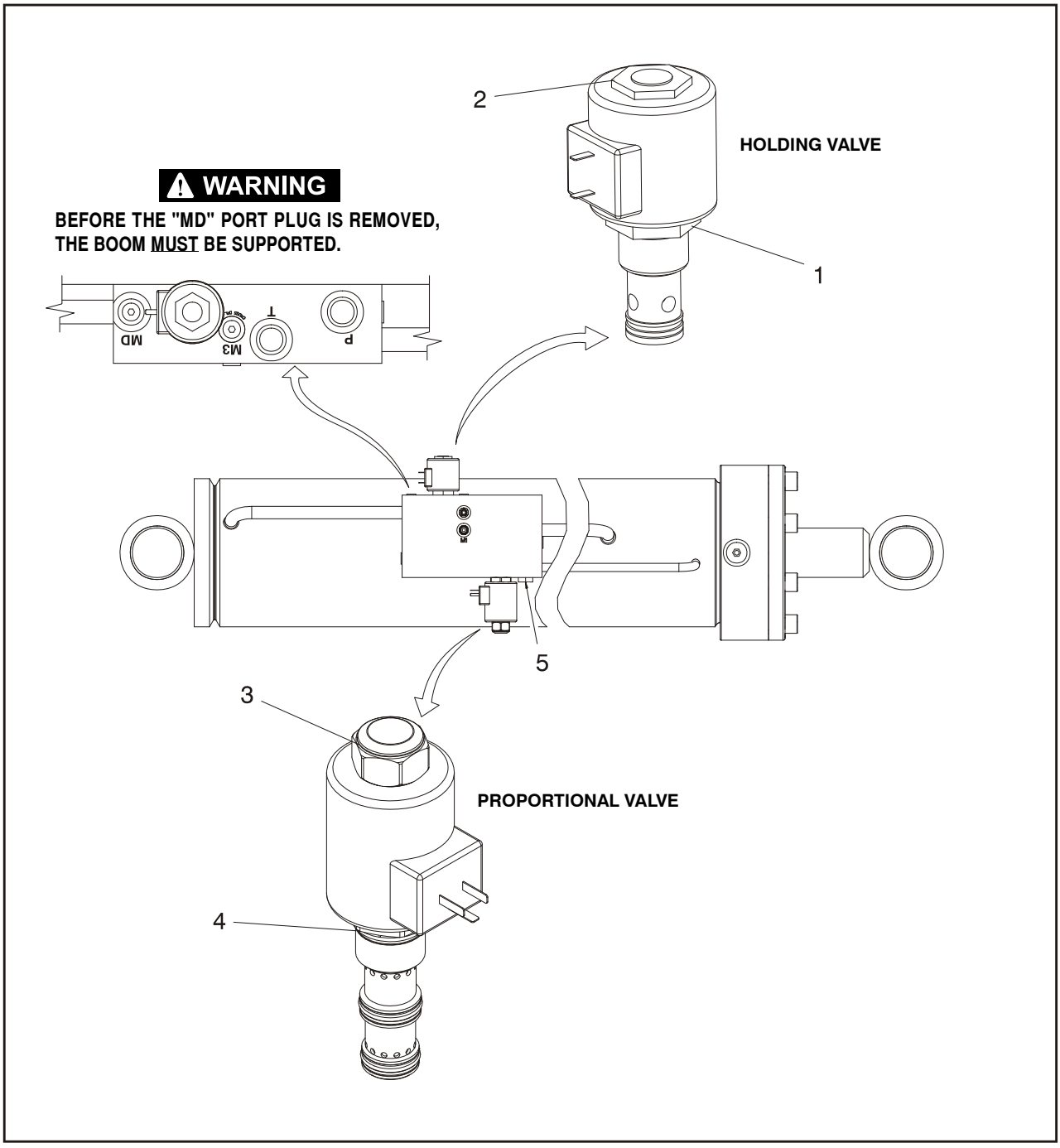
5. Being careful not to mar the chromed surface, secure the rod so that the piston nut can be removed. Remove the piston nut, piston, spacer tube (if any) and rod guide.

NOTE: *The position and orientation of the seals before replacing them*

6. Be careful not to scratch the seal grooves when removing the old seals. The seals can be removed with a sharp tool like an awl by carefully pushing the point partially into the seal and prying the seal from the groove. Carefully cutting the seal apart with an X-acto knife will also ease removal.
7. Inspect the seal grooves and clean away any contamination. Apply a thin coating of clean oil to the new seals to ease installation and prevent scuffing of the sealing surfaces.
8. If the cylinder utilizes a teflon piston seal, special care must be taken when installing the new seal. Teflon seals are not as elastic as rubber or urethane seals. Teflon seals should not be stretched excessively because they may break or the cross section may be permanently reduced to the point that the teflon ring may not seal. One suggested method of installation is to work about half of the seal into the groove with a shoe string or fat nylon tie looped inside the rings inside diameter. The string or tie can be used to lift and guide the teflon ring into the groove (the o-ring expander ring must be installed first). When the teflon ring is nearly all the way in the groove, the string or tie can be pulled free. Warming the teflon ring will make it more pliable and will ease the installation process. Once the teflon seal is positioned in the groove it must be resized so that it is uniform contact with the o-ring expander underneath. This can be accomplished with properly sized piston ring compressor. If equipment and material are available, a cone shaped resizing die could be fabricated for installation purposes.
9. Assemble the guide and piston on the rod. Be sure to slip the retaining plate (if used) and snap ring on the rod ahead of the guide and piston if they cannot pass over the rod mount. Install and tighten the piston nut to required torque.
10. Apply a light coating of clean oil to the piston and guide O.D. and mouth of the cylinder barrel. Carefully insert the piston into the wall and push the rod assembly into the bore. When the piston is located approximately half way down the bore, carefully position the rod guide with the barrel mouth and push the guide down the bore so that the front face of the guide clears the snap ring groove. Be careful not to mar the chromed rod surface. The guide may have to be driven down the bore with a punch or wooden dowel and hammer. Install the rod guide retaining snap ring and be certain that it is nested into the bottom of the groove all around. Install the outboard retaining plate or spiral ring if used.
11. Check cylinder for external leaks using rated hydraulic pressure. any leaks should be evident after the cylinder has been pressurized for one minute. Remove Pressure from cylinder. If the seals are oil tight, the cylinder is ready for service.

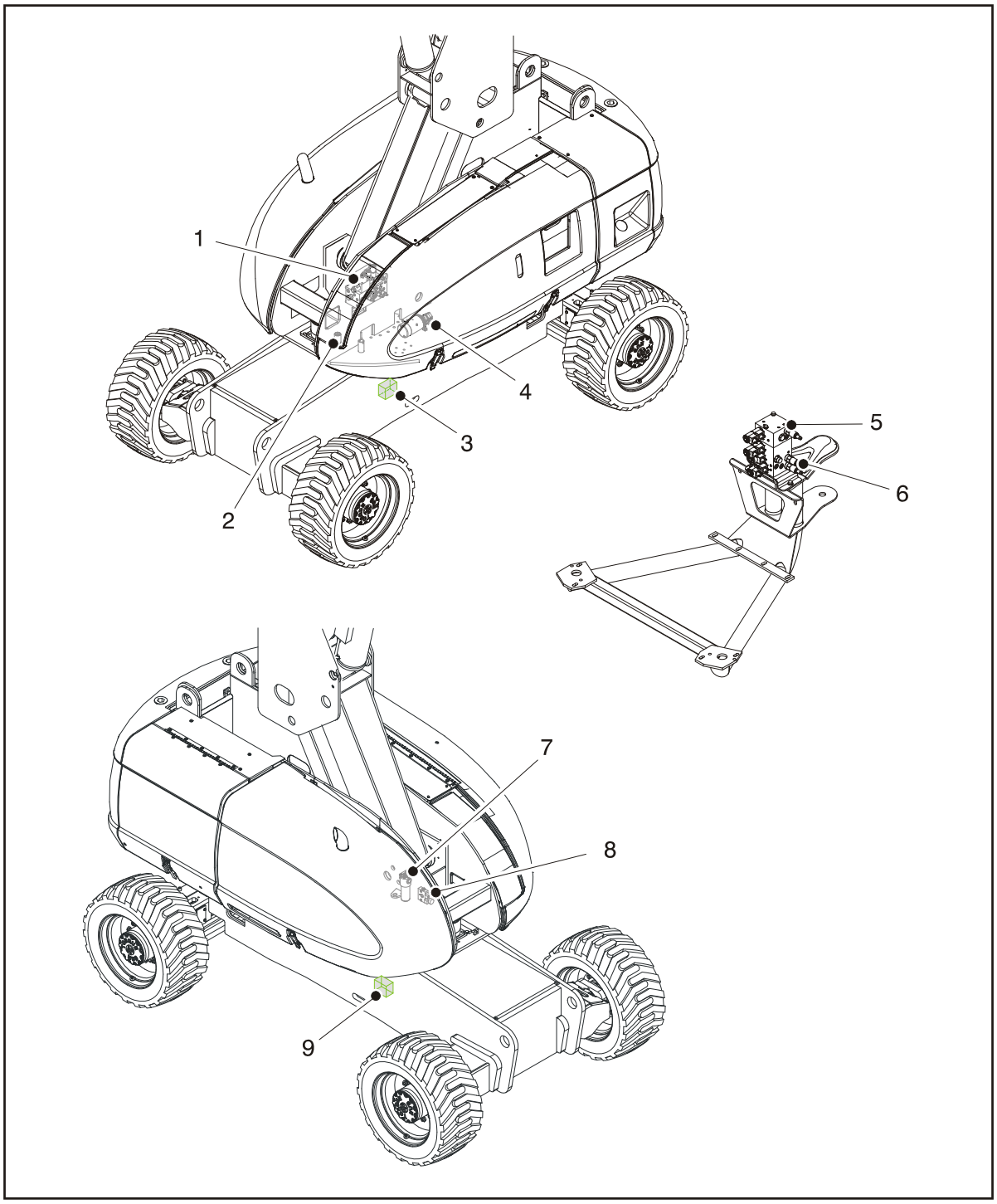
⚠ WARNING

KEEP AWAY FROM JETS OF HIGH PRESSURE OIL. HIGH PRESSURE OIL JETS CAN PENETRATE SKIN AND CAUSE SEVERE INJURY OR DEATH.



1. 1. 30 ft. lbs. (40.6 Nm)
2. 5 ft. lbs. (6.7 Nm)
3. 10-12 ft. lbs. (13.5-16.2 Nm)
4. 35 ft. lbs. (47.4 Nm)
5. 20 ft. lbs. (27 Nm)

Figure 5-13. Lift Cylinder Valve Cartridge Torque Values



1. Main Valve
2. Platform Valve Filter
3. Dual Flow Divider (4WD)
4. Auxiliary Pump
5. Jib Valve
6. Platform Valve
7. Hydraulic Filter
8. Dual Select Valve
9. Flow Divider (2WD)

Figure 5-14. Control Valve Installation

5.3 PRESSURE SETTING PROCEDURE

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

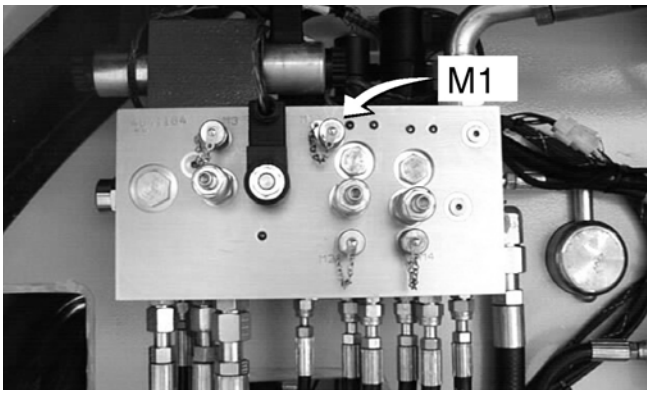
To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps in Section 5.4, Start Up Procedures must be followed.
2. Set up of the function pump.
3. Adjustments made at the main valve block.
4. Adjustments made at the platform valve.

Set Up of the Function Pump

STAND BY PRESSURE OR LOAD SENSE PRESSURE

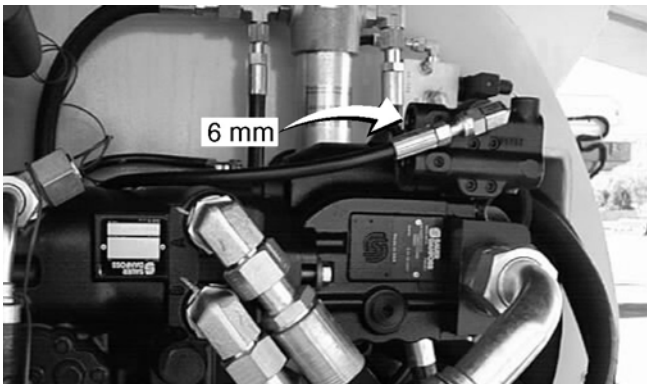
1. Install a low pressure gauge at port “M1” of the main valve block. A low pressure gauge capable of reading 500 psi.



2. Start the engine from the ground control. The gauge should read between 400-440 psi (27.5 to 30 Bar). To make an adjustment to this pressure, go to the engine compartment, locate the function pump.
3. There are (2) adjustments at the top of the pump. They are located on the pump compensator which has (4) bolts mounting it to the pump. The stand by adjustment is at the top. To adjust this, a 4 mm and 6 mm allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.
   a. First, using the 4 mm wrench, loosen the set screw on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.

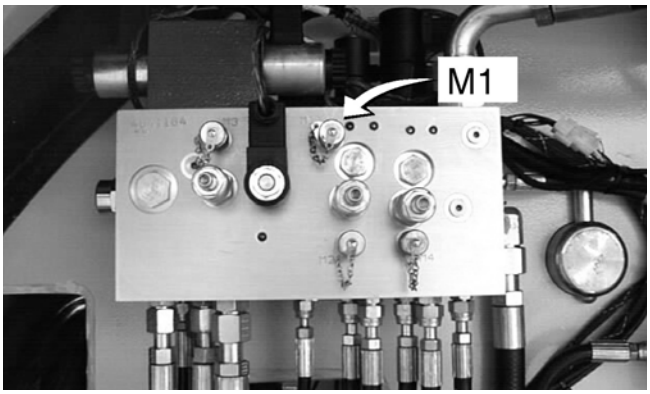


   b. Next, using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. The pressure should read between 400-440 psi (27.5 to 30 Bar).



HIGH PRESSURE RELIEF

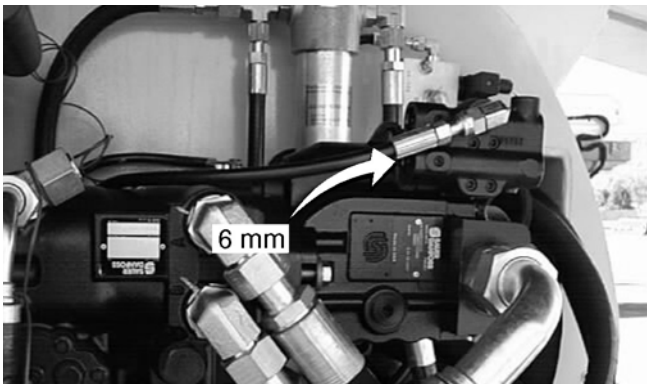
1. Install a high pressure gauge at the “M1” port of the main valve block.



2. Activate telescope in. The gauge should read 2800 psi.
3. To make an adjustment to this pressure, go back to the engine compartment to the function pump. The high pressure relief adjustment is the lower one of the (2) on the compensator. To adjust this, a 4 mm and 6 mm allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.
   a. First, using the 4 mm wrench, loosen the set screw on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.



   b. Next, using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. This adjustment will be re-set at the end of this procedure to 2500 psi (172 Bar). This is the **maximum** relief pressure for all functions governed by this pump.



Adjustments Made at the Main Valve Block

TELESCOPE OUT

1. Install a high pressure gauge at the “M3” port of the main valve block.
2. Activate Telescope out. The gauge should read 2500 psi (172 Bar).
3. The relief valve is located directly below the M3 port. Turn clockwise to increase, counterclockwise to decrease.

SWING LEFT AND RIGHT

1. Lock the Turn-table lock pin.
2. Install the hi-pressure gauge at M2.
3. Activate swing, the gauge should read 1700 psi (117 Bar).
4. The adjustment cartridge is located right above the M2 port. Turn clockwise to increase, counterclockwise to decrease.

STEER

1. Install a hi-pressure gauge at port M4. Activate steer left or right. The gauge should read 2500 psi (172 Bar).
2. The relief valve is located right above port M4. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Platform Valve Assembly

NOTE: *When replacing the level up or level down cartridge, the function should be cycled, and then the crack pressure value calibrated.*

PLATFORM LEVEL UP

1. Install a high pressure gauge at port “M1”. Activate level up to the end of stroke, you should read 2600 psi (179 Bar).
2. The level up relief valve is located to the right and above port M1. Turn clockwise to increase, counter-clockwise to decrease.

PLATFORM LEVEL DOWN

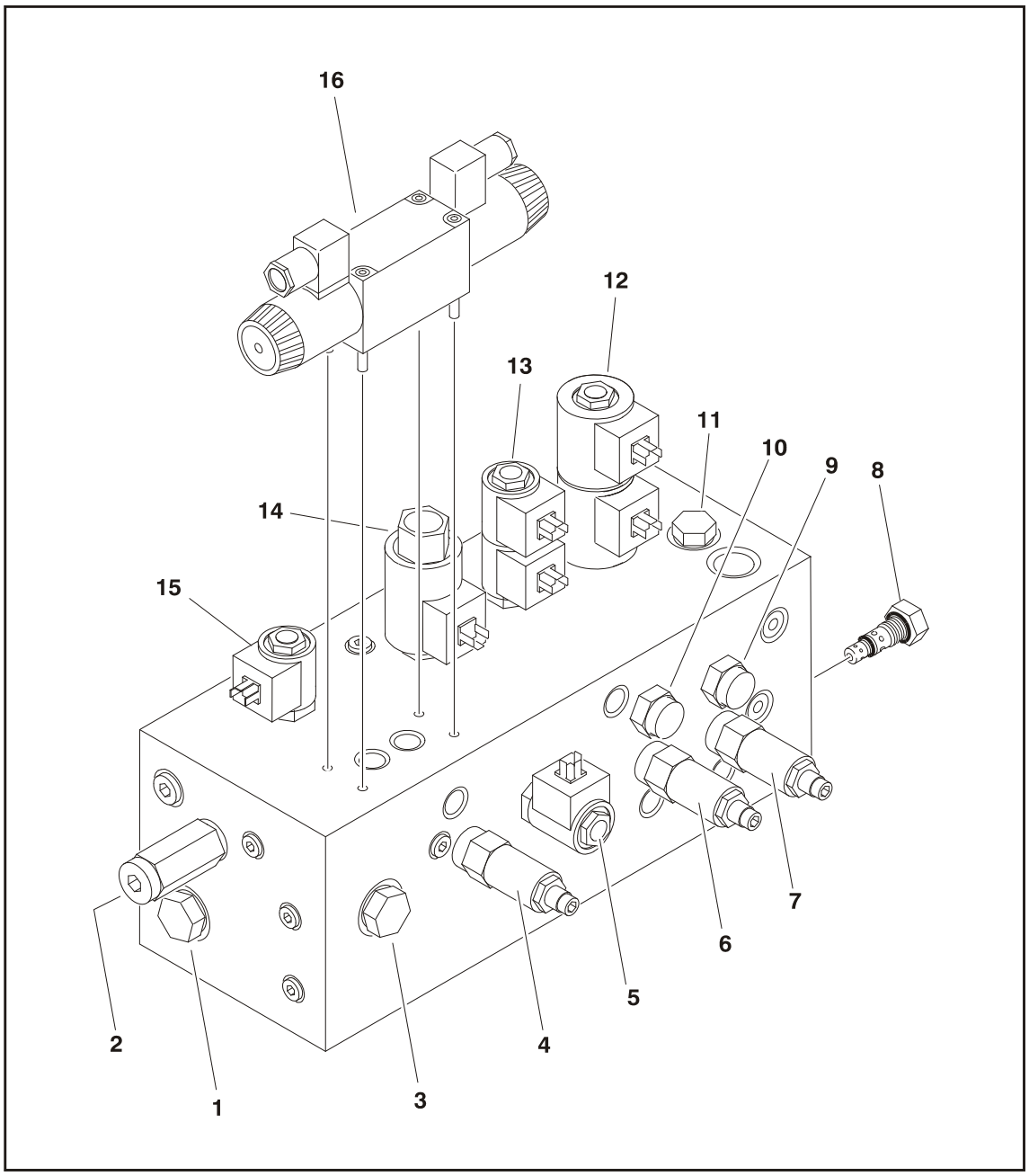
1. Install a high pressure gauge at gauge port “M2”, Activate level down to the end of stroke, you should read 1800 psi (124 Bar).
2. The level down relief valve is located to the right and below port M2. Turn clockwise to increase, counter-clockwise to decrease.

PLATFORM JIB UP AND DOWN

1. Install a high pressure gauge at port M3. Activate jib up or down, you should read 1700 psi (117 Bar).
2. The up relief valve is located above port M3. Turn clockwise to increase, counterclockwise to decrease.

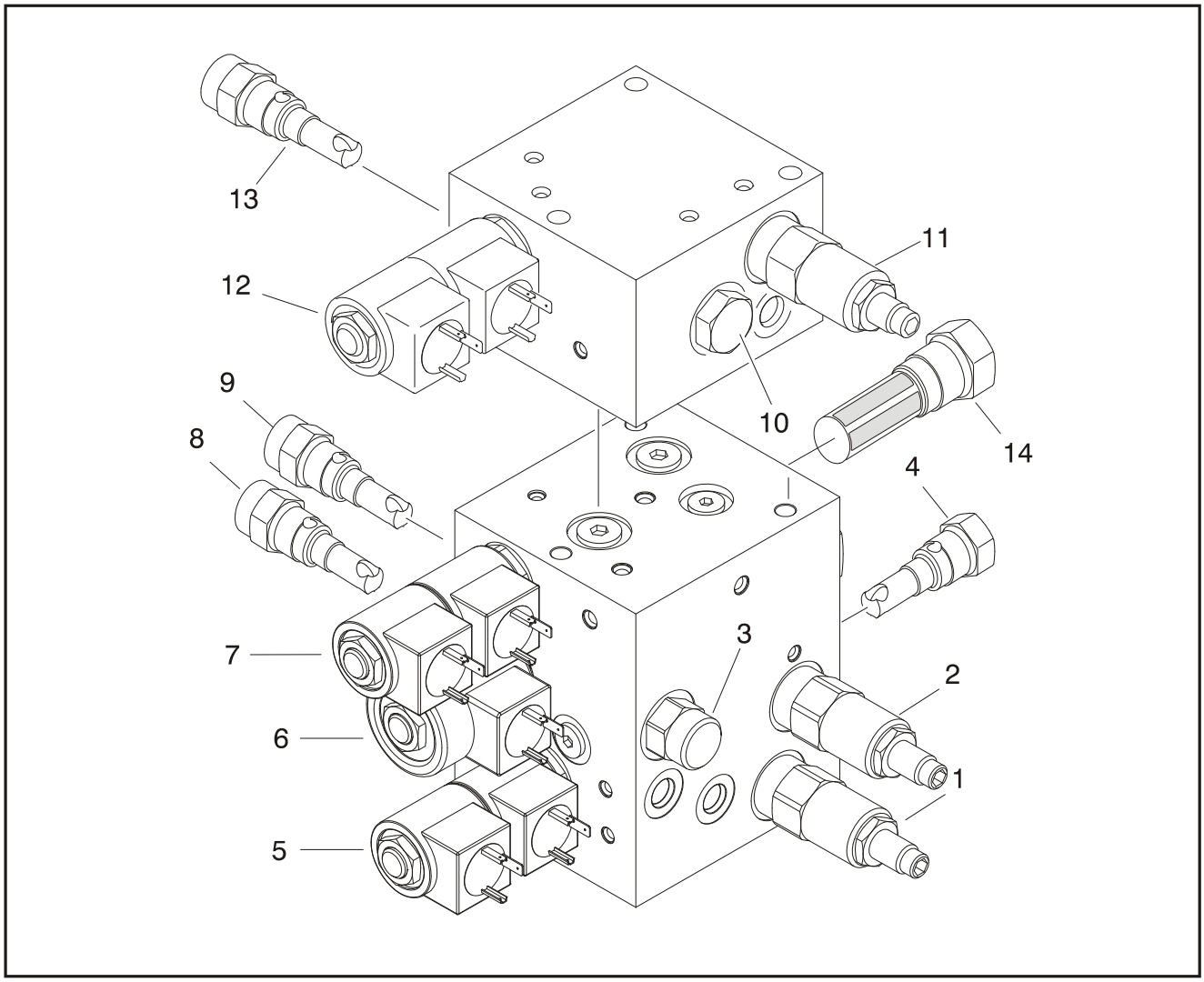
PUMP HI-PRESSURE RELIEF VALVE

Go back to the function pump and re-set the hi-pressure from 2800 psi (193 Bar) back to 2500 psi (172 Bar).



1. Check Valve
2. Pilot Valve - Lift
3. Check Valve (100 psi - 6.9 Bar)
4. Tele Out Relief
5. Lift Up Dump
6. Swing Relief
7. Steer Relief
8. Steer Flow Regulator (6 gpm - 22.7 lpm)
9. Load Sense - Steer
10. Load Sense - Swing
11. Check Valve (60 psi - 4.1 Bar)
12. Steer Control
13. Swing Control
14. Proportional Valve - Tele
15. Main Dump
16. Telescope Control

Figure 5-15. Main Valve Identification



1. Level Down Relief
2. Level Up Relief
3. Flow Regulator (0.5 gpm - 1.9 lpm)
4. Check Valve (25 psi - 1.7 Bar)
5. Platform Level
6. Pressure
7. Rotator
8. Flow Regulator (2 gpm - 7.6 lpm)
9. Flow Regulator (0.2 gpm - 0.75 lpm)
10. Load Sense
11. Jib Relief
12. Jib Control
13. Flow Regulator (2 gpm - 7.6 lpm)
14. Filter

Figure 5-16. Platform Valve Identification

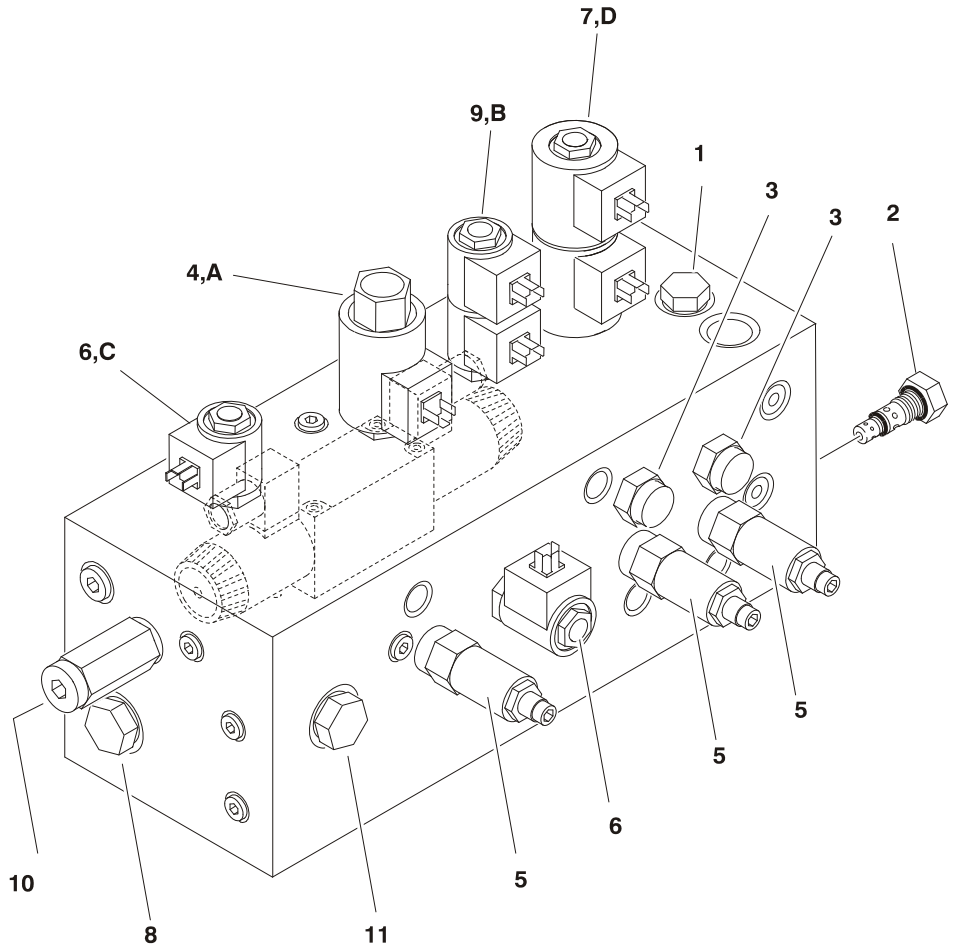


Table 5-3. Cartridge Torque Values

	Ft-Lbs.	Nm
1	20	27.1
2	25	33.9
3	20	27
4	35	47.4
5	20	27.1
6	30	40.6
7	25	33.9
8	30	40.6
9	20	27.1
10	Not Available	
11	Not Available	

Table 5-4. Coil Torque Values

	Ft-Lbs.	Nm
A	10-12	14-16.8
B	5	7
C	5	7
D	5	7

Figure 5-17. Main Valve Cartridge Torque Values

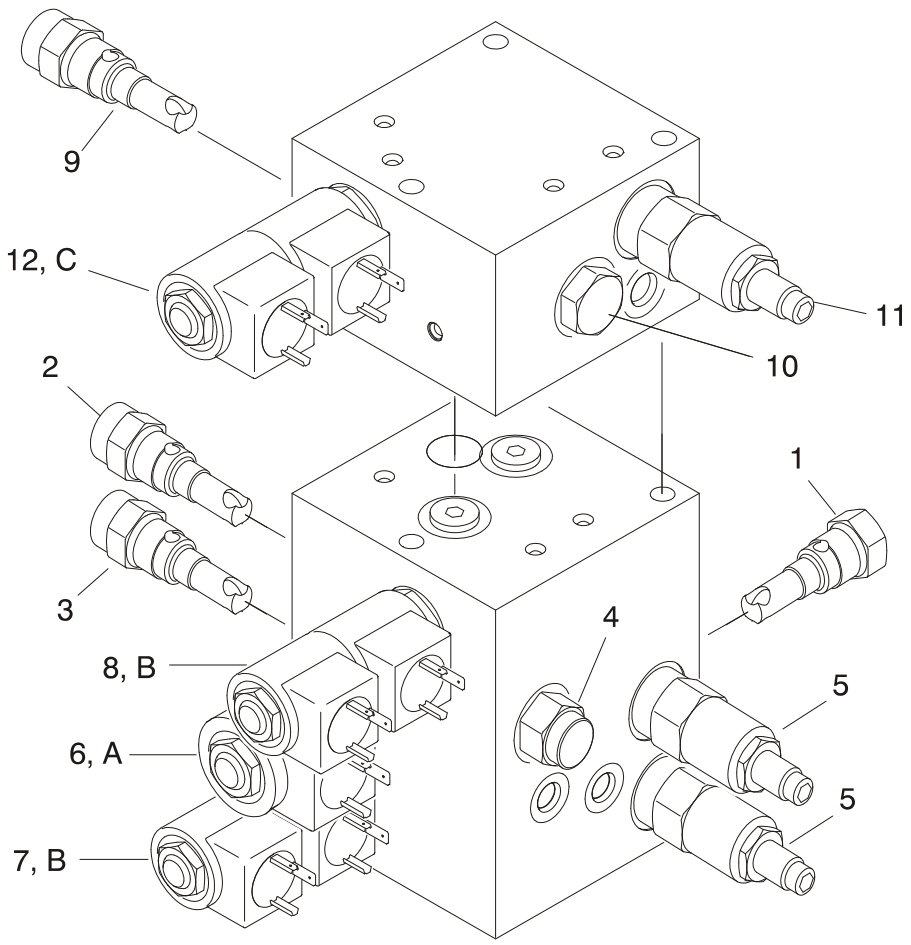


Table 5-5. Cartridge Torque Values

	Ft-Lbs.	Nm
1	20	27
2	20	27
3	20	27
4	20	27
5	20	27
6	25	34
7	20	27
8	20	27
9	20	27
10	20	27
11	20	27
12	20	27

Table 5-6. Coil Torque Values

	Ft-Lbs.	Nm
A	10-12	14-16.8
B	5	7
C	5	7

Figure 5-17. Platform Valve Cartridge Torque Values

5.4 START UP PROCEDURES

Start Up After Overhaul or Replacement of Components

PRE-FILL OF BOTH THE DRIVE AND FUNCTION PUMP

Machine without oil cooler: When filling the oil tank, fill it to the very top of the tank. This will give you enough head pressure from the tank to gravity fill the case on both pumps. The excess oil will be used to fill the cylinders during start up. The top case port on the outside of the drive pump has a ¾" tee fitting. Remove the cap from the end of the tee. You should see oil in 1-2 minutes, tighten up the cap. The drive pump case is done. Next, go the function pump, using a 3/8" allen wrench remove the plug on the inside of the pump next to the turn-table side sheet. When oil flows out of the pump, 2-3 minutes, re-install the plug. Both pumps are pre-filled. Not doing this causes the pumps to start dry, and reduces the efficiency of the pump and can cause premature failure.

Machine with oil cooler: When filling the oil tank, fill it to the very top of the tank. This will help give you enough head pressure from the tank to gravity fill the case on both pumps. The top case port on the outside of the pump has a ¾" tee fitting. Remove the cap from the center of the tee. You should see oil in 1-2 minutes. If not, depending on hose routing, the drive pump may not gravity feed. Oil has to flow through the oil cooler to get to the pump. Hose up an external hand pump to this tee fitting, and give it about (6) pumps after it has started pumping oil. This should be sufficient. Install the cap back onto the tee fitting. The drive pump is done. Next, go the function pump, using a 3/8" allen wrench remove the plug on the inside of the pump next to the turn-table side sheet. When oil flows out of the pump, 2-3 minutes, re-install the plug. Both pumps are pre-filled. Not doing this causes the pumps to start dry, and reduces the efficiency of the pump and can cause premature failure.

PURGING OF THE FUNCTION PUMP SUCTION HOSE.

Large pockets of air get trapped in this line and must be removed at low pressure. Head pressure from the tank is not enough. Here are (3) methods of purging the air from the hose at low pressure.

1. At the main control valve, remove the ¾ inch hose from port "P1", remove the 1 inch hose from port "T". Using a 12-16 connector, connect them together. Start the machine and let it run for approx. 10 seconds. Shut off the machine, remove the 12-16 adapter and re-hose.
2. Remove the ¾" hose from port "P1" and hold it into a 5 gallon bucket and start the machine. The air should purge very quickly, (seconds). Shut off the machine and re-hose.
3. Remove the ¾" hose from port "P1", using a #12 male union add approx. 30" of ¾" hose to it. Remove the return filter cap at the top of the tank, lift out the element making sure the canister stays in the tank. Hold the hose end down in the canister and start the machine and let it run approx. 10 seconds. Re-install the filter and re-hose the machine.

NOTE: ***If using a shop vac to create suction on the oil tank while doing maintenance, both steps "1" and "2" will need done.*

NOTE: ***If installing a new drive pump, step "1" will need done.*

NOTE: ***If installing a new function pump, step "1" and "2" will need done.*

NOTE: ***If installing a new function pump and the suction hose is capped without draining a lot of oil out of the hose, which creates a large air void, step "2" will not need to be done.*

NOTE: ***When operating a function such as Lift Up, if the function pump makes a loud noise and the lift up stops and starts, that is a sign of cavitation, air going through the pump at high pressure. This will in a short time destroy the pump and contaminate the entire system. Make sure all suction hoses are tight and free of leaks at the tank and pump. A suction hose does not leak when the engine is running, it will allow air to be drawn into the pump causing cavitation. After the machine is shut down, then you will see a very slow leak.*

SECTION 6. JLG CONTROL SYSTEM

6.1 INTRODUCTION

NOTICE

WHEN INSTALLING A NEW GROUND MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS AND PROPERLY CALIBRATE THE TILT SENSOR.

NOTICE

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

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

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

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

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer, JLG part no. 1600244 & Cable, JLG part no. 1600633) which will display two lines of information at a time, by scrolling through the program.

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

The following instructions are for using the hand held analyzer.

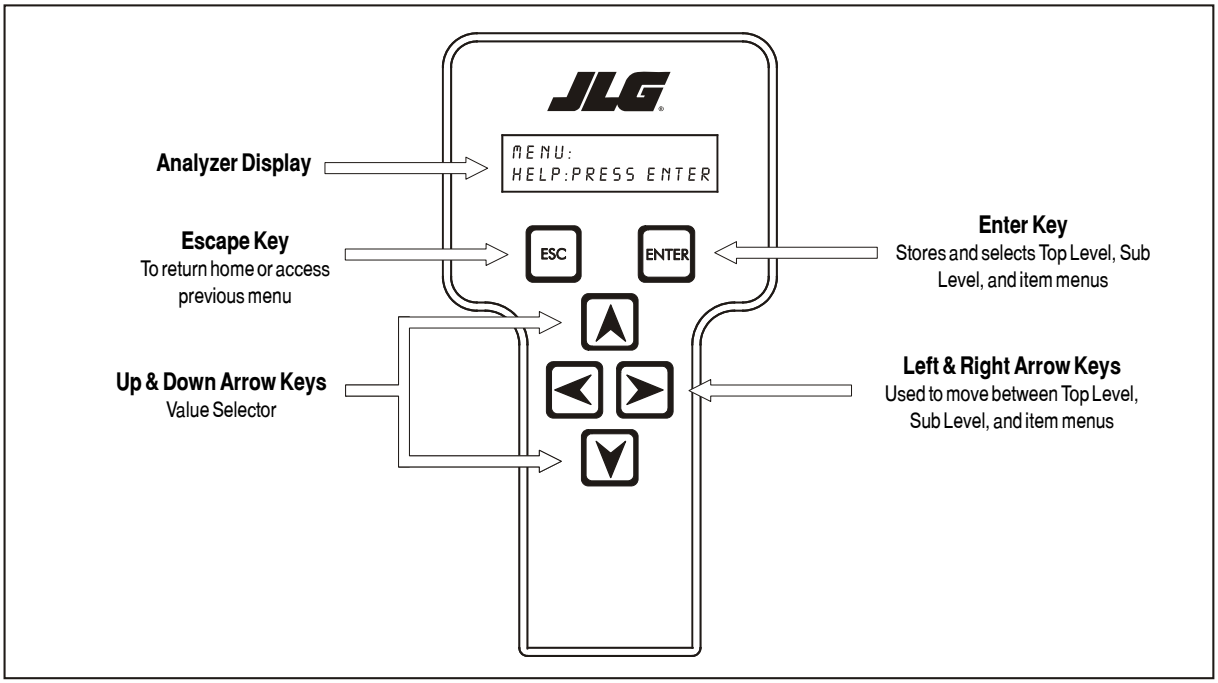


Figure 6-1. Hand Held Analyzer

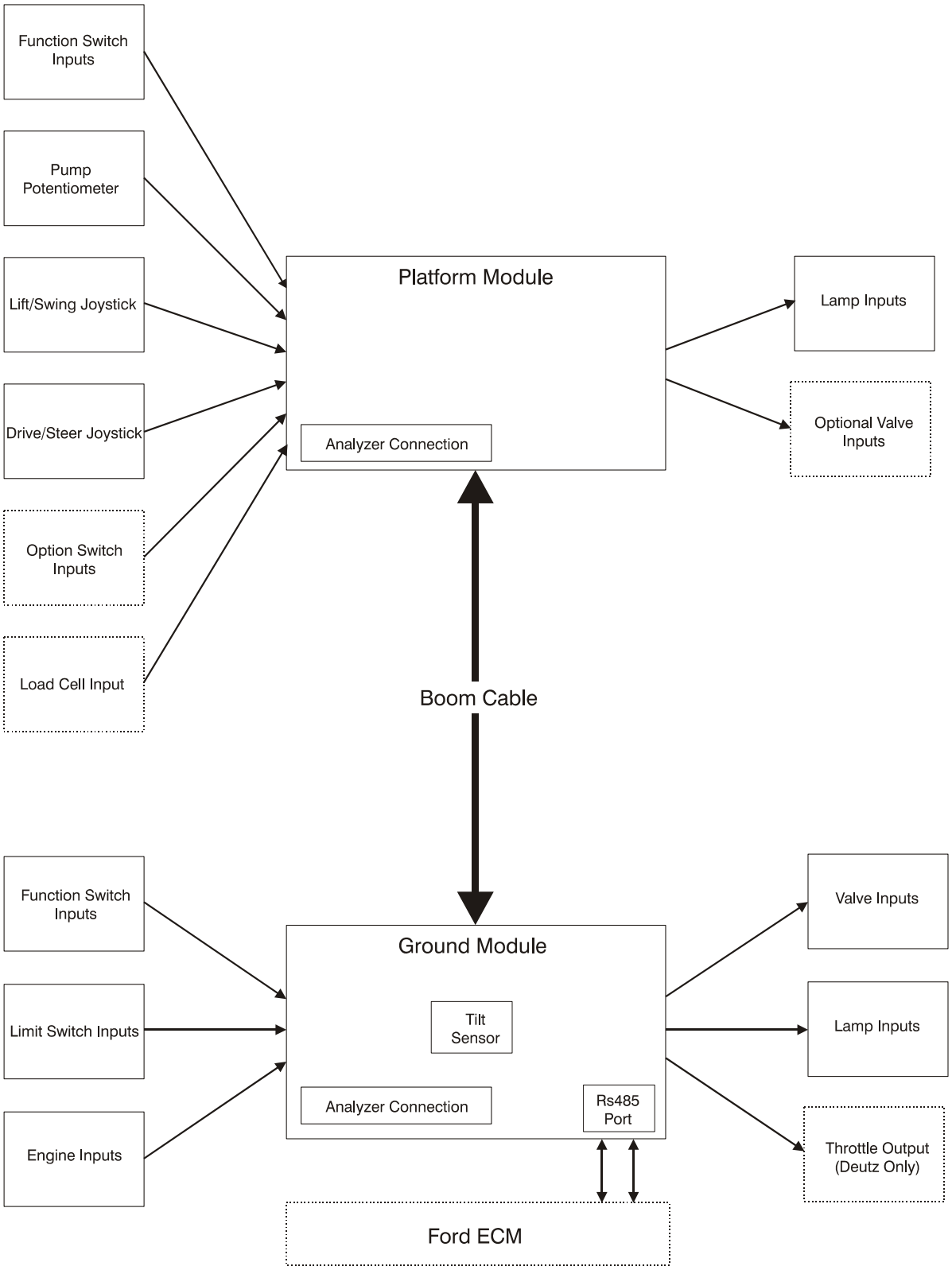


Figure 6-2. EPBCS Block Diagram

To Connect the JLG Control System Analyzer

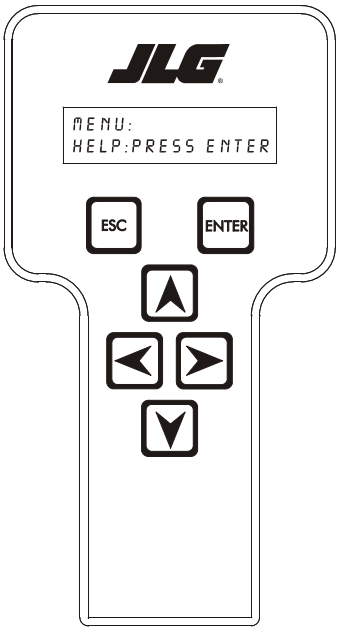
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

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

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

Using the Analyzer

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



HELP:
PRESS ENTER

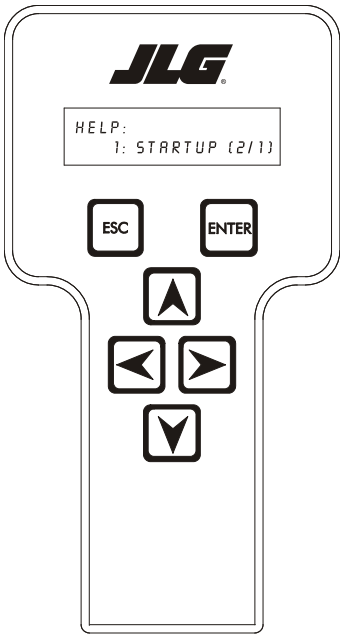
At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
SYSTEM TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
CALIBRATIONS (view only)

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

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

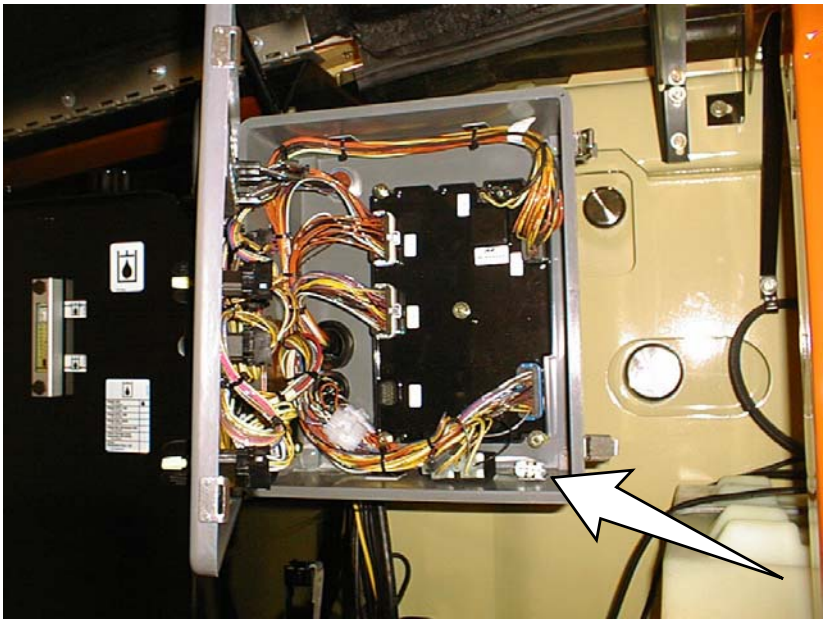


LOGGED HELP
1: POWER CYCLE (0/0)

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC.** two times. **POWER CYCLE (0/0)** indicates a power up.



PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-3. Analyzer Connecting Points

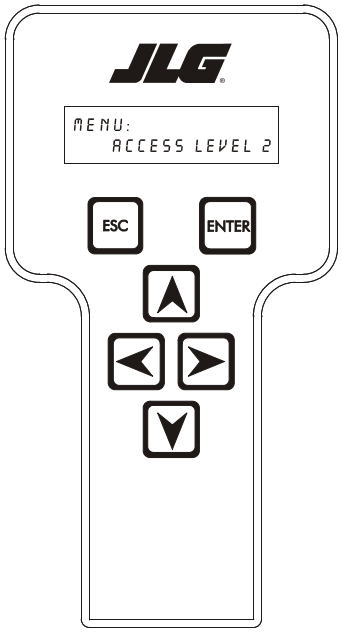
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESC.** key.

Changing the Access Level of the Hand Held Analyzer

When the analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:



MENU:
ACCESS LEVEL 2

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

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

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

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

Continue using the arrow keys until all the remaining digits of the password is shown.

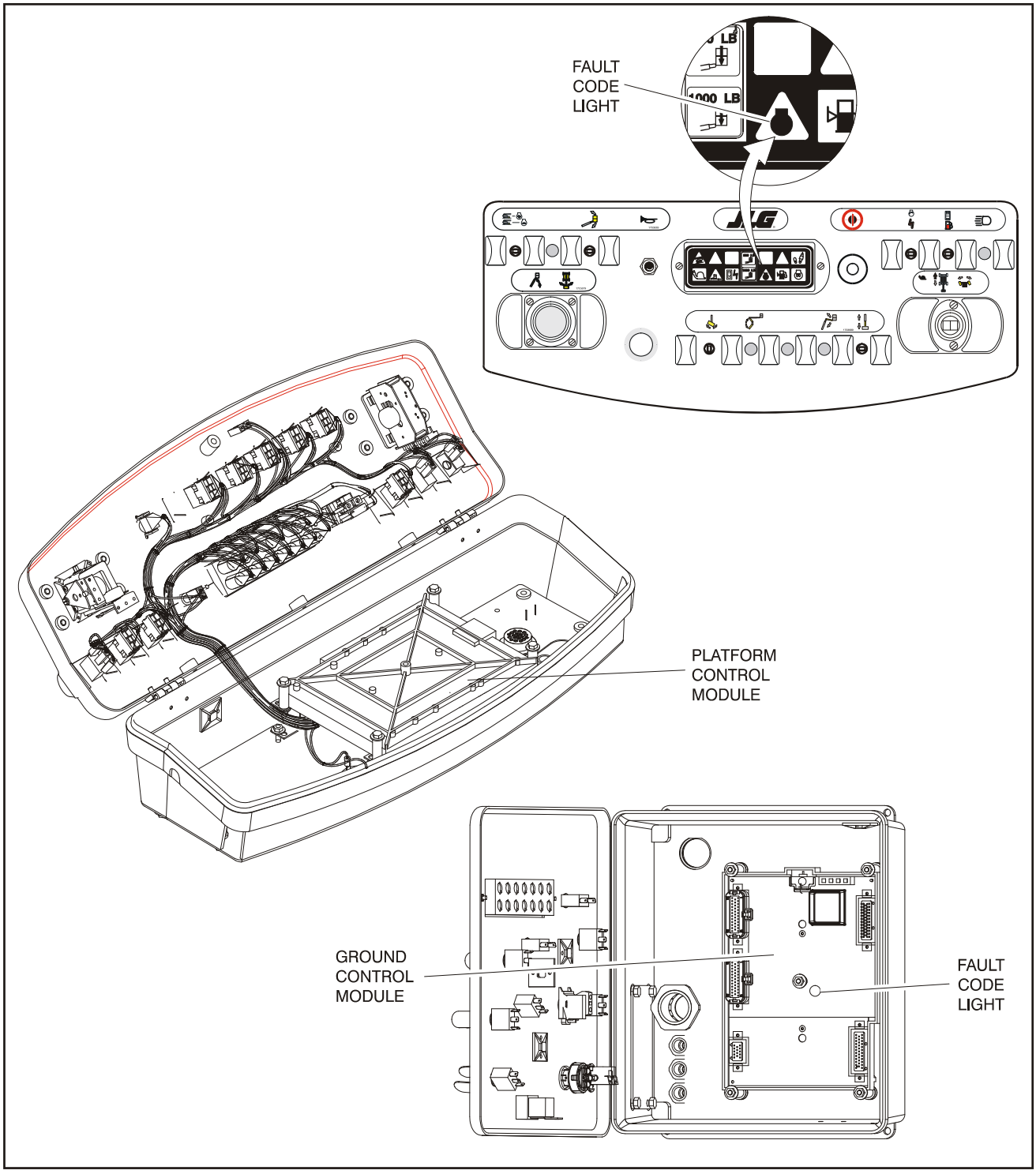
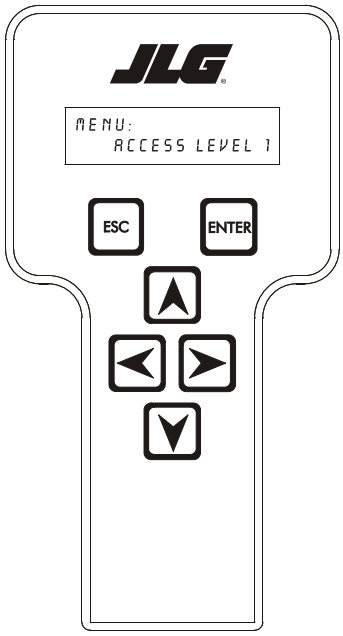


Figure 6-4. Control Module Location

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

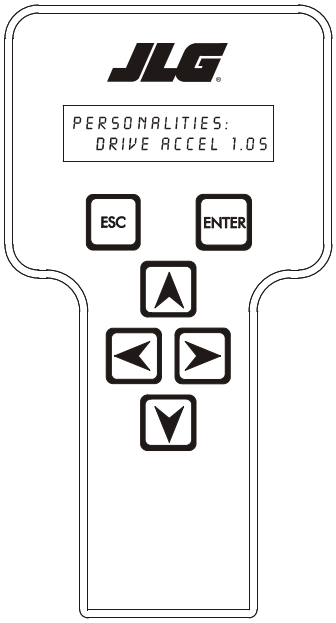


MENU:
ACCESS LEVEL 1

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

Adjusting Parameters Using the Hand Held Analyzer

Once you have gained access to level 1, and a personality item is selected, press the UP or DOWN arrow keys to adjust its value, for example:

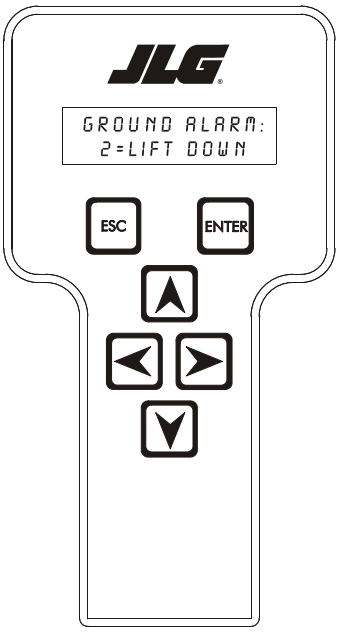


PERSONALITIES:
DRIVE ACCEL 1.0s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and won arrows, check the access level to ensure you are at access level 1.

Machine Setup

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



GROUND ALARM:
2 = LIFT DOWN

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

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

NOTE: *Refer to Table 6-1, Personality Ranges/Defaults, and in this Service Manual for the recommended factory settings.*

NOTE: *Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.*

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

⚠ WARNING

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

NOTICE

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

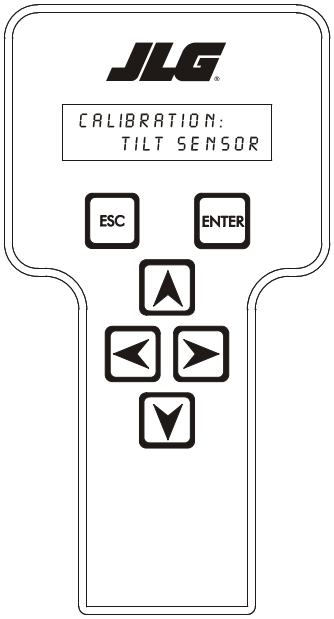
Level Vehicle Description

NOTICE

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

⚠ WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

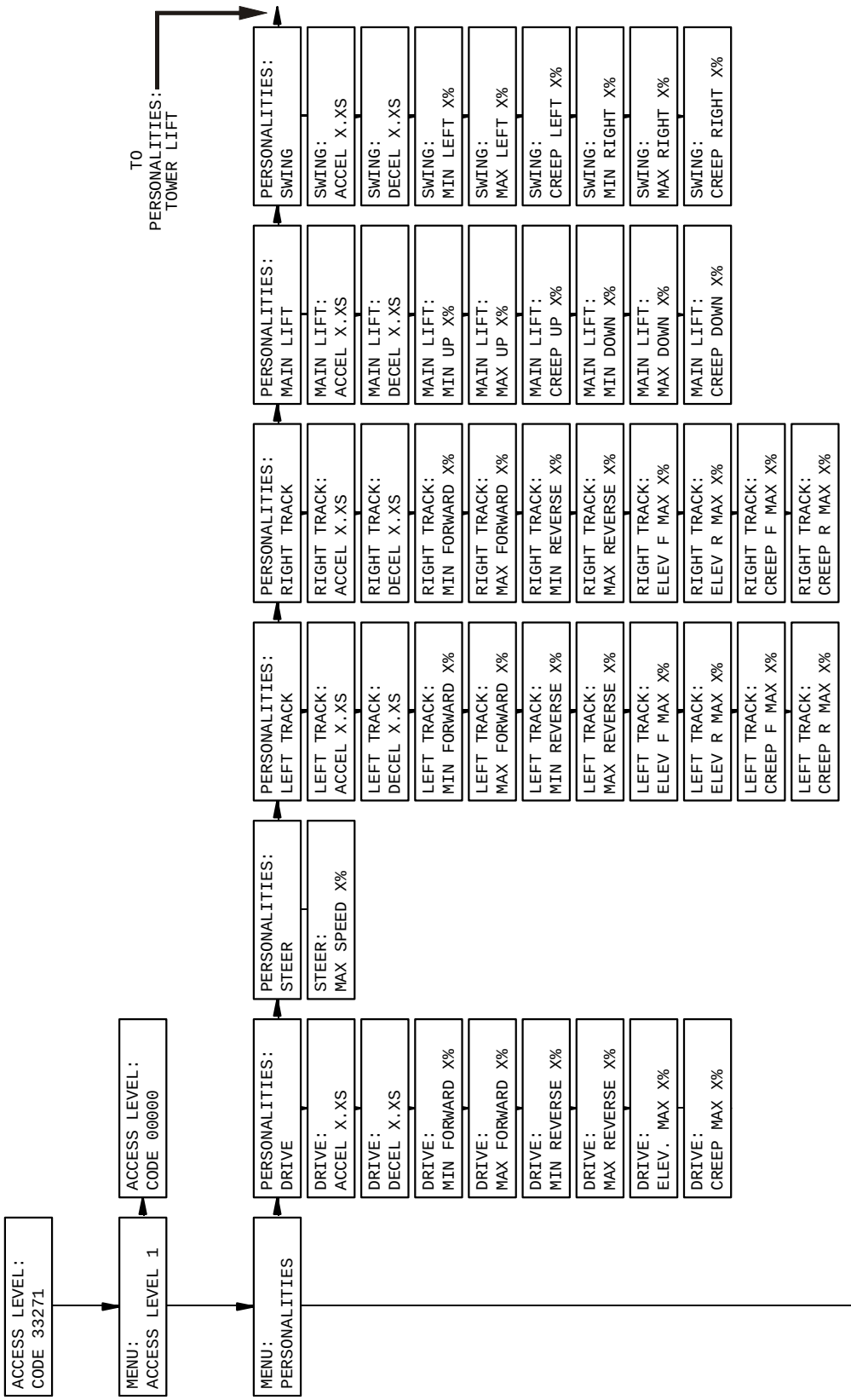
To level machine chose:

CALIBRATION:
TILT SENSOR

Press ENTER.

When prompted, swing machine 180°

Press ENTER.



Note: Some screens may not be available depending upon machine configuration.

Figure 6-5. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 1 of 4

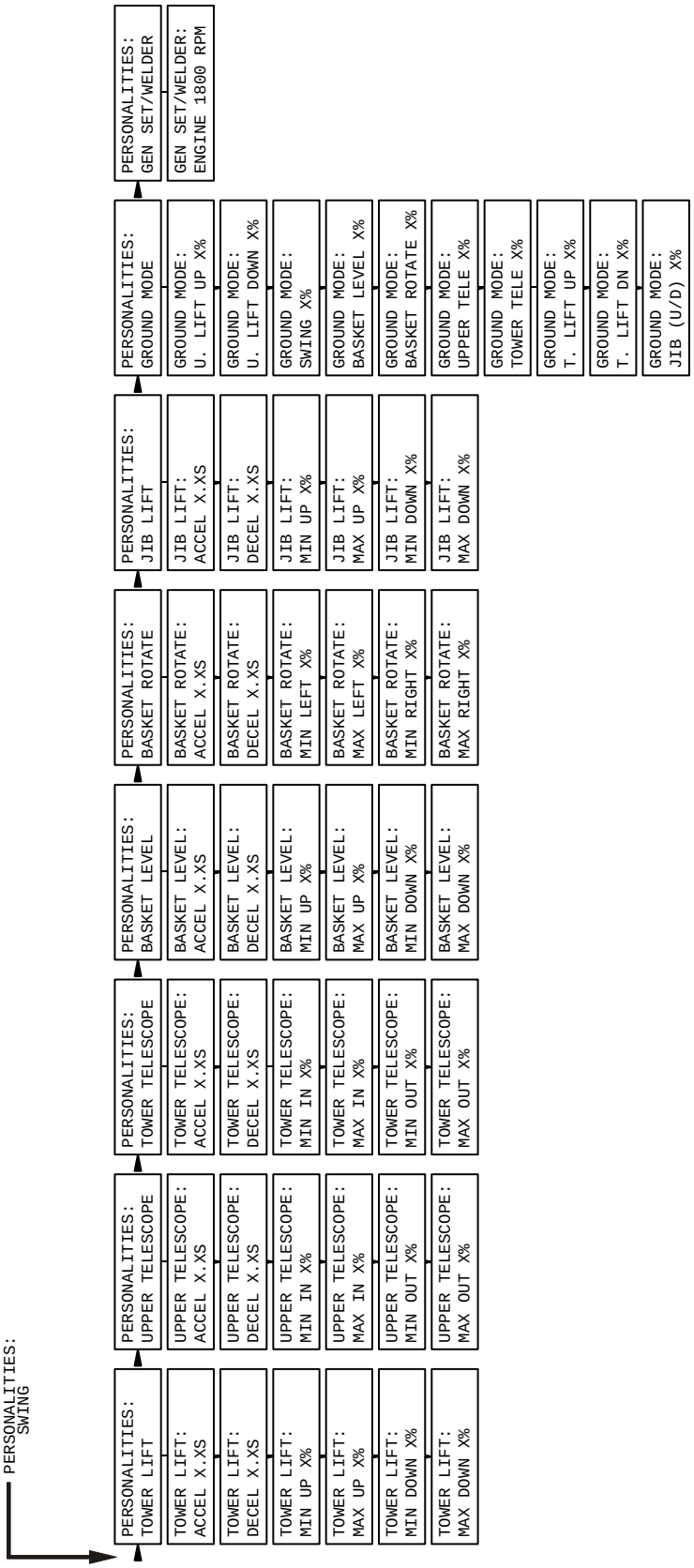


Figure 6-6. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 2 of 4

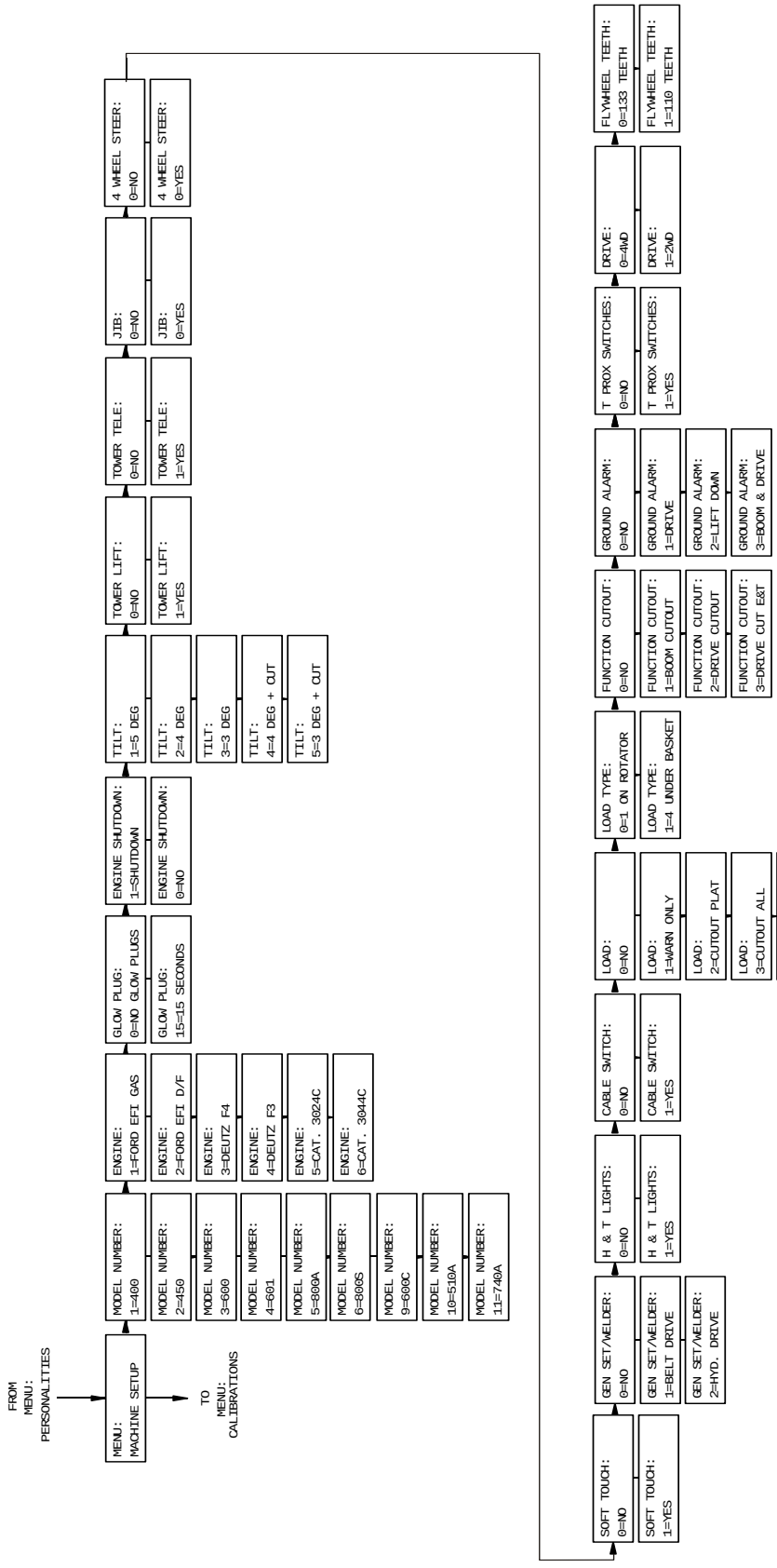


Figure 6-7. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 3 of 4

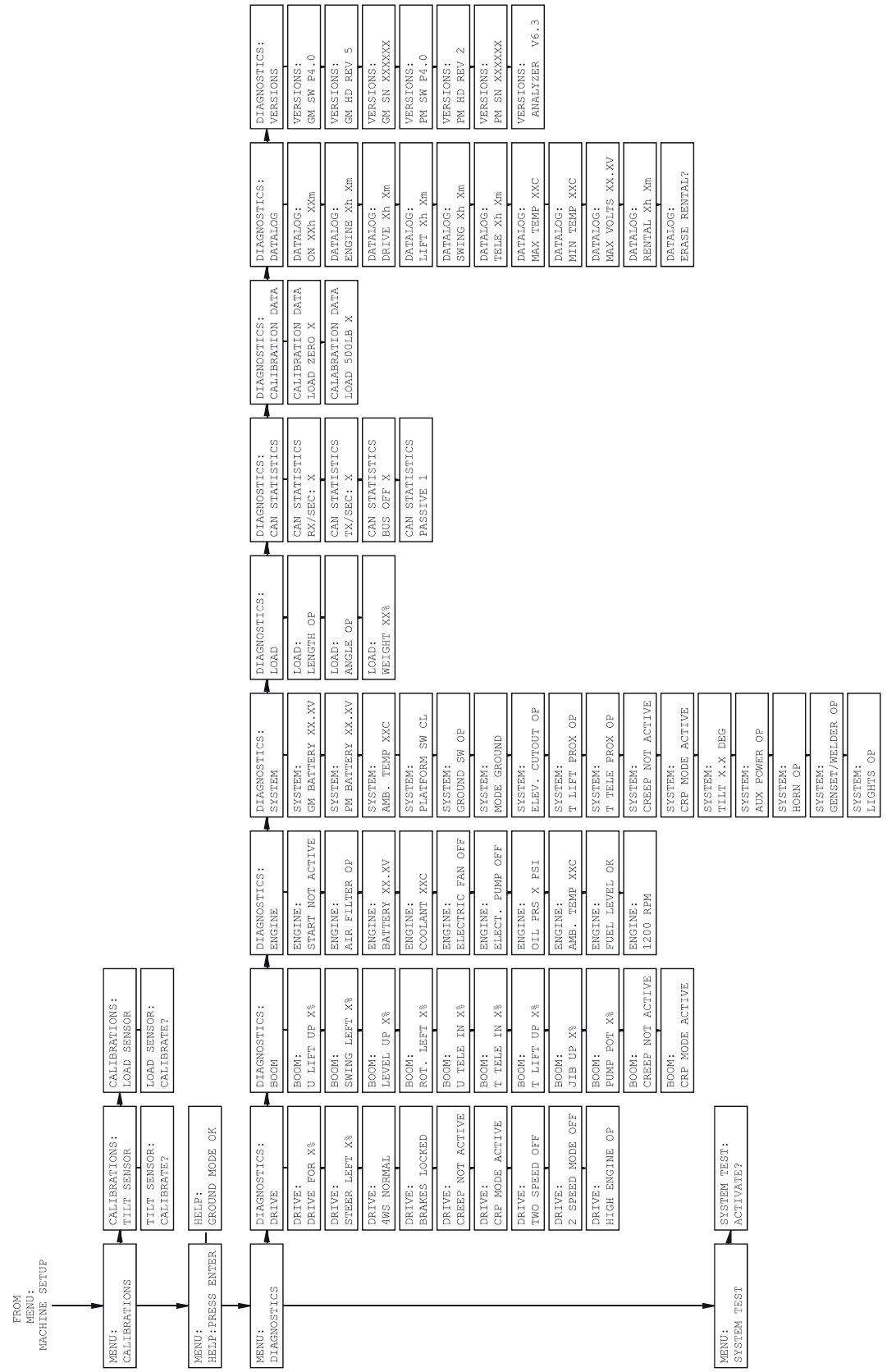
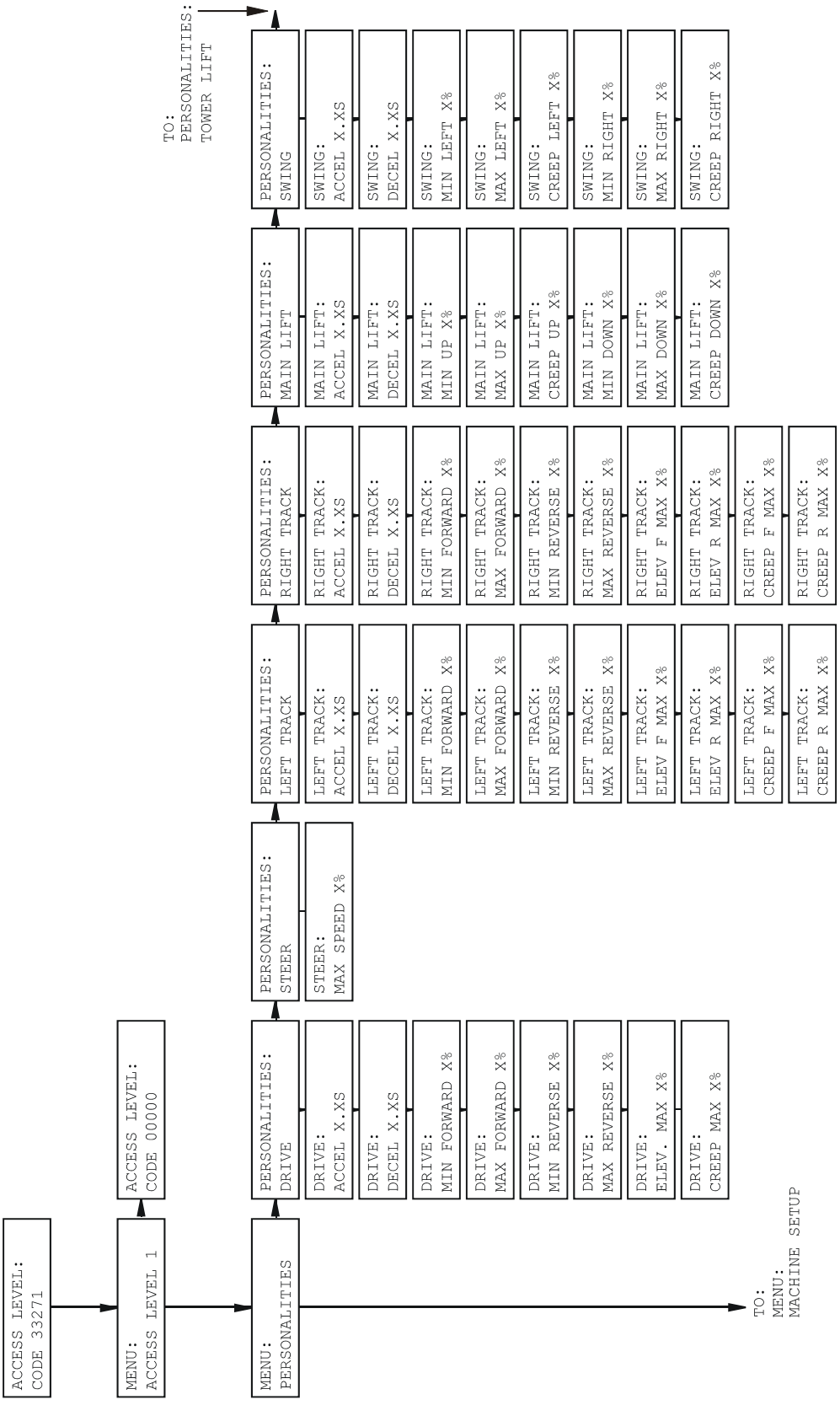


Figure 6-8. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 4 of 4



NOTE: *Some screens may not be available depending upon machine configuration.*

Figure 6-9. Analyzer Flow Chart, Version 5.X Software - Sheet 1 of 4

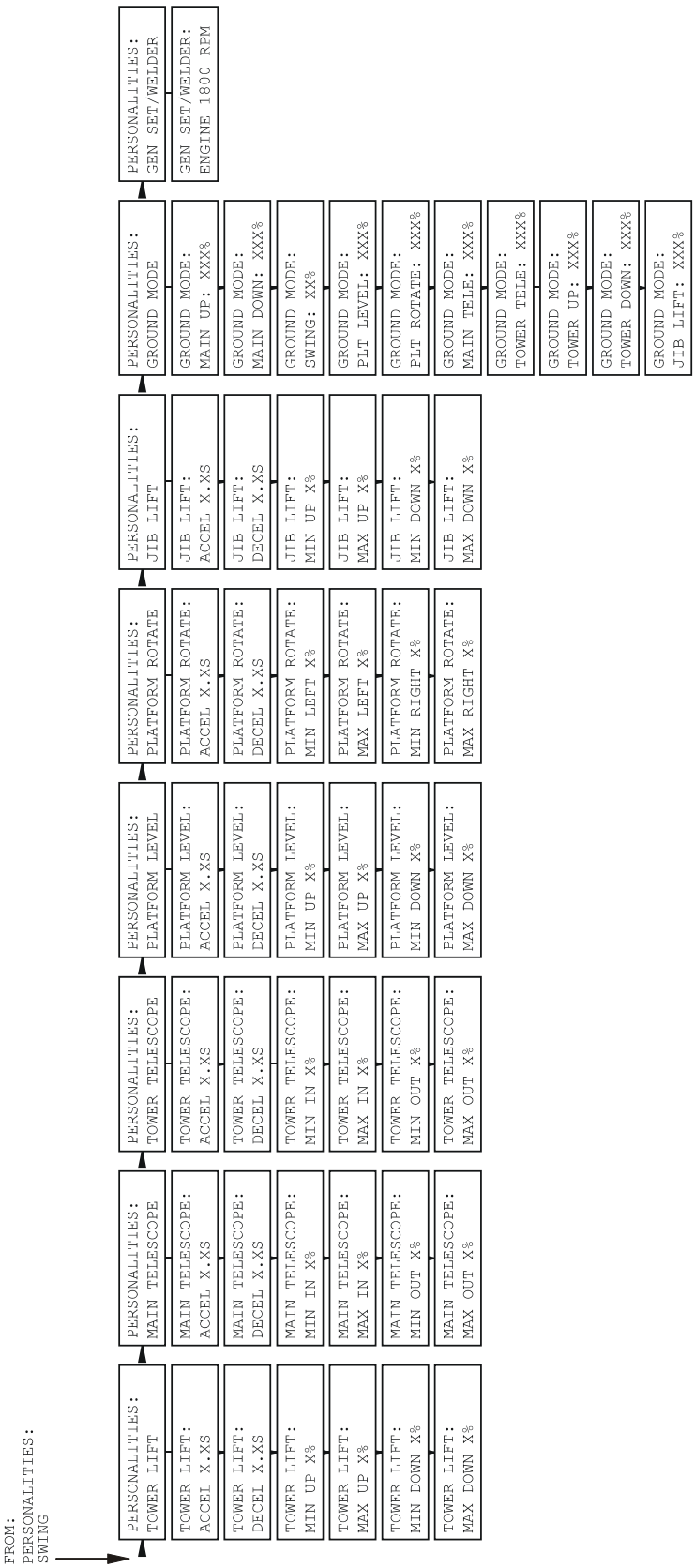


Figure 6-10. Analyzer Flow Chart, Version 5.X Software - Sheet 2 of 4

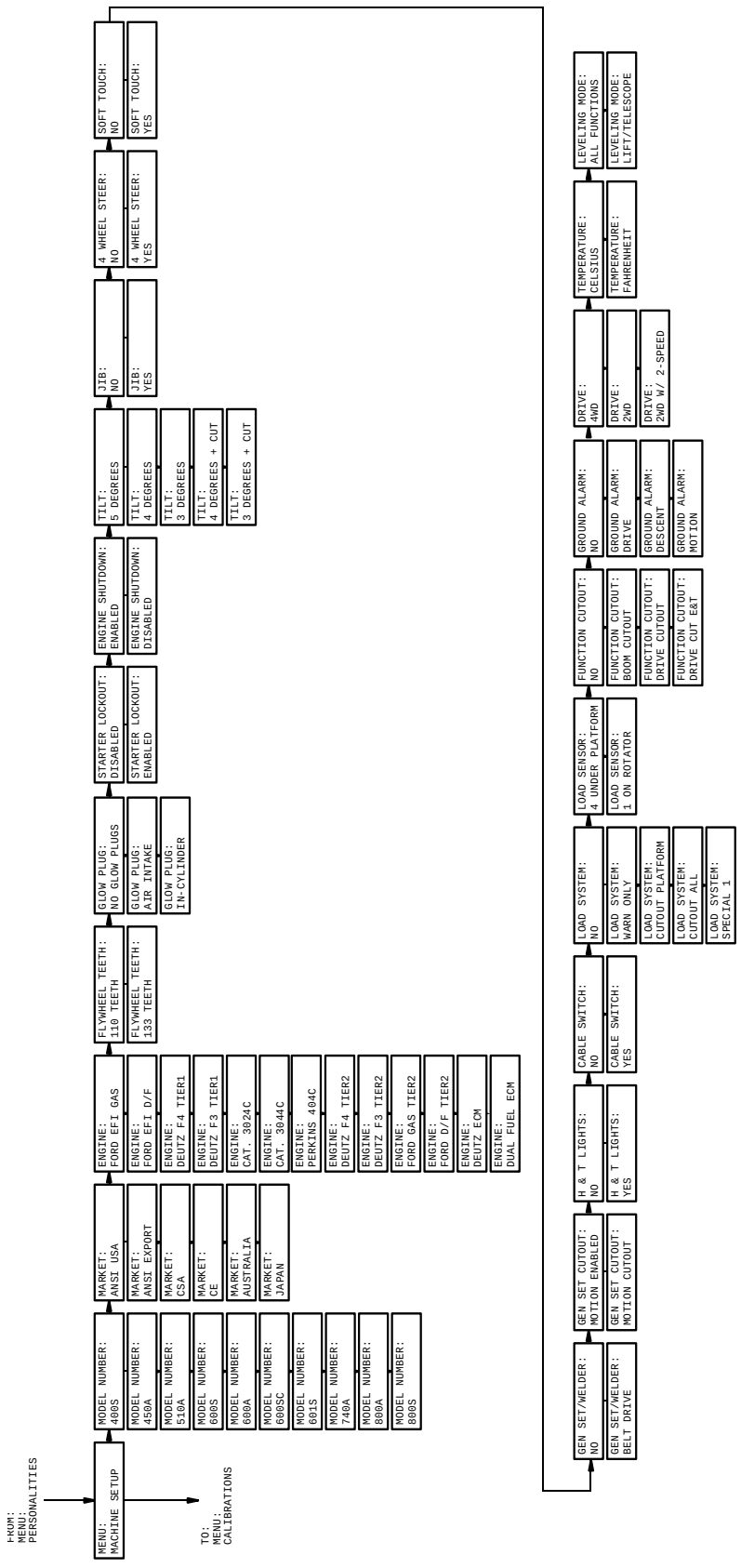


Figure 6-11. Analyzer Flow Chart, Version 5.X Software - Sheet 3 of 4

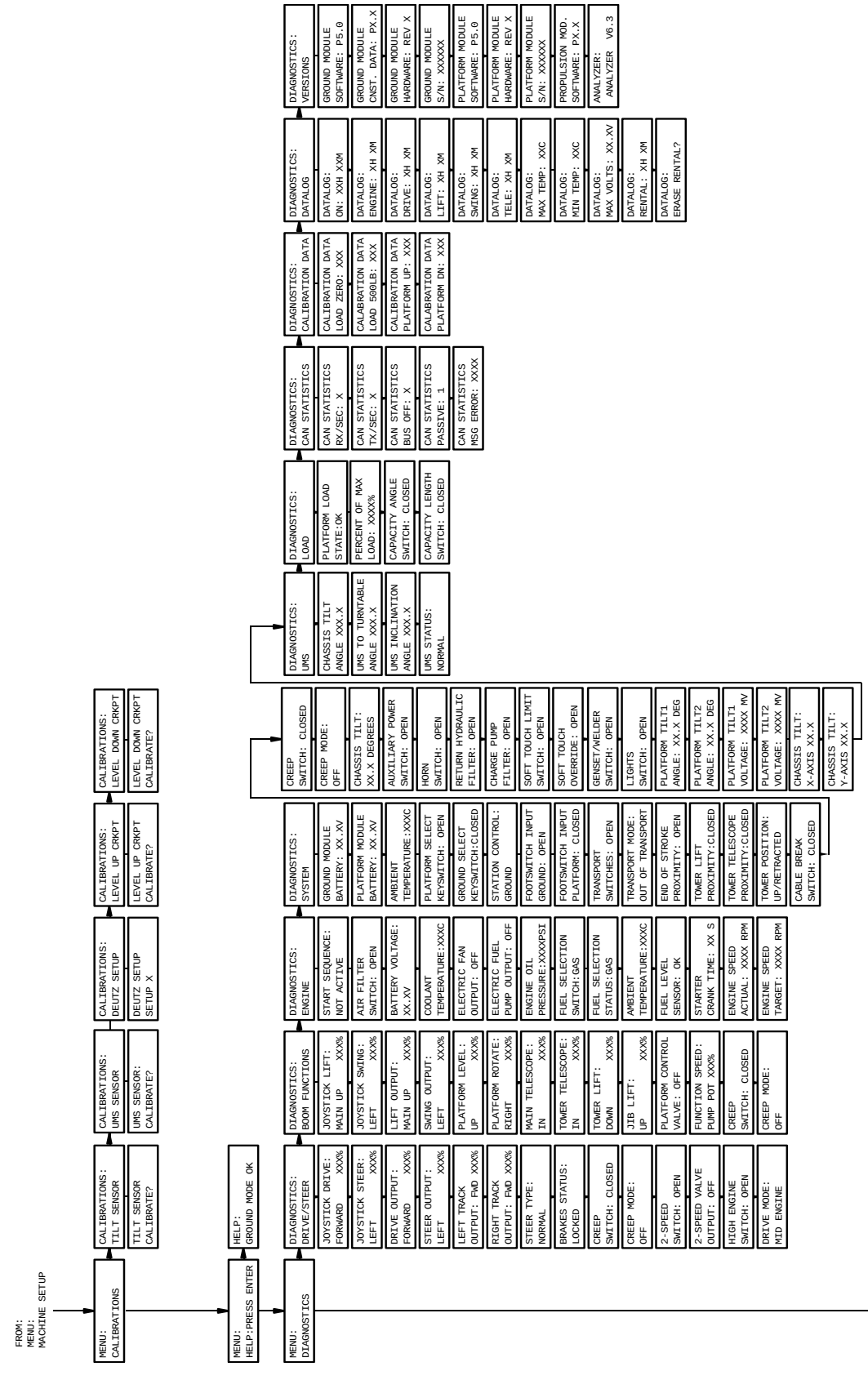


Figure 6-12. Analyzer Flow Chart, Version 5.X Software - Sheet 4 of 4

Machine Personality Settings

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 6-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 800S	DEFAULTS - 860SJ
DRIVE	ACCELeration	0.1s to 5.0s	2.0	2.0
	DECELeration	0.1s to 3.0s	2.0	2.0
	MINimum speed (Fwd. & Rev.)	0 to 35%	4	4
	MAXimum speed (Fwd. & Rev.)	0 to 100%	30	30
	ELEVATED MAXimum speed	0 to 50%	20	20
	CREEP MAXimum speed	0 to 50%	20	20
	Engine RPM	800 to 2900	1800	1800
LIFT	ACCELeration	0.1 to 5.0	2.5	2.5
	DECELeration	0.1 to 3.0	1.0	1.0
	MINimum UP speed	0 to 60%	10	10
	MAXimum UP speed	0 to 100	75	75
	CREEP Maximum UP speed	0 to 65	30	30
	MINimum DOWN speed	0 to 60	10	10
	MAXimum DOWN speed	0 to 100	76	76
	CREEP maximum DOWN speed	0 to 75	30	30
	Engine RPM	800 to 2900	1800	1800
SWING	ACCELeration	0.1 to 5.0s	2.7	2.7
	DECELeration	0.1 to 3.0s	2.0	2.0
	MINimum LEFT speed	0 to 50%	22	22
	MAXimum LEFT speed	0 to 100%	76	76
	CREEP maximum LEFT speed	0 to 65%	55	55
	MINimum RIGHT speed	0 to 50%	22	22
	MAXimum RIGHT speed	0 to 100%	78	78
	CREEP maximum RIGHT speed	0 to 65%	55	55
	Engine RPM	800 to 2900	1400	1400

Table 6-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 800S	DEFAULTS - 860SJ
TELEscope	ACCELeration	0.1 to 5.0	3.5	3.5
	DECELeration	0.1 to 3.0	1.0	1.0
	MINimum IN speed	0 to 65	22	22
	MAXimum IN speed	0 to 100	67	67
	MINimum OUT speed	0 to 65	22	20
	MAXimum OUT speed	0 to 100	75	75
	Engine RPM	800 to 2900	1800	1800
BASKET LEVEL	ACCELeration	0.1 to 5.0	0.1	0.1
	DECELeration	0.1 to 3.0	0.1	0.1
	MINimum UP speed	0 to 65	48	48
	MAXimum UP speed	0 to 100	100	100
	MINimum DOWN speed	0 to 65	48	48
	MAXimum DOWN speed	0 to 100	100	100
	Engine RPM	800 to 2900	1500	1500
BASKET ROTATE	ACCELeration	0.1 to 5.0	0.1	0.1
	DECELeration	0.1 to 3.0	0.1	0.1
	MINimum LEFT speed	0 to 65	100	100
	MAXimum LEFT speed	0 to 100	100	100
	MINimum RIGHT speed	0 to 65	100	100
	MAXimum RIGHT speed	0 to 100	100	100
	Engine RPM	800 to 2900	1500	1500
JIB	Lift ACCELeration	0.1 to 5.0	N/A	1.0
	Lift DECELeration	0.1 to 3.0	N/A	0.7
	MINimum UP speed	0 to 65	N/A	40
	MAXimum UP speed	0 to 100	N/A	100
	MINimum DOWN speed	0 to 65	N/A	40
	MAXimum DOWN speed	0 to 100	N/A	100
STEER	MAXimum speed	0 to 100	100	100
	Engine RPM	800 to 2900	1800	1800

Table 6-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 800S	DEFAULTS - 860SJ
GROUND MODE	LIFT speed (Up & Down)	0 to 100	60	60
	SWING speed	0 to 100	60	60
	TELEscope speed	0 to 100	75	75
	BASKET ROTATE speed	0 to 100	100	100
	BASKET LEVEL speed	0 to 100	100	100
	JIB LIFT speed	0 to 100	100	100

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Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
001	EVERYTHING OK
002	GROUND MODE OK
0010	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION
0011	FSW OPEN
0012	RUNNING AT CREEP - CREEP SWITCH OPEN
0013	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION
0014	CHASSIS TILT SENSOR OUT OF RANGE
0015	LOAD SENSOR READING UNDER WEIGHT
0035	APU ACTIVE
211	POWER CYCLE
212	KEYSWITCH FAULTY
213	FSW FAULTY
227	STEER SWITCHES FAULTY
2211	FSW INTERLOCK TRIPPED
2212	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2213	STEER LOCKED - SELECTED BEFORE FOOTSWITCH
2214	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE
2216	D/S JOY. OUT OF RANGE HIGH
2217	D/S JOY. CENTER TAP BAD
2218	L/S JOY. OUT OF RANGE LOW
2219	L/S JOY. OUT OF RANGE HIGH
2220	L/S JOY. CENTER TAP BAD
2221	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2222	WAITING FOR FSW TO BE OPEN
2223	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE
2224	FOOTSWITCH SELECTED BEFORE START
234	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM
235	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER
236	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH
237	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH
259	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS
2513	GENERATOR MOTION CUTOUT ACTIVE
2514	BOOM PREVENTED - DRIVE SELECTED
2516	DRIVE PREVENTED - ABOVE ELEVATION
2517	DRIVE PREVENTED - TILTED & ABOVE ELEVATION
2518	DRIVE PREVENTED - BOOM SELECTED
2519	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE
2520	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER
2530	UMS SENSOR FORWARD LIMIT REACHED
2531	UMS SENSOR OUT OF USABLE RANGE
2532	UMS SENSOR BACKWARD LIMIT REACHED

Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
331	BRAKE - SHORT TO BATTERY
332	BRAKE - OPEN CIRCUIT
3311	GROUND ALARM - SHORT TO BATTERY
3316	RIGHT FORWARD DRIVE PUMP - SHORT TO GROUND
3319	RIGHT FORWARD DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3320	RIGHT REVERSE DRIVE PUMP - SHORT TO GROUND
3323	RIGHT REVERSE DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3324	LEFT FORWARD DRIVE PUMP - SHORT TO GROUND
3327	LEFT FORWARD DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3328	LEFT REVERSE DRIVE PUMP - SHORT TO GROUND
3331	LEFT REVERSE DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3332	FORWARD DRIVE PUMP - SHORT TO GROUND
3333	FORWARD DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3334	REVERSE DRIVE PUMP - SHORT TO GROUND
3335	REVERSE DRIVE PUMP - SHORT TO BATTERY OR OPEN CIRCUIT
3336	ALTERNATOR POWER - SHORT TO GROUND
3340	AUX POWER - SHORT TO GROUND
3341	AUX POWER - OPEN CIRCUIT
3342	AUX POWER - SHORT TO BATTERY
3346	ELECTRIC FAN - SHORT TO GROUND
3347	ELECTRIC FAN - OPEN CIRCUIT
3348	ELECTRIC FAN - SHORT TO BATTERY
3349	ELECTRIC PUMP - SHORT TO GROUND
3350	ELECTRIC PUMP - OPEN CIRCUIT
3351	ELECTRIC PUMP - SHORT TO BATTERY
3352	LP LOCK - SHORT TO GROUND
3353	LP LOCK - OPEN CIRCUIT
3354	LP LOCK - SHORT TO BATTERY
3355	LP START ASSIST - SHORT TO GROUND
3356	LP START ASSIST - OPEN CIRCUIT
3357	LP START ASSIST - SHORT TO BATTERY
3358	MAIN DUMP VALVE - SHORT TO GROUND
3359	MAIN DUMP VALVE - OPEN CIRCUIT
3360	MAIN DUMP VALVE - SHORT TO BATTERY
3361	BRAKE - SHORT TO GROUND
3362	START SOLENOID - SHORT TO GROUND
3363	START SOLENOID - OPEN CIRCUIT
3364	START SOLENOID - SHORT TO BATTERY
3365	STEER DUMP VALVE - SHORT TO GROUND
3366	STEER DUMP VALVE - OPEN CIRCUIT
3367	STEER DUMP VALVE - SHORT TO BATTERY
3368	TWO SPEED VALVE - SHORT TO GROUND
3369	TWO SPEED VALVE - OPEN CIRCUIT

Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
3370	TWO SPEED VALVE - SHORT TO BATTERY
3371	GROUND ALARM - SHORT TO GROUND
3372	GROUND ALARM - OPEN CIRCUIT
3373	GEN SET/WELDER - SHORT TO GROUND
3374	GEN SET/WELDER - OPEN CIRCUIT
3375	GEN SET/WELDER - SHORT TO BATTERY
3376	HEAD TAIL LIGHT - SHORT TO GROUND
3377	HEAD TAIL LIGHT - OPEN CIRCUIT
3378	HEAD TAIL LIGHT - SHORT TO BATTERY
3379	HOUR METER - SHORT TO GROUND
3382	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
3383	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT
3384	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
3385	PLATFORM LEVEL UP OVERRIDE VALVE - SHORT TO GROUND
3386	PLATFORM LEVEL UP OVERRIDE VALVE - OPEN CIRCUIT
3387	PLATFORM LEVEL UP OVERRIDE VALVE - SHORT TO BATTERY
3388	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
3389	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
3390	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
3391	PLATFORM LEVEL DOWN OVERRIDE VALVE - SHORT TO GROUND
3392	PLATFORM LEVEL DOWN OVERRIDE VALVE - OPEN CIRCUIT
3393	PLATFORM LEVEL DOWN OVERRIDE VALVE - SHORT TO BATTERY
3394	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND
3395	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT
3396	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY
3397	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND
3398	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT
3399	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY
33100	JIB LIFT UP VALVE - SHORT TO GROUND
33101	JIB LIFT UP VALVE - OPEN CIRCUIT
33102	JIB LIFT UP VALVE - SHORT TO BATTERY
33103	JIB LIFT DOWN VALVE - SHORT TO GROUND
33104	JIB LIFT DOWN VALVE - OPEN CIRCUIT
33105	JIB LIFT DOWN VALVE - SHORT TO BATTERY
33106	TOWER LIFT UP VALVE - SHORT TO GROUND
33107	TOWER LIFT UP VALVE - OPEN CIRCUIT
33108	TOWER LIFT UP VALVE - SHORT TO BATTERY
33109	TOWER LIFT DOWN VALVE - SHORT TO GROUND
33110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT
33111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY
33112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND
33113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT
33114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY

Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
33115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND
33116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT
33117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY
33118	SWING RIGHT VALVE - SHORT TO GROUND
33119	SWING RIGHT VALVE - OPEN CIRCUIT
33120	TELESCOPE IN VALVE - SHORT TO BATTERY
33121	SWING RIGHT VALVE - SHORT TO BATTERY
33122	SWING LEFT VALVE - SHORT TO GROUND
33123	TELESCOPE OUT VALVE - SHORT TO BATTERY
33124	LIFT UP DUMP VALVE - SHORT TO GROUND
33125	LIFT UP DUMP VALVE - OPEN CIRCUIT
33126	LIFT UP DUMP VALVE - SHORT TO BATTERY
33127	LIFT DOWN HOLDING VALVE - SHORT TO GROUND
33128	LIFT DOWN HOLDING VALVE - OPEN CIRCUIT
33129	LIFT DOWN HOLDING VALVE - SHORT TO BATTERY
33130	THROTTLE ACTUATOR - SHORT TO GROUND
33131	THROTTLE ACTUATOR - OPEN CIRCUIT
33132	THROTTLE ACTUATOR - SHORT TO BATTERY
33133	PLATFORM CONTROL VALVE - SHORT TO GROUND
33134	PLATFORM CONTROL VALVE - OPEN CIRCUIT
33135	PLATFORM CONTROL VALVE - SHORT TO BATTERY
33170	LIFT DOWN VALVE - OPEN CIRCUIT
33171	LIFT DOWN VALVE - SHORT TO BATTERY
33172	LIFT DOWN VALVE - SHORT TO GROUND
33175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT
33176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY
33177	JIB ROTATE LEFT VALVE - SHORT TO GROUND
33178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT
33179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY
33180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND
33186	TELESCOPE OUT VALVE - OPEN CIRCUIT
33188	TELESCOPE OUT VALVE - SHORT TO GROUND
33189	TELESCOPE IN VALVE - OPEN CIRCUIT
33190	TELESCOPE IN VALVE - SHORT TO GROUND
33207	HORN - OPEN CIRCUIT
33208	HORN - SHORT TO BATTERY
33209	HORN - SHORT TO GROUND
33279	GLOWPLUG - OPEN CIRCUIT
33280	GLOWPLUG - SHORT TO BATTERY
33281	GLOWPLUG - SHORT TO GROUND
33295	SWING LEFT VALVE - OPEN CIRCUIT
33306	SWING LEFT VALVE - SHORT TO BATTERY
33314	FLOW CONTROL VALVE - OPEN CIRCUIT

Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
33315	FLOW CONTROL VALVE - SHORT TO BATTERY
33316	FLOW CONTROL VALVE - SHORT TO GROUND
33317	DRIVE FORWARD VALVE - OPEN CIRCUIT
33318	DRIVE FORWARD VALVE - SHORT TO BATTERY
33319	DRIVE FORWARD VALVE - SHORT TO GROUND
33320	DRIVE REVERSE VALVE - OPEN CIRCUIT
33321	DRIVE REVERSE VALVE - SHORT TO BATTERY
33322	DRIVE REVERSE VALVE - SHORT TO GROUND
33323	LIFT UP VALVE - OPEN CIRCUIT
33324	LIFT UP VALVE - SHORT TO BATTERY
33325	LIFT UP VALVE - SHORT TO GROUND
33331	DRIVE - CURRENT FEEDBACK READING TOO LOW
33332	LEFT TRACK - CURRENT FEEDBACK READING TOO LOW
33333	RIGHT TRACK - CURRENT FEEDBACK READING TOO LOW
33408	LEFT TRACK - CURRENT FEEDBACK READING LOST
33409	RIGHT TRACK - CURRENT FEEDBACK READING LOST
33410	DRIVE - CURRENT FEEDBACK READING LOST
341	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT
342	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
343	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
344	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT
345	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
346	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
347	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
348	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT
349	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT
3410	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY
3411	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND
3412	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT
3413	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY
3414	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND
3415	JIB LIFT UP VALVE - OPEN CIRCUIT
3416	JIB LIFT UP VALVE - SHORT TO BATTERY
3417	JIB LIFT UP VALVE - SHORT TO GROUND
3418	JIB LIFT DOWN VALVE - OPEN CIRCUIT
3419	JIB LIFT DOWN VALVE - SHORT TO BATTERY
3420	JIB LIFT DOWN VALVE - SHORT TO GROUND
3421	JIB ROTATE LEFT VALVE - OPEN CIRCUIT
3422	JIB ROTATE LEFT VALVE - SHORT TO BATTERY
3423	JIB ROTATE LEFT VALVE - SHORT TO GROUND
3424	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT
3425	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY
3426	JIB ROTATE RIGHT VALVE - SHORT TO GROUND

Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
431	FUEL SENSOR - SHORT TO BATTERY
432	FUEL SENSOR - SHORT TO GROUND
433	OIL PRESSURE - SHORT TO BATTERY
434	OIL PRESSURE - SHORT TO GROUND
435	COOLANT TEMPERATURE - SHORT TO GROUND
436	FORD FAULT CODE ##
437	ENGINE TROUBLE CODE
438	HIGH ENGINE TEMP
439	AIR FILTER BYPASSED
4310	NO ALTERNATOR OUTPUT
4311	LOW OIL PRESSURE
4312	485 COMMUNICATIONS LOST
4313	THROTTLE ACTUATOR FAILURE
4314	WRONG ENGINE SELECTED - ECM DETECTED
4322	LOSS OF ENGINE SPEED SENSOR
4323	SPEED SENSOR READING INVALID SPEED
441	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN
442	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN
445	BATTERY VOLTAGE LOW
662	CANBUS FAILURE - PLATFORM MODULE
664	CANBUS FAILURE - ACCESSORY MODULE
665	CANBUS FAILURE - PROPULSION MODULE
666	CANBUS FAILURE - ENGINE CONTROLLER
6620	CANBUS FAILURE - UMS SENSOR
671	ACCESSORY FAULT
813	CHASSIS TILT SENSOR NOT CALIBRATED
815	CHASSIS TILT SENSOR DISAGREEMENT
816	UMS SENSOR NOT CALIBRATED
817	UMS SENSOR FAULT
825	LSS HAS NOT BEEN CALIBRATED
826	RUNNING AT CREEP - PLATFORM OVERLOADED
827	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED
828	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED
831	PLATFORM LEVELING OVERRIDE ON
832	PLATFORM LEVELING OVERRIDE OFF
833	PLATFORM LEVEL UP CRACKPOINT - NOT CALIBRATED
834	PLATFORM LEVEL DOWN CRACKPOINT - NOT CALIBRATED
835	PLATFORM LEVEL SENSOR #1 - NOT ZERO CALIBRATED
836	PLATFORM LEVEL SENSOR #1 - ZERO OUT OF RANGE
837	PLATFORM LEVEL SENSOR #1 - SHORT TO BATTERY
838	PLATFORM LEVEL SENSOR #1 - SHORT TO GROUND OR OPEN CIRCUIT
839	PLATFORM LEVEL SENSOR #2 - NOT ZERO CALIBRATED
8310	PLATFORM LEVEL SENSOR #2 - ZERO OUT OF RANGE

Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
8311	PLATFORM LEVEL SENSOR #2 - SHORT TO BATTERY
8312	PLATFORM LEVEL SENSOR #2 - SHORT TO GROUND OR OPEN CIRCUIT
8313	PLATFORM LEVEL SENSOR #1 - REFERENCE VOLTAGE OUT OF RANGE
8314	PLATFORM LEVEL SENSOR #2 - REFERENCE VOLTAGE OUT OF RANGE
8315	PLATFORM LEVELING SENSOR - DISAGREEMENT
8316	PLATFORM LEVEL SENSOR #1 - COMMUNICATIONS LOST
8317	PLATFORM LEVEL SENSOR #2 - COMMUNICATIONS LOST
8318	PLATFORM LEVELING SYSTEM TIMEOUT
8639	FRONT LEFT STEER VALVE - OPEN CIRCUIT
8640	FRONT LEFT STEER VALVE - SHORT TO BATTERY
8641	FRONT LEFT STEER VALVE - SHORT TO GROUND
8642	FRONT RIGHT STEER VALVE - OPEN CIRCUIT
8643	FRONT RIGHT STEER VALVE - SHORT TO BATTERY
8644	FRONT RIGHT STEER VALVE - SHORT TO GROUND
8645	REAR LEFT STEER VALVE - OPEN CIRCUIT
8646	REAR LEFT STEER VALVE - SHORT TO BATTERY
8647	REAR LEFT STEER VALVE - SHORT TO GROUND
8648	REAR RIGHT STEER VALVE - OPEN CIRCUIT
8649	REAR RIGHT STEER VALVE - SHORT TO BATTERY
8650	REAR RIGHT STEER VALVE - SHORT TO GROUND
8652	RIGHT TRACK FORWARD VALVE - OPEN CIRCUIT
8653	RIGHT TRACK FORWARD VALVE - SHORT TO BATTERY
8654	RIGHT TRACK FORWARD VALVE - SHORT TO GROUND
8655	RIGHT TRACK REVERSE VALVE - OPEN CIRCUIT
8656	RIGHT TRACK REVERSE VALVE - SHORT TO BATTERY
8657	RIGHT TRACK REVERSE VALVE - SHORT TO GROUND
8658	LEFT TRACK FORWARD VALVE - OPEN CIRCUIT
8659	LEFT TRACK FORWARD VALVE - SHORT TO BATTERY
8660	LEFT TRACK FORWARD VALVE - SHORT TO GROUND
8661	LEFT TRACK REVERSE VALVE - OPEN CIRCUIT
8662	LEFT TRACK REVERSE VALVE - SHORT TO BATTERY
8663	LEFT TRACK REVERSE VALVE - SHORT TO GROUND
871	RETURN FILTER BYPASSED
872	CHARGE PUMP FILTER BYPASSED
998	EEPROM FAILURE - CHECK ALL SETTINGS
9910	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER
9913	FUNCTIONS LOCKED OUT - PROPULSION MODULE SOFTWARE VERSION IMPROPER
9914	PLATFORM MODULE SOFTWARE UPDATE REQUIRED
9915	CHASSIS TILT SENSOR NOT GAIN CALIBRATED
9916	CHASSIS TILT SENSOR GAIN OUT OF RANGE
9917	HIGH RESOLUTION A2D FAILURE - INTERRUPT LOST
9918	HIGH RESOLUTION A2D FAILURE - REINIT LIMIT
9919	GROUND SENSOR REF VOLTAGE OUT OF RANGE

Table 6-2. Analyzer Fault Code Listing

DTC	Analyzer Text
9920	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE
9921	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY
9922	PLATFORM MODULE FAILURE - HWFS CODE 1
9923	GROUND MODULE FAILURE - HWFS CODE 1
9924	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED
9944	CURRENT FEEDBACK GAINS OUT OF RANGE
9945	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
MODEL NUMBER: 1	1 2 3 4 5 6 7 8 9 10	400S 450A 510A 600S 600A 600SC 601S 740A 800A 800S	1
MARKET: 2	0 1 2 3 4 5	ANSI USA ANSI EXPORT CSA CE AUSTRALIA JAPAN	0
ENGINE: 3* * Engine selections vary depending on model selection.	1 2 3 4 5 6 7 8 9 10 11	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1) FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1) DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1) DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1) CAT. 3024C: CAT 3024C Diesel (Tier 2) CAT. 3044C: CAT 3044C Diesel (Tier 2) DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2) DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2) FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2) FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2) DEUTZ ECM: Engine Control Module - ECM	11
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0 1	133 TEETH: 133 flywheel teeth. 110 TEETH: 110 flywheel teeth.	1

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	1
	1	W/O STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	
	2	W/ STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
ENGINE SHUTDOWN: 6	0	DISABLED: No engine shutdown.	1
	1	ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 psi.	
TILT: 7* * Certain market selections will limit tilt options.	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	1
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
		Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.	
JIB: 8* * Only visible under certain model selections	0	NO: No jib installed.	0
	1	YES: Jib installed which has up and down movements only.	
4 WHEEL STEER: 9* * Only visible under certain model selections.	0	NO: No four-wheel steer installed.	0
	1	YES: Four-wheel steer installed.	
SOFT TOUCH: 10* * Only visible under certain model selections.	0	NO: No soft touch system installed.	0
	1	YES: Soft touch system installed.	
GEN SET/WELDER: 11	0	NO: No generator installed.	0
	1	BELT DRIVE: Belt driven setup.	

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GEN SET CUTOUT: 12* * Only visible if Gen Set / Welder Menu selection is not 0.	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
H & T LIGHTS: 13	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 14* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
LOAD SYSTEM: 15* * Only visible under certain model selections. * Certain market selections will limit load system options or alter default setting.	0 1 2 3 4	NO: No load sensor installed. WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	0
LOAD SENSOR: 16* * Only visible if Load Sensor Menu selection is not 0. * Market selections will limit certain load sensor options.	0 1	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. 4 UNDER PLATFORM: Use the EIM for load sensing.	1
FUNCTION CUTOUT: 17* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0 1 2 3	NO: No drive cutout. BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive cutout above elevation. DRIVE CUT E&T: Drive cutout above elevation and tilted.	0

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GROUND ALARM: 18* * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	0
	1	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	2	DESCENT: Descent alarm sounds when lift down is active (Option).	
	3	MOTION: Motion alarm sounds when any function is active (Option).	
DRIVE: 19* * Only visible under certain model selections.	0	4WD: Four wheel drive.	0
	1	2WD: Two wheel drive.	
	2	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
TEMPERATURE: 20	0	CELSIUS: Celsius unit selection.	1
	1	FAHRENHEIT: Fahrenheit unit selection.	
LEVELING MODE: 21* * Only visible on 800S models.	0	ALL FUNCTIONS: Platform level with all functions.	0
	1	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	

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Table 6-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

Table 6-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	7
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	
STARTER LOCKOUT: 6	0	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	

Table 6-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
ENGINE SHUTDOWN: 7	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	1
TILT: 8* *Certain market selections will limit tilt options and alter default setting. *Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.*	1 2 3 4 5	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep. 4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep. 3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep. 4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. 3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	1
JIB: 9* *Only visible under certain model selections.	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 10* *Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
SOFT TOUCH: 11* *Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0
GEN SET/WELDER: 12	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0

Table 6-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
GEN SET CUTOUT: 13* * Only visible if Gen Set / Welder Menu selection is not 0.	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
H & T LIGHTS: 14	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 15* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
LOAD SYSTEM: 16* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting.	0 1 2 3 4	NO: No load sensor installed. WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	0
LOAD SENSOR: 17* * Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.	0 1	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. 4 UNDER PLATFORM: Use the EIM for load sensing.	1

Table 6-4. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
FUNCTION CUTOUT: 18* *Only visible under certain market selections. *Certain market selections will limit function cutout options or alter default setting.	0 1 2 3	NO: No drive cutout. BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive & steer cutout above elevation. DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	0
GROUND ALARM: 19* *Certain market selections will alter default setting.	0 1 2 3	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	3
DRIVE: 20* *Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 21* *Certain market selections will alter default setting.	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1
LEVELING MODE: 22* *Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0

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Table 6-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

Table 6-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	14
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	14	PERKINS ECM	
	15	CAT ECM	
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	

Table 6-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
STARTER LOCKOUT: 6	0 1	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow. ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	0
ENGINE SHUTDOWN: 7	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	1
TILT: 8* * Certain market selections will limit tilt options and alter default setting. *Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.*	1 2 3 4 5	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep. 4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep. 3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep. 4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. 3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	1
JIB: 9* * Only visible under certain model selections.	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 10* * Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
SOFT TOUCH: 11* * Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0

Table 6-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
GEN SET/WELDER: 12	0	NO: No generator installed.	0
	1	BELT DRIVE: Belt driven setup.	
GEN SET CUTOUT: 13* * Only visible if Gen Set / Welder Menu selection is not 0.	0	MOTION ENABLED: Motion enabled when generator is ON.	0
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
H & T LIGHTS: 14	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 15* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0	NO: No broken cable switch installed.	0
	1	YES: Broken cable switch installed.	
LOAD SYSTEM: 16* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting.	0	NO: No load sensor installed.	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	

Table 6-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
LOAD SENSOR: 17* * Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.	0 1	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. 4 UNDER PLATFORM: Use the EIM for load sensing.	1
FUNCTION CUTOUT: 18* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0 1 2 3	NO: No drive cutout. BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive & steer cutout above elevation. DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	0
GROUND ALARM: 19* * Certain market selections will alter default setting.	0 1 2 3	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	3
DRIVE: 20* * Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 21* * Certain market selections will alter default setting.	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1

Table 6-5. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
LEVELING MODE: 22* * Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0
DRIVE CONTROL: 23	0 1 2	NORMAL: Drive coils are energized from the Ground Module. PROPULSION: Drive coils are energized from the Propulsion Module. ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	2
CLEARSKY: 24	0 1	NO: Clearsky (telematics) option is disabled. YES: Clearsky (telematics) option is enabled.	0
CRIBBING OPTION: 25	0 1	NO: Cribbing Option is disabled. YES: Cribbing Option is enabled.	0

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NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed. Shaded cells indicate a hidden menu or selection.*

800S																													
	MODEL NUMBER		MARKET		ENGINE	FLYWHEEL TEETH		GLOW PLUGS			STARTER LOCKOUT		ENGINE SHUTDOWN		TILT					JIB		4 WHEEL STEER		SOFT TOUCH		GEN SET / WELDER		GEN SET CUTOUT	
ANSI USA	***10***		***0***		***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***0***		***0***		***0***	1	***0***	1	***0***	1
ANSI EXPORT	***10***		***1***		***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***0***		***0***		***0***	1	***0***	1	***0***	1
CSA	***10***		***2***		***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***0***		***0***		***0***	1	***0***	1	***0***	1
CE	***10***		***3***		***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	X	***2***	3	4	5	***0***		***0***		***0***	1	***0***	1	***0***	1
AUSTRALIA	***10***		***4***		***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	X	***2***	3	4	5	***0***		***0***		***0***	1	***0***	1	***0***	1
JAPAN	***10***		***5***		***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***0***		***0***		***0***	1	***0***	1	***0***	1

800S																													
	HEAD & TAIL LIGHTS		CABLE BREAK SWITCH		LOAD SYSTEM					LOAD SENSOR		FUNCTION CUTOUT				GROUND ALARM				DRIVE TYPE			TEMPERATURE		LEVELING MODE	
ANSI USA	***0***	1	0	***1***	***0***	X	X	X	X	0	***1***	***0***	X	X	X	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
ANSI EXPORT	***0***	1	0	***1***	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
CSA	***0***	1	0	***1***	***0***	X	X	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
CE	***0***	1	0	***1***	0	X	2	***3***	X	0	***1***	0	***1***	X	X	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
AUSTRALIA	***0***	1	0	***1***	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	***0***	1	***0***	1
JAPAN	***0***	1	0	***1***	0	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed. Shaded cells indicate a hidden menu or selection.*

860SJ																										
	MODEL NUMBER	MARKET	ENGINE	FLYWHEEL TEETH		GLOW PLUGS			STARTER LOCKOUT		ENGINE SHUTDOWN		TILT					JIB	4 WHEEL STEER	SOFT TOUCH		GEN SET / WELDER		GEN SET CUTOUT	
ANSI USA	***10***	***0***	***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1
ANSI EXPORT	***10***	***1***	***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1
CSA	***10***	***2***	***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1
CE	***10***	***3***	***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	X	***2***	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1
AUSTRALIA	***10***	***4***	***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	X	***2***	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1
JAPAN	***10***	***5***	***11***	0	***1***	0	***1***	2	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	***0***	1	***0***	1

860SJ																												
	HEAD & TAIL LIGHTS		CABLE BREAK SWITCH		LOAD SYSTEM					LOAD SENSOR		FUNCTION CUTOUT				GROUND ALARM				DRIVE TYPE			TEMPERATURE		LEVELING MODE	
ANSI USA	***0***	1	0	***1***	***0***	X	X	X	X	0	***1***	***0***	X	X	X	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
ANSI EXPORT	***0***	1	0	***1***	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	0	***1***	***0***	1
CSA	***0***	1	0	***1***	***0***	X	X	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
CE	***0***	1	0	***1***	0	X	2	***3***	X	0	***1***	0	***1***	X	X	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1
AUSTRALIA	***0***	1	0	***1***	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	***0***	1	2	3	***0***	1	2	***0***	1	***0***	1
JAPAN	***0***	1	0	***1***	0	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	***0***	1

Table 6-6. Machine Configuration Parameters

Configuration Digit	Parameter (Displayed on Analyzer 1st Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description	Range	Definition	Data Increment	Default Value
1	Model Number:	1=400 2=450 3=600 4=601 5=800A 6=800S	Displays/adjusts machine model	1 2 3 4 5 6	400 450 600 601 800A 800S	1	1
2	Engine:	1=FORD EFI GAS 2=FORD EFI D/F 3=DEUTZ F4 4=DEUTZ F3	Displays/adjusts engine manufacturer/type	1 2 3	Ford LRG425EFI Gas Ford LRG425EFI Gas with dual fuel Deutz F4M1011F Diesel Deutz F3M1011F Diesel	1	1
3	Glow Plug:	0=NO 1="NUMBER OF MINUTES"	Display/adjusts glow plug presence and on-time	0 1-10	No glow plugs installed Setting this number tells the controller how many minutes after the EMS is pulled to output to the glow plugs before permitting the engine to be started.	1	0
4	ENG SHUTDOWN:	0=NO 1=SHUTDOWN	Displays/adjusts presence of the engine shutdown feature.	0 1	No engine shutdown Shutdown engine when coolant temperature is greater than 130° C (266° F) or the oil pressure is less than 0.5 bar (8 psi).	1	0
5	JOYSTICK TYPE:	1=RESISTIVE 2=INDUCTIVE	Displays/adjusts joystick type	1 2	Resistive Inductive	1	0

Table 6-6. Machine Configuration Parameters

6	Tilt:	1=5Deg 2=4Deg 3=3Deg	Displays/adjusts tilt sensor function	1 2 3	5 degree – reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted ANSI (US); ANSI (EXPORT); CSA; JAPAN-All Models 4 degree - reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. CE; AUSTRALIA - Model 400S Only 3 degree – reduces the maximum speed of all boom functions to creep when titled and above elevation. Reduces drive speed to creep when tilted. CE; AUSTRALIA - Models 450, 600, 601, and 800.	1	1
7	Tower Lift:	0=NO 1=YES	Displays/adjusts tower lift presence	0 1	No Tower Lift installed Yes	1	0
8	Tower Tele:	0=NO 1=YES	Displays/adjusts tower telescope presence	0 1	No Tower Telescope installed Yes	1	0
9	Jib:	0=NO 1=YES 2=SIDESWING	Displays/adjusts jib presence	0 1 2	No Jib installed Jib installed which has up and down movements only Jib installed which has up and down movements and side to side movements	1	0
10	4ws	0=NO 1=YES	Displays/adjusts 4 wheel steer presence	0 1	No 4 wheel steer installed Yes	1	0
11	soft touch	0=NO 1=YES	Displays presence of soft touch system	0 1	No Soft Touch System installed Yes	1	0
12	generator	0=NO 1=YES	Displays presence of generator	0 1	No Generator installed Yes	1	0

Table 6-6. Machine Configuration Parameters

13	Head & Tail LIGHTS	0=NO 1=YES	Displays presence of head and tail lights	0 1	No Head and Tail Lights installed Yes	1	0
14	BROKEN Cable switch	0=NO 1=YES	Displays presence of broken cable switch	0 1	No Broken Cable Switch installed Yes	1	0
15	load SENSOR	0=NO 1=WARN ONLY 2=WARN & CUTOUT	Displays presence/ function of load sensor	0 1 2	No Load Sensor installed Functions in Creep, Overload Lamp Lit, Platform Alarm Beeps Continuously All functions cutout, flash overload light (500mS on, 500mS off), Platform Alarm beeps (5 sec on, 55 sec off, 5 sec on)	1	0
16	angle SENSOR	0=NO 1=DIGITAL 2=ANALOG	Displays presence/ function of angle sensor	0 1 2	No Angle Sensor installed Limit switches are installed An analog sensor is installed	1	0
17	length SENSOR	0=NO 1=DIGITAL 2=ANALOG	Displays presence/ function of length sensor	0 1 2	No Length Sensor Installed Limit switch installed An analog sensor is installed	1	0
18	FUNCTION CUTOUT	0=NO 1=BOOM CUTOUT 2=DRIVE CUTOUT 3=DRIVE CUT E & T	Displays presence/ function of drive cutout.	0 1 2 3	No Drive Cutout Boom Function Cutout While Driving Above Elevation. (CE) Drive Cutout Above Elevation Drive Cutout Above Elevation And Tilted	1	0
19	ground alarm	0=NO 1=DRIVE 2=LIFT DOWN 3=BOOM & DRIVE	Displays/adjusts ground alarm presence/function	0 1 2 3	No Ground Alarm installed Travel alarm – sounds when the drive function is active. (Option) Descent alarm – sounds when either lift down is active. (Option) Motion alarm – sounds when any function is active. (Option)	1	0

Table 6-6. Machine Configuration Parameters

20	PLATFORM ALARM	0=NO 1=FAULT CODE	Displays/adjusts platform alarm presence/functions	0 1	Sounds Continuously When Above Elevation And Tilted Only. Sounds Continuously When Above Elevation And Tilted, And In Conjunction With Fault Code Flashes. (Option)	1	0
21	Tower Prox Switches	0=NO 1=YES	Displays presence/ function of Tower Proximity switches for the models specified.	0 1	No Tower Prox Switches Installed Tower Prox Switches Installed	1	0

Analyzer Diagnostics Menu Structure

In the following structure descriptions, an intended item is selected by pressing ENTER; pressing ESC steps back to the next outer level. The LEFT/RIGHT arrow keys move between items in the same level. The UP/DOWN arrow keys alter a value if allowed

Table 6-7. ADJUSTMENTS - Personality Descriptions

DRIVE	
ACCEL …	Displays/adjusts drive acceleration
DECEL …	Displays/adjusts drive deceleration
MIN FORWARD …	Displays/adjusts minimum forward drive speed
MAX FORWARD …	Displays/adjusts maximum forward drive speed
MIN REVERSE …	Displays/adjusts minimum reverse drive speed
MAX REVERSE …	Displays/adjusts maximum reverse drive speed
ELEVATED MAX …	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX …	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX …	Displays/adjusts the maximum steer speed
LIFT	
ACCEL …	Displays/adjusts upper lift acceleration
DECEL …	Displays/adjusts upper lift deceleration
MIN UP …	Displays/adjusts minimum upper lift up speed
MAX UP …	Displays/adjusts maximum upper lift up speed
CREEP UP …	Displays/adjusts maximum upper lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN …	Displays/adjusts minimum upper lift down speed
MAX DOWN …	Displays/adjusts maximum upper lift down speed
CREEP DOWN …	Displays/adjusts maximum upper lift down speed NOTE: used when creep switch on pump pot is active

Table 6-7. ADJUSTMENTS - Personality Descriptions

SWING	
ACCEL …	Displays/adjusts swing acceleration
DECEL …	Displays/adjusts swing deceleration
MIN LEFT …	Displays/adjusts minimum swing left speed
MAX LEFT …	Displays/adjusts maximum swing left speed
CREEP LEFT …	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active
MIN RIGHT …	Displays/adjusts minimum swing right speed
MAX RIGHT …	Displays/adjusts maximum swing right speed
CREEP RIGHT …	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active
UPPER TELESCOPE	
ACCEL …	Displays/adjusts telescope acceleration
DECEL …	Displays/adjusts telescope deceleration
MIN IN …	Displays/adjusts minimum telescope in speed
MAX IN …	Displays/adjusts maximum telescope in speed
MIN OUT …	Displays/adjusts minimum telescope out speed
MAX OUT …	Displays/adjusts maximum telescope out speed
BASKET LEVEL	
ACCEL …	Displays/adjusts basket level acceleration
DECEL …	Displays/adjusts basket level deceleration
MIN UP …	Displays/adjusts minimum basket level up speed
MAX UP …	Displays/adjusts maximum basket level up speed
MIN DOWN …	Displays/adjusts minimum basket level down speed
MAX DOWN …	Displays/adjusts maximum basket level down speed
BASKET ROTATE	
ACCEL …	Displays/adjusts basket rotate acceleration
DECEL …	Displays/adjusts basket rotate deceleration
MIN LEFT …	Displays/adjusts minimum basket rotate left speed
MAX LEFT …	Displays/adjusts maximum basket rotate left speed
MIN RIGHT …	Displays/adjusts minimum basket rotate right speed
MAX RIGHT …	Displays/adjusts maximum basket rotate right speed
JIB LIFT	Not displayed if JIB = NO

Table 6-7. ADJUSTMENTS - Personality Descriptions

ACCEL …	Displays/adjusts jib acceleration
DECEL …	Displays/adjusts jib deceleration
MIN UP …	Displays/adjusts minimum jib up speed
MAX UP …	Displays/adjusts maximum jib up speed
MIN DOWN …	Displays/adjusts minimum jib down speed
MAX DOWN …	Displays/adjusts maximum jib down speed
MIN LEFT …	Displays/adjusts minimum jib left speed
MAX LEFT …	Displays/adjusts maximum jib left speed
MIN RIGHT …	Displays/adjusts minimum jib right speed
MAX RIGHT …	Displays/adjusts maximum jib right speed
STEER	
MAX SPEED …	Displays/adjusts maximum steer speed, which applies when vehicle speed is at minimum
GROUND MODE	
LIFT UP …	Displays/adjusts fixed lift up speed
LIFT DOWN …	Displays/adjusts fixed lift down speed
SWING …	Displays/adjusts fixed swing speed
TELE …	Displays/adjusts fixed telescope speed
BASKETLEVEL …	Displays/adjusts fixed basket level speed
BASKETROTATE …	Displays/adjusts fixed basket rotate speed
JIB (U/D) …	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)…	Displays/adjusts jib swing speed Not displayed if JIB = NO

Table 6-8. Diagnostic Menu Descriptions

DRIVE	
DRIVE FOR …	Displays drive joystick direction & demand
STEER …	Displays steer switch direction & demand NOTE: steer demand is inversely proportional to vehicle speed
BRAKES …	Displays brake control system status
CREEP …	Displays pump pot creep switch status
TWO SPEED...	Displays two speed switch status
2 SPEED MODE	Displays status of two speed valve
HIGH ENGINE	Displays high engine switch status
BOOM	
U LIFT UP …	Displays lift joystick direction & demand
SWING LEFT …	Displays swing joystick direction & demand
LEVEL UP …	Displays basket level switch direction & demand NOTE: demand is controlled by the pump pot
ROT. LEFT …	Displays basket rotate switch direction & demand NOTE: demand is controlled by the pump pot
U TELE IN …	Displays telescope switch direction & demand NOTE: demand is controlled by the pump pot
JIB UP …	Displays jib lift switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
JIB LEFT …	Displays jib swing switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
PUMP POT …	Displays pump pot demand
ENGINE	
START …	Displays start switch status
AIR FILTER …	Displays air filter status
BATTERY …	Displays measured battery voltage
COOLANT …	Displays coolant temperature
OIL PRS …	Displays oil pressure status
FUEL SELECT …	Displays selected fuel (Dual Fuel only)
FUEL LEVEL …	Displays fuel level status
RPM	Displays Engine RPM
GM BATTERY	Displays battery voltage at ground module

Table 6-8. Diagnostic Menu Descriptions

PM BATTERY …	Displays battery voltage at platform module
TEMP..	Displays ground module temperature
ELEV. CUTOUT …	Displays elevation cutout switch status
FUNC. CUTOUT …	Displays function cutout switch status
CREEP…	Displays creep switch status
TILT …	Displays measured vehicle tilt
AUX POWER …	Displays status of auxiliary power switch
HORN …	Displays status of horn switch
R FILTER …	Displays status of return filter switch
C FILTER …	Displays status of charge pump filter
LOAD LENGTH …	Displays length switch status
ANGLE …	Displays angle switch status
LOAD …	Displays load sensor value NOTE: Not displayed if load = 0.
DATALOG	
ON …	Displays total controller on (EMS) time
ENGINE …	Displays engine run time
DRIVE …	Displays total controller drive operation time
LIFT …	Displays total controller lift operation time
SWING …	Displays total controller swing operation time
TELE …	Displays total controller tele operation time
MAX.TEMP …	Displays maximum measured heatsink temp.
MIN.TEMP …	Displays minimum measured heatsink temp.
MAX.VOLTS …	Displays maximum measured battery voltage
RENTAL …	Displays total controller operation time NOTE: can be reset
ERASE RENTAL	Not available at password level 2
YES:ENTER, NO:ESC	ENTER resets rental datalog time to zero
VERSIONS	
GROUND …	Displays ground module software version
PLATFORM …	Displays platform module software version
ANALYSER …	Displays Analyzer software version

NOTES:

SECTION 7. BASIC ELECTRICAL INFORMATION & SCHEMATICS

7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop. If a problem should develop which is not presented in this section or which is not corrected by listed corrective actions, technically qualified guidance should be obtained before proceeding with any maintenance.

7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the Voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the lead on the other port goes to the positive side of the signal.

Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = milli = (Displayed Number) / 1,000

μ = micro = (Displayed Number) / 1,000,000

Example: 1.2 kΩ = 1200 Ω
Example: 50 mA = 0.05 A

Voltage Measurement

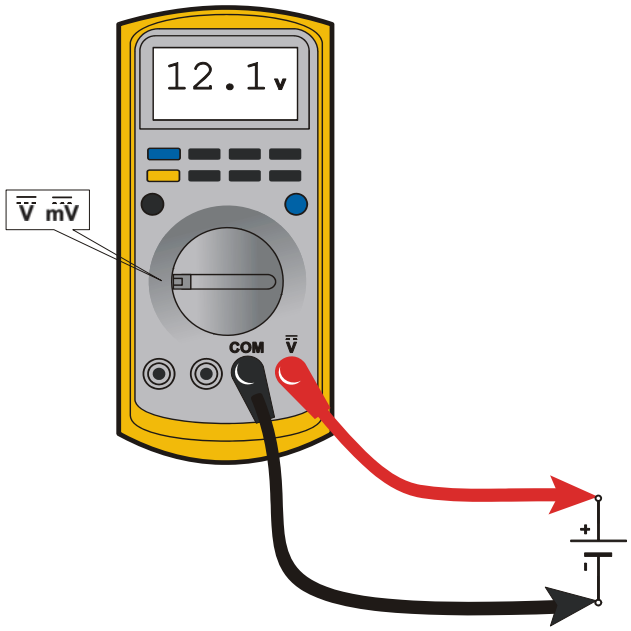


Figure 7-1. Voltage Measurement (DC)

- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Resistance Measurement

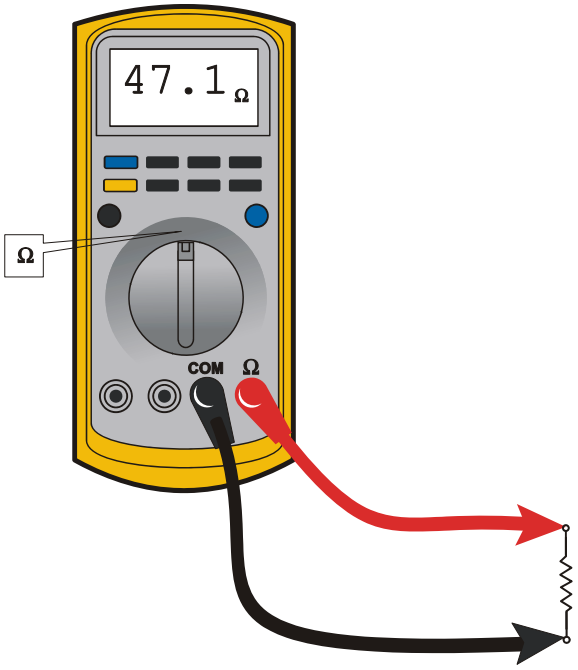


Figure 7-2. Resistance Measurement

- First test meter and leads by touching leads together. Resistance should read a short circuit (very low resistance)
- Circuit power must be turned OFF before testing resistance
- Disconnect component from circuit before testing
- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Continuity Measurement

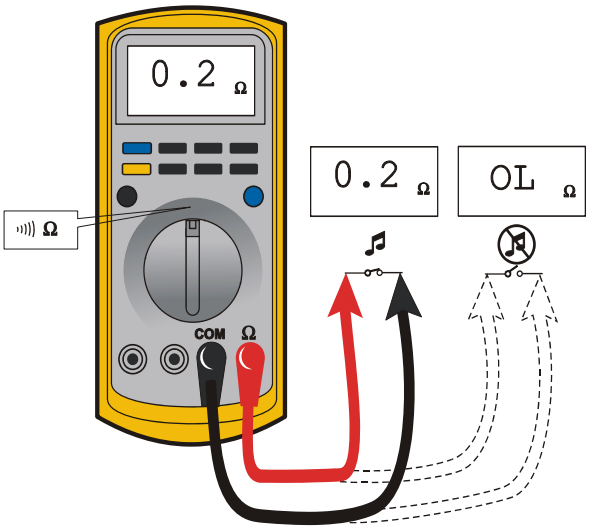


Figure 7-3. Continuity Measurement

- Some meters require a separate button press to enable audible continuity testing
- Circuit power must be turned OFF before testing continuity
- Disconnect component from circuit before testing
- Use firm contact with meter leads
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity

Current Measurement

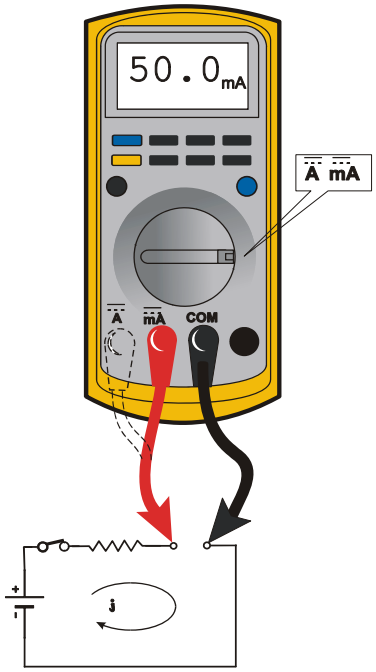


Figure 7-4. Current Measurement (DC)

- Set up the meter for the expected current range
- Be sure to connect the meter leads to the correct jacks for the current range you have selected
- If meter is not auto ranging, set it to the correct range (See multi meter's operation manual)
- Use firm contact with meter leads

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

NOTE: *Do NOT apply dielectric grease to the following connections:*

- Main Boom Rotary sensor connections (on Celesco Sensor),
- LSS Modules connections,
- Deutz EMR 2 ECM connection.

Silicone Dielectric Compound must be used on all electrical connections except for those mentioned above for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

NOTE: *Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.*

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

NOTE: *This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.*

3. Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

NOTE: *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

7.4 AMP CONNECTOR

Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-5.). Proceed as follows:

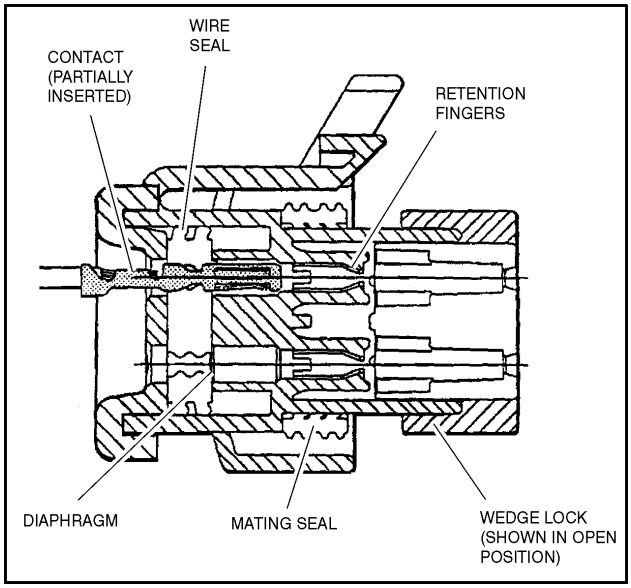


Figure 7-5. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-7.).
2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 7-7.).

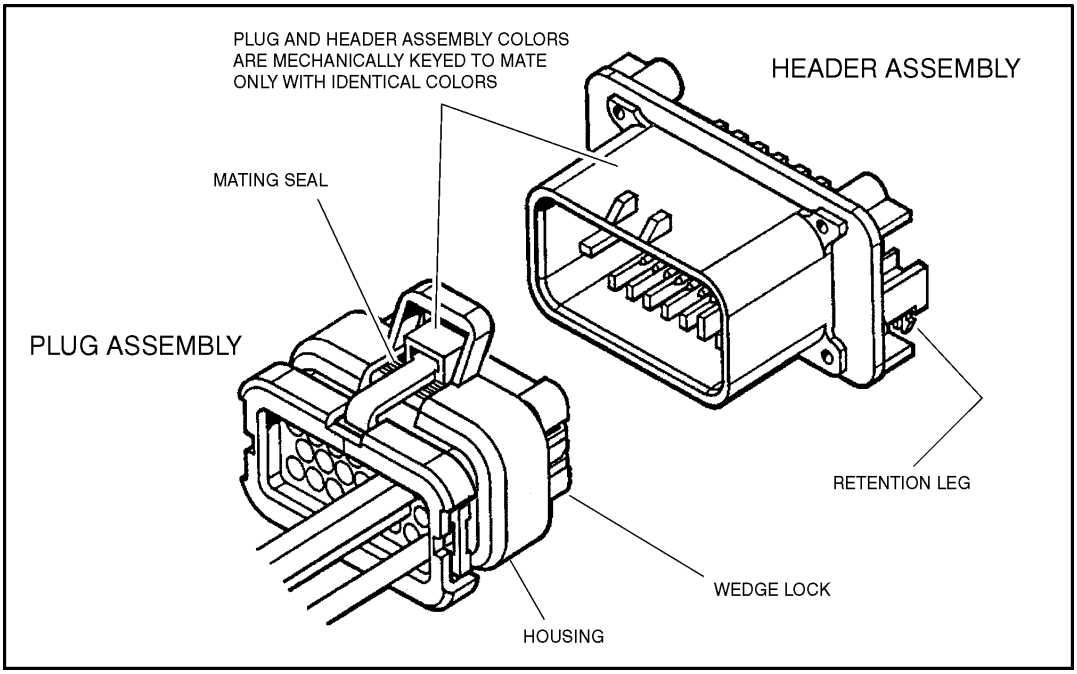


Figure 7-6. AMP Connector

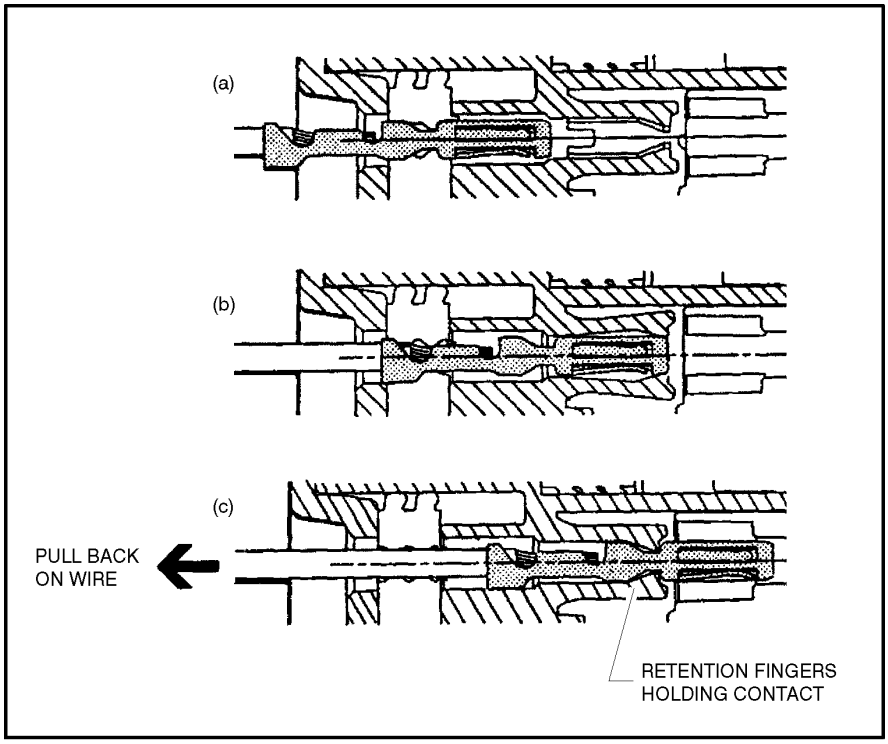


Figure 7-7. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-8.).

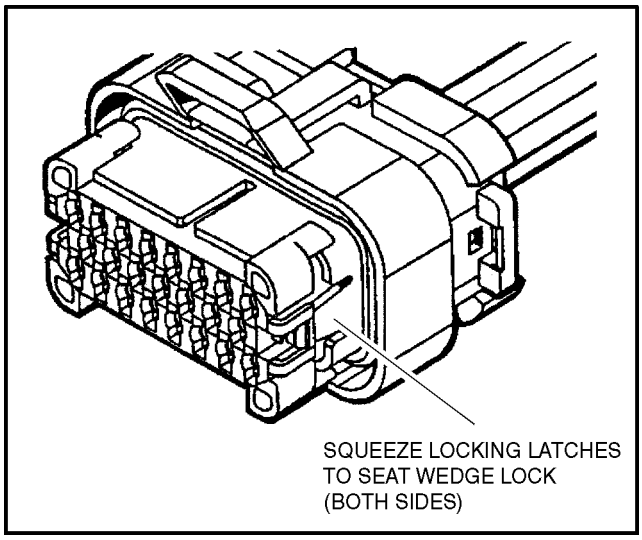


Figure 7-8. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-9.).

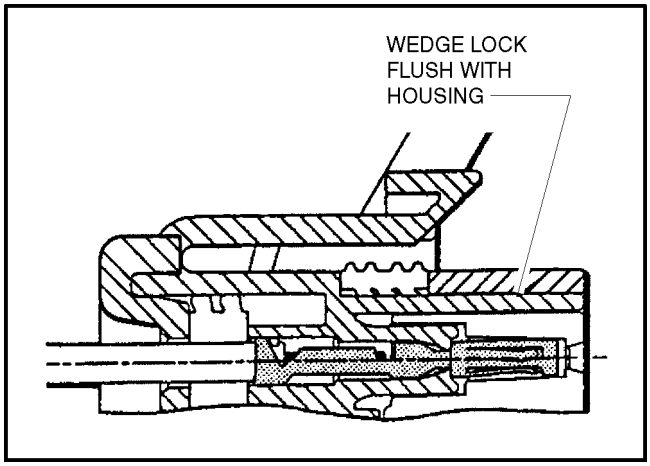


Figure 7-9. Connector Assembly Figure 4

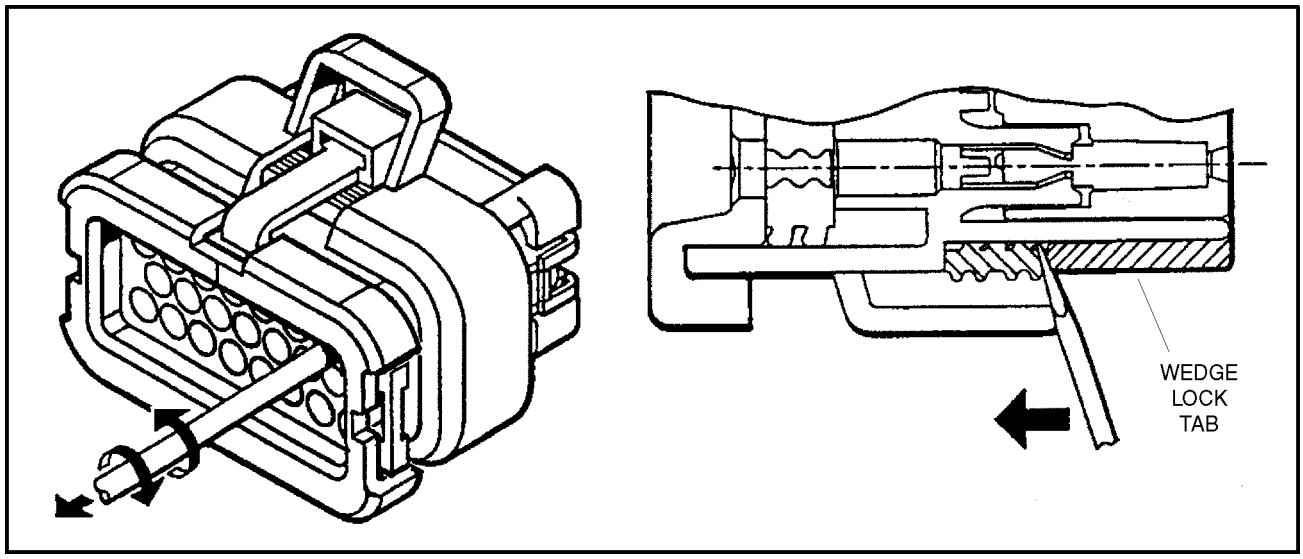


Figure 7-10. Connector Disassembly

Disassembly

5. Insert a 4.8 mm (3/16") wide screwdriver blade between the mating seal and one of the red wedge lock tabs.
6. Pry open the wedge lock to the open position.
7. While rotating the wire back and forth over a half turn (1/4 turn in each direction), gently pull the wire until the contact is removed.

NOTE: *The wedge lock should never be removed from the housing for insertion or removal of the contacts.*

Wedge Lock

The wedge lock has slotted openings in the forward, or mating end. These slots accommodate circuit testing in the field, by using a flat probe such as a pocket knife. DO NOT use a sharp point such as an ice pick.

Service - Voltage Reading

⚠ CAUTION

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

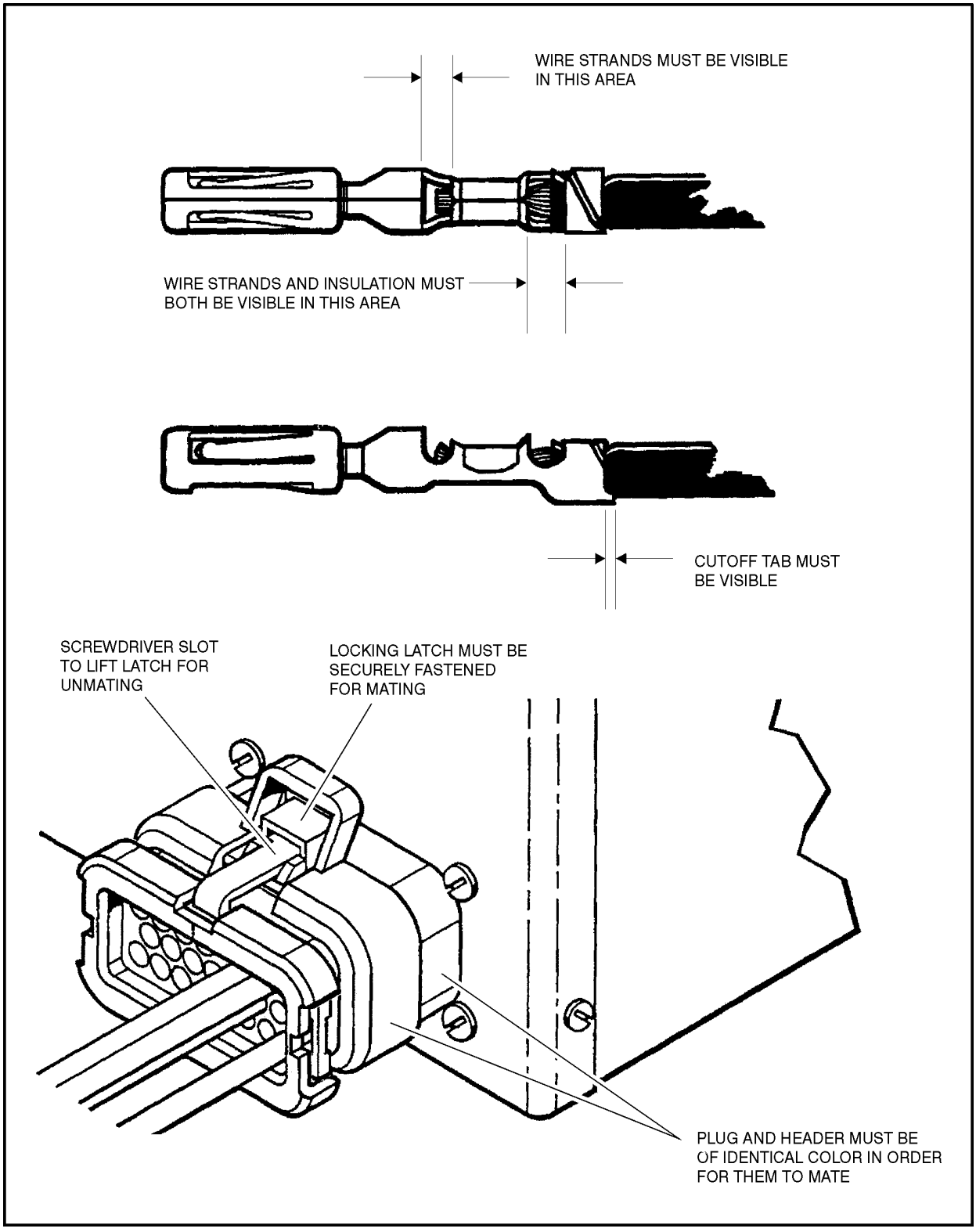


Figure 7-11. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

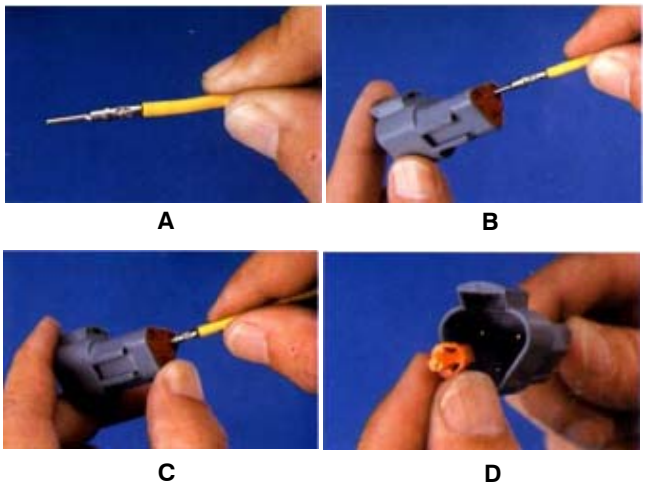


Figure 7-12. DT/DTP Contact Installation

1. Grasp crimped contact about 25mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. Thy may go in either way.

NOTE: *The receptacle is shown - use the same procedure for plug.*

DT/DTP Series Disassembly

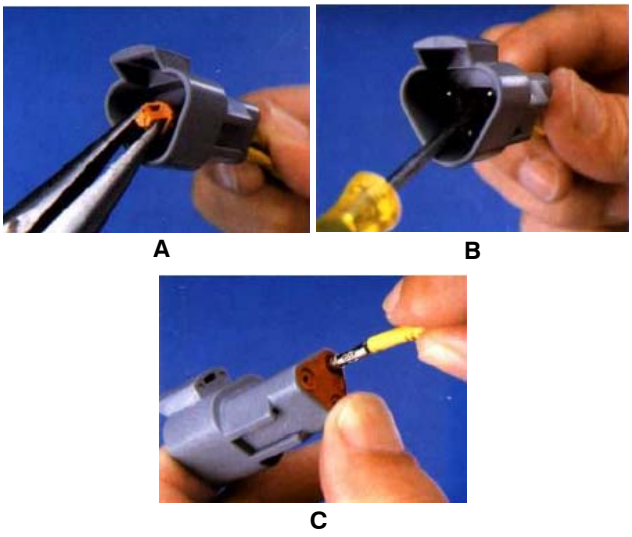


Figure 7-13. DT/DTP Contact Removal

5. Remove wedgelock using needlenose pliers or a hook shaped wire to pull wedge straight out.
6. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.
7. Hold the rear seal in place, as removing the contact may displace the seal.

HD30/HDP20 Series Assembly

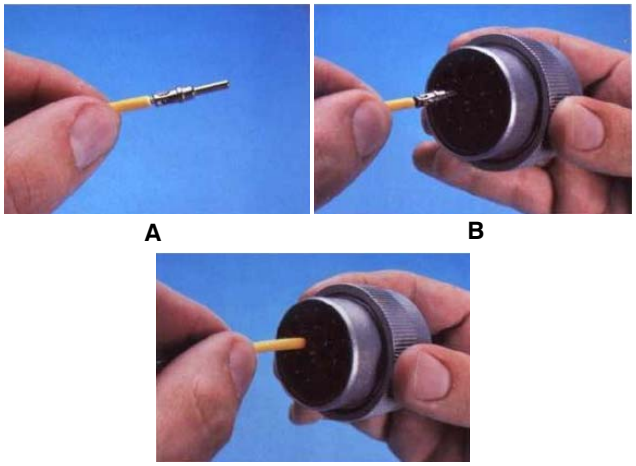


Figure 7-14. HD/HDP Contact Installation

8. Grasp contact about 25mm behind the contact crimp barrel.
9. Hold connector with rear grommet facing you.
10. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.

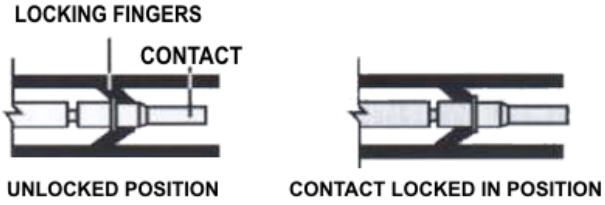


Figure 7-15. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing*

HD30/HDP20 Series Disassembly

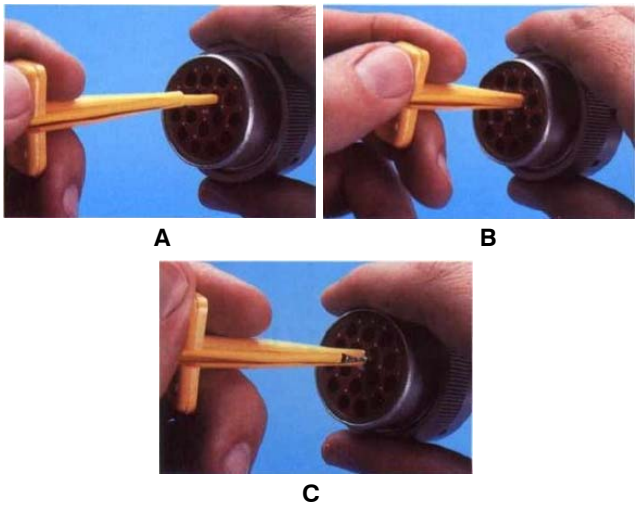


Figure 7-16. HD/HDP Contact Removal

11. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
12. Slide tool along into the insert cavity until it engages contact and resistance is felt.
13. Pull contact-wire assembly out of connector.

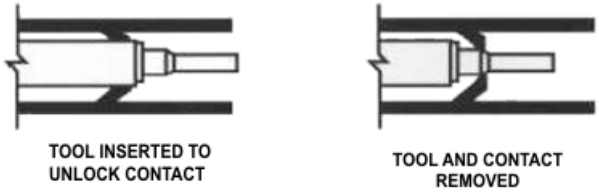


Figure 7-17. HD/HDP Unlocking Contacts

NOTE: *Do Not twist or insert tool at an angle.*

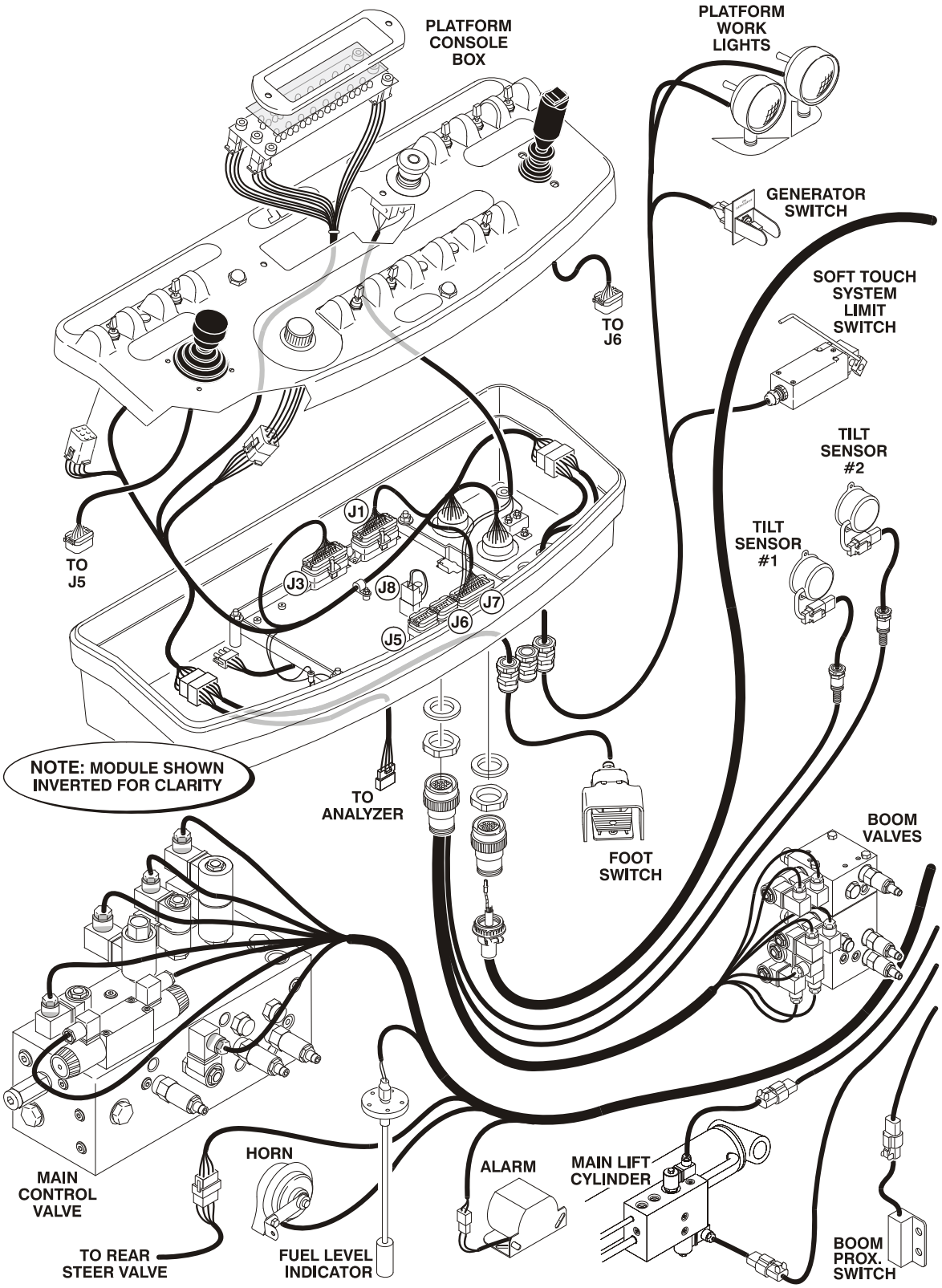


Figure 7-18. Electrical Components Installation (Prior to S/N 0300085332) - Sheet 1

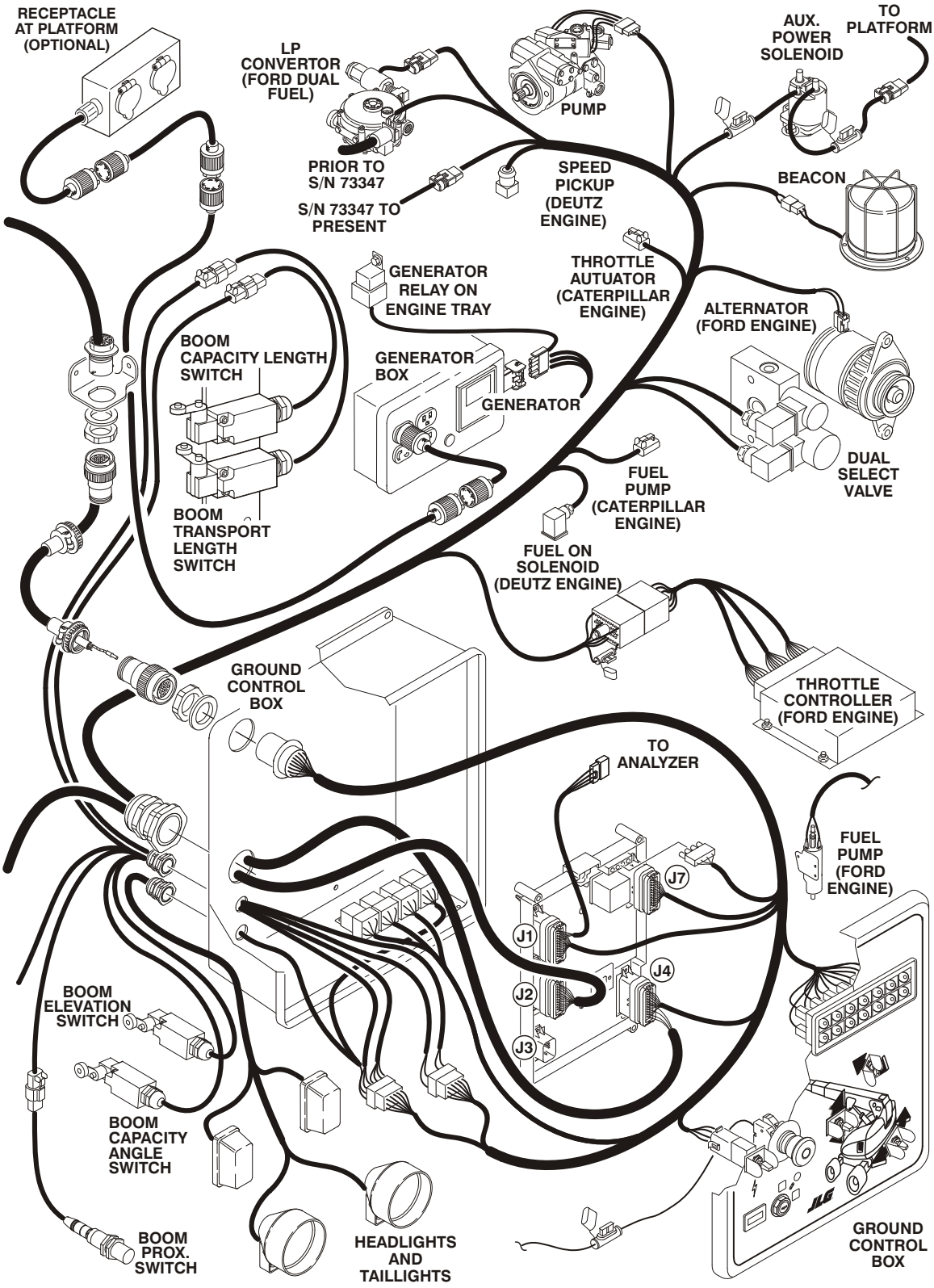


Figure 7-19. Electrical Components Installation (Prior to S/N 0300085332) - Sheet 2

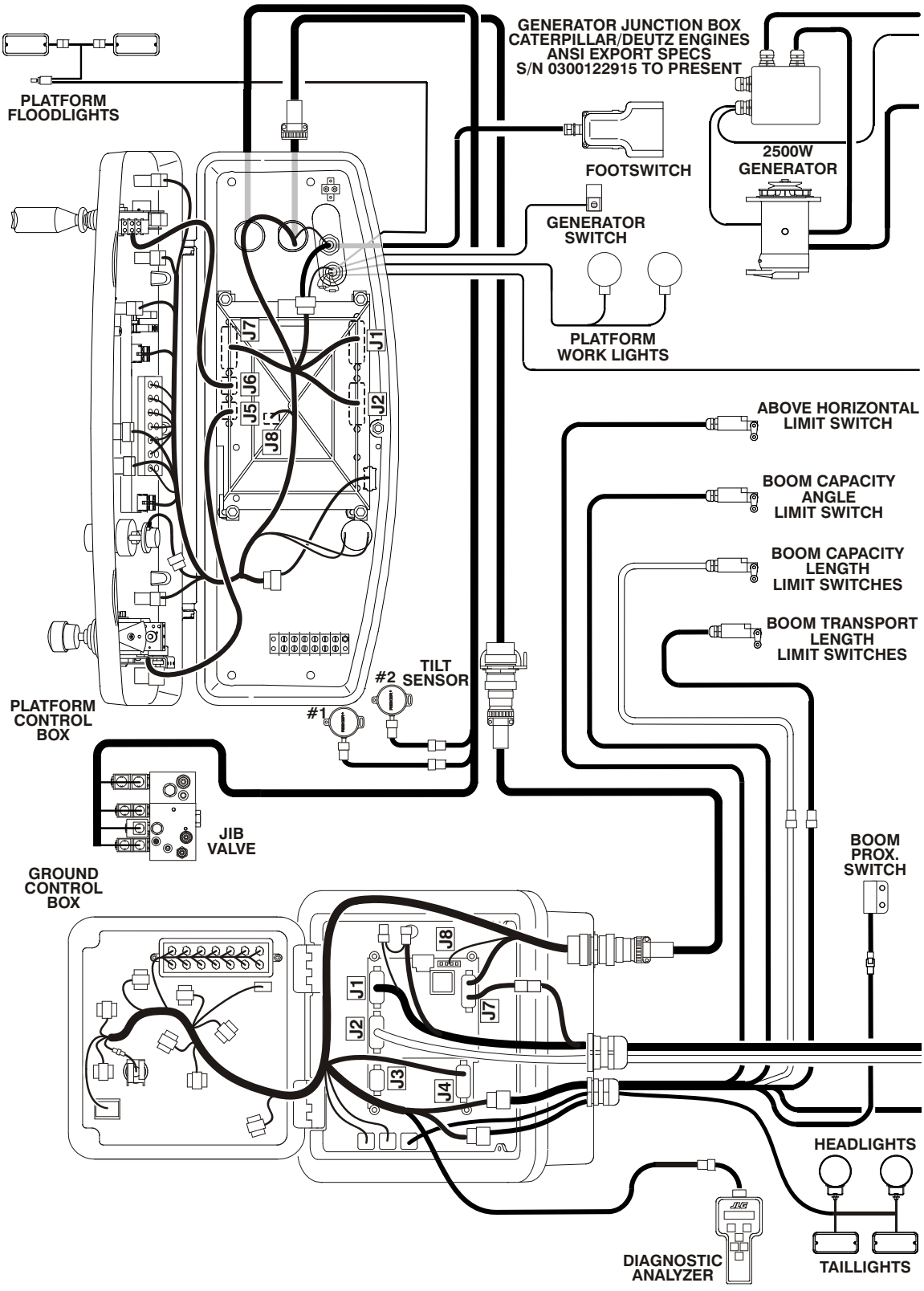


Figure 7-20. Electrical Components Installation (S/N 0300085332 to Present) - Sheet 1

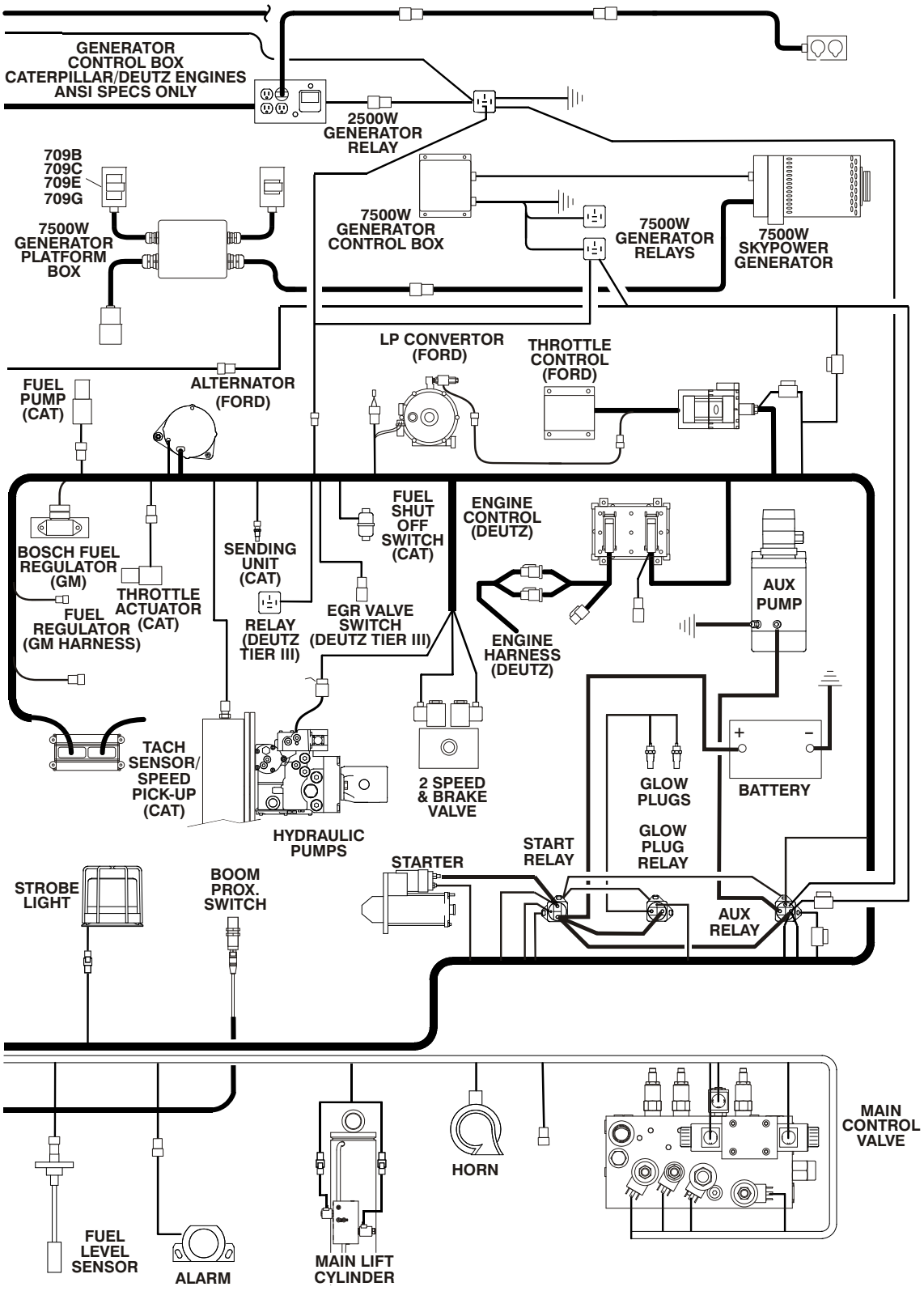


Figure 7-21. Electrical Components Installation (S/N 0300085332 to Present) - Sheet 2

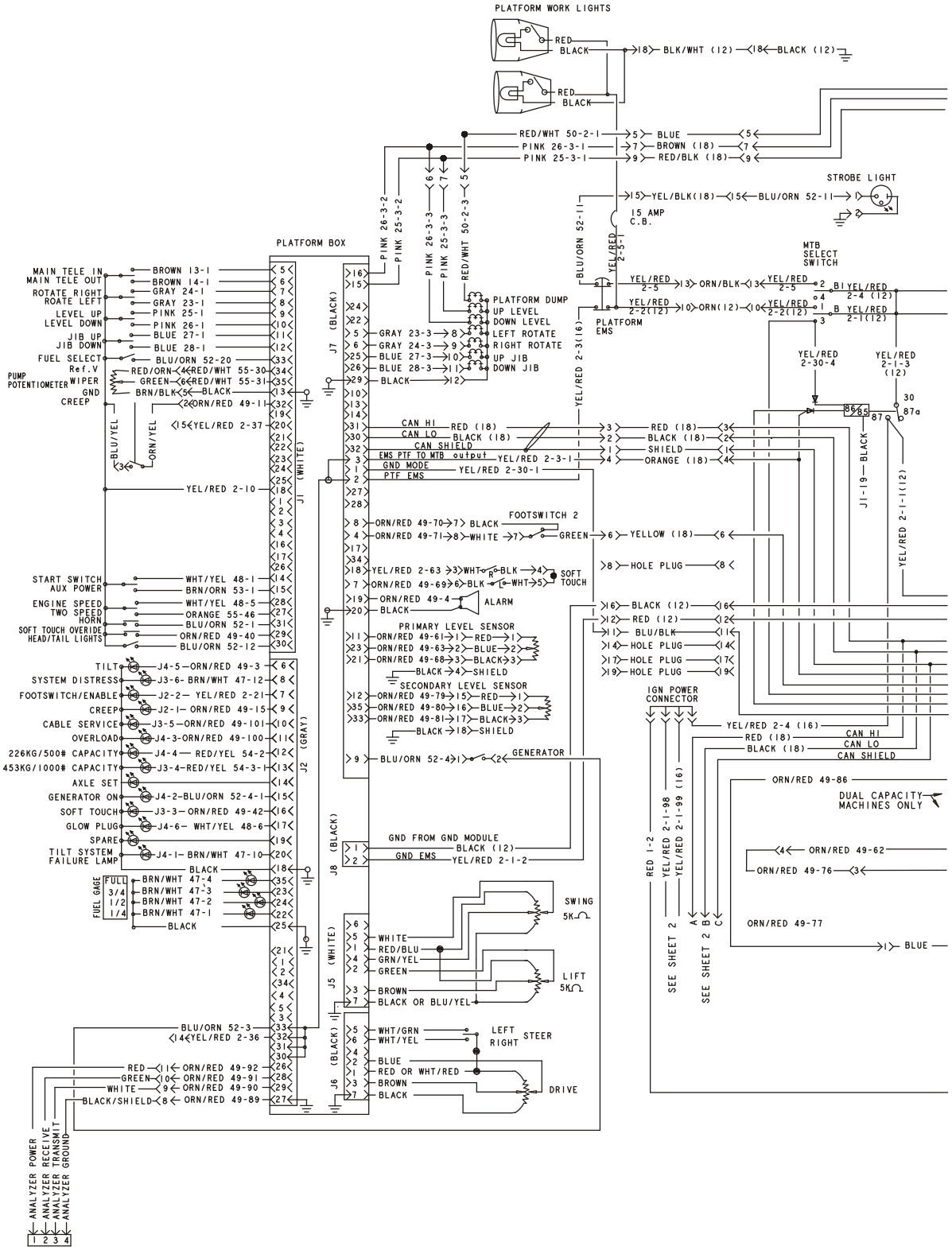
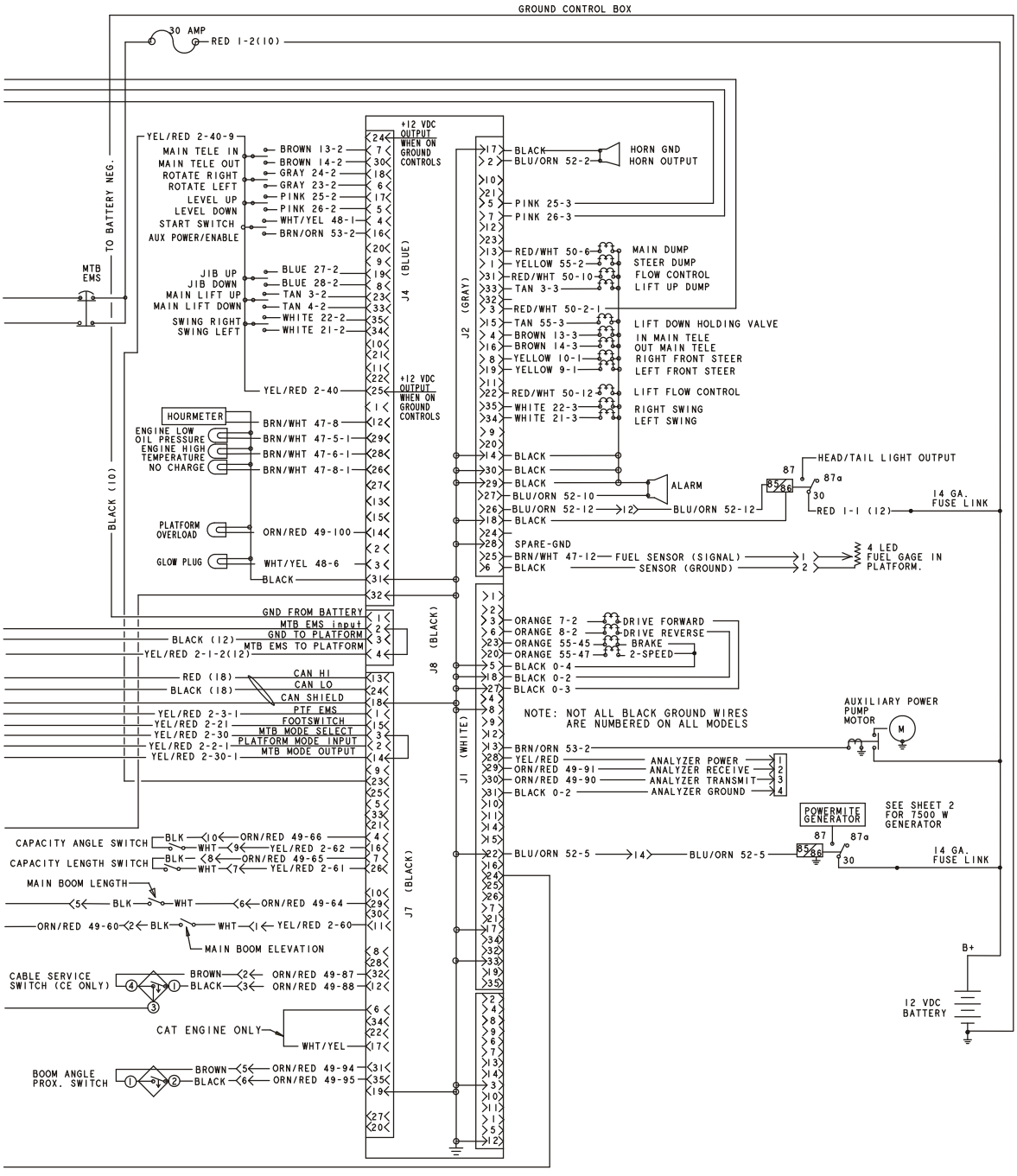


Figure 7-22. Electrical Schematic - Deutz EMR2, GM & Cat - Sheet 1 of 6



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Figure 7-23. Electrical Schematic - Deutz EMR2, GM & Cat - Sheet 2 of 6

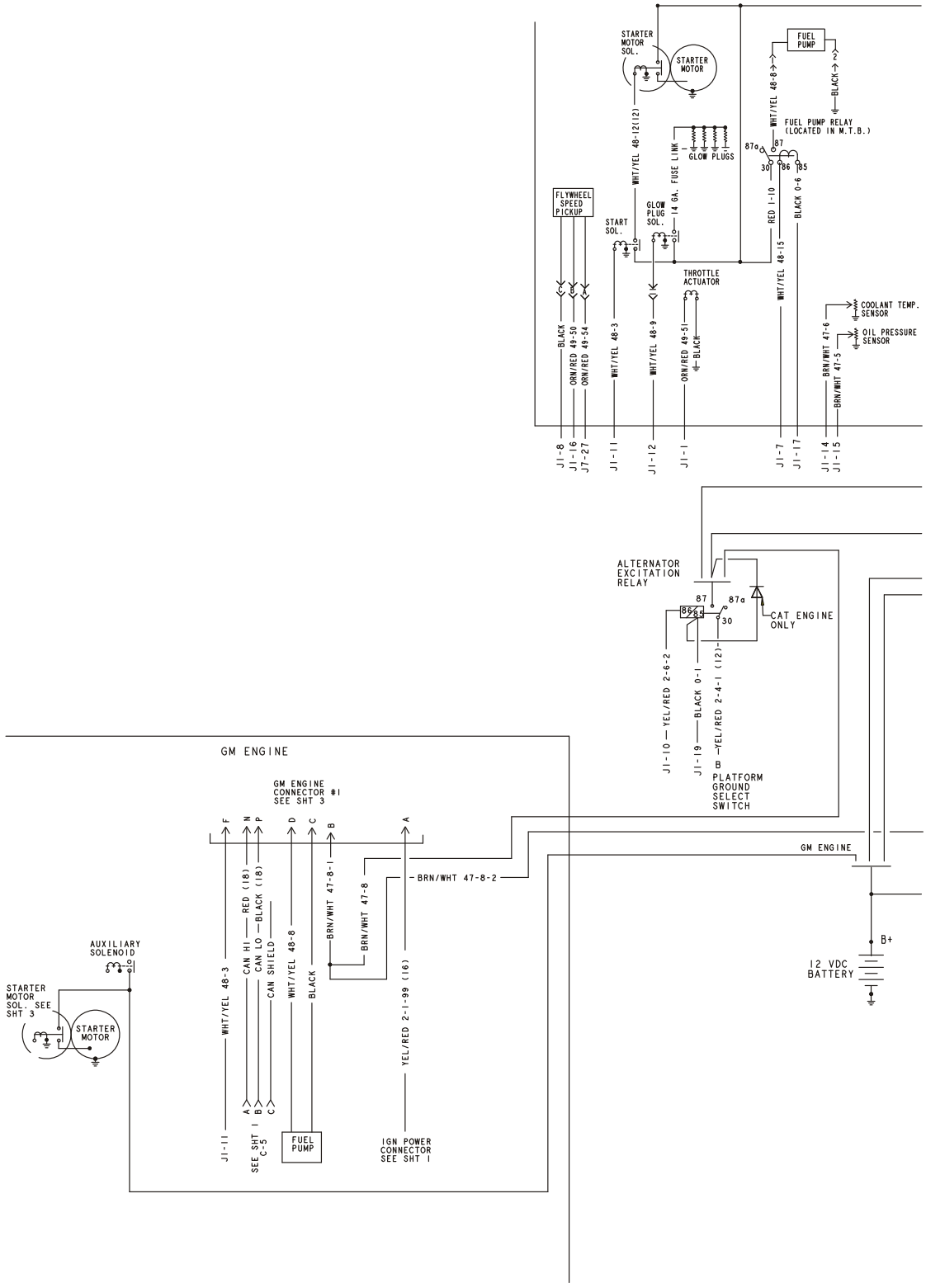
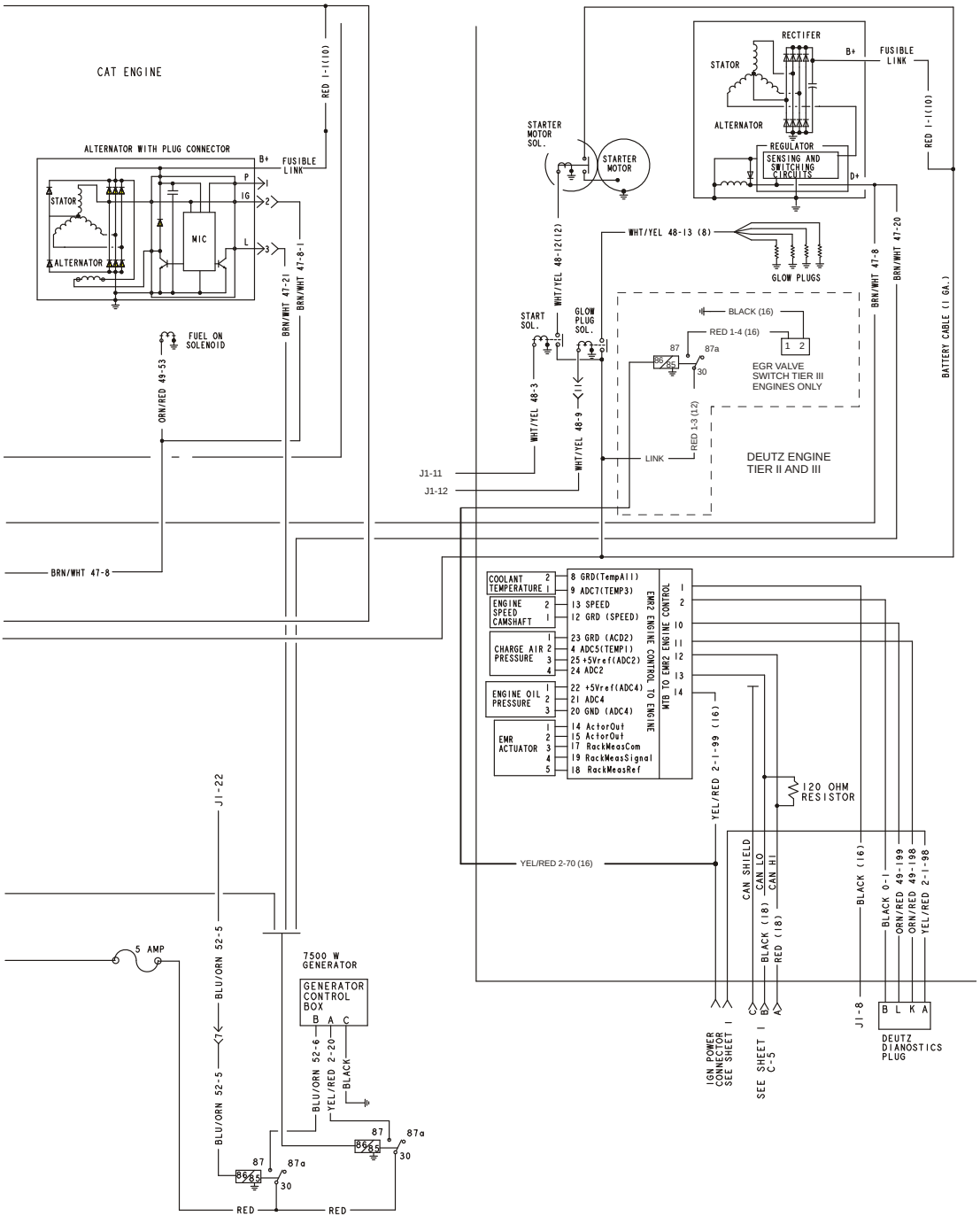


Figure 7-24. Electrical Schematic - Deutz EMR2, GM & Cat - Sheet 3 of 6



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Figure 7-25. Electrical Schematic - Deutz EMR2, GM & Cat - Sheet 4 of 6

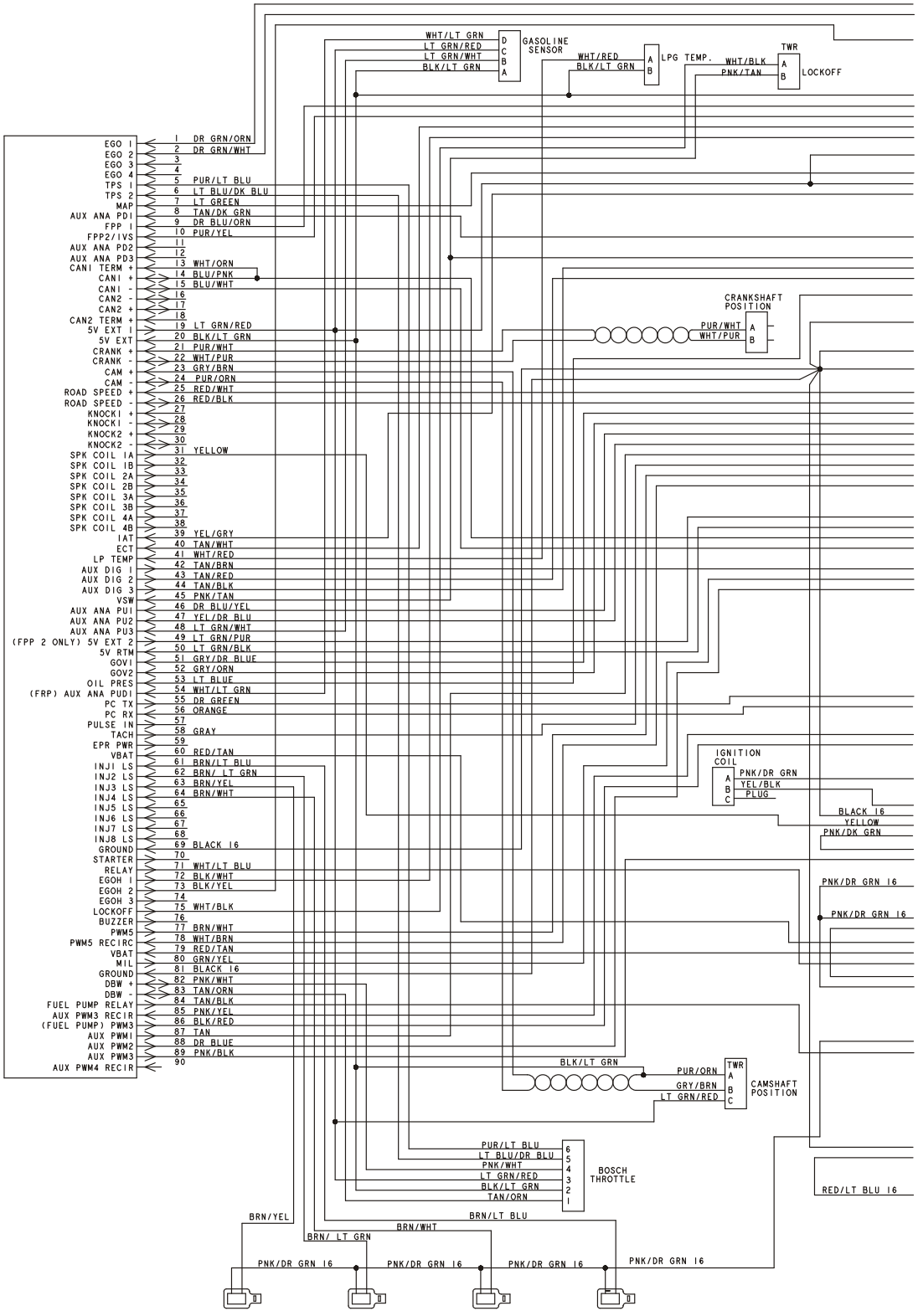
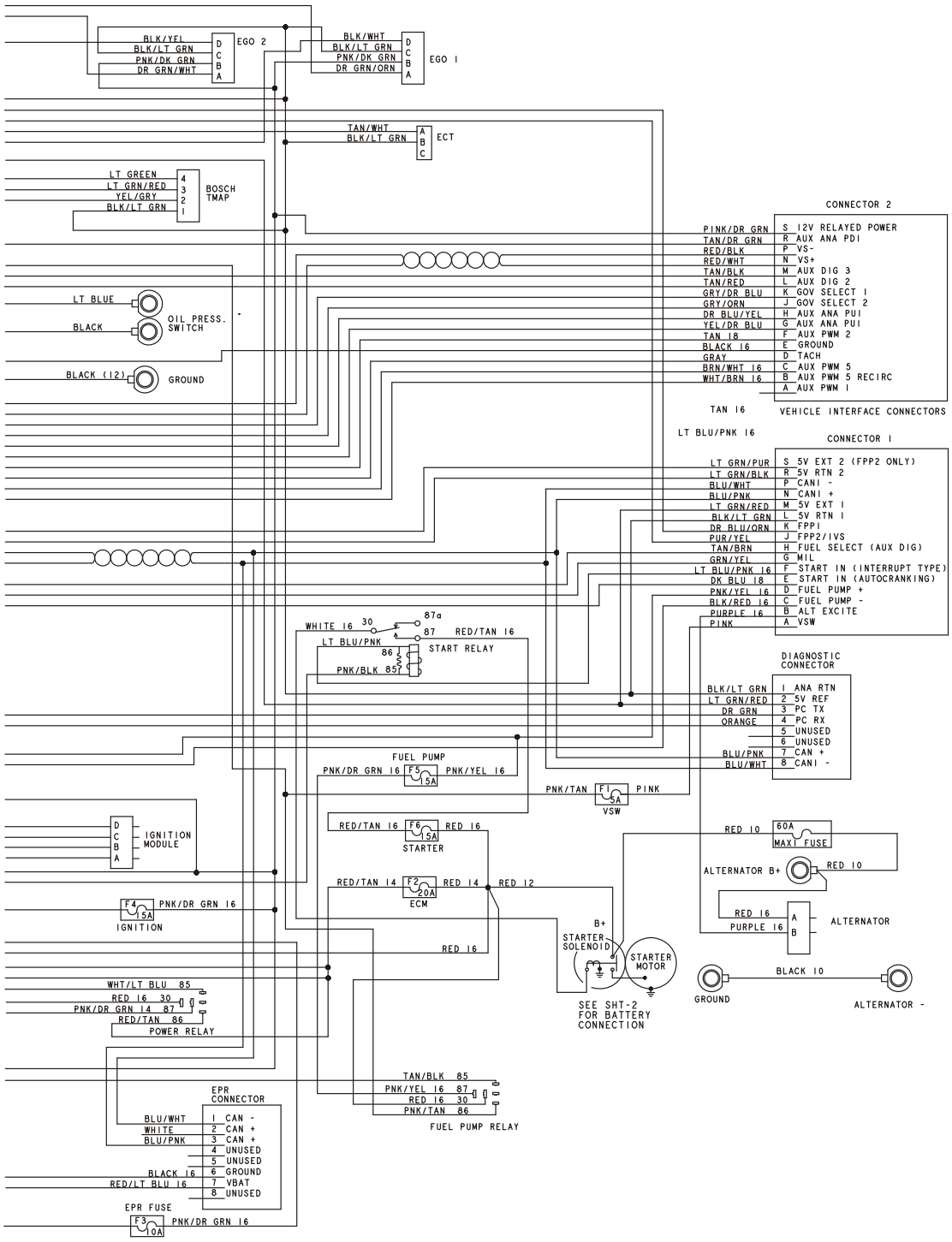


Figure 7-26. Electrical Schematic - Deutz EMR2, GM & Cat - Sheet 5 of 6



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Figure 7-27. Electrical Schematic - Deutz EMR2, GM & Cat - Sheet 6 of 6

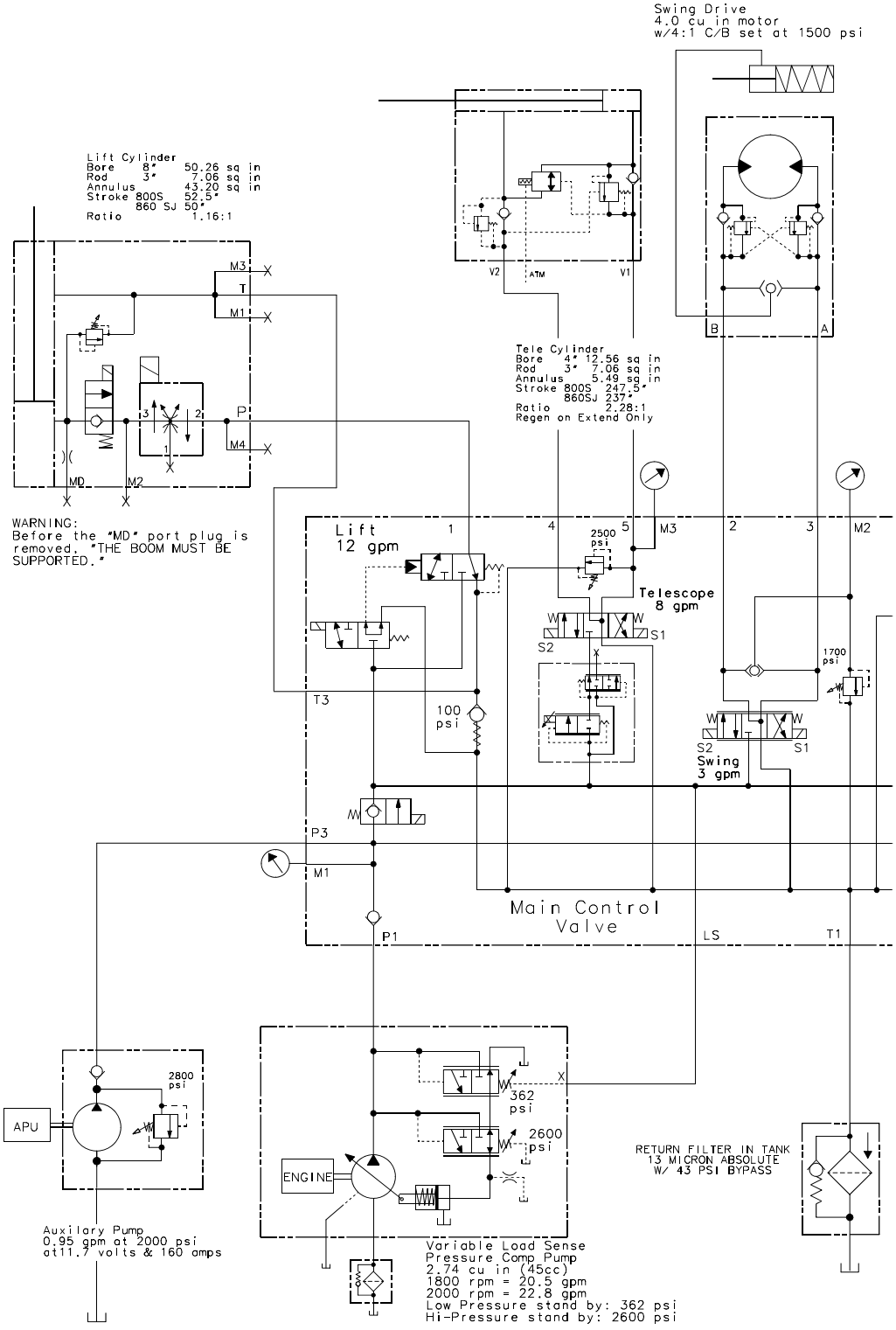
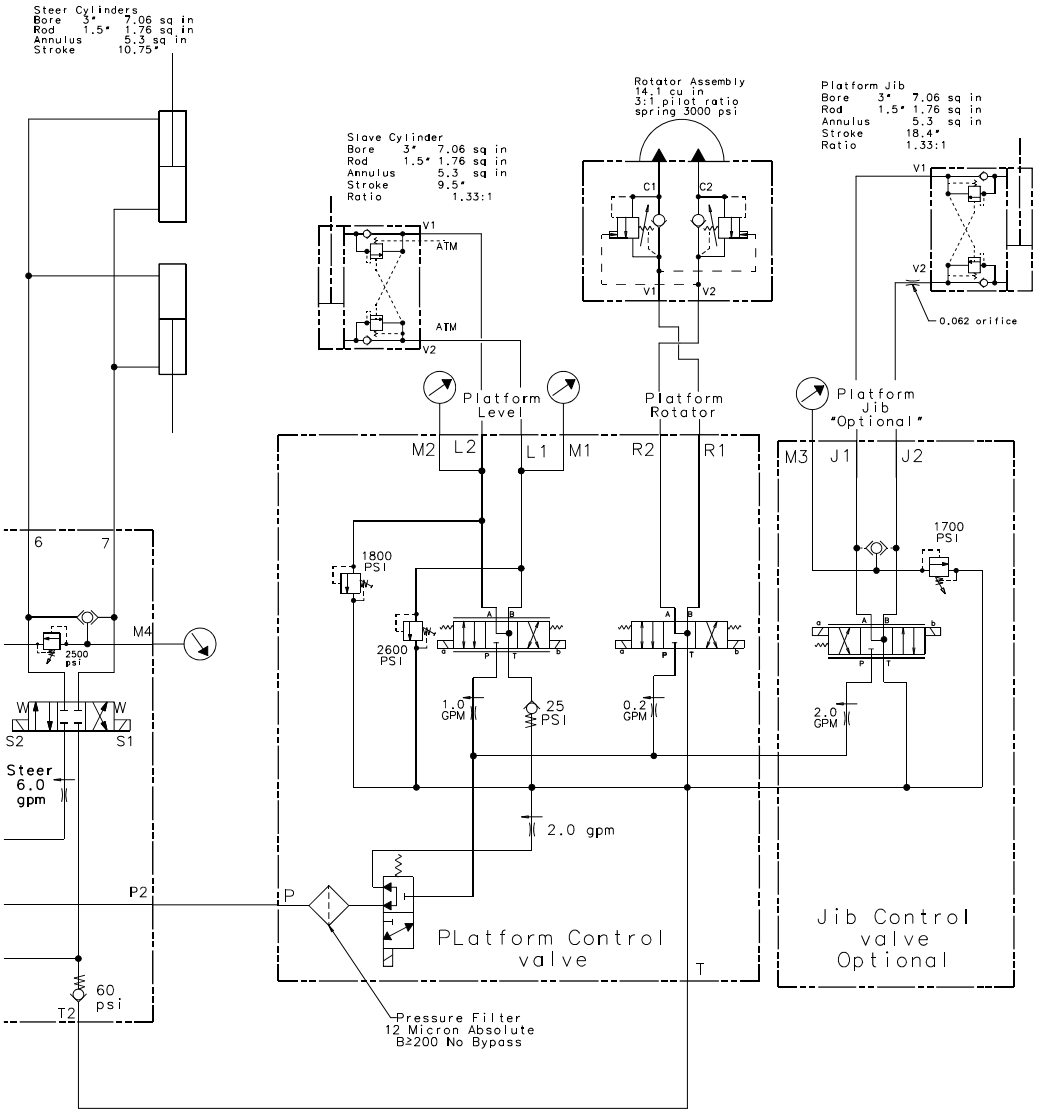


Figure 7-28. Hydraulic Schematic - Sheet 1 of 8



Note:
Volumes of each function at the main control valve are max flows. Lower current settings mean lower flows.

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Figure 7-29. Hydraulic Schematic - Sheet 2 of 8

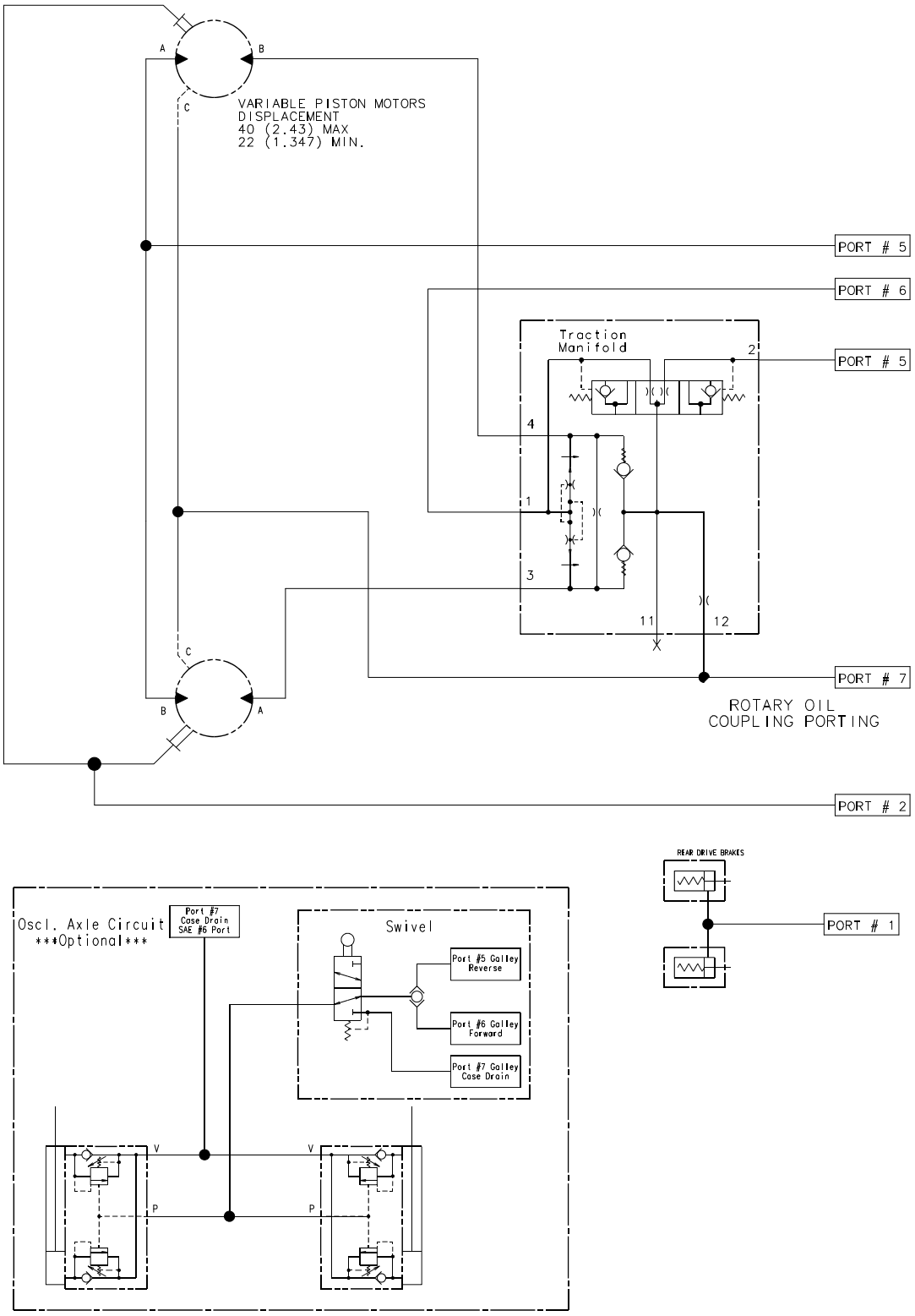
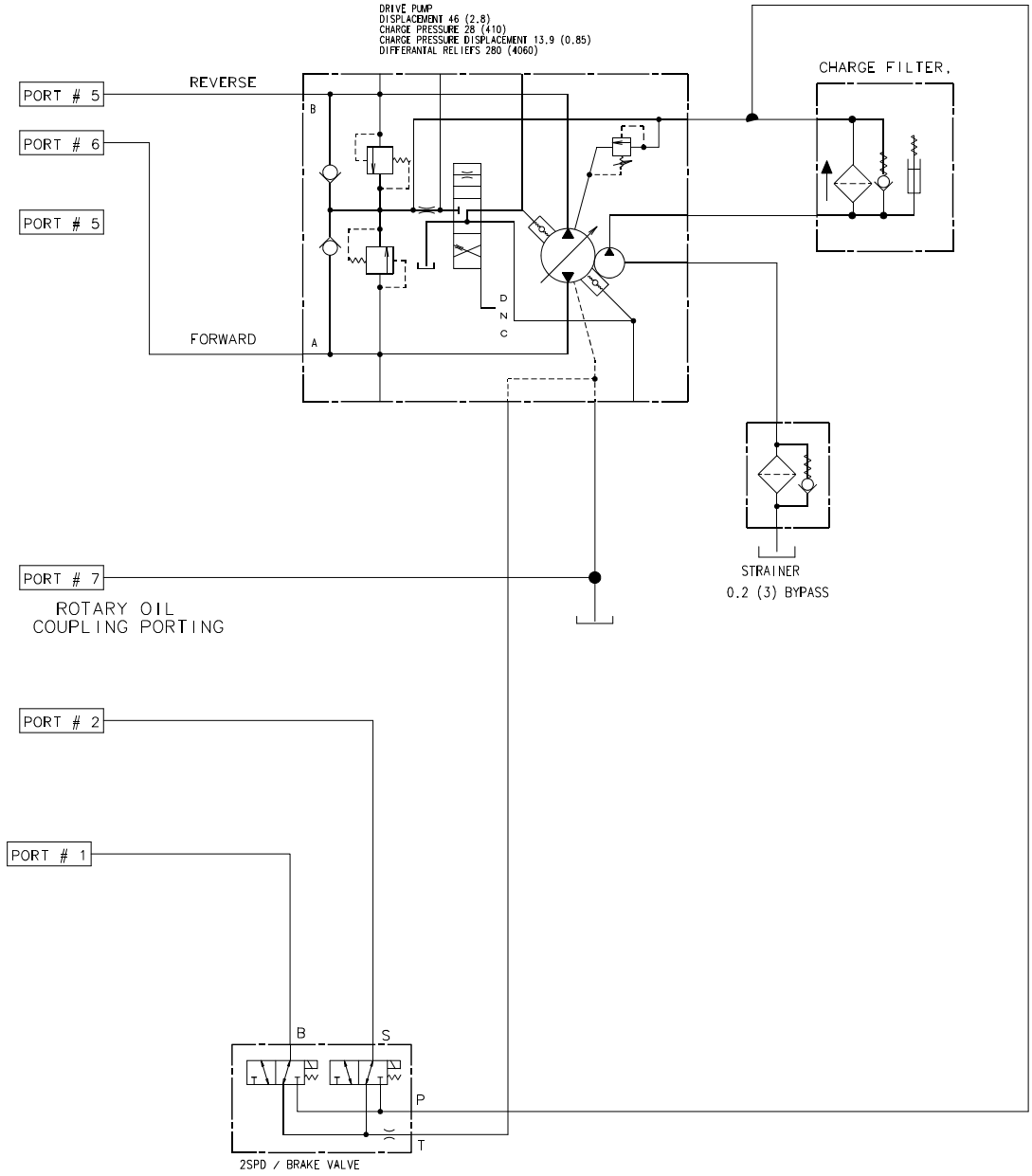


Figure 7-30. Hydraulic Schematic - Sheet 3 of 8



NOTE: PRESSURE: BAR (PSI)
DISPLACEMENT CC (IN3)
FLOW: L/M (GPM)
DIMENION: MM (IN)

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Figure 7-31. Hydraulic Schematic - Sheet 4 of 8

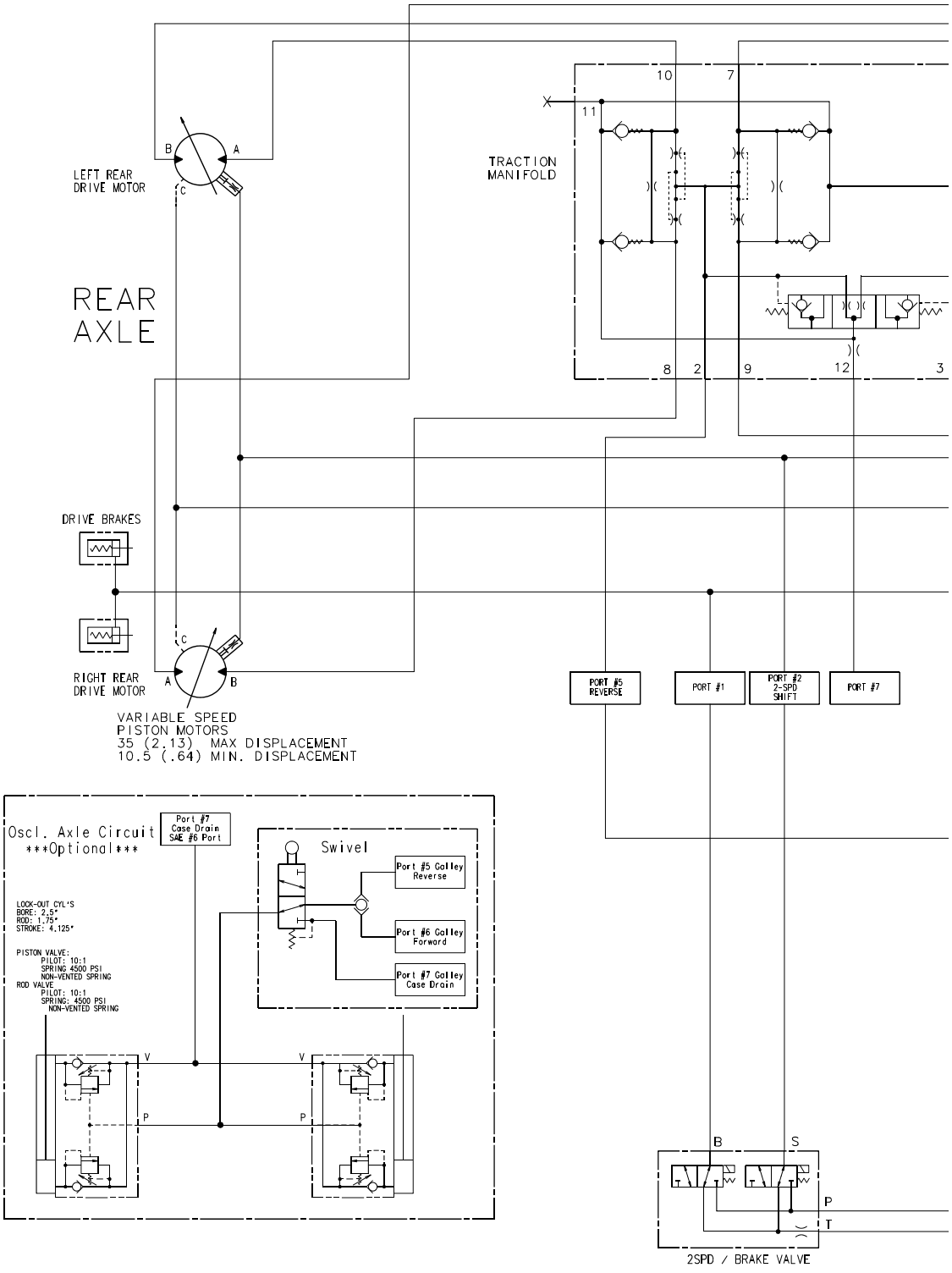
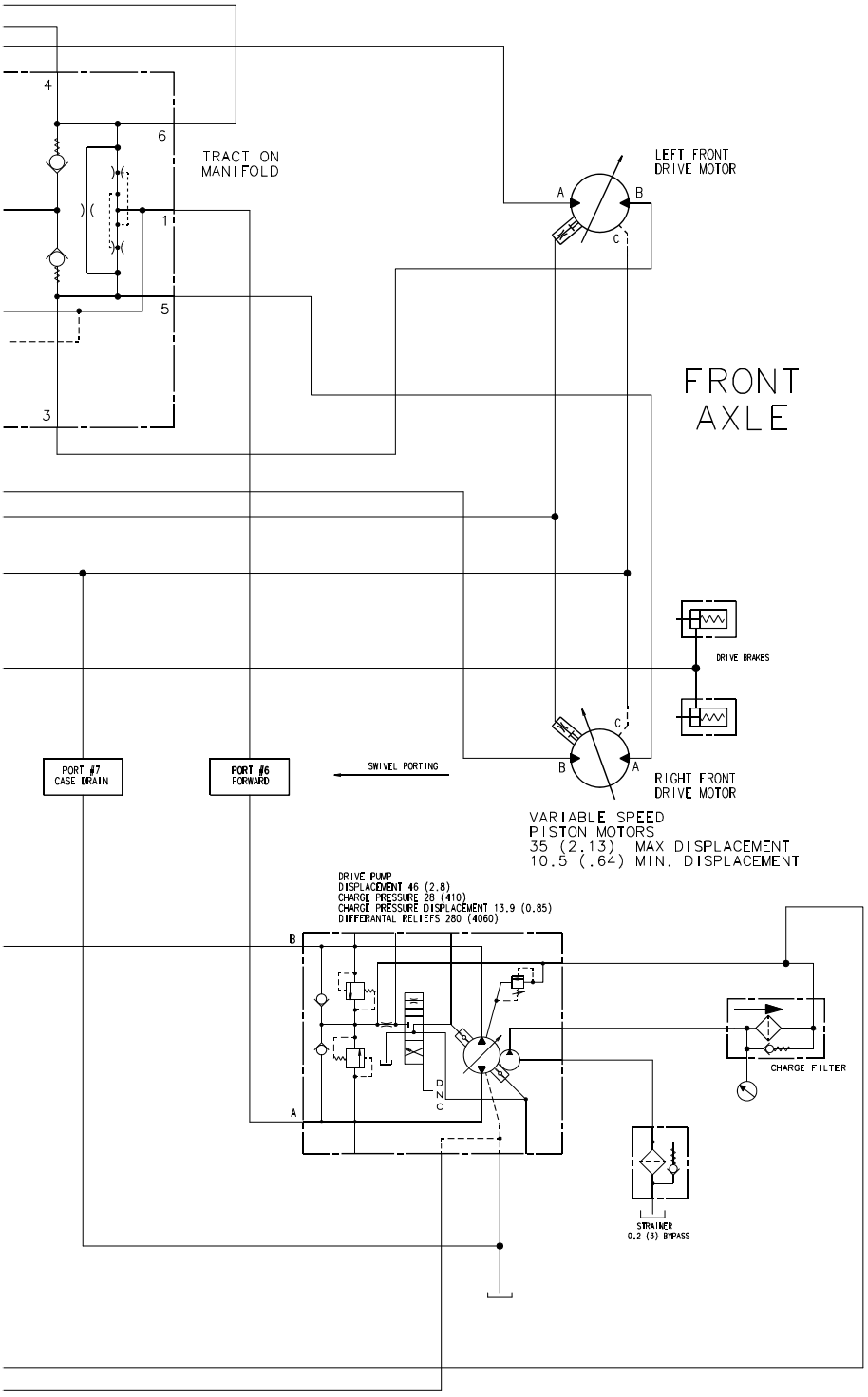


Figure 7-32. Hydraulic Schematic - Sheet 5 of 8



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Figure 7-33. Hydraulic Schematic - Sheet 6 of 8

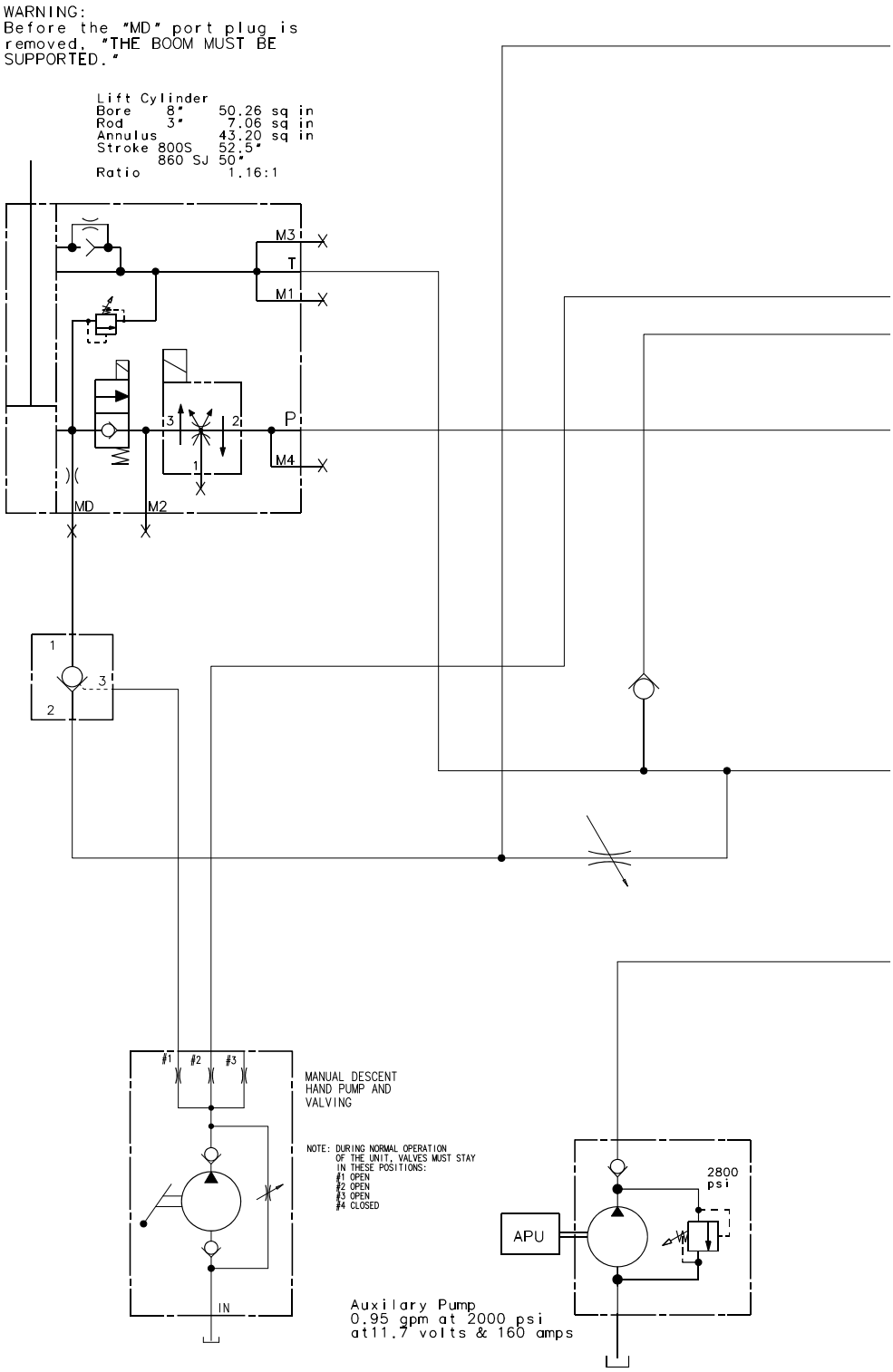
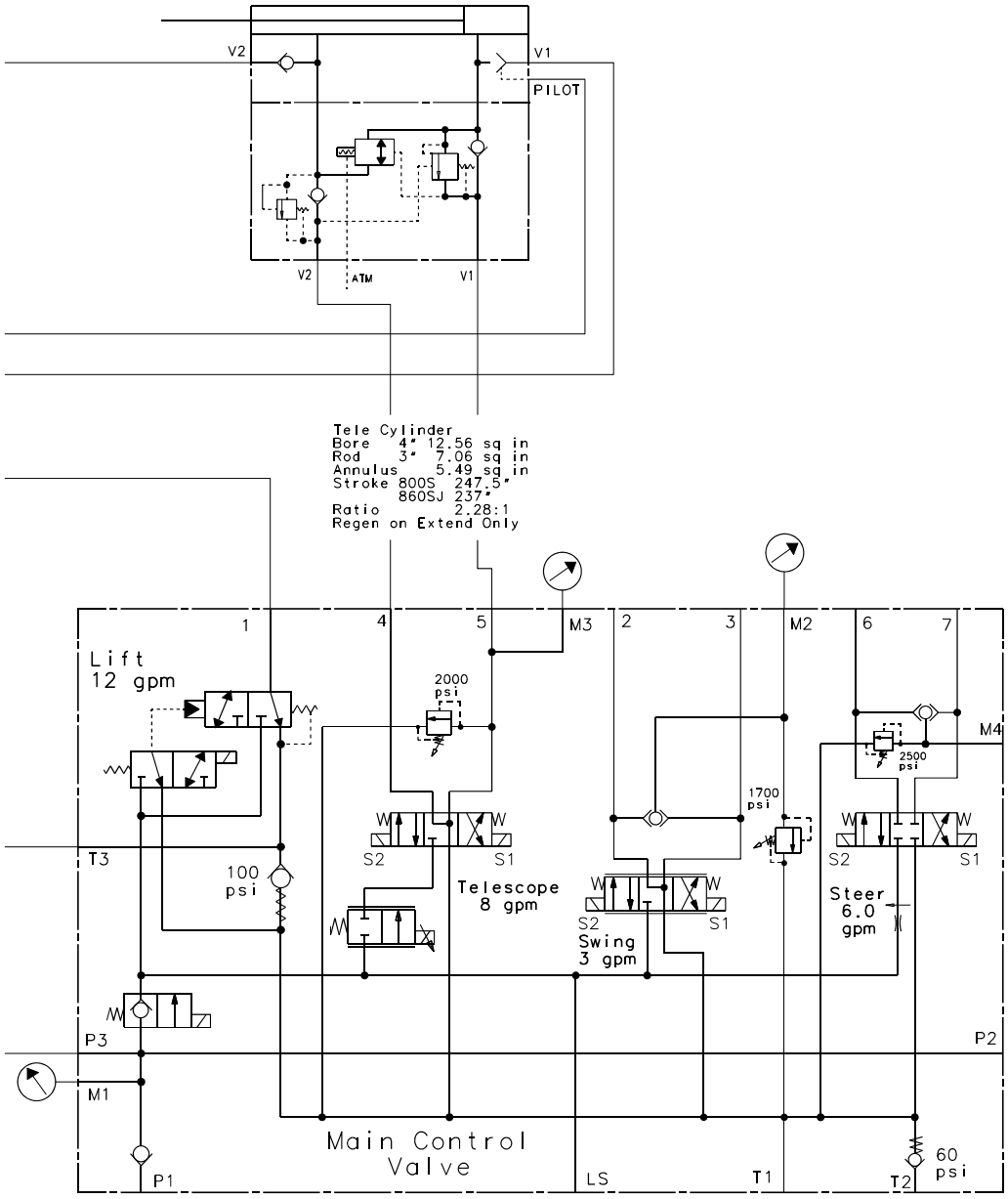


Figure 7-34. Hydraulic Schematic - Sheet 7 of 8



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Figure 7-35. Hydraulic Schematic - Sheet 8 of 8

NOTES:

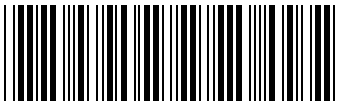
PROPOSITION 65 WARNING

- **Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.**
- **Batteries also contain other chemicals known to the State of California to cause cancer.**
- **Wash hands after handling.**

⚠ WARNING: ⚠

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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