



An Oshkosh Corporation Company

Service and Maintenance Manual

Models

600S

600SJ

660SJ

**SN 0300087000 through
0300171769, SN B300000100
through B300000969**

P/N - 3121202

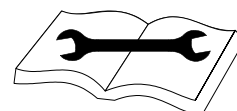
January 30, 2018

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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 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.

Do not use your hand to check for leaks. Use a piece of cardboard or paper to search for leaks. Wear gloves to help protect hands from spraying fluid.



C MAINTENANCE

⚠ WARNING

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 SERVICE MANUAL.
- 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 - SN 0300087000 through 0300099060

Maximum Work Load (Capacity) Unrestricted: Restricted:	500 lbs. (230 kg) 1000 lbs. (450 kg)
Maximum Travel Grade (Gradeability) 2WD 4WD	30% 45%
Maximum Travel Grade (Side Slope)	5°
Turning Radius (outside) 2WS/2WD 2WS/4WD 4WS/2WD 4WS/4WD	17 ft. 9 in. (5.41 m) 20 ft. 4.6875 in. (6.21 m) 11 ft. 4 in. (3.45 m) 11 ft. 2.6875 in. (3.42 m)
Turning Radius (inside) 2WS/2WD 2WS/4WD 4WS/2WD 4WS/4WD	12 ft. (3.66 m) 14 ft. 3.875 in. (5.25 m) 5 ft. 5 in. (1.65 m) 5 ft. 3.625 in. (1.22 m)
Maximum Tire Load 600S & 600SJ 660SJ	11,800 lbs. (5352 kg) 14,200 lbs. (6441 kg)
Ground Bearing Pressure 600S 600SJ 660SJ	67 psi (4.7 kg/cm ²) 70 psi (4.9 kg/cm ²) 75 psi (5.3 kg/cm ²)
Maximum Drive Speed 2WD 4WD	4.5 MPH (7.25 Km/hr.) 4 MPH (6.44 Km/hr.)
Gross Machine Weight (Approximate) 600S - 2WD 600SJ - 2WD 660SJ - 2WD 600S - 4WD 600SJ - 4WD 660SJ - 4WD	22,000 lbs. (9,979.2 kg) 23,500 lbs. (10,660 kg) 25,500 lbs. (11,567 kg) 22,510 lbs. (10,211 kg) 23,980 lbs. (10,877 kg) 25,910 lbs. (11,753 kg)

Table 1-2. Operating Specifications - SN 0300099060 through 0300171769, SN B300000100 through B300000969

Maximum Work Load (Capacity) ANSI Unrestricted: Restricted:	500 lbs. (227 kg) 1000 lbs. (454 kg)
Maximum Work Load (Capacity) CE & Australia Unrestricted: Restricted:	500 lbs. (230 kg) 1000 lbs. (450 kg)
Maximum Travel Grade (Gradeability) 2WD 4WD	30% 45%
Maximum Travel Grade (Side Slope)	5°
Turning Radius (outside) 2WS/2WD 2WS/4WD 4WS/2WD 4WS/4WD	17 ft. 9 in. (5.41 m) 20 ft. 4.6875 in. (6.21 m) 11 ft. 4 in. (3.45 m) 11 ft. 2.6875 in. (3.42 m)
Turning Radius (inside) 2WS/2WD 2WS/4WD 4WS/2WD 4WS/4WD	12 ft. (3.66 m) 14 ft. 3.875 in. (5.25 m) 5 ft. 5 in. (1.65 m) 5 ft. 3.625 in. (1.22 m)
Maximum Tire Load 600S & 600SJ 660SJ	11,800 lbs. (5352 kg) 14,200 lbs. (6441 kg)
Ground Bearing Pressure 600S 600SJ 660SJ	67 psi (4.7 kg/cm ²) 70 psi (4.9 kg/cm ²) 75 psi (5.3 kg/cm ²)
Maximum Drive Speed 2WD 4WD	4.5 MPH (7.25 Km/hr.) 4 MPH (6.44 Km/hr.)
Gross Machine Weight (Approximate) 600S - 2WD 600SJ - 2WD 660SJ - 2WD 600S - 4WD 600SJ - 4WD 660SJ - 4WD	22,000 lbs. (9,979.2 kg) 23,500 lbs. (10,660 kg) 25,500 lbs. (11,567 kg) 22,510 lbs. (10,211 kg) 23,980 lbs. (10,877 kg) 25,910 lbs. (11,753 kg)

1.2 CAPACITIES

Table 1-3. Capacities

Fuel Tank	39 Gallons (147.6 L)
Hydraulic Oil Tank	31 Gallons (117.3 L) w/10% air space
Hydraulic System (Including Tank)	37.2 Gallons (140.8 L)
Torque Hub, Drive*	17 ounces (0.50 L)
Engine Crankcase	
Ford LRG - 425 Gas w/Filter	4.5 Quarts (4.25 L)
Ford LRG - 423 Gas w/Filter	5.00 Quarts (4.73 L)
Deutz F4M1011F Diesel w/Filter	11 Quarts (10.5 L)
Deutz D2011L04	11 Quarts (10.5 L)
Caterpillar 3044C Diesel w/Filter	10.6 Quarts (10 L)
GM	4.5 Quarts (4.25 L) w/Filter
*Torque hubs should be one half full of lubricant.	

1.3 COMPONENT DATA

Engine Data

Table 1-4. Ford LRG - 425 Specifications

Fuel	Gasoline
Oil Capacity	4.5 Quarts (4.25 L) w/Filter
Idle RPM	1000
Low RPM	1800
High RPM	2800
Alternator	40 Amp, belt Drive
Battery	85 Amphour, 550 Cold Cranking Amps, 12 VDC
Fuel Consumption	
Low RPM	3.45 GPH (13.06 lph)
High RPM	4.60 GPH (17.41 lph)
Horsepower	54 @ 2400 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 F4M1011F/F4M2011 Specifications

Fuel	Diesel
Oil Capacity	
Cooling System	5 Quarts (4.5 L)
Crankcase	11 Quarts (10.5L) w/Filter
Total Capacity	16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2800
Alternator	60 Amp, belt Drive
Battery	950 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC
Fuel Consumption	
Low RPM	1.90 GPH (7.19 lph)
High RPM	2.50 GPH (9.46 lph)
Horsepower	65

Table 1-6. Deutz D2011L04 Specifications

Fuel	Diesel
Oil Capacity	
Cooling System	5 Quarts (4.5 L)
Crankcase	11 Quarts (10.5L) w/Filter
Total Capacity	16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2500
Alternator	60 Amp, belt Drive
Battery	950 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC
Fuel Consumption	
Low RPM	1.90 GPH (7.19 lph)
High RPM	2.50 GPH (9.46 lph)
Horsepower	49

Table 1-7. Caterpillar 3044C/3.4

Type	Four Stroke Cycle
Cylinders	4 in-line
Bore	3.70 in. (94 mm)
Stroke	4.72 in. (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 - 3044C	1000
Idle RPM - 3.4	1200
Low RPM	1800
High RPM	2600
Alternator	60 Amp, belt drive
Battery	930 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC

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

Dimensional Data**Table 1-9. Dimensional Data**

Machine Height (Stowed)	8 ft. 4.75 in. (2.56 m)
Machine Length (Stowed) 600S Over Drive Axle 600SJ Over Drive Axle 660SJ Over Drive Axle	27 ft. 11.125 in. (8.51 m) 32 ft. 11.75 in. (10.05 m) 35 ft. 2.875 in. (11.40 m)
Machine Width 2WS/2WD 2WS/4WD 4WS/2WD 4WS/4WD	7 ft. 11.375 in. (2.42 m) 7 ft. 11.4375 in. (2.42 m) 7 ft. 11.4375 in. (2.42 m) 7 ft. 11.375 in. (2.42 m)
Wheelbase	8 ft. 1.50 in. (2.48 m)
Boom Elevation - 600S	+60 ft. 2.13/16 in. (18.36 m) -6 ft. 1.11/16 in. (1.87 m)
Boom Elevation - 600SJ	+60 ft. 5.3/4 in. (18.43 m) -9 ft. 9.3/16 in. (2.98 m)
Boom Elevation - 660SJ	+66 ft. 7.5/8 in. (20.31 m) -11 ft. 5.1/4 in. (3.49 m)

1.4 TORQUE REQUIREMENTS**Table 1-10. Torque Requirements**

Description	Torque Value (Dry)	Interval Hours
Bearing To Chassis	190 ft. lbs. (258 Nm) See Note	50/600*
Bearing To Turntable	190 ft. lbs. (258 Nm) See Note	50/600*
Wire Rope	15 ft. lbs (20 Nm)	150
Wheel Lugs 9 Lug: 10 Lug:	170 ft. lbs (231 Nm) 300 ft. lbs. (407 Nm)	150
Engine Mounting Bolts	165 ft. lbs. (231 Nm)	A/R
Engine Manifold Mounting Bolts	30 ft. lbs. (42 Nm)	A/R
*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter. (See Swing Bearing in Section 3.)		

1.5 TIRES

Table 1-11. Tire Specifications

Size	Load Range	Ply Rating	Tire Pressure
15x19.5	G	14	95 PSI (6.5 Bar)
15x19.5	G	14	Foam - Filled
18x625	H	16	75 PSI (5.2 Bar)
39x15-22.5	G	14	95 PSI (6.5 Bar)
39x15-22.5	G	14	Foam - Filled

1.6 LUBRICATION

Hydraulic Oil

Table 1-12. Hydraulic Oil

HYDRAULIC SYSTEM OPERATING TEMPERATURE RANGE	SAE VISCOSITY GRADE
+0°F to +180°F (-18°C to +83°C)	10W
+0°F to +210°F (-18°C to +99°C)	10W-20, 10W-30
+50°F to +210°F (+10°C to +210°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 below 20°F (-7 degrees C), JLG Industries recommends the use of Mobil DTE 10.

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 1-13. Mobilfluid 424 Specs

SAE Grade	10W30
ISO Grade	55
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 1-14. Mobil DTE 10 Excel 32 Specs

ISO Viscosity Grade	#32
Gravity API	-
Pour Point, Max	-65.2°F (-54°C)
Flash Point, Min.	482°F (250°C)
Viscosity	
at 40°C	32.7 cSt
at 100°C	6.6 cSt
at 100°F	32.7 cSt
at 212°F	6.6 cSt
cP at -30°F	-
Viscosity Index	164
Density@ 15°C	0.85 Kg/l
Density@ 60°F	0.03 lb/in ³

Table 1-15. Exxon Univil HVI 26 Specs

Specific Gravity	32.1
Pour Point	-76°F (-60°C)
Flash Point	217°F (103°C)
Viscosity	
at 40°C	25.8 cSt
at 100°C	9.3 cSt
Viscosity Index	376
NOTE: Mobil/Exxon recommends that this oil be checked on a yearly basis for viscosity.	

Table 1-16. Quintolubric 888-46

Density	0.91 @ 15°C (59°F)
Pour Point	<-20°C (<-4°F)
Flash Point	275°C (527°F)
Fire Point	325°C (617°F)
Autoignition Temperature	450°C (842°F)
Viscosity	
at 0°C (32°F)	360 cSt
at 20°C (68°F)	102 cSt
at 40°C (104°F)	46 cSt
at 100°C (212°F)	10 cSt
Viscosity Index	220

Table 1-17. Mobil EAL 224H Specs (USA Build machine)

ISO Viscosity Grade	32/46
Specific Gravity	0.922
Pour Point	-25°F (-32°C)
Flash Point	428°F (220°C)
Operating Temperature	0 - 180°F (-17°-162°C)
Viscosity	
at 40°C	37 cSt
at 100°C	8.4 cSt
Viscosity Index	213

Table 1-18. Mobil EAL Envirosyn H46 Specs

ISO Viscosity Grade	#46
Pour Point	-49°F (-45°C)
Flash Point, Min.	500°F (260°C)
Viscosity	
at 40°C	48.8 cSt
at 100°C	7.8 cSt
Viscosity Index	145
Density@ 15°C	0.874

Table 1-19. Mobil SHC Hydraulic EAL 46 Specs

ISO Viscosity Grade	#46
Pour Point	-27°F (-33°C)
Flash Point, Min.	568°F (298°C)
Viscosity	
at 40°C	43.3 cSt
at 100°C	7.7 cSt
Viscosity Index	149
Density@ 15°C	0.93

Drive System

Table 1-20. Drive System Specifications

Drive Motor Displacement	2.8 cu. in. max. 1.1 cu. in. min. (46 cm ³ max. 18 cm ³ min.)
Drive Hub Ratio 2WD 4WD	53.58:1 43:1
Drive Brake	Automatic spring applied, hydraulically released disc brakes
Toe-in	adjust for 1/4 in. (6.35 mm) overall

Swing System

Table 1-21. Swing System Specifications

Swing Motor Displacement	4.62 cu. in. (75 cm ³)
Swing Brake	Automatic spring applied, hydraulically released disc brakes
Swing Hub Ratio	50:1
Hydraulic Gear Pump (at 1800 RPM)	7.9 GPM (29.90 lpm)
Pump Displacement	1.02 cu. in. (16 cm ³)
Rotation	Clockwise

Auxiliary Power Pump

Table 1-22. Auxiliary Power Pump Specifications

Output	2.6 GPM (9.84 lpm) @ 1200 PSI. (82.7 BAR)
Pump Displacement	0.244 cu. in. (14 cm ³)
Motor	DC
Rotation	Clockwise

Hydraulic Filters

Table 1-23. Hydraulic Filters

Pressure Filter	In-line
Return - Bypass Type	10 Microns Absolute
Charge	10 Microns Absolute
Hydraulic Strainers (In Tank)	30 Microns

1.7 PERFORMANCE DATA

Table 1-24. Performance Data

Travel Speed 2WD 4WD	4.5 MPH (7.25 Km/hr.) 4 MPH (6.44 Km/hr.)
Gradeability 2WD 4WD	30% 45%

1.8 CYLINDER SPECIFICATIONS

Table 1-25. Cylinder Specifications - 600S

DESCRIPTION	BORE in. (mm)	STROKE in. (mm)	ROD DIA. in. (mm)
Lift	6.00 (152.4)	44.69 (1135.1)	3 (76.2)
Telescope	3.5 (88.9)	177.75 (4514.9)	2.5 (63.5)
Steer	2.5 (63.5)	10.75 (273.1)	1.25 (31.8)
Lockout (2wd)	3.625 (92.1)	4 (101.6)	3.5 (88.9)
Master	3 (76.2)	8.5 (215.9)	1.5 (38.1)
Slave Level	3 (76.2)	8.5 (215.9)	1.5 (38.1)

Table 1-26. Cylinder Specifications - 600SJ

DESCRIPTION	BORE in. (mm)	STROKE in. (mm)	ROD DIA. in. (mm)
Lift	6.00 (152.4)	44.69 (1135.1)	3 (76.2)
Telescope	3.5 (88.9)	143.1875 (3637)	2.5 (63.5)
Steer	2.5 (63.5)	10.75 (273.1)	1.25 (31.8)
Lockout (2wd)	4 (101.6)	3.875 (98.4)	1.5 (38.1)
Master	3.5 (88.9)	13.0625 (331.8)	1.5 (38.1)
Slave Level	3.5 (88.9)	13.0625 (331.8)	1.5 (38.1)
Lift (Articulating Jib Boom)	3 (76.2)	25.5 (647.7)	1.5 (38.1)

Table 1-27. Cylinder Specifications - 660SJ

DESCRIPTION	BORE in. (mm)	STROKE in. (mm)	ROD DIA. in. (mm)
Lift	6.00 (152.4)	44.69 (1135.1)	3 (76.2)
Telescope	3.5 (88.9)	168.4375 (4278.3)	2.5 (63.5)
Steer	2.5 (63.5)	10.75 (273.1)	1.25 (31.8)
Lockout (2wd)	4 (101.6)	3.875 (98.4)	1.5 (38.1)
Master	3.5 (88.9)	13.0625 (331.8)	1.5 (38.1)
Slave Level	3.5 (88.9)	13.0625 (331.8)	1.5 (38.1)
Lift (Articulating Jib Boom)	3 (76.2)	25.5 (647.7)	1.5 (38.1)

1.9 MAJOR COMPONENT WEIGHTS

Table 1-28. Major Component Weights - 600S

Component	LB.	KG.
Platform Control Console	250	113
Platform Level Cylinder	46	21
Main Boom (Includes Lift Cyl, Rotator, and Support)	3527	1600
Turntable Complete (including engine)	7315	3318
Chassis Complete (w/pneumatic tires)	10400	4718
Chassis Complete (w/foam-filled tires)	11680	5300
Machine Complete (GVW) - 2WD w/pneumatic tires	22000	9979
Machine Complete (GVW) - 4WD w/pneumatic tires	22510	10211

Table 1-29. Major Component Weights - 600SJ

Component	LB.	KG.
Platform Control Console	250	113
Platform Level Cylinder	60	27
Main Boom (Includes Lift Cyl, Rotator, and Support)	3483	1580
Turntable Complete (including engine)	7915	3590
Chassis Complete (w/pneumatic tires)	11300	5126
Chassis Complete (w/foam-filled tires)	12580	5707
Machine Complete (GVW) - 2WD w/pneumatic tires	23500	10660
Machine Complete (GVW) - 4WD w/pneumatic tires	23980	10877

Table 1-30. Major Component Weights - 660SJ

Component	LB.	KG.
Platform Control Console	250	113
Platform Level Cylinder	60	27
Main Boom (Includes Lift Cyl, Rotator, and Support)	3783	1716
Turntable Complete (including engine)	9065	4112
Chassis Complete (w/pneumatic tires)	11775	5341
Chassis Complete (w/foam-filled tires)	13055	5922
Machine Complete (GVW) - 2WD w/pneumatic tires	25500	11567
Machine Complete (GVW) - 4WD w/pneumatic tires	25910	11753

1.10 CRITICAL STABILITY WEIGHTS

WARNING

DO NOT REPLACE ITEMS CRITICAL TO STABILITY WITH ITEMS OF DIFFERENT WEIGHT OR SPECIFICATION (FOR EXAMPLE: BATTERIES, FILLED TIRES, COUNTERWEIGHT, ENGINE & PLATFORM) DO NOT MODIFY UNIT IN ANY WAY TO AFFECT STABILITY.

Table 1-31. Critical Stability Weights - 600S

Component		LB.	KG.
Tire and Wheel (Ballasted Only)	Size (15 - 19.5)	253	115
Engine	Ford	460	209
	Deutz	534	242
	Continental	558	253
Counterweight	Weight	2900	1315
Platform	6 ft. (1.83 M)	205	93
	8 ft. (2.44 M)	230	105

Table 1-32. Critical Stability Weights - 600SJ

Component		LB.	KG.
Tire and Wheel (Ballasted Only)	Size (15 - 19.5)	253	115
Engine	Ford	460	209
	Deutz	534	242
	Continental	558	253
Counterweight	Weight	3500	1588
Platform	6 ft. (1.83 M)	205	93
	8 ft. (2.44 M)	230	105

Table 1-33. Critical Stability Weights - 660SJ

Component		LB.	KG.
Tire and Wheel (Ballasted Only)	Size (15 - 19.5)	253	115
Engine	Ford	460	209
	Deutz	534	242
	Continental	558	253
Counterweight	Weight	4650	2109
Platform	6 ft. (1.83 M)	205	93
	8 ft. (2.44 M)	230	105

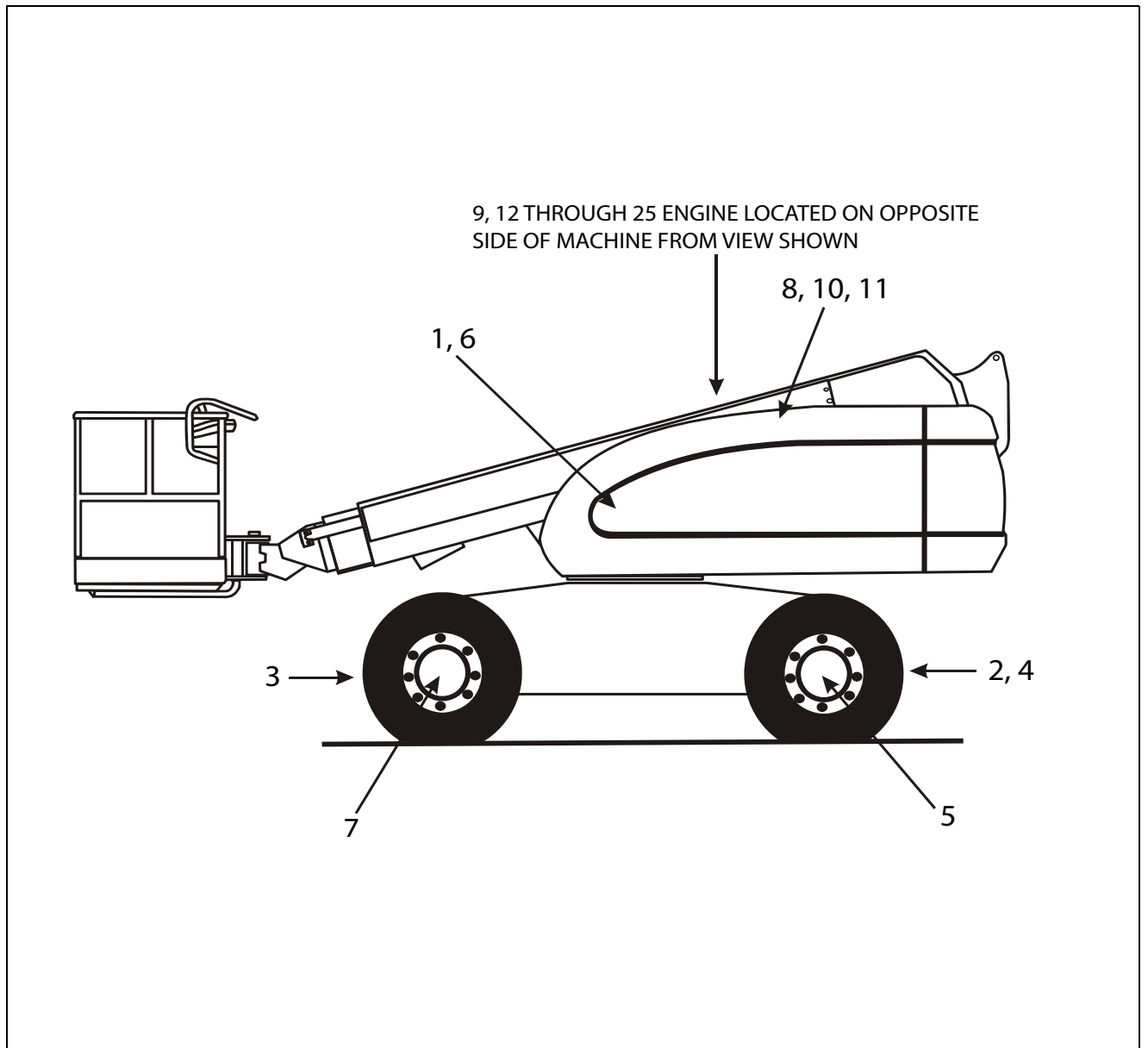


Figure 1-1. Maintenance and Lubrication Diagram

1.11 OPERATOR MAINTENANCE

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

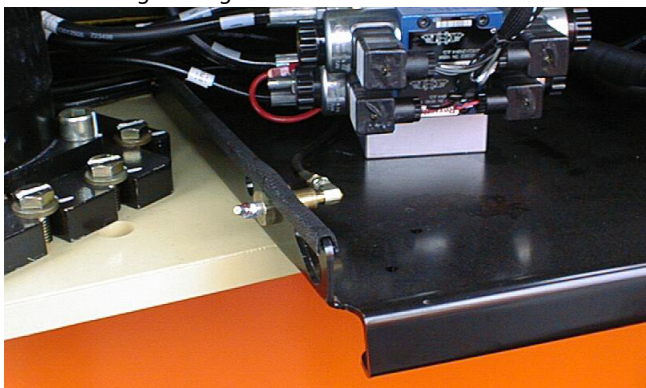
Table 1-34. Lubrication Specifications

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 lbs. 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.

1. Swing Bearing



Lube Point(s) - 1 or 2 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
Comments - Remote Access. Apply grease and rotate in 90 degrees intervals until bearing is completely lubricated.

2. Steer Spindles (2WS)*

Lube Point(s) - 8 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
* Machines after S/N 38047 will have composite bushings and no grease fittings.

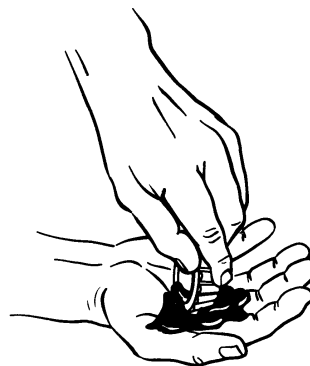
3. Steer Spindles (4WS)*

Lube Point(s) - 2 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
* Machines after S/N 38047 will have composite bushings and no grease fittings.

4. Steer Spindles (4WD)*

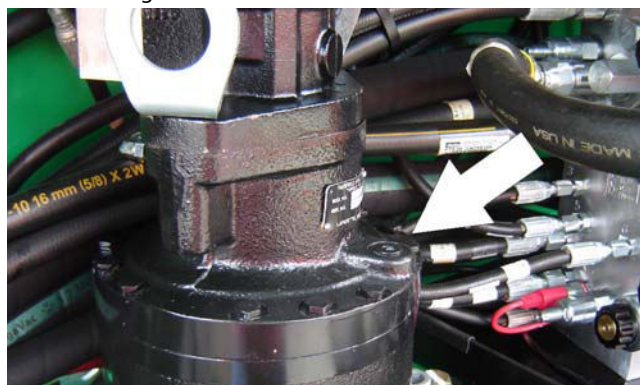
Lube Point(s) - 4 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
* Machines after S/N 38047 will have composite bushings and no grease fittings.

5. Wheel Bearings



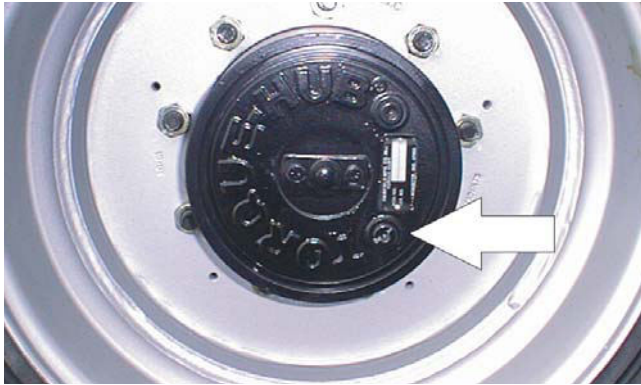
Lube Point(s) - Repack
Capacity - A/R
Lube - MPG
Interval - Every 2 years or 1200 hours of operation.

6. Swing Drive Hub



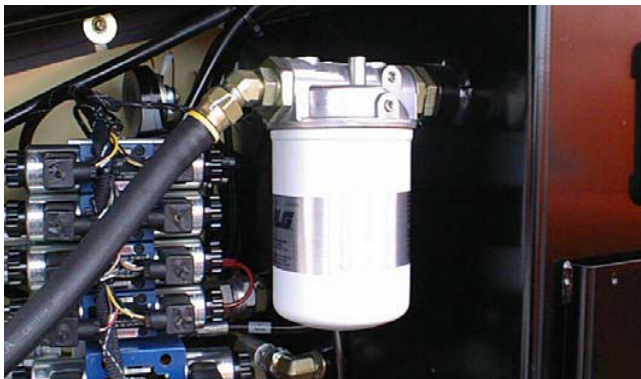
Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (1/2 Full)
Lube - EPGL
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation.

7. Wheel Drive Hub



Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (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.

8. Hydraulic Return Filter



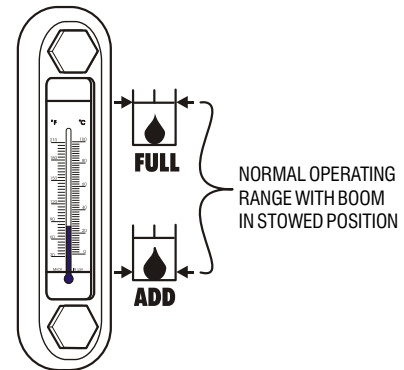
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

9. Hydraulic Charge Filter



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

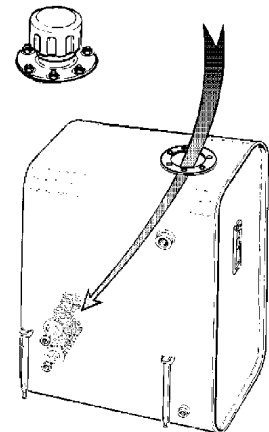
10. Hydraulic Tank



Lube Point(s) - Fill Cap
Capacity - 30.6 gal. Tank; 32.7 gal. System
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

11. Suction Strainers (in tank)

REMOVE FILL CAP PLATE FROM TANK TO GAIN ACCESS TO STRAINERS

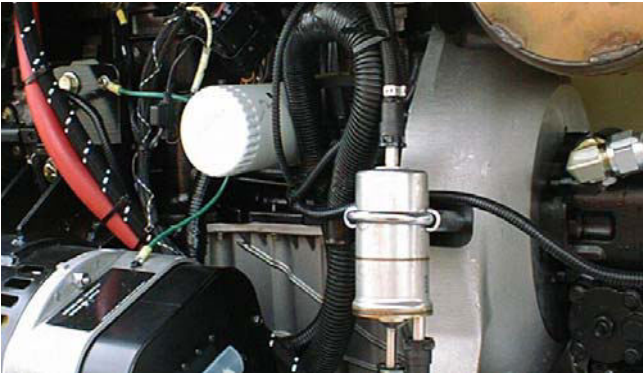


Lube Point(s) - 2
Interval - Every 2 years or 1200 hours of operation, remove and clean at time of hydraulic oil change.

12. Oil Change w/Filter - Ford LRG423
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 5 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

SECTION 1 - SPECIFICATIONS

13. Oil Change w/Filter - Ford LRG425



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.

14. Oil Change w/Filter - Continental

Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 6 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

15. Oil Change w/Filter - Deutz



Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 11 Quarts Crankcase; 5 Quarts Cooler
Lube - EO
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

16. Oil Change w/Filter - Caterpillar

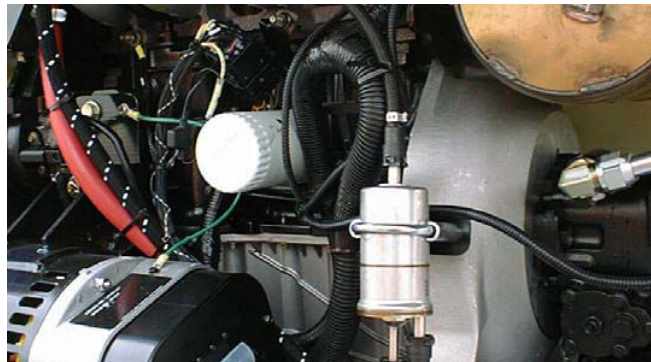
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 10.6 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

17. 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.

18. Fuel Filter - Ford

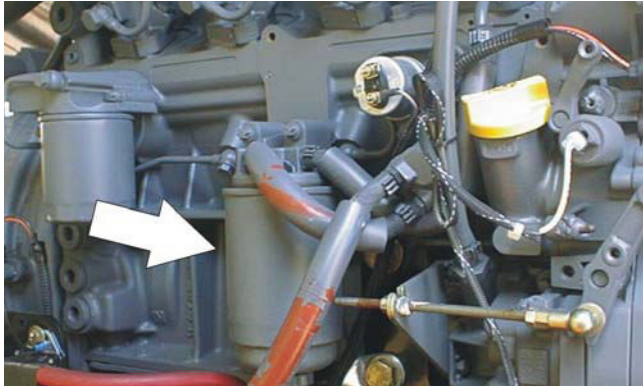


Lube Point(s) - Replaceable Element
Interval - Every Year or 1200 hours of operation.

19. Fuel Filter - Continental

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

20. Fuel Filter - Deutz



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

21. Fuel Filter - Caterpillar

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

22. Fuel Filter (Gasoline) - GM

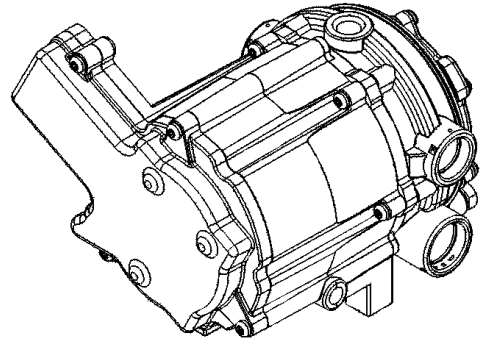
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation.

23. Air Filter



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

24. Electronic Pressure Regulator (LP only)



Interval - 3 Months or 150 hours of operation
Comments - Drain oil build up. Refer to Section 1.12, Draining Oil Build Up From The Propane Regulator (Prior to SN 0300132529).

25. Fuel Filter (Propane) - GM Engine



Interval - 3 Months or 150 hours of operation
Comments - Replace filter. Refer to Section 1.13, Propane Fuel Filter Replacement.

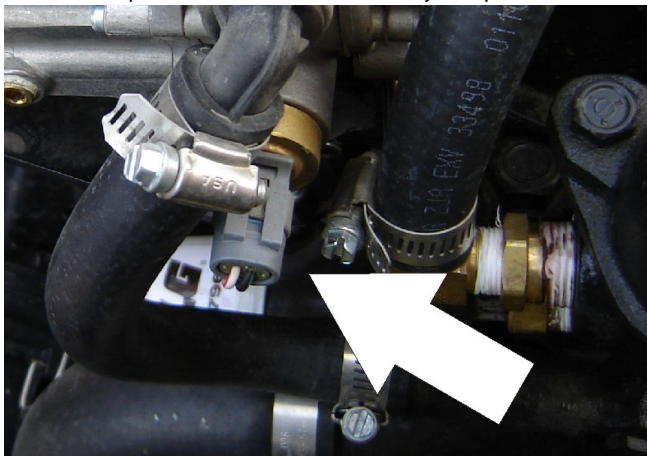
1.12 DRAINING OIL BUILD UP FROM THE PROPANE REGULATOR (PRIOR TO SN 0300132529)

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.

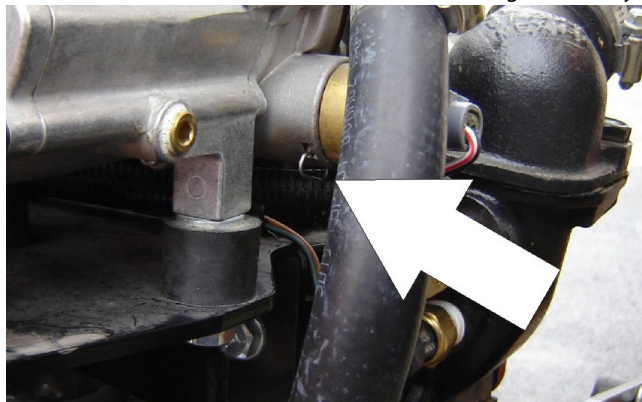
NOTICE

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 per local regulations in a safe and proper fashion.

1.13 PROPANE FUEL FILTER REPLACEMENT

Removal

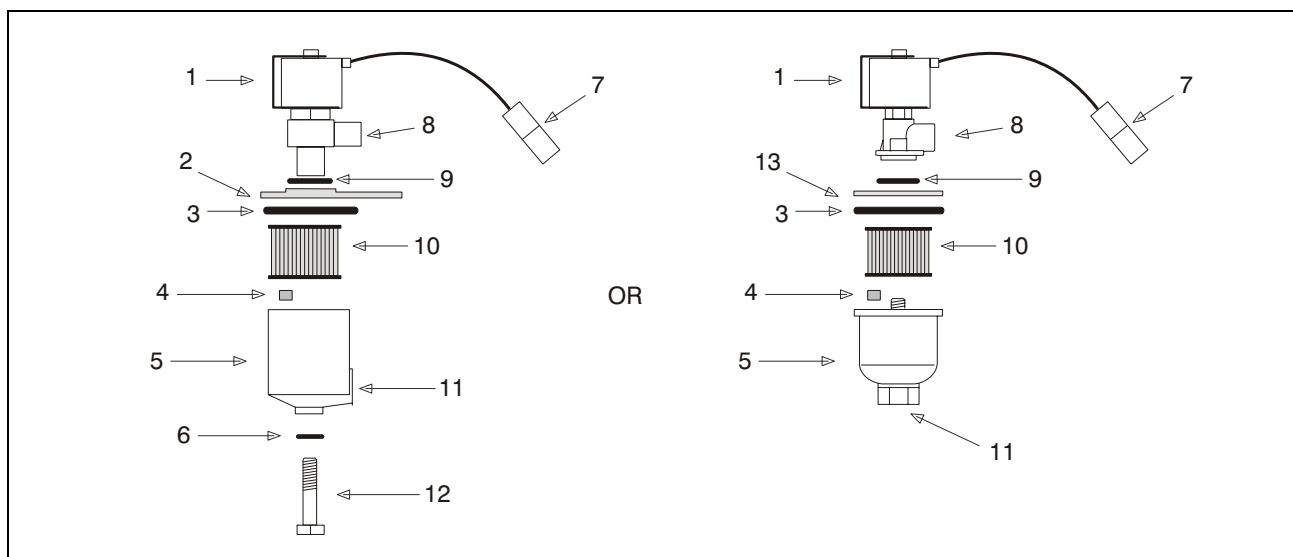
1. Relieve the propane fuel system pressure. Refer to Section 1.14, Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly loosen the Filter housing and remove it.
4. Pull the filter housing from the Electric lock off assembly.
5. Remove the filter from the housing.
6. Locate Filter magnet and remove it.
7. Remove and discard the housing seal.
8. If equipped, remove and discard the retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

Installation

NOTICE

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

1. Install the mounting plate to lock off O-ring seal.
2. If equipped, install the retaining bolt seal.
3. Install the housing seal.
4. Drop the magnet into the bottom of the filter housing.
5. Install the filter into the housing.
6. If equipped, install the retaining bolt into the filter housing.
7. Install the filter up to the bottom of the electric lock off.
8. Tighten the filter bowl retainer 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.



- | | | |
|-------------------------------|-------------------------|--------------------|
| 1. Electric Lock Off Solenoid | 6. Seal | 10. Filter |
| 2. Mounting Plate | 7. Electrical Connector | 11. Fuel Inlet |
| 3. Housing Seal | 8. Fuel Outlet | 12. Retaining Bolt |
| 4. Filter Magnet | 9. O-ring | 13. Ring |
| 5. Filter Housing | | |

Figure 1-2. Filter Lock Assembly

1.14 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.

1.15 SERIAL NUMBER LOCATIONS

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.

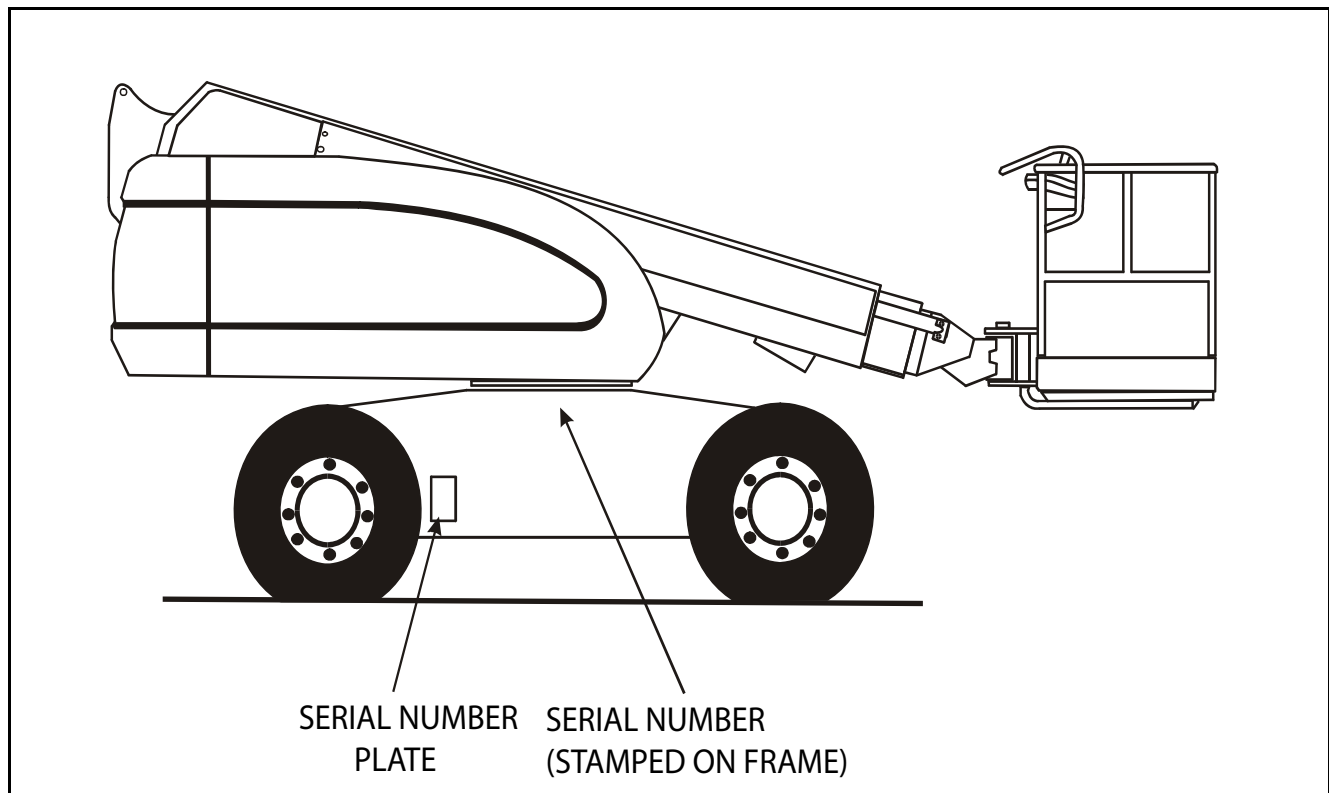


Figure 1-3. Serial Number Locations

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)																		
SAE GRADE 5 BOLTS & GRADE 2 NUTS										SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*								
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loclite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)	Torque (Loclite® 263™ or TITE™ 131)		Clamp Load	Torque (Dry or Loclite® 263 K= 0.20)		Torque (Loclite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loclite® 263™ or TITE™ 131) K=0.15	
					IN-LB	[N.m]	IN-LB	[N.m]		IN-LB	[N.m]		IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	8	0.9	6	0.7										
	48	0.1120	0.00661	420	9	1.0	7	0.8										
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	0.1840	0.01400	900	30	3.4	22	2.5										
	36	0.1840	0.01474	940	31	3.5	23	2.6										
10	24	0.1900	0.01750	1120	43	4.8	32	3.5										
	32	0.1900	0.02000	1285	49	5.5	36	4										
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12								
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15								
					FT-LB	[N.m]	FT-LB	[N.m]										
5/16	18	0.3125	0.0524	3340	17	23	13	18	19	26								
	24	0.3125	0.0580	3700	19	26	14	19	21	29								
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48								
	24	0.3750	0.0878	5600	35	47	25	34	40	54								
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75								
	20	0.4375	0.1187	7550	55	75	40	54	60	82								
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116								
	20	0.5000	0.1599	10700	90	122	65	88	100	136								
9/16	12	0.5625	0.1820	11600	110	149	80	108	123	163								
	18	0.5625	0.2030	12950	120	163	90	122	135	184								
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224								
	18	0.6250	0.2560	16300	170	230	130	176	190	258								
3/4	10	0.7500	0.3340	21300	260	353	200	285	338	440								
	16	0.7500	0.3730	23800	300	407	220	298	330	449								
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646								
	14	0.8750	0.5090	32400	470	637	350	475	520	707								
1	8	1.0000	0.6060	38600	640	868	480	651	719	918								
	12	1.0000	0.6630	42200	700	949	530	719	735	1000								
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142								
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258								
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598								
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768								
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074								
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380								
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754								
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128								

NO. 5000059 REV. K

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
 3. * ASSEMBLY USES HARDENED WASHER

REFERENCE JLG THREAD LOCKING COMPOUND			
JLG P/N	Loclite® P/N	ND Industries P/N	Description
0100011	242™	Vibra-TITE™ 121	Medium Strength (Blue)
0100019	271™	Vibra-TITE™ 140	High Strength (Red)
0100071	262™	Vibra-TITE™ 131	Medium - High Strength (Red)

Figure 1-4. Torque Chart (SAE Fasteners - Sheet 1 of 5)

Values for Magni Coating Fasteners (Ref 4150701)														
SAE GRADE 5 BOLTS & GRADE 2 NUTS					SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*									
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17	Torque (Loclite® 242™ or 271™ OR Vibra-TITE™ K=0.16	Torque (Loclite® 262™ or TITE™ 131) K=0.15	Clamp Load	Torque (Dry or Loclite® 263) K= 0.17	Torque (Loclite® 242™ or 271™ OR Vibra-TITE™ K= .16	Torque (Loclite® 262™ or TITE™ 131) K=0.15			
		In	Sq In	LB	IN-LB	FT-LB	IN-LB	LB	IN-LB	FT-LB	IN-LB	[N.m]		
4	40	0.1120	0.00604	380	7									
	48	0.1120	0.00661	420	8									
6	32	0.1380	0.00909	580	14									
	40	0.1380	0.01015	610	14									
8	32	0.1640	0.01400	900	25									
	36	0.1640	0.01474	940	26									
10	24	0.1900	0.01750	1120	36									
	32	0.1900	0.02000	1285	42									
1/4	20	0.2500	0.0318	2020	86									
	28	0.2500	0.0364	2320	99									
		In	Sq In	LB	FT-LB	IN-LB	FT-LB	LB	FT-LB	IN-LB	FT-LB	[N.m]		
5/16	18	0.3125	0.0524	3340	15	14	19	4720	20	25	20	25		
	24	0.3125	0.0580	3700	15	20	15	5220	25	35	20	25		
3/8	16	0.3750	0.0775	4940	25	34	25	7000	35	50	35	50		
	24	0.3750	0.0878	5600	30	40	28	7900	40	55	35	50		
7/16	14	0.4375	0.1063	6800	40	54	35	9550	60	80	55	70		
	20	0.4375	0.1187	7550	45	60	44	10700	65	90	60	80		
1/2	13	0.5000	0.1419	9050	65	82	55	12750	90	120	85	110		
	20	0.5000	0.1599	10700	75	100	71	14400	100	135	95	120		
9/16	12	0.5625	0.1820	11600	90	120	87	16400	130	175	125	155		
	18	0.5625	0.2030	12950	105	145	90	18250	145	195	135	175		
5/8	11	0.6250	0.2260	14400	130	175	115	20350	180	245	170	220		
	18	0.6250	0.2560	16300	145	195	125	23000	205	280	190	245		
3/4	10	0.7500	0.3340	21300	225	305	200	30100	320	435	300	380		
	16	0.7500	0.3730	23800	255	345	225	33600	355	485	335	430		
7/8	9	0.8750	0.4620	29400	365	495	320	41600	515	700	485	620		
	14	0.8750	0.5090	32400	400	545	355	45800	570	775	535	680		
1	8	1.0000	0.6060	38600	545	740	480	51500	730	995	685	875		
	12	1.0000	0.6630	42300	600	815	530	59700	845	1150	795	1080		
1 1/8	7	1.1250	0.7630	47500	675	920	595	68700	1095	1490	1030	1400		
	12	1.1250	0.8560	53800	755	1025	670	77000	1225	1665	1155	1570		
1 1/4	7	1.2500	0.9690	59600	955	1300	840	87200	1545	2100	1455	1980		
	12	1.2500	1.0730	64100	1055	1435	930	96600	1710	2325	1610	2190		
1 3/8	6	1.3750	1.1550	64100	1250	1700	1100	104000	2025	2755	1905	2590		
	12	1.3750	1.3150	73000	1420	1930	1255	118100	2300	3130	2165	2945		
1 1/2	6	1.5000	1.4050	78000	1660	2260	1465	126500	2690	3660	2530	3440		
	12	1.5000	1.5800	87700	1865	2535	1645	142200	3020	4105	2845	3870		

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

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

SOCKET HEAD CAP SCREWS																
Magni Coating (Ref 4150701)*					Zinc Yellow Chromate Fasteners (Ref 4150707)*											
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K = .17		Torque (Loclitt® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.16		Torque (Loclitt® 262™ or Vibra- TITE™ 131) K=0.15		Clamp Load See Note 4	Torque (Dry) K = .20		Torque (Loclitt® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.18		Torque (Loclitt® 262™ or Vibra- TITE™ 131) K=0.15
		In	Sq In	LB	IN-LB	FT-LB	IN-LB	FT-LB	IN-LB	FT-LB	LB	IN-LB	FT-LB	IN-LB	FT-LB	IN-LB
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	122	14	114	13			2860	143	16	129	15	
	28	0.2500	0.0364	3280	139	16	131	15			3280	164	19	148	17	
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25	4720	25	35	20	25	20
	24	0.3125	0.0580	5220	25	35	20	25	20	25	5220	25	35	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50	7000	45	60	40	55	35
	24	0.3750	0.0878	7900	40	55	40	55	35	50	7900	50	70	45	60	35
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70	9550	70	95	65	90	50
	20	0.4375	0.1187	10700	65	90	60	80	60	80	10700	80	110	70	95	60
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110	12750	105	145	95	130	80
	20	0.5000	0.1599	14400	100	135	95	130	90	120	14400	120	165	110	150	90
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155	16400	155	210	140	190	115
	18	0.5625	0.2030	18250	145	195	135	185	130	175	18250	170	230	155	210	130
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220	20350	210	285	190	260	160
	18	0.6250	0.2560	23000	205	280	190	260	180	240	23000	240	325	215	290	180
3/4	10	0.7500	0.3340	30100	320	435	300	380	280	380	30100	375	510	340	460	280
	16	0.7500	0.3730	33600	355	485	335	455	315	430	33600	420	570	380	515	430
7/8	9	0.8750	0.4620	41600	515	700	485	680	455	620	41600	605	825	545	740	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680	45800	670	910	600	815	500
1	8	1.0000	0.6060	51500	730	995	685	930	645	875	51500	860	1170	775	1055	645
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015	59700	995	1355	895	1215	745
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310	68700	1290	1755	1160	1580	965
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475	77000	1445	1965	1300	1770	1085
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855	87200	1815	2470	1635	2225	1365
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055	96600	2015	2740	1810	2460	1510
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430	104000	2385	3245	2145	2915	1785
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760	118100	2705	3680	2435	3310	2030
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225	126500	3165	4305	2845	3870	2370
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625	142200	3555	4835	3200	4350	2665

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

NO. 5000059 REV. K

Figure 1-6. Torque Chart (SAE Fasteners - Sheet 3 of 5)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)										
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS					CLASS 10.9 METRIC (HEX HEAD) 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) (Lub)	Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)	Clamp Load	Torque (Dry or Loctite® 263™) K = 0.20	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K = 0.18	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.4	3.13			
3.5	0.6	6.78	2.95	2.1	1.6	1.9	4.22			
4	0.7	8.78	3.82	3.1	2.3	2.8	5.47			
5	0.8	14.20	6.18	6.2	4.6	5.6	8.85			
6	1	20.10	8.74	11	7.9	9.4	12	12.5		
7	1	28.90	12.6	18	13	16	18.0	25	23	19
8	1.25	36.60	15.9	26	19	23	22.8	37	33	27
10	1.5	58.00	25.2	50	38	45	36.1	70	65	55
12	1.75	84.30	36.7	88	66	79	52.5	125	115	95
14	2	115	50.0	140	105	126	71.6	200	180	150
16	2	157	68.3	219	164	197	97.8	315	280	235
18	2.5	192	83.5	301	226	271	119.5	430	385	325
20	2.5	245	106.5	426	320	383	152.5	610	550	460
22	2.5	303	132.0	581	436	523	189.0	830	750	625
24	3	353	153.5	737	553	663	222.0	1065	960	800
27	3	459	199.5	1080	810	970	286.0	1545	1390	1160
30	3.5	561	244.0	1460	1100	1320	349.5	2095	1885	1575
33	3.5	694	302.0	1990	1490	1790	432.5	2855	2570	2140
36	4	817	355.5	2560	1920	2300	509.0	3665	3300	2750
42	4.5	1120	487.0	4090	3070	3680	698.0	5865	5275	4395

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

**3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

NO. 5000059 REV. K

Figure 1-7. Torque Chart (SAE Fasteners - Sheet 4 of 5)

Values for Magni Coated Fasteners (Ref 4150701)										
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS					CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*					
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™) K=0.17	Torque (Loctite®262™ OR Vibra-TITE™131) K=0.16	Torque (Loctite®242™ or 271™ OR Vibra- TITE™111 or 140) K=0.15	Clamp Load	Torque (Dry or Loctite® 263™) K= 0.17	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K= 0.16	Torque (Loctite®262™ OR Vibra-TITE™131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.1	1.1	1.0	3.13			
3.5	0.6	6.78	2.95	1.8	1.7	1.5	4.22			
4	0.7	8.78	3.82	2.6	2.4	2.3	5.47			
5	0.8	14.20	6.18	5.3	4.9	4.6	8.85			
6	1	20.10	8.74	9	8.4	7.9	12.5	13	12	11
7	1	28.90	12.6	15	14	13	18.0	21	20	19
8	1.25	36.60	15.9	22	20	19	22.8	31	29	27
10	1.5	58.00	25.2	43	40	38	36.1	61	58	55
12	1.75	84.30	36.7	75	70	66	52.5	105	100	95
14	2	115	50.0	119	110	105	71.6	170	160	150
16	2	157	68.3	186	175	165	97.8	265	250	235
18	2.5	192	83.5	256	240	225	119.5	365	345	325
20	2.5	245	106.5	362	340	320	152.5	520	490	460
22	2.5	303	132.0	494	465	435	189.0	705	665	625
24	3	353	153.5	627	590	555	222.0	905	850	800
27	3	459	199.5	916	860	810	286.0	1315	1235	1160
30	3.5	561	244.0	1245	1170	1100	349.5	1780	1680	1575
33	3.5	694	302.0	1694	1595	1495	432.5	2425	2285	2140
36	4	817	355.5	2176	2050	1920	509.0	3115	2930	2750
42	4.5	1120	487.0	3477	3275	3070	698.0	4985	4690	4395

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

NO. 5000059 REV. K

Figure 1-8. Torque Chart (Metric Fasteners - Sheet 5 of 5)

[illegible]

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 confirm 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 entirely 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-Trained 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-Trained 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.
Preventive 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 a 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. 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

1. 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 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.
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

Theory

When a hydraulic cylinder is supporting a load, cylinder drift may occur as a result of any of the circumstances below:

- Normal leakage of load holding valves or malfunction of load holding valves. See Cylinder Leakage Test and Table 2-2, Cylinder Drift below for evaluation.
- Damaged or worn piston seal.
- Normal thermal expansion and contraction of the hydraulic oil within cylinders (See Cylinder Thermal Drift below).

The first two circumstances may result in cylinder movement due to oil leakage out of the cylinder externally or by leaking back to tank or due to oil leaking internally from one cylinder chamber to the other.

Thermal expansion or contraction of oil in hydraulic cylinders is a normal occurrence and does not result in oil leaking out of the cylinder or leaking internally from one cylinder chamber to the other. Thermal expansion or contraction is the tendency for materials to change size in response to a change in temperature.

Cylinder Leakage Test

Cylinder oil must be at stabilized ambient temperature before beginning this test.

Measure drift at cylinder rod with a calibrated dial indicator.

In an area free of obstructions, cylinder must have load applied and appropriately positioned to detect drift.

Cylinder leakage is acceptable if it passes this test.

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	0.004	0.10
9	228.6	0.003	0.08
NOTE: This information is based on 6 drops per minute cylinder leakage.			

Cylinder Thermal Drift

The oil in all hydraulic cylinders will expand or contract due to thermal effects over time and may result in changes to the boom and/or platform position while the machine is stationary. These effects occur as the cylinder oil changes temperature, usually from a higher oil temperature as it cools and approaches the ambient air temperature. Results of these effects are related to several factors including cylinder length and change in temperature over the time the cylinder remains stationary.

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, peeling, 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 unless otherwise instructed (i.e. sheave pins).
 - 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.
- 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-Delivery ¹ or Frequent ² Inspection	Annual ³ (Yearly) Inspection	Every 2 Years
Boom Assembly			
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	
Boom Assembly	1,2,3,4,5	1,2,3,4,5,7,9,14	
Platform Assembly			
Platform		1,2	
Railing	1	1,2	
Gate	1,5	1,5	
Floor	1	1,2	
Rotator	5,9,15	5,9,15	
Lanyard Anchorage Point	1,2,10	1,2,10	
Turntable Assembly			
Swing Bearing	1,2,14	1,2,3,13,14	
Oil Coupling	9	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			
Tires	16,17,18	16,17,18	
Wheel Nuts/Bolts	15	15	
Wheel Bearings			14,24
Oscillating Axle/Lockout Cylinder Systems	5,8	5,8	
Extendable Axle Systems	5,8	5,8	
Steer Components	1,2	1,2	
Spindle Thrust Bearing/Washers	1,2	1,2	
Drive Hubs	11	11	

Table 2-3. Inspection and Preventive Maintenance Schedule

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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL		
	Pre-Delivery ¹ or Frequent ² Inspection	Annual ³ (Yearly) Inspection	Every 2 Years
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	21,22	
Paint and Appearance	7	7	
Stamp Inspection Date on Frame		22	
Notify JLG of Machine Ownership		22	
Footnotes:			
¹ Prior to each sale, lease, or delivery			
² In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used			
³ 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			

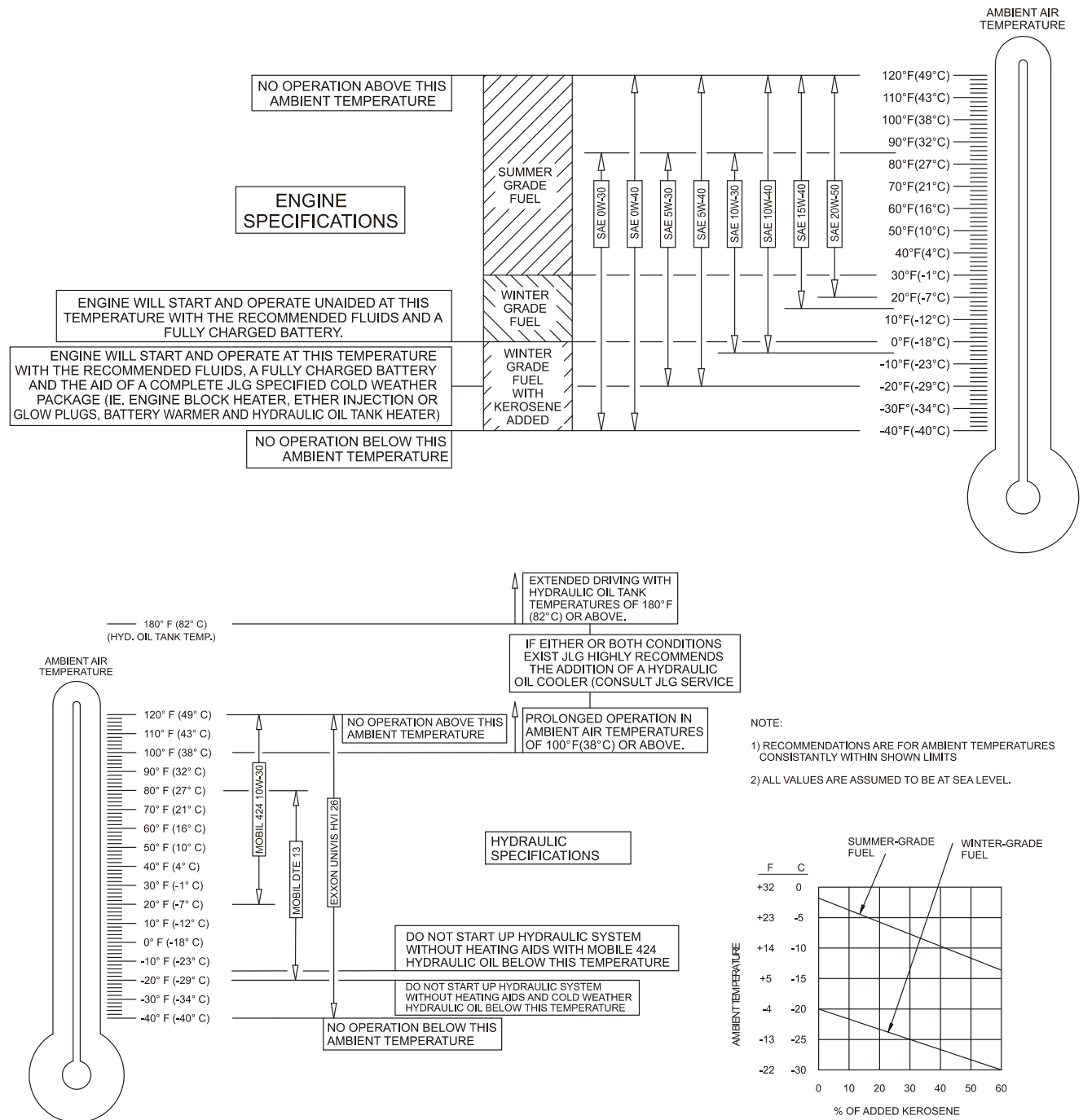
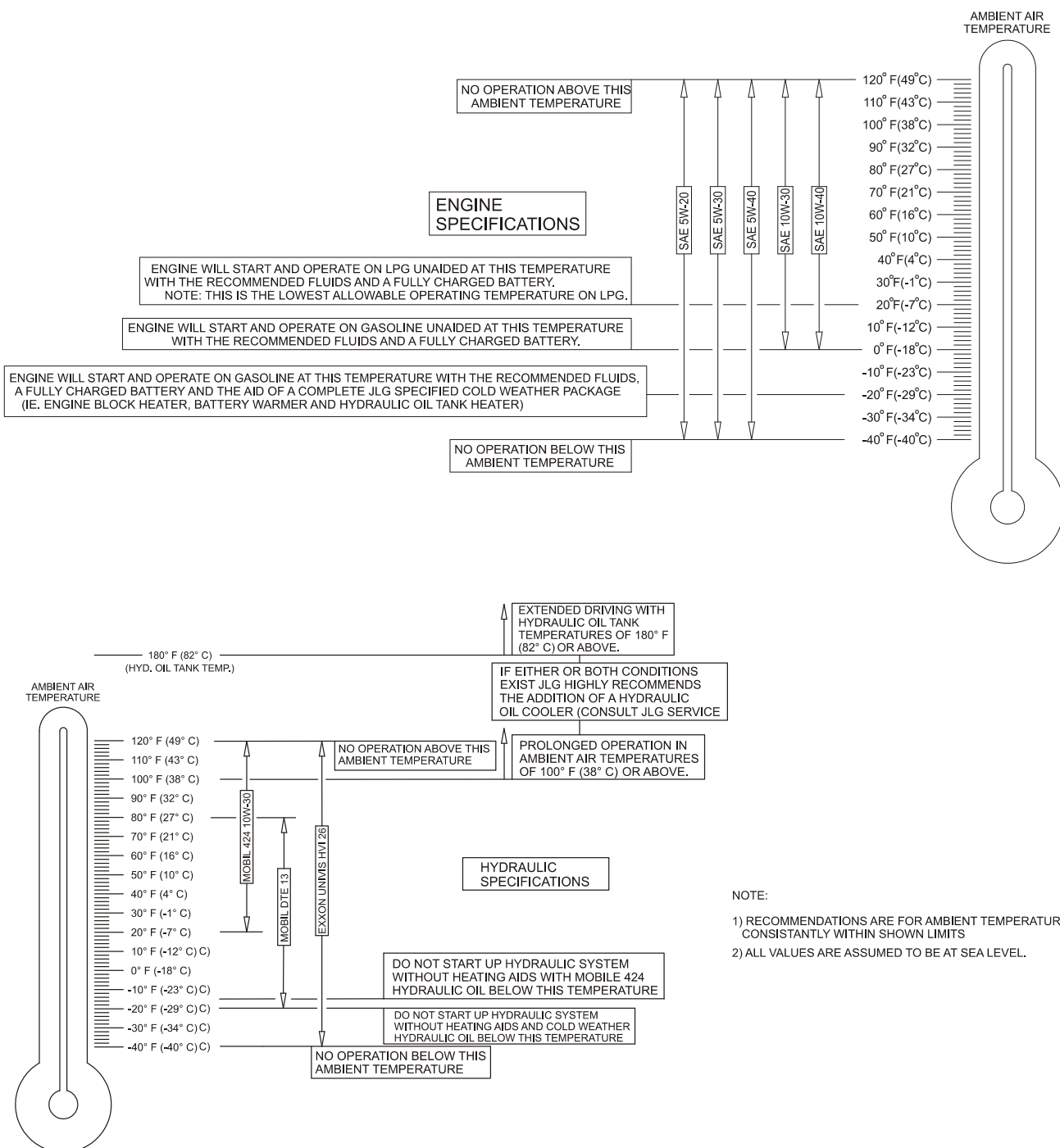


Figure 2-1. Engine Operating Temperature Specifications - Deutz

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Figure 2-2. Engine Operating Temperature Specifications - Ford

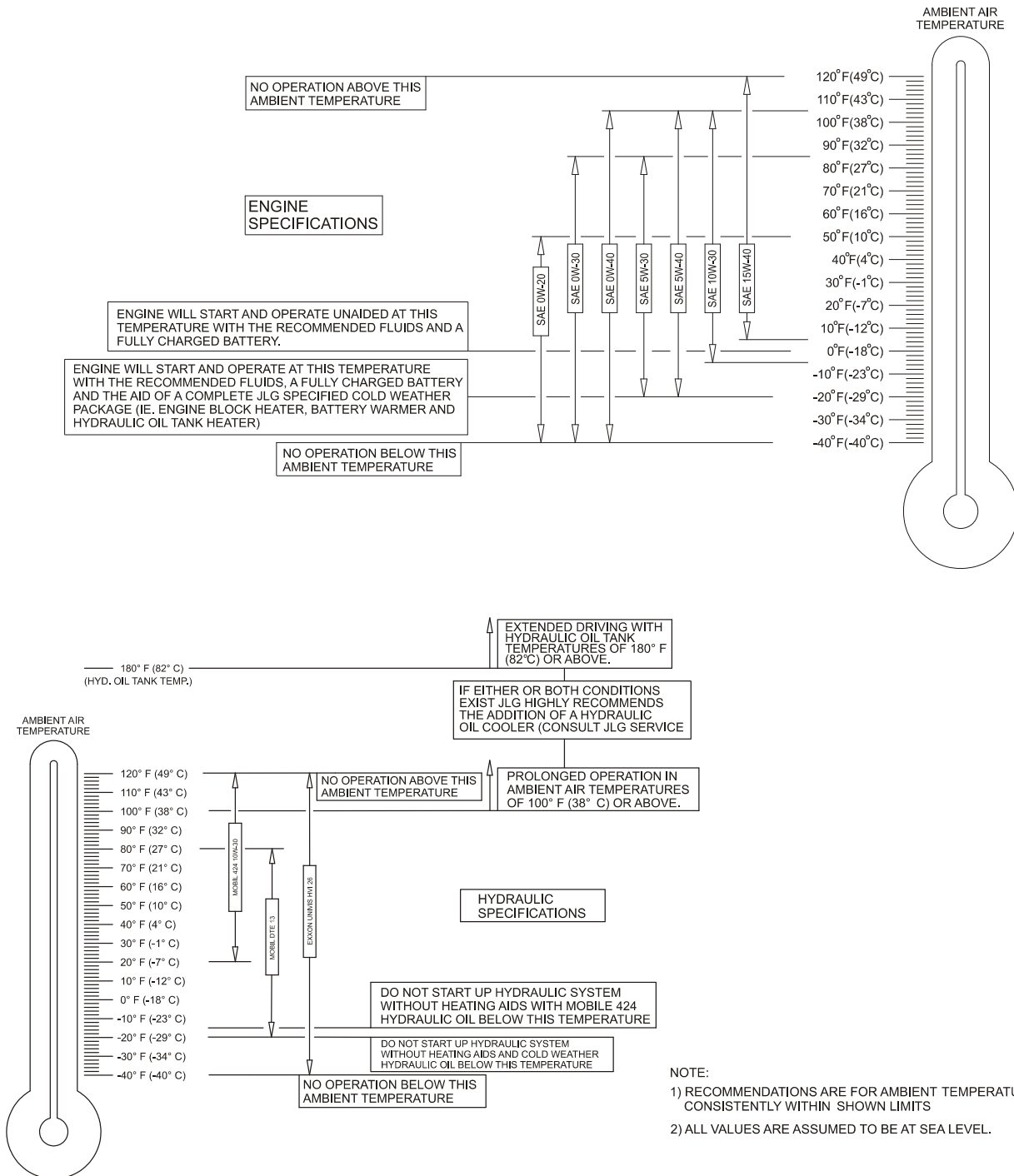
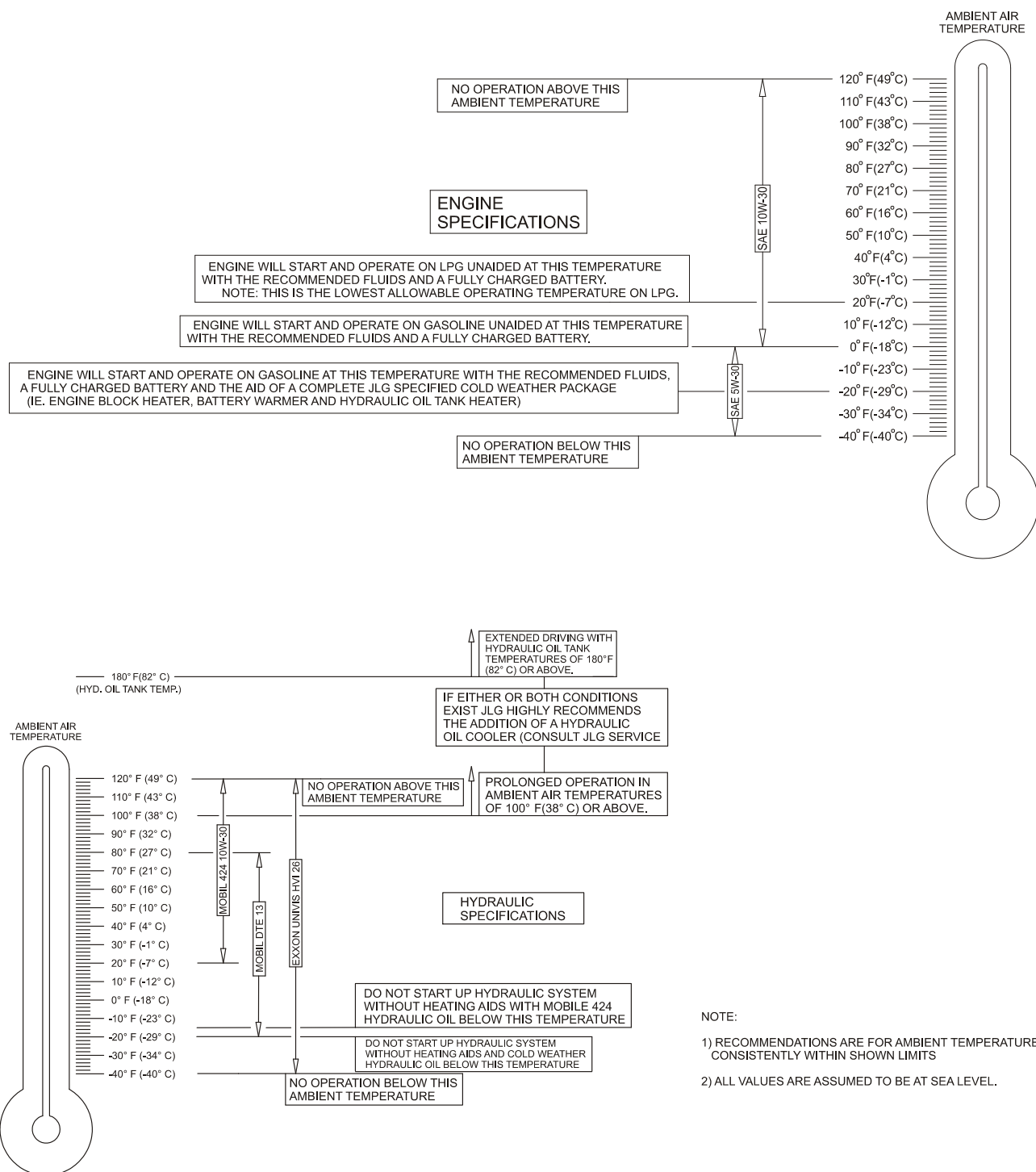


Figure 2-3. Engine Operating Temperature Specifications - Caterpillar



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Figure 2-4. Engine Operating Temperature Specifications - GM



NOTES:

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 in. (2.5 cm) in any direction.
- any punctures which exceed 1 in. 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.
- Approved for the application by the tire manufacturer (Including inflation pressure and maximum tire load).

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

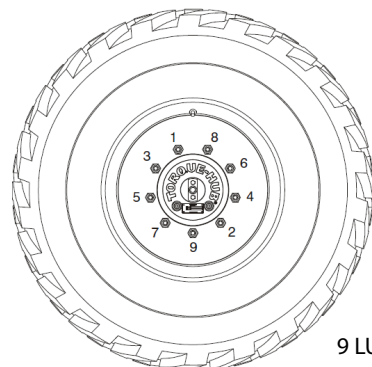
It is extremely important to apply and maintain proper wheel mounting torque.

⚠ WARNING

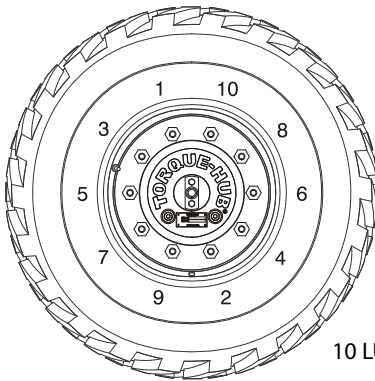
WHEEL NUTS MUST BE INSTALLED AND MAINTAINED AT THE PROPER TORQUE TO PREVENT LOOSE WHEELS, BROKEN STUDS, AND POSSIBLE DANGEROUS SEPARATION OF WHEEL FROM THE AXLE. BE SURE TO USE ONLY THE NUTS MATCHED TO THE CONE ANGLE OF THE WHEEL.

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.



9 LUG PATTERN



10 LUG PATTERN

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 - 9 Lug

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
40 ft. lbs. (55 Nm)	95 ft. lbs. (129 Nm)	170 ft. lbs. (231 Nm)

Table 3-2. Wheel Torque Chart - 10 Lug

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
70 ft. lbs. (95 Nm)	170 ft. lbs. (231 Nm)	300 ft. lbs. (407 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 OSCILLATING AXLE BLEEDING PROCEDURE AND LOCKOUT TEST

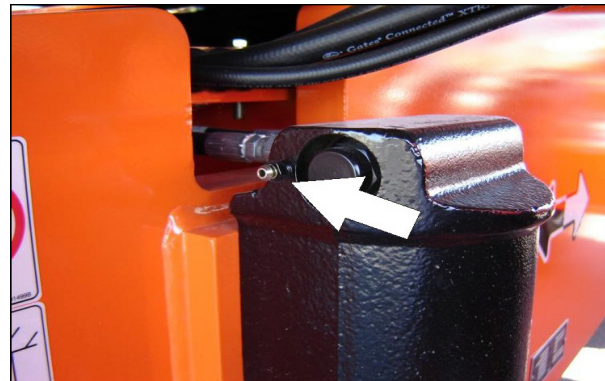
Lockout Cylinder Bleeding

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. Making sure machine is on a level surface and rear wheels are blocked, brake wire is disconnected.
2. Center boom over rear axle to make sure that the oscillation valve in the rotary coupling is activated.
3. Place suitable containers under each lockout cylinder to catch any residual hydraulic fluid.
4. Open both bleeder screws (one on each lockout cylinder).



5. Start the engine, position drive control lever to forward or reverse.
6. Close bleeder screws when there is no more air in the hydraulic oil coming out of the bleeder valve.
7. Perform oscillating axle lockout test.
8. If necessary, repeat steps 1 thru 8.

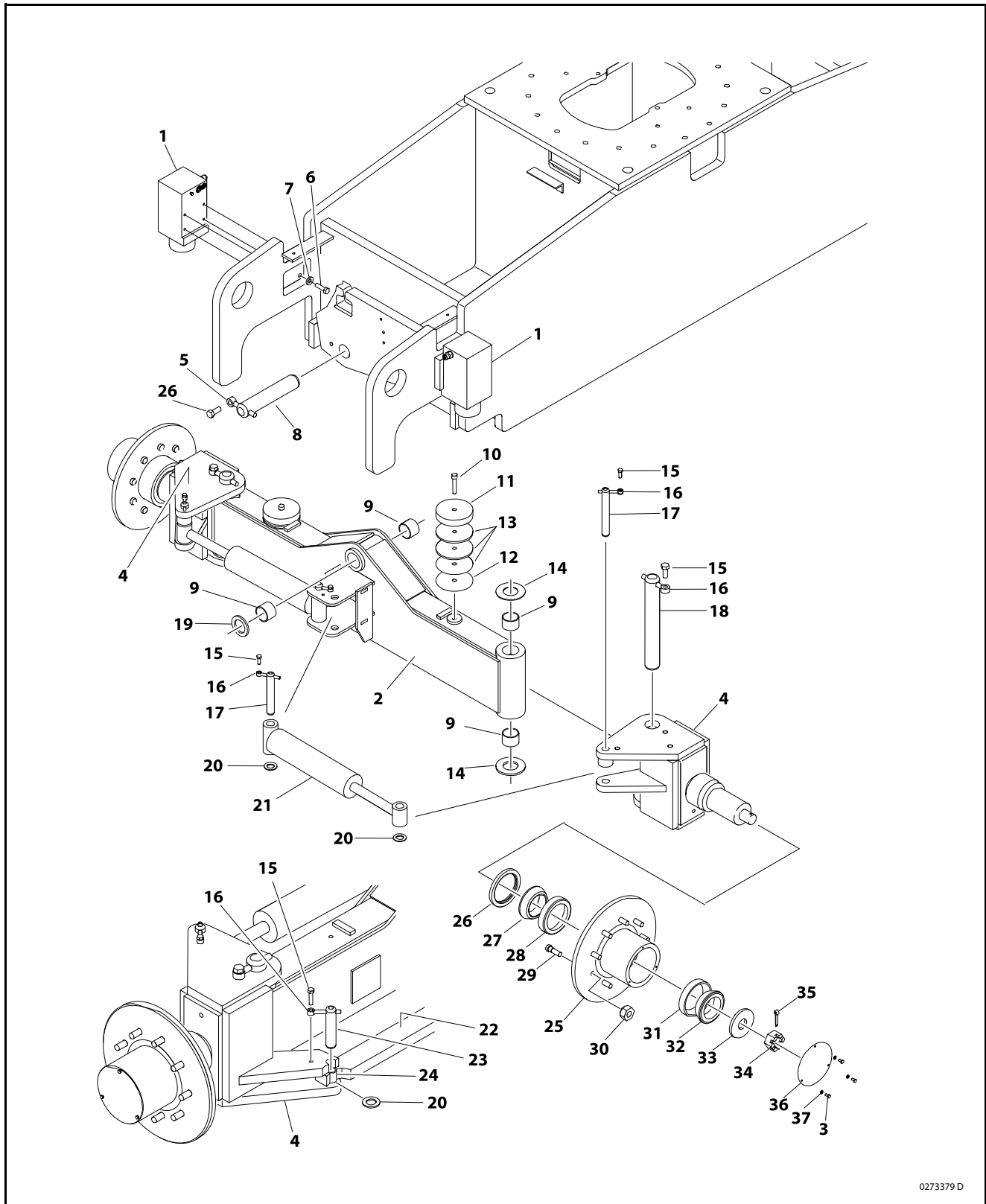
Oscillating Axle Lockout Test (If Equipped)

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 inches (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, start engine.
3. Place the Drive control lever to the forward position and carefully drive machine up ascension ramp until left front wheel is on top of block.
4. Carefully activate Swing control lever and position boom over right side of machine.
5. With boom over right side of machine, place Drive control lever to Reverse and drive machine off of block and ramp.
6. Have an assistant check to see that left front wheel remains locked in position off of ground.
7. 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 to activate Drive to release cylinders.
8. Place the 6 inches (15.2 cm) high block with ascension ramp in front of right front wheel.
9. Place Drive control lever to Forward and carefully drive machine up ascension ramp until right front wheel is on top of block.
10. With boom over left side of machine, place Drive control lever to Reverse and drive machine off of block and ramp.
11. Have an assistant check to see that right front wheel remains locked in position off of ground.
12. 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.
13. If lockout cylinders do not function properly, have qualified personnel correct the malfunction prior to any further operation.

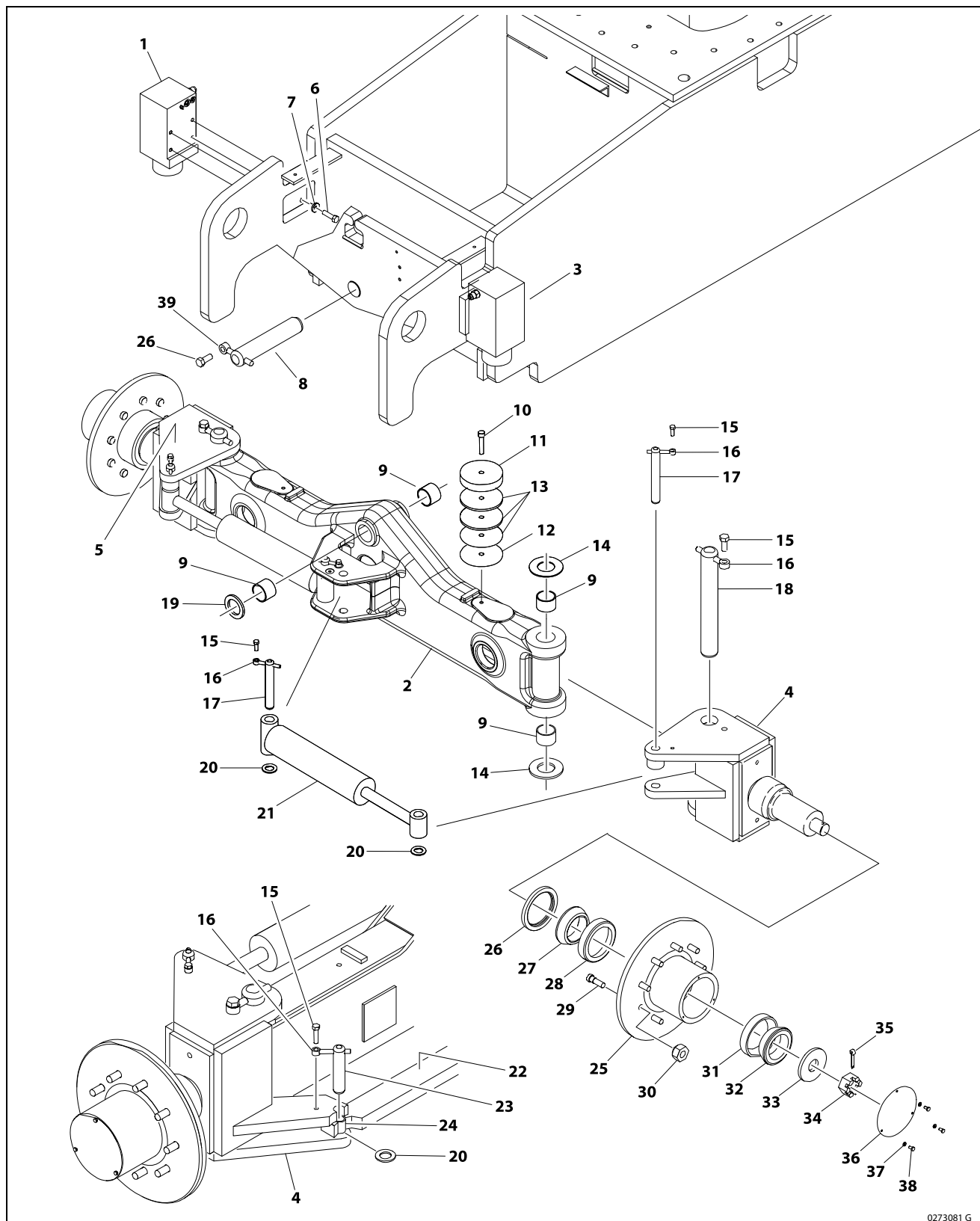


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Figure 3-1. Front Axle And Steering Installations - With Tow Package (2WD) - Sheet 1 of 2

- | | | | |
|------------------------------|-------------------|-----------------------------|------------------|
| 1. Lockout Cylinder Assembly | 11. Stop Plate | 21. Steer Cylinder Assembly | 31. Cup Bearing |
| 2. Axle Weldment | 12. Stop Plate | 22. Tie-rod | 32. Cone Bearing |
| 3. Bolt | 13. Shim | 23. Tie-rod Pin | 33. Flatwasher |
| 4. Spindle | 14. Thrust Washer | 24. Bushing | 34. Slotted Nut |
| 5. Keeper pin | 15. Bolt | 25. Hub | 35. Cotter pin |
| 6. Bolt | 16. Shaftkeeper | 26. Grease Seal | 36. Hub Cap |
| 7. Flatwasher | 17. Pin | 27. Cone Bearing | 37. Lockwasher |
| 8. Pivot Pin | 18. Kingpin | 28. Cup Bearing | |
| 9. Bearing | 19. Thrust Washer | 29. Wheel Stud | |
| 10. Screw | 20. Thrust Washer | 30. Lugnut | |

Figure 3-2. Front Axle And Steering Installations - With Tow Package (2WD) - Sheet 2 of 2



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Figure 3-3. Front Axle And Steering Installations - Without Tow Package (2WD) - Sheet 1 of 2

- | | | | |
|------------------------------|-------------------|-----------------------------|------------------|
| 1. Lockout Cylinder Assembly | 11. Stop Plate | 21. Steer Cylinder Assembly | 31. Cup Bearing |
| 2. Axle Weldment | 12. Stop Plate | 22. Tie-rod | 32. Cone Bearing |
| 3. Lockout Cylinder Assembly | 13. Shim | 23. Tie-rod Pin | 33. Flatwasher |
| 4. Spindle | 14. Thrust Washer | 24. Bushing | 34. Slotted Nut |
| 5. Spindle | 15. Bolt | 25. Hub | 35. Cotter pin |
| 6. Bolt | 16. Shaftkeeper | 26. Grease Seal | 36. Hub Cap |
| 7. Flatwasher | 17. Pin | 27. Cone Bearing | 37. Lockwasher |
| 8. Pivot Pin | 18. Kingpin | 28. Cup Bearing | 38. Bolt |
| 9. Bearing | 19. Thrust Washer | 29. Wheel Stud | 39. Keeper pin |
| 10. Screw | 20. Thrust Washer | 30. Lugnut | |

Figure 3-4. Front Axle And Steering Installations - Without Tow Package (2WD) - Sheet 2 of 2

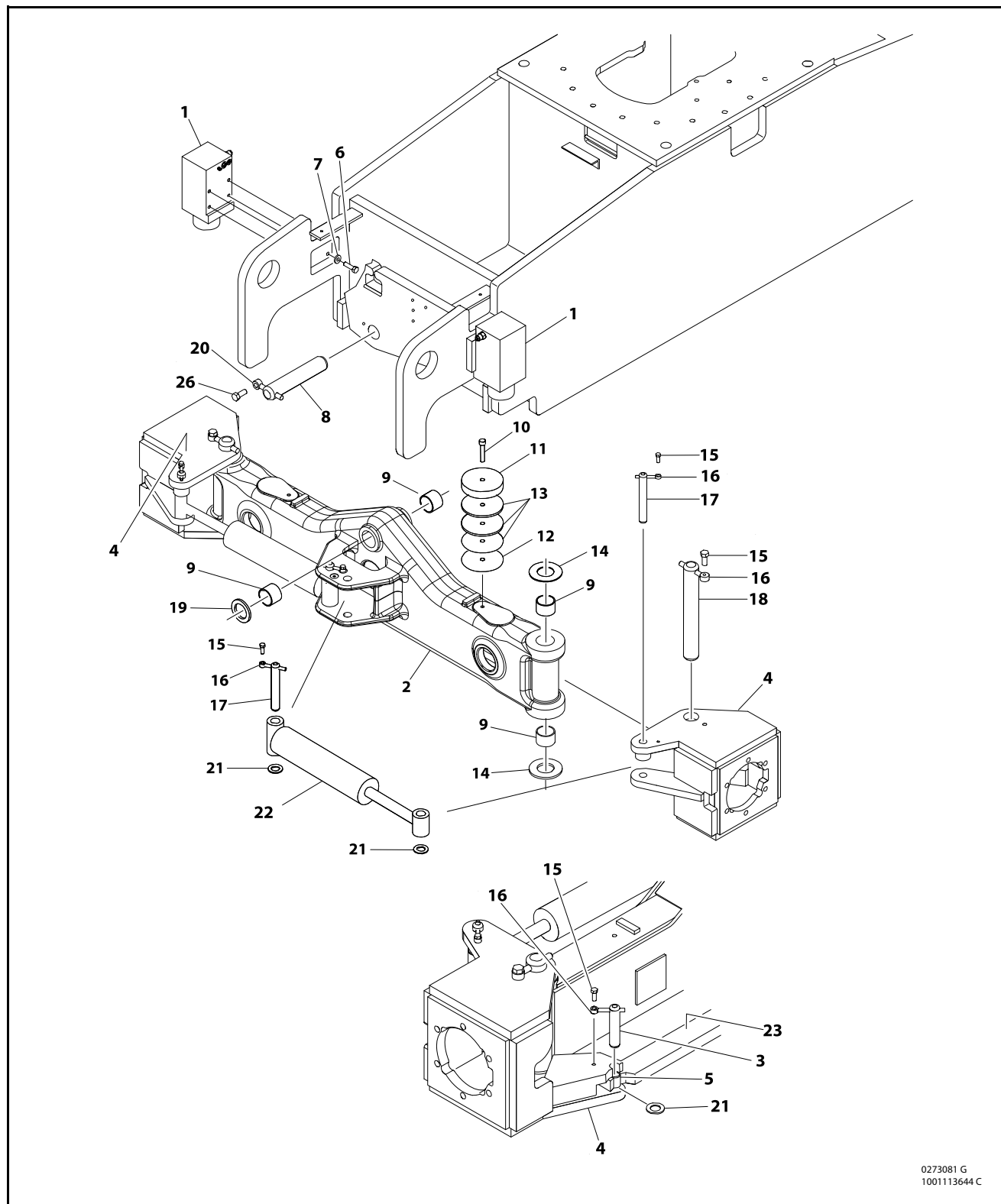
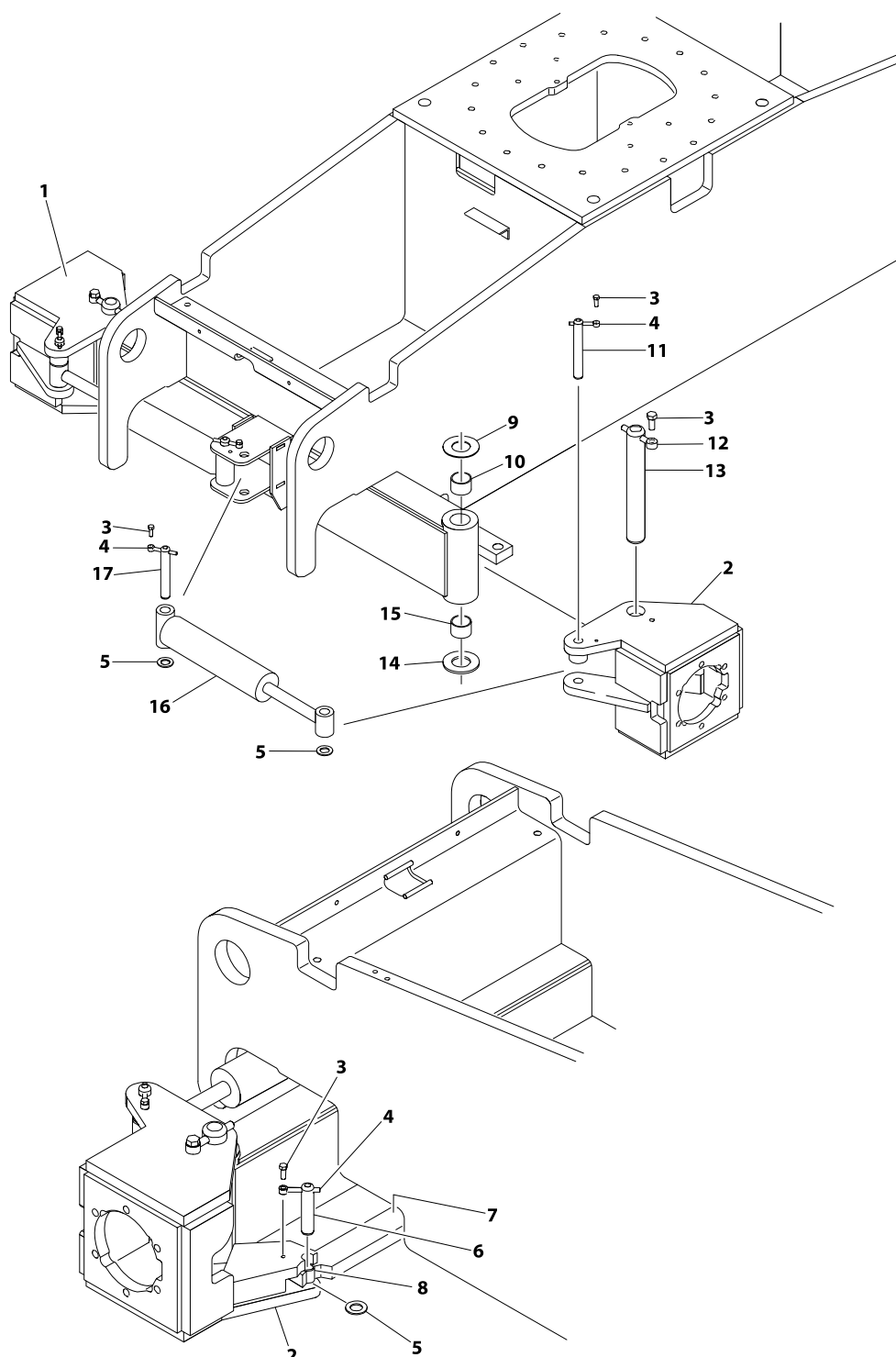


Figure 3-5. Front Axle And Steering Installations (4WD) - Sheet 1 of 2

- | | | |
|------------------------------|-------------------|-----------------------------|
| 1. Lockout Cylinder Assembly | 10. Screw | 19. Thrust Washer |
| 2. Axle Weldment | 11. Stop Plate | 20. Keeper Pin |
| 3. Tie-rod Pin | 12. Stop Plate | 21. Thrust Washer |
| 4. Spindle | 13. Shim | 22. Steer Cylinder Assembly |
| 5. Bushing | 14. Thrust Washer | 23. Tie-rod |
| 6. Bolt | 15. Bolt | |
| 7. Flatwasher | 16. Shaftkeeper | |
| 8. Pivot Pin | 17. Pin | |
| 9. Bearing | 18. Kingpin | |

Figure 3-6. Front Axle And Steering Installations (4WD) - Sheet 2 of 2



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Figure 3-7. Rear Steering Installation - Sheet 1 of 2

- | | | |
|------------------|------------------|-----------------------------|
| 1. Spindle-Right | 7. Tie-rod | 13. Kingpin |
| 2. Spindle-Left | 8. Bushing | 14. Thrust Washer |
| 3. Bolt | 9. Thrust Washer | 15. Bearing |
| 4. Shaft Keeper | 10. Bearing | 16. Steer Cylinder Assembly |
| 5. Thrust Washer | 11. Kingpin | 17. Pin |
| 6. Shaft Keeper | 12. Shaftkeeper | |

Figure 3-8. Rear Steering Installation (4WS) - Sheet 2 of 2

3.3 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 in. (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, start engine.
3. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
4. Carefully activate SWING control lever and position boom over right side of machine.
5. With boom over right side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.
6. Have an assistant check to see that left front wheel remains locked in position off of ground.
7. 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.
8. Place the 6 in. (15.2 cm) high block with ascension ramp in front of right front wheel.
9. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.
10. With boom over left side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.
11. Have an assistant check to see that right front wheel remains locked in position off of ground.
12. 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.
13. If lockout cylinders do not function properly, have trained personnel correct the malfunction prior to any further operation.

3.4 FREE WHEELING OPTION

To Disengage Drive Motors and Brakes (Free Wheel) for Towing, etc.

1. Chock wheels securely if not on flat level surface.
2. Disconnect both drive hubs by reversing the disconnect caps in the center of the hubs.
3. If equipped, move steer/tow selector valve to float (tow) position by pulling control knob out.

To Engage Drive Motors and Brakes (Normal Operation)

1. If equipped, move steer/tow valve to steer position by pushing valve knob in.
2. Connect both drive hubs by inverting disconnect cap in center of hub.
3. Remove chocks from wheels as required.

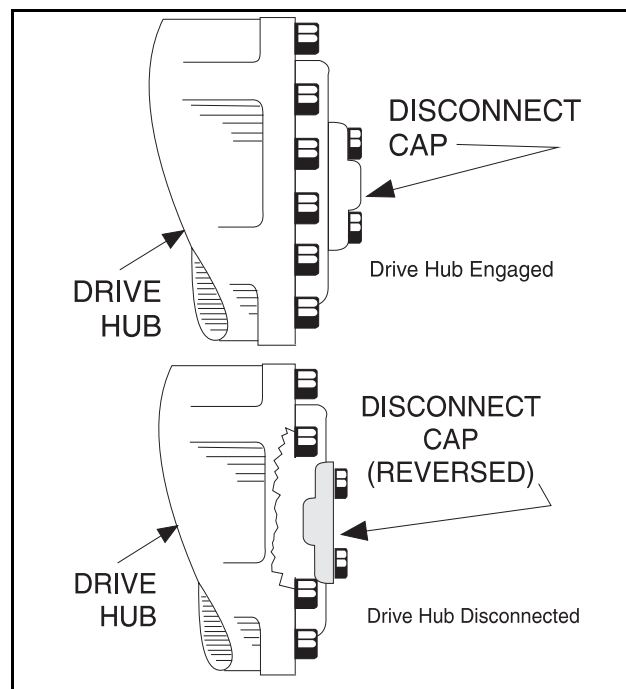


Figure 3-9. Disconnecting the Drive Hubs

3.5 WHEEL DRIVE ASSEMBLY

Removal

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 drive 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 drive hub and drive motor assembly weighs approximately 270 lbs. (122 kg).

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

Installation

1. Install a new o-ring between the drive motor and drive hub. Apply coat of JLG Threadlocker P/N 0100011 on the bolts. Install the bolts and washers to secure them together and torque to 95 ft. lbs. (129 Nm).
2. Place the drive hub flange against the mounting flange on the axle and fasten it in place with the bolts and washers. Torque the bolts to 170 ft. lbs. (298 Nm).
3. Install the tire and wheel assembly.

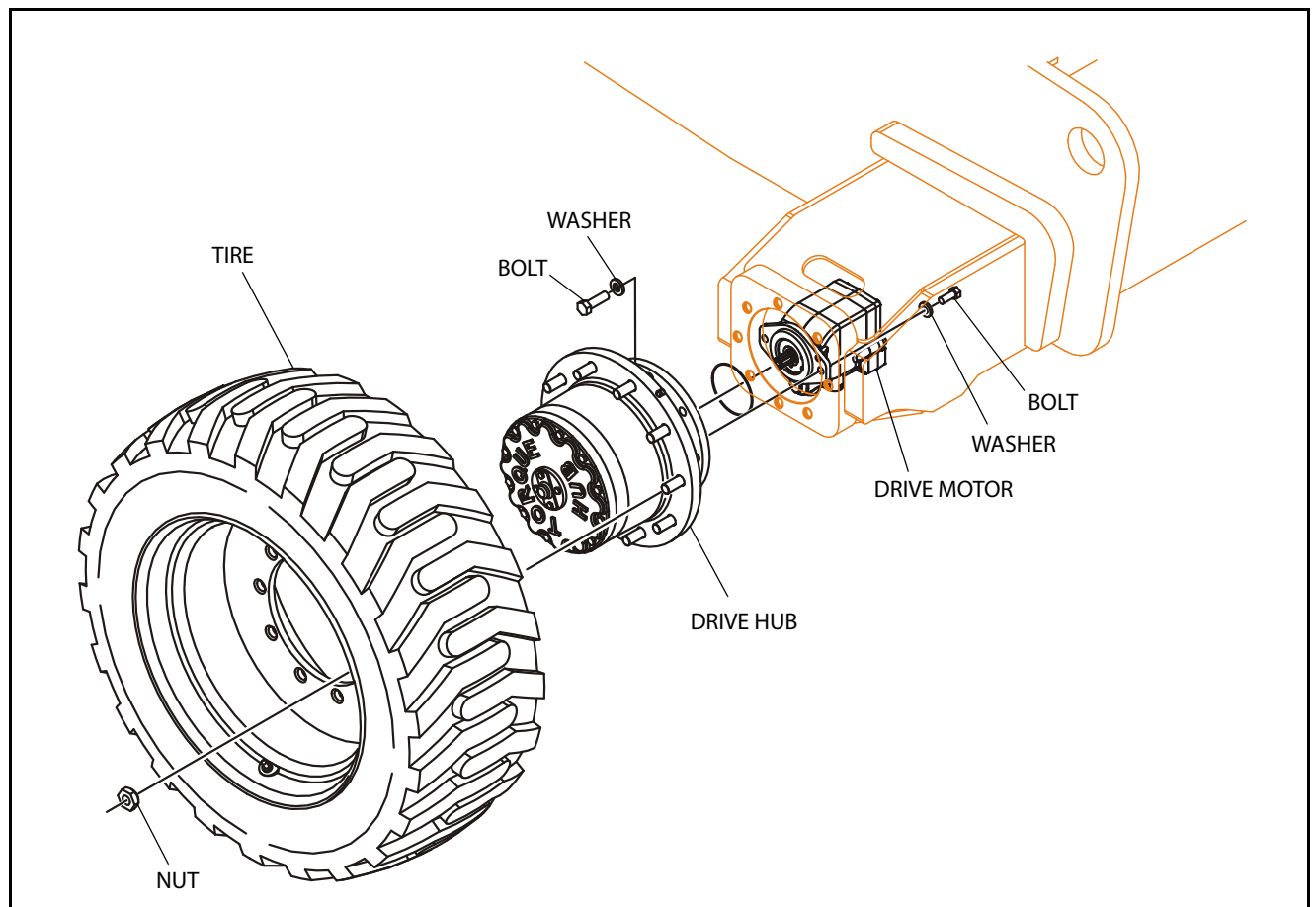


Figure 3-10. Drive Hub Installation

3.6 DRIVE HUB

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 (0.7 bar) for 20 minutes.

THE BRAKE TEST

Reference: Sample Model 7HBE01F0B30057. The underlined letter is the brake option. Options are A, B, C, D, E, or X.

A Input Brake	2,200 in. lbs. (248 Nm) Static, 280 psi (19.3 bar) Full Release 3000 psi (207 bar) maximum o-ring check.
B Input Brake	1,900 in. lbs. (215 Nm) Static, 240 psi (16.5 bar) Full Release 3000 psi (207 bar) maximum o-ring check.
C Input Brake	1,600 in. lbs. (181 Nm) Static, 200 psi (13.8 bar) Full Release 3000 psi (207 bar) maximum o-ring check.
D Input Brake	1,400 in. lbs. (158 Nm) Static, 180 psi (12.4 bar) Full Release 3000 psi (207 bar) maximum o-ring check.
E Input Brake	1,250 in. lbs. (141 Nm) Static, 160 psi (11.0 bar) Full Release 3000 psi (207 bar) maximum o-ring check.
X – No Brake	

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

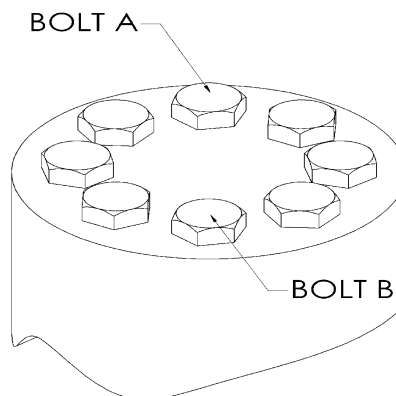
NOTE: *Failure to perform this test may result in damaged or ineffective brake parts.*

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

NOTE: Refer to Figure 3-11., Main Disassembly

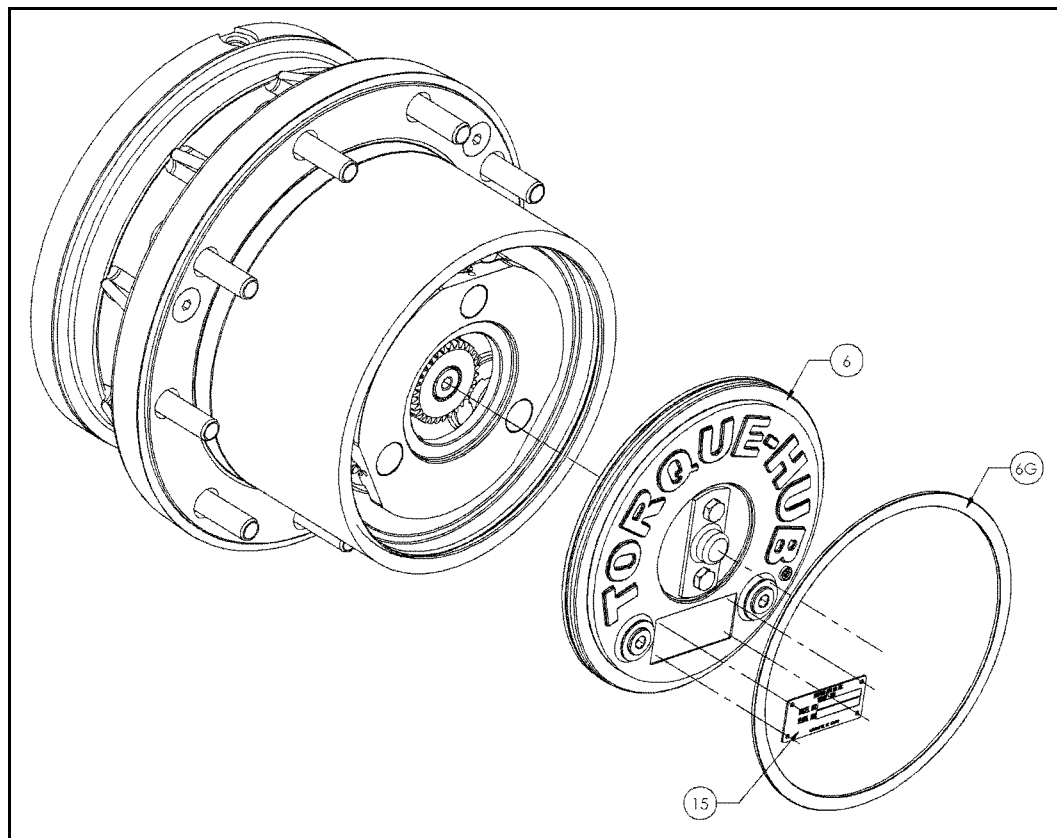
1. Perform roll check, leak check and brake check if applicable prior to disassembling the unit.
2. Drain oil from unit. Note the condition and volume of the oil.
3. Remove retaining ring (6G) by prying the open end of retaining ring out of the groove in the ring gear (1E) with a screwdriver, then grasp the loose end with pliers and pull the retaining ring completely out of the groove.
4. Remove the cover subassembly (6) from the unit. The unit can be carefully pressurized with air to pop the cover out of the unit.
5. Remove the first stage sun gear (10) if applicable.

NOTE: On units with ratios greater than 36:1 numerically, there will not be a separate first stage sun gear (10), as the gear teeth will be integral to the input shaft (9).

6. Remove the Input carrier subassembly (3).
7. Remove the input shaft (9).
8. Remove the second stage sun gear (11).

NOTE: On units with a ratio 48:1, the sun gear (11) and the Input shaft (9) will need to be removed together.

9. Loosen and remove the three flat head bolts (19) that retain the ring gear (1E) to the housing (1G).
10. Lift the ring gear (1E) off of the housing (1D).
11. Remove the O-ring (18) from between the housing (1D) and the ring gear (1E).



- 6. Cover
- 6G. Retaining Ring
- 15. ID Plate

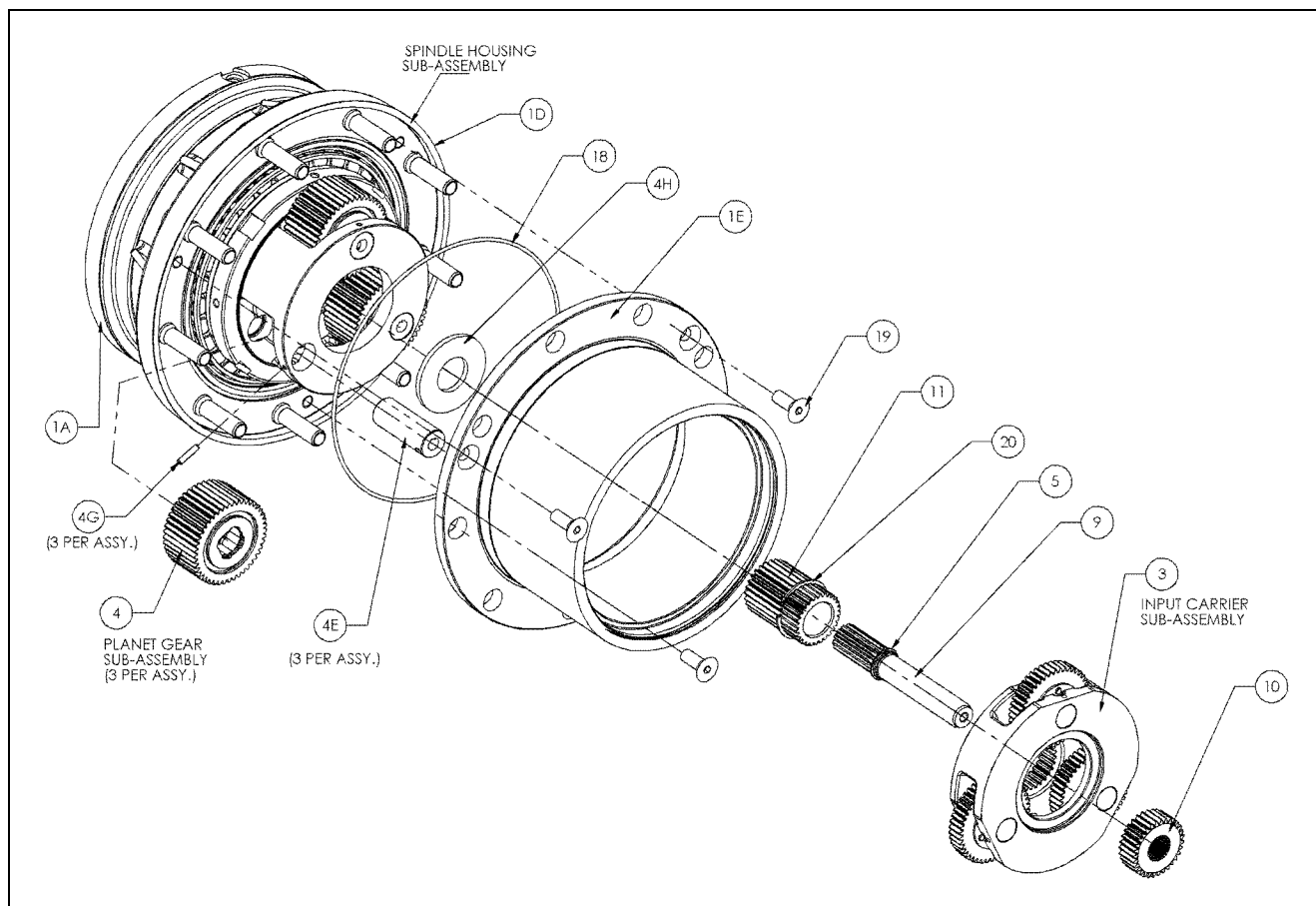
Figure 3-11. Main Disassembly

SECTION 3 - CHASSIS & TURNTABLE

12. Using a 1/8 in. (3.175 mm) diameter punch, drive the roll pin (4G) into the planet shaft (4E) until it bottoms against the spindle (1A).
13. Grasp the roll pin (4G) using needle nosed pliers or some sort of hooked tool, and pull the planet shaft (4E) out of the spindle (1A).
14. Using a 1/8 in. (3.175 mm) diameter punch, drive the roll pin (4G) out of the planet shaft (4E).

NOTE: The roll pins (4G) should not be reused when reassembling the unit.

15. Slide the planet gear subassembly (4) out of the spindle (1A) being careful to not drop the needle bearings (4C) in the process.



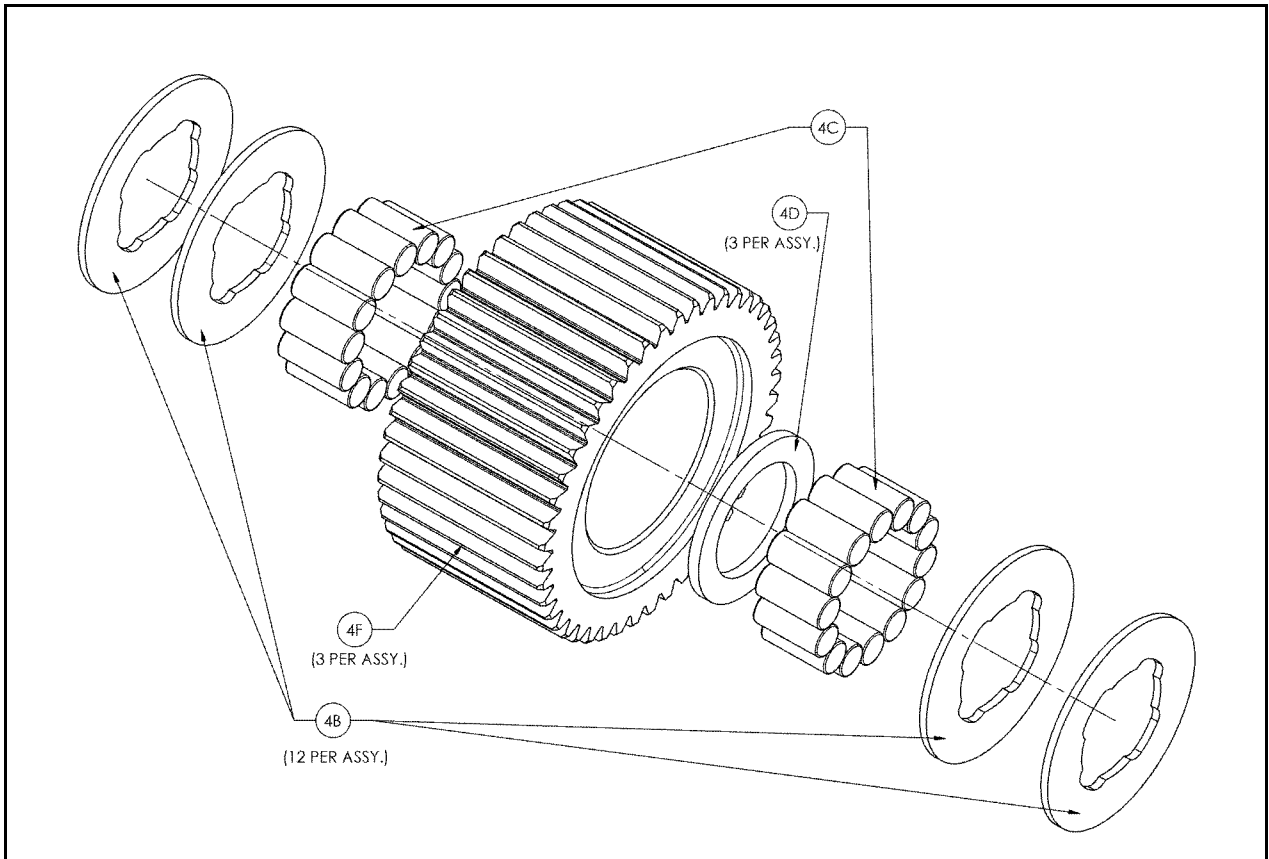
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|------------------|-------------------|---------------------------|--------------------|
| 1A. Spindle | 4. Planet Gear | 5. Retaining Ring | 18. O-ring |
| 1D. Housing | 4E. Planet Shaft | 9. Input Shaft | 19. Bolt |
| 1E. Ring Gear | 4G. Roll Pin | 10. First Stage Sun Gear | 20. Retaining Ring |
| 3. Input Carrier | 4H. Thrust Washer | 11. Second Stage Sun Gear | |

Figure 3-12. Input Carrier

- 16.** Remove 4 thrust washers (4B), 28 needle rollers (4C) and the thrust spacer (4D) from the second stage planet gear (4F).

- 17.** Repeat Steps 12 through 16 for the remaining two planet gears (4F).

- 18.** Remove the thrust washer (4H) from the counterbore in the spindle (1A).

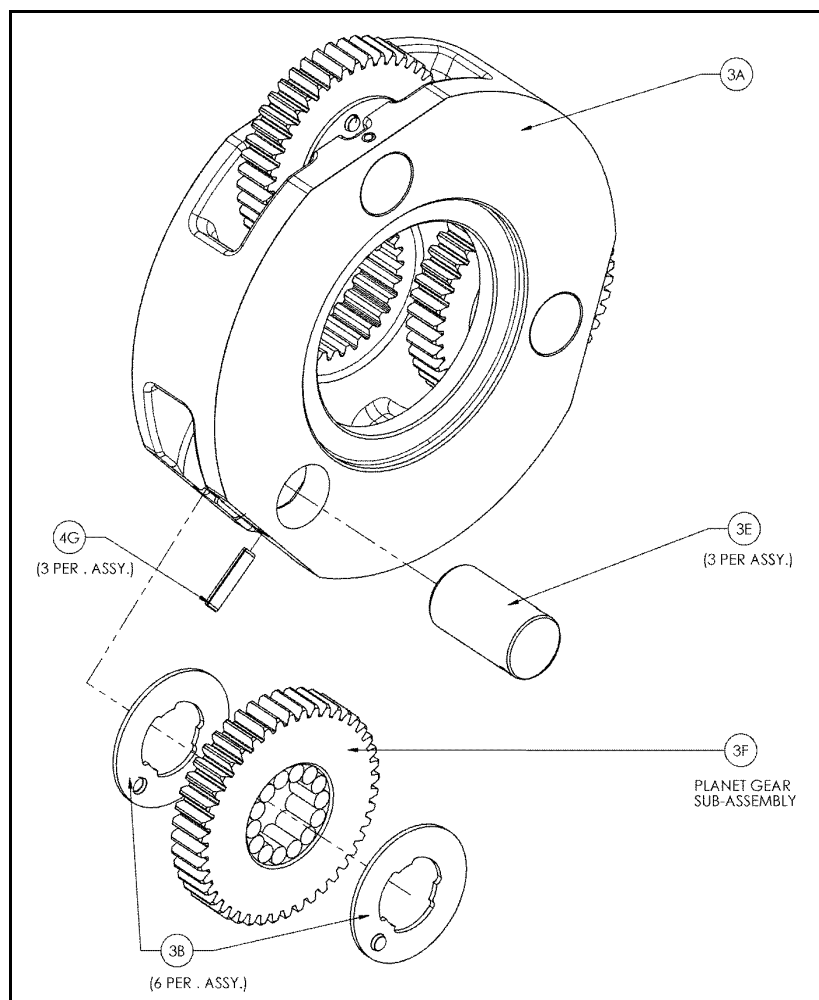


- | | |
|-------------------|-------------------|
| 4B. Thrust Washer | 4D. Thrust Spacer |
| 4C. Needle Roller | 4F. Planet Gear |

Figure 3-13. Planet Gear Sub Assembly

Input Carrier Disassembly

NOTE: Refer to Figure 3-14., Input Carrier



3A. Carrier

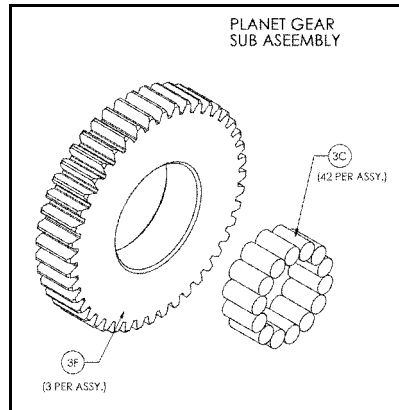
3B. Thrust Washer

3E. Planet Shaft

3F. Planet Gear

4G. Roll Pin

Figure 3-14. Input Carrier



3C. needle Bearing
3F. Planet Gear

Figure 3-15. Planet Gear Subassembly

1. Using a 1/8 in. (3.175 mm) diameter punch, drive the roll pin (4G) into the planet shaft (3E) until it bottoms against the carrier (3A).
2. Using a soft face hammer, tap the planet shaft (3E) out of the carrier (3A).
3. Using a 1/8 in. diameter punch, drive the roll pin (4G) out of the planet shaft (3E).

NOTE: The roll pins (4G) should not be reused when reassembling the unit.

4. Slide the planet gear (3F) and the two thrust washers (3B) out of the carrier (3A).
5. Remove the 14 needle bearings (3C) from the bore of the planet gear (3F).
6. Repeat steps 1 through 5 for each of the two remaining planet gears.

Hub-Spindle Disassembly

NOTE: Refer to Figure 3-16., Hub Spindle

1. Place unit on bench with spindle (1A) end down.
2. Remove 2 set screws (1G) and bearing nut (1F) using T-206569.

NOTE: The holes in the bearing nut (1F) for the set screws (1G) were staked for retention of the set screws (1G). The holes will need to be cleaned up prior to removing the set screws.

3. Remove "A" position bearing cone (1C) from bearing cup (1C) in hub (1D).
4. While supporting the unit on hub (1D) flange, press spindle (1A) out of hub (1D).

5. Lift Hub (1D) off of Spindle (1A). Remove boot seal (1Q) from hub (1D) if applicable.

6. If necessary, press 9 Studs (1H) out of hub (1D). Locate hub (1D) on seal (1B) end.

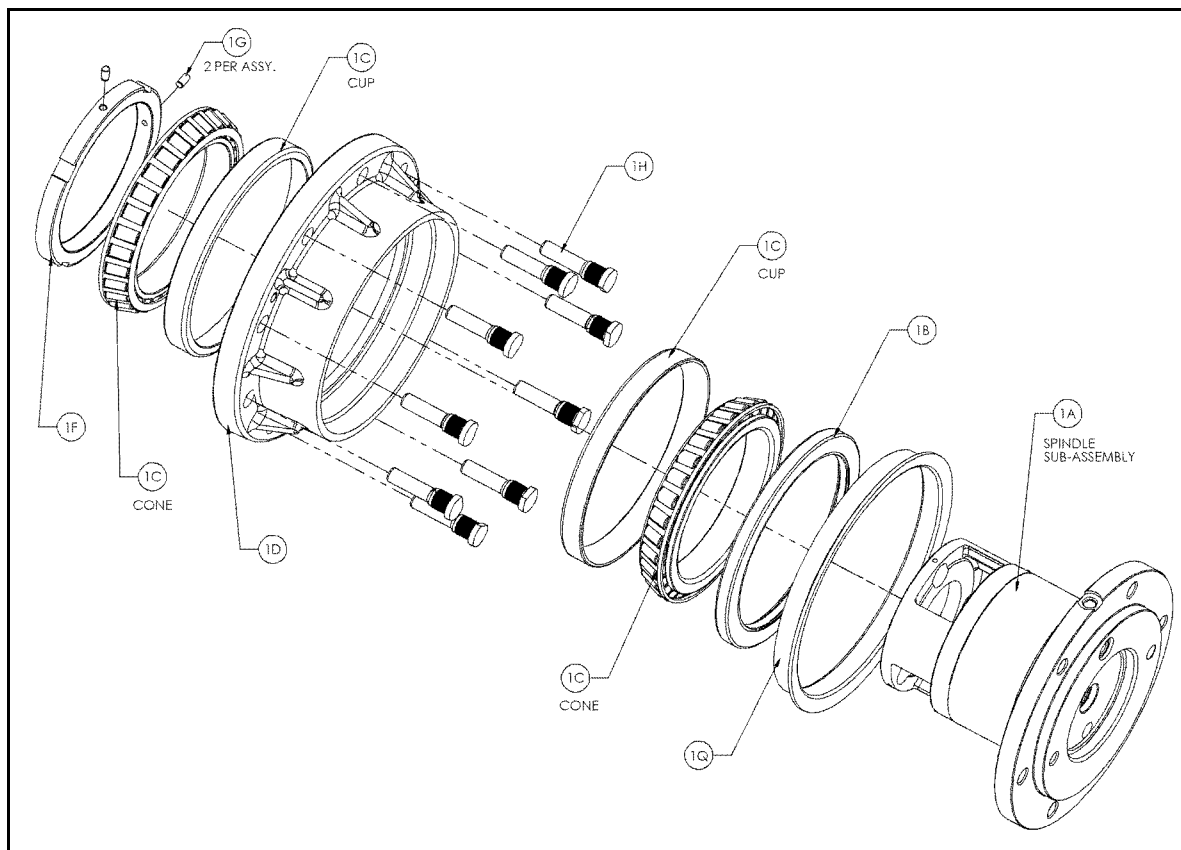
7. Remove seal (1B) from hub (1D).

NOTE: The seal (1B) should NOT be reused when reassembling the unit.

8. Remove "B" position bearing cone (1C) from bearing cup (1C) in hub (1D).

9. Remove "B" position bearing cone (1C) from hub (1D).

10. Using a soft steel rod, knock both bearing cups (1C) out of hub (1D).

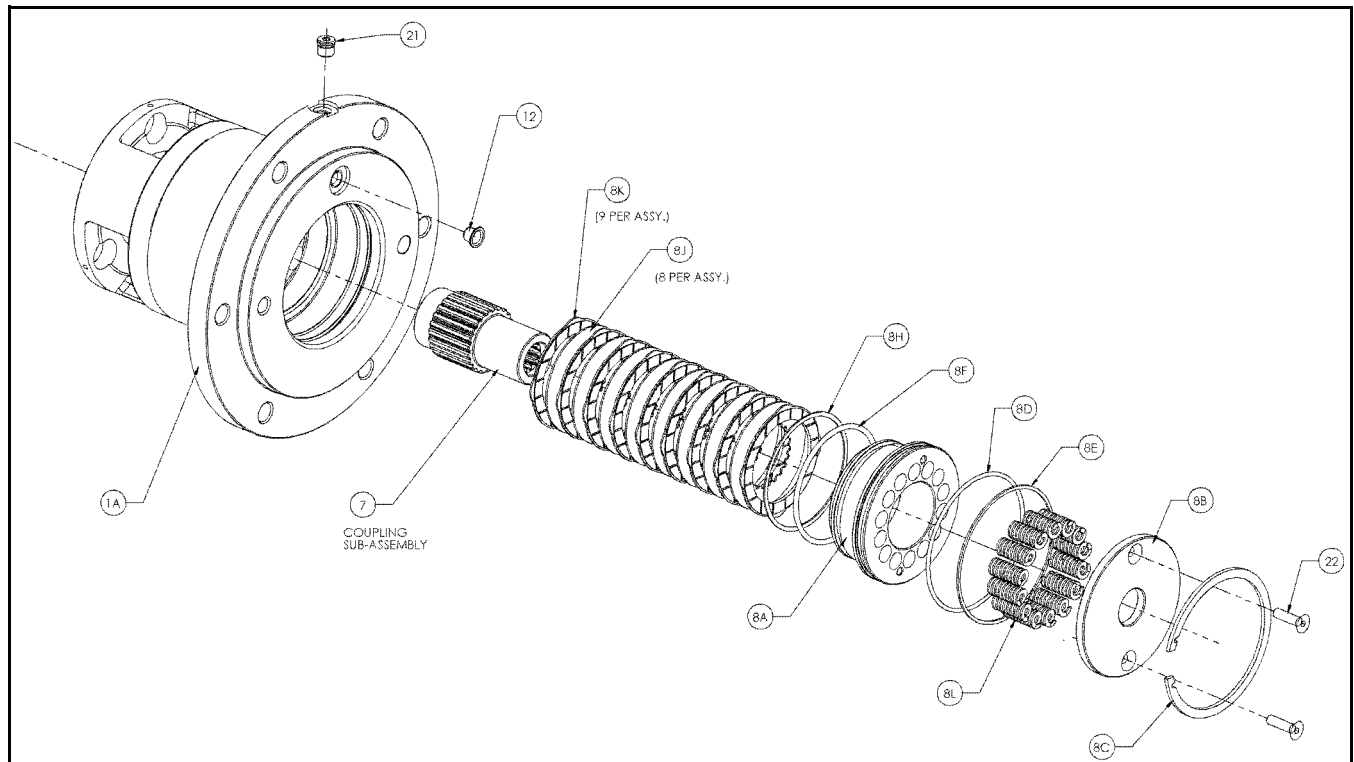


- | | |
|------------------|-----------------|
| 1A. Barrel | 1F. Bearing Nut |
| 1B. Seal | 1G. Setscrew |
| 1C. Bearing Cone | 1H. Stud |
| 1D. Hub | 1Q. Boot Seal |

Figure 3-16. Hub Spindle

Spindle-Brake Disassembly

NOTE: Refer to Figure 3-17., Spindle Brake



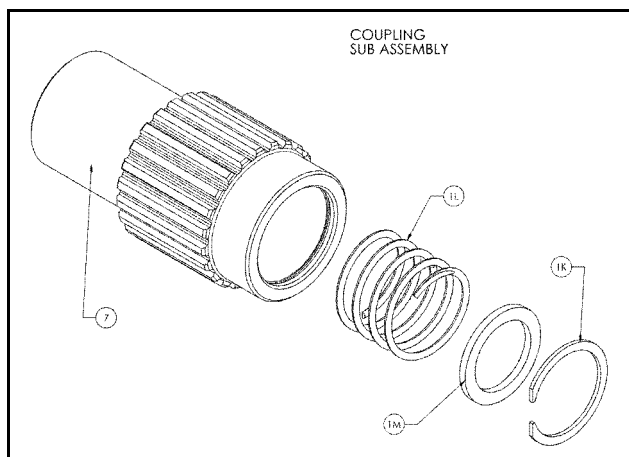
1A. Spindle
7. Coupling Subassembly
8A. Piston
8B. Pressure Plate

8C. Retaining Ring
8D. O-Ring
8E. Backup Ring
8F. O-Ring

8H. Backup Ring
8J. Rotor
8K. Stator
8L. Compression Spring

12. Plastic Plug
21. Pipe Plug
22. Flat Head Capscrew

Figure 3-17. Spindle Brake



- 1K. Retaining Ring
- 1L. Spring
- 1M. Spacer
- 7. Coupling

Figure 3-18. Coupling Subassembly

NOTE: This procedure applies only to units with integral Input brake (8).

CAUTION

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

1. Compress the compression springs (8I) by installing two 1/4-20 x 5/8 in. flat head cap screws (22) through pressure plate (8B) and into piston (8A) and tightening incrementally until spring force has been taken off of the retaining ring (8C).

NOTE: Flat Head cap screws (22) are removed prior to shipping new units since they are for transit and service only. They are included in most brake repair kits.

2. Using retaining ring pliers, remove retaining ring (8C) from the groove in the spindle (1A).
3. Back Flat Head cap screws (22) incrementally out of piston (8A) until spring force is relieved from the Pressure Plate (8B). Then, remove flat head cap screws (22) and pressure plate (8B) from brake cavity in spindle (1A).
4. Remove compression springs (8L) from piston (8A).

CAUTION

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

5. Using an air hose, slowly and carefully pressurize the brake port in the spindle (1A) until the piston (8A) comes out of piston bore of spindle (1A), then pull the piston (8A) the rest of the way out of the spindle (1A) by hand.
6. Remove backup rings (8E) & (8H) and O-rings (8D) & (8F) from grooves in piston (8A).
7. Remove rotors (8J) and stators (8K) from brake cavity in spindle (1A).
8. Remove coupling subassembly (7) from brake cavity in spindle (1A).
9. Remove retaining ring (1K) out of the internal groove using appropriate tool.
10. Remove the spacer (1M) & spring (1L) out of the bore of coupling (7).
11. Remove plastic plug (12) & pipe plug (21) from spindle (1A) if applicable.

Cover Disassembly

NOTE: Refer to Figure 3-19., Cover

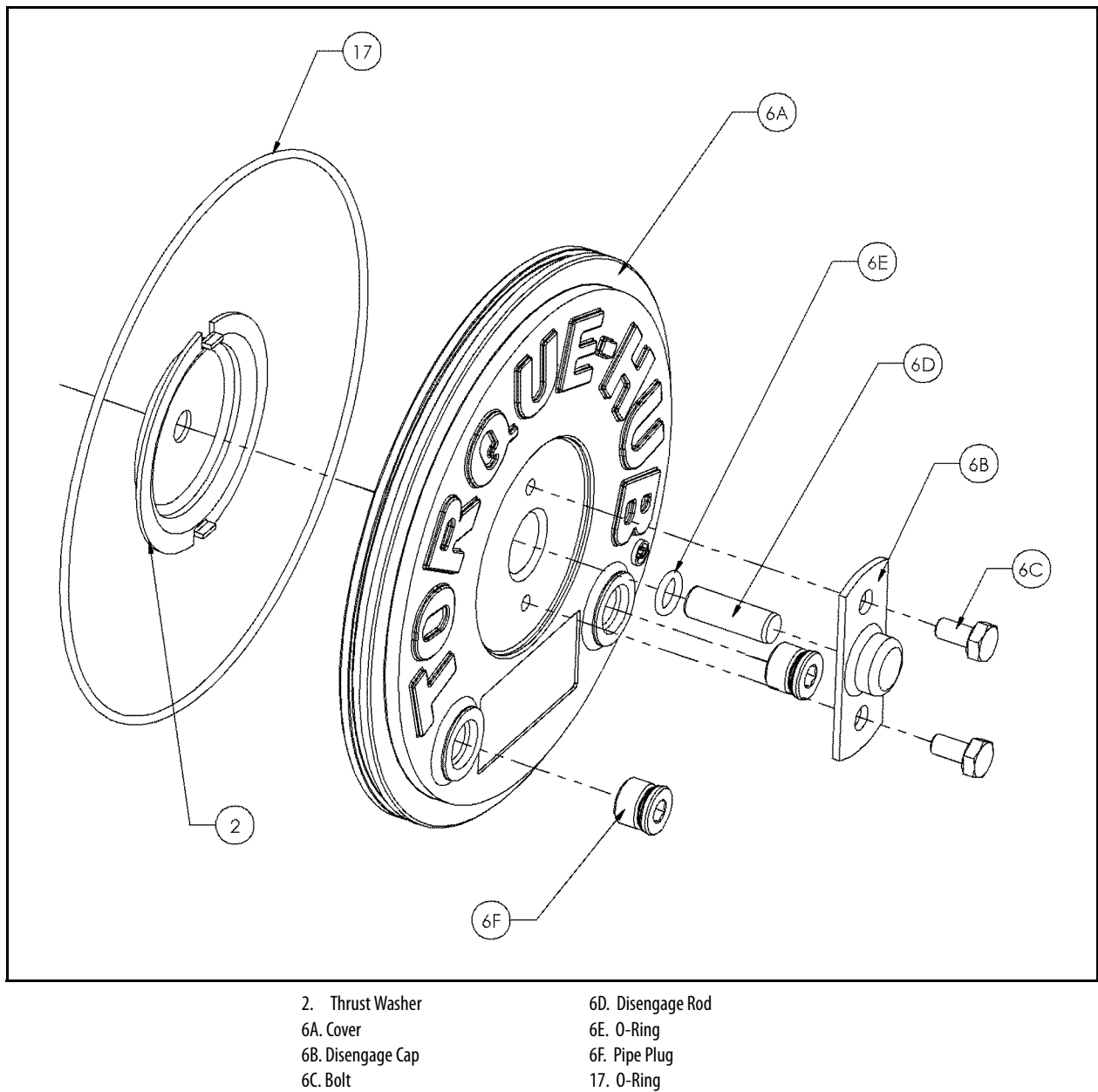


Figure 3-19. Cover

1. Remove O-ring (17) from groove in cover (6A).
2. Remove thrust washer (2) from cover (6A) pockets.
3. Unscrew two hex head bolts (6C) and remove disengage cap (6B) from cover (6A).
4. Pull disengage rod (6D) out from cover (6A).
5. Use appropriate tool to remove O-ring (6E) from internal groove in cover (6A).
6. Remove two O-ring pipe plugs (6F) from cover (6A).

Input Carrier Sub-Assembly

NOTE: Refer to Figure 3-14., Input Carrier

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 which 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. The end of the planet shaft that does NOT have the roll pin hole should be inserted into the carrier FIRST.
5. Place one thrust washer (3B) onto the end of planet shaft (3E). Make sure that the flat faces towards the inside of the carrier and make sure the button fits in the pocket on the inside of the carrier (3A) towards the OD.
6. Following the thrust washer, place planet gear (3F) with needle rollers, onto planet shaft (3E).
7. Following the planet gear, place one more thrust washer (3B) onto planet shaft (3E). Align the thrust washer (3B) in the same manner described in Step 5.
8. Now insert planet shaft (3E) through the opposite planet shaft hole on carrier (3A). Use an alignment punch or similar tool to align the roll pin holes on carrier (3A) and planet shaft (3E).

NOTE: Be sure not to hit the Planet Gears (3F) when driving in the Roll Pins (4G).

9. Drive roll pin (4G) down into the aligned roll pin holes. Pin should be flush with the flat of carrier.
10. Repeat steps 1-9 for the installation of the two remaining planet gears (3F).

NOTE: Some grease may need to be applied to the thrust washers (3B) to hold them in place while installing the planet gears.

Output Planet Gear Sub-Assembly

NOTE: Refer to Figure 3-15., Planet Gear Subassembly

1. Apply a liberal coat of grease to the bore of one Output planet gear (4F).
2. Line the inside of the planet gear (4F) with 14 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 which form the space, and then slid, parallel to the other rollers, into place.

3. Place spacer (4D) into the bore of the output planet (4F).
4. Repeat Step 2 to put in second roll of needle rollers (4C).
5. Apply grease to hold two thrust washers (4B) together and onto output planet gear (4F) counterbore. Do the same to the other side.
6. Repeat steps 1-5 to finish the assembly of the two remaining output planet gears (4F).

Spindle-Brake Sub-Assembly

NOTE: Refer to Figure 3-17., Spindle Brake

1. Place spindle (1A) such that the flange side is up.
2. Place stator (8K) into the spindle (1A) scallop cuts.
3. Place rotor (8J) on top of stator (8K).
4. Repeat steps 2 & 3 until there are a total of 9 stators (8K) and 8 rotors (8J) installed.
5. Place piston (8A) such that the smaller O.D. end is facing upward. Grease the two O-rings and the two backup rings.
6. Install large backup ring (8E) in the large-diameter groove at the bottom of the piston (8A).
7. Install large O-ring (8D) in the large-diameter groove at the bottom of the piston (8A), on top of the large backup ring (8E).
8. Install small O-ring (8F) in the small-diameter groove near the top of the Piston (8A). Make sure the O-ring is seated on the bottom of the groove.

9. Install small backup ring (8H) in the small-diameter groove near the top of the piston (8A), on top of the small O-ring (8F).
10. Insert piston (8A) into spindle (1A) until it contacts the stator (8K).
11. Insert the appropriate number of springs (8L), based on the assembly print, into piston (8A) counterbore.
12. Place spring (1L) into coupling (7) counterbore. Place the pressure plate (1M) on top of spring (1L).
13. Use appropriate tool to install retaining ring (1K) into the retaining ring groove in the coupling (7) counterbore.
14. Insert coupling sub-assembly (7) through rotors (8J).
15. Place pressure plate (8B) on top of springs (8L).
16. Use two ¼ -20 x 0.625 flat head cap screws (22) by bolting the pressure plate (8B) and piston (8A) together or some other appropriate tools to install retaining ring on top of pressure plate (8B) until retaining ring (8C) is seated.

NOTE: Remove 2 Screws from units when done, otherwise brake will not function.

17. Install pipe plug (21) if applicable.

Hub-Spindle Sub-Assembly

NOTE: Refer to Figure 3-16., Hub Spindle

NOTE: Spray a light film of oil on all component parts during assembly. Spray a generous amount of oil on bearings during installation.

1. Press bearing cup of part (1C), position "A", into hub using T-158422 pressing tool.
2. Turn hub over and press Bearing cup of part (1C), position "B", into hub using T-158422 pressing tool (T).
3. Place bearing cone of part (1C), into bearing cup of part (1C), position "B".
4. Grease seal (1B) lip and press seal into hub (1D) using appropriate tool until seal is flush with end of hub (T).
5. Place Hub (1D) into pressing base. Press nine Studs (1H) into Hub.

NOTE: Use enough pressure to press in studs. Don't use excessively high pressure to press in studs or hub may crack.

6. Set spindle assembly (1A) on the bench with the flange down. Turn Hub (1D) over and lower onto Spindle (5). Install boot (21) if applicable.
7. Install bearing cone of part (1C) into bearing cup, position "A".

8. Apply Loctite 243 on Bearing Nut (1F) thread. Screw nut (1F) on top of bearing cone of part (1C) leave 0.003-0.005 inches (0.7-1.3 mm) end play to check the initial rolling torque with the unit tied down. Then torque bearing nut (1F) until rolling torque is 40-50 in. lbs. (4.5-5.5 Nm) greater than initial rolling torque. Using tool T-206569 for the bearing nut.

NOTE: Final torque is initial rolling torque plus 40-50 in. lbs. (4.5-5.5 Nm). E.g., if the initial rolling torque is 30 in. lbs. (3.4 Nm), the final rolling torque is between 70-80 in. lbs. (8-9 Nm). Be sure to rotate hub as the torque is applied to properly seat the bearing. Be sure the torque wrench is tangent to the hub (1D) OD.

9. Using appropriate tool, install two set screws (1G) into bearing nut (1F) threaded holes. Make sure set screw is driven into the spindle thread. Tighten the set screws to damage the thread and stake the edge of the nut around the set screws (1G) so the nut will not loosen.
10. Place thrust washer (4H) into counterbore of spindle (1A).
11. Place planet gear sub-assembly (4) into spindle (1A) through gap between two studs (1H). Align the planet gear bore with one of the planet shaft holes on the spindle (1A) assembly using T-209919.
12. Insert a planet shaft (4E) into the planet shaft hole described in step (11) on spindle (1A). The end of the planet shaft that does not have the roll pin hole should be inserted into the spindle FIRST.
13. Now insert planet shaft (4E) through the first set of thrust washers (4B), planet gear, then the second set of washers (4B). Use an alignment punch or similar tool to align roll pin holes on spindle (1A) and planet shaft (4E).

NOTE: Be sure not to hit the planet gears (4F) when driving in roll pins (4G).

14. Drive roll pin (4G) down into the aligned roll pin holes. Pin should be flush with OD of spindle.
15. Repeat Steps (11-14) for the installation of the two remaining planet gears (4F).

Cover Sub-Assembly

NOTE: Refer to Figure 3-19., Cover

1. Grease O-ring (6E) and insert into internal groove in cover (6A).
2. Assemble disengage cap (6B) onto cover (6A) using two hex head bolts (6C). Torque bolts to 70-80 in. lbs. (8-9 Nm).
3. Insert disengage rod (6D) into hole in cover (6A) until it touches the inside of the disengage cap (6B).

NOTE: The disengage rod can be inserted either end first.

4. Grease face of thrust washer (2) and place in cover (6A) making sure that tangs on washer seat into pockets in cover.
5. Install O-ring pipe plugs (6F) into cover (6A). The plugs should be hand tight.

Main Assembly

NOTE: Refer to Figure 3-11., Main Disassembly

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

1. Place hub-spindle sub-assembly on the bench.
2. Grease O-ring (18) and place it into groove of hub (1D).
3. Place ring gear (1E) onto hub (1D). Align the three shipping cap screw holes on hub (1D) and ring gear (1E).
4. Install three shipping cap screws (19) into ring gear and hub. Torque them to 15-20 ft. lbs. (20-27 Nm).
5. Place external retaining ring (5) over 13T spline to the retaining groove on input shaft (9).

NOTE: For ratio 48:1, assemble output sun gear (11) over input shaft (9) first, then install external retaining ring (5).

6. Using appropriate tool to install retaining ring (20) into groove on output sun (11).
7. Place input shaft (9) spline end into mesh with internal coupling (7) splines.
8. With the modified spline end facing up, place the output gear (11) into mesh with the planet gears from the hub-spindle sub-assembly.
9. Place input carrier sub-assembly (3A) onto output sun gear (11) splines. Drop input sun (10) into mesh with planet gears for specific ratios, if required. (No timing required).
10. Grease O-ring (17) and insert into groove in cover sub-assembly (6).

11. Install cover sub-assembly (6) into ring gear (1E) counterbore and install retaining ring (6G) into groove in ring gear (1E).
12. Attach ID tag (15) onto unit using drive screws (16).
13. Check disconnect, roll and air check unit, leak check brake, and record release pressure.
14. Insert plastic plug (12) into place if applicable.

Integral Brake Check

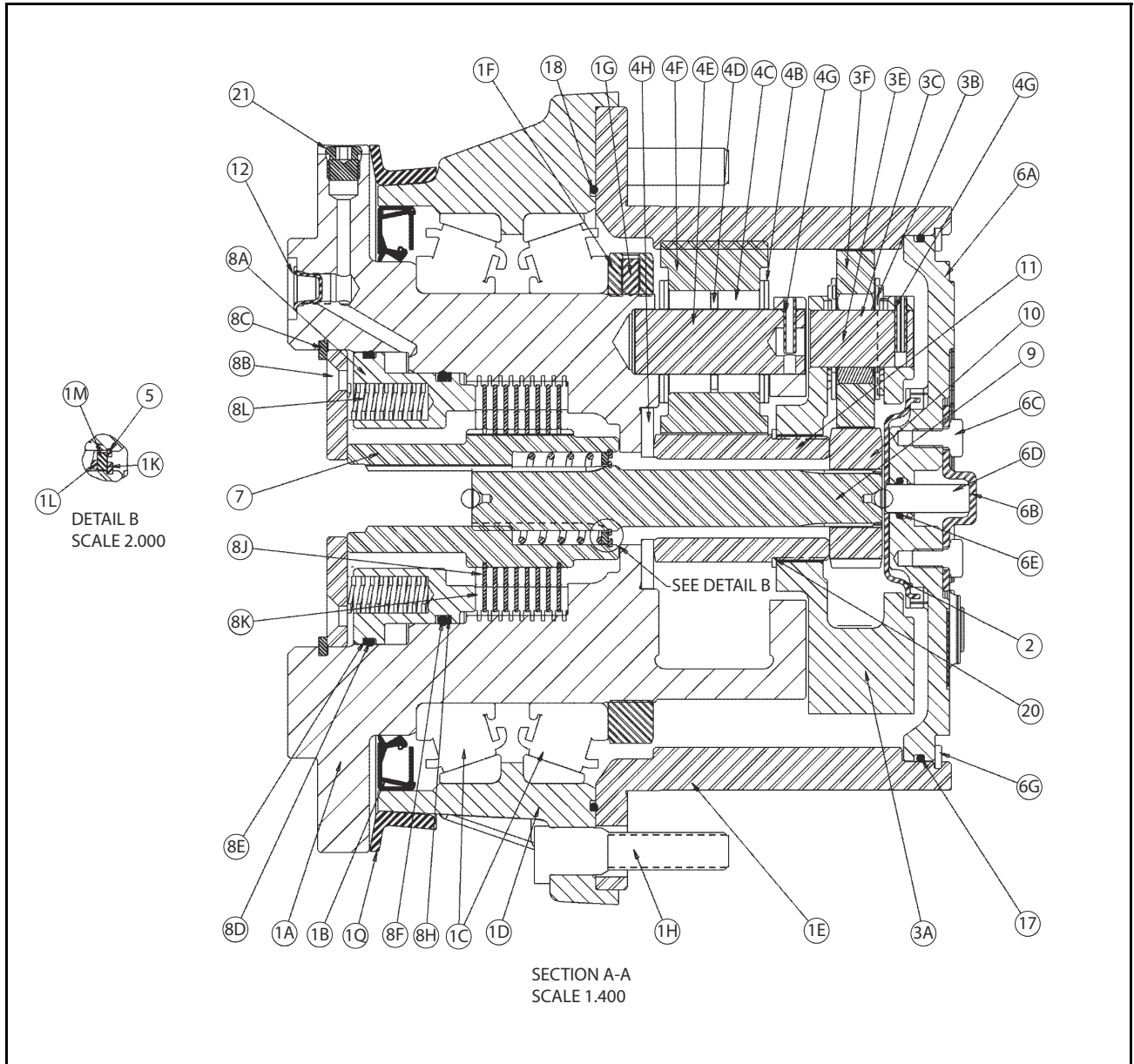
1. Using appropriate fittings, connect hydraulic line from hand pump to brake port.
2. Check to see that brake is set by trying to rotate input shaft (9). This can be accomplished by installing an appropriate tool (any tool that can locate on the splines of the input coupling (7), such as a mating splined shaft) into input coupling (7).
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	JUST RELEASE PRESSURE RANGE	
	PSI	BAR
A	200-260	13.7-17.9
B	170-220	11.7-15.1
C	140-185	9.6-12.7
D	130-155	8.9-10.6
E	115-145	7.9-9.9

4. Increase pressure to 69 bar (1,000 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 (7) is centered in spindle (1A) to make installation of motor possible without release of brake.



- | | | | | | |
|---------------------|--------------------|--------------------|--------------------|------------------|--------------------|
| 1A. Spindle | 1M. Thrust Washer | 4C. Needle Bearing | 6C. Bolt | 8D. O-Ring | 11. Sun Gear |
| 1B. Lip Seal | 1Q. Seal Boot | 4D. Thrust Spacer | 6D. Dowel Pin | 8E. Backup Ring | 12. Plastic Plug |
| 1C. Tapered Bearing | 2. Thrust Spacer | 4E. Planet Shaft | 6E. O-Ring | 8F. O-Ring | 15. ID Plate |
| 1D. Housing | 3A. Carrier | 4F. Planet Gear | 6F. Pipe Plug | 8H. Backup Ring | 16. Drive Screw |
| 1E. Ring Gear | 3B. Thrust Washer | 4G. Roll Pin | 6G. Retaining Ring | 8J. Brake Rotor | 17. O-Ring |
| 1F. Bearing Nut | 3C. Needle Bearing | 4H. Thrust Washer | 7. Coupling | 8K. Brake Stator | 18. O-Ring |
| 1G. Setscrew | 3E. Planet Shaft | 5. Retaining Ring | 8A. Brake Piston | 8L. Spring | 19. Bolt |
| 1H. Stud | 3F. Planet Gear | 6A. Cover | 8B. Pressure Plate | 9. Input Shaft | 20. Retaining Ring |
| 1K. Retaining Ring | 4B. Thrust Washer | 6B. Disengage Cap | 8C. Retaining Ring | 10. Sun Gear | 21. O-Ring Plug |
| 1L. Spring | | | | | |

Figure 3-20. Hub Assembly

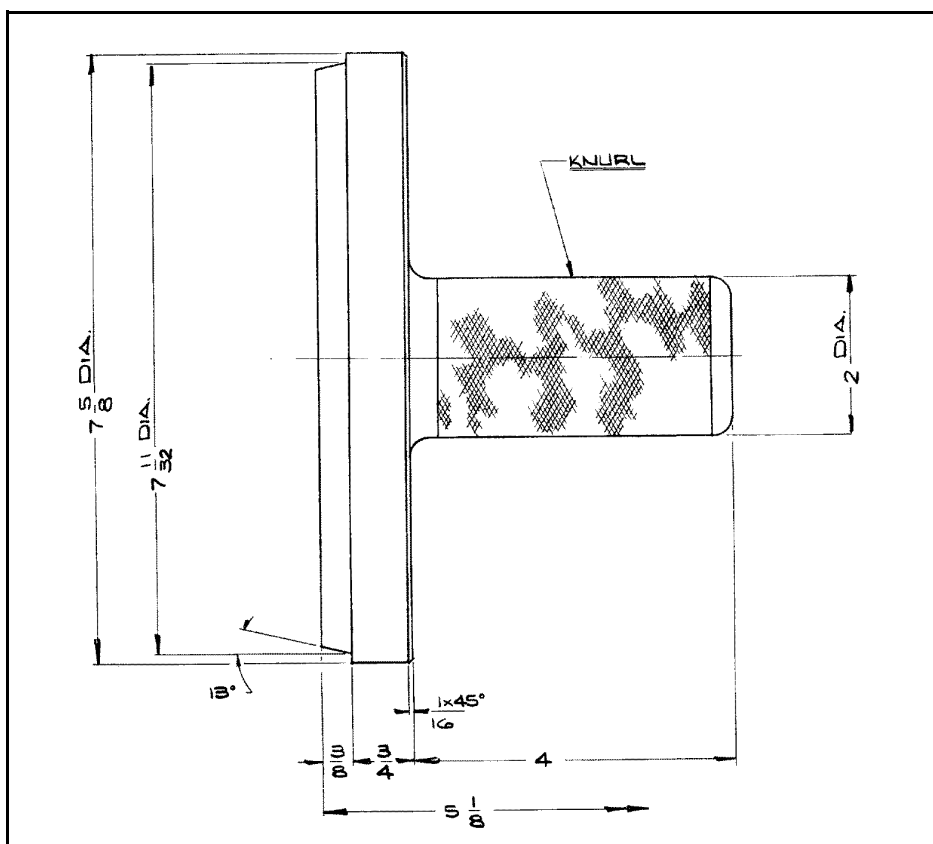


Figure 3-21. Bearing Cup Pressing Tool

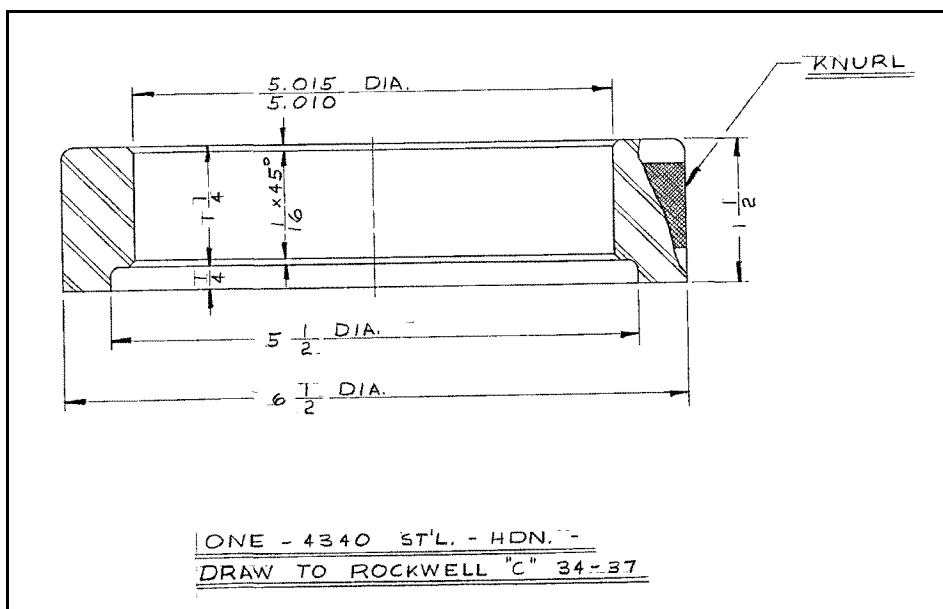


Figure 3-22. Seal Pressing Tool

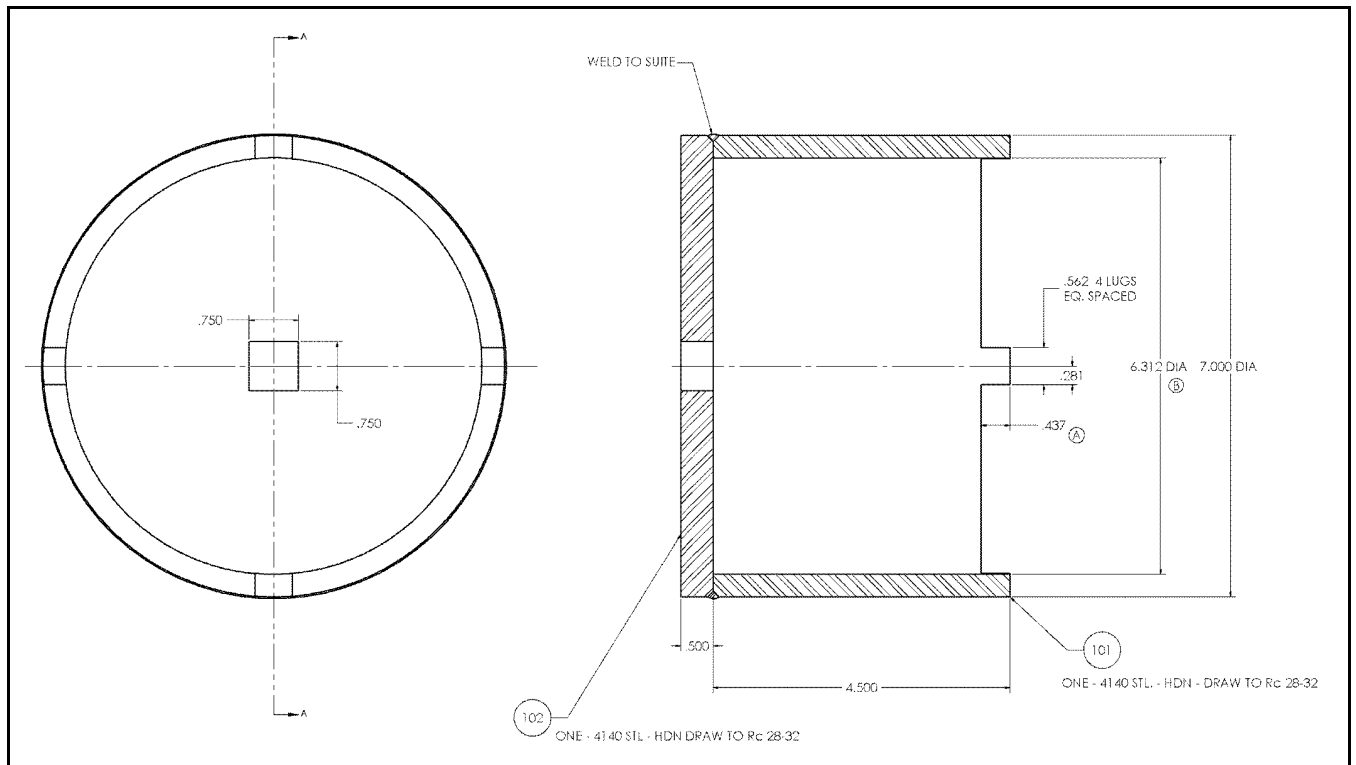


Figure 3-23. Bearing Cup Pressing Tool

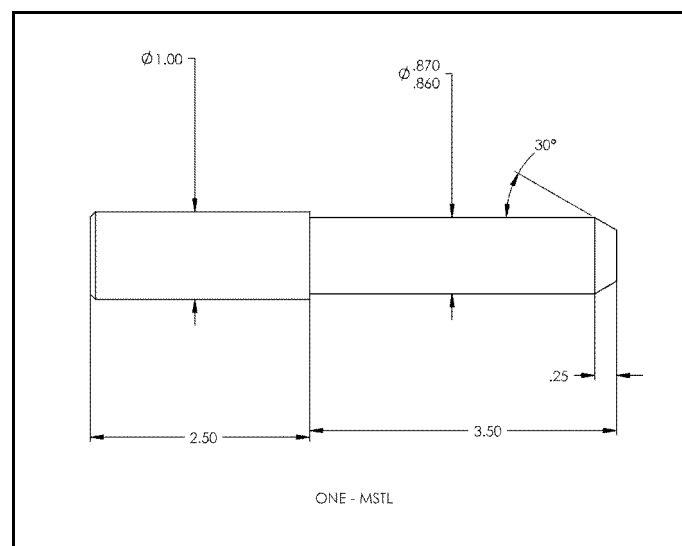
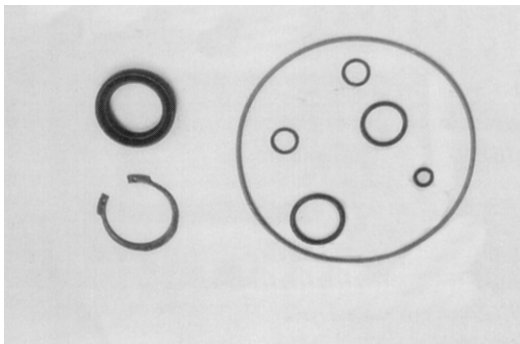


Figure 3-24. Drift Pin for Lining Up Thrust Washers with Output Planet Gear

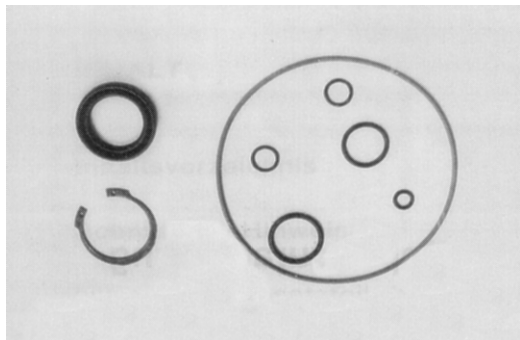
3.7 DRIVE MOTOR - 4WD (SN 0300087000 THROUGH 0300098764)

Spare Parts Kits

1. Sealing kit, existing spare parts: shaft sealing ring, 6 different O-rings and a circlip (sealing mat: perbunan).



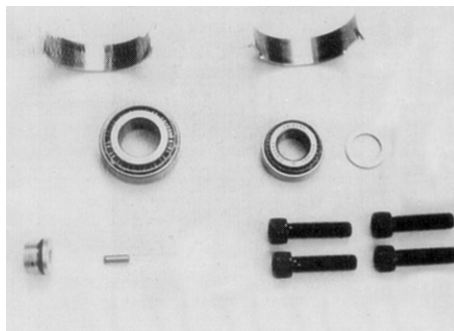
2. Same sealing kit like shown above only seal material changed to Viton.



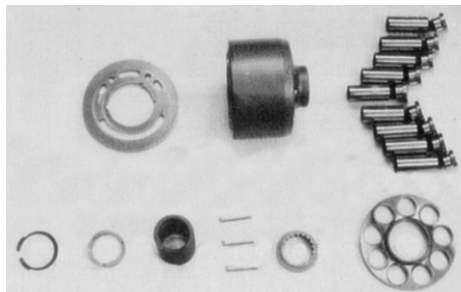
3. Drive shaft.



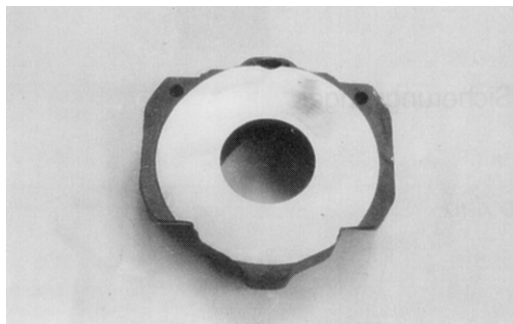
4. Bearing set/miscellaneous parts .



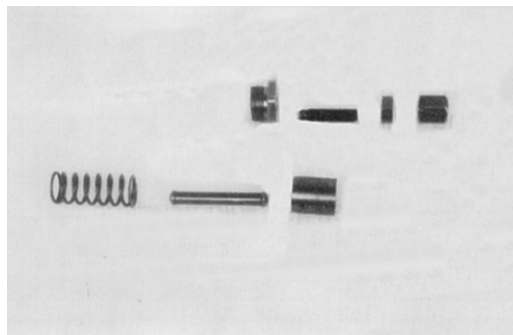
5. Rotary group complete 9 pistons, cylinder sub-assembly, valve plate (cw or ccw corresponding to the order) retaining plate and retaining ball.



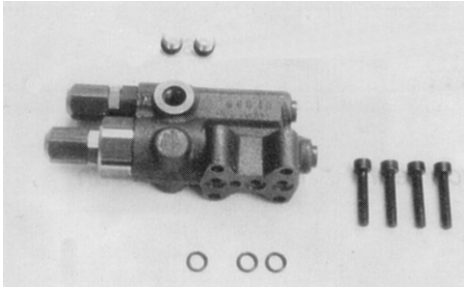
6. Swash Plate.



7. Parts of the control device: control piston, piston rod, plug, spring stopper max flow, hex. nut, and hex. head nut.

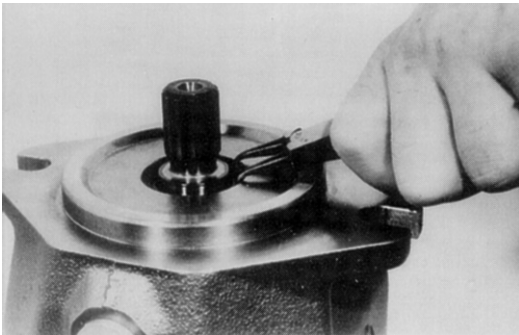


8. Spare parts kit DFR pilot valve.

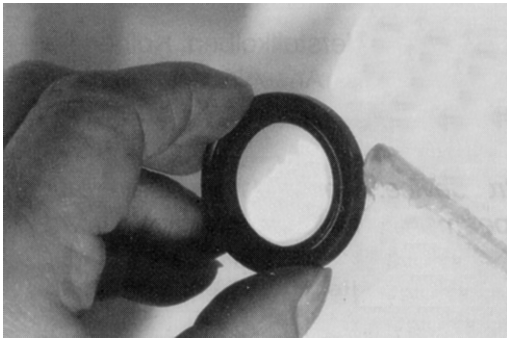


Replacing the Drive Shaft Seal

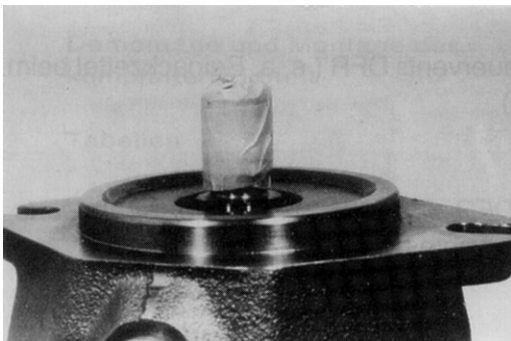
1. Remove the snap ring.



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



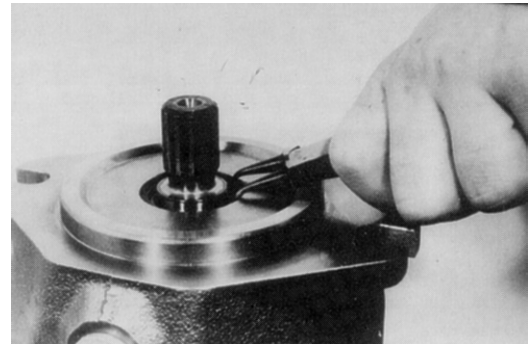
3. Be careful while you seal the drive shaft, use an adhesive tape to protect the splines.



4. Assemble the sealing ring. The fitting tool will hold the sealing ring in the correct position in the pump housing.



5. Assemble the snap ring.

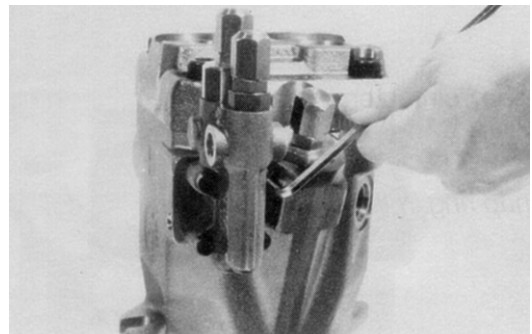


6. Assemble the snap ring in the correct position.



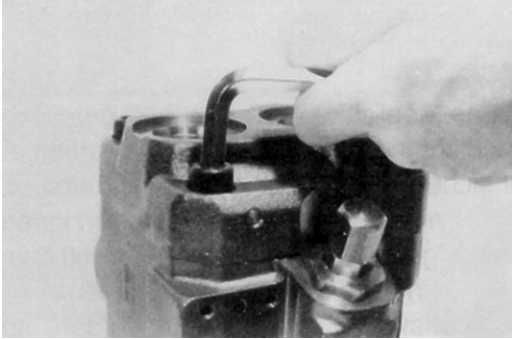
Disassembly and Assembly

1. Disassemble the pilot valve.

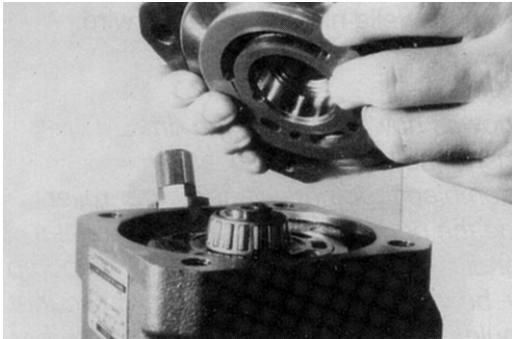


SECTION 3 - CHASSIS & TURNTABLE

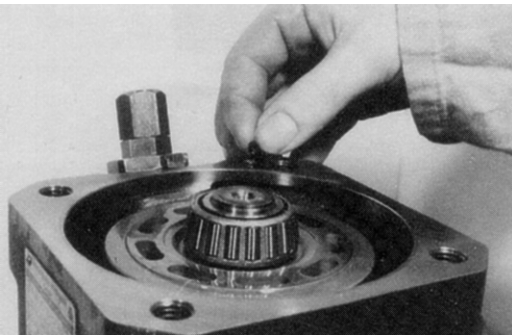
2. Mark the position of the port plate and remove the socket screw from the port plate.



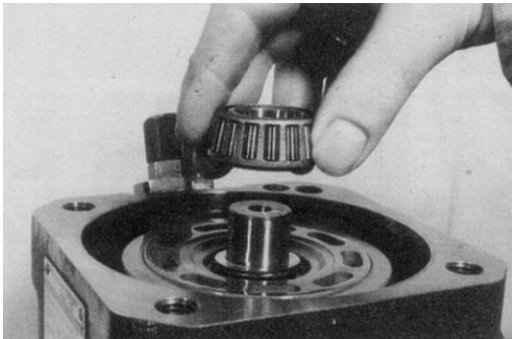
3. Remove the port plate together with the valve plate (hold the valve plate so that the plate can't fall down).



4. Remove the O-ring.



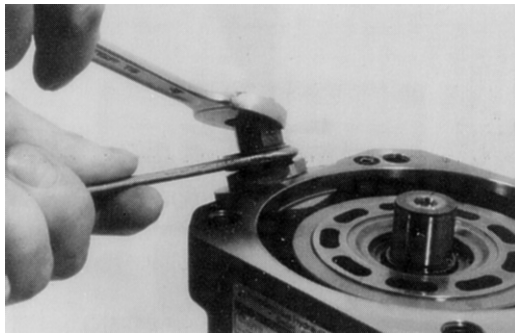
5. Disassemble the taper roller bearing.



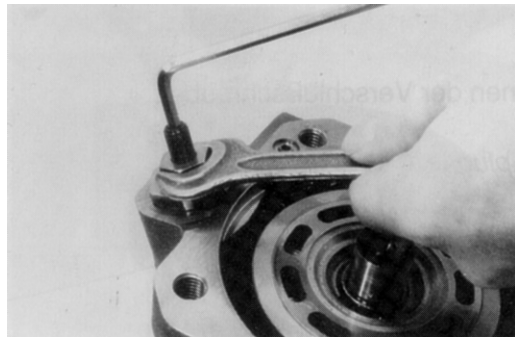
6. Remove the adjustment shim.



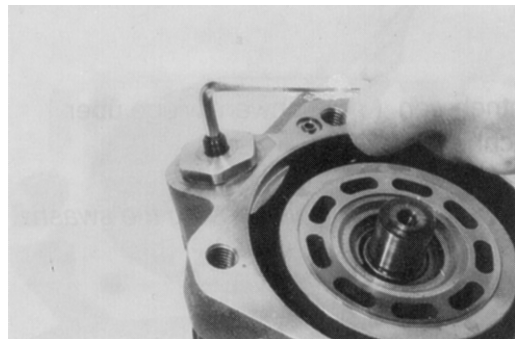
7. Unscrew the cap nut and remove it.



8. Loosen the retaining nut of the stopper max flow and remove it.



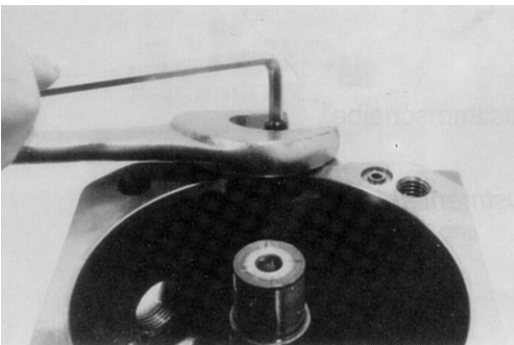
9. Turn in the stopper max flow to get swivel angle zero.



10. Disassemble the rotary group in horizontal position.



11. Disassemble the stopper - max. flow.



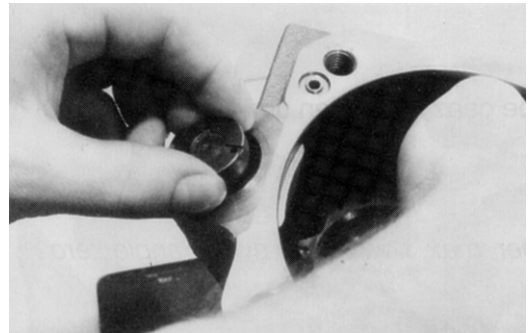
12. Remove the threaded pin (stopper - max.flow).



13. Disassemble the plug.



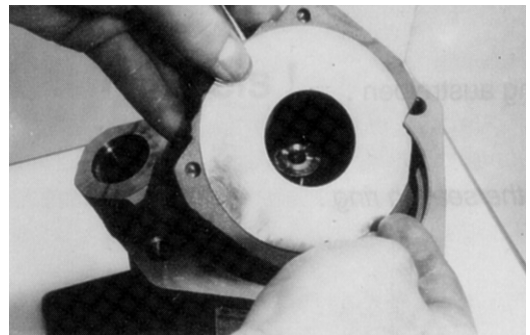
14. Disassemble the control piston while moving the swash plate.



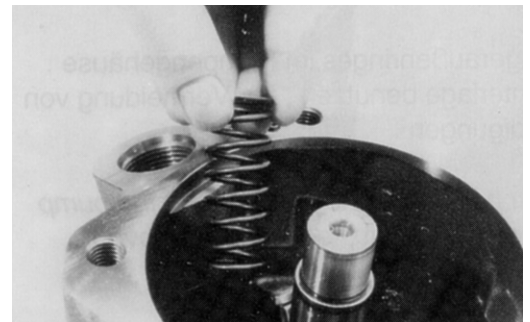
15. The swash plate must be lifted a little bit to disassemble the piston rod.



16. Disassembly of the swash plate.

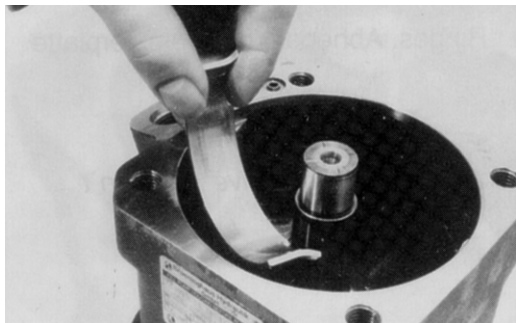


17. Remove the spring.

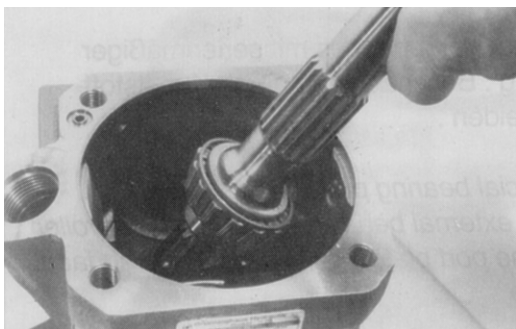


SECTION 3 - CHASSIS & TURNTABLE

- 18.** Remove both bearing shells.



- 19.** Remove the drive shaft.



- 20.** Remove the snap ring.



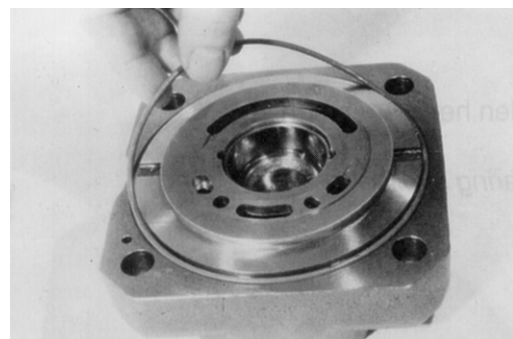
- 21.** Disassemble the sealing ring.



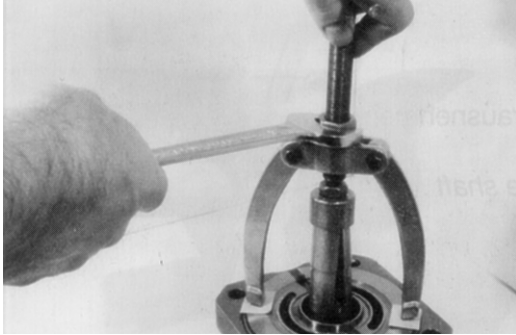
- 22.** The external front bearing ring is pulled out of the pump housing.



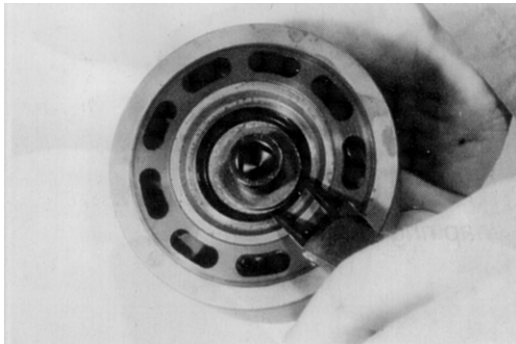
- 23.** Remove the O-ring (Lifting of the valve plate is not shown).



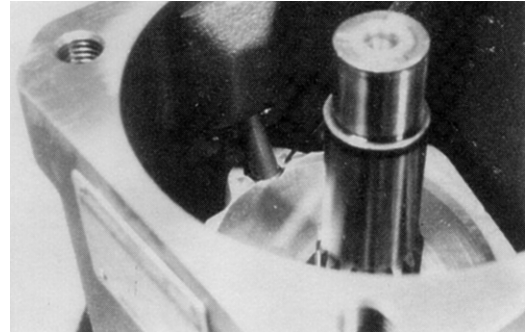
24. A usual commercial bearing puller is used to disassemble the external bearing ring of the taper roller bearing inside the port plate. Take care not to damage the surface of the port plate.



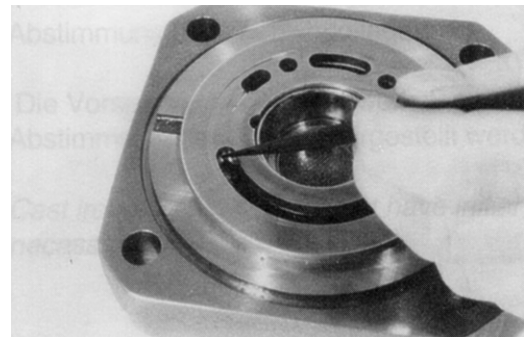
25. The spring has additional pretension while you disassemble the three pressure pins inside the cylinder.



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

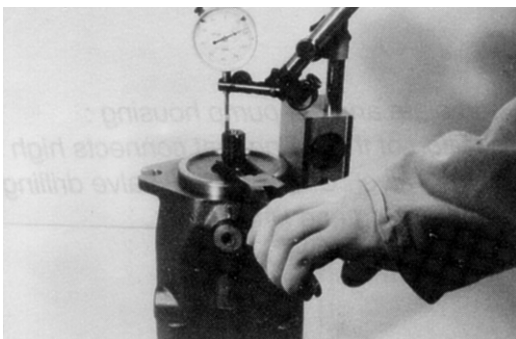


3. Pumps clockwise driven must have a position to the valve plate 4 degrees out of center in the same direction de-centered like drive direction. (Note spare parts exist as cw and ccw valve plates).

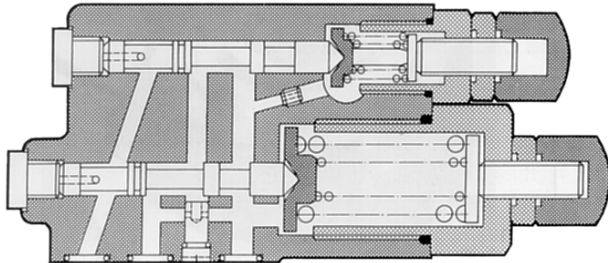


Assembly Notes

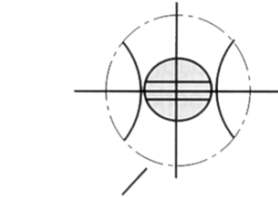
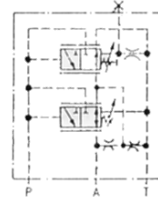
1. Measurement of the taper roller bearing pretension.



all valves shown here do have open position of the orifice (see picture below "pos. of orifice").



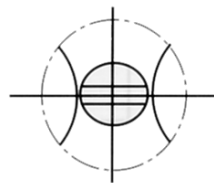
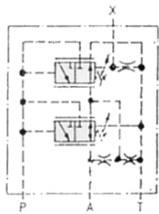
orifice 0,6mm



position of the orifice \varnothing 0,6

pressure compensator DR

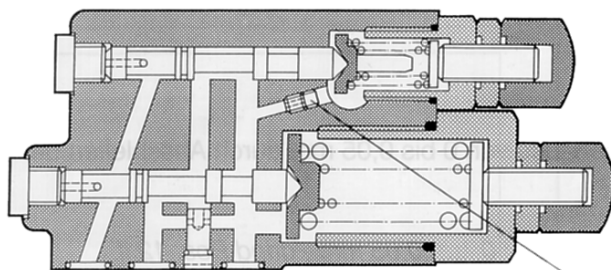
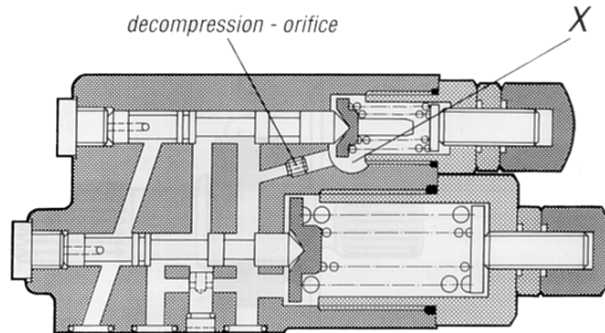
Both X- ports are plugged .
Flow control blocked.



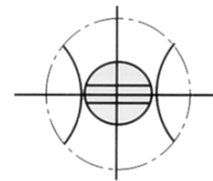
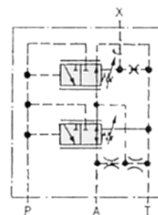
pressure compensator and flow control DFR

One X - port is plugged .

decompression - orifice

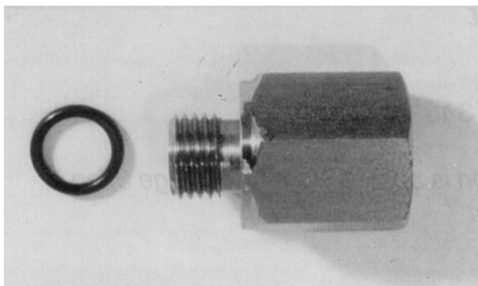


plug



pressure compensator and flow control DFR 1

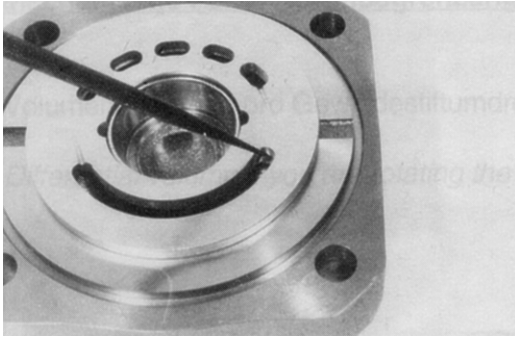
One X - port is plugged . Decompression
orifice X-T is plugged by the plug.



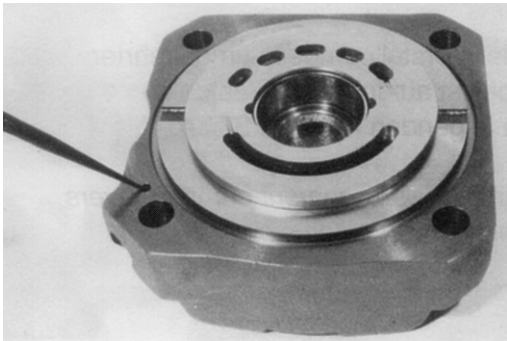
Adapter without orifice of the DFR-pilot valve , if you use
a metric pilot pipe connection X .

Figure 3-25. Flow Control Pilot Valves

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

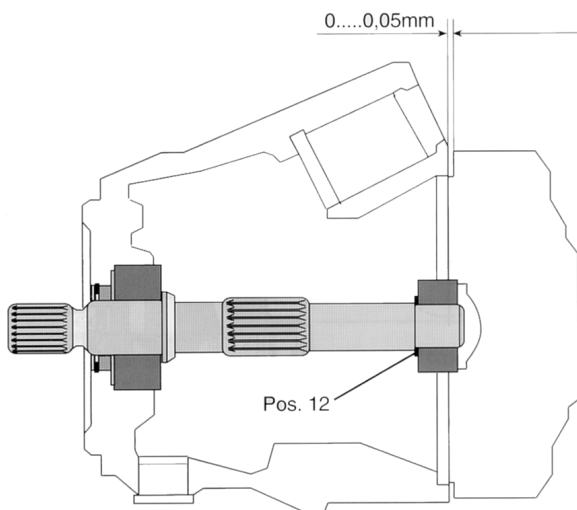


5. Assembly of the port plate and the pump housing: Note the correct position of the drilling that connects high pressure to the control valve. Check control valve drill position at the pump housing and fit together.



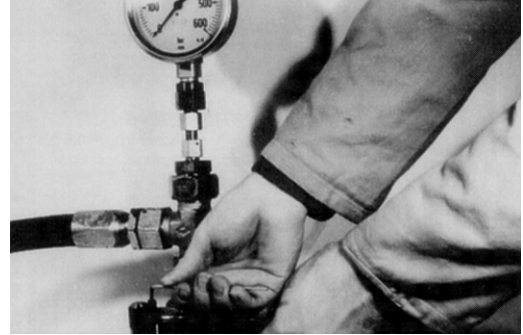
Taper Roller Bearing Initial Tension

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

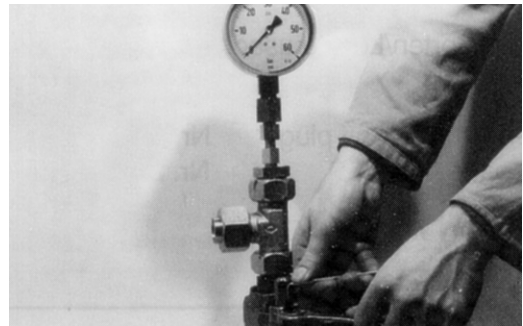


Testing and Setup

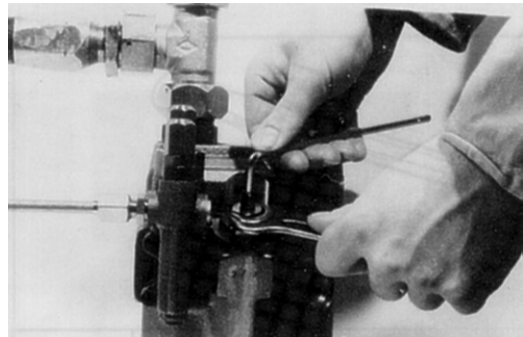
1. DR: When pressure line is closed adjust the pressure of the controller (if it's DFR design then open the adjustable orifice and increase force of the spring - FR).



2. FR: If swivel angle is in the mid position adjust differential pressure 14 bar (203 psi) adjustable orifice is partly closed).



3. Mechanical flow limiter: While screwing in the threaded pin you will be able to reduce the flow from Vg max to 50% of Vg max.



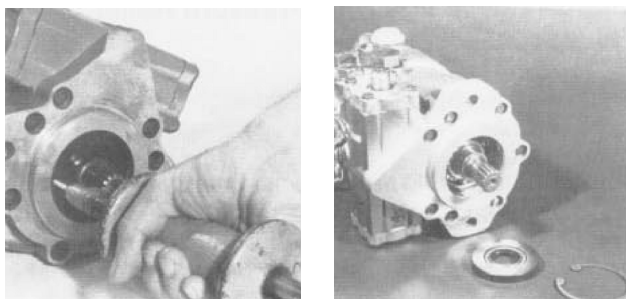
3.8 DRIVE MOTOR - 2WD (SN 0300087000 THROUGH 0300098764)

Shaft Seal Replacement

Lip type shaft seals are used on the drive motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal requires removal of the pump or motor from the machine.

1. Remove the retaining ring from the housing.

Carefully remove the seal from the housing bore. The face of the seal may be punctured with a sharp instrument (such as a screw driver) to aid in prying the seal out, or a slide hammer type puller may be used to remove the seal. Care must be taken not to damage the housing bore or shaft. Once removed the seal is not reusable.



Prior to installing the new seal, inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.

Wrap the spline or key end of shaft with thin plastic to prevent damage to the seal lip during installation. Lubricate the inside diameter of the new seal with petroleum jelly.

NOTE: The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231) prior to installation. This will aid in preventing leaks caused by damage to the housing seal bore.

Slide the new seal over the shaft and press it into the housing bore. Be careful not to damage seal. A seal installer tool can be made to aid in installing the seal.

Reinstall the seal retaining ring.

3.9 DRIVE MOTOR (SN 0300098765 THROUGH 0300171769, SN B300000100 THROUGH B300000969)

Description

1. 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.
2. 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.

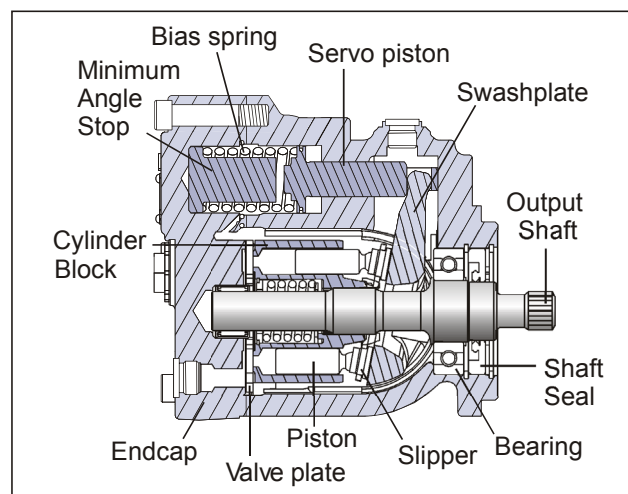


Figure 3-26. Drive Motor Cross Section

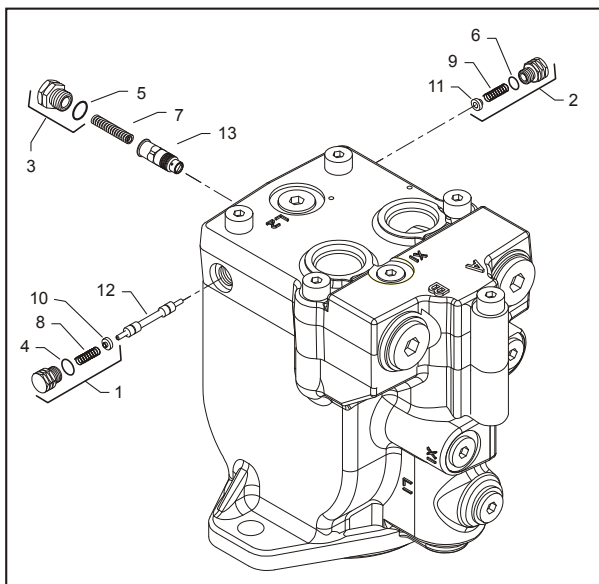
Disassembly

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.

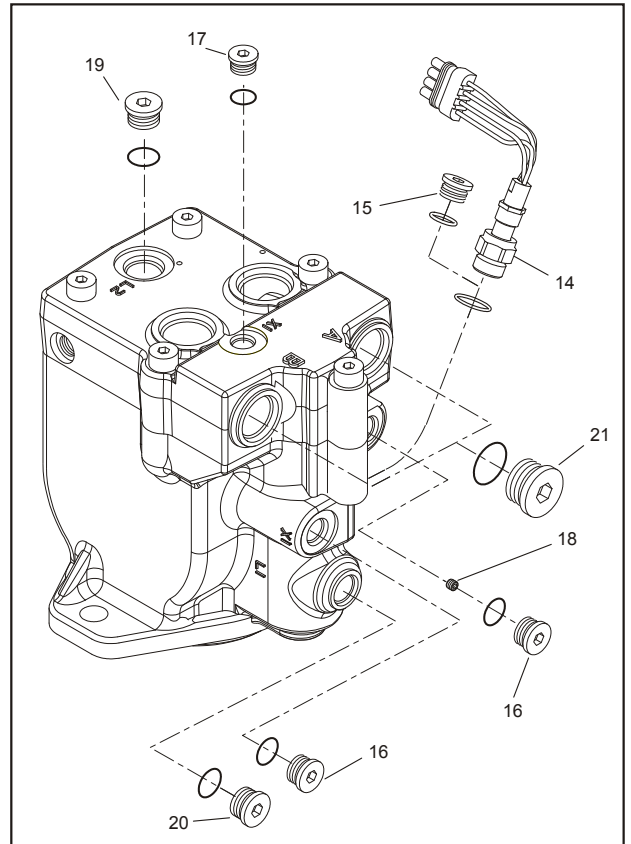
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



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

Figure 3-27. Loop Flushing Spool

- Using a 11/16 in. (17.46 mm) wrench remove plug (1) and (2).
- Using a 5/8 in. (15.87 mm) hex wrench remove plug (3).
- Remove O-rings (4, 5 and 6).
- Using pliers, remove centering springs (7, 8, and 9).
- Remove spring retaining washers (10 and 11).
- Remove shift spool (12).
- Remove orifice poppet (13).



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

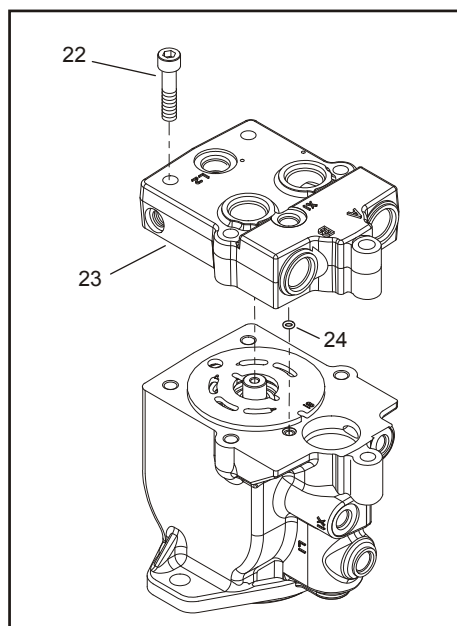
Figure 3-28. Plugs, Fittings, and Speed Sensor

- Remove all fittings from the unit. Discard any O-rings on the fittings.
- Using an 11/16 in. (17.46 mm) hex wrench, loosen the speed sensor lock nut (14) if equipped. Then remove the speed sensor using a Vi in. hex wrench. Units without speed sensor have an O-ring plug (15) installed in that location; remove it with a Va in. internal hex wrench.
- Using a 1/4 in. (6.35 mm) 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.
- Using a 5/16 in. (7.93 mm) internal hex wrench, remove drain plugs (19, 20). Discard O-rings.
- Using a 9/16 in. (14.28 mm) internal hex wrench, remove work port plugs (21, if equipped with axial ports). Discard O-rings.

13. Using an 8 mm internal hex wrench, remove the endcapscrews (22).
14. Remove the endcap (23). Remove O-ring (24) from the housing or endcap.

⚠ CAUTION

WHEN THE ENDCAPSCREWS ARE REMOVED, PRESSURE FROM THE SERVO SPRING WILL CAUSE THE ENDCAP TO BIND ON THE SHAFT. PRESS DOWN ON THE PORTION OF THE ENDCAP COVERING THE SERVO PISTON AND HOLD THE ENDCAP LEVEL WHILE REMOVING.



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

Figure 3-29. End Cap

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

NOTE: 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 and 28).
17. Remove the rear shaft bearing (29) from the endcap with a bearing puller.

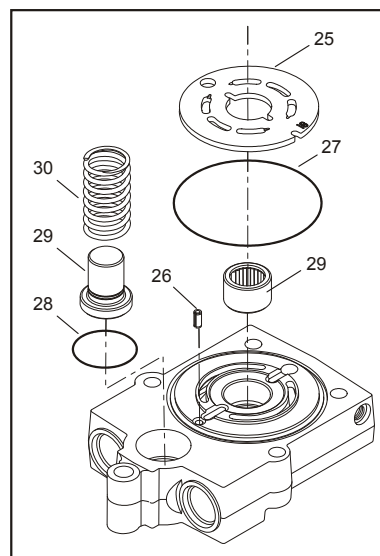
⚠ CAUTION

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.

⚠ CAUTION

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



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

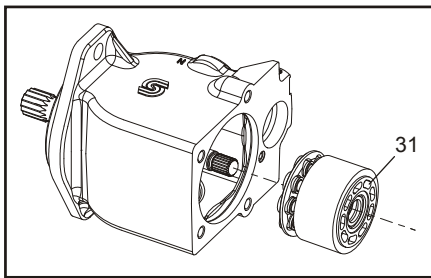
Figure 3-30. Valve Plate & Rear Shaft Bearing

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 3-3. Displacement Identifiers

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



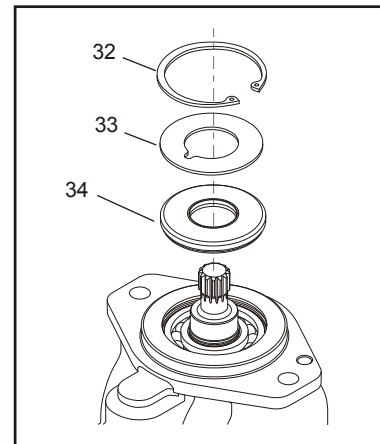
31. Cylinder Kit Assembly

Figure 3-31. Cylinder Kit

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.

⚠ CAUTION

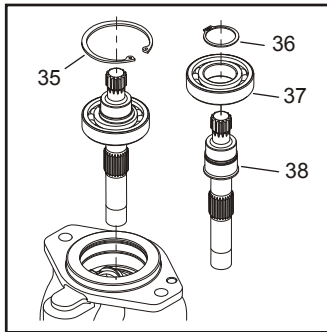
TO AVOID DAMAGING THE SHAFT DURING SEAL REMOVAL. INSTALL A LARGE SHEET METAL SCREW INTO THE CHUCK OF A SLIDE HAMMER. DRIVE THE SCREW INTO THE SEAL SURFACE AND USE THE SLIDE HAMMER TO PULL THE SEAL.



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

Figure 3-32. Shaft Seal

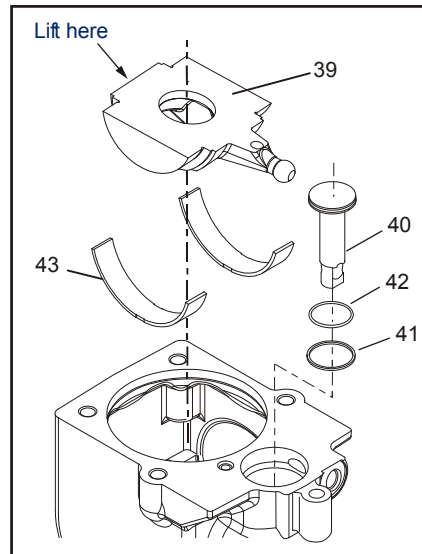
21. Remove the inner snap ring (35) and the shaft / bearing assembly.
22. Remove the snap-ring (36) retaining the shaft front bearing. Pull the bearing (37) off of the shaft (38).



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

Figure 3-33. Shaft & Front Bearing

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.



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

Figure 3-34. Swash Plate & Servo Piston

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

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

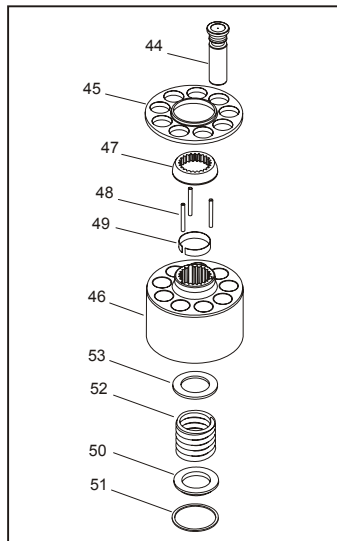
27. Remove the ball guide (47), hold-down pins (48), and retaining ring (49) from the cylinder block.

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

⚠ WARNING

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.



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

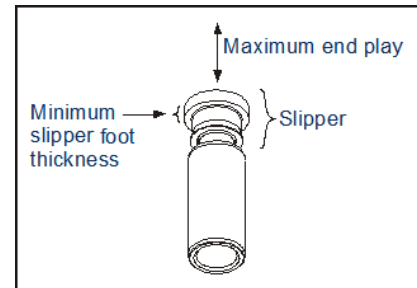
Figure 3-35. Cylinder Kit Disassembly

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 end cap 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 3-4. Slipper Foot Thickness & End Play

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

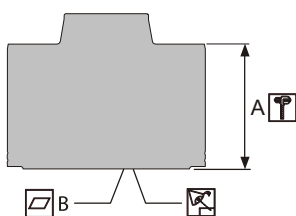
CYLINDER BLOCK

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 specifica-

tions shown in the drawing, provided resurfacing will not reduce the block height below the minimum specification. Table 3-5, Cylinder Block Measurements.

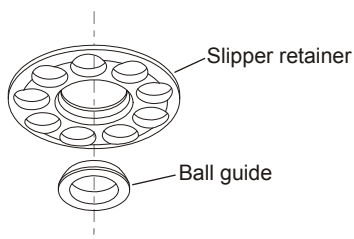
Table 3-5. Cylinder Block Measurements

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)



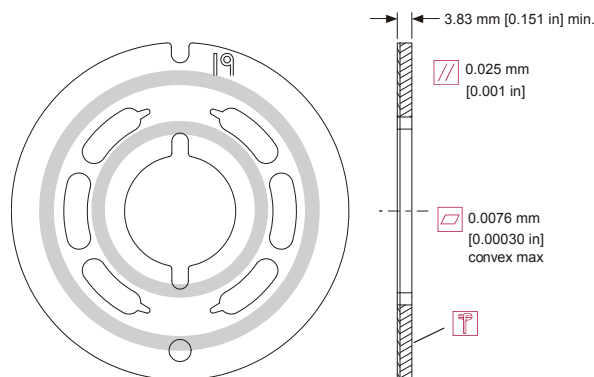
BALL GUIDE AND SLIPPER RETAINER

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.

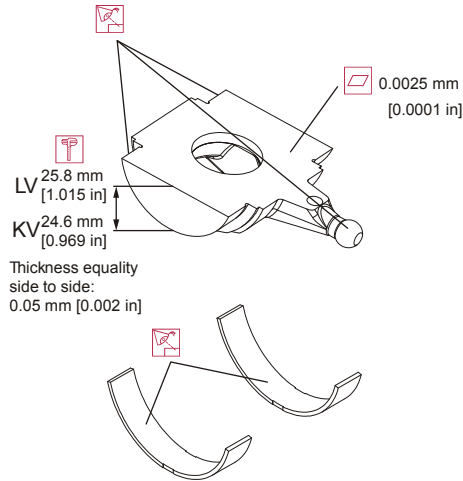


SWASHPLATE AND JOURNAL BEARINGS

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.

SERVO PISTON AND MINIMUM ANGLE STOP

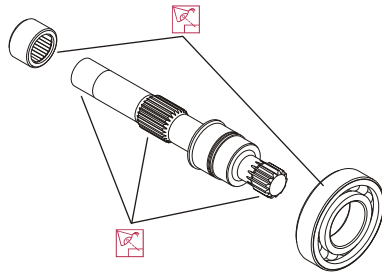
Inspect the minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace swashplate if the difference in thickness from one side to the other exceeds specification.



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

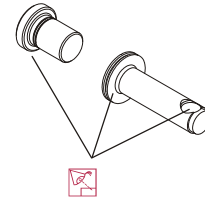
Inspect bearings for excessive wear or contamination. Rotate the bearings while feeling for uneven movement. Bearings should spin smoothly and freely. Replace bearings that appear worn or do not rotate smoothly.



SHAFT

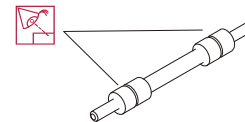
Inspect the motor shaft. Look for damage or excessive wear on the output and block splines. Inspect the bearing surfaces and sealing surface. Replace shafts with damaged or excessively worn splines, bearing surfaces, or sealing surfaces.

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.

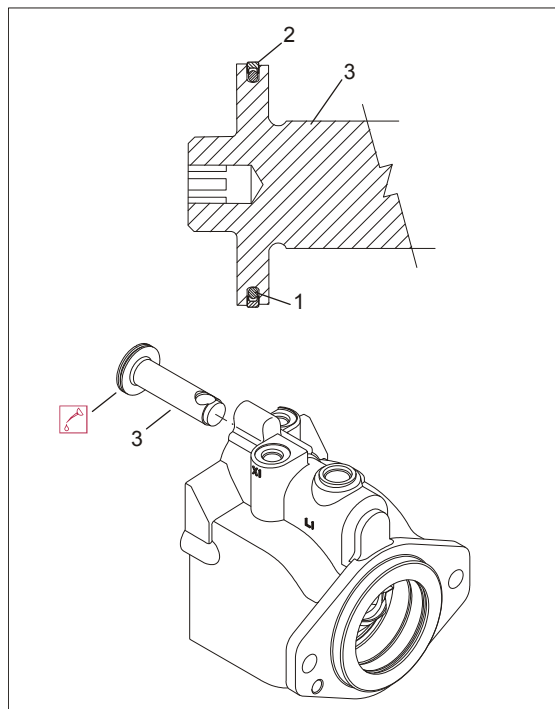
NOTICE

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.

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.

⚠ WARNING

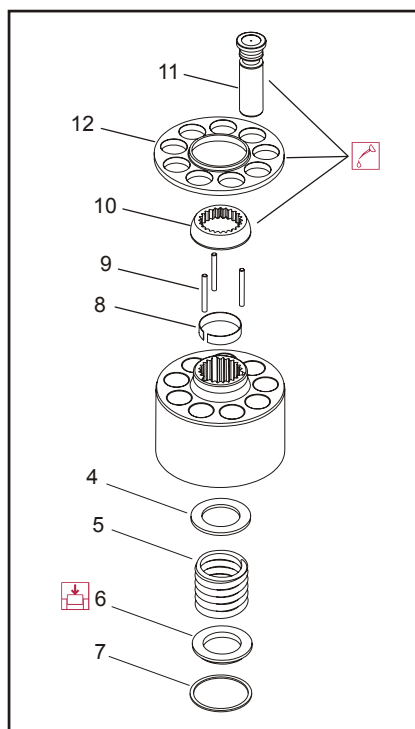
RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 80 TO 90 LBF (350 TO 400 N) OF FORCE. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING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



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

Figure 3-36. Servo Piston

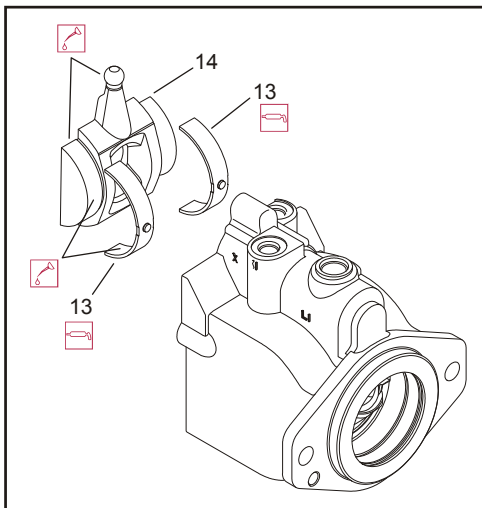
3. Install the inner block spring washer (4), block spring (5), and outer washer (6) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (7) into the groove in the cylinder block.
4. Turn the block over and install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



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

Figure 3-37. Cylinder Kit Assembly

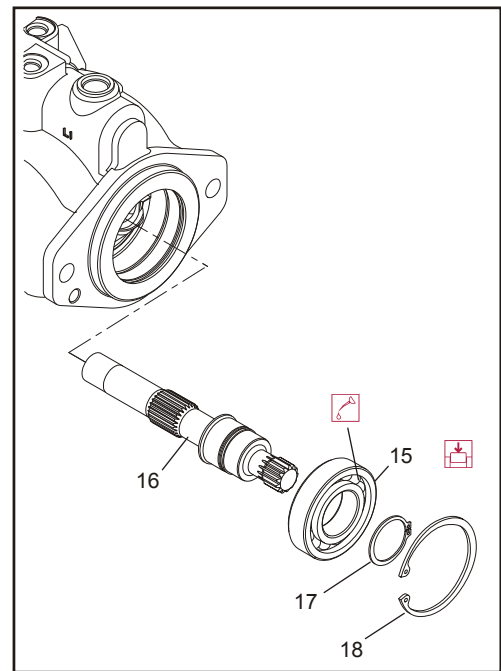
6. Install the journal bearings (13) into the housing seats. Use assembly grease to keep the bearings seated during assembly. Ensure the locating nubs drop into the cavities in the seats. If you're reusing the bearings, install them in the original location and orientation. Lubricate the journal bearings.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



13. Journal Bearings
14. Swash Plate

Figure 3-38. Swash Plate and Journal Bearing

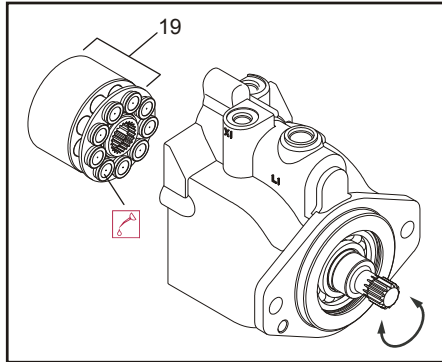
8. Press front shaft bearing (15) onto shaft (16). Press bearing onto shaft with lettering facing out. Lubricate bearing rollers. Install snap-ring (17) onto shaft.
9. While holding the swashplate in place, turn the housing on its side. Install the install shaft/bearing assembly into housing from the flange end. Install the snap-ring (18).



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

Figure 3-39. Shaft and Front Bearing

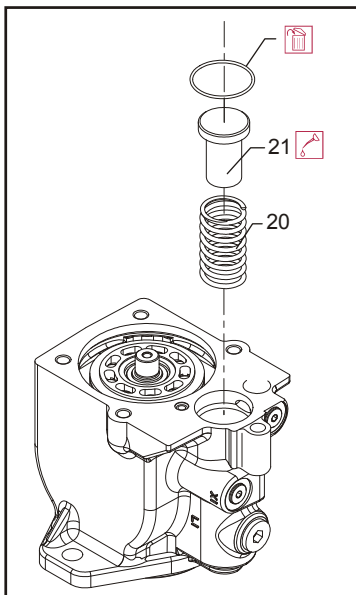
10. Verify swashplate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swashplate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder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



19. Cylinder Kit

Figure 3-40. Cylinder Kit Installation

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

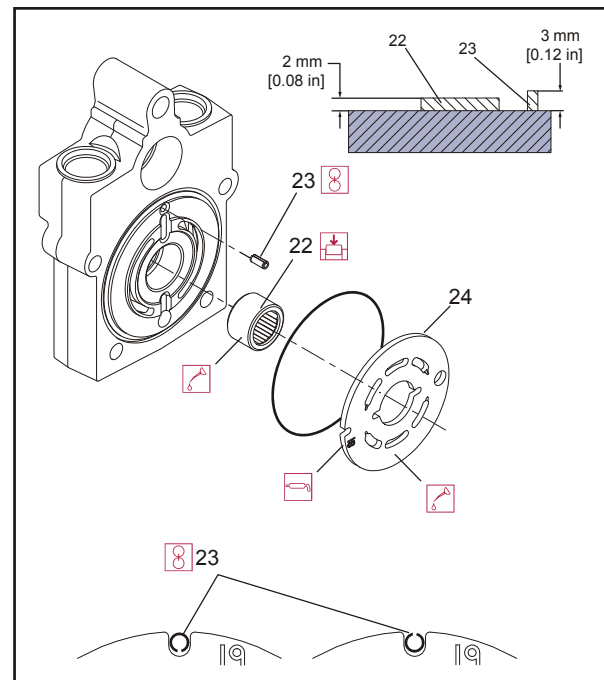


20. Servo Spring

21. Minimum Angle Stop

Figure 3-41. 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.
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.



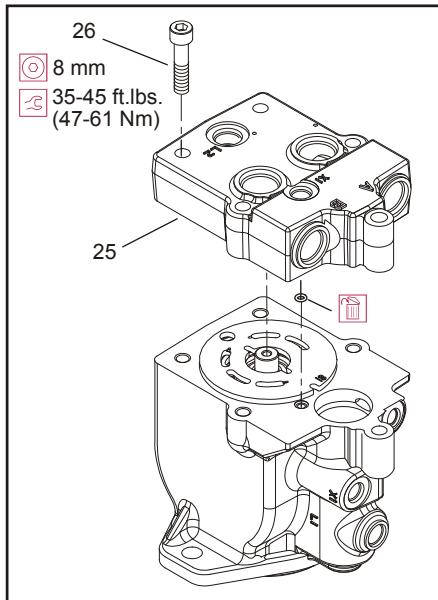
22. Rear Shaft Bearing

23. Timing Pin

24. Valve Plate

Figure 3-42. Valve Plate and Rear Bearing

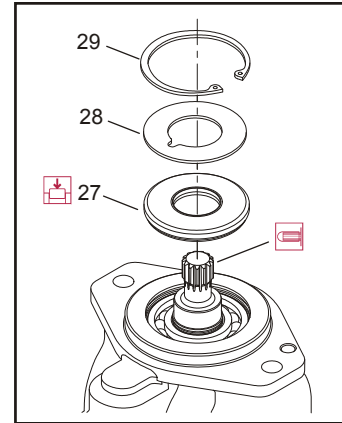
15. Install the endcap (25) onto the housing with the endcapscrews (26). Check to ensure the endcap will properly seat onto the housing without interference. Improper assembly of the internal components may prevent the endcap from seating properly. Ensure the O-rings seat properly when installing the endcap.
16. Using an 8 mm internal hex wrench, tighten the endcapscrews. Tighten the screws in opposite corners slowly and evenly to compress the servo spring and properly seat the endcap. Torque endcapscrews 35-45 ft. lbs. (47-61 Nm).



25. End Cap
26. Screw

Figure 3-43. End Cap

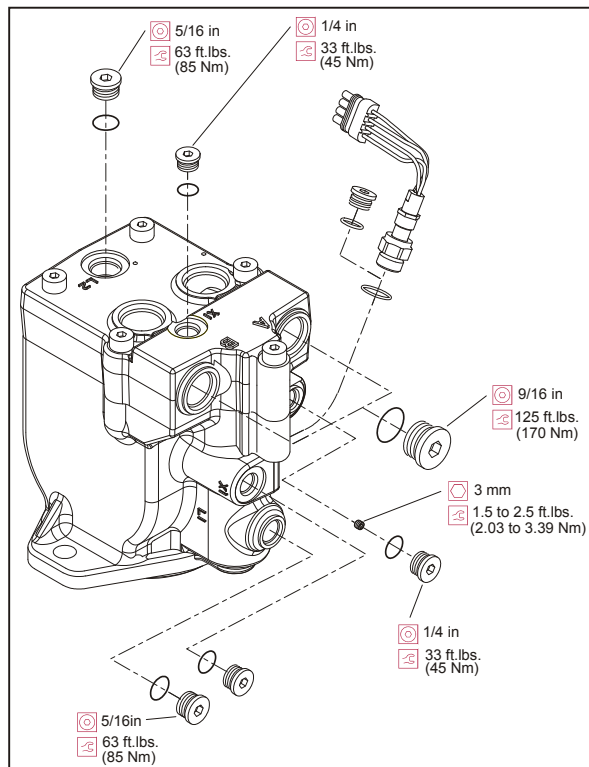
17. Before installing the shaft seal, ensure the shaft turns smoothly with less than 120 in. lbs. (13.5 Nm) of force. If the shaft does not turn smoothly within the specified maximum force, disassemble and check the unit.
18. Cover shaft splines with an installation sleeve. Install a new shaft seal (27) 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 3-44. Shaft Seal

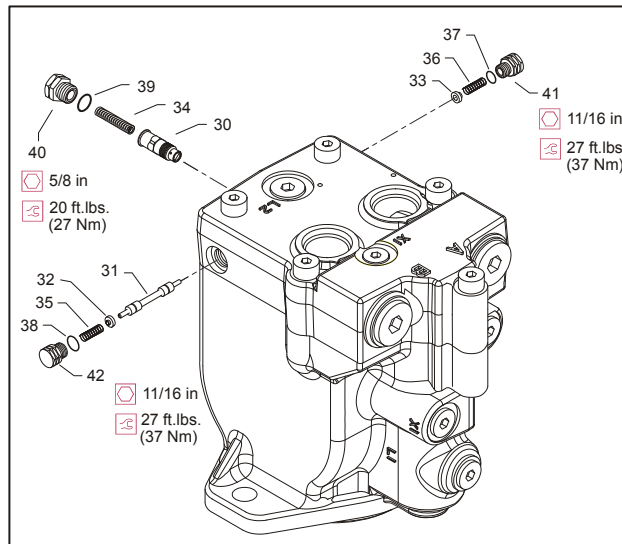
- 19.** Install remaining plugs and fittings to the housing. Refer to the Figure 3-45., Plugs and Fittings Installation for wrench sizes and installation torques.



30. Shaft Seal
31. Seal Support Washer
32. Snap Ring

Figure 3-45. Plugs and Fittings Installation

- 20.** Install orifice poppet (30).



- | | | | |
|--------------------|------------|------------|----------|
| 33. Orifice Poppet | 37. Spring | 40. O-ring | 43. Plug |
| 34. Shift Spool | 38. Spring | 41. O-ring | 44. Plug |
| 35. Spring | 39. Spring | 42. O-ring | 45. Plug |
| 36. Spring | | | |

Figure 3-46. 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. (15.87 mm) wrench torque plug (40) to 20 ft. lbs. (27 Nm).
- 26.** Using a 11/16 in. (17.46 mm) 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 0-500 psi (0-35 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.

Troubleshooting

Table 3-6. 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 3-7. 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.

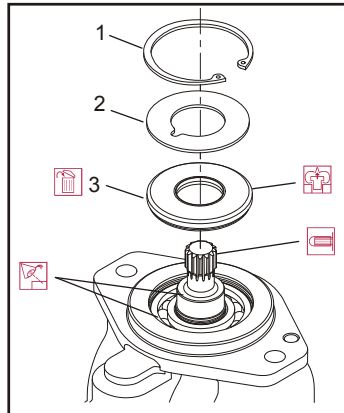
Table 3-8. Won't Shift or Slow to Start

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.

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 3-47. 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.

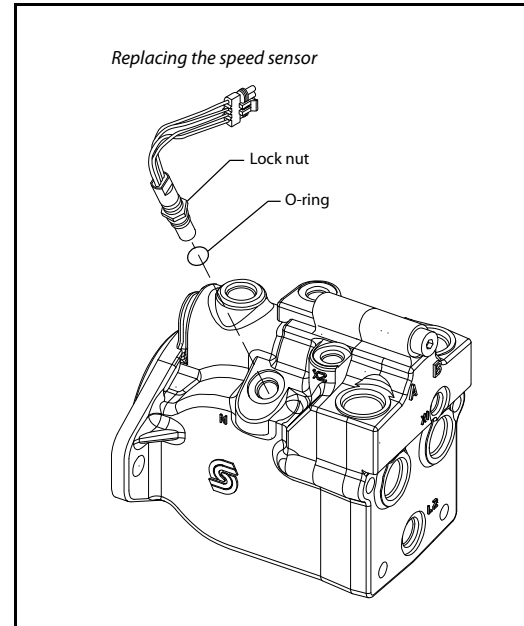
INSTALLATION

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.

Speed Sensor Replacement

REMOVAL

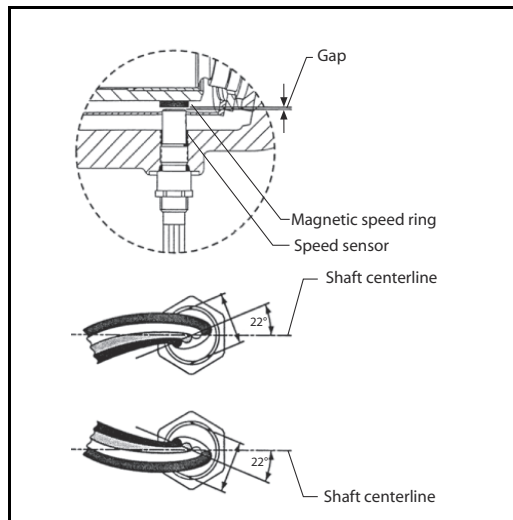
1. Disconnect the speed sensor electrical connector.
2. Using an 11/16 in. wrench, loosen the locknut.
3. Using a 1/2 in. wrench, remove the speed sensor and o-ring from the motor.



INSTALL THE NEW SPEED SENSOR

1. Turn speed sensor with O-ring in (CW) by hand until bottom end gently touches the speed ring.
2. Back out speed sensor (CCW) 1/4 turn. Continue backing out until the flats are 22 degree either side of the motor shaft center line (20-30 degree is acceptable). Do not back out more than 3/4 turn from touching bottom.
3. Using a 1/2 in. wrench to hold the speed sensor, torque the lock nut to 10ft. lbs. (13 Nm) with an 11/16 in. wrench.
4. Plug in electrical connection and start machine to test for proper operation.

Minor Repair



Speed Sensor Adjustment

ADJUSTMENT AND TROUBLESHOOTING

1. Wire configuration

Red = Power
White = Speed signal
Black = Ground (common)
Green = Direction

2. Speed signal

Check for speed output using a Volt Ohm Meter (VOM). Place VOM across the ground and speed pins or terminals, (Black=Ground, White=Speed Signal) and set VOM to the DC Volt scale and low range. To check for an output, turn pump or motor very slowly by hand or check output just as the prime mover is coming to a stop. Note a voltage pulse at meter. It will likely be difficult to read exact, simply note a pulse (approximately 60 pulses per rev). If there is no indication of a pulse, repeat installation steps and recheck.

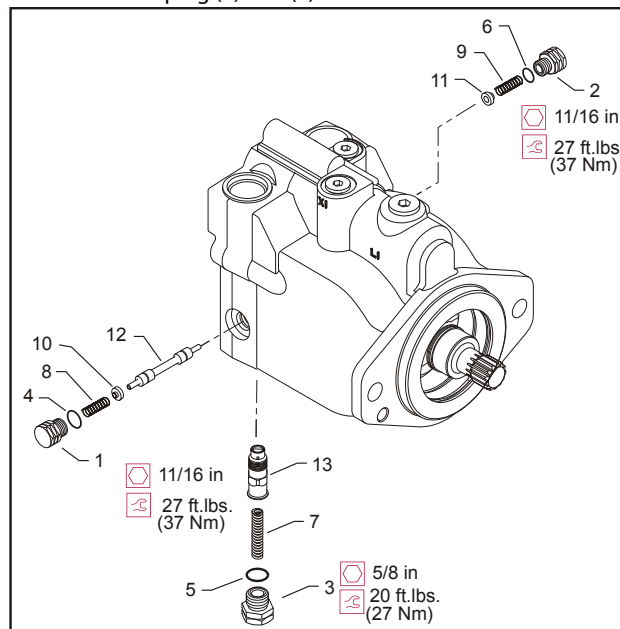
3. Directional signal

Check for a direction signal change using a VOM. Use the same VOM setup as in the above speed signal check. Turn the motor slowly and note a polarity change (\pm) on the VOM display as you change the motor direction.

Loop Flushing Valve

REMOVAL

- Using a 11/16 in. (17.46 mm) internal hex wrench remove plug (1) and (2).



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

Figure 3-48. Loop Flushing Spool

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

3.10 STEER ADJUSTMENTS

NOTE: *Spindles do not stop on cylinder stroke. Adjust steering stops as follows: Adjust item #1 to achieve 44° inside turn angles. Steer full left and adjust RH item #2 to contact axle. Steer full right and adjust LH item #2 to contact axle. (2WS/2WD).*

Spindles do not stop on cylinder stroke. Adjust steering stops as follows: Adjust item #1 to achieve 39° inside turn angles. Steer full left and adjust RH item #2 to contact axle. Steer full right and adjust LH item #2 to contact axle. (2WS/4WD).

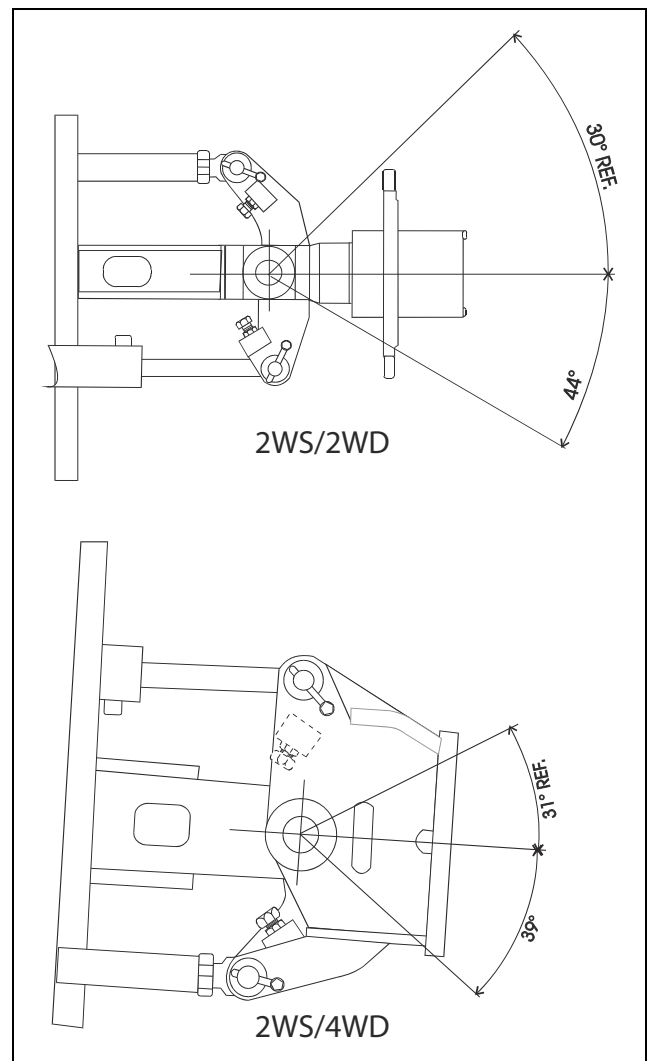


Figure 3-49. Steer Adjustments

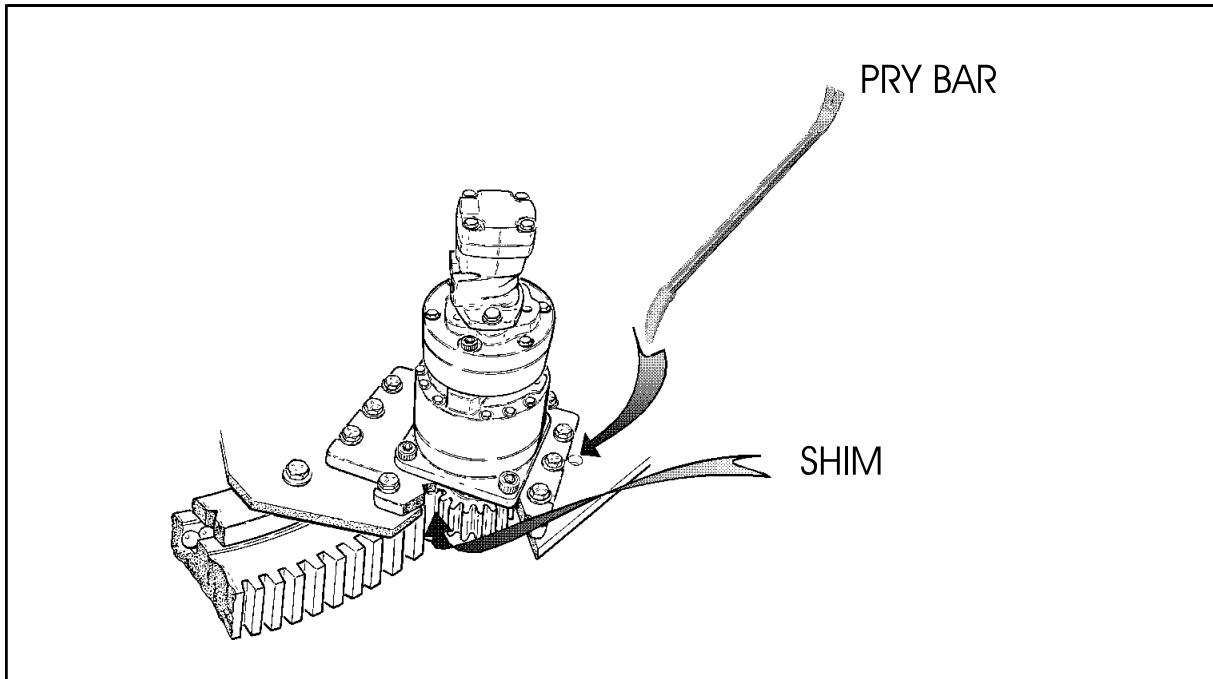
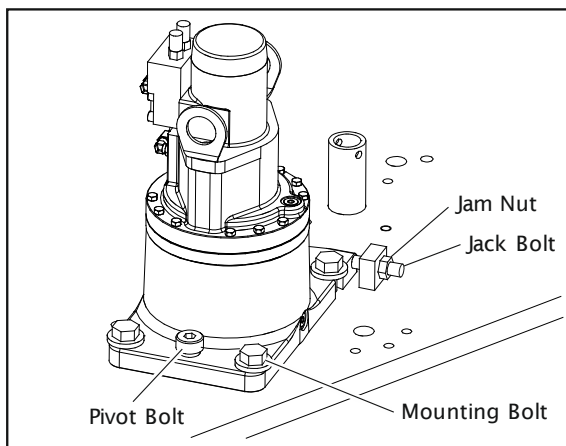


Figure 3-50. Swing Drive Hub Adjustment

3.11 SWING HUB REMOVAL

1. Disconnect all wiring harness terminals connected to the swing motor.
2. Gently loosen the set screw. Do not remove.
3. Remove the pivot bolt using Allen Wrench.
4. Remove the mounting bolts securing swing drive hub to the turntable.
5. Using the suitable lifting device, remove the swing drive hub from mounting plate without damaging the swing gear.
6. Place swing drive hub in the clean area.
7. Refer to Section , for swing drive maintenance.



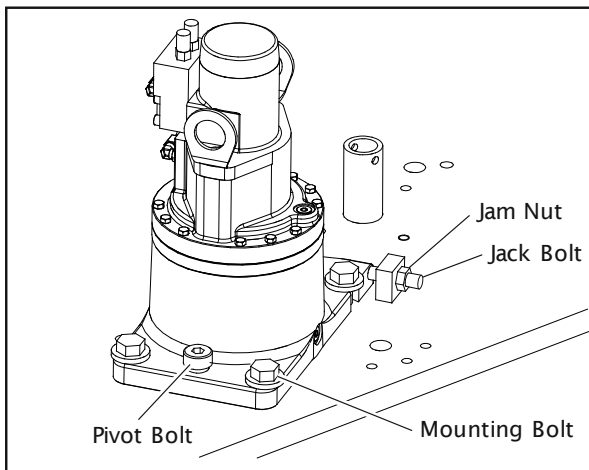
3.12 SWING HUB INSTALLATION

Ensure mounting plate and mounting location of the base plate are clean and painted with a uniform coating of minimum thickness (no runs, drips, etc.).

Procedure For Setting Swing Gear Backlash

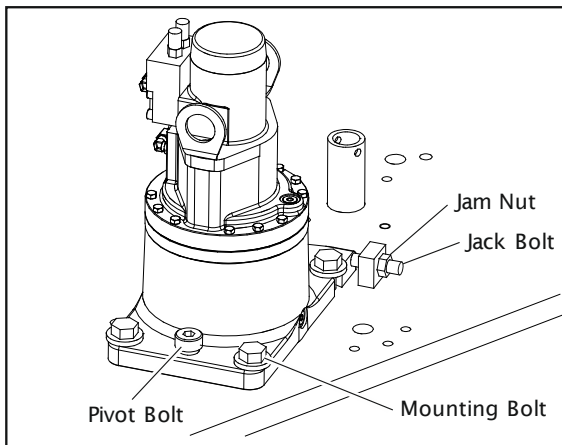
Set backlash to 0.010 in. to 0.015 in. (0.254 mm - 0.381 mm) using the following procedure:

1. Place the machine on firm, level ground.
2. Place shim between pinion and bearing at bearing high spot (shown below).

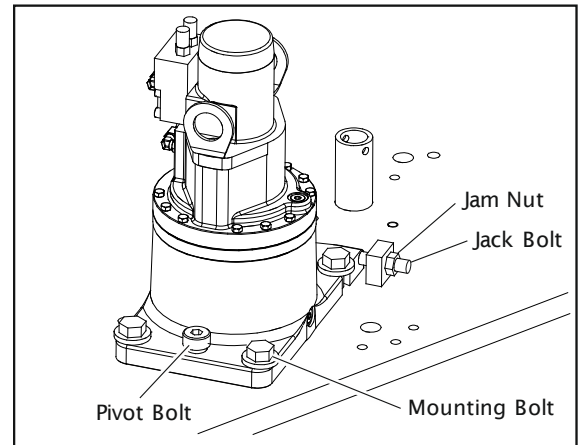


3. Apply JLG Threadlocker P/N 0100019 and torque pivot bolt to 205 ft. lbs. (280 Nm) (shown below).

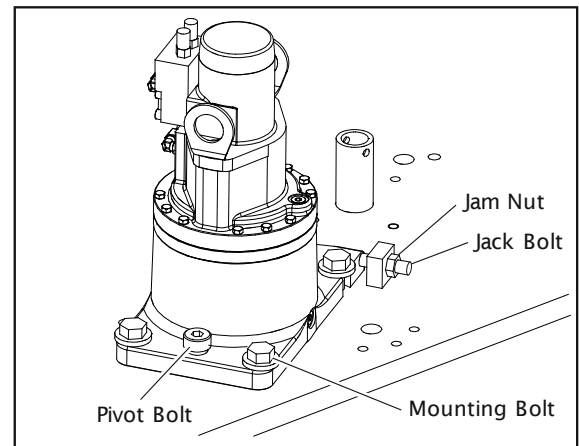
NOTE: Make sure the turntable is properly supported during the following step. The turntable can swing a few degrees when the turntable lock is removed if the turntable is not balanced properly.



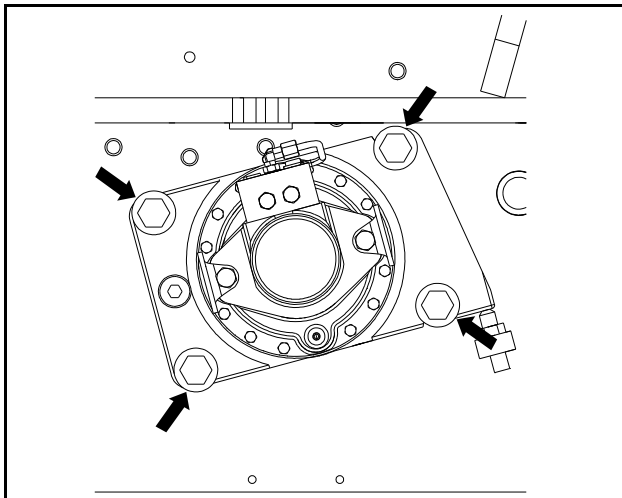
4. Remove turntable lock pin.
5. Apply JLG Threadlocker P/N 0100019 and pre-torque swing drive mounting bolts to 30 ft. lbs. (40 Nm).



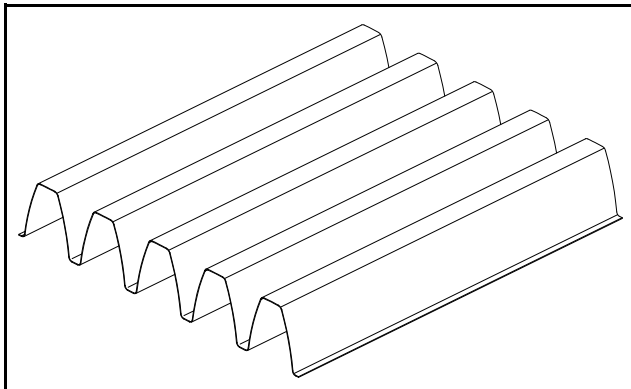
6. Tighten jack bolt until pinion is completely snug against shim and bearing then loosen jack bolt.



7. Apply JLG Threadlocker P/N 0100019 and torque jack bolt 50 ft. lbs. (68 Nm).
8. Apply JLG Threadlocker P/N 0100019 and tighten jam nut.
9. Torque mounting bolts to 340 ft. lbs. (Nm).

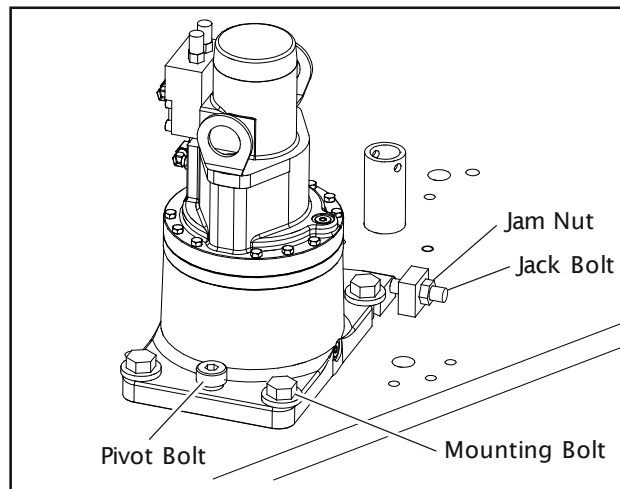


10. Remove shim and discard..



Swing Drive Lubrication

Fill Swing Drive Gearbox with 43 oz (1.27 L) 90w80gear oil with EP additives. Oil should cover the ring gear. Torque pipe plug to 23-25 ft. lbs. (31- 33 Nm).



3.13 SWING HUB (USA BUILT MACHINES, SN 0300087000 THROUGH 0300137441)

Adjustment Procedures

NOTE: The swing bearing high spot is usually marked with a colored paint.

1. Ensure swing drive is located on bearing gear max eccentric tooth (high spot).
2. With mounting free to slide, shim between pinion and bearing gear teeth to achieve 0.008 - 0.012 in. (0.20 - 0.30 mm) backlash.
3. Install a pry bar into hole in turntable base plate and pry swing hub back tight against shim and bearing.
4. Torque bolts according to the torque chart in Section 1.

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 cover (3).
7. Remove the retaining ring (11) from the output shaft (1A) and discard.

CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING (11) 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.

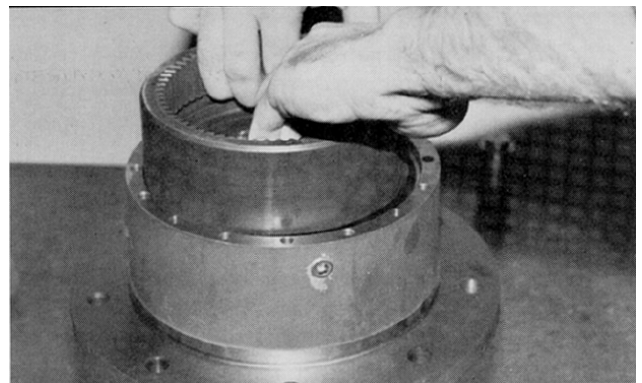
11. To remove the cluster gears (3F) from the carrier (3A), drive the anti-roll pin (3G) into the planet shaft (3E). The planet shaft (3E) may now be tapped out of the carrier. After planet shaft (3E) has been removed the roll pin (3G) can be driven out.
12. The cluster gear (3F) can now be removed from 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

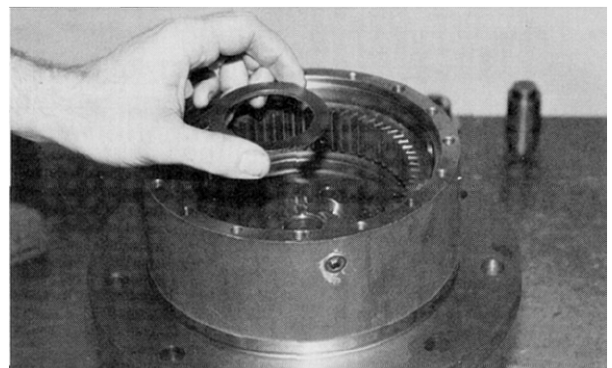
WHEN REBUILDING OR REPAIRING THE UNIT, THE RETAINING RING (11), O-RINGS (5) AND SEAL (1B) SHOULD ALWAYS BE REPLACED.

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.

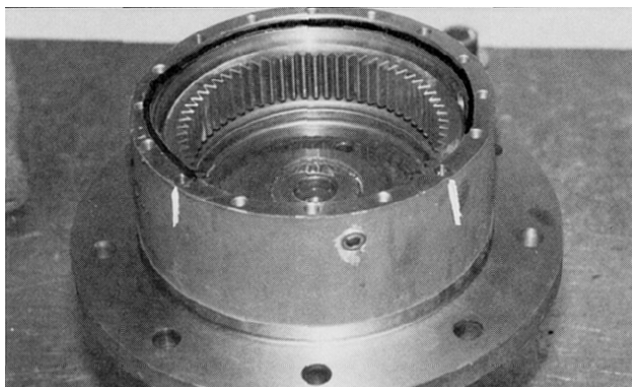


SECTION 3 - CHASSIS & TURNTABLE

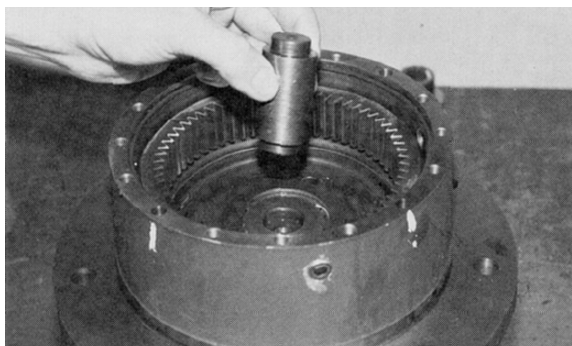
3. Place O-ring (5) into hub counterbore. Use petroleum jelly to hold O-ring in place. Also at this time locate and mark the 4 counter beamed holes in the face of the hub (1G). This is for identification later in the assembly.

⚠ CAUTION

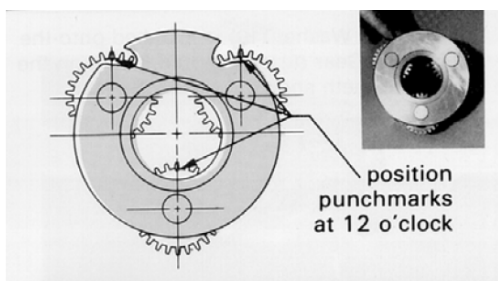
BEWARE OF SHARP EDGES OF THE COUNTERBORE WHILE SEATING THIS O-RING.



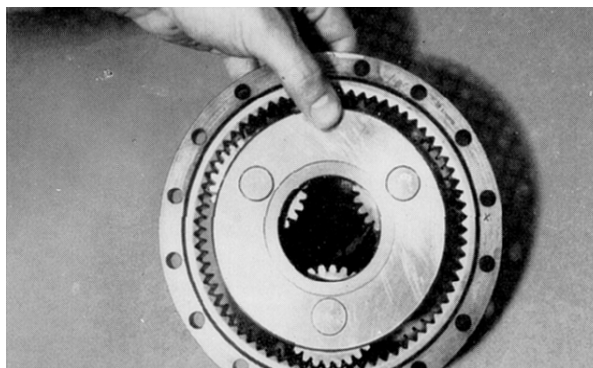
4. Thrust spacer (9) is installed into the bore of the output shaft (1A). This should be a slip fit and thrust spaces should rotate in this location.



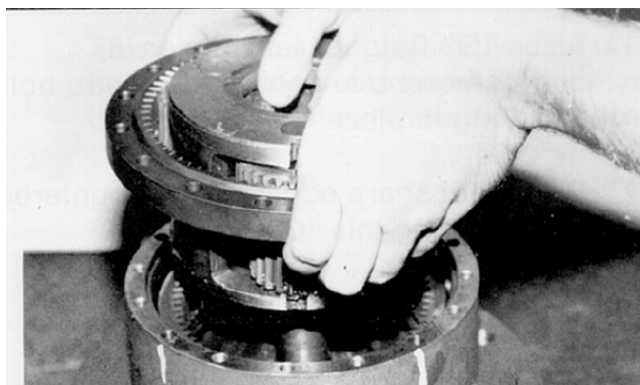
5. Place carrier assembly (3) on a flat surface with the large gears (3F) up and positioned as shown. Find the punch marked tooth on each large gear (3F) and locate at 12 o'clock (straight-up) from each planet pin. Marked tooth will be located just under the carrier (3A) on upper two gears (3F).



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.

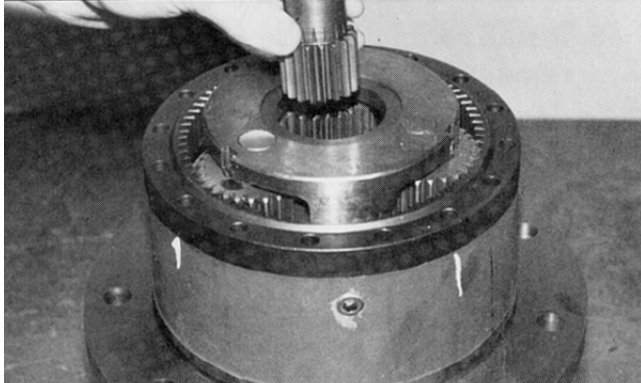


7. While holding ring gear (4) and cluster gears (3F) in mesh, place small side of cluster gears (3F) into mesh with the internal gear (2) and input gear (13). On the ring gear locate the hole marked "X" over one of the marked counterbore holes (step 3) in hub (1G).

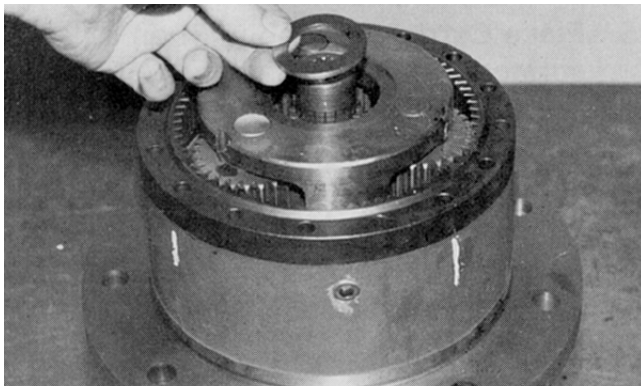


NOTE: If gears do not mesh easily or carrier assembly does not rotate freely, then remove the carrier and ring gear and check the cluster gear timing.

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).



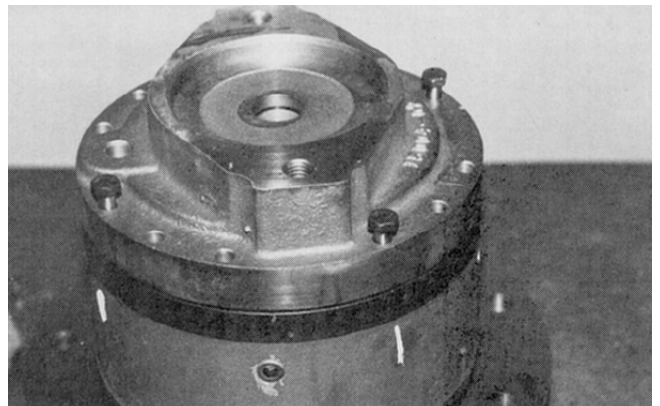
11. Place O-ring (5) into cover (6) counterbore. Use petroleum jelly to hold O-ring in place.

⚠ CAUTION

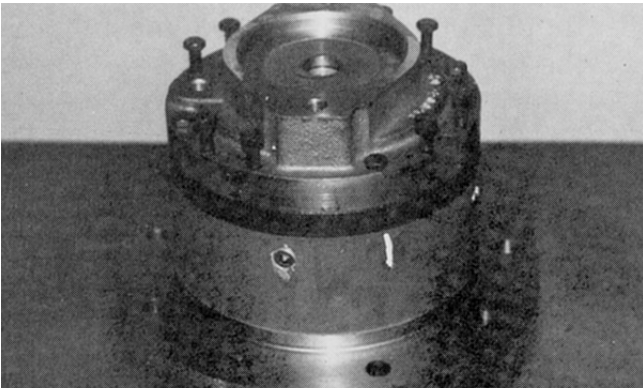
BEWARE OF SHARP EDGES OF THE COUNTERBORE WHILE SEATING THIS O-RING.



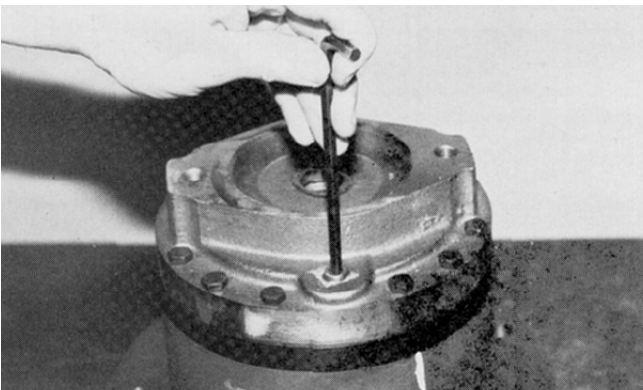
12. The cover (6) is now installed on this assembly. Taking care to correctly align pipe plug hole (20) with those in the hub (1J), usually 90° to one another. Locate the 4 counterbore holes in hub (1G) (marked in step 3) and install 4 shoulder bolts (13). A slight tap with a hammer may be necessary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



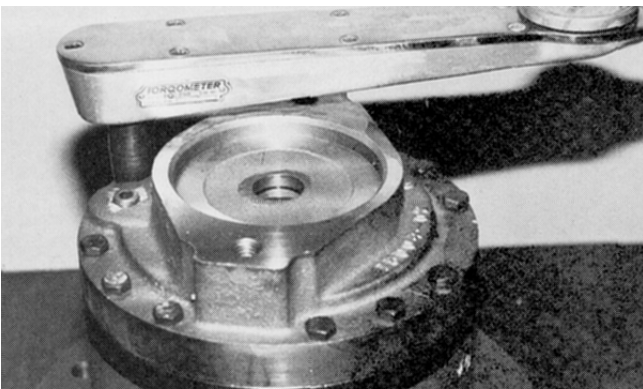
13. Install regular grade 8 bolts (12) into remaining holes.



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



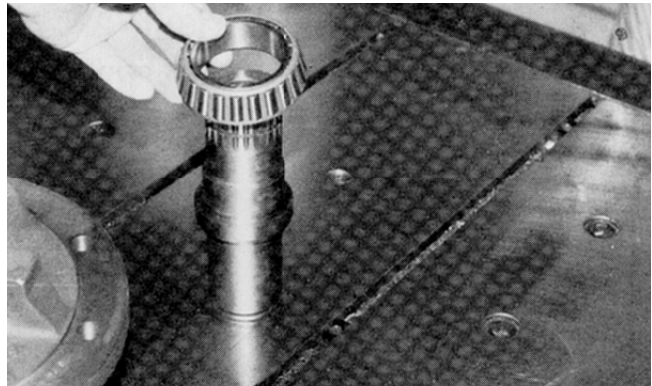
15. Torque shoulder bolts (13) to 23-27 ft. lbs. (31-37 Nm) and regular grade 8 bolts (12) to 23-27 ft. lbs. (31-37 Nm).



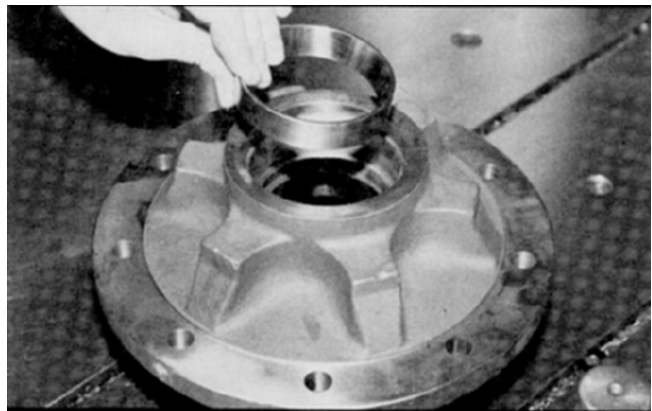
This completes the assembly. The unit must be filled one-half full of EP 90 lubricant before operation if the unit is mounted horizontally, and completely filled if mounted vertically. In vertical mounting application case oil circulation is recommended.

Hub Shaft Sub-Assembly

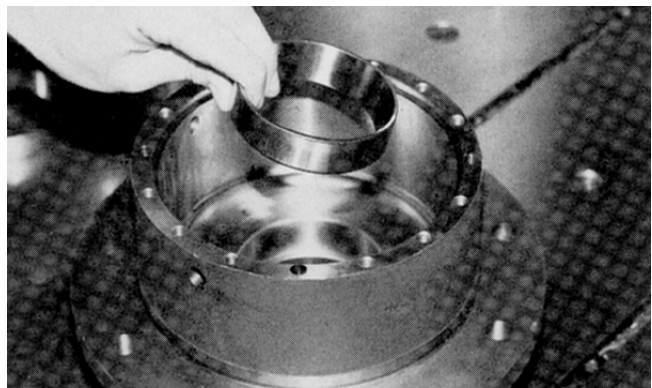
1. Press bearing cone (1D) onto shaft (1A).



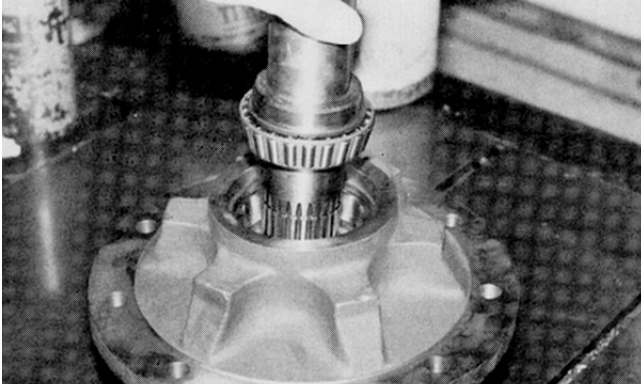
2. Press bearing cup (1C) into hub (1G) taking care to ensure cup start square with the bore of the hub.



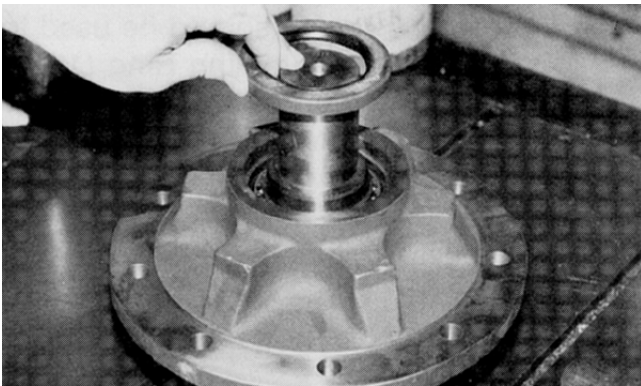
3. Invert hub (1G) and press bearing cup (1E) into intercounterbore of hub (1G).



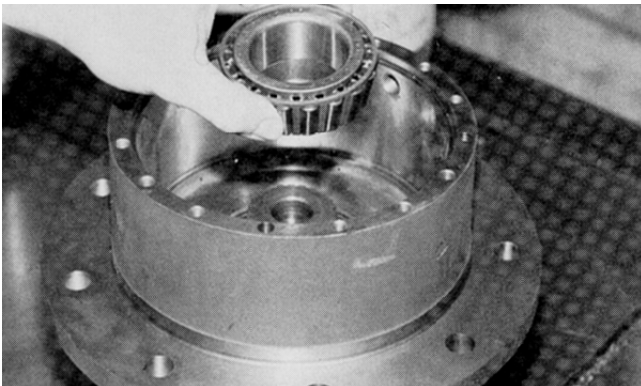
4. Returning the hub (1G) to locate on the large diameter end, the output shaft (1A) is carefully installed into the hub (1G).



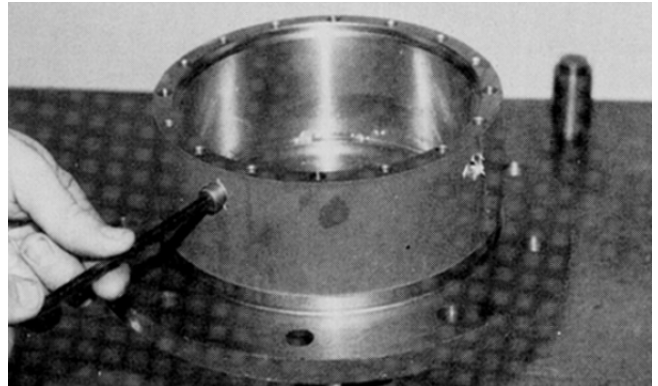
5. The shaft seal (1B) is installed over the output shaft (1A) and into the counterbore of the hub (1G). Care should be taken to ensure the seal (1B) is being correctly installed (smooth face up and located just flush with the counterbore face).



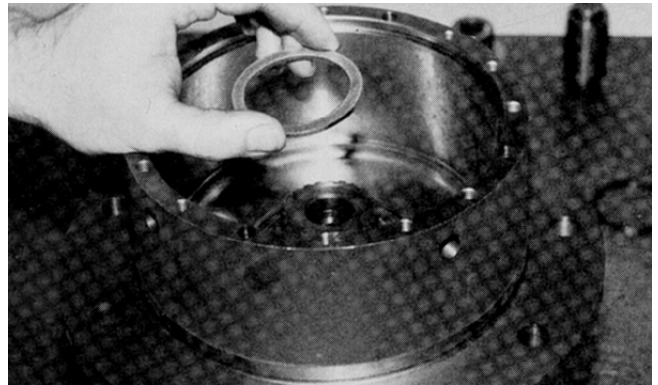
6. The bearing cone (1F) is an interference fit and has to be pressed or tapped on.



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



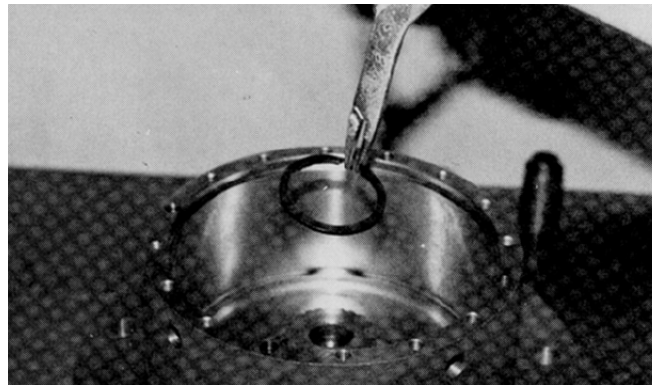
8. Bearing spacer (1H) is installed around the output shaft (1A) and locates on bearing cone (1F).



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

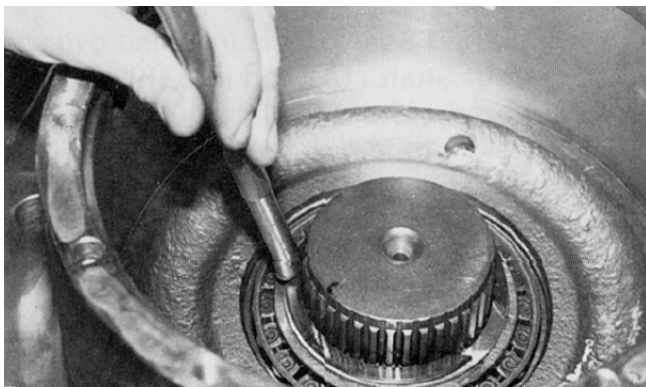
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.



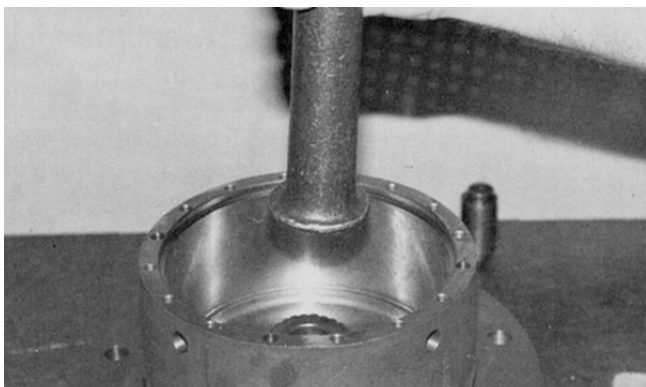
10. A soft metal punch should be used to ensure that this retaining ring (1I) is completely seated in the groove of the output shaft (1A).

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.



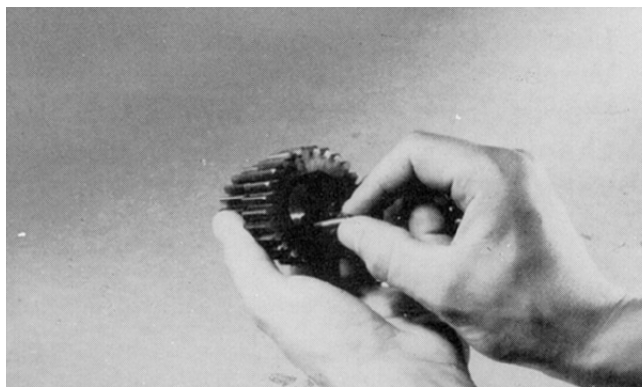
This completes the hub shaft sub-assembly-items (1A) through (1J). If this assembly is not going to be used right away, it should be oiled and covered to help prevent rusting.

Carrier Sub-Assembly

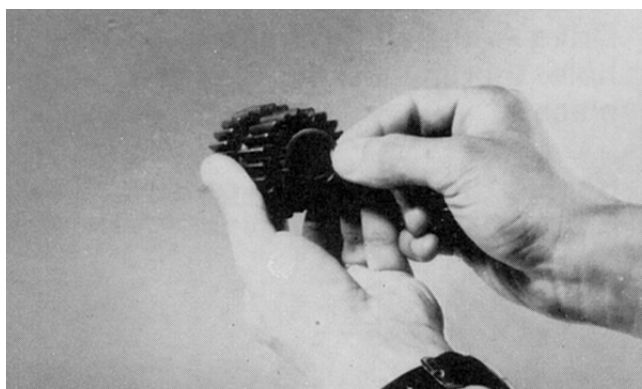
1. Apply a coat of grease or petroleum jelly to cluster gear bore.



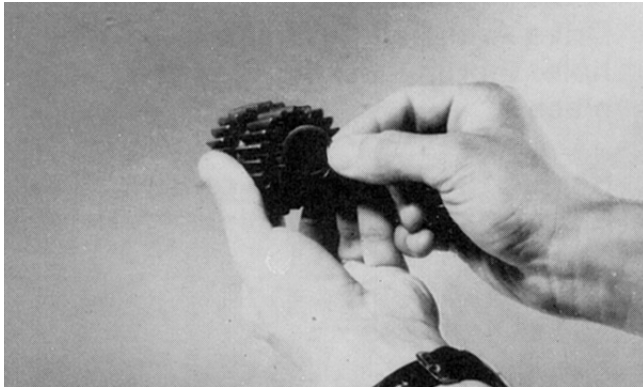
2. Place sixteen needle rollers into cluster gear bore.



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

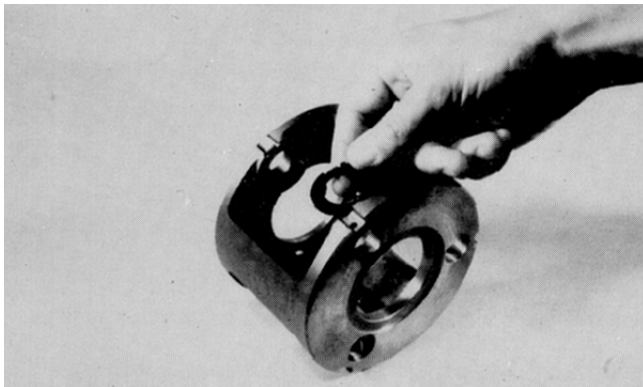


4. Place second set of sixteen needle rollers into cluster gear.

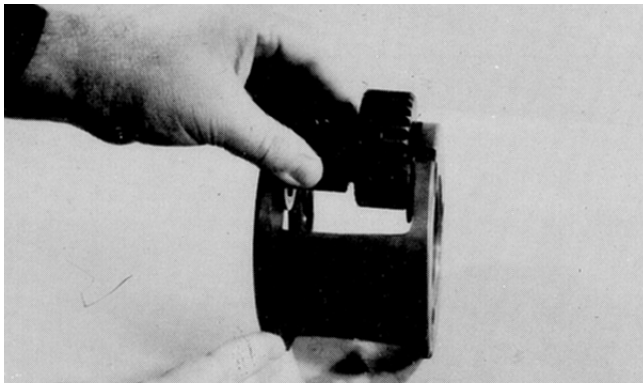


5. Apply grease or petroleum jelly to the tang side of two thrust washers. Place thrust washers against bosses in carrier with washer tang fitting into slot in carrier outside diameter.

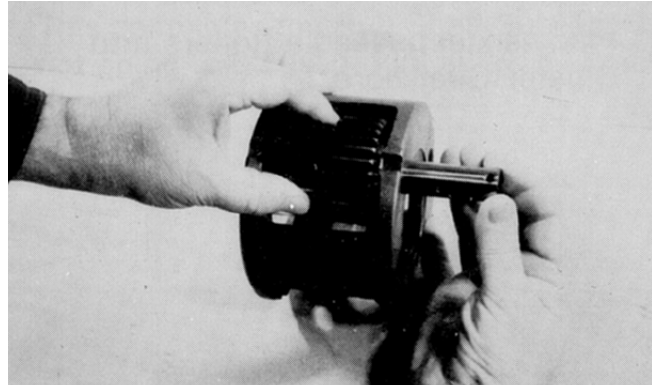
NOTE: Some old style carriers will not have slots and tangs should be located inside boss relief.



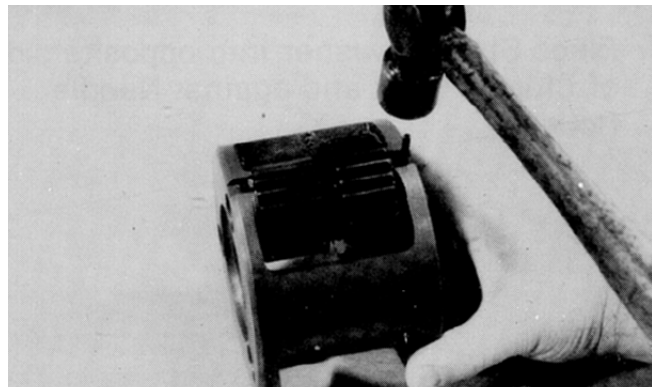
6. While keeping thrust washers in place, slide cluster gear into carrier with the larger gear on the side with the small pin hole.



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.



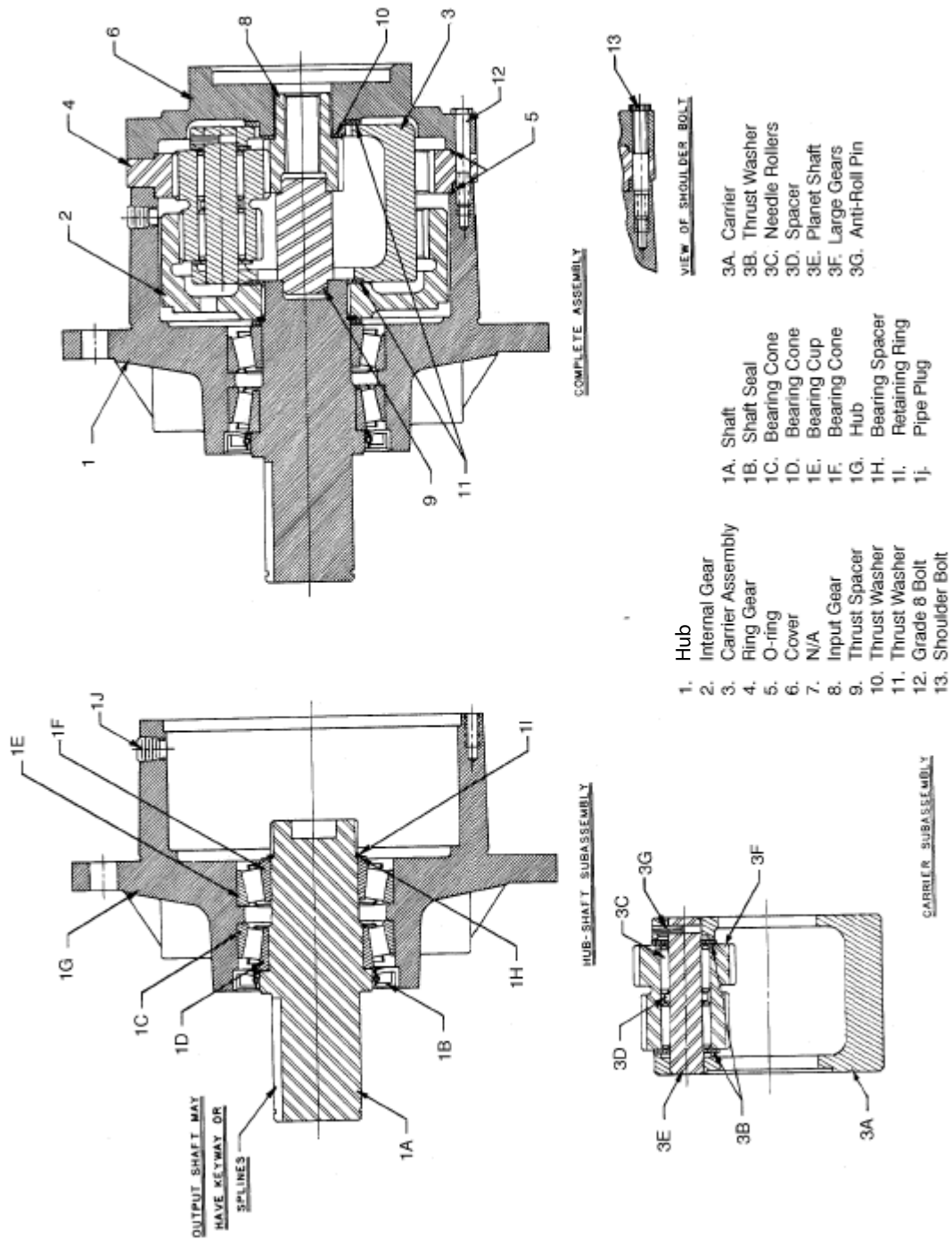
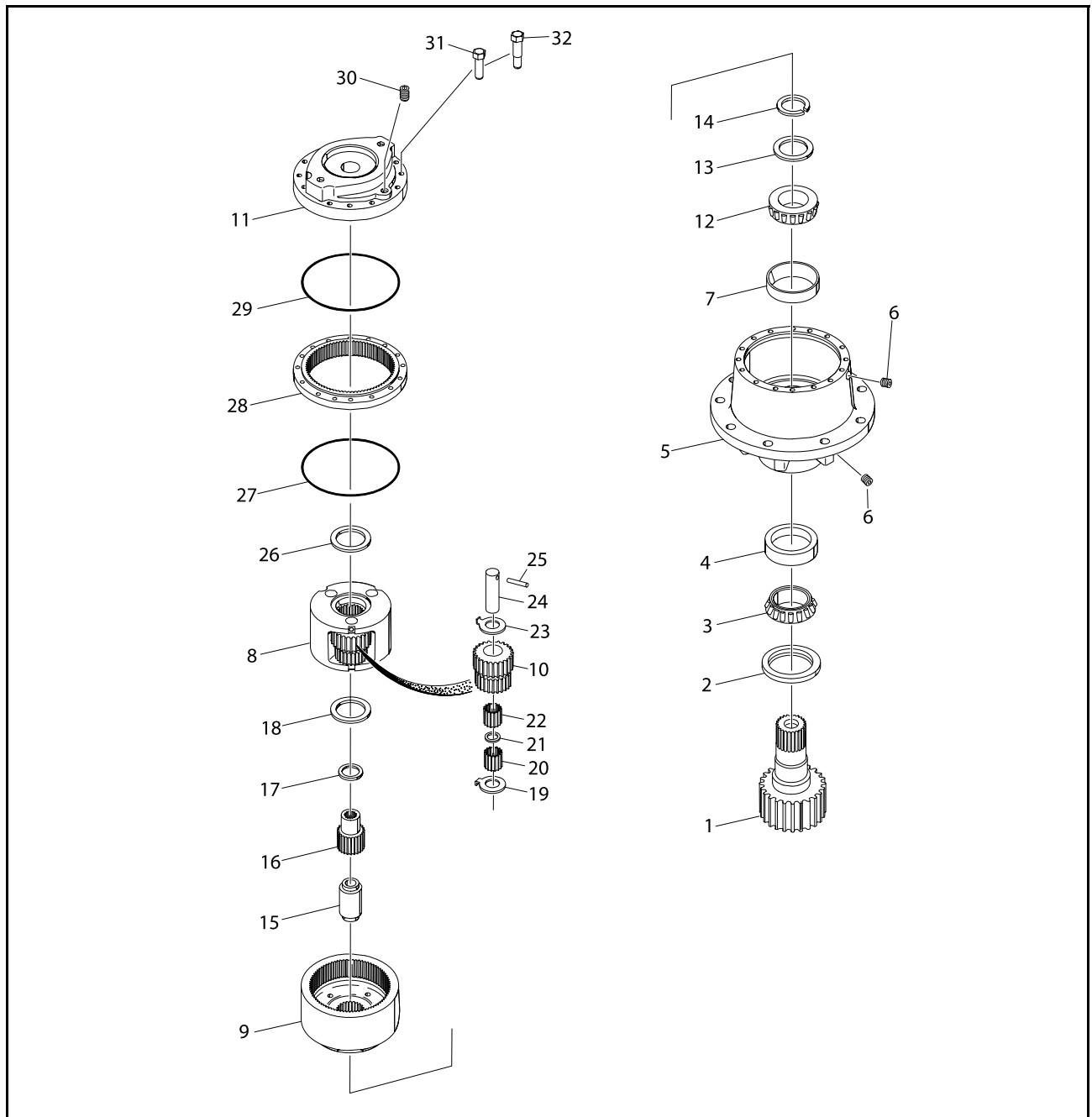


Figure 3-51. Swing Hub



- | | | | |
|-----------------|--------------------|--------------------|-------------------|
| 1. Shaft | 9. Gear | 17. Thrust Washer | 25. Rollpin |
| 2. Lip Seal | 10. Cluster Gear | 18. Thrust Washer | 26. Thrust Washer |
| 3. Cup Bearing | 11. Input Cover | 19. Thrust Washer | 27. O-ring |
| 4. Cone Bearing | 12. Cone Bearing | 20. Needle Bearing | 28. Gear Ring |
| 5. Housing | 13. Thrust Washer | 21. Spacer | 29. O-ring |
| 6. Plug | 14. Retaining Ring | 22. Needle Bearing | 30. Plug |
| 7. Cup Bearing | 15. Spacer | 23. Thrust Washer | 31. Bolt |
| 8. Carrier | 16. Sun Gear | 24. Planet Shaft | 32. Bolt |

Figure 3-52. Swing Hub Assembly

3.14 SWING HUB (USA BUILT MACHINES, SN 0300137441 THROUGH 0300171769 AND CHINA BUILT MACHINES, SN B300000100 THROUGH B300000969)

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 pressure testing using the Brake Leak Test procedure below or by tightening the 12 bolts into the piston through the end plate (See Brake Disassembly Procedure).

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

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. Release the pressure at the Brake Housing (6) and remove the test fixtures.

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 air checker 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 (0.7 bar) for 20 minutes.

Brake Test

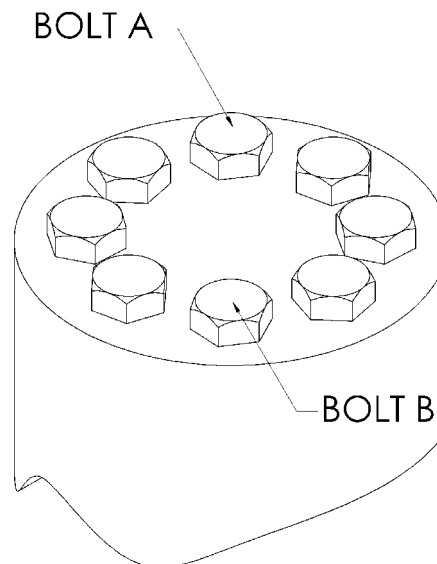
The brake test must be performed with the Motor removed and the Brake Test Plate (T-214404) installed. Install the Hex Bolts through Brake Test Plate and torque to 80 - 100 ft. lbs. (108-135 Nm). Install Roll Checking Tool (T-212731) and apply 210 psi (14 bar) to the o-ring port in the side of the Brake Housing. The roll checking fixture should roll freely. Increase the pressure to 3000 psi (207 bar) and perform the Roll Test.

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 capscrews in a bolt circle.

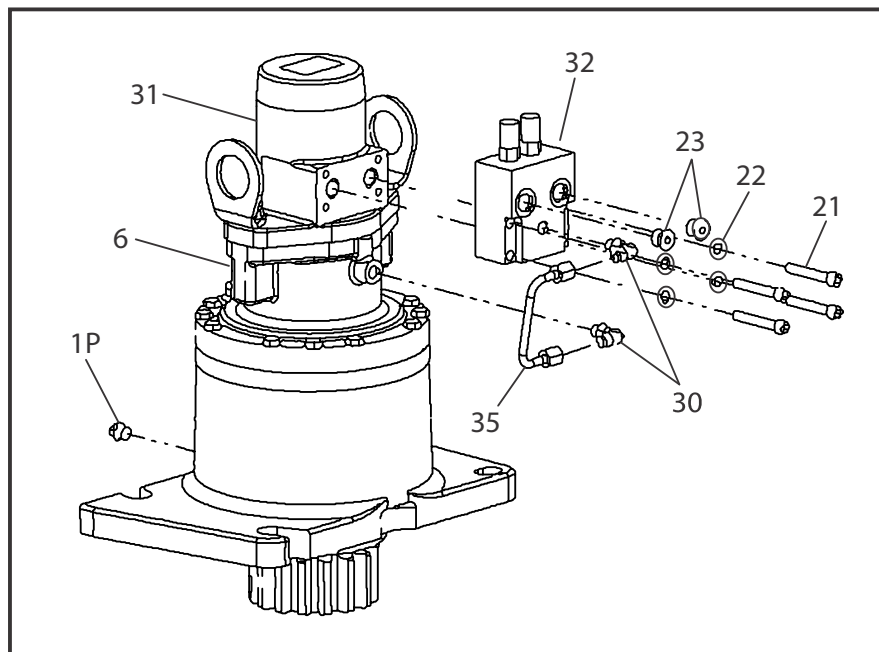


1. Tighten (but do not torque) bolt "A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt "A".
5. Using the same sequence,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

Motor Control Valve Disassembly

NOTE: Refer to Figure 3-53.

1. Place unit on bench with the motor end up.
2. Remove O-ring plug (1P) and drain the oil from the gear-box.
3. Remove hydraulic tubing assembly (35) by loosening fittings on both ends of tube with a wrench.
4. Using a wrench, loosen jam nuts on elbow fittings (30) and remove fittings from brake (6) and Motor control valve (32).
5. Remove O-ring plugs (23) from Motor control valve (32).
6. Remove motor control valve (32) from motor (31) by removing the four bolts (21) and washers (22).



- | | |
|--------------------|-------------------------|
| 1P. O-ring Plug | 30. Elbow Fitting |
| 6. Hydraulic Brake | 31. Hydraulic Motor |
| 21. Hex Bolt | 32. Motor Control Valve |
| 22. Lockwasher | 35. Hydraulic Tubing |
| 23. Plug | |

Figure 3-53. Motor Control Valve

Motor and Brake Disassembly

NOTE: Refer to Figure 3-54.

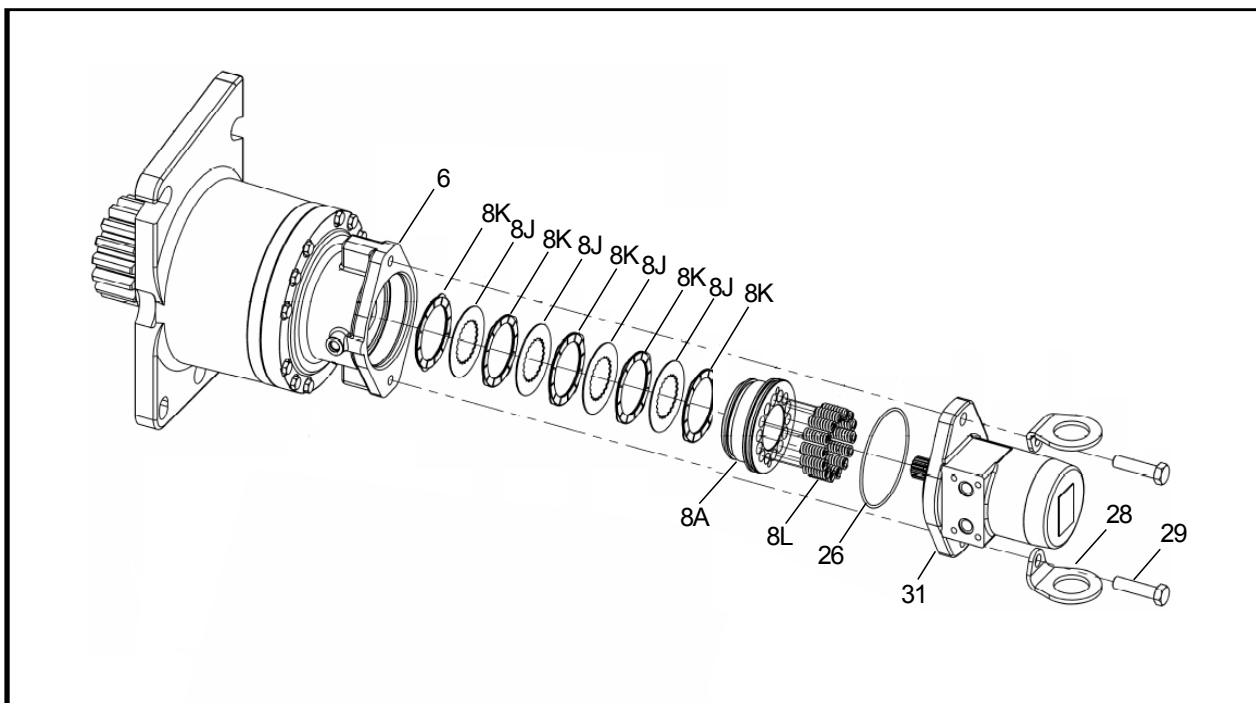
1. With unit resting on bench with motor (31) end up, loosen hex bolts (29) and remove lift lugs (28) from the motor (31).
2. Pull Motor (31) straight up and remove motor (31) from brake housing (6).
3. Remove O-ring (26) from between motor (31) and Brake Housing (6).

4. Remove the springs (8L) from the piston.
5. Apply less than 50 psi (3.45 bar) air to the "brake port" to remove Brake Piston (8A).

⚠ CAUTION

THE PISTON MAY MOVE QUICKLY. EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

6. Remove rotors (8J) and stators (8K) from Brake Housing (6).



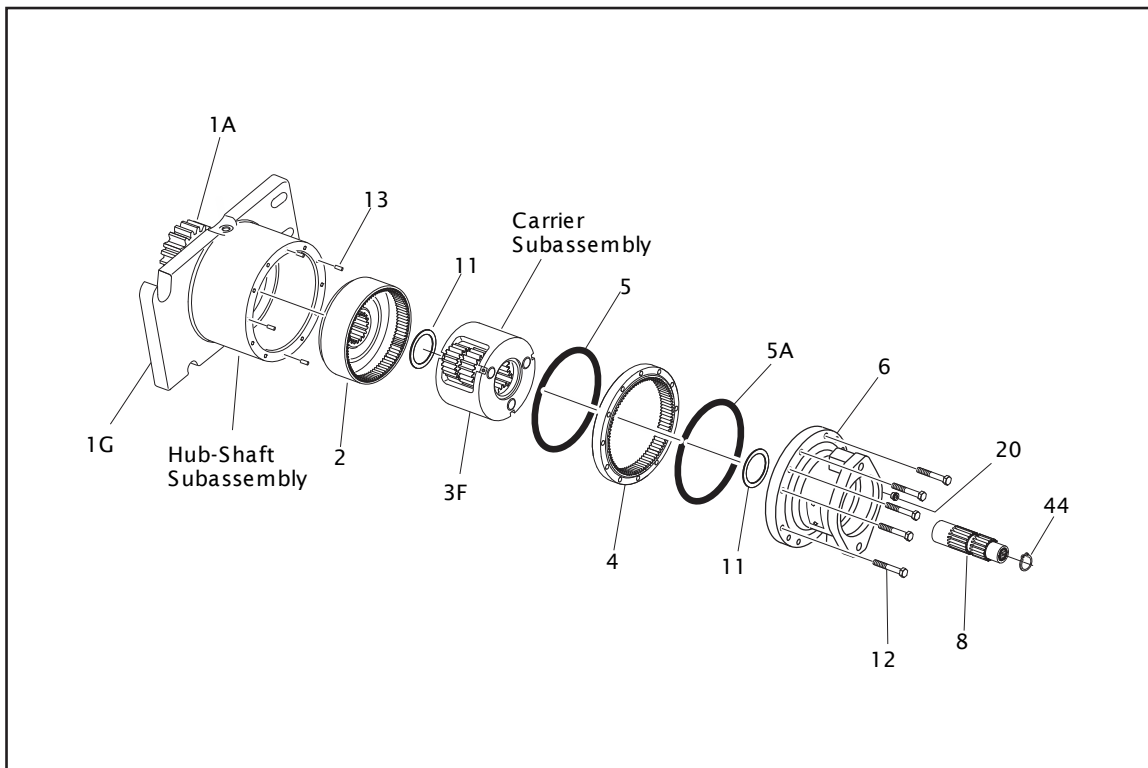
- | | |
|------------------|--------------|
| 6. Brake Housing | 26. O-ring |
| 8A. Brake Piston | 28. Lift Lug |
| 8L. Spring | 29. Hex Bolt |
| 8J. Rotors | 31. Motor |
| 8K. Stator | |

Figure 3-54. Motor and Brake

Main Drive Disassembly

NOTE: Refer to Figure 3-55.

1. Remove sun gear (8) with retaining ring (44) inside.
2. With the unit resting on the output shaft (pinion) (1A), remove the bolts (12) from the brake housing (6).
3. Remove the brake housing (6) from the main assembly.
4. Remove O-ring (5A) from between brake housing (6) and Ring Gear (4).
5. Remove thrust washer (11) from between brake housing (6) and carrier subassembly.
6. Remove ring gear (4) from housing (1G).
7. Remove O-ring (5) from between ring gear (4) and housing (1G).
8. Remove carrier sub-assembly.
9. Remove thrust washer (11) from between carrier sub-assembly and internal gear (2).
10. Remove internal gear (2).



- | | | |
|---------------------------|-------------------|---------------|
| 1A. Output Shaft (Pinion) | 5. O-ring | 12. Bolt |
| 1G. Housing | 5A. O-ring | 13. Dowel Pin |
| 2. Internal Gear | 6. Brake Housing | 20. Pipe Plug |
| 3F. Carrier subassembly | 8. Sun Gear | 44. Ring |
| 4. Ring Gear | 11. Thrust Washer | |

Figure 3-55. Main Drive Assembly

Hub-Shaft Disassembly

NOTE: Refer to Figure 3-56.

1. Using retaining ring pliers remove retaining ring (1I) from groove in Output Shaft (1A) and discard.

⚠ CAUTION

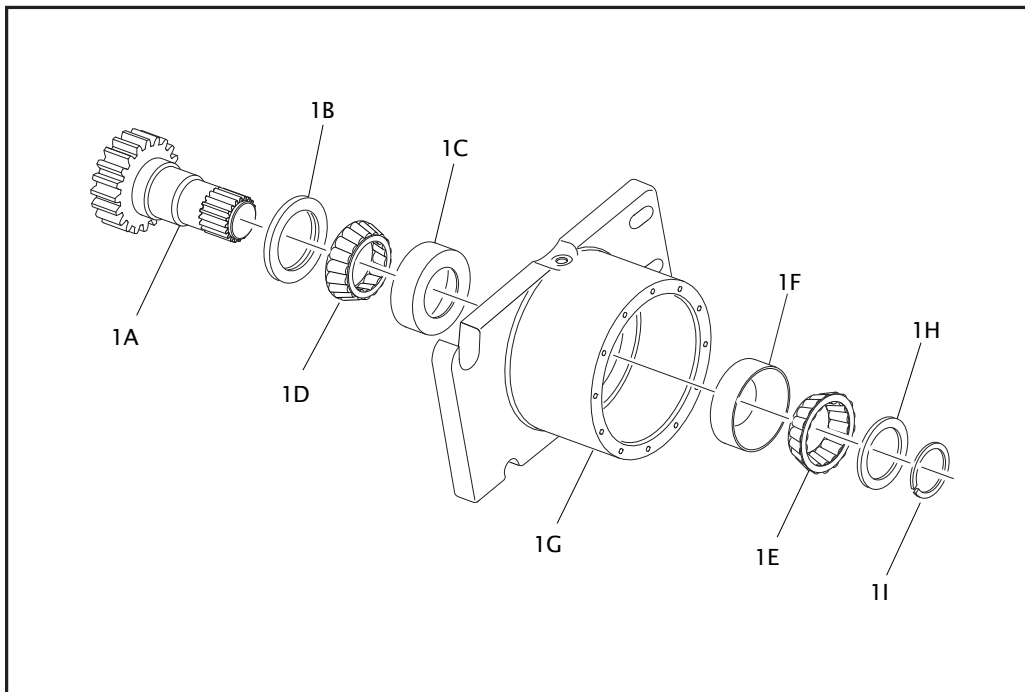
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

2. Remove thrust washer (1H).

3. While supporting the housing (1G) on the output shaft (1A) end, press the output shaft (1A) out of the housing (1G).

NOTE: The lip seal (1B) will be pressed out of the housing (1G) by the bearing cone (1D) during this step.

4. Remove the bearing cone (1E) from the housing (1G).
5. Use a bearing puller to remove the bearing cone (1D) from the shaft (1A).
6. Bearing cups (1C) & (1F) will remain in housing (1G).



- | | |
|------------------|--------------------|
| 1A. Output Shaft | 1F. Bearing Cup |
| 1B. Lip Seal | 1G. Housing |
| 1C. Bearing Cup | 1H. Thrust Washer |
| 1D. Bearing Cone | 1I. Retaining Ring |
| 1E. Bearing Cone | |

Figure 3-56. Hub-Shaft

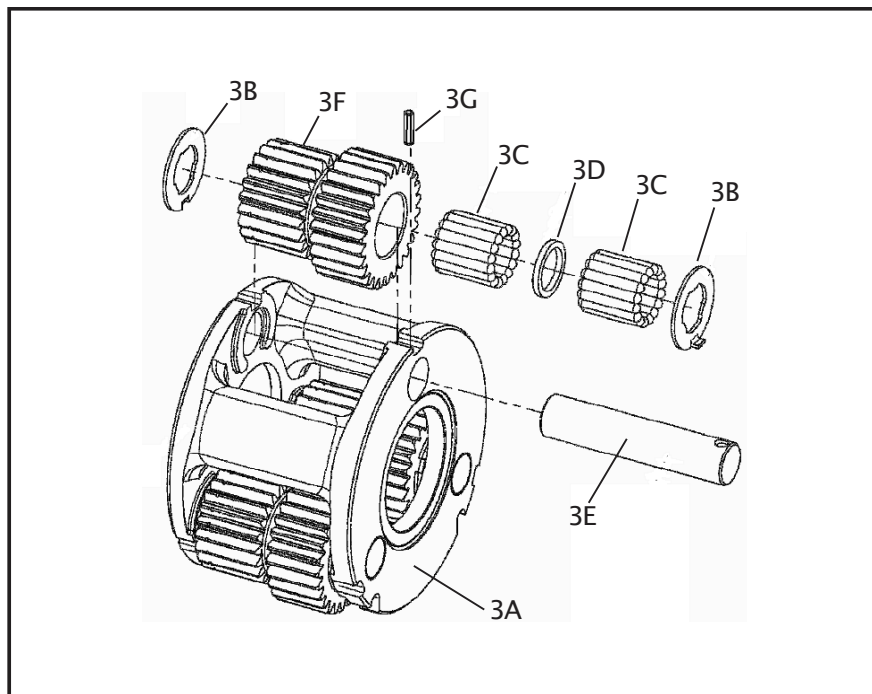
Carrier Disassembly

NOTE: Refer to Figure 3-57.

1. Using a 3/16 in. punch drive the roll pin (3G) which holds the planet shaft (3E) in the carrier (3A) down into the planet shaft (3E) 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 (3E) from the carrier (3A). Use a small punch to remove the roll pin (3D) from the planet shaft (3E).
3. Slide the planet gear (3F), the two thrust washers (3B) out of the carrier (3A).
4. Remove both rows of needle bearings (3C) and the spacer (3D) from the bore of the planet gear (3F).
5. Repeat Steps 1 thru 4 for the remaining two cluster gears (3F).



- | | |
|--------------------|------------------|
| 3A. Carrier | 3E. Planet Shaft |
| 3B. Thrust Washers | 3F. Cluster Gear |
| 3C. Needle Bearing | 3G. Roll Pin |
| 3D. Spacer | |

Figure 3-57. Carrier

Hub-Shaft Assembly

NOTE: Refer to Figure 3-56.

1. Press bearing cup (1C) into housing (1G) taking care to ensure cup starts square with the bore of hub (1G).
2. Place bearing cone (1D) in bearing cup (1C) in housing (1G).
3. Press or tap seal (1B) into the counterbore of housing (1G) to the point where it becomes flush with the housing (1G) face. Care should be taken to ensure seal (1B) is being correctly installed (smooth face up). Apply grease to the rubber portion of the seal bore.
4. Invert hub (1G) and press bearing cup (1E) into counterbore of housing (1G).
5. Carefully lower housing (1G) onto the output shaft (1A) until bearing cone (1D) contacts the output shaft (1A).
6. Press on the small end of the bearing cone (1D), being careful not to contact the bearing cage, until the bearing cone (1D) seats on the shoulder of the output shaft (1A).
7. Start the bearing cone (1F) onto the output shaft (1A).
8. Press or tap the bearing cone (1F) onto the output shaft (1A) until it is just seated in the bearing cup (1E). while rotating the housing (G).
9. Install bearing spacer (1H) onto output shaft (1A) and against bearing cone (1F).
10. Install retaining ring (1I) into the groove in the output shaft (1A). This retaining ring (1I) should never be reused in a repair or rebuild.

WARNING

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

11. Tap the retaining ring (1I) with a soft metal punch to ensure that the retaining ring (1I) is completely seated in the groove of the output shaft (1A).

WARNING

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

12. Install O-ring plug (1P) and torque to 23-24 ft. lbs. (31 - 32 Nm).

Carrier Assembly

NOTE: Refer to Figure 3-57.

1. Apply a liberal Coat of grease to the bore of cluster gear (3F). This will enable the needle rollers (3C) to be held in place during assembly.
2. Install the first row of needle rollers (3C) into the bore of cluster gear (3F).
3. Insert spacer (3D) into bore of cluster gear (3F) on top of the needle rollers (3C).
4. Place second row of needle rollers (3C) into bore of cluster gear (3F) against spacer (3D).
5. Place carrier (3A) so that one of the roll pin holes is straight up.
6. Start planet shaft (3E) through the hole in carrier (3A). Using ample grease to hold it in position, slide one thrust washer (3B) over the planet shaft (3E) with the tang resting in the cast slot of the carrier (3A).
7. With large end of cluster gear (3F) facing the roll pin hole in the Carrier, place the Cluster Gear into position in carrier (3A) and push planet shaft (3E) through the cluster gear (3F) without going all the way through.
8. Slide the second thrust washer (3B) between the cluster gear (3F) and the carrier (3A) with the tang of the washer located in the cast slot of the carrier (3A). Finish sliding the planet shaft (3E) through the thrust washer (3B) and into the carrier (3A).
9. Position the non-chamfered side on the planet shaft (3E) roll pin hole so that it is in line with the hole in the carrier (3A) using a 1/8 in. (3 mm) diameter punch.
10. After using a 3/16 in. (5 mm) punch to align the two roll pin holes. Drive the roll pin (3G) through carrier (3A) and into the planet shaft (3E) until the roll pin (3G) is flush with the bottom of the cast slot in the carrier (3A) outside diameter at the thrust washer (3B) tang. Use a 1/4 in. (6 mm) pin punch to make sure the roll pin (3G) is flush in the slot.
11. Repeat Steps 1 thru 10 for the remaining two cluster gears(3F).

Main Drive Assembly

NOTE: Refer to Figure 3-55.

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 with the spline of the output shaft (1A). This will be a tight fit.
2. Inspect the location of the internal gear (2) on the output shaft (1A). The portion of the output shaft (1A) should protrude through the Internal gear (2) bore.
3. Install 4 dowel pins (13) into counter bore holes in hub (1G).
4. Install thrust washer (11) in counter bore of carrier sub-assembly (small cluster-gear end). Use grease to hold in place.
5. Place O-ring (5) into Hub counter-bore. Use grease to hold O-ring in place.

WARNING

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

6. Place carrier sub-assembly on bench with the large end of cluster gears (3F) facing up with one at the 12 o'clock position. Find the punch marked tooth on each gear at the large end and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears. Check the timing through the slots in the carrier (See carrier sub-assembly).
7. With large shoulder side of ring gear (4) facing down, place ring gear (4) over (into mesh with) cluster gears (3F). Be sure that cluster gear timing marks (punch marks) remain in correct location during ring gear (4) installation. The side of the ring gear (4) with an "X" or punch mark stamped on it should be up.
8. While holding ring gear (4) and cluster gears (3F) in mesh, place small end of cluster gears (3F) into mesh with the Internal Gear (2). On the ring gear (4) locate the hole marked "X", or punch marked, over one of the marked counter-bored holes (Step 5) in hub (1G). Check timing through the slots in the carrier. Rotate carrier in assembly to check for freedom of rotation.

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.

9. Install thrust washer (11) into the counter-bore on the face of the carrier. Use grease to hold in place.
10. Place O-ring (5A) into counter-bore or brake housing (6). Use grease to hold O-Ring in place.

CAUTION

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

11. Install the brake housing (6), taking care to correctly align pipe plug (20) with those in the hub (1G).
12. Install bolts (12) through the brake housing (6) into the hub (1G) and torque to 23-27 ft. lbs. (31-37 Nm).
13. With gearbox standing on the pinion end fill gearbox with 43 oz. of ISO VG150/VG220 gear Oil.
14. Install retaining ring (44) into the groove in the sun gear (8).
15. Install the sun gear (8) into mesh with the planet gears (3F).
16. Install pipe plug (20) into cover (6) torque to 23-24 ft. lbs. (31-32 Nm).

Motor and Brake Assembly

NOTE: Refer to Figure 3-54.

1. Alternate stators (8K) (O.D. lobes) with rotors (8J) (I.D. splines) into bore of brake housing (6). starting with a stator (8K) and ending with a stator (8K).
2. Grease the O-rings (8F) & (8D) and backup rings (8H) & (8E). and place them in their respective grooves in the brake housing (6) and piston (8A). Make sure the backup rings are correctly positioned.
3. Apply grease sparingly to the piston O.D. (8A) and the bore of the brake housing (6). Insert piston (8A) into brake housing (6) be sure not to damage the O-rings.
4. Install springs (8L) into the spring pockets of the piston (8A).
5. Test the brake and perform the roll test. Remove the brake test plate.
6. Install the O-ring (26) onto the pilot of the motor (31), use grease to keep the O-ring in place.
7. Place motor (31) into Brake pilot, and line up holes.
8. Assemble lift lugs (28) onto hex bolts (29). Assemble hex bolts (29) with lift lugs (28) through the motor (31) and brake (6) against Motor flange. Torque to 80-100 ft. lbs. (108-136 Nm).

Motor Control Valve Assembly

NOTE: Refer to Figure 3-53.

1. Lay assembly down with motor ports facing up. Remove the two plastic plugs in the motor ports, being careful not to lose the O-ring in each port. Assemble the motor control valve (32) onto the motor (31) with bolt (21) and lock washers (22). Torque bolts (21) to 23-27 ft. lbs. (31-37 Nm).

NOTE: Be sure to align the holes in the control valve with the motor ports.

2. Install elbow fittings (30) into brake (6). Do not tighten jam nuts.
3. Install elbow fittings (30) into motor control valve (32). Do not tighten jam nuts.
4. Assemble tube (35) into elbow fittings (30) and torque to 13-15 ft. lbs. (18-20 Nm). Tighten the jam nuts on the elbow fittings (30) and torque to 13-15 ft. lbs. (18-20 Nm).
5. Install one O-ring plug (23) into motor control valve (32) and torque to 30-31 ft.lbs. (41-42 Nm).
6. Pressure test brake, tube and control valve connections by applying 3000 psi (207 bar) pressure to the open port in the Motor Control Valve (32) and holding for 1 minute. Check for leaks at the control-valve-motor interface and the tube connections. Release pressure and install the remaining O-ring plug (23) into motor control valve (32) and torque to 30-31 ft. lbs. (41-42 Nm).

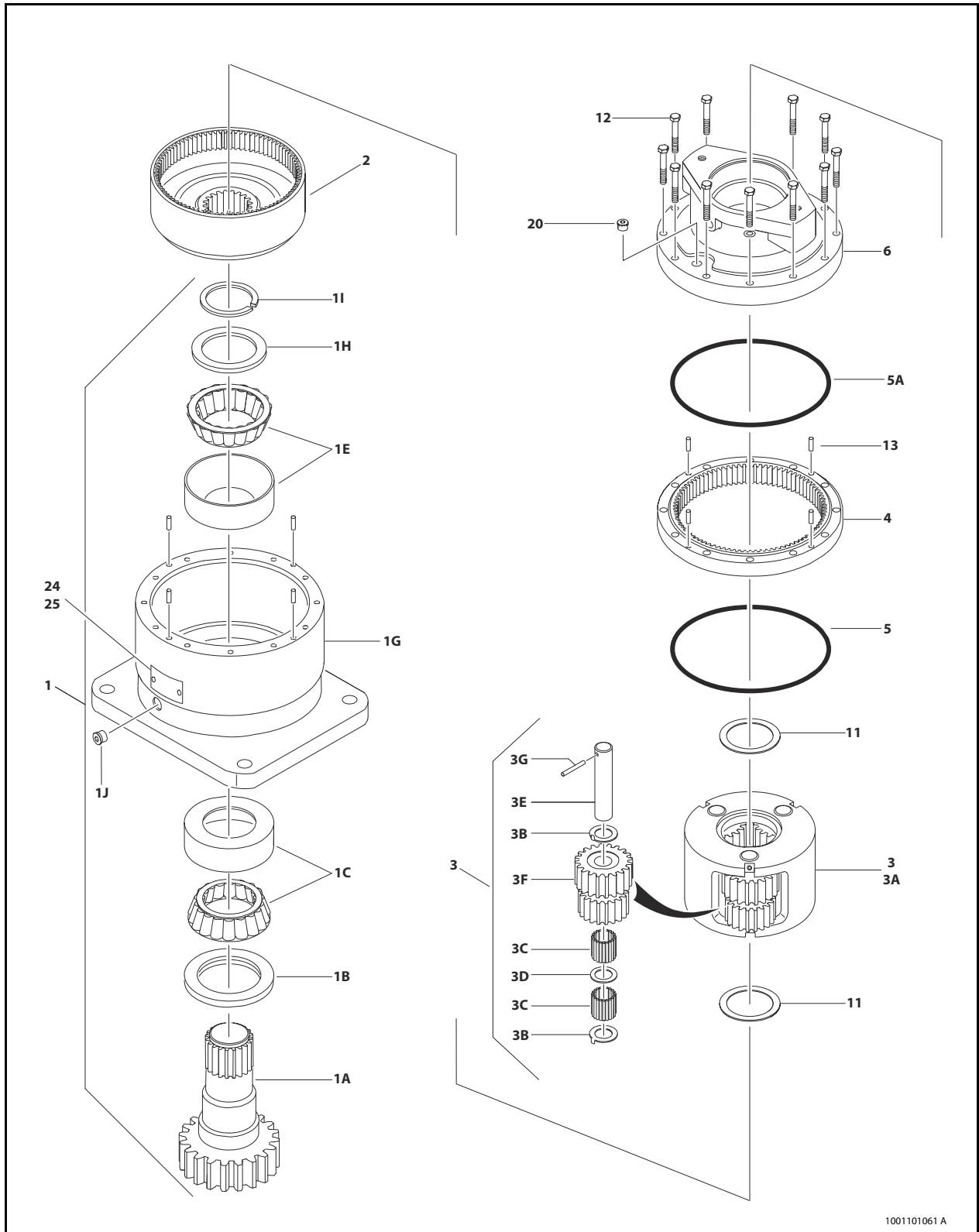


Figure 3-58. Swing Motor/Brake/Hub Assembly (USA Built Machines, SN 0300137441 through 0300171769 and China Built Machines, SN B300000100 through B300000969) - Sheet 1 of 3

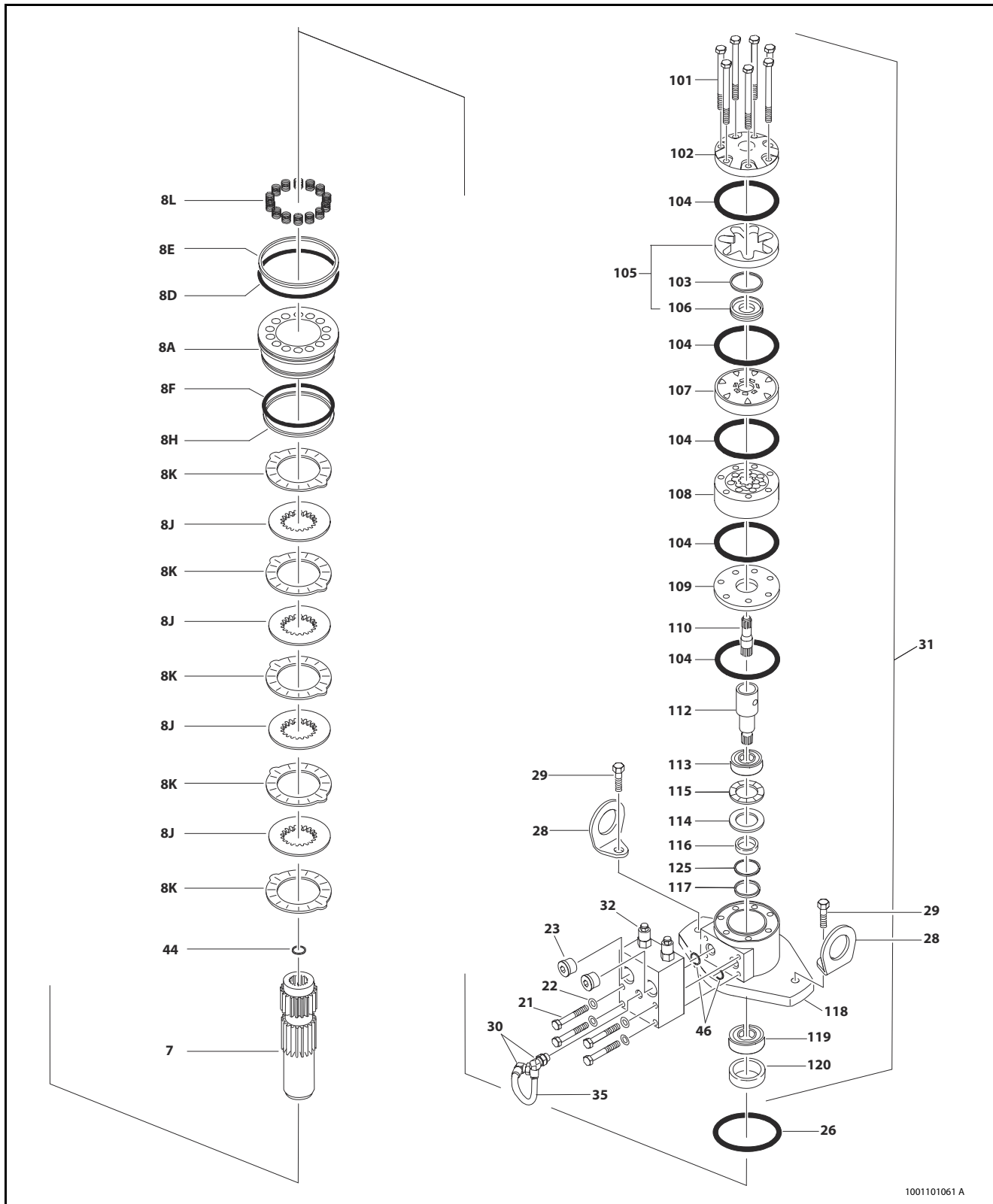


Figure 3-59. Swing Motor/Brake/Hub Assembly (USA Built Machines, SN 0300137441 through 0300171769 and China Built Machines, SN B300000100 through B300000969) - Sheet 2 of 3

1. Housing/Shaft Assembly	4. Gear Ring	21. Bolt	104. Ring Seal
1A. Output Shaft	5. O-ring (Black)	22. Lock Washer	105. Assembly
1B. Lip Seal	5A. O-ring (White)	23. Pipe Plug	106. Ring
1C. Bearing Ki	6. Brake Housing	24. I D Plate	107. Manifold
1E. Bearing Kit	7. Sun Gear	25. Screw Drive	108. Rotor Set
1G. Housing	8. Brake Components	26. O-ring	109. Wear Plate
1H. Thrust Washer	8A. Piston Brake	28. Lifting Lug	110. Drive Link
1I. Retaining Ring	8D. O-ring	29. Bolt	112. Shaft Coupling
1J. Pipe Plug	8E. Backup Ring	30. Elbow	113. Bronze Bushing
2. Internal Gear	8F. O-ring	31. Motor Assembly	114. Thrust Washer
3. Carrier Assembly	8H. Backup Ring	32. Valve	115. Thrust Bearing
3A. Carrier	8J. Rotor Brake	33. Pipe Plug	116. Inner Seal
3B. Tanged Washer	8K. Stator Brake	35. Tube	117. Backup Washer
3C. Bearing Needle	8L. Spring Brake	44. Retaining Ring	118. Housing
3D. Thrust Washer	11. Thrust Washer	46. O-ring	119. Bearing
3E. Planet Shaft	12. Bolt	101. Bolt	120. Seal
3F. Cluster Gear	13. Dowel Pin	102. Cover End	125. Backup Washer
3G. Roll Pin	20. Pipe Plug	103. Commutator Seal	

Figure 3-60. Swing Motor/Brake/Hub Assembly (USA Built Machines, SN 0300137441 through 0300171769 and China Built Machines, SN B300000100 through B300000969) - Sheet 3 of 3

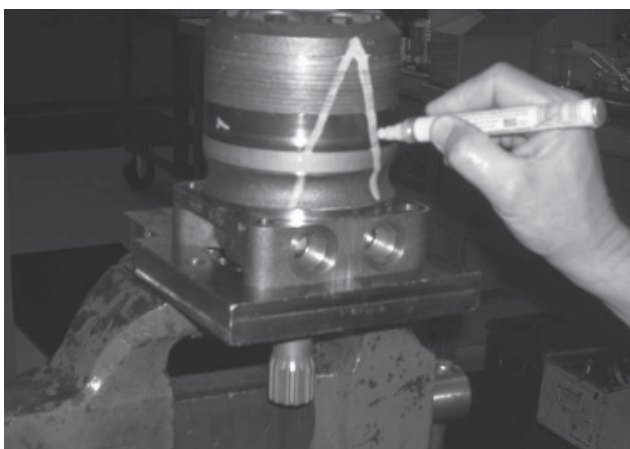
3.15 SWING MOTOR ASSEMBLY

Disassembly and Inspection

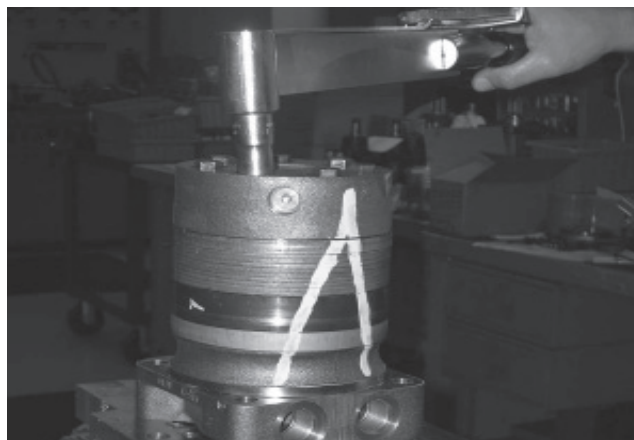
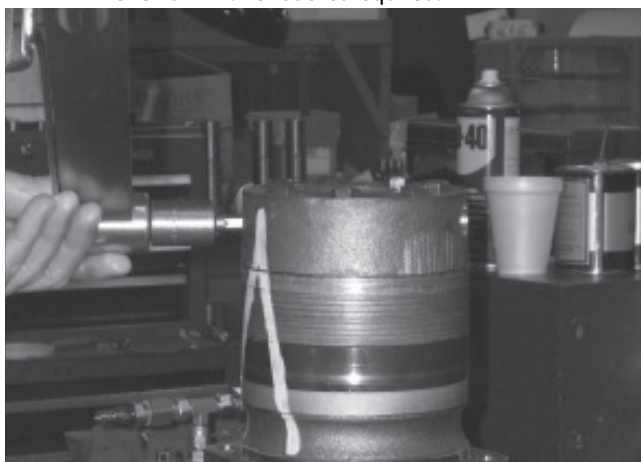
1. Place the Torqmotor™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

WARNING

IF THE TORQMOTOR™ IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DIS-LOGGED DURING THE SERVICE PROCEDURES, CAUSING INJURY.



1. Scribe an alignment mark down and across the Torqmotor™ 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 in. Allen wrench or 1 in. hex socket required.

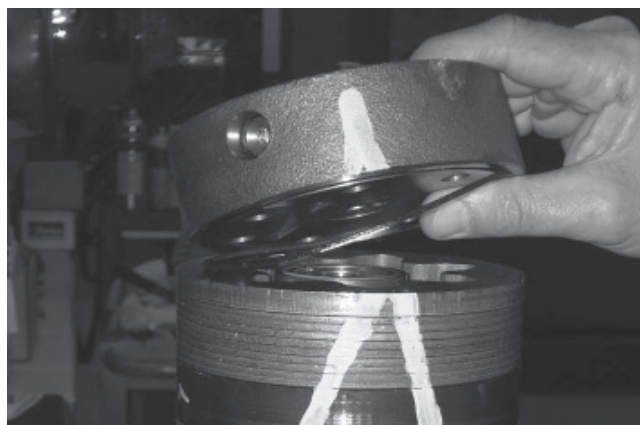


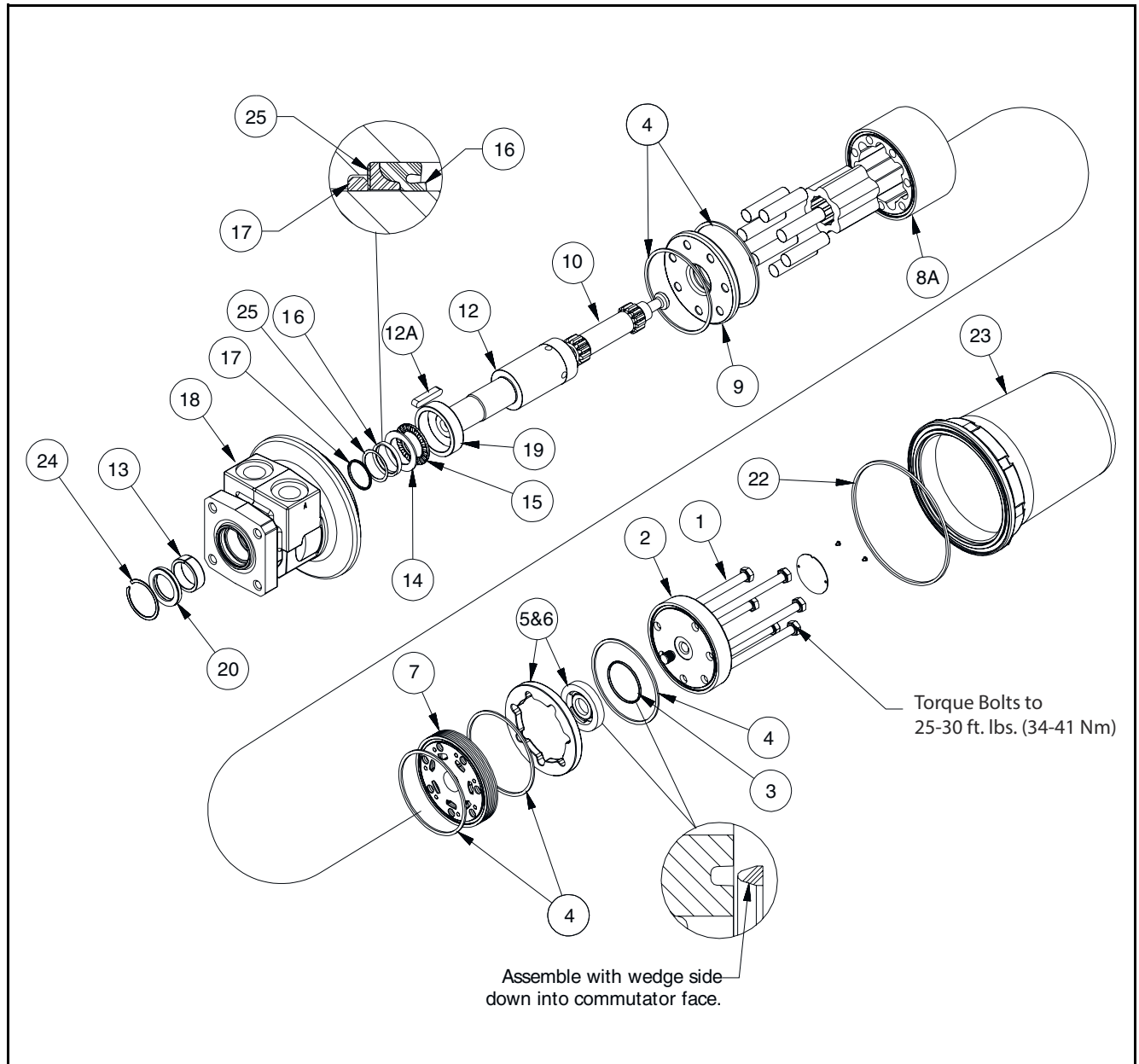
2. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 in. size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.



3. 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 | 8A. Rotor | 13. Inner Bearing/Bushing | 19. Outer Bearing/Bushing |
| 2. Special Bolts | 8B. Stator or Stator Vane | 14. Thrust Washer | 20. Dirt & Water Seal |
| 3. Special Bolts | 8D. Stator Half | 15. Thrust Bearing | 22. O-ring |
| 4. Special Bolts | 9. Wear Plate | 16. Seal | 23. Spring |
| 5. Commutator | 10. Drive Link | 17. Backup Ring | 24. Valve (Shuttle or Relief) |
| 6. Commutator Ring | 12. Coupling Shaft | 18. Housing | 25. Backup Ring |
| 7. Manifold | 12A. Key | | |

Figure 3-61. Swing Drive Motor

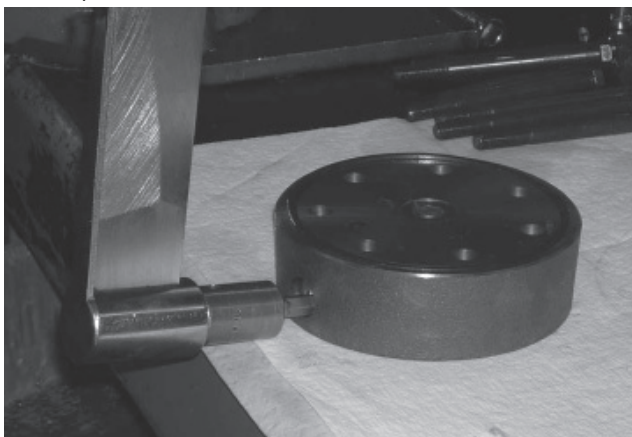
5. If the end cover (2) is equipped with shuttle valve components, remove the two previously loosened plugs (21).

⚠ CAUTION

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.

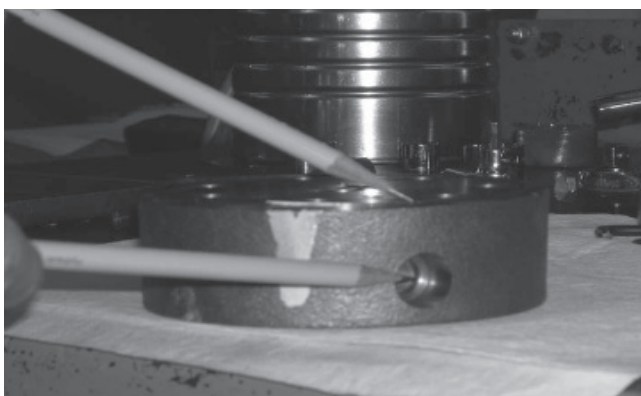
NOTE: O- ring is not included in seal kit but serviced separately, if required.

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.

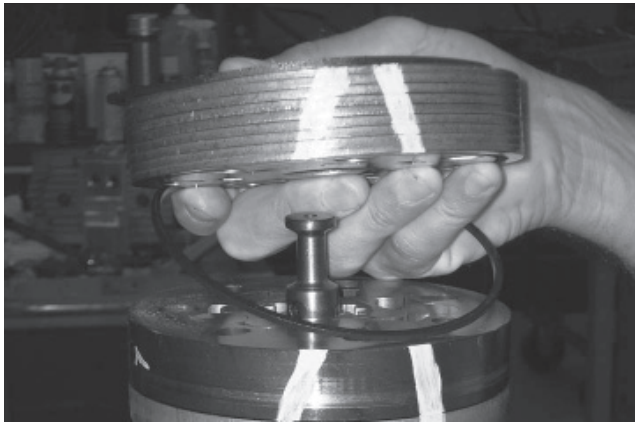


8. Remove commutator (5) and seal ring (3). Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator 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 to further disassembly for service. Compare configuration of both sides of them an if old to ensure that same surface is reassembled against the rotor set.

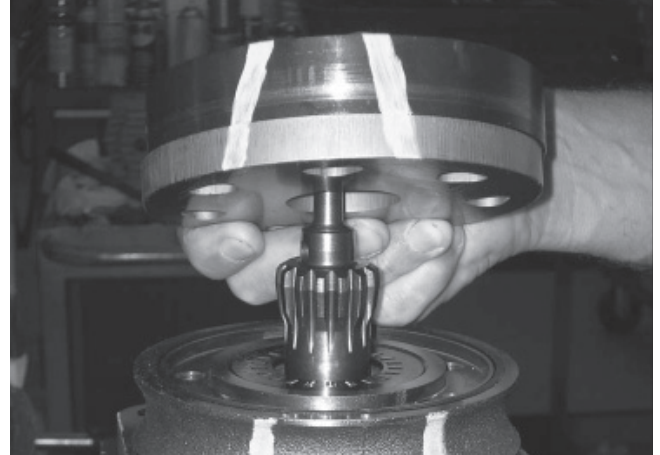


10. Remove rotor set (8) and warplane (9), together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wear plate. You may have to shift the rotor set 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 wear plate.

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 Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set into Torqmotor™. Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set and Torqmotor™.

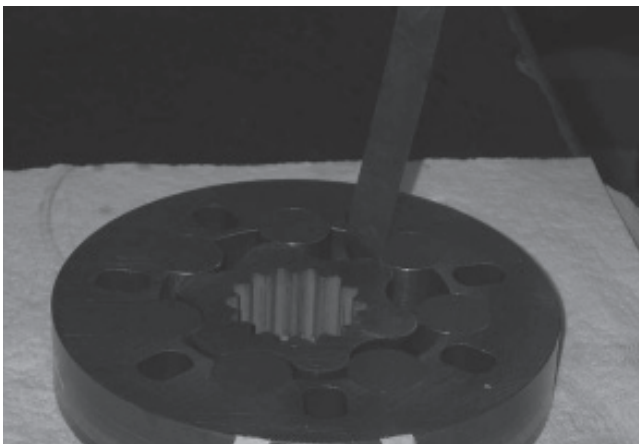
NOTE: Series TG and TH may have a rotor set with two stator halves (8B & 8D) with a seal ring (4) between them and two sets of seven vanes (8C & 8E). Discard seal ring only if stator halves become disassembled during the service procedures.

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

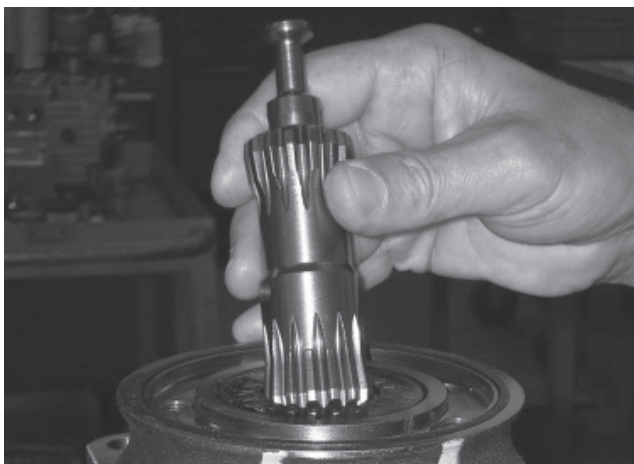


11. Place rotor set (8) and wear plate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180 degrees apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline.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

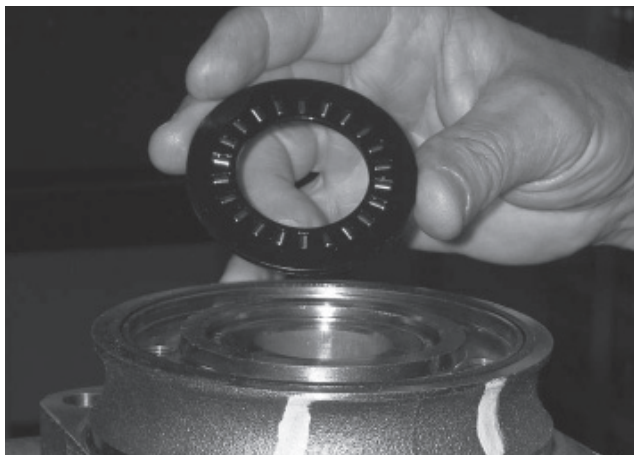
NOTE: If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.



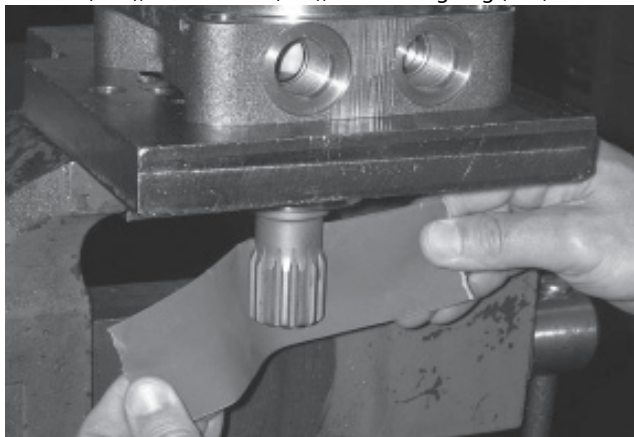
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).



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



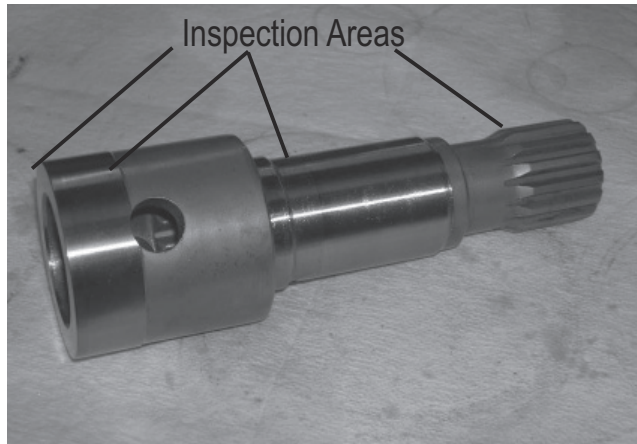
14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used. Remove any key (12A), nut (12B), washer (12C), bolt (12D), lock washer (12E), or retaining ring (12F).



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.



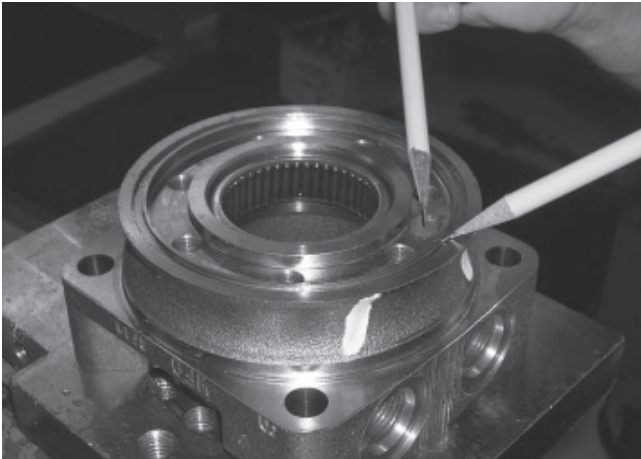
18. Remove seal (16) and backup ring (17) from housing (18) and backup washer. Discard both.



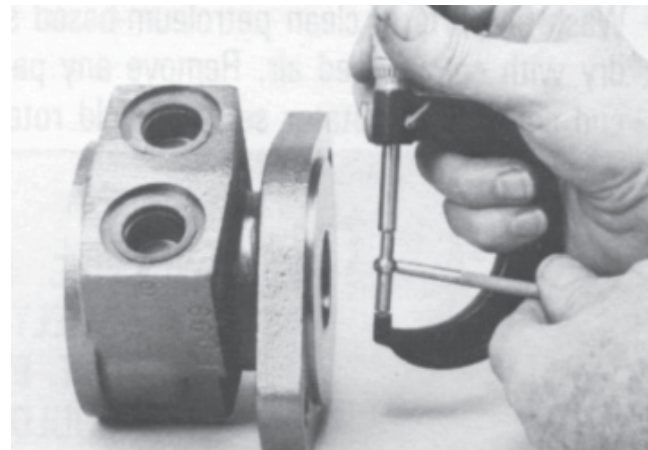
- 19.** Remove housing (18) from vise, invert it and remove and discard seal (20). A blind hole bearing or seal puller is required.



- 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 in. (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 Torqmotor™ 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 Torqmotor™ 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 Torqmotor™ 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.

DANGER

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

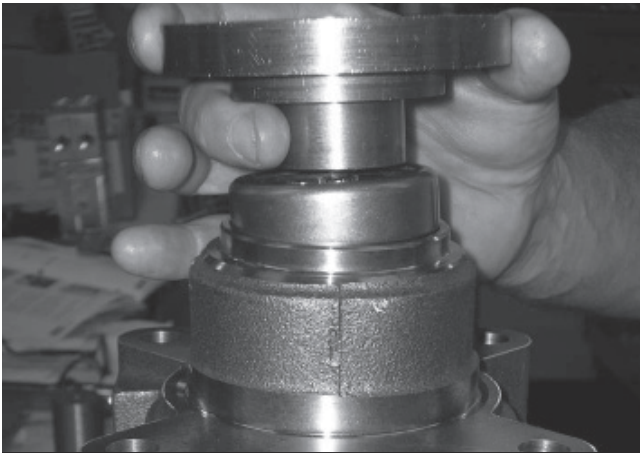
WARNING

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.

Torqmotor™ 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.





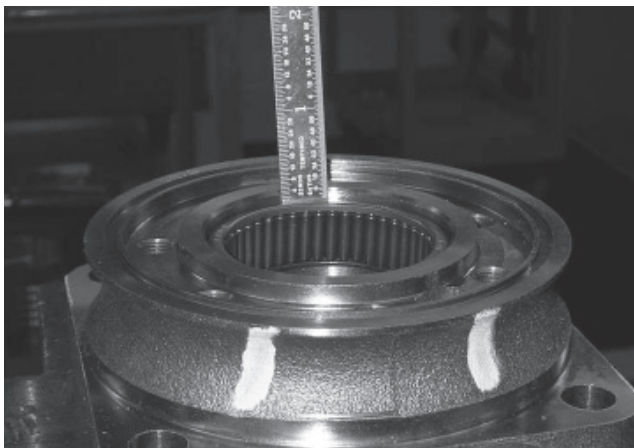
NOTE: Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.

NOTICE

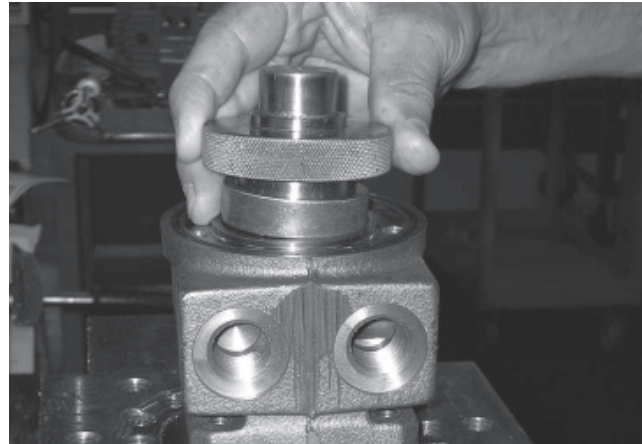
IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT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

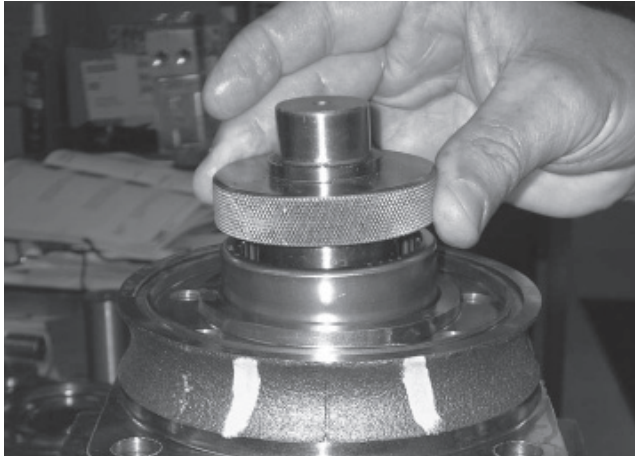
NOTICE

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.



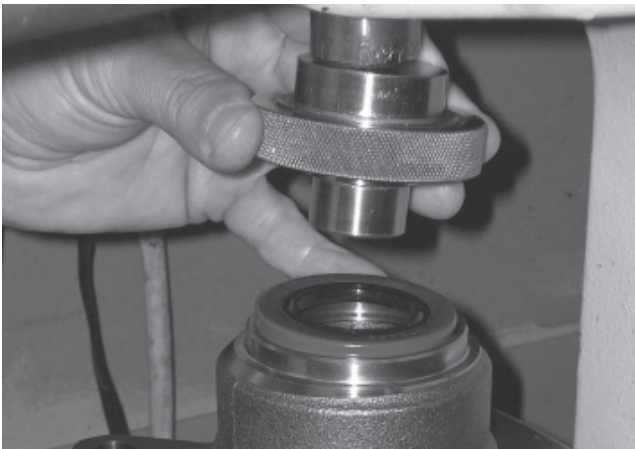
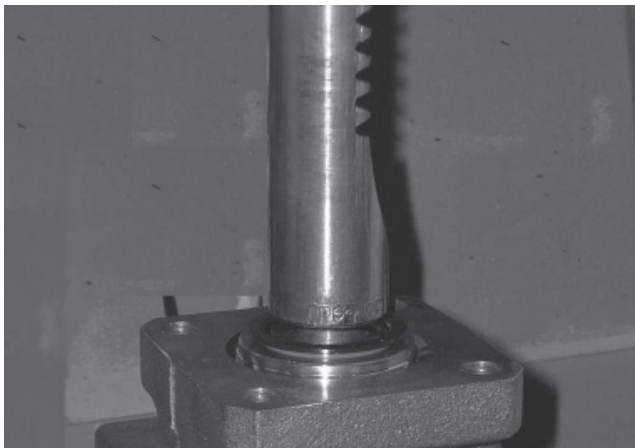
2. The Torqmotor™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 in. (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/ bushing (19).



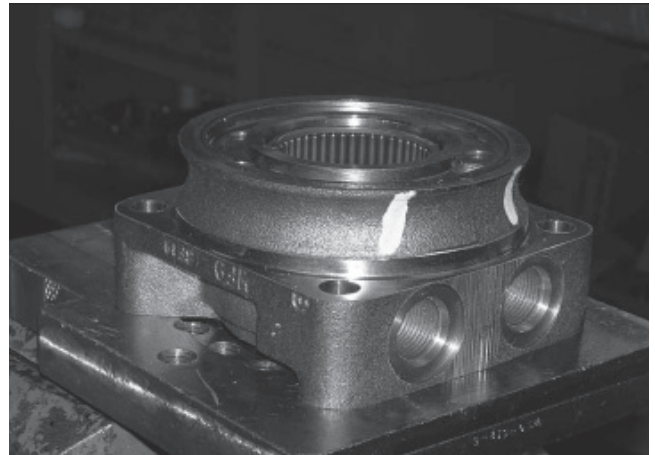


3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore.

The Torqmotor™ 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.

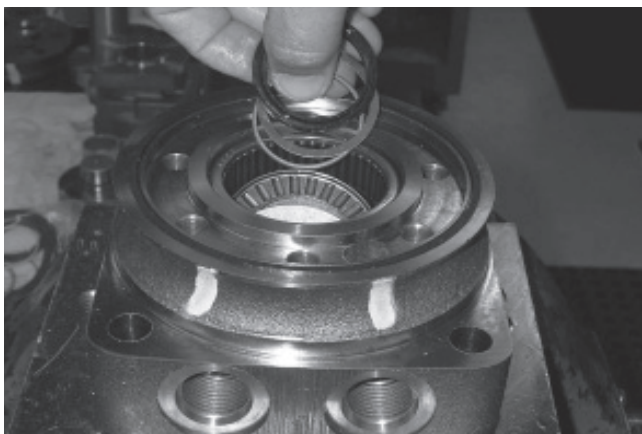


5. On the Torqmotor™ assemble a new backup ring (17), new backup washer (25) and new seal (16) with the seal lip facing toward the inside of Torqmotor™, into their respective counterbores in housing (18) if they were not assembled in procedure 2.

⚠ CAUTION

ORIGINAL DESIGN LARGE FRAME, TF & TG TORQMOTORS™ 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).



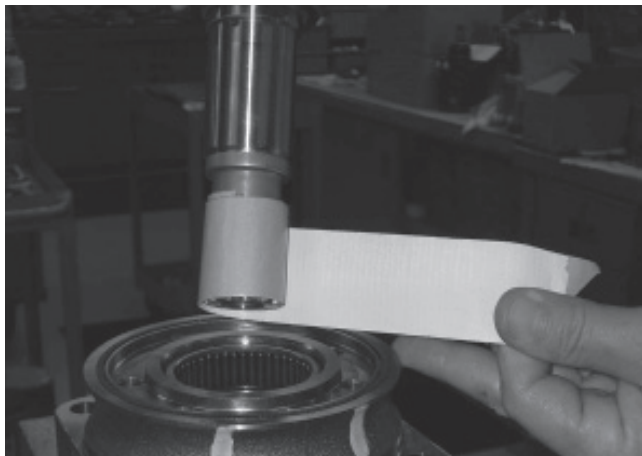


6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Torqmotor™.

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



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

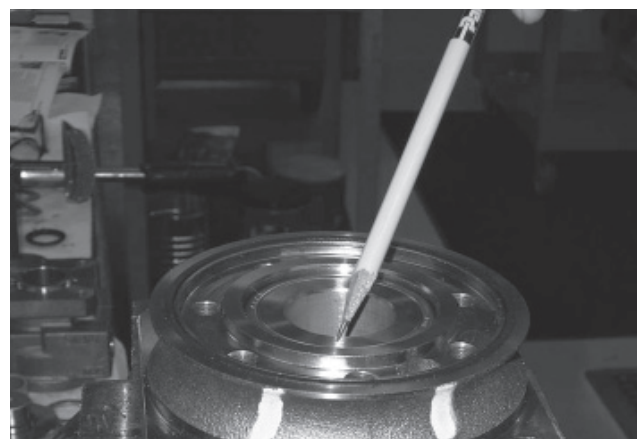
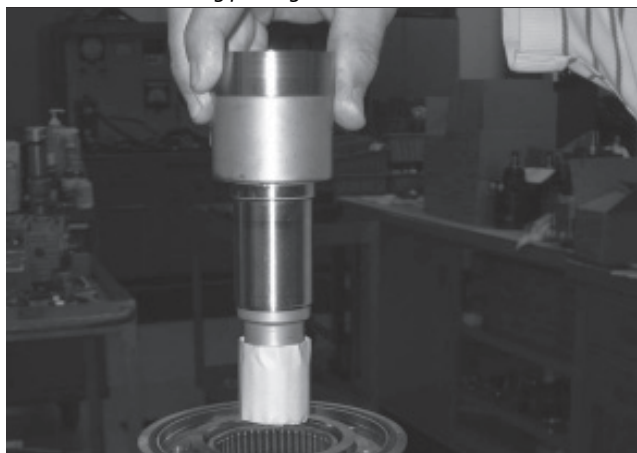


8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in the housings.

⚠ CAUTION

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 OR MOBIL MOBILITH SHC® 460.

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

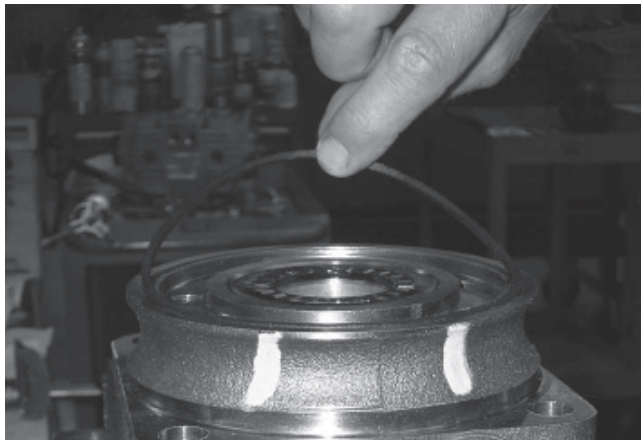


9. Install thrust bearing (11) onto the end of the coupling shaft (12).



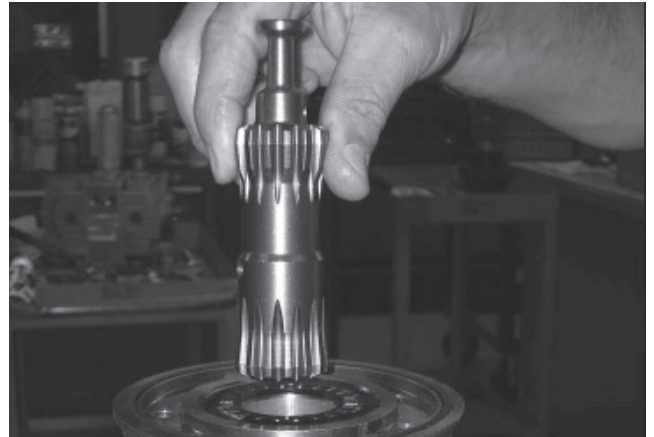
10. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove.

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 in. (12.7 mm) longer than the bolts (1) used in the Torqmotor™.

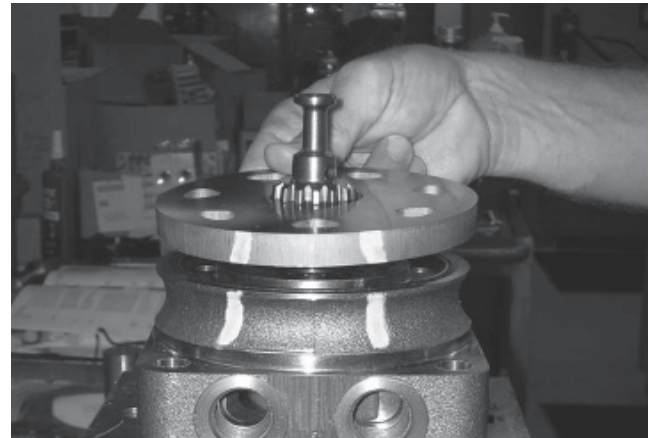


11. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines.

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.

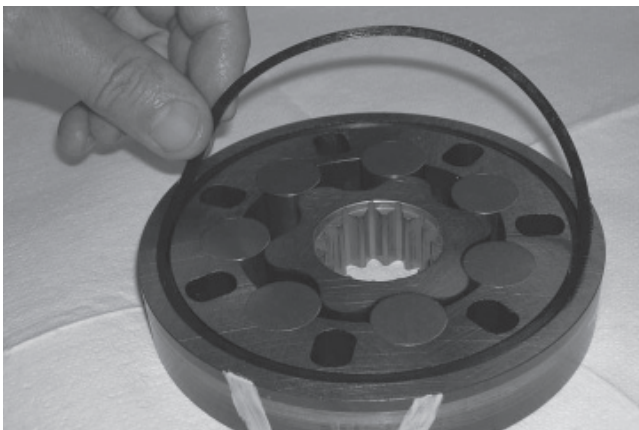


12. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



SECTION 3 - CHASSIS & TURNTABLE

13. 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).



14. 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.

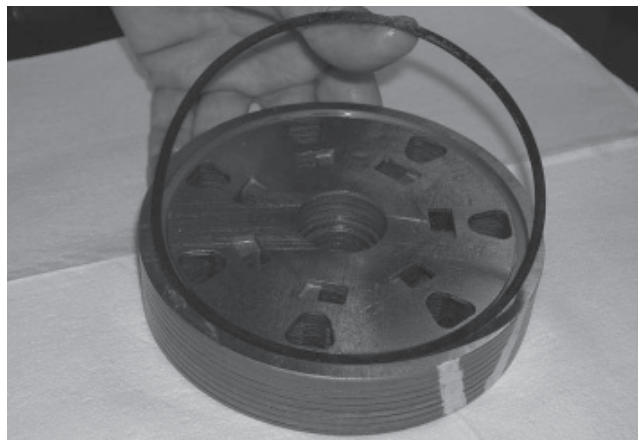
NOTE: If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure."

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).

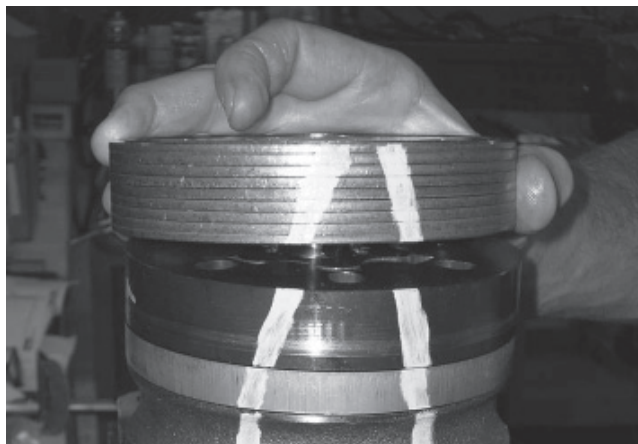


15. Apply clean grease to a new seal ring (4) and assemble it into the seal ring groove in the rotor set contact side of manifold (7).

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.



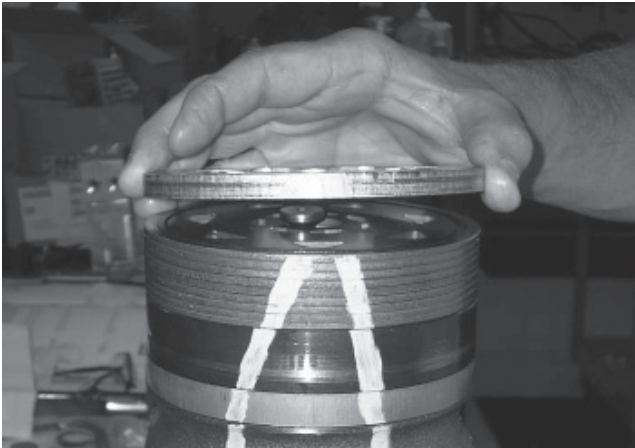
16. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



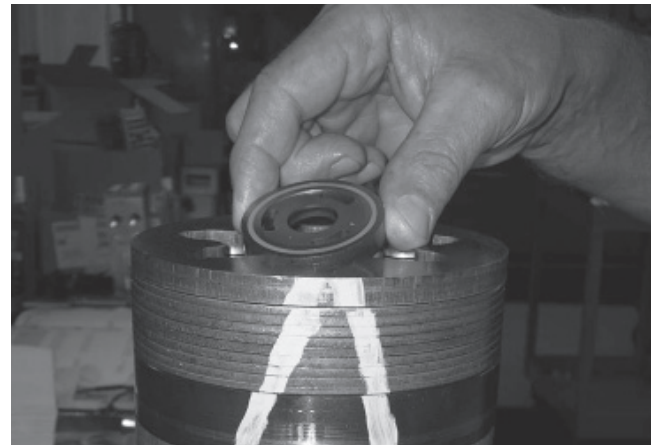
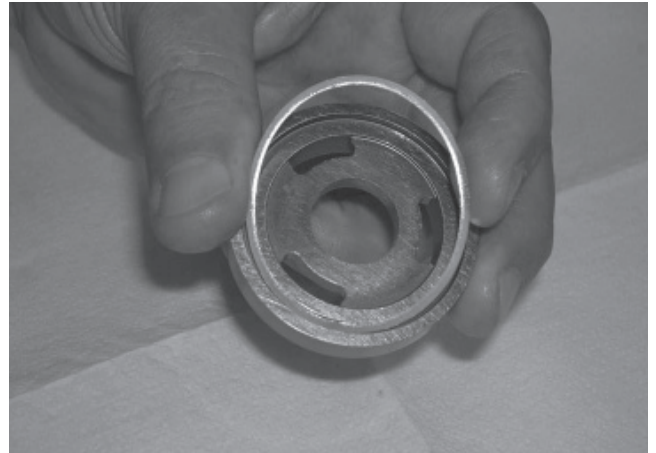
- 17.** Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.



- 18.** Assemble the commutator ring (6) over alignment studs onto the manifold.

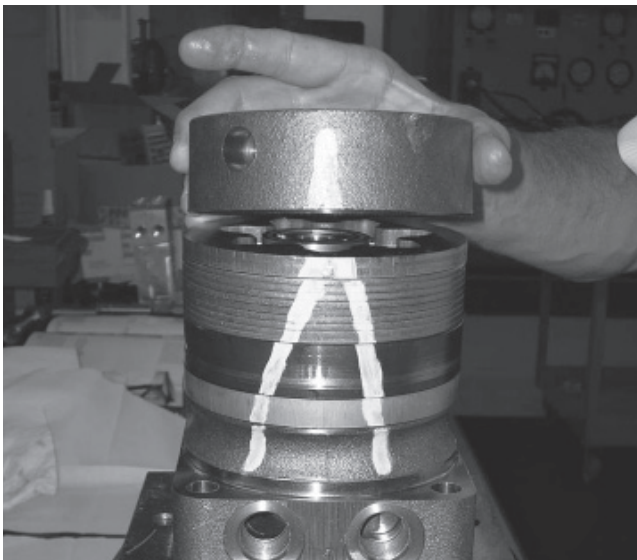
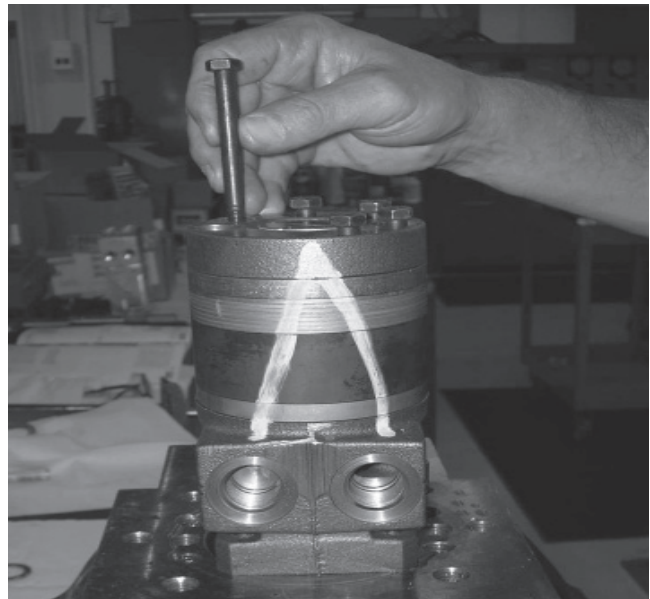
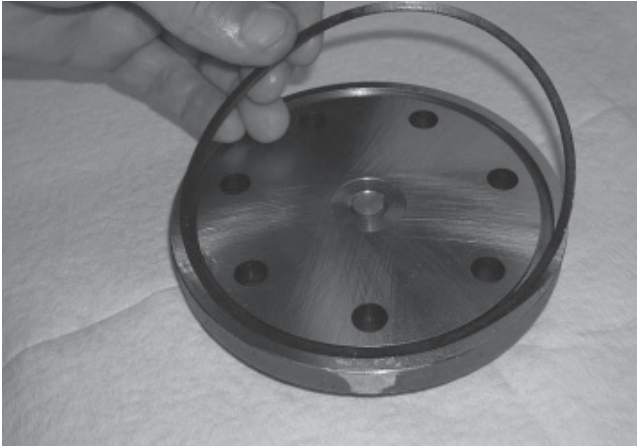


- 19.** Assemble a new seal ring (3) flat side up, into commutator (5) and assemble commutator (5) over the end of drive link (10) onto manifold (7) with seal ring side up.

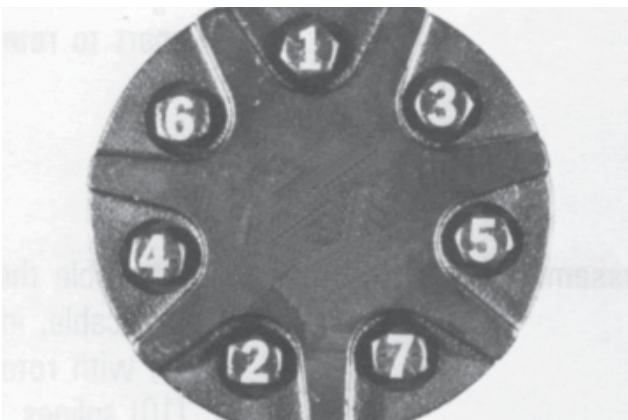
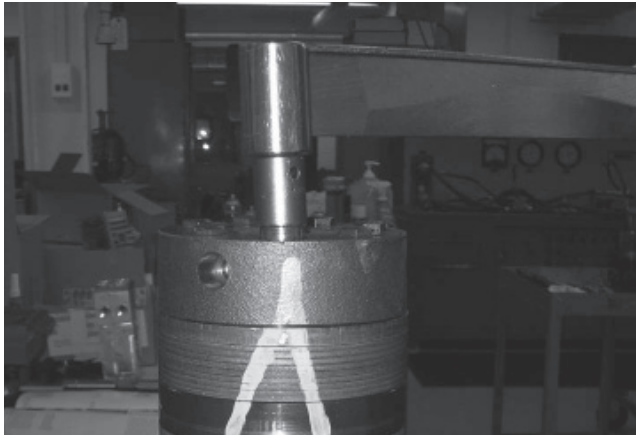
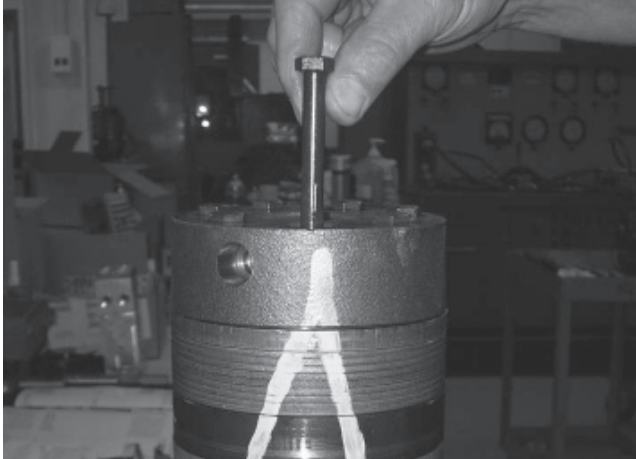


SECTION 3 - CHASSIS & TURNTABLE

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.



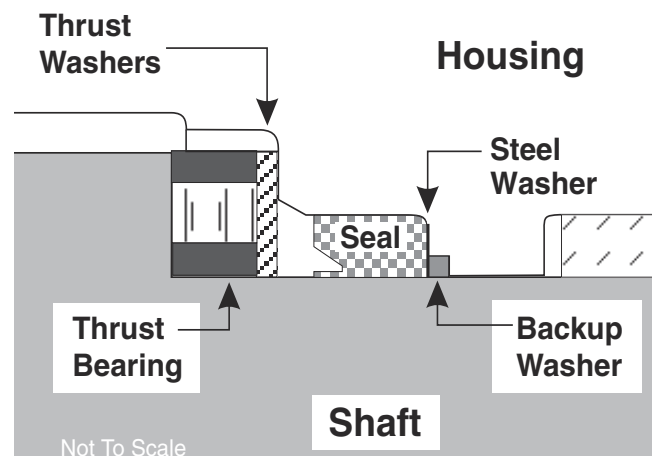
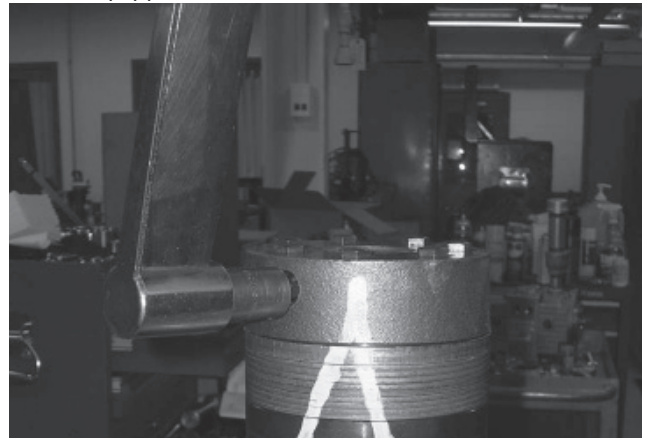
21. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 50-55 ft. lbs.(68-75 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 Nm) if cover is so equipped.

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



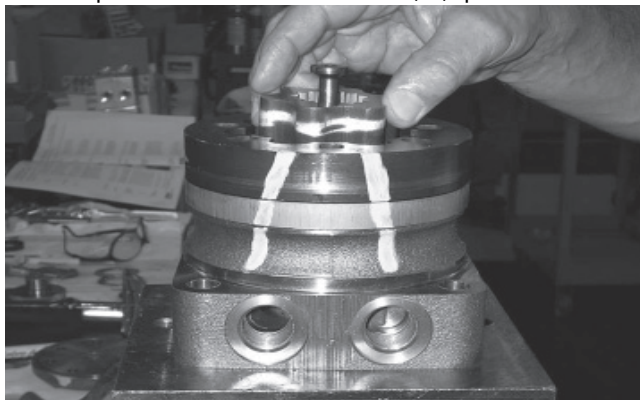
One Piece Stator Construction

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 Torqmotor™ 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.

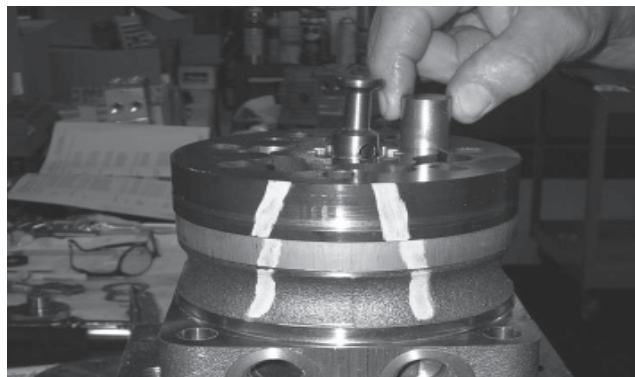


NOTE: If the manifold side of the rotor was etched during Torqmotor disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.

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

⚠ CAUTION

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.

3.16 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 JLG Threadlocker P/N 0100019. 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 retracted boom to 70 degrees (full elevation).
 - b. At the positions indicated on Figure 3-62, try and insert the 0.0015 in. (0.0381 mm) feeler gauge between the bolt head and hardened washer at the arrow indicated position.
 - c. Assure that the 0.0015 in. (0.0381 mm) 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 boom to 70 degrees (full elevation).
 - b. At the positions indicated on Figure 3-62, try and insert the 0.0015 in. (0.0381 mm) 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 3-62, try and insert the 0.0015 in. (0.0381 mm) feeler gauge between the bolt head and hardened washer at the arrow indicated position.

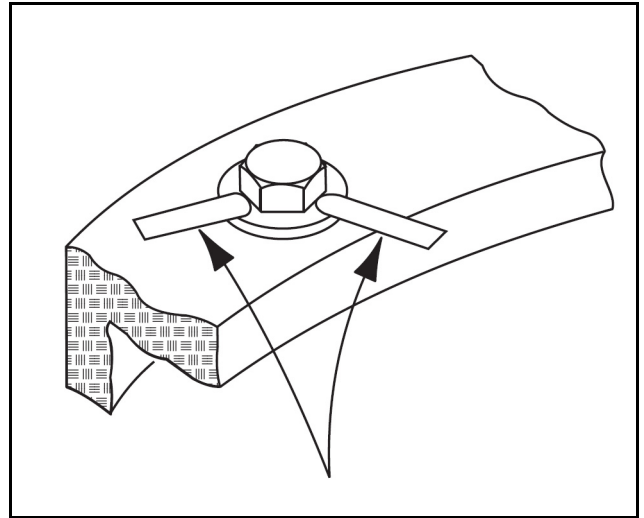


Figure 3-62. Swing Bearing Bolt Feeler Gauge Check

Wear Tolerance

1. From the underside of the machine, at rear center, with the boom fully elevated and fully retracted, as shown in and Figure 3-63., Swing Bearing Tolerance Boom Placement - Swing Bearing Tolerance Boom Placement) A, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. (Figure 3-64., Swing Bearing Tolerance Measuring Point).
2. At the same point, with the boom at horizontal and fully extended, and the tower boom fully elevated as shown in (Figure 3-63., Swing Bearing Tolerance Boom Placement - Swing Bearing Tolerance Boom Placement) B, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. (Figure 3-63., Swing Bearing Tolerance Boom Placement).
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.

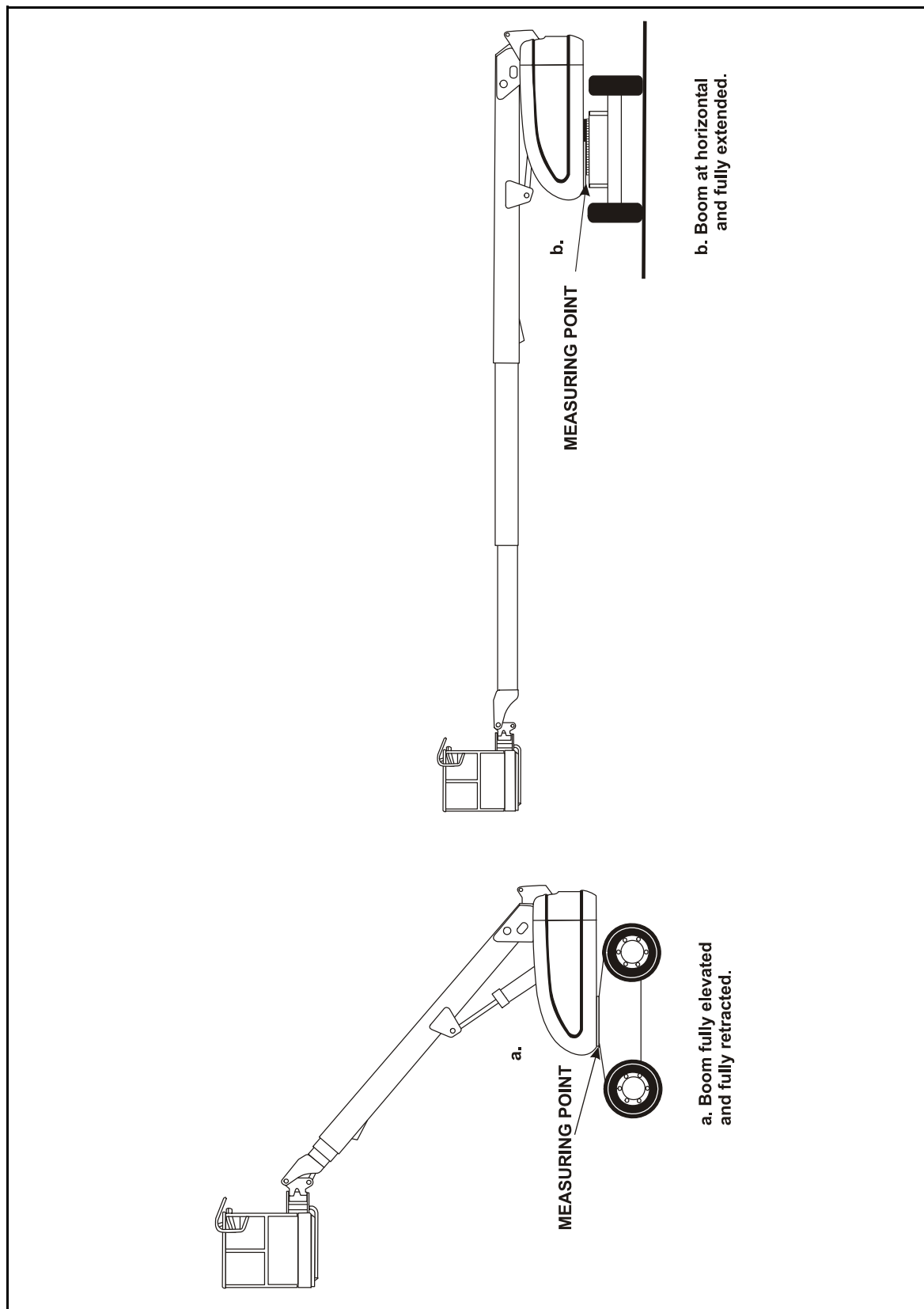


Figure 3-63. Swing Bearing Tolerance Boom Placement

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.

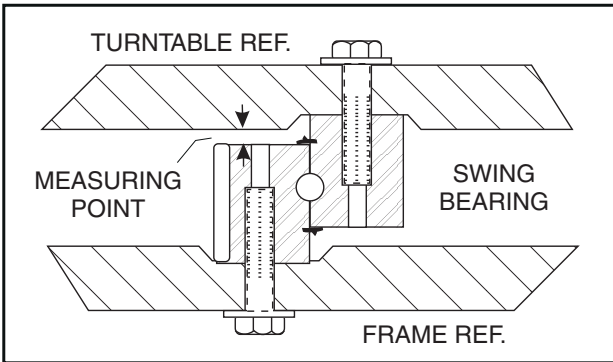


Figure 3-64. Swing Bearing Tolerance Measuring Point

Swing Bearing Replacement

REMOVAL

1. From Ground Control station, operate the boom adequately to provide access to frame opening or, if equipped, 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.
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.

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 filler plug fitting is at 90 degrees from the fore and aft center line of the frame.

⚠ 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 JLG Threadlocker P/N 0100019 to the new bearing bolts, and loosely install the bolts and washers through the frame and outer race of bearing.

⚠ CAUTION

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 3-65., Swing Bearing Torque Sequence. Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to an initial torque of 190 ft. lbs. (260 Nm) w/Loctite.
4. Remove the lifting equipment from the bearing.

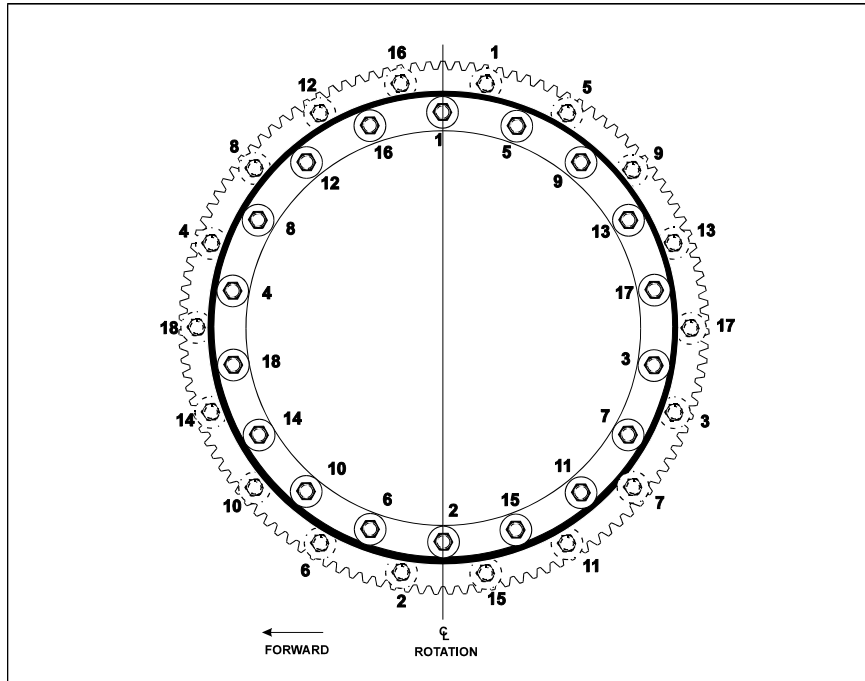


Figure 3-65. Swing Bearing Torque Sequence

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. Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the turntable and inner race of the bearing.
8. Following the Torque Sequence diagram shown in Figure 3-65., 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 JLG Threadlocker P/N 0100011 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.

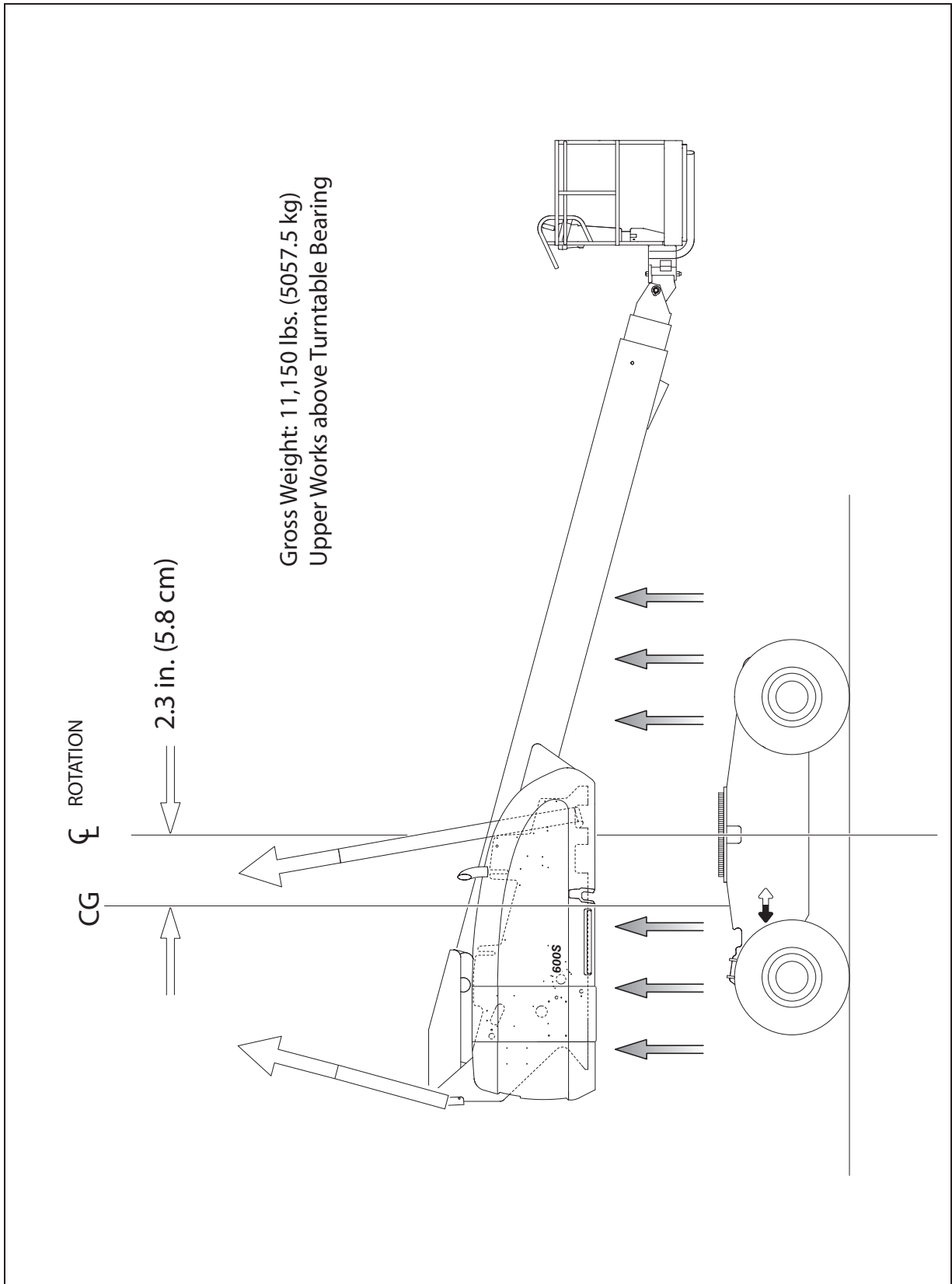


Figure 3-66. Swing Bearing Removal - 600S

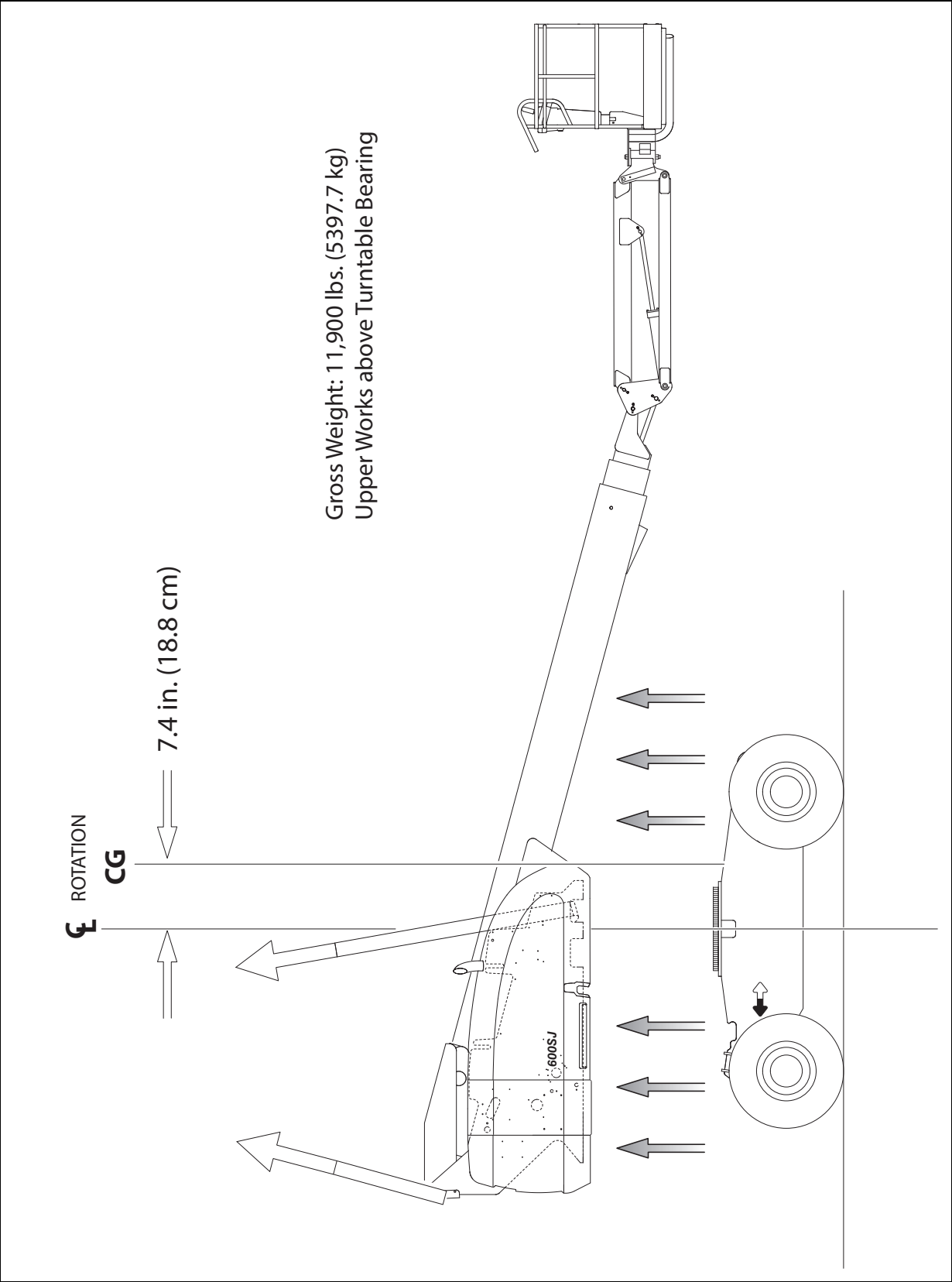


Figure 3-67. Swing Bearing Removal - 600SJ

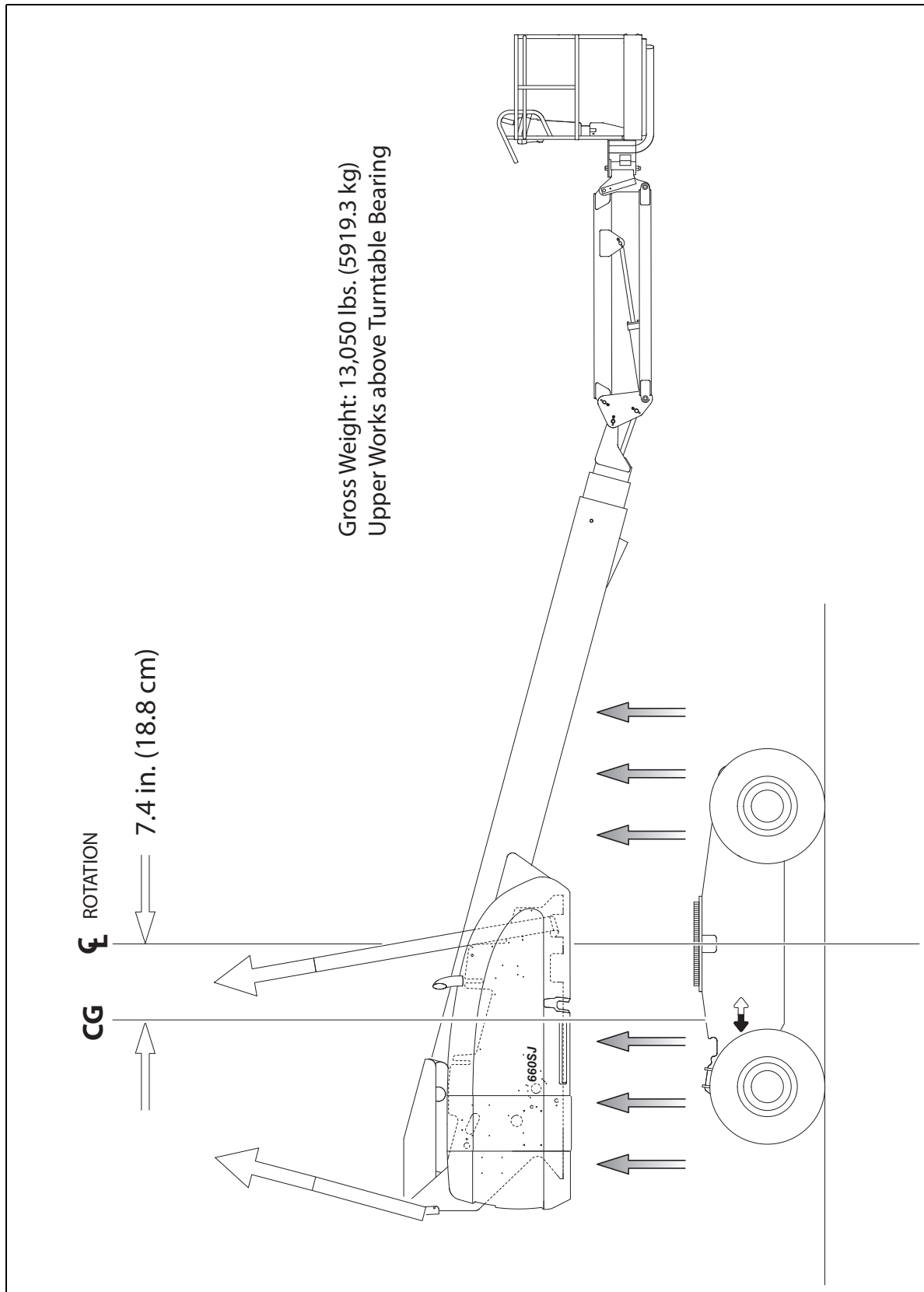


Figure 3-68. Swing Bearing Removal - 660SJ

3.17 SWING BRAKE (SN 0300087000 THROUGH 0300137440)

Disassembly

1. Remove pressure plate (2) from cover (16) by removing washer head capscREW (1).

CAUTION

PRESSURE PLATE IS UNDER SPRING TENSION APPROXIMATELY 2000 LBS (907 KGF). THE TWO WASHER HEAD CAP SCREWS MUST BE LOOSENEED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE 3000 LBS (1361 KGF) MINIMUM, THE PRESSURE PLATE CAN BE HELD IN POSITION WHILE REMOVING THE WASHER HEAD CAPSCREW.

2. Remove case seal (3) from cover (16).
3. Remove piston (6) from pressure plate (2).
4. Remove O-ring (4), backup ring (5), O-ring (7) and backup ring (8) from piston (6).
5. Remove stack assembly consisting of stator disc (10), rotor disc (11) and return plate (12) from cover (16).
6. Remove dowel pins (15), springs (13) and spring retainer (14) from cover (16).

NOTE: Not all the models use will use same number of springs or spring pattern. Record this information for assembly purposes.

7. Remove retaining ring (19) from cover (16).
8. Remove shaft by pressing or soft mallet on male end of shaft (9).
9. Remove retaining ring (20) from cover (16) and press out oil seal (17) and bearings (18), if required.

INSPECTION

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.
3. Discard seals and O-rings.
4. Closely inspect bearings and bearing contact surfaces. Replace as necessary.

NOTE: Bearings may be reused if, after thorough inspection, they are found to be in good condition.

Assembly

NOTE: Lubricate all rubber component from repair kit with clean type of fluid used in the system.

1. Use an alkaline wash to clean the parts before assembly.
2. Press oil seal (17) into cover (16) until it is flush with the bearing shoulder. Note direction of seal.
3. Press bearing (18) into piston until it bottoms out on bore step.
4. Install retaining ring (20) into cover (16).
5. Press Shaft (9) into bearing (18) until bottoms out on shoulder. Bearing (18) inner shoulder must be supported during this operation.
6. Install retaining ring (19) on shaft (9).
7. Insert dowel pins (15), spring retainer (14) and spring (13) into cover (16).

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

8. Insert dowel pins (12) on spring (13).

NOTE: Discs (10) & (11) and plate (12) must remain dry during installation. No oil residue must be allowed to contaminate the disc surface.

9. Install rotor disc (11) and stator disc (10).
10. Install O-ring (4), backup ring (5), O-ring (7) and backup ring (8) on piston (6). Note order of O-rings and backup rings. Insert pressure (6) into pressure plate (2).

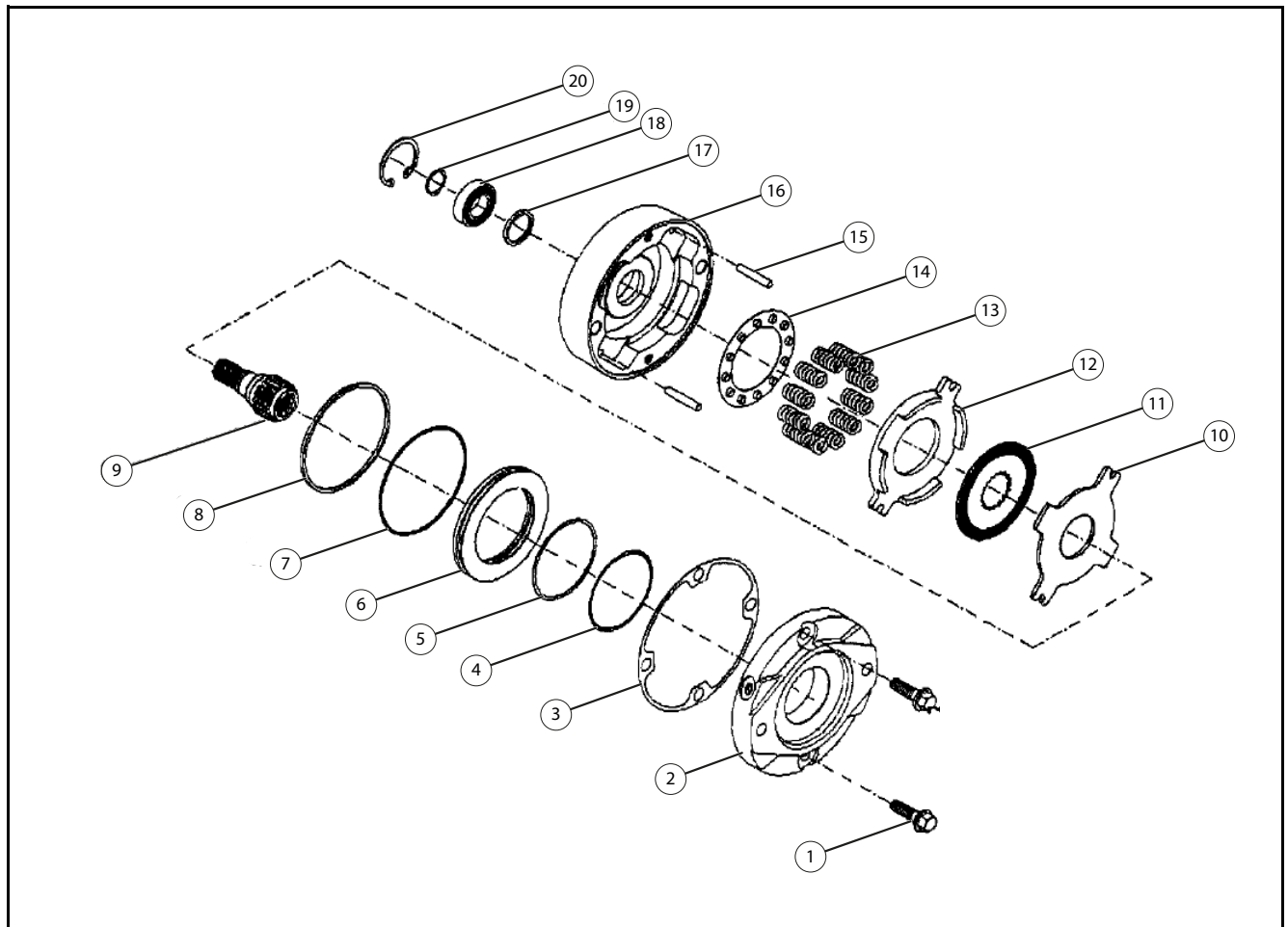
NOTE: Be careful not to share O-rings or backup rings. Be careful not to scratch piston.

11. Install new case seal (3) in cover (16).
12. Position pressure plate (2) on cover (16) aligning dowel pins (15) with holes in pressure plate (2).
13. Install washer head capscREW (1) and tight evenly to draw pressure plate (2) to cover (16). Torque washer head capscREW to 55 ft. lbs. (75 Nm).

NOTE: A hydraulic press will simplify installation of pressure plate on cover. Clamp pressure plate in position while tightening the washer head capscREW.

CAUTION

IF HYDROSTATIC BENCH IS PERFORMED ON BRAKE ASSEMBLY. RELEASE PRESSURE MUST NOT EXCEED 2000 PSI (137.9 BAR) UNLESS TWO ADDITIONAL BOLTS ARE USED FOR SUPPLEMENTARY CLAMPING.



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

Figure 3-69. Swing Brake - (SN 0300087000 through 0300137440)

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.

3.18 ROTARY COUPLING (USA BUILT MACHINES, SN 0300087000 THROUGH 0300138728)

Use the following procedure to install the seal kit.

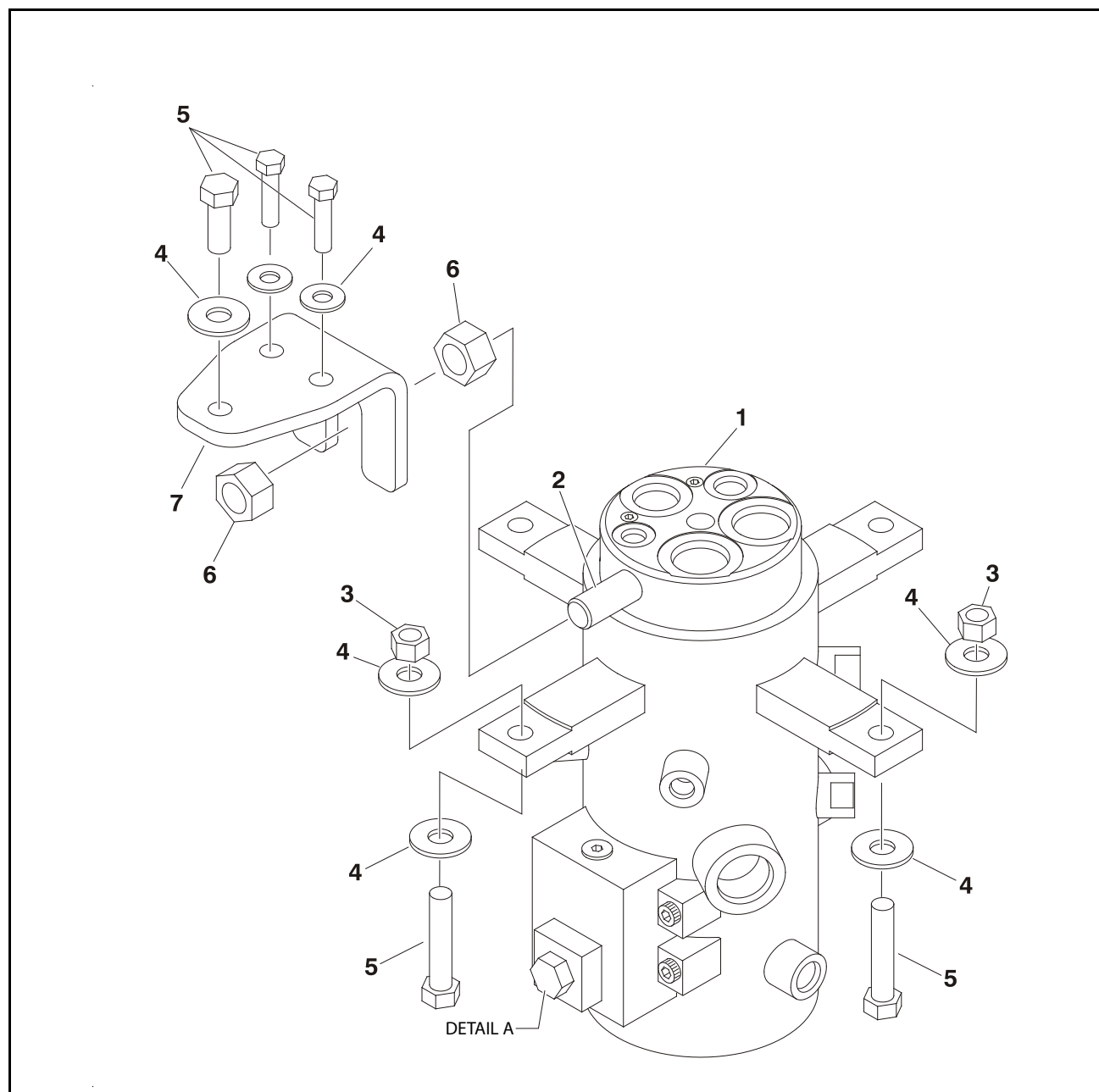
1. If not already removed, remove the axle oscillation valve from the cylinder barrel. The spool of the valve protrudes into the barrel and will damage the spool and seals if left in place.
2. Remove snap ring (12) from end.
3. Remove thrust ring (13) from the same end.
4. Remove center body (10) from housing (11).
5. Cut off old seals (14,15,17 and 18).
6. Assemble lip seals (14) in direction shown in Figure 3-71., Rotary Coupling (USA Built Machines, SN 0300087000 through 0300138728) - Sheet 2 of 2.
7. Reassemble O-ring (18).
8. Heat cap seals (17) 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.

Table 3-10. Coupling Port Information Table - 2WS

Port No.	Out let	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (47)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (259)
4	1	-6	Steer	2500 (172)	3750 (259)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)

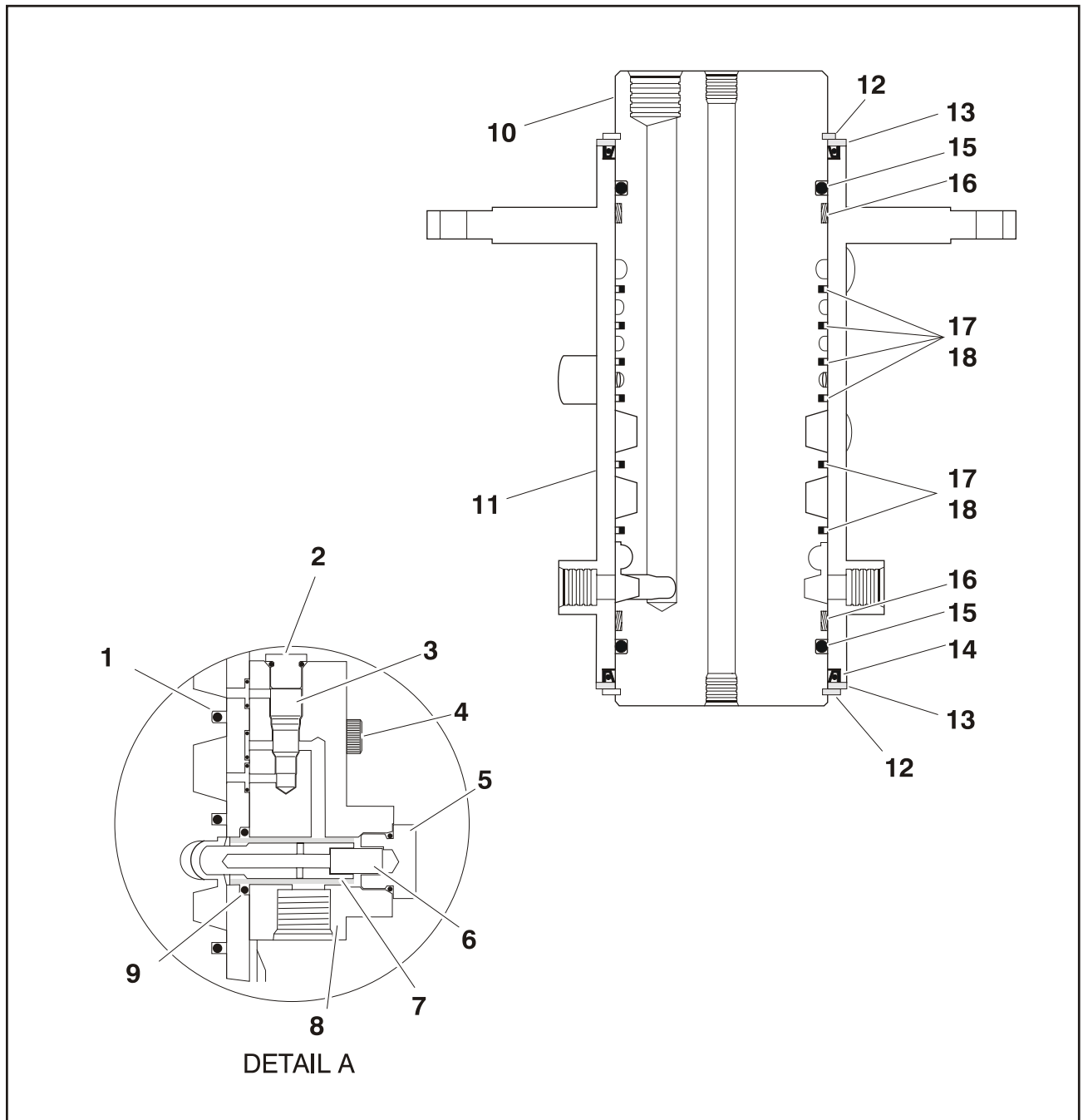
Table 3-11. Coupling Port Information Table - 4WS

Port No.	Out let	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (47)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (259)
4	1	-6	Steer	2500 (172)	3750 (259)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)
8	1	-6	Steer	2500 (172)	3750 (259)
9	1	-6	Steer	2500 (172)	3750 (259)



- | | |
|--------------------|------------|
| 1. Rotary Coupling | 5. Bolt |
| 2. Torque Lug | 6. Nut |
| 3. Locknut | 7. Bracket |
| 4. Flatwasher | |

Figure 3-70. Rotary Coupling (USA Built Machines, SN 0300087000 through 0300138728) - Sheet 1 of 2



- | | | | |
|----------------|------------------------|--------------------|--------------|
| 1. O-ring | 6. Spring | 11. Housing | 16. Bearing |
| 2. Plug | 7. Valve Block Plunger | 12. Retaining Ring | 17. Cap Seal |
| 3. Check Valve | 8. Valve Block | 13. Ring | 18. O-ring |
| 4. Screw | 9. O-ring | 14. Oil Seal | |
| 5. Plug | 10. Body | 15. O-ring | |

Figure 3-71. Rotary Coupling (USA Built Machines, SN 0300087000 through 0300138728) - Sheet 2 of 2

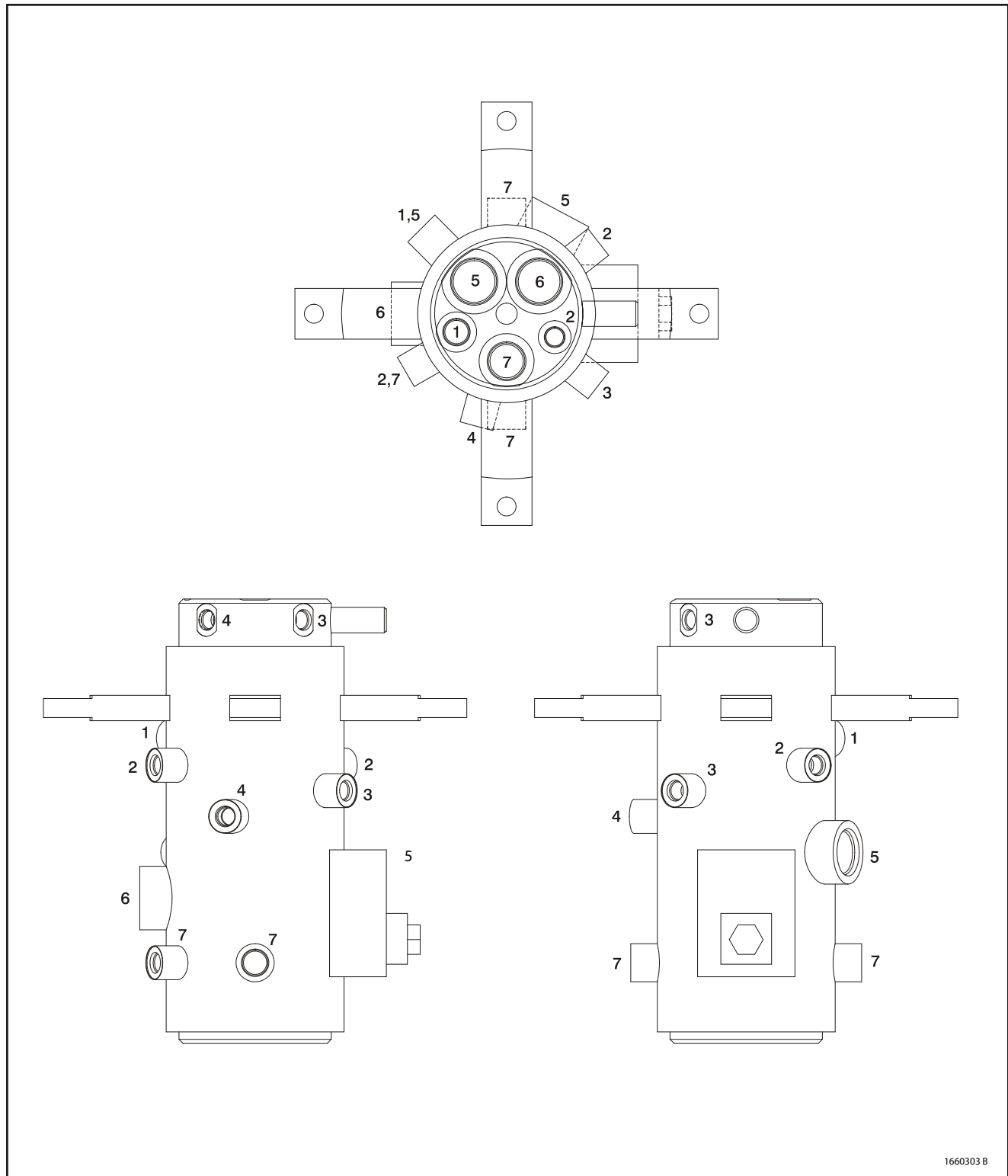


Figure 3-72. Rotary Coupling Port Location (7 Port) - 2WS (USA Built Machines, SN 0300087000 through 0300138728)

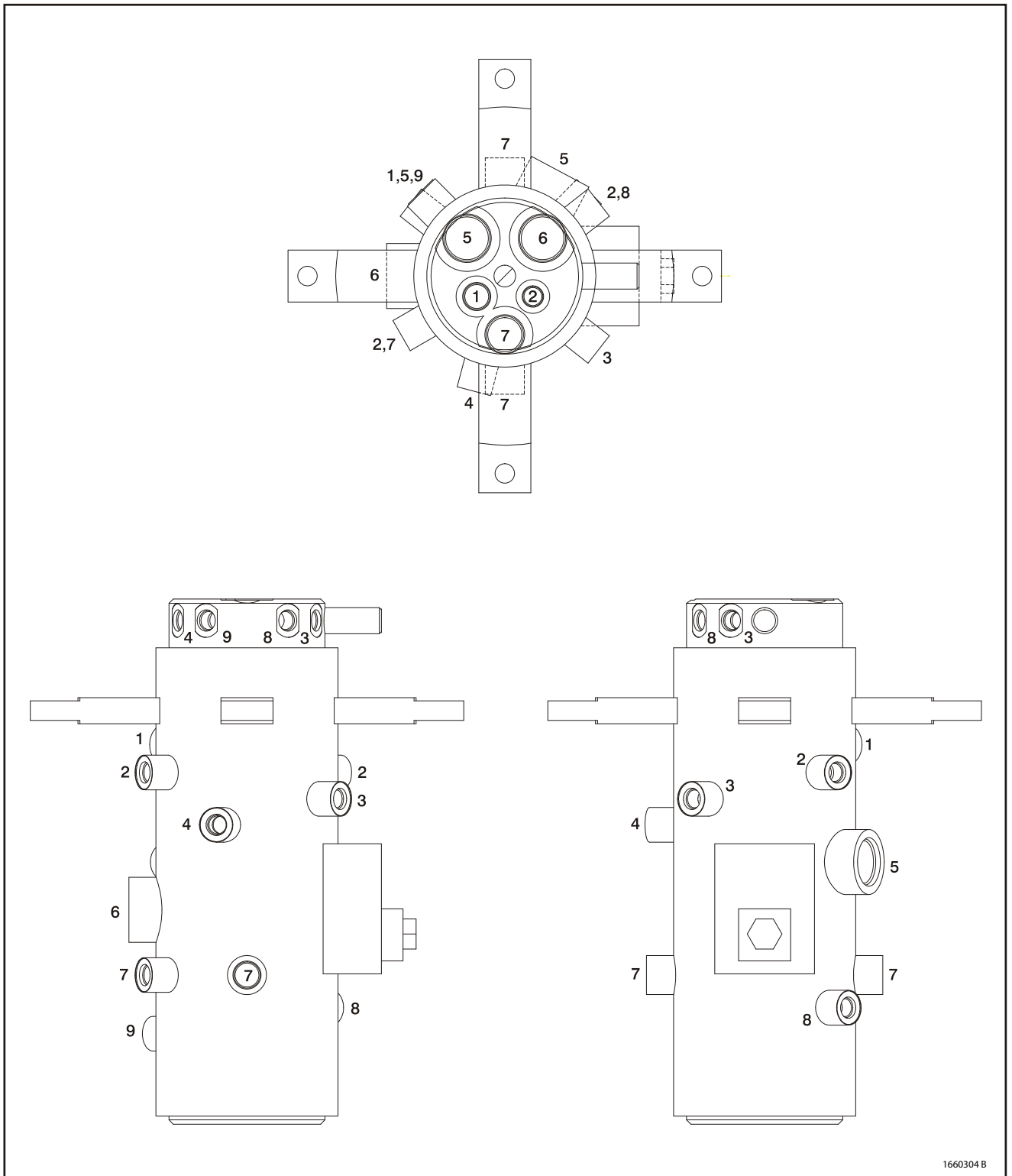


Figure 3-73. Rotary Coupling Port Location (9 Port) - 4WS (USA Built Machines, SN 0300087000 through 0300138728)

3.19 ROTARY COUPLING (USA BUILT MACHINES, SN 0300138729 THROUGH 0300171769 AND CHINA BUILT MACHINES, SN B300000100 THROUGH B300000969)

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 (6) from the same end.
4. Remove center body (1) from housing (3).
5. Cut off old seals (2, 4 and 5).
6. Remove proximity switch.
7. Assemble lip seals (2) in direction shown in (See Figure 3-74.).
8. Reassemble O-ring (4).
9. Heat cap seals (5) in hydraulic oil for 5 minutes at 300° F (149° C).
10. Assemble cap seals over O-rings.
11. Reinsert center body into housing (lube with hydraulic oil).
12. Replace thrust ring and snap ring.
13. Install proximity switch as shown in Figure 3-78.

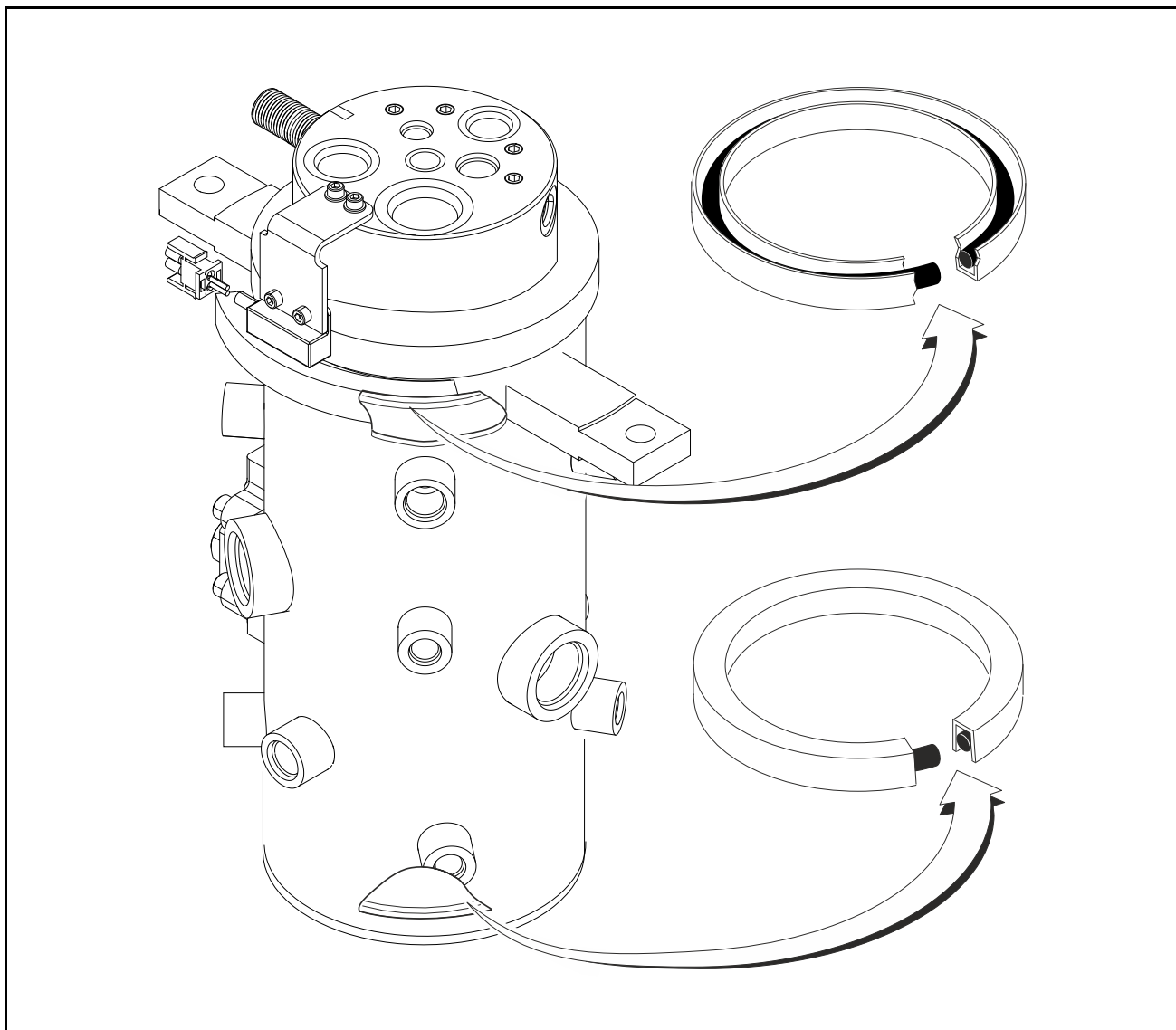
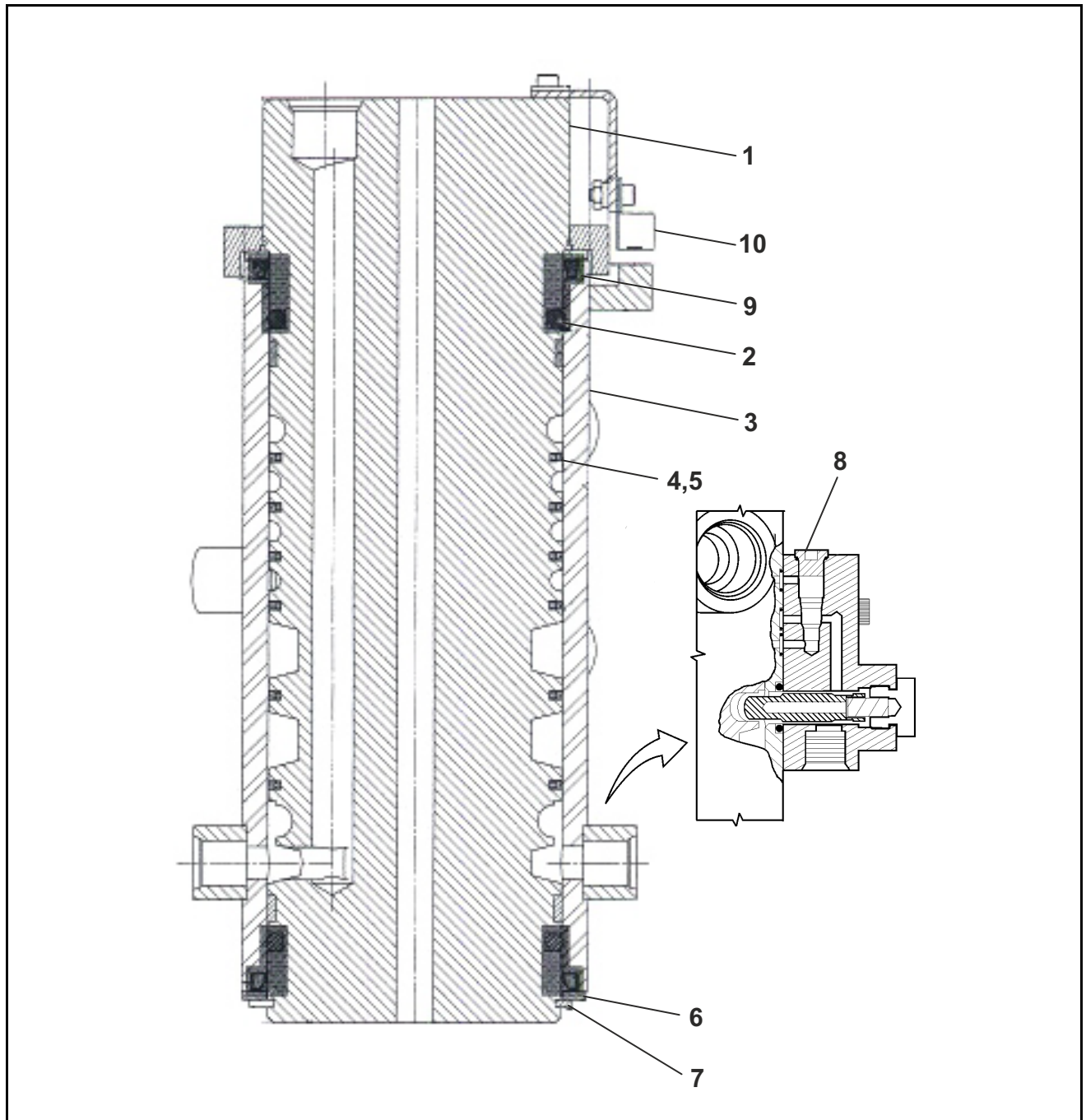


Figure 3-74. Rotary Coupling (USA Built Machines, SN 0300138729 through 0300171769 and China Built Machines, SN B300000100 through B300000969)



- | | |
|----------------|-----------------------------------|
| 1. Center Body | 6. Thrust Ring |
| 2. Seal | 7. Snap Ring |
| 3. Housing | 8. Valve Block (Axle Oscillation) |
| 4. O-ring | 9. O-ring |
| 5. Seal | 10. Proximity Switch |

Figure 3-75. Rotary Coupling Cutaway (USA Built Machines, SN 0300138729 through 0300171769 and China Built Machines, SN B300000100 through B300000969)

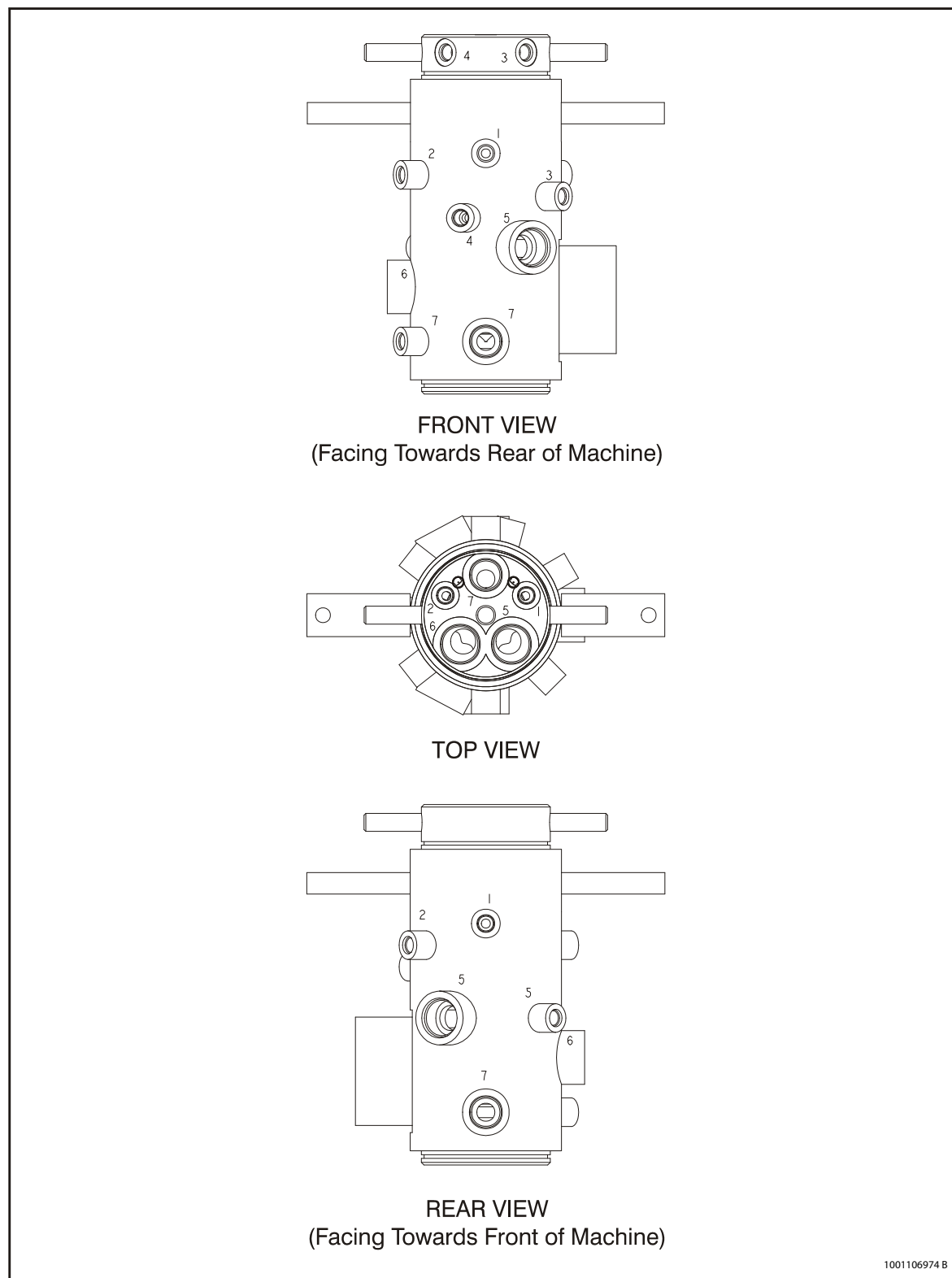


Figure 3-76. Rotary Coupling (7 Port) - 2WS (USA Built Machines, SN 0300138729 through 0300171769 and China Built Machines, SN B300000100 through B300000969)

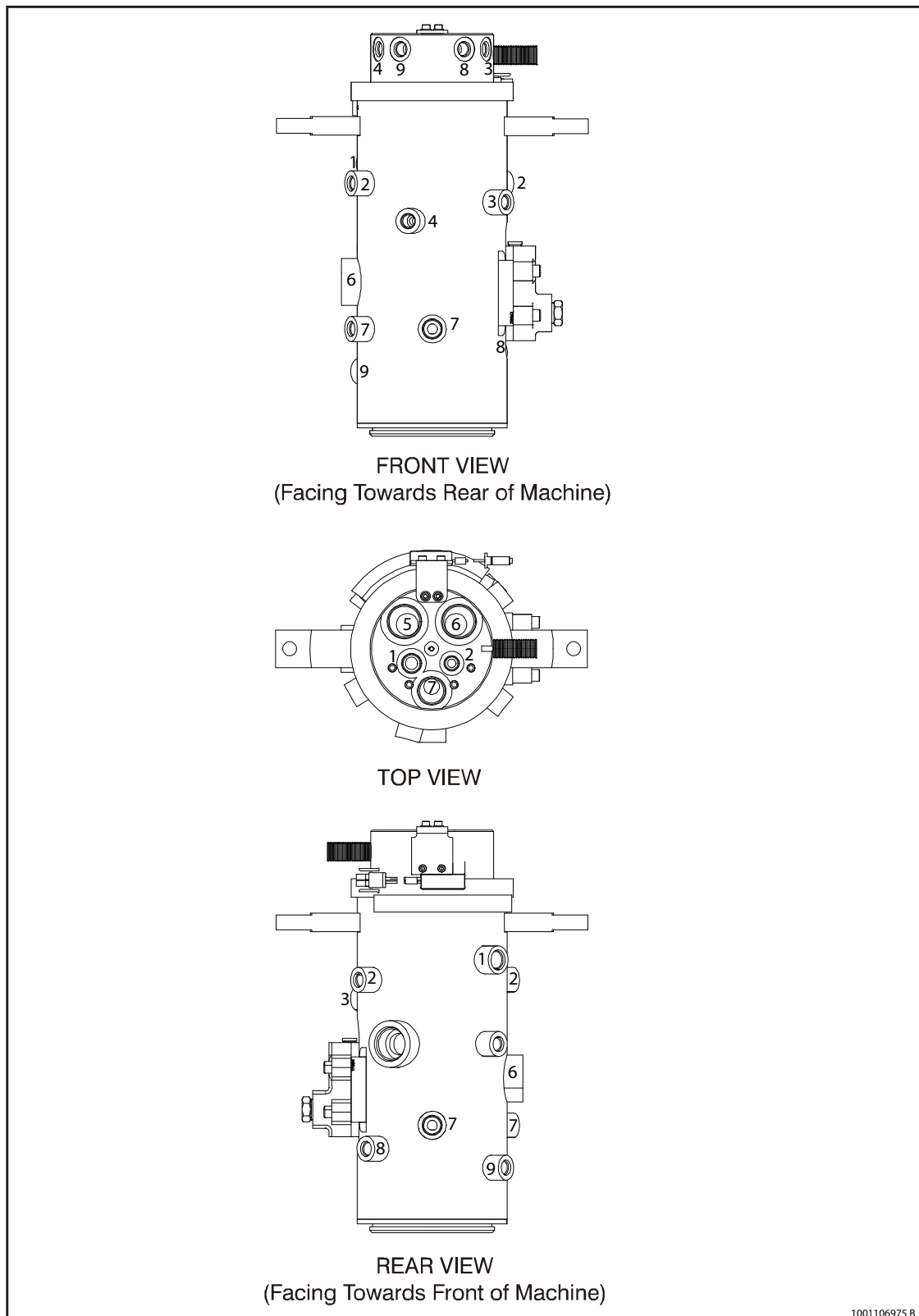
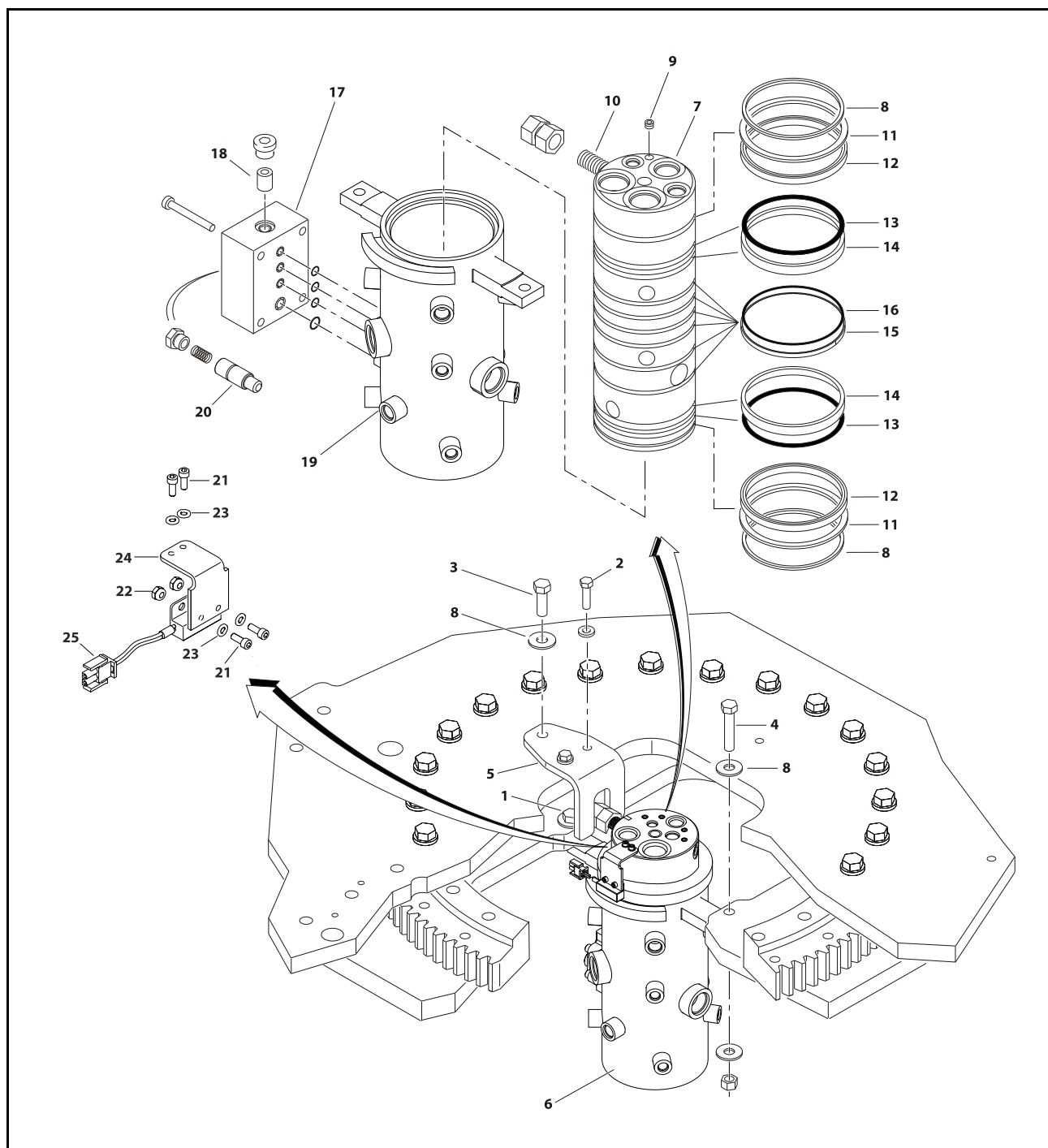


Figure 3-77. Rotary Coupling (9 Port) - 4WS (USA Built Machines, SN 0300138729 through 0300171769 and China Built Machines, SN B300000100 through B300000969)



- | | | | | |
|---------------------|--------------------|--------------|-------------------|----------------------|
| 1. JLG Threadlocker | 6. Rotary Coupling | 11. Ring | 16. O-ring | 21. Bolt |
| 2. Bolt | 7. Spool | 12. Seal | 17. Valve | 22. Nut |
| 3. Bolt | 8. Retaining Ring | 13. O-ring | 18. Check Valve | 23. Washer |
| 4. Bolt | 9. Plug | 14. Bearing | 19. Case | 24. Bracket |
| 5. Bracket | 10. Torque Lug | 15. Cap Seal | 20. Plunger Valve | 25. Proximity Switch |

Figure 3-78. Rotary Coupling (USA Built Machines, SN 0300138729 through 0300171769 and China Built Machines, SN B300000100 through B300000969)

Table 3-12. Coupling Port Information Table (7 port)

Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)

Table 3-13. Coupling Port Information Table (9 port)

Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)
8	1	-6	Steer	2500 (172)	3750 (258.5)
9	1	-6	Steer	2500 (172)	3750 (258.5)

3.20 ENGINE

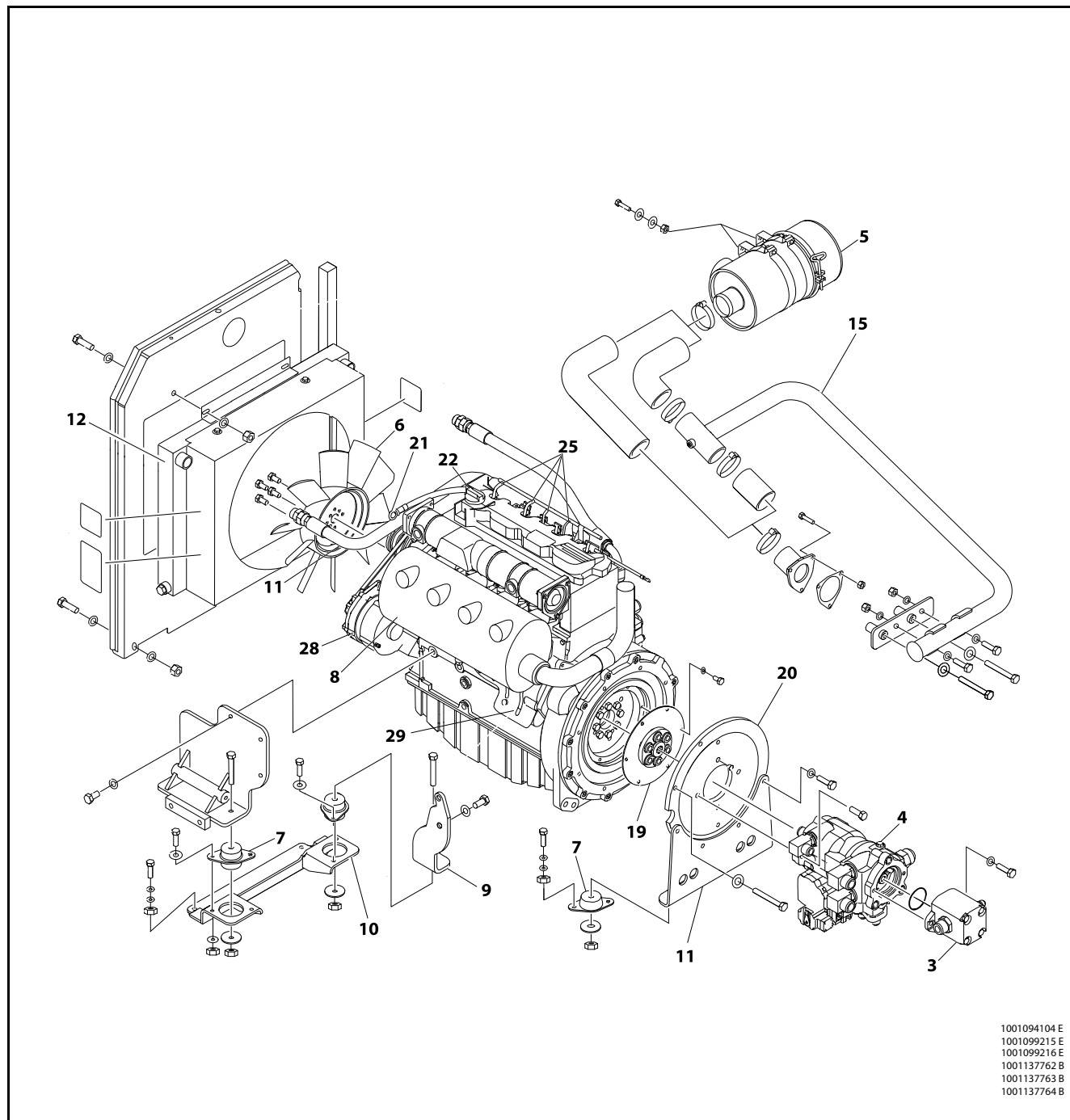
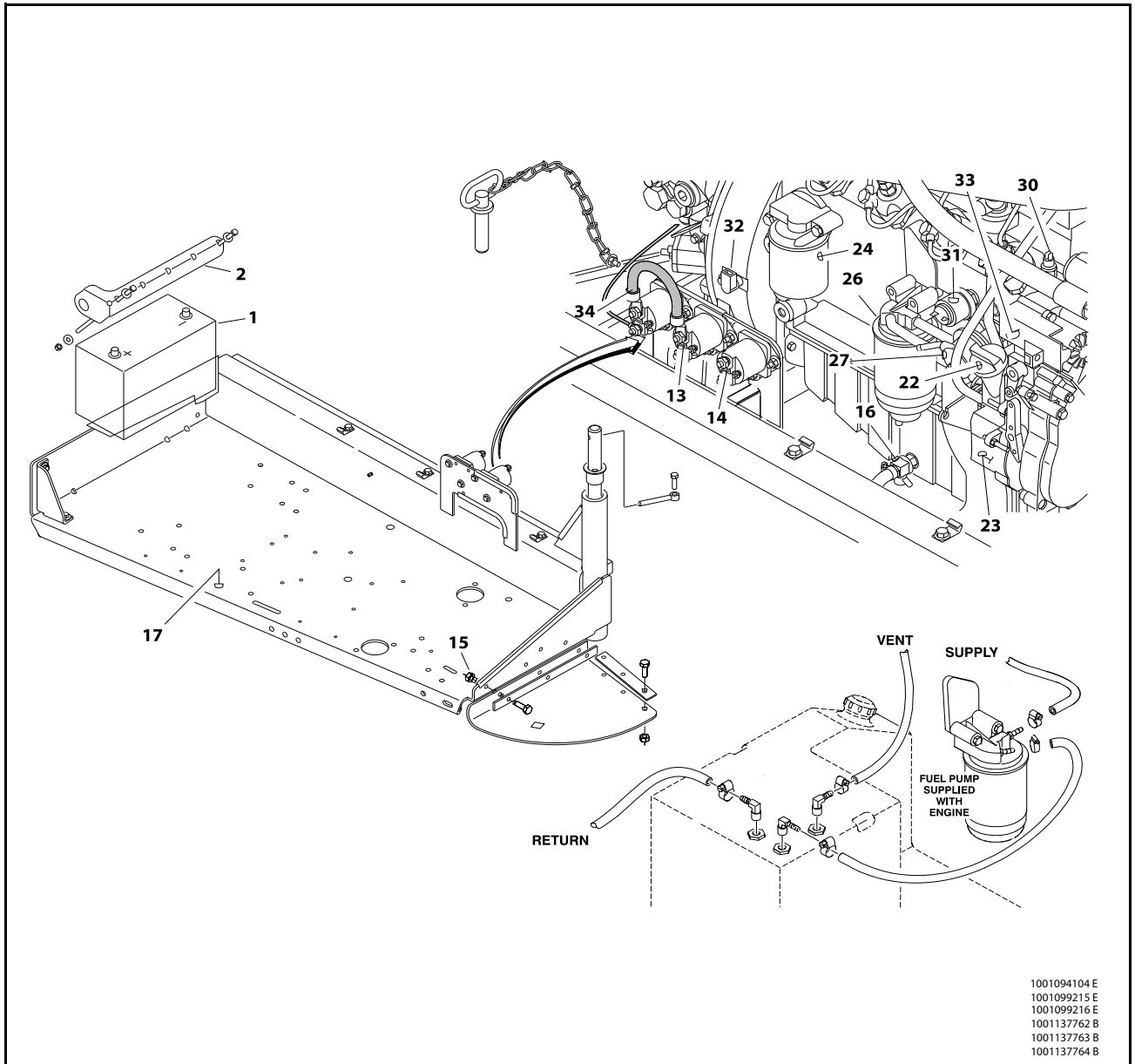


Figure 3-79. Deutz Engine (D2011L04) - Sheet 1 of 2



- | | | |
|--|---------------------------|-------------------------|
| 1. Battery | 13. Starter Relay | 25. Injector Pump |
| 2. Battery Holddown | 14. Aux Pump Relay | 26. Fuel Filter |
| 3. Gear Pump | 15. Tuning Tube | 27. Fuel Supply Pump |
| 4. Piston Pump | 16. Oil Drain Valve | 28. Alternator |
| 5. Air Cleaner | 17. Engine Tray | 29. Starter |
| 6. Fan | 18. Engine Mounting Plate | 30. Temperature Sender |
| 7. Motor Mount | 19. Hayes Coupling | 31. Oil Pressure Sensor |
| 8. Muffler | 20. Pump Adapter Plate | 32. Speed Sensor |
| 9. Front Right Engine Mounting Plate | 21. Dipstick | 33. Throttle Actuator |
| 10. Front Bottom Engine Mounting Plate | 22. Filler Cap | 34. Cable Jumper |
| 11. Rear Engine Mounting Plate | 23. Oil Lube Pump | |
| 12. Radiator | 24. Oil Filter | |

Figure 3-80. Deutz Engine (D2011L04) - Sheet 2 of 2

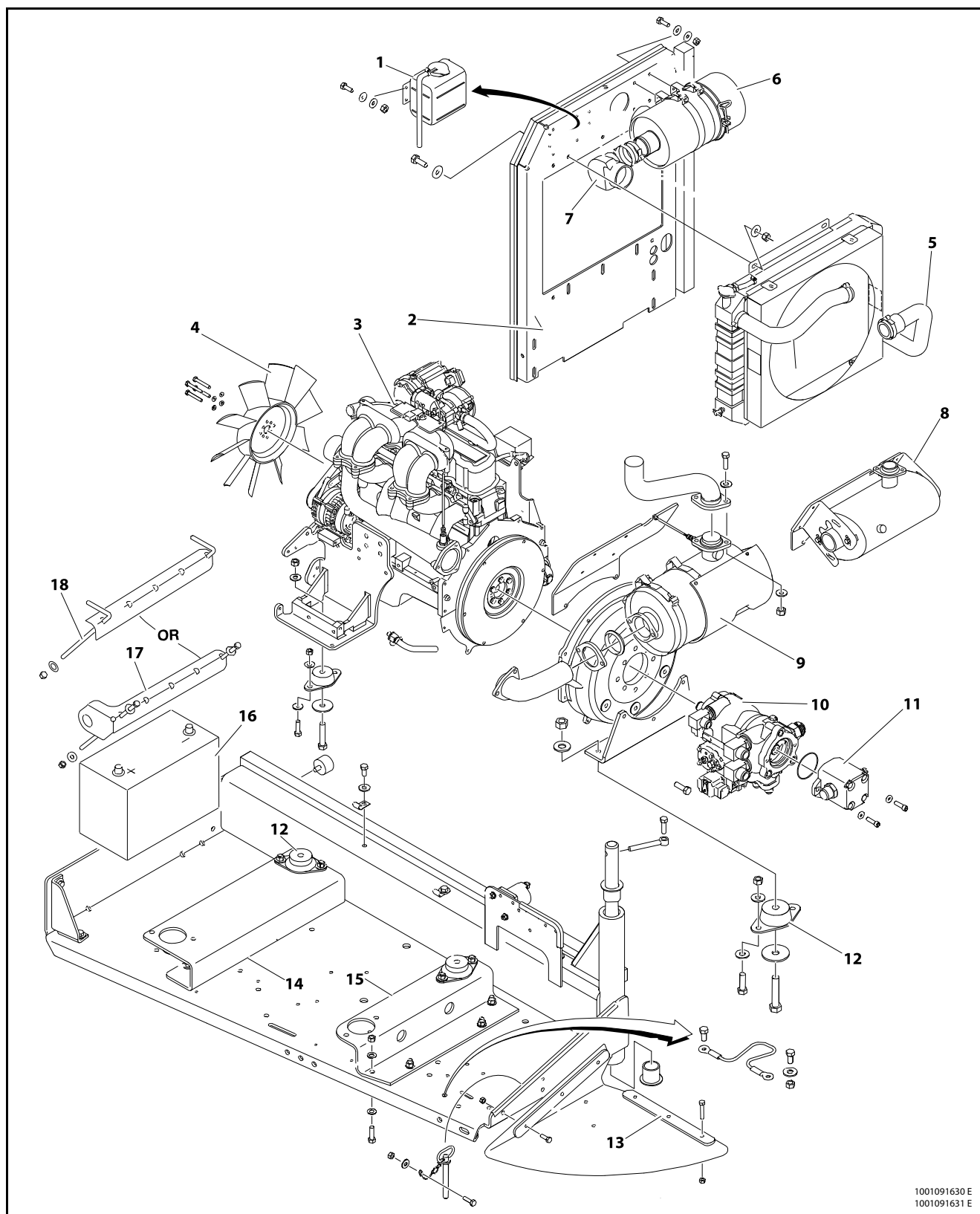


Figure 3-81. GM Engine without UGM - Sheet 1 of 3

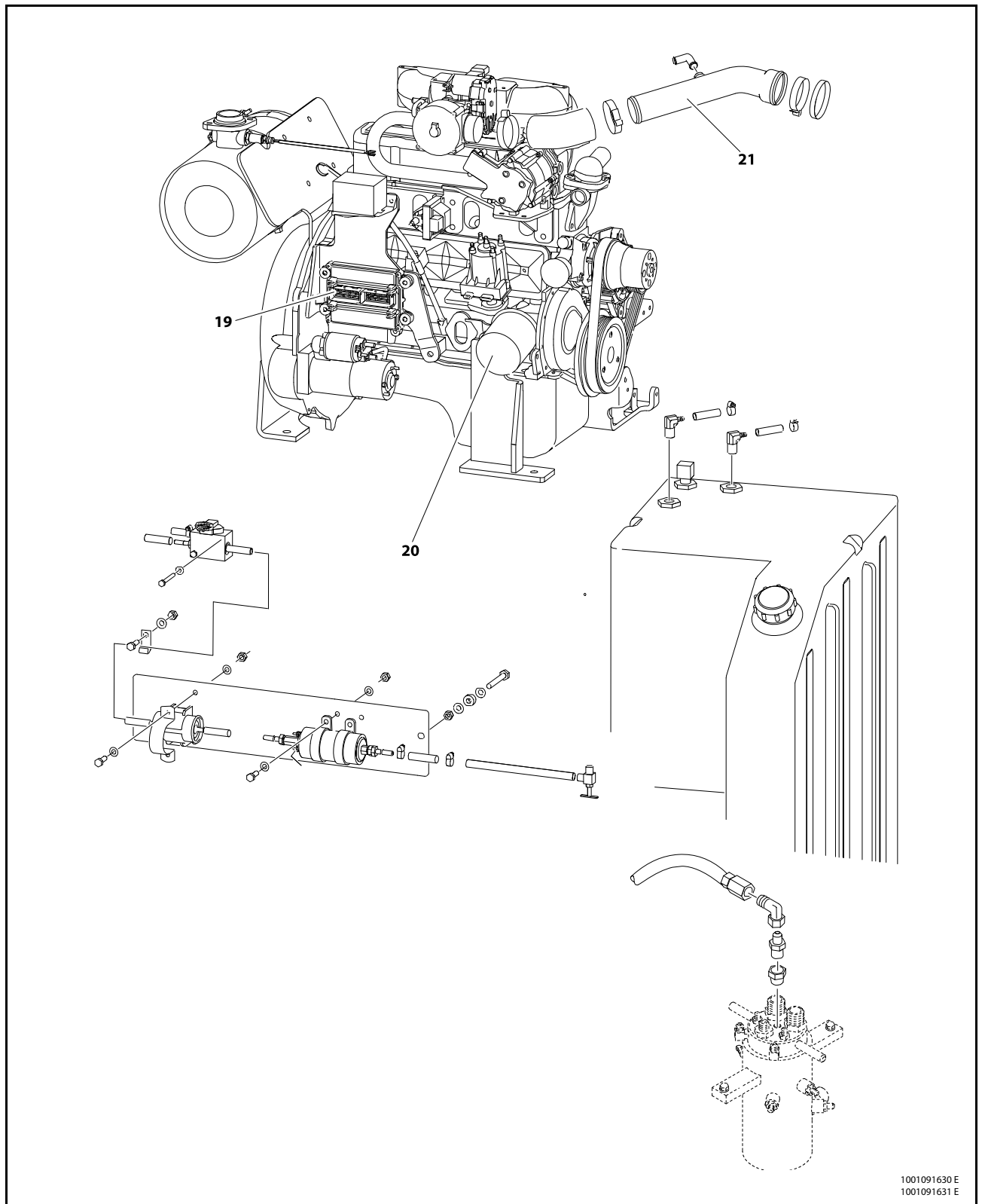


Figure 3-82. GM Engine without UGM - Sheet 2 of 3

- | | | |
|----------------------------|---------------------|------------------------|
| 1. Container | 8. Muffler | 15. Engine Mount Plate |
| 2. Radiator Mounting Plate | 9. Muffler | 16. Battery |
| 3. Oil Filter | 10. Piston Pump | 17. Battery Hold Down |
| 4. Fan | 11. Gear Pump | 18. Battery Hold Down |
| 5. Radiator Hose | 12. Engine Mount | 19. Control Module |
| 6. Air Cleaner Assembly | 13. Hold Down Plate | 20. Oil Filter |
| 7. Fitting | 14. Engine Mount | 21. Intake Tube |

Figure 3-83. GM Engine without UGM - Sheet 3 of 3

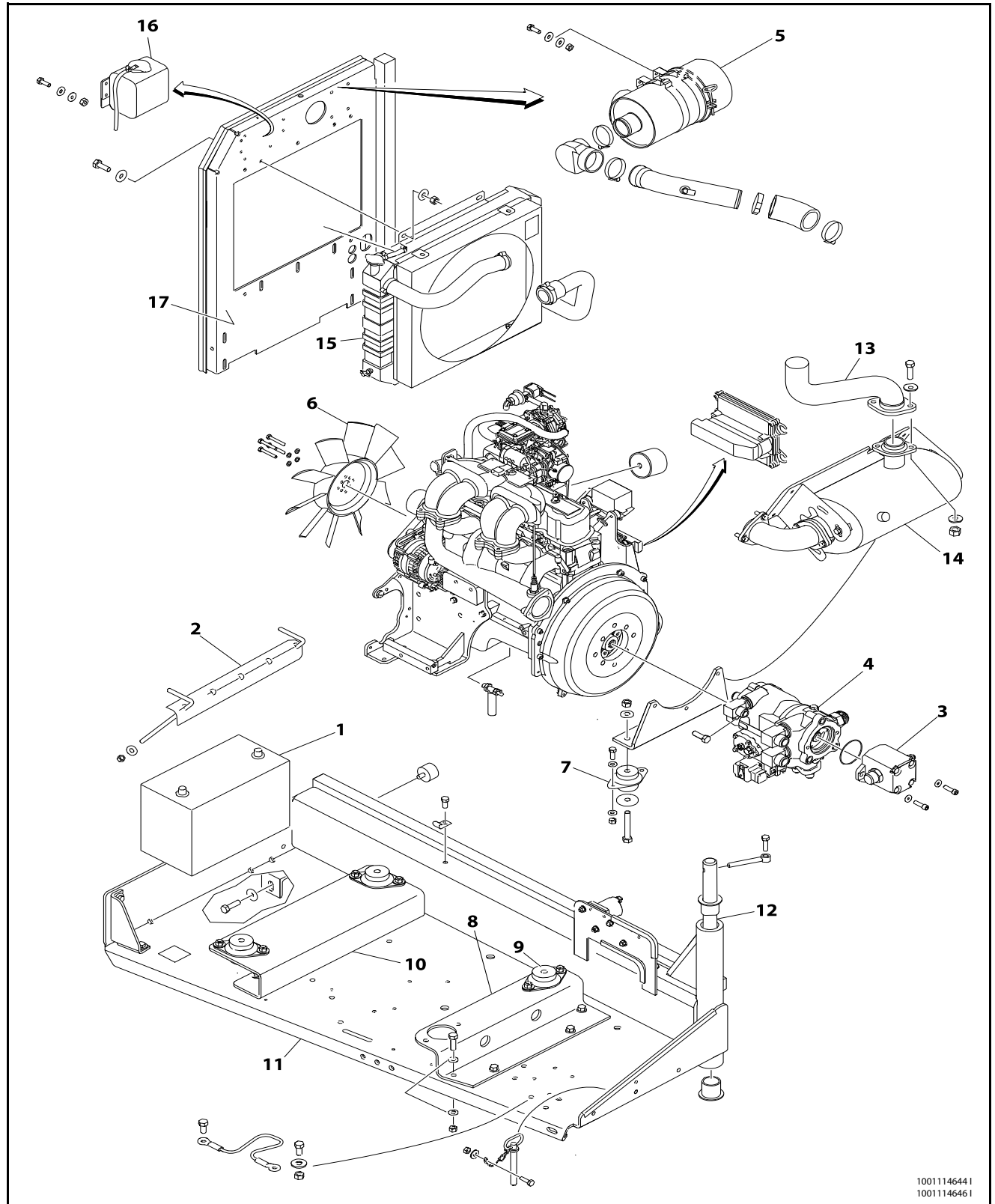


Figure 3-84. GM Engine with UGM - Sheet 1 of 3

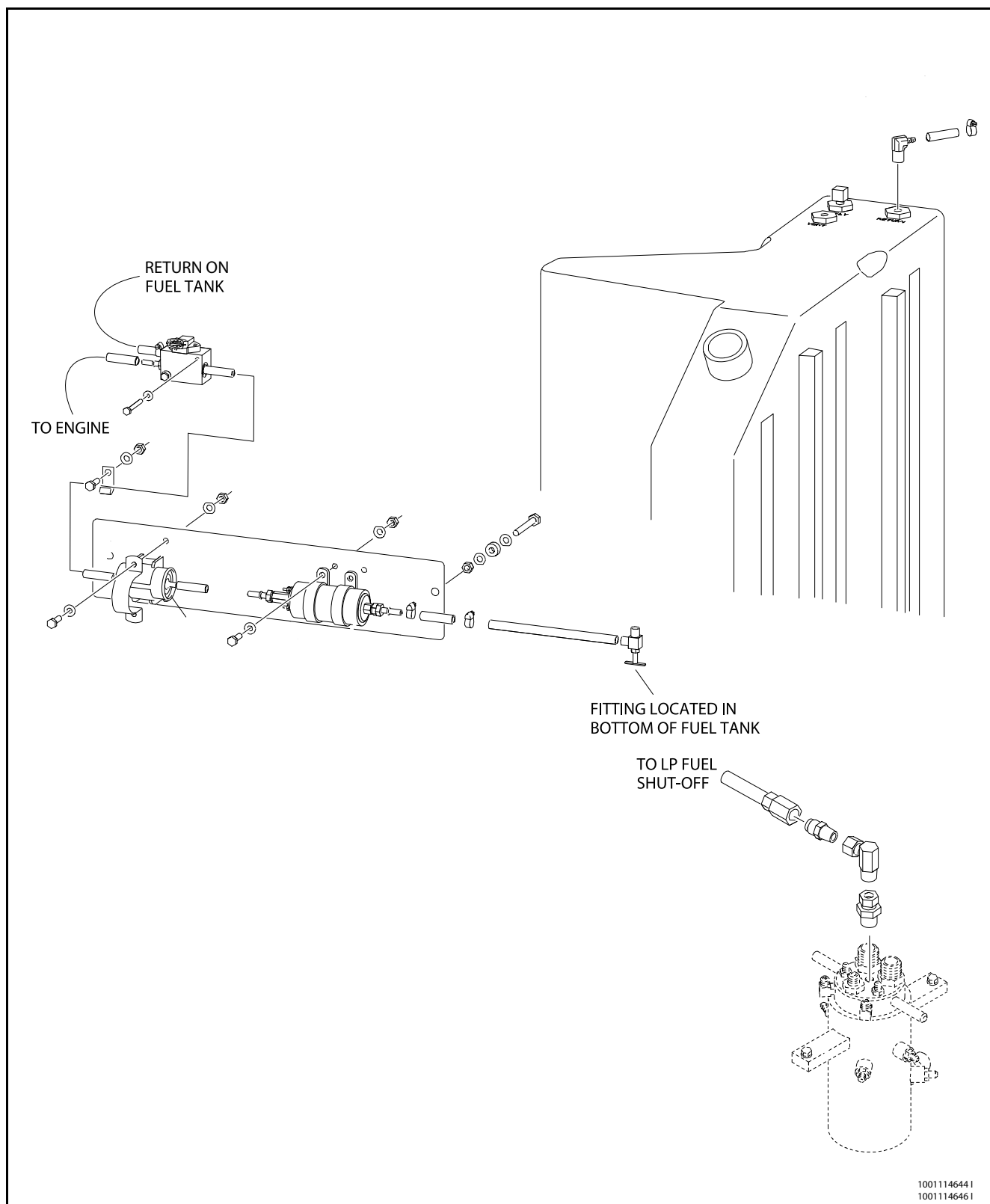
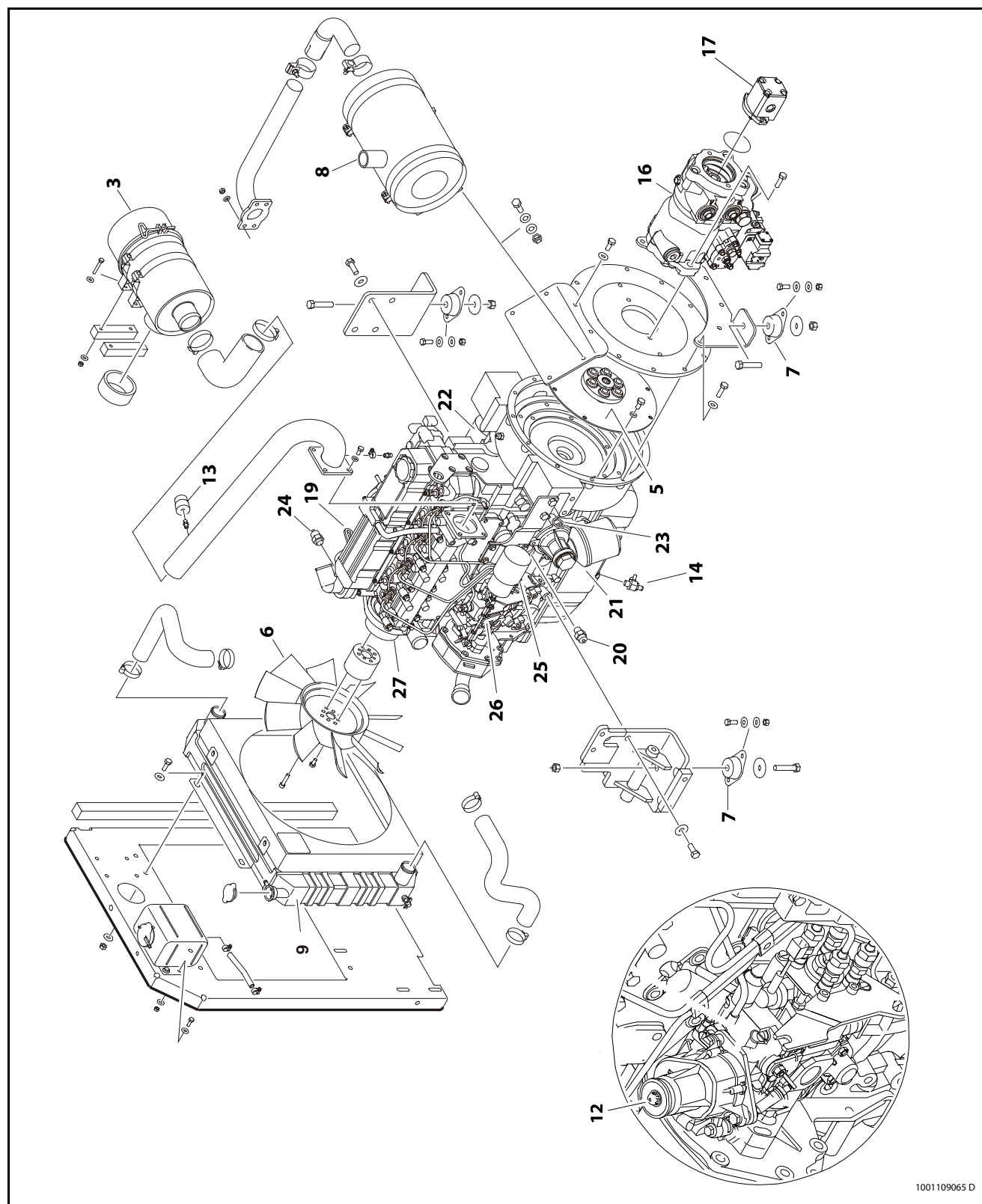


Figure 3-85. GM Engine with UGM - Sheet 2 of 3

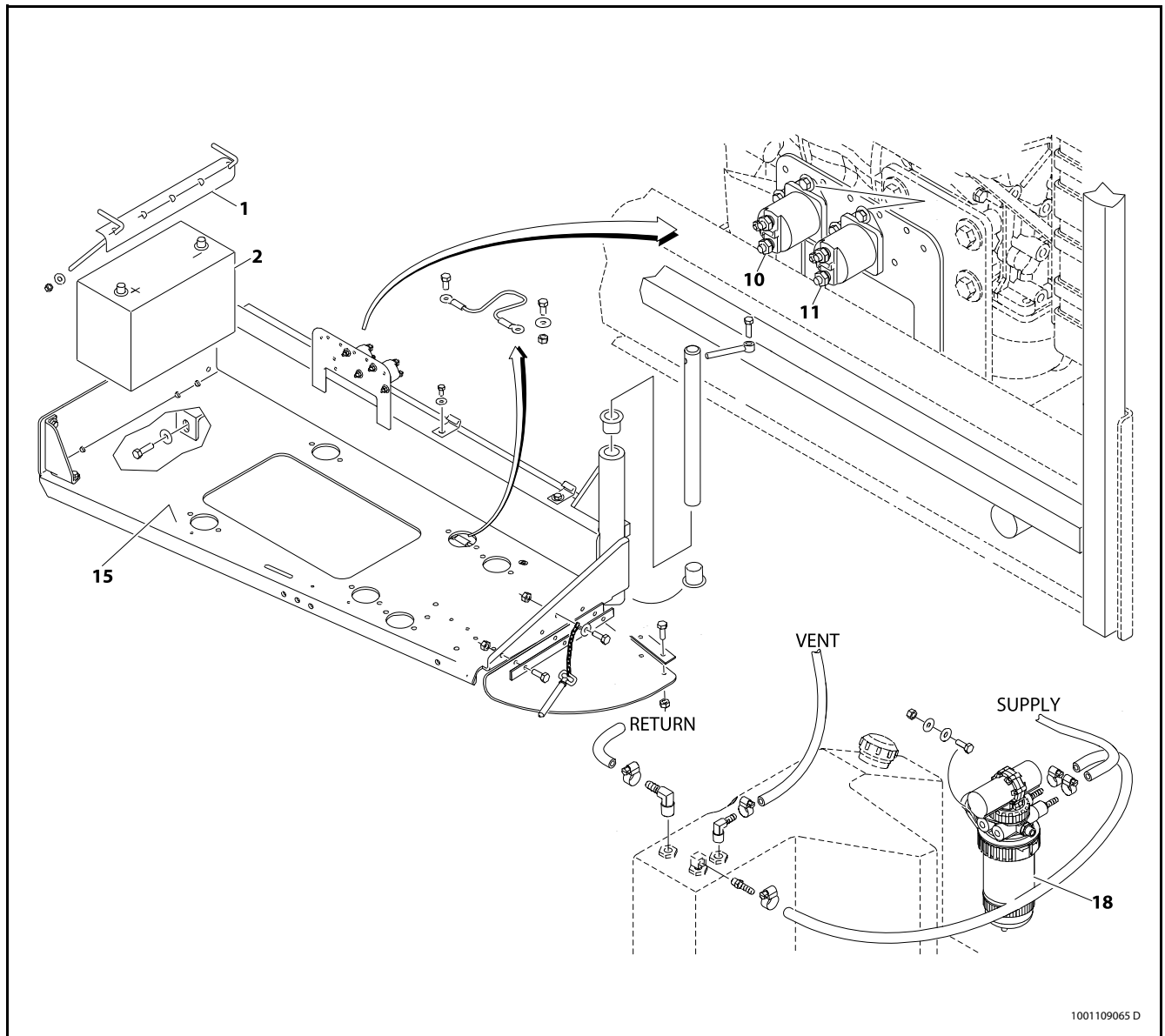
- | | | |
|------------------------|------------------------|--------------------------|
| 1. Battery | 7. Engine Mount | 13. Exhaust Tube |
| 2. Hold Down Battery | 8. Engine Mount Plate | 14. Muffler Insulation |
| 3. Gear Pump | 9. Mount Engine | 15. Radiator |
| 4. Piston Pump | 10. Mount Engine-Front | 16. Container |
| 5. Air Cleaner Element | 11. Tray Engine | 17. Radiator Mount plate |
| 6. Fan | 12. Bearing | |

Figure 3-86. GM Engine with UGM - Sheet 3 of 3



1001109065 D

Figure 3-87. CAT Engine -Sheet 1 of 2



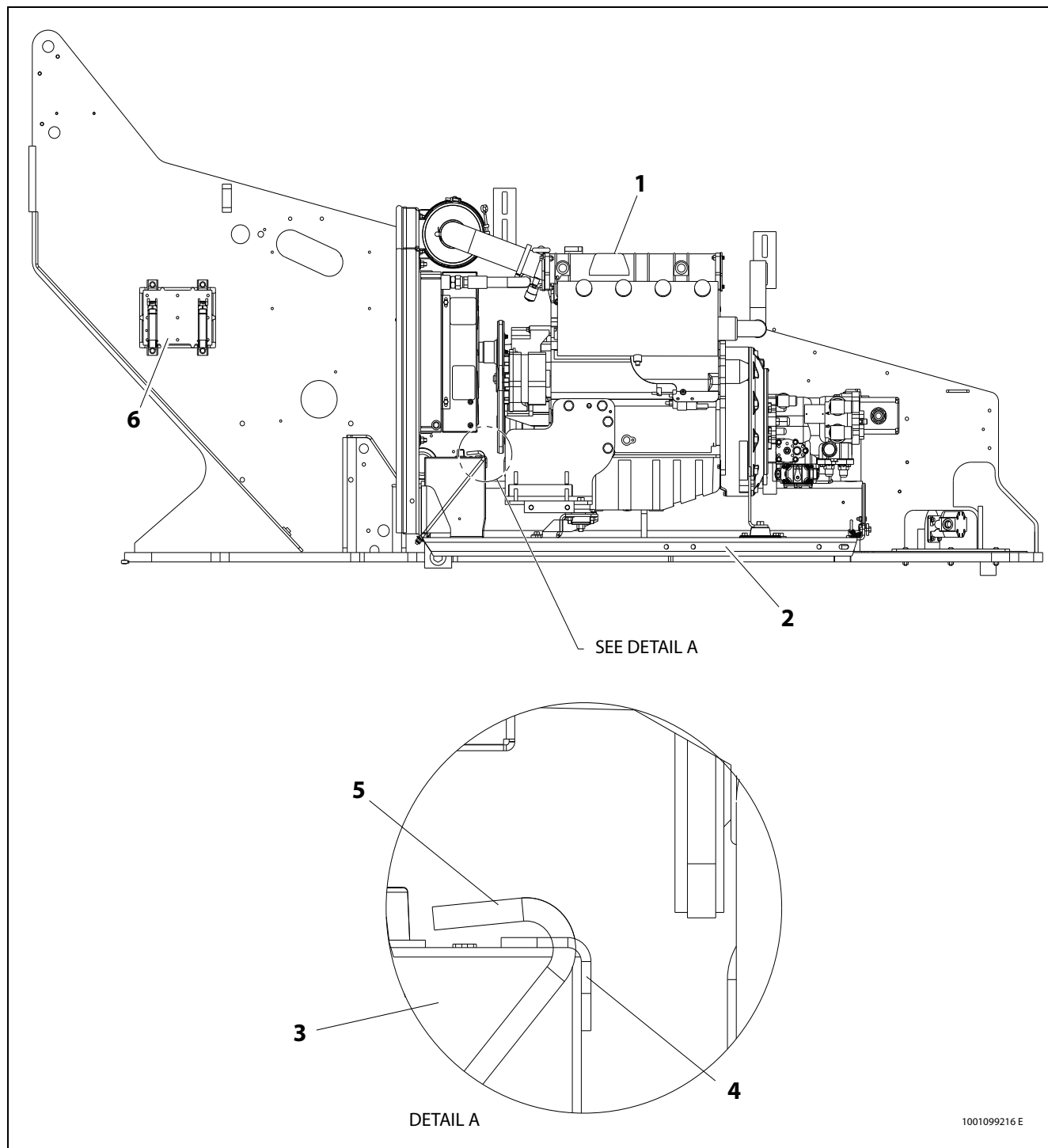
1. Battery Hold-down
2. Battery
3. Air Cleaner
4. Coolant Overflow Container
5. Pump Coupling
6. Fan
7. Engine Mount
8. Muffler
9. Radiator

10. Starter Relay
11. Glow Plug Relay
12. Actuator
13. Restriction Indicator
14. Oil Drain Valve
15. Engine Tray
16. Piston Pump
17. Gear Pump
18. Fuel Filter

19. Alternator
20. Oil Pressure Switch
21. Oil Filter
22. Starter
23. Dipstick
24. Engine Temperature Sender
25. Throttle Actuator
26. Fuel Supply Pump
27. Water Pump

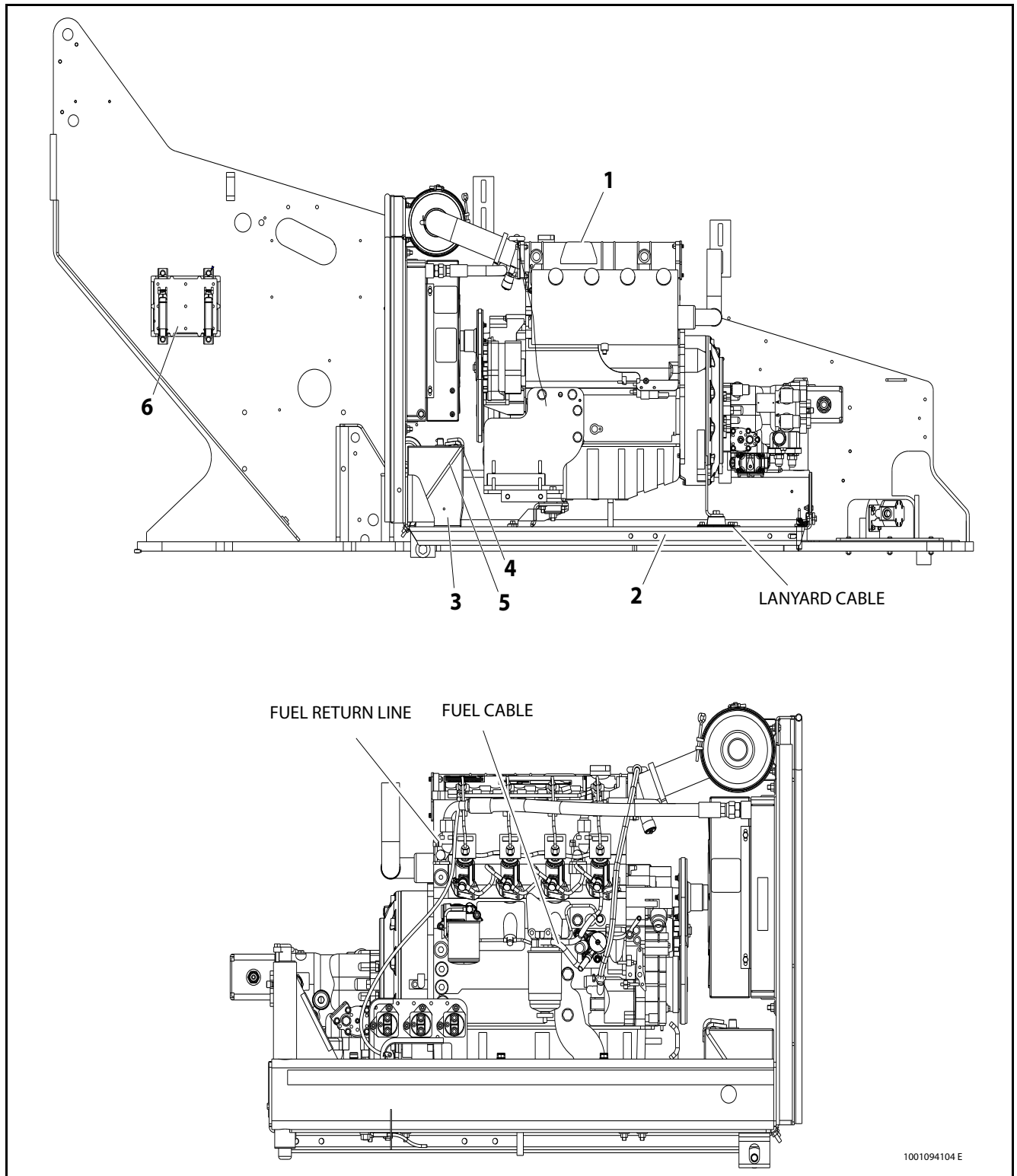
Figure 3-88. CAT Engine -Sheet 2 of 2

Engine Installation



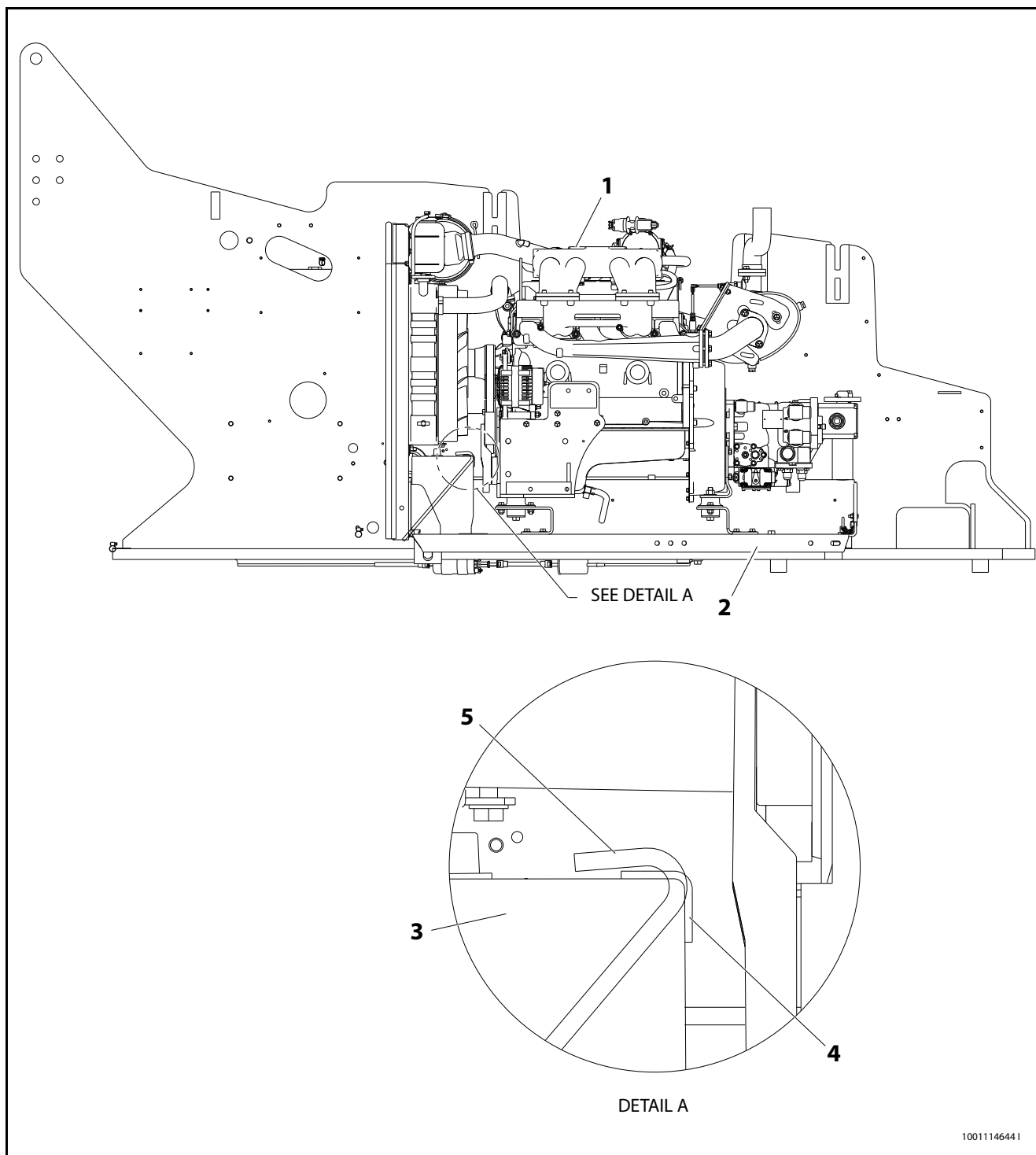
- | | | |
|----------------|--------------------|--------------------------|
| 1. Engine | 3. Battery | 5. J-Bolt |
| 2. Engine Tray | 4. Battery Bracket | 6. Engine Control Module |

Figure 3-89. Deutz 2WD Engine Installation



- | | | |
|----------------|--------------------|--------------------------|
| 1. Engine | 3. Battery | 5. J-Bolt |
| 2. Engine Tray | 4. Battery Bracket | 6. Engine Control Module |

Figure 3-90. Deutz 4WD Engine Installation

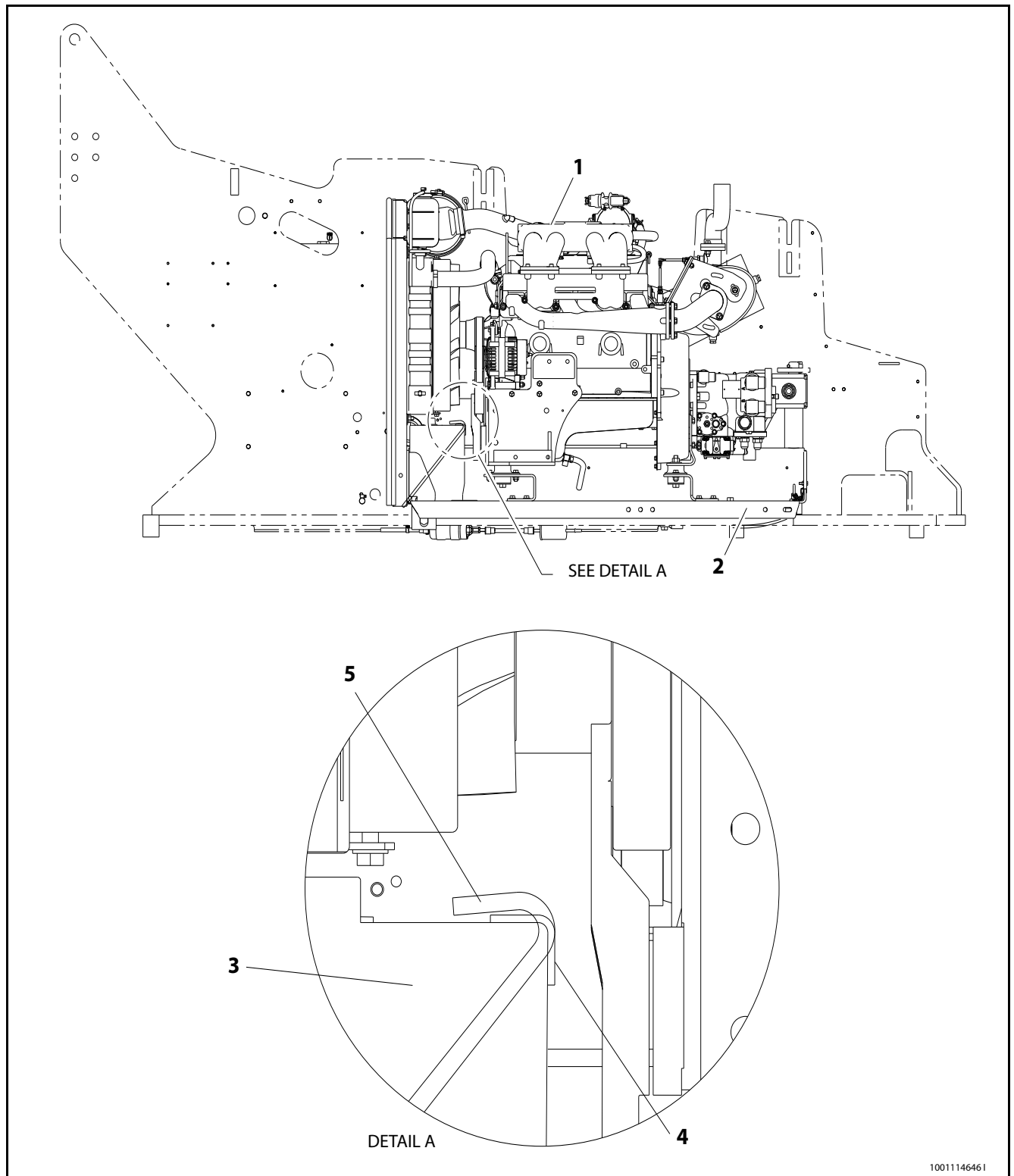


- 1. Engine
- 2. Engine Tray

- 3. Battery
- 4. Battery Bracket

- 5. J-Bolt

Figure 3-91. GM 2WD Engine Installation

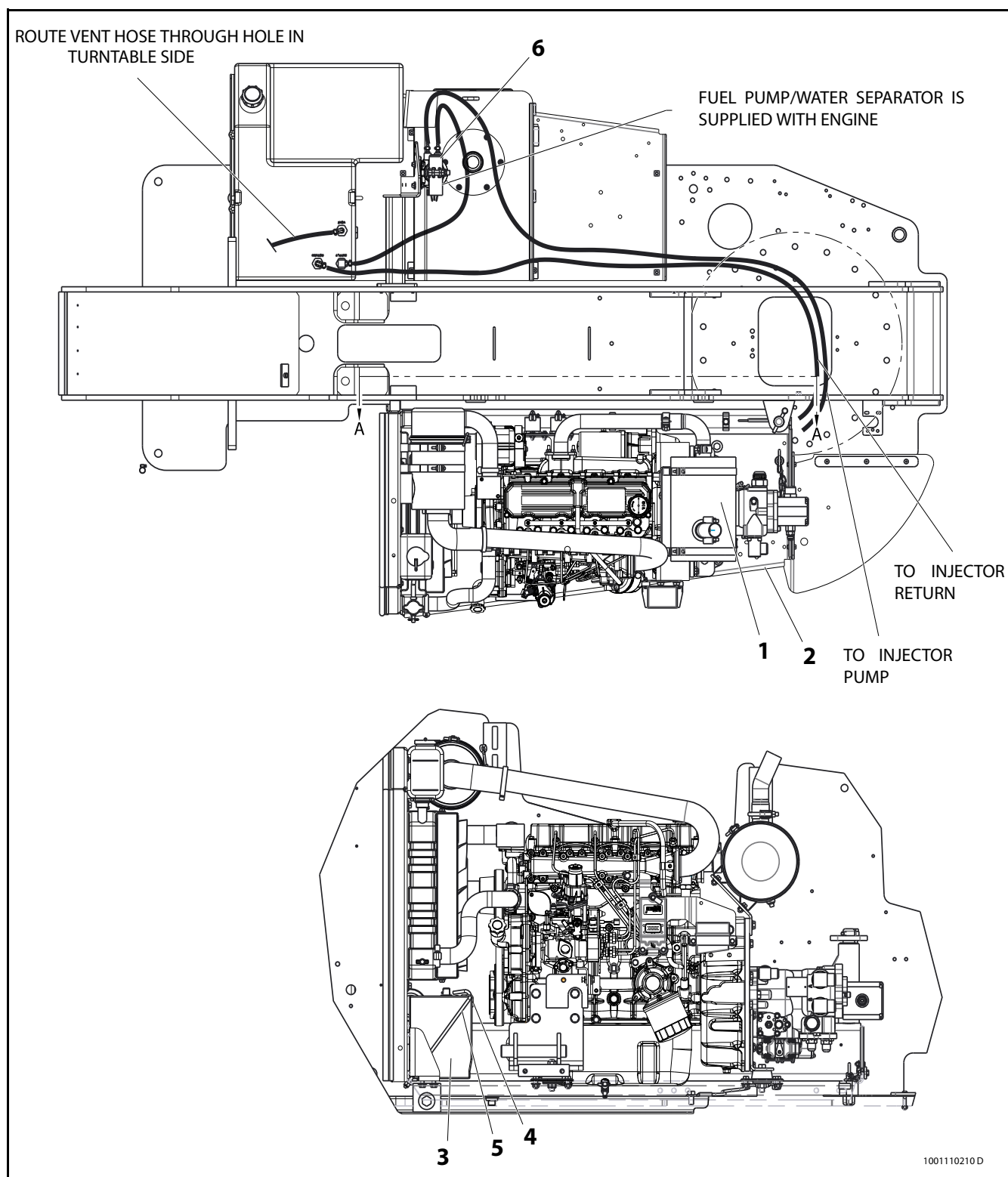


- 1. Engine
- 2. Engine Tray

- 3. Battery
- 4. Battery bracket

- 5. J-Bolt

Figure 3-92. GM 4WD Engine Installation



- 1. Engine
- 2. Engine Tray

- 3. Battery
- 4. Battery Bracket

- 5. J-Bolt
- 6. Fuel Pump

Figure 3-93. CAT 2WD Engine Installation

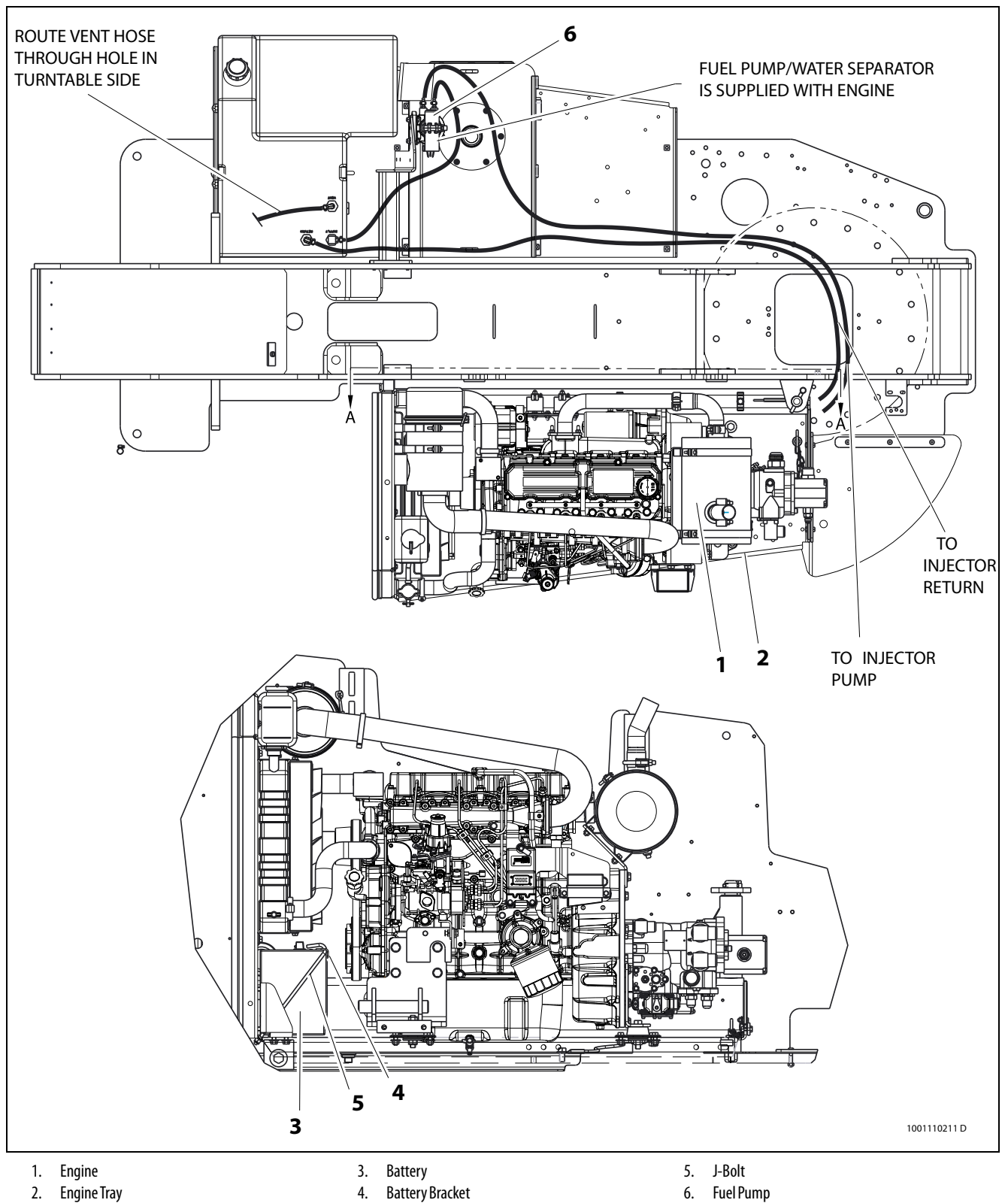
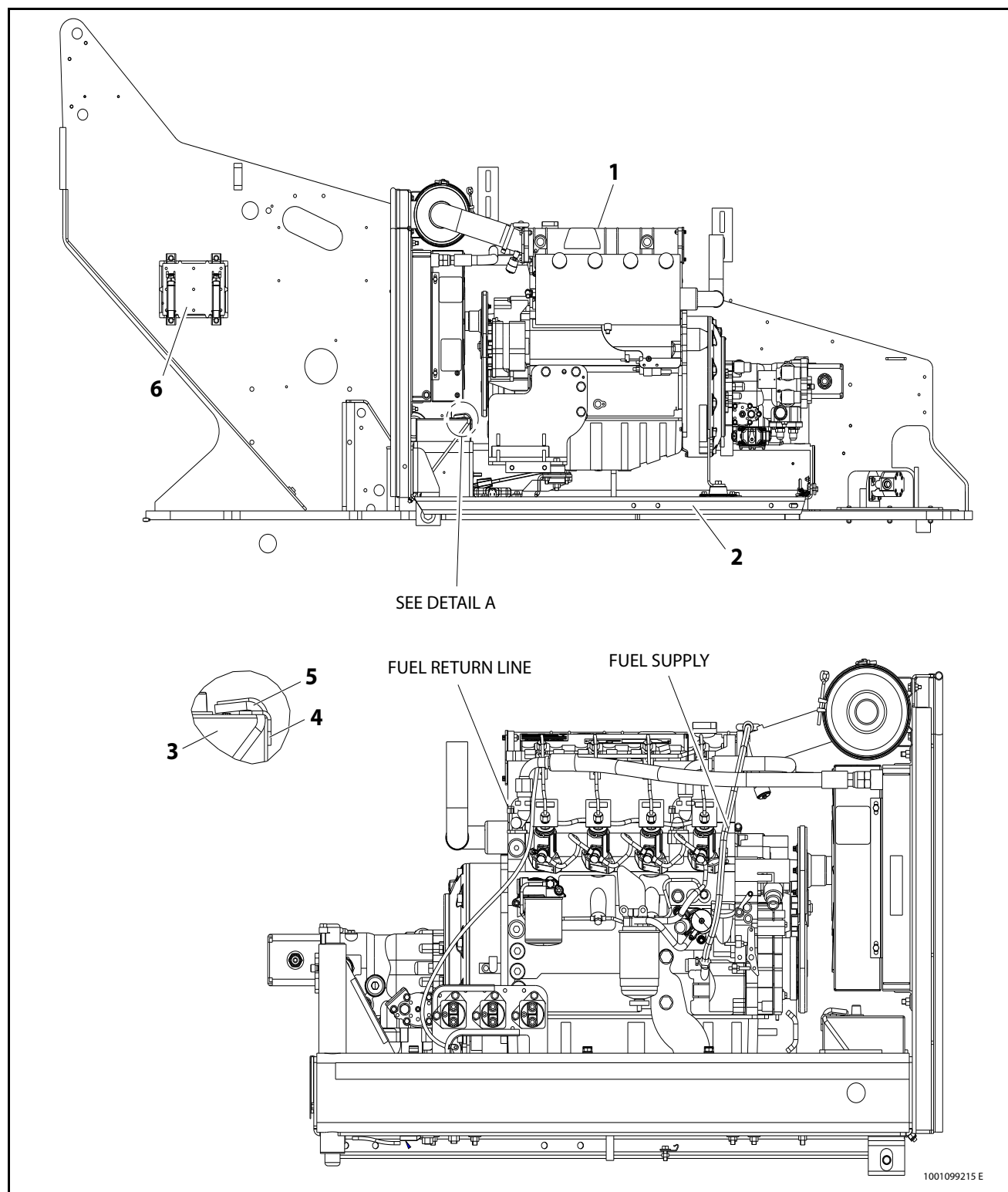


Figure 3-94. CAT 4WD Engine Installation



- 1. Engine
- 2. Engine Tray

- 3. Battery
- 4. Battery Bracket

- 5. J-Bolt
- 6. Engine Control Module

Figure 3-95. Deutz Arctic Engine Installation

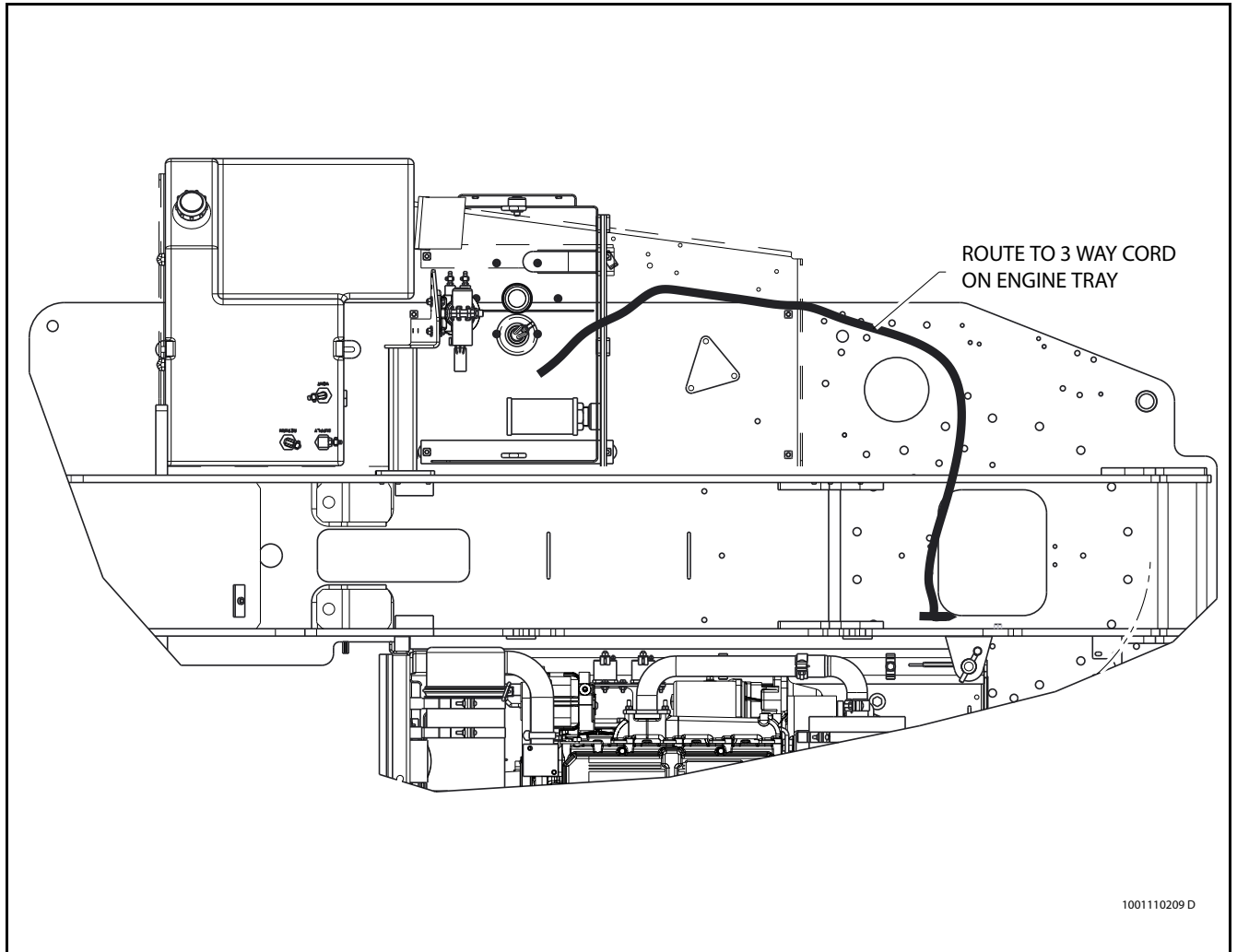
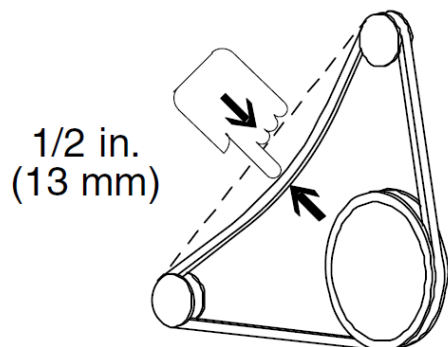


Figure 3-96. CAT Arctic Engine Installation

3.21 GENERATOR

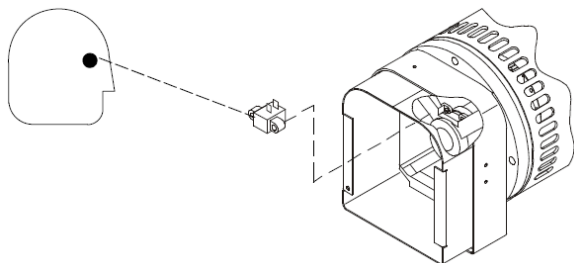
Every 250 hours

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

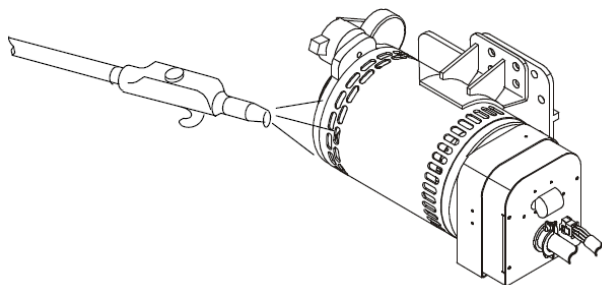


Every 500 hours

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.

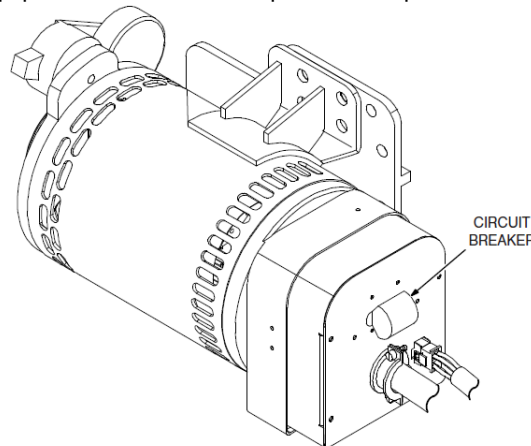


Overload Protection

⚠ 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 3-97., 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.

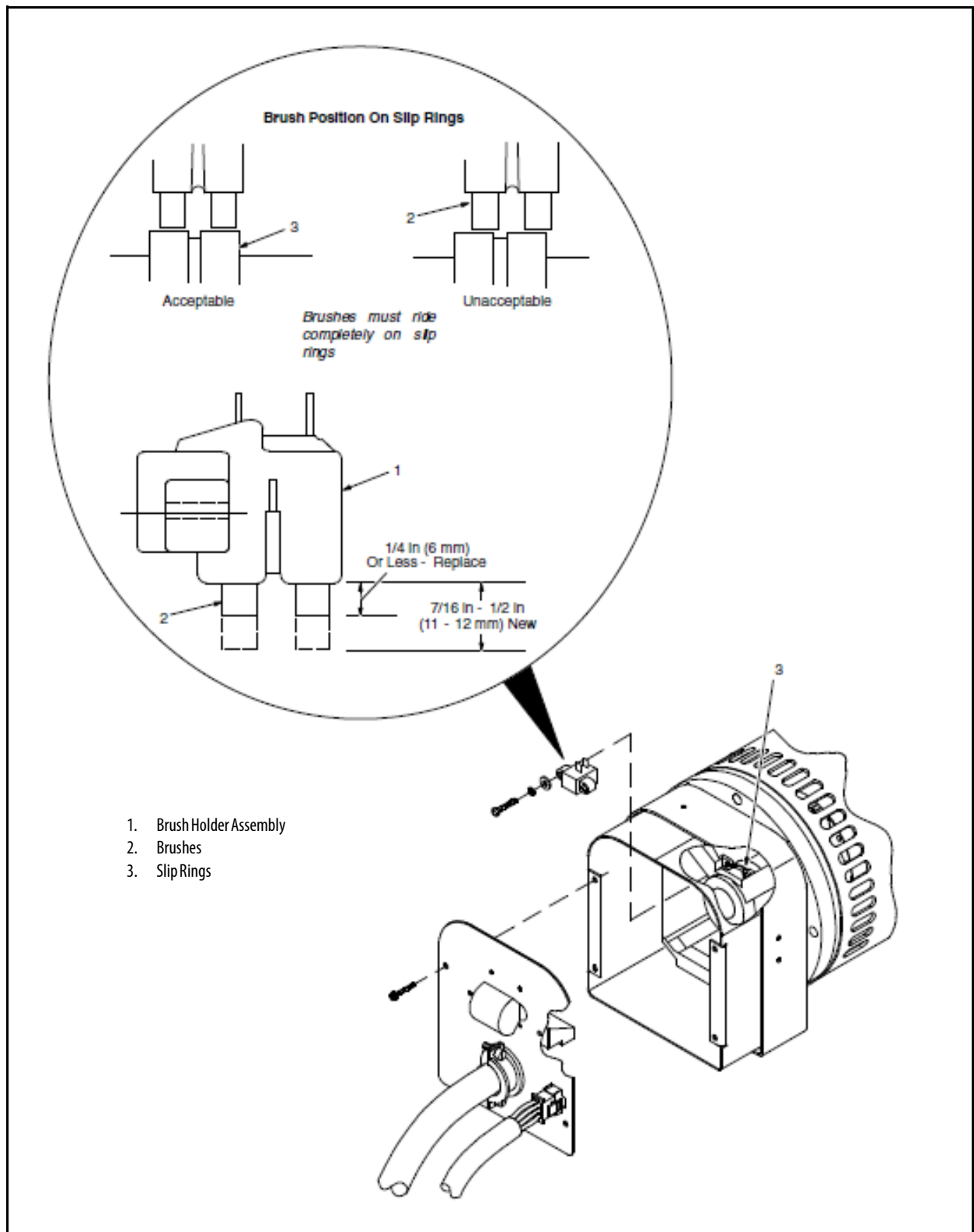
CLEANING SLIP RINGS

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 3-97. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings**

Troubleshooting

Table 3-14. Troubleshooting

Trouble	Remedy
No generator output at platform AC receptacles.	Be sure generator control switch is turned on at platform.
	Check and secure electrical connections at platform, generator, and control box.
	Be sure all equipment is turned off when starting unit.
	Reset circuit breaker CB1.
	Check plug PLG3 connection and/or connections at receptacles RC3 and RC5.
	Be sure + 12 volts DC input voltage is being supplied to control box.
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary. Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1, and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
Low generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1, and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
High generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
Erratic generator output at platform AC receptacles.	Check and secure electrical connections at platform, generator, and control box.
	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Check power board PC1 and connections, and replace if necessary
	Check control board PC2 and connections, and replace if necessary

3.22 SPARK ARRESTER CLEANING INSTRUCTIONS

1. Remove the cleanout plug in the bottom of spark arrester (muffler).
2. Without causing deformation (or any type of damage to the spark arrester) repeatedly tap on the arrester near the cleanout plug. This may be enough to begin drainage of the spark trap.
3. An industrial vacuum cleaner can do a complete job at this point.
 - a. Or, IN A SAFE AREA, start the engine. Then alternate between low idle and high idle for two to three minutes.
 - b. Or, operate the engine as required by the application for two to three minutes.
4. Install the cleanout plug.

3.23 GLOW PLUGS

If the glow plug option is enabled in the JLG Control System, the glow plug and indicator lamp will be energized when the Power/Emergency Stop switch is pulled on if the ambient air temperature is less than 50° F (10° C) and the engine coolant temperature is less than 140° F (60° C). This determination will occur one second after the Power/ Emergency Stop switch has been pulled on. The lamp and glow plugs will remain energized for the period of time specified by the setting in the JLG Control System. Engine start shall be disabled during this period. On Deutz engines, the glow plugs will continue (post glow) after the engine has started for three times the machine digit setting.

3.24 DUAL FUEL SYSTEM (GAS ENGINE ONLY)

The dual fuel system enables the standard gasoline engine to run on either gasoline or LP gas.

CAUTION

IT IS POSSIBLE TO SWITCH FROM ONE FUEL SOURCE TO THE OTHER WITHOUT ALLOWING THE ENGINE TO STOP. EXTREME CARE MUST BE TAKEN AND THE FOLLOWING INSTRUCTIONS MUST BE FOLLOWED.

Changing from Gasoline to LP Gas

1. Start the engine from the ground control station.
2. Open the hand valve on the LP gas supply tank by turning counterclockwise.
3. While engine is operating on GASOLINE under a no-load condition, place FUEL SELECT switch at Platform Control to LP position.

Changing from LP Gas to Gasoline

1. With engine operating on LP under a no-load condition, position FUEL SELECT switch at Platform Control Station to GASOLINE position.
2. Close hand valve on LP gas supply tank by turning clockwise.

3.25 FORD EFI ENGINE

Performing Diagnostics

1. Verify the complaint and determine if it is a deviation from normal operation.
2. Perform a system check that will verify the proper operation of the system in question and check for recent information updates.
3. If a diagnostic trouble code (DTC) is stored, contact a JLG distributor to make an effective repair.
4. If no DTC is stored, select the symptom from the symptom tables and follow the diagnostic path or suggestions to complete the repair.
5. 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.
6. If no matching symptom is available, analyze the complaint and develop a plan for diagnostics utilizing the wiring diagrams, technical assistance, and repair history.
7. 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.

ECM/EPM 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 run. As long as the fault is present, the engine can be restarted. It will run in the previously established injection sequence.

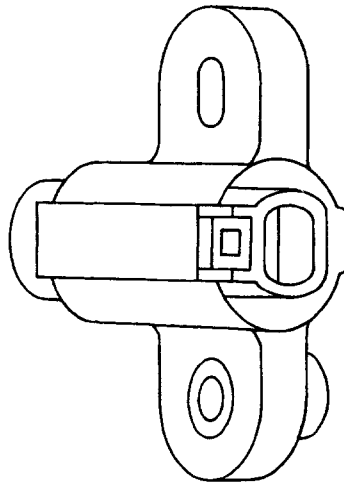


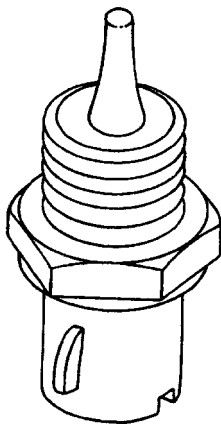
Table 3-15. ECM Diagnostic Trouble Codes

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

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

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

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



ELECTRICALLY ERASABLE PROGRAMMABLE READ ONLY MEMORY (EEPROM)

The electrically erasable programmable read only memory (EEPROM) is a permanent memory chip that is located within the ECM. The EEPROM contains the 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.

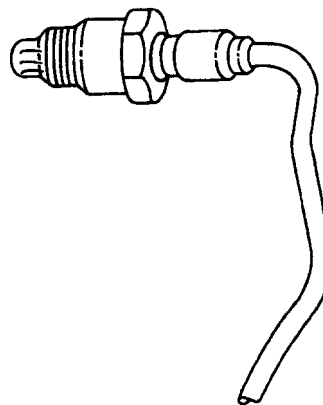
HEATED OXYGEN SENSOR

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 output of the oxygen sensor, the ECM calculates the pulse width command for the injectors to produce the proper combustion chamber mixture.

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

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

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



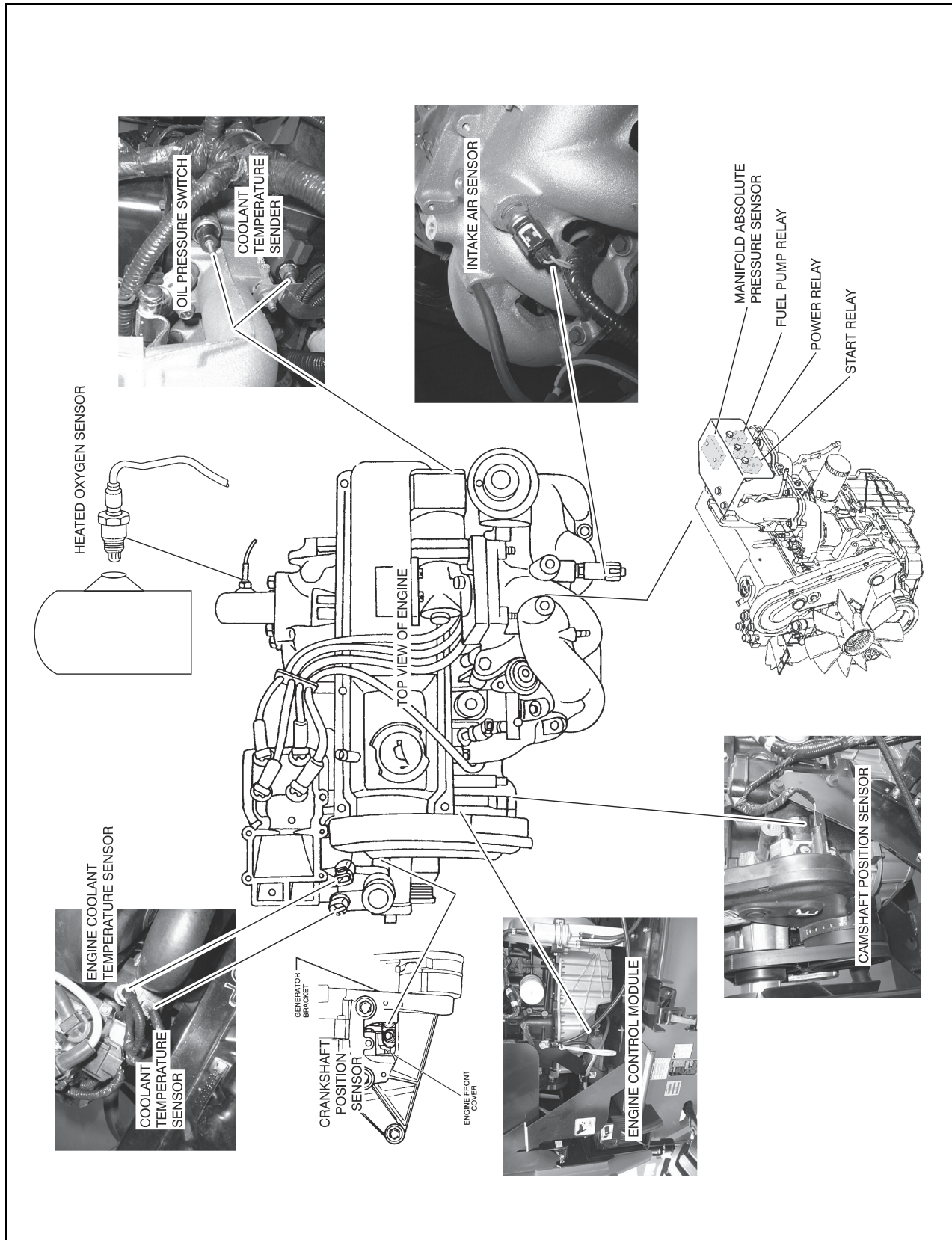
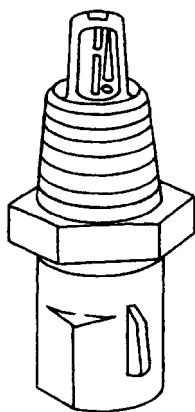


Figure 3-98. EFI Component Location

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 software can be used to display the temperature of the air entering the engine. The temperature should read close to the ambient air temperature when the engine is cold, and rise as engine compartment temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor temperature and engine coolant temperature should read close to each other. A failure in the IAT sensor circuit will set DTC 35 or DTC 45.



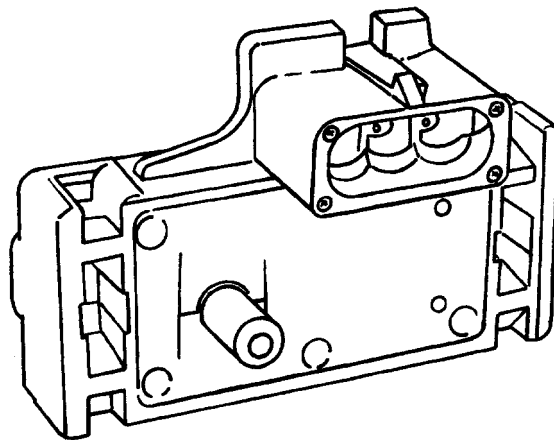
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

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

The MAP sensor is used to determine the following:

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

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



ENGINE CONTROL MODULE (ECM)

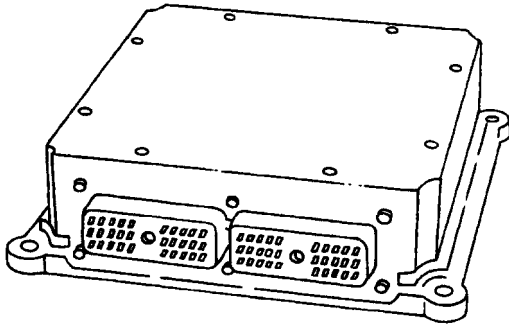
The ECM controls the following:

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

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

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

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



ECM INPUTS/OUTPUTS

Inputs - Operating Conditions

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

Outputs - System Controlled

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

ECM SERVICE PRECAUTIONS

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

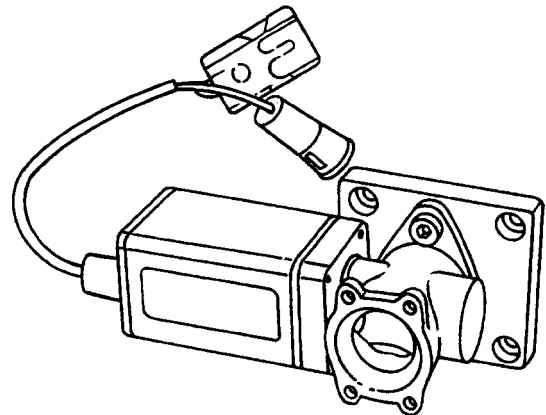
- Do not overload any circuit.
- Do not probe wires for testing. This can cause a voltage drop that would be critical to the operation of the ECM.
- When testing for opens and shorts, do not ground or apply voltage to any of the ECM's circuits unless instructed to do so.
- When measuring voltages, use only a digital voltmeter with an input impedance of at least 10 megohms.

- Do not jump start with more than 12 volts. This could cause damage to the electronic components.
- Do not employ any non-standard practices such as charging the battery with an arc welder.
- Take proper precautions to avoid static damage to the ECM. Refer to "Electrostatic Discharge Damage" for more information.

THROTTLE POSITION (TP) SENSOR

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

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



USE OF CIRCUIT TESTING TOOLS

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

ELECTROSTATIC DISCHARGE DAMAGE

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

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

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

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

To prevent possible electrostatic discharge damage, follow these guidelines:

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

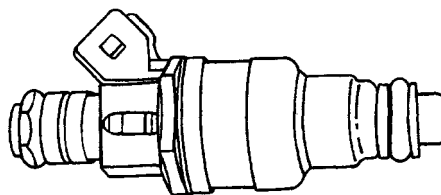
Fuel System

FUEL INJECTOR

The Electronic Fuel Injection (EFI) fuel injector is a solenoid-operated device controlled by the ECM. The ECM energizes the solenoid, which opens a valve to allow fuel delivery.

The fuel is injected under pressure in a conical spray pattern at the opening of the intake valve. Excess fuel not used by the injectors passes through the fuel pressure regulator before being returned to the fuel tank.

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



FUEL METERING SYSTEM COMPONENTS

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

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

BASIC SYSTEM OPERATION

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

FUEL METERING SYSTEM PURPOSE

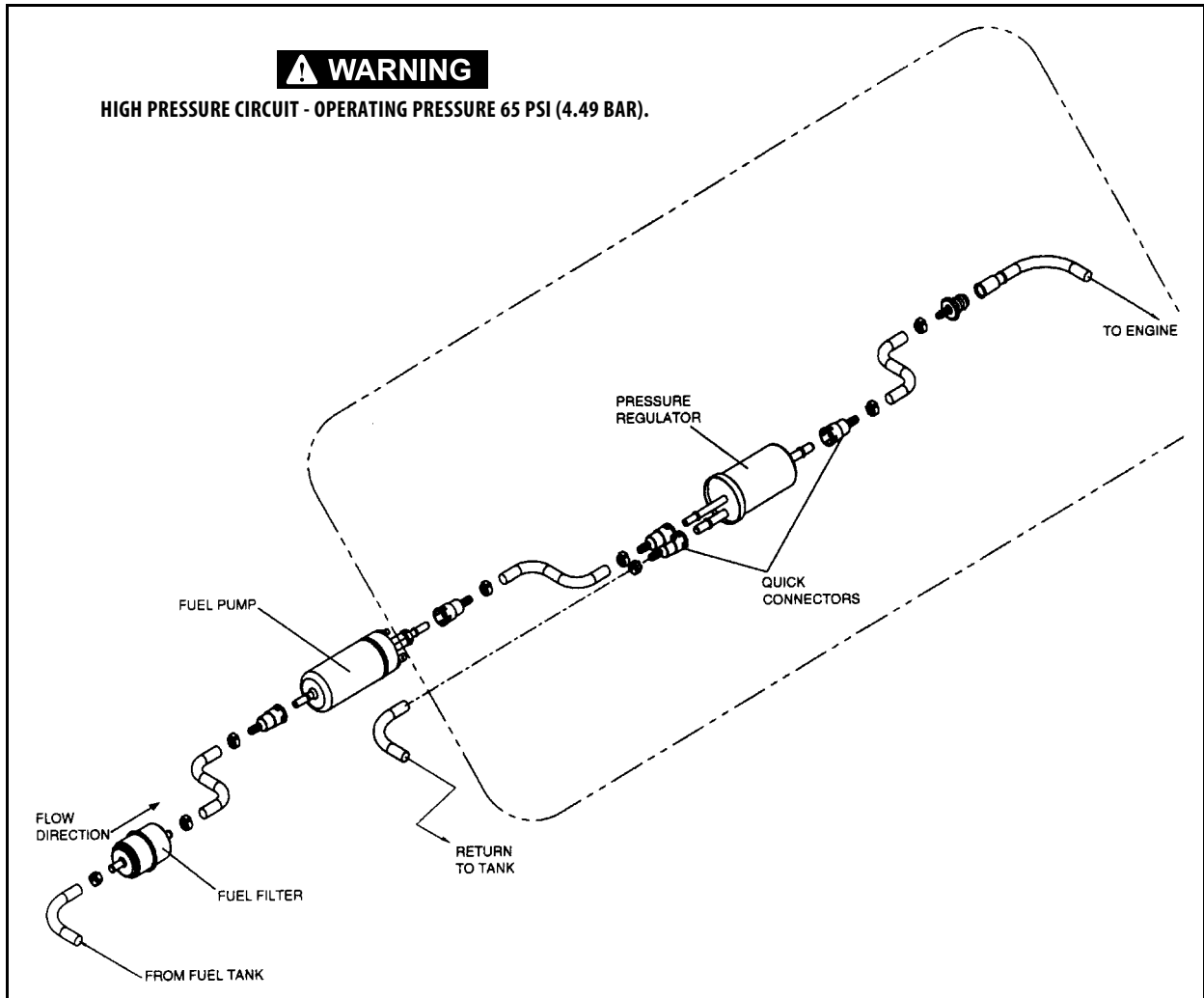


Figure 3-99. Typical Fuel System

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 controlling 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.

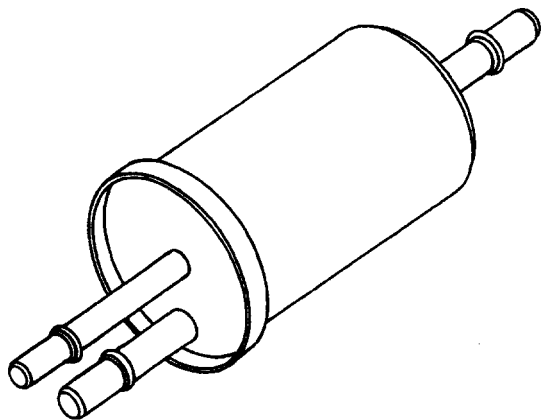
FUEL PRESSURE REGULATOR

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.



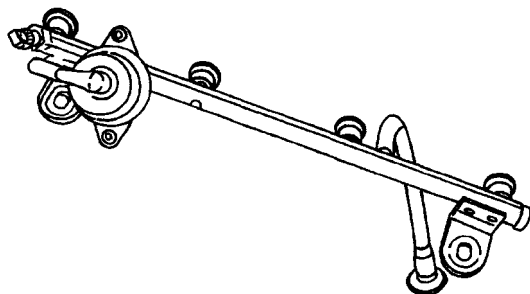
FUEL PUMP ELECTRICAL CIRCUIT

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.

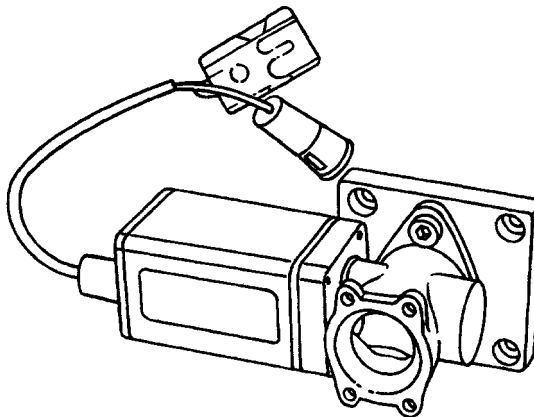
FUEL RAIL

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.

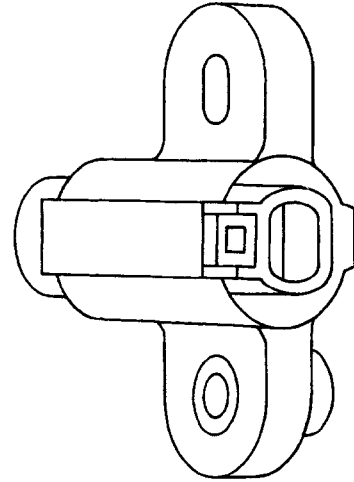
The system remains in open loop until the following conditions are met:

- 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 voltage) the ECM responds by reducing the "on" time of the fuel injectors, thus leaning out the mixture.

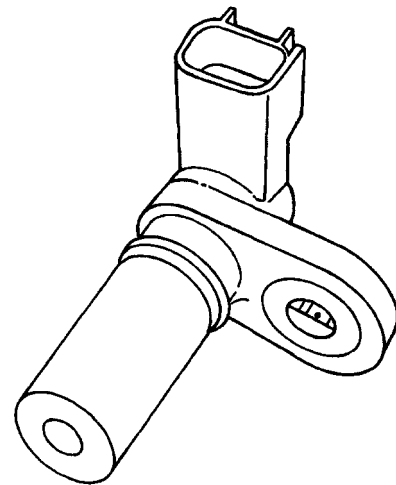
CAMSHAFT POSITION (CMP) SENSOR

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



CRANKSHAFT POSITION (CKP) SENSOR

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



ELECTRONIC IGNITION

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

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

ELECTRONIC IGNITION

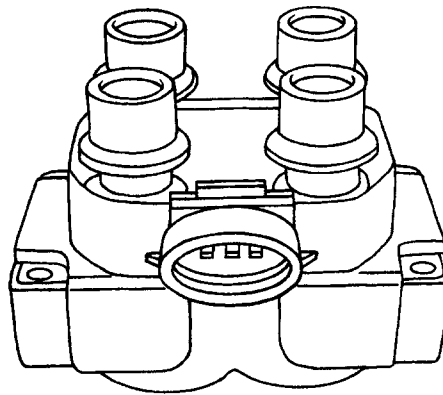
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- No moving parts
- Less maintenance
- Remote mounting capability
- No mechanical load on the engine
- More coil cooldown time between firing events
- Elimination of mechanical timing adjustments
- Increased available ignition coil saturation time

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".

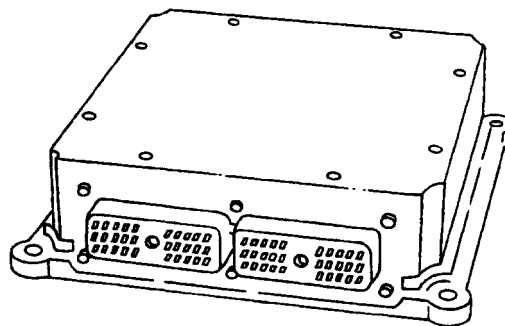
The primary coils in the coil pack are triggered by the "Ignition Coil Feed #1" and "Ignition Coil Feed #2" Signals from the ECM.



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



3.26 FORD LPG SYSTEM

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

Description

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

Regulator

The regulator accepts LPG liquid at tank pressure (min = 30 psi; max = 312 psi [min = 207 kPa; max = 2151 kPa]) and reduces it to a regulator outlet pressure of 1.5-2.5 inches (3.8-6.3 cm) of H₂O at idle flow (approx. 750 RPM / no load). This regulator must have engine coolant flowing through it whenever the engine is running.

Megajector

The megajector is an electronic pressure regulator. This electronic regulator outputs a specific pressure needed at the mixer to maintain the desired air to fuel ratio. The megajector accepts LPG vapor at the regulator outlet pressure (1.5-2.5 inches [3.8-6.3 cm] of H₂O) and reduces it to a pressure value commanded by the EPM. The pressure command is sent by the EPM over the CAN link via the megajector harness. The megajector outlet pressure has units of inches of H₂O. The megajector outlet pressure is defined as the difference between the megajector outlet gas pressure and the balance line pressure (usually at or near barometric pressure depending on air intake restriction). The megajector outlet pressure can vary between -1.00 to -5.00 inches (-2.5 to -12.7 cm) of H₂O depending on the speed and load of the engine. The megajector must be mounted per the 2.5L 2004 Emission Installation Instructions. Torque mounting bolts to a maximum of 60 in. lbs. (7 Nm).

Mixer

The mixer accepts LPG vapor at the megajector outlet pressure (-1.00 to -5.00 inches [-2.5 to -12.7 cm] of H₂O) and mixes it with clean air. This mixture is then sucked into the engine via the actuator.

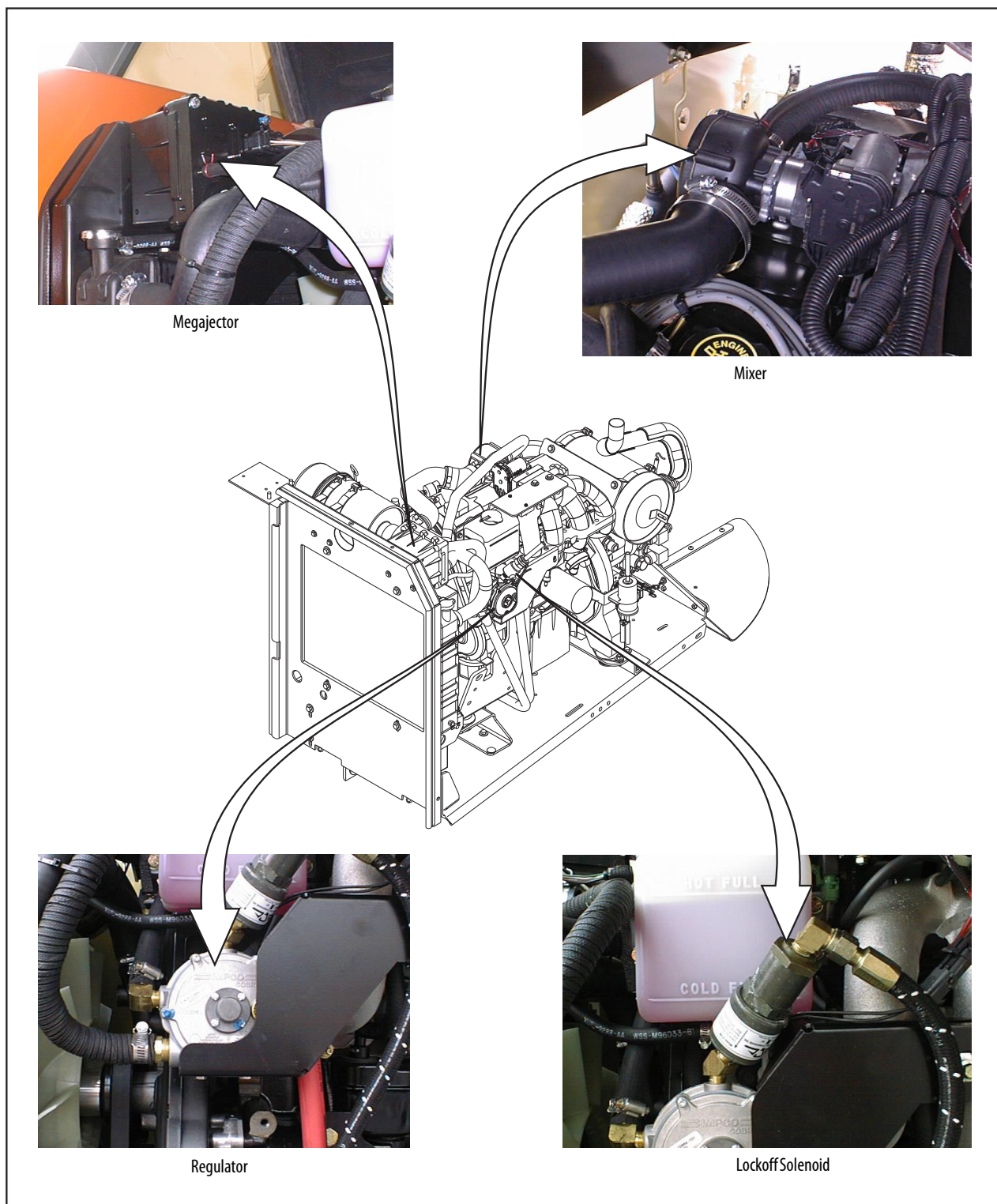


Figure 3-100. Ford LPG System

Lockoff Solenoid

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

Megajector Diagnostic Code Descriptions

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

DTC 353 - Megajector delivery pressure higher than expected. This code will set if the difference between the Megajector actual pressure and the Megajector commanded pressure is greater than 4.00 inches (10.1 cm) of H₂O.

- a. **Fuel Supply** - Check fuel supply pressure at the megajector inlet fitting. Fuel supply pressure on LPG applications should be between 3-5 in. (7.6-12.7 cm) H₂O.
- b. **Lockoff Solenoid** - Check the lockoff to make sure it is sealing when closed. If it is not completely sealing, it could allow pressure creep in the fuel system.
- c. **Reference Line** - Make sure the reference line is in place between the Megajector and the carburetor balance port. Make sure the hose is not kinked or restricted in any way and has no holes in it.
- d. **Regulator** - Observe the regulator with the engine running to see if it is icing up. If it's icing up, refer to Engine Cooling System below.
- e. **Engine Cooling System** - Make sure the engine cooling system is operating properly and there are no air locks in the system. Make sure the engine is operating at the proper temperature. Check the coolant hoses at the regulator and make sure they are both warm to verify proper coolant circulation.

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

DTC 354 - Megajector delivery pressure lower than expected. This code will set if the difference between the Megajector actual pressure and the Megajector commanded pressure is less than -4.00 inches (10.1 cm) of H₂O.

- a. **Fuel Supply** - Check fuel supply pressure at the megajector inlet fitting. Fuel supply pressure on LPG applications should be between 3-5 inch (7.6-12.7 cm) H₂O.

- b. **Fuel System Hoses** - Make sure all fuel system hoses are in good condition. They should be clamped tight, free from kinks with no cuts, pinches, etc.
- c. **Lockoff Solenoid** - Check the lock off to make sure it is opening properly. If it is not opening completely, it could cause low fuel pressure.
- d. **Reference Line** - Make sure the reference line is in place between the Megajector and the carburetor balance port. Make sure the hose is not kinked or restricted in any way and has no holes in it.
- e. **Regulator** - Observe the regulator with the engine running to see if it is icing up. If it's icing up, refer to Engine Cooling System below.
- f. **Engine Cooling System** - Make sure the engine cooling system is operating properly and there are no air locks in the system. Make sure the engine is operating at the proper temperature. Check the coolant hoses at the regulator and make sure they are both warm to verify proper coolant circulation.

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

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

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

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

DTC 361 - Megajector voltage supply high.

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

DTC 362 - Megajector voltage supply low.

- a. **Voltage** - Check battery voltage. If the voltage at the battery is less than 9.5 volts:
The battery is faulty
or
The charging system is faulty
or
The Megajector is faulty.

DTC 363 - Megajector Internal Actuator Fault Detection.

- a. **Connections** - Check power, ground, and CAN circuits at the Megajector in addition to all electrical connections. Repair as necessary and retest.
- b. **Megajector** - Megajector has an internal failure. Contact JLG Industries for further assistance.

DTC 364 - Megajector Internal Circuitry Fault Detection.

SECTION 3 - CHASSIS & TURNTABLE

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

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

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

DTC 365 - Megajector Internal Comm Fault Detection.

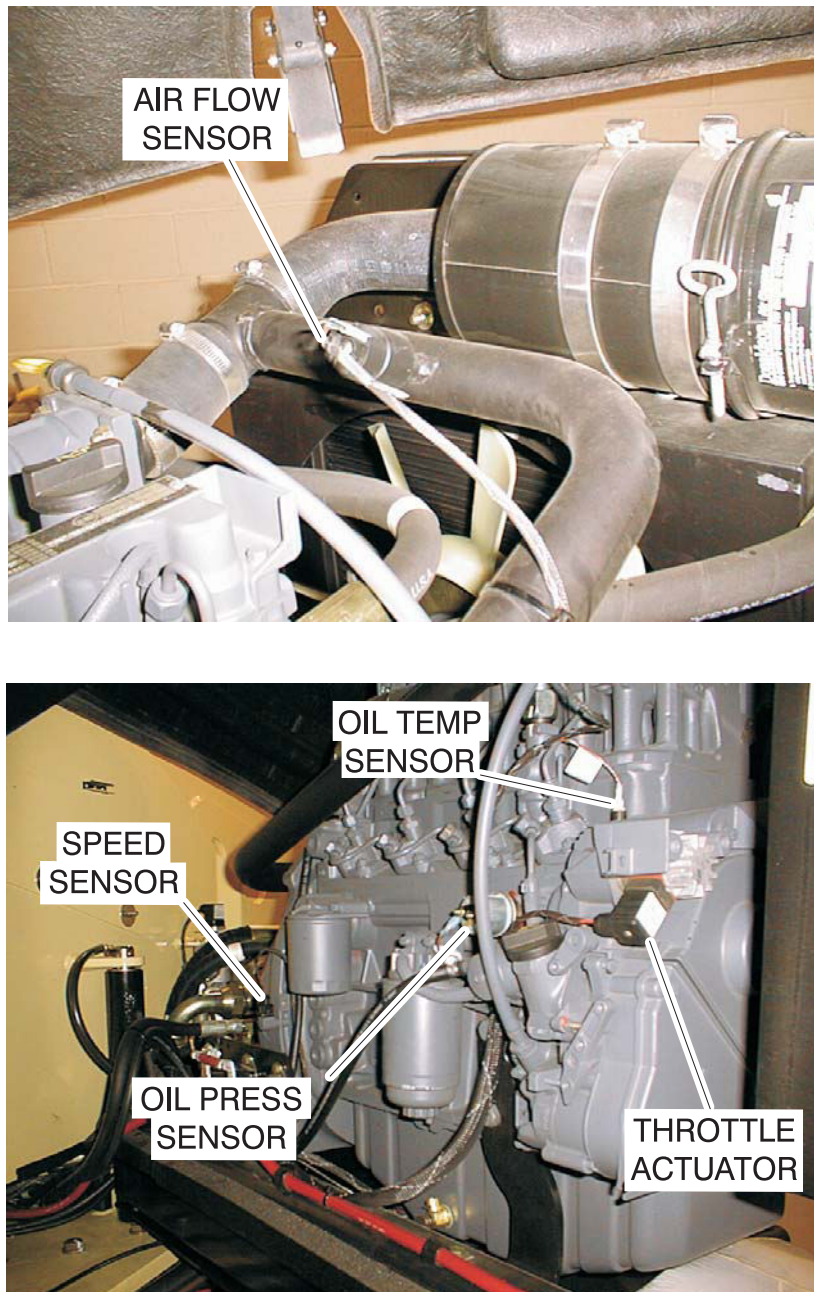


Figure 3-101. Deutz Sensors for JLG Control System

3.27 DEUTZ EMR 2

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

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

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

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

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

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

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

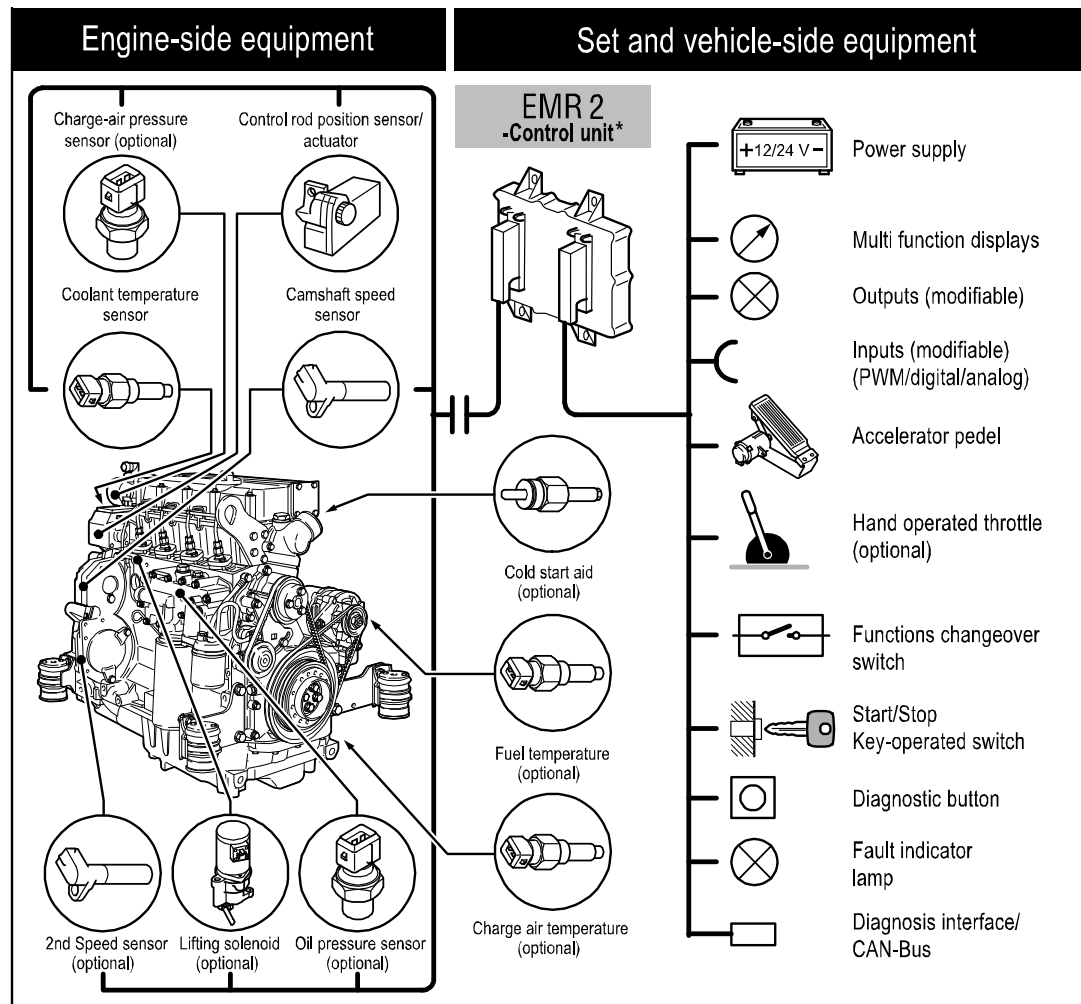


Figure 3-102. EMR 2 Engine Side Equipment

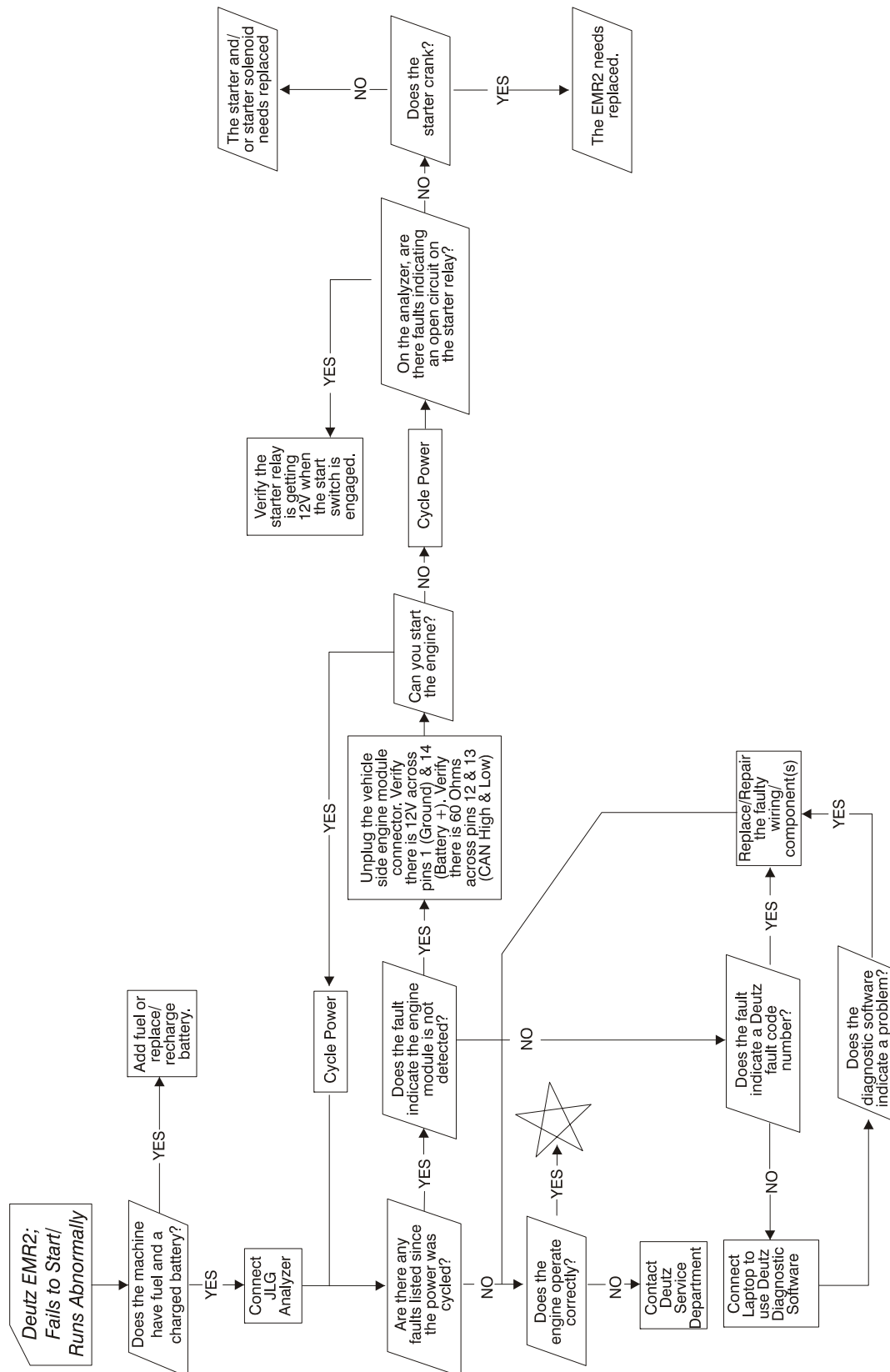


Figure 3-103. Deutz EMR 2 Troubleshooting Flow Chart

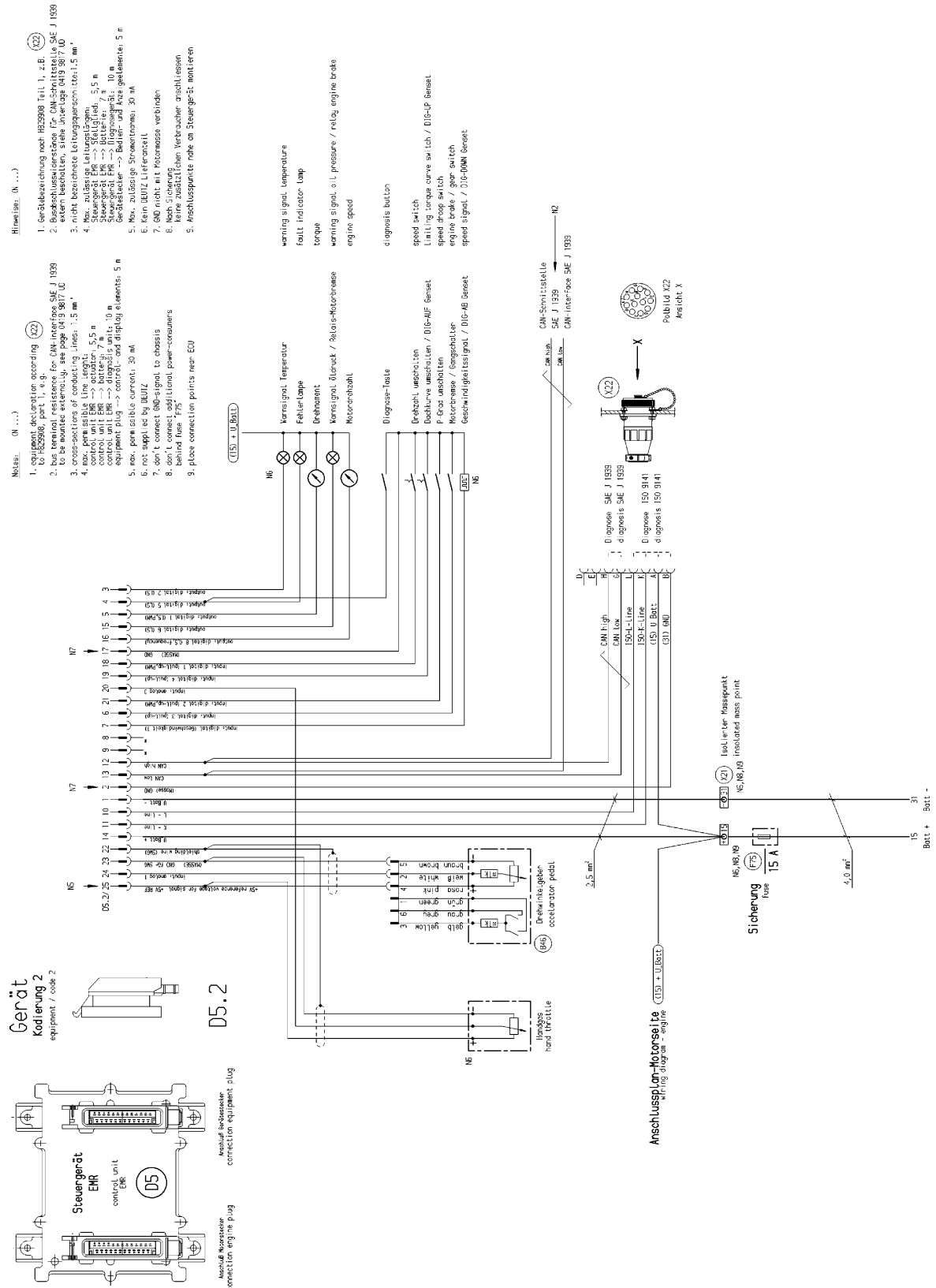


Figure 3-104. Deutz EMR 2 Vehicle Side Connection Diagram

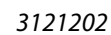


Figure 3-105. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

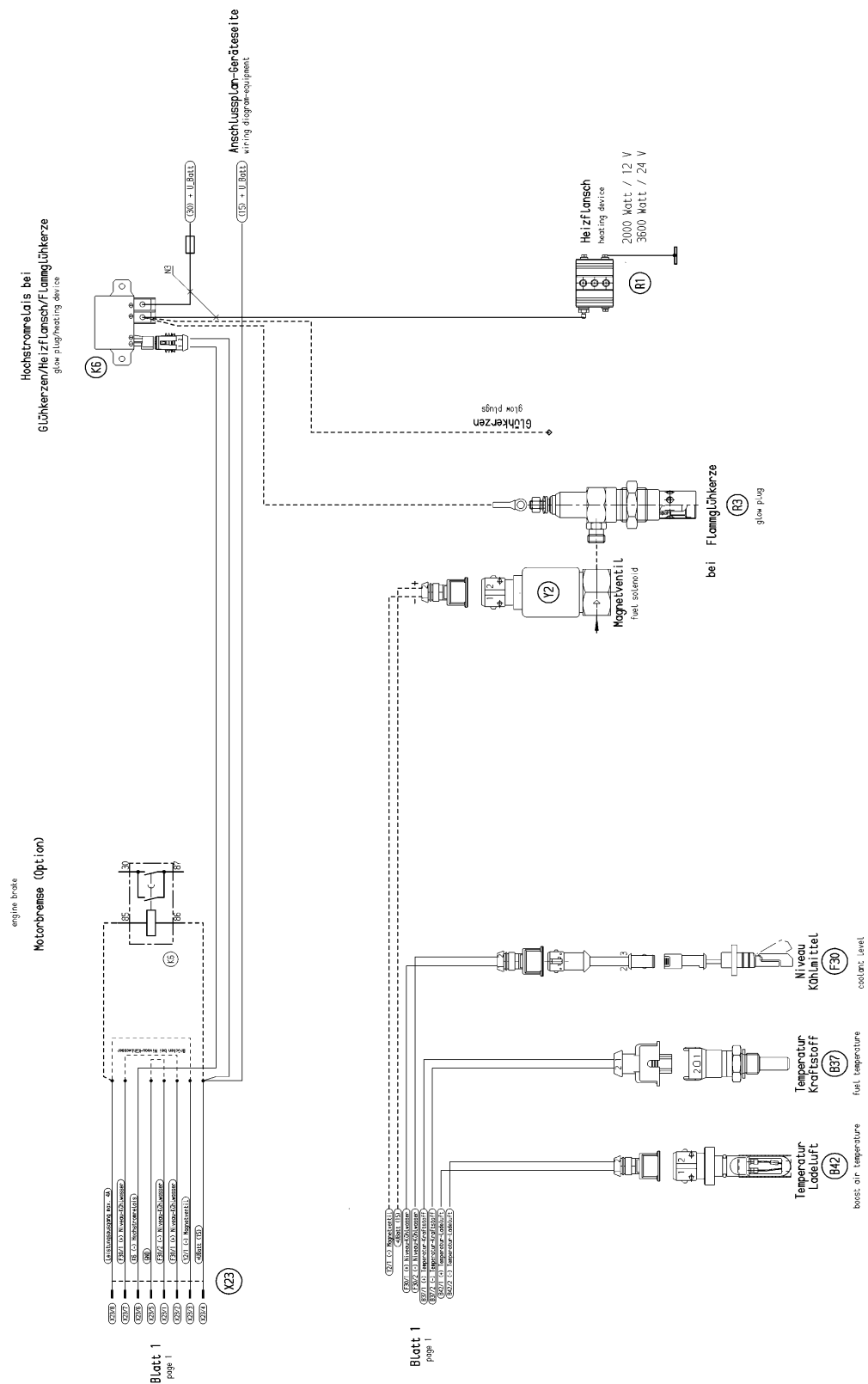
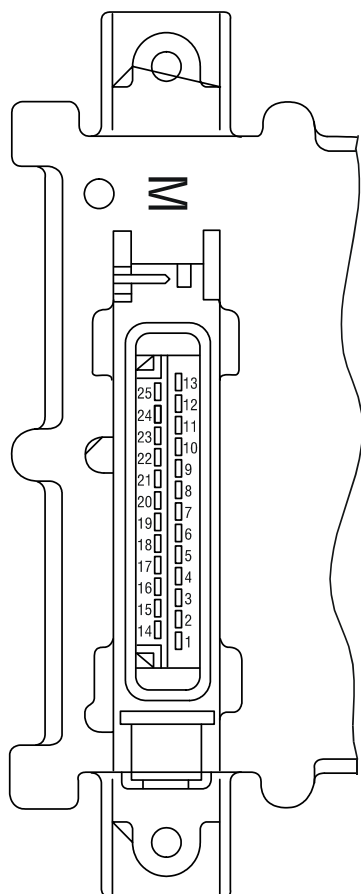


Figure 3-106. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2

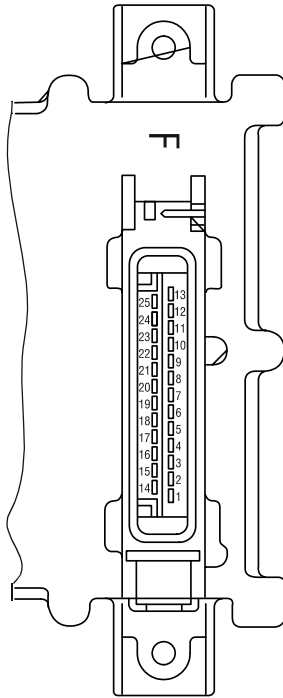


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid ¹⁾
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature ²⁾
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant 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 3-107. 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 3-108. 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). Governor in emergency operation (with sensor 1). Emergency switch-off (if sensor 1 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
	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. 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.	Engine stop.	Check parameter (21). Check speed settings.
Sensors	07	Charge air pressure	102	2			
	08	Oil pressure	100	2			
	09	Coolant temperature	110	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.
	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 3-109. 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 again 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 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.	Check parameters. Check speed settings.
	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 3-110. 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 3-111. 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			
Communication	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: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-112. EMR2 Fault Codes - Sheet 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.	
	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.
Program logic	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 3-113. EMR2 Fault Codes - Sheet 5 of 5

3.28 BIO FUEL IN DEUTZ ENGINES

General

Use of bio fuels is permitted for the compact engines made by DEUTZ.

Distillate fuels with residue oil percentages or mixed fuels may not be used in DEUTZ compact engines. The DEUTZ vehicle engines are designed for diesel fuels in accordance with EN 590 with a cetane number of at least 51. DEUTZ engines for mobile machinery are designed for a cetane number of at least 45. When using fuels of a low cetane number, disturbing white smoke and ignition misfires are to be expected under some circumstances.

A cetane number of at least 40 is permissible for the US market, therefore special engine models have been developed to avoid starting difficulties, extreme white smoke or increased hydrocarbon emissions (EPA specification - US EPA REGULATIONS FOR LARGE NONROAD COMPRESSION- IGNITION ENGINES).

If the white smoke behavior is unacceptable when using a very low cetane number, the use of ignition improvers is to be recommended as a later remedial measure.

The certification measurements for compliance with the legal emission limits are carried out with the test fuels prescribed by law. These correspond to the diesel fuels in accordance with EN 590 and ASTM D 975. No emission values are guaranteed with the other fuels described. It is the obligation of the owner to check the permission for use of the fuels in accordance with regional regulations.

Bio Fuel

PERMITTED BIO-DIESEL FUELS

as a bio-diesel fuel in Europe but fatty acid methylester (FAME) based on other oils have come onto the market increasingly in recent years. However, with the latter there is a risk that the limit values of EN 14214 are not kept in the field. Anyone who uses bio-diesel fuel in DEUTZ engines must therefore choose his supplier very carefully and have him guarantee compliance with the EN 14214 limit values. Since experience has shown that rape seed oil methylester (RME) exceeds the limit values less often than other esters, it is expressly recommended to use only rape seed oil methylester. DEUTZ customers in Germany can additionally ensure the quality by buying bio-diesel fuel with an AGQM certificate (Arbeitsgemeinschaft Qualitäts-Management Biodiesel e.V.).

The use of US bio-diesel based on soy oil methylester is only permissible in mixtures with diesel fuel with a bio-diesel part of a max. 20 weight-%. The US bio-diesel used for the mixture must comply with the ASTM D6751-07a (B100) standard.

Approved Engines

The 912, 913, 914, 1011, 2011, 1012, 2012, 1013, 2013, 413 and 513 series are approved for bio-diesel from year of manufacture 1993 under compliance with the basic conditions specified below.

BASIC CONDITIONS TO BE OBSERVED

- A power loss of 5-9 % in relation to diesel fuel in accordance with EN 590 is possible due to the lower heating value. Blocking of the fuel injector is not allowed.
- The lubricating oil quality must correspond to TR 0199-99-3002. The lubricating oil change interval must be halved in relation to operation with diesel fuel in accordance with EN 590.
- Standstills of longer than 4 to 6 weeks must be avoided with bio-diesel. Otherwise the engine must be started and stopped with diesel fuel.
- Bio-diesels can be mixed with normal diesel fuel but the basic conditions described in this subsection apply for mixtures. Mixtures with up to 5 % (m/m) bio-diesel (B5) which have recently been on sale at European fuel stations are excepted. These fuels must be treated like normal diesel fuels because EN 590 expressly permits adding up to 5 % (m/m) bio-diesel in accordance with EN 14214.
- Approx. 30-50 hours after changing over from diesel fuel to bio-diesel, the fuel filter should be changed as a preventive measure to avoid a drop in performance due to clogged fuel filters. Deposited fuel ageing products are dissolved by bio-diesel and transported into the fuel filter. They should not be changed immediately but after approx. 30 to 50 hours because the dissolving of dirt takes a certain amount of time.

PLANT OIL

NOTICE

PURE PLANT OILS (E.G. RAPE SEED OIL, SOY OIL, PALM OIL) ARE NOT CLASSIFIED AS BIO-DIESEL AND EXHIBIT PROBLEMATICAL PROPERTIES FOR DIESEL ENGINE OPERATION (STRONG TENDENCY TO COKE, RISK OF PISTON SEIZURE, EXTREMELY HIGH VISCOSITY, POOR EVAPORATION BEHAVIOR).

The conversion of DEUTZ engines to rape seed oil fuel operation with conversion kits and modified tanks systems of various manufacturers is not allowed and leads to loss of warranty rights.

Biological Contamination In Fuels

SYMPTOMS

The following symptoms may indicate that a fuel tank is contaminated by micro-organisms:

- . Internal tank corrosion,
- . Filter blockage and the associated loss of power due to gel-like deposits on the fuel filter (especially after long standstills)

CAUSE

Micro-organisms (bacteria, yeasts, fungi) can form bio-sludge under unfavorable conditions (favoured particularly by heat and water).

Penetration by water is usually caused by condensation of the water in the air. Water does not dissolve in fuel so that the penetrating water collects at the bottom of the tank. The bacteria and fungi grow in the watery phase, at the phase boundary to the fuel phase, from which they draw their nutrition. There is an increased risk especially with biodiesel (FAME).

PREVENTIVE MEASURES

- Keep the storage tank clean, regular cleaning of the tank by specialist companies
- Installation of fuel pre-filters with water traps, especially in countries with frequently fluctuating fuel qualities and high percentage of water.

If the fuel system and storage tank have already been attacked by micro-organisms. The biocide must be dosed according to the manufacturer's specifications.

- Avoid direct exposure of the storage tank to sunlight
- Use smaller storage tanks with corresponding low dwell times of the stored fuel

FUEL ADDITIVES

The use of fuel additives is not permitted. The flow improvers mentioned above are an exception. Use of unsuitable additives will result in loss of warranty.

3.29 GM ENGINE GENERAL MAINTENANCE

Maintenance of the Drive Belt

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

When inspecting the belts check for:

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

Check the belt tensioner by pressing down on the midway point of the longest stretch between pulleys. The belt should not depress beyond 1/2 in. (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.

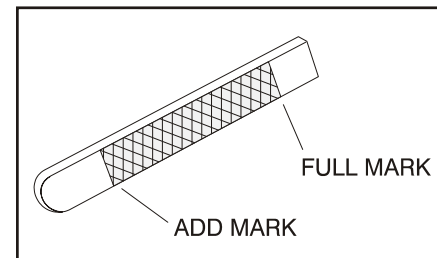


Figure 3-114. Engine Oil Dip Stick

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

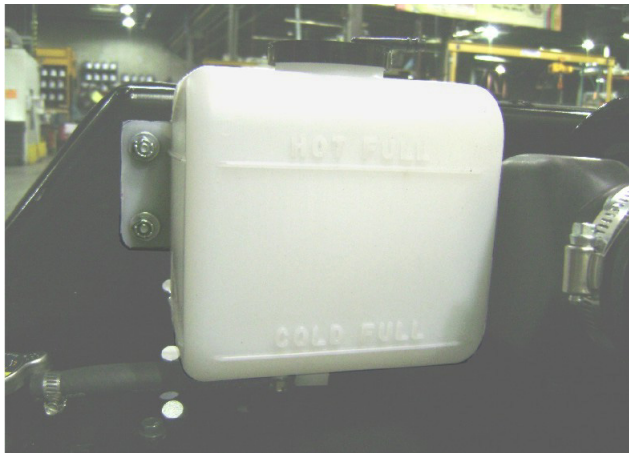
WITH THE ENGINE RUNNING OR WHEN SHUTTING OFF THE ENGINE, SOME HEATED COOLANT MAY SPILL OUT DUE TO AIR "BURPING" OUT OF THE SYSTEM WITH THE RADIATOR CAP OFF.

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.



3.30 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).

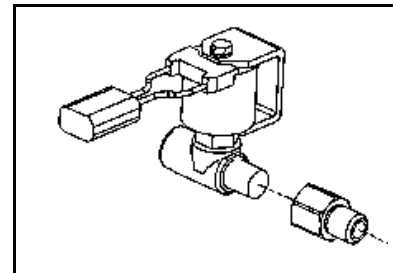
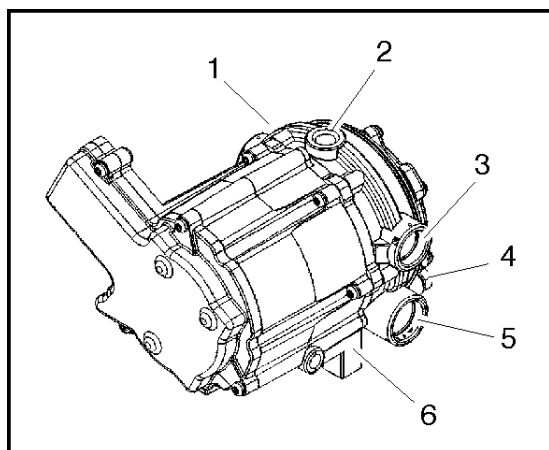


Figure 3-115. Electric Fuel Lock Off

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

Figure 3-116. 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.

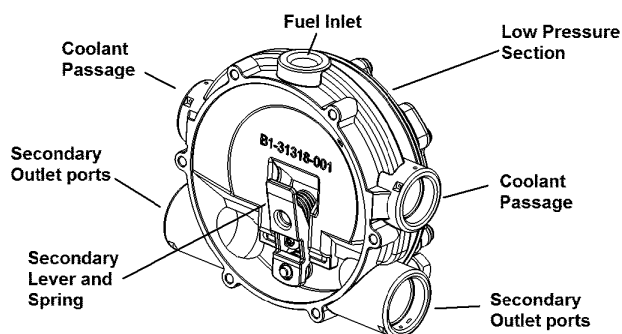


Figure 3-117. Low Pressure Regulators

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 second-

ary chamber the secondary diaphragm is drawn further down forcing the secondary valve lever to open wider.

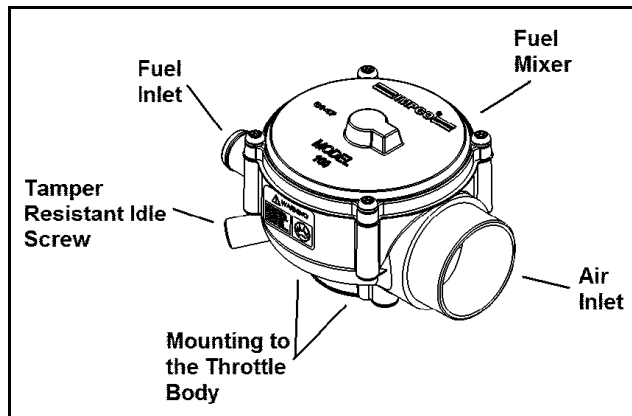


Figure 3-118. Air Fuel Mixer

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.

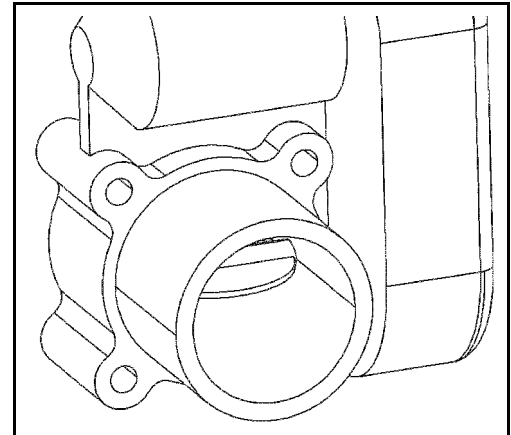


Figure 3-119. ETC Throttle Control Device

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.

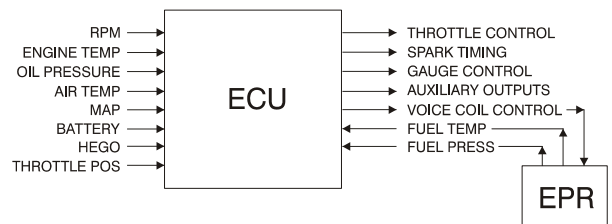


Figure 3-120. LPG Engine Control Unit (ECM)

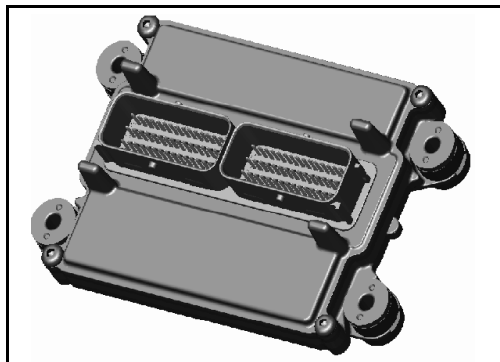


Figure 3-121. ECM Assembly



Figure 3-122. Heated Exhaust Gas Oxygen Sensor

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 be 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.

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 is 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.

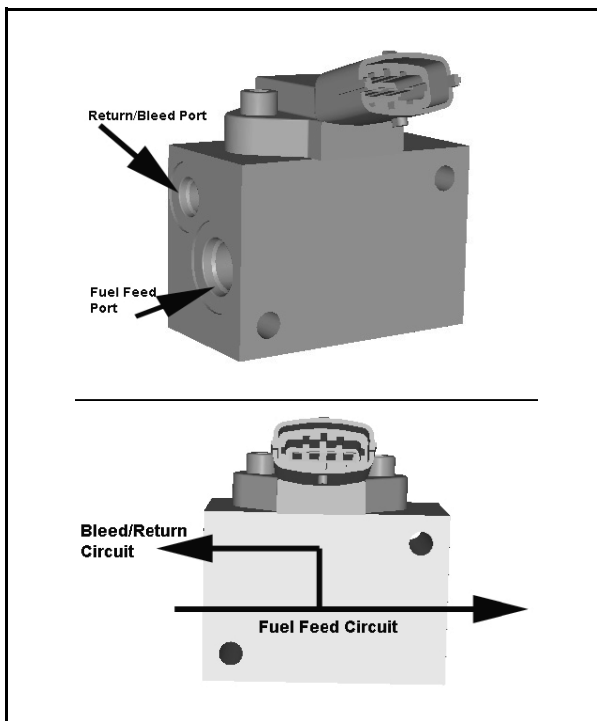


Figure 3-123. Gasoline Fuel Pressure and Temperature Manifold Assembly

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.

3.31 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.

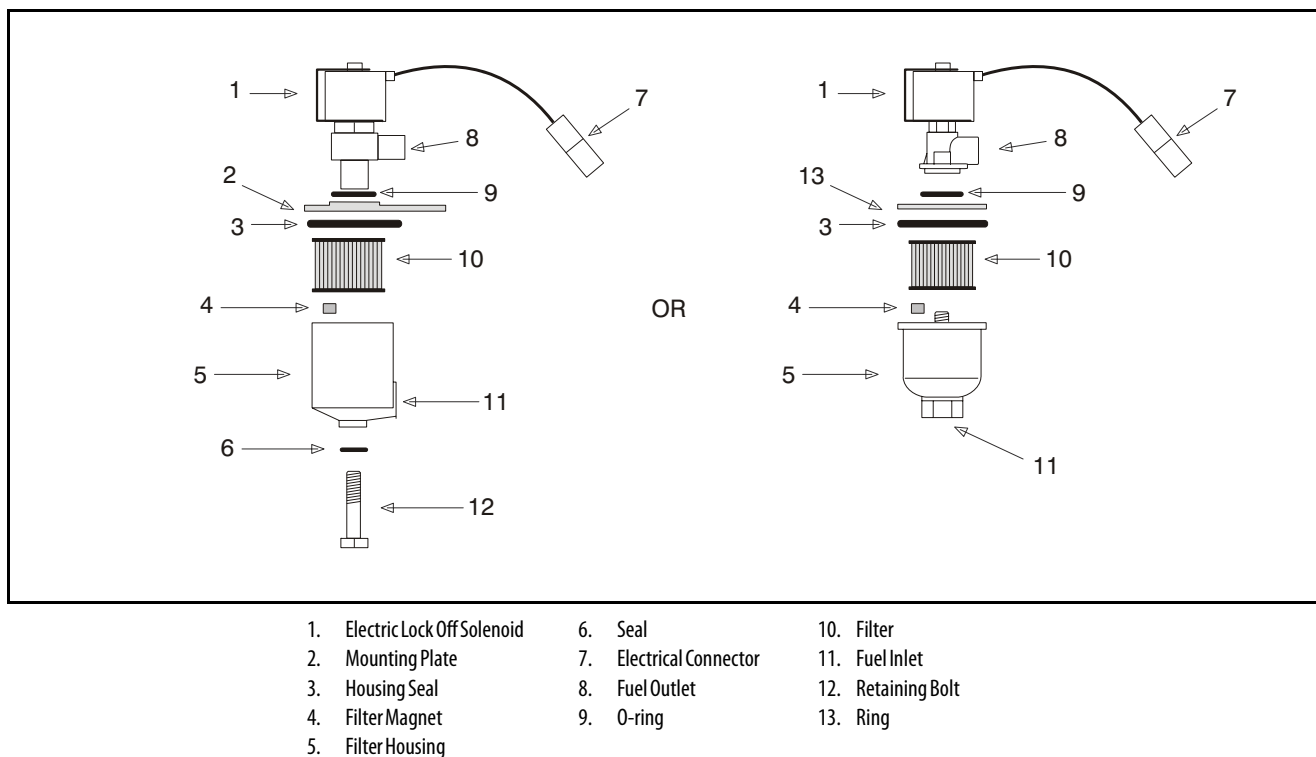


Figure 3-124. Filter Lock Assembly

INSTALLATION

REMOVAL

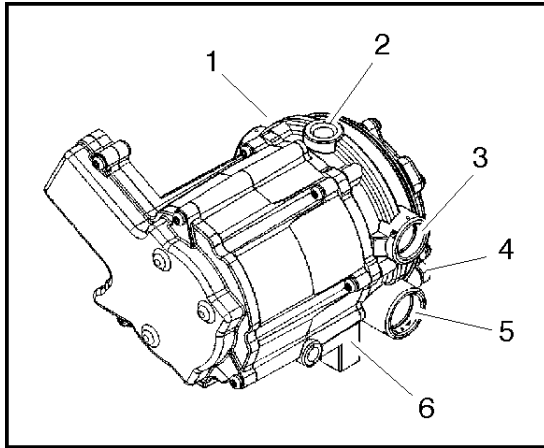
1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly loosen the Filter housing retaining bolt and remove it.
4. Pull the filter housing from the Electric lock off assembly.
5. Remove the filter from the housing.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

NOTICE

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

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

Electronic Pressure Regulator (EPR) Assembly Replacement



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

Figure 3-125. EPR Assembly

The EPR assembly is 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.

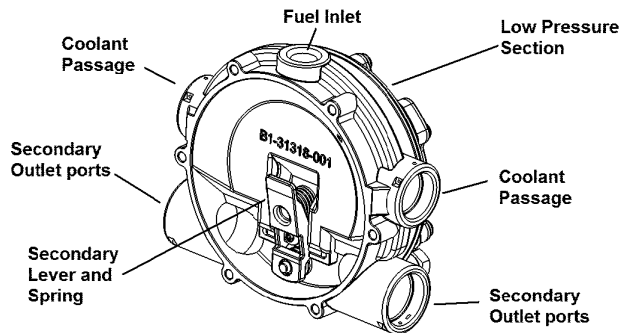


Figure 3-126. Pressure Regulator Section

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

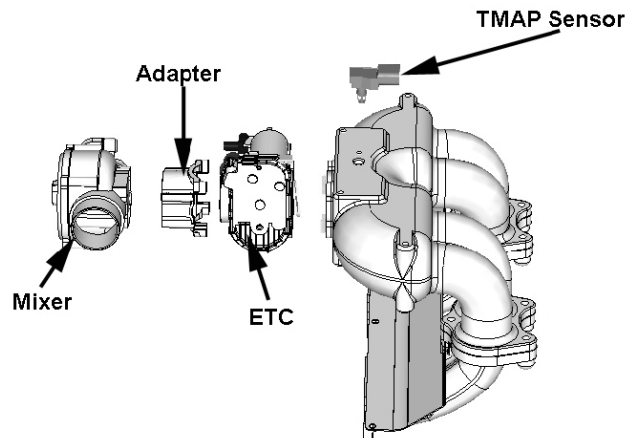


Figure 3-127. (TMAP) Sensor & Electronic Throttle Control (ETC)

REMOVAL

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

INSTALLATION

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

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

Electronic Throttle Control Replacement

See Figure 3-127.

REMOVAL

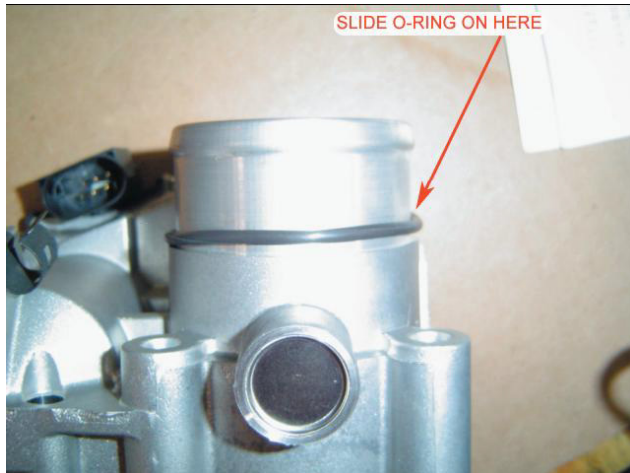
1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Release the hose clamp on the vapor fuel line and remove the vapor hose.
4. Disconnect the TMAP electrical connector.
5. Disconnect the electronic throttle control connector.
6. Remove the manifold to throttle body adapter bolts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

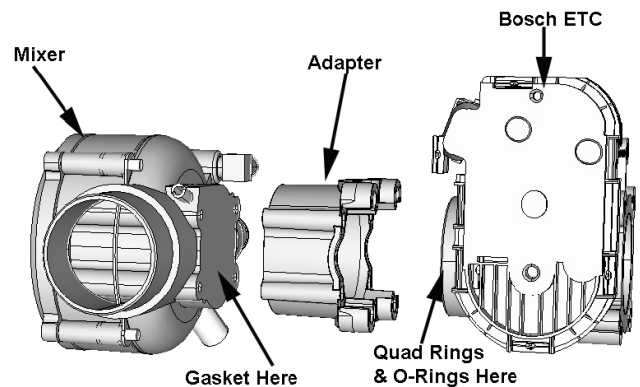


Figure 3-128. Mixer Assembly

Mixer Replacement

See Figure 3-128.

REMOVAL

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

INSTALLATION

NOTICE

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

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

Coolant Hose Replacement

REMOVAL

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

INSTALLATION

NOTE: Use hose material and lengths specified by JLG.

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

Vapor Hose Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

Engine Control Module Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

Heated Exhaust Gas Oxygen Sensor Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

3.32 LP GAS FITTING INSPECTION

NOTICE

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

CAUTION

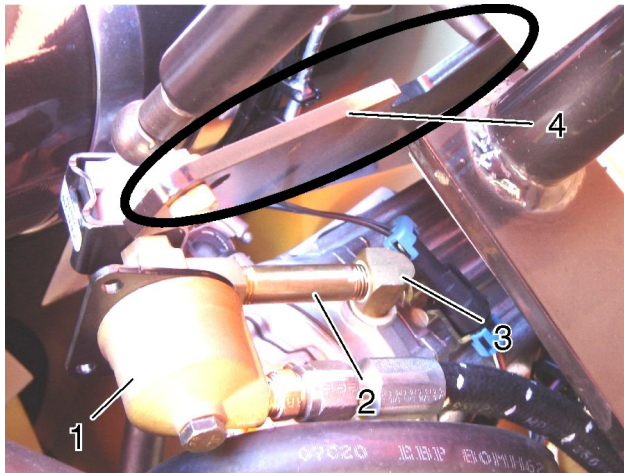
DO NOT SMOKE DURING THIS PROCEDURE.

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

CAUTION

ENSURE THE ENGINE IS COOL PRIOR TO PERFORMING THIS INSPECTION.

4. Locate the 2-1/2 in. (62.7 mm) straight fitting between the LP gas lockoff valve and the LP gas mixer. Refer to Figure 3-129., LP Gas Fitting Components.



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

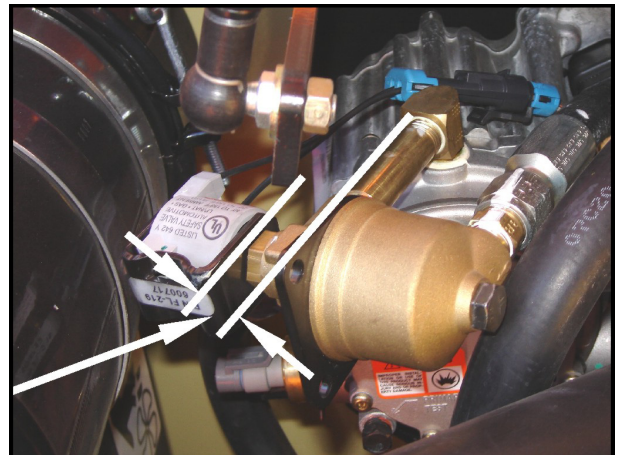
Figure 3-129. LP Gas Fitting Components

5. Refer to Figure 3-129., LP Gas Fitting Components and ensure that the hood-mounting bracket does not interfere with the 1/4 in. NPT X 2-1/2 in. straight tube fitting (JLG P/N 70001531).
6. Refer to Figure 3-130., Hood Mounting Bracket Clearance. If adequate clearance **DOES EXIST** between the straight tube fitting and the hood-mounting bracket, proceed to Step 10. If adequate clearance **DOES NOT EXIST** between the straight tube fitting and the hood-mounting bracket, proceed to Step 7.

NOTICE

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

7. As necessary, disassemble the LP gas system between the lock-off valve and the LP mixer to allow for reorientation of the 1/4 in. NPT X 1/4 in. SPT X 90 degree elbow (JLG P/N 70001307).
8. Properly clean all old thread sealant from the LP gas fittings.
9. Apply Permatex Thread Sealant (Permatex P/N 56525) to the LP gas fittings. Reassemble, allowing for proper clearance of the hood-mounting bracket and the LP gas system that was disassembled in Step 7. Refer to Figure 3-130., Hood Mounting Bracket Clearance for proper clearance. Properly tighten all LP gas connections.



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

Figure 3-130. Hood Mounting Bracket Clearance

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

3.33 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

Fuel System Description

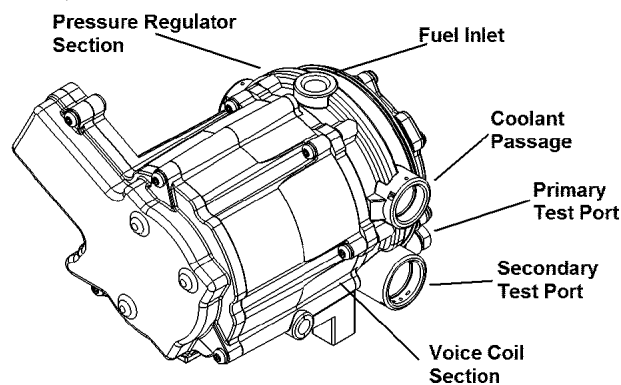


Figure 3-131. EPR Assembly

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 1.0-3.0 psi (6.8-20.6 kPa). The second stage reduces the pressure to approximately negative 1.5 in. (38.1 mm) of water column.

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

Diagnostic Aids

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

TOOLS REQUIRED:

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

DIAGNOSTIC SCAN TOOL

- Diagnostic Display tool.

PRESSURE GAUGES

- IMPCO ITK-2 Test kit.
- Water Column Gauge / Manometer (GM 7333-6 or equivalent).
- 0-10 psi (0-0.68 bar) Gauge.

TEST DESCRIPTION.

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

5. This step determines if the LPR requires replacement.
6. This step determines if the problems are in the mechanical side of the Pressure Regulator or the Electronic Voice Coil.
10. This step determines if the Mixer requires replacement.
14. This step determines if the Lock Off requires replacement.
17. This step determines if the Fuel Filter requires replacement.

Table 3-16. LPG Fuel System Diagnosis

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

Table 3-16. LPG Fuel System Diagnosis

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

Table 3-17. Symptom Diagnosis

Checks	Action
Important Preliminary Checks	
Before Using This Section	<p>Before using this section, you should have performed On Board Diagnostic Check and determined that:</p> <ol style="list-style-type: none"> 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. <p>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.</p>
LPG Fuel System Check	<ol style="list-style-type: none"> 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. <p>IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.</p>
Visual and Physical Checks	<ol style="list-style-type: none"> ² Check all ECM system fuses and circuit breakers. ² Check the ECM ground for being clean, tight and in its proper location. ² Check the vacuum hoses for splits, kinks and proper connections. ² Check thoroughly for any type of leak or restriction. ² Check for air leaks at all the mounting areas of the intake manifold sealing surfaces. ² Check for proper installation of the mixer module assembly. ² Check for air leaks at the mixer assembly. ² Check the ignition wires for the following conditions: <ul style="list-style-type: none"> - Cracking - Hardness - Proper routing - Carbon tracking ² Check the wiring for the following items: <ul style="list-style-type: none"> - Proper connections, pinches or cuts. ² The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.
Intermittent	
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	<ol style="list-style-type: none"> ² Refer to Important Preliminary Checks. ² Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	<ol style="list-style-type: none"> ² Faulty electrical connections or wiring can cause most intermittent problems. ² Check the suspected circuit for the following conditions: <ul style="list-style-type: none"> - Faulty fuse or circuit breaker - Connectors poorly mated - Terminals not fully seated in the connector (backed out) - Terminals not properly formed or damaged - Terminal to wires poorly connected - Terminal tension insufficient. ² Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension. ² Checking for poor terminal to wire connections requires removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.

Table 3-17. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	<p>The following components can cause intermittent MIL and no DTC(s):</p> <ul style="list-style-type: none"> ² A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. ² The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. ² The ignition secondary voltage shorted to a ground. ² The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. ² The Control Module grounds.
Loss of DTC Memory	<p>To check for the loss of the DTC Memory:</p> <ol style="list-style-type: none"> 1. Disconnect the TMAP sensor. 2. Idle the engine until the Malfunction Indicator Lamp illuminates. <p>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</p>
Additional Checks	
No Start	
DEFINITION: The engine cranks OK ²² but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	<p>If a scan tool is available:</p> <ul style="list-style-type: none"> ² Check for proper communication with both the ECM. ² Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. ² Check battery power, ignition power and ground circuits to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity for each circuit.
Sensor Checks	<ul style="list-style-type: none"> ² Check the TMAP sensor. ² Check the Magnetic pickup sensor (RPM).
Fuel System Checks	<p>Important: A closed LPG manual fuel shut off valve will create a no start condition.</p> <ul style="list-style-type: none"> ² Check for air intake system leakage between the mixer and the throttle body. ² Verify proper operation of the low pressure lock-off solenoids. ² Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis. ² Check for proper mixer air valve operation.
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.</p> <ul style="list-style-type: none"> ² Check for the proper ignition voltage output with J 26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS). ² Check the spark plugs for the following conditions: <ul style="list-style-type: none"> - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits ² Check for bare or shorted ignition wires. ² Check for loose ignition coil connections at the coil.
Engine Mechanical Checks	<p>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.</p> <ul style="list-style-type: none"> ² Check for the following: <ul style="list-style-type: none"> - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes

Table 3-17. Symptom Diagnosis

Checks	Action
Exhaust System Checks	² Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> - Inspect the exhaust system for damaged or collapsed pipes. - Inspect the muffler for signs of heat distress or for possible internal failure. ² Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis.
Hard Start	
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	² Refer to Important Preliminary Checks. ² Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	² Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to DTC 111. ² Check the Crankshaft Position (CKP) sensor. ² Check the Throttle position (TPS) sensor.
Fuel System Checks	<p>Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition.</p> ² Verify the excess flow valve in the LPG manual shut-off valve is not tripped. ² Check mixer module assembly for proper installation and leakage. ² Verify proper operation of the low pressure lock-off solenoids. ² Verify proper operation of the EPR. ² Check for air intake system leakage between the mixer and the throttle body. ² Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.</p> ² Check for the proper ignition voltage output with J 26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS). ² Check the spark plugs for the following conditions: <ul style="list-style-type: none"> - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits ² Check for bare or shorted ignition wires. ² Check for moisture in the distributor cap if applicable. ² Check for loose ignition coil connections. <p>Important:</p> <ol style="list-style-type: none"> 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	<p>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.</p> ² Check for the following: <ul style="list-style-type: none"> - Vacuum leaks <ul style="list-style-type: none"> - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes ² Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	² Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> - Inspect the exhaust system for damaged or collapsed pipes. - Inspect the muffler for signs of heat distress or for possible internal failure. ² Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual.

Table 3-17. Symptom Diagnosis

Checks	Action
Additional Checks	
Cuts Out, Misses	
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	² Refer to Important Preliminary Checks.
Ignition System Checks	² Start the engine. ² Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. ² Check for proper ignition output voltage with spark tester J 26792. ² Check for a cylinder misfire. ² Verify that the spark plugs are correct for use with LPG (R42LTS). ² Remove the spark plugs in these cylinders and check for the following conditions: ² Insulation cracks ² Wear ² Improper gap ² Burned electrodes ² Heavy deposits ² Visually/Physically inspect the secondary ignition for the following: ² Ignition wires for arcing, cross-firing and proper routing ² Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	² Perform a cylinder compression check. ² Check the engine for the following: <ul style="list-style-type: none"> - Improper valve timing - Bent push rods - Worn rocker arms - Worn camshaft lobes - Broken or weak valve springs ² Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	² Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. ² Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). ² EMI on the reference circuit can cause a missing condition. ² Monitoring the engine RPM with a scan tool can detect an EMI. ² A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. ² If the problem exists, check the routing of the secondary wires and the ground circuit.
Hesitation, Sag, Stumble	
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	² Check the fuel pressure. Refer to LPG Fuel System Diagnosis. ² Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. ² Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. ² Check LPL electrical connection. ² Check the mixer air valve for sticking or binding. ² Check the mixer module assembly for proper installation and leakage. ² Check the EPR electrical connections.

Table 3-17. Symptom Diagnosis

Checks	Action
Ignition System Checks	<p>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.</p> <p>² Check for the proper ignition voltage output with J26792 or the equivalent.</p> <p>² Verify that the spark plugs are correct for use with LPG (R42LTS).</p> <p>² Check for faulty spark plug wires.</p> <p>² Check for fouled spark plugs.</p>
Additional Check	<p>² Check for manifold vacuum or air induction system leaks.</p> <p>² Check the generator output voltage.</p>
Backfire	
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	² Refer to Important Preliminary Checks.
Ignition System Checks	<p>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.</p> <p>² Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent.</p> <p>² Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.</p> <p>² Check the connection at each ignition coil.</p> <p>² Check for deteriorated spark plug wire insulation.</p> <p>² Check the spark plugs. The correct spark plugs for LPG are (R42LTS)</p> <p>² Remove the plugs and inspect them for the following conditions:</p> <ul style="list-style-type: none"> - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits
Engine Mechanical Check	<p>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.</p> <p>² Check the engine for the following:</p> <ul style="list-style-type: none"> - Improper valve timing - Engine compression - Manifold vacuum leaks - Intake manifold gaskets - Sticking or leaking valves - Exhaust system leakage <p>² Check the intake and exhaust system for casting flash or other restrictions.</p>
Fuel System Checks	² Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.
Lack of Power, Sluggishness, or Sponginess	
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	<p>² Refer to Important Preliminary Checks.</p> <p>² Refer to the LPG Fuel system OBD System Check.</p> <p>² Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics.</p> <p>² Remove the air filter and check for dirt or restriction.</p> <p>² Check the vehicle transmission Refer to the OEM transmission diagnostics.</p>

Table 3-17. Symptom Diagnosis

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

Table 3-17. Symptom Diagnosis

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

Table 3-17. Symptom Diagnosis

Checks	Action
Fuel System Checks	² Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. ² Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. ² Verify proper fuel control solenoid operation. ² Verify that the LPG manual shut-off valve is fully open. ² Check the in-line fuel filter for restrictions.
Ignition System Checks	² Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS). ² Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits - Check the Crankshaft Position (CKP) sensor.
Additional Check	² Check the ECM grounds for being clean, tight, and in their proper locations. ² Check the generator output voltage. ² Check the vacuum hoses for kinks or leaks. ² Check Transmission

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

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

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

DTC	Description	SPN Code	FMI Code
524	Oil Pressure Low	100	1
562	System Voltage Low	168	17
563	System Voltage High	168	15
601	Flash Checksum Invalid	628	13
604	RAM Failure	630	12
606	COP Failure	629	31
642	External 5V Reference Low	1079	4
643	External 5V Reference High	1079	3
685	Power Relay Open	1485	5
686	Power Relay Shorted	1485	4
687	Power Relay Short to Power	1485	3
1111	Fuel Rev Limit	515	16
1112	Spark Rev Limit	515	0
1151	Closed Loop Multiplier High LPG	520206	0
1152	Closed Loop Multiplier Low LPG	520206	1
1155	Closed Loop Multiplier High Gasoline	520204	0
1156	Closed Loop Multiplier Low Gasoline	520204	1
1161	Adaptive Learn High LPG	520202	0
1162	Adaptive Learn Low LPG	520202	1
1165	LPG Cat Monitor	520213	10
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

SECTION 4. BOOM & PLATFORM

4.1 PLATFORM

Support Removal

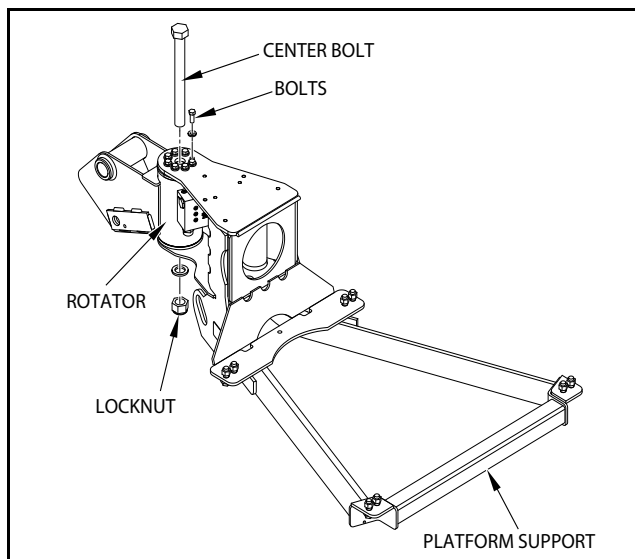
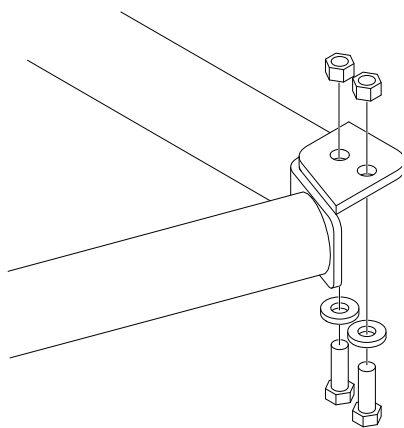


Figure 4-1. Location of Components Platform Support

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

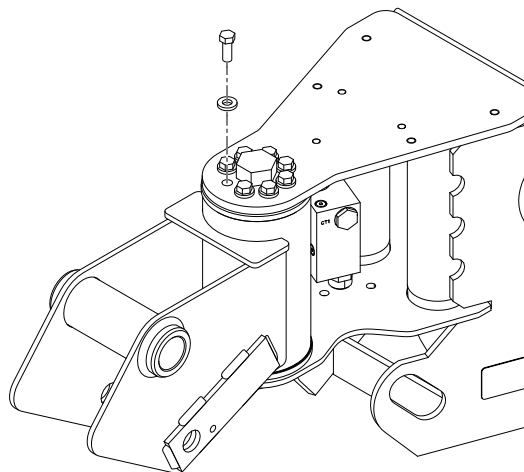
NOTE: The platform weighs approximately 127.9 lbs. (58 kg).



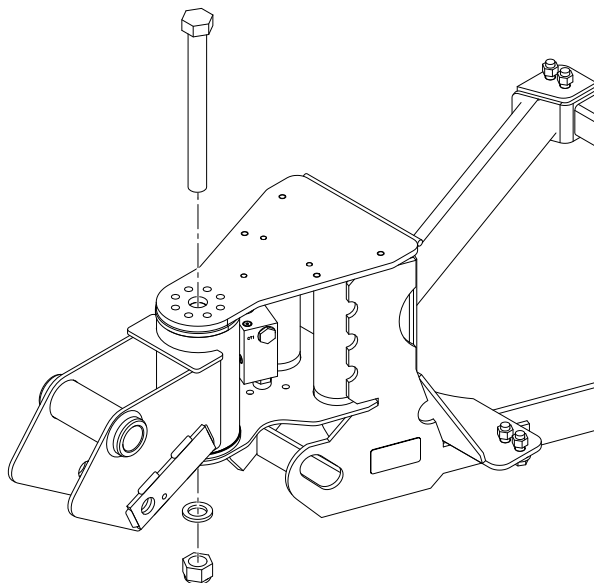
3. Using a suitable device, support the platform support.

NOTE: The platform support weighs approximately 76.4 lbs. (34.7 kg).

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



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



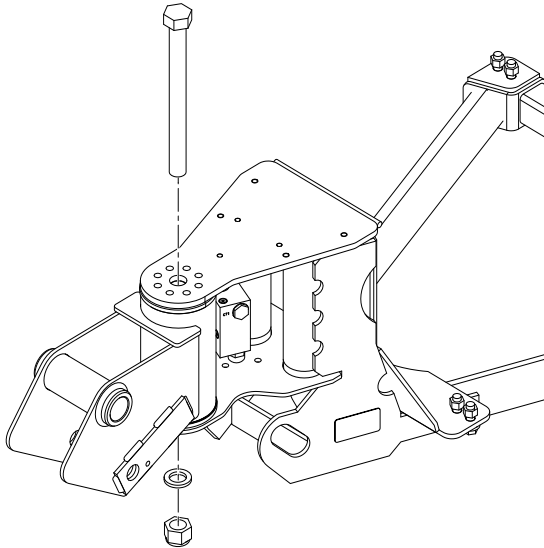
6. Remove the platform support from rotator.

Support Installation

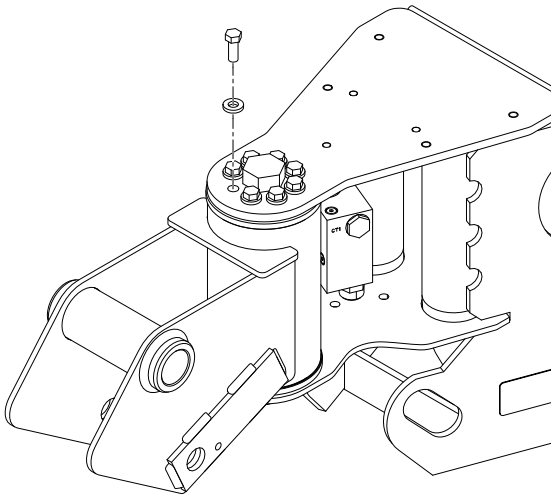
1. Using a suitable device, support the platform support and position it on the rotator.

NOTE: The platform support weighs approximately 76.4 lbs. (34.7 kg).

2. Install the rotator center bolt.

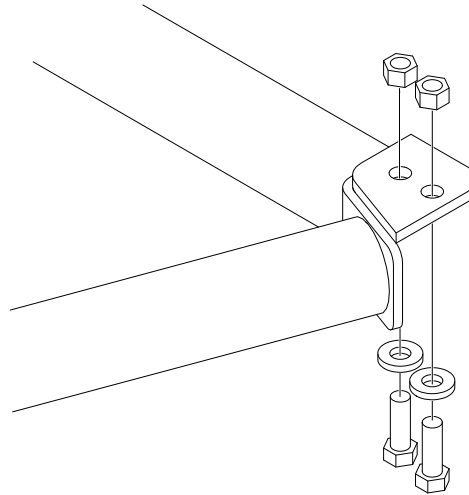


3. Apply JLG Threadlocker P/N 0100011 to the eight bolts and locknut securing the support to the rotator and install the bolts and locknut.

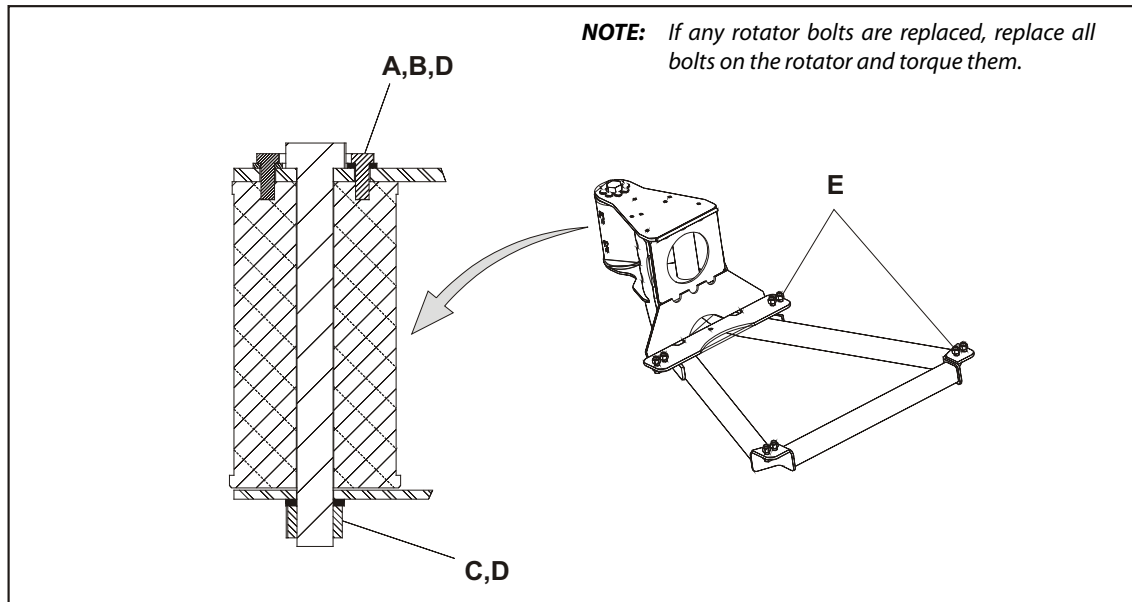


4. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).

5. Position the platform on the platform support and install the bolts securing the platform to the platform support. Torque the bolts to 85 ft. lbs. (116 Nm).



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



- A Torque to 40 ft. lbs. (55 Nm)
- B JLG Threadlocker P/N0100011
- C Torque to 586 ft. lbs. (795 Nm)
- D Check torque every 150 hours of operation
- E Torque to 85 ft. lbs. (116 Nm)

Figure 4-2. Platform Support Torque Values

4.2 ROTATOR AND SLAVE CYLINDER

Removal

600S

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

600SJ/660SJ

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

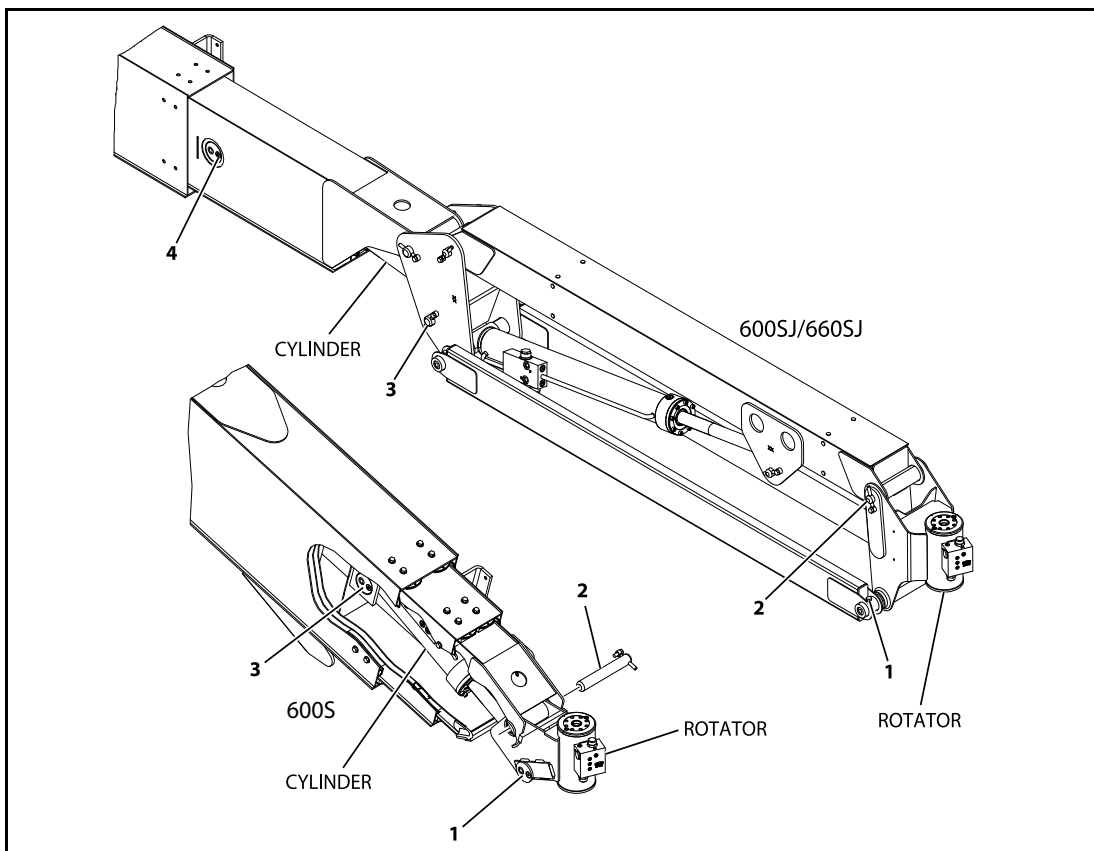


Figure 4-3. Removal of Components - Rotator and Leveling Cylinder

Installation

600S

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

600SJ/660SJ

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

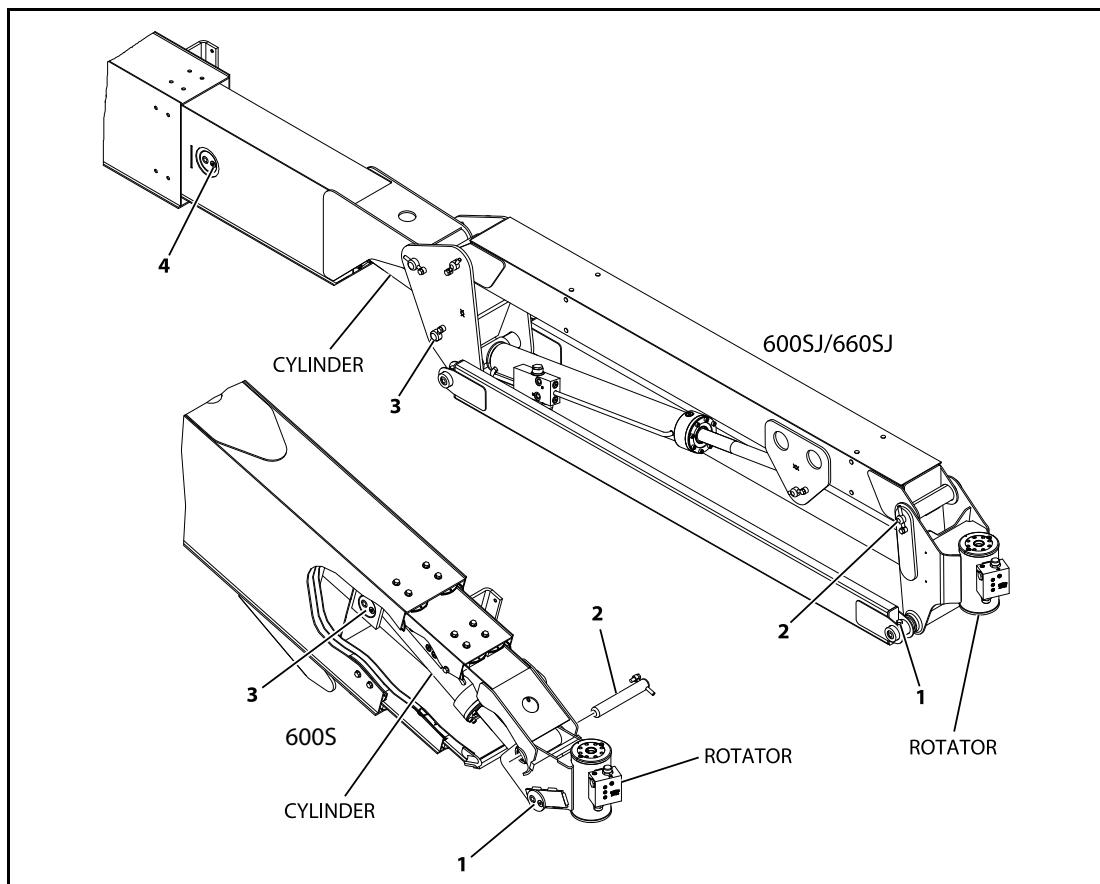


Figure 4-4. Removal of Components - Rotator and Leveling Cylinder

4.3 MAIN BOOM POWERTRACK

Removal

1. Disconnect wiring harness connectors located in turntable.

NOTICE

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

2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect dual capacity indicator limit switch from side of boom section.
4. Remove hydraulic lines and electrical cables from Powertrack.
5. Using suitable lifting equipment, adequately support Powertrack weight along entire length.
6. Remove bolt #1 securing the push tube on the fly boom section.

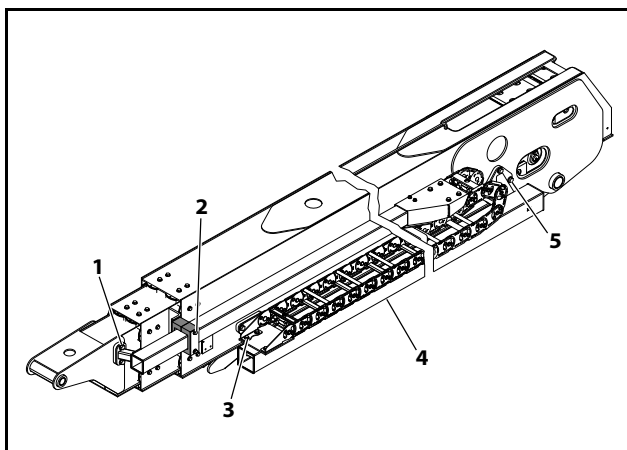


Figure 4-5. Main Boom Powertrack Components

7. Remove bolt #2 securing the push tube on the mid boom section.
8. With Powertrack supported and using all applicable safety precautions, remove bolts #3, #4 and #5 securing rail to the base boom section. Remove Powertrack from boom section.

Installation

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

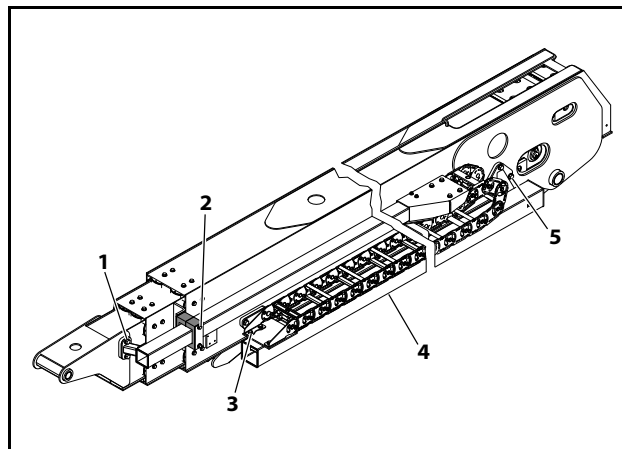


Figure 4-6. Main Boom Powertrack Components

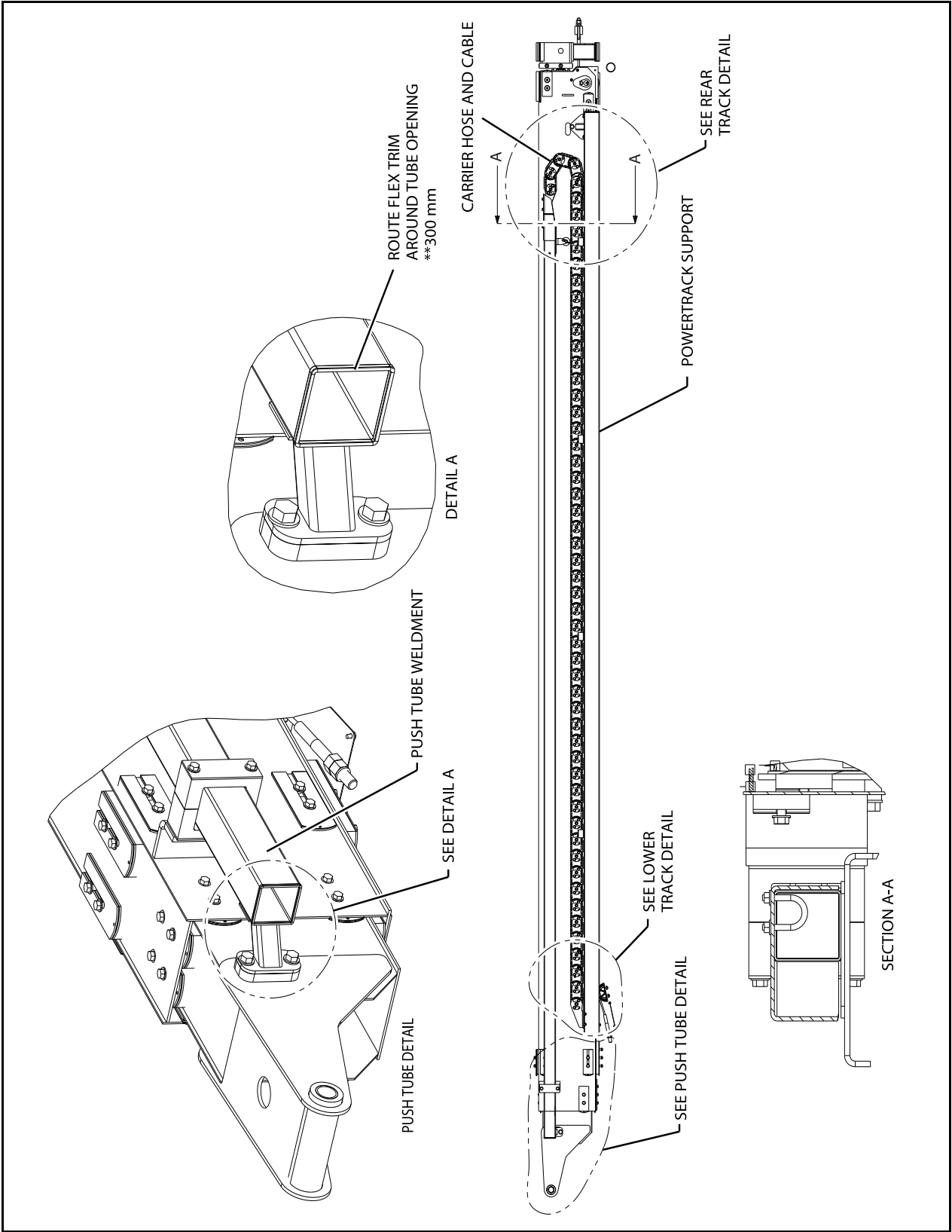


Figure 4-7. Powertrack Installation Main Boom - Sheet 1 of 2

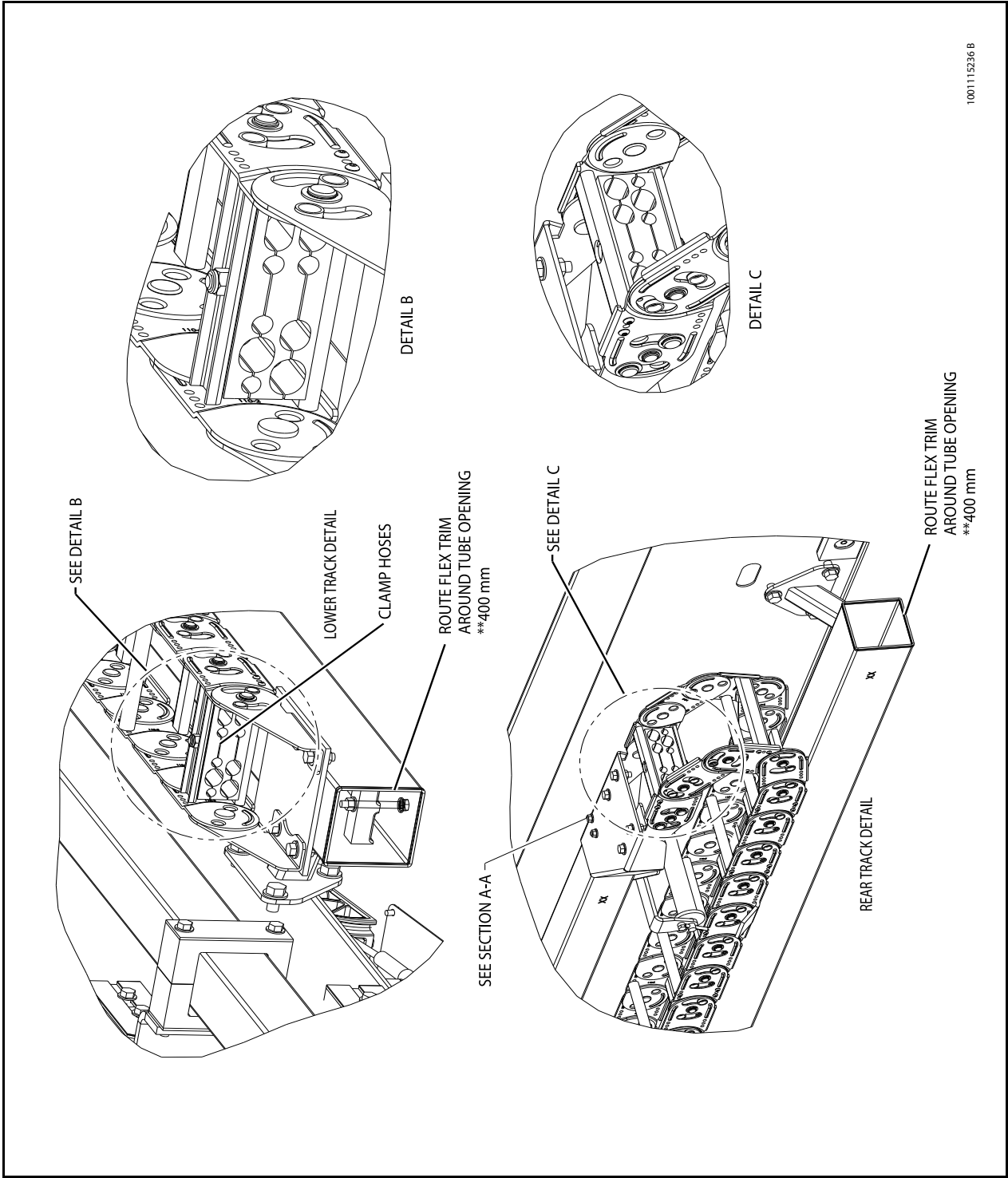


Figure 4-8. Powertrack Installation Main Boom - Sheet 2 of 2

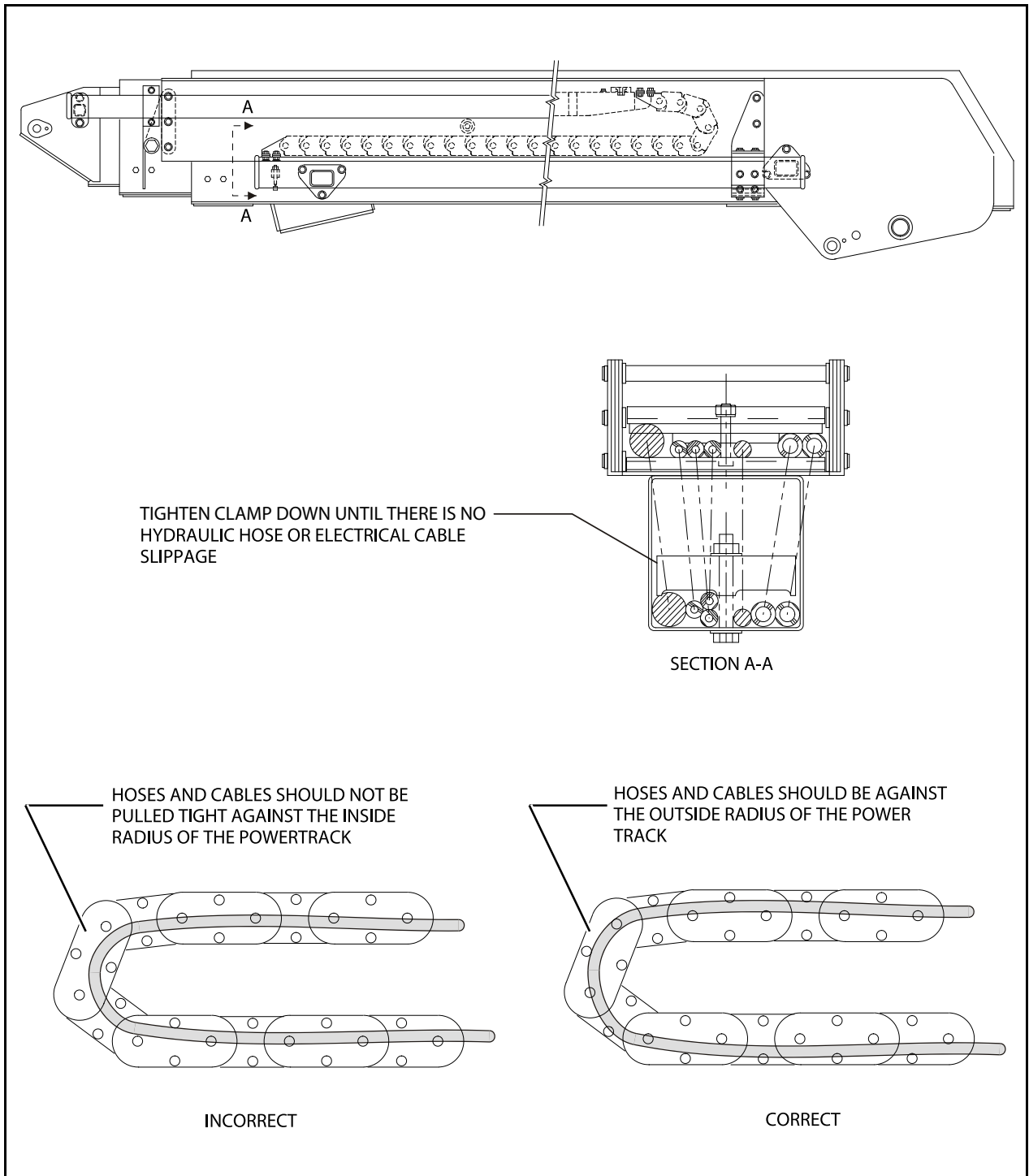
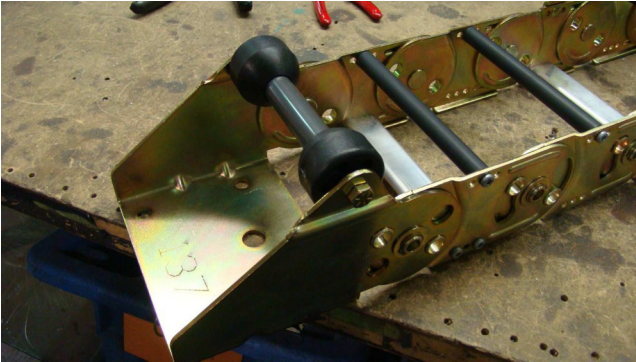


Figure 4-9. Boom Powertrack Installation

4.4 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.



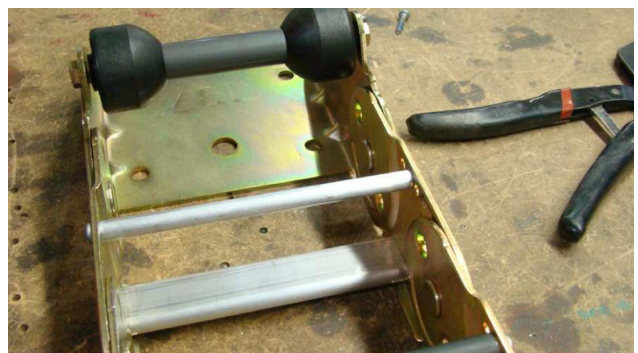
3. Remove the screws from the flat bar on the other side of the powertrack.



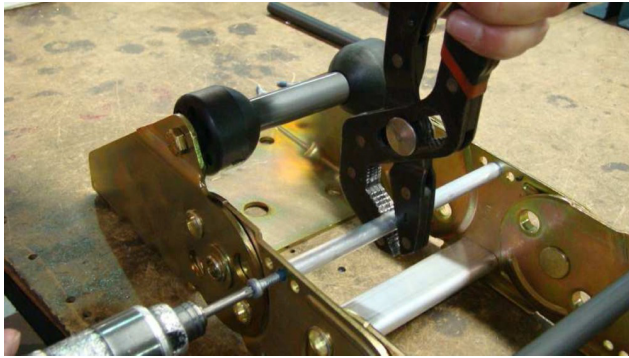
4. Pull up on the loose side of the round bar to allow the poly roller to slide off.



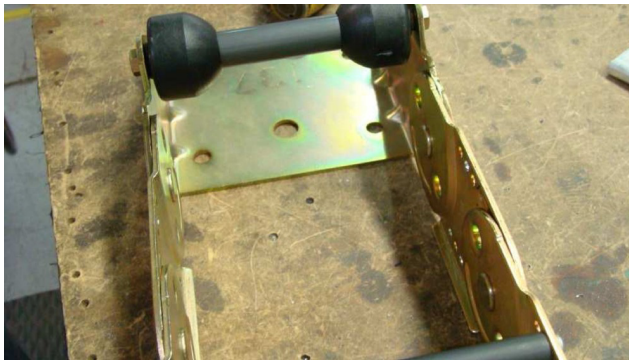
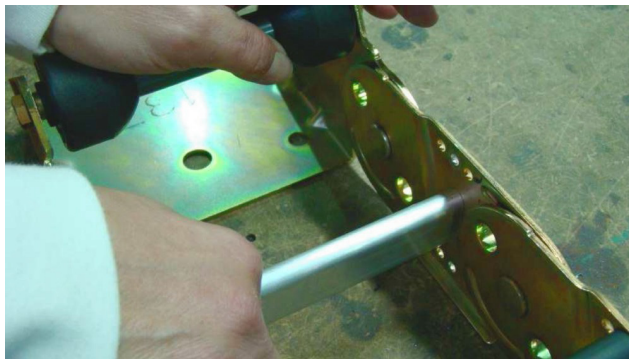
5. Slide the poly roller off of the round bar.



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



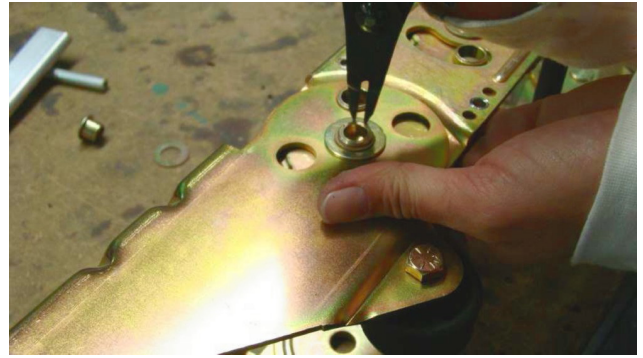
- 7.** Slide the flat bar out.



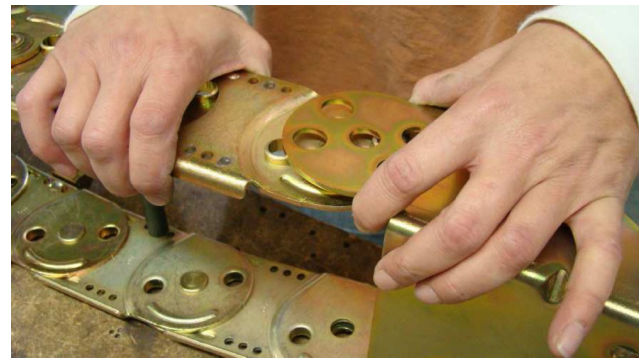
- 8.** Remove the snap ring from one side of the bracket.



- 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.

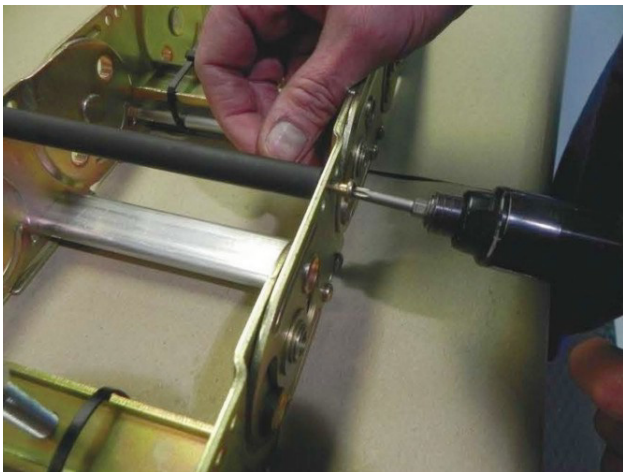


12. Slide the bracket off of the powertrack.

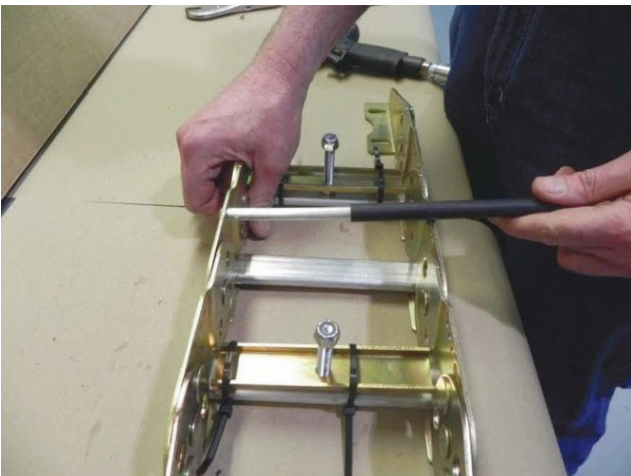


Two Piece Bracket Maintenance

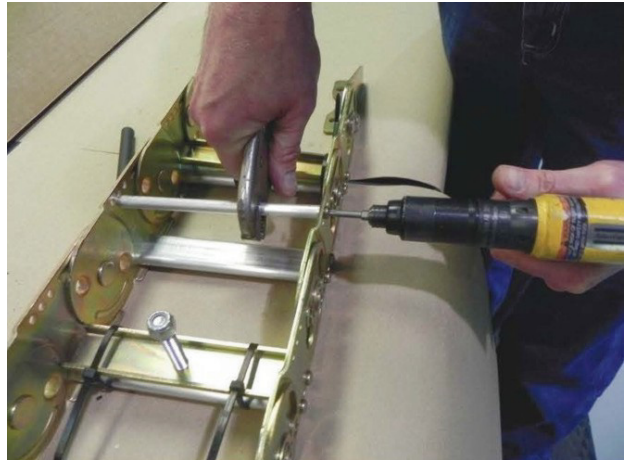
1. Loosen the screw.



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.

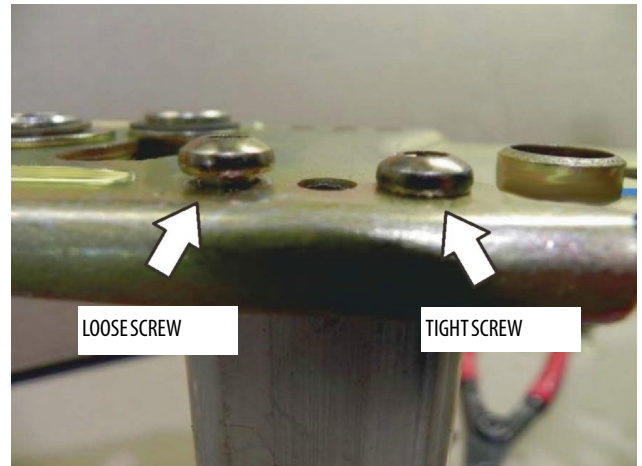


Snap Rings and Screws

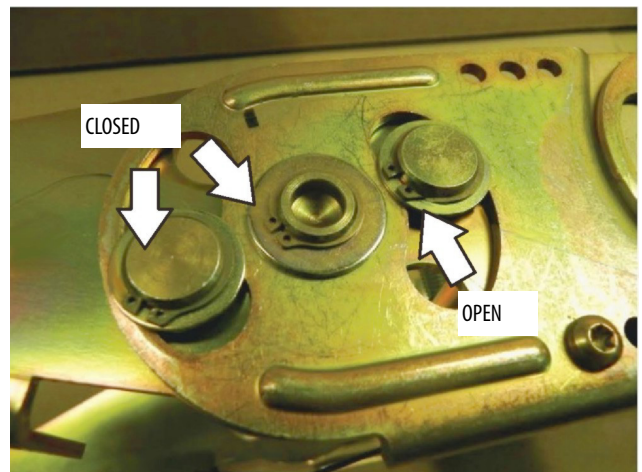
NOTICE

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

Make sure screws are tight and installed properly.



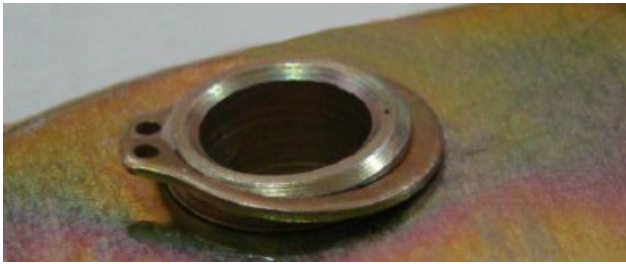
Make sure that all snap rings are closed and seated.



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.

4.5 BOOM CLEANLINESS GUIDELINES

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

1. JLG recommends the use of the JLG Hostile Environment Package if available to keep the internal portions of a boom cleaner and to help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.
2. JLG recommends that you follow all guidelines for servicing your equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to the proper operation of the machine. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.
3. Debris and foreign matter inside of the boom can cause premature failure of components and should be removed. Methods to remove debris should always be done using all applicable safety precautions outlined in the JLG Service & Maintenance Manuals.
4. The first attempt to remove debris from inside the boom must be to utilize pressurized air to blow the debris toward the nearest exiting point from the boom. Make sure that all debris is removed before operating the machine.
5. If pressurized air cannot dislodge the debris, then water with mild solvents applied via a pressure washer can be used. Again the method is to wash the debris toward the nearest exiting point from the boom. Make sure that all debris is removed, that no "puddling" of water has occurred, and that the boom internal components are dry prior to operating the machine. Make sure you comply with all federal and local laws for disposing of the wash water and debris.
6. If neither pressurized air nor washing of the boom dislodges and removes the debris, then disassemble the boom in accordance to the instructions outlined in the JLG Service & Maintenance Manual to remove the debris.

4.6 MAIN BOOM ASSEMBLY

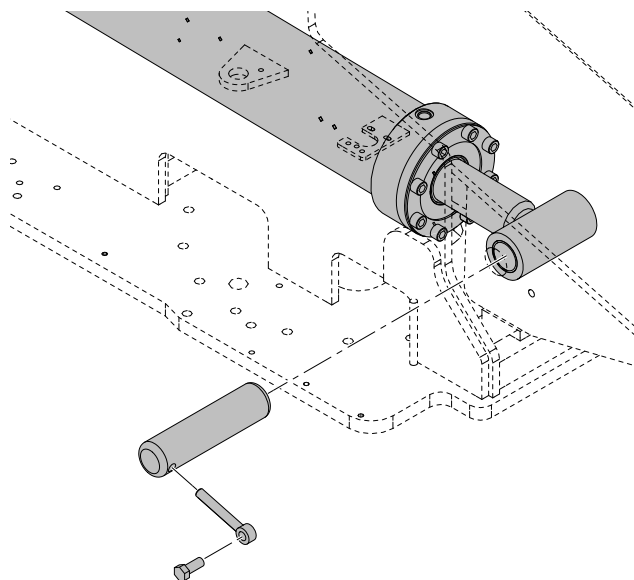
Removal

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

NOTICE

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

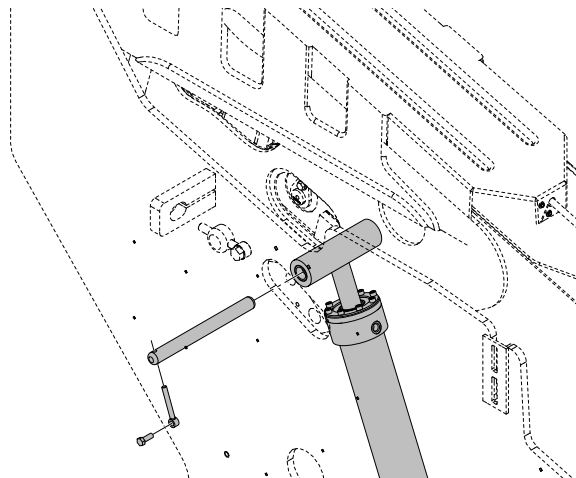
2. Tag and disconnect hydraulic lines from telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Use adequate support for the main boom lift cylinder.
4. Using a suitable brass drift and hammer, remove hardware securing the main boom lift cylinder rod end pin to the base boom section. Remove the main boom lift cylinder pin from base boom. Retract the main boom lift cylinder by using the auxiliary power switch.



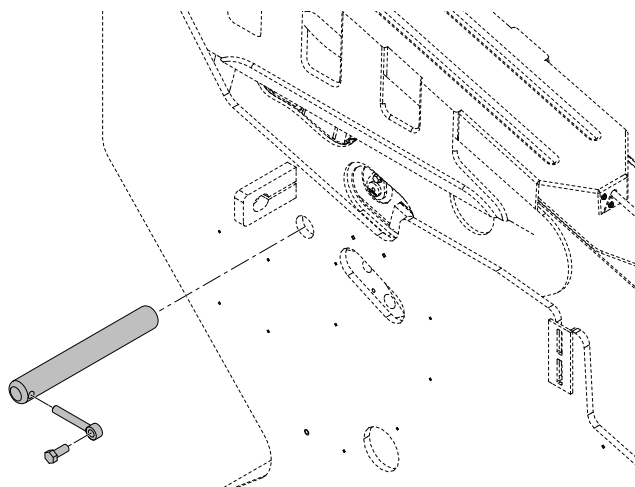
5. Using an adequate supporting device, support the master cylinder so it doesn't fall when the retaining pins are removed.

NOTE: The master cylinder weighs approximately 39.7 lbs. (18 kg).

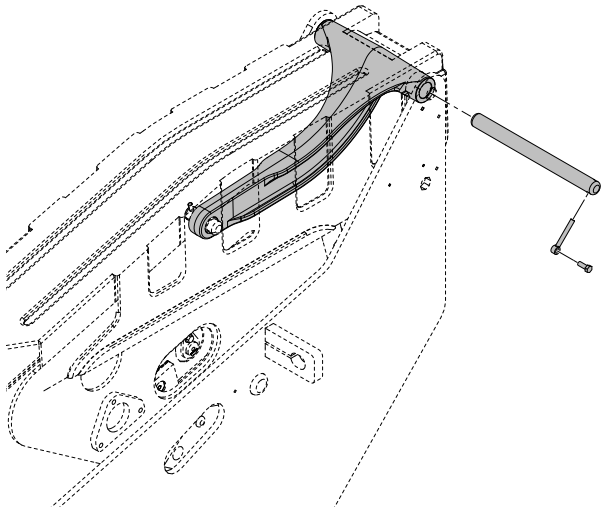
6. Using a suitable brass drift and hammer, remove hardware securing the master cylinder rod end pin to the base boom section. Remove the master cylinder pin from base boom.



7. Using a suitable brass drift and hammer, remove hardware securing the main boom section to the turntable.



8. Using a suitable brass drift and hammer, remove hardware securing the push bar and cover pin to the turntable.



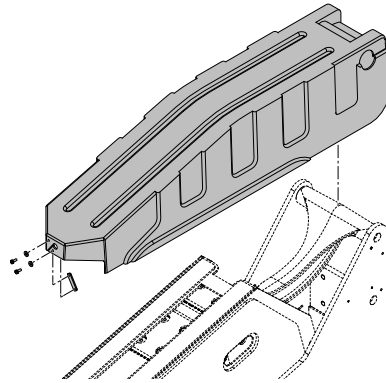
9. Using all applicable safety precautions, carefully lift boom assembly clear of turntable and lower to ground or suitably supported work surface.

NOTE: The main boom alone weighs approximately 2661 lbs. (1207 kg). Including the slave cylinder, rotator, and platform support the assembly weighs approximately 2907 lbs (1319 kg).

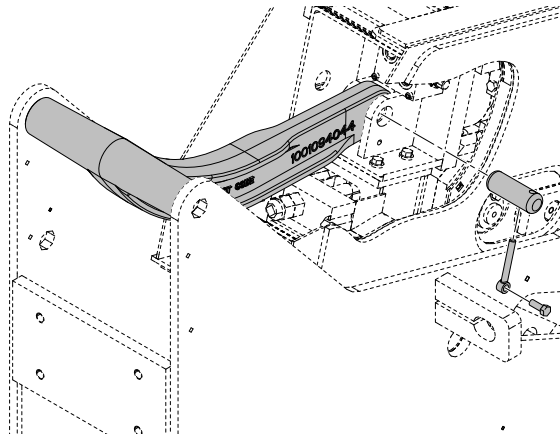
Boom Disassembly

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

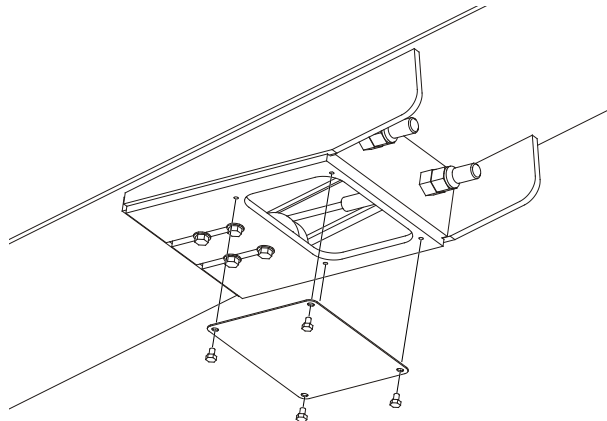
1. Remove hardware securing the cover from the top of main boom.



2. Remove hardware securing the push bar to aft end of the telescope cylinder, then remove pin from cylinder.



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



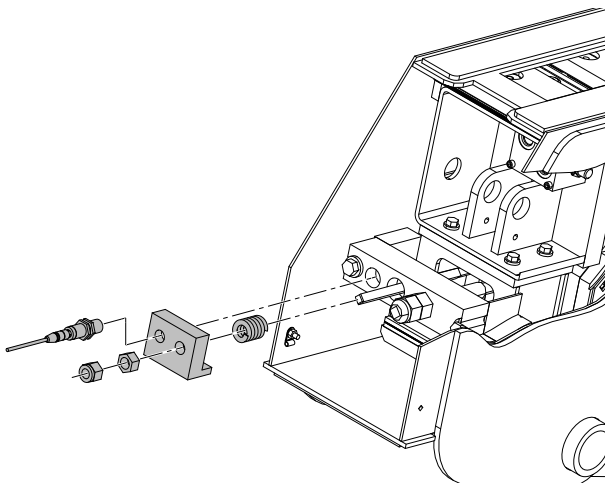
NOTE: Do not allow wire rope to rotate. This may damage the wire rope.

4. Clamp both threaded ends of wire rope to prevent rotation.

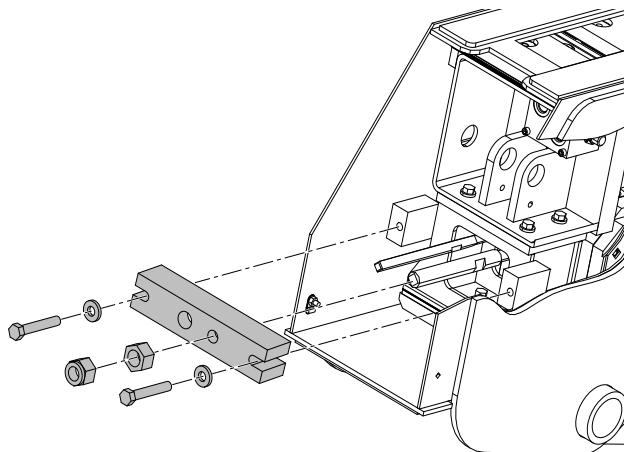
NOTE: Do not clamp on threads. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

NOTE: Step 5 is only applicable to CE specification machines.

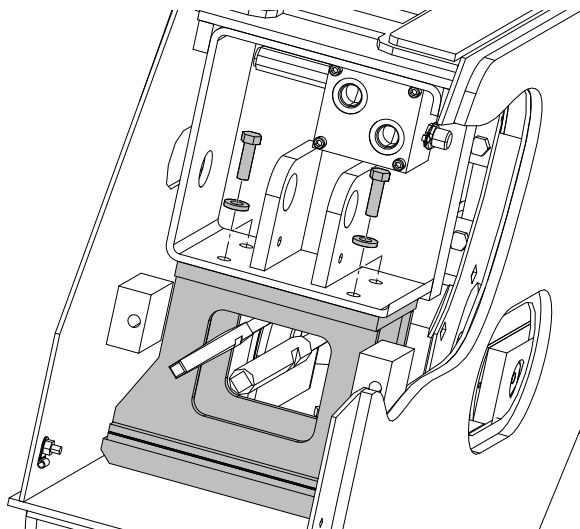
5. Remove the spring mounting plate, spring, and proximity switch from the aft end of the base section.



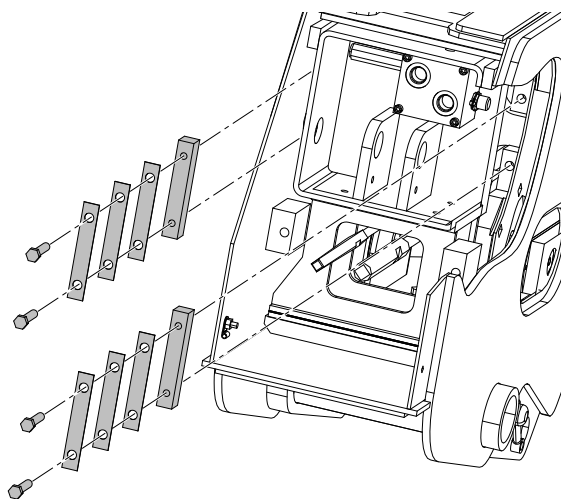
6. Remove hardware securing the wire rope adjustment block to aft end of the base boom section and remove the block.



7. Remove hardware securing the telescope cylinder and support wear pad.



8. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the aft end of mid boom section.



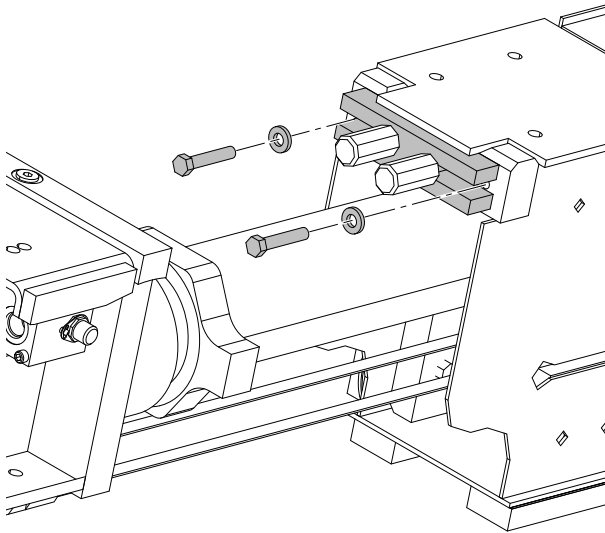
NOTICE

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.

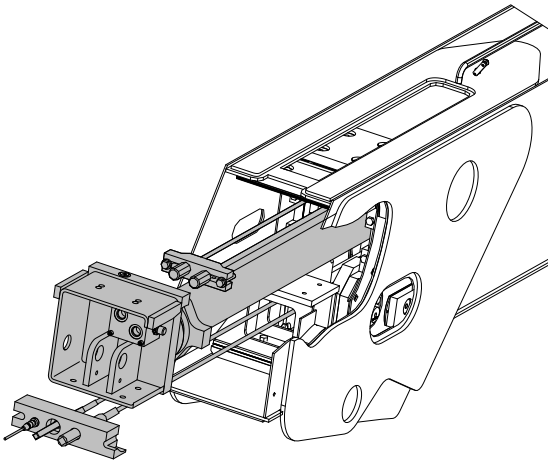
NOTE: The telescope cylinder weighs approximately 421.6 lbs. (191.2 kg).

SECTION 4 - BOOM & PLATFORM

9. Remove bolts securing wire rope attach bar to top of fly boom section.

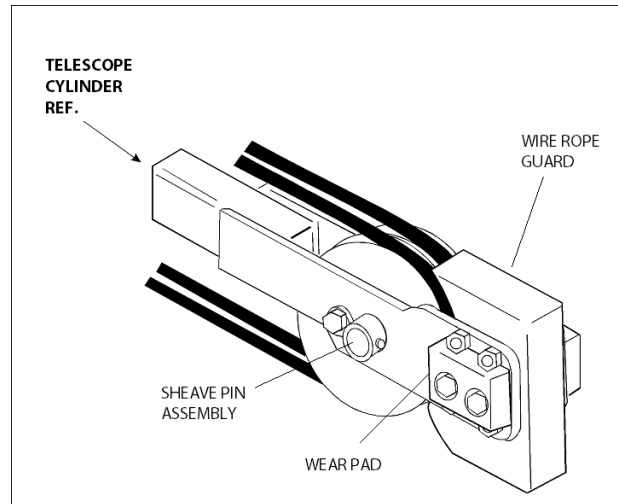


10. Pull the telescope cylinder and wire ropes partially from aft end of the base boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.



11. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.

- Remove hardware from the wear pads; remove wear pads from cylinder.
- Remove hardware from the wire rope guard; remove guard from cylinder.
- Remove hardware from the sheave pin; remove pin and sheave from cylinder.



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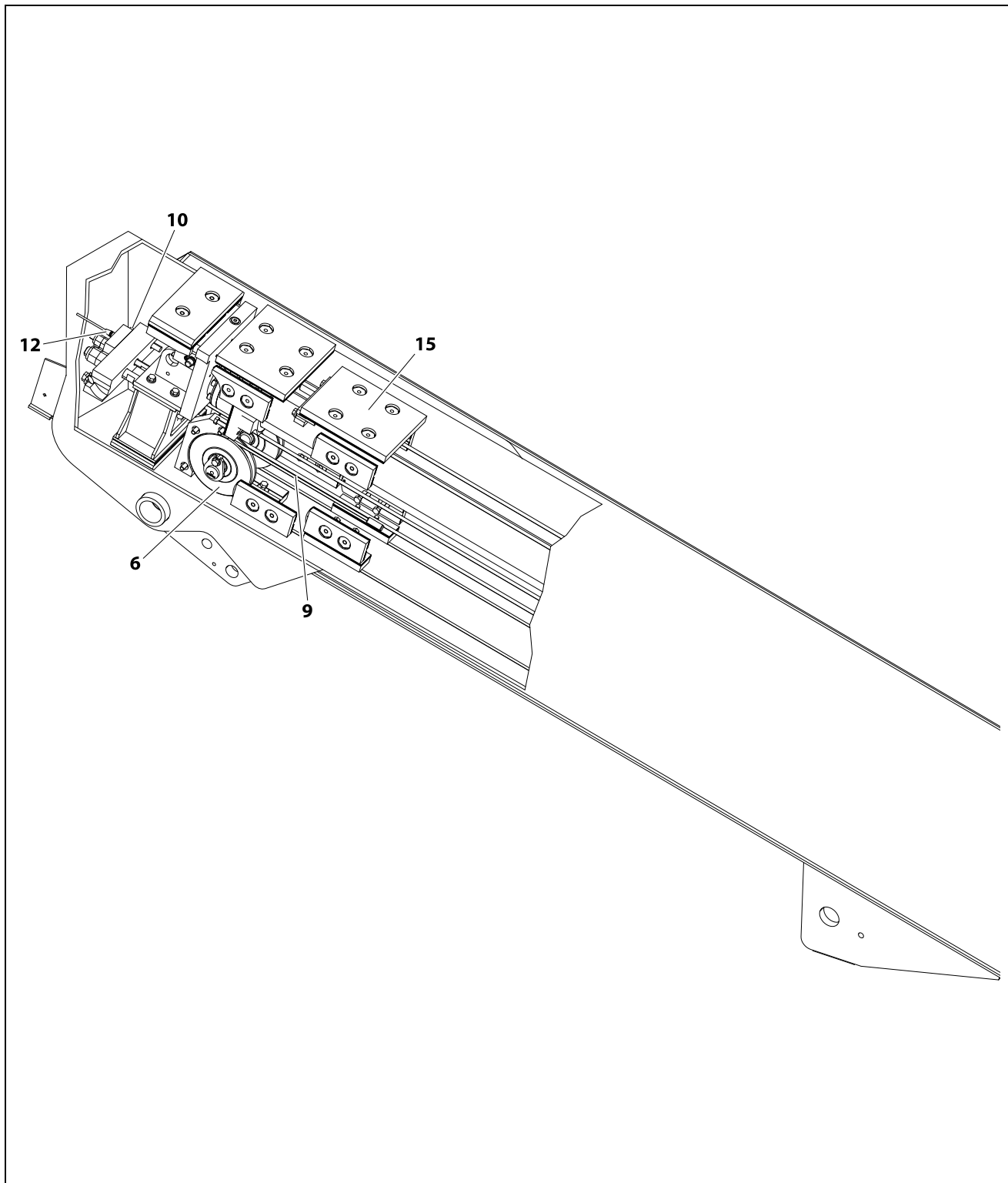


Figure 4-10. Boom Assembly Cutaway - Sheet 1 of 2

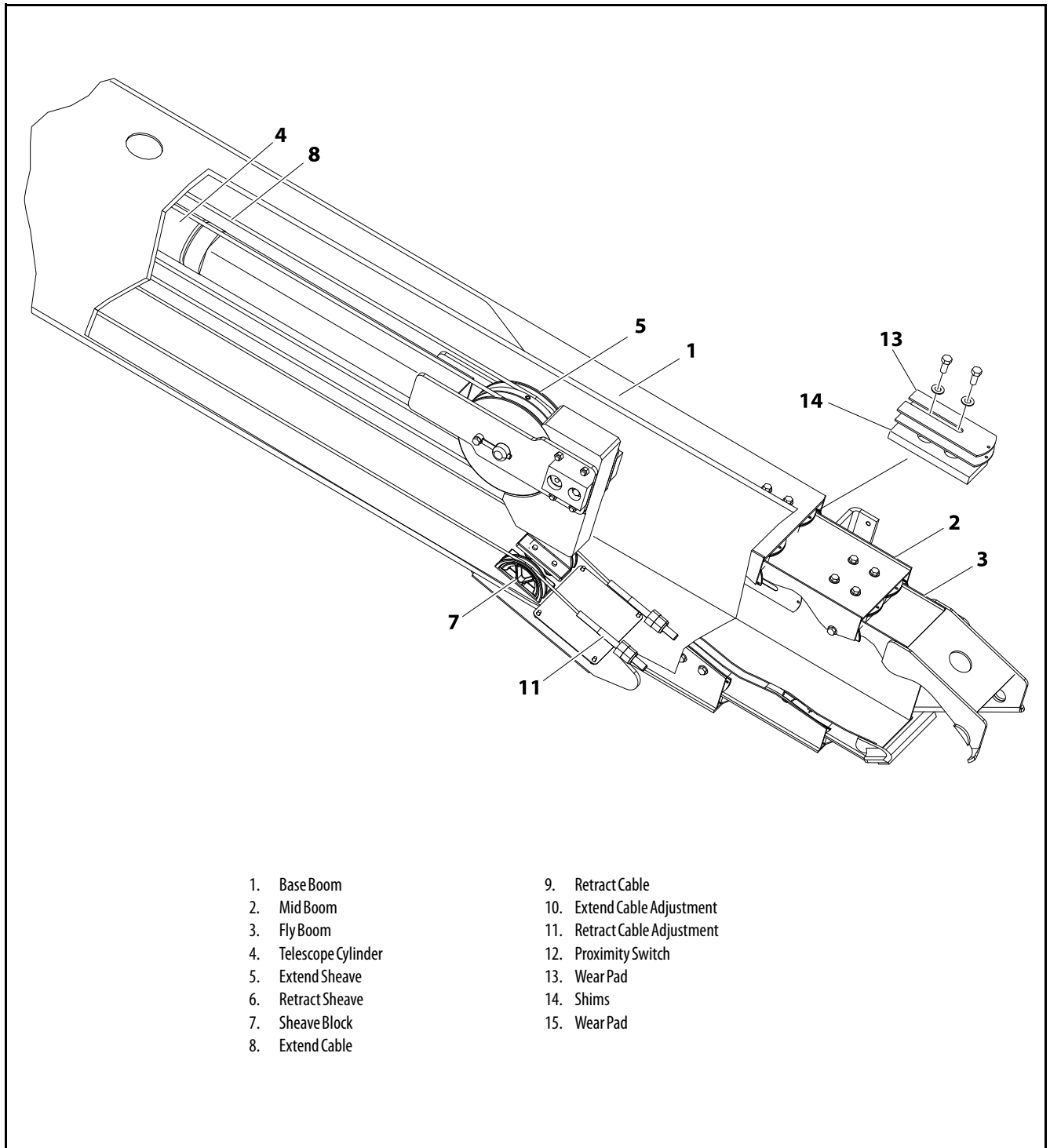


Figure 4-11. Boom Assembly Cutaway - Sheet 2 of 2

SECTION 4 - BOOM & PLATFORM

12. 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.

13. 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.

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

15. Remove hardware which secures the sheave guards and sheave assemblies to mid boom section, remove sheave assemblies from mid boom section.

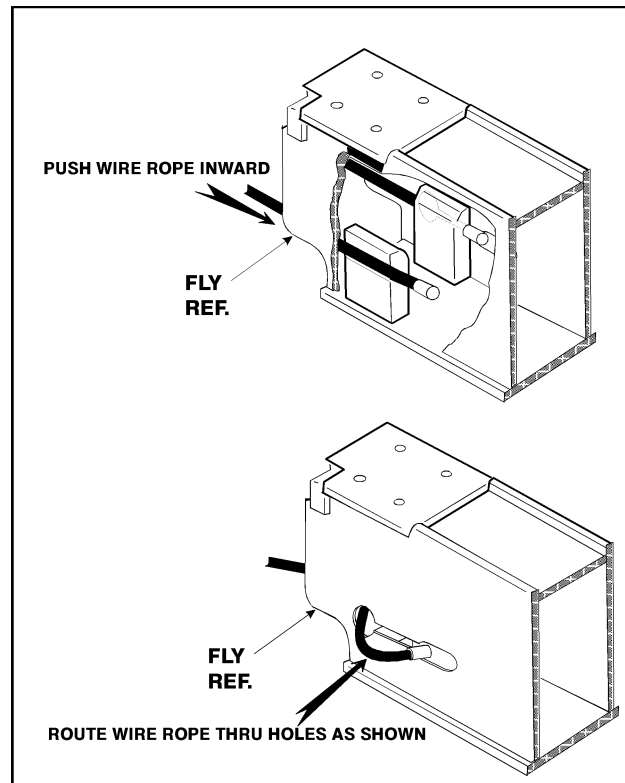
16. Remove hardware which secures the wear pads to the front of mid boom section; remove wear pads from the top, sides and bottom of the mid boom section.

17. 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.

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

19. 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.



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.

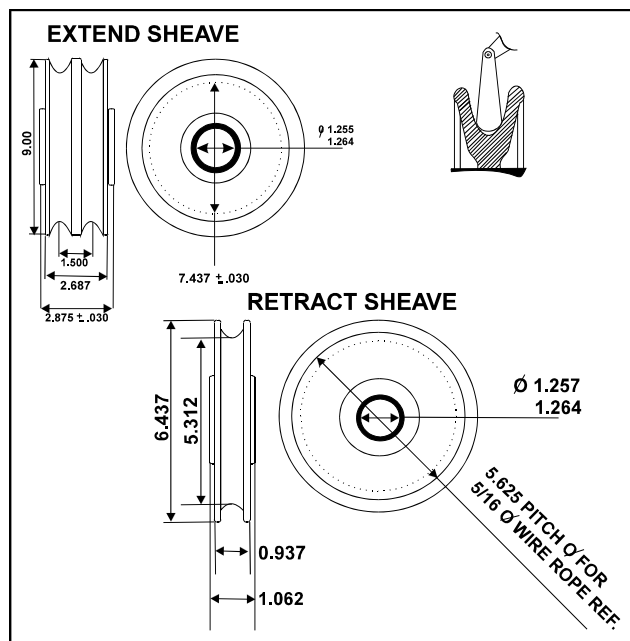


Figure 4-12. Dimension of Sheaves When New

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.
4. Install retract wire ropes into rear end of fly section, route wire ropes through holes in side of fly boom section and pull into slot.

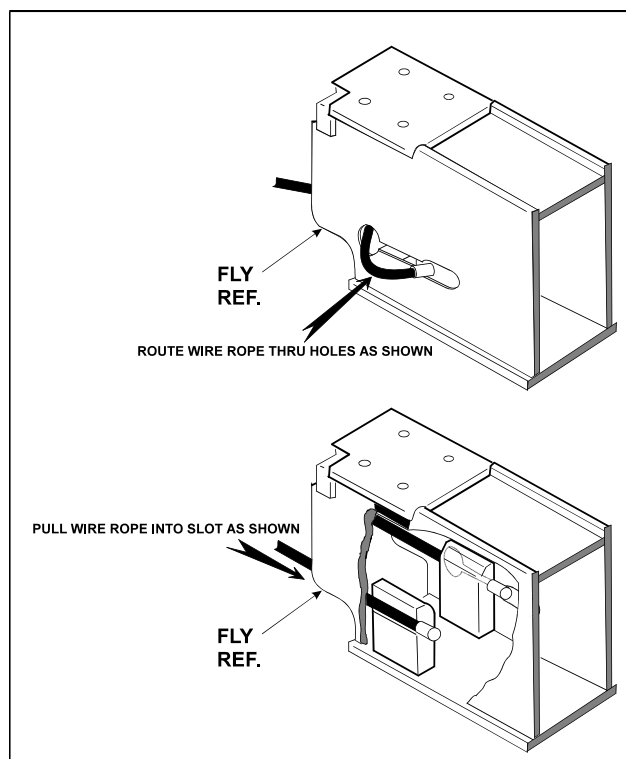


Figure 4-13. Routing Installation of Retract Wire Ropes

SECTION 4 - BOOM & PLATFORM

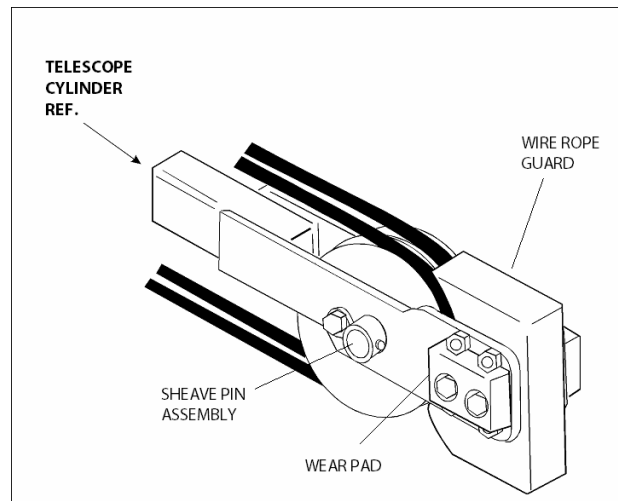
5. Install side, top and bottom wear pads to the rear end of mid section; shim evenly to the measurements of the inside of mid section.

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 (1.58 mm) 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 (1.58 mm) 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 (5.08 mm) 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 (1.58 mm) 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 (5.08 mm) 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 through attachment holes in the bottom of base boom section. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.
15. Align the telescope cylinder barrel-to-sheave attachment point. Install extend sheave pin through the telescope cylinder barrel and sheave assembly; secure pin with mounting hardware.
16. Route extend wire ropes around extend sheave and secure wire ropes to the telescope cylinder.
17. Install extend wire rope mounting blocks to threaded ends of wire ropes. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.

NOTE: When installing wire ropes, care must be taken not to twist or cross the wire ropes.



NOTE: For non CE specification machines, skip step 18 and proceed to step 19.

- 18.** Install extend wire rope mounting blocks, proximity mounting plate and spring to threaded ends of wire ropes. Loosely install nuts and jam nuts onto the

threaded ends of wire ropes. Refer to Figure 4-14. Installing the Proximity Switch.

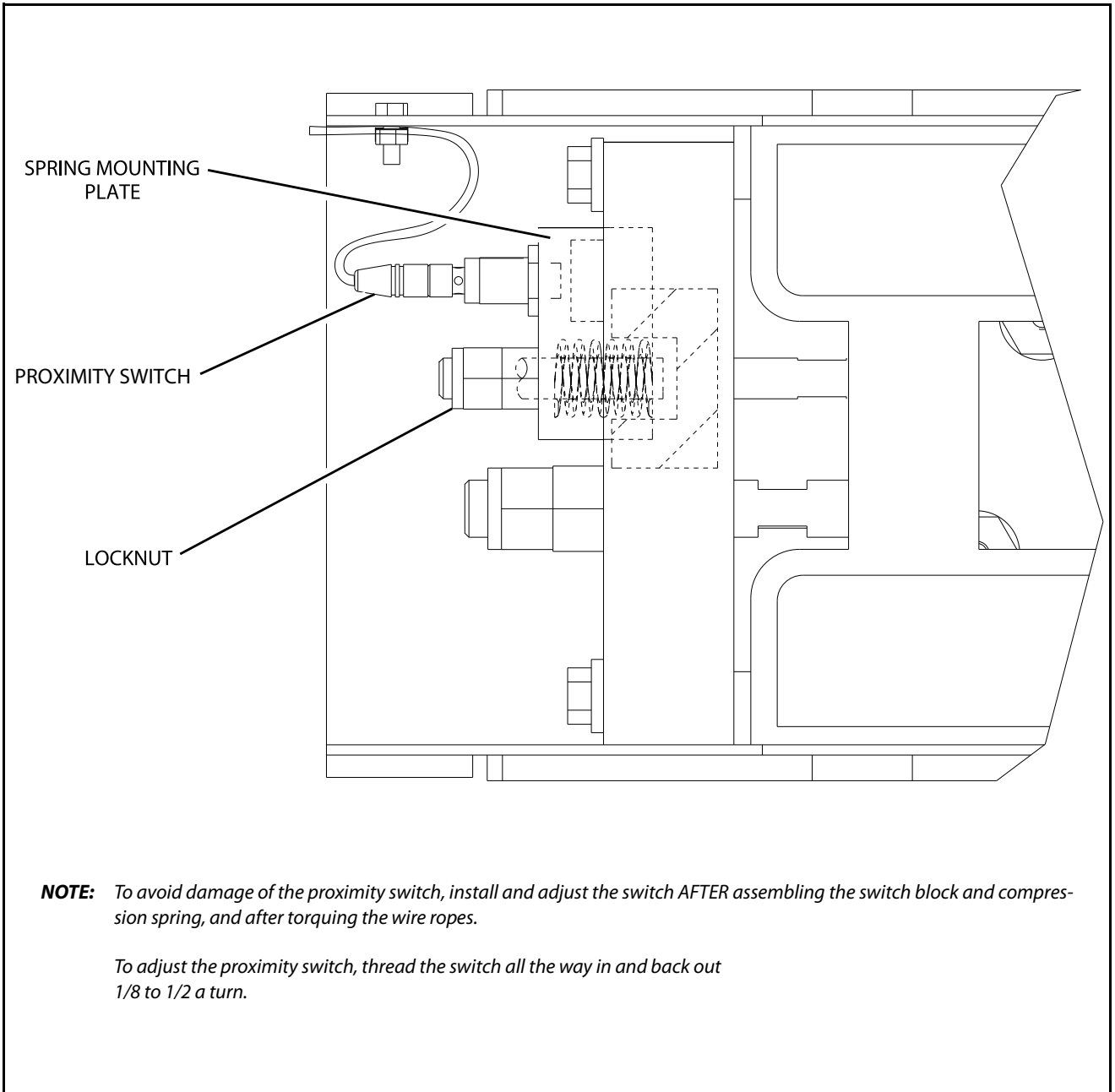


Figure 4-14. Proximity Switch Adjustment

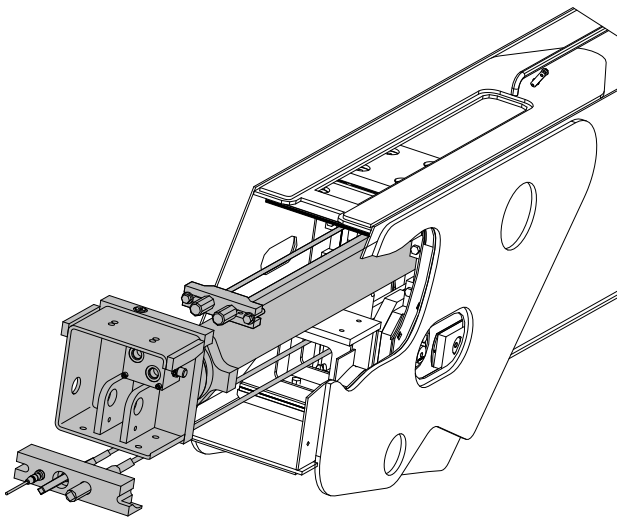
SECTION 4 - BOOM & PLATFORM

19. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

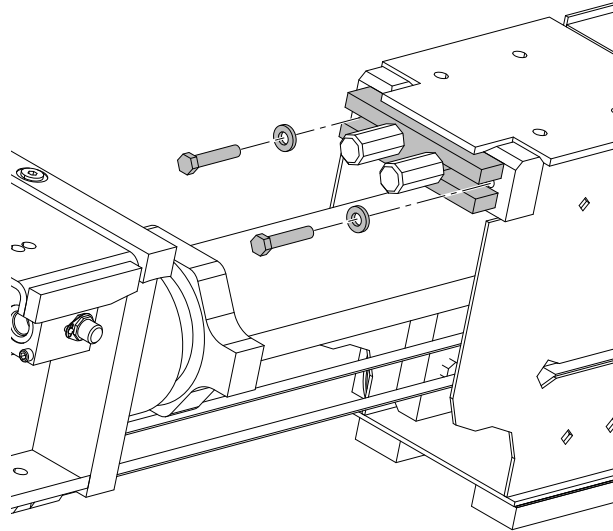
NOTICE

WHEN INSERTING 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 POSITION. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

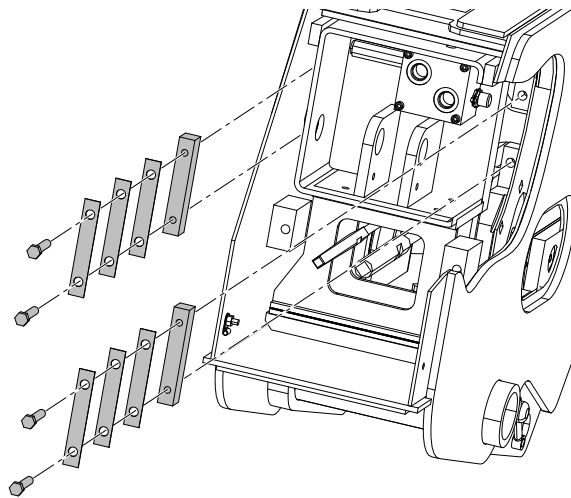
20. Align the cylinder with the slots at aft end of mid boom section, then secure cylinder with mounting hardware.



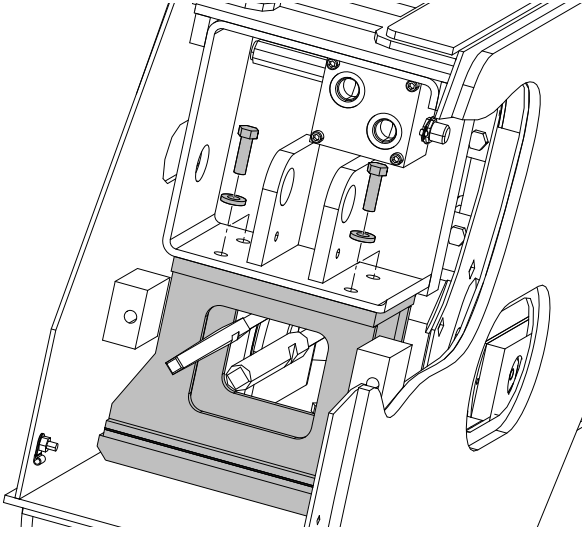
21. Align holes in aft end of the fly boom section with holes in wire rope mounting block, then secure with mounting hardware.



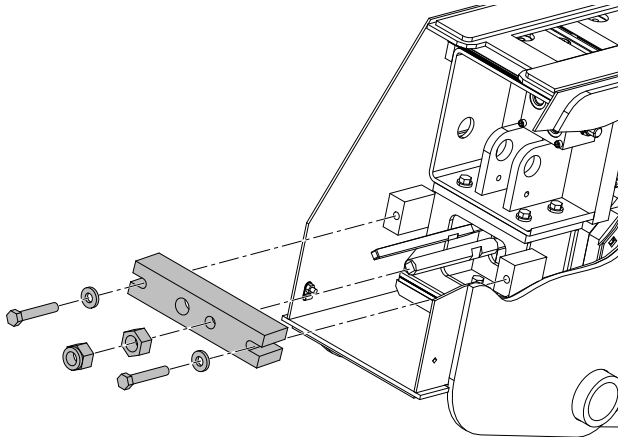
22. Install the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the aft end of mid boom section.



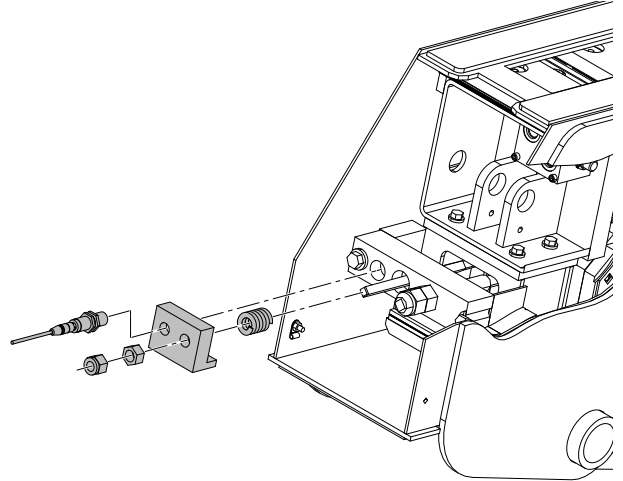
23. Install hardware securing the telescope cylinder and support wear pad.



24. Install hardware securing the wire rope adjustment block to aft end of the base boom section and remove the block.



25. Install the spring mounting plate, spring, and proximity switch from the aft end of the base section.

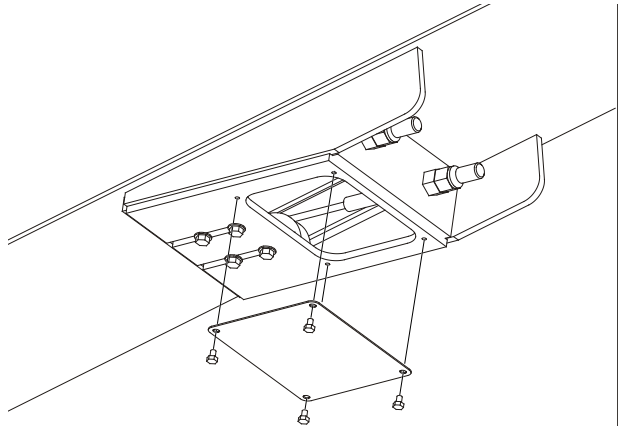


26. Clamp both threaded ends of wire rope to prevent rotation.

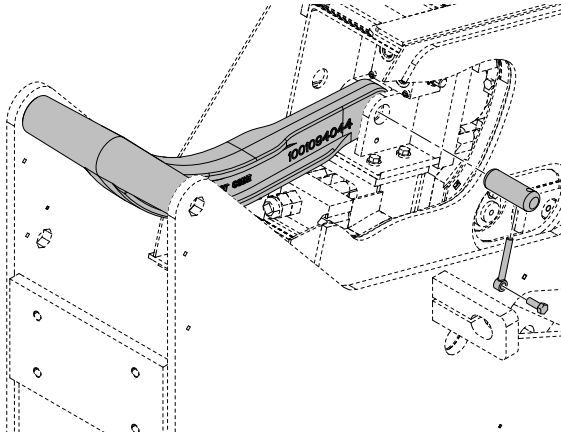
NOTE: Do not clamp on threads. Install jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

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

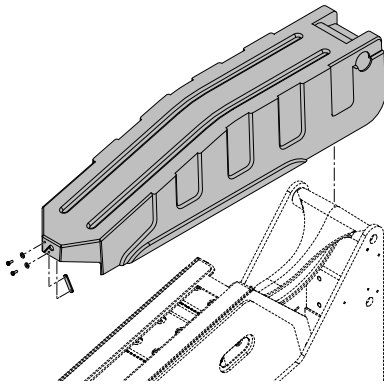
27. Remove hardware securing the cover plate on the bottom front of the base boom section.



28. Align holes in rod end of the telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.



29. Install hardware securing the cover from the top of main boom.



30. Install the hydraulic lines and electrical cables, and the harnessing powertrack components as follows:

- a. Align holes in powertrack rail with attachment holes in side of the base boom section. Secure the rail with mounting hardware.
- b. Install powertrack to rail with mounting hardware.
- c. Attach push tube bracket to the side of the mid boom section with mounting hardware.

NOTE: Do not over tighten attach bolt on push tube bracket. It should pivot freely.

- d. Install slide block and wear pads to the powertrack rail with mounting hardware.
- e. Install powertrack to push tube with mounting hardware.
- f. Carefully feed the hoses and electrical cables through the aft end of the powertrack rail, powertrack and push tube.
- g. Ensure all hoses and cables are properly routed through the powertrack rail, powertrack and push tube. Tighten or install all clamping or securing apparatus to the hoses or cables, as necessary.
- h. Install powertrack cover and push tube rods with mounting hardware.

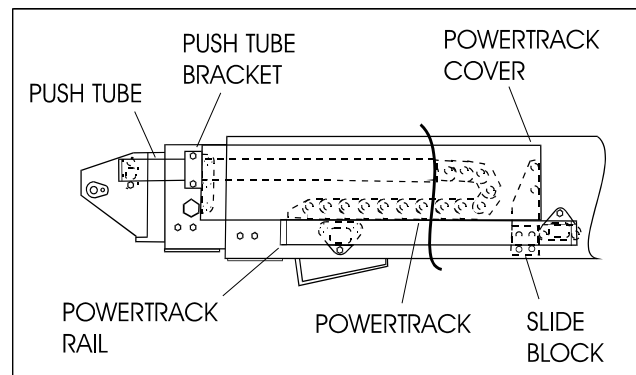
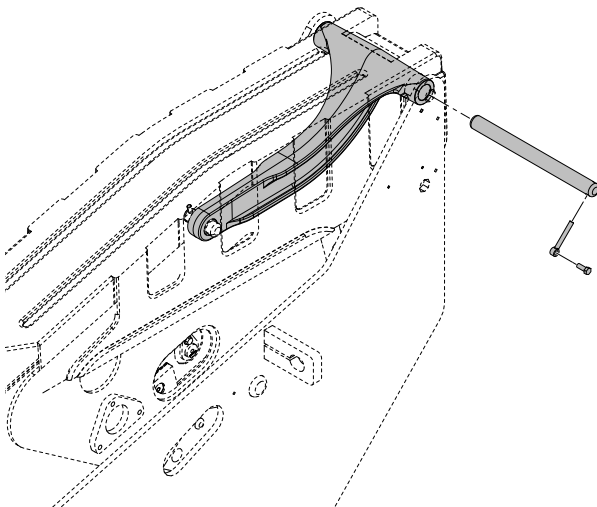


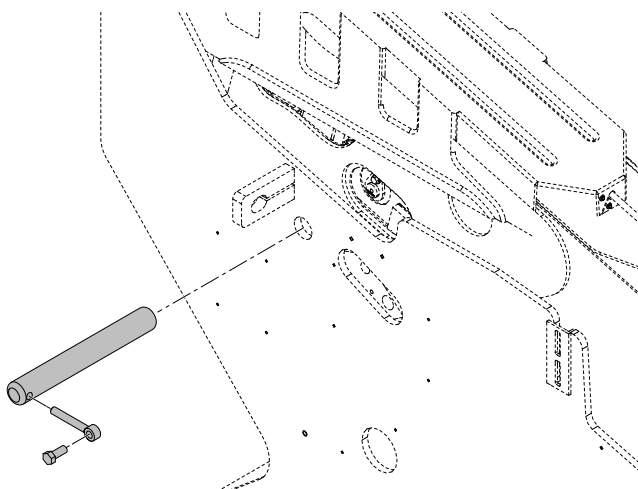
Figure 4-15. Reassembly of Components - Boom Powertrack Assembly

Installation

1. Using a suitable lifting device, position boom assembly on turntable so that the pivot holes of boom, push bar, cover, and turntable are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware..

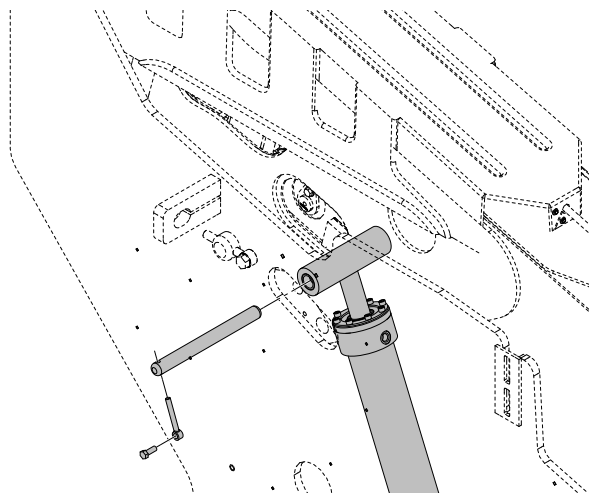


4. Using a suitable brass drift and hammer, install hardware securing the main boom section to the turntable.

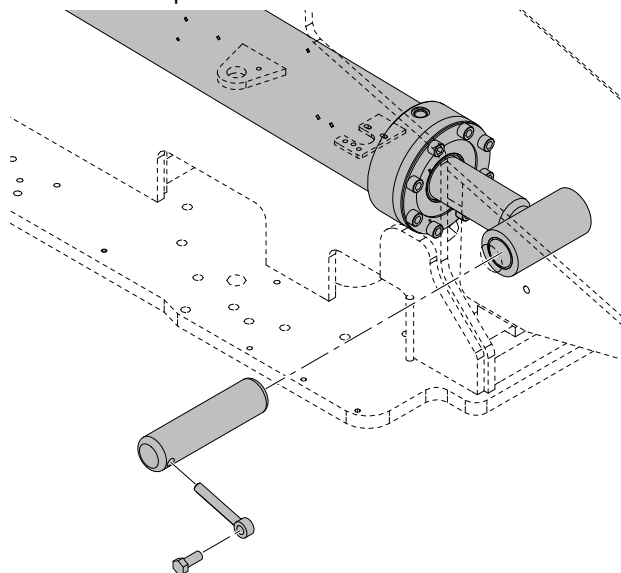


5. Using an adequate supporting device, align the master cylinder with the mounting holes on the boom and upright.
6. Using a suitable brass drift and hammer, install hardware securing the master cylinder rod end pin to the base boom section. Install the master cylinder pin into base boom.

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



7. Connect hydraulic lines to the master cylinder as tagged during removal.
8. Using an adequate supporting device, align the main boom lift cylinder with the mounting holes on the boom section.
9. Extend the main boom lift cylinder by using the auxiliary power switch. Using a suitable brass drift and hammer, install hardware secured to the main boom lift cylinder rod end pin into the base boom section.



10. Connect all wiring to the ground control box.
11. Connect all hydraulic lines running along side of boom assembly.

12. Adjust retract and extend cables to the proper torque. Refer to Section 4.10, Boom Rope Torquing Procedure for boom cable torque procedures.
13. Using all applicable safety precautions, operate machine systems and raise and extend boom fully, noting the performance of the extension cycle.
14. Retract and lower boom, noting the performance of the retraction cycle.

4.7 ARTICULATING JIB BOOM

Removal

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

Disassembly

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

Inspection

NOTE: When inspecting pins and bearings refer to Section 2 - General.

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

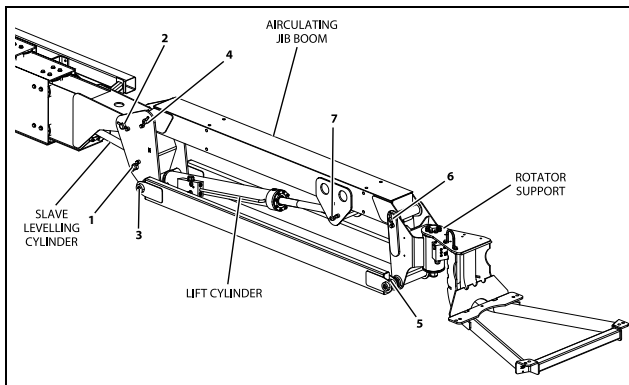


Figure 4-16. Location of Components - Articulating Jib Boom

Assembly

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

Installation

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

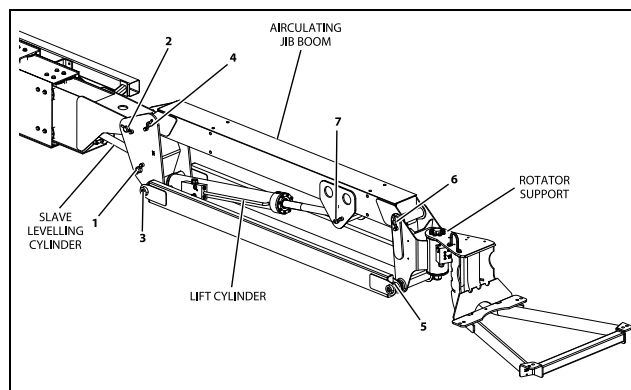


Figure 4-17. Location of Components - Articulating Jib Boom

4.8 LIMIT SWITCHES AND CAM VALVE ADJUSTMENT

Adjust switches and cam valve as shown in Figure 4-18., Horizontal Limit and Dual Capacity Limit Switches Adjustments and Figure 4-19., Transport Switch Adjustments - CE Machines Only.

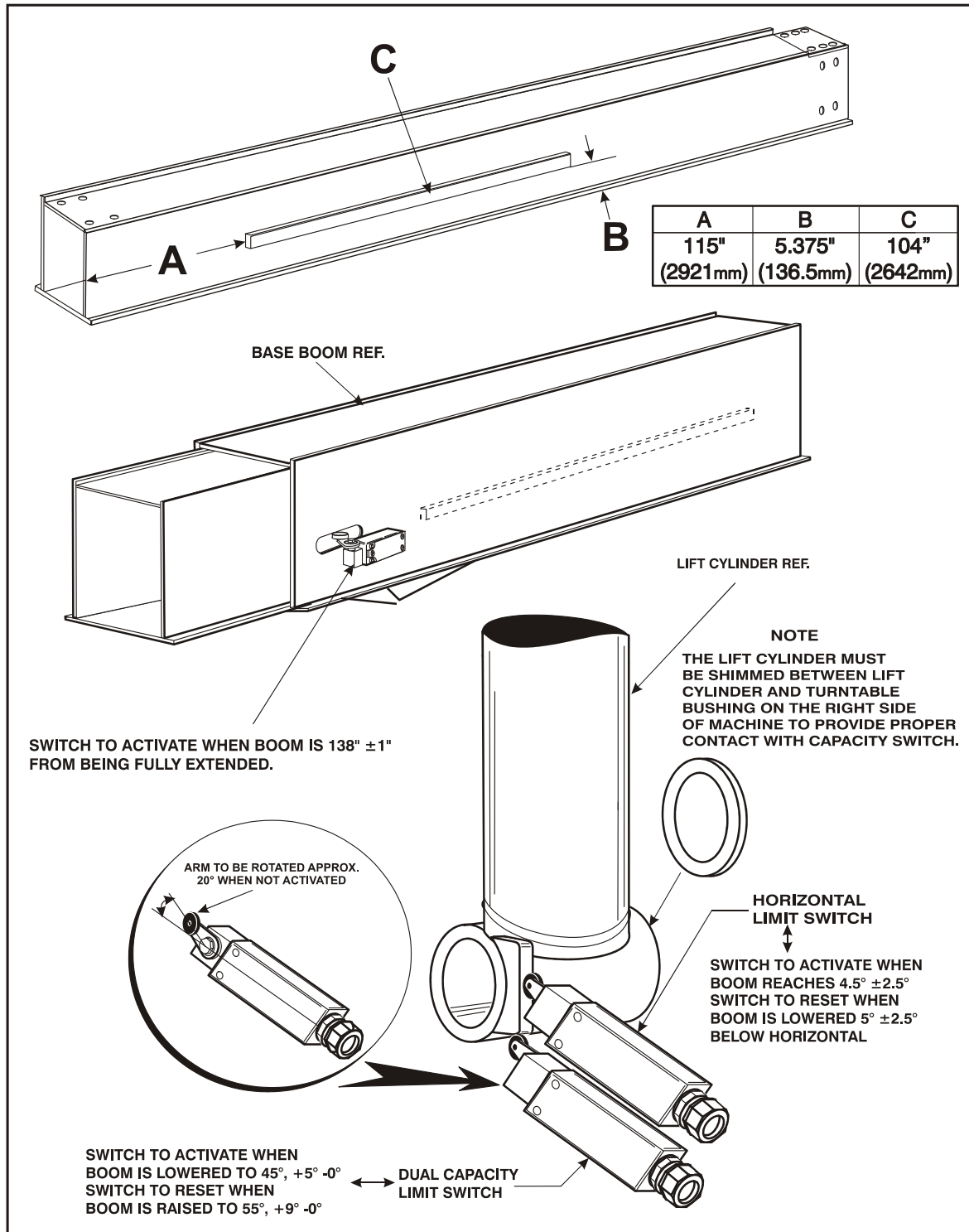


Figure 4-18. Horizontal Limit and Dual Capacity Limit Switches Adjustments

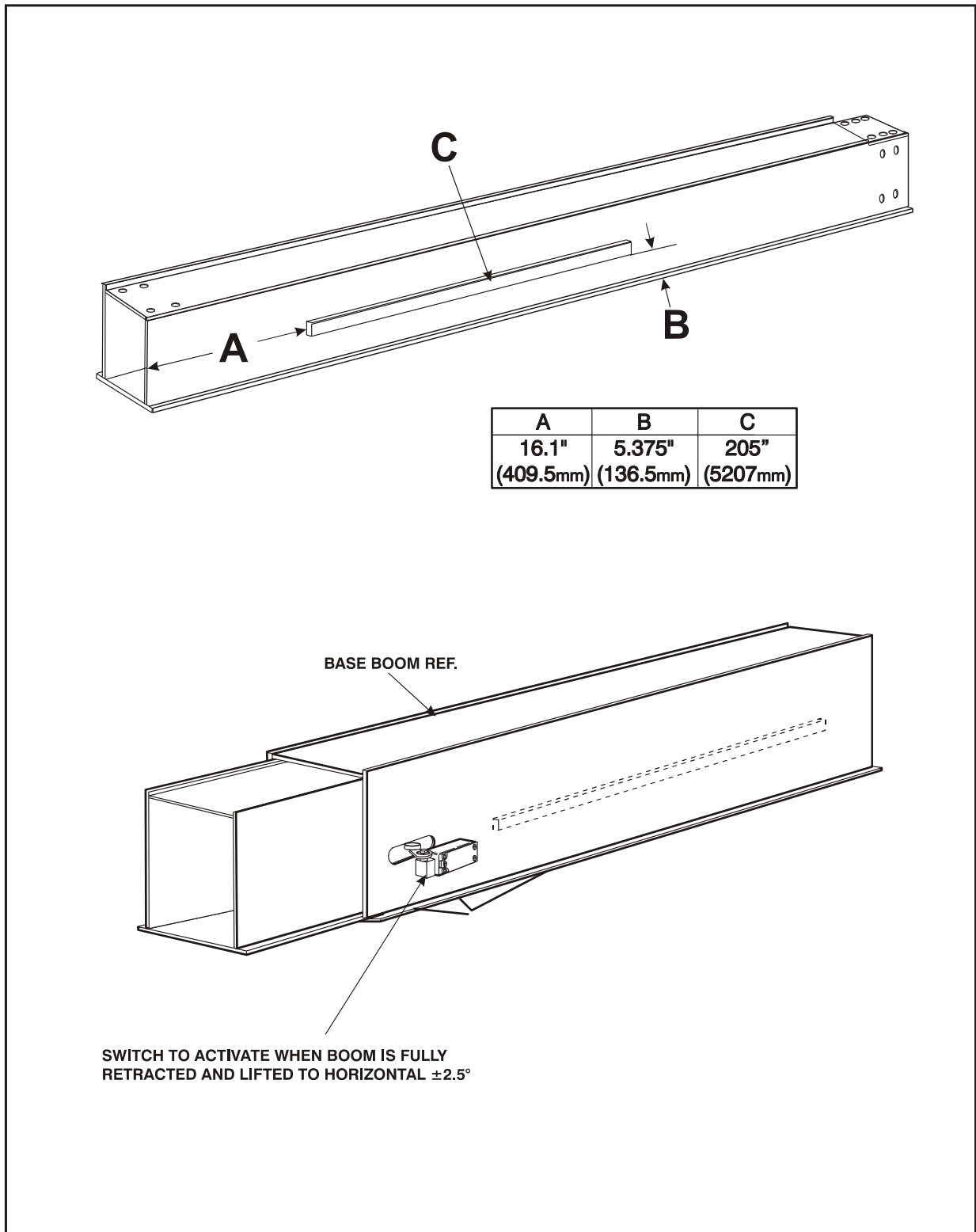


Figure 4-19. Transport Switch Adjustments - CE Machines Only

4.9 PLATFORM

Platform Sections Replacement

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

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

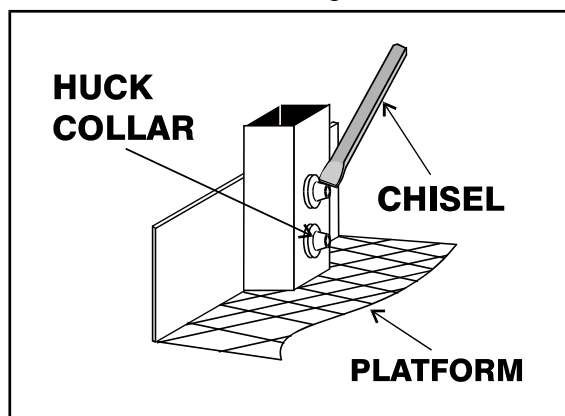


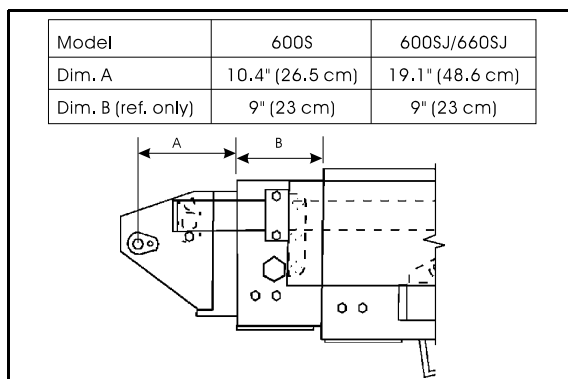
Figure 4-20. Platform Section Replacement

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

4.10 BOOM ROPE TORQUING PROCEDURE

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.

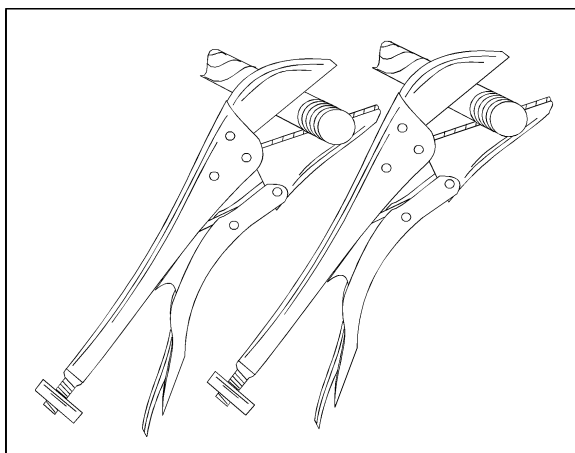


Figure 4-21. Clamping Wire Ropes

3. Install adjusting nuts (or remove nylon collar locknut 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 locknut. Remove all clamping devices and install all cover and guards. Check the boom for proper function.

4.11 WEAR PADS

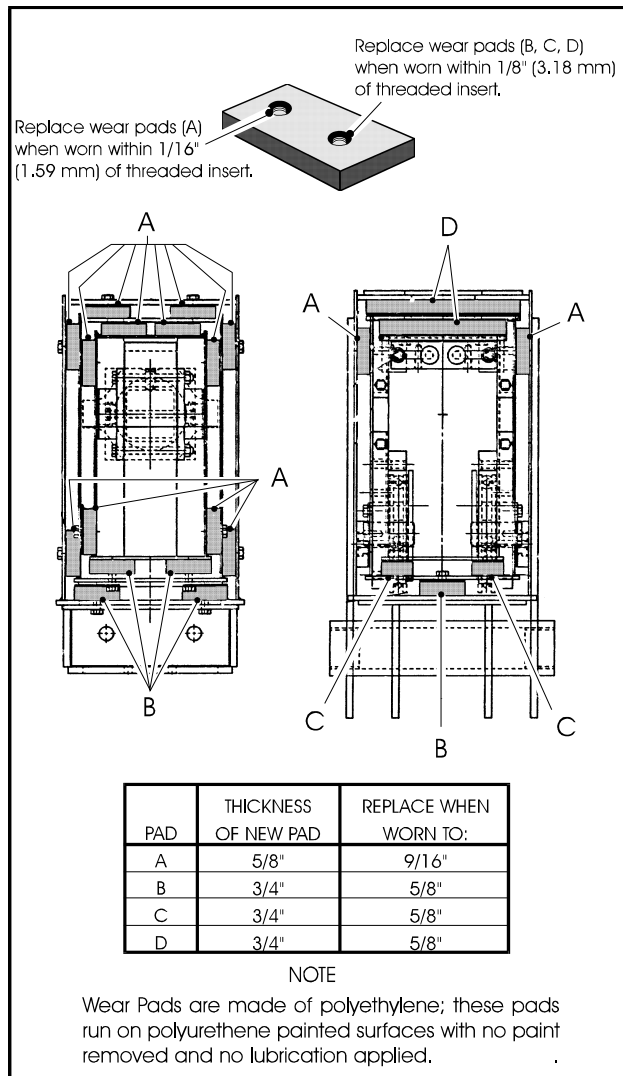


Figure 4-22. Location and Thickness of Wear Pads

Main Boom

1. Shim up wear pads to within 1/32 in. (0.76 mm) tolerance between wear pad and adjacent surface.
2. Replace wear pads when worn within 1/16 in. (1.59 mm) and 1/8 inch (3.18 mm) - B, C, D of threaded insert. See Location and Thickness Of Wear Pads.
3. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
 - a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
 - b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.

4.12 WIRE ROPE

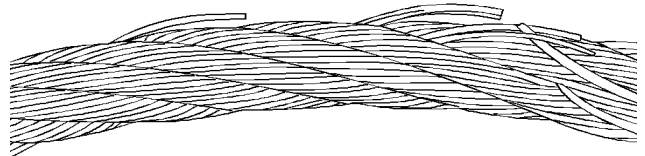
Each day before using the machine:

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

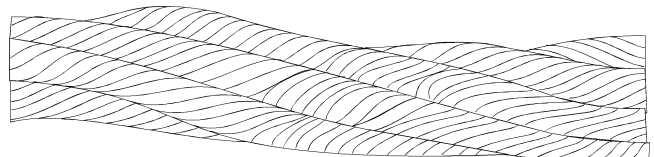
NOTE: The pictures in this paragraph are just samples to show the replacement criteria of the rope.

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



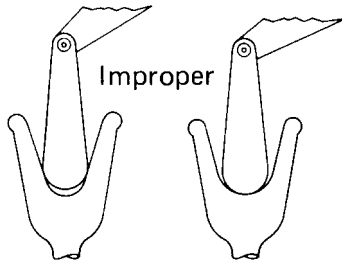
Flexing a wire rope can often expose broken wires hidden in valleys between strands.

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.

12 Year or 7000 Hour 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.

Additional Replacement Criteria

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

4.13 ROTATOR ASSEMBLY

Theory of Operation

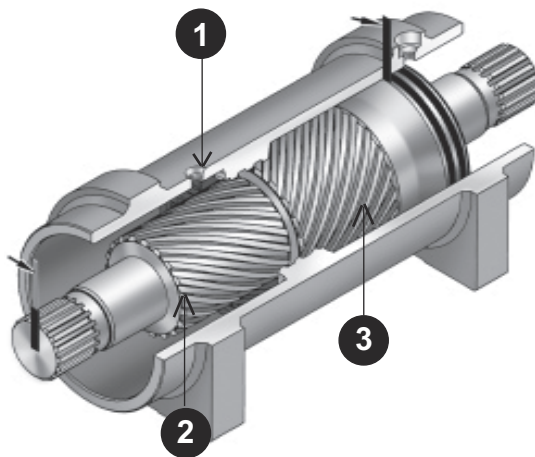
The rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert axial piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear ring (1) and only two moving parts: the central shaft with integrated bearing tube and mounting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

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

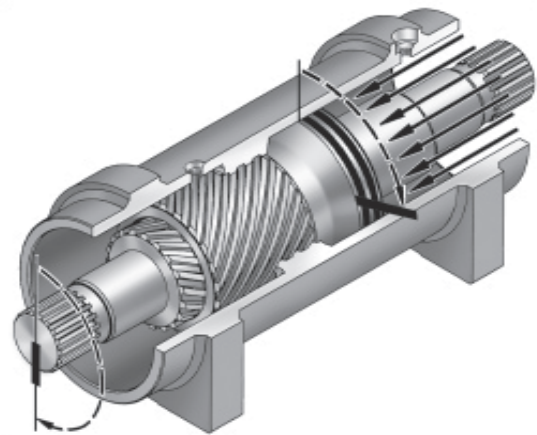
The actuators are equipped with factory installed counterbalance valves, which performs four major functions.

- Protects the actuator in the event of overload
- Enables the actuator to hold position without drifting when external loads are applied
- Reduces hydraulic backlash by pressuring the hydraulic fluid

Provides a constant controlled rate of rotation in over-center load conditions.



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



Applying fluid pressure will displace the piston axially while the helical gearing causes the piston and shaft to rotate simultaneously.

The double helix design compounds rotation: shaft rotation is about twice that of the piston. Applying pressure to the opposite port will return the piston and shaft.

Required Tools

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



1. PIPE VISE
2. HEX WRENCH - Removal and replacement of port plugs and setscrews.
3. ASSORTED SCREWS
4. SAFETY GLASSES
5. END CAP REMOVAL TOOLS (provided with Helac seal kit).
6. DRILL
7. FLASHLIGHT - Helps to locate and examine timing marks, component failure and overall condition.
8. RUBBER Mallet - Removal and installation of shaft and piston sleeve assembly.
9. PLASTIC MANDREL
10. PRY BAR - Removal of end cap and manual rotation of shaft.
11. FELT MARKER - Highlights the timing marks and outline troubled areas.
12. T-HANDLE SCREW EXTRACTOR
13. HEX WRENCH SET - Removal and replacement of port plugs and setscrews (106 & 110).
14. SEAL TOOLS - Removal and installation of seals and wear guides. Directions to make a seal tool are provided below Making a Seal Tool.
15. PUNCH
16. DOWEL PINS - Removal and installation of end cap.

Making a Seal Tool

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

CAUTION

TO AVOID INJURY BE CAREFUL WHILE HANDLING THE HOT SCREWDRIVER.

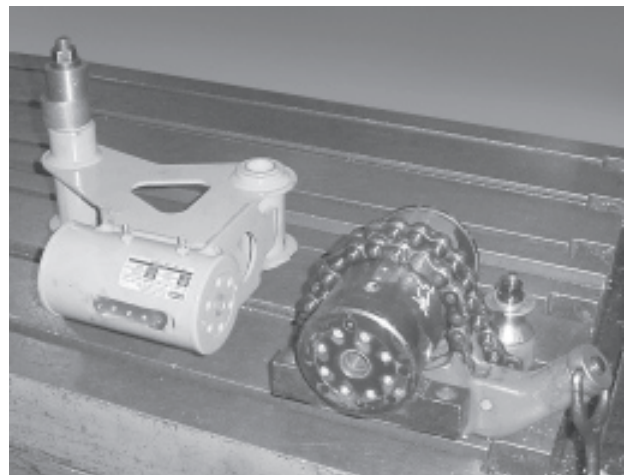
1. Heat the flat end with a torch until it glows.
2. Secure the heated end of the screwdriver in a vise and bend the heated end to a slight radius.
3. Round off all sharp edges of the heated to a polished finish. The tool may be modified slightly to your own personal preference. To avoid injury be careful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



Before Disassembly

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

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



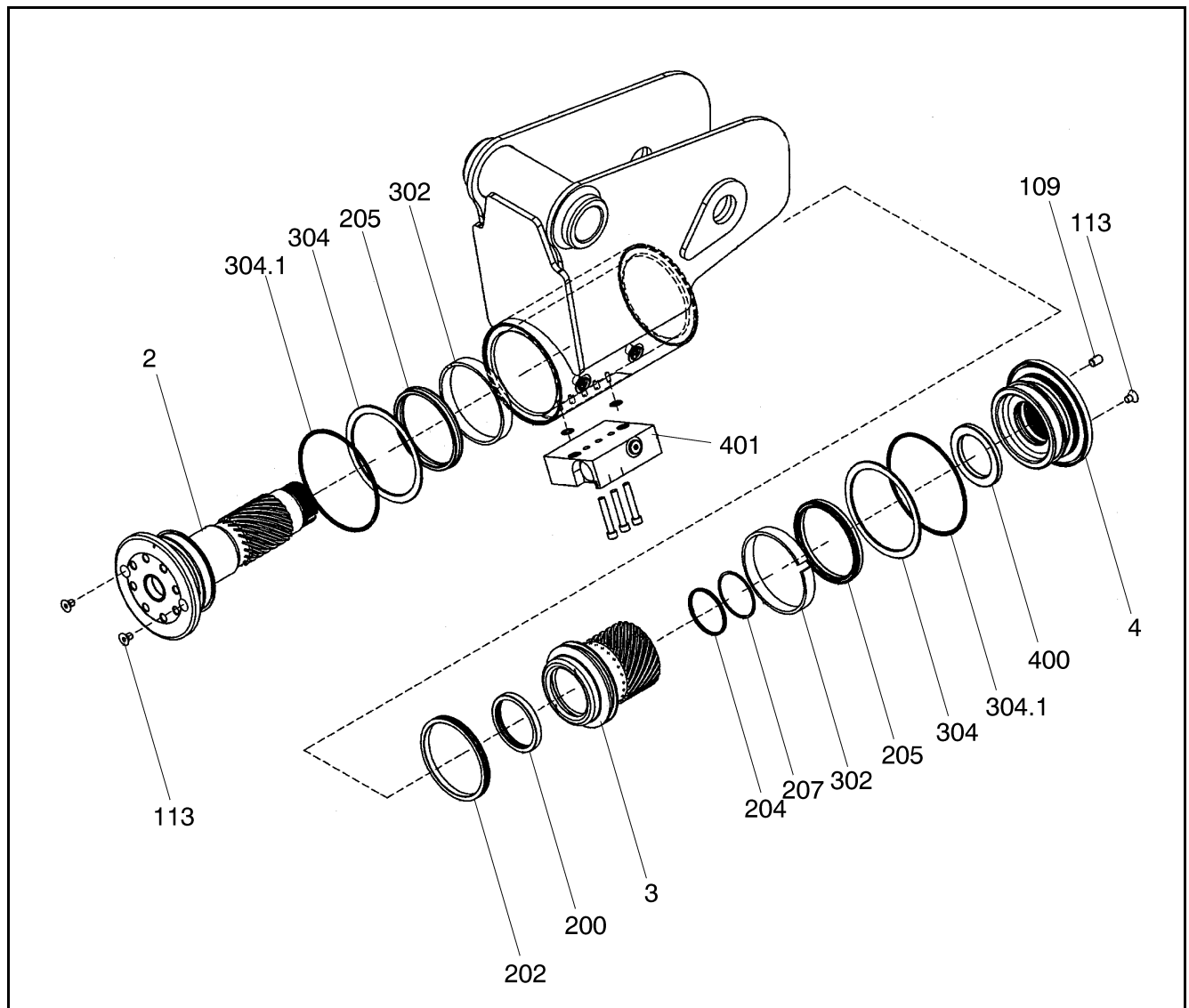
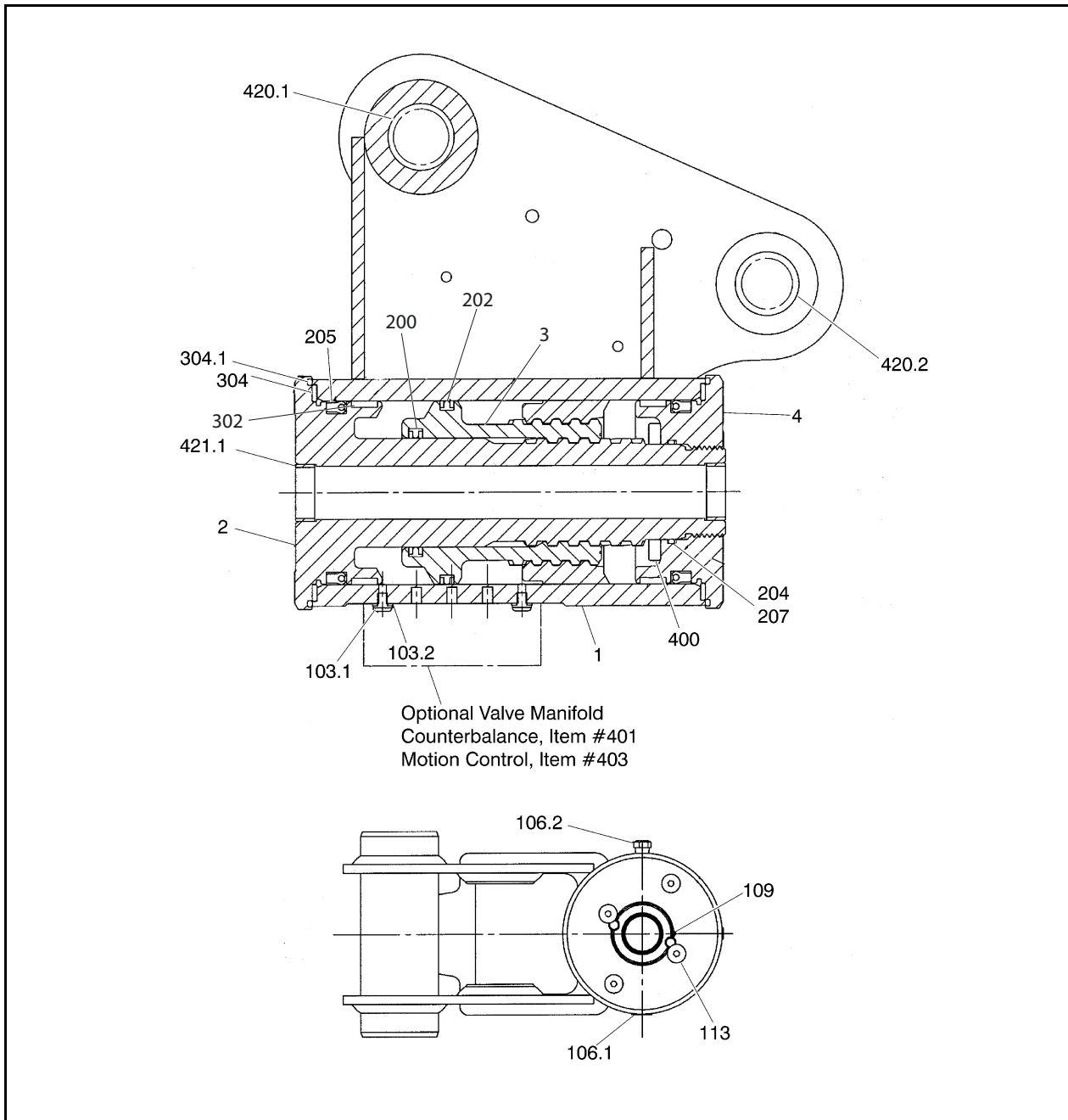


Figure 4-23. Rotary Actuator (Exploded View)



- | | | |
|--------------------------|------------------|---------------------------|
| 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 4-24. Rotary Actuator (Cutaway View)

Disassembly

⚠ CAUTION

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

⚠ CAUTION

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

NOTICE

MAKE SURE WORK AREA IS CLEAN.

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



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



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

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



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



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



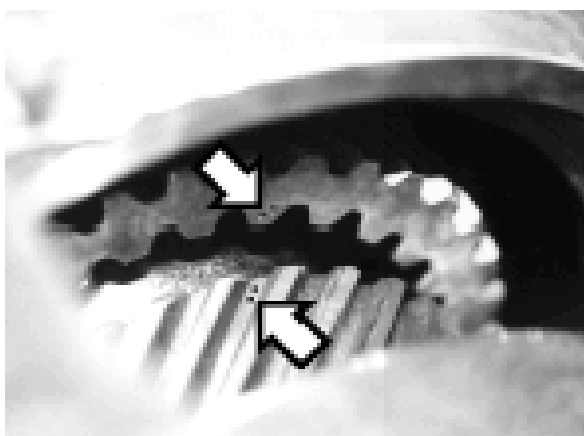
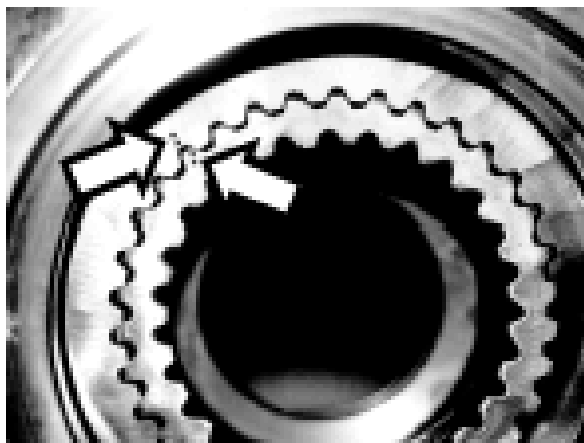
7. Remove the end cap (4) and set aside for later inspection.



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



9. Every actuator has timing marks for proper engagement.



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



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



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



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



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



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



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



SECTION 4 - BOOM & PLATFORM

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



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



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



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



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



Inspection

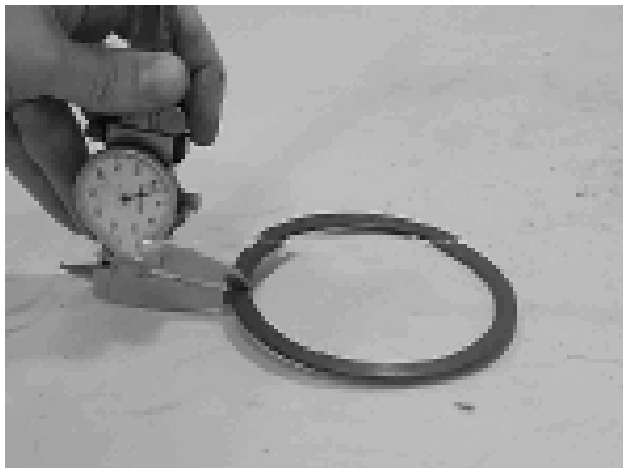
NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

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



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



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



Assembly

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



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



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



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



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



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



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

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

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



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

Repeat this step for the outer seal (202).



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

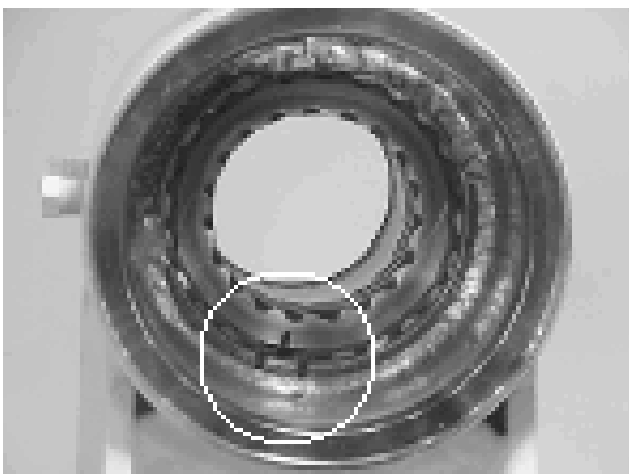


SECTION 4 - BOOM & PLATFORM

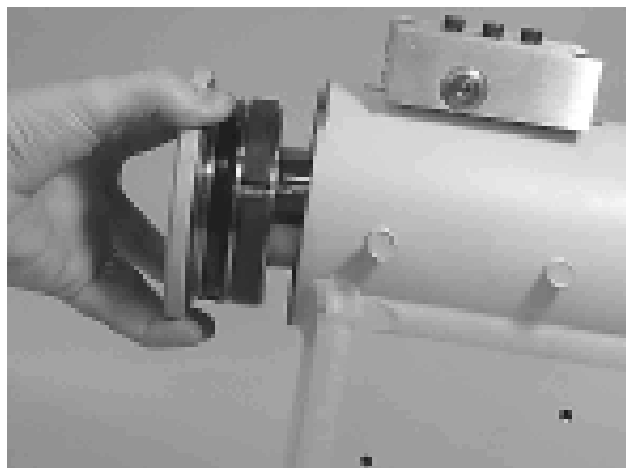
9. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



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



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



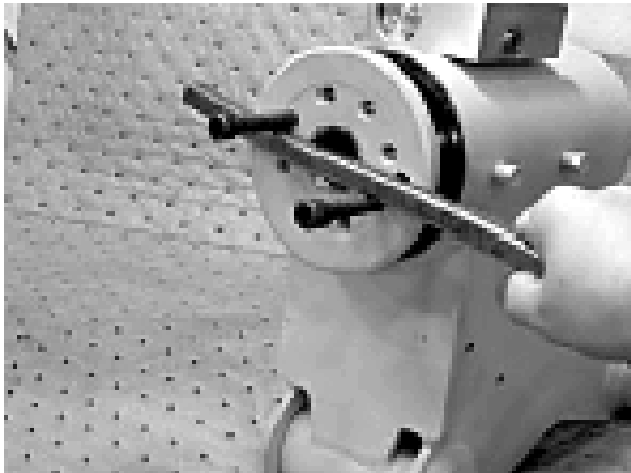
12. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



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

NOTICE

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



14. Install the stop tube (400) onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.



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

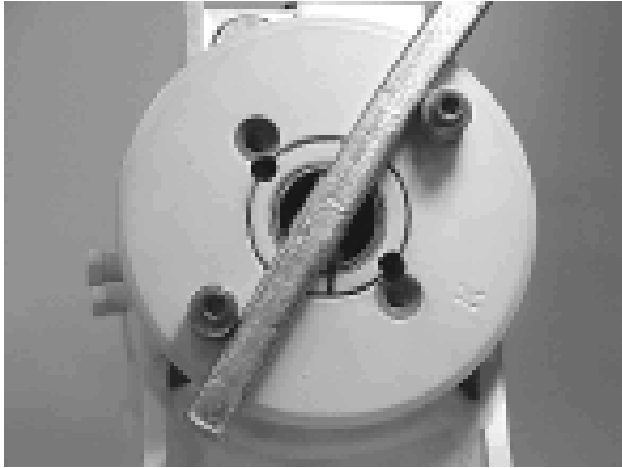


16. Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide remains in place on the end cap as it is threaded into the housing (1).



SECTION 4 - BOOM & PLATFORM

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



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



- 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.



Installing Counterbalance Valve

Refer to Figure 4-25., Rotator Counterbalance Valve.

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

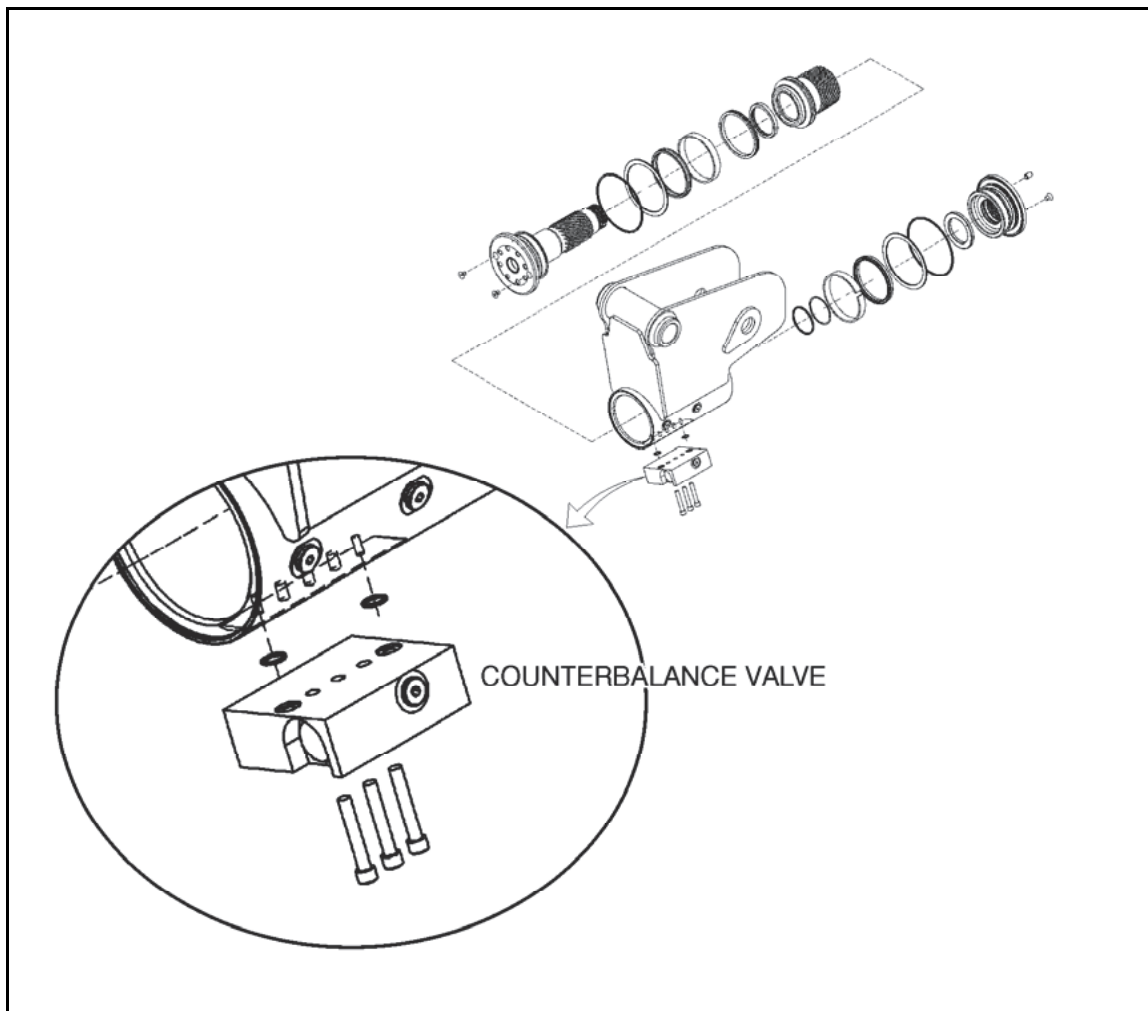


Figure 4-25. Rotator Counterbalance Valve

Greasing Thrust Washers

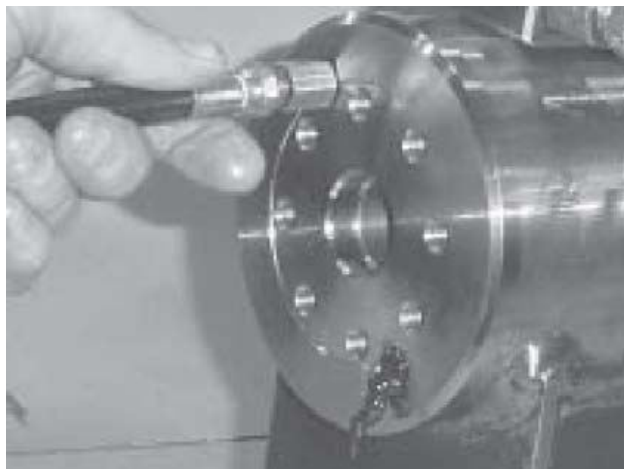
1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.
2. There are two grease ports located on both the shaft flange and the end cap. They are plugged with cap screws (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view).



NOTICE

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

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



Testing the Actuator

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

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

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

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

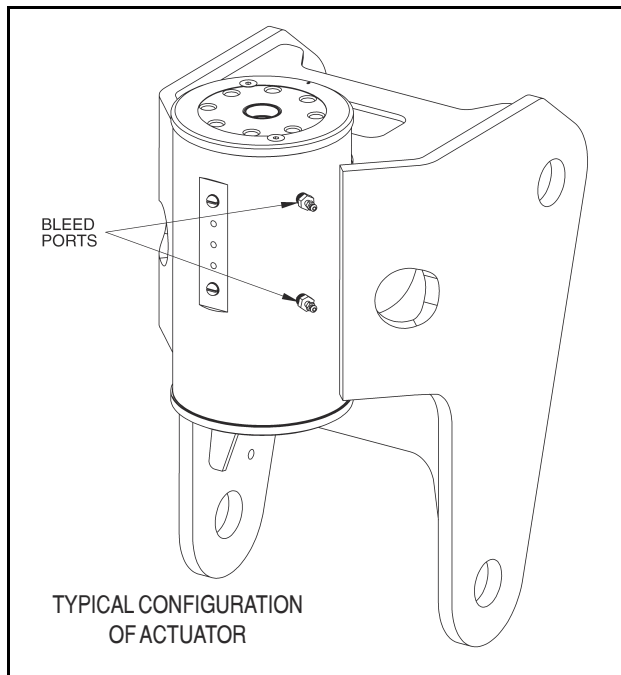
Installation and Bleeding

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

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

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

1. Connect a 3/16 in. inside diameter x 5/16 in. outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure them with hose clamps. Place the vinyl tubes in a clean 5-gallon container to collect the purged oil. The oil can be returned to the reservoir after this procedure is completed.
2. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate the platform to the end of rotation (either clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow a 1/2 gallon of fluid to be purged from the actuator.
3. Keep the fittings open and rotate the platform in the opposite direction to the end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.
4. Repeat steps 2 & 3. After the last 1/2 gallon is purged, close both bleed nipples before rotating away from the end position.



Troubleshooting

Table 4-1. Troubleshooting

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

4.14 FOOT SWITCH ADJUSTMENT

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

SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

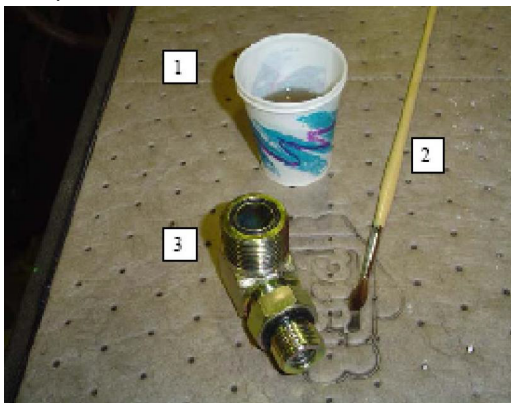
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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

Cup and Brush

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

- A small container for hydraulic oil
- Small paint brush



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



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



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



Dip Method

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

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

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



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



Spray Method

This method requires a pump or trigger spray bottle.

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



Brush-on Method

This method requires a sealed bottle brush.

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



5.2 CYLINDERS - THEORY OF OPERATION

Systems Incorporating Double Acting Cylinders

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

Systems Incorporating Holding Valves

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

5.3 CYLINDER CHECKING PROCEDURE

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

Cylinders Without Counterbalance Valves - Master Cylinder and Steer Cylinder

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

7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, then activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.

Cylinders With Single Counterbalance Valve

(Main Lift Cylinder)

NOTICE

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

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

⚠ WARNING

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

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

Cylinders With Dual Counterbalance Valves

(Articulating Jib Boom Lift, Slave Level and Main Telescope.)

NOTICE

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

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

⚠ WARNING

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

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with bang-bang or proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.

3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the counterbalance valve is defective and must be replaced.
4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.
5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.
6. If used, remove lifting device from upright or remove prop from below main boom, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

5.4 HYDRAULIC CYLINDERS

Axle Lockout Cylinder (USA Built Machines, SN 0300087000 through 0300089728)

DISASSEMBLY

NOTICE

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

⚠ WARNING

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

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

CLEANING AND INSPECTION

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

ASSEMBLY

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

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

NOTICE

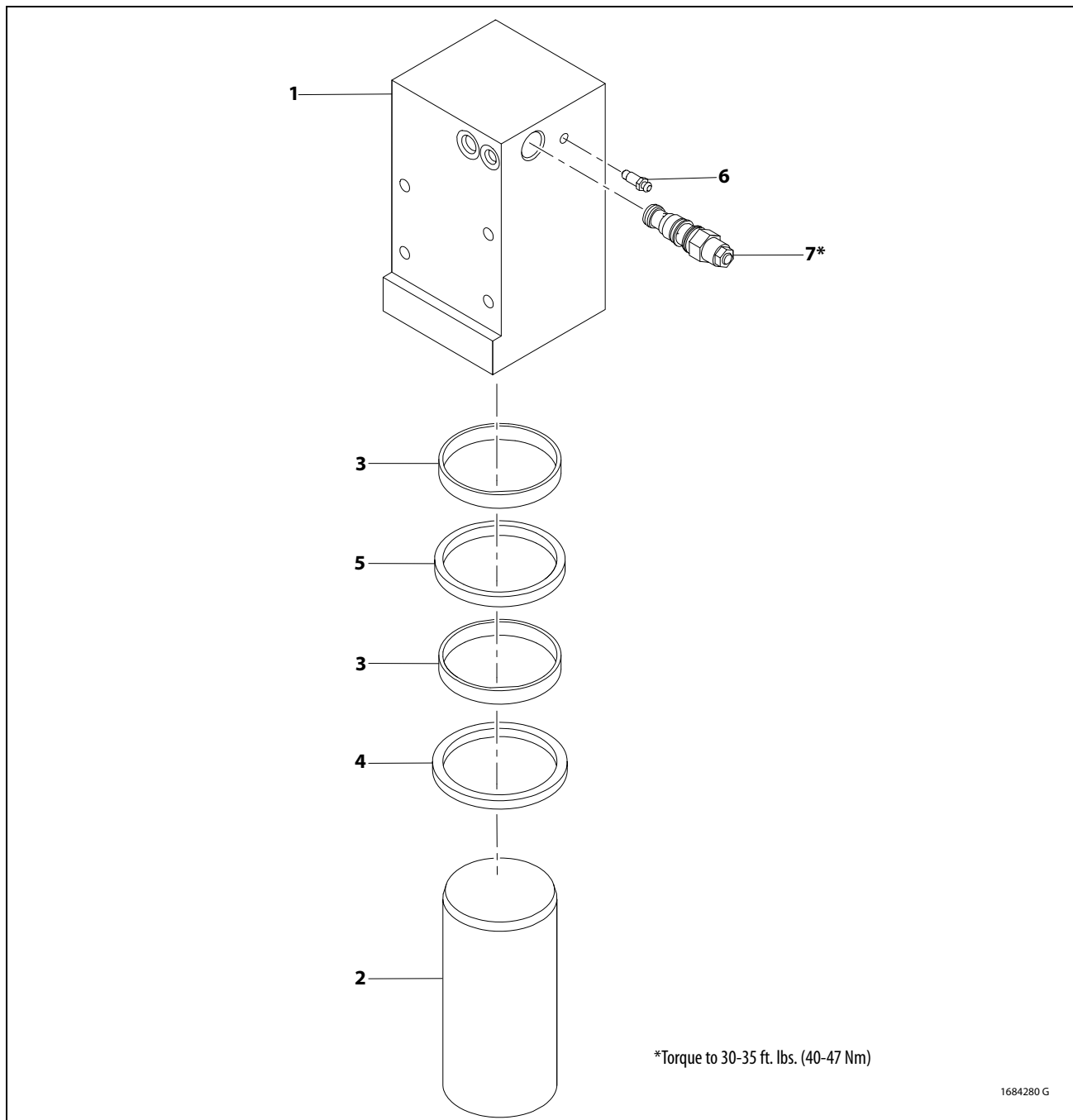
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

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

NOTICE

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

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



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

Figure 5-1. Axle Lockout Cylinder (USA Built Machines, SN 0300087000 through 0300089728)

Axle Lockout Cylinder (USA Built Machines SN 0300089729 through 0300171769 and China Built Machines, SN B300000100 through B300000969)

DISASSEMBLY

NOTICE

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

⚠ WARNING

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

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

CLEANING AND INSPECTION

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

ASSEMBLY

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

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

NOTICE

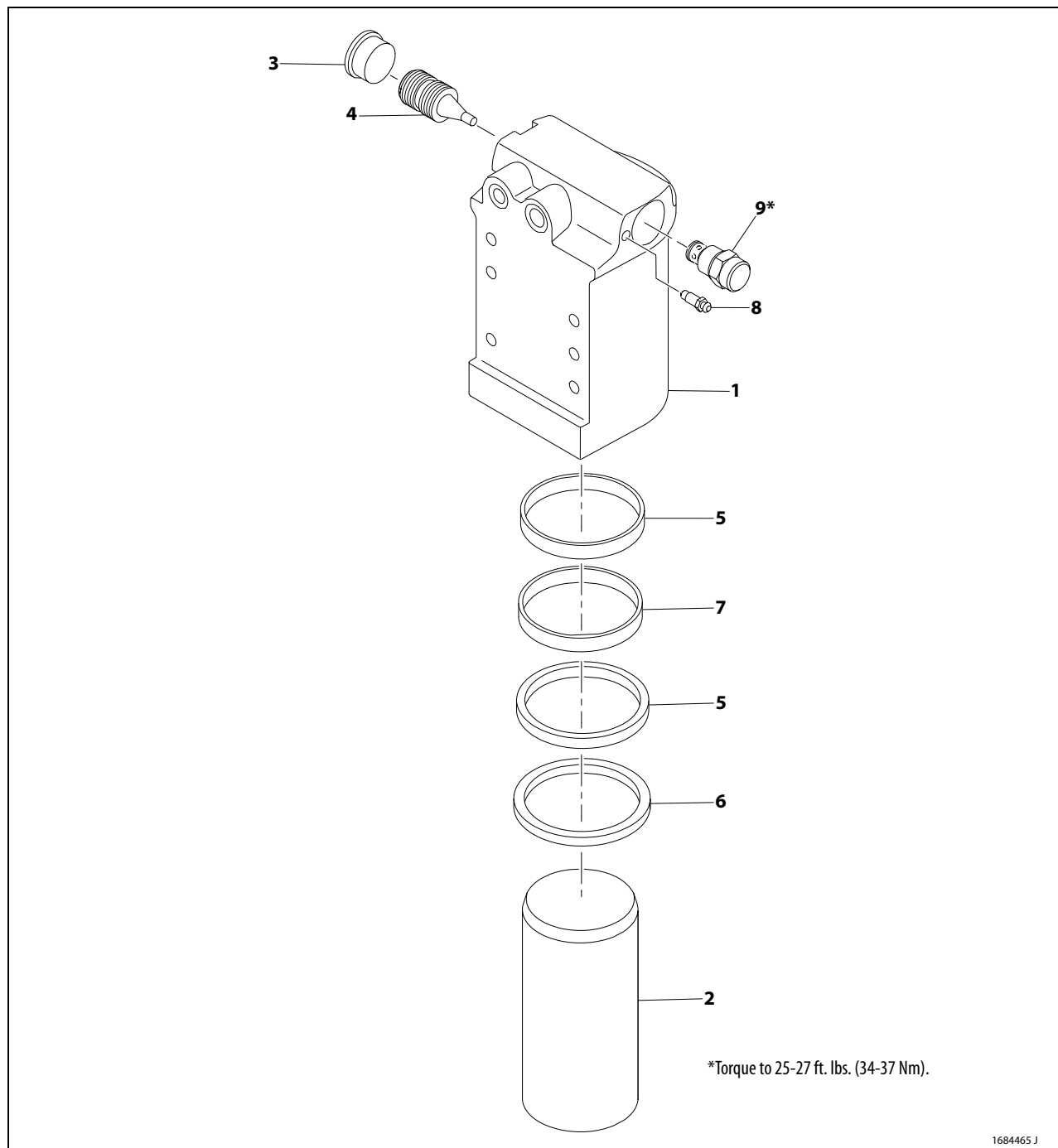
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

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

NOTICE

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

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



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

Figure 5-2. Axle Lockout Cylinder (USA Built Machines, SN 0300089729 through 0300171769 and China Built Machines, SN B300000100 through B300000969)

Platform Level Cylinder

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

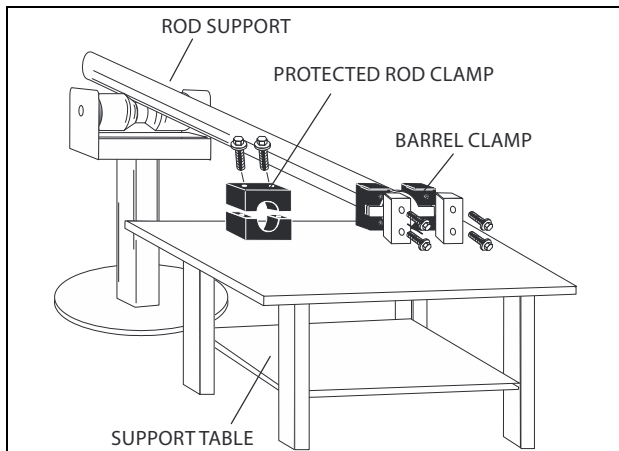


Figure 5-3. Cylinder Barrel Support

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

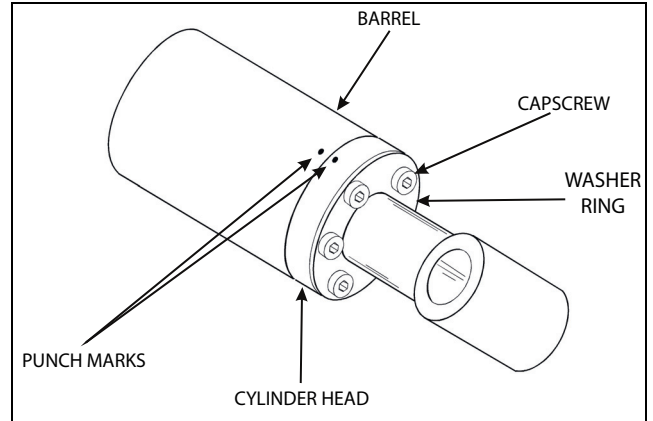


Figure 5-4. Capscrew Removal

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

NOTICE

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

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

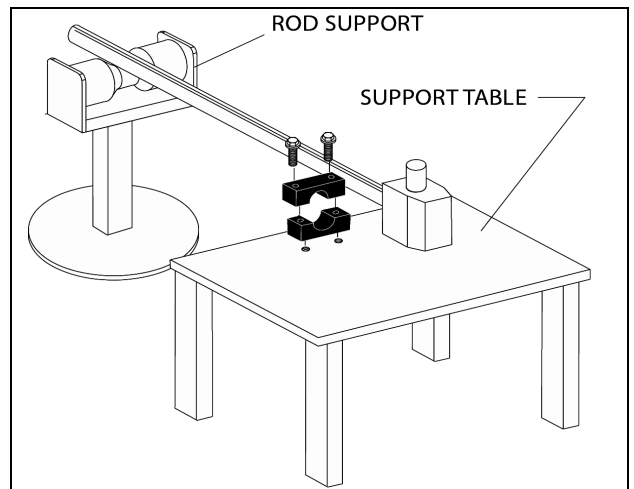
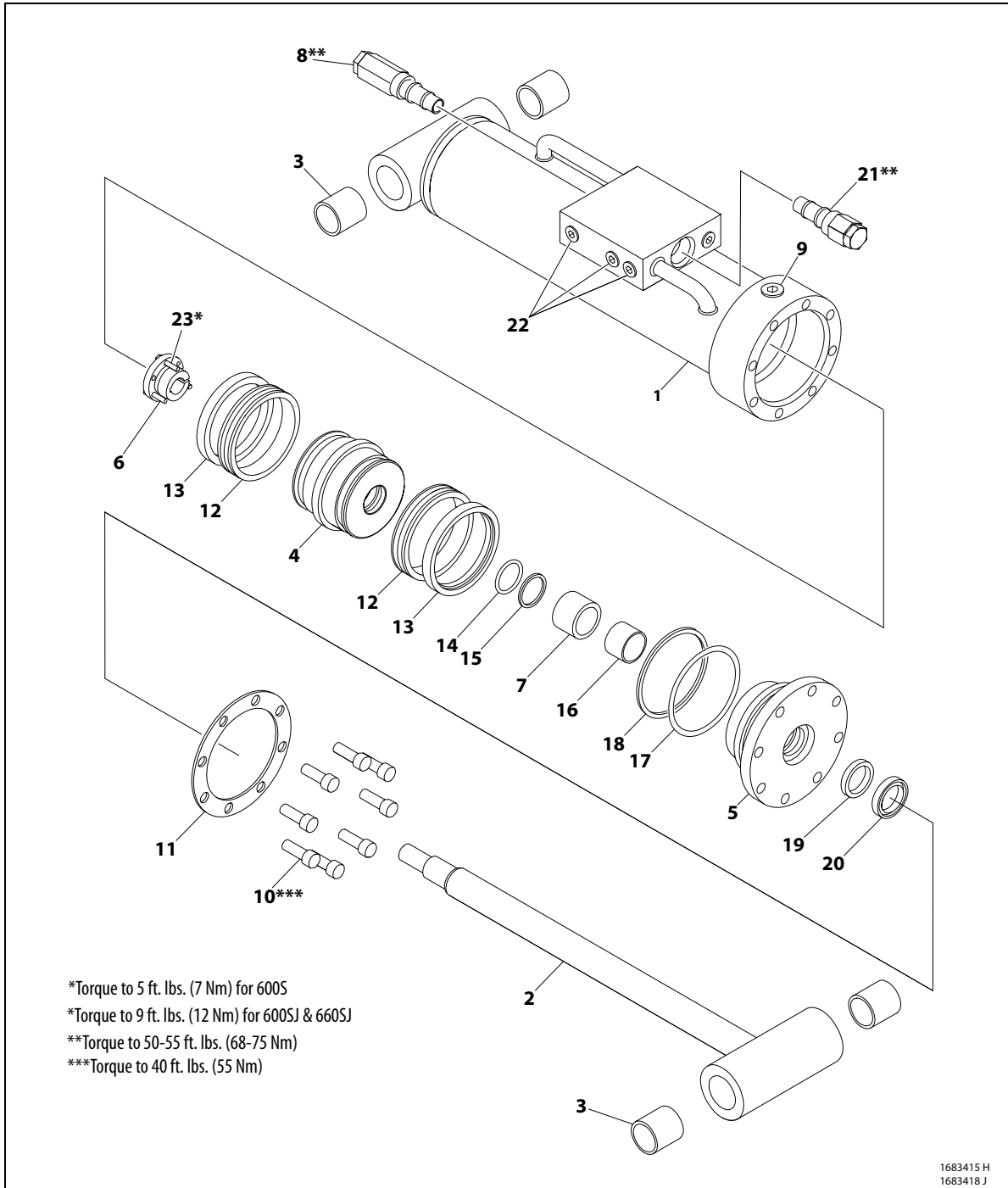


Figure 5-5. Cylinder Rod Support



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

Figure 5-6. Platform Level Cylinder

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

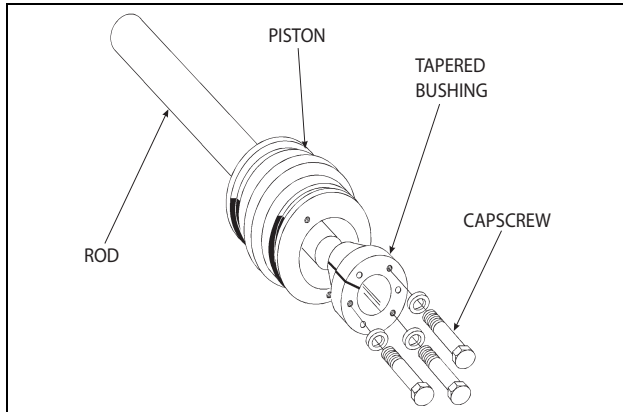


Figure 5-7. Tapered Bushing Removal

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

CLEANING AND INSPECTION

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

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

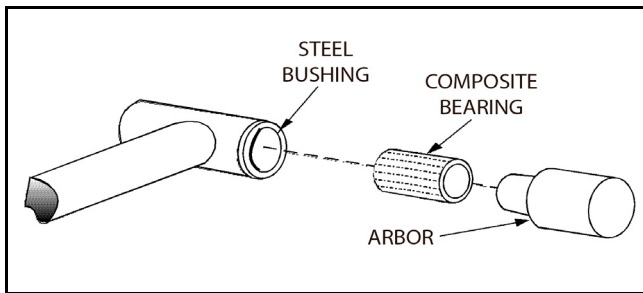


Figure 5-8. Composite Bearing Installation

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

ASSEMBLY

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

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

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

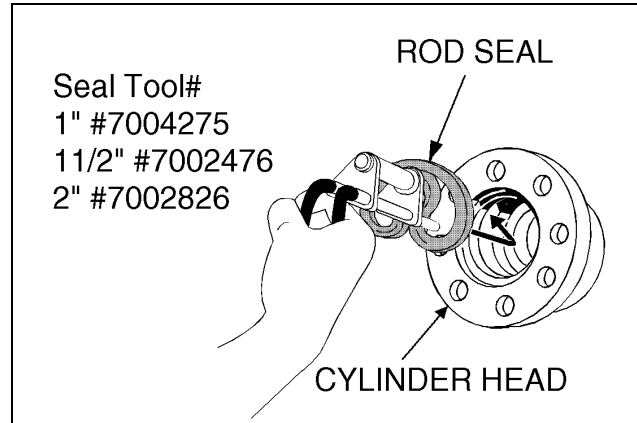


Figure 5-9. Rod Seal Installation

NOTICE

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

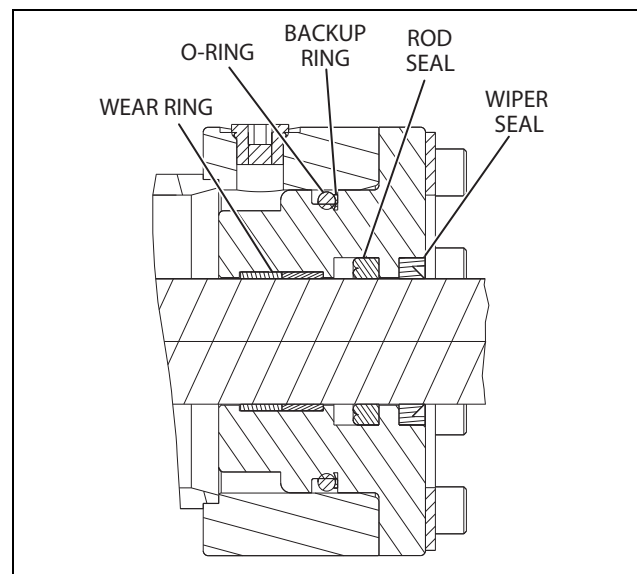


Figure 5-10. Cylinder Head Seal Installation

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.

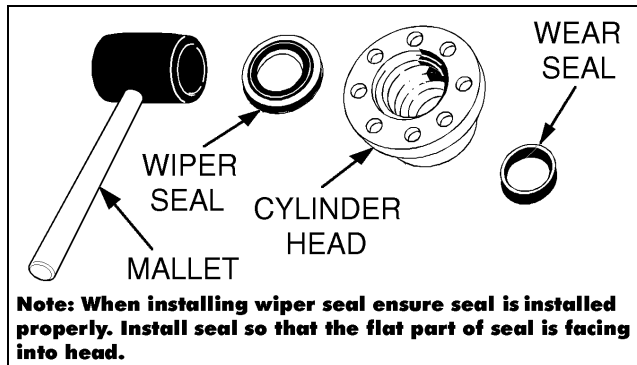


Figure 5-11. Wiper Seal Installation

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

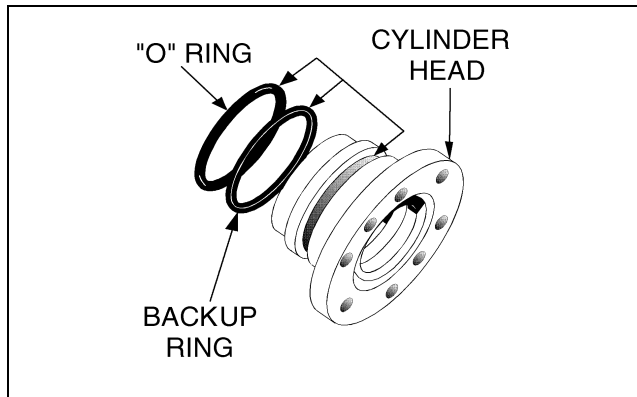


Figure 5-12. Installation of Head Seal Kit

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

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

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

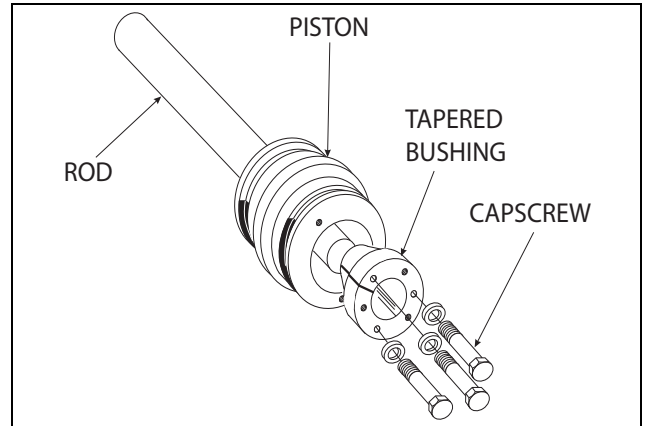


Figure 5-13. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm) for 600S and 9 ft. lbs. (12 Nm) for 600SJ and 660SJ.
12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4 in. in diameter) as follows:
 - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
 - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

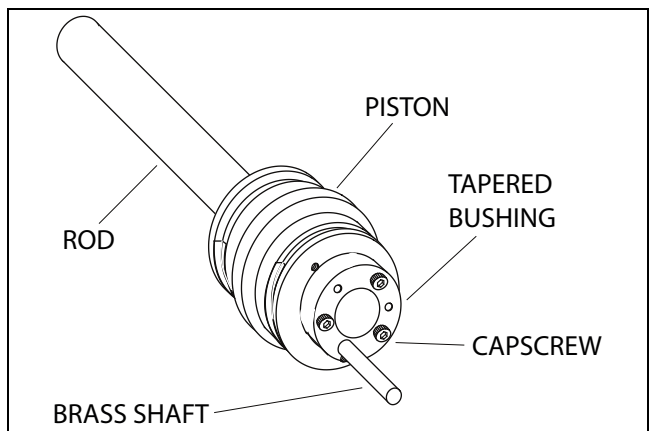


Figure 5-14. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm) for 600S and 9 ft. lbs. (12 Nm) for 600SJ and 660SJ.
14. Remove the cylinder rod from the holding fixture.

NOTICE

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

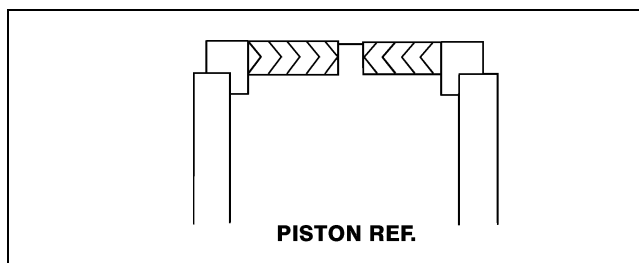


Figure 5-15. Hydrolock Piston Seal Installation

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

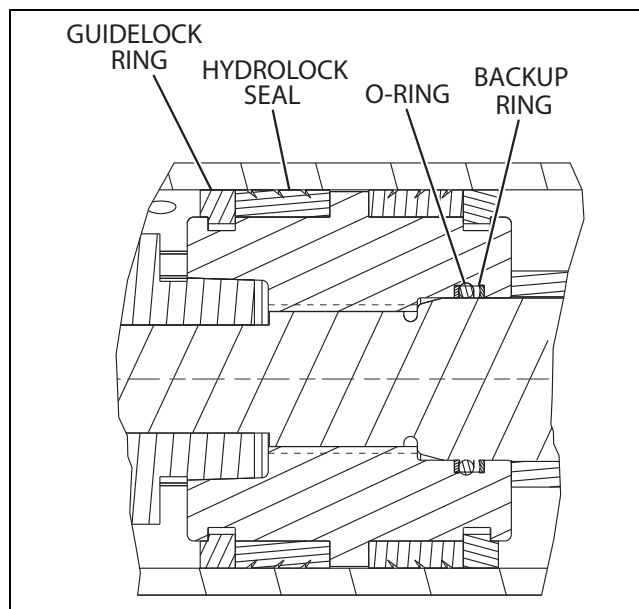


Figure 5-16. Piston Seal Kit Installation

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

NOTICE

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

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals and guidelock rings are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

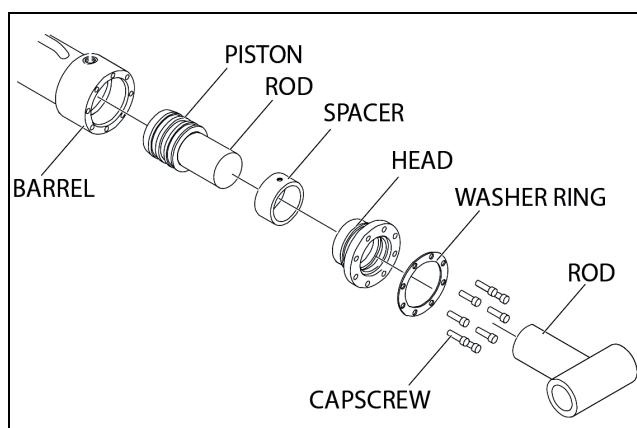


Figure 5-17. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head capscrews and secure the cylinder head gland using the washer ring and capscrews. Torque capscrews to 40 ft. lbs. (55 Nm).
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
21. If applicable, install the counterbalance valves and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Jib Lift Cylinder (600SJ/660SJ)

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

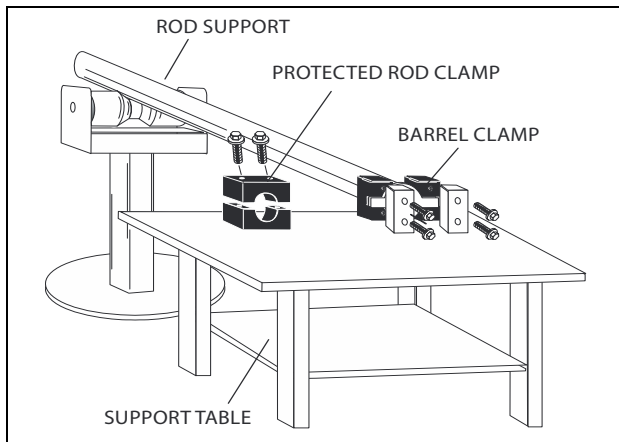


Figure 5-18. Cylinder Barrel Support

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

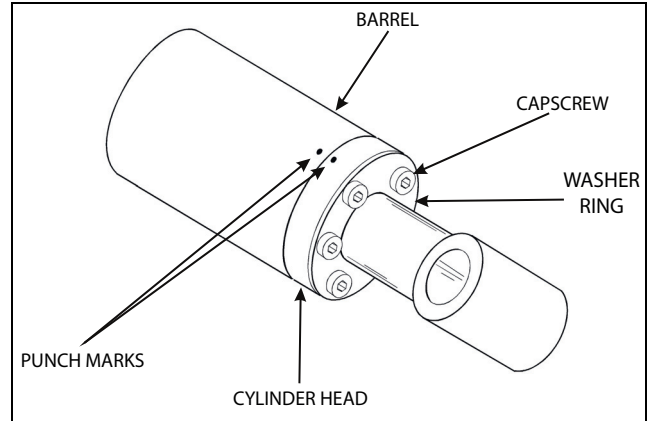


Figure 5-19. Capscrew Removal

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

NOTICE

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

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

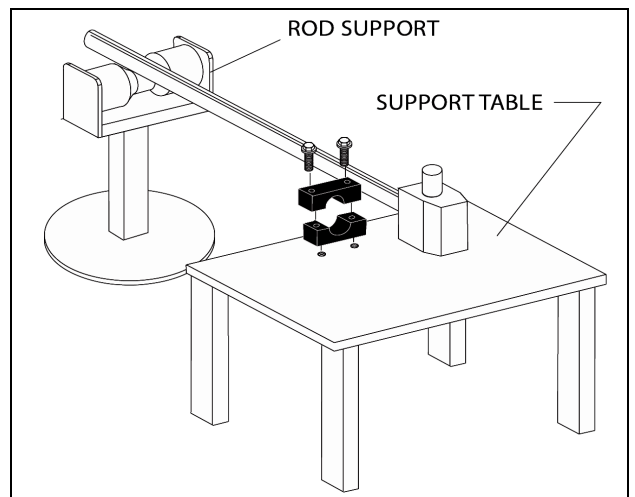
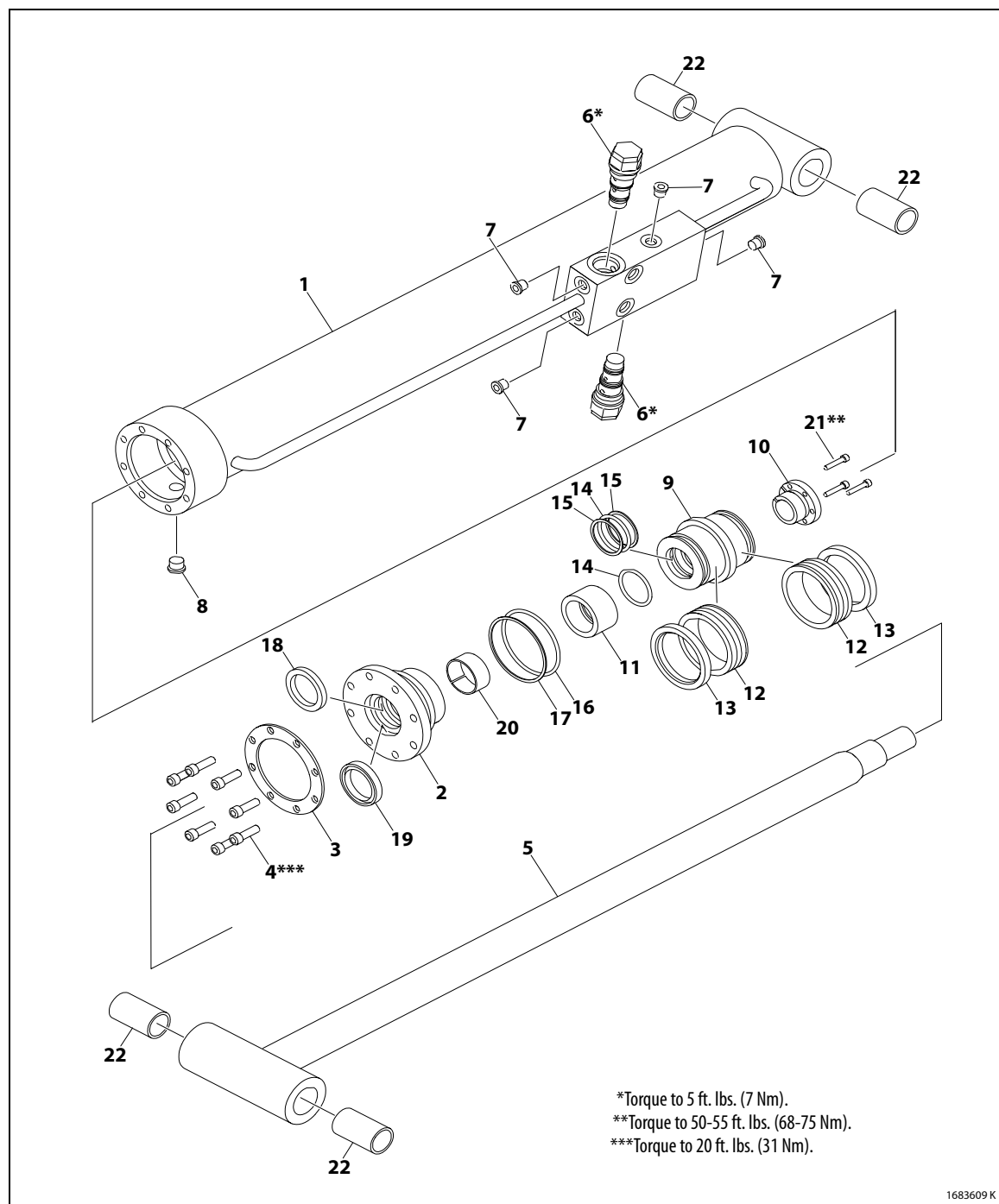


Figure 5-20. Cylinder Rod Support



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

Figure 5-21. Jib Lift Cylinder (600SJ/660SJ)

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

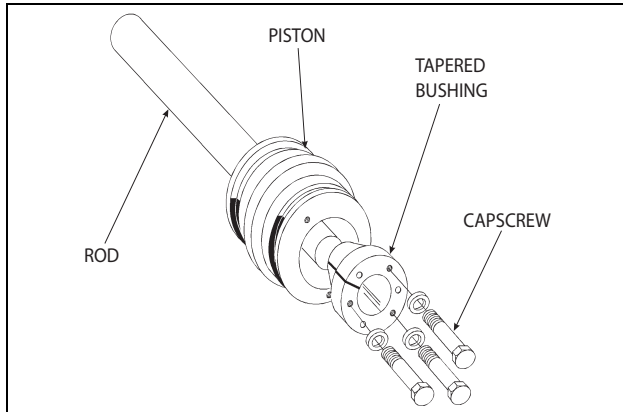


Figure 5-22. Tapered Bushing Removal

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

CLEANING AND INSPECTION

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

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

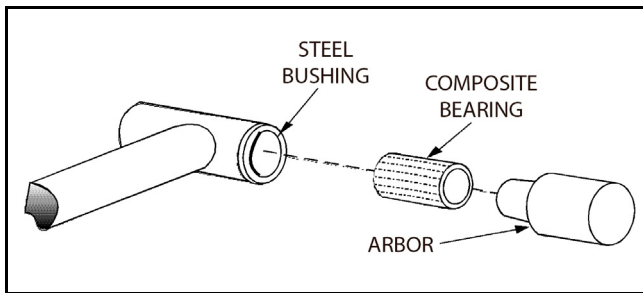


Figure 5-23. Composite Bearing Installation

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

ASSEMBLY

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

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

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

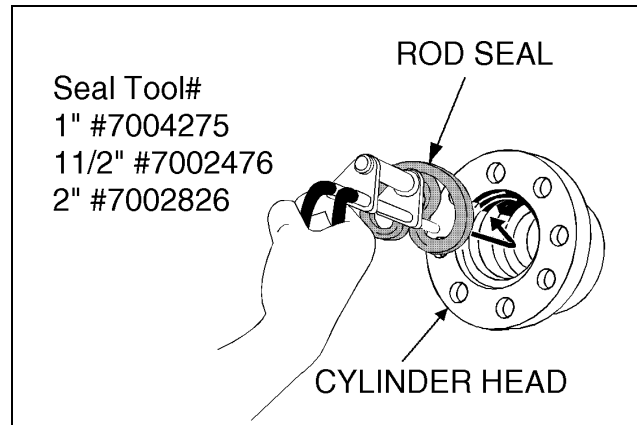


Figure 5-24. Rod Seal Installation

NOTICE

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

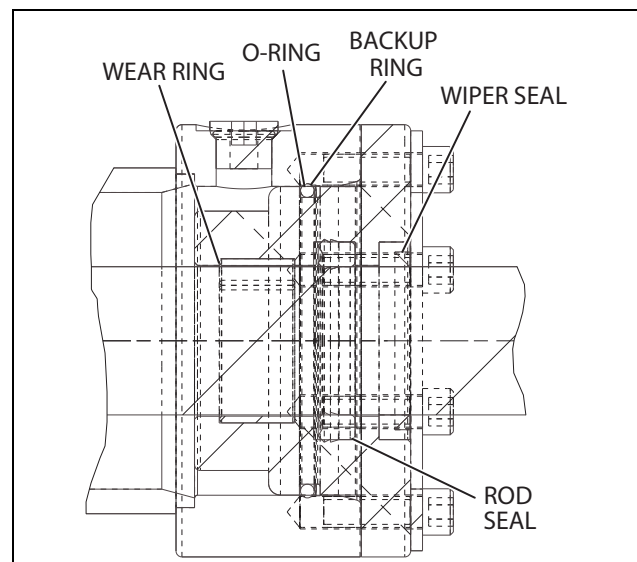


Figure 5-25. Cylinder Head Seal Installation

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

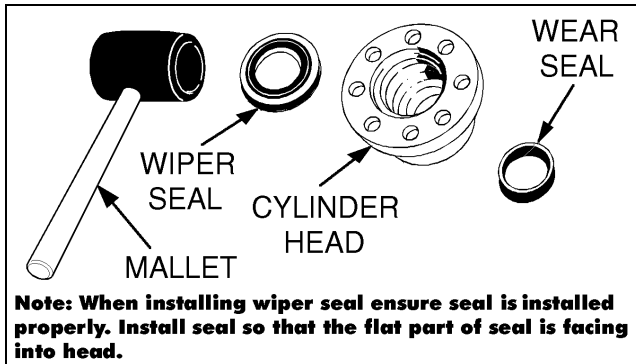


Figure 5-26. Wiper Seal Installation

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

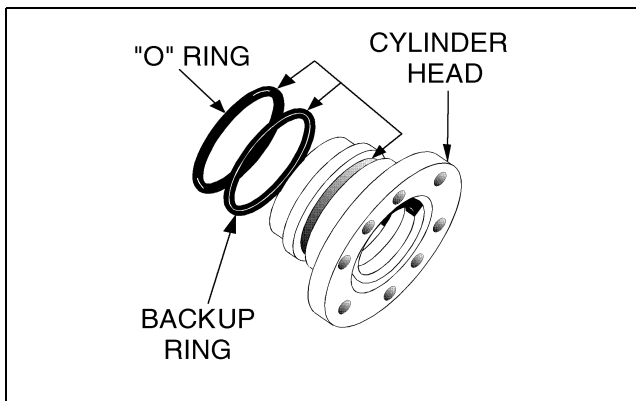


Figure 5-27. Installation of Head Seal Kit

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

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

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

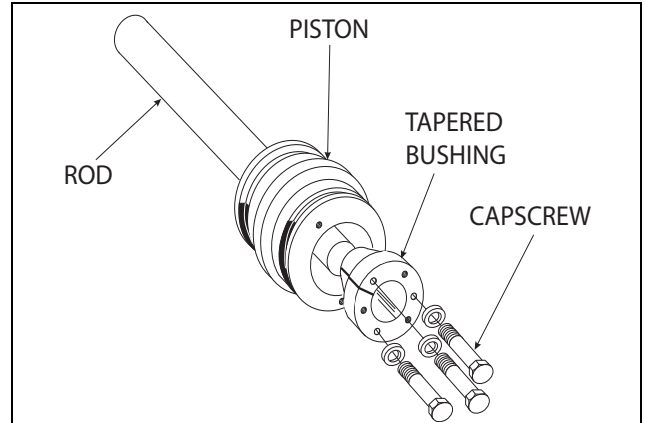


Figure 5-28. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm).
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4 in. in diameter) as follows:
 - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
 - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

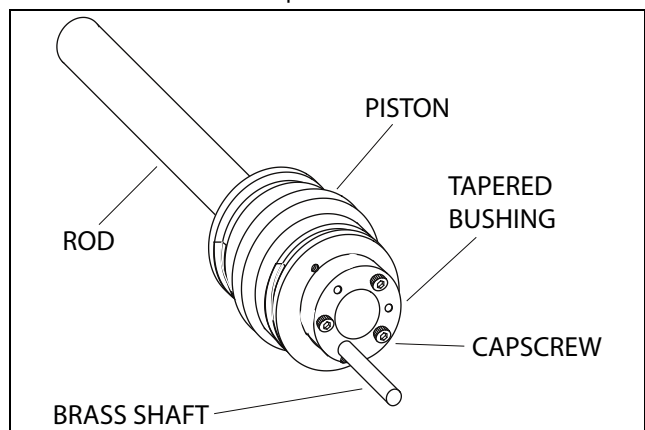


Figure 5-29. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm).
15. Remove the cylinder rod from the holding fixture.

NOTICE

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

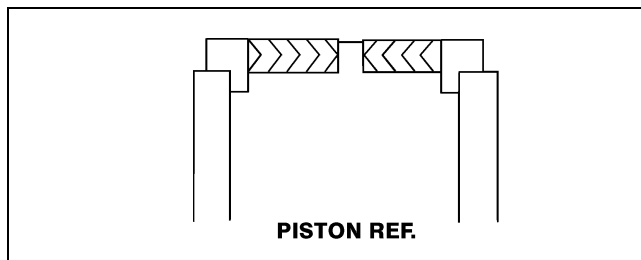


Figure 5-30. Hydrolock Piston Seal Installation

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

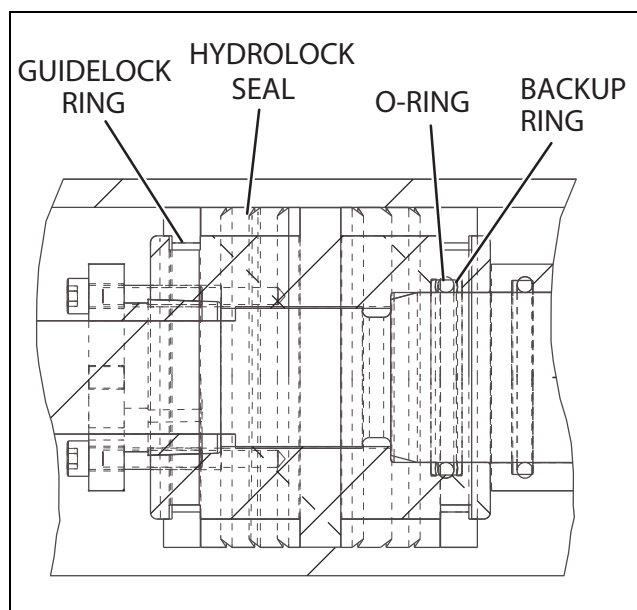


Figure 5-31. Piston Seal Kit Installation

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

NOTICE

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

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

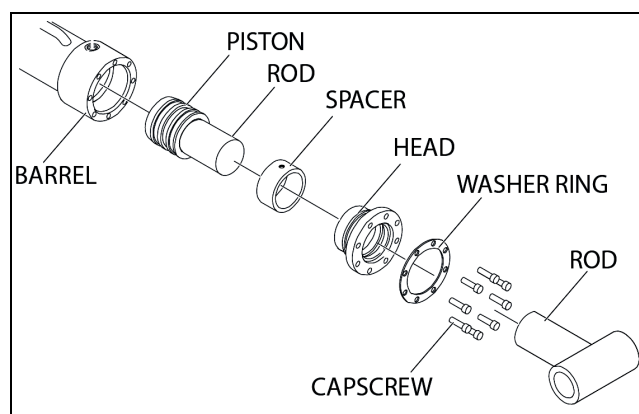


Figure 5-32. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head capscrews and secure the cylinder head gland using the washer ring and capscrews. Torque capscrews to 20 ft. lbs. (27 Nm).
21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.
22. If applicable, install the counterbalance valves and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Main Boom Lift Cylinder

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

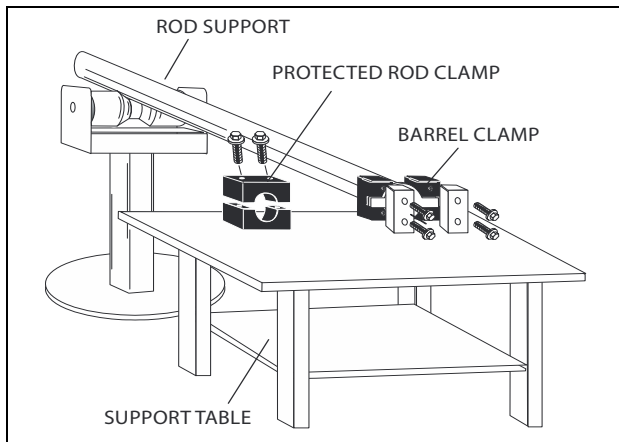


Figure 5-33. Cylinder Barrel Support

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

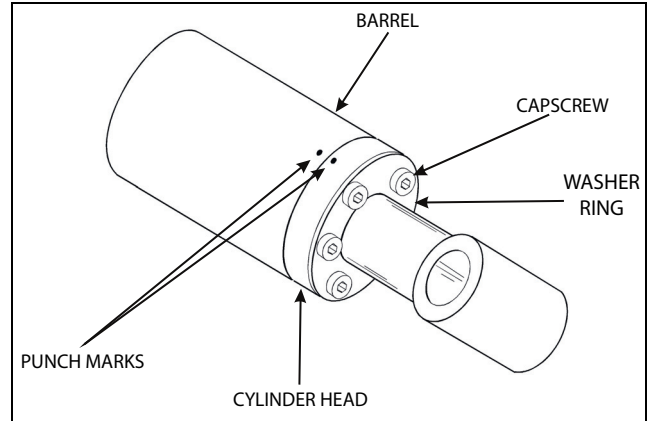


Figure 5-34. Capscrew Removal

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

NOTICE

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

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

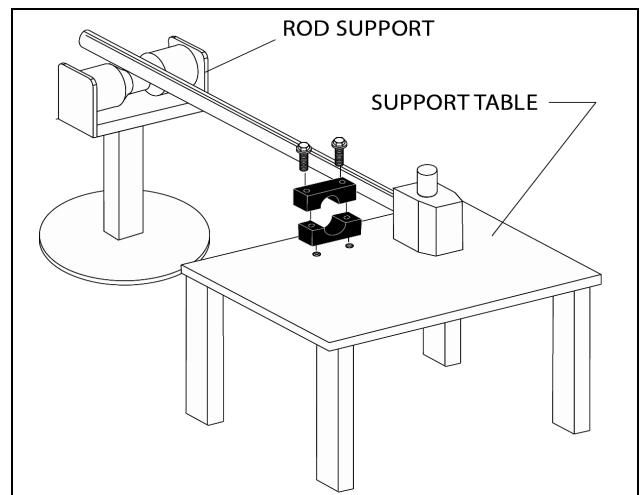
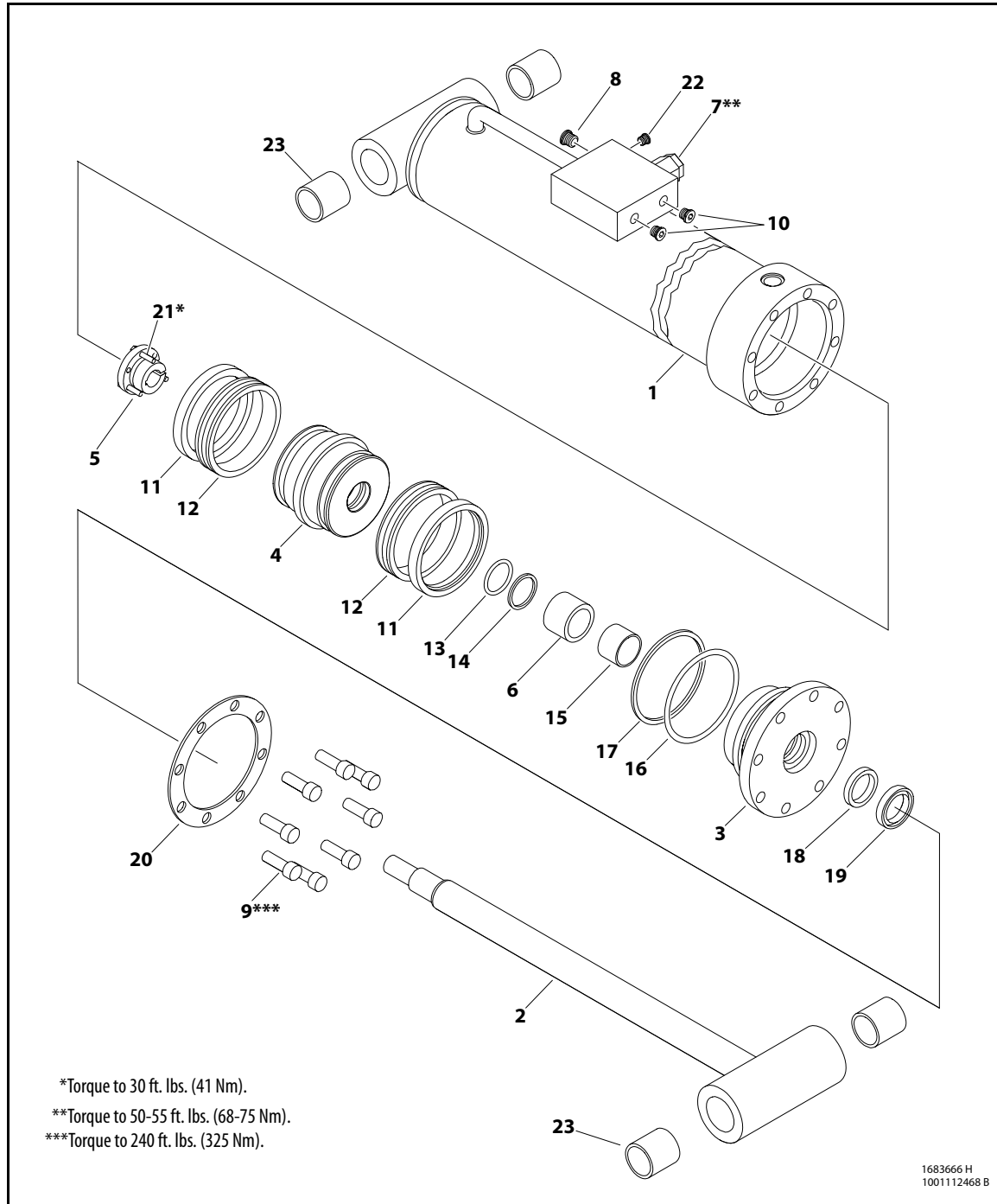


Figure 5-35. Cylinder Rod Support



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

Figure 5-36. Main Boom Lift Cylinder

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

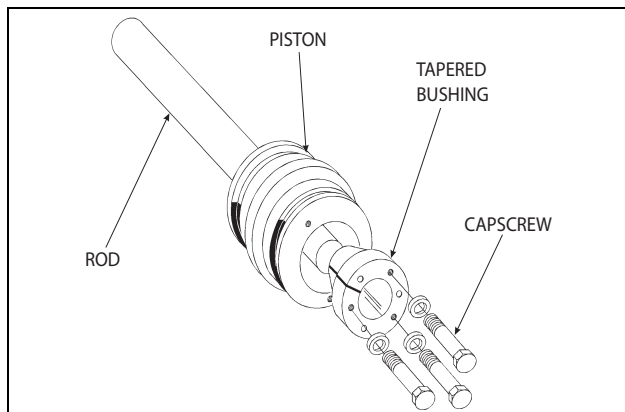


Figure 5-37. Tapered Bushing Removal

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

CLEANING AND INSPECTION

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

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

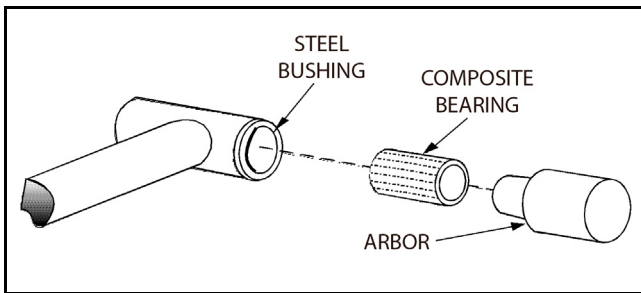


Figure 5-38. Composite Bearing Installation

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

ASSEMBLY

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

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

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

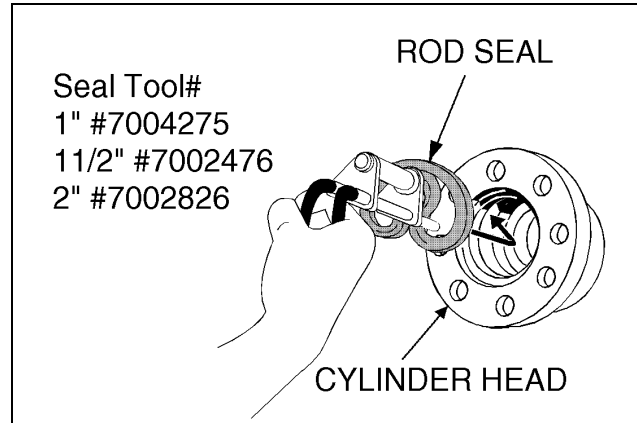


Figure 5-39. Rod Seal Installation

NOTICE

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

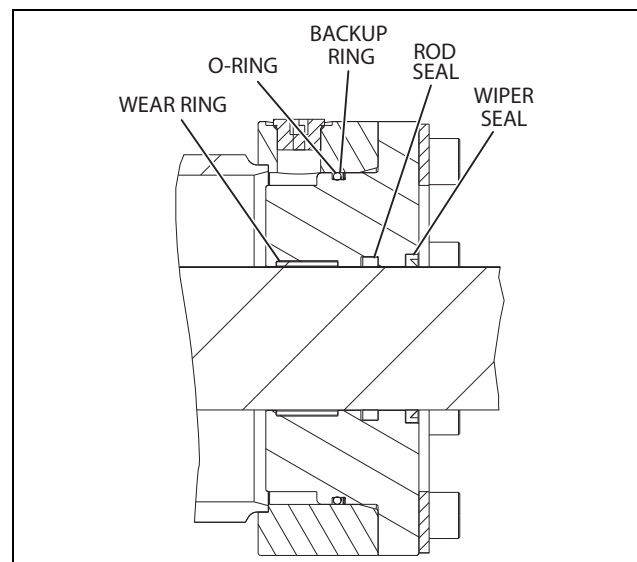


Figure 5-40. Cylinder Head Seal Installation

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

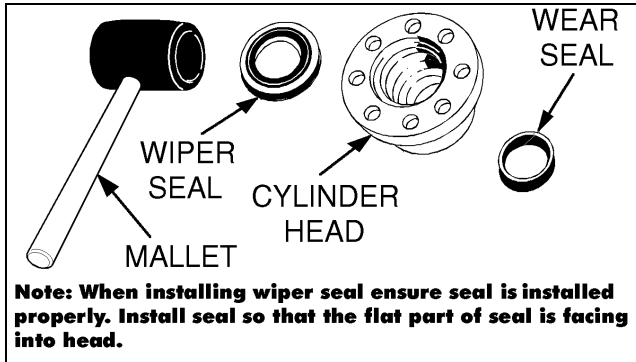


Figure 5-41. Wiper Seal Installation

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

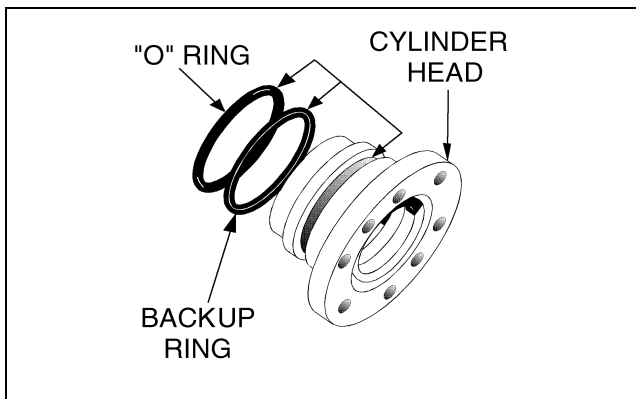


Figure 5-42. Installation of Head Seal Kit

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

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

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

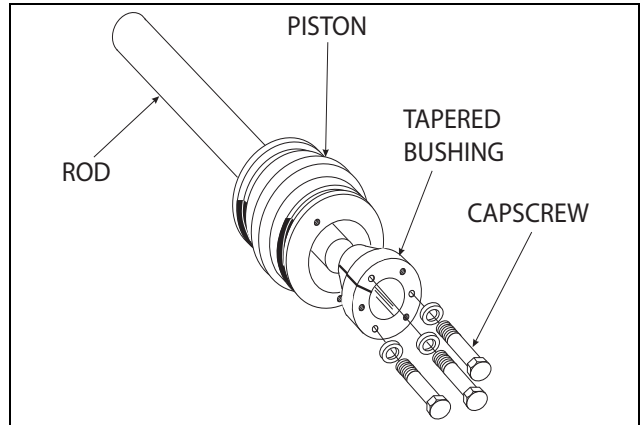


Figure 5-43. Tapered Bushing Installation

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

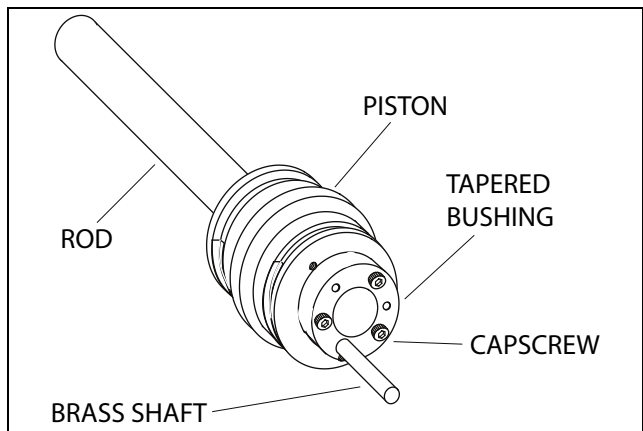


Figure 5-44. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 30 ft. lbs. (41 Nm).
14. Remove the cylinder rod from the holding fixture.

NOTICE

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

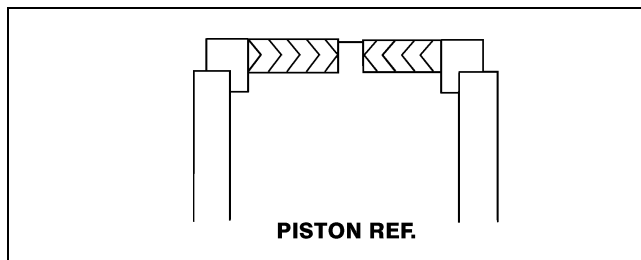


Figure 5-45. Hydrolock Piston Seal Installation

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

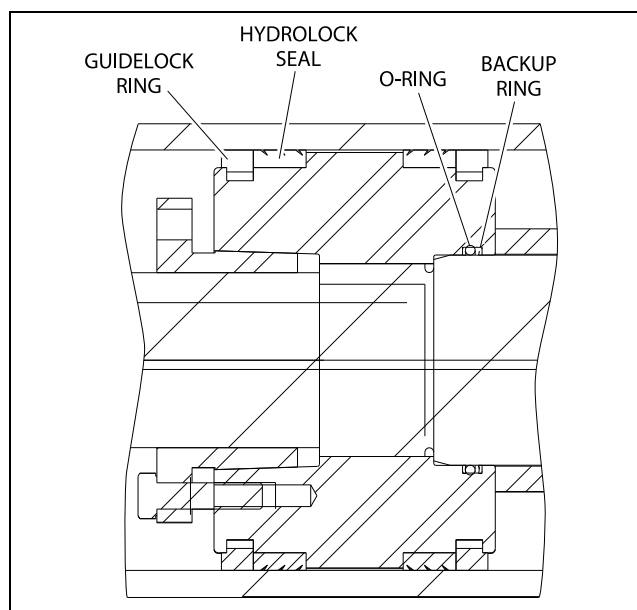


Figure 5-46. Piston Seal Kit Installation

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

NOTICE

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

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals and guidelock rings are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

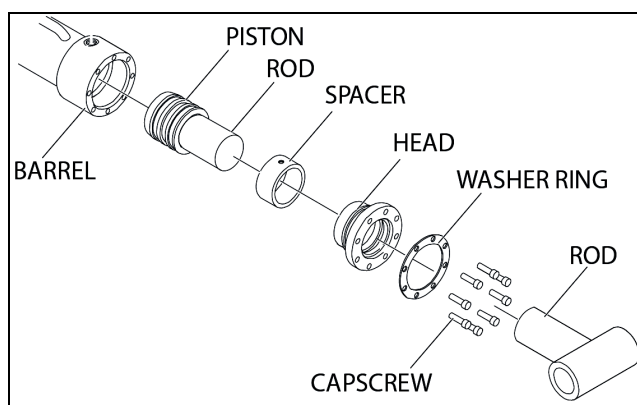


Figure 5-47. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head capscrews and secure the cylinder head gland using the washer ring and capscrews. Torque capscrews to 55 ft. lbs. (75 Nm).
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
21. Install the counterbalance valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Master Cylinder

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

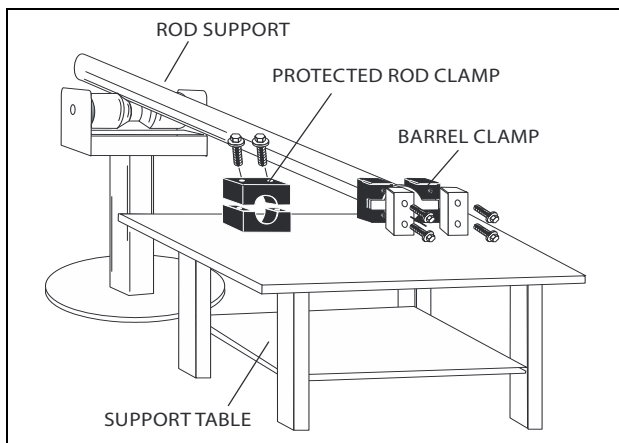


Figure 5-48. Cylinder Barrel Support

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

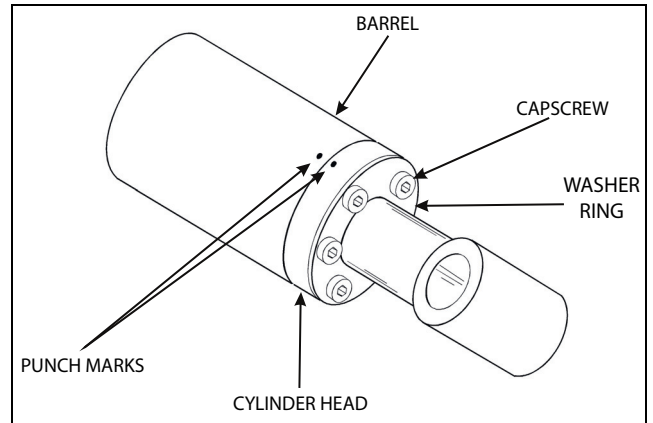


Figure 5-49. Capscrew Removal

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

NOTICE

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

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

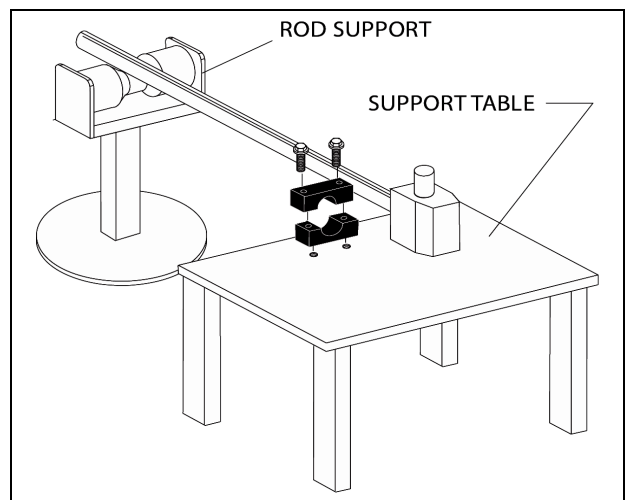
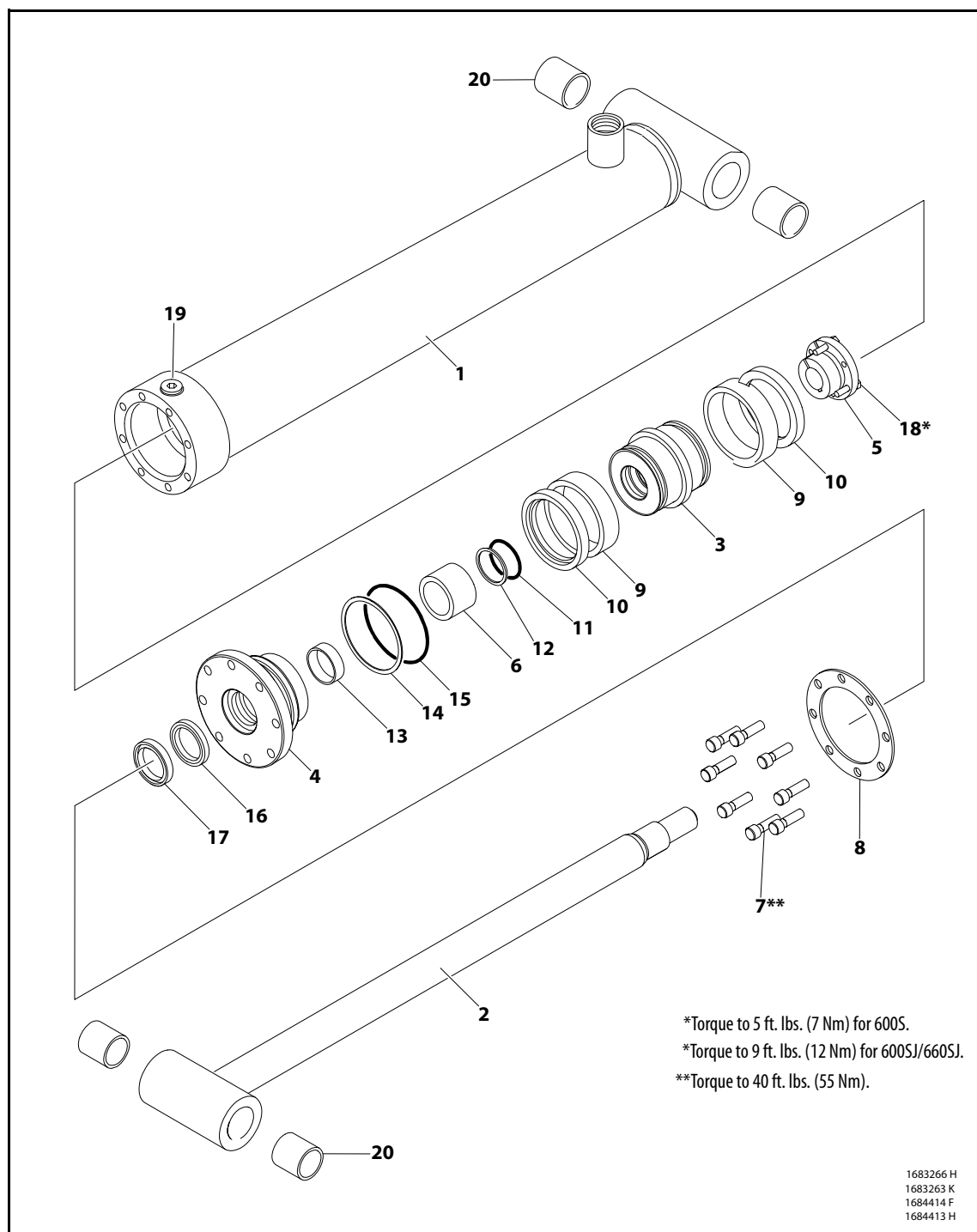


Figure 5-50. Cylinder Rod Support



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

Figure 5-51. Master Cylinder

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

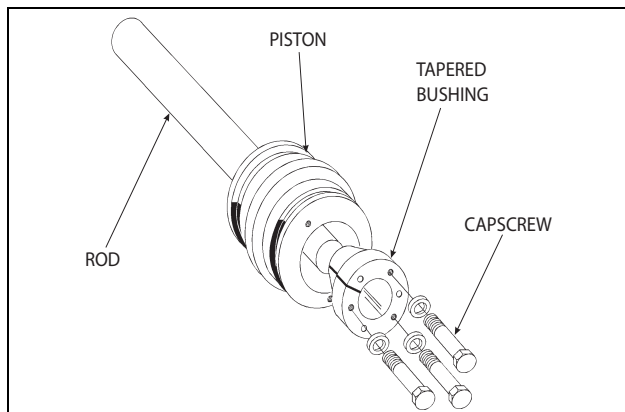


Figure 5-52. Tapered Bushing Removal

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

CLEANING AND INSPECTION

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

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

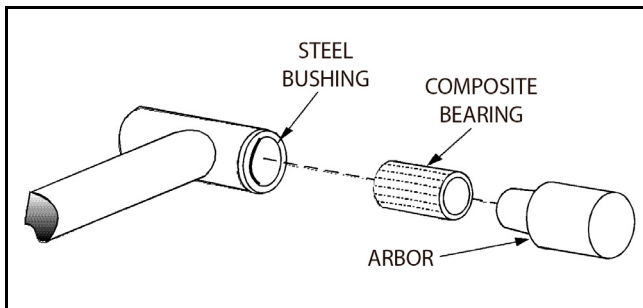


Figure 5-53. Composite Bearing Installation

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

ASSEMBLY

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

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

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

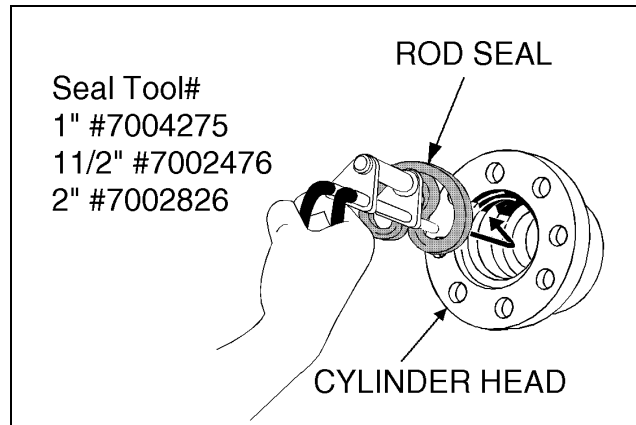


Figure 5-54. Rod Seal Installation

NOTICE

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

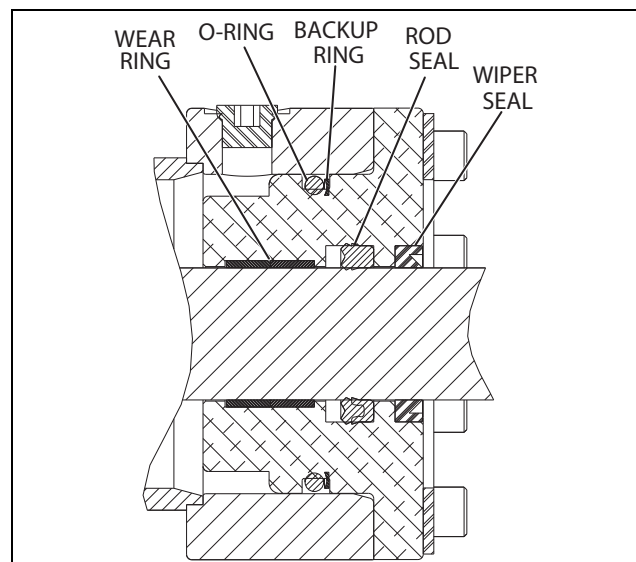


Figure 5-55. Cylinder Head Seal Installation

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

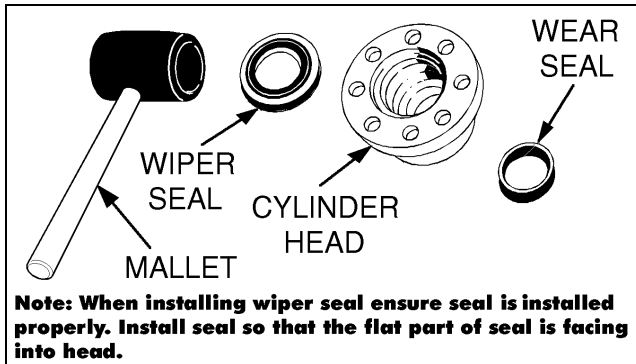


Figure 5-56. Wiper Seal Installation

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

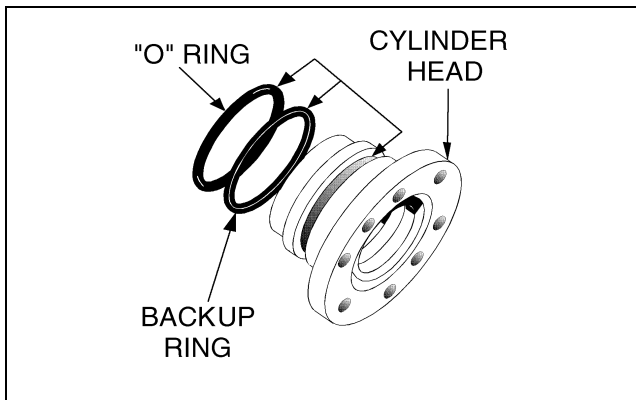


Figure 5-57. Installation of Head Seal Kit

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

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

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

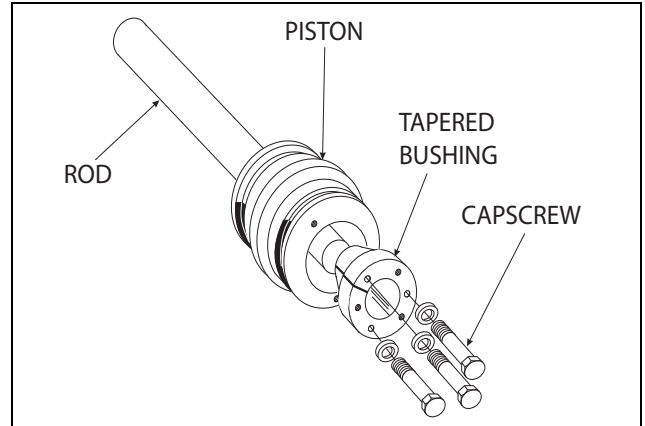


Figure 5-58. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm) for 600S and 9 ft. lbs. (12 Nm) for 600SJ/660SJ.
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4 in. in diameter) as follows:
 - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
 - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

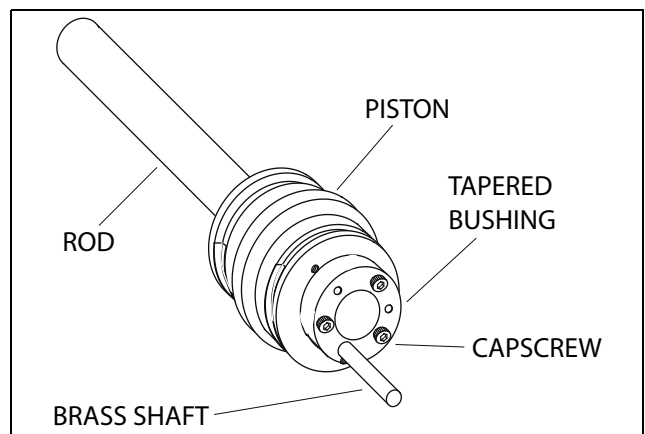


Figure 5-59. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation to 5 ft. lbs. (7 Nm) for 600S and 9 ft. lbs. (12 Nm) for 600SJ/ 660SJ.
15. Remove the cylinder rod from the holding fixture.

NOTICE

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

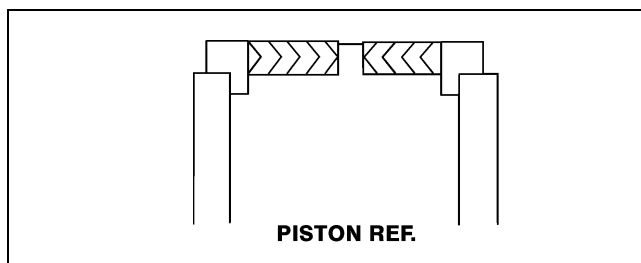


Figure 5-60. Hydrolock Piston Seal Installation

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

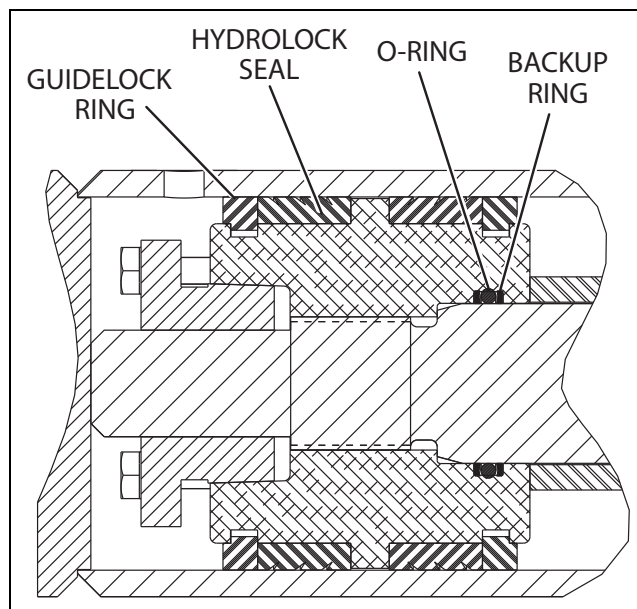


Figure 5-61. Piston Seal Kit Installation

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

NOTICE

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

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

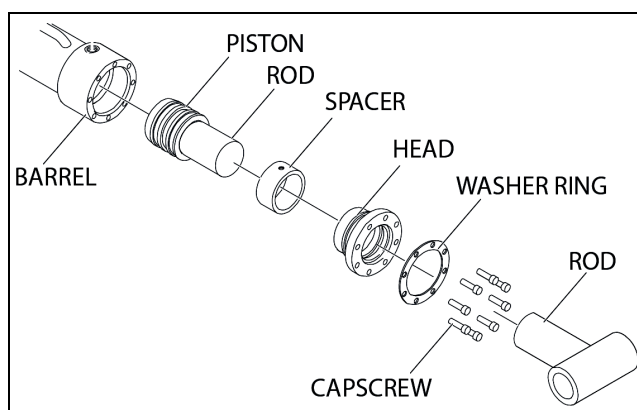


Figure 5-62. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head capscrews and secure the cylinder head gland using the washer ring and capscrews. Torque capscrews to 40 ft. lbs. (55 Nm).
21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves, if applicable.

Steer Cylinder (USA Built Machines, SN 0300087000 through 0300142634)

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

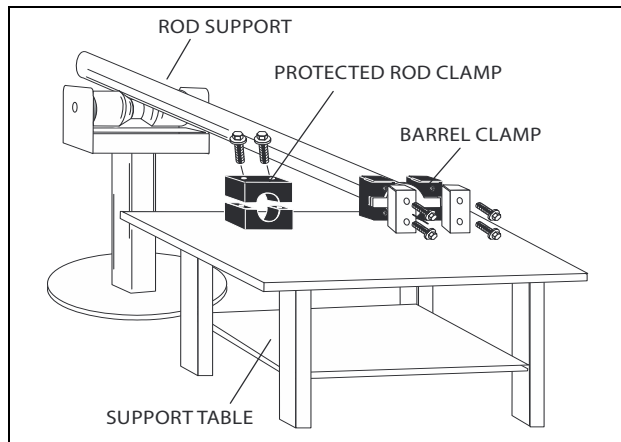


Figure 5-63. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

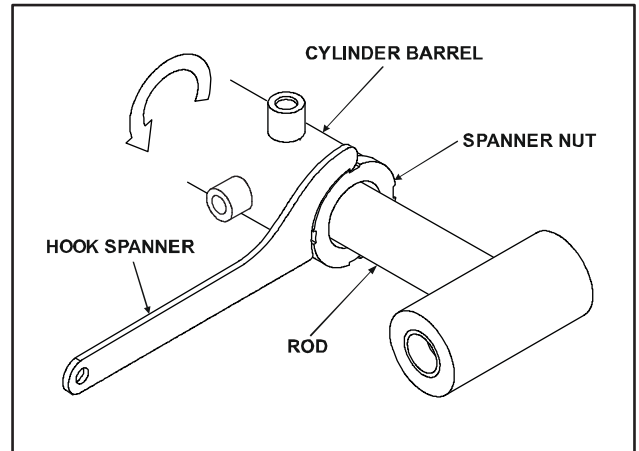


Figure 5-64. Spanner Nut Removal

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

NOTICE

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

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

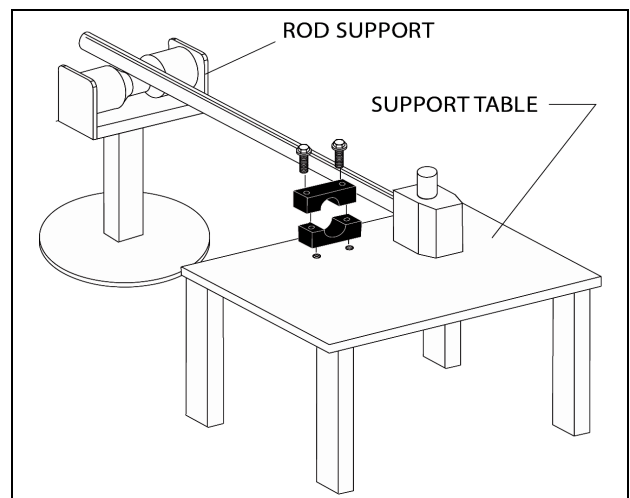
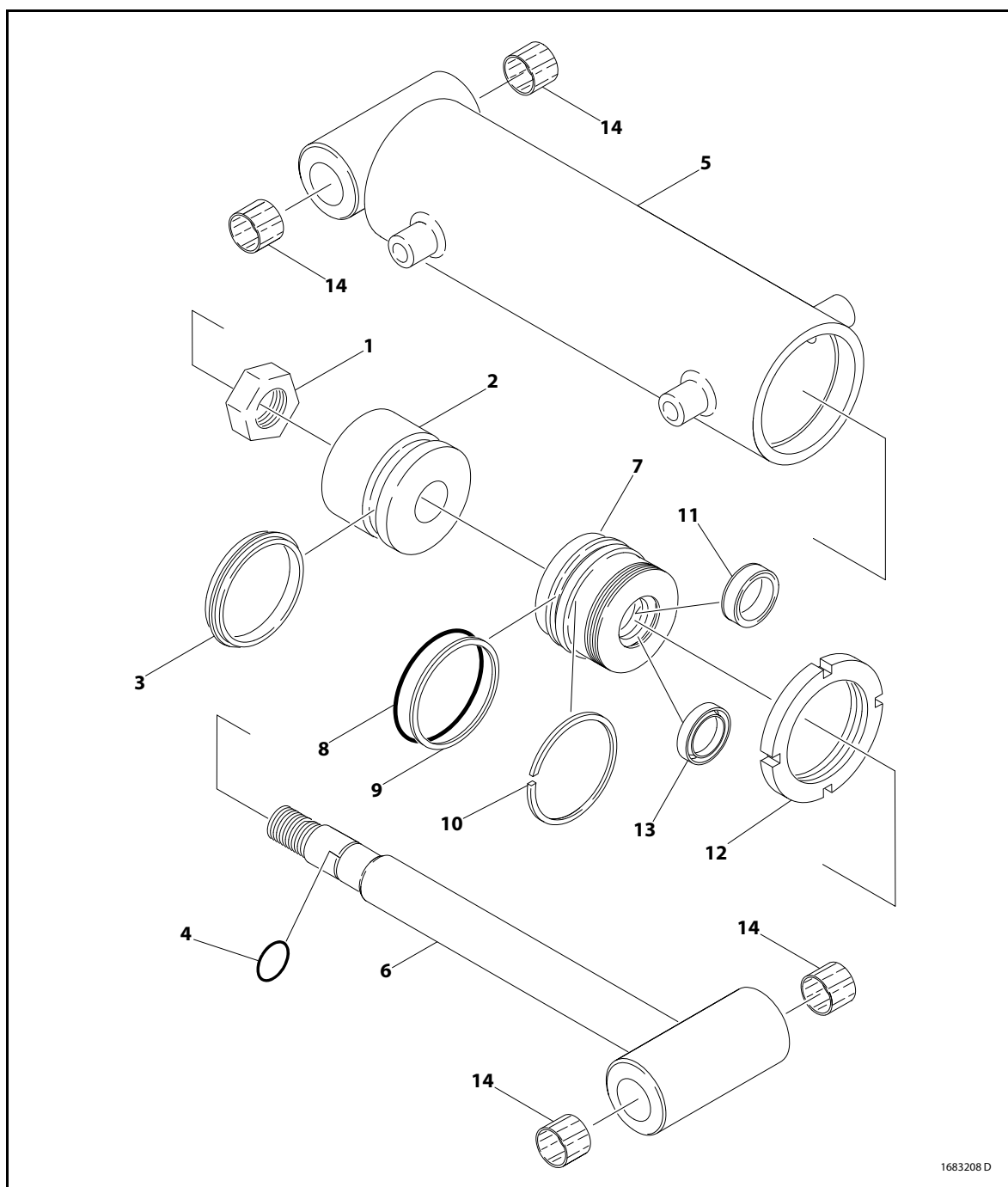


Figure 5-65. Cylinder Rod Support



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- | | | |
|------------|--------------------|-----------------|
| 1. Locknut | 6. Rod | 11. Rod seal |
| 2. Piston | 7. Head | 12. Spanner Nut |
| 3. Seal | 8. O-ring | 13. Wiper Ring |
| 4. O-ring | 9. Backup Ring | 14. Bushing |
| 5. Barrel | 10. Retaining Ring | |

Figure 5-66. Steer Cylinder USA Built Machines, SN 0300087000 through 0300142634)

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove Locknut from the piston rod.
9. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
10. Remove and discard the piston seal.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, retainer ring, rod seal and wiper seal.

CLEANING AND INSPECTION

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

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

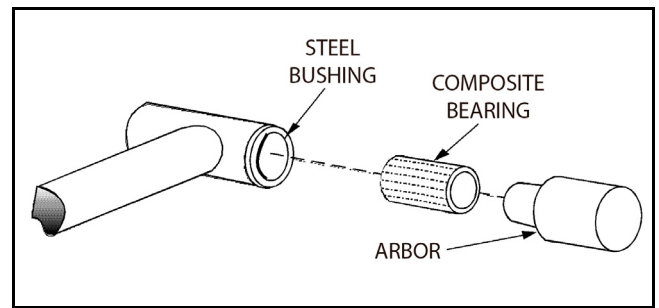


Figure 5-67. Composite Bearing Installation

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

ASSEMBLY

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

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

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

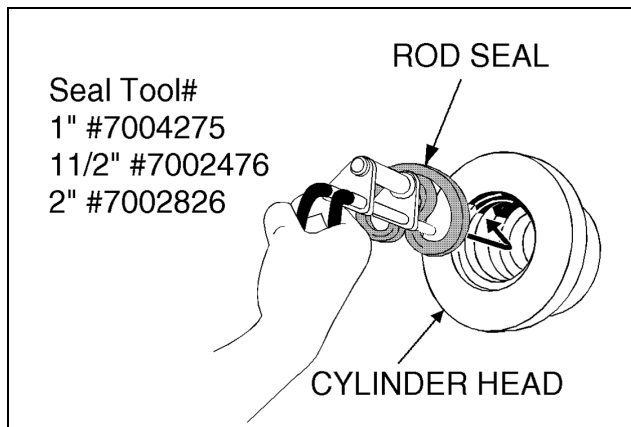


Figure 5-68. Rod Seal Installation

NOTICE

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

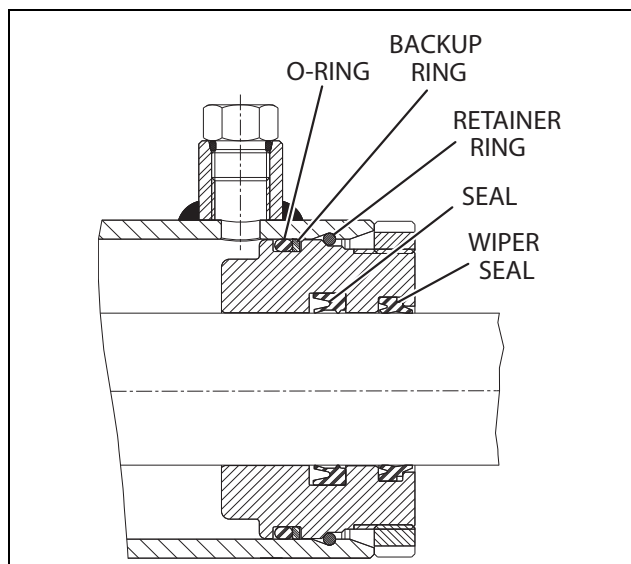


Figure 5-69. Cylinder Head Seal Installation

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

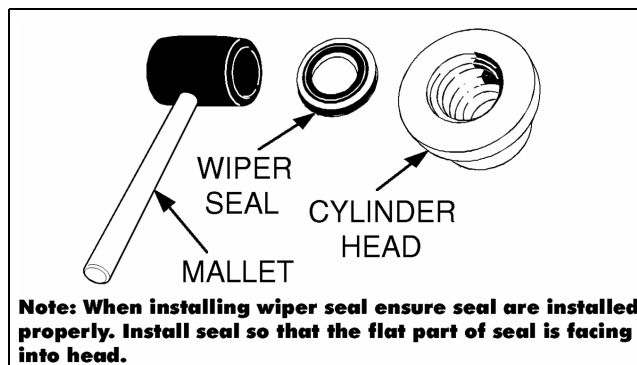


Figure 5-70. Wiper Seal Installation

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

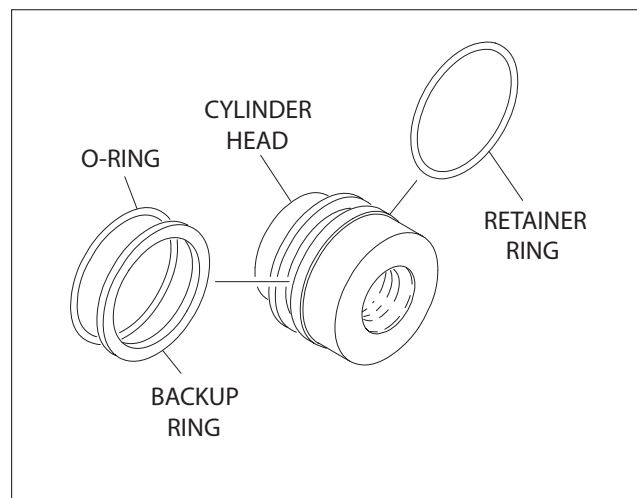


Figure 5-71. Installation of Head Seal Kit

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper seal and rod seal are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring and backup ring are not damaged or dislodged.

7. Install locknut onto the piston rod.
8. Remove the cylinder rod from the holding fixture.
9. Place new piston seal in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

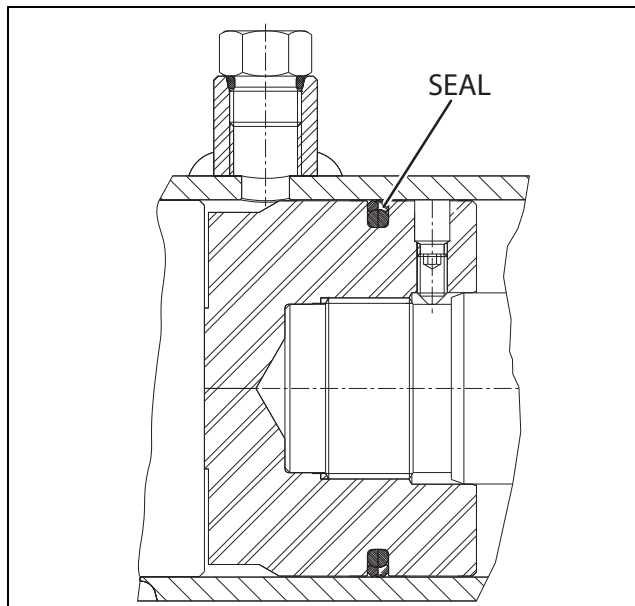


Figure 5-72. Piston Seal Kit Installation

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

NOTICE

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

11. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading piston seal is not damaged or dislodged.
12. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
13. Secure spanner nut into the cylinder barrel. Torque nut to 57-63 ft. lbs. (77-85 Nm).
14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves, if applicable.

Steer Cylinder (USA Built Machines, SN 0300142635 through 0300171769 & China Built Machines SN B300000100 through B300000969)

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

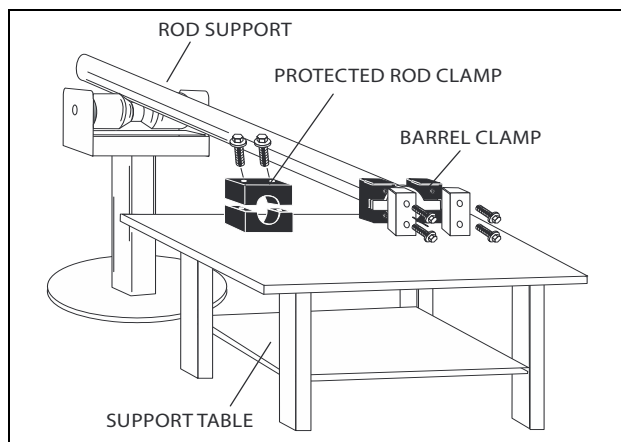


Figure 5-73. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

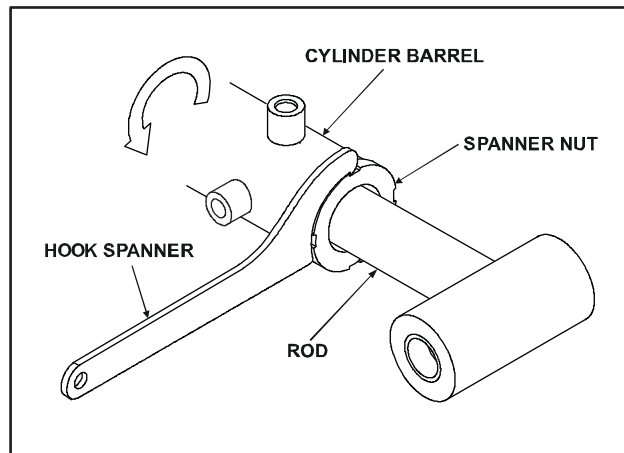


Figure 5-74. Spanner Nut Removal

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

NOTICE

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

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

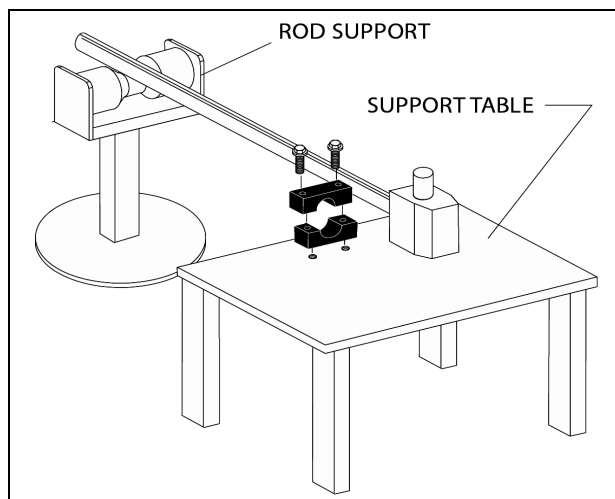
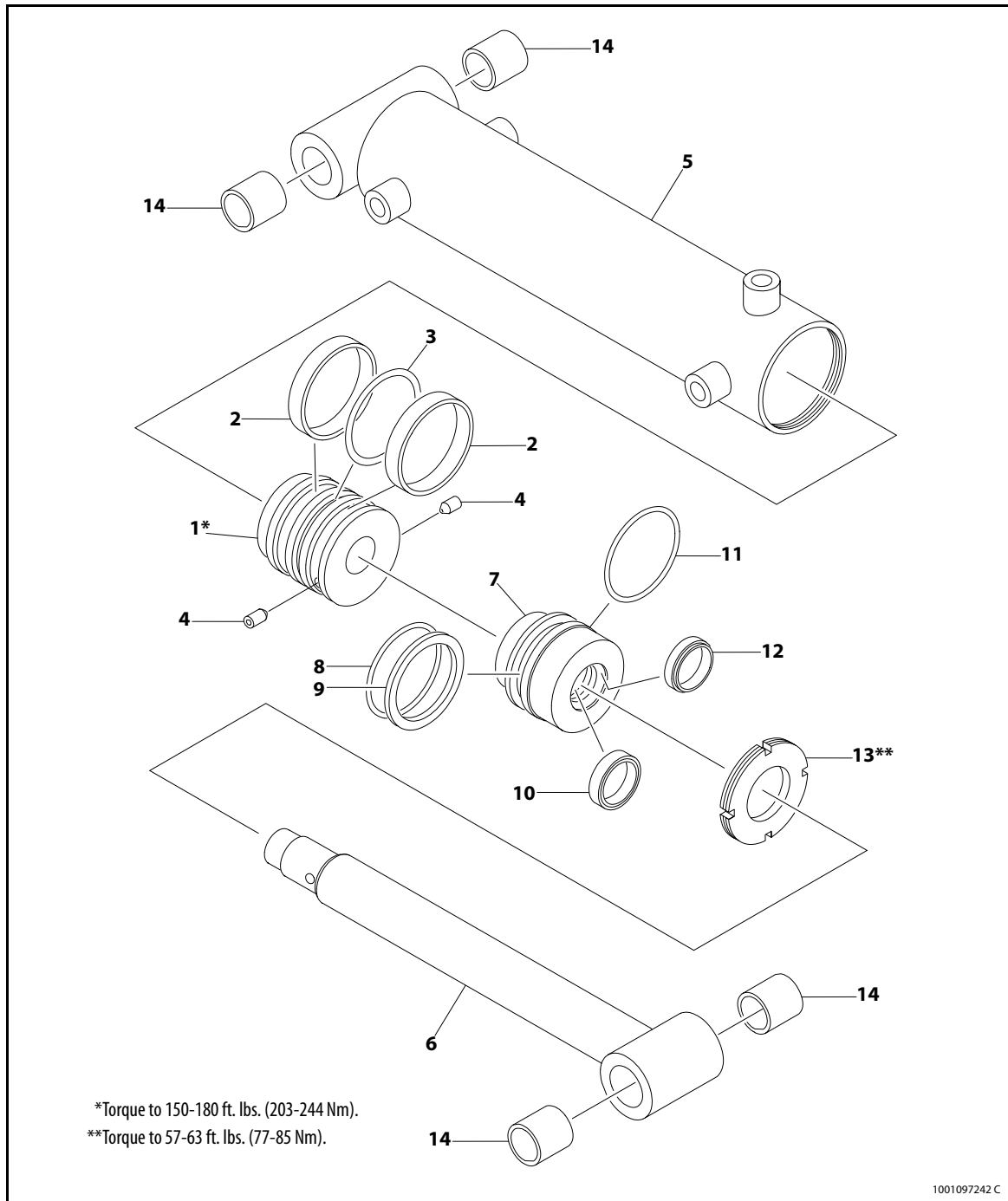


Figure 5-75. Cylinder Rod Support



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

Figure 5-76. Steer Cylinder (USA Built Machines, SN 0300142635 through 0300171769 & China Built Machines, SN B300000100 through B300000969)

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove the setscrews from the piston.
9. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
10. Remove piston seals and discard o-ring.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup ring, rod seal, and wiper seal.

CLEANING AND INSPECTION

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

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

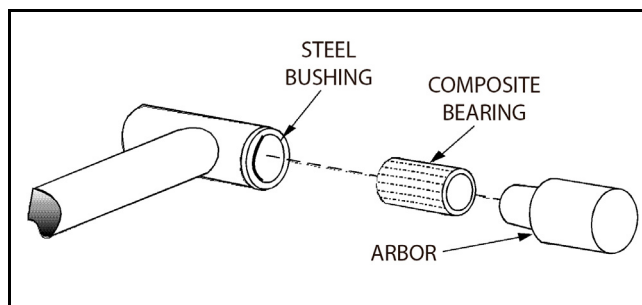


Figure 5-77. Composite Bearing Installation

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

ASSEMBLY

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

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

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

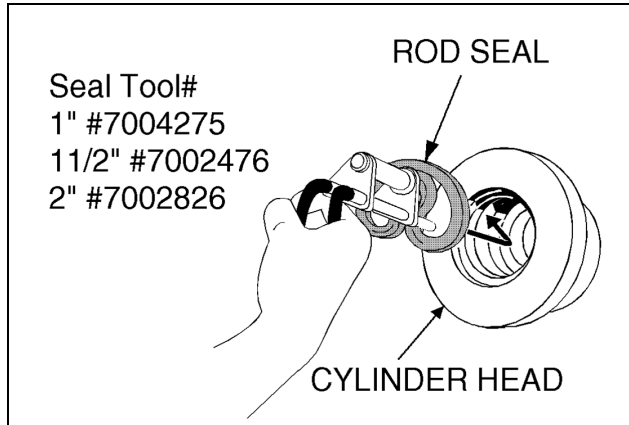


Figure 5-78. Rod Seal Installation

NOTICE

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

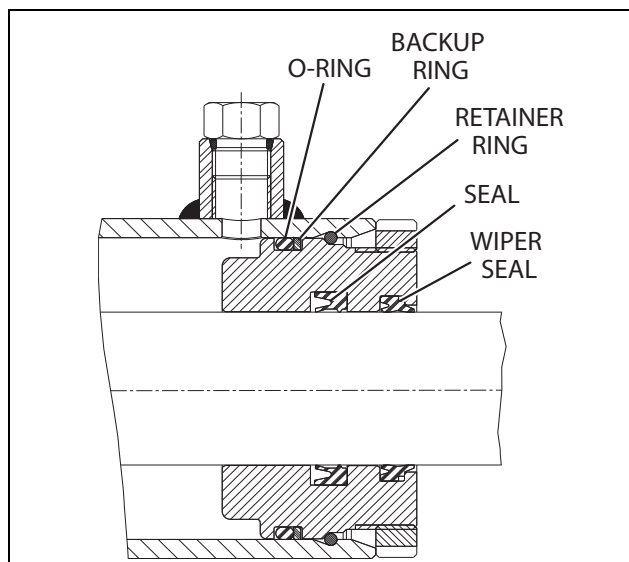


Figure 5-79. Cylinder Head Seal Installation

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

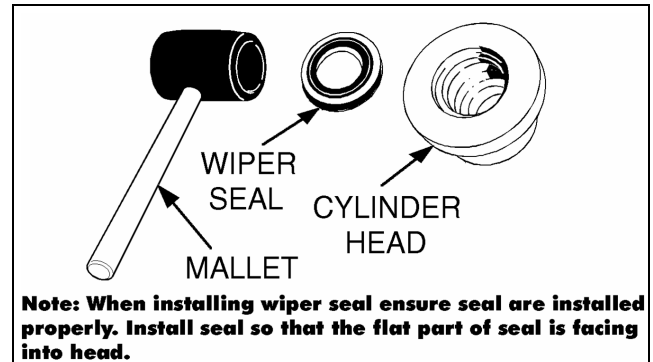


Figure 5-80. Wiper Seal Installation

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

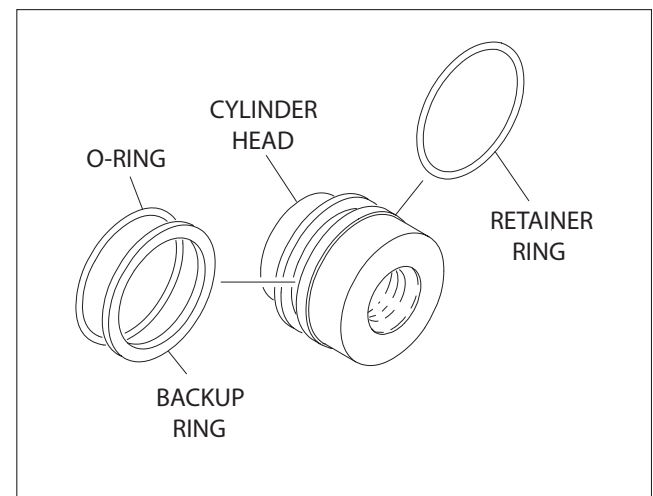


Figure 5-81. Installation of Head Seal Kit

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper seal and rod seal are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring is not damaged or dislodged. Torque to 150-180 ft.lbs. (203-244 Nm).
7. Install the setscrews on the piston.
8. Remove the cylinder rod from the holding fixture.

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

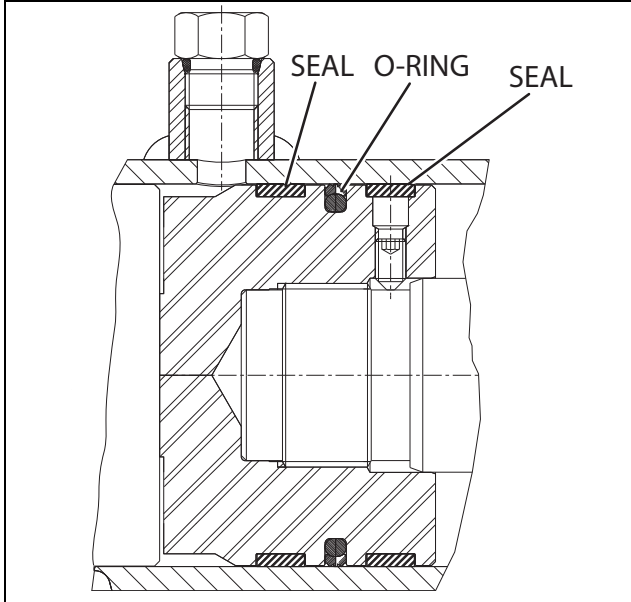


Figure 5-82. Piston Seal Kit Installation

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

NOTICE

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

11. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and piston seals are not damaged or dislodged.
12. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
13. Secure spanner nut into the cylinder barrel. Torque nut to 57-63 ft. lbs. (77-85 Nm).
14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves, if applicable.

Telescope Cylinder

DISASSEMBLY

NOTICE

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

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

WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove capscrews and valve assembly from the barrel end. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

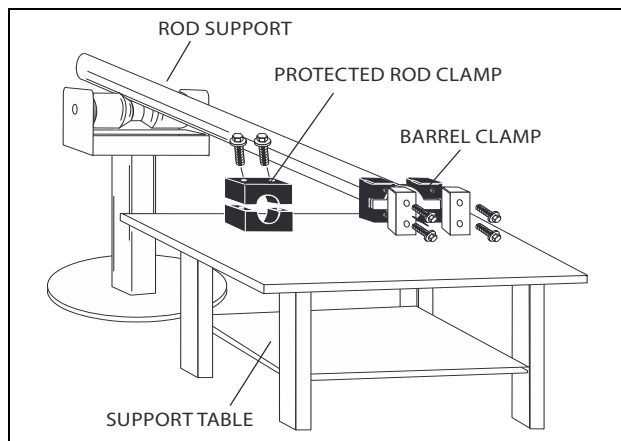


Figure 5-83. Cylinder Barrel Support

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

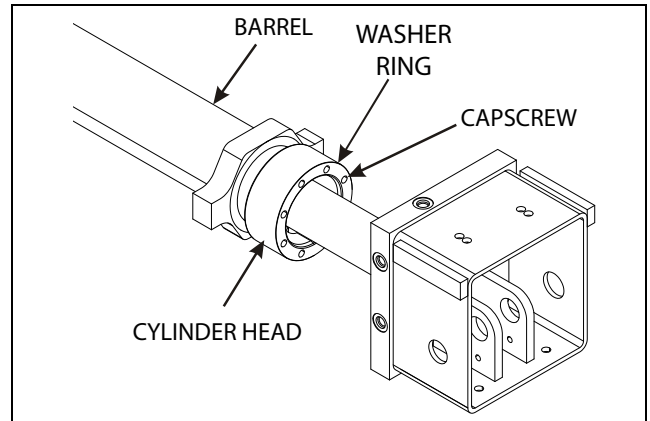


Figure 5-84. Capscrew Removal

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

NOTICE

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

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

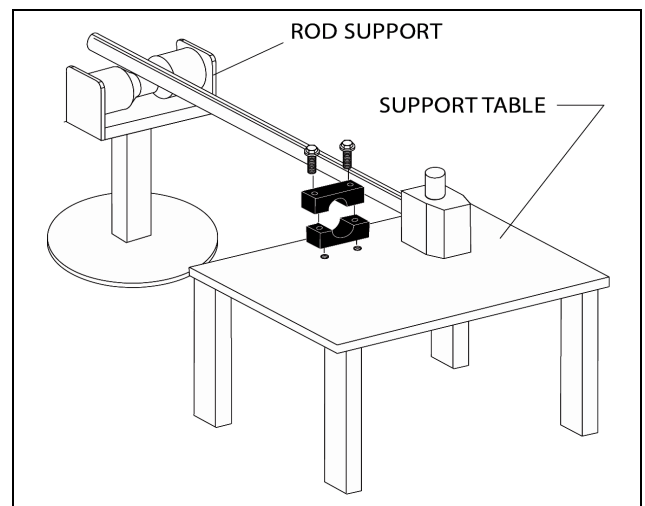
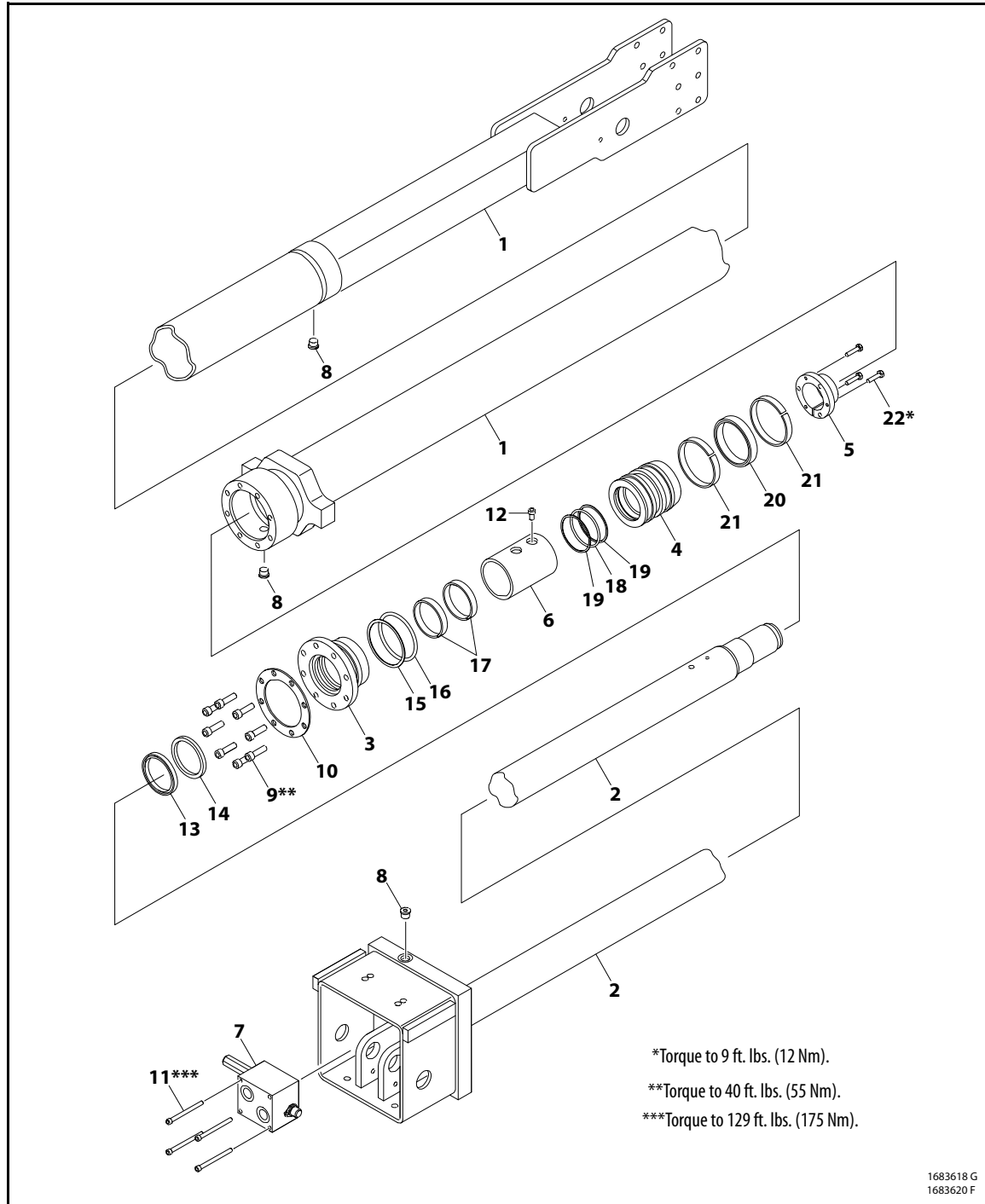


Figure 5-85. Cylinder Rod Support



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

Figure 5-86. Telescope Cylinder

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

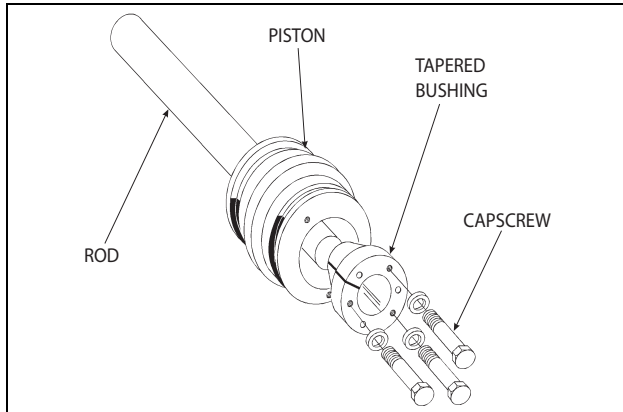


Figure 5-87. Tapered Bushing Removal

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

CLEANING AND INSPECTION

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

ASSEMBLY

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

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

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

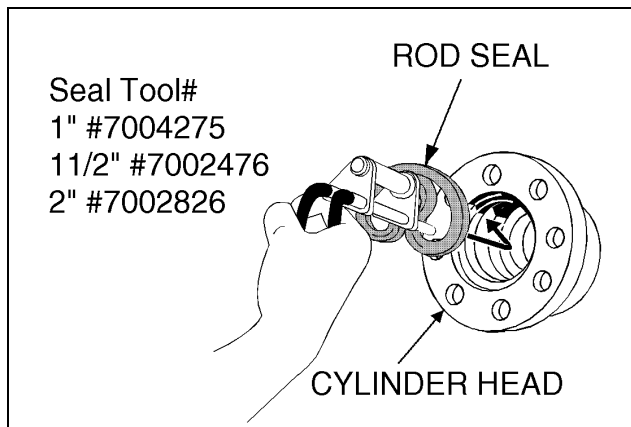


Figure 5-88. Rod Seal Installation

NOTICE

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

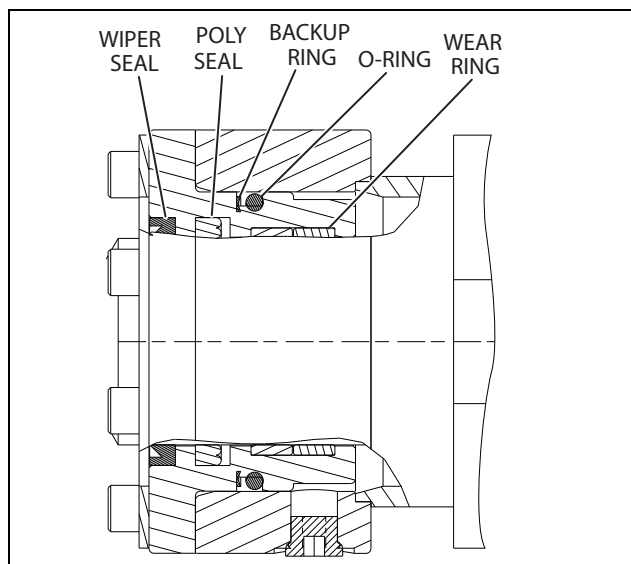


Figure 5-89. Cylinder Head Seal Installation

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

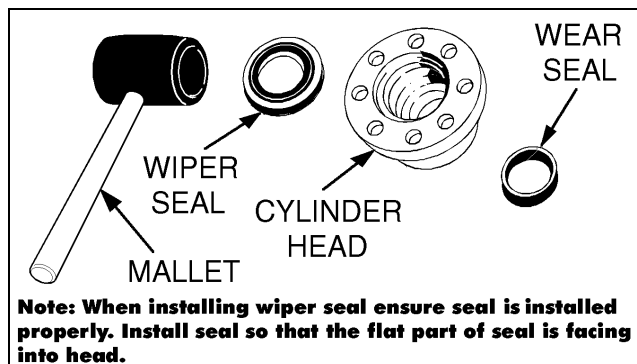


Figure 5-90. Wiper Seal Installation

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

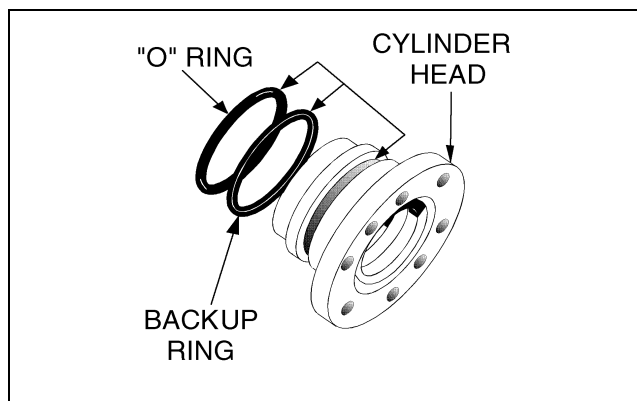


Figure 5-91. Installation of Head Seal Kit

4. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the spacer onto the rod. Secure the spacer onto rod with the capscrew.
6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
7. Place a new o-ring and backup rings in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.
9. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

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

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

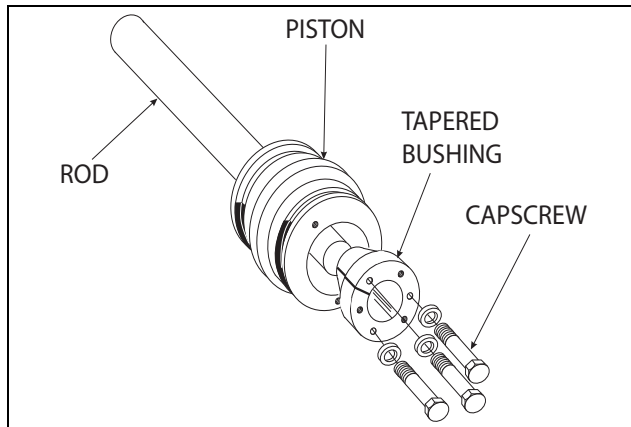


Figure 5-92. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 9 ft. lbs. (12 Nm).
12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4 in. in diameter) as follows:
 - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
 - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

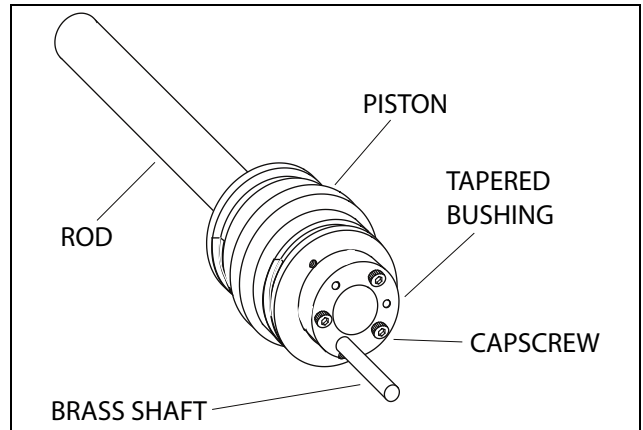


Figure 5-93. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 9 ft. lbs. (12 Nm).
14. Remove the cylinder rod from the holding fixture.
15. Place new T-seal and wear rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

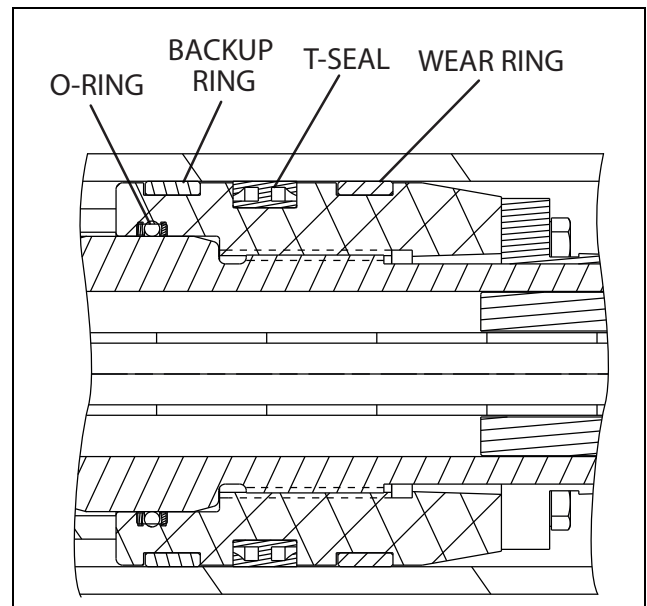


Figure 5-94. Piston Seal Kit Installation

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

NOTICE

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

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

19. Apply JLG Threadlocker P/N 0100011 to the socket head capscrews and secure the cylinder head gland using the washer ring and capscrews. Torque capscrews to 40 ft. lbs. (55 Nm).
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
21. Install o-ring plug onto the rod assembly.
22. Install the valve assembly back onto the rod using capscrews. Torque capscrews to 9 ft. lbs. (12 Nm).

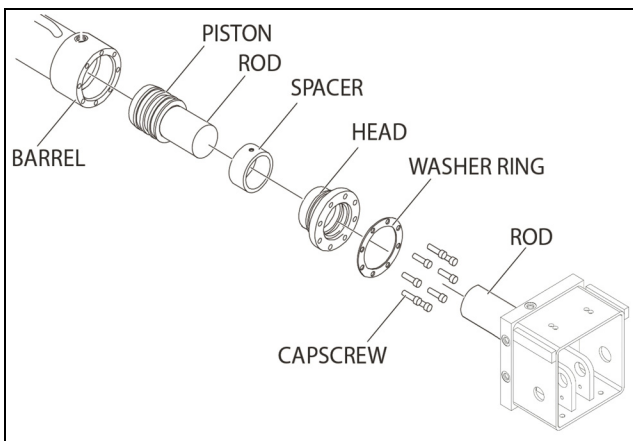


Figure 5-95. Rod Assembly Installation

5.5 CYLINDER REMOVAL AND INSTALLATION

Main Boom Telescope Cylinder Removal

1. Place machine on a flat and level surface, with main boom in the horizontal position.
2. Shut down engine. Support main boom basket end with a prop. (See Figure 5-96.)

NOTICE

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

3. Tag and disconnect hydraulic lines to telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove the hardware securing cover plate on bottom of the base boom section and remove cover.

NOTE: Do not allow cable to rotate. This may damage the cable.

5. Clamp both threaded ends of cable to prevent rotation. Note: Do not clamp on threads. Remove jam nuts and loosen adjustment nuts so there is slack in the cables. (See Section 4 - Boom & Platform).
6. Remove the hardware securing push bar to turntable and telescope cylinder.
7. Using a suitable brass drift, carefully drive the push bar pins from the telescope cylinder rod and turntable.
8. Remove hardware securing cable adjustment block to aft end of the base boom section and remove block.
9. Remove hardware securing telescope cylinder to aft end of the mid boom 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 INTO POSITION: DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

10. Remove bolts securing cable attach bar to top of fly boom section.
11. Pull the telescope cylinder and cables partially from aft end of the base boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
12. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.

Main Boom Telescope Cylinder Installation

1. Route extend cables around extend sheave and secure cables to the telescope cylinder.
2. Install extend cables mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts onto the threaded end of cables.

NOTE: When installing cables care must be taken not to twist or cross the cables.

3. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.
4. Install extend cable mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts onto the threaded ends of cables.

NOTE: When installing cables, care must be taken not to twist or cross the cables.

5. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

NOTICE

WHEN INSERTING 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 POSITION: DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

6. Carefully install the telescope cylinder barrel end support into slots in mid boom and secure with blocks and bolts. Apply JLG Threadlocker P/N 0100019 on bolts.
7. Align holes in aft end of the fly boom section with holes in cable mounting block, then secure with mounting hardware.
8. Align holes in aft end of the base boom section with holes in cable mounting block, then secure with mounting hardware.
9. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
10. Align holes in rod end of the telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.
11. Align holes in push bar with holes in turntable. Install push bar pin and secure with mounting hardware.
12. Boom cables must be torqued after installation of the telescope cylinder. (See Section 4.11, Boom Rope Torquing Procedures).

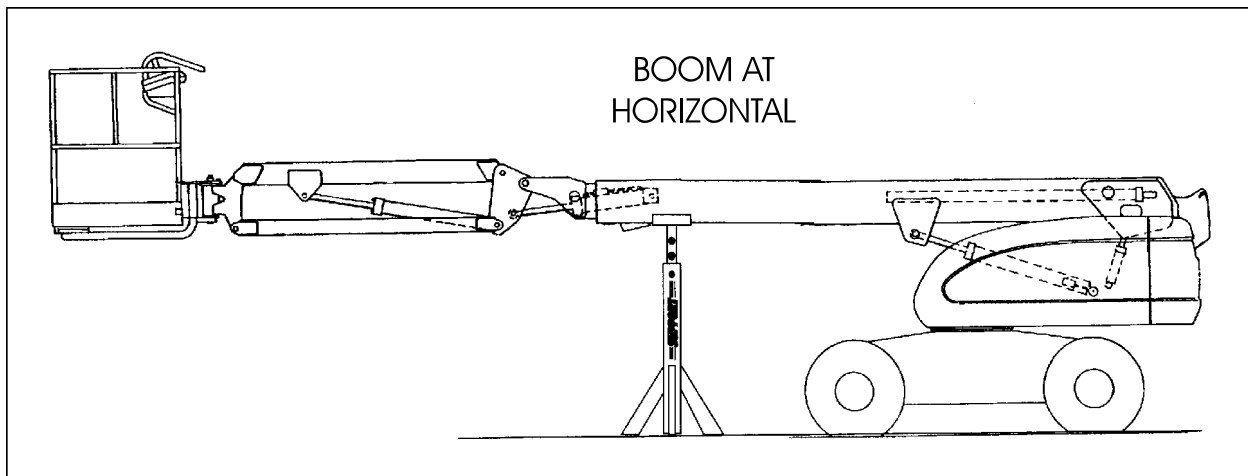
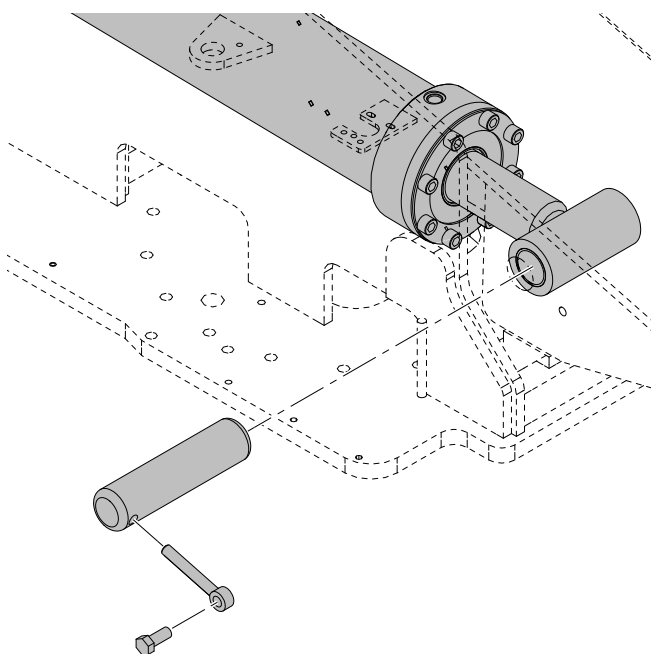


Figure 5-96. Boom Positioning and Support

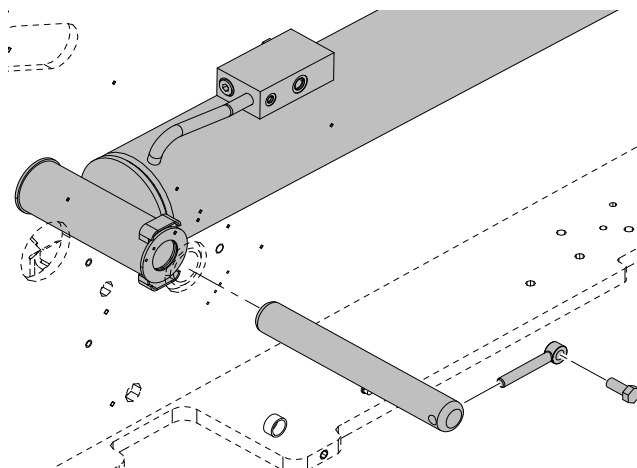
Main Boom Lift Cylinder Removal

1. Place the machine on a flat and level surface. Start the engine and place the main boom in the horizontal position. Shut down engine and prop the boom. (See Figure 5-96.)
2. Remove the hardware retaining the cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



3. Using auxiliary power, retract the lift cylinder rod completely.

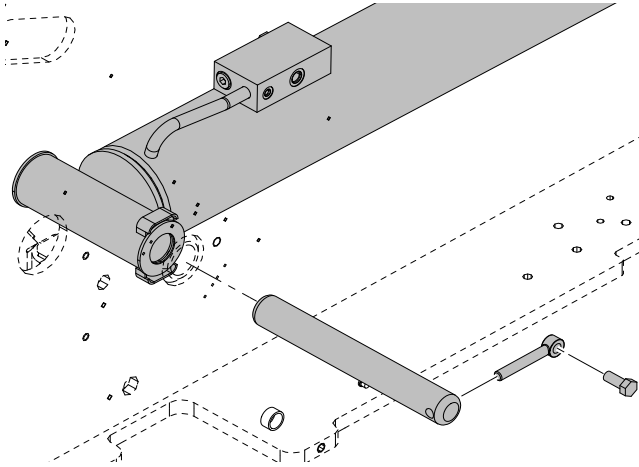
4. Disconnect, cap and tag the main boom lift cylinder hydraulic lines and ports.
5. Remove barrel end attach pin retaining hardware. Using a suitable brass drift drive out the barrel end attach pin from the turntable.



6. Remove the cylinder from the turntable and place in a suitable work area.

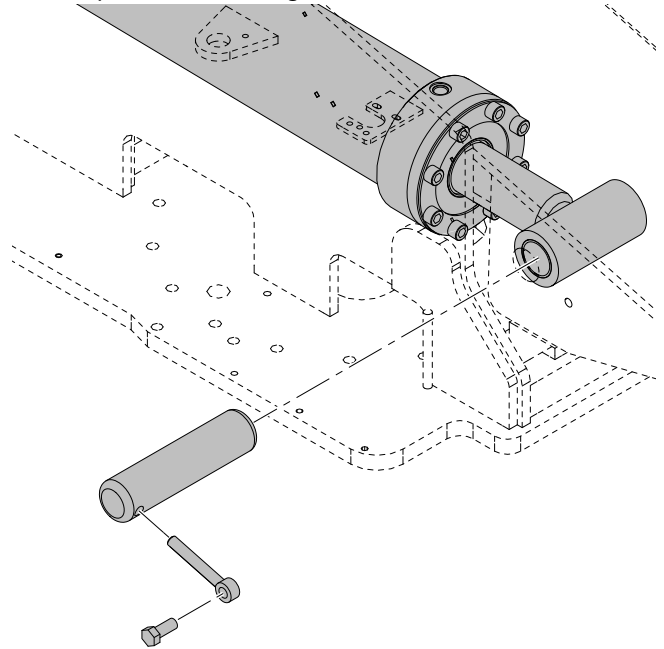
Main Boom Lift Cylinder Installation

1. Install lift cylinder in place using suitable slings or supports, aligning attach pin mounting holes on the turntable.
2. Using a suitable drift, drive the barrel end attach pin through the mounting holes in the lift cylinder and the turntable. Secure in place with the pin retaining hardware.



3. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.

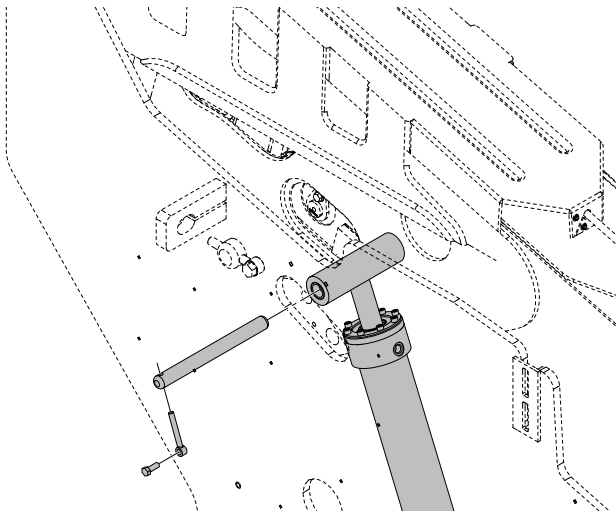
4. Using auxiliary power, extend the cylinder rod until the attach pin hole aligns with those in the boom. Using a suitable soft mallet, drive the cylinder rod attach pin through the boom and lift cylinder. Secure the pin in place with attaching hardware.



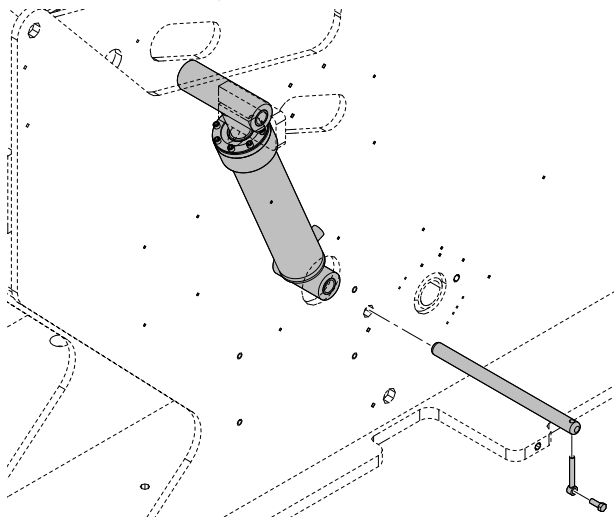
5. Remove boom prop and overhead crane. Activate hydraulic system.
6. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
7. Check fluid level of hydraulic tank and adjust as necessary.

Master Cylinder Removal

1. Place the machine on a flat and level surface. Start the engine and place the main boom in the horizontal position. Shut down engine and prop the boom. (See Figure 5-96.)
2. Remove the hardware retaining the cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



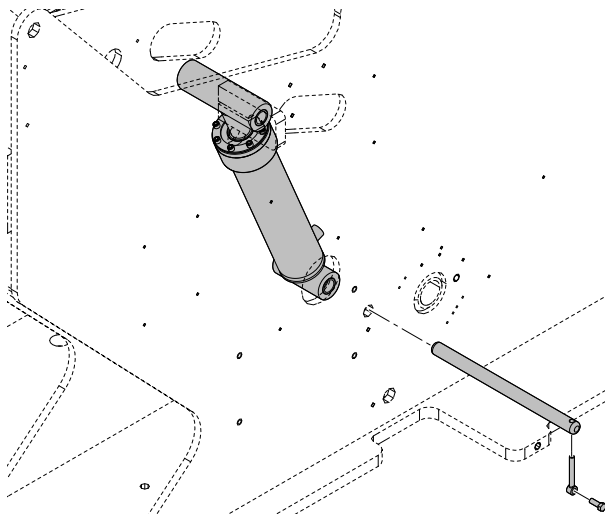
3. Using an adequate supporting device, support the master cylinder so it doesn't fall when the retaining pins are removed.
4. Remove the hardware retaining the cylinder barrel end attach pin to the turntable. Using a suitable brass drift, drive out the cylinder barrel end attach pin.



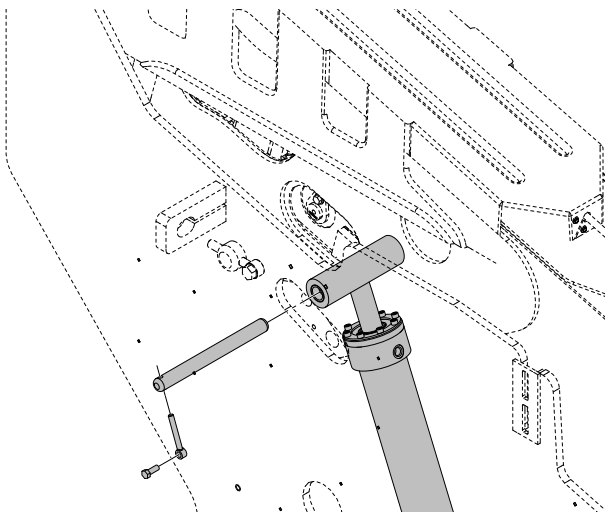
5. Remove the cylinder from the turntable and place in a suitable work area.

Master Cylinder Installation

1. Install master cylinder in place using suitable slings or supports, aligning attach pin mounting holes on the turntable.
2. Using a suitable drift, drive the barrel end attach pin through the mounting holes in the master cylinder and the turntable. Secure in place with the pin retaining hardware.



3. Using auxiliary power, extend the cylinder rod until the attach pin hole aligns with those in the boom. Using a suitable soft mallet, drive the cylinder rod attach pin through the boom and master cylinder. Secure the pin in place with attaching hardware.



4. Using all applicable safety precautions, operate the master cylinder. Check for correct operation and hydraulic leaks. Secure as necessary.

5.6 VARIABLE DISPLACEMENT PUMP (M46 SERIES)

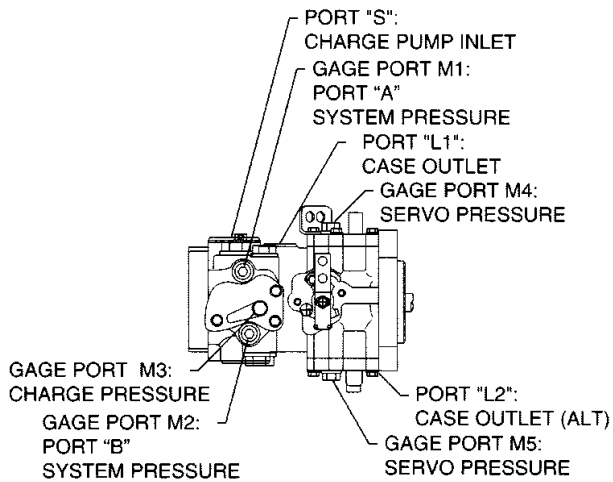
Troubleshooting

GAUGE INSTALLATION

It will be necessary to install a high pressure gauge into the system pressure gauge ports to check the setting of the high pressure relief valves.

Measuring the charge pump inlet vacuum will help locate restrictions in the inlet lines, filter, etc.

Case pressure readings can help locate restrictions in the return lines, oil cooler, and return filter.



Gauge Information		
M1	System Pressure Port A	10,000 PSI or 600 Bar Gauge 9/16-18 O-ring Fitting
M2	System Pressure Port B	10,000 PSI or 600 Bar Gauge 9/16-18 O-ring Fitting
M3	Charge Pressure	1000 PSI or 60 Bar Gauge 9/16-18 O-ring Fitting or Tee into Charge Pressure Filter Outlet Line
L1 L2	Case Pressure	1000 PSI or 60 Bar Gauge 1-1/16-12 O-ring Fitting
S	Charge Pump Inlet Vacuum	Vacuum Gauge Tee into Charge Pump Inlet Line
M4	Servo Pressure	1000 PSI or 60 Bar Gauge 9/16-18 O-ring Fitting
M5	Servo Pressure	1000 PSI or 60 Bar Gauge 9/16-18 O-ring Fitting

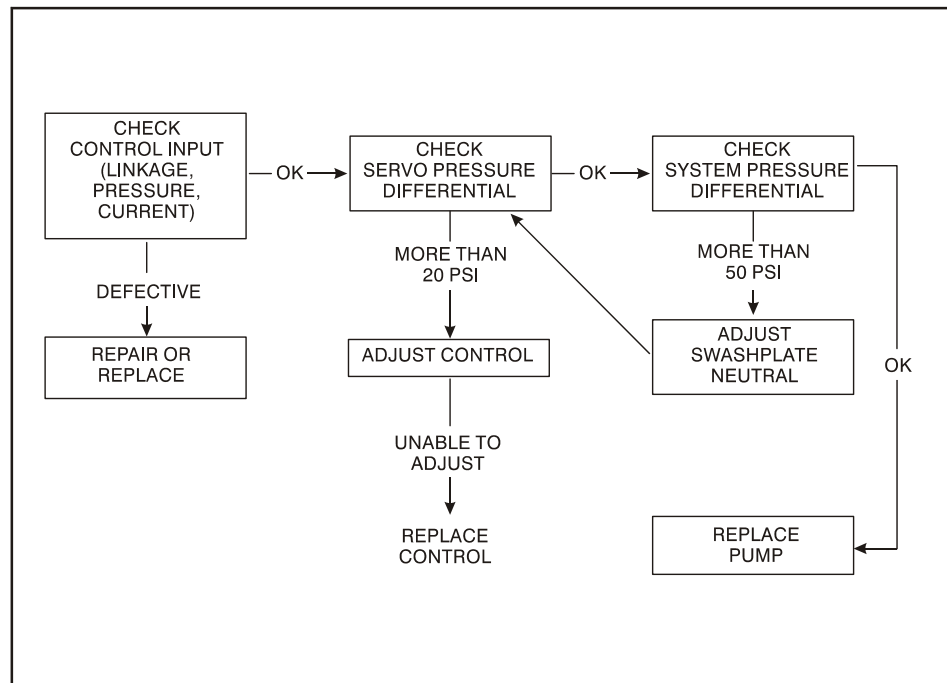


Figure 5-97. Troubleshooting - Neutral Difficult or Impossible to Find

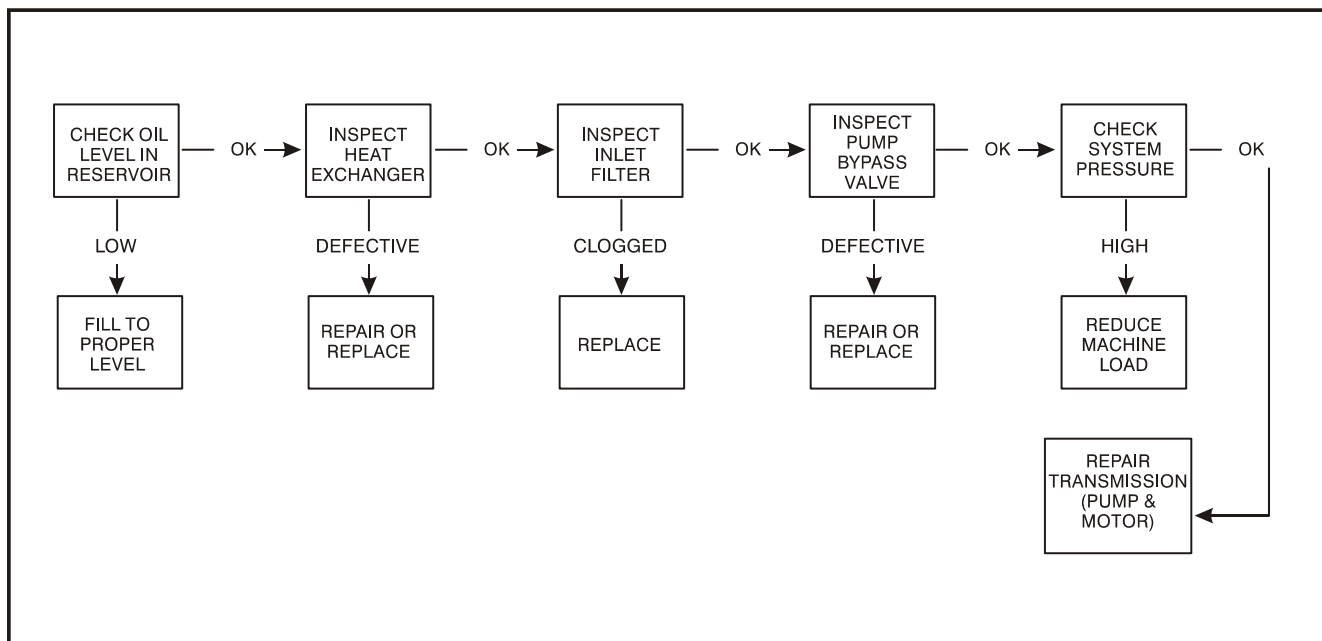


Figure 5-98. Troubleshooting - System Operating Hot

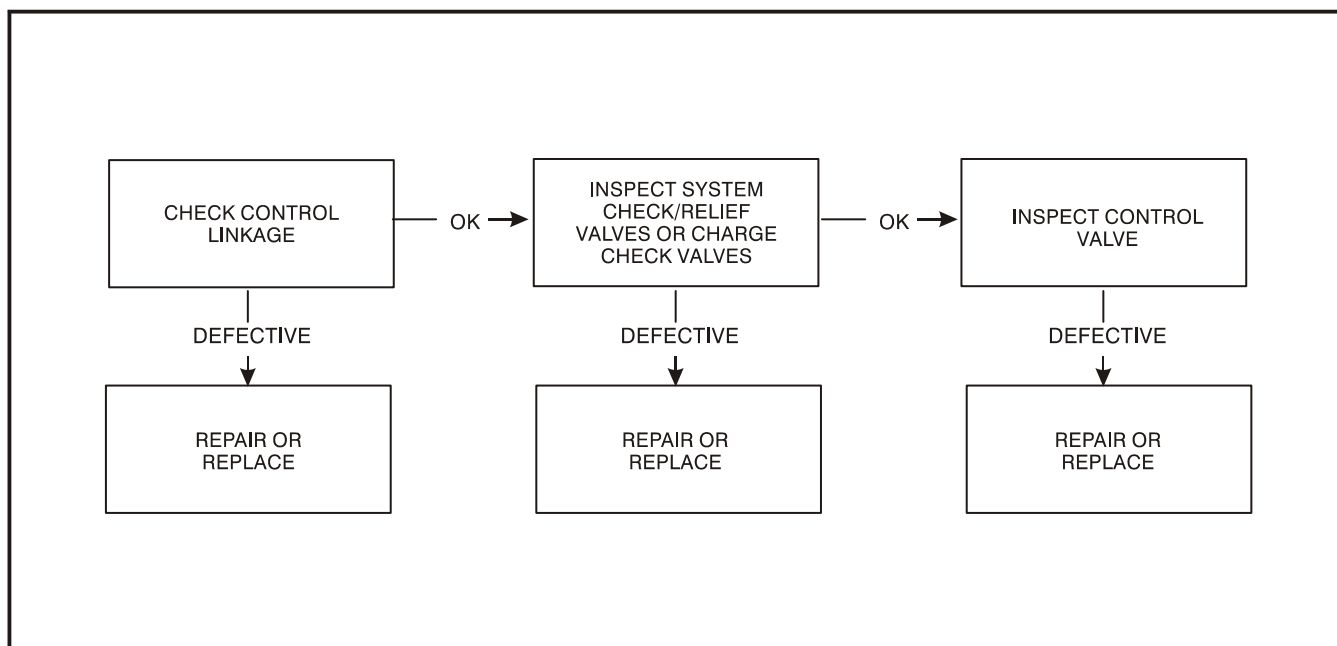


Figure 5-99. Troubleshooting - Transmission Operates in One Direction Only

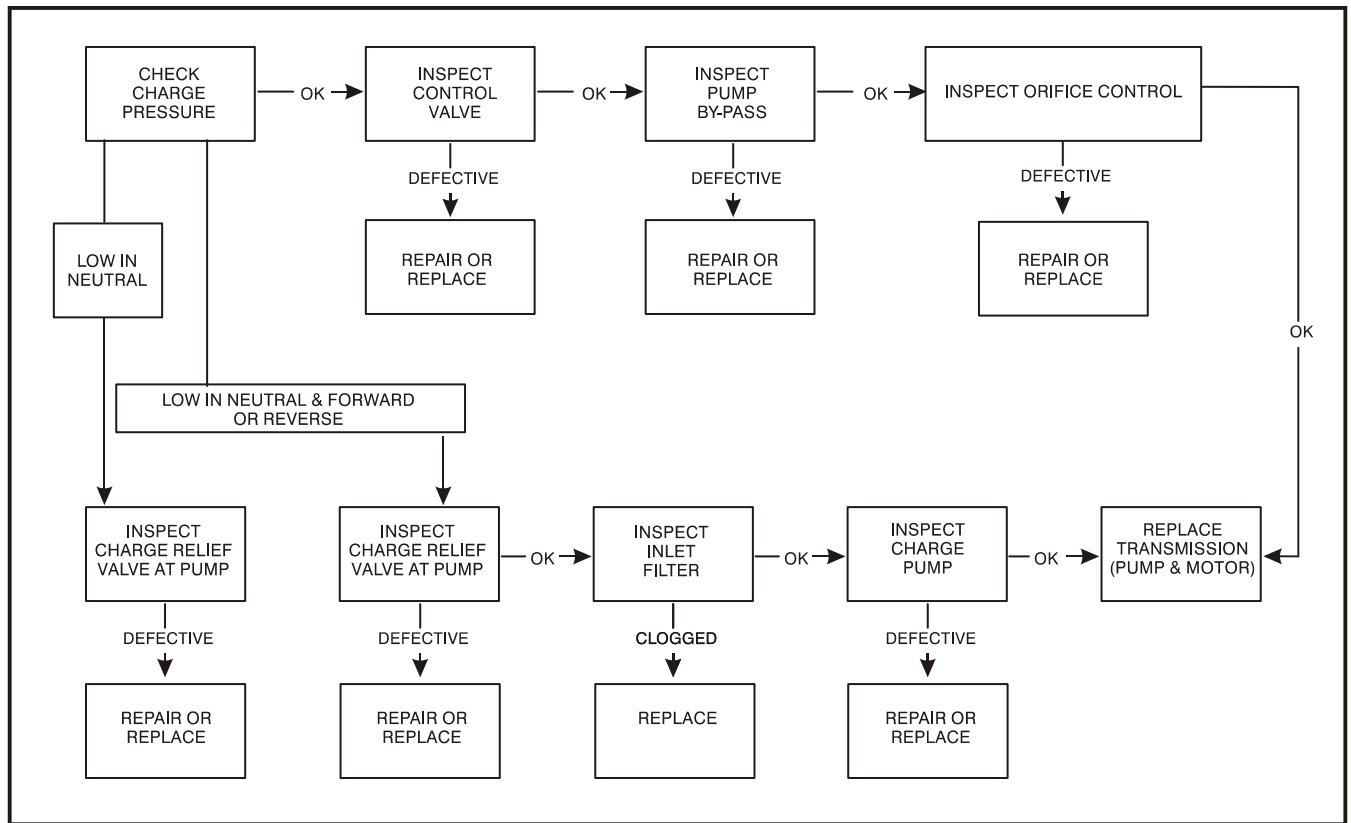


Figure 5-100. Troubleshooting - System Response is Sluggish

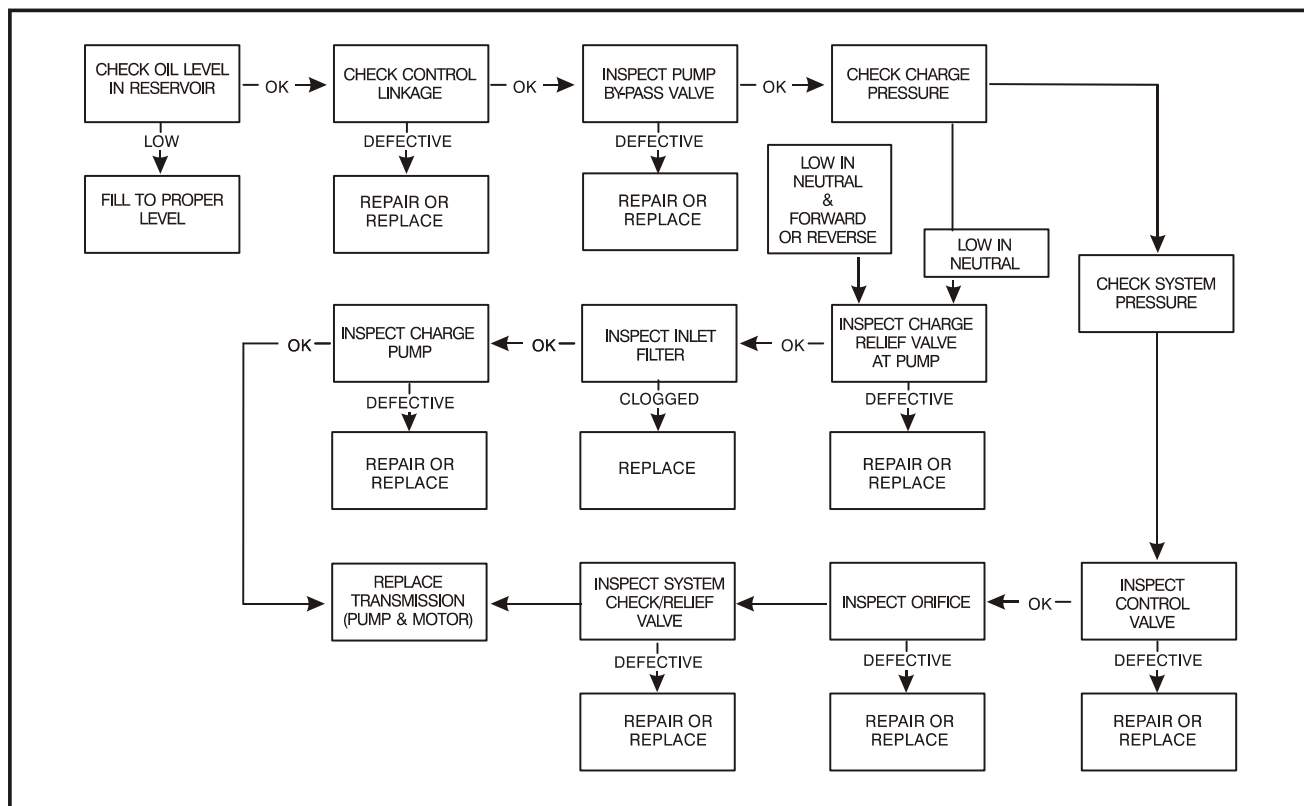
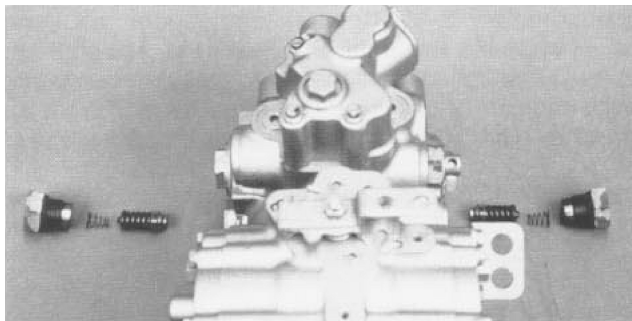


Figure 5-101. Troubleshooting - System Will Not Operate in Either Direction

Inspections and Adjustments

CHECK/HIGH PRESSURE RELIEF VALVES

The system check/relief valves have the dual purpose of providing make-up oil during by-directional rotation and providing protection from system over pressure. When the problem occurs in one direction only, interchange the check/relief valves to see if the problem changes to the other direction. If so, one check/relief valve cartridge is either malfunctioning or does not have the proper setting.

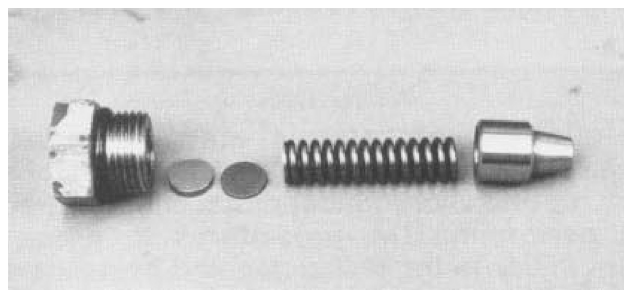


CAUTION

THE RELIEF VALVES ARE FACTORY SET AND SHOULD NOT BE TAMPERED WITH EXCEPT FOR REPLACING THE ENTIRE CARTRIDGE. DISASSEMBLY MAY CHANGE THE SETTING AND CAUSE ERRATIC UNIT OPERATION OR PREMATURE FAILURE.

PUMP CHARGE RELIEF VALVE

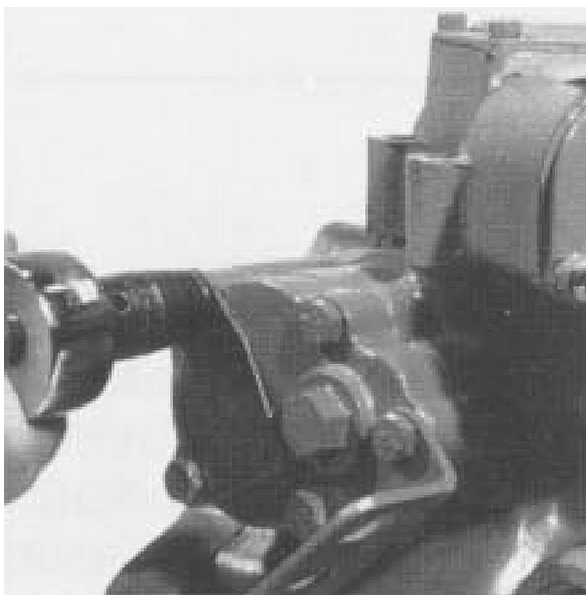
If charge pressure is low (less than 220 psi [15.2 Bar] above case pressure), the charge relief valve should be inspected. Inspect for foreign material holding the poppet open, and for scoring or wear on the poppet and seat in the housing. Adjustments of the charge pressure is accomplished by changing the shim thickness behind the spring.



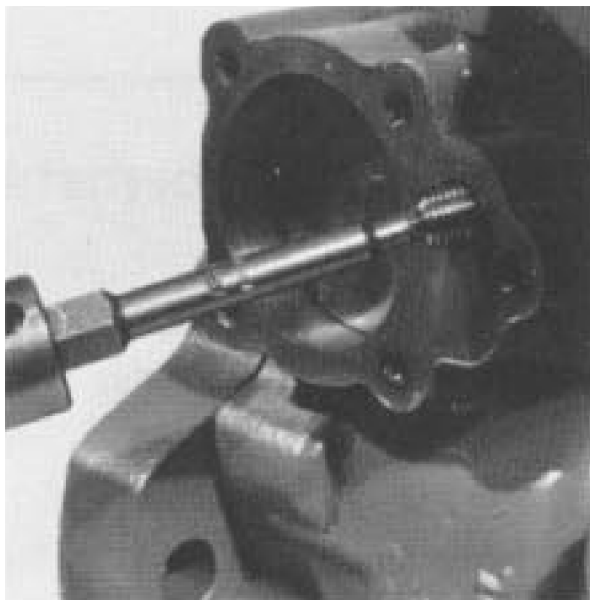
ELECTRICAL DISPLACEMENT CONTROL ORIFICES

NOTE: The pump should have two control orifices located under the servo covers.

1. With a 7/16" wrench, remove the five bolts from the servo cover opposite the neutral adjustment (cover without the adjustment screw).



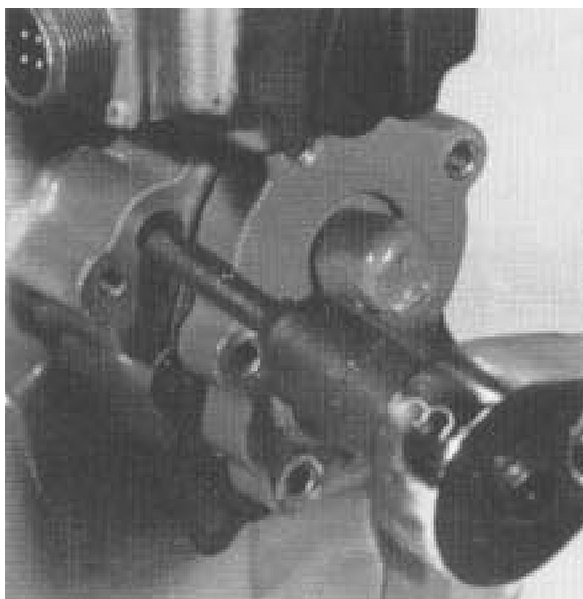
2. With a 7/32" internal wrench, remove and inspect the orifice.



3. Remove the bolts from the servo cover on the neutral adjustment side. Install a spacer or sprocket, approximately 0.75 in. (19 mm) long, under the servo cover opposite the neutral adjustment.



4. Re-install the bolts and tighten until the servo cover on the neutral adjustment side of the pump separates 0.125 in. (3 mm) from the housing. Turn the cover and remove and inspect the orifice.

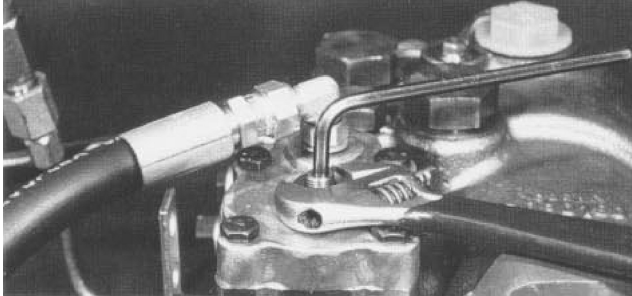


NOTE: The Displacement Control may first have to be removed in order to rotate the servo cover.

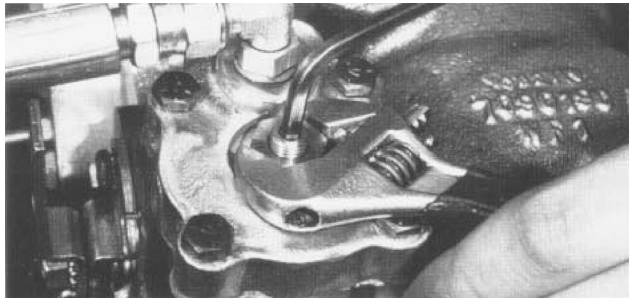
5. Remove spacer, re-install orifices, gaskets, and covers. Torque grade 5 bolts 8 to 11 ft.lbs. (10.8 to 14.9 Nm) and grade 8 bolts 11 to 13 ft.lbs. (14.9 to 17.8 Nm).

SWASHPLATE NEUTRAL ADJUSTMENT

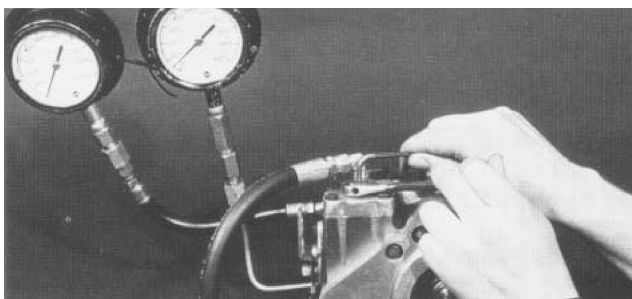
1. Using a low pressure line (500 psi [35 Bar] min.), cross port servo port F to servo port G. This removes the effects of any control pressure on the servo piston.



2. Install pressure gauges (10,000 psi [690 Bar]) in the system pressure gauge ports. Start the engine and slowly accelerate to normal operating RPM.
3. Remove the protective cap and loosen the servo lock nut while holding the servo adjustment screw in position.



4. Turn the servo adjustment screw until the two system pressure gauge readings are equal.
5. Turn the servo adjustment screw clockwise until one of the system pressures starts to increase.



6. Noting the amount of rotation, turn the servo adjustment screw counter-clockwise until the other system pressure starts to increase.
7. Turn the servo adjustment screw clockwise half the amount of rotation noted above.

8. While holding the servo adjustment screw from turning, torque the servo lock nut 13 to 18 ft.lbs. (17.6 to 24.4 Nm). Stop the engine, install a new protective cap, remove the servo cross-port line, and proceed to the appropriate control adjustment.

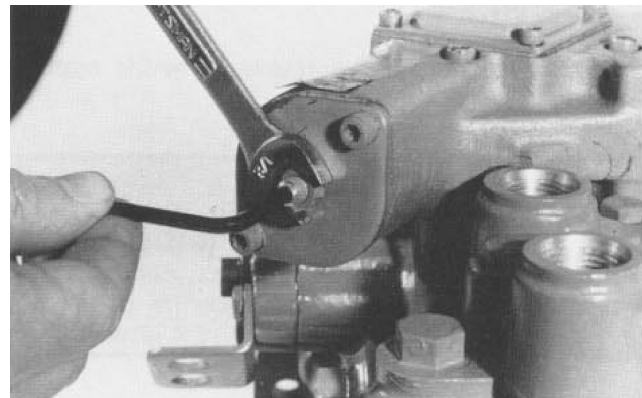
EDC NEUTRAL ADJUSTMENT

1. Remove the electrical connector at the EDC. Remove the servo cross port line (installed while making the swash plate neutral adjustment) and install a 0 to 300 PSI (0 to 21 BAR) gauge in each servo port.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTION DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURES IN ORDER TO PREVENT INJURY TO THE TECHNICIAN AND BYSTANDERS.

2. Start the engine and accelerate to normal operating RPM.
3. Loosen lock nut with 1/2" wrench and slowly rotate the neutral adjustment screw, with 5/32" internal hex wrench, until the pressure is equal on both servo gauges.



4. Slowly rotate the neutral adjustment screw until one of the servo gauges starts to increase in pressure.
5. Noting the amount of rotation, slowly rotate the neutral adjust screw in the opposite direction until the other servo gauge begins to increase in pressure.
6. Turn the neutral adjust screw back one - half the amount noted above. Hold the neutral adjust screw and torque the lock nut to 25 to 30 in.lbs. (2.8 to 3.4 NM).
7. Stop the engine. Connect the control input. Remove the servo pressure gauges. Return the machine to normal operating condition. Restart the engine and assure that the hydrostatic system is in neutral.

Minor Repair and Replacement

Minor repairs may be performed, following the procedures in this section.

Cleanliness is a primary means of assuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign materials and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material.

It is recommended that all gaskets and O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly. All gasket sealing surfaces must be cleaned prior to installing new gaskets.

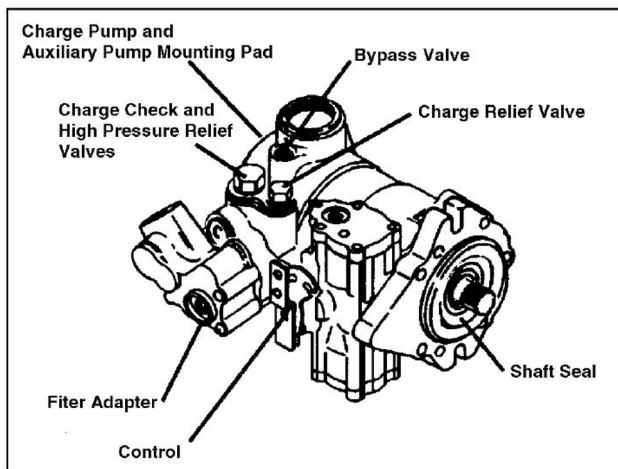


Figure 5-102. Variable Displacement Pump

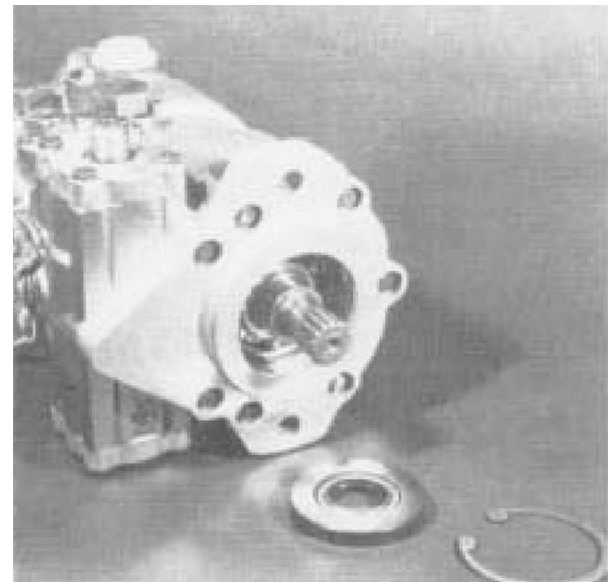
SHAFT SEAL

Lip type shafts are used on Series 40 - M46 pumps and motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal requires removal of the pump from the machine.

1. Remove the retaining ring from the housing.



2. Carefully remove the seal from the housing bore. The face of the seal may be punctured with a sharp instrument (such as a screw driver) to aid in prying the seal out, or a slide hammer type puller may be used to remove the seal. Care must be taken so as not to damage the housing bore or shaft. Once removed, the seal is not reusable.

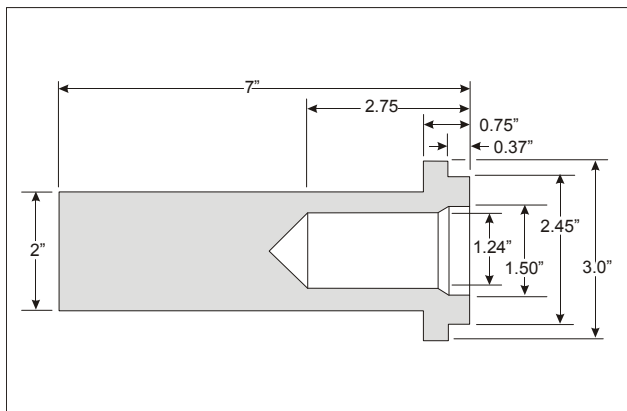


3. Prior to installing the new seal, inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
4. Wrap the spline or key end of the shaft with thin plastic to prevent damage to the seal lip during installation. Lubricate the inside diameter of the new seal with petroleum jelly.

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

NOTE: The outside diameter of the seal may be lightly coated with sealant (such as Loctite High Performance Sealant #59231) prior to installation. This will aid in preventing leaks caused by damage to the housing seal bore.

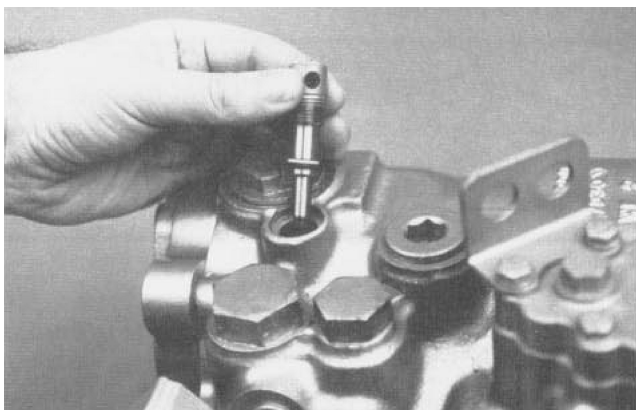
5. Slide the new seal over the shaft and press it into the housing bore. Be careful not to damage seal. A seal installer tool can be made to aid in installing the seal.



6. Reinstall the seal retaining ring.

BYPASS VALVE (PUMP)

1. Unscrew the bypass valve from the housing. Inspect the valve and mating seat for damage or foreign material. It is recommended that the O-ring and back-up ring be replaced.

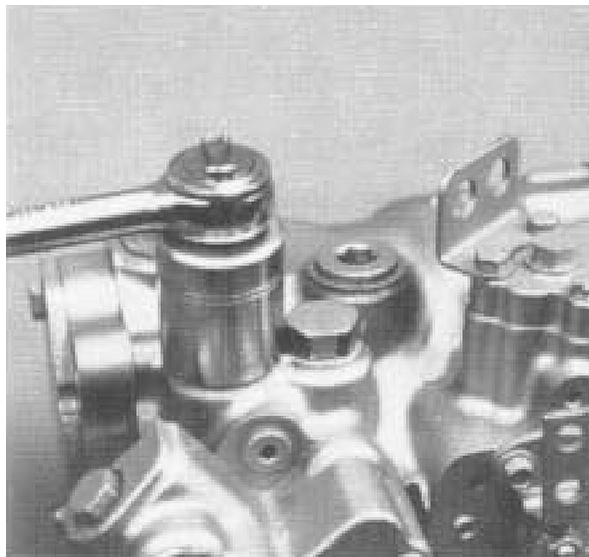


NOTE: Bypass valves are available with integral bypass orifices for specific applications. Refer to the appropriate Service Parts Manual for more information.

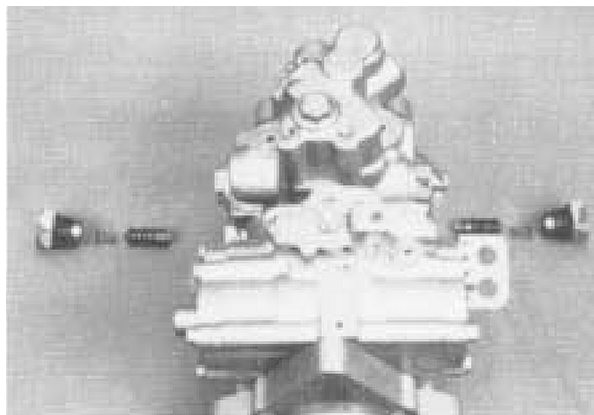
2. Reinstall the bypass valve into the housing. Torque to 7 to 10 ft. lbs. (9.5 - 13.6 Nm).

CHARGE CHECK AND HIGH PRESSURE RELIEF VALVES

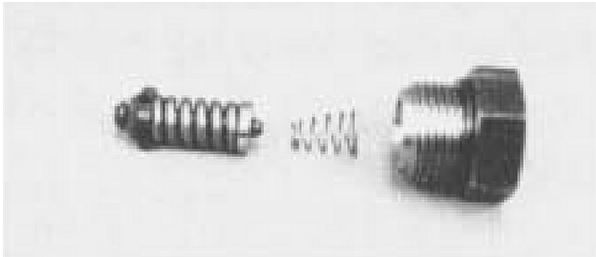
1. Remove the charge check and high pressure relief valve hex plug.



2. Remove the spring and check poppet or valve cartridge from the housing. Inspect the valve and mating seat in the housing for damage or foreign material. It will be necessary to replace the housing if the seat is damaged.



- Several designs of charge check and high pressure relief valves have been used. Do not attempt to mix different vintage parts.



The appropriate check valve kit and/ or check and relief valve kit should be used. Refer to appropriate Service Parts Manual.

NOTE: Always replace ball type charge check valves with the poppet type.

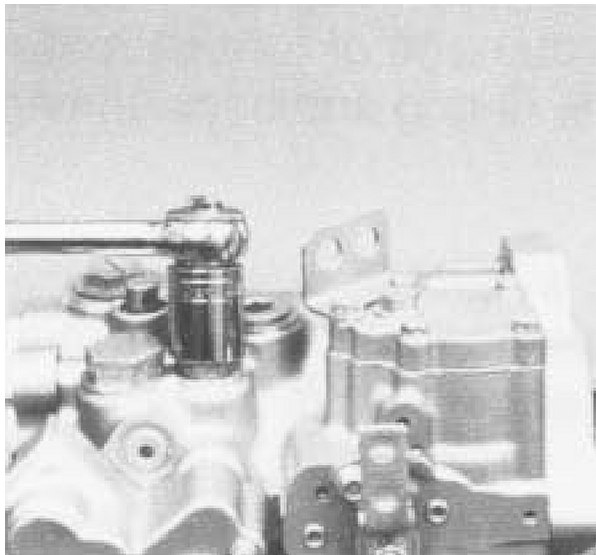
- Reinstall the valve cartridge, spring, and plug (with O-ring) into the housing. Torque the plug to 30 to 70 ft. lbs. (41 to 95 Nm).

⚠ CAUTION

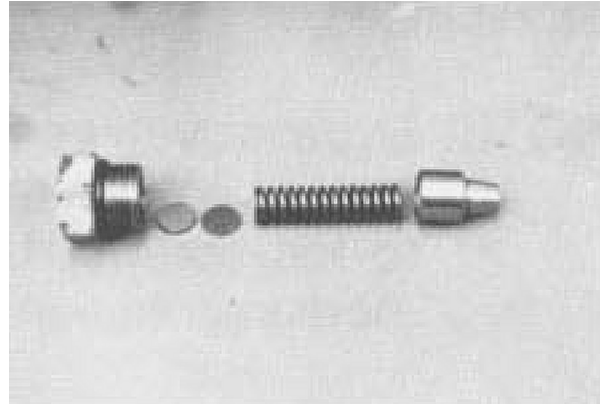
THE RELIEF VALVES ARE FACTORY SET AND SHOULD NOT BE TAMPERED WITH EXCEPT FOR REPLACING THE ENTIRE CARTRIDGE. DISASSEMBLY MAY CHANGE THE SETTING AND CAUSE ERRATIC UNIT OPERATION OR PREMATURE FAILURE.

CHARGE PRESSURE RELIEF VALVE

- Remove charge relief valve hex plug.



- Remove the spring and poppet from the housing. Do not alter the shims or interchange parts with another valve. Inspect the poppet and mating seat in the end cap for damage or foreign material.



- Reinstall the poppet, spring, and plug (with shims and O-ring) into the housing. Torque the plug to 30 to 70 ft. lbs. (41 to 95 Nm).

ELECTRICAL DISPLACEMENT CONTROLS (EDC)

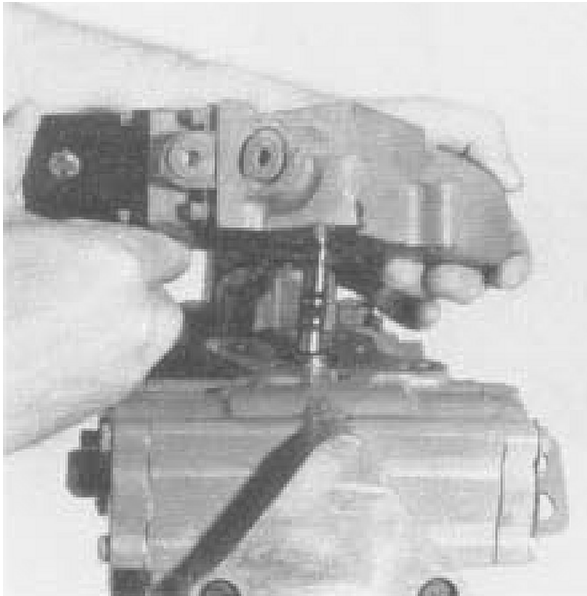
⚠ CAUTION

THE REMOVAL OF ANY PORTION OF THE CONTROL MECHANISM MAY RESULT IN LOSS OF NEUTRAL, WHICH WILL NECESSITATE READJUSTMENT.

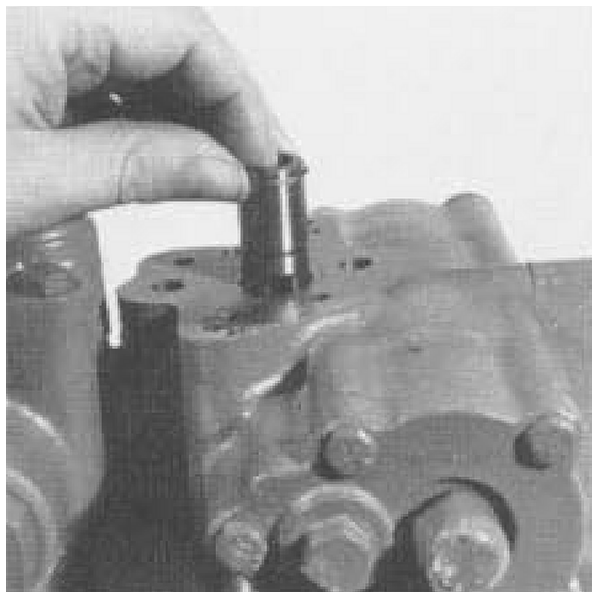
- Remove the four control mounting screws using an internal hex wrench (3/16").



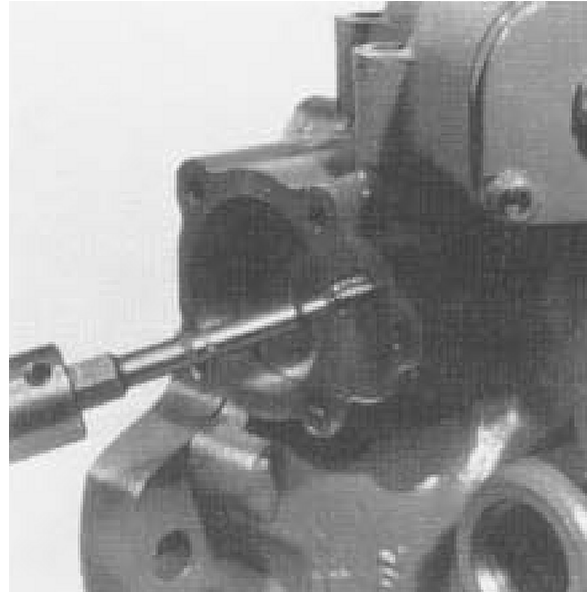
2. Carefully lift the control off the pump housing.



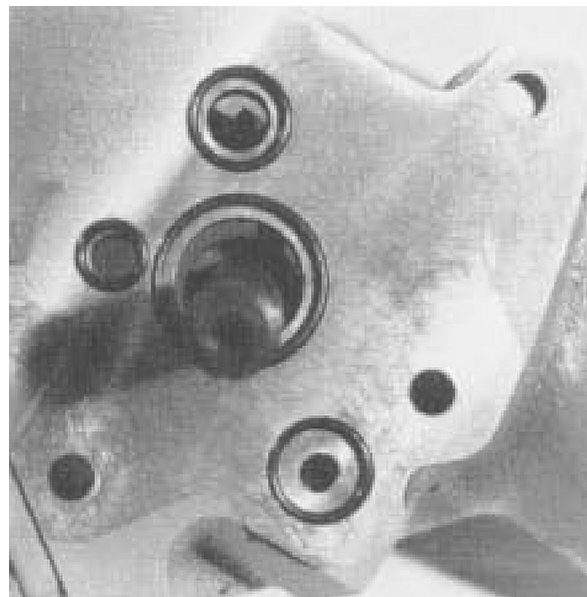
3. Remove the control sleeve from the pump.



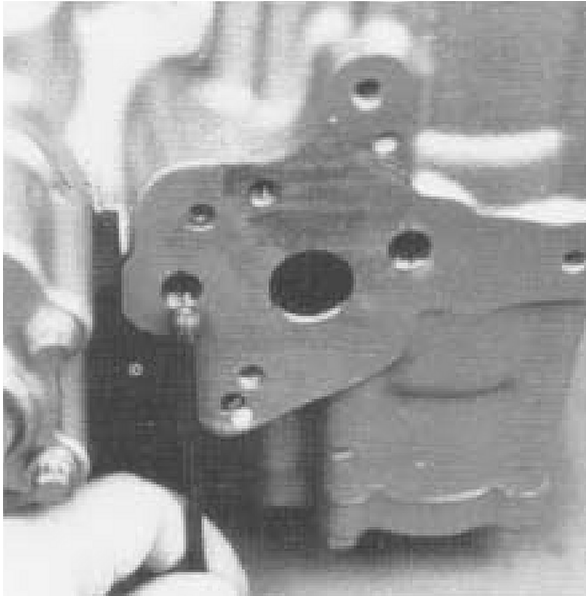
4. Remove the control inlet screen plug from the inlet passage next to the control sleeve bore, using an internal hex wrench (5/32").
5. The control orifice plugs are located in threaded passages under the servo piston cover. Remove the servo piston cover and gasket, and remove the orifice plugs using an internal hex wrench (7/32").



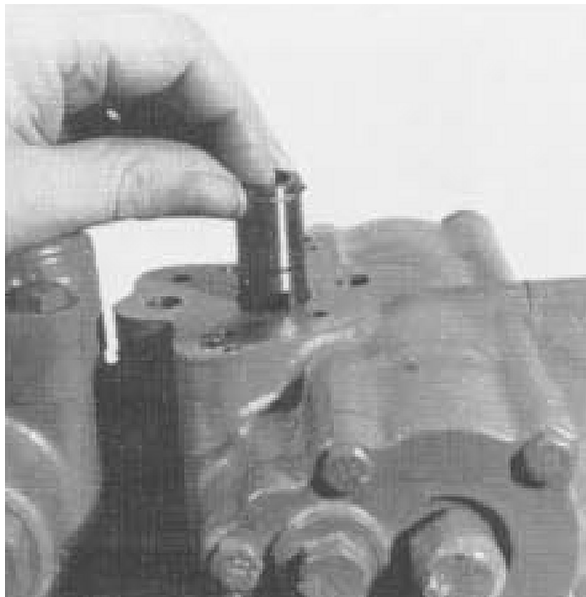
6. Replace the O-ring on the bottom of the control housing. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly. The control spool and sleeve are a matched set and are not available separately.



7. Reinstall the control orifice plugs into their passages and replace the servo piston covers.
8. Install the control inlet screen plug and torque to 20 to 30 in.lbs. (2.2 to 3.4 Nm). Always install a screen plug (with a 0.156" (3.96 mm.) thru hole) when servicing earlier production pumps. Pumps prior to date code 86 - 14 use a plug with a thread that is different from later units. Refer to the Service Parts Manual for plug part numbers.



9. Align the control sleeve so its slot will engage the swash plate feedback pin (slot positioned toward the pump cover) and insert the sleeve into the housing. Carefully align the control spool with the sleeve and install the control onto the pump housing. Install the four mounting screws and torque to 10 to 11 ft.lbs. (13 to 14 Nm).



10. Install the four cover screws and torque to 18 to 24 in. lbs. (2.0 to 2.7 Nm).
11. Readjust the neutral position of the control. Refer to the instructions in the Inspections and Adjustment.

5.7 VALVES - THEORY OF OPERATION

Solenoid Control Valve - Rexroth

Control valves used are four-way three-position solenoid valves of the sliding spool design. When a circuit is activated and the control valve solenoid energizes, the spool is shifted and the corresponding work port opens to permit oil flow to the component in the selected circuit with the opposite work port opening to reservoir. Once the circuit is deactivated (control returned to neutral) the valve spool returns to neutral (center) and oil flow is then directed through the valve body and returns to reservoir. A typical control valve consist of the valve body, sliding spool, and two solenoid assemblies. The spool is machine fitted in the bore of the valve body. Lands on the spool divide the bore into various chambers, which, when the spool is shifted, align with corresponding ports in the valve body open to common flow. At the same time other ports would be blocked to flow. The spool is spring loaded to center position, therefore when the control is released, the spool automatically returns to neutral, prohibiting any flow through the circuit.

Relief Valves

Relief valves are installed at various points within the hydraulic system to protect associated systems and components against excessive pressure. Excessive pressure can be developed when a cylinder reaches its limit of travel and the flow of pressurized fluid continues from the system control. The relief valve provides an alternate path for the continuing flow from the pump, thus preventing rupture of the cylinder, hydraulic line or fitting. Complete failure of the system pump is also avoided by relieving circuit pressure. The relief valve is installed in the circuit between the pump outlet (pressure line) and the cylinder of the circuit, generally as an integral part of the system valve bank. Relief pressures are set slightly higher than the load requirement, with the valve diverting excess pump delivery back to the reservoir when operating pressure of the component is reached.

5.8 PRESSURE SETTING PROCEDURES

NOTICE

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 ALSO RECOMMENDS USING A CALIBRATED GAUGE. PRESSURE READINGS ARE ACCEPTABLE IF WITHIN +/- 5% OF SPECIFIED PRESSURES.

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

1. All applicable steps 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 Block.

Main Relief, Steer, Swing and Lift Down

1. Install pressure gauge at quick disconnect on port MP on main valve
2. With the aid of an assistant, activate telescope in.
3. While monitoring pressure gauge, adjust main relief to 3000 PSI (206.85 Bar).
4. With the aid of an assistant, activate steer left.
5. While monitoring pressure gauge, adjust steer left relief to 1800 PSI (124.1 Bar).
6. With the aid of an assistant, activate steer right.
7. While monitoring pressure gauge, adjust steer right relief to 1800 PSI (124.1 Bar).
8. With the aid of an assistant, activate swing left or right.
9. While monitoring pressure gauge, adjust swing relief to 1700 PSI (117.2 Bar).
10. With the aid of an assistant, activate lift down.
11. While monitoring pressure gauge, adjust lift down relief to 1200 PSI (82.7 Bar).

Platform Level

1. Install pressure gauge at quick disconnect on port M3 on main valve.
2. With the aid of an assistant, activate platform level forward.
3. While monitoring pressure gauge, adjust platform level relief to 2800 PSI (193.06 Bar).
4. Install pressure gauge at quick disconnect on port M4 on main valve.
5. With the aid of an assistant, activate platform level backward.
6. While monitoring pressure gauge, adjust platform level relief to 1800 PSI (124.11 Bar).

Articulating Jib Boom (If Equipped)

1. Install pressure gauge at quick disconnect on articulating valve.
2. With the aid of an assistant, activate articulating jib up.
3. While monitoring pressure gauge, adjust articulating jib up relief to 1500 PSI (103 Bar).
4. With the aid of an assistant, activate articulating jib down.
5. While monitoring pressure gauge, adjust activate articulating jib down relief to 1200 PSI (83 Bar).

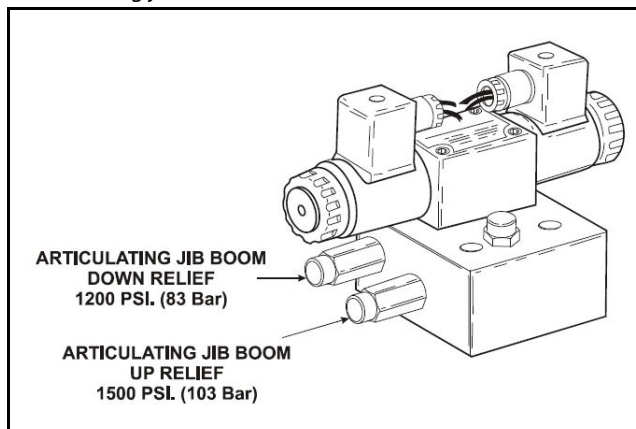
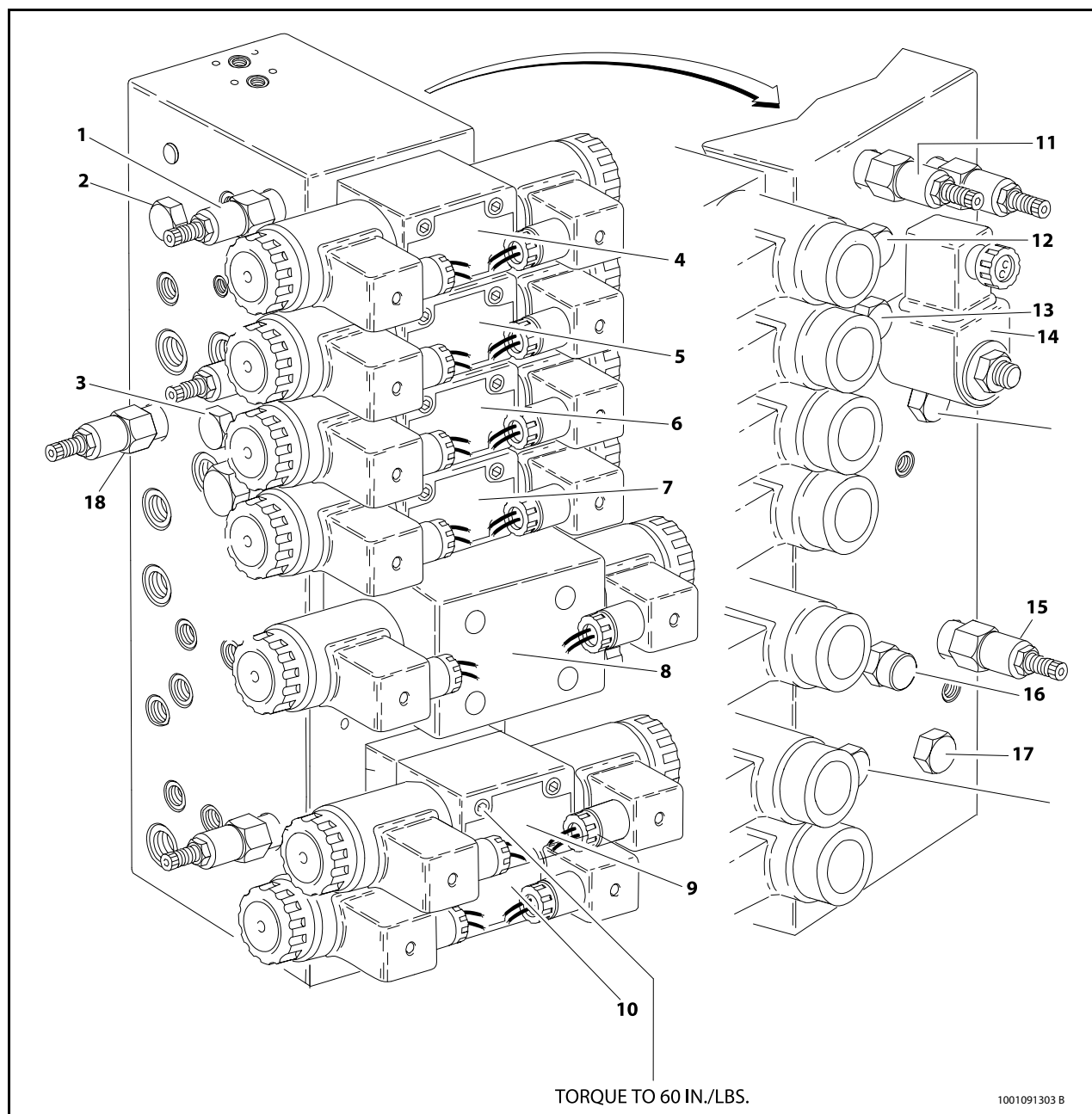


Figure 5-103. Articulating Jib Boom Pressure Adjustments

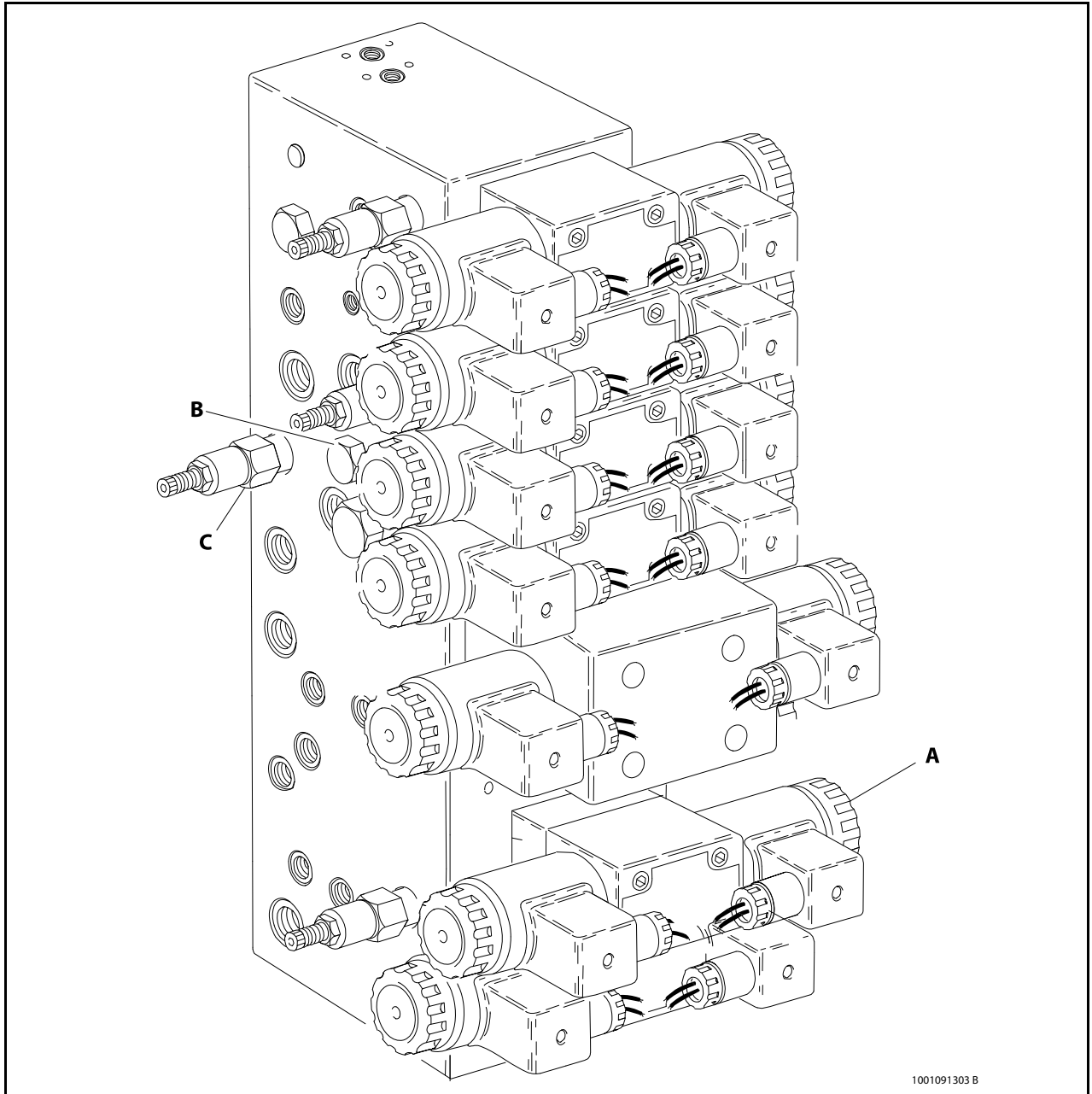
4 Wheel Steer (If Equipped)

1. At the platform console using the steer select switch activate "2 wheel steer".
2. Install a pressure gauge in port MP on main control valve.
3. With the aid of an assistant, activate steer left and right, adjust front steer relief valve to 2500 PSI (172.4 Bar). This pressure only affects the front axle.
4. At the platform console using the steer select switch activate "crab" or "coordinated" steer.
5. At the main control valve block disconnect the wire din connectors on the front steer valve. When steer is activated only the rear steer will work.
6. Install a pressure gauge in port MP on main control valve.
7. With the aid of an assistant, activate steer left and right, adjust rear steer relief valve to 2500 PSI (172.4 Bar). Reading at the valve bank 2500 PSI (172.4 Bar) will give you 2000PSI (137.9 Bar) at the cylinders.
8. Re-connect the front steer din connectors at the valve bank.



- | | | | |
|--------------------------------------|---|--|--|
| 1. Direct Operated Relief Valve | 6. Directional Control Valve (Main Lift) | 10. Directional Control Valve (Platform Level) | 15. Direct Operated Relief Valve |
| 2. Load Shuttle Valve | 7. Directional Control Valve (Flow Control) | 11. Directional Operated Relief Valve | 16. Pressure Compensated Flow Control |
| 3. Pressure Control Load Sense | 8. Directional Control Valve (Main) | 12. Load Shuttle Valve | 17. Pilot Operated Check Valve |
| 4. Directional Control Valve (Steer) | 9. Directional Control Valve (Platform Rotator) | 13. Load Shuttle Valve | 18. Direct Operated Relief Valve (Main Relief) |
| 5. Directional Control Valve (Swing) | | 14. Solenoid Operated 2-Way Valve | |

Figure 5-104. Main Valve Components



1001091303 B

POS	PSI	BAR
A	3000	207
B	230	16
C	50	3

Figure 5-105. Main Valve Components Pressure Adjustments

5.9 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

From a hydrostatic component standpoint, the goal at system start up is to put into functional operation, the hydrostatic system in such a way as to preserve the designed life span of the system. The following start-up procedure should be adhered to whenever a new pump or motor is initially installed into a machine, or a system is restarted after either a pump or motor has been removed and/or replaced.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.

Prior to installing the pump and/or motor, inspect the unit(s) for damage that may have been incurred during shipping and handling. Make certain that all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

NOTE: *If a pump or motor is being replaced due to internal damage, the remaining units (pump or motors) need to be inspected for damage and contamination, and the entire hydraulic system will need to be flushed and the fluid replaced. Failure to do so may cause considerable damage to the entire system.*

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check the inlet line for property tightened fittings and make sure it is free of restrictions and air leaks.

NOTE: *In most cases, the reservoir is above the pump inlet so that the pressure head created by the higher oil level helps to keep the inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to assure that the air is bled from this line. This can be accomplished by loosening the hose at the fitting closest the pump. When oil begins to flow, the line is full, the air has been purged, and the fitting can be retightened to its specified torque. If the tank needs to be pressurized in order to start the flow of oil, a vacuum reading should be taken at the inlet of the pump during operation in order to verify that the pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

NOTE: *It is highly recommended to use the highest possible case drain port, this ensures that the housing contains as much oil as possible and offers the greatest amount of lubrication to the internal components.*

NOTE: *In initial start-up conditions, it may be convenient to fill the housing, just prior to installing the case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

NOTE: *Make certain that the oil being used to fill the component housing is as clean as possible, and store the fill container in such a way as to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in the charge pressure gauge port in order to monitor the charge pressure during start-up.

It is recommended that the external control input signal, (electrical connections for EDC), be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

WARNING

DO NOT START THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

"Jog" or slowly rotate the engine until charge pressure starts to rise. Start the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

NOTE: *With the engine on low idle, "crack", (loosen-don't remove), the system lines at the motor(s). Continue to run the engine at low idle and tighten the system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at the motor the line is full, the air has been purged, and the system hoses should be retightened to their specified torque.*

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine the cause for improper pressure.

WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR'S ABILITY TO CONTROL THE MACHINE.

Shut down the engine and connect the external control input signal. Also reconnect the machine function(s), if disconnected earlier. Start the engine, checking to be certain the pump remains in neutral. With the engine at normal operating RPM, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The machine is now ready for operation.

5.10 HYDRAULIC PUMP W/HAYES PUMP DRIVE COUPLING LUBRICATION

Any time pump or pump drive coupling is removed coat, pump and drive coupling splines with Lithium Soap Base Grease (TEXACO CODE 1912 OR EQUIVALENT) coupling is greased prior to assembly.

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3121202



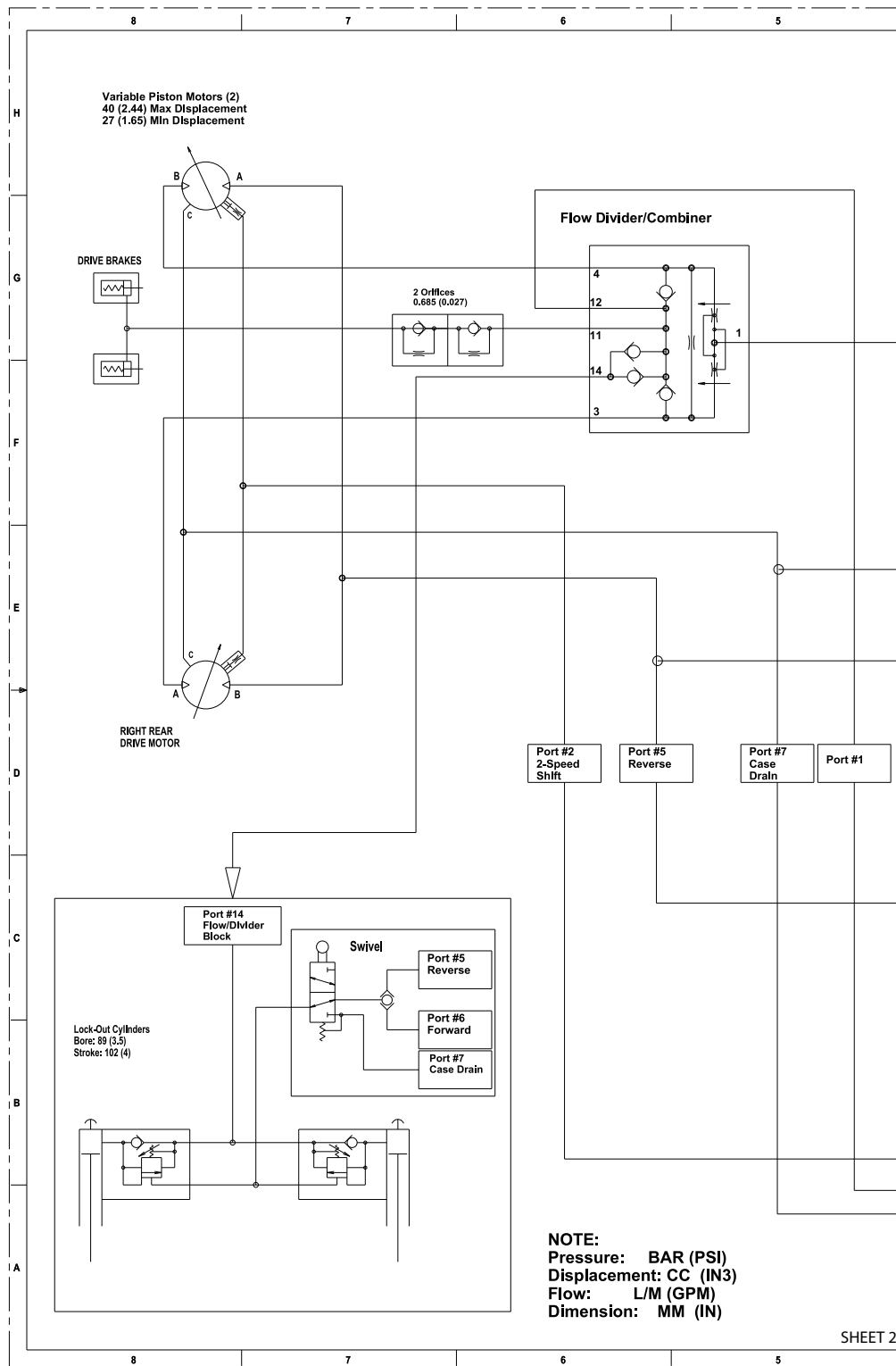


Figure 5-108. Hydraulic Schematic - Sheet 3 of 6

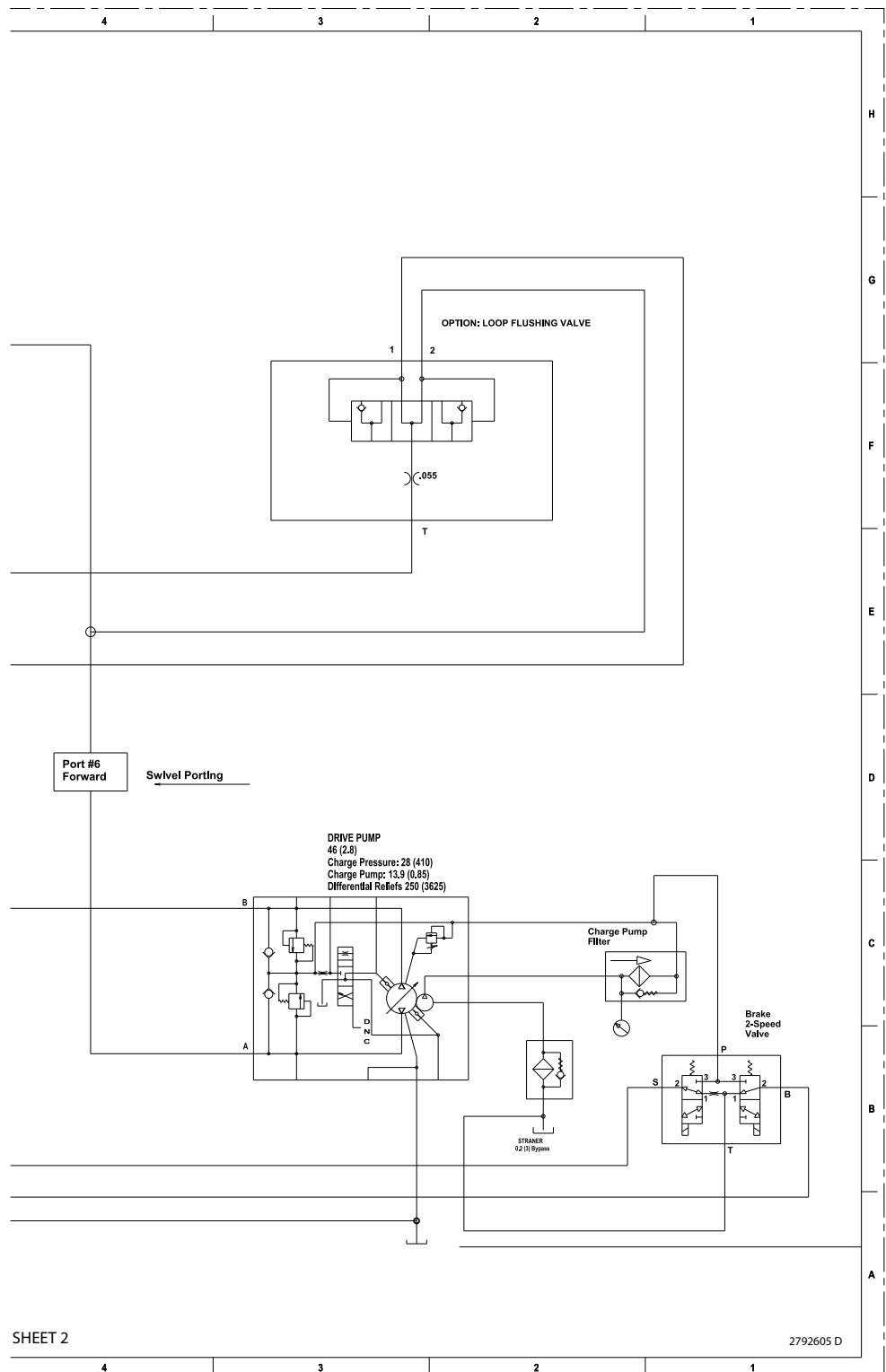


Figure 5-109. Hydraulic Schematic - Sheet 4 of 6

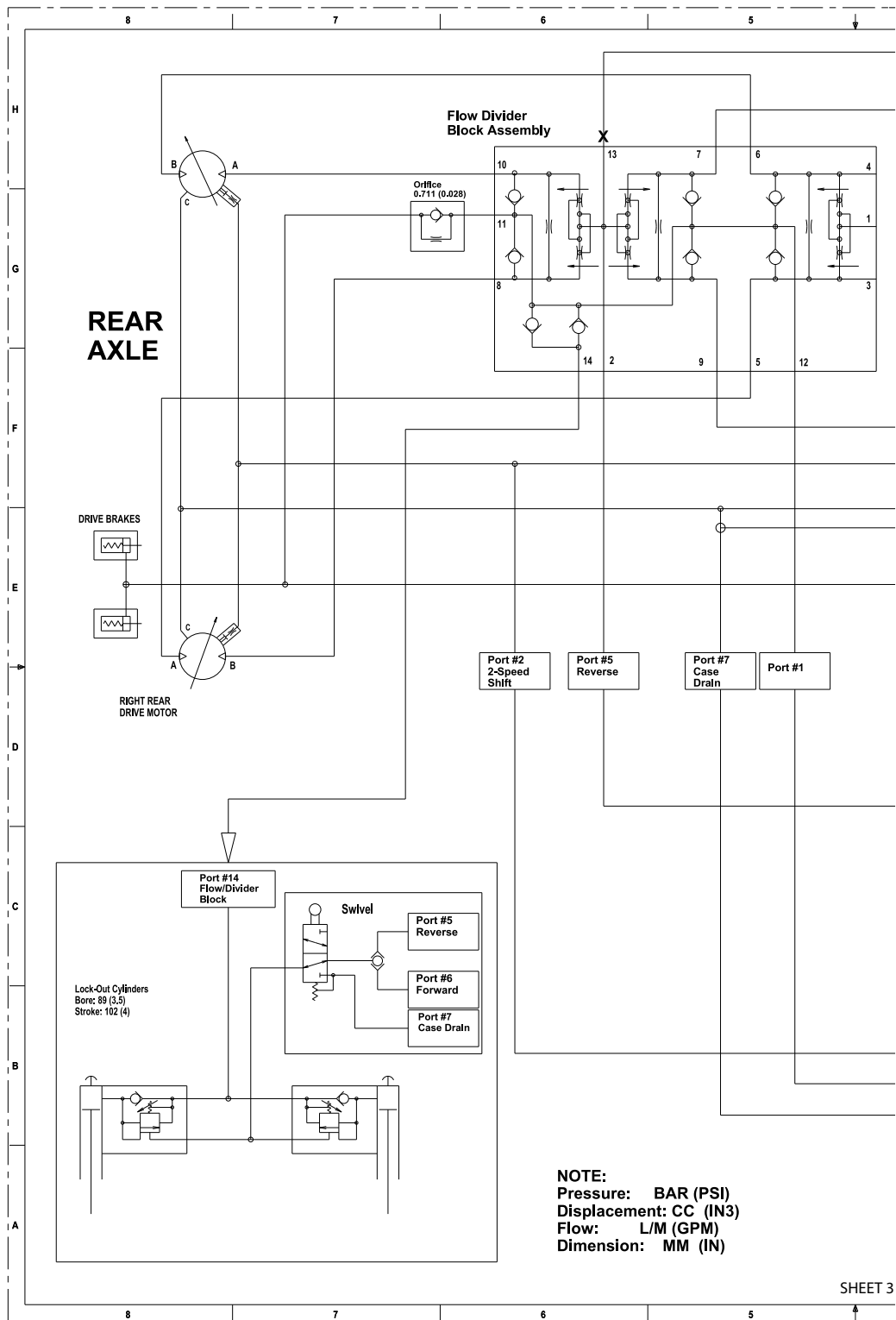


Figure 5-110. Hydraulic Schematic - Sheet 5 of 6

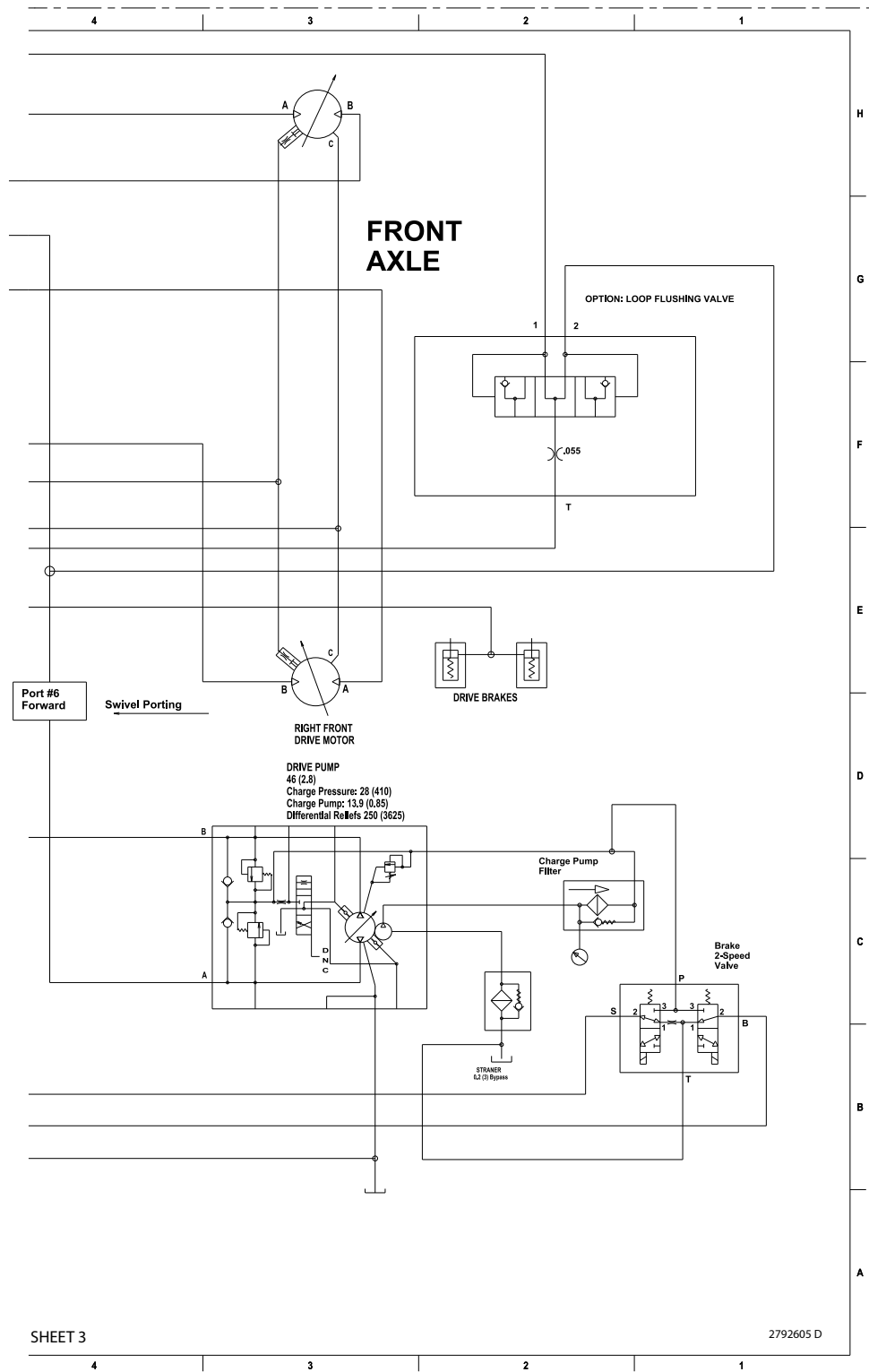


Figure 5-111. Hydraulic Schematic - Sheet 6 of 6

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SECTION 6. JLG CONTROL SYSTEM

6.1 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

Introduction

NOTICE

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

NOTICE

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

The JLG designed Control System is a 12 volt based 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 main 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 Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

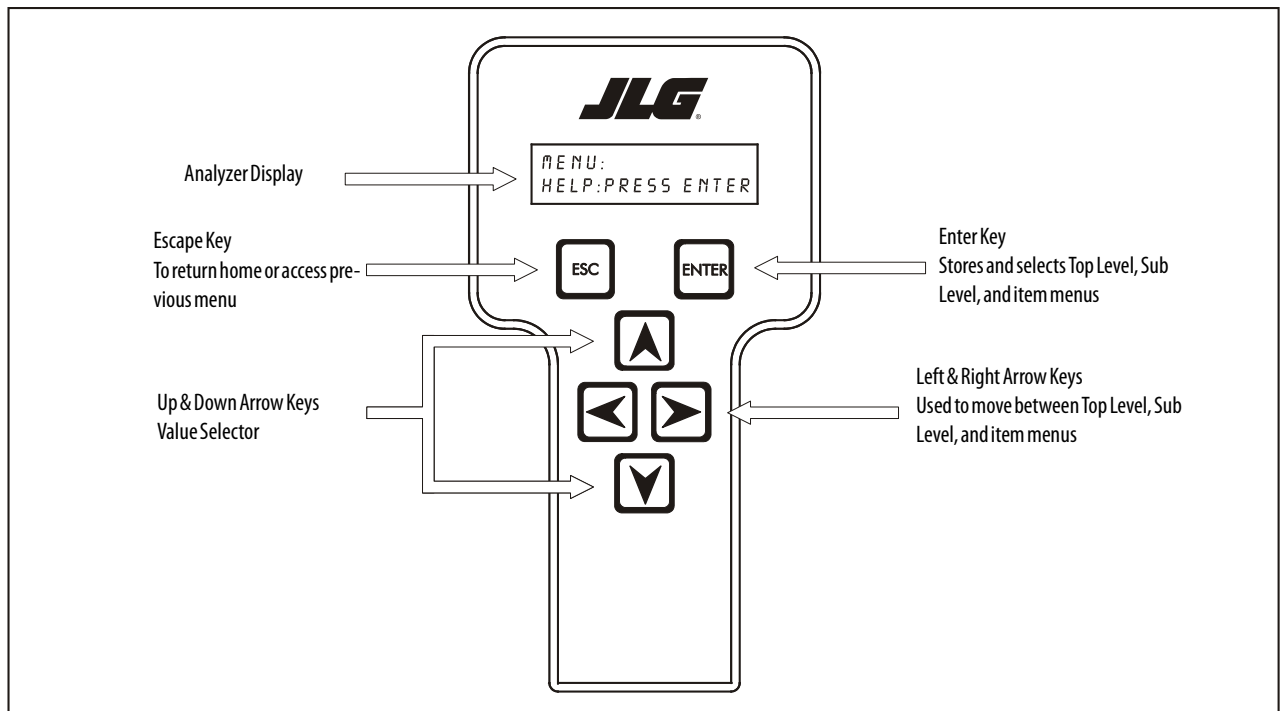


Figure 6-1. Hand Held Analyzer

To Connect the JLG Control System Analyzer

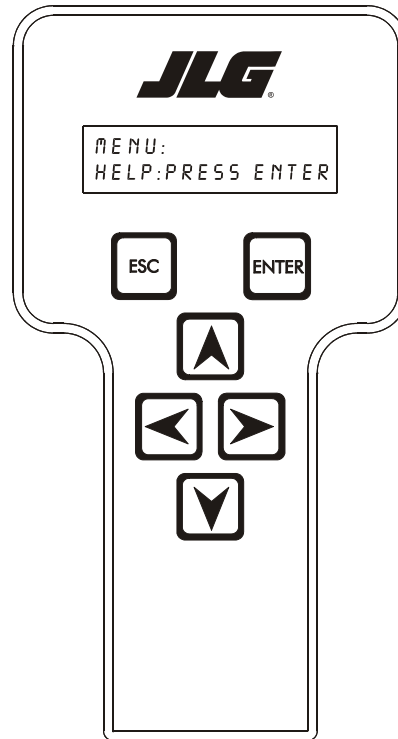
1. Connect the four pin end of the cable supplied with the analyzer, to the motor controller module located in the platform box or at the power module and connect the remaining end of the cable to the analyzer.

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

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


Using the Analyzer

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



**HELP:
PRESS ENTER**


At this point, using the **RIGHT**  and **LEFT**  arrow keys, you can move between the top level menu items. To


select a displayed menu item, press **ENTER** . To cancel a

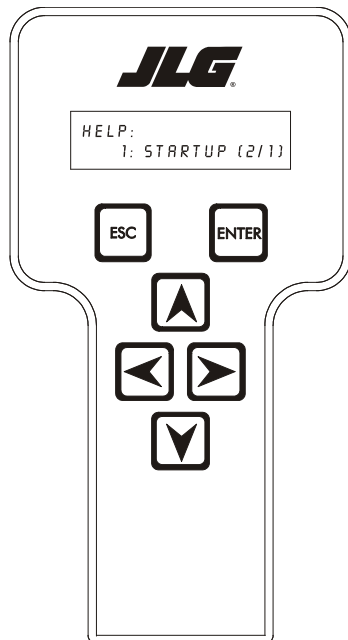
selected menu item, press **ESC** ; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
ACTIVATE TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
LEVEL VEHICLE (level 1 only)
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: STARTUP (2/1)


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. **STARTUP (2/1)** indicates a power up.

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

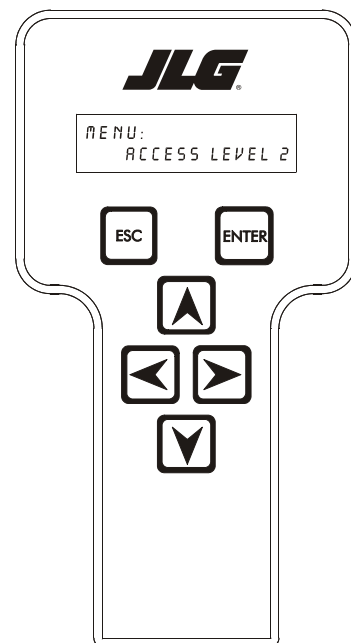
DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

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:




ACCESS LEVEL 2
CODE 00000

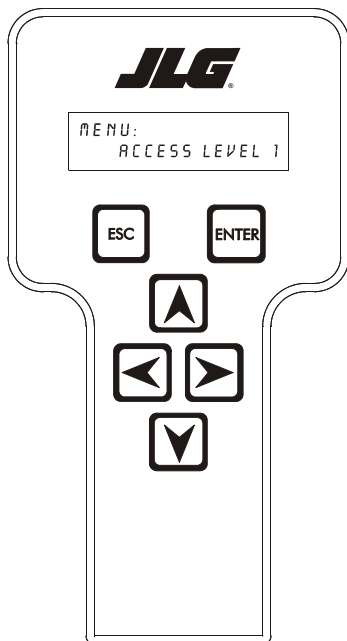
Press **ENTER**  to select the **ACCESS LEVEL** menu.

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

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



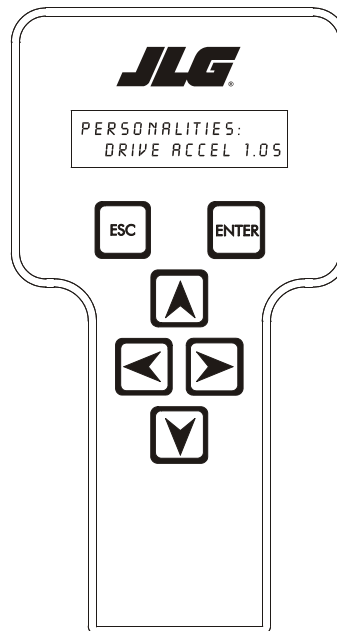
**MENU:
ACCESS LEVEL 1**

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**  / **DOWN**  arrow keys to adjust its value, for example:




**PERSONALITIES:
DRIVE ACCEL 1.5s**



There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP**

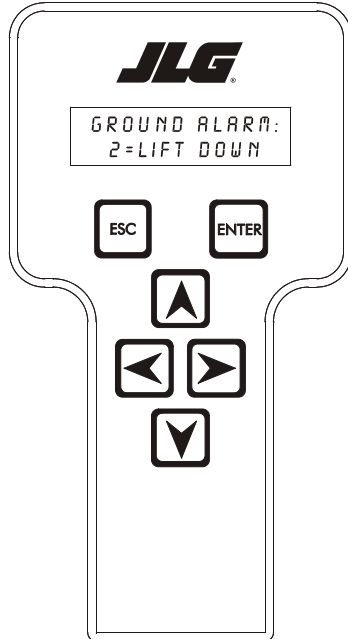


arrow is pressed when at the maximum value nor will

the value decrease if the **DOWN**  arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at 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 driving. There are certain settings allowed to install optional features or select the machine model.

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

NOTE: Refer to *Personality Ranges/Defaults* 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 (30.5 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.

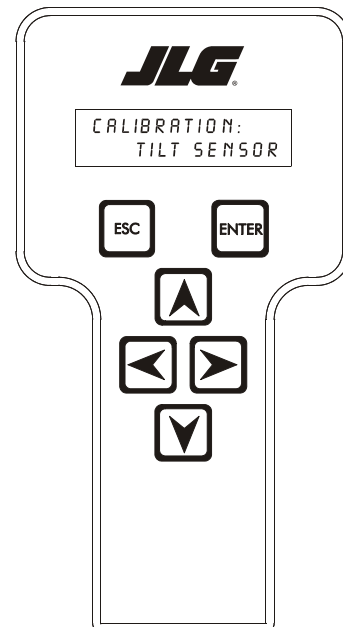
Level Vehicle Description

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 to 180°.

Press **ENTER** .

Table 6-1. Analyzer Abbreviations

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

Table 6-1. Analyzer Abbreviations

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

Table 6-1. Analyzer Abbreviations

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

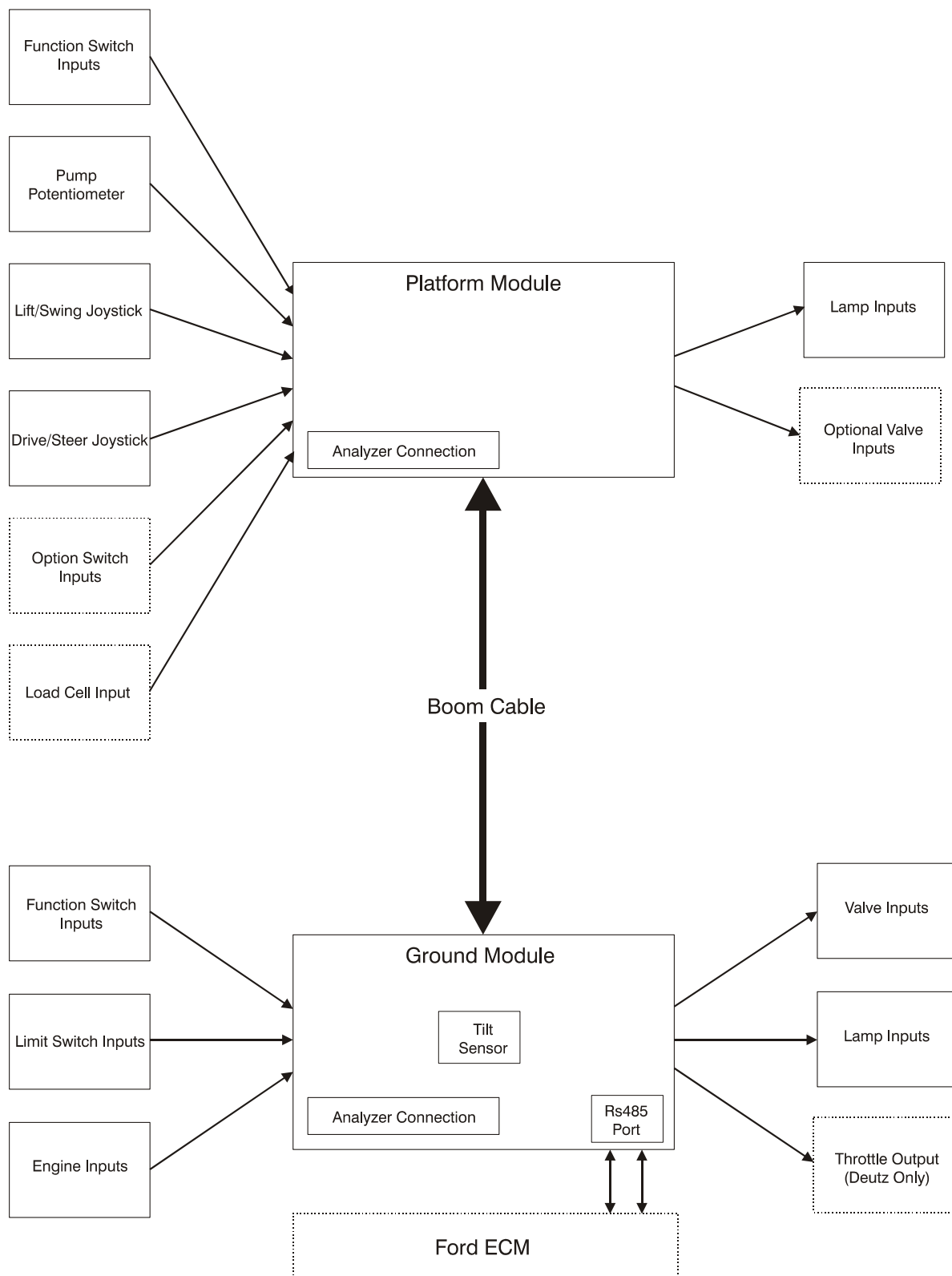


Figure 6-2. ADE Block Diagram

Table 6-2. 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

SECTION 6 - JLG CONTROL SYSTEM

Table 6-2. 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.	
		<i>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.</i>	
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 6-2. 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	MOTION ENABLED: Motion enabled when generator is ON.	0
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
H & T LIGHTS: 13	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 14* * 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: 15* * Only visible under certain model 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).	
LOAD SENSOR: 16* * Only visible if Load Sensor Menu selection is not 0. * Market selections will limit certain load sensor options.	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
FUNCTION CUTOUT: 17* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive cutout above elevation.	
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).	
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.	

Table 6-2. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
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 6-3. 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 6-3. 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 EFID/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 6-3. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/Digit	Number	Description	Default Number
ENGINE SHUTDOWN: 7	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: 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	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.	
JIB: 9* * 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: 10* * Only visible under certain model selections.	0	NO: No four-wheel steer installed.	0
	1	YES: Four-wheel steer installed.	
SOFT TOUCH: 11* * Only visible under certain model selections.	0	NO: No soft touch system installed.	0
	1	YES: Soft touch system installed.	
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.	

SECTION 6 - JLG CONTROL SYSTEM

Table 6-3. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/Digit	Number	Description	Default Number
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).	
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 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
FUNCTION CUTOUT: 18* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	3	DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	

Table 6-3. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/Digit	Number	Description	Default Number
GROUND ALARM: 19* * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	3
	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: 20* * 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: 21* * Certain market selections will alter default setting.	0	CELSIUS: Celsius unit selection.	1
	1	FAHRENHEIT: Fahrenheit unit selection.	
LEVELING MODE: 22* * 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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SECTION 6 - JLG CONTROL SYSTEM

Table 6-4. 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 6-4. 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	DEUTZF4 TIER1: Deutz F4M1011FDiesel (Tier 1)	
	4	DEUTZF3 TIER1: Deutz F3M1011FDiesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZF4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZF3 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.	
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.	

SECTION 6 - JLG CONTROL SYSTEM

Table 6-4. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/Digit	Number	Description	Default Number
ENGINE SHUTDOWN: 7	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: 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	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.	
JIB: 9* * 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: 10* * Only visible under certain model selections.	0	NO: No four-wheel steer installed.	0
	1	YES: Four-wheel steer installed.	
SOFT TOUCH: 11* * Only visible under certain model selections.	0	NO: No soft touch system installed.	0
	1	YES: Soft touch system installed.	
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.	

Table 6-4. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/Digit	Number	Description	Default Number
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).	
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 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
FUNCTION CUTOUT: 18* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	3	DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	

SECTION 6 - JLG CONTROL SYSTEM

Table 6-4. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/Digit	Number	Description	Default Number
GROUND ALARM: 19* * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	3
	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: 20* * 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: 21* * Certain market selections will alter default setting.	0	CELSIUS: Celsius unit selection.	1
	1	FAHRENHEIT: Fahrenheit unit selection.	
LEVELING MODE: 22* * 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.	
DRIVE CONTROL: 23	0	NORMAL: Drive coils are energized from the Ground Module.	2
	1	PROPULSION: Drive coils are energized from the Propulsion Module.	
	2	ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	
CLEARSKY: 24	0	NO: Clearsky (telematics) option is disabled.	0
	1	YES: Clearsky (telematics) option is enabled.	
CRIBBING OPTION: 25	0	NO: Cribbing Option is disabled.	0
	1	YES: Cribbing Option is enabled.	

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Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
NOTE: For version 6.X software , some screens may not be available depending upon machine configuration and software versions.			
NOTE: The machine configuration must be completed before any personality settings can be changed. Changing the personality settings first and then changing the model number of the machine configuration will cause the personality settings to return to default values.			
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	
	6	GB	

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORDEFI GAS: Ford LRG425 EFI Gas (Tier 1)	14
	2	FORDEFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZF4TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZF3TIER1: 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	DEUTZF4TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZF3TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORDGASTIER2: 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	PERKINSECM	
	15	CATECM	
	16	DEUTZ EMR4: Deutz Engine Control Module (Tier 4 Final)	
	17	FORD DUAL FUEL	
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.	

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
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.	
FUEL CUTOFF 7 * This menu item is only visible if non dual fuel engines are selected.	0	RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached.	0
	1	ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached.	
	2	ENGINE STOP: Engine not able to restart when very low fuel level is reached.	
ENGINE SHUTDOWN: 8	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 (0.55 bar).	

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
TILT: 9* * Certain market selections will limit tilt options and alter default setting. <i>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.</i>	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.	
	6	5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	7	5 DEG + DRV CUT: 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 when drive reversal is allowed, drive is disallowed otherwise.	
	8	4 DEG + DRV CUT: 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 when drive reversal is allowed, drive is disallowed otherwise.	
	9	3 DEG + DRV CUT: 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 when drive reversal is allowed, drive is disallowed otherwise.	
JIB: 10* * 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: 11* * Only visible under certain model selections.	0	NO: No four-wheel steer installed.	0
	1	YES: Four-wheel steer installed.	

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
STOUCH / SKYGUARD: 12	0	NONE: No soft touch or skyguard system installed.	0
	1	SOFT TOUCH - Soft touch only installed.	
	2	SKYGUARD - Skyguard only installed.	
	3	BOTH (CUTOUT) - Soft touch and Skyguard installed.	
GEN SET/WELDER: 13	0	NO: No generator installed.	0
	1	BELT DRIVE: Belt driven setup.	
GEN SET CUTOUT: 14* * 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: 15	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 16* * 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.	

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
LOAD SYSTEM: 17* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting. * LOAD SYSTEM will not be visible in CE and defaulted to CUTOUT ALL for machines equipped with MSSO.	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).	
LOAD SENSOR: 18* * 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 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
	2	SINGLE CELL: Single Cell, CANbus based sensor.	
FUNCTION CUTOUT: 19* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	3	DRIVE CUTE&T: Drive & steer cutout above elevation and tilted.	
GROUND ALARM: 20* * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	3
	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: 21* * 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.	

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
DISPLAY UNITS: 22* *Certain market selections will alter default setting.	0 1	IMPERIAL: DEG F, PSI, LBS. METRIC: DEG C, KPA, KGS	0
LEVELING MODE: 23* *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: 24	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
DRIVE PUMP 25* *Only visible on 600A, 600S, and 800S models.	0 1 2 3	SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump EATON: Machine equipped with Eaton drive pump. M46 - XXXX: Machine equipped with M46 - XXXX drive pump. 830XXXXX: Machine equipped with 830XXXXX: drive pump.	0
BOOM CONTROL: 26	0 1	NORMAL: Boom function coils are energized from the Ground Module. ENHANCED: Boom function are energized from the Ground Module and the ground side of the drive coils and brought back to current feedback returns.	0
FUNCTION SPEED KNOB: 27	0 1	YES: Machine is equipped with Function Speed Knob. NO: Machine is equipped with Operation Speed Switch.	0
CLEARSKY: 28	0 1	NO: Clearsky (telematics) option is disabled. YES: Clearsky (telematics) option is enabled.	0

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
CRIBBING OPTION: 29	0	NO: Cribbing Option is disabled.	0
	1	YES: Cribbing Option is enabled.	
FUEL TANK SIZE: 30	0	31 Gallon Tank	0
	1	52 Gallon Tank	
ALARM / HORN: 31	0	SEPERATE: Separate alarm and horn.	0
	1	COMBINED: Combination alarm / horn.	
ALERT / BEACON: 32	0	OFF FOR CREEP: Alert beacon will not flash while in Creep.	0
	1	20 FPS FOR CREEP: Alert beacon will flash at 20 FPS while in Creep.	
TEMP CUTOUT: 33	0	NO: Temp Cutout is Disabled	0
	1	YES: Temp Cutout is Enabled	
PLAT LVL OVR CUT: 34	0	NO: Platform Level Override will always be functional.	0
	1	YES: Platform Level Override will only be functional when In Transport.	
WATER IN FUEL SENSOR: 35*	0	NO: Water in Fuel Sensor Disabled.	0
	1	YES: Water in Fuel Sensor Enabled.	
*This menu item is only visible if Deutz EMR 4 engine is selected. *Only visible under certain market selections.			

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Table 6-6. 600S Machine Configuration Programming Settings

600 S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	4	4	4	4	4	4	4
Market	0	1	2	3	4	5	3
Engine	12	12	12	12	12	12	12
Flywheel Teeth	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Glow Plug	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Starter Lockout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Engine Shut-down	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Tilt	1	1	1	X	X	1	X
	2	2	2	X	2	2	X
	3	3	3	X	3	3	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	X	X	6	X
	7	7	7	X	X	7	X
	8	8	8	8	8	8	8
	9	9	9	9	9	9	9
Jib	0	0	0	0	0	0	0
4 Wheel Steer	0	0	0	0	0	0	0
Soft Touch/Skyguard	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Gen Set/Welder	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Gen Set Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Head & Tail-lights	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cable Break Switch	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Load System	0	0	0	0	0	0	0
	X	1	X	X	X	1	X
	X	2	X	2	2	2	2
	X	3	X	3	X	3	3
	X	4	X	X	X	4	X

Table 6-6. 600S Machine Configuration Programming Settings

600 S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Load Sensor	X	0	X	0	0	0	0
	1	1	1	1	1	1	1
	X	2	X	2	2	2	2
Function Cut-out	0	0	0	0	0	0	0
	X	1	1	1	1	1	1
	2	2	2	X	2	2	2
	X	3	3	X	3	3	3
Ground Alarm	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Drive Type	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Display Units	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Leveling Mode	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Drive Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Drive Pump	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Boom Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Function Speed Knob	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Clearsky	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cribbing Option	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel Tank Size	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Alarm/Horn	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Alert Beacon	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Temp Cutout	X	0	X	0	X	X	0
	X	1	X	1	X	X	1
Plat Lvl Ovr Cut	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

Table 6-6. 600S Machine Configuration Programming Settings

600 S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Water Fuel Sensor	X	0	X	X	X	X	0
	X	1	X	X	X	X	1
Dual Capacity	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

BOLD BLUE text indicates the default setting. Plain text indicates another available selection. **RED ITALIC** text indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

Table 6-7. 600SJ Machine Configuration Programming Settings

600 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	4	4	4	4	4	4	4
Market	0	1	2	3	4	5	3
Engine	12	12	12	12	12	12	12
Flywheel Teeth	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Glow Plug	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Starter Lockout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Engine Shut-down	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Tilt	1	1	1	X	X	1	X
	2	2	2	X	2	2	X
	3	3	3	X	3	3	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	X	X	6	X
	7	7	7	X	X	7	X
	8	8	8	8	8	8	8
	9	9	9	9	9	9	9
Jib	1	1	1	1	1	1	1
4 Wheel Steer	0	0	0	0	0	0	0
Soft Touch/Skyguard	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Gen Set/Welder	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Gen Set Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Head & Tail-lights	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cable Break Switch	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Load System	0	0	0	0	0	0	0
	X	1	X	X	X	1	X
	X	2	X	2	2	2	2
	X	3	X	3	X	3	3
	X	4	X	X	X	4	X

Table 6-7. 600SJ Machine Configuration Programming Settings

600 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Load Sensor	X	0	X	0	0	0	0
	1	1	1	1	1	1	1
	X	2	X	2	2	2	2
Function Cut-out	0	0	0	0	0	0	0
	X	1	1	1	1	1	1
	2	2	2	X	2	2	2
Ground Alarm	X	3	3	X	3	3	3
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Drive Type	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
	0	0	0	0	0	0	0
Display Units	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	0	0	0	0	0	0	0
Leveling Mode	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Drive Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Drive Pump	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	2	2	2	2	2	2	2
Boom Control	3	3	3	3	3	3	3
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Function Speed Knob	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
Clearsky	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cribbing Option	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
Fuel Tank Size	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Alarm / Horn	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
Alert Beacon	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Temp Cutout	X	0	X	0	X	X	0
	X	1	X	1	X	X	1
	0	0	0	0	0	0	0
Plat Lvl Ovr Cut	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

Table 6-7. 600SJ Machine Configuration Programming Settings

600 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Water Fuel Sensor	X	0	X	X	X	X	0
	X	1	X	X	X	X	1
Dual Capacity	0	0	0	0	0	0	0
	1	<i>1</i>	1	1	1	<i>1</i>	<i>1</i>

BOLD BLUE text indicates the default setting. Plain text indicates another available selection. **RED ITALIC** text indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

Table 6-8. 660SJ Machine Configuration Programming Settings

660 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	4	4	4	4	4	4	4
Market	0	1	2	3	4	5	3
Engine	12	12	12	12	12	12	12
Flywheel Teeth	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Glow Plugs	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Starter Lockout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Engine Shut-down	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	1	1	1	1	1	1	1
Tilt	1	1	1	X	X	1	X
	2	2	2	X	2	2	X
	3	3	3	X	3	3	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	X	X	6	X
	7	7	7	X	X	7	X
	8	8	8	8	8	8	8
	9	9	9	9	9	9	9
Jib	1	1	1	1	1	1	1
4 Wheel Steer	0	0	0	0	0	0	0
Soft Touch/Skyguard	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Gen Set/Welder	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

SECTION 6 - JLG CONTROL SYSTEM

Table 6-8. 660SJ Machine Configuration Programming Settings

660 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Gen Set Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Head & Tail-lights	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cable Break Switch	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Load System	0	0	0	0	0	0	0
	X	1	X	X	X	1	X
	X	2	X	2	2	2	2
	X	3	X	3	X	3	3
	X	4	X	X	X	4	X
Load Sensor	X	0	X	0	0	0	0
	1	1	1	1	1	1	1
	X	2	X	2	2	2	2
Function Cut-out	0	0	0	0	0	0	0
	X	1	1	1	1	1	1
	2	2	2	X	2	2	2
	X	3	3	X	3	3	3
Ground Alarm	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Drive Type	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Display Units	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Leveling Mode	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Drive Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Drive Pump	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Boom Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Function Speed Knob	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Clearsky	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cribbing Option	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

Table 6-8. 660SJ Machine Configuration Programming Settings

660 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Fuel Tank Size	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Alarm / Horn	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Alert Beacon	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Temp Cutout	X	0	X	0	X	X	0
	X	1	X	1	X	X	1
Plat Lvl Ovr Cut	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Water Fuel Sensor	X	0	X	X	X	X	0
	X	1	X	X	X	X	1
Dual Capacity	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

BOLD BLUE text indicates the default setting. Plain text indicates another available selection. **RED ITALIC** text indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

6.2 MACHINE PERSONALITY SETTINGS AND FUNCTION SPEEDS

NOTE: Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.

Table 6-9. Machine Personality Settings

FUNCTION	PERSONALITY	RANGE	DEFAULTS-600S
DRIVE	ACCEleration	0.0 to 5.0 s	2.5
	DECEleration	0.0 to 3.0 s	0.8
	FORward MINimum speed	1 to 35%	4
	FORward MAXimum speed	1 to 100%	30
	REVerse MINimum speed	1 to 35%	4
	REVerse MAXimum speed	1 to 100%	31
	ELEVATED MAXimum speed	1 to 100%	18
	CREEP MAXimum speed	1 to 90%	15
STEER	MAXimum speed	1 to 100%	100
MAIN LIFT	ACCEleration	0.0 to 5.0s	2.5
	DECEleration	0.0 to 3.0s	1
	MINimum UP speed	1 to 60%	40
	MAXimum UP speed	1 to 100%	93
	CREEP UP speed	1 to 65%	65
	MINimum DOWN speed	1 to 60%	40
	MAXimum DOWN speed	1 to 100%	100
	CREEP DOWN speed	1 to 75%	69
SWING	ACCEleration	0.0 to 5.0s	2
	DECEleration	0.0 to 3.0s	1.8
	MINimum LEFT speed	1 to 50%	45
	MAXimum LEFT speed	1 to 100%	76
	CREEP maximum LEFT speed	1 to 65%	63
	MINimum RIGHT speed	1 to 50%	45
	MAXimum RIGHT speed	1 to 100%	76
	CREEP maximum RIGHT speed	1 to 65%	63
MAIN TELESCOPE	ACCEleration	0.0 to 5.0s	3.5
	DECEleration	0.0 to 3.0s	1.5
	MINimum IN speed	1 to 65%	48
	MAXimum IN speed	1 to 100%	80
	MINimum OUT speed	1 to 65%	49
	MAXimum OUT speed	1 to 100%	100
	Medium Speed	0.01 to 1.00	0.45

Table 6-9. Machine Personality Settings

FUNCTION	PERSONALITY	RANGE	DEFAULTS-600S
PLATFORM LEVEL	ACCEleration	0.0 to 5.0s	2.5
	DECEleration	0.0 to 3.0s	0.5
	MINimum UP speed	1 to 65%	30
	MAXimum UP speed	1 to 100%	75
	MINimum DOWN speed	1 to 65%	30
	MAXimum DOWN speed	1 to 100%	75
	Medium Speed	0.01 to 1.00	0.40
PLATFORM ROTATE	ACCEleration	0.0 to 5.0s	1.9
	DECEleration	0.0 to 3.0s	0.8
	MINimum LEFT speed	1 to 100%	25
	MAXimum LEFT speed	1 to 100%	100
	MINimum RIGHT speed	1 to 100%	25
	MAXimum RIGHT speed	1 to 100%	100
	Medium Speed	0.01 to 1.00	0.45
JIB LIFT	Lift ACCEleration	0.0 to 5.0s	1.8
	Lift DECEleration	0.0 to 3.0s	0.8
	MINimum UP speed	1 to 65%	30
	MAXimum UP speed	1 to 100%	40
	MINimum down	1 to 65%	30
	MAXimum Down	1 to 100%	43
	Medium Speed	0.01 to 1.00	0.60
GROUND MODE	Tower LIFT UP speed	1 to 100%	N/A
	Tower LIFT DOWN speed	1 to 100%	N/A
	Main LIFT UP speed	1 to 100%	85
	Main LIFT DOWN speed	1 to 100%	92
	SWING speed	1 to 100%	75
	Main TELEscope speed	1 to 100%	70
	Tower TELEscope speed	1 to 100%	N/A
	Platform ROTATE speed	1 to 100%	99
	Platform LEVEL speed	1 to 100%	74
	Jib LIFT (UP/DOWN) speed	1 to 100%	39
	Jib Swing (LEFT/RIGHT) speed	1 to 100%	N/A
Note: Ground Mode speed are automatically limited to being lower than platform speed for a given function.			

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6.3 MACHINE ORIENTATION WHEN DOING SPEED TESTS

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

Swing: Boom at Full Elevation. Telescope Retracted. Swing the Turntable off center and stop. Swing the opposite direction and start the test when the turntable is centered up. This eliminates ramp up and down on the controller affecting times.

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

Drive: Test should be done on a smooth level surface. Drive Select Switch should be set to high speed. Start approximately 25 ft. (7.62 m) from the starting point so that the unit is at maximum speed when starting the test. Results should be recorded for a 200 ft. (60.96 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

Drive (Above Horizontal): Test should be done on a smooth level surface. Drive Select Switch should be set to High Engine, High Speed. The boom should be raised above horizontal. The platform speed control knob should be selected out of creep speed. Results should be recorded for a 50 ft. (15.2 m) 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.

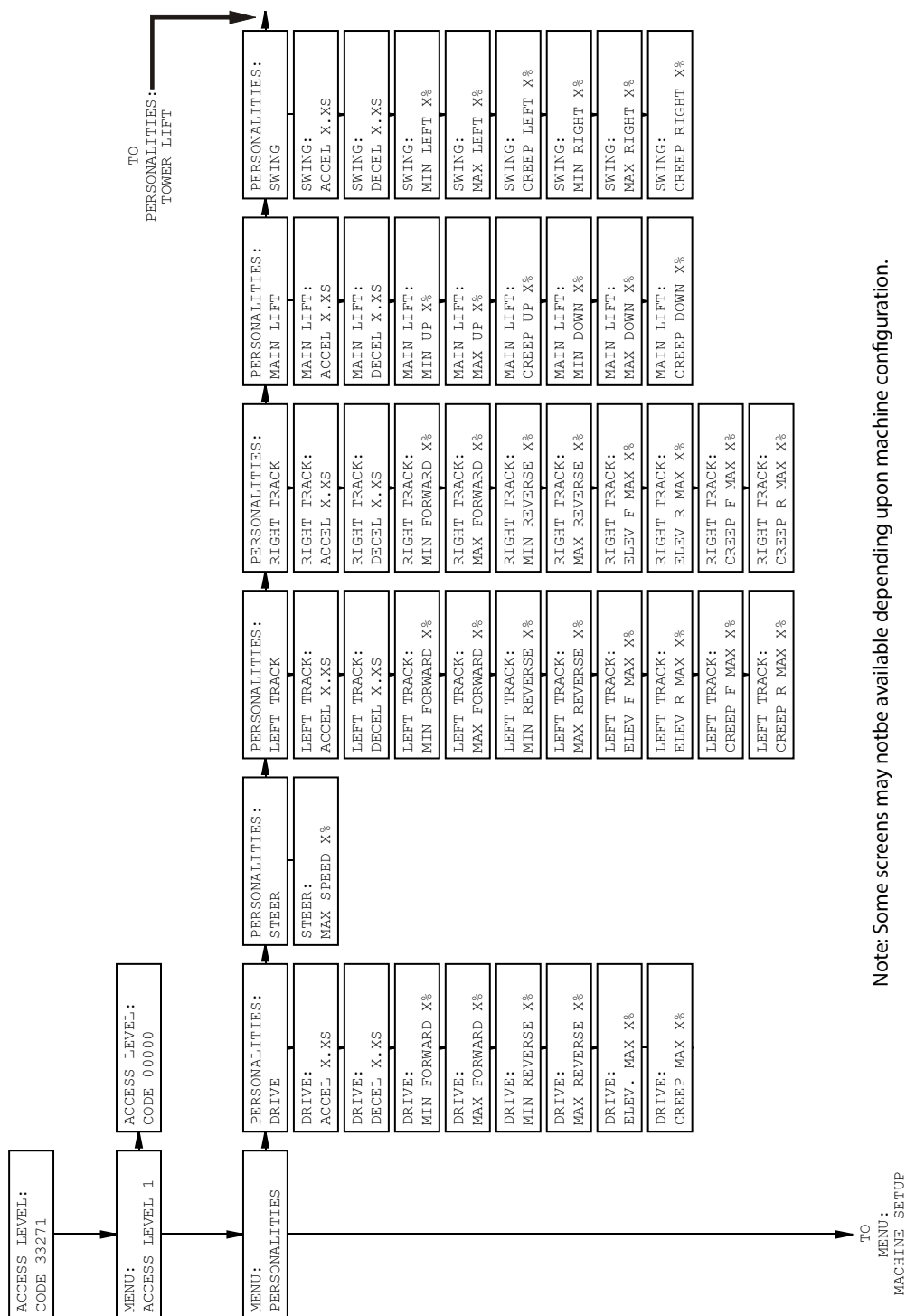
Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. Drive test results reflect on 600S, 600SJ & 660SJ, air or foam filled.
3. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
4. The platform speed knob control must be at full speed (turned clockwise completely).
5. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).
6. Some flow control functions may not work with the speed knob clicked into the creep position.

Table 6-10. Function Speeds (In Seconds)

Function	Speed (Seconds)
Lift Up	46 - 60
Lift Down	33 - 43
Swing Right & Left (No more than 10% difference between swing left and swing right.)	79 - 101
Telescope In	25 - 33
Telescope Out	50 - 67
Platform Rotate Right & Left (No more than 15% difference between rotate left and rotate right.)	16 - 25
Articulating Jib Up	22 - 34
Articulating Jib Down	16 - 26
Drive (2 - WD & 4 - WD) (Other Engines) (Forward & Reverse)	30 - 34 (4.25 MPH)
Drive (2 - WD & 4 - WD) (Deutz Engine) (Forward & Reverse)	34 - 38 (4.02 MPH)
Drive (2 - WD & 4 - WD) (Above Horizontal) (Forward & Reverse)	46 - 54 (0.68 MPH)

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Note: Some screens may not be available depending upon machine configuration.

Figure 6-3. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 1 of 4

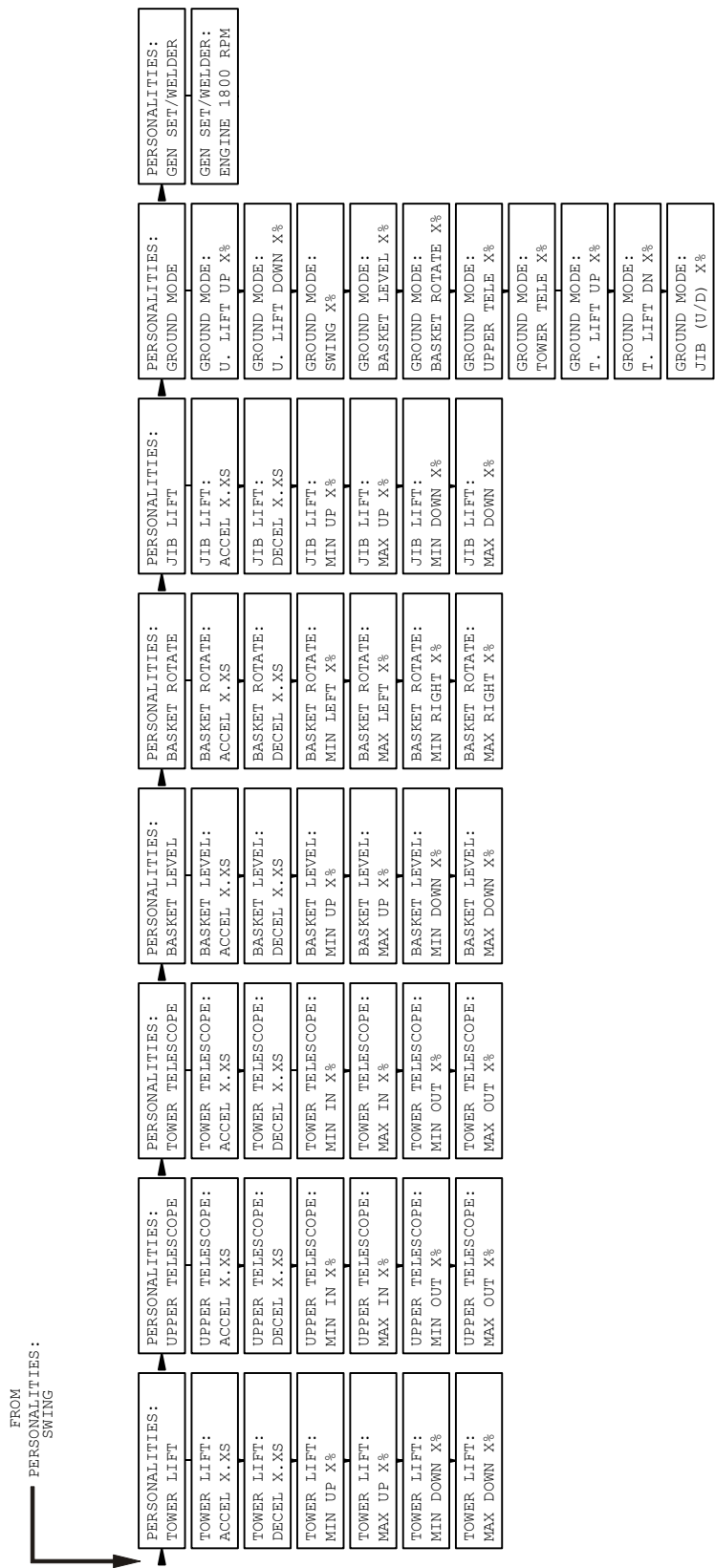


Figure 6-4. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 2 of 4

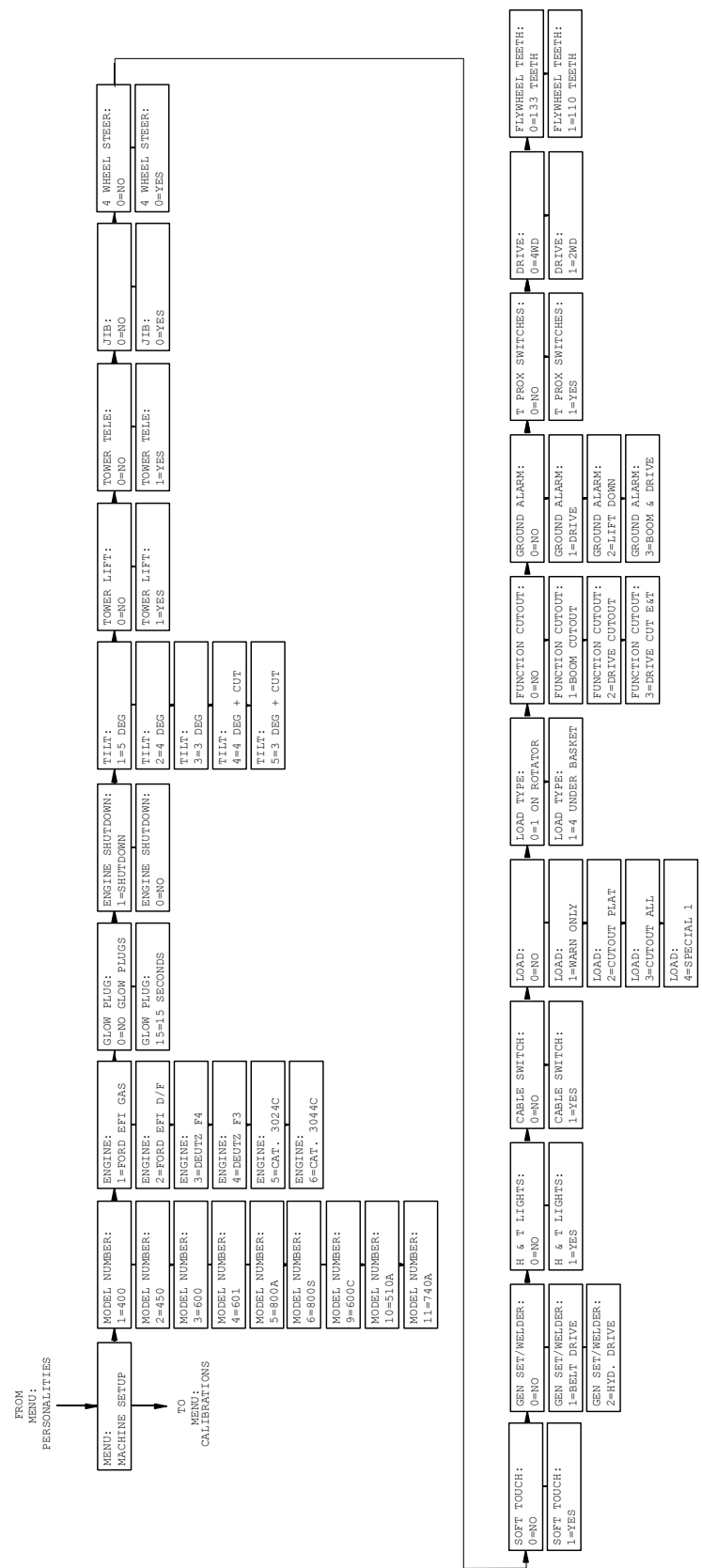


Figure 6-5. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 3 of 4

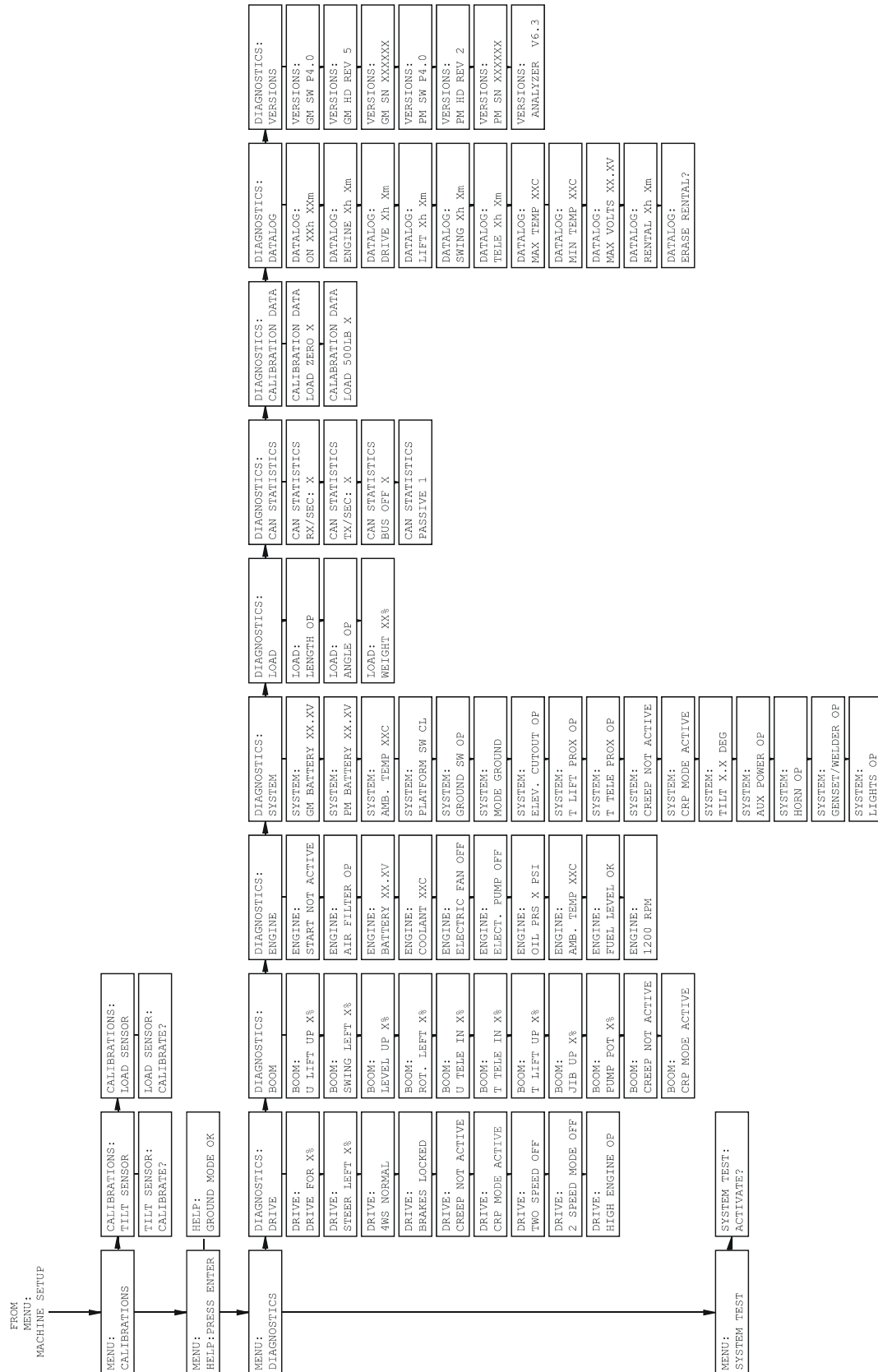
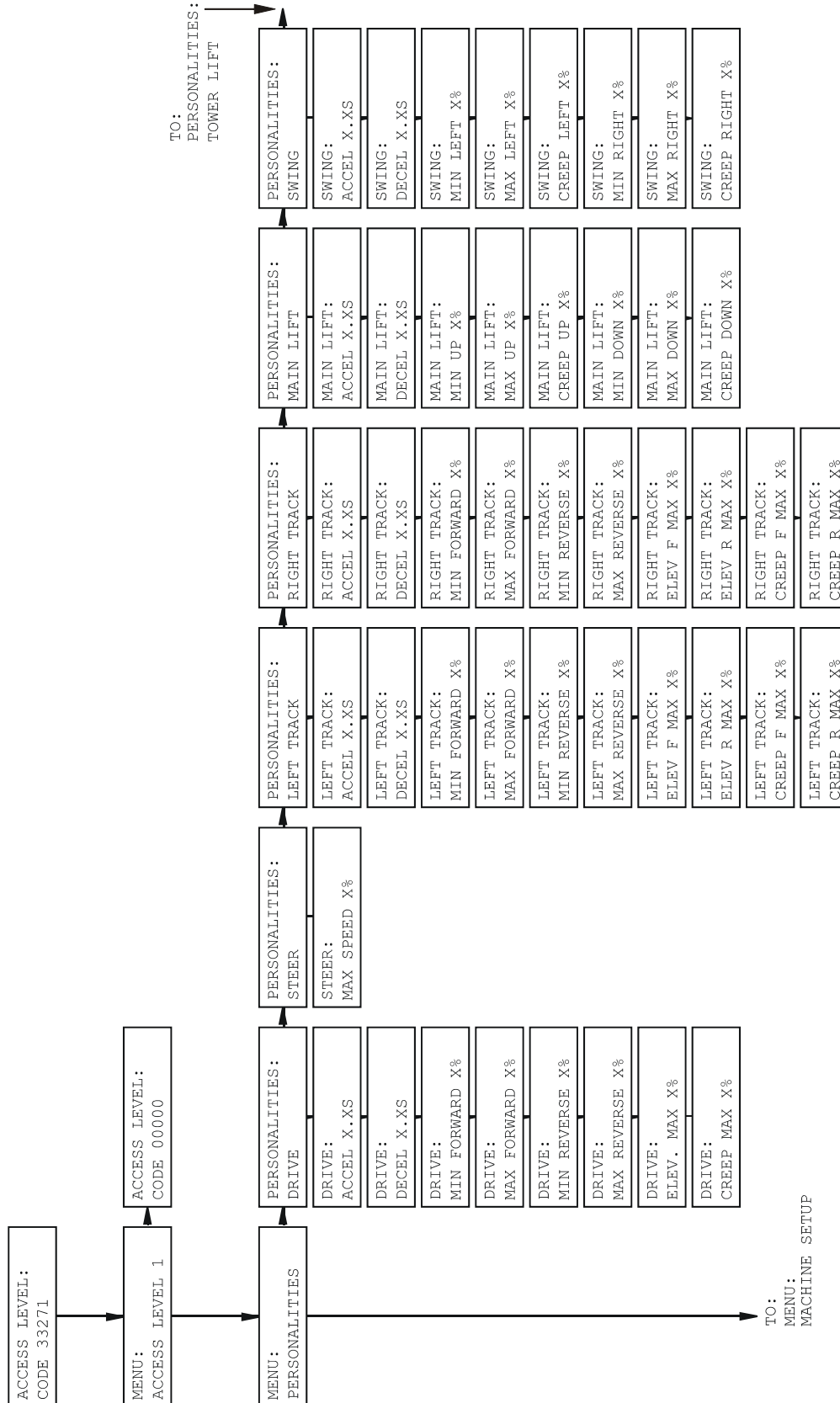


Figure 6-6. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 4 of 4



NOTE: Some screens may not be available depending upon machine configuration.

Figure 6-7. Analyzer Flow Chart, Version 5.X Software - Sheet 1 of 4

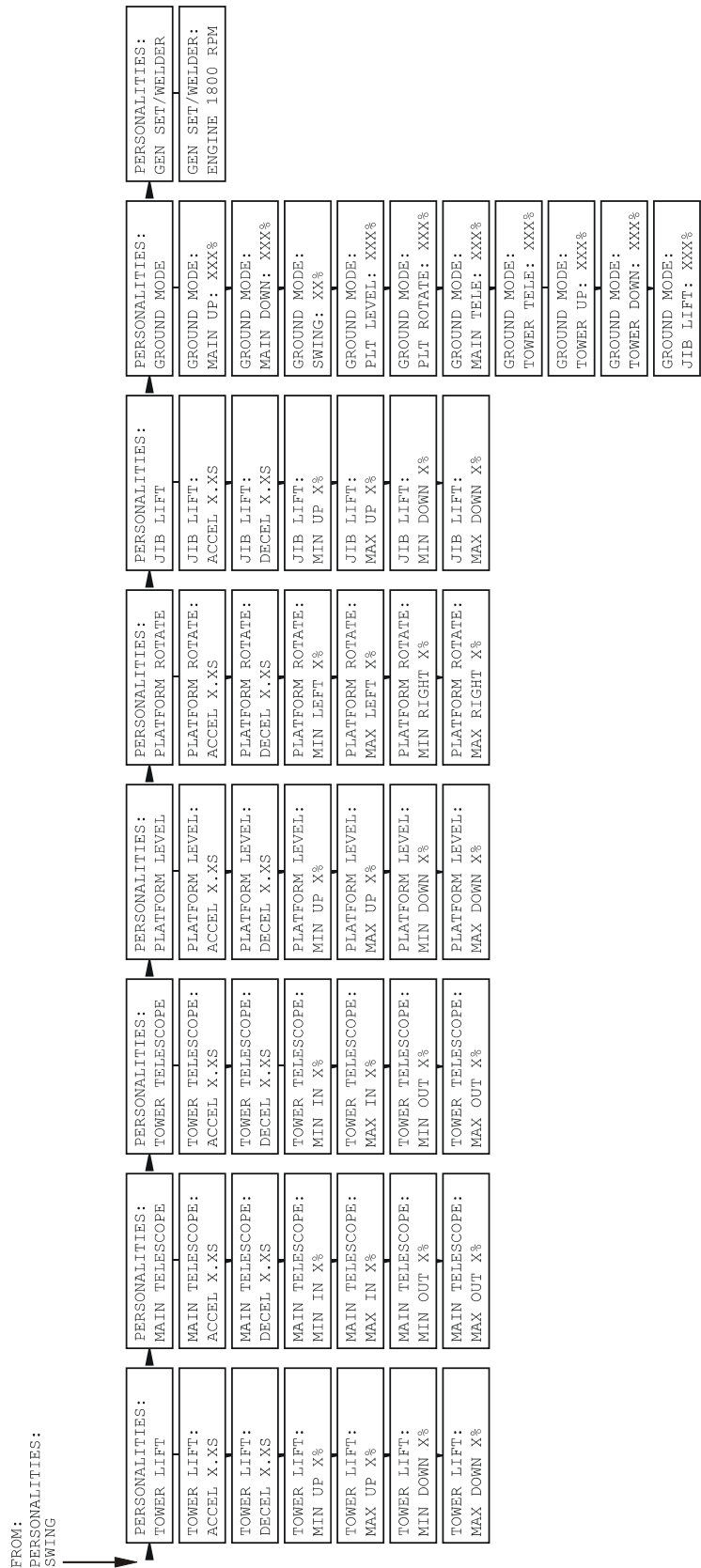


Figure 6-8. Analyzer Flow Chart, Version 5.X Software - Sheet 2 of 4

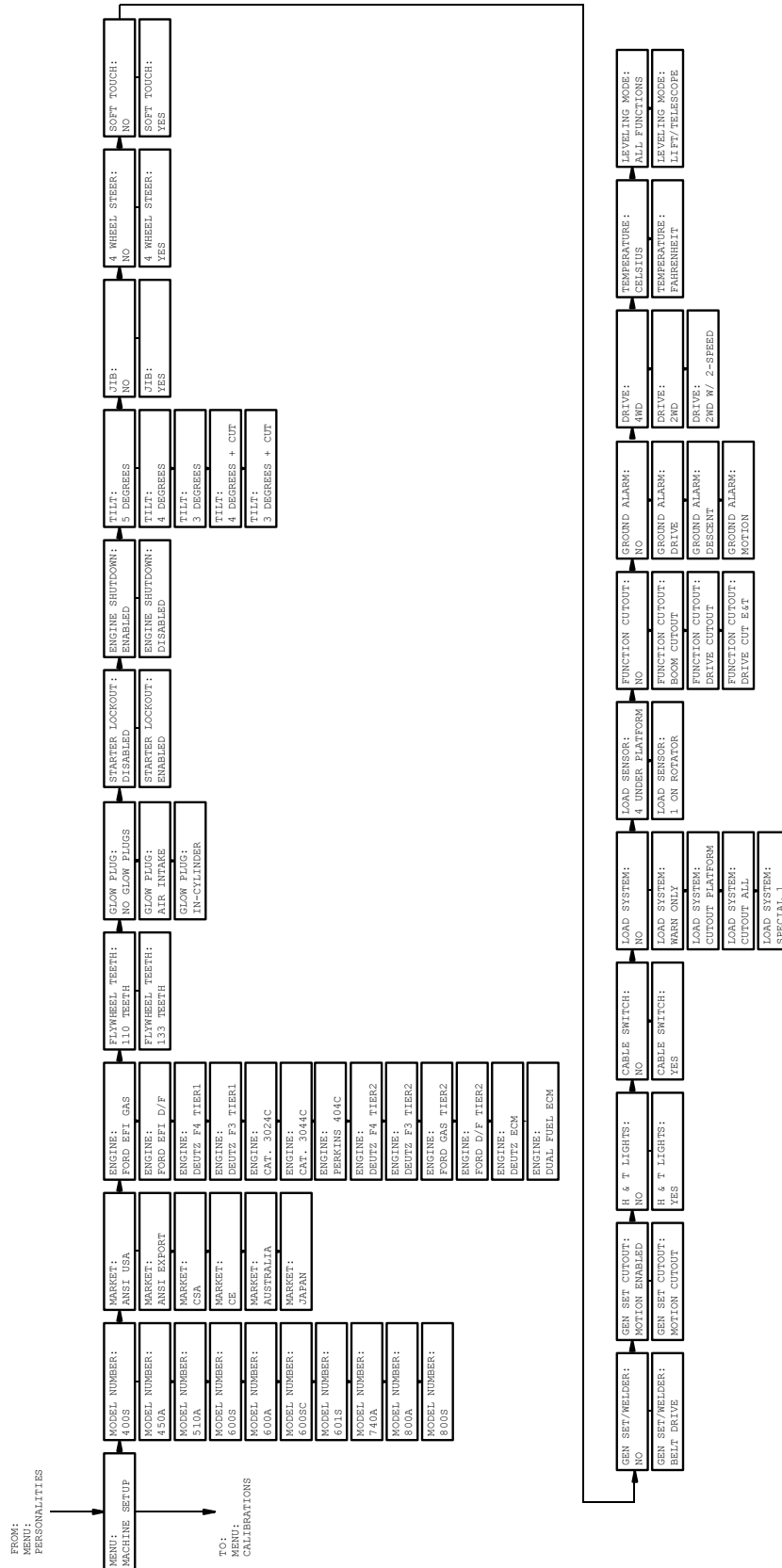


Figure 6-9. Analyzer Flow Chart, Version 5.X Software - Sheet 3 of 4

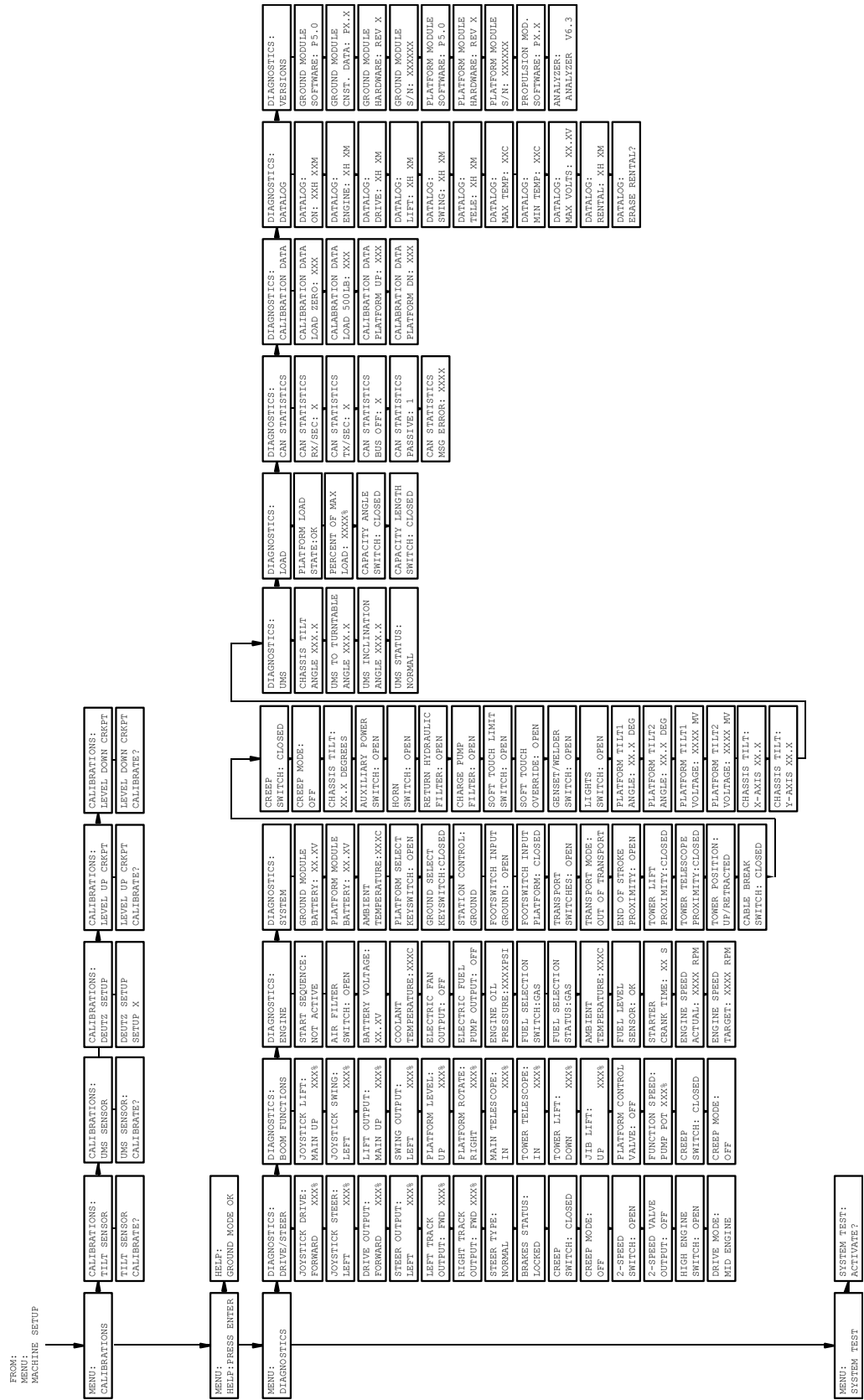
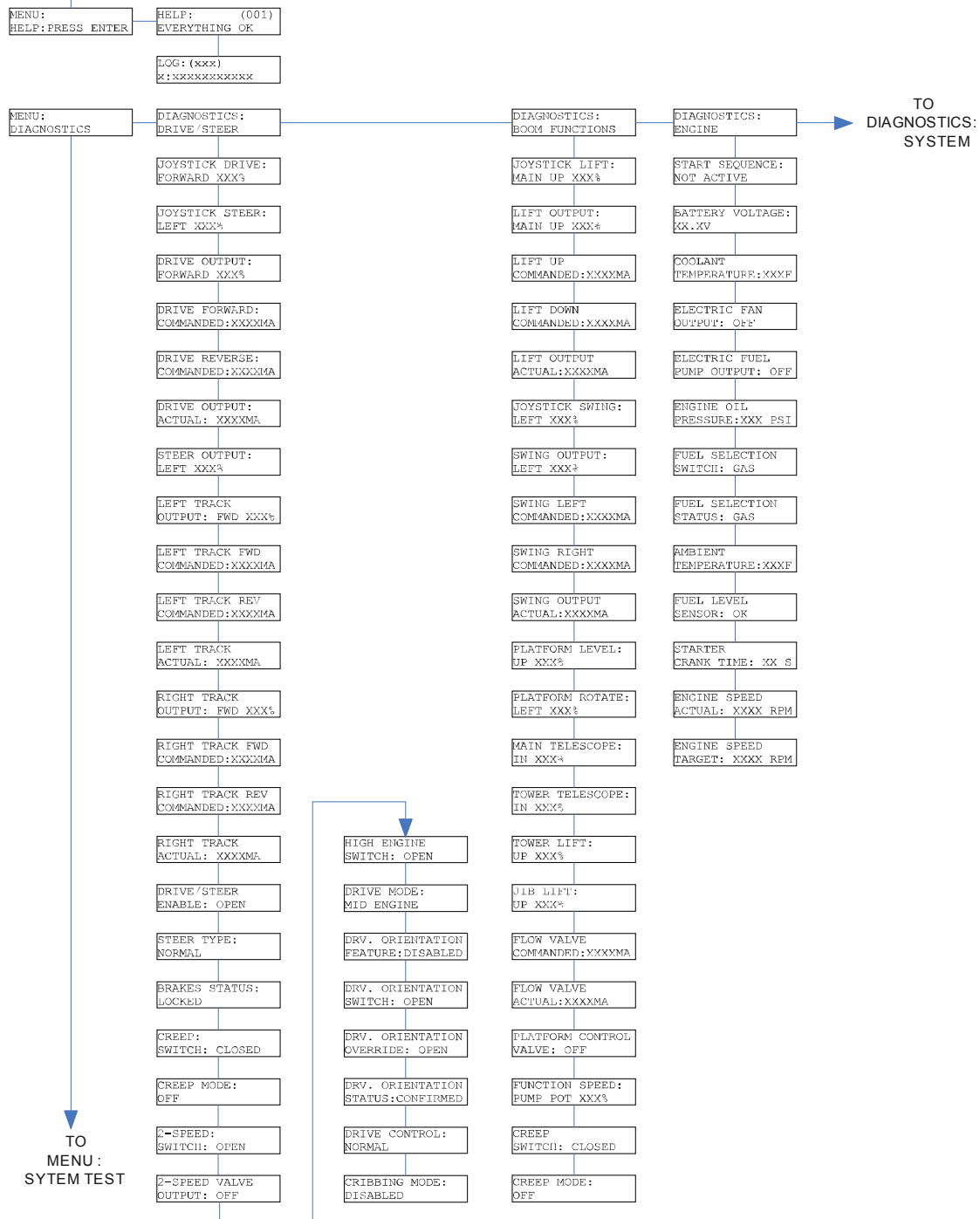


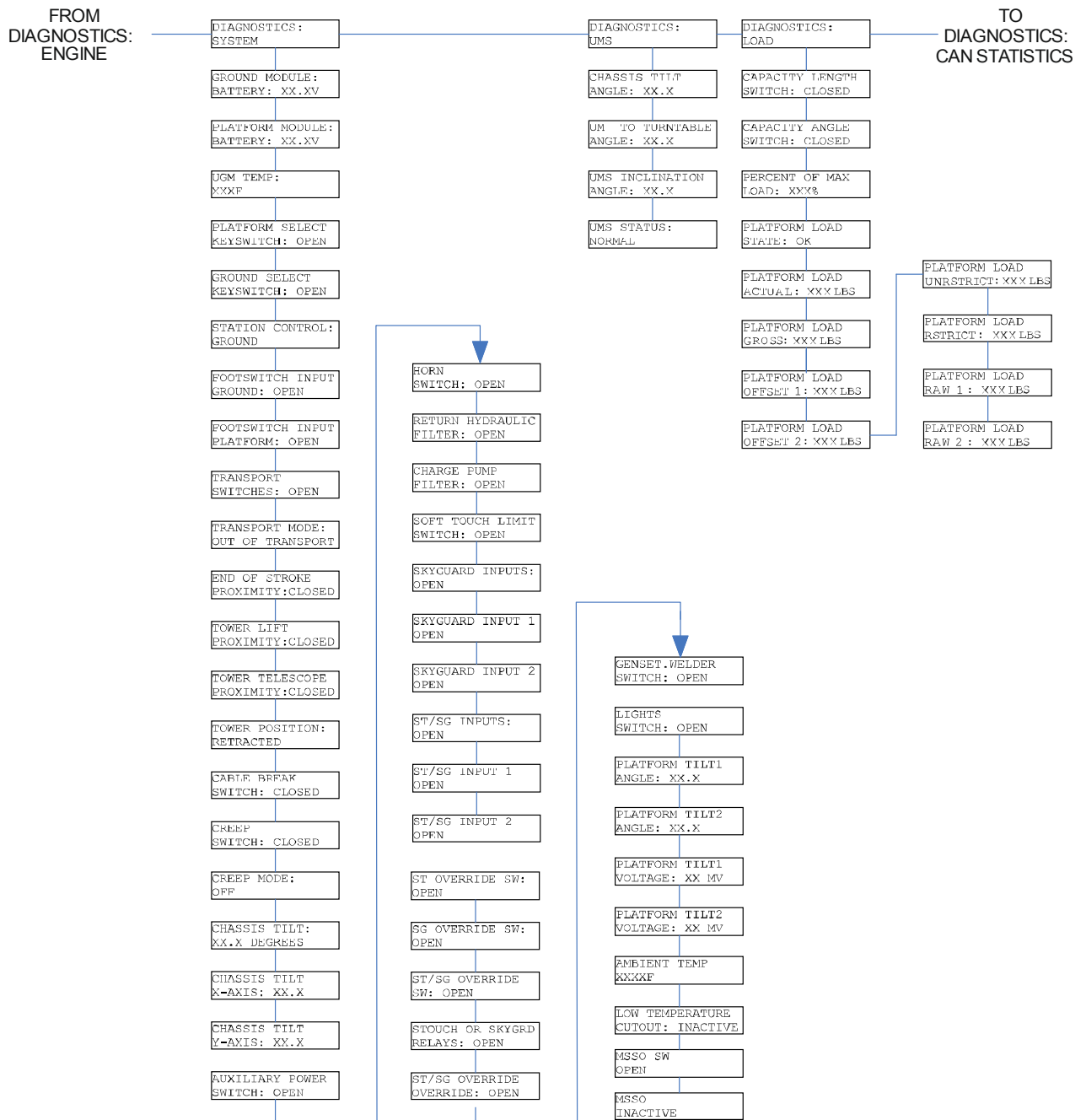
Figure 6-10. Analyzer Flow Chart, Version 5.X Software - Sheet 4 of 4

ANALYZER MENU STRUCTURE



NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-11. Analyzer Flow Chart -Sheet 1 of 8



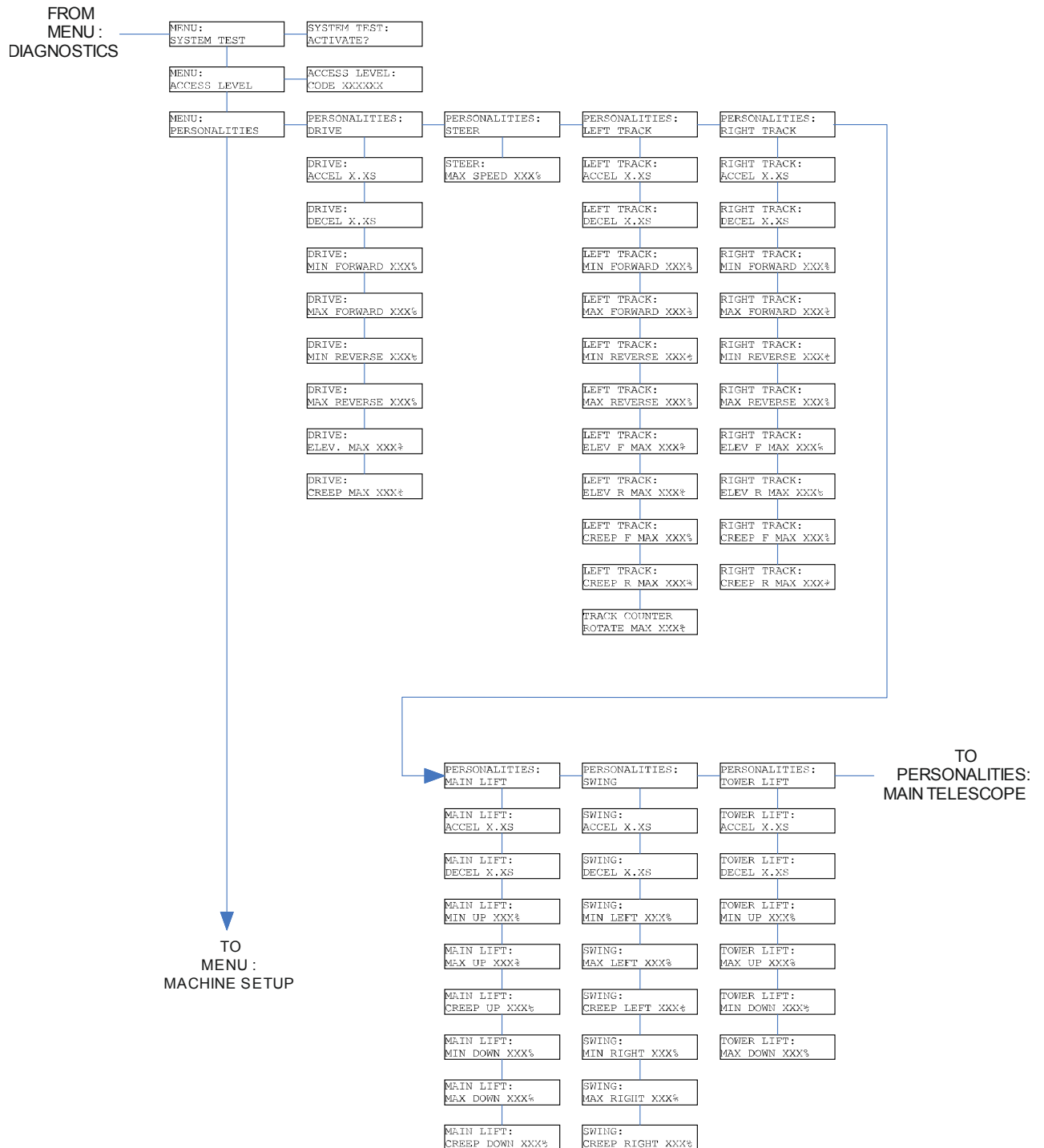
NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-12. Analyzer Flow Chart -Sheet 2 of 8



NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-13. Analyzer Flow Chart -Sheet 3 of 8



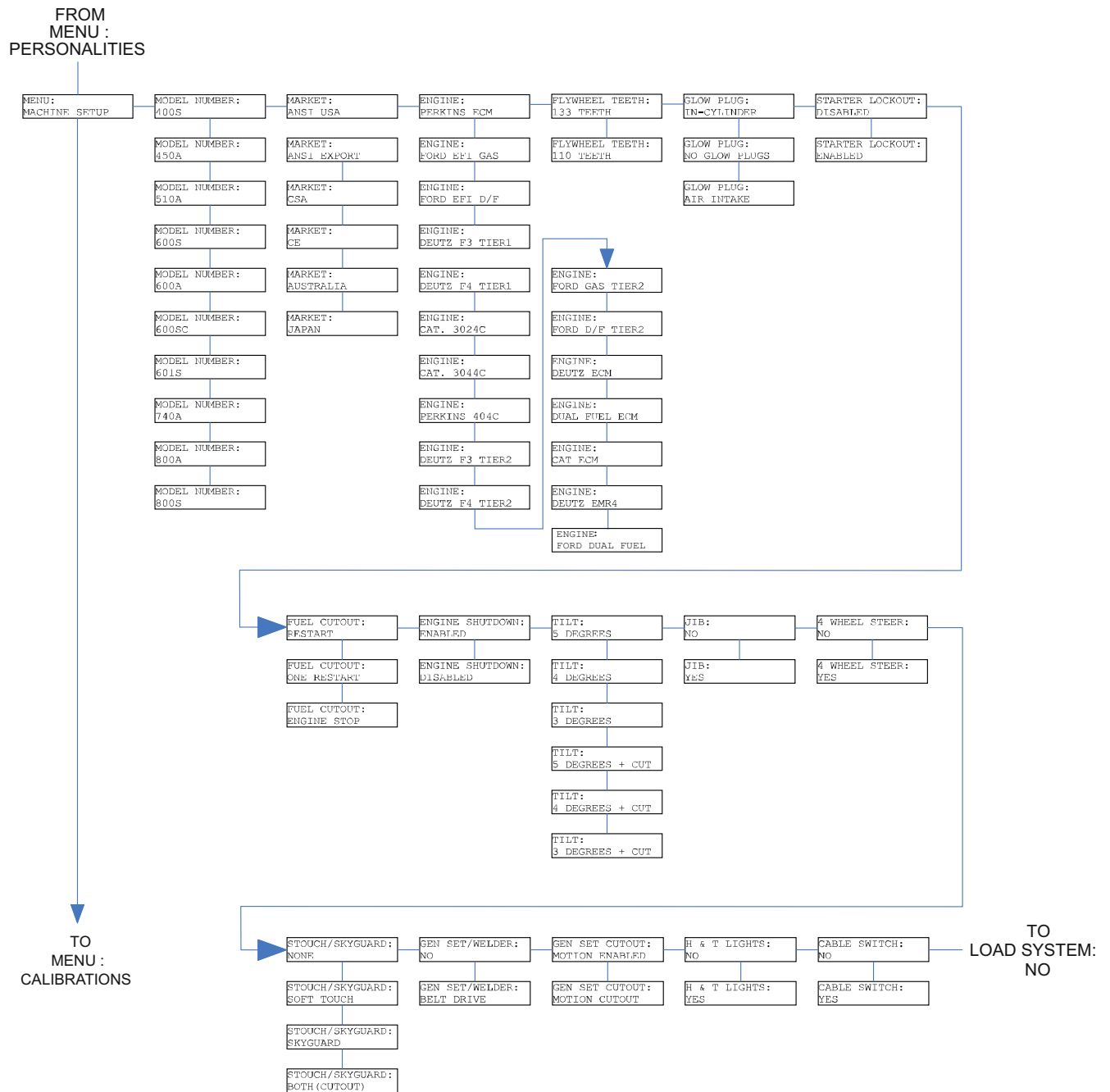
NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-14. Analyzer Flow Chart -Sheet 4 of 8



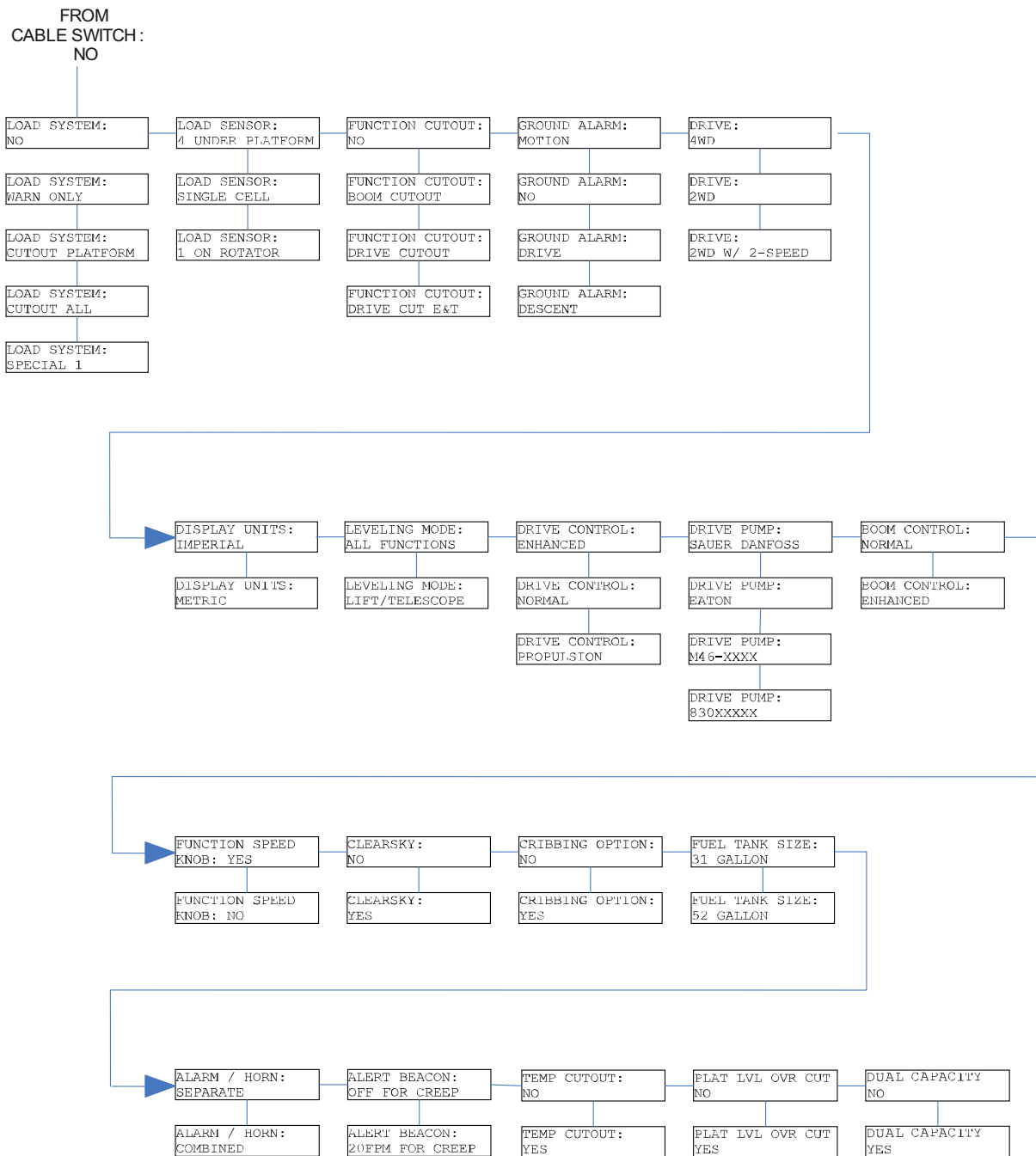
NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-15. Analyzer Flow Chart -Sheet 5 of 8



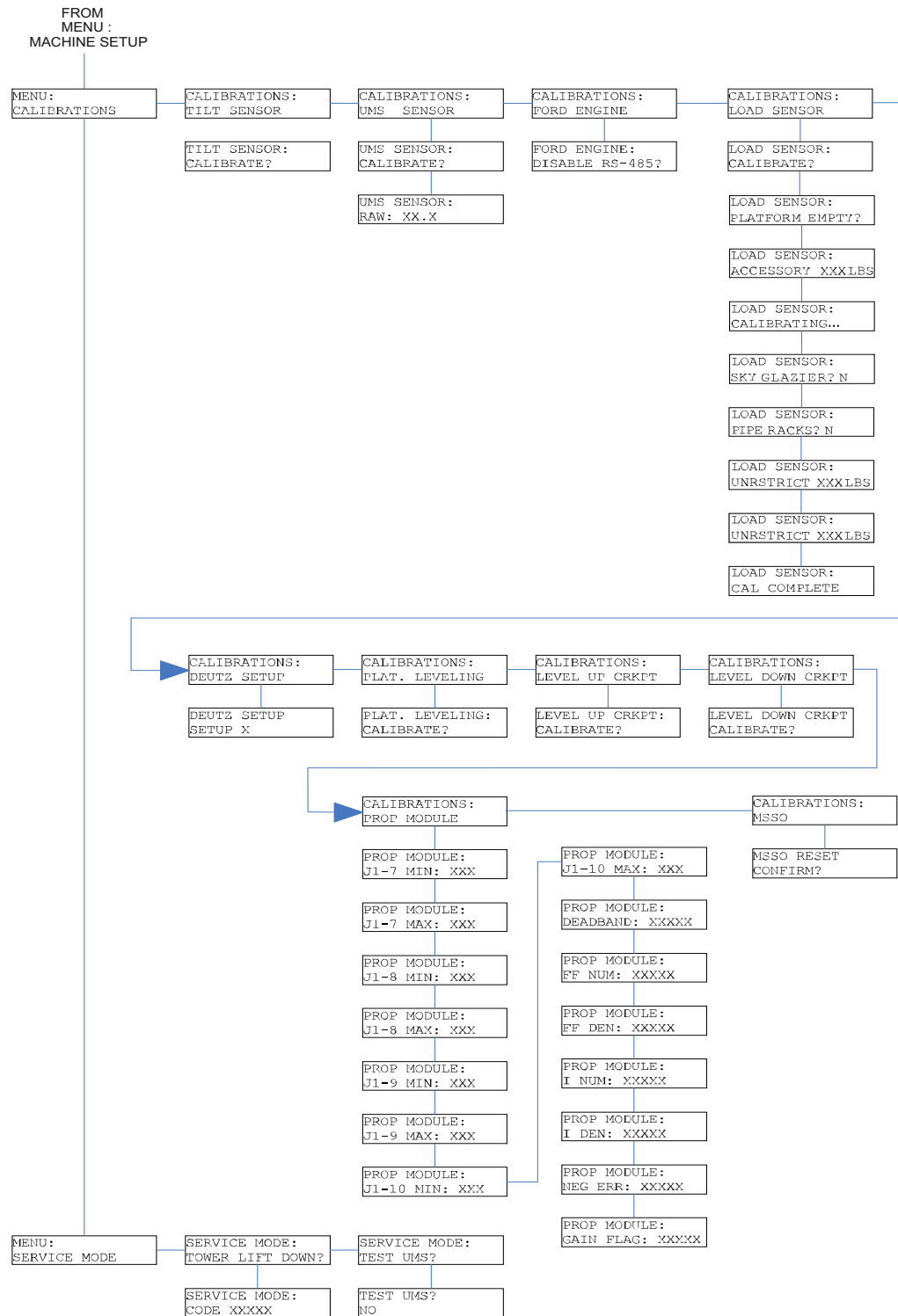
NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-16. Analyzer Flow Chart -Sheet 6 of 8



NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-17. Analyzer Flow Chart - Sheet 7 of 8



NOTE: The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-18. Analyzer Flow Chart -Sheet 8 of 8

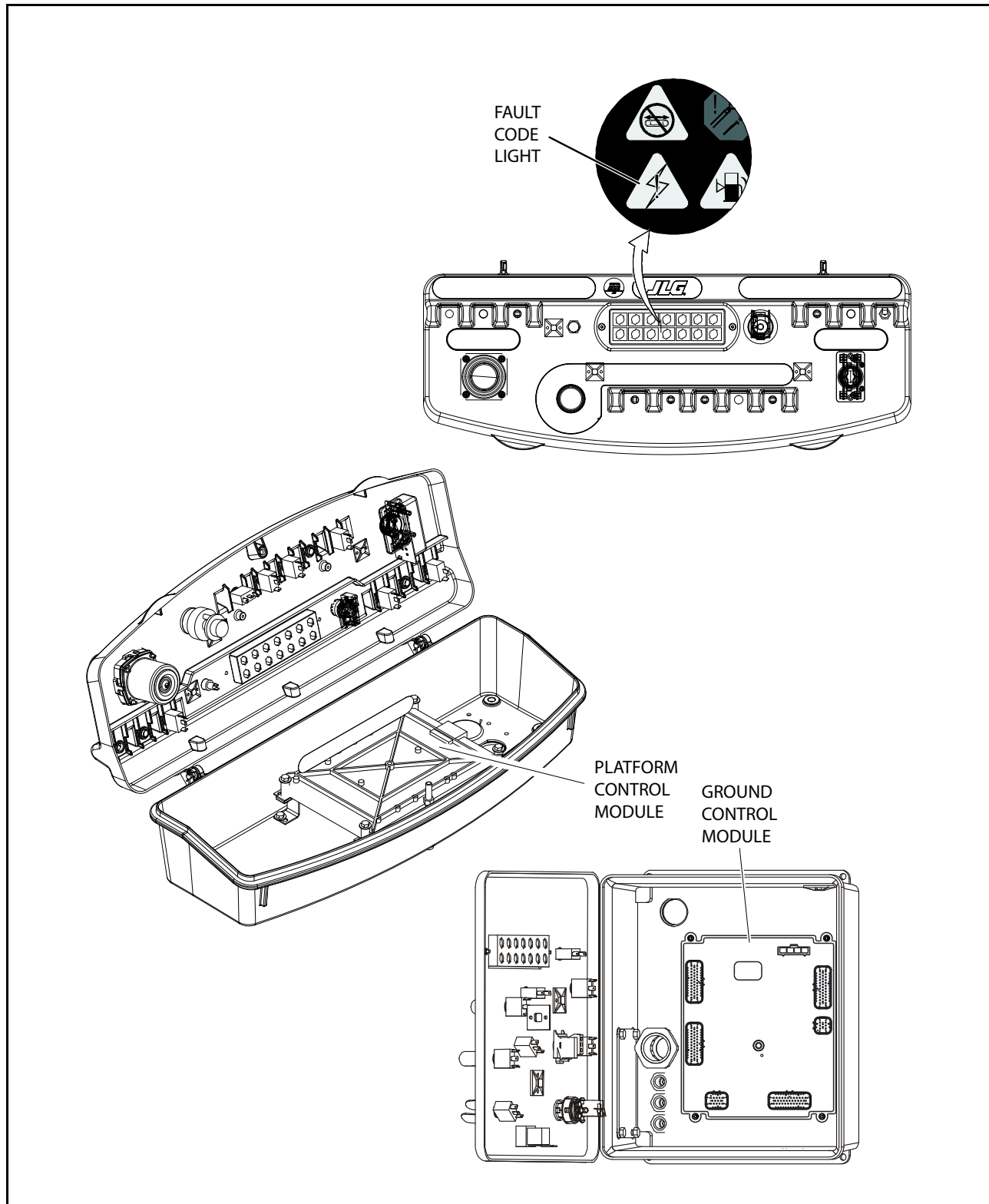
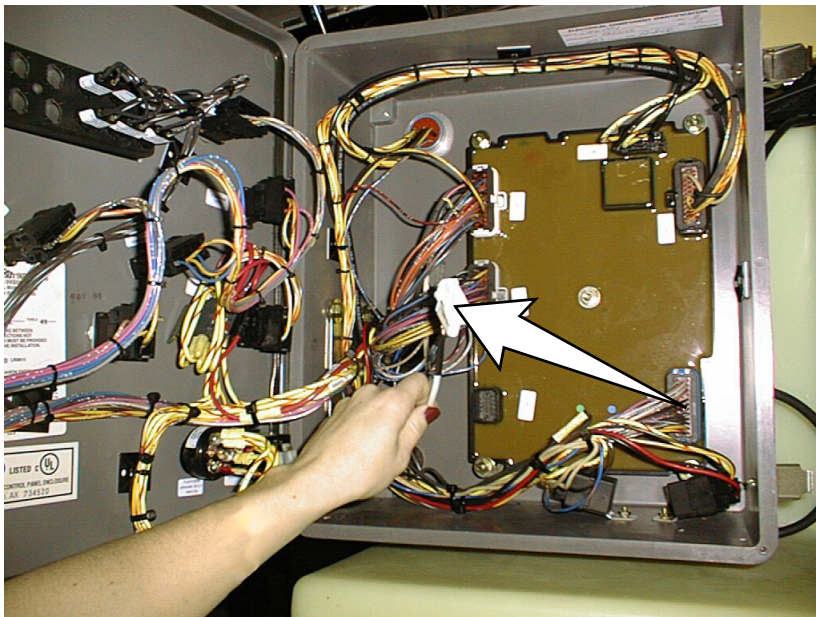


Figure 6-19. Control Module Location



PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-20. Analyzer Connecting Points

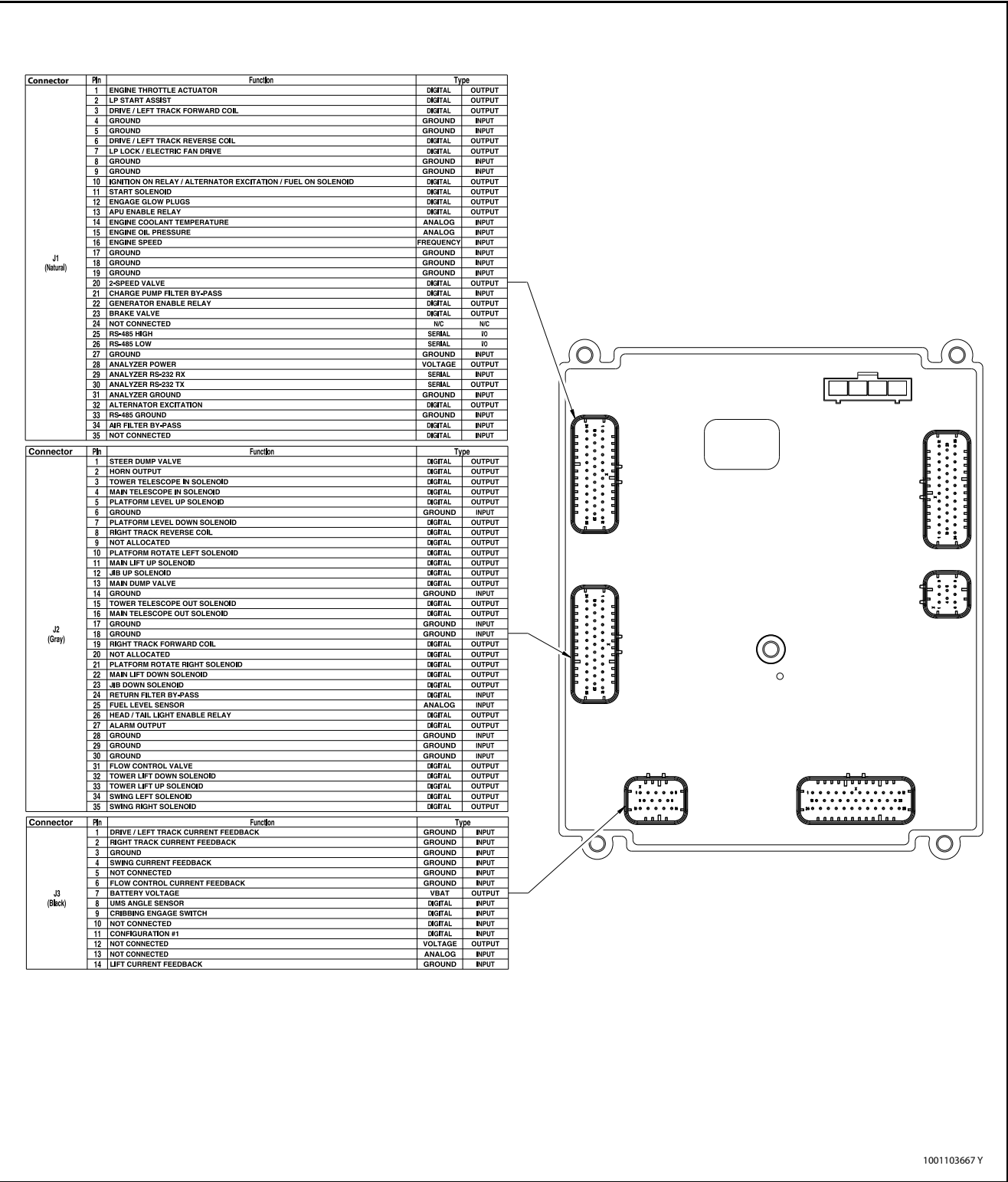


Figure 6-21. Ground Control Module - Sheet 1 of 3

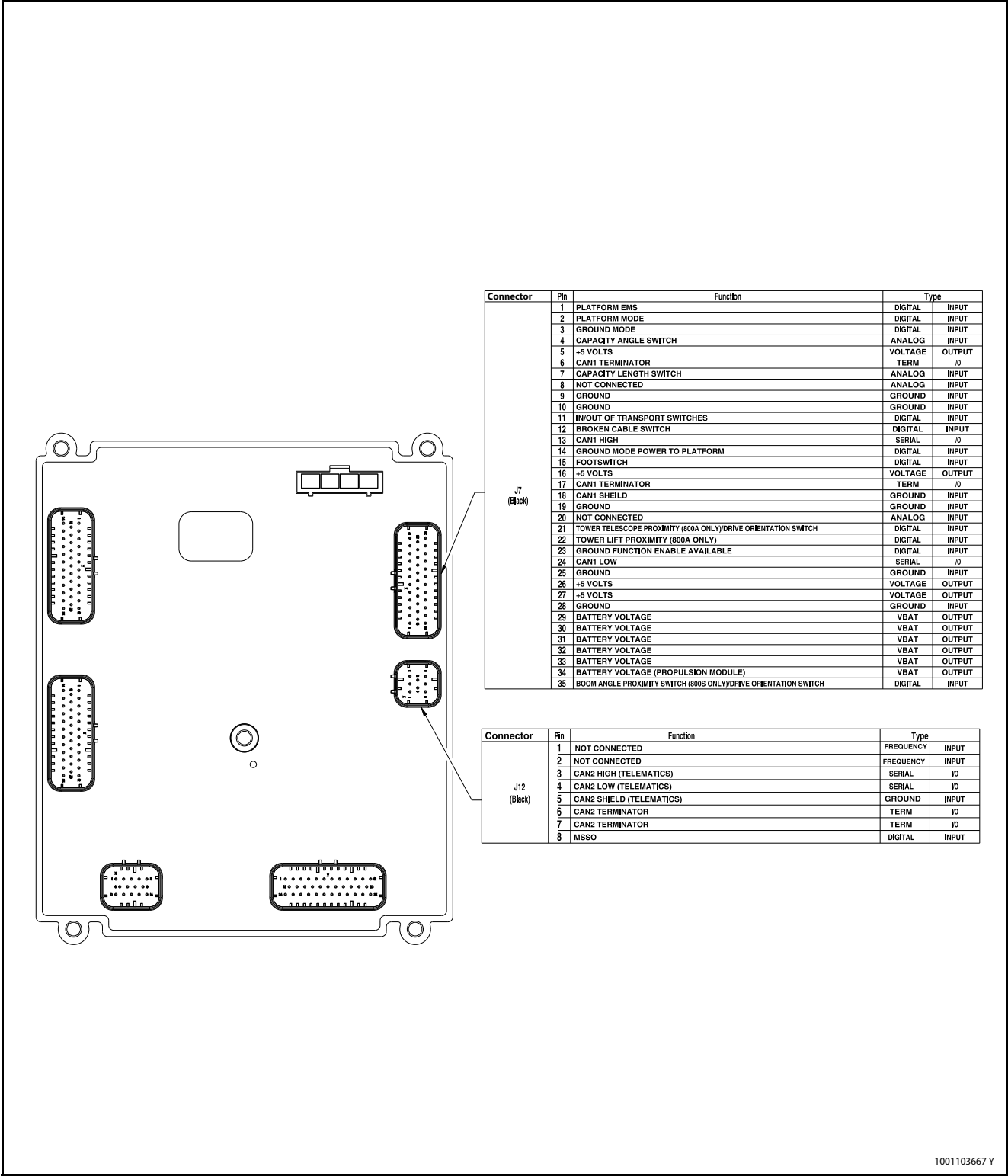
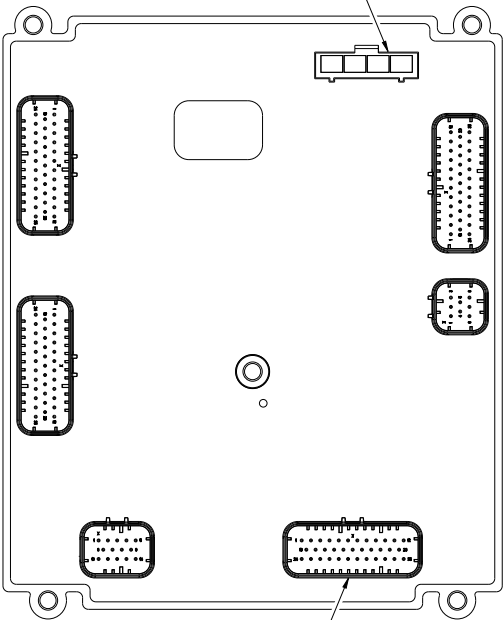


Figure 6-22. Ground Control Module - Sheet 2 of 3

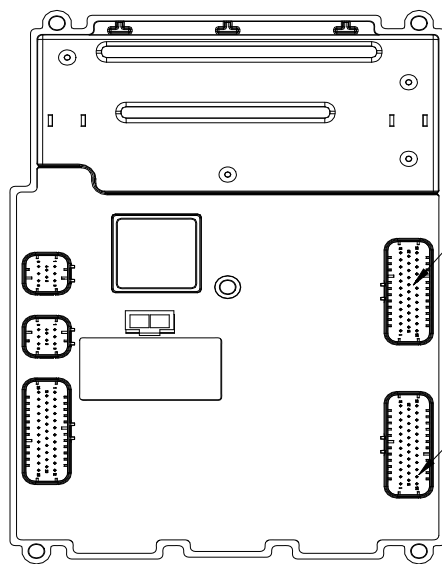
Connector	Pin	Function	Type	
J8 (Black)	1	MODULE GROUND	GROUND	OUTPUT
	2	MODULE POWER	VBAT	INPUT
	3	GROUND TO PLATFORM MODULE	GROUND	INPUT
	4	POWER TO PLATFORM MODULE	VBAT	OUTPUT



Connector	Pin	Function	Type	
J4 (Blue)	1	CRIBBING ENGAGED INDICATOR	DIGITAL	OUTPUT
	2	500 LB CAPACITY LAMP	DIGITAL	OUTPUT
	3	GLOWPLUG INDICATOR	DIGITAL	OUTPUT
	4	ENGINE START	DIGITAL	INPUT
	5	PLATFORM LEVEL DOWN	DIGITAL	INPUT
	6	PLATFORM ROTATE LEFT	DIGITAL	INPUT
	7	MAIN TELESCOPE IN	DIGITAL	INPUT
	8	JIB DOWN	DIGITAL	INPUT
	9	JIB LEFT	DIGITAL	INPUT
	10	TOWER LIFT UP	DIGITAL	INPUT
	11	TOWER TELESCOPE IN	DIGITAL	INPUT
	12	HOURLY METER	DIGITAL	OUTPUT
	13	RETURN FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	14	PLATFORM OVERLOADED INDICATOR	DIGITAL	OUTPUT
	15	BOOM MALFUNCTION INDICATOR	DIGITAL	OUTPUT
	16	AUXILIARY POWER / FUNCTION ENABLE	DIGITAL	INPUT
	17	PLATFORM LEVEL UP	DIGITAL	INPUT
	18	PLATFORM ROTATE RIGHT	DIGITAL	INPUT
	19	JIB UP	DIGITAL	INPUT
	20	JIB RIGHT	DIGITAL	INPUT
	21	TOWER LIFT DOWN	DIGITAL	INPUT
	22	TOWER TELESCOPE OUT	DIGITAL	INPUT
	23	MAIN LIFT UP	DIGITAL	INPUT
	24	BATTERY VOLTAGE	VBAT	OUTPUT
	25	BATTERY VOLTAGE - (GROUND ENABLE PRESENT)	VBAT	OUTPUT
	26	BATTERY LOW / NOT CHARGING INDICATOR	DIGITAL	OUTPUT
	27	CHARGE PUMP FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	28	ENGINE HIGH COOLANT TEMPERATURE INDICATOR	DIGITAL	OUTPUT
	29	ENGINE LOW OIL PRESSURE INDICATOR	DIGITAL	OUTPUT
	30	MAIN TELESCOPE OUT	DIGITAL	INPUT
	31	GROUND	GROUND	INPUT
	32	GROUND	GROUND	INPUT
	33	MAIN LIFT DOWN	DIGITAL	INPUT
	34	SWING LEFT	DIGITAL	INPUT
	35	SWING RIGHT	DIGITAL	INPUT

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Figure 6-23. Ground Control Module - Sheet 3 of 3



CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J2 GRAY	1	UNALLOCATED	DIGITAL INPUT
	2	UNALLOCATED	DIGITAL INPUT
	3	BATTERY VOLTAGE	HS DIGITAL INPUT
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL INPUT
	5	UNALLOCATED	LAMP OUTPUT
	6	CHASSIS TILTED INDICATOR	LAMP OUTPUT
	7	FUNCTION ENABLE INDICATOR	LAMP OUTPUT
	8	VEHICLE SYSTEM DISTRESS INDICATOR	LAMP OUTPUT
	9	CREEP SPEED INDICATOR	LAMP OUTPUT
	10	BROKEN CABLE INDICATOR	LAMP OUTPUT
	11	PLATFORM OVERLOADED INDICATOR	LAMP OUTPUT
	12	500 LB CAPACITY INDICATOR	LAMP OUTPUT
	13	1000 LB CAPACITY INDICATOR	LAMP OUTPUT
	14	DRIVE ORIENTATION SYSTEM INDICATOR	LAMP OUTPUT
	15	GENERATOR ON INDICATOR	LAMP OUTPUT
	16	SOFT TOUCH TRIGGERED INDICATOR	LAMP OUTPUT
	17	GLOW PLUG ENGAGED INDICATOR	LAMP OUTPUT
	18	LAMP RETURN	GROUND
	19	DRIVE DISABLED INDICATOR	LAMP OUTPUT
	20	UPRIGHT TILTED INDICATOR	LAMP OUTPUT
	21	LOW FUEL INDICATOR	LAMP OUTPUT
	22	1/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	23	3/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	24	1/2 FUEL LEVEL INDICATOR	LAMP OUTPUT
	25	FUEL LEVEL INDICATORS RETURN	GROUND
	26	ANALYZER POWER	ANALYZER POWER
	27	ANALYZER GROUND	ANALYZER GROUND
	28	ANALYZER RX	ANALYZER RX
	29	ANALYZER TX	ANALYZER TX
	30	BATTERY VOLTAGE	BATTERY VOLTAGE
	31	BATTERY VOLTAGE	BATTERY VOLTAGE
	32	BATTERY VOLTAGE	BATTERY VOLTAGE
	33	BATTERY VOLTAGE	BATTERY VOLTAGE
	34	SWITCH POWER	BATTERY VOLTAGE
	35	FULL FUEL LEVEL INDICATOR	LAMP OUTPUT

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J1 NATURAL	1	TOWER LIFT UP	DIGITAL INPUT
	2	TOWER LIFT DOWN	DIGITAL INPUT
	3	TOWER TELESCOPE IN	DIGITAL INPUT
	4	TOWER TELESCOPE OUT	DIGITAL INPUT
	5	MAIN TELESCOPE IN	DIGITAL INPUT
	6	MAIN TELESCOPE OUT	DIGITAL INPUT
	7	PLATFORM ROTATE RIGHT	DIGITAL INPUT
	8	PLATFORM ROTATE LEFT	DIGITAL INPUT
	9	PLATFORM LEVEL UP	DIGITAL INPUT
	10	PLATFORM LEVEL DOWN	DIGITAL INPUT
	11	JIB UP	DIGITAL INPUT
	12	JIB DOWN	DIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START	DIGITAL INPUT
	15	AUXILIARY POWER	DIGITAL INPUT
	16	CRAB STEER SELECT	DIGITAL INPUT
	17	COORDINATED STEER SELECT	DIGITAL INPUT
	18	SWITCH POWER	BATTERY VOLTAGE
	19	UNALLOCATED	DIGITAL INPUT
	20	UNALLOCATED	DIGITAL INPUT
	21	UNALLOCATED	DIGITAL INPUT
	22	DRIVE ORIENTATION SYSTEM FEATURE ENABLE	DIGITAL INPUT
	23	UNALLOCATED	DIGITAL INPUT
	24	UNALLOCATED	DIGITAL INPUT
	25	UNALLOCATED	DIGITAL INPUT
	26	UNALLOCATED	DIGITAL INPUT
	27	TWO SPEED VALVE (HIGH ENGINE)	DIGITAL INPUT
	28	TORQUE MODE	DIGITAL INPUT
	29	SOFT TOUCH OVERRIDE	DIGITAL INPUT
	30	HEAD/TAIL LIGHT	DIGITAL INPUT
	31	HORN	DIGITAL INPUT
	32	CREEP MODE	DIGITAL INPUT
	33	DUAL-FUEL SELECT	DIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	35	SPEED PUMP POTENTIOMETER	DIGITAL INPUT

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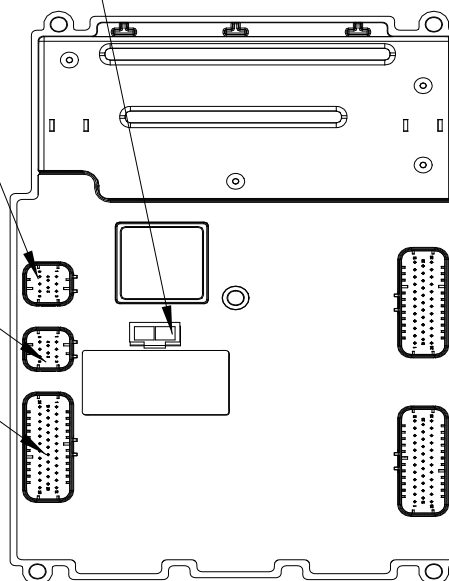
Figure 6-24. Platform Control Module (With UGM) - Sheet 1 of 2

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J8	1	MODULE GROUND	GROUND
	2	MODULE POWER	BATTERY VOLTAGE

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J5 NATURAL	1	LIFT / SWING JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	LIFT CENTER TAP	INPUT
	3	LIFT SIGNAL	INPUT
	4	SWING SIGNAL	INPUT
	5	SWING CENTER TAP	INPUT
	6	NOT CONNECTED	INPUT
	7	LIFT / SWING JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

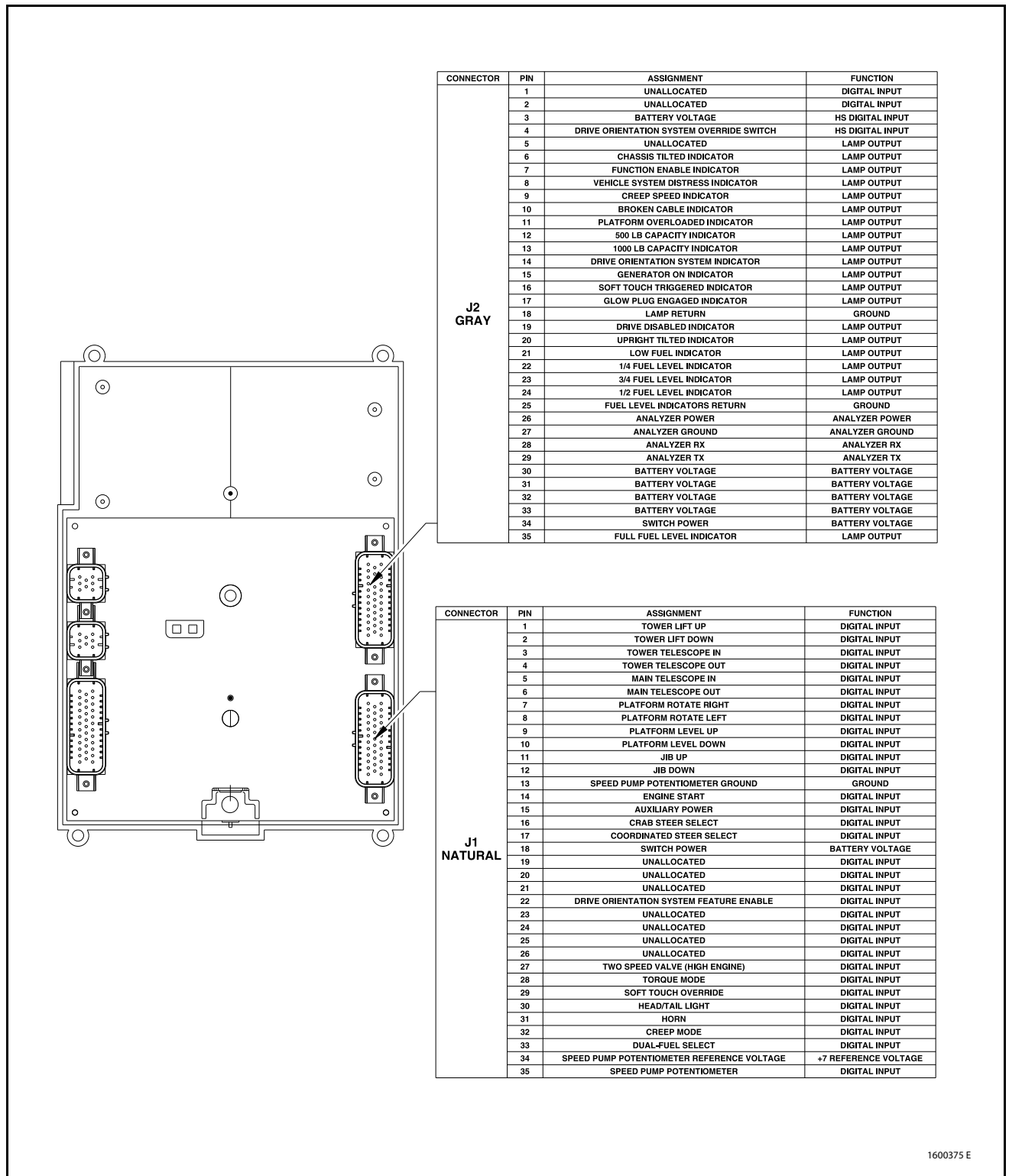
CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J6 BLACK	1	DRIVE / STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	DRIVE CENTER TAP	INPUT
	3	DRIVE SIGNAL	INPUT
	4	STEER SIGNAL	INPUT
	5	STEER LEFT	INPUT
	6	STEER RIGHT	INPUT
	7	DRIVE / STEER JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMS TO GROUND MODULE	PLATFORM MODE
	4	FOOTSWITCH (FUNCTION ENABLE SWITCH) POWER	BATTERY VOLTAGE
	5	GENERATOR SWITCH POWER	BATTERY VOLTAGE
	6	JIB BLOCK LIMIT SWITCH POWER	BATTERY VOLTAGE
	7	SOFT TOUCH LIMIT SWITCH POWER	BATTERY VOLTAGE
	8	FOOTSWITCH SIGNAL	DIGITAL INPUT
	9	GENERATOR ON SIGNAL	DIGITAL INPUT
	10	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	11	LOAD CELL INPUT 1	ANALOG INPUT
	12	LOAD CELL INPUT 2	ANALOG INPUT
	13	UNALLOCATED	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	LOAD CELL REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	16	LOAD CELL RETURN	GROUND
	17	JIB BLOCK LIMIT SWITCH	HS DIGITAL INPUT
	18	SOFT TOUCH LIMIT SWITCH	HS DIGITAL INPUT
	19	PLATFORM ALARM	LAMP OUTPUT
	20	ALARM RETURN	GROUND
	21	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	22	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	23	GROUND RETURN	GROUND
	24	GROUND RETURN	GROUND
	25	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	26	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	27	UNALLOCATED	ME DIGITAL OUTPUT
	28	UNALLOCATED	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	34	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	35	GROUND RETURN	GROUND



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Figure 6-25. Platform Control Module (With UGM) - Sheet 2 of 2



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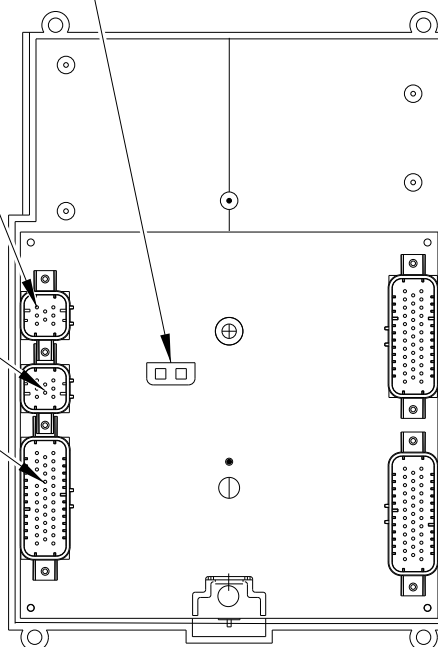
Figure 6-26. Platform Control Module (Without UGM) - Sheet 1 of 2

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J8	1	MODULE GROUND	GROUND
	2	MODULE POWER	BATTERY VOLTAGE

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J5 NATURAL	1	LIFT / SWING JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	LIFT CENTER TAP	INPUT
	3	LIFT SIGNAL	INPUT
	4	SWING SIGNAL	INPUT
	5	SWING CENTER TAP	INPUT
	6	NOT CONNECTED	INPUT
	7	LIFT / SWING JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J6 BLACK	1	DRIVE / STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	DRIVE CENTER TAP	INPUT
	3	DRIVE SIGNAL	INPUT
	4	STEER SIGNAL	INPUT
	5	STEER LEFT	INPUT
	6	STEER RIGHT	INPUT
	7	DRIVE / STEER JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND



CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMS TO GROUND MODULE	PLATFORM MODE
	4	FOOTSWITCH (FUNCTION ENABLE SWITCH) POWER	BATTERY VOLTAGE
	5	GENERATOR SWITCH POWER	BATTERY VOLTAGE
	6	JIB BLOCK LIMIT SWITCH POWER	BATTERY VOLTAGE
	7	SOFT TOUCH LIMIT SWITCH POWER	BATTERY VOLTAGE
	8	FOOTSWITCH SIGNAL	DIGITAL INPUT
	9	GENERATOR ON SIGNAL	DIGITAL INPUT
	10	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	11	LOAD CELL INPUT 1	ANALOG INPUT
	12	LOAD CELL INPUT 2	ANALOG INPUT
	13	UNALLOCATED	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	LOAD CELL REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	16	LOAD CELL RETURN	GROUND
	17	JIB BLOCK LIMIT SWITCH	HS DIGITAL INPUT
	18	SOFT TOUCH LIMIT SWITCH	HS DIGITAL INPUT
	19	PLATFORM ALARM	LAMP OUTPUT
	20	ALARM RETURN	GROUND
	21	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	22	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	23	GROUND RETURN	GROUND
	24	GROUND RETURN	GROUND
	25	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	26	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	27	UNALLOCATED	ME DIGITAL OUTPUT
	28	UNALLOCATED	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	34	UNALLOCATED/NOT POPULATED	ME DIGITAL OUTPUT
	35	GROUND RETURN	GROUND



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Figure 6-27. Platform Control Module (Without UGM) - Sheet 2 of 2

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 6-11. 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
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
MAIN TELESCOPE	
ACCEL	Displays/adjusts telescope acceleration
DECEL	Displays/adjusts telescope deceleration
MIN IN	Displays/adjusts minimum telescope in speed

Table 6-11. ADJUSTMENTS - Personality Descriptions

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
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
BASKET LEVEL	Displays/adjusts fixed basket level speed
BASKET ROTATE	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 6-12. 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
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

Table 6-12. Diagnostic Menu Descriptions

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

Table 6-13. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
None		No flash code is indicated for the following help messages. They are intended to hint at a possible problem if the vehicle is not behaving as expected.	1
	EVERYTHING OK	The "normal" help message in platform mode	
	GROUND MODE OK	The "normal" help message in ground mode	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	
	RUNNING AT CREEP – CREEP SWITCH OPEN	All function speeds are limited to creep because the creep switch is open.	
	RUNNING AT CREEP – TILTED AND ABOVE ELEVATION	All boom function speeds are limited to creep because the vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK – ABOVE ELEVATION	Drive speed is limited to "ELEVATED MAX" because the vehicle is above elevation.	
	TILT SENSOR OUT OF RANGE	The tilt sensor has indicated a tilt angle greater than 19 degrees for more than 4 seconds. Not reported during 2 second power-up.	
	LOAD SENSOR READING UNDER WEIGHT	The load sensor is reading 20% or more under the calibrated zero point. This fault may occur if the basket is resting on the ground. Not reported during 2 second power-up.	
1/1		Flash code 1/1 indicates a "sleep" mode. NOT REQUIRED	
2/1		Flash code 2/1 indicates problems with footswitch.	2
	FSW FAULTY	The two footswitch inputs have read the same state for more than one second.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	
2/2		Flash code 2/2 indicates problems with drive & steer selection. Except where noted, these faults are not reported during 2 second power-up sequence.	3
	DRIVE LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Drive was selected before and during footswitch closure. Can be reported during power-up sequence.	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected. Can be reported during power-up sequence.	
	STEER LOCKED – SELECTED BEFORE FOOTSWITCH	Steer was selected before and during footswitch closure.	
	STEER SWITCHES FAULTY	Both steer switches are active together.	
	DRIVE / STEER WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.	
	D/S JOY. QPROX BAD	These faults only occur with inductive joysticks. They indicate that the Q-Prox sensor is reading above 3.18 volts.	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is less than the centertap voltage minus half the center tap voltage minus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered below 1.05 volts. If the centertap is at the low end of the range, these faults will be triggered below 0.79 volts.	
	D/S JOY. OUT OF RANGE HIGH	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is more than the centertap voltage plus half the centertap voltage plus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered above 4.35 volts. If the centertap is at the low end of the range, these faults will be triggered above 3.8 volts.	
	D/S JOY. CENTER TAP BAD	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when the center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected. Can be reported during power-up sequence.	

Table 6-13. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
2/3		Flash code 2/3 indicates problems with boom function selection.	3
	LIFT/SWING LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Platform upper lift or swing was selected before and during footswitch closure.	
	PUMP SWITCHES FAULTY – CHECK DIAGNOSTICS/BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE FOOTSWITCH	A platform boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch or footswitch closure.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE AUX POWER	A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before aux power.	
	LIFT / SWING WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.	
	I/s joy. qprox bad	These faults only occur with inductive joysticks. They indicate that the Q-Prox sensor is reading above 3.18 volts.	
	I/s joy. out of range low	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is less than the centertap voltage minus half the center tap voltage minus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered below 1.05 volts. If the centertap is at the low end of the range, these faults will be triggered below 0.79 volts.	
	I/s joy. out of range high	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is more than the centertap voltage plus half the centertap voltage plus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered above 4.35 volts. If the centertap is at the low end of the range, these faults will be triggered above 3.8 volts.	
	I/s joy. center tap bad	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when the center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE START SWITCH	This fault occurs when a hydraulic function switch is closed before the start switch is closed.	
	FOOTSWITCH SELECTED BEFORE START	The user attempted to start the machine with the footswitch engaged.	
2/4		Flash code 2/4 indicates that steering digital inputs are faulty. NOT REQUIRED	
2/5		Flash code 2/5 indicates that a function is prevented due to a cutout.	4
	BOOM PREVENTED – DRIVE SELECTED	A boom function is selected while a drive function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	
	DRIVE PREVENTED – BOOM SELECTED	Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	
	MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	User changed the model number using the analyzer. User must cycle power before the hydraulics system will be active again.	11
2/7		Flash code 2/7 indicates that the accelerator input is faulty. NOT REQUIRED	
2/8		Flash code 2/8 indicates a problem with a hydraulic filter. Not reported during 2 second power-up.	5
	RETURN FILTER BYPASSED	Hydraulic return filter clogged	
	charge pump filter bypassed	Charge pump filter clogged	

Table 6-13. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
3/1		Flash code 3/1 indicates that a contactor did not close when energized. NOT REQUIRED	
3/2		Flash code 3/2 indicates that a contactor did not open when energized. NOT REQUIRED	
3/3		Flash code 3/3 indicates a driver problem. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.	6
	ALTERNATOR/ECM POWER SHORT TO GROUND		
	HOUR METER SHORT TO GROUND		
	HOUR METER SHORT TO BATTERY		
	HORN SHORT TO GROUND		
	HORN OPEN CIRCUIT		
	HORN SHORT TO BATTERY		
	AUX POWER SHORT TO GROUND		
	AUX POWER OPEN CIRCUIT		
	AUX POWER SHORT TO BATTERY		
	GLOW PLUG SHORT TO GROUND		
	GLOW PLUG OPEN CIRCUIT		
	GLOW PLUG SHORT TO BATTERY		
	LP LOCK SHORT TO GROUND		
	LP LOCK OPEN CIRCUIT		
	LP LOCK SHORT TO BATTERY		
	LP START ASSIST SHORT TO GROUND		
	LP START ASSIST OPEN CIRCUIT		
	LP START ASSIST SHORT TO BATTERY		
	MAIN DUMP SHORT TO GROUND		
	MAIN DUMP OPEN CIRCUIT		
	MAIN DUMP SHORT TO BATTERY		
	PARKING BRAKE SHORT TO GROUND		
	PARKING BRAKE OPEN CIRCUIT		
	PARKING BRAKE SHORT TO BATTERY		
	START SOLENOID SHORT TO GROUND		
	START SOLENOID OPEN CIRCUIT		
	START SOLENOID SHORT TO BATTERY		
	STEER DUMP SHORT TO GROUND		
	STEER DUMP OPEN CIRCUIT		
	STEER DUMP SHORT TO BATTERY		
	TWO SPEED SHORT TO GROUND		
	TWO SPEED OPEN CIRCUIT		
	TWO SPEED SHORT TO BATTERY		
	GROUND ALARM SHORT TO GROUND		

Table 6-13. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	GROUND ALARM OPEN CIRCUIT		
	GROUND ALARM SHORT TO BATTERY		
	GENERATOR SHORT TO GROUND		
	GENERATOR OPEN CIRCUIT		
	GENERATOR SHORT TO BATTERY		
	WELDER SHORT TO GROUND		
	WELDER OPEN CIRCUIT		
	WELDER SHORT TO BATTERY		
	HEAD TAIL LIGHT SHORT TO GROUND		
	HEAD TAIL LIGHT OPEN CIRCUIT		
	HEAD TAIL LIGHT SHORT TO BATTERY		
	BASKET UP OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	BASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	BASKET LEFT OPEN CIRCUIT		
	BASKET LEFT SHORT TO BATTERY		
	BASKET LEFT SHORT TO GROUND		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		
	JIB LEFT OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	TOWER UP SHORT TO GROUND		

Table 6-13. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	TOWER UP OPEN CIRCUIT		
	TOWER UP SHORT TO BATTERY		
	TOWER DOWN SHORT TO GROUND		
	TOWER DOWN OPEN CIRCUIT		
	TOWER DOWN SHORT TO BATTERY		
	TOWER IN SHORT TO GROUND		
	TOWER IN OPEN CIRCUIT		
	TOWER IN SHORT TO BATTERY		
	TOWER OUT SHORT TO GROUND		
	TOWER OUT OPEN CIRCUIT		
	TOWER OUT SHORT TO BATTERY		
	UPPER IN SHORT TO GROUND		
	UPPER IN OPEN CIRCUIT		
	UPPER IN SHORT TO BATTERY		
	UPPER OUT SHORT TO GROUND		
	UPPER OUT OPEN CIRCUIT		
	UPPER OUT SHORT TO BATTERY		
	LIFT UP DUMP SHORT TO GROUND		
	LIFT UP DUMP OPEN CIRCUIT		
	LIFT UP DUMP SHORT TO BATTERY		
	LIFT DOWN HOLDING SHORT TO GROUND		
	LIFT DOWN HOLDING OPEN CIRCUIT		
	LIFT DOWN SHORT TO BATTERY		
	HOUR METER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	FORD ECM POWER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	FORD ECM POWER SHORT TO BATTERY	This fault cannot be detected during normal operation. It may be reported during self test.	
3/4		Flash code 3/4 indicates a driver problem on a platform valve block valve driver. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.	6
	BASKET UP SHORT TO BATTERY		
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	BASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling.	
	BASKET LEFT SHORT TO BATTERY		
	BASKET LEFT SHORT TO GROUND		
	BASKET LEFT OPEN CIRCUIT		

Table 6-13. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	BASKET RIGHT SHORT TO BATTERY		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		
	JIB LEFT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	PLATFORM CONTROL VALVE SHORT TO BATTERY	Only occurs on machines with electronic basket leveling	
	PLATFORM CONTROL VALVE SHORT TO GROUND	Only occurs on machines with electronic basket leveling	
	PLATFORM CONTROL VALVE OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
3/5		Flash code 3/5 indicates a brake pressure problem. NOT REQUIRED	
4/2		Flash code 4/2 indicates that the engine is over temperature. NOT REQUIRED	
4/3		Flash code 4/3 indicates problems with the engine. Except where noted, these faults are not reported during 2 second power-up sequence.	9
	high engine temp	Occurs when the engine temperature is above 117 degrees Celsius for the Ford engines, and above 130 degrees Celsius for the Deutz engines.	
	AIR FILTER BYPASSED	Air filter clogged	
	NO ALTERNATOR OUTPUT	The engine has been running for 15 seconds or more and the battery voltage is still below 12.5 volts.	
	LOW OIL PRESSURE	If a Deutz engine is installed, the oil pressure is below 8 PSI and the engine has been running for at least 10 seconds. If a Ford engine is installed, the Ford ECM has reported a low oil pressure fault.	
	OIL PRESSURE SHORT TO BATTERY	If a Deutz engine is installed, this indicates that the oil pressure sensor is reading above 6.6 volts.	
	OIL PRESSURE SHORT TO GROUND	If a Deutz engine is installed, this indicates that the oil pressure sensor is reading below 0.1 volts for more than 5 seconds. This fault is not detected during crank.	
	COOLANT TEMPERATURE SHORT TO GROUND	If a Deutz engine is installed, this indicates that the coolant temperature is reading below 0.1 volts.	
	FORD FAULT CODE ##	All Ford fault codes except 63 are simply passed through from the FORD ECM. They only occur if a Ford engine is selected in the machine configuration digits. Can be reported during power-up sequence.	
	FORD FAULT CODE UNKNOWN	An unrecognized Ford ECM fault code has been received. Can be reported during power-up sequence.	
	485 communications lost	This fault only occurs with a Ford engine. It occurs when no responses are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
	FUEL SENSOR SHORT TO BATTERY	Indicates that the fuel sensor is reading above 4.3 volts.	
	FUEL SENSOR SHORT TO GROUND	Indicates that the fuel sensor is reading below 0.2 volts.	
4/4		Flash code 4/4 indicates problems with the battery supply. Not reported during 2 second power-up.	7

Table 6-13. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	BATTERY LOW	Battery voltage is below 11V for more than 5 seconds. This fault is not detected during crank. This is a warning – the controller does not shut down.	
	BATTERY TOO HIGH – SYSTEM SHUT DOWN	Battery voltage is above 16V. EMS recycle required.	
	BATTERY TOO LOW – SYSTEM SHUT DOWN	Battery voltage is below 9V.	
5/5		Flash code 5/5 indicates problems with vehicle engine RPM or the encoder. Not reported during 2 second power-up.	8
	SPEED SENSOR READING INVALID SPEED	This fault is detected with diesel engines only. The RPM pickup is indicating a speed that greater than 4000 RPM or approximately 8875 Hz.	
	SPEED INPUT LOST	This fault is detected with diesel engines only. It occurs if there is no RPM detected and the oil pressure input is reading above 8 PSI for more than three seconds. This is probably due to wiring problems at the ground module or a faulty speed sensor.	
6/6		Flash code 6/6 indicates problems with the CAN bus.	10
	CAN BUS FAILURE:	The ground module or platform module is not receiving CAN messages. This is probably due to wiring problems between the platform and ground modules.	
7/7		Flash code 7/7 indicates problems with a motor. NOT REQUIRED	
9/9		Flash code 9/9 indicates problems with the controller.	11
	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	Platform module code is too old to support the EIM or BPE load sensor and the machine is configured to use one of these two sensors. The PM code must be updated to a newer version.	
	HIGH RESOLUTION A2D FAILURE – INTERRUPT LOST	The ADS1213 chip in the platform module has stopped asserting its interrupt (DRDY) line for some reason. An EMS cycle is required.	
	HIGH RESOLUTION A2D FAILURE-REINIT LIMIT	The ADS1213 has needed to be reset 3 or more times.	
	PLATFORM MODULE FAILURE: hwfs CODE 1	Platform module V(Low) FET has failed	
	GROUND MODULE FAILURE: hwfs CODE 1	Ground module V(Low) FET has failed	
	GROUND SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	EEPROM FAILURE – CHECK ALL SETTINGS	A critical failure occurred with the EEPROM. Personalities, machine configuration digits, etc. may be reset to default values and should be checked.	
	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	Indicates that the chassis tilt sensor calibration information has been lost. Machine will indicate that it is tilted at all times. This calibration data is programmed into the unit at the factory.	
	CHASSIS TILT SENSOR GAIN OUT OF RANGE	Indicates that the chassis tilt sensor calibration has become corrupted.	

Table 6-14. Diagnostic Trouble Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
OK	0	0	CLEAR WHEN FAULT IS REMOVED
DRIVING AT CREEP - TILTED	0	0	CLEAR WHEN FAULT IS REMOVED
FSW OPEN	0	0	CLEAR WHEN FAULT IS REMOVED
RUNNING AT CREEP - CREEP SWITCH OPEN	0	0	CLEAR WHEN FAULT IS REMOVED
RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	0	0	CLEAR WHEN FAULT IS REMOVED
RUNNING AT CUTBACK - ABOVE ELEVATION	0	0	CLEAR WHEN FAULT IS REMOVED
TILT SENSOR OUT OF RANGE	0	0	CLEAR WHEN FAULT IS REMOVED
LOAD SENSOR READING UNDER WEIGHT	0	0	CLEAR WHEN FAULT IS REMOVED
FSW FAULTY	2	1	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
KEYSWITCH FAULTY	2	1	CLEAR WHEN FAULT IS REMOVED
DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	2	2	CLEAR WHEN FAULT IS REMOVED
FSW INTERLOCK TRIPPED	2	2	CLEAR WHEN FAULT IS REMOVED
STEER LOCKED - SELECTED BEFORE FOOTSWITCH	2	2	CLEAR WHEN FAULT IS REMOVED
STEER SWITCHES FAULTY	2	2	CLEAR WHEN FAULT IS REMOVED
D/S JOY. QPROX BAD	2	2	CLEAR WHEN FAULT IS REMOVED
L/S JOY. QPROX BAD	2	3	CLEAR WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE LOW	2	2	CLEAR WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE HIGH	2	2	CLEAR WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE LOW	2	3	CLEAR WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE HIGH	2	3	CLEAR WHEN FAULT IS REMOVED
D/S JOY. CENTER TAP BAD	2	2	CLEAR WHEN FAULT IS REMOVED
L/S JOY. CENTER TAP BAD	2	3	CLEAR WHEN FAULT IS REMOVED
WAITING FOR FSW TO BE OPEN	2	2	CLEAR WHEN FAULT IS REMOVED
PUMP POT FAULTY	2	3	CLEAR WHEN FAULT IS REMOVED
PUMP SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	2	3	CLEAR WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE FOOTSWITCH	2	3	CLEAR WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE START SWITCH	2	3	CLEAR WHEN FAULT IS REMOVED
FOOTSWITCH SELECTED BEFORE START	2	3	CLEAR WHEN FAULT IS REMOVED
BOOM PREVENTED - DRIVE SELECTED	2	5	CLEAR WHEN FAULT IS REMOVED
DRIVE PREVENTED - ABOVE ELEVATION	2	5	CLEAR WHEN FAULT IS REMOVED
DRIVE PREVENTED - TILTED & ABOVE ELEVATION	2	5	CLEAR WHEN FAULT IS REMOVED
DRIVE PREVENTED - BOOM SELECTED	2	5	CLEAR WHEN FAULT IS REMOVED
FORD ECM POWER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 6-14. Diagnostic Trouble Code Listing

HELP MESSAGE	FAULT	FAULT REMOVAL
HORN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 6-14. Diagnostic Trouble Code Listing

HELP MESSAGE	FAULT	FAULT REMOVAL
GENERATOR SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 6-14. Diagnostic Trouble Code Listing

HELP MESSAGE	FAULT	FAULT REMOVAL
TOWER UP OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO GROUND	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT OPEN CIRCUIT	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO BATTERY	3 3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
FUEL SENSOR SHORT TO BATTERY	3 3	CLEAR WHEN FAULT IS REMOVED
FUEL SENSOR SHORT TO GROUND	3 3	CLEAR WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO BATTERY	4 3	CLEAR WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO GROUND	4 3	CLEAR WHEN FAULT IS REMOVED
COOLANT TEMPERATURE SHORT TO GROUND	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 12	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 13	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 14	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 15	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 21	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 22	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 23	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 24	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 25	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 26	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 31	4 3	CLEAR WHEN FAULT IS REMOVED

Table 6-14. Diagnostic Trouble Code Listing

HELP MESSAGE	FAULT	FAULT REMOVAL
FORD FAULT CODE 32	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 33	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 34	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 35	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 36	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 41	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 42	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 43	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 44	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 45	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 46	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 51	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 52	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 53	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 54	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 55	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 56	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 57	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 61	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 62	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 63	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE 64	4 3	CLEAR WHEN FAULT IS REMOVED
FORD FAULT CODE UNKNOWN	4 3	CLEAR WHEN FAULT IS REMOVED
RETURN FILTER BYPASSED	2 8	CLEAR WHEN FAULT IS REMOVED
CHARGE PUMP FILTER BYPASSED	2 8	CLEAR WHEN FAULT IS REMOVED
BATTERY LOW	4 4	CLEAR WHEN FAULT IS REMOVED
BATTERY TOO HIGH - SYSTEM SHUT DOWN	4 4	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BATTERY TOO LOW - SYSTEM SHUT DOWN	4 4	CLEAR WHEN FAULT IS REMOVED
SPEED SENSOR READING INVALID SPEED	5 5	CLEAR WHEN FAULT IS REMOVED
SPEED INPUT LOST	5 5	CLEAR WHEN FAULT IS REMOVED
ENGINE TEMP HIGH	4 3	CLEAR WHEN FAULT IS REMOVED
AIR FILTER BYPASSED	4 3	CLEAR WHEN FAULT IS REMOVED
NO ALTERNATOR OUTPUT	4 3	CLEAR WHEN FAULT IS REMOVED

Table 6-14. Diagnostic Trouble Code Listing

HELP MESSAGE	FAULT	FAULT REMOVAL
OIL PRESSURE LOW	4 3	CLEAR WHEN FAULT IS REMOVED
485 COMMUNICATIONS LOST	4 3	CLEAR WHEN FAULT IS REMOVED
CAN BUS FAILURE	6 6	CLEAR WHEN FAULT IS REMOVED
LOAD SENSOR NOT CALIBRATED	9 9	CLEAR WHEN FAULT IS REMOVED
TILT SENSOR NOT CALIBRATED	9 9	CLEAR WHEN FAULT IS REMOVED
EEPROM FAILURE - CHECK ALL SETTINGS	9 9	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PLATFORM MODULE FAILURE: HWFS CODE 1	9 9	CLEAR WHEN FAULT IS REMOVED
GROUND MODULE FAILURE: HWFS CODE 1	9 9	CLEAR WHEN FAULT IS REMOVED

[illegible]

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.

NOTE: Some of the procedures/connectors shown in this section may not be applicable to all models.

7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting of 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 kW = 1200 W

Example: 50 mA = 0.05 A

Voltage Measurement

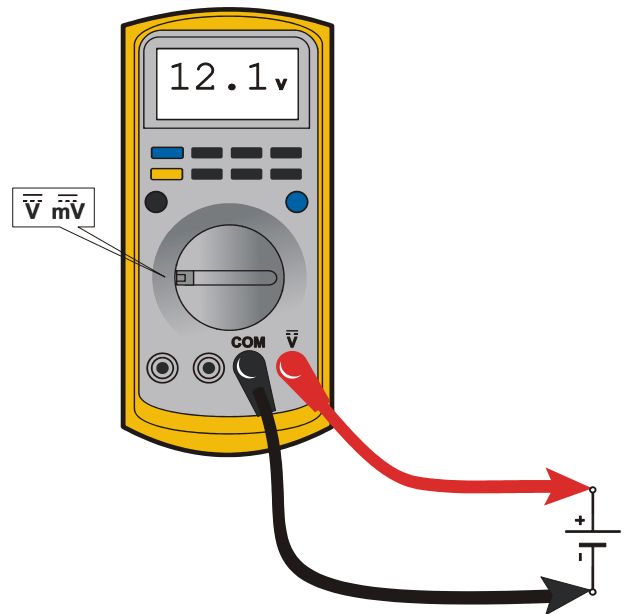


Figure 7-1. Voltage Measurement (DC)

- 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

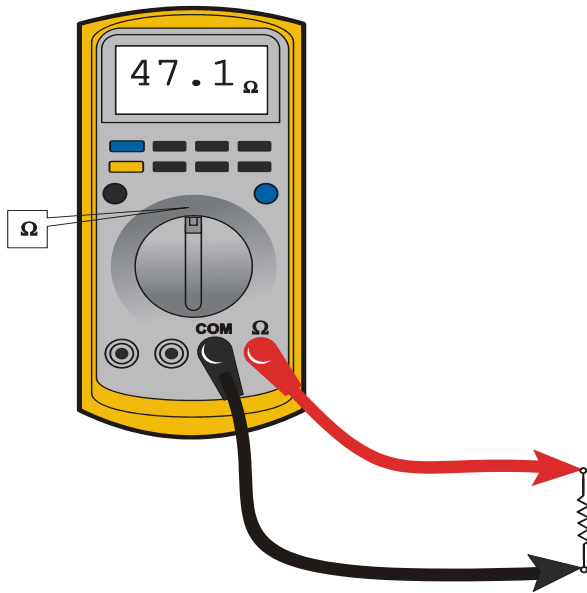


Figure 7-2. Resistance Measurement

- 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).

Continuity Measurement

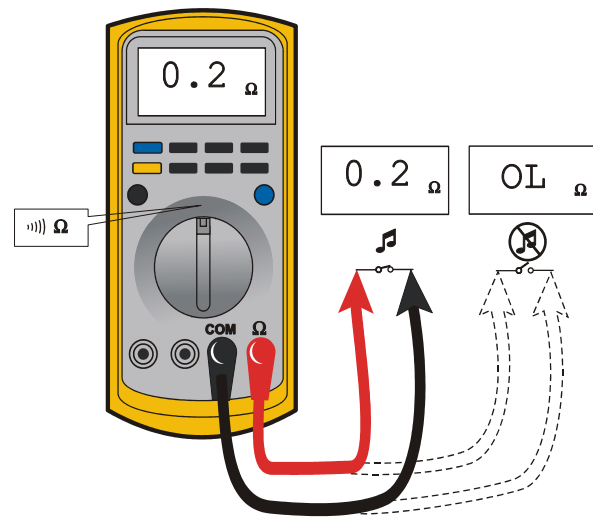


Figure 7-3. Continuity Measurement

- 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

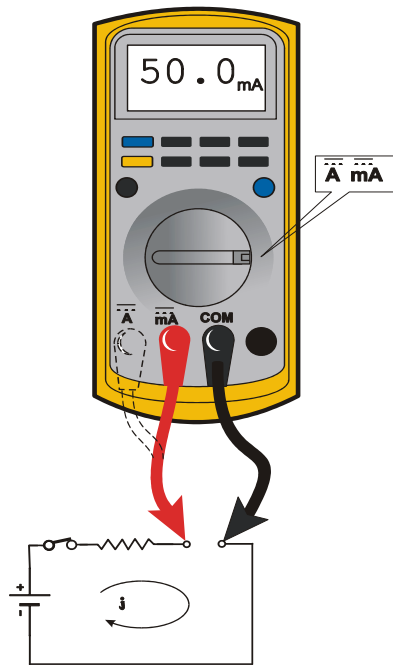


Figure 7-4. Current Measurement (DC)

- 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: This section is not applicable for battery terminals.

NOTICE

JLG P/N 0100048 DIELECTRIC GREASE (NOVAGARD G661) IS THE ONLY MATERIAL APPROVED FOR USE AS A DIELECTRIC GREASE.

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.

- 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.*

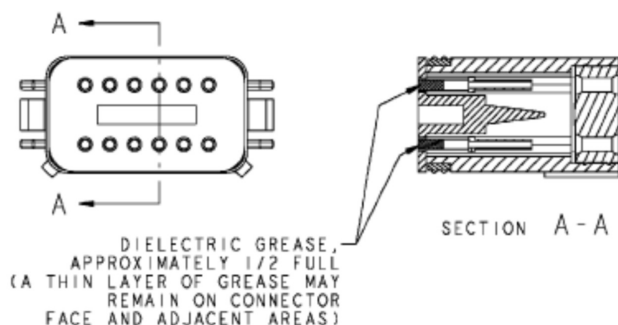
When applied to electrical connections, dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

Dielectric grease shall be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

Installation of Dielectric Grease

Before following these instructions, refer to excluded connector types (See Exclusions below).

- Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
- Apply dielectric grease to the female contact (fill it approximately $\frac{1}{2}$ full; see example below)
- Leave a thin layer of dielectric grease on the face of the connector
- Assemble the connector system immediately to prevent moisture ingress or dust contamination
- Pierce one of the unused wire seals prior to assembly if the connector system tends to trap air (i.e. AMP Seal) and then install a seal plug.



Deutsch HD, DT, DTM, DRC Series

The Deutsch connector system is commonly used for harsh environment interconnect. Follow the installation instructions.



AWP Seal

The AMP Seal connector system is used on the Control ADE Platform and Ground Modules.

Apply dielectric grease to the female contact. If trapped air prevents the connector from latching, pierce one of the unused wire seals. After assembly, install a seal plug (JLG #4460905) in that location to prevent moisture ingress.

Note that seal plugs may be installed by the wire harness manufacturer if an unused wire seal becomes compromised (wire inserted in the wrong cavity during assembly and then corrected).



Figure 7-5. Application to Plug/Male Contacts

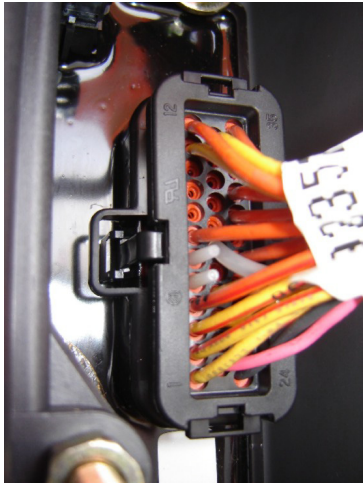
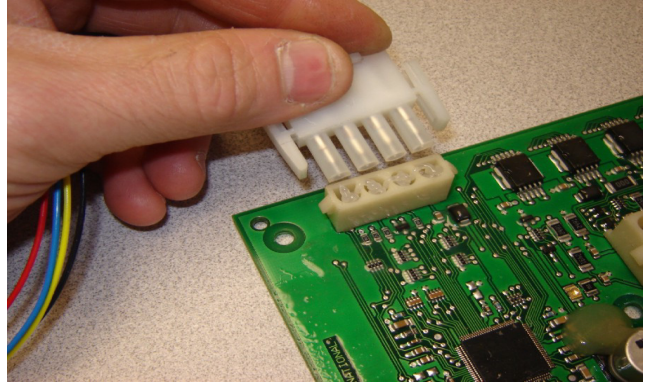


Figure 7-6. Use of Seal Plugs

AMP Mate-N-Lok

This connector system is widely used inside enclosures for general-purpose interconnect. Follow the installation instructions.



DIN Connectors

This connector is typically used on hydraulic valves. Follow the installation instructions.



Exclusions

A limited number of connectors do not benefit from dielectric grease, or may be permanently damaged by application. Dielectric grease may not be required in properly sealed enclosures.

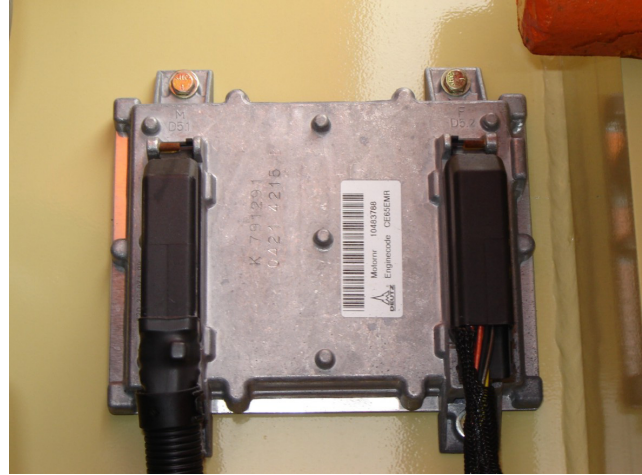
BRAD HARRISON / PHOENIX CONTACT M12

The connector uses gold contact material to resist corrosion and an o-ring seal for moisture integrity. If dielectric grease is mistakenly applied to this connector system, the low-force contacts cannot displace the grease to achieve electrical contact. Once contaminated, there is no practical way to remove the dielectric grease (replacement of female contacts required). The JLG Load Sensing System and 1250AJP Rotary Angle Sensors are examples of components with the M12 connector system.



AMP JUNIOR TIMER

This type of connector uses back-seals for moisture integrity. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The EMR2 engine control module from Deutz employs this connector system (for example).



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 7-7.). Proceed as follows:

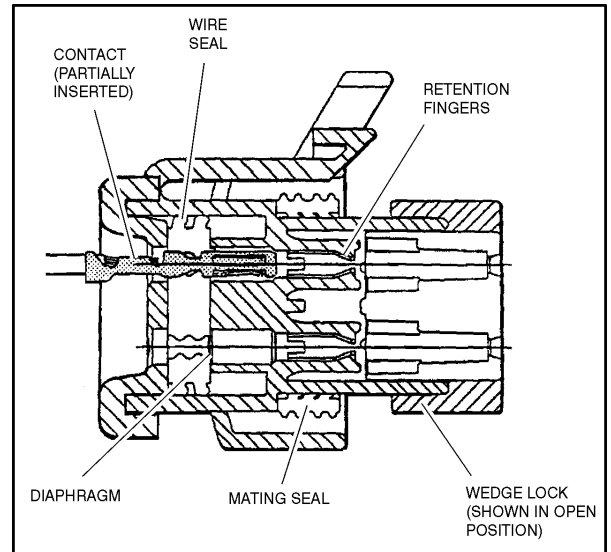


Figure 7-7. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-9.).
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 7-9.).

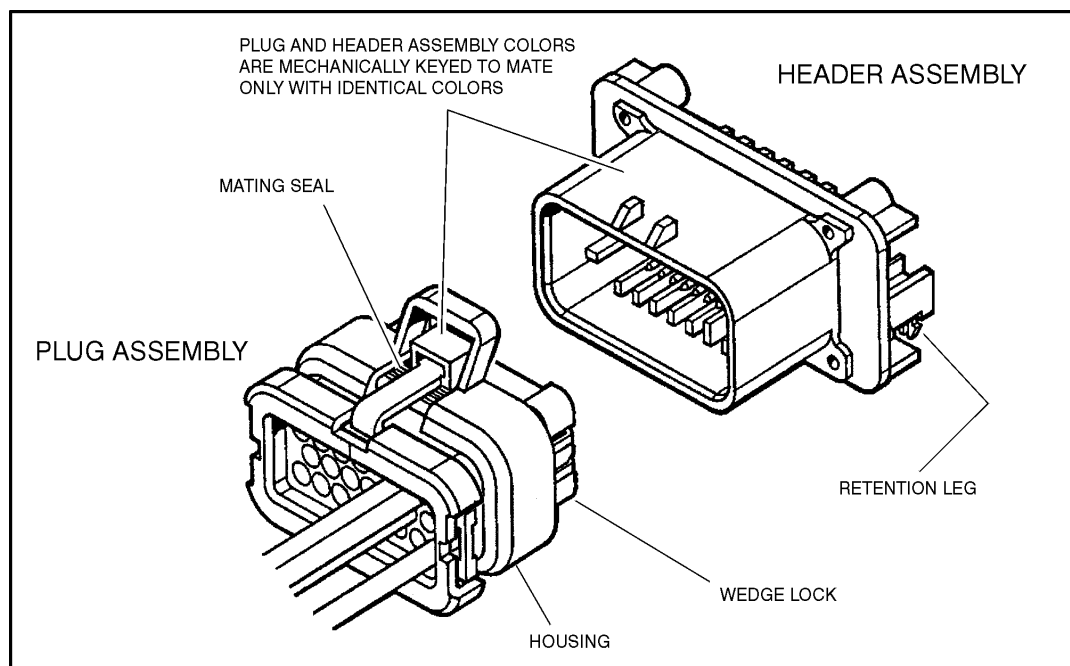


Figure 7-8. AMP Connector

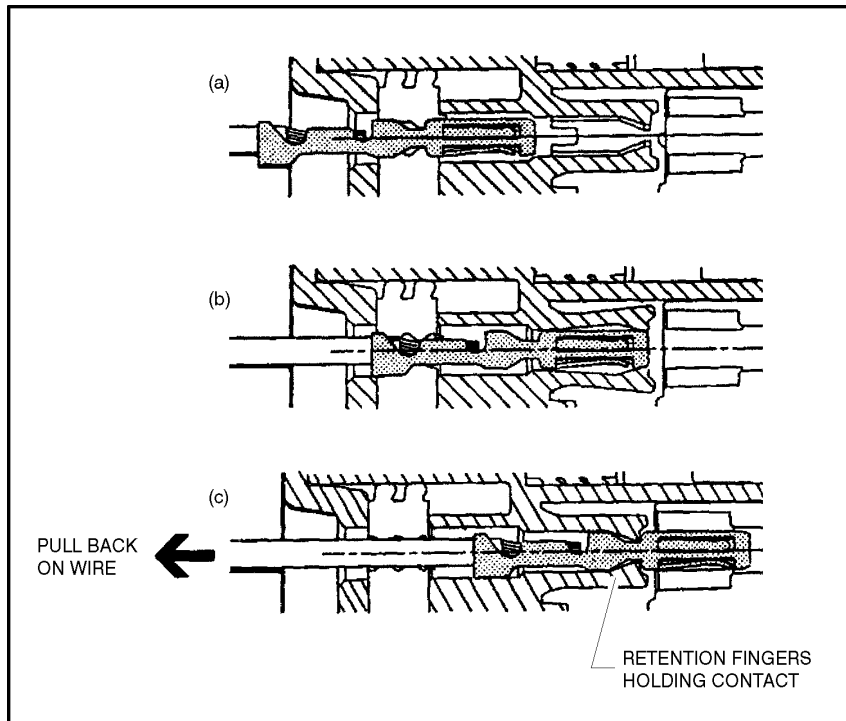


Figure 7-9. Connector Assembly Figure 2

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 7-10.).

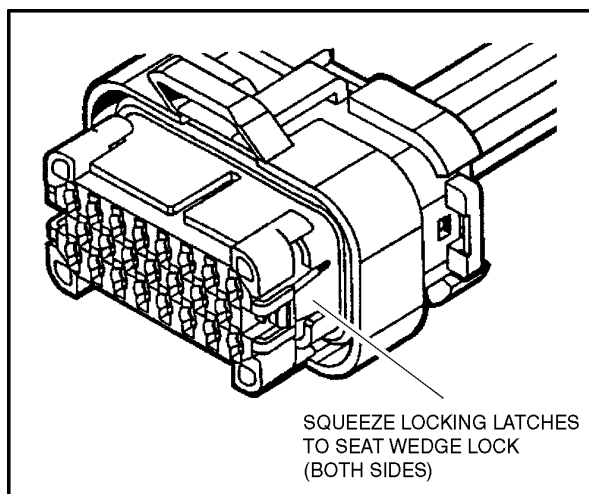


Figure 7-10. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-11.).

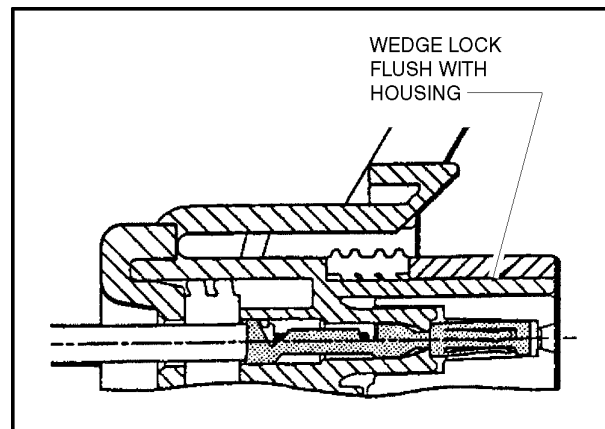


Figure 7-11. Connector Assembly Figure 4

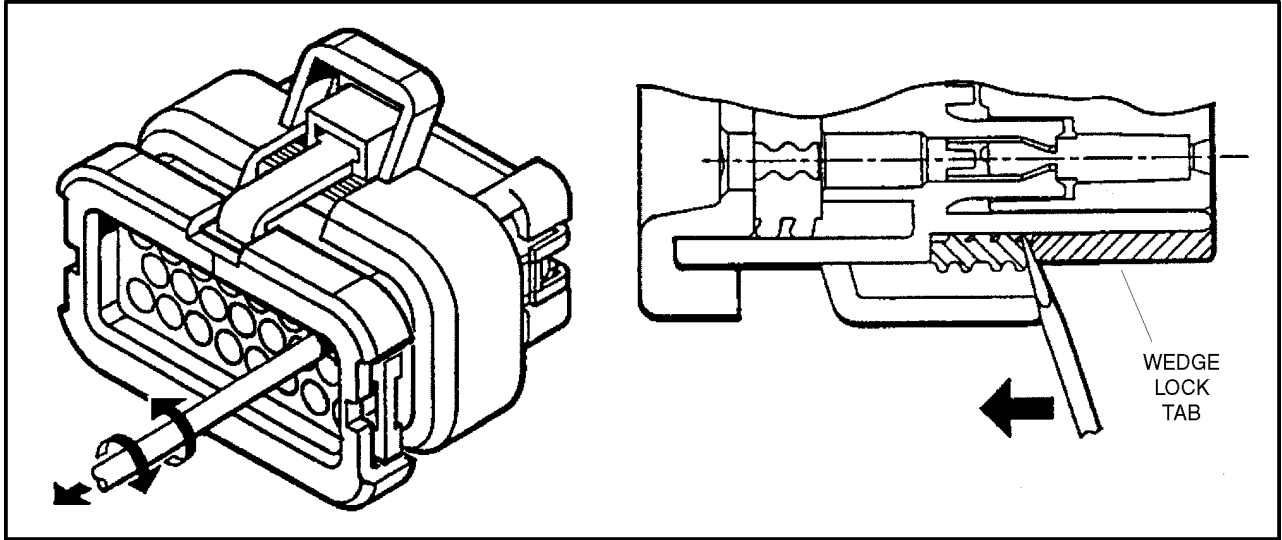


Figure 7-12. Connector Disassembly

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

NOTICE

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.

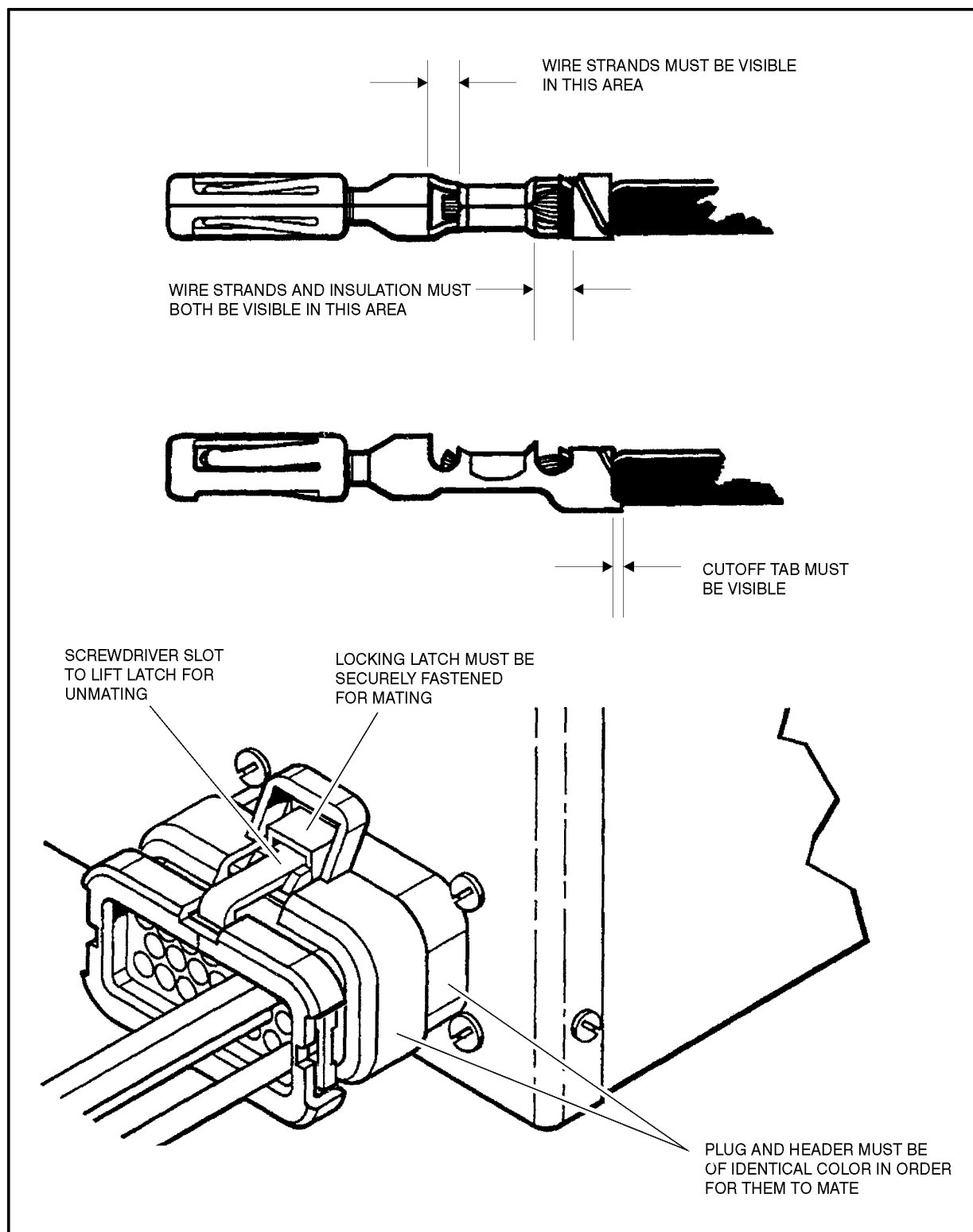


Figure 7-13. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

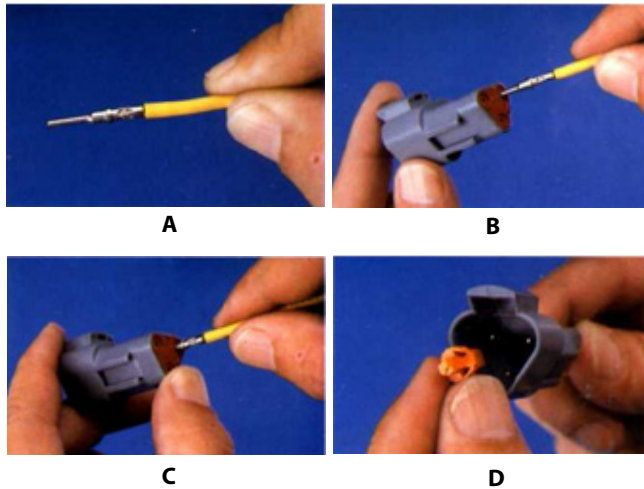


Figure 7-14. DT/DTP Contact Installation

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. They may go in either way.

NOTE: The receptacle is shown use the same procedure for plug.

DT/DTP Series Disassembly

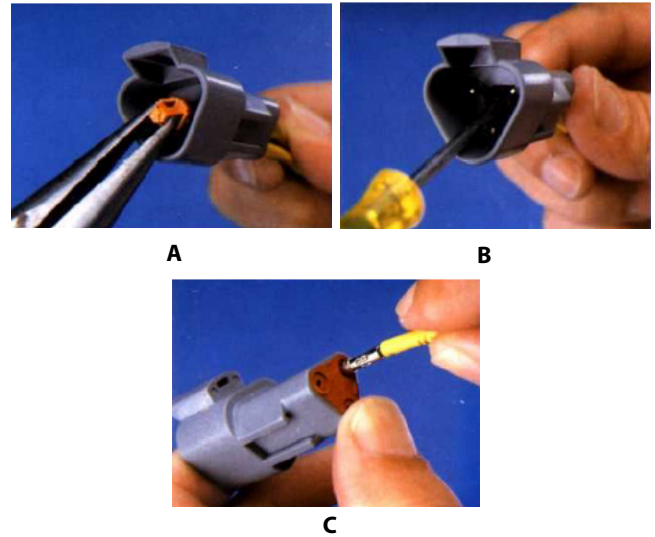


Figure 7-15. DT/DTP Contact Removal

5. Remove wedgelock using needle nose 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

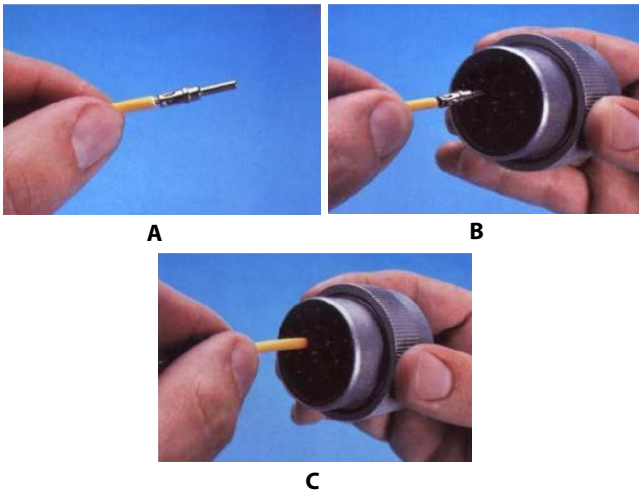


Figure 7-16. HD/HDP Contact Installation

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.

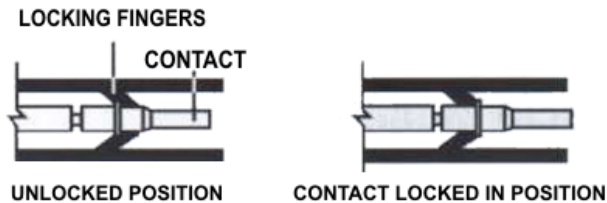


Figure 7-17. HD/HDP Locking Contacts Into Position

NOTE: For unused wire cavities, insert sealing plugs for full environmental sealing.

HD30/HDP20 Series Disassembly

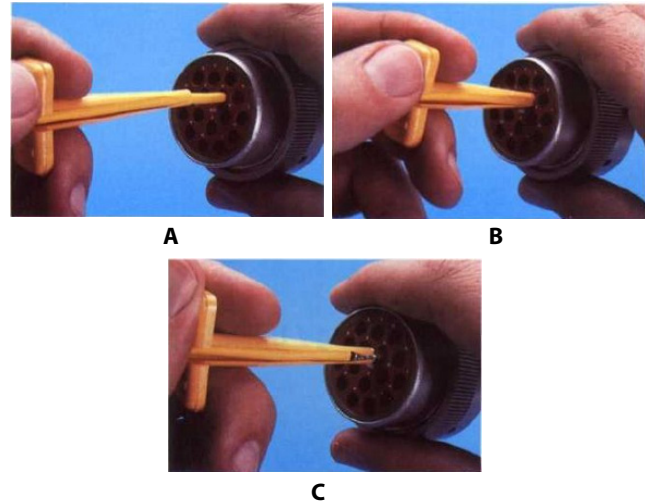


Figure 7-18. HD/HDP Contact Removal

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.

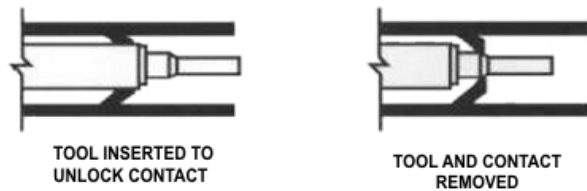


Figure 7-19. HD/HDP Unlocking Contacts

NOTE: Do Not twist or insert tool at an angle.

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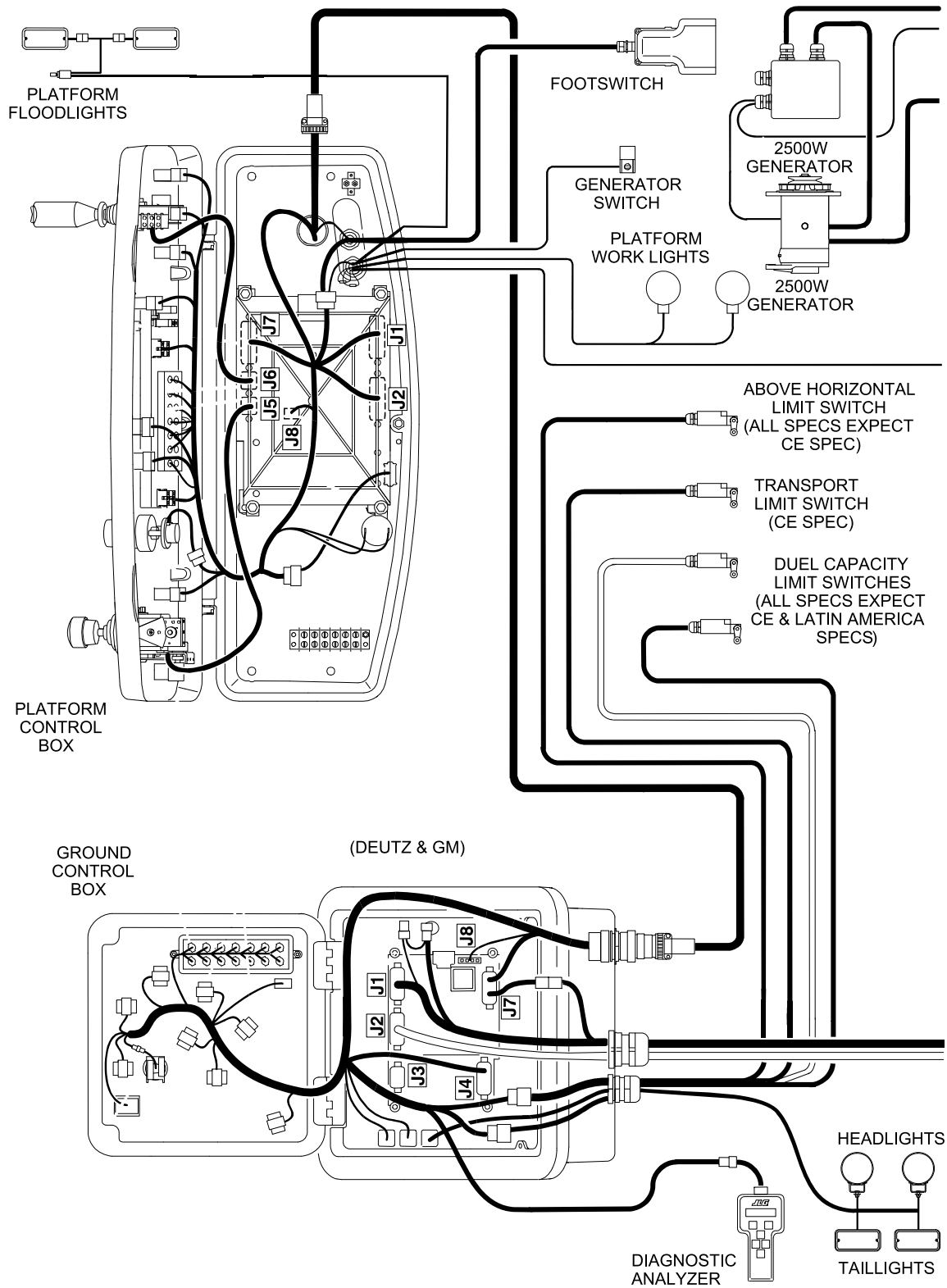


Figure 7-20. Electrical Components Installation (Without UGM) - Sheet 1 of 2

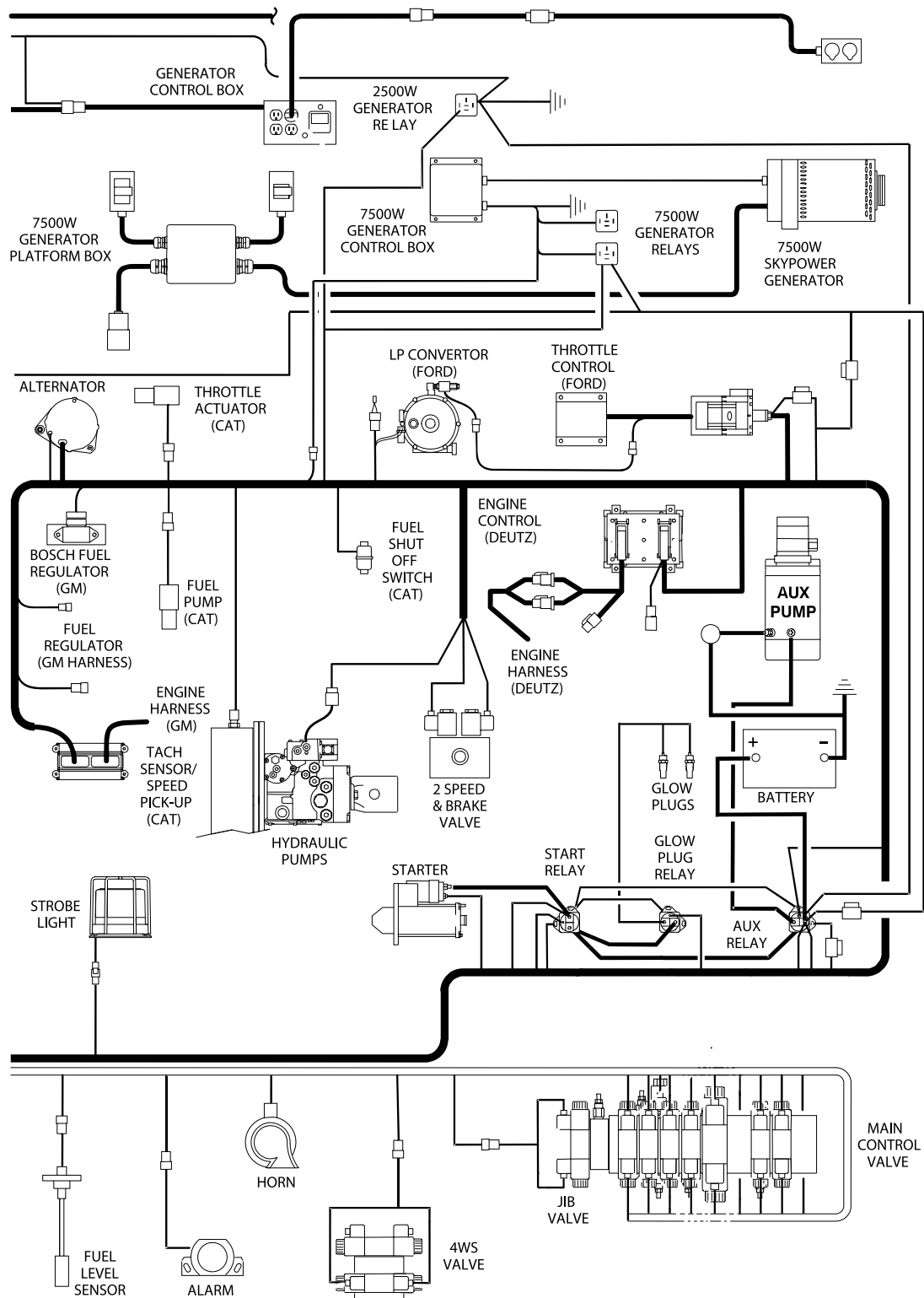


Figure 7-21. Electrical Components Installation (Without UGM) - Sheet 2 of 2

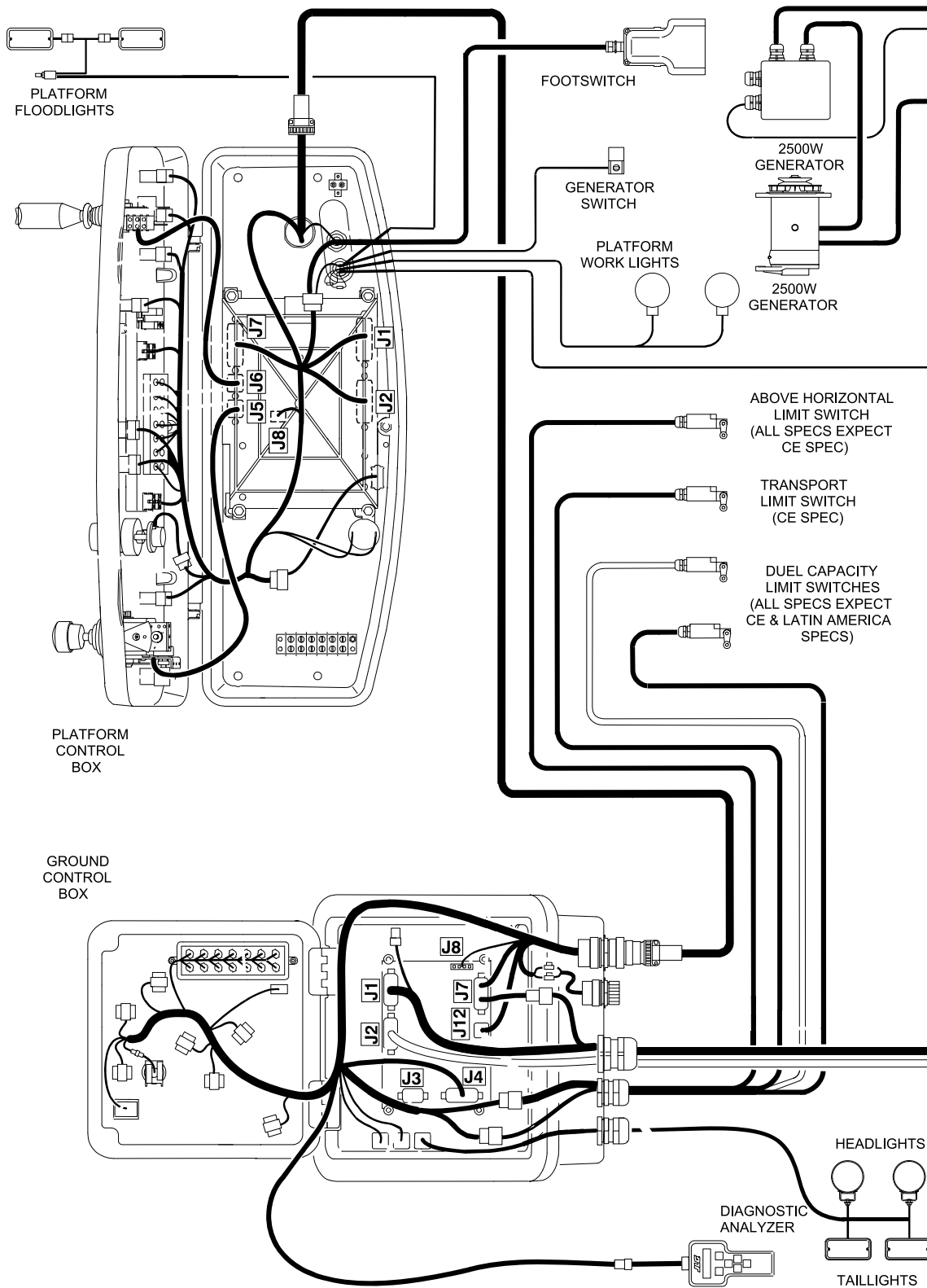


Figure 7-22. Electrical Components Installation (With UGM) - Sheet 1 of 2

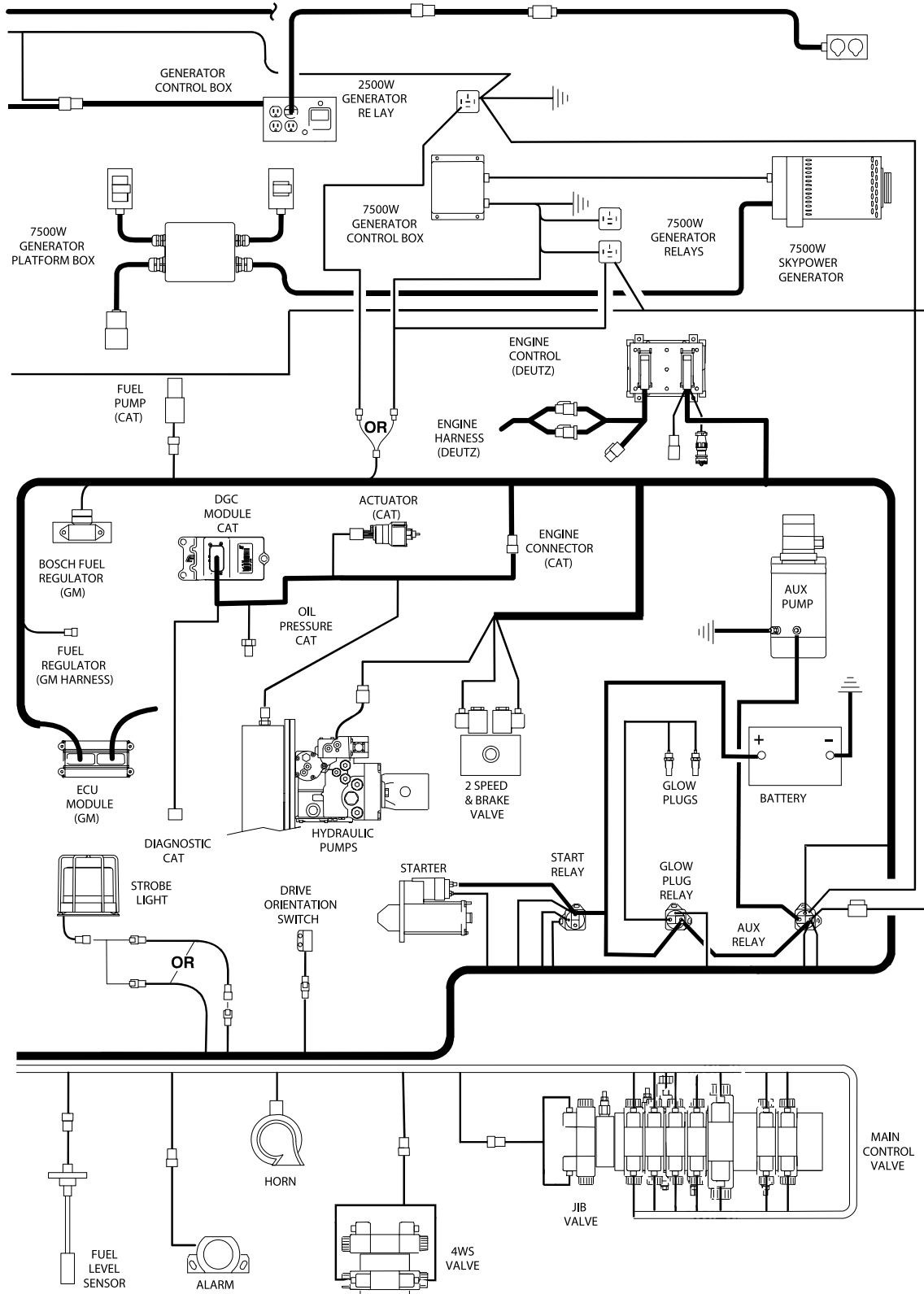


Figure 7-23. Electrical Components Installation (With UGM) - Sheet 2 of 2

7.6 ELECTRICAL SCHEMATICS

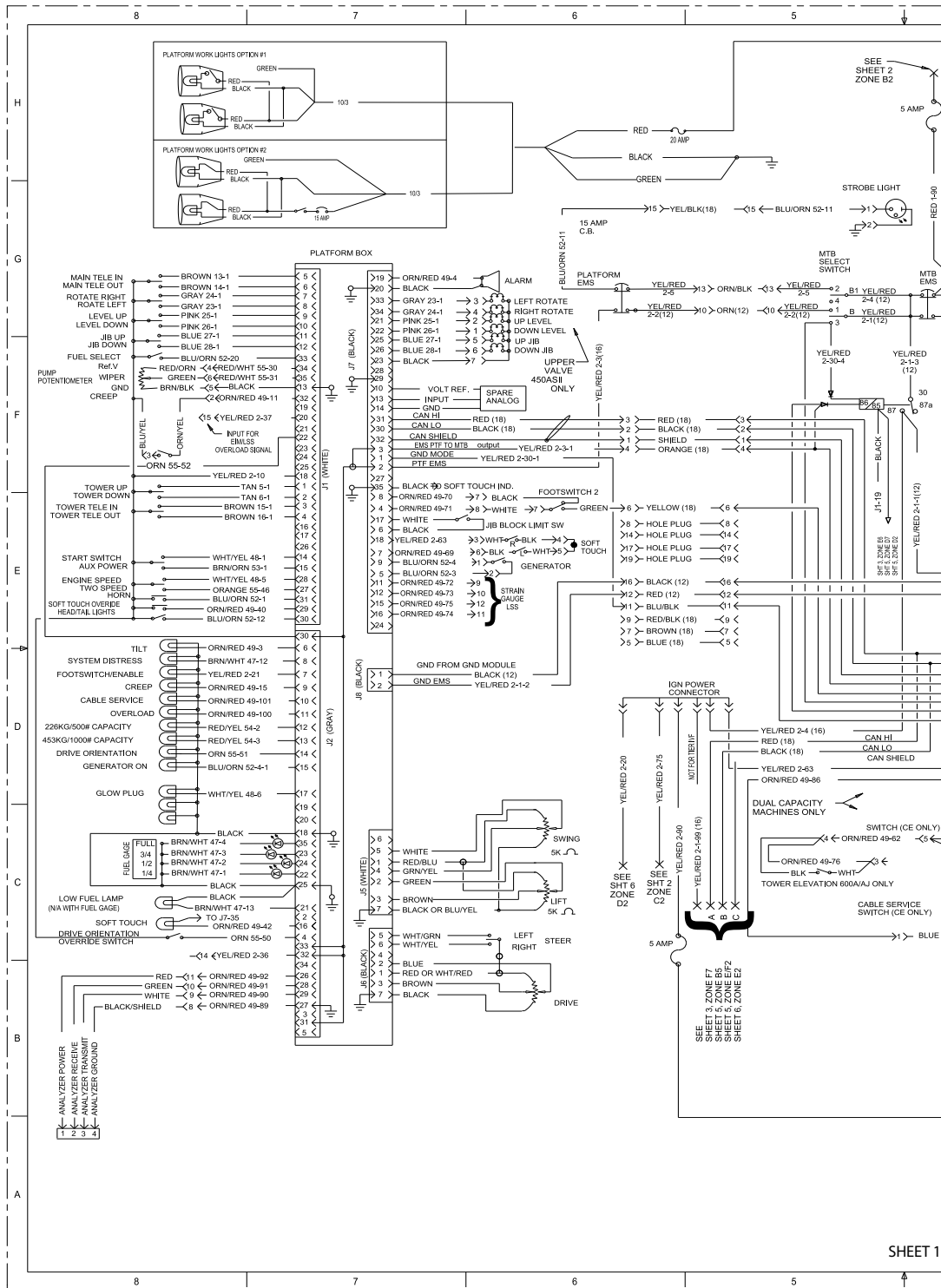


Figure 7-24. Electrical Schematic - Sheet 1 of 10

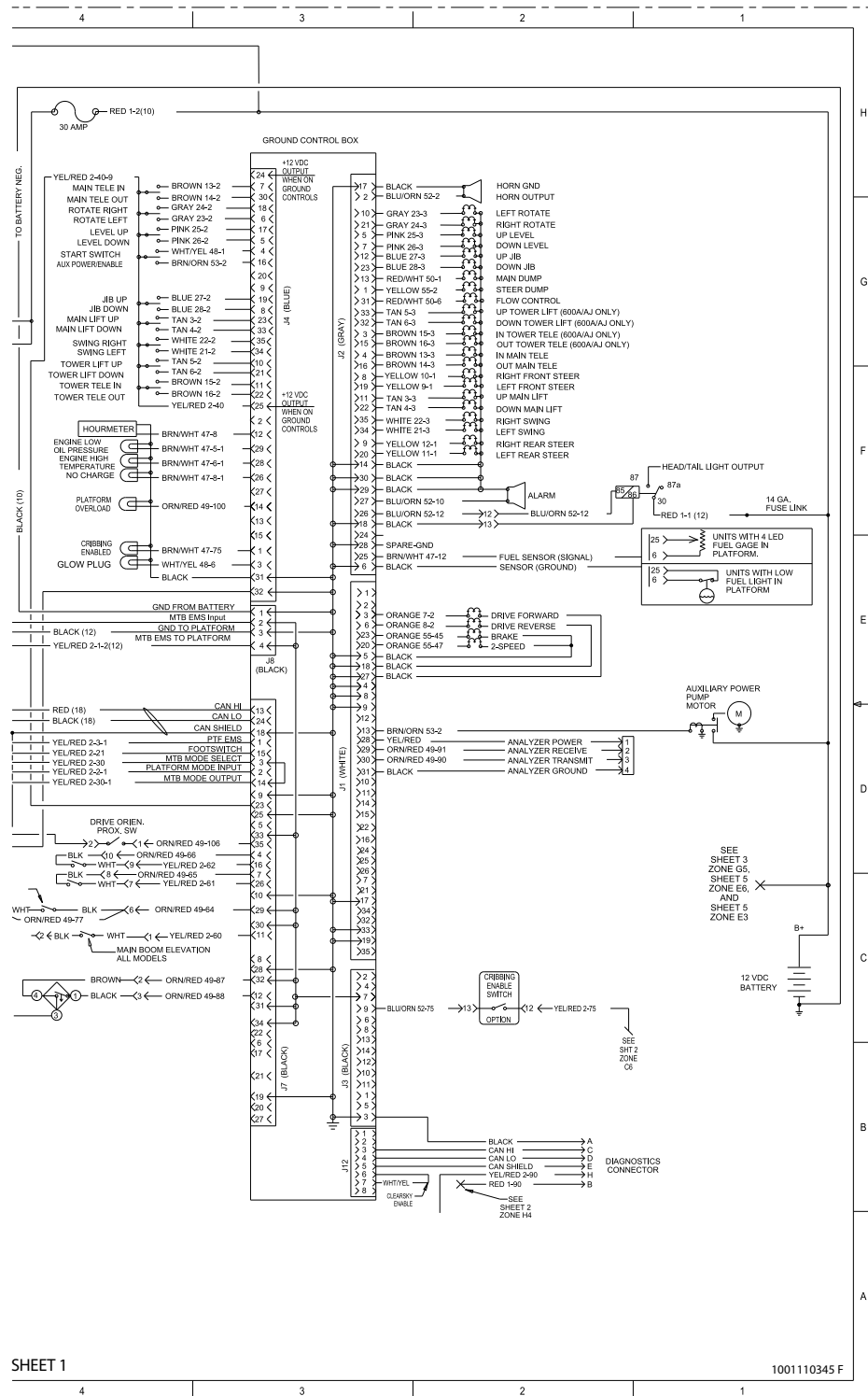


Figure 7-25. Electrical Schematic - Sheet 2 of 10

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

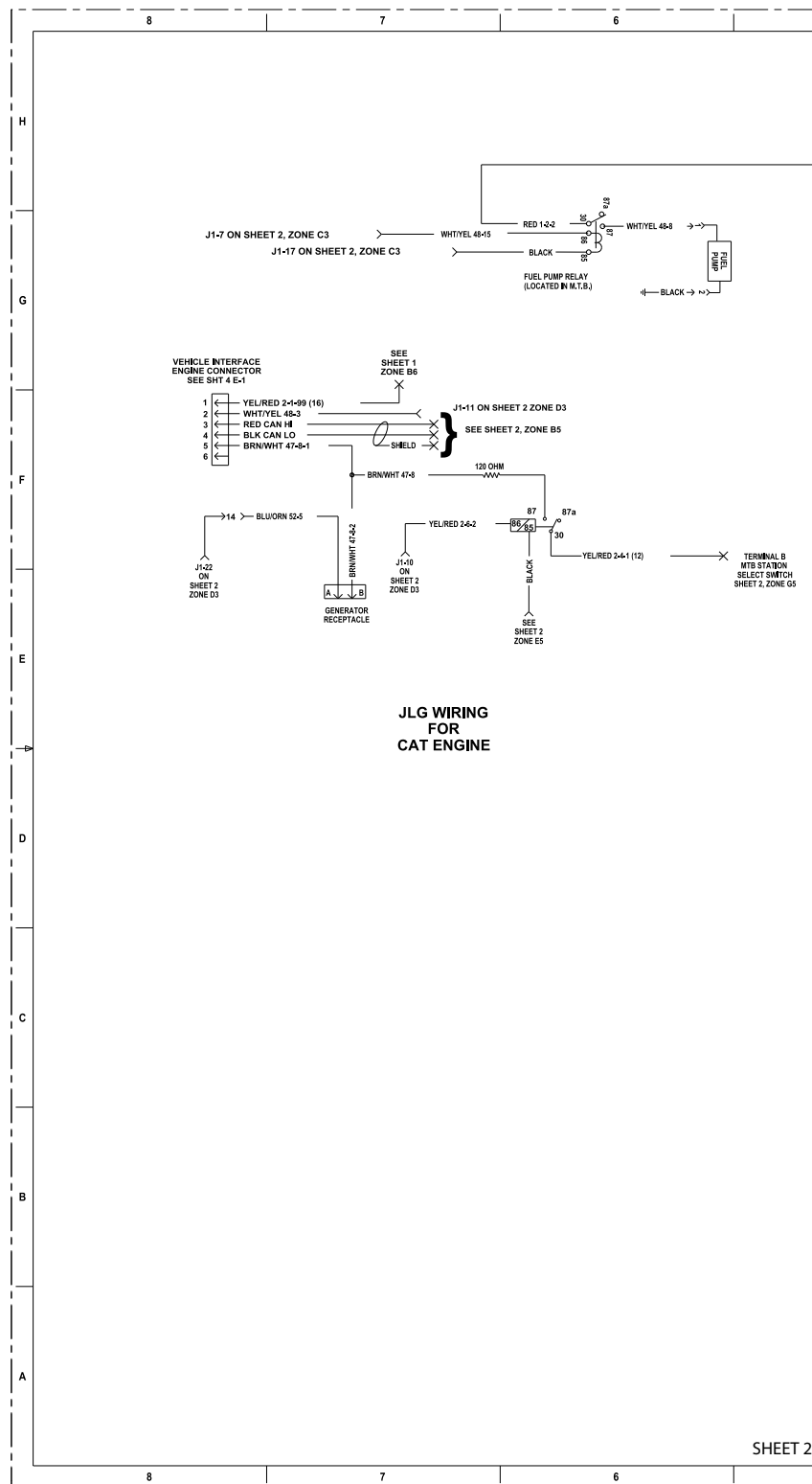


Figure 7-26. Electrical Schematic - Sheet 3 of 10

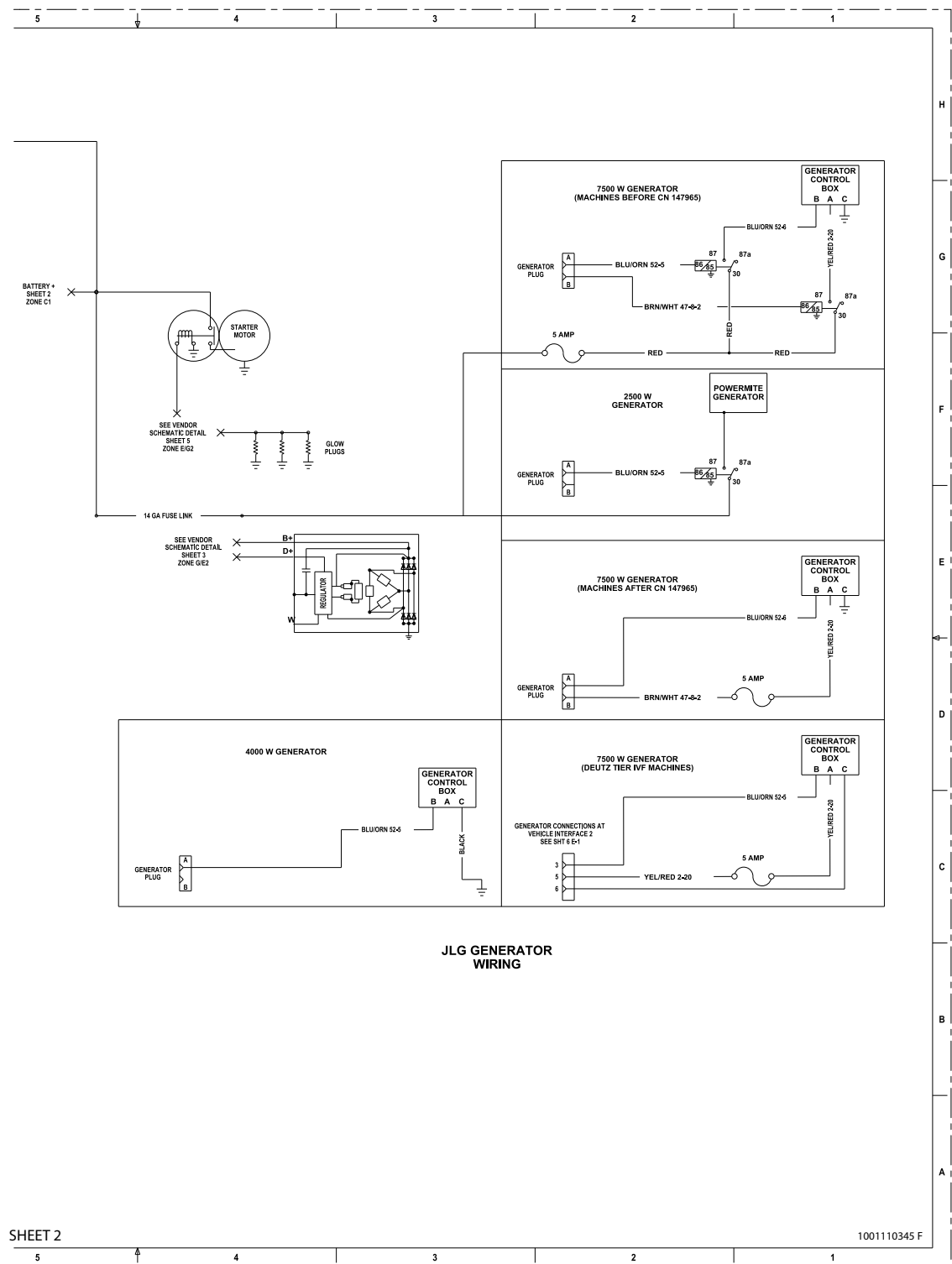


Figure 7-27. Electrical Schematic - Sheet 4 of 10

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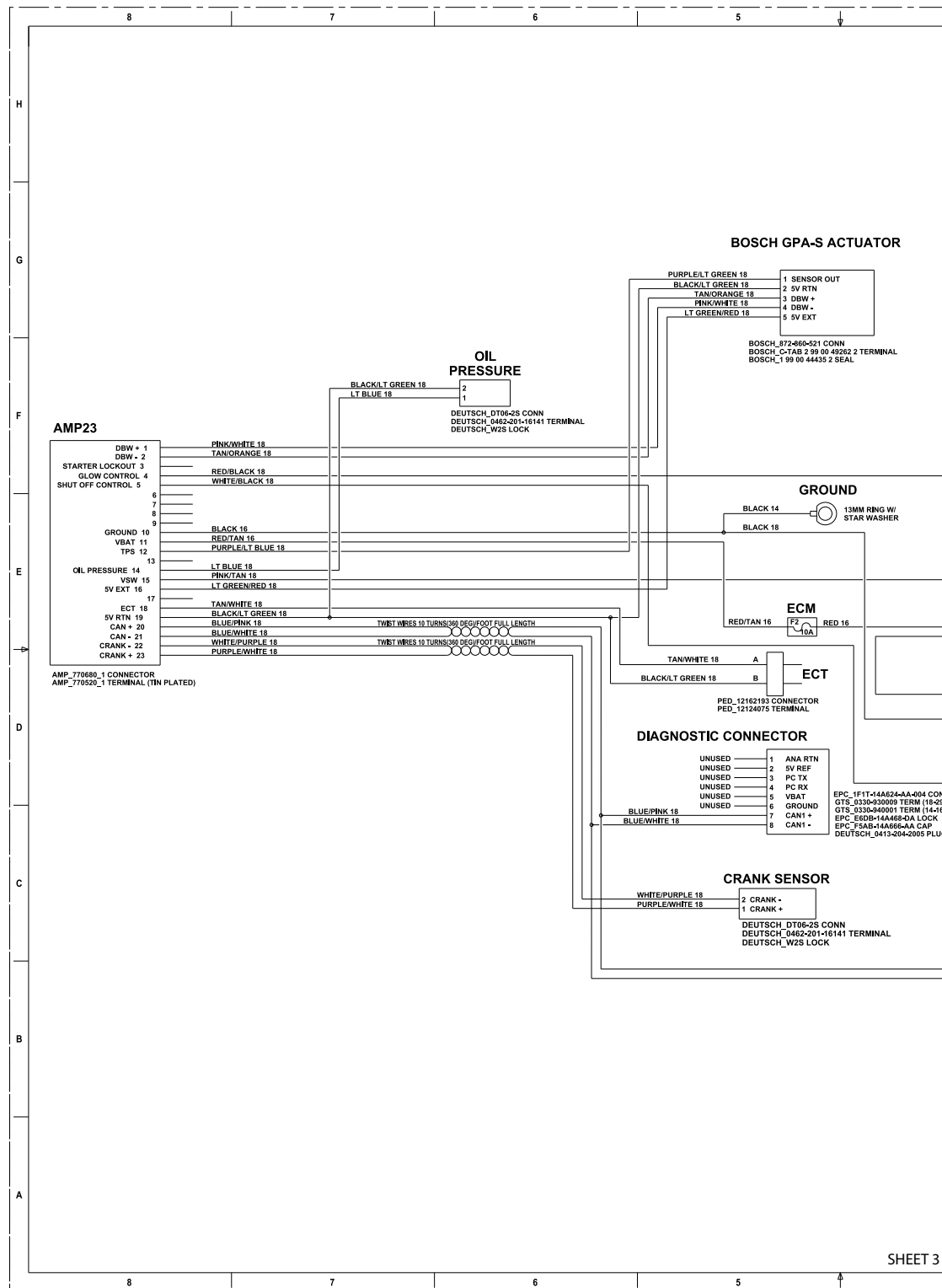


Figure 7-28. Electrical Schematic - Sheet 5 of 10

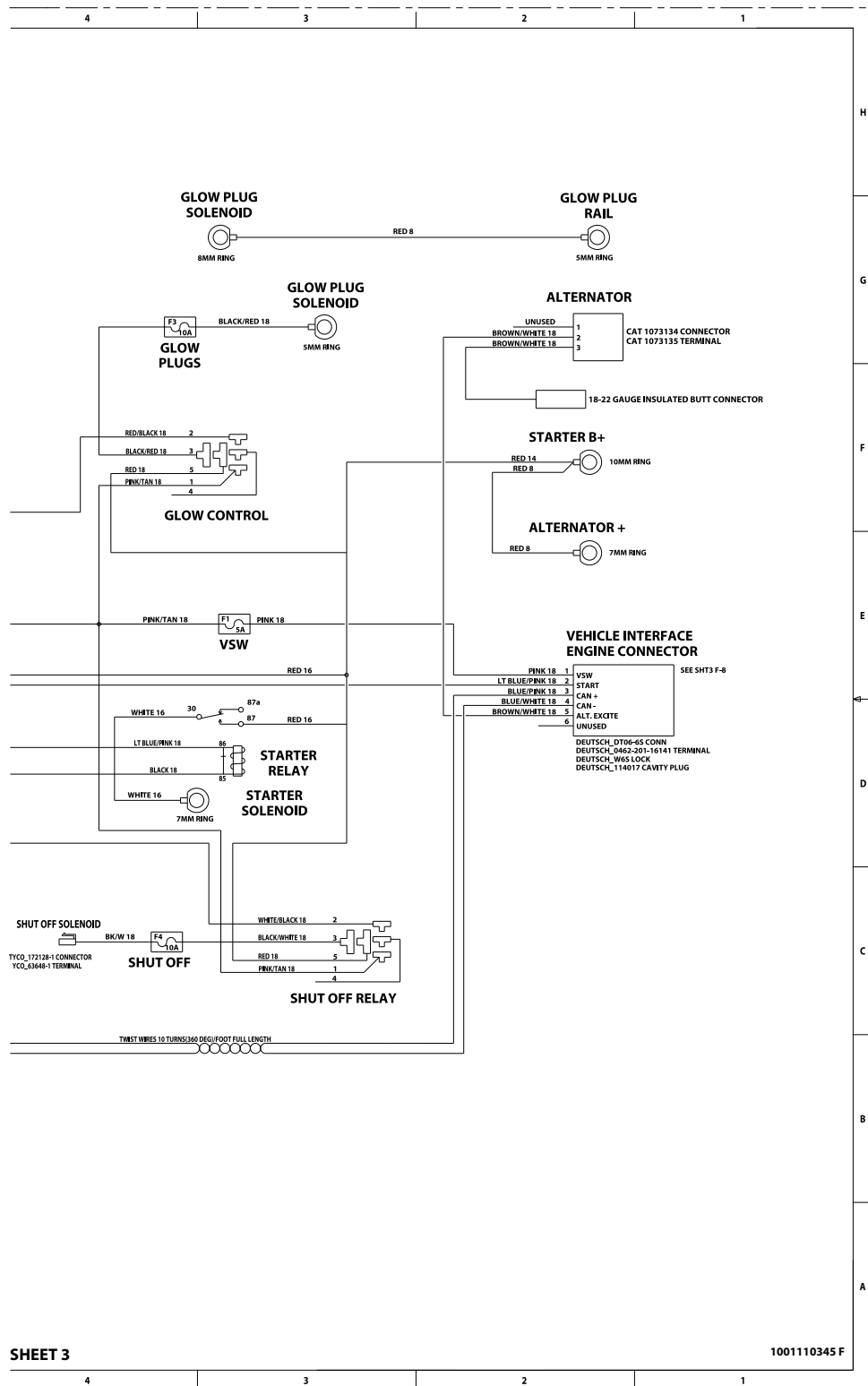


Figure 7-29. Electrical Schematic - Sheet 6 of 10

7-24



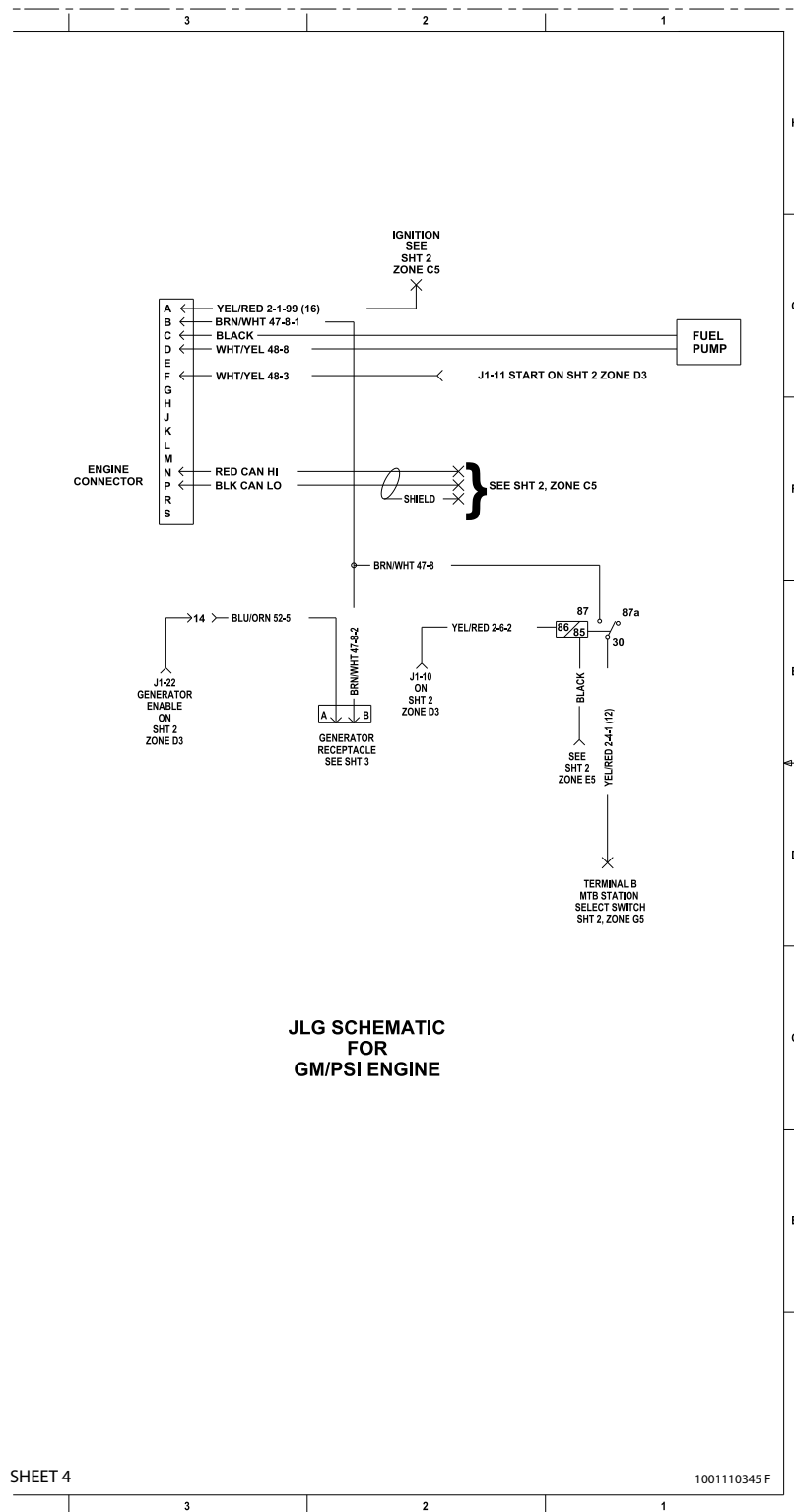


Figure 7-31. Electrical Schematic - Sheet 8 of 10

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SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

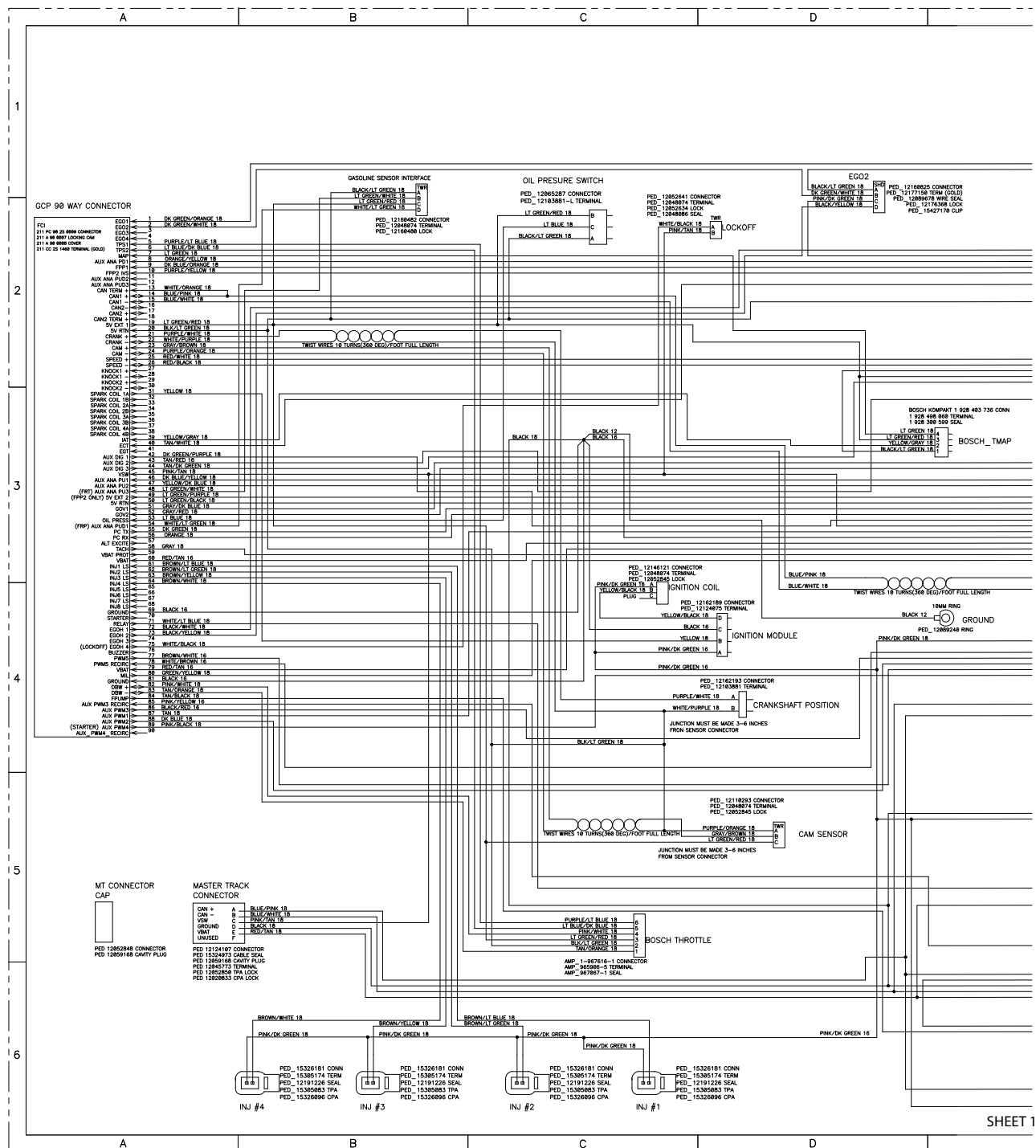


Figure 7-34. Electrical Schematic GM - Sheet 1 of 2

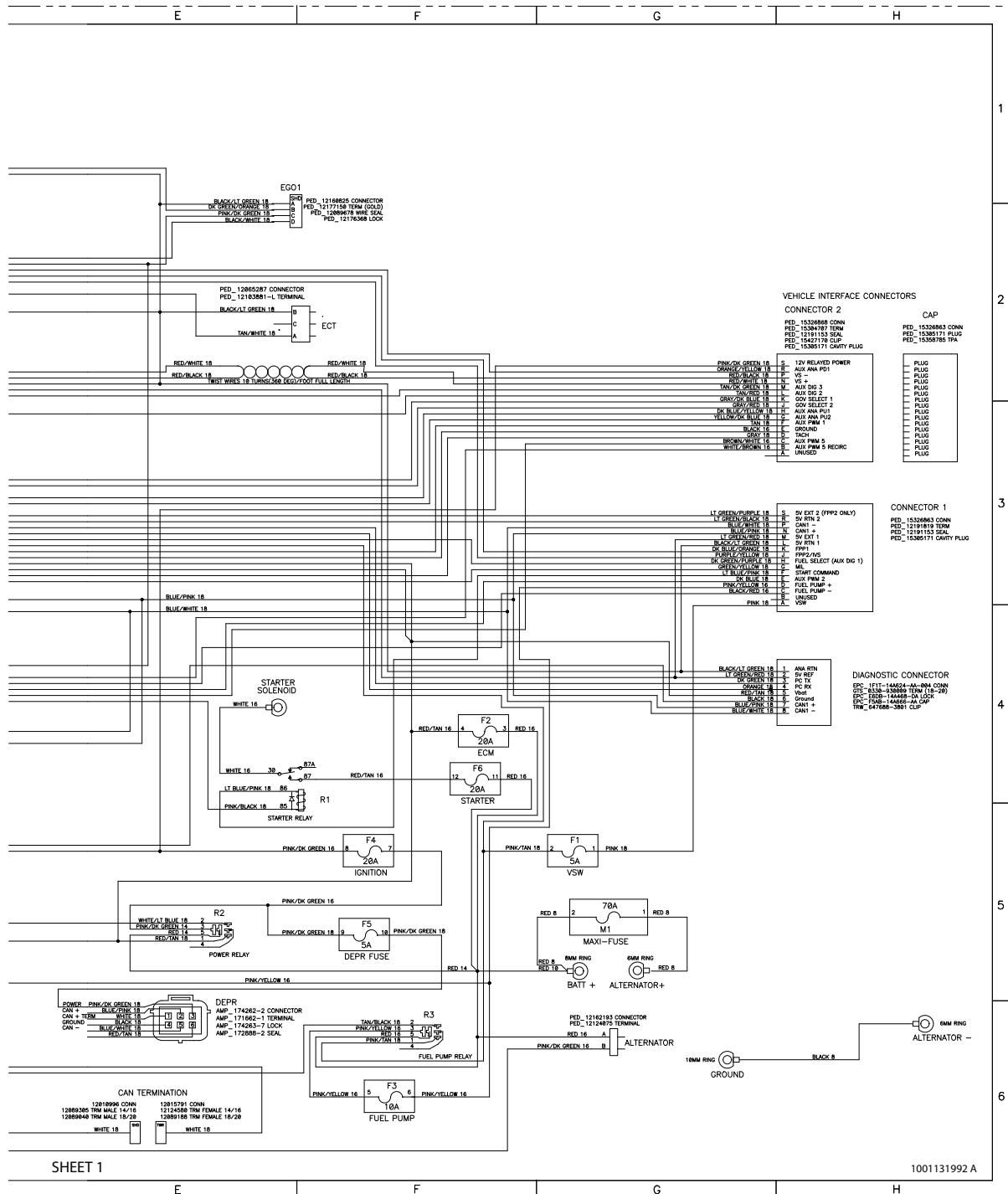


Figure 7-35. Electrical Schematic GM - Sheet 2 of 2

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.

1702961



3121202



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