An Oshkosh Corporation Company

Service and Maintenance Manual

Model
680S

Prior to SN 0300189341

P/N - 3121234

December 05, 2017

ANSI

CE

AS/NZS

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.

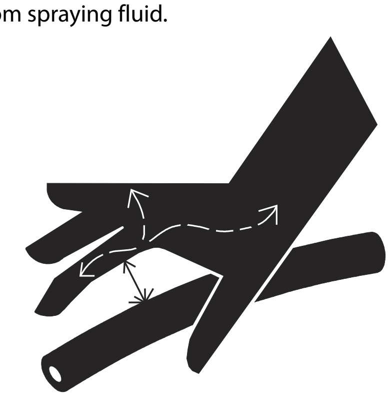
⚠ WARNING

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 JEWELLERY 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.

REVISON LOG

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SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Table 1-1. Operating Specifications

Maximum Work Load (Capacity) Unrestricted: Restricted	 500 lbs. (230 kg) Refer to Capacity Decals on machine for restricted platform capacities
Maximum Travel Grade (Gradeability)* 2WD 4WD	 30% 45%
Maximum Travel Grade (Side Slope)*	5°
Maximum Vertical Platform Height:	68 ft. (20.7 m)
Maximum Horizontal Platform Reach	59 ft. (17.9 m)
Turning Radius (outside)	22 ft. 6 in. (6.8 m)
Turning Radius (inside)	12 ft. (3.6 m)
Maximum Drive Speed:	3.5 mph (1.5 m/s)
Max. Hydraulic System Pressure	4500 psi (310 Bar)
Maximum Wind Speed	28 mph (12.5 m/s)
Maximum Manual Force	400 N
Electrical System Voltage	12 Volts
Gross Machine Weight (Platform Empty)	34,700 lbs. (15,740 kg)

* With boom in stowed position

1.2 SPECIFICATIONS AND PERFORMANCE DATA

Table 1-2. Specifications and Performance Data

Swing	360°
Tail Swing	4 ft. 8 in. (1.42 m)
Platforms	36 in. x 72 in. (0.91m x 1.83m) 36 in. x 96 in. (0.91m x 2.44m)
Overall Width	8 ft. 2 in. (2.5 m)
Stowed Height	9 ft. 10.6 in. (3.01 m)
Stowed Length	37 ft. 3.25 in. (11.4 m)
Wheel base	10 ft. (3.04 m)
Ground Clearance	15.625 in. (0.4 m)
Drive Speed Stowed 2WD Stowed 4WD Elevated	 3.0 mph (5.5 kph) 3.5 mph (5.6 kph) 0.75 mph (1.2 kph)
Ground Bearing Pressure 15-625 15-625FF 41/18LLx22.5	 72 psi (5.0 kgm/cm^2) 79 psi (5.5 kgm/cm^2) 68 psi (4.7 kgm/cm^2)
Max. Tire Load 15-625 15-625FF 41/18LLx22.5	 16,900 lbs. (7665 kg) 17,200 lbs. (7802 kg) 17,300 lbs. (7848 kg)

1.3 CAPACITIES

Table 1-3. Capacities

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

1.4 COMPONENT DATA

Engine Data

Table 1-4. Ford LRG-425 Specifications

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

Table 1-5. Deutz F4M2011 Specifications (Prior to SN 0300129454)

Type	Liquid Cooled (Oil)
Fuel	Diesel
Oil Capacity Cooling System Crankcase Total Capacity	 5 Quarts (4.5 L) 11 Quarts (10.5 L) w/Filter 16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2800
Alternator	55 Amp, belt drive
Fuel Consumption Low RPM High RPM	 1.90 GPH (7.19 lph) 2.50 GPH (9.46 lph)
Horsepower	65 @ 2800 RPM, full load

Table 1-6. Deutz D2011L04 Specifications (SN 0300129454 to 0300189341)

Type	Liquid Cooled (Oil)
Fuel	Diesel
Oil Capacity Cooling System Crankcase Total Capacity	 5 Quarts (4.5 L) 11 Quarts (10.5 L) w/Filter 16 Quarts (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2600
Alternator	55 Amp, belt drive
Fuel Consumption Low RPM High RPM	 1.90 GPH (7.19 lph) 2.50 GPH (9.46 lph)
Battery	950 Cold Cranking Amps, 205 minutes Reserve Capacity, 12 VDC
Horsepower	61.6 @ 2600 RPM, full load

Table 1-7. Caterpillar 3044C/Caterpillar 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	1000
Low RPM	1800
High RPM - 3044C	2600
High RPM - 3.4	2500
Alternator	60 Amp, belt drive

Table 1-8. GM 3.0L

Fuel	Gasoline/LP Gas
No. of Cylinders	4
BHP Gasoline/LP	80 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)
Coolant Capacity	10.8 qts. (10.2 L)
Minimum Oil Pressure At Idle Hot	 6 psi (0.4 Bar) @ 1000 rpm 18 psi (1.2 Bar) @ 2000 rpm
Compression Ratio	9.2:1
Firing Order	1-3-4-2
Max. RPM	2800

Battery

Table 1-9. Battery Specifications

Voltage	12 Volt
Type	31-950
Cold Cranking Amps	950 CCA @ 0° F (-18° C)
Reserve Capacity	205 Minutes @ 80° F (27° C)

1.5 TIRES

Table 1-10. Tire Specifications

Size	Type	Ply Rating	Load Range	Weight (Tire & Wheel)
15 - 625	Pneumatic 95 psi (6.5 Bar)	16	H	269 lbs. (122 kg)
15 - 625	Foam-Filled	16	H	544 lbs. (247 kg)
18 - 625	Pneumatic 85 psi (5.9 Bar)	16	H	288 lbs. (131 kg)
18 - 625	Foam-Filled	16	H	601 lbs. (273 kg)
41/18LL x 22.5	Foam-Filled	16	H	724 lbs. (329 kg)

1.6 TORQUE REQUIREMENTS

Table 1-11. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Wheel Lugs	300 ft. lbs. (407 Nm)	150
Swing Bearing Bolts	190 ft. lbs. (258 Nm)	50/600*
Starter Solenoid Contacts Coil	 95 in. lbs. (9.5 Nm) 40 in. lbs. (4 Nm)	As required

*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter. (See Swing Bearing in Section 3.)

NOTE: *When maintenance becomes necessary or a fastener has loosened, refer to the Torque Chart to determine proper torque value.*

1.7 LUBRICATION

Hydraulic Oil

Table 1-12. Hydraulic Oil

Hydraulic System Operating Temperature Range	S.A.E. Viscosity Grade
+0° to + 180° F (-18° to +83° C)	10W
+0° to + 210° F (-18° to +99° C)	10W-20, 10W-30
+50° to + 210° F (+10° to +99° C)	20W-20

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

NOTE: *When temperatures remain consistently below 20 degrees F. (-7 degrees C.), JLG Industries recommends the use of Mobil DTE10.*

NOTE: *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.*

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. Mobil EAL 224H Specs

Type	Synthetic Biodegradable
ISO Viscosity Grade	32/46
Specific Gravity	0.922
Pour Point, Max	-25°F (-32°C)
Flash Point, Min.	428°F (220°C)
Operating Temp.	0 to 180°F (-17 to 82°C)
Weight	7.64 lb. per gal. (0.9 kg per liter)
Viscosity	
at 40° C	37 cSt
at 100° C	8.4 cSt
Viscosity Index	213
NOTE: *Must be stored above 32°F (14°C)*	

Table 1-16. UCon Hydrolube HP-5046

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

Table 1-17. Exxon Univis 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.*

1.8 PRESSURE SETTING

Table 1-18. Pressure Settings

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

1.9 MAJOR COMPONENT WEIGHTS

Table 1-19. Component Weights

Component	Pounds	Kilograms
Turntable (no other components included)	3700	1678
Counterweight	7000	3175
Upright	1050	476
Tower	685	311
Fly Boom	490	222
Mid Boom	740	336
Base Boom	1410	640
Boom Assembly	3337	1514
Telescope Cylinder	590	268
Slave Cylinder	73	33
Drive Hub (2WD)	218	99
Tire & Wheel (pneu)	269	122
Tire & Wheel (FF)	544	247

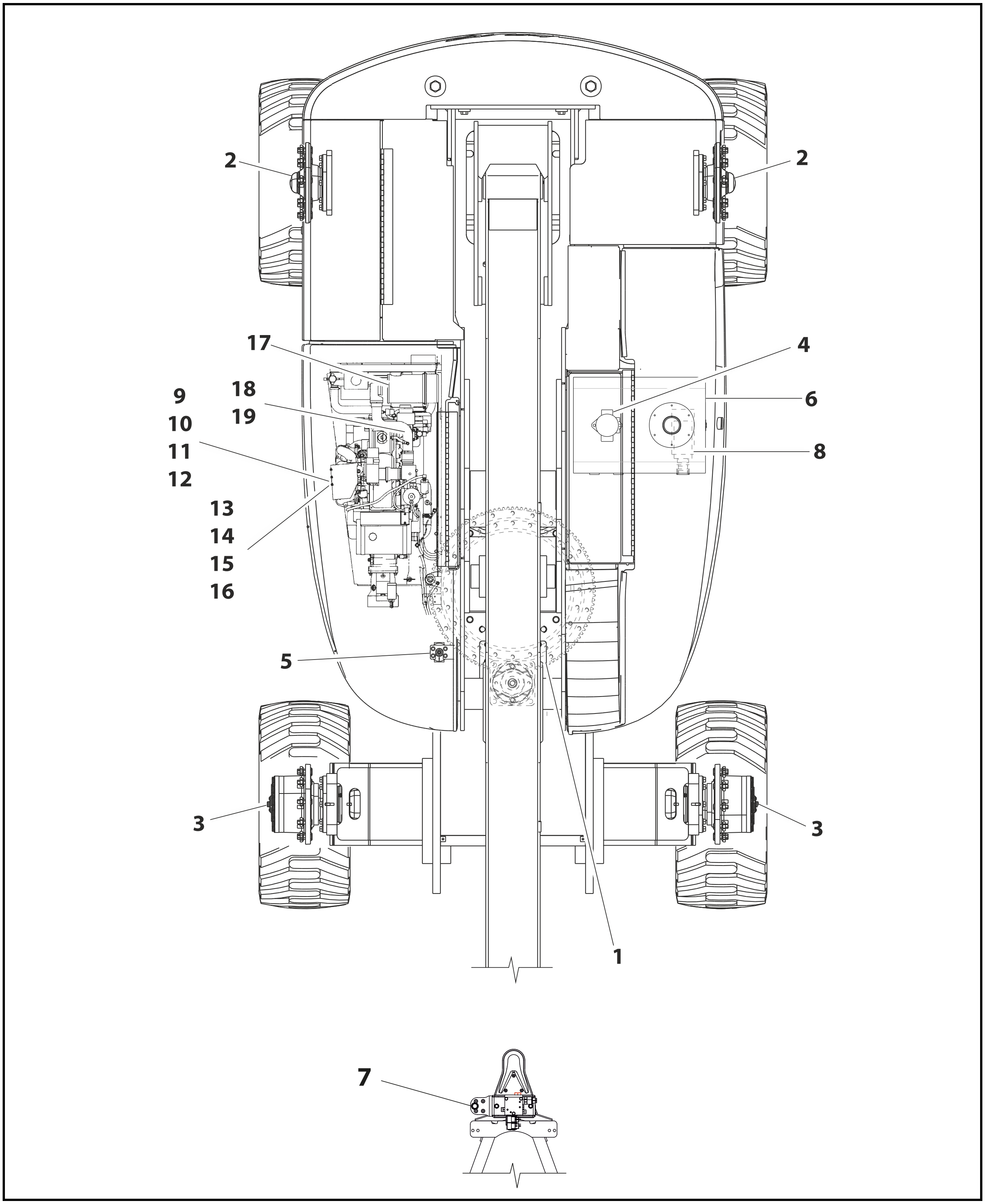


Figure 1-1. Operator Maintenance and Lubrication Diagram

1.10 OPERATOR MAINTENANCE

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

Table 1-20. Lubrication Specifications

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

NOTICE

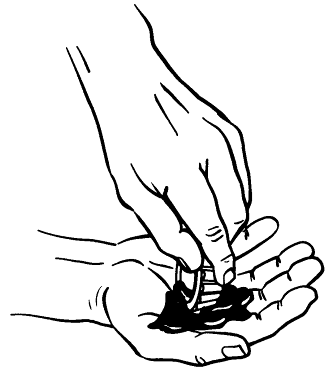
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

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

1. Swing Bearing - Internal Ball Bearing

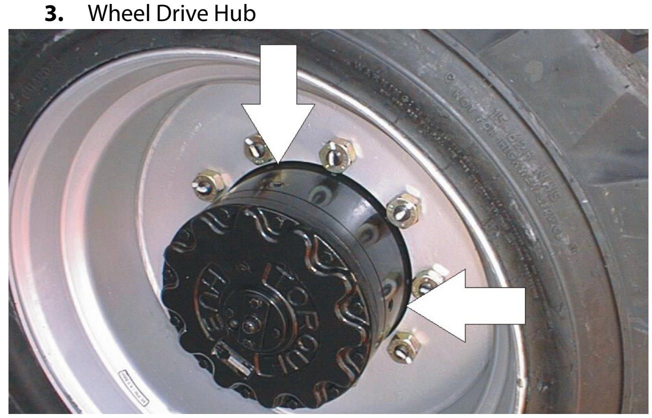
Lube Point(s) - 1 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
Comments - Remote Access.

2. Wheel Bearings



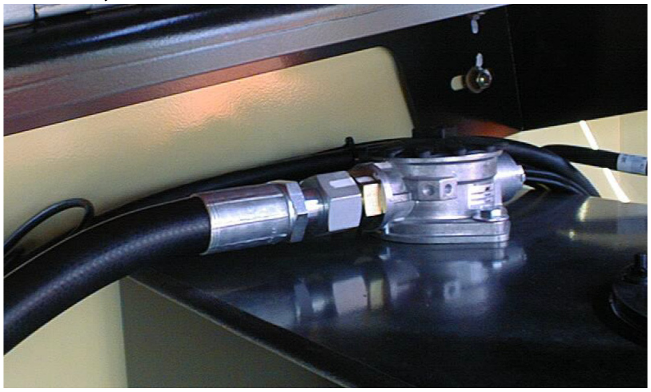
Lube Point(s) - Repack
Capacity - A/R
Lube - MPG
Interval - Every 2 years or 1200 hours of operation.

3. Wheel Drive Hub



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

4. Hydraulic Return Filter



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

5. Hydraulic Charge Filter

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

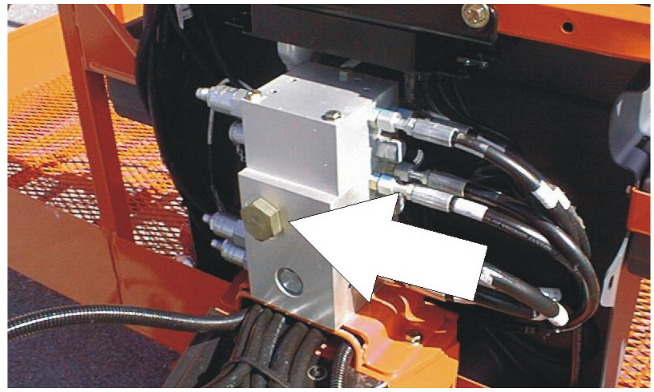
6. Hydraulic Tank

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

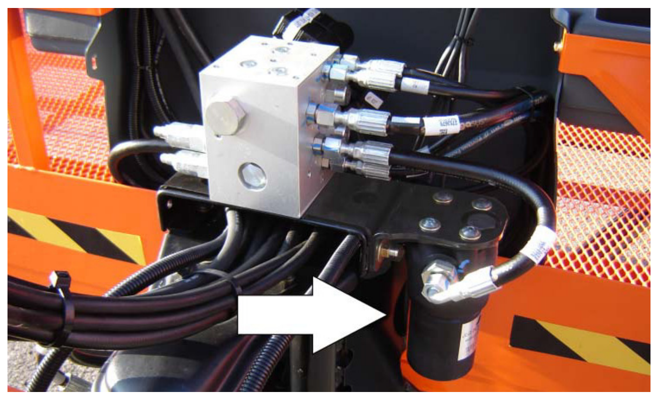
7. Platform Filter

   a. Platform Filter (Prior to SN 0300141319)

   Interval - Change as necessary.

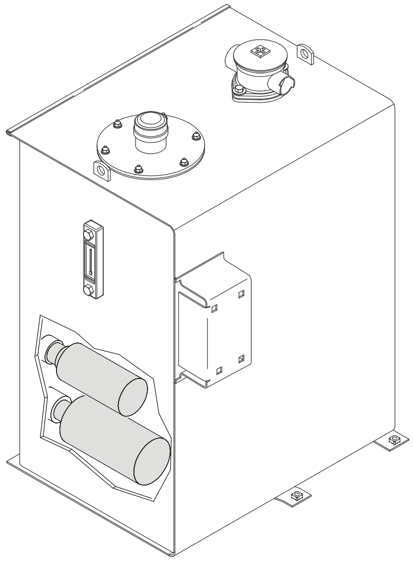


   b. Platform Filter (SN 0300141319 through 0300189341)



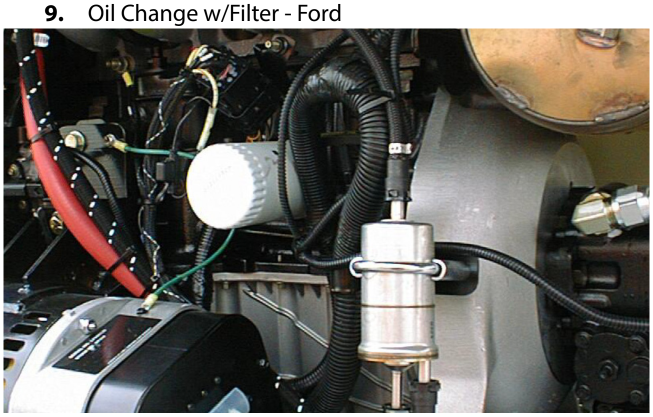
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation

8. Suction Strainers



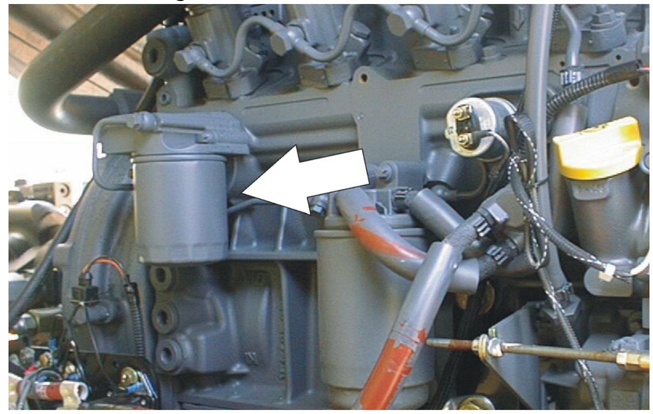
Lube Point(s) - 2
Interval - Every 2 years or 1200 hours of operation, remove and clean at time of hydraulic oil change.

9. Oil Change w/Filter - Ford



Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7014501)
Capacity - 4.5 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

10. Oil Change w/Filter - Deutz

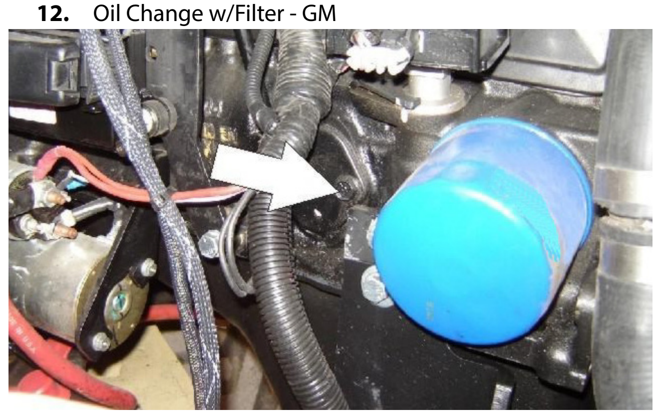


Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7016331)
Capacity - 11 Quarts(10.5 L) Crankcase;
Lube - EO
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

11. Oil Change w/Filter - Caterpillar

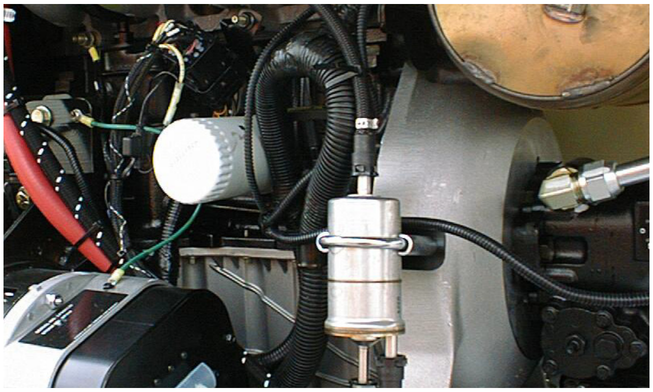
Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7026855)
Capacity - 10.6 Quarts
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

12. Oil Change w/Filter - GM



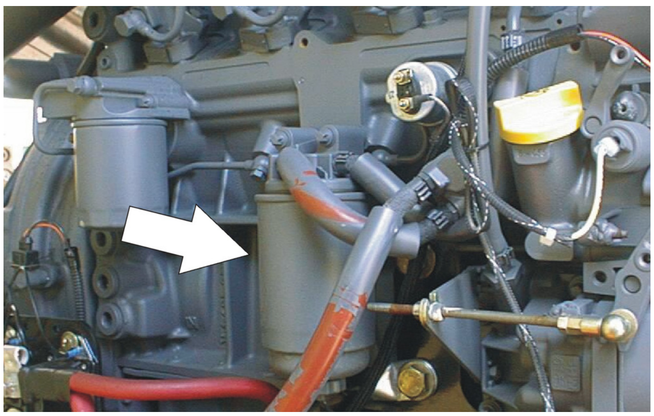
Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7027965)
Capacity - 4.5 qt. (4.25 L) w/filter
Lube - EO
Interval - 3 Months or 150 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

13. Fuel Filter - Ford



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

14. Fuel Filter - Deutz



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

15. Fuel Filter - Caterpillar

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

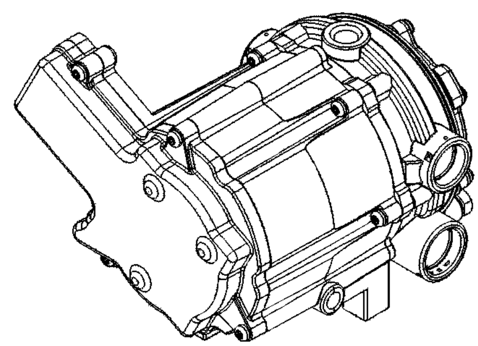
16. Fuel Filter (Gasoline) - GM

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

17. Air Filter

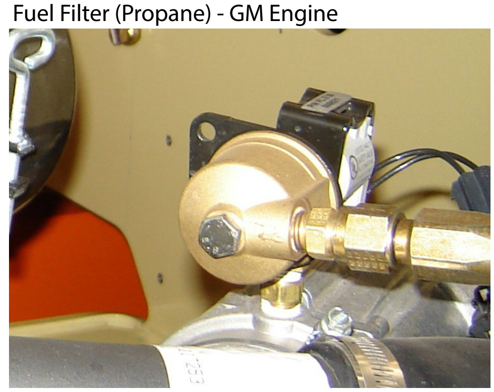
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator

18. Electronic Pressure Regulator (LP only)



Interval - 3 Months or 150 hours of operation
Comments - Drain oil build up. Refer to Section 1.11, Draining Oil Build Up from the Propane Regulator (Prior to SN 0300134626).

19. Fuel Filter (Propane) - GM Engine



Interval - 3 Months or 150 hours of operation
Comments - Replace filter. Refer to Section 1.12, Propane Fuel Filter Replacement.

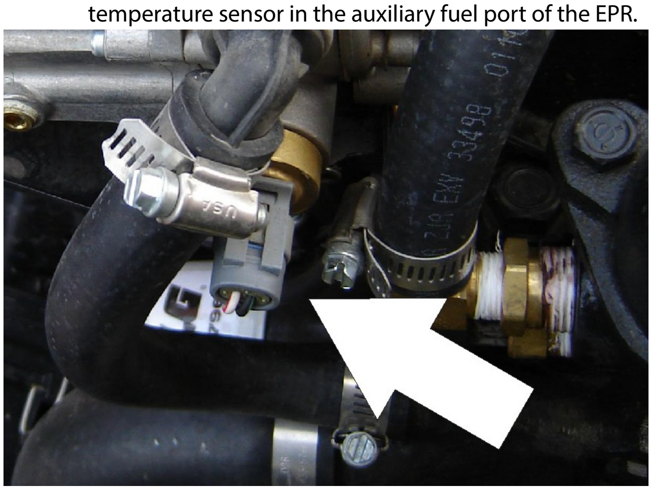
1.11 DRAINING OIL BUILD UP FROM THE PROPANE REGULATOR (PRIOR TO SN 0300134626)

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 1.10, Operator Maintenance for maintenance intervals. More frequent draining may be required if the fuel supply has been contaminated.

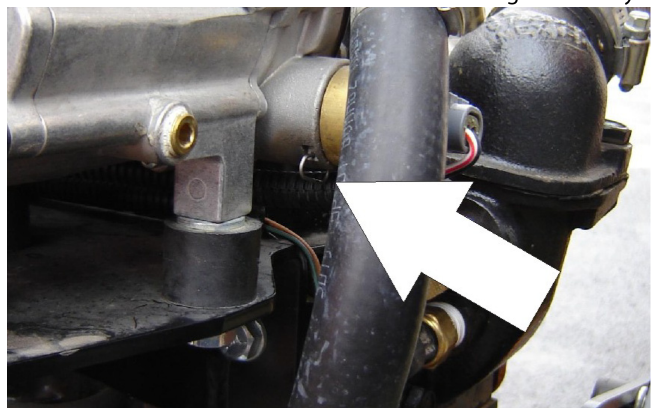
NOTICE

FOR BEST RESULTS WARM THE ENGINE TO OPERATING TEMPERATURE BEFORE DRAINING. THIS WILL ALLOW THE OILS TO 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.



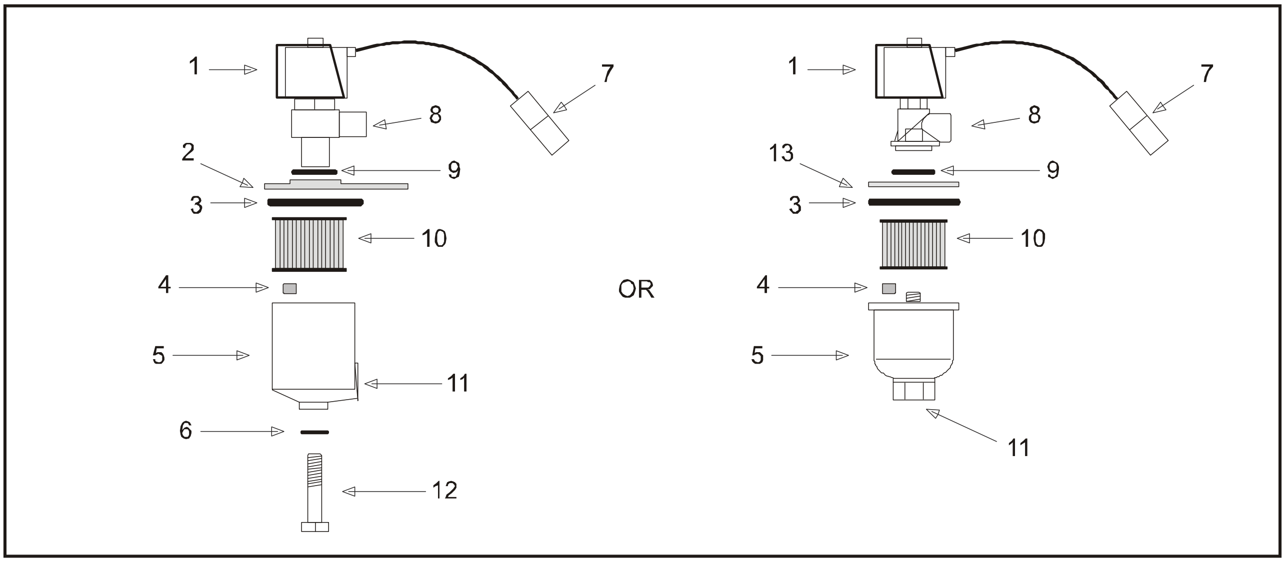
6. Remove the retainer clip for the LPG fuel temperature sensor and remove the sensor from the regulator body.



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.

1.12 PROPANE FUEL FILTER REPLACEMENT



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

Figure 1-2. Filter Lock Assembly

REMOVAL

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

INSTALLATION

NOTICE

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

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

1.13 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.

1.14 SERIAL NUMBER LOCATION

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

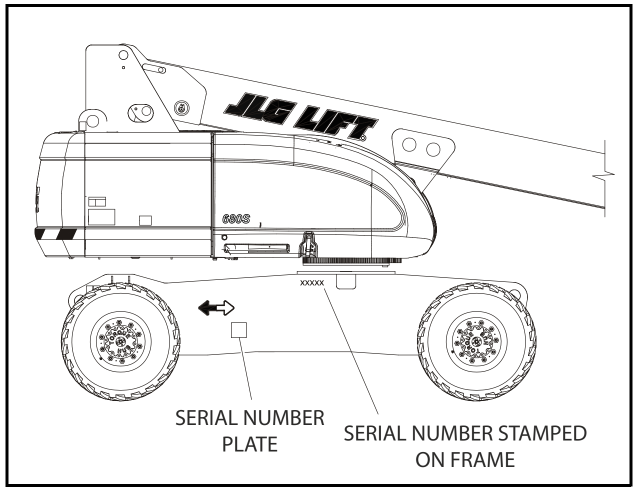


Figure 1-3. Serial Number Locations

				Values for Zinc 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 (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 131)		Clamp Load	Torque (Dry or Loctite® 263) K= 0.20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	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	0.1640	0.01400	900	30	3.4	22	2.5											
	36	0.1640	0.01474	940	31	3.5	23	2.6					1320	43	5				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5					1580	60	7				
	32	0.1900	0.02000	1285	49	5.5	36	4					1800	68	8				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12			2860	143	16	129	15		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15			3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	17	23	13	18	19	26	16	22	4720	25	35	20	25	20	25
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38	7000	45	60	40	55	35	50
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61	9550	70	95	65	90	50	70
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92	12750	105	145	95	130	80	110
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133	16400	155	210	140	190	115	155
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183	20350	210	285	190	260	160	220
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	21300	260	353	200		285	388	240	325	30100	375	510	340	460	280	380
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523	41600	605	825	545	740	455	620
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676	142200	3555	4835	3200	4350	2665	3625

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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REFERENCE JLG THREAD LOCKING COMPOUND

JLG P/N	Loctite® 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 (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15		Clamp Load	Torque (Dry or Loctite® 263) K= 0.17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	7	0.8											
	48	0.1120	0.00661	420	8	0.9											
6	32	0.1380	0.00909	580	14	1.5											
	40	0.1380	0.01015	610	14	1.6											
8	32	0.1640	0.01400	900	25	2.8											
	36	0.1640	0.01474	940	26	2.9					1320	37	4				
10	24	0.1900	0.01750	1120	36	4.1					1580	51	6				
	32	0.1900	0.02000	1285	42	4.7					1800	58	7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9			2860	122	14	114	13		
	28	0.2500	0.0364	2320	99	11.1	95	11			3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20	4720	20	25	20	25	20	25
	24	0.3125	0.0580	3700	15	20	15	21	15	20	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34	7000	35	50	35	50	35	50
	24	0.3750	0.0878	5600	30	40	28	38	25	34	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48	9550	60	80	55	75	50	70
	20	0.4375	0.1187	7550	45	60	44	60	40	54	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75	12750	90	120	85	115	80	110
	20	0.5000	0.1599	10700	75	100	71	97	65	88	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109	16400	130	175	125	170	115	155
	18	0.5625	0.2030	12950	105	145	97	132	90	122	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156	20350	180	245	170	230	160	220
	18	0.6250	0.2560	16300	145	195	136	185	125	170	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272	30100	320	435	300	410	280	380
	16	0.7500	0.3730	23800	255	345	238	324	225	306	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435	41600	515	700	485	660	455	620
	14	0.8750	0.5090	32400	400	545	378	514	355	483	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	38600	545	740	515	700	480	653	51500	730	995	685	930	645	875
	12	1.0000	0.6630	42200	600	815	563	765	530	721	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	47500	755	1025	713	969	670	911	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237	142200	3020	4105	2845	3870	2665	3625

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 (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15		Clamp Load See Note 4	Torque (Dry) K = .20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604														
	48	0.1120	0.00661														
6	32	0.1380	0.00909														
	40	0.1380	0.01015														
8	32	0.1640	0.01400														
	36	0.1640	0.01474														
10	24	0.1900	0.01750														
	32	0.1900	0.02000														
1/4	20	0.2500	0.0318	2860	122	14	114	13			2860	143	16	129	15		
	28	0.2500	0.0364	3280	139	16	131	15			3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	320	435	300		280	380	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875	51500	860	1170	775	1055	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625	142200	3555	4835	3200	4350	2665	3625

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)	Torque (Loctite® 262™ OR Vibra-TITE™ 131)	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]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.2	1.4	3.13			
3.5	0.6	6.78	2.95	2.1	1.6	1.9	2.3	4.22			
4	0.7	8.78	3.82	3.1	2.3	2.8	3.4	5.47			
5	0.8	14.20	6.18	6.2	4.6	5.6	6.8	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	19	18.0	25	23	19
8	1.25	36.60	15.9	26	19	23	28	22.8	37	33	27
10	1.5	58.00	25.2	50	38	45	55	36.1	70	65	55
12	1.75	84.30	36.7	88	66	79	97	52.5	125	115	95
14	2	115	50.0	140	105	126	154	71.6	200	180	150
16	2	157	68.3	219	164	197	241	97.8	315	280	235
18	2.5	192	83.5	301	226	271	331	119.5	430	385	325
20	2.5	245	106.5	426	320	383	469	152.5	610	550	460
22	2.5	303	132.0	581	436	523	639	189.0	830	750	625
24	3	353	153.5	737	553	663	811	222.0	1065	960	800
27	3	459	199.5	1080	810	970	1130	286.0	1545	1390	1160
30	3.5	561	244.0	1460	1100	1320	1530	349.5	2095	1885	1575
33	3.5	694	302.0	1990	1490	1790	2090	432.5	2855	2570	2140
36	4	817	355.5	2560	1920	2300	2690	509.0	3665	3300	2750
42	4.5	1120	487.0	4090	3070	3680	4290	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.

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Figure 1-7. Torque Chart (Metric 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.

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

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.

With proper care, maintenance, and inspections performed per JLG's recommendations, and with any and all discrepancies corrected, this product will be fit for continued use.

Preparation, Inspection, and Maintenance

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

Pre-Start Inspection

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

Pre-Delivery Inspection and Frequent Inspection

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

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

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

Annual Machine Inspection

The Annual Machine Inspection must be performed on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries recommends this task be performed by a Factory Trained Service Technician. 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.
Preventative Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

2.2 SERVICE AND GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

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

Components Removal and Installation

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

Component Disassembly and Reassembly

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

Pressure-Fit Parts

When assembling pressure-fit parts, use a molybdenum disulfide base compound or equivalent to lubricate the mating surface.

Bearings

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

Gaskets

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

Bolt Usage and Torque Application

NOTICE

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

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

Hydraulic Lines and Electrical Wiring

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

Hydraulic System

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

Lubrication

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

Battery

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

Lubrication and Servicing

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

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.

2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.

3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, the system must be drained, flushed, and refilled with clean oil.

4. It is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

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

Hydraulic Oil

Refer to Section 1 for recommendations for viscosity ranges.

Changing Hydraulic Oil

1. Filter elements must be changed after the first 50 hours of operation and every 300 hours (unless specified otherwise) thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils.

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, pealing, scoring, or scratches on the pin surface.
   c. Rusting of the pin in the bearing area.
4. Re-assembly of pinned joints using filament wound bearings.
   a. Housing should be blown out to remove all dirt and debris. Bearings and bearing housings must be free of all contamination.
   b. Bearing / pins should be cleaned with a solvent to remove all grease and oil. Filament wound bearing are a dry joint and should not be lubricated.
   c. Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the bearing during installation and operation.

2.6 WELDING ON JLG EQUIPMENT

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

Do the Following When Welding on JLG Equipment

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

Do NOT Do the Following When Welding on JLG Equipment

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

NOTICE

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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL		
	Pre-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	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

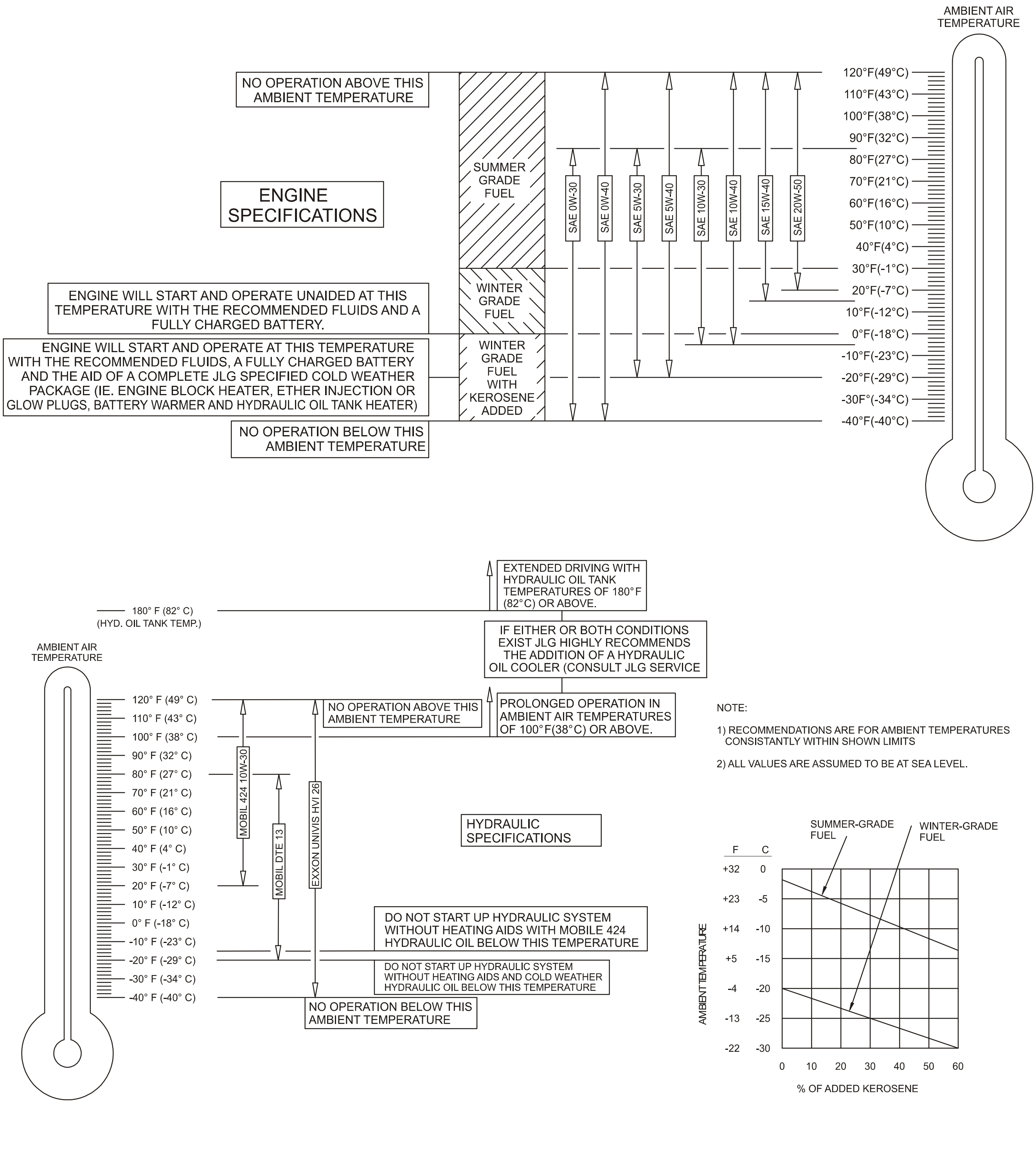


Figure 2-1. Engine Operating Temperature Specifications - Deutz

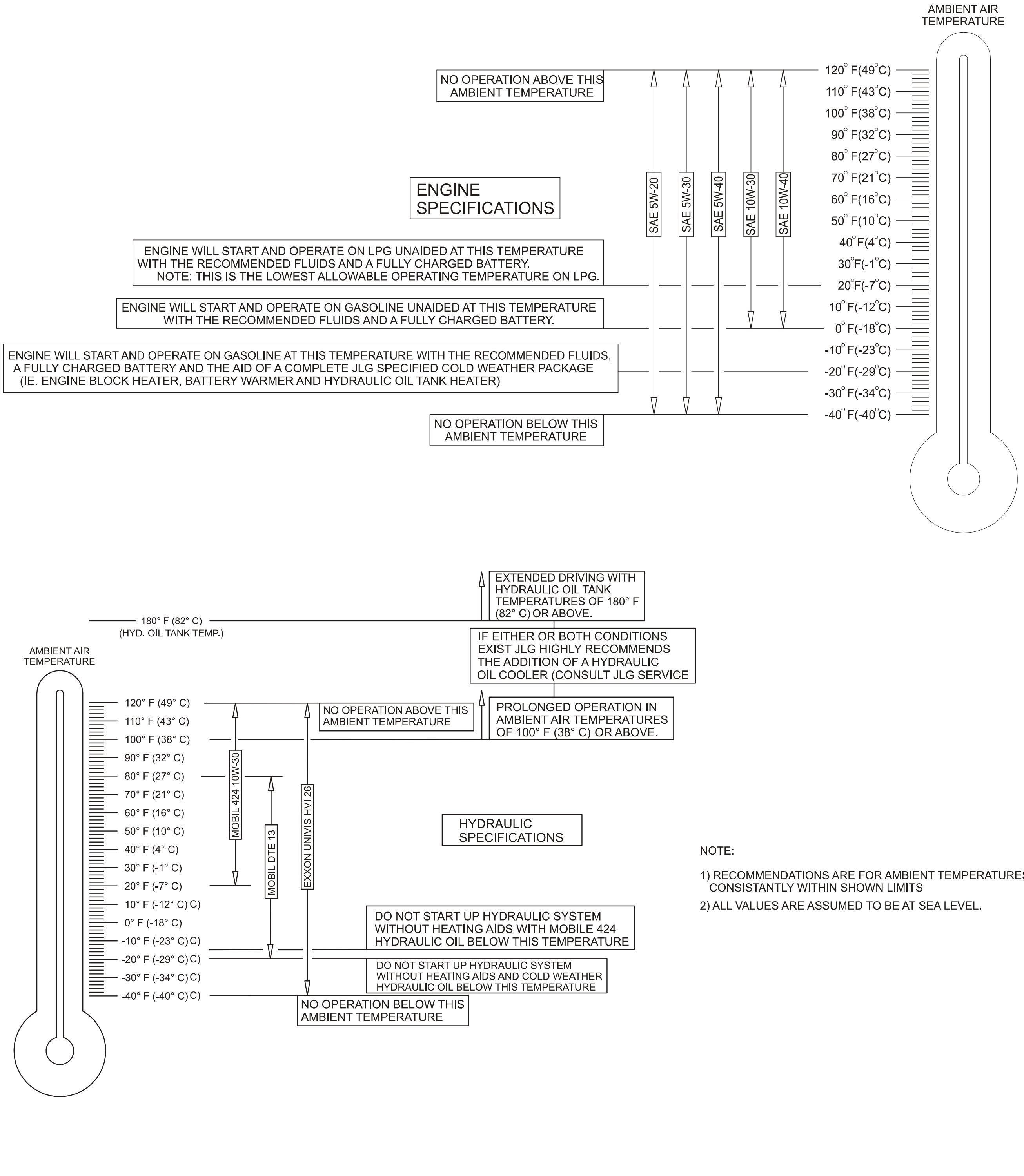


Figure 2-2. Engine Operating Temperature Specifications - Ford

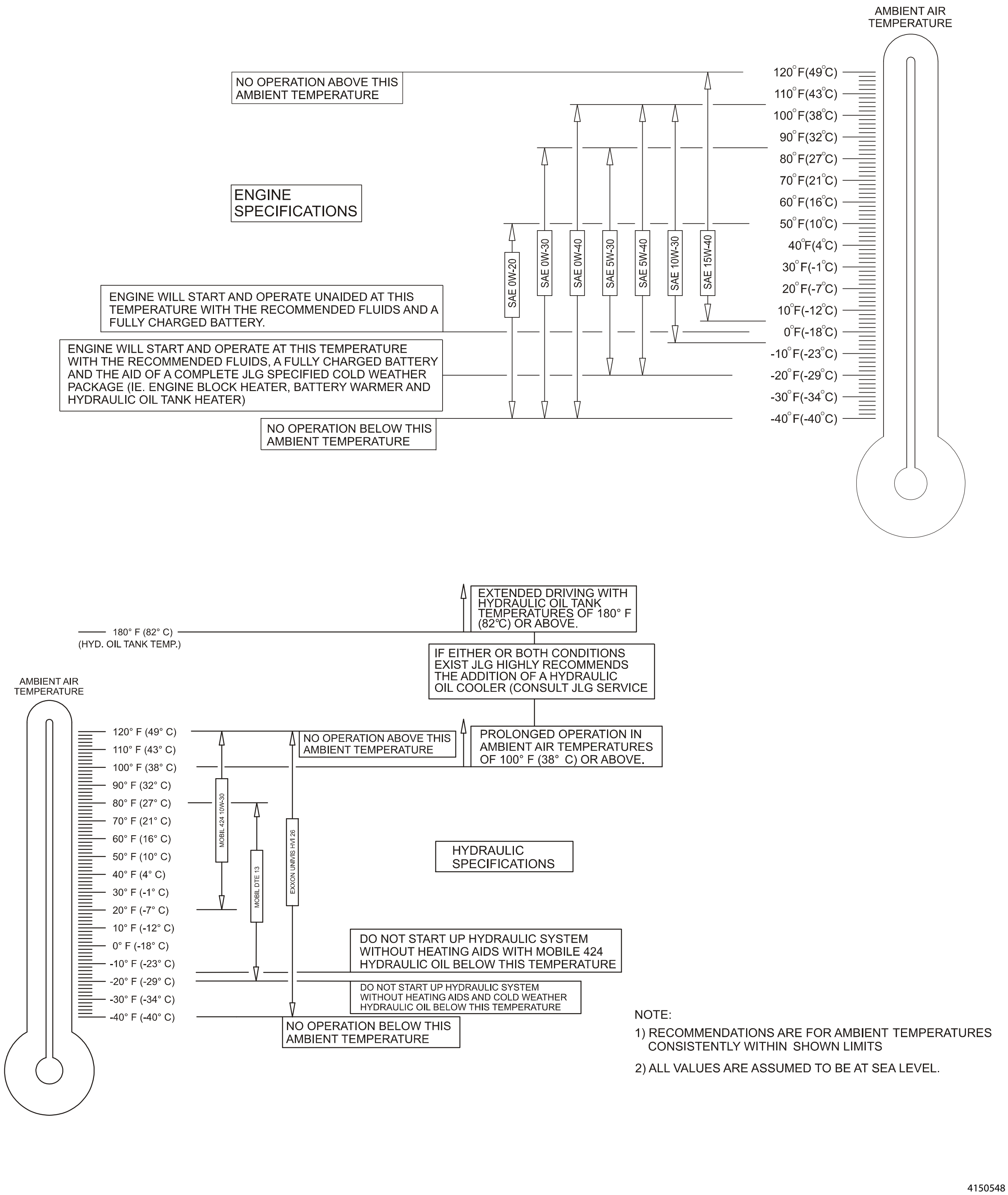


Figure 2-3. Engine Operating Temperature Specifications - Caterpillar

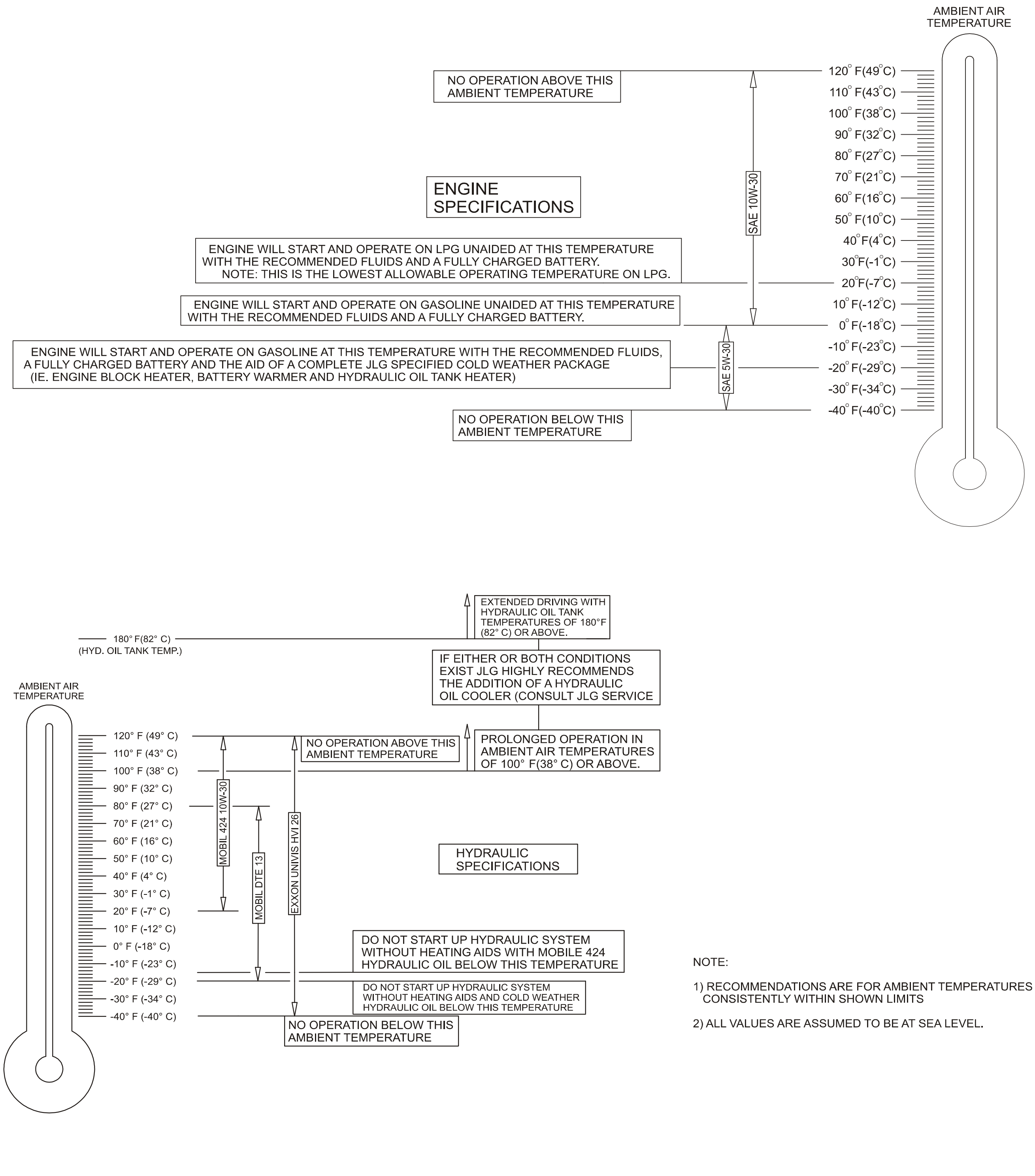


Figure 2-4. Engine Operating Temperature Specifications - GM

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 in. (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 ensure 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.

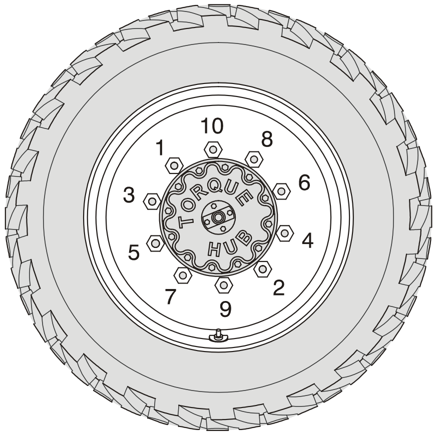
⚠ WARNING

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. Tighten all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.

2. Tighten nuts in the following sequence:



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

Table 3-1. Wheel Torque Chart

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

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

3.2 LOCKOUT CYLINDER BLEEDING

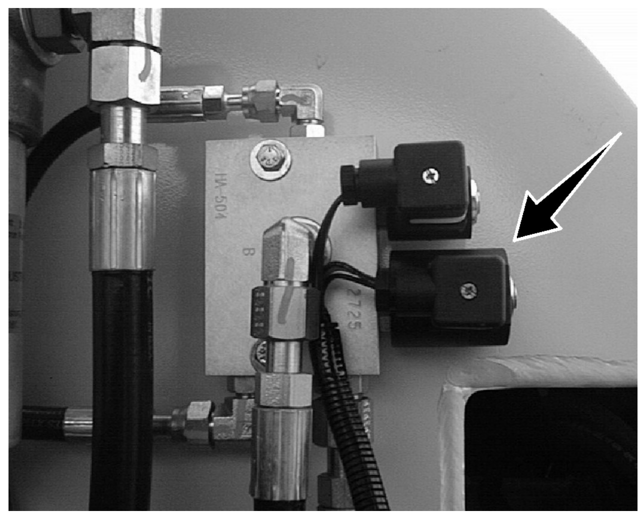
NOTICE

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

NOTICE

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

1. Make sure machine is on a level surface.
2. Center boom over rear axle to make sure the cam valve in the rotary coupling is depressed.
3. Place chocks under the tires to ensure the machine does not move. Remove the coil from the valve stem.



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

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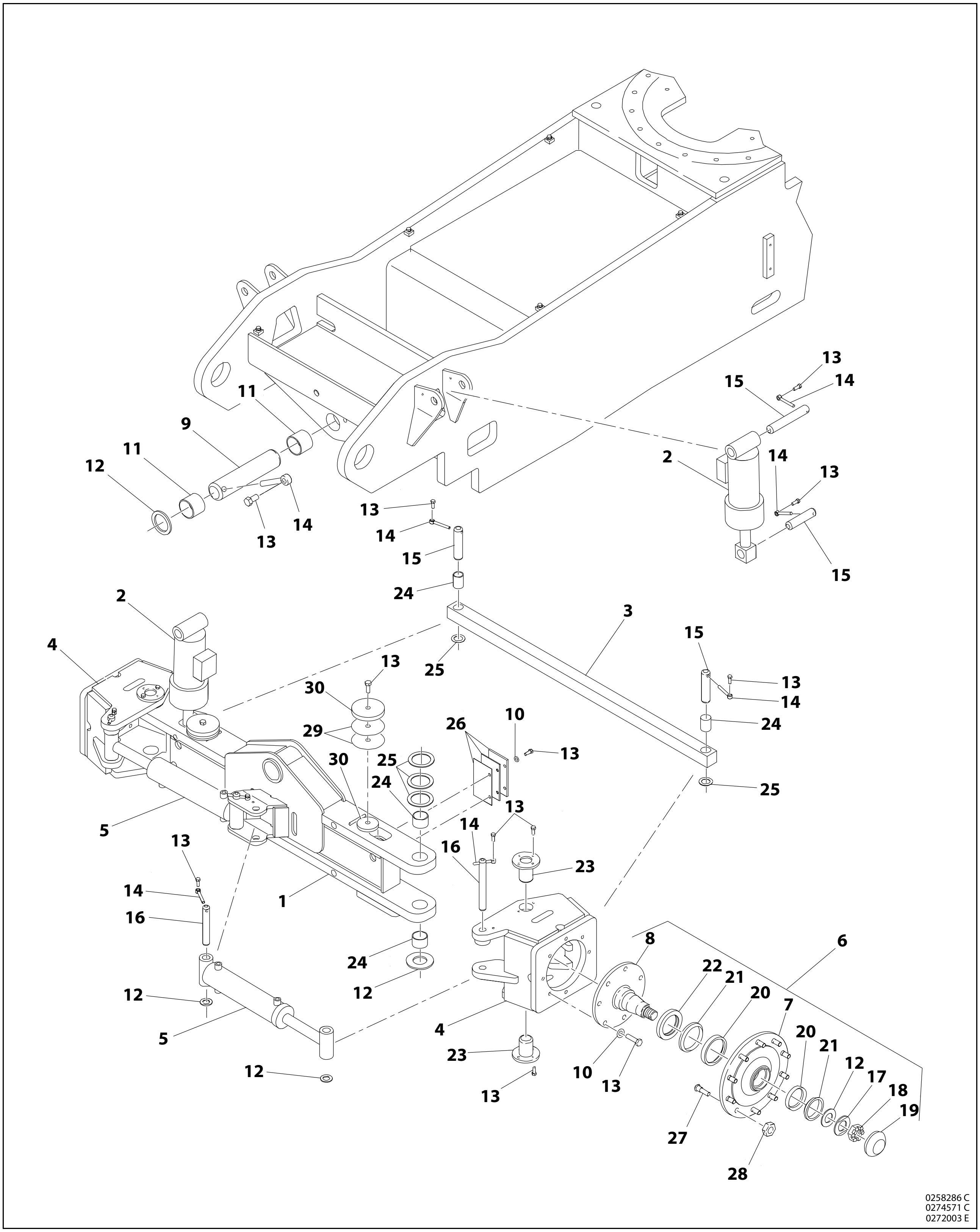


Figure 3-1. Axle and Steering Installation without Tow Package - Sheet 1 of 2

1. Axle Weldment
2. Lockout Cylinder Assembly
3. Tie Rod
4. Spindle Weldment
5. Steer Cylinder Assembly
6. Hub Assembly
7. Housing
8. Spindle
9. Pivot Pin
10. Washer
11. Bushing
12. Washer
13. Bolt
14. Keeper Pin
15. Tie Rod Pin
16. Attach Pin
17. Tanged Washer
18. Bearing Nut
19. Dust Cap
20. Cup Bearing
21. Cone Bearing
22. Lip Seal
23. King Pin
24. Bearing
25. Washer
26. Wear Shim
27. Stud
28. Lugnut
29. Shim
30. Stop Plate

Figure 3-2. Axle and Steering Installation without Tow Package - Sheet 2 of 2

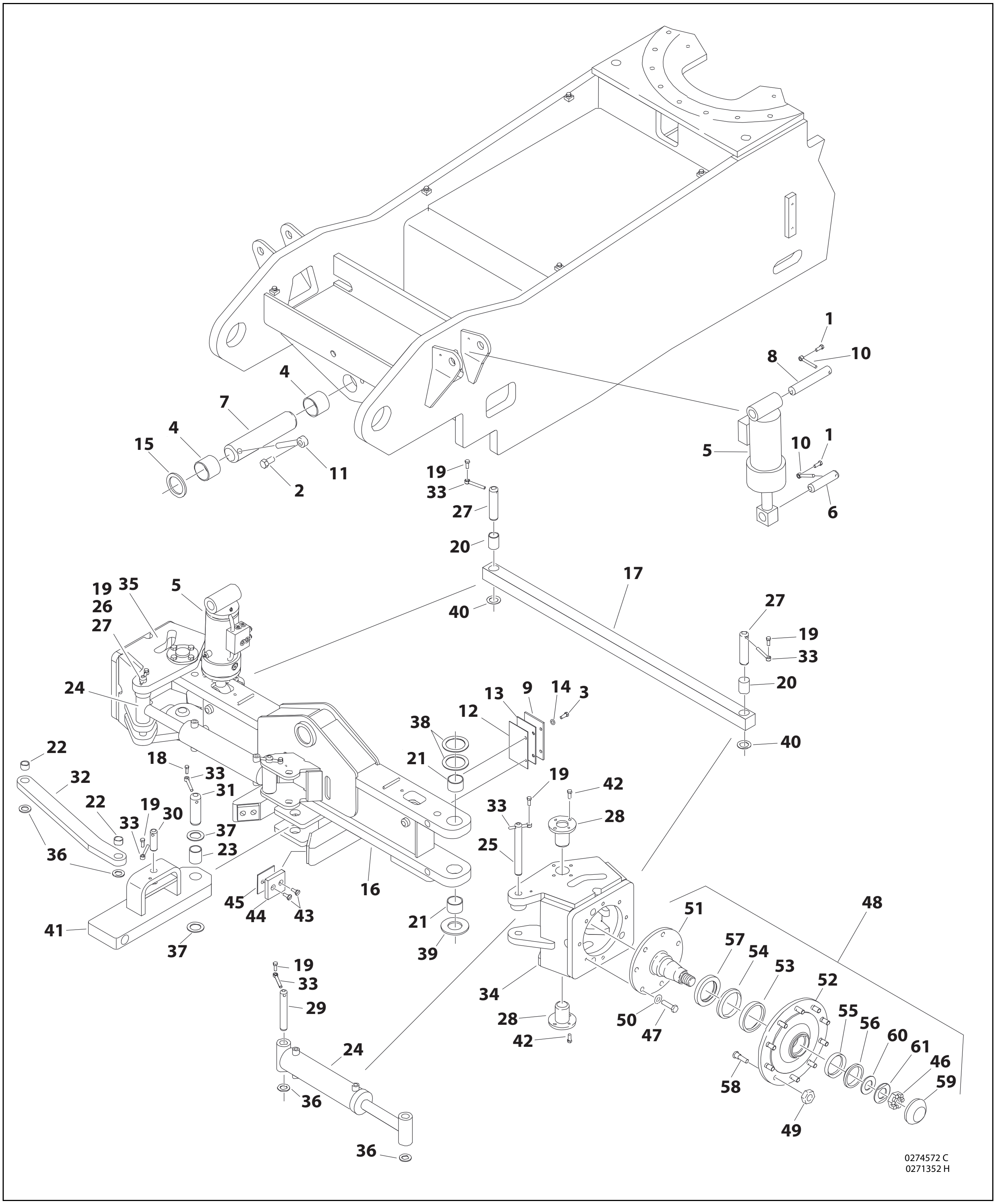
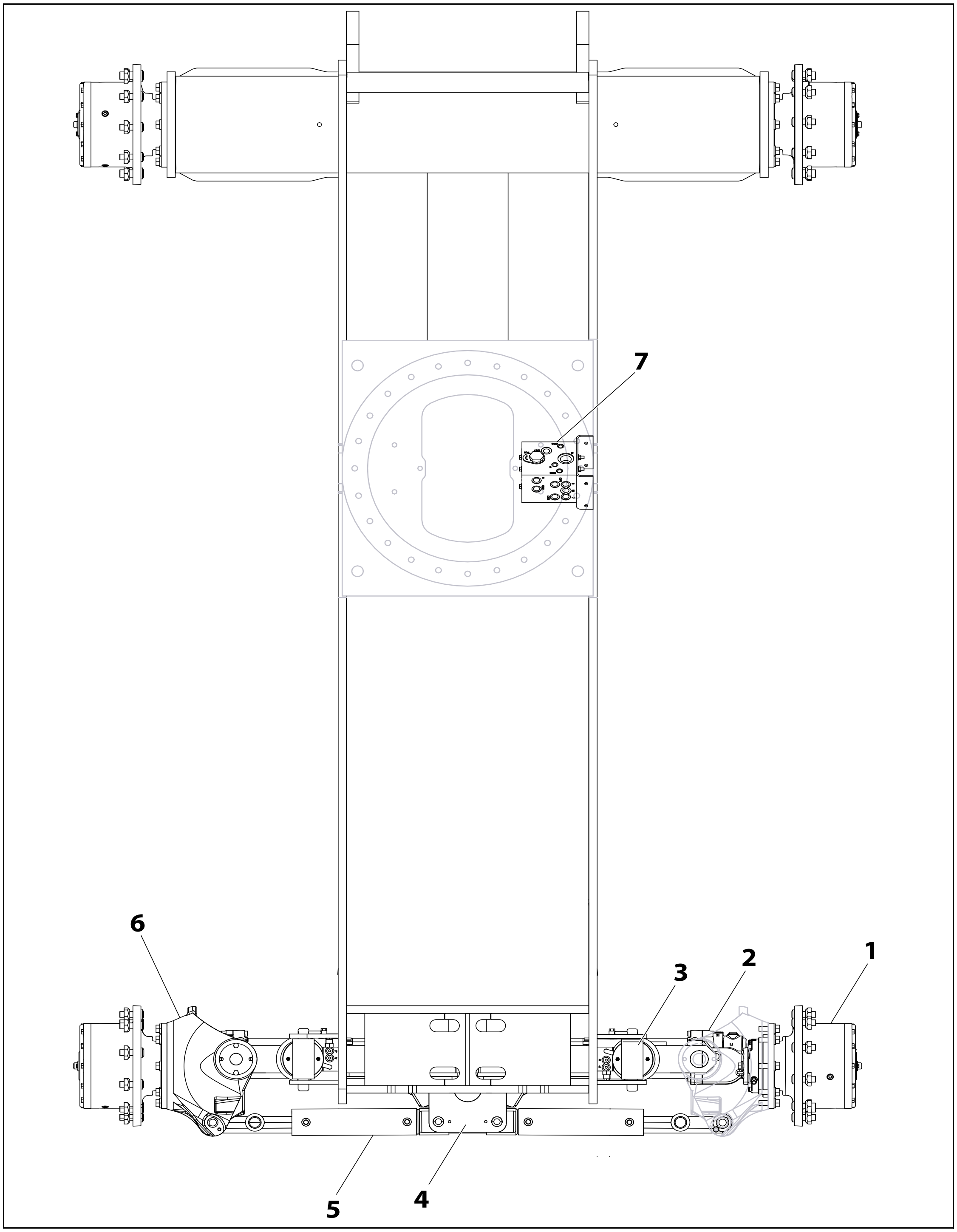


Figure 3-3. Axle and Steering Installation with Tow Package- Sheet 1 of 2

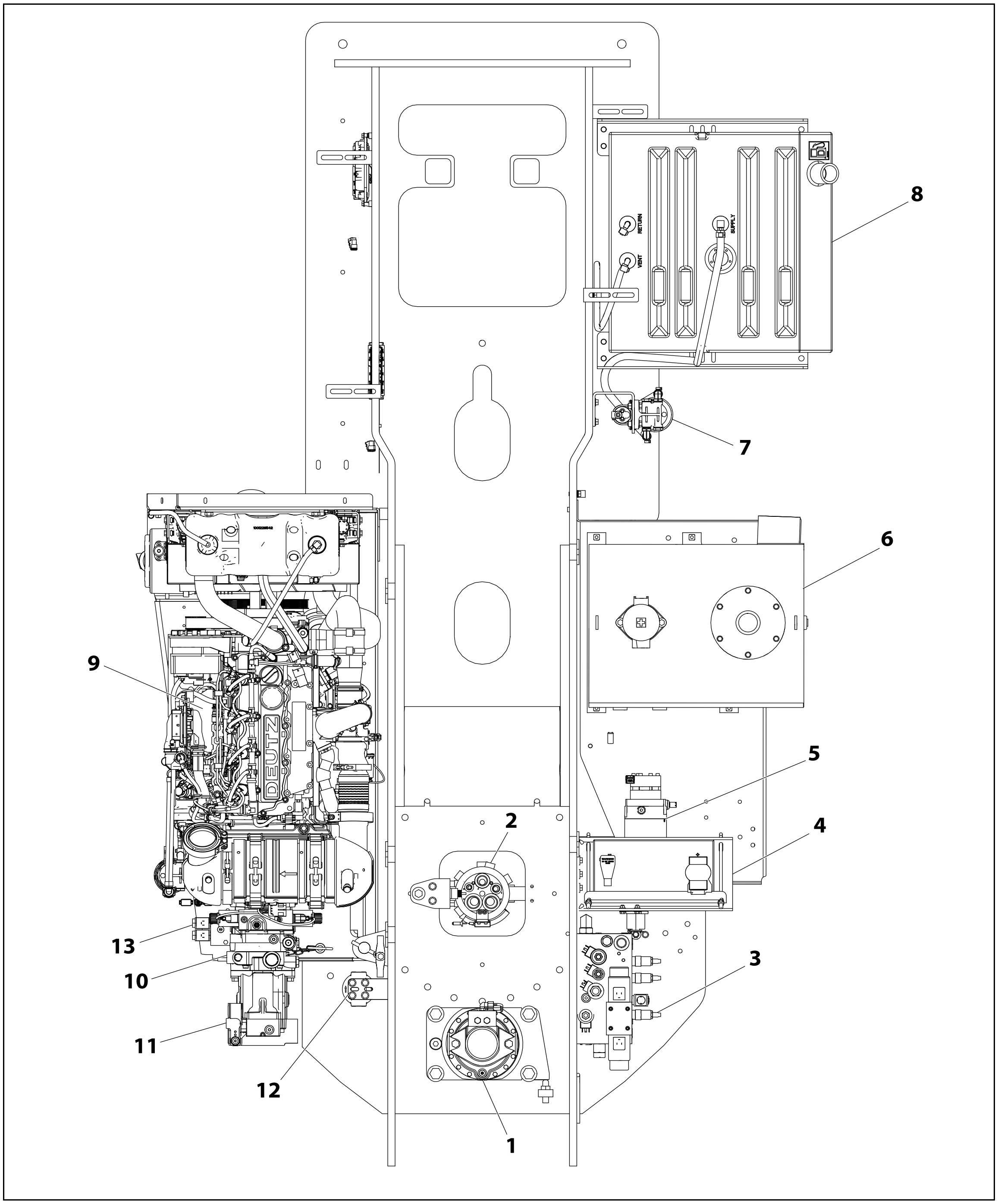
1. Bolt
2. Bolt
3. Bolt
4. Garmax Bushing
5. Lockout Cylinder Assembly
6. Pin
7. Main Pivot Pin
8. Pin
9. Axle Wear Shim
10. Keeper Shaft
11. Keeper Shaft
12. Axle Wear Shim
13. Axle Wear Shim
14. Flatwasher
15. Special Washer
16. Axle Weldment
17. Tie Rod
18. Bolt
19. Bolt
20. Garmax Bearing
21. Bearing
22. Garmax Bearing
23. Garmax Bearing
24. Steer Cylinder Assembly
25. Steer Spindle Attach Pin (RH)
26. Steer Spindle Attach Pin (LH)
27. Tie Rod Pin
28. Kingpin
29. Attach Pin
30. Pin
31. Hitch Pin
32. Connecting link
33. Keeper Shaft
34. Spindle Weldment (LH)
35. Spindle Weldment (RH)
36. Special Washer
37. Thrustwasher
38. Thrustwasher
39. Thrustwasher
40. Special Washer
41. Pivot Bar
42. Bolt
43. Screw
44. Stop pad
45. Shim
46. Bearing Nut
47. Bolt
48. Hub Assembly
49. Lugnut
50. Flatwasher
51. Spindle
52. Housing
53. Inner Bearing Cup
54. Inner Bearing Cone
55. Outer Bearing Cup
56. Outer Bearing Cone
57. Lip Seal
58. Stud
59. Dust Cap
60. Special Washer
61. Tanged Washer

Figure 3-4. Axle and Steering Installation with Tow Package - Sheet 2 of 2



1. Drive Hub
2. Drive Motor
3. Axle Lockout Cylinder
4. Axle
5. Steer Cylinder
6. Spindle
7. Flow Divider Valve

Figure 3-5. Chassis Component Location



1. Swing Drive
2. Rotary Coupling
3. Main Control Valve
4. Battery
5. Auxiliary Power Pump
6. Hydraulic Oil Tank
7. Return Filter Assembly
8. Fuel Tank
9. Engine
10. Piston Pump
11. Gear Pump
12. Hydraulic Filter
13. Brake and Two Speed Valve

Figure 3-6. Turntable Component Location

3.3 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 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 or right rear wheel remains elevated 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 or left rear wheel remains elevated 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.

3.4 EMERGENCY TOWING

⚠ WARNING

RUNAWAY VEHICLE/MACHINE HAZARD. MACHINE HAS NO TOWING BRAKES. TOWING VEHICLE MUST BE ABLE TO CONTROL MACHINE AT ALL TIMES. ON-HIGHWAY TOWING NOT PERMITTED. FAILURE TO FOLLOW INSTRUCTIONS COULD CAUSE SERIOUS INJURY OR DEATH.
MAXIMUM TOWING SPEED 5 M.P.H. (8 K.M.H.)
MAXIMUM TOWING GRADE 25%.

⚠ CAUTION

DO NOT TOW MACHINE WITH ENGINE OPERATING OR DRIVE HUBS ENGAGED.

1. Retract, lower and position boom in travel position; lock turntable.
2. Disconnect drive hubs by inverting disconnect cap.

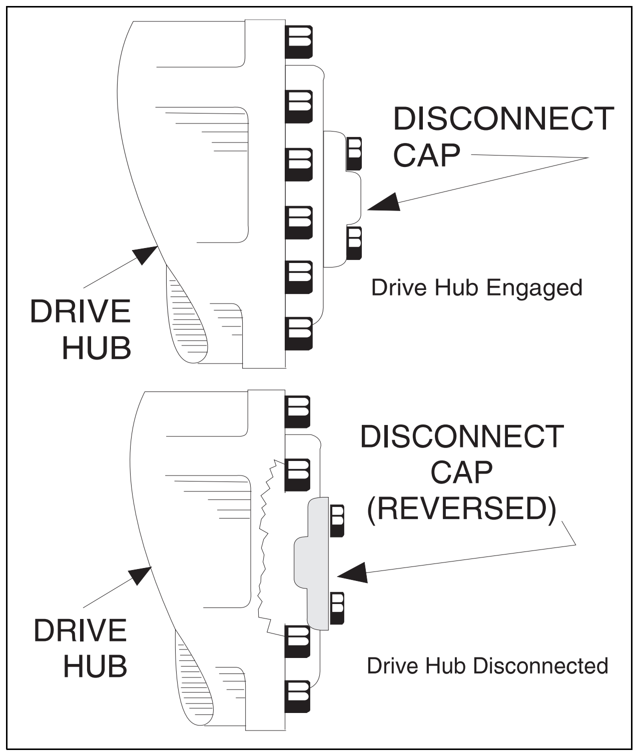


Figure 3-7. Drive Disconnect Hub

3. Reconnect the drive hubs by inverting the disconnect cap when towing is complete.

3.5 WHEEL DRIVE ASSEMBLY, 2WD

Removal

NOTE: *The drive motor and/or drive brake can be removed through the axle flange as part of the wheel drive assembly or they can be removed separately through the bottom of the frame while leaving the 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 and drive brake. Cap or plug all openings to ensure no dirt enters the hydraulic system.

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

4. Use a supporting device capable of handling the weight of the drive hub, drive brake, and drive motor and unbolt the drive hub from the frame. Remove the entire assembly from the machine.

5. Remove the nuts and washers that secure the drive motor to the drive hub and drive brake and remove the drive motor. Remove and discard the o-ring between the drive motor and drive brake.

6. Remove the drive brake from the drive hub. Remove and discard the o-ring between the drive brake and drive hub.

7. If necessary, remove the studs from the drive hub.

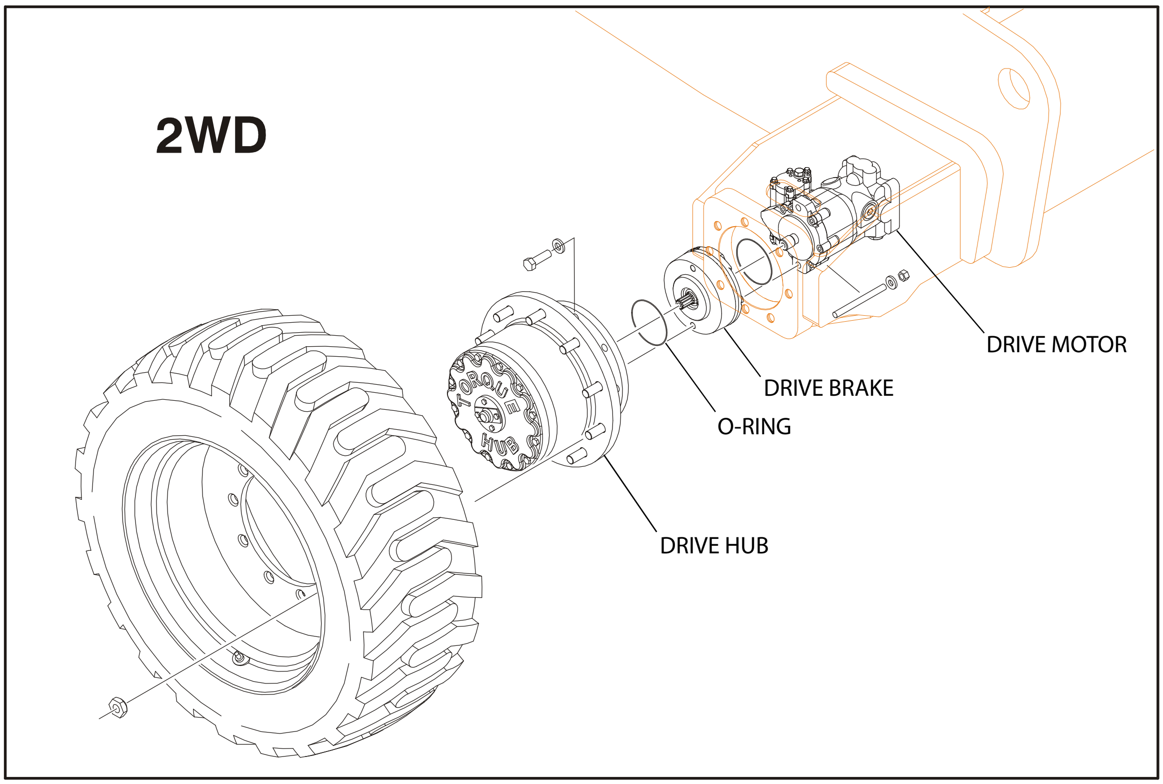
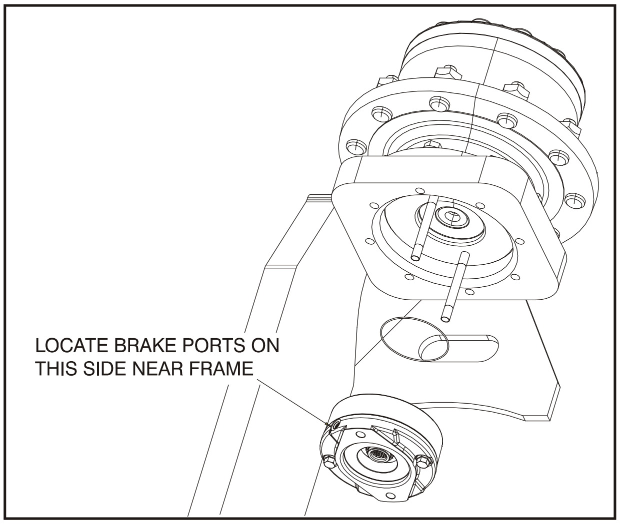


Figure 3-8. Drive Hub Installation - 2WD

Installation

1. If re-installing the existing studs or installing new ones, coat the threads of the studs with JLG Threadlocker PN 0100011 before screwing them into the drive hub.
2. Install a new o-ring between the drive brake and drive hub and slide the drive brake over the studs with the brake port positioned as shown.



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

3.6 DRIVE HUB (4WD MACHINES W/ INTEGRAL BRAKE)

Roll, Leak and Brake Testing

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

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

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

THE ROLL TEST

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

THE LEAK TEST (MAIN UNIT)

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

THE BRAKE TEST

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

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

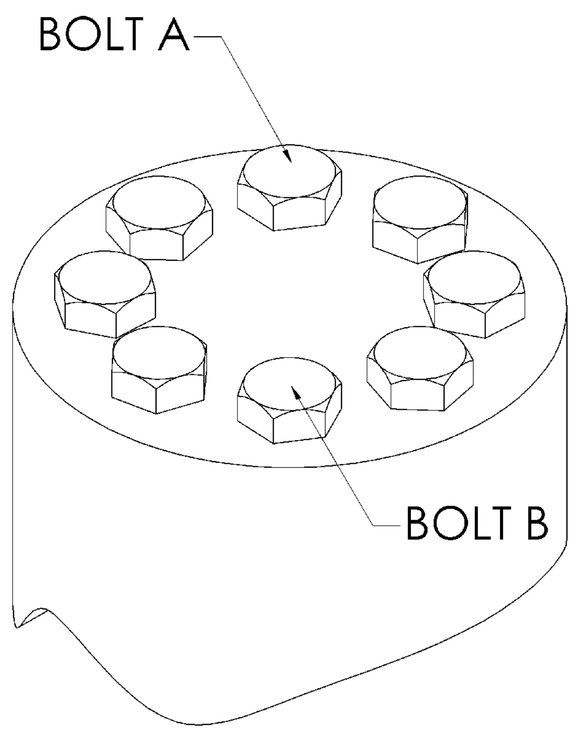
NOTE: *Failure to perform this test may result in damaged or ineffective brake parts.*

Tightening and Torquing Bolts

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

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

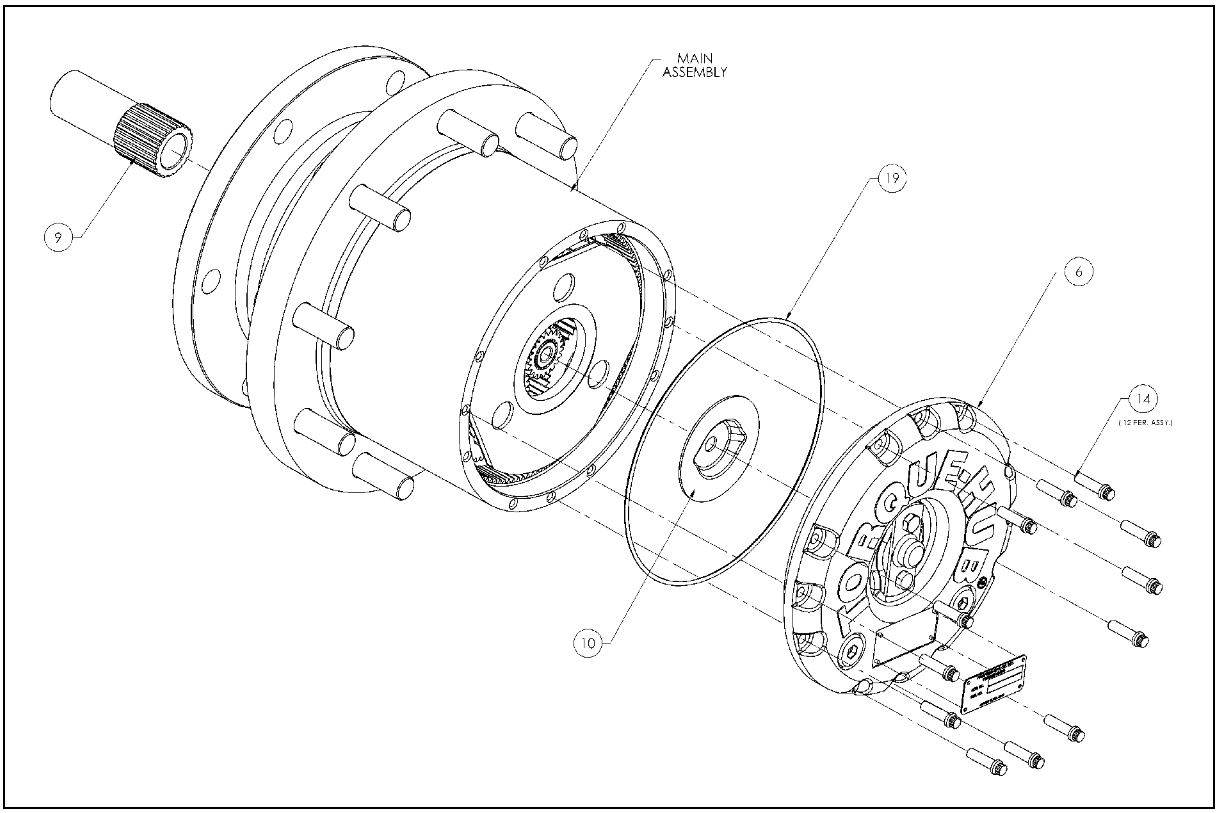
1. Tighten (but do not torque) bolt "A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt "A".
5. Using the same sequence,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



Main Disassembly

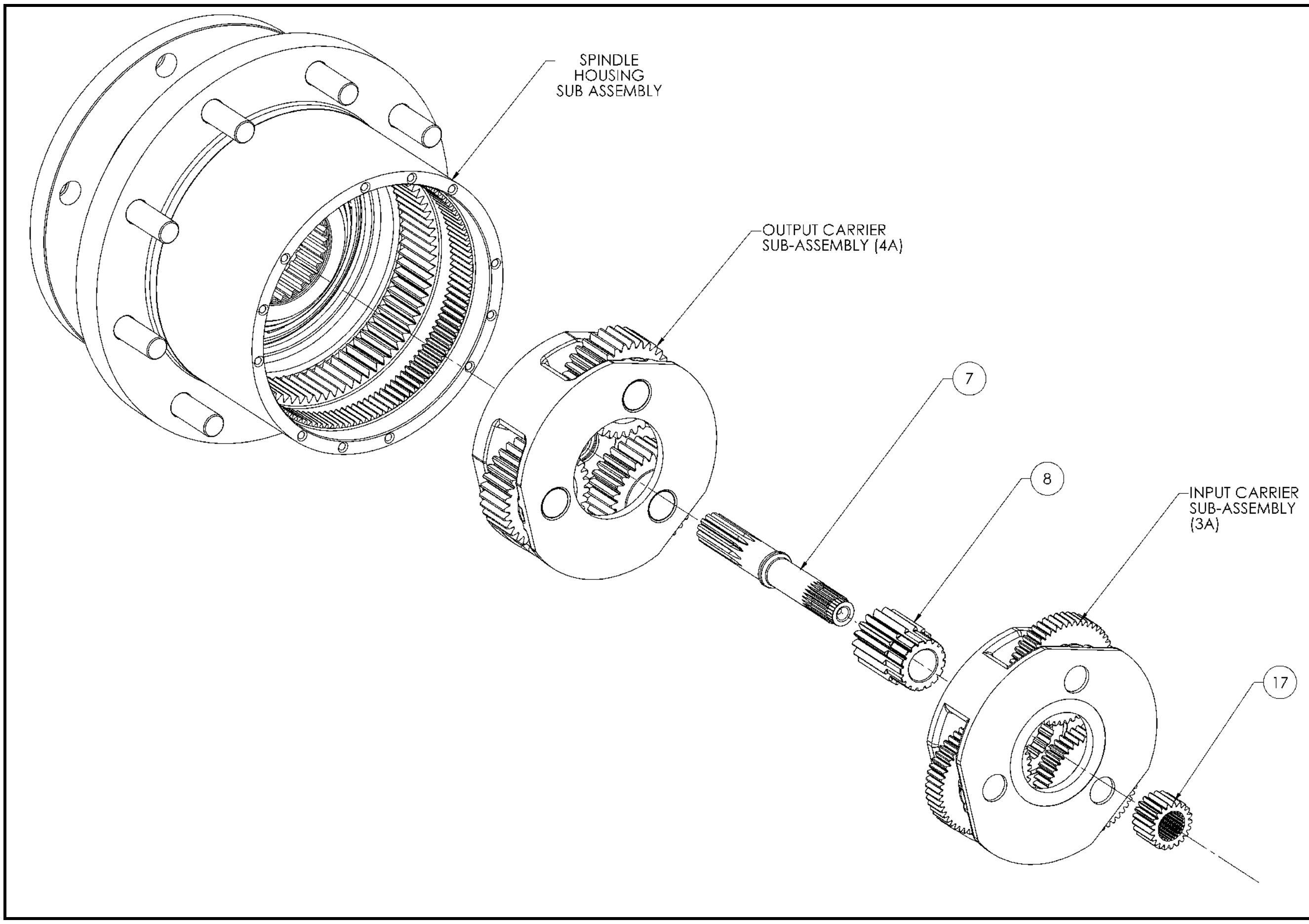
NOTE: *Refer to Figure 3-9., Main Disassembly - Sheet 1 of 2 and Figure 3-10., Main Disassembly - Sheet 2 of 2.*

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



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

Figure 3-9. Main Disassembly - Sheet 1 of 2



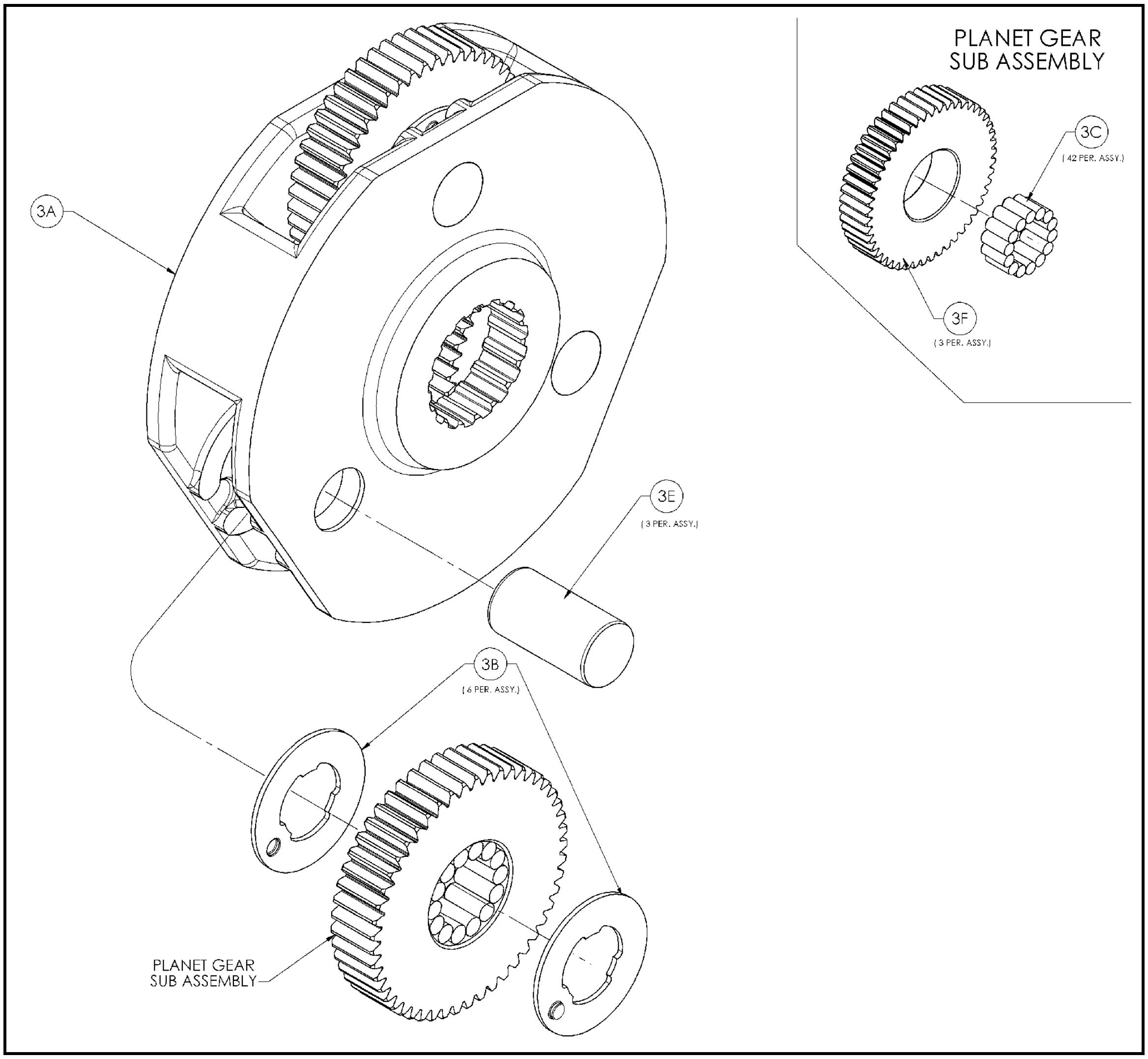
7. Input Shaft
8. Output Sun Gear
17. Input Sun Gear

Figure 3-10. Main Disassembly - Sheet 2 of 2

Input Carrier Disassembly

NOTE: *Refer to Figure 3-11., Input Carrier Disassembly.*

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



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

Figure 3-11. Input Carrier Disassembly

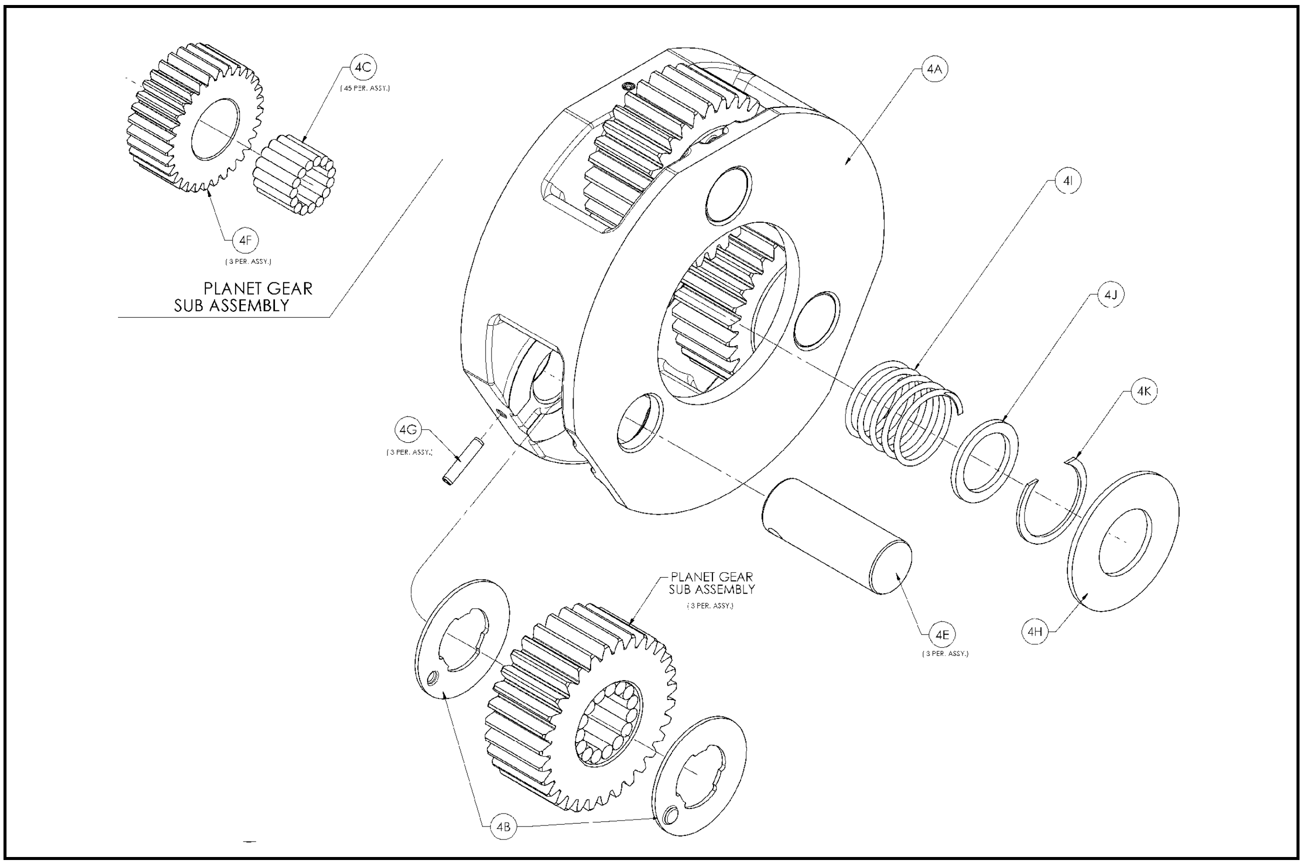
Output Carrier Disassembly

NOTE: *Refer to Figure 3-12., Output Carrier Assembly.*

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

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

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



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

Figure 3-12. Output Carrier Assembly

Housing-Spindle Disassembly

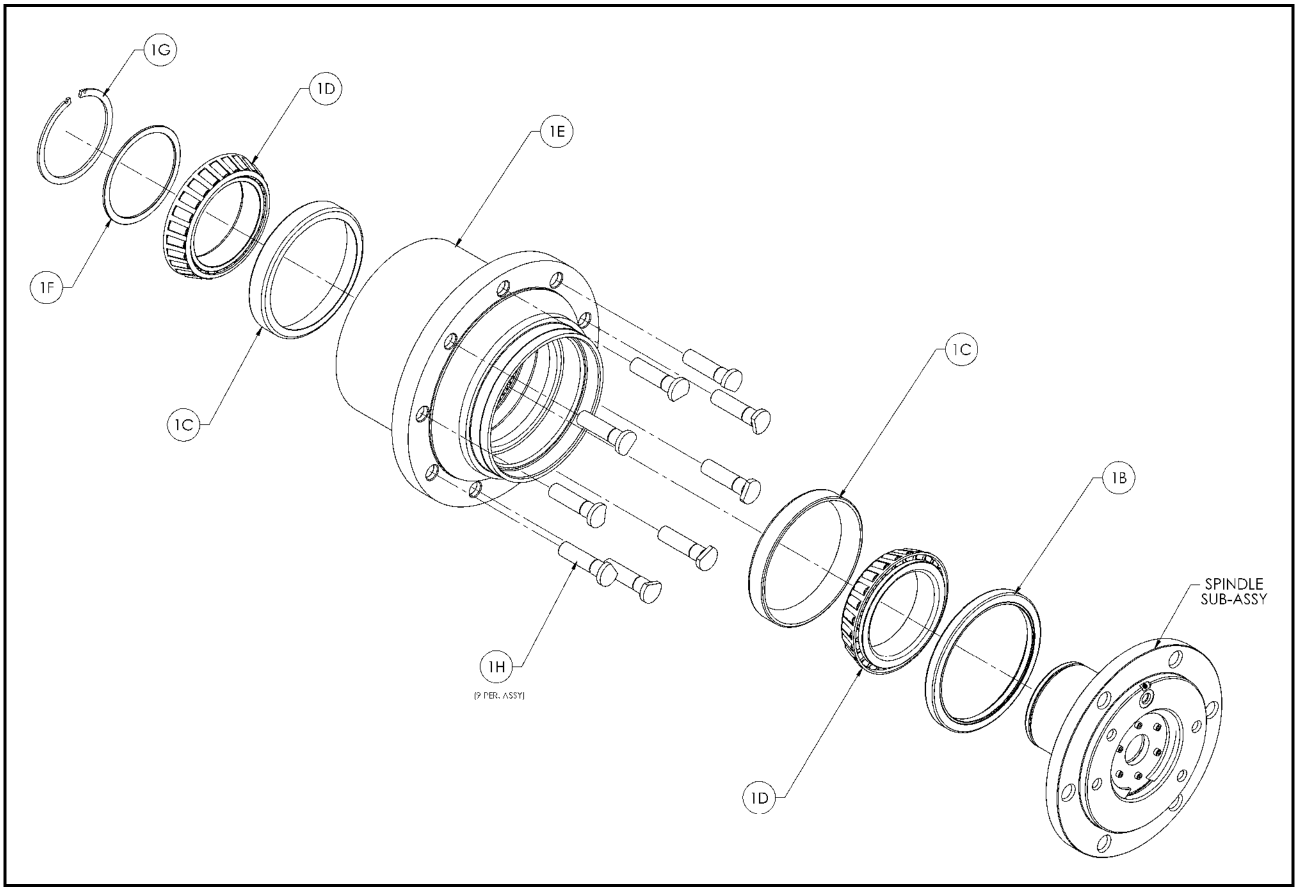
NOTE: *Refer to Figure 3-13., Housing-Spindle Disassembly.*

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

CAUTION

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

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



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

Figure 3-13. Housing-Spindle Disassembly

Spindle-Brake Disassembly

NOTE: *Refer to Figure 3-14., Spindle Brake Disassembly.*

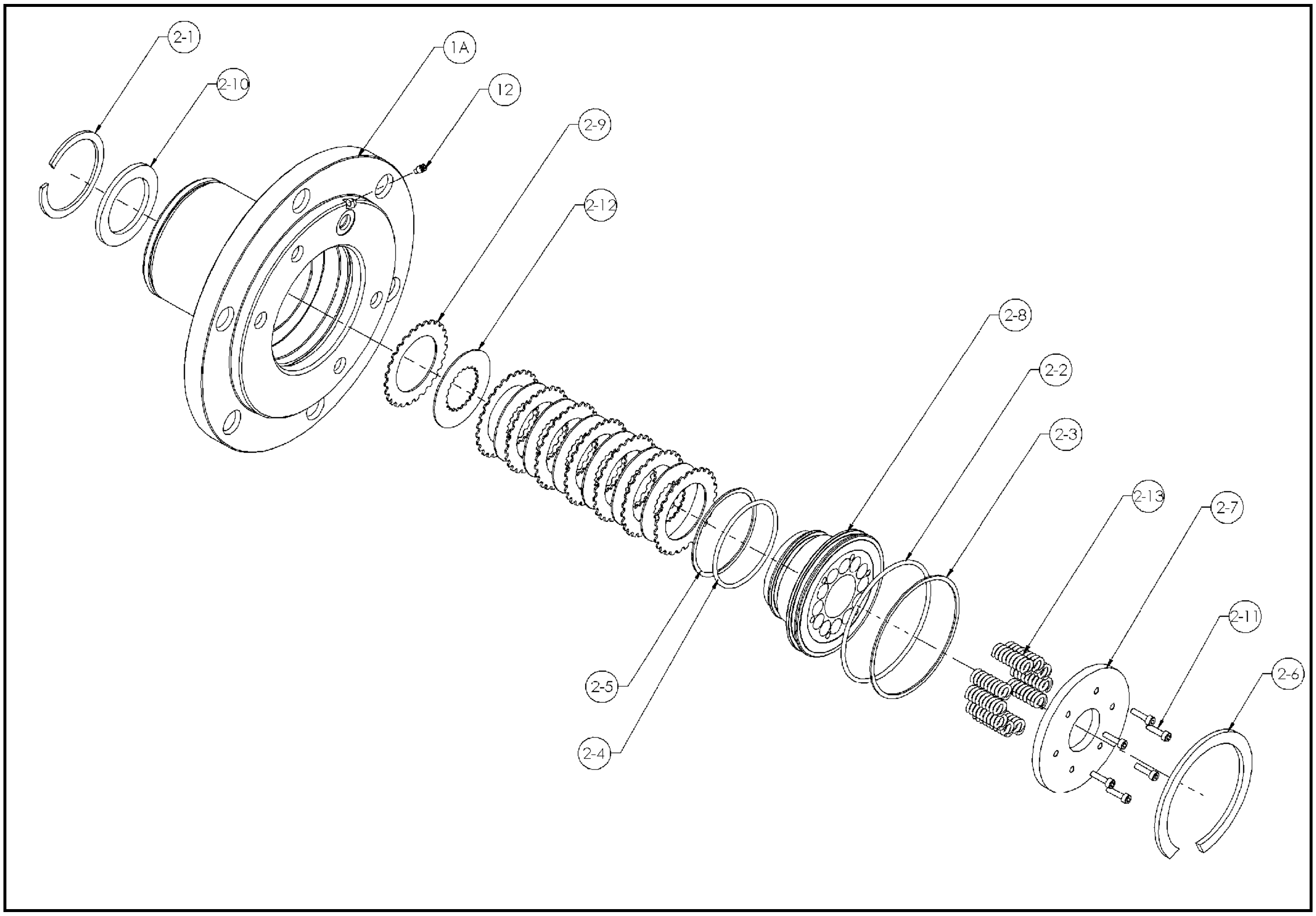
NOTE: *This procedure applies only to units with integral input brake (2).*

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

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

CAUTION

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



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

Figure 3-14. Spindle Brake Disassembly

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

⚠ CAUTION

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

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

⚠ CAUTION

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

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

Input Carrier Sub-Assembly

NOTE: *Refer to Figure 3-15., Input Carrier Sub-Assembly.*

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

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

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

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

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

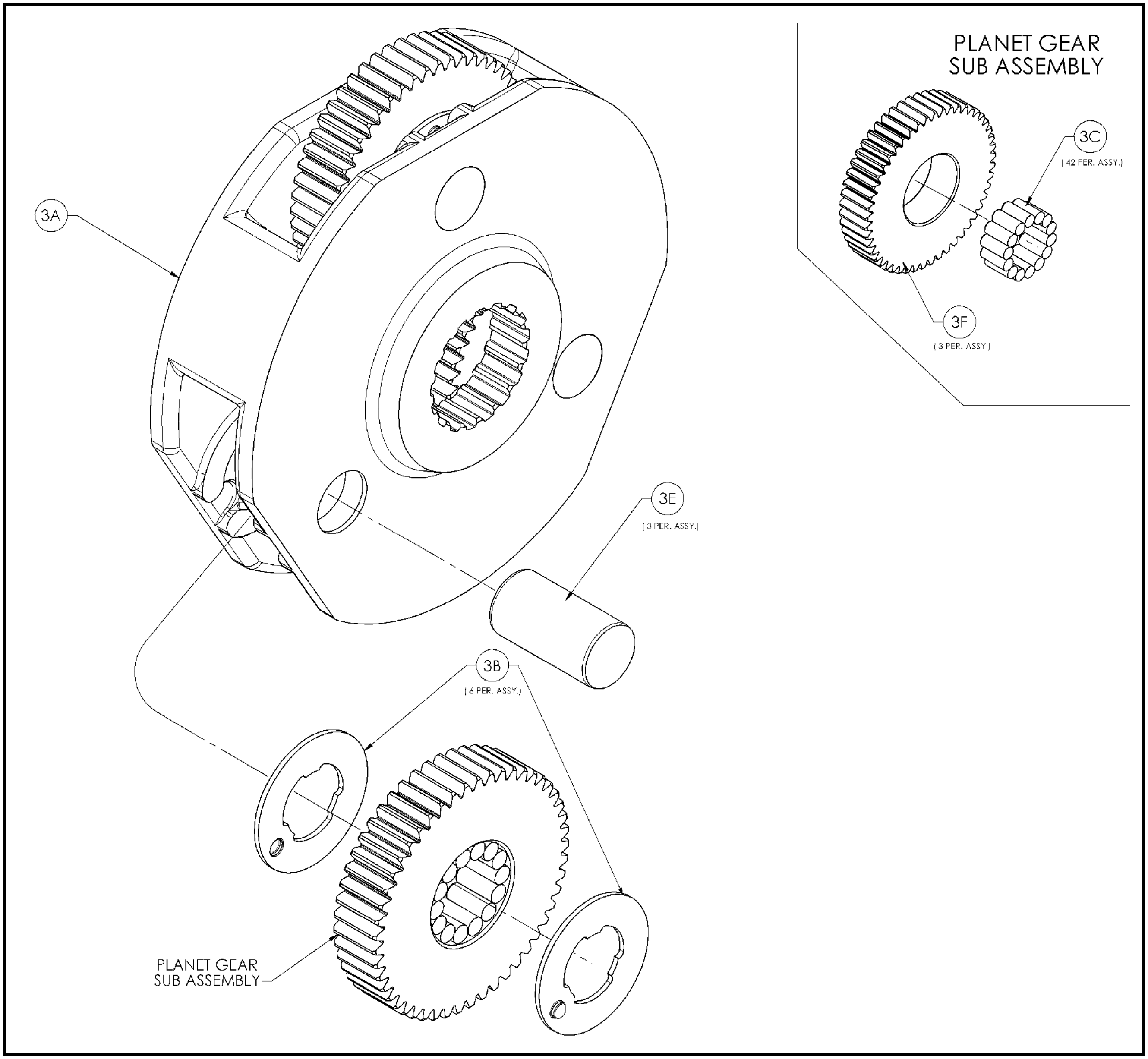
⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

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

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

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



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

Figure 3-15. Input Carrier Sub-Assembly

Output Carrier Sub-Assembly

NOTE: *Refer to Figure 3-16., Output Carrier Sub-Assembly.*

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

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

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

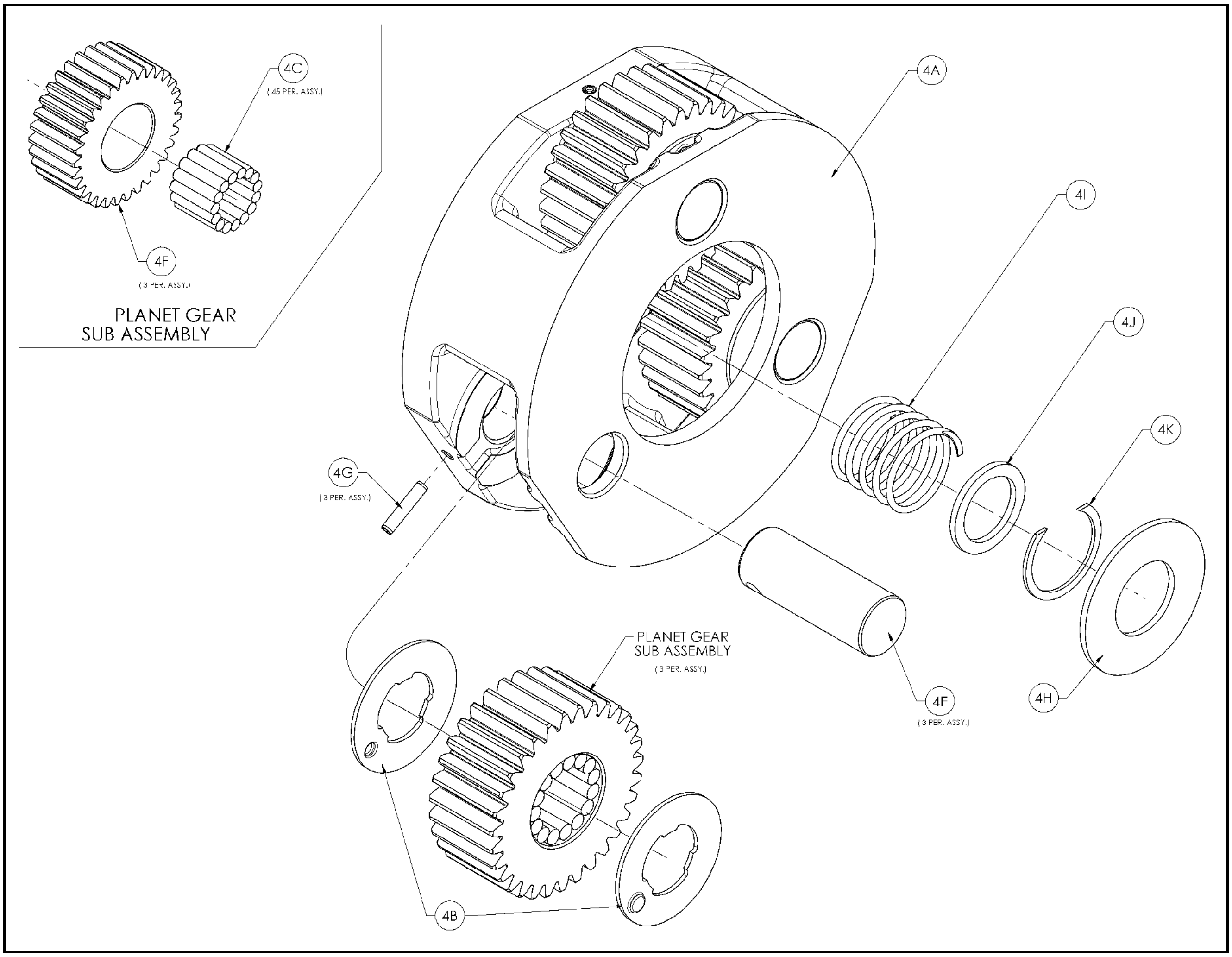
NOTE: *The last roller installed must be installed end wise. That is, the end of the last roller must be placed in between the ends of the two rollers that form the space, and then slid, parallel to the other rollers, into place.*

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

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

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



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

Figure 3-16. Output Carrier Sub-Assembly

Spindle Brake Sub-Assembly

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

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

NOTE: *For this procedure, use the Brake Assembly Drawing (Figure 3-17.), which will show the proper balloon numbers for the individual brake components. In the following instructions, if the number has a "-" between two numbers, it refers to the Brake Assembly Drawing only and NOT the Drive Hub Assembly Drawing.*

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

1. Install Pressure Plug (12) into Spindle (1A) using following procedure:
   a. Clean hole in spindle using appropriate Loctite spray.
   b. Dip collar of plug in Loctite 290 or 680 (keep unplugged portion of hole free of Loctite).
   c. Using appropriate tool, install plug flush with surface of spindle.

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

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

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

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

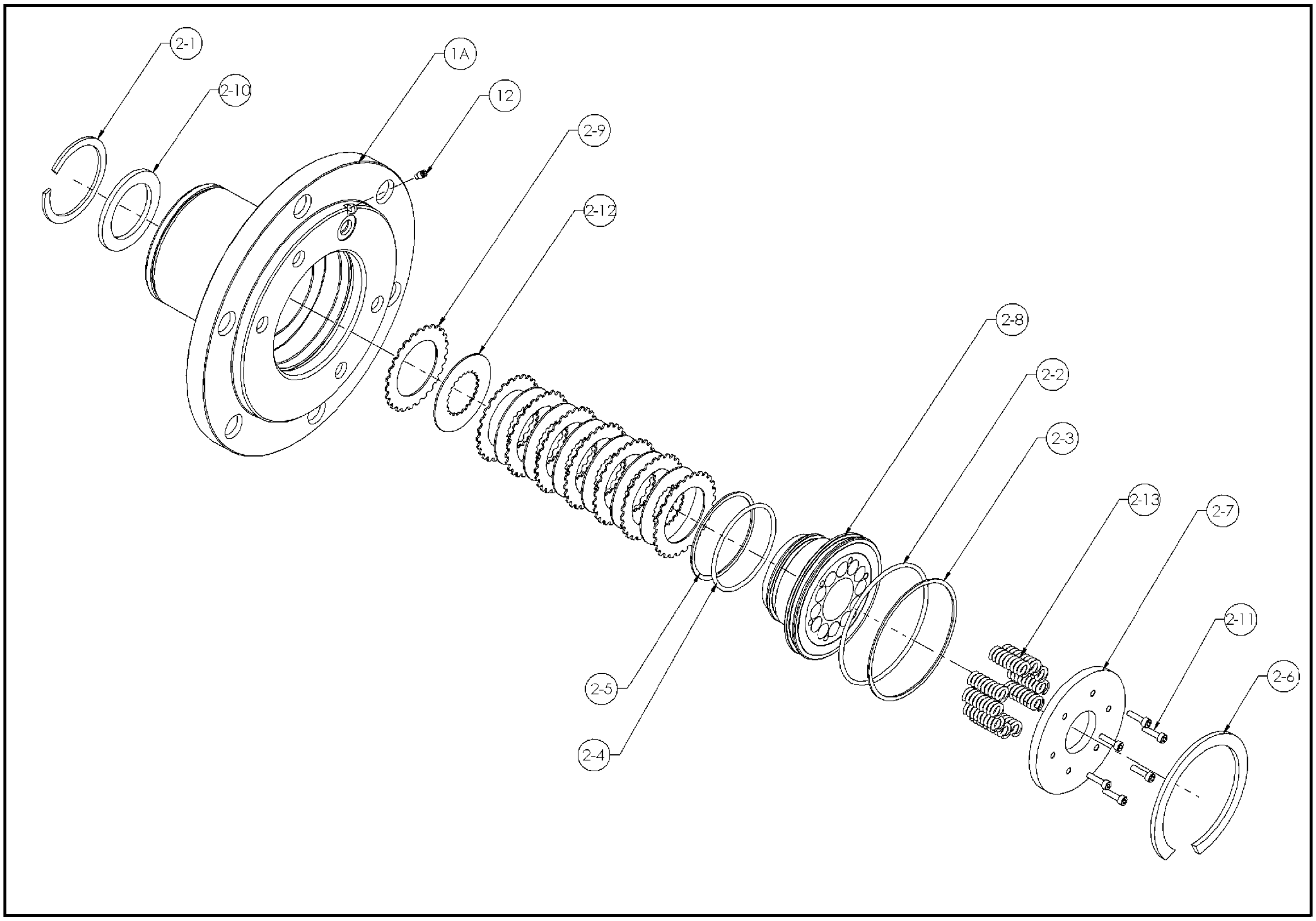
BRAKE CODE	BRAKE P/N	NUMBER OF SPRINGS
A	902337	12
B	902341	10
C	902342	8
D	902343	6
E	902345	9

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

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT TWO STEPS.

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



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

Figure 3-17. Spindle Brake Sub-Assembly

Housing-Spindle Sub-Assembly

NOTE: *Refer to Figure 3-18., Housing-Spindle Assembly.*

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

⚠ CAUTION

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

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

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

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

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

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

DW2B Integral Brake Check

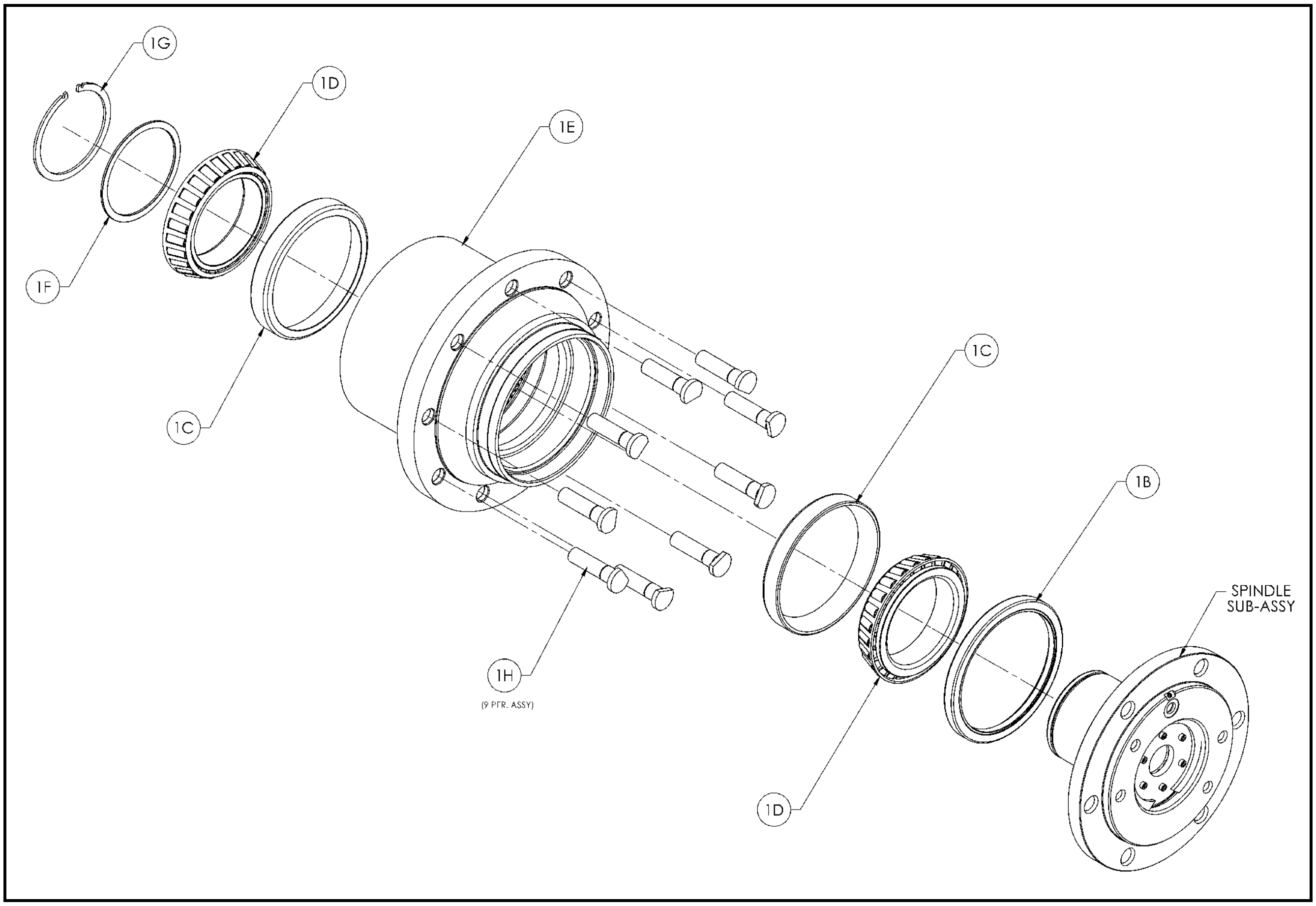
1. Using appropriate fittings, connect hydraulic line from hand pump to brake port.
2. Check to see that brake is set by trying to rotate Input Shaft (7). This can be accomplished by installing an appropriate tool (any tool that can locate on the splines of the Input Coupling (9), such as a mating splined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

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

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

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

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



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

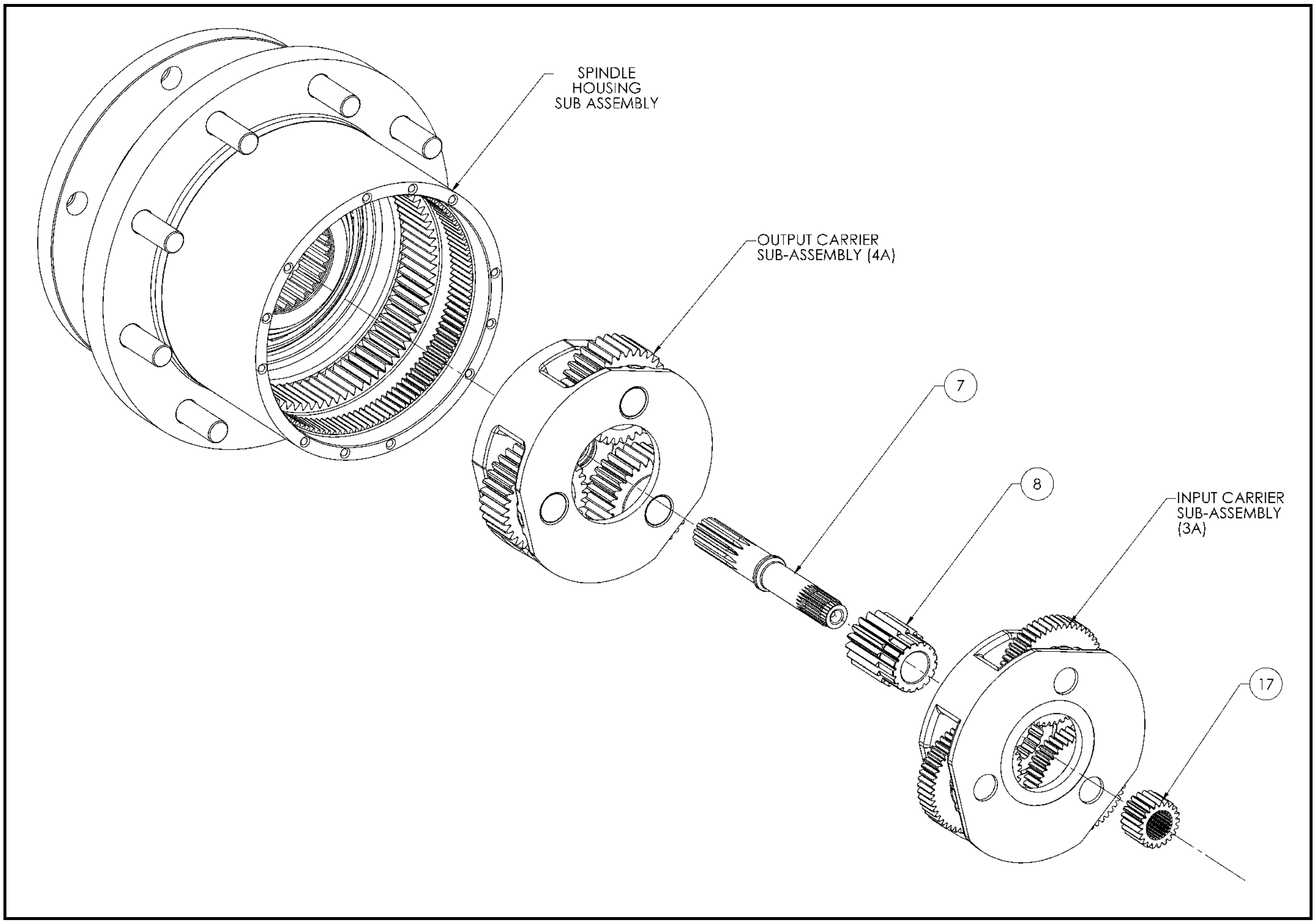
Figure 3-18. Housing-Spindle Assembly

Main Assembly

NOTE: *Refer to Figure 3-19., Main Assembly - Sheet 1 of 2 and Figure 3-20., Main Assembly - Sheet 2 of 2.*

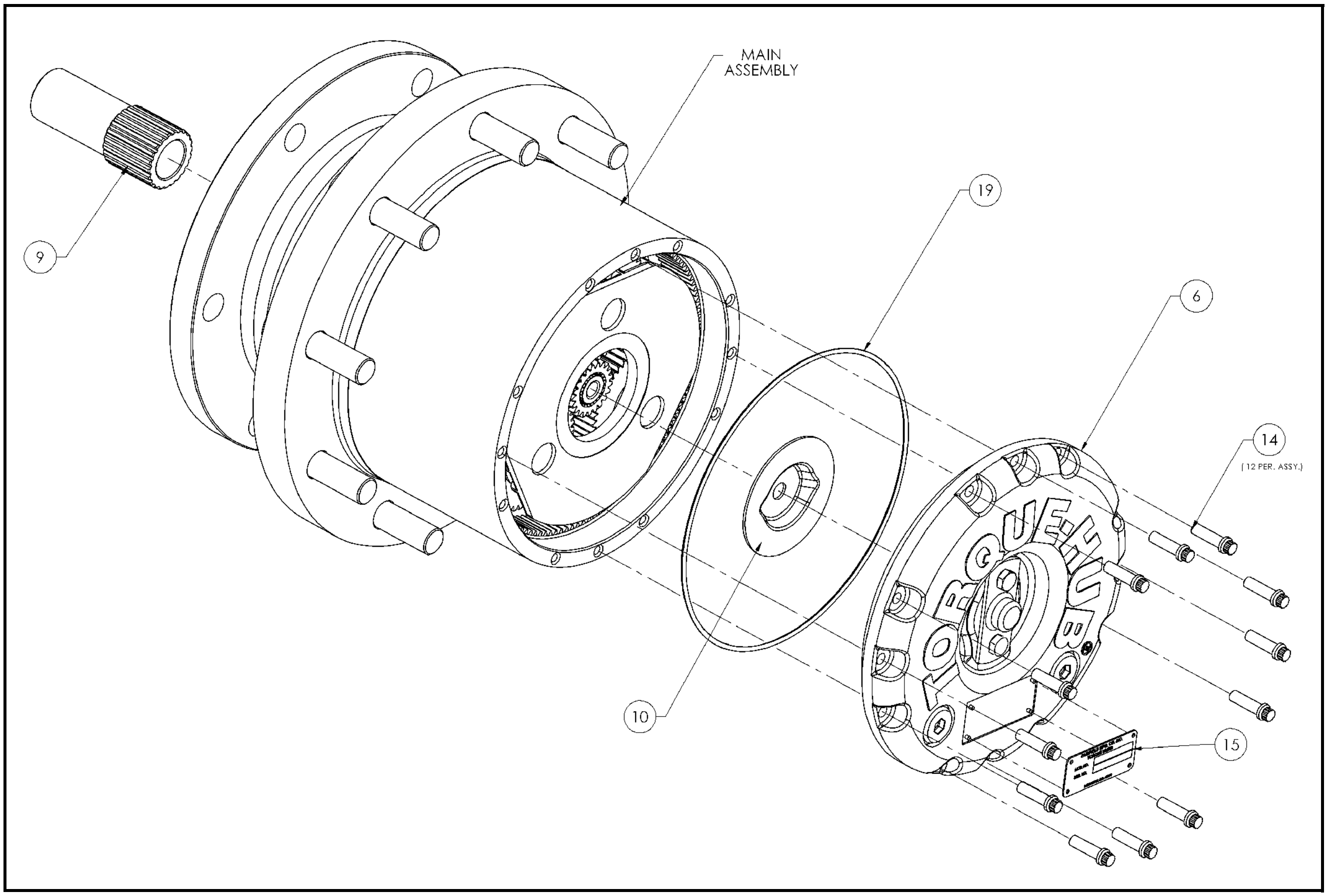
NOTE: *All components should receive a generous amount of lubricant oil as they are being assembled.*

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



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

Figure 3-19. Main Assembly - Sheet 1 of 2



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

Figure 3-20. Main Assembly - Sheet 2 of 2

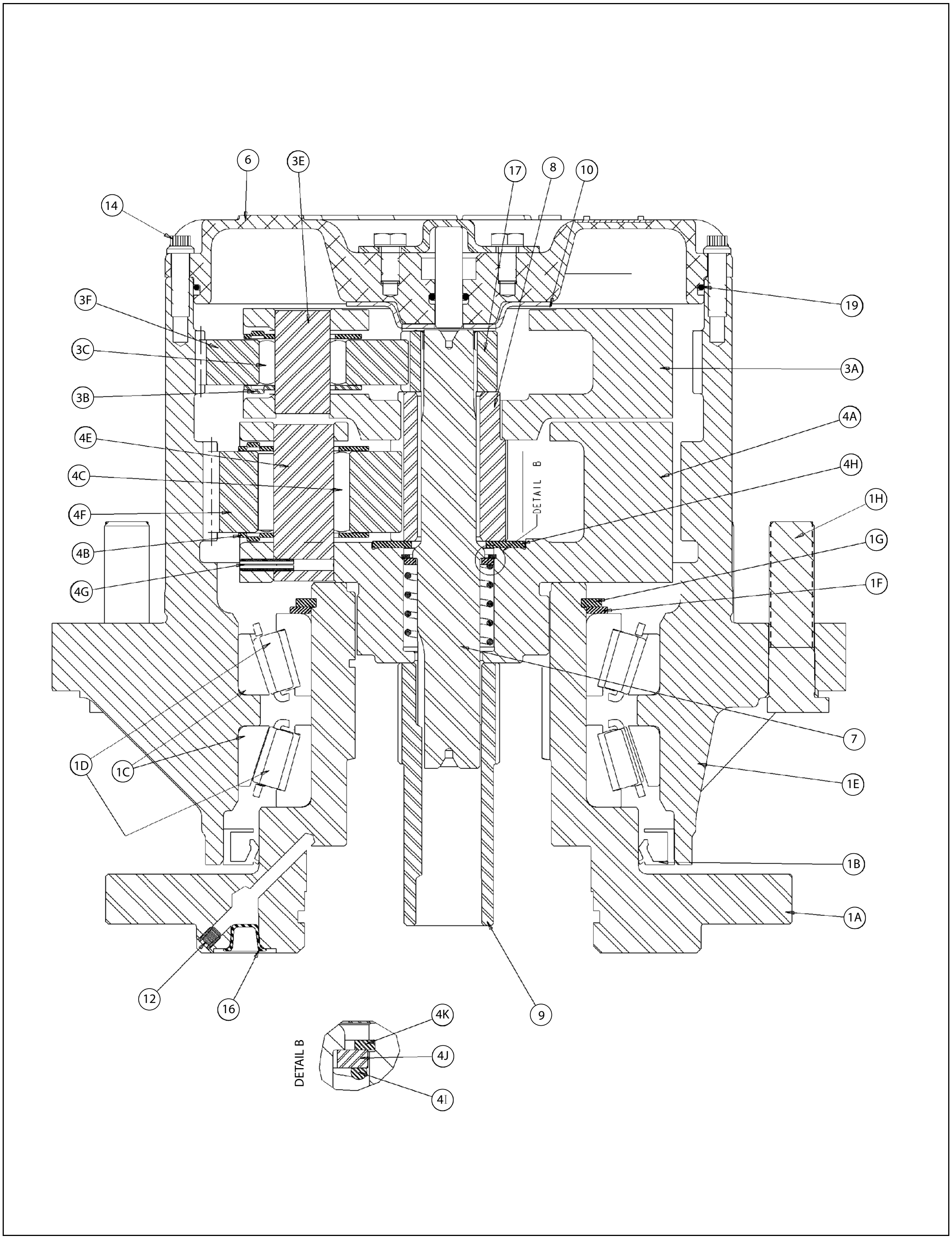


Figure 3-21. Assembly Drawing - Without Integral Input Brake - Sheet 1 of 2

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

Figure 3-22. Assembly Drawing - Without Integral Input Brake - Sheet 2 of 2

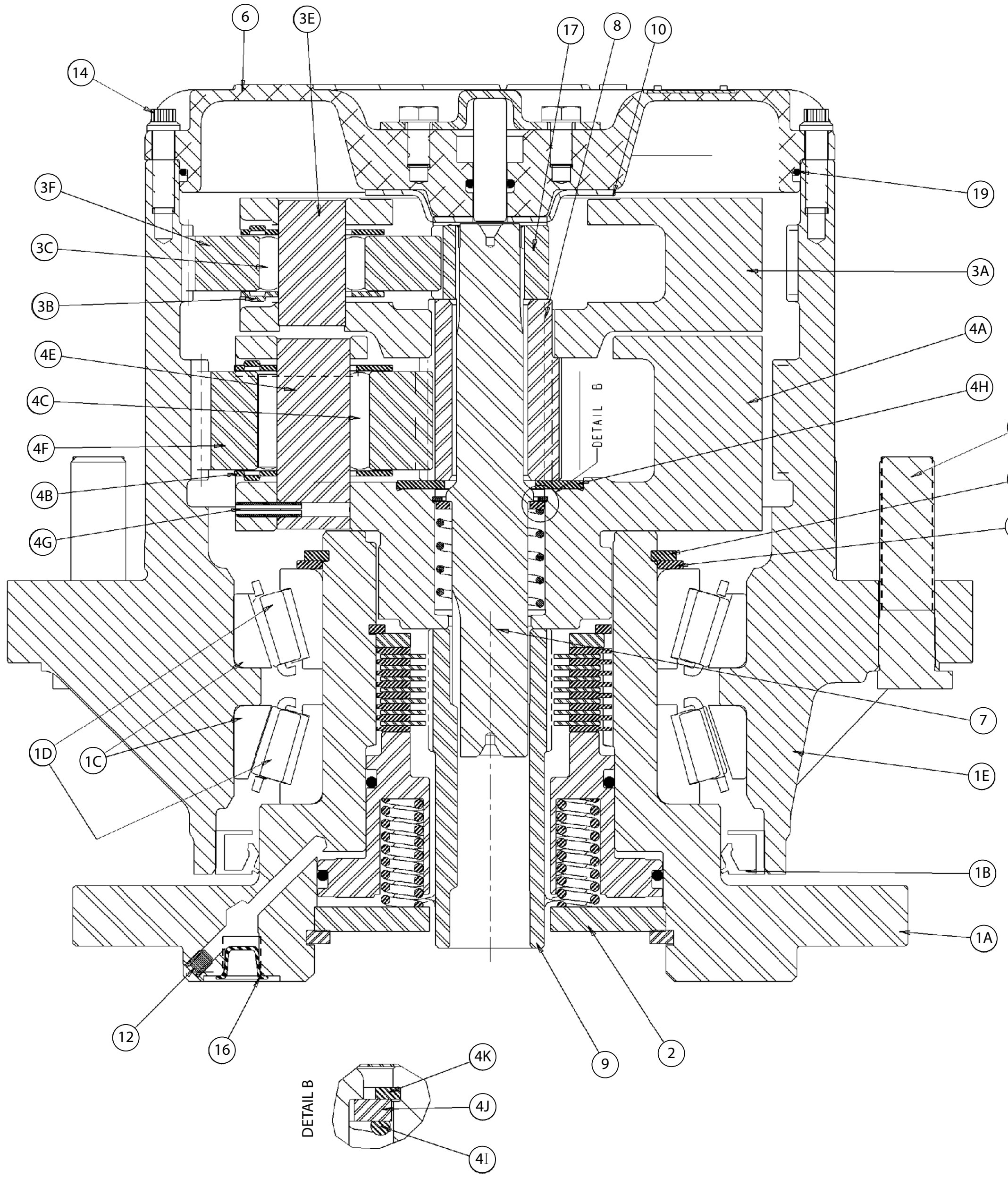


Figure 3-23. Assembly Drawing - With Integral Input Brake - Sheet 1 of 2

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

Figure 3-24. Assembly Drawing - With Integral Input Brake - Sheet 2 of 2

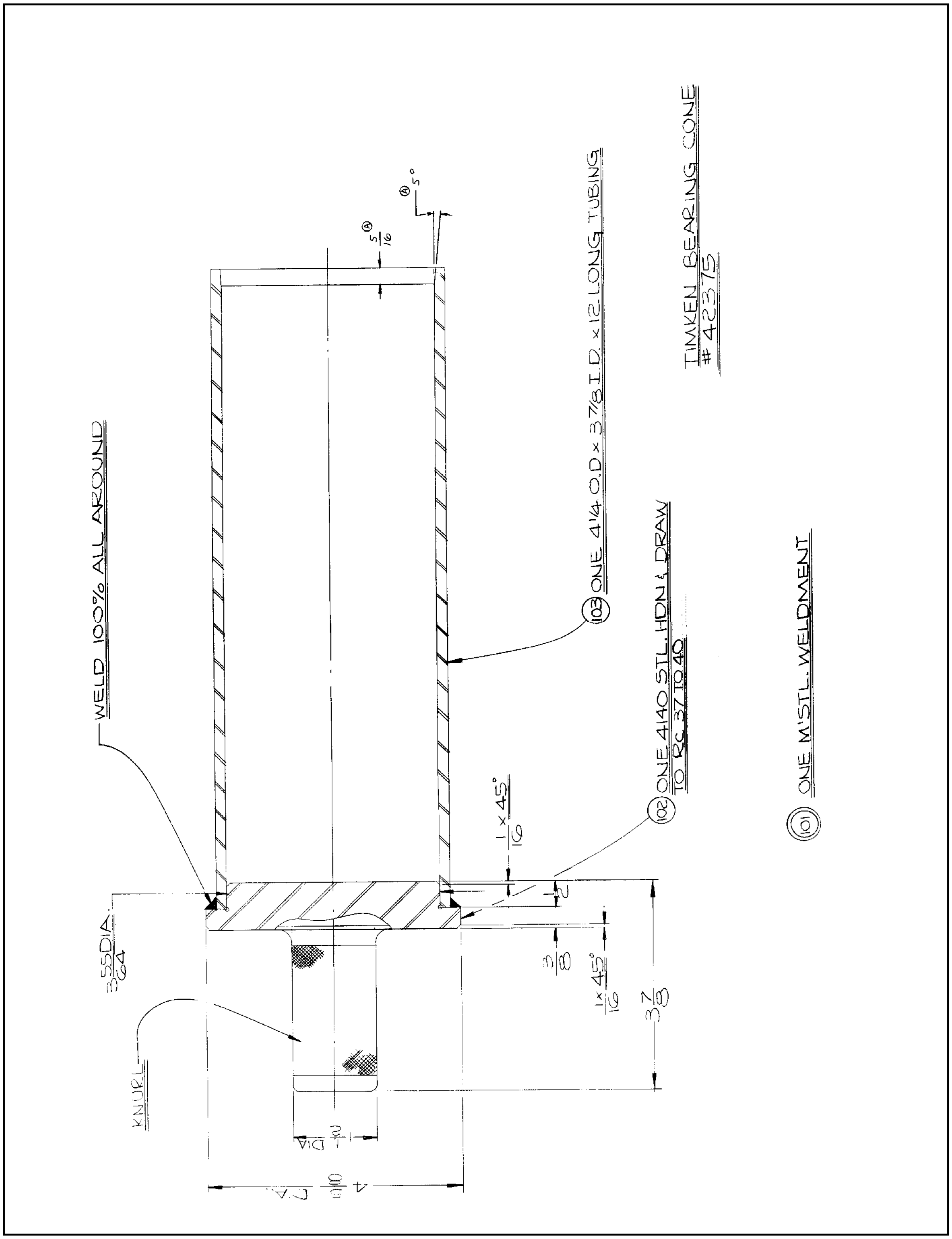


Figure 3-25. Assembly Tools - Bearing Cone Pressing - "B" Bearing

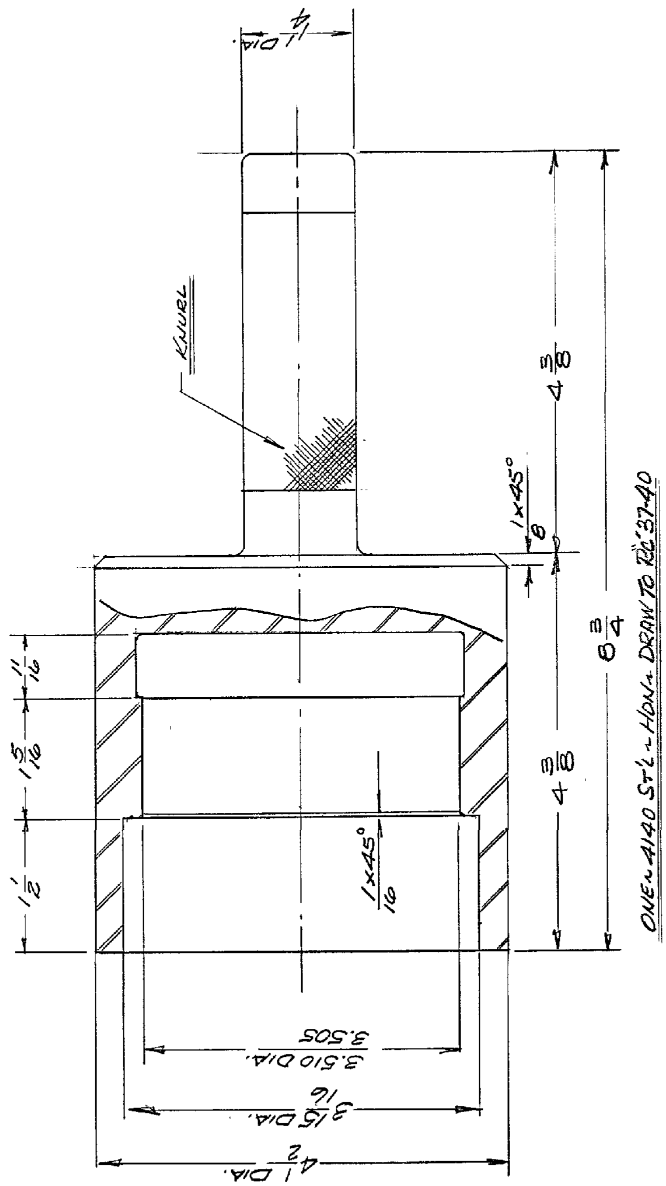


Figure 3-26. Assembly Tools - Bearing Cone Pressing - "A" Bearing

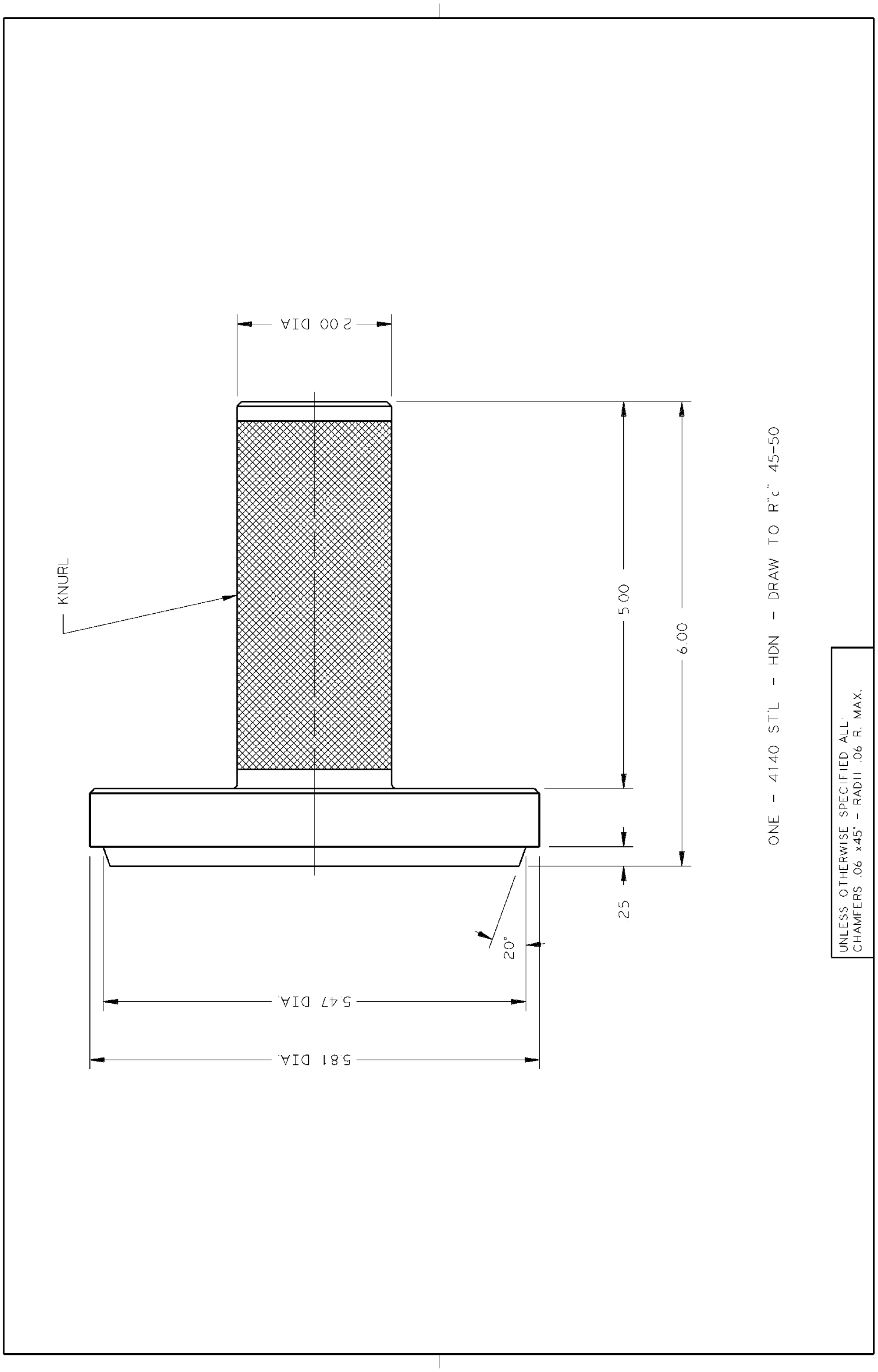


Figure 3-27. Assembly Tools - Bearing Cup Pressing - "A" & "B" Bearings

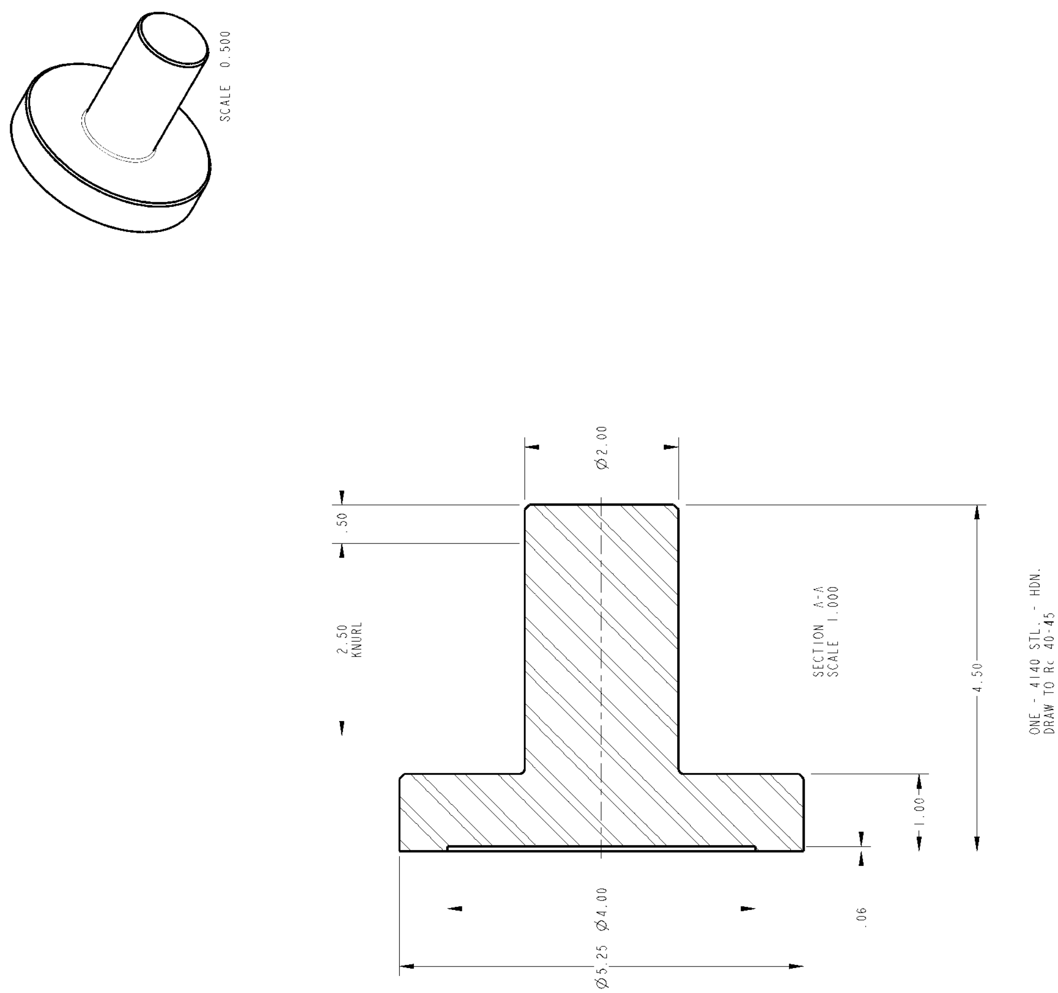


Figure 3-28. Assembly Tools - Seal Pressing

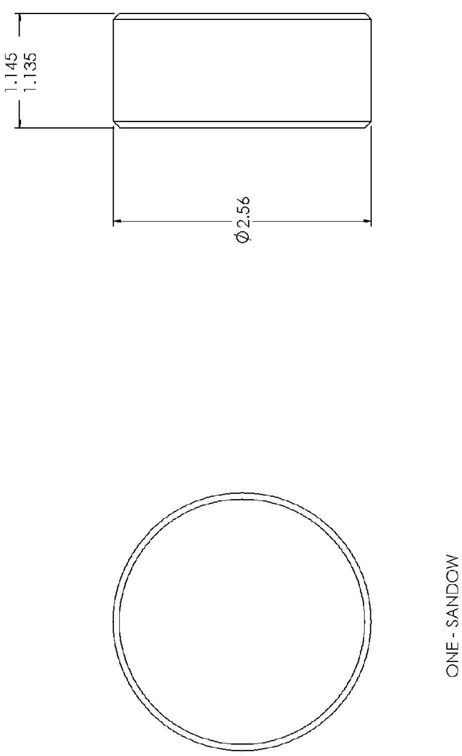


Figure 3-29. Assembly Tools - Spacer - Brake Disc Installation

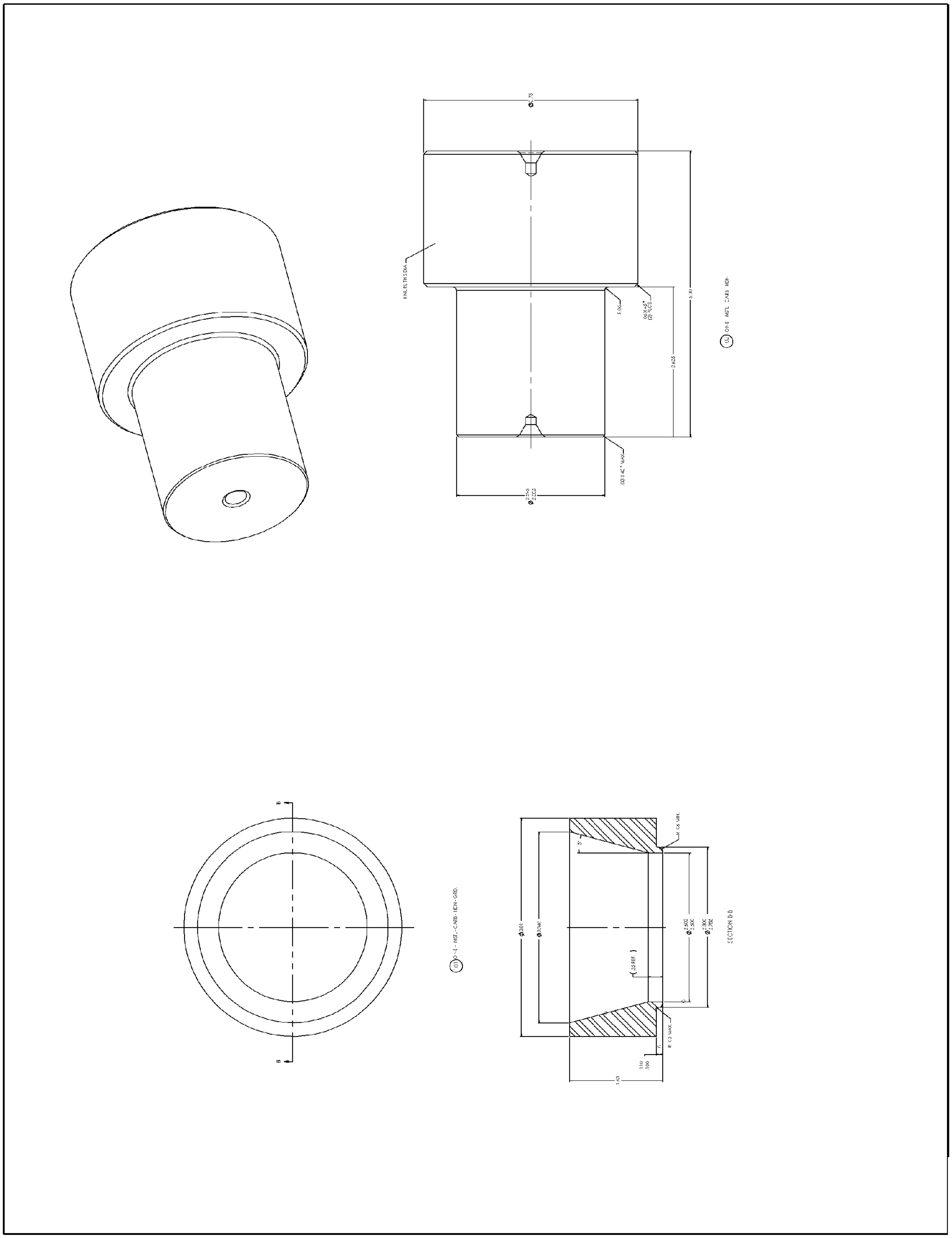
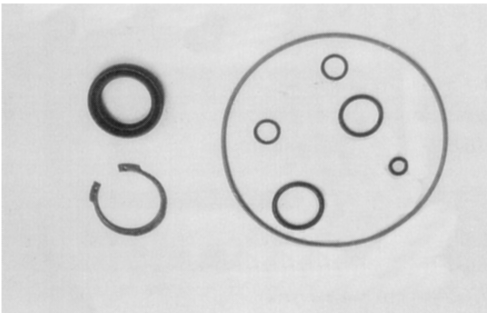


Figure 3-30. Assembly Tools - Brake Retaining Ring Installation

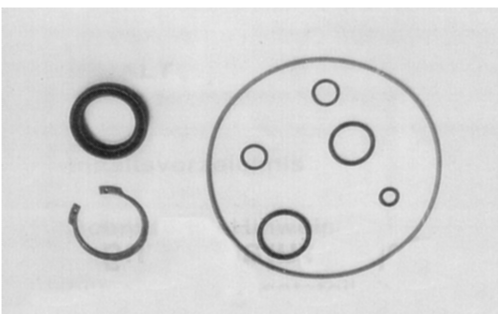
3.7 DRIVE MOTOR - 2WD (PRIOR TO SN 0300083331)

Spare Parts Kits

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

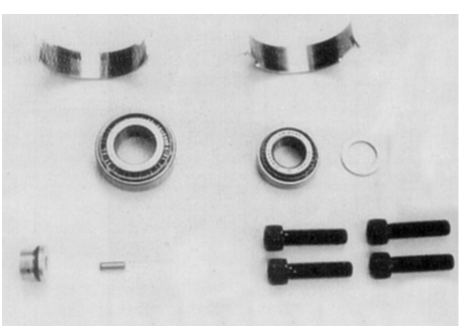


Same sealing kit like shown above only seal material changed to Viton.

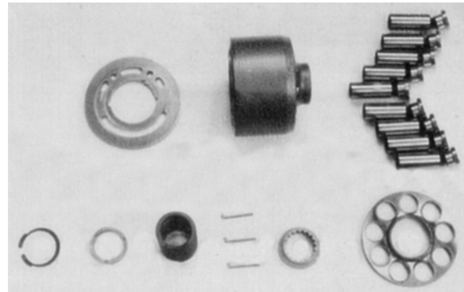


Drive shaft

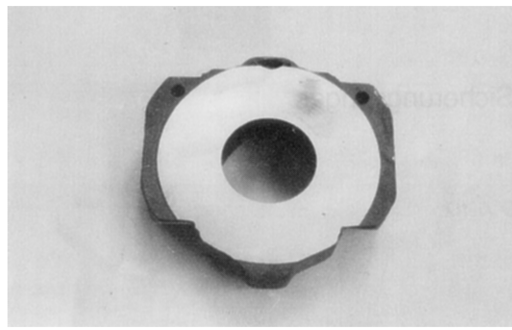
Bearing set/miscellaneous parts



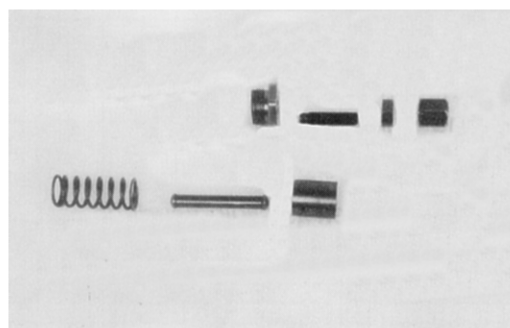
Rotary group complete 9 pistons, cylinder sub-assembly, valve plate (cw or ccw corresponding to the order) retaining plate and retaining ball.



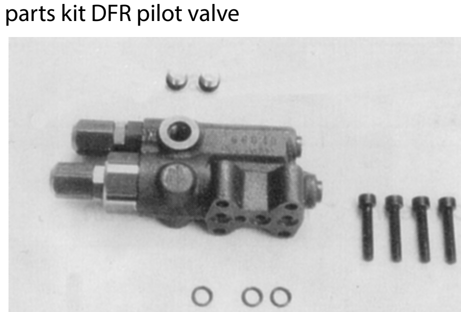
Swashplate



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



Spare parts kit DFR pilot valve



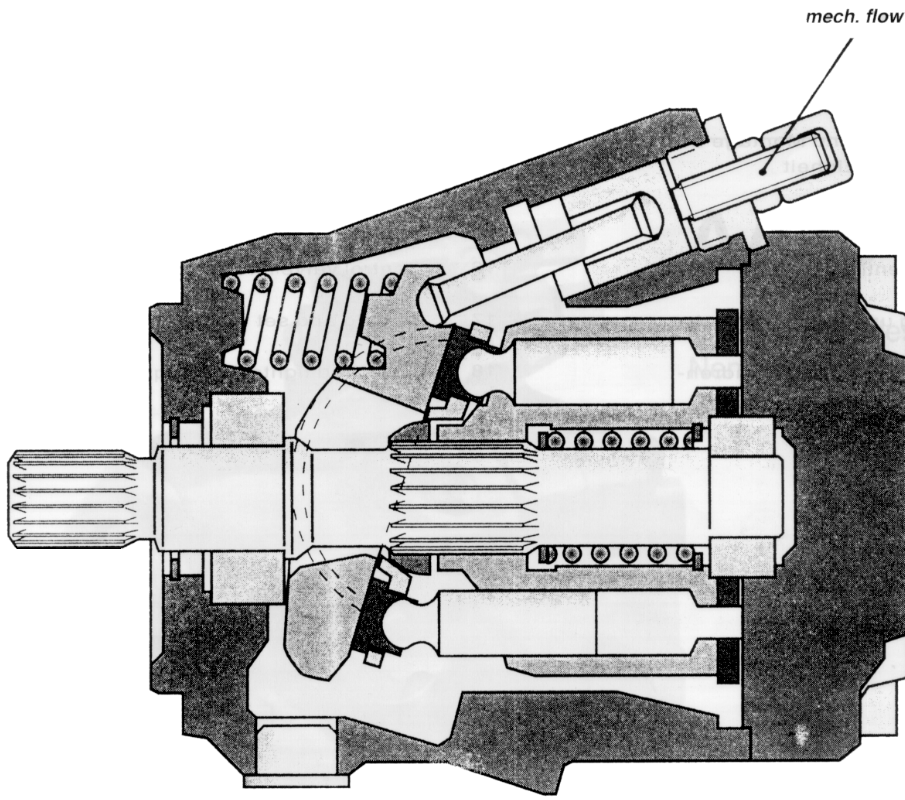
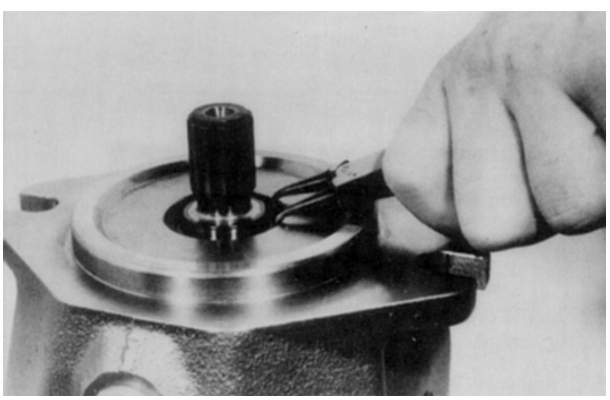


Figure 3-31. Drive Motor Cutaway

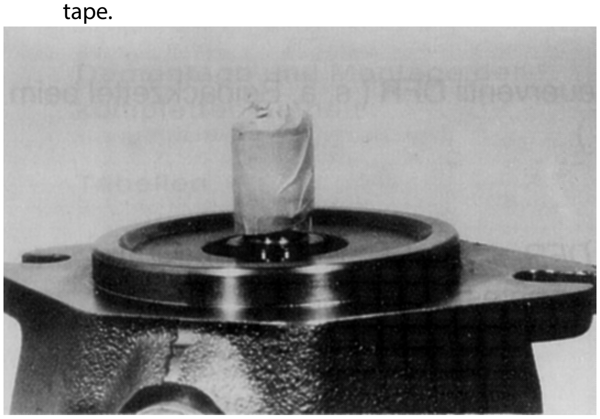
Replacing the Drive Shaft Seal

1. Remove snap ring.

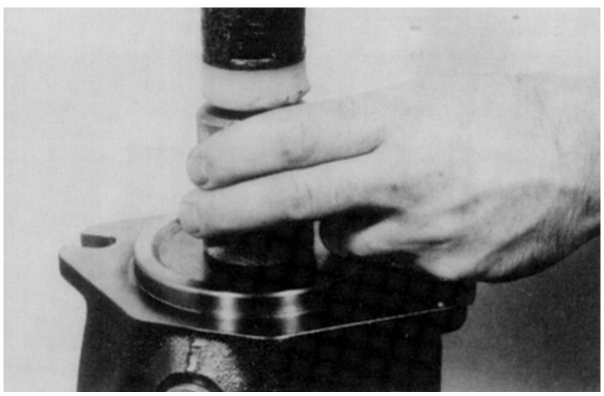


2. Change the shaft seal and check its sliding surface (drive shaft) and housing. Grease the sealing ring.

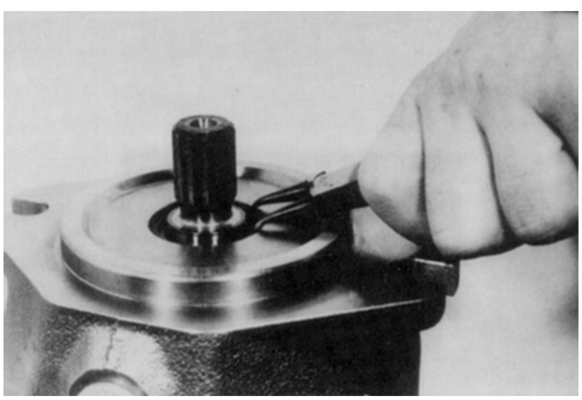
3. Be careful while you seal the drive shaft, use an adhesive tape.



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



5. Assemble the snap ring.

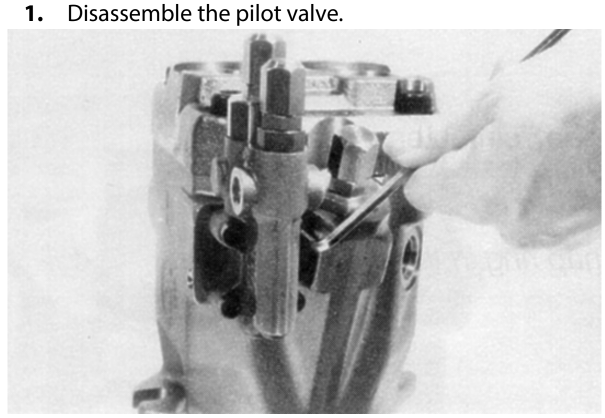


6. Assemble the snap ring in the correct position.

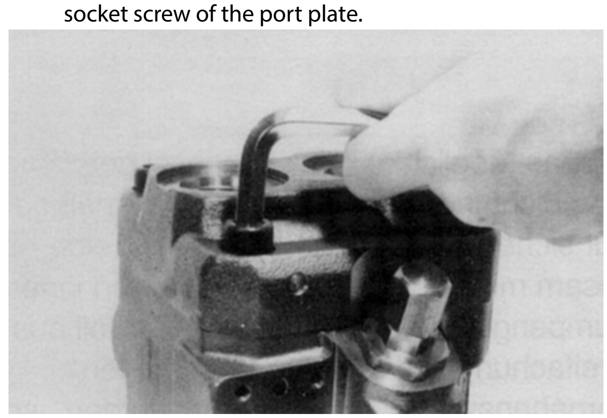
NOTE: *This description shows how to change the drive shaft sealing ring but isn't the way of serial assembly. the sealing ring is assembled together with the taper roller bearing from inside the pump housing normally to get a secure condition. If you decide to repair the pump in the shown way be very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

Disassembly

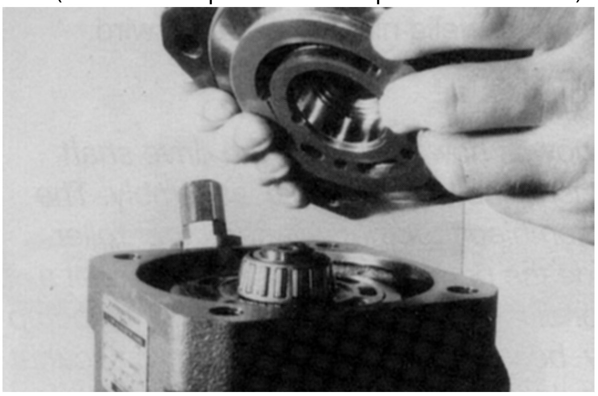
1. Disassemble the pilot valve.



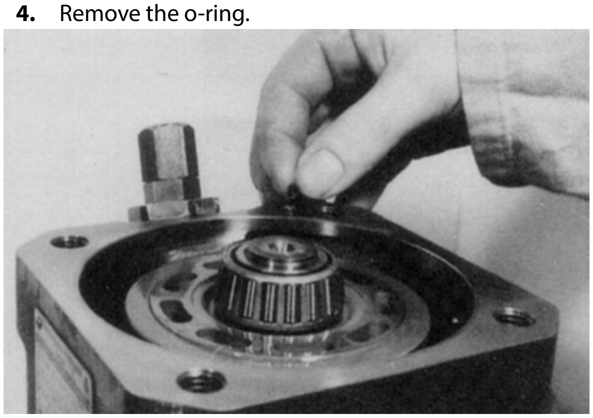
2. Mark the position of the port plate and remove the socket screw of the port plate.



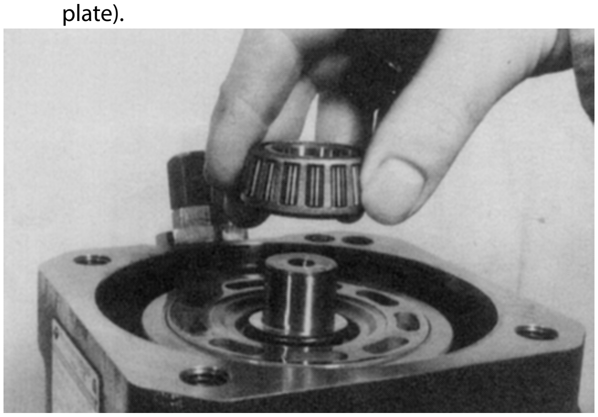
3. Remove the port plate together with the valve plate (hold the valve plate so that the plate can't fall down).



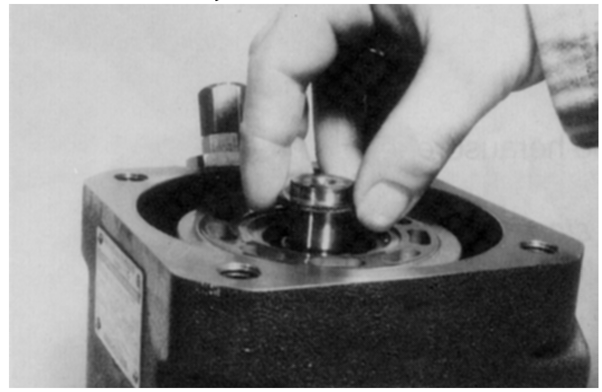
4. Remove the o-ring.



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

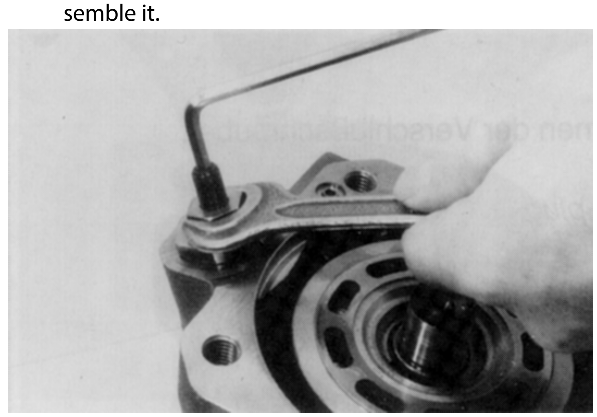


6. Remove the adjustment shim.

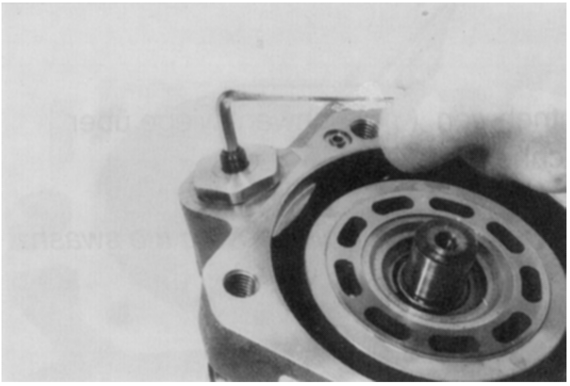


7. Unscrew the cap nut and remove it.

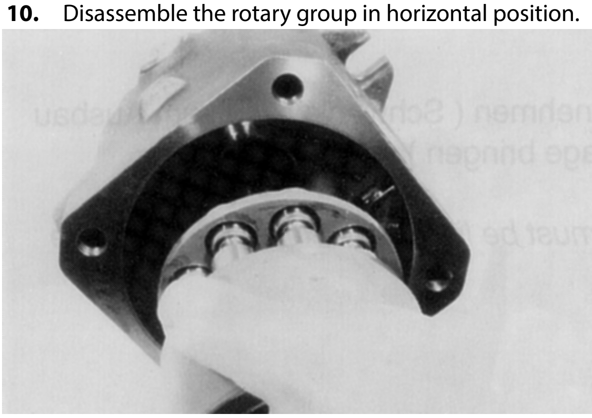
8. Loosen the fixing nut of the stopper max flow and disassemble it.



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

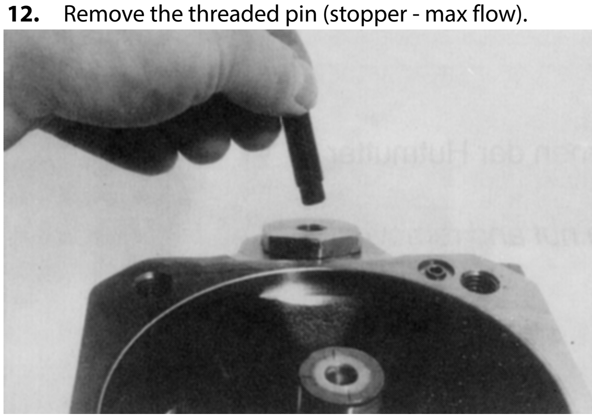


10. Disassemble the rotary group in horizontal position.



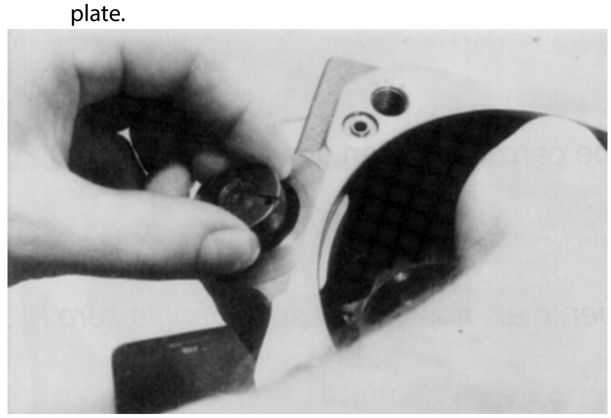
11. Disassemble the stopper - max flow.

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



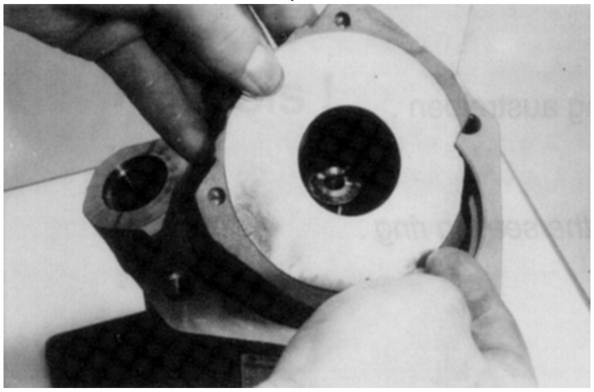
13. Disassemble the plug.

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

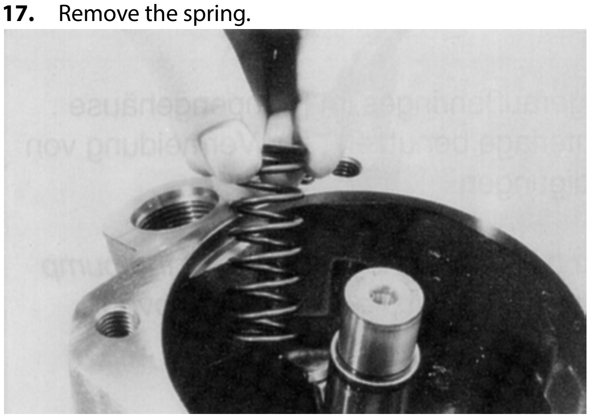


15. The swashplate must be lifted a little bit to disassemble the piston rod.

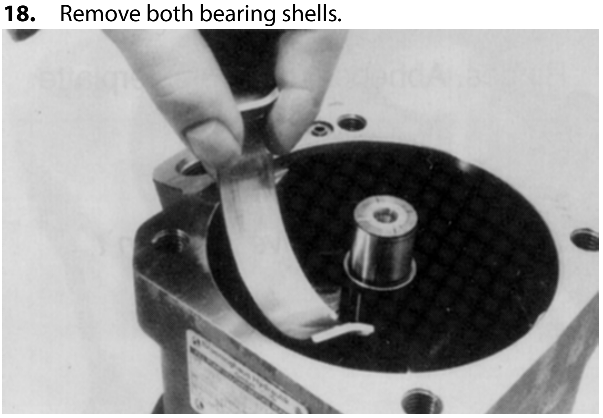
16. Disassemble the swashplate.



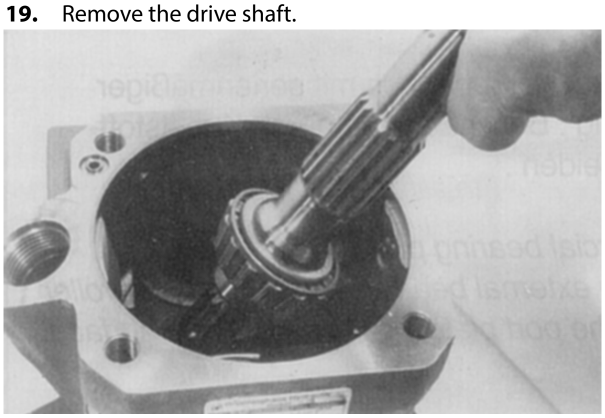
17. Remove the spring.



18. Remove both bearing shells.



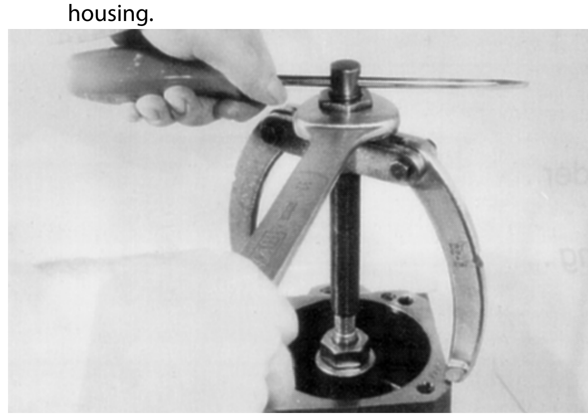
19. Remove the drive shaft.



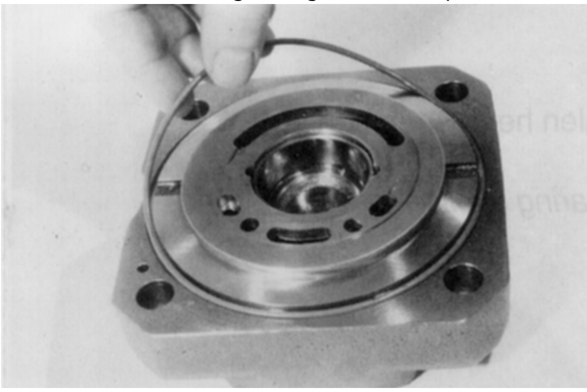
20. Disassemble the snap ring.

21. Disassemble the sealing ring.

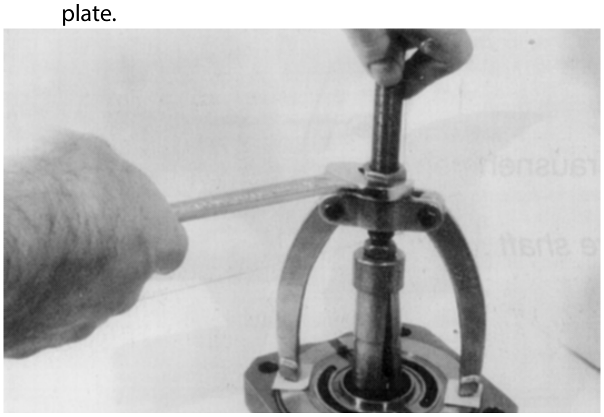
22. The external front bearing ring is pulled out of the pump housing.



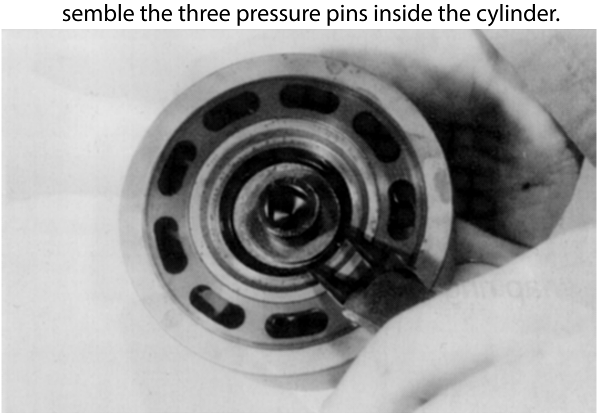
23. Remove the o-ring. Lifting of the valve plate isn't shown.



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



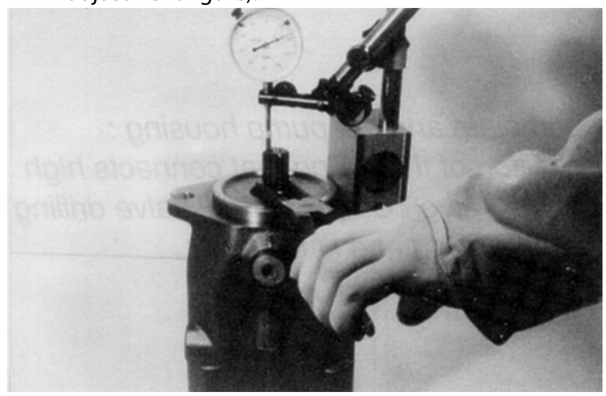
25. The spring has additional pretension while you disassemble the three pressure pins inside the cylinder.



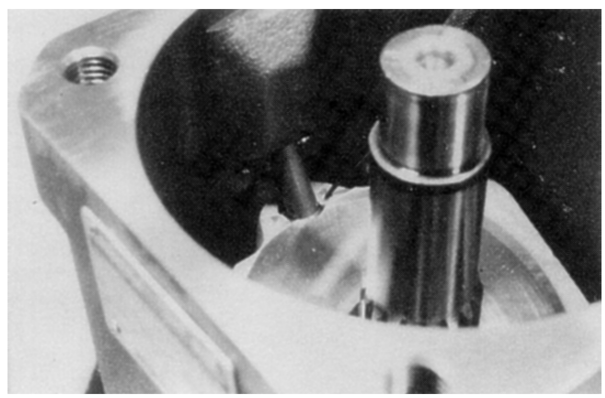
Assembly

1. Assemble the variable displacement pump in reverse order.

2. Measurement of the taper roller bearing pretension (see adjustment figure).

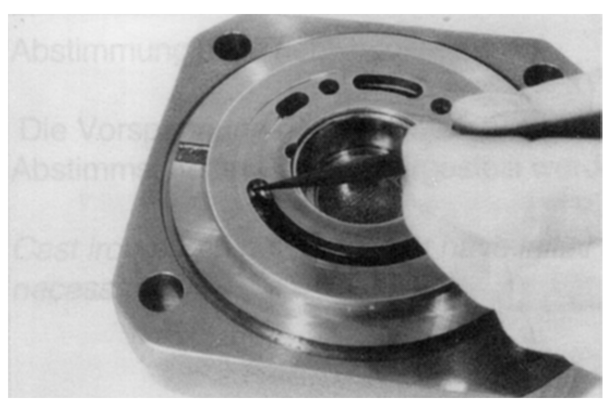


NOTE: *There is a correct connection of the piston rod and swashplate.*

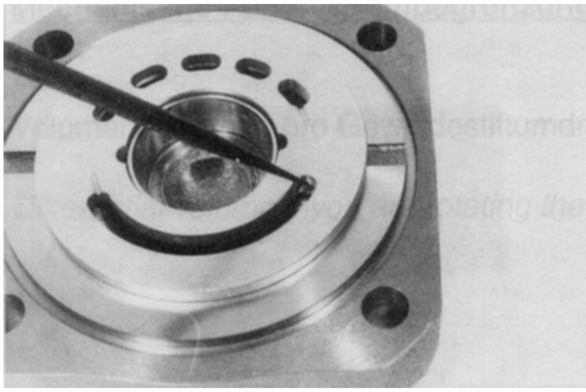


3. Pumps clockwise driven must have a position of the valve plate 4° out of center in the same direction decentered like drive direction.

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

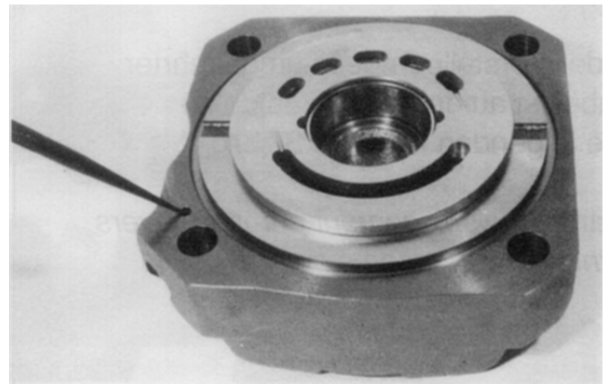


4. Pumps anti-clockwise driven must have a position of the valve plate 4° decentered in counter-clockwise position.

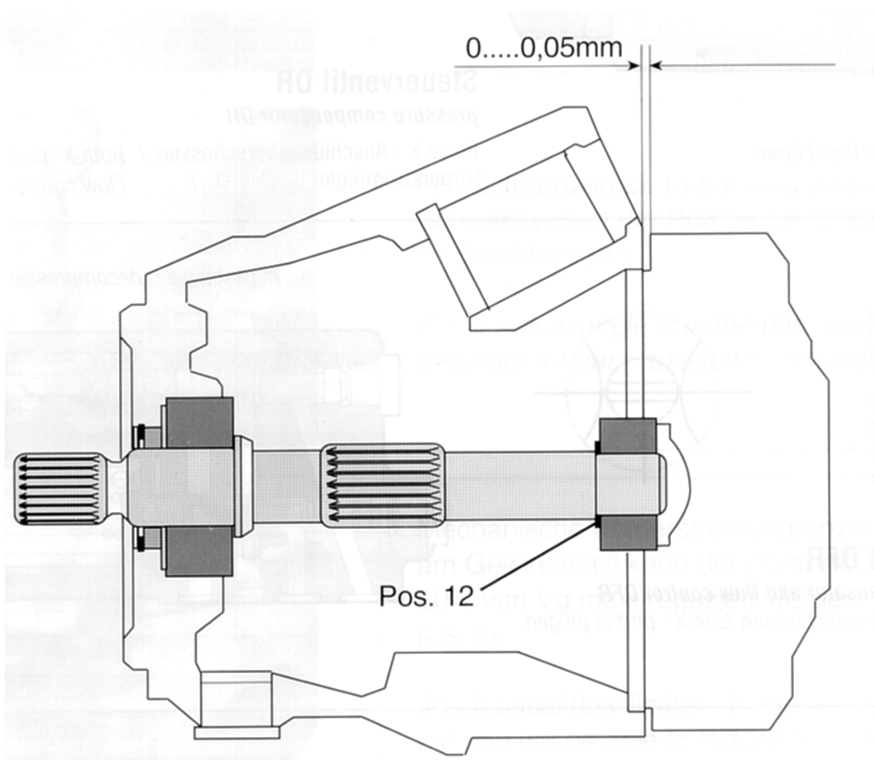


5. Assembly of the port plate and pump housing:

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



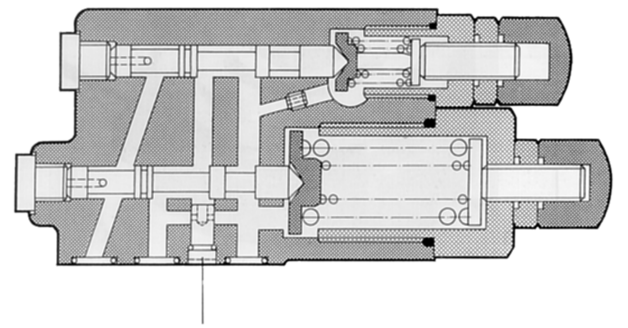
Taper roller bearing initial tension

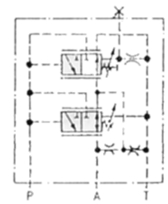


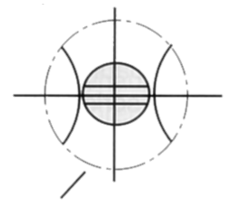
Cast iron pump housing must have initial tension of the bearings : 0........0,05 mm , grind Pos. 12 if necessary.

Figure 3-32. Bearing Tension

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



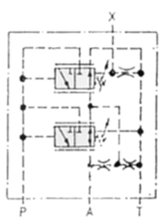


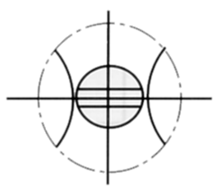


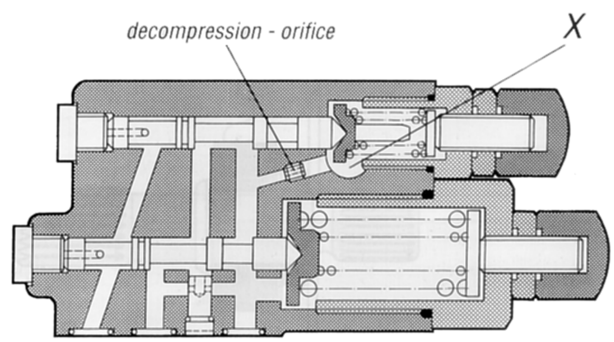
position of the orifice Ø 0,6

pressure compensator DR

Both X- ports are pluged .
Flow control blocked.

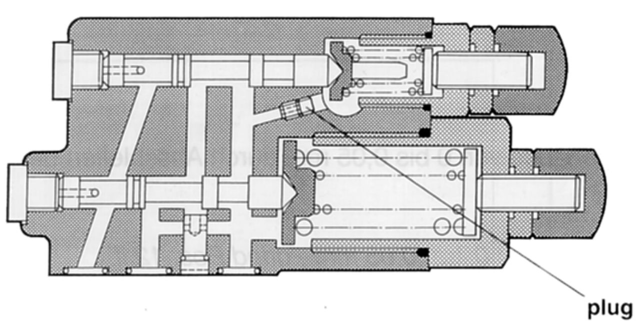


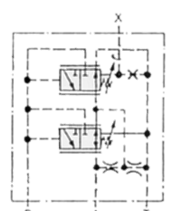


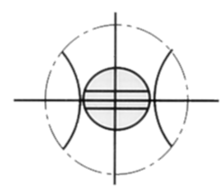


pressure compensator and flow control DFR

One X - port is plugged .

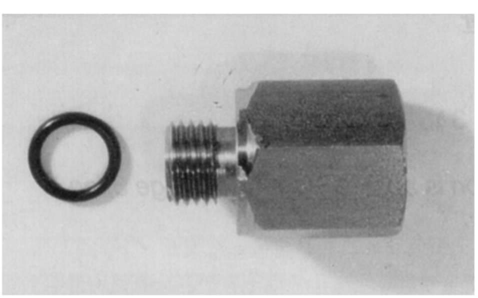






pressure compensator and flow control DFR 1

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



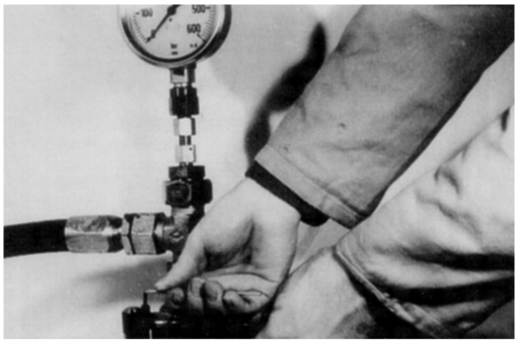
Adapter without orifice of the DFR-pilot valve , if you use a metric pilot pipe connection X .

NOTE: *Differential volume if you are rotating the threaded pin - each rotation is appr. 3,1 cm^3.*

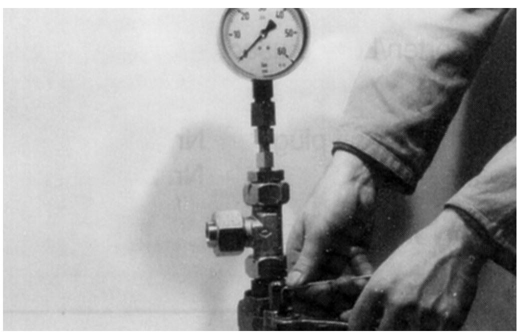
Figure 3-33. Flow Control Pilot Valves

Testing and Setup

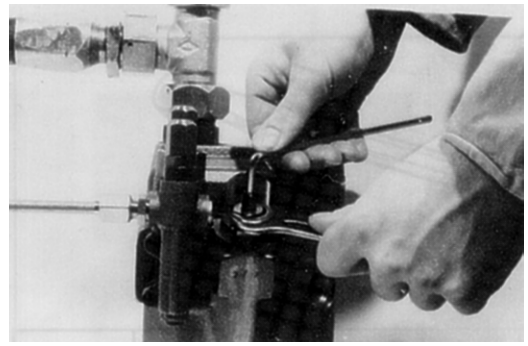
DR: When pressure line is closed adjust the pressure of the controller (if it's DFR design then open the adjustable orifice and increase force of the spring - FR -).



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



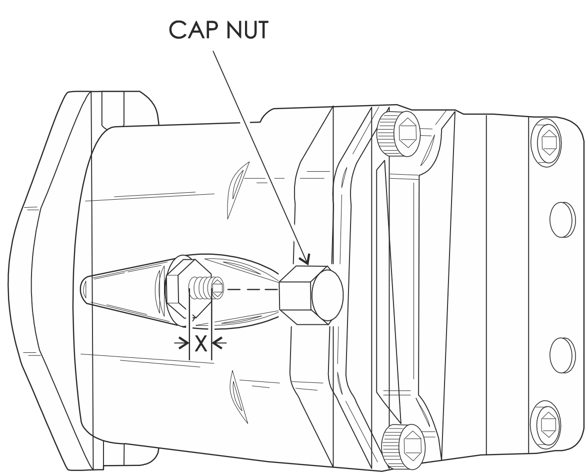
Mechanical flow limiter: While screwing in the threaded pin you will be able to reduce the flow from Vg max to 50% of Vg max.



Drive Motor Adjustment Procedure

1. Remove the cap nut from adjustment screw.
2. Loosen jam nut on the adjustment screw and make adjustment.
3. Measure from top of jam nut to the end of adjustment screw. Refer to Figure 3-34., Drive Motor Adjustment.
4. Tighten jam nut, install cap nut.

NOTE: *The o-ring must be seated in groove in cap nut.*



MODEL	"X" MEASUREMENT		DISPLACEMENT
	mm	inches	cu. in. /rev
4-WD	11	0.433	1.000

Figure 3-34. Drive Motor Adjustment

3.8 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 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 hardware securing wheel and remove wheel assembly. Using suitable lifting device lift the wheel assembly and place in a suitable area.

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 282 lbs. (128 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.

Installation

1. Apply a coat of JLG Threadlocker P/N 0100011 on capscrews. Install the washers and capscrews to secure the drive hub and drive motor, and torque to 70 ft. lbs. (95 Nm).

2. Place the drive hub flange against the mounting flange on the axle using a suitable lifting device and fasten it in place with the capscrews and washers. Torque the capscrews to 190 ft. lbs. (258 Nm).

3. Using adequate support, install wheel into wheel assembly and secure with bolts and nuts. Torque the nuts to 300 ft. lbs. (407 Nm).

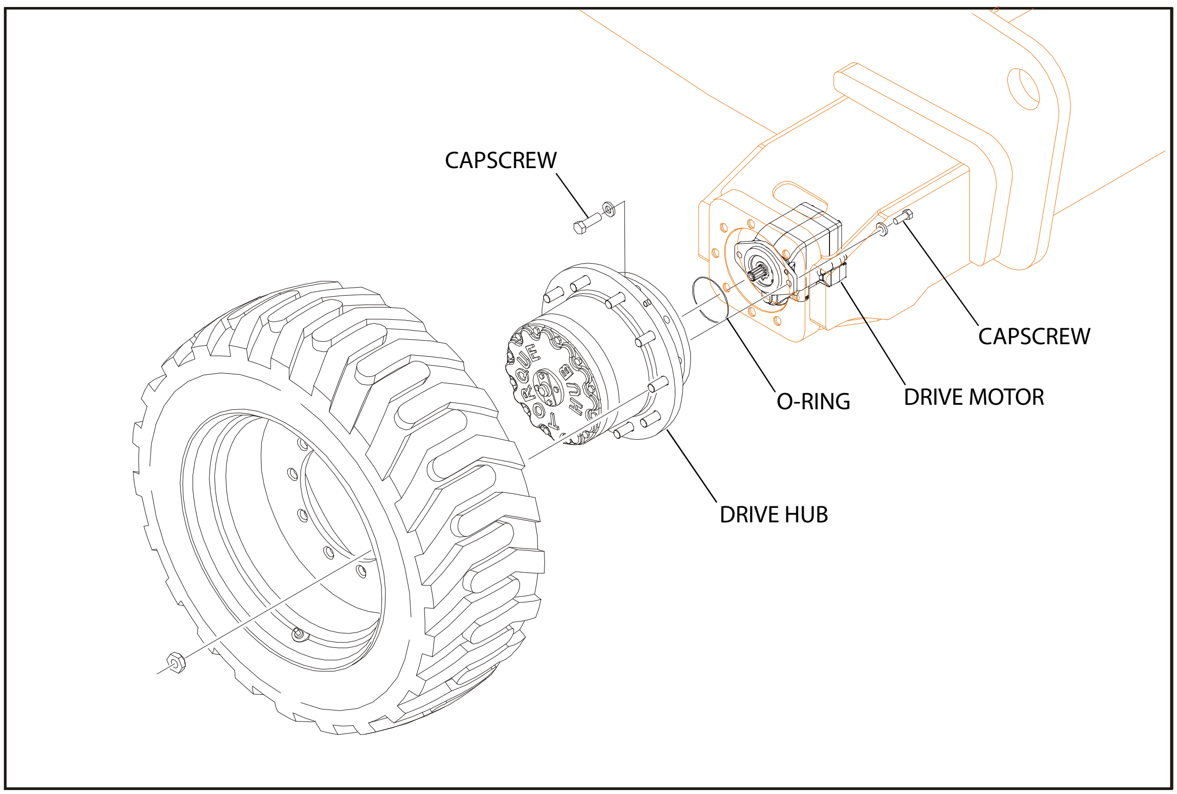


Figure 3-35. Drive Hub Installation

3.9 DRIVE HUB

Disassembly

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

CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL.

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

NOTICE

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

Cleaning and Inspection

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

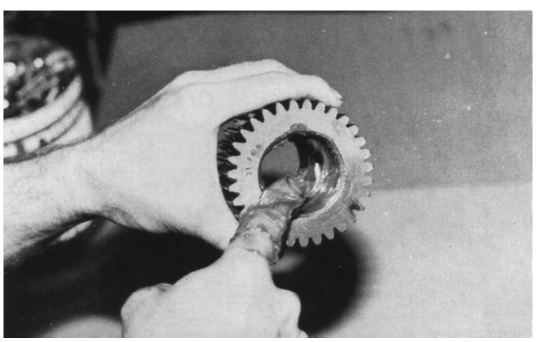
Repair

1. Cover Assembly:
   a. Remove two bolts (25) securing disconnect cap (26) to cover (23) and remove cap.
   b. Remove two bolts (25) securing cover cap (24) to cover and remove cap.
   c. Remove disconnect rod (27) from cap and remove o-rings (28, 29) from cover cap. Discard o-rings.
   d. If necessary, remove pipe plug (30) from cover.
   e. Clean and inspect parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
   f. If removed, screw pipe plug into cover.
   g. Slip o-ring (29) over cover cap and against face.
   h. Place o-ring (28) into cover cap internal groove. Disconnect rod may be used to push o-ring into groove.
   i. Place cover cap into cover with large hole located over pipe plug. Secure cover cap to cover with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).

- **j.** Place disconnect cap over cover cap with nipple facing out and secure with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9 Nm).
- **k.** Turn cover over and push disconnect rod into cover cap. Rod will be held in place by friction from o-ring.

2. Carrier Assembly:

- **a.** Drive anti-roll pin (19) into planet shaft (17) using a suitable punch.
- **b.** Using a suitable press, press planet shaft from carrier (13). After planet shaft is removed, drive anti-roll pin from shaft.
- **c.** Remove cluster gear (18) and thrust washers (14) from carriers.
- **d.** Remove sixteen needle rollers (15) from cluster gear bore.
- **e.** Remove spacer (16) from cluster gear bore and remove second set of sixteen needle rollers (15).
- **f.** Repeat steps (a) through (e) for remaining two cluster gears.
- **g.** Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
- **h.** Apply a coat of grease or petroleum jelly to cluster gear bore.

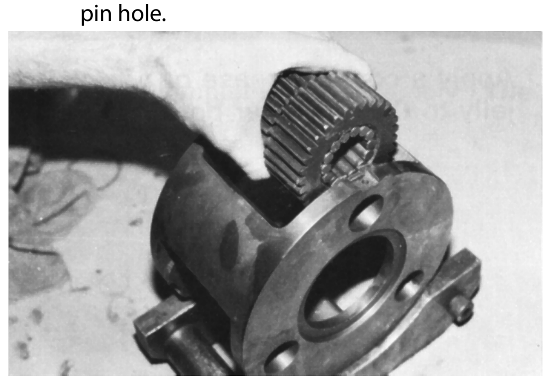


- **i.** Place sixteen needle rollers into cluster gear bore.

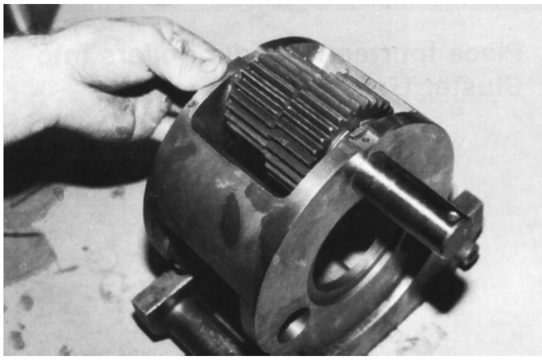
- **j.** Place spacer into opposite side of cluster gear and against needle rollers.

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

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



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



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

3. Input Shaft Assembly:

⚠ CAUTION

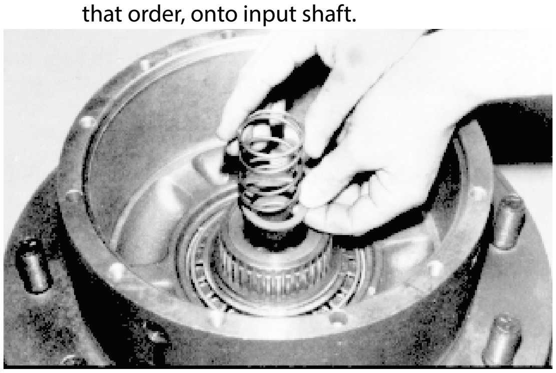
EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL AND INSTALLATION.

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

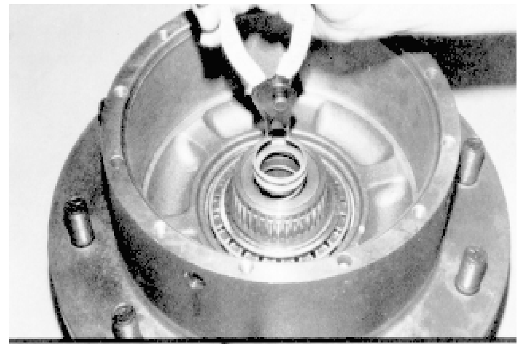
b. Remove two spacers (31) and spring (32) from input shaft.

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

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

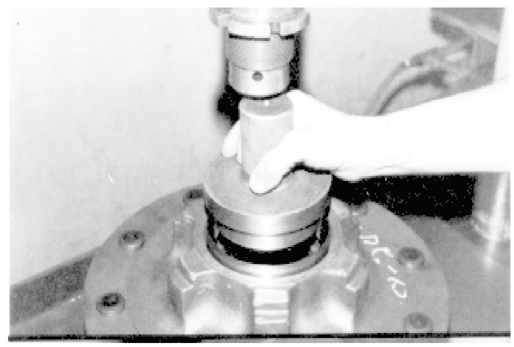


e. Install retaining ring into input shaft groove to secure spacers and spring to shaft.

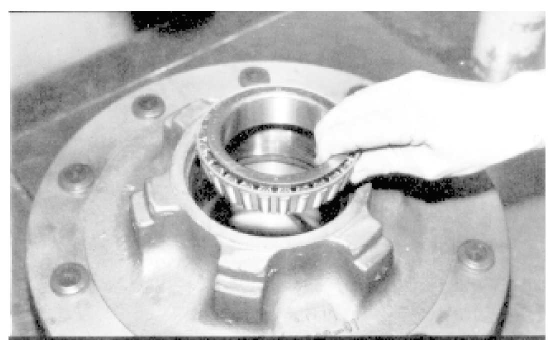


Assembly

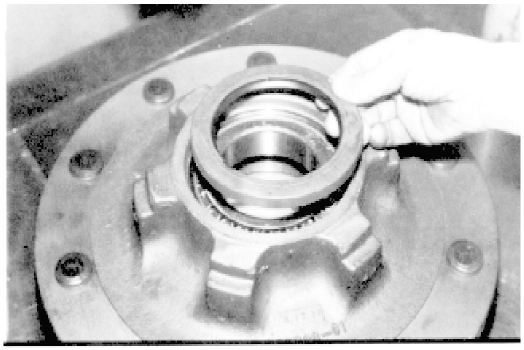
1. Using a suitable press, press new bearing cups (3, 5), with large inside diameters facing out, into hub (7) counterbore.



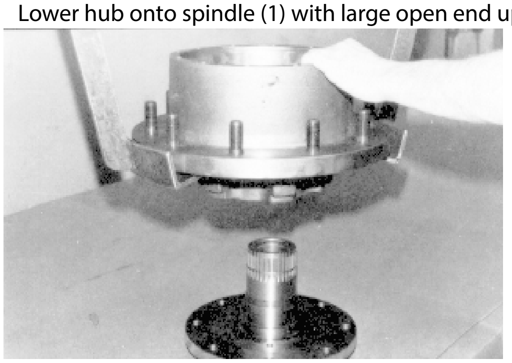
2. Place bearing cone (4) into bearing cup (3) in small end of hub.



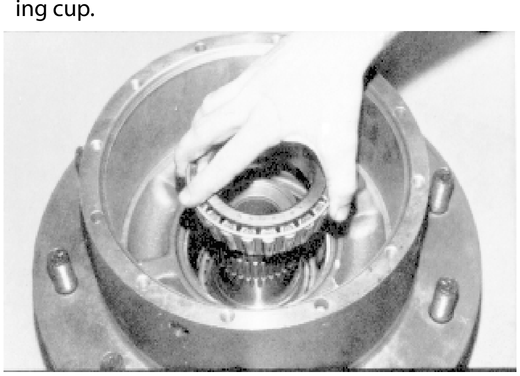
3. Press new seal (2) into hub counterbore with flat metal side facing in. Use a flat object to ensure that seal is pressed evenly and is flush with hub face.



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



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



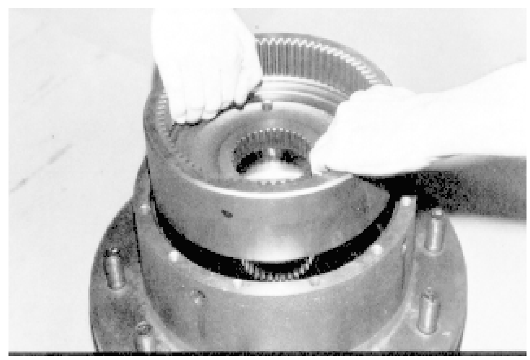
6. Place bearing shim (8) over end of spindle and against bearing cone.

CAUTION

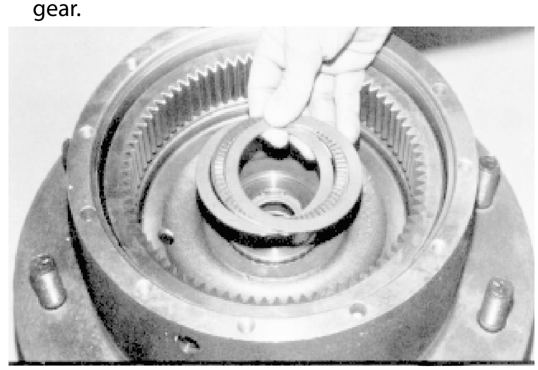
EYE PROTECTION SHOULD BE WORN DURING RETAINING RING INSTALLATION.

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

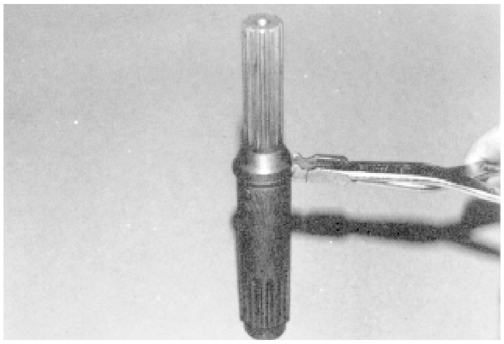
8. Place internal gear (12) onto end of spindle.



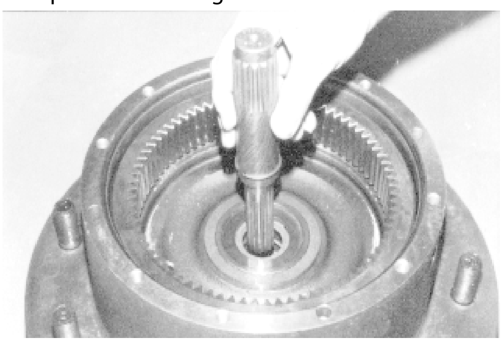
9. Install thrust washers and thrust bearing (39, 40) on the portion of the spindle which extends into the internal gear.



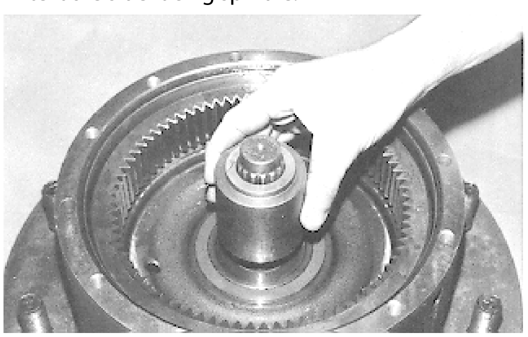
10. Install retaining ring (34) into input shaft retaining ring groove.



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

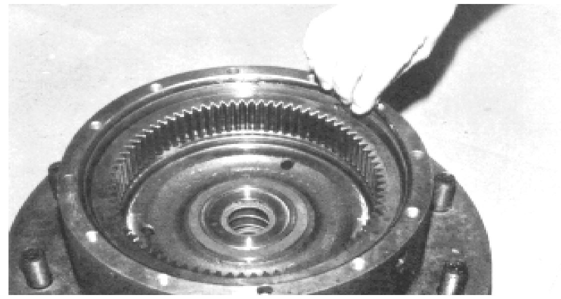


12. Place thrust spacer (36) over input shaft (35) with counterbore side facing spindle.

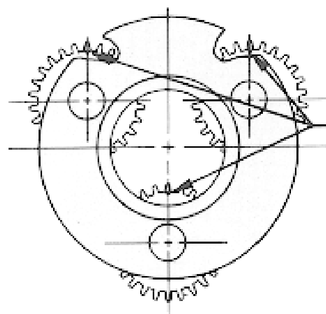


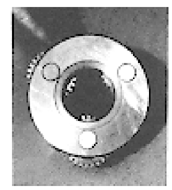
13. Locate the four counter reamed holes in the face of the hub, mark them for later identification.

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

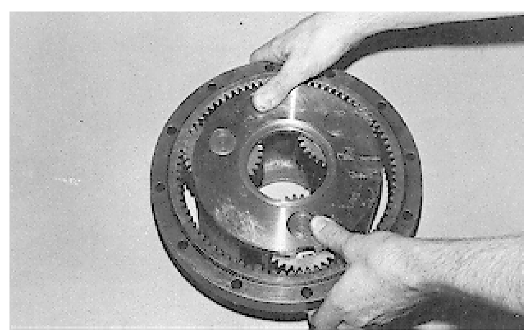


15. Place carrier assembly on a flat surface with large gears up and positioned as shown. Find punch marked tooth on each large gear and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under carrier on upper two gears.

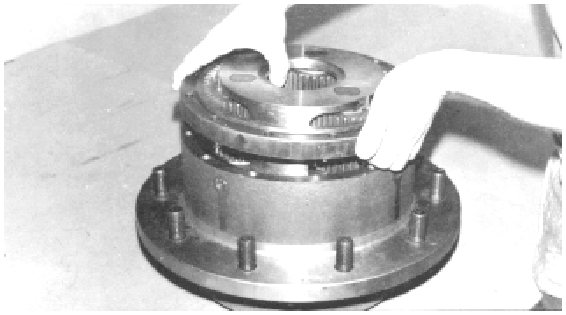




16. With shoulder side of ring gear (21) facing down, place ring gear over (into mesh with) large gears. Ensure punch marks remain in correct location during ring gear installation.

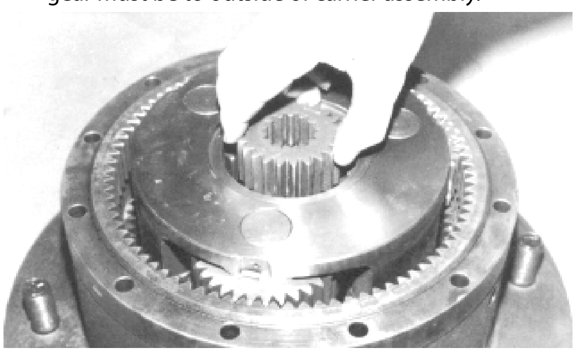


17. While holding ring gear, input gear, and cluster gears in mesh, place small side of cluster gears into mesh with internal gear. On ring gear, locate hole marked ‘X’ over one of counterbore holes in hub.

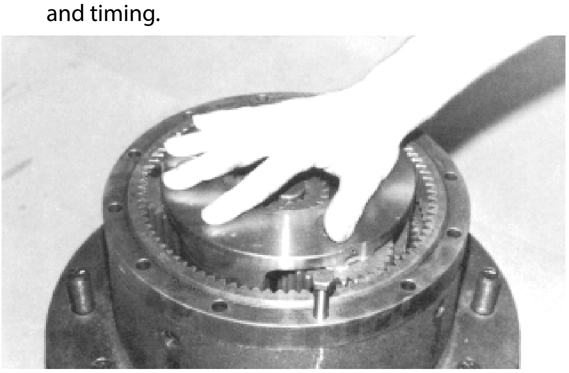


NOTE: *If gears do not mesh easily or carrier assembly does not rotate freely, then remove carrier and ring gear and check cluster gear timing.*

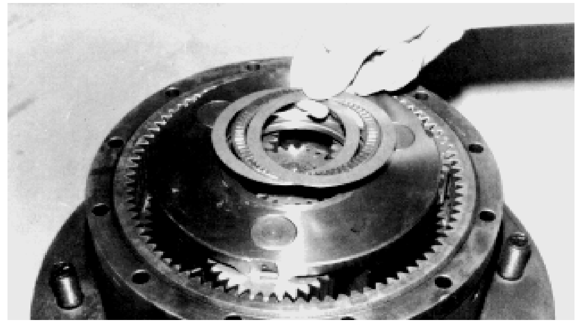
18. Install input gear (37) into carrier, meshing with large diameter cluster gears (18). Counterbore in bore of input gear must be to outside of carrier assembly.



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



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

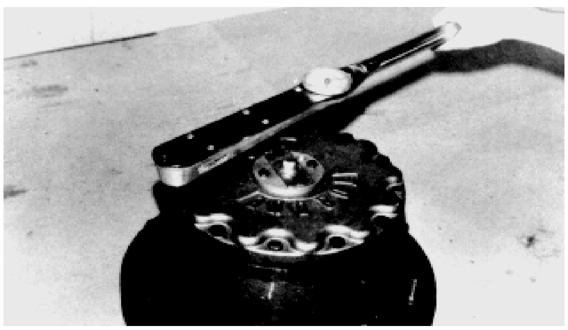


21. Place o-ring (22) into cover assembly counterbore. Use petroleum jelly or grease to hold o-ring in place.

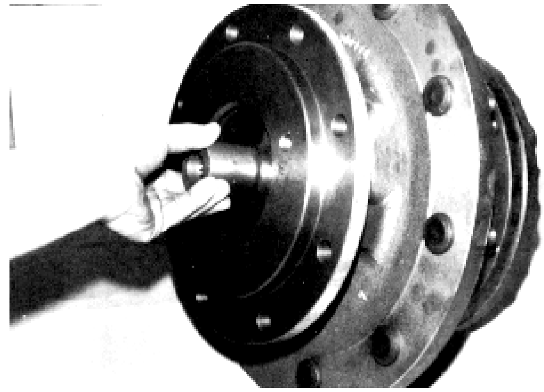
22. Place cover assembly over ring gear with oil level check plug in cover located approximately 90 degrees from oil fill plug in hub.

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

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



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



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

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

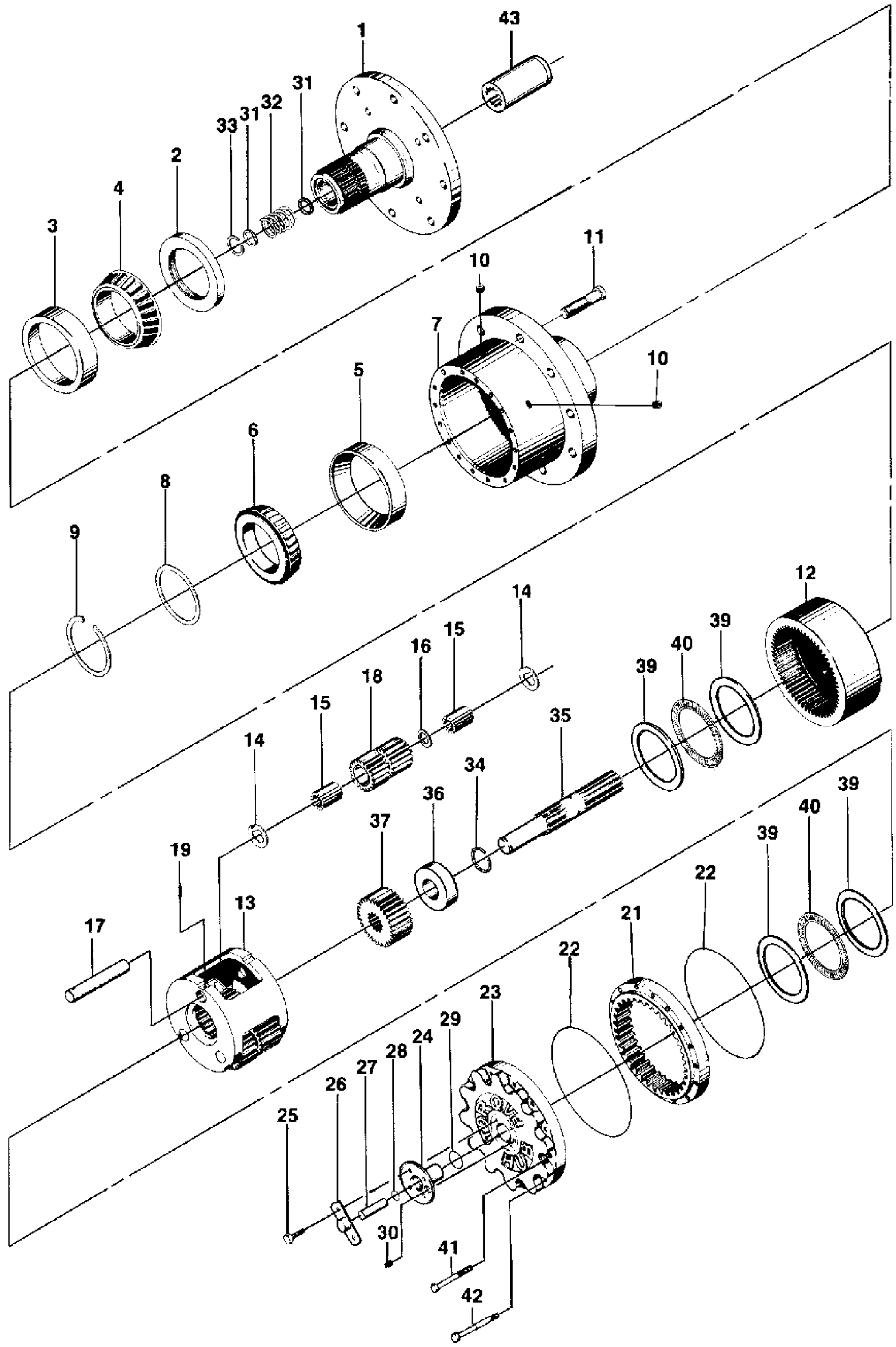


Figure 3-36. Drive Hub

3.10 DRIVE BRAKE

Disassembly

1. Supporting brake: remove the six socket head capscrews and washers (13 & 14) in equal increments to ensure the spring pressure within the brake is reduced gradually and evenly.

   If a press is available, the cylinder housing (8) can be restrained while removing the six capscrews and washers (13 & 14).

   The brake assembly can now be fully dismantled and the parts examined.

2. Remove cylinder housing (8) and piston (9) subassembly and dismantle if required, removing o-ring seals (15 & 17) and backing rings (16 & 18) as necessary.
3. Remove gasket (7) from housing (2).
4. Remove friction plates (3 & 6) and pressure plate (4).
5. Remove two dowel pins (19).
6. Remove springs (22 & 23).
7. Should it be necessary to replace ball bearing (10) or shaft seal (12), reverse remainder of brake subassembly, supporting on face C of housing (2).
8. Remove internal retaining ring (11).
9. Using arbor press or similar to break Loctite seal, remove brake shaft (1) from housing (2) and lay aside.
10. Reverse housing (2) and press out ball bearing (10). Shaft seal (12) can also be removed if necessary.

Inspection

1. Inspect friction plates (3 & 6) and friction surface on pressure plate (4) for wear or damage.
2. Examine friction plates (3) and brake shaft (1) for wear or damage to the splines.
3. Examine input and output splines of brake shaft (1) for wear or damage.
4. Examine compression springs (22 & 23) for damage or fatigue.
5. Check ball bearing (10) for axial float or wear.
6. Examine o-ring seals (15 & 17) and backing rings (16 & 18) for damage.

Assembly

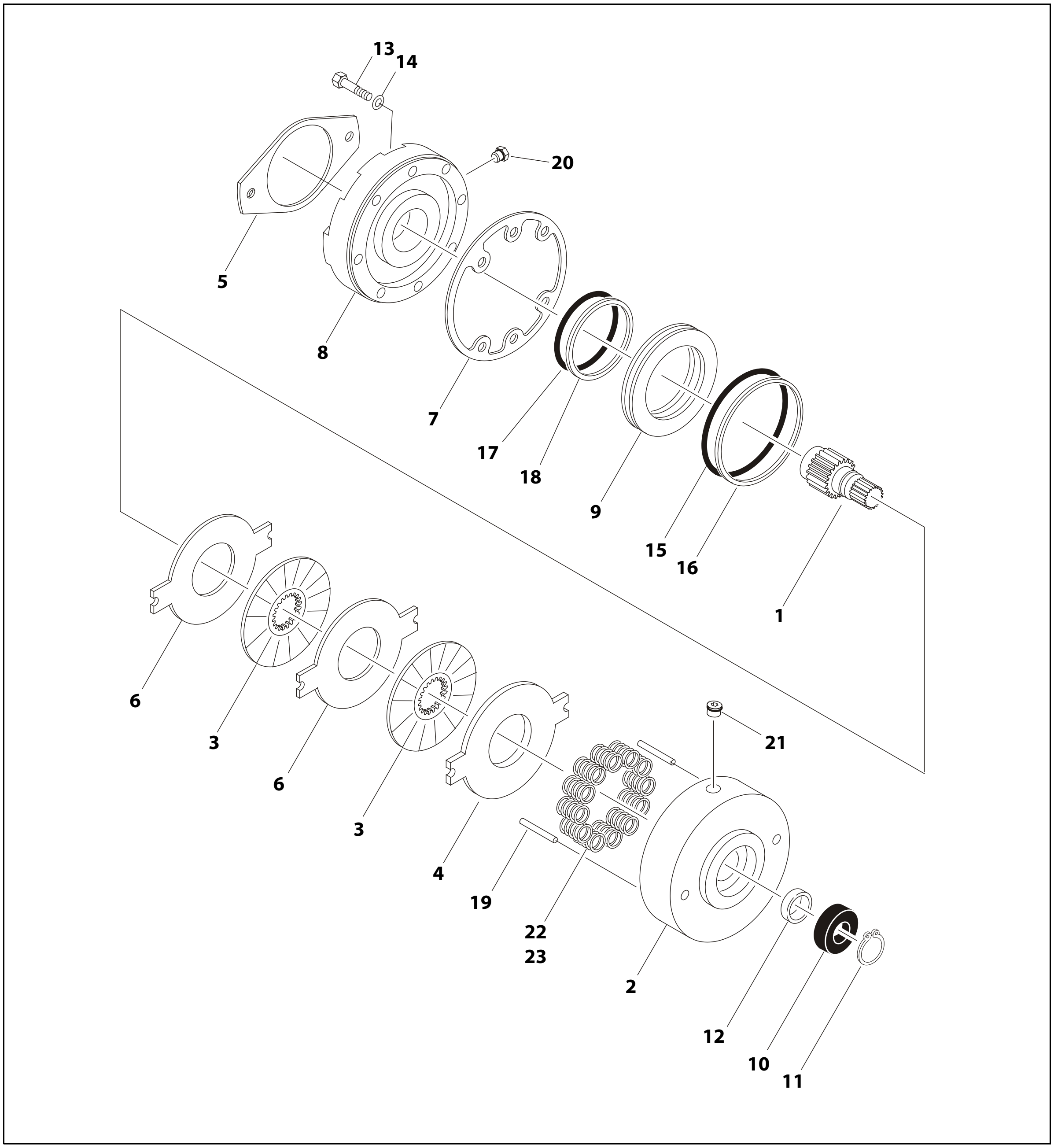
1. Lightly lubricate rotary shaft seal (12) and assemble to housing (2) taking care not to damage seal lip.
2. Apply ring of Loctite 641 or equivalent adhesive to full circumference of housing (2) bearing recess adjacent to shoulder.

   Apply complete coverage of Loctite 641 to outside diameter of bearing (10) and assemble fully In housing (2), retaining with internal retaining ring (11). Remove excess adhesive with a clean cloth.

   Press shaft (1) through bearing (10), ensuring bearing inner ring Is adequately supported.

3. Assemble correct quantity of springs (22 & 23) in orientation required.
4. Lubricate o-ring seals (15 & 17) with Molykote 55M (or equivalent) silicon grease and assemble together with backing rings (16 & 18) to piston (9). To ensure correct brake operation. It is important that the backing rings are assembled opposite to the pressurized side of piston.
5. Correctly orientate piston (9) aligning spaces with the two dowel pin holes and, assemble into cylinder housing (8) taking care not to damage seals and carefully lay aside.
6. Locate 2-off pins (19) in housing (2) followed by pressure plate (4) and friction plates i.e. an inner (3) followed by an outer (6) in correct sequence.
7. Position gasket (7) in correct orientation.
8. Align two holes in cylinder with dowel pins (19) and assemble piston & cylinder sub-assembly to remainder of brake securing with 6 capscrews and washers (13 & 14). Torque to 55 ft. lbs. (75 Nm).

NOTE: *The use of a suitable press (hydraulic or arbor) pressing down on cylinder end face B will ease assembly of the capscrews (13).*



1. Shaft	6. Outer Plate	11. Retaining Ring	16. Backup Ring	21. Plug
2. Housing	7. Gasket	12. Shaft Seal	17. O-ring	22. Spring (Natural)
3. Friction Plate	8. Cylinder	13. Capscrew	18. Backup Ring	23. Spring (Blue)
4. Pressure Plate	9. Piston	14. Lockwasher	19. Dowel Pin	
5. Gasket	10. Ball Bearing	15. O-ring	20. Plug	

Figure 3-37. Drive Brake

3.11 DRIVE MOTOR (SN 0300183331 THROUGH 0300189341)

Description

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

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

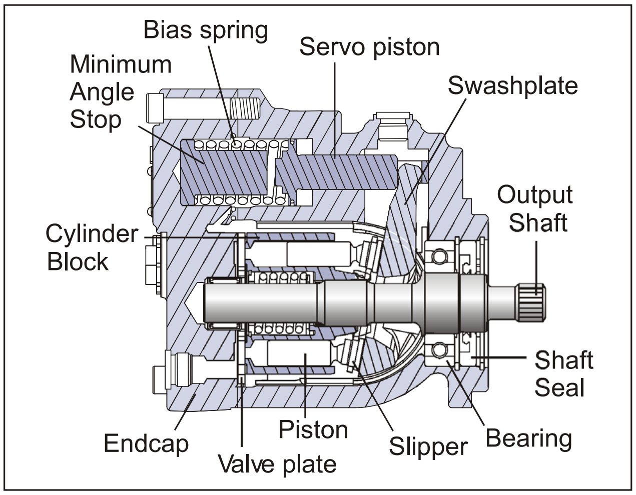


Figure 3-38. Drive Motor Cross Section

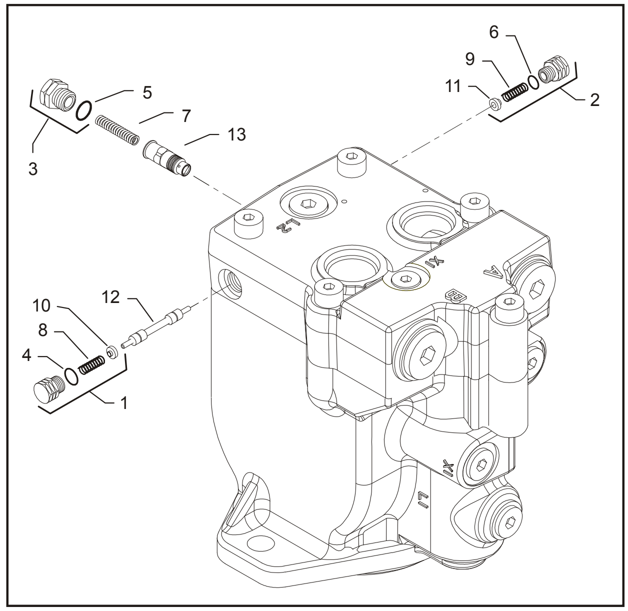
Disassembly

NOTE: *Removal of the end cap voids warranty.*

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

Replace all o-rings and gaskets.

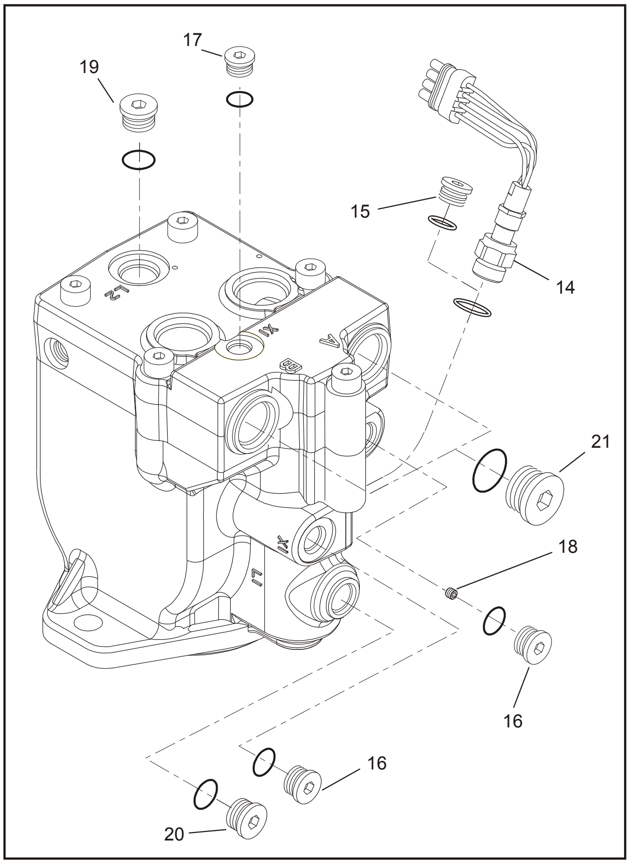
It is recommended that all o-rings be replaced. Lightly lubricate all o-rings with clean petroleum jelly prior to assembly.



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

Figure 3-39. Loop Flushing Spool

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



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

Figure 3-40. Plugs, Fittings and Speed Sensor

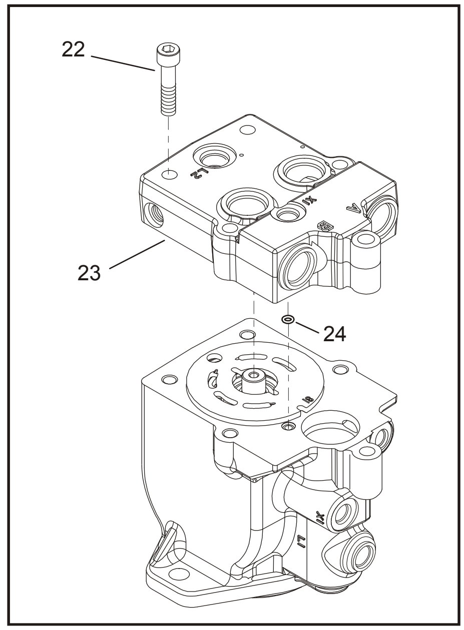
8. Remove all fittings from the unit. Discard any o-rings on the fittings.

9. Using an 11/16 in. 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.

10. Using a 1/4 in. internal hex wrench, remove control line plugs (16, 17). Discard o-rings. Using a 3 mm hex wrench, remove cavity plug (18, if equipped with two-line control) from X2 cavity.

11. Using a 5/16 in. internal hex wrench, remove drain plugs (19, 20). Discard o-rings.

12. Using a 9/16 in. internal hex wrench, remove work port plugs (21, if equipped with axial ports). Discard o-rings.



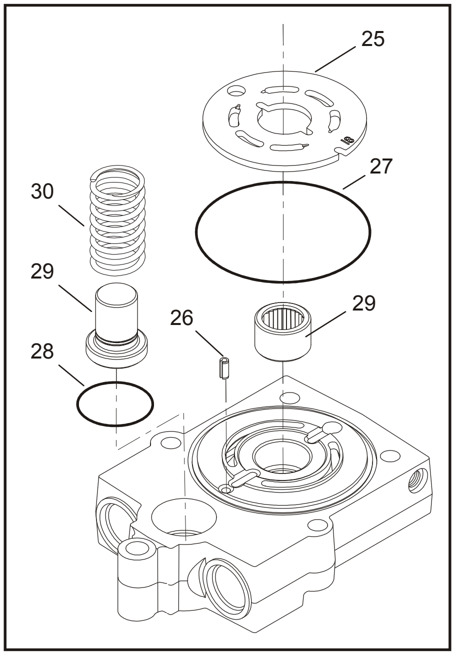
22. Screw
23. End Cap
24. O-ring

Figure 3-41. End Cap

13. Using an 8 mm internal hex wrench, remove the end capscrews (22).

14. Remove the end cap (23). Remove o-ring (24) from the housing or end cap.

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



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

Figure 3-42. Valve Plate & Rear Shaft Bearing

⚠ CAUTION

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

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

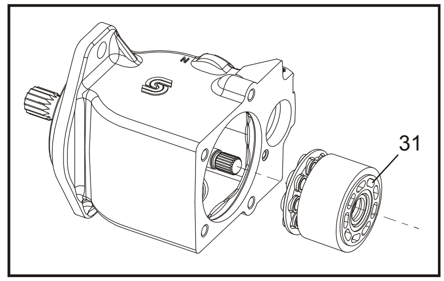
NOTE: *Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.*

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

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

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

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



31. Cylinder Kit Assembly

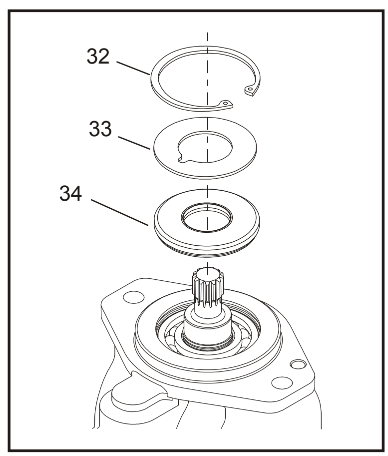
Figure 3-43. Cylinder Kit

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

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

Table 3-2. Displacement Identifiers

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

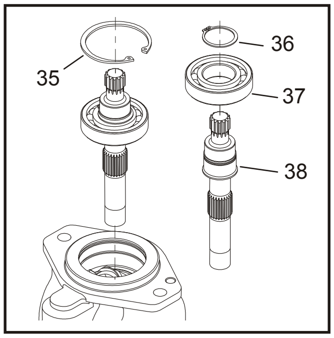


32. Snap Ring
33. Support Washer
34. Shaft Seal

Figure 3-44. Shaft Seal

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

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

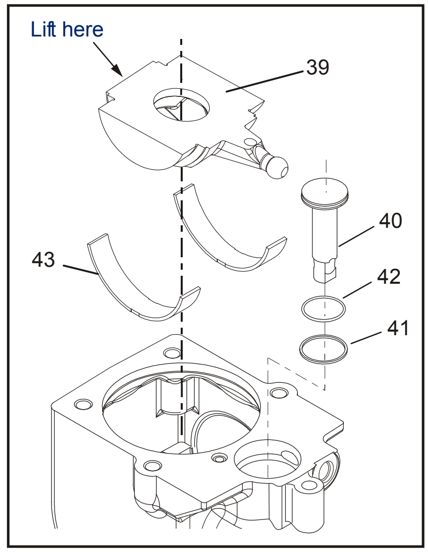


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

Figure 3-45. Shaft & Front Bearing

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

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



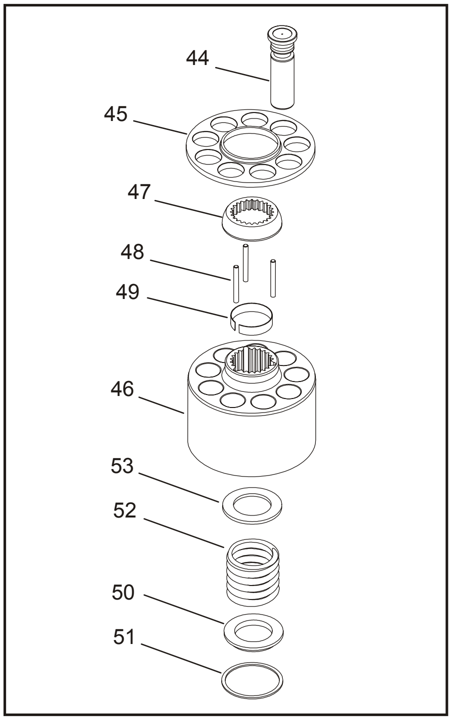
39. Swashplate
40. Servo Piston
41. Piston Seal
42. O-ring
43. Journal Bearings

Figure 3-46. Swashplate & Servo Piston

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

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

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



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

Figure 3-47. Cylinder Kit Disassembly

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.

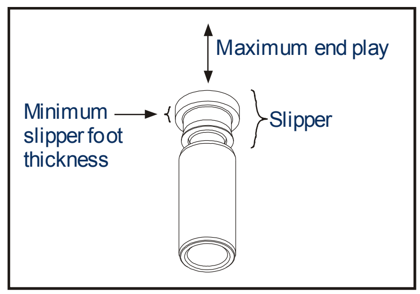
28. Turn the block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress the spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release the pressure and remove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

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 3-3. Slipper Foot Thickness & End Play

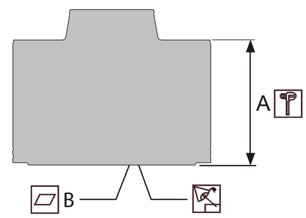
Measurement	L Frame mm (in.)	K Frame mm (in.)
Slipper Foot Thickness	2.71 (0.11)	4.07 (0.16)
Piston/Slipper End Play	0.15 (0.006)	

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 specifications shown in the drawing, provided resurfacing will not reduce the block height below the minimum specification. Table 3-4, Cylinder Block Measurements.

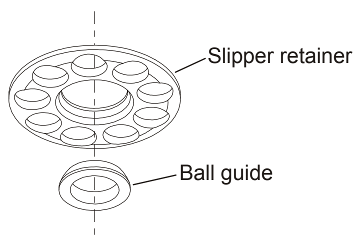
Table 3-4. Cylinder Block Measurements

Measurement	L25 mm (in.)	L30 mm (in.)	L35 mm (in.)	K38 mm (in.)	K45 mm (in.)
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 (7.9)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)



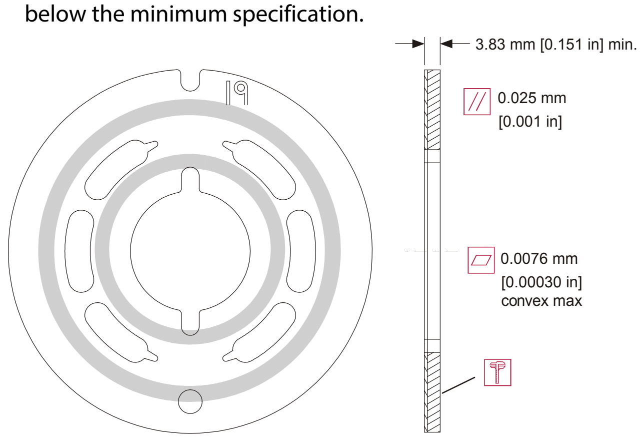
BALL GUIDE AND SLIPPER RETAINER

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



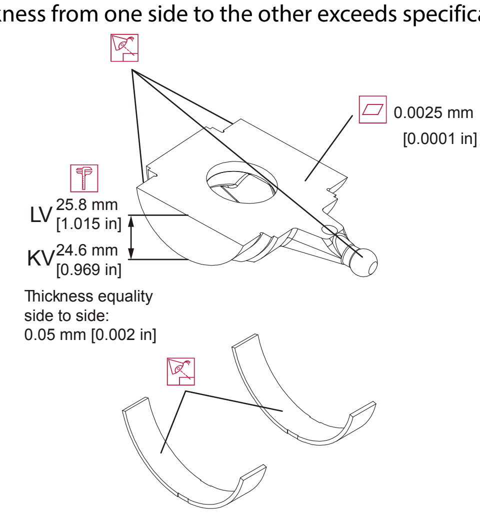
VALVE PLATE

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



SWASHPLATE AND JOURNAL BEARINGS

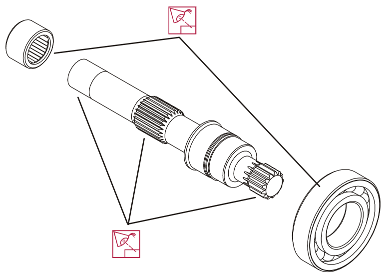
Inspect the running face, servo ball-joint and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable providing the surface condition meets specifications shown. Measure the swashplate thickness from the journals to the running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



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

SHAFT BEARINGS

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

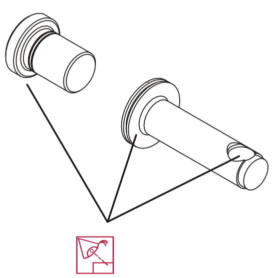


SHAFT

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

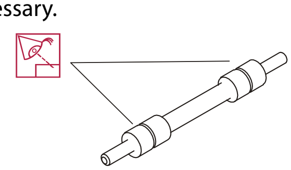
SERVO PISTON AND MINIMUM ANGLE STOP

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



LOOP FLUSHING SPOOL

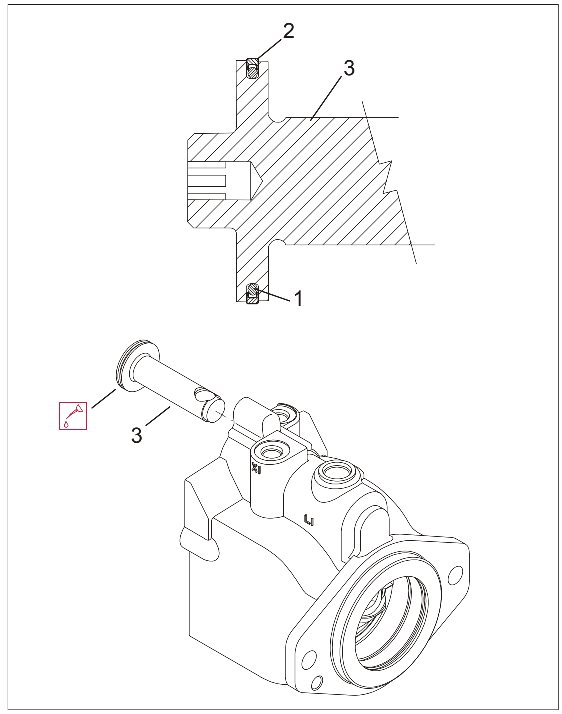
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



Assembly

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

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



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

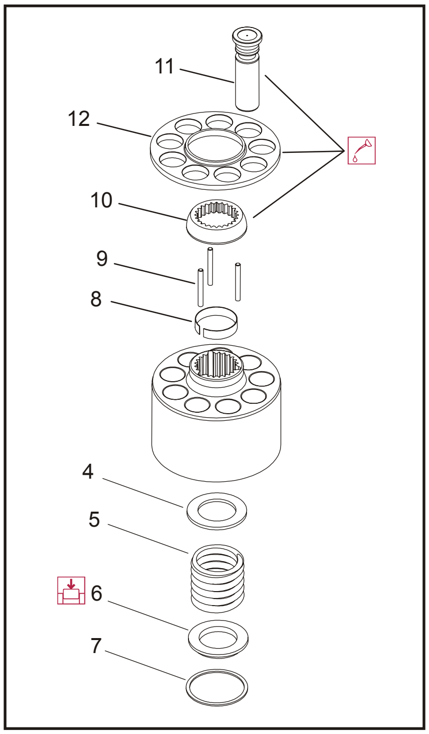
Figure 3-48. Servo Piston

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

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.

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



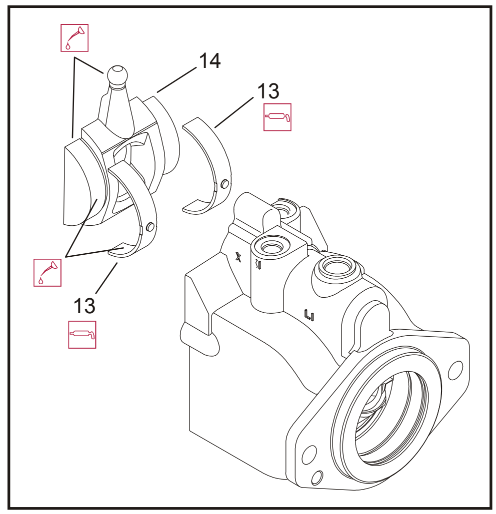
4. Block Spring Washer
5. Block Spring
6. Outer Washer
7. Spiral Retaining Ring
8. Retaining Ring
9. Holddown Pins
10. Ball Guide
11. Piston
12. Slipper Retainer

Figure 3-49. Cylinder Kit Assembly

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

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

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

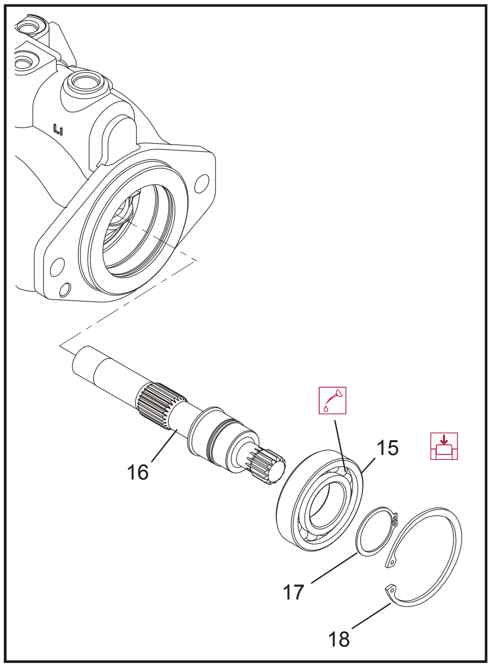


13. Journal Bearings
14. Swashplate

Figure 3-50. Swashplate and Journal Bearing

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

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

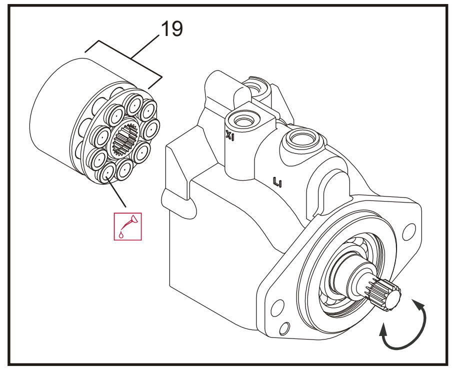


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-51. Shaft and Front Bearing

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

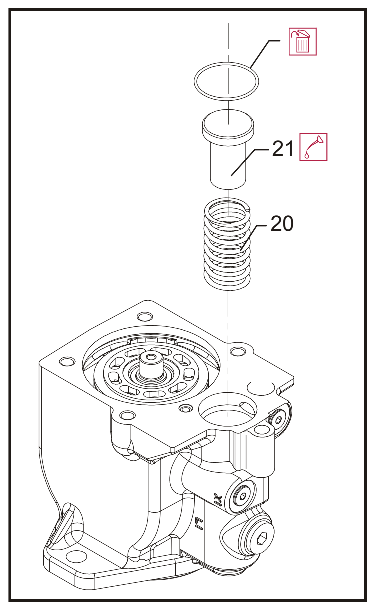
10. Verify swashplate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swashplate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder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



19. Cylinder Kit

Figure 3-52. Cylinder Kit Installation

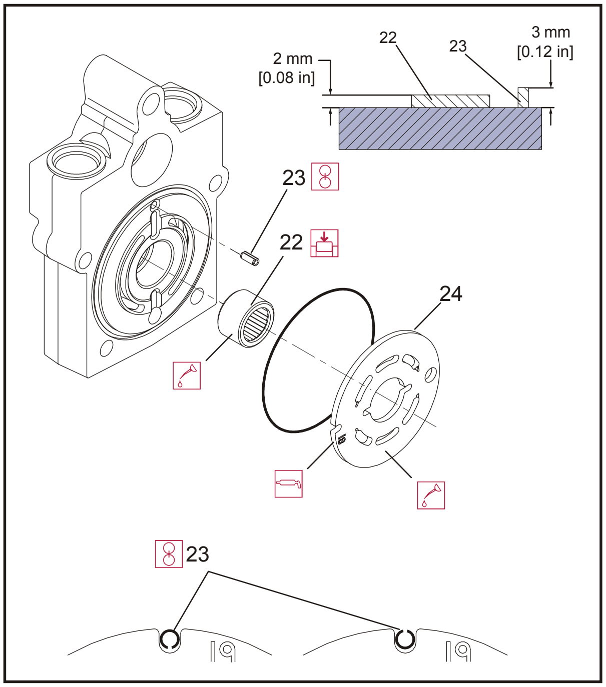
11. Lubricate and install the servo spring (20) and minimum angle stop (21) into the housing bore.



20. Servo Spring
21. Minimum Angle Stop

Figure 3-53. Servo Spring and Minimum Angle Stop

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



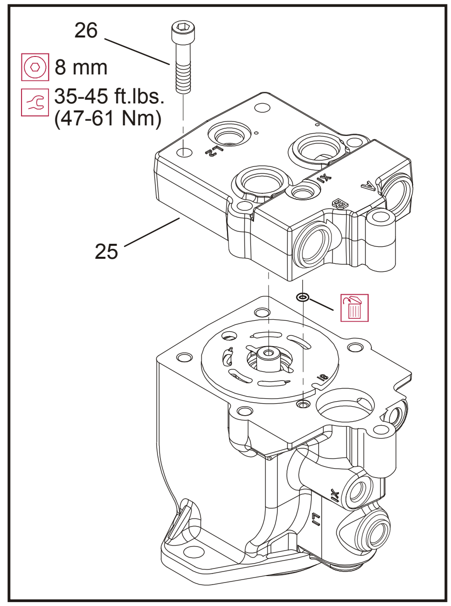
22. Rear Shaft Bearing
23. Timing Pin
24. Valve Plate

Figure 3-54. Valve Plate and Rear Bearing

13. Install timing pin (23) into its bore in the end cap. 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 end cap surface.

14. Install the valve plate (24) onto the end cap. 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 end cap side of the valve plate to keep it in place during installation.

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



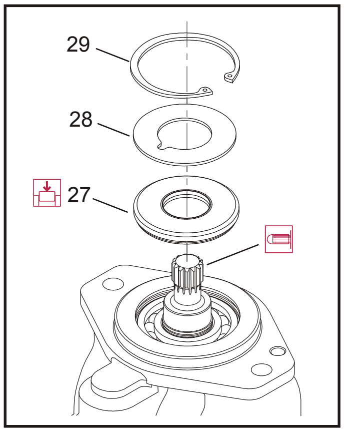
25. End Cap
26. Screw

Figure 3-55. End Cap

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

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

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



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

Figure 3-56. Shaft Seal

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

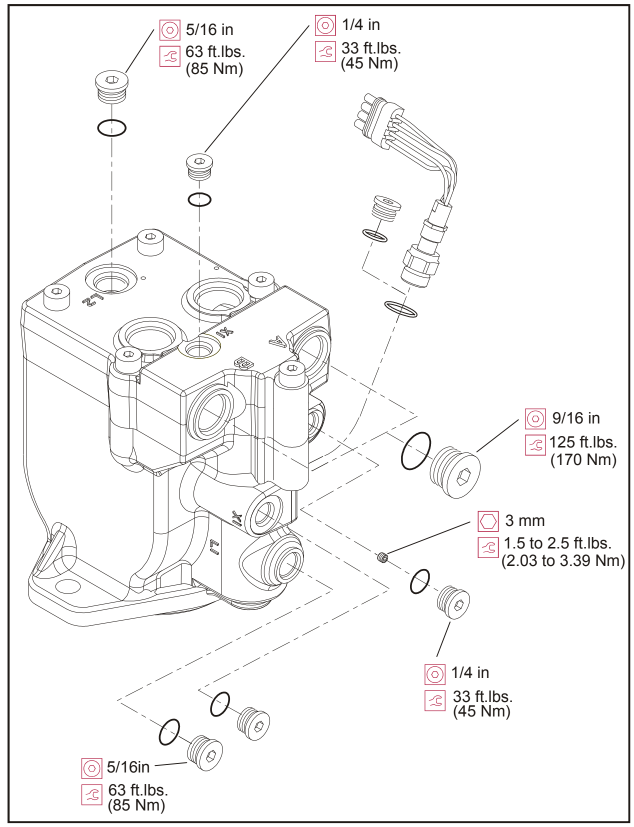
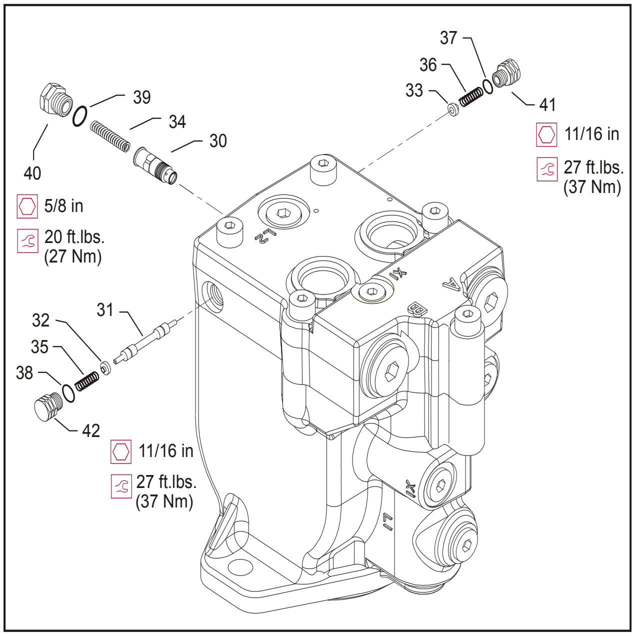


Figure 3-57. Plugs and Fittings Installation

20. Install orifice poppet (30).



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

Figure 3-58. Loop Flushing Spool

21. Install shift spool (31).

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

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

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

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

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

Initial Start-up Procedures

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

⚠ WARNING

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

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

1. Fill the reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.
2. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
3. Fill the pump and motor housing with clean hydraulic fluid. Pour filtered oil directly into the upper most case drain port.
4. To ensure the pump and motor stay filled with oil, install case drain lines into the upper most case drain ports.
5. Install a 0 to 500 psi (0 to 35 bar) gauge in the charge pressure gauge port of the pump to monitor system pressure during start up.

NOTE: *Follow recommendations in the vehicle / machine operator's manual for prime mover start up procedures.*

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 3-5. 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 3-6. 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.

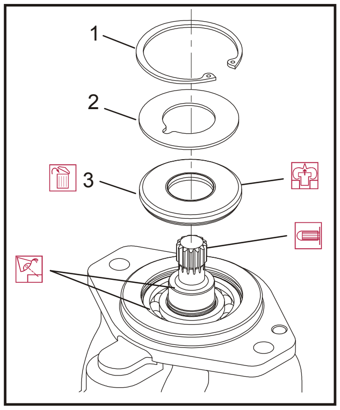
Table 3-7. Won't Shift or Slow to Start

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 3-59. Removing the Shaft Seal

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

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

4. Discard the seal.

INSPECT THE COMPONENTS

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

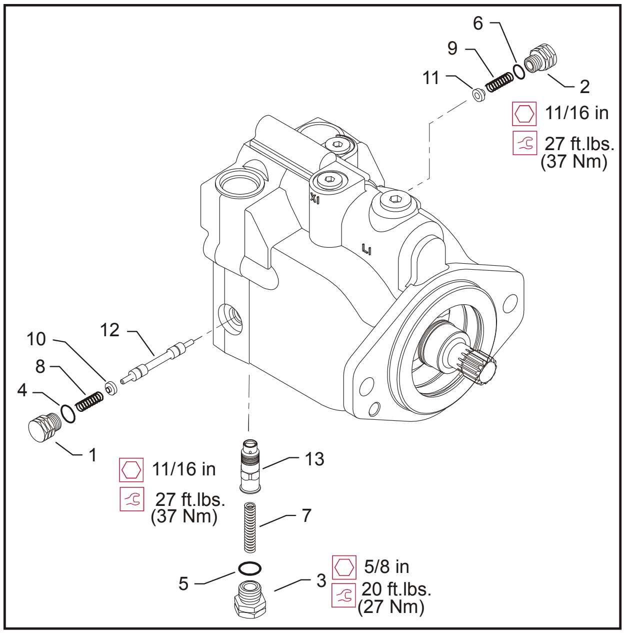
INSTALLATION

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

Loop Flushing Valve

REMOVAL

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



1. Plug	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 3-60. Loop Flushing Spool

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

INSPECT THE COMPONENTS

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

INSTALLATION

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

3.12 RE-ALIGNING DRIVE HUB INPUT COUPLING

The following procedure applies to drive hubs with integral brakes.

Equipment Required

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

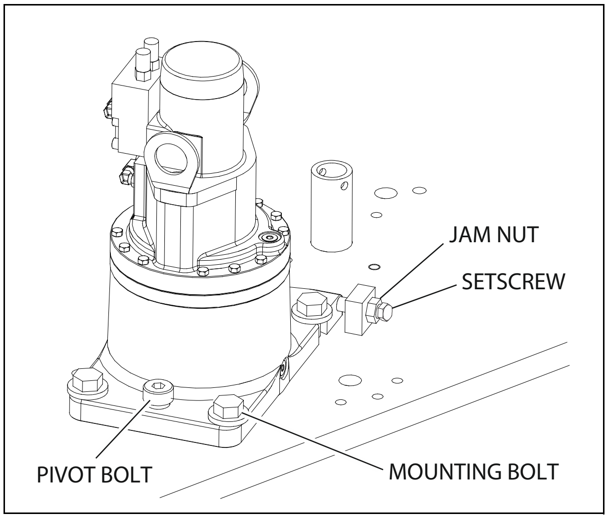
Procedure

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

3.13 SWING DRIVE

Removal

1. Disconnect all wiring harness terminals connected to the swing motor.
2. Gently loosen the setscrew. 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 3.14 and Section 3.18 for swing drive maintenance.

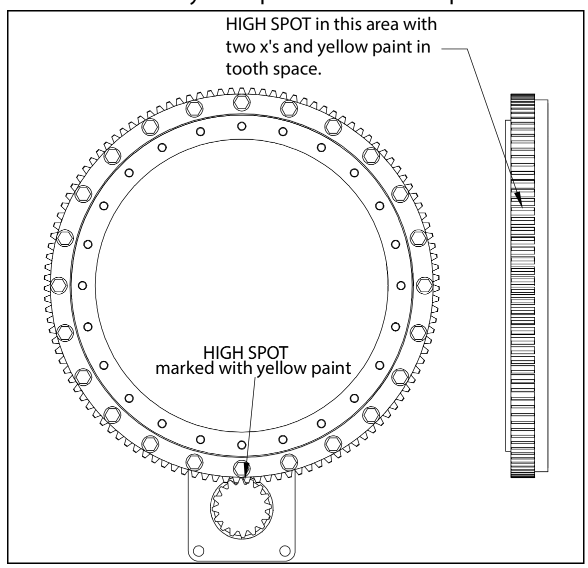
Installation

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

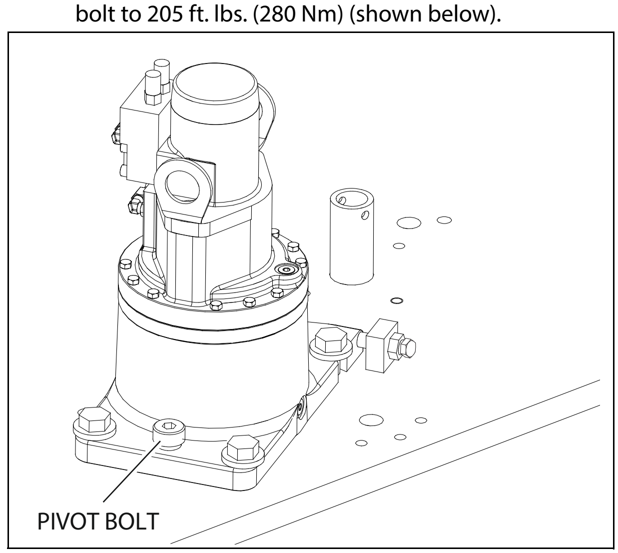
Procedure for Setting Swing Gear Backlash

Set backlash to 0.008 to 0.012 in. (0.203 - 0.304 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). The bearing high spot should be stamped with “X” on the surface below teeth and marked with yellow paint in the tooth space.

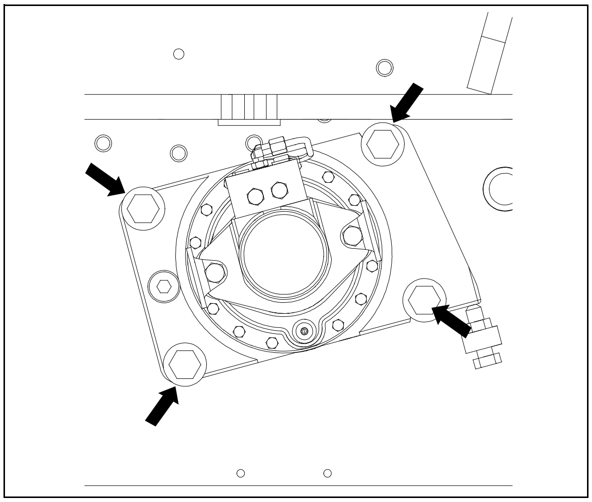


3. Apply JLG Threadlocker P/N 0100019 and torque pivot bolt to 205 ft. lbs. (280 Nm) (shown below).

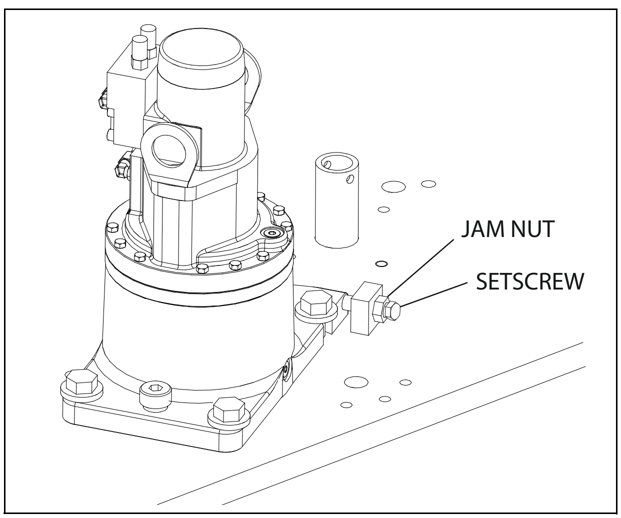


NOTE: *Torque shoulder bolt against turntable baseplate. Shoulder bolt will not tighten against the swing drive mounting plates.*

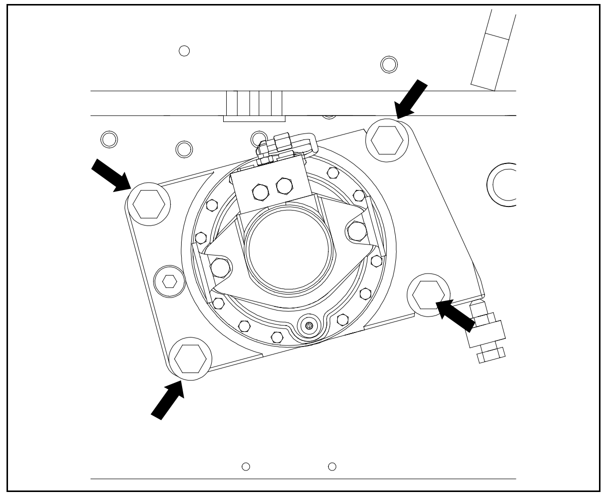
4. Remove turntable lock pin.
5. Apply JLG Threadlocker P/N 0100019 and pre-torque swing drive mounting bolts to 30 ft. lbs. (42 Nm).



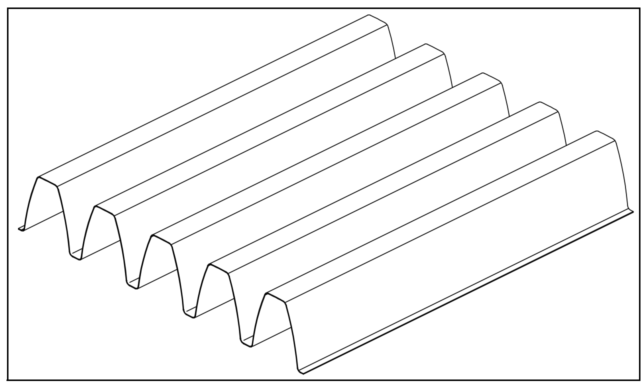
6. Tighten the setscrew until the pinion is completely snug against the shim and bearing and then back off the setscrew.



7. Apply JLG Threadlocker P/N 0100019 and torque setscrew 50 ft. lbs. (68 Nm).
8. Apply JLG Threadlocker P/N 0100019 to the jam nut and tighten.
9. Torque the bolts to 340 ft. lbs. (461 Nm).

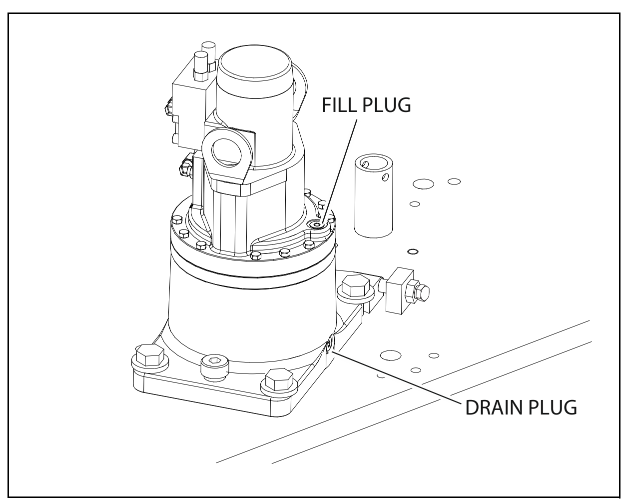


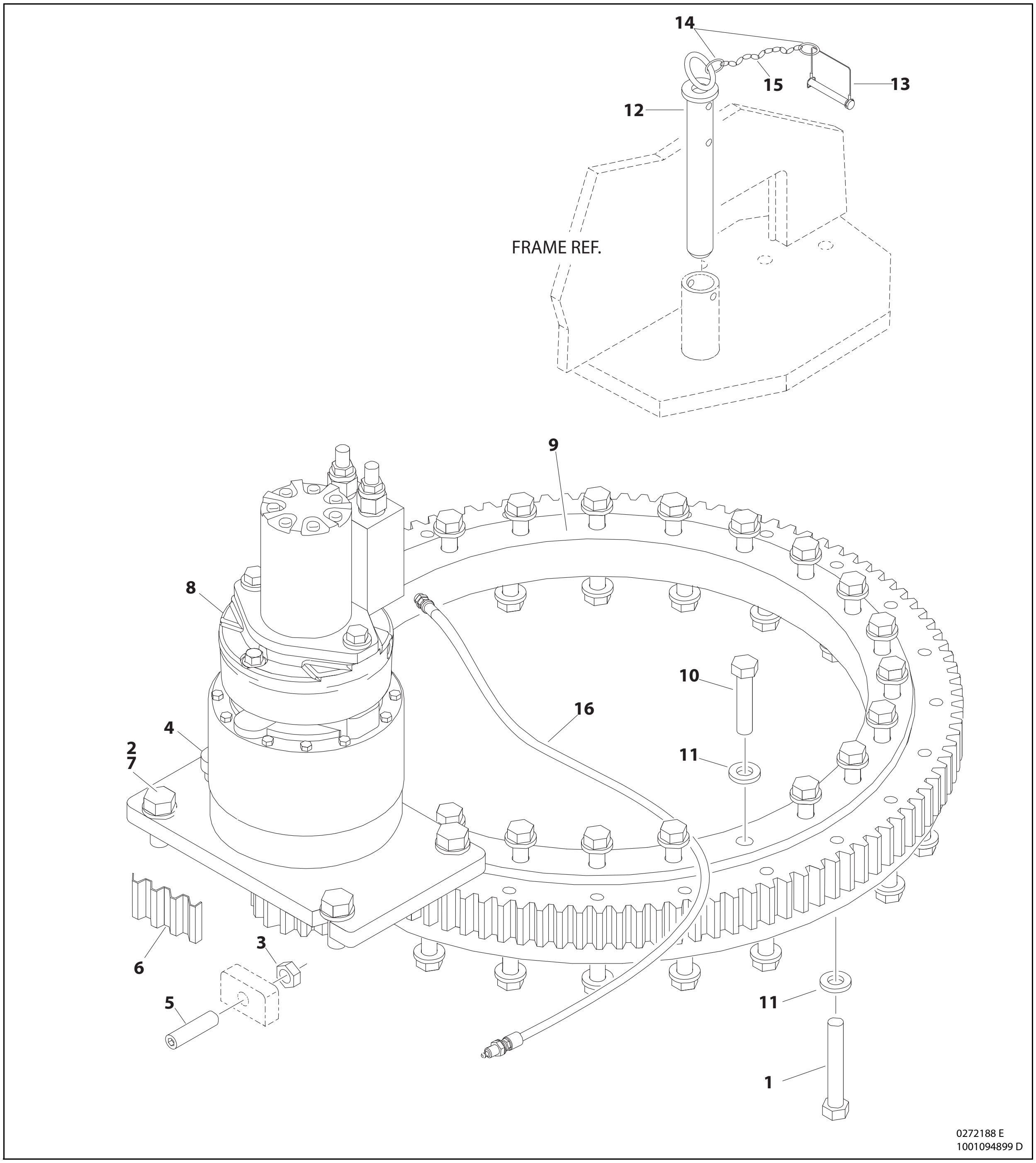
10. Remove shim and discard.



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).





1.	Bolt	5.	Setscrew	9.	Turntable Bearing	13.	Snap Pin
2.	Bolt	6.	Shim	10.	Bolt	14.	Quick Release Ring
3.	Jam Nut	7.	Flatwasher	11.	Flatwasher	15.	Chain
4.	Shoulder Bolt	8.	Swing Motor/Hub	12.	Pin	16.	Hose and Fitting

Figure 3-61. Swing Drive and Turntable Bearing

3.14 SWING HUB (PRIOR TO SN 0300134352)

Disassembly

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

CAUTION

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

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

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

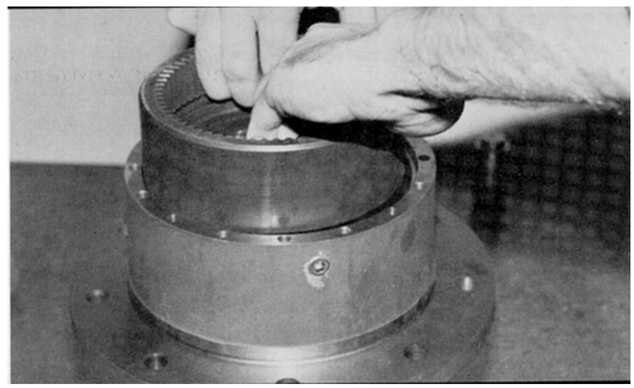
11. To remove the cluster gears (3F) from the carrier (3A), drive the anti-roll pin (3G) into the planet shaft (3E) may now be tapped out of the carrier. After planet shaft (3E) has been removed the roll pin (3G) can be driven out.
12. The cluster gear (3F) can now be removed from the carrier (3A). The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

NOTICE

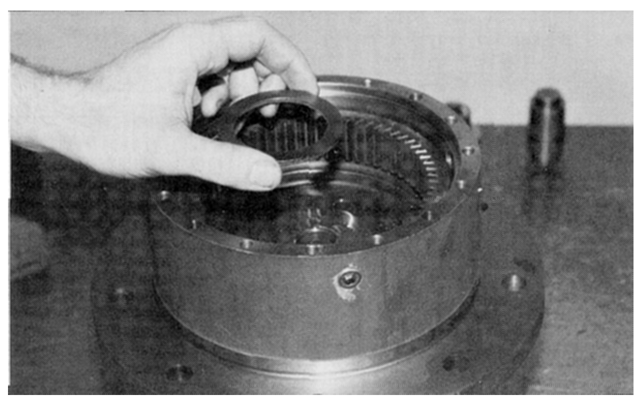
WHEN REBUILDING OR REPAIRING THE UNIT, THE RETAINING RING (1I), O-RINGS (5) AND SEAL (1B) SHOULD ALWAYS BE REPLACED.

Main Assembly Procedure

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



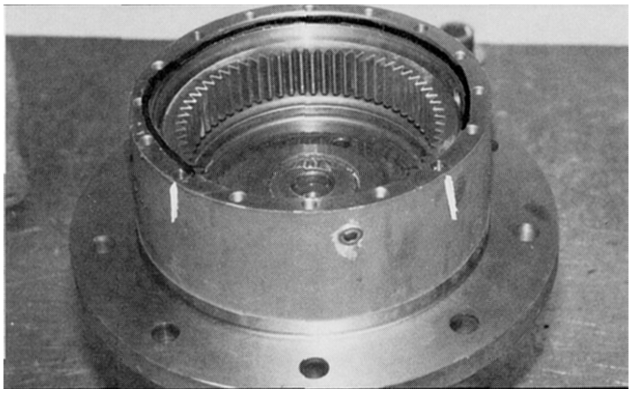
2. Thrust washer (11) is installed on the face of the output shaft (1A). Sufficient grease or petroleum jelly should be used to hold thrust washer in place.



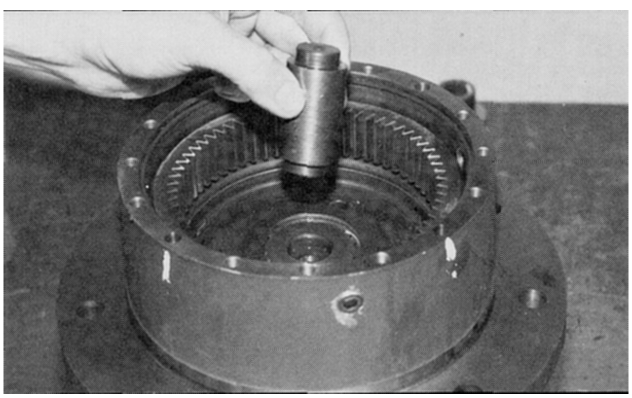
3. Place o-ring (5) into hub counterbore. Use petroleum jelly to hold o-ring in place. Also at this time locate and mark the 4 counter beamed holes in the face of the hub (1G). This is for identification later in the assembly.

CAUTION

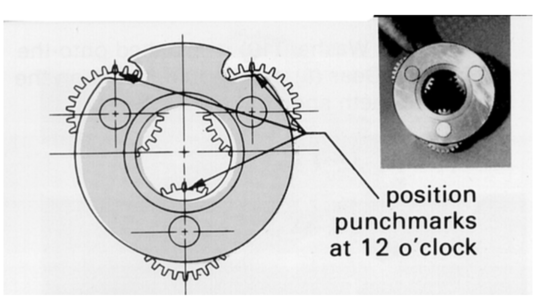
BEWARE OF SHARP EDGES OF THE COUNTERBORE WHILE SEATING THIS O-RING.



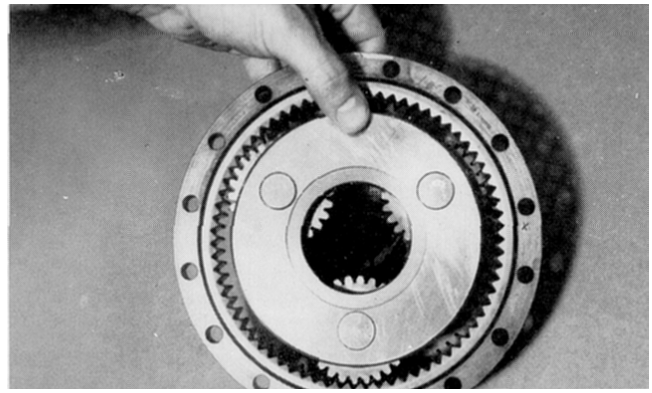
4. Thrust spacer (9) is installed into the bore of the output shaft (1A). This should be a slip fit and thrust spaces should rotate in this location.



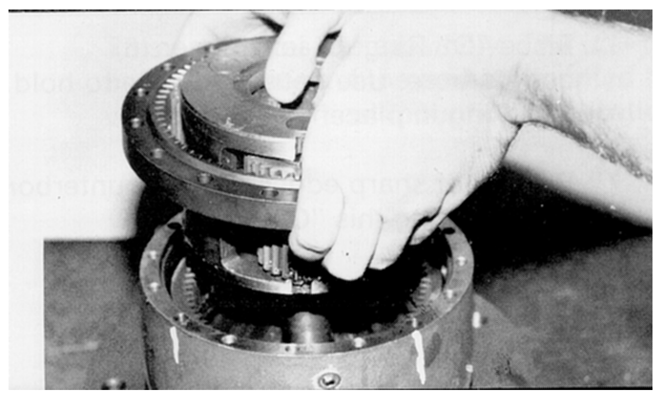
5. Place carrier assembly (3) on a flat surface with the large gears (3F) up and positioned as shown. Find the punch marked tooth on each large gear (3F) and locate at 12 0'clock (straight-up) from each planet pin. Marked tooth will be located just under the carrier (3A) on upper two gears (3F).



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

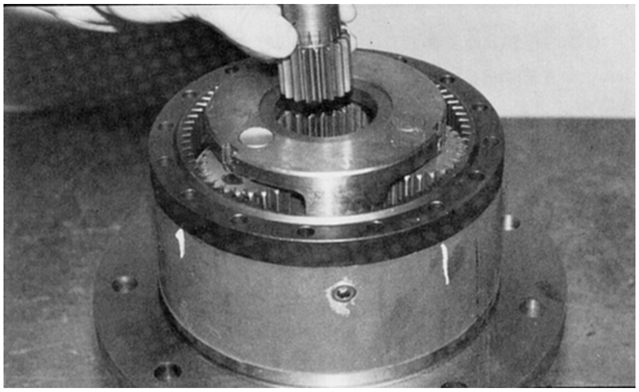


7. While holding ring gear (4) and cluster gears (3F) in mesh, place small side of cluster gears (3F) into mesh with the internal gear (2) and input gear (13). On the ring gear locate the hole marked "x" over one of the marked counterbore holes (step 3) in hub (1G).

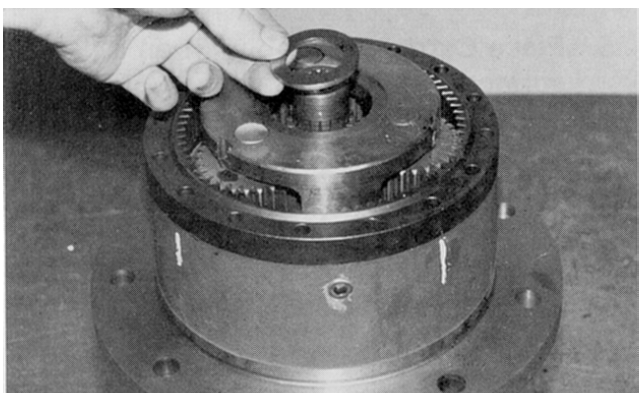


NOTE: *If gears do not mesh easily or carrier assembly does not rotate freely, then remove the carrier and ring gear and check the cluster gear timing.*

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



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

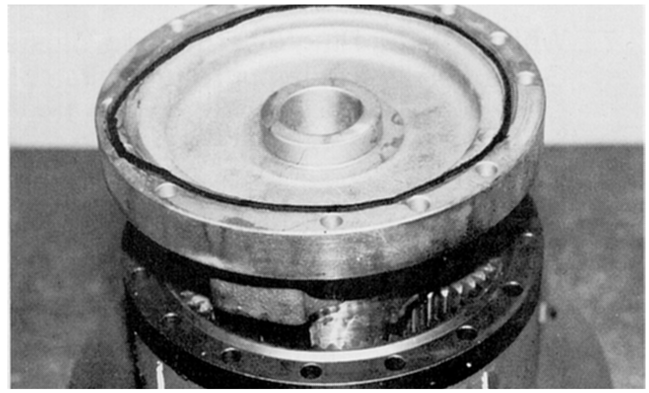


10. Thrust washer (11) is installed into the counterbore of the carrier (3).

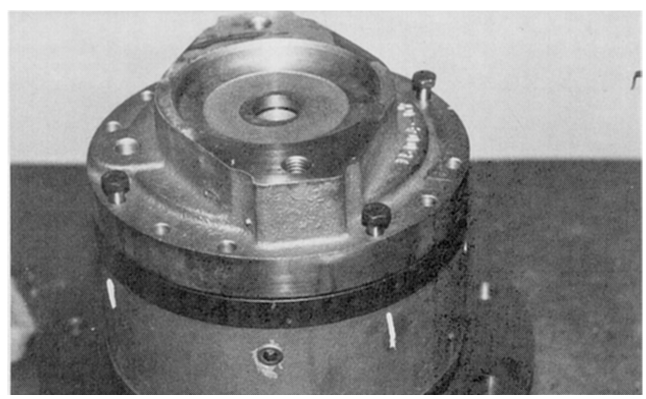
11. Place o-ring (5) into cover (6) counterbore. Use petroleum jelly to hold o-ring in place.

CAUTION

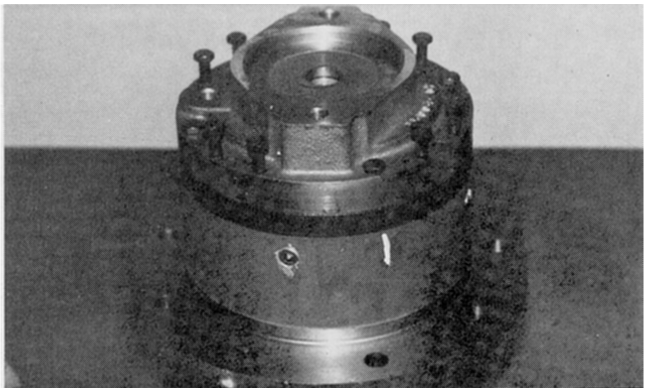
BEWARE OF SHARP EDGES OF THE COUNTERBORE WHILE SEATING THIS O-RING.



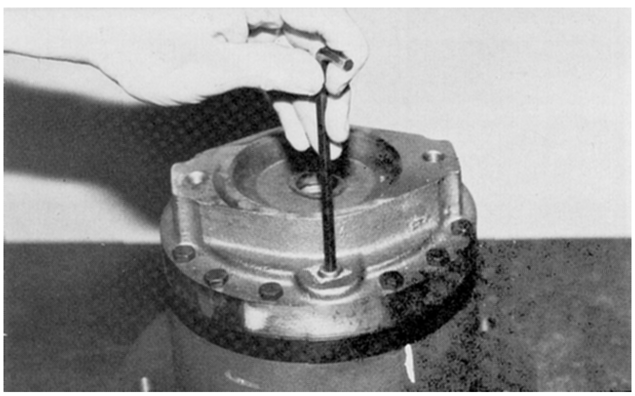
12. The cover (6) is now installed on this assembly. Taking care to correctly align pipe plug hole (20) with those in the hub (1J), usually 90° to one another.
Locate the 4 counterbore holes in hub (1G) (marked in step 3) and install 4 shoulder bolts (13). A slight tap with a hammer may be necessary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



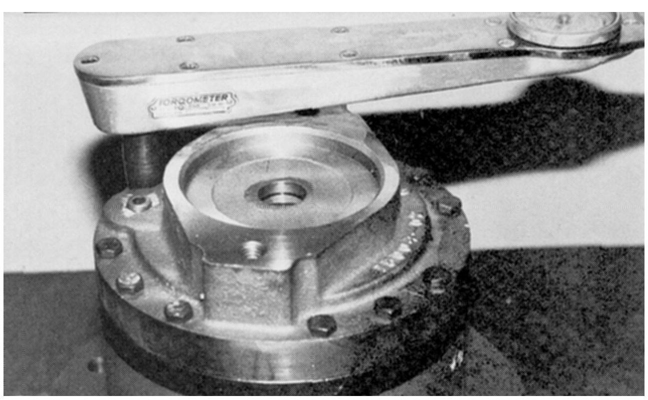
13. Install regular grade 8 bolts (12) into remaining holes.



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



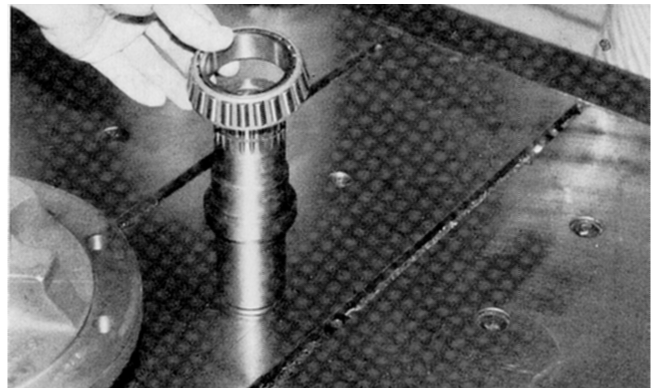
15. Torque shoulder bolts (13) to 23-27 ft. lbs. (31-37 Nm) and regular grade 8 bolts (12) to 23-27 ft. lbs. (31-37 Nm).



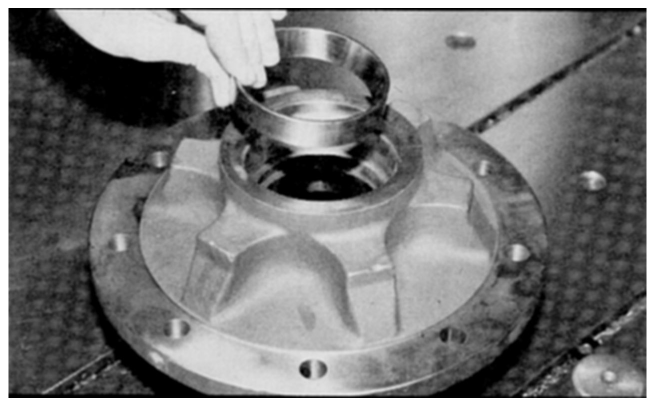
This completes the assembly. The unit must be filled one-half full of EP 90 lubricant before operation if the unit is mounted horizontally, and completely filled if mounted vertically. In vertical mounting application case oil circulation is recommended.

Hub Shaft Sub-Assembly

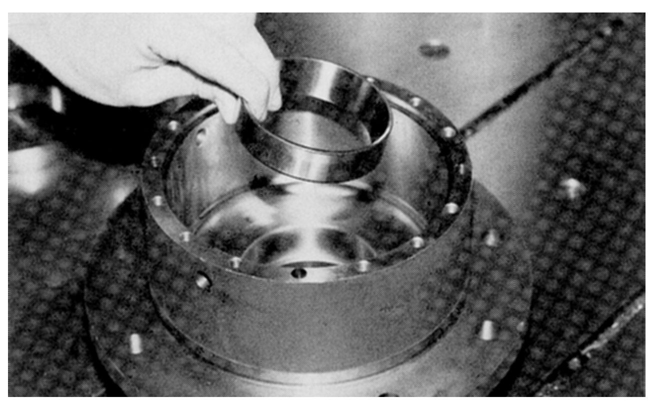
1. Press bearing cone (1D) onto shaft (1A).



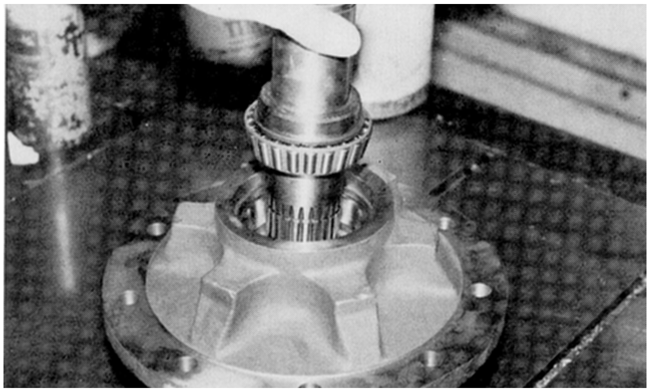
2. Press bearing cup (1C) into hub (1G) taking care to insure cup start square with the bore of the hub.



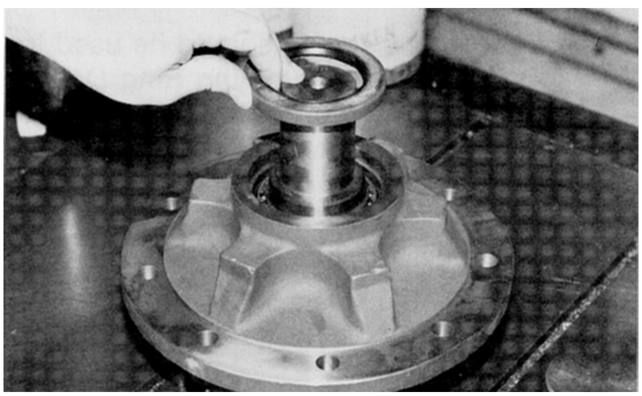
3. Invert hub (1G) and press bearing cup (1E) into inter counterbore of hub (1G).



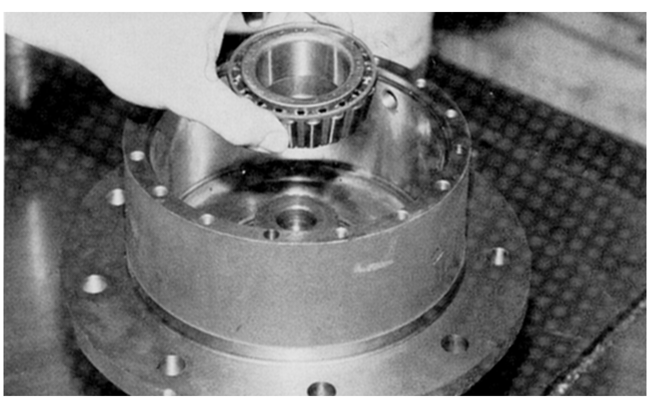
4. Returning the hub (1G) to locate on the large diameter end, the output shaft (1A) is carefully installed into the hub (1G).



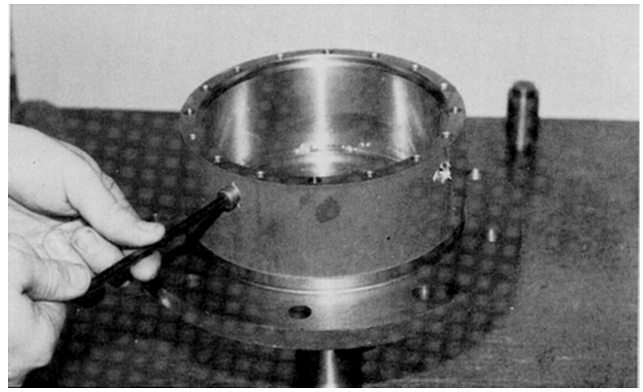
5. The shaft seal (1B) is installed over the output shaft (1A) and into the counterbore of the hub (1G). Care should be taken to insure the seal (1B) is being correctly installed (smooth face up and located just flush with the counterbore face).



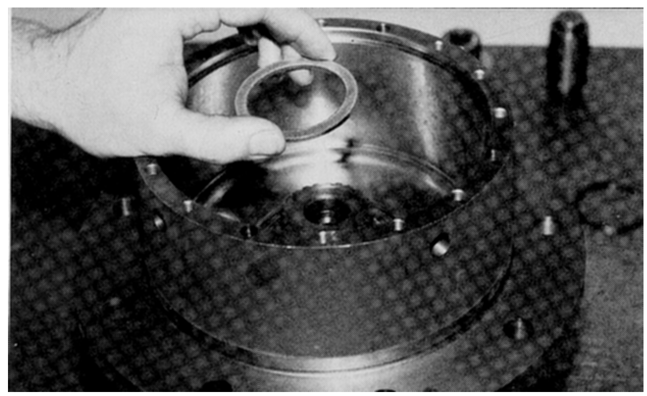
6. The bearing cone (1F) is an interference fit and has to be pressed or tapped on.



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



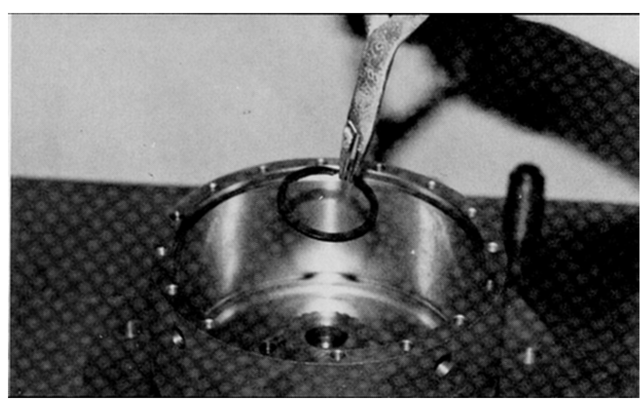
8. Bearing spacer (1H) is installed around the output shaft (1A) and locates on bearing cone (1F).



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

CAUTION

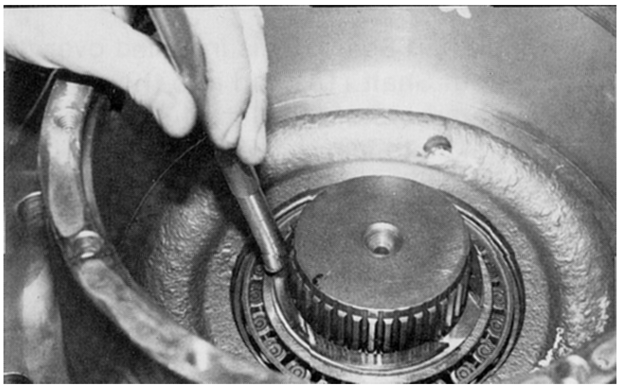
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.



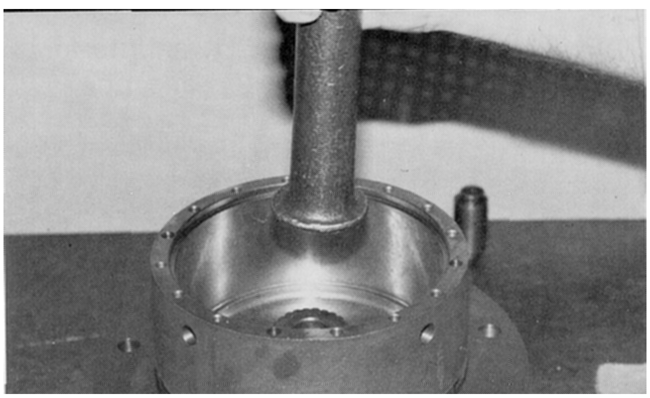
10. A soft metal punch should be used to ensure that this retaining ring (1I) is completely seated in the groove of the output shaft (1A).

⚠ 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.

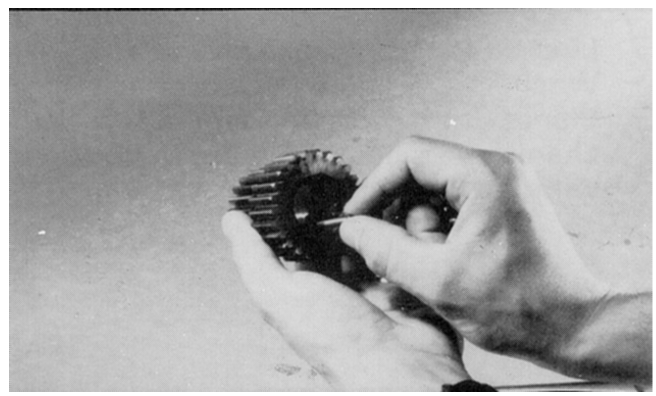


This completes the hub shaft sub-assembly —items (1A) through (1J). If this assembly is not going to be used right away, it should be oiled and covered to help prevent rusting.

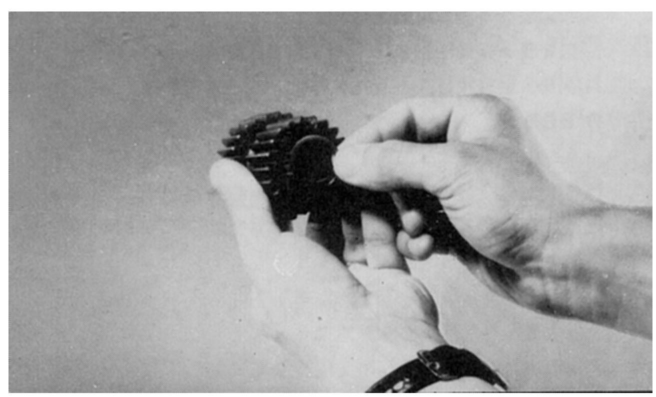
Carrier Sub-Assembly

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

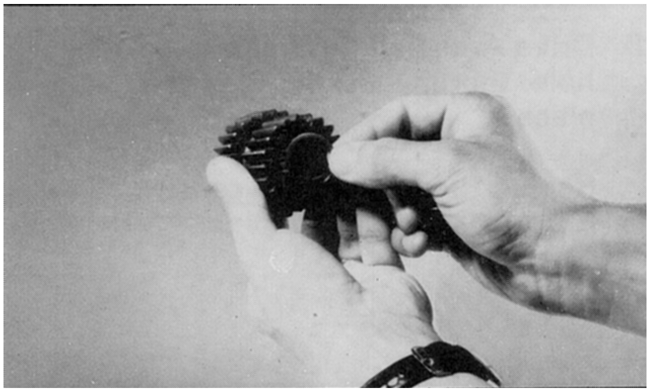
2. Place sixteen needle rollers into cluster gear bore.



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

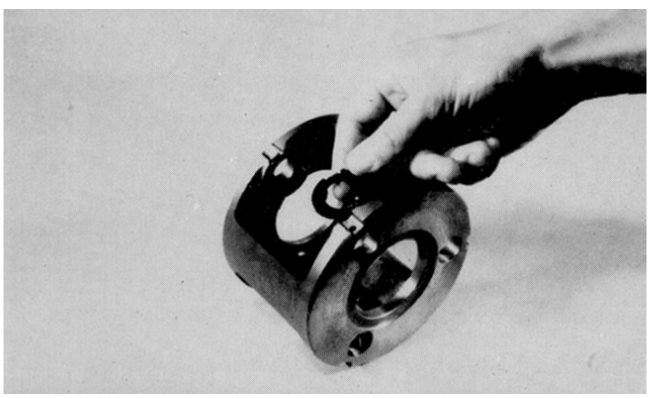


4. Place second set of sixteen needle rollers into cluster gear.

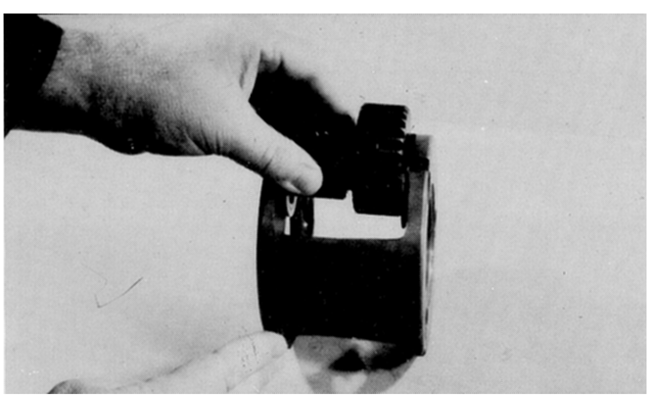


5. Apply grease or petroleum jelly to the tang side of two thrust washers. Place thrust washers against bosses in carrier with washer tang fitting into slot in carrier outside diameter.

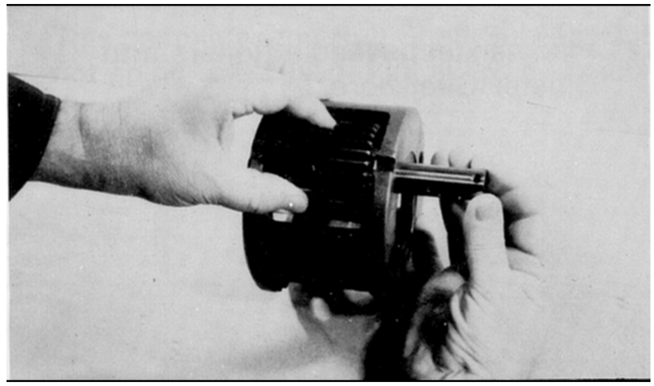
NOTE: *Some old style carriers will not have slots and tangs should be located inside boss relief.*



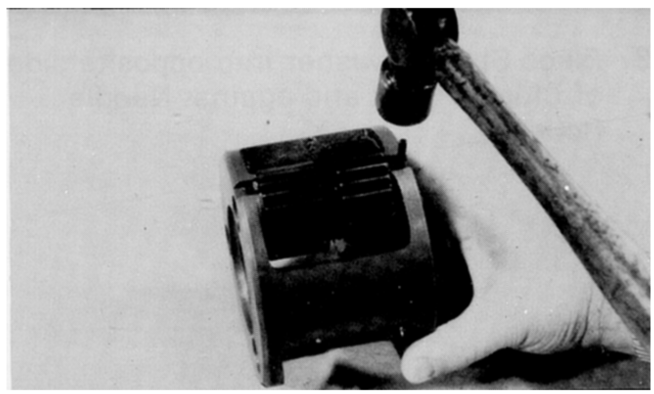
6. While keeping thrust washers in place, slide cluster gear into carrier with the larger gear on the side with the small pin hole.



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.



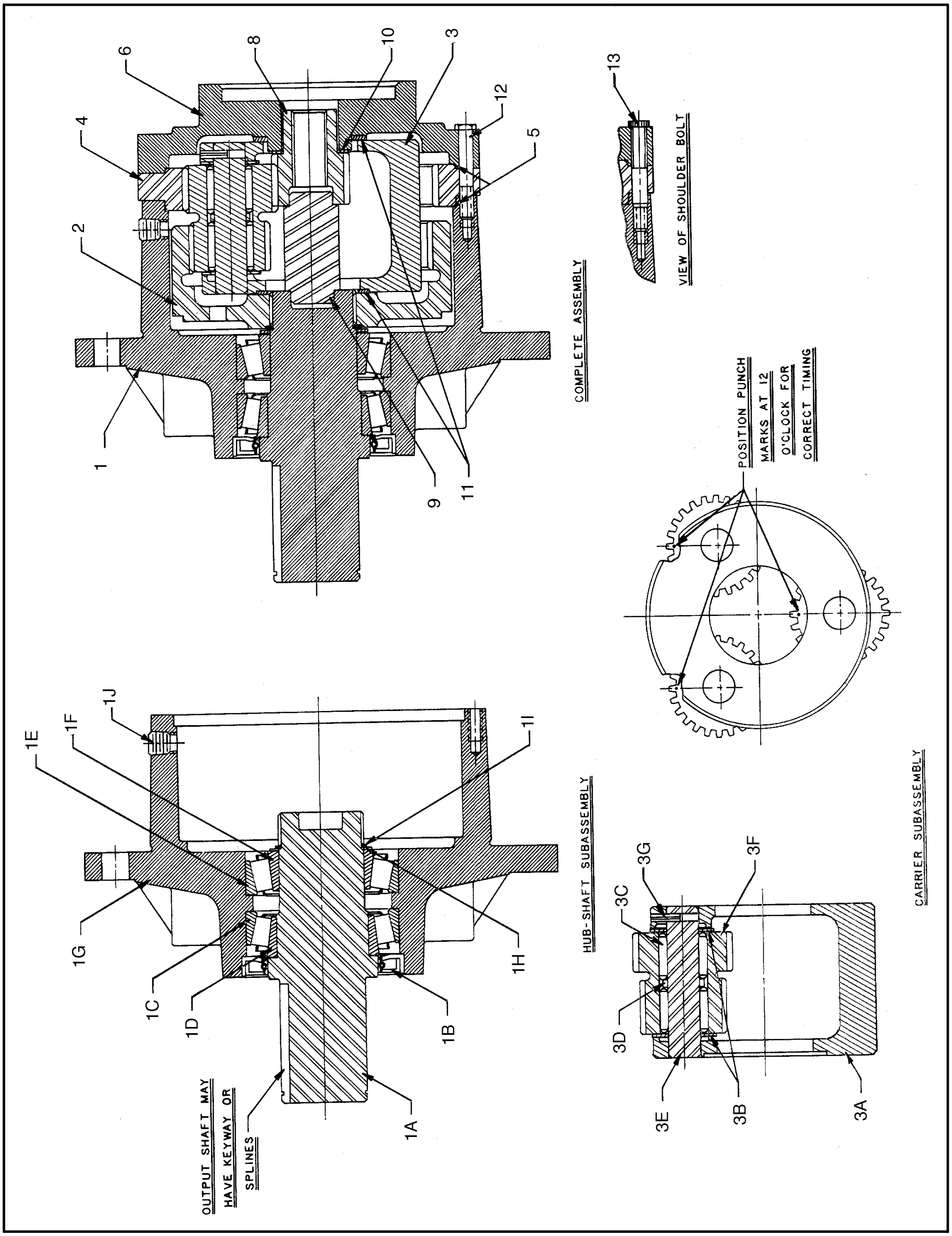


Figure 3-62. Swing Hub (Prior to SN 0300134352)

3.15 SWING BRAKE (PRIOR TO SN 0300134352)

Disassembly

1. Supporting brake:, remove the six socket head capscrews and washers (13 & 14) in equal increments to ensure the spring pressure within the brake is reduced gradually and evenly.

   If a press is available, the cylinder housing (8) can be restrained while removing the six capscrews and washers (13 & 14).

   The brake assembly can now be fully dismantled and the parts examined.

2. Remove cylinder housing (8) and piston (9) subassembly and dismantle if required, removing o-ring seals (15 & 17) and backing rings (16 & 18) as necessary.
3. Remove gasket (7) from housing (2).
4. Remove friction plates (3 & 6) and pressure plate (4).
5. Remove two dowel pins (19).
6. Remove springs (22 & 23).
7. Should it be necessary to replace ball bearing (10) or shaft seal (12), reverse remainder of brake subassembly, supporting on face C of housing (2).
8. Remove internal retaining ring (11).
9. Using arbor press or similar to break Loctite seal, remove brake shaft (1) from housing (2) and lay aside.
10. Reverse housing (2) and press out ball bearing (10). Shaft seal (12) can also be removed if necessary.

Inspection

1. Inspect friction plates (3 & 6) and friction surface on pressure plate (4) for wear or damage.
2. Examine friction plates (3) and brake shaft (1) for wear or damage to the splines.
3. Examine input and output splines of brake shaft (1) for wear or damage.
4. Examine compression springs (22 & 23) for damage or fatigue.
5. Check ball bearing (10) for axial float or wear.
6. Examine o-ring seals (15 & 17) and backing rings (16 & 18) for damage.

Assembly

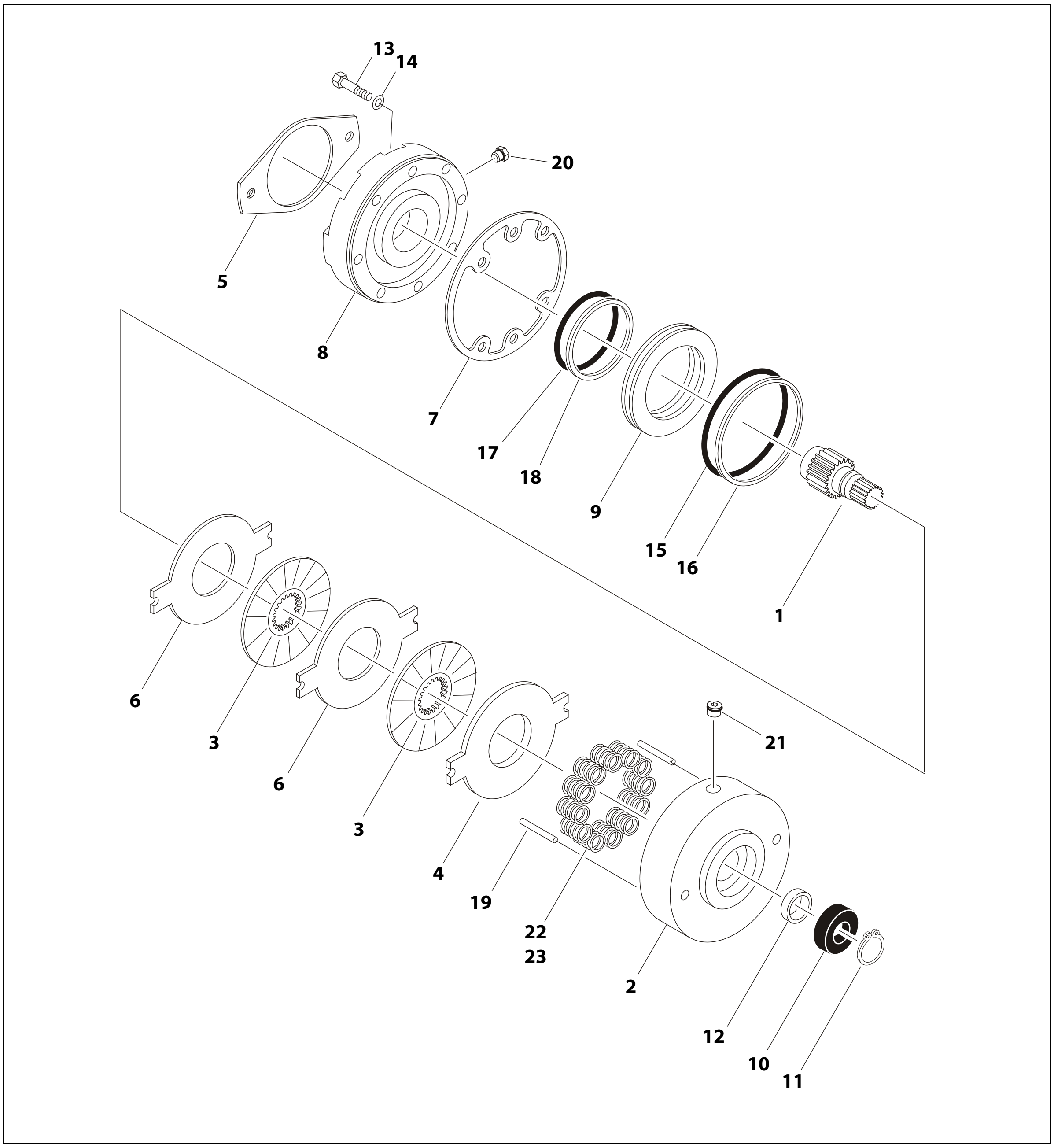
1. Lightly lubricate rotary shaft seal (12) and assemble to housing (2) taking care not to damage seal lip.
2. Apply ring of Loctite 641 or equivalent adhesive to full circumference of housing (2) bearing recess adjacent to shoulder.

   Apply complete coverage of Loctite 641 to outside diameter of bearing (10) and assemble fully In housing (2), retaining with internal retaining ring (11). Remove excess adhesive with a clean cloth.

   Press shaft (1) through bearing (10), ensuring bearing inner ring Is adequately supported.

3. Assemble correct quantity of springs (22 & 23) in orientation required.
4. Lubricate o-ring seals (15 & 17) with Molykote 55M (or equivalent) silicon grease and assemble together with backing rings (16 & 18) to piston (9). To ensure correct brake operation. It is important that the backing rings are assembled opposite to the pressurized side of piston.
5. Correctly orientate piston (9) aligning spaces with the two dowel pin holes and, assemble into cylinder housing (8) taking care not to damage seals and carefully lay aside.
6. Locate 2-off pins (19) in housing (2) followed by pressure plate (4) and friction plates i.e. an inner (3) followed by an outer (6) in correct sequence.
7. Position gasket (7) in correct orientation.
8. Align two holes in cylinder with dowel pins (19) and assemble piston & cylinder sub-assembly to remainder of brake securing with 6 capscrews and washers (13 & 14). Torque to 55 ft. lbs. (75 Nm).

NOTE: *The use of a suitable press (hydraulic or arbor) pressing down on cylinder end face B will ease assembly of the capscrews (13).*



1. Shaft
2. Housing
3. Friction Plate
4. Pressure Plate
5. Gasket
6. Outer Plate
7. Gasket
8. Cylinder
9. Piston
10. Ball Bearing
11. Retaining Ring
12. Shaft Seal
13. Capscrew
14. Lockwasher
15. O-ring
16. Backup Ring
17. O-ring
18. Backup Ring
19. Dowel Pin
20. Plug
21. Plug
22. Spring (Natural)
23. Spring (Blue)

Figure 3-63. Swing Brake (Prior to SN 0300134352)

3.16 SWING DRIVE BRAKE

Disassembly

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

⚠ CAUTION

PRESSURE PLATE IS UNDER SPRING TENSION OF APPROXIMATELY 2000 LBS (907 KGF). THE TWO CAPSCREWS MUST BE LOOSENED 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 CAPSCREWS. COVER PLATE (16) MUST BE SUPPORTED AS SHOWN IN FIGURE 3-37.

2. Remove case seal (4) from cover plate (16).
3. Remove piston (6) from pressure plate (2).
4. Remove o-ring (4), back-up ring (5), o-ring (7) and back-up 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 models use the 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 using a soft mallet on the male end of the shaft (9).
9. Remove retaining ring (20) from cover (16) and press out oil seal (17) and bearing (18) if required.

Assembly

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

1. Use an alkaline wash to clean parts before assembly.
2. Press oil seal (17) into cover plate (16) until it is flush with bearing shoulder. Note direction of seal.
3. Press bearing (18) into position until it bottoms out on borestep.
4. Install retaining ring (20) in cover plate (16).
5. Press shaft (9) into bearing (18) until it bottoms on the shoulder. Bearing (18) inner race must be supported during this operation.
6. Install retaining ring (19) on shaft (10).
7. Insert dowel pins (15), spring retainer (14) and springs (13) in cover (16).

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

8. Position plate (12) on spring (13).

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

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

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

11. Install new case seal (3) in cover plate (16).
12. Position pressure plate (2) on cover plate (16) aligning dowel pins (15) with holes in pressure plate.
13. Install washer head cap screws (1) and tighten evenly to draw pressure plate (2) to cover (16). Torque washer head cap screws 55 ft. lbs. (74.6 Nm).

NOTE: *A hydraulic press will simplify installation of pressure plate on cover. Clamp pressure plate in position while tighten¦ing the capscrews. Cover plate (16) must be supported as indicated in Figure 3-37.*

⚠ CAUTION

IF HYDROSTATIC BENCH TESTING IS PERFORMED ON THE BRAKE ASSEMBLY, RELEASE PRESSURE MUST NOT EXCEED 137.9 BARS (2000 PSI) UNLESS TWO ADDITIONAL BOLTS ARE USED FOR SUPPLEMENTAL CLAMPING.

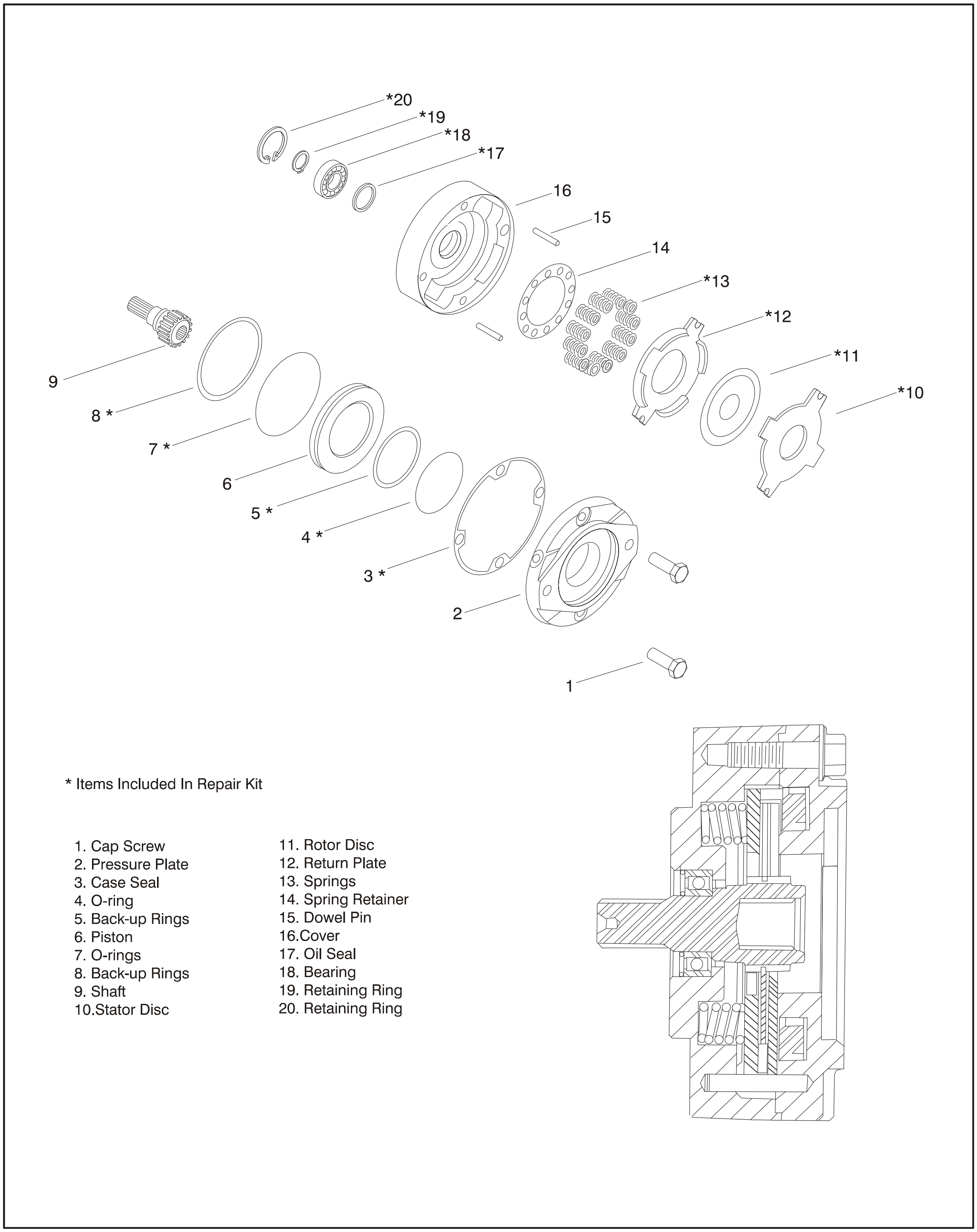
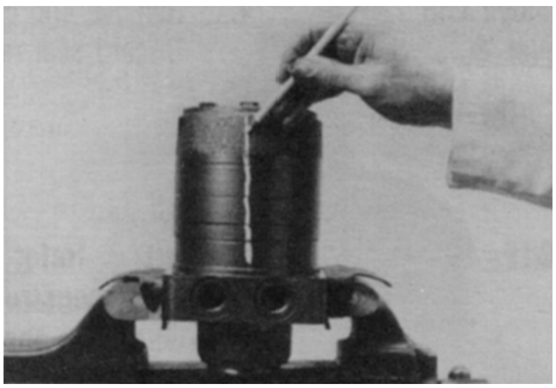


Figure 3-64. Swing Brake

3.17 SWING MOTOR (PRIOR TO SN 0300134352)

Disassembly and inspection

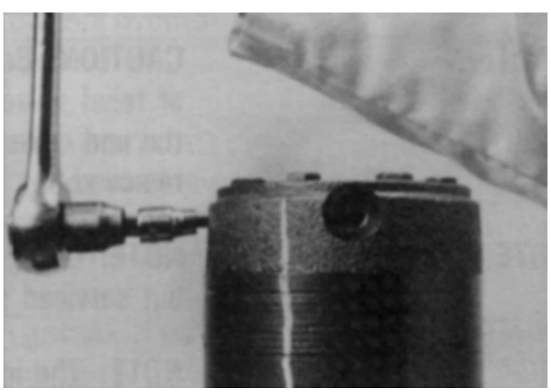
1. Place the Torqlink™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

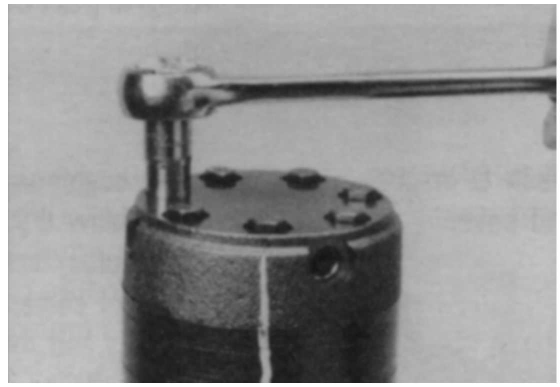


⚠ CAUTION

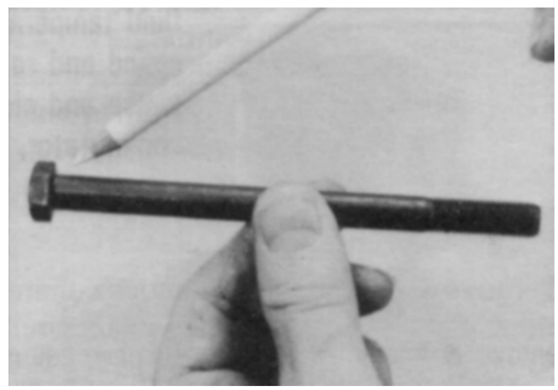
IF THE TORQLINK™ IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DISLODGED DURINGTHE SERVICE PROCEDURES, CAUSING INJURY.

2. Scribe an alignment mark down and across the Torqlink™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 in. (4.76 or
9.52 mm) allen wrench or 1 in. hex socket required.

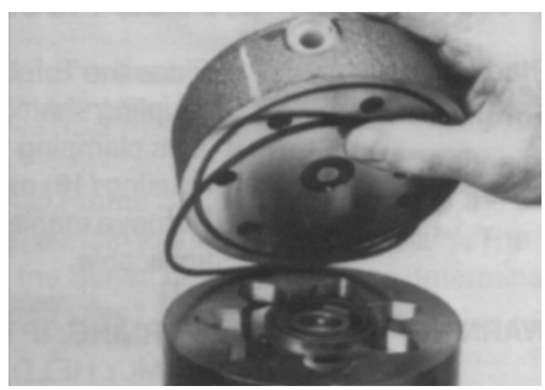




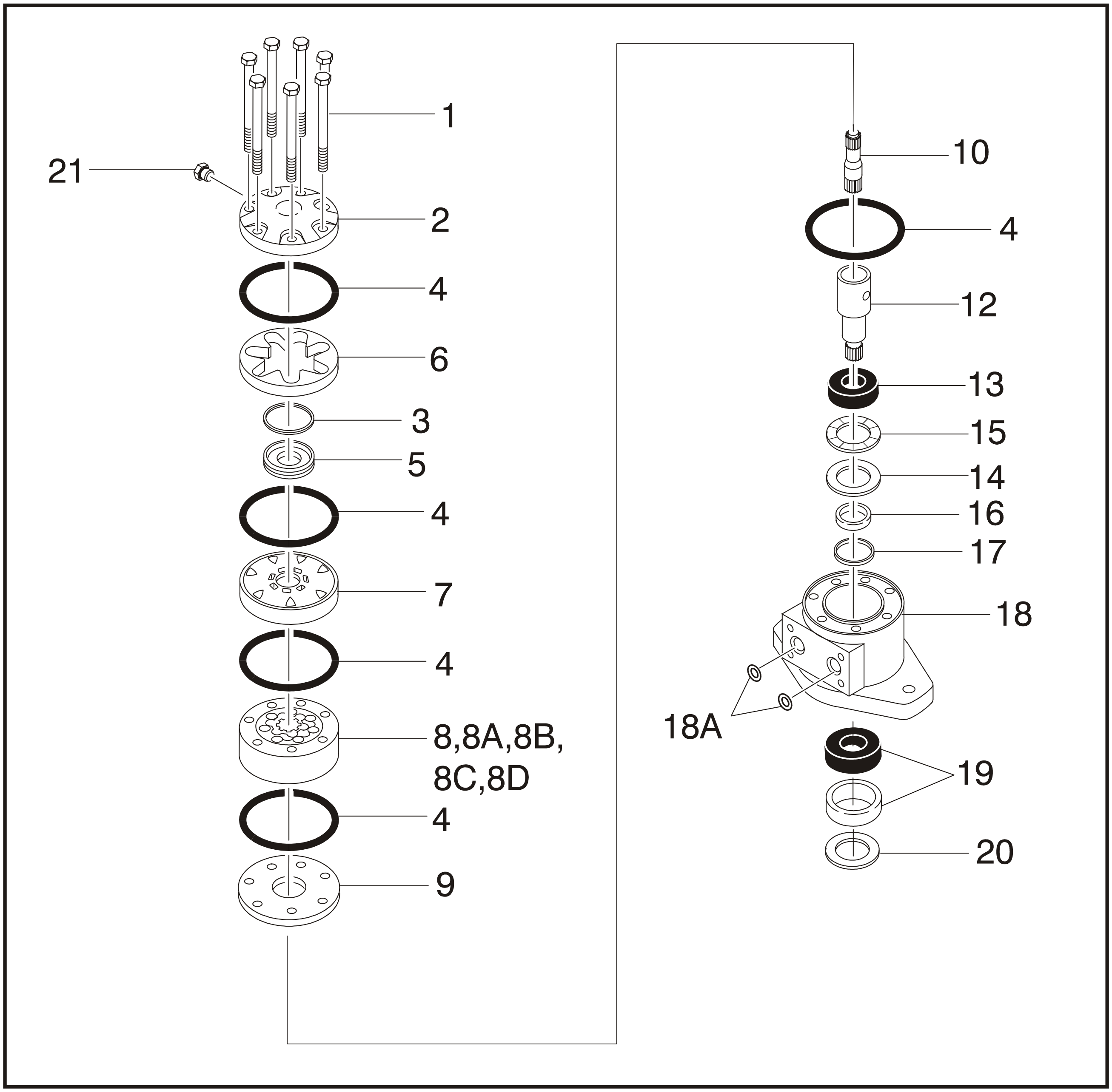
3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 in. (12.7 or 14.28 mm) size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.



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



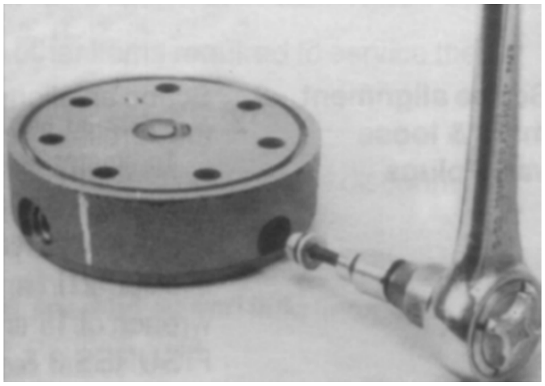
NOTE: *Refer to the appropriate “alternate cover construction” on the exploded view to determine the end cover construction being serviced.*



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

Figure 3-65. Swing Drive Motor (Prior to SN 0300134352)

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

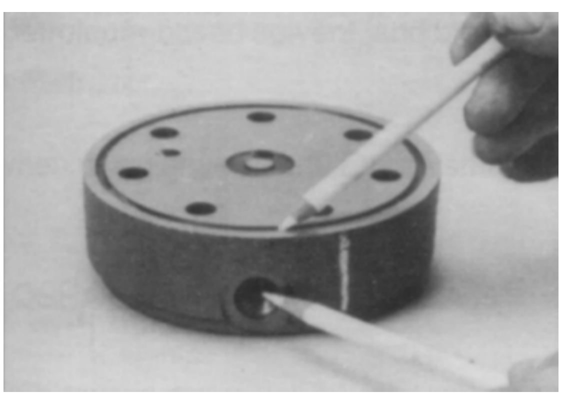


NOTICE

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

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

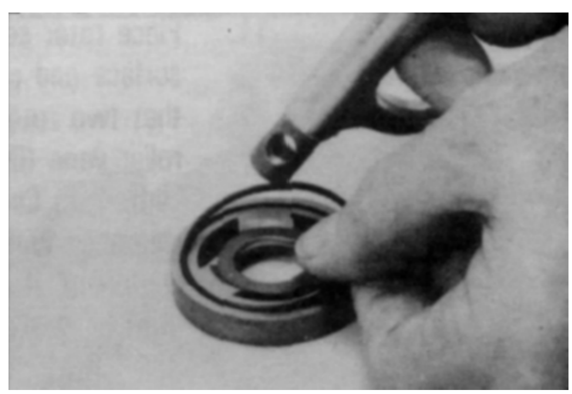
6. Thoroughly wash end cover (2) in proper solvent and blow dry. Be sure the end cover valve apertures, including the internal orifice plug, are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary.



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

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

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

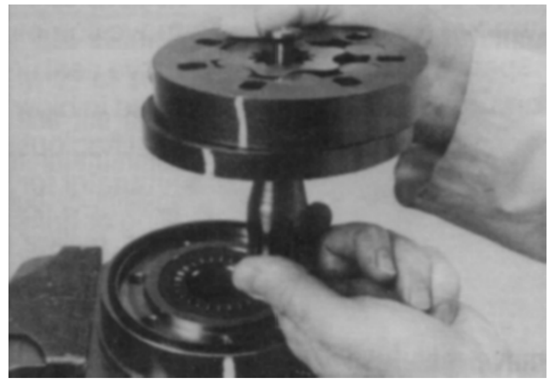


9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.

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

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

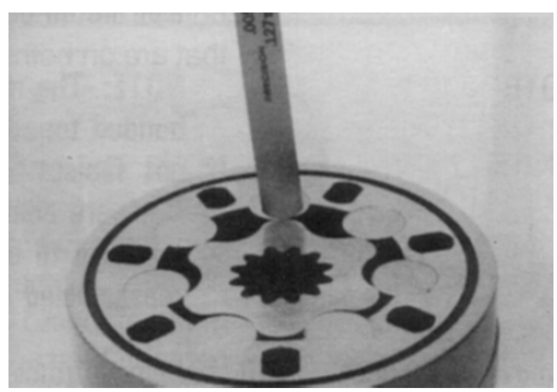
NOTE: *The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqlink™ will ensure correct reassembly of rotor into stator and rotor set into Torqlink™. Marking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



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

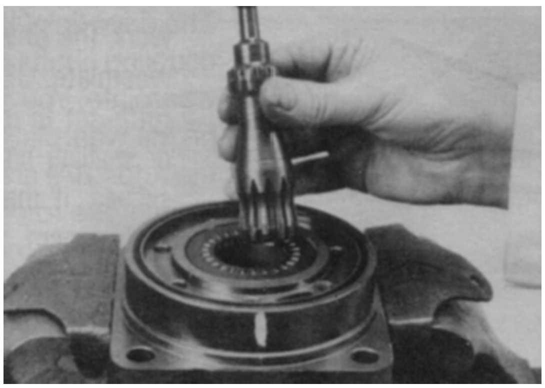
NOTE: *A polished pattern on the wear plate from rotor rotation is normal.*

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



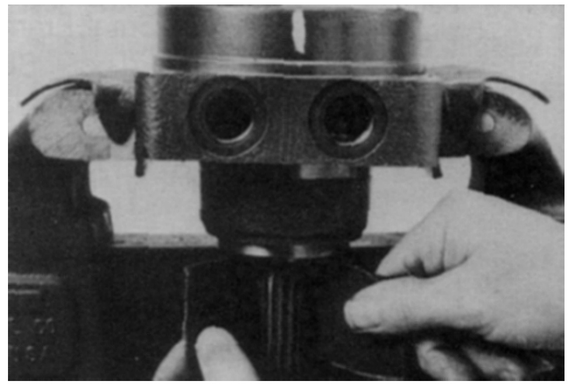
NOTE: *If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.*

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

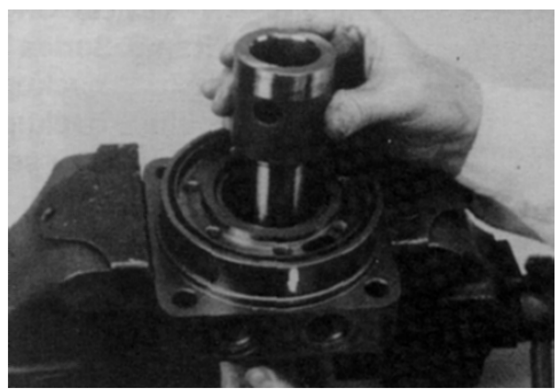


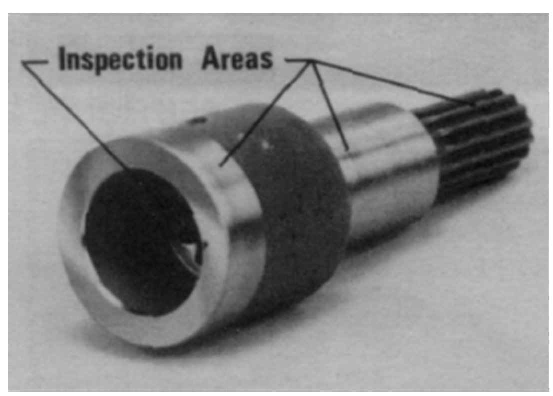
13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.

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



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





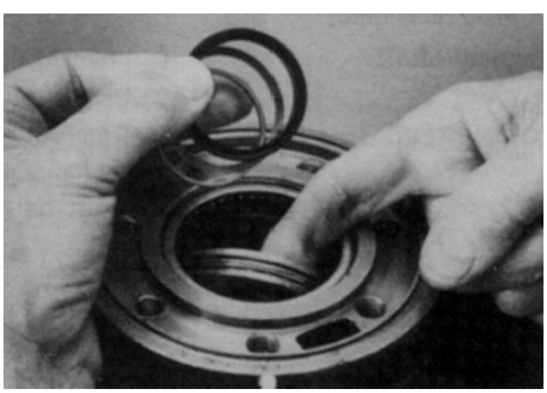
NOTE: *Minor shaft wear in seal area is permissible. If wear exceeds 0.020 in. (0.51 mm) diametrically, replace coupling shaft.*

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

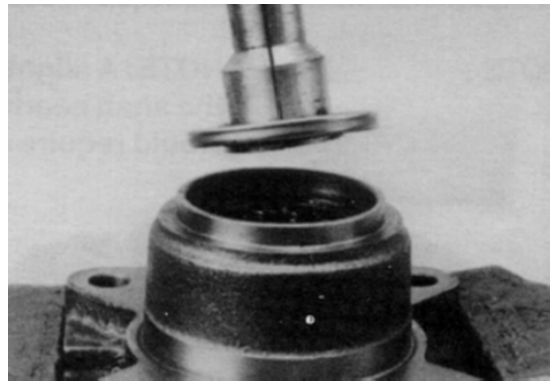
16. Remove and discard seal ring (4) from housing (18).

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

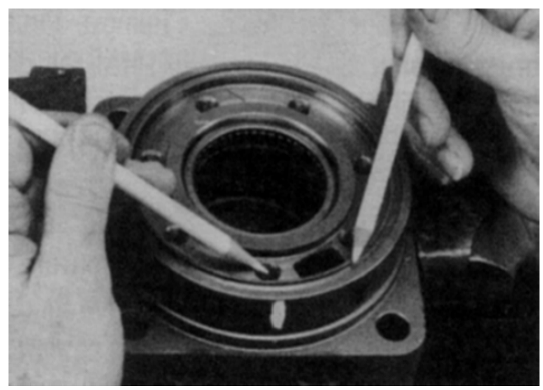
18. Remove seal (16) and back up washer (17) from Small Frame, housing (18). Discard both.



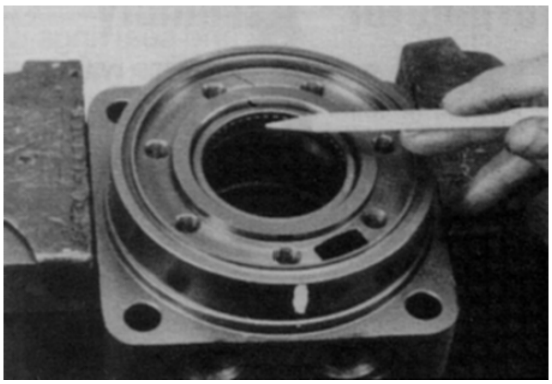
19. Remove housing (18) from vise, invert it and remove and discard seal (20). A blind hole bearing or seal puller is required.

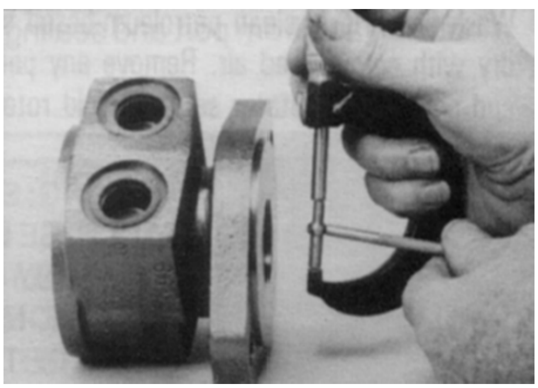


20. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly.

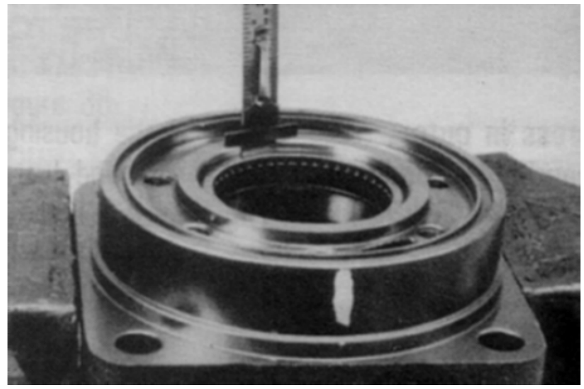


21. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate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

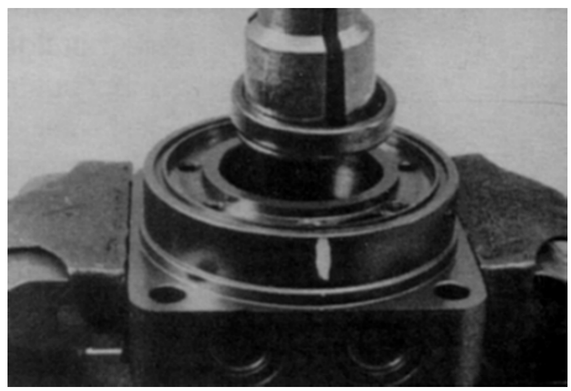


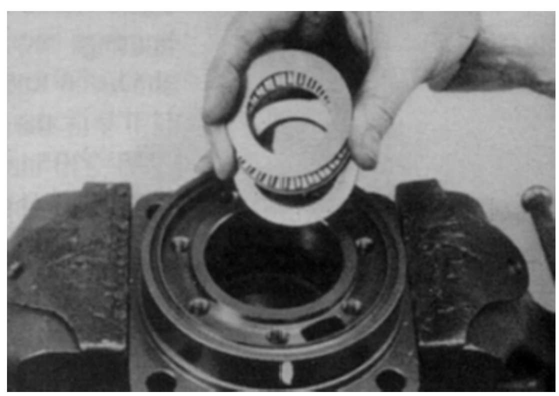


NOTE: *The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counter bore should be measured and noted before removing the bearings/bushings. This will facilitate the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



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





Assembly

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

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

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

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

⚠ WARNING

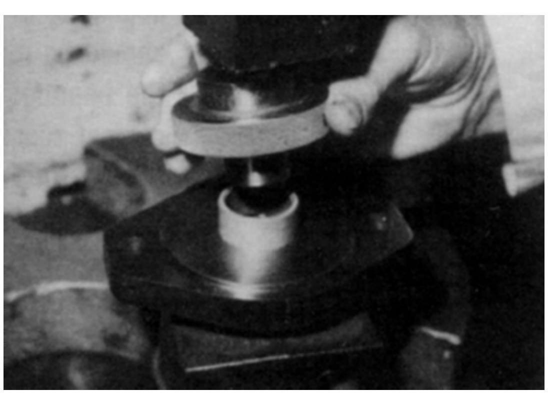
SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

⚠ CAUTION

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

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

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



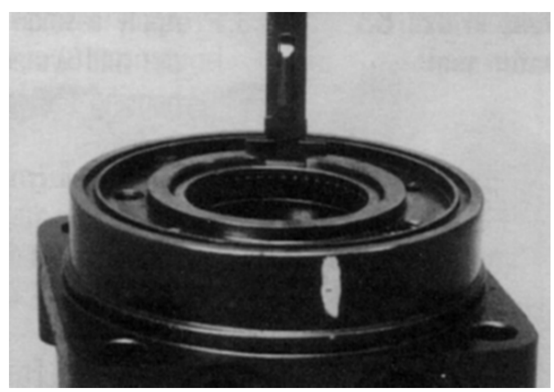
NOTE: *Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.*

NOTICE

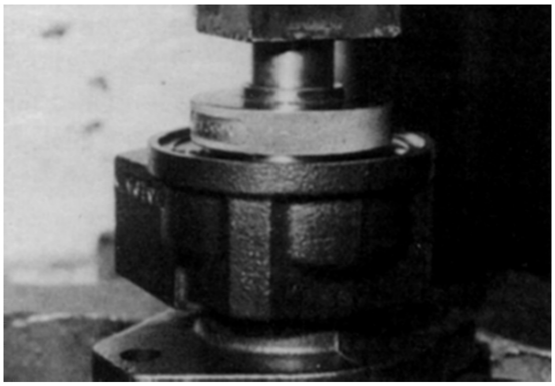
IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT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

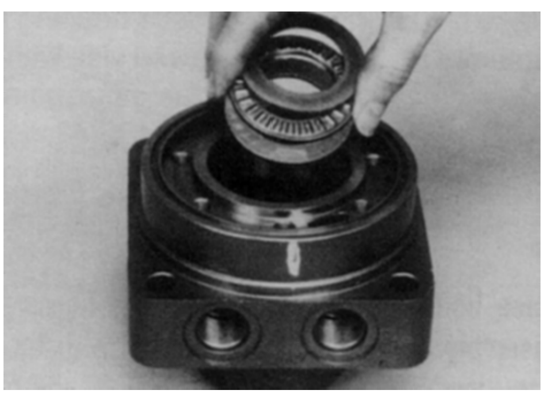
NOTICE

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



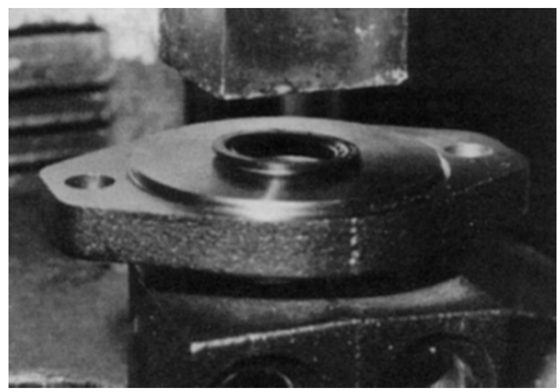
2. The Torqlink™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 in. (0.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing (19).

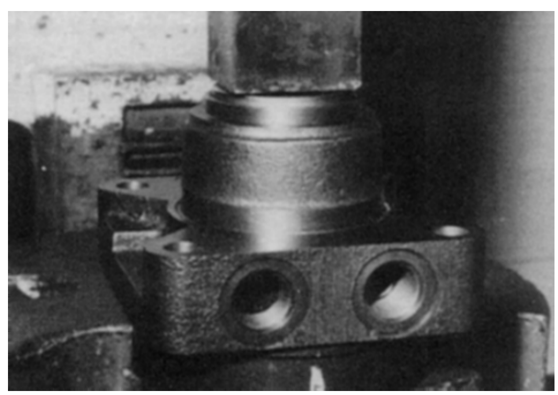




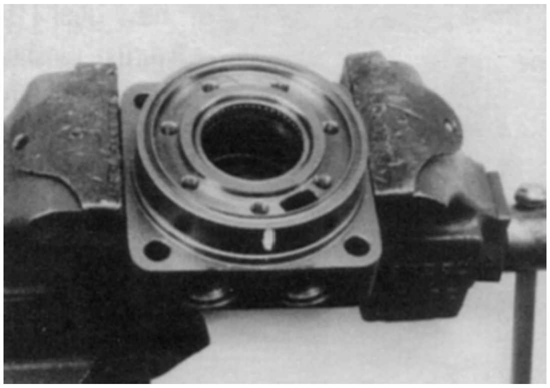
3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore.

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

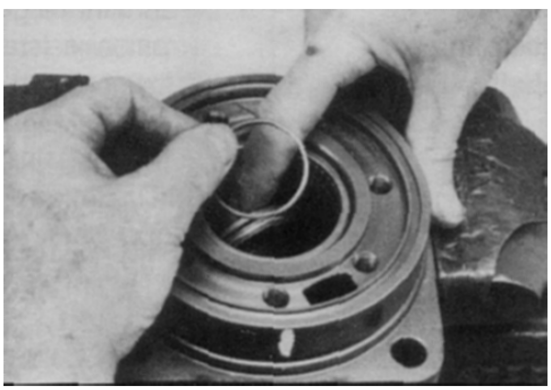




4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



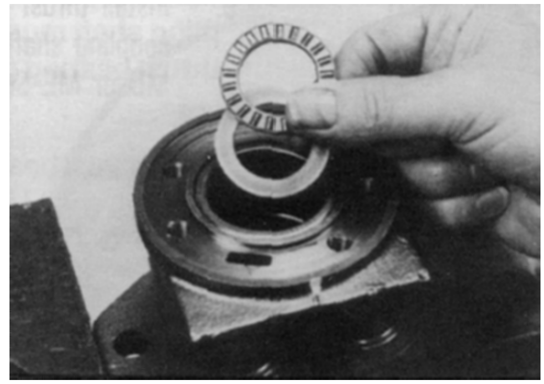
5. On the Torqlinks™ assemble a new backup washer (17) and new seal (16) with the seal lip facing toward the inside of Torqlink™, into their respective counterbores in housing (18) if they were not assembled in procedure 2.



NOTICE

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

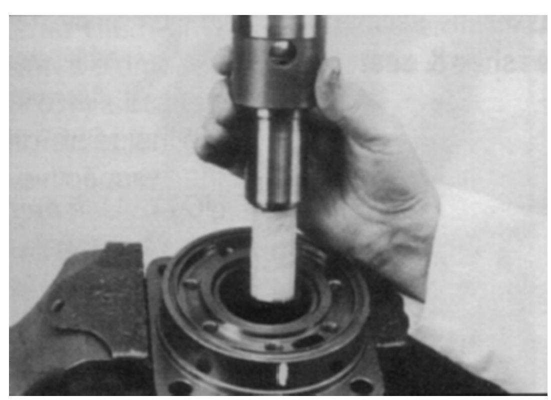
6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Torqlink™.



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

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

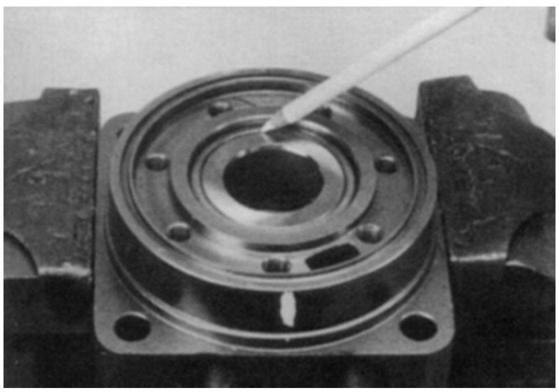
8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in the housings.



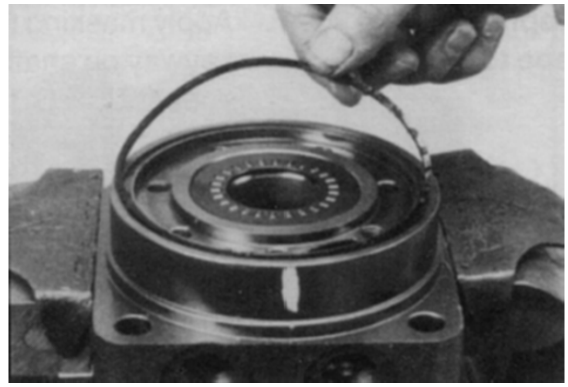
NOTICE

THE OUTER BEARING (19) IS NOT LUBRICATED BY THE SYSTEM'S HYDRAULIC FLUID. BE SURE IT IS THOROUGHLY PACKED WITH THE RECOMMENDED GREASE, PARKER GEAR GREASE SPECIFICATION #045236, E/M LUBRICANT #K-70M OR MOBIL MOBILITH SHC R 460.

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

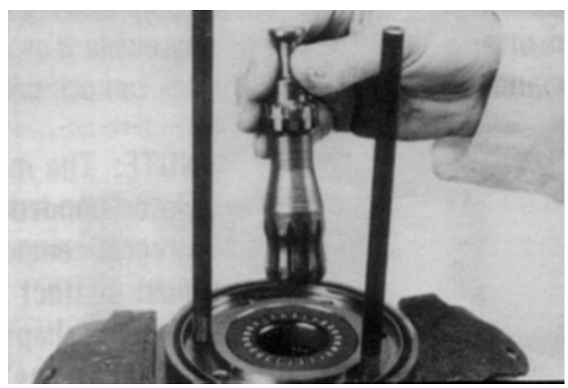


9. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove.



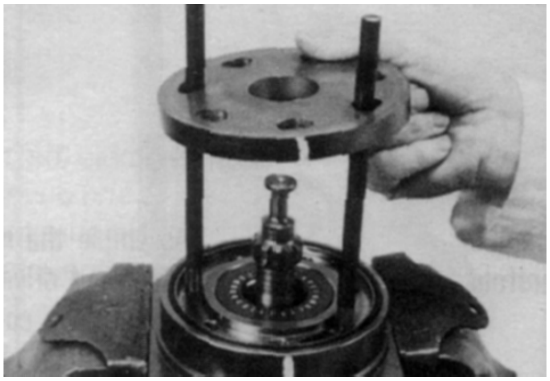
NOTE: *One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures.The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over 0.5 in. (12.7 mm) longer than the bolts (1) used in the Torqlink.*

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

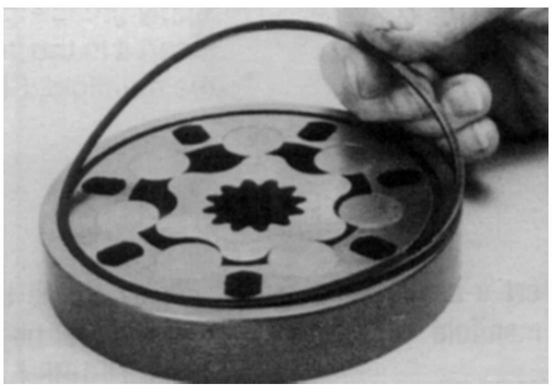


NOTE: *Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.*

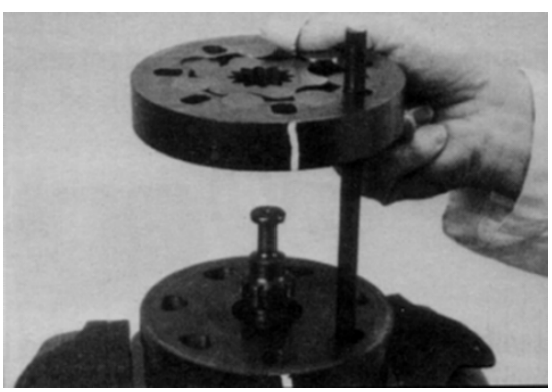
11. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



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



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

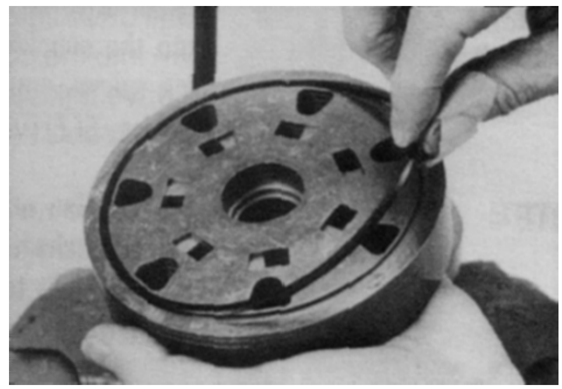


NOTE: *It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.*

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

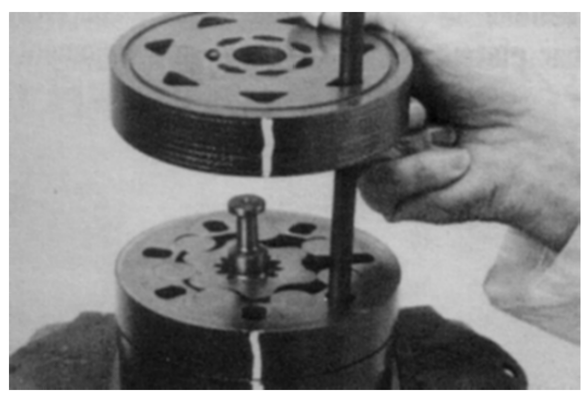
NOTE: *The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the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

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

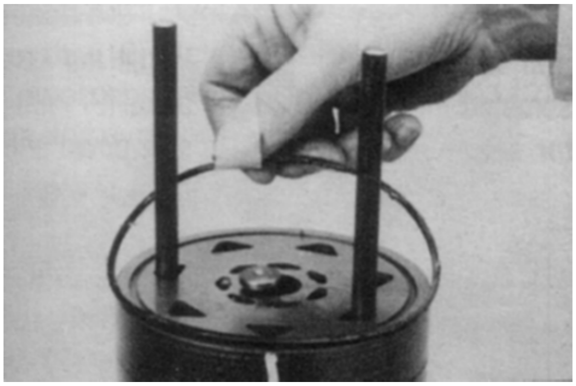


NOTE: *The manifold (7) is made up of several plates bonded together permanently to form an integral component.The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter.The polished impression left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

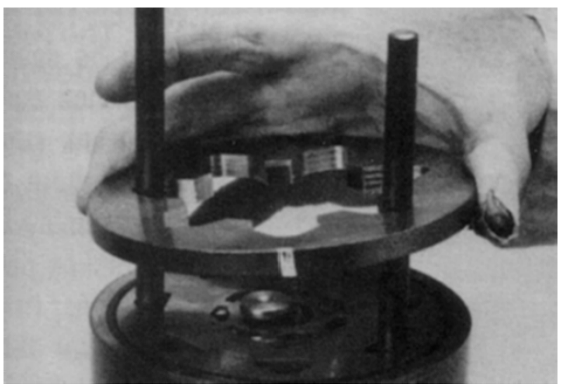
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



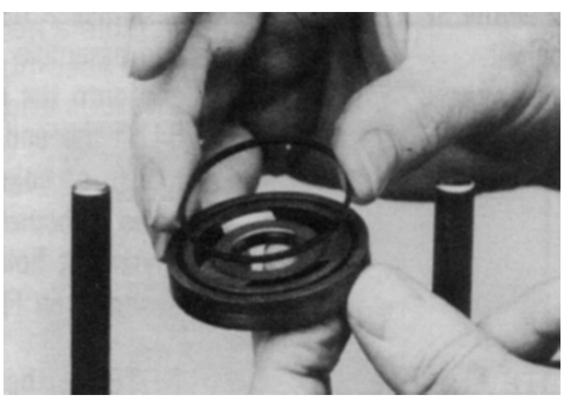
16. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.

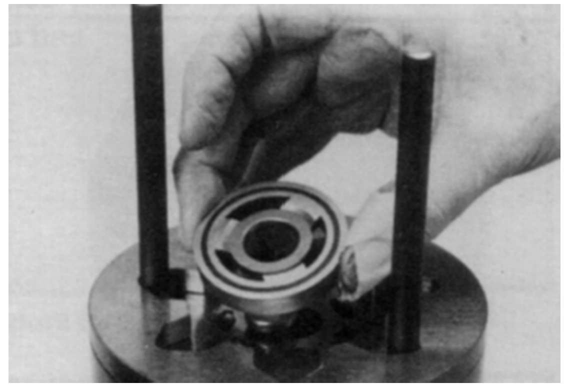


17. Assemble the commutator ring (6) over alignment studs onto the manifold.



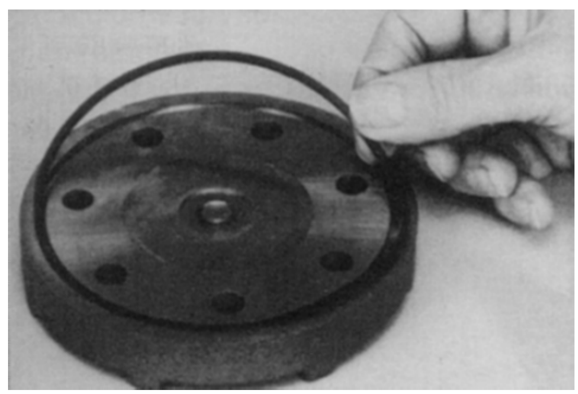
18. Assemble a new seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.

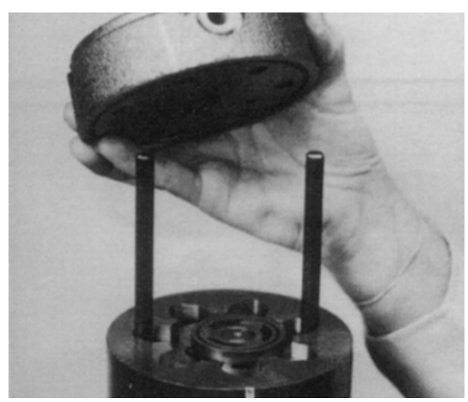


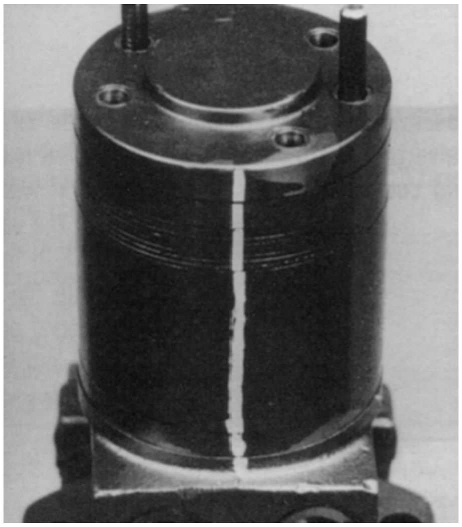


19. If shuttle valve components items #21, were removed from the end cover (2) turn a plug (21), loosely into one end of the valve cavity in the end cover. A 3/16 in. allen wrench is required.

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

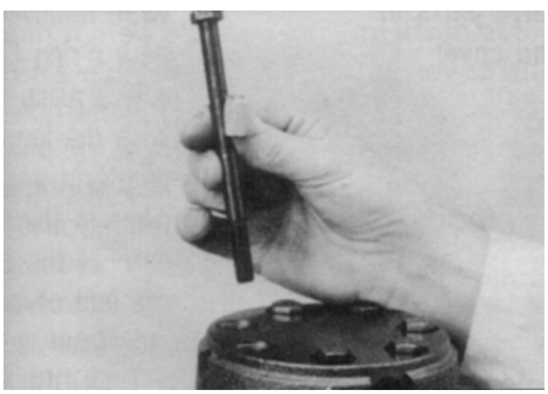


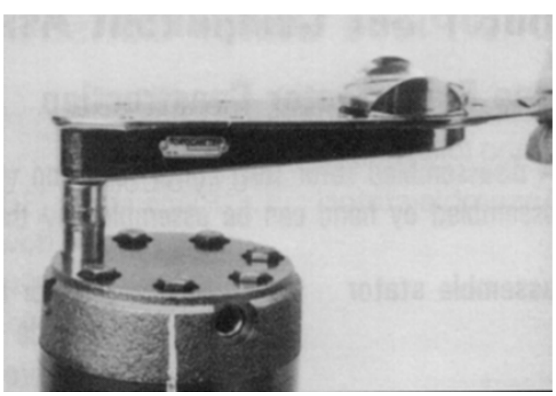


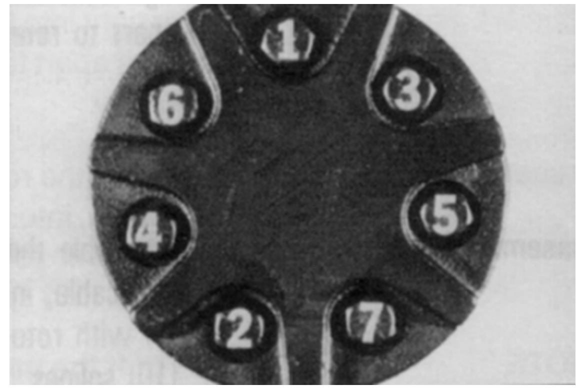


NOTE: *If the end cover has a valve (24) or has five bolt holes, use the line you previously scribed on the cover to radially align the end cover into its original position.*

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



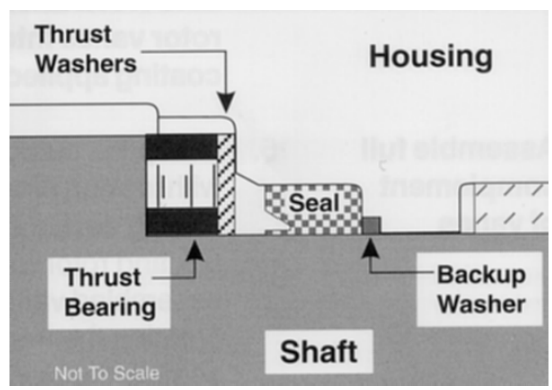




NOTE: *The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.*

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.

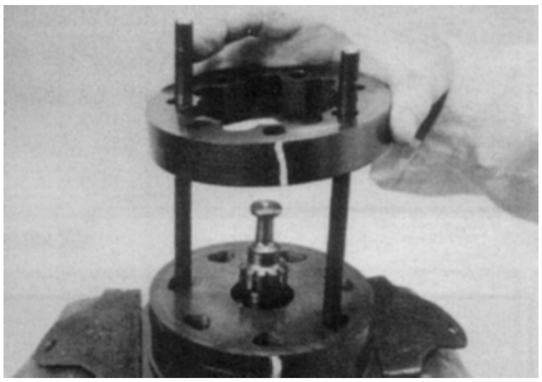
Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs. (61-75 Nm) if cover is so equipped.



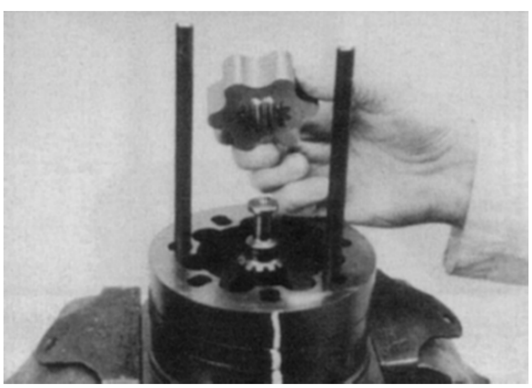
One Piece Stator Construction

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 Torqlink™ assembly procedures 1 through 13. Be sure the seal ring is in place.

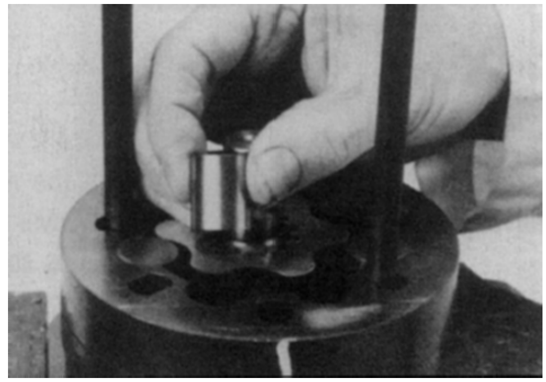


2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.
3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.



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

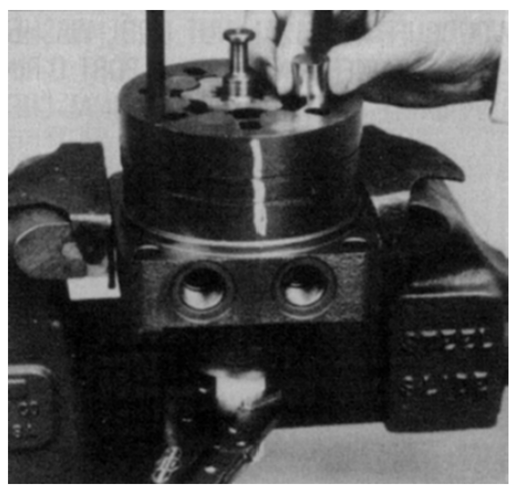
4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.



NOTICE

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

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



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

3.18 SWING HUB (SN 0300134352 THROUGH 0300189341)

Roll, Leak And Brake Testing

Drive 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

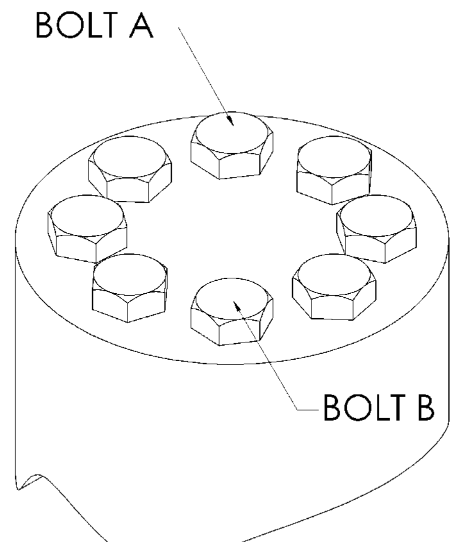
The brake test must be performed with the Motor removed and the Brake Test Plate (T-214404) installed. Install the Hex Bolts through Brake Test Plate and torque to 80-100 ft. lbs. (108-135 Nm). Install Roll Checking Tool (T-212731) and apply 210 psi (14 bar) to the o-ring port in the side of the Brake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

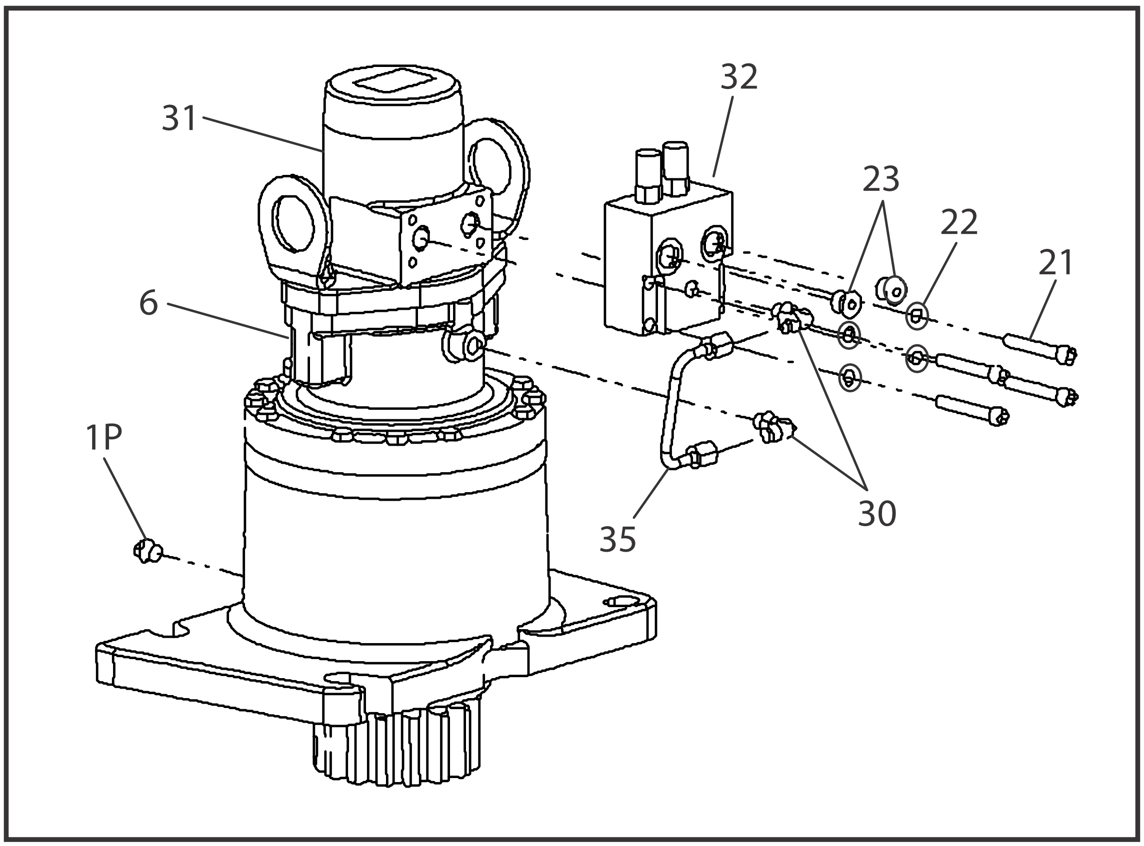


1. Tighten (but do not torque) bolt “A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt “B” until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt “A”.
5. Using the same sequence,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

Motor Control Valve Disassembly

NOTE: *Refer to Figure 3-66., Motor Control Valve.*

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 3-66. Motor Control Valve

Motor and Brake Disassembly

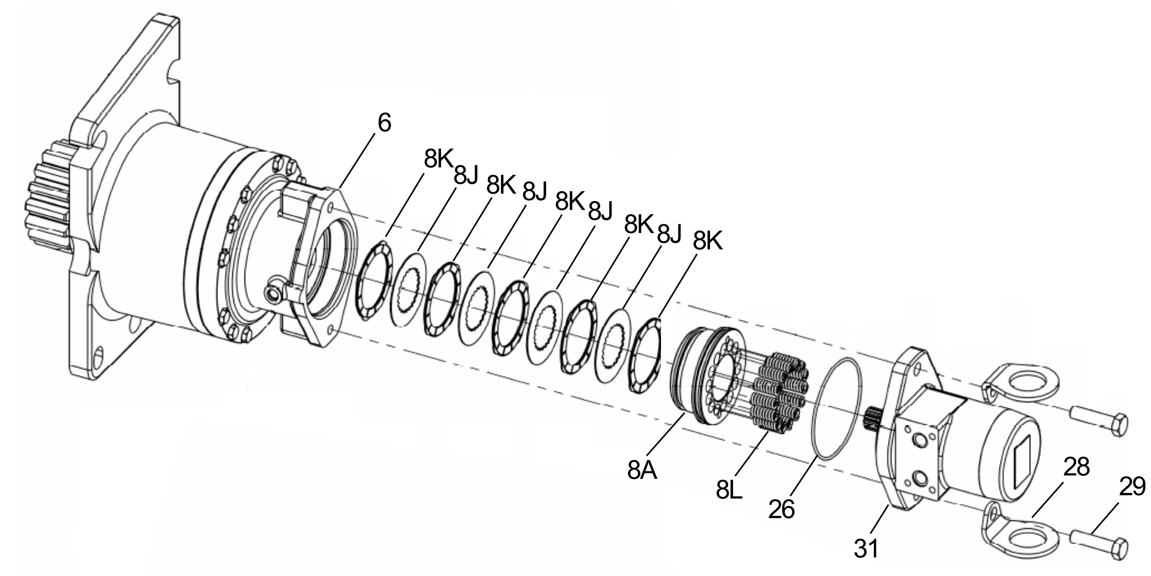
NOTE: *Refer to Figure 3-67., Motor and Brake.*

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).



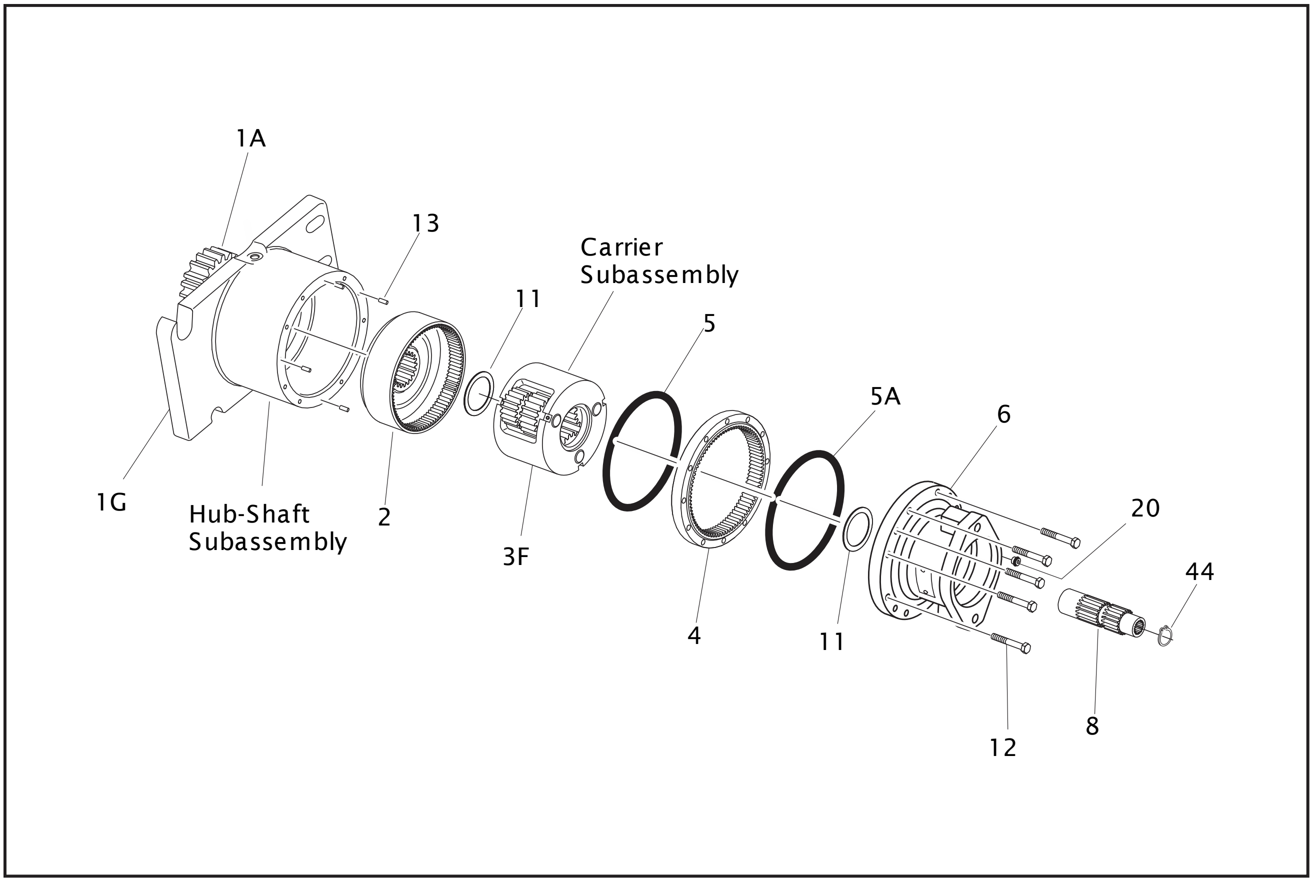
6. Brake Housing	26. O-ring
8A. Brake Piston	28. Lift Lug
8L. Spring	29. Hex Bolt
8J. Rotors	31. Motor
8K. Stator	

Figure 3-67. Motor and Brake

Main Drive Disassembly

NOTE: *Refer to Figure 3-68., Main Drive Assembly.*

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

Figure 3-68. Main Drive Assembly

Hub-Shaft Disassembly

NOTE: *Refer to Figure 3-69., Hub-Shaft.*

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

CAUTION

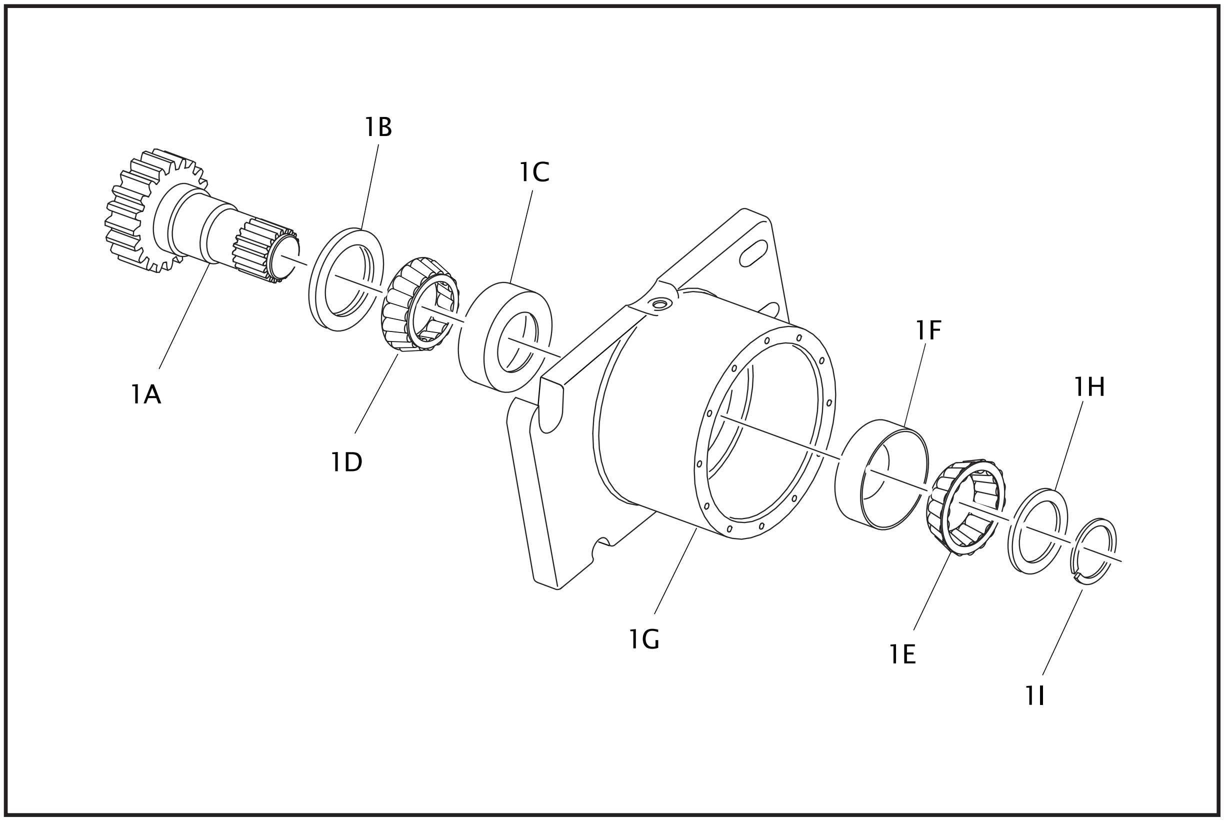
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

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).

NOTE: *If bearing replacement is necessary, the Bearing Cups (1C & 1F) can be removed with a slide hammer puller or driven out with punch.*



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

Figure 3-69. Hub-Shaft

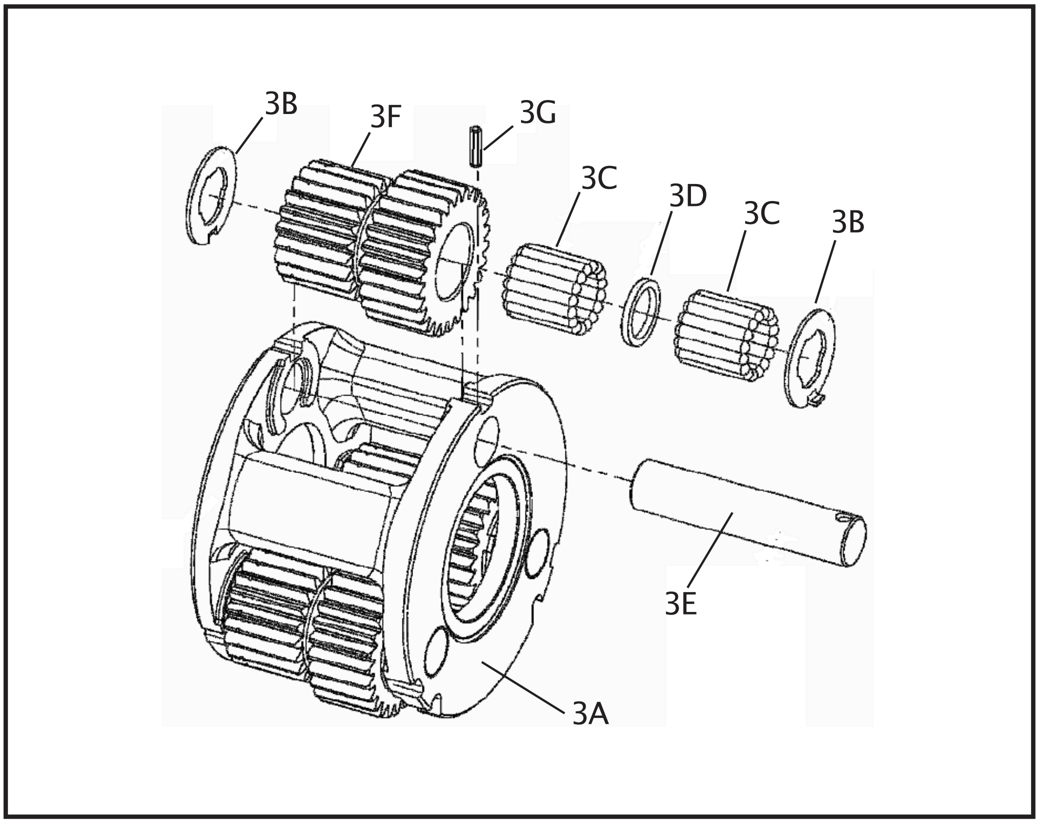
Carrier Disassembly

NOTE: *Refer to Figure 3-70., Carrier.*

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 through 4 for the remaining two Cluster Gears (3F).



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

Figure 3-70. Carrier

Hub-Shaft Assembly

NOTE: *Refer to Figure 3-69., Hub-Shaft.*

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 insure 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 3-70. Carrier.*

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" (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 through 10 for the remaining two Cluster Gears (3F).

Main Drive Assembly

NOTE: *Refer to Figure 3-68., Main Drive Assembly.*

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 counterbore holes in Hub (1G).
4. Install Thrust Washer (11) in counterbore 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 COUNTERBORE WHILE SEATING THIS ORING.

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 counterbore on the face of the carrier. Use grease to hold in place.
10. Place O-ring (5A) into counterbore of 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 hole (20) with those in the Hub (I G).
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 3-67., Motor and Brake.*

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).

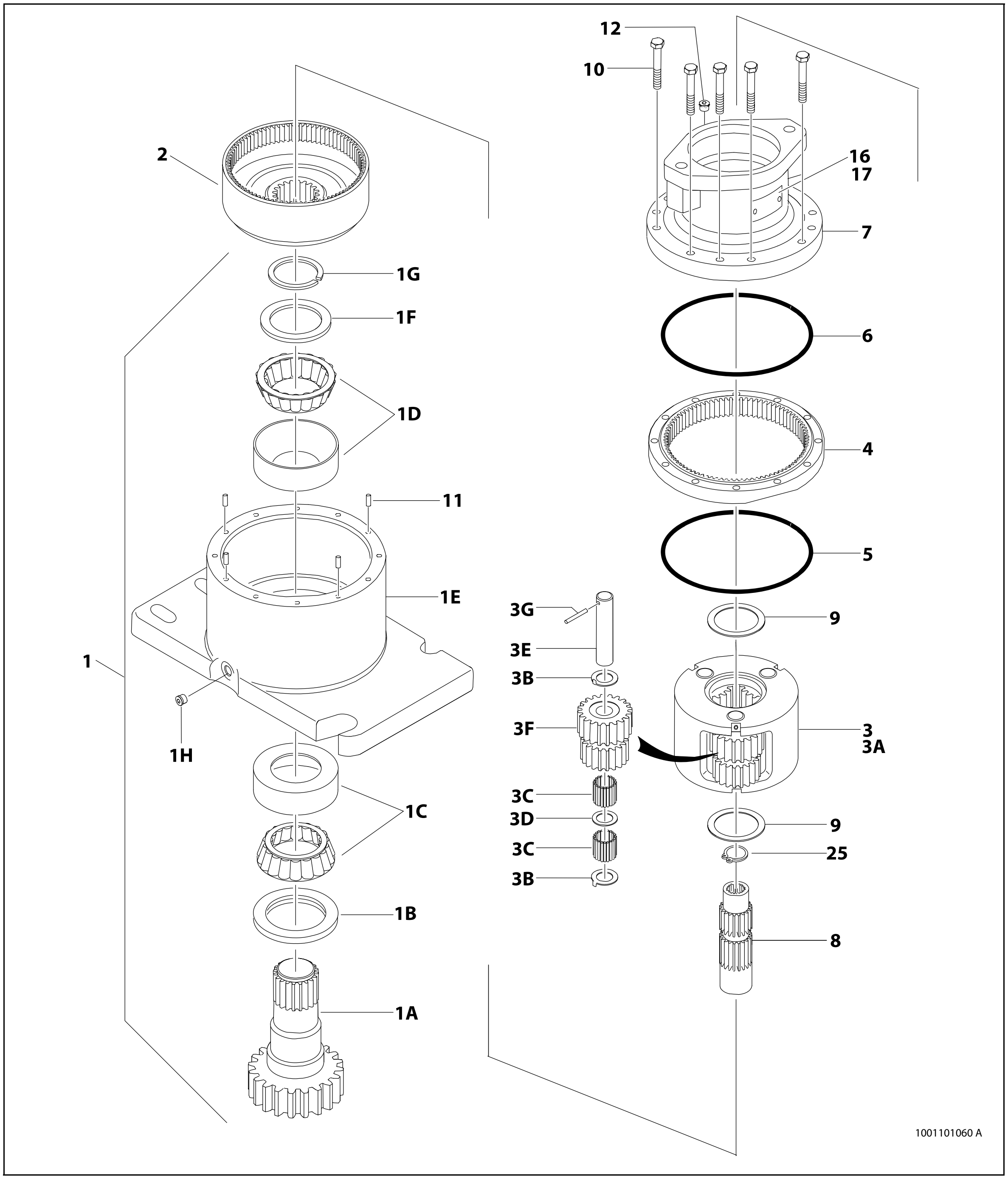
Motor Control Valve Assembly

NOTE: *Refer to Figure 3-66., Motor Control Valve.*

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).

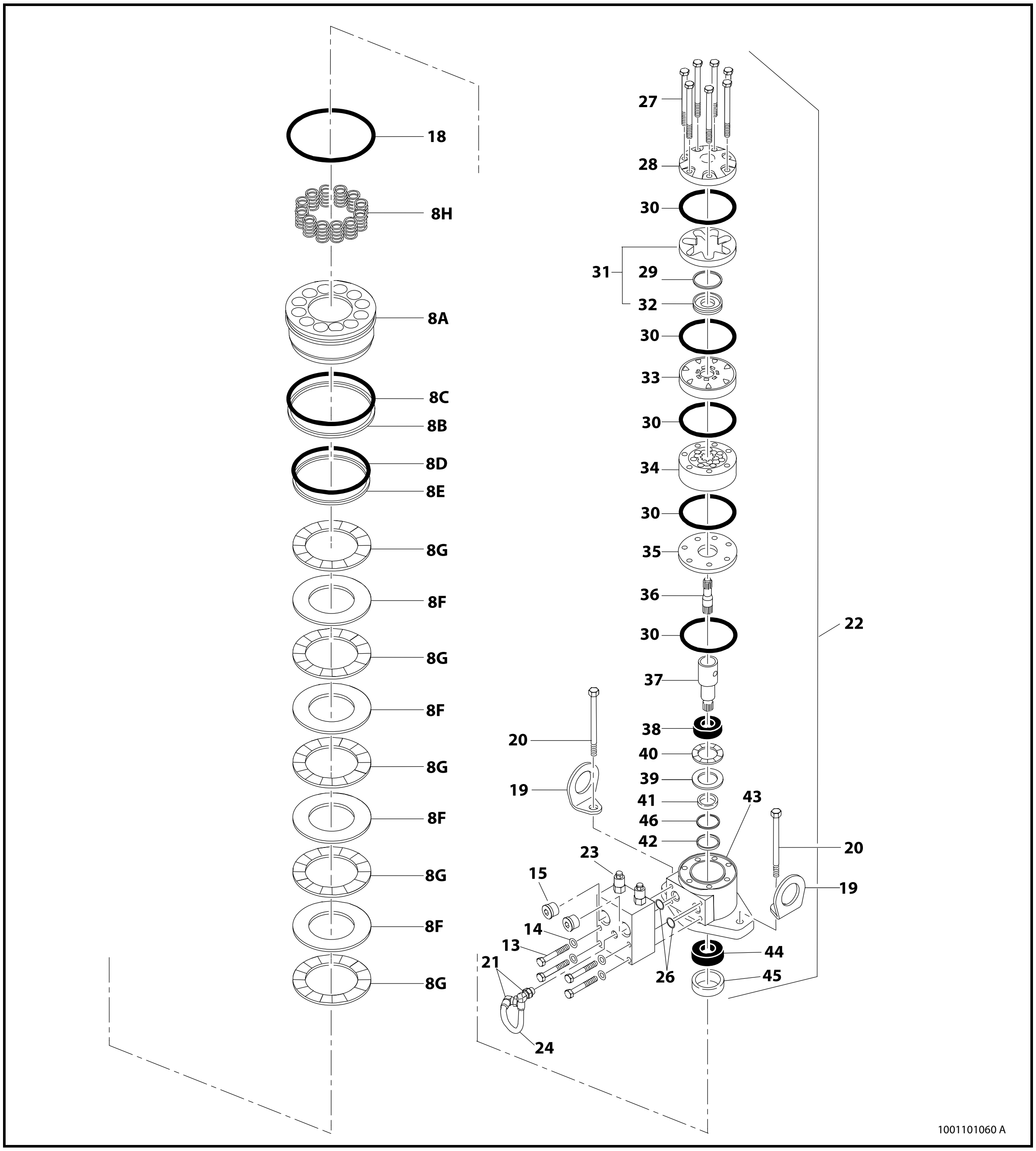
NOTE: *Be sure to align the holes in the control valve with the motor ports.*

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).



1. Housing	1F. Thrust Washer	3B. Tanged Washer	4. Ring Gear	10. Bolt
1A. Output Shaft	1G. Retaining Ring	3C. Needle Bearing	5. O-ring	11. Dowel Pin
1B. Lip Seal	1H. Pipe Plug	3D. Thrust Washer	6 O-Ring	12. Pipe Plug
1C. Bearing	2. Internal Gear	3E. Planet Shaft	7. Brake Housing	16. ID Plate
1D. Bearing	3. Carrier Assembly	3F. Cluster Gear	8. Sun Gear	17. Screw Drive
1E. Housing	3A. Carrier	3G. Rollpin	9. Thrust washer	25. Internal Retaining Ring

Figure 3-71. Swing Drive Assembly (SN 0300134352 to 0300189341)



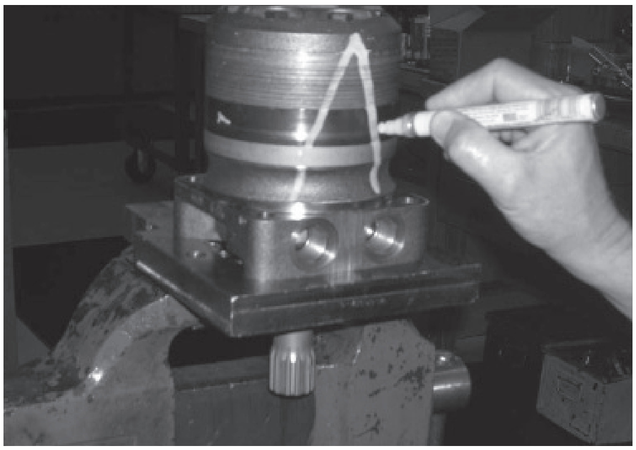
8A. Piston	13. Bolt	23. Valve Assembly	32. Ring	40. Thrust Bearing
8B. 0-Ring	14. Lock washer	24. Tube	33. Manifold	41. Inner Seal
8C. Backup Ring	15. Pipe Plug	26. O-ring	34. Rotor Set	42. Backup Washer
8D. O-Ring	18. 0-Ring	27. Bolt	35. Wear Plate	43. Housing
8E. Backup Ring	19. Lifting lug	28. End Cover	36. Drive Link	44. Backup Washer
8F. Rotor Disc	20. Bolt	29. Commutator Seal	37. Coupling Shaft	45. Seal
8G. Stator Disc	21. Elbow	30. Ring Seal	38. Inner Bearing	46. Washer
8H. Spring	22. Motor Assembly	31. Commutator and Ring Assy	39. Thrust Washer	

Figure 3-72. Swing Motor and Brake Assembly (SN 0300134352 to 0300189341)

3.19 SWING MOTOR (SN 0300134352 TO 0300189341)

Disassembly

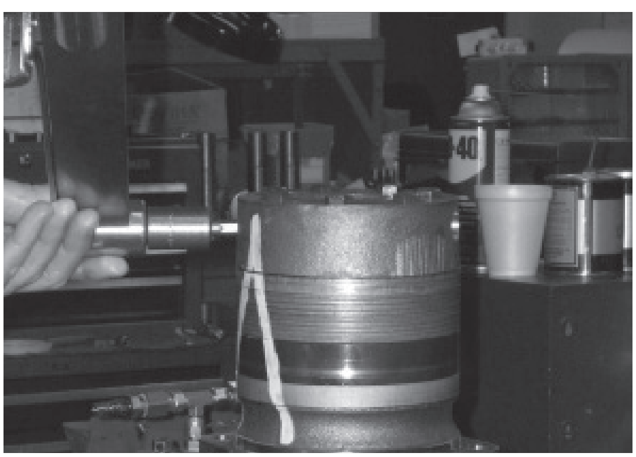
1. Place the Torqmotor™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port o-rings (18A) if applicable.

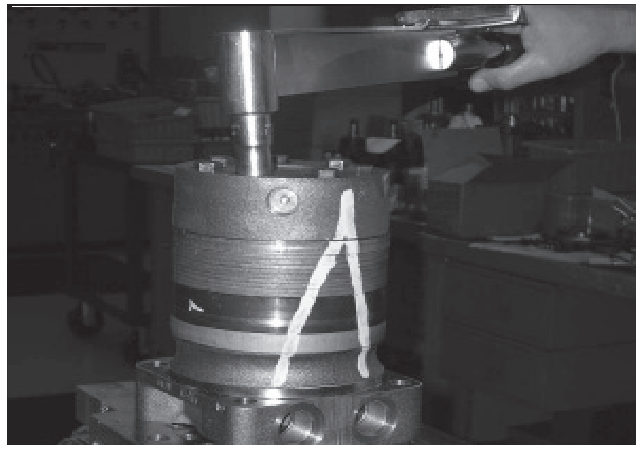


⚠ WARNING

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

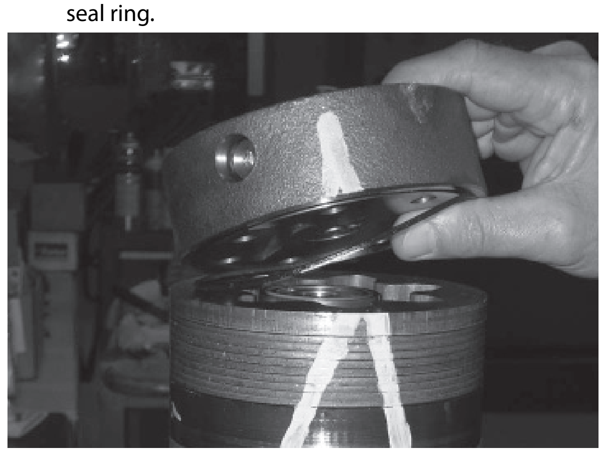
2. Scribe an alignment mark down and across the Torqmotor™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 in. Allen wrench or 1 in. hex socket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



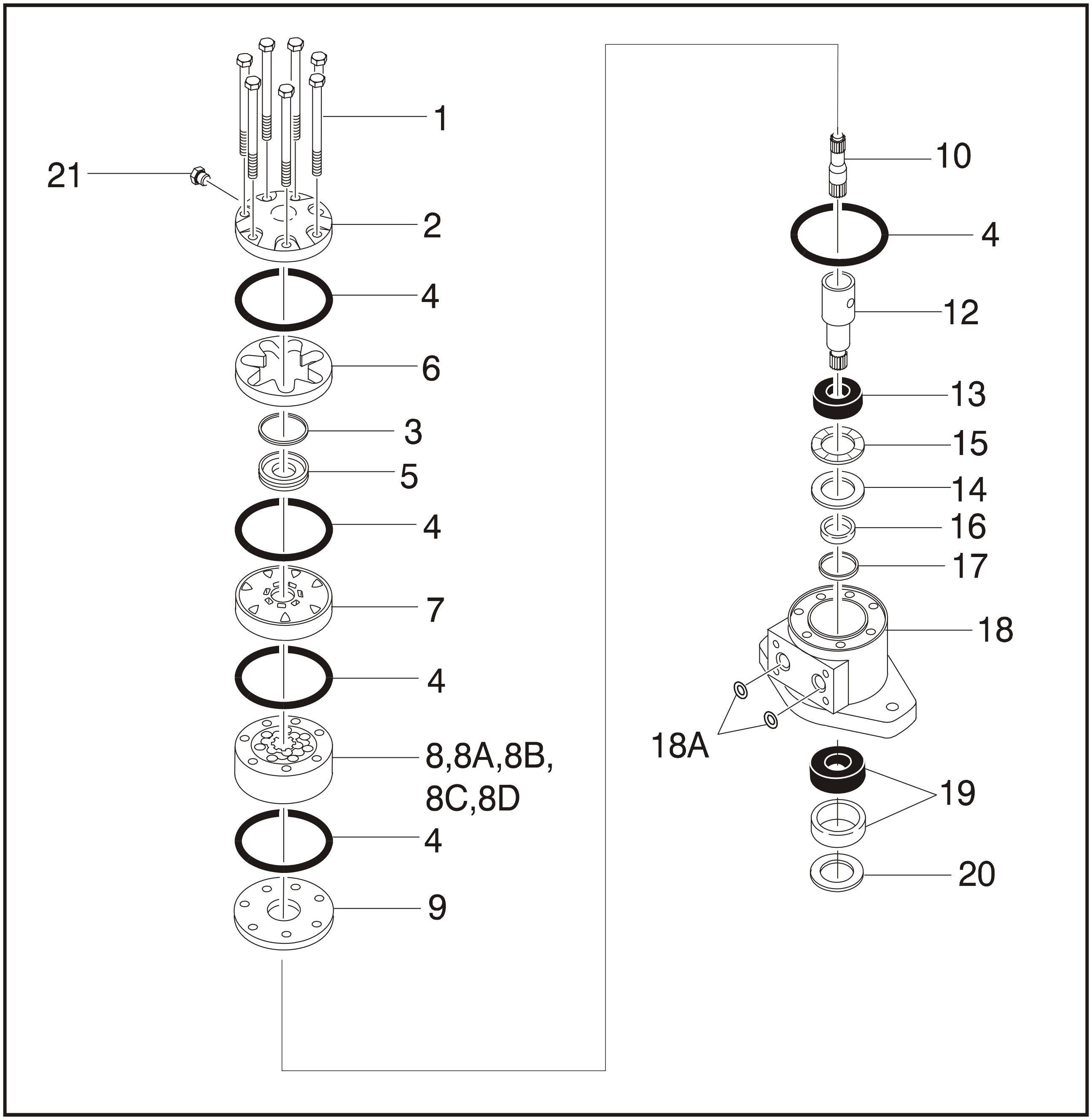


3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 in. size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.

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



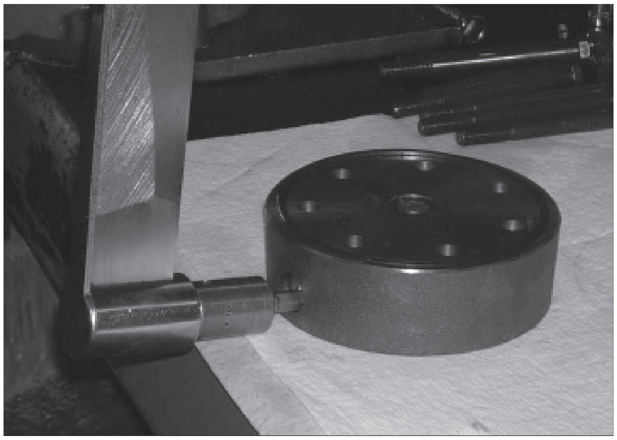
NOTE: *Refer to the appropriate "alternate cover construction" on the exploded view to determine the end cover construction being serviced.*



1. Special Bolts
2. End Cover
3. Seal Ring-Commutator
4. Seal Ring
5. Commutator Ring
6. Commutator Ring
7. Manifold
8. Rotor Set
8A. Rotor
8B. Stator or Stator Vane
8D. Stator Half
9. Wear Plate
10. Drive Link
11. Not Used
12. Coupling Shaft
13. Bearing/Bushing, Inner
14. Thrust Washer
15. Thrust Bearing
16. Seal
17. Backup Washer
18. Housing
18A. O-Ring
19. Bearing/Bushing, Outer
20. Dirt & Water Seal
21. Plug

Figure 3-73. Swing Drive Motor (SN 0300134352 to 0300189341)

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



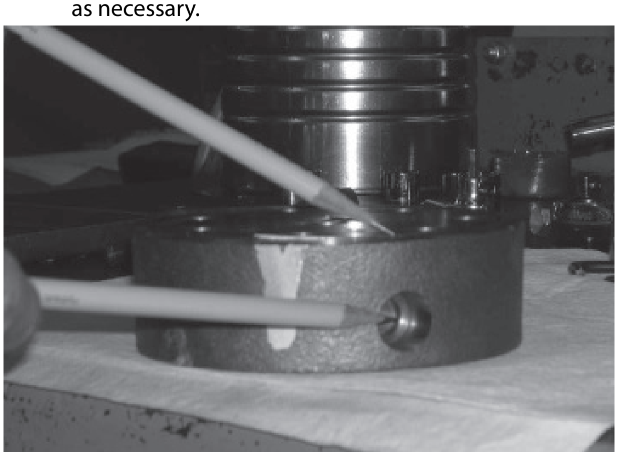
NOTICE

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

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

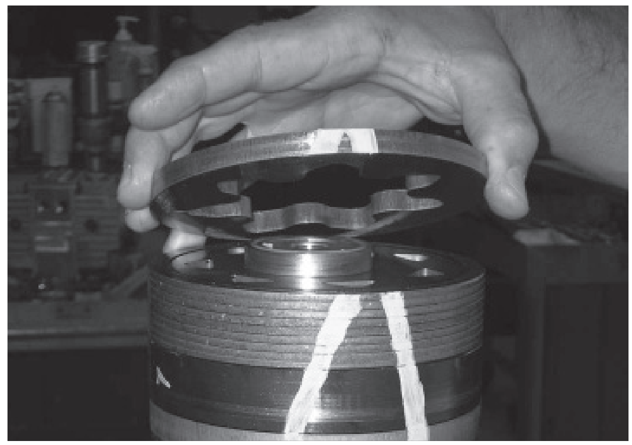
NOTE: *The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.*

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.



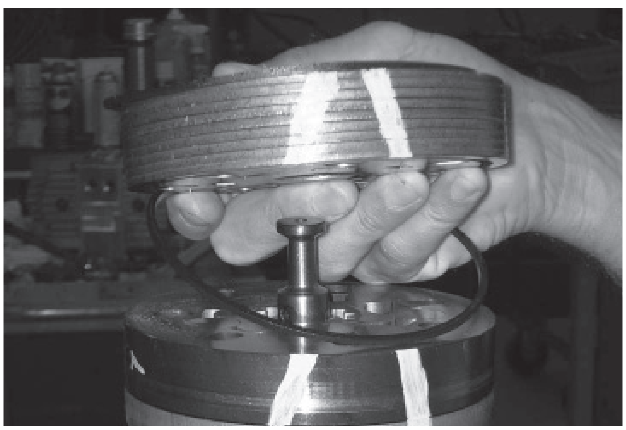
NOTE: *A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.*

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



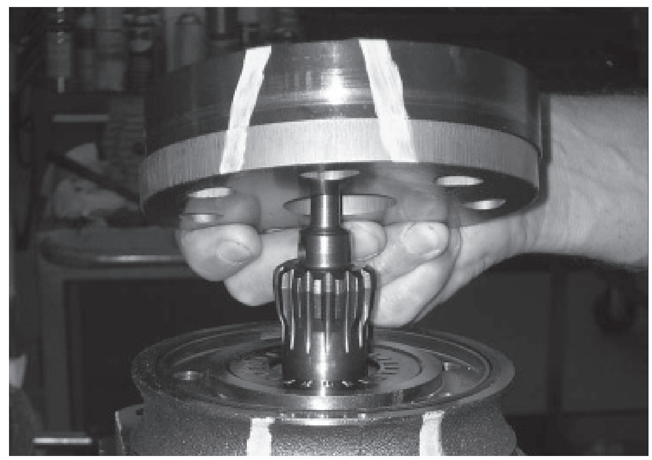
8. Remove commutator (5) and seal ring (3) Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator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

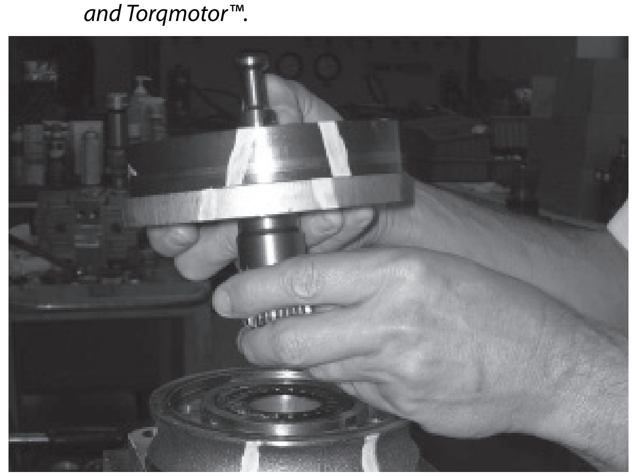


NOTE: *The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides oft hem an if old to ensure that same surface is reassembled against the rotor set.*

10. Remove rotor set (8) and wear plate (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 wear plate to work the drive link out of the rotor (8A) and wear plate. 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.



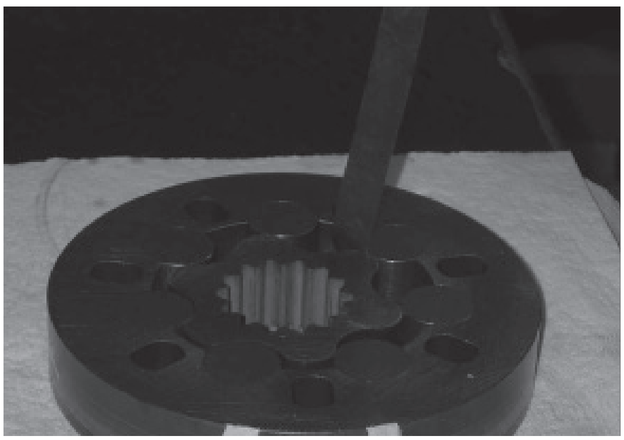
NOTE: *The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set into Torqmotor™.Marking 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.*

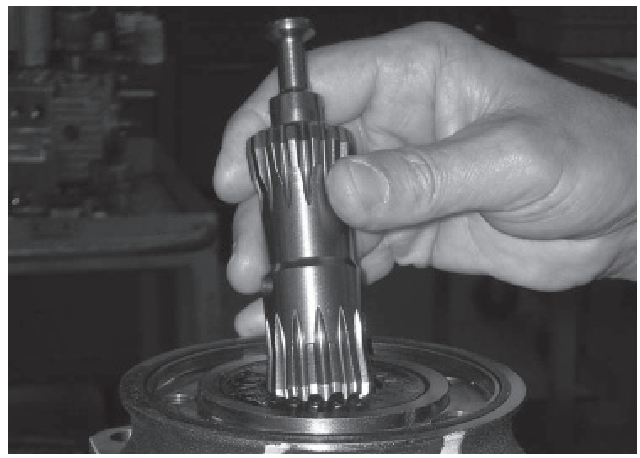
NOTE: *A polished pattern on the wear plate from rotor rotation is normal.*

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 in. (0.13 mm) of clearance, replace rotor set.

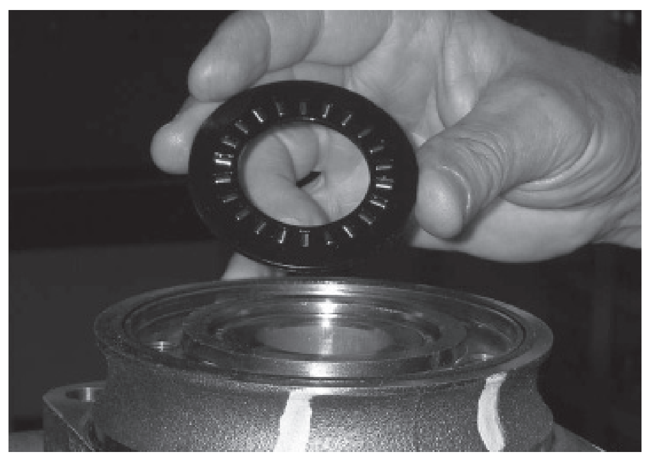


NOTE: *If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.*

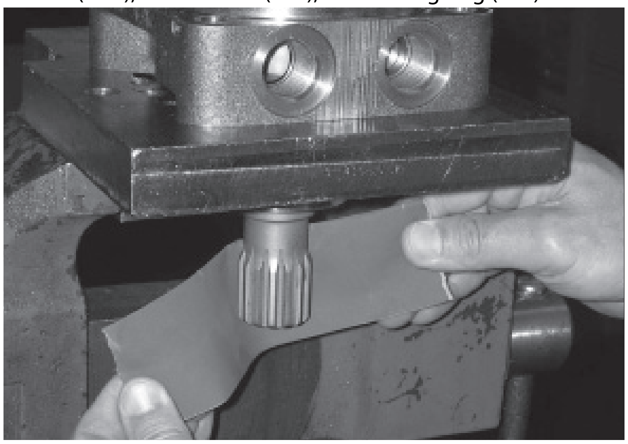
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).



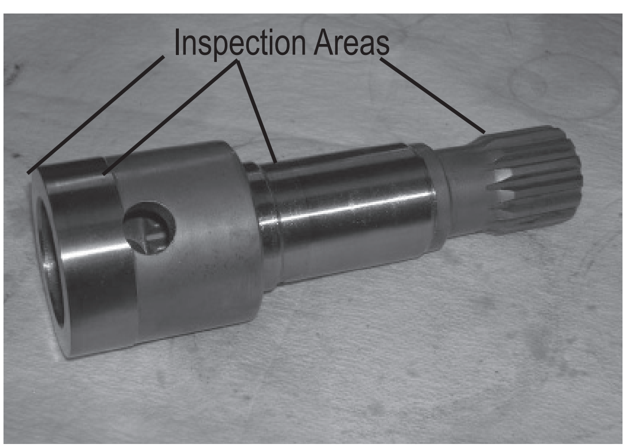
13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



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.

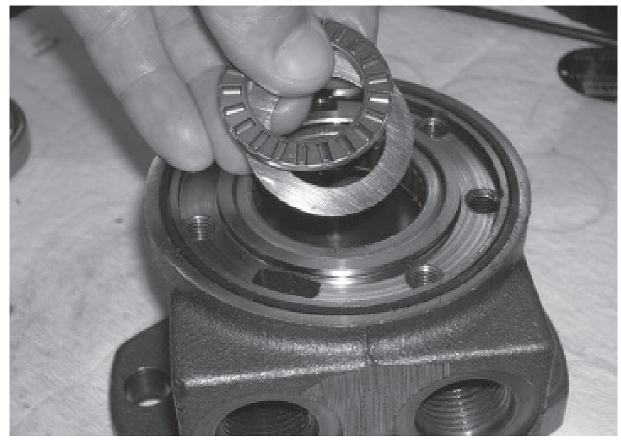


NOTE: *Minor shaft wear in seal area is permissible. If wear exceeds 0.020 in. (0.51 mm) diametrically, replace coupling shaft.*

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

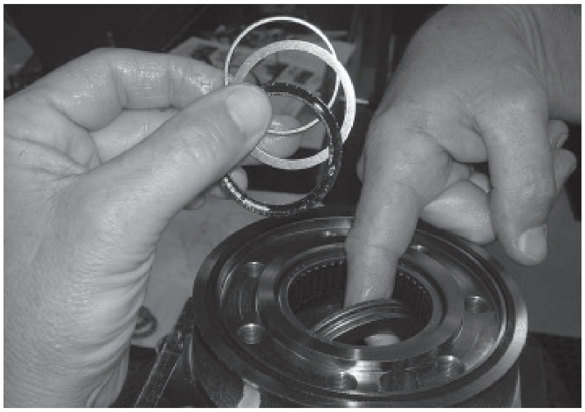
16. Remove and discard seal ring (4) from housing (18).

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

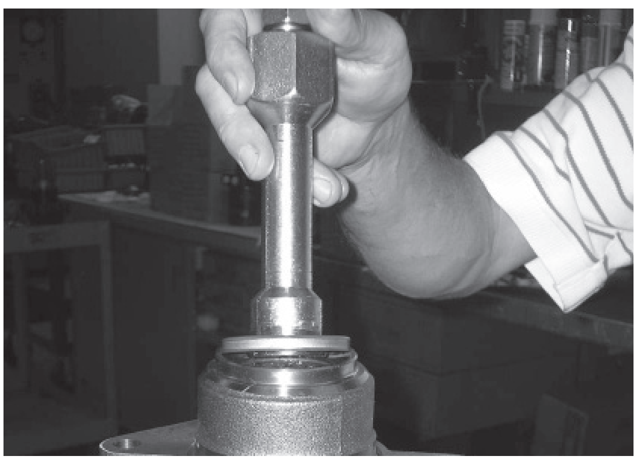


18. Remove seal (16) and backup ring (17) from Small Frame, housing (18) and backup washer (25). Discard both.

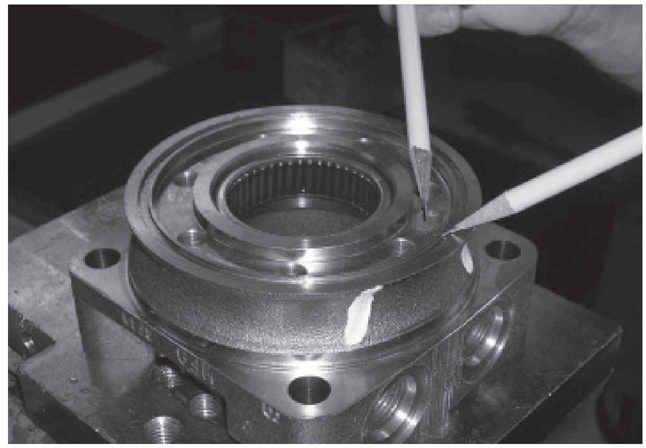
19. Remove seal (16), backup ring (17) and backup washer (25) from large frame, housing by working them around unseated thrust washers (14) and thrust bearing (15) and out of the housing. Discard seal and washers.



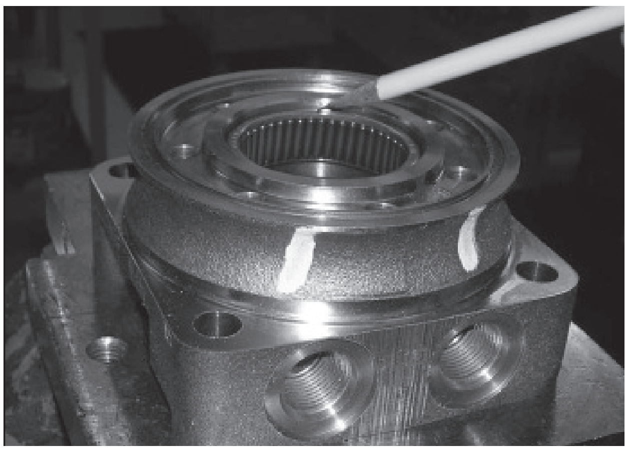
20. Remove housing (18) from vise, invert it and remove and discard seal. A blind hole bearing or seal puller is required.

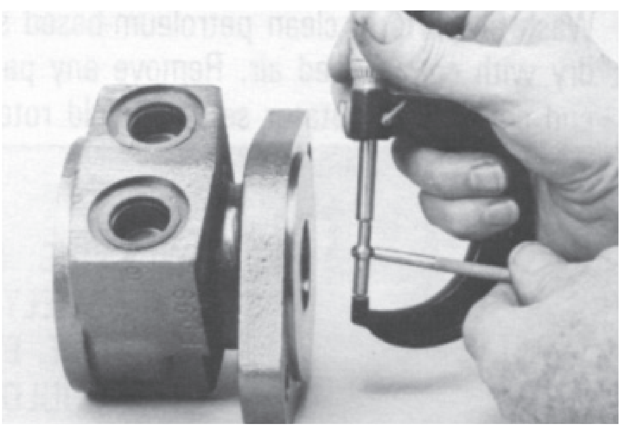


21. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly.



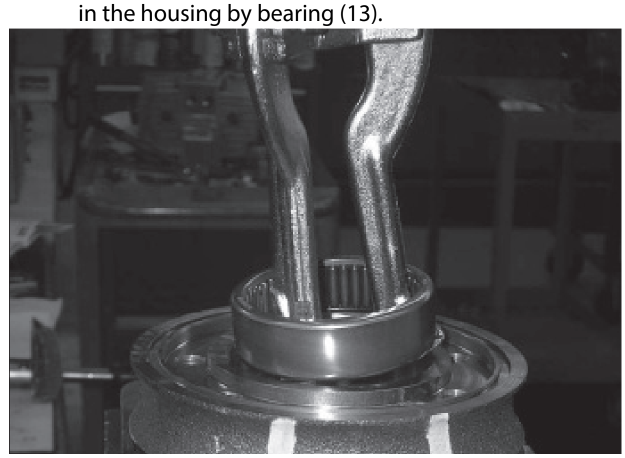
22. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate 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.

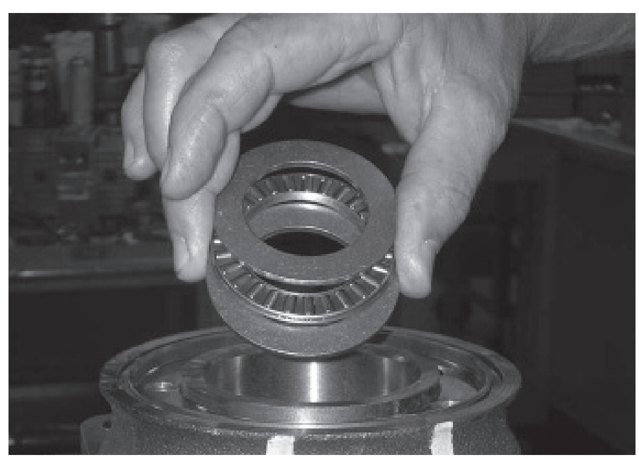




NOTE: *The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counterbore should be measured and noted before removing the bearings/ bushings. This will facilitate the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

23. 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

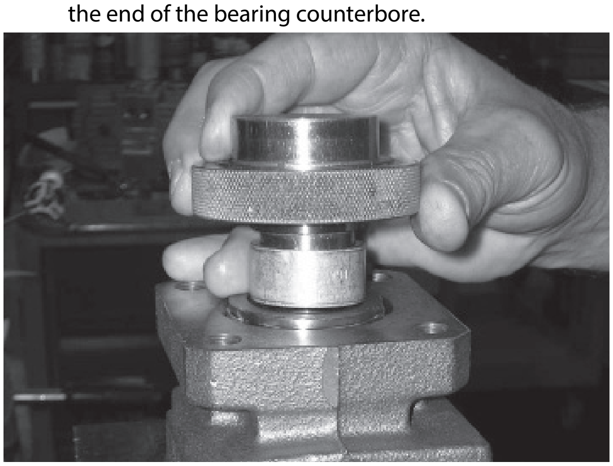
SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

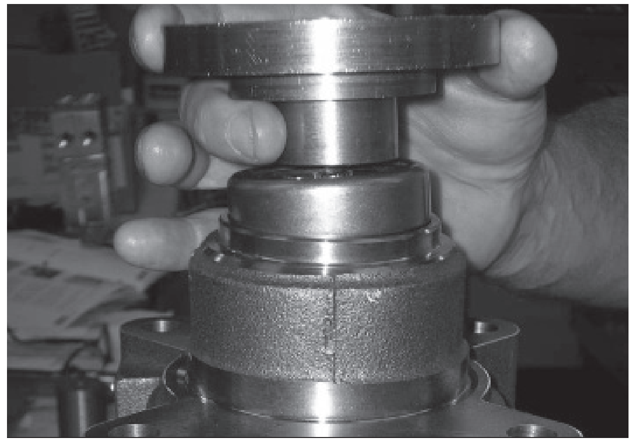
WARNING

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 in. (3.84/4.09 mm) from the end of the bearing counterbore.





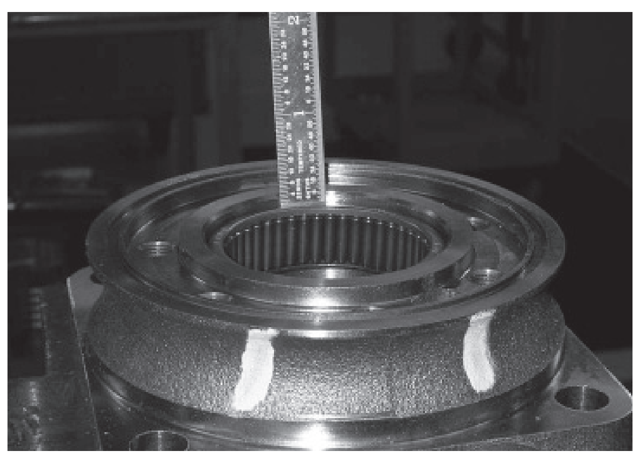
NOTE: *Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.*

NOTICE

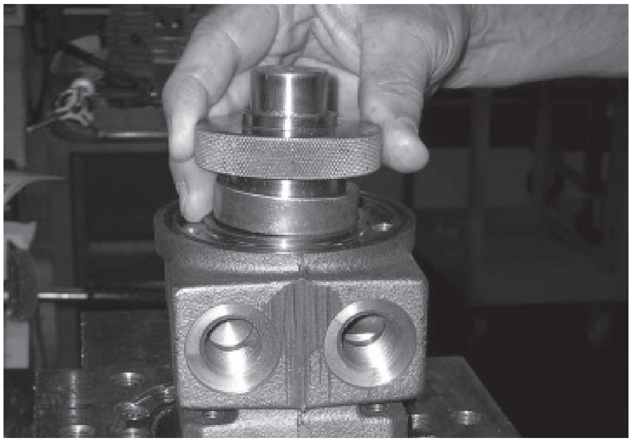
IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT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

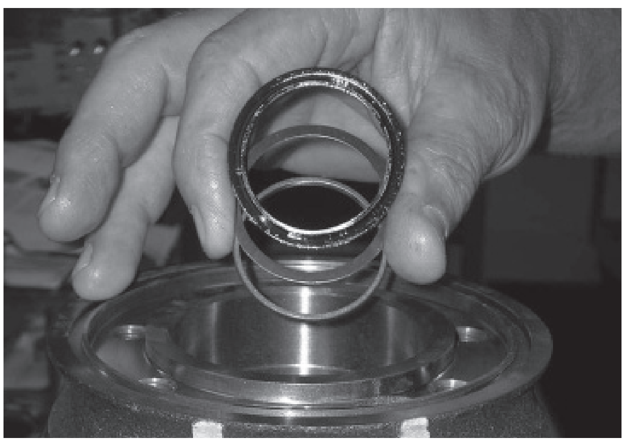
NOTICE

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.



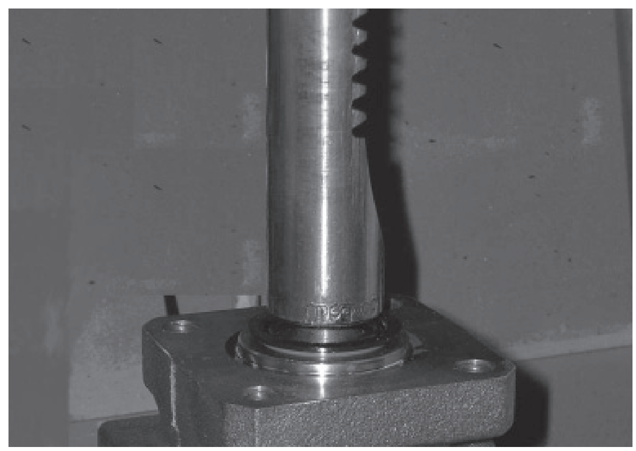
2. The Torqmotor™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 in. (0.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/ bushing (19).

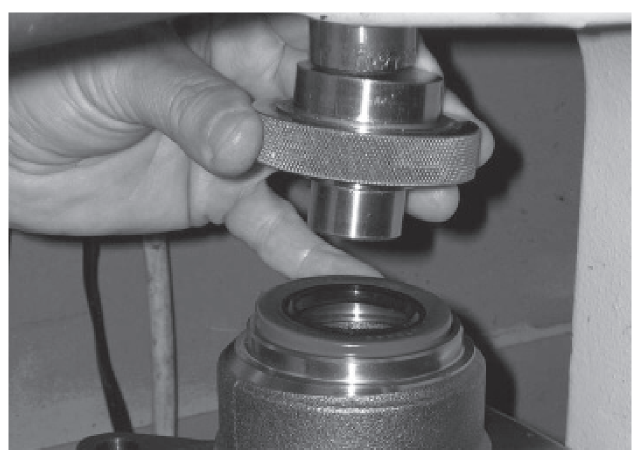




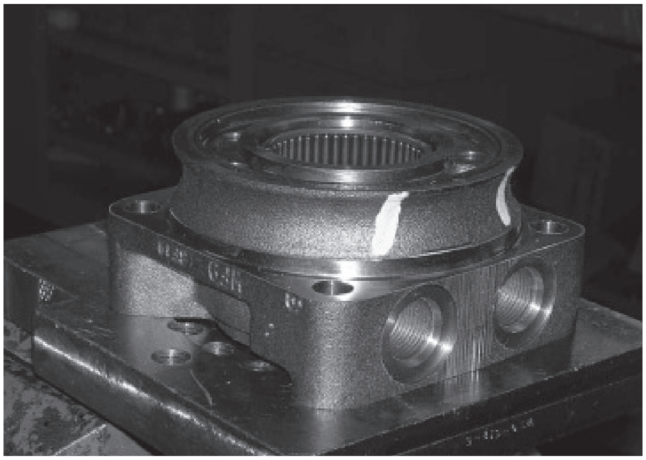
3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore.

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

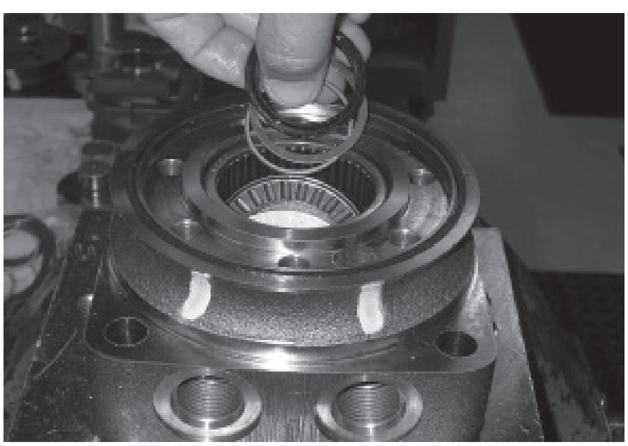




4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



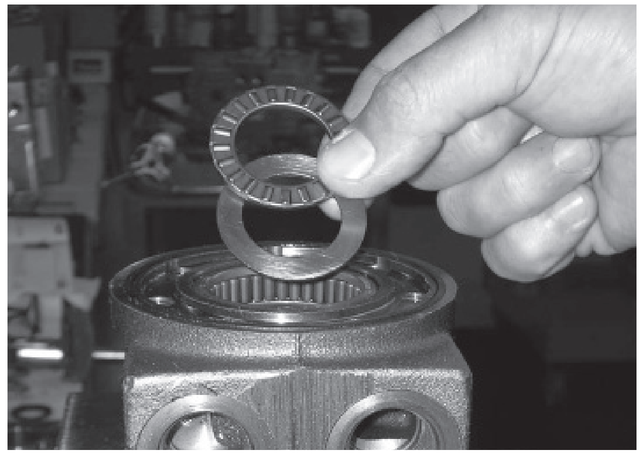
5. On the Torqmotor™ assemble a new backup washer (17) and new seal (16) with the seal lip facing toward the inside of Torqmotor™, into their respective counterbores in housing (18) if they were not assembled in procedure 2.



NOTICE

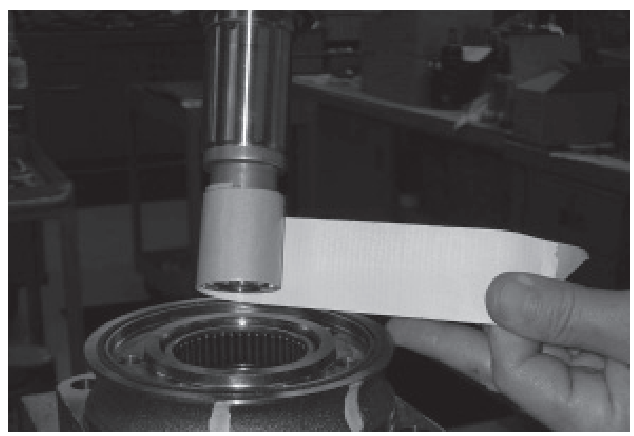
ORIGINAL DESIGN LARGE FRAME, TF & TG TORQMOTORS™ THAT DO NOT HAVE BACKUP WASHER (25) WHEN DISASSEMBLED MUST BE ASSEMBLED WITH A NEW BACKUP WASHER (17), NEW BACKUP WASHER (25), AND NEW SEAL (16).

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

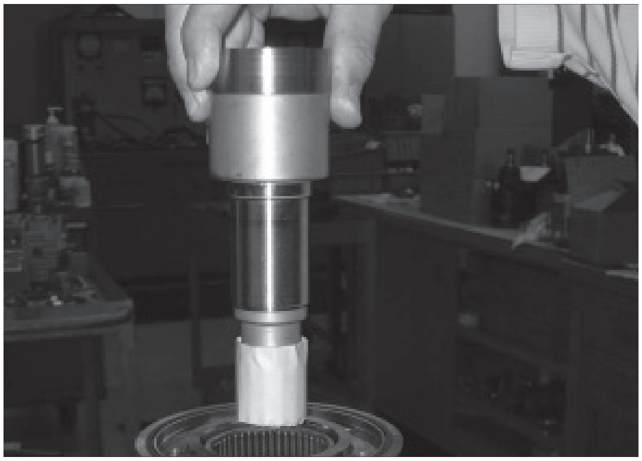


NOTE: *Torqmotors™ require one thrust washer (14) with thrust bearing (15).The coupling shaft will be seated directly against the thrust.*

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



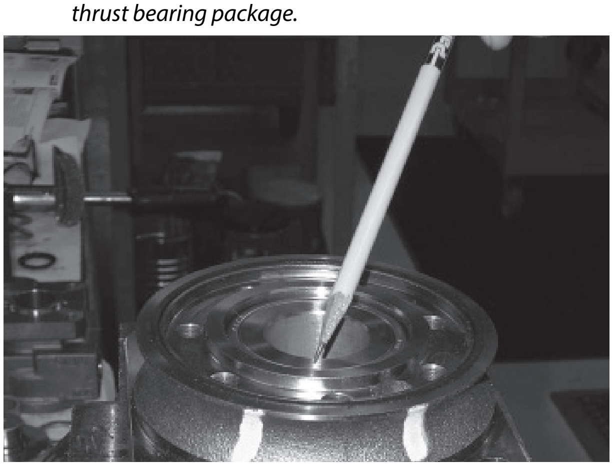
8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in the housings.



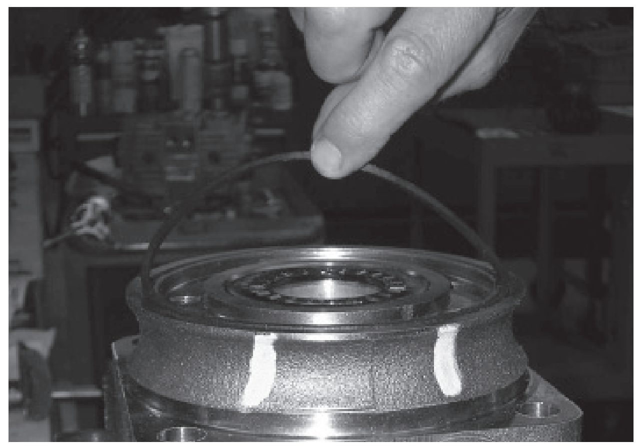
NOTICE

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

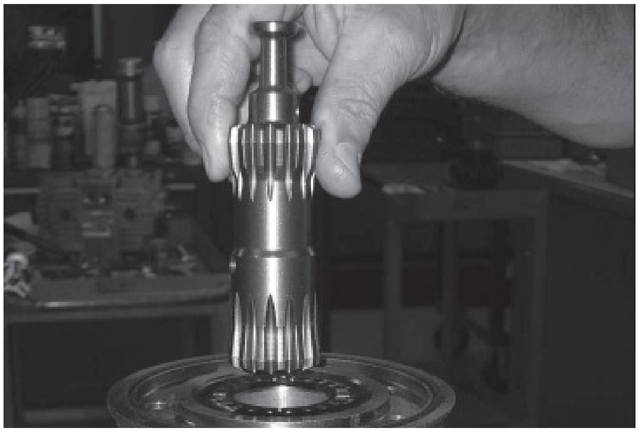


9. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove.



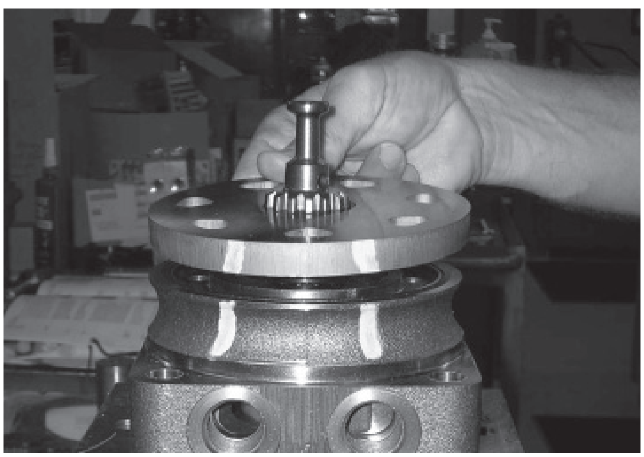
NOTE: *One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures.The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over 0.5 in. (12.7 mm) longer than the bolts (1) used in the Torqmotor™.*

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

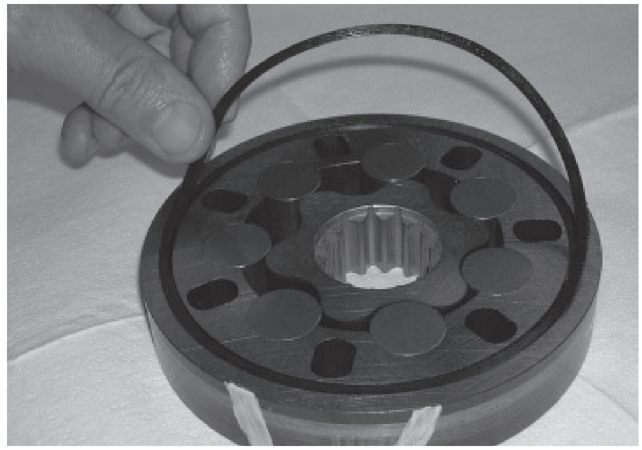


NOTE: *Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.*

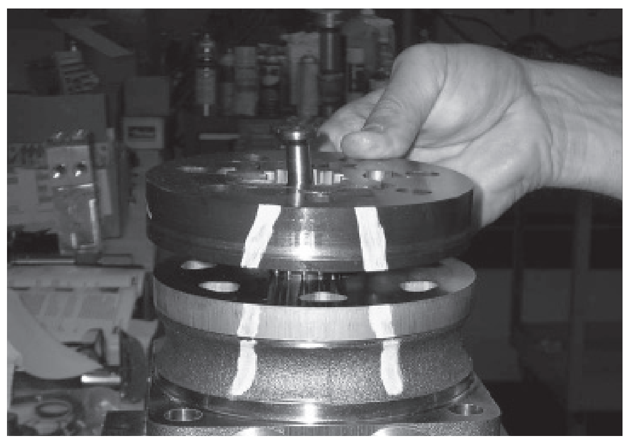
11. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



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



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

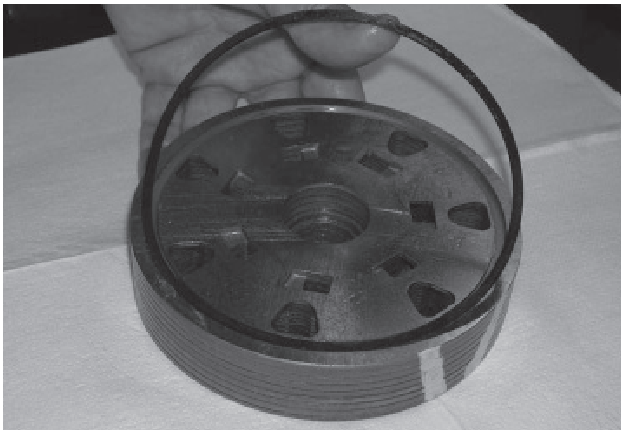


NOTE: *It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.*

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

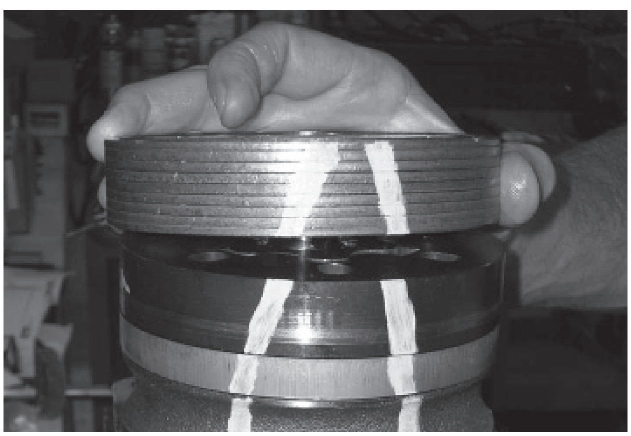
NOTE: *The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the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

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

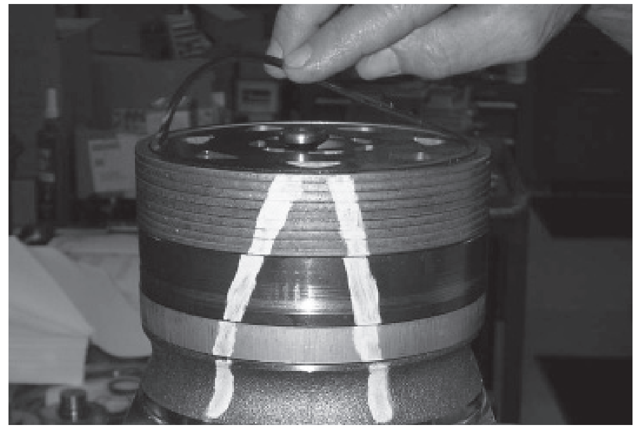


NOTE: *The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression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

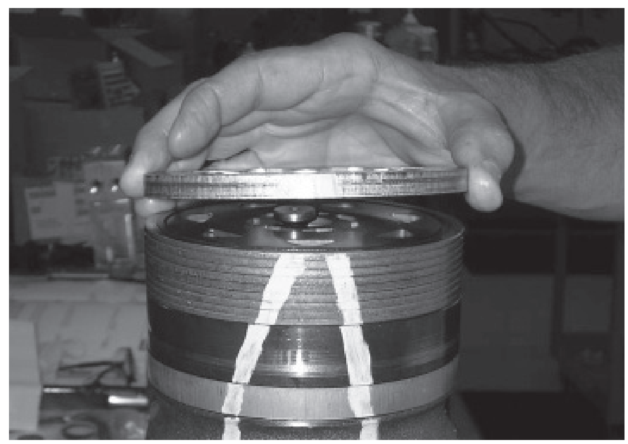
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



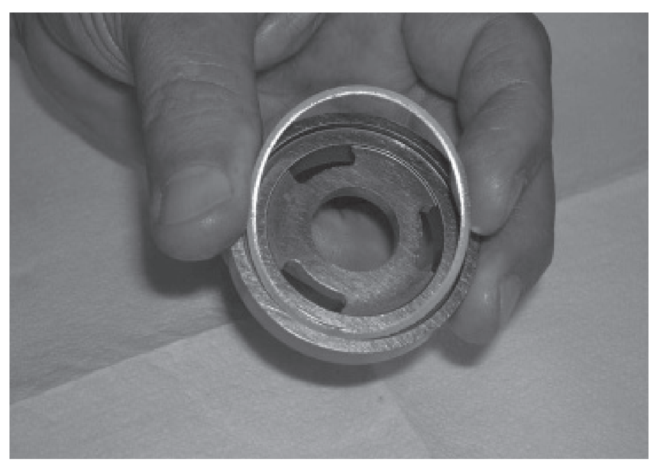
16. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.

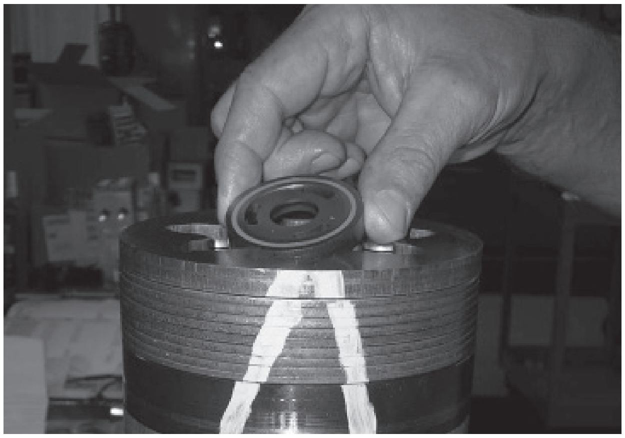


17. Assemble the commutator ring (6) over alignment studs onto the manifold.

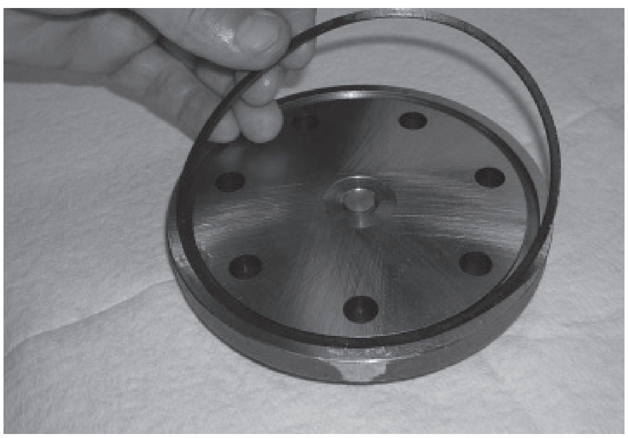


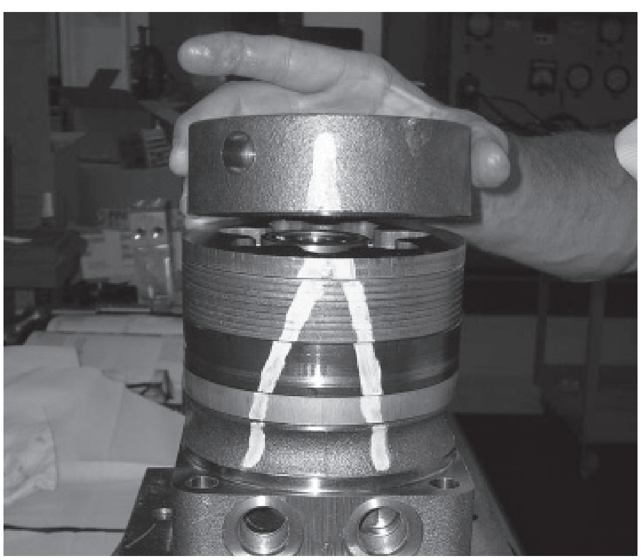
18. Assemble a new seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.

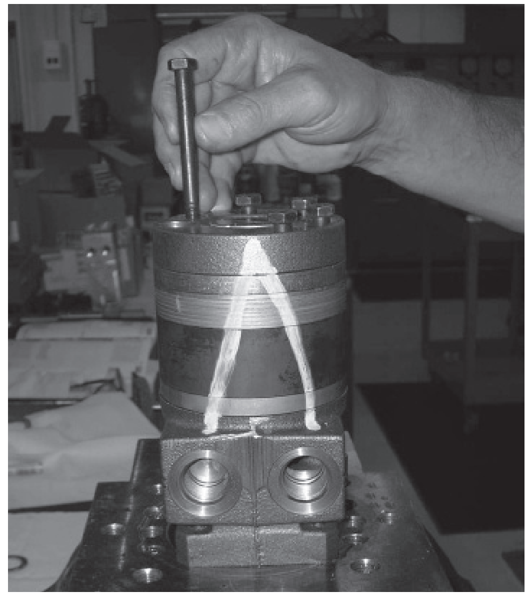




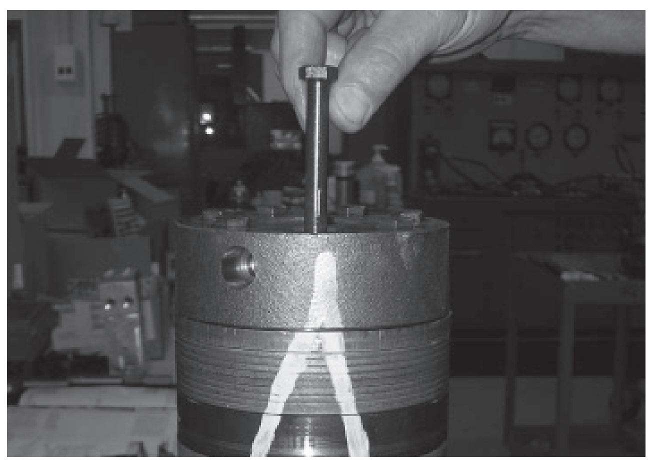
19. Assemble a new seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18). The correct 5 bolt end cover bolt hole relationship to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

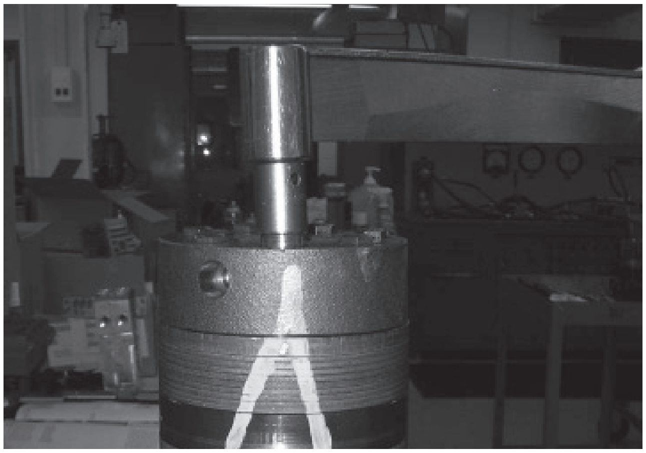


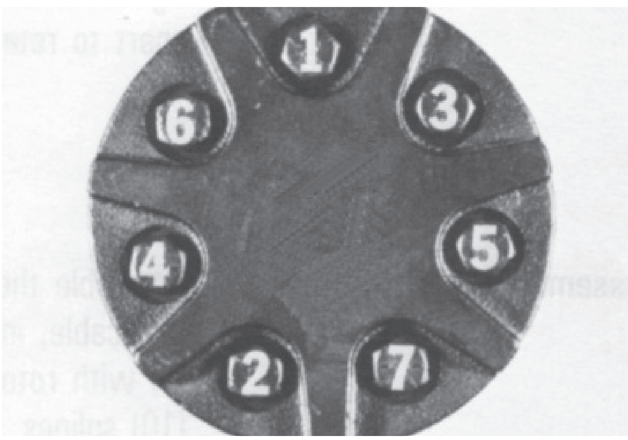




20. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 50-55 ft. lbs. (68-75 Nm) for the seven 3/8-24 threaded bolts.



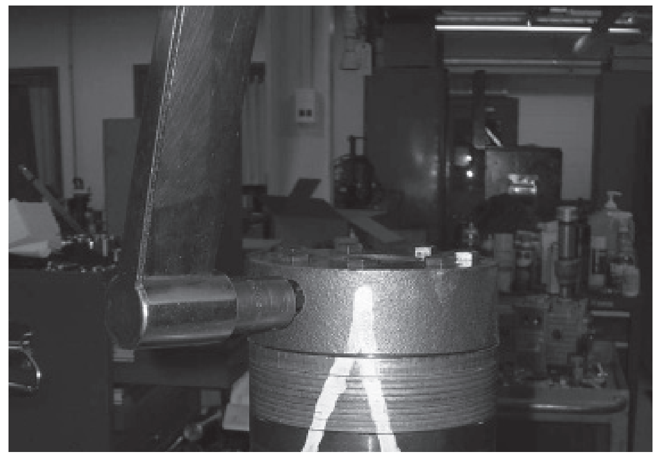


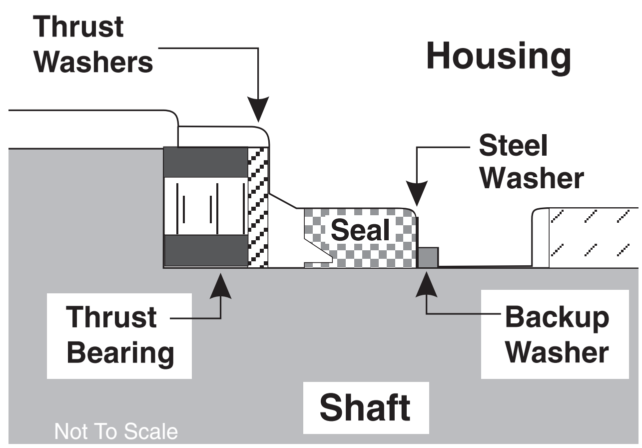


NOTE: *The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.*

21. 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.





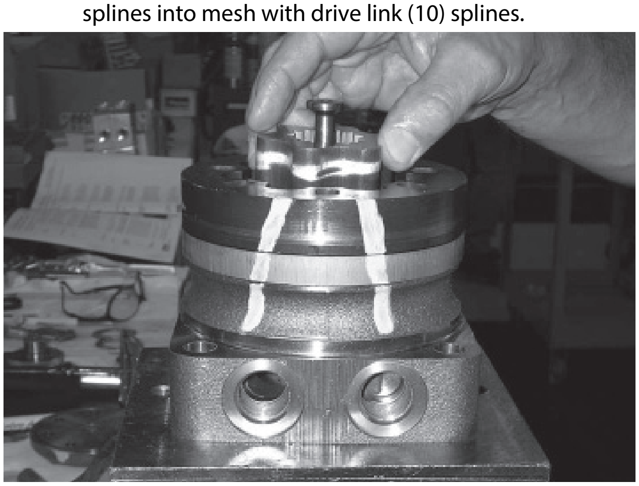
One Piece Stator Construction

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.

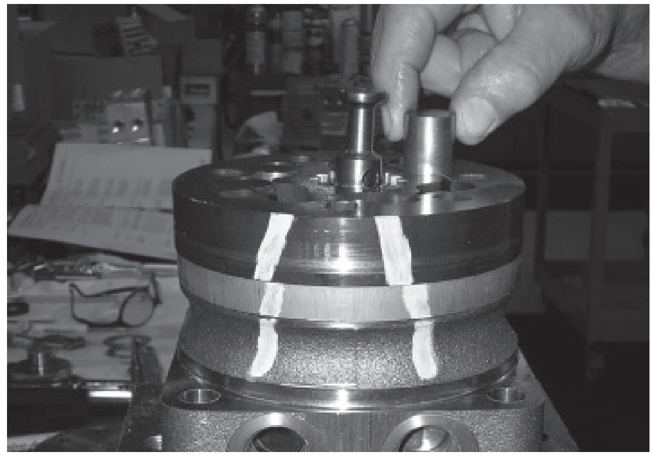
2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

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.



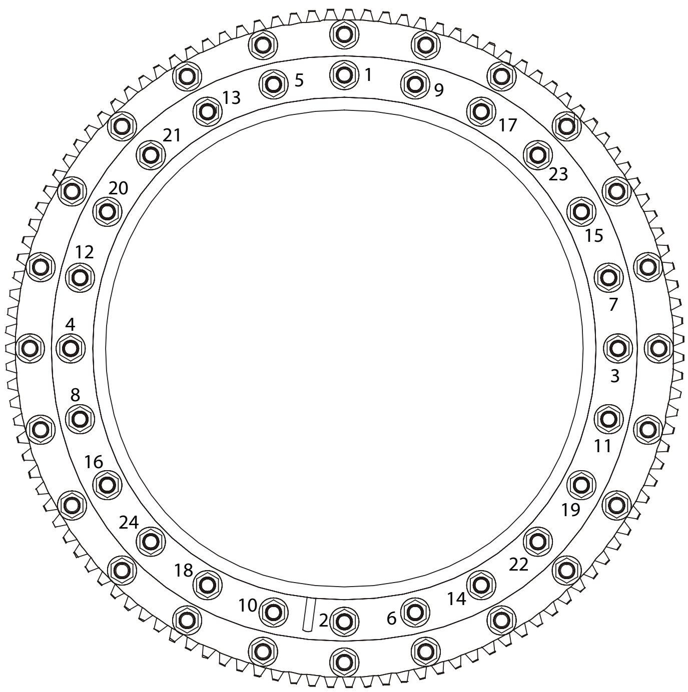
NOTICE

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

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

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

3.20 SWING BEARING



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

Figure 3-74. Swing Bearing Torque Sequence

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 extended main boom to horizontal. (See Figure 3-76.)
- **b.** At the positions indicated on Figure 3-78., try to insert a 0.0015 in. feeler gauge between the bolt and hardened washer at the arrow indicated position.
- **c.** Ensure that the 0.0015 in. feeler gauge will not penetrate under the bolt head to the bolt shank.
- **d.** Swing the turntable 90 degrees, and check some selected bolts at the new position.
- **e.** Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.

2. Check the turntable to bearing Attach bolts as follows:

- **a.** Elevate the fully retracted main boom to full elevation. (See Figure 3-75.)
- **b.** At the position indicated on Figure 3-78., try to insert the 0.0015 in. 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 3-78., try and insert the 0.0015 in. feeler gauge between the bolt head and hardened washer at the arrow indicated position.

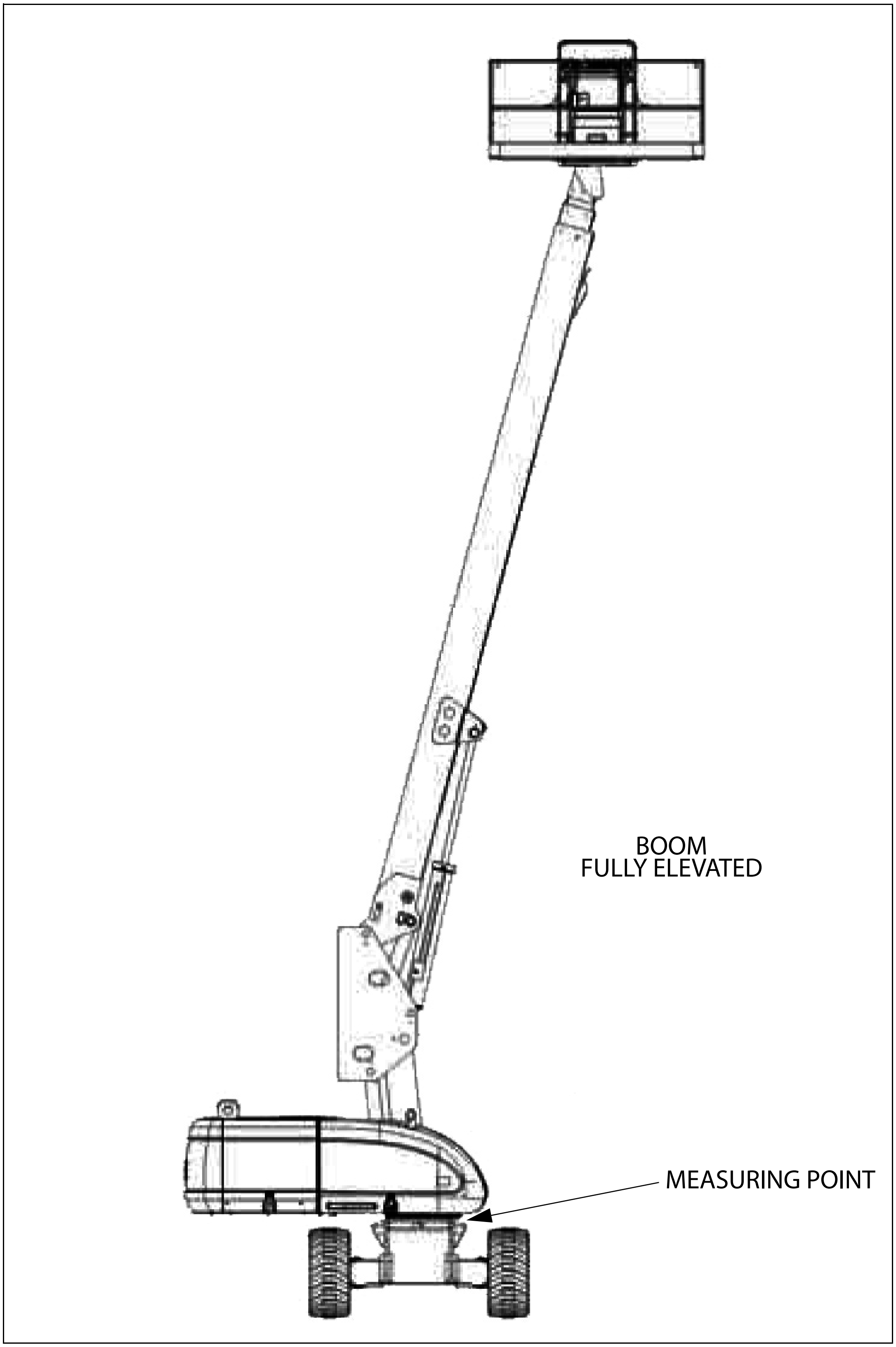


Figure 3-75. Swing Bearing Tolerance Boom Placement - Sheet 1 of 2

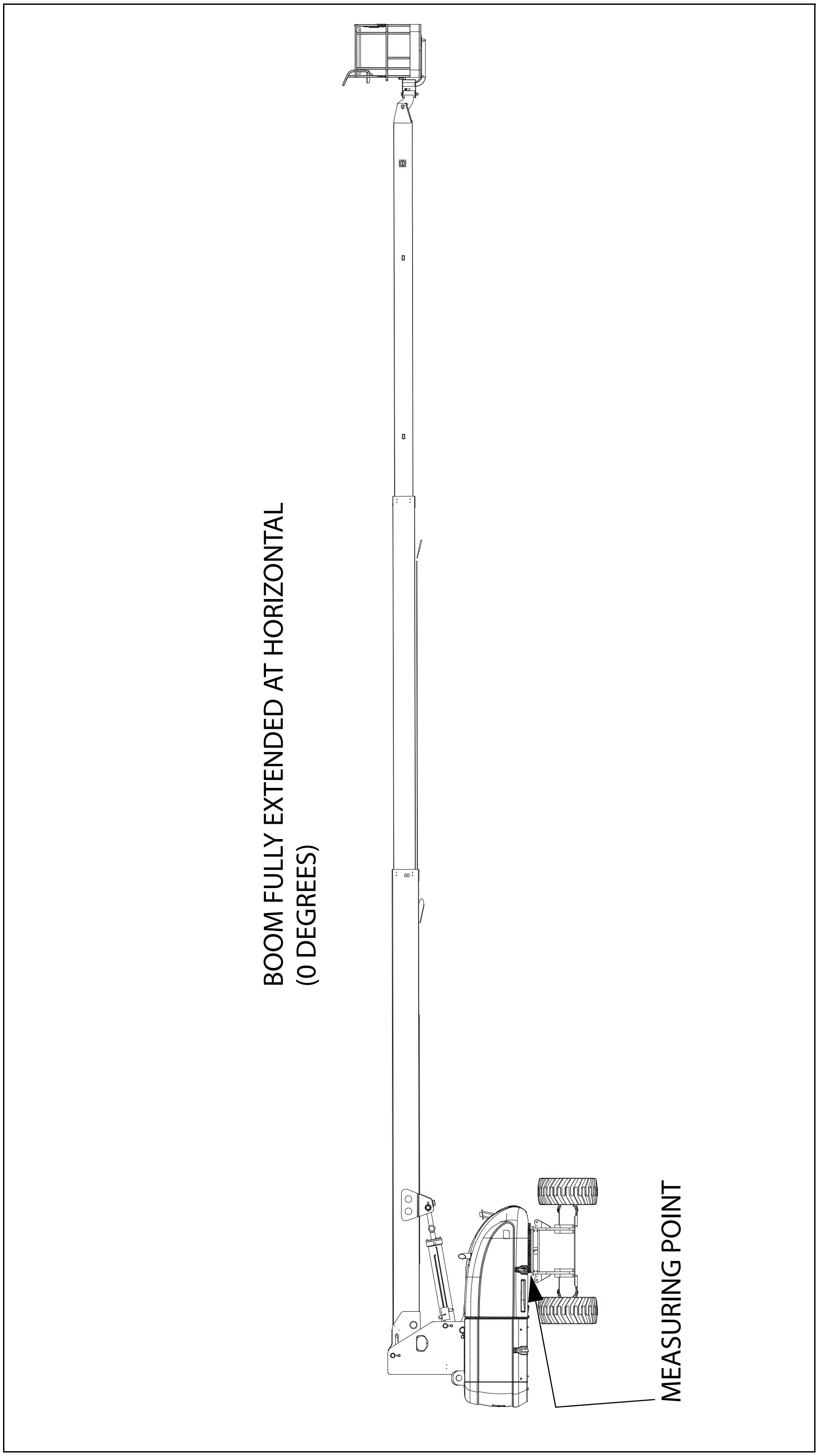


Figure 3-76. Swing Bearing Tolerance Boom Placement - Sheet 2 of 2

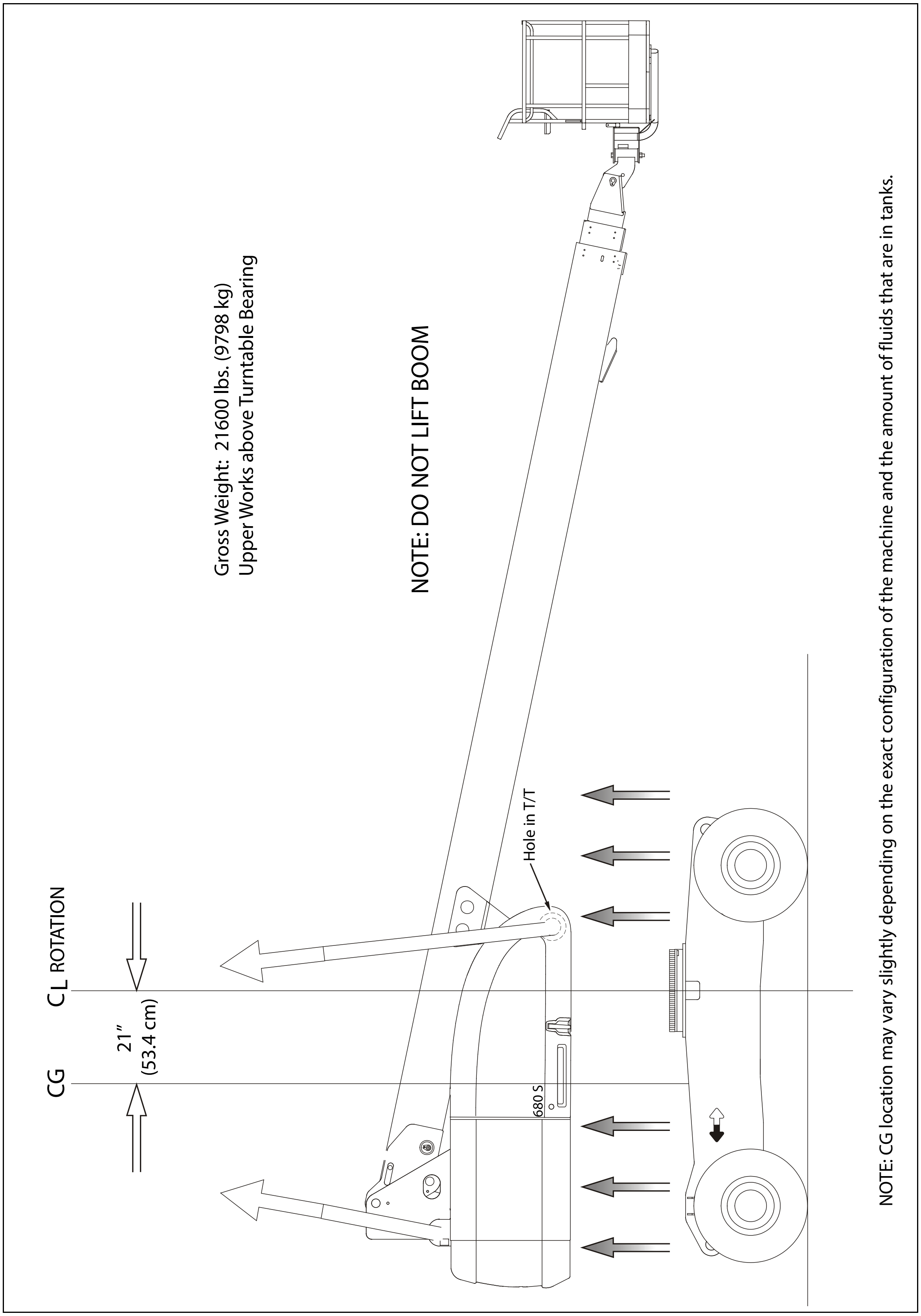


Figure 3-77. Swing Bearing Removal

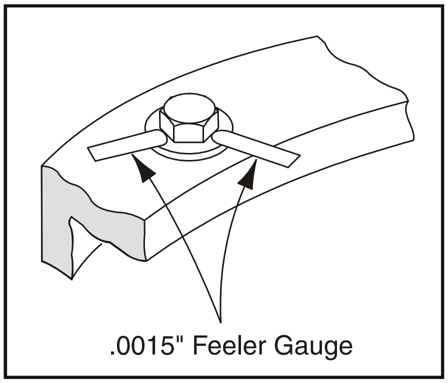


Figure 3-78. Swing Bolt Feeler Gauge Check.

Wear Tolerance

1. From the underside of the machine, at rear center, with the main boom fully elevated and fully retracted, as shown in Figure 3-75., Swing Bearing Tolerance Boom Placement - Sheet 1 of 2, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-79., Swing Bearing Tolerance Measuring Point.
2. At the same point, with the main boom at horizontal and fully extended, as shown in Figure 3-76., Swing Bearing Tolerance Boom Placement - Sheet 2 of 2. Using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-79., Swing Bearing Tolerance Measuring Point.
3. If a difference greater than 0.079 in. (2.00 mm) is determined, the swing bearing should be replaced.
4. If a difference less than 0.079 in. (2.00 mm) is determined, and any of the following conditions exist, the bearing should be removed, disassembled, and inspected for the following:
    a. Metal particles in the grease.
    b. Increased drive power required.
    c. Noise.
    d. Rough rotation.
5. If bearing inspection shows no defects, reassemble and return to service.

NOTICE

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

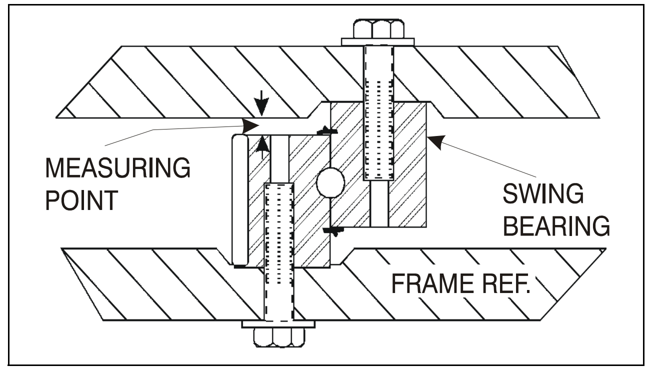


Figure 3-79. Swing Bearing Tolerance Measuring Point.

Swing Bearing Removal

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

WARNING

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

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

NOTICE

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

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

8. Carefully place the turntable on a suitably supported trestle.

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

Swing Bearing Installation

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

CAUTION

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

2. Apply a light coating of 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.

NOTICE

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

3. Refer to the Torque Sequence diagram as shown in Figure 3-74., Swing Bearing Torque Sequence. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of JLG Threadlocker P/N 0100019 to the new bearing bolts, and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to a torque of 190 ft. lbs. (258 Nm) w/ Loctite.

4. Remove the lifting equipment from the bearing.

5. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.

6. Carefully lower the turntable onto the swing bearing, ensuring that the scribed line of the inner race of the bearing aligns with scribed line on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the turntable.

7. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of JLG Threadlocker P/N 0100019 to the new bearing bolts, and install the bolts and washers through the turntable and inner race of the bearing.

8. Following the Torque Sequence diagram shown in Figure 3-74., 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.

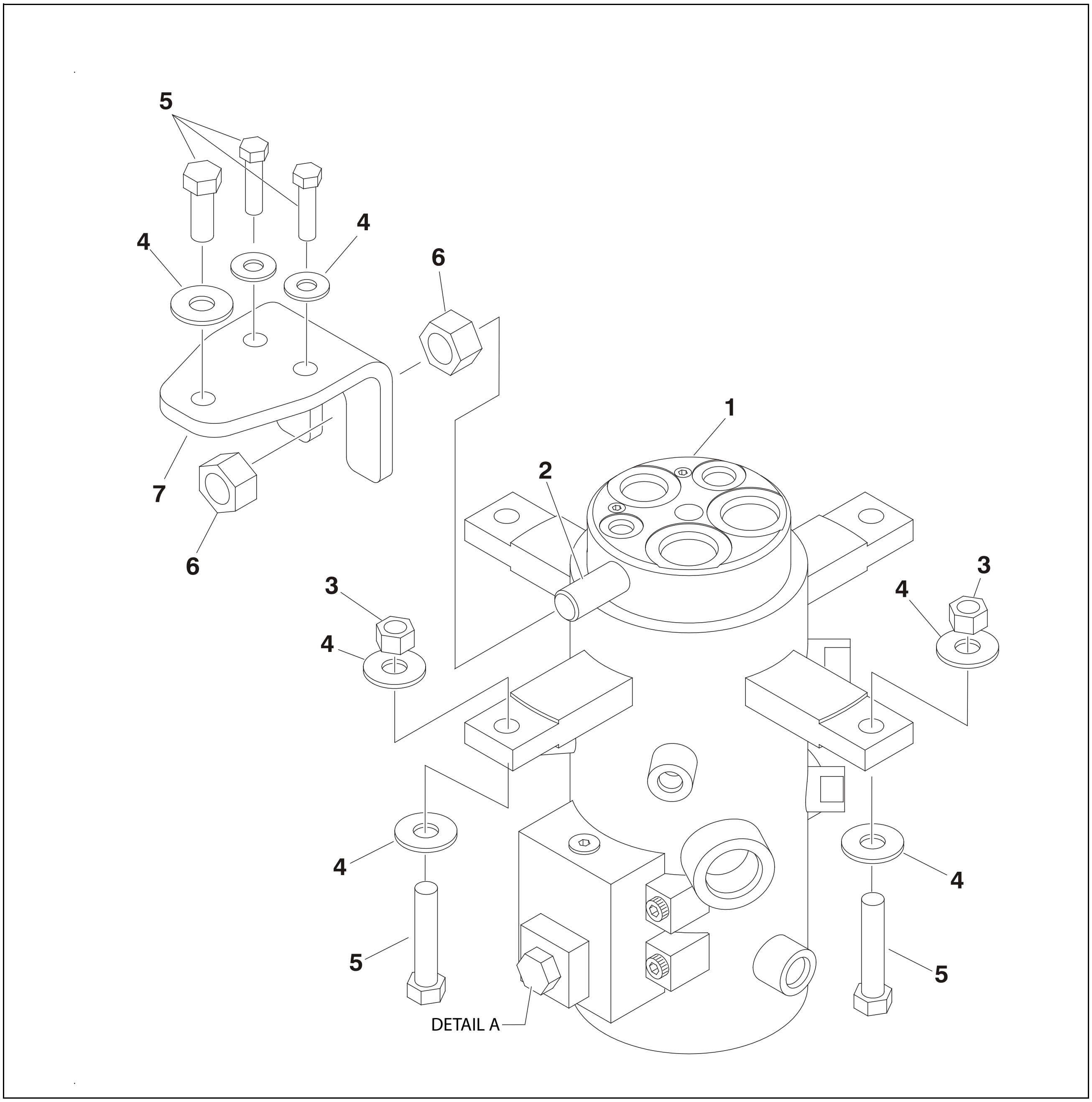
3.21 ROTARY COUPLING (PRIOR TO SN 0300137913)

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 3-81., Rotary Coupling (Prior to SN 0300137913) - 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.

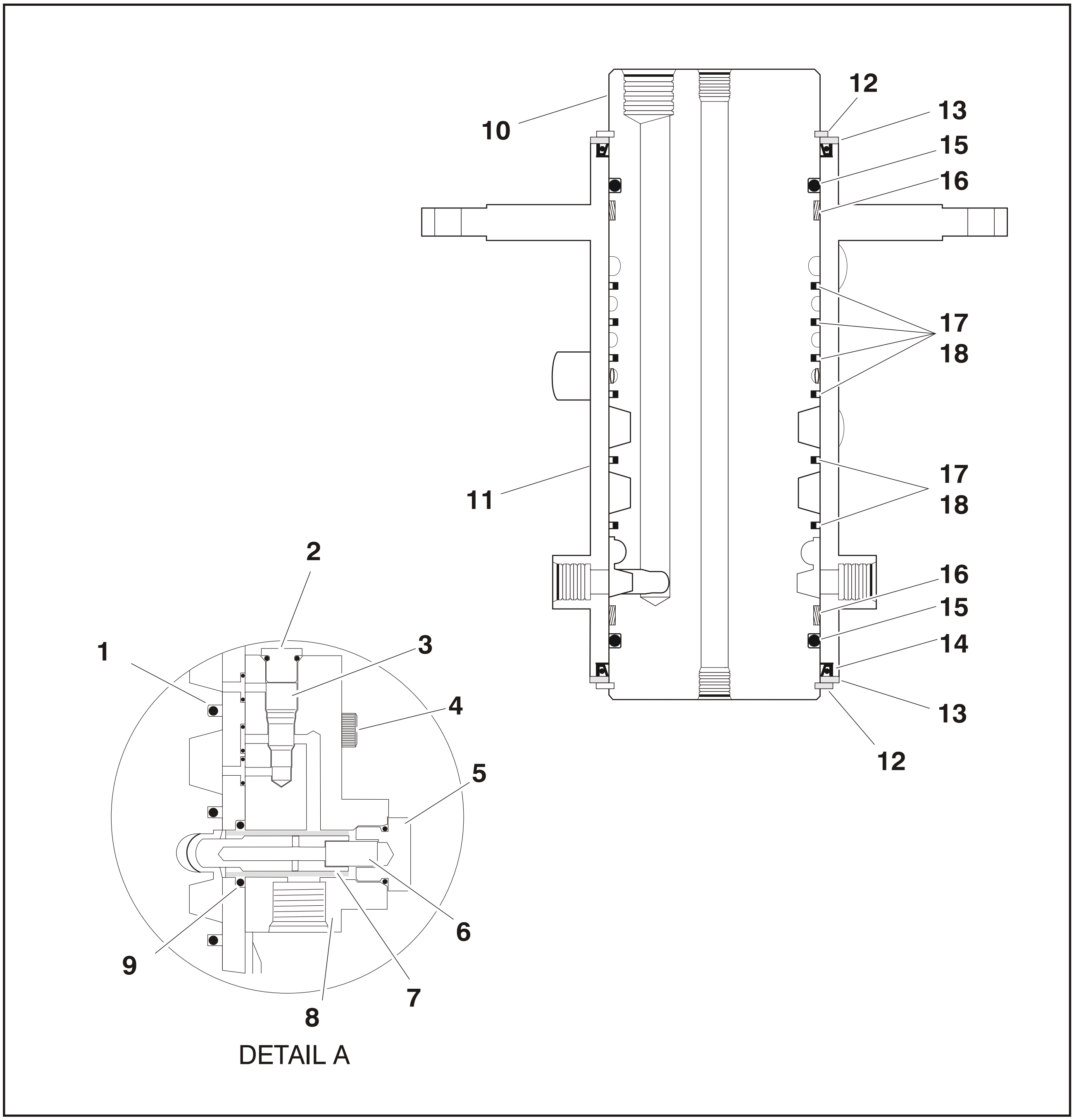
Table 3-8. Coupling Port Information Table (Prior to SN 0300137913)

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)



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

Figure 3-80. Rotary Coupling (Prior to SN 0300137913) - Sheet 1 of 2



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

Figure 3-81. Rotary Coupling (Prior to SN 0300137913) - Sheet 2 of 2

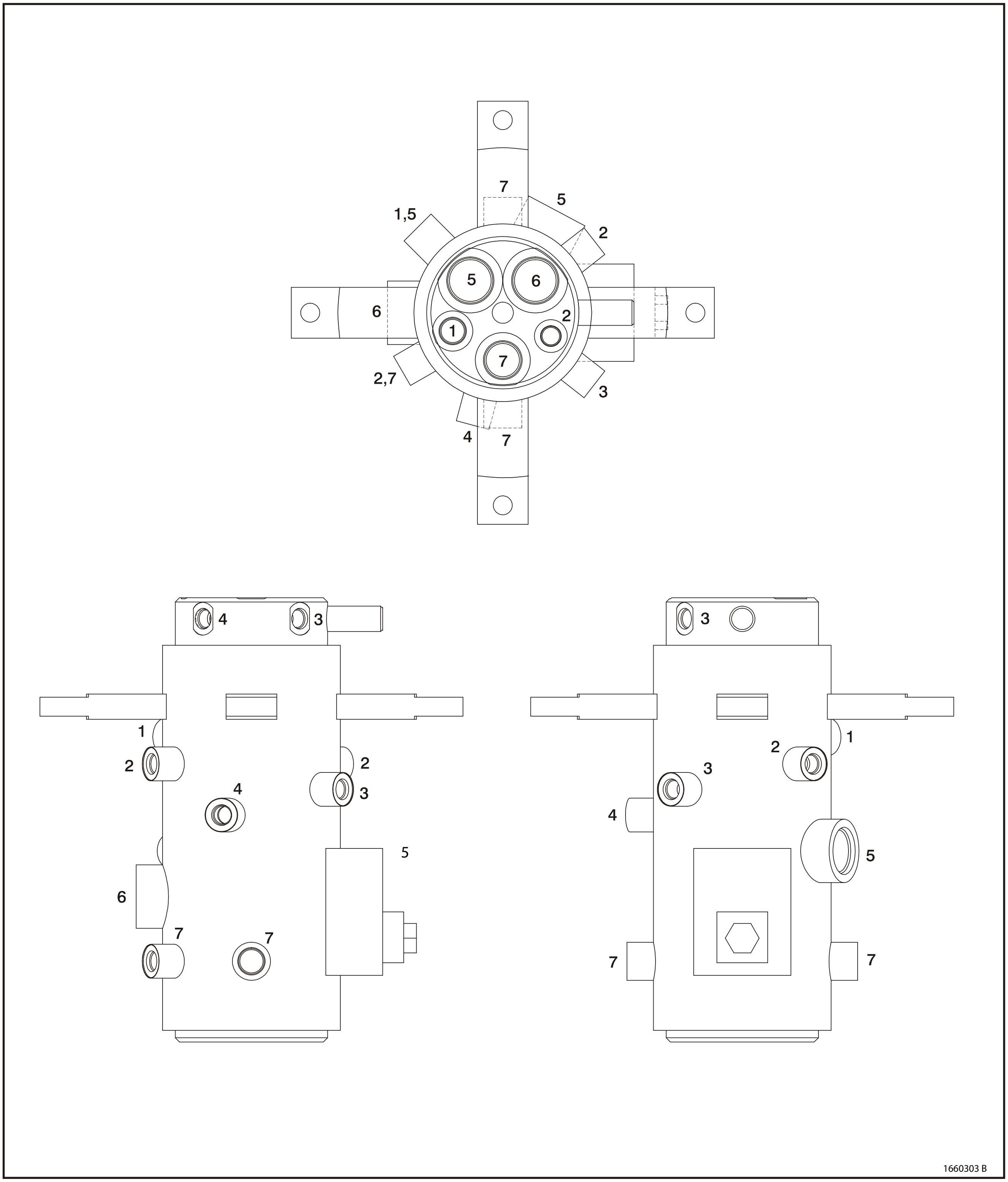


Figure 3-82. Rotary Coupling Port Location (Prior to SN 0300137913)

3.22 ROTARY COUPLING (SN 0300137913 THROUGH 0300189341)

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, 5).
6. Remove proximity switch.
7. Assemble lip seals (2) in direction shown in Figure 3-83., Rotary Coupling Seal Installation (SN 0300137913 through 0300189341).
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.

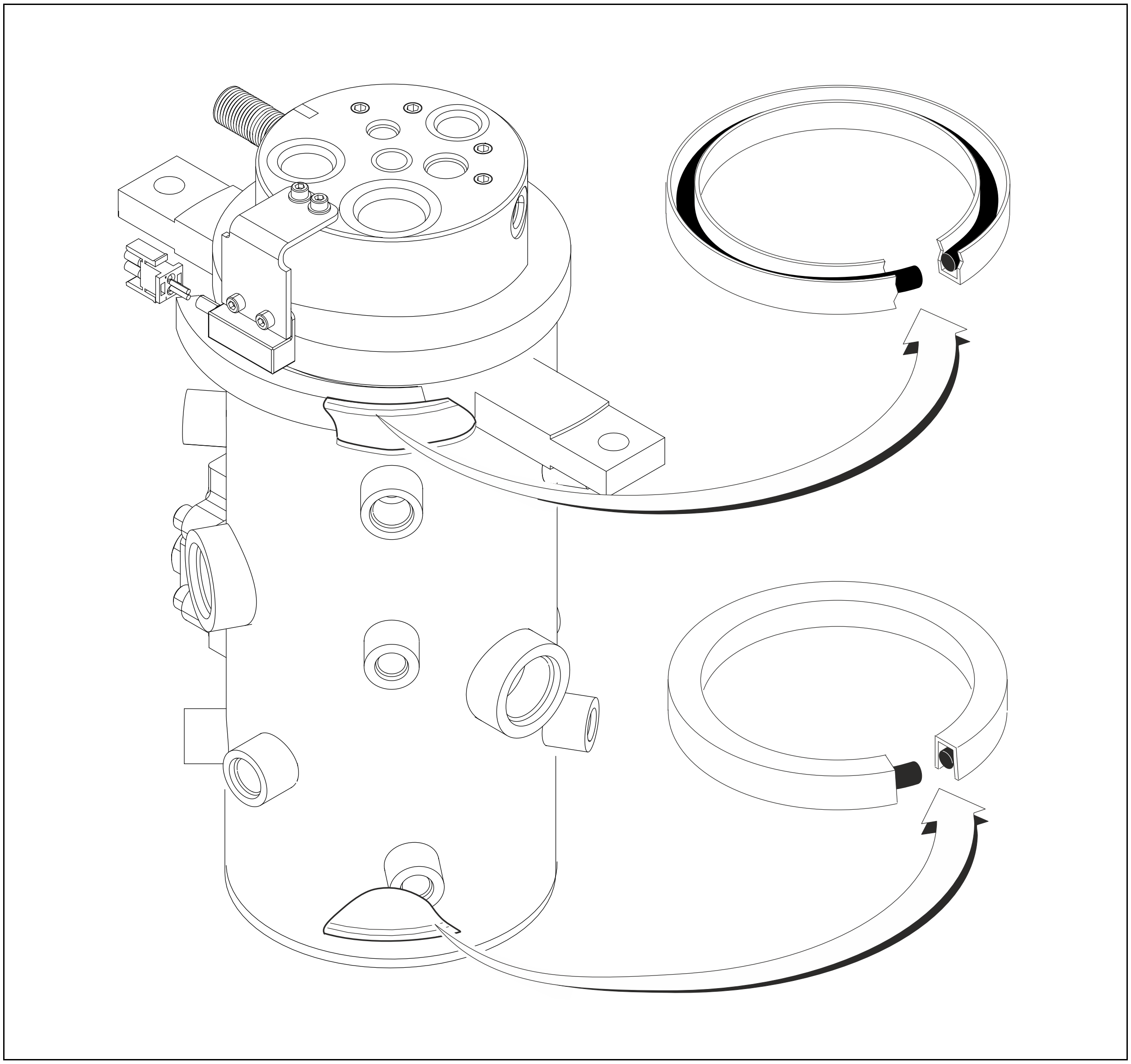
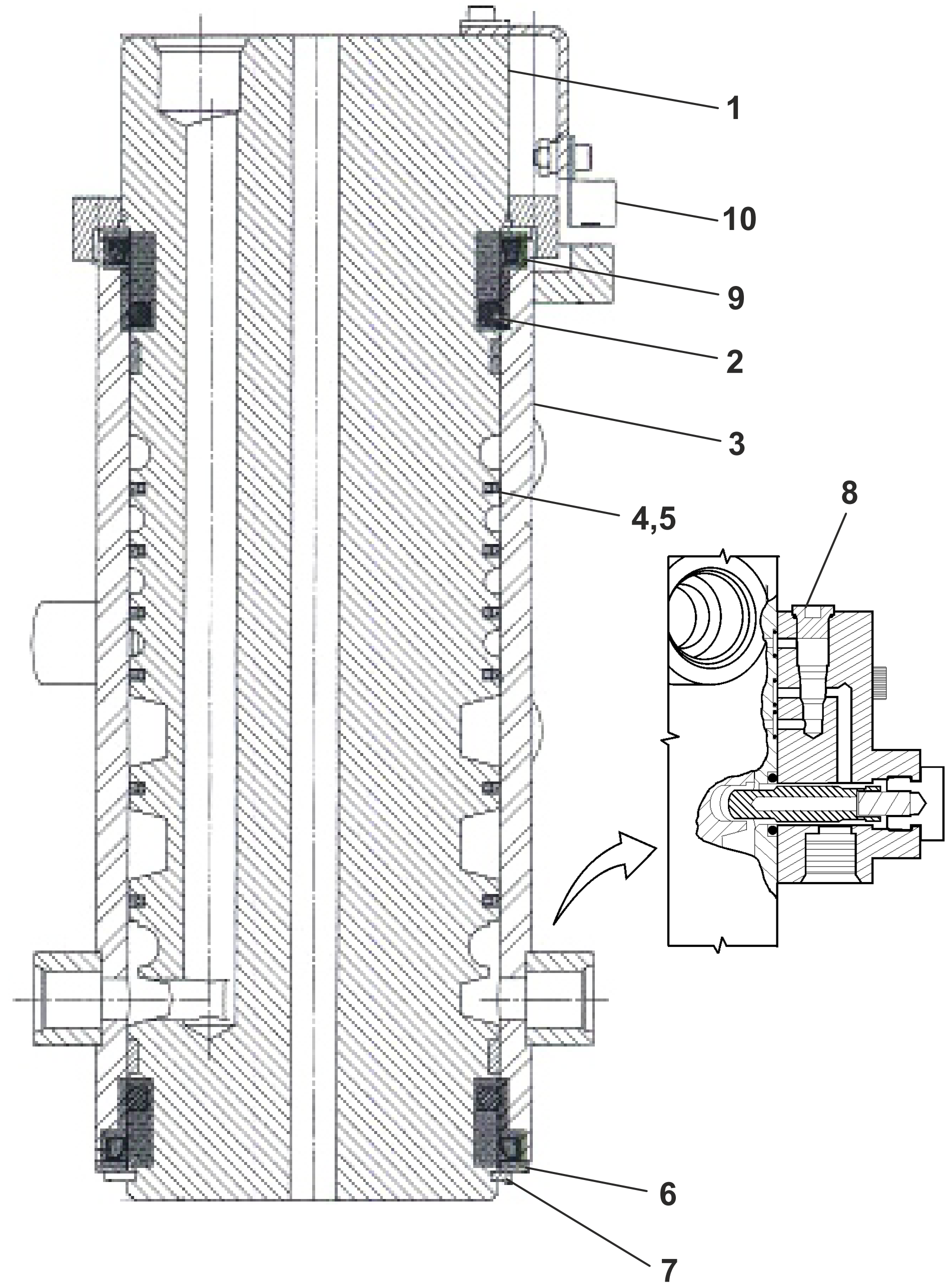


Figure 3-83. Rotary Coupling Seal Installation (SN 0300137913 through 0300189341)



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 3-84. Rotary Coupling Cutaway (SN 0300137913 through 0300189341)

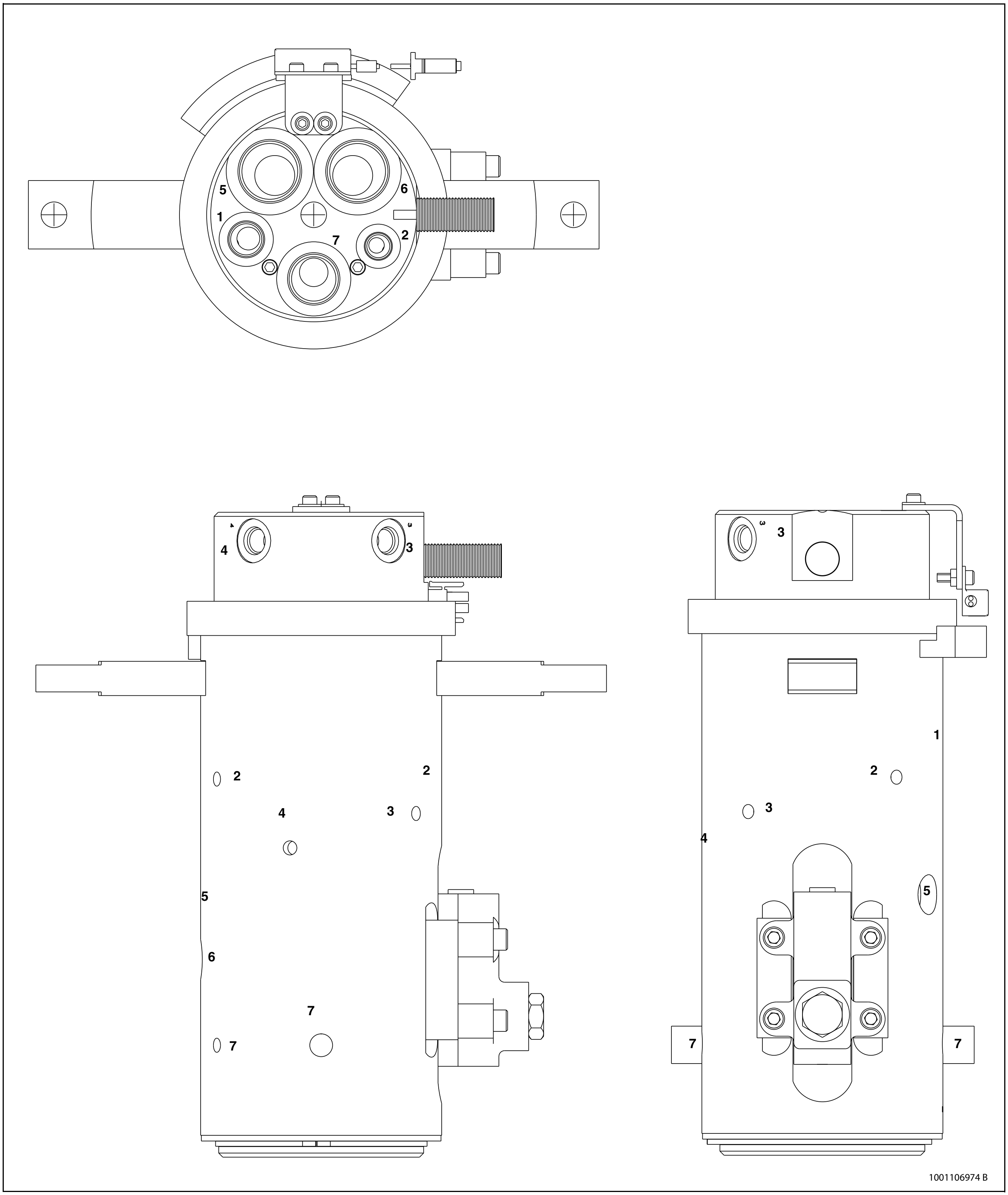
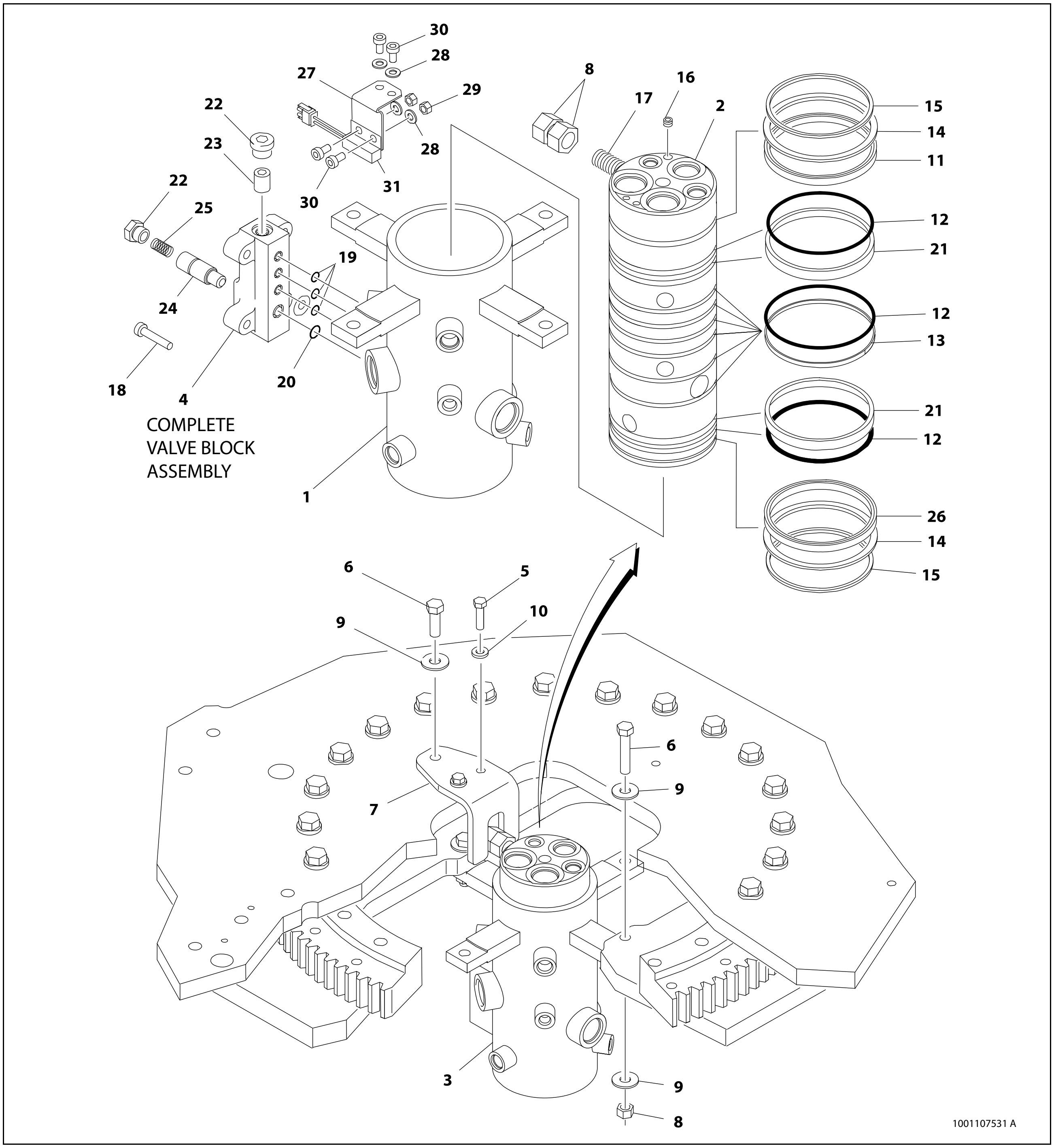


Figure 3-85. Rotary Coupling Port Location (SN 0300137913 through 0300189341)



1. Housing	7. Bracket	13. Cap Seal	18. Capscrew	23. Check Valve	28. Washer
2. Body	8. Locknut	14. Thrust Ring	19. O-ring	24. Plunger Valve	29. Locknut
3. Rotary Coupling	9. Washer	15. Retaining Ring	20. O-ring	25. Spring	30. Capscrew
4. Valve Block Assembly	10. Washer	16. Plug	21. Bearing	26. Seal	31. Proximity Switch
5. Bolt	11. Seal	17. Torque Lug	22. Plug	27. Bracket	
6. Bolt	12. O-ring				

Figure 3-86. Rotary Coupling Installation

Table 3-9. Coupling Port Information Table (SN 0300137913 through 0300189341)

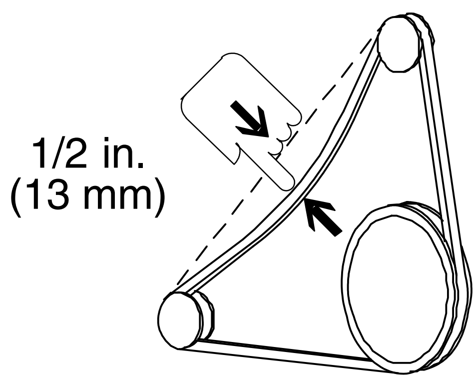
Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive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

3.23 GENERATOR

Maintenance Schedule

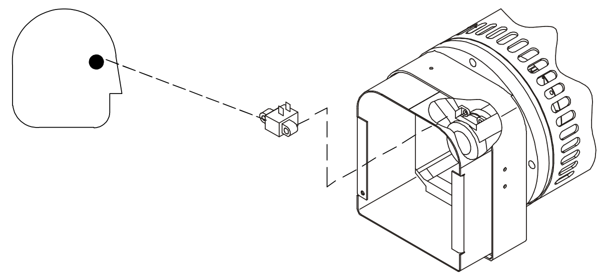
EVERY 250 HOURS

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

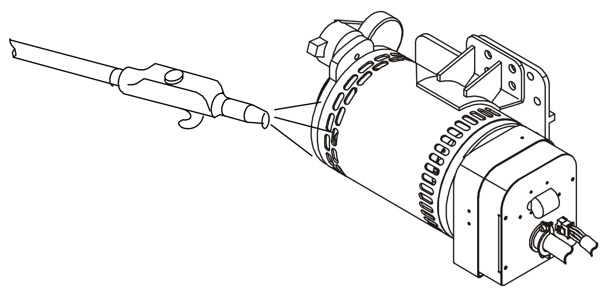


EVERY 500 HOURS

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.

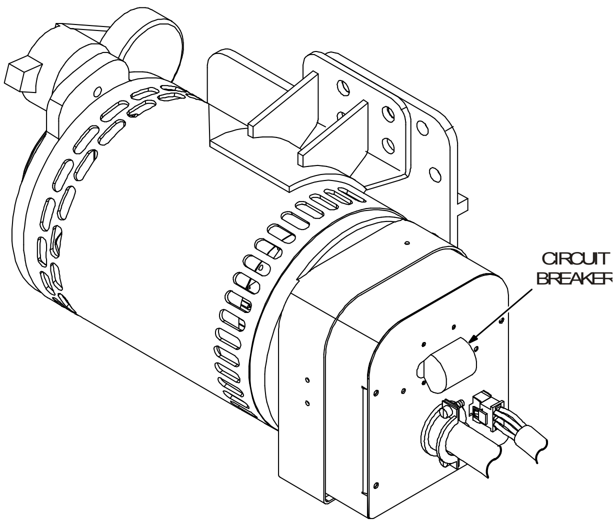


Overload Protection

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 3-87., 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.

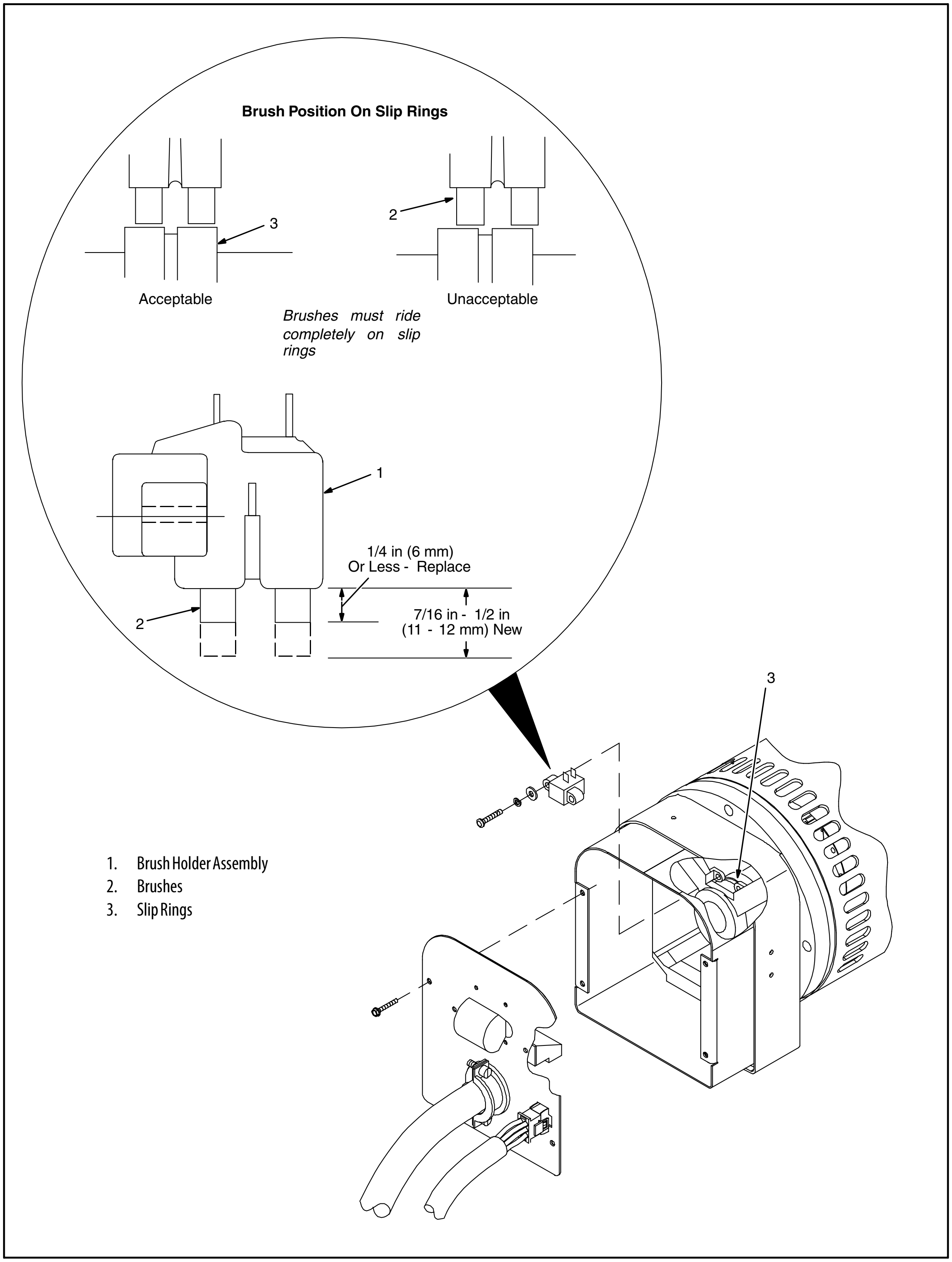


Figure 3-87. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

Generator Disassembly and Assembly

Refer to Figure 3-89. and Figure 3-90. to determine if trouble is in stator, rotor, control box, or combination of these components.

1. Rotor
2. Stator Assembly

⚠ CAUTION

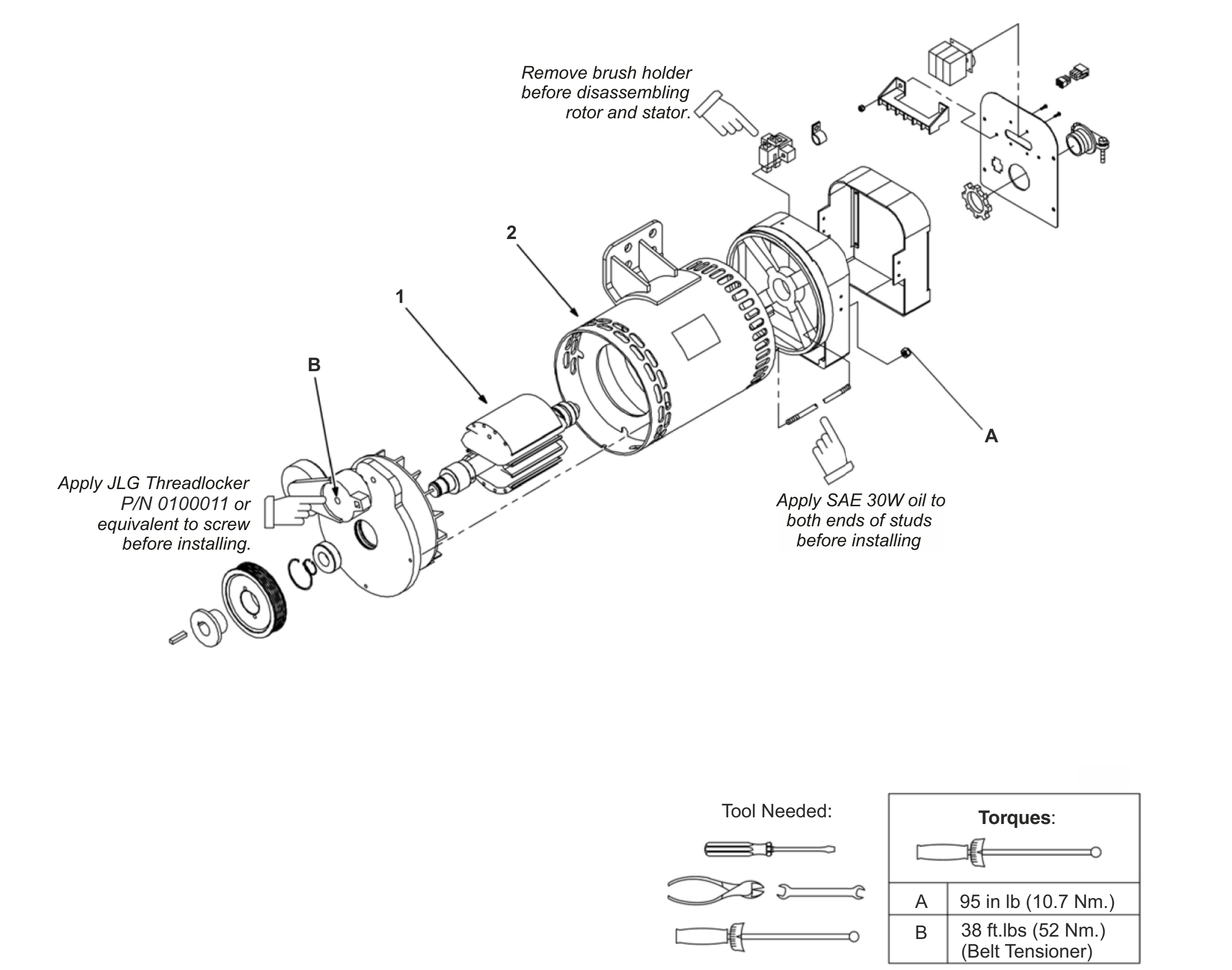
DO NOT DAMAGE ROTOR OR STATOR WINDINGS DURING DISASSEMBLY AND ASSEMBLY PROCEDURE.

DISASSEMBLY

1. Mark and disconnect all electrical leads, secure using cable ties.
2. Remove brush holder assembly.
3. Disassemble generator parts shown in Figure 3-88.
4. Clean all parts with approved solvent and dry with compressed air, if applicable.
5. Inspect all part for damage. Replace if necessary.

ASSEMBLY

1. Assemble generator parts using torque values in table.
2. Reconnect all leads. Use cable ties to secure leads away from moving or hot parts.



Torques:	
A	95 in lb (10.7 Nm.)
B	38 ft.lbs (52 Nm.) (Belt Tensioner)

Figure 3-88. Generator Disassembly and Assembly

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Resistance Values

a) Tolerance – ±10% unless specified

b) Condition – 70°F (21°C); cold machine (no warm-up)

c) Wiring Diagram

d) Stop generator before checking resistance

R1	26 ohms
R2	1 ohm
R3 thru R5	Less than 1 ohm

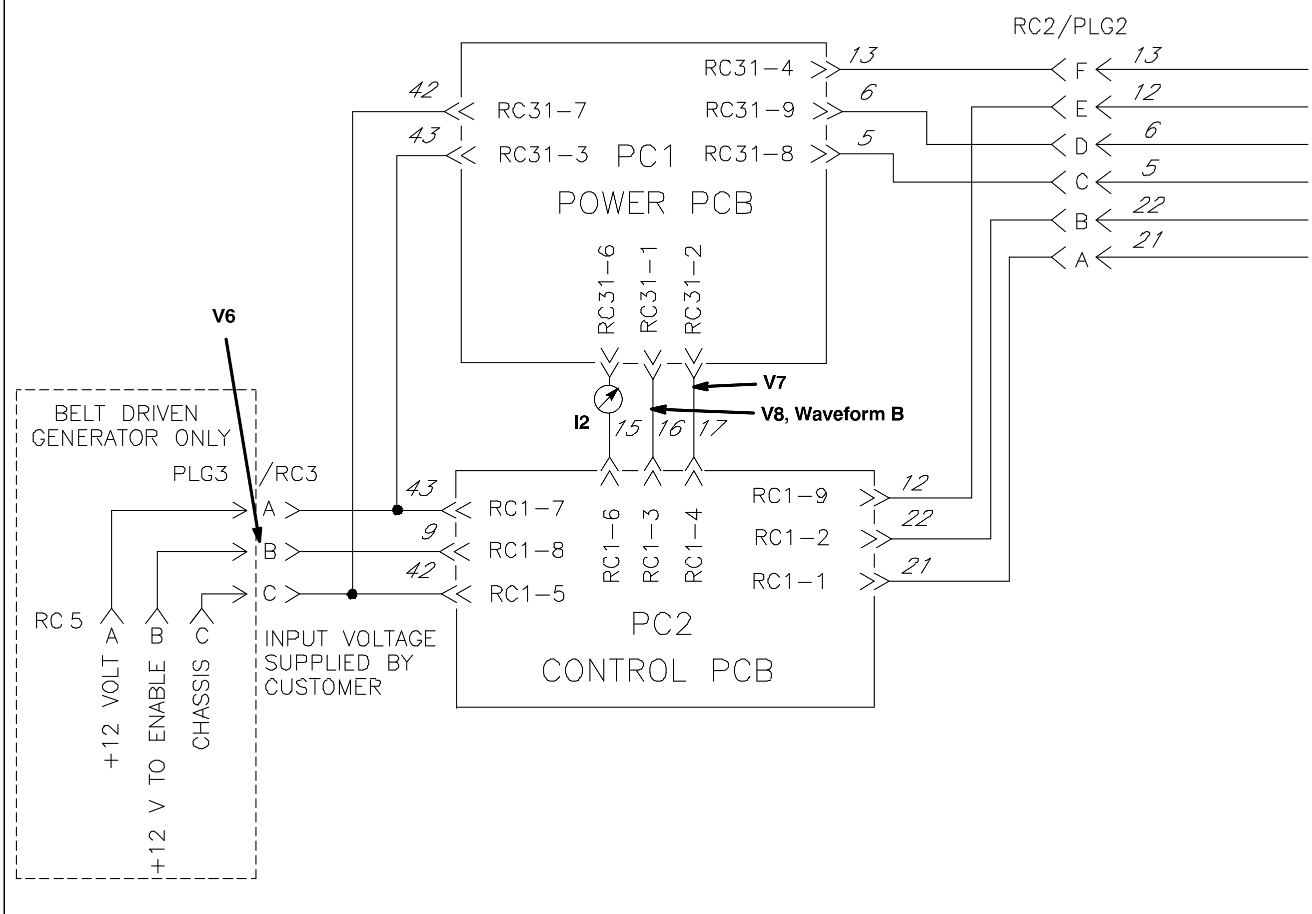
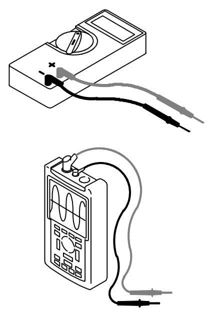


Figure 3-89. Generator Troubleshooting Circuit Diagram - Sheet 1 of 2

Test Equipment Needed:



Amperage Readings	
a) Tolerance – ±5% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up); no load	
I1	1 amps DC (60 Hz) No greater than 3.5 amps DC under load
I2	1 amps DC (60 Hz) No greater than 3.5 amps DC under load

Voltage Readings	
a) Tolerance – ±10% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up); no load	
c) Weld/power rpm unless specified	
d) Reference – single arrow: reference to circuit common (lead 42); double arrow: reference to points indicated	
e) Wiring Diagram	
V1	Rotor: +25 volts DC at no load ±20%; +75 volts DC at full load ±10%
V2	Exciter: 150 volts AC
V3	Voltage Feedback: 240 volts AC
V4	Output (Odd Leg): 245 volts AC
V5	Output: 120 volts AC
V6	Generator Enable: +12 volts DC when generator is enabled (On); 0 volts DC when not enabled (Off)
V7	Shutdown Signal: +12 volts DC when shutdown is latched; 0 volts DC when not latched
V8	PWM Signal: 0 to +15 volts DC

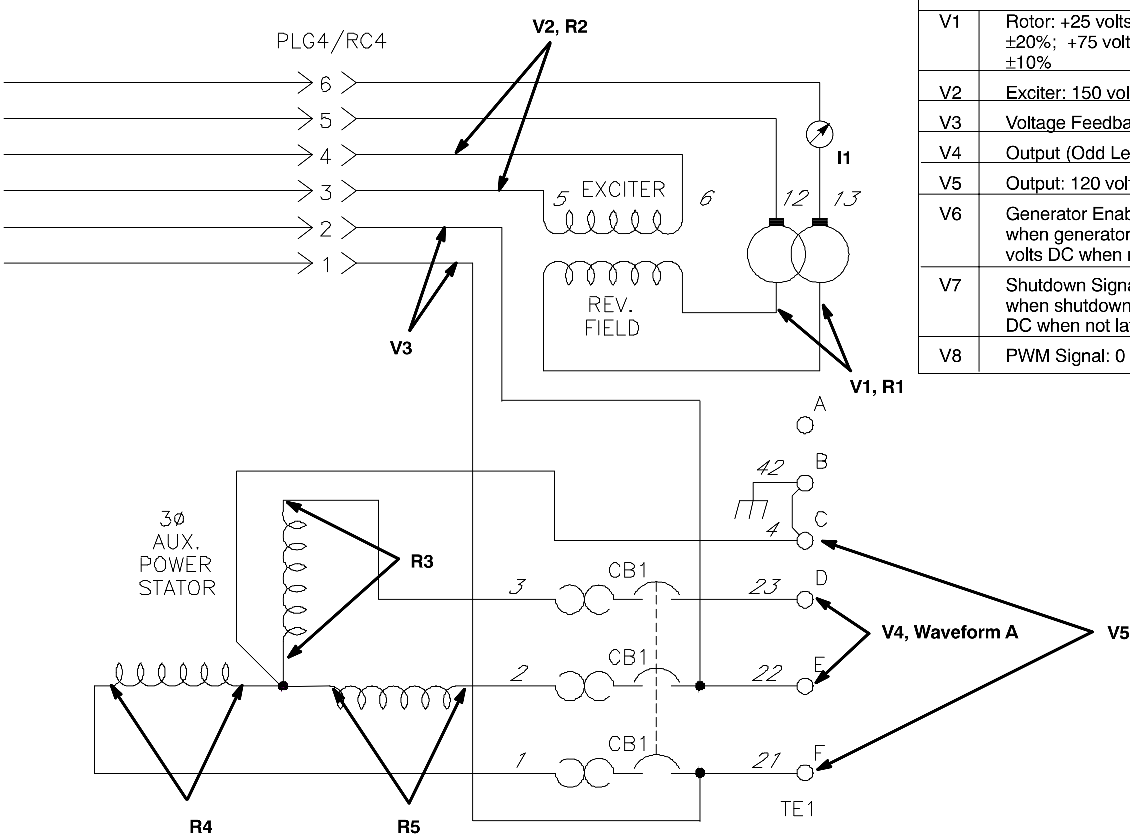


Figure 3-90. Generator Troubleshooting Circuit Diagram - Sheet 2 of 2

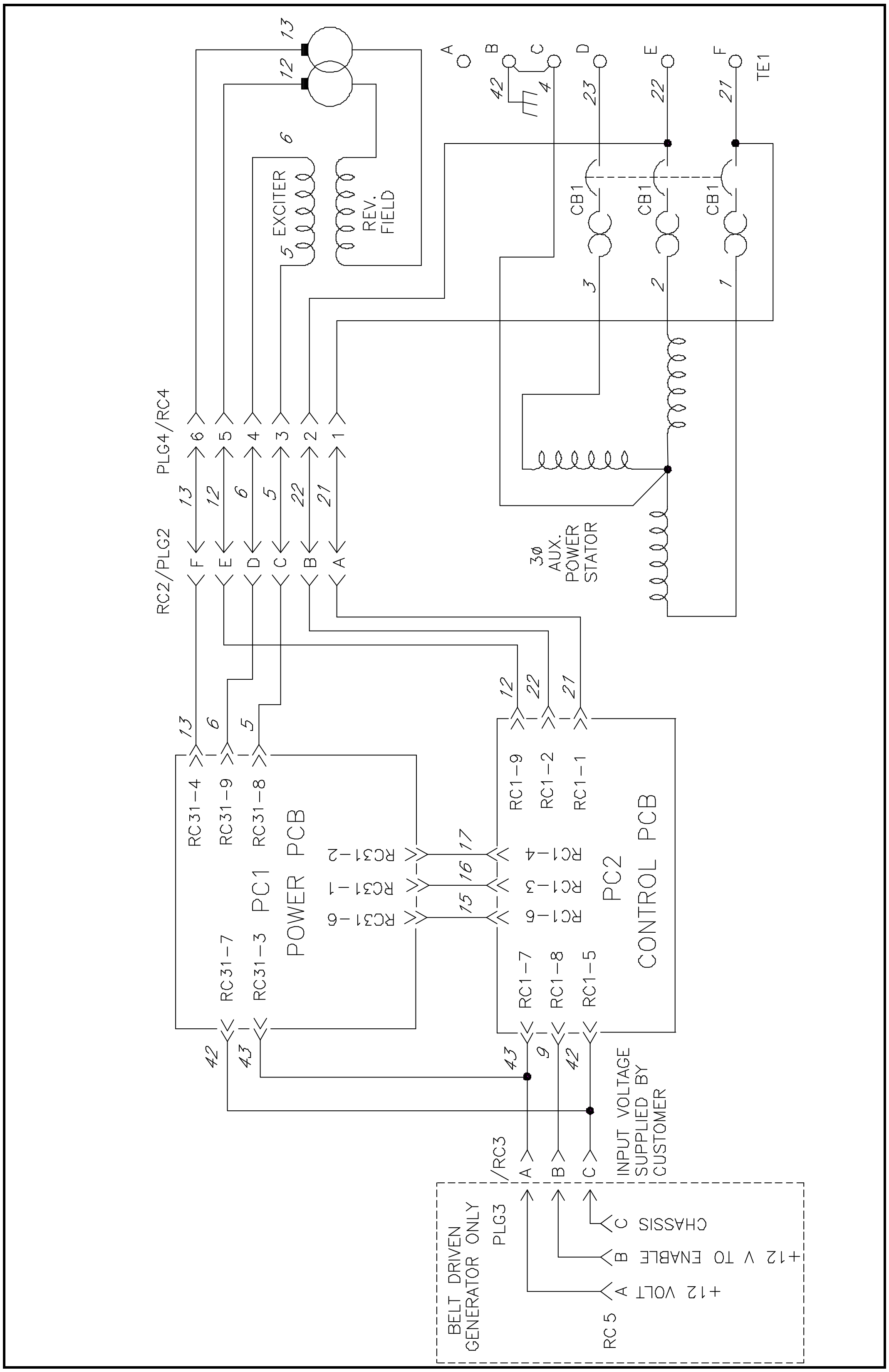


Figure 3-91. Generator Electrical Circuit Diagram

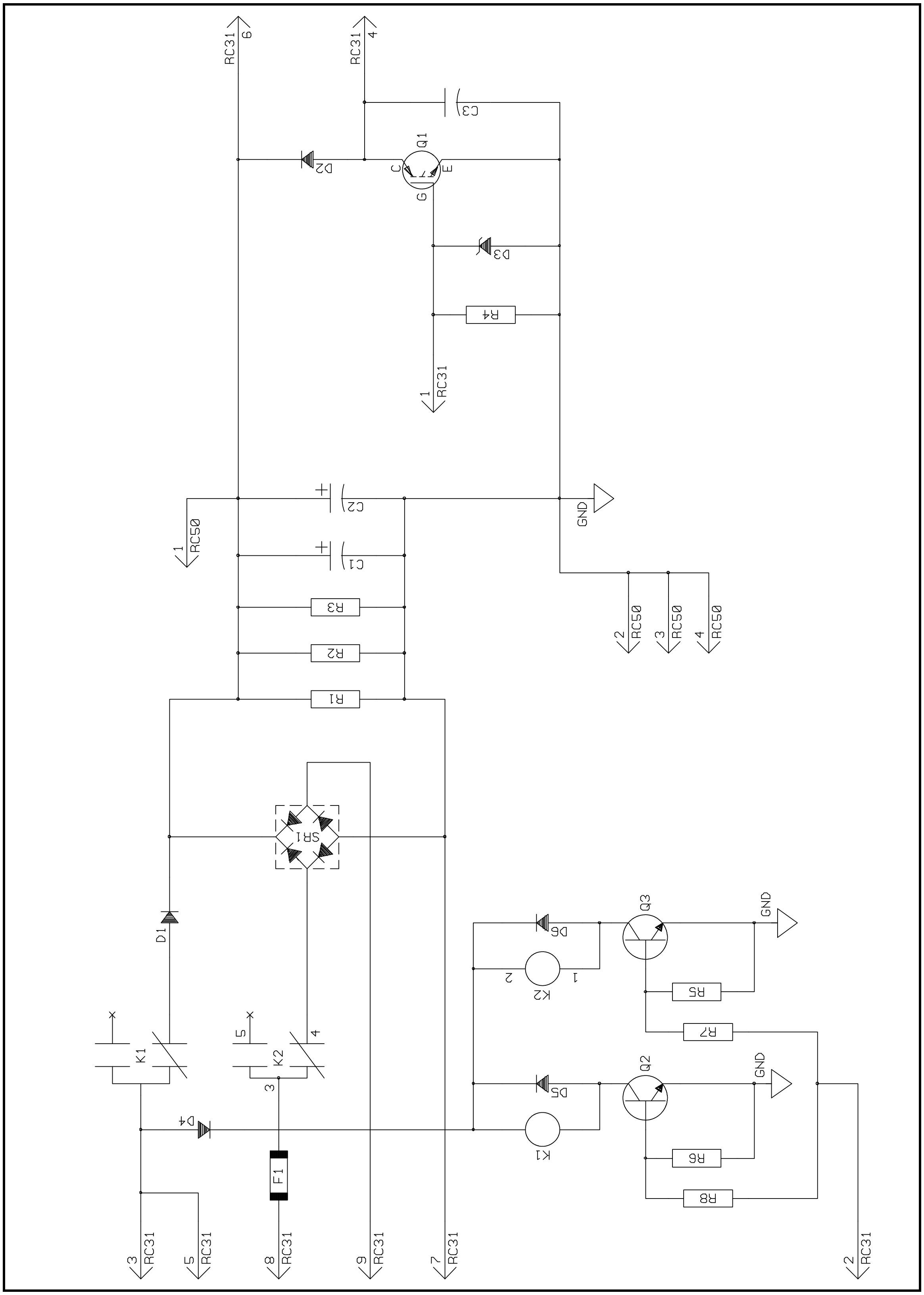


Figure 3-92. Power Board PC1 Electrical Circuit Diagram

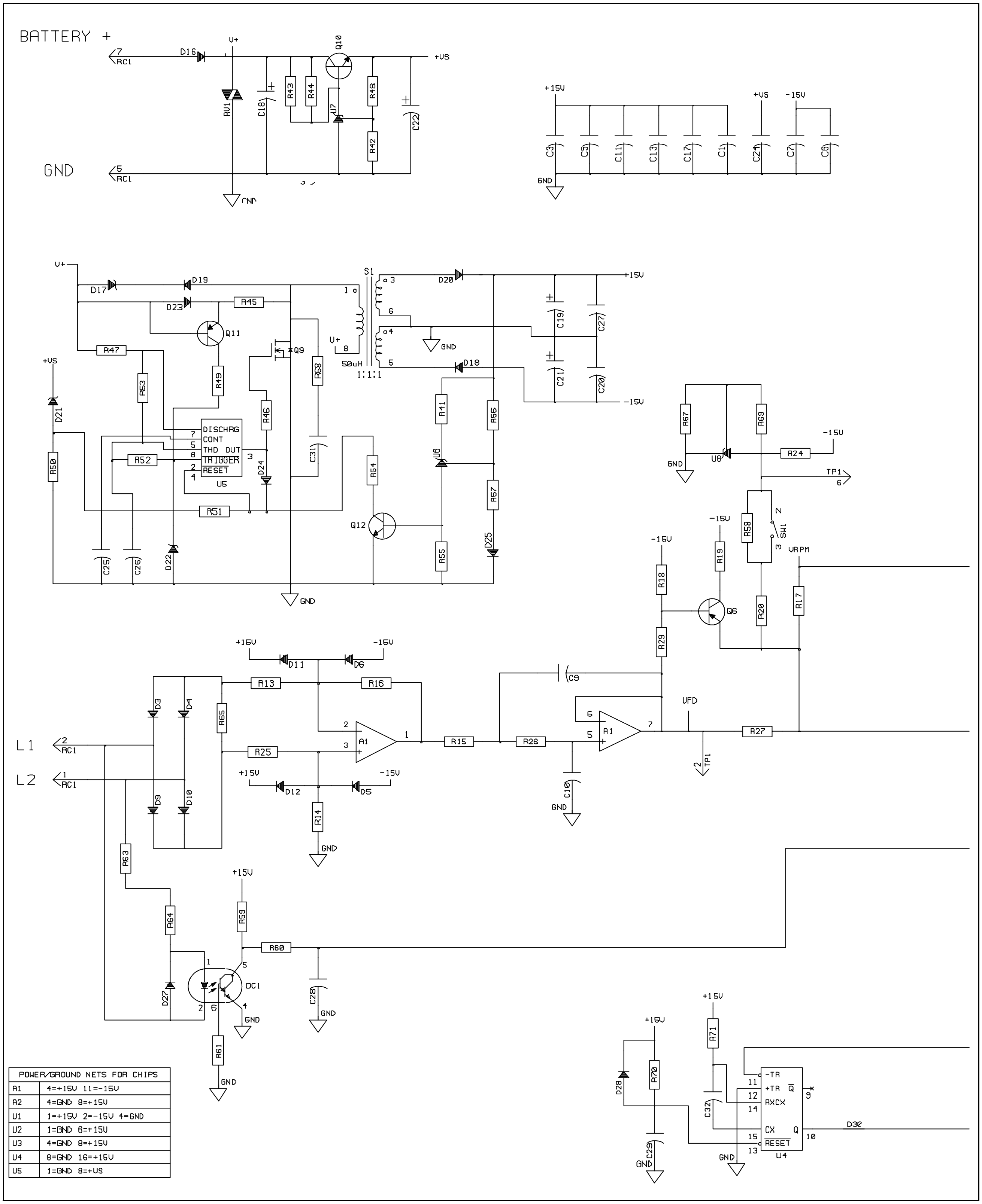


Figure 3-93. Power Board PC2 Electrical Circuit Diagram - Sheet 1 of 2

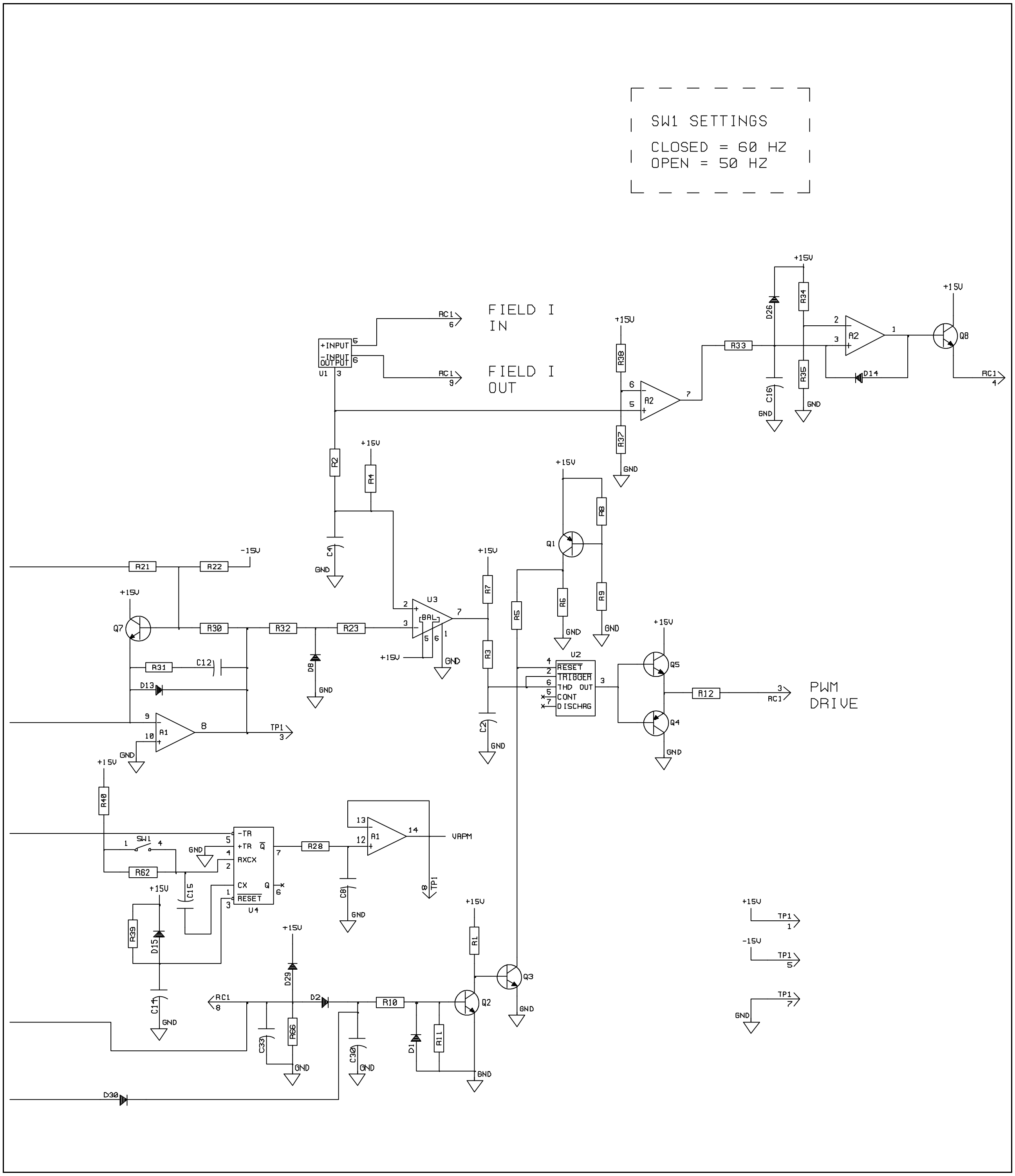


Figure 3-94. Power Board PC2 Electrical Circuit Diagram - Sheet 2 of 2

Lead Connection List for Generator

NOTE: *Table shows physical lead connections and should be used with circuit diagram (table replaces wiring diagram).*

NOTE: *Apply small amount of dielectric grade, nonconductive electric grease to connectors where factory-applied grease had been present.*

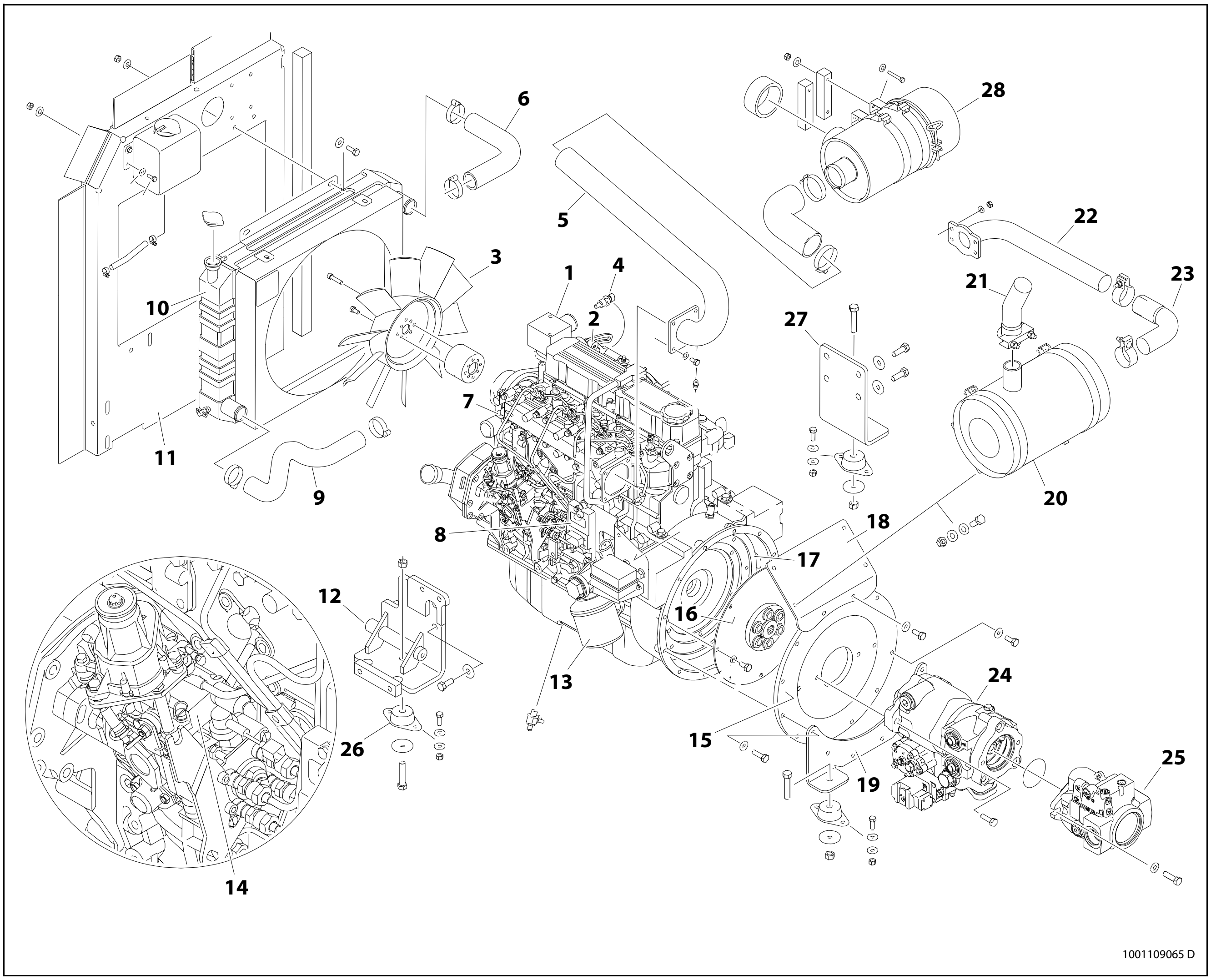
Table 3-10. Lead Connection List for Generator

Leads	Connections
1A	STATOR TO CB1
2A	STATOR TO CB1
3A	STATOR TO CB1
4A	STATOR TO TE1 (C)
5A	STATOR TO RC4 (3)
5B	PLG2 (C) TO PLG4 (3)
5C	RC2 (C) PLG31 (8)
6A	STATOR TO RC4 (4)
6B	PLG2 (D) TO PLG4 (4)
6C	RC2 (D) PLG31 (9)
9A	RC5 (B) TO PLG3 (B) (Customer Supplied)
9B	RC3 (B) PLG1 (8)
12A	PLG2 (E) TO PLG4 (5)
12B	RC2 (E) PLG1 (9)
12C	RC4 (5) TO BRUSH
13A	PLG2 (F) TO PLG4 (6)
13B	RC2 (F) PLG31 (4)
13C	RC4 (6) TO BRUSH
15A	PLG1 (6) TO PLG31 (6)
16A	PLG1 (3) TO PLG31 (1)
17A	PLG1 (4) TO PLG31 (2)
21A	CB1 TO TE1 (F)
21B	PLG2 (A) TO PLG4 (1)
21C	PLG1 (1) TO RC2 (A)
21D	RC4 (1) TO CB1
22A	CB1 TO TE1 (E)
22B	PLG2 (B) TO PLG4 (2)
22C	PLG1 (2) TO RC2 (B)
22D	RC4 (2) TO CB1
23A	CB1 TO TE1 (D)
42A	RC5 (C) TO PLG3 (C) (Customer Supplied)
42B	RC3 (C) TO CONNECTION POINT 1
42C	PLG31 (7) TO CONNECTION POINT 1
42D	PLG1 (5) TO CONNECTION POINT 1
42F	END BELL SHROUD TO ENGINE MOUNT
42G	CHASSIS TO TE1 (B)
43A	RC5 (A) TO PLG3 (A) (Customer Supplied)
43B	RC3 (A) TO CONNECTION POINT 2
43C	PLG31 (3) TO CONNECTION POINT 2
43D	PLG1 (7) TO CONNECTION POINT 2

Troubleshooting

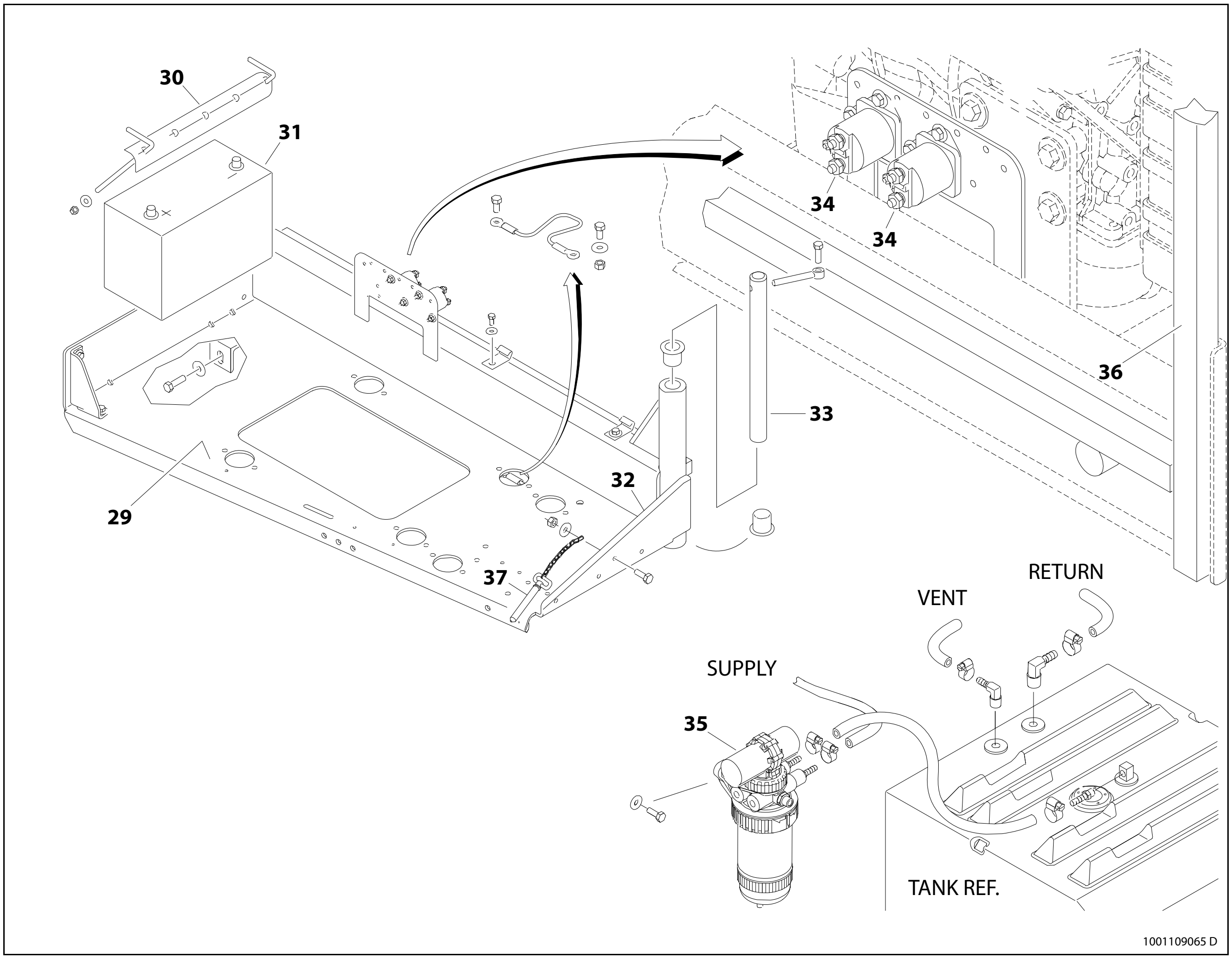
Table 3-11. Troubleshooting

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.
	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.
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 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.



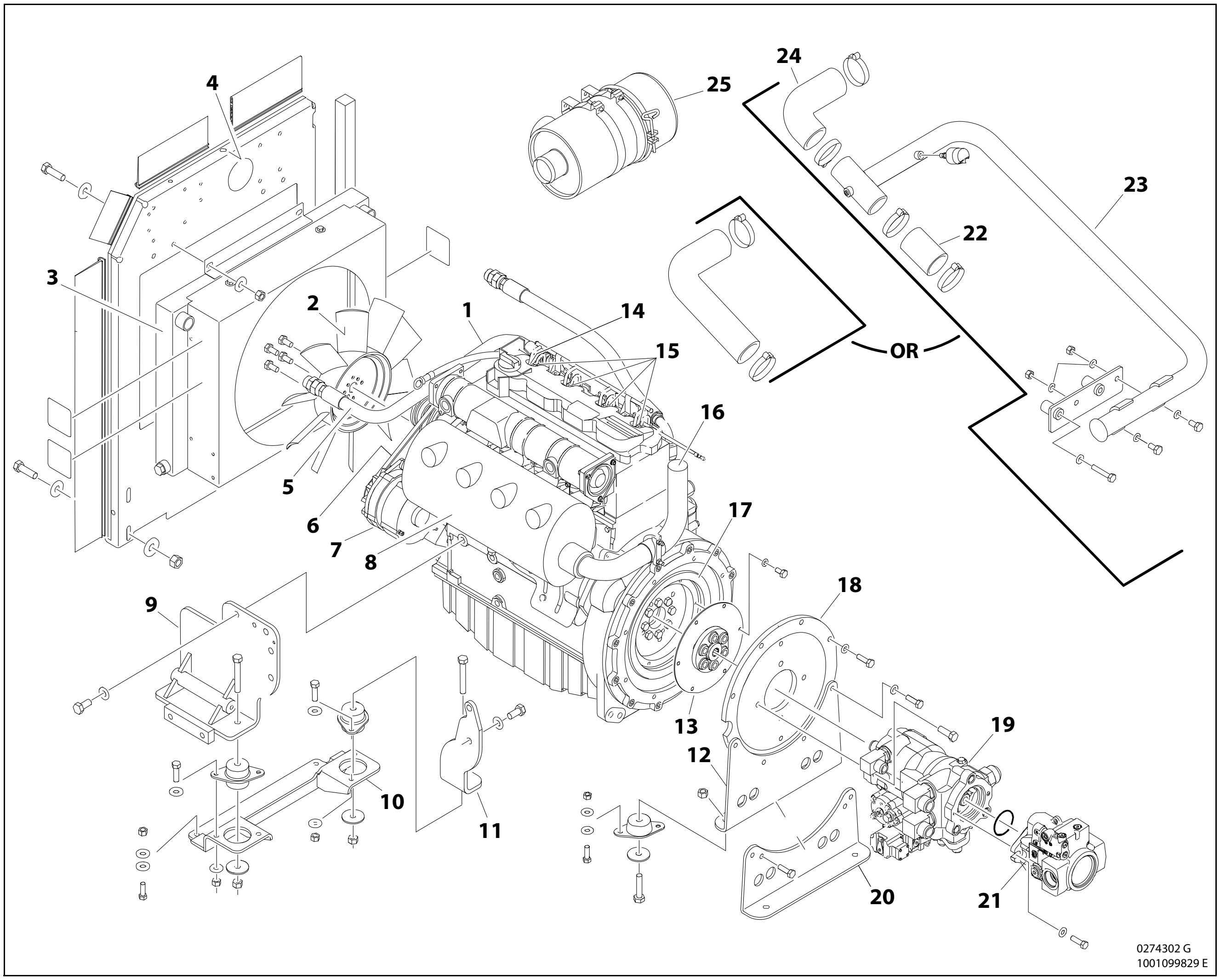
1. Engine Assembly	8. ECM Module	15. Adaptor	22. Exhaust Tube Weldment
2. Alternator	9. Radiator Hose (Bottom)	16. Coupling	23. Exhaust Tube
3. Fan	10. Radiator	17. Flywheel	24. Piston Pump
4. Temperature Sensor	11. Radiator Mounting Plate	18. Muffler Bracket	25. Load Sensing Pump
5. Intake Tube	12. Engine Mount Plate	19. Engine Mount Plate (Rear)	26. Engine Mount
6. Radiator Hose (Top)	13. Oil Filter	20. Muffler	27. Motor Mount Plate
7. Water Pump	14. Fuel Injection Pump	21. Exhaust Pipe	28. Air Cleaner Assembly

Figure 3-95. Caterpillar Tier IVi Engine Assembly - Sheet 1 of 2



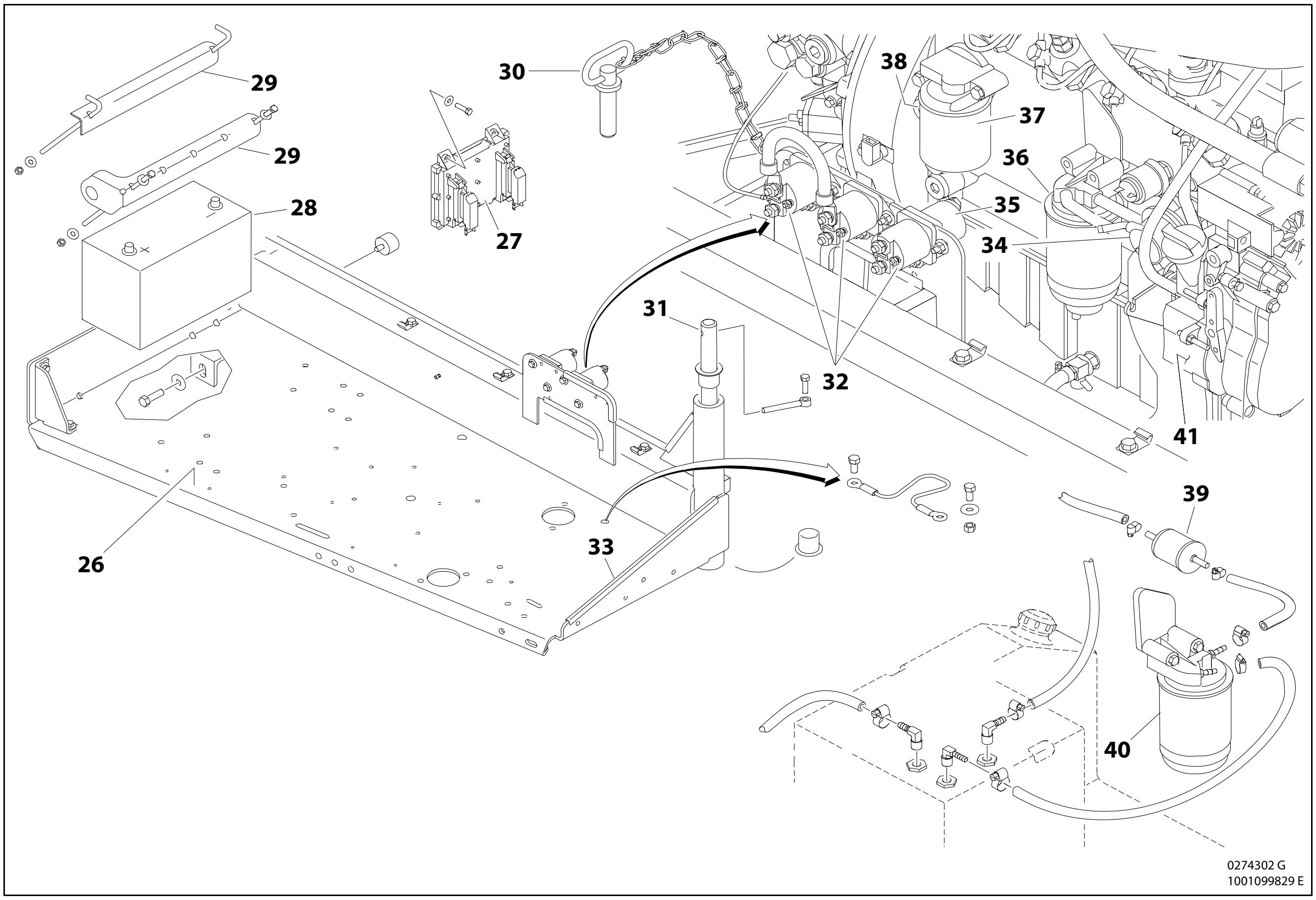
29. Tray	32. Flex Trim	35. Fuel Pump
30. Battery Hold-down	33. Pivot Pin	36. Exhaust Tube Weldment
31. Battery	34. Relay	37. Hitch Pin

Figure 3-96. Caterpillar Tier IVi Engine Assembly - Sheet 2 of 2



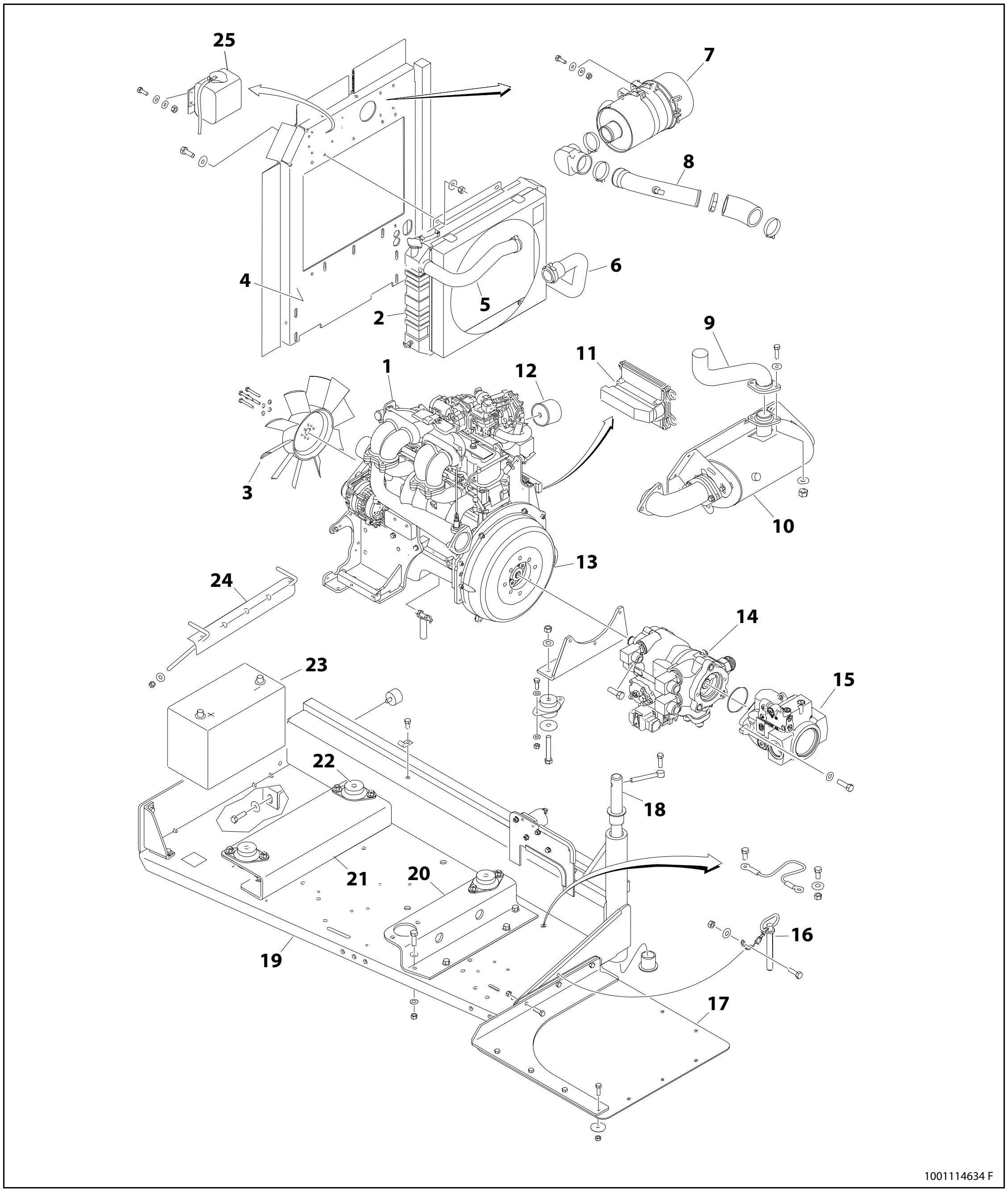
1. Engine Assembly
2. Fan
3. Radiator
4. Radiator Mounting Plate
5. Oil Cooler Hose
6. V Belt
7. Alternator
8. Muffler
9. Engine Mount Plate (Front Left)
10. Engine Mount Plate (Front Bottom)
11. Engine Mount Plate (Front Right)
12. Engine Mount Plate (Rear)
13. Coupling
14. Glow Plug
15. Injector Pump
16. Exhaust Tube
17. Flywheel
18. Pump Adapter Plate
19. Piston Pump Assembly
20. Engine Mount Plate (Rear)
21. Sensing Pump Assembly
22. Air Cleaner Hose
23. Tuning Tube
24. Elbow
25. Air Cleaner

Figure 3-97. Deutz Engine Installations - Sheet 1 of 2



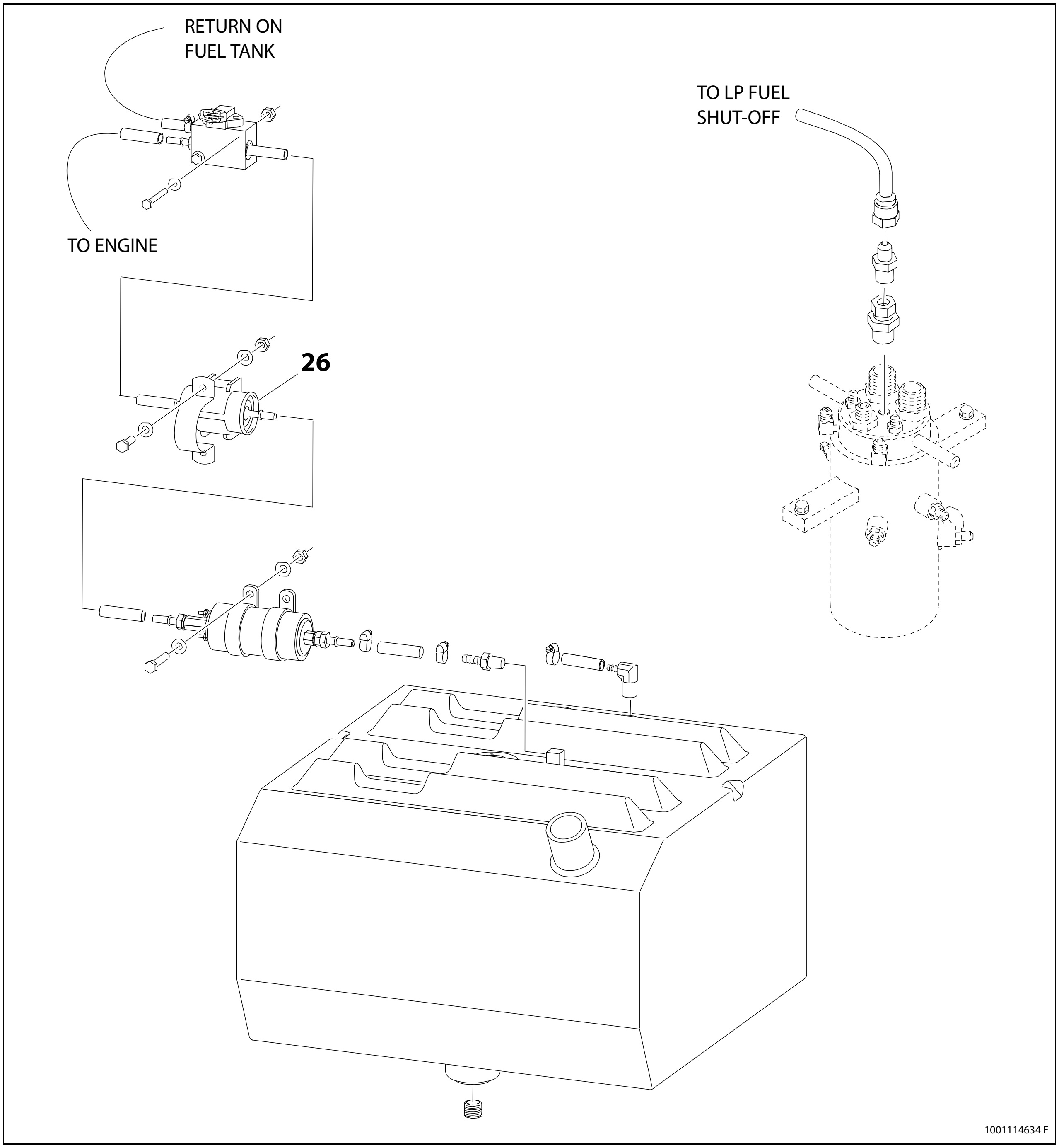
26. Tray
27. EMR2 Controller Module
28. Battery
29. Battery Hold-down
30. Hitch Pin
31. Pivot Pin
32. Relay
33. Flex Trim
34. Fuel Pump
35. Relay
36. Fuel Filter
37. Oil Filter
38. Thermostat
39. Fuel In-line Filter
40. Fuel Pump

Figure 3-98. Deutz Engine Installations - Sheet 2 of 2



1. Engine Assembly
2. Radiator
3. Fan
4. Radiator Mounting Plate
5. Radiator Hose (Top)
6. Radiator Hose (Bottom)
7. Air Cleaner Assembly
8. Intake Tube
9. Oil Drain Valve
10. Muffler
11. Module Control
12. Oil Filter
13. Coupling
14. Piston Pump Assembly
15. Load Sensing Pump Assembly
16. Hitch Pin
17. Rubber Panel
18. Pin
19. Tray
20. Engine Mount Plate
21. Engine Mount (Front)
22. Engine Mount
23. Battery
24. Battery Hold-down
25. Coolant Overflow Container

Figure 3-99. GM Engine 3.0L Tier III/IV Installation - Sheet 1 of 2



26.Fuel Filter

Figure 3-100. GM Engine 3.0L Tier III/IV Installation - Sheet 2 of 2

3.24 DEUTZ ENGINE - TD2011L04

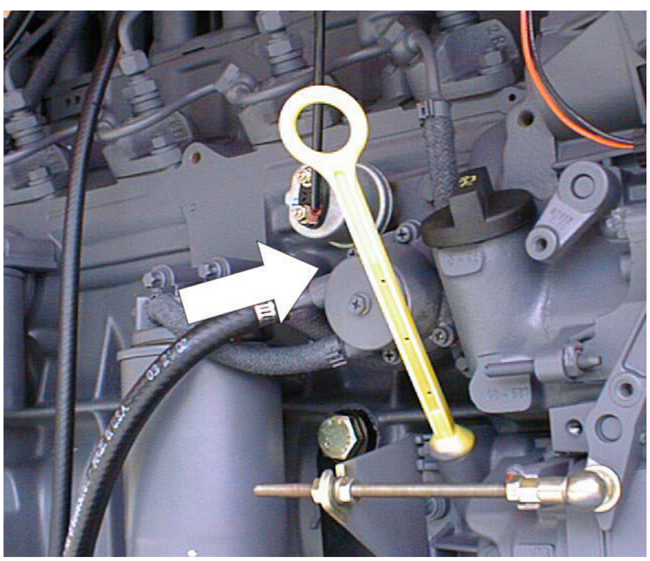
NOTE: *Refer to engine manufacturer's manual for detailed operating and maintenance instructions. Limited engine maintenance items are presented here for convenience but detailed engine maintenance items and schedule are included in the engine manufacturer's manual.*

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.

Check Oil Level

1. Switch the engine off before checking oil level.
2. Make sure the machine and engine are level.
3. Remove the oil dipstick.
4. Wipe the dipstick with non-fibrous, clean cloth.
5. Insert the dipstick to the stop and remove again.



6. Check the oil level, and if necessary, top the oil level up to the MAX mark with an approved grade and type of oil as outlined in the engine manufacturer's operator's manual. Refer to Figure 3-101., Deutz Engine Dipstick.

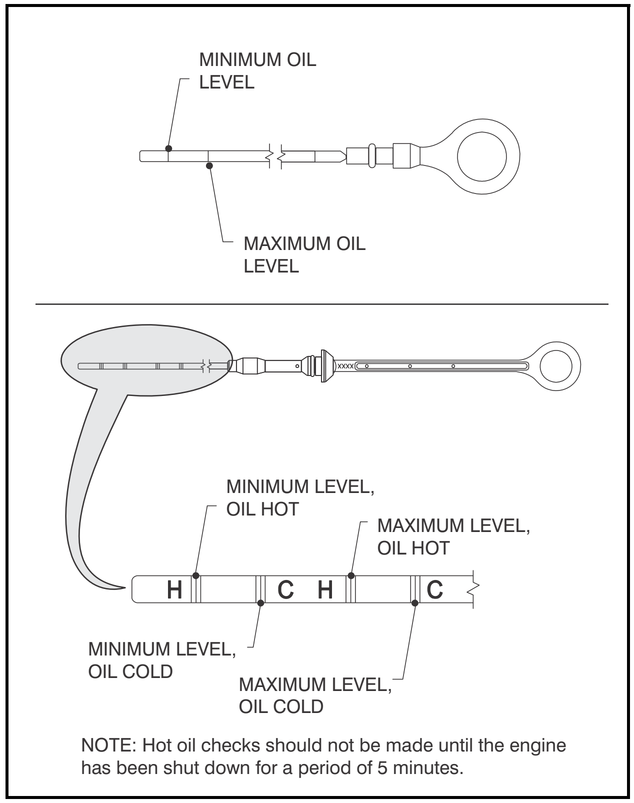


Figure 3-101. Deutz Engine Dipstick

7. Replace the dipstick making sure that it is fully seated in the dipstick tube to seal off the crankcase.

Replacing Engine Oil

1. Allow the engine to warm up. The engine oil should reach approximately 176° F (80° C).
2. Make sure the machine and engine are level.
3. Switch off the engine.
4. Place an oil tray under the engine.

CAUTION

HOT ENGINE OIL CAN CAUSE BURNS, AVOID CONTACT WITH HOT OIL WHEN DRAINING.

NOTICE

COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

5. Open the oil drain valve.
6. Drain the oil.
7. Close the oil drain valve.
8. Pour in new engine oil. Refer to Section 1 for capacity and refer to Figure 3-102., Engine Oil Viscosity for the proper grade.

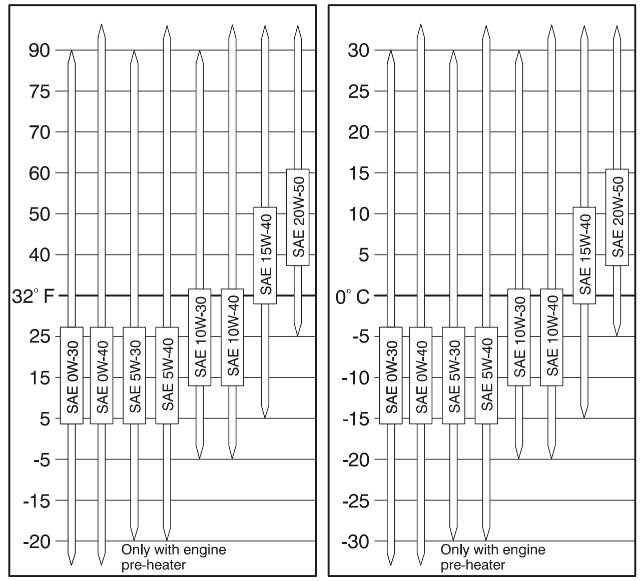
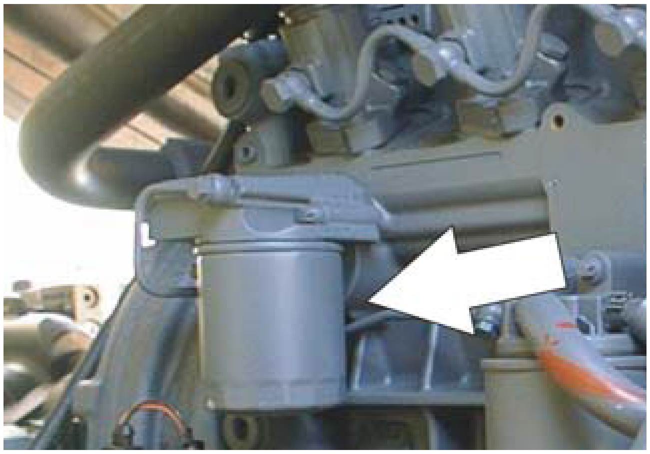
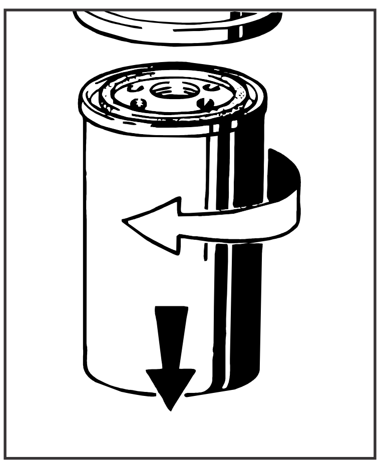


Figure 3-102. Engine Oil Viscosity

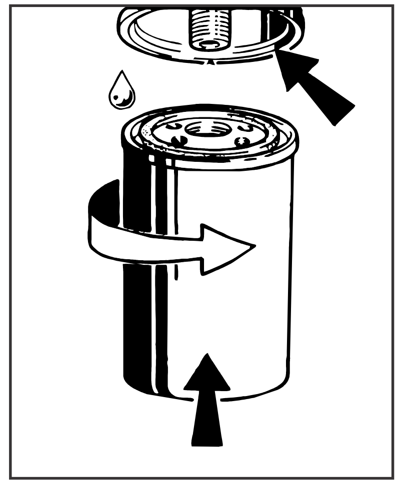
Replacing the Oil Filter



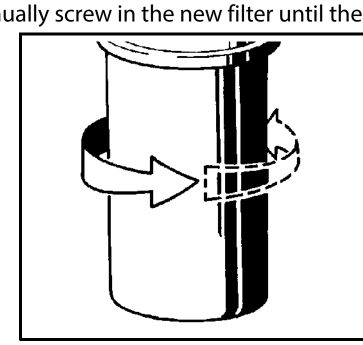
1. Wipe the area around the filter to clean any dirt from the area.
2. Using a suitable oil filter removal tool, loosen lube oil filter element and spin off.



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil.

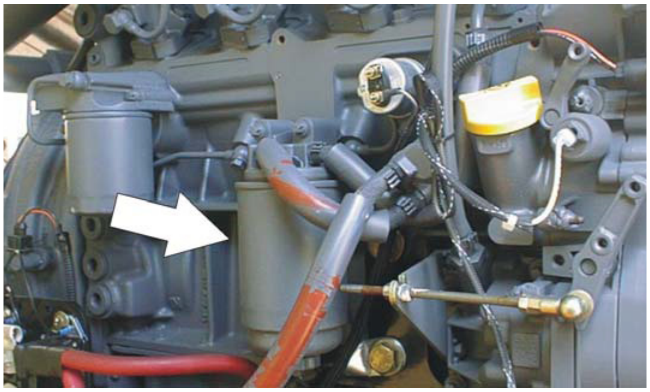


6. Manually screw in the new filter until the gasket is flush.



7. Hand-tighten filter another half-turn.
8. Check oil level.
9. Check oil pressure.
10. Check the oil filter cartridge and make sure there are no leaks.

Replacing the Fuel Filter



⚠ WARNING

FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEMS.

1. Wipe the area around the filter to clean any dirt from the area.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Undo the fuel filter cartridge and spin off.
4. Catch any escaping fuel.
5. Clean any dirt from the filter carrier sealing surface.
6. Apply a light film of oil or diesel fuel to the rubber gasket of the new filter cartridge.
7. Manually screw in the new filter until the gasket is flush.
8. Tighten the fuel filter cartridge with a final half-turn.
9. Check for leaks.

3.25 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.

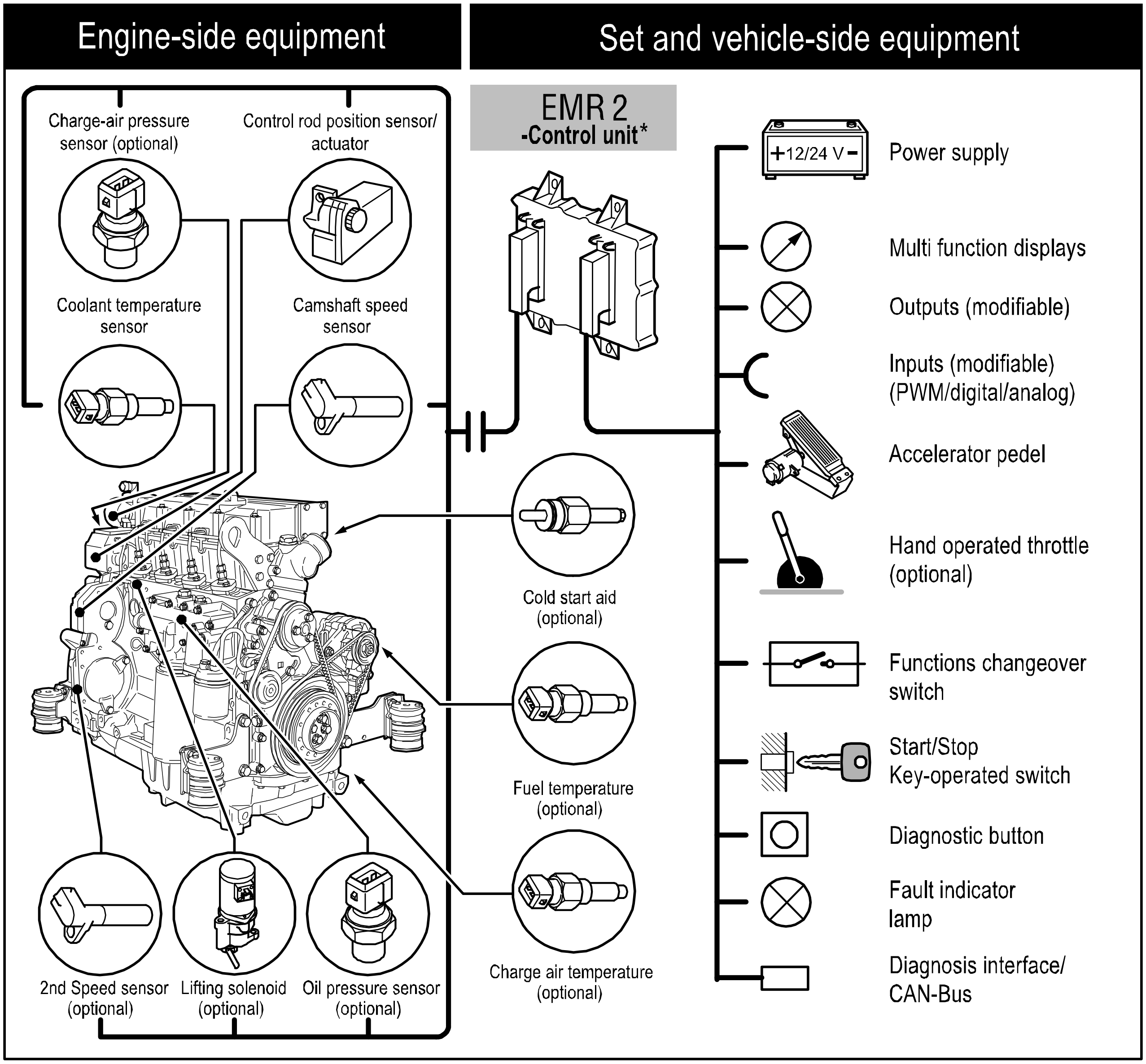


Figure 3-103. EMR 2 Engine Side Equipment

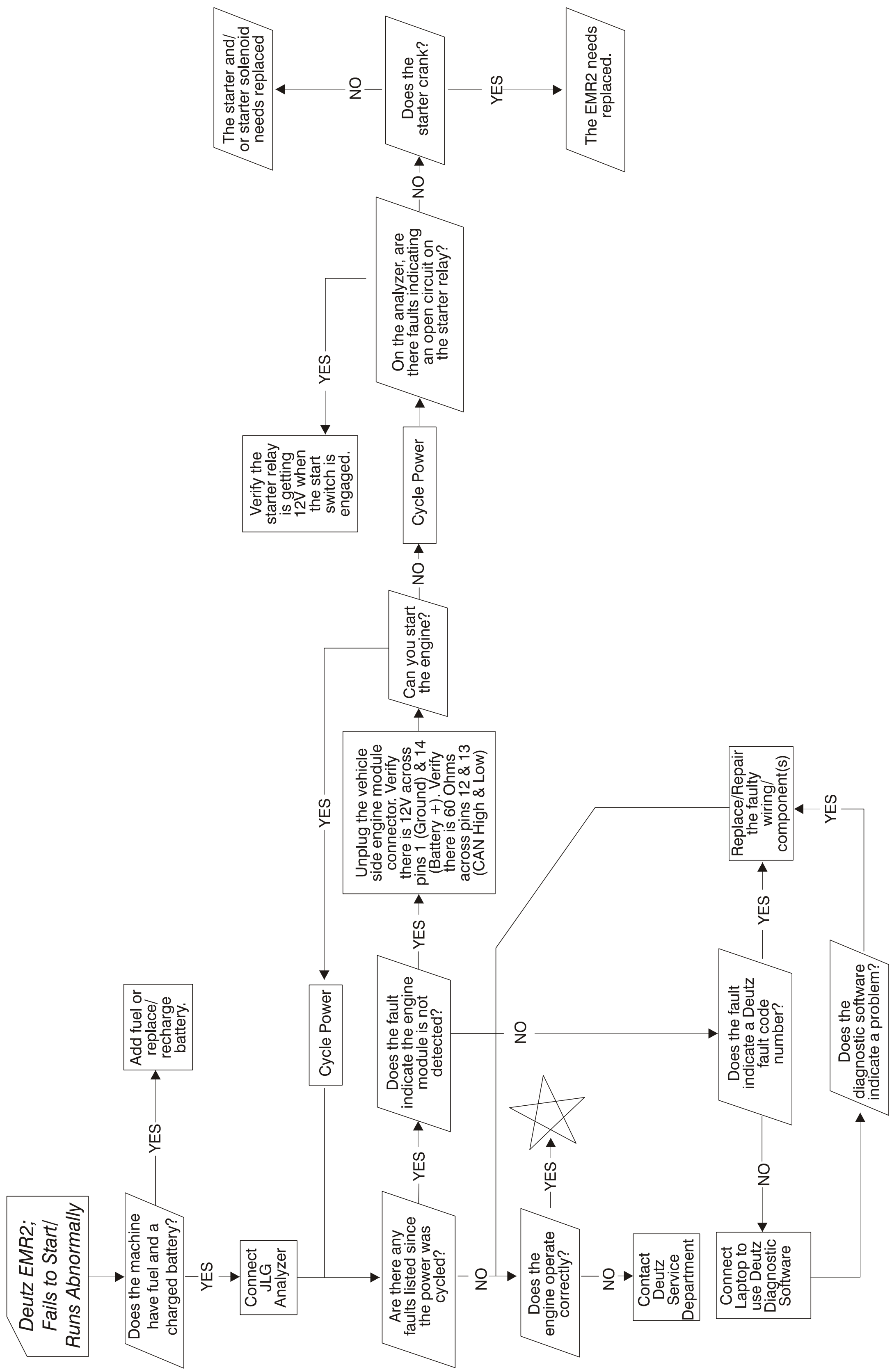


Figure 3-104. Deutz EMR 2 Troubleshooting Flow Chart

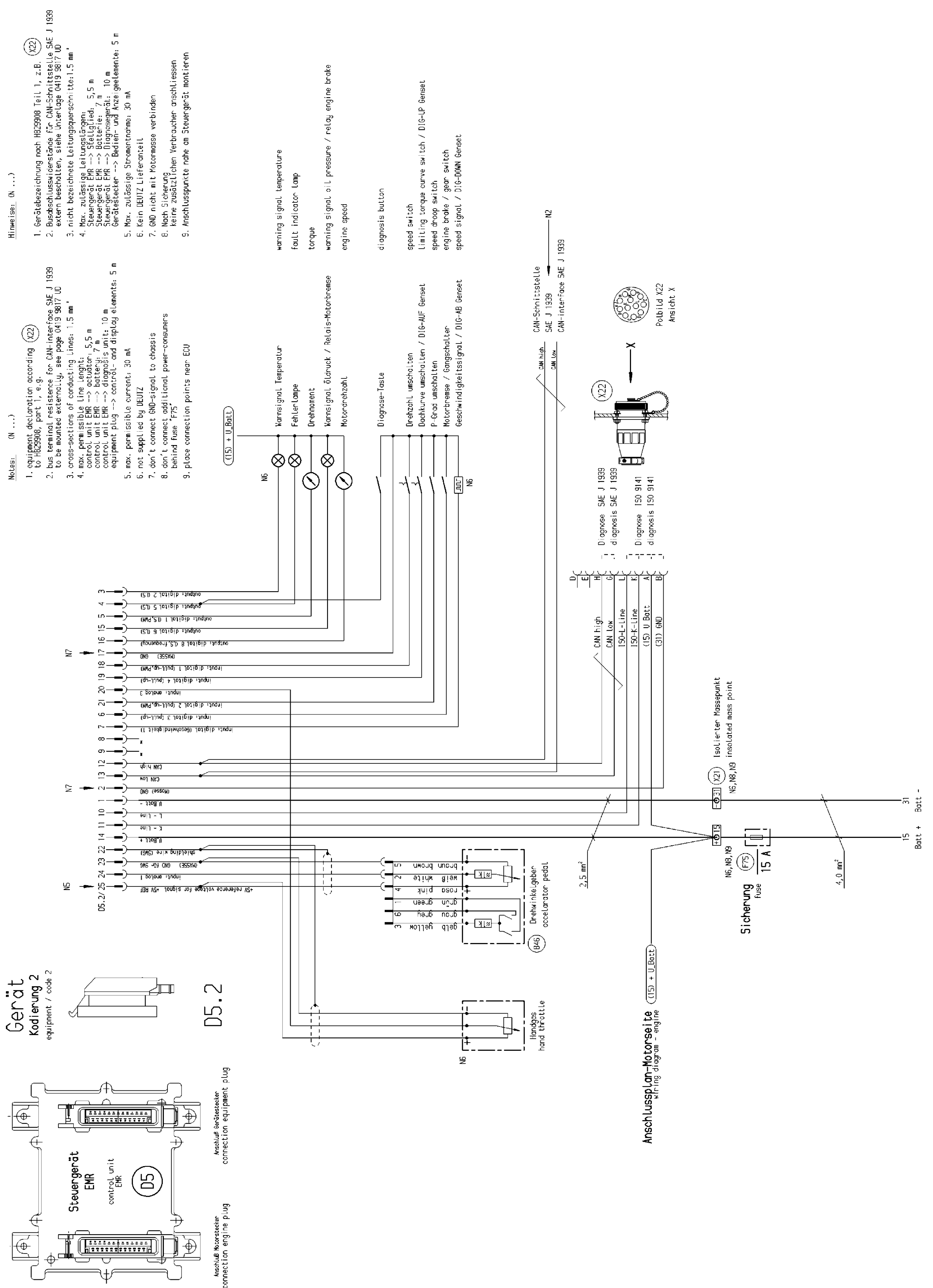


Figure 3-105. Deutz EMR 2 Vehicle Side Connection Diagram

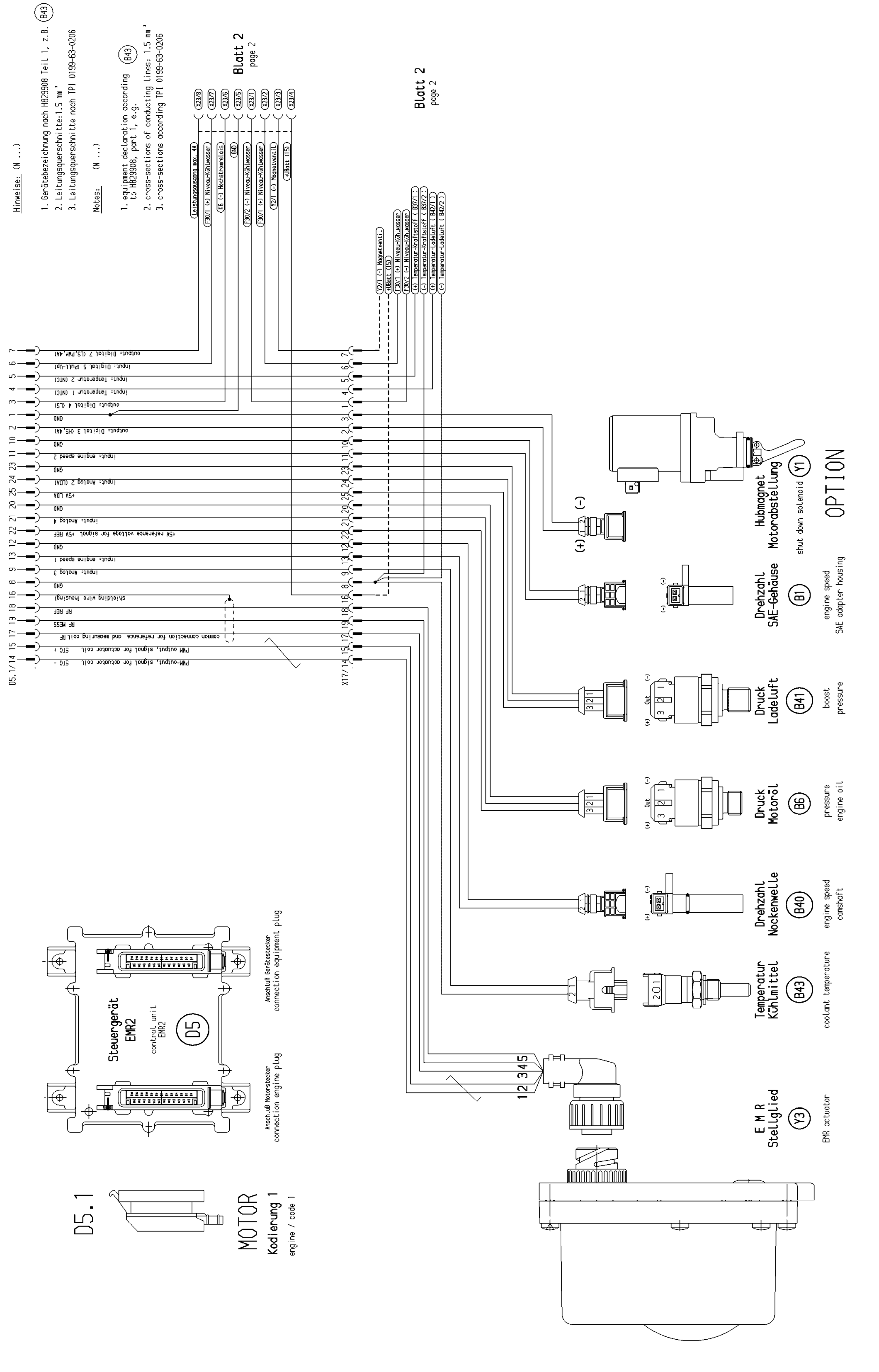


Figure 3-106. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

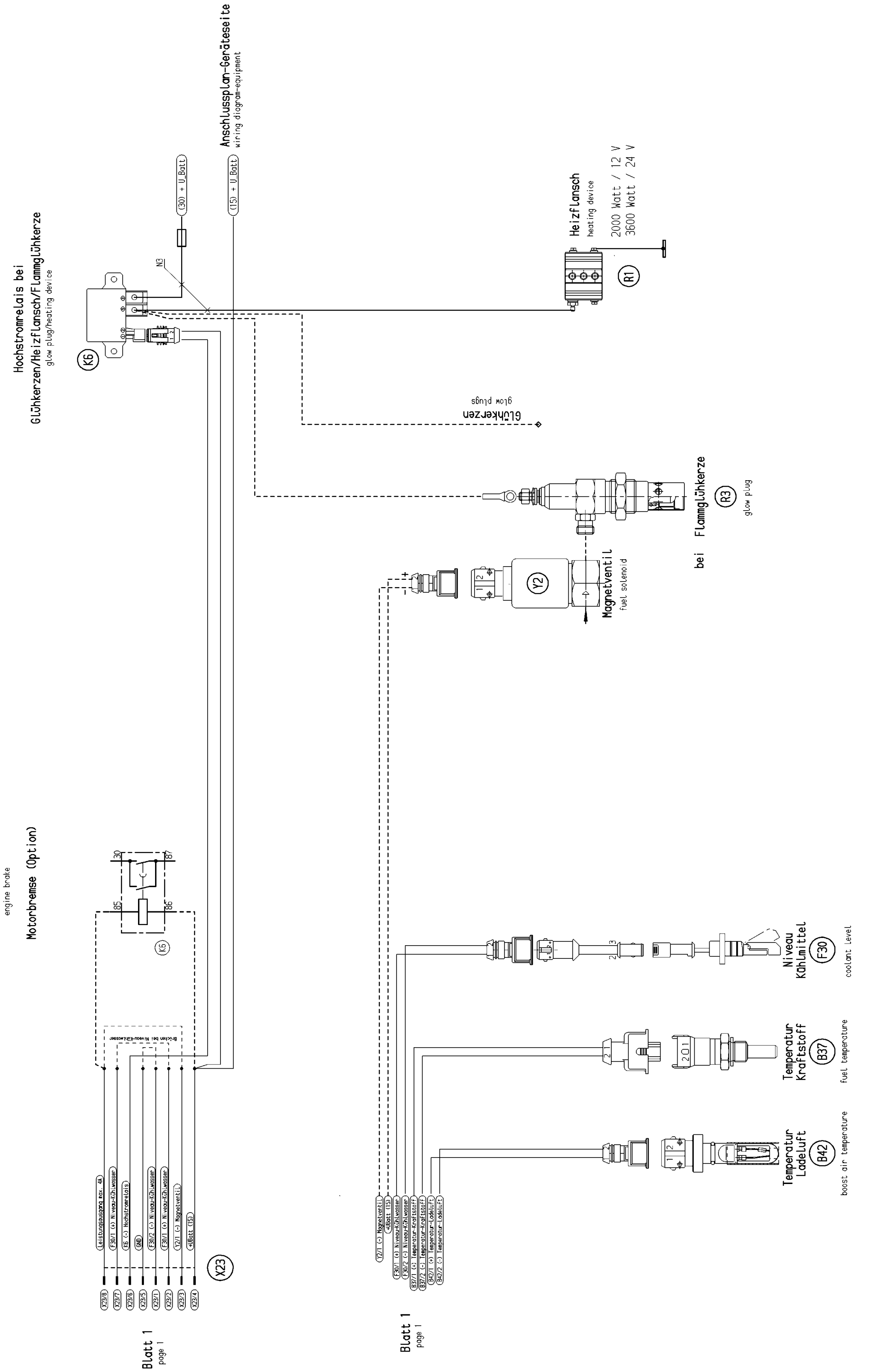
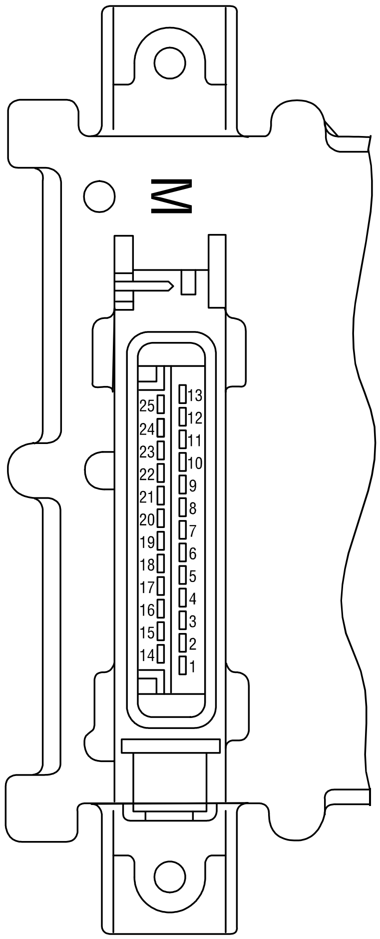


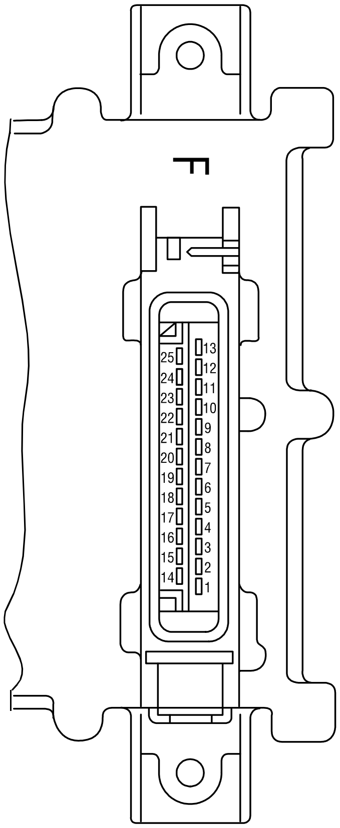
Figure 3-107. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



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 3-108. 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 3-109. 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	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor, the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2			
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

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

Figure 3-110. EMR2 Fault Codes - Sheet 1 of 5

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

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

Figure 3-111. 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 3-112. EMR2 Fault Codes - Sheet 3 of 5

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

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

Figure 3-113. EMR2 Fault Codes - Sheet 4 of 5

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

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

Figure 3-114. EMR2 Fault Codes - Sheet 5 of 5

3.26 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.

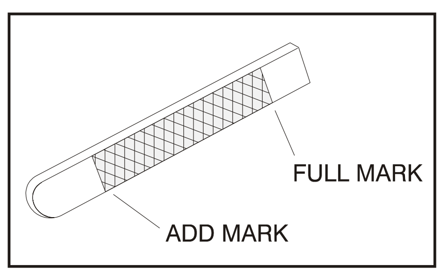


Figure 3-115. Engine Oil Dip Stick

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

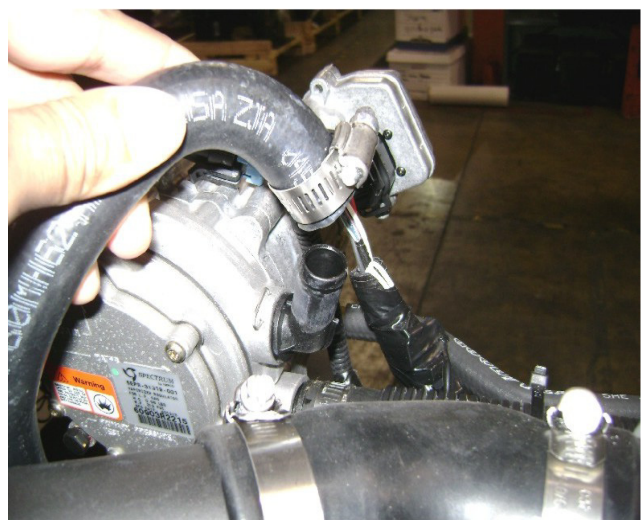
NOTICE

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.

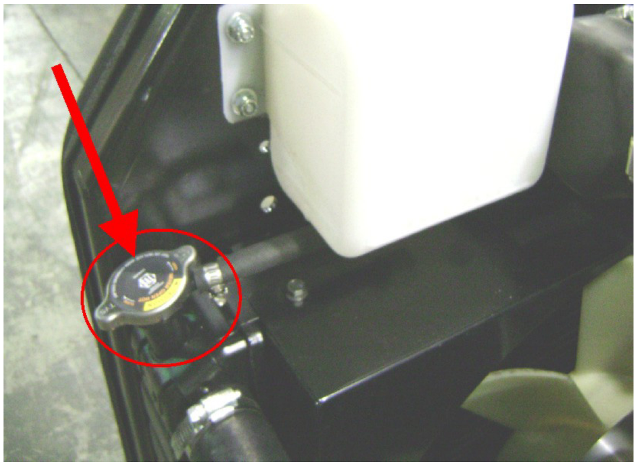
CAUTION

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

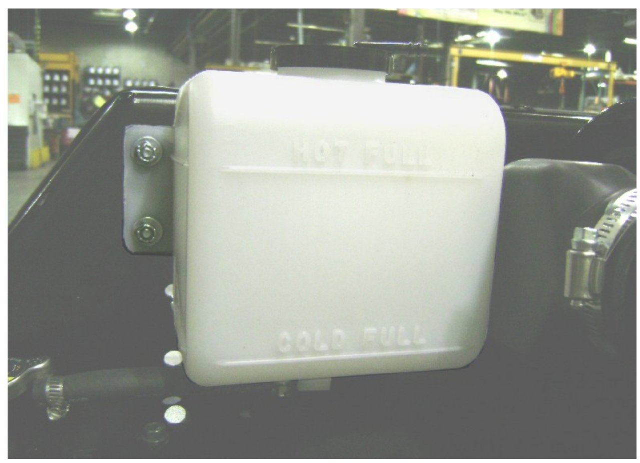
WITH THE ENGINE RUNNING OR WHEN SHUTTING OFF THE ENGINE, SOME HEATED COOLANT MAY SPILL OUT DUE TO AIR "BURPING" OUT OF THE SYSTEM WITH THE RADIATOR CAP OFF.

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.



3.27 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 in. (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).

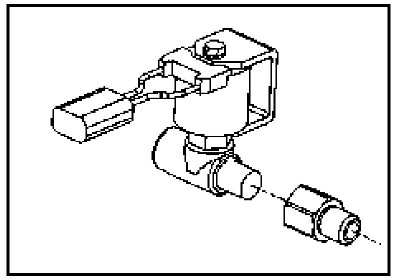
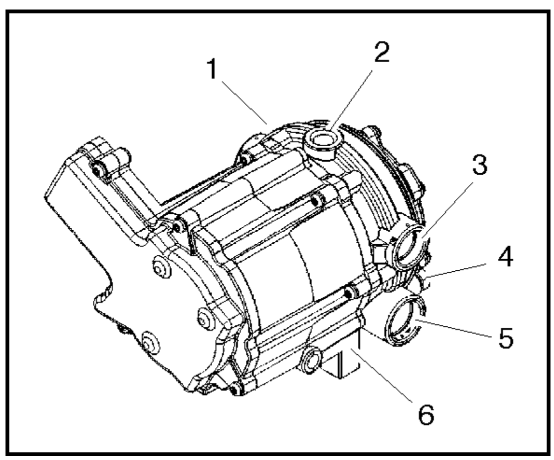


Figure 3-116. Electric Fuel Lock Off

EPR Assembly

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



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

Figure 3-117. 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.

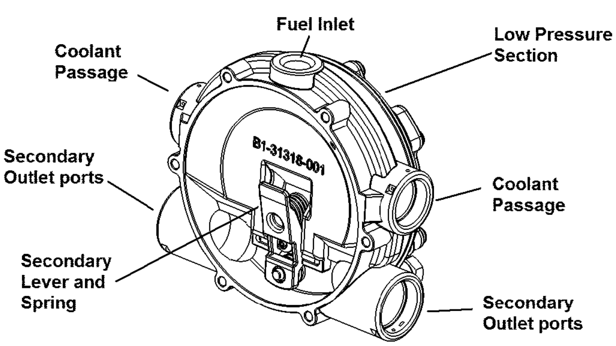


Figure 3-118. Low Pressure Regulators

Air Fuel Mixer

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

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

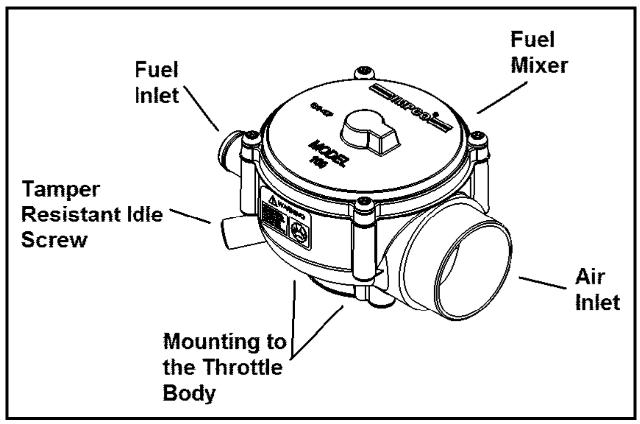


Figure 3-119. Air Fuel Mixer

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.

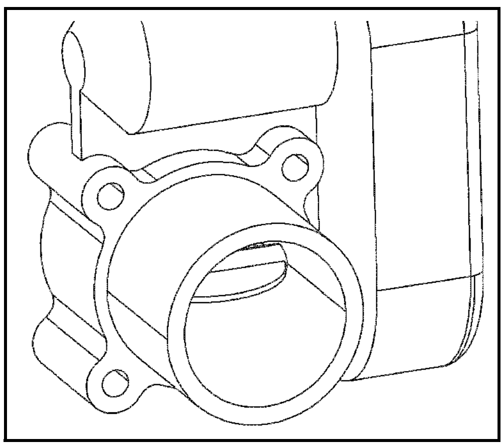


Figure 3-120. ETC throttle control device

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.

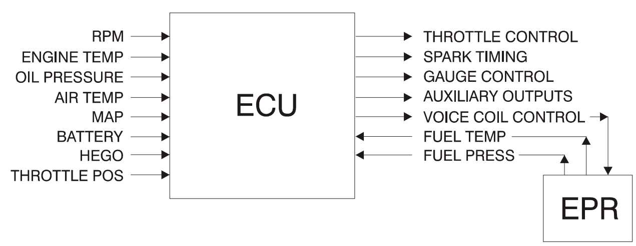


Figure 3-121. LPG Engine Control Unit (ECM)

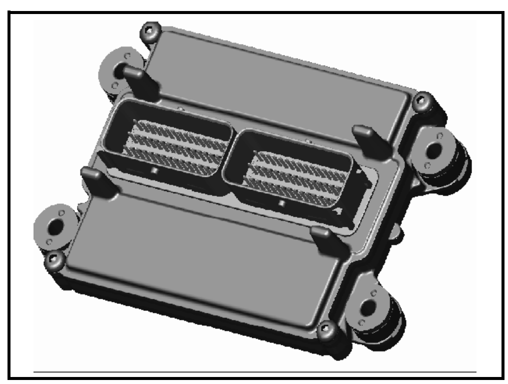


Figure 3-122. ECM Assembly

Heated Exhaust Gas Oxygen Sensor

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

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

NOTICE

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

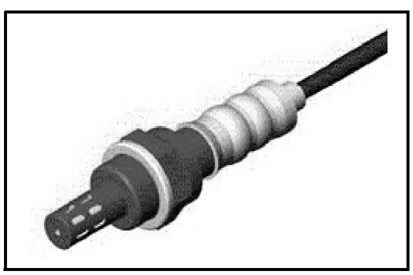


Figure 3-123. Heated Exhaust Gas Oxygen Sensor (HEGO)

Gasoline Multi Point Fuel Injection System (MPFI)

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

Gasoline Fuel Pump

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

Gasoline Pressure and Temperature Sensor Manifold

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

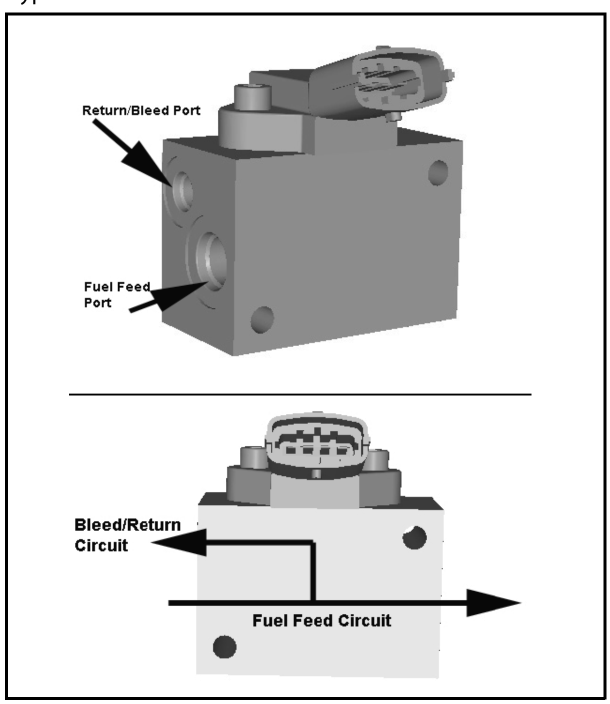


Figure 3-124. Gasoline Fuel Pressure and Temperature Manifold Assembly

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.

3.28 GM ENGINE FUEL SYSTEM REPAIR

Propane Fuel System Pressure Relief

CAUTION

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

To relieve propane fuel system pressure:

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

NOTICE

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

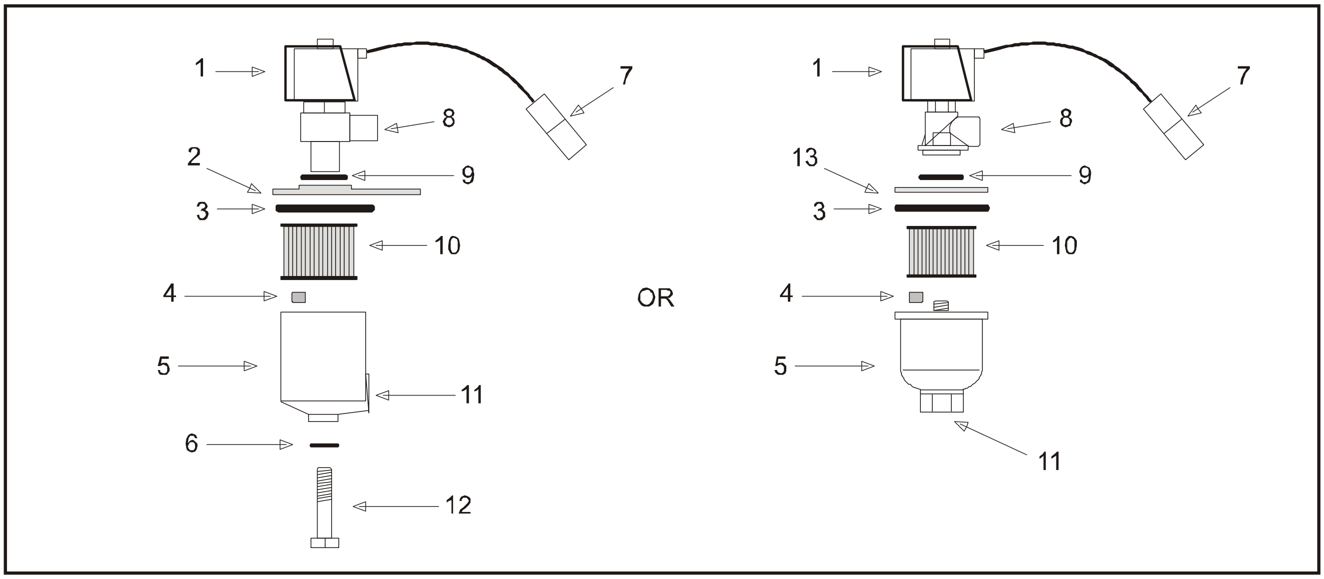
Propane Fuel System Leak Test

CAUTION

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

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

Propane Fuel Filter Replacement



1.	Electric Lock Off Solenoid	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 3-125. Filter Lock Assembly

REMOVAL

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

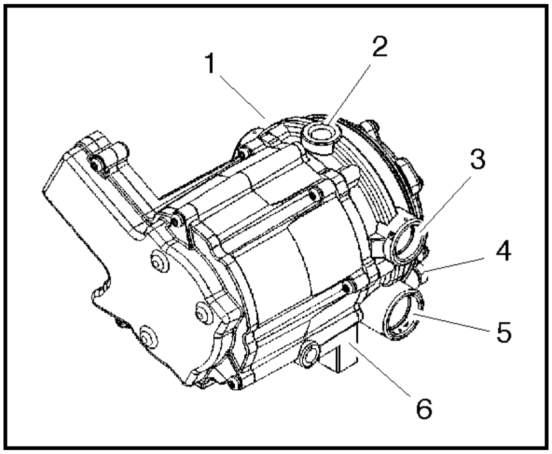
INSTALLATION

NOTICE

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

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

Electronic Pressure Regulator (EPR) Assembly Replacement



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

Figure 3-126. EPR Assembly

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

REMOVAL

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

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

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

INSTALLATION

NOTICE

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

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

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

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

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

3. Install the fuel temperature sensor into the regulator opening and lock in place with the locking pin, connect the electrical connector.
4. Insert the fuel vapor line and fitting into the regulator port and lock in place with the locking pin.
5. Install both the water hoses and fittings into the regulator and lock in place with the locking pin remove the clamp pliers from the hoses.
6. Install the electric lock off into the regulator inlet and tighten into proper location, connect the electrical connector.
7. Connect the fuel supply line and tighten until fully seated.
8. Connect the EPR electrical connector.
9. Open the manual valve.

10. Start the vehicle and leak check the propane fuel system at each serviced fitting Refer to Propane Fuel System Leak Test.

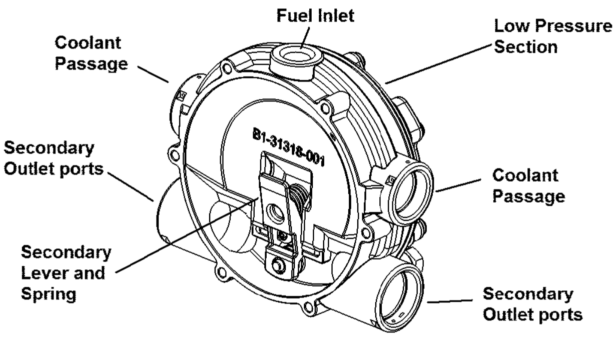


Figure 3-127. Pressure Regulator Section

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

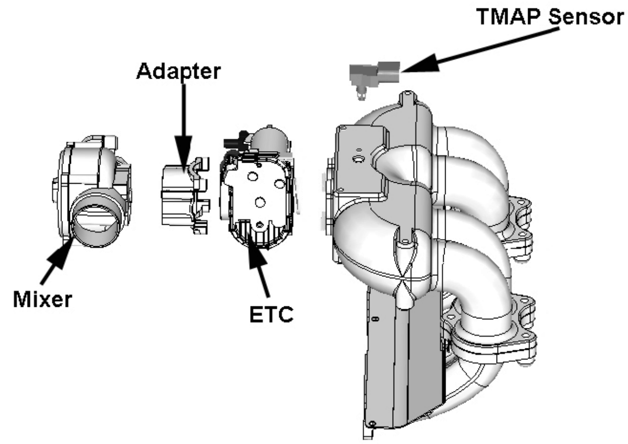


Figure 3-128. (TMAP) Sensor & Electronic Throttle Control (ETC)

REMOVAL

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

INSTALLATION

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

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

Electronic Throttle Control Replacement

See Figure 3-128.

REMOVAL

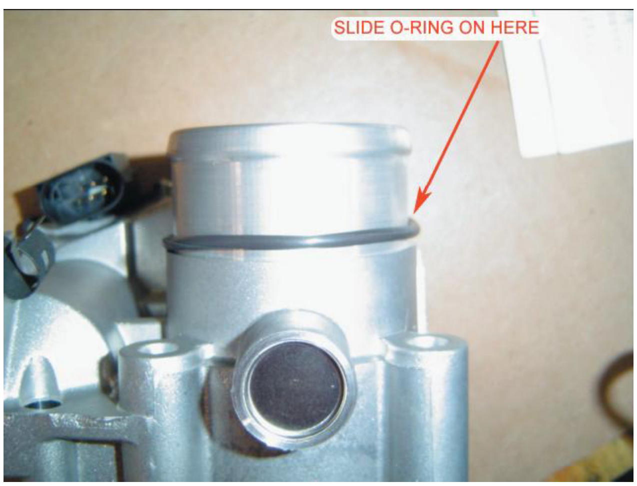
1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Release the hose clamp on the vapor fuel line and remove the vapor hose.
4. Disconnect the TMAP electrical connector.
5. Disconnect the electronic throttle control connector.
6. Remove the manifold to throttle body adapter bolts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

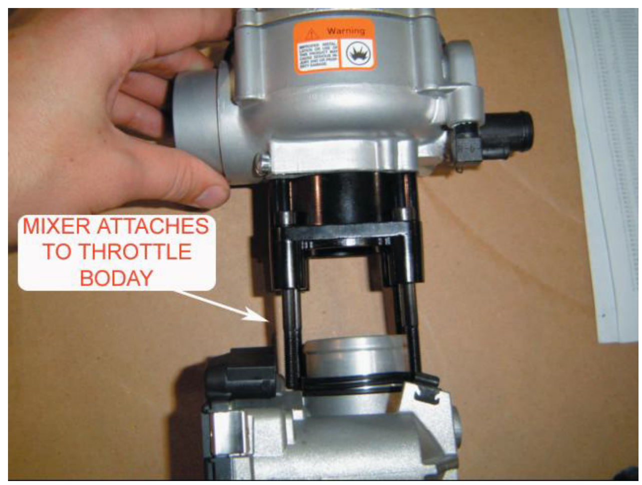
LIGHTLY LUBRICATE BOTH THROTTLE CONTROL DEVICE TO ADAPTER O-RINGS.

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.

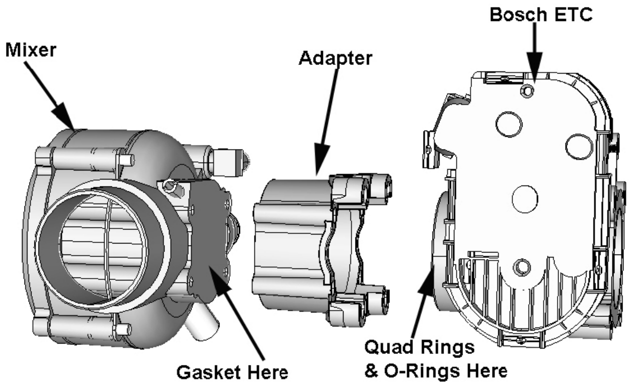


Figure 3-129. Mixer Assembly

Mixer Replacement

See Figure 3-129.

REMOVAL

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

INSTALLATION

NOTICE

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

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

Coolant Hose Replacement

REMOVAL

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

INSTALLATION

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

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

Vapor Hose Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

Engine Control Module Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

Heated Exhaust Gas Oxygen Sensor Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

3.29 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

Fuel System Description

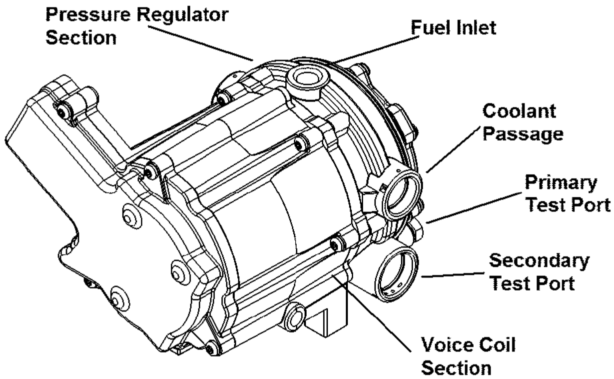


Figure 3-130. EPR Assembly

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

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

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

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

Diagnostic Aids

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

Tools Required:

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

Diagnostic Scan Tool

- Diagnostic Display tool.

Pressure Gauges

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

Test Description

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

5. This step determines if the LPR requires replacement

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

10. This step determines if the Mixer requires replacement

14. This step determines if the Lock Off requires replacement

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

Table 3-12. LPF Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
1	Were you referred to this procedure by a DTC diagnostic chart?	--	Go to Step 3	Go to Step 2
2	Perform the On Board Diagnostic (OBD) System Check. Are any DTCs present in the ECM?	--	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?	-1.0" to -2.0" w.c	Go to Step 25	Go to Step 6
6	1. Disconnect the EPR electrical connectors. NOTE: This action will cause a DTC to be set by the ECM 2. With the engine idling observe the pressure reading on the secondary test port. Is the fuel pressure WITHIN the specified range?	-1.0" to -2.0" w.c	Go to Fuel Control System Diagnosis	Go to Step 7
7	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the fuel hose connection between the LPR and mixer assembly for damage or leakage. 3. Inspect any vacuum hoses for leaks Was a problem found and corrected?	--	Go to Step 26	Go to Step 22
8	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR secondary pressure. Does the fuel pressure indicate a vacuum is present?	--	Go to Step 12	Go to Step 9
9	1. Remove Air induction hose to the mixer 2. Observe the air valve for movement while the engine is cranking. Note: Movement of the air valve will be minimal at cranking speeds. Does the air valve move when the engine is cranked?	--	Go to Step 11	Go to Step 10
10	1. Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses from the mixer for proper connection and condition. Was a problem found and repaired?	--	Go to Step 26	Go to Step 24
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	--	Go to Step 26	Go to Step 12
12	1. Connect a 0-10 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is the fuel pressure ABOVE the specified value?	1-3 PSI	Go to Step 22	Go to Step 13
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 3-12. LPF 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 3-13. Symptom Diagnosis

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

Table 3-13. Symptom Diagnosis

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

Table 3-13. Symptom Diagnosis

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

Table 3-13. 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	Refer to Important Preliminary Checks.
Ignition System Checks	Start the engine. Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. Check for proper ignition output voltage with spark tester J 26792. Check for a cylinder misfire. Verify that the spark plugs are correct for use with LPG (R42LTS) Remove the spark plugs in these cylinders and check for the following conditions: Insulation cracks Wear Improper gap Burned electrodes Heavy deposits Visually/Physically inspect the secondary ignition for the following: Ignition wires for arcing, cross-firing and proper routing Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	Perform a cylinder compression check. Check the engine for the following: - Improper valve timing - Bent pushrods - Worn rocker arms - Worn camshaft lobes - Broken or weak valve springs Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). EMI on the reference circuit can cause a missing condition. Monitoring the engine RPM with a scan tool can detect an EMI. A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. If the problem exists, check the routing of the secondary wires and the ground circuit.
Hesitation, Sag, Stumble	
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	Check the fuel pressure. Refer to LPG Fuel System Diagnosis. Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. Check LPL electrical connection. Check the mixer air valve for sticking or binding. Check the mixer module assembly for proper installation and leakage. Check the EPR electrical connections.

Table 3-13. Symptom Diagnosis

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

Table 3-13. Symptom Diagnosis

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

Table 3-13. Symptom Diagnosis

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

Table 3-13. Symptom Diagnosis

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

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

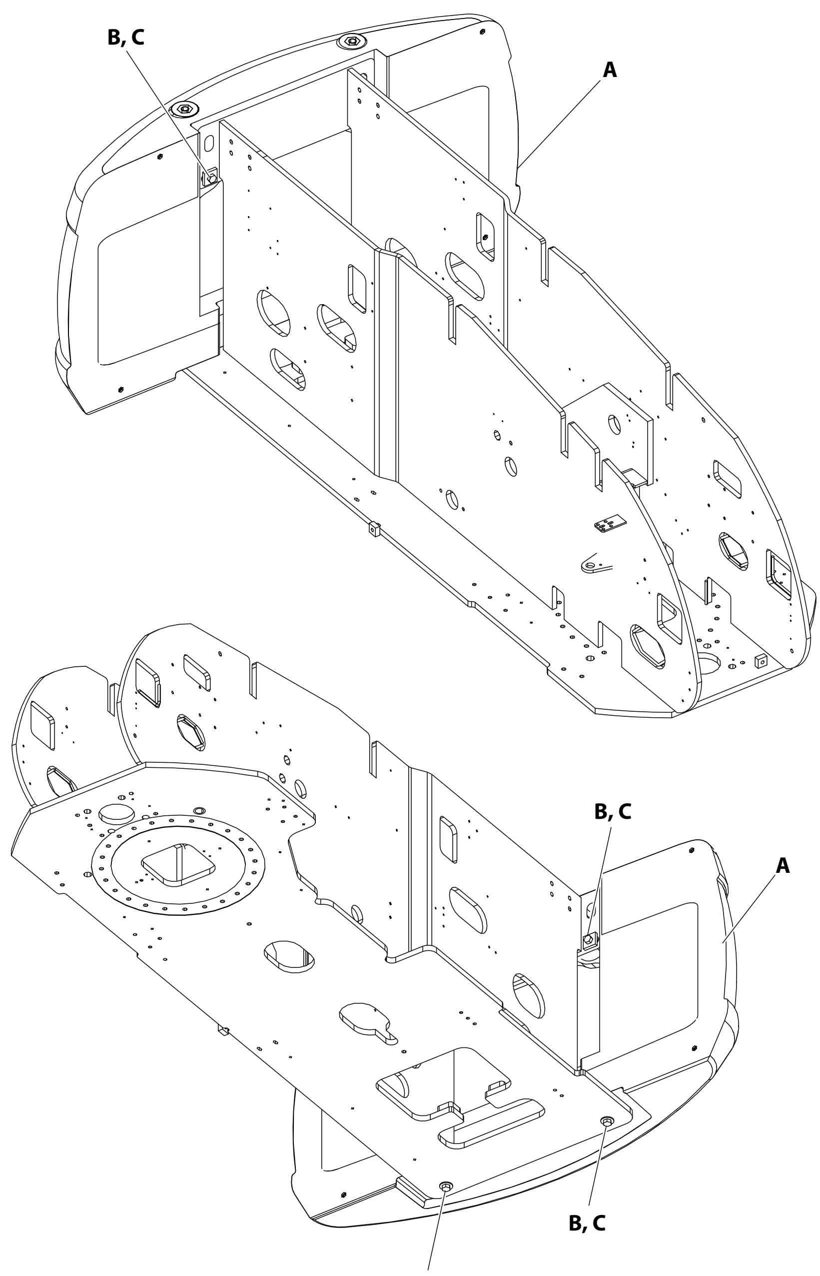
DTC	Description	SPN Code	FMI Code
16	Crank Never Synced at Start	636	8
91	Fuel Pump Low Voltage	94	4
92	Fuel Pump High Voltage	94	3
107	MAP Low Voltage	106	4
108	MAP High Pressure	106	16
111	IAT Higher Than Expected 1	105	15
112	IAT Low Voltage	105	4
113	IAT High Voltage	105	3
116	ECT Higher Than Expected 1	110	15
117	ECT Low Voltage	110	4
118	ECT High Voltage	110	3
121	TPS 1 Lower Than TPS 2	51	1
122	TPS 1 Signal Voltage Low	51	4
123	TPS 1 Signal Voltage High	51	3
127	IAT Higher Than Expected 2	105	0
129	BP Low Pressure	108	1
134	EGO 1 Open/Inactive	724	10
154	EGO 2 Open/Inactive	520208	10
171	Adaptive Learn High Gasoline	520200	0
172	Adaptive Learn Low Gasoline	520200	1
182	Fuel Temp Gasoline Low Voltage	174	4
183	Fuel Temp Gasoline High Voltage	174	3
187	Fuel Temp LPG Low Voltage	520240	4
188	Fuel Temp LPG High Voltage	520240	3
217	ECT Higher Than Expected 2	110	0
219	Max Govern Speed Override	515	15
221	TPS 2 Signal Voltage Low	51	0
222	TPS 2 Signal Low Voltage	520251	4
223	TPS 2 Signal High Voltage	520251	3
261	Injector Driver 1 Open	651	5
262	Injector Driver 1 Shorted	651	6
264	Injector Driver 2 Open	652	5
265	Injector Driver 2 Shorted	652	6
267	Injector Driver 3 Open	653	5
268	Injector Driver 3 Shorted	653	6
270	Injector Driver 4 Open	654	5
271	Injector Driver 4 Shorted	654	6
336	Crank Sync Noise	636	2
337	Crank Loss	636	4
341	Cam Sync Noise	723	2
342	Cam Sensor Loss	723	4
420	Gasoline Cat Monitor	520211	10
524	Oil Pressure Low	100	1

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

DTC	Description	SPN Code	FMI Code
562	System Voltage Low	168	17
563	System Voltage High	168	15
601	Flash Checksum Invalid	628	13
604	RAM Failure	630	12
606	COP Failure	629	31
642	External 5V Reference Low	1079	4
643	External 5V Reference High	1079	3
685	Power Relay Open	1485	5
686	Power Relay Shorted	1485	4
687	Power Relay Short to Power	1485	3
1111	Fuel Rev Limit	515	16
1112	Spark Rev Limit	515	0
1151	Closed Loop Multiplier High LPG	520206	0
1152	Closed Loop Multiplier Low LPG	520206	1
1155	Closed Loop Multiplier High Gasoline	520204	0
1156	Closed Loop Multiplier Low Gasoline	520204	1
1161	Adaptive Learn High LPG	520202	0
1162	Adaptive Learn Low LPG	520202	1
1165	LPG Cat Monitor	520213	10
1171	LPG Pressure Higher Than Expected	520260	0
1172	LPG Pressure Lower Than Expected	520260	1
1173	EPR Comm Lost	520260	31
1174	EPR Voltage Supply High	520260	3
1175	EPR Voltage Supply Low	520260	4
1176	EPR Internal Actuator Fault	520260	12
1177	EPR Internal Circuitry Fault	520260	12
1178	EPR Internal Comm Fault	520260	12
1612	RTI 1 loss	629	31
1613	RTI 2 Loss	629	31
1614	RTI 3 Loss	629	31
1615	A/D Loss	629	31
1616	Invalid Interrupt	629	31
1625	Shutdown Request	1384	31
1626	CAN Tx Failure	639	12
1627	CAN Rx Failure	639	12
1628	CAN Address Conflict Failure	639	13
1629	Loss of TSC 1	639	31
2111	Unable to Reach Lower TPS	51	7
2112	Unable to Reach Higher TPS	51	
2135	TPS 1/2 Simultaneous Voltages	51	31
2229	BP Pressure High	108	0

3.30 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-131., Counterweight.



A. Counterweight Casting
B. Apply JLG Threadlocker P/N 0100019 to Bolt Threads and to Threads in Counterweight.
C. Torque to 285 ft. lbs. (386 Nm). Typical Four Places.

Figure 3-131. Counterweight

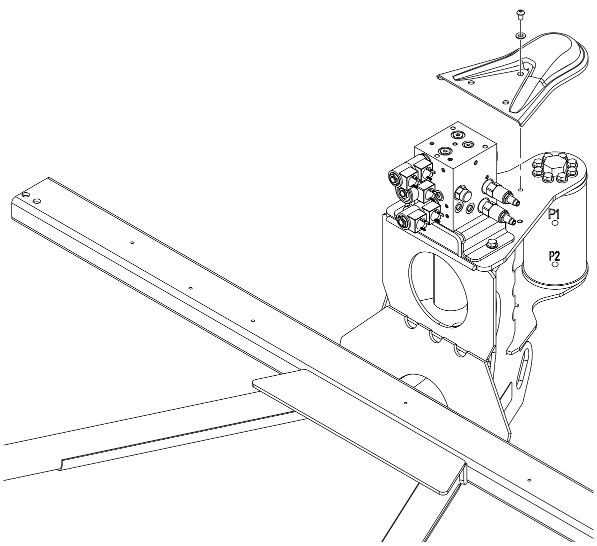
NOTES:

SECTION 4. BOOM & PLATFORM

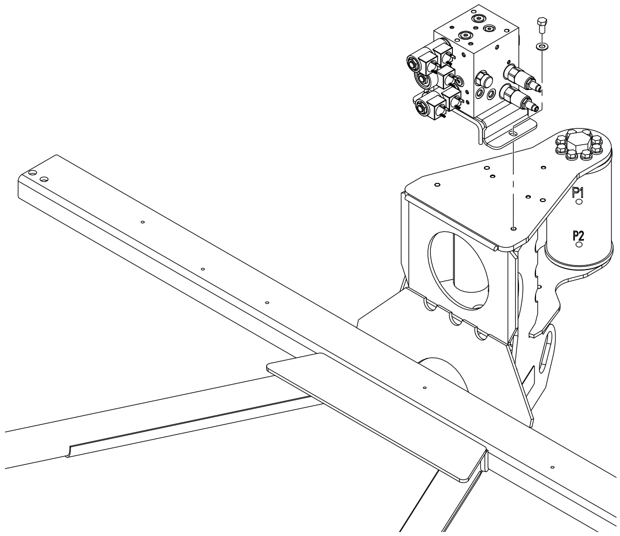
4.1 PLATFORM

Platform Valve Removal (Prior to SN 0300141319)

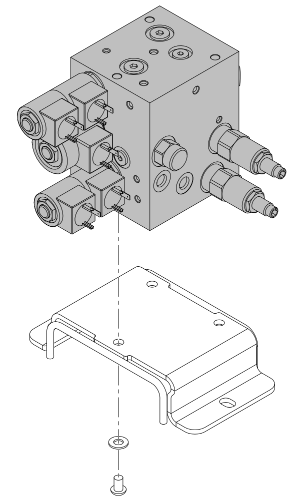
1. Remove hardware securing cover to the platform support. Remove cover.



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

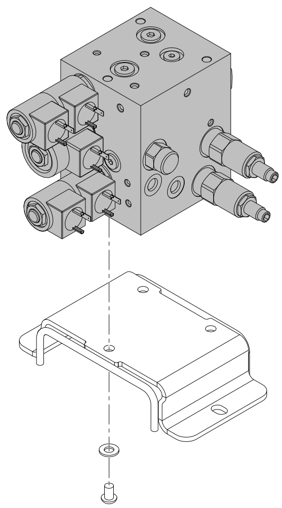


3. Remove hardware securing the platform control valve to the mounting bracket. Remove platform control valve.

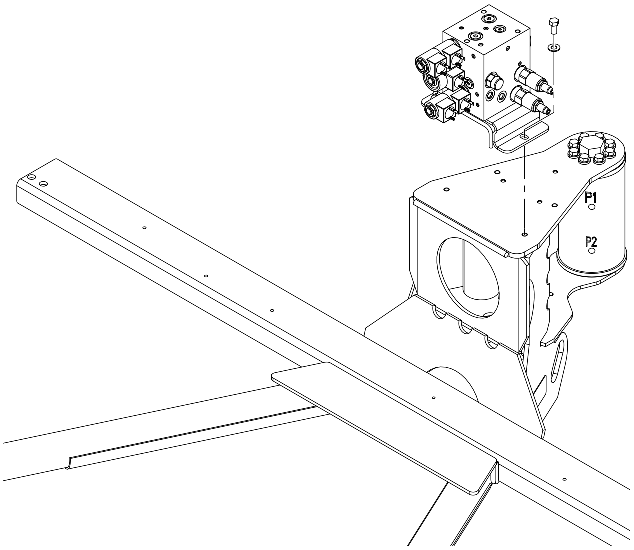


Platform Valve Installation (Prior to SN 0300141319)

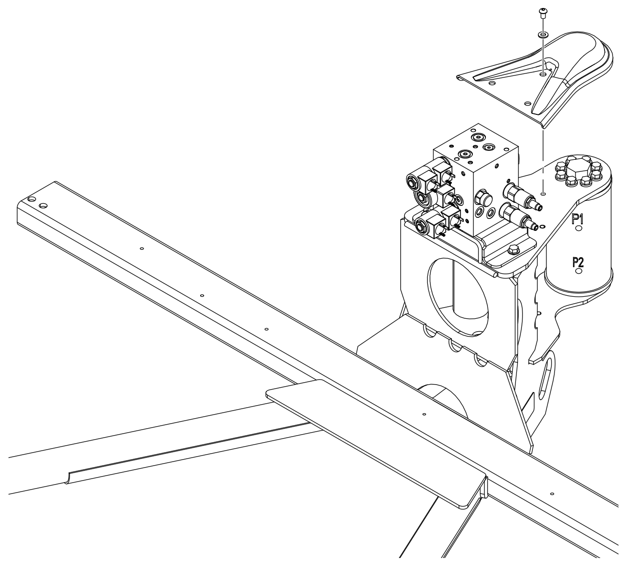
1. Install platform control valve onto the mounting bracket and secure using hardware.



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



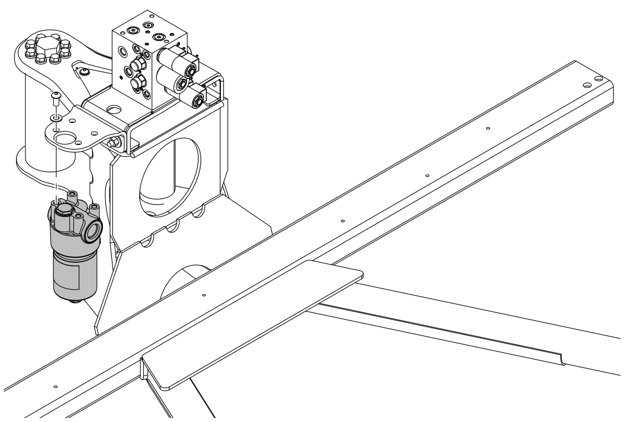
3. Install cover onto the platform support and secure with mounting hardware.



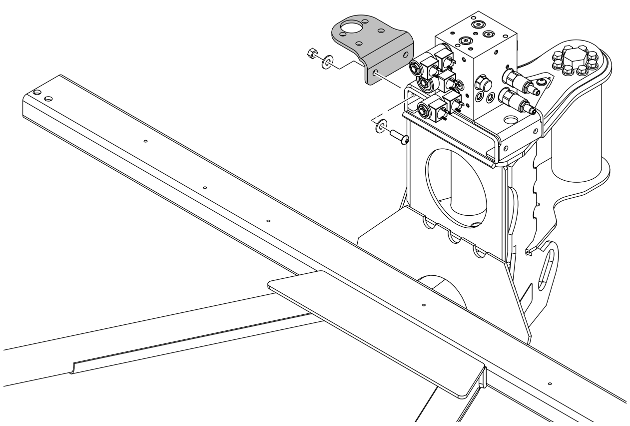
4. Remove tag and reconnect the hydraulic lines to the platform control valve.

Platform Valve Removal (SN 0300141319 through 0300189341)

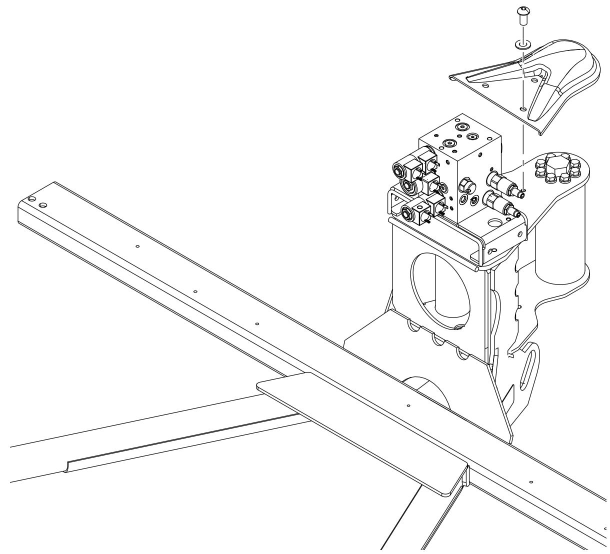
1. Tag and disconnect the hydraulic lines from the platform control valve. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Remove hardware securing high pressure filter to filter mounting bracket. Remove high pressure filter.



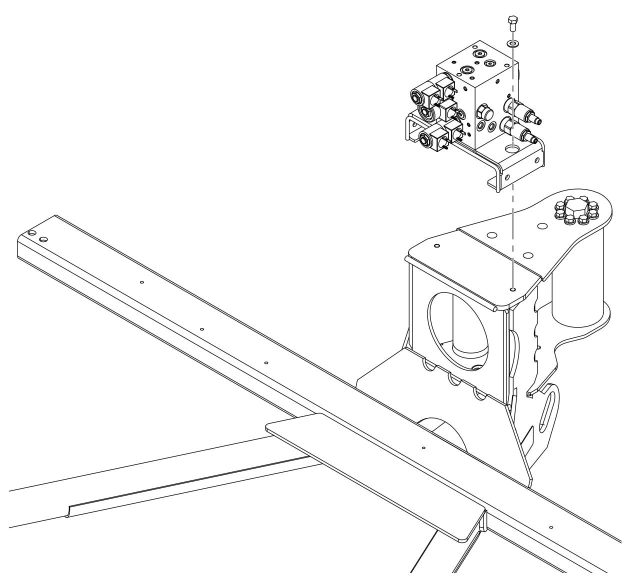
3. Remove hardware securing filter mounting bracket to valve mount. Remove filter mounting bracket.



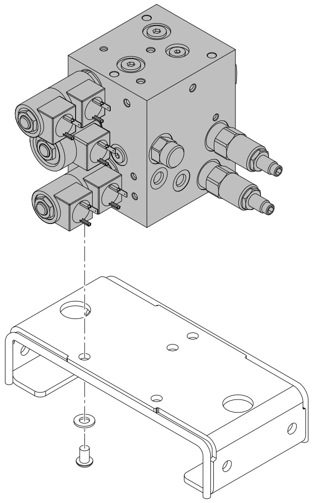
4. Remove hardware securing cover to the platform support. Remove cover.



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

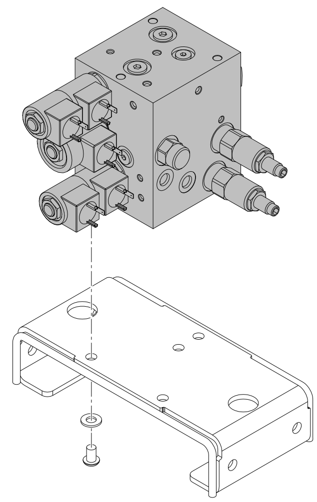


6. Remove hardware securing the platform control valve to the mounting bracket. Remove platform control valve.

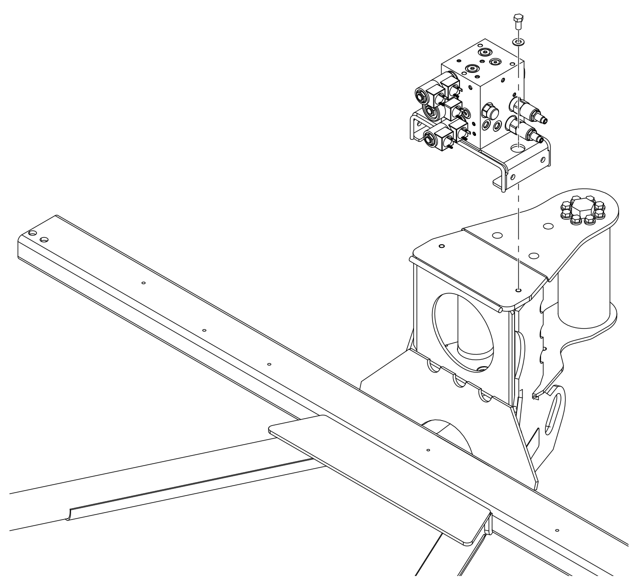


Platform Valve Installation (SN 0300141319 through 0300189341)

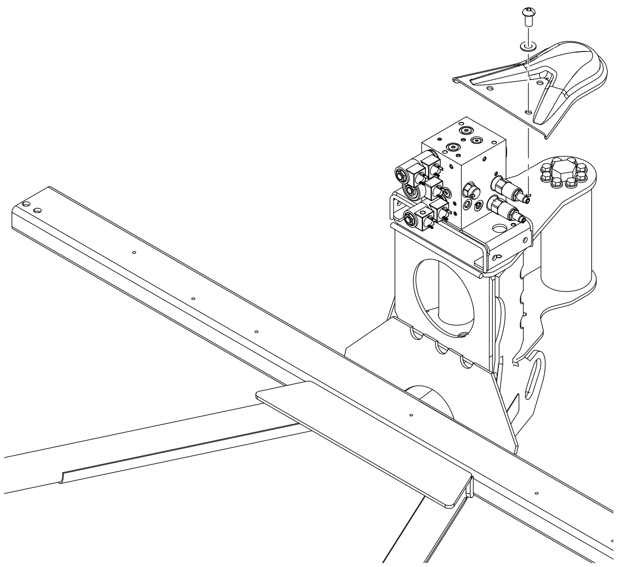
1. Install platform control valve onto the mounting bracket and secure using hardware.



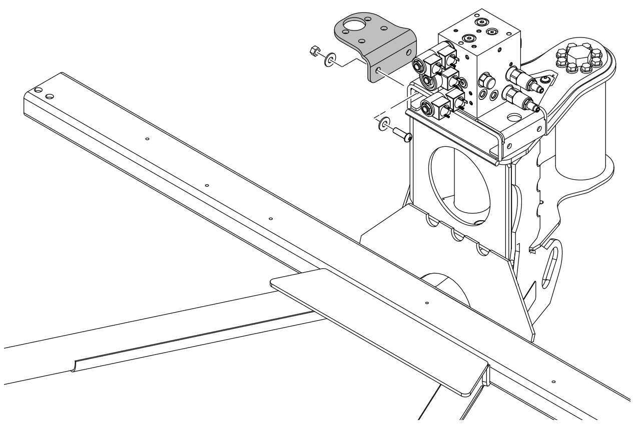
2. Install the mounting bracket onto the platform support and secure using hardware.



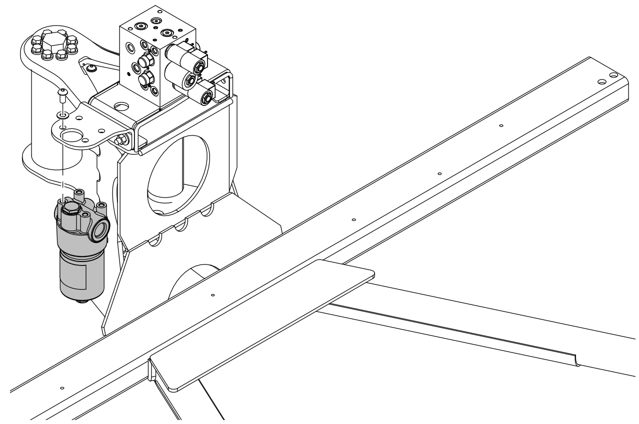
3. Install cover onto the platform support and secure with mounting hardware.



4. Install filter mounting bracket on side of valve mount and secure with mounting hardware.



5. Install high pressure filter onto filter mounting bracket and secure with mounting hardware.



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

Support Removal

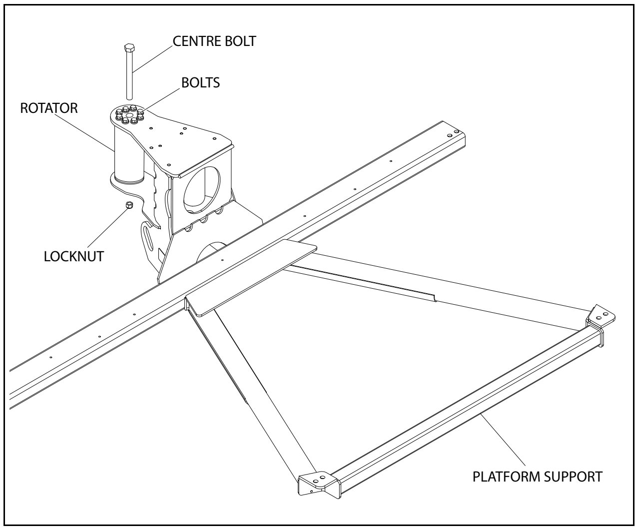
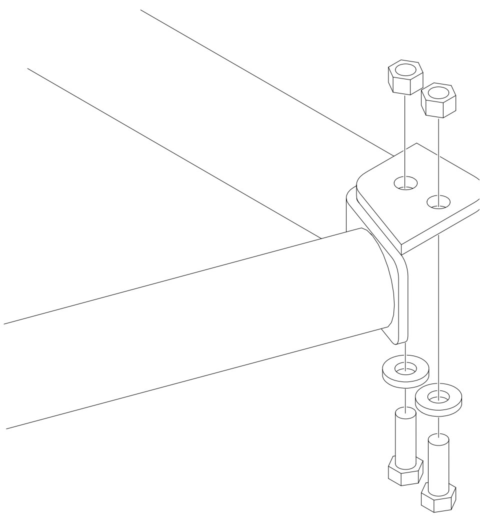


Figure 4-1. Location of Components - Platform Support

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

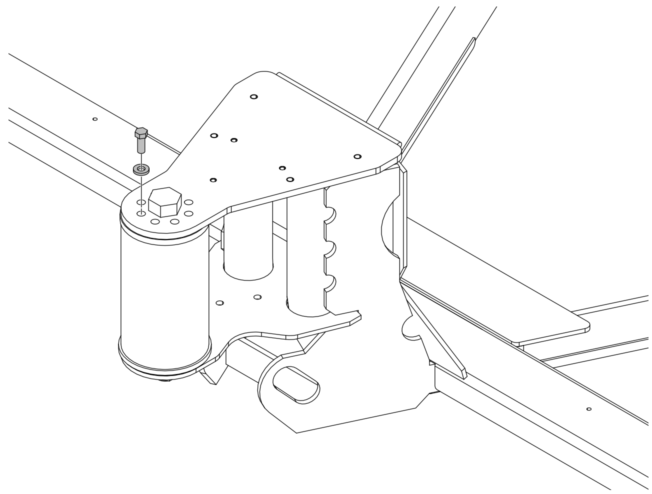
NOTE: *The platform support weighs approximately 134.5 lbs. (61 kg).*



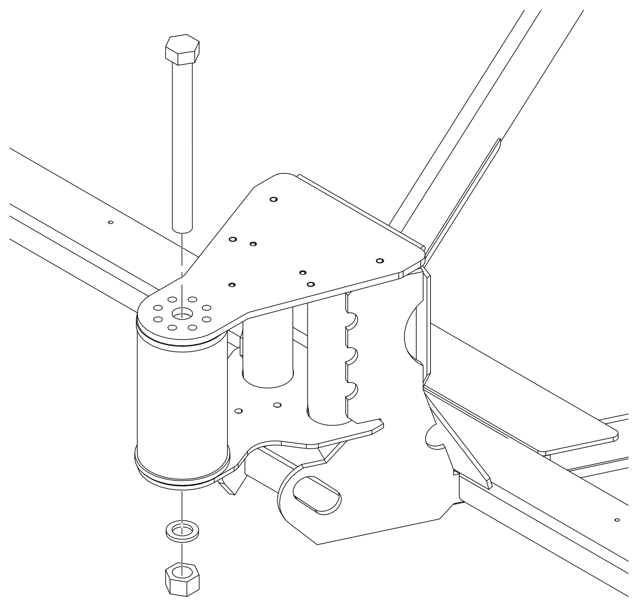
3. Using a suitable device, support the platform support.

NOTE: *The platform support weighs approximately 135 lbs. (61 kg).*

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



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

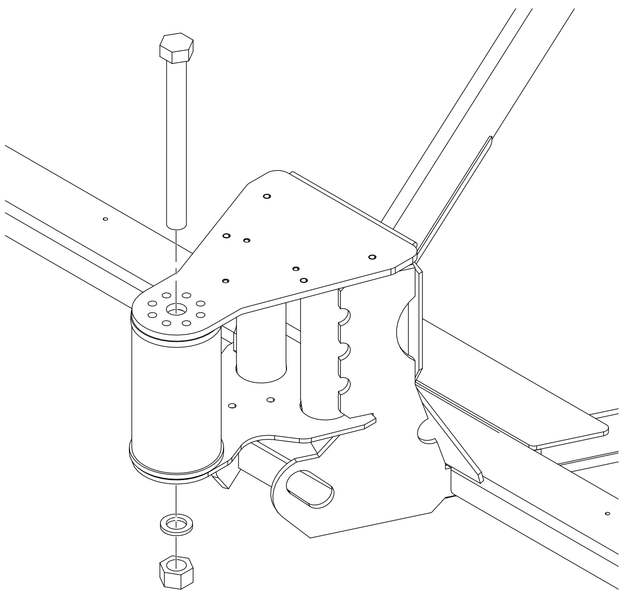


Support Installation

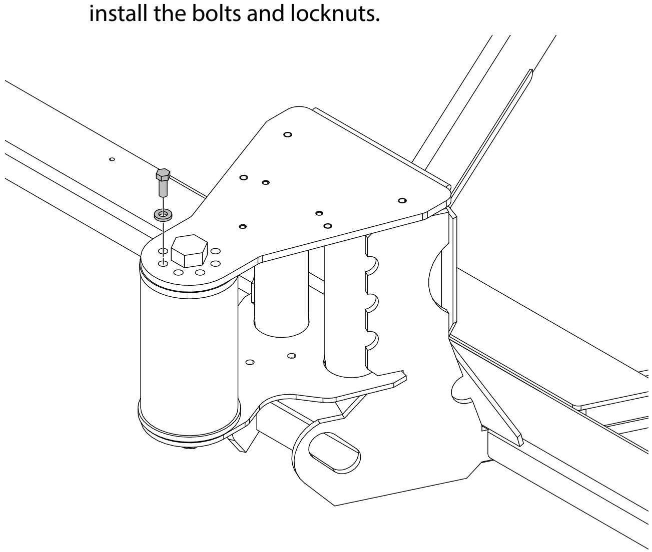
1. Using a suitable device, support the platform support and position it on the rotator.

NOTE: *The platform support weighs approximately 135 lbs. (61 kg).*

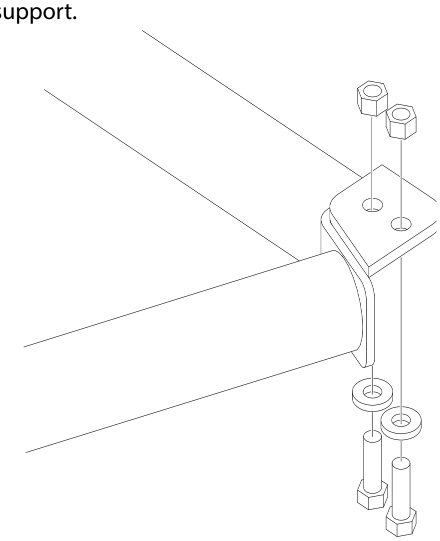
2. Install the rotator center bolt.



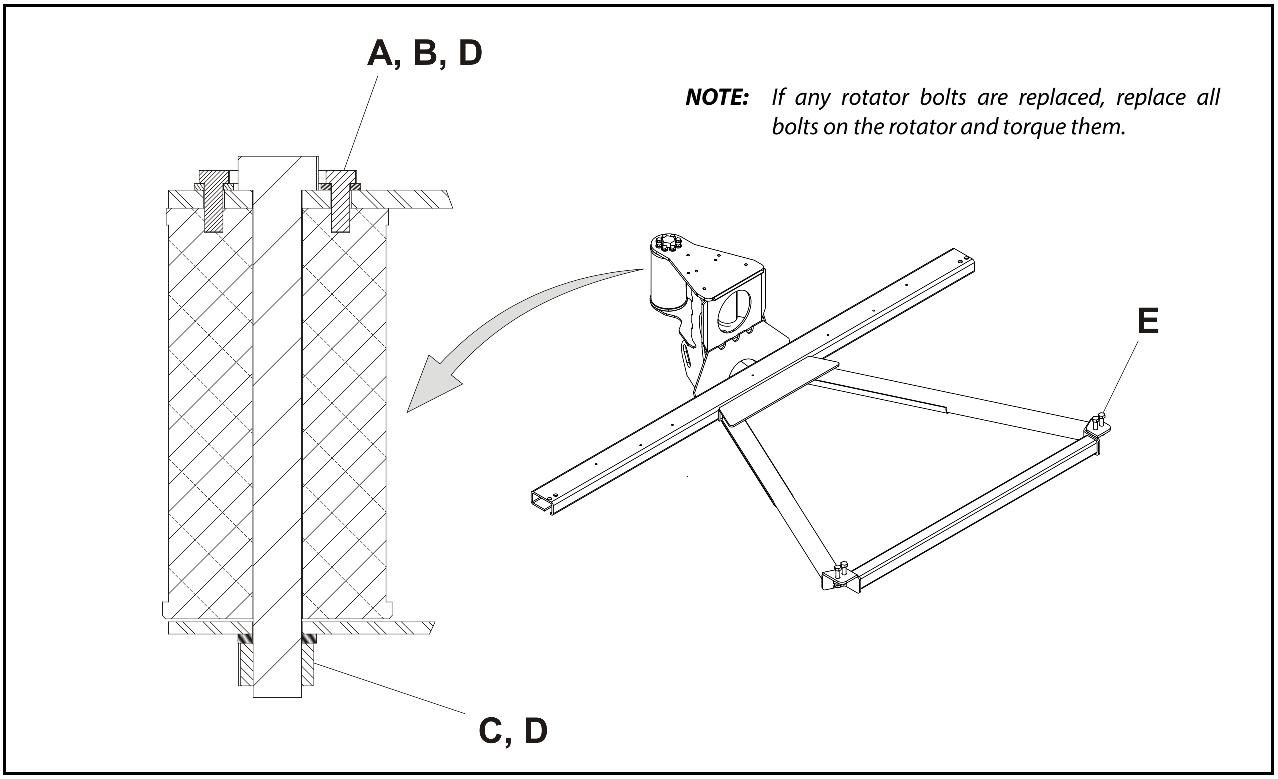
3. Apply JLG Threadlocker P/N 0100011 to the eight bolts and locknuts securing the support to the rotator and install the bolts and locknuts.



4. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).
5. Position the platform on the platform support and install the bolts securing the platform to the platform support.



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



A Torque to 40 ft. lbs. (55 Nm)
B JLG Threadlocker P/N 0100011
C Torque to 586 ft. lbs. (795 Nm)
D Check torque every 150 hours of operation
E Torque to 75 ft. lbs. (102 Nm)

Figure 4-2. Platform Support Torque Values

4.2 ROTATOR AND SLAVE CYLINDER

Removal

NOTICE

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

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

NOTE: *The rotator and slave cylinder assembly weighs approximately 112 lbs. (51 kg).*

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. Telescope the fly section out approximately to gain access to the slave cylinder.
5. Supporting the slave cylinder remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the fly boom and remove slave cylinder.
6. Tag and disconnect hydraulic lines to the slave cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.

Installation

1. Telescope the fly section out approximately to gain access to the slave cylinder.
2. Using adequate support, align the holes of slave cylinder with fly boom. Using a suitable brass drift and hammer, install pin #3 to the fly boom. Install mounting hardware securing pin #3.
3. Using adequate support, align the hole of rotator assembly with fly boom. Using a suitable brass drift and hammer, install pin #2 to the fly boom. Install mounting hardware securing pin #2. Torque the hardware to 35 ft. lbs. (50 Nm).
4. Align holes of slave cylinder and rotator assembly, Using a suitable brass drift and hammer, install pin #1 to the rotator assembly and slave cylinder. Install mounting hardware securing pin #1.
5. Remove tag and reconnect the hydraulic lines to the rotator assembly and the slave cylinder.

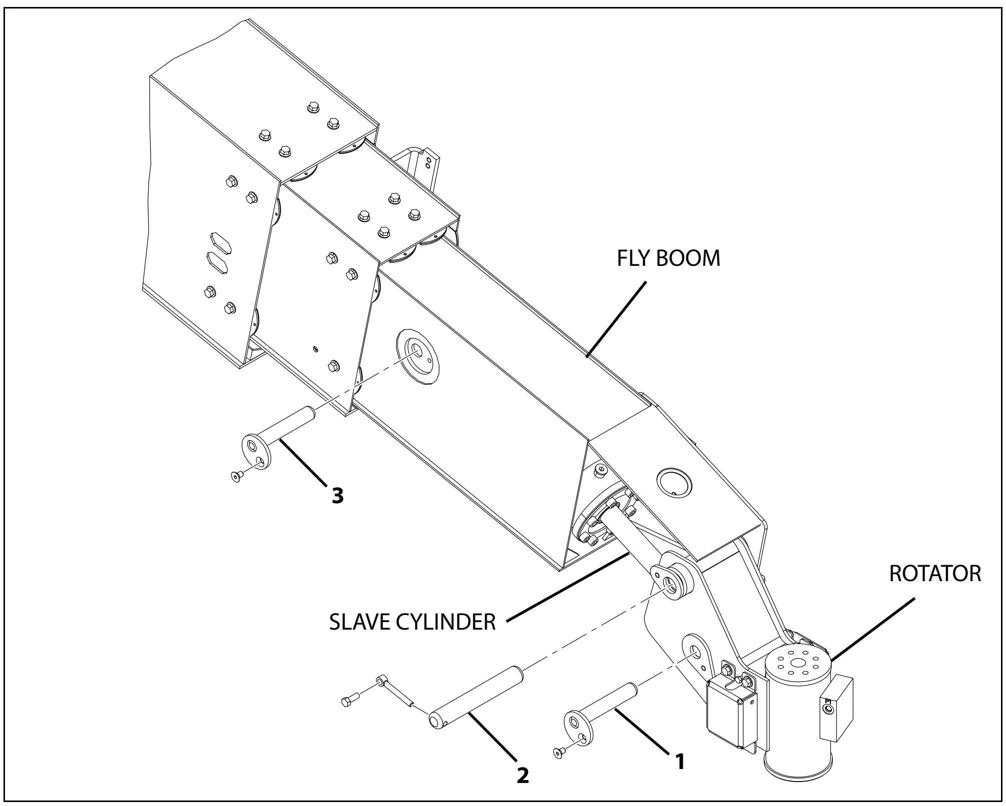


Figure 4-3. Location of Components - Rotator and Slave Cylinder

4.3 MAIN BOOM POWERTRACK

Removal

1. Disconnect wiring harness connectors located in tower upright.

NOTICE

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

2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to 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.
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, align and install bolts #3, #4, and #5 securing rail to the base boom.
3. Install bolts #2 that attaches rail to the push tube on the mid boom section.
4. Install bolts #1 securing the push tube on the fly boom section.
5. Reconnect dual capacity indicator limit switch from side of boom section.
6. Remove tag and reconnect all hydraulic lines and electrical cable to the powertrack.

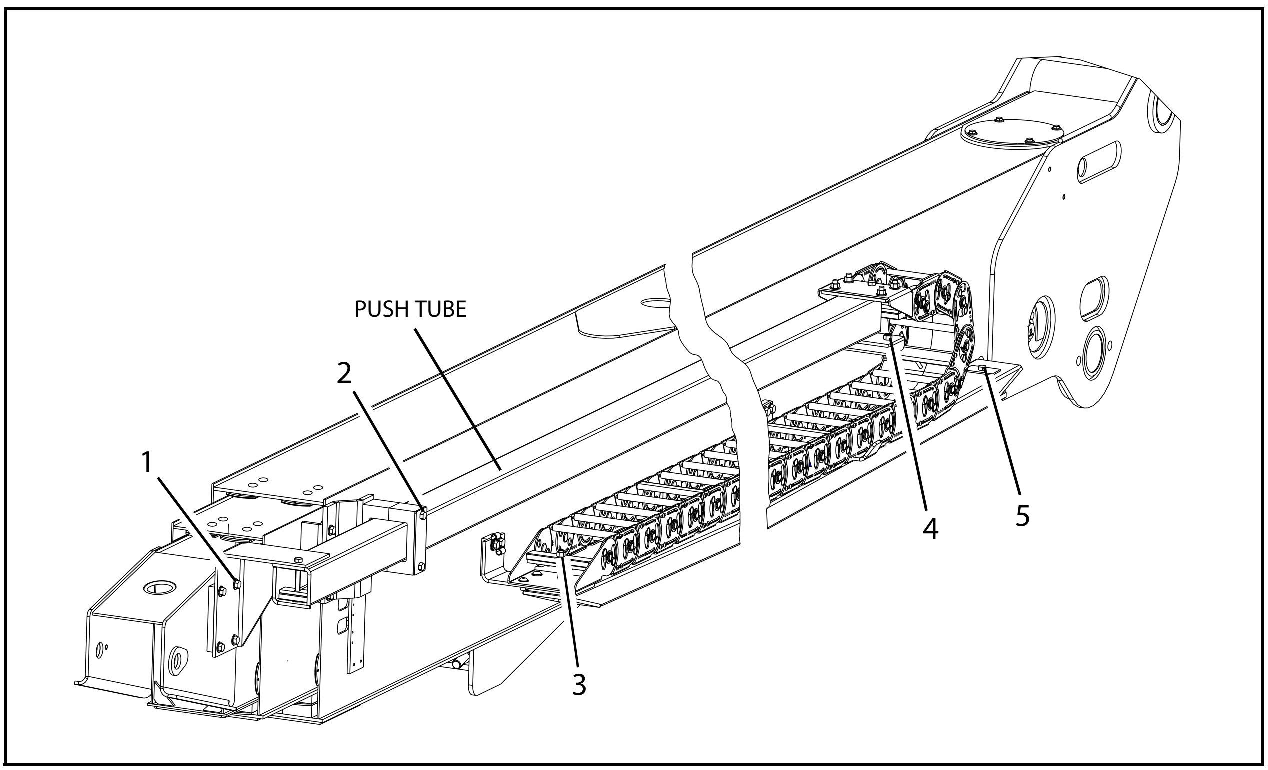


Figure 4-4. Location of Components - Main Boom Powertrack

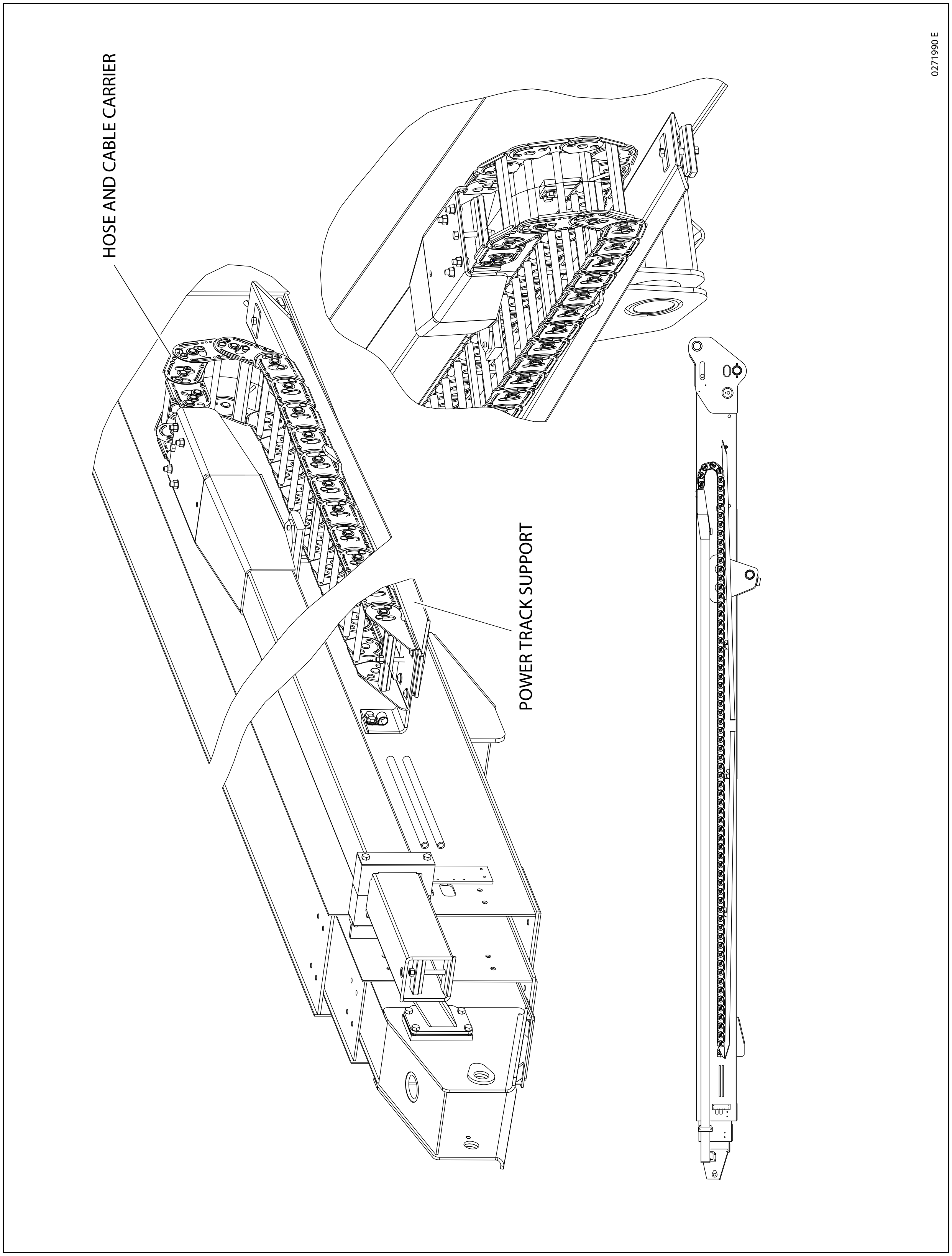


Figure 4-5. Powertrack Installation Main Boom - Sheet 1 of 2

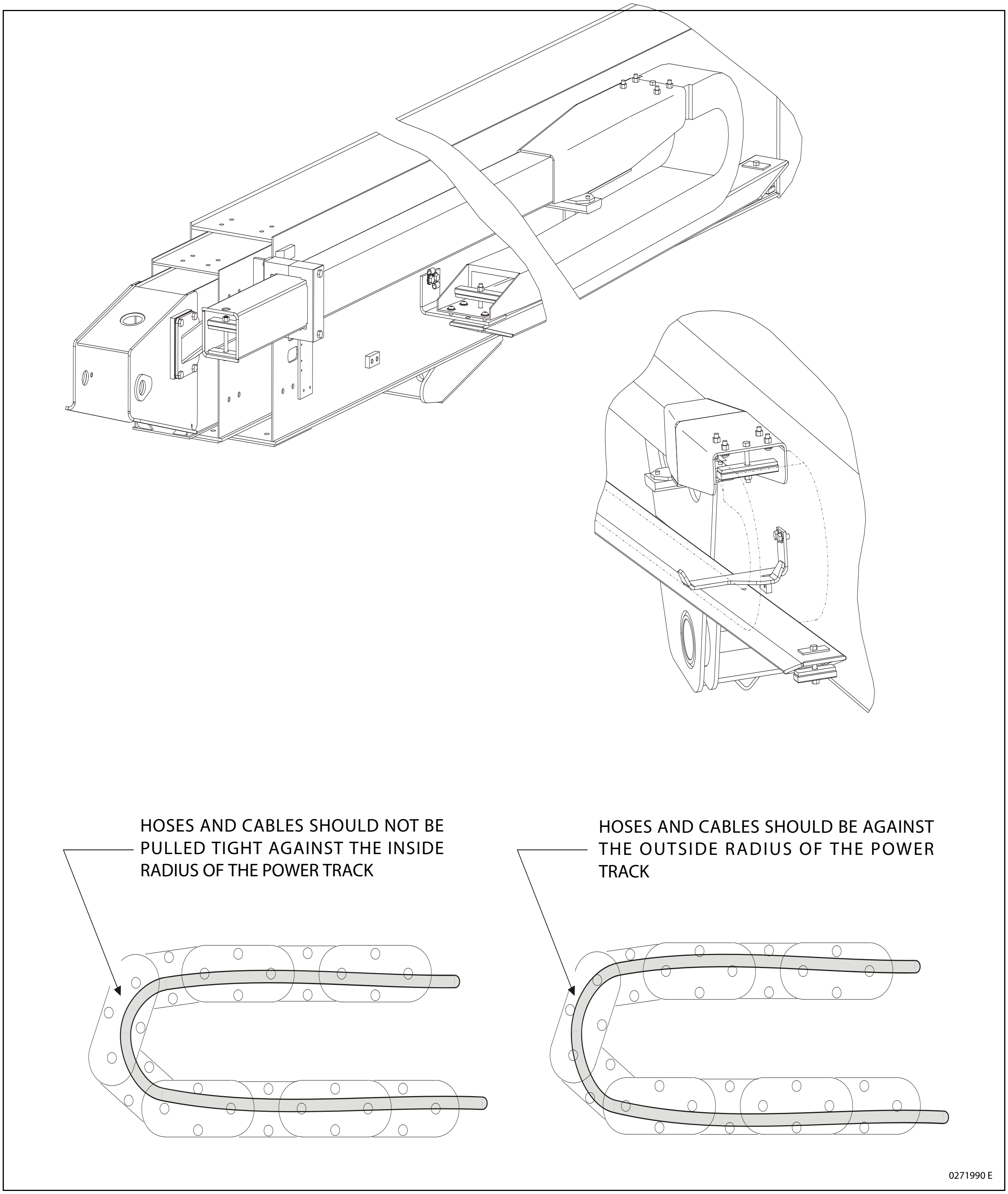
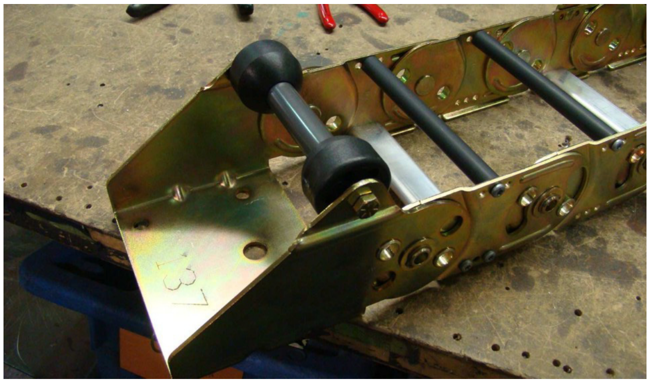


Figure 4-6. Powertrack Installation Main Boom - Sheet 2 of 2

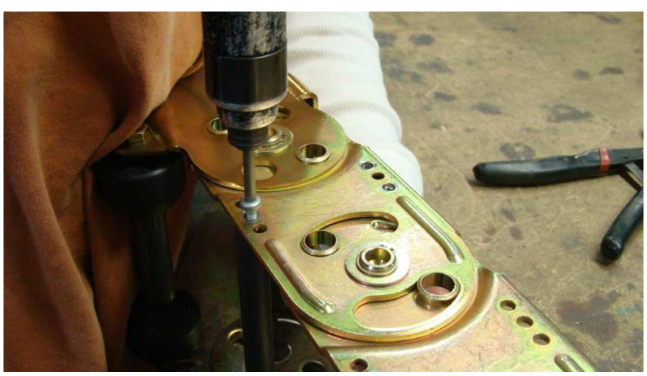
4.4 POWERTRACK MAINTENANCE

One Piece Bracket Maintenance

1. Place the powertrack on a workbench.



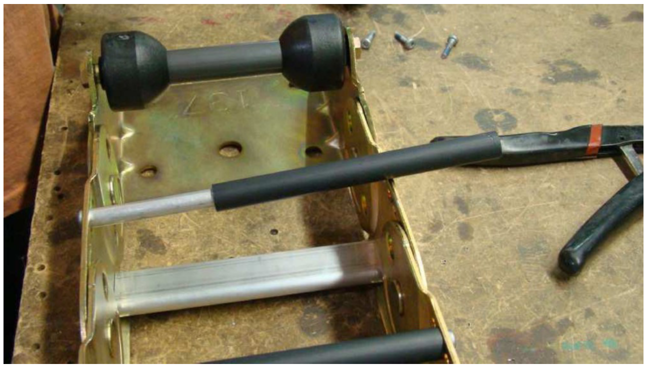
2. Remove the screws from the bars on one side of the powertrack on the first link.

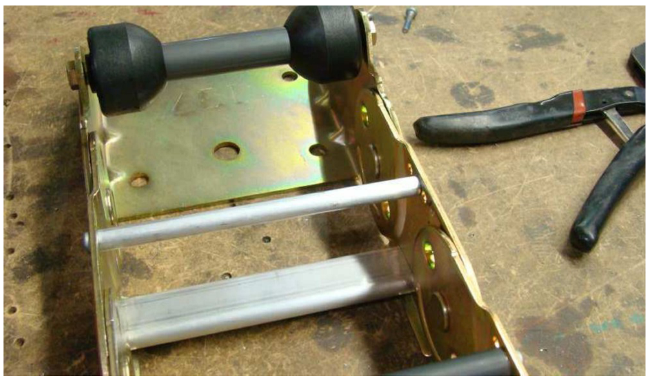


3. Remove the screws from the flat bar on the other side of the powertrack.

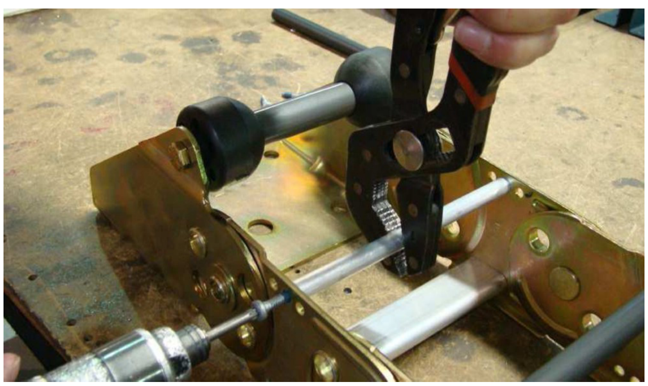
4. Pull up on the loose side of the round bar to allow the poly roller to slide off.

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

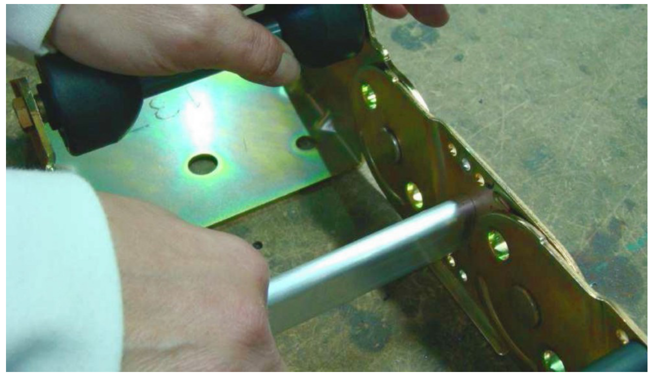


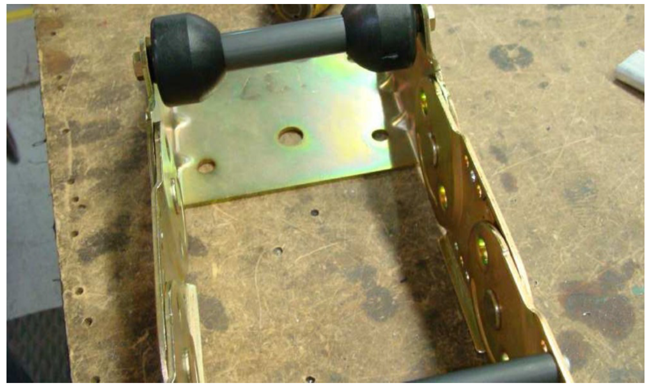


6. Hold the round bar to remove the other screw.

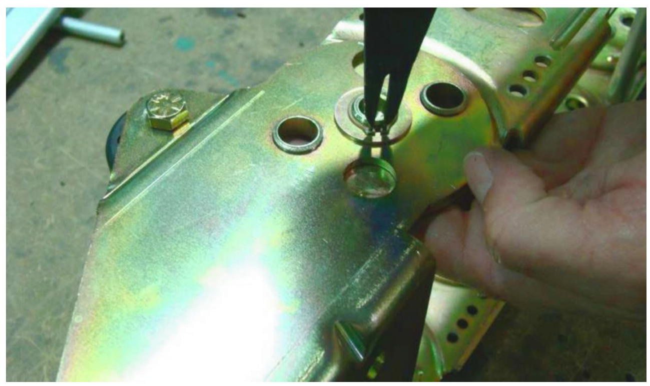


7. Slide the flat bar out.



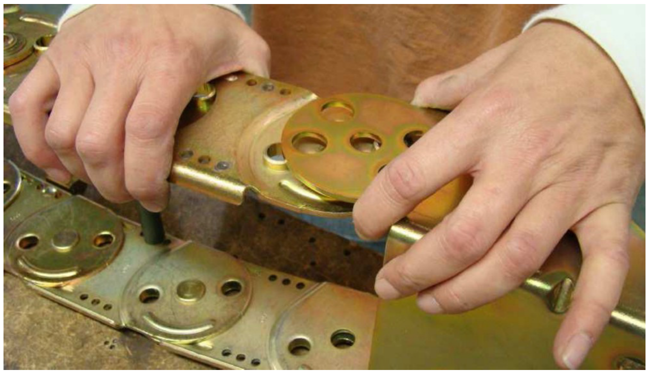


8. Remove the snap ring from one side of the bracket.



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.

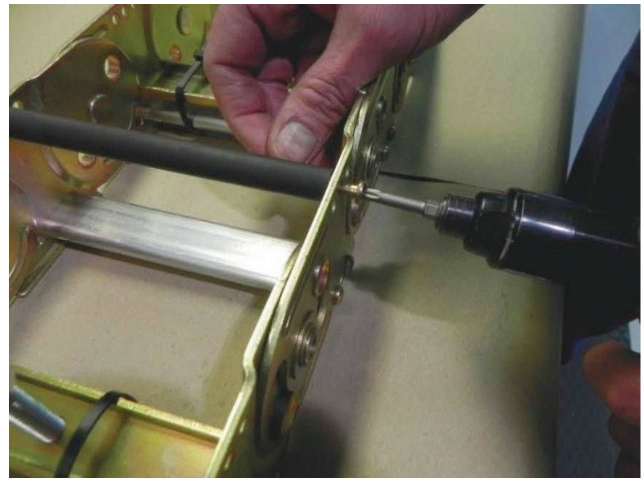


11. Repeat the previous step on the other side.

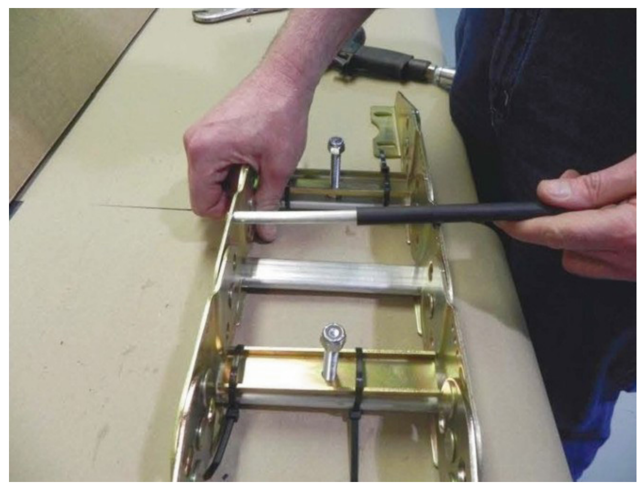
12. Slide the bracket off of the powertrack.

Two Piece Bracket Maintenance

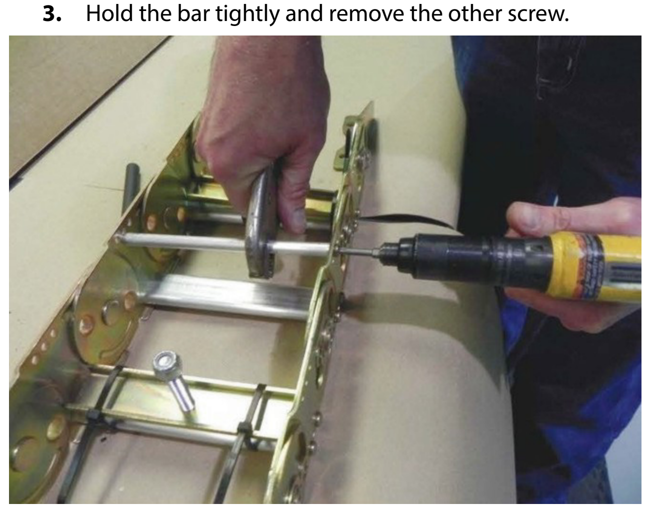
1. Loosen the screw.



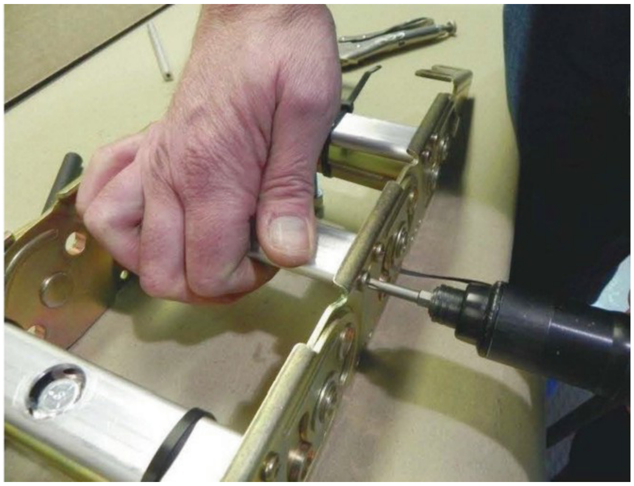
2. Slide the roller off the bar.



3. Hold the bar tightly and remove the other screw.

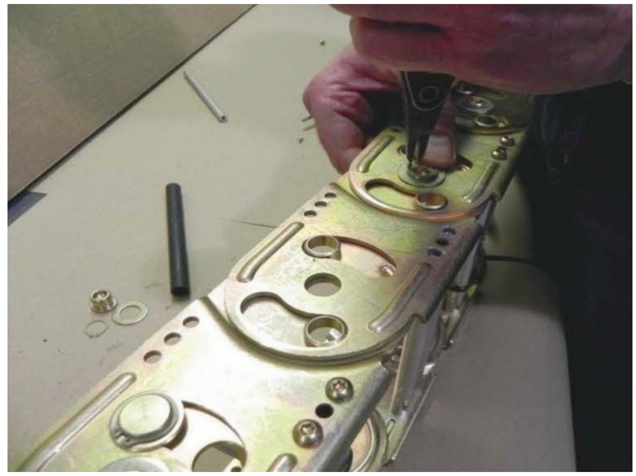


4. Hold the flat bar and remove the screws.

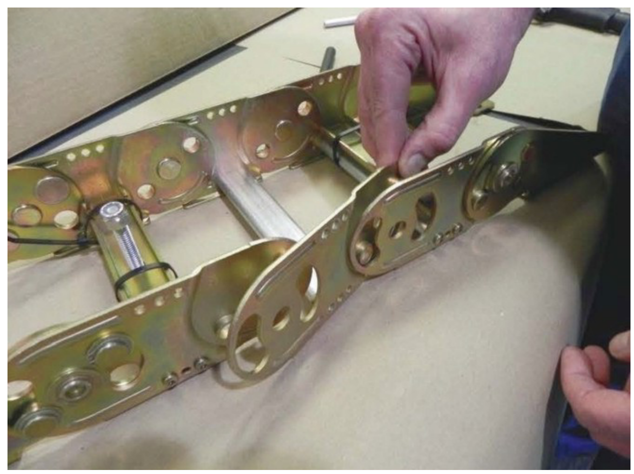


5. Remove the snap rings and pins.

6. Remove the screws from the bar. Remove the snap ring and pin.



7. Slide the link out.

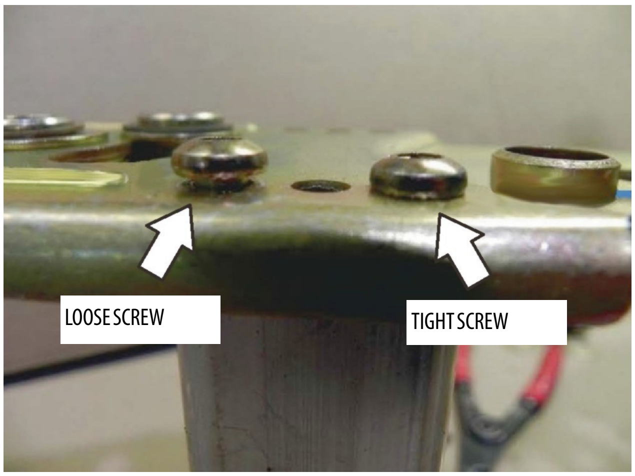


Snap Rings and Screws

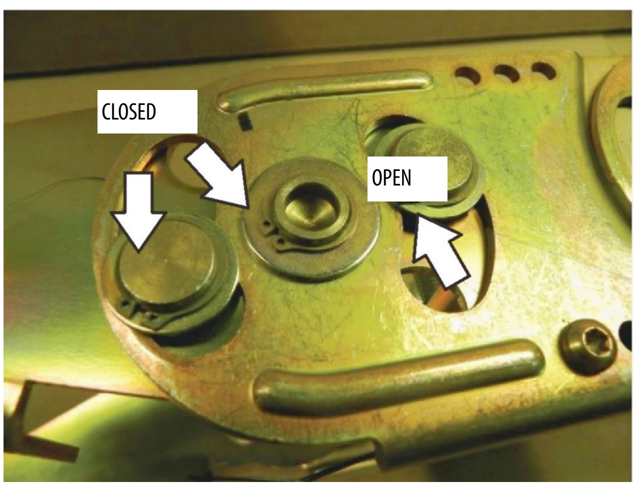
NOTICE

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

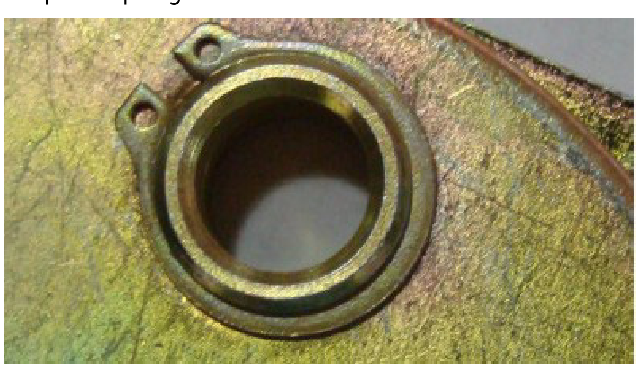
Make sure screws are tight and installed properly.



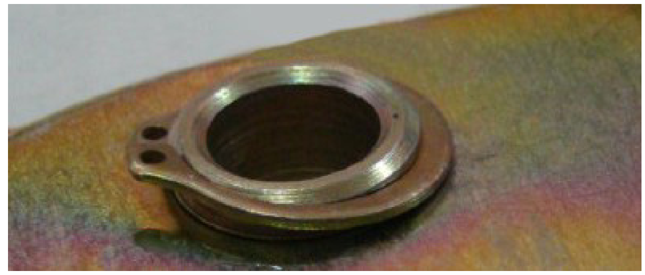
Make sure that all snap rings are closed and seated.



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 to follow all guidelines for servicing the equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for the 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 to 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.

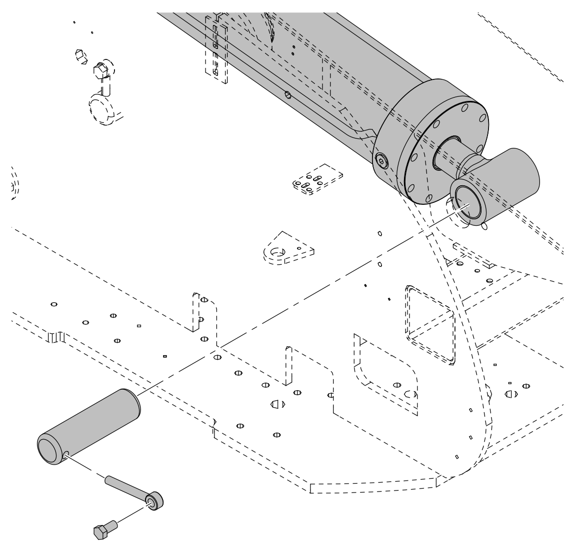
NOTICE

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 an adequate support for the main boom lift cylinder. Extend main boom cylinder with auxiliary power switch to gain access to remove rod end pin.

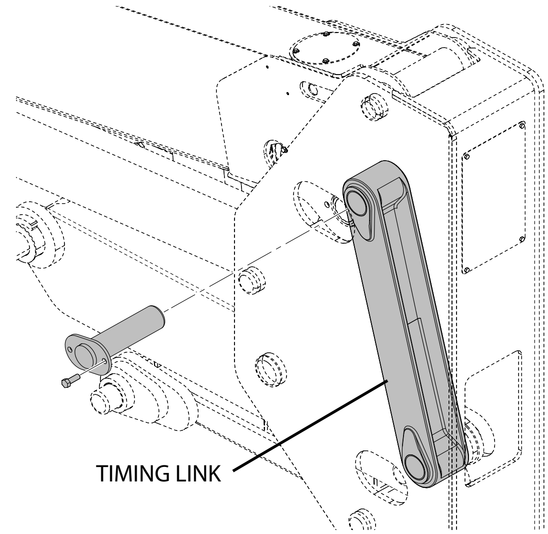
NOTE: *The main boom lift cylinder weighs approximately 615 lbs. (279 kg).*

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.

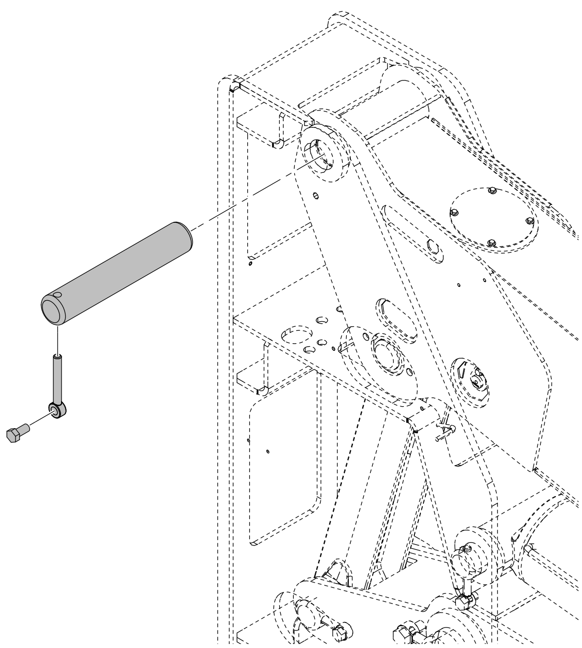


5. Using an adequate supporting device, support the timing link so it doesn’t fall when the pin is removed.

6. Remove hardware securing timing link to boom assembly. Remove pin from boom assembly.



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

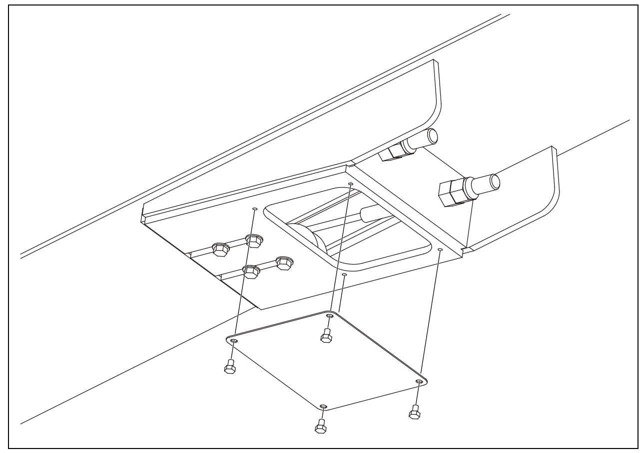


8. Using all applicable safety precautions, carefully lift boom assembly clear of upright and lower to ground or suitably supported work surface.

Disassembly

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

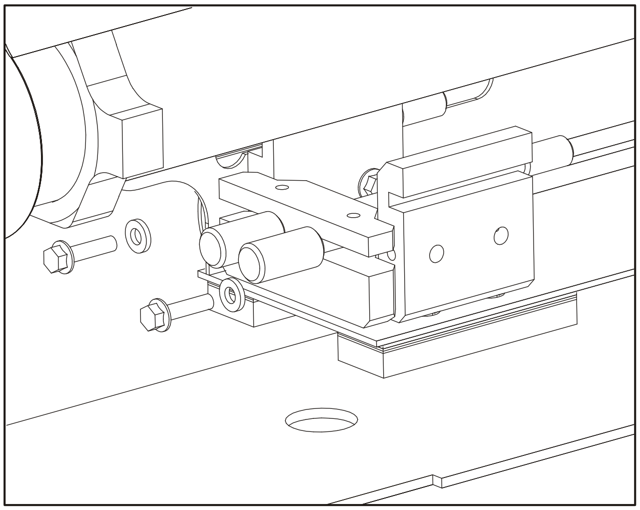
1. Extend the boom approximately 2 ft. (0.6 m). This will enable access to the bolts that secure the cable mount block to the boom fly section.
2. Remove hardware securing the telescope cylinder.
3. Remove hardware securing the cover plate on the bottom front of the base boom section.



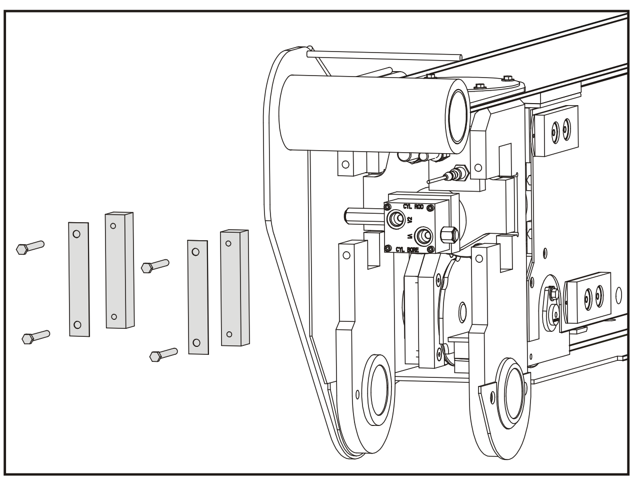
NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

4. Clamp both threaded ends of wire rope to prevent rotation. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

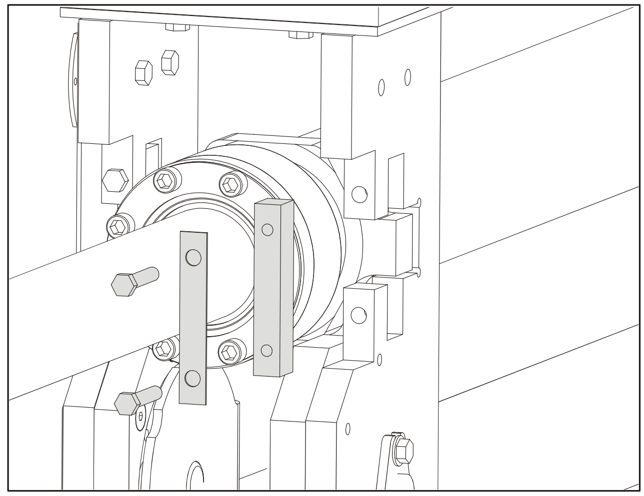
5. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, remove the bolts and washers securing the cable mount block to the boom fly section.



6. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the boom base section.



7. Remove the four bolts, shims, and attachment blocks that secure the telescope cylinder barrel to the boom mid section.

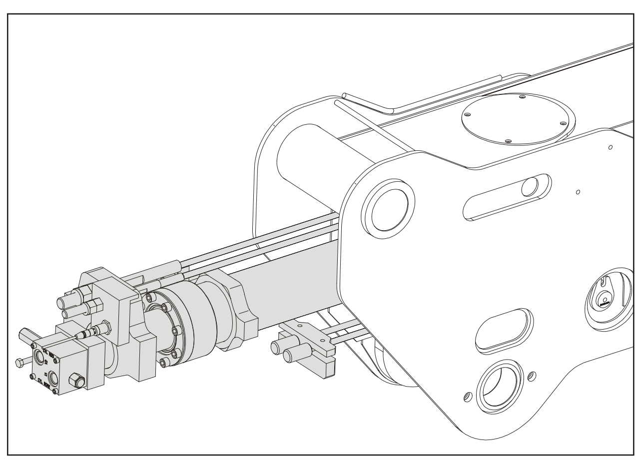


NOTICE

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 496 lbs. (225 kg).*

8. Using overhead cranes or other suitable lifting/supporting devices, carefully pull the telescope cylinder out from the back of the boom. At the same time, also pull the cable mount block out so the extension cables come out with the telescope cylinder and do not bind. The lifting/supporting devices will have to be repositioned to support the weight of the cylinder as it is drawn out of the boom.



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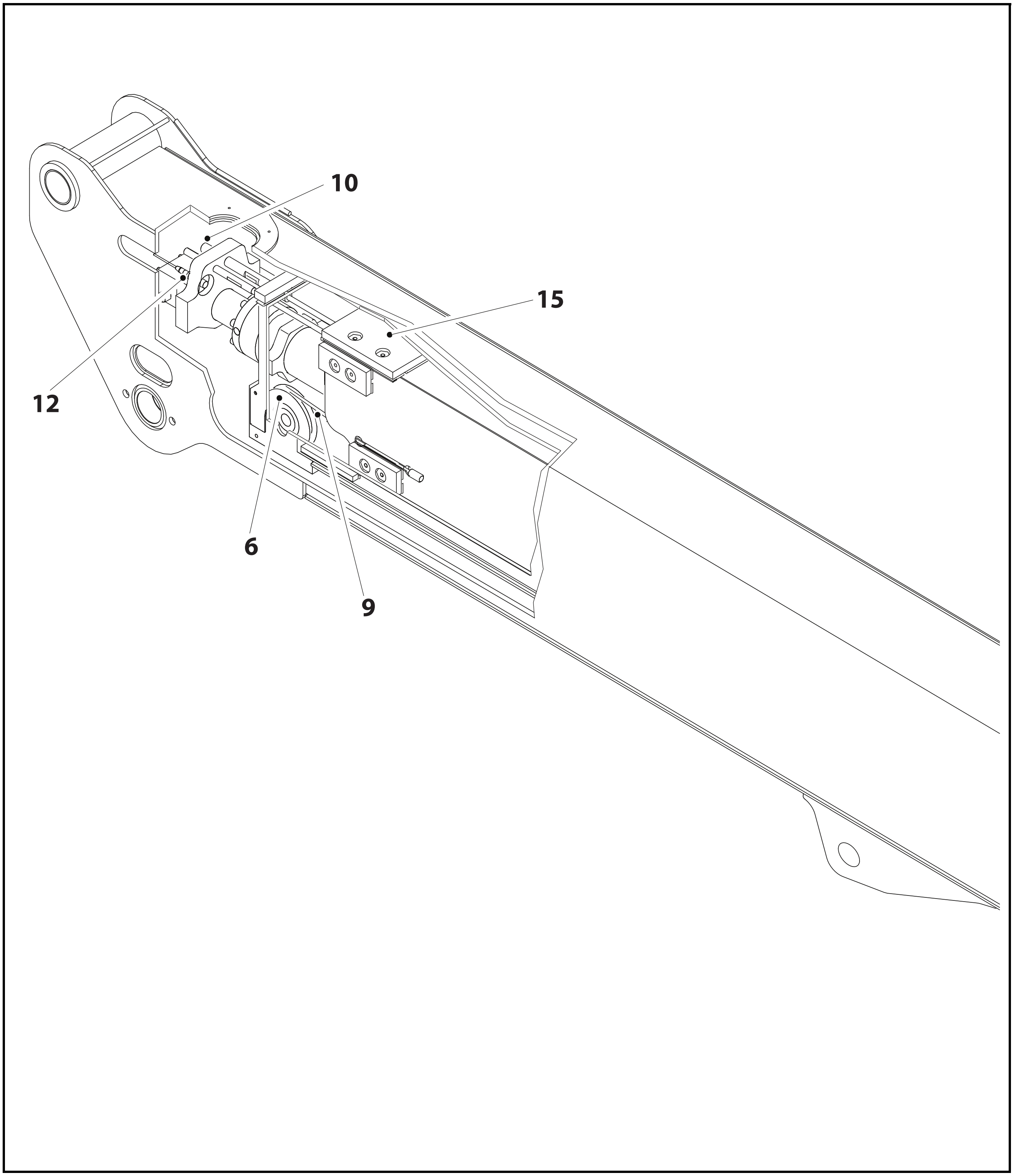
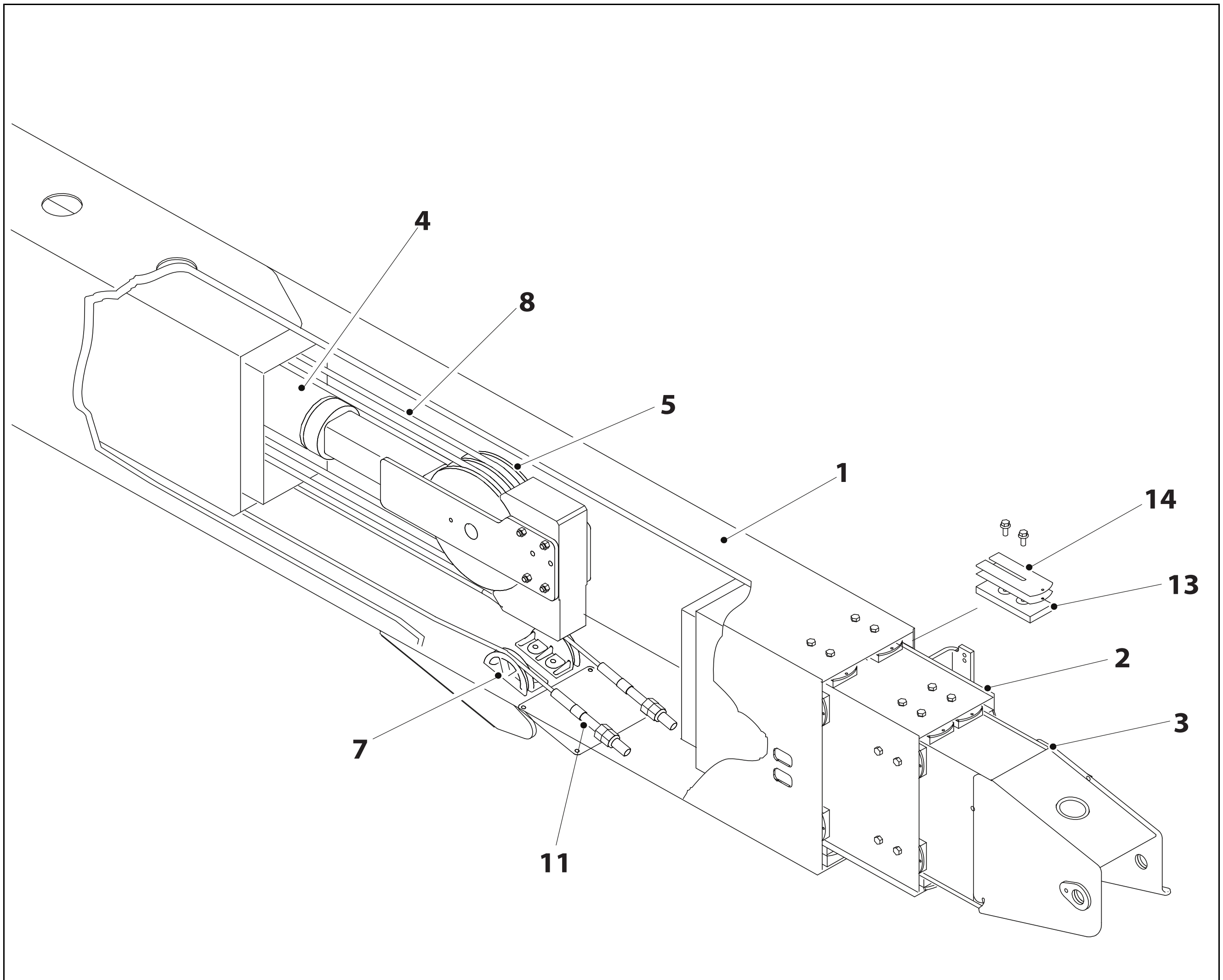
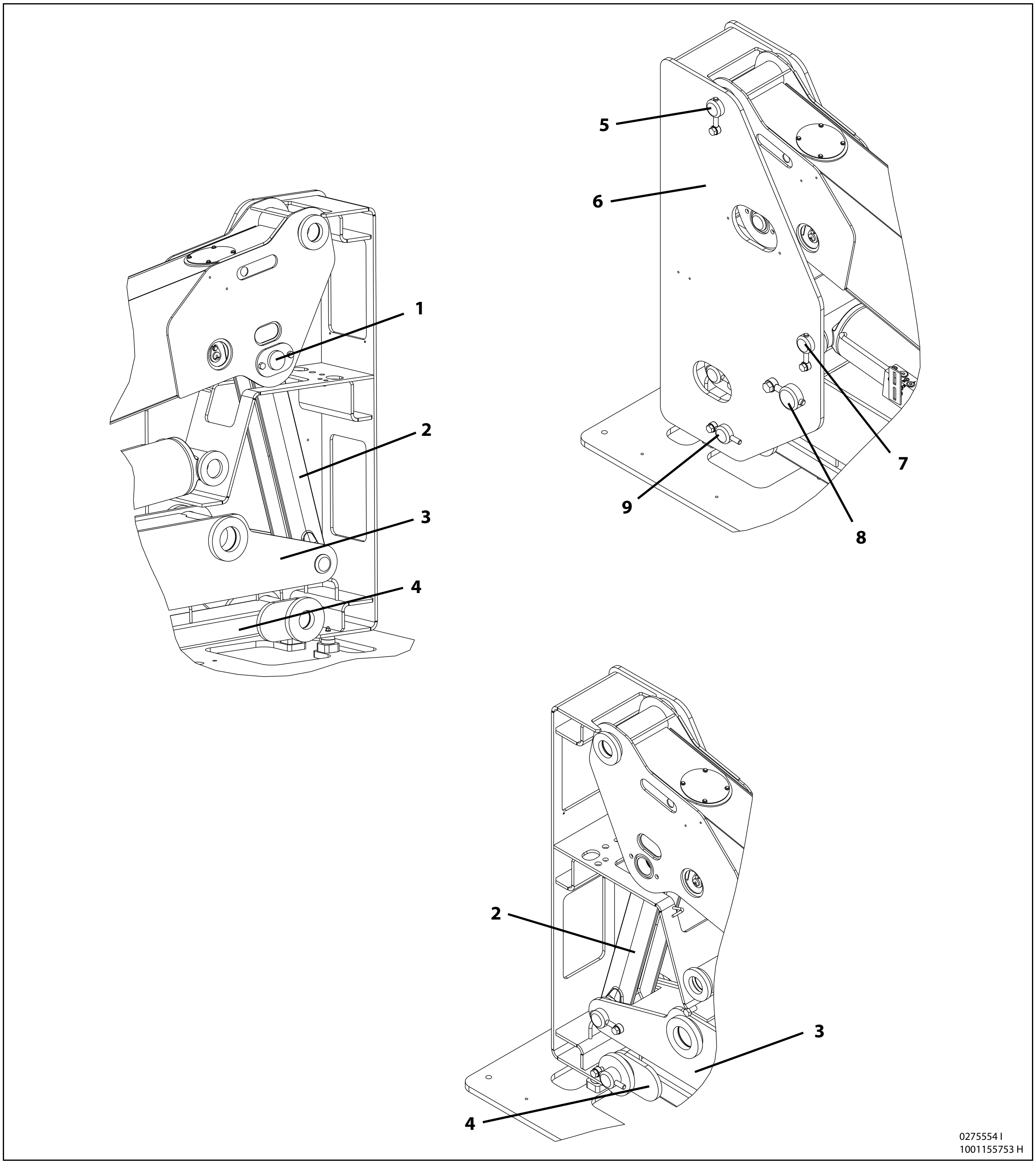


Figure 4-7. Boom Assembly Cutaway - Sheet 1 of 2



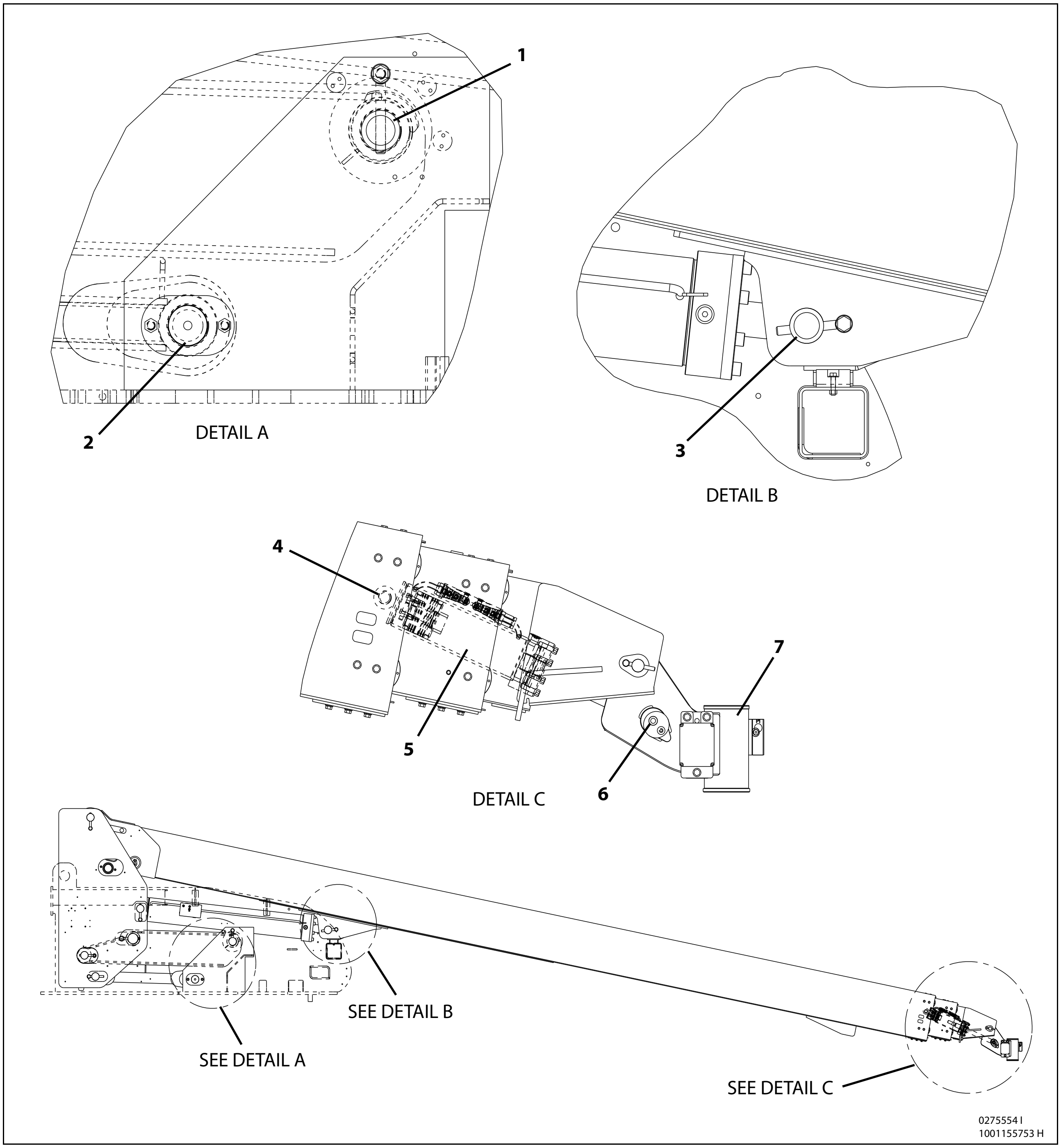
1. Base Boom
2. Mid Boom
3. Fly Boom
4. Telescope Cylinder
5. Extend Sheave
6. Retract Sheave
7. Sheave Block
8. Extend Cable
9. Retract Cable
10. Extend Cable Adjustment
11. Retract Cable Adjustment
12. Proximity Switch
13. Wear Pad
14. Shims
15. Wear Pad

Figure 4-8. Boom Assembly Cutaway - Sheet 2 of 2



1. Pivot Pin
2. Timing Link
3. Tower Weldment
4. Tension Link
5. Boom Pivot Pin
6. Upright
7. Lift Cylinder Pivot Pin
8. Tower Pin
9. Level Link Pin

Figure 4-9. Boom Components - Sheet 1 of 2



1. Pivot Pin
2. Tension Link Pivot Pin
3. Lift Cylinder Pivot Pin
4. Level Cylinder Attach Pin
5. Level Cylinder
6. Level Cylinder Pivot Pin
7. Rotator

Figure 4-10. Boom Components - Sheet 2 of 2

9. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.
   a. Remove hardware from the wear pads; remove wear pads from cylinder.
   b. Remove hardware from the wire rope guard; remove guard from cylinder.
   c. Remove hardware from the sheave pin; remove pin and sheave from cylinder.

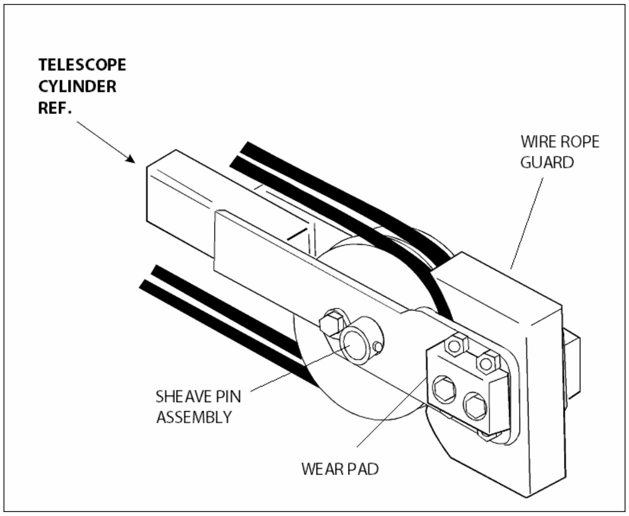


Figure 4-11. Disassembly of Sheave Assembly

9. Remove hardware which secures the wear pads to the front of base boom section; remove wear pads from the top, sides and bottom of the base boom section.
10. Using an overhead crane or suitable lifting device, remove mid and fly boom sections from base section.

NOTE: *When removing mid and fly boom sections from base boom section, retract wire rope must be dragged along with boom sections.*

11. Remove hardware which secures the wear pads to the rear end of mid boom section; remove the wear pads from the top, sides and bottom of the mid boom section.
12. Remove hardware which secures the sheave guards and sheave assemblies to mid boom section, remove sheave assemblies from mid boom section.
13. Remove hardware which secures the wear pads to the front of mid boom section; remove wear pads from the top, sides and bottom of the mid boom section.
14. Using an overhead crane or suitable lifting device, remove fly boom section from mid section.

NOTE: *When removing fly boom section from mid boom section, retract wire rope must be dragged along with fly boom section.*

15. Remove hardware which secures the wear pads to the rear end of fly boom section; remove wear pads from the top, sides and bottom of the fly boom section.
16. When removing wire rope from fly boom section, push the cable into fly boom. Route wire rope back through holes in the side of the fly boom section.

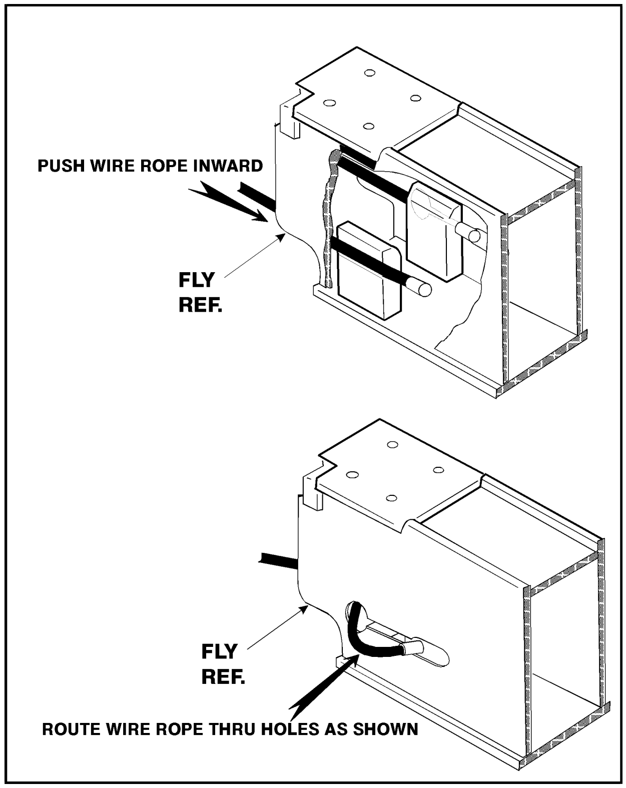


Figure 4-12. Disassembly Wire Rope Routing Procedure

Inspection

NOTE: *When inspecting pins and bearings Refer to the guidelines established in Section 2 - General.*

1. Inspect all sheaves (extend and retract wire ropes and telescope cylinder) for excessive groove wear, burrs or other damage. Replace sheaves as necessary.

NOTE: *To check the size, contour and amount of wear, a groove gauge is used. Replace the sheave if worn as shown in the following drawing.*

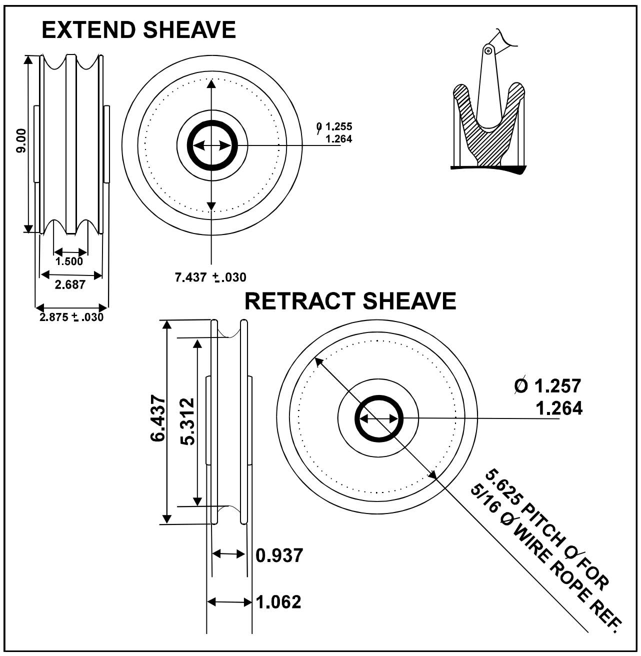


Figure 4-13. Dimension of Sheaves When New

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 in. (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.

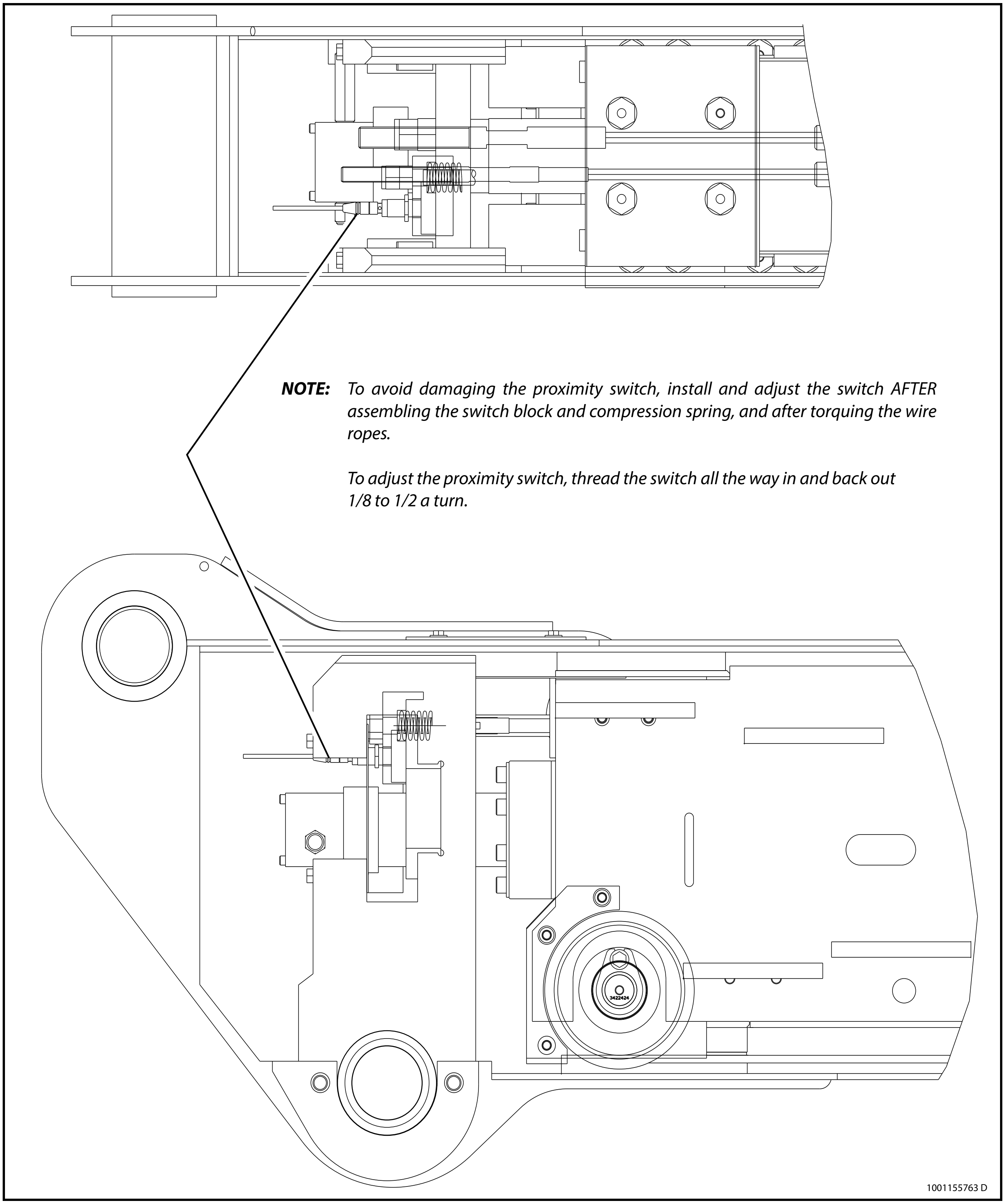


Figure 4-14. Proximity Switch Adjustment

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.

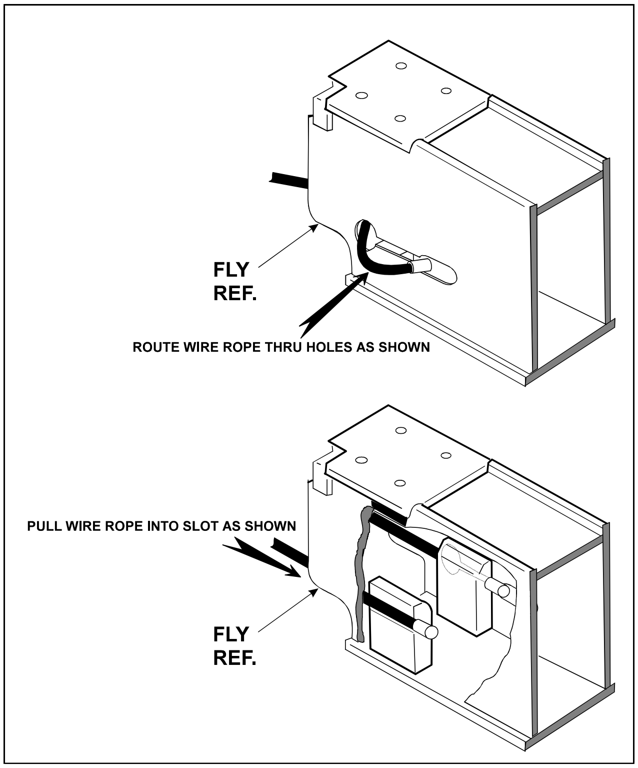


Figure 4-15. Routing Installation of Retract Wire Ropes

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

NOTICE

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

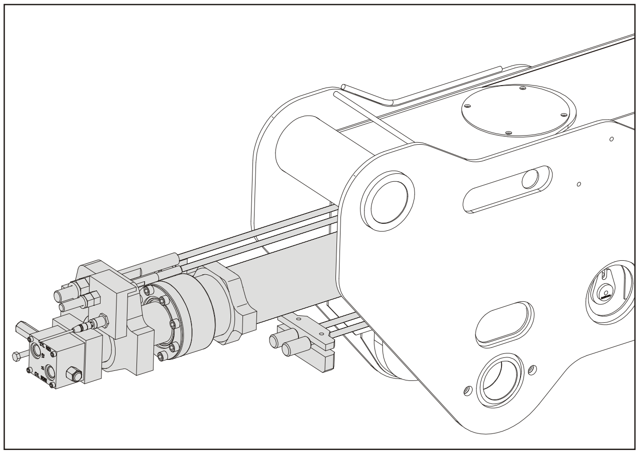
6. Shim the insides of the boom sections for a total of 1/16 in. (1.6 mm) clearance (if the action is centered, there will be 1/32 clearance on each side).
7. Slide fly boom section into the mid boom section. Shim boom, if necessary, for a total of 1/16 in. (1.6 mm) clearance.
8. Install wear pads into the forward position of the mid boom section. Shim boom, if necessary, for a total of 2/10 in. (5 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 in. (1.6 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 in. (5 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. Pull the boom sections out to approximately where they were extended to for telescope cylinder removal.
16. Install a new extend sheave on the end of the telescope cylinder.
17. Route new extend cables around the telescope cylinder. Loosely fasten the threaded end of the cables to the rod end of the telescope cylinder with the adjusting nuts and lock nuts. Install the opposite end of the cables in the cable mount block.
18. Use tape or tie straps to fasten the cables to the telescope cylinder assembly. It is important that the tape or straps be strong enough to hold the cable in place yet weak enough to break and fall away when the cables are adjusted.

NOTICE

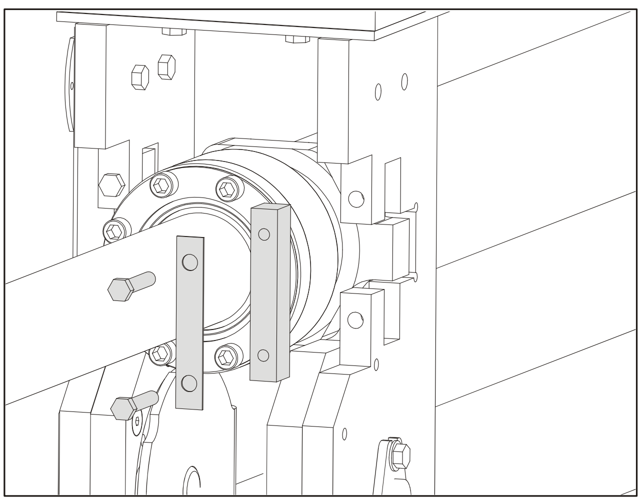
WHEN PUSHING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The telescope cylinder weighs approximately 496 lbs. (225 kg).*

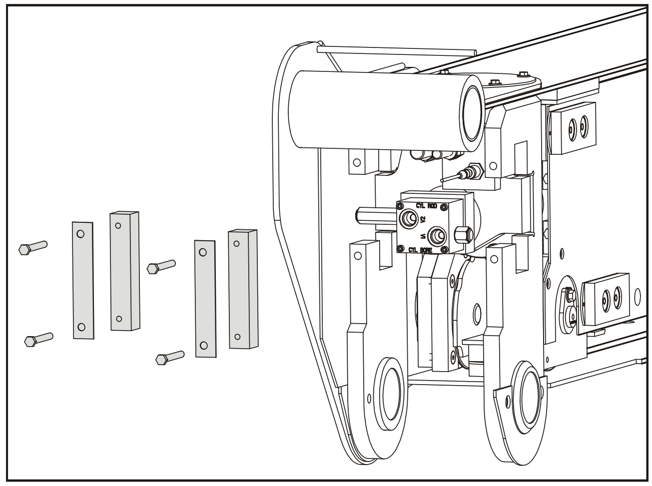
19. Using adequate lifting equipment, carefully push the telescope cylinder assembly and cables back into the boom.



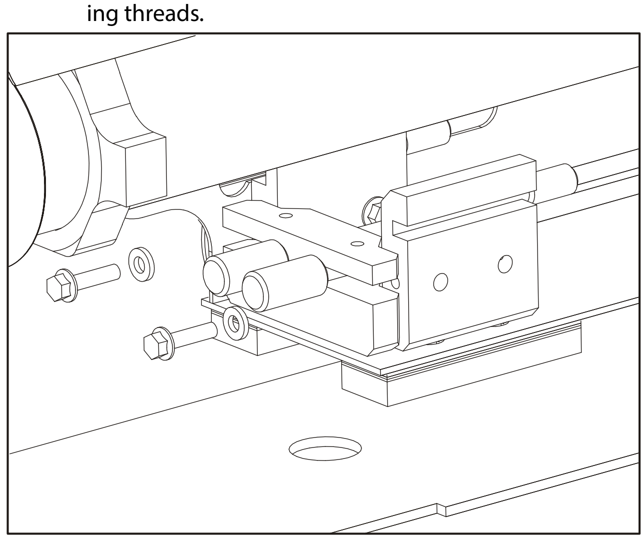
20. Apply JLG Threadlocker P/N 0100011 to the bolts and fasten the telescope cylinder barrel to the boom mid section with the bolts, shims, mounting blocks.



21. Apply JLG Threadlocker P/N 0100011 to the bolts and fasten the telescope cylinder rod to the boom base section with the bolts, shims, mounting blocks.



22. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, install the bolts and washers securing the cable mount block to the boom fly section. Tape the bolts to the socket at the end of the extension to prevent it from coming out of the socket before it engages the mounting threads.

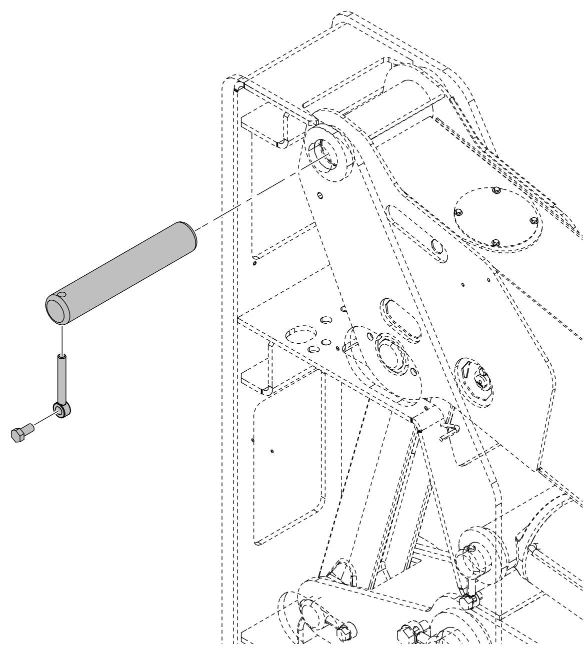


23. Connect all the hydraulic lines to the cylinder as tagged during the removal procedure.

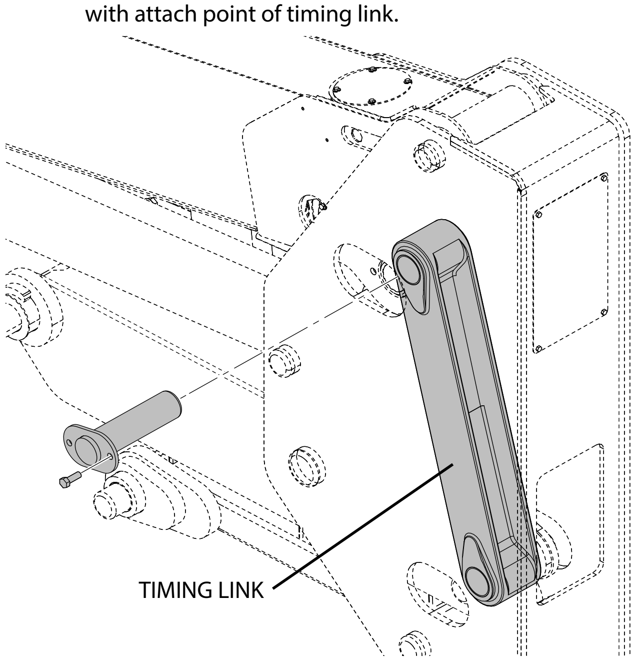
24. Adjust the boom cables as outlined under Section 4.9, Boom Rope Torquing Procedures.

Installation

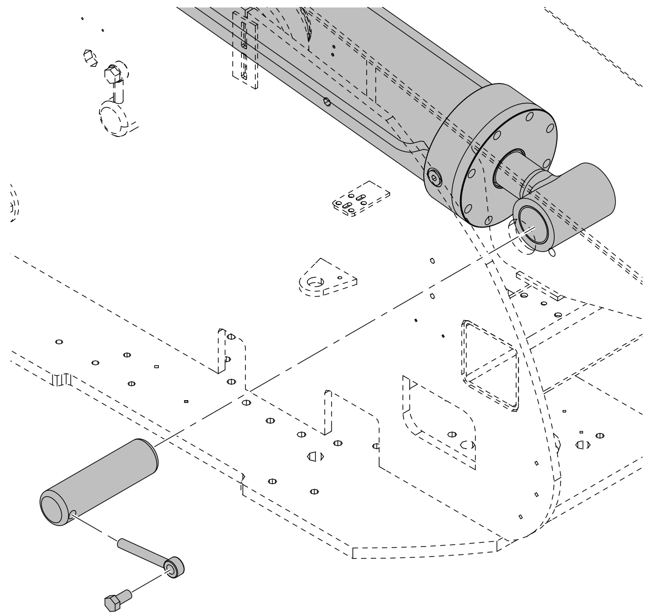
1. Using a suitable lifting device, position boom assembly on upright so that the pivot holes in both boom and upright are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on upright.
3. If necessary, gently tap pin into position with soft headed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



4. Align holes of boom assembly and timing link, install pivot pin, ensuring that location of hole in pin is aligned with attach point of timing link.



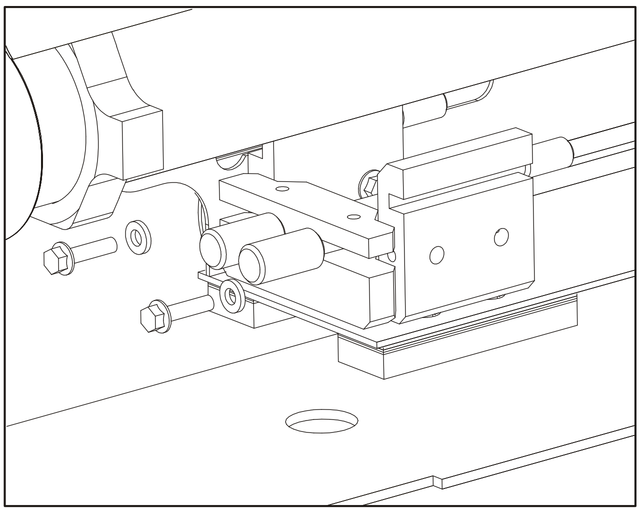
5. Using suitable lifting device, align main lift cylinder rod end with mounting holes on boom assembly.
6. Extend the main lift cylinder by using the auxiliary power switch. Using a suitable brass drift and hammer, install hardware secured to the main lift cylinder rod end pin into the base boom section.



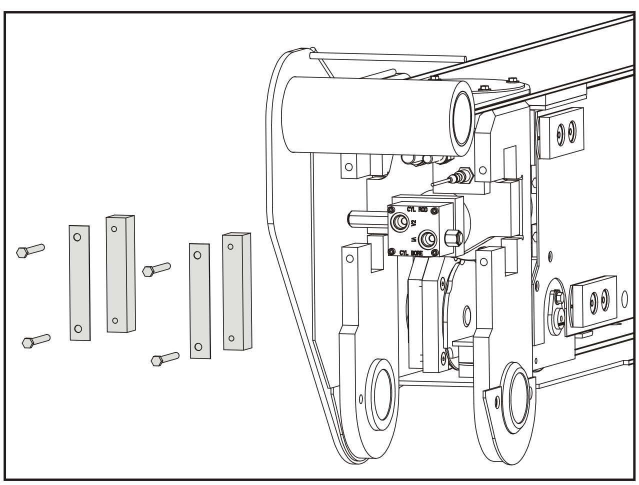
7. Connect all wiring to the ground control box.
8. Connect all hydraulic lines running along side of boom assembly.
9. Adjust retract and extend cables to the proper torque. Refer to Section 4.9, Boom Rope Torquing Procedures.
10. Using all applicable safety precautions, operate machine systems and raise and extend boom fully, noting the performance of the extension cycle.
11. Retract and lower boom, noting the performance of the retraction cycle.

Telescope Cylinder/Boom Cable Removal

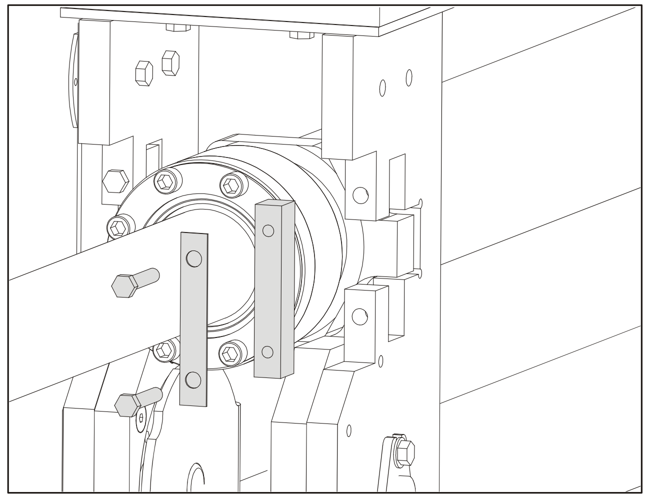
1. Make sure the machine is on a firm, level surface.
2. Raise the boom to a horizontal position.
3. Extend the boom approximately 2 ft. (0.6 m). This will enable access to the bolts that secure the cable mount block to the boom fly section.
4. Tag and disconnect all hydraulic hoses running to the telescope cylinder. Cap or plug all openings to prevent any foreign matter from entering the hydraulic system.
5. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, remove the bolts and washers securing the cable mount block to the boom fly section.



6. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the boom base section.



7. Remove the four bolts, shims, and attachment blocks that secure the telescope cylinder barrel to the boom mid section.

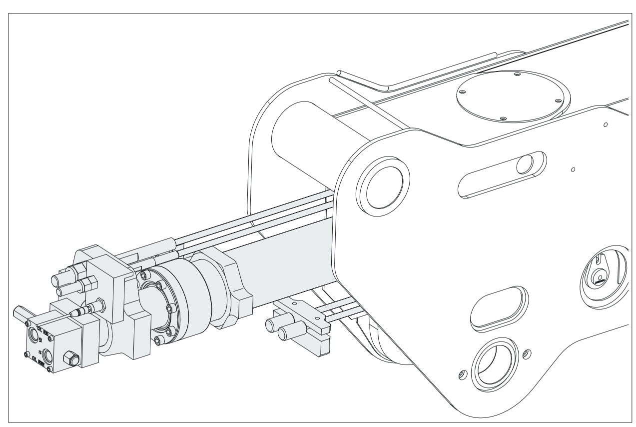


NOTICE

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.

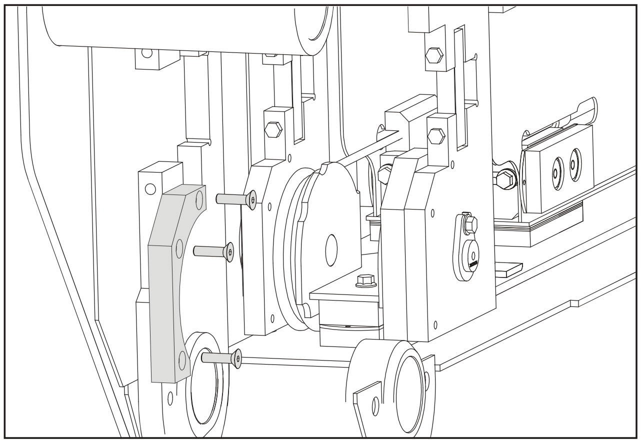
NOTE: *The telescope cylinder weighs approximately 496 lbs. (225 kg).*

8. Using overhead cranes or other suitable lifting/supporting devices, carefully pull the telescope cylinder out from the back of the boom. At the same time, also pull the cable mount block out so the extension cables come out with the telescope cylinder and do not bind. The lifting/supporting devices will have to be repositioned to support the weight of the cylinder as it is drawn out of the boom.

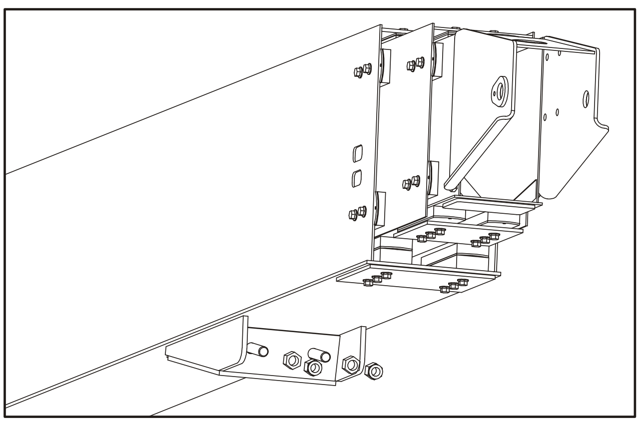


9. Push the boom fly sections back in to gain access to the boom retraction cable.

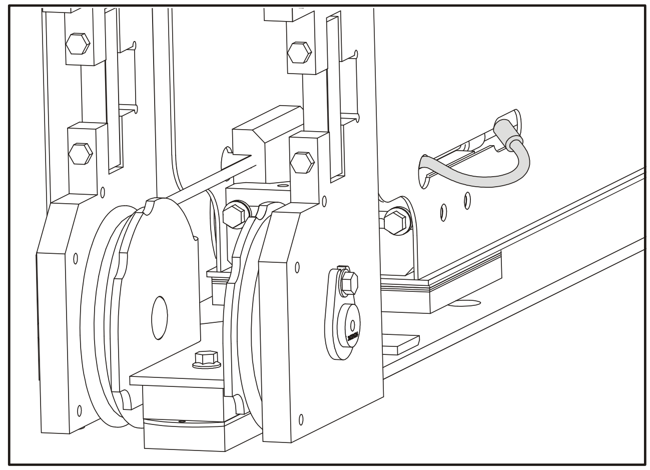
10. Remove the screws securing the sheave guards to the boom mid section and remove the sheave guards.



11. Remove the adjusting nuts and lock nuts from the opposite end of the retraction cables at the front of the boom base section. To aid in installing new retraction cables, fasten a length of tie wire as long as the retraction cables to the ends of the cables.



12. Twist the ends of the retraction cables to remove the ends of the cables from the slots in the side of the boom fly section.



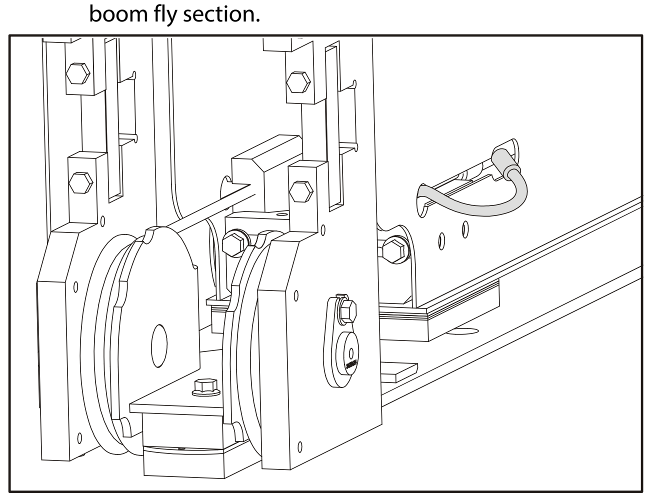
13. From the rear of the boom, pull out the boom retraction cables.

Telescope Cylinder/Boom Cable Installation

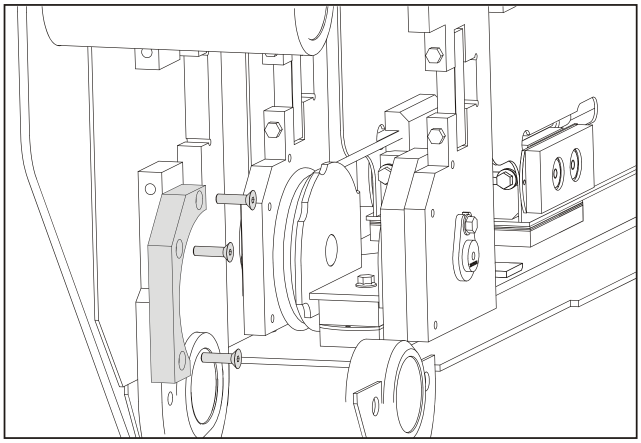
1. Attach the threaded end of the new retraction cables to the tie wires used in the removal procedure.

2. From the front of the boom, pull the retraction cables through the boom and through the attachment holes in the bottom of the boom base section. Loosely install the adjustment nuts and jam nuts.

3. Install new retract sheaves, then route the opposite end of the retraction cables around the sheaves. Push the ends of the cables through the slots in the side of the boom fly section.



4. Install the sheave guards and secure them in place with the retaining screws.



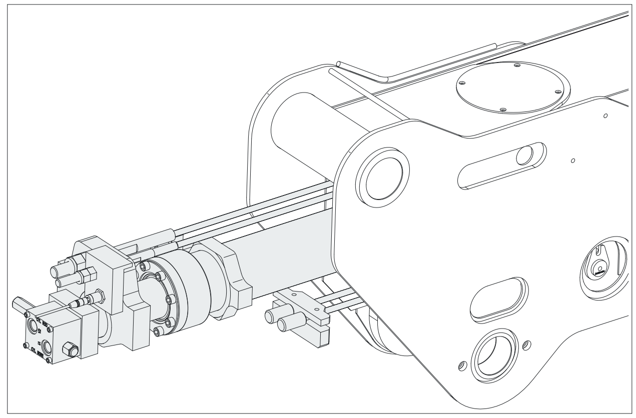
5. Pull the boom sections out to approximately where they were extended to for telescope cylinder removal.
6. Install a new extend sheave on the end of the telescope cylinder.
7. Route new extend cables around the telescope cylinder. Loosely fasten the threaded end of the cables to the rod end of the telescope cylinder with the adjusting nuts and lock nuts. Install the opposite end of the cables in the cable mount block.
8. Use tape or tie straps to fasten the cables to the telescope cylinder assembly. It is important that the tape or straps be strong enough to hold the cable in place yet weak enough to break and fall away when the cables are adjusted.

NOTICE

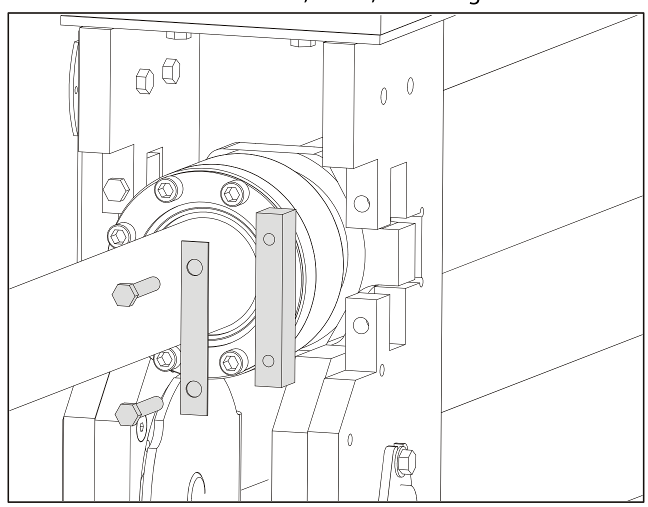
WHEN PUSHING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The telescope cylinder weighs approximately 496 lbs. (225 kg).*

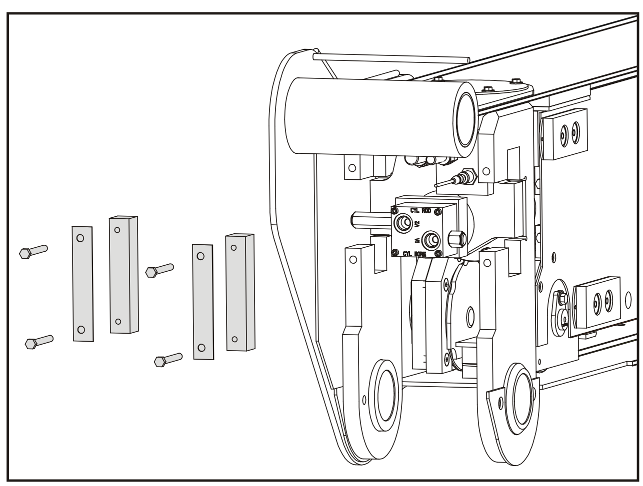
9. Using adequate lifting equipment, carefully push the telescope cylinder assembly and cables back into the boom.



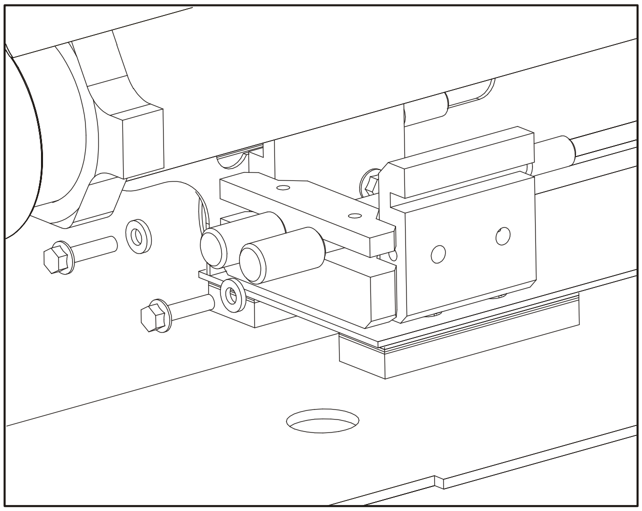
10. Apply JLG Threadlocker P/N 0100011 to the bolts and fasten the telescope cylinder barrel to the boom mid section with the bolts, shims, mounting blocks.



11. Apply JLG Threadlocker P/N 0100011 to the bolts and fasten the telescope cylinder rod to the boom base section with the bolts, shims, mounting blocks.



12. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, install the bolts and washers securing the cable mount block to the boom fly section. Tape the bolts to the socket at the end of the extension to prevent it from coming out of the socket before it engages the mounting threads.



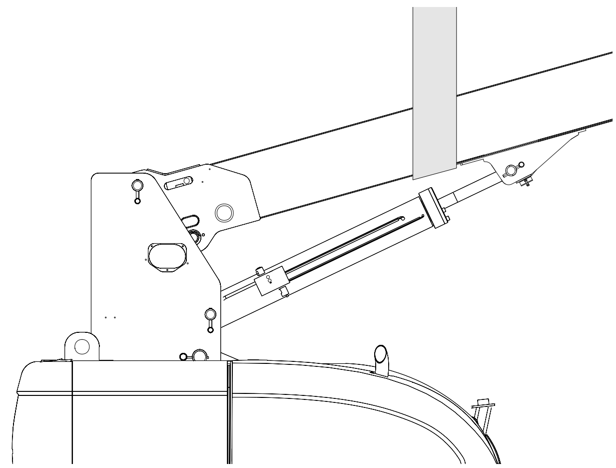
13. Connect all the hydraulic lines to the cylinder as tagged during the removal procedure.
14. Adjust the boom cables as outlined under Section 4.9, Boom Rope Torquing Procedures.
15. Run the boom through all lift and telescope functions and check for proper operation or any leakage.

4.7 MAIN LIFT CYLINDER

Removal

1. Elevate the boom enough to gain access to the lift cylinder lower pivot pin.
2. Use an adequate supporting device to support the weight of the boom and associated components as shown below.

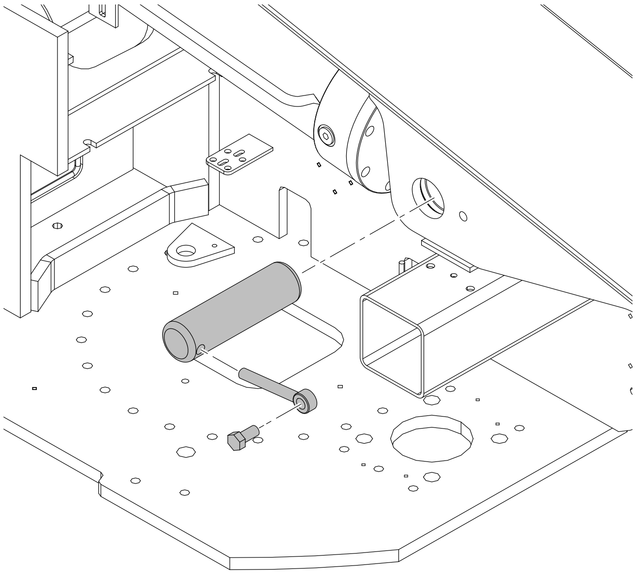
NOTE: *The supporting device must be able to support approximately 5350 lbs (2430 kg).*



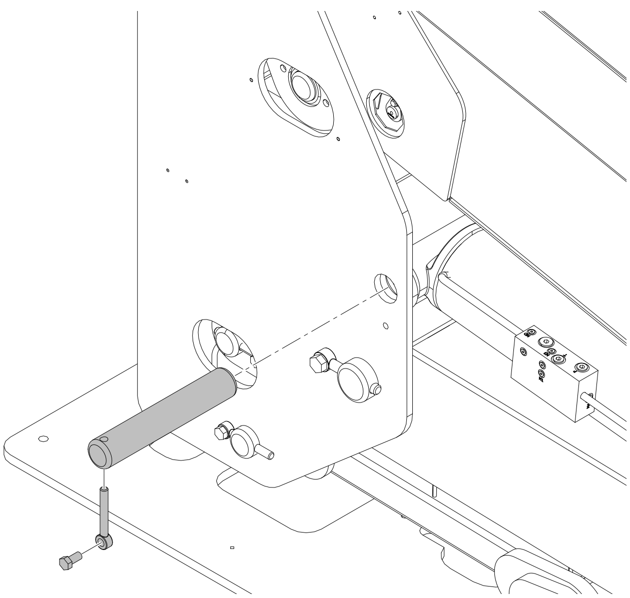
3. Tag and disconnect the hydraulic hoses from the lift cylinder.
4. Use an adequate lifting device to support the lift cylinder.

NOTE: *The lift cylinder weighs approximately 615 lbs. (279 kg).*

5. Remove the hardware securing the rod end pivot pin and remove the pivot pin.



6. Remove the hardware pin securing the barrel end of pivot pin and remove the pivot pin.



7. Using the lifting device, slide the lift cylinder back enough to allow the cylinder end to clear the attachment point on the boom.

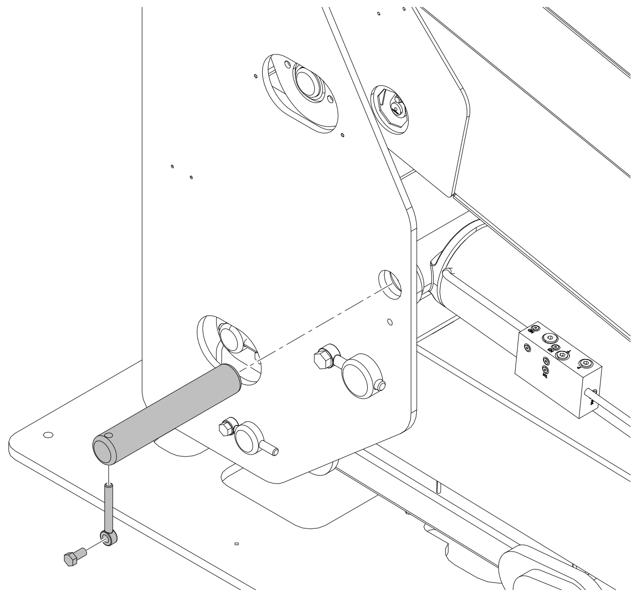
8. Slide the lift cylinder sideways enough to remove it from the machine.

Installation

1. Using an adequate lifting device, position the lift cylinder in the machine in the same manner that it was removed.

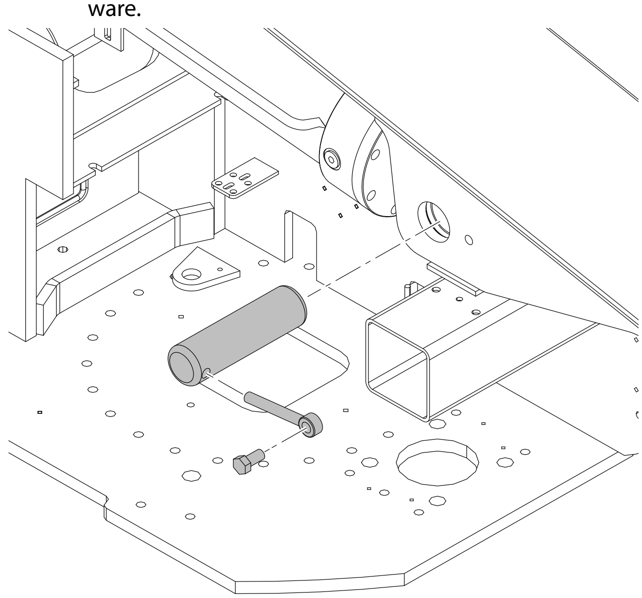
NOTE: *The lift cylinder weighs approximately 615 lbs (279 kg).*

2. Using a suitable brass drift and hammer, install the barrel end pivot pin. Secure pivot pin with mounting hardware.



3. Extend the cylinder rod until it aligns with the attachment point on the boom. Take care not to extend the cylinder rod too far.

4. Using a suitable brass drift and hammer, install the rod end pivot pin. Secure pivot pin with mounting hardware.



5. Connect the hydraulic lines to the cylinder as tagged during removal.
6. Remove the supporting device and function check the boom to make sure the lift cylinder operates properly and there are no leaks.

4.8 WIRE ROPE

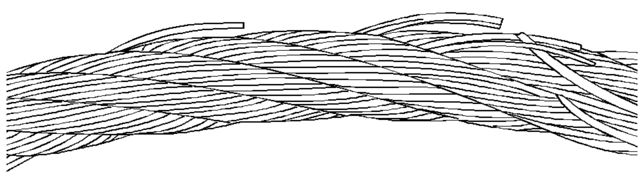
Each day before using the machine:

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

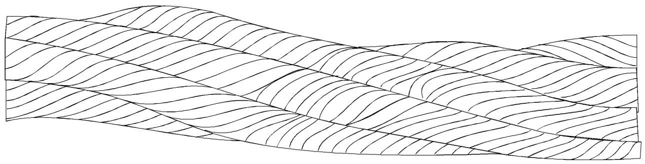
NOTE: *The pictures in this paragraph are just samples to show the replacement criteria of the rope.*

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



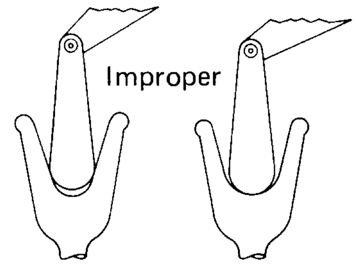
Flexing a wire rope can often expose broken wires hidden in valleys between strands.

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 Replacement

Mandatory wire rope and sheave replacement.

Additional inspection required if:

1. Machine is exposed to hostile environment or conditions.
2. Erratic boom operation or unusual noise exists.
3. Machine is idle for an extended period.
4. Boom is overloaded or sustained a shock load.
5. Boom exposed to electrical arc. Wires may be fused internally.

Replacement Criteria

1. Sheaves and wire rope must be replaced as sets.
2. Rusted or corroded wire ropes.
3. Kinked, "bird caged", or crushed ropes.
4. Ropes at end of adjustment range.
5. Sheaves failing wearout gage inspection.
6. Ropes with 6 total broken wires in one rope lay, 3 in one strand in one rope lay, 1 valley break, or 1 break at any end termination.

4.9 BOOM ROPE TORQUING 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.*

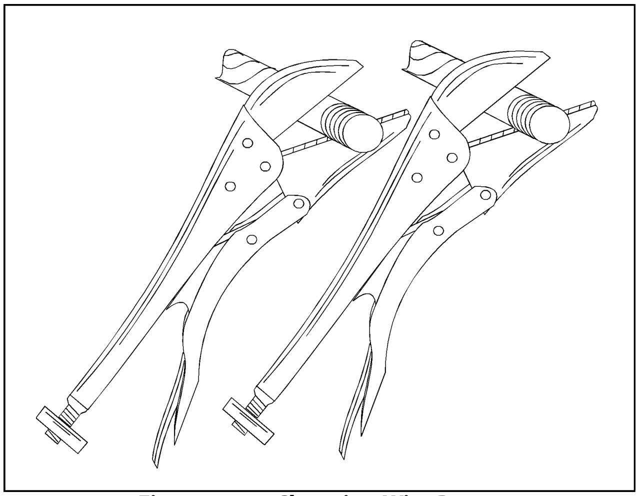


Figure 4-16. Clamping Wire Ropes

3. Install adjusting nuts (or remove nylon collar locknuts if re-adjusting) to both retract and extend wire ropes.
4. Torque retract adjusting nuts (platform end) to 15 ft. lbs. (20 Nm) alternating between the two wire ropes and keeping approximately the same amount of thread beyond the adjusting nut.

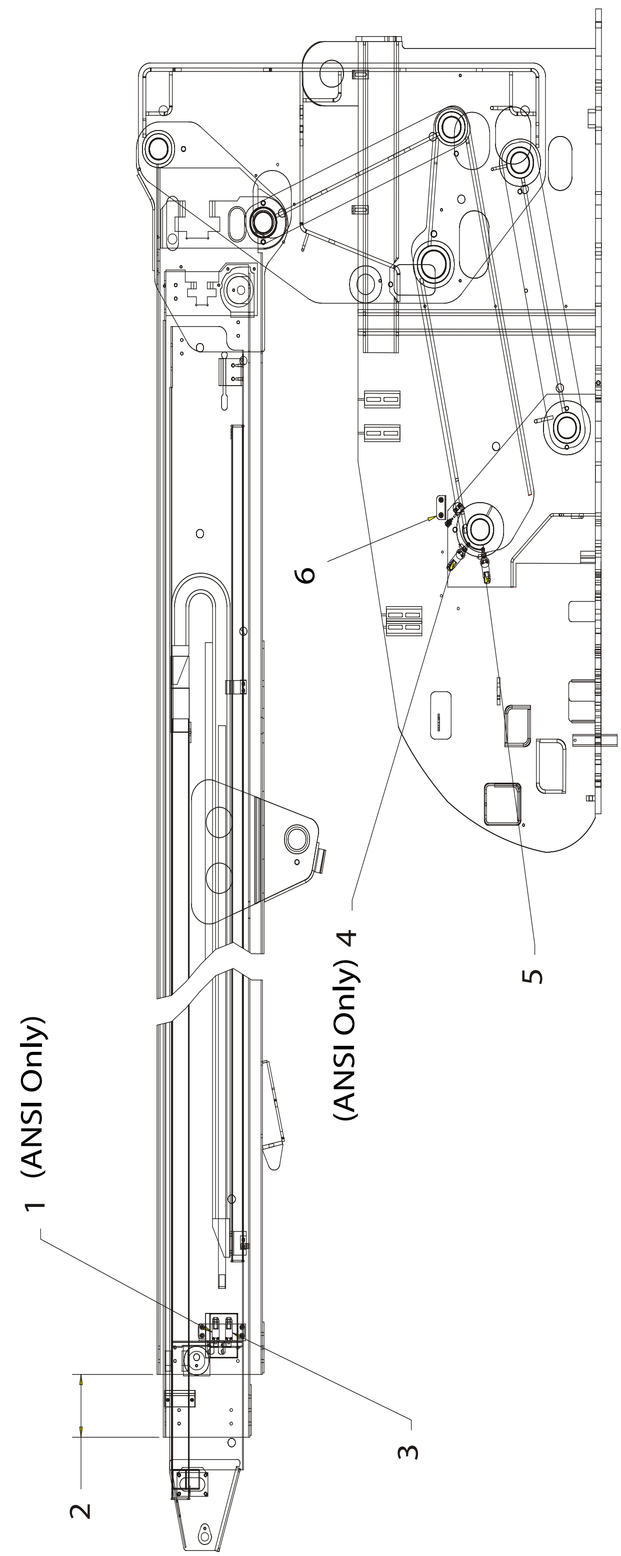
NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

5. Repeat the torque procedure in step #4 to the extend wire ropes (turntable end).
6. Extend the boom 2 - 3 ft. using the telescope function. Repeat step #4.
7. Retract the boom 1 - 2 ft. using the telescope function. Do not bottom out telescope cylinder. Repeat step #5.
8. Extend the boom approximately 2 - 3 ft. again and check torque on the retract wire ropes.
9. Retract the boom without bottoming out telescope cylinder and check torque on the extend wire ropes.

NOTE: *Step #8 and #9 may need to be repeated to equalize the torque on all 4 wire ropes.*

10. After all wire ropes have been properly torqued, install nylon collar locknuts. Remove all clamping devices and install all covers and guards. Check the boom for proper function.

4.10 ELEVATION & CAPACITY SWITCHES



1	Boom Capacity Length Switch to trip boom when it's 216" ± 1" (5486mm ± 25mm) from fully extended
2	150.75" ± 1" (3829mm ± 25mm) position of boom sections to Trip Capacity Length Switch (ANSI Only) 18.25" ± 1" (463.5mm ± 25mm) position of boom sections to trip Transport Length Switch
3	Boom Transport Length Switch to trip when boom is 18" ± 1" from fully retracted
4	Boom Capacity Angle Switch to trip when upper boom is 50° to 55° above horizontal. 52° is the preferred trip angle Boom Capacity Angle Switch to reset when upper boom is 59° to 64° above horizontal. 61° is the preferred reset angle
5	Boom Elevation Switch to trip when upper boom is 7° to 12° above horizontal. 9° is the preferred trip angle Boom Elevation Switch to reset when upper boom is 3° below horizontal to 2° above horizontal. 0° is the preferred reset angle
6	End of Stroke Switch should trip when boom is 5° - 7° from end of extended cylinder stroke

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Figure 4-17. Elevation, Dual Capacity and Transport Switch Information (Prior to SN 0300103969) - Sheet 1 of 2

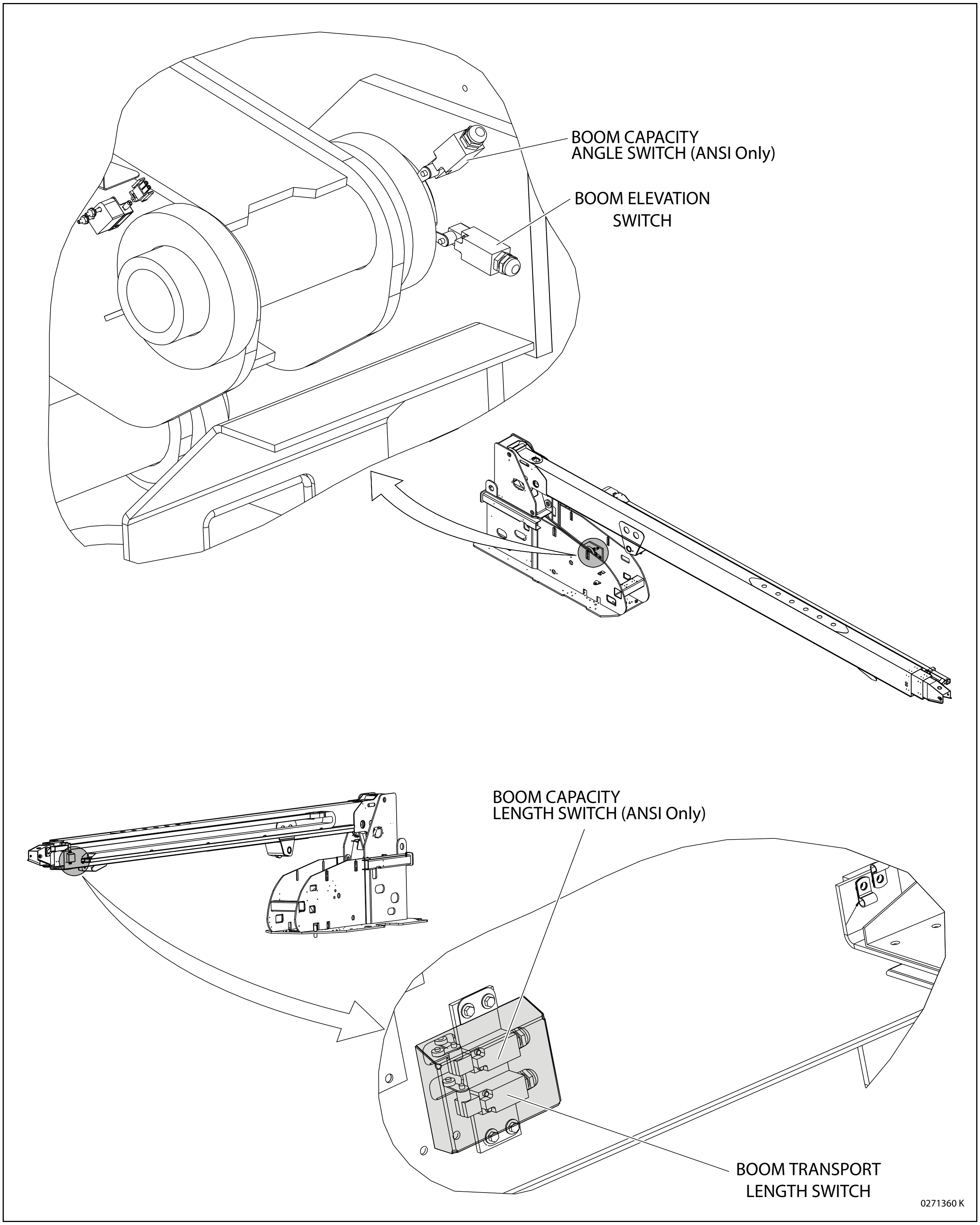
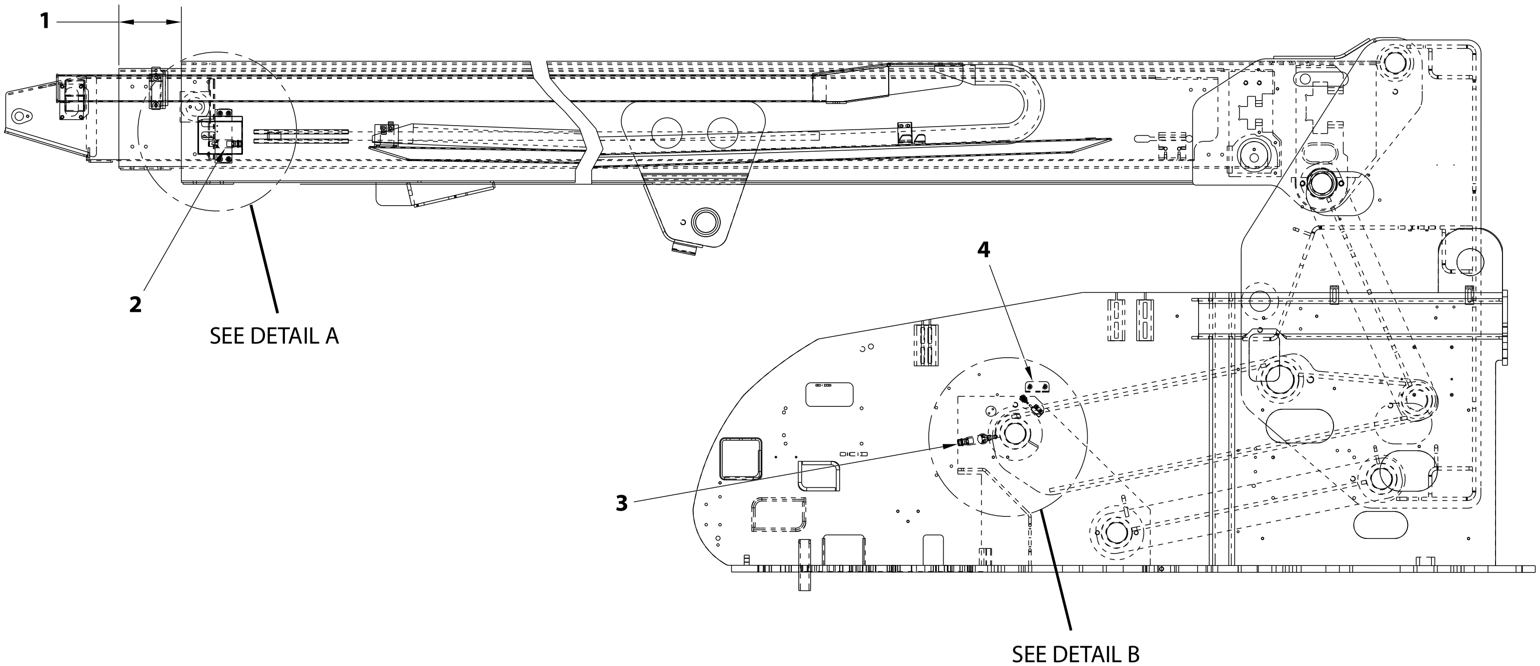


Figure 4-18. Elevation, Dual Capacity and Transport Switch Information (Prior to SN 0300103969) - Sheet 2 of 2



1	18.25" ± 1" (463.5mm ± 25mm) position of boom sections to trip Transport Length Switch
2	Boom Transport Length Switch to trip when boom is 18" ± 1" from fully retracted
3	Boom Elevation Switch to trip when main boom is 7° to 12° above horizontal. 9° is the preferred trip angle Boom Elevation Switch to reset when upper boom is 3° below horizontal to 2° above horizontal. 0° is the preferred reset angle
4	End of Stroke Switch should trip when boom is 5° to 7° from end of extended cylinder stroke

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Figure 4-19. Elevation, Dual Capacity and Transport Switch Information (SN 0300103969 through 0300189341) - Sheet 1 of 2

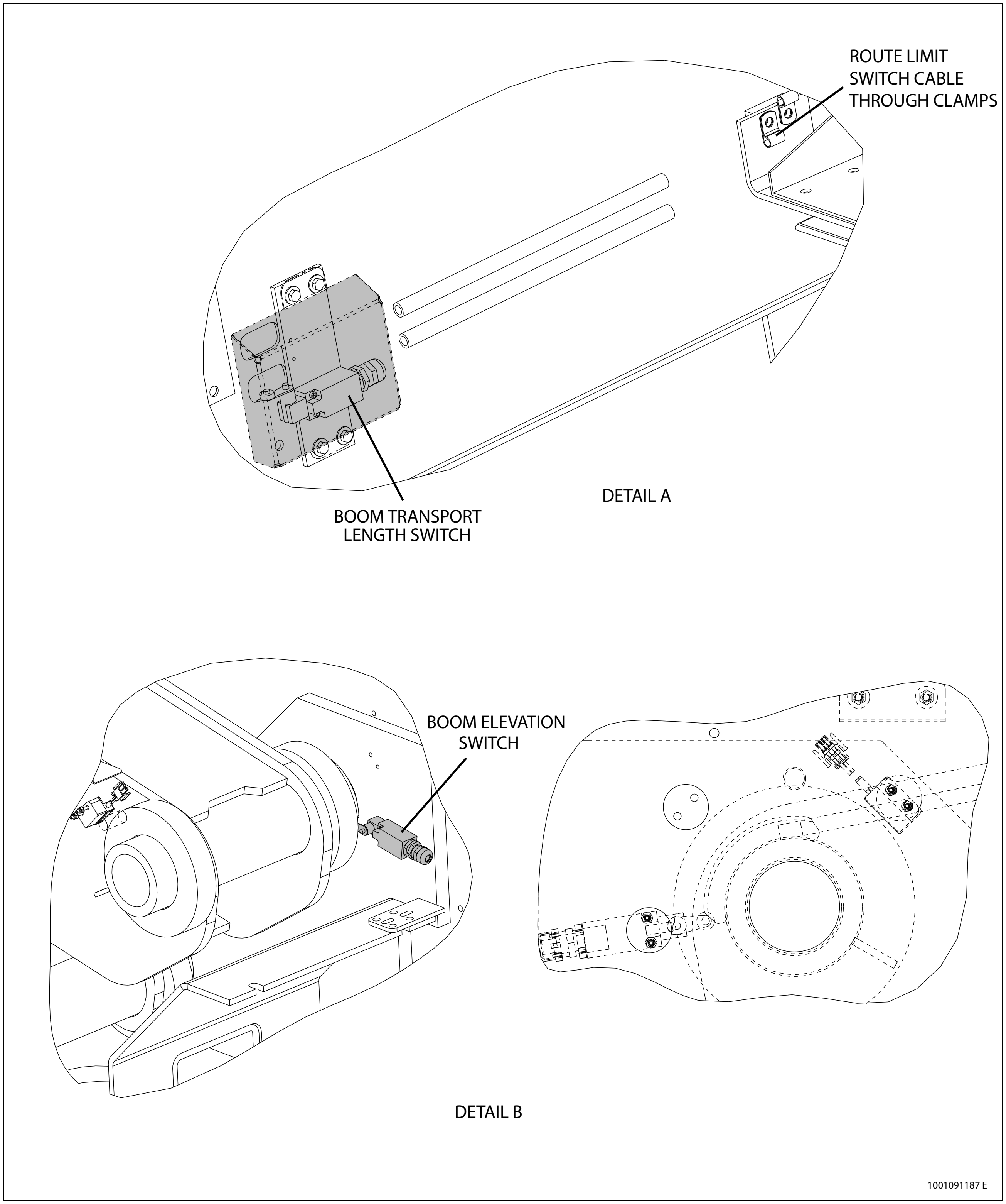


Figure 4-20. Elevation, Dual Capacity and Transport Switch Information (SN 0300103969 through 0300189341) - Sheet 2 of 2

4.11 ELECTRONIC PLATFORM LEVELING

Description

Electronic platform leveling replaces the conventional hydraulic method of platform leveling. The term “platform leveling” does not refer to the system maintaining the platform at level (or 0°) with respect to gravity, but instead refers to the controls automatically maintaining the platform within several degrees of a preset angle.

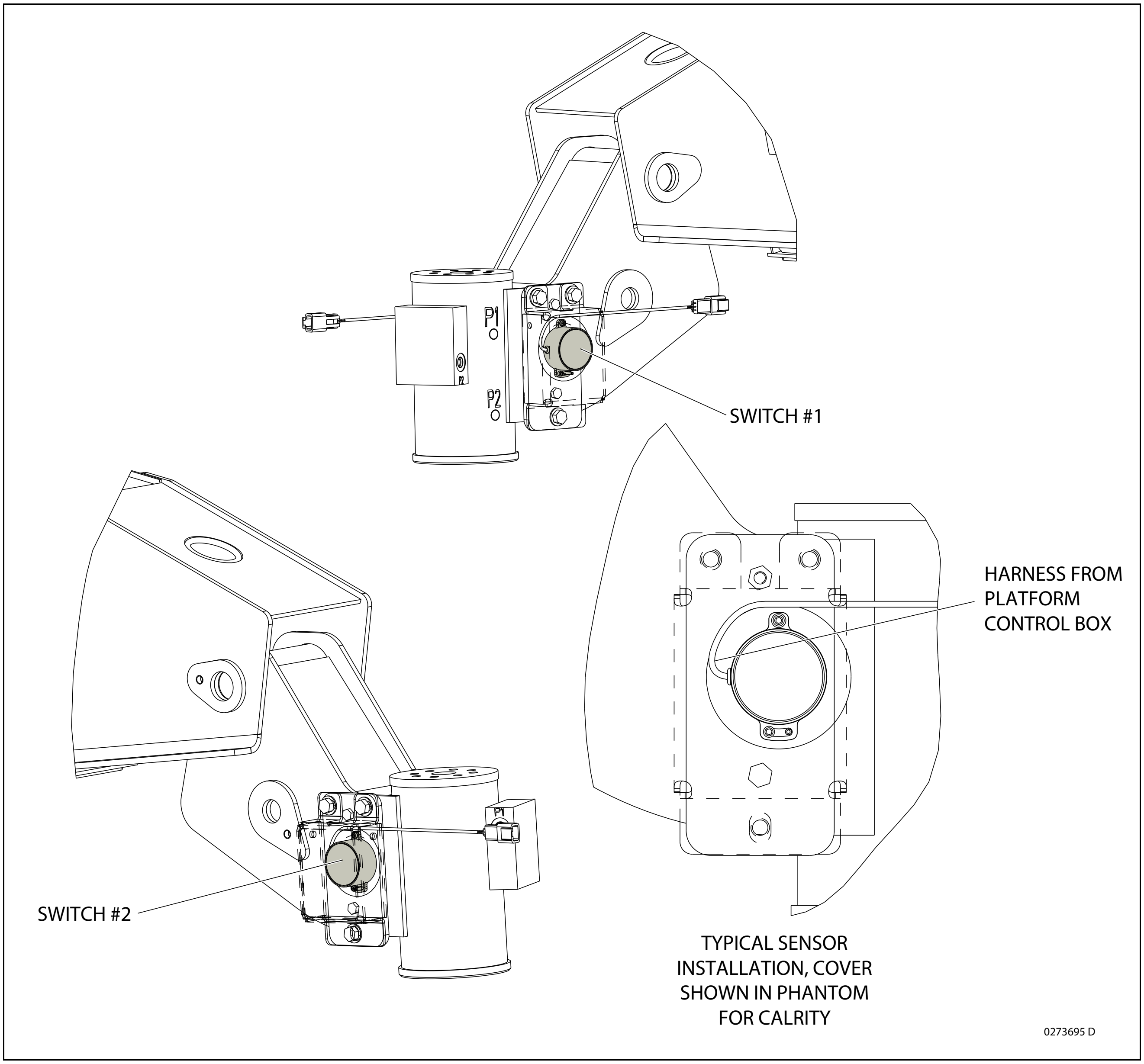
To control electronic platform leveling the platform is equipped with a pair of tilt sensors, one primary and one secondary, mounted to the non-rotating portion of the platform rotator, level up and level down valves that are used to provide proportional hydraulic flow for each directional function, and a control module that interprets the sensor readings and actuates the leveling valves.

PRIMARY AND SECONDARY TILT SENSOR INTERACTION

Two tilt sensors, mounted on each side of the platform support, are used to measure the incline of the platform with respect to gravity and control the automatic platform angle control function. The right one (as viewed from standing in the platform) is used as the primary sensor and the left one as a secondary backup sensor.

If a fault occurs with the primary sensor, control will revert to the secondary sensor. (This is discussed in more detail in the error response section.)

Because of the mounting orientation of the tilt sensors, the primary tilt sensor will output ascending voltage values with increases in positive platform tilt angle. The backup or secondary tilt sensor will output descending voltage values with increases in positive platform angle.



SWITCH #1			
PIN#	DESCRIPTION	SWITCH	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	GREEN	BLUE
PIN #3	GROUND	BLACK	BLACK

SWITCH #2			
PIN#	DESCRIPTION	SWITCH	HARNESS
PIN #1	POWER	RED	RED
PIN #2	PWM OUT	GREEN	BLUE
PIN #3	GROUND	BLACK	BLACK

Figure 4-21. Level Switches

PLATFORM VALVES

The platform specific valves are located in a manifold at the platform.

There are six valves that control various platform functions. Two control Platform Level up and down for the leveling function, two are used to rotate the platform, and two to control jib up and down.

All platform valves are Pulse Width Modulated (PWM'd). PWM is a method of setting the voltage across a valve, and therefore the flow through it, by varying the On/Off duty cycle of the control module output. PWM permits proportional flow control.

There is also a Platform Dump Valve, located in the platform valve manifold, which is used to hydraulically isolate the control valves and to improve hydraulic response.

The Ground Module controls this valve to enable automatic platform leveling and to provide manual platform leveling in the event that the Platform Module is inoperable.

In ground mode, the platform dump valve is turned on whenever any platform or jib valve output is turned on. Whenever all platform and jib valves are turned off, the platform dump valve is turned off.

In platform mode, the platform dump valve is turned on whenever the footswitch is depressed.

Normal Operation

AUTOMATIC PLATFORM ANGLE CONTROL

The level system will assume a new fixed set point (fixed incline of the platform with respect to gravity) each time the control system is powered up (cycling of the EMS) and each time the footswitch is engaged.

Automatic platform angle control only functions while operating drive, telescope, lift or swing. It does not adjust the platform angle while operating any other function (e.g. rotate, jib, or steer). Furthermore, machines equipped with control system software P5.0 and later, automatic platform angle control for drive and swing may be disabled by using the analyzer. For this case, the platform angle setpoint is taken when the joystick moves from a non-leveling function (drive/swing) to a leveling function (lift/tele).

The machine controls attempt to maintain the angle of the platform to setpoint by providing a command proportional to the angular error from setpoint. Since the sensors used to measure the platform angle are fluid-filled, gravity-based sensors, reading the sensors in real time would cause constant correction of the platform position due to machine vibration and inertial changes of the boom. Therefore, the sensor readings are averaged over time, or filtered, in order to achieve a more uniform reading. This filtering has the advantage of providing smoother operation, but has the disadvantage of causing a lag (or sluggishness) in the system response. This lag may cause the platform to be several degrees from setpoint.

In order to provide a better system response, the controls also compute the rate of angular change of the platform position and set the leveling valve positions to achieve a matching velocity. The measured velocity is the average platform speed over the last 0.5 seconds. The desired valve command is computed by comparing the measured velocity to the desired velocity and setting the valve opening to correspond to the required amount of make-up angle. The amount the valve opens when making an automatic correction is proportional to and directly affected by:

- Crackpoint setting
- Velocity error (proportional factor)
- Sum of velocity errors over time (integral factor)

These three factors are summed together with appropriate gain factors to compute the resulting current to the valves. The operator does not have control over the latter two factors, but can affect the resulting current by adjusting the crackpoint. Increasing the crackpoint makes the valve current higher, resulting in quicker more aggressive control and larger amounts of overshoot. Decreasing the crackpoint will result in smoother operation but may not permit enough platform velocity to keep up with the boom (i.e., may get platform timeout alarms) in some multi-function operations. The platform controls are set up to provide smooth leveling operations for the majority of conditions and will perform best for steady operator command, as opposed to command values for function, that change frequently.

In order to obtain acceptable performance while performing all hydraulic functions, five sets of parameters are used. These "zones" allow compensation for differences in how the basket level changes when doing different functions. These zones are as follows:

1. Lift up
2. Lift down
3. Other boom functions
4. Drive
5. Auxiliary

The other boom functions zone includes Swing, Telescope, Jib swing (It is not necessary to level with jib lift, since the mechanical linkage keeps the basket level).

These zones are prioritized when multiple functions are active. The priorities are as follows.

1. Auxiliary power and any other function, zone = auxiliary power
2. Drive and any other function, zone = Drive
3. Lift up and any other function, zone = Lift up
4. Lift down and any other function, zone = Lift down
5. Other boom functions, zone = Other boom functions

During the power-up procedure, function enable, in both Platform and Ground Mode, is delayed during the 1.5 second startup lamp test. During this 1.5 second startup period, the basket level up valve will be energized at 100% duty cycle for 0.5 second, and then the basket level down valve energized at 100% duty cycle for 0.5 second. This will help to keep the valves from sticking.

PLATFORM LEVEL MANUAL OVERRIDE

In addition to automatic platform angle control, the operator is able to manually adjust the platform level position by means of the level override switches located at the platform and ground control positions (similar to a Slave hydraulic system).

If a command from the Platform Level Up and Down toggle switch on either the platform or the ground is received, automatic platform angle control will cease and the appropriate output will be commanded to turn on.

The duty cycle of the output shall be scaled from the pump potentiometer. When the toggle switch is released, after one second, the current filtered value of tilt angle will be taken as the new set point.

In other words the operator can chose a platform level incline other than level with gravity and the system will maintain the chosen platform angle within several degrees of setpoint.

Platform Leveling Fault

The JLG Control System takes a snapshot of the two sensor values and records the difference once on each power up. The Control system allows a ±5 degrees difference from those values. For example, if Sensor 1 is at 5 degrees and Sensor 2 is at 11 degrees, the difference is 6 degrees and the DTC is triggered when the sensors are 1 degree (or less) apart or 11 degrees (or more) apart.

If a fault occurs in the platform leveling system the following will occur:

1. Automatic platform angle control will stop and the platform dump valve will be disabled (level, rotate, and jib functions disabled). The exception is when there is a fault in only one sensor automatic platform angle control will remain active as the control system will use the other sensor to control leveling.
2. The level system fault lamp will flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position see below).

To reset the fault the emergency stop switch should be recycled.

NOTICE

IF THE LEVEL SYSTEM FAULT INDICATOR REMAINS ILLUMINATED, RETURN THE PLATFORM TO THE STOWED POSITION, SHUT DOWN THE MACHINE, AND REPAIR THE LEVELING SYSTEM.

ERROR RESPONSE

If basket level varies from the current **setpoint** by ± 5.5° for more than 2 seconds for large variations from setpoint when the platform is not in the transport position, the controls assume the system is not properly set up or has degraded and initiate a fault.

When the unit is in the transport position and driving and the current setpoint varies by ± 5.5° for more than 10 seconds the events 1,2,3 & 4 above will occur. (Note function speeds will operate normally). Since the control system can not anticipate all conditions under which a machine is to be operated, these parameters have been chosen to provide reasonable performance and safe operation. If an error occurs, cycling the EMS will clear the fault. The operator should evaluate the operating situation and assess his machine to determine the source of the fault.

VALVE DRIVER ERRORS

There are three possible level valve driver errors, short to battery, short to ground, and open circuit.

1. In the case of a **short to ground or an open circuit**, the platform valve cannot be turned on and the following will occur:
   a. All interactions with platform leveling shall cease
   b. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   c. The platform alarm will sound.
   d. A system fault will be logged.
   e. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).
2. In the case of a **short to battery** on one of the platform leveling valves, the valve cannot be turned off and the following will occur:
   a. The platform dump valve will be turned off to prevent unintended tilting of the platform.
   b. All interactions with platform leveling shall cease.
   c. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   d. The platform alarm will sound.

e. A system fault will be logged.
f. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position)

3. In the case of a **short to battery on the platform dump valve**, the valve cannot be turned off. The controllability of the platform leveling function will be impaired and the following will occur:

   a. All interactions with platform leveling shall cease.
   b. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
   c. The platform alarm will sound.
   d. A system fault will be logged.
   e. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).

Lift, swing, drive and telescope will continue to operate.

In each of the cases above it shall be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

TILT SENSOR ERRORS

If the secondary tilt sensor is faulty, the control system will continue to utilize information from the primary sensor.

If the primary sensor is faulty, the control system will switch to the backup sensor for control.

In both cases above the following will occur:

1. The Electronic Leveling System Fault Lamp will flash (to indicate that there is a leveling fault).
2. The platform alarm will sound.
3. A system fault will be logged.
4. All function speeds (lift, swing, telescope, jib and drive) will be placed in creep mode (except when the platform is in the transport position).
5. Automatic platform angle control remains active.

Lift, swing, drive and telescope will continue to operate.

In each of the cases above it will be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

When both sensors appear to be working but have measurements that disagree by ±5.5º The following will occur:

1. All interactions with platform leveling shall cease.
2. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).

At this point, the operator must use the level up and down toggle switch to manually level during descent. It shall be necessary to re-cycle the EMS to clear the fault.

CAN Errors

The Ground Module has two direct outputs dedicated to overriding the Platform Module’s control of the leveling valves. The EPBC Ground Module “Platform Level Up/Down” outputs are used to control the platform level up and down valves.

When in ground mode, if the Ground Module reads a platform leveling switch command, the switch command is communicated over CAN to the Platform Module where it is handled normally.

If Ground Module determines that CAN communication is inoperable, it turns on the platform control valve and the appropriate platform leveling override outputs while the switch is engaged.

If the Platform Module is still running when CAN is down nothing will operate when in platform mode. When the operator switches to ground mode, the platform will not control any of its valve outputs and a CAN error message is signaled.

Replacing the Level Sensors

Earlier generations of this machine had three different generations of level sensors that were used on this machine. JLG P/N 4360503, P/N 4360528, and P/N 4360544. P/N 4360528 and 4360544 supersede P/N 4360503. If one of the 4360503 sensors fail, BOTH sensors must be replaced with two P/N 4360544 sensors. 4360503 Sensors can be identified by the code SSY0185-13 which is printed on the sensor. Otherwise, single 4360528 or 4360544 9999 sensors may be replaced.

Additional Platform and Jib Valves

The high side drivers for the platform left and right and the jib up and down valves are be located in the Platform Module and are PWM'd. The control for these functions are the same as currently implemented for the EPBC except that the flow through the valves is individually controllable instead of controlled by single the flow control valve. The individually controlled duty cycle will be the same as would otherwise have been commanded to the flow control valve.

Only one platform or jib function is allowed at one time to limit the amount of current draw, minimizing the voltage drop on the supply to the PM.

The function is enabled first shall remain active until it is released. Any other function commanded while another function is active is ignored.

If only one other function is commanded when the active function is released, the other function will be activated.

If more than one function is commanded when the active function is released, only one function shall be activated.

Platform Leveling Calibration Procedure

STEP 1: SETTING THE PLATFORM VALVE MINIMUMS

1. Put machine into "Ground Mode".
2. Start machine and plug in Analyzer.
3. Go to the "Access Level 2" screen.
4. Enter "33271" to get into Access Level 1 mode.
5. Go to the "Personalities" menu and adjust the following personalities. Refer to the Personality Ranges/Defaults table in Section 6 - JLG Control System for proper setting values.

   Basket Level Up Min
   Basket Level Up Max
   Basket Level Down Max
   Jib Up Min
   Jib Down Min

6. Recycle EMS.

STEP 2: CALIBRATING THE PLATFORM LEVEL SENSORS (FOR PLATFORM SOFTWARE PRIOR TO VERSION P3.4)

1. Put machine into "Ground Mode".
2. Start machine and plug in Analyzer.
3. Manually level the platform with the switch on the MTB.
4. Go to the "Access Level 2" screen.
5. Enter "33271" to get into Access Level 1 mode.
6. Go to the "Calibrations" menu and hit ENTER.
7. Use RIGHT ARROW go to "Plat. Leveling" screen.
8. Hit ENTER. "Calibrate?" prompt should appear.
9. Hit ENTER again to calibrate level sensors.
10. When calibration has been successful "Cal Complete" should appear.
11. Cycle power to the machine.

STEP 3: BLEEDING THE PLATFORM VALVES

Start up the machine and exercise the following platform functions (from the ground) eight (8) to ten (10) times for 5 seconds in each direction.

Basket Rotate
Basket Level
Jib U/D (if configured)

STEP 4: CALIBRATING THE PLATFORM LEVEL UP AND DOWN VALVE CRACKPOINTS

NOTE: *Since the valve position which allows minimum oil flow (crackpoint) is dependent on the oil pressure, verify the proper stand-by pressure as outlined in Section 5.3 prior to setting the crackpoints.*

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Go to the “Access Level 2” screen.
4. Enter “33271” to get into Access Level 1 mode.
5. Go to the “Calibrations” menu and hit ENTER.
6. Go to the “Basket U Crkpt” Screen. Hit ENTER.
7. “Calibrate?” prompt should appear. Hit ENTER again.
8. The engine will rise to 1800 rpm.
9. Using UP ARROW, increase the value until you see the basket up movement. (Typically from 275 – 425).
10. Hit ENTER again. “Cal Complete” message should appear
11. Engine should again return to idle.
12. Hit ESC should return to “Basket U Crkpt” screen.
13. Hit RIGHT ARROW to get to the “Basket D Crkpt” screen. Hit ENTER.
14. “Calibrate?” prompt should appear. Hit ENTER again.
15. The engine will rise to 1800 rpm.
16. Using UP ARROW, increase the value until you see the basket down movement. (Typically from 275 – 425).
17. Hit ENTER again. “Cal Complete” message should appear.
18. Engine should again return to idle.
19. Hit ESC to exit.
20. Cycle power to the machine.
21. The preceding steps will provide acceptable crackpoint settings for the majority of machines. However, if the operator can feel small jolts in the platform from the valve opening during a leveling operation, the crackpoint is likely too high for this machine. A high crackpoint may also lead to “over-leveling”, causing the platform to drift beyond the set point. An example of this would be the platform tilting too far backwards during a Lift Up operation. Therefore, use the following guidelines to evaluate whether further crackpoint adjustment is required.
    a. Telescope the machine halfway.
    b. Perform Lift Up. If the basket leans backward (over compensates), the Level Down crackpoint is too high. If the basket leans forward or a BASKET LEVELING SYSTEM TIMEOUT fault occurs, the Level Down crackpoint is too low.
    c. Perform Lift Down. If the basket leans forward (over compensates), the Level Up crackpoint is too high. If the basket leans backwards or the Tilt Cutout Alarm comes on, the Level Up crackpoint is too low.
22. If Platform Level is slow to respond during Lift commands, causing PLATFORM LEVEL TIMED OUT faults, it may be necessary to increase the crackpoint settings. Use the following guidelines to evaluate whether further crackpoint adjustment is required.
    a. Perform a continued Lift Up command (do not cycle the joystick on/off repeatedly). If the PLATFORM LEVEL TIMED OUT fault sets or if Platform Level Down seems slow to respond, an increase in the Platform Level Down crackpoint may be necessary.
    b. Perform a continued Lift Down command (do not cycle the joystick on/off repeatedly). If the PLATFORM LEVEL TIMED OUT fault sets or if Platform Level Up seems slow to respond an increase in the Platform Level Up crackpoint may be necessary.

4.12 ROTARY ACTUATOR

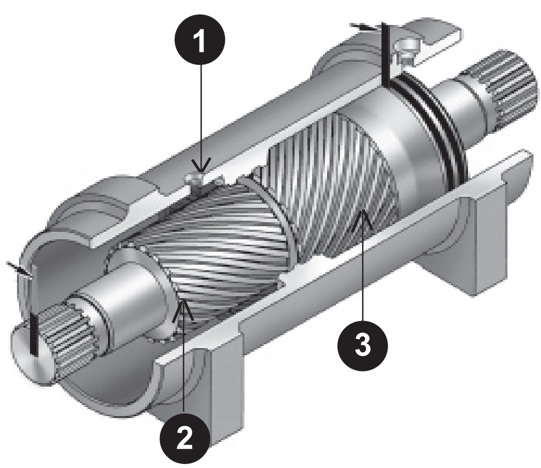
Theory of Operation

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.

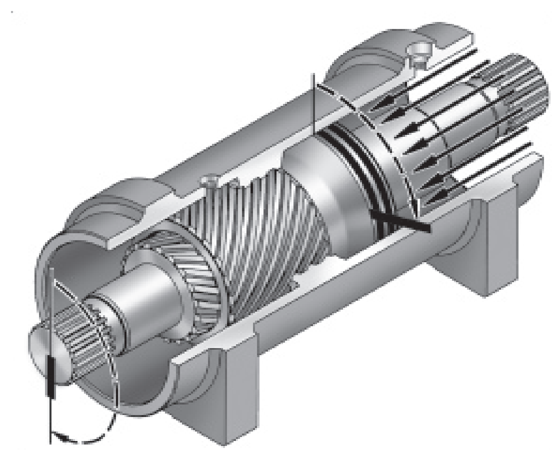
The shaft is supported radially by the large upper radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the upper and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

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

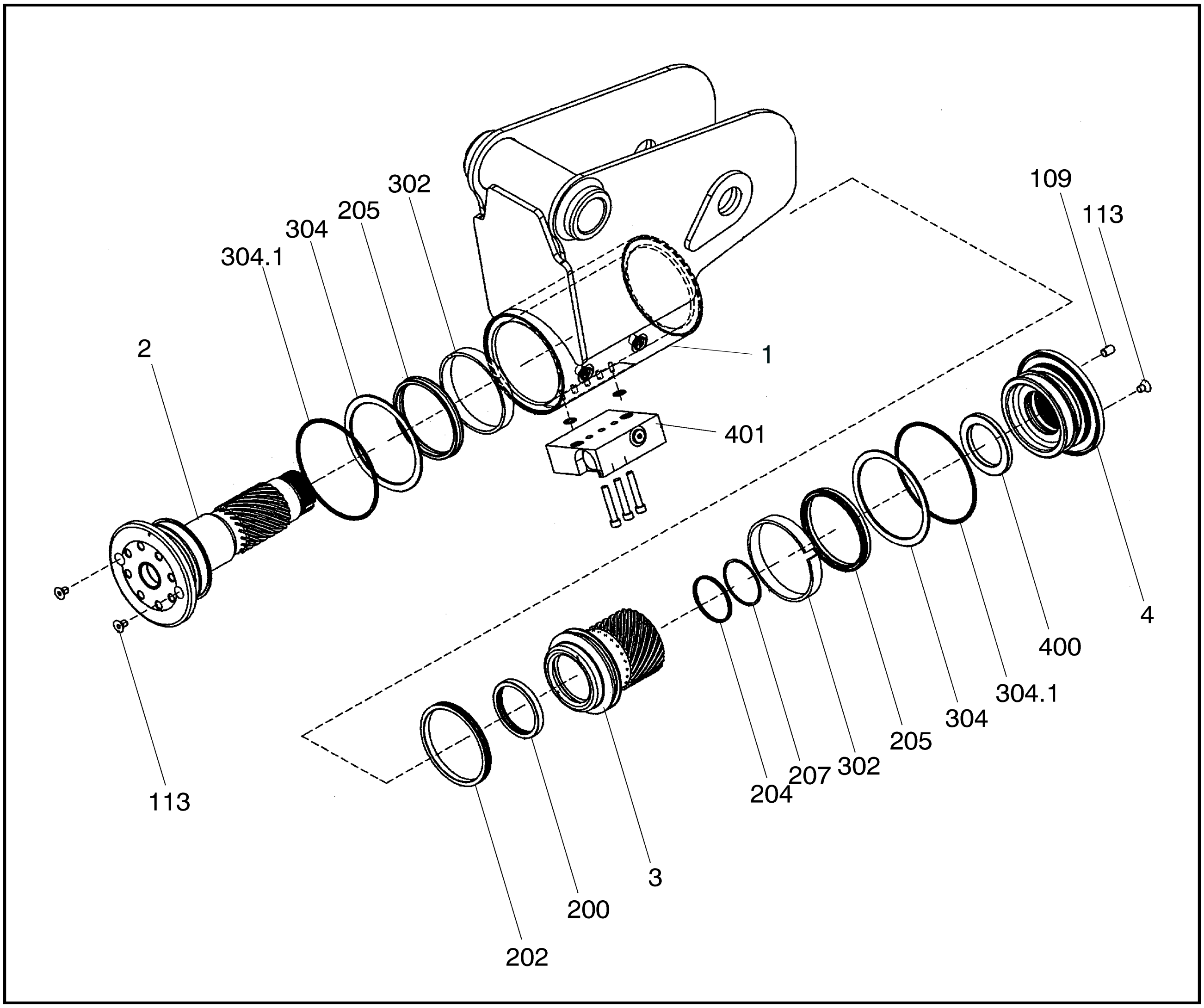


Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.



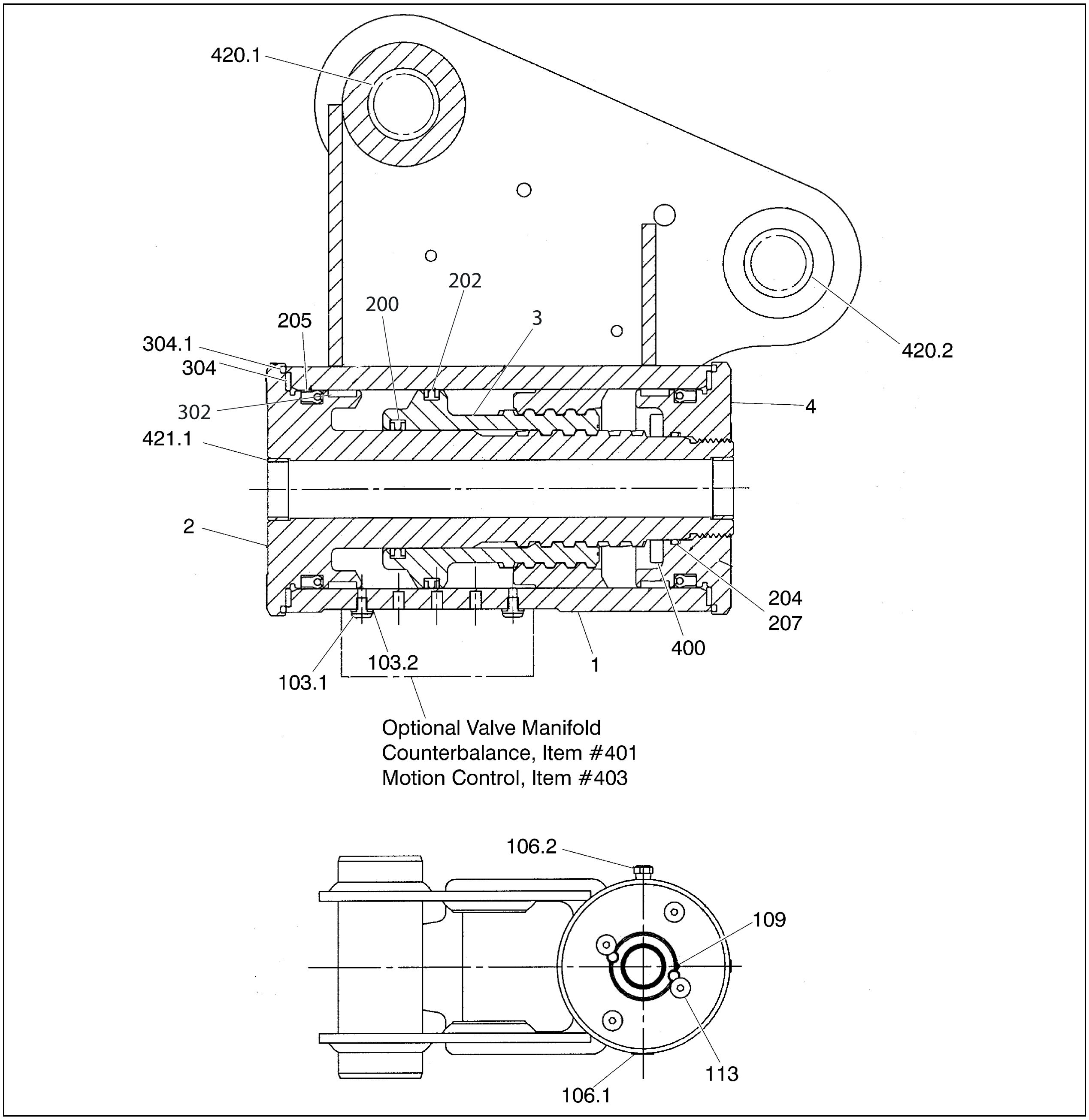
Applying fluid pressure will displace the piston axially while the helical gearing causes the piston and shaft to rotate simultaneously.

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 to their original starting positions.



1. Housing	200. T-Seal	302. Wear Guide
2. Shaft	202. T-Seal	304. Thrust Washer
3. Piston Sleeve	204. O-ring	304.1. Wiper Seal
4. End Cap	205. Cup Seal	400. Counterbalance Valve
109. Lock Pin	207. Backup Ring	401. Counterbalance Valve
113. Capscrew		

Figure 4-22. Rotary Actuator (Exploded View)



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

Figure 4-23. Rotary Actuator (Cutaway View)

Tools Required for Assembly/Disassembly

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

1. Pipe Vise
2. Hex Wrench - Removal and replacement of port plugs and set screws.
3. Assorted Screws
4. Safety Glasses
5. End Cap Removal Tools
6. Drill
7. Flashlight - Helps in locating and examining timing marks, component failure and overall condition.
8. Rubber Mallet - Removal and installation of shaft and piston sleeve assembly.
9. Plastic Mandrel
10. Pry Bar - Removal of end cap and manual rotation of shaft.
11. Felt Marker- Highlights timing marks and outlines troubled areas. Permanent ink is recommended.
12. T - Handle Screw Extractor
13. Hex Wrench Set - Removal and replacement of port plugs and set screws (106,110).
14. Seal Tools - Removal and installation of seals and wear guides. Directions on making a seal tool are provided at bottom.
15. Punch
16. Dowel Pins - Removal and installation of end cap.

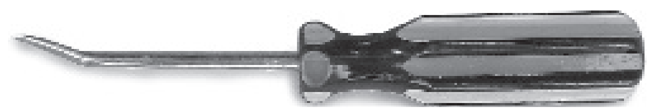
Making a Seal Tool

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

CAUTION

TO AVOID INJURY BE CAREFUL WHILE HANDLING THE HOT SCREWDRIVER.

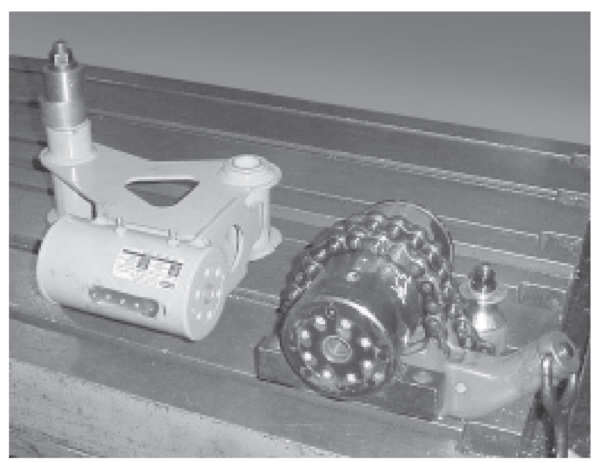
1. Heat the flat end with a torch until it glows.
2. Secure the heated end of the screwdriver in a vise and bend the heated end to a slight radius.
3. Round off all sharp edges of the heated to a polished finish. The tool may be modified slightly to one's own personal preference. To avoid injury be careful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



Disassembly

CAUTION

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

CAUTION

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

NOTICE

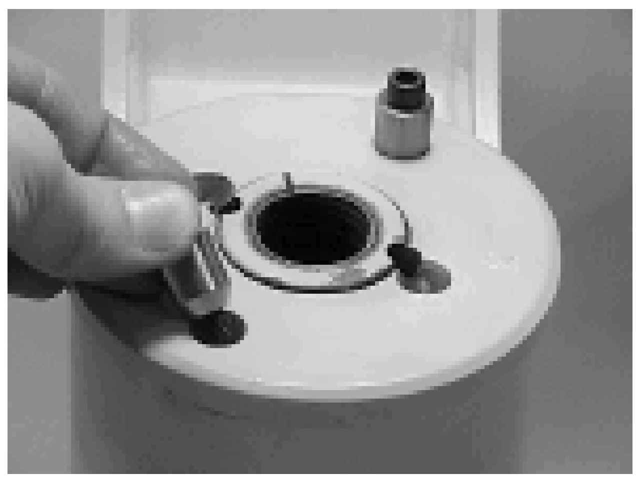
MAKE SURE WORK AREA IS CLEAN.

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

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

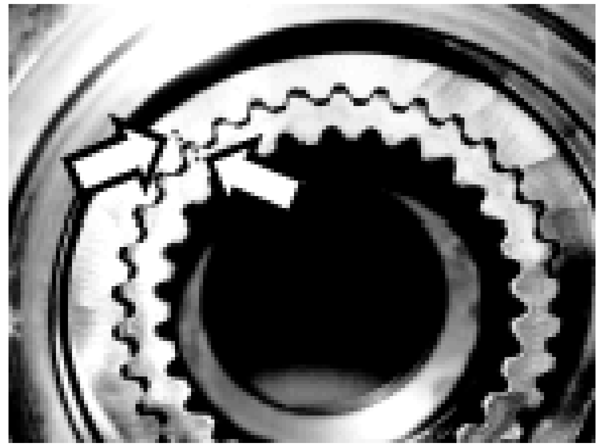


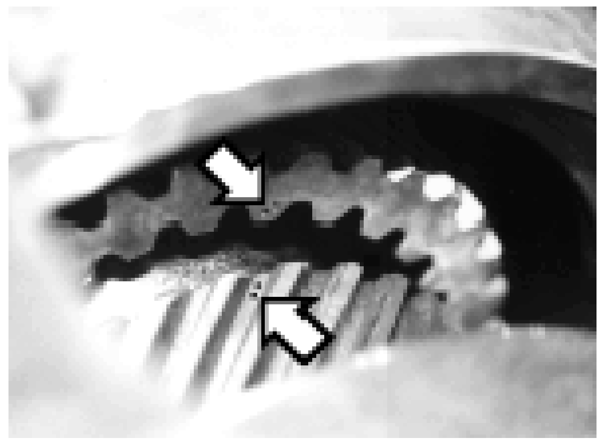
6. Using a metal bar, or similar tool, unscrew the end cap (4) by turning it counterclockwise.

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

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

9. Every actuator has timing marks for proper engagement.





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

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

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

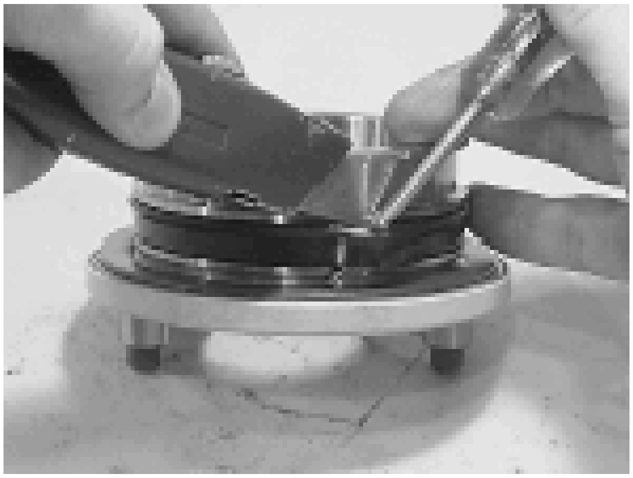
13. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.

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

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

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

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



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

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

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

21. Remove the piston I.D. seal (200) and proceed to the inspection process.

Inspection

NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

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

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

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

Assembly

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

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

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

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

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

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

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

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

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

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

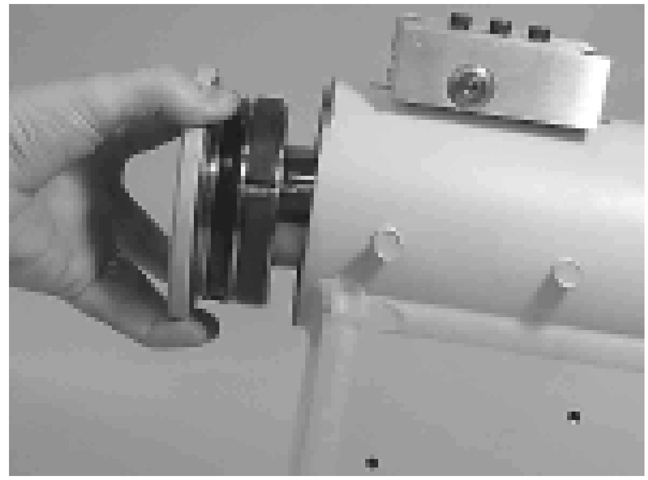
Repeat this step for the outer seal (202).

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

9. Looking from the angle shown, rotate the piston (3) until the marks 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 contact.

10. Look from the opposite end of the housing (1) to see if the 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 against the ring gear.

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

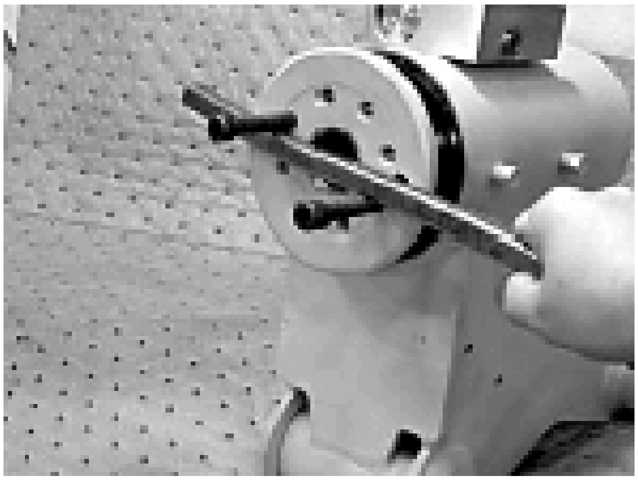


12. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.

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

NOTICE

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



14. Install the stop tube (400) onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.

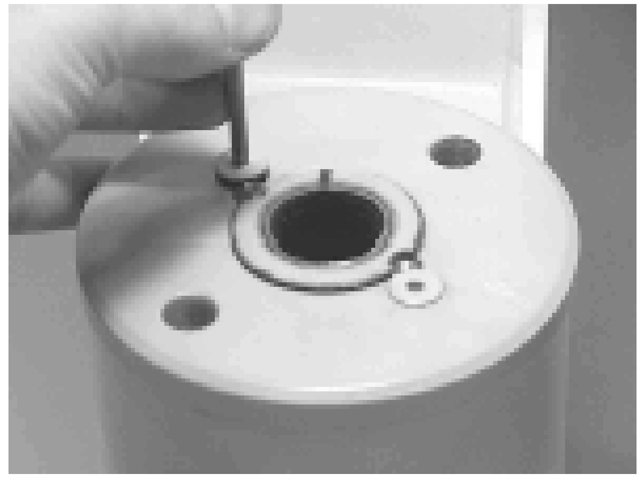
15. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.

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

17. Tighten the end cap (4). In most cases the original holes for the lock pins will line up.

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

19. Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.8 Nm).



Installing Counterbalance Valve

Refer to Figure 4-24., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old JLG Threadlocker.

2. Make sure the new valve has the o-rings in the counterbores of the valve to seal it to the actuator housing.

3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. JLG Threadlocker P/N 0100011 should be applied to the shank of the three bolts at the time of installation.

4. Torque the 1/4 in. bolts 110 to 120 in. lbs. (12.4 to 13.5 Nm). Do not torque over 125 in. lbs. (14.1 Nm). Torque the 5/16 in. bolts 140 in. lbs. (15.8 Nm). Do not torque over 145 in. lbs. (16.3 Nm).

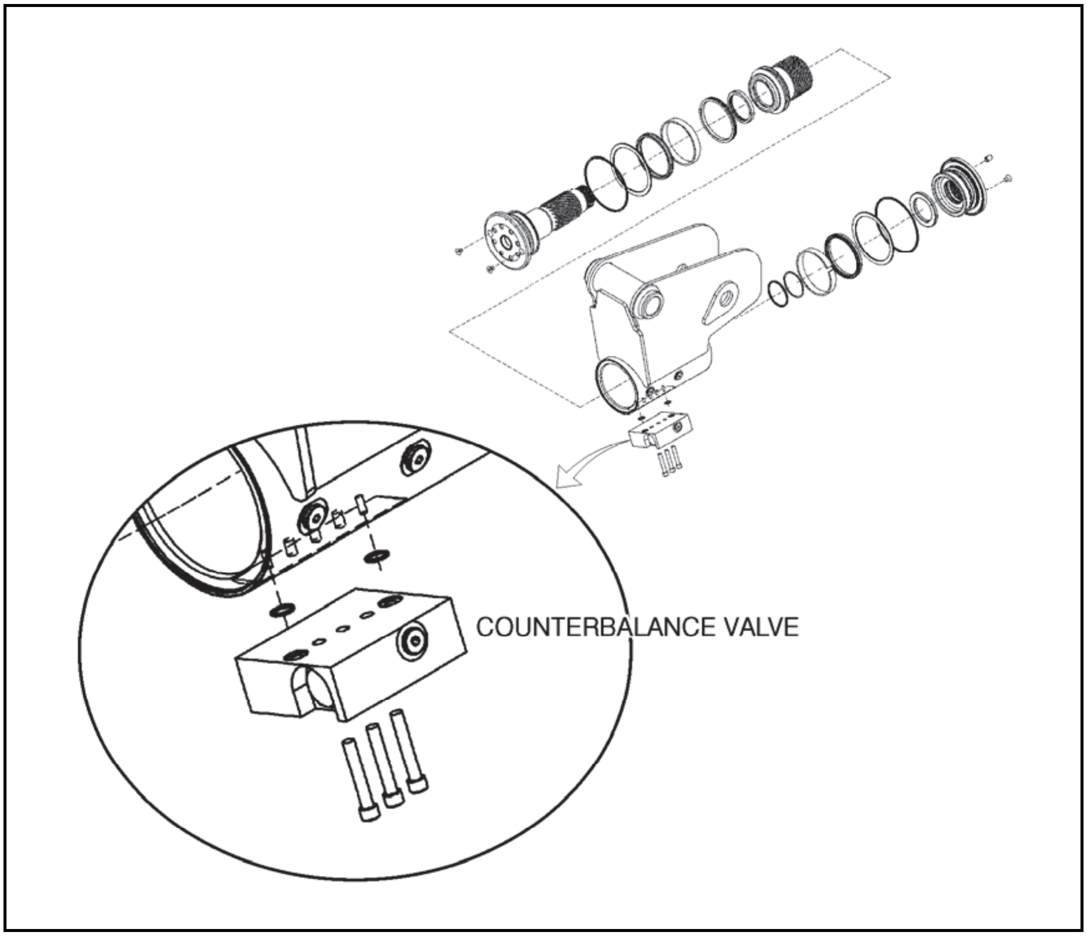


Figure 4-24. Rotator Counterbalance Valve

Greasing Thrust Washers

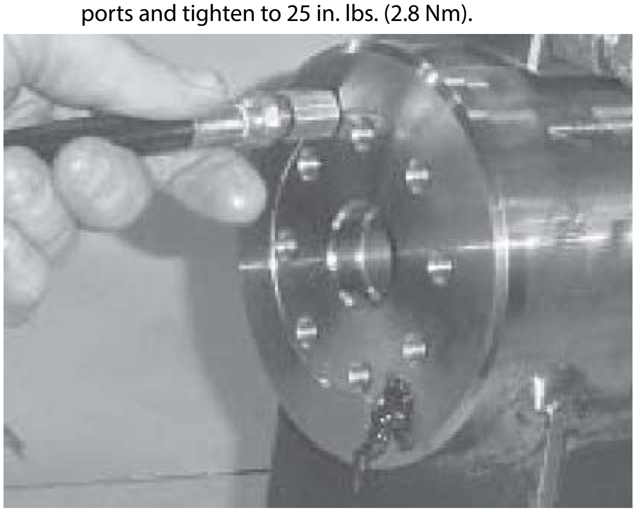
5. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

6. There are two grease ports located on both the shaft flange and the end cap. They are plugged with capscrews (6) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)

NOTICE

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

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



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 (207 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 (207 bar) and maintain pressure. Remove the hydraulic line from the non-pressurized side.

Continuous oil flow from the open housing port indicates internal leakage across the piston. Replace the line and rotate the shaft to the end of rotation in the opposite direction. Repeat the test procedure outlined above for the other port. If there is an internal leak, disassemble, inspect and repair.

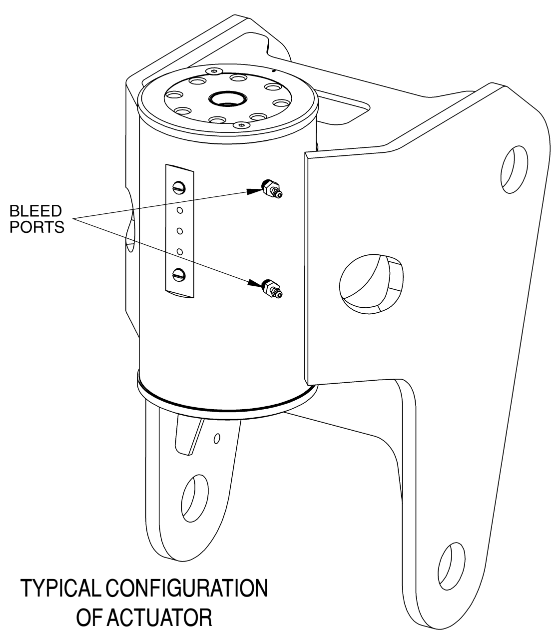
Installation and Bleeding

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

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

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

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



TYPICAL CONFIGURATION
OF ACTUATOR

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

Troubleshooting

Table 4-1. Troubleshooting

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

4.13 LOAD SENSING DEVICE

Calibrating the Load Sensor

NOTE: *Refer to Section 6 - JLG Control System.*

1. Place the boom in the following position.
   a. Boom - Stowed
   b. Telescope - In
   c. Jib - 0 Degrees
   d. Swing - 0 Degrees
   e. Basket Level - 0 Degrees
   f. Basket Rotate - 0 Degrees
   g. Weight in Basket - 0
   h. Machine parked on firm, level surface
2. Activate both emergency stop switches and turn the key switch to the platform position.
3. Remove all loads from the platform, including the operator.
4. Turn P1 clockwise (in) until the potentiometer begins to click.
5. Plug the analyzer into the port in the platform.
6. Select Access Level from Main Menu.
7. Enter 33271.
8. Select Machine Set-Up>Load Cell>1 Warn Only.
9. Select Machine Diagnostics>System Load Cell on the Analyzer.
10. Adjust P2 until the Load = 0%.
11. Place 525 lbs. (238 kg) in the center of the basket.
12. Adjust P1 until the Load = 100%
13. Verify that the overload indicator lights continuously and the alarm sounds continuously during an overload condition.
14. Remove the weight from the platform.
15. Adjust P2 until the Load = 0%.
16. Place 525 lbs. (238 kg) in the center of the basket.
17. Adjust P1 until the Load = 100%
18. Remove the weight from the basket.
19. Seal the potentiometers with fingernail polish.

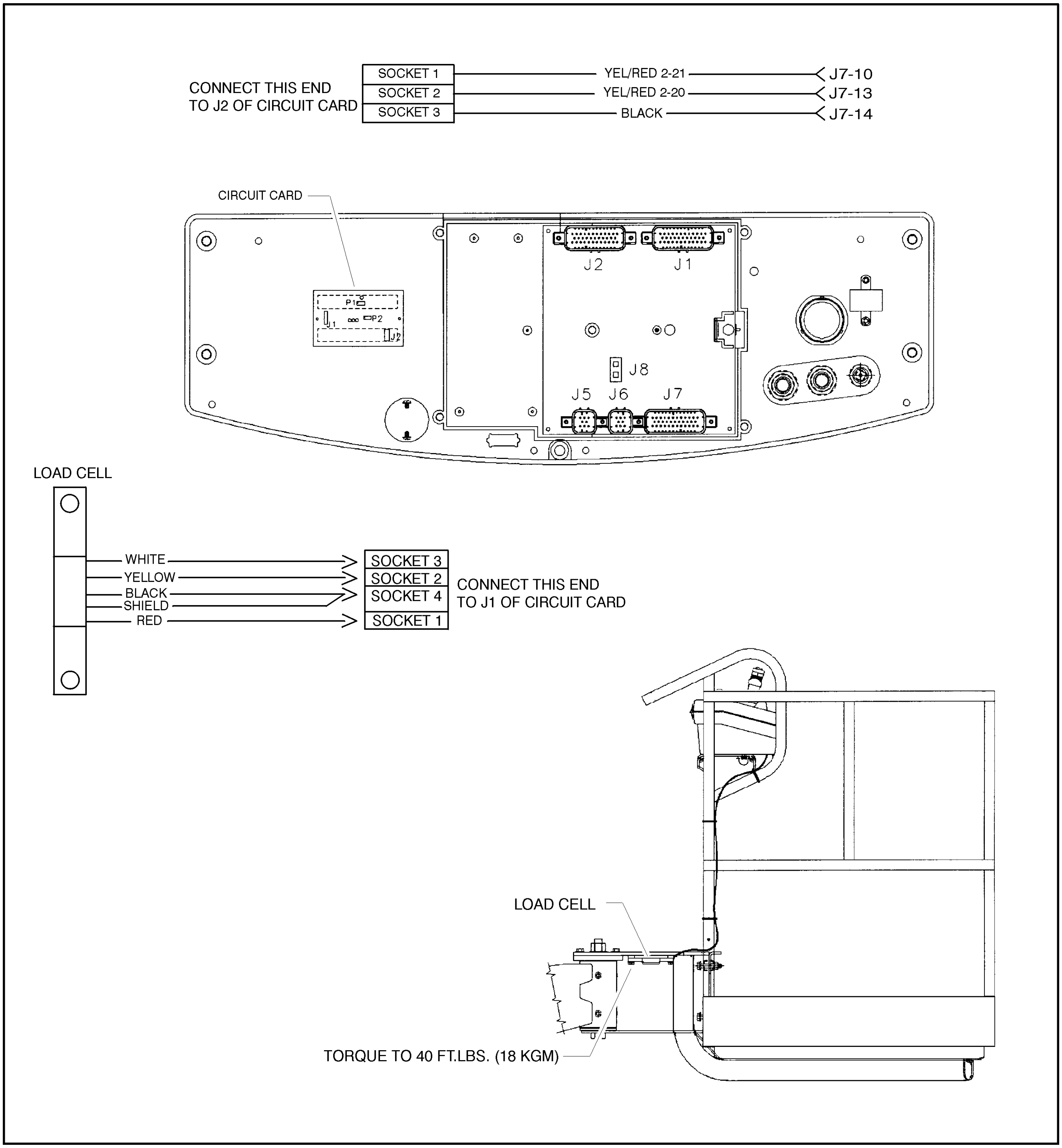


Figure 4-25. Load Sensing Device

4.14 SKYGUARD

Operation

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

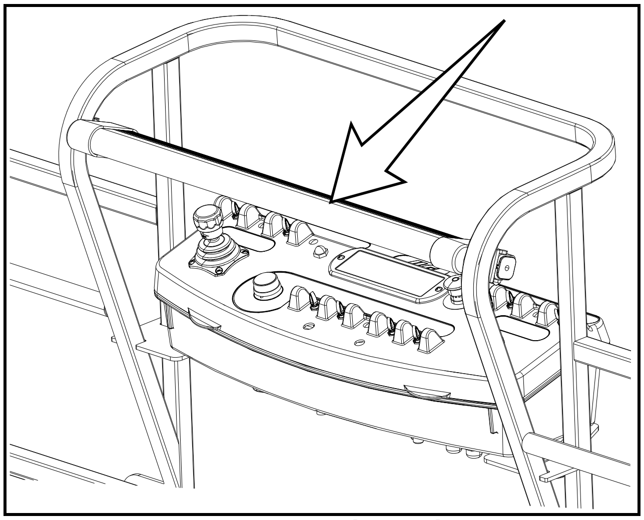


Figure 4-26. Skyguard

Functional Test

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

In Platform Mode:

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

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

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

In Ground Mode:

Operation will be allowed regardless of SkyGuard sensor activation.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "BOTH" IS SELECTED.

In Platform Mode:

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

1. In an area free of obstructions, from platform controls test the SkyGuard feature by operating the telescopic out functions and engaging the SkyGuard sensor, telescopic out function will be stopped, soft touch indicator light will flash at 3HZ, the horn will be turned on until the SkyGuard sensor and footswitch is disengaged.

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

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

In Ground Mode:

Operation will be allowed regardless of SkyGuard switch activation.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "SOFT TOUCH" IS SELECTED.

Machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "NONE" IS SELECTED.

Skyguard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostic & Troubleshooting

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

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

   If SkyGuard does Not Function with sensor engaged.

⚠ CAUTION

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

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

   Depending on configurations, diagnostics menu will read:

   Diagnostics->System->Skyguard switch

   Diagnostics->System->STOUCH OR SG

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

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

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

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

   Diagnostics->System->Skyguard switch

   Diagnostics->System->STOUCH OR SG

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

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

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

   Both relays failed (low probability).

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

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

Table 4-2. SkyGuard Function Table

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

NOTES:

SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

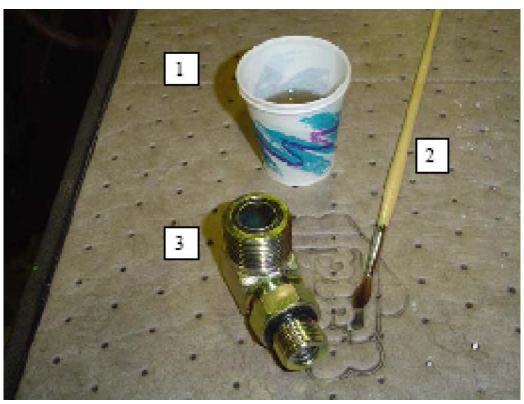
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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 HYDRAULIC CYLINDERS

Axle Lockout Cylinder

DISASSEMBLY

NOTICE

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

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

⚠ WARNING

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

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

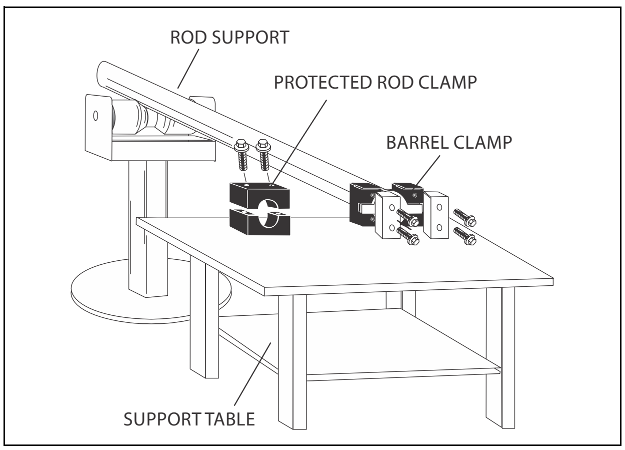


Figure 5-1. Cylinder Barrel Support

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

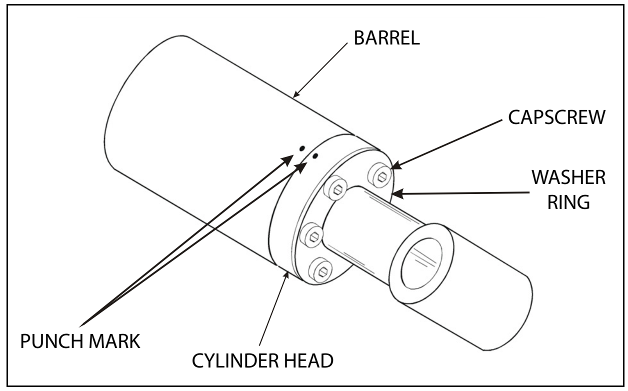


Figure 5-2. Capscrew Removal

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.

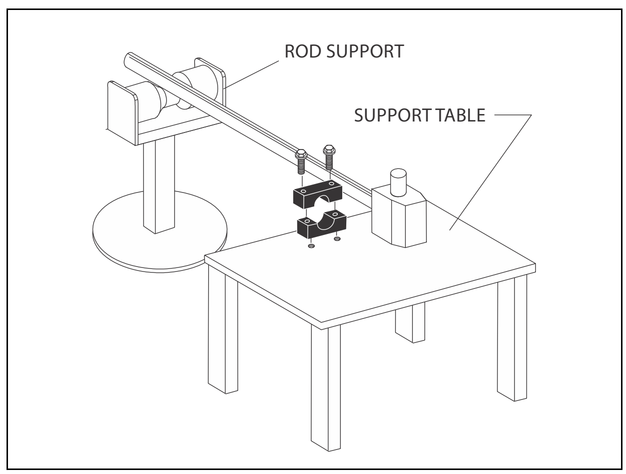
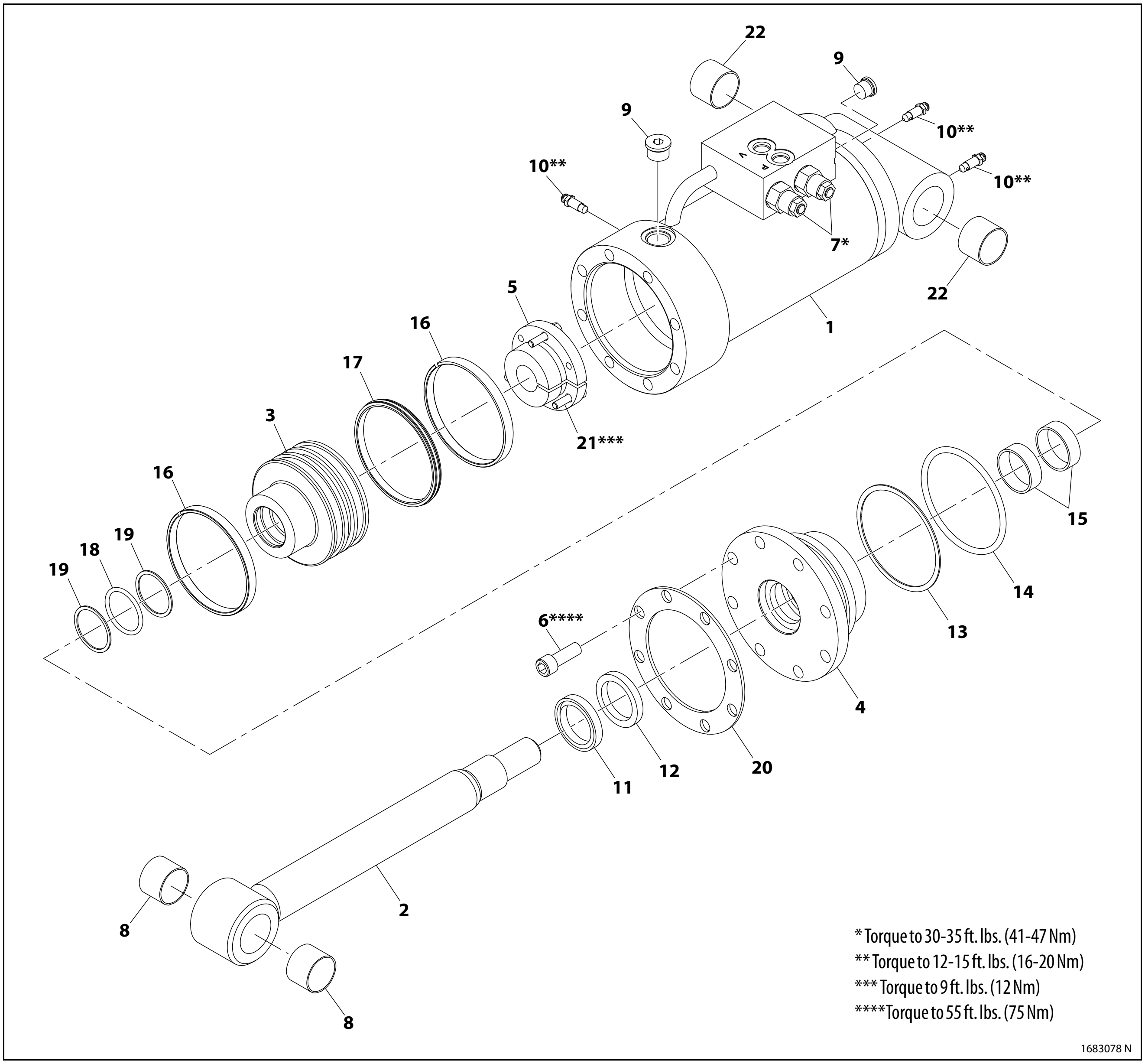


Figure 5-3. Cylinder Rod Support



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

Figure 5-4. Axle Lockout 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.

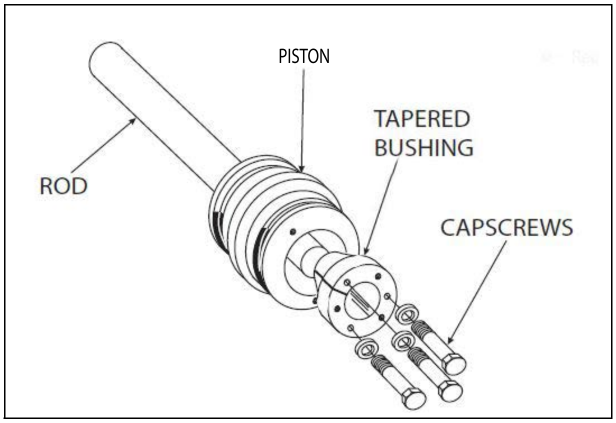


Figure 5-5. Tapered Bushing Removal

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

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
10. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
11. Inspect cylinder head outside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
12. 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 inner of the 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.*

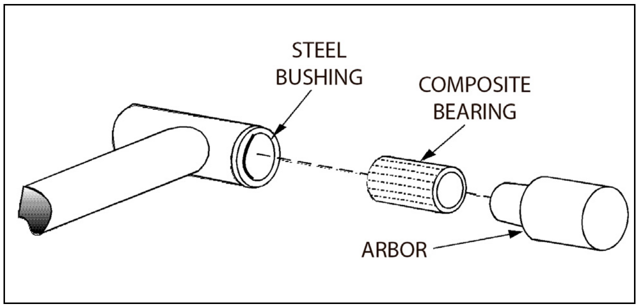


Figure 5-6. Composite Bearing Installation

13. If applicable, inspect port block fittings and relief valve. Replace if necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace if necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See the respective 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.

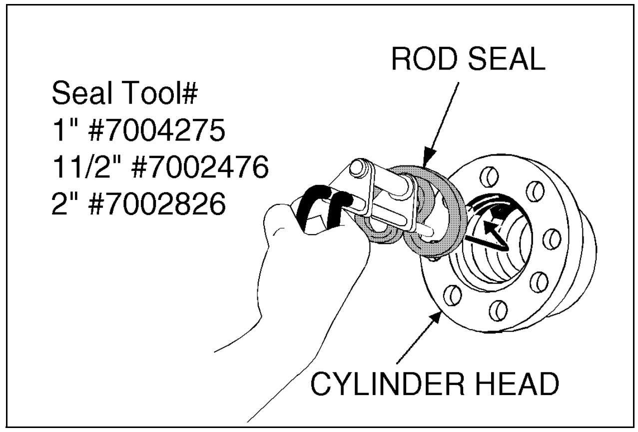


Figure 5-7. Rod Seal Installation

NOTICE

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

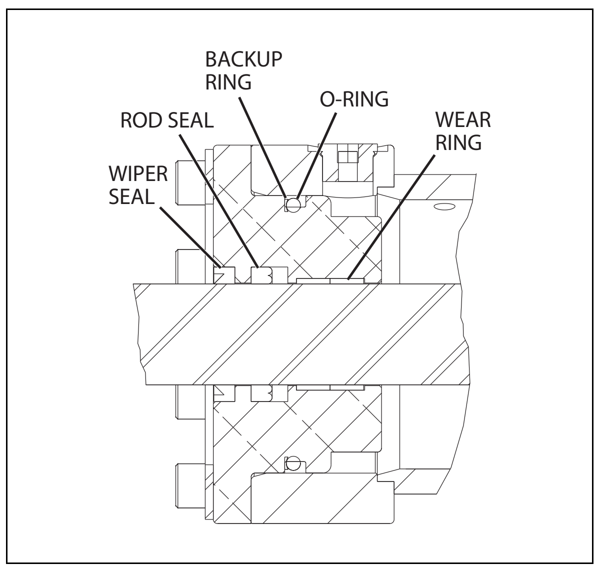
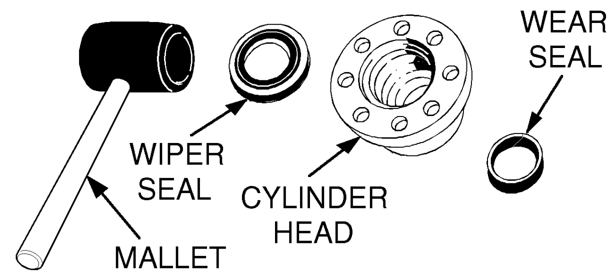


Figure 5-8. Cylinder Head Seal Installation

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.



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-9. Wiper Seal Installation

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

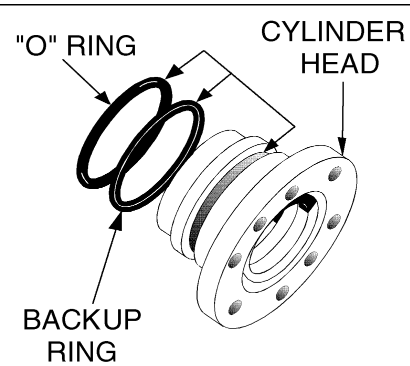


Figure 5-10. Installation of Head Seal Kit

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

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

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

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

8. Insert the tapered bushing into piston

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

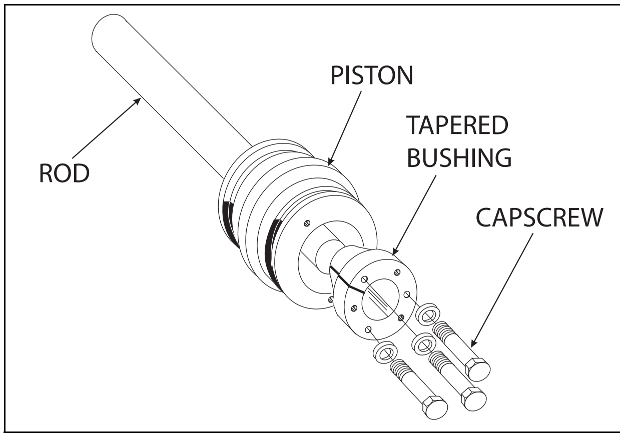


Figure 5-11. Tapered Bushing Installation

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

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

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

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

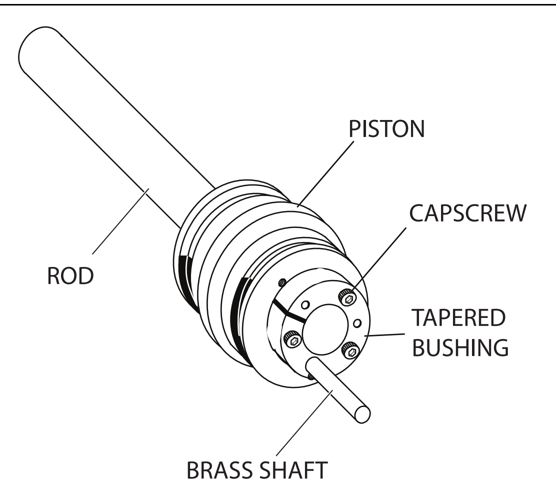


Figure 5-12. Seating the Tapered Bearing

12. Rotate the capscrews evenly and progressively in rotation to 9 ft. lbs. (12 Nm).
13. Remove the cylinder rod from the holding fixture.
14. Place new wear rings and T-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).

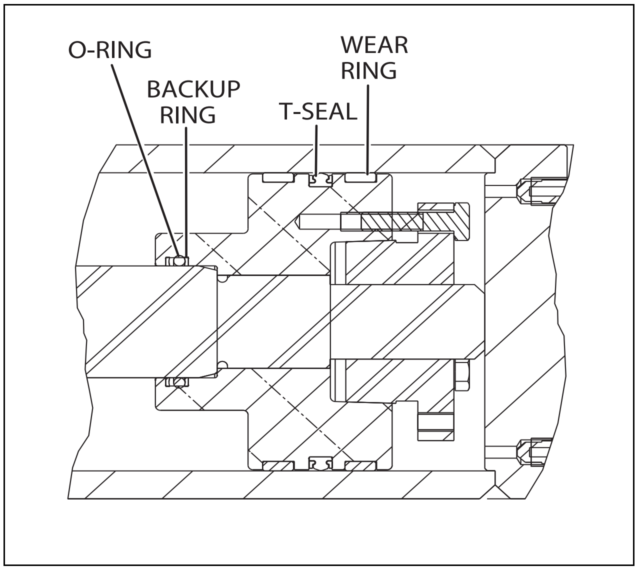


Figure 5-13. Piston Seal Kit Installation

15. 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.

16. With barrel clamped secured and 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.
17. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

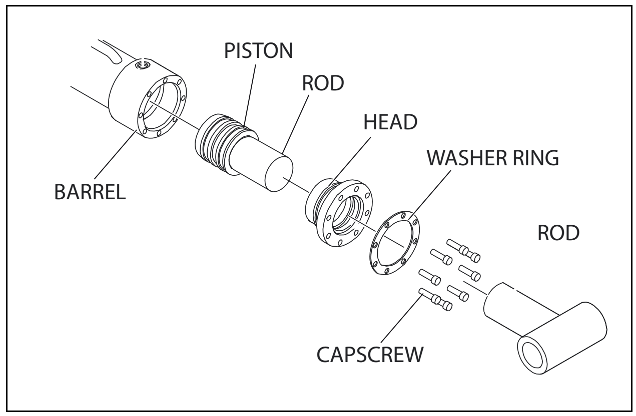


Figure 5-14. Rod Assembly Installation

18. Apply JLG Threadlocker P/N 0100011 to the socket head capscrews and secure the cylinder head gland using the capscrews. Torque capscrews to 55 ft. lbs. (75 Nm).
19. 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.
20. Install the counterbalance valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 30-35 ft. lbs. (41-47 Nm).
21. Install the bleeder valve in the rod port block. Torque to 12-15 ft. lbs. (16-20 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 relief valve, plugs, and fittings. Discard the o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

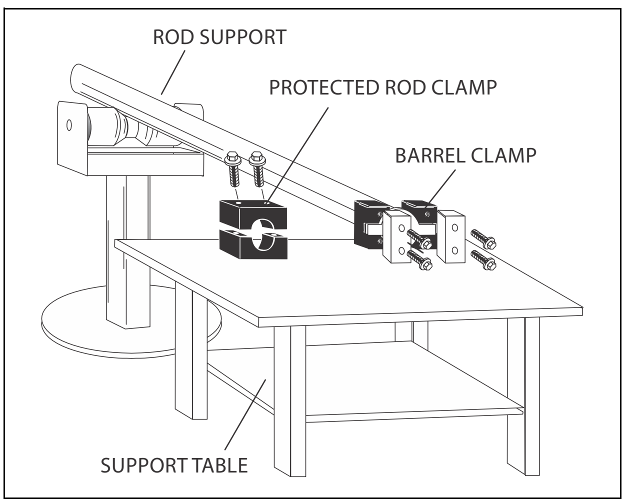


Figure 5-15. Cylinder Barrel Support

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

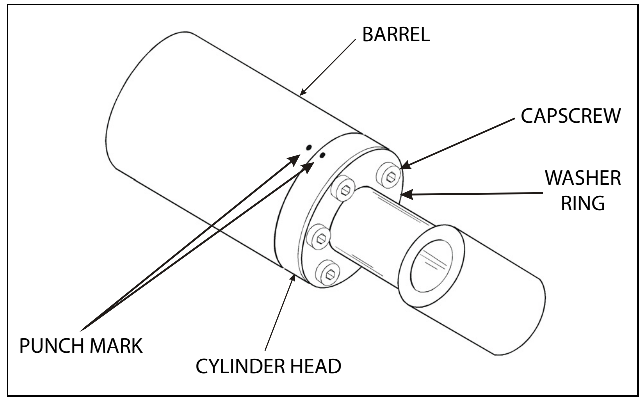


Figure 5-16. Capscrew Removal

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.

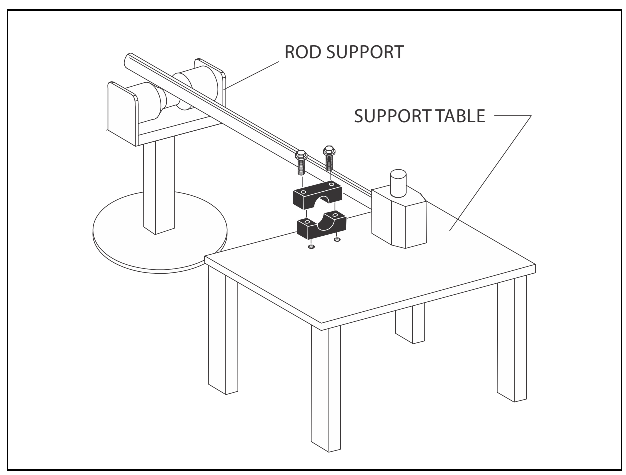
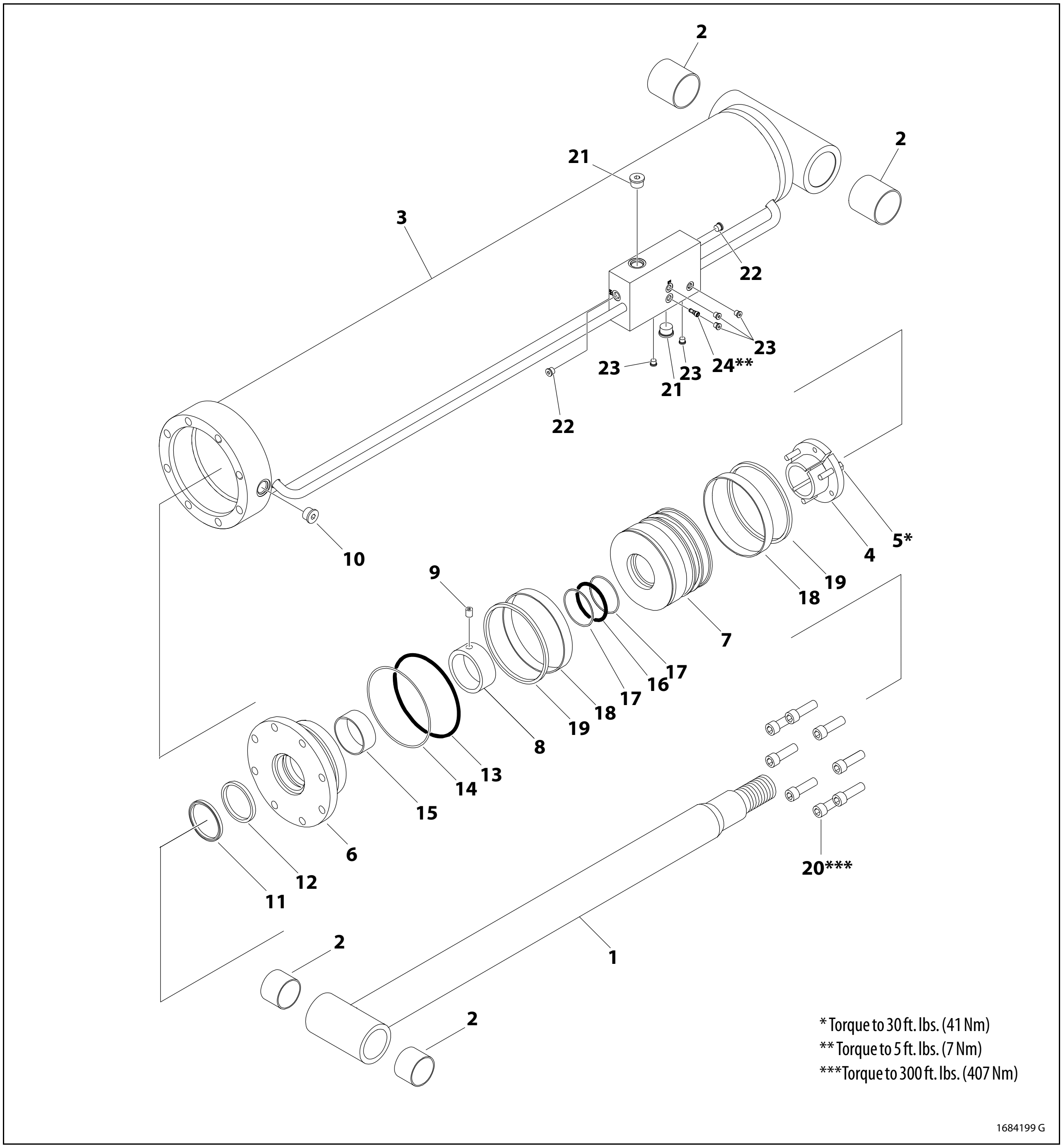


Figure 5-17. Cylinder Rod Support



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

Figure 5-18. 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.

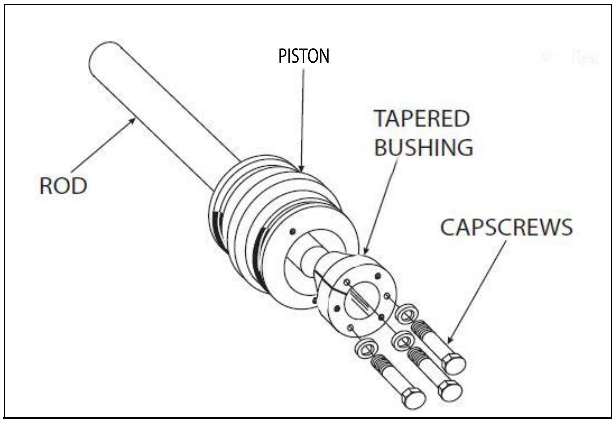


Figure 5-19. Tapered Bushing Removal

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

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

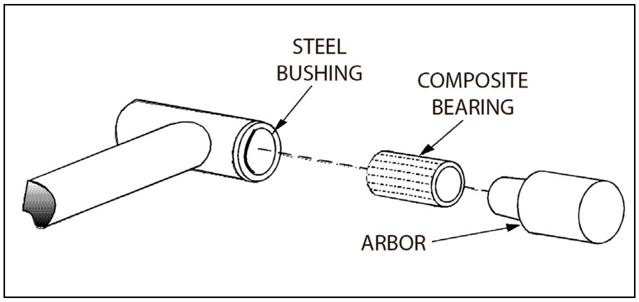


Figure 5-20. Composite Bearing Installation

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

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See the respective 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.

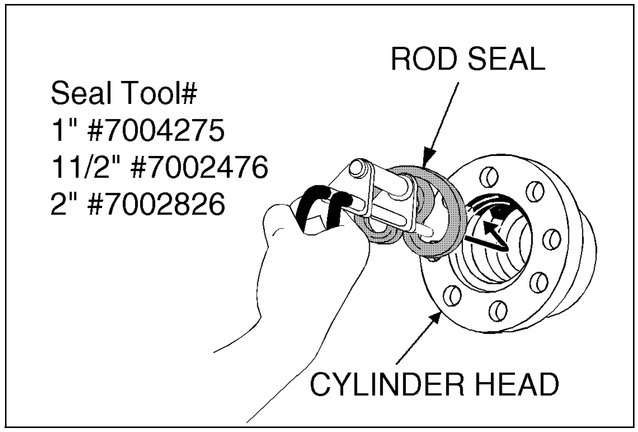


Figure 5-21. Rod Seal Installation

NOTICE

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

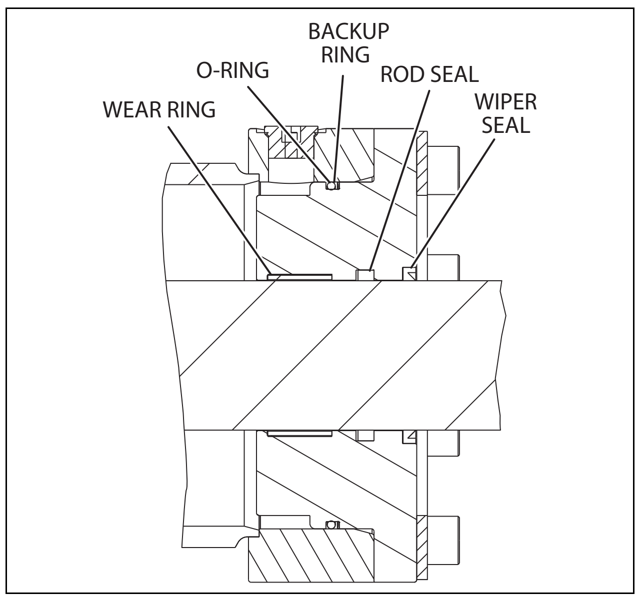
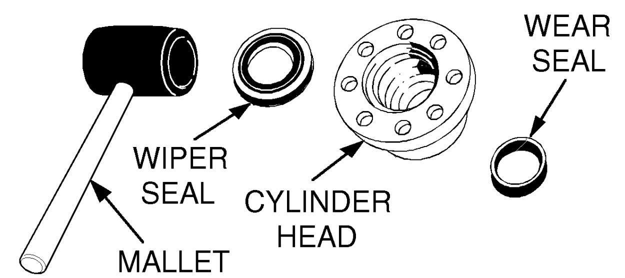


Figure 5-22. Cylinder Head Seal Installation

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.



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-23. Wiper Seal Installation

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

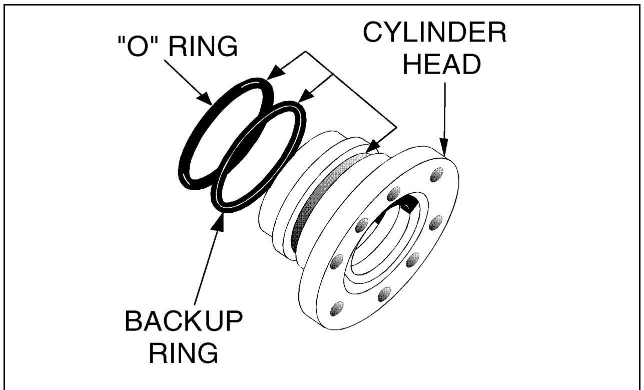


Figure 5-24. Installation of Head Seal Kit

4. 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 onto the rod.

NOTE: *Apply JLG Threadlocker P/N 0100011 on threads of setscrew before installation.*

6. Install setscrew onto the spacer.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
8. Place a new o-ring and backup rings in the inner piston diameter groove.
9. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.
10. Insert the tapered bushing into piston.

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.

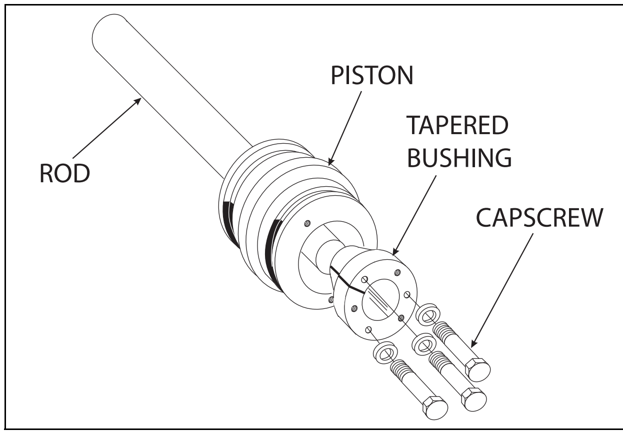


Figure 5-25. Tapered Bushing Installation

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

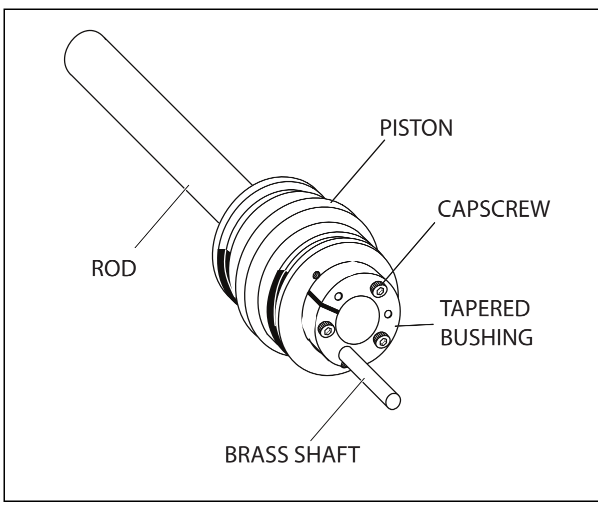


Figure 5-26. Seating the Tapered Bearing

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

15. Remove the cylinder rod from the holding fixture.

NOTICE

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

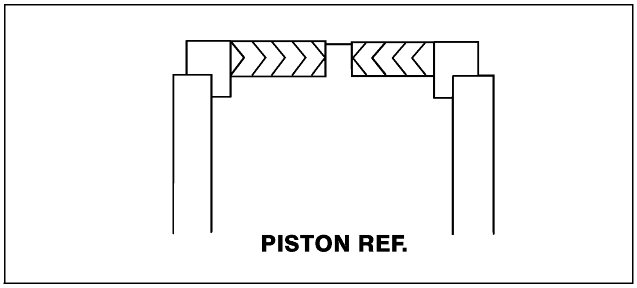


Figure 5-27. Hydrolock Piston Seal Installation

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).

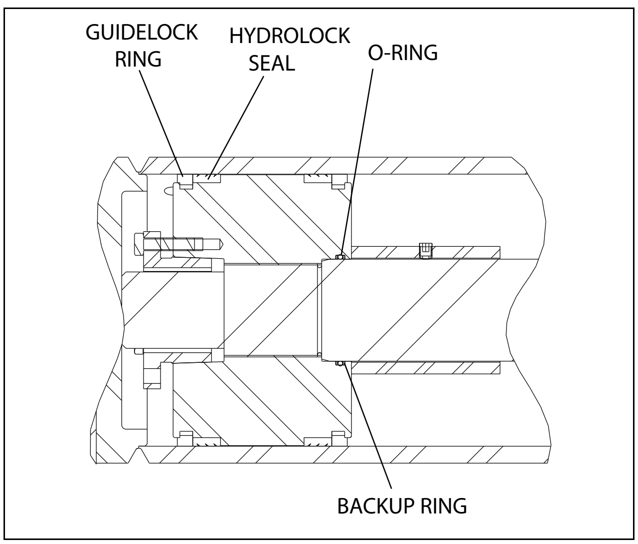


Figure 5-28. Piston Seal Kit Installation

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 secured and 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.

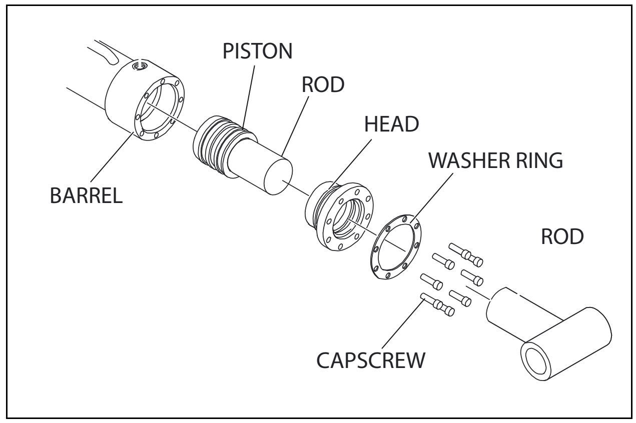


Figure 5-29. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the capscrews. Torque capscrews to 300 ft. lbs. (407 Nm).

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

22. Install the relief valve before installing the plug. Torque the relief valve to 5 ft. lbs. (7 Nm). Install the remaining plugs, using new o-rings as applicable.

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

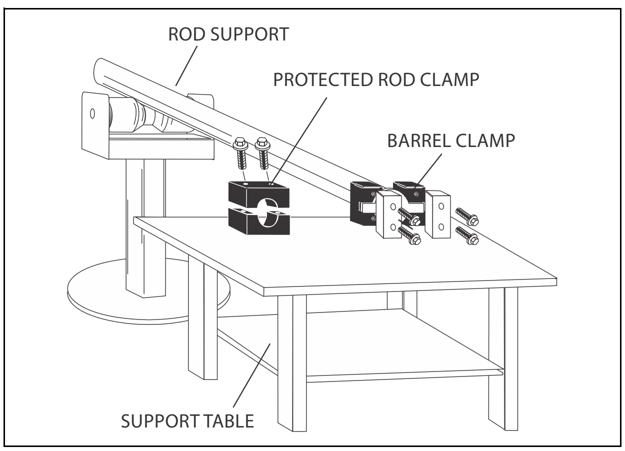


Figure 5-30. Cylinder Barrel Support

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.

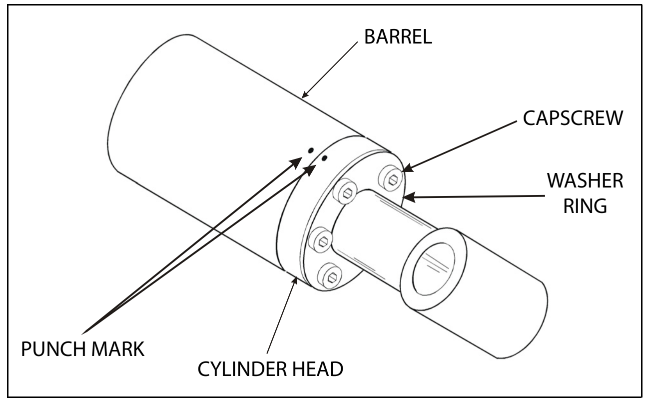


Figure 5-31. Capscrew Removal

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.

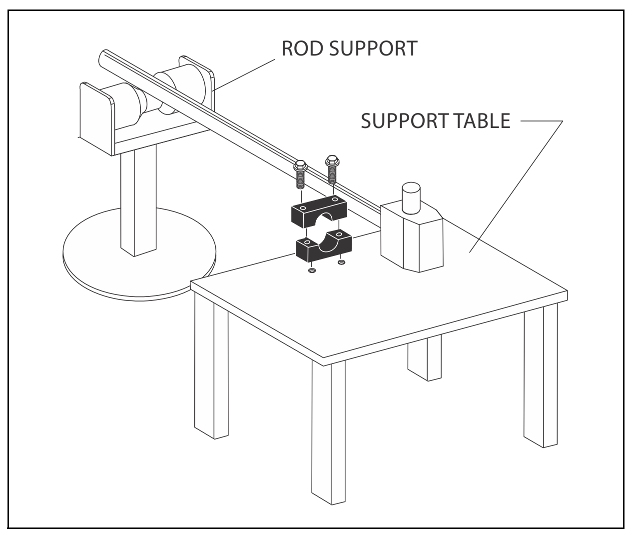
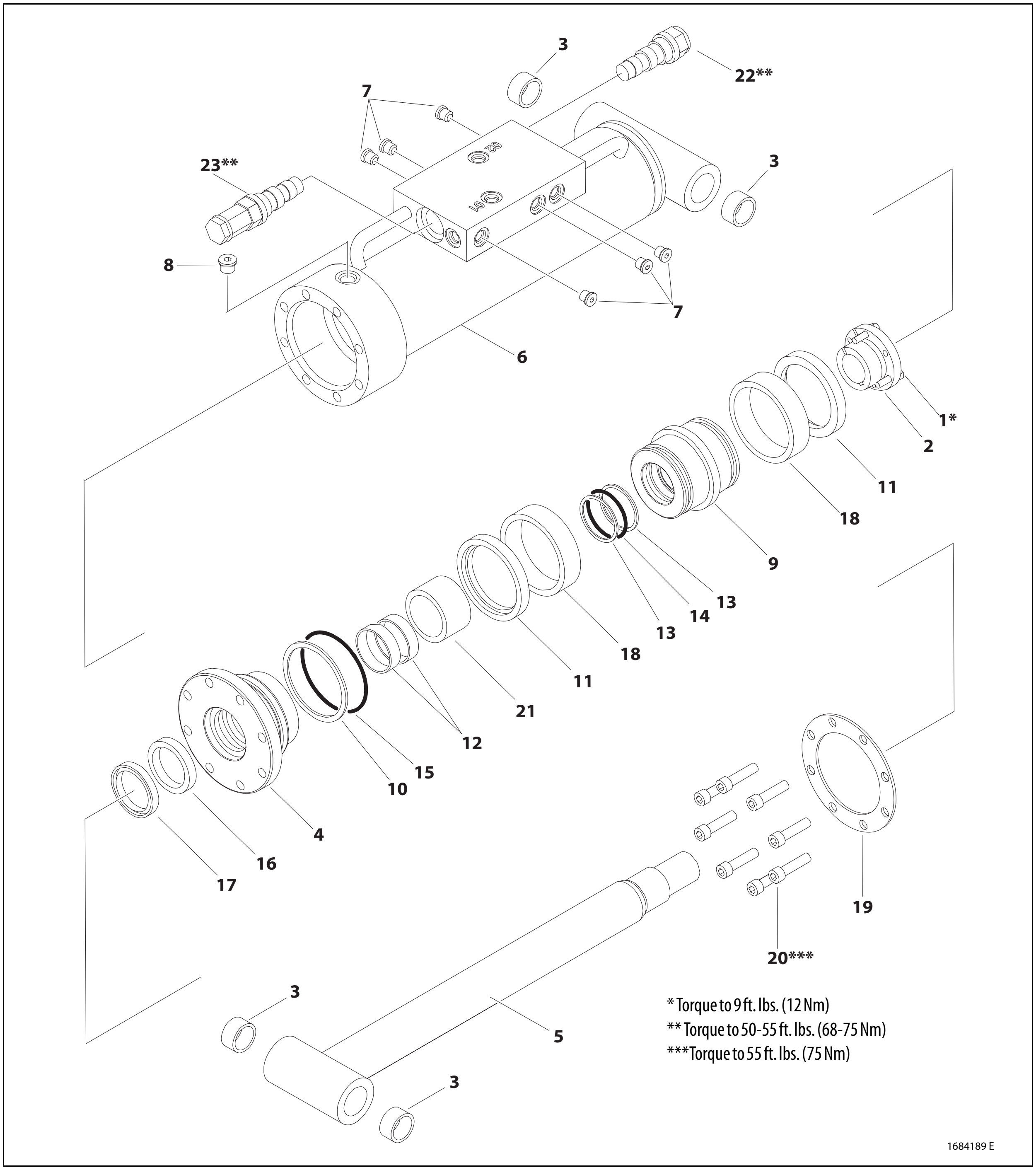


Figure 5-32. Cylinder Rod Support



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

Figure 5-33. Platform Level Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrews from drilled 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 loose on the piston.
11. Remove the bushing from the piston.

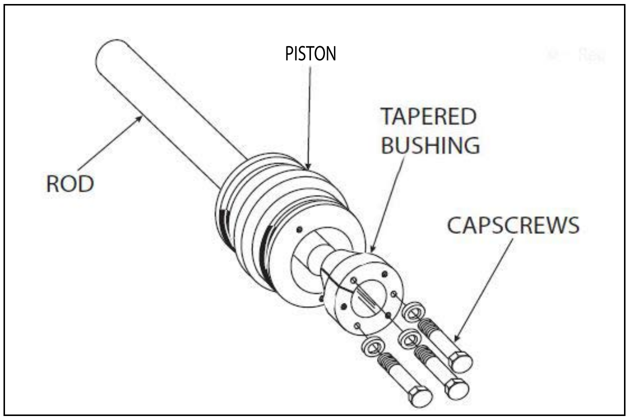


Figure 5-34. Tapered Bushing Removal

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

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

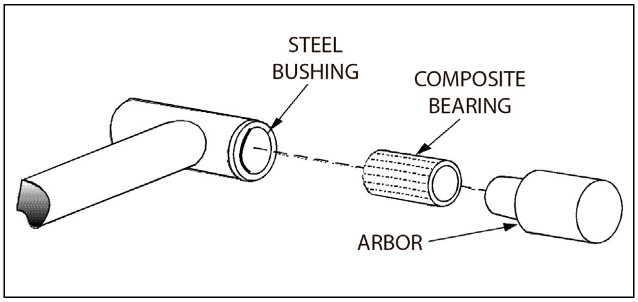


Figure 5-35. Composite Bearing Installation

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

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See the respective 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.

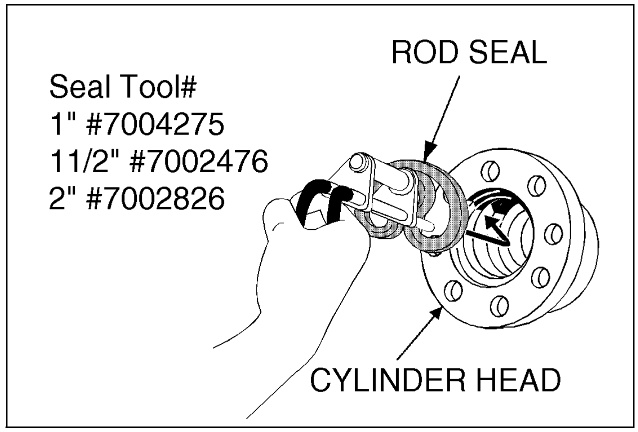


Figure 5-36. Rod Seal Installation

NOTICE

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

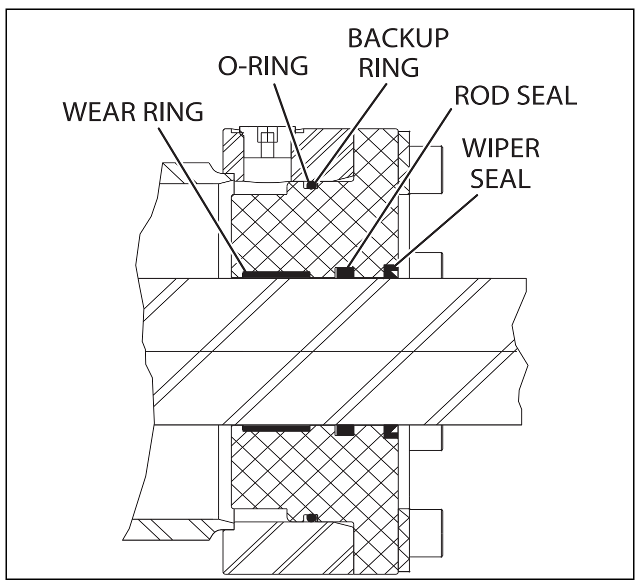
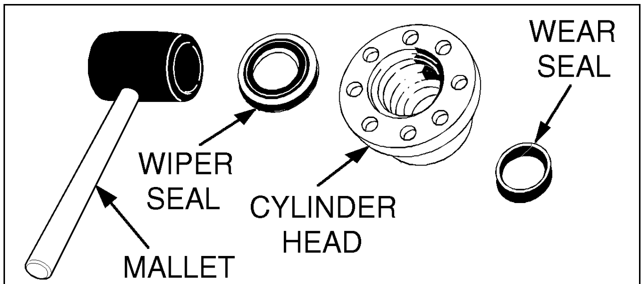


Figure 5-37. Cylinder Head Seal Installation

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



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-38. Wiper Seal Installation

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

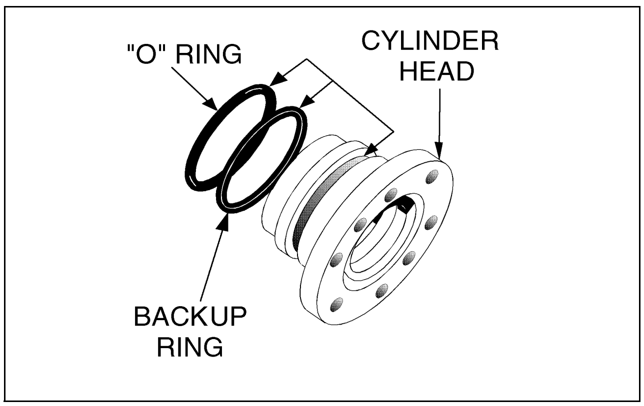


Figure 5-39. Installation of Head Seal Kit

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

5. Carefully slide the piston spacer on the rod.

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

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

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

9. Insert the tapered bushing into piston.

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.

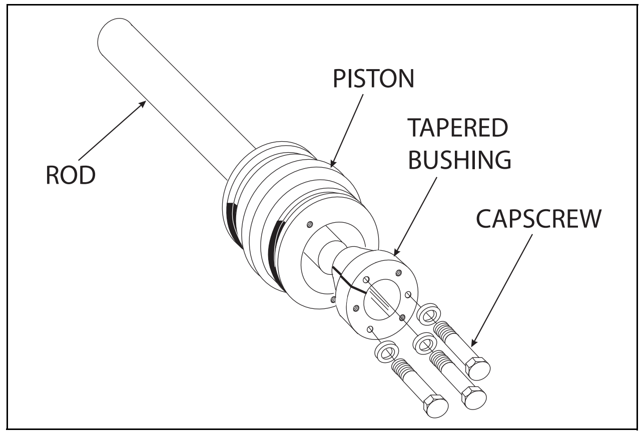


Figure 5-40. Tapered Bushing Installation

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

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

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

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

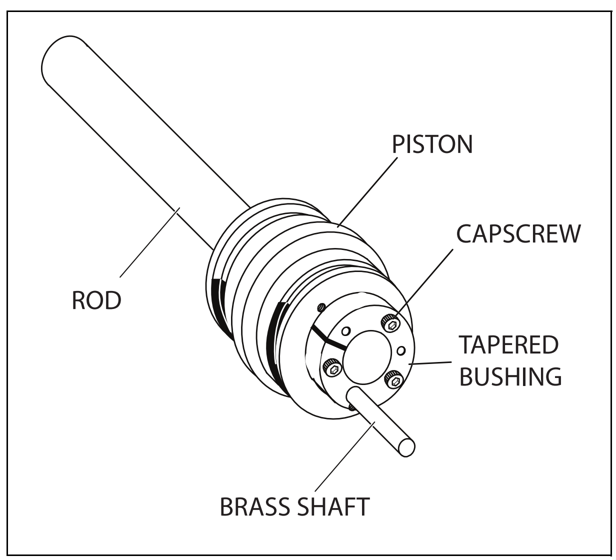


Figure 5-41. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 9 ft. lbs. (12 Nm).
14. Remove the cylinder rod from the holding fixture.

NOTICE

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

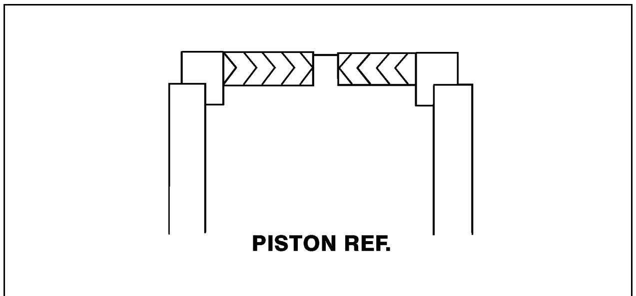


Figure 5-42. Hydrolock Piston Seal Installation

15. Place new hydrolock seal 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).

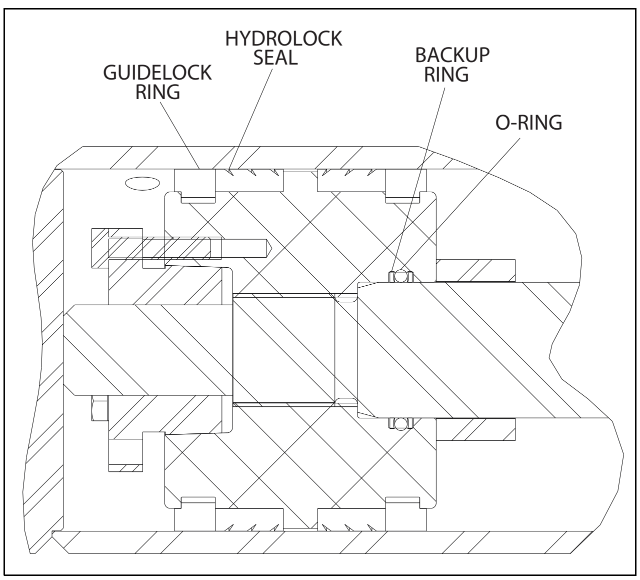


Figure 5-43. Piston Seal Kit Installation

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 secured and adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading guidelock rings and hydrolock seals are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

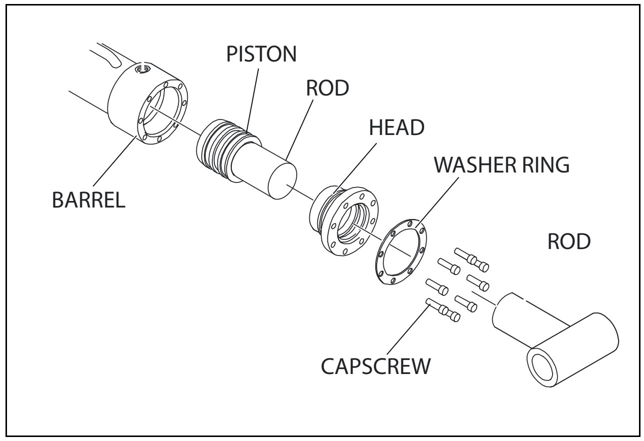


Figure 5-44. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and 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 reinstallation of any holding valve or valves.
21. 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).

Steer Cylinder (Prior to SN 0300142666)

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.

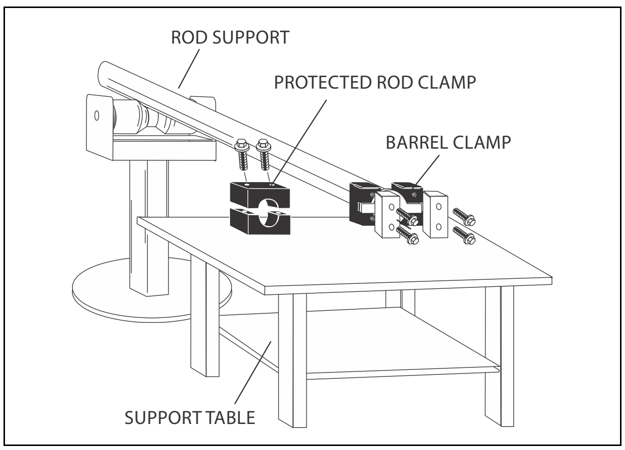


Figure 5-45. Cylinder Barrel Support

4. Using a hook Spanner, loosen the spanner nut and remove spanner nut from cylinder barrel.

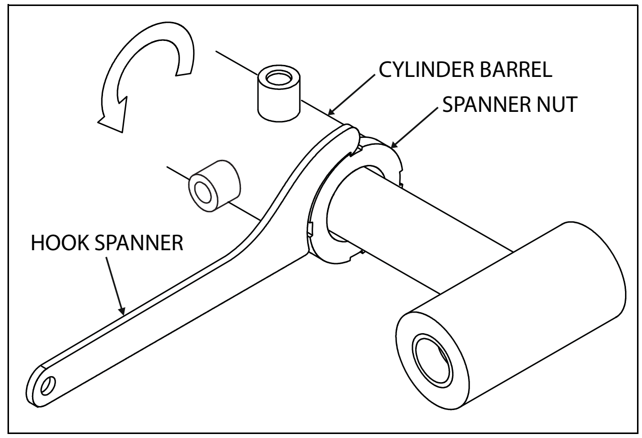


Figure 5-46. Spanner Nut Removal

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.

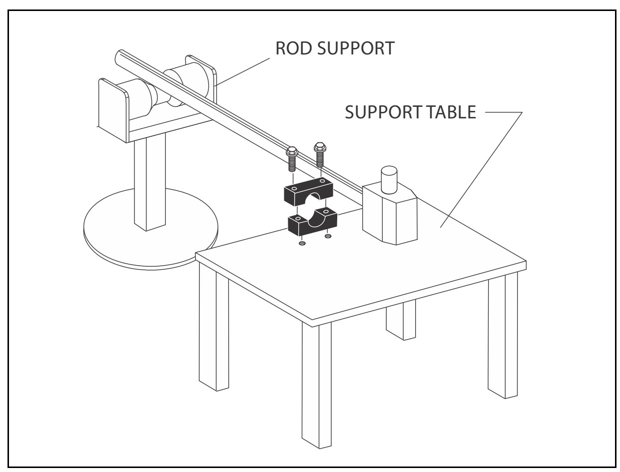
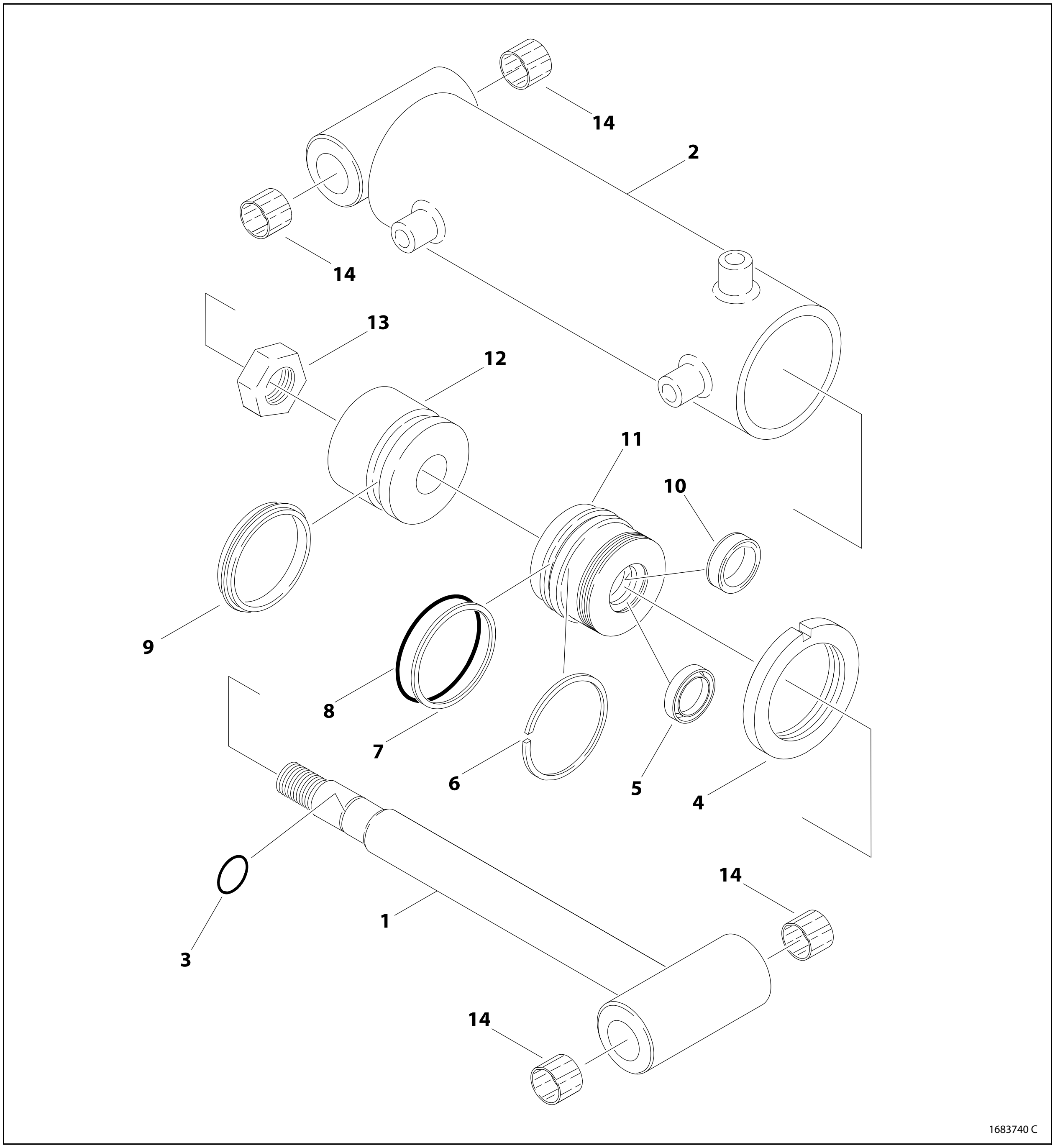


Figure 5-47. Cylinder Rod Support



1. Rod	6. Retainer Ring	11. Head
2. Barrel	7. Backup Ring	12. Piston
3. O-Ring	8. O-Ring	13. Locknut
4. Spanner Nut	9. Seal	14. Bushing
5. Wiper Seal	10. Rod Seal	

Figure 5-48. Steer Cylinder (Prior to SN 0300142666)

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 o-rings and seal rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seal, retainer 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, tapering, ovality or other damage. Replace if 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, tapering or ovality other damage. Replace if necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

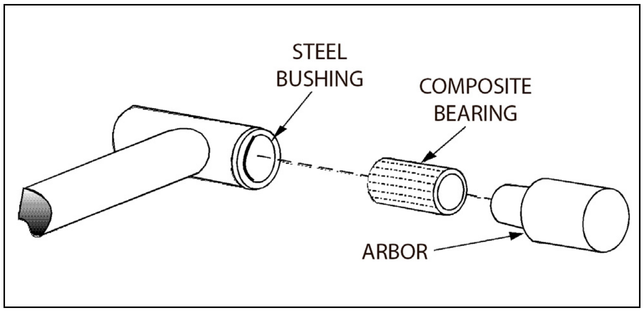


Figure 5-49. Composite Bearing Installation

12. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
13. Inspect piston rings for cracks or other damage. Replace if necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See the respective 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.

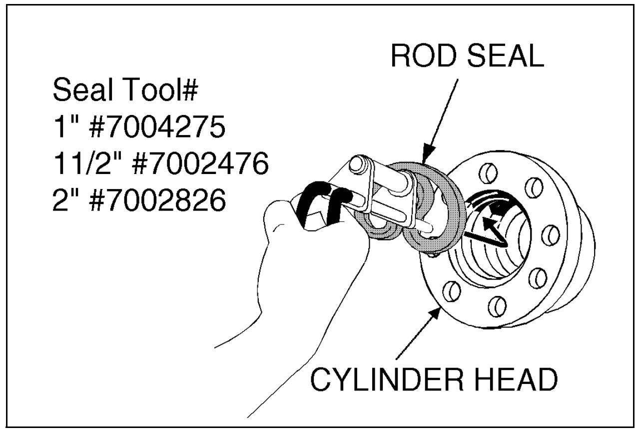


Figure 5-50. Rod Seal Installation

NOTICE

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

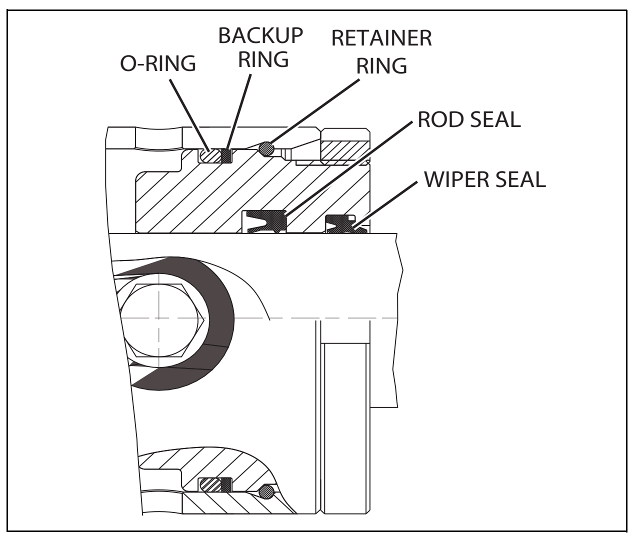


Figure 5-51. Cylinder Head Seal Installation

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

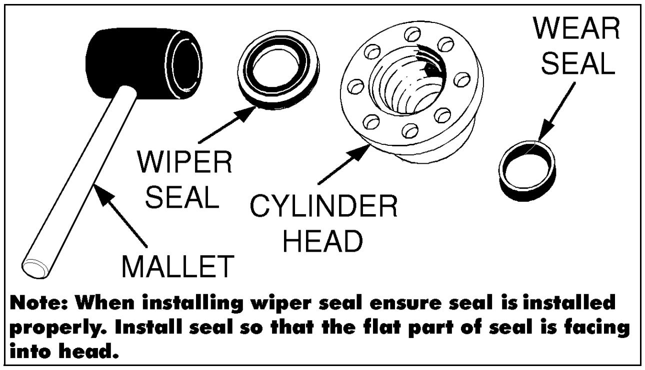


Figure 5-52. Wiper Seal Installation

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

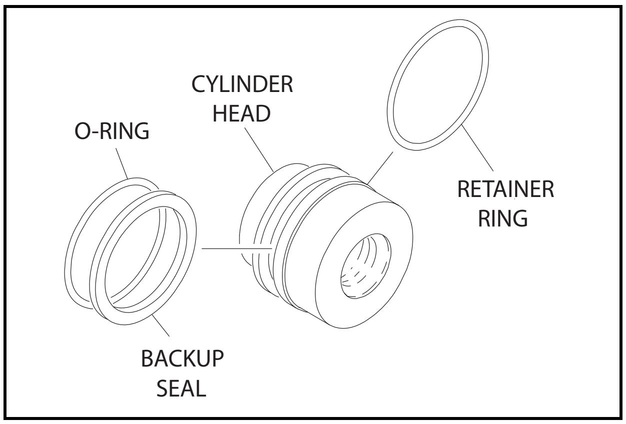


Figure 5-53. Installation of Head Seal Kit

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring is not damaged or dislodged.
7. Install locknut onto the piston rod.
8. Remove the cylinder rod from the holding fixture.
9. Place new seals in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

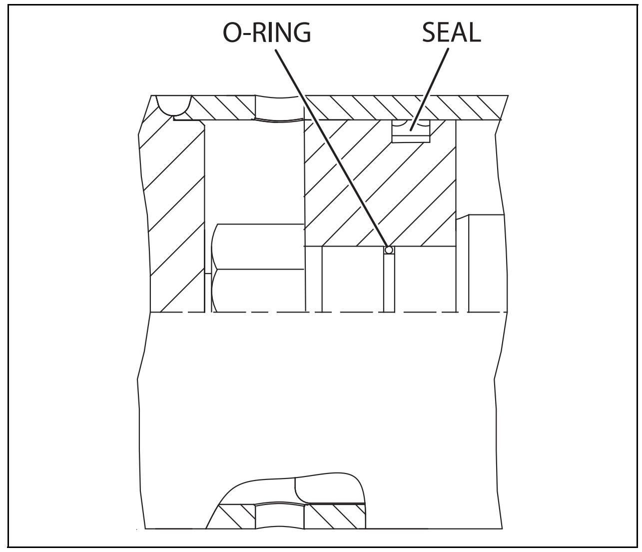


Figure 5-54. Installation of Piston Seal Kit

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 secured and adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
12. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
13. Secure the cylinder head gland using the spanner nut and tighten.
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.

NOTE: **Steer cylinder spanner nut is tightened as per Spec. "CYR" Cylinder spanner nut tightening procedure. Pressurize cylinder on retract to 80/100 psi to push rod guide firmly against the round retaining ring. (Apply 1 drop of JLG Threadlocker P/N 0100011, 2 places, at 180° apart. Hand tighten nut, then tighten 1/4 turn with spanner wrench).*

Steer Cylinder (SN 0300142666 through 0300189340)

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.

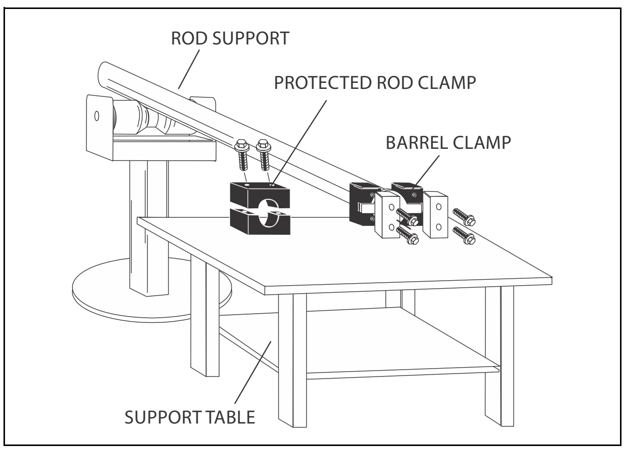


Figure 5-55. Cylinder Barrel Support

4. Using a hook Spanner, loosen the spanner nut and remove spanner nut from cylinder barrel.

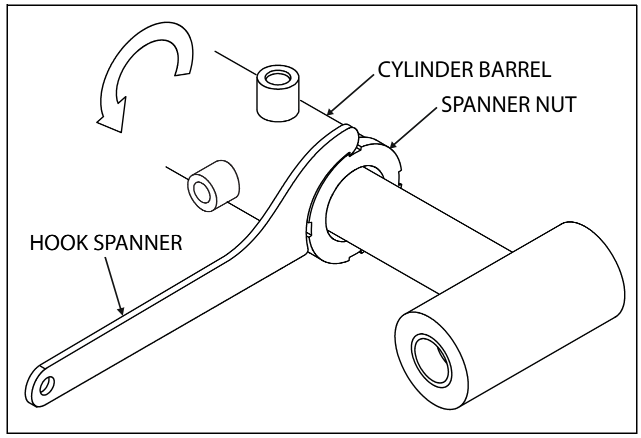


Figure 5-56. Spanner Nut Removal

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.

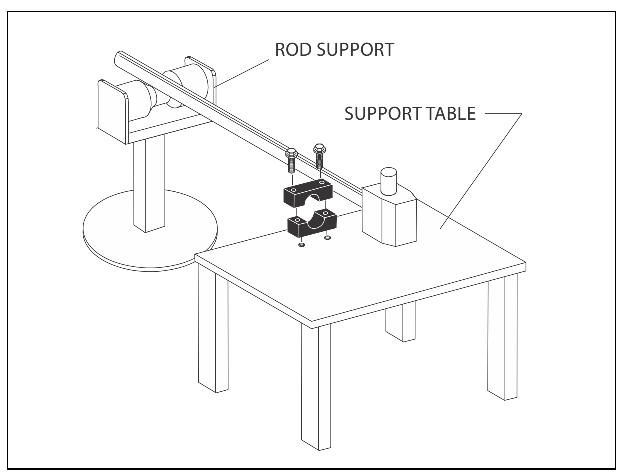
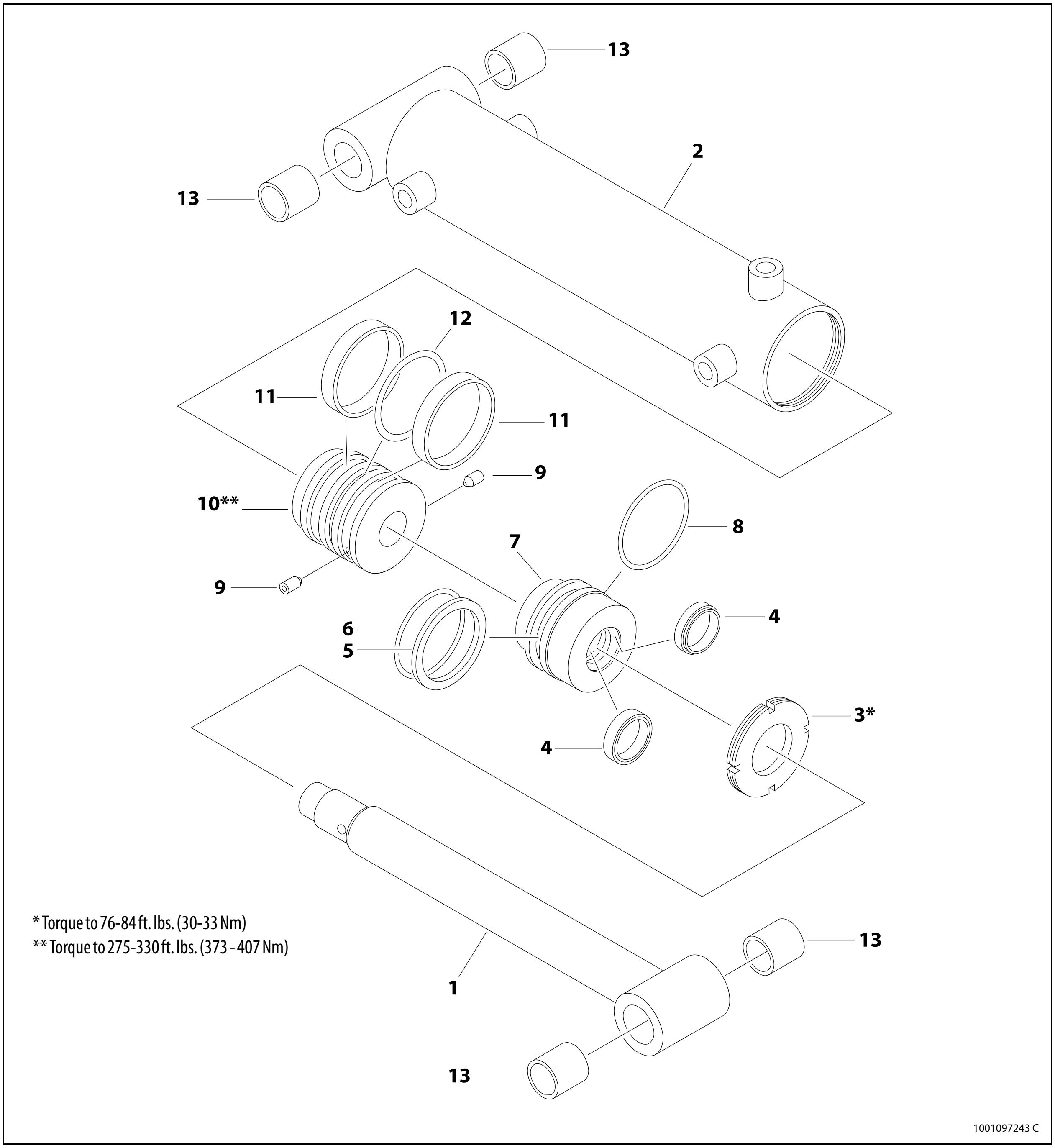


Figure 5-57. Cylinder Rod Support



1. Rod
2. Barrel
3. Spanner Nut
4. Seal
5. Backup Ring
6. O-Ring
7. Head
8. Retainer Ring
9. Setscrew
10. Piston
11. Seal
12. Seal
13. Bushing

Figure 5-58. Steer Cylinder (SN 0300142666 through 0300189340)

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Loosen and remove setscrew which attaches the piston to the rod.
9. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
10. Remove and discard the piston o-rings and seal rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seal, retainer 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, tapering, ovality or other damage. Replace if 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, tapering or ovality other damage. Replace if necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

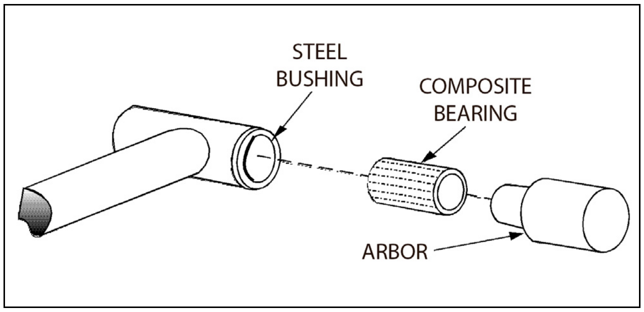


Figure 5-59. Composite Bearing Installation

12. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
13. Inspect piston rings for cracks or other damage. Replace if necessary.

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See the respective 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.

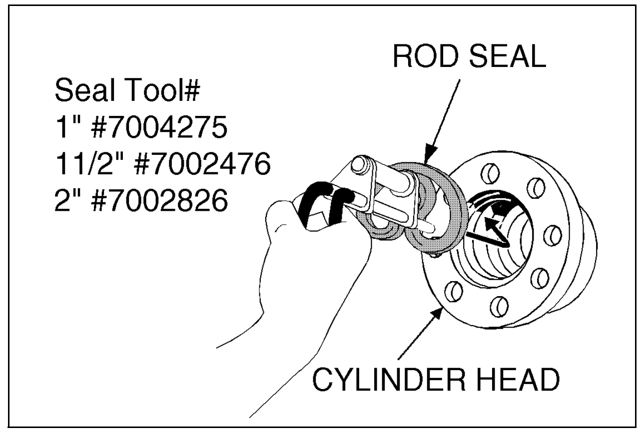


Figure 5-60. Rod Seal Installation

NOTICE

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

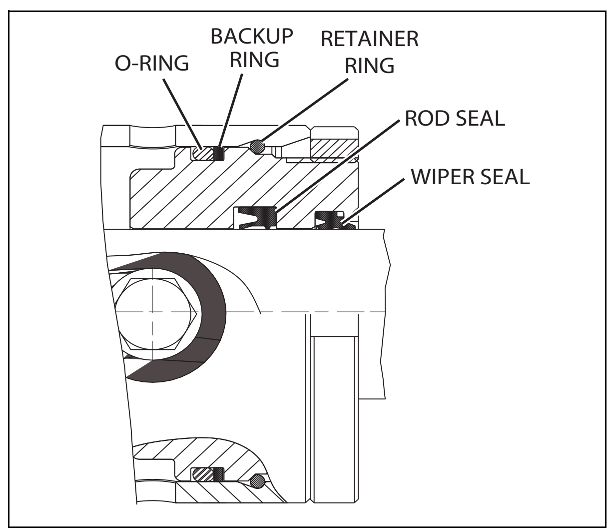
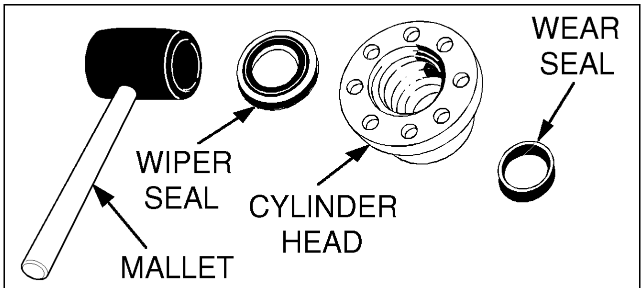


Figure 5-61. Cylinder Head Seal Installation

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



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-62. Wiper Seal Installation

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

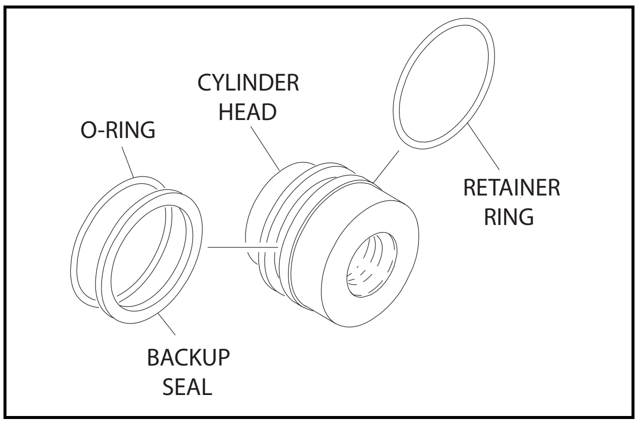


Figure 5-63. Installation of Head Seal Kit

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

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

6. Carefully thread the piston on the cylinder rod and hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged. Torque the piston to 76-84 ft. lbs. (30-33 Nm).

7. Install the setscrews which attach the piston to the rod and tighten.

8. Remove the cylinder rod from the holding fixture.

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

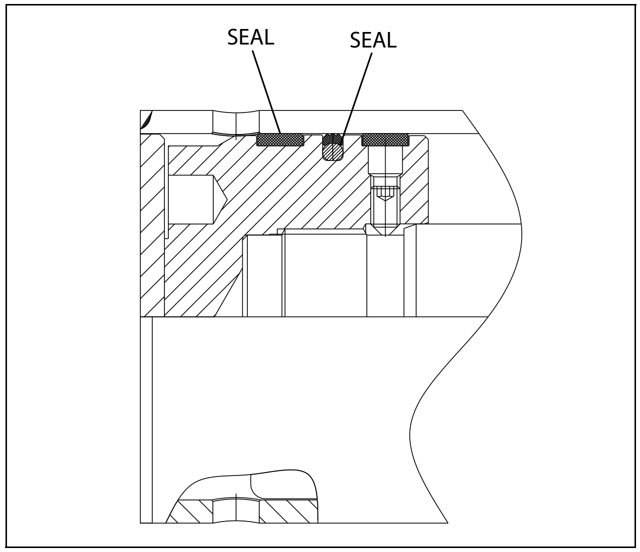


Figure 5-64. Installation of Piston Seal Kit

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 secured and adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

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

13. Secure the cylinder head gland using the spanner nut. Torque to 275-330 ft. lbs. (373- 407 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.

NOTE: **Steer cylinder spanner nut is tightened as per Spec. "CYR" Cylinder spanner nut tightening procedure. Pressurize cylinder on retract to 80/100 psi to push rod guide firmly against the round retaining ring. (Apply 1 drop of JLG Threadlocker P/N 0100011, 2 places, at 180° apart. Hand tighten nut, then tighten 1/4 turn with spanner wrench).*

STEER CYLINDER SEAL REPAIR INSTRUCTIONS

1. The cylinder should be disassembled in a clean environment to prevent dirt or other contamination from entering the interior of the cylinder. Clean any accumulated dirt or debris from the port openings and guide area. Remove the port plugs and drain oil from the cylinder. Do not reinstall the port plugs at this time. No special tools are required for disassembly, but snap ring pliers would ease removal of the snap ring that retains the rod guide. Items that should be at hand are a vise, Flat punch, hammer, rubber hammer, clean oil, and a wrench for removal of the piston nut. A piston ring compressor is suggested for resizing new teflon piston seals used in some cylinders.

2. Secure in vise at approximately the mid-point of the cylinder wall. Do not tighten vise excessively, the wall may be distorted.

3. If the steer cylinder has a retaining plate on front of the rod guide, remove the capscrews and dismount the retaining plate. Remove the retaining ring with snap ring pliers. If the steer cylinder has an external spiral retaining ring ahead of the rod guide internal retaining ring, carefully remove both rings.

4. Pull the rod vigorously outward and allow the piston to bump the rod guide. The momentum of the rod should be sufficient to pull the rod guide an piston from the cylinder barrel. Be careful not to mar the chromed surface rod.

NOTE: *The piston seal and rod guide static seal will likely be cut on removal from the barrel. This is normal and cannot be avoided on disassembly.*

5. Being careful not to mar the chromed surface, secure the rod so that the piston nut can be removed. Remove the piston nut, piston, spacer tube (if any) and rod guide.

NOTE: *The position and orientation of the seals before replacing them.*

6. Be careful not to scratch the seal grooves when removing the old seals. The seals can be removed with a sharp tool like an awl by carefully pushing the point partially into the seal and prying the seal from the groove. Carefully cutting the seal apart with an Xacto knife will also ease removal.

7. Inspect the seal grooves and clean away any contamination. Apply a thin coating of clean oil to the new seals to ease installation and prevent scuffing of the sealing surfaces.

8. If the cylinder utilizes a teflon piston seal, special care must be taken when installing the new seal. Teflon seals are not as elastic as rubber or urethane seals. Teflon seals should not be stretched excessively because they may break or the cross section may be permanently reduced to the point that the teflon ring may not seal. One suggested method of installation is to work about half of the seal into the groove with a shoe string or fat nylon tie looped inside the rings inside diameter. The string or tie can be used to lift and guide the teflon ring into the groove (the o-ring expander ring must be installed first). When the teflon ring is nearly all the way in the groove, the string or tie can be pulled free. Warming the teflon ring will make it more pliable and will ease the installation process. Once the teflon seal is positioned in the groove it must be resized so that it is uniform contact with the o-ring expander underneath. This can be accomplished with properly sized piston ring compressor. If equipment and material are available, a cone shaped resizing die could be fabricated for installation purposes.

9. Assemble the guide and piston on the rod. Be sure to slip the retaining plate (if used) and snap ring on the rod ahead of the guide and piston if they cannot pass over the rod mount. Install and tighten the piston nut to required torque.

10. Apply a light coating of clean oil to the piston and guide O.D. and mouth of the cylinder barrel. Carefully insert the piston into the wall and push the rod assembly into the bore. When the piston is located approximately half way down the bore, carefully position the rod guide with the barrel mouth and push the guide down the bore so that the front face of the guide clears the snap ring groove. Be careful not to mar the chromed rod surface. The guide may have to be driven down the bore with a punch or wooden dowel and hammer. Install the rod guide retaining snap ring and be certain that it is nested into the bottom of the groove all around. Install the outboard retaining plate or spiral ring if used.

11. Check cylinder for external leaks using rated hydraulic pressure. any leaks should be evident after the cylinder has been pressurized for one minute. Remove Pressure from cylinder. If the seals are oil tight, the cylinder is ready for service.

⚠ WARNING

KEEP AWAY FROM JETS OF HIGH PRESSURE OIL. HIGH PRESSURE OIL JETS CAN PENETRATE SKIN AND CAUSE SEVERE INJURY OR DEATH.

Telescope Cylinder

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

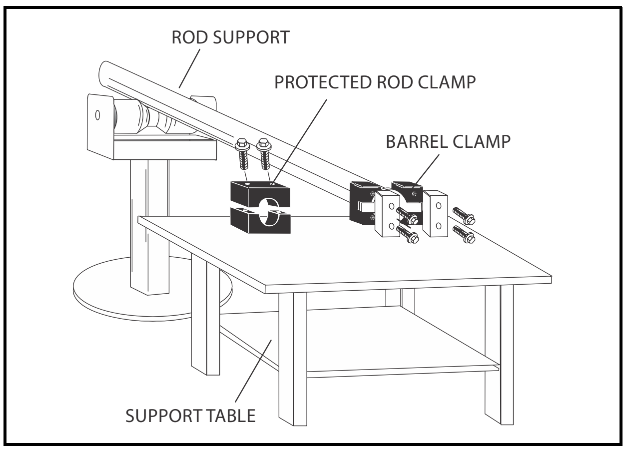


Figure 5-65. Cylinder Barrel Support

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.

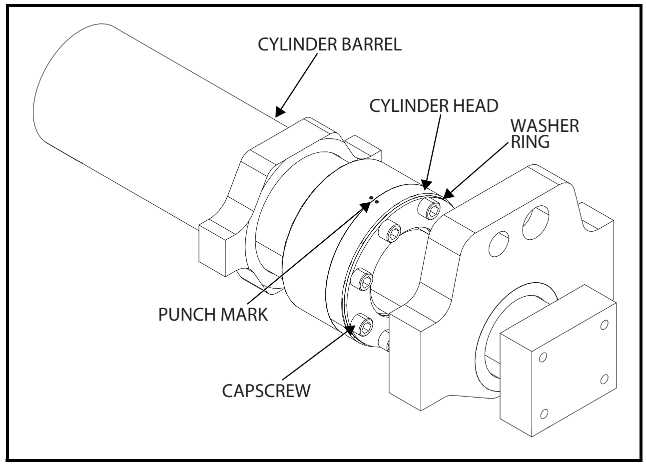


Figure 5-66. Capscrew Removal

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.

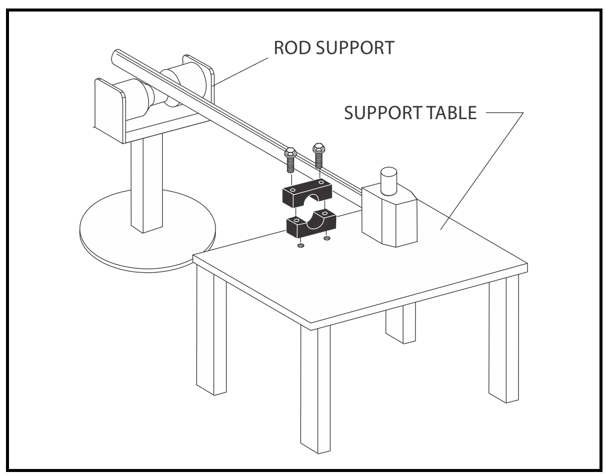
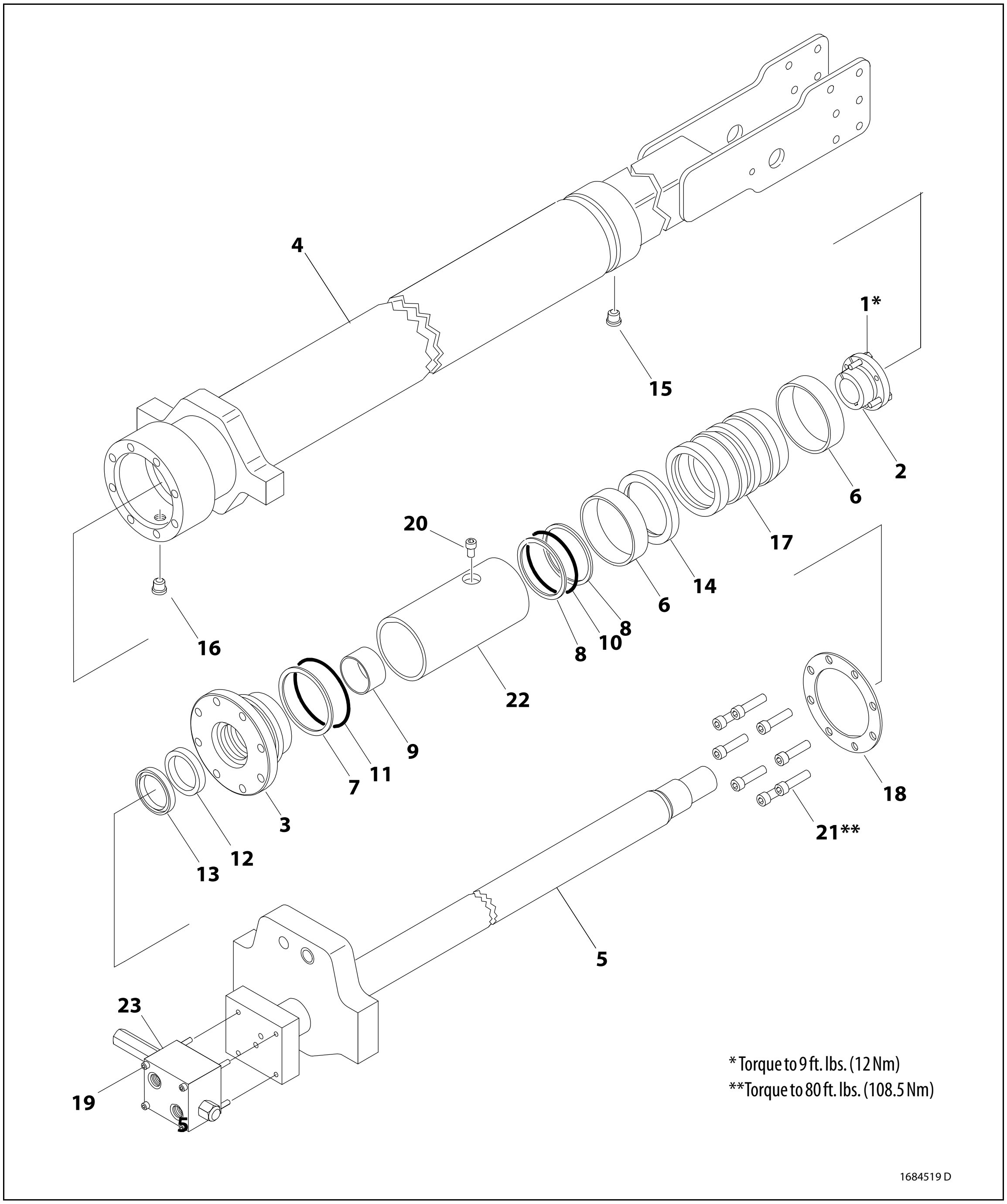


Figure 5-67. Cylinder Rod Support



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

Figure 5-68. 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.

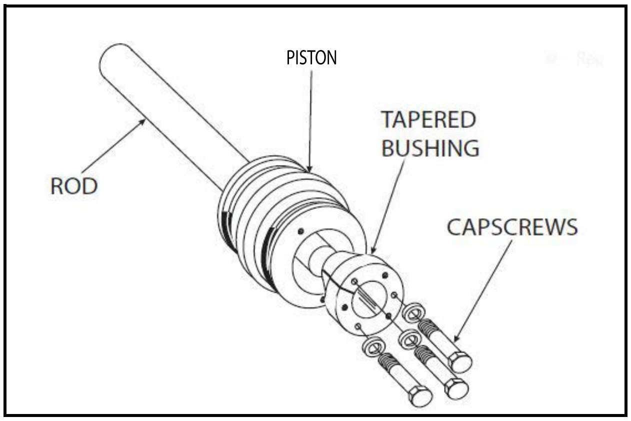


Figure 5-69. Tapered Bushing Removal

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

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. . Replace if 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, tapering, ovality or other damage. Replace if 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 inner side 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.*

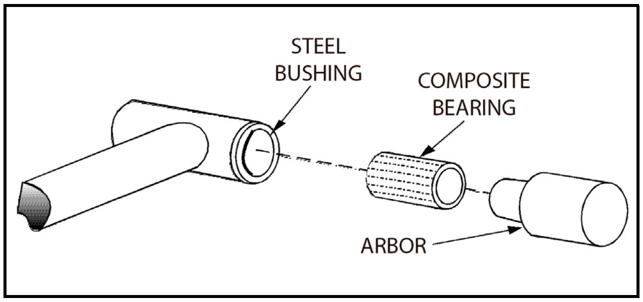


Figure 5-70. Composite Bearing Installation

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

ASSEMBLY

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See the respective 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.

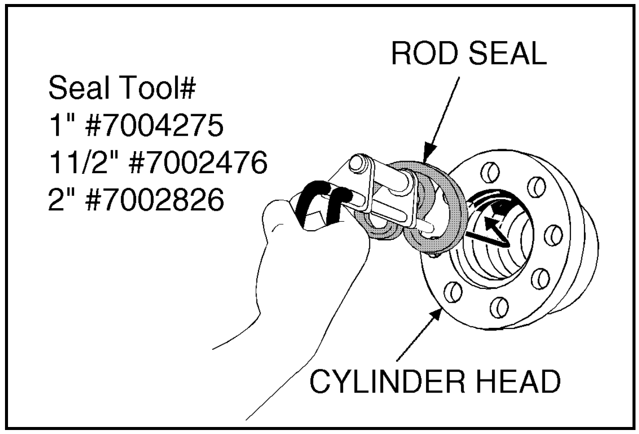


Figure 5-71. Rod Seal Installation

NOTICE

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

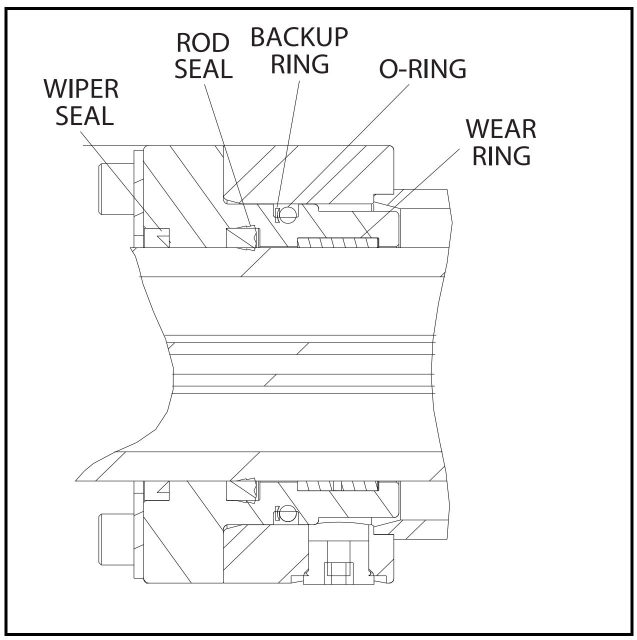


Figure 5-72. Cylinder Head Seal Installation

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.

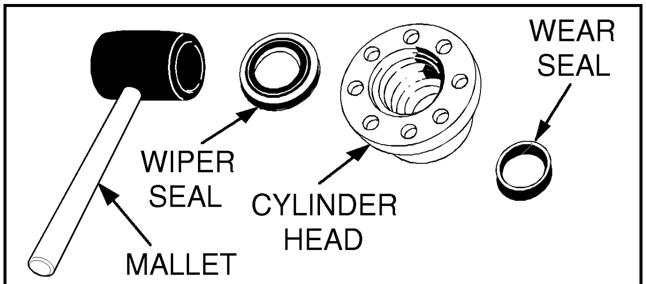


Figure 5-73. Wiper Seal Installation

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

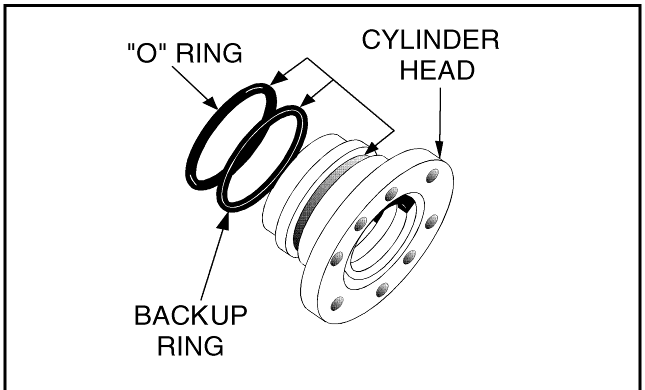


Figure 5-74. Installation of Head Seal Kit

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

5. Carefully slide the piston spacer on the rod.

NOTE: *Apply JLG Threadlocker P/N 0100011 on threads of setscrew before installation.*

6. Install setscrew onto the spacer.

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

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

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

10. Insert the tapered bushing into piston.

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.

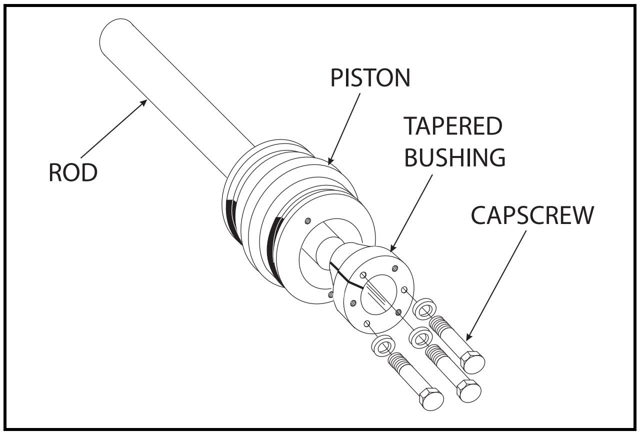


Figure 5-75. Tapered Bushing Installation

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

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

- **a.** Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
- **b.** Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

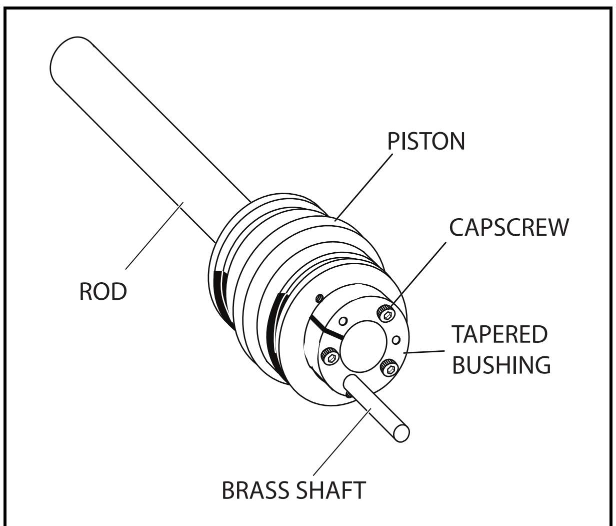


Figure 5-76. Seating the Tapered Bearing

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

15. Remove the cylinder rod from the holding fixture.

16. Place new 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).

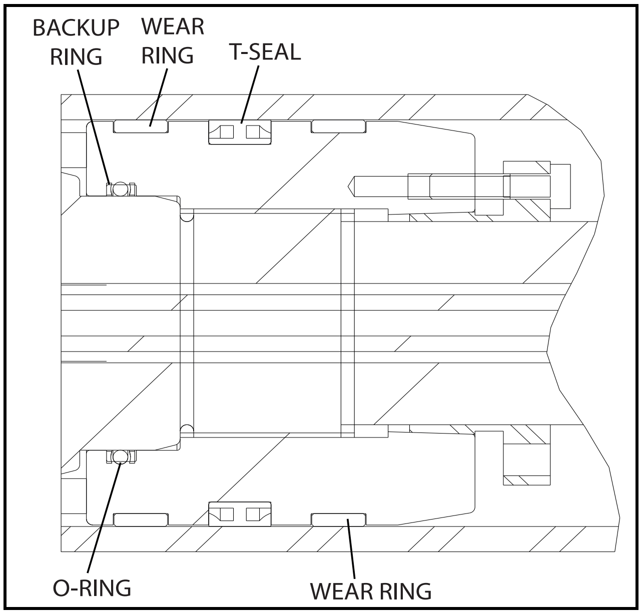


Figure 5-77. Piston Seal Kit Installation

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 secured, and 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.

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

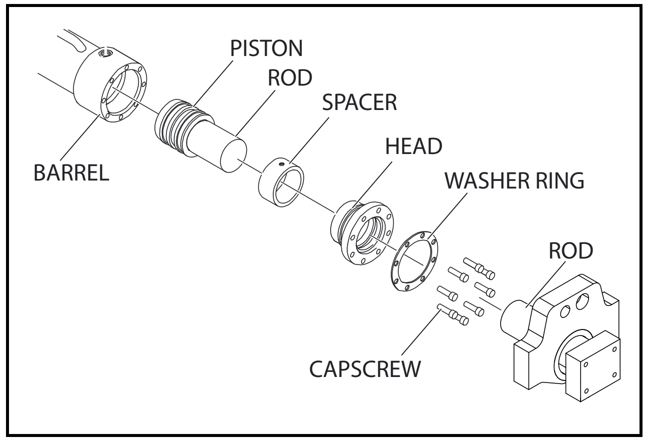
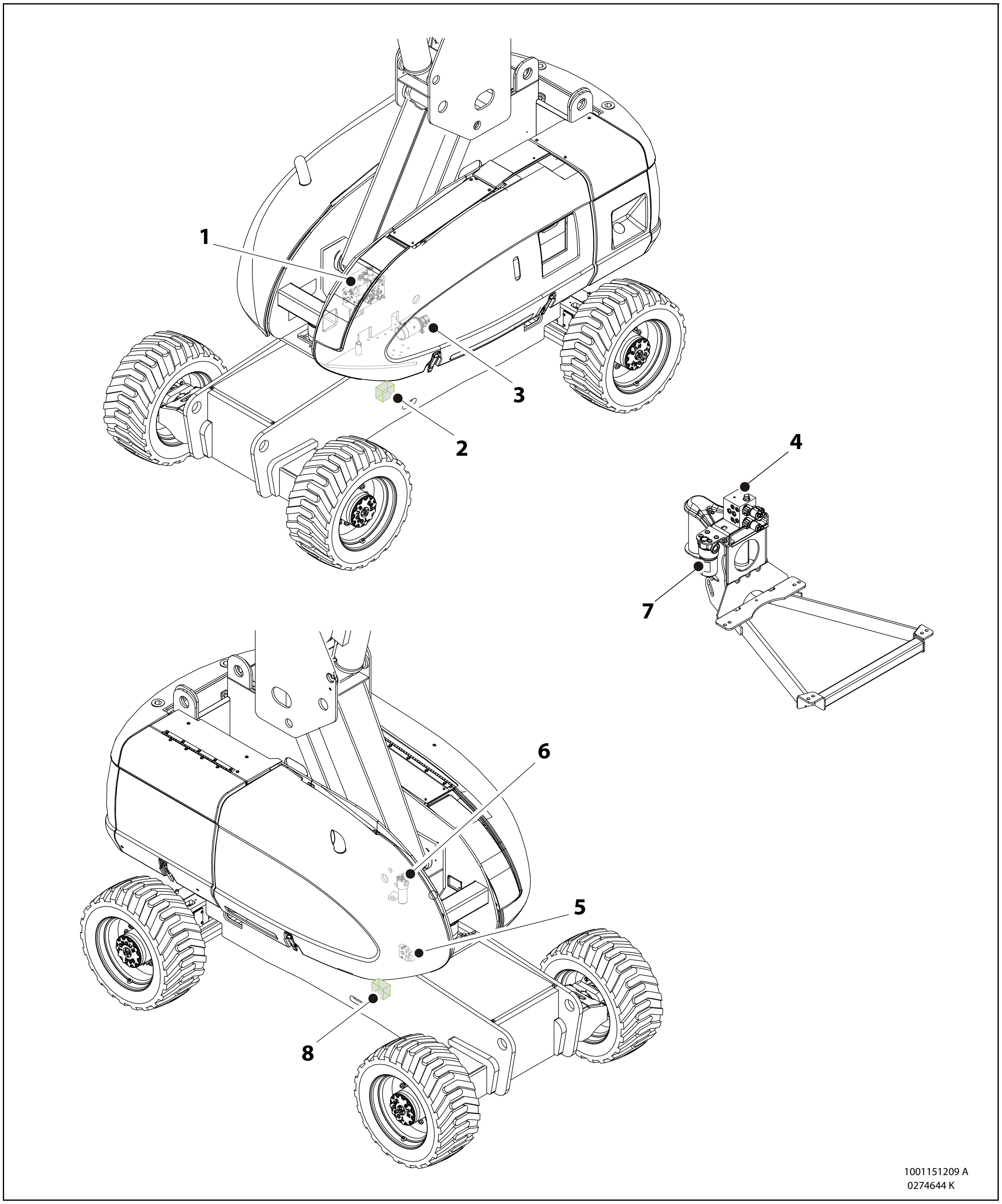


Figure 5-78. Rod Assembly Installation

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 55 ft. lbs. (75 Nm).

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

22. Install the valve assembly.



1. Main Control Valve	3. Auxiliary Pump	5. Dual Select Valve	7. High Pressure Filter
2. Flow Divider (4WD)	4. Platform Valve	6. Hydraulic Filter	8. Flow Divider (2WD)

Figure 5-79. Control Valve Installation

5.3 PRESSURE SETTING PROCEDURE

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

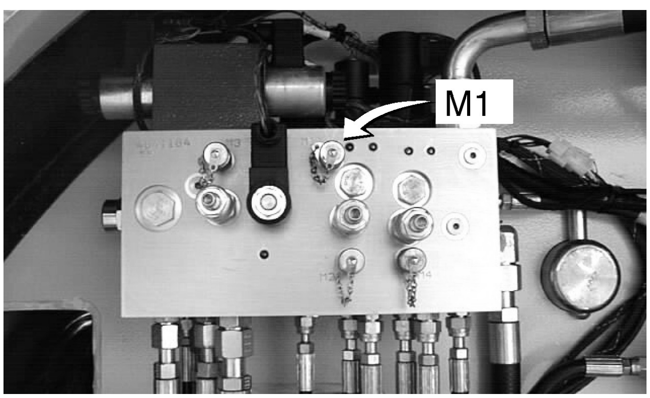
To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps in Section 5.4, Start Up Procedures must be followed.
2. Set up of the function pump.
3. Adjustments made at the main valve block.
4. Adjustments made at the platform valve.

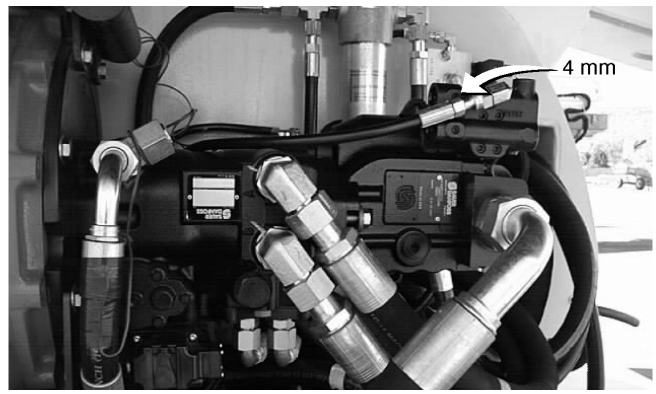
Set Up of the Function Pump

STAND BY PRESSURE OR LOAD SENSE PRESSURE

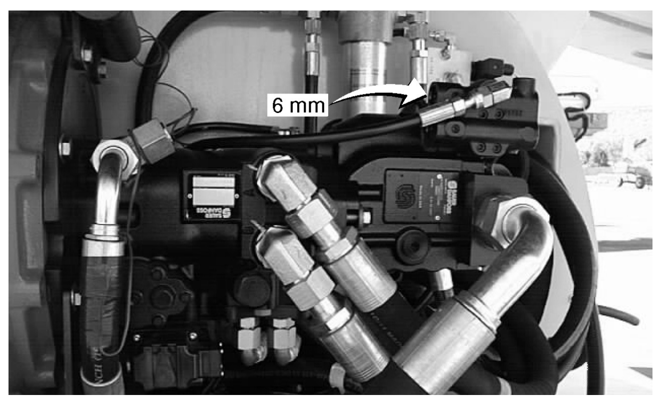
1. Install a low pressure gauge at port “M1” of the main valve block. A low pressure gauge capable of reading 500 psi (34.5 bar).



2. Start the engine from the ground control. The gauge should read between 400-440 psi (27.5 to 30 Bar). To make an adjustment to this pressure, go to the engine compartment and locate the function pump.
3. There are (2) adjustments at the top of the pump. They are located on the pump compensator which has (4) bolts mounting it to the pump. The stand by adjustment is at the top. To adjust this, a 4 mm and 6 mm allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.
   a. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.

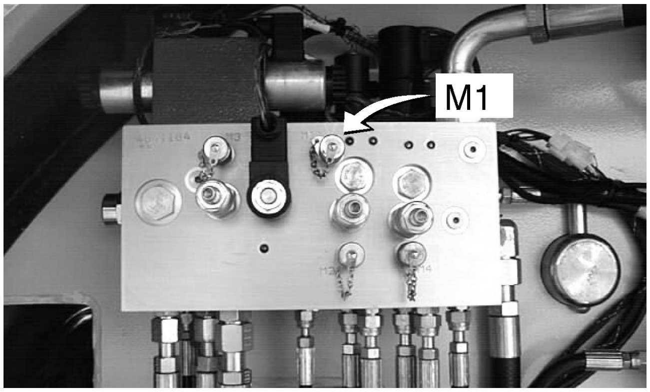


   b. Next, using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. The pressure should read between 400-440 psi (27.5 to 30 Bar).

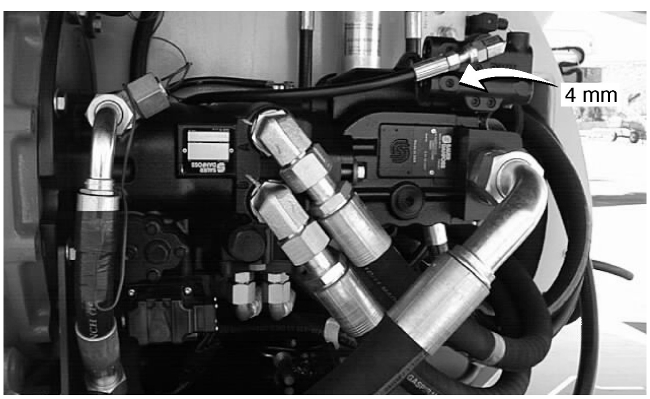


HIGH PRESSURE RELIEF

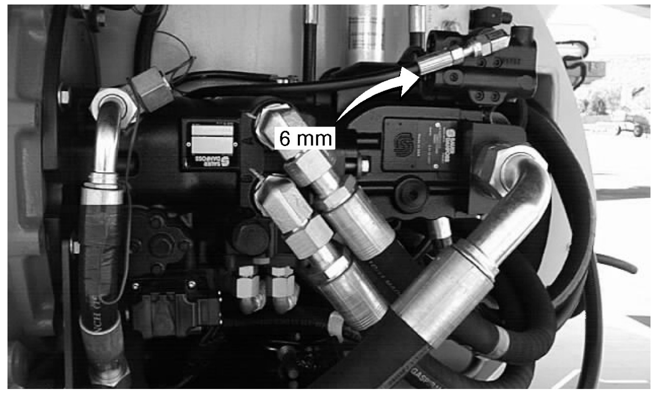
1. Install a high pressure gauge at the “M1” port of the main valve block.



2. Activate telescope in and hold. The gauge should read 2800 psi (179.3 bar).
3. To make an adjustment to this pressure, go back to the engine compartment to the function pump. The high pressure relief adjustment is the lower one of the (2) on the compensator. To adjust this, a 4 mm and 6 mm allen wrench will be needed. The adjustment screw is facing the shaft end of the pump, or toward the engine.
   a. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.



   b. Next, using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. This adjustment will be reset at the end of this procedure to 2500 psi (172.3 bar). This is the **maximum** relief pressure for all functions governed by this pump.



Adjustments Made at the Main Control Valve Block

TELESCOPE OUT

1. Install a high pressure gauge at the “M3” port of the main valve block.
2. Activate Telescope out. The gauge should read 2500 psi (172.3 Bar).
3. The relief valve is located directly below the M3 port. Turn clockwise to increase, counterclockwise to decrease.

SWING LEFT AND RIGHT

1. Lock the turntable lock pin.
2. Install the hi-pressure gauge at M2.
3. Activate swing, the gauge should read 1700 psi (117 Bar).
4. The adjustment cartridge is located right above the M2 port. Turn clockwise to increase, counterclockwise to decrease.

STEER

1. Install a high pressure gauge at port M4. Activate steer left or right. The gauge should read 2500 psi (172.3 bar).
2. The adjustment cartridge is located on the left face of the valve block.
3. There are two adjustable relief valves on this face. The steer relief is the lower one. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Platform Valve Assembly

NOTE: *When replacing the level up or level down cartridge, the function should be cycled, and then the crack pressure value calibrated.*

PLATFORM LEVEL UP

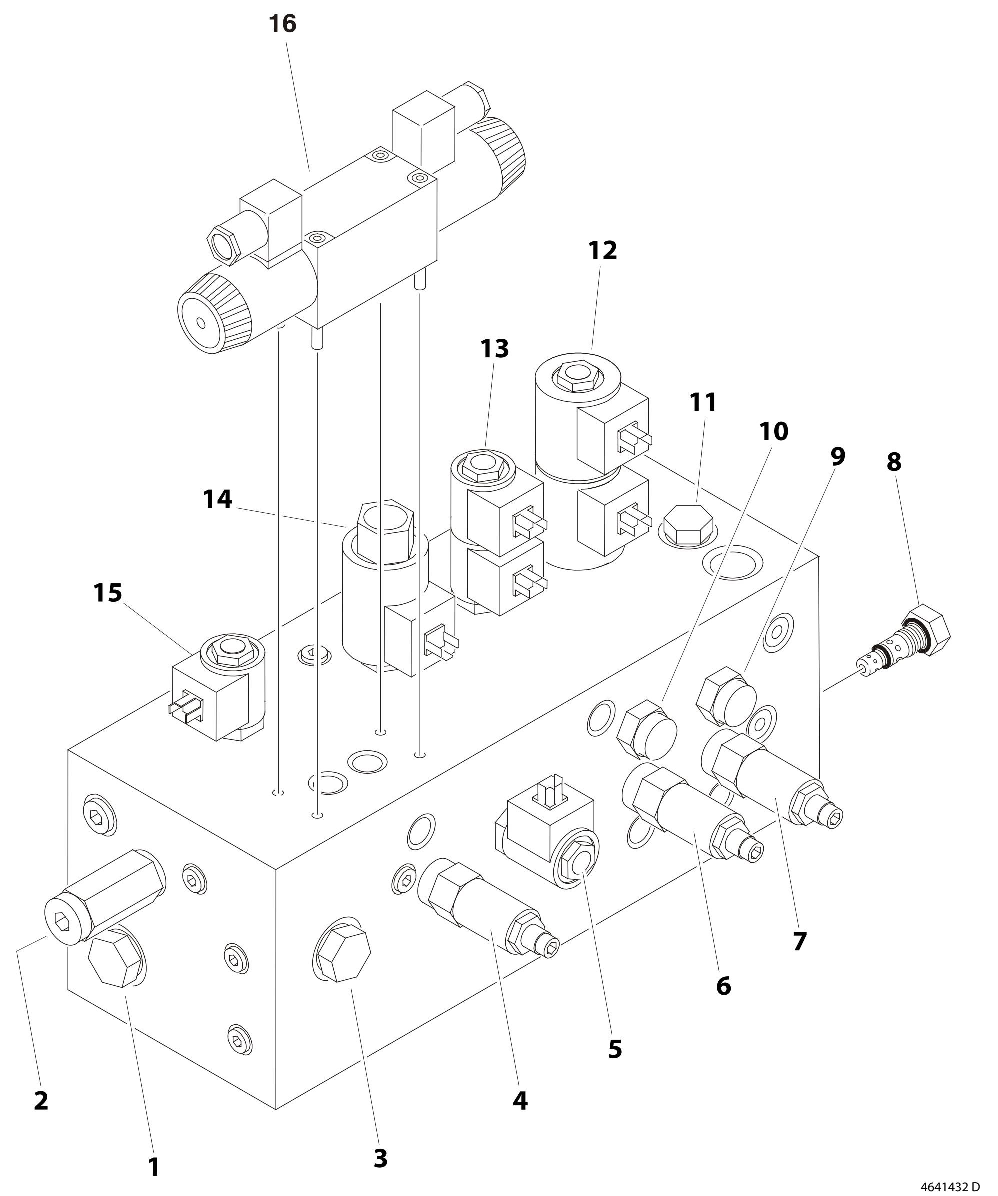
1. Install a high pressure gauge at port “M1”. Activate level up to the end of stroke, you should read 2600 psi (179 Bar).
2. The level up relief valve is located to the right and above port M1. Turn clockwise to increase, counterclockwise to decrease.

PLATFORM LEVEL DOWN

1. Install a high pressure gauge at gauge port “M2”, Activate level down to the end of stroke, you should read 1800 psi (124 Bar).
2. The level down relief valve is located to the right and below port M2. Turn clockwise to increase, counterclockwise to decrease.

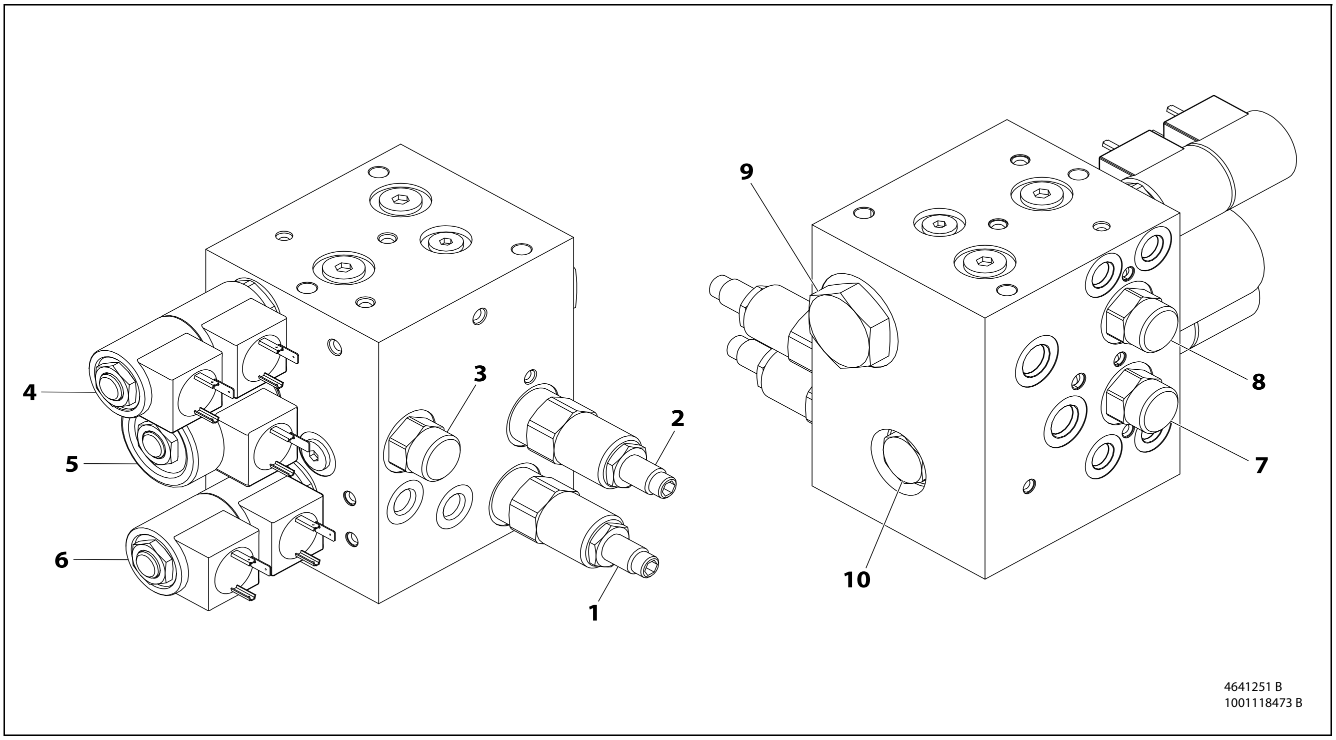
PUMP HI-PRESSURE RELIEF VALVE

Go back to the function pump and re-set the hi-pressure from 2800 psi (193 Bar) back to 2500 psi (172 Bar).



1. Check Valve
2. Pilot Valve - Lift
3. Check Valve (100 psi - 6.9 Bar)
4. Tele Out Relief
5. Lift Up Dump
6. Swing Relief
7. Steer Relief
8. Steer Flow Regulator (6 gpm - 22.7 lpm)
9. Load Sense - Steer
10. Load Sense - Swing
11. Check Valve (60 psi - 4.1 Bar)
12. Steer Control
13. Swing Control
14. Proportional Valve - Tele
15. Main Dump
16. Telescope Control

Figure 5-80. Main Valve Identification



1. Level Down Relief
2. Level Up Relief
3. Flow Regulator
4. Rotator Solenoid
5. Pressure Solenoid
6. Platform Level Solenoid
7. Flow Regulator
8. Flow Regulator
9. Filter
10. Check Valve

Figure 5-81. Platform Valve Identification

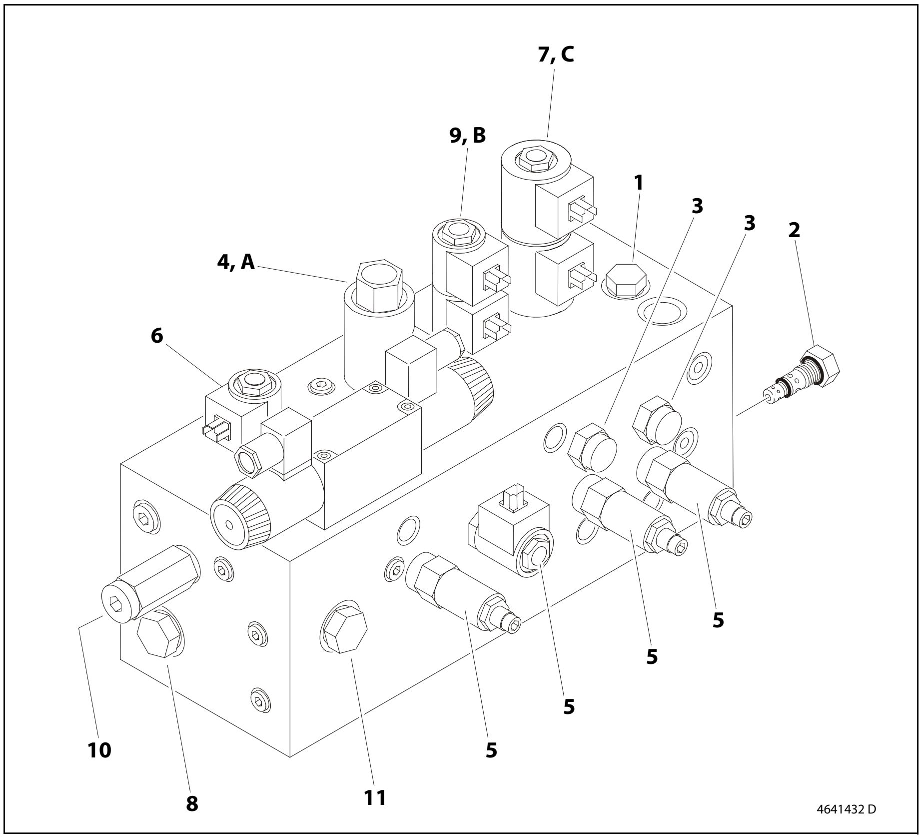


Table 5-1. Cartridge Torque Values

	Ft-Lbs.	Nm
1	18-20	24-27
2	33-37	45-50
3	19-21	26-28
4	50-55	68-75
5	19-21	26-28
6	50-55	68-75
7	24-26	33-35
8	70-80	95-108
9	19-21	26-28
10	50-55	68-75
11	24-26	33-35

Table 5-2. Coil Torque Values

	Ft-Lbs.	Nm
A	5-7	7-9
B	5-7	7-9
C	5-7	7-9

Figure 5-82. Main Valve Cartridge Torque Values

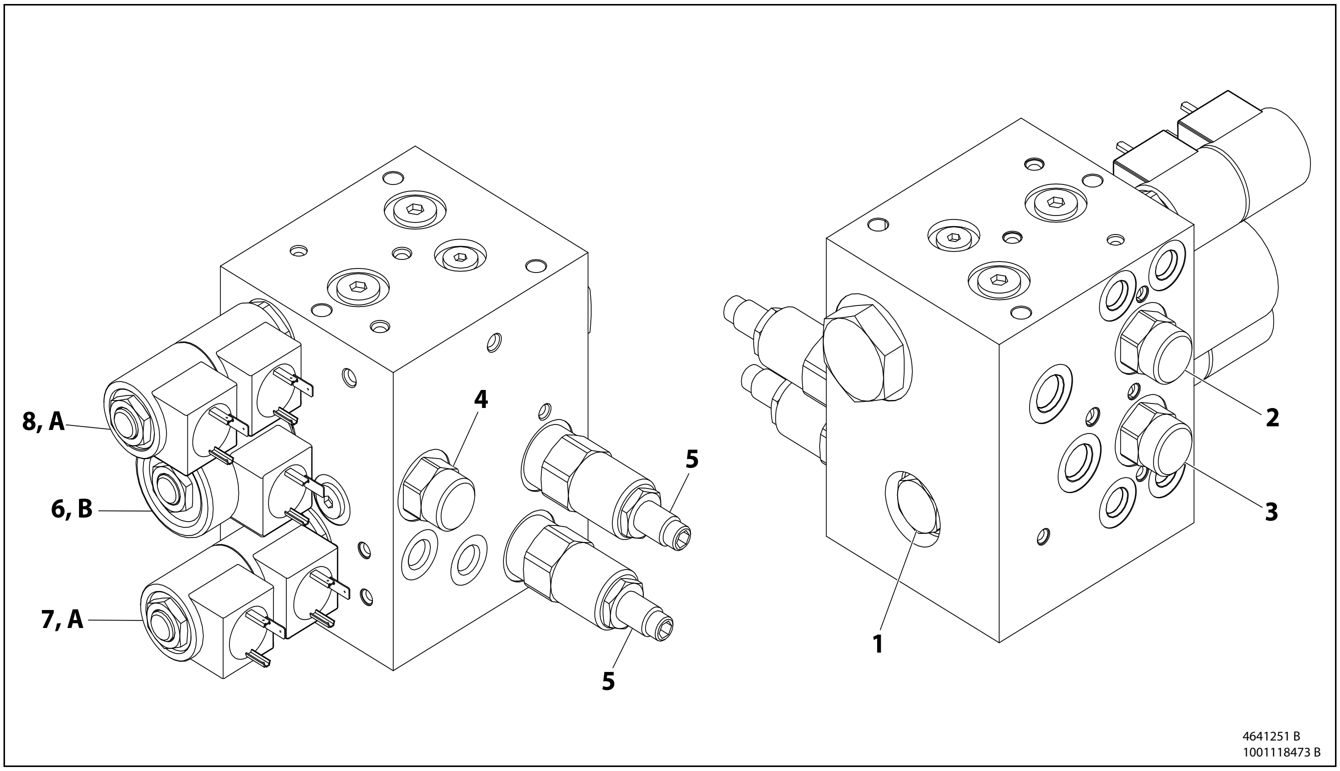


Table 5-3. Cartridge Torque Values

	Ft-Lbs.	Nm
1	20	27
2	20	27
3	20	27
4	20	27
5	20	27
6	25	34
7	20	27
8	20	27

Table 5-4. Coil Torque Values

	Ft-Lbs.	Nm
A	5	7
B	5	7

Figure 5-83. Platform Valve Cartridge Torque Values

5.4 START UP PROCEDURES

Start Up After Overhaul or Replacement of Components

PRE-FILL OF BOTH THE DRIVE AND FUNCTION PUMP

Machine without oil cooler: When filling the oil tank, fill it to the very top of the tank. This will give enough head pressure from the tank to gravity fill the case on both pumps. The excess oil will be used to fill the cylinders during start up. The top case port on the outside of the drive pump has a 3/4 in. tee fitting. Remove the cap from the end of the tee. You should see oil in 1-2 minutes, tighten up the cap. The drive pump case is done. Next, go the function pump, using a 3/8 in. allen wrench remove the plug on the inside of the pump next to the turn-table side sheet. When oil flows out of the pump, 2-3 minutes, re-install the plug. Both pumps are pre-filled. Not doing this causes the pumps to start dry, and reduces the efficiency of the pump and can cause premature failure.

Machine with oil cooler: When filling the oil tank, fill it to the very top of the tank. This will help give enough head pressure from the tank to gravity fill the case on both pumps. The top case port on the outside of the pump has a 3/4 in. tee fitting. Remove the cap from the center of the tee. You should see oil in 1-2 minutes. If not, depending on hose routing, the drive pump may not gravity feed. Oil has to flow through the oil cooler to get to the pump. Hose up an external hand pump to this tee fitting, and give it about six pumps after it has started pumping oil. This should be sufficient. Install the cap back onto the tee fitting. The drive pump is done. Next, go the function pump, using a 3/8 in. allen wrench remove the plug on the inside of the pump next to the turn-table side sheet. When oil flows out of the pump, 2-3 minutes, re-install the plug. Both pumps are pre-filled. Not doing this causes the pumps to start dry, and reduces the efficiency of the pump and can cause premature failure.

PURGING OF THE FUNCTION PUMP SUCTION HOSE.

Large pockets of air get trapped in this line and must be removed at low pressure. Head pressure from the tank is not enough. Here are three methods of purging the air from the hose at low pressure.

1. At the main control valve, remove the 3/4 in. hose from port "P1" and remove the 1 in. hose from port "T" by using a 12-16 connector, connect them together. Start the machine and let it run for approx. 10 seconds. Shut off the machine, remove the 12-16 adapter and re-hose.

2. Remove the 3/4 in. hose from port "P1" and hold it into a 5 gallon bucket and start the machine. The air should purge very quickly, (seconds). Shut off the machine and re-hose.

3. Remove the 3/4 in. hose from port "P1", using a #12 male union add approx. 30 in. of 3/4 in. hose to it. Remove the return filter cap at the top of the tank, lift out the element making sure the canister stays in the tank. Hold the hose end down in the canister and start the machine and let it run approx. 10 seconds. Re-install the filter and re-hose the machine.

NOTE: *If using a shop vac to create suction on the oil tank while doing maintenance, both steps "1" and "2" will need done.*

NOTE: *If installing a new drive pump, step "1" will need done.*

NOTE: *If installing a new function pump, step "1" and "2" will need done.*

NOTE: *If installing a new function pump and the suction hose is capped without draining a lot of oil out of the hose, which creates a large air void, step "2" will not need to be done.*

NOTE: *When operating a function such as Lift Up, if the function pump makes a loud noise and the lift up stops and starts, that is a sign of cavitation, air going through the pump at high pressure. This will in a short time destroy the pump and contaminate the entire system. Make sure all suction hoses are tight and free of leaks at the tank and pump. A suction hose does not leak when the engine is running, it will allow air to be drawn into the pump causing cavitation. After the machine is shut down, then you will see a very slow leak.*

5.5 PISTON PUMP (PRIOR TO SN 0300180778)

Table 5-5. Symbols Used

Symbol	Meaning	Symbol	Meaning
	Non-reusable part, use a new part		Inspect for wear or damage
	Option - either part may exist		Note correct orientation
	Internal hex head		Torque specification
ORB	O-ring boss port		Pull out with tool - press fit
	Lubricate with hydraulic fluid		Cover splines with installation sleeve
	Apply grease /petroleum jelly		Pressure measurement / gauge location or specification
The symbols above can be found in the pump illustrations. The legend above is provided to define each symbol and explain its purpose.			

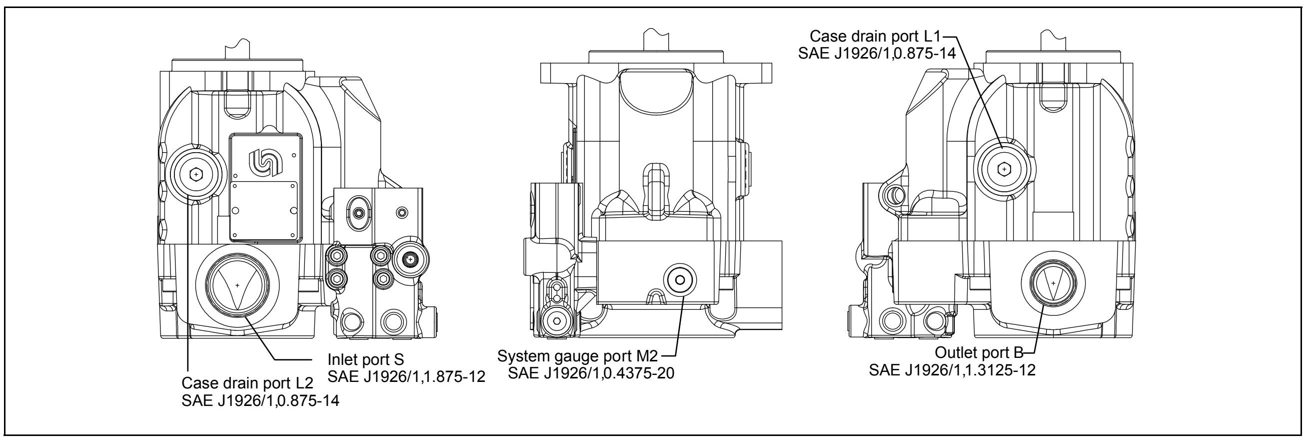


Figure 5-84. Gauge Port Locations

Table 5-6. Gauge and Port information

Port	Purpose	Range of Pump	Fitting
M2	System pressure	0-5000 psi (0-300 bar)	7/16 - 20 o-ring fitting
M4	Servo pressure	0-5000 psi (0-300 bar)	7/16 - 20 o-ring fitting
L1,L2	Case pressure	0-100 psi (0-10 bar)	7/8 - 14 o-ring fitting
X1	Load Sense signal	0-5000 psi (0-300 bar)	7/16 - 20 o-ring fitting (tee into Load Sense signal line)

Initial Start-up Procedures

Follow this procedure when starting-up a new pump or when the pump has been removed.

WARNING

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

Prior to installing the pump, 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. Install the pump on the engine. Ensure the pump shaft is properly aligned.

CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

2. Fill the reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter pouring into the reservoir. Never reuse hydraulic fluid.
3. Fill the main pump housing with clean hydraulic fluid. Pour filtered oil directly into the main most case drain port.
4. 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.
5. To ensure the pump stays filled with oil, install the case drain line in the main most case drain port.
6. Install a gauge at port M2 to monitor system pressure during start up.
7. While watching the pressure gauge installed at M2, jog the engine or run 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, shutdown the engine, determine cause, and take corrective action. Refer to Troubleshooting.
8. Operate the hydraulic system for at least fifteen minutes under light load conditions.
9. Check and adjust control settings as necessary after installation. Refer to Adjustments.
10. Shut down the engine and remove the pressure gauge. Replace plug at port M2.
11. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The pump is now ready for operation.

Fluid and Filter Maintenance

To ensure optimum life of products, perform regular maintenance of the fluid and filter. Contaminated fluid is the main cause of unit failure. Take care to maintain fluid cleanliness while servicing.

Check the reservoir daily for proper fluid level, the presence of water, and rancid fluid odor. Water in the fluid may be noted by a cloudy or milky appearance or free water in the bottom of the reservoir. Rancid odor indicated the fluid has been exposed to excessive heat. Change the fluid immediately if these conditions occur.

Change the fluid and filter as per the vehicle/machine manufacturer's recommendations or at these intervals:

Table 5-7. Fluid and Filter Change Interval

Reservoir Type	Maximum Change Interval
Sealed	2000 Hours
Breather	500 Hours

Change the fluid more frequently if it becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid is subjected to temperature levels greater than the recommended maximum.

NOTE: *Dispose off used hydraulic fluid properly. Never reuse hydraulic fluid.*

Change filters whenever the fluid is changed or when the filter indicator shows that it is necessary to change the filter. Replace all fluid lost during filter change.

Troubleshooting

Table 5-8. Excessive Noise and/ or Vibration

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will cause cavitation.	Fill the reservoir to proper level.
Check for air in system.	Air in system will cause noisy, erratic control.	Purge air and tighten fittings. Check inlet for leaks.
Check pump inlet pressure / vacuum.	Improper inlet conditions will cause erratic behavior and low output flow.	Correct pump inlet pressure / vacuum conditions. Refer to Hydraulic parameters.
Inspect shaft couplings.	A loose or incorrect shaft coupling will cause excessive noise and/or vibration.	Repair or replace coupling and ensure that correct coupling is being used.
Check shaft alignment.	Misaligned shafts will create excessive noise and/or vibration.	Correct shaft misalignment.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.

Table 5-9. Actuator Response is Sluggish

Item	Description	Action
Check external system relief valve setting.	Low external relief valve setting will slow down system.	Adjust external relief valve setting per manufacturer's recommendations. External relief setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and LS control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check Load Sense control signal pressures.	Incorrect Load Sense signal will not allow pump to operate correctly.	Inspect system, ensure that proper Load Sense signal is transmitted to the pump.
Internal system leaks.	Worn internal parts will not allow the pump to operate properly.	Refer to Authorized Service Center for repairs as required.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system valving.	Malfunctioning valving may not allow system to respond properly.	Repair or replace system valving as required.
Check pump case pressure.	High case pressure will cause the system to be sluggish.	Correct case drain line restrictions.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.

Table 5-10. System Operating Hot

Item	Description	Action
Check fluid level in reservoir.	Insufficient volume of hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level. Verify proper size of reservoir.
Inspect heat exchanger. Check air flow and input air temperature for the heat exchanger.	Insufficient air flow, high input air temperature, or undersized heat exchanger will not meet cooling demands of the system.	Clean, repair, or replace heat exchanger as required. Verify proper size of heat exchanger.
Check external system relief valve setting.	Fluid passing through relief valve adds heat to system.	Adjust external system relief valve setting per manufacturer's recommendations. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check pump inlet pressure / vacuum.	High inlet vacuum adds heat to system.	Correct inlet pressure / vacuum conditions.

Table 5-11. Low Pump Output Flow

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will limit output flow and cause internal damage to pump.	Fill the reservoir to proper level.
Hydraulic fluid viscosity above acceptable limits.	Fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system relief valve setting.	External relief valve set below Pressure Compensator setting will cause low output flow.	Adjust external relief valve per manufacturer's recommendation. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and Load Sense control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.
Check input speed.	Low input speeds decrease flow.	Adjust input speed.
Check pump rotation.	Incorrect rotational configuration will cause low flow.	Use pump with appropriate rotational configuration.

Table 5-12. Pressure or Flow Instability

Item	Description	Action
Check for air in system.	Air in system will cause erratic operation.	Activate Pressure Compensator, allowing system to bleed air. Check inlet line for leaks and eliminate source of air ingression.
Check control spools.	Sticking control spools will cause erratic operation.	Inspect spools for free movement in bore. Clean or replace as needed.
Check Load Sense setting.	Low Load Sense setting may cause instability.	Adjust Load Sense setting to proper level. See Adjustments.
Check Load Sense signal line.	Blocked Load Sense signal line will interfere with proper Load Sense operation.	Remove blockage.
Check external relief valve and Pressure Compensator setting.	Insufficient pressure differential between Pressure Compensator Pressure Compensator setting and external relief valve.	Adjust external relief valve or Pressure Compensator control settings to appropriate level. Relief valve setting must be above Pressure Compensator setting for proper operation.
Check external relief valve.	Chattering external relief valve may cause unstable feedback to pump control.	Adjust or replace relief valve.

Table 5-13. System Pressure Not Reaching Pressure Compensator Setting

Item	Description	Action
Check Pressure Compensator control setting.	System pressure will not rise above Pressure Compensator setting.	Adjust Pressure Compensator to appropriate setting.
Check external relief valve.	External relief valve setting below Pressure Compensator setting will prevent pressure compensation.	Adjust external relief valve per manufacturer's recommendations. External relief valve must be set above Pressure Compensator setting for proper operation.
Inspect Pressure Compensator control spring.	Broken, damaged, or missing spring will cause erratic operation.	Replace spring as required.
Inspect Pressure Compensator spool for wear.	Wear of the Pressure Compensator spool will cause internal leakage in the control.	Replace the spool as required.
Inspect Pressure Compensator spool for proper orientation.	Improper orientation will result in poor operation.	Correct orientation of spool.
Check Pressure Compensator control for contamination.	Contamination may interfere with movement of the Pressure Compensator Spool.	Clean Pressure Compensator control components, take appropriate action to eliminate contamination.

Table 5-14. High Inlet Vacuum

Item	Description	Action
CAUTION HIGH INLET VACUUM CAUSES CAVITATION WHICH CAN DAMAGE INTERNAL PUMP COMPONENTS.		
Check fluid temperature.	Low temperature increases viscosity. High fluid viscosity causes high inlet vacuum.	Allow system to warm up before operation.
Inspect inlet screen.	Blocked or restricted inlet screen will cause high inlet vacuum.	Clean screen / remove blockage.
Check inlet piping.	Too many fittings, bends, or long piping will cause high inlet vacuum.	Eliminate fittings to make path more direct.
Hydraulic fluid viscosity above acceptable limits.	High fluid viscosity causes high inlet vacuum.	Select fluid with appropriate viscosity for expected operating temperature.

Set Up the Function Pump

(The pump that is mounted on the back of the drive pump).

1. **Set Stand by pressure or load sense pressure**

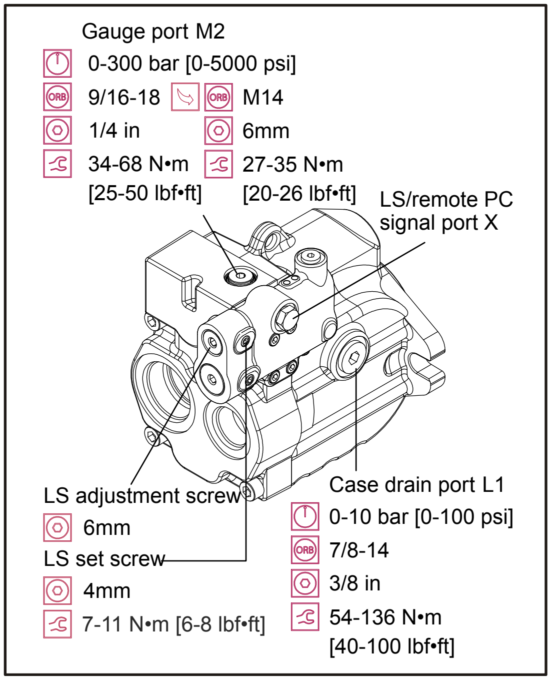


Figure 5-85. Load Sensing Control Adjustment

a. Install a low pressure gauge at port **"MP"** of the main valve block. A gauge capable of reading **400 psi (27.58 bar)**.

b. Remove the wires from the main boom lift, valve coils on the main boom main valve block. Start the engine and activate main lift up or down. Hold the function for 10-15 seconds. This bleeds the air out of the sense line. The gauge should be reading between **400-440 psi (28-30 bar)**.

c. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. There are (2) adjustments at the top of the pump. They are located on the pump compensator which has (4) bolts mounting it to the pump. The stand by adjustment is at the top.

d. To adjust this, a 4 mm and 6 mm allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.

e. Then using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. The pressure should read between **400-440 psi (27.58-30.34 bar)**.

2. **Set High pressure relief**

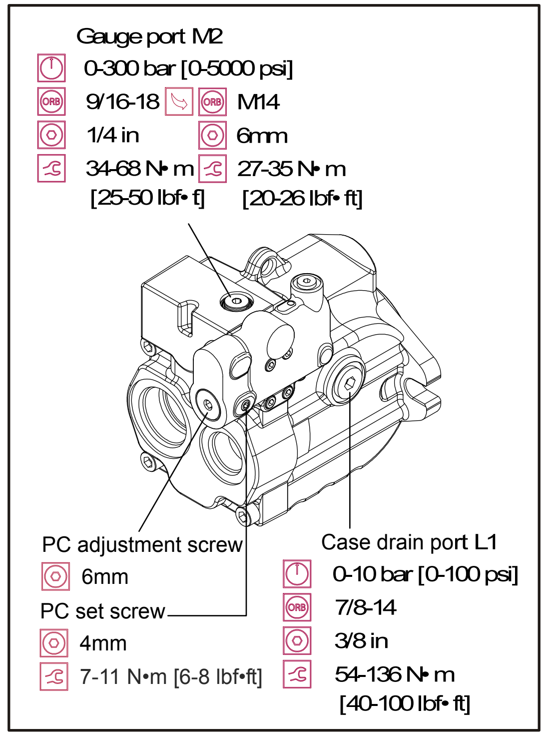


Figure 5-86. Pressure Compensation Control Adjustment

a. Install a high pressure gauge at the **"MP"** port of the main valve block.

b. Activate main boom telescope in. The gauge should read **2600 psi (179 bar)**.

c. To make an adjustment to this pressure, go back to the engine compartment to the function pump. The high pressure relief adjustment is the lower one of the (2) on the compensator. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.

d. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.

Then using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. This is the **maximum** relief pressure for all functions governed by this pump.

Shaft Seal Replacement

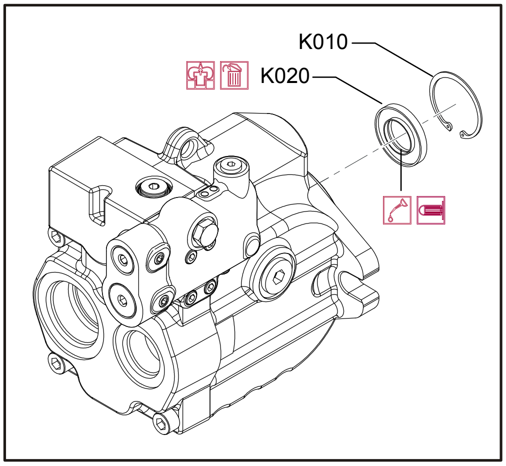


Figure 5-87. Shaft Seal and Retaining Ring

A lip type shaft seal is used in the pump and can be replaced without major disassembly of the unit. Replacement of the shaft seal requires removal of the pump from the machine.

REMOVAL

1. Using the appropriate snap-ring pliers, remove the retaining ring (K010) from the housing.
2. Remove the shaft seal (K020) from the bore in the pump housing and discard. Avoid damaging the pump housing or shaft. Puncture the face of the seal with a packing hook, or use a slide-hammer type puller to remove the seal.

INSTALLATION

1. Inspect the pump housing and new seal for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
2. Lubricate the lip of the new shaft seal with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation.

⚠ CAUTION

PREMATURE BEARING FAILURE CAN RESULT IF THE SHAFT SEAL CONTACTS THE SHAFT BEARING. PRESS THE SEAL INTO THE HOUSING ONLY FAR ENOUGH TO CLEAR THE RETAINING RING GROOVE.

3. Keeping the seal perpendicular to the shaft, press the new seal into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation.
4. Using the appropriate snap ring pliers, install the seal retaining ring.
5. Remove the installation sleeve.

Control Assembly

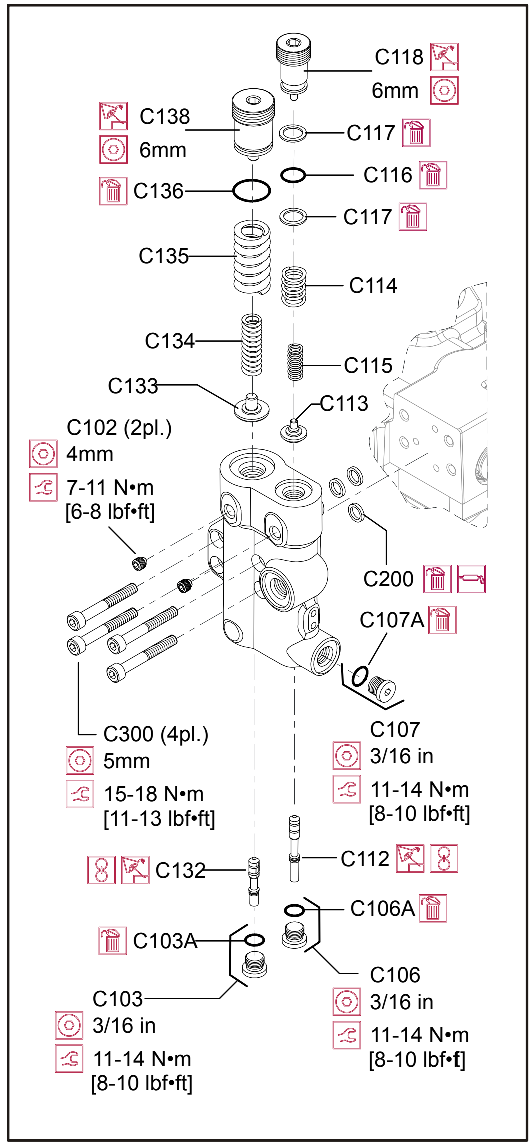


Figure 5-88. Control Assembly

DISASSEMBLY

1. Remove the four screws (C300) holding the control housing onto the end cap.
2. Remove the control and discard the three interface o-rings (C200).
3. Remove the Pressure Compensator set screw (C102), Pressure Compensator adjustment screw (C138), o-ring (C136), springs (C135, C134), and seat (C133). Discard the o-ring.
4. Remove the plug (C103), o-ring (C103A),and Pressure Compensator spool (C132) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.
5. Remove the plug (C107) and o-ring (C107A); discard the o-ring.

NOTE: *For Pressure Compensator only controls, skip steps 6 and 7.*

6. Remove the Load Sense set screw (C102), Load Sense adjustment screw (C118), o-ring (C116), backup rings (C117), springs (C114, C115), and seat (C113); discard the o-ring.
7. Remove the plug (C106), o-ring (C106A), and Load Sense spool (C112) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.

INSPECTION

1. Inspect the adjustment screws for wear at the tips and where they contact the springs; replace as necessary.
2. Inspect the springs and spring guides for wear or damage; replace as necessary.
3. Carefully inspect the spools. Ensure the sealing lands are free of nicks and scratches. Check the ends that contact the spring guides for wear. Replace spools as necessary.
4. Inspect the control housing for damage. Check the spool bores for excessive wear.
5. Clean all parts and lubricate spools, springs, guides and new o-rings with clean hydraulic fluid.

REASSEMBLY

1. Install the Pressure Compensator spool, spherical end first, into the Pressure Compensator bore. The Pressure Compensator spool is the shorter of the two. Using a new o-ring, install the plug (C103). Torque to 8-10 ft. lbs. (11-14 Nm).
2. Place the two Pressure Compensator springs onto the spring guide and install into the Pressure Compensator bore. Place a new o-ring onto the Pressure Compensator adjustment screw and thread it into the Pressure Compensator bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft. lbs. (7-11 Nm).

NOTE: *For Pressure Compensator only controls, skip steps 3 and 4.*

3. Install the Load Sense spool, spherical end first, into the Load Sense bore. The Load Sense spool is the longer of the two. Using a new o-ring, install the plug (C106). Torque to 8-10 ft. lbs. (11-14 Nm).
4. Place the two Load Sense springs onto the spring guide and install into the Load Sense bore. Place a new o-ring and backup rings onto the Load Sense adjustment screw and thread it into the Load Sense bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft. lbs. (7-11 Nm).
5. Using a new o-ring, install the plug (C107). Torque to 8-10 ft. lbs. (11-14 Nm).
6. Using petroleum jelly to retain them, install the three interface o-rings (C200) in the recesses on the control housing.
7. Install the control assembly onto the endcap using the four screws (C300). Torque to 11-13 ft. lbs. (15-18 Nm). Torque screws in a criss-cross pattern and re-torque the first screw to ensure proper torque retention.

Plug and Fitting Sizes and Torques

If any plugs or fittings are removed from the unit during service, install and torque as indicated here. This drawing is a composite. Your configuration may differ but the appropriate wrench size and torque can be found here.

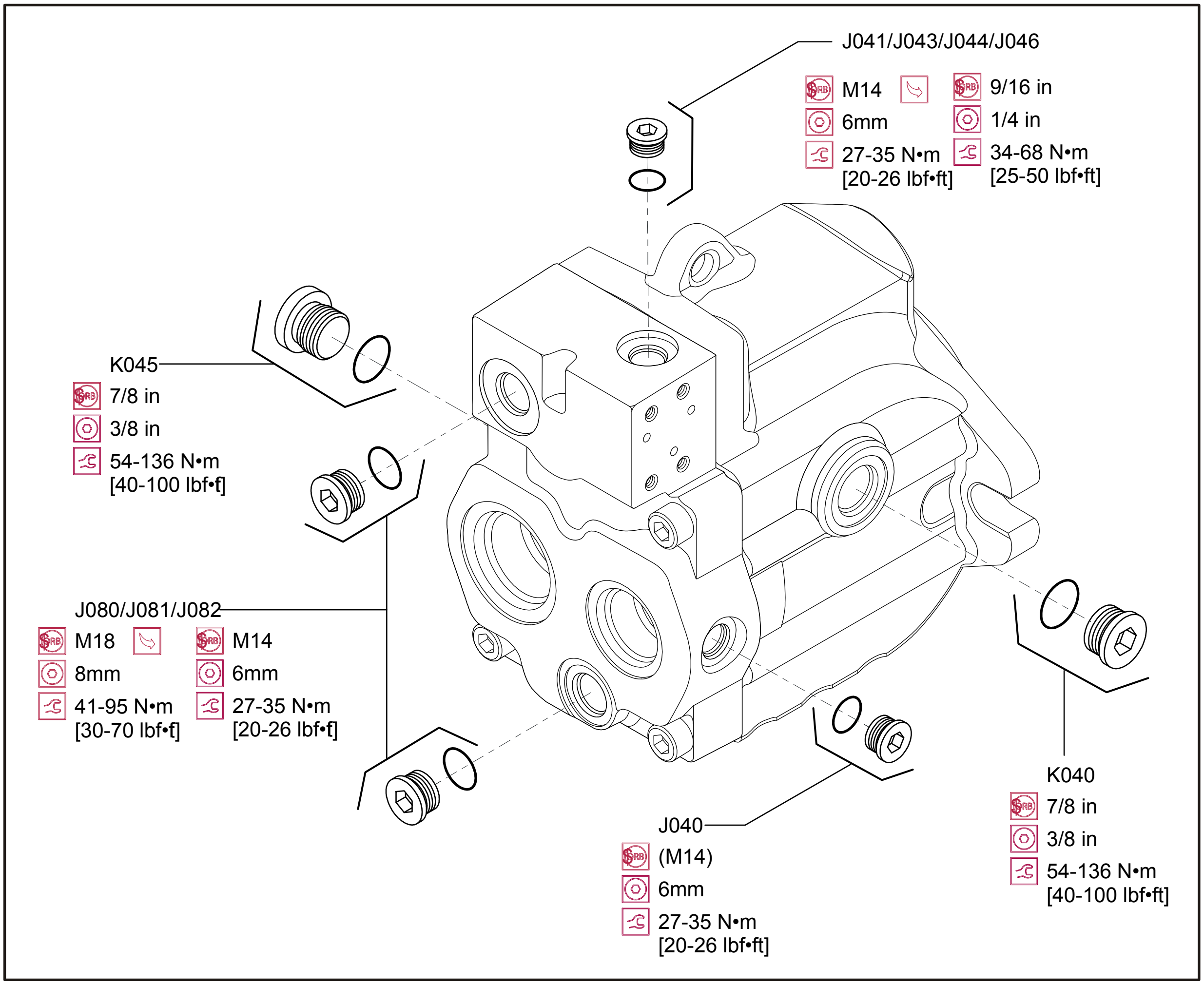


Figure 5-89. Plug Locations, Sizes, and Torques

5.6 PISTON PUMP (SN 0300180778 THROUGH 0300189341)

Servo Controlled Piston Pump

DISASSEMBLY

The following instructions apply to a single servo controlled piston pump with or without a gerotor charge pump. A tandem pump assembly should be separated into individual pumps before disassembly.

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the capscrews up. Mark the relationship of the working ports (for assembly identification) to the servo control assembly with a scribe. Remove the four capscrews retaining endcover.
2. Lift the charge pump adapter assembly straight up off endcover, shaft and gerotor. Gerotor may stay in adapter or on endcover.
3. Remove o-ring from charge pump adapter.
4. Remove outer gerotor ring from either the charge pump adapter or the inner gerotor ring.

NOTE: *Refer to "Charge Pump Adapter Assembly" for disassembly and inspection of charge pump adapter assembly.*

5. Remove the inner gerotor ring and key from drive shaft or inner gerotor ring and coupler assembly from shaft.
6. Lift endcover straight up off shaft and housing. Remove valve plate from endcover or from rotating kit assembly, still in housing.
7. From endcover, remove bypass valve or plug, and relief valve assemblies. Note: Mark the relief valve in relationship to the cavity it was removed, for reassembly purposes.

Endcover Inspection

- Check the bearing (press fit) in endcover. If needles remain in cage, move freely, and setting is at the dimension shown in Figure 5-90., removal not required.
- Check roll pin in endcover. If tight and set to the dimension shown in Figure 5-90., removal not required.

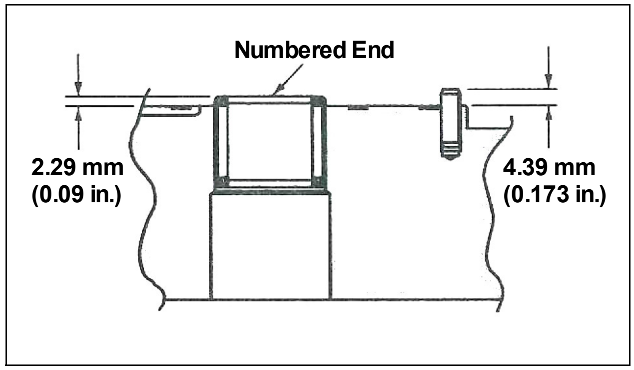


Figure 5-90. Endcover Inspection

1. Remove housing gasket from housing or endcover.
2. With pump still in vise, remove the six capscrews retaining the manual servo control assembly. Remove the control assembly and control housing gasket from the housing. Remove orifice plates, noting location for reassembly. Remove nut and lock washer from control arm, remove arm. Note position of control arm for reassembly.

NOTE: *Refer to "Manual Servo Control Basic Assembly" for disassembly and Inspection of control assembly.*

3. To remove rotating kit assembly from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing and shaft from rotating kit assembly, and swashplate.
4. Remove swash plate from rotating kit assembly and servo piston follower from swashplate.

NOTE: *Refer to "Rotating Kit Assembly" for disassembly and Inspection of rotating kit.*

Swashplate Inspection

- The finish on the piston shoe surfaces of the swash plate should show no signs of scoring.
- Inspect swashplate bushing surface for wear and surface for coating transfer from bushing.

1. To remove servo piston assembly from housing, start with the four each capscrews and washers retaining each cover plate.
2. In removing the cover plate from the servo piston bolt, remove jam nut, washer, and seal washer. Hold the servo piston bolt with hex key and unscrew cover plate off of bolt.
3. Remove servo piston assembly and seal sub-assemblies (two sets) from housing.

NOTE: *Disassembly of servo piston assembly is not required.*

4. Remove retaining ring from the front of housing. Press the shaft, shaft seal or spacer, and washer from housing. Remove retaining ring, thrust washer, thrust bearing, second thrust washer, and second retaining ring from shaft.

Housing Inspection

- Check the bearing (press fit) in housing. If needles remain in cage, move freely, and setting at the dimension shown in Figure 5-91., removal not required.

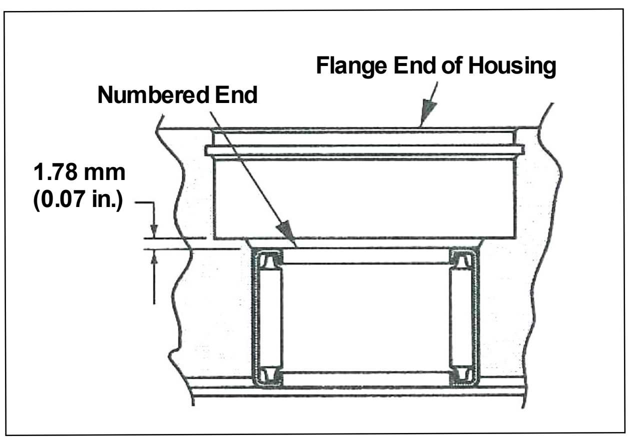


Figure 5-91. Housing Inspection

1. To remove cradle sub-assembly, remove the two capscrews retaining cradle inside housing. Removing cradle subassembly from housing.
2. Remove button head capscrews (2 Qty.) to remove bushing from cradle.

Bushing Inspection

- Inspect bushing for contamination embedment within coating of bushing surface coming in contact with swashplate.

1. Remove all plugs from housing.
2. Discard the shaft seal, gaskets, and o-rings from all assemblies. Replace with new seals upon reassembly.

ASSEMBLY

1. All parts should be cleaned and critical moving parts lubricated before reassembly.
2. If necessary, press new bearing in housing to dimension shown in Figure 5-91., with the numbered end of bearing outward.
3. Install the two new seal sub-assemblies into the servo piston cavity of housing.
4. Screw the cover plate onto the servo piston assembly. Install new cover plate gasket in place on housing. Install servo piston assembly and cover plate into servo piston bore in right side of housing (as shown in Figure 5-92. Retain cover plate with four each washers and capscrews. Torque capscrews 40 to 48 in.lbs (4.5 to 5.4 Nm). To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston 0.5 in. (12.7 mm) from surface of housing servo bore as shown in Figure 5-92.

NOTE: *Re-adjustment may be required for neutral at unit start-up.*

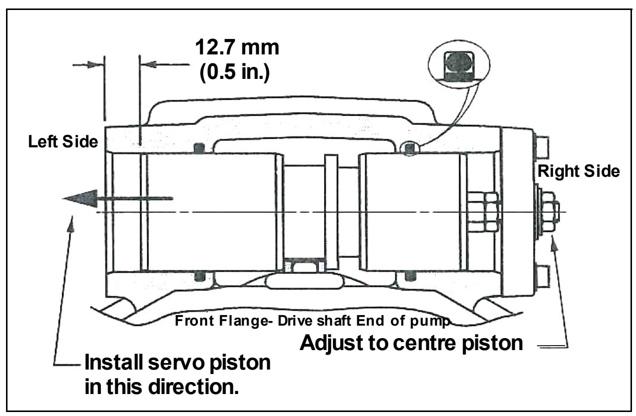


Figure 5-92. Servo Piston Installation

5. Install new seal washer, washer, and jam nut to servo piston bolt. Holding servo piston bolt with hex key wrench Torque jam nut (150 to 160 in.lbs) 17 to 18 Nm. Check the centering of servo piston assembly. Install new cover plate gasket and cover plate to left side of servo piston and retain with four each washers and #10-24 capscrews. Torque capscrews 40 to 48 in.lbs (4.5 to 5.4 Nm).

6. To assemble cradle sub-assembly, install bushing onto cradle retaining with button head capscrews. Torque button head capscrew 14 to 16 in. lbs. (1.6 to 1.8 Nm).

7. Place cradle sub-assembly into housing making sure cradle is completely seated into housing. Retain cradle sub-assembly with two capscrews. Torque capscrews 20 to 24 ft. lbs. (27 to 33 Nm).

8. To install shaft, place exterior retaining ring, thrust race, thrust bearing, second thrust race, and second retaining ring onto shaft. Position washer and shaft seal or spacer onto shaft.

9. Install shaft assembly into front of housing for units with spacer, retain with interior retaining ring and go on to step 10. For units with shaft seal. seat seal into position with seal driver and retain with interior retaining ring.

10. Install servo piston follower onto swashplate dowel pin. Install swashplate carefully onto bushing (coat bushing surface with hydraulic oil), aligning servo piston follower with slot in servo piston assembly.

NOTE: *Refer to "Rotating Kit Assembly" for reassembly of rotating kit assembly.*

11. To install rotating kit assembly, leave housing and shaft in the horizontal position. Holding swashplate into position with screw driver thru controller linkage passageway at the top of housing. place rotating kit assembly over shaft and into housing until pistons are in against swashplate. Make sure all parts are in housing completely and properly positioned. Return the pump to the vise with open end of housing up. clamping housing on the outer portion of the flange.

12. Install gasket on to housing.

13. If necessary, press new bearing and roll pin in endcover to dimension shown in figure 1-3. Bearing installed with the numbered end outward. Roll pin installed with split oriented away from bearing.

14. Install new o-ring on relief valves. Install relief valve in its original cavity in endcover that it was removed. Torque 100 to 110 ft. lbs. (136 to 149 Nm).

15. Install new o-ring on bypass valve or plug. Install bypass valve or plug into endcover.

NOTE: *Make sure paddle of bypass valve is perpendicular to relief valve axis prior to installing or damage could result.*

16. Apply a small amount of petroleum jelly to the steel side of valve plate to hold in place for installation. Aligning the index pin, place the valve plate in position onto the endcover, with steel side against endcover.

17. Install endcover assembly onto housing assembly. Make sure ports are positioned correctly, valve plate and gasket stay in place.

18. Install key and inner ring gerotor onto shaft or coupler assembly. Lubricate inner ring gerotor.

NOTE: *Refer to "Charge Pump Adapter Assembly" for assembly of charge relief valve in adapter plate.*

19. Insta ll o-ring and outer ring gerotor onto adapter plate. Lubricate both a-ring and outer ring to hold in position during assembly of adapter plate. Install adapter plate onto endcover. Make sure o-ring and gerotor ring stay in place.

20. Retain endcover and adapter plate (when used) with four capscrews, Torque 27 to 31 ft. lbs. (37 to 42 Nm).

NOTE: *Refer to "Manual Servo Control Basic Assembly" for reassembly of manual servo control assembly.*

21. Install control housing gasket onto housing. Install orifices into control assembly and retain in position with petroleum jelly. Position the feedback link at 90 degrees from control housing. Install manual servo control assembly onto housing making sure feedback link entered small groove in servo piston assembly.

22. Retain control assembly with six capscrews, torque 40 to 48 in. lbs. (4.5 to 5.4 Nm).

23. Install control arm onto control assembly input arm. Retain with lock washer and nut, torque 4 to 6 ft. lbs. (5 to 8 Nm).

24. Install new o-rings on all plugs. Install plugs into housing. Torque 3/4 in. plug 21 to 24 ft. lbs. (28 to 32 Nm). Torque 1-1/4 in. plug 40 to 45 ft. lbs. (54 to 61 Nm).

25. Refer to "Start-up Procedure" .

Charge Pump Adapter Assembly

DISASSEMBLY

1. Remove plug, shims, spring, and poppet from adapter assembly as shown in Figure 5-94.

Inspection

- Inspect the charge pump relief valve seat inside the charge pump adapter. Check to insure that seat is smooth and free of burrs or other defects.
- Inspect the charge pump relief valve spring.
- Inspect the bearing or bushing inside the charge pump adapter. The bearing needles must remain in the bearing cage and bearing at dimension shown in Figure 5-93. The bushing must have no excessive scoring.
- Inspect the gerotor pocket inside the charge pump adapter assembly. It should not be scored excessively.

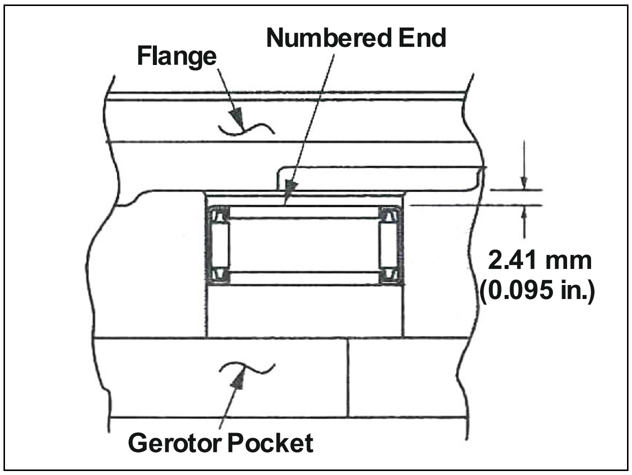
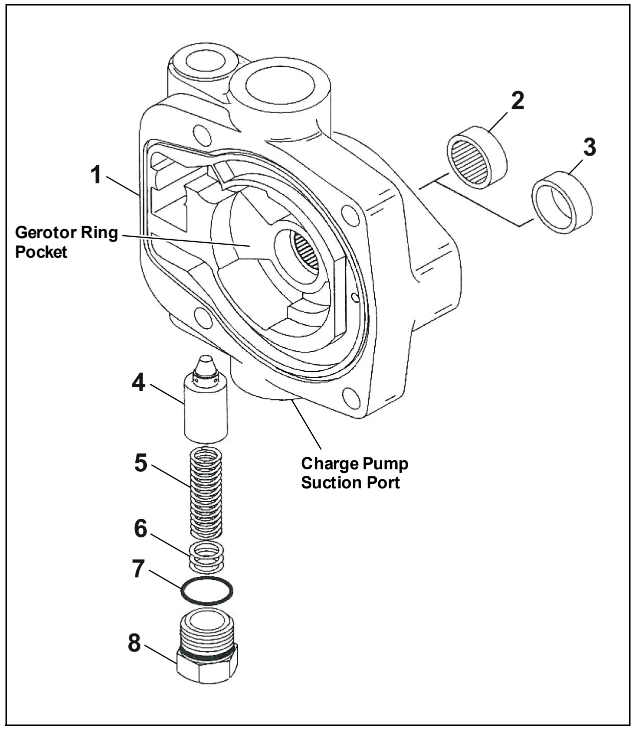


Figure 5-93. Bearing or Bushing Inspection



1. Charge Pump Adapter
2. Bearing
3. Bushing
4. Poppet
5. Spring
6. Shims
7. O-ring
8. Plug

Figure 5-94. Charge Pump Adapter Assembly

ASSEMBLY

1. If necessary, press new bearing or bushing in adapter assembly. The bearing to dimension shown in Figure 5-93. with the numbered end of bearing outward and closest to mounting flange. The bushing is to be pressed flush to 0.254 mm (0.010 in.) recessed.
2. Install poppet. spring, shims, new o-ring on plug, and plug into adapter assembly. Torque plug 30 to 27 ft. lbs. (40.7 to 36.6 Nm).

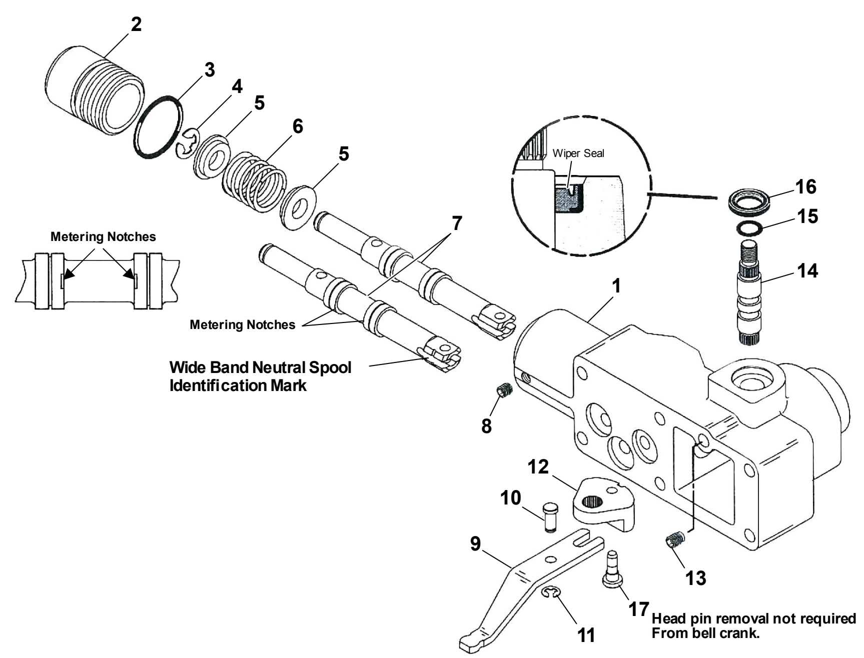
Manual Servo Control Basic Assembly

DISASSEMBLY

1. Remove wiper seal with screw driver. Remove set screw retaining input shaft and remove input shaft from control housing.
2. Remove set screw from plug retaining valve spool and remove plug.
3. Remove E-ring from pin retaining feedback link and valve spool. Remove pin, feedback link, valve spool, and bell crank from control housing.
4. Compress spring and remove E-ring, spring retainer, spring, and second spring retainer from valve spool.
5. Remove o-rings from plug and input shaft. Clean all parts and lubricate in prep for reassembly.

ASSEMBLY

1. Install spring retainer, spring, and second spring retainer onto spool. Compress spring with retainer and retain with E-ring onto valve spool.
2. Install valve spool into control housing making sure that metering notches on valve spool can be seen in the metering ports. Notches shown in Figure 5-95.
3. Position bell crank in housing. Slide feedback link into position between clevis on valve spool, aligning holes, and install dowel pin retaining with E-ring.
4. Install new o-ring onto input shaft. Hold bell crank in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.
5. JLG Threadlocker P/N 0100011 or equivalent to set screw and install, retaining input shaft. Adjust set screw until it bottoms out on input shaft and back out one-quarter turn.
6. Install wiper seal on input shaft as shown in Figure 5-95. Install new o-ring onto plug. retaining valve spool, and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with set screw. Torque set screw 17 to 25 in. lbs. (2 to 3 Nm).



1. Control Housing	6. Spool Centering Spring	10. Dowel Pin	14. Input Shaft
2. Plug	7. Valve Spool	11. Retaining Ring	15. O-ring
3. O-ring	8. Set Screw	12. Bell Crank	16. Wiper Seal
4. Retaining Ring	9. Feedback Link	13. Set Screw	17. Head Pin
5. Spring Retainer			

Figure 5-95. Manual Servo Control Basic Assembly

Manual Servo Control Assembly Options

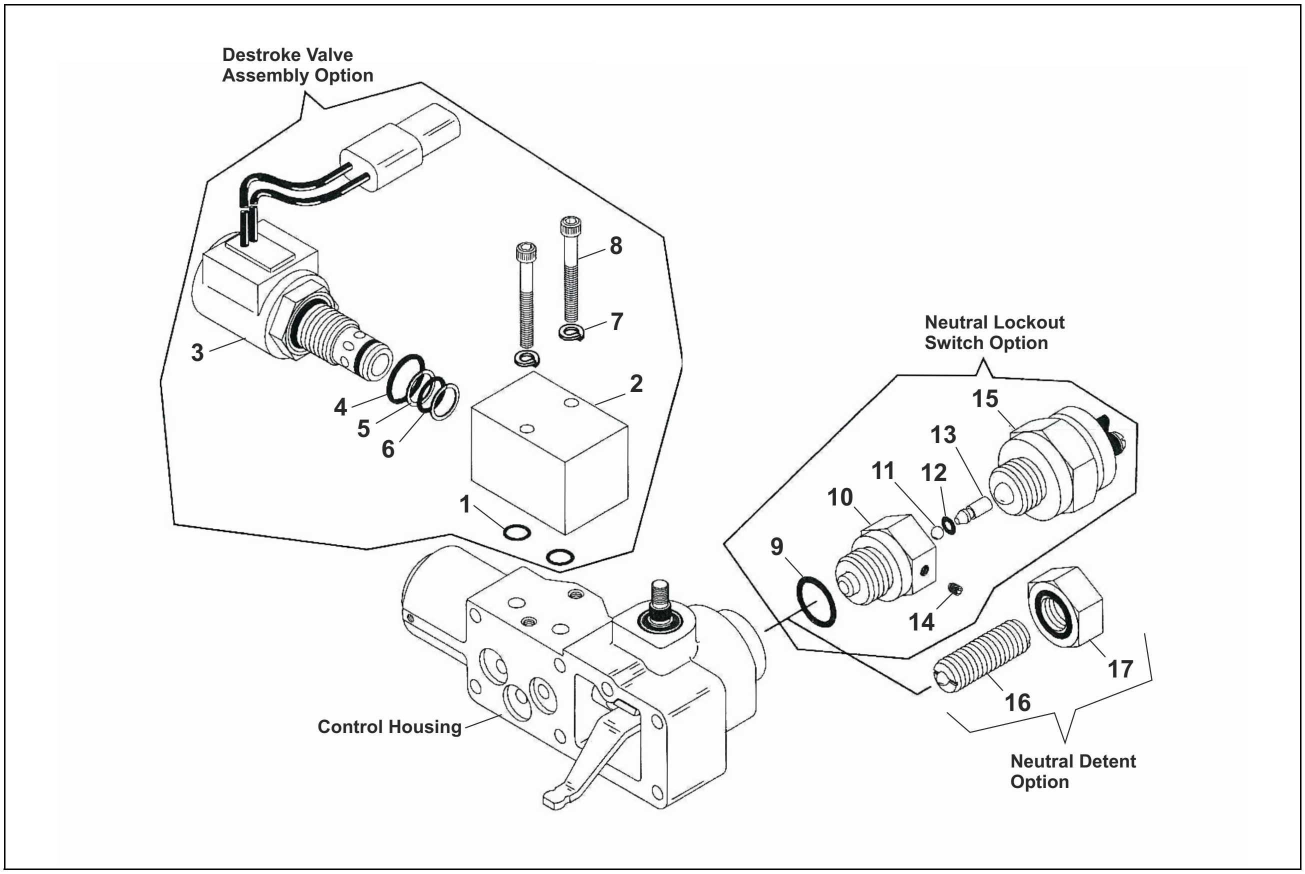
DISASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Remove the two capscrews and lock washers from manifold. Removing destroke valve assembly and two a-rings.
2. Remove destroke valve from manifold in order to remove o-rings and backup washers.

NOTE: *In order to remove destroke valve the solenoid may need to be removed from core first (not shown).*

ASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Install new o-rings and backup washers onto destroke valve.
2. Install destroke valve into manifold by hand until top o-ring is met by manifold. Then wrench tighten to 25 ft. lbs. (34 Nm) max. Loosen Nut retaining coil to reposition if necessary and re-torque 4 to 5 ft. lbs. (5.4 to 7 Nm).
3. Lubricate the two o-rings and install onto manifold. Install destroke valve assembly onto control assembly. Retain with lock washers and capscrews. Torque 2.2 to 2.6 ft. lbs. (3 to 3.5 Nm).



1. O-ring
2. manifold
3. Destroke Valve
4. O-ring
5. Backup Washer
6. O-ring
7. Lock Washer
8. Capscrew
9. O-ring
10. Neutral Lockout Adapter
11. Ball
12. O-ring
13. Pin
14. Set Screw
15. Neutral Lockout Switch
16. Ball Plunger
17. Nut Seal

Figure 5-96. Manual Servo Control Basic Assembly Option

DISASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Loosen set screw in adapter and remove neutral lockout switch from adapter.
2. Remove neutral lockout adapter from control assembly.
3. Remove pin, ball. and a-rings from adapter.

ASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Install new a-ring onto adapter and new o-ring onto pin.
2. Install ball and pin into adapter. Lubricate with petroleum jelly to hold in place during installation.
3. Install adapter into control assembly. Torque 44 to 53 ft. lbs. (60 to 70 Nm).
4. Apply Loctite #222 or equivalent to threads of switch and install neutral lockout switch into adapter. The adjustment procedures for the switch are as follows.
   a. Install switch, while moving control arm back and forth, until “detent” action is detected. Back out the switch until the “detent” action is very slight.
   b. Obtain a test light or use a multimeter. Attach the leads from the test light to the switch or the wiring connector.
   c. Move the control arm out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position “A”. See Figure 5-97. Move the control arm to the detent position and the test light should come back on.
   d. Leaving the control arm in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position"B".
   e. Unscrew the switch one third of the distance between "B" and "A". Install and tighten the hex socket head set screw in one of the main quadrants of the hex of the switch adapter. See Figure 5-97. Torque set screw 2.3 to 2.8 in. lbs. (3.2 to 3.8 Nm).
5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.
6. Remove test light and put servo control assembly into operation.

DISASSEMBLY - NEUTRAL DETENT OPTION

1. Loosen seal nut and remove ball plunger from control housing.

ASSEMBLY- NEUTRAL DETENT OPTION

1. Install ball plunger into control housing until contact with bell crank detent is detected. After contact screw in 1/2 turn and retain with seal nut. Torque nut 10 to 22 ft. lbs. (14 to 30 Nm).

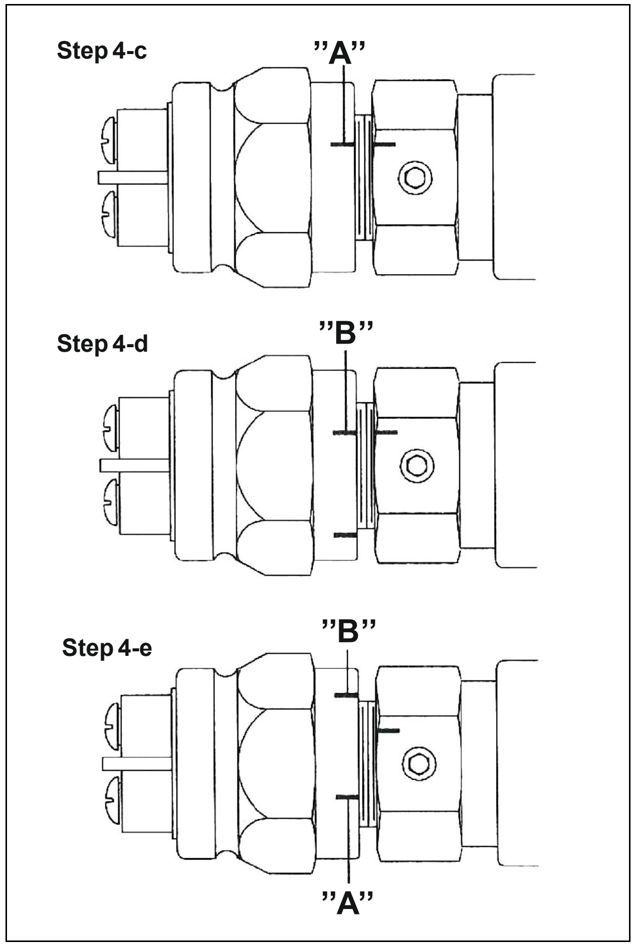


Figure 5-97. Neutral Lockout Switch Assembly

Rotating Kit Assembly

DISASSEMBLY

Disassembly of rotating assembly is required for inspection only.

1. Remove the nine piston assemblies, shoe retainer, and shoe retainer pivot from cylinder barrel.

Inspection

- Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the swashplate. **Do not lap piston shoes.**
- Examine the shoe retainer for wear in the pivot area.
- Examine the pivot to insure smoothness and no signs of wear.
- Inspect the cylinder barrel surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. Do not lap piston block.
- The pistons should move freely in the cylinder barrel bore. If they are sticky in the bore, examine the bore for scoring or contamination.

2. To inspect pins and spring caution should be taken in removing spring. The spring is highly compressed and the retaining ring should not be removed without compressing the spring safely.

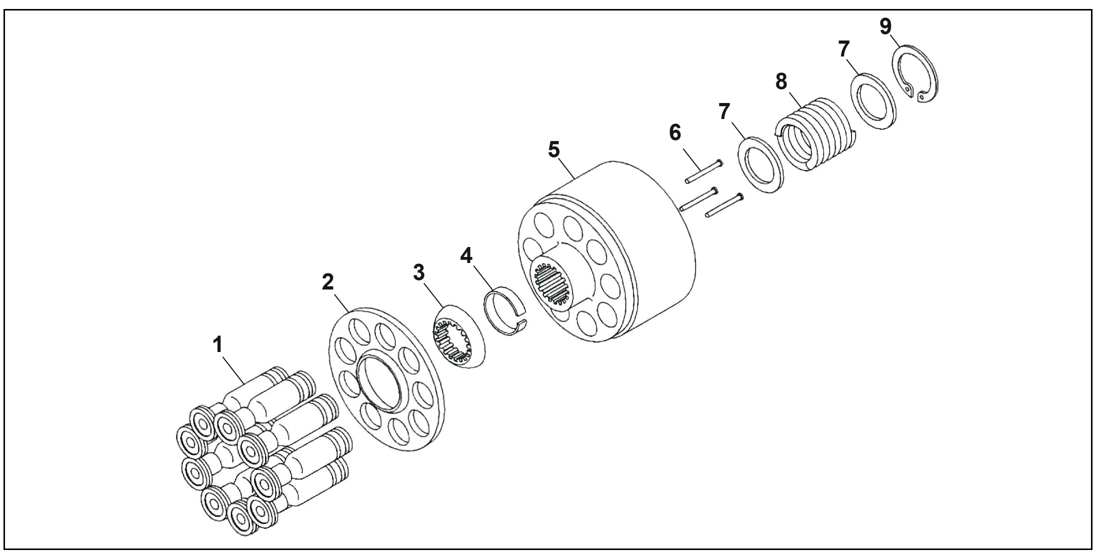
The following parts are required to disassemble the cylinder barrel:

2 ea.	3/8 in. I.D. x 1-1/8 in. O.D. flat washers
1 ea.	3/8 in. x 3-1/4 in. N.C. capscrew, and
1 ea.	3/8 in. N.C. nut

To remove spring, place one of the flat washers over the 3/8 in. x 3-1/4 in. capscrew. Put capscrew through the center of the cylinder barrel and apply the second washer. Let washer rest on the three pins and retain with nut. Turning nut and compressing spring inside the barrel. Use a pair of retaining ring pliers and remove the internal retaining ring. Remove nut, bolt, and the two washers from barrel. Remove the washer, spring, second washer, three pins, and pin keeper at the same time.

ASSEMBLY

1. To reassemble the rotating kit assembly complete the following: Compress the pin keeper and install in the spline of the cylinder barrel. Insta ll the three pins with head end to the inside of the barrel and position in the special grooves of the cylinder barrel spline.
2. Install the washer, spring, and second washer into the cylinder barrel. Use the two 3/8 in. I. D. washers, nut, and 3/8 in. x 3-1/4 in. capscrew to compress the spring and retain with retaining ring. Remove the nut. capscrew, and the two washers.
3. Install the pivot onto the three pins, shoe retainer on the pivot, and piston assemblies through the shoe retainer and into cylinder barrel resting on shoe retainer.



1.	Piston assemblies	4.	Retainer	6.	Pins	8.	Spring
2.	Shoe Retainer	5.	Cylinder Barrel	7.	Washer	9.	Retaining Ring
3.	Shoe Retainer Pivot						

Figure 5-98. Rotating Kit Assembly

Fault-logic Troubleshooting

Match the transmission symptoms with the problem statements and follow the action steps shown in the box diagrams. This will give expedient aid in correcting minor problems eliminating unnecessary machine down time.

Following the fault - logic diagrams are diagram action comments of the action steps shown in the diagrams. Where applicable, the comment number of the statement appears in the action block of the diagrams.

RECOMMENDED GAUGE LOCATIONS

Gauges Recommended

Inlet vacuum gauge: 30 PSI to 14.8 PSI (2 bar to 1 bar)

System pressure gauge: 10,000 PSI (700 bar)

Charge pressure gauge: 0 to 600 PSI (0 to 50 bar)

Case pressure gauge: 0 to 300 PSI (0 to 25 bar)

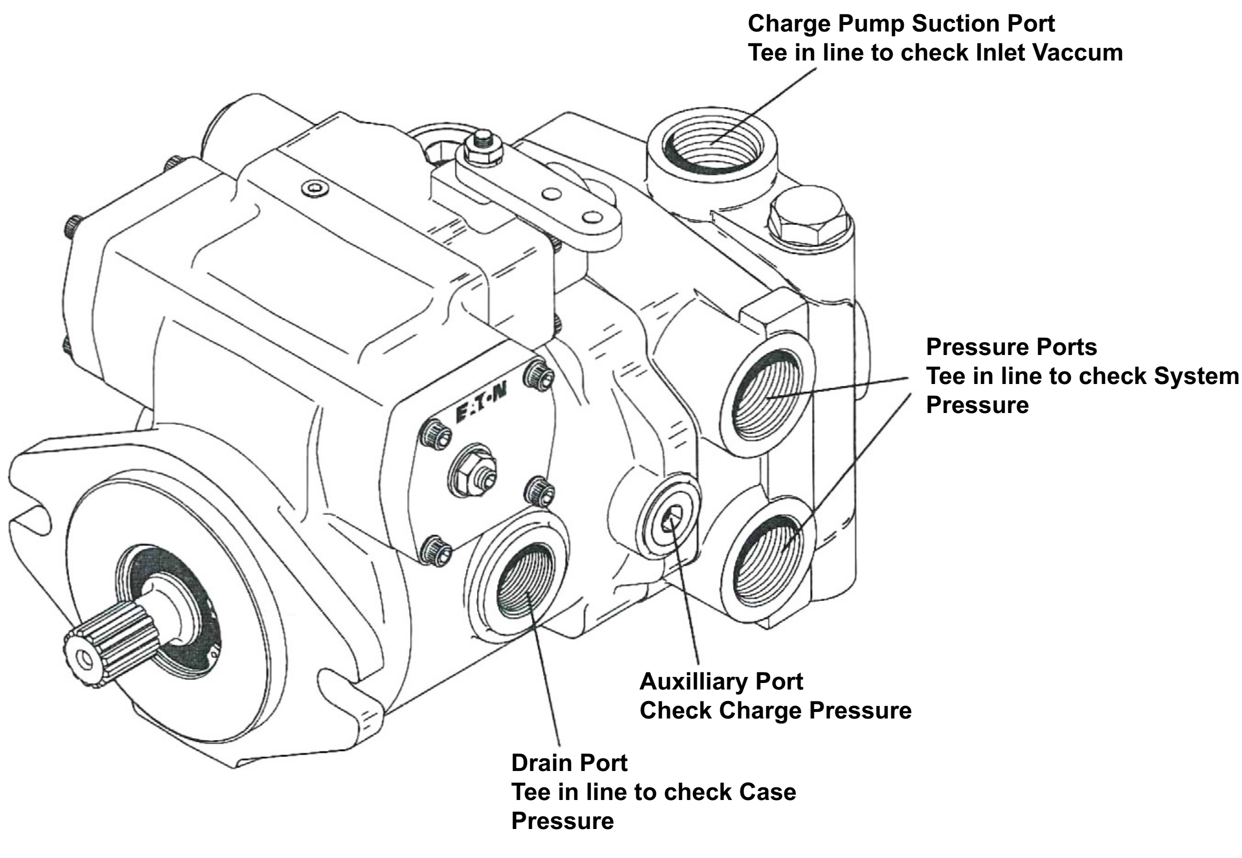


Figure 5-99. Gauge Locations

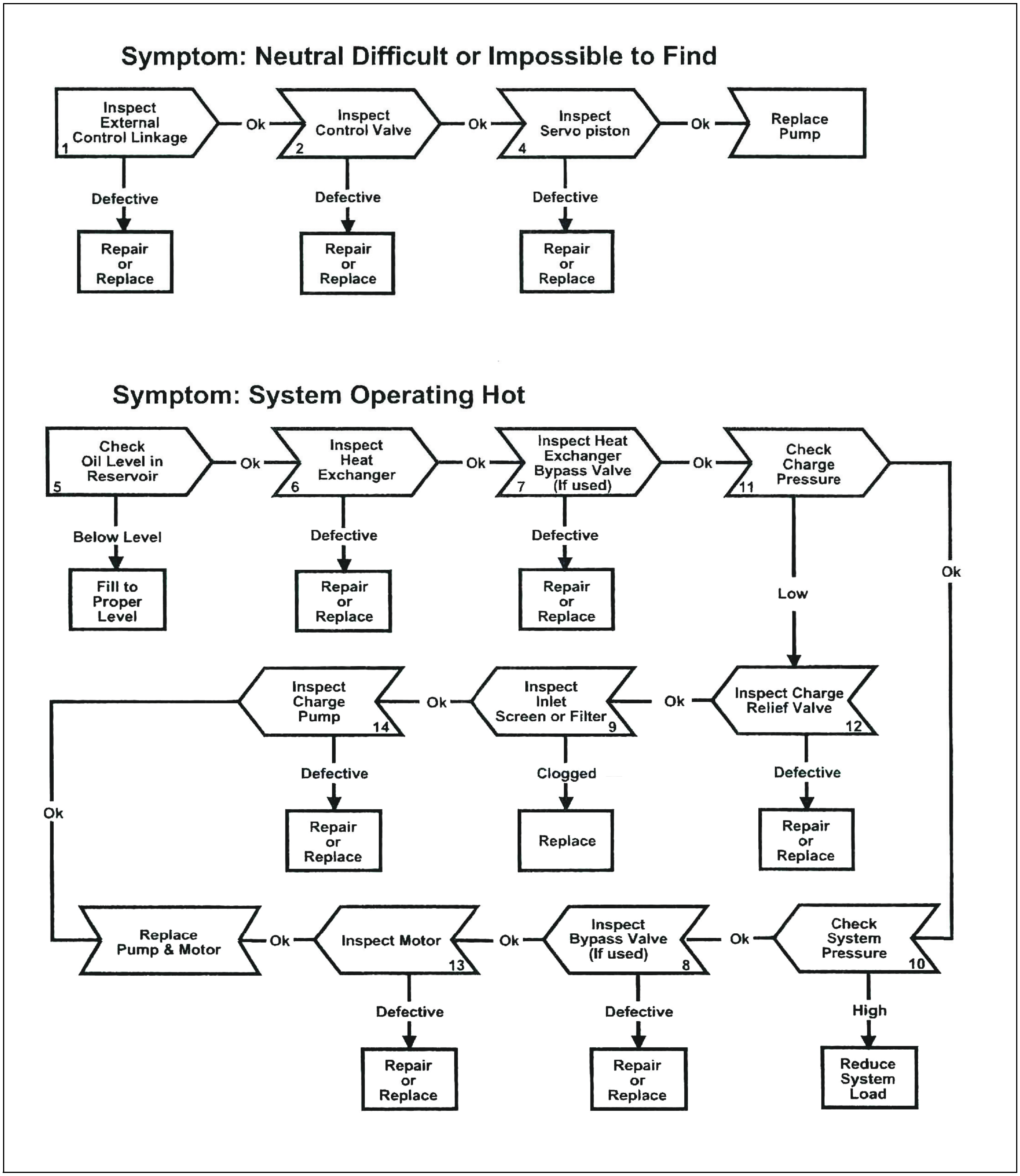


Figure 5-100. Fault - logic Troubleshooting

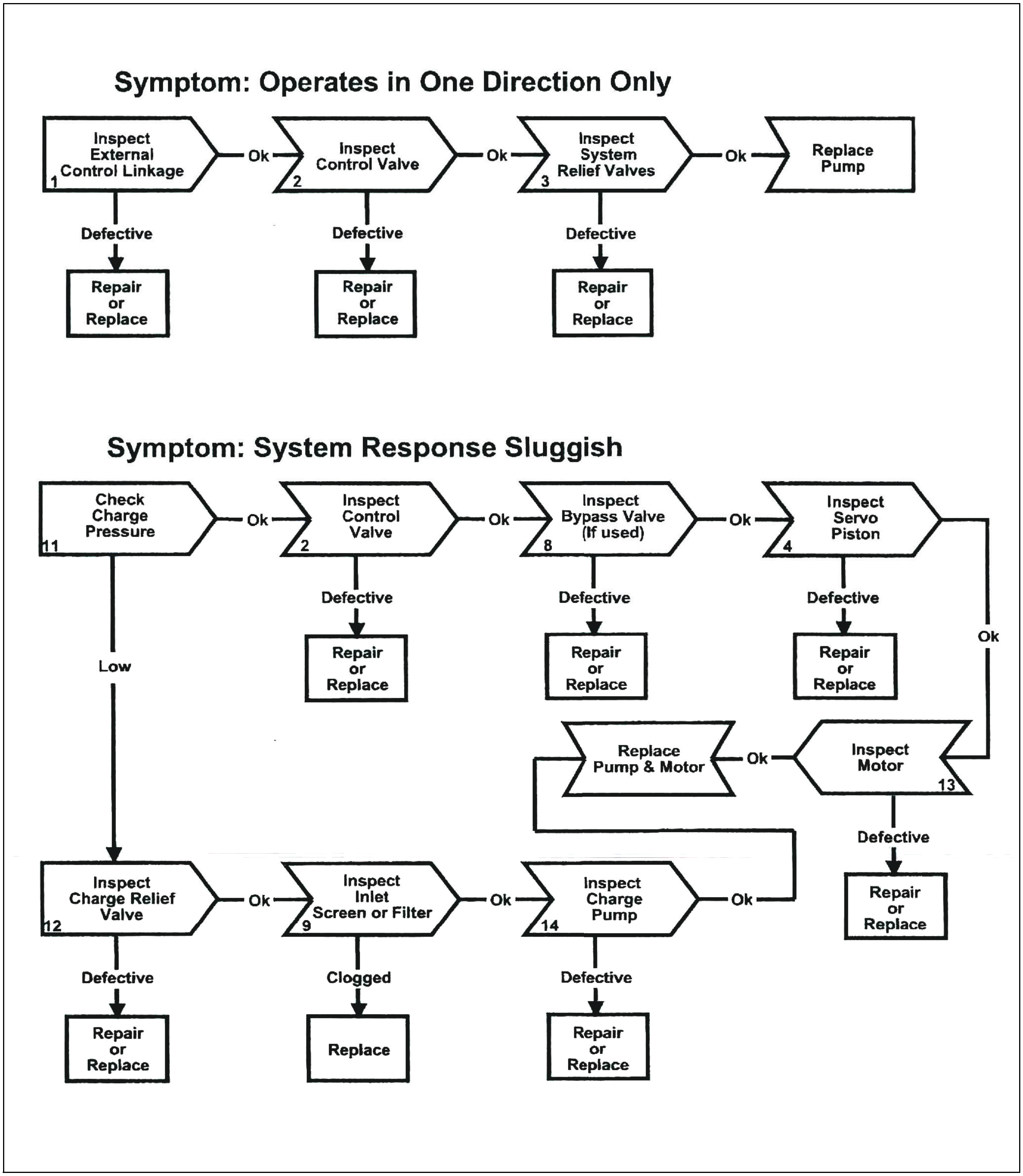


Figure 5-101. Fault - logic Troubleshooting

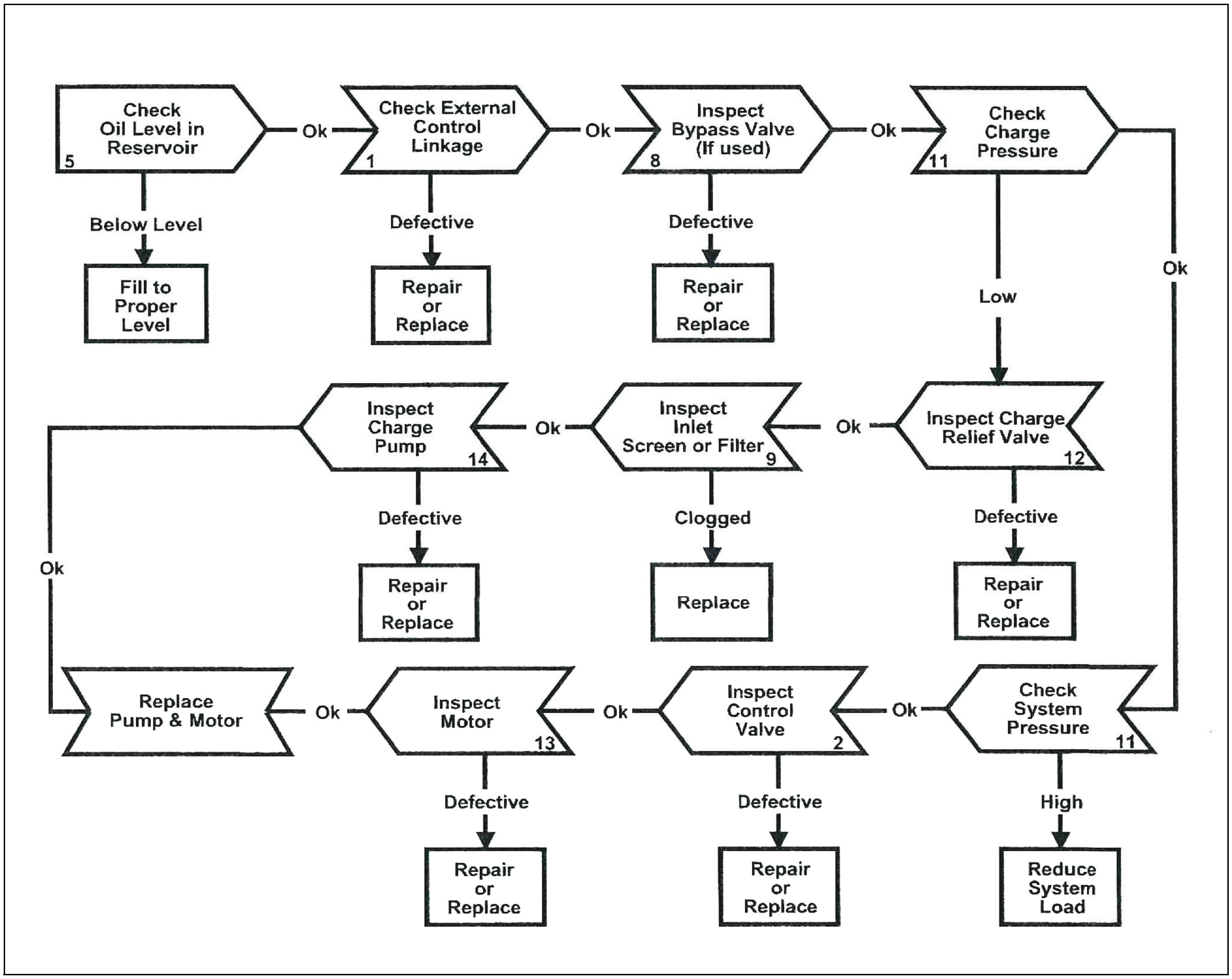


Figure 5-102. Fault - logic Troubleshooting

DIAGRAM ACTION STEP COMMENTS

1. **Inspect External Control Linkage for:**
   a. Misadjusted or disconnected
   b. Binding, bent or broken
2. **Inspect Control Valve for:**
   a. Plugged control orifice(s)
   b. Damaged mounting gasket
   c. Misadjusted, damaged or broken neutral return spring
   d. Broken control connector pin
   e. Faulty destroke valve (if used)
   f. Galled or stuck control spool
   g. Neutral detent or lockout switch misadjusted (if used)
3. **Inspect System Relief Valves for:**
   a. Improper pressure relief setting
   b. Damaged or broken spring
   c. Valve held off seat
   d. Damaged valve seat
4. **Inspect Servo Piston for:**
   a. Misadjusted, damaged or broken neutral return spring assembly
   b. Galled or stuck servo piston
   c. Damaged or missing o-ring and/or backup ring
5. **Check Oil Level in Reservoir:**
   a. Consult owner/operators manual for the proper type fluid and level
6. **Inspect Heat Exchanger for:**
   a. Obstructed air flow (air cooled)
   b. Obstructed water flow (water cooled)
   c. Improper plumbing (inlet to outlet)
   d. Obstructed fluid flow
7. **Inspect Heat Exchanger Bypass Valve for:**
   a. Improper pressure adjustment
   b. Stuck or broken valve
8. **Inspect Bypass Valve for: {if used)**
   a. Held in a partial or full open position
9. **Inspect Inlet Screen or Filter for:**
   a. Plugged or clogged screen or filter element
   b. Obstructed inlet or outlet
   c. Open inlet to charge pump
10. **Check System Pressure:**
    a. See Figure 5-99. for location of pressure gauge installation
    b. Consult owner/operators manual for maximum system relief valve settings
11. **Check Charge Pressure:**
    a. See Figure 5-99. for location of charge pressure gauge installation
    b. Consult owner/operators manual for maximum charge relief valve settings
12. **Inspect Charge Relief Valve for:**
    a. Improper charge relief pressure setting
    b. Damaged or broken spring
    c. Poppet valve held off seat
13. **Inspect Motor for:**
    a. Consult owner/operator manual for motor operation and trouble shooting
14. **Inspect Charge Pump for:**
    a. Broken or missing drive key
    b. Damaged or missing o-ring
    c. Excessive gerotor clearance
    d. Galled or broken gerotor set

System/Charge Relief Valve Pressure Settings

Inlet Vacuum	2.94 PSI (0.203 bar) max.
Case Pressure	25 PSI (1.7 bar) maximum
Charge Pressure	250 to 300 PSI (17.24 to 20.68 bar)
System Pressure	5000 PSI (345 bar) maximum
	3000 PSI (207 bar) continuous

The high pressure relief valves are all factory preset and cannot be readjusted.

The pressure setting is stamped on each valve with a three digit number. To identify, multiply the noted number by 10 to get the valves pressure setting.

Example: 10 x 500 = 5000 PSI (345 bar)

Start-up Procedure

When initially starting a new or a rebuilt transmission system. it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the unit which might occur if the system was not properly purged of air before start-up.

1. After the transmission components have been properly installed, fill the servo pump housing at least half full with filtered system oil. Connect all hydraulic lines and check to be sure they are tight.

2. Install and adjust all control linkage.

3. Fill the reservoir with an approved oil that has been filtered through a 10 micron filter. Refer to Eaton Hydraulics Technical Data sheet number 3-401 titled Hydraulic Fluid Recommendations.

4. Gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injectors and turn the engine over for 15 seconds.

5. Replace the coil wire or return the fuel flow to the injectors. Place the transmission unit in the neutral position, start the engine and run it at a low idle. The charge pump should immediately pick up oil and fill the system. If there is no indication of fill in 30 seconds, stop engine and determine the cause.

6. After the system starts to show signs of fill, slowly move pump swashplate to a slight cam angle. Continue to operate system slowly with no load on motors until system responds fully.

7. Check fluid level in the reservoir and refill if necessary to the proper level with an approved filtered oil.

8. Check all line connections for leaks and tighten if necessary.

9. The machine is now ready to be put into operation.

10. Frequent filter changes are recommended for the first two changes after placing the machine back into operation. Change the first filter in 3-5 hours and the second at approximately 50 hours. Routinely scheduled filter changes are recommended for maximum life of the hydraulic system.

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5.7 HYDRAULIC SCHEMATICS

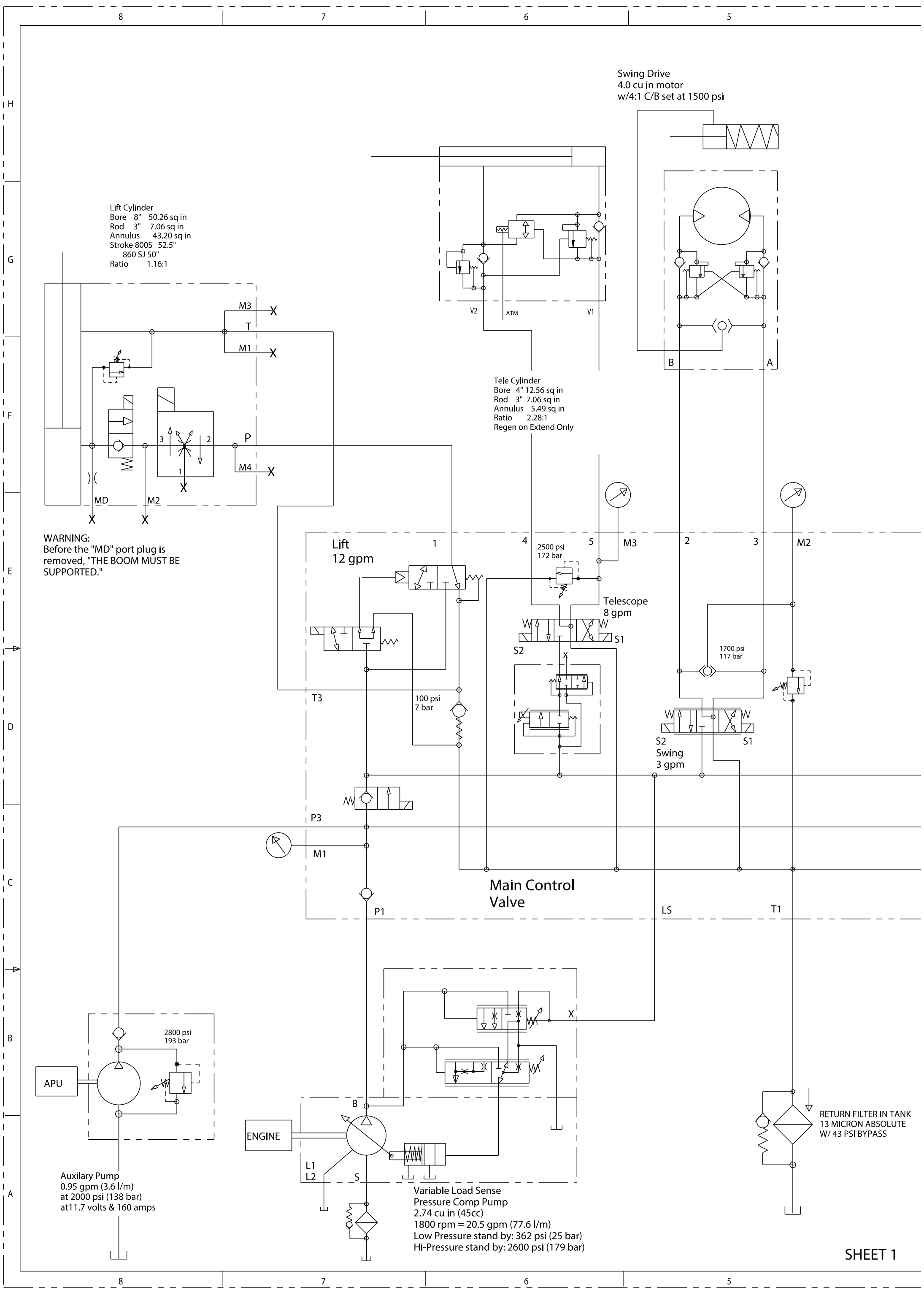


Figure 5-103. Hydraulic Schematic - Sheet 1of 8

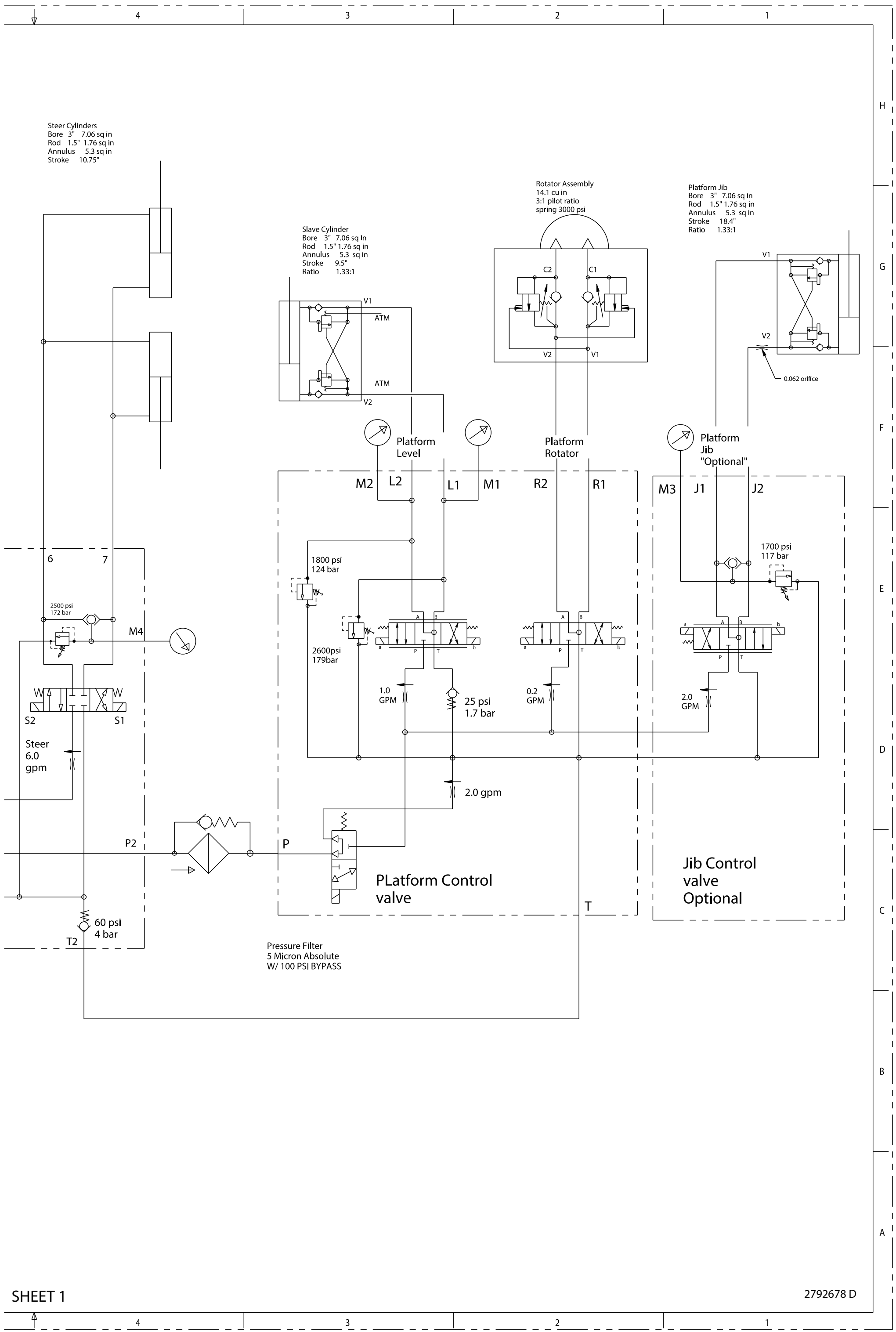


Figure 5-104. Hydraulic Schematic - Sheet 2 of 8

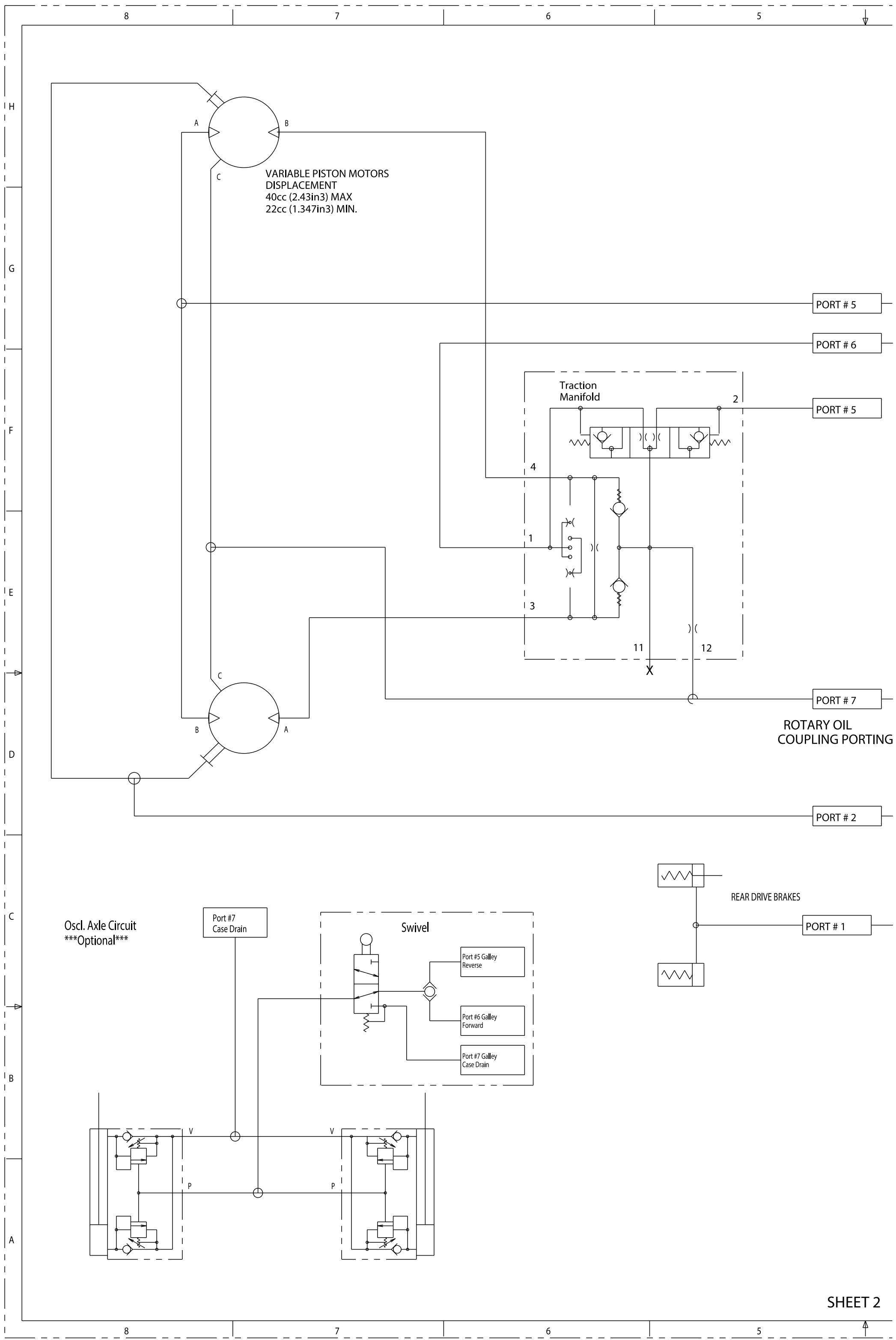


Figure 5-105. Hydraulic Schematic - Sheet 3 of 8

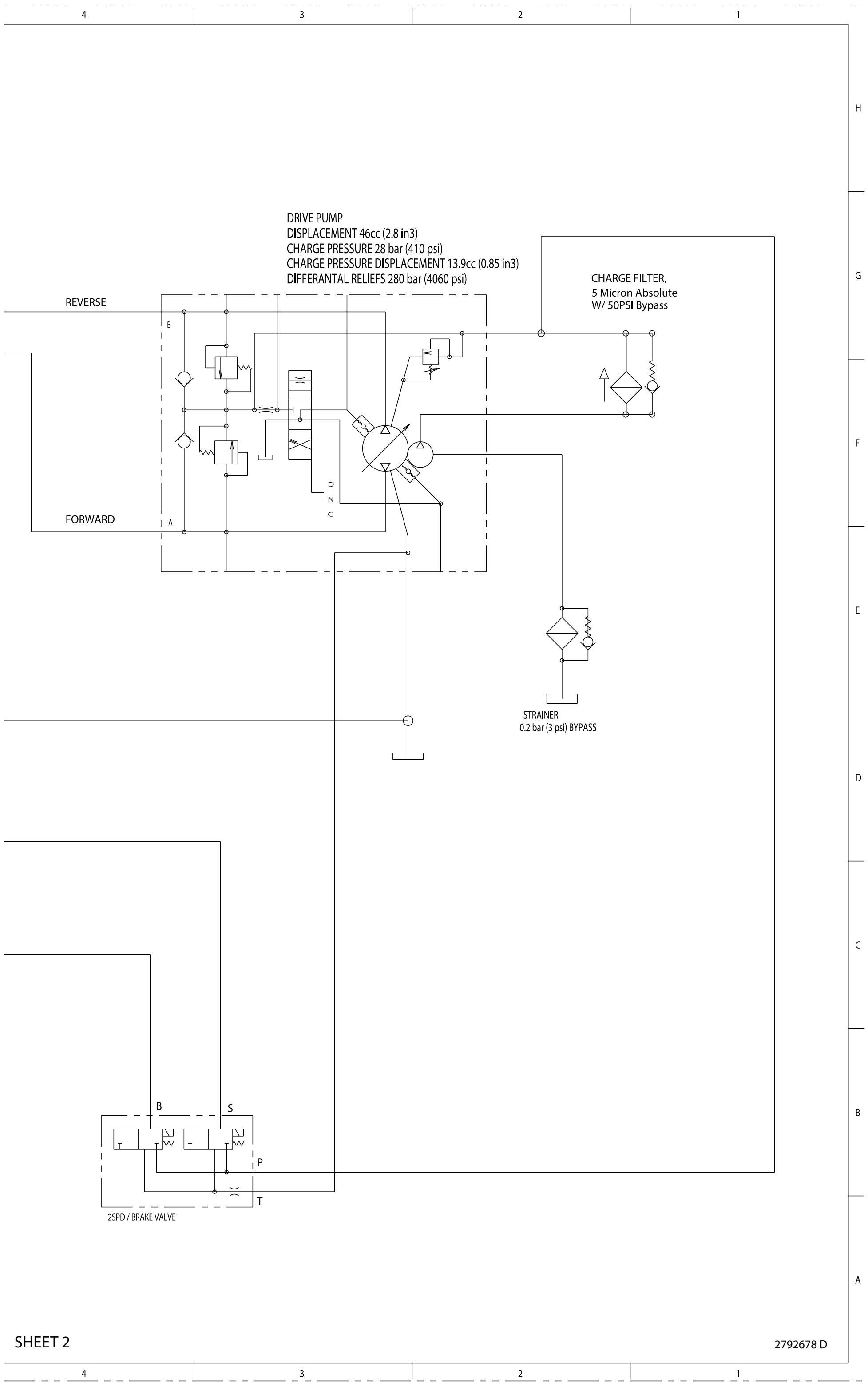


Figure 5-106. Hydraulic Schematic - Sheet 4 of 8

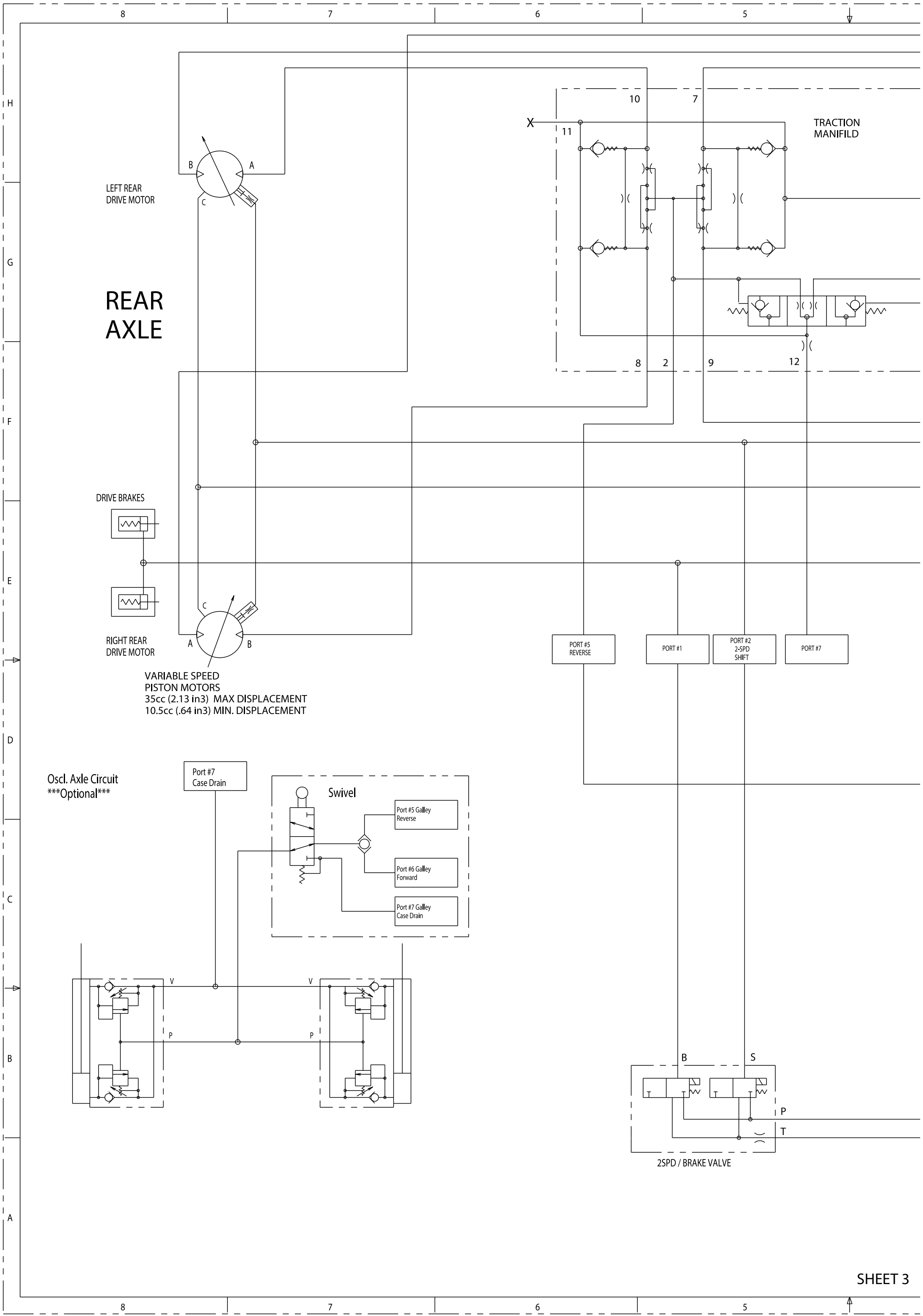


Figure 5-107. Hydraulic Schematic - Sheet 5 of 8

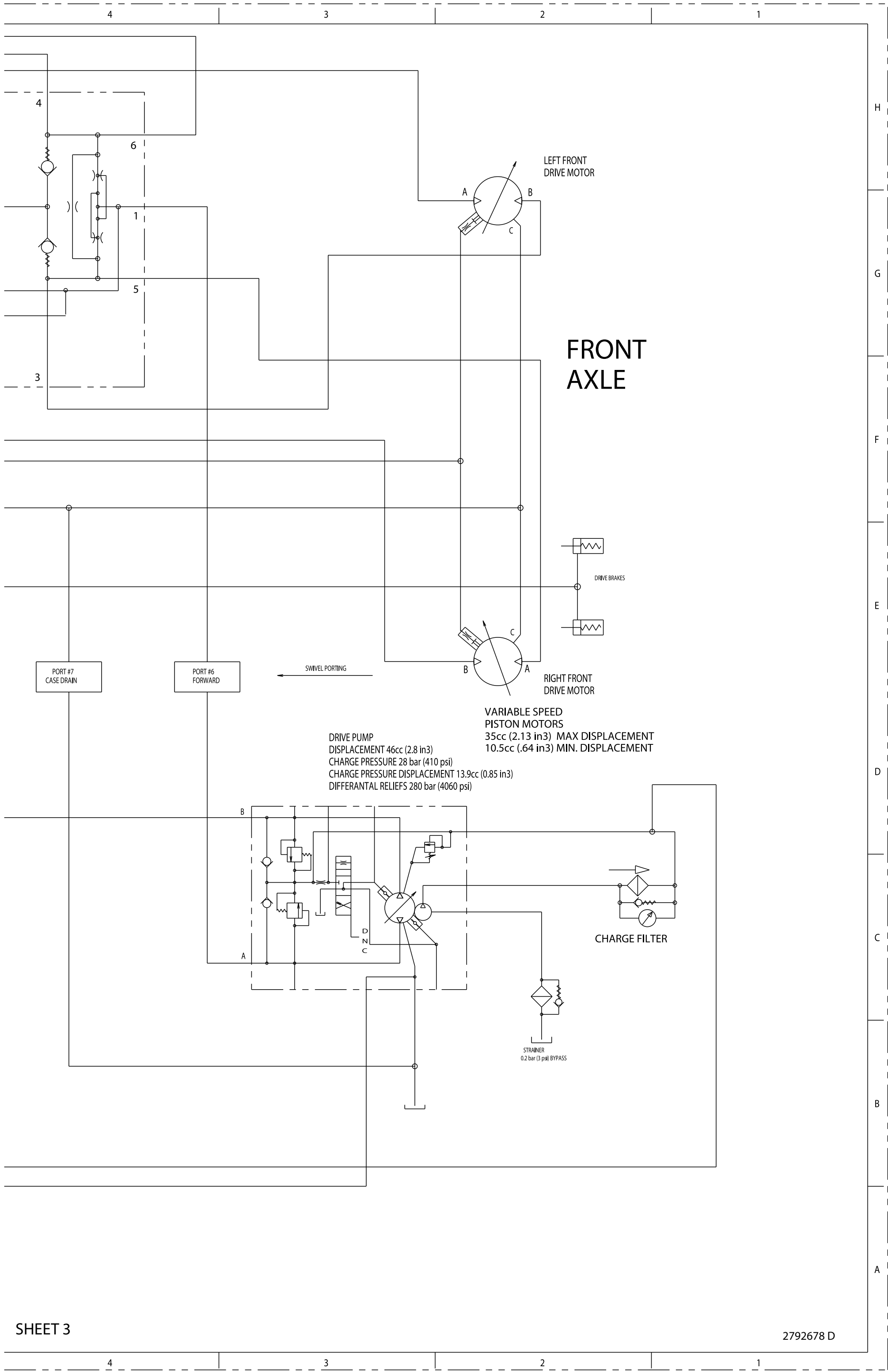


Figure 5-108. Hydraulic Schematic - Sheet 6 of 8

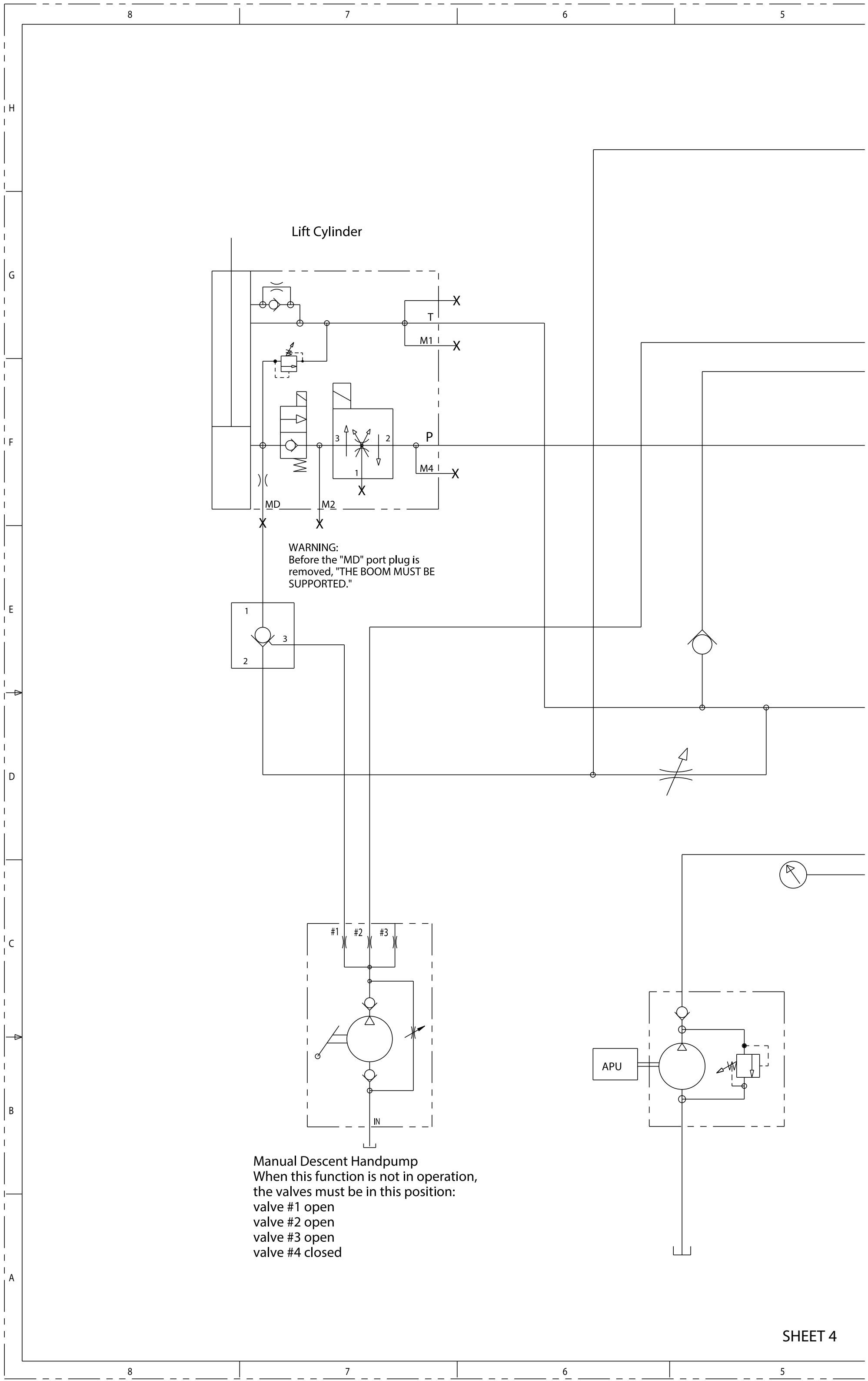


Figure 5-109. Hydraulic Schematic - Sheet 7 of 8

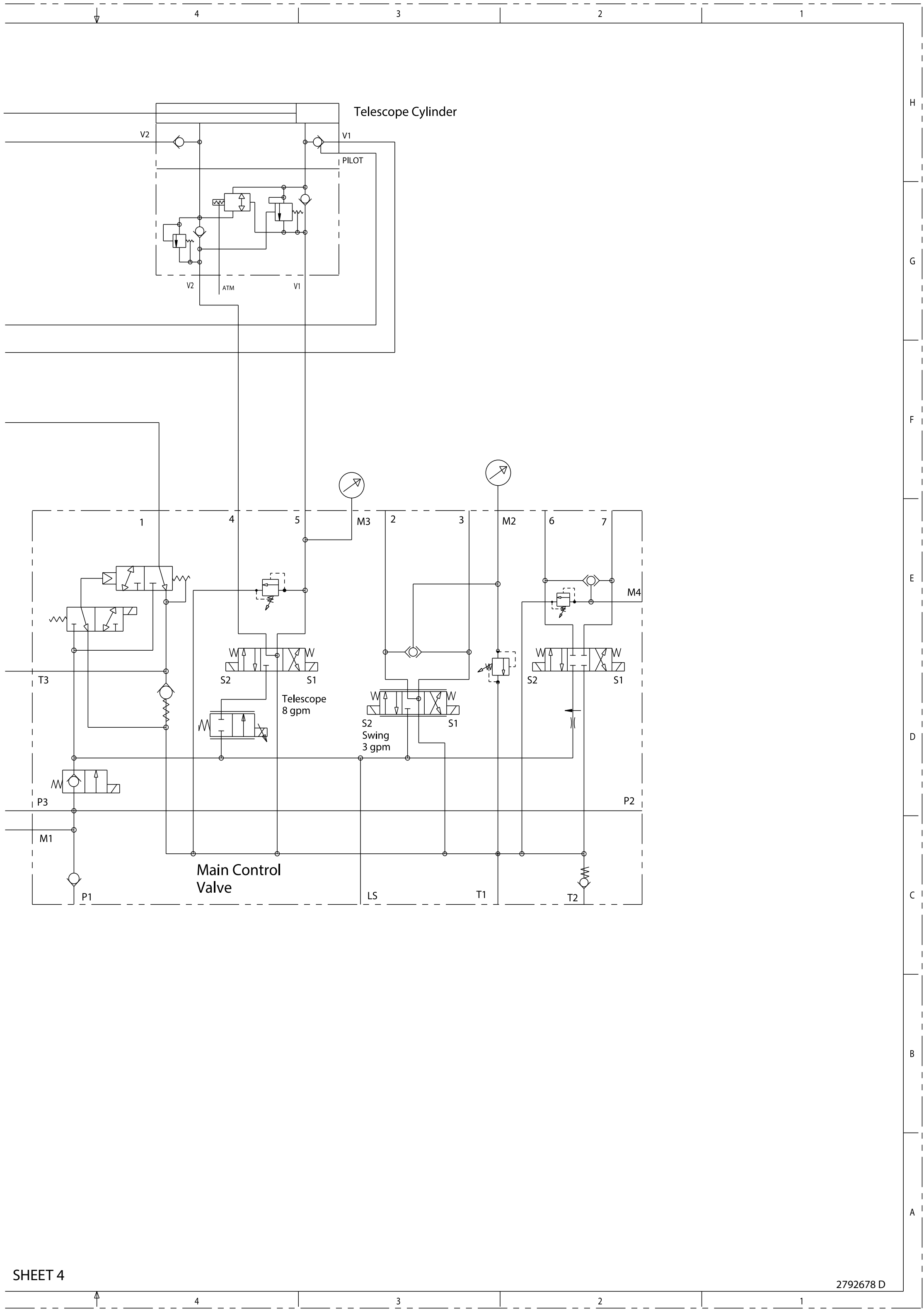


Figure 5-110. Hydraulic Schematic - Sheet 8 of 8

NOTES:

SECTION 6. JLG CONTROL SYSTEM

6.1 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

Introduction

NOTICE

ON ANY ANALYZER MENUS THAT REQUIRE MACHINE MODEL SELECTION, USE THE 800S SELECTION TO SET UP FOR THE 680S MACHINE. THE SOFTWARE DOES NOT INCLUDE A 680S SELECTION.

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.

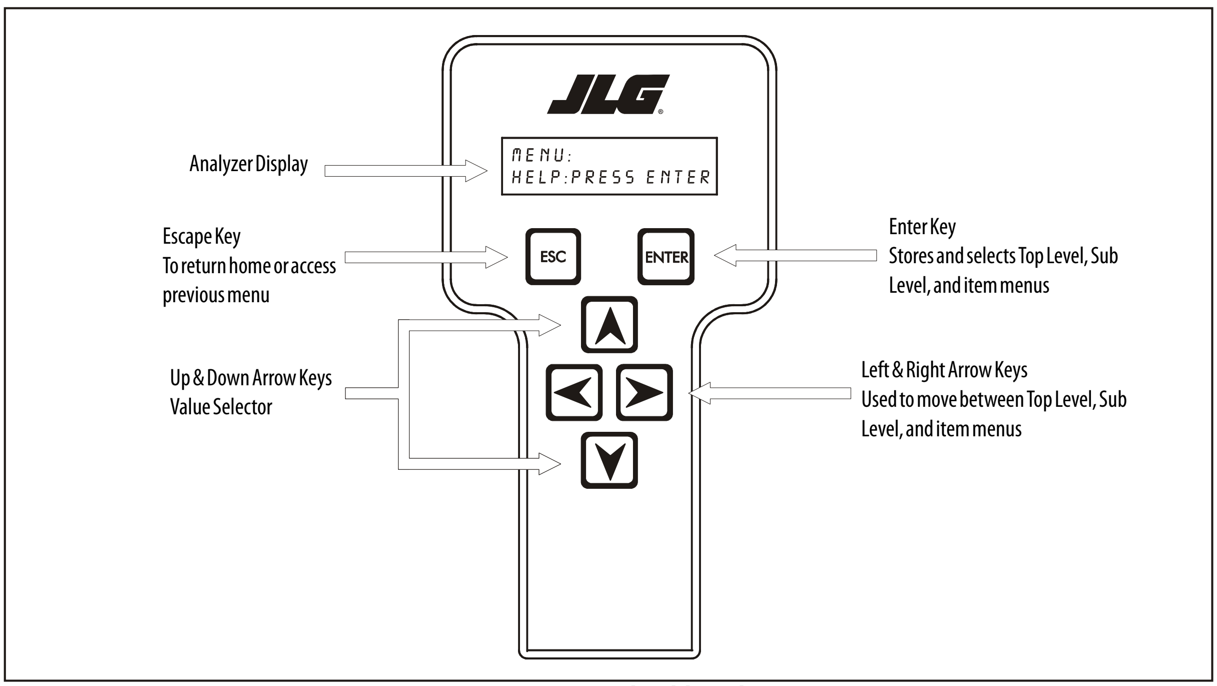


Figure 6-1. Hand Held Analyzer

To Connect the JLG Control System Analyzer

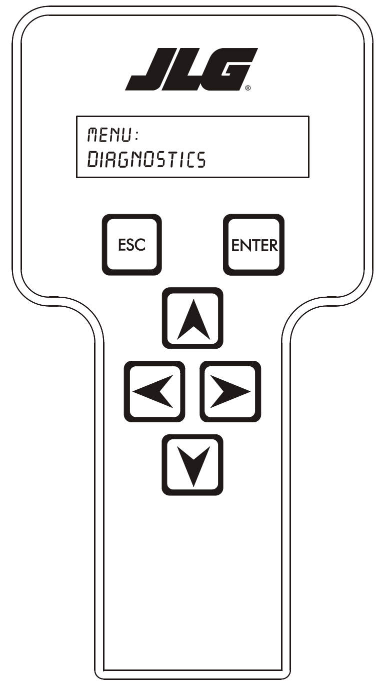
1. Connect one end of the cable, supplied with the analyzer, to the correct four pin connector on the motor control unit; there will be only one connector which correctly fits the cable.
2. Connect the other end of the cable to the analyzer.

NOTE: *The ends of the cable are identical and can be reversed; the cable end can only be inserted one way into the matching connector.*

3. Power up the vehicle by turning the key to the platform or ground position and pulling the emergency stop buttons on; this will power the SMART System and the analyzer.

Using the Analyzer

The analyzer will display the current top level menu item, for example:



MENU:
DIAGNOSTICS

Press LEFT & RIGHT to move between menu items; press ENTER to select the displayed menu item.

When a top level menu item is selected, a new set of menu items may be offered; press **LEFT** & **RIGHT** arrows then **ENTER** again to select the required item.

To cancel a selected menu item, press **ESCAPE** ; then a different menu item can be chosen.

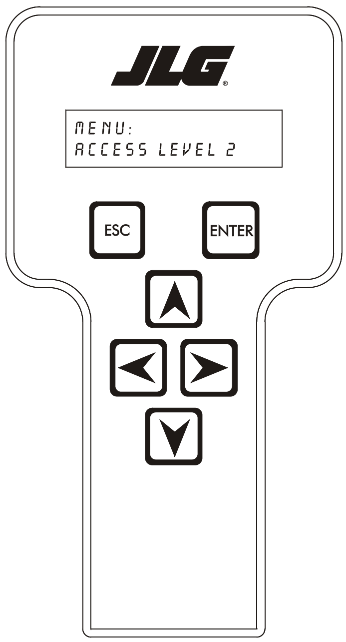
The available menu items will vary depending on the vehicle; check the vehicle manual for more information.

Changing the Access Level of the Hand Held Analyzer

When the analyzer is first connected, its access level ensures that most configurations cannot be changed; this ensures that a setting cannot be accidentally altered.

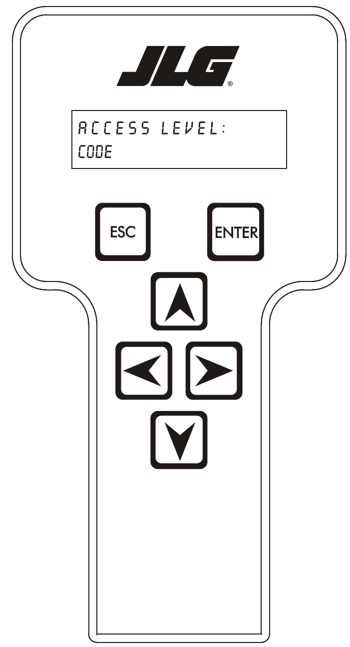
To change the access level, a PASSWORD must be entered; the password must be known.

To enter a password, first find the appropriate top level menu item:



MENU:
ACCESS LEVEL 2

Press **ENTER** to select the ACCESS LEVEL item; then press **UP** & **DOWN** arrows and **LEFT** & **RIGHT** arrows to enter the correct five digit password:



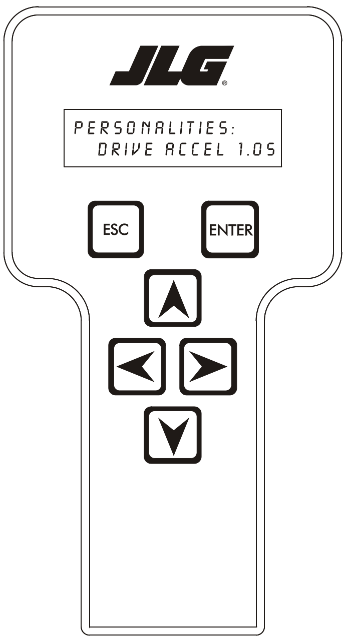
ACCESS LEVEL:
CODE 33271

When the correct password is displayed, press **ENTER** to confirm it; the access level will change to match the password (if not, press **ENTER** to check and correct the password).

The correct passwords will vary depending on the vehicle; check the vehicle manual for more information.

Adjusting Configuration Using the Hand Held Analyzer

When a personality item is selected, press **UP** & **DOWN** arrows to adjust its value, for example:



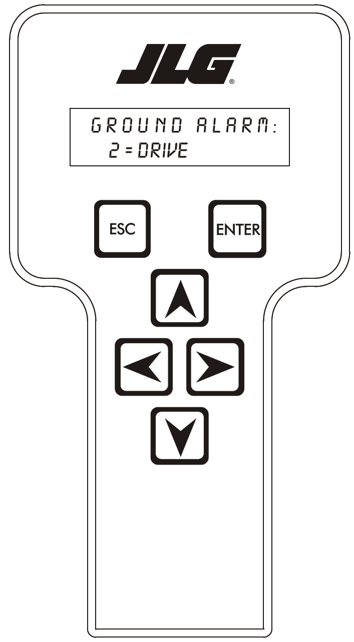
PERSONALITIES:
DRIVE ACCEL 1.0s

There will be a maximum and minimum for the value to ensure safe, operation; the value will not increase if **UP** is pressed when at the maximum, or if **DOWN** is pressed when at the minimum.

If the value does not change when **UP** or **DOWN** is pressed, check the access level.

Machine Setup

When a machine digit item is selected, press **UP** & **DOWN** to adjust its value, for example:



GROUND ALARM:
2 = DRIVE

The effect of the machine digit value is displayed along with its value; there will only be certain settings allowed to ensure safe operation.

If the value does not change when **UP** or **DOWN** is pressed, check the access level.

The available personality and machine digit items will vary depending on the vehicle; check the vehicle manual for more information.

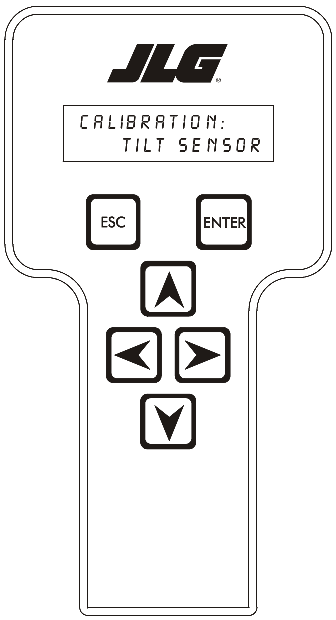
Level Vehicle Description

NOTICE

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

⚠ WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

To level machine chose:

CALIBRATION:
TILT SENSOR

Press ENTER 

.

When prompted, swing machine 180°

Press ENTER 

.

Table 6-1. Analyzer Abbreviations

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

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
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

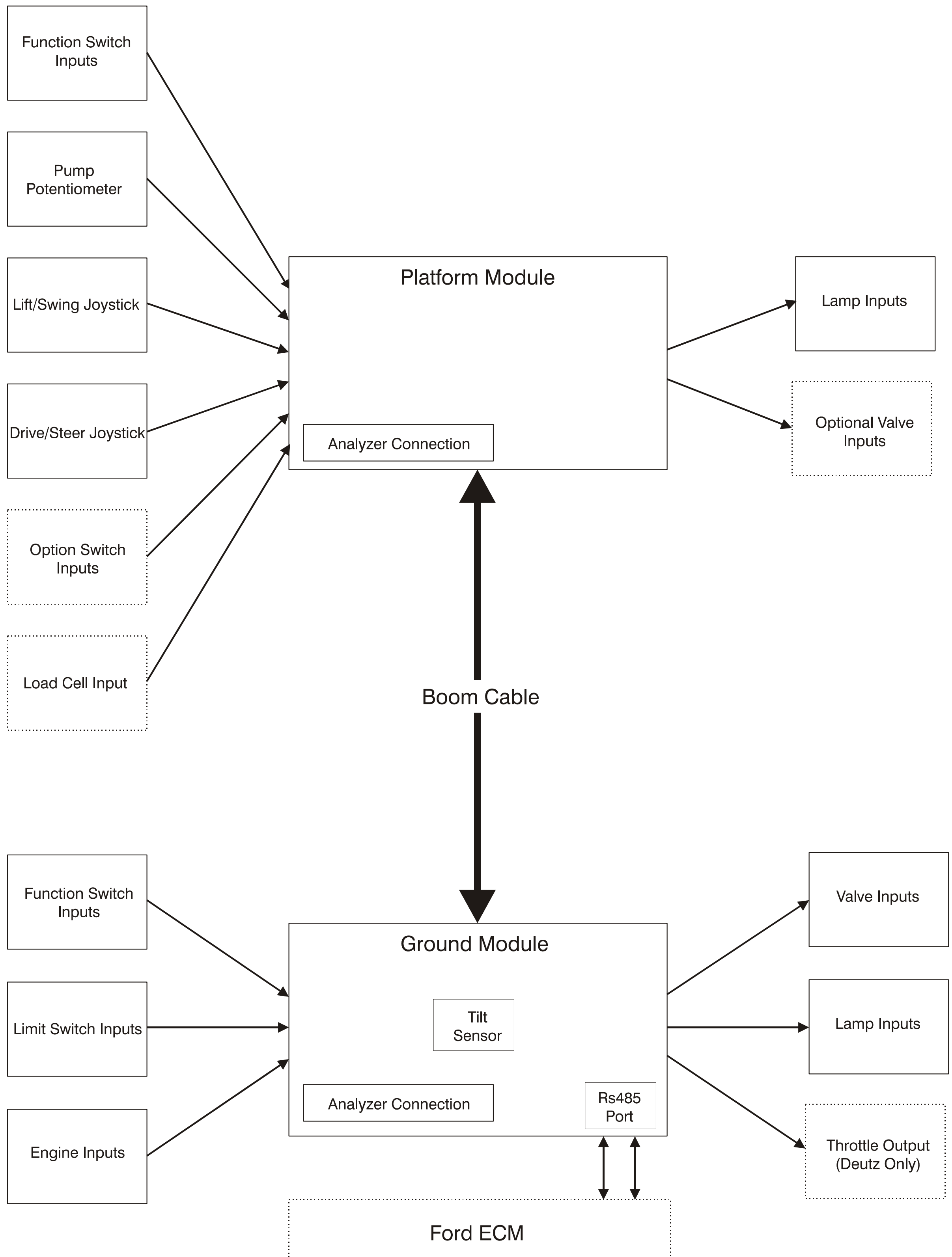


Figure 6-2. ADE Block Diagram

Table 6-2. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
MODEL NUMBER: 1	**1** 2 3 4 5 6 7 8 9 10	**400S** 450A 510A 600S 600A 600SC 601S 740A 800A 800S	**1**
MARKET: 2	**0** 1 2 3 4 5	**ANSI USA** ANSI EXPORT CSA CE AUSTRALIA JAPAN	**0**
ENGINE: 3* * Engine selections vary depending on model selection.	1 2 3 4 5 6 7 8 9 10 **11**	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1) FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1) DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1) DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1) CAT. 3024C: CAT 3024C Diesel (Tier 2) CAT. 3044C: CAT 3044C Diesel (Tier 2) DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2) DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2) FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2) FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2) **DEUTZ ECM: Engine Control Module - ECM**	**11**
FLYWHEEL TEETH: 4* * This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0 **1**	133 TEETH: 133 flywheel teeth. **110 TEETH: 110 flywheel teeth.**	**1**

Table 6-2. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0 **1** 2	NO GLOW PLUGS: No glow plugs installed. **W/O STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.** W/ STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	**1**
ENGINE SHUTDOWN: 6	0 **1**	DISABLED: No engine shutdown. **ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 psi.**	**1**
TILT: 7* *Certain market selections will limit tilt options.	**1** 2 3 4 5	**5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.** 4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep. 3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep. 4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. 3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. *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**
JIB: 8* *Only visible under certain model selections	**0** 1	**NO: No jib installed.** YES: Jib installed which has up and down movements only.	**0**
4 WHEEL STEER: 9* *Only visible under certain model selections.	**0** 1	**NO: No four-wheel steer installed.** YES: Four-wheel steer installed.	**0**
SOFT TOUCH: 10* *Only visible under certain model selections.	**0** 1	**NO: No soft touch system installed.** YES: Soft touch system installed.	**0**
GEN SET/WELDER: 11	**0** 1	**NO: No generator installed.** BELT DRIVE: Belt driven setup.	**0**

Table 6-2. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
GEN SET CUTOUT: 12* * Only visible if Gen Set / Welder Menu selection is not 0.	**0** 1	**MOTION ENABLED: Motion enabled when generator is ON.** MOTION CUTOUT: Motion cutout in platform mode only.	**0**
H & T LIGHTS: 13	**0** 1	**NO: No head and tail lights installed.** YES: Head and tail lights installed.	**0**
CABLE SWITCH: 14* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	**0** 1	**NO: No broken cable switch installed.** YES: Broken cable switch installed.	**0**
LOAD SYSTEM: 15* * Only visible under certain model selections. * Certain market selections will limit load system options or alter default setting.	**0** 1 2 3 4	**NO: No load sensor installed.** WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	**0**
LOAD SENSOR: 16* * Only visible if Load Sensor Menu selection is not 0. * Market selections will limit certain load sensor options.	0 **1**	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. **4 UNDER PLATFORM: Use the EIM for load sensing.**	**1**
FUNCTION CUTOUT: 17* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	**0** 1 2 3	**NO: No drive cutout.** BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive cutout above elevation. DRIVE CUT E&T: Drive cutout above elevation and tilted.	**0**
GROUND ALARM: 18* * Certain market selections will alter default setting.	**0** 1 2 3	**NO: No ground alarm installed.** DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	**0**
DRIVE: 19* * Only visible under certain model selections.	**0** 1 2	**4WD: Four wheel drive.** 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	**0**

Table 6-2. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
TEMPERATURE: 20	0 **1**	CELSIUS: Celsius unit selection. **FAHRENHEIT: Fahrenheit unit selection.**	**1**
LEVELING MODE: 21* * Only visible on 800S models.	**0** 1	**ALL FUNCTIONS: Platform level with all functions.** LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	**0**

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Table 6-3. Machine Configuration Programming Information (Software Version P5.X)

Configuration Digit	Number	Description	Default Number
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	
	11	H800A	
MARKET: 2	**0**	**ANSI USA**	**0**
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	
	6	GB	

Table 6-3. Machine Configuration Programming Information (Software Version P5.X)

Configuration Digit	Number	Description	Default Number
ENGINE: 3* *Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	**12**
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	**DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)**	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	14	PERKINS ECM	
	15	CAT ECM	
	16	DEUTZ ECM T4F: Deutz Engine Control Module (Tier 4 Final)	
	17	FORD DUAL FUEL	
	18	KUBOTA D1305	
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 6-3. Machine Configuration Programming Information (Software Version P5.X)

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0 1 **2**	NO GLOW PLUGS: No glow plugs installed. AIR INTAKE: Glow plugs installed in the air intake on the manifold. **IN-CYLINDER: Glow plugs installed in each cylinder.**	**2**
STARTER LOCKOUT: 6	**0** 1	**DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.** ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	**0**
FUEL CUTOUT 7* * This menu item is only visible if non dual fuel engines are selected.	**0** 1 2	**RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached.** ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached. ENGINE STOP: Engine not able to restart when very low fuel level is reached.	**0**
ENGINE SHUTDOWN: 8	0 **1**	DISABLED: No engine shutdown. **ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.**	**1**

Table 6-3. Machine Configuration Programming Information (Software Version P5.X)

Configuration Digit	Number	Description	Default Number
TILT: 9* * Certain market selections will limit tilt options and alter default setting. Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.	**1** 2 3 4 5 6 7 8 9	**5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.** 4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep. 3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep. 4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. 3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up. 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. 5 DEGREES + DRIVE 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. 4 DEGREES + DRIVE 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. 3 DEGREES + DRIVE 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.	**1**
JIB: 10* * Only visible under certain model selections.	**0** 1	**NO: No jib installed.** YES: Jib installed which has up and down movements only.	**0**
4 WHEEL STEER: 11* * Only visible under certain model selections.	**0** 1	**NO: No four-wheel steer installed.** YES: Four-wheel steer installed.	**0**

Table 6-3. Machine Configuration Programming Information (Software Version P5.X)

Configuration Digit	Number	Description	Default Number
ST TOUCH / SKYGUARD: 12	**0** 1 2 3	**NONE: No soft touch or skyguard system installed.** SOFT TOUCH - Soft touch only installed. SKYGUARD - Skyguard only installed. BOTH (CUTOUT) - Soft touch and Skyguard installed.	**0**
GEN SET/WELDER: 13	**0** 1	**NO: No generator installed.** BELT DRIVE: Belt driven setup.	**0**
GEN SET CUTOUT: 14* * Only visible if Gen Set / Welder Menu selection is not 0.	**0** 1	**MOTION ENABLED: Motion enabled when generator is ON.** MOTION CUTOUT: Motion cutout in platform mode only.	**0**
H & T LIGHTS: 15	**0** 1	**NO: No head and tail lights installed.** YES: Head and tail lights installed.	**0**
CABLE SWITCH: 16* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	**0** 1	**NO: No broken cable switch installed.** YES: Broken cable switch installed.	**0**

Table 6-3. Machine Configuration Programming Information (Software Version P5.X)

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** 1 2 3 4	**NO: No load sensor installed.** WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	**0**
LOAD SENSOR: 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** 2	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. **4 UNDER PLATFORM: Use the EIM for load sensing.** SINGLE CELL: Single Cell, CANbus based sensor.	**1**
FUNCTION CUTOUT: 19* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	**0** 1 2 3	**NO: No drive cutout.** BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive & steer cutout above elevation. DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	**0**
GROUND ALARM: 20* * Certain market selections will alter default setting.	0 1 2 **3**	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). **MOTION: Motion alarm sounds when any function is active (Option).**	**3**
DRIVE: 21* * Only visible under certain model selections.	**0** 1 2	**4WD: Four wheel drive.** 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	**0**

Table 6-3. Machine Configuration Programming Information (Software Version P5.X)

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 6-3. Machine Configuration Programming Information (Software Version P5.X)

Configuration Digit	Number	Description	Default Number
CRIBBING OPTION: 29	**0** 1	**NO: Cribbing Option is disabled.** YES: Cribbing Option is enabled.	**0**
FUEL TANK SIZE: 30	**0** 1	**31 Gallon Tank** 52 Gallon Tank	**0**
ALARM / HORN: 31	**0** 1	**SEPERATE: Separate alarm and horn.** COMBINED: Combination alarm / horn.	**0**
ALERT / BEACON: 32	**0** 1	**OFF FOR CREEP: Alert beacon will not flash while in Creep.** 20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep.	**0**
TEMP CUTOUT: 33	**0** 1	**NO: Temp Cutout is Disabled.** YES: Temp Cutout is Enabled.	**0**
PLAT LVL OVR CUT: 34	**0** 1	**NO: Platform Level Override will always be functional.** YES: Platform Level Override will only be functional when In Transport.	**0**
WATER IN FUEL SENSOR: 35* *This menu item is only visible if Deutz EMR 4 engine is selected. *Only visible under certain market selections.	**0** 1	**NO: Water in Fuel Sensor Disabled.** YES: Water in Fuel Sensor Enabled.	**0**
DUAL CAPACITY: 36	**0** 1	**NO: Dual Capacity is Disabled.** YES: Dual Capacity is Enabled.	**0**

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Table 6-4. Machine Configuration Programming Settings

680S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	10	10	10	10	10	10	10
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
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

Table 6-4. Machine Configuration Programming Settings

680S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
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	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
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

Table 6-4. Machine Configuration Programming Settings

680S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
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
Water In 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 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 6-5. Machine Personality Settings and Function Speeds

FUNCTION	PERSONALITY	RANGE	SAUER DANFOSS	EATON
DRIVE	ACCELeration	0.1 to 5.0 s	2.0	2.0
	DECELeration	0.1 to 3.0 s	2.0	2.0
	FORward MINimum speed	0 to 35%	4	15
	FORward MAXimum speed	0 to 100%	30	53
	REVerse MINimum speed	0 to 35%	4	15
	REVerse MAXimum speed	0 to 100%	30	53
	ELEVATED MAXimum speed	0 to 50%	20	28
	CREEP MAXimum speed	0 to 50%	20	30
	Engine RPM	800 to 2900	1800	1800
STEER	MAXimum speed	0 to 100%	100	100
	Engine RPM	800 to 2900	1800	1800
MAIN LIFT	ACCELeration	0.1 to 5.0s	2.5	2.5
	DECELeration	0.1 to 3.0s	1.5	1.5
	MINimum UP speed	0 to 60%	15	15
	MAXimum UP speed	0 to 100%	80	80
	CREEP maximum UP speed	0 to 65%	30	30
	MINimum DOWN speed	0 to 60%	15	15
	MAXimum DOWN speed	0 to 100%	80	80
	CREEP maximum DOWN speed	0 to 75%	30	30
	Engine RPM	800 to 2900	1800	1800
SWING	ACCELeration	0.1 to 5.0s	2.8	2.8
	DECELeration	0.1 to 3.0s	1.7	1.7
	MINimum LEFT speed	0 to 50%	14	14
	MAXimum LEFT speed	0 to 100%	65	65
	CREEP maximum LEFT speed	0 to 65%	43	43
	MINimum RIGHT speed	0 to 50%	14	14
	MAXimum RIGHT speed	0 to 100%	68	68
	CREEP maximum RIGHT speed	0 to 65%	49	49
	Engine RPM	800 to 2900	1800	1800

Table 6-5. Machine Personality Settings and Function Speeds

FUNCTION	PERSONALITY	RANGE	SAUER DANFOSS	EATON
MAIN TELESCOPE	ACCELeration	0.1 to 5.0s	3.5	3.5
	DECELeration	0.1 to 3.0s	1.0	1.0
	MINimum IN speed	0 to 65%	24	24
	MAXimum IN speed	0 to 100%	63	63
	MINimum OUT speed	0 to 65%	26	26
	MAXimum OUT speed	0 to 100%	65	65
	Medium Speed	0.01 to 1.00	0.50	0.50
	Engine RPM	800 to 2900	1800	1800
PLATFORM LEVEL	ACCELeration	0.1 to 5.0s	0.1	0.1
	DECELeration	0.1 to 3.0s	0.1	0.1
	MINimum UP speed	0 to 65%	48	48
	MAXimum UP speed	0 to 100%	100	100
	MINimum DOWN speed	0 to 65%	48	48
	MAXimum DOWN speed	0 to 100%	100	100
	Medium Speed	0.01 to 1.00	0.10	0.10
	Engine RPM	800 to 2900	1800	1800
PLATFORM ROTATE	ACCELeration	0.1 to 5.0s	0.1	0.1
	DECELeration	0.1 to 3.0s	0.1	0.1
	MINimum LEFT speed	0 to 65%	69	69
	MAXimum LEFT speed	0 to 100%	90	90
	MINimum RIGHT speed	0 to 65%	69	69
	MAXimum RIGHT speed	0 to 100%	90	90
	Medium Speed	0.01 to 1.00	0.30	0.30
	Engine RPM	800 to 2900	1800	1800
GROUND MODE	Main LIFT UP speed	0 to 100%	63	63
	Main LIFT DOWN speed	0 to 100%	63	63
	SWING speed	0 to 100%	64	64
	Main TELEscope speed	0 to 100%	62	62
	BASKET ROTATE speed	0 to 100%	89	89
	BASKET LEVEL speed	0 to 100%	99	99
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: Telescope Retracted. Lift Up, and Record Time. Lift Down and Record Time.

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

Telescope: Boom lift at Full Elevation, Telescope Out and Record Time. Telescope In and Record Time.

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

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

Platform Rotate: Platform level and completely rotated one direction. Rotate 180 degrees and Record Time. Rotate the other direction, Record Time.

Test Notes

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

Table 6-6. Function Speeds (In Seconds)

Function	680S
Main Lift Up	59-75
Main Lift Down	57-75
Swing Right & Left*	110-135
NOTE: *No more than 10% difference between swing left and swing right.*	
Main Telescope Out	50-56
Main Telescope In	38-49
Platform Rotate Right & Left*	18-30
NOTE: *No more than 15% difference between rotate left and rotate right.*	
Drive (Forward)	33-45
Drive (Reverse)	33-45
Drive (Elevated)	46-75

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6.4 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform Module, Ground Module, Boom Length Angle Module and the Chassis Module providing bi-directional communications.

Two-wire: One wire (red) is driven high (5v) and the other low (black) (0v) to send a signal; both wires "float" (2.5v) when no signal is being sent.

Differential: Any electrical line noise can affect the high or the low wires but never both, so communications is not corrupted.

Serial Link: Messages are being sent bit by bit along the wires; the high bus speed allow all modules to be constantly updated around 20 times per second. Typical traffic is 300 - 500 messages per second.

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station or below the BLAM. Each individual circuit from the modules is approximately 120 ohms.

The GROUND MODULE (UGM) is the master system controller. Most functions are dispatched and coordinated from this module, The PLATFORM MODULE handle sub-tasks. All characterized information (values) are stored into the ground module (i.e. Personalities or Calibrations).

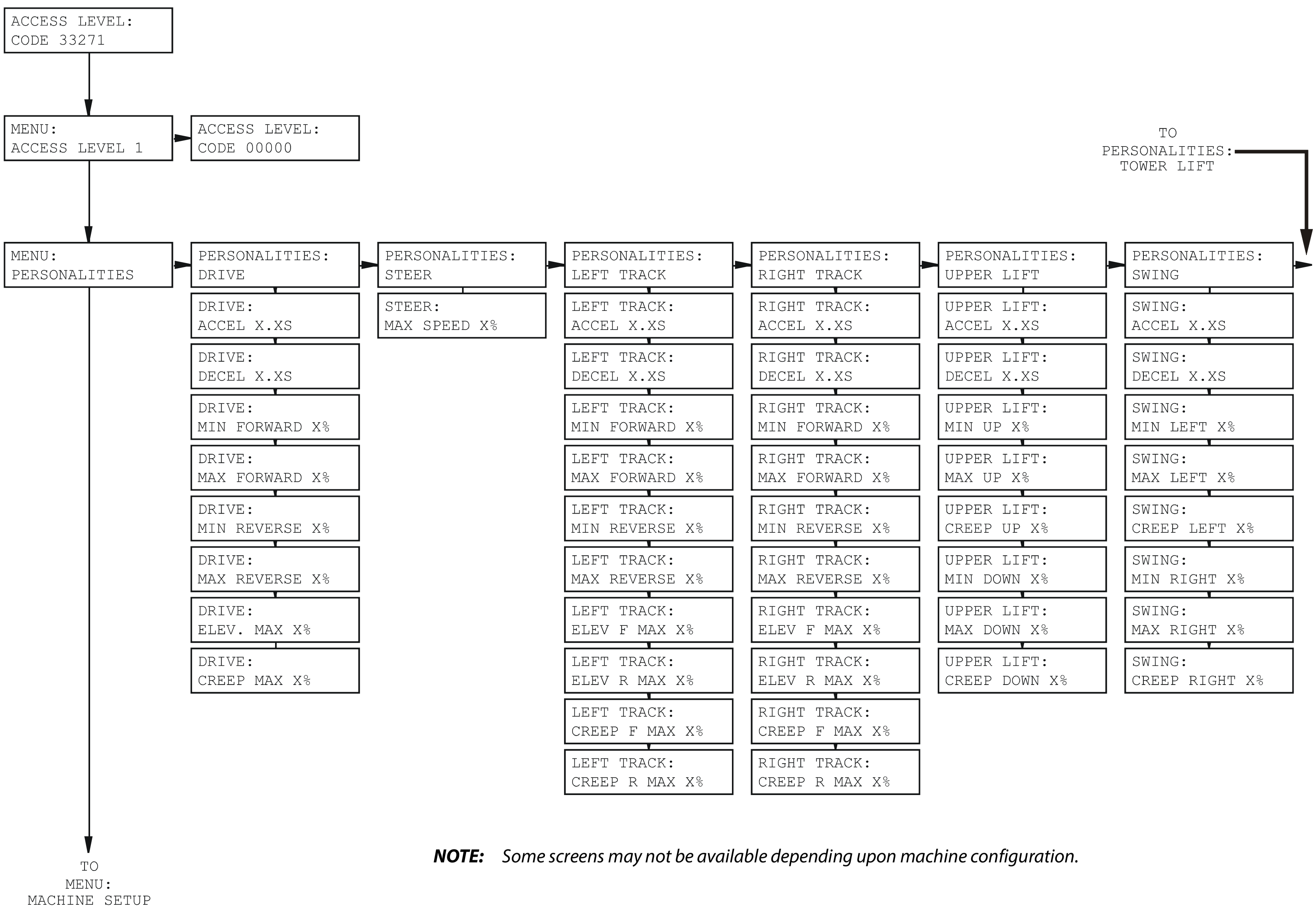
Interlocks: Any device that sends an electrical input. (For an example a limit switch, proximity switch, etc).

Platform Level: The GROUND MODULE stores the default values and handles interlocks. The PLATFORM MODULE reads the sensors mounted on the platform assembly and controls the Level Up / Down valves to maintain setpoint sent from the GROUND MODULE.

Steer: The GROUND MODULE stores crack points and sends desired drive direction, steering mode and axle extend/retract commands. The PLATFORM MODULE reports the steering switch position to the GROUND MODULE.

Drive: The GROUND MODULE stores crack points, sends commands for each drive pump. (Command is computed from drive joystick input, interlocks, wheel angle, etc).

Lift, Tele, & Swing: The GROUND MODULE stores default values and handles interlocks and calibration information. Lift, Telescope and Swing commands are dependent upon interlocks through out the machine. Boom angle, length and swing are controlled by the GROUND MODULE.



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

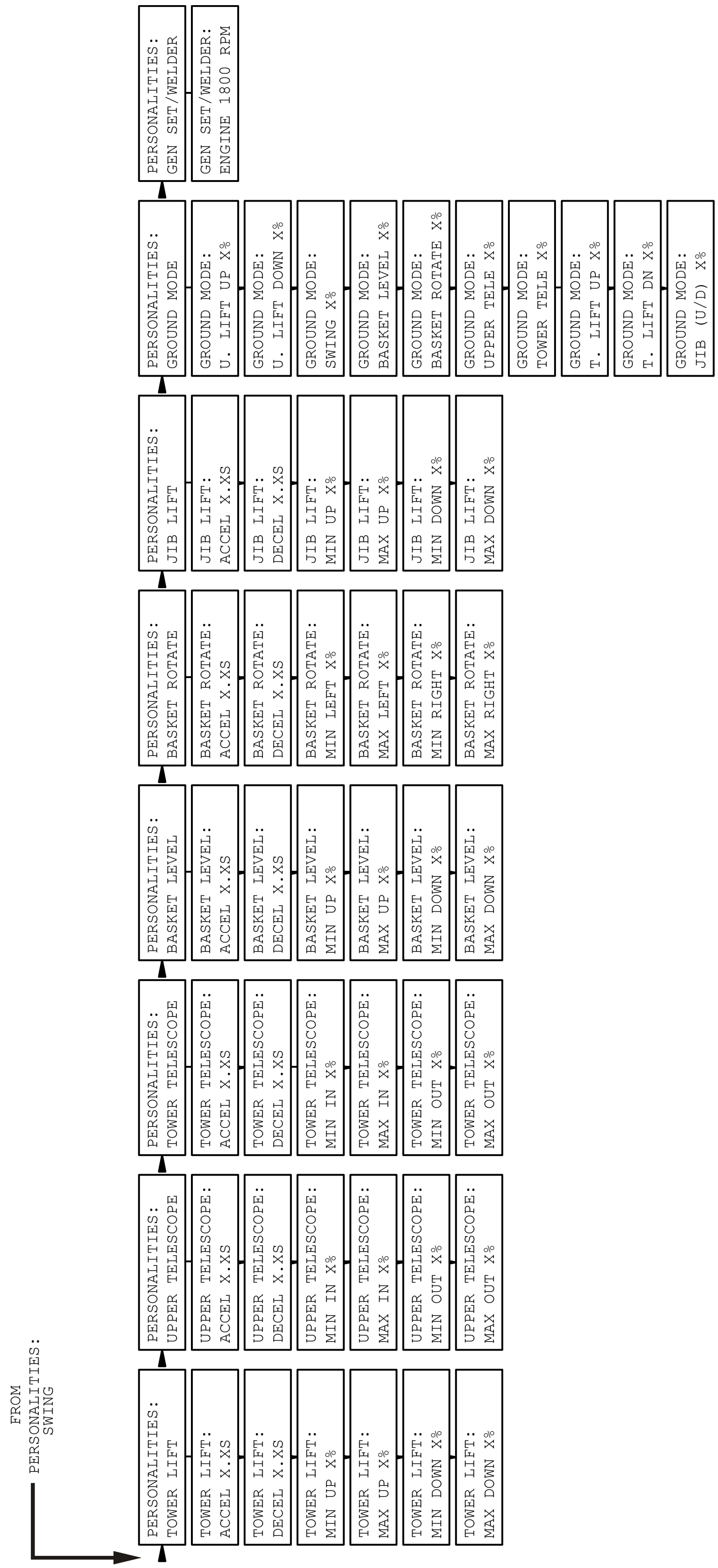


Figure 6-4. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 2 of 4

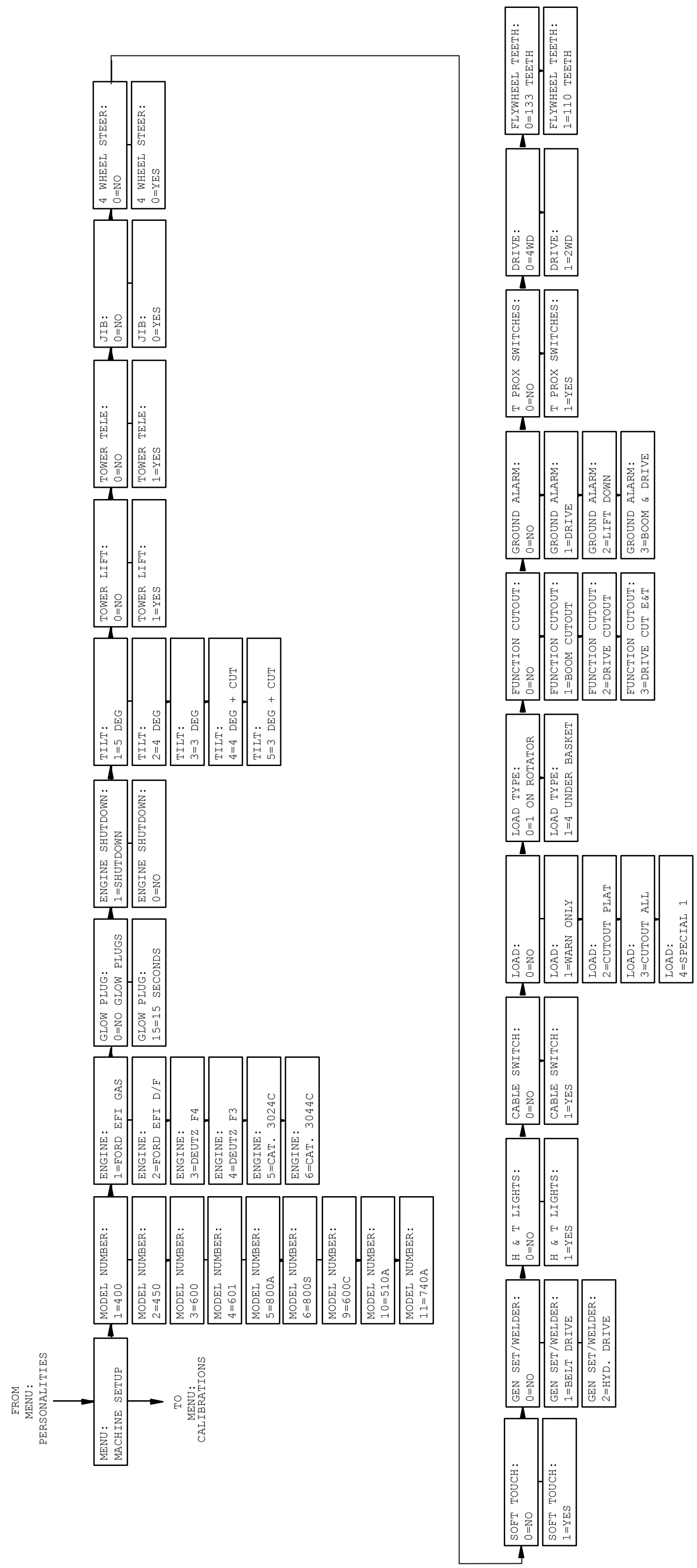


Figure 6-5. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 3 of 4

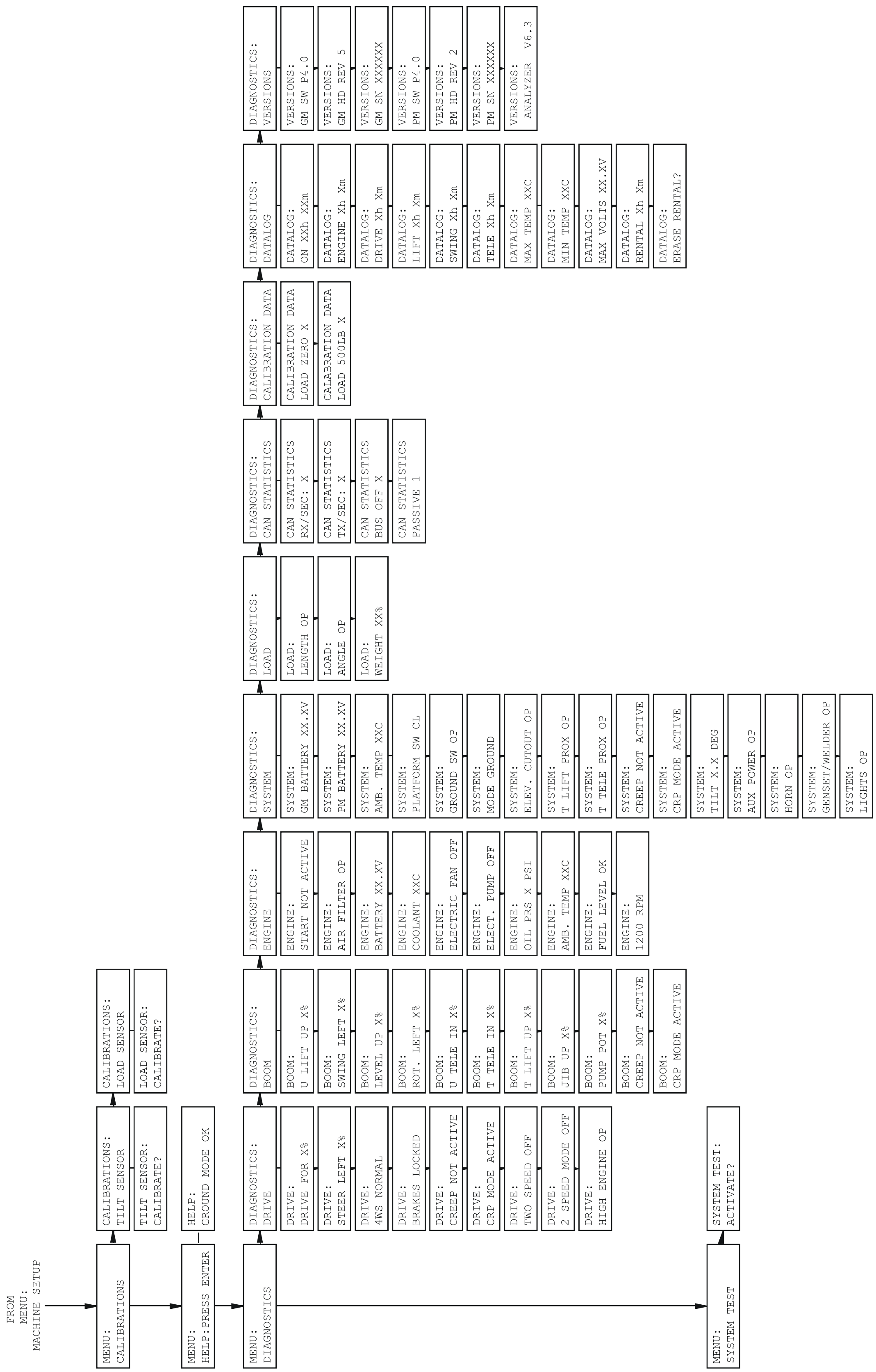
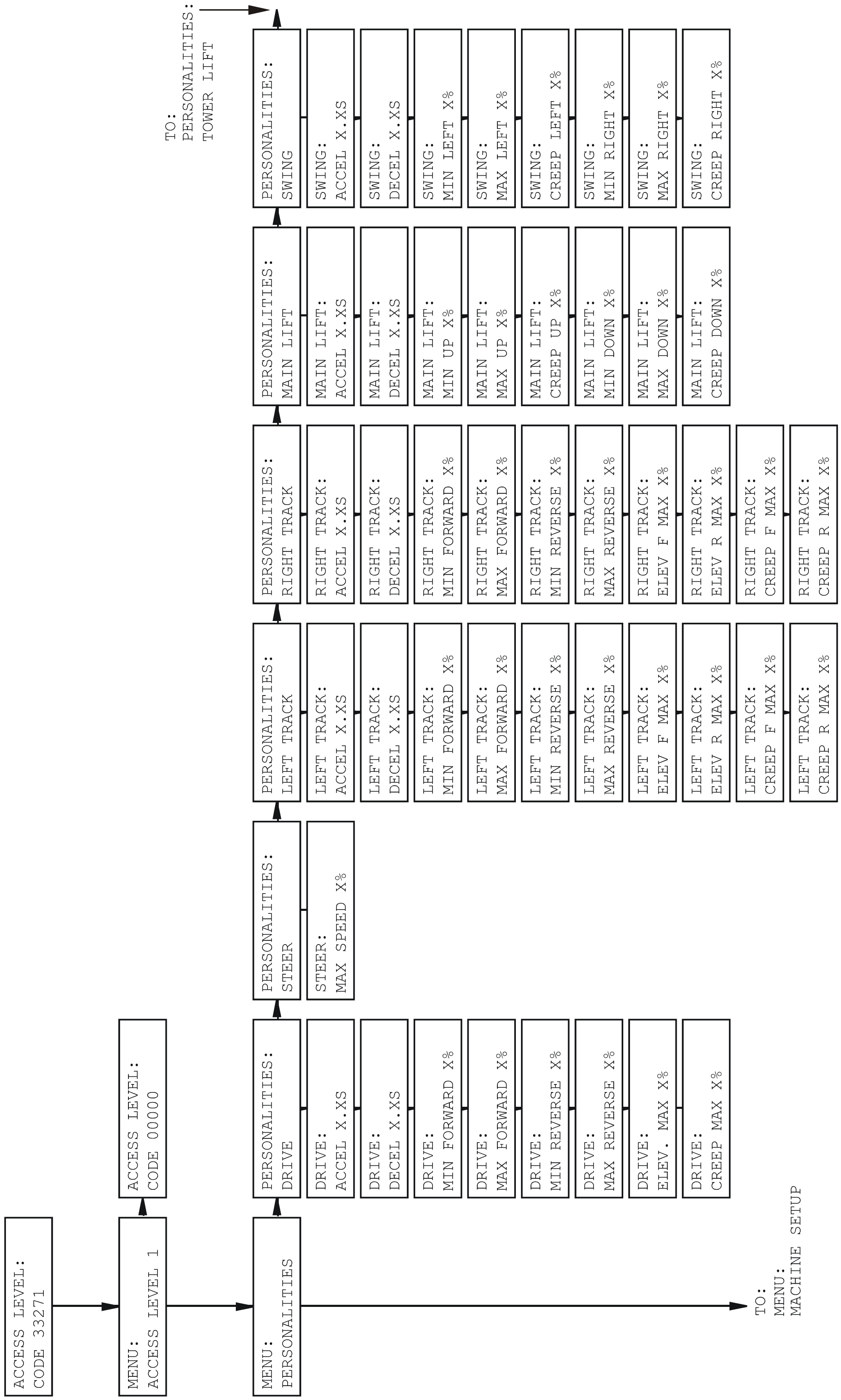


Figure 6-6. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 4 of 4



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

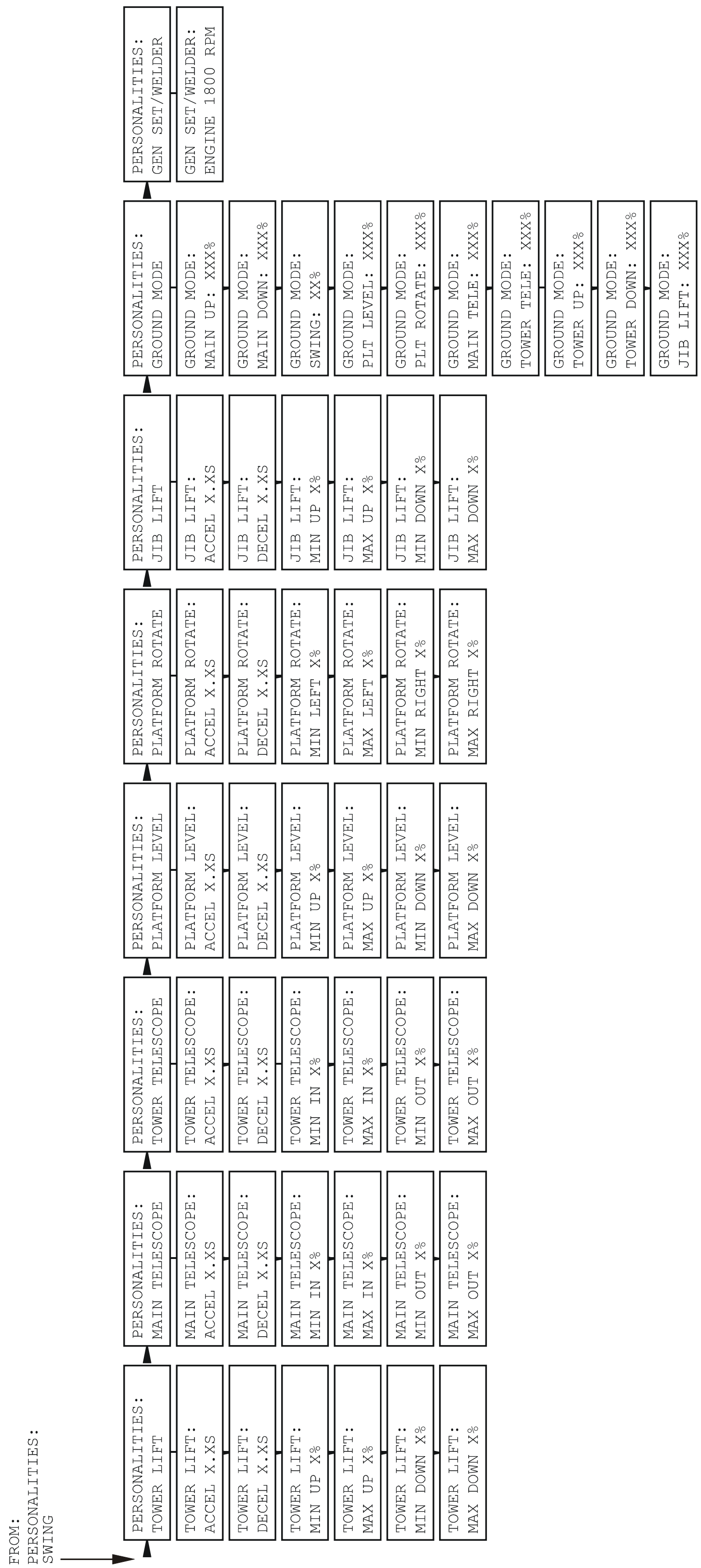


Figure 6-8. Analyzer Flow Chart, Version 5.X Software - Sheet 2 of 4

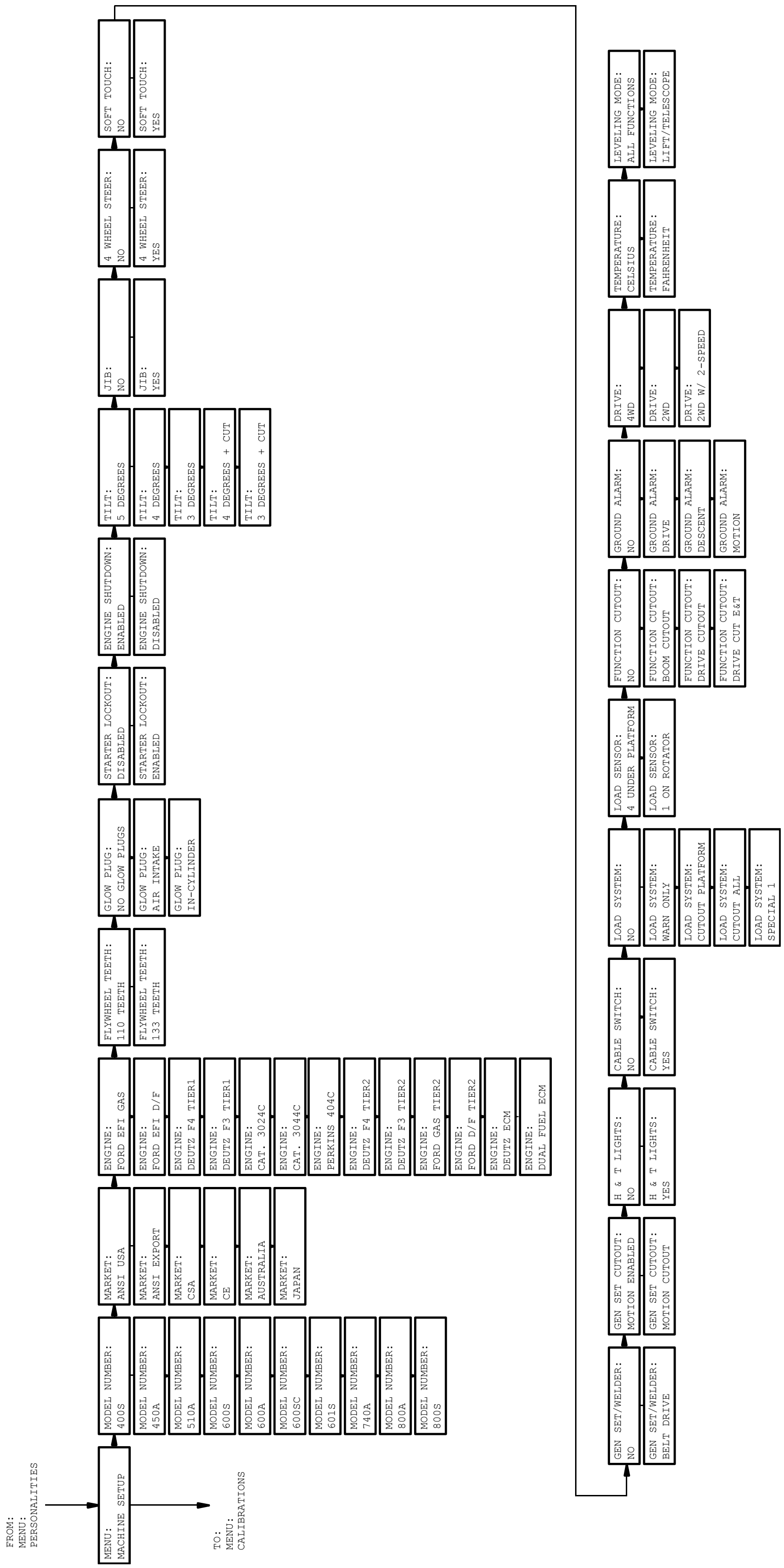


Figure 6-9. Analyzer Flow Chart, Version 5.X Software - Sheet 3 of 4

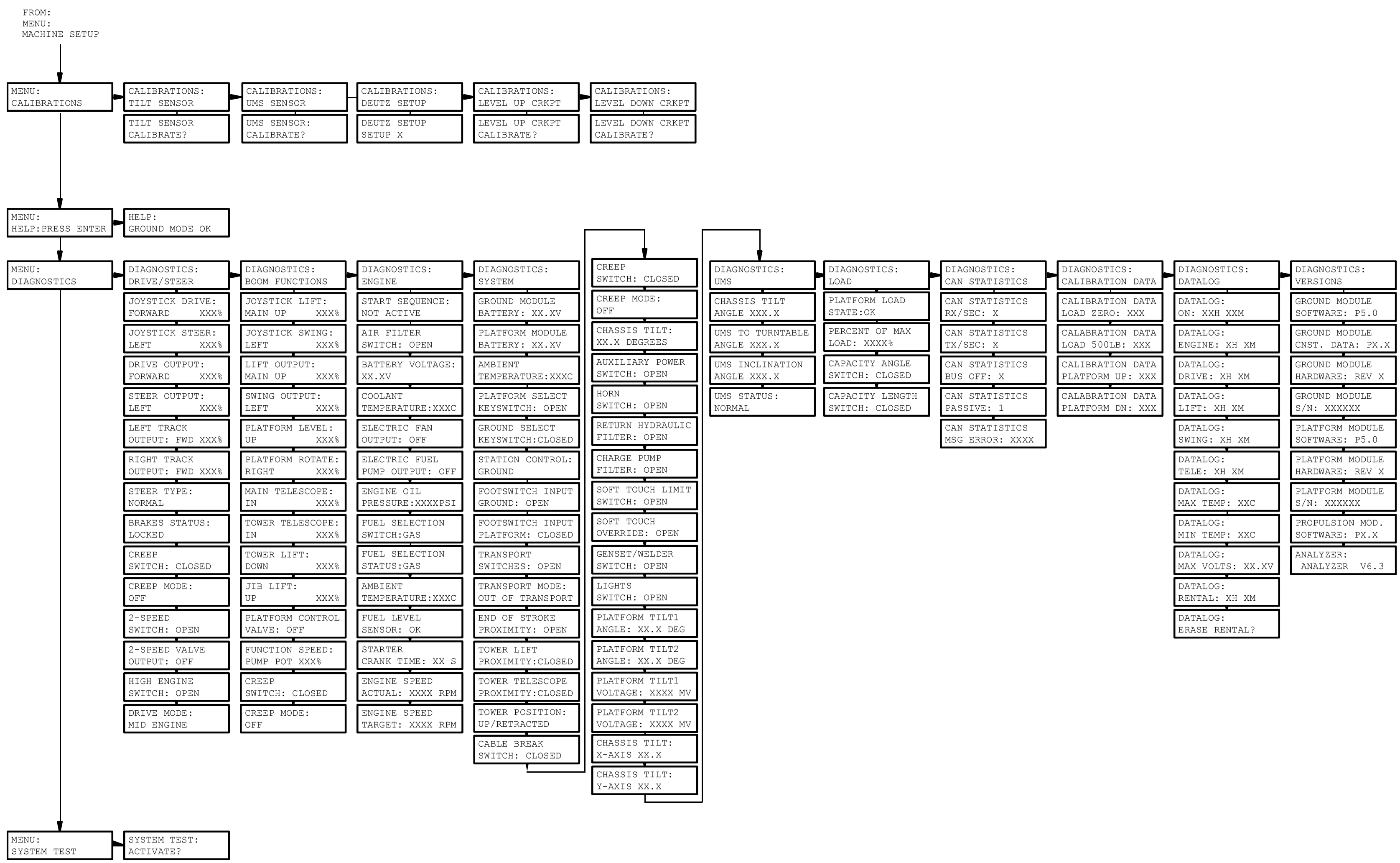
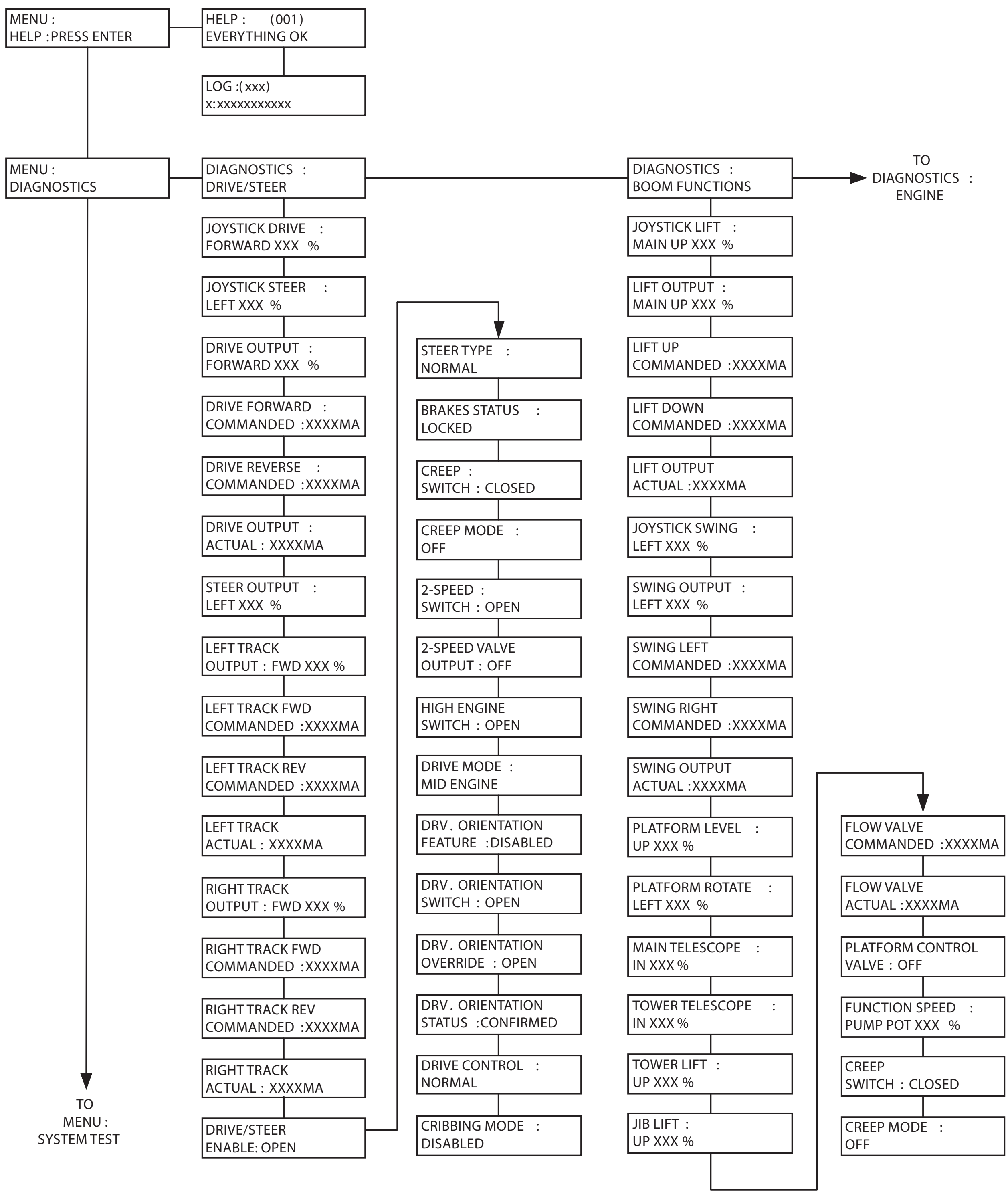
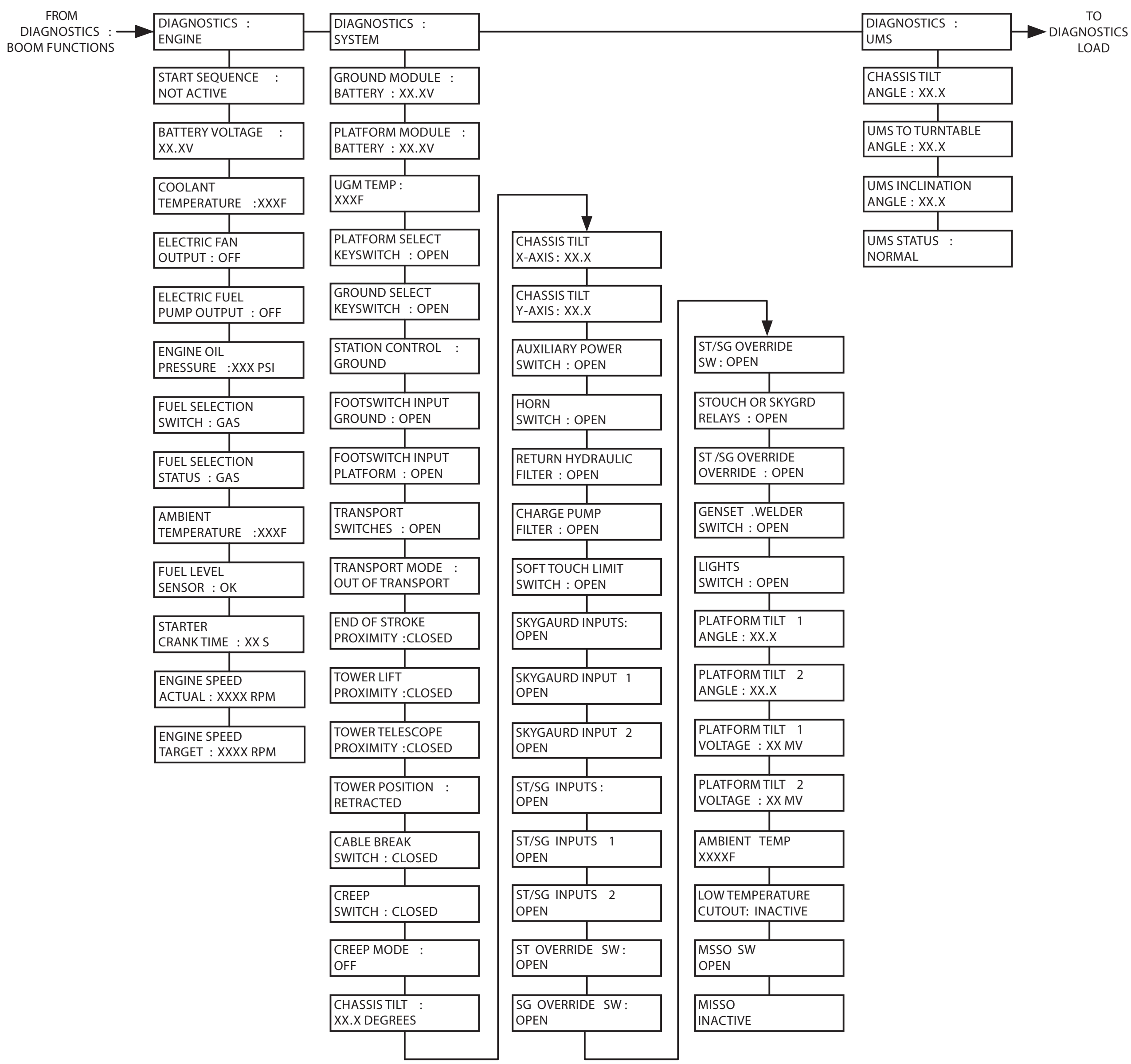


Figure 6-10. Analyzer Flow Chart, Version 5.X Software - Sheet 4 of 4



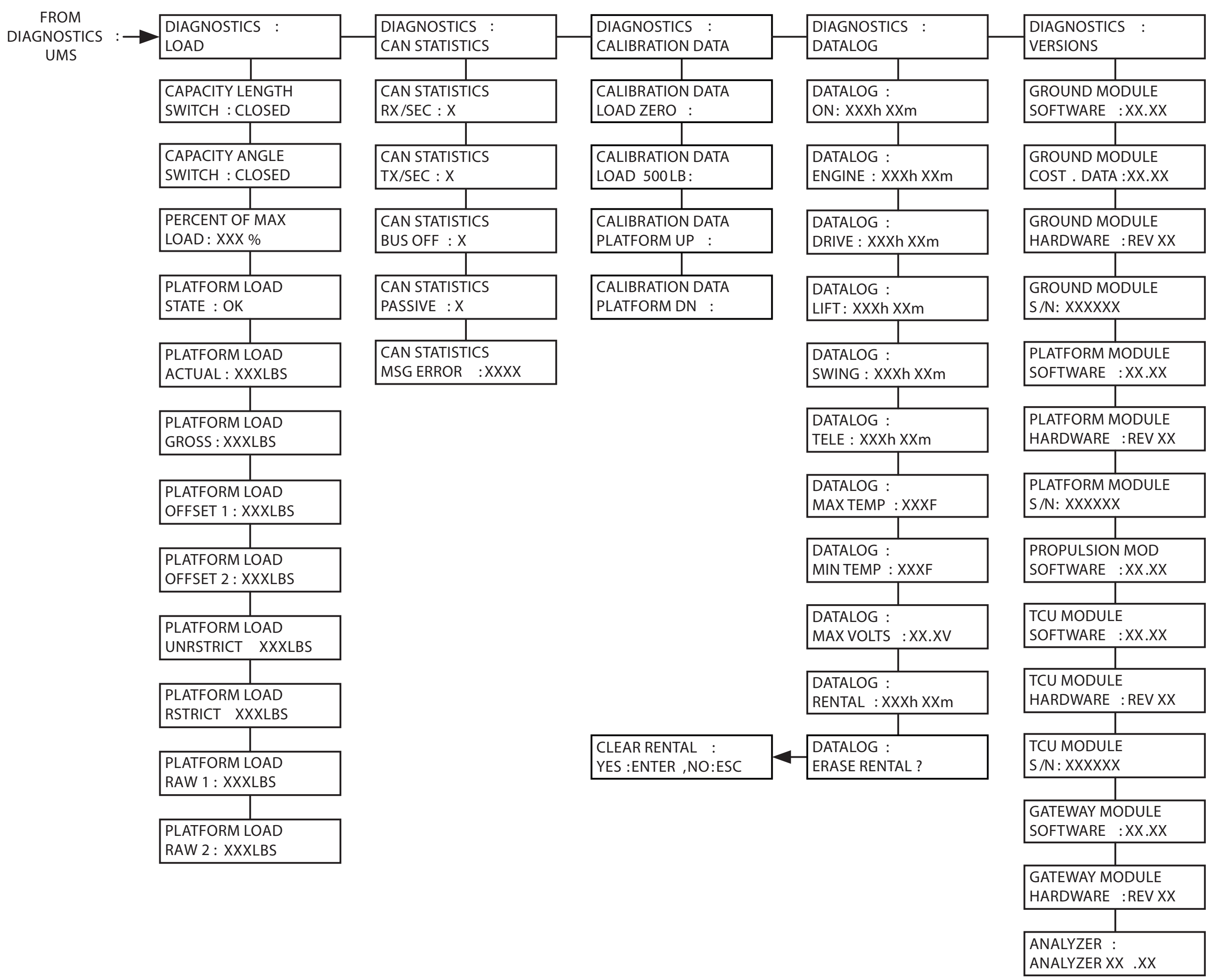
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-11. Analyzer Flow Chart Version 6.X Software -Sheet 1 of 9



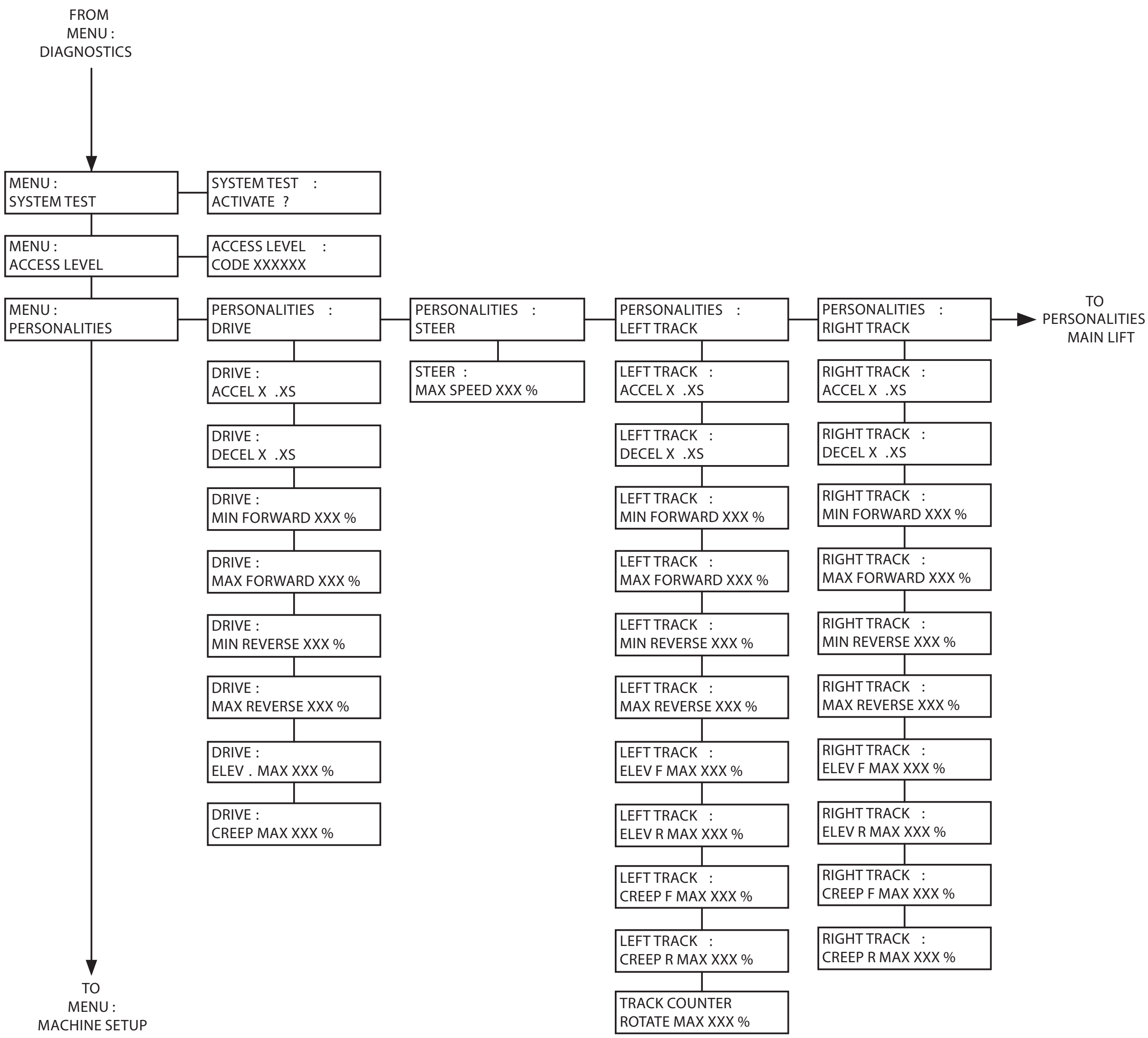
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-12. Analyzer Flow Chart Version 6.X Software -Sheet 2 of 9



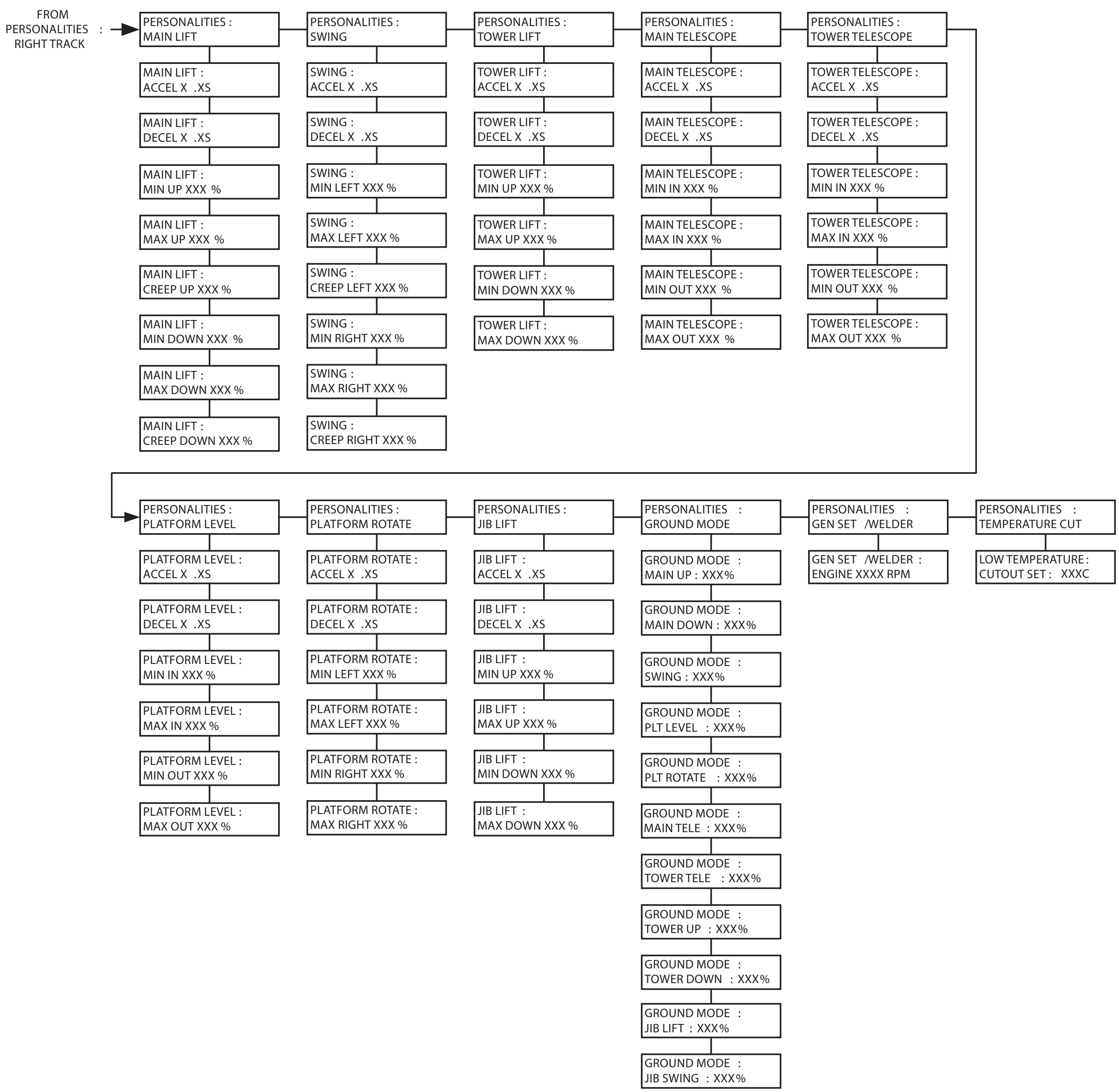
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-13. Analyzer Flow Chart Version 6.X Software -Sheet 3 of 9



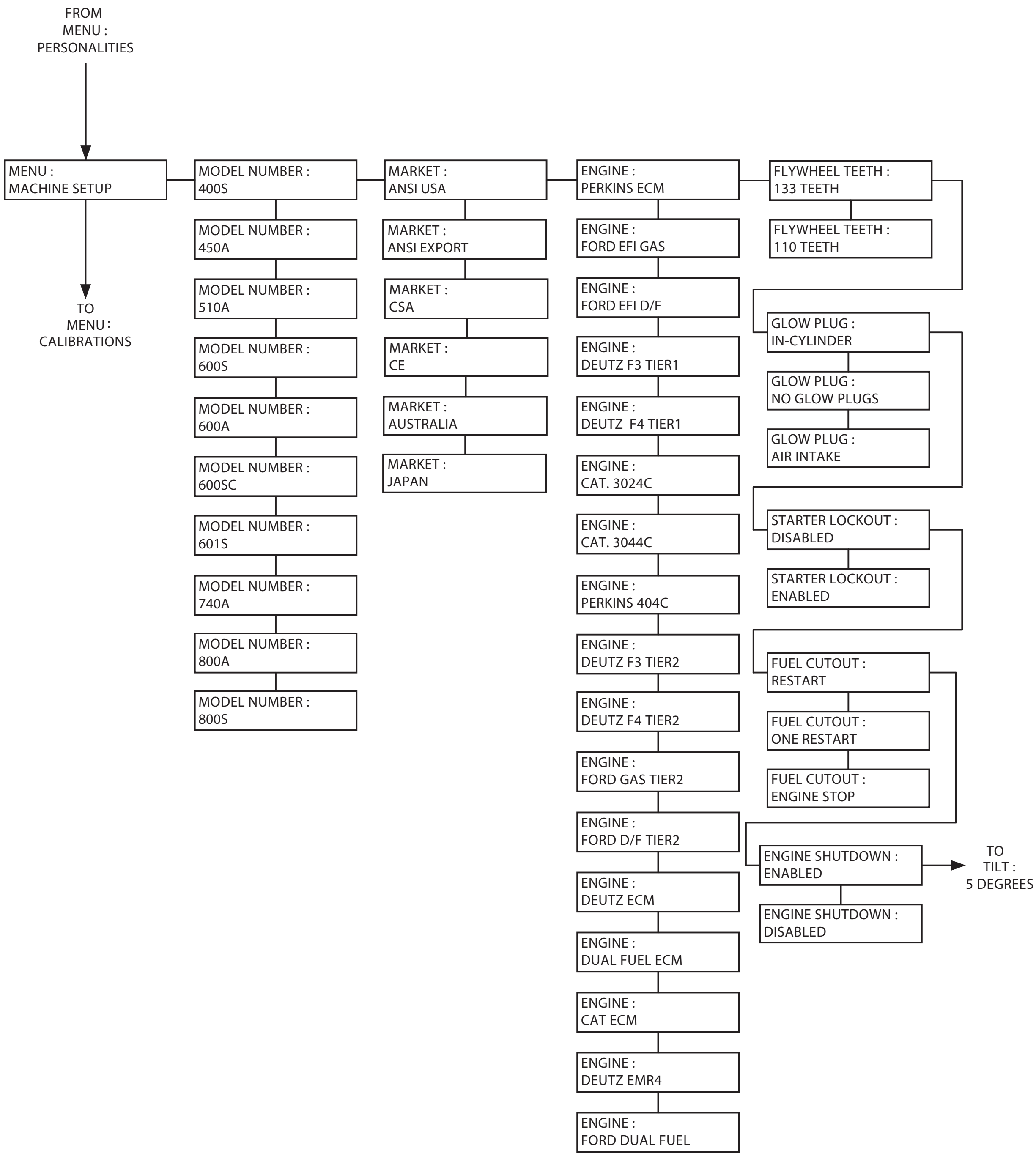
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-14. Analyzer Flow Chart Version 6.X Software -Sheet 4 of 9



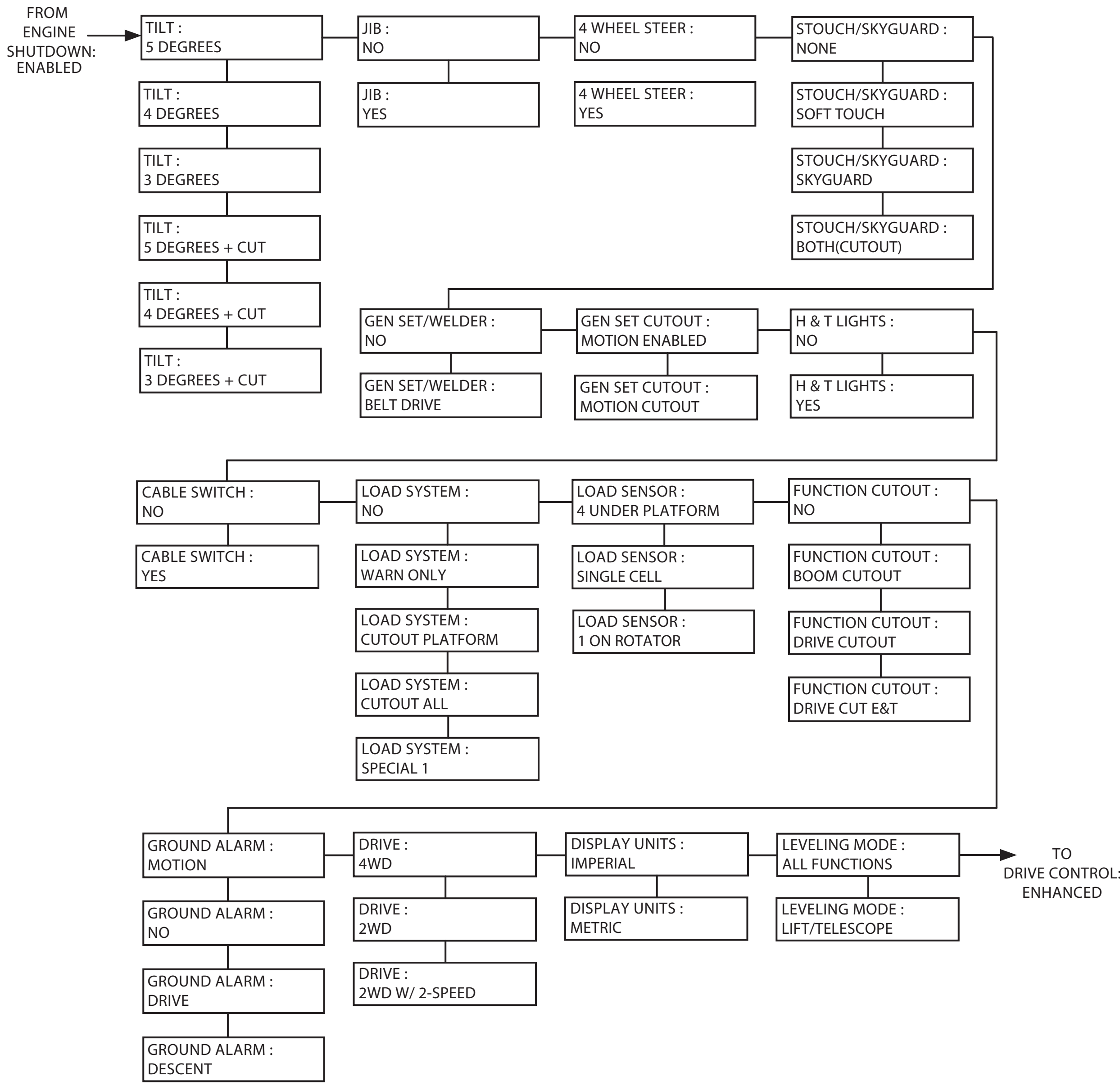
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-15. Analyzer Flow Chart Version 6.X Software -Sheet 5 of 9



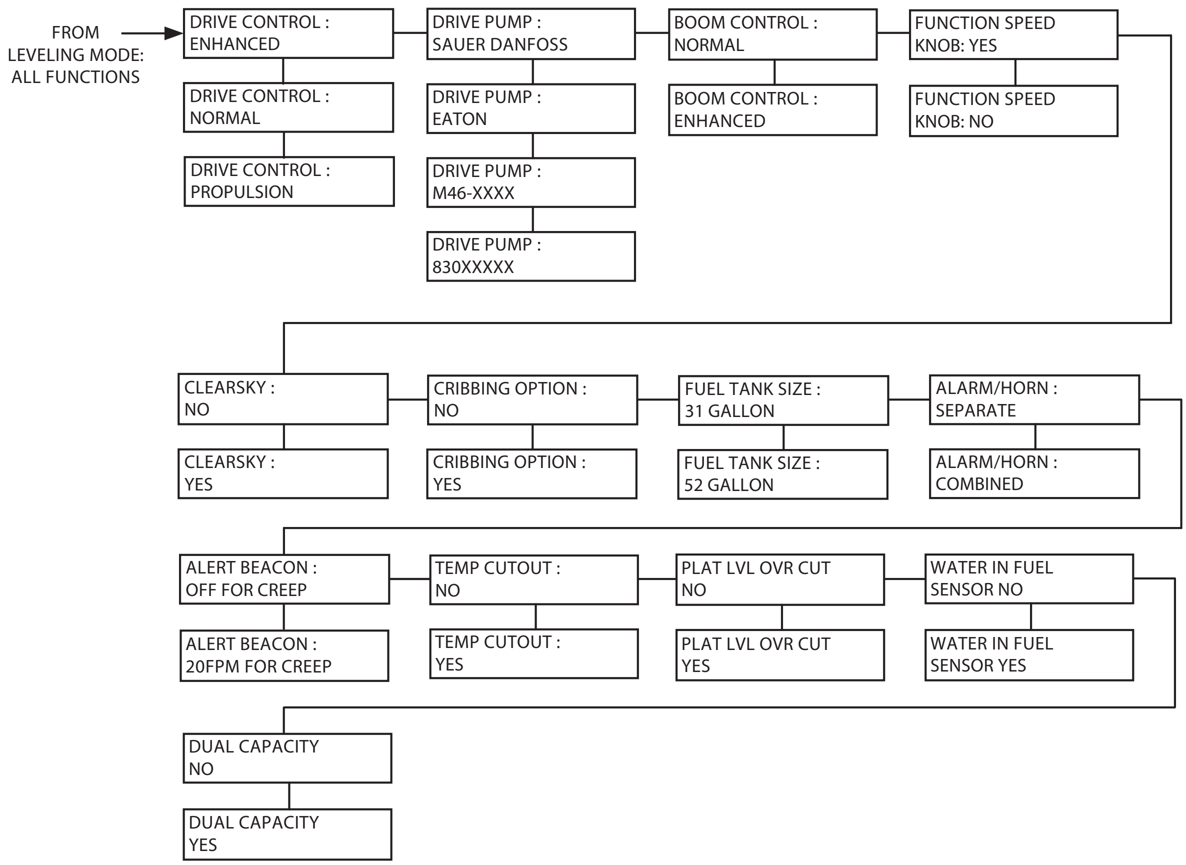
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-16. Analyzer Flow Chart Version 6.X Software -Sheet 6 of 9



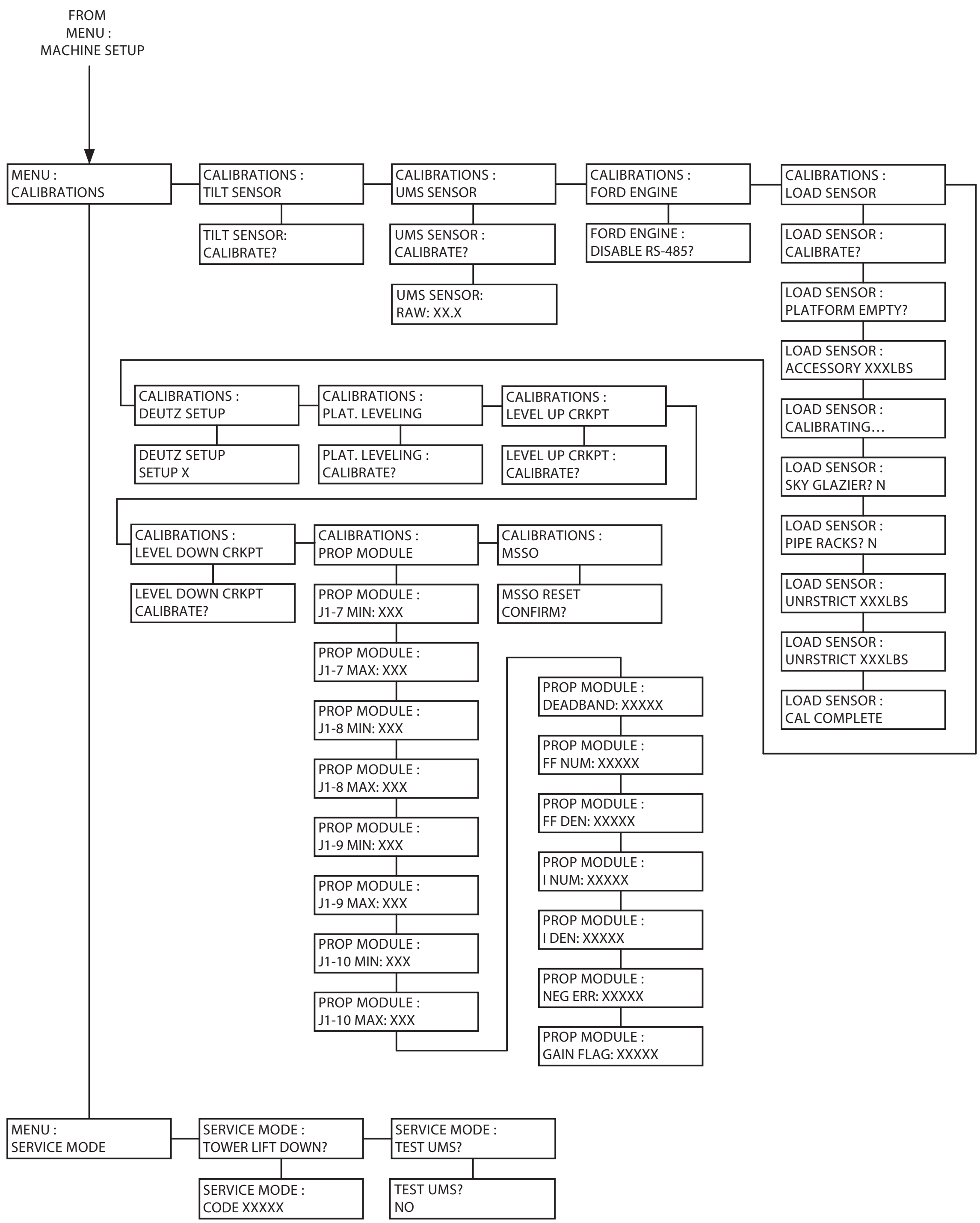
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-17. Analyzer Flow Chart Version 6.X Software -Sheet 7 of 9



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 Version 6.X Software -Sheet 8 of 9



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 6-19. Analyzer Flow Chart Version 6.X Software -Sheet 9 of 9

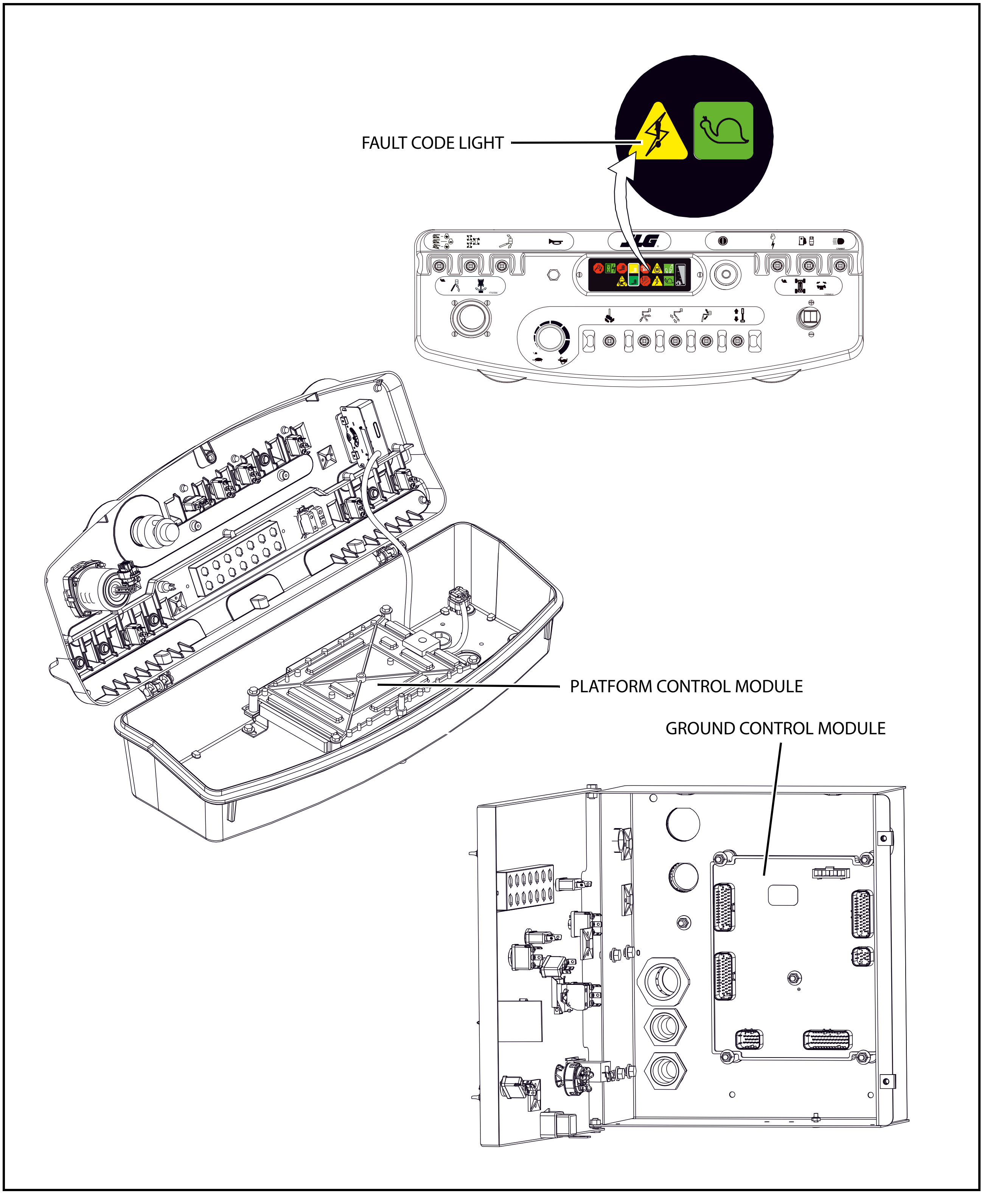
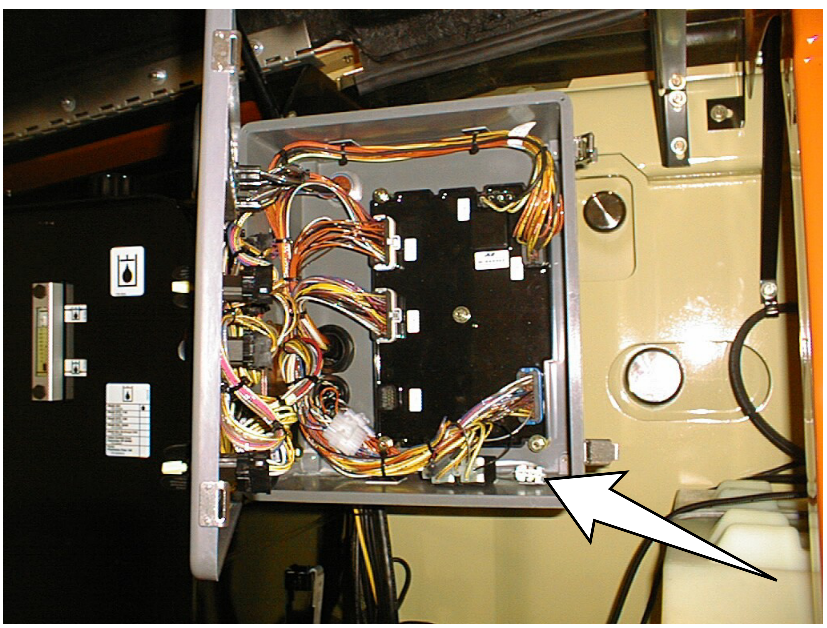


Figure 6-20. Fault Code Light and Module Location

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-21. Analyzer Connecting Points

Connector	Pin	Function	Type	
J1 (Natural)	1	ENGINE THROTTLE ACTUATOR	DIGITAL	OUTPUT
	2	LP START ASSIST	DIGITAL	OUTPUT
	3	DRIVE / LEFT TRACK FORWARD COIL	DIGITAL	OUTPUT
	4	GROUND	GROUND	INPUT
	5	GROUND	GROUND	INPUT
	6	DRIVE / LEFT TRACK REVERSE COIL	DIGITAL	OUTPUT
	7	LP LOCK / ELECTRIC FAN DRIVE	DIGITAL	OUTPUT
	8	GROUND	GROUND	INPUT
	9	GROUND	GROUND	INPUT
	10	IGNITION ON RELAY / ALTERNATOR EXCITATION / FUEL ON SOLENOID	DIGITAL	OUTPUT
	11	START SOLENOID	DIGITAL	OUTPUT
	12	ENGAGE GLOW PLUGS	DIGITAL	OUTPUT
	13	APU ENABLE RELAY	DIGITAL	OUTPUT
	14	ENGINE COOLANT TEMPERATURE	ANALOG	INPUT
	15	ENGINE OIL PRESSURE	ANALOG	INPUT
	16	ENGINE SPEED	FREQUENCY	INPUT
	17	GROUND	GROUND	INPUT
	18	GROUND	GROUND	INPUT
	19	GROUND	GROUND	INPUT
	20	2-SPEED VALVE	DIGITAL	OUTPUT
	21	CHARGE PUMP FILTER BY-PASS	DIGITAL	INPUT
	22	GENERATOR ENABLE RELAY	DIGITAL	OUTPUT
	23	BRAKE VALVE	DIGITAL	OUTPUT
	24	NOT CONNECTED	N/C	N/C
	25	RS-485 HIGH	SERIAL	I/O
	26	RS-485 LOW	SERIAL	I/O
	27	GROUND	GROUND	INPUT
	28	ANALYZER POWER	VOLTAGE	OUTPUT
	29	ANALYZER RS-232 RX	SERIAL	INPUT
	30	ANALYZER RS-232 TX	SERIAL	OUTPUT
	31	ANALYZER GROUND	GROUND	INPUT
	32	ALTERNATOR EXCITATION	DIGITAL	OUTPUT
	33	RS-485 GROUND	GROUND	INPUT
	34	AIR FILTER BY-PASS	DIGITAL	INPUT
	35	NOT CONNECTED	DIGITAL	INPUT

Connector	Pin	Function	Type	
J2 (Gray)	1	STEER DUMP VALVE	DIGITAL	OUTPUT
	2	HORN OUTPUT	DIGITAL	OUTPUT
	3	TOWER TELESCOPE IN SOLENOID	DIGITAL	OUTPUT
	4	MAIN TELESCOPE IN SOLENOID	DIGITAL	OUTPUT
	5	PLATFORM LEVEL UP SOLENOID	DIGITAL	OUTPUT
	6	GROUND	GROUND	INPUT
	7	PLATFORM LEVEL DOWN SOLENOID	DIGITAL	OUTPUT
	8	RIGHT TRACK REVERSE COIL	DIGITAL	OUTPUT
	9	NOT ALLOCATED	DIGITAL	OUTPUT
	10	PLATFORM ROTATE LEFT SOLENOID	DIGITAL	OUTPUT
	11	MAIN LIFT UP SOLENOID	DIGITAL	OUTPUT
	12	JIB UP SOLENOID	DIGITAL	OUTPUT
	13	MAIN DUMP VALVE	DIGITAL	OUTPUT
	14	GROUND	GROUND	INPUT
	15	TOWER TELESCOPE OUT SOLENOID	DIGITAL	OUTPUT
	16	MAIN TELESCOPE OUT SOLENOID	DIGITAL	OUTPUT
	17	GROUND	GROUND	INPUT
	18	GROUND	GROUND	INPUT
	19	RIGHT TRACK FORWARD COIL	DIGITAL	OUTPUT
	20	NOT ALLOCATED	DIGITAL	OUTPUT
	21	PLATFORM ROTATE RIGHT SOLENOID	DIGITAL	OUTPUT
	22	MAIN LIFT DOWN SOLENOID	DIGITAL	OUTPUT
	23	JIB DOWN SOLENOID	DIGITAL	OUTPUT
	24	RETURN FILTER BY-PASS	DIGITAL	INPUT
	25	FUEL LEVEL SENSOR	ANALOG	INPUT
	26	HEAD / TAIL LIGHT ENABLE RELAY	DIGITAL	OUTPUT
	27	ALARM OUTPUT	DIGITAL	OUTPUT
	28	GROUND	GROUND	INPUT
	29	GROUND	GROUND	INPUT
	30	GROUND	GROUND	INPUT
	31	FLOW CONTROL VALVE	DIGITAL	OUTPUT
	32	TOWER LIFT DOWN SOLENOID	DIGITAL	OUTPUT
	33	TOWER LIFT UP SOLENOID	DIGITAL	OUTPUT
	34	SWING LEFT SOLENOID	DIGITAL	OUTPUT
	35	SWING RIGHT SOLENOID	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
J3 (Black)	1	DRIVE / LEFT TRACK CURRENT FEEDBACK	GROUND	INPUT
	2	RIGHT TRACK CURRENT FEEDBACK	GROUND	INPUT
	3	GROUND	GROUND	INPUT
	4	SWING CURRENT FEEDBACK	GROUND	INPUT
	5	NOT CONNECTED	GROUND	INPUT
	6	FLOW CONTROL CURRENT FEEDBACK	GROUND	INPUT
	7	BATTERY VOLTAGE	VBAT	OUTPUT
	8	UMS ANGLE SENSOR	DIGITAL	INPUT
	9	CRIBBING ENGAGE SWITCH	DIGITAL	INPUT
	10	NOT CONNECTED	DIGITAL	INPUT
	11	CONFIGURATION #1	DIGITAL	INPUT
	12	NOT CONNECTED	VOLTAGE	OUTPUT
	13	NOT CONNECTED	ANALOG	INPUT
	14	LIFT CURRENT FEEDBACK	GROUND	INPUT

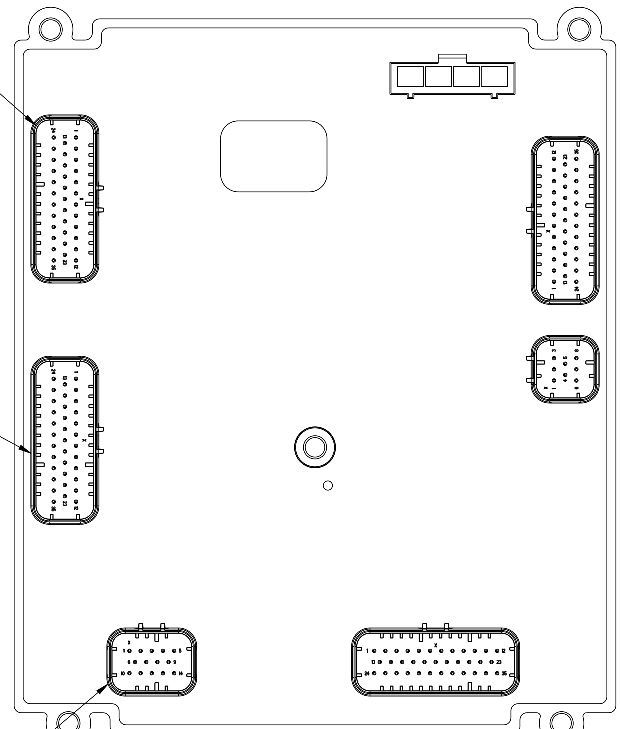


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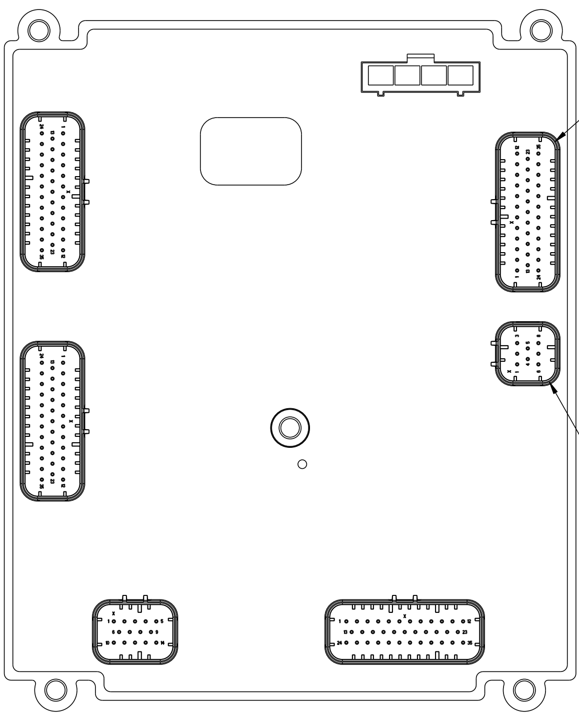
Figure 6-22. Ground Control Module - Sheet 1 of 3



Connector	Pin	Function	Type	
J7 (Black)	1	PLATFORM EMS	DIGITAL	INPUT
	2	PLATFORM MODE	DIGITAL	INPUT
	3	GROUND MODE	DIGITAL	INPUT
	4	CAPACITY ANGLE SWITCH	ANALOG	INPUT
	5	+5 VOLTS	VOLTAGE	OUTPUT
	6	CAN1 TERMINATOR	TERM	I/0
	7	CAPACITY LENGTH SWITCH	ANALOG	INPUT
	8	NOT CONNECTED	ANALOG	INPUT
	9	GROUND	GROUND	INPUT
	10	GROUND	GROUND	INPUT
	11	IN/OUT OF TRANSPORT SWITCHES	DIGITAL	INPUT
	12	BROKEN CABLE SWITCH	DIGITAL	INPUT
	13	CAN1 HIGH	SERIAL	I/0
	14	GROUND MODE POWER TO PLATFORM	DIGITAL	INPUT
	15	FOOTSWITCH	DIGITAL	INPUT
	16	+5 VOLTS	VOLTAGE	OUTPUT
	17	CAN1 TERMINATOR	TERM	I/0
	18	CAN1 SHEILD	GROUND	INPUT
	19	GROUND	GROUND	INPUT
	20	NOT CONNECTED	ANALOG	INPUT
	21	TOWER TELESCOPE PROXIMITY (800A ONLY)/DRIVE ORIENTATION SWITCH	DIGITAL	INPUT
	22	TOWER LIFT PROXIMITY (800A ONLY)	DIGITAL	INPUT
	23	GROUND FUNCTION ENABLE AVAILABLE	DIGITAL	INPUT
	24	CAN1 LOW	SERIAL	I/0
	25	GROUND	GROUND	INPUT
	26	+5 VOLTS	VOLTAGE	OUTPUT
	27	+5 VOLTS	VOLTAGE	OUTPUT
	28	GROUND	GROUND	INPUT
	29	BATTERY VOLTAGE	VBAT	OUTPUT
	30	BATTERY VOLTAGE	VBAT	OUTPUT
	31	BATTERY VOLTAGE	VBAT	OUTPUT
	32	BATTERY VOLTAGE	VBAT	OUTPUT
	33	BATTERY VOLTAGE	VBAT	OUTPUT
	34	BATTERY VOLTAGE (PROPULSION MODULE)	VBAT	OUTPUT
	35	BOOM ANGLE PROXIMITY SWITCH (800S ONLY)/DRIVE ORIENTATION SWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J12 (Black)	1	NOT CONNECTED	FREQUENCY	INPUT
	2	NOT CONNECTED	FREQUENCY	INPUT
	3	CAN2 HIGH (TELEMATICS)	SERIAL	I/0
	4	CAN2 LOW (TELEMATICS)	SERIAL	I/0
	5	CAN2 SHIELD (TELEMATICS)	GROUND	INPUT
	6	CAN2 TERMINATOR	TERM	I/0
	7	CAN2 TERMINATOR	TERM	I/0
	8	MSSO	DIGITAL	INPUT

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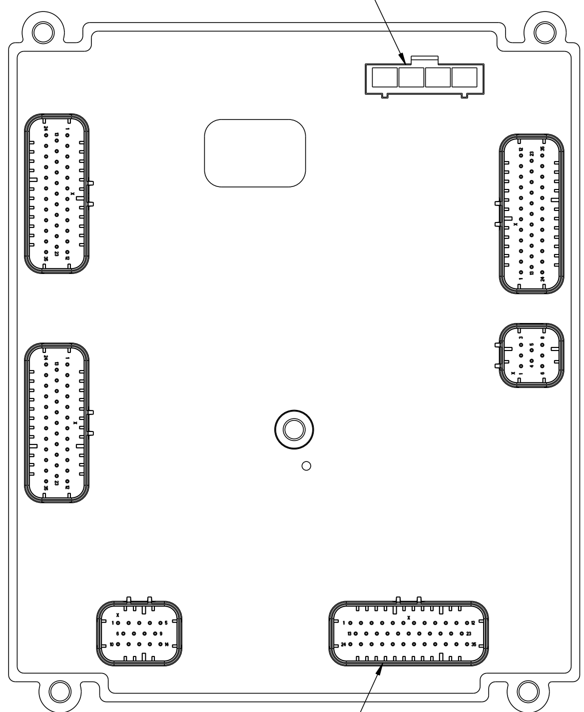
Figure 6-23. Ground Control Module - Sheet 2 of 3

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	HOURMETER	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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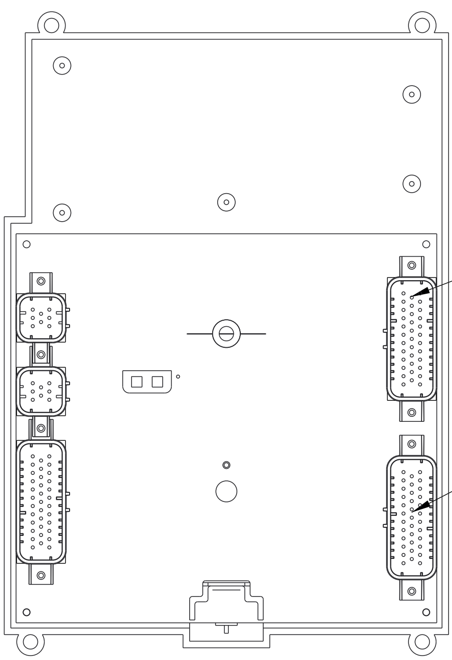
Figure 6-24. Ground Control Module - Sheet 3 of 3



CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J2 BLUE	1	SPARE PIN	HS DIGITAL INPUT
	2	SPARE PIN	HS DIGITAL INPUT
	3	BATTERY VOLTAGE	BATTERY VOLTAGE
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL INPUT
	5	PLATFORM STOWED	HS DIGITAL INPUT
	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	SPARE PIN	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	SPARE PIN	LAMP OUTPUT
	31	SPARE PIN	DIGITAL OUTPUT
	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	HS DIGITAL INPUT
	2	TOWER LIFT DOWN	HS DIGITAL INPUT
	3	TOWER TELESCOPE IN	HS DIGITAL INPUT
	4	TOWER TELESCOPE OUT	HS DIGITAL INPUT
	5	MAIN TELESCOPE IN	HS DIGITAL INPUT
	6	MAIN TELESCOPE OUT	HS DIGITAL INPUT
	7	PLATFORM ROTATE RIGHT	HS DIGITAL INPUT
	8	PLATFORM ROTATE LEFT	HS DIGITAL INPUT
	9	PLATFORM LEVEL UP	HS DIGITAL INPUT
	10	PLATFORM LEVEL DOWN	HS DIGITAL INPUT
	11	JIB UP	HS DIGITAL INPUT
	12	JIB DOWN	HS DIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START	HS DIGITAL INPUT
	15	AUXILIARY POWER	HS DIGITAL INPUT
	16	CRAB STEER SELECT	HS DIGITAL INPUT
	17	COORDINATED STEER SELECT	HS DIGITAL INPUT
	18	SWITCH POWER	BATTERY VOLTAGE
	19	JIB 1000LB ENABLE	HS DIGITAL INPUT
	20	EIM PLATFORM OVERLOAD	HS DIGITAL INPUT
	21	500/1000 LB. CAPACITY SELECT	HS DIGITAL INPUT
	22	DRIVE ORIENTATION SYSTEM FEATURE ENABLE	HS DIGITAL INPUT
	23	SPARE PIN	HS DIGITAL INPUT
	24	SPARE PIN	HS DIGITAL INPUT
	25	LEVEL SENSOR 1 SIGNAL	HS DIGITAL INPUT
	26	LEVEL SENSOR 2 SIGNAL	HS DIGITAL INPUT
	27	TWO SPEED VALVE (HIGH ENGINE)	HS DIGITAL INPUT
	28	TORQUE MODE	HS DIGITAL INPUT
	29	SOFT TOUCH OVERRIDE	HS DIGITAL INPUT
	30	HEAD/TAIL LIGHT	HS DIGITAL INPUT
	31	HORN	HS DIGITAL INPUT
	32	CREEP MODE	HS DIGITAL INPUT
	33	DUAL-FUEL SELECT	HS DIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	35	SPEED PUMP POTENTIOMETER	ANALOG INPUT

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Figure 6-25. Platform Control Module - 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	ANALOG INPUT
	3	LIFT SIGNAL	ANALOG INPUT
	4	SWING SIGNAL	ANALOG INPUT
	5	SWING CENTER TAP	ANALOG INPUT
	6	NOT CONNECTED	ANALOG INPUT
	7	LIFT / SWING JOYSTICK RETURN	GROUND
	8	SPARE PIN	BLANK

CONNECTOR	PIN	ASSIGNMENT	FUNCTION
J6 BLACK	1	DRIVE / STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	DRIVE CENTER TAP	ANALOG INPUT
	3	DRIVE SIGNAL	ANALOG INPUT
	4	STEER SIGNAL	ANALOG INPUT
	5	STEER LEFT	ANALOG INPUT
	6	STEER RIGHT	ANALOG INPUT
	7	DRIVE / STEER JOYSTICK RETURN	GROUND
	8	SPARE PIN	BLANK

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	PLATFORM ROTATE LEFT	ME DIGITAL OUTPUT
	6	PLATFORM ROTATE RIGHT	ME DIGITAL OUTPUT
	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	SPARE PIN	+5V REFERENCE VOLTAGE
	12	SPARE PIN	+5V REFERENCE VOLTAGE
	13	SPARE PIN	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	PLATFORM LEVEL UP	HS DIGITAL OUTPUT
	16	PLATFORM LEVEL DOWN	HS DIGITAL OUTPUT
	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	SPARE PIN	GROUND
	22	SPARE PIN	GROUND
	23	SPARE PIN	ANALOG INPUT
	24	SPARE PIN	DIGITAL OUTPUT
	25	JIB UP	ME DIGITAL OUTPUT
	26	JIB DOWN	ME DIGITAL OUTPUT
	27	JIB RIGHT	ME DIGITAL OUTPUT
	28	JIB LEFT	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	SPARE PIN	GROUND
	34	SPARE PIN	GROUND
	35	SPARE PIN	ANALOG INPUT

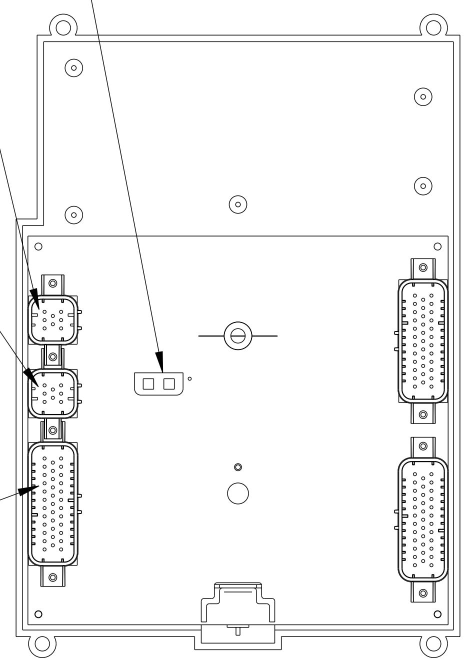

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Figure 6-26. Platform Control Module - Sheet 2 of 2

Analyzer Diagnostics Menu Structure

In the following structure descriptions, an intended item is selected by pressing ENTER ENTER; pressing **ESC** ESC steps back to the next outer level.

The **LEFT** /**RIGHT** arrow keys move between items in the same level. The **UP** / **DOWN** arrow keys alter a value if allowed.

Table 6-7. Adjustments - Personality Descriptions

DRIVE	
ACCEL	Displays/adjusts drive acceleration
DECEL	Displays/adjusts drive deceleration
MIN FORWARD	Displays/adjusts minimum forward drive speed
MAX FORWARD	Displays/adjusts maximum forward drive speed
MIN REVERSE	Displays/adjusts minimum reverse drive speed
MAX REVERSE	Displays/adjusts maximum reverse drive speed
ELEVATED MAX	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX	Displays/adjusts the maximum steer speed
LIFT	
ACCEL	Displays/adjusts upper lift acceleration
DECEL	Displays/adjusts upper lift deceleration
MIN UP	Displays/adjusts minimum upper lift up speed
MAX UP	Displays/adjusts maximum upper lift up speed
CREEP UP	Displays/adjusts maximum upper lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN	Displays/adjusts minimum upper lift down speed
MAX DOWN	Displays/adjusts maximum upper lift down speed
CREEP DOWN	Displays/adjusts maximum upper lift down speed NOTE: used when creep switch on pump pot is active
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
MAX IN	Displays/adjusts maximum telescope in speed
MIN OUT	Displays/adjusts minimum telescope out speed

Table 6-7. Adjustments - Personality Descriptions

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
BASKETLEVEL	Displays/adjusts fixed basket level speed
BASKETROTATE	Displays/adjusts fixed basket rotate speed
JIB (U/D)	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)	Displays/adjusts jib swing speed Not displayed if JIB = NO

Table 6-8. Diagnostic Menu Descriptions

DRIVE	
DRIVE FOR . . .	Displays drive joystick direction & demand
STEER . . .	Displays steer switch direction & demand NOTE: steer demand is inversely proportional to vehicle speed
BRAKES . . .	Displays brake control system status
CREEP . . .	Displays pump pot creep switch status
TWO SPEED. . .	Displays two speed switch status
2 SPEED MODE	Displays status of two speed valve
HIGH ENGINE	Displays high engine switch status
BOOM	
U LIFT UP . . .	Displays lift joystick direction & demand
SWING LEFT . . .	Displays swing joystick direction & demand
LEVEL UP . . .	Displays basket level switch direction & demand NOTE: demand is controlled by the pump pot
ROT. LEFT . . .	Displays basket rotate switch direction & demand NOTE: demand is controlled by the pump pot
U TELE IN . . .	Displays telescope switch direction & demand NOTE: demand is controlled by the pump pot
JIB UP . . .	Displays jib lift switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
JIB LEFT . . .	Displays jib swing switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
PUMP POT . . .	Displays pump pot demand
ENGINE	
START . . .	Displays start switch status
AIR FILTER . . .	Displays air filter status
BATTERY . . .	Displays measured battery voltage
COOLANT . . .	Displays coolant temperature
OIL PRS . . .	Displays oil pressure status
FUEL SELECT . . .	Displays selected fuel (Dual Fuel only)
FUEL LEVEL . . .	Displays fuel level status
RPM	Displays Engine RPM
GM BATTERY	Displays battery voltage at ground module
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 6-8. 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 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
001	00	EVERYTHING OK	No response required for this DTC.
002	00	GROUND MODE OK	No response required for this DTC.
0010	00	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	Response described in Drive Modes section.
000	00	<<< HELP COMMENT >>>	
0011	00	FSW OPEN (Foot switch open)	The UGM shall not Enable the Machine.
0012	00	RUNNING AT CREEP - CREEP SWITCH OPEN	The UGM shall limit the machine to Creep speed.
0013	00	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	
0014	00	CHASSIS TILT SENSOR OUT OF RANGE	Not reported during power-up.
0015	00	LOAD SENSOR READING UNDER WEIGHT	
0031	00	FUEL LEVEL LOW - ENGINE SHUTDOWN	Response described in Fuel Shutdown section.
0035	00	APU ACTIVE	Response described in Auxiliary Power/Emergency Descent Mode section.
0039	00	SKYGUARD ACTIVE - FUNCTIONS CUTOUT	Response described in Sky-Guard section.
0040	00	RUNNING AT CREEP - CREEP SWITCH CLOSED	
210	21	<<< POWER-UP >>>	
211	21	POWER CYCLE	
212	21	KEYSWITCH FAULTY	The UGM shall assume a station selection of Ground.
213	21	FSW FAULTY	The UGM shall not Enable the Machine.
220	22	<<< PLATFORM CONTROLS >>>	
227	22	STEER SWITCHES FAULTY	The UGM shall prohibit Steer; The UGM shall limit Drive to Creep The Steer Left switch input = Low; The Steer Right switch input = Low; Steer and full Drive speed permitted after controls are initialized
2211	22	FSW INTERLOCK TRIPPED	Can be reported during power- up.
2212	22	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	Can be reported during power- up.
2213	22	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	The UGM shall not Enable the Machine.
2214	22	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE	
2216	22	D/S JOY. OUT OF RANGE HIGH	Resistive joysticks. If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2217	22	D/S JOY. CENTER TAP BAD	Resistive joysticks. - There is a +/-.1V range. around these values due to resistor tolerances.
2219	22	L/S JOY. OUT OF RANGE HIGH	Resistive joysticks. - If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
2220	22	L/S JOY. CENTER TAP BAD	Resistive joysticks. - There is a +/- 1V range. around these values due to resistor tolerances.
2221	22	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, the UGM shall prohibit Lift and Swing. If triggered by Lift and/or Swing joystick is not in the neutral position when Footswitch becomes active or while DTC 2212, 2213 or 2223 is active, the UGM shall not Enable the Machine.
2222	22	WAITING FOR FSW TO BE OPEN	Can be reported during power- up.
2223	22	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	The UGM shall not Enable the Machine.
2224	22	FOOTSWITCH SELECTED BEFORE START	The UGM shall prohibit Engine Start.
2269	22	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER	
234	23	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	Disable whichever boom functions whose boom control inputs are triggering the fault. If Engine Start/ Aux at fault, disable Engine Start but permit Auxiliary Power/ Emergency Descent.
235	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	
236	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	
237	23	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	The UGM shall prohibit Engine Start.
23163	23	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED	No response required for this DTC Power Cycled.
240	24	<<< OTHER CONTROLS >>>	
241	24	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; If the Machine is in Ground Mode; No response required for this DTC.
242	24	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	Check Ambient Temperature sensor reading < 85C.
250	25	<<< FUNCTION PREVENTED >>>	
259	25	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
2513	25	GENERATOR MOTION CUTOUT ACTIVE	The UGM shall not Enable the Machine.
2514	25	BOOM PREVENTED - DRIVE SELECTED	The UGM shall prohibit all boom functions.

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
2516	25	DRIVE PREVENTED - ABOVE ELEVATION	The UGM shall prohibit Drive and Steer.
2517	25	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	The UGM shall prohibit Drive and Steer.
2518	25	DRIVE PREVENTED - BOOM SELECTED	The UGM shall prohibit Drive and Steer.
2519	25	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE	
2520	25	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER	
2530	25	UMS SENSOR FORWARD LIMIT REACHED	
2531	25	UMS SENSOR OUT OF USABLE RANGE	
2532	25	UMS SENSOR BACKWARD LIMIT REACHED	
2563	25	SKYGUARD SWITCH - DISAGREEMENT	Response detailed in Sky-Guard section.
2568	25	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	If the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
2576	25	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION	The UGM shall suspend Platform Level Up and Down commands; The UGM shall prohibit Platform Level Up and Down
2577	25	DRIVE PREVENTED - START BATTERY CONNECTED	Check the battery.
330	33	<<< GROUND OUTPUT DRIVER >>>	
331	33	BRAKE - SHORT TO BATTERY	Check Harness for damage.
332	33	BRAKE - OPEN CIRCUIT	Check Harness for damage.
3311	33	GROUND ALARM - SHORT TO BATTERY	Ground Alarm equipped vehicles only.
3336	33	ALTERNATOR POWER - SHORT TO GROUND	Check Harness for damage.
3340	33	AUX POWER - SHORT TO GROUND	Check Harness for damage.
3341	33	AUX POWER - OPEN CIRCUIT	Check Harness for damage.
3342	33	AUX POWER - SHORT TO BATTERY	Check Harness for damage.
3346	33	ELECTRIC FAN - SHORT TO GROUND	Check Harness for damage.
3347	33	ELECTRIC FAN - OPEN CIRCUIT	Check Harness for damage.
3348	33	ELECTRIC FAN - SHORT TO BATTERY	Check Harness for damage.
3349	33	ELECTRIC PUMP - SHORT TO GROUND	Check Harness for damage.
3350	33	ELECTRIC PUMP - OPEN CIRCUIT	Check Harness for damage.
3351	33	ELECTRIC PUMP - SHORT TO BATTERY	Check Harness for damage.
3352	33	LP LOCK - SHORT TO GROUND	Check Harness for damage.
3353	33	LP LOCK - OPEN CIRCUIT	Check Harness for damage.
3354	33	LP LOCK - SHORT TO BATTERY	Check Harness for damage.
3355	33	LP START ASSIST - SHORT TO GROUND	Check Harness for damage.
3356	33	LP START ASSIST - OPEN CIRCUIT	Check Harness for damage.
3357	33	LP START ASSIST - SHORT TO BATTERY	Check Harness for damage.
3358	33	MAIN DUMP VALVE - SHORT TO GROUND	Check Harness for damage.

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
3359	33	MAIN DUMP VALVE - OPEN CIRCUIT	Check Harness for damage.
3360	33	MAIN DUMP VALVE - SHORT TO BATTERY	Check Harness for damage.
3361	33	BRAKE - SHORT TO GROUND	Check Harness for damage.
3362	33	START SOLENOID - SHORT TO GROUND	Check Harness for damage.
3363	33	START SOLENOID - OPEN CIRCUIT	Check Harness for damage.
3364	33	START SOLENOID - SHORT TO BATTERY	Check Harness for damage.
3365	33	STEER DUMP VALVE - SHORT TO GROUND	Check Harness for damage.
3366	33	STEER DUMP VALVE - OPEN CIRCUIT	Check Harness for damage.
3367	33	STEER DUMP VALVE - SHORT TO BATTERY	Check Harness for damage.
3368	33	TWO SPEED VALVE - SHORT TO GROUND	Check Harness for damage.
3369	33	TWO SPEED VALVE - OPEN CIRCUIT	Check Harness for damage.
3370	33	TWO SPEED VALVE - SHORT TO BATTERY	Check Harness for damage.
3371	33	GROUND ALARM - SHORT TO GROUND	Check Harness for damage.
3372	33	GROUND ALARM - OPEN CIRCUIT	Check Harness for damage.
3373	33	GEN SET/WELDER - SHORT TO GROUND	Check Harness for damage.
3374	33	GEN SET/WELDER - OPEN CIRCUIT	Check Harness for damage.
3375	33	GEN SET/WELDER - SHORT TO BATTERY	Check Harness for damage.
3376	33	HEAD TAIL LIGHT - SHORT TO GROUND	Check Harness for damage.
3377	33	HEAD TAIL LIGHT - OPEN CIRCUIT	Check Harness for damage.
3378	33	HEAD TAIL LIGHT - SHORT TO BATTERY	Check Harness for damage.
3379	33	HOUR METER - SHORT TO GROUND	Check Harness for damage.
3382	33	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	Check Harness for damage.
3383	33	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	Check Harness for damage.
3384	33	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	Check Harness for damage.
3388	33	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
3389	33	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
3390	33	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
3394	33	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
3395	33	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
3396	33	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
3397	33	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
3398	33	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
3399	33	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
33100	33	JIB LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
33101	33	JIB LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
33102	33	JIB LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
33103	33	JIB LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
33104	33	JIB LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
33105	33	JIB LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
33106	33	TOWER LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
33107	33	TOWER LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
33108	33	TOWER LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
33109	33	TOWER LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
33110	33	TOWER LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
33111	33	TOWER LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
33112	33	TOWER TELESCOPE IN VALVE - SHORT TO GROUND	Check Harness for damage.
33113	33	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT	Check Harness for damage.
33114	33	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY	Check Harness for damage.
33115	33	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND	Check Harness for damage.
33116	33	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT	Check Harness for damage.
33117	33	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY	Check Harness for damage.
33118	33	SWING RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
33119	33	SWING RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
33120	33	TELESCOPE IN VALVE - SHORT TO BATTERY	Check Harness for damage.
33121	33	SWING RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
33122	33	SWING LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
33123	33	TELESCOPE OUT VALVE - SHORT TO BATTERY	Check Harness for damage.
33130	33	THROTTLE ACTUATOR - SHORT TO GROUND	Check Harness for damage.
33131	33	THROTTLE ACTUATOR - OPEN CIRCUIT	Check Harness for damage.
33132	33	THROTTLE ACTUATOR - SHORT TO BATTERY	Check Harness for damage.
33170	33	LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
33171	33	LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
33172	33	LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
33175	33	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
33176	33	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
33177	33	JIB ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
33178	33	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
33179	33	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
33180	33	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
33182	33	LIFT VALVES - SHORT TO BATTERY	Check Harness for damage.
33186	33	TELESCOPE OUT VALVE - OPEN CIRCUIT	Check Harness for damage.
33188	33	TELESCOPE OUT VALVE - SHORT TO GROUND	Check Harness for damage.
33189	33	TELESCOPE IN VALVE - OPEN CIRCUIT	Check Harness for damage.
33190	33	TELESCOPE IN VALVE - SHORT TO GROUND	Check Harness for damage.
33207	33	HORN - OPEN CIRCUIT	Check Harness for damage.
33208	33	HORN - SHORT TO BATTERY	Check Harness for damage.
33209	33	HORN - SHORT TO GROUND	Check Harness for damage.
33279	33	GLOWPLUG - OPEN CIRCUIT	Check Harness for damage.
33280	33	GLOWPLUG - SHORT TO BATTERY	Check Harness for damage.
33281	33	GLOWPLUG - SHORT TO GROUND	Check Harness for damage.
33287	33	LIFT - CURRENT FEEDBACK READING TOO LOW	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
33295	33	SWING LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
33306	33	SWING LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
33314	33	FLOW CONTROL VALVE - OPEN CIRCUIT	Check Harness for damage.
33315	33	FLOW CONTROL VALVE - SHORT TO BATTERY	Check Harness for damage.
33316	33	FLOW CONTROL VALVE - SHORT TO GROUND	Check Harness for damage.
33317	33	DRIVE FORWARD VALVE - OPEN CIRCUIT	Check Harness for damage.
33318	33	DRIVE FORWARD VALVE - SHORT TO BATTER	Check Harness for damage.
33319	33	DRIVE FORWARD VALVE - SHORT TO GROUND	Check Harness for damage.
33320	33	DRIVE REVERSE VALVE - OPEN CIRCUIT	Check Harness for damage.
33321	33	DRIVE REVERSE VALVE - SHORT TO BATTERY	Check Harness for damage.
33322	33	DRIVE REVERSE VALVE - SHORT TO GROUND	Check Harness for damage.
33323	33	LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
33324	33	LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
33325	33	LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
33331	33	DRIVE - CURRENT FEEDBACK READING TOO LOW	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33410	33	DRIVE - CURRENT FEEDBACK READING LOST	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33412	33	SWING VALVES - SHORT TO BATTERY	Check Harness for damage.
33414	33	SWING - CURRENT FEEDBACK READING TOO LOW	Check wiring and coil.
33415	33	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33417	33	LIFT - CURRENT FEEDBACK READING LOST	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized.
33418	33	SWING - CURRENT FEEDBACK READING LOST	Check wiring and coil.
33419	33	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33488	33	SWING FLOW CONTROL VALVE - SHORT TO GROUND	Check Harness for damage.
33575	33	ECM PULL DOWN RESISTOR - OPEN CIRCUIT	Check Harness for damage.
340	34	<<< PLATFORM OUTPUT DRIVER >>>	
341	34	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	Check Harness for damage.
342	34	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	Check Harness for damage.

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
343	34	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	Check Harness for damage.
344	34	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	Check Harness for damage.
345	34	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
346	34	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
347	34	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
348	34	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	Check Harness for damage.
349	34	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
3410	34	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
3411	34	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
3412	34	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
3413	34	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
3414	34	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
3415	34	JIB LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
3416	34	JIB LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
3417	34	JIB LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
3418	34	JIB LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
3419	34	JIB LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
3420	34	JIB LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
3421	34	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
3422	34	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
3423	34	JIB ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
3424	34	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
3425	34	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
3426	34	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
430	43	<<< ENGINE >>>	
431	43	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT	Energize fuel sensor per System Indicators
432	43	FUEL SENSOR - SHORT TO GROUND	Energize fuel sensor per System Indicators
433	43	OIL PRESSURE - SHORT TO BATTERY	Deutz engine only.
434	43	OIL PRESSURE - SHORT TO GROUND	Deutz engine only. - Not reported during engine start.
435	43	COOLANT TEMPERATURE - SHORT TO GROUND	Deutz engine only.
436	43	FORD FAULT CODE ##	
437	43	ENGINE TROUBLE CODE	Report and log in Help If [(MACHINE SETUP > DEUTZ EMR2) or (MACHINE SETUP > DEUTZ EMR4) and SPN:FMI = 535:7], prohibit engine cranking.
438	43	HIGH ENGINE TEMP	Ford / Deutz engine only.
439	43	AIR FILTER BYPASSED	Check Airfilter for clogging
4310	43	NO ALTERNATOR OUTPUT	Activate the No Charge indicator J4-26 per System Indicators.
4311	43	LOW OIL PRESSURE	Ford / Deutz engine only.
4312	43	485 COMMUNICATIONS LOST	

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
4313	43	THROTTLE ACTUATOR FAILURE	
4314	43	WRONG ENGINE SELECTED - ECM DETECTED	
4322	43	LOSS OF ENGINE SPEED SENSOR	Diesel engine only.
4323	43	SPEED SENSOR READING INVALID SPEED	Diesel engine only.
4331	43	SOOT LOAD WARNING - LOW	Check Engine.
4332	43	SOOT LOAD WARNING - HIGH	Check Engine.
4333	43	SOOT LOAD WARNING - SEVERE	Check Engine.
4334	43	ENGINE COOLANT - LOW LEVEL	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine; Activate High Engine Temperature indicator J4-28.
440	44	<<< BATTERY SUPPLY >>>	
441	44	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN	
442	44	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	
445	44	BATTERY VOLTAGE LOW	
660	66	<<< COMMUNICATION >>>	
662	66	CANBUS FAILURE - PLATFORM MODULE	
664	66	CANBUS FAILURE - ACCESSORY MODULE	Check the Wiring.
666	66	CANBUS FAILURE - ENGINE CONTROLLER	ECM equipped engine only.
6620	66	CANBUS FAILURE - UMS SENSOR	
6622	66	CANBUS FAILURE - TCU MODULE	
6623	66	CANBUS FAILURE - GATEWAY MODULE	
6629	66	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH	
6657	66	CANBUS FAILURE - TEMPERATURE SENSOR	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
671	67	ACCESSORY FAULT	
680	68	<<< TELEMATICS >>>	
681	68	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNC- TIONS IN CREEP	
810	81	<<< TILT SENSOR >>>	
813	81	CHASSIS TILT SENSOR NOT CALIBRATED	
815	81	CHASSIS TILT SENSOR DISAGREEMENT	
816	81	UMS SENSOR NOT CALIBRATED	
817	81	UMS SENSOR FAULT	

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
820	82	<<< PLATFORM LOAD SENSE >>>	
825	82	LSS HAS NOT BEEN CALIBRATED	UGM to set Platform Load State = Overloaded
826	82	RUNNING AT CREEP - PLATFORM OVERLOADED	
827	82	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	
828	82	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED	
8639	86	FRONT LEFT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8640	86	FRONT LEFT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8641	86	FRONT LEFT STEER VALVE - SHORT TO GROUND	Check Harness for damage.
8642	86	FRONT RIGHT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8643	86	FRONT RIGHT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8644	86	FRONT RIGHT STEER VALVE - SHORT TO GROUND	Check Harness for damage.
8645	86	REAR LEFT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8646	86	REAR LEFT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8647	86	REAR LEFT STEER VALVE - SHORT TO GROUND	Check Harness for damage.
8648	86	REAR RIGHT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8649	86	REAR RIGHT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8650	86	REAR RIGHT STEER VALVE - SHORT TO GROUND	Check Harness for damage.
871	87	RETURN FILTER BYPASSED	Check Hydraulic Return Filter.
872	87	CHARGE PUMP FILTER BYPASSED	Check Charge Pump Filter.
873	87	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	Response described in MSSO Influence on Machine Operation section.
998	99	EEPROM FAILURE - CHECK ALL SETTINGS	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start); reset the section of EEPROM where the failure occurred to defaults.
9910	99	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	Activate the platform alarm continuously Creep mode is active If Platform Mode is active, disable all Drive, Steer, and Boom functions and do not permit Machine Enable.
9914	99	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	
9915	99	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	
9916	99	CHASSIS TILT SENSOR GAIN OUT OF RANGE	
9919	99	GROUND SENSOR REF VOLTAGE OUT OF RANGE	Not reported during power-up.
9920	99	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	Not reported during power-up.
9921	99	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY	
9922	99	PLATFORM MODULE FAILURE - HWFS CODE 1	
9923	99	GROUND MODULE FAILURE - HWFS CODE 1	

Table 6-9. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
9924	99	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	Display ??? or NO MODEL at Analyzer MACHINE SETUP menu MACHINE SETUP->MODEL NUMBER Do not report any other faults Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
9944	99	CURRENT FEEDBACK GAINS OUT OF RANGE	A gain of 1 is used for the factory gain(s) that was out of range; all functions shall be placed in Creep mode.
9945	99	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	
9979	99	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).

NOTES:

SECTION 7. BASIC ELECTRICAL INFORMATION & SCHEMATICS

7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop. If a problem should develop which is not presented in this section or which is not corrected by listed corrective actions, technically qualified guidance should be obtained before proceeding.

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 your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the Voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the lead on the other port goes to the positive side of the signal.

Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = mili = (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

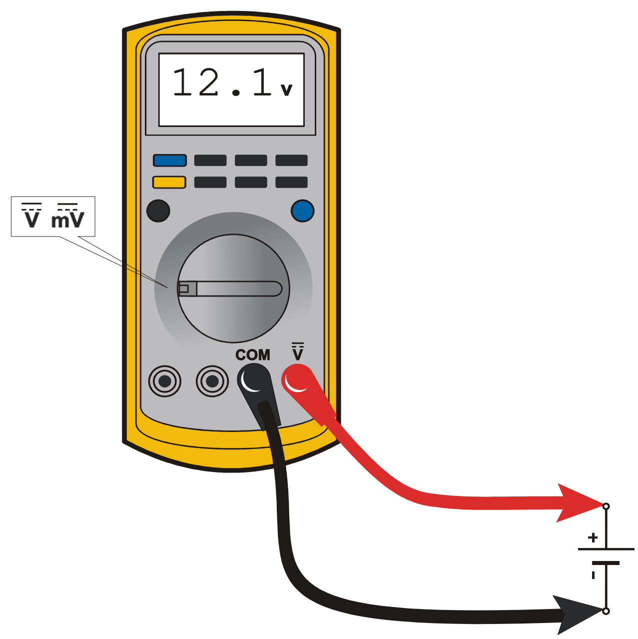


Figure 7-1. Voltage Measurement (DC)

- 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

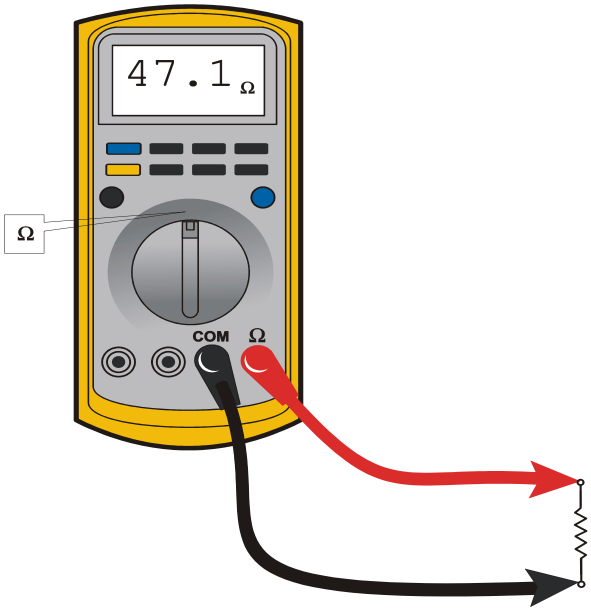


Figure 7-2. Resistance Measurement

- 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).
- Use firm contact with meter leads.

Continuity Measurement

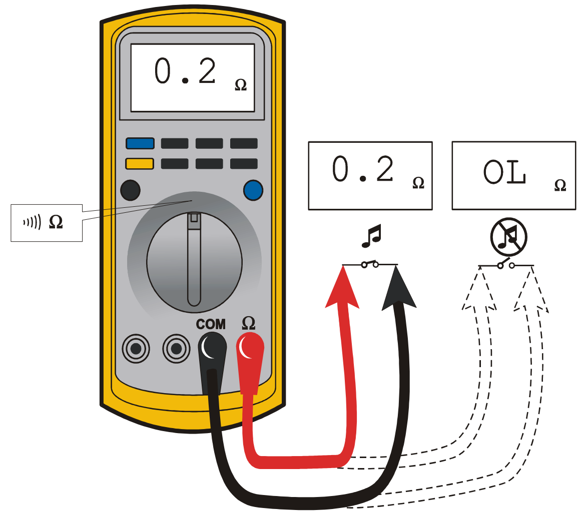


Figure 7-3. Continuity Measurement

- Some meters require a separate button press to enable audible continuity testing.
- Circuit power must be turned OFF before testing continuity.
- Disconnect component from circuit before testing.
- Use firm contact with meter leads.
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity.

Current Measurement

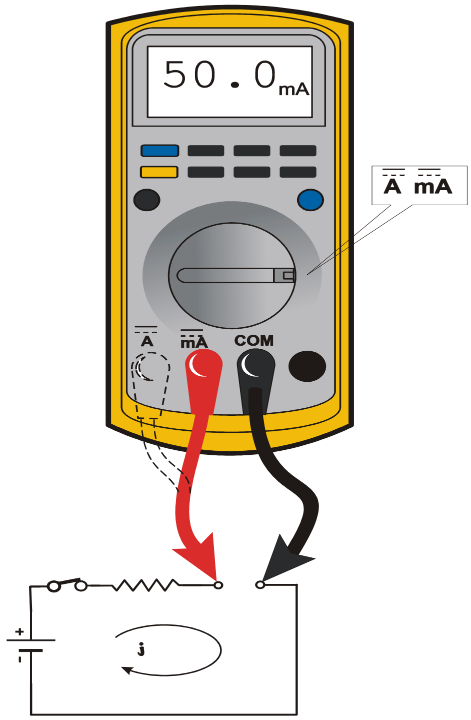


Figure 7-4. Current Measurement (DC)

- Set up the meter for the expected current range.
- Be sure to connect the meter leads to the correct jacks for the current range you have selected.
- If meter is not auto ranging, set it to the correct range (See multi meter's operation manual).
- Use firm contact with meter leads.

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

NOTE: *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.*

3. Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

NOTE: *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

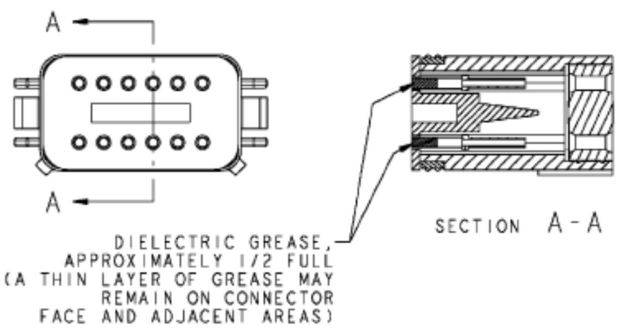
When applied to electrical connections, dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

Dielectric grease shall be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

Installation of Dielectric Grease

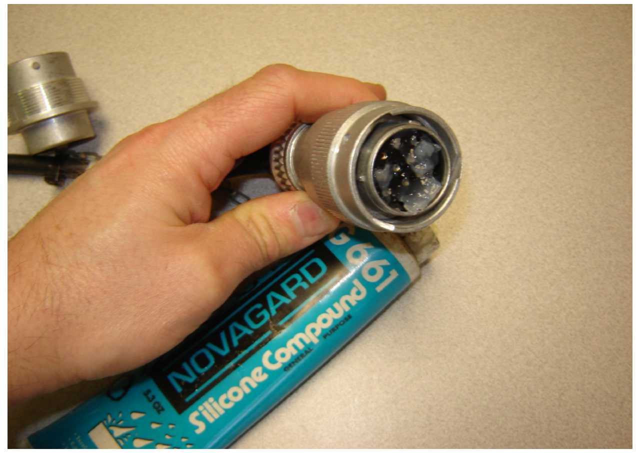
Before following these instructions, refer to excluded connector types (See Exclusions below).

1. Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
2. Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals (fill it approximately full; see example below).
3. Leave a thin layer of dielectric grease on the face of the connector.
4. Assemble the connector system immediately to prevent moisture ingress or dust contamination.
5. 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.



AMP 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

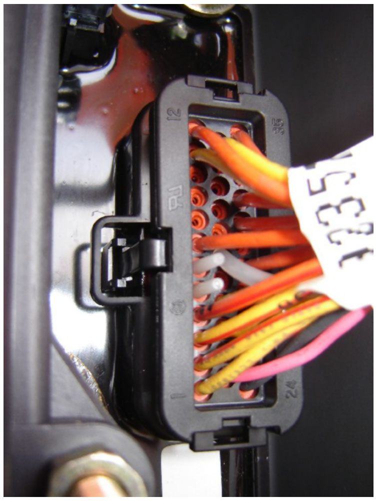
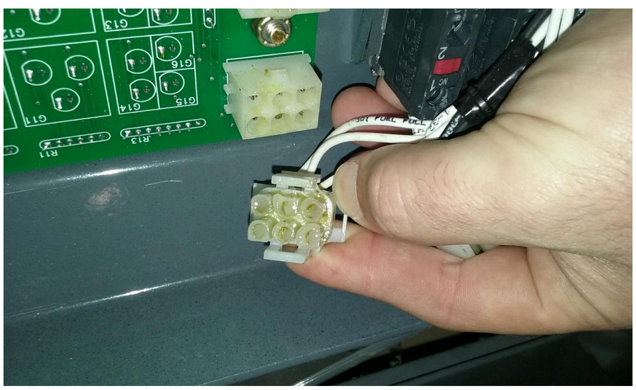


Figure 7-6. Use of Seal Plugs

AMP Mate-N-Lok

This connector system is widely used inside enclosures for general purpose interconnect. Follow the general guidance for installation.



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 Rotary Angle Sensors are examples of components with the M12 connector system.

Figure 7-7. Brad-Harrison M12

Figure 7-8. Phoenix Contact M12

ENGINE CONTROL UNIT CONNECTORS

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 EMR4 engine control module from Deutz employs this connector system (for example).

SEALED ENCLOSURES

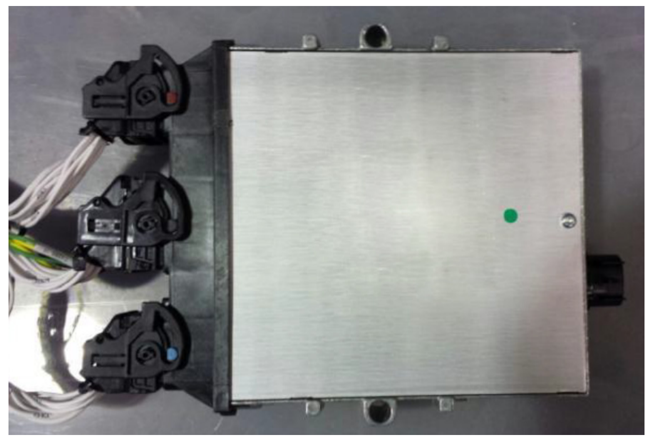
Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP66 (dust tight; protected from powerful jets of water). The enclosure must be fitted with a high quality, continuous gasket and all wiring must pass through cable entrances.

MIL-C-5015 SPEC CONNECTOR'S

Crown Connector Inc's recommendation is to not use dielectric grease for this series connector. For similar model series connectors, the manufacturer should be contacted for confirmation before applying dielectric grease. A typical application for this connector is on David Clark Intercom connections in Aerial Work Platforms.

MOLEX CMC SERIES CONNECTORS

The CMC connector family is a sealed, high-density connection system using matte-seal technology for CP 0.635 and 1.50 mm terminals. To guarantee IP6K7 and IP6K9 sealing, a seal plug option is used. 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 flexbox control modules from JDES employ 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 7-9.). Proceed as follows:

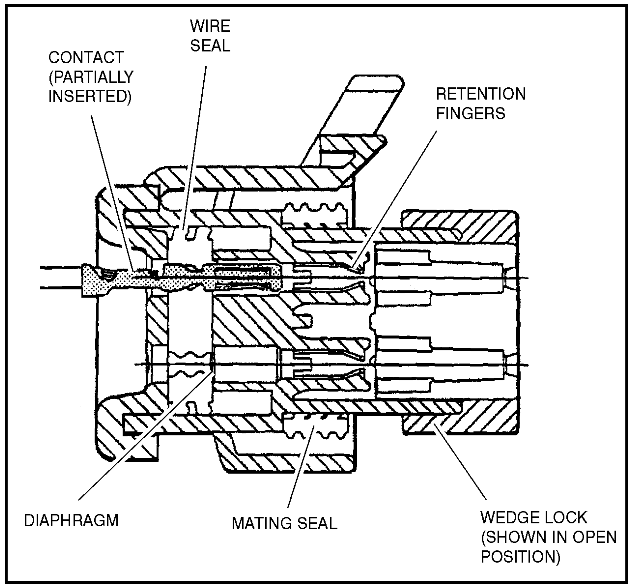


Figure 7-9. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-11.).
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 7-11.).

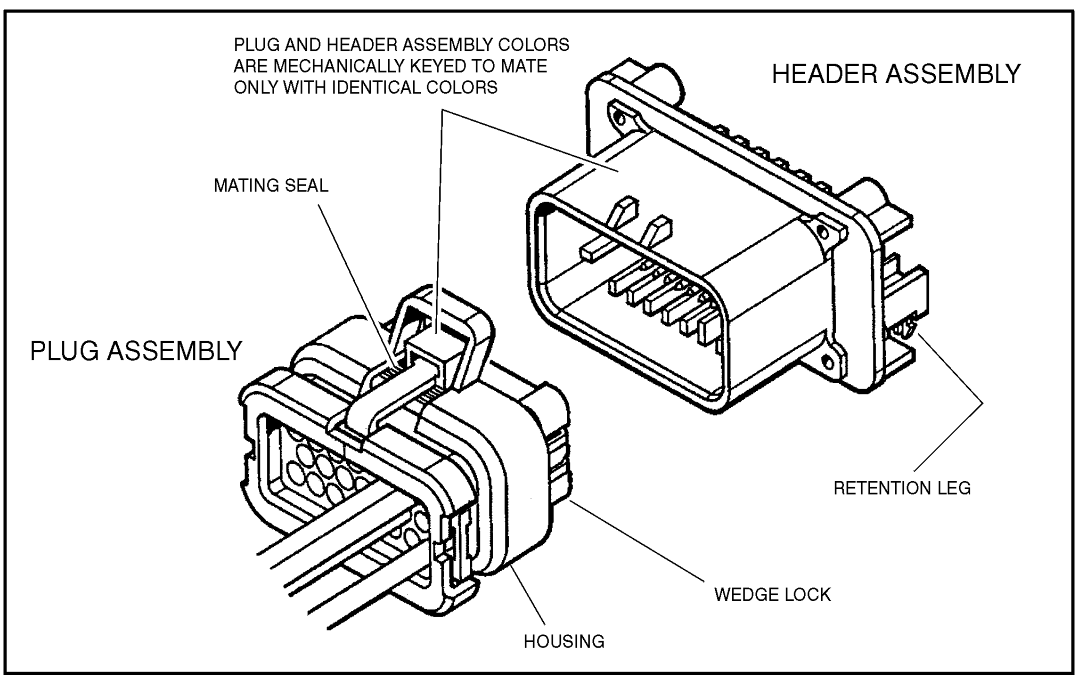


Figure 7-10. AMP Connector

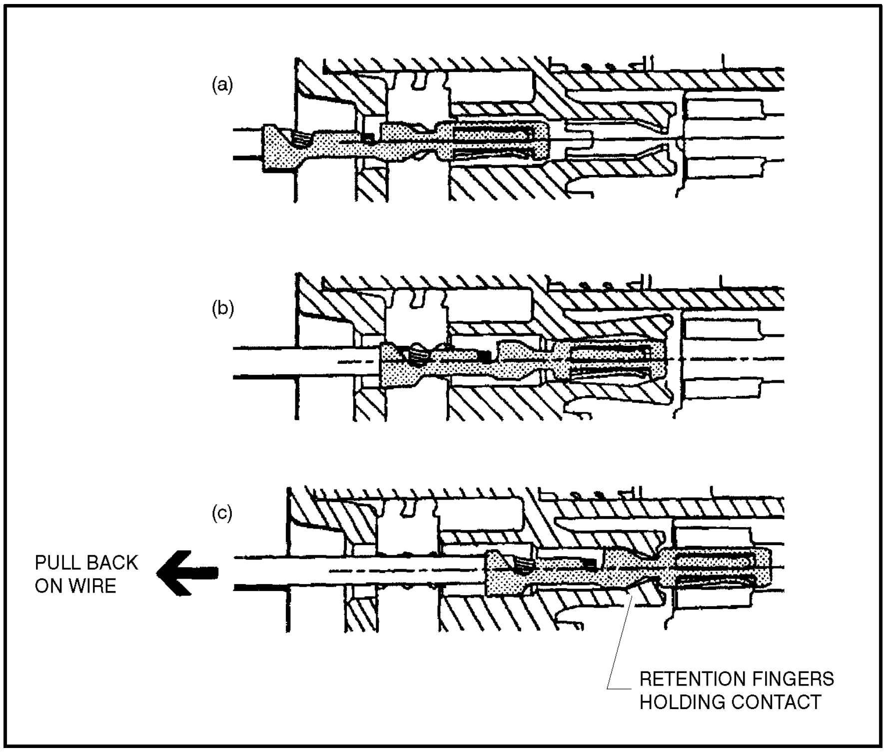


Figure 7-11. Connector Assembly Figure 2

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 7-12.).

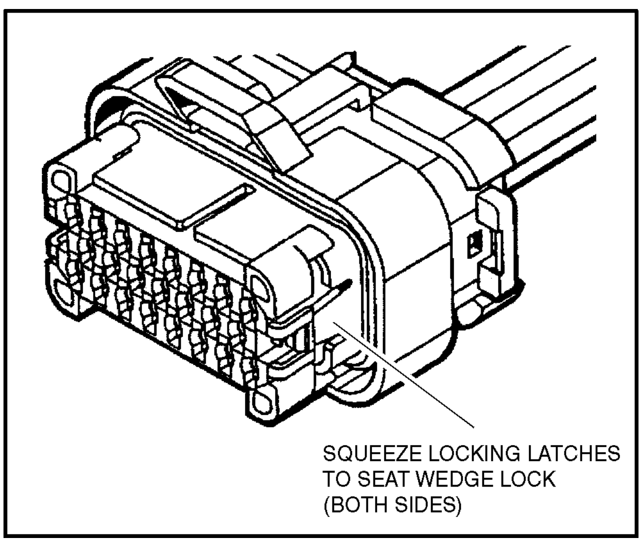


Figure 7-12. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-13.).

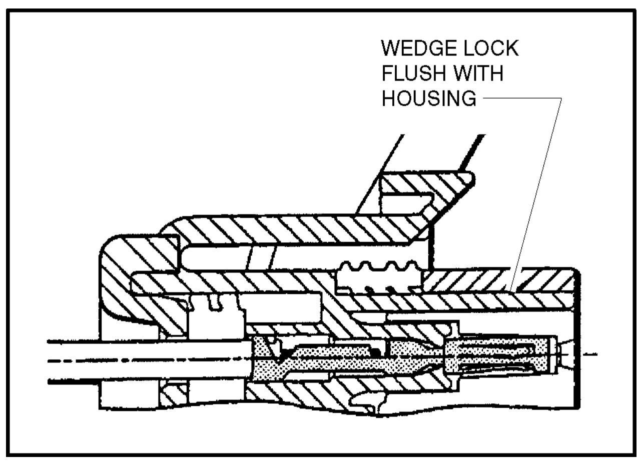


Figure 7-13. Connector Assembly Figure 4

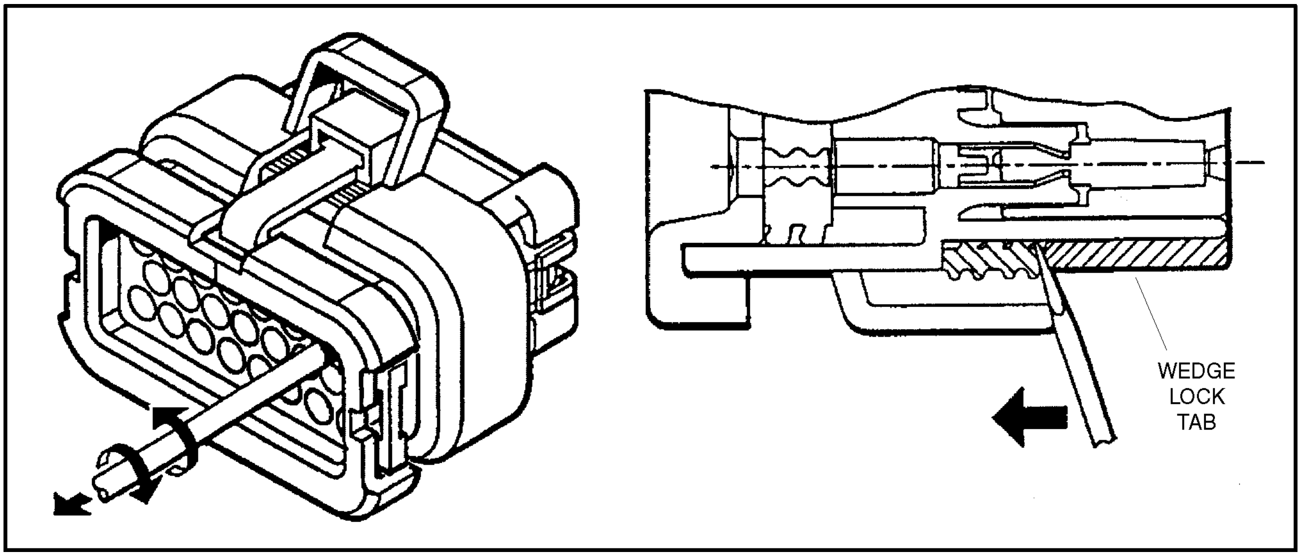


Figure 7-14. Connector Disassembly

Disassembly

5. Insert a 4.8 mm (3/16 in.) 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 AMP-SEAL 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.

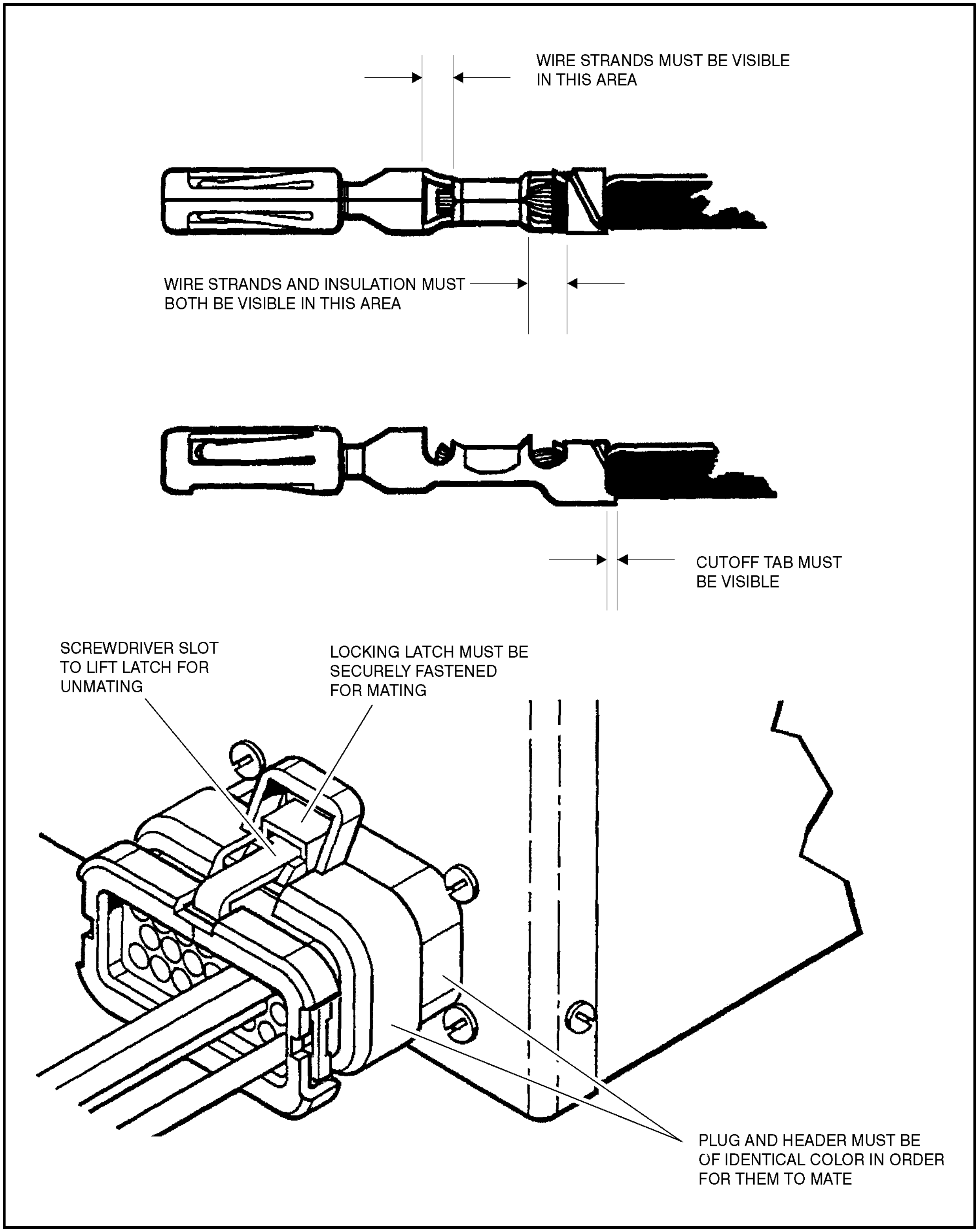
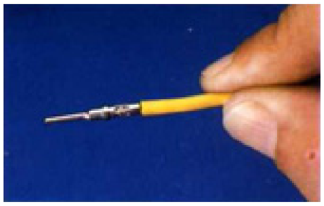


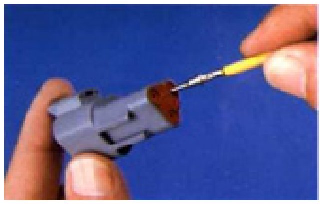
Figure 7-15. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

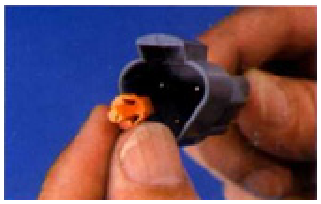


A



B

C



D

Figure 7-16. DT/DTP Contact Installation

1. Grasp crimped contact about 25 mm 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

A

B

C

Figure 7-17. DT/DTP Contact Removal

1. Remove wedgelock using needle nose pliers or a hook shaped wire to pull wedge straight out.
2. 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.
3. Hold the rear seal in place, as removing the contact may displace the seal.

HD30/HDP20 Series Assembly

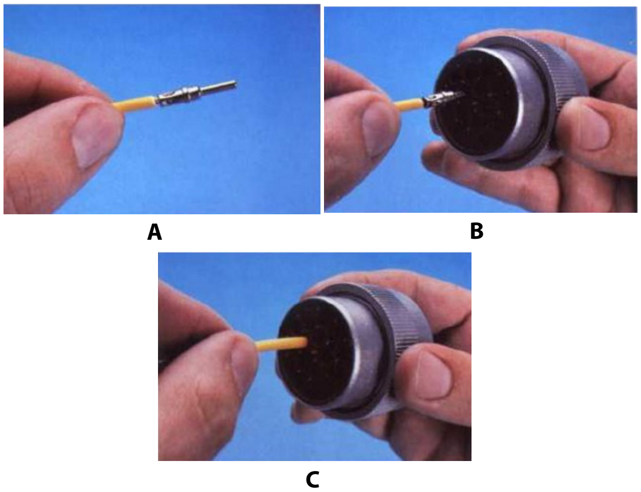


Figure 7-18. HD/HDP Contact Installation

1. Grasp contact about 25 mm behind the contact crimp barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.

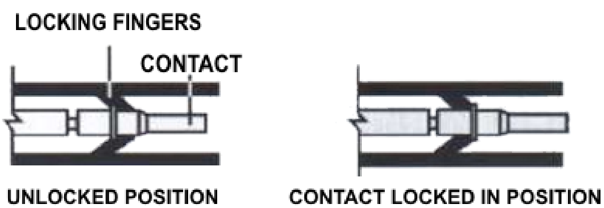


Figure 7-19. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing.*

HD30/HDP20 Series Disassembly

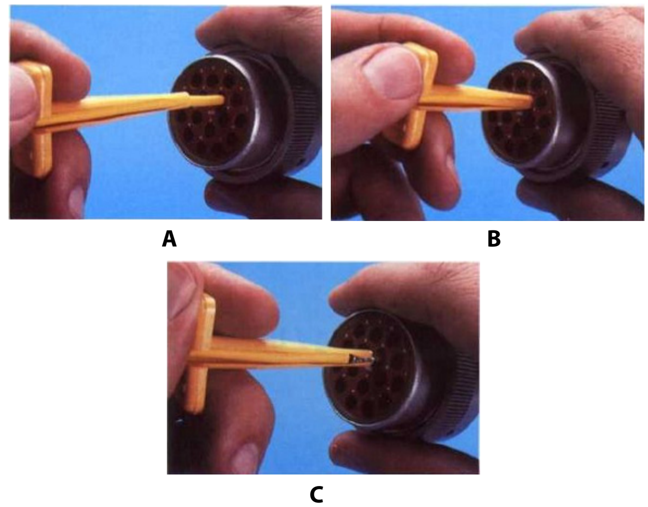


Figure 7-20. HD/HDP Contact Removal

1. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
2. Slide tool along into the insert cavity until it engages contact and resistance is felt.
3. Pull contact-wire assembly out of connector.

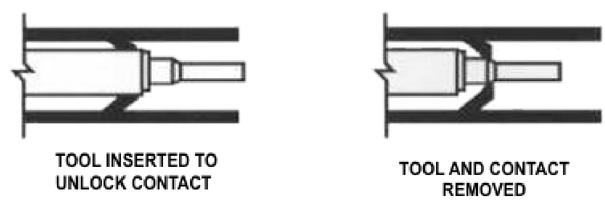


Figure 7-21. HD/HDP Unlocking Contacts

NOTE: *Do Not twist or insert tool at an angle.*

7.6 ELECTRICAL COMPONENT

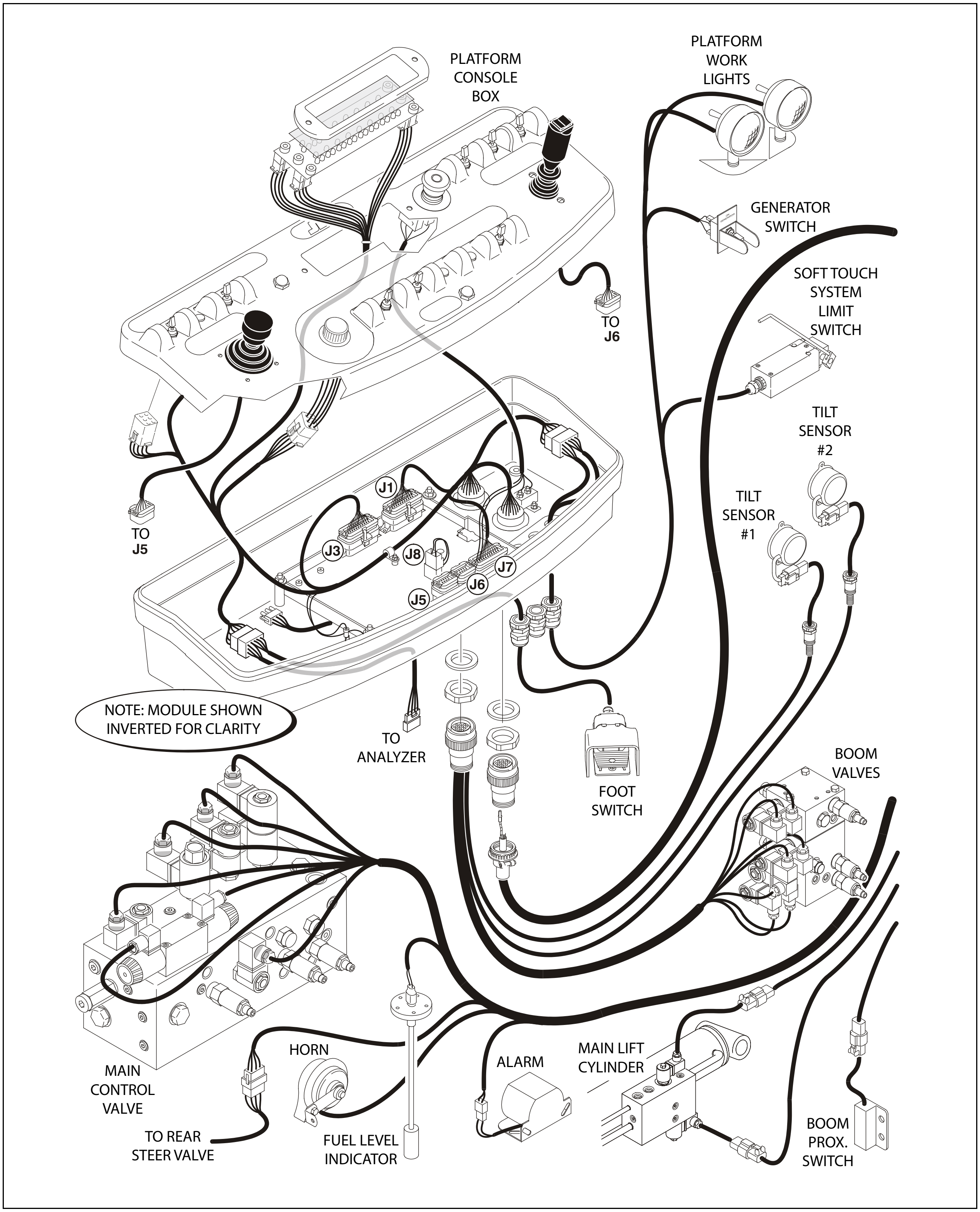


Figure 7-22. Electrical Components Installation - Sheet 1 of 2

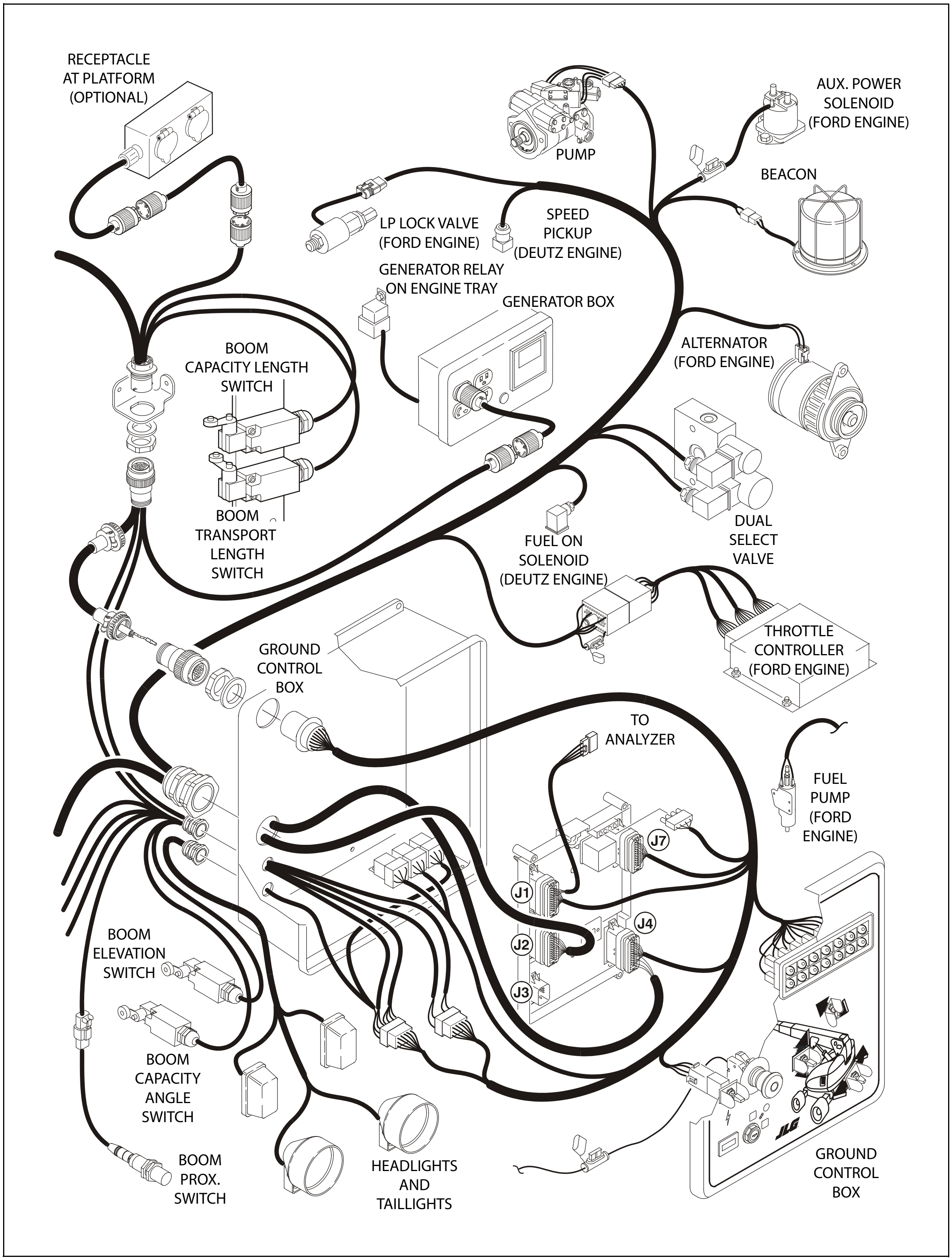


Figure 7-23. Electrical Components Installation - Sheet 2 of 2

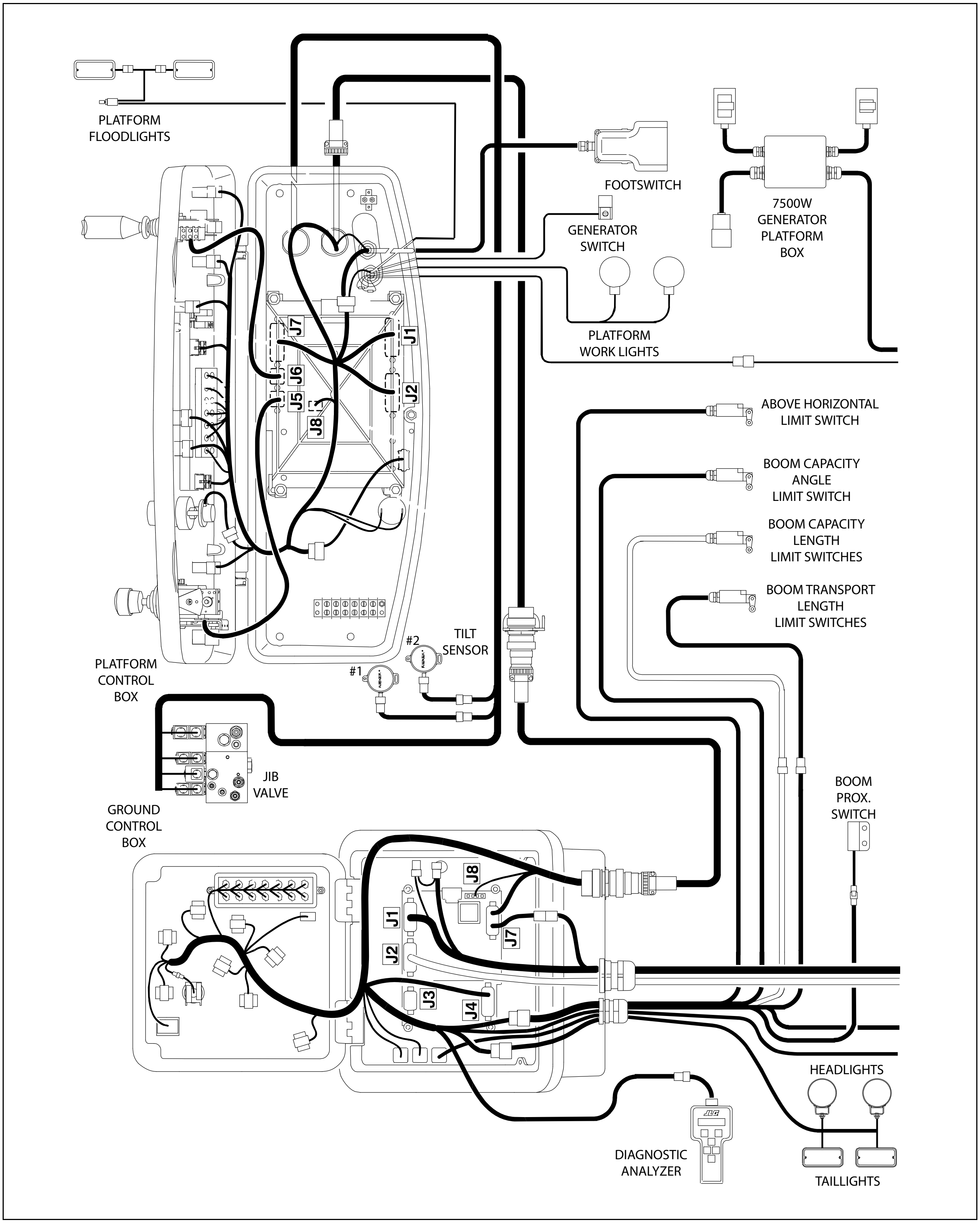


Figure 7-24. Electrical Components Installation (Without UGM) - Sheet 1 of 2

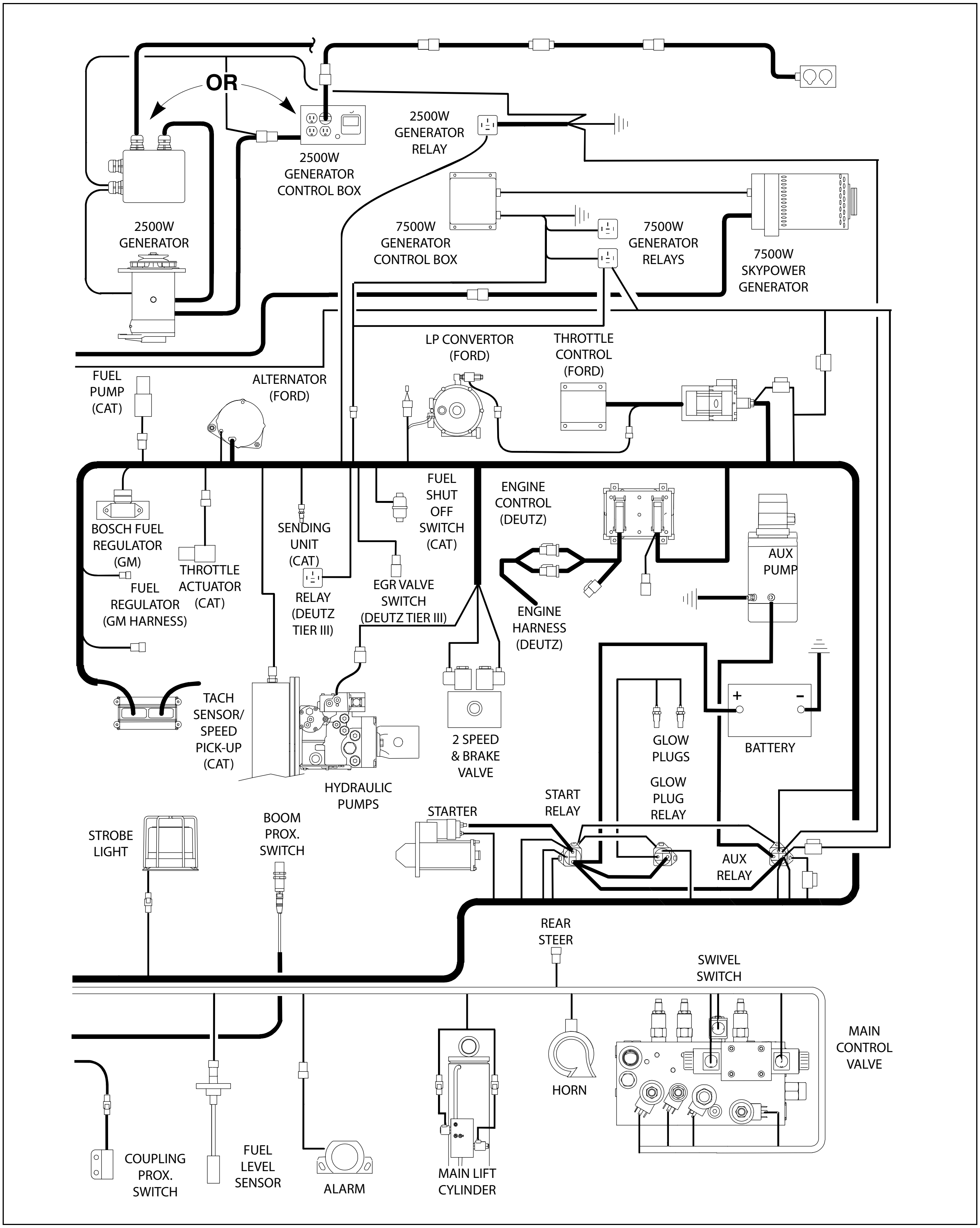


Figure 7-25. Electrical Components Installation (Without UGM) - Sheet 2 of 2

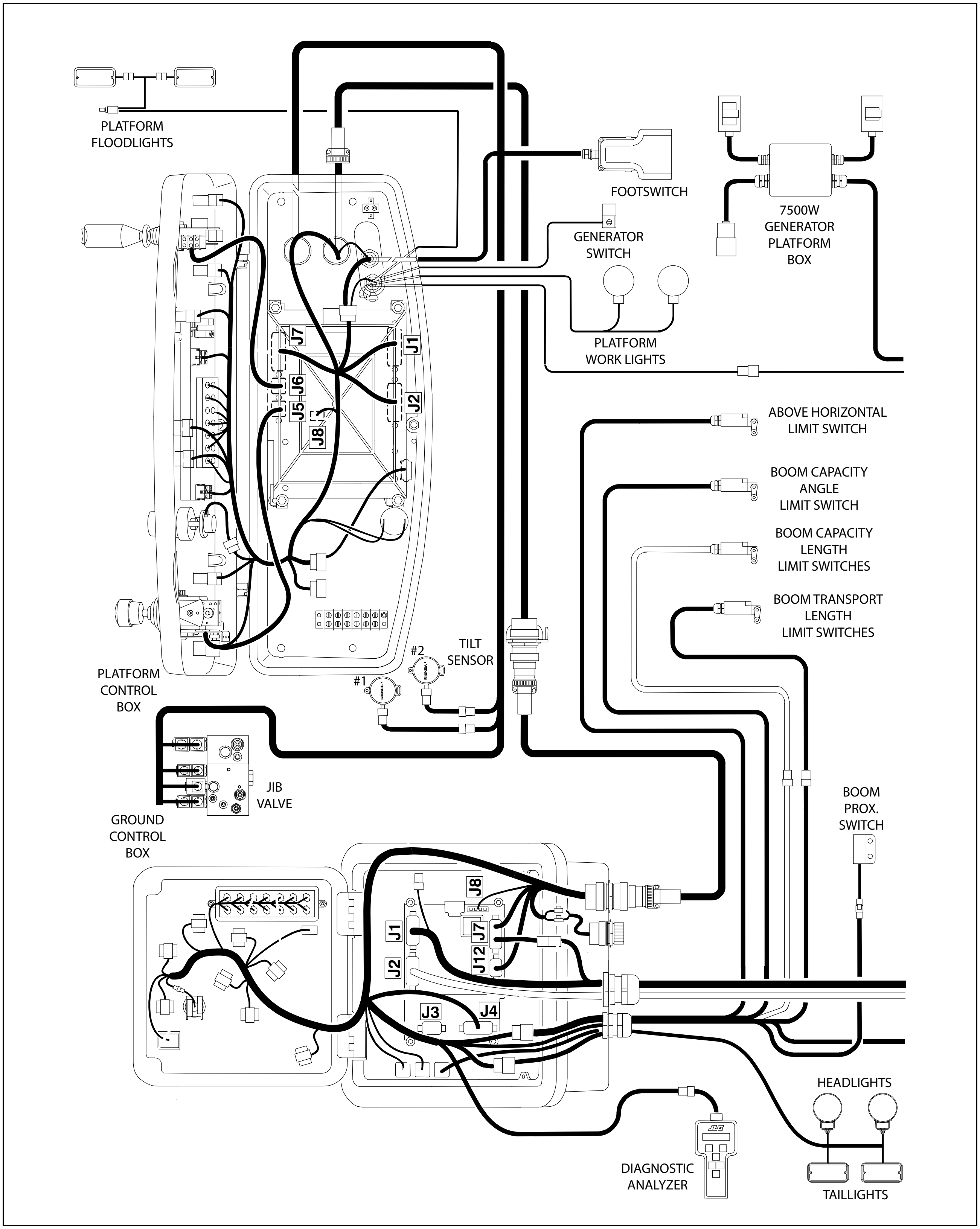


Figure 7-26. Electrical Components Installation (With UGM) - Sheet 1 of 2

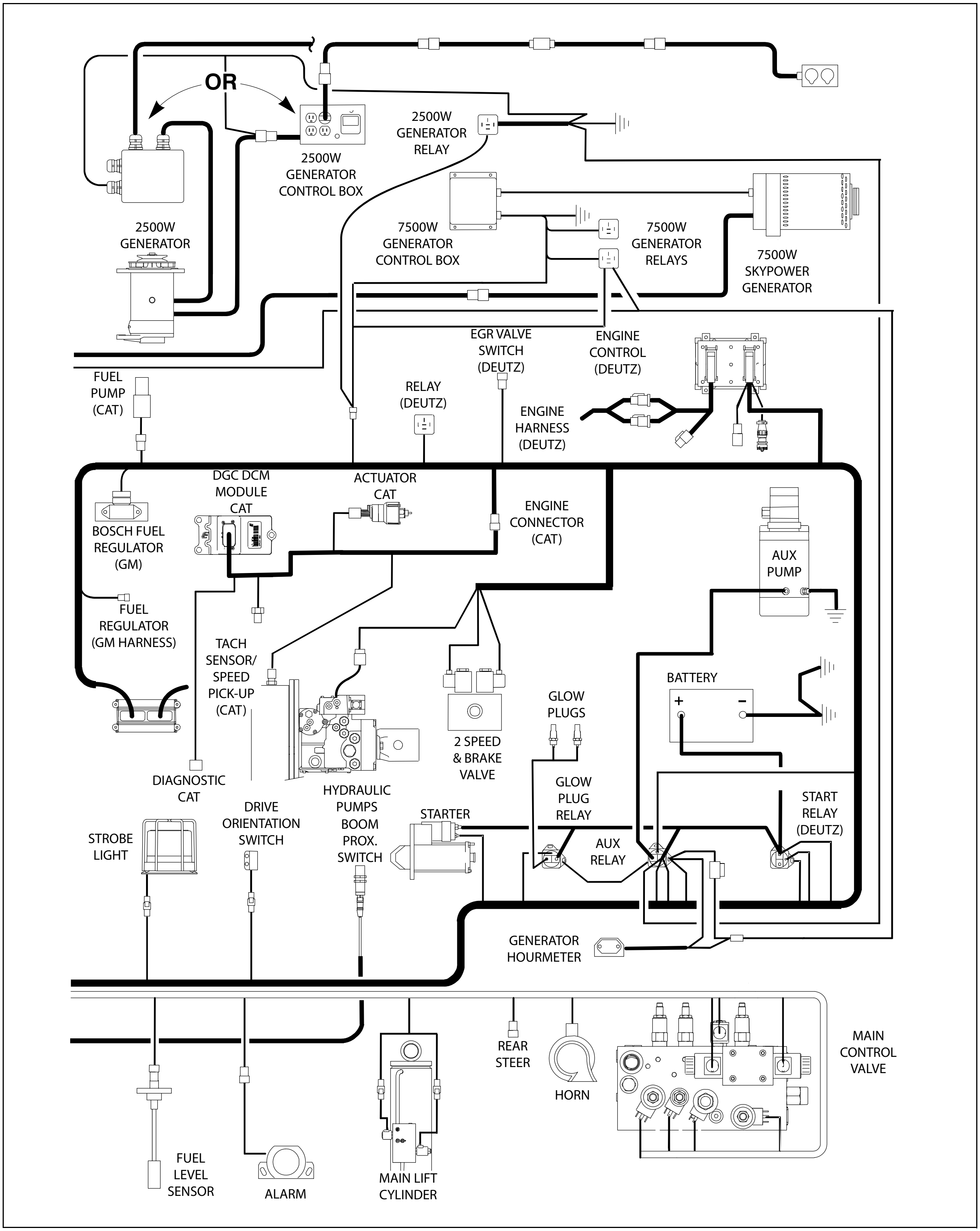


Figure 7-27. Electrical Components Installation (With UGM) - Sheet 2 of 2

7.7 ELECTRICAL SCHEMATICS

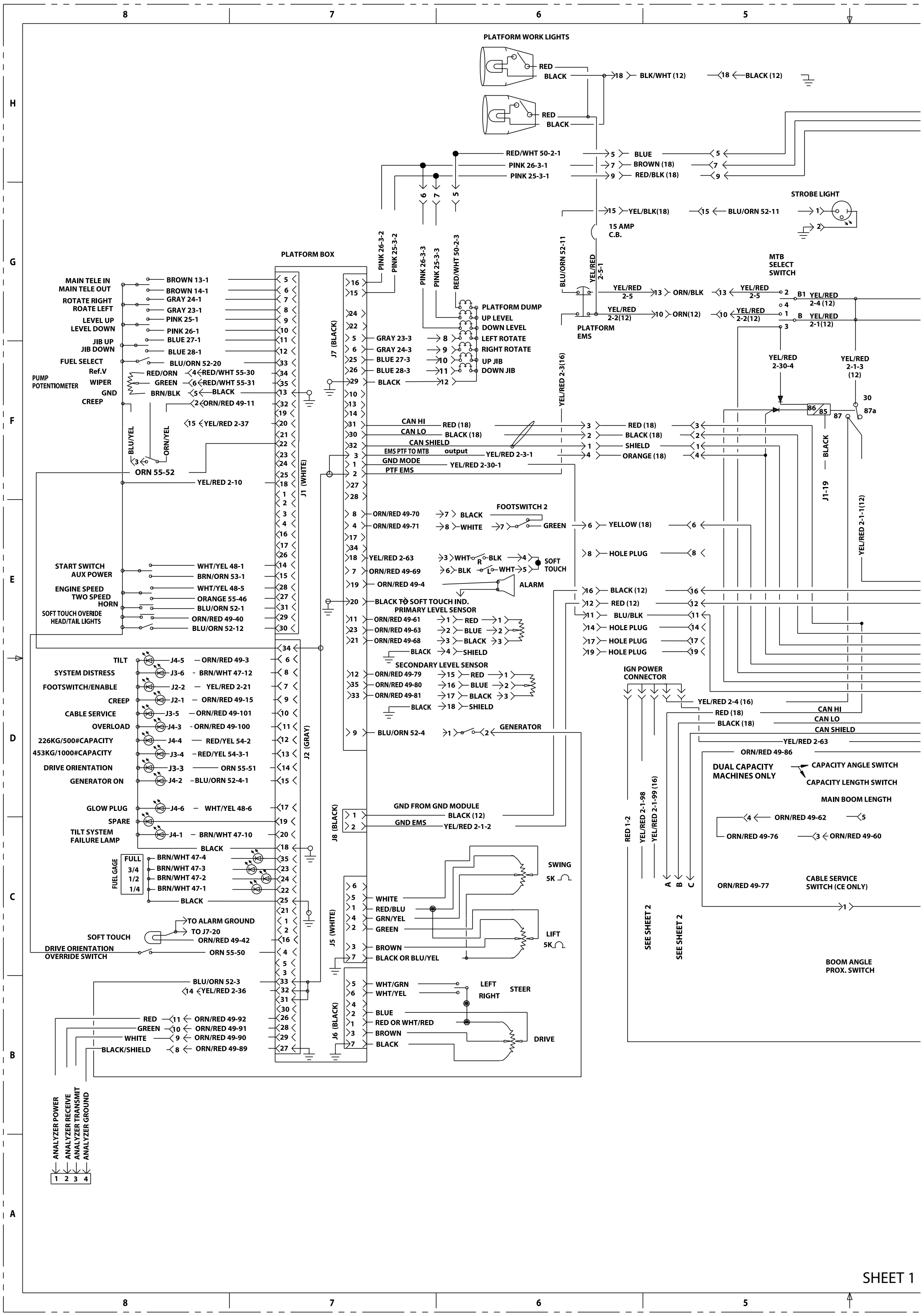


Figure 7-28. Electrical Schematics Caterpillar, Deutz EMR2 and GM (Prior to SN 0300139080) - Sheet 1 of 6

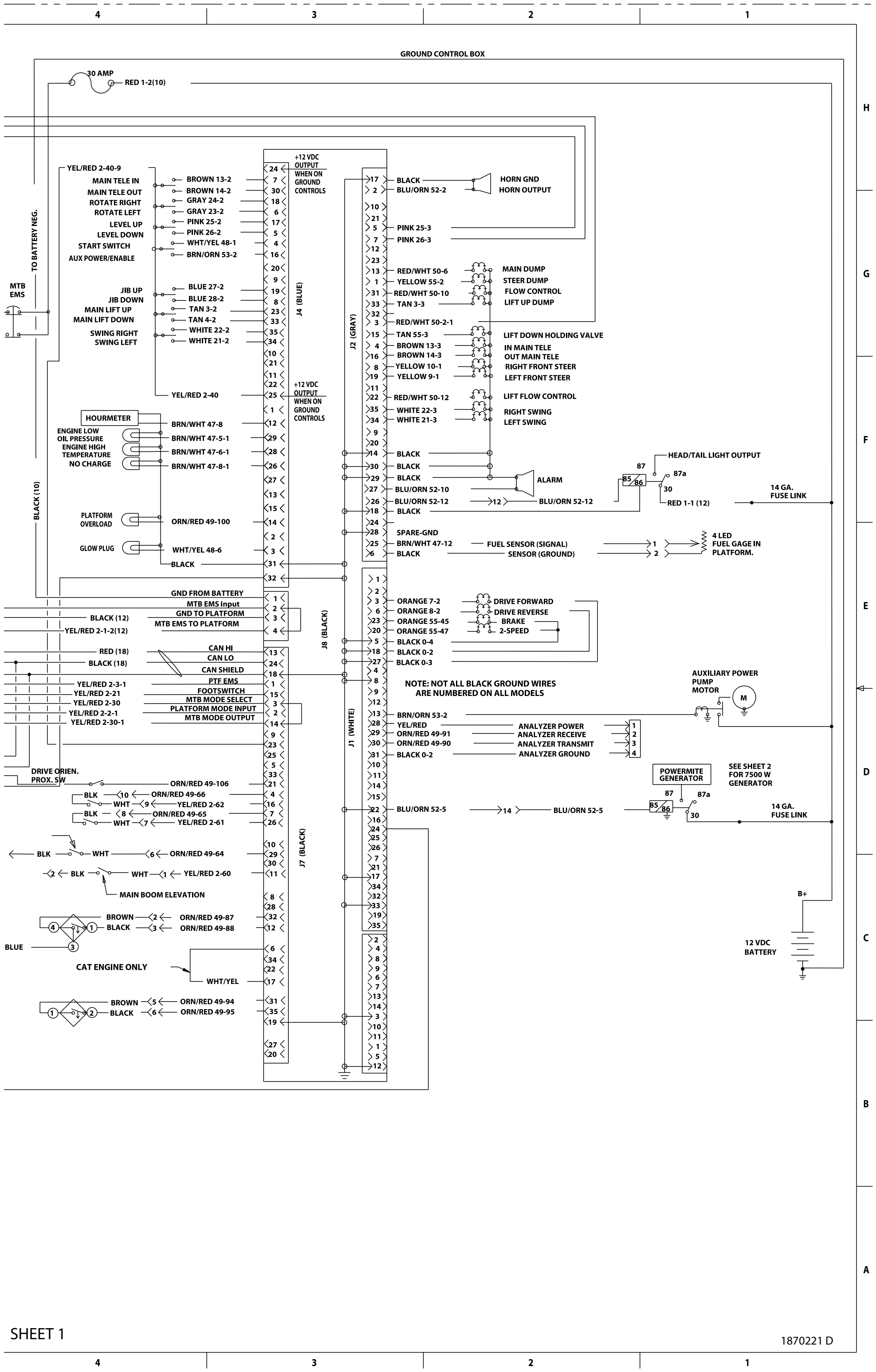


Figure 7-29. Electrical Schematics Caterpillar, Deutz EMR2 and GM (Prior to SN 0300139080) - Sheet 2 of 6

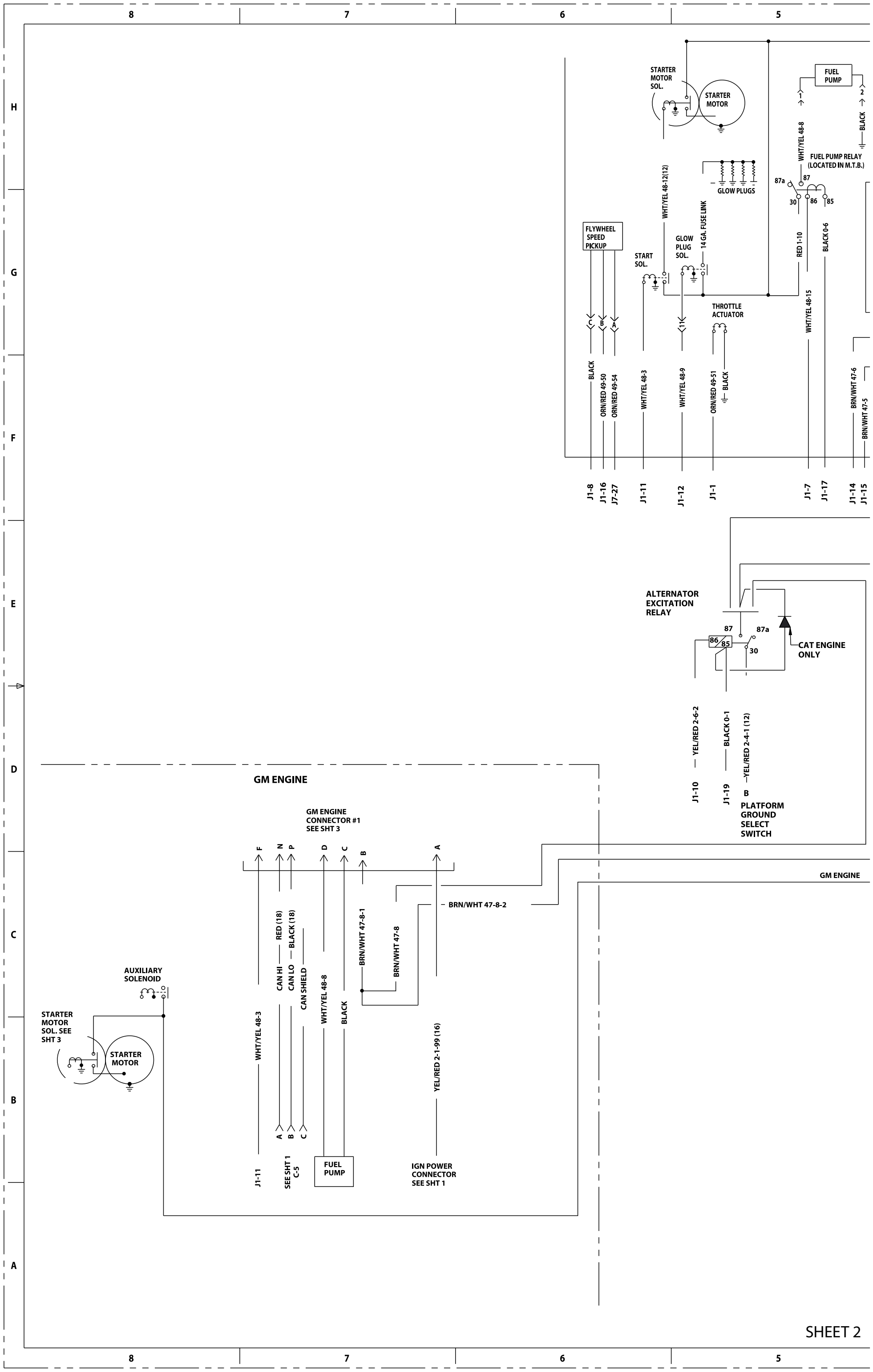


Figure 7-30. Electrical Schematics Caterpillar, Deutz EMR2 and GM (Prior to SN 0300139080) - Sheet 3 of 6

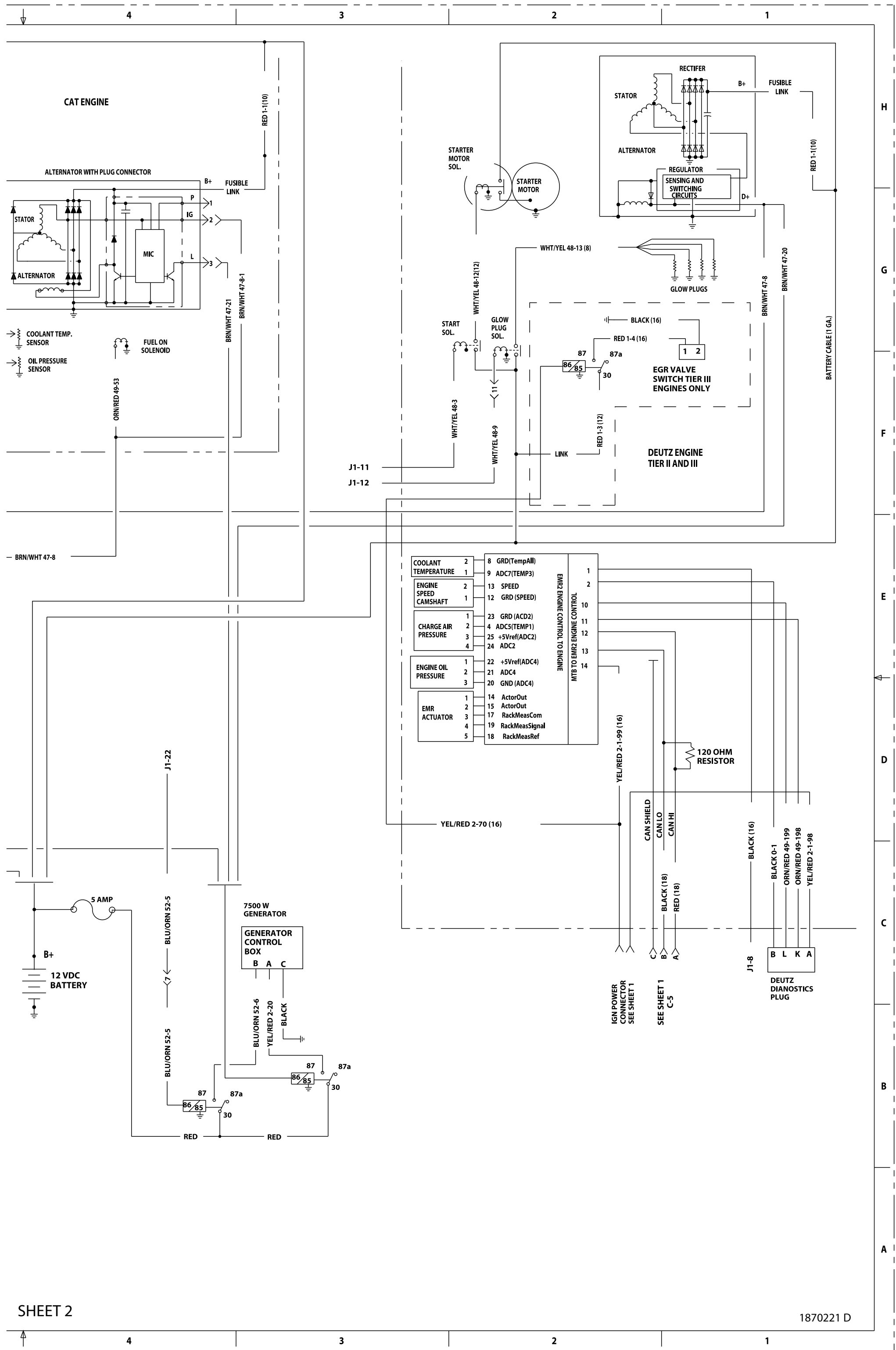


Figure 7-31. Electrical Schematics Caterpillar, Deutz EMR2 and GM (Prior to SN 0300139080) - Sheet 4 of 6

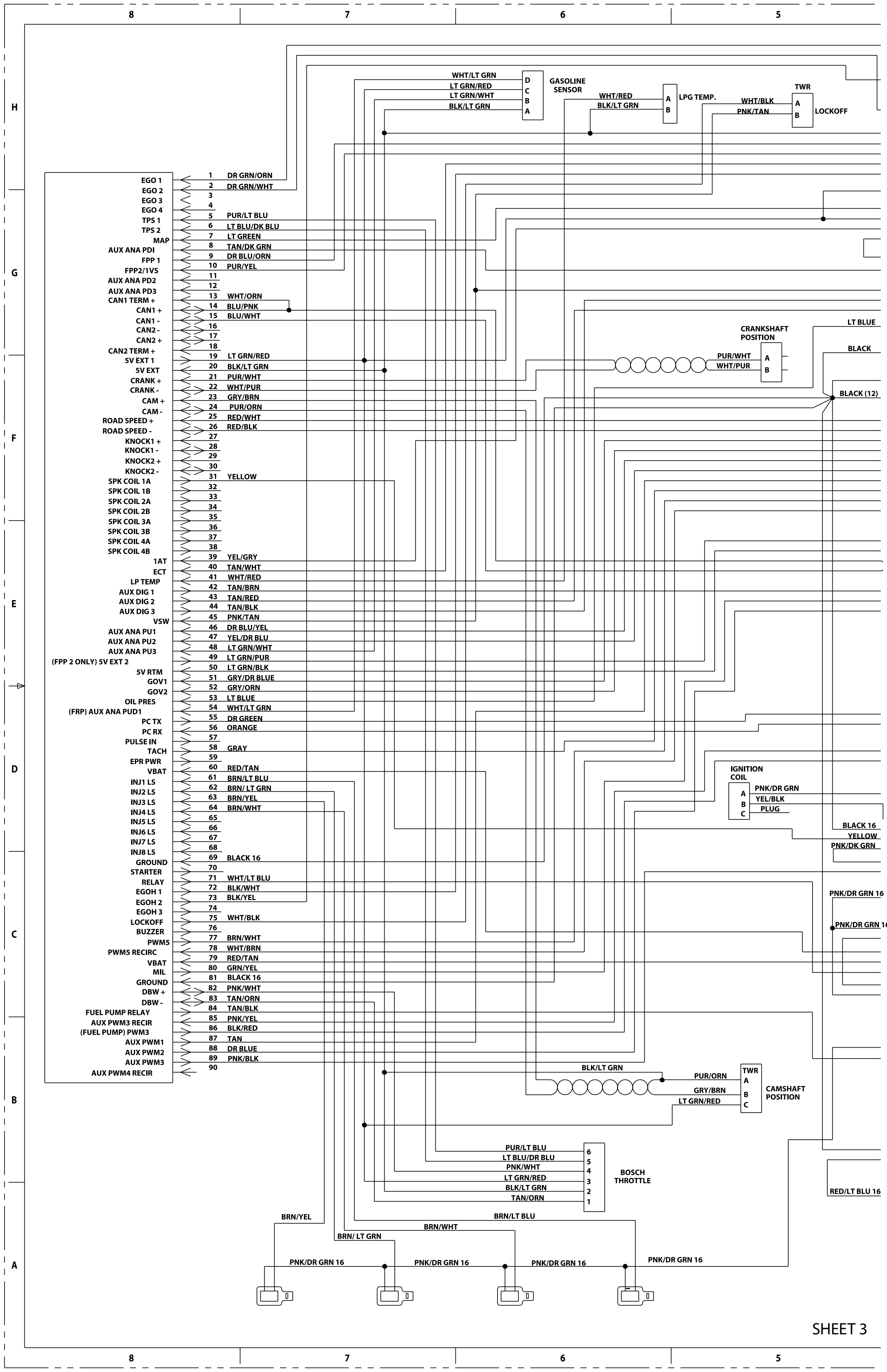


Figure 7-32. Electrical Schematics Caterpillar, Deutz EMR2 and GM (Prior to SN 0300139080) - Sheet 5 of 6

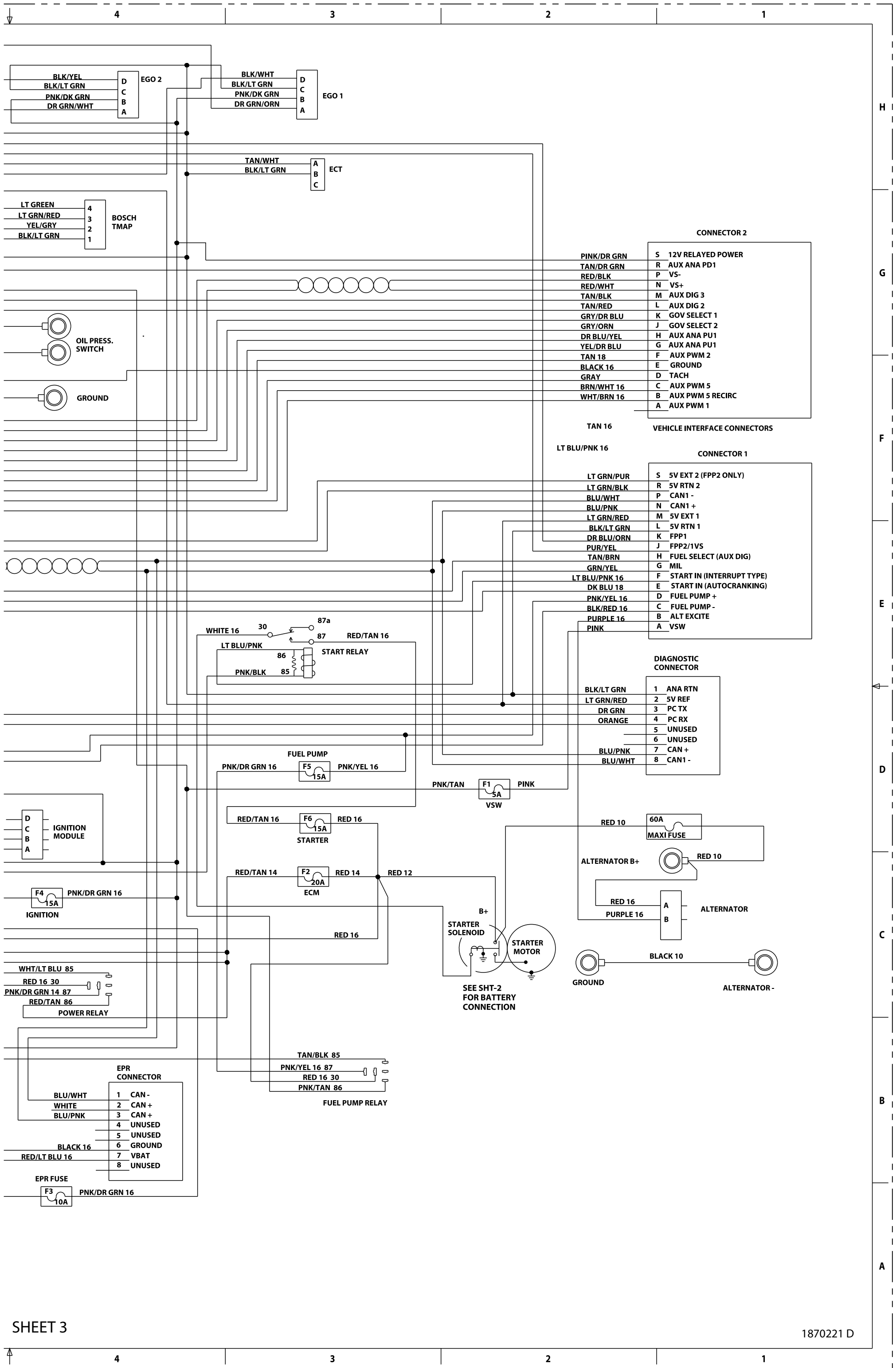


Figure 7-33. Electrical Schematics Caterpillar, Deutz EMR2 and GM (Prior to SN 0300139080) - Sheet 6 of 6

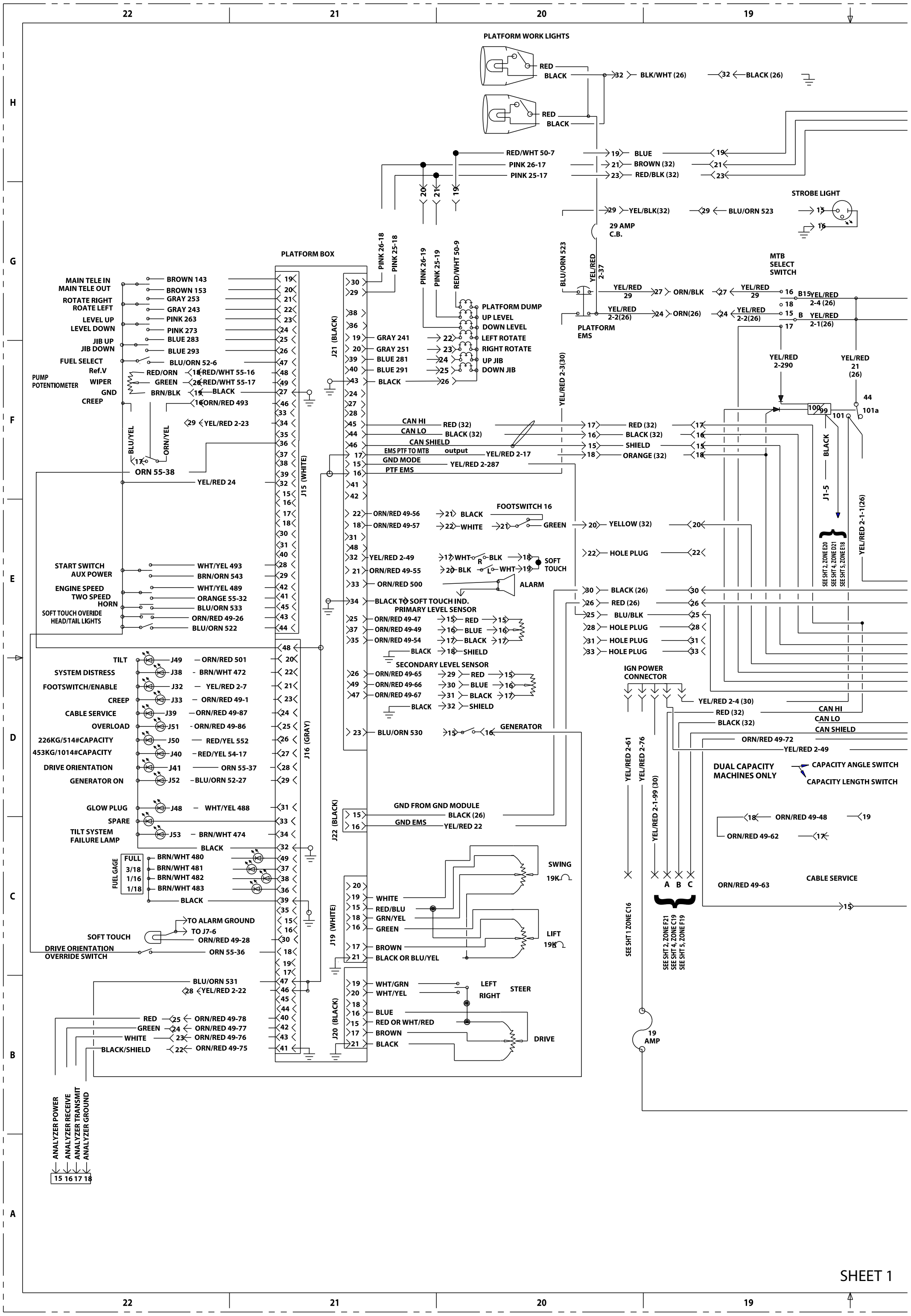


Figure 7-34. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 1 of 10

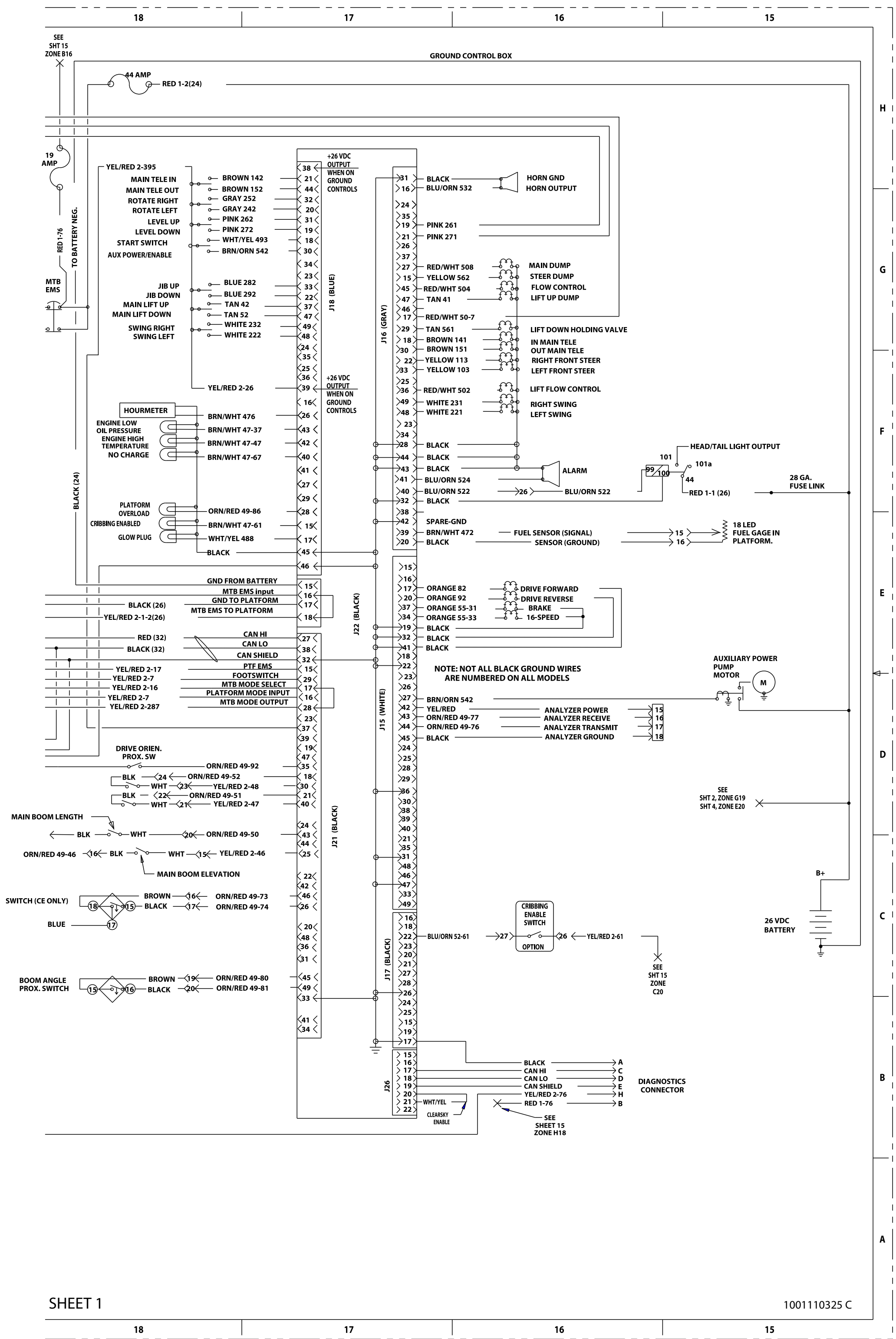


Figure 7-35. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 2 of 10

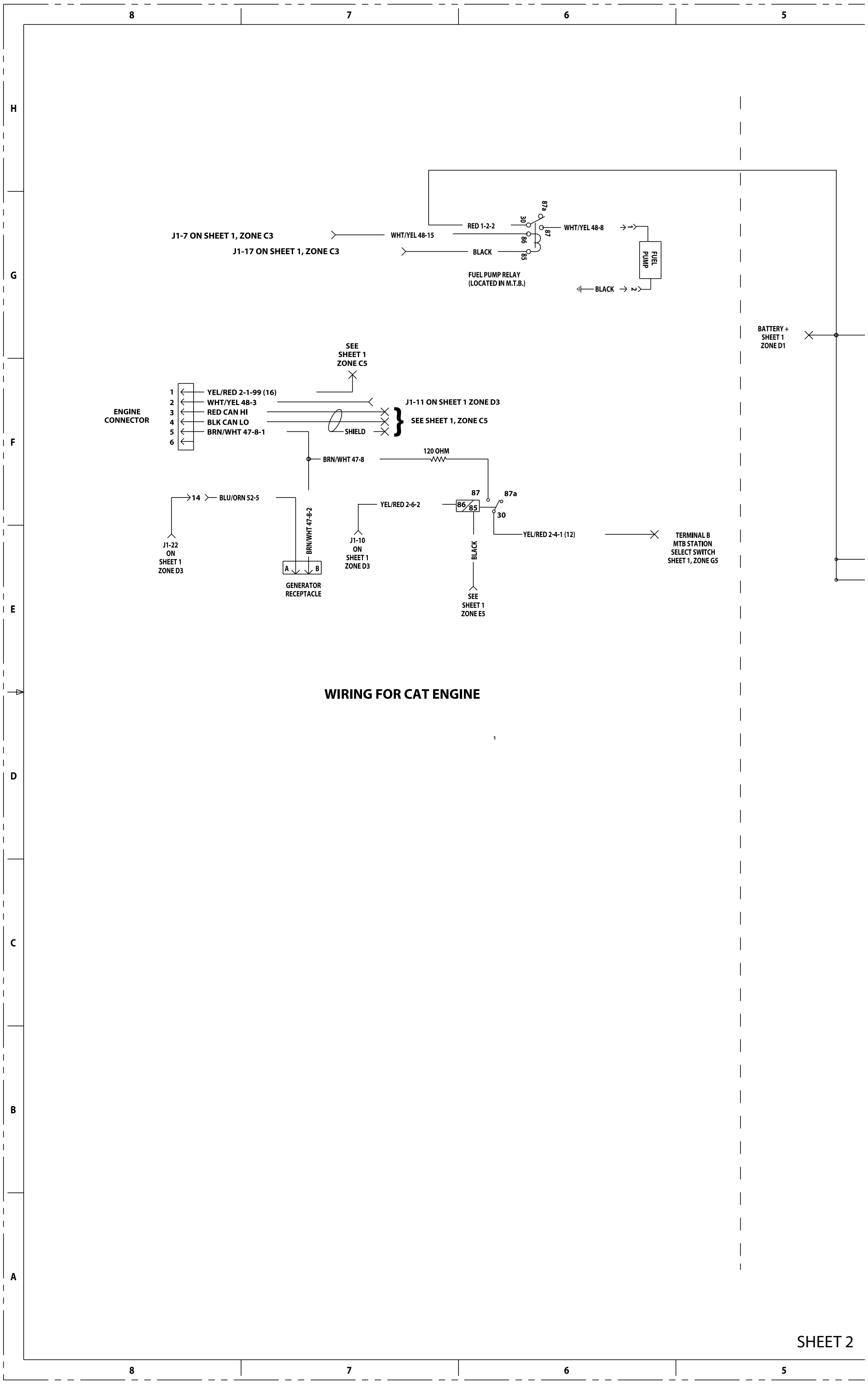


Figure 7-36. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 3 of 10

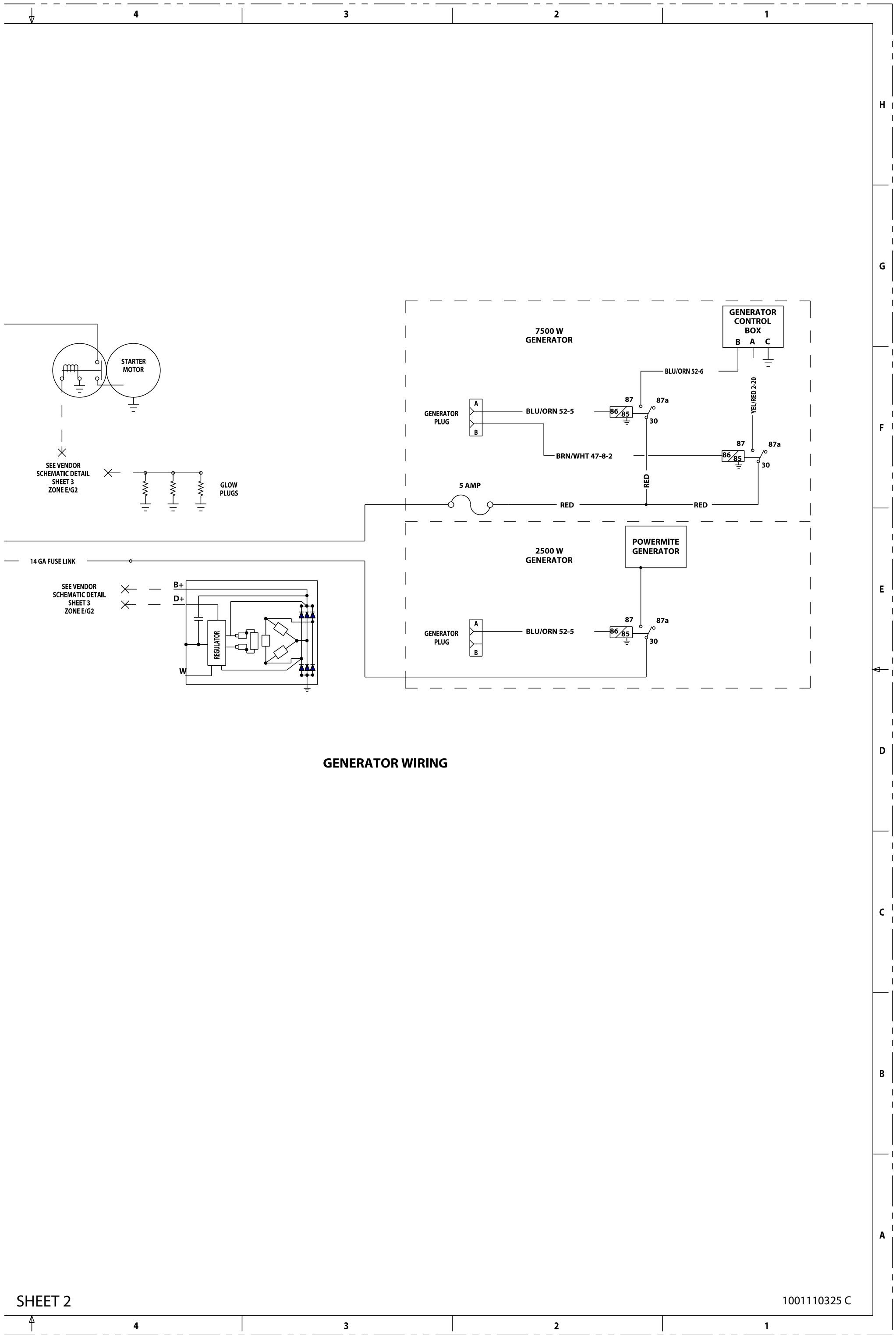


Figure 7-37. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 4 of 10

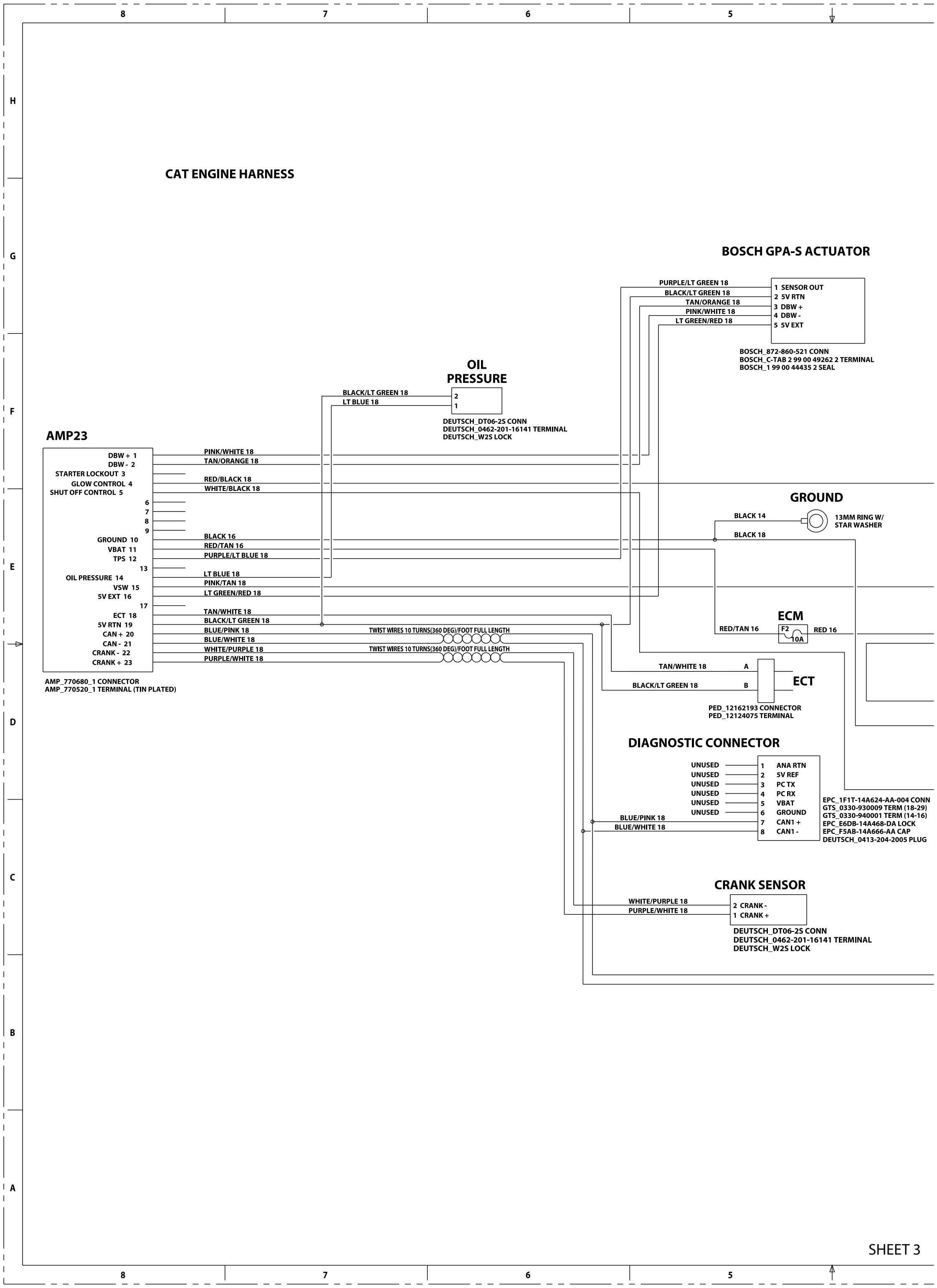


Figure 7-38. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 5 of 10

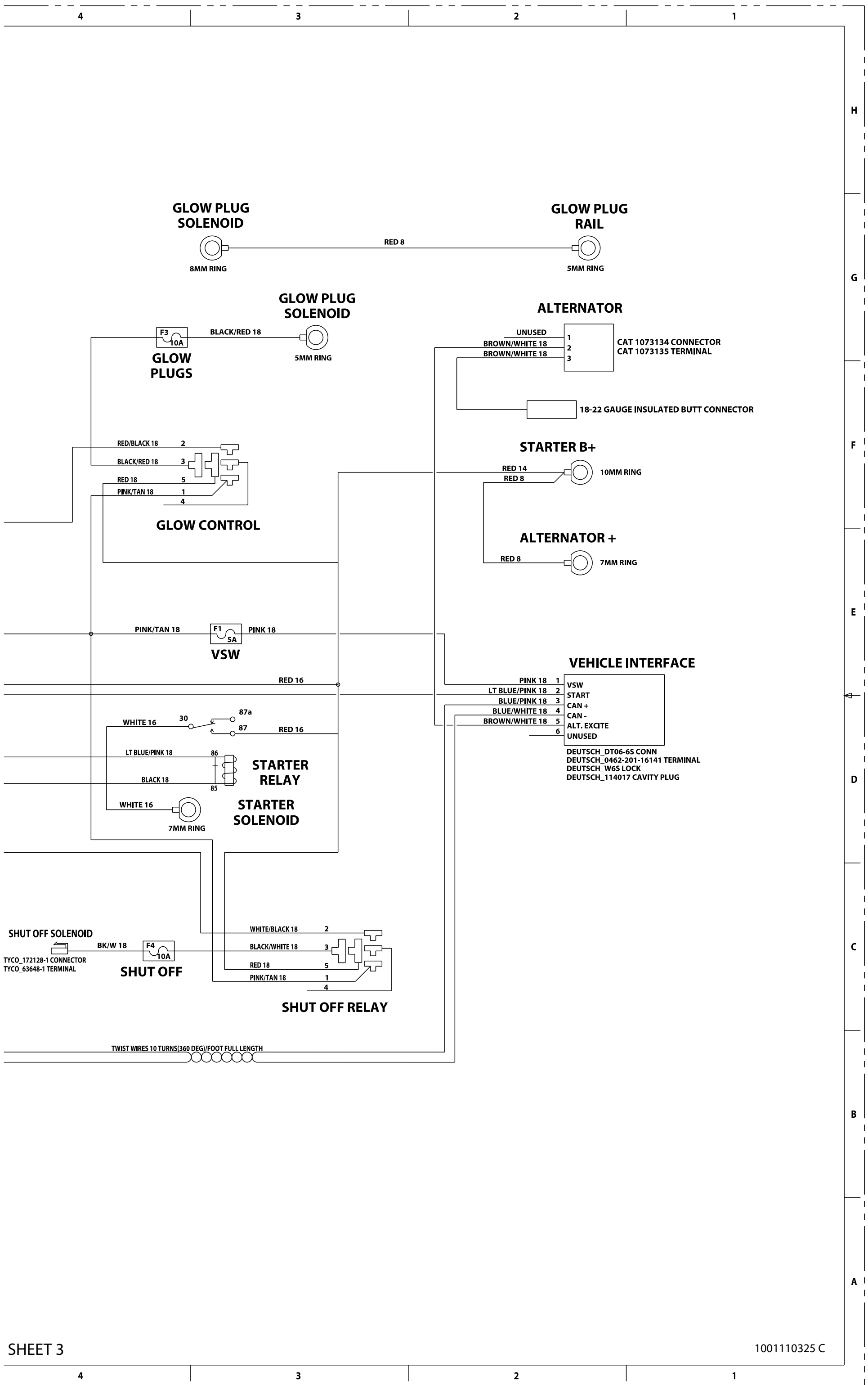


Figure 7-39. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 6 of 10

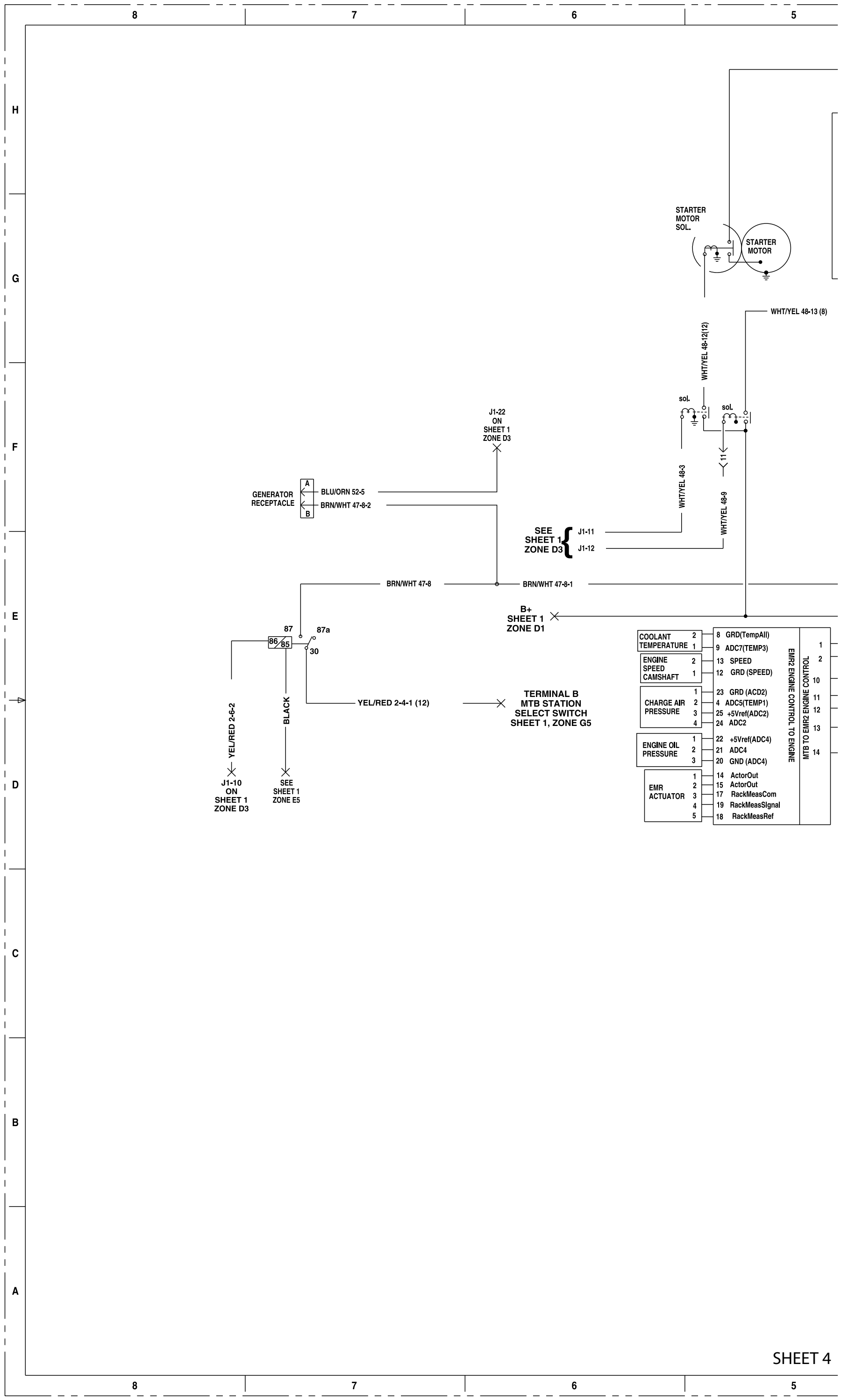


Figure 7-40. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 7 of 10

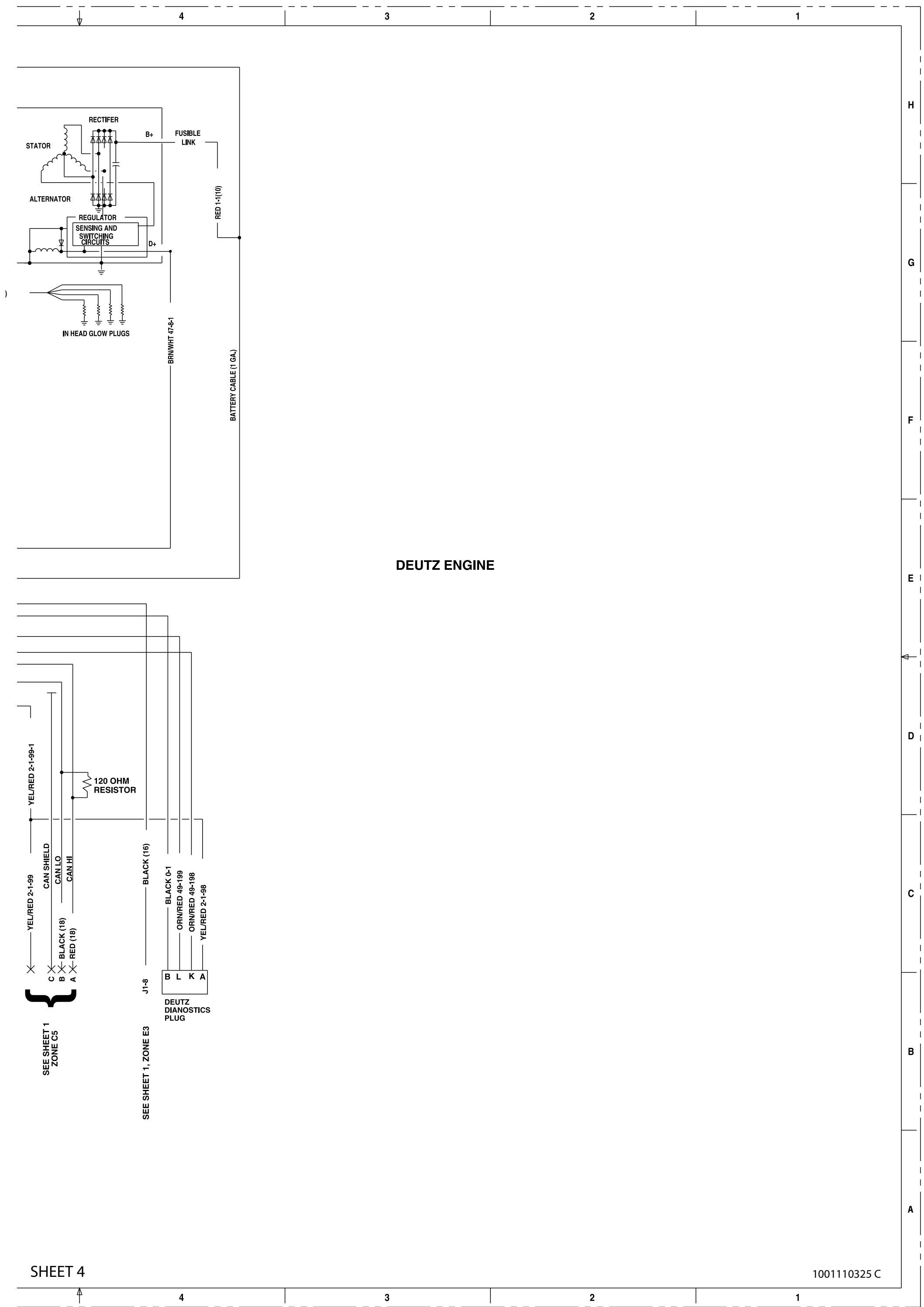


Figure 7-41. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 8 of 10

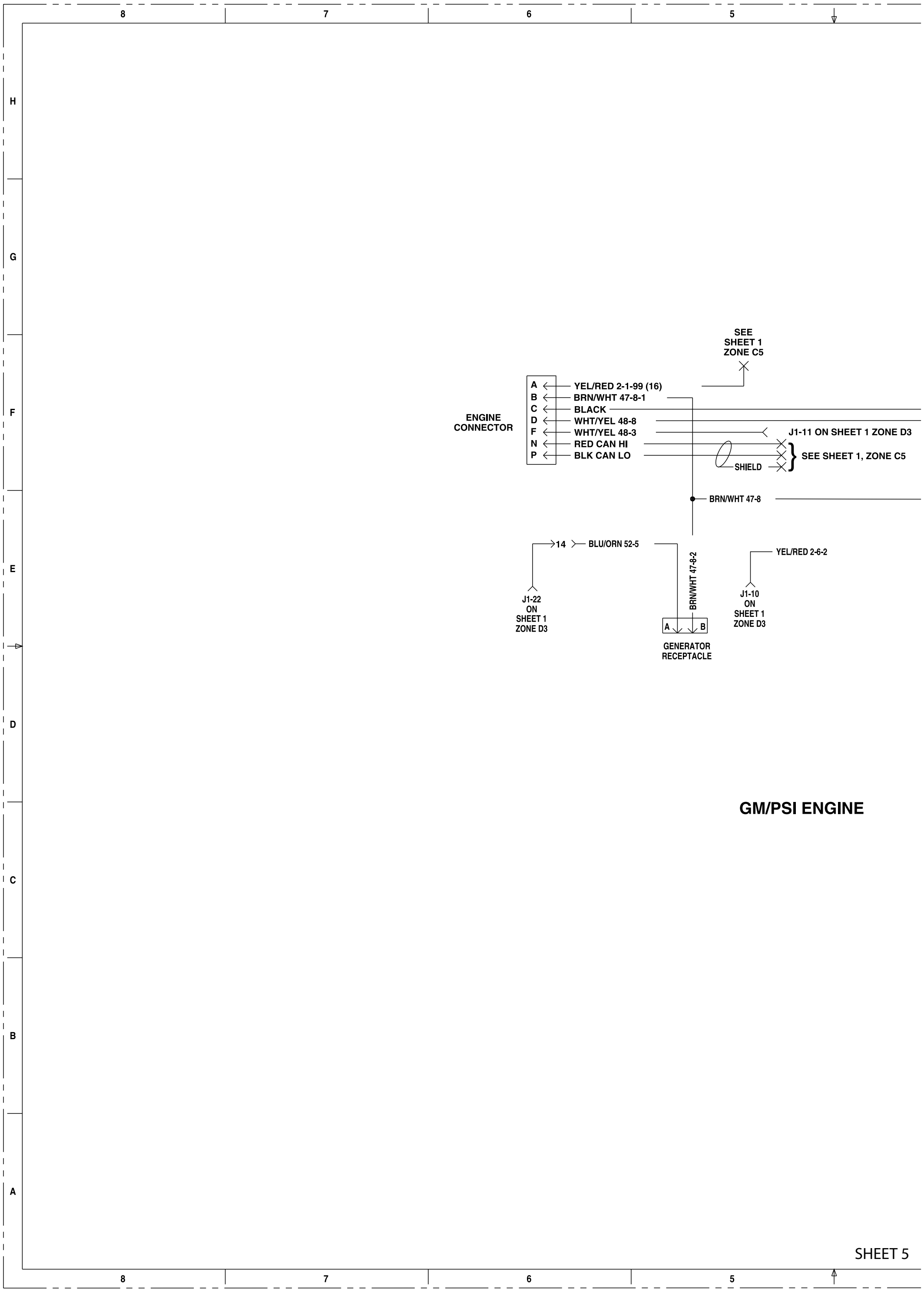


Figure 7-42. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 9 of 10

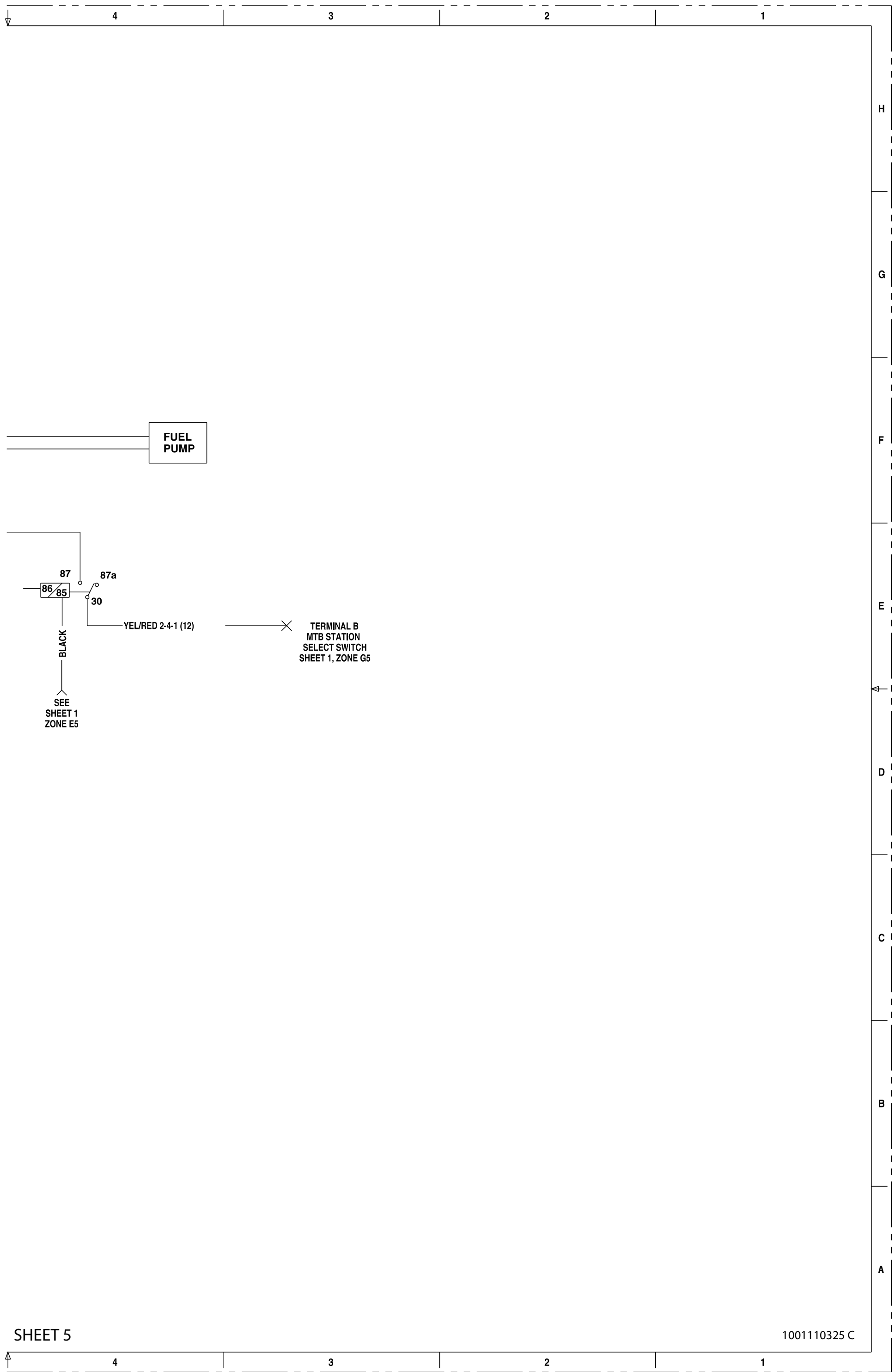


Figure 7-43. Electrical Schematics Caterpillar, Deutz EMR2 and GM (SN 0300139080 through 0300161729) - Sheet 10 of 10

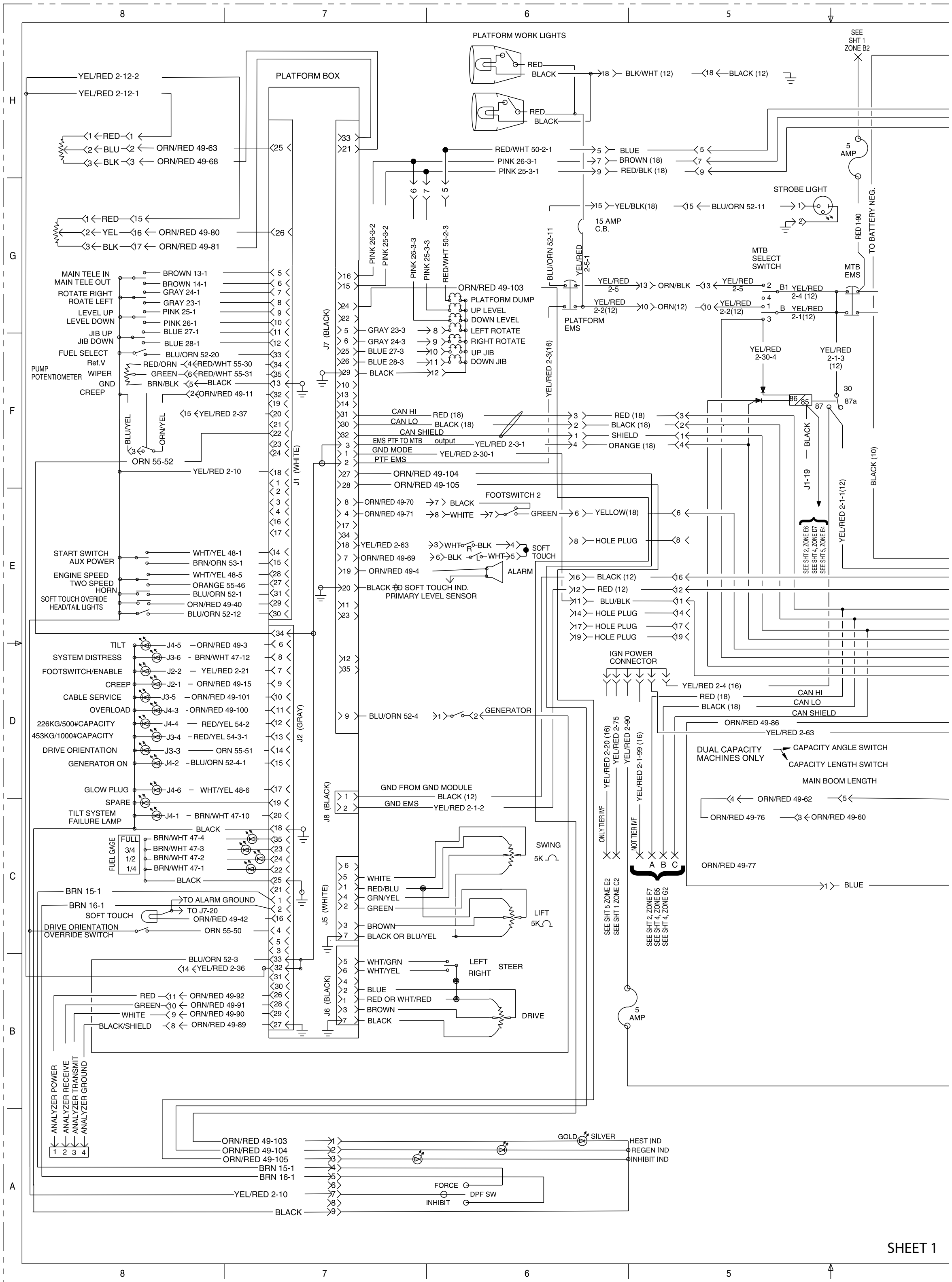


Figure 7-44. Electrical Schematic (0300161730 to 0300189341) - Sheet 1 of 10

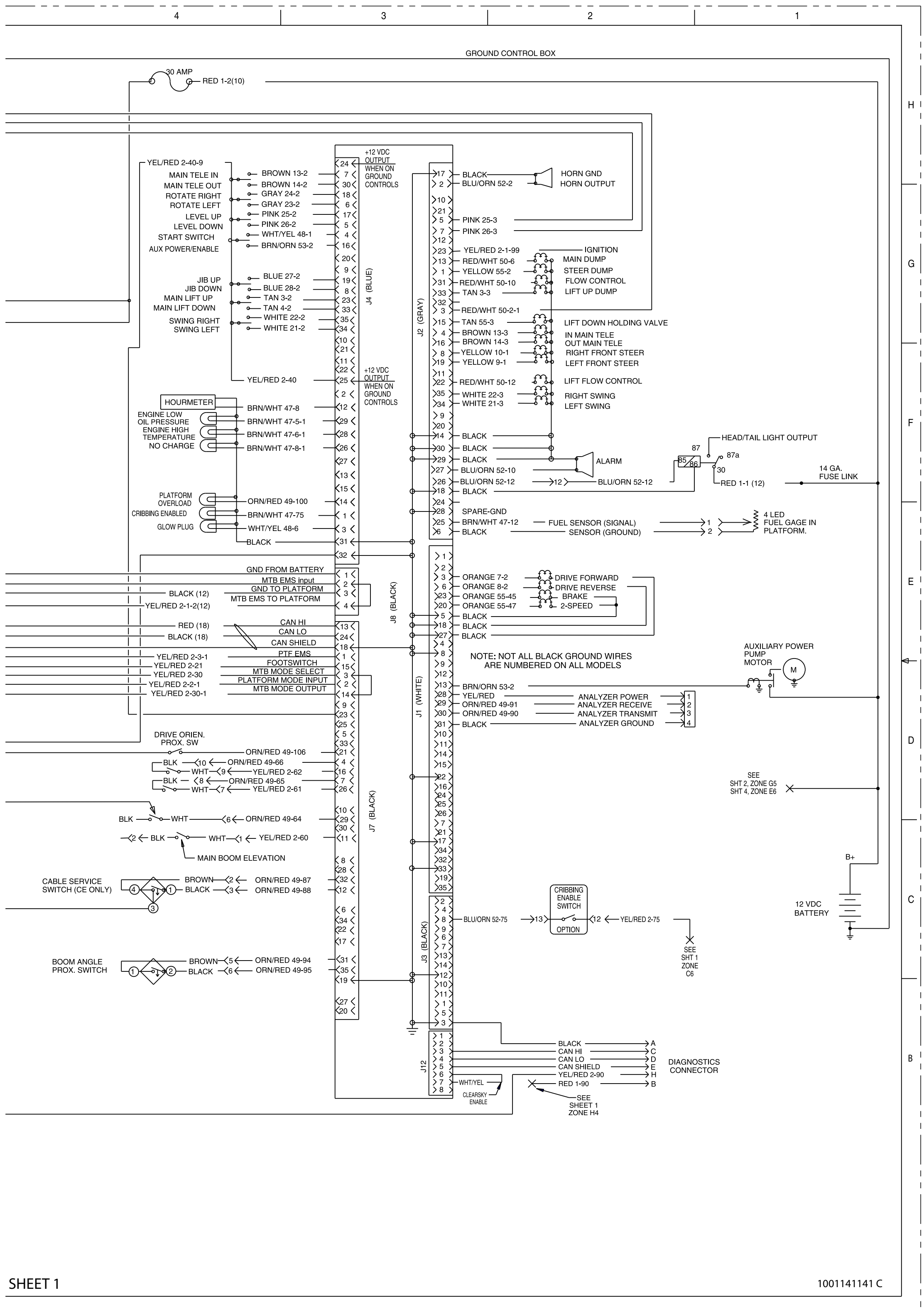


Figure 7-45. Electrical Schematic (0300161730 to 0300189341) - Sheet 2 of 10

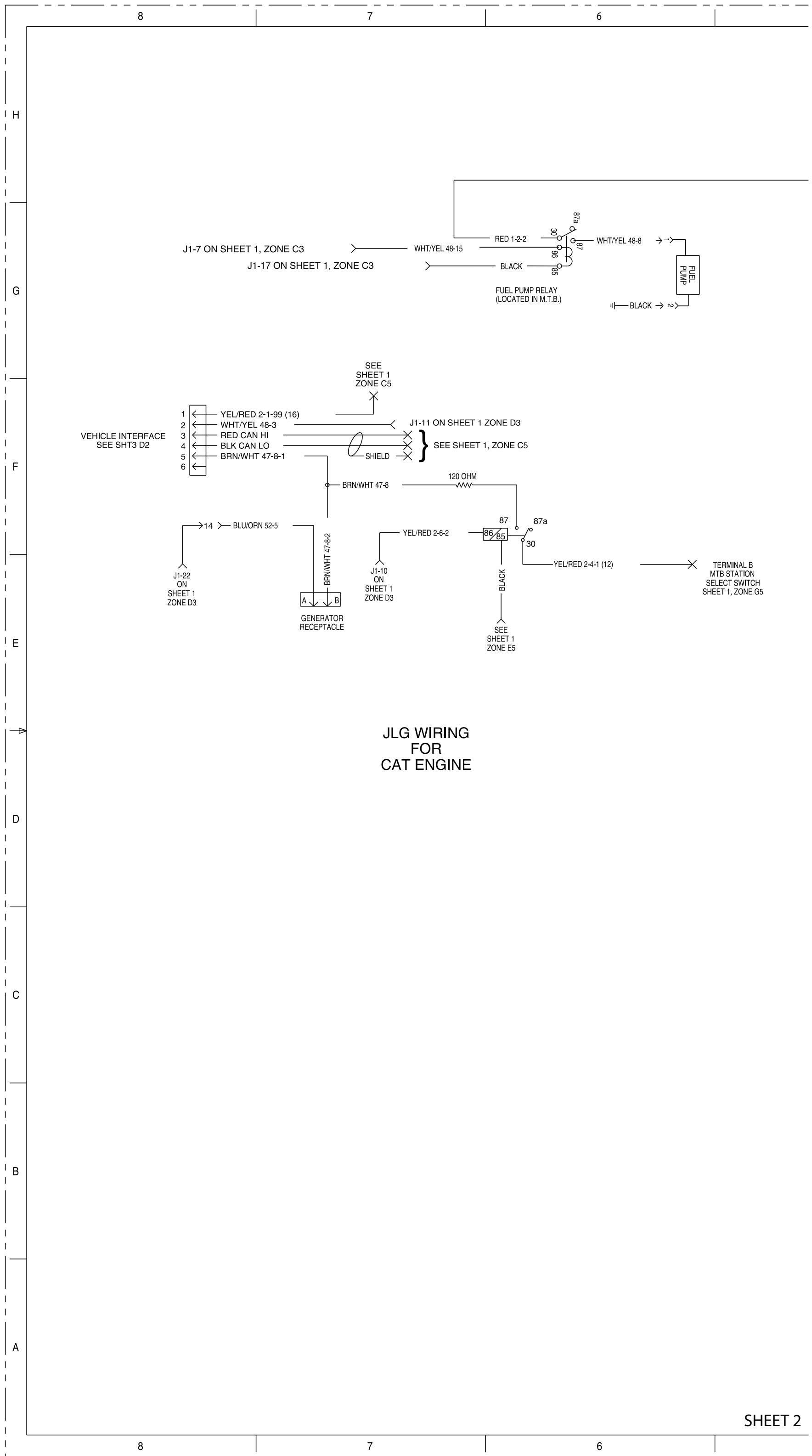


Figure 7-46. Electrical Schematic (0300161730 to 0300189341) - Sheet 3 of 10

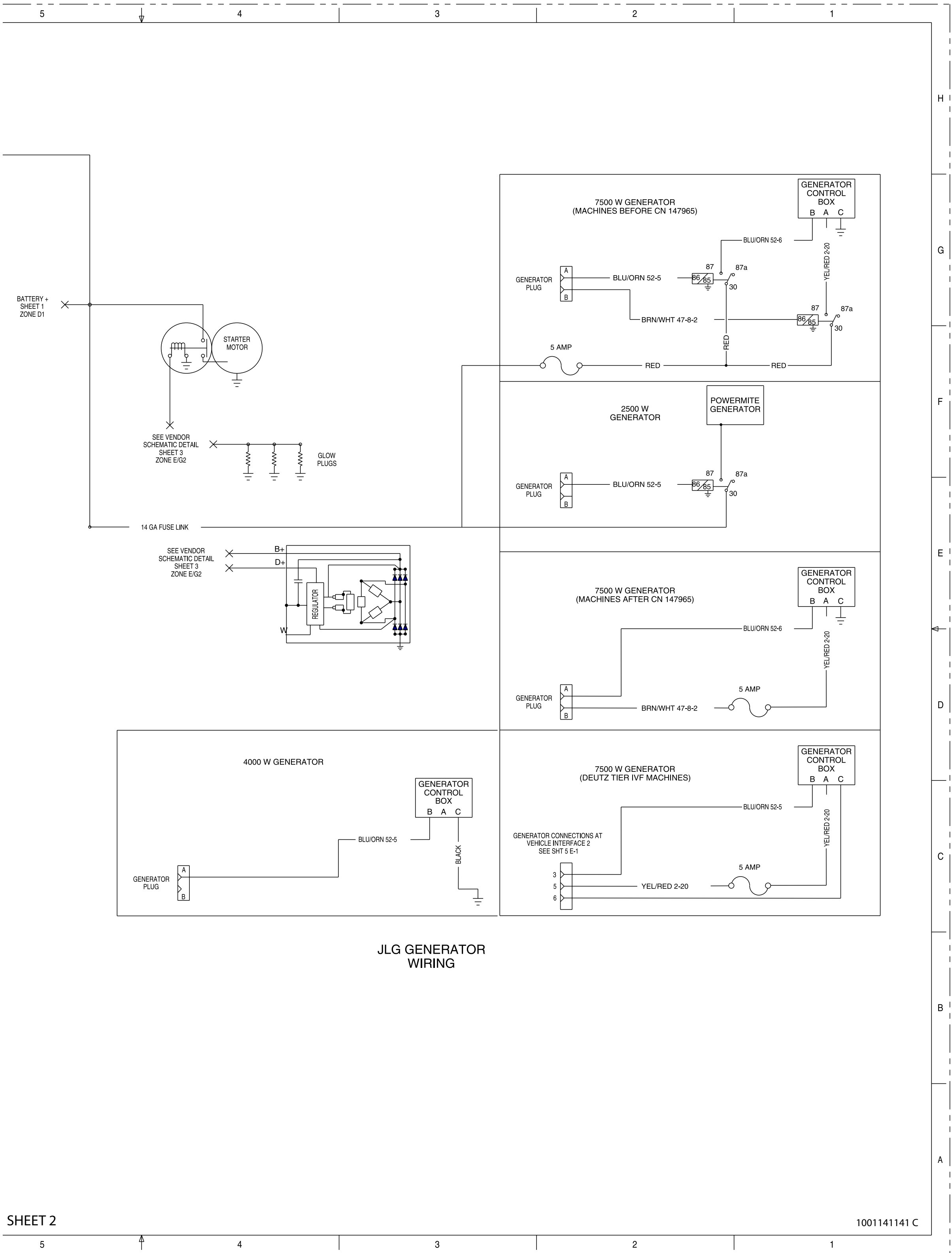


Figure 7-47. Electrical Schematic (0300161730 to 0300189341) - Sheet 4 of 10

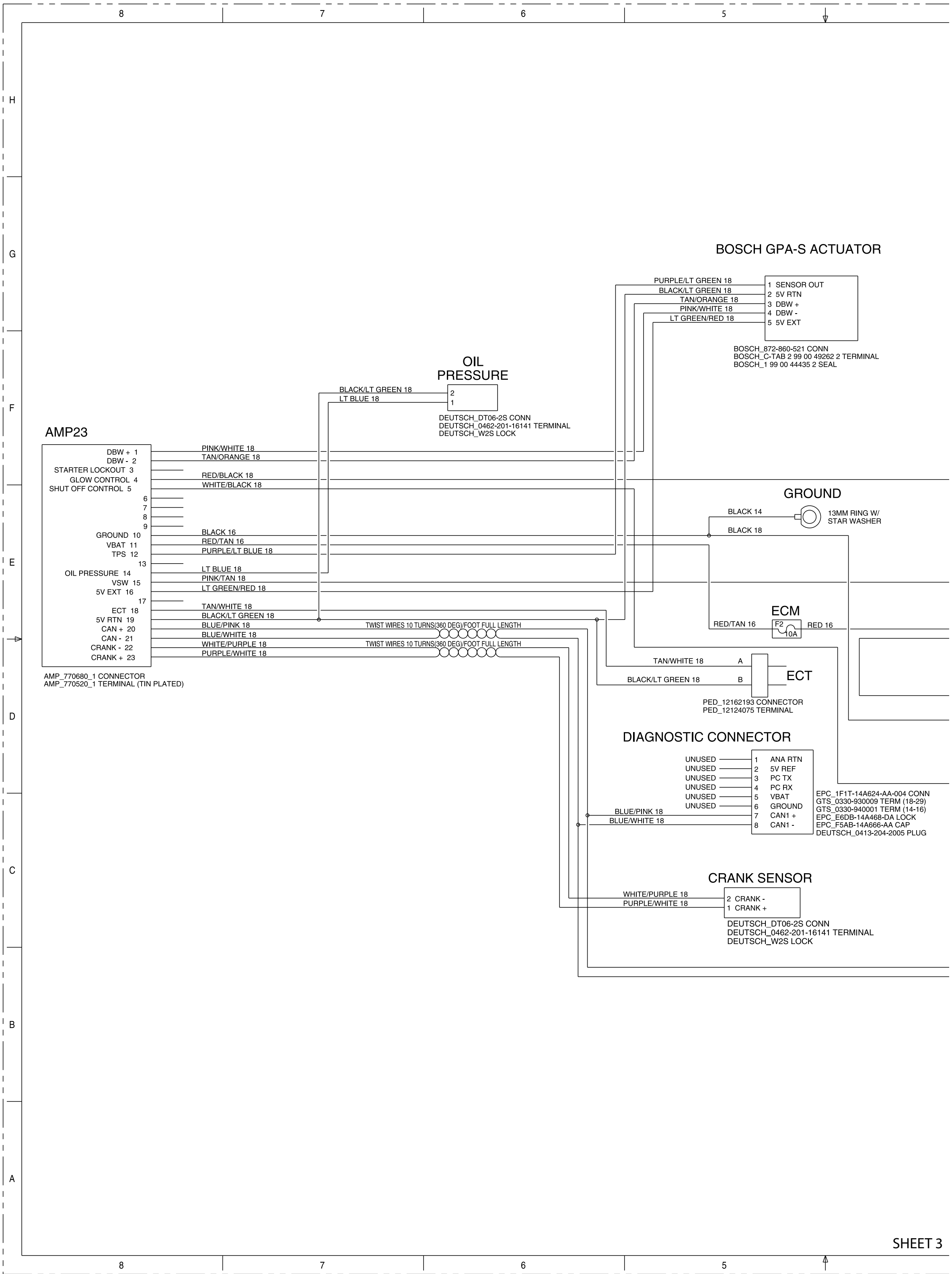


Figure 7-48. Electrical Schematic (0300161730 to 0300189341) - Sheet 5 of 10

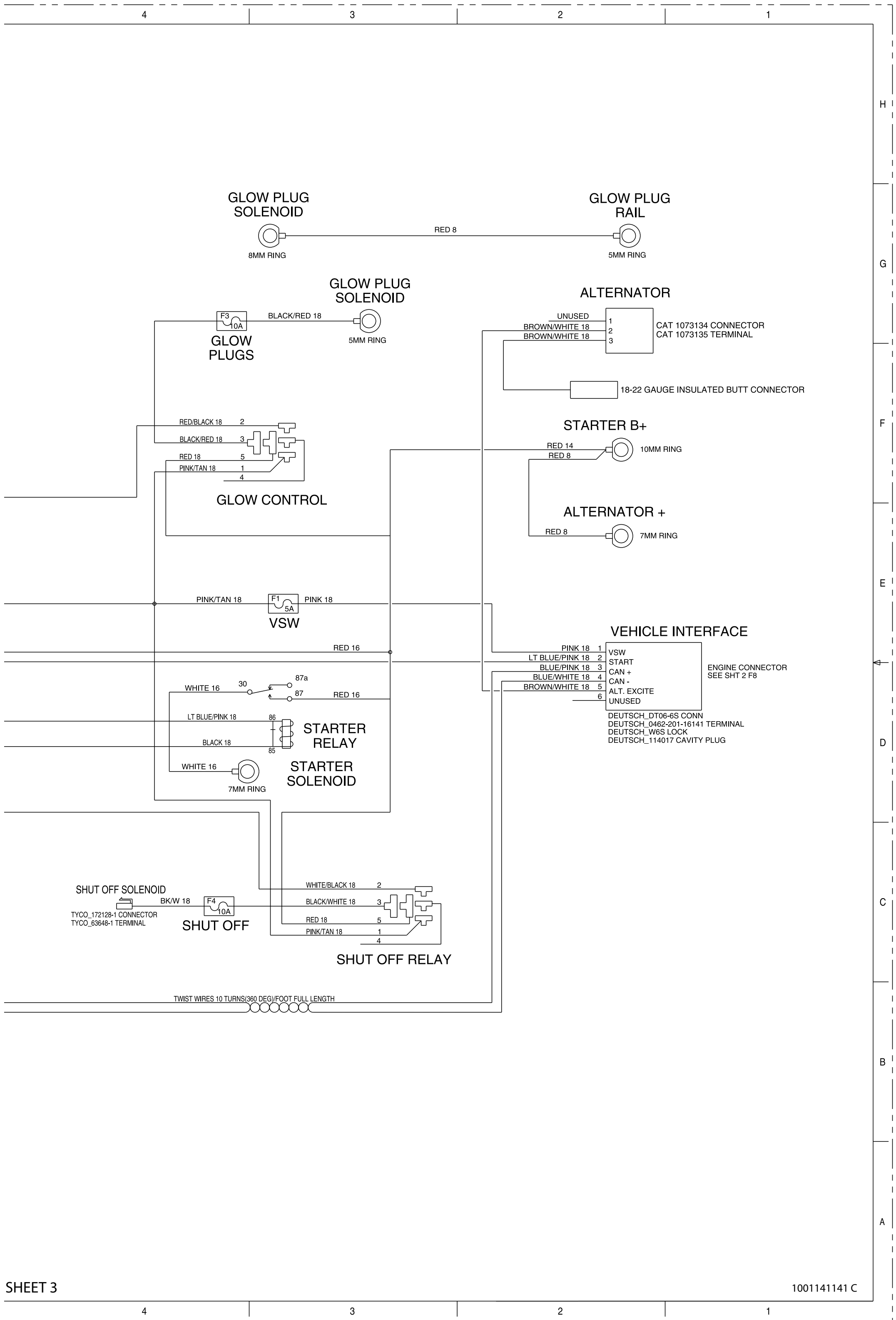


Figure 7-49. Electrical Schematic (0300161730 to 0300189341) - Sheet 6 of 10

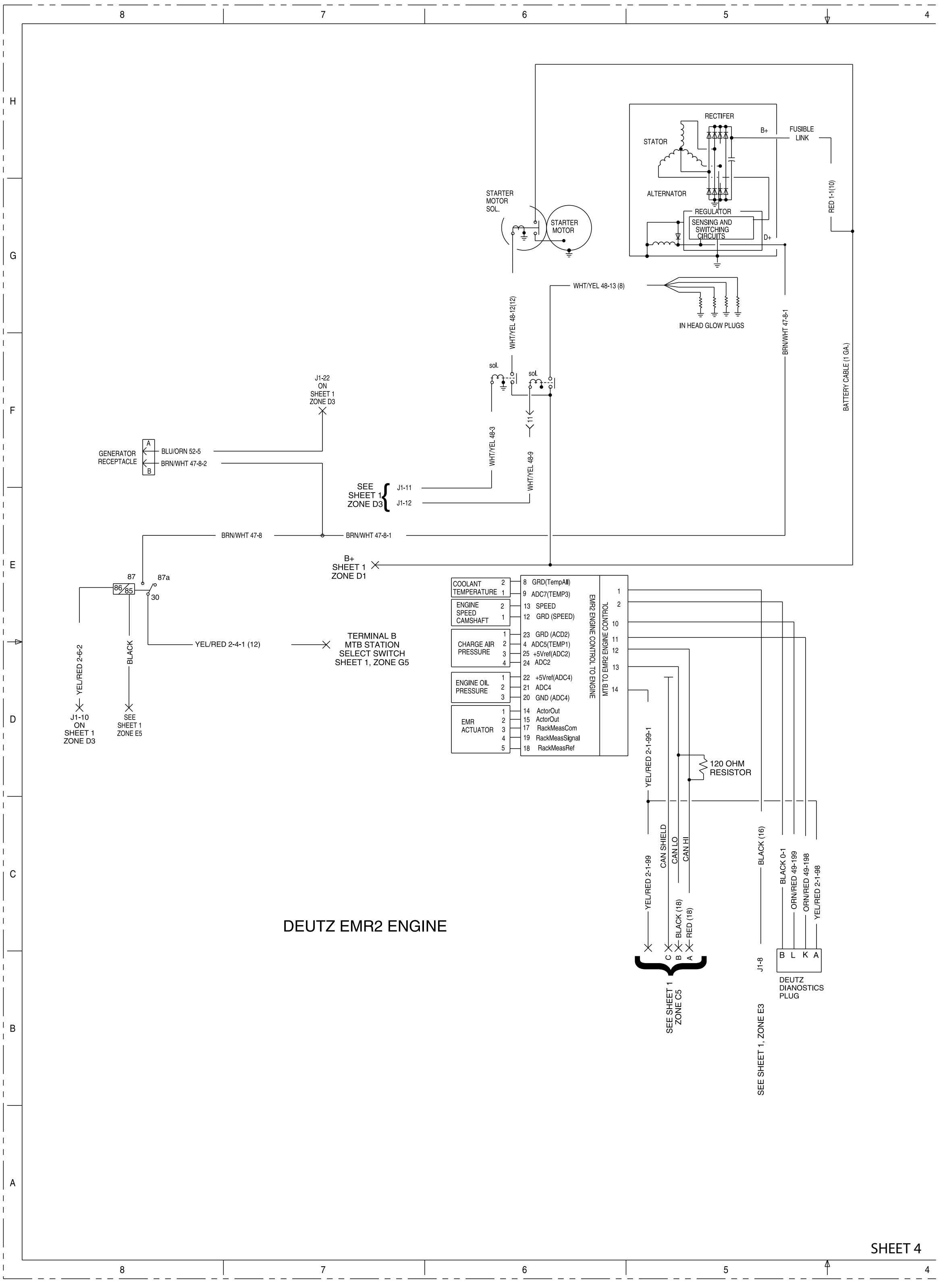


Figure 7-50. Electrical Schematic (0300161730 to 0300189341) - Sheet 7 of 10

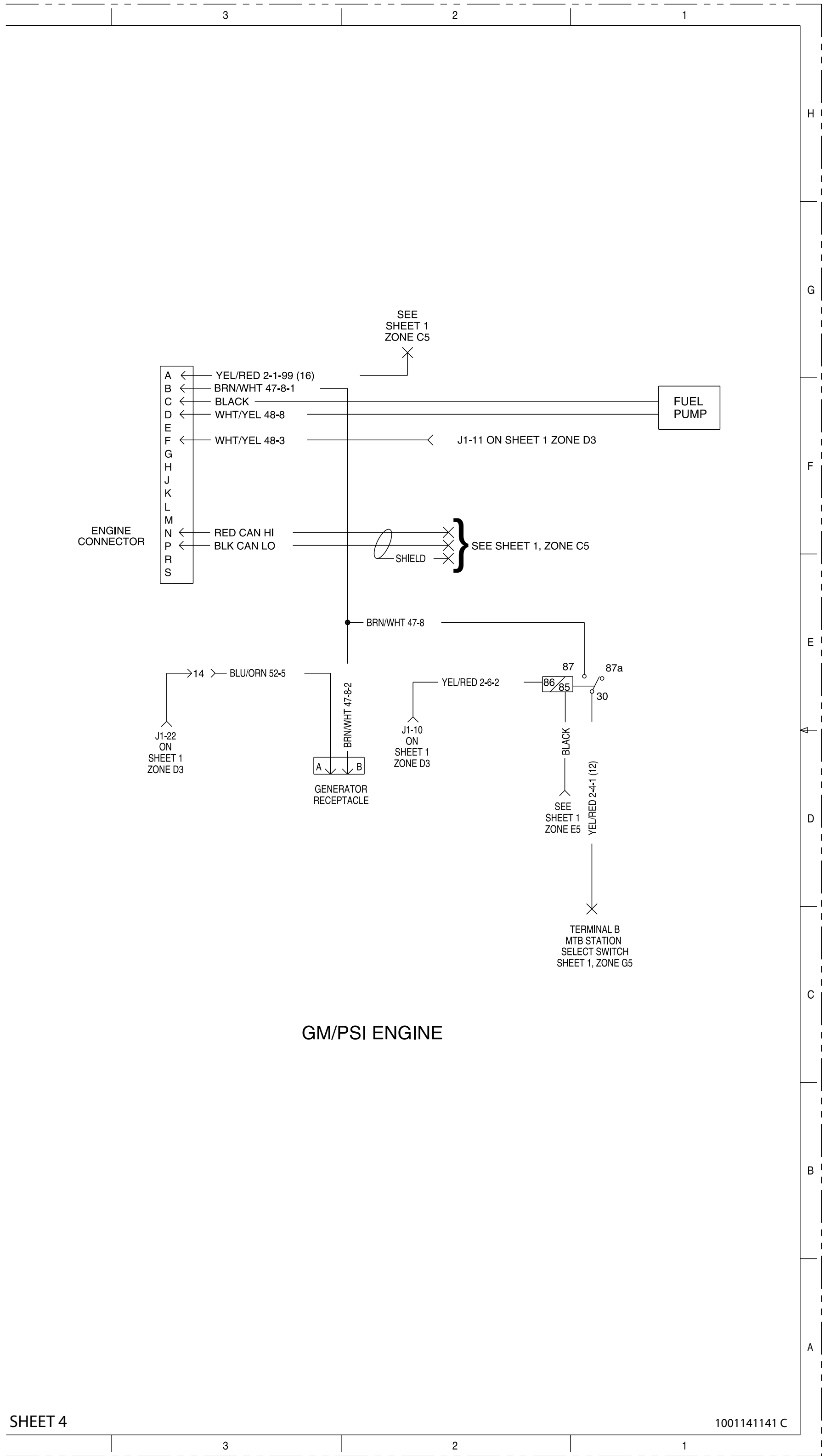


Figure 7-51. Electrical Schematic (0300161730 to 0300189341) - Sheet 8 of 10

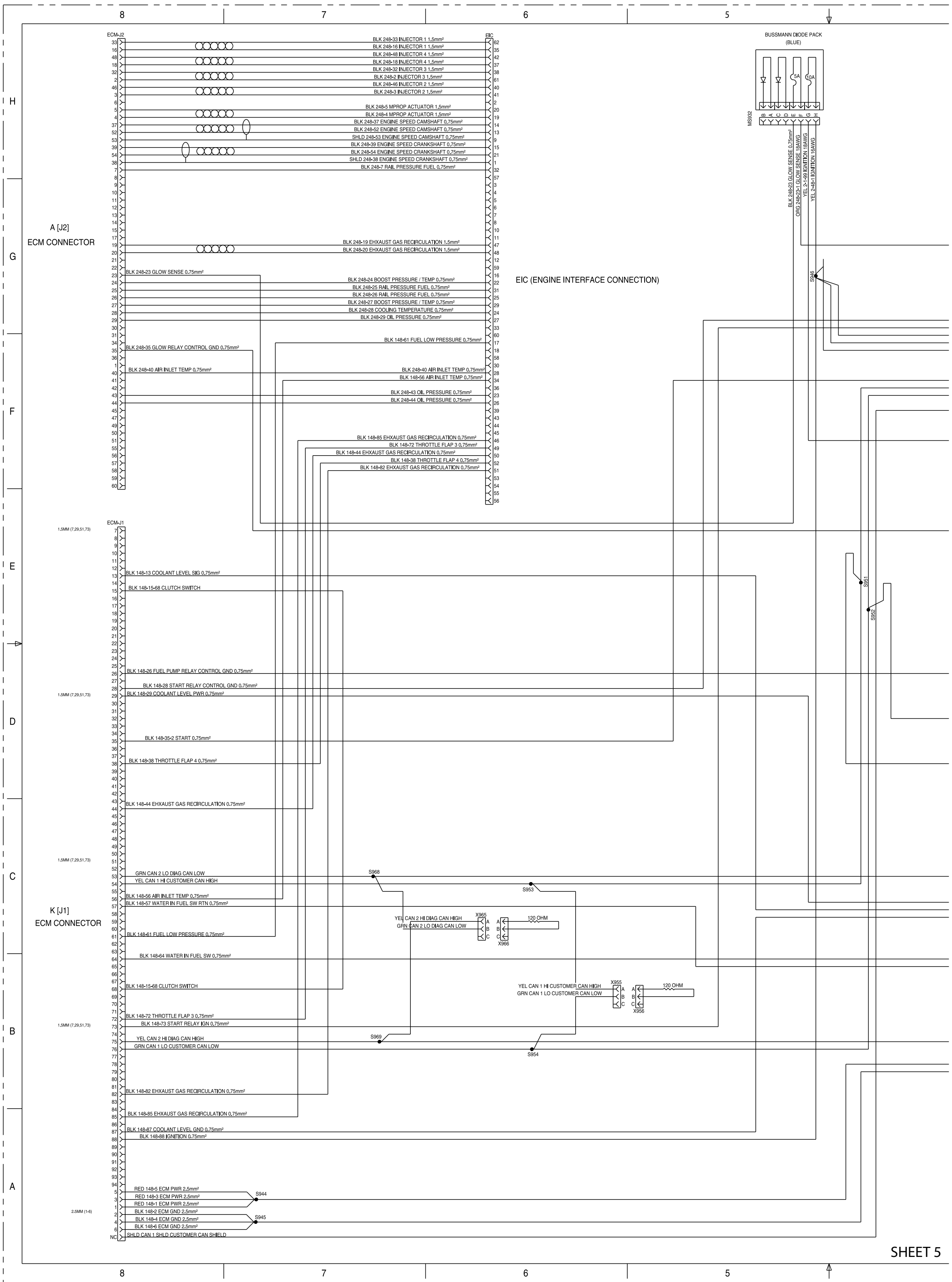


Figure 7-52. Electrical Schematic (0300161730 to 0300189341) - Sheet 9 of 10

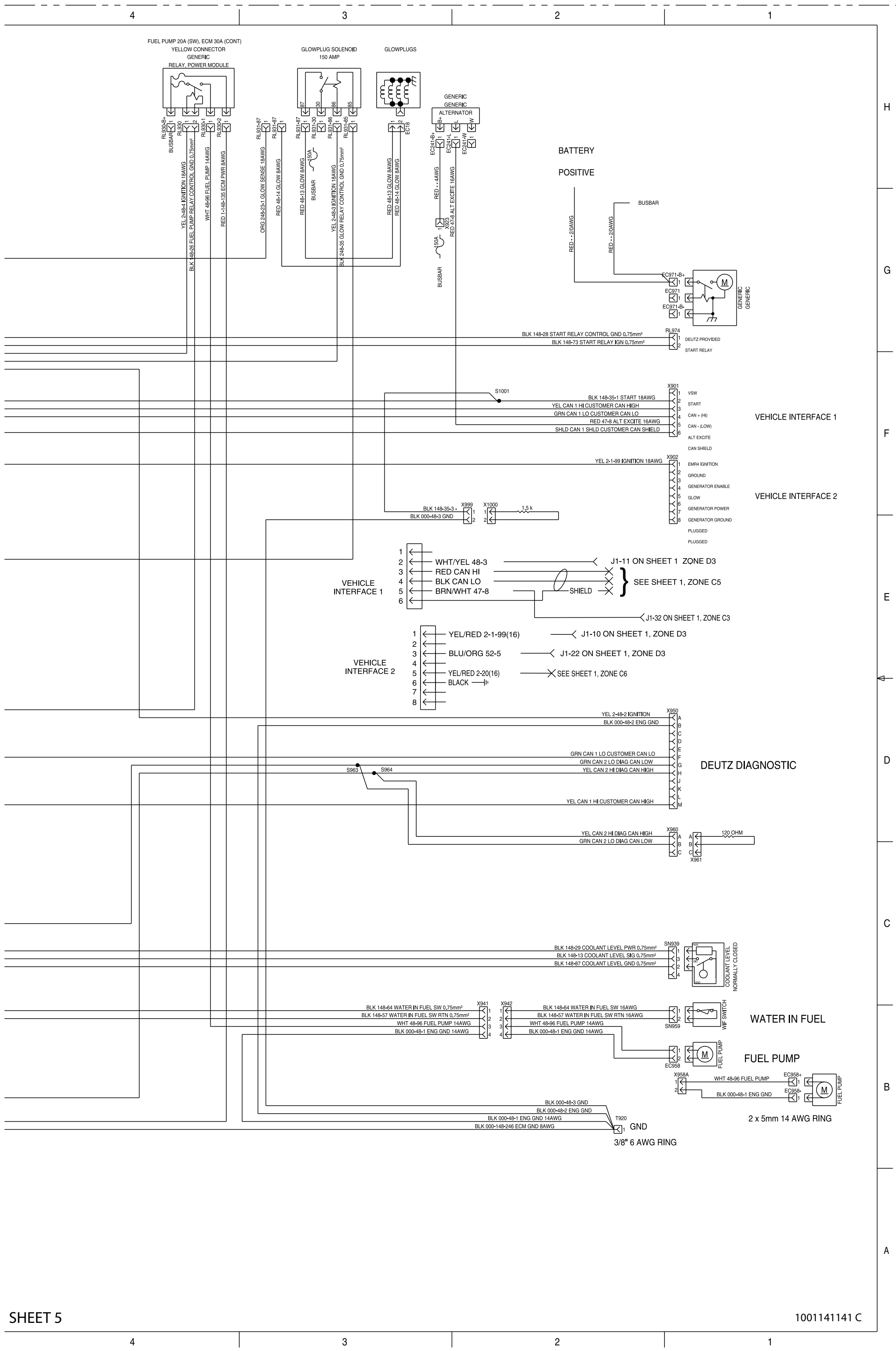


Figure 7-53. Electrical Schematic (0300161730 to 0300189341) - Sheet 10 of 10

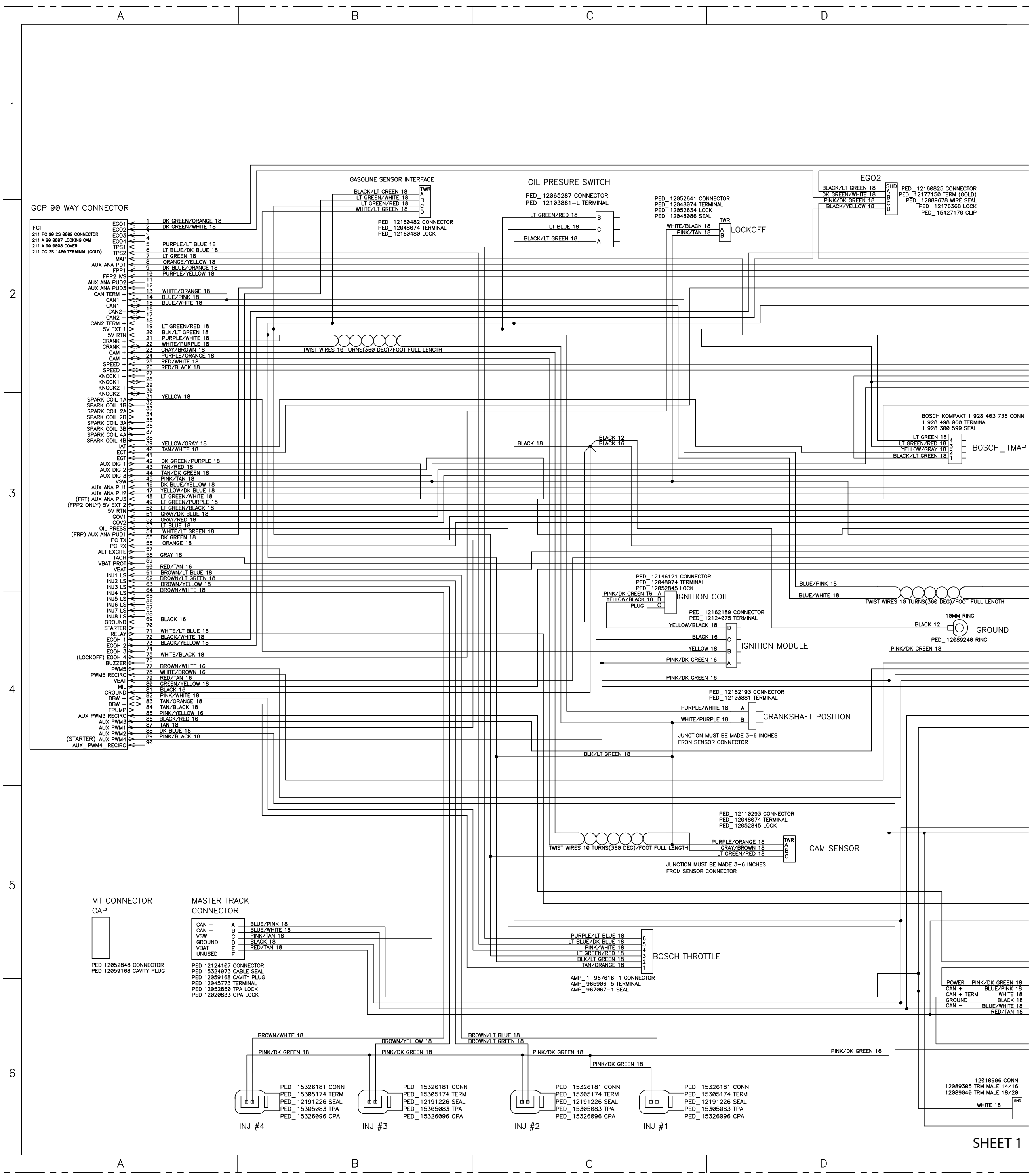


Figure 7-54. Electrical Schematic GM - Sheet 1 of 2

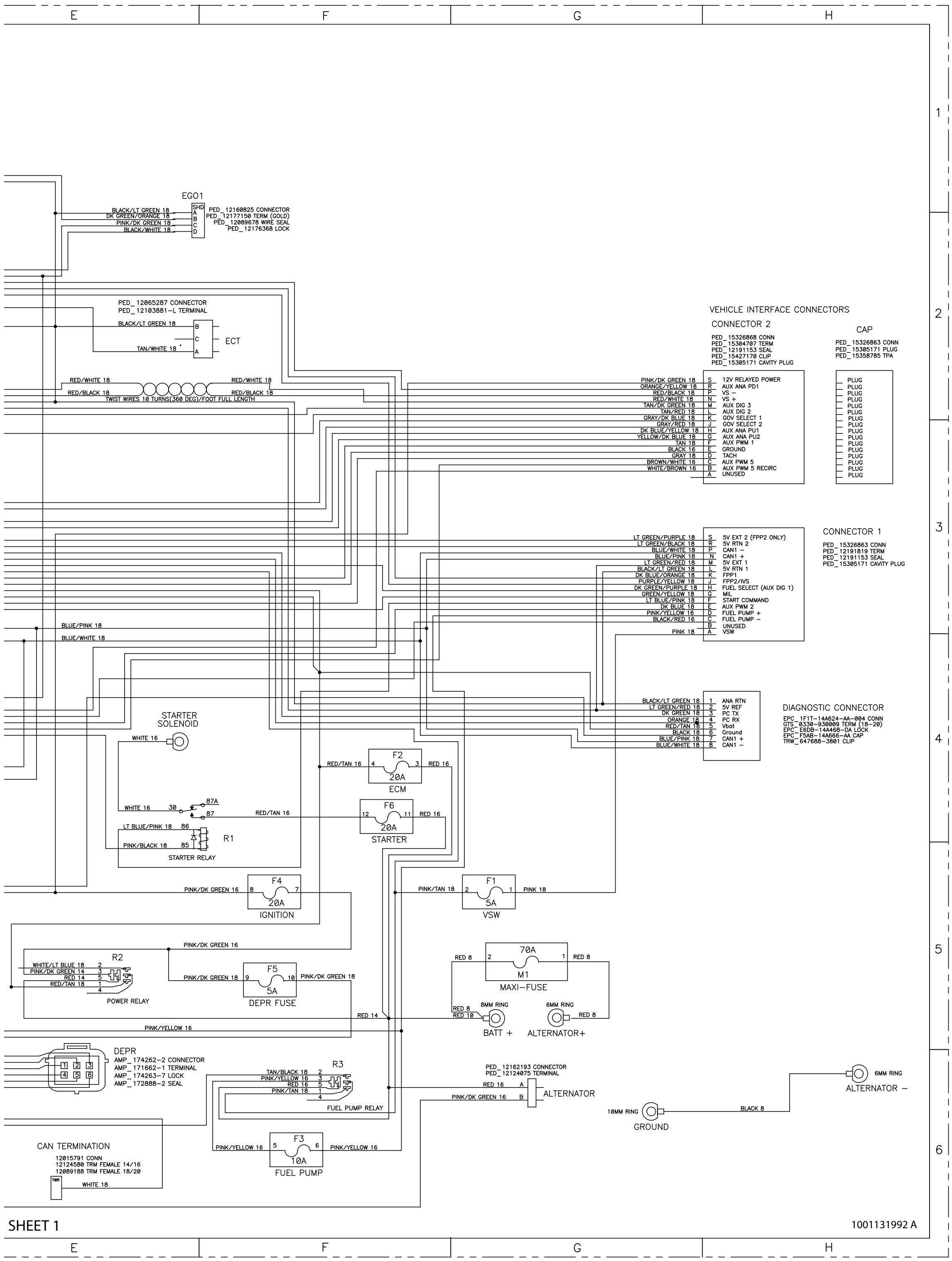


Figure 7-55. Electrical Schematic GM - Sheet 2 of 2

NOTES:

PROPOSITION 65 WARNING

- Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.
- Batteries also contain other chemicals known to the State of California to cause cancer.
- Wash hands after handling.

⚠ WARNING: ⚠

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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