Manitowoc 777

Service/Maintenance Manual

SERVICE/MAINTENANCE MANUAL

This manual has been prepared for and is considered part of -

777

Crane Model Number

7771Ref

Crane Serial Number

This manual is divided into the following sections:

SECTION 1	**INTRODUCTION**
SECTION 2	**HYDRAULIC SYSTEM**
SECTION 3	**ELECTRIC SYSTEM**
SECTION 4	**BOOM**
SECTION 5	**HOISTS**
SECTION 6	**SWING**
SECTION 7	**POWER TRAIN**
SECTION 8	**UNDER CARRIAGE**
SECTION 9	**LUBRICATION**
SECTION 10	**TROUBLESHOOTING**

NOTICE

The serial number of the crane and applicable attachments (i.e. luffing jib, MAX-ER®) is the only method your Manitowoc dealer or Manitowoc Crane Care has of providing you with correct parts and service information.

The serial number is located on a crane identification plate attached to the operator's cab and each attachment. Refer to the Nameplate and Decal Assembly Drawing in Section 2 of this manual for the exact location of the crane identification plate.

Always furnish serial number of crane and its attachments when ordering parts or discussing service problems with your Manitowoc dealer or Manitowoc Crane Care.

⚠ WARNING

To prevent death or serious injury:

- Avoid unsafe operation and maintenance.

  Crane and attachments must be operated and maintained by trained and experienced personnel. Manitowoc is not responsible for qualifying these personnel.
- Do not operate or work on crane or attachments without first reading and understanding instructions contained in Operator Information Manual and Service Manual supplied with crane and applicable attachments.
- Store Operator Information Manual and Service Manual in operator's cab.

  If Operator Information Manual or Service Manual is missing from cab, contact your Manitowoc dealer for a new one.

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SECTION 1
INTRODUCTION

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SECTION 1
INTRODUCTION

SAFE MAINTENANCE PRACTICES

WARNING

Importance of safe maintenance cannot be over emphasized. Carelessness and neglect on part of maintenance personnel can result in their death or injury and costly damage to the crane or property.

Safety information in this publication is intended only as a guide to assist qualified maintenance personnel in safe maintenance. Manitowoc cannot foresee all hazards that will arise in field; therefore, ***safety remains responsibility of maintenance personnel and crane owner***.

Maintenance Instructions

To ensure safe and proper operation of Manitowoc cranes, they must be maintained according to the instructions contained in this manual and the Operator's Manual provided with the crane.

Crane maintenance and repair must be performed by personnel who by reason of training and experience are thoroughly familiar with the crane's operation and required maintenance. These personnel must ***read Operator's Manual and Service Manual before attempting any maintenance procedure***. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc dealer for assistance.

Training/qualification of maintenance personnel is responsibility of crane owner.

Safe Maintenance Practices

1. Perform following steps (as applicable) before starting a maintenance procedure:
   a. Park crane where it will not interfere with other equipment or operations.
   b. Lower all loads to ground or otherwise secure them against movement.
   c. Lower boom onto blocking at ground level, if possible, or otherwise secure boom against dropping.
   d. Move all controls to off and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.
   e. Stop engine and render starting means inoperative.
   f. Place a warning sign at start controls alerting other personnel that crane is being serviced and engine must not be started. *Do not remove sign until it is safe to return crane to service.*
2. Do not attempt to maintain or repair any part of crane while engine is running, unless absolutely necessary.

   If engine must be run, keep your clothing and all parts of your body away from moving parts. ***Maintain constant verbal communication between person at controls and person performing maintenance or repair procedure***.
3. Wear clothing that is relatively tight and belted.
4. Wear appropriate eye protection and approved hard hat.
5. Never climb onto or off a moving crane. ***Climb onto and off crane only when it is parked and only with operator's permission***.

   Use *both hands* and handrails, steps and ladders provided to climb onto and off crane.

   Lift tools and other equipment which cannot be carried in pockets or tool belts onto and off crane with hand lines or hoists.
6. Boom and gantry are not intended as ladders. Do not attempt to climb lattice work of boom or gantry to get to maintenance points. If boom or gantry is not equipped with an approved ladder, lower them before performing maintenance or repair procedures.
7. Do not remove cylinders until working unit has been securely restrained against movement.
8. Pinch points are impossible to eliminate; watch for them closely.
9. Pressurized air, coolant, and hydraulic oil can cause serious injury. Make sure all air, coolant, and hydraulic lines, fittings, and components are tight and serviceable.

   Do not use your hands to check for air and hydraulic oil leaks:
   - Use a soap and water solution to check for air leaks (apply to fittings and lines and watch for bubbles).
   - Use a piece of cardboard or wood to check for coolant and hydraulic oil leaks.
10. Relieve pressure before disconnecting air, coolant, and hydraulic lines and fittings.
11. Do not remove radiator cap while coolant is hot or under pressure. Stop engine, wait until pressure drops and coolant cools, then slowly remove cap.

12. Avoid battery explosion: do not smoke while performing battery maintenance, do not short across battery terminals to check its charge.

13. Read safety information in battery manufacturer's instructions before attempting to charge a battery.

14. Avoid battery acid contact with skin and eyes. If contact occurs, flush area with water and immediately consult a doctor.

15. Stop engine before refueling crane.

16. Do not smoke or allow open flames in refueling area.

17. Use a safety-type can with an automatic closing cap and flame arrestor for refueling.

18. Hydraulic oil can also be flammable. Do not smoke or allow open flames in area when filling hydraulic tanks.

19. Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.

20. Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.

21. When inflating tires, use a tire cage, a clip-on inflator, and an extension hose which permits standing well away from tire.

22. Only use cleaning solvents which are non-volatile and non-flammable.

23. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.

24. Use care while welding or burning on crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.

25. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform following steps ***before welding on crane***:

- Disconnect all cables from batteries.
- Disconnect output cables at engine junction box.
- Attach ground cable from welder directly to part being welded and as close to weld as possible.

Do not weld on engine or engine mounted parts (per engine manufacturer).

26. Disconnect and lock power supply switch before attempting to service high voltage electrical components and before entering tight areas (such as carbody openings) containing high voltage components.

27. When assembling and disassembling booms, jibs, or masts on ground (with or without support of boom rigging pendants or straps), securely block each section to provide adequate support and alignment.

Do not go under boom, jib, or mast sections while connecting bolts or pins are being removed.

28. Unless authorized in writing by Manitowoc, do not alter crane in any way that affects crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/hydraulic components). Doing so will invalidate all warranties and capacity charts and make crane owner/user liable for any resultant accidents.

29. ***Keep crane clean.*** Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.

30. Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in operator's cab or on walkways and stairs.

31. Do not store flammable materials on crane.

32. Do not return crane to service at completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from hydraulic systems, safety devices have been reactivated, and all maintenance equipment has been removed.

33. Perform a function check to ensure proper operation at completion of maintenance or repair.

IDENTIFICATION AND LOCATION OF COMPONENTS

Crane Orientation

Terms RIGHT, LEFT, FRONT, REAR used in this section refer to operator's right, left, front, and rear sides when seated in operator's cab looking forward.

See Figures 1-1 through 1-3 for graphic identification of crane components.

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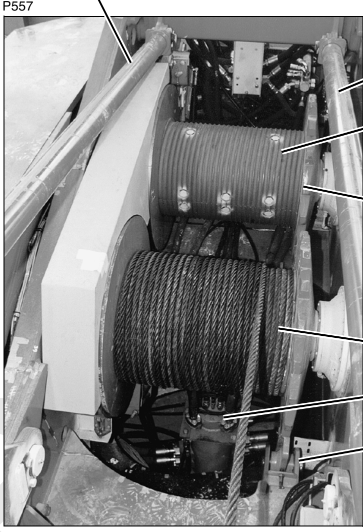

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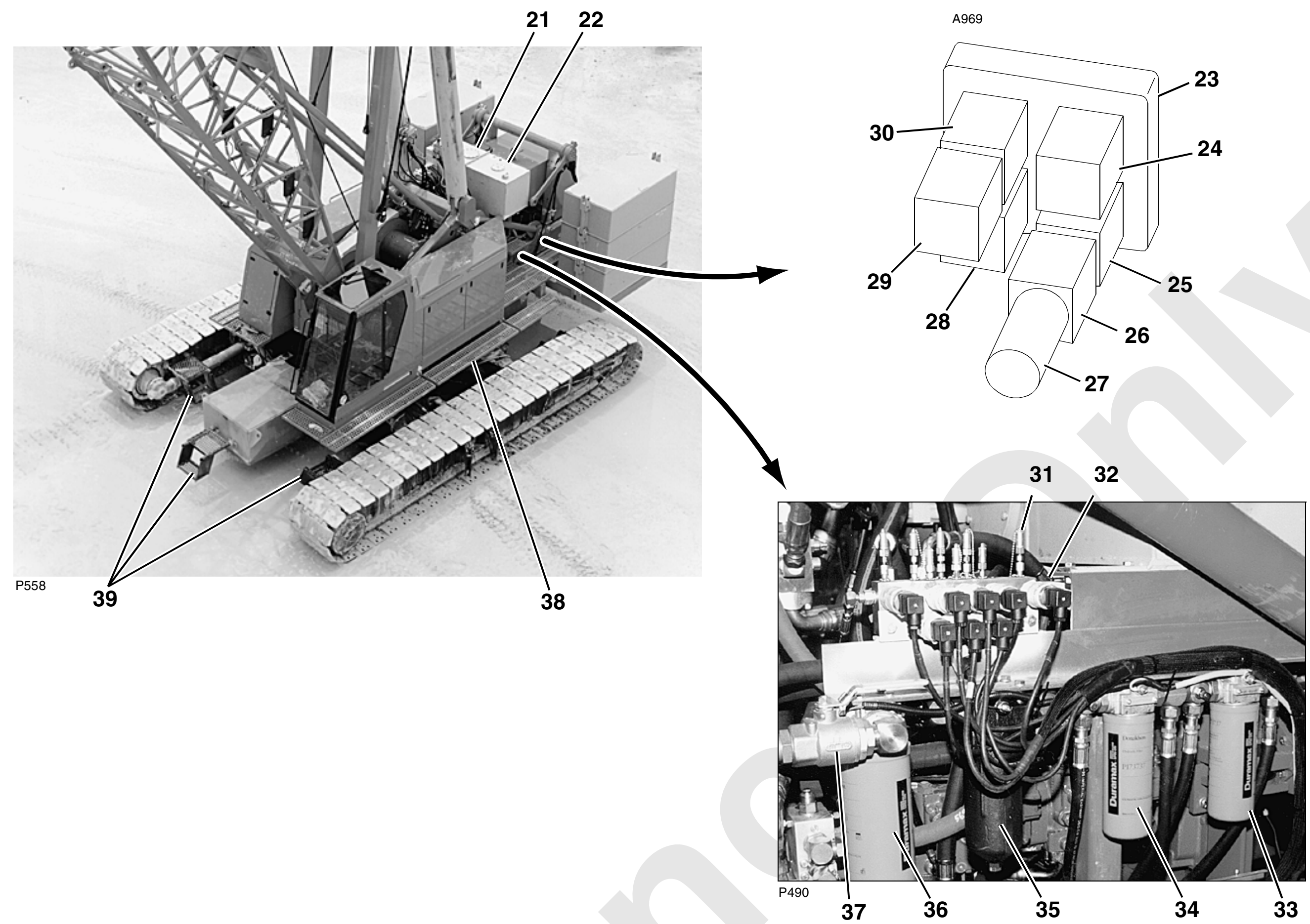
FIGURE 1-1



Item	Description	Item	Description
1	Lower Boom Point	21	Hydraulic Tank
2	Wire Rope Guide (boom top)	22	Fuel Tank
3	#78 Boom	23	Pump Drive
4	Wire Rope Guide (boom butt)	24	Front Drum Pump
5	Mast	25	Right Crawler Pump
6	Boom Hoist Cylinder	26	Left Crawler Pump
7	Telescopic Boom Stop	27	Supercharge and Accessory Pump
8	Counterweight Handling Pivot Frame	28	Rear Drum or Luffing Hoist Pump
9	Upper Counterweight	29	Swing Pump
10	Engine	30	Boom Hoist Pump
11	Carbody Counterweight	31	Diagnostic Gauge Coupler *
12	Left Side Enclosure	32	Hydraulic Pressure Sender
13	Carbody	33	Hydraulic Filter 4 (rear drum)
14	Operator's Cab	34	Hydraulic Filter 3 (front drum)
15	Crawler	35	Hydraulic Filter 2 (accessory)
16	Drum Pawl	36	Hydraulic Filter 1 (supercharge)
17	Hydraulic Swivel	37	Shut-Off Valve (supercharge filter)
18	Front Drum	38	Catwalk (both sides of carbody)
19	Rear Drum	39	Stairs (both ends of carbody)
20	Lagging	* See decal on bracket for pressure sensor identification.	

FIGURE 1-1 continued

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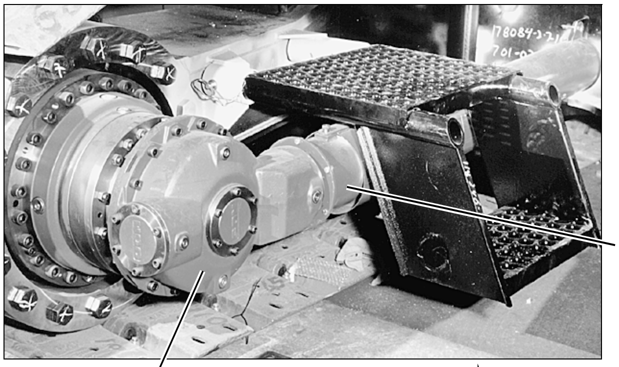

Typical 2 Places

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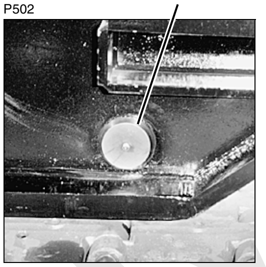

Typical 20 Places

Item	Description
1	Crawler Input Planetary
2	Crawler Drive Shaft
3	Crawler Intermediate Roller
4	Crawler Front Roller
5	Crawler Motor
6	Crawler Brake
7	Crawler Output Planetary
8	Jack Pad (stored)
9	Carbody
10	Carbody and Crawler Control Valves
11	Ring Gear (with turntable bearing)
12	Swing Gear
13	Carbody Jacking Cylinder

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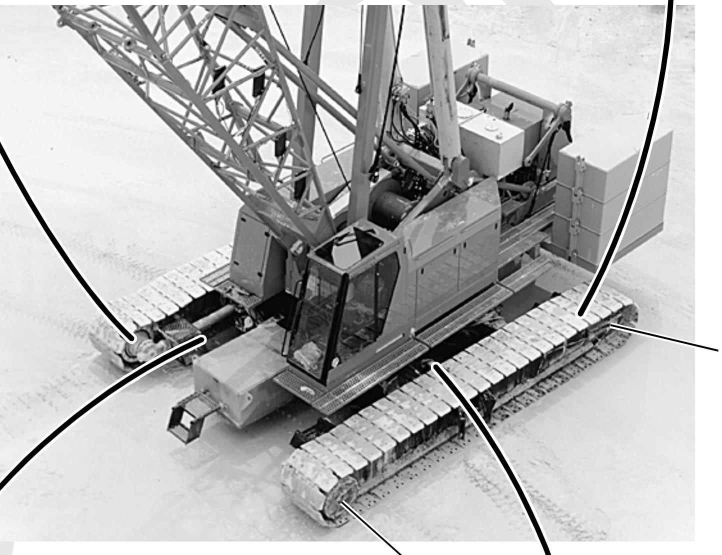
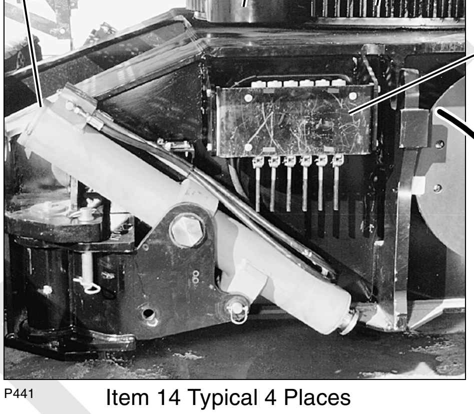
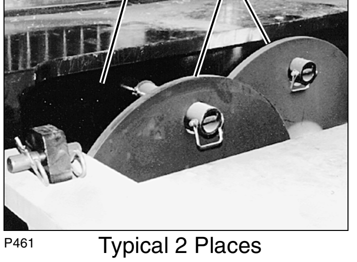
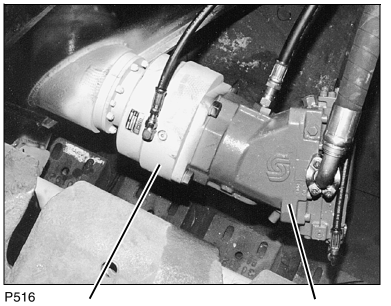




P441 Item 14 Typical 4 Places

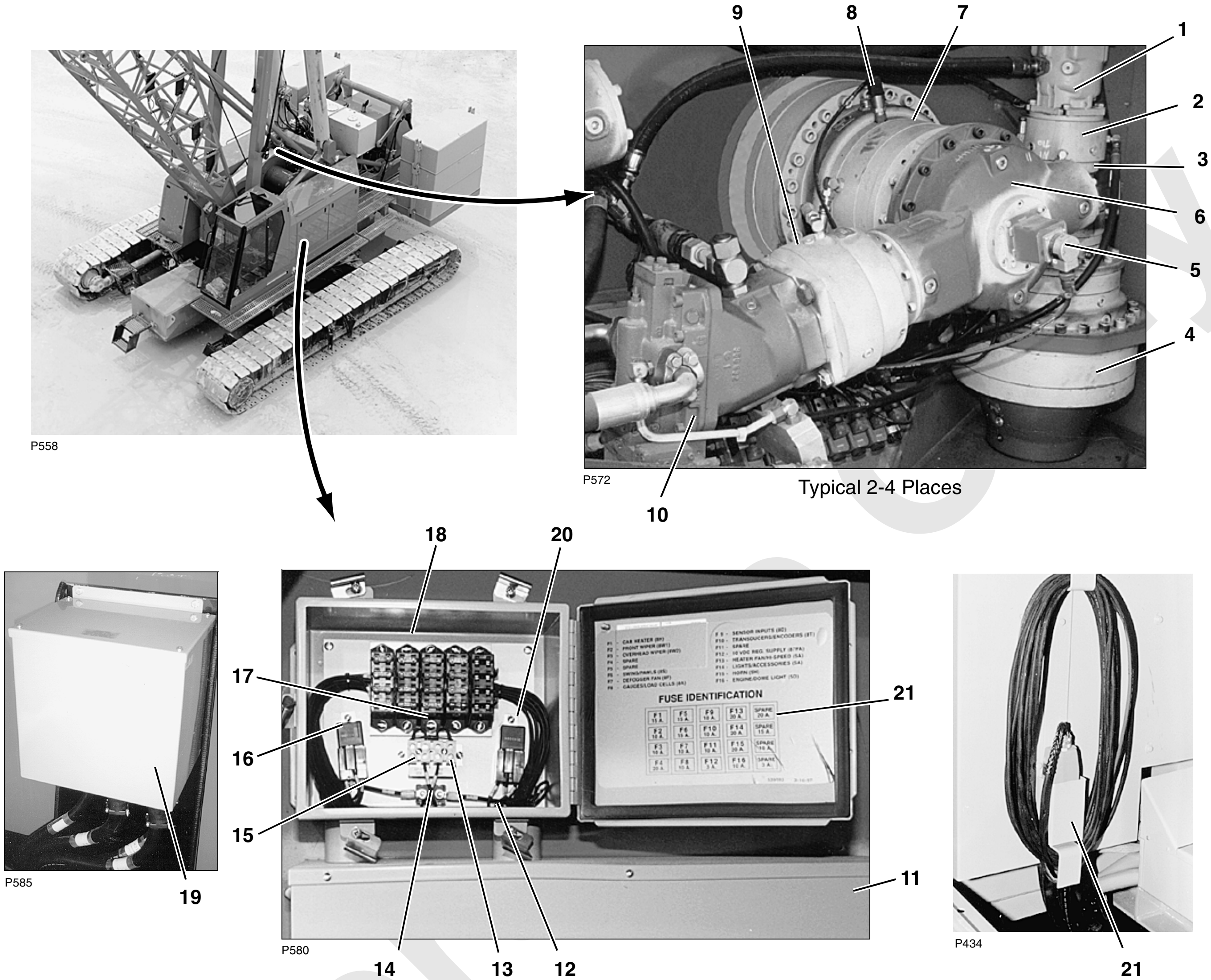


P461 Typical 2 Places



P516 Typical 2 Places

FIGURE 1-2



Item	Description	Item	Description
1	Swing Motor	12	Junction Box Fuse
2	Swing Lock	13	System Ground
3	Swing Brake	14	50 Amp Circuit Breaker
4	Swing Planetary	15	12 Volt DC Power Supply
5	Drum Motor Speed Sensor	16	70 Amp Cab Power Relay
6	Drum Planetary	17	Transient Suppressor Diode
7	Drum Clutch	18	Fuses (see item 21)
8	Drum Clutch Switch Engaged	19	Programmable Controller (in cab)
9	Drum Brake	20	70 Amp DC Power Output
10	Drum Motor	21	Fuse Identification
11	Main Junction Box	22	Counterweight Remote Control (in left side enclosure)

FIGURE 1-3

GENERAL OPERATION

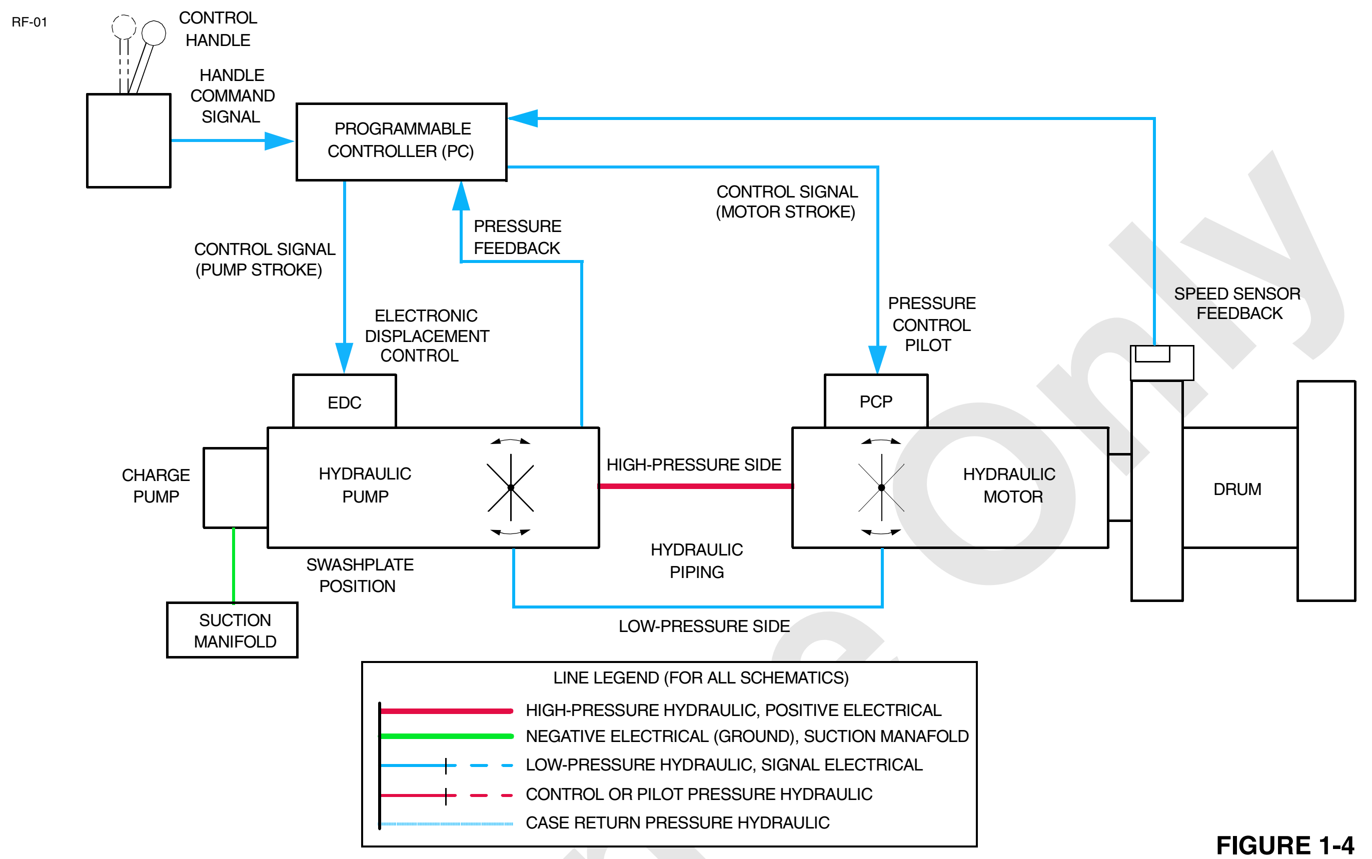


FIGURE 1-4

Operating System

A safety mechanism that prevents systems operation until the cab seat is occupied by the operator, governs operation of the EPIC® Hydraulic-Series crane. When the engine is running and the operator is not seated, the seat switch circuit is open, all control handles are inoperable, all park brakes are applied (including free fall) and travel detent systems are turned off. The display indicates an operating limit message FUNCTION IS PARKED.

Hydraulic Components

See Figure 1-4 for following procedure.

Each system is controlled through a programmable controller (PC) and is independently powered by a hydraulic pump and an actuator in a closed-loop hydraulic system. See Table 1-1 for the types of pump and actuator in each system, and to Sundstrand Series 90 Service Manual for an operational description of a hydrostatic transmission.

In a closed-loop hydraulic system, the oil output from the system pump drives an actuator, and then returns directly to the pump's input instead of returning to the crane's hydraulic tank.

Table 1-1
Pump and Actuator Description

Pump System	Description
Front and Rear Hoists (Load Drums), Auxiliary Hoist, Boom, Swing, and Travel.	Variable Displacement, Axial Piston
Accessory	Fixed Displacement, Gear
Actuator System	**Description**
Front and Rear Hoists (Load Drums), Auxiliary Hoist, Travel.	Variable Displacement, Bent-Axial Piston Motor
Boom Hoist	Two Bi-Directional Cylinders
Swing	Fixed Displacement, Axial/ Piston Motor
Travel motors are normally in minimum displacement position (low torque, high speed). Travel motors start to shift to maximum displacement position at approximately 3,500 psi (241 bar) (high torque, low speed).	

A gear pump on each system pump supplies oil at charge pressure to maintain the closed-loop system's minimum pressure requirements. This oil is also used to regulate the oil flow from the pump by moving a swashplate servomechanism within the pump in response to an external electric displacement control (EDC).

An accessory tandem gear pump supplies supercharged filtered oil to the suction ports of some of these pumps, provides oil to establish cylinder valve actuation, and pressure oil to establish band brake release.

The PC controls each pump EDC in reaction to operator commands through the system's control handles. The PC compares the handle commands with feedback information it derives from continuous monitoring of the system's sensors. Data derived from this monitoring can be viewed on a digital display screen in the operator's cab by selecting the desired information.

Hydraulic Pumps

See Figures 1-5 and 1-6 for following procedures.

Variable displacement, axial piston pumps are used in the boom, front and rear hoists, swing, travel, and auxiliary hoist (optional) systems. Each pump contains a cylinder block in which the pistons are positioned axially around the drive shaft, a tiltable swashplate against which the pistons ride, a servo mechanism that tilts the swashplate, and two multifunction valve cartridges.

Pump displacement is dependent upon the speed at which the engine drives the pump through the pump drive gearbox and the angle at which the swashplate is tilted. The engine provides the horsepower available for work, while the swashplate tilt provides speed control. An electrical hand throttle sets engine speed; temporary increases are accomplished with an electrical foot throttle.

The pump's external EDC sets the amount and direction that the swashplate is tilted by internal servo control cylinder. Tipping direction establishes the direction that the oil flows from the pump to the system actuator. This determines the direction of motor rotation or cylinder movement.

A gerotor type gear pump is internally mounted on the end of each system pump's drive shaft. Charge pump (2) draws oil directly from the hydraulic tank's suction manifold or filtered make-up oil. The charge pump delivers it to the closed-loop at approximately 350 psi (24 bar) depending upon load and engine speed and the setting of charge pump relief valve (3). The charge oil provides oil cooling, positive pressure maintenance in the low-pressure side of the loop, control pressure for the pump swashplate servo mechanism, and make-up oil for replacement due to internal leakage. From the charge pump, the oil flows to charge flow make-up check valves (4) in the multifunction cartridge, and passes over the check valve on the low side of the loop. It combines with oil returning from the system actuator and enters the system pump.

In the system pump, the oil pressure holds each piston in turn against the face of the swashplate as the engine rotates the cylinder block.

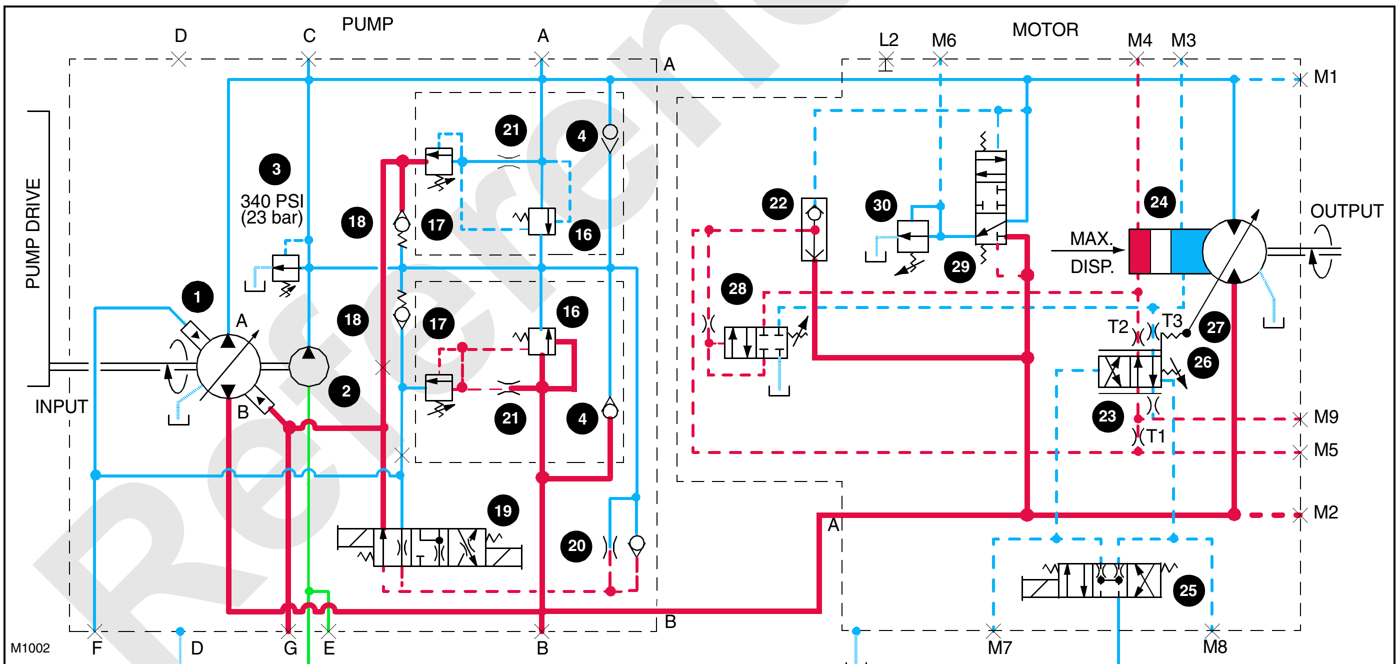


FIGURE 1-5

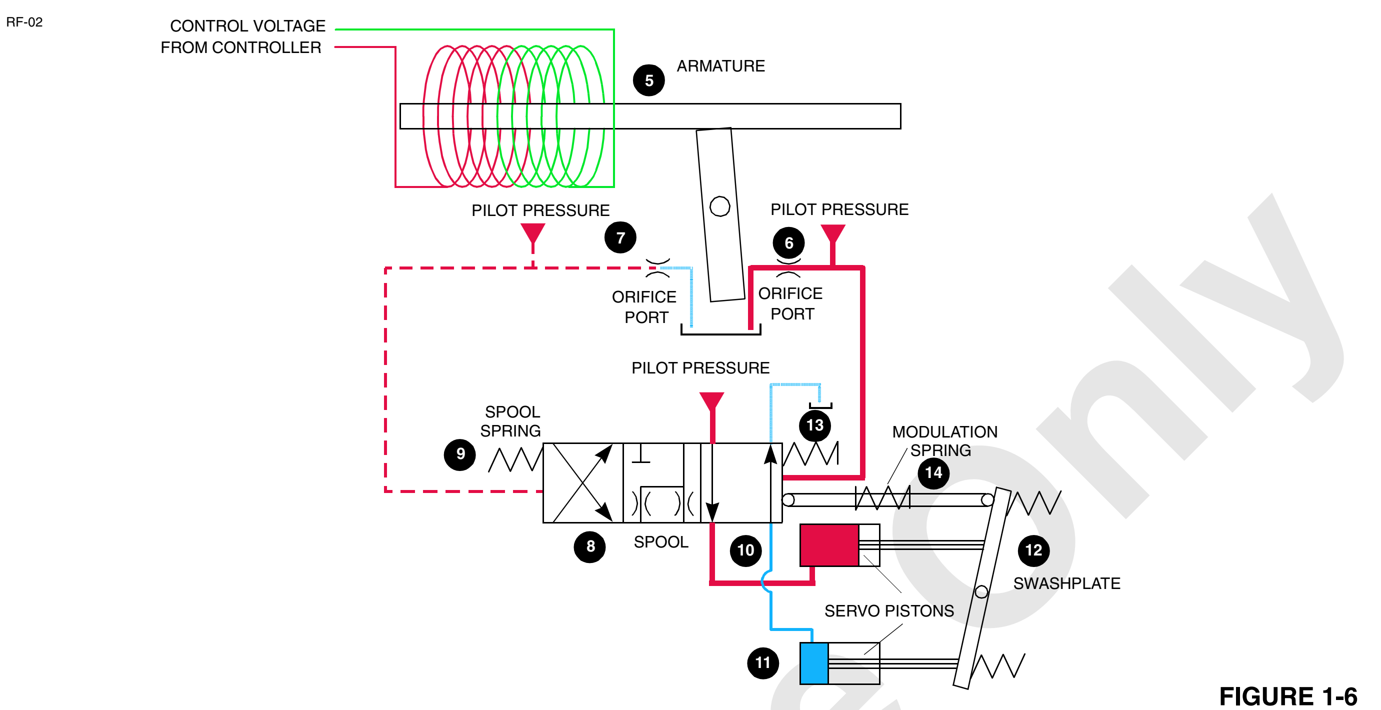


FIGURE 1-6

The PC transmits a command signal to one of the two coils in the EDC via two of the four EDC connector pins. The first pin energizes the coil. The current travels through the coil and returns to the connector as negative charge through the second pin. The polarity changes for opposite stroke direction and positive current returns to the coil through the second pin and back to negative through the first pin. This charge cycle causes armature (Figure 1-6) to become more magnetized, initiating its movement to begin blocking orifice. The increasing blockage of orifice causes a larger pressure increase in right port than in left port, resulting in a pressure imbalance across spool. This pressure imbalance overcomes the resistance of spring and initiates the movement of spool causing internal servo control cylinder to pressurize and servo oil to be routed to tank. This movement causes swashplate to shift, and initiate the flow of oil out of the pump. As swashplate shifts, spring chamber is pulled opposite the direction of spool with linkage. This actuation centers and maintains spool in a neutral position until the 16 psi (1.1 bar) preset pressure of spring is reached.

Because the swashplate is now tilted, the pistons are reciprocated within the cylinder block as the block rotates. The lengthening stroke of each piston draws returning oil into the cylinder; as the stroke shortens, the oil is pumped out of the pump cylinder to the motor cylinders at system pressure. Note that when the swashplate is not tilted, there is no output from the pump.

The amount that the swashplate is tilted determines the amount of oil that is pumped to the motor or cylinder. Increasing the swashplate tilt increases the stroke length, causing more oil to be pumped to the system motor or cylinders.

At this point, pressure develops within the closed-loop system while the resistance of the load on the system actuator is overcome. When movement begins, the volume displacement of the pump maintains the actuator speed. More flow from the pump operates the actuated system faster to perform the desired activity.

Since each system pump operates in a bi-directional closed-loop circuit, the pumps contain two different multifunction valve cartridges, each of which consists of system relief valve (16, Figure 1-5), make-up check valves (4), and pressure limiting valve (17) which protect the crane's hydraulic system from excessive pressure and heat buildup. When the preset system pressure is reached in the loop, the multifunction valves limit system pressure by causing the pump to destroke and/or allowing oil to transfer from the high pressure side of the loop to the low pressure side.

In the travel pump's main hydraulic loop, the system relief make-up check valve, and pressure limiting sections of the multifunction valve will respond when the preset relief pressure at port B is reached. At this time, the oil pressure actuates the spring in pressure limiting valve (17), shifting its spool to open an exhaust path for the oil. Since servo check valves (18) are spring loaded with an opening pressure of 750 psi (52 bar), the oil flows through the exhaust port of displacement control valve (19). The exhaust port of displacement control valve is restricted by orifices (A), causing flow to pressurize servo control cylinder (1) and destrokes the pump's swashplate to limit the system pressure. When rapid loading produces pressure spikes, system relief valve (16) shifts, allowing the high pressure oil to be returned to tank through charge pump relief valve (3) or transferring the oil into the low pressure side of the loop through charge flow make-up check valve (4).

In all other system pumps (both load drums, boom, auxiliary hoist, and swing), the pressure limiting feature of the multifunction valve is not present. Orifices (A) in the multifunction valve and flow control orifice (20) are removed from the EDC. In addition, servo check valves (18) are removed from the pump and the paths to the servo control cylinders are plugged. These internal changes to the pump configuration permit the pump to react more quickly to commands from the PC.

Also in these systems, pressure limiting valves (17) function as pilot valves to open system relief valves (16) when the relief pressure setting is reached. For example, when a pressure imbalance occurs on both sides of flow restrictor (21), pressure limiting valve (17) opens and system relief valve (16) relieves the system pressure from the circuit by directing the oil to tank through charge pump relief valve (3) or transferring the flow to the low pressure side of the loop through charge flow make-up check valve (4).

Hydraulic Motors

Variable displacement low torque/high speed, bent-axis piston motors are used in the hydrostatic transmissions of the load drum, travel, and auxiliary hoist (optional) systems. A fixed displacement low torque/high speed axial piston motor is used in the hydrostatic transmission of the swing system. Each motor contains a cylinder block, nine pistons, output shaft flange, and loop flushing (purge) valve assembly. The load drum motors are without a loop flushing valve assembly since these systems have external loop flushing valves. The load drum and auxiliary hoist (optional) bent-axis motors are also have a pressure control pilot (PCP) valve that serves the same basic function and demonstrates similar operating characteristics as the pump EDC. Each travel motor contains a pressure compensator regulator (PCR) valve to accomplish the pressure control function.

The cylinder block of all system motors (except swing) is tilted at an angle to the output shaft with the pistons fitted axially around its axis. (The swing motor is perpendicular to the shaft.) The internal end of the output shaft has a large flange face, which provides similar function to that of the pump swashplate. Since the motor piston ends are retained to the output flange face, the pistons cannot rotate around the axis of the rotatable flange as the pump pistons do on the stationary swashplate.

Oil entering the motor from a system pump provides force against the motor pistons, causing the retained piston ends to thrust against the output flange with a rotational torque that turns the output shaft on its axis. This thrust also rotates the cylinder block on its axis while its tilt to the flange face reciprocates the pistons as they rotate. The oil displaced by the pistons returns to the system pump.

All motors, excluding the swing system motor, have a servo mechanism that tilts the cylinder block to vary the oil displacement. Contingent upon the particular system motor, the servo mechanism includes shuttle valve (22), servo control valve (23), and servo cylinder (24). These servo mechanism components initiate the motor operation for the load drums, and auxiliary hoist (optional) at maximum displacement. This provides maximum starting torque at a lower speed. When the servo mechanism tilts the cylinder block to the position of minimum oil displacement, the shaft output speed is approximately five times faster and the available output torque decreases to approximately one-fifth of the maximum torque value.

The actuation of the travel motor servo mechanism is opposite of the other system motors. The travel motors begin operation at minimum displacement and cylinder block tilts to maximum displacement at about 3,500 psi as the operation commences. Servo control oil is supplied from the low pressure line of motor port A or B and travels through shuttle valve (22) and servo control valve (23) before entering servo cylinder (24).

The load drum hoist motors remain in maximum displacement until servo control valve (23) receives a command from PCP valve (25) to direct the constant pressure and flow from shuttle valve (22) to the minimum (or maximum) displacement side of servo cylinder (24) which shifts the motor. As the PCP valve opens in proportion to the current received from the PC, pilot oil from its system charge pump is directed to shift servo control valve (23). After overcoming adjustable valve spring (26) and valve spring (27), which is preset by the cylinder block tilt angle, servo control valve (23) shifts and directs pressurized oil to stroke the motor into minimum displacement output. If the load on the motor increases, the cylinder block force on adjustable valve spring (26) increases. This forces servo control valve (23) to destroke the motor to maximum displacement for safe load handling.

Load drum circuits also have pressure compensated over-ride (PCOR) system valve (28) which activates at a preset pressure of 4,930 psi (340 bar). When increasing system pressure exceeds the PCOR setting, PCOR valve (28) shifts to direct oil flow from shuttle valve (22) into the maximum displacement side of servo cylinder (24). PCOR valve (28) over-rides the command from servo control valve (23), causing an increase in motor displacement and output torque and a reduction in output speed. When PCOR valve (28) closes, the control of the motor returns to servo control valve (23).

All hydraulic motors have case oil drainage that lubricates the motors and provides a source of for continuous recirculation of the oil supply to control heat generation in the closed-loop circuit. In addition to oil slippage for the prevention of excessive heat buildup, the 777 swing and track motors incorporate an integral loop flushing (purge valve) system consisting of control valve (29) and relief valve (30). This loop flushing system allows 5 gpm (19 l/m) of oil at 350 psi (24 bar) to be removed from the main hydraulic circuit for additional cooling and purification. When pressurized by oil from the high pressure lines of motor ports A or B, control valve shifts, initiating the flow of oil from the low pressure side of the circuit through the control valve and over relief valve (30) into the motor case.

The load drum motor circuits, like the swing and track motor circuits, contain loop flushing (purge valve) systems; the loop flushing valve is independent of the motor in each of the motor circuits. The flushing valves allow 4 gpm (15.5 l/m) of oil at 275 psi (19 bar) to be removed from the main hydraulic circuit for additional cooling and purification.

Charge Pressure

The diagnostic display can be used to obtain information about the system charge pressure. When a system handle is in the neutral position, the system diagnostic screens (DRUM 1, 2, and 8; BHST; SWING; and TRACK) can provide this information (see Diagnostic Display in Section 10 of this manual).

Charge pressure in each of the closed-loop systems is established by setting the poppet-type relief valve in the system's charge pump. The charge pressure relief is preset by the manufacturer at 350 psi (24 bar) and will maintain the system pressure at a value greater or equal to this value depending on engine rpm. The charge pressure must be at a minimum of 120 to 150 psi (8 to 10 bar) for closed-loop system pump operation to occur; lower pressures cause a slowing or ceasing of system operation. When charge pressure is low, the PC does not destroke closed-loop system pumps.

If the rear load drum charge pressure pump would lower the disc brakes for the rear load drum, swing, and travel applications may begin to apply. The source of the brake pressure for the front load drum and auxiliary hoist is from their own respective charge pump. The brakes begin to apply at about system pressure of 250 psi (17 bar) for the load drums, auxiliary hoist (optional), and travel brakes, and 260 psi (18 bar) for the swing systems. The brakes are fully applied at a system pressure of 190 psi (13 bar) for the load drums and travel brakes, 220 psi (15 bar) for the swing brake system, and about 165 psi (11 bar) for the auxiliary hoist brake systems.

The charge pressure system of the rear hoist provides pilot pressure to shift the servo cylinders of the rear hoist drum and auxiliary hoist motors from maximum to minimum displacement, and the travel motor from minimum to maximum displacement. The front hoist charge pump pressure also provides the pilot pressure to shift the servo cylinder of the front hoist drum motor from maximum to minimum displacement.

Main System Pressure

The diagnostic display can also be used to acquire information about the main system pressure. When in use, the system diagnostic screens (DRUM 1, 2, and 8; BHST; SWING; and TRACK) can provide this information (see 777 Diagnostic Display in Section 10 of this manual). A more accurate indication of system pressure an be obtained by monitoring the diagnostic manifold with a high pressure gauge (7,500 psi [517 bar] minimum) when the pump is stroked. As previously described, the system pressure for the load drum, boom, swing, travel, and auxiliary pumps is controlled by one of two different configurations of multifunction valve cartridges consisting of system relief and pressure limiting valves. The pressure setting of the multifunction valves for each pump is listed in Table 1-2. The limits should not be reached unless there is a failure in these systems.

This pressure limiting action prevents overheating of travel system oil by reducing discharging flow rate through relief valve feature of system multifunction valve.

The relief valve feature of the multifunction valves in all system pumps protects the pump systems from damage by limiting pressure above the system limits in each direction.

Accessory System Pressure

See Figures 1-7 and 1-8 for following procedures.

The crane setup hydraulic circuit is controlled through the use of the 25.6 gpm (high idle) middle section of a tandem gear pump called the accessory pump (1) and a mobile-type valve called the lower accessory valve (3). The control valve has parallel operating circuits and contains a relief valve (4) pre-set at 3,100 psi (214 bar).

When moving a system handle to pressurize a valve section in the setup system, the center flow-through passage of the control valve is blocked, stopping oil flow to pilot-operated check valve (5). The pressurized oil within the pilot cavity of valve (5) exhausts to tank through bleed-off orifice (6) and permits the valve to close. The flow output from accessory pump (1) is no longer discharged to hot oil boom shuttle valve (30) through check valve (5) but supplied to a function of the lower accessory valve (3).

Hydraulic Supply

See Figure 1-8 for following procedures.

The hydraulic supply is maintained by accessory pump (1) which provides 30 gpm of oil at 3,100 psi (215 bar) to all setup system hydraulic cylinders and 60 gpm of oil at up to 100 psi (7 bar) maximum pressure to the filtration super charge circuit. The super-charged oil is supplied to the boom, swing, and travel pumps.

Hydraulic Tank

Hydraulic tank (7) is mounted on the right side of the rotating bed. It has a vented fill cap, high and low level sight gauge, temperature and level sensors. The digital display indicates if the hydraulic oil temperature exceeds 180°F (82°C), and a low oil level in the hydraulic reservoir.

Filtration

See Figures 1-8 and 1-9 for following procedures.

Hydraulic circuit filters remove contaminants introduced by replacement oil or parts, dust particles acquired from the surrounding work area, and impurities generated from normal wear during system operation. To protect the crane's hydraulic circuit from harmful concentrations of these contaminants, filter elements should be periodically changed in accordance with an established maintenance schedule.

The hydraulic system provides various filtration circuits for maintaining the manufacturer's standards for hydraulic oil purity. The methods of filtration include inline, charge pressure, supercharge pressure, and suction filtration.

All oil exiting hydraulic tank is suctioned through a 200 mesh strainer with a 3 psi (0.21 bar) bypass valve. The bypass valve opens to permit oil flow to the various crane systems when the strainer is dirty or the oil temperature is too cold for direct operating conditions. At this time, hydraulic vacuum switch closes to complete a circuit to the PC. The PC responds by sending a diagnostic message HYDRAULIC FILTER 5 to the operator display, indicating the strainer requires servicing. In addition, the PC activates fault system light and fault system alarm. If activation of the fault system continues after the oil has warmed to normal operating temperatures, the tank strainer must be cleaned and/or the hydraulic oil changed as soon as possible to meet the operational viscosity requirements. Oil may exit the hydraulic tank through safety check valve.

The inline filter or filter 4 has a 50 psi (3.4 bar) bypass valve and a filter element with a rating of 13 micron absolute. As the element becomes soiled, the pressure differential between the inlet and discharge flow ports of the filter increases, causing the element to lift, permitting oil to bypass the filter element. Prior to the oil bypassing the filter, the filter 4 hydraulic sensing switch on the filter head closes to complete the circuit to the PC. The PC responds by sending a diagnostic message HYDRAULIC FILTER 4 to the operator display, indicating filter 4 requires servicing, and activating fault system light and fault system alarm. The filter must be replaced at this time.

The pressure limiting feature of the multifunction valves in the travel pumps is not disabled. Should the pressure reach 6,090 psi (420 bar), the multifunction valves will destroke the pumps as needed.

Table 1-2
System Pressure Settings

System	Load Drums		Boom		Swing	Travel
Function	Hoist PORT A	Lower PORT B	Up PORT A	Down PORT B	Left/Right PORT A / PORT B	Fwd / Rev PORT A / PORT B
Pressure psi (bar)	6,090 (420)	2,900 (200)	6,090 (420)	2,900 (200)	6,090 (420)	6,090 (420)

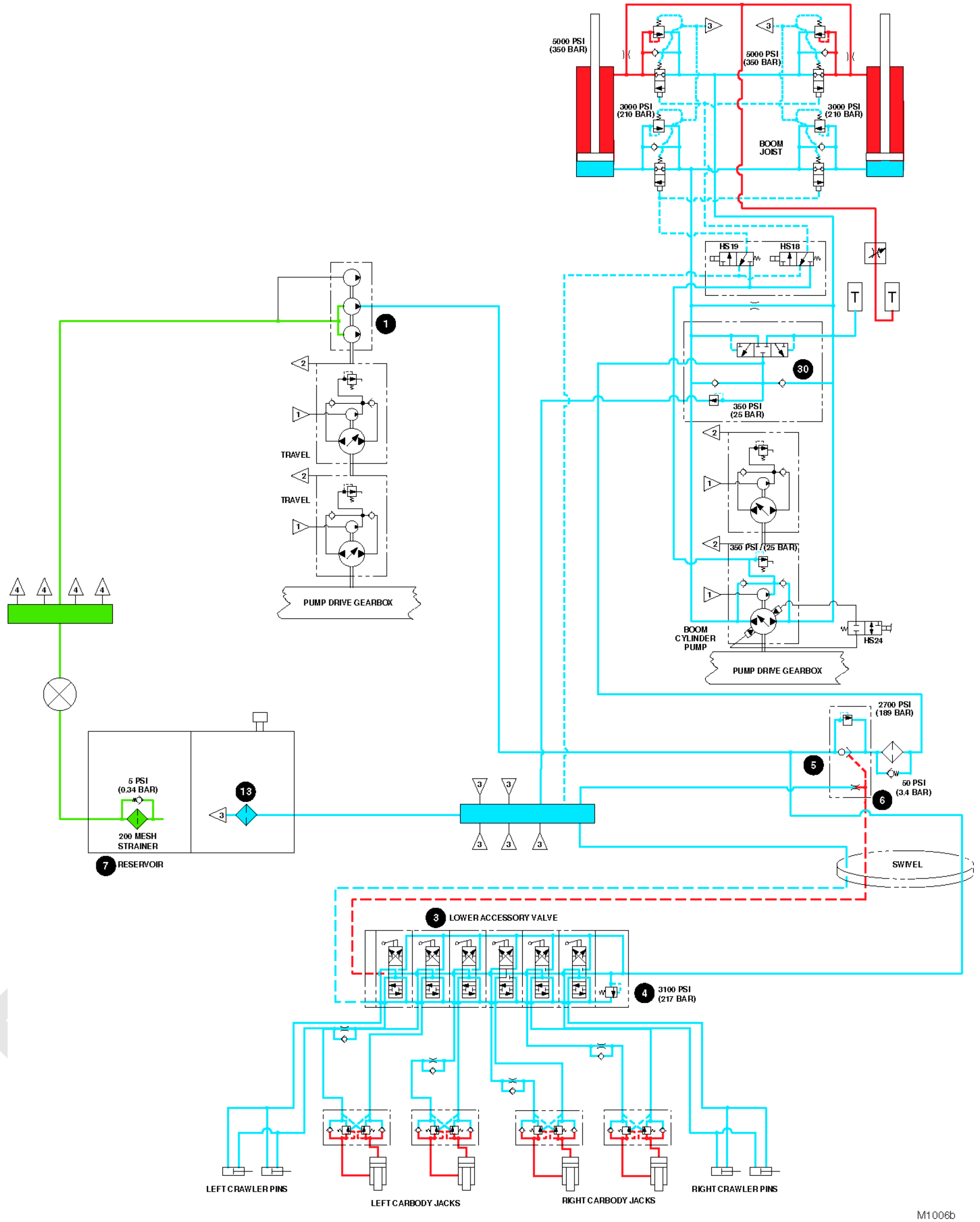

5000 PSI
(350 BAR)
5000 PSI
(350 BAR)
3000 PSI
(210 BAR)
3000 PSI
(210 BAR)
BOOM
HOIST
HS19
HS18
30
350 PSI
(25 BAR)
350 PSI / (25 BAR)
BOOM
CYLINDER
PUMP
HS24
PUMP DRIVE GEARBOX
1
TRAVEL
TRAVEL
PUMP DRIVE GEARBOX
2700 PSI
(189 BAR)
5
50 PSI
(3.4 BAR)
6
5 PSI
(0.34 BAR)
13
200 MESH
STRAINER
7 RESERVOIR
SWIVEL
3 LOWER ACCESSORY VALVE
4 3100 PSI
(217 BAR)
LEFT CRAWLER PINS
LEFT CARBODY JACKS
RIGHT CARBODY JACKS
RIGHT CRAWLER PINS
M1006b

FIGURE 1-7

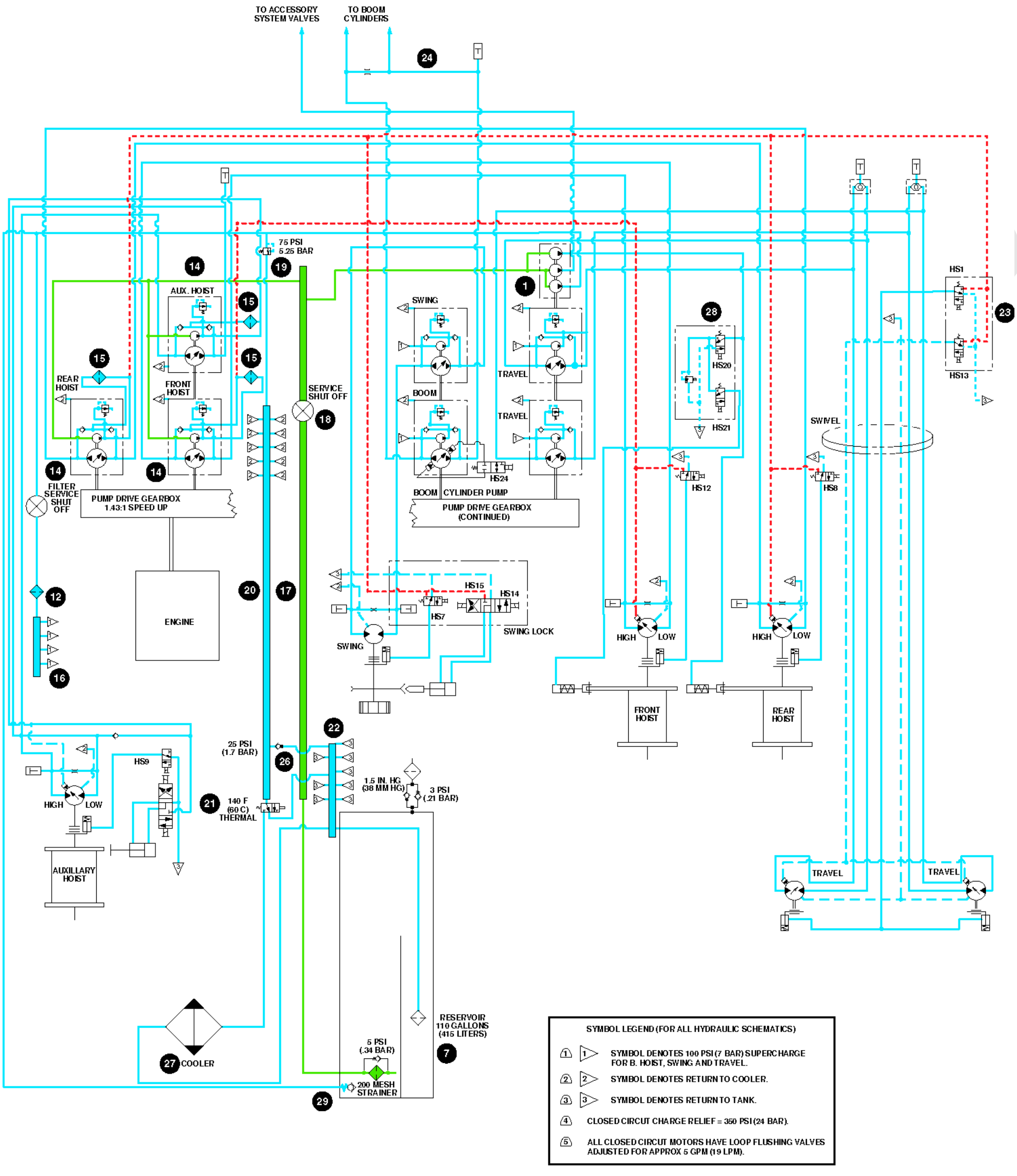

TO ACCESSORY SYSTEM VALVES
TO BOOM CYLINDERS
75 PSI 5.25 BAR
AUX. HOIST
REAR HOIST
FRONT HOIST
SWING
BOOM
TRAVEL
TRAVEL
HS24
BOOM
CYLINDER PUMP
PUMP DRIVE GEARBOX (CONTINUED)
SERVICE SHUT OFF
FILTER SERVICE SHUT OFF
PUMP DRIVE GEARBOX 1.43:1 SPEED UP
ENGINE
HS20
HS21
HS12
HS8
HS1
HS13
SWIVEL
HS15
HS14
HS7
SWING LOCK
SWING
HIGH
LOW
FRONT HOIST
REAR HOIST
25 PSI (1.7 BAR)
HS9
140 F (60 C) THERMAL
1.5 IN. HG (38 MM HG)
3 PSI (.21 BAR)
AUXILLARY HOIST
TRAVEL
TRAVEL
RESERVOIR 110 GALLONS (415 LITERS)
5 PSI (.34 BAR)
200 MESH STRAINER
COOLER
SYMBOL LEGEND (FOR ALL HYDRAULIC SCHEMATICS)
1 SYMBOL DENOTES 100 PSI (7 BAR) SUPERCHARGE FOR B. HOIST, SWING AND TRAVEL.
2 SYMBOL DENOTES RETURN TO COOLER.
3 SYMBOL DENOTES RETURN TO TANK.
4 CLOSED CIRCUIT CHARGE RELIEF = 350 PSI (24 BAR).
5 ALL CLOSED CIRCUIT MOTORS HAVE LOOP FLUSHING VALVES ADJUSTED FOR APPROX 5 GPM (19 LPM).
M1005a

FIGURE 1-8

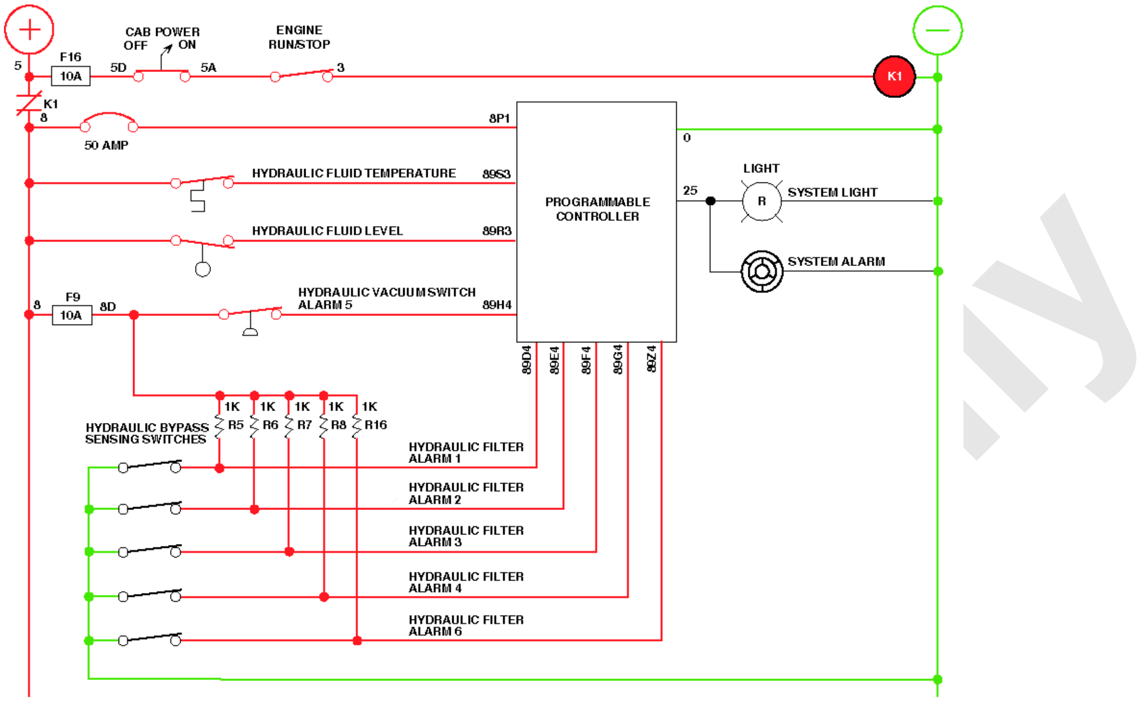


FIGURE 1-9

The front, rear, and auxiliary (optional) hoist pumps have charge pressure filtration to meet the needs of each hoist's closed-loop circuit. In this method of filtration, charge pump section of each pump (14) withdraws oil from the tank and pumps it through a remote filter adapter into each filter (15) to be processed. The oil is then routed back into the front, rear, or auxiliary hoist pump through the remote filter adapter. Note that the filter element contained in each filter (15) has a rating of 13. As the element becomes soiled, the pressure differential between the inlet and discharge flow ports of the filter increases. When the filter 2, 3, or 6 hydraulic sensing switch on the filter head detects the pressure differential to be 40 psi (2.8 bar), the switch closes to complete the circuit to the PC. The PC responds by sending a diagnostic message HYDRAULIC FILTER 2 for front hoist, HYDRAULIC FILTER 3 for rear hoist, hydraulic filter 6 for auxiliary drum) to the operator display, indicating filter 2, 3, or 6 requires servicing, and activating fault system light and fault system alarm. The affected filter must be replaced at this time.

A supercharge filtration circuit supplies filtered oil to the charge pumps of the boom, swing, and travel systems. This circuit uses accessory pump (1) to withdraw oil from the tank and deliver it at a pressure up to 75 psi (5 bar) through filter 1 and into supercharge manifold (16). The pressure differential between the inlet and discharge flow ports of the filter increases as the element becomes soiled, causing the filter 1 hydraulic sensing switch on the filter head to close and complete the circuit to the PC. The PC responds by sending a diagnostic message HYDRAULIC FILTER 1 to the operator display, indicating filter 1 requires servicing, and activating fault system light and fault system alarm. The filter must be replaced at this time.

System filtration does not transform oil that has deteriorated from prolonged use into a purified fluid. Factors affecting the service life of hydraulic fluid include high operating temperatures, excessive exposure to moisture or dust in the work area, high concentrations of contaminant particles in the oil, or admixtures to the oil of unlike viscosity or chemical composition. A program to test or replace the hydraulic oil at timely intervals should be established in order to ensure efficient operation of the crane's hydraulic system.

See the Lubrication Guide in Section 9 if this manual for recommended replacement oil for the hydraulic system.

Suction Manifold

Supply oil to load drum and auxiliary hoist pumps (14) and accessory pump (1) is obtained from suction manifold (17).

Suction manifold has a 3-inch service shut-off valve (18). During hydraulic system maintenance operation, the valve can be closed.

Supercharge Manifold

The front section of tandem accessory pump (1) delivers up to 58 gpm of supercharge oil to supercharge manifold (16). The oil is filtered as it enters manifold through filter 1 (12). Pressure in manifold is controlled by relief valve (19), which is preset for 75 psi (5.25 bar). Manifold distributes oil to the charge pumps of the boom, swing, and travel systems.

Oil Return Manifolds and Cooling System

The hydraulic system oil temperature is controlled by routing the return oil from all pump and motor case drain lines and the supercharge relief valve discharge line to return-to-cooler manifold (20). If thermal control valve (21) detects that the temperature of the return oil in manifold is below 140°F (60°C), it directs the flow into return-to-tank manifold (22). Here, it combines with return oil from all hydraulic system brake valves, 2-speed travel valve (23), boom cylinders counterbalance valves (24), load drum band brake valves (28), load drum loop flush valve drain (29, Figure 1-5), lower accessory valve (3, Figure 1-7), and cooler bypass safety valve (26) which is preset at 25 psi (1.7 bar). The combined flow from return-to-tank manifold (22) is then routed to tank.

If thermal control valve (21) detects that the temperature of the return oil in manifold (20) is above 140°F (60°C), it directs the flow into cooler (27) before returning to tank.

EPIC Programmable Controller (PC)

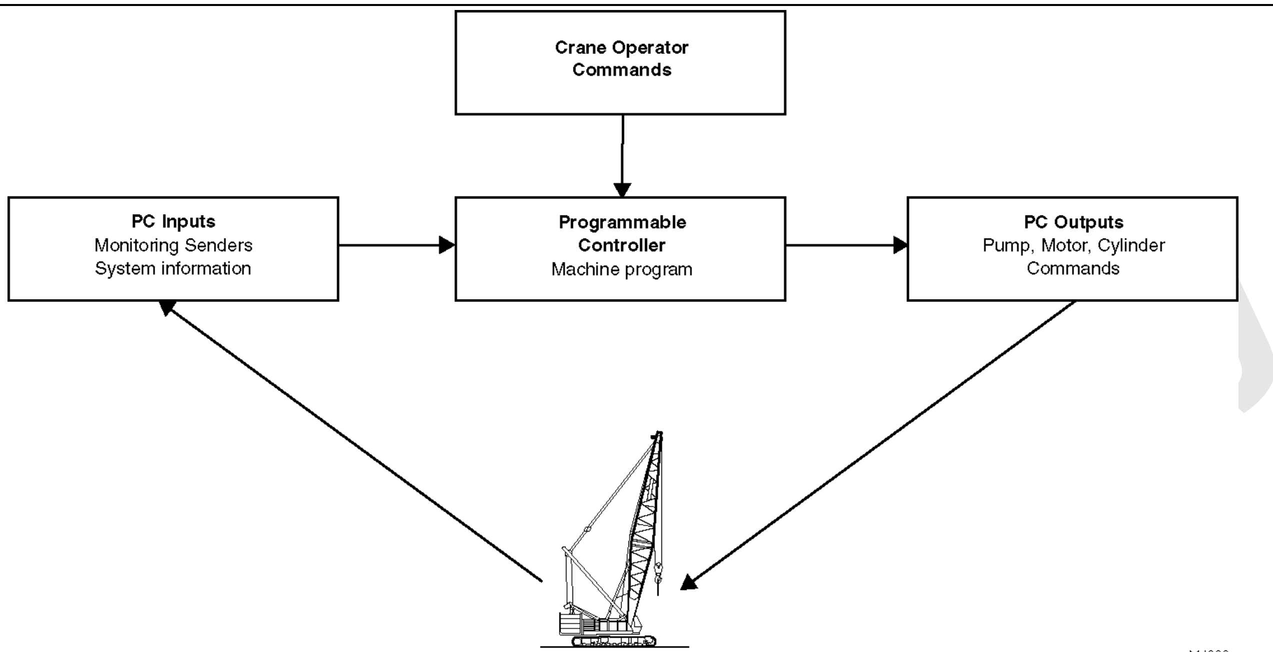
See Figures 1-10 and 1-11 for following procedures.

Most of the crane's solenoid valves, pumps, and motors are directly controlled by electronic components on the PC's printed circuit boards. This simplifies the crane's electrical control system by avoiding mechanical control switches and relays; reliability and service convenience is increased, while service down-time is decreased.

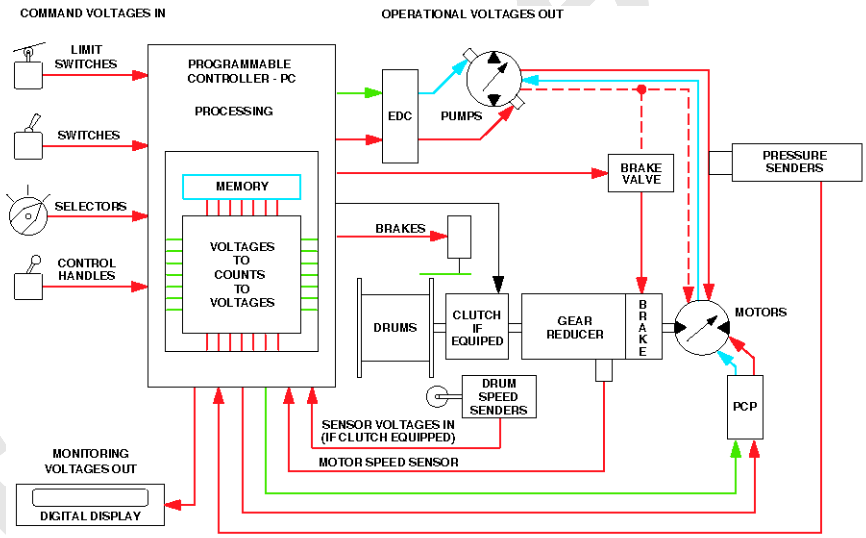
The EPIC (Electric Proportional Independent Control) programmable controller system is a control process operating in a closed loop. The programmable controller operates within the loop by collecting information from the system's monitoring sensors, such as pressure senders, speed senders, and limit switches. It accepts desired reference commands given by the crane operator, through voltage inputs from hand controllers, selectors, and switches. This closes the loop as per PC program directives by establishing commands to the pumps, motors, cylinders, etc., that cause the direct movements the crane encounters during normal working cycles. This is an ongoing process operating continuously in 12 millisecond cycles.

The PC's standard or custom programming enhances operation convenience and precision control of the crane. The programming allows the PC to automatically adjust each operational mode's acceleration rate and speed, as well as apply brakes and release clutches.

The PC provides solenoid valves, pump EDCs, and motor PCPs with the appropriate voltages to obtain the selected functions, operation speed rates and direction. The PC varies the voltage levels and polarity outputs to correspond with the voltage inputs to the PC from the control handles.



M1038
FIGURE 1-10



M1008
FIGURE 1-11

The programmable controller uses the binary mathematical system for its basic alphabet.

The binary system is based on 2 rather than 10 as is our mathematical system. This is because the controller recognizes only 0 and 1 as OFF and ON voltages. As 0 and 1 are two numbers, the system is called binary, meaning composed of two alternate units or bits (the digits 0 and 1).

The basic letters of this system or counts are exponents of the number 2. These are formed into words or bytes of eight (or sixteen) numbers each. These numbers must be 1, 2, 4, 8, 16, 32, 64, and 128 (for an 8-bit controller), or a combination thereof up to 255.

They are used to represent the electrical inputs to the controller. The controller processes this information by comparing it to its programming requirements, and its stored data or memory, and then provides appropriate voltages to the electric control devices of the crane's components.

The monitoring sensors include limit switches; engine operation, hydraulic oil, and boom angle senders; pressure senders in each closed-loop hydraulic circuit; and boom, load drum, and auxiliary hoist (optional) motor speed senders.

Pressure senders measure system pressures and supply the PC with equivalent voltages. The pressures are memorized in the form of binary counts at crucial points during lift crane operation.

The PC uses the pressure senders in any liftcrane full power operation to determine the oil pressure needed to hold the load, boom, or luffing jib (optional) and prevent it from lowering momentarily when starting after releasing the brake.

- Drum speed senders detect the amount and direction of drum movement. The PC receives this information in the form of two out-of-phase square wave voltages. (For example, after this information is received from the encoder, the PC will signal the display to print the drum rotational speed, drum rotational direction (+ on display for HOIST UP) (- on display for HOIST LOWER), and actuate the handle thumper in a proportional rhythm to the impulse received.)

The PC uses the speed senders to determine when to apply the brakes and to trim or adjust pump flow.

The PC also uses the monitored data and programmed memory in providing voltage and hydraulic solenoids for automatic control of the brakes and clutches in their operational systems.

The operational systems function in direct relation to the control handle commands while the PC automatically accounts for system conditions, equipment positions, and desired actions or limitations entered into the PC's program directives.

Standard Crane Mode

Hoisting or lowering a load are operations performed using the load drums. Raising or lowering are operations performed with the boom. For simplification, the handle commands for these operations will be referred to as up or down.

When an up or down command is received from a control handle in full power mode, the PC compares the command with current operating information (i.e. hydraulic sender voltage readings) and to previously memorized information (pressure memory) in order to control brake application and pump output. Enough system pressure must be available to hold the load before the PC releases the brakes. This also prevents momentary lowering of the load. Should there be a change pressure loss, the brakes are automatically applied.

The control handle position provides a linear electric analog input to the PC, increasing or decreasing in proportion to the handle movement. The PC responds to the handle movement with an analog output to the pump EDC that is appropriate for the task being performed. For example, in drum operation, the program provides more precise control needed during initial handle movement.

The PC receives the linear analog input handle voltage and adjusts the voltage output to the appropriate load drum hoist pump EDC and motor PCP. During hoisting, the voltage is increased at a slower rate during the first half of handle travel than the last half. During lowering, the voltage is decreased at a slower rate as the handle gets closer to the off position until a switch in the handle opens the control circuit to the PC at the off position.

The voltage sent to the pump EDC is either negative or positive (0 to 2.7 volts) as appropriate to obtain commanded operation direction. The EDC tilts the pump swashplate to a position that strokes the pump to obtain the flow amount needed to perform the operation speed commanded: the more voltage received, the more the EDC tilts the swashplate. Operation is regulated in response to movement of the handle. Oil then flows from pump to motor; and at the appropriate moment when pressure memory is met, the PC releases the drum brakes.

When the load drums have clutches and when operating in full power mode, the PC compares the drum speed sender output to the motor speed sender output to determine a speed difference. If there is a speed difference of the drum while lowering or if the drum lowers while raising (indicating a faulty clutch), the PC will apply the drum brakes.

As the control handle is moved back toward the off position, the PC proportionally decreases voltage to the EDC to decrease pump output flow. When the control handle is moved near the off position, the PC applies the park brakes.

Brake Application

As the control handle nears the off position, the PC compensates for hydraulic system leakage. Changing load weight or changing engine speed causes system leakage. The PC adjusts the swashplate in the up direction until the load is supported, the handle command is off, and the drum speed sensor output is zero (indicating the drum has stopped moving). The PC then memorizes the holding pressure and applies the park brakes.

Brake Release

In all operation commands, even after an engine shutdown, the PC will not release the brakes until there is sufficient pump displacement (pressure memory) to hold the load.

In an up operation, when the previously memorized holding pressure is reached as determined from the pressure senders, the PC releases the park brakes and movement begins.

In a down operation, the PC first tilts the swashplate momentarily in the up direction by applying voltage to the EDC opposite to the control handle command. The PC then releases the park brakes when the previously memorized holding pressure is reached. After releasing the brakes, the PC reverses the voltage polarity to the EDC and responds directly to the control handle down command.

Other Crane Modes

The PC activates brake and clutch application, controls pump speeds, and arranges control handle use depending on crane operation modes.

- In clamshell operation, the PC allows two drums to be operated at the same time with one control handle and turns on the power down and closing features of this mode. The PC operates the EDC and engages and disengages the clutches when the drums are operated in free fall mode. The PC controls the park brakes.
- In luffing jib mode with free fall, the PC disables free fall function for the luffing drum.
- In crane setup mode, the PC commands the swing function to operate at 1/2 normal swing speed and does not free coast, the boom-up limit is bypassed, the seat switch does not have to be activated, functions as in full power mode except the set-up remote cable is enabled.

Digital Display

A digital display in the operator's cab shows the operating conditions, operating limits, and system faults being monitored by the PC. The information is accessible by scrolling to the desired display with the display selector scroll switch.

A listing of the specific data that is viewable on the digital display is shown in the three tables of the Digital Display Readings topic in Section 3 of the Operator's Manual.

Information concerning the status of all main crane components and PC operational input/outputs can be viewed on the diagnostic screen. See Diagnostic Screen in Section 10 of this manual for additional information.

Voltage Availability

See Figures 1-12, 1-13, 1-14 and 1-15 for following procedures.

Accessory Circuits

Voltage is available at key-operated cab power on/off switch, dome light switch, and horn switch. After cab power switch is activated, voltage is available to the run/stop, which when activated, provides power to cab power relay KI, DC power output relay K2, and Air Conditioner Relay ACR.

When the contacts of KI close, voltage is available to the accessory controls including front and overhead wiper motor three-speed position switches, and defogger motor switch. Power is also available to the heater/AC switch when activated, provides power for AC or heater function depending upon mode selected. When heater function is selected, water valve relay WVR energizes and closes the contacts to WA solenoid permitting engine water to flow through the heater core. When AC function is selected and when the climatic temperature control switch is in the closed position, the clutch relay CLR energizes causing the contacts to close and the AC clutch to engage. The fan motor used with either the heater or AC system, is also activated when the heater/AC switch selects the desired mode. Fan motor three-speed selector switch provides low and medium speeds that are directly controlled by inline resistance and high speed. When fan motor is selected, high speed relay HSR closing contacts, HSR providing full current at higher amperage level to the fan motor.

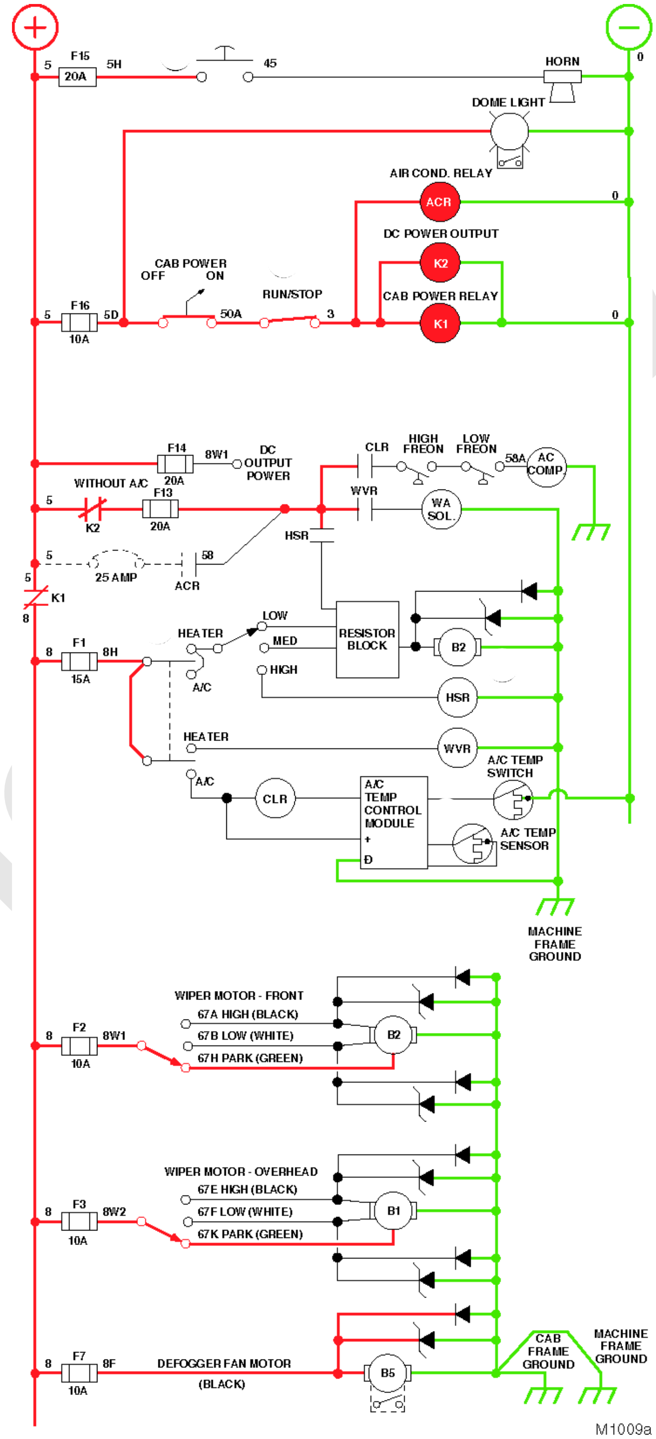


FIGURE 1-12

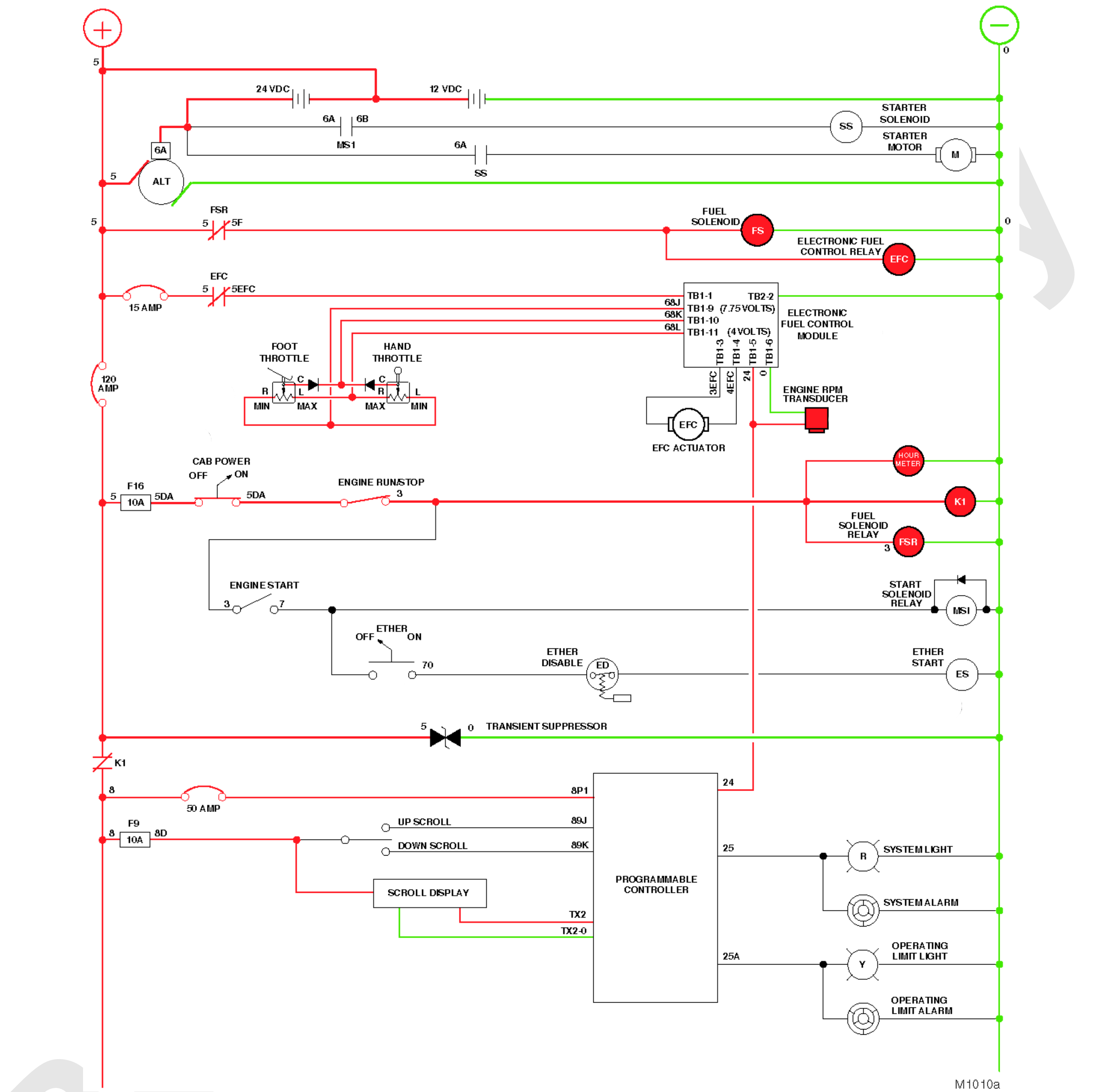


FIGURE 1-13

Engine Start Circuit

See Figure 1-13 for following procedures.

Since voltage to engine start switch is provided through cab power switch and engine run/stop switch, these switches must be closed before attempting to start the engine. When engine start switch is activated, power is supplied to start solenoid relay MS1. When the contacts of MS1 close, voltage is available to starter solenoid SS that closes contacts to the starter motor.

The primary components of the crane throttle system include electronic fuel control (EFC) module, EFC actuator, magnetic engine rpm transducer, foot throttle, and hand throttle.

When throttles are moved from the off position, a regulated voltage circuit from the throttle linear potentiometer is complete to EFC module. The EFC module compares this input signal to an electric signal received from engine rpm transducer, which monitors the speed of the engine flywheel via a magnetic pickup.

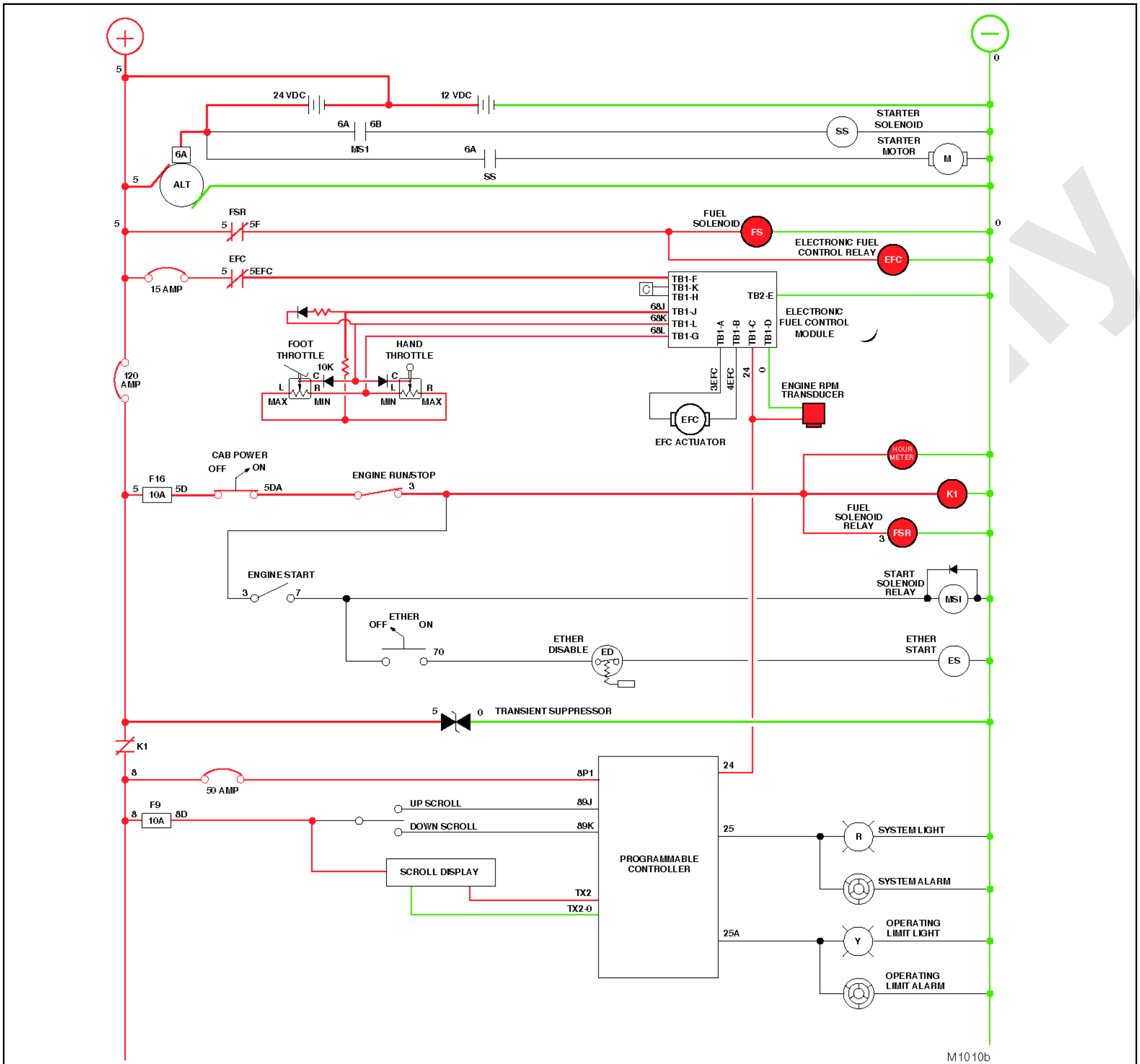


FIGURE 1-13 continued

When detecting a difference in the two signals, module changes the current input to EFC actuator, causing the actuator shaft to rotate in the appropriate direction to either increase or decrease the fuel flow and engine speed and power.

In addition to communicating with EFC module, the transducer also provides an AC electronic signal to the PC. The PC interrupts the incoming signal and provides engine speed data for the scroll display. The PC will also limit travel speed by maintaining maximum travel motor hydraulic displacement when track movement is initiated below 1800 engine rpms and will resume the lower travel speed when engine speed falls below 1500 rpm.

Activating engine start switch also provides power to ether starting aid switch. In order to prime the ether injection mechanism for assisting with crane startup, engine start switch and ether switch must be depressed and held at the same time to complete the circuit to ether start switch ES and ether disable switch ED. Releasing ether switch after approximately three seconds of priming, discharges the ether into the engine air inlet manifold and disables the injection mechanism.

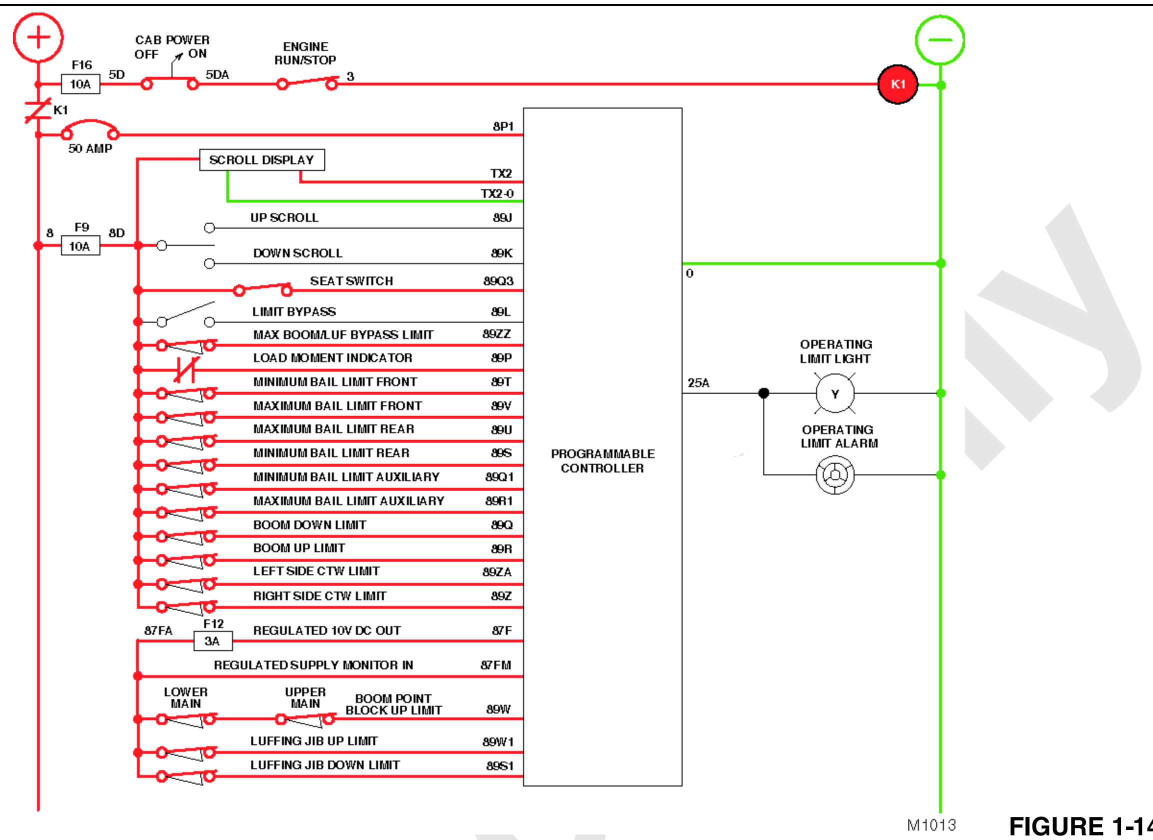


FIGURE 1-14

Limit Switch

See Figure 1-14 for following procedures.

When KI is energized and contact KI is closed, voltage is available to operating limit switches, seat switch, and limit bypass switch.

The seat switch is located under the operator's seat. This switch is closed and all control handle functions become operable when pressure is exerted downward on the seat by the operator's body weight. When the seat switch is opened, all control handles are inoperable and at the time of attempted handle actuation, the display will display an operating limit fault message: FUNCTION IS PARKED.

During normal operation, all limit switches are closed, completing circuits to the PC. The PC will complete circuits to the pump EDCs and drum park brake solenoid valves to allow the pumps to be operated and the park brakes to be released.

If a limit switch is opened, the PC will open the appropriate circuit to the pump EDC and the brake solenoid. The pump then strokes to off and the solenoid valve closes, causing the brake to apply. Any function can be operated in the opposite direction to correct the problem.

The limits are actuated and the PC responds as follows:

- BOOM UP LIMIT automatically stops the boom when it is raised to a preset maximum angle (82° inline top, 83° Offset top, 88° Luffing Jib).
- BOOM DOWN LIMIT automatically stops the boom when it is lowered to a preset minimum angle (usually 0°).
- BLOCK-UP LIMIT automatically stops the boom or hoist from lowering and the load drums from hoisting if the load contacts a block-up limit switch.
- LUFFING JIB UP LIMIT automatically stops the luffing jib when the boom-to-luffing angle is 168°.
- LUFFING JIB DOWN LIMIT automatically stops the luffing jib when the boom-to-luffing jib angle is 60°.
- MAXIMUM BAIL LIMIT automatically stops the corresponding load drum from hoisting when there is a preset maximum number of wire rope layers on a drum.
- MINIMUM BAIL LIMIT automatically stops the corresponding load drum when there are three wraps of wire rope remaining on the drum.
- SEAT SWITCH prevents the crane from being operated by rendering all control handles inoperable, maintaining application of all park brakes, and turning off free fall and travel detent systems.

NOTE: If a control handle is moved when the operator is out of seat, the FUNCTION IS PARKED fault message is displayed.

- RATED CAPACITY INDICATOR/LIMITER This function depending upon installation, may or may not automatically stop a lifting function if load picked is beyond the limits of the crane's capacity. See operator's manual of crane being used for description of function.
- LEFT/RIGHT COUNTERWEIGHT LIMITS automatically stops lifting the counterweights when installing them onto the crane. The crane also automatically stops when booming down with the hold down pendants installed.

The operating limit alerts activates when one of the limit switches is opened. The digital display identifies the operating limit by displaying it on scroll display and actuates an intermittent blinking yellow light and beeper in the cab when any operating limit listed in Digital Display Readings in Section 10 of this manual, can be reached. The limit is shown in the operating limit section of the digital display if display scroll switch is used to scroll the display up or down to the operating limits display function. After the cause for the limit is corrected, the alert turns off.

Limit bypass switch allows the crane functions to be operated beyond the limits for maintenance purposes only. For example, excess wire rope can be spooled onto the load drum or removed from the load drums after an operating limit has been activated with use of the limit bypass switch.

When depressing the limit bypass switch and scroll up switch at the same time, diagnostic information is displayed on the display screen in addition to the normal operating screens. The diagnostic information provided gives the status of many of the crane components, and PC inputs and outputs during normal operation.

Pressure Monitoring Senders

See Figure 1-15 for following procedures.

When KI is energized and contact KI is closed, voltage is available to the crane hydraulic pressure monitoring senders. In addition to providing hydraulic system pressure information for the scroll display, the PC also uses this information to control the operation of the crane, such as pressure memory to hold and control the load, and observation of the track system ensuring both crawlers rotate in unison for straightness in direction of travel.

During normal operation of the hydraulic pressure sender, system voltage or 12 volts nominal is available to the pressure senders when KI relay energizes. The voltage supply passes through the voltage regulator and is reduced to a regulated 8 volts before entering the instrumentation amplifier and strain gauge/resistor bridge.

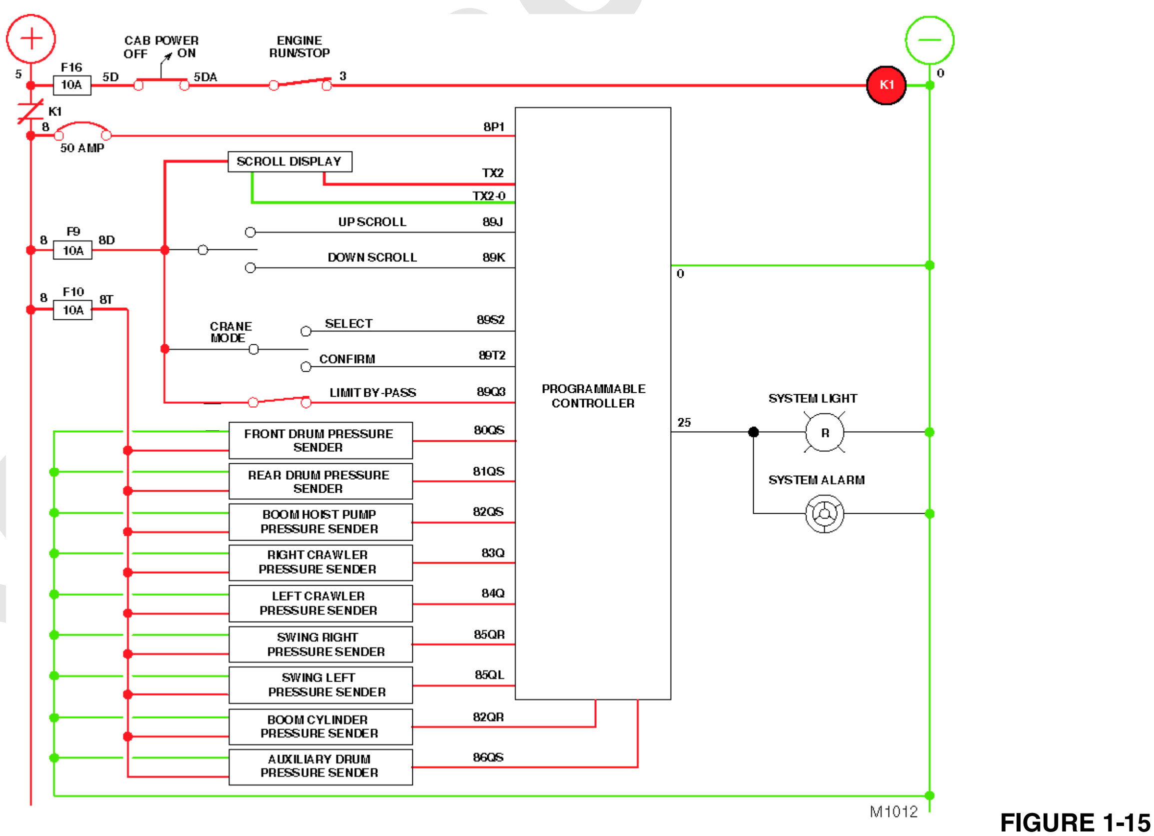


FIGURE 1-15

At 0 psi (this situation can only occur when the engine is off and power is on) approximately 8 volts regulated enters the strain gage and resistor bridge. At this time resistance values measured across the resistors and strain gauges are of equal value; likewise, the two lines entering the instrumentation amplifier from the bridge are equal in value causing the output signal from the instrumentation amplifier to the PC to be approximately 1 volt.

When the pressure sender is exposed to system pressure, a pressure greater than 0 psi, the strain gages (located on the flathead sensor) will stretch and increase in resistance. A milivoltage voltage differential then occurs in the two lines going to the instrumentation amplifier from the strain gage/ resistor bridge. The differential voltage is amplified causing the output voltage from the instrumentation amplifier to be greater than one volt. The output voltage signal to the PC is proportional to the increase in pressure. At full pressure the voltage signal is 5 volts. This situation is true of any pressure transducer used.

Crane Select and Confirm Switch

The operator uses the crane selector mode switch to select and confirm the crane operation mode at startup. Modes that can be selected and confirmed are: standard, clamshell, dragline, and luffing.

Calibrate the hydraulic pressure senders by establishing a 0 reference for pressure before engine startup. This process will occur when the crane Select/Confirm switch is held in the confirm position prior to placing the Run/Stop switch into the run position while continuing to hold the Confirm/Select switch in the confirm position for 60 seconds. The calibration of each hydraulic pressure sender will remain in the PC's memory until the next calibration. The pressure senders should be calibrated when the displayed pressure changes from normal operating range or possibly at six months maintenance intervals.

Holding the Select/Confirm switch in the Select position while actuating the Limit Bypass switch at the same time allows the operator to select the desired display language: English or applicable foreign language.

Engine and Fluid Monitoring

See Figure 1-16 for following procedures.

The crane has a engine oil pressure switch, engine coolant temperature switch, hydraulic fluid level switch, and hydraulic fluid temperature switch. These switches provide a system fault alert or warning to the operator by displaying the system fault on scroll display, and actuate an intermittent blinking red light and beeper when the switch of the affected system opens or closes and is detected by the PC. All system fault alerts that may occur while operating the crane are listed in Table 10-3 of the Digital Display Readings in Section 10 of this manual. The faults can be accessed by the operator in the system fault section of the digital. After the cause for the fault is corrected, the alert turns off.

The PC also makes regulated voltage available to boom and luffing jib angle indicators. The angle indicators are inclinometers that provide the PC with a logarithmic voltage, which is proportional to the position of the boom or jib. The PC interprets the information and displays it in degrees on the scroll display.

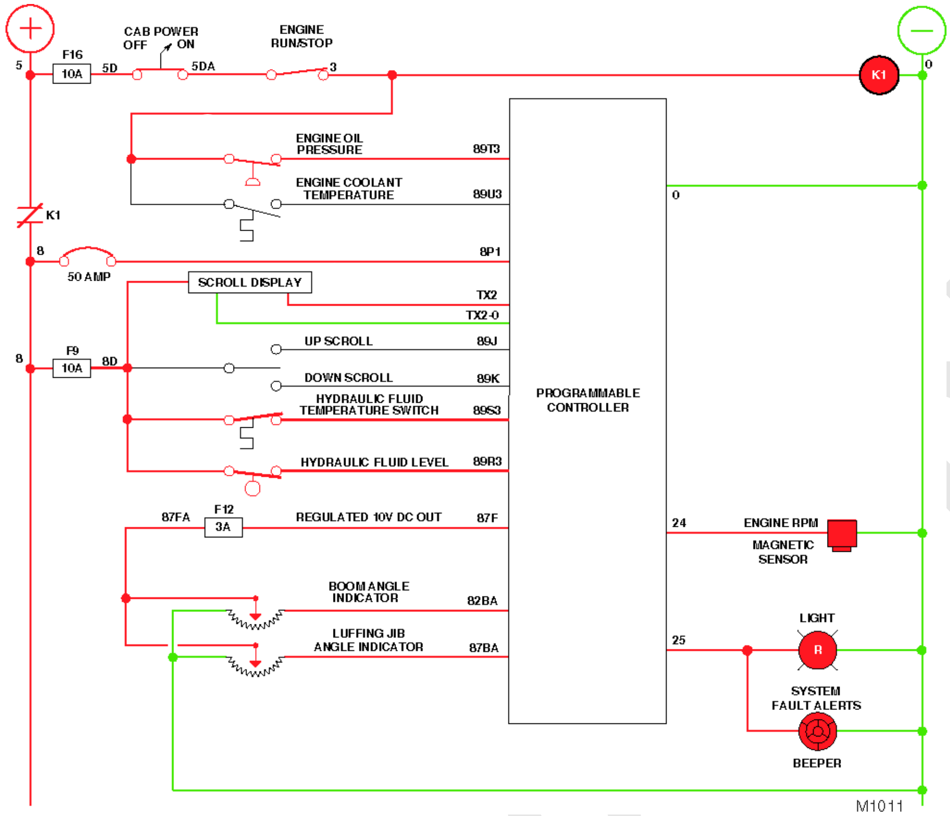


FIGURE 1-16

Brake Release System

The load drum, travel, swing, and auxiliary hoist disc brakes are hydraulically released. The load drums also have a hydraulically released band-type brake.

Hydraulically Released

The PC automatically controls release of the load drum, travel, and auxiliary hoist brakes once the selected system's park switch is placed in the off position and its control handle is moved from off. The release of the swing brake is controlled independently when the operator places the swing brake switch in the off position.

When the rear load drum, travel, or swing, brake hydraulic solenoid is energized, the applicable valve shifts to block the tank port and to supply charge pressure from the rear drum charge pump to the appropriate brake. The brake then releases. The front load drum brake or auxiliary hoist is released by pressure from their own system charge pump.

When a brake solenoid is de-energized, the valve closes to block the pump port and to vent pressure in the brake to tank. The brake then spring-applies.

If brake pressure or electric current is lost for any reason during operation, the brakes will spring-apply to stop the function.

Working Brakes (with free fall)

See Figure 1-17 for following procedures.

When in free fall, the operator can control the lowering of a load by applying a linear force to the working brake pedal (4) to control pressure to the working brake (band brake cylinder) of the selected drum. The working brake pedal can be described as a reverse modulating valve operating between the system pressure of 2500 psi (no foot pressure applied and in unlatched position) to 50 psi (maximum applied foot pressure or in latched position).

The brake pressure is in direct proportion to brake pedal movement. When applying manual force, with the foot to the working brake pedal, a proportional amount of hydraulic pressure is released from the band brake cylinder through the working brake valve to tank, causing the release springs of the cylinder to expand and apply brake band pressure against the drum. When pedal is fully applied or latched full brake application is obtained. Conversely, by releasing manual force to the brake pedal, a proportional amount of hydraulic pressure is applied to the brake band cylinder causing the release springs to compress and remove brake band pressure to the drum. When pedal is fully released, the release spring is fully compressed, allowing the band brake to be fully released.

The working brake section of the auxiliary systems pump provides an adequate hydraulic fluid supply at a maximum system pressure of 2,500 psi for band brake actuation. The system flow pressure is controlled by relief valve preset to 2,500 psi (175 bar) and is regulated in pressure operating range of 50 to 2,500 psi as it passes through the reverse modulating valve. The flow passes through system solenoid control valves which are held open when in free fall mode and open and close by the drum control handle when in standard operating mode. The pressurized fluid supply enters the band brake cylinder causing the cylinder piston to rise or retract in proportion to applied spring force and system regulated pressure.

Pressure switch provides information to the PC concerning the position of the working brake when entering free fall mode. If the PC is able to detect system pressure (working brake is unlatched), the PC will not release the clutch and permit free fall. The working brake pedal must be latched (pressure switch is unable to detect pressure) when entering free fall.

Load Drum Clutch Release System (with free fall)

The clutch assemblies of the front and rear load drums are hydraulic actuated. Each assembly is spring-applied-hydraulic released. The PC automatically controls the clutches in conjunction with movement of the selected load drum control handle when hoisting a load in free fall.

When in free fall mode with the control handle in the neutral position, the PC closes the circuit to HS20 and the oil flows to drum clutch. The clutch application spring is compressed so the clutch disconnects the drum from the motor drive assembly.

When the control handle is moved into the hoisting position while in the free fall mode, the PC opens the circuit to rear/luffing drum or front drum clutch valve solenoid HS20. Manifold pressure is blocked from entering the valve and oil is exhausted from the cylinder as the clutch spring applies.

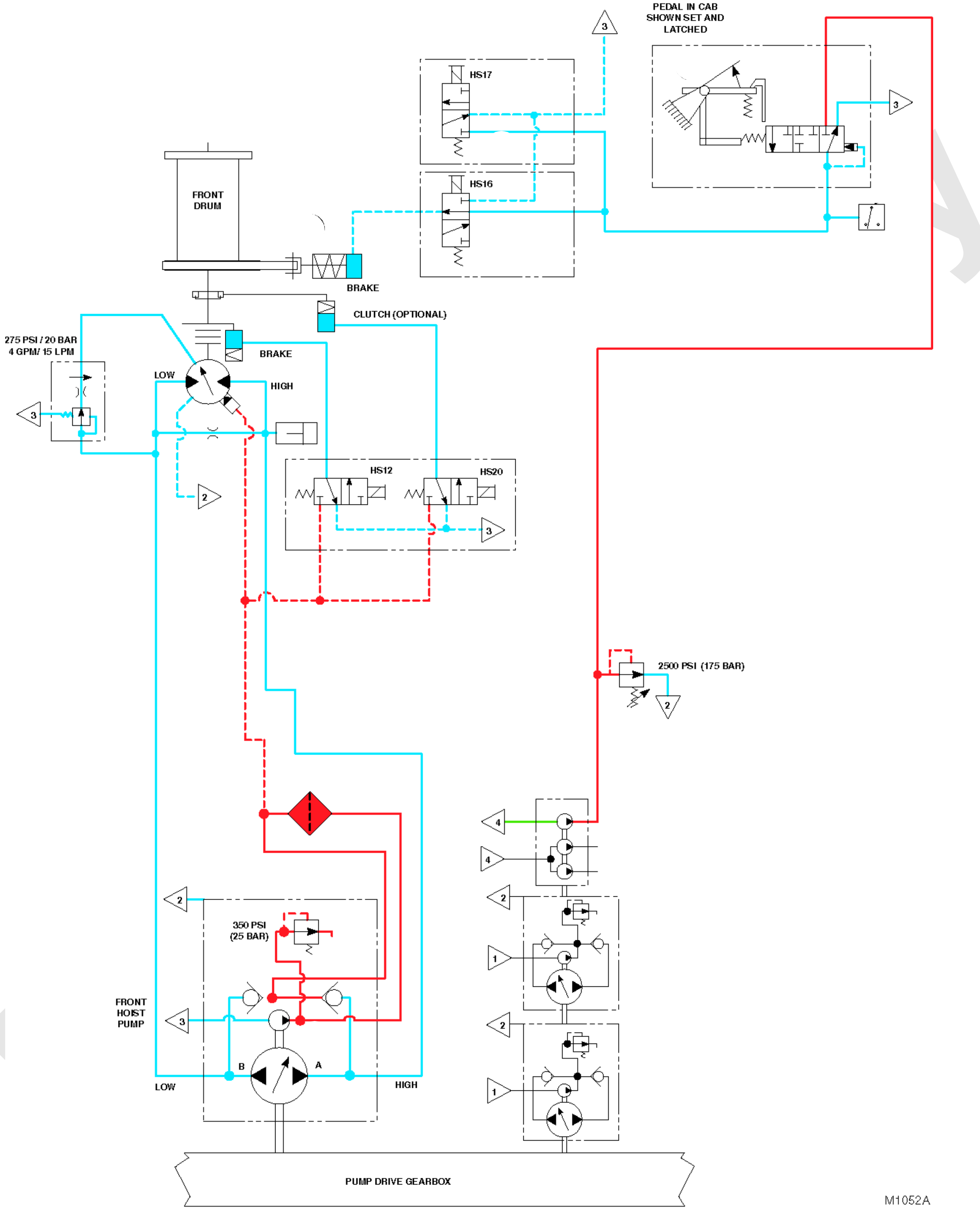

PEDAL IN CAB
SHOWN SET AND
LATCHED
HS17
HS16
FRONT
DRUM
BRAKE
CLUTCH (OPTIONAL)
275 PSI / 20 BAR
4 GPM/ 15 LPM
BRAKE
LOW
HIGH
HS12
HS20
2500 PSI (175 BAR)
350 PSI
(25 BAR)
FRONT
HOIST
PUMP
B
A
LOW
HIGH
PUMP DRIVE GEARBOX
M1052A

FIGURE 1-17

BOOM SYSTEM

See Figures 1-18 and 1-19 for following procedures.

If boom pump charge pressure is lost for any reason, boom load holding solenoid valves HS18 and HS19 shift to block boom cylinder movement. The boom load holding valves prevent cylinder movement when not operating or when the cab power switch is off.

When the cab power switch is placed in the on position, the PC sends a digital signal to boom load holding solenoid valve HS19. The solenoid valve shifts to block the tank ports and supplies pilot pressure from the charge pump to the boom load holding valves at the piston end of the boom cylinders. The pilot pressure shifts the boom load holding valves and opens a path for oil flow to/from the piston end of the boom cylinders. This path of oil flow from the piston end of the boom cylinders is open when the cab power switch is in the on position and the cylinder pressure monitored at the pressure sender is greater than 600 psi (42 bar). If the cylinder pressure is less than 600 psi (42 bar), the boom holding valve opens only with a retract command.

If the pressure monitored at the boom cylinder pressure sender drops below 600 psi (42 bar) and the boom control handle is in neutral, the PC shifts the boom load holding solenoid valve HS19 to move the boom load holding valve to block boom cylinder movement.

If the boom is raised to the maximum boom stop position (83° above horizontal while in Standard mode), the boom up limit switch opens the circuit to the PC. Boom cylinder pump then strokes to off. The boom load holding valves hold the boom in position.

The boom cylinders are held in position with boom load holding valves at each cylinder port. Each boom load holding valve assembly contains a two position boom load holding valve and two counterbalance valves. Each counterbalance valve consist of a check valve section to permit free flow into cylinder and a pilot operated relief valve section that limits the pressures inside the cylinder to the preset value(s). The pilot operated relief valves relieve the rod side of the cylinder at 5,000 psi (350 bar) and the piston side at 3,000 psi (210 bar). These valves are located on a manifold at the base of each boom cylinder.

Boom cylinder pump does not stroke in response to boom handle movement when the boom hoist park switch is on.

It is possible for the boom cylinder to drift over time because of temperature changes. If cylinder drift occurs, the PC can send an analog signal to stroke the boom pump to maintain the boom cylinder position. The boom cylinder pump can only stroke if the boom cylinder hold switch is in the on position. The boom control handle must remain in neutral position.

Twenty percent more oil is required from the boom pump to extend the boom cylinders (lowering the boom) than there is oil returning back to the boom pump. Also, there is 20 percent more oil returning to the boom pump inlet from the cylinder than is pumped to the cylinder when retracting the cylinders (raising the boom).

The boom hydraulic circuit provides supplemental oil when lowering the boom and removes excess oil from the circuit when raising the boom. The accessory pump supplies oil for boom circuit oil replenishment. When the lower accessory valve is not being used, a pilot signal from the lower accessory valve opens a pilot operated check valve, permitting oil flow from the accessory pump to the hot oil shuttle valve. The supply of supplemental oil enters the closed-loop circuit through shuttle valve and check valve when lowering the boom. The excess oil returns to tank from the boom cylinder over relief valve when raising or lowering the boom. The relief valve maintains the closed-loop circuit pressure at 350 psi (25 bar).

Boom cylinder disable pump solenoid HS24 de-strokes the boom pump to prevent the boom from moving up or down without boom handle movement. Two boom cylinder pin speed senders at the base of boom, monitor boom up or down movement. If the boom cylinder pin speed senders detect an up or down movement and the boom control handle is in neutral, the PC removes power from the boom cylinder pump disable solenoid HS24 to allow oil in the boom pump servo valves to equalize, de-stroking the pump. BOOM HOIST MOTION fault message is shown on the digital display. To clear the fault, the operator must shut down the crane, and restart.

When the boom is either raising or lowering, the rotational signal from the right boom cylinder speed sender is compared with the rotational signal from the left boom cylinder speed sender. If the PC determines the boom cylinders are not extending or retracting together, the display screen CYLINDER ALIGNMENT message is displayed. The system red fault light flashes and the fault alert beeper sounds. The cause should be determined and corrected.

Boom Hoist Rotation Indicator

Whenever the boom raises or lowers, the left boom cylinder speed sender signal is translated by the PC into a pulse signal to drive the rotation thumper in the boom control handle. This pulse signal enables the rotation thumper pulsation pin to move in a reciprocating motion that indicates to the operator the boom raising or lowering speed.

Counterweight Handling

When the Setup mode is selected and confirmed, the counterweight Remote control is enabled. The Remote control is the master controller and overrides the boom control handle command, if both controllers are operated at the same time. Boom operates at a reduced speed when in the Setup mode.

Boom Off

When the boom control handle is in the off or neutral position, all commands from the boom control handle to the

PC are blocked by the neutral switch on the control handle. Unless the Boom Cylinder Hold switch is on, the boom pump does not stroke and the boom load holding valves maintain the position of the boom cylinders.

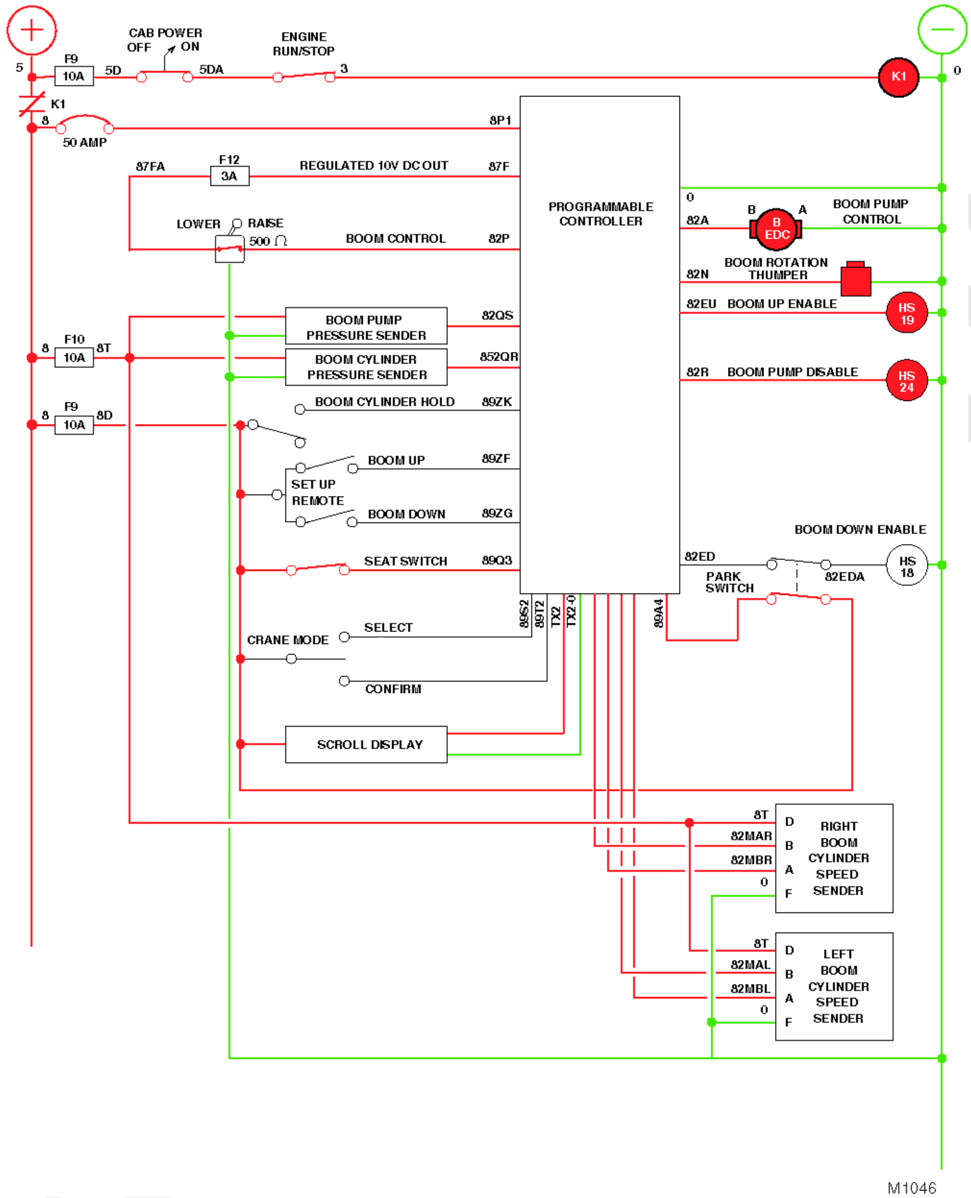


FIGURE 1-18

Manitowoc Crane Care

Boom Raise

See Figures 1-18 and 1-19 for following procedures.

When the boom control handle is off or in neutral, the PC monitors the boom cylinder pressure sender for the pressure required to support the boom. This supporting pressure is the pressure memory.

The boom control handle neutral switch closes when the handle is moved back for up operation. An analog input of 5 volts or greater is sent to the PC and processed. The PC sends a regulated voltage to the boom pump EDC. The boom pump swashplate tilts to stroke the boom pump in the up direction. When the hydraulic pressure in the system equals the pressure memory of the boom cylinders, the PC allows boom control handle operation. The boom pump circuit operates only if the boom park switch is in the off position, the boom up limit switch is closed, and there are no shut down operating faults present.

Boom pump pressure sender supplies the PC with pressure information that the PC compares to the load holding pressure, monitored by the boom cylinder pressure sender. High pressure oil flows through each check valve of each counterbalance valve and enters the rod end of each cylinder. The oil in the piston end of the cylinders exhaust to the boom pump inlet and also through hot oil shuttle valve to pressure relief valve.

The PC controls the boom raising speed by varying the voltage to the boom pump EDC in proportion with control handle movement. The pump swashplate tilt angle is increased as the control handle is moved back, pumping more oil in the rod end of the boom cylinders and raising the boom faster. As the boom control handle is returned to the off or neutral position, the PC decreases the boom pump swashplate tilt angle. This change in swashplate tilt angle reduces pump output oil flow and slows boom movement.

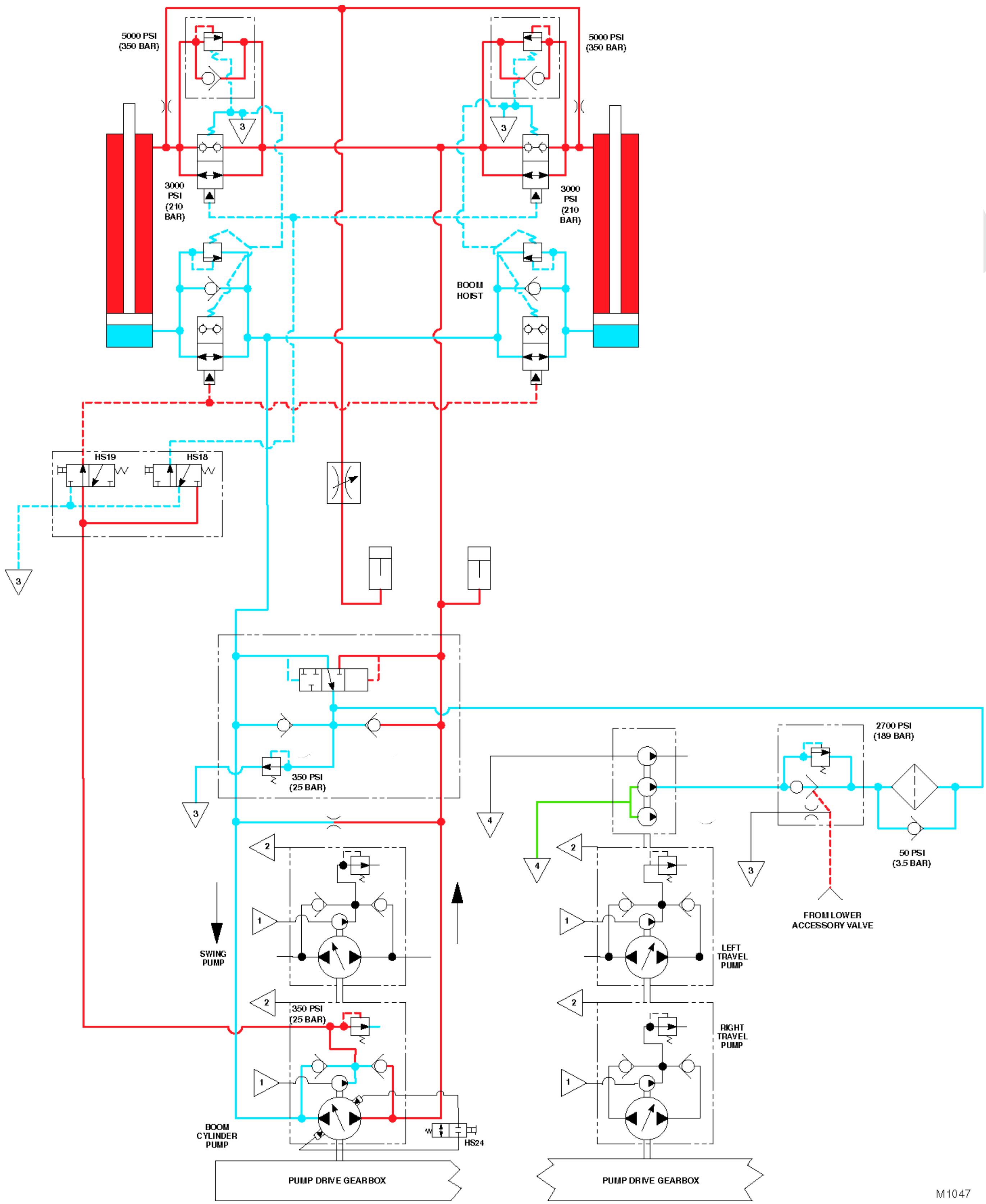

5000 PSI
(350 BAR)
5000 PSI
(350 BAR)
3000
PSI
(210
BAR)
3000
PSI
(210
BAR)
BOOM
HOIST
HS19
HS18
350 PSI
(25 BAR)
2700 PSI
(189 BAR)
50 PSI
(3.5 BAR)
FROM LOWER
ACCESSORY VALVE
SWING
PUMP
LEFT
TRAVEL
PUMP
350 PSI
(25 BAR)
RIGHT
TRAVEL
PUMP
BOOM
CYLINDER
PUMP
HS24
PUMP DRIVE GEARBOX
PUMP DRIVE GEARBOX
M1047

FIGURE 1-19

Boom Lower

See Figures 1-20 and 1-21 for following procedures.

When the boom control handle is off or in neutral, the PC monitors the boom cylinder pressure sender for pressure level required to support the boom. This pressure level is the pressure memory.

The boom control handle neutral switch closes when the handle is moved forward for down operation. An analog input of 5 volts or less is sent to the PC and processed. The PC sends a regulated voltage to the boom pump EDC. The boom pump swashplate tilts to stroke the pump in the down direction. When the hydraulic pressure in the system equals the pressure memory of the boom cylinders, the PC allows boom control handle operation. The pump circuit operates only if the boom park switch is in the OFF position, the boom down limit switch is closed, and there are no shut down operating faults present.

Boom pump pressure sender supplies the PC with pressure information that the PC compares to the load holding pressure, monitored by the boom cylinder pressure sender. When the monitored pressure is enough to hold the load, the PC closes the circuit to the boom load holding solenoid valve HS18. The valve shifts to block the tank ports and supply pilot pressure from the boom charge pump to the load holding valve at the rod end of each boom cylinder. The pilot pressure shifts the two position boom load holding valve and allows oil to exit the rod end of the cylinders. The oil in the rod end of the cylinders exhaust to the boom pump inlet and also through hot oil shuttle valve to pressure relief valve.

The weight of the boom attempts to extend the boom cylinders when lowering. The PC controls the boom lowering speed by varying the voltage to the boom pump EDC in proportion with control handle movement. The pump swashplate tilt angle is increased as the control handle is moved forward, pumping more oil in the piston end of the boom cylinders and lowering the boom faster. As the boom control handle is returned to the off or neutral position, the PC decreases the boom pump swashplate tilt angle. This change in swashplate tilt angle reduces pump output oil flow and slows boom movement. Replenishing oil is supplied to the circuit by the accessory pump. When the boom control handle is off or in neutral, the PC monitors the boom cylinder pressure sender for information required to support the boom. The pressure level is the pressure memory.

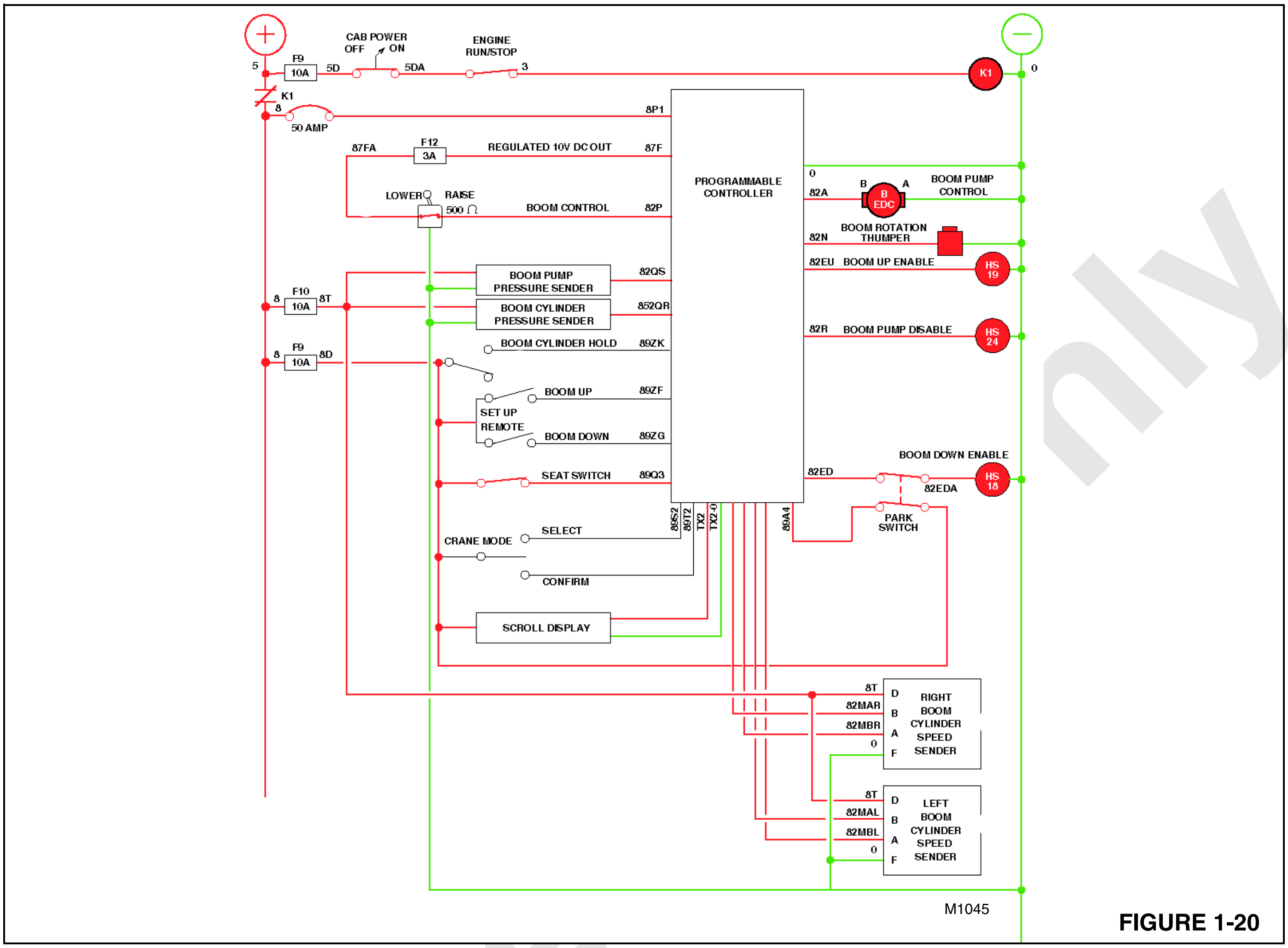

CAB POWER
OFF ON
ENGINE
RUN/STOP
F9
10A
5D
5DA
3
K1
0
K1
8
50 AMP
8P1
87FA
F12
3A
REGULATED 10V DC OUT
87F
PROGRAMMABLE
CONTROLLER
LOWER
RAISE
500 Ω
BOOM CONTROL
82P
82A
B
EDC
A
BOOM PUMP
CONTROL
BOOM ROTATION
THUMPER
82N
82EU BOOM UP ENABLE
HS
19
BOOM PUMP
PRESSURE SENDER
82QS
F10
10A
8T
BOOM CYLINDER
PRESSURE SENDER
852QR
82R BOOM PUMP DISABLE
HS
24
BOOM CYLINDER HOLD
89ZK
8D
BOOM UP
89ZF
SET UP
REMOTE
BOOM DOWN
89ZG
BOOM DOWN ENABLE
SEAT SWITCH
89Q3
82ED
82EDA
HS
18
89S2
89T2
TX2
TX2-0
89A4
PARK
SWITCH
CRANE MODE
SELECT
CONFIRM
SCROLL DISPLAY
8T
82MAR
82MBR
D
B
A
F
RIGHT
BOOM
CYLINDER
SPEED
SENDER
82MAL
82MBL
LEFT
BOOM
CYLINDER
SPEED
SENDER
M1045

FIGURE 1-20

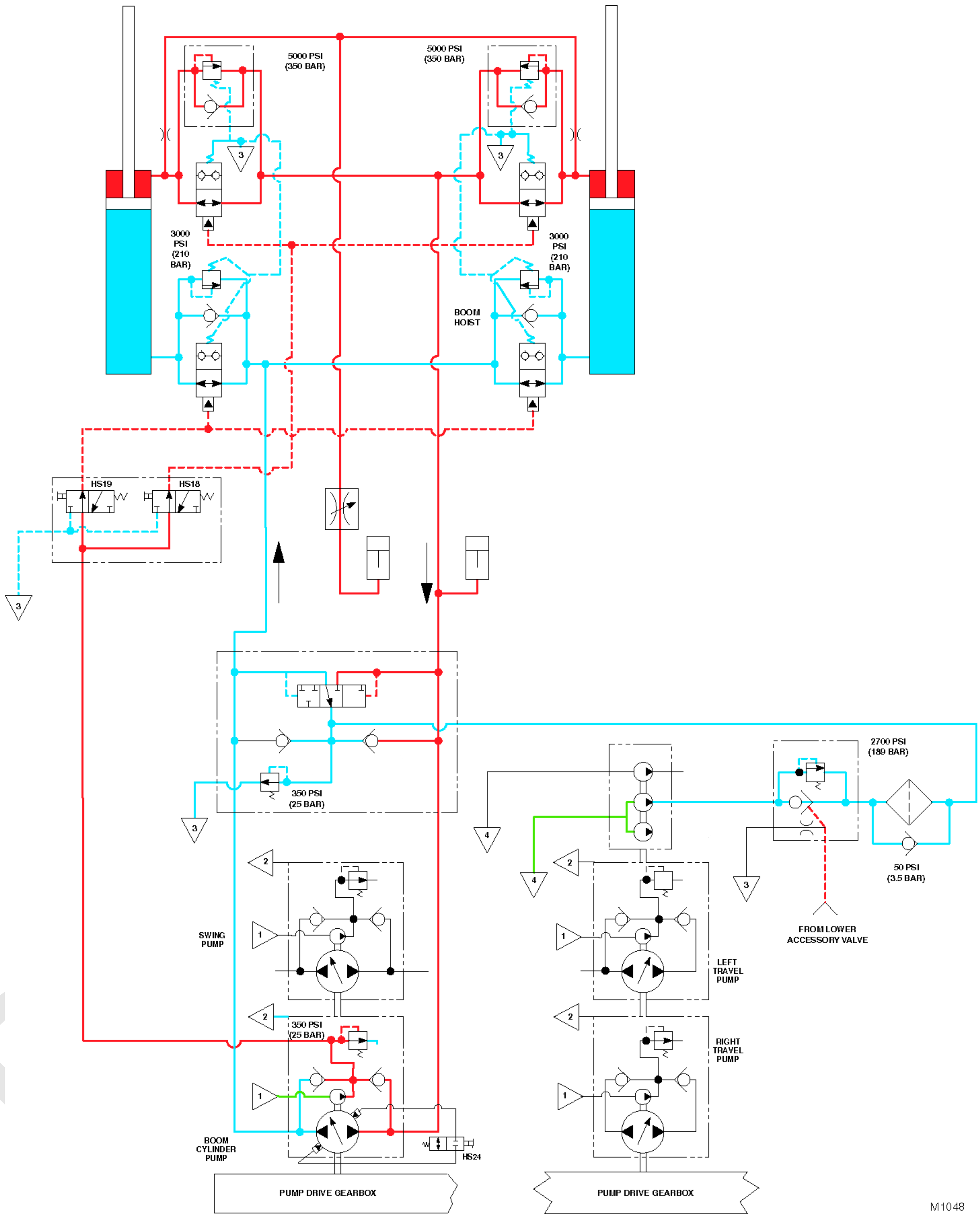

5000 PSI
(350 BAR)
5000 PSI
(350 BAR)
3
3
3000
PSI
(210
BAR)
3000
PSI
(210
BAR)
BOOM
HOIST
HS19
HS18
3
350 PSI
(25 BAR)
3
2700 PSI
(189 BAR)
4
4
2
3
50 PSI
(3.5 BAR)
FROM LOWER
ACCESSORY VALVE
2
1
SWING
PUMP
1
LEFT
TRAVEL
PUMP
2
350 PSI
(25 BAR)
2
RIGHT
TRAVEL
PUMP
1
1
BOOM
CYLINDER
PUMP
HS24
PUMP DRIVE GEARBOX
PUMP DRIVE GEARBOX
M1048

FIGURE 1-21

SWING SYSTEM

See Figures 1-22 and 1-23 for following procedures.

In order for normal swing operation to occur, the rear load drum charge pressure must be about 232 psi (16 bar). If the charge pressure drops below this amount, the hydraulic brake will begin to partially or fully apply.

After startup, swing park switch, located on the right console in the operator's cab, is placed in the off position, closing the circuit to swing park brake hydraulic solenoid HS7. Swing brake control valve is shifted against its spring, opening a path for oil supply from the rear load drum charge pump to flow through to swing park brake. The pressure compresses the brake spring to release the brake.

When swing park switch is placed in the on position, the circuit to swing brake hydraulic solenoid HS7 is opened. Spring force shifts swing brake valve, closes the path of oil supply from the rear load drum charge pump and the pressure in swing park brake is vented to tank so the brake spring-applies.

Swing holding brake switch, located on the side of swing control handle, provides the operator with a means of preventing swing movement. Depressing switch opens a circuit to the PC. The PC then opens this circuit to the swing pump EDC, which places swing pump in neutral and applies the brake by closing the circuit to swing park brake hydraulic solenoid HS7.

To prevent damage to the swing system components, swing holding brake switch should only be applied when the machine is in a stand-still position. When in a swinging motion, the preferred method of stopping or slowing the crane is to move swing control handle beyond center in the opposite direction of movement. This action causes a hydrodynamic slowing of the rotating bed.

Swing Lock

See Figures 1-22 and 1-24 for following procedures.

The swing lock mechanism is located between the swing motor and swing brake on the swing motor planetary.

When the swing lock switch, located on the right console in the operator's cab, is placed in the disengaged position, the circuit to swing lock disengage hydraulic solenoid HS15 closes, and the circuit to swing lock engage hydraulic solenoid HS14 opens. Swing lock valve shifts, opening a path for oil supply from the rear load drum charge pump to extend side of the swing lock mechanism piston while oil from the retract side of the swing lock piston exhaust to tank through swing lock valve.

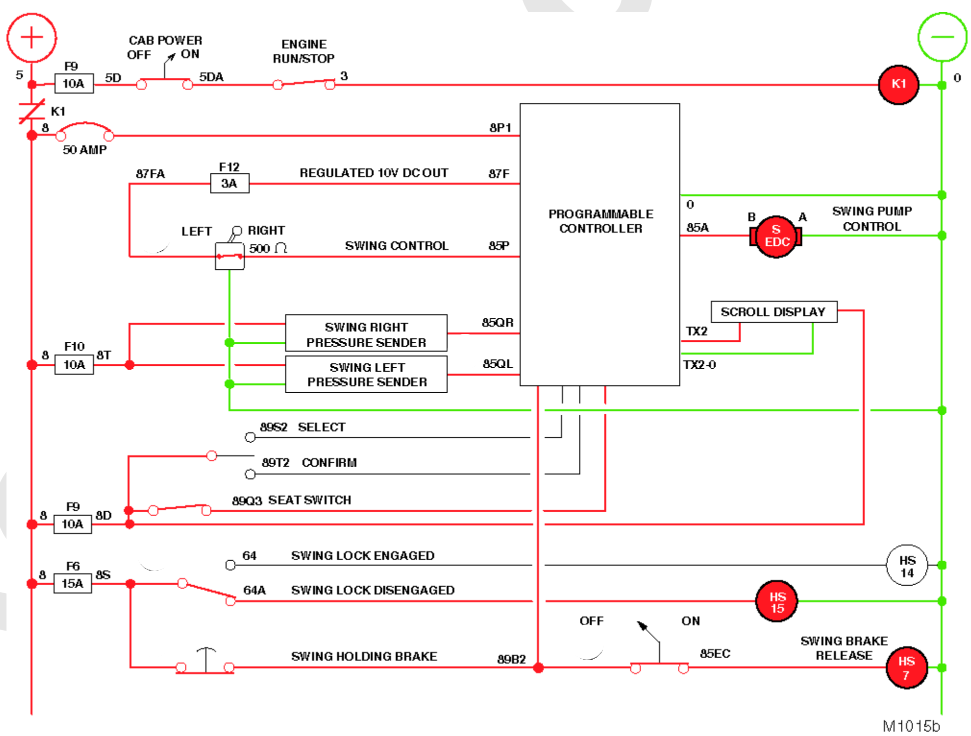


FIGURE 1-22

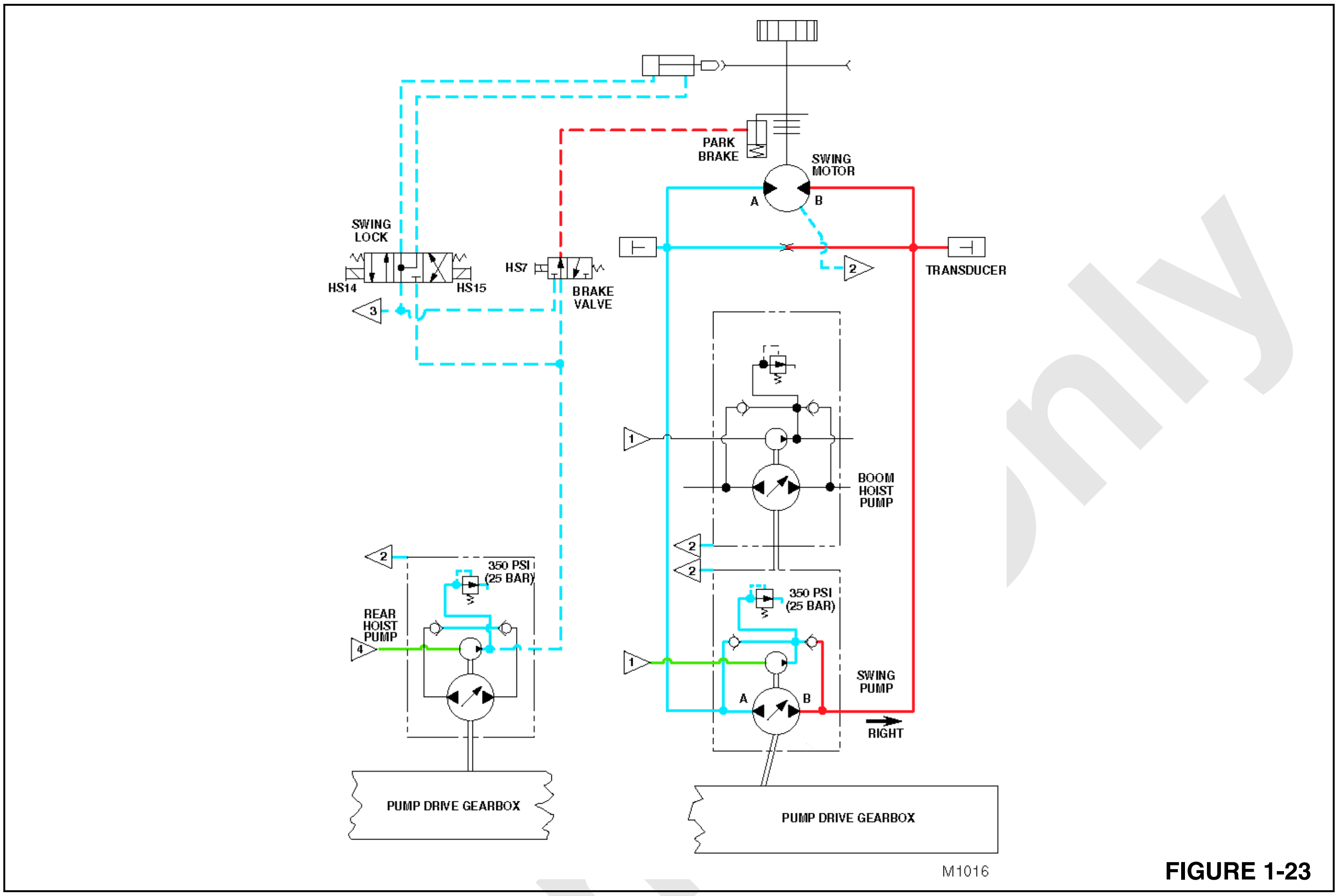


FIGURE 1-23

The piston extends to detent location for the extend position, disengages locking pins from slots concentrically located on the shaft locking flange, permitting the crane to swing in either direction after the parking brake is released. The opposite function occurs when the swing lock switch is placed in the engage position.

Off

See Figures 1-22 and 1-23 for following procedures.

When swing control handle is in the off position, the PC opens a circuit to the swing pump EDC and swing pump does not stroke. The rotating bed is free to coast if the swing brake is released and the swing lock is disengaged.

During free coast, the PC maintains balanced pressure between swing motor ports A and B to eliminate swing movement even though the handle is not commanding displacement.

Swing

See Figures 1-22 and 1-23 for following procedures.

NOTE: The schematics show electric current flow to the swing EDC and hydraulic oil flow to the motor for swing right operation. The flows are opposite for swing left operation.

When swing control handle is moved in either direction from off, the handle neutral switch closes and a controlled regulated variable voltage for an appropriate command is sent to the PC. The PC provides corresponding voltage direction and gain to the swing pump EDC. The PC tilts the pump swashplate an amount that generates an oil displacement output relative to handle movement.

When swing right is commanded, swing pump is stroked in the appropriate direction so oil flows from pump port A to port A of the swing motor, rotating the rotating bed in the corresponding direction and desired speed.

The orifice across swing motor ports A and B, the low and high sides of the hydraulic circuit, enables smoother oil flow shifting when swinging from one direction to the other.

Pressure senders inform the PC of the pressure data concerning both sides of the closed loop hydraulic circuit. The PC uses this information to provide a free coasting effect when swing control handle is returned to neutral and helps provide a boom centering effect when picking loads to help prevent side loading of the boom.

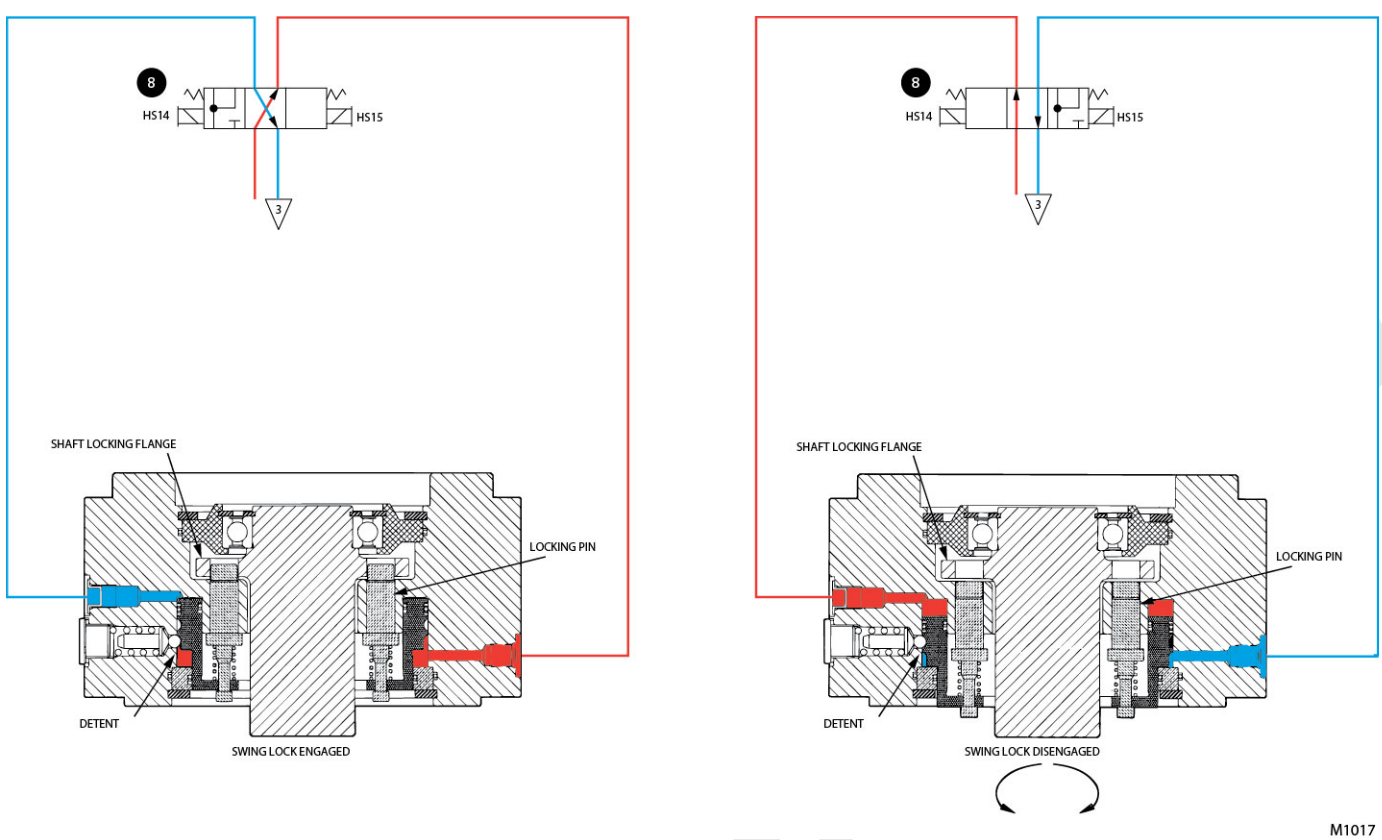

8
HS14
HS15
3
SHAFT LOCKING FLANGE
LOCKING PIN
DETENT
SWING LOCK ENGAGED
8
HS14
HS15
3
SHAFT LOCKING FLANGE
LOCKING PIN
DETENT
SWING LOCK DISENGAGED
M1017

FIGURE 1-24

TRAVEL SYSTEM

See Figures 1-25 and 1-26 for following procedures.

When travel park brake switch, located on the front console in the operator's cab, is placed in the on position, the control opens the travel command input circuit to the PC and does not energize travel brake hydraulic solenoid HS1. Travel park brakes remain applied and travel pumps do not stroke in response to commands from right and left crawler control handles.

When travel park brake switch is placed in the off position, the travel command input voltage circuit to the PC is completed. After receiving the voltage signal, the PC prepares the crane's travel system for activation.

Off

When crawler control handles are in the off position, the PC circuits are open to the right and left travel pump EDCs and travel brake hydraulic solenoid HS1. Travel pumps do not stroke and travel park brakes remain spring-applied to hold the crane in position.

Left Crawler Forward

NOTE: Electric current to the EDCs and the hydraulic oil flow to the motor are opposite for reverse travel.

When left crawler control handle is moved in the forward direction, the PC closes a regulated reverse polarities voltage (0 to 2.7 volts) circuit to the left travel pump EDC and completes a circuit to HS1 through travel park brake switch. Travel park brake valve shifts to release travel park brakes with charge pressure from rear hoist pump before left travel pump strokes.

The EDC tilts the swashplate of left travel pump in the forward direction, and the pump strokes on. Oil flows from port A of pump through the swivel to port B of left travel motor. The PC controls voltage to the left travel pump EDC, governing travel speed in response to movement of left crawler control handle. If right crawler control handle is moved in the forward direction, oil flows from port B of right travel pump to port A of right travel motor.

The travel motors are variable displacement in configuration and shift internally via an adjustable spring in each of the motors' pressure compensator regulator (PCR) valves preset at 3,915 psi (270 bar). With the system pressure below the compensator setting and high speed travel switch open (high speed position), the travel motor is maintained in the minimum displacement position. When the system pressure exceeds the PCR setting, the pressure causes the servo mechanism to tilt the cylinder block, increasing motor displacement and output torque and decreasing the motor speed. When the crawler begins to move, the motor PCR valve shifts the motor into the maximum displacement position (low speed high torque) required for breakaway torque, then gradually returns to minimum displacement output when the crawler is moving with less effort.

The travel motor may be externally shifted into the maximum displacement position (low speed) during periods when precise controllability over the load is required. The motor shifts when high speed travel switch is closed (low speed position), completing an input circuit to the PC. The PC energizes travel speed hydraulic solenoid HS13 and 2-speed travel valve shifts, directing pressure from the rear hoist charge pump to externally shift the travel motor to maximum displacement and remain in this position until high speed travel switch is opened.

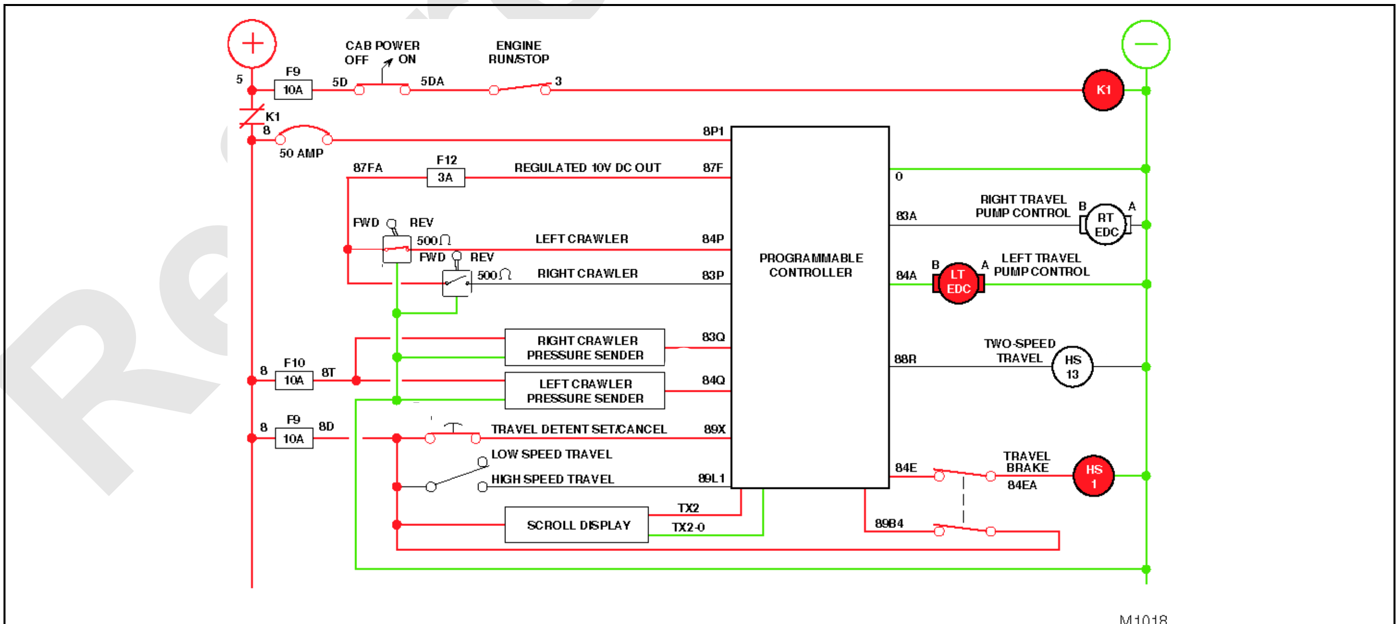


FIGURE 1-25

To ensure crane travel in a straight forward or reverse direction, both crawler hydraulic drive circuits in the travel system have pressure senders and shuttle valves. When traveling, the PC monitors signals from pressure senders and adjusts the displacement of the travel pumps to achieve and maintain equal pressure in each crawler drive circuit. This causes the crane to track in a straight and controlled condition.

Travel Detent Button

Travel detent button, located on right crawler control handle, allows any travel command to be locked in. This allows the crawlers to be operated in either direction at a selected speed without the operator's hand being on the crawler control handles. When travel detent button is lifted into the dome of the handle, the PC memorizes and locks in the travel command received from one or both crawler control handles. When the operator releases the handle(s) back to the off position, the PC maintains selected speed and direction of travel.

Lifting travel detent button again or moving either control handle in the opposite direction, opens the travel detent circuit and returns direct control of the travel system to the operator via actuation of the control handle(s).

This control also serves as a parking function. Lifting the travel detent button when the crawler control handles are in the off position, locks in the off condition (brakes applied) and ensures the crawler control handles are inoperable until the detent button is released.

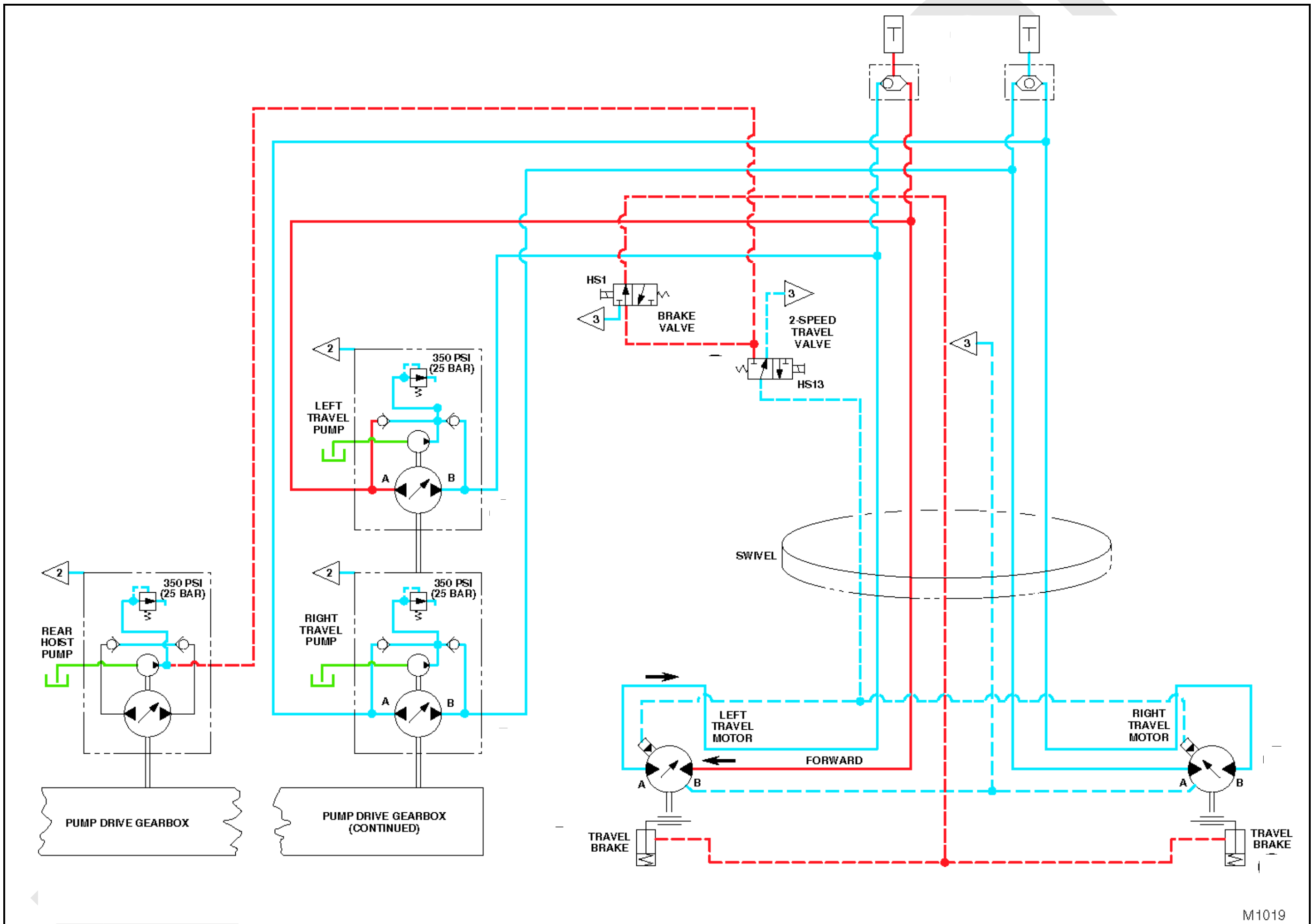


FIGURE 1-26

LOAD DRUM PAWL

See Figure 1-27 and 1-28 for following procedures.

The following description does not include auxiliary drum (boom mounted) pawl application. This material will be covered later with the description for the auxiliary drum.

The ratchet and pawl mechanisms provide a positive means of locking the front and rear load drums. Each pawl system operates independently and is controlled by a 2-position, double throw switch located on the front console.

The pawl should be used to maintain loadline positions, especially when the crane is in the park position or left unattended. Likewise, the front and rear drum pawls should be used for locking the corresponding drum in position when not in use. The pawl of a selected drum must be disengaged before drum can rotate, because the PC will not command down against the pawl.

Should a pawl switch be accidentally activated, the PC opens the circuit to the appropriate drum brakes. The load drum brakes then applies, both hydraulic and band.

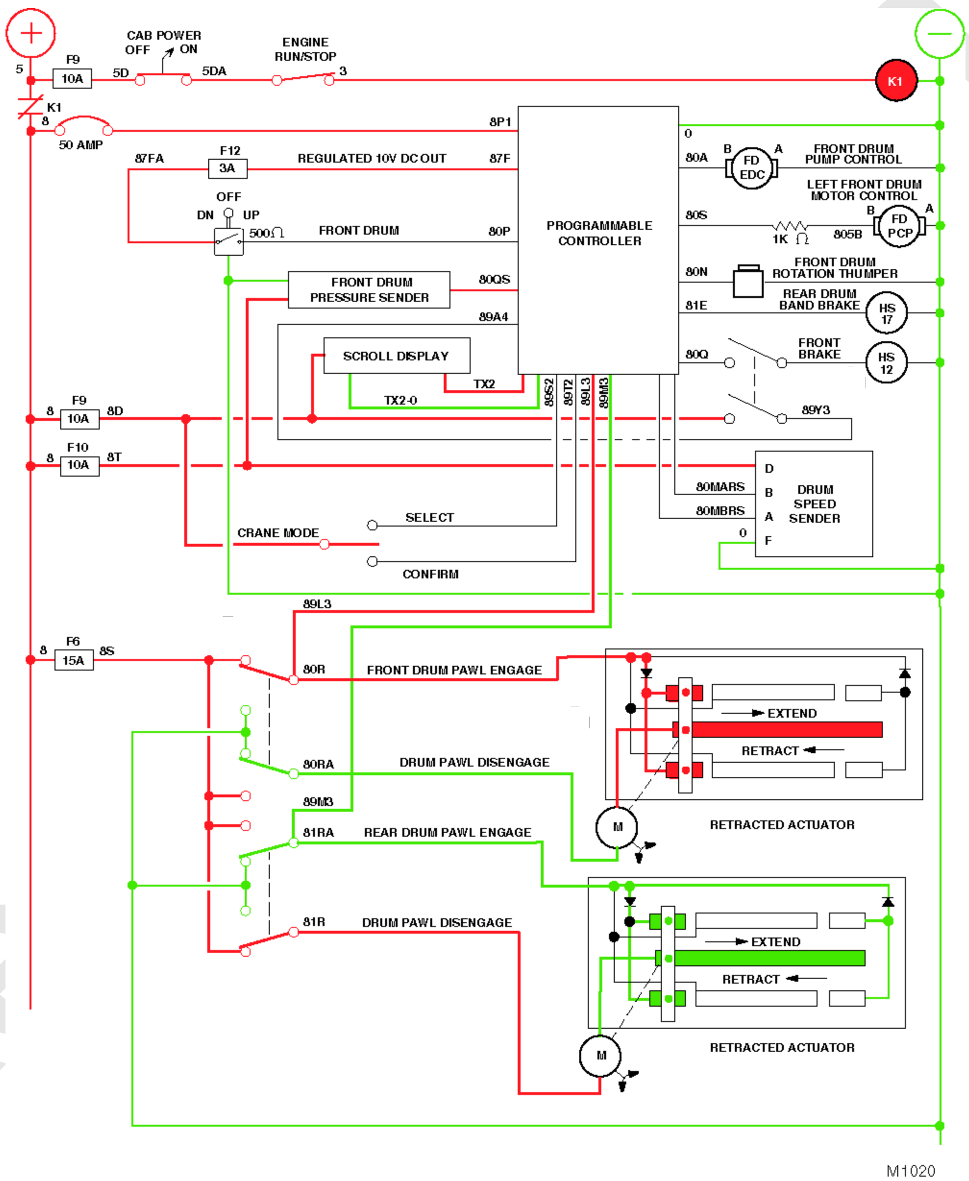


FIGURE 1-27

Drum Pawl Engage

The following description is for the front drum only. The rear drum actuator orientation is the opposite, as well as its actuation.

When a selected pawl switch is placed in the engage position, a circuit is completed from the switch to the PC ensuring no down command against the pawl. This keeps the appropriate park brake solenoids de-energized (so the brake remains applied) and prevents the corresponding system's hydraulic pump from stroking. In addition, a circuit is completed to the pawl's linear actuator, causing the front drum actuator rod to retract (rear hoist drum actuator rod extend), moving the pawl in (out). The drum is secure and will not move in the lowering direction until its pawl switch is disengaged and its park brake is released.

Drum Pawl Disengage

When a selected pawl switch is placed in the disengage position, the park brake remains applied and a circuit is completed to the pawl's linear actuator. This causes the front drum actuator to extend (rear hoist drum actuator rod retract) and moves the pawl out (in).

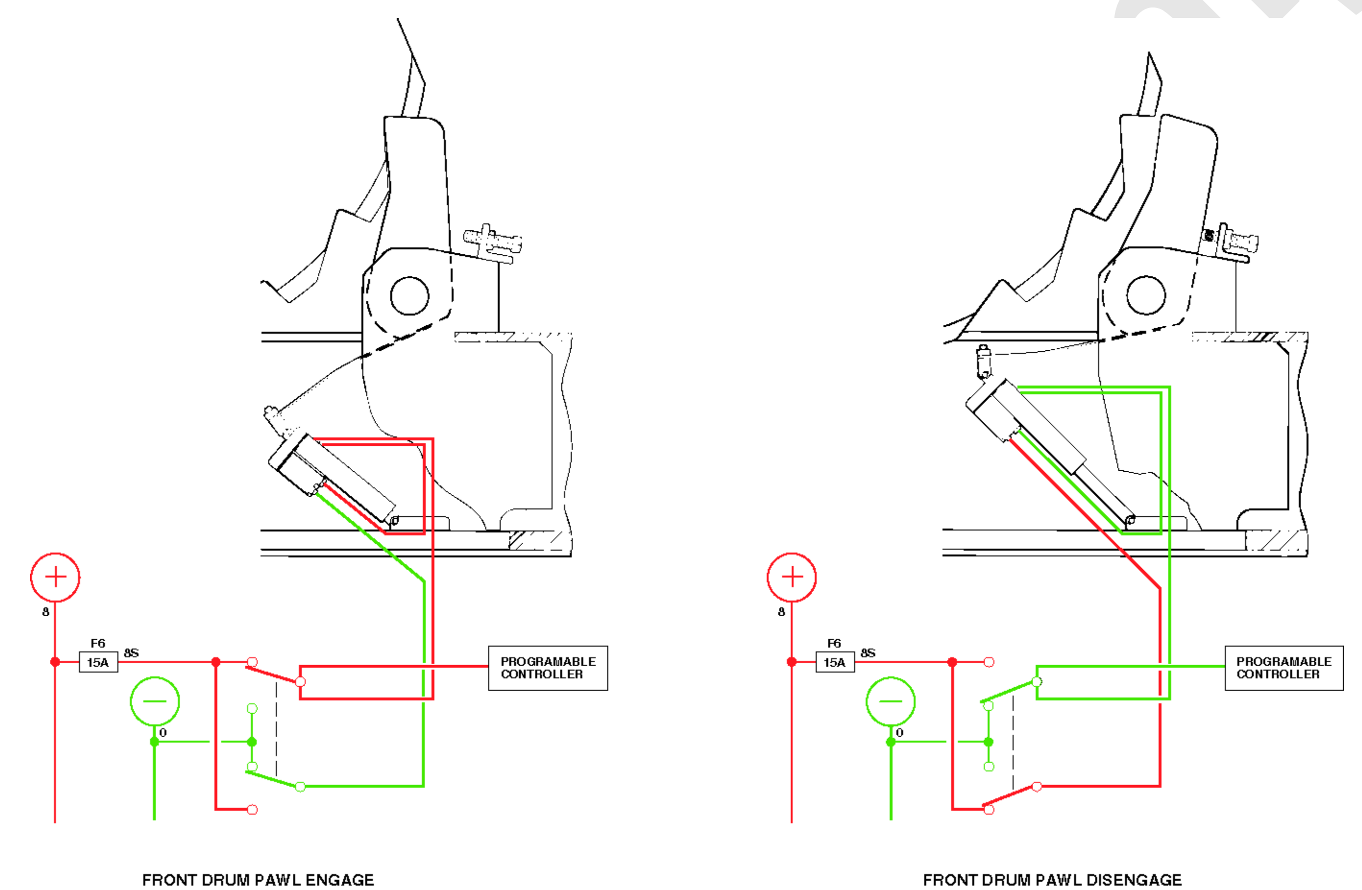


FIGURE 1-28

LOAD DRUM (FULL POWER MODE)

See Figures 1-29, 1-30, and 1-31 for following procedures.

The following description is for the front drum without optional clutch assembly while operating in full power mode. Function of the rear drum in full power mode is identical. The clutch assembly is described in the free fall mode section of this manual.

With free fall, the free fall switch must be closed for brakes to release and pump to go on stroke.

Front and rear hoist control handles are located adjacent to one another on right console in the operator's cab. The position of these handles may be interchanged depending on the functional orientation of the front and rear drums.

The hydraulic connection between front hoist pump and front hoist motor forms a simple closed-loop circuit. Make-up oil from front hoist charge pump replaces oil in the system that is primarily displaced due to internal leakage of the pump and motor assemblies.

If front drum park switch located on the front console in the operator's cab, is placed in the ON position, the front hoist control handle circuit to the PC opens and does not complete the circuit from the PC to front drum disc brake hydraulic solenoid HS12 and band brake solenoid HS16. Because these circuits are open, front drum hydraulic disc and band brakes remain applied and front hoist pump does not stroke in response to movement of front hoist control handle.

When performing liftcrane, clamshell, or luffing operations in full power mode, the brake function employs two independent brake systems, band brake and hydraulic disc brake, each hydraulically actuated.

The hydraulic disc brake is spring applied/pressure released and is controlled automatically by the PC in conjunction with movement of front drum control handle. Release of brake during operation of the front drum is sourced from 350 psi (24 bar) charge pressure pump of the closed-loop circuit.

When releasing brake, charge pressure is directed into brake valve through HS12. If the charge pressure drops to below 295 psi (20 bar), hydraulic brake application begins; if the pressure continues to drop to approximately 220 psi (15 bar) or lower, the brake is fully applied.

The band brake is actuated when heavy duty coil spring is decompressed and the brake band applies a holding resistance against the drum flange. The PC automatically energizes the band brake hydraulic solenoid HS16 opening a path of flow from auxiliary pump to band brake release cylinder. The brake cylinder piston extends, causing the heavy duty coil spring to compress, releasing the holding resistance applied to the drum flange.

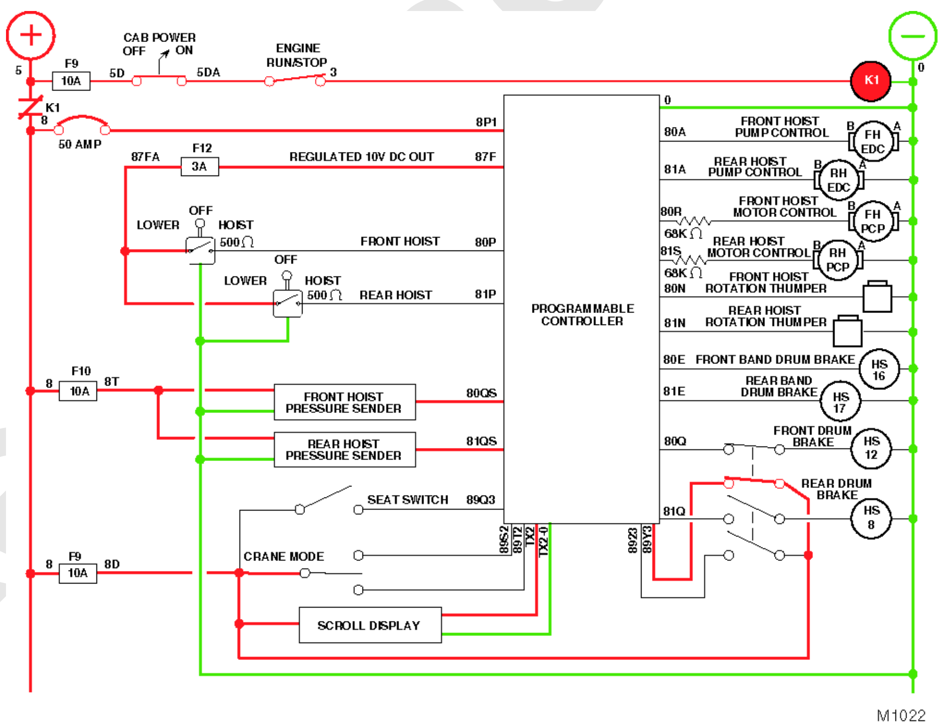


FIGURE 1-29

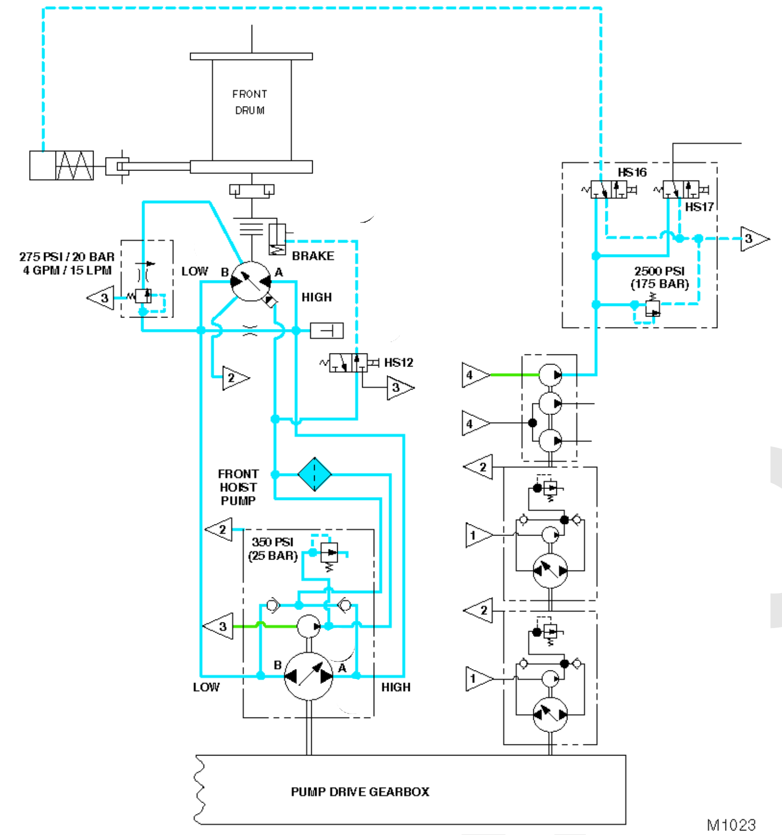


FIGURE 1-30

Liftcrane Operation

When FULL-POWER mode is selected and confirmed at crane mode selector, the crane is ready for general liftcrane usage, and the PC ensures the clamshell, luffing, and setup operations are inoperable.

When the front drum park switch is placed in the off position while in full power mode, the PC automatically controls the front drum hydraulic disc and band brakes in conjunction with movement of front hoist control handle.

Front Hoist Rotation Indicator

Whenever the front drum rotates, front drum speed sender completes a circuit to the PC, which activates rotation thumper in control handle. This causes the rotation thumper to move up and down with a varying frequency that conveys the rotational speed of the front drum to the operator.

Off

See Figures 1-31, and 1-32 for following procedures.

When front hoist control handle is in the off position, the handle neutral switch is open and the control circuit from the handle potentiometer to the PC is not completed. The PC receives no voltage from the handle, and it opens the circuits to the front hoist pump EDCs, front hoist motor PCP valve, front drum disc brake solenoid HS12, and band brake solenoid HS16. Because these circuits are open, front hoist pump does not stroke, front hoist motor remains at low speed, and front drum brakes remain applied to prevent the front drum from turning.

Hoist

See Figures 1-33, 1-34, and 1-35 for following procedures.

When front hoist control handle is pulled back for up operation, the handle neutral switch closes, completing a regulated voltage circuit from the handle potentiometer to the PC. The PC interprets the signal for speed and direction and closes voltage regulated circuits to the front hoist pump EDC, front hoist motor PCP, and front drum brake solenoid HS12 releasing the disc brake. These circuits close only if the seat switch is closed, drum park switch is closed, applicable operating limit switches are closed free fall switch is closed, and no operating faults are present.

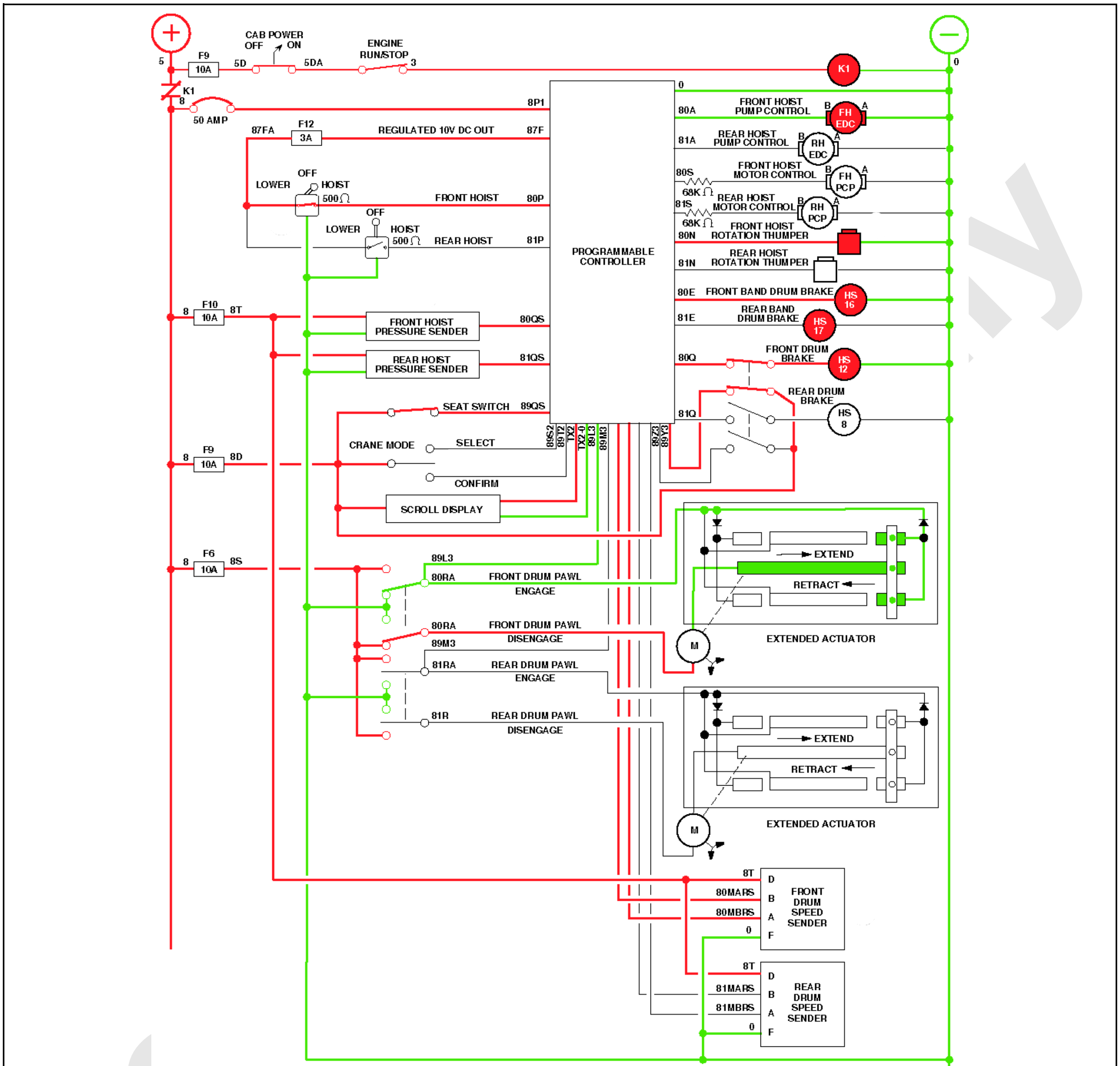


FIGURE 1-31

PC programming requires front hoist pump to stroke before the front drum band brake HS16 is released. This ensures adequate pressure is present to hold the load after full release of the brake. The regulated voltage to the front hoist pump EDC tilts the pump swashplate to stroke the pump in the up direction. Oil then flows from pump port A to port A of front hoist motor. If after about 2 seconds, speed sender detects speed and brake is not released, the PC will command release.

Front hoist pressure sender supplies the PC with pressure information which the PC compares to the memorized holding pressure of the front hoist. When adequate pressure is available, the PC energizes HS16 and shifts the band brake valve. This initiates full release of the band brake and front hoist motor raises the load.

The PC governs the raising speed of the load by varying the voltage to the pump EDC in proportion to movement of the control handle. The angle of the pump swashplate is increased as the control handle is moved farther backward, pumping more oil to the motor and raising the load faster.

As control handle approaches the full handle command position, and if lifting conditions permit, the PC instructs the front hoist motor PCP valve to shift in proportion to handle position and redirect oil flow to motor servo cylinder This allows the servo mechanism to shift the motor gradually forward to a minimum displacement for maximum motor speed at less operating torque.

As control handle is returned to the off position, the PC commands the front hoist pump EDC to decrease the angle of the pump swashplate, causing a reduction in oil flow output. The PC also instructs the front hoist motor PCP valve to shift, in proportion to handle position, the front hoist motor to maximum displacement for slower output speed to slow the drum rotation. When the control handle is fully off, the PC memorizes the pressure required to support the load and de-energizes HS12 and HS16 to apply the brakes after the control handle neutral switch opens or after receiving a zero command from front drum speed sender.

Lower

See Figures 1-33, 1-34, and 1-35 for following procedures.

When front hoist control handle is pushed forward for down operation, the handle neutral switch closes, completing a regulated voltage circuit from the handle potentiometer to the PC. The PC interprets the signal for speed and direction and closes regulated polarity voltage circuit to the front hoist pump EDC, a regulated voltage to front hoist motor PCP, and front drum disc brake solenoid HS12. These circuits close only if seat switch is closed, free fall switch, the front drum park switch is off, the front drum pawl switch is disengaged, applicable operating limit switches are closed and no system or operating faults are present.

PC programming requires front hoist pump, to stroke momentarily in the hoisting direction to reach memorized load holding pressure before the front band brake is released. This ensures adequate pressure is present to hold the load after full release of the band brake. Front hoist pressure sender, supplies the PC with pressure development data which the PC compares to the memorized holding pressure of the front hoist. When adequate pressure is available, the PC energizes HS16 shifting the brake valve. This initiates full release of band brake, front drum brake and front hoist motor lowers the load. A regulated reverse polarity voltage to the front hoist pump EDC then tilts the pump swashplate to stroke the pump in the down direction. Oil then flows from pump port B to port B of front hoist motor.

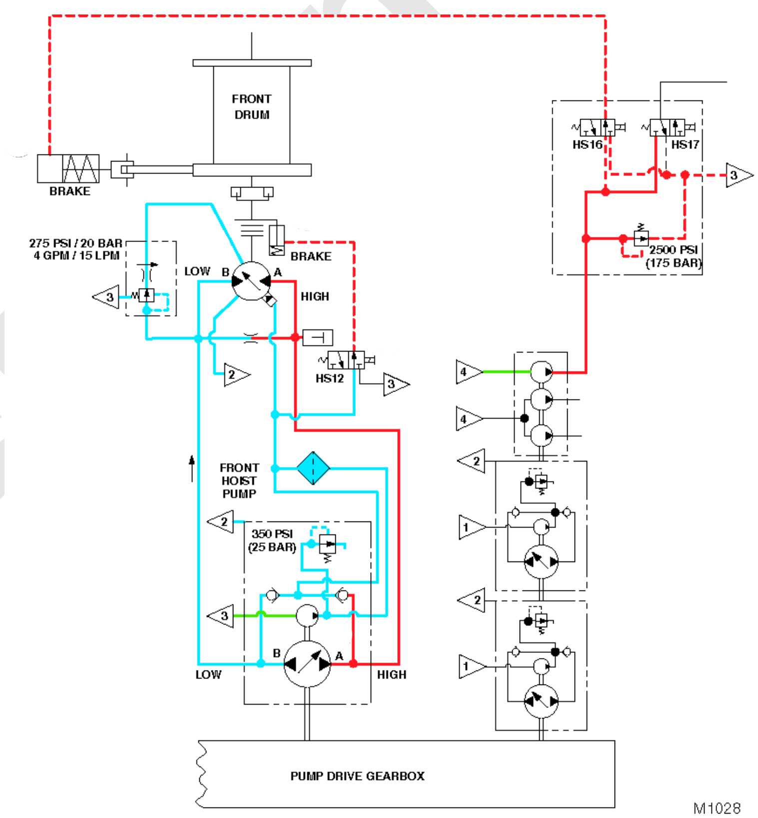


FIGURE 1-32

The weight of the load on the front drum will attempt to drive the motor faster than return oil is available to the pump. Front hoist charge pump maintains the oil supply in the closed loop circuit at a positive pressure to front hoist motor.

The position of the pump swashplate restricts the returning oil flow, and pressure builds on the return side of the closed-loop circuit, acting as a brake against the front hoist motor to control the lowering speed.

The PC governs the lowering speed of the load by varying the voltage to the pump EDC in proportion to movement of the control handle. The angle of the pump swashplate increases as the control handle is moved farther forward; more oil is allowed to return to the pump, more oil is pumped to the motor, and the front drum lowers the load faster.

As control handle approaches the full handle command position, and if lifting conditions permit, the PC instructs the front hoist motor PCP valve, to shift and redirect oil flow to motor servo cylinder. This allows the servo mechanism to shift the motor to minimum displacement for maximum motor speed and less operating torque.

As control handle is returned to the off position, the PC commands the front hoist pump EDC to decrease the angle of the pump swashplate, causing a reduction in oil flow output. The PC also instructs the front hoist motor PCP valve, to shift front hoist motor to maximum displacement in proportion to return handle position for slower output speed to slow the drum rotation. When the control handle is fully off, the PC memorizes the pressure required to support the load and de-energizes solenoid HS16 to apply the band brake after the control handle neutral switch opens and about 5 seconds later solenoid HS12 de-energizes to apply the drum brakes.

Clamshell Operation: Clamshell Mode

See Figure 1-33 for following procedures.

The load drum hydraulic systems for clamshell operation in full power mode are identical to those illustrated for liftcrane operation in full power mode.

When CLAMSHELL excavator mode is selected and confirmed at crane mode selector, front hoist control handle operates the front drum for opening and closing the bucket, and rear hoist control handle operates the front and rear drums for raising and lowering the bucket.

Programming

The PC controls the speed of the drums in proportion to movement of the control handles and the weight of the bucket. The more the bucket weighs and/or the farther the handle is moved in the forward direction, the faster the bucket will lower.

When an open or closed bucket is lowered, the PC monitors both front and rear drum speed senders for variance in rotational speed of the drums. If a speed difference is determined, the PC calculates a speed correction factor which is then used to increase or decrease the displacement of each load drum pump as needed to maintain equal rotational speed of the drums.

To ensure the bucket remains closed when raising, the PC monitors the high pressure side of both load drum systems for variance in working pressures. If pressure differences are detected, the PC calculates a pressure correction factor which is then used to increase or decrease the displacement of each load drum pump as needed to maintain equal working pressures.

When the bucket comes in contact with an object that offers resistance, such as striking a pile of excavatable material, the hoist lines relax and system pressure decreases. Front and rear hoist pressure senders supply the PC with data obtained from the high pressure side of both load drum hydraulic systems. The PC monitors this data and uses it to destroke the load drum pumps when pressure decreases and automatically stops the load drums from turning.

Off

See Figure 1-33 for following procedures.

When front and rear hoist control handles are in the off position, the following conditions exist:

- Front and rear hoist pump EDC circuits are opened, and the pumps do not stroke.
- Front and rear drum park brake solenoids HS12, HS8 and front and rear drum band brake solenoids HS16 and HS17 are de-energized, causing front and rear drum park brakes to spring-apply and prevent drums from turning.

Close Bucket

See Figure 1-33 for following procedures.

When front hoist control handle is pulled back, the PC closes a regulated voltage circuit to the front hoist pump EDC. The EDC tilts the pump swashplate in the hoisting direction, causing the bucket to close with the closing line. The PC governs the closing speed by varying the current to the EDC in conjunction with movement of the front hoist control handle.

The PC energizes front drum park brake solenoid HS12 and front drum band brake solenoid HS16. As the solenoids shift, hydraulic system pressure is supplied to release the front drum hydraulic park brakes. The brakes then release, permitting the front hoist motor to rotate the front drum in the hoisting direction and close the bucket.

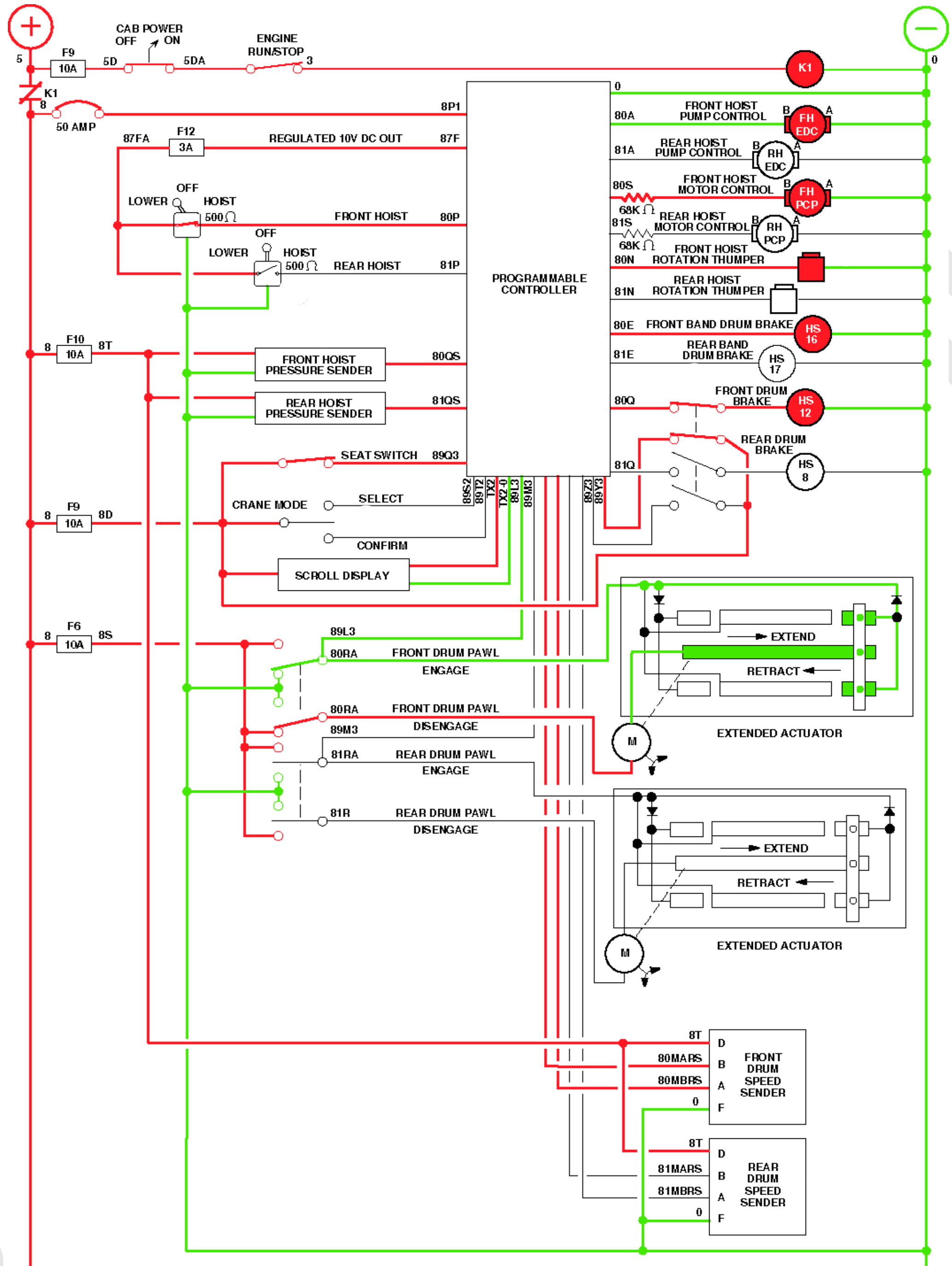


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FIGURE 1-33

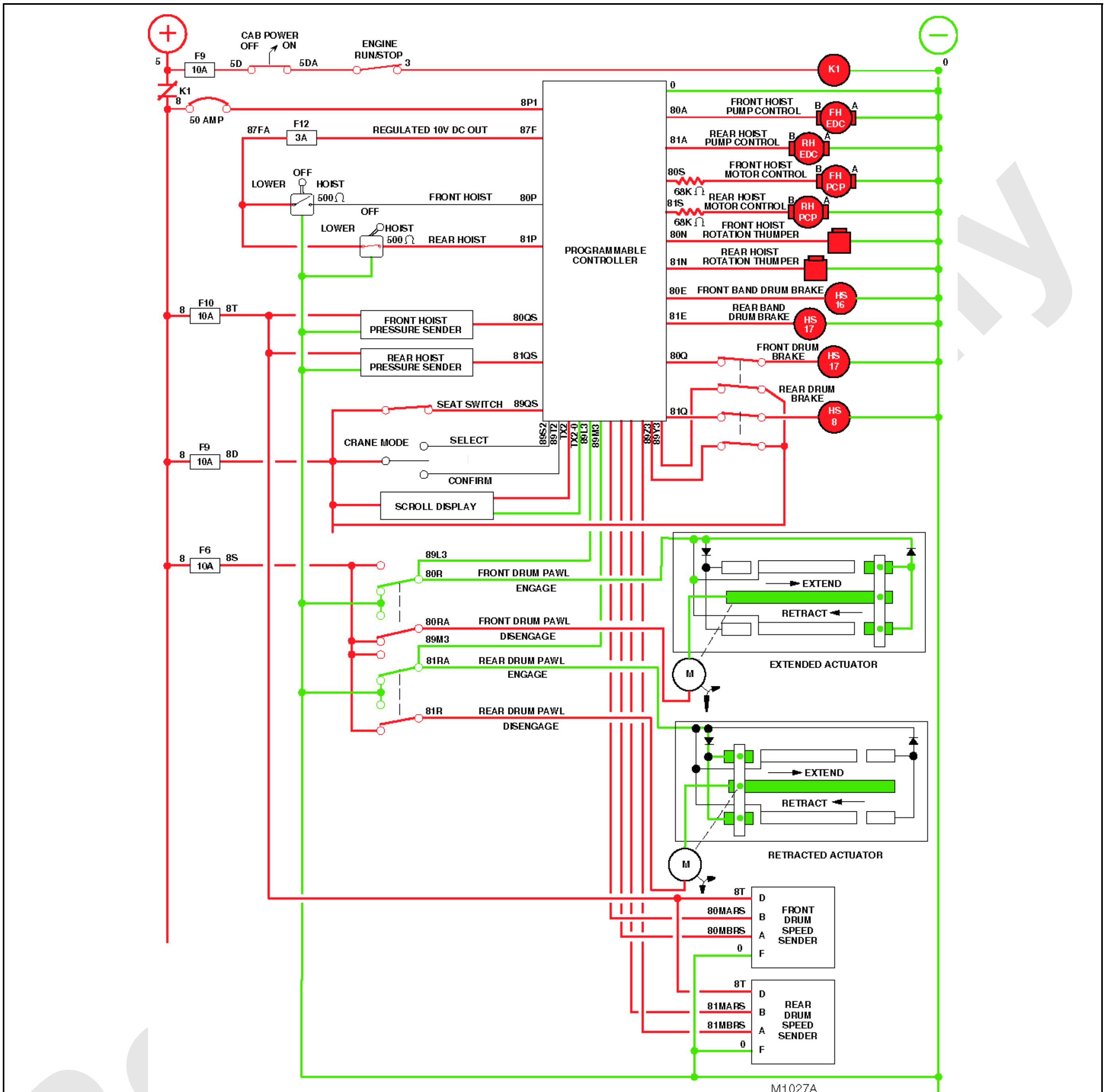

FIGURE 1-34

Hoist Bucket

See Figure 1-34 for following procedures.

When rear hoist control handle is pulled back, the PC energizes front and rear drum park brake solenoids HS12, HS8, and front and rear drum band brake solenoids HS16, and HS17. As the solenoids shift, hydraulic system pressure is supplied to release the front and rear drum hydraulic park brakes.

At the same time, the PC closes regulated voltage circuits to the front and rear hoist pump EDCs. The EDCs tilt the pump swashplates in the hoisting direction, causing the front and rear hoist motors to rotate the drums and raise the bucket. To ensure the bucket remains closed when raising, the PC monitors the high pressure side of both load drum systems for differences in working pressures. The PC compares this data and then calculates a correction factor to maintain equal lifting pressure in both systems. This correction factor is then used to increase or decrease the displacement of each pump to control both system working pressures.

Open Bucket

See Figure 1-33 for following procedures.

When front hoist control handle is pushed forward, the PC closes a regulated voltage circuit to the front hoist pump EDC. The EDC tilts the pump swashplate in the lowering direction, causing the bucket to open with the closing line. The PC governs the opening speed by varying the current to the EDC in conjunction with movement of the front hoist control handle.

NOTE: During clamshell open bucket condition, rear drum pawl is out and rear drum brake switch is closed.

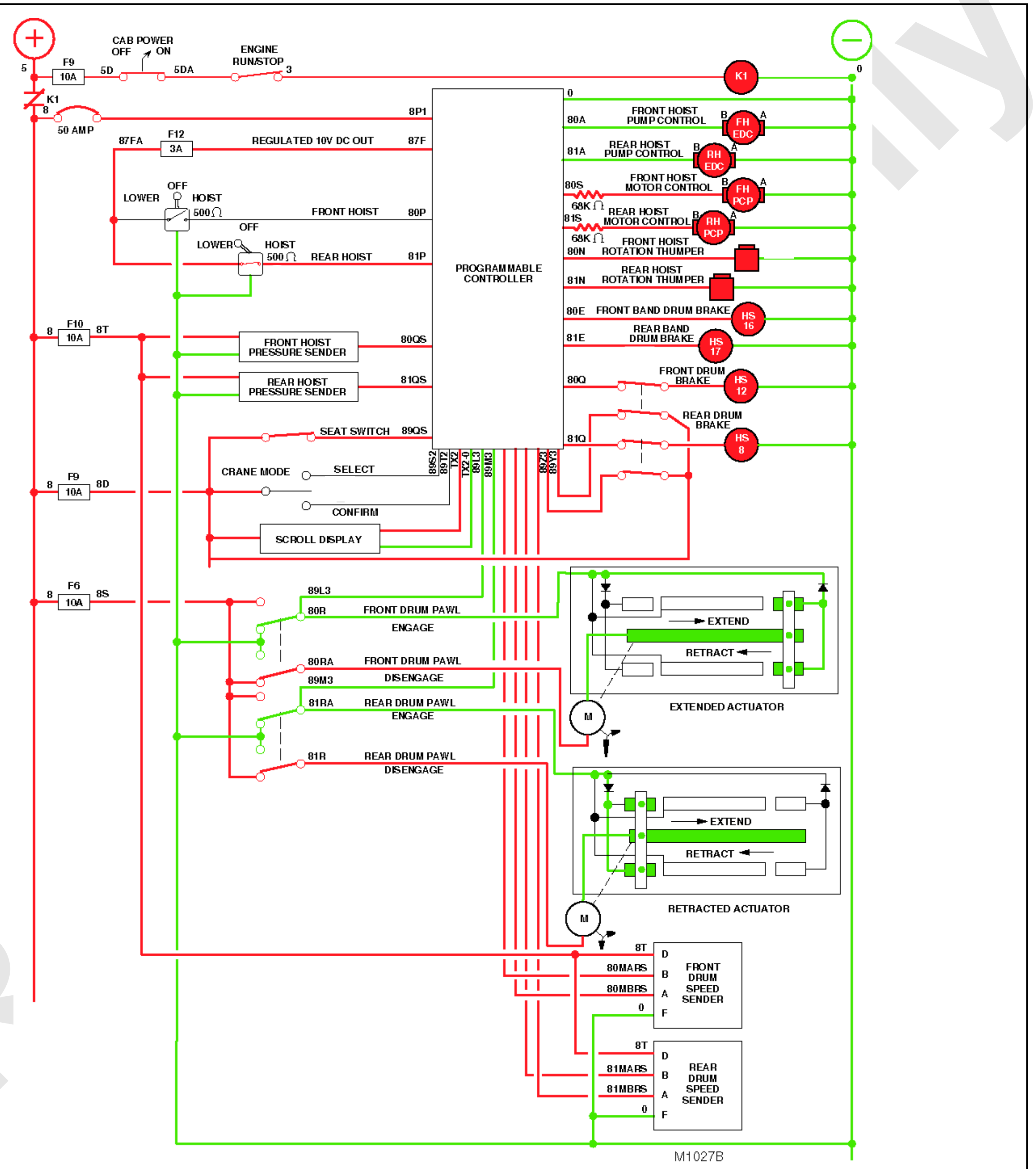

FIGURE 1-35

The PC also energizes front drum park brake solenoid HS12 and front drum band brake solenoid HS16. As the solenoid shift, hydraulic system pressure is supplied to release the front drum hydraulic park brakes. The brakes then release, permitting the front hoist motor to rotate the front drum in the lowering direction, opening the bucket.

Lower Bucket

See Figure 1-35 for following procedures.

When rear hoist control handle is pushed forward, the PC energizes front and rear drum park brake solenoids HS12, HS8, and front and rear drum band brake solenoids HS16, and HS17. As the solenoids shift, hydraulic system pressure is supplied to release the front and rear drum hydraulic park brakes.

At the same time, the PC closes reverse regulated polarity voltage circuits to the front and rear hoist pump EDCs. The EDCs tilt the pump swashplates in the lowering direction, causing the front and rear hoist motors to rotate the drums and lower the bucket. The PC maintains equal linepull on the drums by monitoring the speed data received from front and rear drum speed senders and making the necessary adjustments. The PC also governs the lowering speed by varying the current to the front and rear hoist pump EDCs in conjunction with movement of rear hoist control handle.

LOAD DRUM (FREE FALL MODE)

See Figures 1-36 and 1-37 for following procedures.

Drum pawl must be disengaged before attempting to lower a load in free fall.

The following description is for the front drum if the crane has free fall and is operating in free fall mode. Operation of the rear drum is identical.

The PC will not allow a drum to be switched to free fall mode until its working brake pedal is latched down, the drum parking brakes switched off, and the free fall is confirmed and selected.

The PC automatically applies the park brakes only when the load drum park brake switch is placed in the park position.

Always park load drums not in use and fully apply and latch the working brake for the load drum being used.

When the working brake pedal is fully depressed and latched, front drum parking brake switch is off or in closed position and the operator has selected and confirmed free fall at switch, full pressurized system flow path from pump is blocked at working brake pedal valve permitting the release of the coil spring at band brake cylinder to expand and apply pressure against the drum while its exhausting oil goes back to tank through working brake pedal valve. Free fall safety pressure switch at this time opens a circuit to the PC which allows the front drum to be placed into free fall mode and free fall drum system light on the front console is illuminated indicating the front drum to be in free fall mode.

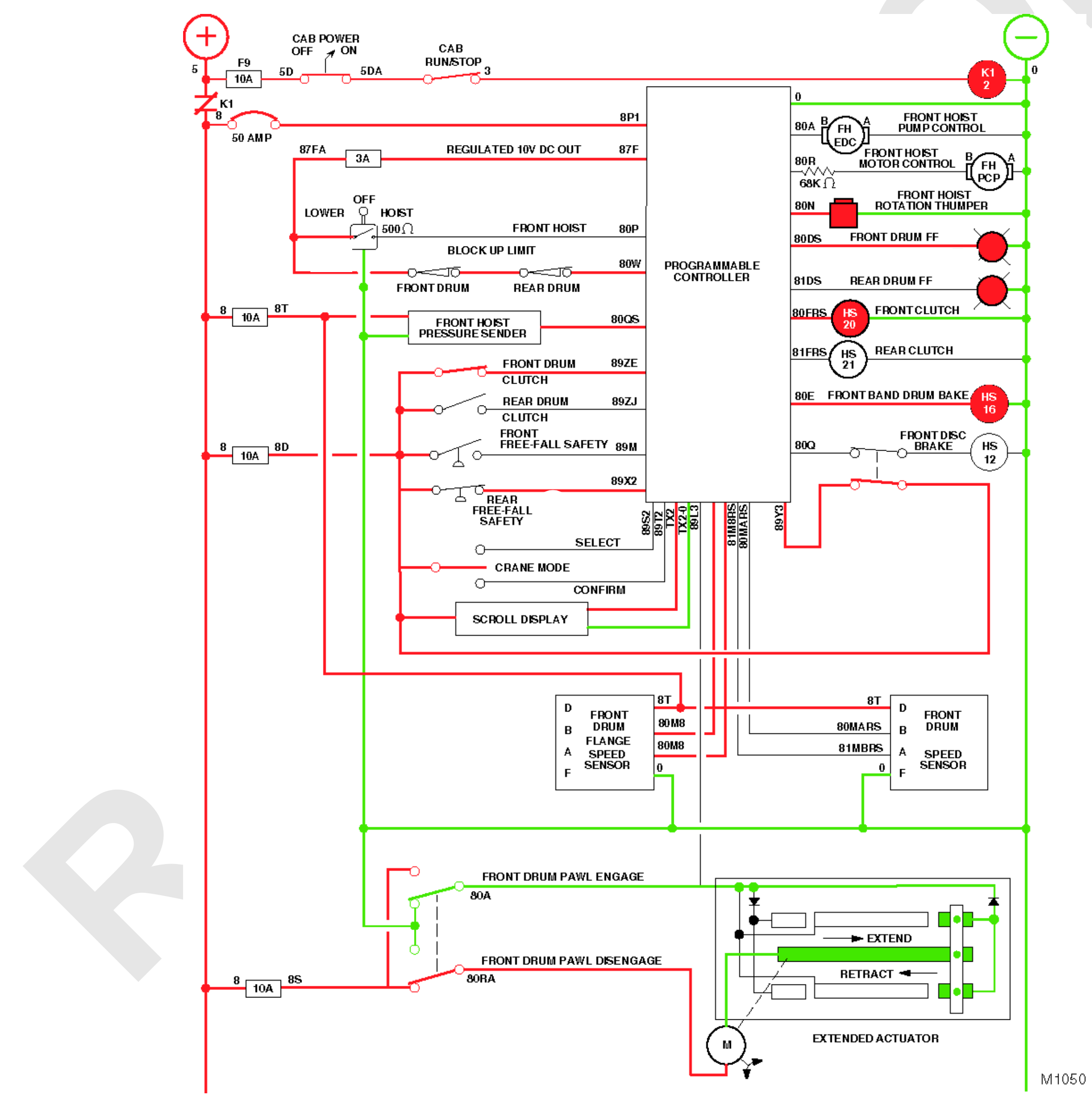

FIGURE 1-36

Manitowoc Crane Care

When the front drum is placed in free fall mode, the PC closes a circuit to front drum clutch solenoid HS20. A path for oil supply is opened from the front drum hoist charge pump to clutch cylinder and the clutch is released disconnecting the load drum from its drive motor.

Clutch opens when in free fall mode. When returning to or in Standard, Luffing, or Clam Shell mode the clutch switch must be closed to the PC for verification the clutch is engaged before brakes can be released.

When front hoist control handle is in the off position, the PC opens the circuit to the front hoist pump EDC and the front hoist pump does not stroke.

Should a fault relating to the load drum occur while in free fall mode, the clutch will re-engage load drum with its drive motor and brakes apply.

WARNING

Dropping Load!

Apply working brake if a limit or operating fault occurs while hoisting or power lowering.

Hoisted load will drop if working brake is not applied!

Should charge pressure drop below 295 psi (20 bar) on the low pressure side of the closed-loop while hoisting, power lowering, or in free fall, the hydraulic park brakes begin to apply. If pressure drops below 220 psi (15 bar), the park brakes are fully applied.

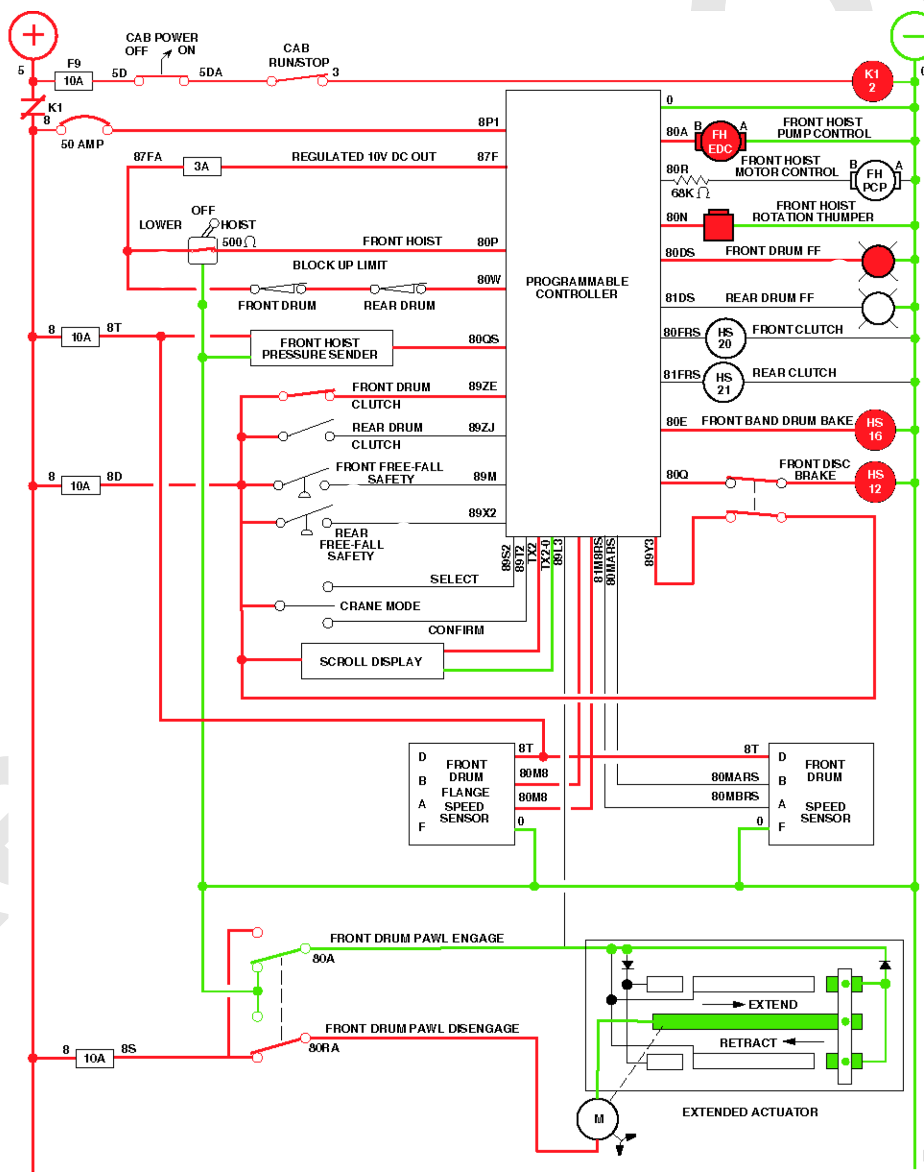

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FIGURE 1-37

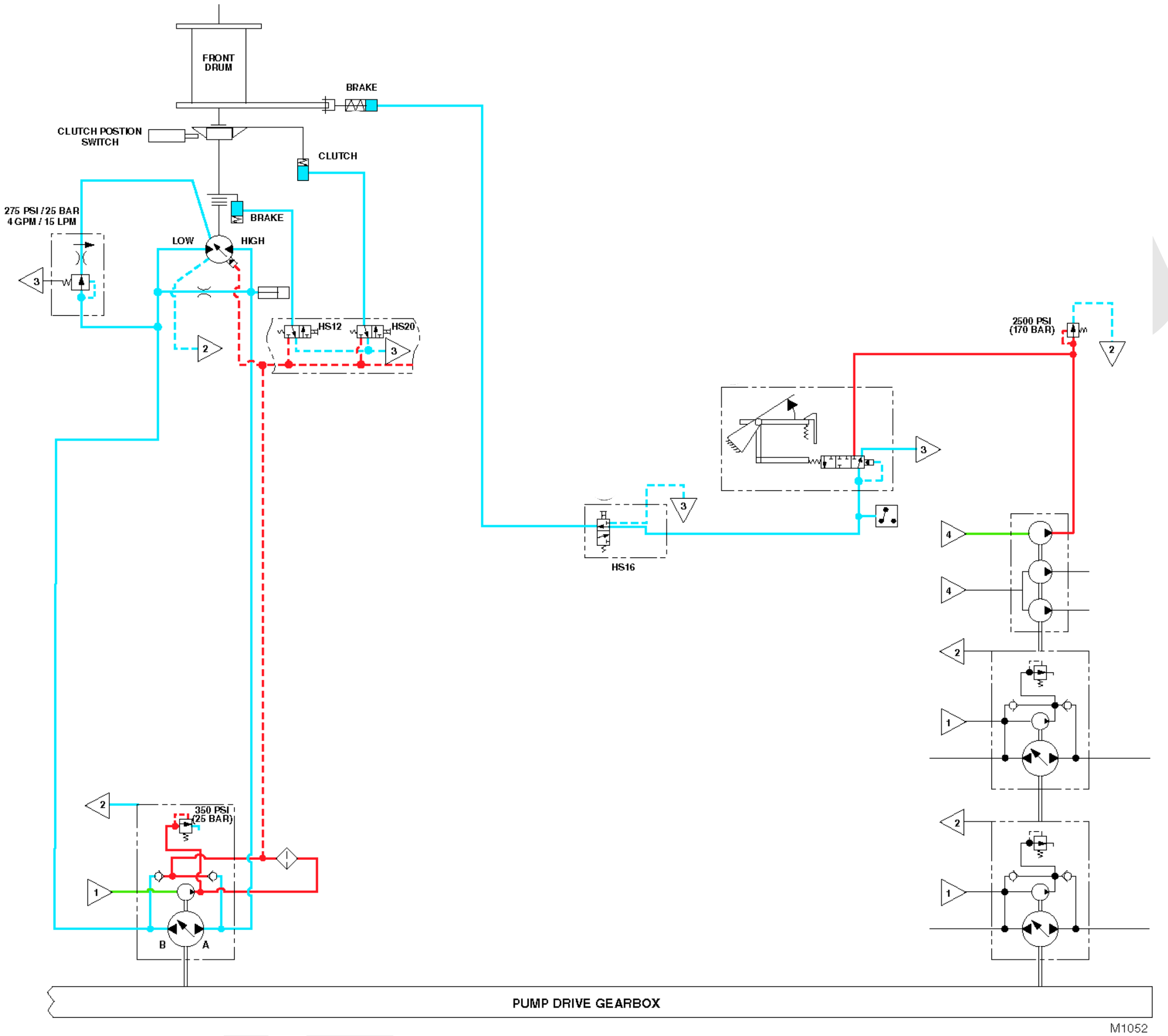


FIGURE 1-38

Front Drum in Free Fall

See Figures 1-37 and 1-38 for following procedures.

For free fall lowering, front hoist control handle must be in the off position. The PC then closes the circuit to front drum clutch solenoid HS20, supplying hydraulic pressure to the front drum clutch cylinder which disconnects the front drum from the front hoist motor drive assembly.

NOTE: When the drum working brakes are released, the load on the drum will free fall. Lowering speed must be controlled with the drum working brake.

If control handle is moved in up direction from off, the PC immediately opens the circuit to HS20, spring-applying the clutch to connect the front drum to the motor drive assembly. The load is then powered in the up direction. When control handle is returned to off, the clutch is again released, returning the drum to the free fall condition. At this time, a hoisted load will drop unless controlled by application of the working brake.

CAUTION

Momentary Load Drop!

Begin moving control handle before releasing working brake to hold load while clutch engages and power becomes available to drum.

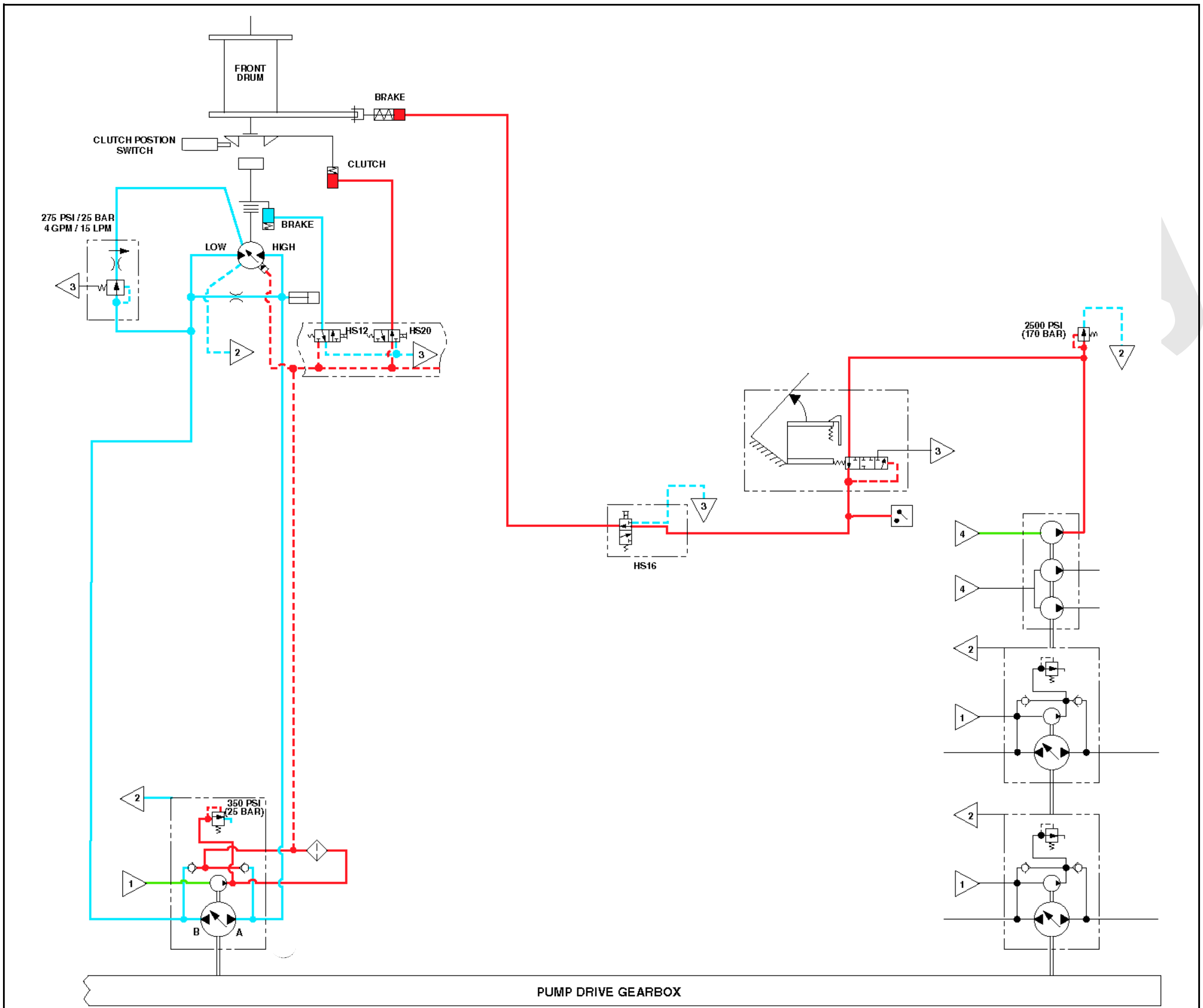
Load will drop immediately unless held by working brake!

When front drum control handle is pulled back in the hoist position, the PC opens and closes the following circuits:

- OPENS circuit to front drum clutch solenoid HS20. This releases hydraulic pressure from the cylinder of the front drum clutch. The clutch spring-applies, connecting the drum to the motor drive assembly.
- CLOSES a regulated voltage circuit to the front hoist pump EDC.
- CLOSES clutch switch to verify clutch engagement.

The circuit to front drum brake solenoid HS12 and front drum band brake solenoid HS16 remains closed, keeping the park brakes released.

The front drum clutch applies first, then the front hoist pump EDC strokes the front hoist pump to hoist the load. The PC governs the hoisting speed by varying the voltage to the EDC with movement of the front hoist control handle and its program requirements.



FRONT DRUM
BRAKE
CLUTCH POSTION SWITCH
CLUTCH
275 PSI / 25 BAR
4 GPM / 15 LPM
BRAKE
LOW
HIGH
HS12
HS20
HS16
2500 PSI
(170 BAR)
350 PSI
(25 BAR)
B
A
PUMP DRIVE GEARBOX
M1053

FIGURE 1-39

CRANE SETUP SYSTEMS

See Figure 1-40 for following procedures.

With the crane setup operating mode selected and confirmed at the crane mode selector, the PC activates the remote controller for the raise and lower functions of the boom hoist cylinders used during assembly and disassembly.

The crane setup hydraulic cylinder circuits are controlled through the use of one mobile-type control valve called the lower accessory valve. The control valve has parallel operating circuits and contains relief valve that is preset for 3,100 psi (214 bar). The lower accessory valve controls carbody jacking cylinders and crawler lock pin cylinders. These valve sections are activated by spring-centered hand levers that return to a neutral position when not activated.

The output flow from the crane setup pump section of tandem gear accessory pump is discharged to tank through pilot-operated check valve when all sections of the control valve are not being used. The oil then flows through check valve through system return filter, into the boom hoist hot oil shuttle valve, ensuring proper charge pressure for the boom hoist circuit.

When actuating a valve section of the lower accessory valve, the supply flow passages are blocked, stopping oil flow to check valve. The oil within the pilot cavity of valve exhausts to tank through bleed-off orifice and permits the check valve to close. The output from the setup pump section of accessory pump is no longer discharged to tank through the hot oil shuttle valve but supplied to the function of the lower accessory valve.

Carbody Jacking System

The following description is for one carbody jacking cylinder. Operation of one or all four cylinders is identical; and all cylinders can be operated at the same time if the crane is in a level position.

Each carbody jacking cylinder has a counterbalance valve at the cylinder port. These valves ensure smooth control when raising or lowering the crane; and lock the carbody jacking cylinders in place when not in use, in the event of a hydraulic line breakage, or during the occurrence of accidental or unauthorized operation of the control valve when the crane's power system is shut down. In addition, the counterbalance valves provide relief protection for the cylinders and shield them from unforeseen mechanical overloading.

The accessory valve used in this circuit contains a motor spool (both cylinder ports and tank port of the valve spool section are connected in the center or neutral position). This spool selection prevents premature opening of the counterbalance valves.

Jacking Cylinder Extend

See Figure 1-42 for following procedures.

When a carbody jacking cylinder control valve handle is held in the extend position, moving the lever downward on lower accessory valve, the valve section shifts to direct oil flow from the setup pump section of accessory pump into relief valve (preset to 3,100 psi / 214 bar) section of lower accessory valve. Note the system pump flow pressure is limited by relief valve in system disable valve which is preset to approximately 2,700 psi (186 bar).

The oil exits the desired function valve section of lower accessory valve into counterbalance valve. The oil then enters the head end of carbody jacking cylinder, extending the cylinder to lift the carbody.

Oil returning to tank from the rod end of the carbody jacking cylinder is blocked by the free-flow poppet (check valve) section of counterbalance valve and flows through the valve's load restraining section which is preset to 3,500 psi (241 bar). The counterbalance valve serves as a deceleration control and functions with a 3:1 pilot ratio of the pressure setting, permitting the valve to open when the pressure in the rod end of the cylinder is approximately 1,170 psi (81 bar). The restraining section of counterbalance valve opens, controlling the oil flow out of the carbody jacking cylinder. The oil then flows through the free-flow poppet (check valve) section of flow control valve before proceeding to lower accessory valve. The oil leaving the lower accessory valve returns to tank.

Jacking Cylinder Neutral

See Figure 1-42 for following procedures.

When a carbody jacking cylinder control valve handle is not activated, it assumes a neutral position and oil flow passage to carbody jacking cylinder is blocked. In this position, the valve section cylinder ports are connected to tank which prevents inline pressure from opening counterbalance valve. The carbody load is essentially held in position by the counterbalance valve.

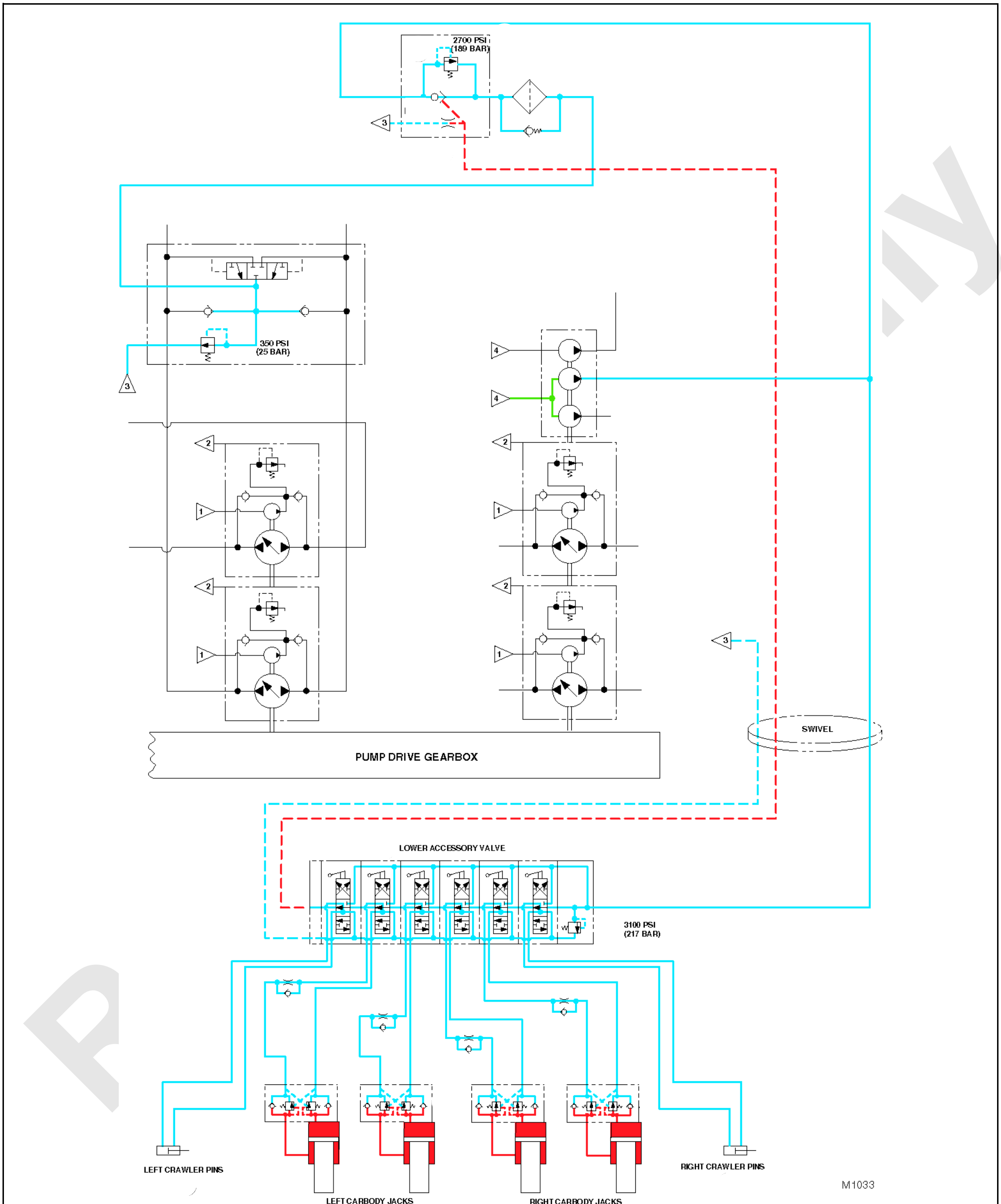

2700 PSI
(189 BAR)
3
350 PSI
(25 BAR)
3
4
4
2
1
2
1
2
1
2
1
3
SWIVEL
PUMP DRIVE GEARBOX
LOWER ACCESSORY VALVE
3100 PSI
(217 BAR)
LEFT CRAWLER PINS
LEFT CARBODY JACKS
RIGHT CARBODY JACKS
RIGHT CRAWLER PINS
M1033

FIGURE 1-40

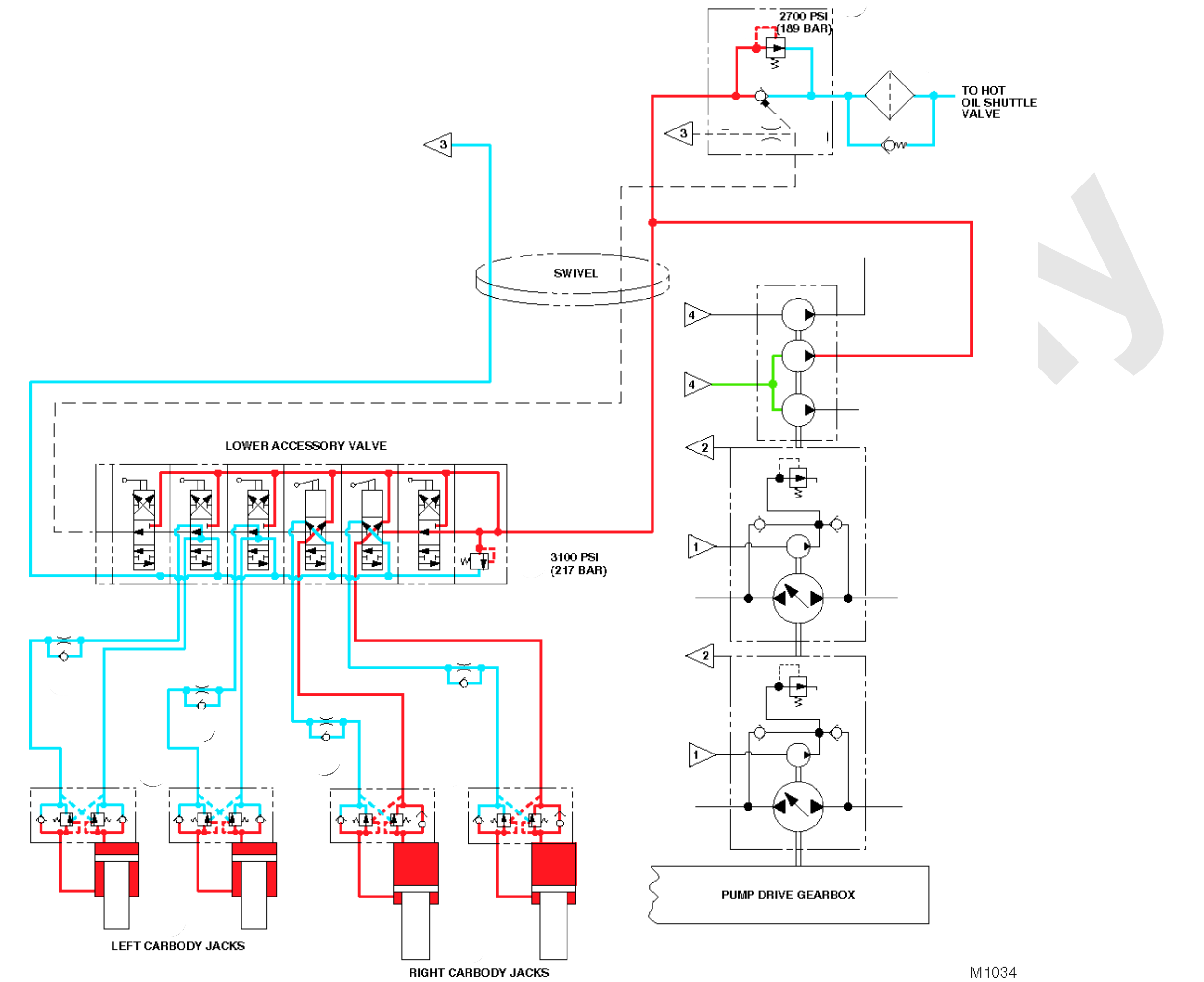


FIGURE 1-41

Jacking Cylinder Retract

See Figure 1-43 for following procedures.

When a jacking cylinder control valve handle is held in the retract position, moving the lever upward on lower accessory valve, the valve section shifts to direct oil flow from the setup pump section of accessory pump and into relief valve (preset to 3,100 psi / 214 bar) section of lower accessory valve. Note the system pump flow pressure is limited by relief valve in system disable valve which is preset to approximately 2,700 psi (186 bar).

The oil exits the desired function valve section of lower accessory valve and flows through the restraining section of flow control valve that controls the speed at which the cylinder retracts by limiting the velocity of oil flow before passing through the free-flow poppet (check valve) section of counterbalance valve. The oil then proceeds into the rod end of carbody jacking cylinder.

NOTE: Hydraulic pressure entrapped by the cylinder counterbalance valve at the head end of the carbody jacking cylinder supports the weight and gravitational force of the carbody.

Oil exhausting from the head end of the carbody jacking cylinder is blocked by the free-flow poppet (check valve) section of counterbalance valve and flows through the valve's load restraining section which is preset to 3,500 psi (241 bar). The counterbalance valve serves as a deceleration control and functions with a 3:1 pilot ratio of the pressure setting, permitting the valve to open when the pressure in the rod end of the cylinder is approximately 1,170 psi (81 bar). The restraining section of counterbalance valve opens which controls oil flow out of the carbody jacking cylinder to lower accessory valve. The oil leaving the lower accessory valve returns to tank.

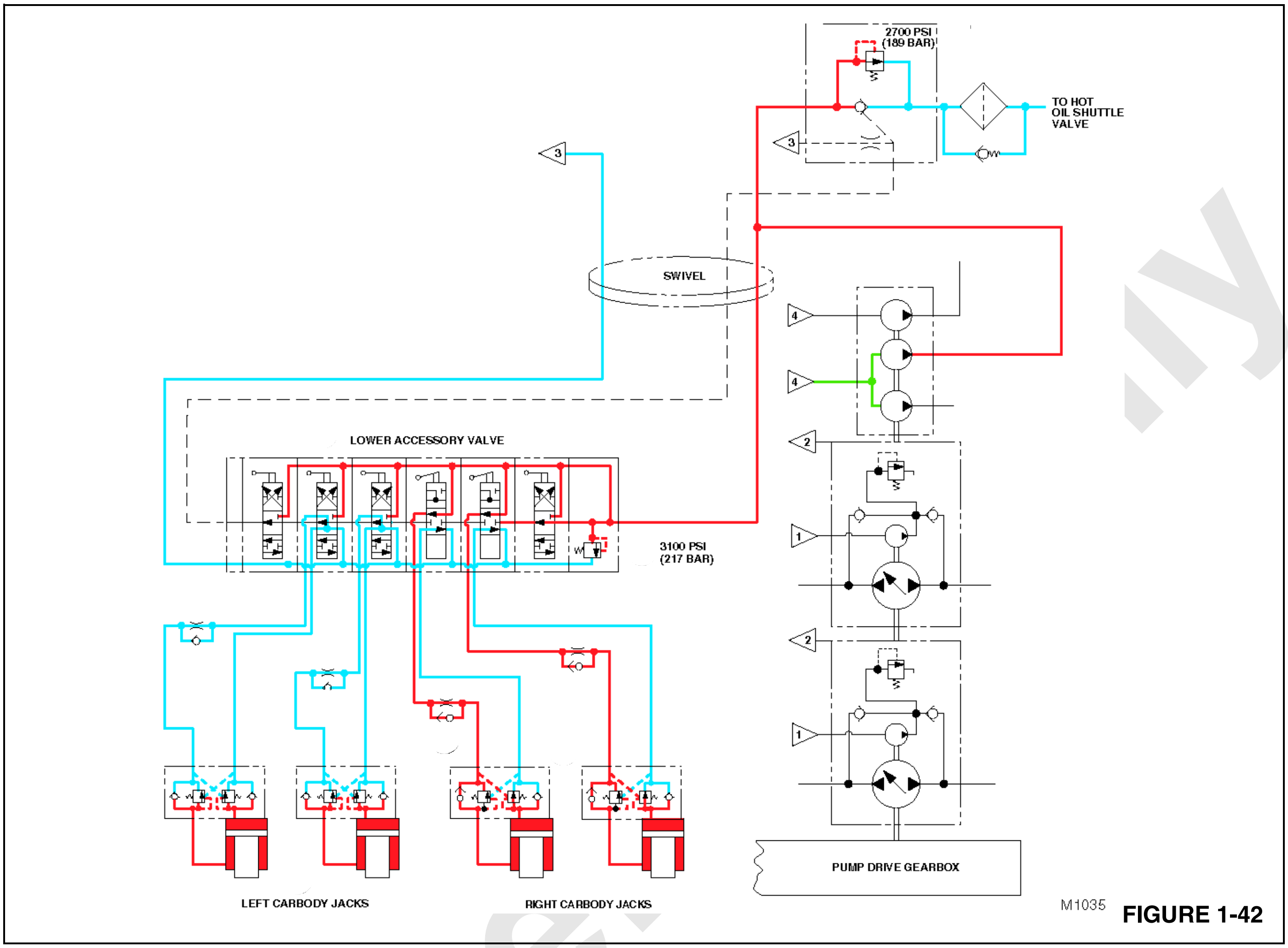

2700 PSI
(189 BAR)
TO HOT
OIL SHUTTLE
VALVE
3
3
SWIVEL
4
4
2
1
2
1
LOWER ACCESSORY VALVE
3100 PSI
(217 BAR)
PUMP DRIVE GEARBOX
LEFT CARBODY JACKS
RIGHT CARBODY JACKS
M1035

FIGURE 1-42

Crawler Attachment System

The following description is for one set of crawler lock pin cylinders. Operation of both sets of cylinders is identical.

Crawler Lock Pin Extend

See Figure 1-43 for following procedures.

When a crawler lock pin control valve handle is held in the extend position, moving the lever downward on lower accessory valve, the valve section shifts to direct oil flow from the setup pump section of accessory pump and into relief valve (preset to 3,100 psi / 214 bar) section of lower accessory valve. Note the system pump flow pressure is limited by relief valve in system disable valve which is preset to approximately 2,700 psi (186 bar).

The oil leaves the desired function valve section of lower accessory valve and enters the head end of crawler lock pin cylinders, causing the cylinder rod to extend, pushing attachment pins into place, securing the crawler to the carbody.

Oil exhausting from the rod end of crawler lock pin cylinder returns to lower accessory valve and returns to tank.

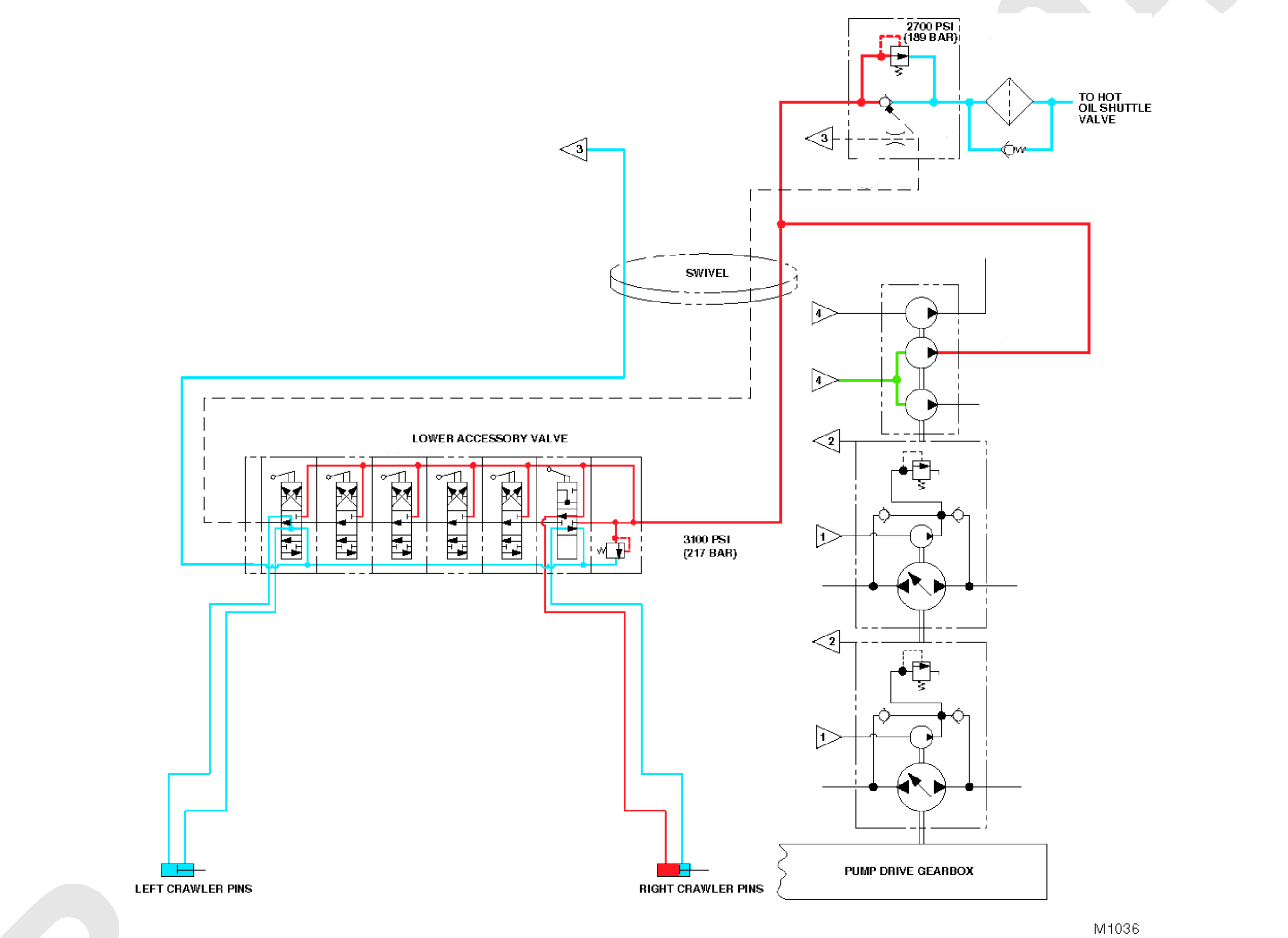


FIGURE 1-43

Crawler Lock Pin Retract

See Figure 1-44 for following procedures.

When a crawler lock pin cylinder control valve handle is held in the retract position, moving the lever upward on lower accessory valve, the valve section shifts to direct oil flow from the setup pump section of accessory pump into relief valve (preset to 3,100 psi / 214 bar) section of lower accessory valve. Note the system pump oil flow is pressure limited to relief valve system disable valve which is preset to approximately 2,700 psi (186 bar).

The oil leaves the pin cylinder valve section of lower accessory valve and enters the rod end of crawler lock pin cylinder, causing the cylinder rod to retract the pins, permitting the crawler to be released and separated from the carbody.

Oil exhausting from the head end of both crawler lock pin cylinders returns to lower accessory valve and returns to tank.

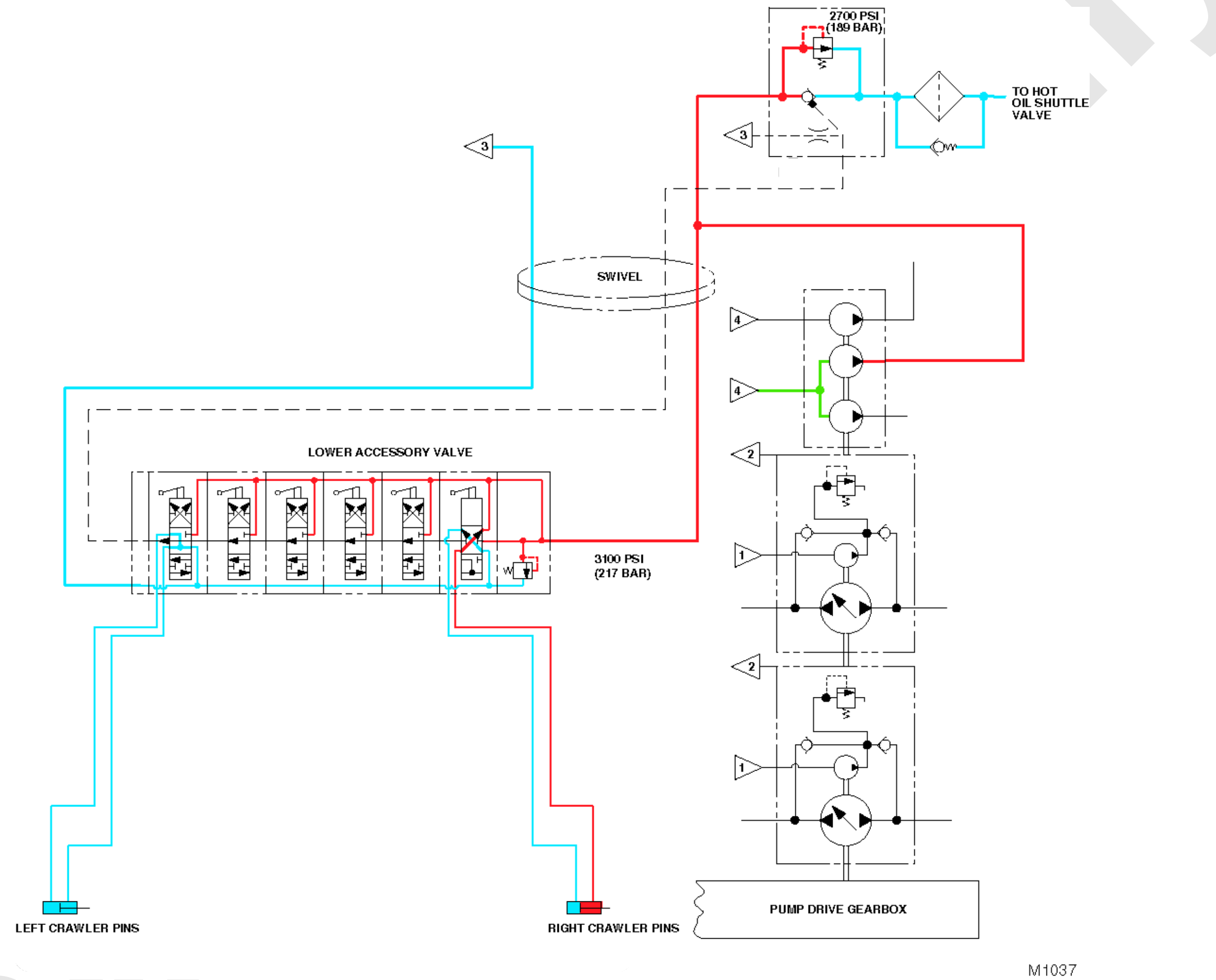


FIGURE 1-44

OPTIONAL SYSTEMS

Luffing Jib Hoist System

See Figure 1-46 for following procedures.

If crane has optional clutch assembly, the PC opens the circuit to rear drum clutch hydraulic solenoid HS21 when entering luffing jib mode. This ensures manifold oil is blocked from entering the solenoid valve, and the valve's exhaust port is open to the drum clutch. The rear drum clutch remains applied during the luffing function.

With optional clutch assembly, free fall switch must be closed for brakes to release and pump to go on stroke.

In the luffing mode, the rear drum operates the luffing jib while the front drum is the whip line. The front and rear (luffing jib) hoist control handles are located adjacent to one another on the right console in the operator's cab.

If a BLOCK UP LIMIT or RCL operating fault occurs while luffing, the PC will command the rear drum to stop lowering. The corrective action for these operating faults is to raise the jib. In full power mode corrective action requires lowering the load with the rear drum.

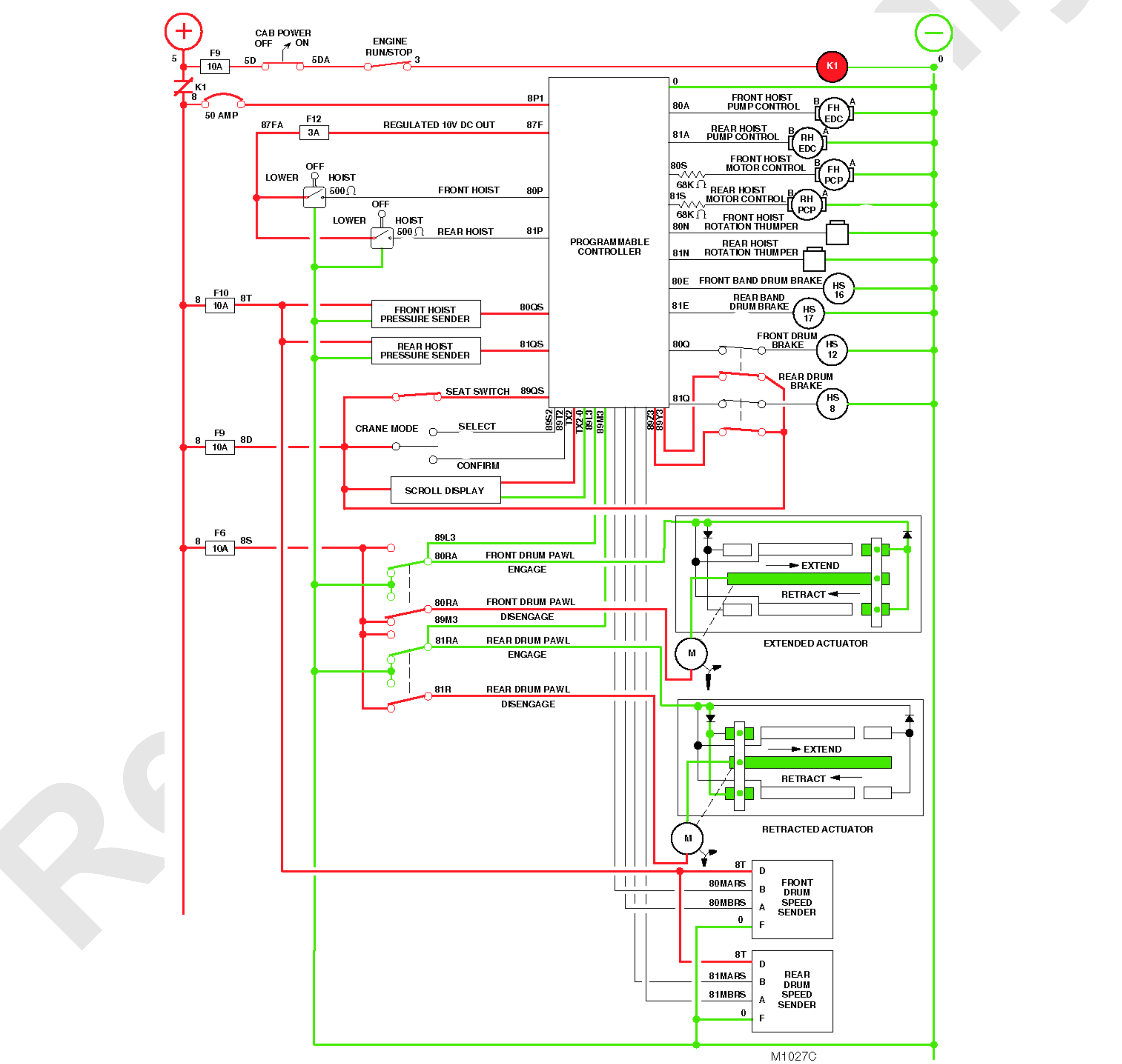


FIGURE 1-45

When luffing jib has been selected and confirmed at crane mode selector, and rear drum park brake switch, located on the front console in the operator's cab, is placed in the off position, the PC is prepared for any luffing commands received from rear hoist control handle. With control handle in the off position, the regulated voltage circuit for all luffing commands to the PC remains open. Rear drum park brake solenoid HS8 and rear drum band brake solenoid HS17 are not energized and the rear hoist pump does not stroke until the control handle is moved in either direction from off.

The description of all normal load handling operations with the rear drum in luffing mode are identical to those described for the front drum while performing liftcrane operations in full power mode.

Auxiliary Hoist System

See Figures 1-46 and 1-47 for following procedures.

If crane has an auxiliary hoist, its drum is located in boom butt.

Unlike all other system pumps, displacement in the auxiliary hoist pump is controlled by both coils in the EDC valve and function only with straight current rather than straight and reverse polarity.

If auxiliary hoist charge pressure is lost for any reason, auxiliary hoist park brake will apply to stop the hoist since the brake is directly sourced from this pressure.

Like all other crane systems, the hydraulic connection between auxiliary hoist pump and auxiliary hoist motor forms a simple closed-loop circuit. Make-up oil from auxiliary hoist charge pump replaces oil in the system that is primarily displaced due to internal leakage of the pump and motor assemblies.

If auxiliary drum park switch, located on the front console in the operator's cab, is placed in the on position, the auxiliary hoist control handle circuit to the PC opens and does not complete the circuit from the PC to auxiliary drum brake hydraulic solenoid HS9. Because these circuits are open, auxiliary drum park brake remains applied and auxiliary hoist pump will not stroke in response to movement of auxiliary hoist control handle.

The hydraulic actuation of auxiliary drum park brake is spring-applied/pressure released and controlled automatically by the PC in conjunction with movement of auxiliary hoist control handle. Release of brake is with auxiliary charge pressure and from low pressure side of its closed-loop circuit through check valve.

When releasing brake, charge pressure is directed into brake valve chamber through HS9. If the charge pressure drops to below 250 psi (17 bar), brake application begins, and if the pressure continues to drop to approximately 165 psi (11 bar) or lower, the brake is fully applied.

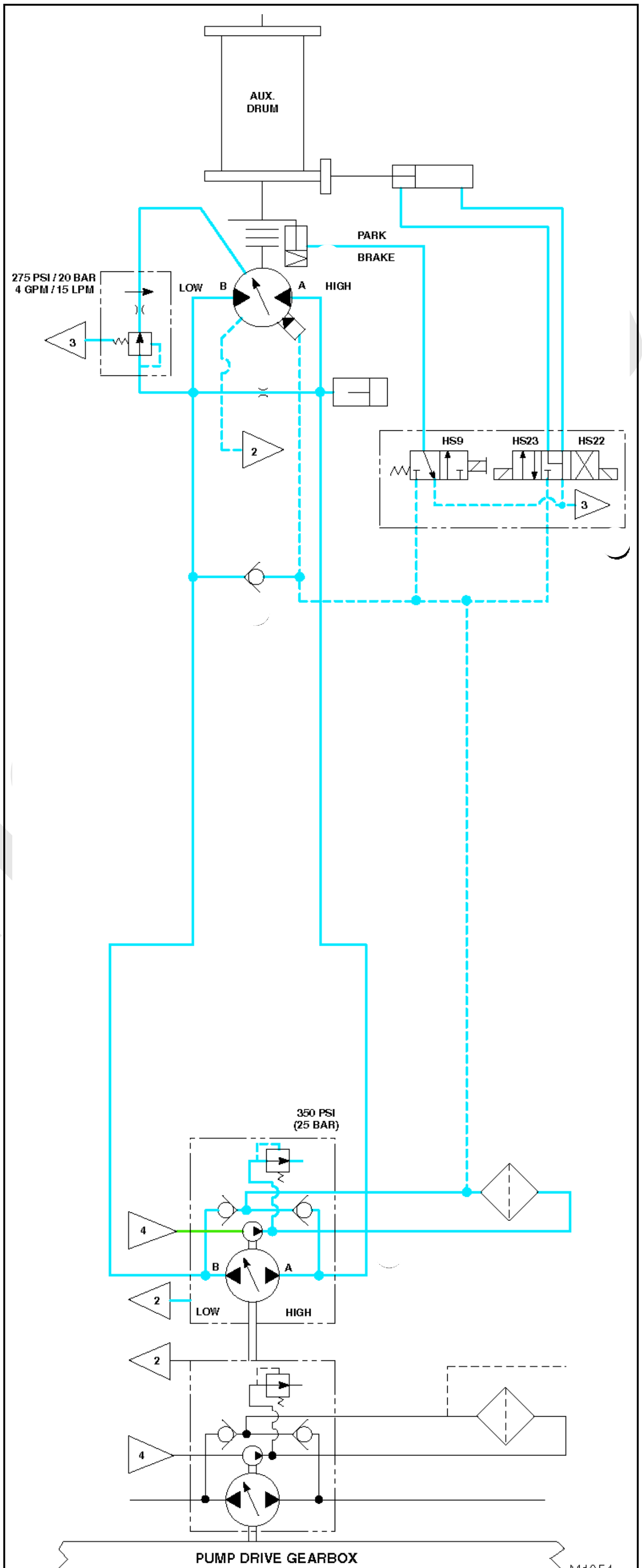


FIGURE 1-46

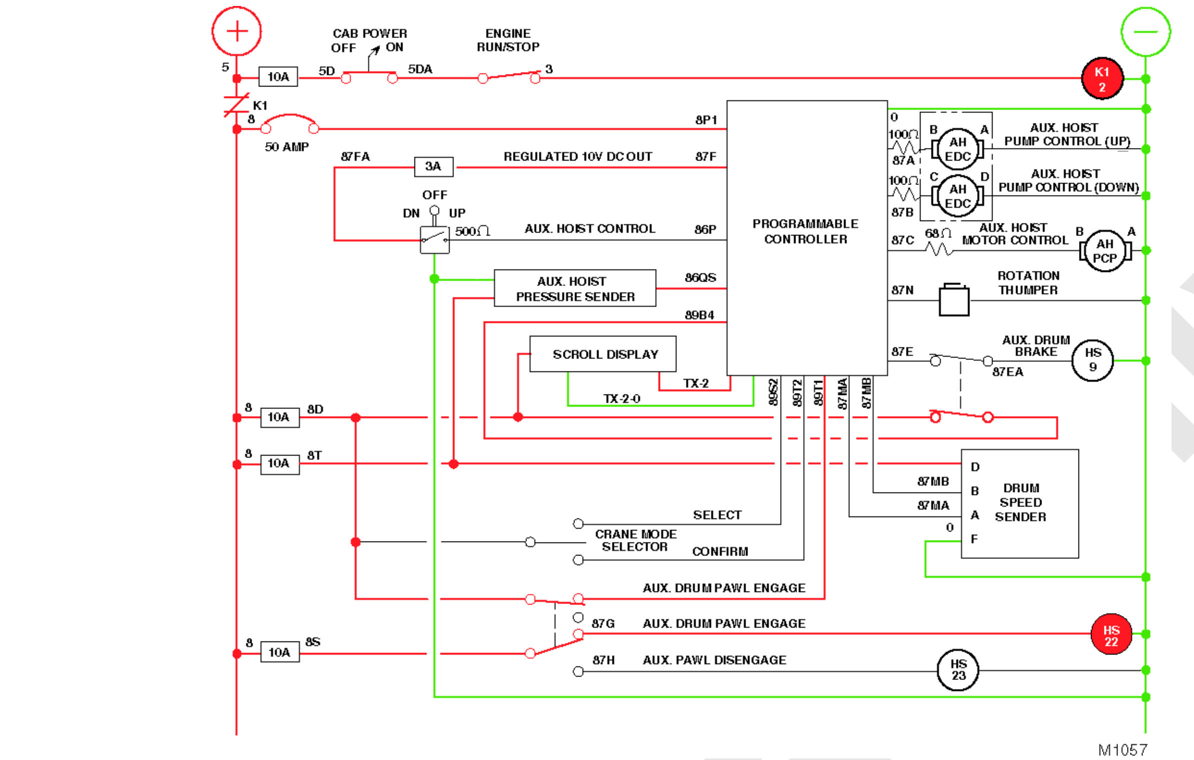


FIGURE 1-47

Auxiliary Hoist Rotation Indicator

Whenever the auxiliary drum rotates, auxiliary drum speed sender completes a circuit to the PC that activates rotation thumper in control handle. This causes rotation thumper to move up and down with a varying frequency that conveys the rotational speed of the drum to the operator.

Auxiliary Drum Pawl System

The ratchet and pawl mechanism provides a positive means of locking the position of auxiliary drum. The pawl system operates independently and is controlled by a 2-position double throw switch located on the front console.

The pawl should be used to maintain loadline locations, especially when the crane is in the park position or left unattended. Likewise, the front and rear drums should be used for locking the corresponding drum in position when not in use. The auxiliary drum pawl when selected to be operated must be disengaged before it can be rotated downward because the PC will not command release of the brake by energizing HS9 and command the auxiliary pump EDC to stroke the auxiliary pump in the down direction.

Should the pawl switch be accidentally activated, the PC program opens the circuits to the auxiliary drum brakes. The auxiliary drum brakes then apply.

Auxiliary Hoist Off

See Figures 1-46 and 1-47 for following procedures.

When auxiliary hoist control handle, located on the right console in the operator's cab, is in the off position, the handle neutral switch is open, the PC receives no voltage from the handle, and the PC opens the circuits to the auxiliary hoist pump EDC, auxiliary hoist motor PCP valve, and auxiliary drum brake hydraulic solenoid HS9. Because these circuits are open, auxiliary hoist pump does not stroke, auxiliary hoist motor remains at low speed, and auxiliary drum park brake remains spring-applied to prevent the auxiliary drum from turning.

Auxiliary Hoist Raise

See Figures 1-48 and 1-49 for following procedures.

When control handle is pulled back for up operation, the handle neutral switch closes, completing a regulated voltage circuit from the handle potentiometer to the PC. The PC interprets the signal for speed and direction and closes regulated voltage circuits to the auxiliary hoist pump (up) EDC, auxiliary hoist motor PCP and auxiliary drum park brake hydraulic solenoid HS9. These circuits will close only if the auxiliary drum park switch is off, applicable operating limit switches are closed, and no system or operating faults are present.

PC programming requires auxiliary hoist pump to stroke before the auxiliary drum park brake is released. This ensures adequate pressure is present to hold the load after full release of the park brake. The regulated voltage to the auxiliary hoist pump (up) EDC tilts the pump swashplate to stroke the pump in the up direction. Oil then flows from pump port A to port A of auxiliary hoist motor.

Auxiliary hoist pressure sender supplies the PC with pressure information, which the PC compares to the memorized holding pressure of the auxiliary hoist. When adequate pressure is available, the PC energizes HS9 to shift the brake valve. This initiates full release of park brake and auxiliary hoist motor raises the load.

The PC governs the raising speed of the load by varying the voltage to the pump (up) EDC in proportion to movement of the control handle. The angle of the pump swashplate is increased as the control handle is moved farther backward, pumping more oil to the motor and raising the load faster.

As control handle approaches the full handle command position, and if lifting conditions permit, the PC instructs the auxiliary hoist motor PCP valve to shift in proportion to handle position and redirect oil flow to motor servo cylinder. This allows the servo mechanism to shift the motor gradually toward to minimum displacement for maximum motor speed at less operating torque.

As control handle returns to the off position, the PC commands the auxiliary hoist pump (up) EDC to decrease the angle of the pump swashplate, causing a reduction in oil flow output. The PC also instructs the auxiliary hoist motor PCP valve to shift in proportion to handle position, the auxiliary hoist motor to maximum displacement for slower output speed to slow the drum rotation. When the control handle is fully off, the PC memorizes the pressure required to support the load and de-energizes HS9 to apply the brake after the control handle neutral switch opens or after receiving a zero command from drum speed sender.

Auxiliary Hoist Lower

See Figures 1-48 and 1-49 for following procedures.

When control handle is pushed forward for down operation, the handle neutral switch closes, completing a regulated voltage circuit from the handle potentiometer to the PC. The PC interprets the signal for speed and direction and closes regulated voltage circuits to the auxiliary hoist pump (down) EDC, auxiliary hoist motor PCP, and auxiliary drum park brake hydraulic solenoid HS9. These circuits will close only if the seat switch is closed, if the auxiliary drum park switch is off, the auxiliary drum pawl switch is disengaged, applicable operating limit switches are closed, and no system or operating faults are present.

Before the auxiliary drum brake is released, the PC supplies regulated voltage to the auxiliary pump (up) EDC. The PC programming requires auxiliary hoist pump to stroke momentarily in the hoisting direction to ensure adequate pressure is present to hold the load after full release of the brake.

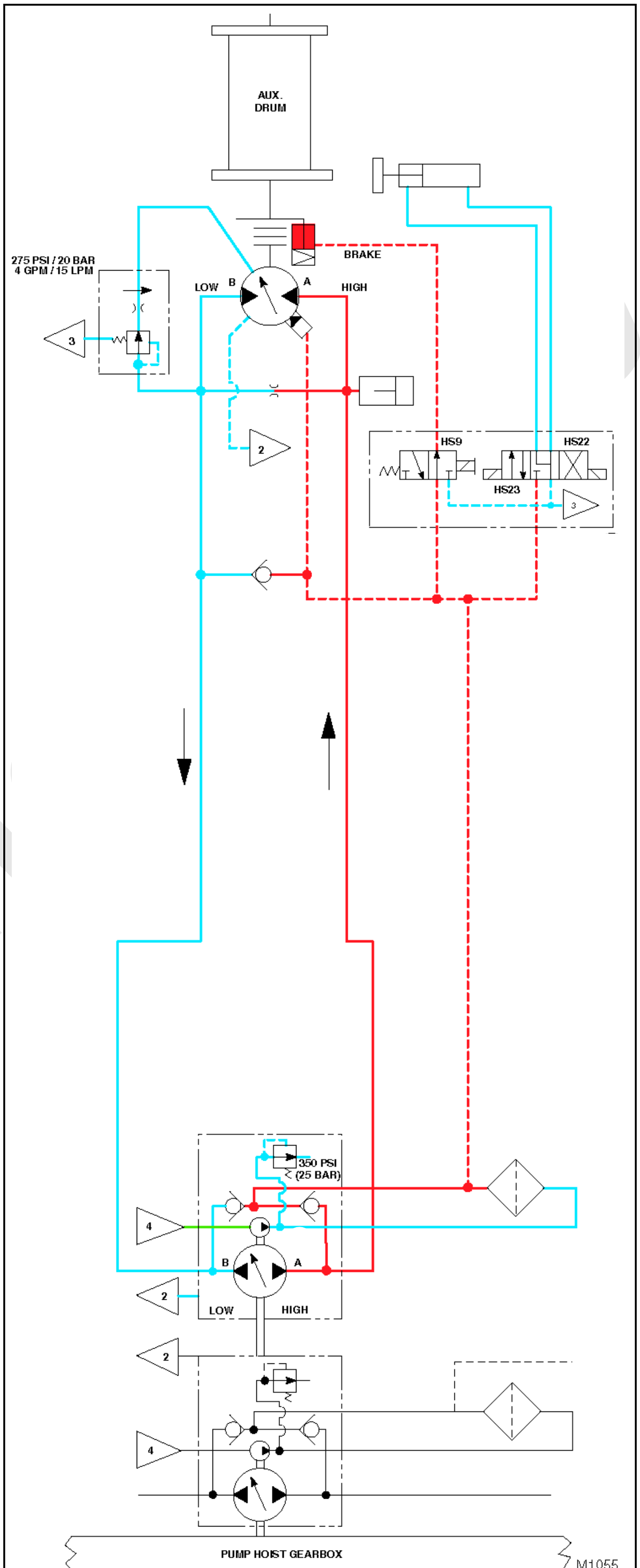


FIGURE 1-48

Auxiliary hoist pressure sender supplies the PC with pressure development data that the PC compares to the memorized holding pressure of the auxiliary hoist. When adequate pressure is available, the PC energizes HS9 to shift brake valve, releasing the drum brake while de-energizing the (up) EDC and energizing the (down) EDC. The regulated voltage to the auxiliary hoist pump (down) EDC then causes the swashplate to tilt, stroking the pump in the down direction and directing oil flow from pump port B to port B of auxiliary hoist motor.

The weight of the load on the auxiliary drum will attempt to drive the motor faster than return oil is available to the pump. The auxiliary hoist charge pump maintains the oil supply in the closed loop circuit at a positive pressure to auxiliary hoist motor.

The position of the pump swashplate restricts the returning oil flow and pressure builds on the return side of the closed-loop circuit, acting as a brake against the auxiliary hoist motor to control the lowering speed.

The PC governs the lowering speed of the load by varying the voltage to the pump (down) EDC in proportion to movement of the control handle. The angle of the pump swashplate increases as the control handle is moved farther forward; more oil is allowed to return to the pump, more oil is pumped to the motor, and the auxiliary drum lowers the load faster.

As control handle approaches the full handle command position, and if lifting conditions permit, the PC instructs the auxiliary hoist motor PCP valve to shift and redirect oil flow to motor servo cylinder. This allows the servo mechanism to shift the motor to minimum displacement for maximum motor speed and less operating torque.

As control handle returns to the off position, the PC commands the auxiliary hoist pump (down) EDC to decrease the angle of the pump swashplate, causing a reduction in oil flow output. The PC also instructs the auxiliary hoist motor PCP valve to shift auxiliary hoist motor to maximum displacement in proportion to return handle position for slower output speed to slow the drum rotation. When the control handle returns to the neutral handle position, the PC monitors the system pressure sender while de-energizing the (down) EDC and momentarily energizing the (up) EDC to develop the required pressure to support the load. The monitored load supporting pressure is retained in the pressure memory bank of the PC. The (up) EDC then de-energizes while HS9 de-energizes to set the brake after the control handle neutral switch opens or after receiving a zero command from drum speed sender.

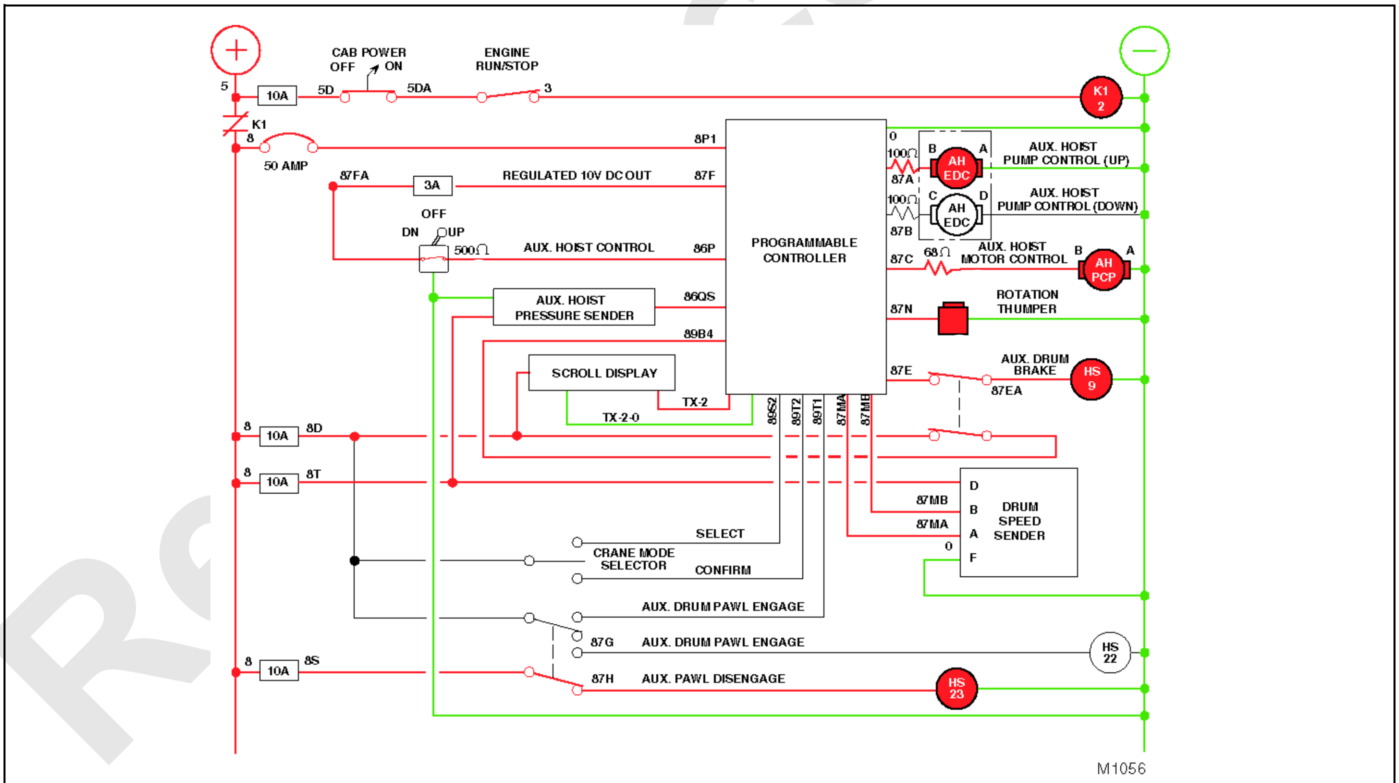


FIGURE 1-49

ABBREVIATIONS

Hydraulic Solenoid Valves

Item	Description
HS1	Travel Park Brake
HS7	Swing Park Brake
HS8	Rear/Luffing Drum Park Brake
HS9	Auxiliary Drum Park Brake
HS12	Front Drum Park Brake
HS13	Two-speed Travel
HS14	Swing Lock Engage
HS15	Swing Lock Disengage
HS16	Front Drum Band Brake
HS17	Rear Drum Band Brake
HS18	Boom Up Enable
HS19	Boom Down Enable
HS20	Front Drum Clutch
HS21	Rear Drum Clutch
HS22	Auxiliary Drum Pawl Engage
HS23	Auxiliary Drum Pawl Disengage

Pump and Motor Controls

Item	Description
AH	Auxiliary Hoist Pump
BH	Boom Hoist Pump
FH	Front Hoist Pump
LT	Left Travel Pump
RH	Rear Hoist Pump
RT	Right Travel Pump
S	Swing Pump

Abbreviations

Item	Description
ALT	Alternator
B1, B2	Motor
ED	Ether Disable
EDC	Electric Displacement Control (Pump)
EFC	Electronic Fuel Control
ELEC MOT	Electric Motor
ES	Ether Start
FS	Fuel Solenoid
FSR	Fuel Solenoid Relay
K1, K2	Contactor
M	Motor
M/C	Motor Control
MS	Motor Starter Solenoid
PC	Programmable Controller
P/C	Pump Control
PCOR	Pressure Compensated Over-Ride (Motor)

NOTE 1: Closed in reference to an electric system means current can flow.

NOTE 2: Closed in reference to an air or hydraulic system means air or oil cannot flow.

NOTE 3: All solenoid valves are 2-position valves.

SECTION 2
HYDRAULIC SYSTEM

TABLE OF CONTENTS

SECTION 2
HYDRAULIC SYSTEM

HYDRAULIC SCHEMATICS

Applicable hydraulic schematics are attached at the end of this section.

HYDRAULIC SYSTEM – GENERAL

This section contains hydraulic system maintenance, adjustment, and test procedures for the hydraulic system and related components on the Model 777.

Experienced technicians, trained in the operation of this crane and its hydraulic system, shall perform the procedures described this section. The technicians shall read, understand, and comply with the instructions in this section and with the display screen instructions in Section 3 of this manual.

Contact Manitowoc Crane Care for an explanation of any procedure not fully understood.

Adjustments in this section were made to the crane before it was shipped from the factory. Adjustments by field personnel should be required only when parts are replaced or when instructed by Manitowoc Crane Care.

CAUTION

Do not alter hydraulic system specifications given in this section without approval of Manitowoc Crane Care.

Damage to hydraulic components and improper operation of crane can occur if specifications are altered.

CHECKING AND REPLACING HYDRAULIC HOSES

CAUTION

Burn Hazard!

Oil in hydraulic tank may be under pressure and extremely hot.

Ensure that the hydraulic hose is depressurized before loosening any connections.

1. Visually inspect all hydraulic hose assembles every month or at 250 hours of service life for the following:
    - **a.** Leaks at hose fittings or in hose.
    - **b.** Damaged, cut or abraded cover.
    - **c.** Exposed reinforcement.
    - **d.** Kinked, crushed, flattened or twisted hose.
    - **e.** Hard, stiff, heat cracked or charred hose.
    - **f.** Blistered, soft, degraded, or loose cover.
    - **g.** Cracked, damaged or badly corroded fittings.
    - **h.** fitting slippage on hose.
    - **i.** Other signs of significant deterioration.

    If any of these conditions exist, evaluate the hose assemblies for correction or replacement.

2. At the same service interval, visually inspect all other hydraulic components and valves for the following:
    - **a.** Leaking ports.
    - **b.** Leaking valve sections or manifolds and valves installed into cylinders or onto motors.
    - **c.** Damaged or missing hose clamps, guard or shields.
    - **d.** Excessive dirt and debris around hose assemblies.

    If any of these conditions exist, address them appropriately.

    See Table 2-1 below for following items.

3. Hydraulic hose assembles operating in a temperate climate ***zone C*** are recommended to be replaced after 8,000 hours of service life.
4. Hydraulic hose assembles operating in climate ***zone A*** and ***zone B*** with high ambient temperatures and high duty circuits could see hose service life reduced by 40% to 50%. High duty circuits can include, but are not limited to hoist(s), boom lift, swing, travel, pump suction and discharge to directional valves and directional valve return to reservoir. It is recommended to replace these hoses after 4,000 to 5,000 hours of service life.

Table 2-1 Climate Zone Classification:

Item	Description
A	Tropical Moist: All months average above 65° F (18° C). Latitude: 15° - 25° N & S
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° - 35° N & S
C	Moist Mid-Latitude: Temperate with mild winters. Latitude: 30° - 50° N & S
D	Moist Mid-Latitude: Cold winters. Latitude 50° - 70° N & S
E	Polar: Extremely cold winters and summers. Latitude: 60° - 75° N & S

5. Hydraulic hose assembles operating in climate ***zone D*** and ***zone E***, cold climates, should expect a degrade of

mechanical properties and long term exposure to these cold temperatures will negatively impact service life. It is recommended for these hoses to be inspected to step 1 above as service life may be more than 8,000 hours.

HYDRAULIC SYSTEM MAINTENANCE

Safety

Lower or securely block hydraulically operated attachments and loads before servicing. Do not rely on controls to support attachments or loads.

Stop engine and relieve hydraulic pressure to zero before servicing or disconnecting any part of hydraulic system. After stopping engine, operate controls in both directions to relieve pressure.

Before servicing hydraulic system, attach warning sign to engine start controls to warn other personnel not to start engine.

Do not perform hydraulic system maintenance, adjustment or repair procedures unless authorized to do so. And then, make sure all applicable instructions have been read and are thoroughly understood.

Do not alter specified pressure settings. Higher than specified pressures can cause structural or hydraulic failure. Lower than specified pressures can cause loss of control.

Never check for hydraulic leaks with hands. Oil under pressure can penetrate skin, causing serious injury. Oil escaping from a small hole can be nearly invisible so check for leaks with a piece of cardboard or wood.

Storing and Handling Oil

- Store oil drums in clean, cool, dry location. ***Avoid outdoor storage***.
- Store oil drums on their side and cover them to prevent water and dirt from collecting on them.
- When handling drums and transfer containers, use care to avoid damage which can cause leaks and entry of dirt or water into oil.
- Before opening a drum, carefully clean top of it. Also clean faucet or pump to remove oil from drum.
- Only use clean transfer containers.
- Do not take oil from storage until oil is needed. If oil cannot be used immediately, keep transfer container tightly covered.

Storing and Handling Parts

- Store new parts (valves, pumps, motors, hoses, tubes) in clean, dry indoor location.
- Do not unpack parts or remove port plugs until parts are needed.
- Once unpacked, carefully inspect each part for damage that may have occurred during shipping. Remove all shipping material from ports of parts before installing.
- Fittings, hoses, and tubes that do not have shipping caps or plugs must be cleaned before they are used. Flush fittings, hoses, and tubes with clean hydraulic oil. Then seal all openings until use at assembly.
- Do not use rags to plug openings. Use clean plastic shipping plugs and caps.

Inspecting System

The damaging effects of dirt, heat, air, and water in the hydraulic system can only be prevented by regular, thorough inspection of the system. The frequency of inspection depends on operating conditions and experience with the system; however, the more often the system is inspected and deficiencies corrected, the less likely the system will malfunction.

1. A good inspection program will include the following checks:

   a. Keep accurate records so future maintenance needs can be projected.

   b. Only use approved hydraulic oil in system (see Section 9, Lubrication in this manual).

   c. Check oil level in tank daily. Carefully clean area around fill cap before removing it to add oil. When adding oil to tank, filter oil through 10-micron filter.

   d. Clean exterior of system often; do not let dirt accumulate on or around any part of system.

2. Check for external leaks. Leaks are not only unsafe; they also attract dirt and in some cases allow air and water to enter system. Do not return leakage oil back to hydraulic tank.

   a. Do not to use your hands to check for leaks.

   b. Look for oil leaking from fittings and from between parts that are bolted together. Tighten loose fittings and attaching bolts to proper torque; do not overtighten.

   c. If leakage persists at these points, replace seals or gaskets.

   d. Look for oil leaking from pump and motor shaft ends, from valve spool ends, and from cylinder shaft ends. Replace seal if leakage is found at any of these points.

   e. Replace tubes that are cracked, kinked, or bent.

   f. Replace hoses that are cracked, split, or abraded.

3. Listen to pumps and motors for unusual noises; a high pitched whine or scream can indicate that air is being drawn in.
   a. An air leak can be pinpointed by flooding inlet fitting, hose, or tube with oil. If there is an air leak, the oil will cause a noticeable reduction in noise.
   b. Correct cause for any air leak, or pump/motor will be ruined.
4. A high pitched whine or scream from the pump can also indicate cavitation (pump being starved of oil). This condition is caused by the following problems:
   a. Plugged suction filter.
   b. Collapsed or plugged suction line.
   c. Wrong oil (viscosity too high).
5. Look for signs of overheating: heat peeled parts, burned and scorched oil odor, and darkening and thickening of oil. Maximum temperature of oil in tank must not exceed 180°F (82°C).
6. Have hydraulic oil analyzed at regular intervals to determine condition of oil and extent of system contamination.

   By having the oil analyzed on a regular basis, an oil change interval meeting your operating conditions can be established.

   Contact your oil supplier for the availability of oil analysis services and the steps that should be taken to obtain these services.

Servicing Pumps

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, close the shut-off valve (Figure 2-4, View C) in the pump suction manifold.

Open the valve before starting the engine after servicing the pumps. The valve has a latch that allows the valve to be locked open with a padlock installed.

CAUTION

Avoid Damage to Pumps!

Open shut-off valve at hydraulic tank (Figure 2-4, View C) and at Filter 1 (Figure 2-2, View B) before starting engine. Failing to perform this step will cause damage to pumps from cavitation.

Cleaning Fill Cap Assembly

1. Clean fill cap monthly to ensure that ventilating ports in fill cap remain open.
   a. Clean area around fill cap assembly.
   b. Remove fill cap from flange (see Figure 2-1).
   c. Thoroughly clean fill cap with clean, nonflammable solvent. Blow dry with compressed air.
   d. Reattach fill cap to flange.

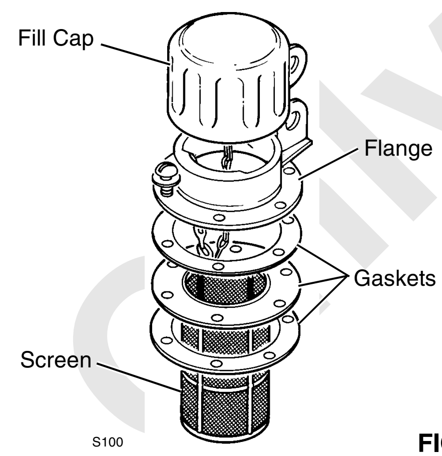


FIGURE 2-1

2. Clean entire fill cap assembly whenever hydraulic oil is changed.
   a. Clean area around fill cap assembly.
   b. Disassemble fill cap assembly (see Figure 2-1).
   c. Clean fill cap and screen in clean, nonflammable solvent and blow dry with compressed air.
   d. Replace screen if it is damaged.
   e. Install new gaskets, if necessary.
   f. Assemble screen, gaskets, and flange to tank; tighten screws evenly.
   g. Securely fasten fill cap to flange.

Replacing Filter Elements

This topic contains procedures for replacing the following hydraulic filter elements (see Figure 2-2):

- Filter 1 for supercharge system.
- Filter 2 for accessory system.
- Filters 3 and 4 for drums.

System fault alert will come on in operator's cab when any filter is plugged with dirt (see Operating Controls or Digital Display Readings in Section 3 of Crane Operator's Manual). Alert indicates which filter needs servicing.

It is normal for alert to come on at start-up when oil is cold. If filters are not plugged, alert will turn off after hydraulic oil warms up.

NOTE: Filter 5 (not shown) in suction line to pumps is located in hydraulic tank. Tank must be drained to clean filter. See procedures under Changing Oil.

Filter 1

See Figure 2-2 for following procedure.

1. Stop engine.
2. Close shut-off valve at filter inlet (turn clockwise). Oil in hydraulic tank will drain if filter is removed while valve is open.
3. Place a container below filter element to catch oil.
4. Clean area around filter element and filter housing.
5. Using filter wrench, loosen filter element.
6. Remove filter element and discard.

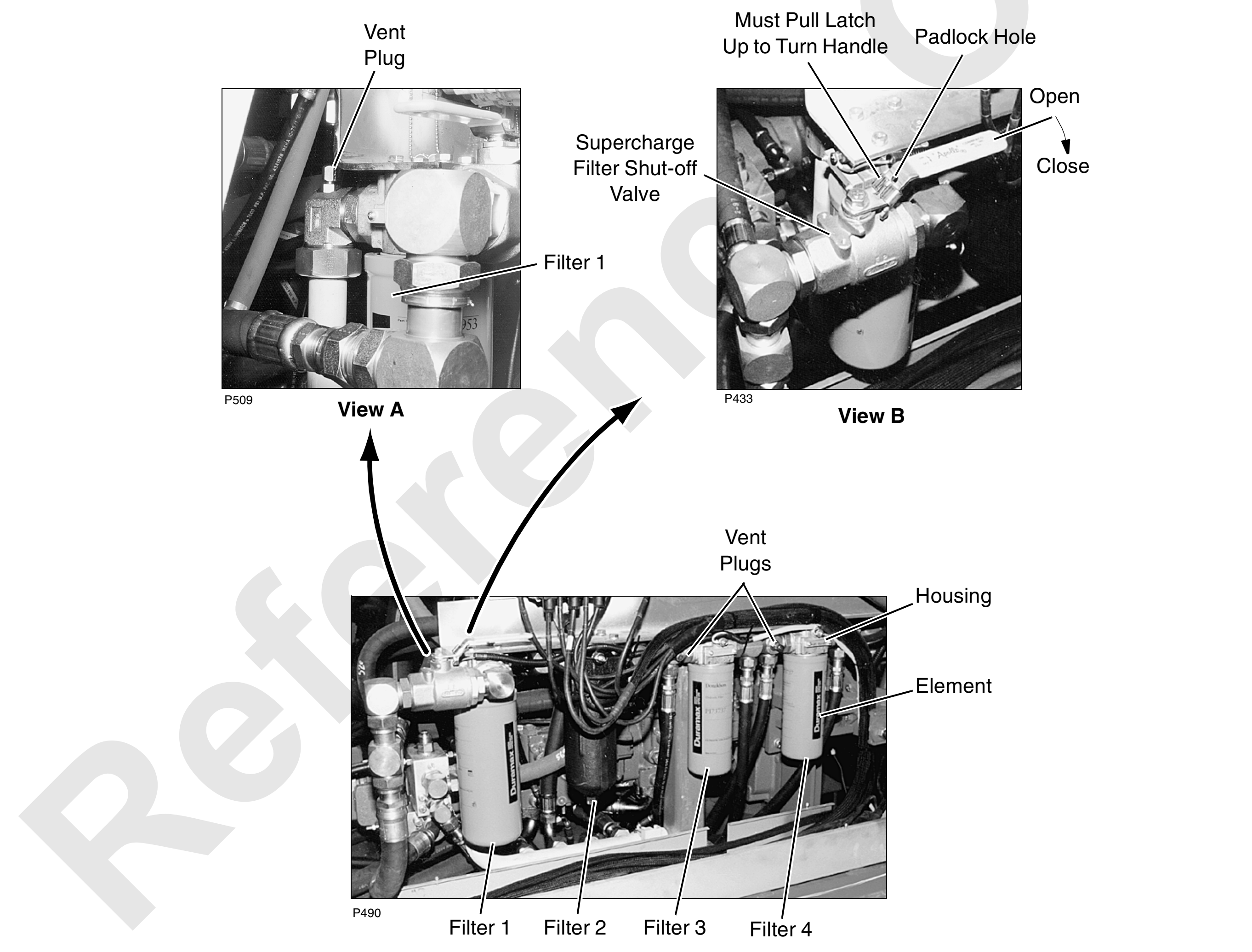


FIGURE 2-2

7. Lubricate seal on new filter element with clean hydraulic oil.
8. Install new filter element hand tight on filter housing. ***Do not fill new element with oil.***
9. Using a filter wrench, tighten element an additional 1/4 turn.
10. Loosen vent plug at outlet port of filter housing (Figure 2-2, View A).
11. Open shut-off valve at filter inlet (turn counterclockwise) and allow hydraulic oil from tank to fill filter element.
12. Watch for oil coming from vent plug at filter outlet (Figure 2-2, View A).
13. Securely tighten vent plug when oil appears. This filter supplies oil to charge pump inlets. ***It is important that this filter be full before starting engine. If filter is not full, air will be pumped into hydraulic system.***
14. Start engine and allow hydraulic system pressure and temperature to rise to normal.
15. Check filter element for leaks. Repeat step 9 if element is leaking.

Filter 2

See Figure 2-3 for following procedure.

1. Clean area around filter bowl and head.
2. Place a container below bowl to catch oil.
3. Open drain plug at bottom of bowl and drain oil into container.
4. Using a filter wrench, loosen bowl.
5. Remove bowl. Element will remain attached to head.
6. Remove filter element and discard.
7. Lubricate new O-ring with clean hydraulic oil and install in bowl.
8. Push new filter element into head and seat element.
9. Fasten bowl hand tight on head. ***Do not fill bowl with oil.***
10. Using a filter wrench, tighten bowl an additional 1/4 turn.
11. If necessary, install a new O-ring on drain plug and securely install drain plug in bottom of bowl.
12. Start engine and allow hydraulic system pressure and temperature to rise to normal.
13. Check filter bowl for leaks. Repeat step 10 if element is leaking.

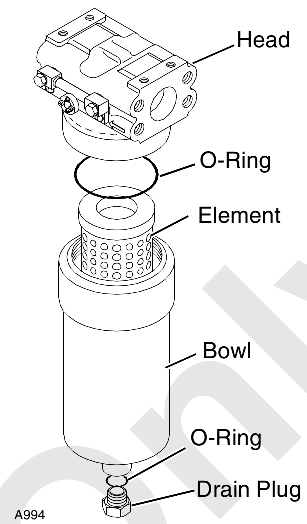


FIGURE 2-3

Filters 3 and 4

See Figure 2-2 for following procedure.

1. Stop engine.
2. Place a container below filter element to catch oil.
3. Clean area around filter element and filter housing.
4. Using a filter wrench, loosen filter element.
5. Remove filter element and discard.
6. Lubricate seal of new filter element with clean hydraulic oil.
7. Install new filter element hand tight on filter housing. ***Do not fill new element with oil.***
8. Using a filter wrench, tighten element an additional 1/4 turn.
9. Start engine and allow hydraulic system pressure and temperature to rise to normal.
10. Check filter element for leaks. Repeat step 8 if element is leaking.

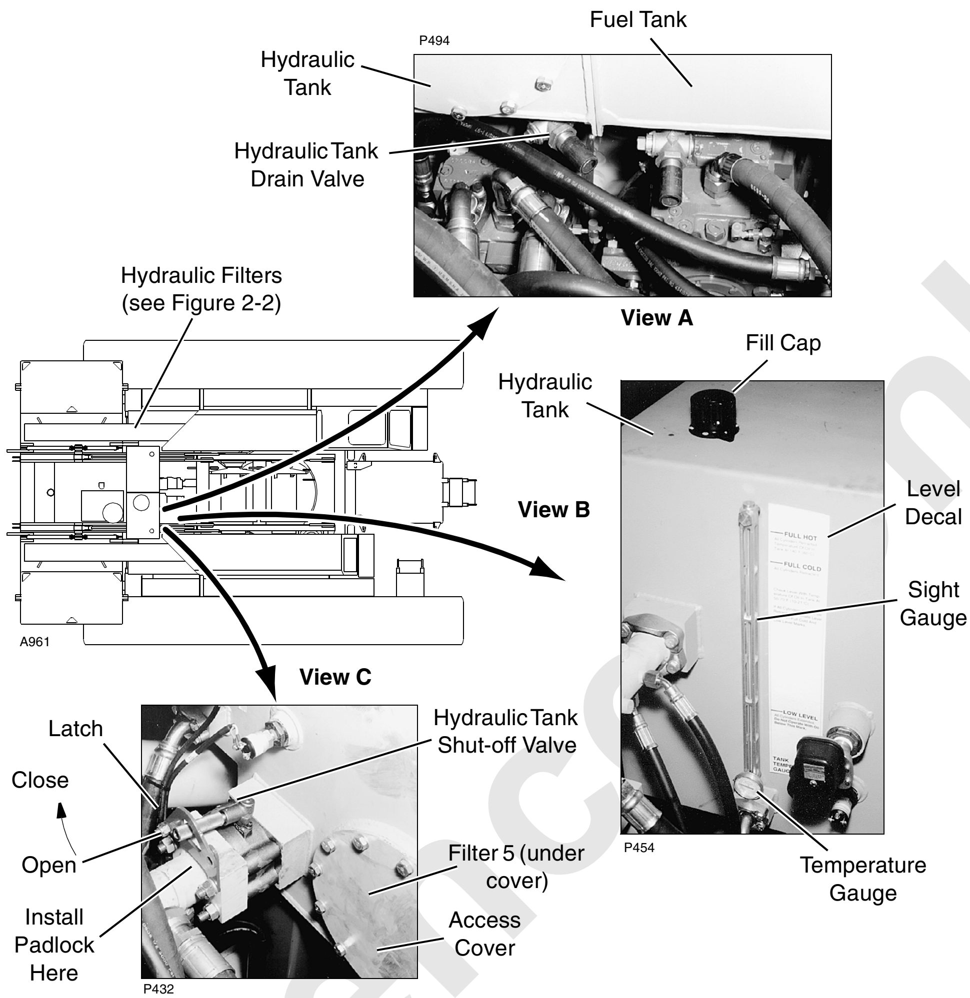

Fuel Tank
P494
Hydraulic Tank
Hydraulic Tank Drain Valve
Hydraulic Filters (see Figure 2-2)
View A
Fill Cap
Hydraulic Tank
Level Decal
View B
Sight Gauge
A961
View C
Hydraulic Tank Shut-off Valve
Latch
Close
Open
Filter 5 (under cover)
P454
Temperature Gauge
Install Padlock Here
Access Cover
P432

FIGURE 2-4

Changing Oil

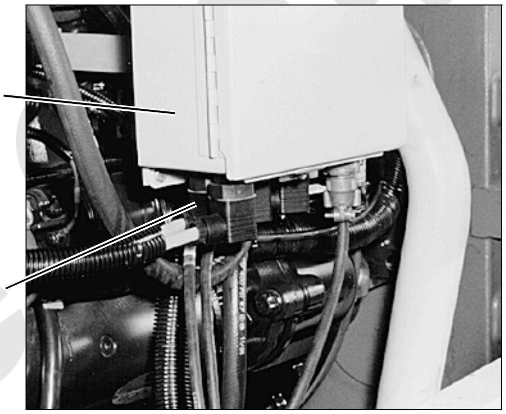
Drain and refill hydraulic system every 1,000 hours or semiannually, whichever comes first, unless an alternate interval is established through an oil analysis program.

CAUTION

Equipment Damage!

Be sure to drain oil from and add oil to hydraulic tank, not fuel tank. The two tanks are next to each other on right side of crane. Hydraulic tank is right tank.

1. Operate crane until hydraulic oil is at normal operating temperature. This will help prevent impurities from settling in system.
2. Stop engine.
3. Open drain valve (Figure 2-4, View A) on hydraulic tank to completely drain tank. Catch oil in suitable containers. Tank capacity is 120 gallons (454 liters).
4. Clean all dirt off access covers on tank. Remove all three covers. Take precautions to prevent dust and wind-blown dirt from entering tank while covers are off.
5. Flush out any sediment inside tank.
6. Using a wrench, remove Filter 5 from inside tank. Filter 5 is accessible through cover on front of tank (Figure 2-4, View C).
7. Soak Filter 5 in clean, nonflammable solvent. Brush off outer surface, and flush from inside out. Replace if damaged.
8. Reinstall Filter 5.
9. Use new seals and securely fasten access covers to tank.
10. Clean fill cap assembly (Figure 2-1).
11. Replace all filter elements (Figure 2-2).
12. Open shut-off valve at tank (Figure 2-4, View C).
13. Check that engine clutch is engaged.
14. Open shut-off valve at Filter 1 (Figure 2-2, View B).
15. Loosen vent plug at Filter 1 (Figure 2-2, View A).
16. Loosen vent plugs at Filters 3 and 4 (Figure 2-2).
17. Fill hydraulic tank to proper level as indicated on decal next to tank sight gauge (Figure 2-4, View B). Use proper hydraulic oil (see Lubrication Guide in Section 9 of this manual). Filter oil with a 10-micron element as oil is added to tank.
18. Monitor vent plug at Filter 1 (Figure 2-2). Oil will flow by gravity to vent plug. Tighten vent plug once oil appears.
19. Disconnect engine fuel solenoid electrical plug from junction box on right side of engine (Figure 2-5). This step is required to keep engine from starting while filling Filters 3 and 4.



Right Side of Engine

FIGURE 2-5

20. Crank engine for 10 seconds. Oil should appear at vent plugs at Filters 3 and 4 (Figure 2-2). If oil does not appear, crank engine for 10 more seconds. Tighten vent plugs once oil appears.
21. Reconnect engine fuel solenoid electrical plug to junction box on engine (Figure 2-5).
22. Start and run engine at low idle for 10 – 15 minutes to fill all lines with oil and bleed any remaining air from system.
23. Stop engine and fill hydraulic tank to proper level as indicated on sight gauge (Figure 2-4, View B).

NOTE: If hydraulic system is extremely dirty (gum or lacquer formation on parts indicated by erratic, jerky, or sluggish operation) repeat Changing Oil procedure after 48 hours of operation.

Tightening Hydraulic Connections

- Make sure fittings and O-rings being used are proper size and style.
- Flush sealing surfaces with clean hydraulic oil to remove any dirt.
- Carefully inspect threads and sealing surfaces for nicks, gouges, and other damage. Do not use damaged parts; they will leak.
- Carefully inspect O-rings for cuts and other damage. Do not use damaged O-rings; they will leak.
- Always lubricate O-rings when assembling to fittings.
- Be careful not to cut O-rings when assembling to fittings. Use thimble as shown in Figure 2-6 when assembling O-ring over threads.

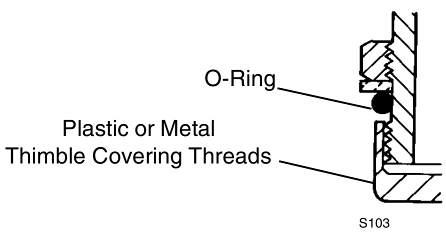


FIGURE 2-6

Pipe Thread Connection

1. Apply sealant (Loctite 92 or equivalent) to male threads, never to female threads. Do not apply sealant to first two male threads.

CAUTION

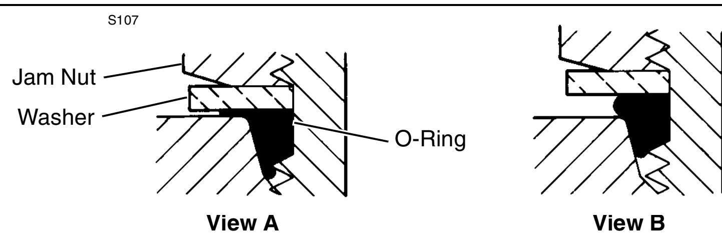
Hydraulic System Damage!

Do not use FTE- fluorocarbon tape to seal threads; pieces of tape will enter hydraulic system and cause damage.

2. Tighten fittings about 4-1/2 turns by hand and then 3 additional turns with a wrench.

Table 2-2
Pipe Thread Leakages

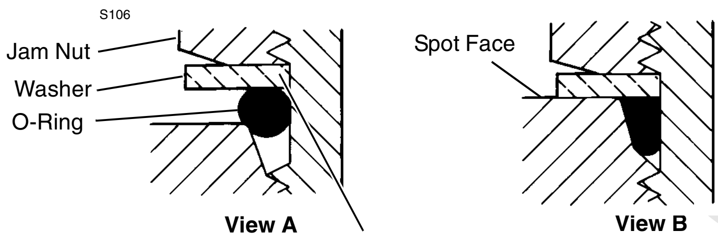
Causes	Cures
Fitting loose.	Tighten.
Fitting too tight causing thread distortion.	Replace damaged parts.
Threads on fitting or in port wrong size.	Use proper size threads.
Threads dirty, galled or nicked.	Clean or replace parts.
Straight thread used instead of tapered thread.	Use proper type and size thread.
Female threads expanded from heat.	Tighten when hot.
Fitting loosened by vibration.	Retighten.



When jam nut and washer are not backed up, there is not enough room for O-ring when squeeze takes place.

Washer cannot seat properly on spot face. Compressed rubber between washer and spot face will cold flow out of compression, causing fitting to loosen and leak.

FIGURE 2-7



Nut and washer backed up to end of smooth portion on fitting.

FIGURE 2-8

SAE Straight Thread Connection

This type connection leaks most often because the jam nut and washer are not backed up before assembly.

When the jam nut and washer are not backed up, there is not enough room for the O-ring when the squeeze takes place and the washer cannot seat properly as shown in Figure 2-7, View A. The compressed rubber between the washer and the spot face will cold flow out of compression, causing the fitting to loosen and leak as shown in Figure 2-7, View B.

Tighten SAE straight thread connections, as follows:

1. Back up jam nut and washer to end of smooth portion on fitting as shown in Figure 2-8, View A.

2. Lubricate O-ring with clean oil; this is very important.

3. Thread fitting into port until washer bottoms against spot face as shown in Figure 2-8, View B.

NOTE: If an elbow is being used, back it out as necessary to align it with hose.

4. Tighten jam nut. When fitting is properly installed, O-ring will completely fill seal cavity and washer will be tight against spot face as shown in Figure 2-8, View B.

Table 2-3
Straight Thread Leakage

Causes	Cures
Jam nut and washer not backed up, causing O-ring to be pinched.	Replace O-ring and tighten fitting properly.
O-ring cut.	Replace.
O-ring wrong size.	Replace with proper size.
Sealing surfaces gouged or scratched.	Repair if possible or replace damaged parts.
Sealing surfaces dirty.	Clean and lubricate.

ORS Connection

NOTE: ORS is the registered trade mark for a face-type seal manufactured by Aeroquip Corporation.

- Lubricate and install O-ring in adapter groove (Figure 2-9).
- Lubricate threads.
- Tighten nut to torque value given in Table 2-4.

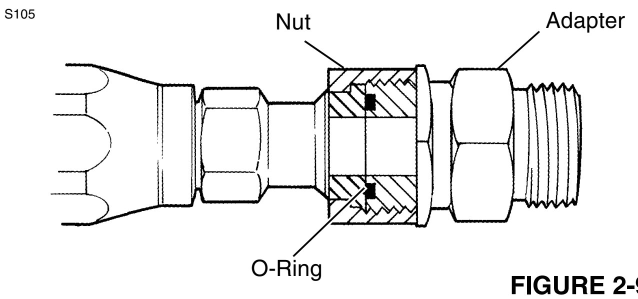


FIGURE 2-9

Table 2-4
ORS Assembly Torque

Nut Size inch across flats	**Fitting Size**	**Torque** in-lb	**Torque** Nm
5/8	-04	120 – 145	14 – 16
13/16	-06	203 – 245	23 – 28
15/16	-08	380 – 470	43 – 53
1-1/8	-10	550 – 680	62 – 77
1-3/8	-12	763 – 945	86 – 107
1-5/8	-16	1110 – 1260	125 – 142
1-7/8	-20	1500 – 1680	170 – 190

Table 2-5
ORS Leakage

Causes	**Cures**
Nut Loose.	Tighten to proper torque.
O-ring cut.	Replace.
O-ring wrong size.	Replace with proper size.
Sealing surfaces gouged or scratched.	Repair if possible or replace damaged parts.
Sealing surfaces dirty.	Clean and lubricate.

Split Flange Connection

Lubricate and install O-ring in shoulder groove (see Figure 2-10).

1. Align shoulder with port and assemble flanges over shoulder.
2. Bolts used must be grade-5 or better. Grade-5 bolt has three dashes in head.
3. Snug bolts in a diagonal manner (see Figure 2-10) to 1/3 of torque given in Table 2-6.
4. Repeat step 3 to 2/3 of final torque. Repeat step 3 to final torque.

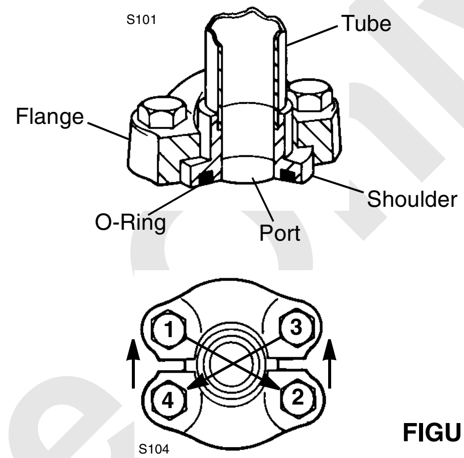


FIGURE 2-10

Table 2-6
Split Flange Assembly Torque

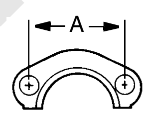
"A" Dimension (inch) 	**Flange Size**	**Torque** in-lb	**Torque** Nm
Standard Pressure Series			
1-1/2	-08	175 – 225	20 – 25
1-7/8	-12	225 – 350	25 – 40
2-1/16	-16	325 – 425	37 – 48
2-5/16	-20	425 – 550	48 – 62
2-3/4	-24	550 – 700	62 – 79
3-1/16	-32	650 – 800	73 – 90
High Pressure Series			
1-9/16	-08	175 – 225	20 – 25
2	-12	300 – 400	34 – 45
2-1/4	-16	500 – 600	57 – 68
2-5/8	-20	750 – 900	85 – 102
3-1/8	-24	1400 – 1600	158 – 181
3-13/16	-32	2400 – 2600	271 – 294

Table 2-7
Split Flange Leakage

Causes	Cures
Flanges not tight.	Tighten bolts evenly to proper torque.
Flanges tightened unevenly causing extrusion of O-ring.	Replace O-rings. Tighten bolts evenly to proper torque.
O-ring cut.	Replace.
O-ring wrong size.	Replace with proper size.
Sealing surfaces not smooth; scratched or gouged.	Repair if possible or replace parts.
Sealing surfaces dirty.	Clean.
Flanges keep getting loose in service.	Use SAE grade 5 bolts or better. Retighten bolts after system is hot.

SAE Flare Connection

1. Tighten nut finger tight until sealing surfaces touch.
2. Mark a line (use felt pen or marker) on adapter and extend it onto connector nut (Figure 2-11, View A).
3. Using wrenches, tighten connector nut the number of flats shown in Table 2-8 (Figure 2-11, View B).
4. Misalignment of marks will show how much nut has been tightened, and that it has been tightened.

Table 2-8
SAE 37° Flare Tightening

Connector Nut Size inch across flats	Fitting Size	Adapter Flats to Rotate
9/16	-04	2-1/2
5/8	-05	2-1/2
11/16	-06	2
7/8	-08	2
1	-10	1-1/2 – 2
1-1/4	-12	1
1-1/2	-16	3/4 – 1
2	-20	3/4 – 1
2-1/4	-24	1/2 – 3/4

Table 2-9
SAE 37° Flare Leakage

Causes	Cures
Joint loose.	Tighten properly.
Sealing surfaces dirty.	Clean.
Sealing surfaces not smooth; scratched or gouged.	Replace faulty parts.
Sealing surfaces cracked.	Replace faulty parts.
SAE 45° parts used with SAE 37° parts.	Use only SAE 37° parts.

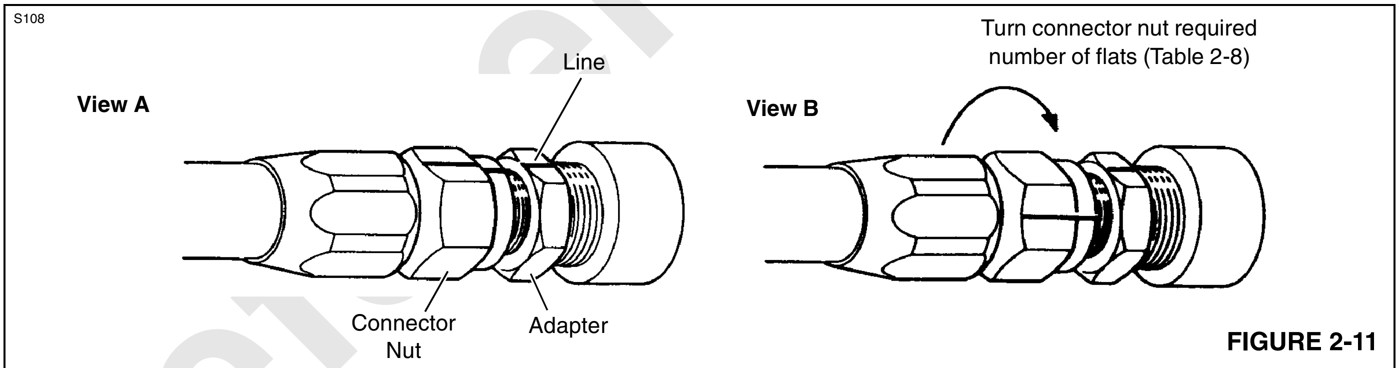


FIGURE 2-11

PROGRAMMABLE CONTROLLER CALIBRATION PROCEDURES

To ensure proper operation of the crane functions, the controls and pressure senders must be properly calibrated as described below.

Controls Calibration

The controls must be calibrated at the following intervals:

- When a pump is replaced.
- When a pump control (EDC or PCP) is replaced.
- When a new programmable controller is installed.
- When a new CPU board is installed.
- When a new controller chip is installed.
- When there is a noticeable increase in the time it takes a crane function to engage when the handle is pulled back from off.
- Every 6 months.

To calibrate the controls, proceed as follows:

1. Engage swing lock.
2. Calibrate pressure senders.
3. Start and run engine at:
   - 1,900 rpm or higher for past production units (Tier 1 engine).
   - 1,600 rpm or higher for current production units (Tier 2 and 3 engine).
4. Depress and hold swing holding brake switch (on swing handle) for ONE MINUTE.
5. Repeat steps 3 and 4 a second time.

Pressure Sender Calibration

The pressure senders must be calibrated (zeroed) at the following intervals:

- When a new programmable controller is installed.
- When a new CPU board is installed.
- When a new controller chip is installed.
- When a pressure sender is replaced (see Pressure Sender Replacement in this section for procedure).
- When displayed pressure is wrong.
- Every 6 months.

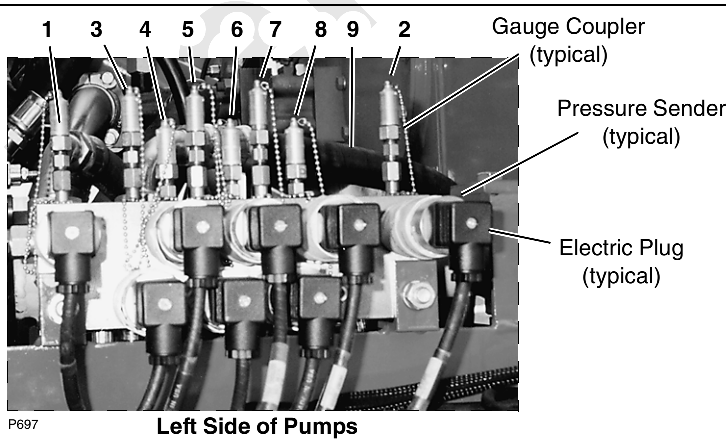
To calibrate the pressure senders, proceed as follows:

1. Stop engine.
2. Turn ON cab power switch.
3. Turn crane mode selector key counterclockwise to CONFIRM position and hold.
4. Press engine run/stop switch to RUN position.
5. Continue to hold crane mode selector key in CONFIRM position for ONE MINUTE after performing step 4. Repeat steps 3 and 4 a second time.
6. Confirm that pressure senders are properly calibrated by checking charge pressure on diagnostic screens of digital display (see Section 10 in this manual):
   a. With engine off (key in RUN), charge pressure for each crane function should be 50 psi (3.4 bar) or less.
   b. With engine running, charge pressure for each crane function should be within normal operating range – approximately 275 (19.0 bar) at low idle to 400 psi (27.6 bar) at high idle.

PRESSURE SENDER REPLACEMENT

The instructions in this topic must be followed to ensure safe removal of faulty pressure senders and to ensure proper operation after installation of new pressure senders.

See Figure 2-12 for identification of the pressure senders.



Left Side of Pumps

Item	Description
1	Left Track Forward/Reverse
2	Right Track Forward/Reverse
3	Swing Left
4	Swing Right
5	Boom Hoist Cylinder (Boom Up)
6	Boom Hoist Pump (Boom Up)
7	Front Load Drum (Hoist)
8	Rear Load Drum (Hoist)
9	Auxiliary Load Drum (Hoist) (optional)

FIGURE 2-12

Load Drums, Swing, Track, and Boom Hoist Pump

WARNING

High Pressure Oil Hazard!

Do not attempt to remove load drum, swing, track, or boom hoist pump pressure senders unless following steps are performed. High pressure oil will exhaust from pressure sender ports.

1. Lower all loads to ground.
2. Move all control handles to off and park all crane functions.
3. **Stop engine.**
4. Place a suitable container under pressure senders to catch oil leakage.

Perform steps 5-9 only at faulty pressure senders.

5. Disconnect electric plug from pressure senders.
6. *Slowly loosen* pressure senders only enough to allow any remaining pressure to exhaust.
7. Remove pressure senders.
8. Install new pressure senders and connect electric cords.

   Pressure senders have pipe threads. Be sure to install thread sealant.

9. Bleed pressure senders as follows:
   a. Connect bleed lines with shut-off valves to couplers on pressure sender manifold. Open valve in bleed lines. Use a suitable container to catch oil flow.
   b. With all control handles off, start engine and allow it to idle.
   c. Observe oil flowing from bleed lines.
   d. Close valve in bleed lines when clear oil flows (no air bubbles in oil).
   e. Stop engine.
   f. Remove bleed lines from couplers at pressure senders.
10. Calibrate pressure senders (see procedure in this section).

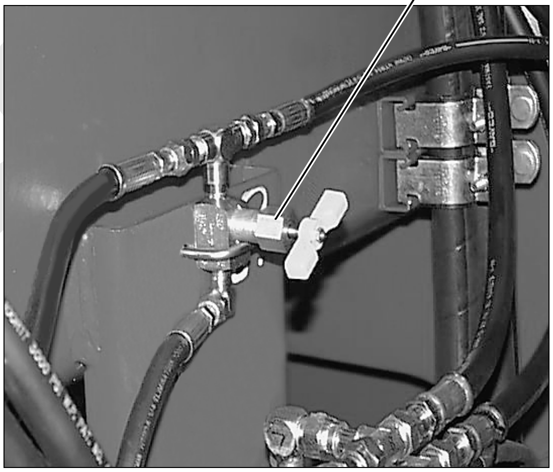
Boom Hoist Cylinder

WARNING

Falling Boom Hazard!

Do not remove boom hoist cylinder pressure sender until following steps are performed. Boom will lower uncontrolled.

1. Move boom hoist control handle to off and park boom hoist.
2. Stop engine.
3. *Close shut-off valve for boom hoist cylinder pressure sender* (Figure 2-13) — turn CLOCKWISE.



View Between Rear Drum and Hydraulic Tank

FIGURE 2-13

4. Place a suitable container under boom hoist cylinder pressure sender to catch oil leakage.
5. Disconnect electric plug from boom hoist cylinder pressure sender.
6. *Slowly loosen* boom hoist cylinder pressure sender only enough to allow pressure to exhaust.
7. Remove boom hoist cylinder pressure sender.
8. Install new boom hoist cylinder pressure sender and connect electric cord.

   Pressure sender has pipe threads. Be sure to install thread sealant.

9. Calibrate pressure senders *before proceeding* (see procedure in Crane Operator's Manual).

10. Bleed air from boom hoist cylinder pressure sender as follows:

a. Connect a bleed line with a shut-off valve to coupler for boom hoist cylinder pressure sender (Figure 2-12). Open valve in bleed line. Use a suitable container to catch oil flow.

b. With all control handles in off, start engine and allow it to idle.

c. Crack open shut-off valve — 1/4 turn COUNTERCLOCKWISE — for boom hoist cylinder pressure sender (Figure 2-13) so oil flows to bleed line. ***Boom may lower slowly during this step.***

d. Observe oil flowing from bleed line at boom hoist cylinder pressure sender.

e. Close shut-off valve for boom hoist cylinder pressure sender (Figure 2-13) when clear oil flows from bleed line (no air bubbles in oil).

f. Stop engine.

g. Remove bleed line from coupler at boom hoist cylinder pressure sender.

11. Fully open shut-off valve for boom hoist cylinder pressure sender (Figure 2-13) — turn COUNTERCLOCKWISE. ***Erratic operation will result if this step is not performed.***

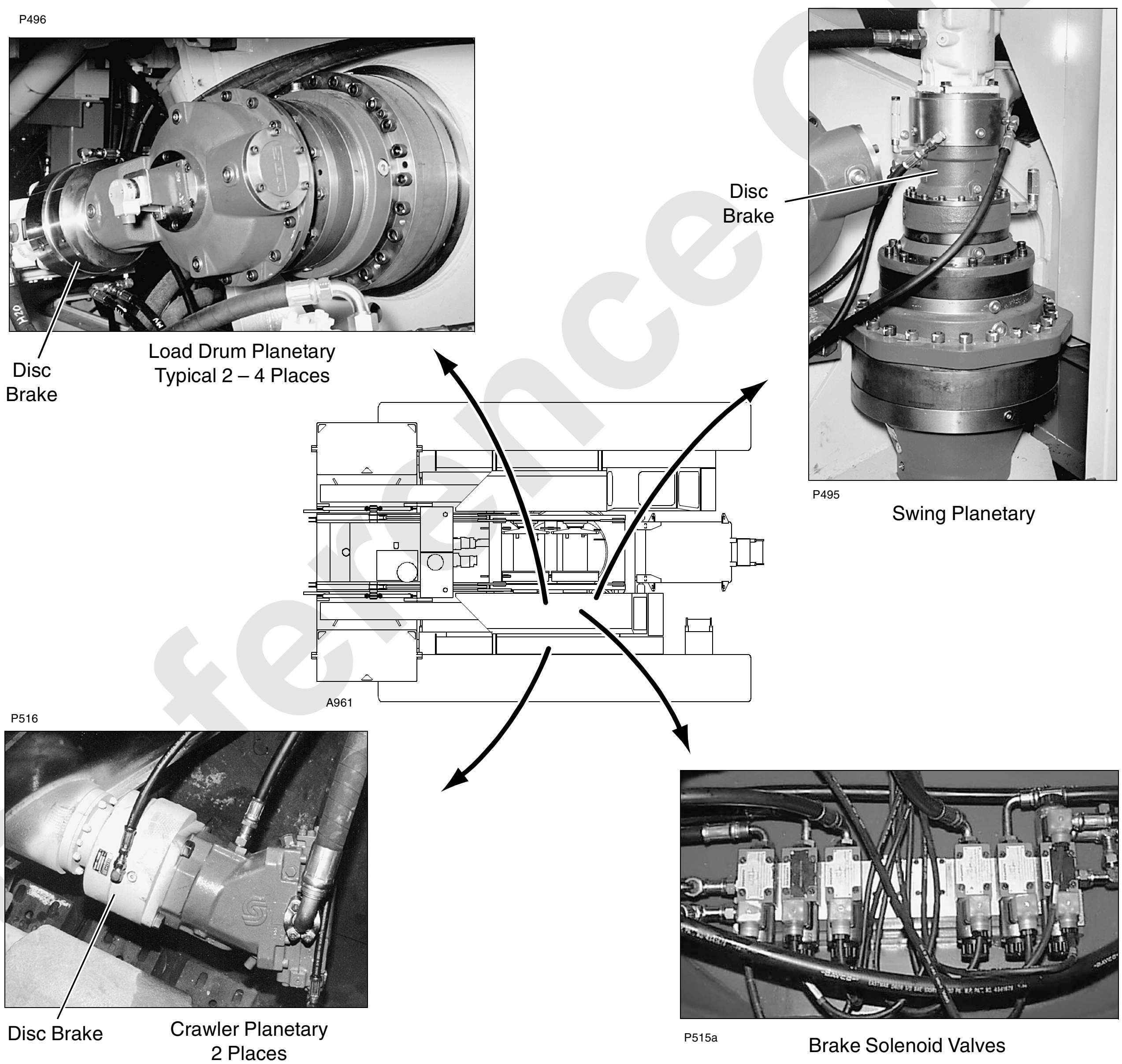


FIGURE 2-14

Solenoid Valves Right Side Enclosure

Solenoid	Function	Description
1	Travel Brake (crawler crane only)	Controls two brakes.
2	Rear Drum Brake	Controls one or two brakes.
3	Front Drum Brake	Controls one or two brakes.
4	Swing Brake	Controls one brake.

FIGURE 2-15

DISC BRAKE OPERATIONAL TEST

There is no physical way to check the disc brakes for travel, front and rear drums, and swing. An operational test of each brake must be performed weekly. Figure 2-14 shows brake and brake solenoid valve locations.

Operational Test

NOTE: For all pumps except swing, system pressure is preset at 6,000 psi (413 bar). For swing pump, system pressure is preset at 5,000 psi (345 bar).

Electrical plugs at brake solenoid valves must be disconnected to stall crane functions during tests (Figure 2-15).

1. Start engine and allow it to idle.

2. Select and confirm SETUP mode (faulty pressures will be recorded in any other mode).

NOTE: For load drums, make sure crane is in full power mode (free fall OFF). In free fall OFF mode, band brake will release but disc brake will remain applied.

3. Disconnect electrical plug for brake being checked (Figure 2-15).

4. Scroll to corresponding diagnostics screen for brake being checked. Monitor pump pressure and pump command while moving control handles.

5. For all functions, move control handle in both directions, one at a time, to check brake operation in both directions.

CAUTION

Overheat Hazard!

Do not hold any function on stall for more than 5 seconds. Damage to system components may occur.

6. Slowly move handle for function being checked. Specified system pressure must be reached before 50% pump command is reached and ***brake must not slip.***

WARNING

Falling Load/Moving Crane Hazard!

If any disc brake slips when operational test is performed, repair or replace corresponding brake before placing crane back into service. Loads could fall or crane could move if brakes are not operating properly.

For load drums with a disc brake on both ends of drum, repair or replace both disc brakes.

See planetary manufacturer's manual for disc brake repair instructions.

7. Reconnect electrical plugs at all brake solenoid valves at completion of operational test.

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SHOP PROCEDURE

This topic covers hydraulic adjustments for the hydraulic system and related components on the 777 crane.

Experienced technicians, trained in the operation of this crane and its hydraulic system, shall perform the procedures in this topic. These technicians shall read, understand, and comply with the instructions in this topic.

All adjustments identified in this topic were made to the crane before it was shipped from the factory. Adjustments by field personnel are required only when parts are replaced or when instructed by the factory Service Department.

Comply with the pressure and flow settings specified in this topic. Altering settings without the approval of the factory Service Department can damage crane components or cause the crane to operate improperly. Procedures for connecting hydraulic fittings are provided in Hydraulic System Maintenance in this section.

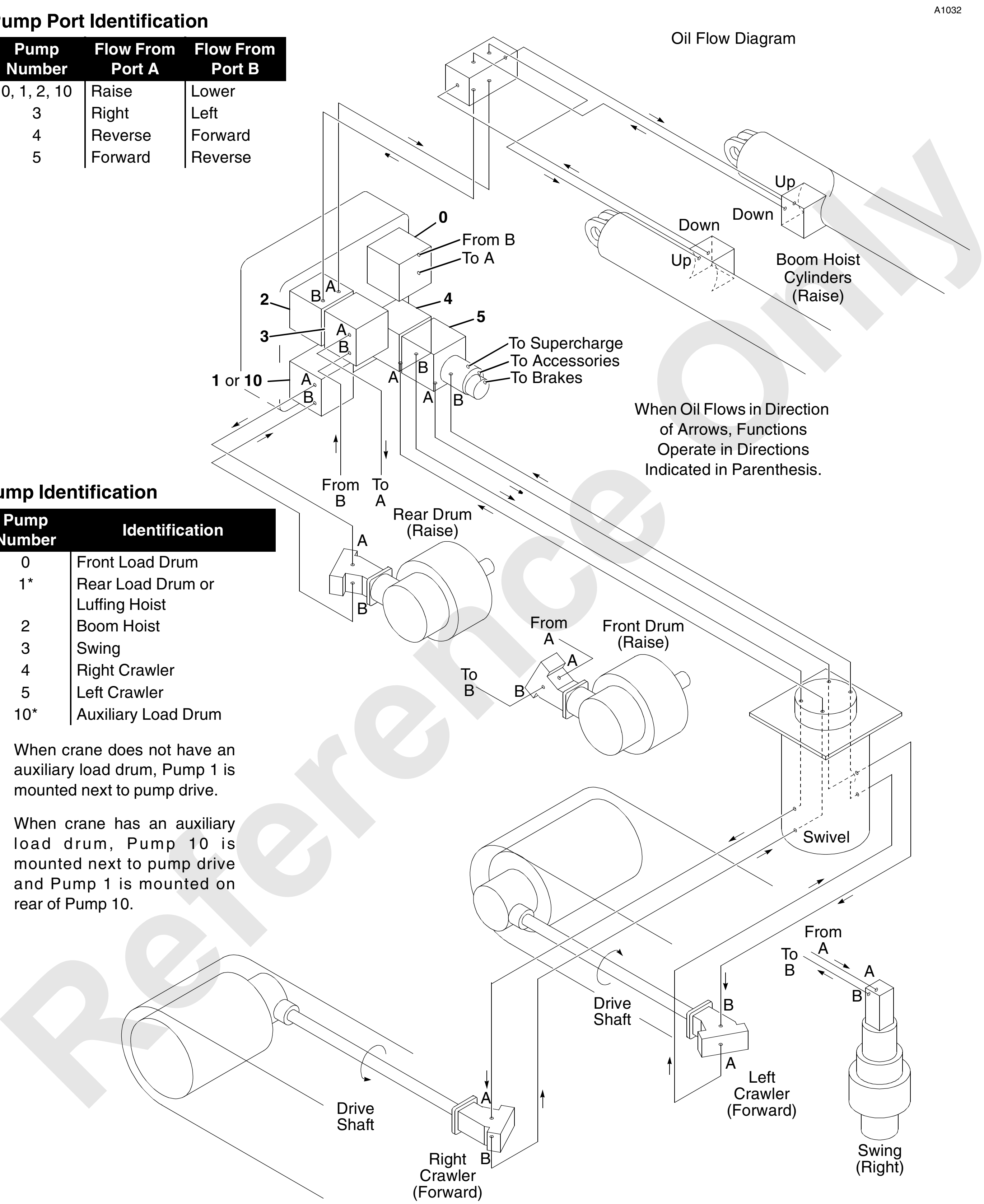
During some procedures described in this topic, it will be necessary to monitor data on the diagnostic screens of the digital display. See Diagnostic Display in Section 10 of this manual, for descriptions and operation of the diagnostic screens.

When a procedure states ***determine cause and correct***, proceed as follows:

- MCC Assembly Personnel — contact Engineering Department.
- Field Service Personnel — contact Factory Service Department.

Pump Port Identification

Pump Number	Flow From Port A	Flow From Port B
0, 1, 2, 10	Raise	Lower
3	Right	Left
4	Reverse	Forward
5	Forward	Reverse



Pump Identification

Pump Number	Identification
0	Front Load Drum
1*	Rear Load Drum or Luffing Hoist
2	Boom Hoist
3	Swing
4	Right Crawler
5	Left Crawler
10*	Auxiliary Load Drum

* When crane does not have an auxiliary load drum, Pump 1 is mounted next to pump drive.

When crane has an auxiliary load drum, Pump 10 is mounted next to pump drive and Pump 1 is mounted on rear of Pump 10.

FIGURE 2-16

Item	Description
1	EDC (Electronic Displacement Control)
2	Manual Override Control
3	Displacement Adjusting Screw (Note 1)
4	Case Drain Port (Note 2)
5	Charge Pressure Relief Valve
6	Filter Adapter (Note 3)
7	Multi-Function Valve (Note 4)
8	Charge Pressure Gauge Port
9	Charge Pump Inlet Port
10	Pump Port B
11	Pump Port B Gauge Port
12	Pump Port A
13	Pump Port A Gauge Port
14	Neutral Adjusting Screw

NOTE 1: Travel Pumps Only

NOTE 2: Both Sides of Pump

NOTE 3: Load Drum Pumps Only

NOTE 4: Valve is Opposite Port it Protects

Pump Components

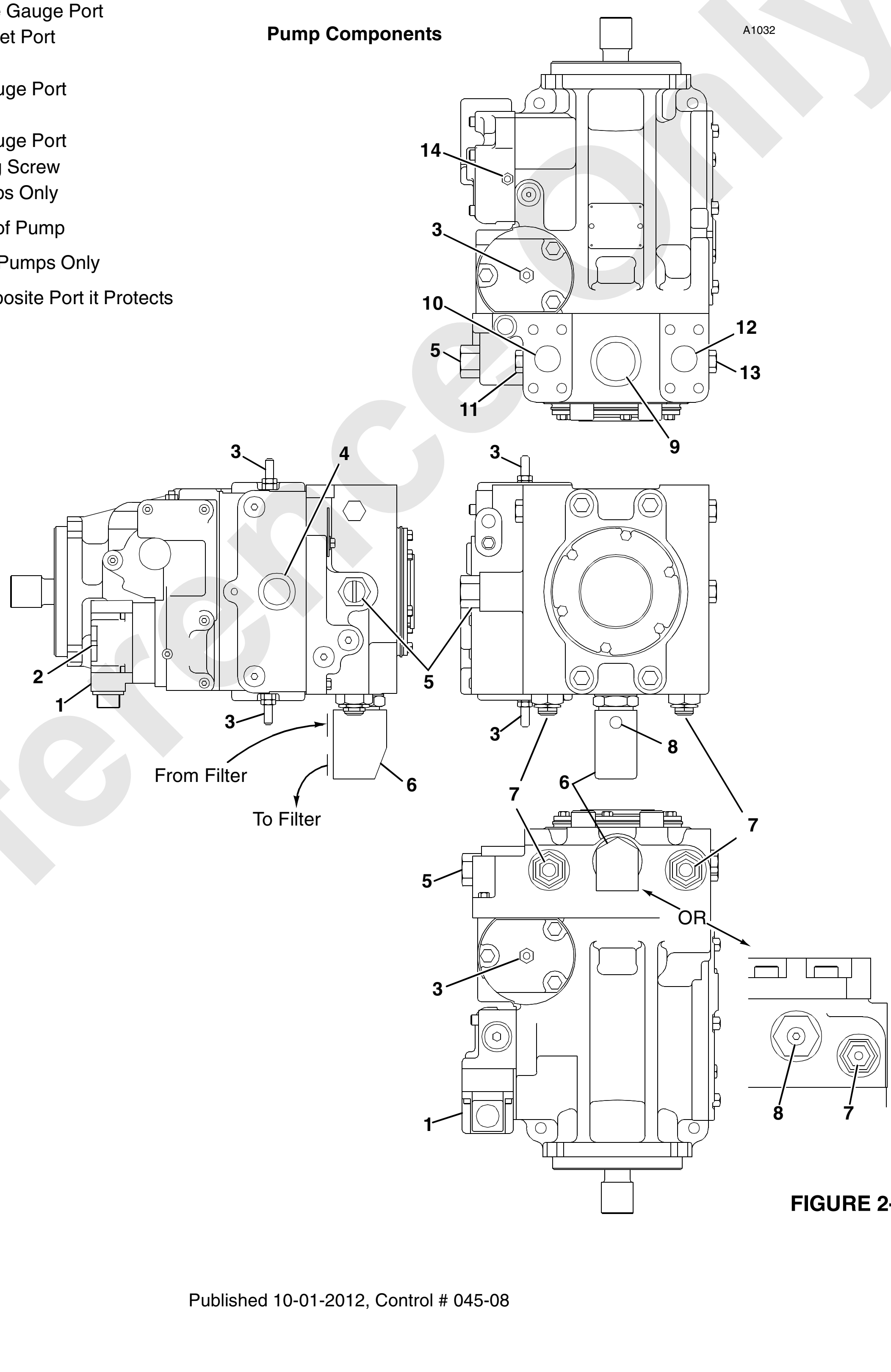
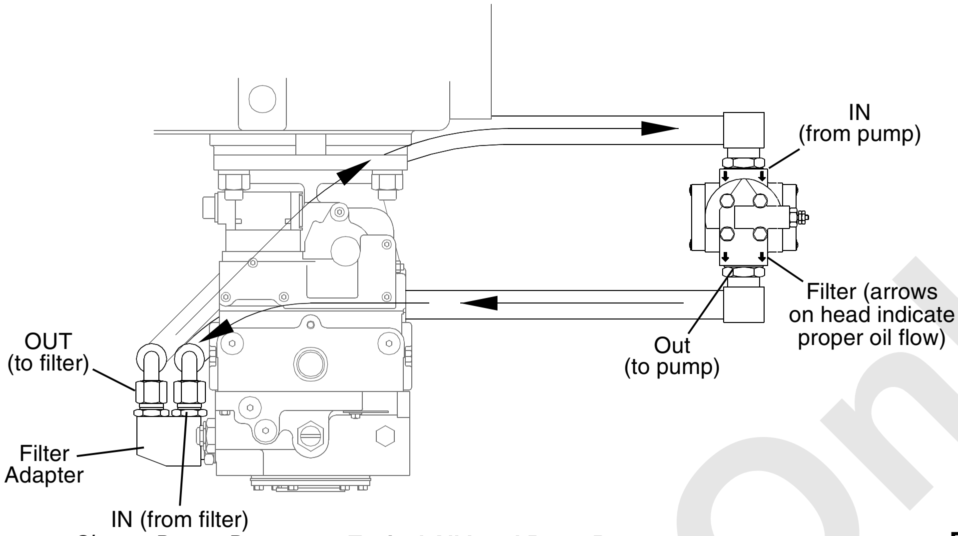


FIGURE 2-17



Typical All Load Drum Pumps **FIGURE 2-17**

Initial Oil Fill

1. Check for correct piping between load drum pumps and filters. Oil must flow as shown in Figure 2-17.

CAUTION

Equipment Damage!

Incorrect oil flow through filters will result in damage to pumps and motors.

---

2. Fill all pump cases (except auxiliary) with oil to level of case drain ports (4, Figure 2-17). Use new oil filtered through a 10-micron element.
3. Fill all motor cases with oil to level of case drain ports (Figure 2-18). ***Use new hydraulic oil filtered through a 10-micron filter.***
4. If crane has an auxiliary load drum, fill auxiliary pump case as follows:
   - **a.** Disconnect case drain hose (1, Figure 2-19) from manifold on hydraulic tank.
   - **b.** Place end of hose (1) in a container below level of auxiliary pump.
   - **c.** Disconnect case drain hose (2, Figure 2-19) from oil cooler manifold under fuel tank.
   - **d.** Fill hose (2) with oil until oil flows out hose (1). ***Use new oil filtered through a 10-micron element.***
   - **e.** Securely reconnect hoses (1 and 2, Figure 2-19).
5. Make sure main tank and supercharge filter shut-off valves are fully opened (Figure 2-20).
6. At engine, check that engine clutch is engaged (Figure 2-21).
7. Remove cap from bleed port at Filters 1, 3, 4, and 6 if equipped (Figure 2-22).

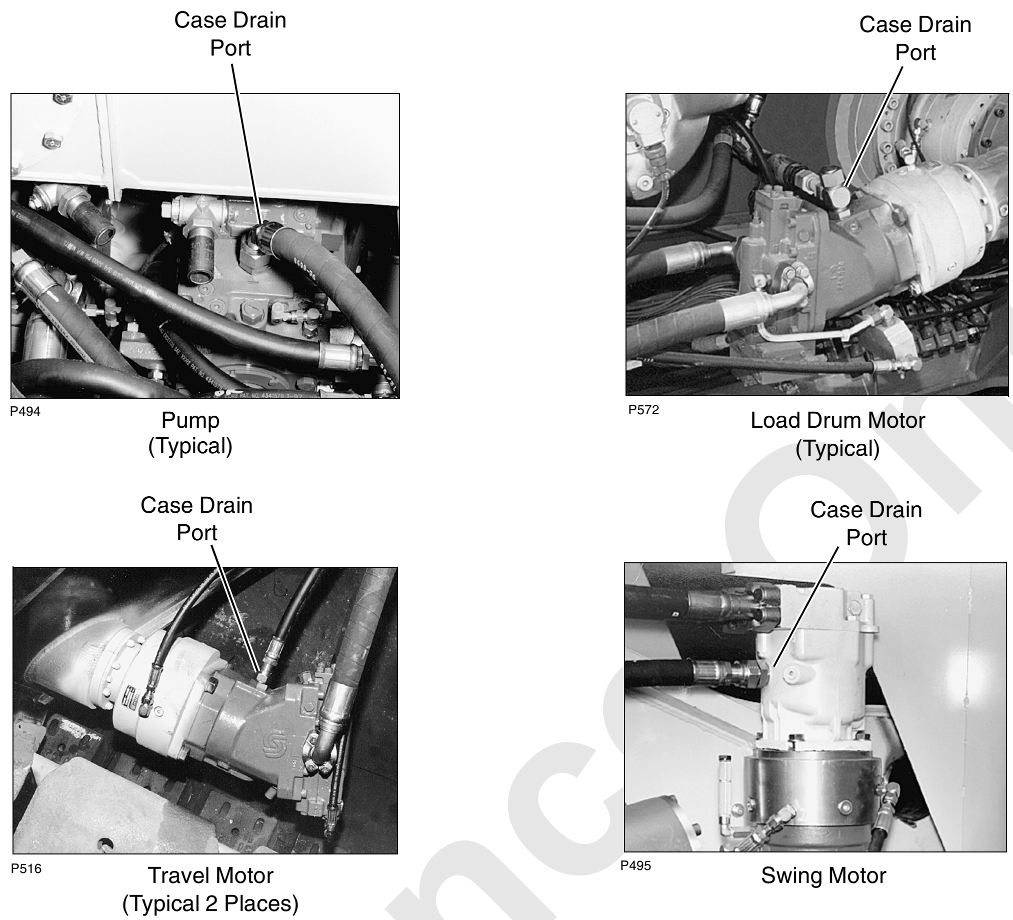


FIGURE 2-18

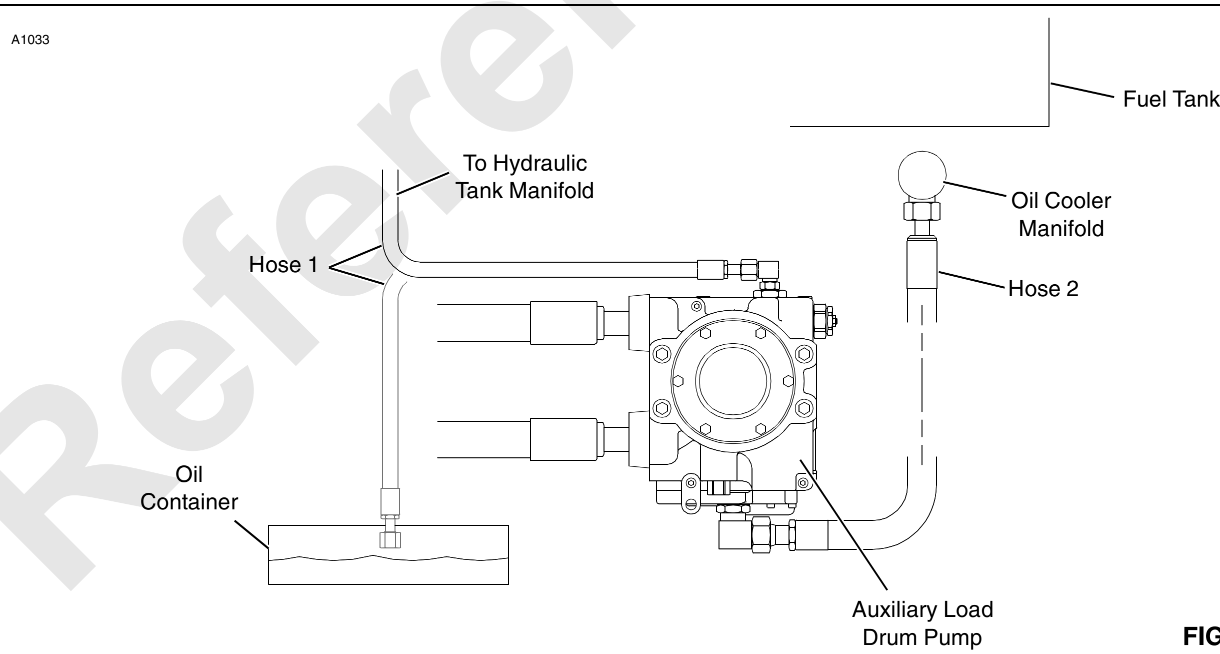
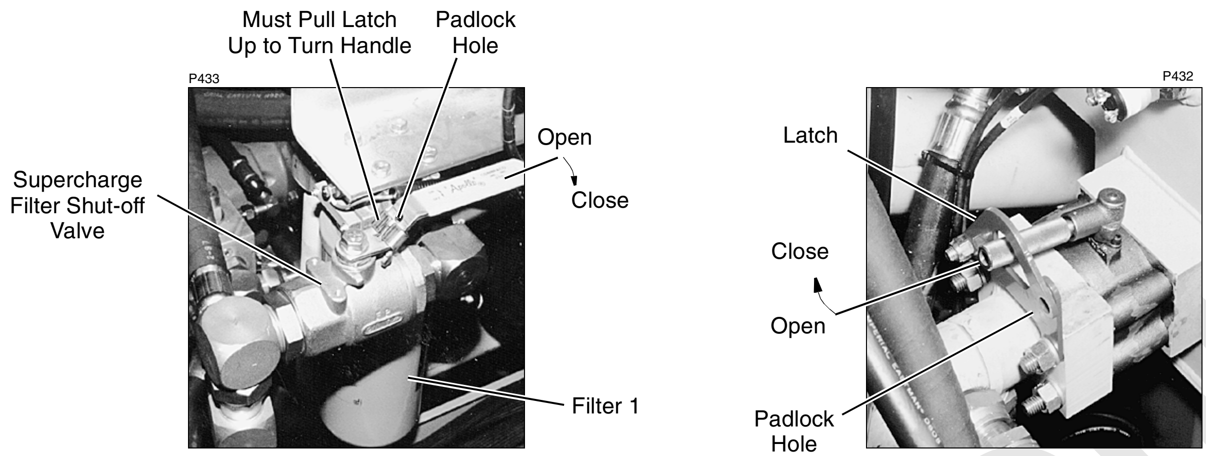


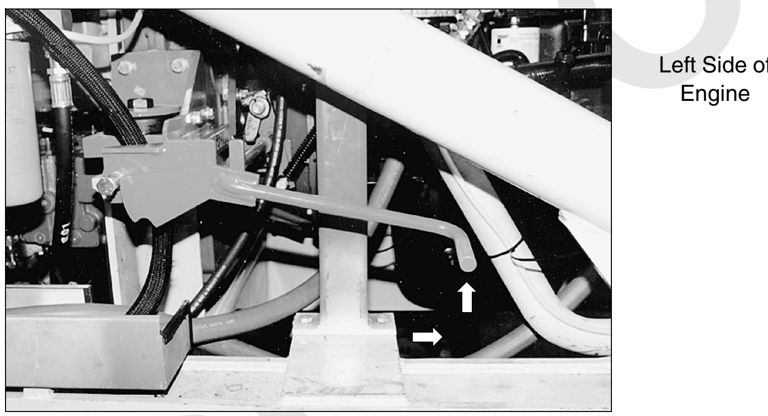
FIGURE 2-19



Left Side of Pumps

Front of Hydraulic Tank

FIGURE 2-20



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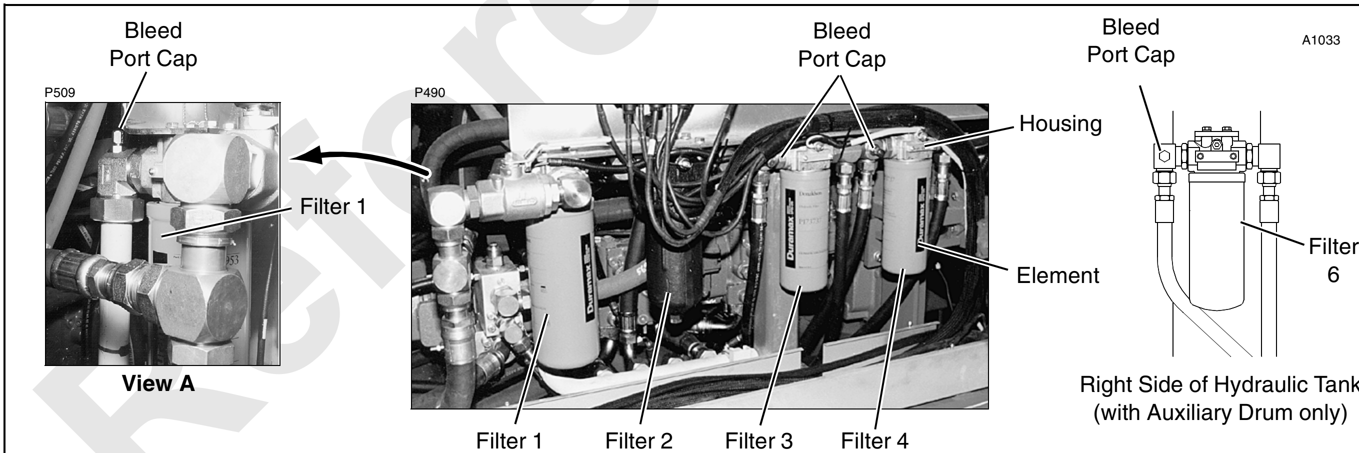
Engine Clutch Engaged

FIGURE 2-21



Left Side of Pumps

FIGURE 2-22

8. Fill hydraulic tank to FULL HOT level mark on sight gauge (Figure 2-23).

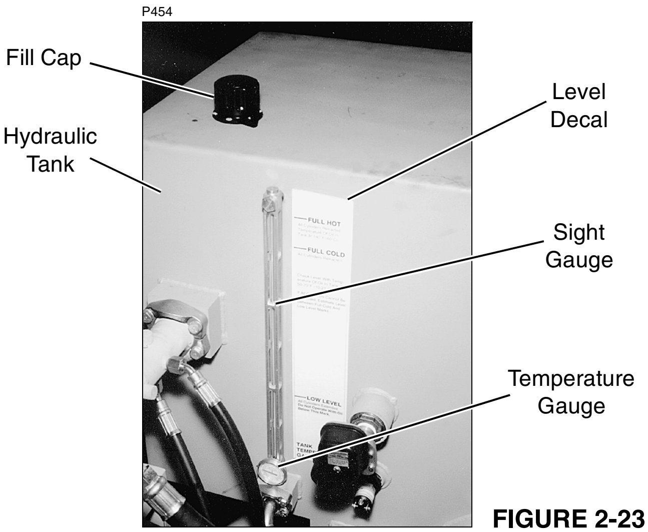
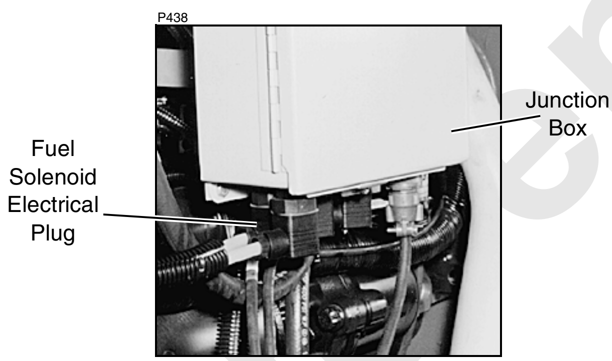


FIGURE 2-23

9. As tank is filled, monitor bleed port at Filter 1 (Figure 2-22). Oil will flow by gravity from hydraulic tank to filter.

   Securely install cap on bleed port when clear oil flows.

10. Disconnect fuel solenoid electrical plug (Figure 2-24) to keep engine from starting while filling Filters 3, 4, and 6.



Right Side of Engine **FIGURE 2-24**

11. Crank engine for 10 seconds or until clear oil flows from bleed port at Filters 3, 4, and 6 (Figure 2-22). If oil does not appear, crank engine for 10 more seconds.

    Securely install cap on bleed ports when clear oil flows.

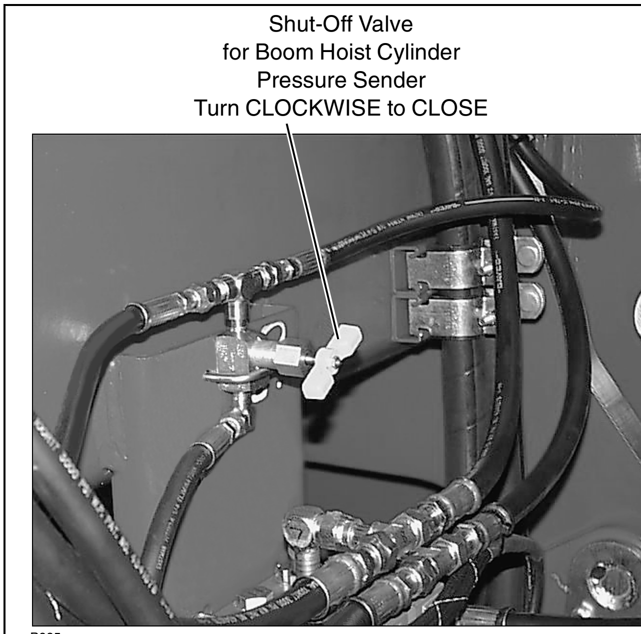
12. Reconnect fuel solenoid electrical plug (Figure 2-24).

Pressure Sender Calibration

Perform this procedure before Initial Start-Up.

The following procedure only applies when the crane does not a boom. ***When the crane has a boom, use the procedure contained in Pressure Sender Calibration in this section.***

1. Stop engine.
2. Perform following steps for boom hoist cylinder pressure sender before proceeding:
   a. *Securely close shut-off valve for boom hoist cylinder pressure sender* (Figure 2-25) — turn CLOCKWISE.
   b. Connect a bleed line with a shut-off valve to coupler for boom hoist cylinder pressure sender (item 5, Figure 2-27).
   c. Open valve in bleed line to bleed oil. Use a suitable container to catch oil flow.
3. Turn ON cab power switch.
4. Turn crane mode selector key counterclockwise to CONFIRM position and hold.
5. Press engine run/stop switch to RUN position.
6. Continue to hold crane mode selector key in CONFIRM position for ONE MINUTE after performing step 5.
7. Check for proper calibration — with engine off (key in RUN), charge pressure on diagnostic screen for each crane function should be 50 psi (3.4 bar) or less.
8. Remove bleed line from coupler for boom hoist cylinder pressure sender.
9. Fully open shut-off valve for boom hoist cylinder pressure sender (Figure 2-25). ***Erratic boom hoist operation will occur if this step is not performed.***

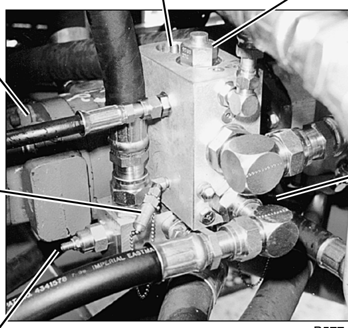


Between Rear Drum and Hydraulic Tank **FIGURE 2-25**

2

Initial Start-Up

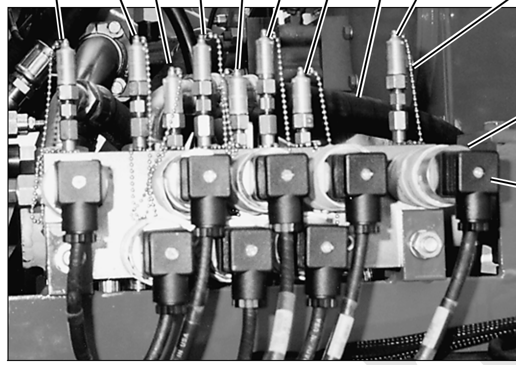
1. Calibrate pressure transducers, if not already done.
2. ***Before starting engine first time with free fall,*** remove adjusting screw from drum clutch pressure reducing valve (Figure 2-31). Then reinstall screw 1/4 in. (6 mm). The pressure reducing valve will be adjusted later in this procedure.
3. Connect a 0 – 500 psi (0 – 34.5 bar) hydraulic gauge to coupler at supercharge relief valve (Figure 2-26).



Under Left Side of Pumps

FIGURE 2-26

4. Loosen nut. Turn supercharge relief valve screw out fully to stop (counterclockwise) (Figure 2-26).
5. Connect bleed lines with shut-off valves to couplers on pressure sender manifold (Figure 2-27). Open valve on each bleed line. Use a suitable container to catch oil flow.



Left Side of Pumps

Item	Description
1	Left Track Forward/Reverse
2	Right Track Forward/Reverse
3	Swing Left
4	Swing Right
5	Boom Hoist Cylinder (Boom Up)
6	Boom Hoist Pump (Boom Up)
7	Front Load Drum (Hoist)
8	Rear Load Drum (Hoist)
9	Auxiliary Load Drum (Hoist) (optional)

FIGURE 2-27

WARNING

Personal Injury Hazard!

With engine running, crane components can operate unexpectedly while system pressures are checked and adjusted. Disconnect power to brake valves before beginning adjustments.

Past Production

Current Production

FIGURE 2-28

6. ***To prevent accidental operation of crane functions,*** disconnect electrical plugs at disc brake solenoids for load drums, travel, and swing (Figure 2-28). If crane has an auxiliary load drum, disc brake solenoid is mounted on drum in boom butt.

7. Support boom hoist cylinders so they can extend and retract freely. ***Cylinders must be disconnected from mast.***

NOTE: The following procedures require rapid response to changing operating conditions. Two people are needed for checking pressures and making adjustments. Become familiar with these procedures before starting the engine.

Keep area in front of crane clear of all personnel. Boom hoist cylinders will extend as they fill with oil.

8. With all control handles in off, start engine and allow it to idle.

Have one person bleed pressure senders (step 9) while a second person checks pressures (step 10).

9. Bleed pressure senders:

a. Observe oil flowing from bleed line at each pressure sender (Figure 2-27).

b. Close valve in each bleed line when clear oil flows (no air bubbles in oil).

NOTE: Oil may not flow from bleed line for boom hoist cylinder pressure sender until Initial Start-Up steps 14 and 15 are performed.

CAUTION

Equipment Damage!

Pump pressures displayed in operator's cab must be checked during first minute of operation. If pressure for any pump is less than 200 psi (13.8 bar) or greater than 500 psi (34.5 bar), shut down engine immediately to prevent pump damage. Troubleshoot system to determine cause of problem.

10. In operator's cab, check pump pressures for following pumps: each load drum, boom hoist, swing, left and right travel (see Diagnostic Display Readings in Section 10 of this manual).

- Pressures must be checked during first minute of operation.
- Make sure pressure reading for each pump is 200 – 500 psi (13.8 – 34.5 bar).

If pump pressures are not within acceptable range, stop engine immediately. ***Determine cause and correct.***

NOTE: Boom hoist pressure may be less than specified above for the first few minutes because the pump will be filling and extending the cylinders. ***Hydraulic tank level will lower rapidly as cylinders fill. Keep tank level above LOW LEVEL mark at all times.***

It may be necessary to stop the engine periodically as the cylinders extend to fill the tank. Do not overfill the tank, or it will overflow when the boom hoist cylinders are retracted. Pressure will gradually rise as the cylinders fill with oil, and the cylinders will stop extending part way out in their strokes.

11. While boom hoist cylinders are extending, turn supercharge relief valve screw (Figure 2-26) in (clockwise) until pressure on gauge reads 75 – 100 psi (5.2 – 6.9 bar). Tighten nut once proper pressure is obtained.

12. With engine at idle, move boom hoist lever to DOWN position to fully extend boom hoist cylinders.

Monitor tank level as described earlier and make sure boom hoist charge pressure stays within 200 – 250 psi (13.8 – 17.2 bar) during this step.

NOTE: The tank low level alarm should come on when the cylinders are fully extended. If the alarm does not come on, determine cause and correct.

13. Once boom hoist cylinders are fully extended, make sure tank level is not lower than LOW LEVEL mark.

14. Move boom hoist lever to UP position to fully RETRACT boom hoist cylinders.

NOTE: Oil should start to flow from bleed line for boom hoist cylinder pressure sender as Initial Start-Up steps 14 and 15 are performed. Close valve in bleed line when clear oil flows (no air bubbles in oil).

15. Repeat steps 12 – 14 one more time.

16. Stop engine.

17. Remove bleed lines from couplers at pressure sender manifold (Figure 2-27). Install dust caps over couplers.

18. Remove gauge from coupler at supercharge relief valve (Figure 2-26). Install dust cap over coupler.

19. Do not reconnect electrical plugs to brake valves at this time. Electrical plugs will be reconnected later in procedure.

NOTE: *Manitowoc Shop Personnel* — pressures and speeds noted in remaining procedures and any adjustments you make to correct them must be recorded in RECORD OF INSPECTION form for crane you are working on.

Controls Calibration

1. Calibrate pressure transducers, if not already done.

2. Engage swing lock.

3. Start and run engine at high idle.

4. Depress and hold swing holding brake switch (on swing handle) for ONE MINUTE.

5. Repeat steps 3 and 4 a second time.

Pressure Adjustments

Charge Pressure Checks

NOTE: Charge pressure can also be monitored on the diagnostic screen for each function. Charge pressure shown on the diagnostic screens can vary

±100 psi (6.9 bar) from that shown on the pressure gauges.

1. Check boom hoist charge pressure as follows:

a. Connect a 0 – 1,000 psi (0 – 69.0 bar) pressure gauge to BOOM HOIST PUMP coupler at transducer manifold (Figure 2-27).

b. Start engine and run it at low idle.

c. Turn boom hoist hot oil relief valve screw (Figure 2-29) out until pressure on gauge stops going down. This indicates boom hoist charge pressure setting. Pressure must be 325 – 375 psi (22.4 – 25.9 bar).

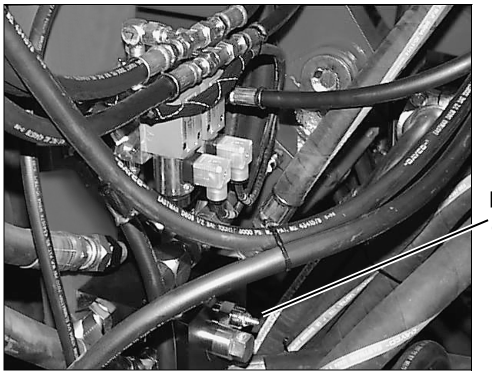


FIGURE 2-29

d. If proper pressure is not obtained, adjust charge pressure relief valve at boom hoist pump. See instructions in pump manufacturer's manual.

e. Run engine at high idle. Pressure should not rise above 450 psi (31.0 bar).

f. Run engine at low idle.

g. Turn hot oil relief valve screw (Figure 2-29) in until pressure just starts to rise above boom hoist charge pressure setting obtained in step 1c.

h. Continue to turn screw in until pressure is 25 psi (1.7 bar) higher than what was recorded in step 1g. This is the hot oil relief valve setting.

i. Tighten nut on relief valve screw to lock adjustment.

j. Stop engine and remove gauge from transducer manifold. Install dust cap over coupler.

2. Check charge pressure for remaining pumps, as follows:

a. Connect 0 – 1,000 psi (0 – 69.0 bar) pressure gauge to coupler for desired pump at pressure sender manifold (Figure 2-27).

b. Start engine and run it at low idle.

c. Note and record gauge reading. Gauge should read 325 – 375 psi (22.4 – 25.9 bar) and not exceed 450 psi (31.0 bar) at high idle.

If proper pressure is not obtained, adjust charge pressure relief valve for corresponding pump. See instructions in pump manufacturer's manual.

d. Stop engine and remove gauge from coupler at pressure sender manifold (Figure 2-27). Install dust cap over coupler.

Accessory System Pressure Checks

1. Connect a 0 – 1,000 psi (0 – 69.0 bar) pressure gauge to coupler at accessory system relief valve (Figure 2-26).

2. Start and run engine at low idle. Gauge should read 500 psi (34.5 bar) maximum. This is accessory system unload pressure.

3. Remove gauge installed in step 1 and replace it with a 0 – 5,000 psi (0 – 344.8 bar) pressure gauge.

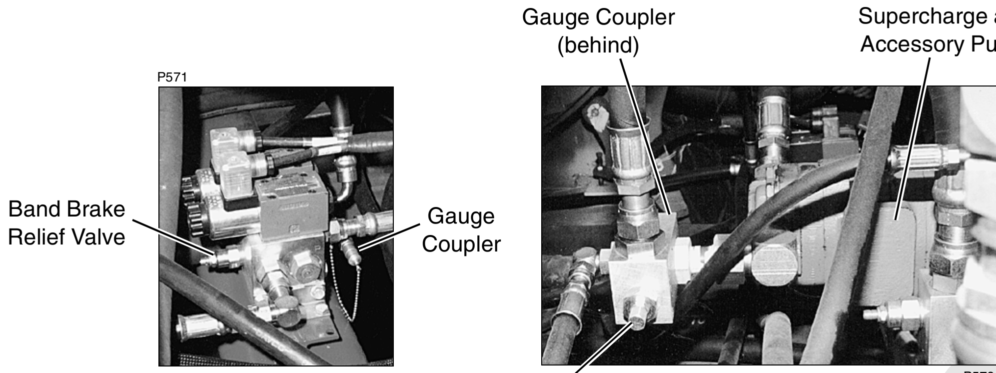
4. Using controls on carbody, fully retract any carbody jack to stall accessory system relief valve. Gauge should read approximately 3,000 psi (206.9 bar).

5. If proper pressure is not obtained, adjust accessory system relief valve to obtain 2,900 – 3,100 psi (200.0 – 213.7 bar) pressure setting (turn relief valve screw in to increase pressure or out to decrease pressure). This is the accessory system pressure setting.

6. Tighten nut on screw to lock adjustment.

7. Stop engine and remove gauge from coupler. Install dust cap over coupler.

2



Right Side of Crane Behind Rear Drum When Crane does not have Free Fall.

Left Side of Pumps When Crane has Free Fall

FIGURE 2-30

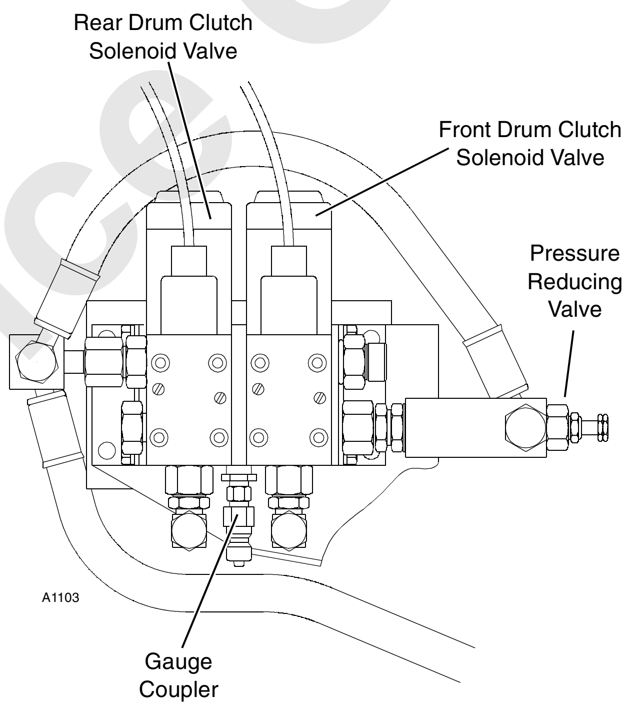
Band Brake Relief Valve Pressure Check

1. Connect a 0 – 5,000 psi (0 – 344.8 bar) pressure gauge to coupler at band brake relief valve (Figure 2-30).
2. Start and run engine at low idle. Gauge must read 2,400 – 2,600 psi (165.5 – 179.3 bar).
3. If proper pressure is not obtained, turn relief valve screw in to increase pressure or out to decrease pressure.
4. Tighten nut on screw to lock adjustment.
5. Stop engine and remove gauge from coupler. Install dust cap over coupler.

Drum Clutch Pressure Adjustment

Perform following procedure only if crane has free fall.

1. Connect a 0 – 5,000 psi (0 – 344.8 bar) pressure gauge to coupler at drum clutch pressure reducing valve (Figure 2-31).
2. Start and run engine at low idle.
3. Turn adjusting screw in to increase pressure until gauge reads 1,200 – 1,300 psi (82.7 – 89.6 bar).
4. Tighten nut on screw to lock adjustment.
5. Stop engine and remove gauge from coupler. Install dust cap over coupler.



Located in Right Enclosure Between Drum Drives

FIGURE 2-31

Operating Pressure Checks

NOTE: It will be necessary to monitor pressure and pump command on the diagnostic screens of the digital display during the following steps. See Diagnostic Display Readings in Section 10 of this manual. Do not confuse pump command with handle command on the display.

Electrical plugs must be disconnected at brake solenoids (Figure 2-28).

CAUTION

Overheating Damage!

It is necessary to stall hydraulic system during following pressure checks. Do not stall system longer than 10 seconds, or components may be damaged from overheating

1. Start and run engine at 1,000 – 1,400 rpm.
2. Select and confirm SETUP mode.
3. For each load drum, pull control handle back to check pressure in hoist direction only.

   Hoist pressure should be 6,000 psi (413.7 bar) when pump command is less than 40%, and brake must not slip.
4. For travel, move control handle in both directions, one at a time, to check pressure in both directions.

   Travel pressure in both directions should be 6,000 psi (413.7 bar) when pump command is less than 40%, and brake must not slip.
5. For swing, move control handle in both directions, one at a time, to check pressure in both directions.

   Swing pressure in both directions should be 4,900 psi (337.9 bar) when pump command is less than 60%, and brake must not slip.
6. Check boom hoist pressure by fully retracting boom hoist cylinders (stall) until pressure reaches 5,000 psi (344.8 bar). Pump command must be less than 40%.
7. Reconnect electrical plugs to all brake solenoids (Figure 2-28).

Boom Hoist Leakage Test

WARNING

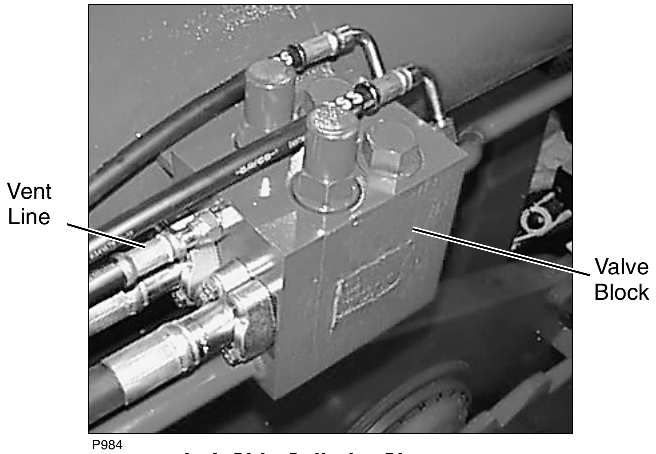
Falling boom Hazard!

Only disconnect vent lines during following procedure. Disconnecting any other line could cause boom to lower uncontrolled.

The following procedure requires a fully rigged boom with a 5,000 lb (2 268 kg) load suspended from boom point.

1. Stop engine.
2. Disconnect vent line from both cylinder valve blocks (Figure 2-32).
3. Plug end of both hoses (08 ORS). Do not cap end of adapter fittings (leave them open).
4. Start and run engine at high idle.
5. Check for oil leakage from both vent ports with boom hoist in neutral and while raising and lowering boom.

   Oil leakage in a five minute period must not exceed 1 drop per second. If leakage is greater than specified, *determine cause and correct*.
6. Stop engine and securely reconnect vent lines to adapter fittings. Make sure fittings are clean and O-rings are installed.



Left Side Cylinder Shown (Right Side Similar) **FIGURE 2-32**

Operating Speed Checks

Check operating speeds for below listed functions in SETUP mode with engine running at high idle and control handles moved fully forward and back.

Load drum speeds are shown on diagnostic screens for each pump.

Count number of revolutions rotating bed rotates in one minute to determine swing speed. ***Make sure crane is in an area where nothing will interfere with boom or rotating bed while swinging.***

Mark both crawler tumblers and count number of revolutions they turn in one minute to determine travel speed. ***Make sure crane is in an area where it can travel without interference.***

If proper speeds are not indicated, ***determine cause of problem and take corrective action***.

Table 2-10
Operating Speed

Function	Speed
Front and Rear Load Drums (standard line speed)	52 – 58 rpm HOIST 44 – 55 rpm LOWER
Front and Rear Load Drums (optional high line speed)	74 – 82 rpm HOIST 66 – 78 rpm LOWER
Auxiliary Load Drum	64 – 71 rpm HOIST 57 – 67 rpm LOWER
Boom Hoist Cylinders (without boom)	115 seconds (from fully extended to fully retracted)
Swing	3 rpm
Travel	10 – 11-1/2 rpm (at tumbler)

SECTION 3
ELECTRIC SYSTEM

TABLE OF CONTENTS

SECTION 3
ELECTRIC SYSTEM

ELECTRICAL DRAWINGS AND SCHEMATICS

Applicable electrical system drawings and schematics are attached at the end of this Section.

CHECKING AND REPLACING ELECTRICAL COMPONENTS

DANGER

Electrical Shock Hazard!

Ensure that the battery cables are disconnected from the batteries before loosing any electrical connections.

1. Visually inspect all electrical harnesses and cables every month or at 200 hours of service life for the following:
   - **a.** Damaged, cut or deteriorated harness loom covering.
   - **b.** Damaged, cut or abraded individual wires or cable insulation.
   - **c.** Exposed bare copper conductors.
   - **d.** Kinked, crushed, flattened harnesses or cables.
   - **e.** Blistered, soft, degraded wires and cables.
   - **f.** Cracked, damaged, or badly corroded battery terminal connections.
   - **g.** Inspect all machine ground connections for damaged terminals or excessive corrosion.
   - **h.** Other signs of significant deterioration.

   If any of these conditions exist, evaluate the harness for repair or replacement.
2. At the same service interval, visually inspect all Controller Area Network (CAN) nodes and electrical junction boxes for the following:
   - **a.** Damaged or loose connectors.
   - **b.** Damaged or missing electrical clamps or tie straps.
   - **c.** Excessive corrosion or dirt on the junction boxes.
   - **d.** Loose junction box mounting hardware.

   If any of these conditions exist, address them appropriately.

   See Table 3-1 below for following items.
3. Harness and battery cables operating in a temperate climate ***zone C*** are recommended to be replaced after 10,000 hours of service life.
4. Harness and cables operating in climate ***zone A*** and ***zone B*** with high ambient temperatures and high duty circuits could see electrical service life reduced by 25% to 40%. It is recommended to replace these assemblies after 8,000 hours of service life.
5. Harness and cable assemblies operating in climate ***zone D*** and ***zone E***, cold climates, should expect a degrade of mechanical properties and long term exposure to these cold temperatures will negatively impact service life. It is recommended for these electrical harnesses and cable assemblies to be inspected to step 1 above as service life may be more than 10,000 hours.
6. Harness and cable assemblies operating in salt water climates could see a significant reduction in service life. Therefore it is recommended for these electrical harnesses and cable assemblies to be inspected to step 1 above as service life may be more than 8,000 hours.

Table 3-1 Climate Zone Classification:

Item	Description
A	Tropical Moist: All months average above 64°F (18° C) Latitude: 15° - 25° N & S
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° - 35° N & S
C	Moist Mid-Latitude: Temperate with mild winters. Latitude: 30° - 50° N & S
D	Moist Mid-Latitude: Cold winters. Latitude 50° - 70° N & S
E	Polar: Extremely cold winters and summers. Latitude: 60° - 75° N & S

ABBREVIATIONS AND SYMBOLS

See Table 3-2 for abbreviation and symbols used in this section.

Table 3-2 Abbreviations and Symbols

ITEM	DEFINITION	ITEM	DEFINITION	ITEM	DEFINITION
+/-	Plus/Minus Value	D1	Digital - On/Off Inputs	N/C	Normally Closed (Switch)
+	Plus/Positive Volts	D2	Digital Inputs	Nm	Newton Meters
-	Minus/Negative Volts	D3	Digital Inputs or Outputs	N/O	Normally Open (Switch)
%	Percent	DI	Digital Inputs	No.	Number
° or DEG	Degrees - Angular	DO	Digital Outputs	OEM	Original Equipment Manufacturer
°F or DEG F	Degrees - Temperature	EDC	Electrical Displacement Control		
				PC	Programmable Computer
A (amp)	Ampere	FFall	Free Fall	PCP	Pressure Controller Pilot
A1	Handle Inputs	Ft. lbs	Foot Pounds	Pot	Potentiometer
A2	Pump Control Outputs	GND	Ground	PSI/PRESS	Pounds Per Square Inch
A3	Programmer's Screen	GPM	Gallons Per Minute	PSIA	PSI Absolute
AC	Alternating Current	HYD	Hydraulic	RCL	Rated Capacity Indicator/Limiter
ACC	Accessory System	I/O	Input/Output		
ANG	Angle	INFALL	Intermediate Fall	Reg.	Regulated
Aux.	Auxiliary	LED	Light Emitting Diode	RPM	Revolution Per Minute
BHST	Boom Hoist	L/m	Liters Per Minute	SAE	Society of Automotive Engineers
CAL or CALIB	Calibration	Luff	Luffing		
CHA or CHB	Channel A or B	mA	Mega Amps	TB	Terminal Block
COMM	Communication	MAX	Maximum	TEMP	Temperature
CON	Configuration	MIN	Minimum	TRK	Track (Crawler
CPU	Central Processing Unit	MM	Millimeter	V	Volts
CYL	Cylinder	MPH	Mile Per Hour	VAC	Volts Alternating Current
DC	Direct Current	NC	No Connection	VDC	Volts Direct Current

TEST VOLTAGES

This section contains test voltages sorted into three categories:

Controller Board Layout

The board locations in the programmable controller are shown below.

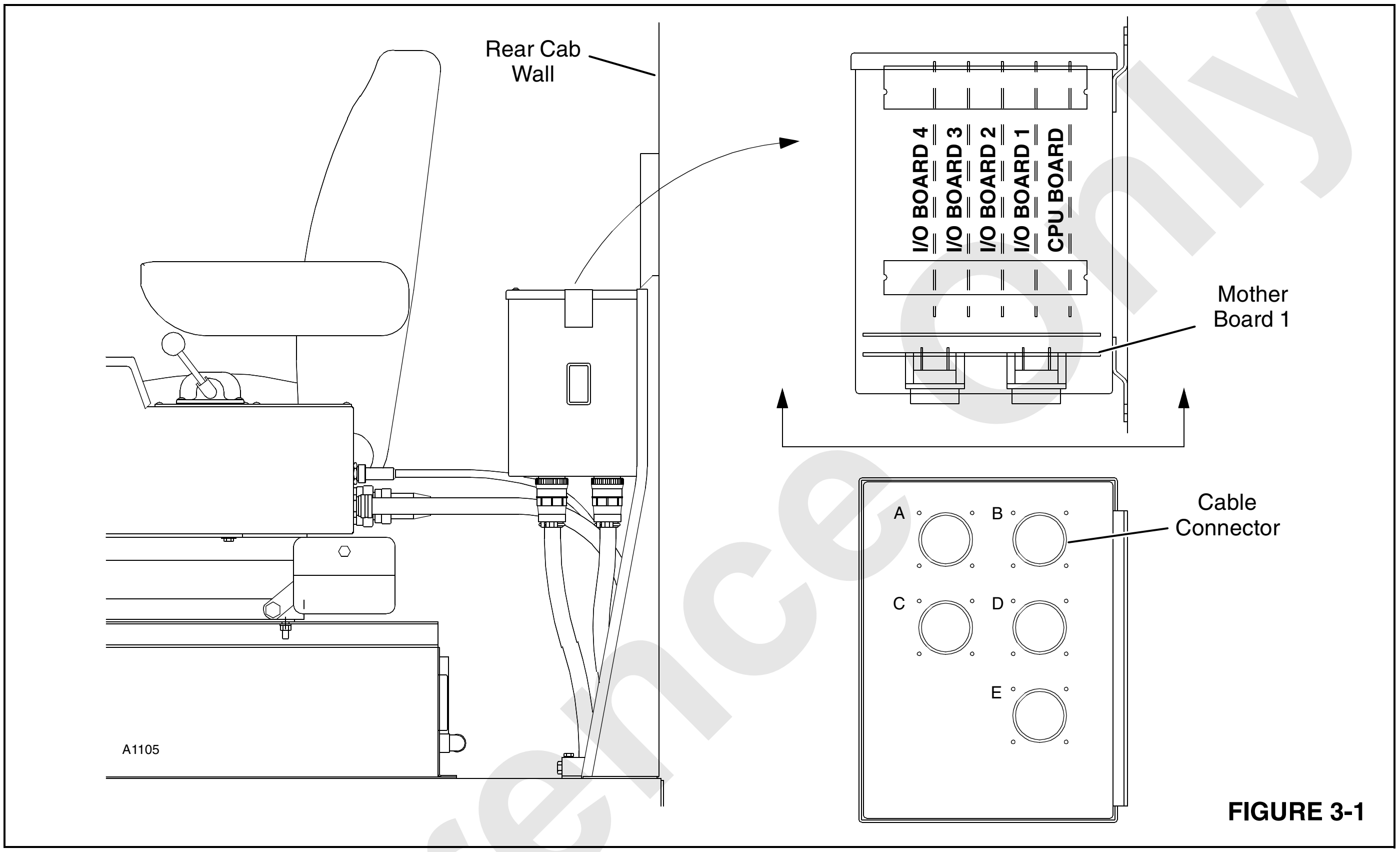


FIGURE 3-1

Pin Identification

Pin #	Wire #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
A-01	87F	—	10 VDC Regulated	10 VDC	
A-02	68KA	AI-35	Foot Throttle	0.101 to 10.09 Volts	CPU J3-64
A-03	80P	AI-1	Front Drum Handle (Handle 1)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-50
A-04	81P	AI-2	Rear Drum Handle (Handle 2)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-52
A-05	82P	AI-3	Boom Cylinder Handle (Handle 3)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-54
A-06	83P	AI-4	Right Track Handle (Handle 5)	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 1 J5-56
A-07	84P	AI-5	Left Track Handle (Handle 6)	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 1 J5-58
A-08	85P	AI-6	Swing Handle (Handle 4)	0 VDC Neutral; 5 to 1.4 VDC Right; 5 to 8.6 VDC Left	I/O 1 J5-60
A-09	86P	AI-7	Auxiliary Drum Handle (Handle 7)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-62
A-10		AI-8	Spare		I/O 1 J5-64
A-11		—	Shield		
A-12	83PF	AI-9	Right Track Pedal 1	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 2 J7-50
A-13	84PF	AI-10	Left Track Pedal 2	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 2 J7-52
A-14	8TA	AI-11	Battery Voltage	6.5 VDC at 13 VDC	I/O 2 J7-54
A-15	89ZL	AI-12	Load Indicator Select Mode	12 VDC Nominal	I/O 2 J7-56
A-16	87FM	AI-13	10 VDC Regulated Monitor	5 VDC	I/O 2 J7-58
A-17	68KK	AI-14	Hand Throttle	12 VDC Nominal	I/O 2 J7-60
A-18	89ZN	AI-15	Load Indicator Display Scroll Up	12 VDC Nominal	I/O 2 J7-62
A-19	89ZP	AI-16	Load Indicator Display Scroll Down	12 VDC Nominal	I/O 2 J7-64
A-20	82BA	AI-17	Boom Angle Indicator	1.88 VDC at 0°F; 8.7 VDC 82°F; 6.88 VDC at 60°F	CPU J3-49
A-21	87BA	AI-18	Luffing Jib Angle Indicator	3.33 VDC at 0°F; 6.66 VDC 60°F; 7.88 VDC at 82°F	CPU J3-51
A-22	80QS	AI-19	Front Drum System Pressure (Pump 0A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-53
A-23	81QS	AI-20	Rear Drum System Pressure (Pump 1A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-55
A-24	82QS	AI-21	Boom Cylinder Extend Pressure	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-57
A-25	85QR	AI-22	Swing Right Pressure (Pump 3A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-59
A-26	85QL	AI-23	Swing Left Pressure (Pump 3B)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-61
A-27	86QS	AI-24	Aux. Drum System Pressure (Pump 10A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-63
A-28	82QR	AI-25	Boom Cylinder Retract Pressure	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-50
A-29		AI-26	Spare		CPU J3-52
A-30		AI-27	Spare		CPU J3-54
A-31		AI-28	Spare		I/O 3 J9-50
A-32		AI-29	Spare		I/O 3 J9-52
A-33		AI-30	Spare		I/O 3 J9-54
A-34	SIG 1	AI-31	Load Cell 1	0 to10 VDC Nominal	CPU J3-56
A-35	SIG 2	AI-32	Load Cell 2	0 to10 VDC Nominal	CPU J3-58
A-36	SIG 3	AI-33	Load Cell 3	0 to10 VDC Nominal	CPU J3-60
A-37	SIG 4	AI-34	Load Cell 4	0 to10 VDC Nominal	CPU J3-62
B-01	89X	DI-1	Travel Detent	12 VDC Nominal	I/O 1 J6-07
B-02	89V	DI-2	Front Drum Maximum Bail Limit	12 VDC Nominal	I/O 1 J6-08
B-03	89T	DI-3	Front Drum Minimum Bail Limit	12 VDC Nominal	I/O 1 J6-09

Pin #	Wire #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
B-04	89ZA	DI-4	Left Side Counterweight Limit	12 VDC Nominal	I/O 1 J6-10
B-05	89ZB	DI-5	Right Side Counterweight Limit	12 VDC Nominal	I/O 1 J6-11
B-06	89W	DI-6	Block Up Limit	10 VDC Nominal	I/O 1 J6-12
B-07	89U	DI-7	Rear Drum Maximum Bail Limit	12 VDC Nominal	I/O 1 J6-13
B-08	89S	DI-8	Rear Drum Minimum Bail Limit	12 VDC Nominal	I/O 1 J6-14
B-09	89S2	DI-9	Crane Mode Select	12 VDC Nominal	I/O 1 J6-15
B-10	89T2	DI-10	Crane Mode Confirm	12 VDC Nominal	I/O 1 J6-16
B-11	89ZZ	DI-11	Maximum Boom/Luffing Angle Limit Bypass	12 VDC Nominal	I/O 1 J6-17
B-12	89R	DI-12	Boom Maximum Up Limit	12 VDC Nominal	I/O 1 J6-18
B-13	89Q	DI-13	Boom Maximum Down Limit	12 VDC Nominal	I/O 1 J6-19
B-14	89W1	DI-14	Luffing Jib Maximum Up Limit	10 VDC Nominal	I/O 1 J6-20
B-15	89S1	DI-15	Luffing Jib Maximum Down Limit	10 VDC Nominal	I/O 2 J8-07
B-16	89R3	DI-16	Hydraulic Fluid Level	0 VDC Low Level; 12 VDC High Level	I/O 2 J8-08
B-17	89S3	DI-17	Hydraulic Fluid Temperature	0 VDC above 180°F; 12 VDC below 180°F	I/O 2 J8-09
B-18	89T3	DI-18	Engine Oil Pressure	8 PSI (switch on)	I/O 2 J8-10
B-19	89U3	DI-19	Engine Coolant Temperature	0 VDC below 210°F; 12 VDC above 210°F	I/O 2 J8-11
B-20	89ZD	DI-20	Left Front Drum Clutch Switch	12 VDC Nominal	I/O 2 J8-12
B-21	89X2	DI-21	Rear Drum Free Fall Enable	12 VDC Nominal	I/O 2 J8-13
B-22	89ZE	DI-22	Right Front Drum Clutch Switch	12 VDC Nominal	I/O 2 J8-14
B-23	89M	DI-23	Front Drum Free Fall Enable	12 VDC Nominal	I/O 2 J8-15
B-24	89P	DI-24	Rated Capacity Indicator/Limiter	12 VDC Nominal	I/O 2 J8-16
B-25	89L	DI-25	Limit Bypass	12 VDC Nominal	I/O 2 J8-17
B-26	89J	DI-26	Display Scroll Up	12 VDC Nominal	I/O 2 J8-18
B-27	89ZF	DI-27	Set-up Remote Boom Up	12 VDC Nominal	I/O 2 J8-19
B-28	89ZG	DI-28	Set-up Remote Boom Down	12 VDC Nominal	I/O 2 J8-20
B-29	89L3	DI-29	Front Drum Pawl In	12 VDC Nominal	I/O 3 J10-07
B-30	89M3	DI-30	Rear Drum Pawl In	12 VDC Nominal	I/O 3 J10-08
B-31	89ZH	DI-31	Left Rear Drum Clutch Switch	12 VDC Nominal	I/O 3 J10-09
B-32	89T1	DI-32	Auxiliary Drum Pawl In	12 VDC Nominal	I/O 3 J10-10
B-33	89K	DI-33	Display Scroll Down	12 VDC Nominal	I/O 3 J10-11
B-34	89Q3	DI-34	Seat Switch	12 VDC Nominal	I/O 3 J10-12
B-35	89L1	DI-35	High Speed Travel Switch	12 VDC Nominal	I/O 3 J10-13
B-36	89ZJ	DI-36	Right Rear Drum Clutch Switch	12 VDC Nominal	I/O 3 J10-14
B-37	NC	Key	Receptacle Insert	12 VDC Nominal	
C-01	8P1	—	12 VDC System	12 VDC Nominal	
C-02	0	—	System Ground	0 VDC	
C-03	8P1	—	12 VDC System	12 VDC Nominal	
C-04	0	—	System Ground	0 VDC	
C-05	80A	AO-S1	Front Drum Pump Control (Servo Driver 1)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Up; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Down	I/O 1 J6-41
C-06	81A	AO-S2	Rear Drum Pump Control (Servo Driver 2)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Up; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Down	I/O 1 J6-42
C-07	80E	DO-1	Front Drum Band Brake	12 VDC Nominal	I/O 1 J6-21-22
C-08	81E	DO-2	Rear Drum Band Brake	12 VDC Nominal	I/O 1 J6-23-24
C-09	82EU	DO-3	Boom Up Enable	12 VDC Nominal	I/O 1 J6-25-26
C-10	84E	DO-4	Travel Parking Brake	12 VDC Nominal	I/O 1 J6-27-28
C-11	82ED	DO-5	Boom Down Enable	12 VDC Nominal	I/O 1 J6-29-30
C-12	8P1	—	12 VDC System	12 VDC Nominal	
C-13	0	—	System Ground	0 VDC	

Pin #	Wire #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
C-14	82A	AO-S3	Boom Cylinder Pump Control (Servo Driver 3)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Down; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Up	I/O 2 J8-41
C-15	83A	AO-S4	Right Track Pump Control (Servo Driver 4)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Forward; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Reverse	I/O 2 J8-42
C-16	80FRS	DO-6	Right Front Drum Clutch Free Fall	12 VDC Nominal	I/O 1 J6-31-32
C-17	81FRS	DO-7	Right Rear Drum Clutch Free Fall	12 VDC Nominal	I/O 1 J6-34-33
C-18	80Q	DO-8	Front Drum Disc Brake Solenoid	12 VDC Nominal	I/O 1 J6-35-36
C-19	81Q	DO-9	Rear Drum Disc Brake Solenoid	12 VDC Nominal	I/O 1 J6-37-38
C-20	68KB	DO-10	Engine Throttle Interface	12 VDC Nominal	I/O 1 J6-39-40
C-21	8P1	—	12 VDC System	12 VDC Nominal	
C-22	0	—	System Ground	0 VDC	
C-23	84A	AO-S5	Left Track Pump Control (Servo Driver 5)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Reverse; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Forward	I/O 3 J10-41
C-24	85A	AO-S6	Swing Pump Control (Servo Driver 6)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Right; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Left	I/O 3 J10-42
C-25	87E	DO-11	Auxiliary. Drum Disc Brake Solenoid	12 VDC Nominal	I/O 2 J8-21-22
C-26		DO-12	Spare		I/O 2 J8-23-24
C-27	25X	DO-13	Swing/Travel Alarms	12 VDC Nominal	I/O 2 J8-25-26
C-28	25A	DO-14	Operating Limit Alarms	12 VDC Nominal	I/O 2 J8-27-28
C-29	25	DO-15	System Fault Alarms	12 VDC Nominal	I/O 2 J8-29-30
C-30	8P1	—	12 VDC System	12 VDC Nominal	
C-31	0	—	System Ground	0 VDC	
C-32		DO-16	Spare		I/O 2 J8-31-32
C-33	80FLS	DO-17	Left Front Drum Clutch Free Fall	12 VDC Nominal	I/O 2 J8-33-34
C-34	82R	DO-18	Boom Pump Enable	12 VDC Nominal	I/O 2 J8-35-36
C-35	80DS	DO-19	Front Drum Free Fall Light	12 VDC Nominal	I/O 2 J8-37-38
C-36	81DS	DO-20	Rear Drum Free Fall Light	12 VDC Nominal	I/O 2 J8-39-40
C-37	NC	Key	Cable Plug Insert		
D-01	80MA	ECA1	Front Drum Flange Speed Encoder Channel A1	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-01
D-02	80MB	ECB1	Front Drum Flange Direction Encoder Channel B1	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-02
D-03	81MA	ECA2	Rear Drum Flange Speed Encoder Channel A2	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-03
D-04	81MB	ECB2	Rear Drum Flange Direction Encoder Channel B2	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-04
D-05		ECA3	Spare Encoder Channel A3		I/O 2 J8-01
D-06		ECB3	Spare Encoder Channel B3		I/O 2 J8-02
D-07	24	MP1	Engine RPM Transducer	Above 9.0 Volts AC	I/O 1 J6-05
D-08	89Y3	DI-37	Front Drum Disc Brake Park Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-15
D-09	89Z3	DI-38	Rear Drum Disc Brake Park Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-16
D-10	89A4	DI-39	Boom Cylinder Enable	12 VDC Nominal (when brake is applied)	I/O 3 J10-17
D-11	89B4	DI-40	Travel Park Disc Brake Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-18
D-12	89C4	DI-41	Auxiliary Drum Disc Brake Park Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-19
D-13	89Q1	DI-42	Auxiliary Drum Minimum Bail Limit	12 VDC Nominal (when brake is applied)	I/O 3 J10-20
D-14	89R1	DI-43	Auxiliary Drum Maximum Bail Limit	12 VDC Nominal (when brake is applied)	I/O 4 J12-07
D-15	89B2	DI-44	Swing Park Switch/Holding Brake	12 VDC Nominal (when brake is applied)	I/O 4 J12-08
D-16	RX1	—	RS-232 Receptacle (Receive I/O)		CPU J4-02
D-17	TX1	—	RS-232 Receptacle (Transmit I/O)		CPU J4-01
D-18	TX1-0	—	RS-232 Receptacle (Common I/O)		CPU J4-03-04

Pin #	Wire #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
D-19	TX2	—	Display - White (Input)	Approximately 2.5 VDC	CPU J4-05
D-20	TX2-0	—	Display - Black (Common)		CPU J4-07-08
D-21	RX3	—	2nd Computer (Receive I/O)		CPU J4-10
D-22	TX3	—	2nd Computer (Transmit I/O)		CPU J4-09
D-23	NC	Key	Cable Plug Insert		Keyhole
D-24	80S	AO-1	Front Drum Motor Control Right and Left Side	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 1 J6-06
D-25	81S	AO-2	Rear Drum Motor Control Right and Left Side	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 2 J8-06
D-26		DO-21	Spare		I/O 3 J10-23
D-27	80N	DO-22	Front Drum Rotation Indicator	12 VDC Nominal	I/O 3 J10-23-24
D-28	81N	DO-23	Rear Drum Rotation Indicator	12 VDC Nominal	I/O 3 J10-25-26
D-29	82N	DO-24	Boom Cylinder Up/Down Indicator	12 VDC Nominal	I/O 3 J10-27-28
D-30	87N	DO-25	Auxiliary Drum Rotation Indicator	12 VDC Nominal	I/O 3 J10-29-30
D-31	88R	DO-26	Track Motor (2-Speed)	12 VDC Nominal	I/O 3 J10-31-32
D-32		DO-27	Spare		I/O 3 J10-33-34
D-33		DO-28	Spare		I/O 3 J10-35-36
D-34		DO-29	Spare		I/O 3 J10-37-38
D-35		DO-30	Spare		I/O 3 J10-39-40
D-36		DO-31	Spare		I/O 4 J12-21-22
D-37		DO-32	Spare		I/O 4 J12-23-24
E-01	87MA	ECA4	Auxiliary Drum Speed Encoder Channel A4	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 2 J8-03
E-02	87MB	ECB4	Aux. Drum Direction Encoder Channel B4	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 2 J8-04
E-03	80MARS	ECA5	Right Front Drum Shaft Speed Encoder Channel A5	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-01
E-04	80MBRS	ECB5	Right Front Drum Shaft Direction Encoder Channel B5	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-02
E-05	81MARS	ECA6	Right Rear Drum Shaft Speed Encoder Channel A6	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-03
E-06	81MBRS	ECB6	Right Rear Drum Shaft Direction Encoder Channel B6	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-04
E-07	MAG PU2	MP2	Spare Magnetic Pick-Up		I/O 2 J8-05
E-08	83Q	AI-36	Travel Pressure Right Track	1.2 VDC at 300 PSI; 1 VDC at No Pressure	I/O 2 J9-56
E-09	84Q	AI-37	Travel Pressure Left Track	1.2 VDC at 300 PSI; 1 VDC at No Pressure	I/O 2 J9-58
E-10		AI-38	Spare		I/O 2 J9-60
E-11		AI-39	Spare		I/O 2 J9-62
E-12		AI-40	Spare		I/O 2 J9-64
E-13	89D4	DI-45	Hydraulic Filter Alarm 1	12 VDC Nominal (when filter bypassing)	I/O 4 J12-09
E-14	89E4	DI-46	Hydraulic Filter Alarm 2	12 VDC Nominal (when filter bypassing)	I/O 4 J12-10
E-15	89F4	DI-47	Hydraulic Filter Alarm 3	12 VDC Nominal (when filter bypassing)	I/O 4 J12-11
E-16	89G4	DI-48	Hydraulic Filter Alarm 4	12 VDC Nominal (when filter bypassing)	I/O 4 J12-12
E-17	89H4	DI-49	Hydraulic Filter Alarm 5	12 VDC Nominal (when strainer is clean)	I/O 4 J12-13
E-18	89ZK	DI-50	Boom Cylinder Hold	12 VDC Nominal	I/O 4 J12-14
E-19		DI-51	Spare		I/O 4 J12-15
E-20	82MARS	DI-52	Boom Right Cylinder Encoder Channel A7	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-16
E-21	82MBRS	DI-53	Boom Right Cylinder Encoder Channel B7	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-17
E-22	82MALS	DI-54	Boom Left Cylinder Encoder Channel A8	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-18
E-23	82MBLS	DI-55	Boom Left Cylinder Encoder Channel B8	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-19
E-24	89Z4	DI-56	Hydraulic Filter Alarm 6	12 VDC Nominal (when filter is bypassing)	I/O 4 J12-20

Pin #	Wire #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
E-25	80MALS	ECA7	Left Front Drum Encoder Channel A	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-01
E-26	80MBLS	ECB7	Left Front Drum Encoder Channel B	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-02
E-27	81MALS	ECA8	Left Rear Drum Encoder Channel A	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-03
E-28	81MBLS	ECB8	Left Rear Drum Encoder Channel B	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-04
E-29		AO-3	Spare		I/O 3 J10-06
E-30	87C	AO-4	Auxiliary. Drum Motor Control	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 4 J12-06
E-31	NC	—	Computer 12 VDC		
E-32	NC	—	Computer Ground		
E-33		DO-33	Spare		I/O 4 J12-25-26
E-34		DO-34	Spare		I/O 4 J12-27-28
E-35		DO-35	Spare		I/O 4 J12-29-30
E-36	87A	DO-36	Auxiliary Drum Pump Control Up	0 to 2.8 VDC Engine On; 0 to 2.4 VDC Engine Off	I/O 4 J12-31-32
E-37	87B	DO-37	Auxiliary Drum Pump Control Down	0 to 2.8 VDC Engine On; 0 to 2.4 VDC Engine Off	I/O 4 J12-33-34

Wire Identification

Wire #	Pin #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
	A-10	AI-8	Spare		I/O 1 J5-64
	A-11	—	Shield		
	A-29	AI-26	Spare		CPU J3-52
	A-30	AI-27	Spare		CPU J3-54
	A-31	AI-28	Spare		I/O 3 J9-50
	A-32	AI-29	Spare		I/O 3 J9-52
	A-33	AI-30	Spare		I/O 3 J9-54
	C-26	DO-12	Spare		I/O 2 J8-23-24
	C-32	DO-16	Spare		I/O 2 J8-31-32
	D-05	ECA3	Spare Encoder Channel A3		I/O 2 J8-01
	D-06	ECB3	Spare Encoder Channel B3		I/O 2 J8-02
	D-26	DO-21	Spare		I/O 3 J10-23
	D-32	DO-27	Spare		I/O 3 J10-33-34
	D-33	DO-28	Spare		I/O 3 J10-35-36
	D-34	DO-29	Spare		I/O 3 J10-37-38
	D-35	DO-30	Spare		I/O 3 J10-39-40
	D-36	DO-31	Spare		I/O 4 J12-21-22
	D-37	DO-32	Spare		I/O 4 J12-23-24
	E-10	AI-38	Spare		I/O 2 J9-60
	E-11	AI-39	Spare		I/O 2 J9-62
	E-12	AI-40	Spare		I/O 2 J9-64
	E-19	DI-51	Spare		I/O 4 J12-15
	E-29	AO-3	Spare		I/O 3 J10-06
	E-33	DO-33	Spare		I/O 4 J12-25-26
	E-34	DO-34	Spare		I/O 4 J12-27-28
	E-35	DO-35	Spare		I/O 4 J12-29-30
MAG PU2	E-07	MP2	Spare Magnetic Pick-Up		I/O 2 J8-05
NC	B-37	Key	Receptacle Insert	12 VDC Nominal	
NC	C-37	Key	Cable Plug Insert		
NC	D-23	Key	Cable Plug Insert		Keyhole
NC	E-31	—	Computer 12 VDC		
NC	E-32	—	Computer Ground		
RX1	D-16	—	RS-232 Receptacle (Receive I/O)		CPU J4-02
RX3	D-21	—	2nd Computer (Receive I/O)		CPU J4-10
TX1	D-17	—	RS-232 Receptacle (Transmit I/O)		CPU J4-01
TX2	D-19	—	Display - White (Input)	Approximately 2.5 VDC	CPU J4-05
TX3	D-22	—	2nd Computer (Transmit I/O)		CPU J4-09
0	C-02	—	System Ground	0 VDC	
0	C-04	—	System Ground	0 VDC	
0	C-13	—	System Ground	0 VDC	
0	C-22	—	System Ground	0 VDC	
0	C-31	—	System Ground	0 VDC	
TX1-0	D-18	—	RS-232 Receptacle (Common I/O)		CPU J4-03-04
TX2-0	D-20	—	Display - Black (Common)		CPU J4-07-08
SIG 1	A-34	AI-31	Load Cell 1	0 to10 VDC Nominal	CPU J3-56
SIG 2	A-35	AI-32	Load Cell 2	0 to10 VDC Nominal	CPU J3-58

Wire #	Pin #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
SIG 3	A-36	AI-33	Load Cell 3	0 to10 VDC Nominal	CPU J3-60
SIG 4	A-37	AI-34	Load Cell 4	0 to10 VDC Nominal	CPU J3-62
8P1	C-01	—	12 VDC System	12 VDC Nominal	
8P1	C-03	—	12 VDC System	12 VDC Nominal	
8P1	C-12	—	12 VDC System	12 VDC Nominal	
8P1	C-21	—	12 VDC System	12 VDC Nominal	
8P1	C-30	—	12 VDC System	12 VDC Nominal	
8TA	A-14	AI-11	Battery Voltage	6.5 VDC at 13 VDC	I/O 2 J7-54
24	D-07	MP1	Engine RPM Transducer	Above 9.0 Volts AC	I/O 1 J6-05
25	C-29	DO-15	System Fault Alarms	12 VDC Nominal	I/O 2 J8-29-30
25A	C-28	DO-14	Operating Limit Alarms	12 VDC Nominal	I/O 2 J8-27-28
25X	C-27	DO-13	Swing/Travel Alarms	12 VDC Nominal	I/O 2 J8-25-26
68KA	A-02	AI-35	Foot Throttle	0.101 to 10.09 Volts	CPU J3-64
68KB	C-20	DO-10	Engine Throttle Interface	12 VDC Nominal	I/O 1 J6-39-40
68KK	A-17	AI-14	Hand Throttle	12 VDC Nominal	I/O 2 J7-60
80MALS	E-25	ECA7	Left Front Drum Encoder Channel A	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-01
80MARS	E-03	ECA5	Right Front Drum Shaft Speed Encoder Channel A5	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-01
80MBLS	E-26	ECB7	Left Front Drum Encoder Channel B	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-02
80MBRS	E-04	ECB5	Right Front Drum Shaft Direction Encoder Channel B5	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-02
80A	C-05	AO-S1	Front Drum Pump Control (Servo Driver 1)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Up; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Down	I/O 1 J6-41
80DS	C-35	DO-19	Front Drum Free Fall Light	12 VDC Nominal	I/O 2 J8-37-38
80E	C-07	DO-1	Front Drum Band Brake	12 VDC Nominal	I/O 1 J6-21-22
80FLS	C-33	DO-17	Left Front Drum Clutch Free Fall	12 VDC Nominal	I/O 2 J8-33-34
80FRS	C-16	DO-6	Right Front Drum Clutch Free Fall	12 VDC Nominal	I/O 1 J6-31-32
80MA	D-01	ECA1	Front Drum Flange Speed Encoder Channel A1	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-01
80MB	D-02	ECB1	Front Drum Flange Direction Encoder Channel B1	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-02
80N	D-27	DO-22	Front Drum Rotation Indicator	12 VDC Nominal	I/O 3 J10-23-24
80P	A-03	AI-1	Front Drum Handle (Handle 1)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-50
80Q	C-18	DO-8	Front Drum Disc Brake Solenoid	12 VDC Nominal	I/O 1 J6-35-36
80QS	A-22	AI-19	Front Drum System Pressure (Pump 0A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-53
80S	D-24	AO-1	Front Drum Motor Control Right and Left Side	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 1 J6-06
81MALS	E-27	ECA8	Left Rear Drum Encoder Channel A	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-03
81MARS	E-05	ECA6	Right Rear Drum Shaft Speed Encoder Channel A6	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-03
81MBLS	E-28	ECB8	Left Rear Drum Encoder Channel B	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-04
81MBRS	E-06	ECB6	Right Rear Drum Shaft Direction Encoder Channel B6	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-04
81A	C-06	AO-S2	Rear Drum Pump Control (Servo Driver 2)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Up; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Down	I/O 1 J6-42
81DS	C-36	DO-20	Rear Drum Free Fall Light	12 VDC Nominal	I/O 2 J8-39-40
81E	C-08	DO-2	Rear Drum Band Brake	12 VDC Nominal	I/O 1 J6-23-24
81FRS	C-17	DO-7	Right Rear Drum Clutch Free Fall	12 VDC Nominal	I/O 1 J6-34-33
81MA	D-03	ECA2	Rear Drum Flange Speed Encoder Channel A2	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-03

Wire #	Pin #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
81MB	D-04	ECB2	Rear Drum Flange Direction Encoder Channel B2	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-04
81N	D-28	DO-23	Rear Drum Rotation Indicator	12 VDC Nominal	I/O 3 J10-25-26
81P	A-04	AI-2	Rear Drum Handle (Handle 2)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-52
81Q	C-19	DO-9	Rear Drum Disc Brake Solenoid	12 VDC Nominal	I/O 1 J6-37-38
81QS	A-23	AI-20	Rear Drum System Pressure (Pump 1A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-55
81S	D-25	AO-2	Rear Drum Motor Control Right and Left Side	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 2 J8-06
82MALS	E-22	DI-54	Boom Left Cylinder Encoder Channel A8	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-18
82MARS	E-20	DI-52	Boom Right Cylinder Encoder Channel A7	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-16
82MBLS	E-23	DI-55	Boom Left Cylinder Encoder Channel B8	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-19
82MBRS	E-21	DI-53	Boom Right Cylinder Encoder Channel B7	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-17
82A	C-14	AO-S3	Boom Cylinder Pump Control Servo Driver 3	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Down; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Up	I/O 2 J8-41
82BA	A-20	AI-17	Boom Angle Indicator	1.88 VDC at 0°F; 8.7 VDC 82°F; 6.88 VDC at 60°F	CPU J3-49
82ED	C-11	DO-5	Boom Down Enable	12 VDC Nominal	I/O 1 J6-29-30
82EU	C-09	DO-3	Boom Up Enable	12 VDC Nominal	I/O 1 J6-25-26
82N	D-29	DO-24	Boom Cylinder Up/Down Indicator	12 VDC Nominal	I/O 3 J10-27-28
82P	A-05	AI-3	Boom Cylinder Handle (Handle 3)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-54
82QR	A-28	AI-25	Boom Cylinder Retract Pressure	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-50
82QS	A-24	AI-21	Boom Cylinder Extend Pressure	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-57
82R	C-34	DO-18	Boom Pump Enable	12 VDC Nominal	I/O 2 J8-35-36
83A	C-15	AO-S4	Right Track Pump Control (Servo Driver 4)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Forward; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Reverse	I/O 2 J8-42
83P	A-06	AI-4	Right Track Handle (Handle 5)	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 1 J5-56
83PF	A-12	AI-9	Right Track Pedal 1	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 2 J7-50
83Q	E-08	AI-36	Travel Pressure Right Track	1.2 VDC at 300 PSI; 1 VDC at No Pressure	I/O 2 J9-56
84A	C-23	AO-S5	Left Track Pump Control (Servo Driver 5)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Reverse; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Forward	I/O 3 J10-41
84E	C-10	DO-4	Travel Parking Brake	12 VDC Nominal	I/O 1 J6-27-28
84P	A-07	AI-5	Left Track Handle (Handle 6)	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 1 J5-58
84PF	A-13	AI-10	Left Track Pedal 2	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 2 J7-52
84Q	E-09	AI-37	Travel Pressure Left Track	1.2 VDC at 300 PSI; 1 VDC at No Pressure	I/O 2 J9-58
85A	C-24	AO-S6	Swing Pump Control (Servo Driver 6)	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Right; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Left	I/O 3 J10-42
85P	A-08	AI-6	Swing Handle (Handle 4)	0 VDC Neutral; 5 to 1.4 VDC Right, 5 to 8.6 VDC Left	I/O 1 J5-60
85QL	A-26	AI-23	Swing Left Pressure (Pump 3B)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-61
85QR	A-25	AI-22	Swing Right Pressure (Pump 3A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-59
86P	A-09	AI-7	Auxiliary Drum Handle (Handle 7)	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-62
86QS	A-27	AI-24	Aux. Drum System Pressure (Pump 10A)	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-63
87MA	E-01	ECA4	Auxiliary Drum Speed Encoder Channel A4	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 2 J8-03
87MB	E-02	ECB4	Aux. Drum Direction Encoder Channel B4	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 2 J8-04
87A	E-36	DO-36	Auxiliary Drum Pump Control Up	0 to 2.8 VDC Engine On; 0 to 2.4 VDC Engine Off	I/O 4 J12-31-32

Wire #	Pin #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
87B	E-37	DO-37	Auxiliary Drum Pump Control Down	0 to 2.8 VDC Engine On; 0 to 2.4 VDC Engine Off	I/O 4 J12-33-34
87BA	A-21	AI-18	Luffing Jib Angle Indicator	3.33 VDC at 0°F; 6.66 VDC 60°F; 7.88 VDC at 82°F	CPU J3-51
87C	E-30	AO-4	Auxiliary Drum Motor Control	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 4 J12-06
87E	C-25	DO-11	Auxiliary Drum Disc Brake Solenoid	12 VDC Nominal	I/O 2 J8-21-22
87F	A-01	—	10 VDC Regulated	10 VDC	
87FM	A-16	AI-13	10 VDC Regulated Monitor	5 VDC	I/O 2 J7-58
87N	D-30	DO-25	Auxiliary Drum Rotation Indicator	12 VDC Nominal	I/O 3 J10-29-30
88R	D-31	DO-26	Track Motor (2-Speed)	12 VDC Nominal	I/O 3 J10-31-32
89A4	D-10	DI-39	Boom Cylinder Enable	12 VDC Nominal (when brake is applied)	I/O 3 J10-17
89B2	D-15	DI-44	Swing Park Switch/Holding Brake	12 VDC Nominal (when brake is applied)	I/O 4 J12-08
89B4	D-11	DI-40	Travel Park Disc Brake Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-18
89C4	D-12	DI-41	Auxiliary Drum Disc Brake Park Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-19
89D4	E-13	DI-45	Hydraulic Filter Alarm 1	12 VDC Nominal (when filter bypassing)	I/O 4 J12-09
89E4	E-14	DI-46	Hydraulic Filter Alarm 2	12 VDC Nominal (when filter bypassing)	I/O 4 J12-10
89F4	E-15	DI-47	Hydraulic Filter Alarm 3	12 VDC Nominal (when filter bypassing)	I/O 4 J12-11
89G4	E-16	DI-48	Hydraulic Filter Alarm 4	12 VDC Nominal (when filter bypassing)	I/O 4 J12-12
89H4	E-17	DI-49	Hydraulic Filter Alarm 5	12 VDC Nominal (when strainer is clean)	I/O 4 J12-13
89J	B-26	DI-26	Display Scroll Up	12 VDC Nominal	I/O 2 J8-18
89K	B-33	DI-33	Display Scroll Down	12 VDC Nominal	I/O 3 J10-11
89L	B-25	DI-25	Limit Bypass	12 VDC Nominal	I/O 2 J8-17
89L1	B-35	DI-35	High Speed Travel Switch	12 VDC Nominal	I/O 3 J10-13
89L3	B-29	DI-29	Front Drum Pawl In	12 VDC Nominal	I/O 3 J10-07
89M	B-23	DI-23	Front Drum Free Fall Enable	12 VDC Nominal	I/O 2 J8-15
89M3	B-30	DI-30	Rear Drum Pawl In	12 VDC Nominal	I/O 3 J10-08
89P	B-24	DI-24	Rated Capacity Indicator/Limiter	12 VDC Nominal	I/O 2 J8-16
89Q	B-13	DI-13	Boom Maximum Down Limit	12 VDC Nominal	I/O 1 J6-19
89Q1	D-13	DI-42	Auxiliary Drum Minimum Bail Limit	12 VDC Nominal (when brake is applied)	I/O 3 J10-20
89Q3	B-34	DI-34	Seat Switch	12 VDC Nominal	I/O 3 J10-12
89R	B-12	DI-12	Boom Maximum Up Limit	12 VDC Nominal	I/O 1 J6-18
89R1	D-14	DI-43	Auxiliary Drum Maximum Bail Limit	12 VDC Nominal (when brake is applied)	I/O 4 J12-07
89R3	B-16	DI-16	Hydraulic Fluid Level	0 VDC Low Level; 12 VDC High Level	I/O 2 J8-08
89S	B-08	DI-8	Rear Drum Minimum Bail Limit	12 VDC Nominal	I/O 1 J6-14
89S1	B-15	DI-15	Luffing Jib Maximum Down Limit	10 VDC Nominal	I/O 2 J8-07
89S2	B-09	DI-9	Crane Mode Select	12 VDC Nominal	I/O 1 J6-15
89S3	B-17	DI-17	Hydraulic Fluid Temperature	0 VDC above 180°F; 12 VDC below 180°F	I/O 2 J8-09
89T	B-03	DI-3	Front Drum Minimum Bail Limit	12 VDC Nominal	I/O 1 J6-09
89T1	B-32	DI-32	Auxiliary Drum Pawl In	12 VDC Nominal	I/O 3 J10-10
89T2	B-10	DI-10	Crane Mode Confirm	12 VDC Nominal	I/O 1 J6-16
89T3	B-18	DI-18	Engine Oil Pressure	8 PSI (switch on)	I/O 2 J8-10
89U	B-07	DI-7	Rear Drum Maximum Bail Limit	12 VDC Nominal	I/O 1 J6-13
89U3	B-19	DI-19	Engine Coolant Temperature	0 VDC below 210°F; 12 VDC above 210°F	I/O 2 J8-11
89V	B-02	DI-2	Front Drum Maximum Bail Limit	12 VDC Nominal	I/O 1 J6-08
89W	B-06	DI-6	Block Up Limit	10 VDC Nominal	I/O 1 J6-12
89W1	B-14	DI-14	Luffing Jib Maximum Up Limit	10 VDC Nominal	I/O 1 J6-20
89X	B-01	DI-1	Travel Detent	12 VDC Nominal	I/O 1 J6-07
89X2	B-21	DI-21	Rear Drum Free Fall Enable	12 VDC Nominal	I/O 2 J8-13
89Y3	D-08	DI-37	Front Drum Disc Brake Park Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-15

Wire #	Pin #	I/O #	Description	Test Voltage (DC unless otherwise specified)	Connection
89Z3	D-09	DI-38	Rear Drum Disc Brake Park Switch	12 VDC Nominal (when brake is applied)	I/O 3 J10-16
89Z4	E-24	DI-56	Hydraulic Filter Alarm 6	12 VDC Nominal (when filter is bypassing)	I/O 4 J12-20
89ZA	B-04	DI-4	Left Side Counterweight Limit	12 VDC Nominal	I/O 1 J6-10
89ZB	B-05	DI-5	Right Side Counterweight Limit	12 VDC Nominal	I/O 1 J6-11
89ZD	B-20	DI-20	Left Front Drum Clutch Switch	12 VDC Nominal	I/O 2 J8-12
89ZE	B-22	DI-22	Right Front Drum Clutch Switch	12 VDC Nominal	I/O 2 J8-14
89ZF	B-27	DI-27	Set-up Remote Boom Up	12 VDC Nominal	I/O 2 J8-19
89ZG	B-28	DI-28	Set-up Remote Boom Down	12 VDC Nominal	I/O 2 J8-20
89ZH	B-31	DI-31	Left Rear Drum Clutch Switch	12 VDC Nominal	I/O 3 J10-09
89ZJ	B-36	DI-36	Right Rear Drum Clutch Switch	12 VDC Nominal	I/O 3 J10-14
89ZK	E-18	DI-50	Boom Cylinder Hold	12 VDC Nominal	I/O 4 J12-14
89ZL	A-15	AI-12	Load Indicator Select Mode	12 VDC Nominal	I/O 2 J7-56
89ZN	A-18	AI-15	Load Indicator Display Scroll Up	12 VDC Nominal	I/O 2 J7-62
89ZP	A-19	AI-16	Load Indicator Display Scroll Down	12 VDC Nominal	I/O 2 J7-64
89ZZ	B-11	DI-11	Maximum Boom/Luffing Angle Limit Bypass	12 VDC Nominal	I/O 1 J6-17

Description Identification

Description	Wire #	Pin #	I/O #	Test Voltage (DC unless otherwise specified)	Connection (Signal Type)
10 VDC Regulated	87F	A-01	—	10 VDC	
10 VDC Regulated Monitor	87FM	A-16	AI-13	5 VDC	I/O 2 J7-58
12 VDC System	8P1	C-01	—	12 VDC Nominal	
12 VDC System	8P1	C-03	—	12 VDC Nominal	
12 VDC System	8P1	C-12	—	12 VDC Nominal	
12 VDC System	8P1	C-21	—	12 VDC Nominal	
12 VDC System	8P1	C-30	—	12 VDC Nominal	
2nd Computer (Receive I/O)	RX3	D-21	—		CPU J4-10
2nd Computer (Transmit I/O)	TX3	D-22	—		CPU J4-09
Auxiliary Drum Direction Encoder Channel B4	87MB	E-02	ECB4	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 2 J8-04
Auxiliary Drum Disc Brake Park Switch	89C4	D-12	DI-41	12 VDC Nominal (when brake is applied)	I/O 3 J10-19
Auxiliary Drum Disc Brake Solenoid	87E	C-25	DO-11	12 VDC Nominal	I/O 2 J8-21-22
Auxiliary Drum Handle (Handle 7)	86P	A-09	AI-7	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-62
Auxiliary Drum Maximum Bail Limit	89P1	D-14	DI-43	12 VDC Nominal (when brake is applied)	I/O 4 J12-07
Auxiliary Drum Motor Control	87C	E-30	AO-4	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 4 J12-06
Auxiliary Drum Minimum Bail Limit	89Q1	D-13	DI-42	12 VDC Nominal (when brake is applied)	I/O 3 J10-20
Auxiliary Drum Pump Control Down	87B	E-37	DO-37	0 to 2.8 VDC Engine On; 0 to 2.4 VDC Engine Off	I/O 4 J12-33-34
Auxiliary Drum Pump Control Up	87A	E-36	DO-36	0 to 2.8 VDC Engine On; 0 to 2.4 VDC Engine Off	I/O 4 J12-31-32
Auxiliary Drum Pawl In	89T1	B-32	DI-32	12 VDC Nominal	I/O 3 J10-10
Auxiliary Drum Rotation Indicator	87N	D-30	DO-25	12 VDC Nominal	I/O 3 J10-29-30
Auxiliary Drum Speed Encoder Channel A4	87MA	E-01	ECA4	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 2 J8-03
Auxiliary Drum System Pressure Pump 10A	86QS	A-27	AI-24	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-63
Battery Voltage	8TA	A-14	AI-11	6.5 VDC at 13 VDC	I/O 2 J7-54
Block Up Limit	89W	B-06	DI-6	10 VDC Nominal	I/O 1 J6-12
Boom Angle Indicator	82BA	A-20	AI-17	1.88 VDC at 0°, 8.7 VDC 82°, 6.88 VDC at 60°	CPU J3-49
Boom Cylinder Extend Pressure	82QS	A-24	AI-21	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-57
Boom Cylinder Handle (Handle 3)	82P	A-05	AI-3	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-54
Boom Cylinder Hold	89ZK	E-18	DI-50	12 VDC Nominal	I/O 4 J12-14
Boom Cylinder Pump Control (Servo Driver 3)	82A	C-14	AO-S3	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Down; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Up	I/O 2 J8-41
Boom Cylinder Retract Pressure	82QR	A-28	AI-25	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-50
Boom Down Enable	82ED	C-11	DO-5	12 VDC Nominal	I/O 1 J6-29-30
Boom Cylinder Up/Down Indicator	82N	D-29	DO-24	12 VDC Nominal	I/O 3 J10-27-28
Boom Cylinder Enable	89A4	D-10	DI-39	12 VDC Nominal (when brake is applied)	I/O 3 J10-17
Boom Left Cylinder Encoder Channel A8	82MALS	E-22	DI-54	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-18
Boom Left Cylinder Encoder Channel B8	82MBLS	E-23	DI-55	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-19
Boom Maximum Down Limit	89Q	B-13	DI-13	12 VDC Nominal	I/O 1 J6-19
Boom Maximum Up Limit	89R	B-12	DI-12	12 VDC Nominal	I/O 1 J6-18
Boom Pump Enable	82R	C-34	DO-18	12 VDC Nominal	I/O 2 J8-35-36
Boom Right Cylinder Encoder Channel A7	82MARS	E-20	DI-52	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-16
Boom Right Cylinder Encoder Channel B7	82MBRS	E-21	DI-53	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-17
Boom Up Enable	82EU	C-09	DO-3	12 VDC Nominal	I/O 1 J6-25-26
Cable Plug Insert	NC	C-37	Key		
Cable Plug Insert	NC	D-23	Key		Keyhole

Description	Wire #	Pin #	I/O #	Test Voltage (DC unless otherwise specified)	Connection (Signal Type)
Computer 12 VDC	NC	E-31	—		
Computer Ground	NC	E-32	—		
Crane Mode Confirm	89T2	B-10	DI-10	12 VDC Nominal	I/O 1 J6-16
Crane Mode Select	89S2	B-09	DI-9	12 VDC Nominal	I/O 1 J6-15
Display - Black (Common)	TX2-0	D-20	—		CPU J4-07-08
Display - White (Input)	TX2	D-19	—	Approximately 2.5 VDC	CPU J4-05
Display Scroll Down	89K	B-33	DI-33	12 VDC Nominal	I/O 3 J10-11
Display Scroll Up	89J	B-26	DI-26	12 VDC Nominal	I/O 2 J8-18
Engine Coolant Temperature	89U3	B-19	DI-19	0 VDC below 210°F; 12 VDC above 210°F	I/O 2 J8-11
Engine Oil Pressure	89T3	B-18	DI-18	8 PSI (switch on)	I/O 2 J8-10
Engine RPM Transducer	24	D-07	MP1	Above 9.0 Volts AC	I/O 1 J6-05
Engine Throttle Interface	68KB	C-20	DO-10	12 VDC Nominal	I/O 1 J6-39-40
Foot Throttle	68KA	A-02	AI-35	0.101 to 10.09 Volts	CPU J3-64
Front Drum Band Brake	80E	C-07	DO-1	12 VDC Nominal	I/O 1 J6-21-22
Front Drum Disc Brake Park Switch	89Y3	D-08	DI-37	12 VDC Nominal (when brake is applied)	I/O 3 J10-15
Front Drum Disc Brake Solenoid	80Q	C-18	DO-8	12 VDC Nominal	I/O 1 J6-35-36
Front Drum Flange Direction Encoder Channel B1	80MB	D-02	ECB1	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-02
Front Drum Flange Speed Encoder Channel A1	80MA	D-01	ECA1	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-01
Front Drum Free Fall Enable	89M	B-23	DI-23	12 VDC Nominal	I/O 2 J8-15
Front Drum Free Fall Light	80DS	C-35	DO-19	12 VDC Nominal	I/O 2 J8-37-38
Front Drum Handle (Handle 1)	80P	A-03	AI-1	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-50
Front Drum Motor Control Right and Left Side	80S	D-24	AO-1	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 1 J6-06
Front Drum Maximum Bail Limit	89V	B-02	DI-2	12 VDC Nominal	I/O 1 J6-08
Front Drum Minimum Bail Limit	89T	B-03	DI-3	12 VDC Nominal	I/O 1 J6-09
Front Drum Pump Control (Servo Driver 1)	80A	C-05	AO-S1	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Up; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Down	I/O 1 J6-41
Front Drum Pawl In	89L3	B-29	DI-29	12 VDC Nominal	I/O 3 J10-07
Front Drum Rotation Indicator	80N	D-27	DO-22	12 VDC Nominal	I/O 3 J10-23-24
Front Drum System Pressure (Pump 0A)	80QS	A-22	AI-19	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-53
Hand Throttle	68KK	A-17	AI-14	12 VDC Nominal	I/O 2 J7-60
High Speed Travel Switch	89L1	B-35	DI-35	12 VDC Nominal	I/O 3 J10-13
Hydraulic Filter Alarm 1	89D4	E-13	DI-45	12 VDC Nominal (when filter bypassing)	I/O 4 J12-09
Hydraulic Filter Alarm 2	89E4	E-14	DI-46	12 VDC Nominal (when filter bypassing)	I/O 4 J12-10
Hydraulic Filter Alarm 3	89F4	E-15	DI-47	12 VDC Nominal (when filter bypassing)	I/O 4 J12-11
Hydraulic Filter Alarm 4	89G4	E-16	DI-48	12 VDC Nominal (when filter bypassing)	I/O 4 J12-12
Hydraulic Filter Alarm 5	89H4	E-17	DI-49	12 VDC Nominal (when strainer is clean)	I/O 4 J12-13
Hydraulic Filter Alarm 6	89Z4	E-24	DI-56	12 VDC Nominal (when filter is bypassing)	I/O 4 J12-20
Hydraulic Fluid Level	89R3	B-16	DI-16	0 VDC Low Level; 12 VDC High Level	I/O 2 J8-08
Hydraulic Fluid Temperature	89S3	B-17	DI-17	0 VDC above 180°F; 12 VDC below 180°F	I/O 2 J8-09
Left Front Drum Clutch Free Fall	80FLS	C-33	DO-17	12 VDC Nominal	I/O 2 J8-33-34
Left Front Drum Clutch Switch	89ZD	B-20	DI-20	12 VDC Nominal	I/O 2 J8-12
Left Front Drum Encoder Channel A	80MALS	E-25	ECA7	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-01
Left Front Drum Encoder Channel B	80MBLS	E-26	ECB7	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-02
Left Rear Drum Clutch Switch	89ZH	B-31	DI-31	12 VDC Nominal	I/O 3 J10-09
Left Rear Drum Encoder Channel A	81MALS	E-27	ECA8	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-03

Description	Wire #	Pin #	I/O #	Test Voltage (DC unless otherwise specified)	Connection (Signal Type)
Left Rear Drum Encoder Channel B	81MBLS	E-28	ECB8	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 4 J12-04
Left Side Counterweight Limit	89ZA	B-04	DI-4	12 VDC Nominal	I/O 1 J6-10
Left Track Handle (Handle 6)	84P	A-07	AI-5	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 1 J5-58
Left Track Pump Control (Servo Driver 5)	84A	C-23	AO-S5	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Reverse; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Forward	I/O 3 J10-41
Left Track Pedal 2	84PF	A-13	AI-10	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 2 J7-52
Limit Bypass	89L	B-25	DI-25	12 VDC Nominal	I/O 2 J8-17
Load Cell 1	SIG 1	A-34	AI-31	0 to10 VDC Nominal	CPU J3-56
Load Cell 2	SIG 2	A-35	AI-32	0 to10 VDC Nominal	CPU J3-58
Load Cell 3	SIG 3	A-36	AI-33	0 to10 VDC Nominal	CPU J3-60
Load Cell 4	SIG 4	A-37	AI-34	0 to10 VDC Nominal	CPU J3-62
Load Indicator Display Scroll Down	89ZP	A-19	AI-16	12 VDC Nominal	I/O 2 J7-64
Load Indicator Display Scroll Up	89ZN	A-18	AI-15	12 VDC Nominal	I/O 2 J7-62
Load Indicator Select Mode	89ZL	A-15	AI-12	12 VDC Nominal	I/O 2 J7-56
Rated Capacity Indicator/Limiter	89P	B-24	DI-24	12 VDC Nominal	I/O 2 J8-16
Luffing Jib Angle Indicator	87BA	A-21	AI-18	3.33 VDC at 0°F; 6.66 VDC 60°F; 7.88 VDC at 82°F	CPU J3-51
Luffing Jib Maximum Down Limit	89S1	B-15	DI-15	10 VDC Nominal	I/O 2 J8-07
Luffing Jib Maximum Up Limit	89W1	B-14	DI-14	10 VDC Nominal	I/O 1 J6-20
Maximum Boom/Luffing Angle Limit Bypass	89ZZ	B-11	DI-11	12 VDC Nominal	I/O 1 J6-17
Operating Limit Alarms	25A	C-28	DO-14	12 VDC Nominal	I/O 2 J8-27-28
Rear Drum Band Brake	81E	C-08	DO-2	12 VDC Nominal	I/O 1 J6-23-24
Rear Drum Disc Brake Park Switch	89Z3	D-09	DI-38	12 VDC Nominal (when brake is applied)	I/O 3 J10-16
Rear Drum Disc Brake Solenoid	81Q	C-19	DO-9	12 VDC Nominal	I/O 1 J6-37-38
Rear Drum Flange Direction Encoder Channel B2	81MB	D-04	ECB2	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-04
Rear Drum Flange Speed Encoder Channel A2	81MA	D-03	ECA2	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 1 J6-03
Rear Drum Free Fall Enable	89X2	B-21	DI-21	12 VDC Nominal	I/O 2 J8-13
Rear Drum Free Fall Light	81DS	C-36	DO-20	12 VDC Nominal	I/O 2 J8-39-40
Rear Drum Handle (Handle 2)	81P	A-04	AI-2	0 VDC Neutral; 5 to 1.4 VDC Lower; 5 to 8.6 VDC Raise	I/O 1 J5-52
Rear Drum Motor Control Right and Left Side	81S	D-25	AO-2	0 VDC Up to 1/3 Handle Movement; 0.96 to 2.19 VDC 1/3 to Full Handle Movement	I/O 2 J8-06
Rear Drum Maximum Bail Limit	89U	B-07	DI-7	12 VDC Nominal	I/O 1 J6-13
Rear Drum Minimum Bail Limit	89S	B-08	DI-8	12 VDC Nominal	I/O 1 J6-14
Rear Drum Pump Control (Servo Driver 2)	81A	C-06	AO-S2	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Up; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Down	I/O 1 J6-42
Rear Drum Pawl In	89M3	B-30	DI-30	12 VDC Nominal	I/O 3 J10-08
Rear Drum Rotation Indicator	81N	D-28	DO-23	12 VDC Nominal	I/O 3 J10-25-26
Rear Drum System Pressure (Pump 1A)	81QS	A-23	AI-20	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-55
Receptacle Insert	NC	B-37	Key	12 VDC Nominal	
Right Front Drum Clutch Free Fall	80FRS	C-16	DO-6	12 VDC Nominal	I/O 1 J6-31-32
Right Front Drum Clutch Switch	89ZE	B-22	DI-22	12 VDC Nominal	I/O 2 J8-14
Right Front Drum Shaft Direction Encoder Channel B5	80MBRS	E-04	ECB5	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-02
Right Front Drum Shaft Speed Encoder Channel A5	80MARS	E-03	ECA5	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-01
Right Rear Drum Clutch Free Fall	81FRS	C-17	DO-7	12 VDC Nominal	I/O 1 J6-34-33

Description	Wire #	Pin #	I/O #	Test Voltage (DC unless otherwise specified)	Connection (Signal Type)
Right Rear Drum Clutch Switch	89ZJ	B-36	DI-36	12 VDC Nominal	I/O 3 J10-14
Right Rear Drum Shaft Direction Encoder Channel B6	81MBRS	E-06	ECB6	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-04
Right Rear Drum Shaft Speed Encoder Channel A6	81MARS	E-05	ECA6	7.5 VDC Plus or 0 VDC Not Moving; 3.5 VDC Moving	I/O 3 J10-03
Right Side Counterweight Limit	89ZB	B-05	DI-5	12 VDC Nominal	I/O 1 J6-11
Right Track Handle (Handle 5)	83P	A-06	AI-4	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 1 J5-56
Right Track Pump Control (Servo Driver 4)	83A	C-15	AO-S4	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Forward; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Reverse	I/O 2 J8-42
Right Track Pedal 1	83PF	A-12	AI-9	0 VDC Neutral; 5 to 1.4 VDC Reverse; 5 to 8.6 VDC Forward	I/O 2 J7-50
RS-232 Receptacle (Common I/O)	TX1-0	D-18	—		CPU J4-03-04
RS-232 Receptacle (Receive I/O)	RX1	D-16	—		CPU J4-02
RS-232 Receptacle (Transmit I/O)	TX1	D-17	—		CPU J4-01
Seat Switch	89Q3	B-34	DI-34	12 VDC Nominal	I/O 3 J10-12
Set-up Remote Boom Down	89ZG	B-28	DI-28	12 VDC Nominal	I/O 2 J8-20
Set-up Remote Boom Up	89ZF	B-27	DI-27	12 VDC Nominal	I/O 2 J8-19
Shield		A-11	—		
Spare		D-26	DO-21		I/O 3 J10-23
Spare		A-10	AI-8		I/O 1 J5-64
Spare		A-29	AI-26		CPU J3-52
Spare		A-30	AI-27		CPU J3-54
Spare		A-31	AI-28		I/O 3 J9-50
Spare		A-32	AI-29		I/O 3 J9-52
Spare		A-33	AI-30		I/O 3 J9-54
Spare		C-26	DO-12		I/O 2 J8-23-24
Spare		C-32	DO-16		I/O 2 J8-31-32
Spare		D-32	DO-27		I/O 3 J10-33-34
Spare		D-33	DO-28		I/O 3 J10-35-36
Spare		D-34	DO-29		I/O 3 J10-37-38
Spare		D-35	DO-30		I/O 3 J10-39-40
Spare		D-36	DO-31		I/O 4 J12-21-22
Spare		D-37	DO-32		I/O 4 J12-23-24
Spare		E-10	AI-38		I/O 2 J9-60
Spare		E-11	AI-39		I/O 2 J9-62
Spare		E-12	AI-40		I/O 2 J9-64
Spare		E-19	DI-51		I/O 4 J12-15
Spare		E-29	AO-3		I/O 3 J10-06
Spare		E-33	DO-33		I/O 4 J12-25-26
Spare		E-34	DO-34		I/O 4 J12-27-28
Spare		E-35	DO-35		I/O 4 J12-29-30
Spare Encoder Channel A3		D-05	ECA3		I/O 2 J8-01
Spare Encoder Channel B3		D-06	ECB3		I/O 2 J8-02
Spare Magnetic Pick-Up	MAG PU2	E-07	MP2		I/O 2 J8-05
Swing Handle (Handle 4)	85P	A-08	AI-6	0 VDC Neutral; 5 to 1.4 VDC Right; 5 to 8.6 VDC Left	I/O 1 J5-60
Swing Left Pressure (Pump 3B)	85QL	A-26	AI-23	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-61

Description	Wire #	Pin #	I/O #	Test Voltage (DC unless otherwise specified)	Connection (Signal Type)
Swing Pump Control (Servo Driver 6)	85A	C-24	AO-S6	0 to 2.8 ± 10% (110 Ma ± 10%) VDC Right; 0 to -2.8 ± 10% (-110 Ma ± 10%) VDC Left	I/O 3 J10-42
Swing Park Switch/Holding Brake	89B2	D-15	DI-44	12 VDC Nominal (when brake is applied)	I/O 4 J12-08
Swing Right Pressure (Pump 3A)	85QR	A-25	AI-22	1 VDC at No Pressure; 1.2 VDC at 300 PSI	CPU J3-59
Swing/Travel Alarms	25X	C-27	DO-13	12 VDC Nominal	I/O 2 J8-25-26
System Fault Alarms	25	C-29	DO-15	12 VDC Nominal	I/O 2 J8-29-30
System Ground	0	C-02	—	0 VDC	
System Ground	0	C-04	—	0 VDC	
System Ground	0	C-13	—	0 VDC	
System Ground	0	C-22	—	0 VDC	
System Ground	0	C-31	—	0 VDC	
Track Motor (2-Speed)	88R	D-31	DO-26	12 VDC Nominal	I/O 3 J10-31-32
Travel Detent	89X	B-01	DI-1	12 VDC Nominal	I/O 1 J6-07
Travel Park Disc Brake Switch	89B4	D-11	DI-40	12 VDC Nominal (when brake is applied)	I/O 3 J10-18
Travel Parking Brake	84E	C-10	DO-4	12 VDC Nominal	I/O 1 J6-27-28
Travel Pressure Left Track	84Q	E-09	AI-37	1.2 VDC at 300 PSI; 1 VDC at No Pressure	I/O 2 J9-58
Travel Pressure Right Track	83Q	E-08	AI-36	1.2 VDC at 300 PSI; 1 VDC at No Pressure	I/O 2 J9-56

DISPLAY READINGS

Display allows operator to monitor three groups of crane information: operating conditions (normal and diagnostic), operating limits, and system faults.

Depress top or bottom of digital display selector to scroll up ▲ or down ▼ through display readings. Release selector when desired information is displayed.

To access diagnostic screens:

1. Turn limit bypass key clockwise and hold.
2. Scroll up at least one screen, release key, and scroll up ▲ or down ▼ until desired screen appears.

To turn off diagnostic screens:

1. Turn limit bypass key clockwise and hold.
2. Scroll down ▼ at least one screen and release key.

   Stopping engine will also turn off diagnostic screens.

See Table 3-2 for a list of abbreviations used in tables. See Figure 3-7 for drum identification.

Operating Conditions

Table 3-3 lists operating conditions which can be displayed and the normal operating range of each.

When an operating condition is selected (such as ENGINE SPEED), the current status of the condition displays (see Figure 3-2).

ENGINE SPEED 900 RPM

FIGURE 3-2

Operating Limits

Table 3-4 lists operating limits which can be displayed.

When one or more operating limits is reached, the operating limit alert (yellow light and buzzer in cab) turns on to warn operator. At the same time, operating limit display immediately appears (see Figure 3-3) and automatically scrolls through names of limits, stopping at each for approximately three seconds.

OPERATING LIMIT BLOCK UP

FIGURE 3-3

Operating limit alert turns off when cause of each limit is corrected. Name of each limit reached during operation is retained in memory, however, ***until two things happen***:

1. Name of limit appears on display at least once.
2. Cause of limit is corrected.

For this reason, it is normal for names of limits to appear when you scroll to operating limit group, even when operating limit alert is off.

To erase names of inactive limits, scroll to operating limit group. Wait until display scrolls through name of each limit. Names of inactive limits will be erased automatically. If alert is on, only names of active limits will remain.

NO FAULT appears on display (see Figure 3-4) when no limits have been reached.

OPERATING LIMIT NO FAULT

FIGURE 3-4

System Faults

Table 3-5 lists system faults which can be displayed.

When one or more system faults occur, system fault alert (red light and beeper in cab) turns on to warn operator. At the same time, system fault display immediately appears (see Figure 3-5) and automatically scrolls through names of the faults, stopping at each for approximately three seconds.

SYSTEM FAULT ENGINE OIL PRESSURE

FIGURE 3-5

System fault alert turns off when cause of each fault is corrected. Name of each fault that has occurred during operation is retained in memory, however, ***until two things happen***:

1. Name of fault appears on display at least once.
2. Cause of fault is corrected.

For this reason, it is normal for the names of faults to appear when you scroll to system fault group, even when system fault alert is off.

To erase names of inactive faults, scroll to system fault group. Wait until display scrolls through name of each fault. Names of inactive faults will be erased automatically. If alert is on, only names of active faults will remain.

NO FAULT appears on display (see Figure 3-6) when there are no faults

.

SYSTEM FAULT NO FAULT

FIGURE 3-6

3

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Selecting Display Language

Current software for Model 777 contains English and several foreign-language display readings. When a new computer chip is installed, any one of the languages could appear on the screen when the system is powered up the first time. Once desired language is selected, it will remain in memory until another language is selected.

To select a different display language, perform both of the following steps at the same time:

1. Depress limit bypass switch.
2. Turn digital display confirm/select key switch to confirm position.

Repeat steps until screen displays desired language.

Table 3-3
Operating Conditions

Listed below are operating conditions that can be viewed on display.

Display Reading	Unit of Measure	Operating Range
NORMAL OPERATING CONDITIONS The operating conditions listed below are displayed by scrolling up or down with the digital display selector.		
ENGINE SPEED	RPM	Low idle and high idle settings determined by engine manufacturer.
BOOM ANGLE	DEG	Degrees boom is positioned above horizontal.
LUFFING JIB ANGLE [2]	DEG	Degrees luffing jib is positioned above horizontal.
BOOM TO LUFF JIB ANG [2]	DEG	Degrees between centerline of boom and centerline of luffing jib.
CLAM CLOSING PRESS	PSI	See Crane Mode Selector instructions in this section for procedure to adjust pressure.
CRANE MODE (name of mode)	—	See Crane Mode Selector instructions in this section for procedure to select and confirm desired crane mode.
DIAGNOSTIC SCREENS Operating conditions listed below are displayed only by depressing limit bypass switch and scrolling up with digital display selector. To turn off diagnostic screens, depress limit bypass switch and scroll down or stop and restart engine.		
A1	2 Rows of numbers	These numbers are used to monitor and troubleshoot controls and hydraulic systems. See Diagnostics Display in Section 10 of this manual for explanation of these screens.
A2		
A3		
D1		
D2		
D3		
DRUM 1		
DRUM 2		
DRUM 8 [2]		
BHST		
SWING		
TRACK		
PROGRAM M000000.0FP	—	Computer Program Version. ***Factory service personnel will request these numbers when troubleshooting crane problems***.
CON 00000000000	—	Computer and Crane Configuration Code. ***Factory service personnel will request these numbers when troubleshooting crane problems***.

[1] Boom angle and luffing jib angle are displayed at same time.

[2] Optional Item.

3] Angles at which boom stops vary with attachment.
See Operating Controls in Section 3 of Crane Operator's Manual for specifications.

Table 3-4
Operating Limits

Listed below are limits which turn on the operating limit alert (yellow light and continuous buzzer). When the alert comes on, OPERATING LIMIT group of digital display will indicate which limit has been reached; take corrective action.

Display Reading	Function Response	Corrective Action
BLOCK UP	Load drums stop hoisting and boom or jib hoist stops lowering.	Lower corresponding load or raise boom or jib.
BOOM MAXIMUM DOWN	Boom stops lowering [3].	Raise boom.
BOOM MAXIMUM UP	Boom stops rising [3].	Lower boom.
CONFIRM MODE	All drums inoperable until an operating mode is selected and confirmed.	Select and confirm the desired operating mode (see Operating Controls for procedure).
DRUM 1 MAXIMUM BAIL [2]	Drum stops hoisting.	Operate drum in lowering direction.
DRUM 2 MAXIMUM BAIL [2]		
DRUM 8 MAXIMUM BAIL [2]		
DRUM 1 MINIMUM BAIL [2]	Drum stops lowering.	Operate drum in hoisting direction.
DRUM 2 MINIMUM BAIL [2]		
DRUM 8 MINIMUM BAIL [2]		
DRUM 1 PAWL IN	Drum doesn't lower or stops lowering.	Disengage pawl. It may be necessary to hoist slightly before pawl will disengage.
DRUM 2 PAWL IN		
DRUM 8 PAWL IN [2]		
COUNTERWEIGHT MAX UP	Boom hoist inoperable in lowering direction.	Disconnect and store counterweight lifting pendants (see Operating Controls).
JIB BELOW HORIZONTAL [2]	Luffing jib operable. See capacity chart for luffing jib minimum operating angles.	Raise luffing jib above horizontal.
LOAD MOMENT	All load drums stop hoisting and boom and luffing jib hoist stop lowering.	Land load on load drum or raise boom or jib.
LUFFING JIB MAX DOWN [2]	Luffing jib stops lowering when boom to jib angle is 60°.	Raise luffing jib.
LUFFING JIB MAX UP [2]	Luffing jib stops raising when boom to jib angle is 168°.	Lower luffing jib.
FUNCTION IS PARKED	Function inoperable because it is parked.	Turn corresponding park switch off or sit down in operator's seat.
CYLINDER ALIGNMENT	Boom cylinders out of alignment. Stops boom movement.	Check hydraulic system for blockage or replace problem cylinder encoder.
BOOM HOIST MOTION	Unintended boom motion in either direction.	Boom hoist inoperable in either direction (cannot boom up or down). Stop and restart engine to correct fault (reboot programmable controller). Troubleshoot system to determine cause of fault (electronic displacement control or pump).

Display Reading	Function Response	Corrective Action
REMOTE ACTIVE FAULT	Control in cab inoperable.	Do not attempt to operate controls in cab when operating counterweight remote control.
DATALOGGER FAULT	Does not affect operation.	Fault will appear on screen for 60 seconds at startup if there is a datalogger problem (most likely caused by real time clock).

Table 3-5
System Faults

Listed below are faults which turn on system fault alert (red light and beeper). When the alert comes on, the SYSTEM FAULT group of the digital display will indicate which fault has occurred; take corrective action.

The beeper sounds intermittently (I) or continuously (C) as indicated in alert column.

Display Reading	Alert	Cause of Fault	Function Response
BOOM ANGLE SENDER	I	Sender output voltage 0 volts or above 9.7 volts. Fault not active when crane is in SETUP mode.	All functions operable, but BOOM ANGLE and BOOM TO LUFFING JIB ANGLE display will be faulty; correct cause of transducer fault as soon as possible.
ENGINE OIL PRESSURE	I	Oil pressure below 15 psi (1.0 bar).	Does not affect operation. Correct cause of low oil pressure as soon as possible to prevent engine damage.
ENGINE TEMPERATURE	I	Engine coolant temperature above 205°F (96°C).	Does not affect operation. Correct cause of overheating as soon as possible to prevent engine damage.
HYD TANK FLUID TEMP	I	Oil temperature in hydraulic tank above 180°F (82°C).	Does not affect operation. Reduce loads and/or speeds to allow oil to cool.
HYD TANK FLUID LEVEL	I	Hydraulic oil at CAUTION LOW LEVEL indicated on tank gauge.	Does not affect operation. Fill tank as soon as possible.
HYDRAULIC FILTER 1	I	Corresponding filter is dirty.	All functions operable. Replace filter as soon as possible.
HYDRAULIC FILTER 2	I		
HYDRAULIC FILTER 3	I		
HYDRAULIC FILTER 4	I		
HYDRAULIC FILTER 5	I	Strainer is dirty.	All functions operable. Clean strainer in tank on crane as soon as possible.
LUFF JIB ANGLE SEND [2]	I	Sender output voltage 0 volts or above 9.7 volts. Fault not active when crane is in SETUP mode.	All functions operable, but LUFFING JIB ANGLE and BOOM TO LUFFING JIB ANGLE display will be faulty; correct cause of transducer fault as soon as possible.
MOTOR TEMPERATURE	I	Temperature of hydraulic motor 240°F (116°C) or higher.	All functions operable. Stop operating or reduce speed and load of corresponding motor until temperature lowers to normal. To determine which motor is overheating, disconnect and connect DIN connector at switch on each motor. Fault on screen will turn off when proper DIN connector is disconnected.

[2] Optional item.

[3] Angles at which boom stops vary with attachment. See Operating Controls in the section for specifications.

CRANE DIAGNOSTICS

To activate the diagnostic display screens, depress the limit bypass switch and scroll up. Once this step is performed, you can scroll up and down through the diagnostic screens in addition to the normal operating screens. To deactivate the diagnostic screens, depress the limit bypass switch and scroll down. The normal operating screens will remain active.

The diagnostic display provides information about the status of all main crane components as well as the controller inputs and outputs during operation. There are a total of twelve diagnostic screens:

- Six which display information about particular crane functions — DRUMS 1, 2, and 8, BHST (Boom Hoist), SWING, and TRACK.
- Three which display information about digital inputs and outputs — D1 (outputs from crane controller), D2 (inputs to crane controller), and A1 (handle/pedal inputs to crane controller).
- Three which display controller programming information — A2, A3, and D3. These screens are for factory use only, and are not shown in this section.

See Figures 3-7 – 3-9 for drum, handle/pedal, and pump identification.

Drum 1, 2, and 8

_ _1_ _	_ _2_ _	_ _3_	4	5
_ _6_ _	_ 7_			DRUM X

1. Handle command in percent from neutral (+ raise, – lower)*
2. Pump command in percent from neutral (+ raise, – lower).
3. Motor command in percent (0% max. displacement, 100% min. displacement).
4. Parking brake command (1 release, 0 engage).
5. Clutch command (1 release, 0 engage) (applies only to drums with free fall, otherwise has no meaning).
6. Measured pump pressure (port A) in psi.
7. Measured drum speed in rpm (+ raise, – lower).

X Corresponding drum number appears.

*For certain operating conditions handle command can be set to neutral by the controller even if handle is not in neutral.

BHST (Boom Hoist)

_ _1_ _	_ _2_ _	_ _3_ _	_ _4_ _	
_ _5_ _	_ _6_ _	_ _7_ _		BHST

1. Handle command in percent from neutral (+ up, – down)
2. Pump command in percent from neutral (+ up, – down)
3. Measured pump pressure (up) in psi
4. Measured cylinder pressure (up) in psi
5. Port 0 count – right cylinder position (+ retract, – extend)
6. Port 1 count – left cylinder position (+ retract, – extend)
7. Boom valves (1 raise holding valve on, 2 lower holding valve on, 3 both holding valves on, 4 pump enable valve on, 5 pump enable valve and raise holding valve on, 6 pump enable valve and lower holding valve on, 7 pump enable valve and both holding valves on)

Swing

_ _1_ _	_ _2_ _	
_ _3_ _	_ _4_ _	SWING

1. Handle command in percent from neutral (+ right, – left)*.
2. Pump command in percent from neutral (+ right, – left)
3. Measured pump pressure swing right (port A) in psi.
4. Measured pump pressure swing left (port B) in psi.

*For certain operating conditions handle command can be set to neutral by the controller even if handle is not in neutral.

Track

_ _1_ _	_ _2_ _	_ _3_ _	_ _4_ _	
_ _5_ _	_ _6_ _	7		TRACK

1. Right handle/pedal command in percent from neutral (+ forward, – backward)*.
2. Left handle/pedal command in percent from neutral (+ forward, – backward)*.
3. Right pump command in percent from neutral (+ forward, – backward).
4. Left pump command in percent from neutral (+ forward, – backward).
5. Measured system pressure right track in psi.
6. Measured system pressure left track in psi.

7. Parking brake command (1 release, 0 engage).

*For certain operating conditions handle command can be set to neutral by the controller even if handle is not in neutral.

A1 (Handles)

The variable control handle output voltage is represented in the controller by a number between 0 (0 Volts) and 255 (10 Volts). Diagnostic screen A1 displays this number for each of the control handles/pedals. The normal operating outputs of the handles range from:

- Approximately 38 (1.5 Volts) to 120 (4.7 Volts) for lower/reverse/right**.
- Approximately 136 (5.3 Volts) to 215 (8.5 Volts) for raise/forward/left**.A switch opens when the handle is in the neutral range (4.7 – 5.3 volts). In the neutral range, the screen reads 0 (0 volts).

_1_	_2_	_3_	_4_	_5_
_6_	_7_	_8_	_9_	**A1**

1. Handle 1 – Front Drum

2. Handle 2 – Rear Drum

3. Handle 3 – Boom Hoist

4. Handle 5 – Right Track

5. Handle 6 – Left Track

6. Handle 4 – Swing

7. Handle 7 – Auxiliary Drum

8. Pedal 1 – Right Track

9. Pedal 2 – Left Track

*For certain operating conditions handle command can be set to neutral by the controller even if handle is not in neutral.

**Some dual-axis handles (joysticks) are internally limited and will not put out the full range stated here.

D1 and D2 (Digital Outputs and Inputs)

The status of the digital outputs from the controller and the inputs to the controller is displayed in several banks in screens D1 and D2. Each bank can indicate the state of up to eight individual digital inputs or outputs.

_1_	_2_	_3_	_4_	_5_
_6_	_7_	_8_		**D** X

1 – 8. Bank number.

X Corresponding digital screen number (1 or 2) appears.

Each individual input/output is assigned a number (identifier) in the binary system (powers of two). The identifiers of all inputs/outputs that are ON (active), are added to a total in each bank. Thus, the number displayed for each bank is the sum of all identifiers of the inputs/outputs that are ON (0 – 255). With this system, each possible ON/OFF combination per bank has a unique total.

For identification of the digital outputs and inputs (and the crane components connected to them) see Tables 3-7 and 3-8 in this section.

To determine the state of the individual inputs/outputs in a bank, find the number displayed for the bank in the first column in Table 3-8. In the corresponding row the identifier numbers that are ON (active) in the bank are shaded. Use Tables 3-7 and 3-8 to identify the crane components associated with the identifiers for the corresponding bank.

Example 1: The number displayed in Bank 5 of screen D2 of the digital display is 41. Go to row number 41 in Table 3-8. The boxes for identifiers 1, 8 and 32 are shaded in this row, indicating that the corresponding inputs are active. Find the component description for the identifiers in Table 3-8, Bank 5. In this example, the inputs for Front Pawl In (1), Auxiliary Drum Pawl In (8), and Seat Switch (32) are active.

Example 2: You want to know if the controller output for the rear drum band brake is ON. In Table 3-7 you will find Rear Drum Band Brake in Bank 1 (identifier 2). Look up the current number for Bank 1 in screen D1 on the digital display (e.g. 152). Then go to the corresponding row number (152) in Table 3-8. Identifier 2 box is not shaded in this row, indicating that the controller output to the rear drum band brake is OFF.

NOTE: All numbers in screen D1, and the pump/motor command values in screens DRUM, SWING and TRACK represent controller commands to the corresponding output devices only. The state of a certain output port on the controller may not necessarily correspond to the actual state of the associated crane component (brake valve, clutch valve, etc.), since the connection between the controller and the component may be faulty due to loose connections, corroded terminals, broken wiring or improperly operating components.

Table 3-6 D1 (Digital Outputs)

Identifier*	Component
Bank 1	
1	Front Drum Band Brake
2	Rear Drum Band Brake
4	Boom Up Enable
8	Travel Park Brake
16	Boom Down Enable
32	Right Front Drum Clutch Free Fall
64	Right Rear Drum Clutch Free Fall
128	Front Drum Disc Brake
Bank 2	
1	Rear Drum Disc Brake
2	Spare
Bank 3	
1	Auxiliary Drum Disc Brake
2	Spare
4	Swing & Travel Alarm
8	Operating Limit Alarm
16	System Fault Alarm
32	Boom Pump Enable Valve
64	Left Front Drum Clutch Free Fall
128	Left Rear Drum Clutch Free Fall
Bank 4	
1	Front Drum Free Fall Light
2	Rear Drum Free Fall Light
Bank 5	
1	Spare
2	Front Drum Rotation Indicator
4	Rear Drum Rotation Indicator
8	Boom Cylinder Up/Down Indicator
16	Auxiliary Drum Rotation Indicator
32	2-Speed Travel Valve
64	Spare Digital Output-27
128	Spare Digital Output-28
Bank 6	
1	Spare Digital Output-29
2	Spare Digital Output-30
Bank 7	
1	Spare Digital Output-31
2	Spare Digital Output-32
4	Spare Digital Output-33
8	Spare Digital Output-34
16	Spare Digital Output-35
32	Auxiliary Drum Pump Control – Up
64	Auxiliary Drum Pump Control – Down

*Binary

**These digital ports are pulsed for auxiliary pump control. For both ports a digital ON is displayed when pulsing, to prevent a flickering number for the corresponding bank.

Table 3-7 D2 (Digital Inputs)

Identifier*	Component
Bank 1	
1	Travel Detent Set/Cancel
2	Maximum Bail Limit – Front Drum
4	Minimum Bail Limit – Front Drum
8	Left Side Counterweight Limit Switch
16	Right Side Counterweight Limit Switch
32	Boom Point Block-Up Limit
64	Maximum Bail Limit – Rear Drum
128	Minimum Bail Limit – Rear Drum
Bank 2	
1	Select Mode
2	Confirm Mode
4	Max Boom/Luffing Angle Limit Bypass
8	Boom Maximum Up Limit
16	Boom Maximum Down Limit
32	Luffing Jib Maximum Up Limit
Bank 3	
1	Luffing Jib Maximum Down Limit
2	Minimum Hydraulic Fluid Level
4	Maximum Hydraulic Fluid Temperature
8	Engine Oil Pressure
16	Engine Coolant Temperature
32	Left Front Drum Clutch Switch
64	Rear Drum Free Fall Safety Switch
128	Right Front Drum Clutch Switch
Bank 4	
1	Front Drum Free Fall Safety Switch
2	Rated Capacity Indicator/Limiter
4	Limit Bypass
8	Display Scroll Up
16	Setup Remote – Boom Up
32	Setup Remote – Boom Down
Bank 5	
1	Front Drum Pawl In
2	Rear Drum Pawl In
4	Left Rear Drum Clutch Switch
8	Auxiliary Drum Pawl In
16	Display Scroll Down
32	Seat Switch
64	High-Speed Travel
128	Right Rear Drum Clutch Switch
Bank 6	
1	Front Drum Disc Brake
2	Rear Drum Disc Brake
4	Boom Cylinder Enable
8	Travel Park Brake
16	Auxiliary Drum Disc Brake
32	Auxiliary Drum Minimum Bail Limit
Bank 7	
1	Spare
2	Swing Park Brake
4	Hydraulic Filter Alarm 1
8	Hydraulic Filter Alarm 2
16	Hydraulic Filter Alarm 3
32	Hydraulic Filter Alarm 4
64	Hydraulic Filter Alarm 5
128	Boom Cylinders Hold
Bank 8	
1	Spare
2	Boom Right Cylinder Encoder Channel A7
4	Boom Right Cylinder Encoder Channel B7
8	Boom Left Cylinder Encoder Channel A8
16	Boom Left Cylinder Encoder Channel B8
32	Hydraulic Filter Alarm 6

Drum Identification

Drum Number	Drum
1	Front Load Drum
2	Rear Load Drum
8	Auxiliary Load Drum (in boom butt)

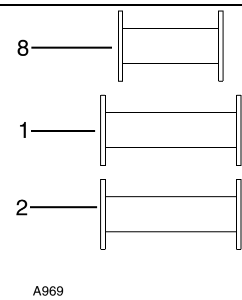


FIGURE 3-7

Handle/Pedal Identification

Handle Number	Handle
1	Front Load Drum
2	Rear Load Drum or Luffing Hoist*
3	Boom Hoist
4	Swing
5	Right Crawler
6	Left Crawler
7	Auxiliary Load Drum (in butt)
Pedal Number	**Pedal**
1	Right Crawler
2	Left Crawler

* Activated only in LUFFING JIB Mode.

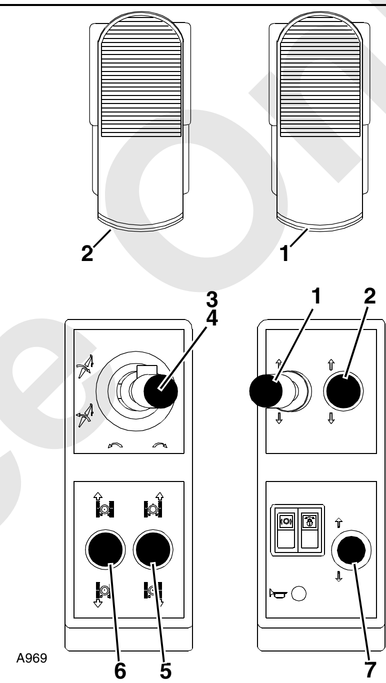


FIGURE 3-8

Pump Identification

Pump Number	Pump
0	Front Load Drum
1	Rear Load Drum or Luffing Hoist
2	Boom Hoist
3	Swing
4	Right Crawler
5	Left Crawler
10	Auxiliary Load Drum (in butt)

** If without an auxiliary load drum, pump 1 is mounted next to pump drive.
With an auxiliary load drum, pump 10 is mounted next to pump drive and pump 1 is mounted on rear of pump 10.

Pump Port Identification

Pump Number	Port A	Port B
0, 1, 2, 10	Raise	Lower
3	Right	Left
4	Forward	Reverse
5	Reverse	Forward

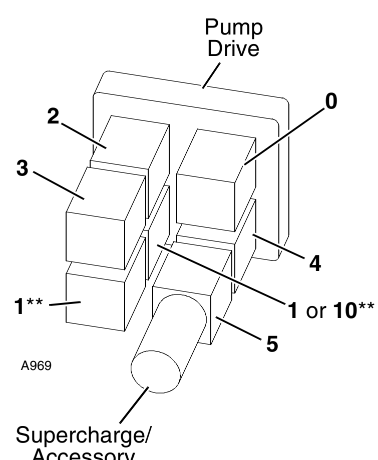


FIGURE 3-9

Table 3-8
8-Bit Binary System

	1	2	4	8	16	32	64	128
1	■							
2		■						
3	■	■						
4			■					
5	■		■					
6		■	■					
7	■	■	■					
8				■				
9	■			■				
10		■		■				
11	■	■		■				
12			■	■				
13	■		■	■				
14		■	■	■				
15	■	■	■	■				
16					■			
17	■				■			
18		■			■			
19	■	■			■			
20			■		■			
21	■		■		■			
22		■	■		■			
23	■	■	■		■			
24				■	■			
25	■			■	■			
26		■		■	■			
27	■	■		■	■			
28			■	■	■			
29	■		■	■	■			
30		■	■	■	■			
31	■	■	■	■	■			
32						■		
33	■					■		
34		■				■		
35	■	■				■		
36			■			■		
37	■		■			■		
38		■	■			■		
39	■	■	■			■		
40				■		■		
41	■			■		■		
42		■		■		■		
43	■	■		■		■		
44			■	■		■		
45	■		■	■		■		
46		■	■	■		■		
47	■	■	■	■		■		
48					■	■		
49	■				■	■		
50		■			■	■		
51	■	■			■	■		
52			■		■	■		
53	■		■		■	■		
54		■	■		■	■		
55	■	■	■		■	■		
56				■	■	■		
57	■			■	■	■		
58		■		■	■	■		
59	■	■		■	■	■		
60			■	■	■	■		
61	■		■	■	■	■		
62		■	■	■	■	■		
63	■	■	■	■	■	■		
64							■	
65	■						■	
66		■					■	
67	■	■					■	
68			■				■	
69	■		■				■	
70		■	■				■	
71	■	■	■				■	
72				■			■	
73	■			■			■	
74		■		■			■	
75	■	■		■			■	
76			■	■			■	
77	■		■	■			■	
78		■	■	■			■	
79	■	■	■	■			■	
80					■		■	
81	■				■		■	
82		■			■		■	
83	■	■			■		■	
84			■		■		■	
85	■		■		■		■	
86		■	■		■		■	
87	■	■	■		■		■	
88				■	■		■	
89	■			■	■		■	
90		■		■	■		■	
91	■	■		■	■		■	
92			■	■	■		■	
93	■		■	■	■		■	
94		■	■	■	■		■	
95	■	■	■	■	■		■	
96						■	■	
97	■					■	■	
98		■				■	■	
99	■	■				■	■	
100			■			■	■	
101	■		■			■	■	
102		■	■			■	■	
103	■	■	■			■	■	
104				■		■	■	
105	■			■		■	■	
106		■		■		■	■	
107	■	■		■		■	■	
108			■	■		■	■	
109	■		■	■		■	■	
110		■	■	■		■	■	
111	■	■	■	■		■	■	
112					■	■	■	
113	■				■	■	■	
114		■			■	■	■	
115	■	■			■	■	■	
116			■		■	■	■	
117	■		■		■	■	■	
118		■	■		■	■	■	
119	■	■	■		■	■	■	
120				■	■	■	■	
121	■			■	■	■	■	
122		■		■	■	■	■	
123	■	■		■	■	■	■	
124			■	■	■	■	■	
125	■		■	■	■	■	■	
126		■	■	■	■	■	■	
127	■	■	■	■	■	■	■	
128								■
129	■							■

Dark shaded boxes indicate ON; white boxes OFF.

Table 3-8
8-Bit Binary System (continued)

	1	2	4	8	16	32	64	128
130		■						■
131	■	■						■
132			■					■
133	■		■					■
134		■	■					■
135	■	■	■					■
136				■				■
137	■			■				■
138		■		■				■
139	■	■		■				■
140			■	■				■
141	■		■	■				■
142		■	■	■				■
143	■	■	■	■				■
144					■			■
145	■				■			■
146		■			■			■
147	■	■			■			■
148			■		■			■
149	■		■		■			■
150		■	■		■			■
151	■	■	■		■			■
152				■	■			■
153	■			■	■			■
154		■		■	■			■
155	■	■		■	■			■
156			■	■	■			■
157	■		■	■	■			■
158		■	■	■	■			■
159	■	■	■	■	■			■
160						■		■
161	■					■		■
162		■				■		■
163	■	■				■		■
164			■			■		■
165	■		■			■		■
166		■	■			■		■
167	■	■	■			■		■
168				■		■		■
169	■			■		■		■
170		■		■		■		■
171	■	■		■		■		■
172			■	■		■		■

	1	2	4	8	16	32	64	128
173	■		■	■		■		■
174		■	■	■		■		■
175	■	■	■	■		■		■
176					■	■		■
177	■				■	■		■
178		■			■	■		■
179	■	■			■	■		■
180			■		■	■		■
181	■		■		■	■		■
182		■	■		■	■		■
183	■	■	■		■	■		■
184				■	■	■		■
185	■			■	■	■		■
186		■		■	■	■		■
187	■	■		■	■	■		■
188			■	■	■	■		■
189	■		■	■	■	■		■
190		■	■	■	■	■		■
191	■	■	■	■	■	■		■
192							■	■
193	■						■	■
194		■					■	■
195	■	■					■	■
196			■				■	■
197	■		■				■	■
198		■	■				■	■
199	■	■	■				■	■
200				■			■	■
201	■			■			■	■
202		■		■			■	■
203	■	■		■			■	■
204			■	■			■	■
205	■		■	■			■	■
206		■	■	■			■	■
207	■	■	■	■			■	■
208					■		■	■
209	■				■		■	■
210		■			■		■	■
211	■	■			■		■	■
212			■		■		■	■
213	■		■		■		■	■
214		■	■		■		■	■
215	■	■	■		■		■	■

	1	2	4	8	16	32	64	128
216				■	■		■	■
217	■			■	■		■	■
218		■		■	■		■	■
219	■	■		■	■		■	■
220			■	■	■		■	■
221	■		■	■	■		■	■
222		■	■	■	■		■	■
223	■	■	■	■	■		■	■
224						■	■	■
225	■					■	■	■
226		■				■	■	■
227	■	■				■	■	■
228			■			■	■	■
229	■		■			■	■	■
230		■	■			■	■	■
231	■	■	■			■	■	■
232				■		■	■	■
233	■			■		■	■	■
234		■		■		■	■	■
235	■	■		■		■	■	■
236			■	■		■	■	■
237	■		■	■		■	■	■
238		■	■	■		■	■	■
239	■	■	■	■		■	■	■
240					■	■	■	■
241	■				■	■	■	■
242		■			■	■	■	■
243	■	■			■	■	■	■
244			■		■	■	■	■
245	■		■		■	■	■	■
246		■	■		■	■	■	■
247	■	■	■		■	■	■	■
248				■	■	■	■	■
249	■			■	■	■	■	■
250		■		■	■	■	■	■
251	■	■		■	■	■	■	■
252			■	■	■	■	■	■
253	■		■	■	■	■	■	■
254		■	■	■	■	■	■	■
255	■	■	■	■	■	■	■	■

Dark shaded boxes indicate ON; white boxes OFF.

CRANE SOFTWARE INSTALLATION

If needed, contact your Manitowoc dealer or Crane Care in Manitowoc for detailed instructions for installing crane software and capacity chart files.

CPU AND EPROM COMPATIBILITY

Faulty central processing units (CPU) in the field are replaced with new CPU 366113 which will work in any Manitowoc EPIC controlled crane with a 5-plug Eder CPU. The new CPU requires 150 nano second EPROMs (chips). ***Past production 200 nano second chips cannot be used in a new CPU; crane will not operate properly***.

The new CPU does not include chips. When ordering a new CPU check the existing chips on your crane to determine if you already have 150 nano second chips (see chip identification below). If not, you must order new chips programmed for your crane.

1. The 150 nano second chips will work in any Manitowoc EPIC controlled crane with a 5-plug Eder CPU, as long as the chips are programmed for the specific crane.
2. The Model 777 must be replaced with CPU 366113 and 150 nano second chips.
3. New chips sent to you from Manitowoc will be 150 nano second speed and not require identification. The chips will work in any Manitowoc EPIC controlled crane with a 5-plug Eder CPU, as long as the chips are properly programmed.

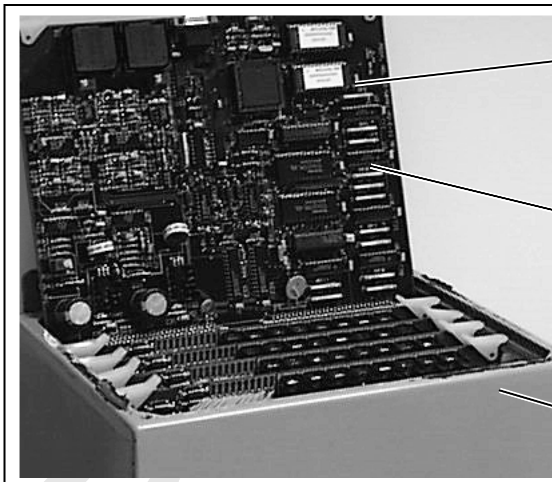


FIGURE 3-10

EPROM (CHIP) IDENTIFICATION

There are 4 brands of 150 nano second chips that will work with CPU 366113 or CPU card 366116: AMD, Fairchild, Tompson, and Texas Instruments. All of these chips are available from Manitowoc.

To identify a chip, remove the label from the top of the chip. Do this to one chip at a time so they do not get mixed up. ***Be sure to reinstall label over window in chip. They are light sensitive.***

AMD – Hold the AMD chip with the notch to the top. The word MALAYSIA will appear on the top surface near the notch. Below the window, an 8-digit code will appear in the first line and –150 must appear in the second line.

Fairchild – Hold the Fairchild chip with the notch to the top. The chip will be blank above the window. Below the window, F and a 7-digit code will appear in the first line, a 10-digit code will appear in the second line, and 150 will appear in the third line.

Texas Instruments – Hold the Texas Instruments chip with notch to the top. The chip will be blank above the window. Below the window, the Texas Instruments symbol and a 5-digit code will appear in the first line and a 6-digit code followed by –15 will appear in the second line.

Thompson – Hold the Thompson chip with the notch to the top. The chip will be blank above the window. Below the window, an 8-digit code will appear in the first line and –15 will appear in the second line.

If you have questions regarding chip identification, please contact your Manitowoc dealer.

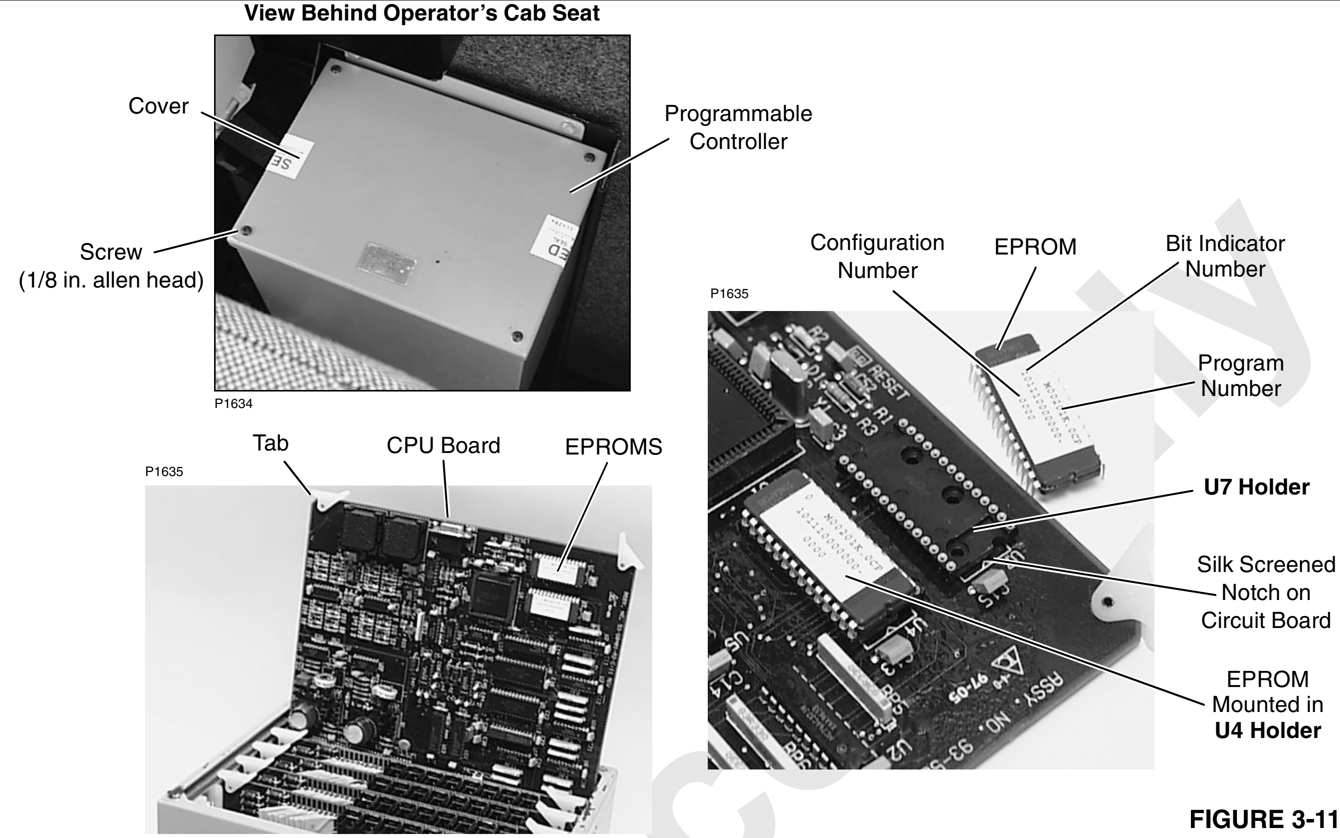


FIGURE 3-11

EPROM REPLACEMENT

See Figure 3-11 in following procedure.

To ensure proper operation of EPIC cranes, extreme care must be taken to properly install eproms (computer chips).

1. Lower any suspended loads to ground and apply all parking brakes and locks.
2. Turn engine run/stop switch to STOP position and turn cab power switch to OFF position.
3. Remove cover from top of programmable controller.
4. Remove CPU board from programmable controller by pulling up on tabs on sides of board (CPU board is board closest to mounting brackets on box).
5. Carefully remove both EPROMs from upper right corner of CPU board. An EPROM remover should be used.
6. Each EPROM has a label containing A Manitowoc program number, configuration number, and bit indicator.
7. Install new EPROMs on CPU board.
8. Notch in each EPROM must line up with silk screened notch at end of each EPROM holder.
   - **a.** Install EPROM with bit indicator number of 1 in EPROM holder U7.
   - **b.** Install EPROM with bit indicator number of 0 in EPROM holder U4.
   - **c.** Use care not to bend prongs on EPROMS, each prong engages corresponding terminal in holder.
9. Reinstall CPU board in programmable controller.
10. Reinstall cover on programmable controller.
11. Read all publications sent with new EPROMs.
12. Before starting engine, power up programmable controller (cab power switch ON and engine run/stop switch in RUN) and set any operator programmable control features (i.e. swing speed, etc.).
13. Follow instructions in operator's manual to calibrate pressure senders (transducers) and pump control thresholds (feed forward).
14. Test all crane functions.
15. If you have any problems with the new software, contact Manitowoc Crane Care.

Return old EPROMs to your Manitowoc dealer.

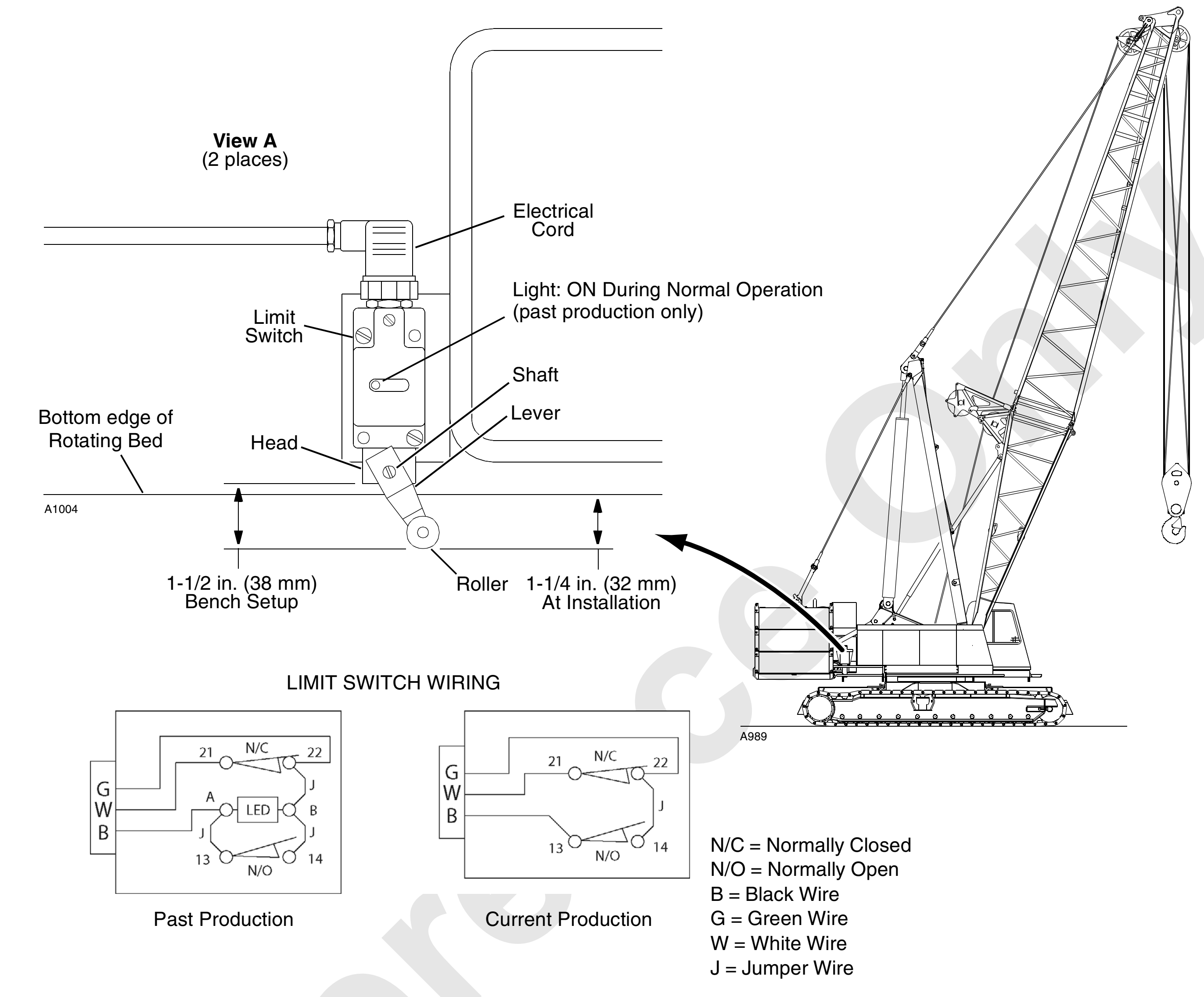


FIGURE 3-12

COUNTERWEIGHT LIMIT SWITCH ADJUSTMENT

NOTE: Do the adjustment in this topic ***before*** installing the counterweights. The counterweight limit switches are inaccessible once the counterweights are installed.

The counterweight limit switches prevent over-tensioning the counterweight handling pendants when installing counterweights and parking the boom.

If the boom is lowered too far while the handling pendants are installed, the counterweight tray rises and trips open either of the two limit switches located under the rear of the rotating head (Figure 3-12). The computer then stops the boom down operation, the operating limit alert turns on and COUNTERWEIGHT MAX UP appears on the digital display.

Adjustment

Bench Setup

Adjust the position of the limit switch lever on the shaft so that there is 1-1/2 in. (38 mm) between the limit switch head and the outer edge of the roller (Figure 3-12, View A).

Installation

1. Mount limit switches and adjust position to installation dimension in Figure 3-12, View A.
2. Securely tighten screws.
3. Connect electrical cord to switches.

Test Before Installing Counterweights

Test the operation of the counterweight limit switches before installing the counterweights.

When the crane is running normally, test each switch as follows:

1. Rotate the limit switch lever up to horizontal and verify that:
   - Light on switch turns off (past production only).
   - Operating limit alert comes on and COUNTER-WEIGHT MAX UP appears on digital display. Boom down operation should be inoperable.
2. Release limit switch lever and verify that:
   - Light on switch turns on (past production only).
   - Crane operation returns to normal.

Troubleshoot the electrical system if the above operations fail to occur.

ENGINE CONTROL MODULE GROUND MODIFICATION

The Cummins QSC 8.3 engine ECM (Engine Control Module) on the models listed below may not be grounded properly.

The following serial numbers require this modification:

- Model 7771113
- Models 7771118 through 7771128.

Order parts from the MCC Parts Department. Ask for modification kit #A07769.

Rewire and isolate ECM wires and new ground cable to battery (see modification drawing A07769).

1. Remove the #18 awg ECM ground wires from starting motor ground stud or engine block.
2. Bolt ECM ring terminals and cable assembly to bolt, lock washer and nut provided.
3. Tape bolted connection with putty tape provided.
4. Cover putty tape with black vinyl tape provided.
5. Route cable assembly to negative post (ground) on the cranes battery.

NOTE: Be sure the routed cable assembly is separated from battery/starter negative cable at a minimum of 12 in. (30 cm).

DIELECTRIC GREASE

The following Figures show the proper application of dielectric grease on J - tech type connectors.

Dielectric grease is need when assembling J - tech type connectors. A bead of grease needs to be applied on O-ring and face of the socket connector ***and only on the O-ring for a pin connector.***

FIGURE 3-13

The size of the grease bead on the O-ring is as follows:

- On a 3 pin connector a 1/16 inch (1,59 mm) bead is required.
- On a 24 pin connector a 1/8 inch (3,18 mm) bead is required.
- On a 37 pin connector a 3/16 inch (4,76 mm) bead is required.

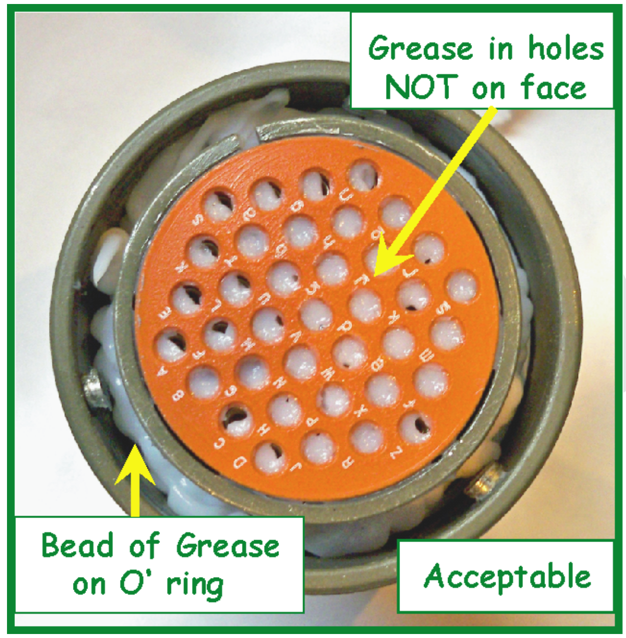


FIGURE 3-14

Place a small amount of grease on your finger for the application on the connector's face. Wipe your finger across the face leaving grease inside the socket holes and less than 0.001 inch (0,025 mm) on the connector's face. This helps assure that water will be kept out of the connectors and keep the pins from fretting.

FIGURE 3-15

CONNECTOR PIN IDENTIFICATION

This section is provided to assist service and maintenance personnel in identifying connector pins for all Brad Harrison type connectors used on Manitowoc cranes:

- Extension cords with plug on both ends — M (male) one end and F (female) other end.
- Cords with plug on only one end — either M (male) or F (female).
- Receptacles — either M (male) or F (female).

Mini-Change Type Connectors

2-Pole Plugs

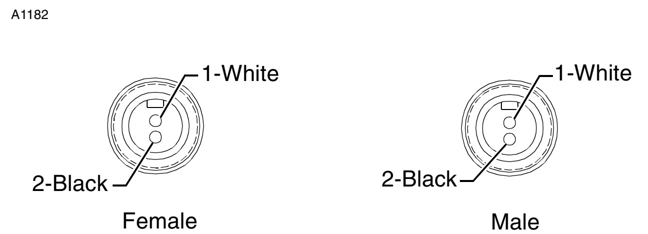


FIGURE 3-16

Extension:

Length	Plug	Part #
3 ft (0.9 m)	M/F	477485
3 ft (0.9 m)	M/F	A02087
6 ft (1.8 m)	M/F	477486
6 ft (1.8 m)	M/F	477491
8 ft (2.4 m)	M/F	477390
10.4 ft (3.1 m)	M/F	477391
12 ft (3.7 m)	M/F	477487
12 ft (3.7 m)	M/F	477492
12 ft (3.7 m)	M/F	911046
15 ft (4.6 m)	M/F	477493
15.4 ft (4.7 m)	M/F	477392
19.4 ft (5.9 m)	M/F	477393
20.4 ft (6.2 m)	M/F	477394
21.4 ft (6.5 m)	M/F	477395
24 ft (7.3 m)	M/F	477338
25.4 ft (7.7 m)	M/F	477396
30.4 ft (9.6 m)	M/F	477397
35 ft (10.7 m)	M/F	477479
40.4 ft (12.3 m)	M/F	477398

Length	Plug	Part #
60 ft (18.3 m)	M/F	477438
65 ft (19.8 m)	M/F	911031
70 ft (21.3 m)	M/F	477494
130 ft (40.0 m)	M/F	477354
130 ft (40.0 m)	M/F	477562
150 ft (45.7 m)	M/F	477561
205 ft (62.5 m)	M/F	911028
210 ft (64.0 m)	M/F	477371
325 ft (99.1 m)	M/F	477420

Plug With Cord:

Length	Plug	Part #
3 ft (0.9 m)	M	572334
3 ft (0.9 m)	F	572444
3 ft (0.9 m)	M	572514
3 ft (0.9 m)	F	572518
3 ft (0.9 m)	M	911879
6 ft (1.8 m)	M	572335
6 ft (1.8 m)	F	572485
6 ft (1.8 m)	F	572515
6 ft (1.8 m)	M	572592
12 ft (3.7 m)	M	572336
12 ft (3.7 m)	F	572345
12 ft (3.7 m)	F	572573
15 ft (4.6 m)	M	572416
15 ft (4.6 m)	F	572497
15 ft (4.6 m)	F	572509
20 ft (6.1 m)	F	572406
20 ft (6.1 m)	M	572572
20 ft (6.1 m)	M	572574
30 ft (9.1 m)	F	477389
50 ft (15.2 m)	F	572407
100 ft (30.5 m)	F	A05250

Receptacle:

Plug	Part #
F	589650
F 90°	589651
M	589654
M 90°	589944

3-Pole Plugs

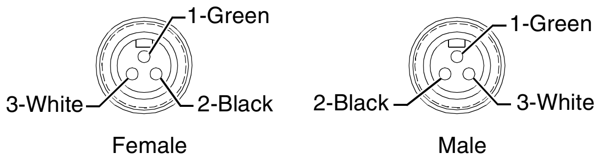


FIGURE 3-17

Extension:

Length	Plug	Part #
3 ft (0.9 m)	M/F	477445
12 ft (3.7 m)	M/F	477333
25 ft (7.6 m)	M/F	572434
30 ft (9.1 m)	M/F	572502
35 ft (10.7 m)	M/F	572480
40 ft (12.2 m)	M/F	572410

Plug With Cord:

Length	Plug	Part #
3 ft (d0.9 m)	M	572324
3 ft (0.9 m)	F	572495
3 ft (0.9 m)	F	572519
3 ft (0.9 m)	F	572531
6 ft (1.8 m)	M	572325
6 ft (1.8 m)	F	572499
12 ft (3.7 m)	M	572326
12 ft (3.7 m)	F	572498
12 ft (3.7 m)	M	572516
12 ft (3.7 m)	F	572587
15 ft (4.6 m)	M	297998
15 ft (4.6 m)	M	572511
15 ft (4.6 m)	F	572550
20 ft (6.1 m)	M	572488
20 ft (6.1 m)	F	572489
25 ft (7.6 m)	M	572372
25 ft (7.6 m)	F	572510
25 ft (7.6 m)	M	572594
30 ft (9.1 m)	F	572477
30 ft (9.1 m)	M	572491
30 ft (9.1 m)	F	572576
35 ft (10.7 m)	M	572386
50 ft (15.2 m)	M	572402
50 ft (15.2 m)	M	572591
50 ft (15.2 m)	F	A00954

Receptacle:

Plug	Part #
F	589635
F 90°	589636
M	589871
M 90°	589938

4-Pole Plugs

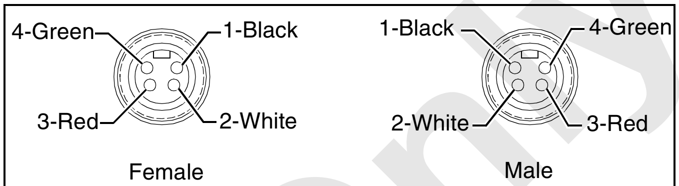


FIGURE 3-18

Extension:

Length	Plug	Part #
12 ft (3.7 m)	M/F	477449

Plug With Cord:

Length	Plug	Part #
3 ft (0.9 m)	M	572330
3 ft (0.9 m)	M	572508
3 ft (0.9 m)	F	572532
6 ft (1.8 m)	M	572331
6 ft (1.8 m)	M	572419
6 ft (1.8 m)	F	572513
6 ft (1.8 m)	F	572521
12 ft (3.7 m)	M	572332
12 ft (3.7 m)	F	572527
15 ft (4.6 m)	M	572599
20 ft (6.1 m)	F	572417
25 ft (7.6 m)	M	572374
30 ft (9.1 m)	F	572577
50 ft (15.2 m)	M	572441

Receptacle:

Plug	Part #
F	589630
F 90°	589638
M	589872
F	589908

5-Pole Plugs

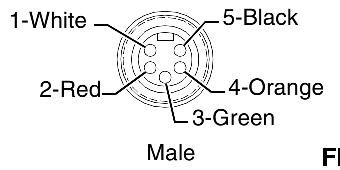


FIGURE 3-19

Plug With Cord:

Length	Plug	Part #
15 ft (4.6 m)	M	572398

Receptacle:

Plug	Part #
F 90°	589839

6-Pole Plugs

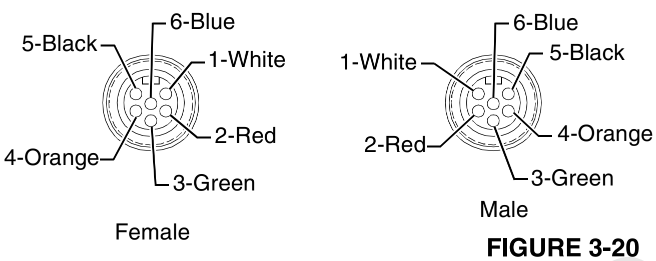


FIGURE 3-20

Extension:

Cord	Plug	Part #
20 ft (6.1 m)	M/F	572400
80 ft (24.4 m)	M/F	477426
130 ft (40.0 m)	M/F	477444
200 ft (61.0 m)	M/F	477419
210 ft (64.0 m)	M/F	477443
350 ft (106.7 m)	M/F	477399

Plug With Cord:

Length	Plug	Part #
3 ft (0.9 m)	F	572520
3 ft (0.9 m)	F	572528
3 ft (0.9 m)	M	572569
6 ft (1.8 m)	M	572442
6 ft (1.8 m)	F	572517
12 ft (3.7 m)	M	572415
12 ft (3.7 m)	F	572568
20 ft (6.1 m)	M	572391
30 ft (9.1 m)	F	A02463
50 ft (15.2 m)	M	572500

Receptacle:

Plug	Part #
F	589805
M	589836
F 90°	589974

3

8-Pole Plugs

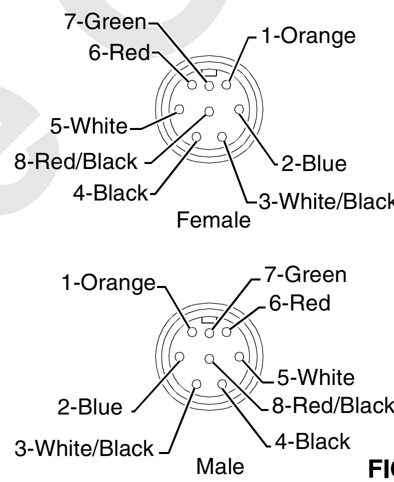


FIGURE 3-21

Plug With Cord:

Length	Plug	Part #
12 ft (3.7 m)	M	572512
12 ft (3.7 m)	M	572529

Receptacle:

Plug	Part #
F	589933

10-Pole Plugs

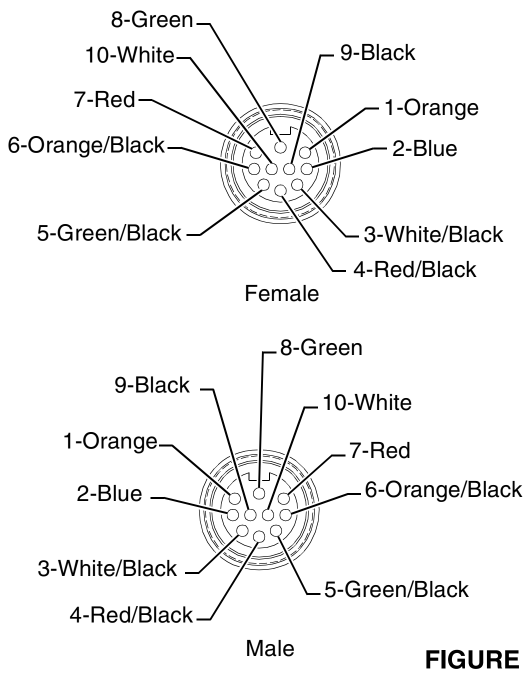


FIGURE 3-22

Extension:

Length	Plug	Part #
12 ft (3.7 m)	M/F	477484
25 ft (7.6 m)	M/F	477466
35 ft (10.7 m)	M/F	477467
45 ft (13.7 m)	M/F	477476
300 ft (91.4 m)	M/F	477413
300 ft (91.4 m)	M/F	477414

Plug With Cord:

Length	Plug	Part #
12 ft (3.7 m)	M	572443
50 ft (15.2 m)	M	572399

Receptacle:

Plug	Part #
F	589869
M	589969

12-Pole Plugs

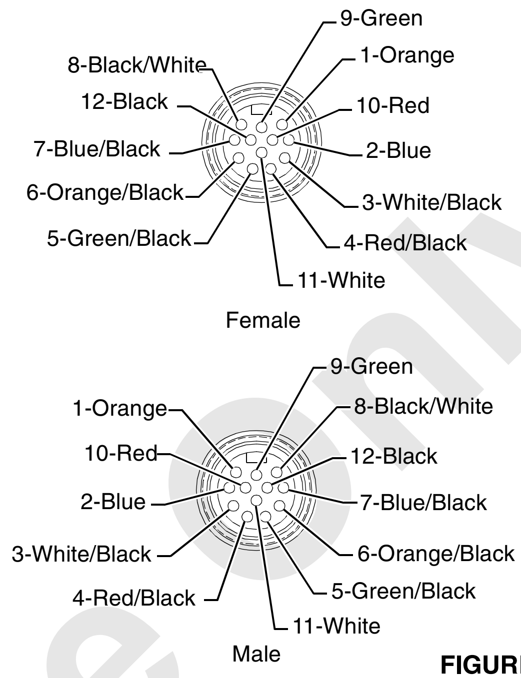


FIGURE 3-23

Extension:

Length	Plug	Part #
21 ft (6.4 m)	M/F	A03688
27 ft (8.2 m)	M/F	477468
38 ft (12.0 m)	M/F	477469
41.5 ft (12.6 m)	M/F	477441
350 ft (107.0 m)	M/F	477442
400 ft (122.0 m)	M/F	477481

Plug With Cord:

Length	Plug	Part #
6 ft (1.8 m)	F	572327
12 ft (3.7 m)	F	572389
20 ft (6.1 m)	M	572507
25 ft (7.6 m)	F	572382

Receptacle

Plug	Part #
M	589646
F	589915

Micro-Change Type Connectors

4-Pole Plugs

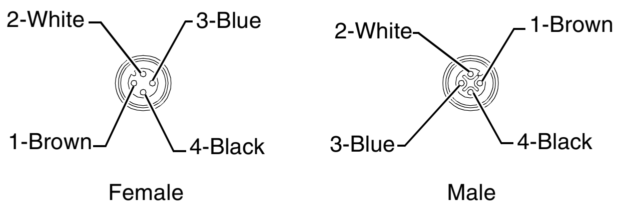


FIGURE 3-24

Extension:

Length	Plug	Part #
3 ft (0.9 m)	M/F	477463
6.6 ft (2.0 m)	F/F	477447
6.6 ft (2.0 m)	M/F	477475
6.6 ft (2.0 m)	F/F 90°	477488
6.6 ft (2.0 m)	M/F 90°	477489
13.1 ft (4.0 m)	F/F	477473
13.1 ft (4.0 m)	M/F	477474
16.4 ft (5.0 m)	M/F	477436
16.4 ft (5.0 m)	F/F	477478
19.7 ft (6.0 m)	M/F	477339
32.8 ft (10.0 m)	M/F	477433
32.8 ft (10.0 m)	F/F	477554
90 ft (27.4 m)	F/F	477453
131.2 ft (40.0 m)	M/F	477334
150.9 ft (46.0 m)	M/F	477560
400 ft (122.0 m)	M/F	477439

Plug With Cord:

Length	Plug	Part #
3.28 ft (1.0 m)	F	572575
6 ft (1.8 m)	F 90°	572504
6.6 ft (2.0 m)	F	572418
9.8 ft (3.0 m)	F	572586
13.1 ft (4.0 m)	M	572474
13.1 ft (4.0 m)	F	572476
16 ft (4.9 m)	F	572472
16 ft (4.9 m)	F 90°	572501
16.4 ft (5.0 m)	M	572475
23 ft (7.0 m)	F	572503
32.8 ft (10.0 m)	M	A01666
32.8 ft (10.0 m)	F	A02673

Receptacle:

Plug	Part #
M	589870
F	589908

Quick-Change Type Connectors

2-Pole Plugs

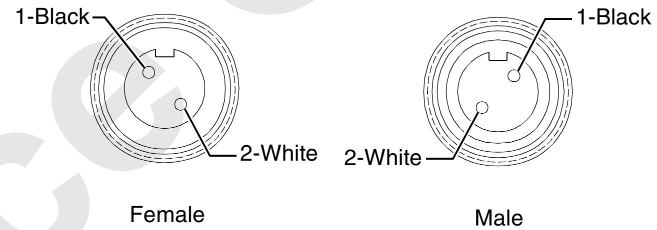


FIGURE 3-25

Extension

Length	Plug	Part #
25 ft (7.6 m)	M/F	477479

Plug With Cord:

Length	Plug	Part #
6 ft (1.8 m)	F	572432
30 ft (9.1 m)	F	572565

Receptacle:

Plug	Part #
M	589862
M	589963

3-Pole Plugs

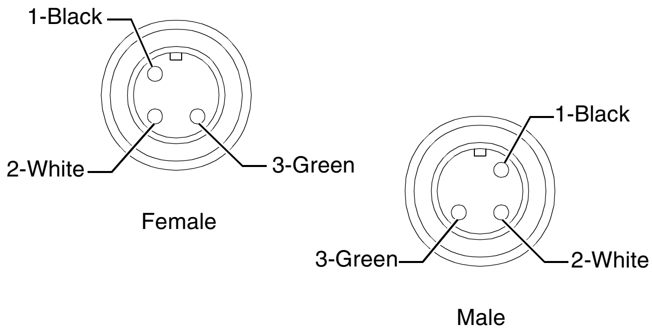


FIGURE 3-26

Extension:

Length	Plug	Part #
8 ft (2.4 m)	M/F	477416
12 ft (3.7m)	M/F	477432
20 ft (6.1 m)	M/F	477430
45 ft (13.7 m)	M/F	477448

Plug With Cord:

Length	Plug	Part #
12 ft (3.7 m)	F	572403
12 ft (3.7 m)	M	572437
12 ft (3.7 m)	M	572552
25 ft (7.6 m)	F	572478
35 ft (7.6 m)	F	572597
50 ft (15.2 m)	M	572438

Receptacle:

Plug	Part #
M	589853
F	589861
M	589862
F	589866
M	589942
F	589952

4-Pole Plugs

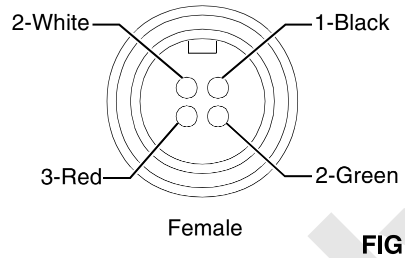


FIGURE 3-27

Plug With Cord:

Length	Plug	Part #
20 ft (6.1 m)	F	572566

SECTION 4
BOOM

TABLE OF CONTENTS

4

SECTION 4
BOOM

AUTOMATIC BOOM STOP ADJUSTMENT

Maximum Boom Angle

Boom stop limit switch (2, Figure 4-1) automatically stops the boom and applies the boom hoist brake when the boom is raised to **Angle A**.

Operation

See Figure 4-1 for following description.

When the boom is below the maximum angle, limit switch (2) is closed and its LED (light-emitting diode) (if equipped) is ON. The boom hoist can be operated.

When the boom is raised to the maximum angle, actuator (3) opens limit switch (2) and the LED (if equipped) goes off. Boom hoist operation stops automatically because the open limit switch turns off power to the boom hoist electric circuit. The boom hoist pump shifts to neutral and the holding valves close to stop boom movement.

WARNING

Falling Attachment Hazard!

If boom fails to stop for any reason, stop engine immediately. Troubleshoot system to determine problem.

Do not resume operation until problem has been corrected.

Maintenance

At least once weekly, check that the automatic boom stop stops the boom at the specified maximum angle. If not, replace any worn or damaged parts and/or adjust the boom stop.

Once the automatic boom stop is properly adjusted, it should not require periodic adjustment. Adjustment is required, however, when:

- The luffing jib is installed or removed.
- Parts are replaced.

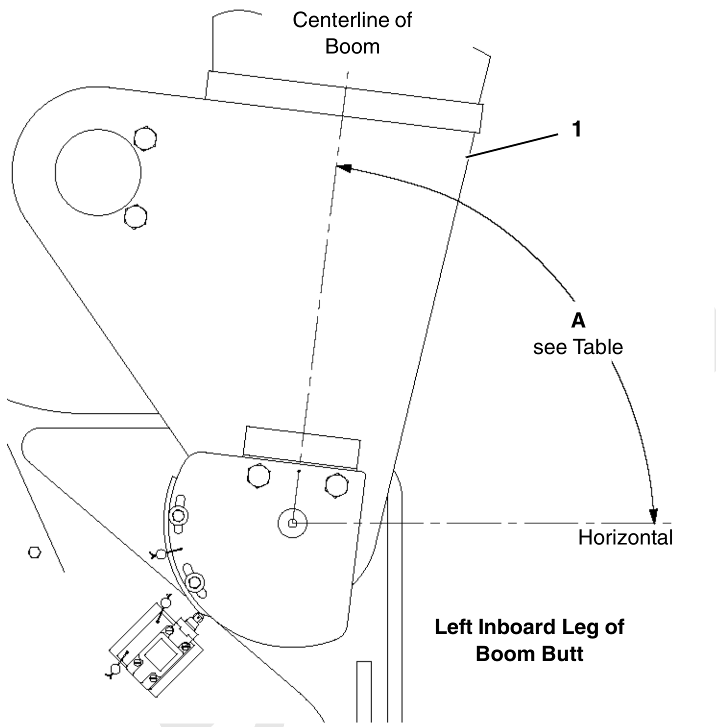
WARNING

Falling Attachment Hazard!

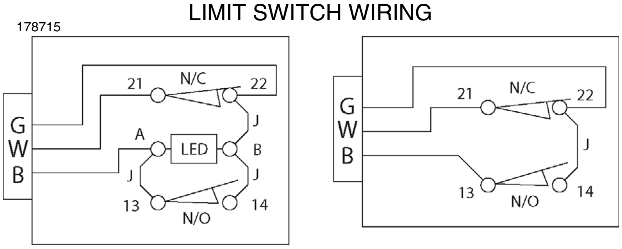
Do not operate crane unless automatic boom stop is properly adjusted and operational. Do not adjust maximum operating angle higher than specified. Boom could be pulled over backwards or collapse, causing death or serious injury.

Angle A	
83°	#78 Boom.
88°	#78 Boom with #139 Luffing Jib when the boom up limit **can be bypassed.***
89°	#78 Boom with #139 Luffing Jib when the boom up limit **cannot be bypassed.***

* To determine if the boom up limit on your crane can be bypassed or not, perform Bypass Limit Test on page 4-3.



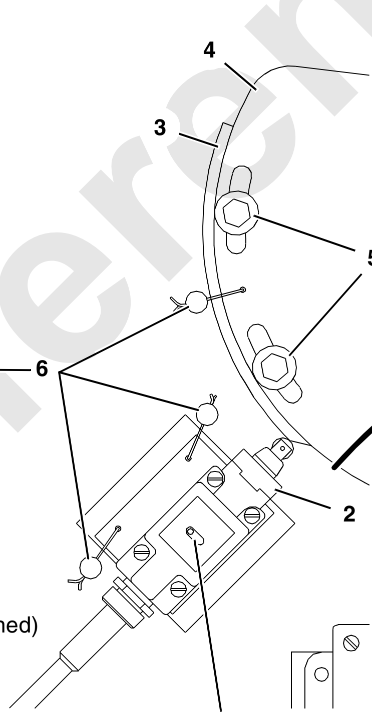
LIMIT SWITCH WIRING



Past Production

Current Production

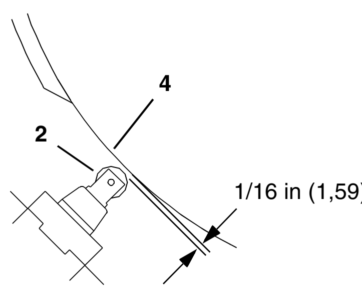
N/C = Normally Closed
N/O = Normally Open
B = Black Wire
G = Green Wire
W = White Wire
J = Jumper Wire



Drill for 1/8 in (3,2 mm) dowel. Install wire and seal lead after adjustments are made.

VIEW A
(switch opened)

LED (past production)
OFF = Switch Open
ON = Switch Closed



VIEW B
(switch closed)

Item	Description
1	Boom Butt
2	Limit Switch
3	Actuator
4	Actuator Bracket
5	Cap Screw with Flat Washer and Lock Washer
6	Dowel Roll Pin with Seal Lead and Wire
7	Digital Level (see Figure 4-2)

FIGURE 4-1

Bypass Limit Test

Perform the following test to determine if the boom up limit on your crane can be bypassed or not.

⚠ WARNING

Crush Hazard!

Maintain constant communication between operator and assistant during following steps.

Stay clear of moving parts.

---

1. Lower the boom onto blocking at ground level.
2. Have an assistant push the limit switch plunger down to trip the boom stop limit switch open.
3. Rotate the limit bypass key (in crane cab) to the bypass position and hold.
4. Try to boom up — do not raise the boom any higher than necessary to perform the test:
   - **a.** If the boom rises, your boom up limit ***can be bypassed***.
   - **b.** If the boom does not rise, your boom up limit ***cannot be bypassed***.
5. The test is complete. Release the limit bypass key and the limit switch plunger to the normal operating positions.

Adjustment

See Figure 4-1 for following procedure.

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.
2. Loosen cap screws (5, View A).
3. Rotate actuator (3) out of the way so it does not contact the roller on limit switch (2) when step 4 is performed.
4. Raise the boom to specified **Angle A** while monitoring the angle on the mechanical indicator or on the operating conditions screen of the front-console display.
5. Verify that the boom is at the proper Angle A:
   - **a.** Place an accurate digital level (7) on the boom butt as shown in Figure 4-2. The corresponding **Digital Level Angle** should appear on the digital level.
   - **b.** Raise or lower the boom as necessary.
6. Check the position of the limit switch roller with relation to actuator bracket (4, View B). If necessary, loosen the limit switch mounting screws and adjust the limit switch up or down in the mounting slots to obtain the dimension in View B. Securely tighten the mounting screws.

Limit switch will not trip open if it is too far from actuator bracket. Limit switch could be damaged from over-travel if it is too close to actuator bracket.

7. Rotate actuator (3, View A) against the roller of limit switch (2) until the limit switch just "clicks" open and hold. The LED (if equipped) should go off when the switch opens.
8. Securely tighten cap screws (5) to secure actuator (4).
9. Test the adjustment as follows:
   - **a.** Lower the boom several degrees below the specified Angle A (LED comes on if equipped).
   - **b.** Slowly raise the boom.
   - **c.** ***Boom must stop at specified Angle A*** (LED goes off if equipped); if the boom does not stop at the specified angle:
     - Stop raising the boom (move control handle to off).
     - Lower the boom several degrees below the specified angle.
     - Repeat adjustment steps 2 through 9.
10. Seal the adjustment as shown in Figure 4-1.

Boom Angle	Digital Level Angle
83°	76.5°
88°	81.5°
89°	82.5°

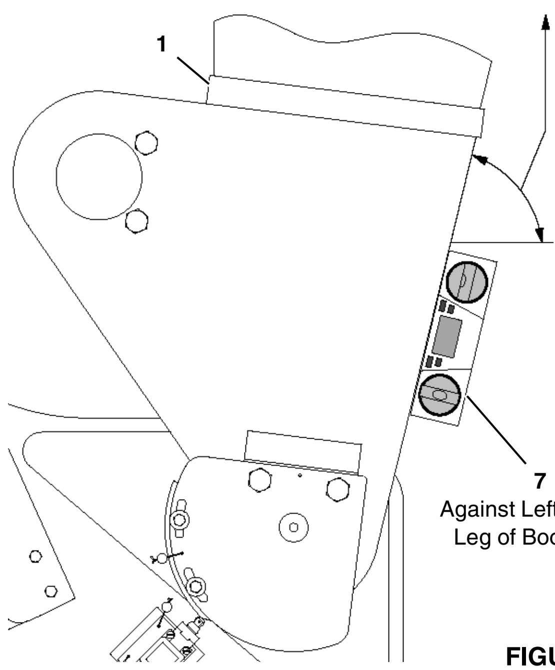


FIGURE 4-2

4

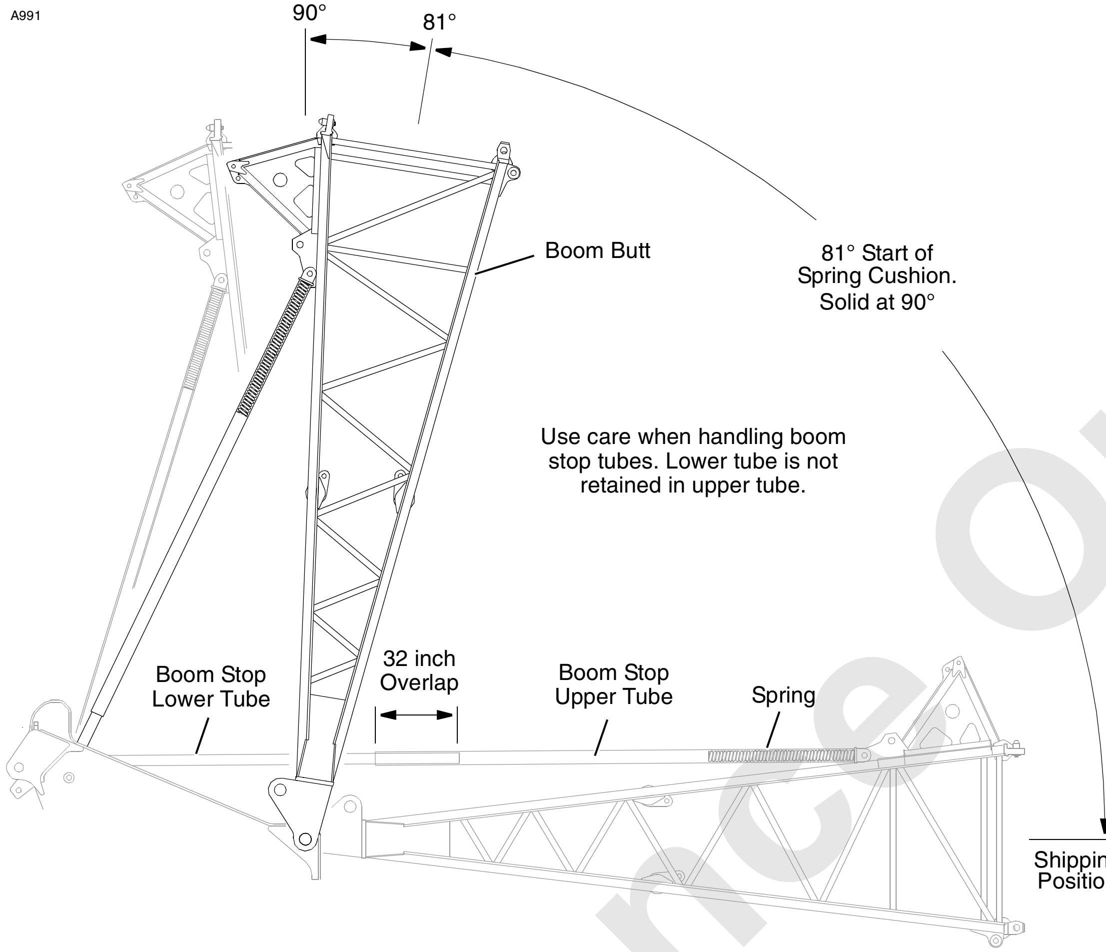


FIGURE 4-3

PHYSICAL BOOM STOP

The physical boom stop assembly (Figure 4-3) serves the following functions:

- Assist in stopping the boom smoothly at any angle above 81°.
- Assist in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 81°.
- Assist in moving the boom forward when lowering the boom from any angle above 81°.
- Provide a physical stop at 90°.

WARNING

Falling Load Hazard!

Physical boom stop must be installed for all crane operations. Physical boom stop does not automatically stop boom at maximum operating angle. Automatic boom stop must be installed and properly adjusted.

Operation

See Figure 4-3 for following procedure.

1. When the boom is raised to 81°, the springs in the boom stop tube begin to compress.
2. As the boom is raised higher, spring compression increases to exert greater force against the boom.
3. If for any reason the boom is raised to 90°, the boom stop springs will fully compress to provide a physical stop.

Removal

Normally, the boom stop tubes are not removed unless they need repair or replacement.

WARNING

Falling Load Hazard!

Use care if boom stop tubes are removed for any reason. Lower tube is not retained by upper tube and they may separate when detached.

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BOOM ANGLE INDICATOR

An angle sending unit mounted on the boom butt (Figure 4-4) monitors the boom angle.

The sending unit houses a sensor which sends an electric signal to the crane's programmable controller. The programmable controller converts the electric signal into an angle which can be monitored on the digital display in the operator's cab.

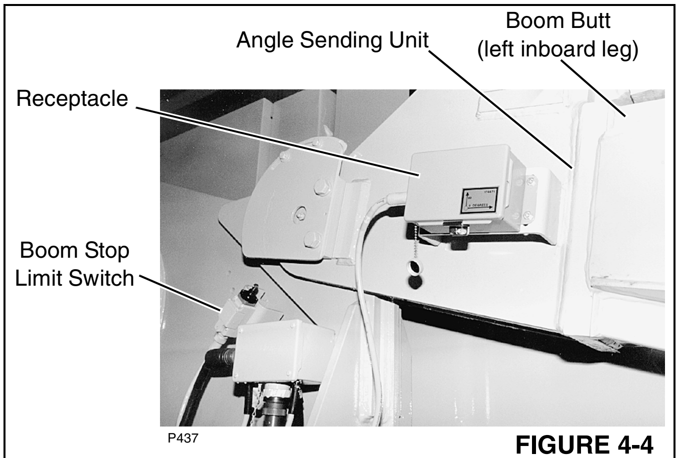

FIGURE 4-4

Adjusting Angle Indicator

Perform following adjustment steps at initial installation, after installing a new sending unit or potentiometer, and at least monthly when boom is lowered to ground (Figure 4-5).

1. Locate punch marks on line through centerline of boom butt as shown in Figure 4-5. If necessary, scribe a line through punch marks.

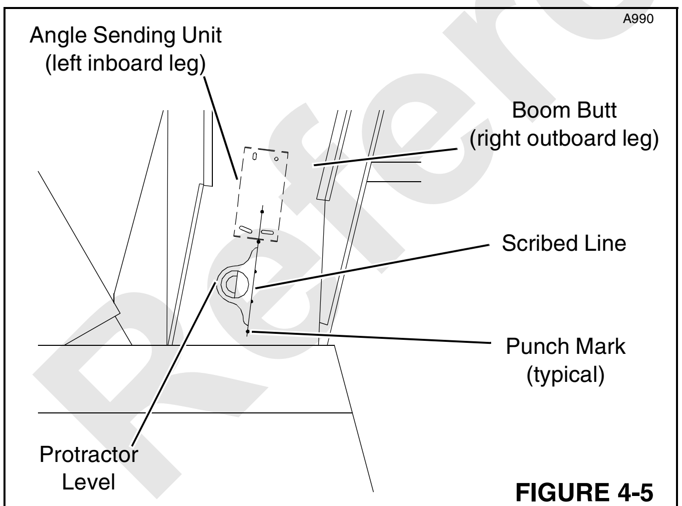

FIGURE 4-5

2. Hold a protractor-level along scribed line.
3. Record angle indicated on protractor-level.
4. Scroll to boom angle on digital display in operator's cab.
5. Angle shown on digital display must match angle recorded in step 3 plus or minus one degree.
6. If necessary, loosen mounting screws and rotate sending unit in mounting slots until reading on digital display matches angle on protractor-level.
7. Securely tighten mounting screws to lock adjustment.

Sensor Replacement

Replacement sending units can be either the pendulum-type 120° potentiometer (past production) or solid state sensor (current production).

Pendulum-Type 120° Potentiometer

When replacing parts in the pendulum-type potentiometer sending unit, take the following precautions (see Figure 4-6, View A):

Mount potentiometer at angle shown.

Connect black, green, and white wires from receptacle to proper terminals on terminal strip.

Connect wires from potentiometer to proper terminals on terminal strip.

Make sure all parts are securely fastened to their mounting position.

Solid State Sensor

When replacing existing pendulum-type potentiometer with current production solid state sensor, take the following precautions (see Figure 4-6, View B):

Identify all input wires to existing potentiometer.

Cut existing input wires near terminal strip (if used) to allow for splicing.

Remove existing potentiometer and terminal strip (if used).

Mount new sensor in existing holes at 52.5° as shown in View B.

Refer to wiring chart in View B and parallel splice sensor wires to existing input wires with crimp, solder, and heat shrink tubing.

Seal green wire on sensor with heat shrink tubing and coil up.

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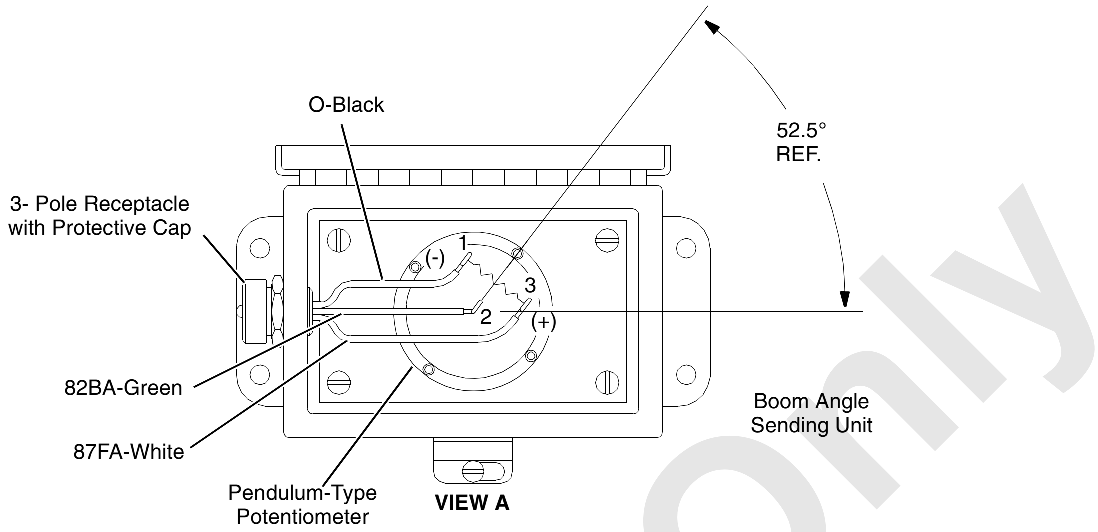

A1294

Solid State Sensor (+/- 60×)
M.C.C. #A09716
Vendor #CS17

Input Wires Color	Sensor Wires Color	Operation Code
From	To	
Black	Black	Ground
Green	White	Signal
White	Red	10 Volts DC
	Green	N/C

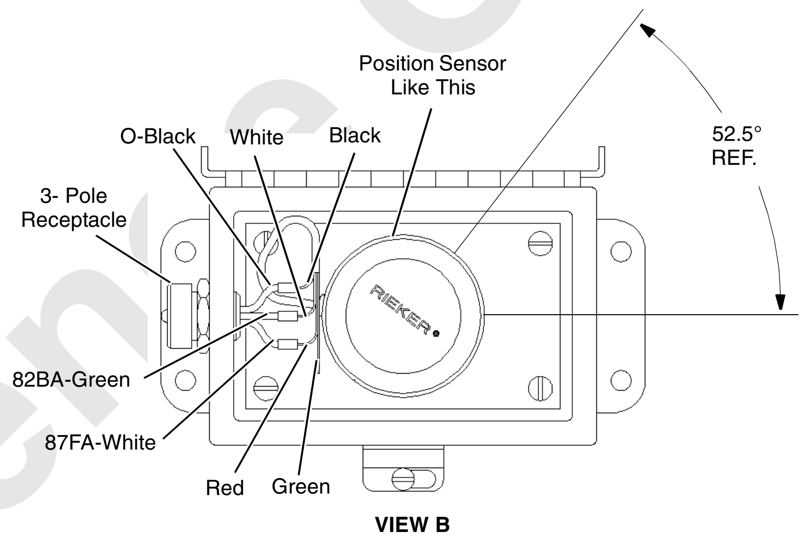

FIGURE 4-6

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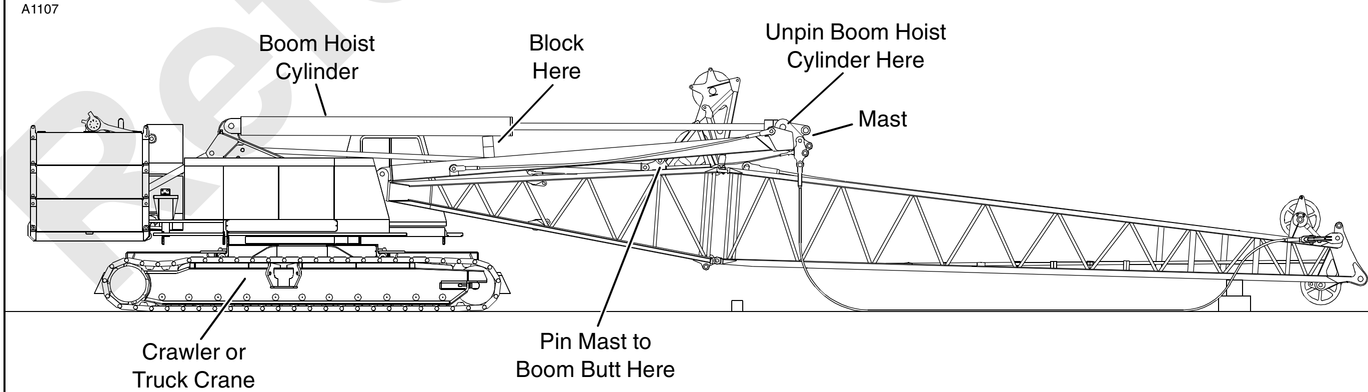


FIGURE 4-7

SERVICING BOOM HOIST CYLINDER

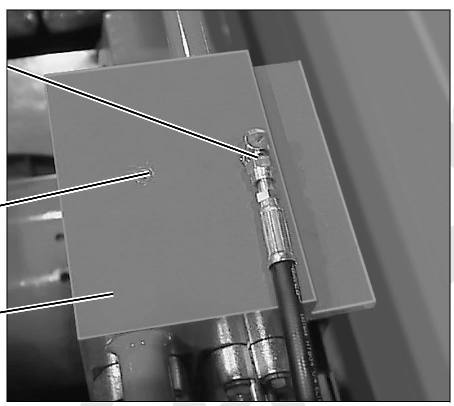
WARNING

Falling Boom Hazard!

Do not attempt to service boom hoist cylinders (remove holding valves or disconnect hoses) until following steps are performed. Boom will lower uncontrolled.

1. Lower boom onto blocking at ground level (Figure 4-7).
2. Fully lower mast and pin to boom butt as shown in Figure 4-7.
3. Move boom hoist control handle to off and park boom hoist.
4. Stop engine.
5. Exhaust pressure from cylinder valve blocks, as follows:
   a. ***Slowly*** unscrew and remove vent plug from valve block (Figure 4-8).
   b. ***Slowly*** unscrew and disconnect pressure sender line from elbow in valve block (Figure 4-8).

P986



Right Side Cylinder Shown (Left Side Cylinder Similar)

FIGURE 4-8

6. It is now safe to remove holding valves, disconnect remaining hoses, and remove cylinders as required.
7. If boom hoist cylinders were removed, install them at this time:
   a. Pin head end of cylinders to rotating bed. Block valves on cylinders must face inward.
   b. Securely block cylinder bodies on mast (see Figure 4-7). Do not connect rod end pins to mast. Both cylinders must be free to extend and retract when bleeding air.
8. Install holding valves and connect hoses as required:
   a. Thoroughly clean all fittings.
   b. Make sure all O-rings are properly installed.
   c. Apply thread sealant to vent plug threads and securely install vent plugs.
   d. Install and securely tighten holding valves, fittings, and hoses.
9. Bleed air from boom hoist cylinders as follows:
   a. Both cylinder rod ends must be disconnected from mast. Perform step 7b if not already done.
   b. Start and run engine at high idle.
   c. Fully extend and retract boom hoist cylinders twice. ***Use care not to allow cylinder rod ends to contact mounting lugs on mast.***
   d. Check for oil leaks at cylinder valve blocks as cylinders are operated. Stop engine and correct leaks if found.
   e. Remove blocking and connect cylinder rod ends to mast.
10. Bleed boom hoist cylinder pressure sender and calibrate pressure senders (see Pressure Sender Calibration procedure in Section 2 of this manual).
11. Disconnect mast from boom butt.
12. Slowly raise boom to desired operating position. Then slowly lower boom approximately 20°. Continue this procedure until operation is smooth in both directions.

BOOM HOIST CYLINDERS — WELDING

When welding on the subject cranes, weld current can arc from the boom hoist cylinder barrels to the pistons or rods. This action can cause damage to the pistons and rods, causing premature seal failure. Leakage will occur, and ***the boom may lower on its own.***

Before Welding on Crane

Take the following precautions to prevent damage to the boom hoist cylinders (and other crane parts such as bearings, swivels, slewing ring, computers, etc.):

- Disconnect all cables from batteries.
- Disconnect output cables at engine junction box.
- Attach ground cable from welder directly to part being welded and as close to weld as possible.
- Do not weld on engine or engine mounted parts (per engine manufacturer).

If weld arcing at the boom hoist cylinders is detected, carefully inspect the cylinders for damage: pitting in rods, leakage at rod seals, cylinder drift (internal leakage). If damage is found, contact the Service Department at Manitowoc Cranes for repair/replacement instructions.

BOOM AND JIB INSPECTION AND LACING REPLACEMENT

Crane owners should use this section as a guide for properly inspecting and repairing lattice sections in the field.

For inspection or repair procedures not covered in this publication, contact your Manitowoc distributor.

WARNING

Component Failure!

If damage was caused by overload or shock load or if there is damage to other major structural components, we recommend that a thorough inspection be made by a qualified person. A nondestructive test of all critically stressed members must be made.

Inspection Intervals

Regular inspection is necessary to ensure that the attachment can safely lift its rated load. Inspection should be performed by a *qualified person* at the following intervals:

- Routinely on a weekly basis (this interval can vary depending on operating conditions, application, and crane history).
- Prior to initial use.
- After transport.
- After an overload or shock load condition has occurred.
- If the attachment has come into contact with another object — for example: power lines, building, another crane.
- If the attachment has been struck by lightning.

Inspection Guidelines

1. Position the crane on a level surface.
2. Block the attachment so it is level; blocking should be placed under each connection point to eliminate all sag.
3. Thoroughly clean the attachment of all dirt, grease, oil, etc. so a thorough inspection can be made.
4. Visually inspect the entire attachment looking for the following types of damage:
   a. Dents in lacings, chords, and platework.
   b. Corrosion or abrasion in lacings, chords, and platework.
   c. Bent, kinked, or distorted lacings, chords, and platework.
   d. Cracked lacings, chords, and platework.
   e. Cracked welds.
5. Closely examine those areas where the paint is chipped, wrinkled, or missing and where faint rust lines or marks appear.
6. Fill in the inspection checklist at the end of this publication and make a detailed report of the type and degree of damage found.
7. Repair or replace damaged lattice sections.

WARNING

Structural Failure!

If damage not within allowable criteria is found, do not operate crane until appropriate lattice section has been properly repaired or replaced.

Operating crane with damaged lattice sections can result in structural failure or collapse of attachment.

Replacement Criteria

CAUTION

Lacing Replacement!

Any lacings damaged beyond the allowable criteria given in this publication must be replaced.

Contact Manitowoc Crane Care for any damage to chords or platework exceeding the allowable criteria contained in this publication. Special instructions are required for repair or replacement of these components.

Refer to the Lacing Drawings in the Attachment Section of the Parts Manual supplied with your crane for the wall thickness of tubular lacings and chords.

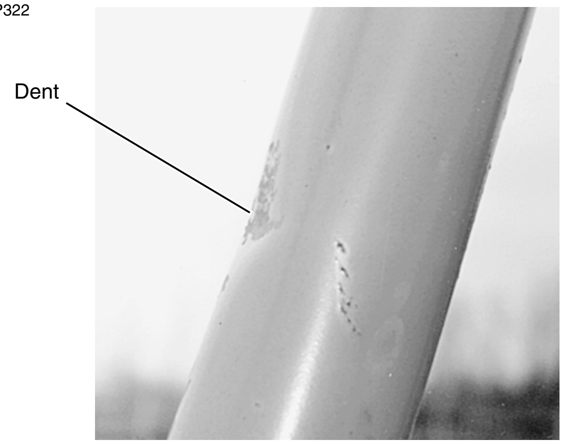
Dents

Refer to Figure 4-9.

For tubular lacings or chords, dents must not be deeper than the wall thickness or 1/8 in (3.2 mm), whichever is less.

For angular lacings or chords and all platework, dents must not be deeper than 1/8 in (3.2 mm).

P322



DENTED LACING

FIGURE 4-9

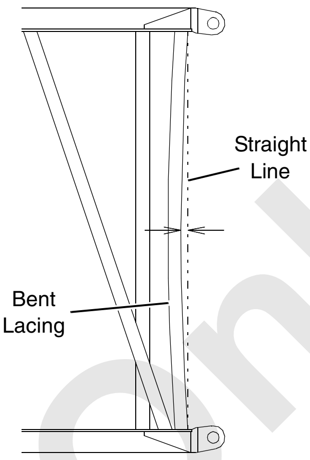
Gradual and Sweeping Bends

Refer to Figure 4-10.

For tubular lacing, gradual and sweeping bends must not deviate from straight more than 5 percent of the lacing diameter.

For angular lacing, gradual and sweeping bends must not deviate from straight more than 5 percent of the angle leg length.

B231



BENT LACING

FIGURE 4-10

Gradual and sweeping bends in lacings can be straightened by cold bending them back into alignment. Take extreme care not to kink or further damage the lacings.

Corrosion and Abrasion

Refer to Figure 4-11.

Corrosion and abrasion must not be deeper than 10 percent of the wall thickness, the angle thickness, or the plate thickness.

CORRODED CHORD

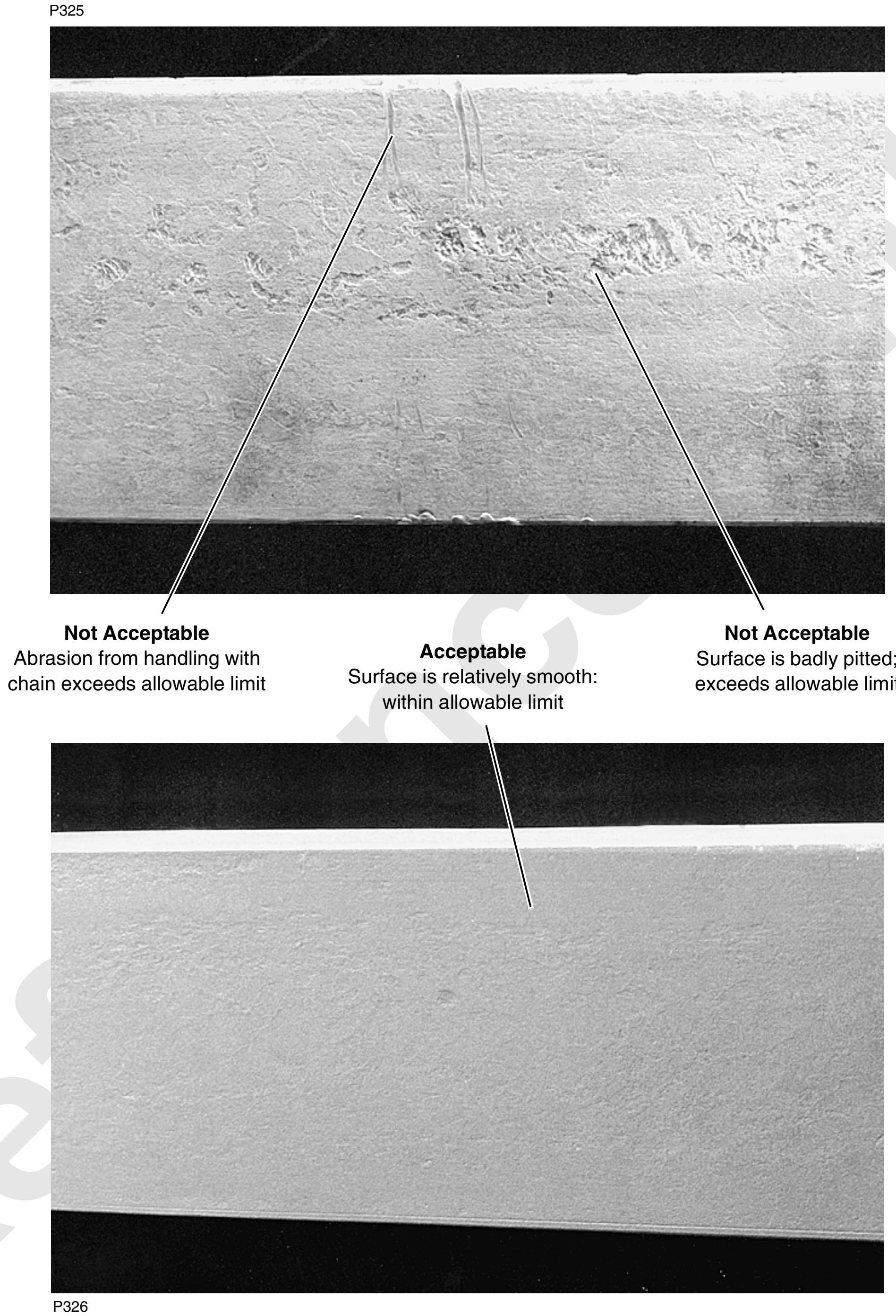


FIGURE 4-11

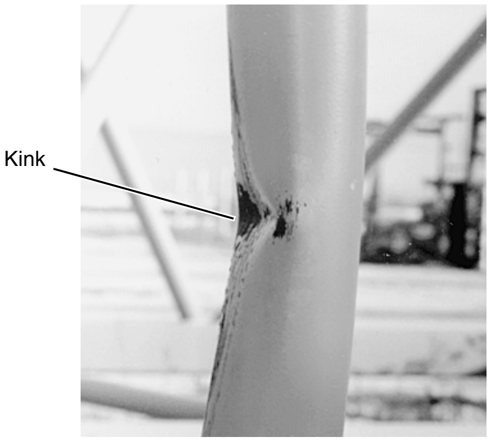
Kinks

Refer to Figure 4-12.

Kinked lacings must be replaced; *do not bend kinked lacings back into alignment*.

If any chord or platework is kinked, contact Manitowoc Crane Care for approved repair instructions. *Do not bend kinked chords or platework back into alignment*.

P323



KINKED LACING

FIGURE 4-12

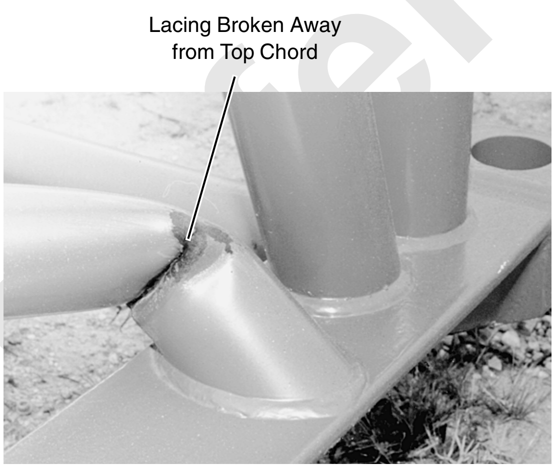
Cracks and Breaks

Refer to Figure 4-13.

Cracked and broken lacings must be replaced; *do not attempt to repair cracked or broken lacings*.

If any chord or platework is cracked or broken, contact Manitowoc Crane Care for approved repair instructions. D*o not attempt to repair cracked or broken chords or platework*.

P324



BROKEN LACING

FIGURE 4-13

Chord Straightness

Refer to Figure 4-14.

If visual inspection indicates that a chord may not be straight, proceed as follows:

1. Remove the suspect lattice section from the attachment.
2. Place wood blocks or steel plates having the same thickness against both ends of the section (X_1 and X_2).
3. Stretch a line (string or wire) over the outside of the wood blocks or steel plates.
4. Stretch the line as tight as possible and tie it off at both ends.
5. Measure the distance from the chord (on either side of lacing intersection) to the line as shown in Figure 4-14.
6. Measurements must be taken in two planes at each chord (dimensions A and B). To eliminate the effect of sag in the line, take all measurements in the horizontal plane.
7. Take the first set of measurements, then roll the insert over 90 degrees, and take the second set of measurements.
8. Tubular and angular chords must not deviate from straight more than plus or minus 3/16 in (4.8 mm) at any lacing intersection (dimension A). Deviation between any two adjacent lacings must not exceed plus or minus 3/16 in (4.8 mm).
9. On angular chords, *waviness at toe of chord* (dimension B) must not deviate from straight more than plus or minus 1/4 in (6.4 mm) at any point. Furthermore, waviness between any two adjacent lacings must not exceed plus or minus 1/4 in (6.4 mm).

   Gradual and sweeping bends in chords can be straightened by cold bending them back into alignment. Take care not to kink or further damage the chords.

B231

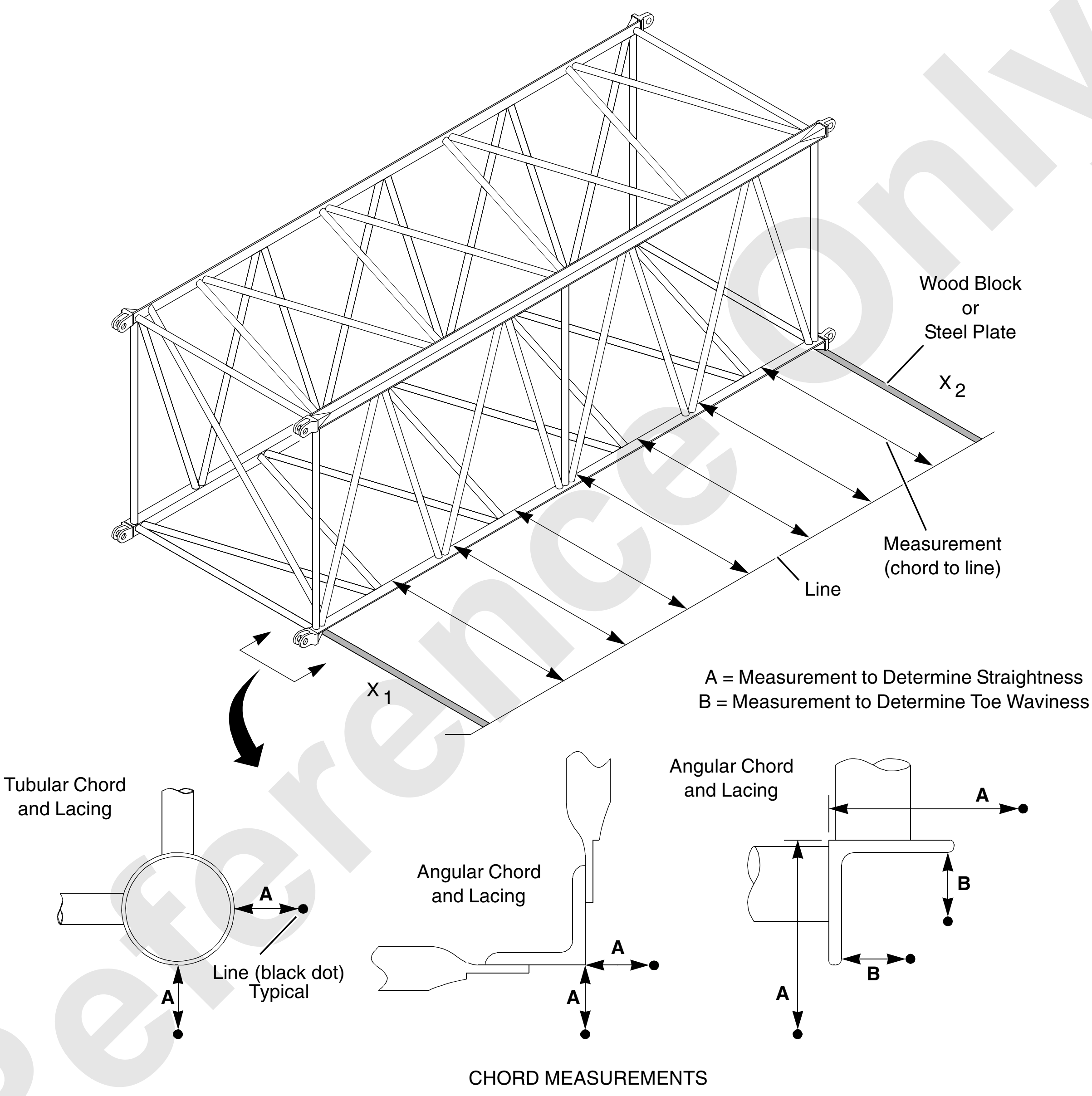


FIGURE 4-14

4

ORDERING LACINGS

This topic is divided into two sections:

a. Ordering boom or jib lacings from LACING DRAWINGS contained in the Attachment Section of the Parts Manual furnished with the crane.

b. Ordering boom or jib lacings when LACING DRAWINGS ARE NOT AVAILABLE.

Assistance

If you are in doubt as to which lacings to order, DO NOT GUESS. Contact your Manitowoc distributor for assistance.

Boom or Jib Identification

All parts orders for lacings must contain the boom or jib identification number and the component part number:

- **Past Production** (View A, Figure 4-15):

  Boom or jib number, component part number, and manufacturing code stamped into two connectors (diagonally opposite) on both ends of each insert and on end of top and butt.

- **Current Production** (View B, Figure 4-15):

  Boom or jib number, component part number, and manufacturing code stamped into a plate mounted on all four chords of each lattice section.

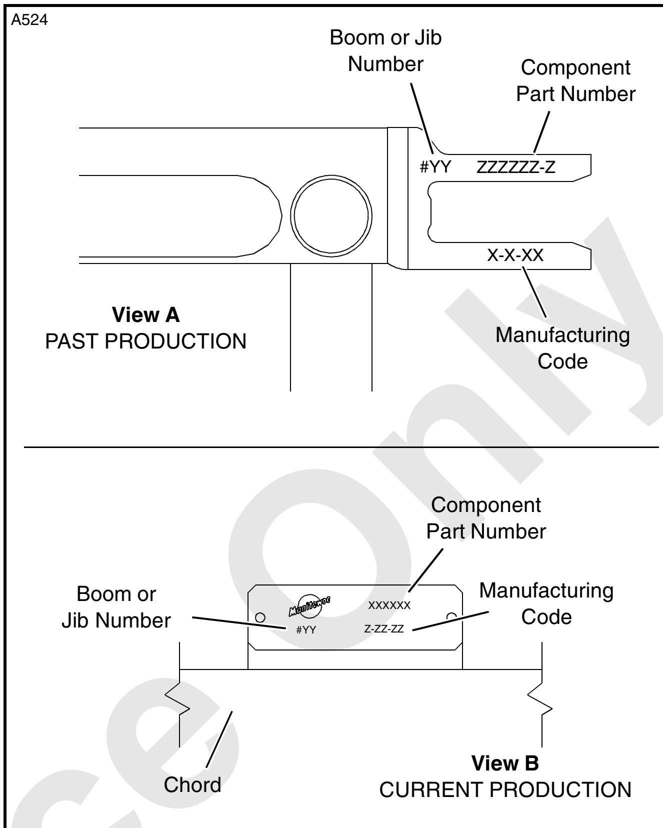


FIGURE 4-15

A. Ordering Lacings from Lacing Drawings

The parts order must contain the following information to ensure that Manitowoc provides you with the correct lacings:

1. Crane serial number (can be found on builders plate in operator's cab.)
2. Boom or jib identification number.
3. Quantity of lacings.
4. Component part number and lacing identification number (from lacing drawing in Section F of Parts Manual).
5. Component name.

EXAMPLE: Assume you have a number 22 boom and the lacings with circled letters in Figure 4-16 are damaged. Your parts order should be similar to the following example:

Crane Serial Number: **00000** (from Crane Identification Plate).

Boom Identification Number: **#22 Boom**

Required:

1 each 48153-9 (N) for 30 ft Butt

1 each 33426-3 (B) for 20 ft Insert

1 each 33426-3 (D) for 20 ft Insert

1 each 50453-2 (C) for 40 ft Top

Quantity **Component Part Number** **Lacing Identification Number** **Component Name**

4

A924

SAMPLE ONLY
DO NOT USE LETTERS IN THIS SAMPLE WHEN ORDERING LACINGS. USE LETTERS IN LACING DRAWINGS IN PARTS MANUAL FOR YOUR CRANE.

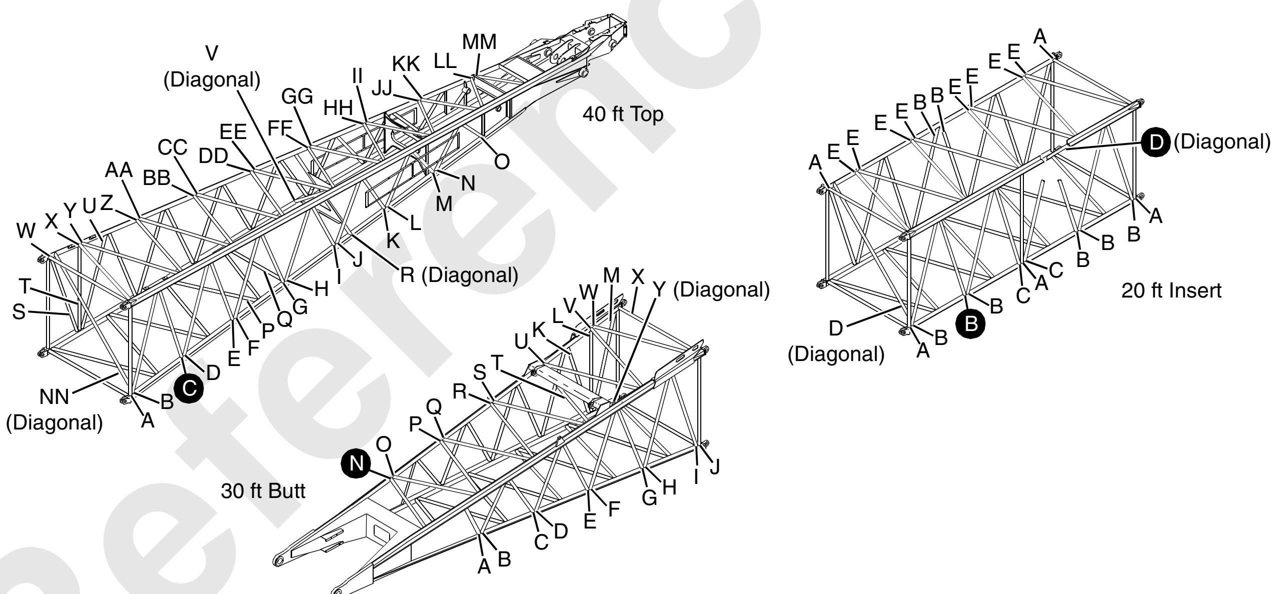


FIGURE 4-16

B. Ordering Lacings without Lacing Drawings

The parts order must contain the following information to ensure that Manitowoc provides you with the correct lacings:

1. Crane serial number (can be found on builders plate in operator's cab.)
2. Boom or jib identification number.
3. Quantity, lacing location, and lacing number.
4. Boom or jib component name (butt, insert, or top) and part number.

NOTE To obtain the lacing location and number, view the boom or the jib from the butt end looking forward. Identify the side on which the damaged lacing is located: left side, top side, right side, or bottom side. Count each lacing up to and including the damaged lacing, starting with **first lacing nearest butt end** of the component as shown in Figure 4-17.

Do not count a diagonal lacing as the first lacing. Identify diagonal lacing separately; lower end diagonal lacing or upper end diagonal lacing.

EXAMPLE: Assume you have a number 22 boom and the lacings with circled numbers in Figure 4-17 are damaged. Your parts order should be similar to the following example:

Crane Serial Number: **00000** (from Crane Identification plate).

Boom Identification Number: **#22 Boom**

Required:

1 each Top Side Lacing (1) for 30 ft Butt 48153-9

1 each Right Side Lacing (5) for 30 ft Butt 48153-9

1 each Bottom Side Lacing (3) for 20 ft Insert 33426-3

1 each Bottom Side Lacing (6) for 20 ft Insert 33426-3

1 each Top Side Lacing (2) for 40 ft Top 50453-2

Quantity | **Lacing Location** | **Lacing Identification Number** | **Component Name and Part Number**

A924

SAMPLE ONLY

DO NOT USE LETTERS IN THIS SAMPLE WHEN ORDERING LACINGS. USE LETTERS IN LACING DRAWINGS IN PARTS MANUAL FOR YOUR CRANE.

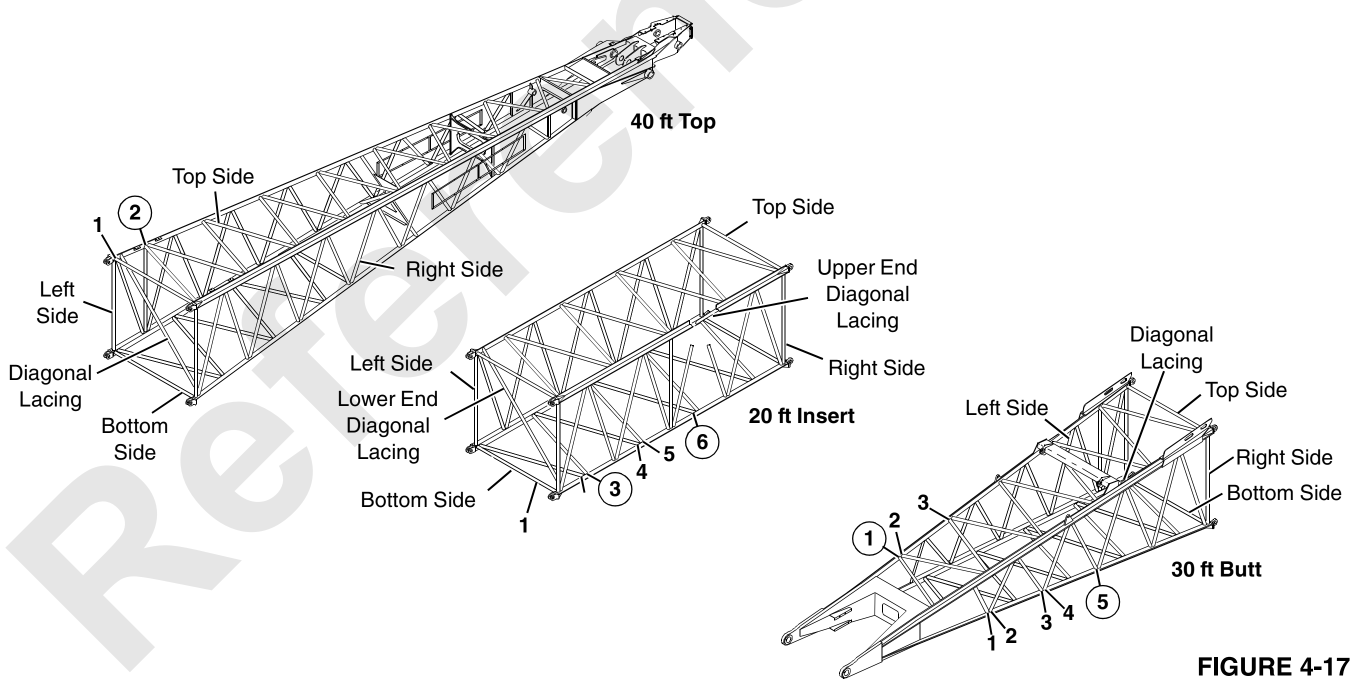


FIGURE 4-17

REPAIR PROCEDURE

Extent of Repair

Field repair is limited to replacing damaged lacings — ***unless otherwise approved by Manitowoc*** — but only if the following conditions are complied with:

- The lacings are ordered from Manitowoc.
- The welding is done by *competent welders* qualified to work with the types of steel involved. *Manitowoc recommends that welders be qualified per Section 5 of AWS D1.1 Structural Steel code or an equivalent code.*
- The welding procedures and specifications supplied by Manitowoc are adhered to.

WARNING

Component Failure!

Unless otherwise approved by Manitowoc, no welding shall be done to chord members or platework except to attach lacings.

No chord member or platework may be replaced in whole or in part. The complete lattice section must be replaced if damage to chords or platework exceeds the allowable criteria contained in this publication.

Welding chord members or platework without approval from Manitowoc could result in structural failure of the attachment.

Preparing for Welding

Many of Manitowoc's current production cranes are equipped with sensitive electronic equipment and controls. To prevent serious damage to these components, take the following precautions before you start welding:

1. Obtain factory approval before performing any welding.
2. Stop the engine, disconnect all positive (+) and negative (-) battery cables from the batteries or use the battery disconnect, if equipped.
3. Do not attach welding cables to or near any electrical components. If welding is required near any electrical components, the component should be removed from the unit prior to welding and reinstalled after welding is completed.
4. Attach the welding ground cable as near as possible to the area being welded. Do not lay the welding ground on the lattice section — secure it tightly with a C-clamp if necessary.
5. Do not bridge electrical components and machined bearing surfaces.
6. Cover electrical components and machined surfaces as required prior to welding to protect them from welding sparks and spalls.

Repair Facility

To ensure proper welding, the repair area must:

1. Be heated to 70° F (21° C) minimum.
2. Be free of wind drafts.
3. Be rain and snow proof.
4. Have proper ventilation.
5. Have proper lighting and electrical service.
6. Have proper air compressor capacity to support air arc gouging and grinding equipment.
7. Have sufficient room to pin another lattice section to the work piece if necessary.

Outdoor Repairs

Welding shall not be done when the outside temperature is lower than 45° F (7° C) or when surfaces are wet or exposed to rain, snow, or high wind velocities.

Welding is permitted if a heated structure or shelter is constructed around the weld area to maintain the temperature adjacent to the weldment at 45° (7°C) or higher.

REGARDLESS OF OUTSIDE TEMPERATURE, THE BASE MATERIAL TEMPERATURE MUST BE MAINTAINED AT THE MINIMUM INTERPASS TEMPERATURE DURING ALL WELDING OPERATIONS.

General Equipment Requirements

The following equipment is required:

1. 350+ amp DC power source (needed for carbon arc gouging and welding).
2. Stick electrode (see page page 4-27 for determining required amount).
3. Carbon arc torch.
4. Stick electrode oven and proper storage for electrodes.

NOTE Stick electrode can be purchased in hermetically sealed packages from Manitowoc Crane Care.

- Electrode: A.W.S. A5.5
- 3/32 in (2,5 mm) E9018M-H4
- 1/8 in (3,2 mm) E9018M-H4

The maximum exposure time to the atmosphere for E9018-M stick electrode is one hour. The electrode must then be returned to an oven that is held at a minimum of 250°F (121°C) for four hours.

5. Safe and properly sized rigging for lifting and blocking equipment.

6. Proper safety equipment for working at heights above the ground.
7. Proper safety apparel.
8. Safe and proper hand tools (wire brush, clamps, grinder, etc.).
9. Oxy-fuel cutting and preheating torch.
10. Heat resistant blankets for covering the weld repairs and protecting the lattice section from sparks and spalls.

Repair Procedures and Processes

Manitowoc Crane Care will supply the following documentation when required:

1. Welding instructions.
2. Modification drawings.
3. Non-destructive testing and inspection requirements.
4. Straightening requirements and processes.
5. Machining requirements.
6. Paint requirements and recommendations.

Lacing Replacement

1. The lacing/lacings will need to be identified prior to removal. Do not remove more than one lacing at a time on a panel to ensure straightness of the chords. Use a fillet weld gauge to measure the toe/heel of the weld and record the dimension for reference.

NOTE Always replace diagonal lacings first. Diagonal lacings run from one corner to another (for example, from upper left chord to lower right chord).

Always replace the center lacing first in a series of damaged lacings. This will assist in maintaining the cross sectional dimensions of the section. Then replace the remaining lacings, first on one side and then on the other side of center.

Special instructions are provided starting on page page 4-19 for removing:

- End lacing.
- Lacings on a tapered lattice section.
- Lacings on a lattice section with a bent or bowed chord member.

2. Use a paint marker to reference the location of the damaged lacing on the chord member (Figure 4-18). Transfer the marks out of the repair area so they are not removed during the lacing replacement process. These marks will help locate the replacement lacing.

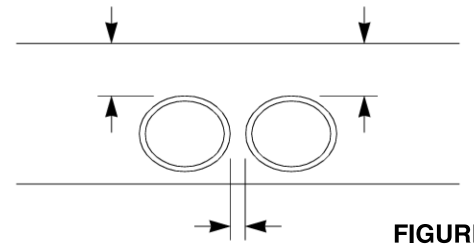


FIGURE 4-18

3. Use the following settings for the carbon arc electrode size being used:

Table 1 Carbon Arc Parameters

Electrode Size	Minimum Amperage	Maximum Amperage
5/32 in (4,0 mm)	90 amps	150 amps
3/16 in (4,8 mm)	200 amps	250 amps
1/4 in (6,4 mm)	300 amps	400 amps

4. Leave a minimum of 1/8" (3,2 mm) of material and grind the remaining material to match the existing chord profile. Take care not to damage the chord or reduce the wall thickness.
5. A cutting torch may be used to remove the lacing. Leave at least 1/4 in (6 mm) of material and grind the remaining material to match the existing chord profile. Take care not to overheat or gouge the chord when using a torch for removal.
6. Gouge marks on the chord are unacceptable. ***Stop all work if chord is damaged and contact Manitowoc Crane Care via your Manitowoc Distributor***.
7. M.T. or P.T. inspect the chord for soundness prior to fitting the new lacing.

NOTE Manitowoc recommends the N.D.T personnel be certified to A.S.N.T. Level II.

8. Remove all grease, paint and oil from the weld zone on the replacement lacing.
9. Fit and tack the new lacing using the reference marks and existing lacings on both sides for location.

The gap between the chord and lacing must not exceed 1/16 in (1,6 mm) at either end.

10. Use S.M.A.W. for tacking (Figure 4-19). All tack welds must be crack free and small enough to weld over. Use 3/32 in (2,4 mm) diameter stick electrode for tacking the lacing.
    - A total of two tack welds are to be made only in the locations shown in Figure 4-19. ***Do not tack weld toe or heel of lacing***.
    - The tacks should be 1-1/2 in (38,1 mm) long and located on the sides of the lacing.

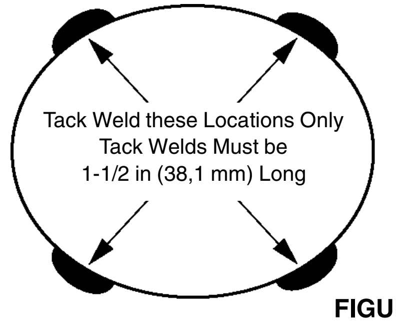


FIGURE 4-19

11. Whenever possible, welding shall be done in the horizontal position.

a. Use the following sequence for horizontal and overhead welding. The weld pass should start at the heel of the lacing and end on the toe (Figure 4-20). Pass placement will differ from the horizontal and the overhead position.

NOTE See Figure 4-24 for pass placement.

Horizontal and Overhead Welding Sequence

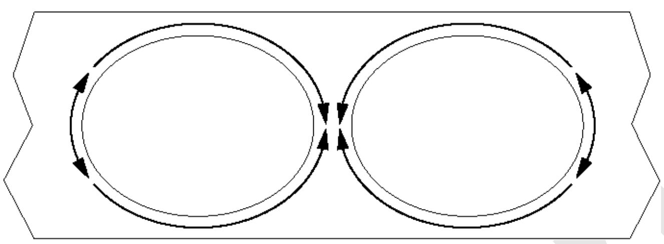


FIGURE 4-20

b. Use the following sequence for vertical welding. The weld pass shall start at the 6:00 O'clock position and end at the 12:00 O'clock position (Figure 4-21).

NOTE See Figure 4-24 for pass placement.

Vertical Welding Sequence

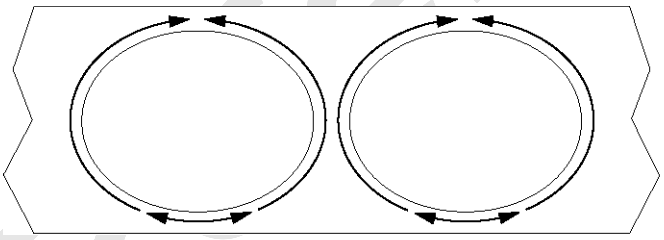


FIGURE 4-21

Weld profiles shall be smooth and blend gradually into the base metal. Undercut shall not exceed 0.010 in (0.25 mm) deep on any lacing-to-chord joint. ***No piping porosity is allowed in any weld repairs***.

12. Use the following preheat and interpass temperatures:

- Minimum of 150°F (66° C)
- Maximum of 350°F (177° C)

NOTE All welders are required to monitor minimum and maximum interpass temperatures by use of temperature sticks. Apply heat evenly to avoid spot heating any one area.

13. Use the weld size dimensions recorded during Lacing Replacement step 1 on page page 4-18 to determine the weld size for the replacement lacings. Refer to Figure 4-24 for weld size and pass placement. The finished weld must match the profile and size of the corresponding lacings.

No excessive weaving is allowed. The Maximum bead width is 5/16 in (8 mm).

14. Allow all finished welds to cool slowly to ambient temperature.

15. Visually inspect for proper workmanship and correct weld size. M.T. or P.T. inspect for soundness 48 hours after welding is completed.

Do not use the lattice section during the 48 hour wait period.

NOTE The 48 hour wait period prior to the final M.T. or P.T. inspection can be waived if welding was performed by a qualified Manitowoc representative.

Any welder that has taken and passed Manitowoc's Boom Lacing Replacement Class is considered qualified by Manitowoc.

Manitowoc recommends the N.D.T personnel be certified to A.S.N.T. Level II.

16. Prime and paint the welded area.

17. Send all completed inspection reports to Manitowoc Crane Care. If possible, digital photographs should be taken and submitted with the inspection reports.

End Lacing Replacement

End Lacings are the lacings that are closest to the connectors and run perpendicular to the chords as shown in Figure 4-22.

The end lacings hold the back-to-back and diagonal dimensions of the chords and connectors. It is critical that the original manufacturing connector tolerance be maintained. Removing these lacings without properly bracing the lattice section will make it extremely difficult to pin the repaired section to another section.

Only one lacing should be replaced at any given time to help hold the dimensions of the chords and connectors. The procedure for removing the end lacings from an insert is different from the procedure for a top or butt lattice section.

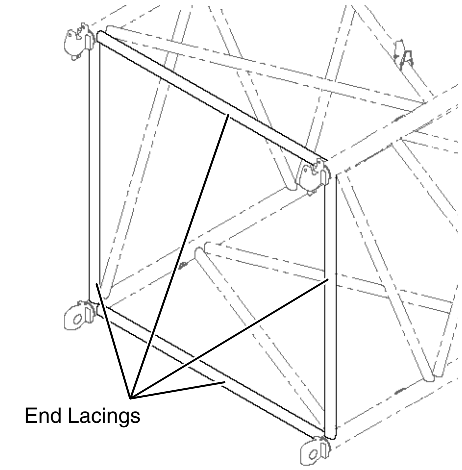


FIGURE 4-22

End Lacing Replacement on an Insert (Angle and Tubular Chords)

1. This procedure can be used for replacing the end lacing on a top or butt lattice section with angle chords.
2. Pin another lattice section to the end of the section being repaired. The connectors should be wedged over to ensure no lateral movement.
3. If another lattice section is not available, tack weld a temporary brace to the connectors parallel to the damaged lacing (see Figure 4-23).

   Care must be taken to not damage the machined surface of the connector.

   - The temporary brace will need to be strong enough to not allow the connectors to move in or out. A minimum 4 in (102 mm) by 4 in (102 mm) by 3/8 in (10 mm) angle is required.
   - The connectors shall be preheated to a minimum of 150°F (66° C) before tacking.
   - Use 3/32 in (2,5 mm) E9018-M stick electrode for tacking the temporary brace.
   - Tacks shall be 1 to 1-1/2 in (25 to 38 mm) long. The tacks shall be sound with no undercut to the connector.
   - Do not tack to any machined surfaces.
4. Use the same process for removing and replacing lacing as specified in Lacing Replacement on page page 4-18.
5. Remove the temporary bracing without damaging the connectors.

   Do not cut or gouge the connector. ***Stop all work if connector is damaged and contact Manitowoc Crane Care***.
6. Send all completed inspection reports to Manitowoc Crane Care. Digital photographs should be taken and sent with the inspection reports.

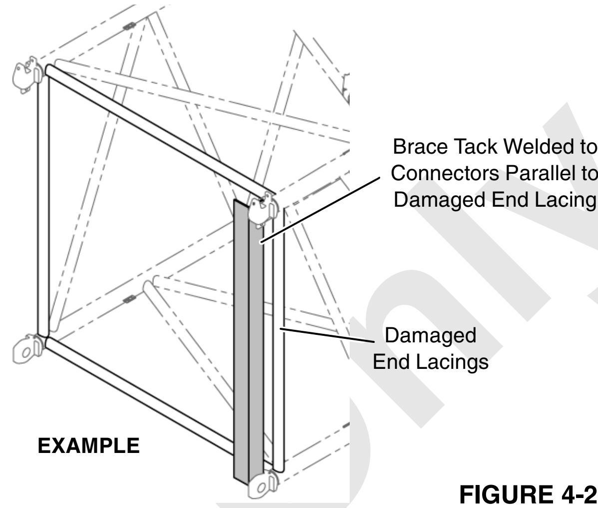


FIGURE 4-23

End Lacing Replacement on Tapered Sections (Tubular Chords)

1. This procedure applies specifically to tapered lattice sections that have tubular chords. Examples: tops, butts, and transition inserts.
2. The replacement end lacing cannot be installed into a tapered lattice section due to clearance issues with the connector. For this reason, the connectors cannot be restrained to install the replacement lacing. Therefore the section being repaired must be pinned to another section.
3. Perform Lacing Replacement steps 1-7 on page page 4-18. ***Do not replace more than one lacing at a time***.
4. The lacing must be installed and not tack welded.

   Safety Note: Make sure the lacing cannot fall out and injure someone.
5. Pin another lattice section to the end of the section being repaired. The connectors should be wedged to prevent lateral movement of the sections.
6. Only after the section is pinned to another section can the replacement end lacing be tack welded into position.
7. Perform Lacing Replacement steps 8-14 starting on page page 4-18.
8. Send all completed inspection reports to Manitowoc Crane Care. Digital photographs should be taken and sent with the inspection reports.

Lacing Removal — Boom Section with a Bent or Bowed Chord Member

1. This procedure applies to all lattice sections that have a bent/bowed chord member. Perform the Chord Straightness inspection on page page 4-12 to determine if the chord is out of allowable tolerance.
2. Bent or bowed chords in a lattice section are typically the result of some form of structural damage such as kinked lacings. Perform a thorough inspection of the lacings and identify the lacings that will need to be replaced.
3. Remove all of the damaged lacings by performing Lacing Replacement steps 1-7 on page page 4-18. It may be necessary to remove more than one lacing to straighten the chord.

NOTE Pin another lattice section to the end of the section being repaired or install a temporary brace if replacing an end lacing.

4. Check the chord for straightness after removing the damaged lacings.

   It may be necessary to manipulate the chord to achieve the desired results: use a pipe and a jack to move the chord out or a lever-operated hoist to bring the chord in.

   Check the back-to-back dimensions to the inside of the chord on an insert.
5. Remove all grease, paint and oil from the weld zone on the replacement lacing.
6. Fit and tack weld all of the new lacings. Use the reference marks and any existing lacings on both sides of the section to properly locate the new lacings.

   All of the lacings should be tack welded before welding is started.
7. Perform Lacing Replacement steps 8-14 starting on page page 4-18.
8. Send all completed inspection reports to Manitowoc Crane Care. Digital photographs should be taken and submitted with the inspection reports.

Determining Amount of Stick Electrode Needed

Use the following formula to determine approximately how much stick electrode (weld metal) is needed to replace lacings. Actual use could be higher or lower depending on a number of factors outside of Manitowoc's control, such as over or under welding, damaged electrodes, length of discarded electrode stubs, etc.

$$W=2F^2DL$$

- **W** = amount of weld metal that should be ordered (in pounds)
- **F** = required filet weld leg size (in inches)
- **D** = lacing tube diameter (in inches)
- **L** = number of lacings being replaced (quantity)

EXAMPLE: If ten 4-1/2 in diameter lacings will be replaced and a 3/8 in fillet weld is required —

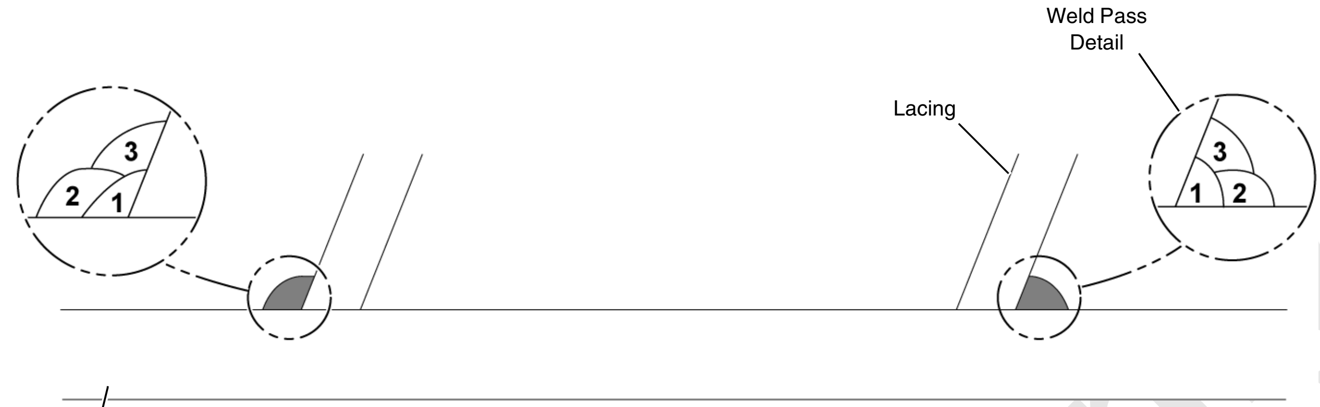
$$W = 2 \times F^2 \times D \times L$$

$$W = 2 \times 0.375^2 \times 4.50 \times 10$$

W = 12.7 lb

Stick electrode can be ordered from your Manitowoc distributor in hermetically sealed foil packs using the following parts numbers:

E9018M-H4 Electrode Size	Quantity	Part Number
1/8 in (3,2 mm)	4.4 lb Package	409758
3/32 in (2,5 mm)	3.0 lb Package	409759

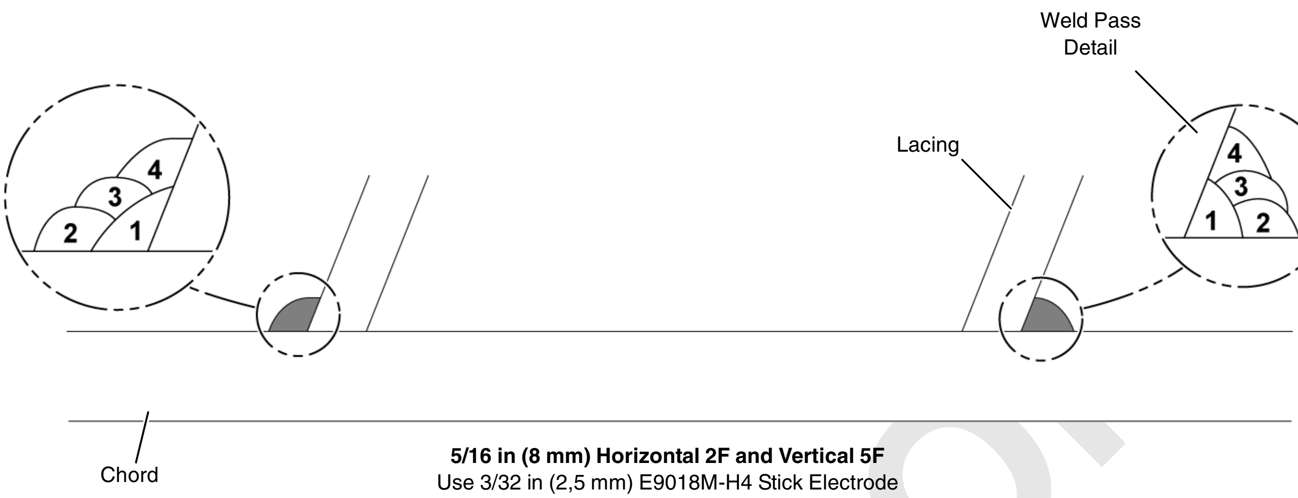


1/4 in (6 mm) Horizontal 2F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode

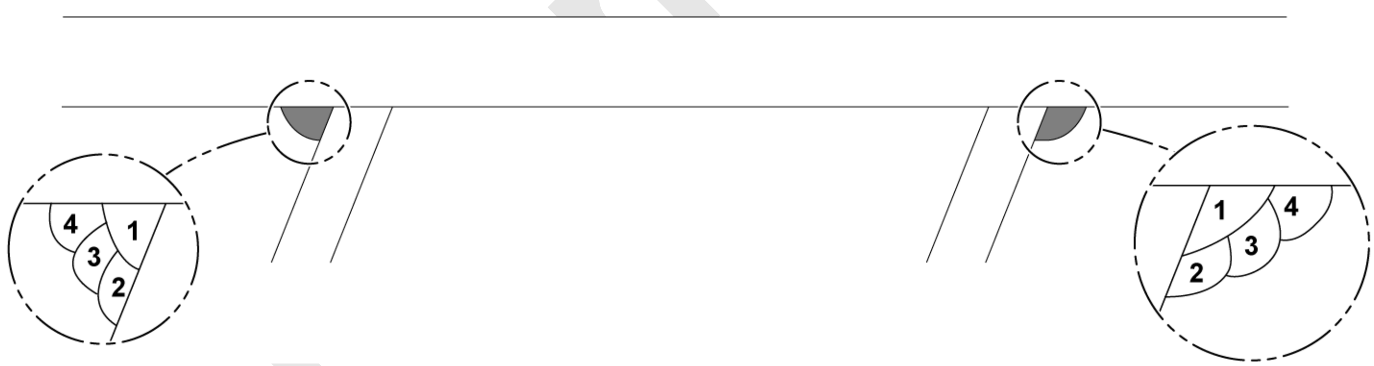
1/4 in (6 mm) Vertical 5F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode

1/4 in (6 mm) Overhead 4F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode

FIGURE 4-24

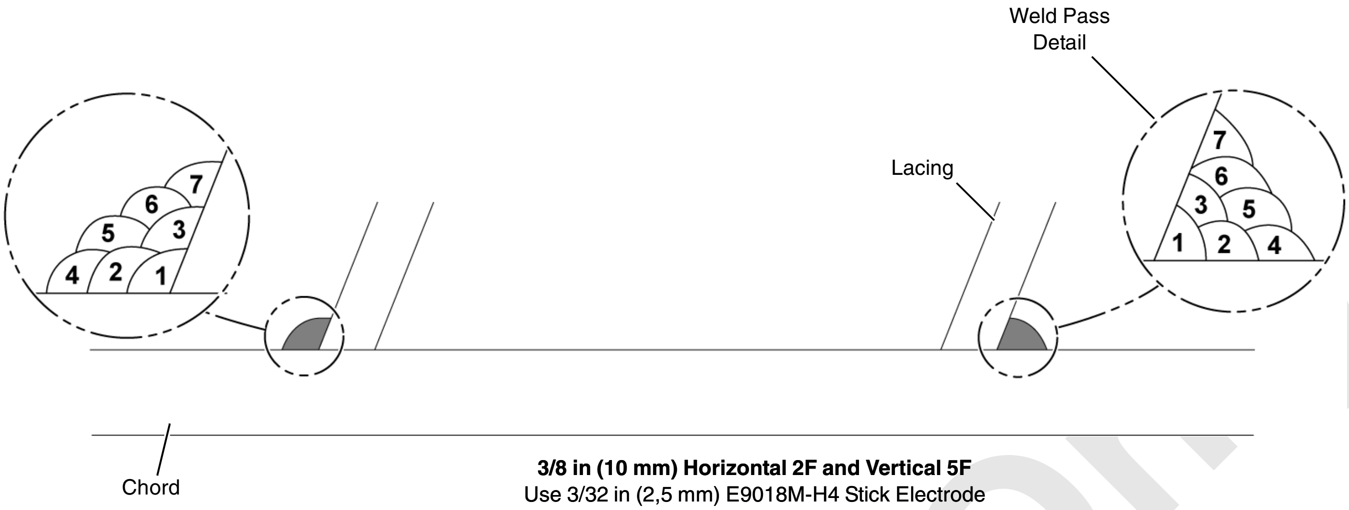


5/16 in (8 mm) Horizontal 2F and Vertical 5F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode

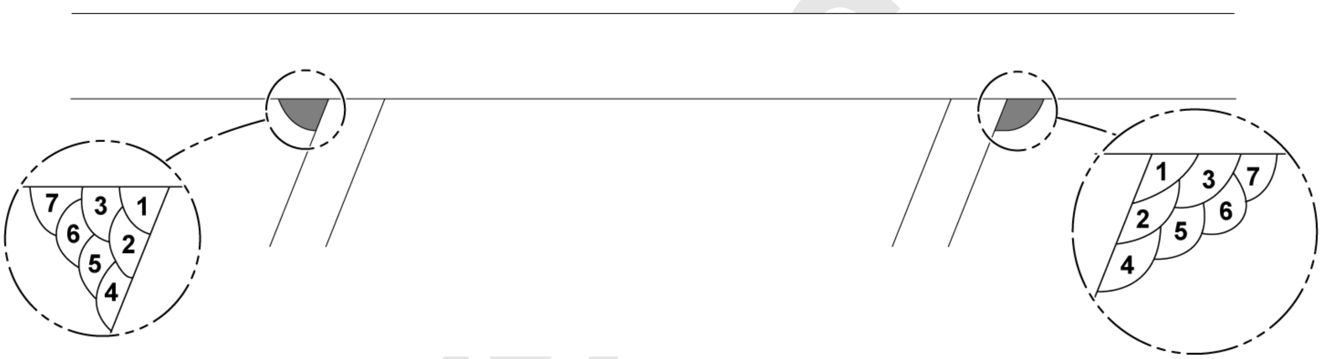


5/16 in (8 mm) Overhead 4F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode

FIGURE 4-24 continued

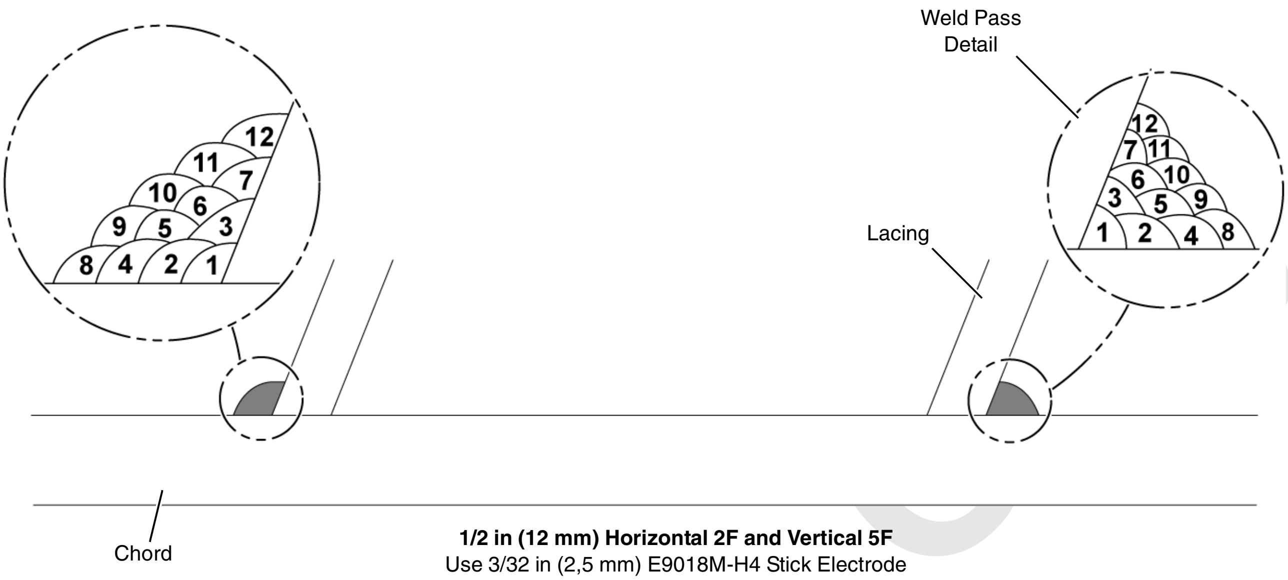


3/8 in (10 mm) Horizontal 2F and Vertical 5F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode
OR
1/8 in (3,2 mm) E9018M-H4 Stick Electrode

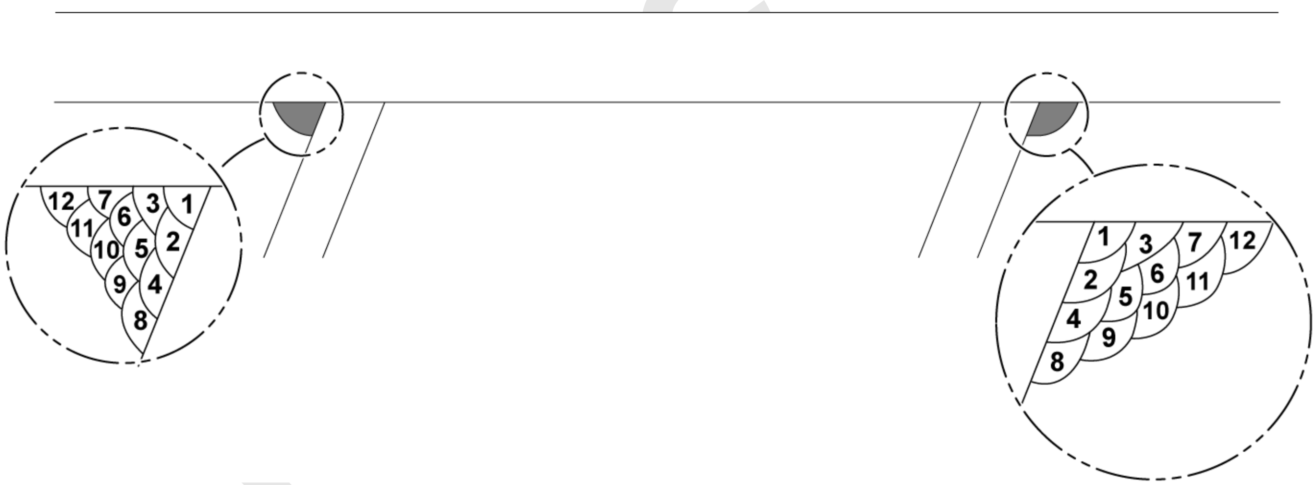


3/8 in (10 mm) Overhead 4F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode
OR
1/8 in (3,2 mm) E9018M-H4 Stick Electrode

FIGURE 4-24 continued



1/2 in (12 mm) Horizontal 2F and Vertical 5F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode
OR
1/8 in (3,2 mm) E9018M-H4 Stick Electrode



1/2 in (12 mm) Overhead 4F
Use 3/32 in (2,5 mm) E9018M-H4 Stick Electrode
OR
1/8 in (3,2 mm) E9018M-H4 Stick Electrode

FIGURE 4-24 continued

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INSPECTION CHECKLIST

Use the following checklist to record any damage found while inspecting lattice sections.

If no damage is found or the damage is within the allowable criteria, check the box next to the item to indicate that the section is okay.

If the damage is not within the allowable criteria, indicate so in the box next to the item — for example: **D** to indicate damage. Then make a detailed report of the type and degree of damage found. Space is provided for drawing sketches or attaching photographs.

It is recommended that damaged areas be marked for quick identification by repair personnel. Brightly colored tape works well for this purpose. As a reminder, the type of defect can be noted on the tape.

WARNING

If damage found that is not within allowable criteria, do not operate crane until appropriate lattice section has been properly repaired or replaced.

Operating crane with damaged lattice sections can result in structural failure or collapse of attachment.

RECORD KEEPING

A separate copy of this checklist must be filled out for the boom, jib, tower, and mast on each crane you own.

Signed and dated copies of completed checklists must be kept on file at all times, as they may be required to verify warranty or product liability claims.

Inspector's Name __________ **Signature** __________ **Date** __________

BUTT: Manufacturing Code __________ Part Number __________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

TOP: Manufacturing Code __________ Part Number __________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length ________ft Manufacturing Code __________ Part Number __________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length ________ft Manufacturing Code __________ Part Number __________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length ________ft Manufacturing Code ________________ Part Number ______________

Dents ☐ Bends ☐ Kinks ☐ Cracks ☐ Breaks ☐

Corrosion ☐ Abrasion ☐ Straightness ☐ Welds ☐ Other ☐

Insert: Length ________ft Manufacturing Code ________________ Part Number ______________

Dents ☐ Bends ☐ Kinks ☐ Cracks ☐ Breaks ☐

Corrosion ☐ Abrasion ☐ Straightness ☐ Welds ☐ Other ☐

Insert: Length ________ft Manufacturing Code ________________ Part Number ______________

Dents ☐ Bends ☐ Kinks ☐ Cracks ☐ Breaks ☐

Corrosion ☐ Abrasion ☐ Straightness ☐ Welds ☐ Other ☐

Insert: Length ________ft Manufacturing Code ________________ Part Number ______________

Dents ☐ Bends ☐ Kinks ☐ Cracks ☐ Breaks ☐

Corrosion ☐ Abrasion ☐ Straightness ☐ Welds ☐ Other ☐

Insert: Length ________ft Manufacturing Code ________________ Part Number ______________

Dents ☐ Bends ☐ Kinks ☐ Cracks ☐ Breaks ☐

Corrosion ☐ Abrasion ☐ Straightness ☐ Welds ☐ Other ☐

Insert: Length ________ft Manufacturing Code ________________ Part Number ______________

Dents ☐ Bends ☐ Kinks ☐ Cracks ☐ Breaks ☐

Corrosion ☐ Abrasion ☐ Straightness ☐ Welds ☐ Other ☐

NOTES

DRAW SKETCHES OR ATTACH PHOTOGRAPHS HERE AND NEXT PAGE

SECTION 5
HOISTS

Table of Contents

5

SECTION 5
HOISTS

HOIST DRAWINGS

Applicable hoist and load block drawings are attached at the end of this Section.

MINIMUM BAIL LIMIT ADJUSTMENT

The minimum bail limit assembly is a protective device. It automatically stops the corresponding load drum from lowering when there are three to four wraps of wire rope remaining on the drum.

The drum can be operated in the ***hoist*** direction when the minimum bail limit is contacted.

⚠ WARNING

Falling Load Hazard!

Do not operate auxiliary load drum with less than three full wraps of wire rope remaining on drum. Doing so can cause wire rope to be pulled out of drum and load to drop.

Weekly Maintenance

See Figure 5-2 for following procedure.

1. Check for proper operation of minimum bail limit assembly, as follows:

   a. Land load.

   b. Pay out wire rope from auxiliary drum.

   c. Load drum must stop when there are three to four wraps of wire rope remaining on drum.

2. Check that cap screws holding rollers on bail limit lever are tight.

3. Check tension of return spring. If necessary, adjust eyebolt so spring holds bail limit rollers snugly against bare drum.

Wire Rope Removal

To remove wire rope from any load, activate limit bypass switch on front console in cab. This action allows the drum to be operated in the ***lower*** direction when the minimum bail limit is contacted.

Electric Wiring

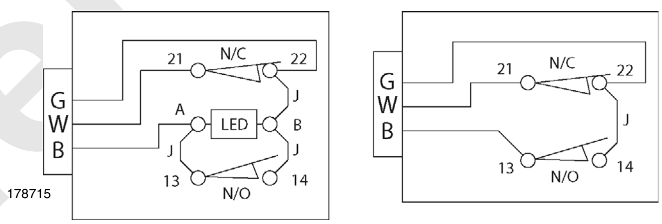
See the Electric Schematic at the end of Section 3 of this manual.

Past production limit switches have a light (LED) that indicates proper operation as follows:

- Light ***on*** — limit switch closed (normal operation).
- Light ***off*** — limit switch open (drum stopped in lowering direction).

See Figure 5-1 for limit switch wiring.

LIMIT SWITCH WIRING

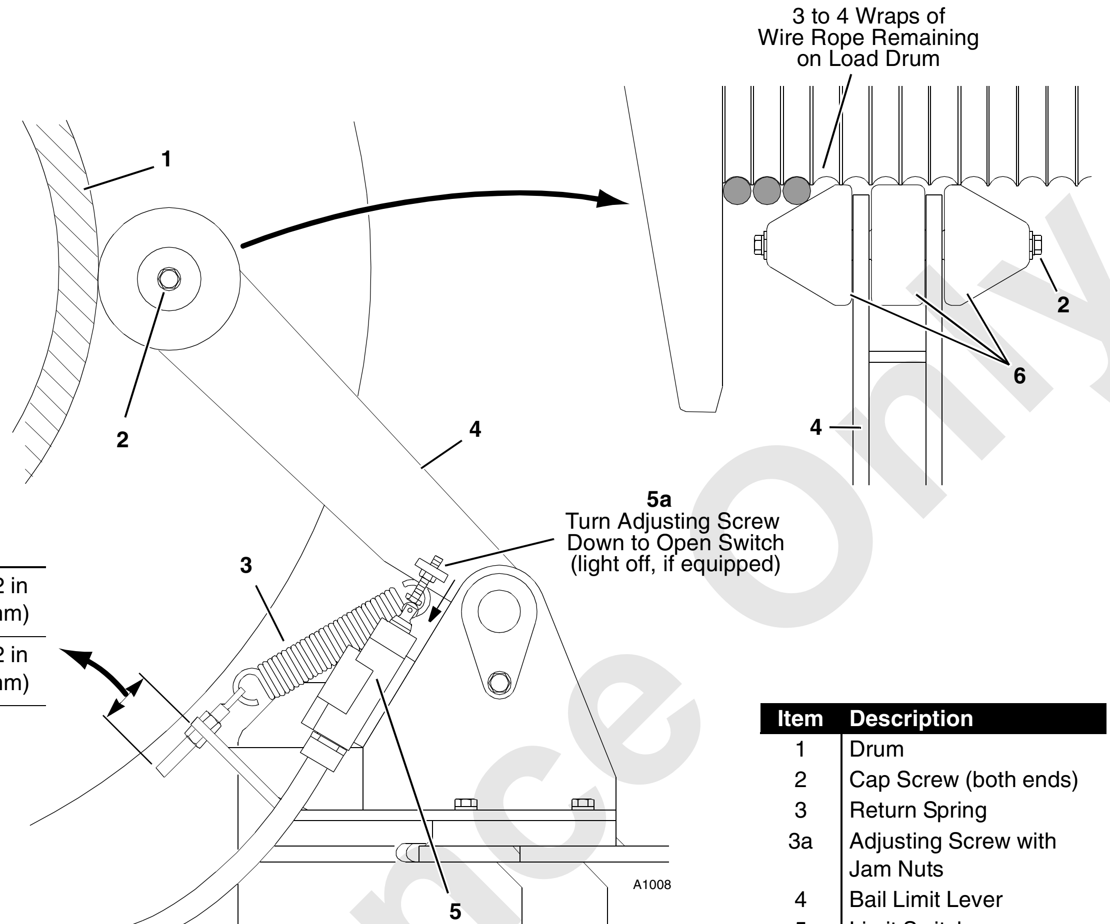


Past Production

Current Production

N/C = Normally Closed
N/O = Normally Open
B = Black Wire
G = Green Wire
W = White Wire
J = Jumper Wire

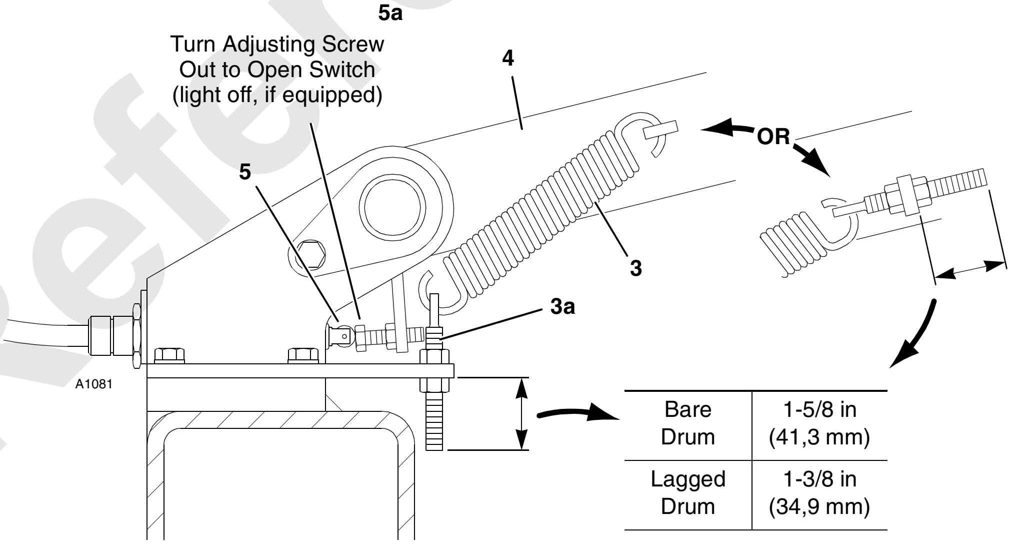
FIGURE 5-1



Bare Drum	1-21/32 in (42,1 mm)
Lagged Drum	1-15/32 in (37,3 mm)

View at Front Drum
(Rear Drum Similar

Item	Description
1	Drum
2	Cap Screw (both ends)
3	Return Spring
3a	Adjusting Screw with Jam Nuts
4	Bail Limit Lever
5	Limit Switch
5a	Adjusting Screw with Jam Nut
6	Bail Limit Rollers



Bare Drum	1-5/8 in (41,3 mm)
Lagged Drum	1-3/8 in (34,9 mm)

View at Auxiliary Drum

FIGURE 5-2

Adjustment

See Figure 5-2 for following procedure.

1. *Land load* for drum being adjusted.
2. Loosen jam nut on adjusting screw and turn screw away from lever so screw does not contact switch when step 3 is performed.
3. Pay out wire rope until bail limit rollers are against bare or lagged drum with three full wraps of wire rope remaining on drum.
4. Turn adjusting screw against limit switch roller only enough to “click” limit switch open (light off, if equipped).
5. Securely tighten jam nut on adjusting screw to lock adjustment.
6. Adjust return spring eyebolt to dimension shown.
7. Spool six to seven wraps of wire rope onto load drum.

   Pay out wire rope from load drum. Drum must stop when there are three to four wraps of wire rope remaining on drum.
8. If necessary, repeat adjustment.

BLOCK-UP LIMIT INSTALLATION AND ADJUSTMENT

A block-up limit control (also called anti two-block device) is a two-blocking prevention device which automatically stops the load drum from hoisting and the boom from lowering when a load is hoisted a predetermined distance.

DEFINITION: Two-blocking is the unsafe condition in which the load block or the weight ball contacts the sheave assembly from which either is suspended.

Two-blocking can result in failure of sheaves and wire rope, possibly causing load to fall.

WARNING

Two-Blocking Hazard!

Block-up limit control is a protective device designed only to assist operator in preventing a two-blocking condition; any other use is neither intended nor approved.

Block-up limit control may not prevent two-blocking when load is hoisted at maximum single line speed. Operator must determine fastest line speed that allows block-up limit control to function properly and not exceed that line speed.

The block-up limit controls consist of the following components (see Figure 5-3):

1. Normally closed limit switch assembly fastened at any or all of the following locations (multiple limit switches are wired in series):
   a. Lower boom point.
   b. Upper boom point.
   c. Fixed jib point.
   d. Luffing jib point.
   e. Universal anchor joint.
2. Weight freely suspended by chain from each limit switch actuating lever (weight encircles load line as shown in Figure 5-4).
3. Lift block clamped to single-part load line or lift plates fastened to multiple-part load block.

Operation

See Figure 5-3 and Figure 5-8 for component identification.

NOTE: See wiring diagrams Boom Wiring, Limits, and Load Indicator Electrical Assembly drawings at end of this section.

Block-Up Limit Control Deactivated

During normal operation, the weight overcomes the spring force and rotates the actuating lever away from the limit switch lever. This action allows the limit switch to close the load drum ***up*** and boom/luffing jib ***down*** electric circuits. The load can be hoisted and the boom/luffing jib can be lowered.

Block-Up Limit Control Activated

When the weight is lifted by the lift block or the lift plates, spring force rotates the actuating lever against the limit switch lever. This action causes the corresponding limit switch to open the load drum ***up*** and boom/luffing jib ***down*** electric circuits.

The load drum and boom hoist pumps stroke to off. At the same time, the load drum and boom/luffing jib parking brakes apply to stop the load drum from hoisting and the boom/luffing jib from lowering.

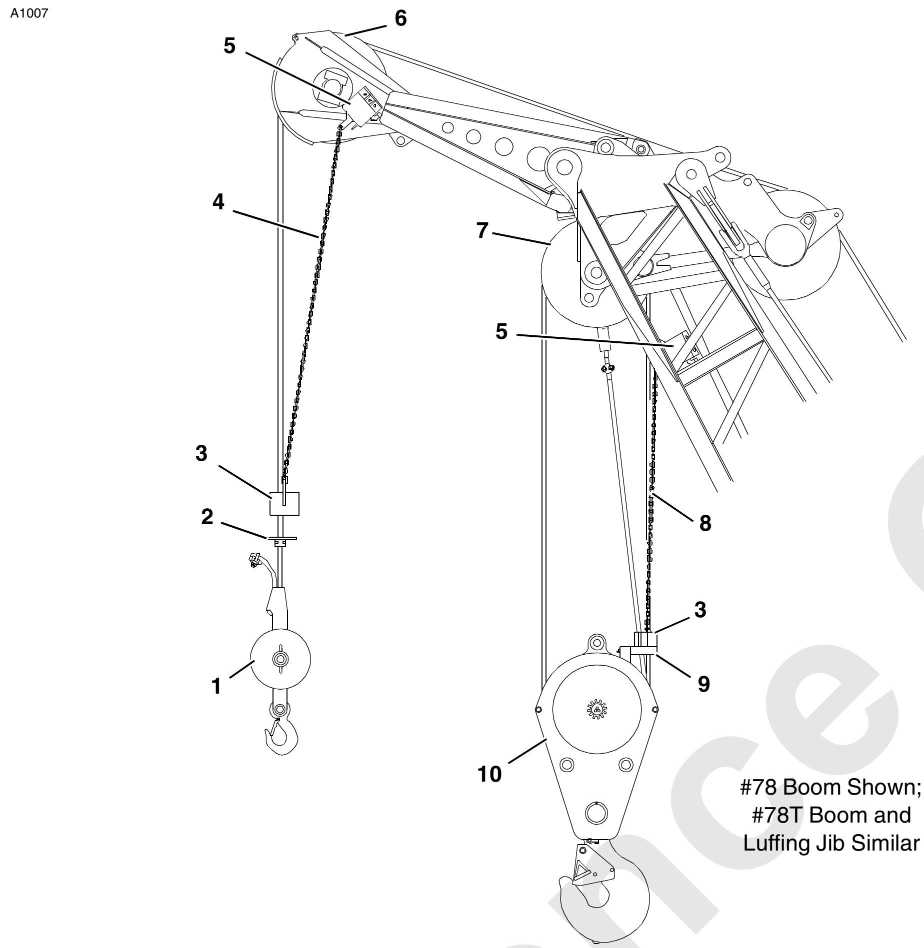
Installation

The block-up limit control must be installed according to Boom Wiring, Limits and Load Indicator Electrical Assembly drawings.

Securely fasten the electric cords to the boom and jib with the metal straps and nuts provided.

When there is more than one block-up limit switch, ***wire limit switches in series***. Connect the electric wires to the normally-closed contacts inside each limit switch.

See Figure 5-4 for installation of the weights.



Item	Description
1	Weight Ball
2	Lift Block
3	Weight
4	Chain - 8 ft (2.4 m)
5	Limit Switch Assembly
6	Upper Boom Point
7	Lower Boom Point
8	Chain - 8 ft (2.4 m)
9	Lift Plate
10	Load Block

FIGURE 5-3

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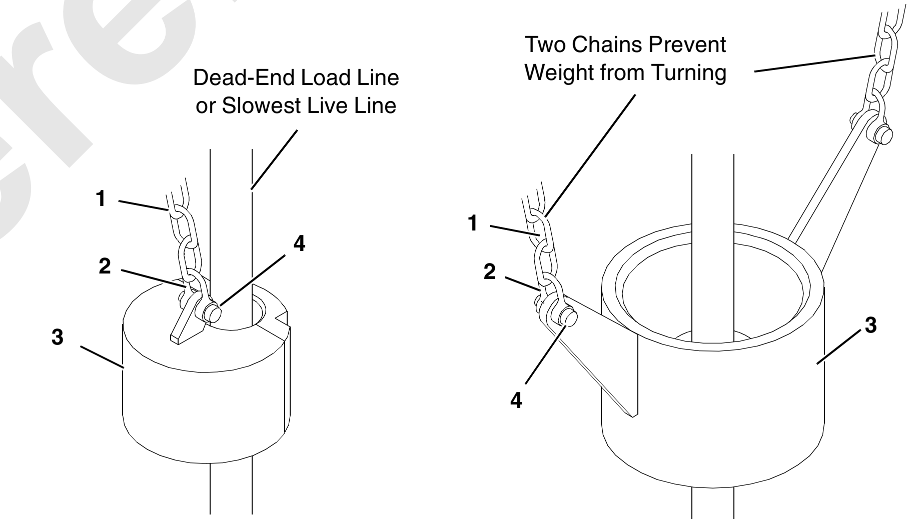
See Load Block Reeving drawing for Suggested Location of Weight

Item	Description
1	Chain
2	Shackle
3	Weight
4	Connecting Pin



Lower Boom Point (multiple part),
Lower Boom Point (two lines over point),
Universal Anchor Joint, or
Luffing Jib Point (multiple part)

Fixed Jib Point,
Upper Boom Point,
Luffing Jib Point (single part), or
Lower Boom Point (single part)

FIGURE 5-4

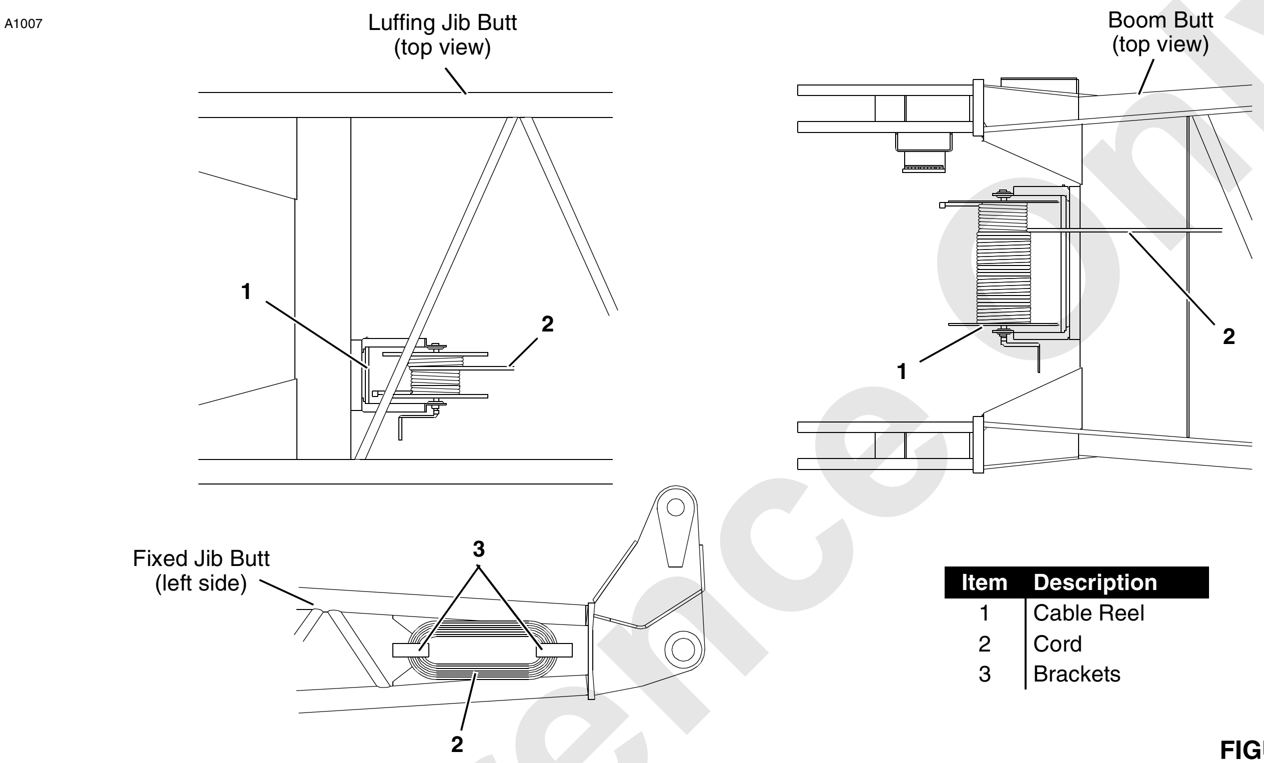
Storing Electric Cable

See Figure 5-5 for component identification.

The electric cords for the boom, fixed jib, and luffing jib are long enough to accommodate the maximum length of each attachment.

Store the excess cords for the boom and luffing jib on the reel mounted on either butt. The reel has a locking pin. Disengage the locking pin to allow the reel to be wound. Engage the locking pin to lock the reel in position. The power supply cord to the reel must be disconnected before the reel can be wound.

Store the excess electric cord for the fixed jib by winding it around the brackets on the fixed jib butt.



Item	Description
1	Cable Reel
2	Cord
3	Brackets

FIGURE 5-5

	Description
	Cable Reels
CR1	Cable Reel on Boom Butt
CR2	Cable Reel on Luffing Jib Butt
	Electric Cords
C1	Cord from Main Junction Box Behind Operator's Cab
C2	Cord to Cable Reel on Boom Butt
C3	Cord from Cable Reel on Boom Butt
C4	Cord to Boom Top Junction Box (JB3)
C5	Cord to Upper Boom Point Limit Switch
C6	Cord to Lower (or Lower Right) Boom Point Limit Switch
C7	Cord from Boom Top Adapter Junction Box
C8	Cord to Luffing Jib Cable Reel or Fixed Jib Cable
C9	Cord from Luffing Jib Cable Reel or Fixed Jib Cable
C10	Cord to Lower Jib Point Limit Switch
C11	Cord to Upper Jib Point Limit Switch
C12	Cord to Boom Top Junction Box (JB5)
C13	Cord to Lower Left Boom Point Limit Switch
	Junction Boxes
JB1	Boom Junction Box (on Rotating Bed)
JB2	Boom Top Adaptor Junction Box
JB3	Boom Top Junction Box (Heavy Lift Top)
JB4	Jib Top Junction Box
JB5	Boom Top Junction Box (Heavy Lift Top)
JB6	Boom Top Junction Box (Long Reach Top)

Item	Description
	Limit Switches
LS1	Upper Boom Point Limit Switch
LS2	Lower Boom Point Limit Switch
LS3	Lower Jib Point Limit Switch
LS4	Lower Boom Point Left Limit Switch
LS5	Lower Boom Point Right Limit Switch
LS6	Upper Jib Point Limit Switch
	Shorting Plugs
SP1	Block-Up Limit System
SP2	Upper Boom Point Shorting Plug
SP3	Lower (or Lower Right) Boom Point Shorting Plug
SP4	Lower Jib Point Shorting Plug
SP5	Upper Jib Point Shorting Plug
SP6	Lower Left Boom Point Shorting Plug
	Miscellaneous
M1	Luffing Jib Angle Sensor Shorting Plug
M2	Luffing Jib Minimum Angle Shorting Plug
M3	Luffing Jib Maximum Angle Shorting Plug
M4	Cord from Luffing Jib Maximum Angle Limit
M5	Cord from Luffing Jib Minimum Angle Limit
M6	Cord to Luffing Jib Angle Sensor
M7	Cord to Jib or Luffing Jib Load Indicator Sheave
M8	Cord from Lower Boom Point Load Indicator Sheave
M9	Cord from Upper Boom Point Load Indicator Sheave

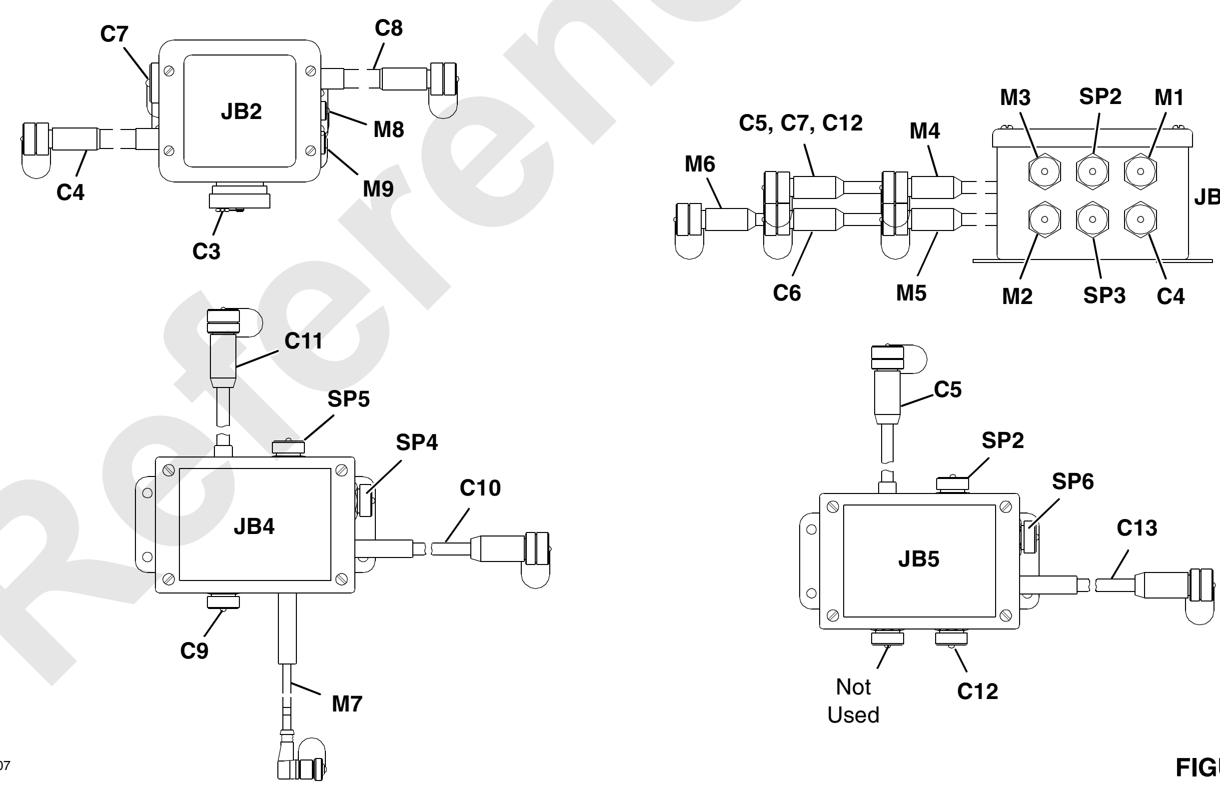
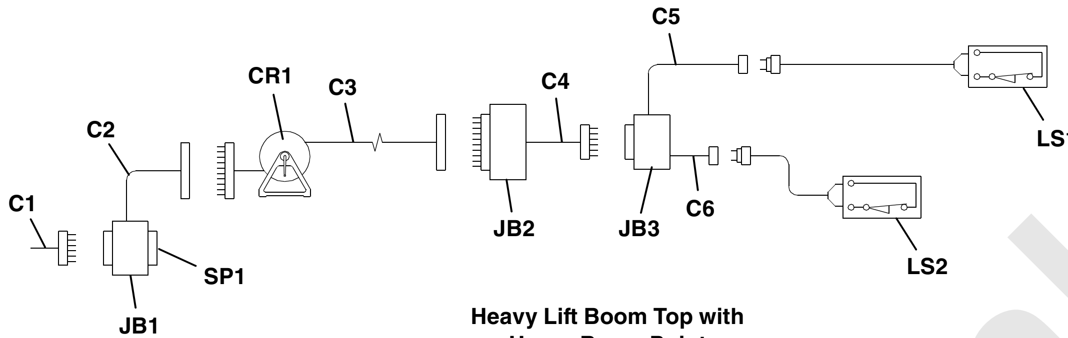
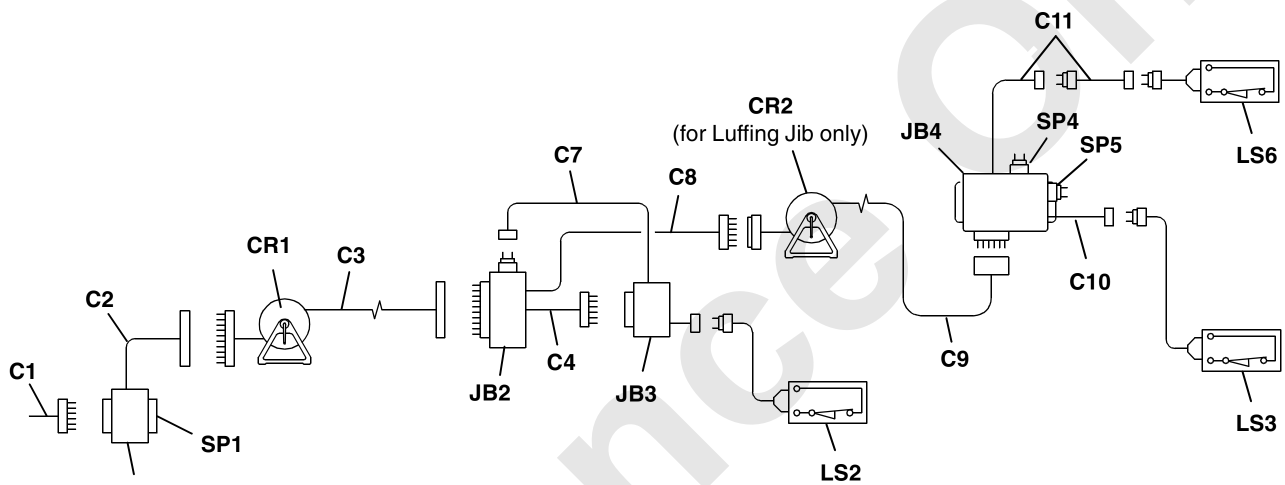


FIGURE 5-6

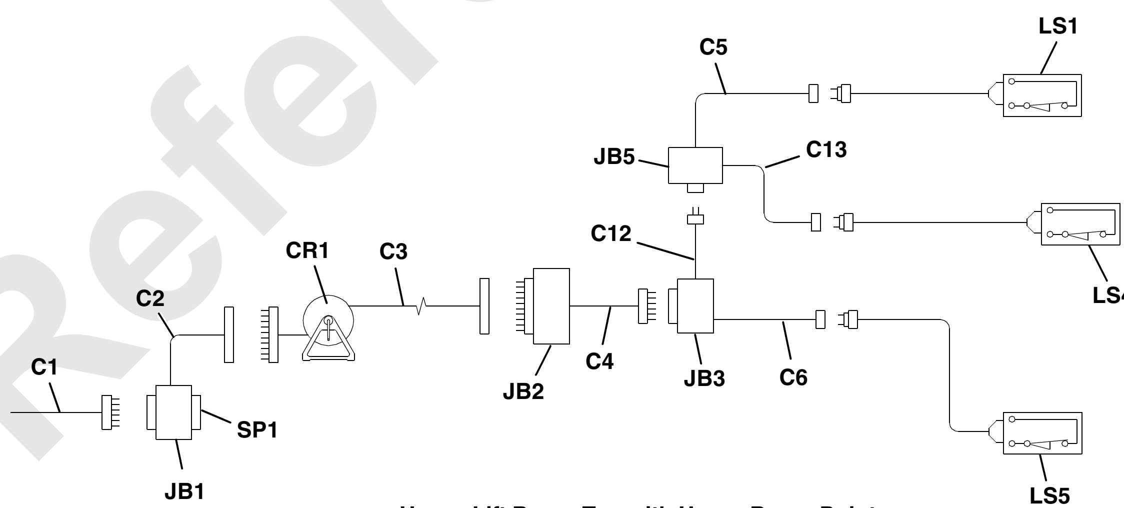
5



Heavy Lift Boom Top with Upper Boom Point



Heavy Lift or Long Reach Boom Top with Fixed Jib or Luffing Jib or Fixed Jib on Luffing Jib



Heavy Lift Boom Top with Upper Boom Point and Two Load Lines Over Lower Point

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FIGURE 5-6 continued

Disconnecting Block-Up Limit Control

See Figures 5-6 and 5-7 for identification of the electric cords and shorting plugs.

Shorting plug SP1 is provided on the left front corner of rotating bed so the block-up limit controls can be disconnected for the following reasons:

- Crane setup and rigging.
- Maintenance.
- Operations not requiring use of a block-up limit control (clamshell and drag-line).

To disconnect the block-up limit controls, proceed as follows:

1. Disconnect electric cord (C2) from cable reel (CR1).
2. Remove the closure cap from shorting plug (SP1).
3. Connect electric cord (C2) to shorting plug (SP1).
4. Reverse the steps to reconnect the block-up limit control.

Removing Jib or Boom Point

See Figures 5-6 and 5-7 for identification of the electric cords and shorting plugs.

The junction boxes on the boom and luffing jib points have shorting plugs.

If the fixed jib point, upper boom point, or luffing jib point has a block-up limit switch, the electric cord from the limit switch must be connected to the proper shorting plug when the corresponding attachment is removed.

Failing to perform this step will prevent the load drum from hoisting and the boom from lowering. Also the operating limit alert will come on.

Be sure to reconnect electric cord to proper block-up limit switch when corresponding attachment is reinstalled.

FIGURE 5-7

Maintenance

See Figure 5-8 for following procedure

Inspect and test the block-up limit controls ***weekly*** or ***every 40 hours of operation***, as follows:

CAUTION

Do not operate crane until cause for improper operation and all hazardous conditions are found and corrected.

---

1. Lower the boom onto blocking at ground level and carefully inspect the following items:
   - **a.** Inspect each limit switch lever and actuating lever for freedom of movement. Apply one-half shot of grease to the fitting on the actuating lever. Wipe away any excess grease.
   - **b.** Inspect each weight for freedom of movement on the load line.
   - **c.** Inspect each weight, each chain, each shackle and each connecting pin for excessive or abnormal wear. Make sure cotter pins for shackles are installed and spread.
   - **d.** Inspect the entire length of electric cords for damage.
   - **e.** Check that the electric cords are clear of all moving parts on the boom and jib and that the cords are securely fastened to the boom and jib with metal straps.
   - **f.** Check that all plugs are securely fastened.
2. Test the block-up limit controls for proper operation using either of the following methods:
   - **a.** BOOM LOWERED: Manually lift each weight — ***one at a time*** — while the engine is running. The load drum should not operate in the ***hoist*** direction and the boom/luffing hoist should not operate in the ***lower*** direction.
   - **b.** BOOM RAISED: ***Slowly*** hoist each load block and weight ball — ***one at a time*** — against the weight. When the chain goes slack, the corresponding load drum should stop hoisting and the boom/luffing hoist should not operate in the lower direction.

CAUTION

Use extreme care when testing block-up limit controls when boom is raised. If block-up limit control fails to stop load, immediately stop load by moving drum control handle to off or by applying drum working brake; otherwise, two-blocking may occur.

5

Adjustment

See Figure 5-8 for following procedure.

Lower the boom onto blocking at ground level and adjust each limit switch as follows:

1. Adjust spring tension so there is enough force to lift the weight of the chain and rotate the actuating lever when the weight is lifted.
2. Loosen the setscrew in the limit switch lever so the lever is free to rotate.
3. Manually lift the weight to allow the actuating lever to rotate upward.
4. Hold lever at Dimension A.
5. Hold the roller on the limit switch lever against the actuating lever while performing step 6
6. Turn the limit switch shaft ***clockwise*** only enough to click limit switch open and hold. Then securely tighten the setscrew in the limit switch lever.

Test the limit switch for proper operation (see Maintenance); repeat the adjustment steps until the limit switch operates properly.

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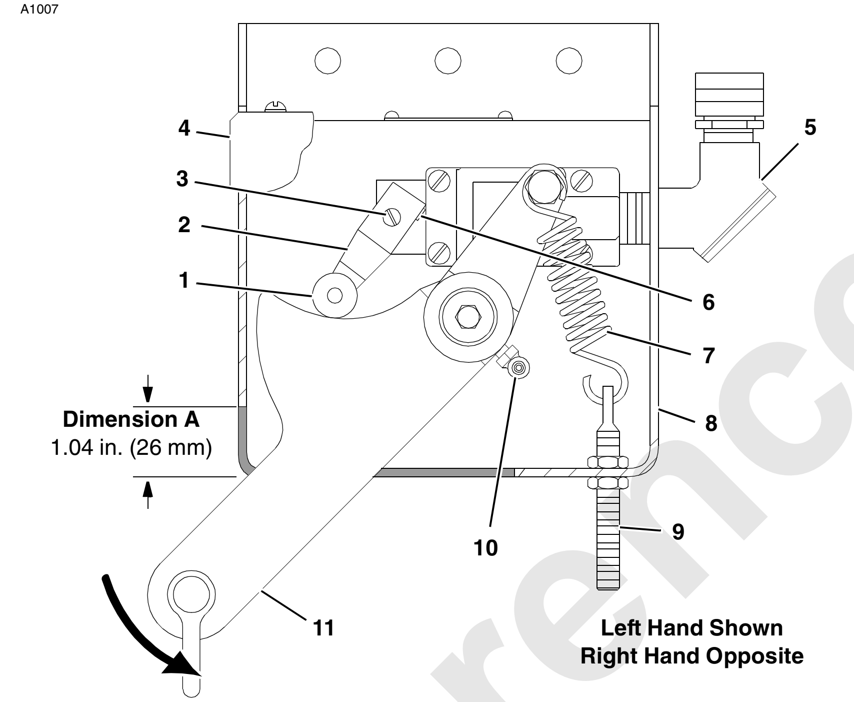

Item	Description
1	Roller
2	Limit Switch Lever
3	Shaft
4	Cover
5	Elbow with Cable Gripper
6	Setscrew
7	Spring
8	Enclosure
9	Adjusting Screw (spring tension)
10	Grease Fitting
11	Actuating Lever

FIGURE 5-8

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DRUM BRAKE ADJUSTMENT

Two types of brakes are provided on right end of both load drums:

- An external, contracting, band-type brake (wrapped around drum flange) and an actuator. See Figure 5-12.
- A disc brake between drive motor and planetary.

NOTE: If your crane has optional high line pull drum, brakes identical to those on right end of drum are also mounted on left end of drum.

Full-Power Operation (Free Fall Off)

Band and disc brakes operate automatically in conjunction with operation of load drum control handles:

- When a drum control handle is moved in either direction from off to hoist or lower a load, corresponding band and disc brakes are hydraulically released.
- When drum control handle is returned to off, band and disc brakes are spring applied to stop drum and hold the load in position.

Free Fall Operation (Optional)

Automatic operation of band brakes is turned off:

- When a drum control handle is moved in either direction from off to hoist or lower a load, corresponding band brake must be manually released with foot pedal to allow drum to turn.
- When drum control handle is returned to off, corresponding band brake must be manually applied with foot pedal to stop drum and hold the load in position. Braking control is variable, from fully applied to fully released, depending on position of the foot pedal.

Automatic operation of disc brakes remains on:

- When a drum control handle is moved in either direction from off to hoist or lower a load the corresponding disc brake is hydraulically released to allow the drum to turn.
- When drum control handle is returned to off the disc brake is spring applied. The brake prevents motor side of drive from turning until free fall clutch is fully engaged before hoisting or lowering a load.

WARNING

Personnel Injury Hazard!

Brake inspection and adjustment, requires two people: one to operate drum brakes and one to perform inspection and adjustment steps. Steps are performed with engine running. Maintain constant communication between operator and adjuster so load drums are not operated while adjuster is in contact with parts.

- Lower all loads to ground so load lines are slack. Keep loads on ground for all inspection and adjustment steps.
- Adjuster, avoid injury from moving machinery. Stay clear of all moving parts while drum brakes are being operated.
- Operator, make sure load drum handles are in off position while inspection and adjustment steps are performed. Do not operate drum brakes until adjuster is clear of moving parts.

NOTE: Disc brakes are not adjustable. See Disc Brake Operational Test in Section 2 of this manual for testing and servicing instructions.

Brake Inspection

See Figure 5-12 for following procedure.

1. Inspect all pins and linkage for excessive wear; replace parts as required. Excessively worn pins and linkage make it difficult to obtain proper drum-to-lining clearance.
2. Lubricate pins in linkage with a few drops of engine oil. Lubricate grease fittings according to Lubrication Guide.
3. With drum brakes applied, check each brake for proper adjustment at drum brake adjustment indicator (Figure 5-12, View B). Check adjustment when linings are cold for liftcrane work or warm from operation for duty-cycle work.
   - As brake lining wears, leading edge of spring sleeve inside brake actuator moves closer to end of actuator.
   - Readjust brake when leading edge of spring sleeve reaches line at end of ***safe working range*** on adjustment indicator.

   The SAFE WORKING RANGE is 3/8 in. (9.5 mm) wide.

WARNING

Falling Load Hazard!

Do not operate crane if leading edge of spring sleeve is past line at end of ***safe working range*** on adjustment indicator. Brake will not provide proper braking torque, and load may lower through brake.

4. Cranes with free fall, check each foot pedal latch and latch bar for wear (Figure 5-9). Pedal latch must securely hold pedal down in fully applied position.

WARNING

Falling Load Hazard!

Do not operate crane if any pedal latch is not operating properly. Pedal could unlatch, allowing a suspended load to fall.

Item	Description
1	Jam Nut
2	Free-Play Adjusting Screw
3	Pedal
4	Latch
5	Latch Bar
6	Valve

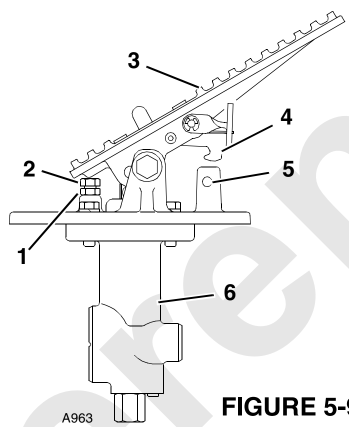


FIGURE 5-9

5. Thoroughly inspected the brake bands for cracks and corrosion when the bands are removed for relining. This inspection procedure also applies to band assemblies that are received in exchange for bands that were removed for relining.

   The inspection method shall include non-destructive testing — magnetic particle (MT) or ultrasound (UT).

   The primary area to inspect is the dead-end attachment area on the band (see Figure 1).

   If there is evidence of cracks or 10% reduction in area due to corrosion, destroy and discard the band and replace with it a new band or a band that has passed non-destructive test/inspection. Contact your Manitowoc dealer for brake band thickness. Please have the band part number available at the time of the request.

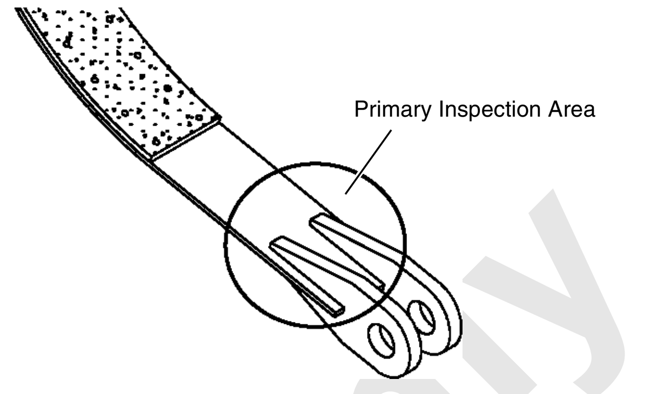


FIGURE 5-10

Brake Adjustment

To prevent injury when adjusting brakes, operator and adjuster must observe all safety precautions following Safety heading.

Brake adjustment requires corresponding load drum to be in STANDARD mode with FREE FALL OFF (optional). Detailed procedures for selecting operating modes are in Operating Controls in Section 3 of Crane Operator's Manual.

The actuator must be disconnected from brake band to adjust brake. The actuator's total weight is 260 lb (118 kg). ***A means of supporting the actuator when it is disconnected must be provided by crane owner/user.***

To prevent drum control handle from having to be operated (load remains on ground), manual override in the corresponding brake solenoid valve (Figure 5-11) will be used to apply and release drum brake as described in Brake Adjustment step 5.

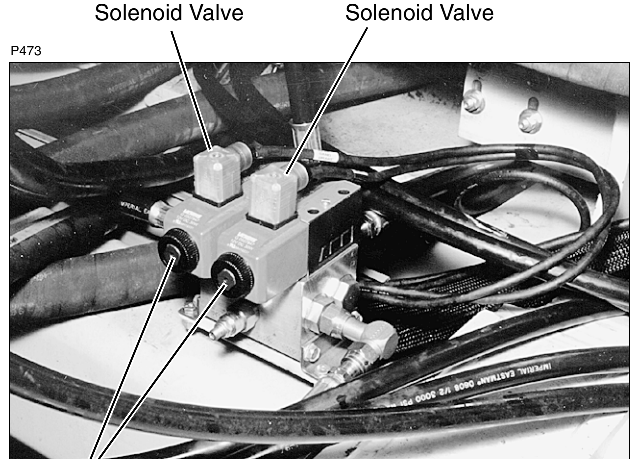


FIGURE 5-11

1. Select and confirm STANDARD mode for corresponding load drum.
2. Select and confirm FREE FALL OFF for corresponding load drum.
3. Remove guard covering drum flanges.
4. Loosen jam nut on actuator connector (Figure 5-11, View C).
5. To release and apply corresponding brake, proceed as follows:
   a. Release brake: insert a 1/8 in. (3 mm) diameter rod (screw driver or other instrument) into hole in end of brake solenoid valve (Figure 5-11). Push manual override pin in fully and hold.
   b. Apply brake: release manual override pin and remove rod.
6. Release corresponding drum brake (see Brake Adjustment step 5).
7. Support actuator so connecting pin is loose, and remove pin (Figure 5-11, View C).
8. Lower actuator so actuator connector is clear of band.
9. Turn actuator connector ***in*** desired amount (this will shorten distance between band end and actuator).

NOTE: Turning actuator connector 2-1/2 turns moves leading edge of spring sleeve 3/8 in. (9.5 mm).

10. Engage actuator connector with band, align holes, and install connecting pin (Figure 5-11, View C).
11. Apply drum brake (see Brake Adjustment step 5).
12. Check to see if leading edge of spring sleeve is at starting point of ***safe working range*** indicator (View B). If not, repeat Brake Adjustment steps 6 – 11.
13. Securely tighten jam nut to lock adjustment
14. After each brake adjustment, check clearance between lining and drum flange when lining is cold. Clearance must be equal all around drum flange. If adjustment is necessary, proceed as follows:
    a. Release corresponding brake (see Brake Adjustment step 5).
    b. Loosen lock nut on spring guide eyebolt (Figure 5-12, View A). Adjust spring guide as needed by tightening or loosening adjusting nut on eyebolt. Tighten lock nut.
    c. Loosen nuts on bolts at roller guide bracket and lock nut on set screw (Figure 5-12, View D). Adjust roller guide by turning set screw in or out. Tighten lock nut and capscrews.
    d. Apply brake (see Brake Adjustment step 5).

CAUTION

Drum Flange Damage!

Brake lining must not rub against drum flange when brake is released; otherwise, lining will overheat during operation, possibly resulting in cracks in drum flange.

15. Check lining wear after each brake adjustment. Linings normally wear faster at dead-end of band; check that area first. Brake lining is 1/2 in. (13 mm) thick when new. Replace lining when thinnest area has worn to 9/32 in. (7 mm) thick. ***Check lining wear more frequently after making two full brake adjustments.***

WARNING

Faulty Operation Hazard!

Use only Manitowoc original equipment lining. Other lining may not provide proper braking torque.

Install guard over drum flanges (Figure 5-12).

Foot Pedal Adjustment

See Figure 5-9 for following procedure.

The pedal adjusting screw is adjusted by the manufacturer to take out free-play and should not require readjustment.

If excessive pedal free-play is noticed (as a result of wear), proceed as follows:

1. Land load on corresponding drum.
2. Loosen jam nut and turn screw in until it is clear of pedal.
3. Slowly turn screw out only enough to remove pedal free-play and securely tighten jam nut to lock adjustment.

CAUTION

Prevent Lining Wear!

Do not turn pedal adjusting screw out any further than necessary to remove pedal free-play. If screw is turned out too far, pedal will start to press valve plunger and cause brake to partially apply. This action could cause brake band to rub against drum flange when brake is released, resulting in premature lining wear.

Item	Description
1	Eyebolt
2	Spring Guide
3	Drum Flange
4	Brake Lining
5	Adjusting nut
6	Lock Nut
7	Leading Edge of Spring Sleeve
8	Starting Point
9	Readjust Point
10	Guard
11	Dead End
12	Brake Actuator
13	Connecting Pin
14	Jam Nut
15	Actuator Connector
16	Brake Band
17	Nuts and Bolts
18	Set Screw
19	Roller Guide

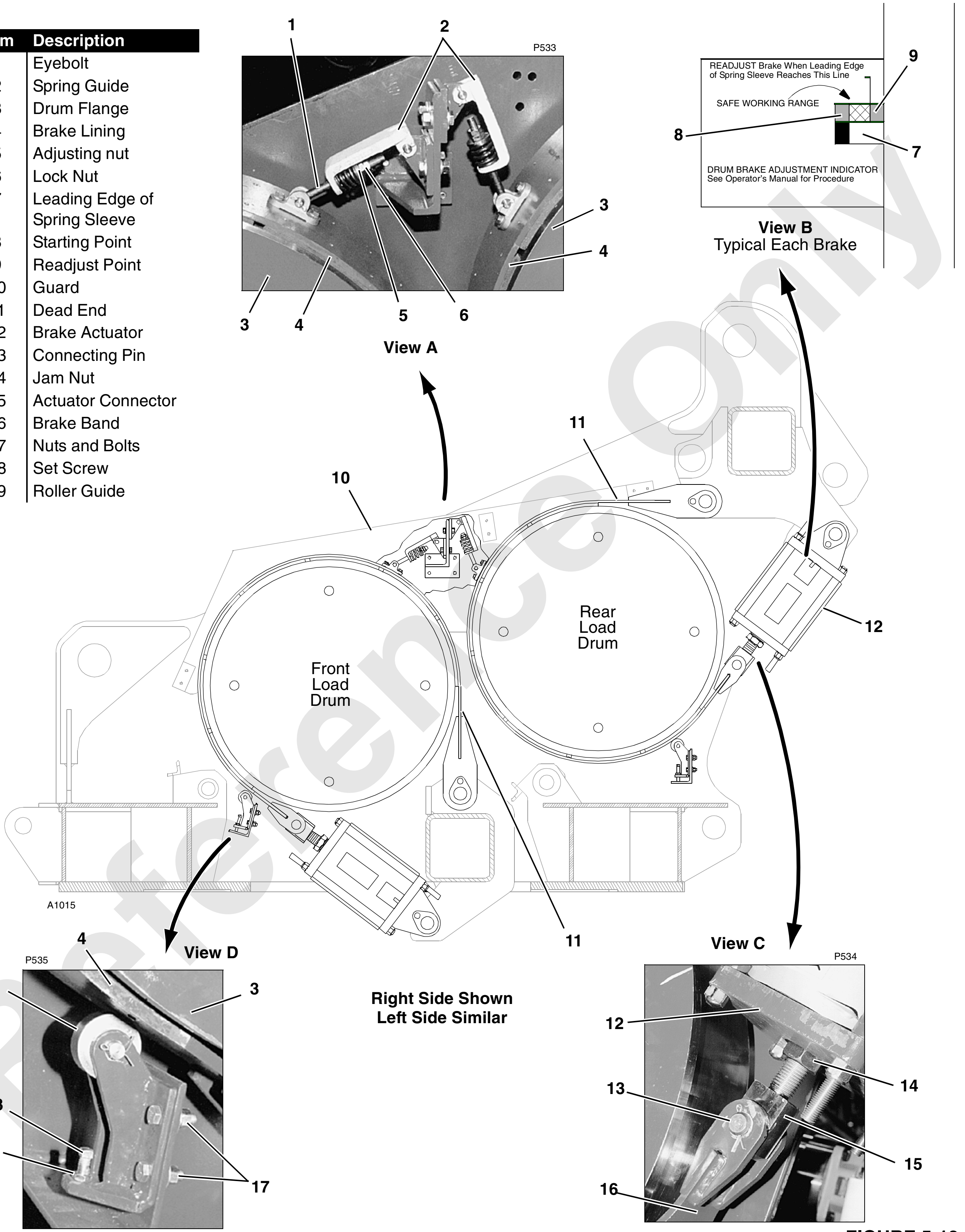


FIGURE 5-12

DRUM PAWL ADJUSTMENT

The drum pawls are positive locking devices which, when engaged, prevent the load drums from turning in the lowering direction.

The drum pawls are engaged and disengaged electrically by motor driven screw-type actuators. A limit switch inside both ends of each actuator turns off the motor when the actuator is fully extended or retracted.

The drum pawls are adjusted at the factory and should not need further adjustment during the service life of the actuators. Adjustment is necessary when a new actuator is installed.

Actuator Removal

See Figure 5-13 for following procedure.

1. Fully disengage corresponding pawl and stop engine.
- Front drum actuator will extend.
- Rear drum actuator will retract.

NOTE: It may be necessary to hoist slightly before pawl will fully disengage.

2. Disconnect electrical cord from actuator being removed.

3. Back out adjusting screw until leaf spring is fully relaxed.

DANGER

Flying Part Hazard!

Leaf springs are preloaded. Do not proceed to step 4 until step 3 is performed. Parts will fly apart with sudden and dangerous force if preload is not relieved.

4. Remove pins holding actuator to mounting lug and bracket.

5. If necessary, loosen mounting bracket nuts to loosen actuator connecting pins.

6. Remove actuator.

Actuator Installation and Adjustment

See Figure 5-13 for following procedure.

1. Move cab power switch to ON position and engine run-stop switch to RUN position. ***Do not start engine***.

2. If necessary, move corresponding pawl switch to DISENGAGED position.

WARNING

Pinch Point Hazard!

Actuator rod will either extend or retract when step 3 is performed, To prevent crushing injury to hands, keep actuator clear of all other parts while performing step 3.

3. Connect electrical cord to actuator:
- Front drum actuator will extend.
- Rear drum actuator will retract.

4. Pin actuator to mounting bracket and lug.

5. Loosen mounting bracket nuts.

6. Slide mounting bracket rearward until dimension between pawl and ratchet teeth is 7/8 inch (22 mm) as shown in View B or D or bracket bottoms out in slots, whichever occurs first.

7. Tighten nuts to hold mounting bracket in position.

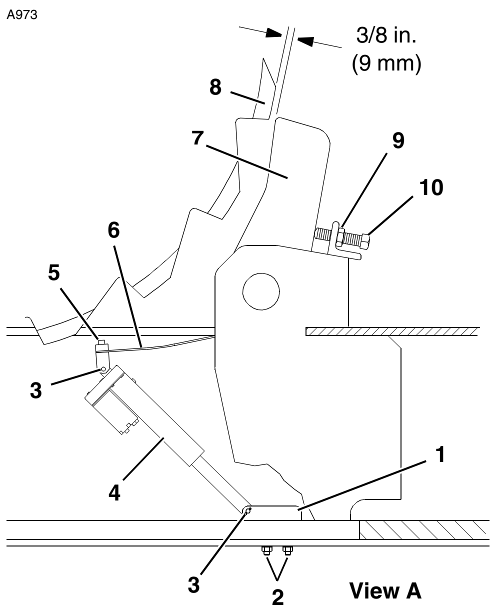
8. Turn adjusting screw ***in*** until dimension between pawl and ratchet teeth is 3/8 in. (9 mm) as shown in View A or View C.

9. Securely tighten jam nut to lock adjusting screw.

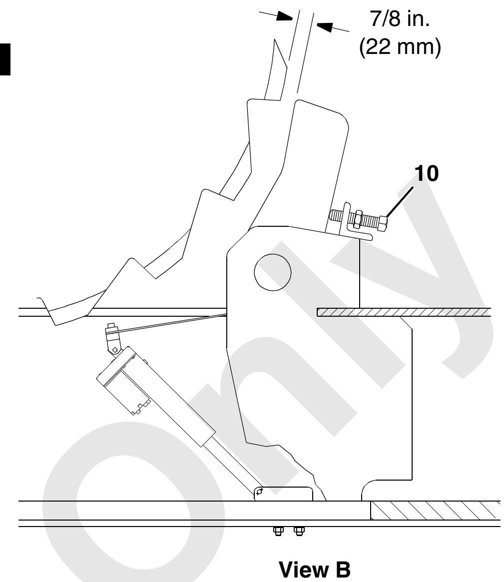
10. Operate pawl to make sure that internal limit switches stop actuator motor when actuator is fully extended and fully retracted and that pawl fully engages and disengages ratchet.

CAUTION

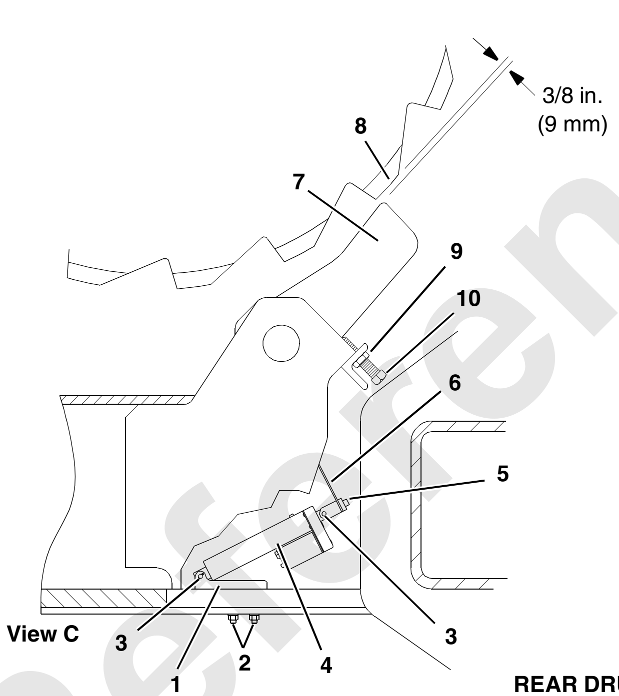
Actuator must be free to fully extend and retract. Motor will overheat if actuator stroke is restricted in either direction.



Item	Description
1	Mounting Bracket
2	Nuts
3	Pin
4	Actuator
5	Mounting Lug
6	Leaf Spring
7	Pawl
8	Ratchet
9	Jam Nut
10	Adjusting Screw



FRONT DRUM PAWL



REAR DRUM PAWL

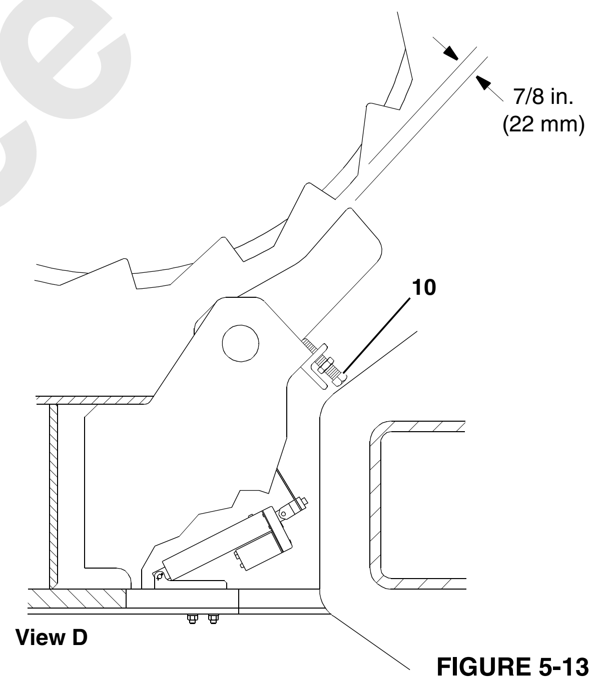


FIGURE 5-13

5

DRUM PRESSURE ROLLER ADJUSTMENT

General

Optional pressure roller assemblies are available for the front and rear load drums.

The rollers are spring loaded to assist in maintaining proper wire rope spooling by firmly holding the wire rope against the drum and subsequent layers.

WARNING

Crush Hazard!

Rollers are spring loaded. Stop drums and turn off engine before adjusting.

Adjustment

The operator must monitor drum spooling during operation.

If the wire rope jumps layers or does not wind smoothly onto the drum, perform following steps:

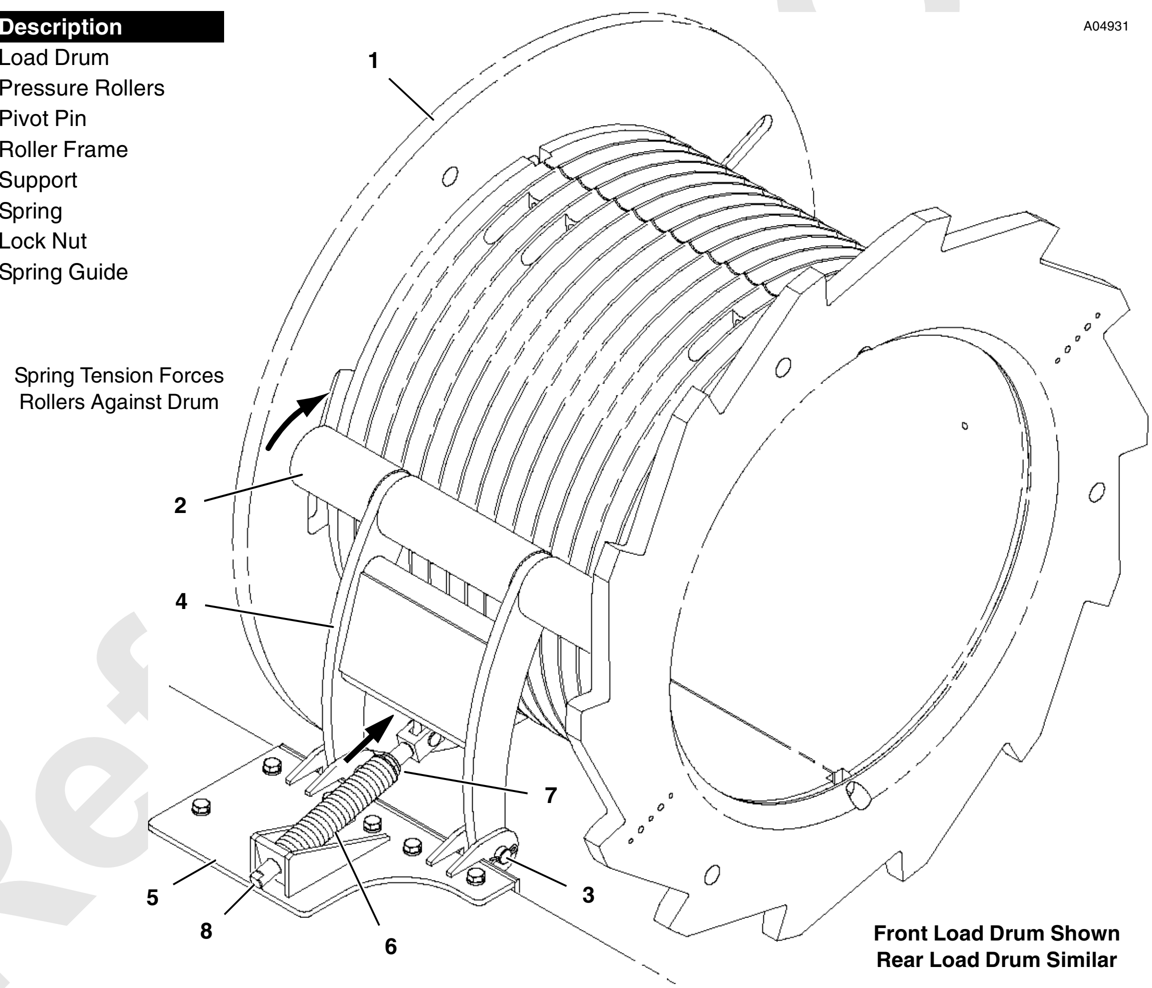
1. Hold spring guide (8) wrench flats.
2. Tighten lock nut (7) to increase spring tension.

CAUTION

Avoid Machinery Damage!

Remove *optional* rear drum pressure roller for liftcrane operation. Rear drum pressure roller is required for duty-cycle applications only.

Item	Description
1	Load Drum
2	Pressure Rollers
3	Pivot Pin
4	Roller Frame
5	Support
6	Spring
7	Lock Nut
8	Spring Guide



Front Load Drum Shown
Rear Load Drum Similar

WIRE ROPE LUBRICATION

Refer to the Lubrication Guide supplied with your crane for recommendations.

WIRE ROPE INSPECTION AND REPLACEMENT

The inspection and replacement guidelines which follow comply with United States regulations.

It is impossible to predict when a wire rope will fail; however, frequent and periodic careful inspection by a qualified inspector will indicate when the potential for failure exists.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Inspecting Wire Rope

Frequent Inspection

Visually inspect all running ropes in service once each work shift and observe the rope during operation. Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-Up Points — sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End attachments — the point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum.
- Abuse points — the point where the wire rope is subjected to abnormal scuffing and scraping.

Inspect all rope which can be reasonably expected to be in use during operation for obvious damage which poses an immediate hazard, such as the following:

1. Rope distortion such as kinking, crushing, un-stranding, bird caging, main strand displacement, and core protrusion.

   Loss of rope diameter and unevenness of the outer strands indicate that the rope should be replaced.
2. Corrosion (clean and lubricate).
3. Broken or cut strands.
4. Broken wires (see Periodic Inspection for additional information).
5. Core failure in rotation resistant rope (indicated by lay lengthening and reduction in diameter).

Periodic Inspection

The periodic inspection interval must be determined by a qualified inspector and be based on the following factors:

- Expected rope life as indicated by the rope manufacturer or past experience as determined by the qualified inspector.
- Severity of the environment the rope is operated in.
- Size, nature, and frequency of lifts.
- The rope's exposure to shock loading and other abuse.
- Rope maintenance practices.

The periodic inspection must be performed at least annually.

During the periodic inspection, the entire length of wire rope must be inspected for the following types of damage. Any damage found must be recorded and a determination made as to whether continued use of the rope is safe.

1. All points listed under frequent inspection.
2. Reduction in rope diameter below the nominal diameter caused by loss of core support, internal or external corrosion, or wear of the outside wires.
3. Severely corroded or broken wires at end attachments.
4. Severely corroded, cracked, bent, worn, or improperly applied end attachments.

Rope Not In Regular Use

Wire rope must be given a complete inspection if it has been idle for a month or more due to shutdown or storage of the crane on which the rope is installed. The inspection must be performed by a qualified inspector looking for the damage identified under both Frequent and Periodic Inspection.

Replacing Wire Rope

The final decision as to when a wire rope should be replaced is the responsibility of the qualified inspector. Discovery of any of the following conditions is sufficient reason for questioning a wire rope's safety and for replacing it.

Wire Rope Diameter

Measure and record the diameter of a new wire rope after initial loading for comparison with future inspections. A reduction in rope diameter is often the first outward sign that the wire rope core is damaged. When reduction in diameter is noted, the rope must be removed from service.

Measure the rope's diameter across crowns of the strands so the true diameter is measured as shown in Figure 5-14.

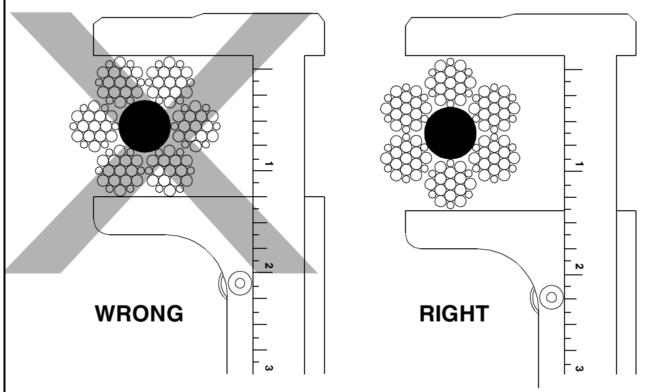


FIGURE 5-14

Wire rope shall be taken out of service when reduction from nominal diameter is more then 5%.

Broken Wires

Thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off pick-up points, and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire which appears loose or moves excessively.

Wire rope shall be taken out of service when it has following number of broken wires.

See Figure 5-15 for a description of lay length.

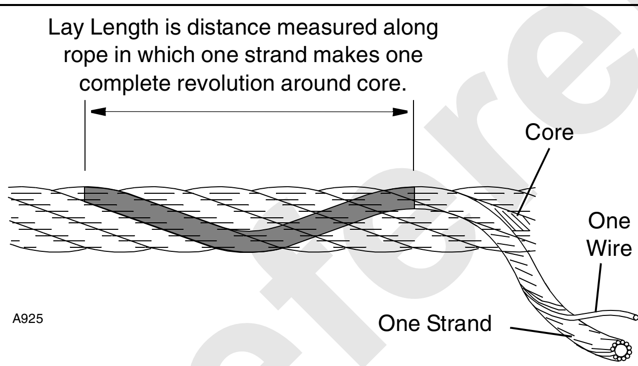


FIGURE 5-15

- Running Ropes (working lines) — six randomly distributed broken wires in one lay length, or three broken wires in one strand of one lay length.
- Rotation Resistant Rope — two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in thirty rope diameters.
- Standing Ropes (pendants) — more than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (Figure 5-16).
- Any Rope — one outer wire broken at the point of contact with the core. The broken wire protrudes or loops out of the rope structure.

NOTE: United States Steel states *Replacement criteria for galvanized strand boom suspension pendants are 25 percent of the outer wires fractured, or 10 percent of the total numbers, whichever comes first*.

WARNING

Replace wire rope when more than one broken wire appears at point marked by arrow.

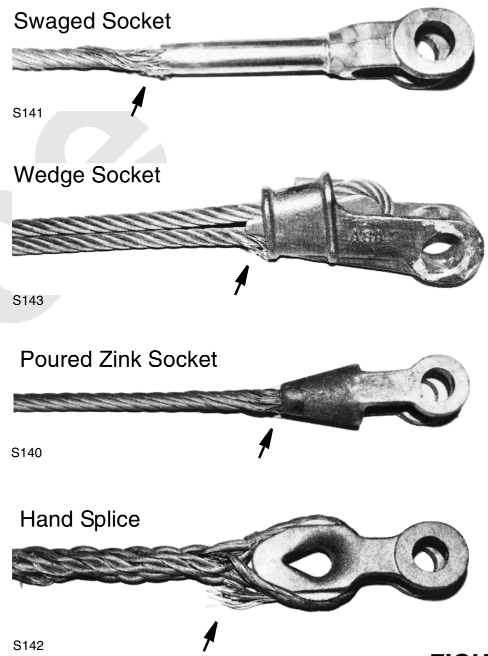


FIGURE 5-16

Wear and Other Damage

See Figure 5-17 for examples of wire rope damage.

Wire rope shall be taken out of service if:

- Rope core protrudes from between outer strands.
- Severe corrosion – indicated by pitting – exists.
- Obvious damage exists from any heat source, to include – but not limited to – welding, power line strike, or lighting.
- Kinking, crushing, bird caging, or any other damage resulting in distortion of wire rope structure exists.

⚠ WARNING

Falling Load Hazard!

Wire rope can break if following precaution is not observed.

Replacement wire rope must meet specifications given in Wire Rope Specifications Chart (load lines) or Boom Rigging Drawing (boom hoist) supplied with your crane.

Distributing Wire Rope Wear

Wire rope wear at the ***critical wear points*** can be reduced and the life of the wire rope extended by moving the rope at regular intervals so different sections of rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

To move the wire rope, cut off a piece of wire rope at the drum and refasten it. The piece cut off should be long enough to move wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece of it, reverse the rope end for end and refasten it

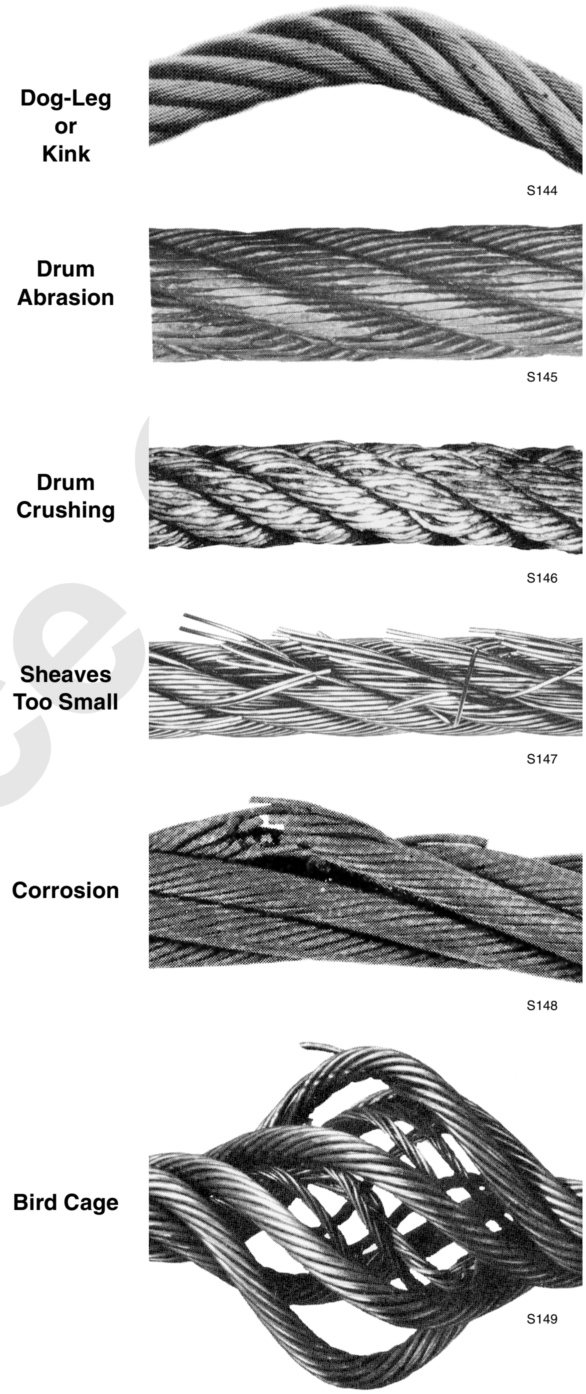


FIGURE 5-17

5

Sheave, Roller, And Drum Inspection

Perform the following inspections WEEKLY.

1. Check drum clutches and brakes for proper adjustment.
2. Check sheaves, rollers, and drums for following conditions:
   a. Unusual noises.
   b. Freedom of movement -- must turn freely by hand. Wire rope may have to be loosened to perform this inspection.
   c. Wobble -- must turn true with very little side-to-side or up-and-down play.
   d. Signs of rust (indicating that water may have entered bearing).
   e. Grease leaks (indicating a faulty seal or water in grease).

   Above problems indicate bearing damage. If found, sheave, roller, or drum should be disassembled for further inspection. New bearings should be installed.

   For sheaves not equipped with grease fittings, be sure to pack new bearings with grease at assembly.

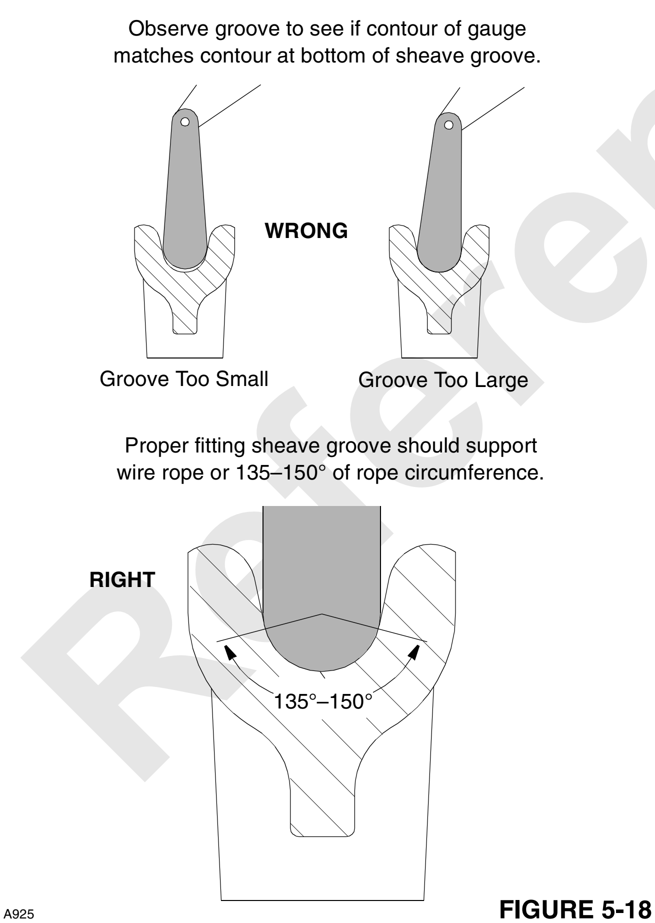


FIGURE 5-18

3. For steel sheaves, check depth, width, and contour of each sheave using a groove gauge as shown in Figure 5-18. Replace sheaves that have over or under size grooves.
4. Replace grooved drums that allow one wrap of wire rope to contact next wrap as rope spools onto drum.
5. Inspect sheaves to verify they **do not** contact another sheave or structural plate work. There should be uniform clearance between sheaves in a cluster. Repair or replace worn or damaged sheaves.
6. Re-machine or replace steel sheaves, drums, or rollers that have been corrugated by the wire rope's print as shown in Figure 5-19.

NOTE: Depending on the type of wire rope used, It is normal for nylon sheaves to show the wire rope print. ***Do not re-machine nylon sheaves***.

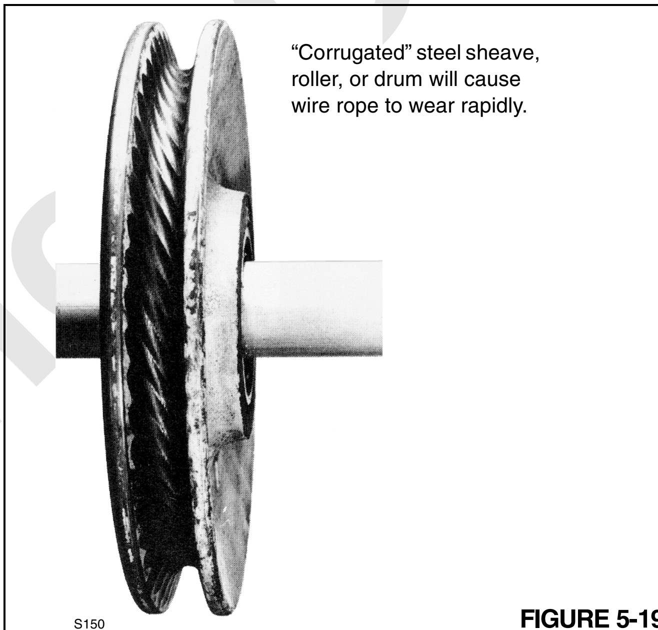


FIGURE 5-19

7. Inspect nylon sheaves for excessive measured for excessive tread diameter wear at locations E in Figure 5-21. Measure at three positions to check for uneven wear.

   Wear must not exceed limits given in table. Replace worn or damaged sheave.

NOTE: Nylon sheaves cannot be accurately inspected using conventional methods such as sheave gauges.

Due to the characteristics of nylon sheaves, the nylon material will actually move to better support the wire rope as the sheave wears normally.

Nylon sheave properties will be degraded in temperatures above 140° F.

8. Inspect nylon sheaves to verify they have not separated and "walked off" steel inserts or bearings as shown in Figure 5-20. Maximum sideways displacement is 1/8 in. (3 mm). Replace worn or damaged sheave assembly.

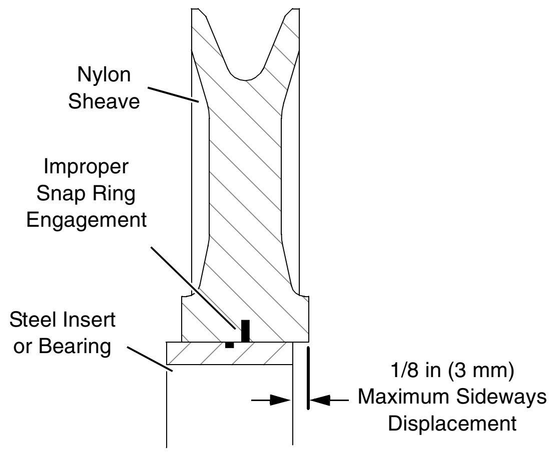


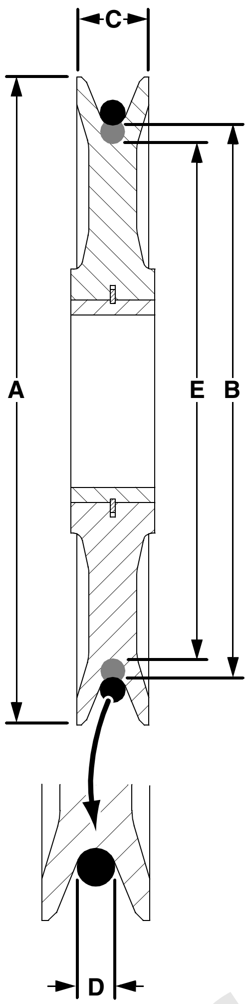
FIGURE 5-20

9. Make sure sheaves, drums, and rollers are properly lubricated according to lubrication instructions in Operator's Manual.

Many current production sheaves are not equipped with grease fittings, but are packed with grease at assembly. Repack the bearings of these sheaves with CraneLUBE EP #2 grease when the sheaves are overhauled.

Due to application and design variations, it is not possible to give specific grease repacking intervals or life expectancy of components.

NOTE: For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may have to be replaced.



SHEAVE DATA

Sheave Part No.	A Outside Diameter		B Tread Diameter [1]		C Width		D Rope Diameter	
	inch	mm	inch	mm	inch	mm	inch	mm
912738 631054 631056	13.19	335.0	11.42	290.1	1.77	45.0	5/8	16
631065	16.00	406.4	13.37	339.6	2.17	55.1	9/16	14
631071	16.00	406.4	13.88	352.6	2.17	55.1	5/8	16
631526	19.25	489.0	16.63	422.4	2.00	50.8	7/8	22
631527	19.25	489.0	16.63	422.4	2.00	50.8	5/8	16
631055	19.69	500.1	17.60	447.0	1.85	47.0	7/8	22
631067	19.69	500.1	17.75	450.9	1.97	50.0	3/4	19
631529	20.00	508.0	17.00	431.8	3.00	76.2	1	25
631519	23.00	584.2	20.13	511.0	2.25	57.2	7/8	22
631084 631102 631520 A00049 A00083	23.00	584.2	20.13	511.0	2.50	63.5	7/8	22
631082 631096 631103 A00050 A00051	27.00	685.8	23.00	584.2	3	76.2	1	28
631100	30.00	762.0	27.00	685.8	3.00	76.2	1-1/8	29

[1] If tread print exists in root of sheave groove, measure to maximum tread diameter.

REPLACEMENT DATA

E = B - 3/16 in (4.8 mm) Maximum from Original Tread Diameter

FIGURE 5-21

Load Block and Hook-And-Weight Ball

Maintenance and Inspection

⚠ WARNING

Falling Load Hazard!

To prevent load from dropping due to structural failure of load block or hook-and-weight ball:

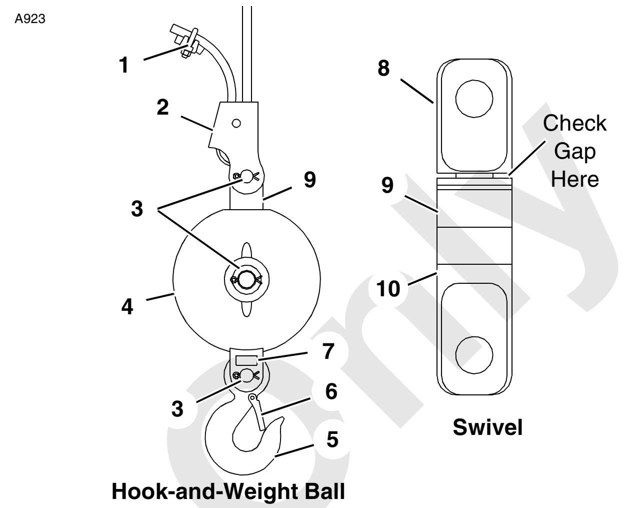
- Only use a load block or a hook-and-weight ball which has a capacity equal to or greater than load to be handled.
- Do not remove or deface nameplate (Figure 5-22) attached to load blocks and hook-and-weight balls.
- See "Duplex Hook" topic in Section 4 of Operator's Manual for recommended sling angles and capacity restrictions when load block has duplex or quadruplex hook.

FIGURE 5-22

The operating condition of the load block and the hook-and-weight ball can change daily with use. They must be inspected daily (at start of each shift) and observed during operation for any defects which could affect their safe operation. Correct all defects before using the load block or the hook-and-weight ball.

Daily inspection and maintenance will include the following points (see Figure 5-23 and 5-24):

1. Clean load block or the hook-and-weight ball.
2. Lubricate sheaves (if fittings provided), hook trunnion, hook swivel, and any other part with a grease fitting at the intervals specified in Lubrication in Section 9 of this manual.
3. Tighten loose tie-bolts, cap screws, and set screws. Check that all cotter keys are installed and opened.
4. Check sheaves for uneven wear in the grooves and on flanges. Check for loose or wobbly sheaves. These conditions indicate faulty bearings or bushings.



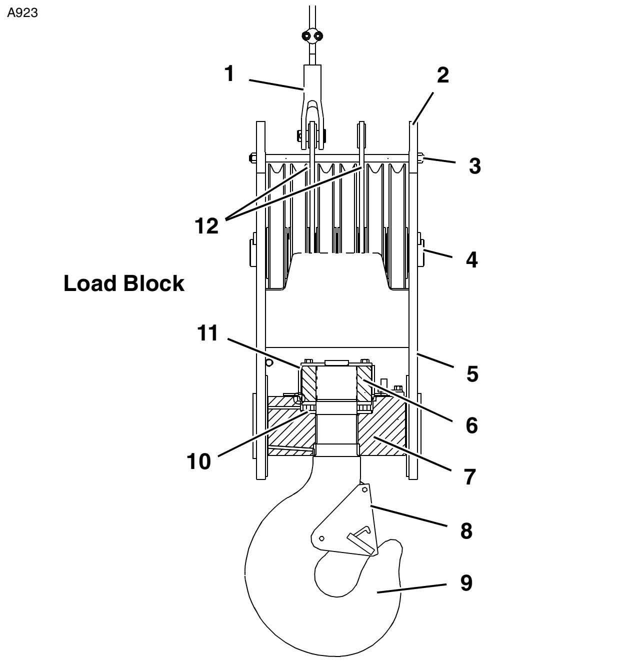
Item	Description	Item	Description
1	Dead End Clip	6	Hook Latch
2	Socket and Wedge	7	Nameplate
3	Tie Bolts	8	Shank
4	Weight Ball	9	Hook Swivel
5	Hook	10	Barrel

FIGURE 5-23

5. Check the fit of wire rope in the groove of each sheave. An oversize wire rope can crack the lip of sheave flange causing rapid wear of wire rope and sheave. The groove must be larger than wire rope, and the groove must be free of rough edges and burrs.
6. Check that hook, trunnion, and swivel rotate freely without excessive play. Faulty operation indicates faulty bushings or bearings or inadequate lubrication.
7. Check swivel of hook-and-weight ball for the following conditions:
   - Overloading: Spin swivel by hand; if the motion is rough or has a ratchet-like effect, swivel bearings are damaged.
   - Side loading: Swivel will turn freely in one spot and lock-up in another. This condition can also be checked by looking at the gap (see Figure 5-23) between barrel and shank (swivel must be removed from weight ball to check); if the gap is wide on the side and closed on the other, damage is present.

   The gap between barrel and shank is normally 0.020 to 0.050 inches. If the gap increases, swivel-bearing failure is indicated.

8. Check load block for signs of overloading: spread side plates, elongated holes, bent or elongated tie-bolts, and cracks.



Item	Description	Item	Description
1	Dead End Socket	7	Trunnion
2	Side Plate	8	Sling Retainer
3	Tie Bolt	9	Hook
4	Sheave Pin	10	Thrust Bearing
5	Nameplate	11	Locking Cap
6	Hook Nut	12	Center Plates

FIGURE 5-24

9. Check all welds for defects and cracks.

10. Check wire rope for wear and broken wires at the point were wire rope enters dead-end socket. Check socket for cracks. Tighten wire-rope clips at dead end of the wire rope.

11. Check that each hook has a hook latch and hook latch operates properly. Latch must not be wired open or removed.

WARNING

Falling Load Hazard!

To prevent load from dropping:

Hook latch must retain slings or other rigging in hook under slack conditions. Hook latch is not intended as anti-fouling device, and caution must be taken to prevent hook latch from supporting any part of load. Slings or other rigging must be seated in hook when handling load; they must never be in position to foul hook latch.

12. Check each hook and shackle for damage as shown in Figure 5-24.

    See ASME B30-10 Standard specific hook replacement guidelines.

    ASME (formerly ANSI) standards, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 0700-2900 (call toll free – US & Canada 800-843-2763, Mexico 95-800-843-2763, Universal 973-882-1167 or fax 973-882-1717 or 973-882-5155 or E-mail *infocentral@asme.org*).

    Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.

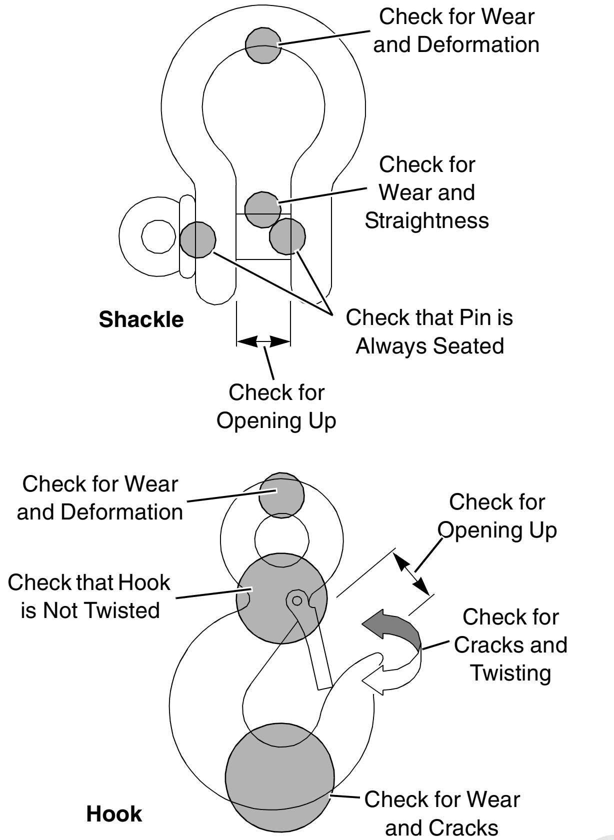
13. Check each hook and shackle at least yearly for cracks using a dye penetrant test, MAG particle test, ultrasonic test, or by X-raying.

WARNING

Falling Load Hazard!

To prevent load from dropping due to hook or shackle failure:

Do not attempt to repair cracks in hooks and shackles by welding. Furthermore, do not weld on any load bearing component unless proper welding methods are used (contact your Manitowoc dealer for material and welding specifications).



Hook and Shackle Inspection **FIGURE 5-25**

SECTION 6
SWING

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SECTION 6
SWING

MANUAL RELEASE OF SWING BRAKE AND LOCK

The hydraulic swing brake and hydraulic swing lock must be released when the swing planetary is removed and reinstalled to allow alignment of the gear teeth in the swing shaft with the teeth in the ring gear.

WARNING

Unexpected Crane Movement!

Crane can swing suddenly when swing brake is released. Before releasing swing brake, secure crane by lower boom onto blocking at ground level to prevent sudden uncontrolled swinging.

The procedure given in this section is for servicing purposes only. Swing brake and swing lock must be fully operational when operating crane.

Figure 6-1 shows the swing planetary and the type of swing lock.

FIGURE 6-1

Manual Release Procedure

Hydraulic hand pumps *with pressure gauges* are needed to manually release the swing brake and swing lock.

1. Disconnect hoses from fitting at brake release port and, if equipped, at swing lock OUT port.
2. Attach hand pump to each port — brake release and swing lock OUT.
3. Pressurize brake and swing lock to 350 psi (24 bar).
4. Proceed to remove or install swing planetary.
5. Relieve pressure and remove hand pumps.

CAUTION

Avoid damage to parts!

Do not exceed 350 psi (24 bar) pressure when releasing swing brake or swing lock.

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SECTION 7
POWER TRAIN

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SECTION 7
POWER TRAIN

BATTERY MAINTENANCE

Safety Information

WARNING

Battery gases are explosive!

Batteries can explode with great violence and spraying of acid if a spark or flame is brought too near them. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

Avoid sparks while charging batteries; do not disturb connection between batteries until charger is ***off***.

Another source of explosion is the reverse connection of charging equipment. This hazard is present with all types of chargers, but particularly with high-rate equipment. Carefully check the connections before turning charger ***on***.

Improper use of a booster battery to start a crane when the normal battery is inadequate presents a definite explosion hazard. To minimize this hazard, the following procedure is suggested:

1. First connect both jumper cables to the battery on the crane to be started. Do not allow ends of cables to touch.
2. Then connect the positive cable to the positive terminal of the booster battery.
3. Finally, connect the remaining cable to the frame or block of the starting vehicle. ***Never*** connect it to the grounded terminal of the starting vehicle.

If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water. Seek first aid if discomfort continues.

Causes of Battery Failure

Overcharging

Overcharging is the number one cause of battery failure, and is most often caused by a malfunctioning voltage regulator.

Excessive heat is the result of overcharging. Overheating causes the plates to warp which can damage separators and cause a short circuit within a cell. This resultant bubbling and gassing of the electrolyte can wash the active material from the plates, reducing the battery's capacity or causing an internal short.

Undercharging

Undercharging can cause a type of sulfate to develop on the plates. The sulfate causes strains in the positive plates which results in plate buckling. Buckled plates can pinch the separators and cause a short circuit. An undercharged battery is not only unable to deliver power, but may freeze (see Table 7-1).

Table 7-1
Battery Freeze Points

State of Charge	Specific Gravity	Freeze Point	
		°F	°C
100%	1.26	-70	-57
75%	1.23	-39	-38
50%	1.20	-16	-26
25%	1.17	-2	-19
DISCHARGED	1.11	+17	-8

The sulfate condition can eventually be converted to metallic lead which can short the positive and negative plates. These small shorts can cause low cell voltage when the battery is charged.

Lack of Water

The plates must be completely covered. If the plates are exposed, the resultant high acid concentration will char and disintegrate the separators. The plates cannot take a full charge if not completely covered by electrolyte.

Hold-Downs

Loose hold-downs will allow the battery to vibrate in the holder. This can cause cracks or wear in the container and cause acid to leak. Leaking acid corrodes terminals and cables resulting in high resistance battery connections. This weakens the power of the battery. Overtightened hold-downs can distort or crack the container resulting in the same problem.

Overloads

Avoid prolonged cranking or the addition of extra electric devices which will drain the battery and may cause excessive heat.

Multiple Battery System

Multiple battery systems are connected either in series or in parallel. Always refer to your wiring diagram for correct connection.

NOTE: Installing batteries with reversed electrical connections will not only damage batteries but also crane's electrical system, voltage regulator, and/or alternator.

Maintenance

Weekly – Check Electrolyte Level

1. Clean the top of the battery before removing the vent caps. Keep foreign material out.
2. Distilled water should be used. Drinking water is, however, satisfactory. Water with a high mineral content (well, creek, pond) must not be used.
3. Never overfill the cells. Overfilling will cause electrolyte to pump out, and corrosion damage will result.

   Any spills on painted or metal surfaces must be immediately cleaned and acid neutralized with baking soda or ammonia.
4. Look for heavy deposits of black lead like mineral on the bottom of the vent caps. This indicates that active material is being shed (a result of overcharging).

   An excessive amount of water consumption also indicates overcharging.
5. Sulfuric acid must never be added to a cell unless it is known that acid has been spilled out or otherwise lost — consult your battery dealer for instructions.

Every 2 Months – Test Batteries

NOTE: Before testing a battery: determine that the alternator is putting out current, that the current is flowing to the battery, and that the voltage delivered is within acceptable limits.

Hydrometer Test

1. The electrolyte level in each cell must be at its proper height to get reliable readings.
2. Readings should not be taken immediately after water is added. The solution must be thoroughly mixed by charging.
3. Likewise, readings should not be taken after a battery has been discharged at a high rate, such as cranking.
4. When reading a hydrometer, hold the barrel vertical with the float freely suspended.
5. Draw the electrolyte in and out several times to bring the float temperature to that of the electrolyte.
6. Take the reading across the bottom of the liquid level; disregard curvature of the liquid.
7. Readings must be temperature corrected. Subtract 0.004 from the reading for each 10° below 80°F. Add 0.004 for each 10° above 80°F.

NOTE: It is the electrolyte temperature which is important, not air temperature.

8. See Table 7-2 to interpret the readings.

Table 7-2
Hydrometer Readings

Temperature corrected hydrometer readings may be interpreted as follows:

Hydrometer Reading — SP. GR.	% Charge
1.260 – 1.280 =	100%
1.230 – 1.250 =	75%
1.200 – 1.220 =	50%
1.170 – 1.190 =	25%
1.140 – 1.160 =	Very little useful capacity
1.110 – 1.130 =	Discharged

If any two cells show more than 50 points (0.050 SP. GR.) variation, try to recharge the battery. If the variation persists, the battery should be replaced

NOTE: For more specific hydrometer test information, see the instructions provided with your hydrometer.

Open-Circuit Voltage Test

A sensitive voltmeter can be used to determine a battery's state-of-charge as shown in Table 7-3.

The open circuit test is not as reliable in determining a battery's condition as the hydrometer test. This test is acceptable for stored batteries, but not ones in use.

This test must not be performed on batteries being charged or delivering power; charging causes an increase in voltage which may persist for an extended period.

Table 7-3
Open Circuit Cell Voltage

% Charge	Specific Gravity	Approximate Open Circuit Cell Voltage
100	1.260	2.10
75	1.230	2.07
50	1.200	2.04
25	1.170	2.01
Discharged	1.110	1.95

NOTE: Detailed test information is provided by the meter manufacturer.

High Resistance Test

A voltage drop (while cranking) of more than 0.2 volts between the starting motor cable and ground can result in hard starting regardless of a battery's condition. The voltage drop can be caused by a poor contact between the cable terminal and ground or between the clamp terminal and the battery post. Poor start-switch contacts and frayed, broken, or corroded cables can also be the cause.

Quarterly

1. Thoroughly clean the batteries and the holder with baking soda.
2. If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill drain holes.
3. Clean the posts and terminals. The posts can be lightly coated with grease to prevent corrosion.
4. Make sure the hold-downs are in good condition; replace faulty parts.
5. Replace frayed, broken, or corroded cables.
6. Replace the batteries if their containers are cracked or worn to the point they leak.
7. Ensure good contact (tight) between the clamp terminals and battery posts.

Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

Charging

If at all possible, the battery should be at room temperature when recharging. Before a battery is recharged, it must be thoroughly cleaned. Take care not to allow dirt to enter the cells.

A battery should be recharged in the way it was discharged. If it was discharged over a long period of time, it should be recharged slowly at 6 to 10 amps for up to 10 hours. A rule-of-thumb value for a slow rate is a current equal to about one-half the number of plates per cell in the battery. A battery with 13 plates per cell, should be charged at 7 amps.

If a battery was discharged rapidly (cranking until dead), it can be recharged on a fast charger with an output of up to 40 amps for a maximum of 2 hours. If the electrolyte temperature reaches 125°F or if it gases violently, the charging current must be reduced or halted to avoid battery damage.

For optimum charging results, adhere to the charger manufacturer's instructions.

Storage

When the machine is left idle for prolonged periods, it should be run periodically to charge the batteries.

When storing a battery, make sure it is at least 75% charged to prevent the possibility of freezing.

Follow your battery dealer's recommendations.

Battery Electrical Disconnect Switch

See Figure 7-1 in following procedure.

The battery electrical disconnect switch is located in left side enclosure. Turn switch handle counter-clockwise to disconnect the batteries for crane maintenance. Make sure engine ignition switch has been off two minutes before disconnecting batteries.

CAUTION

Engine Damage!

To avoid possible engine fault codes and undesirable operation, make sure engine ignition switch has been off two minutes before disconnecting batteries.

Do not rely on this switch to protect crane's electronic systems when welding. Disconnect battery cables at batteries before welding.

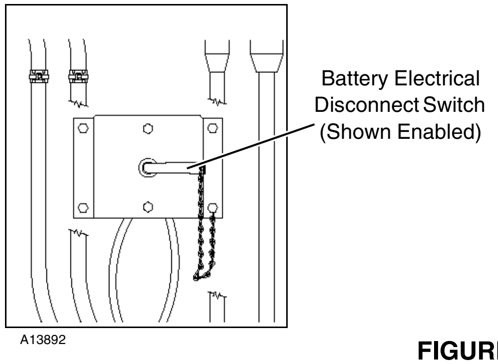


FIGURE 7-1

7

ENGINE AIR CLEANER MAINTENANCE

Servicing the engine air cleaner is an important maintenance function:

- A clogged air cleaner filter will prevent adequate air flow to the engine, resulting in poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can result in engine damage.

Mounting

The air cleaner is mounted horizontally and fastened to the engine air intake manifold with rubber elbows and metal tubes (Figure 7-2).

Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals:

1. Check the service indicator (Figure 7-2) ***daily*** with the engine running.

   The indicator gives a visual signal when it is time to replace the filter.

   The red flag in the indicator window rises as the filter fills with dirt. ***Replace filter when red flag locks in place at top of indicator.***

   When locked in place, the red flag will remain up after the engine is stopped. When the filter is replaced, push the button in on the indicator to reset it.
2. Inspect the rubber fittings and the tubes between the air cleaner and the engine for cracks or other damage which might allow unfiltered air to enter the engine. Replace damaged or worn parts.
3. Check the filter body for dents or other damage that may allow unfiltered air to enter the engine. Replace the filter if damaged.
4. Check for loose tubing clamps, flange bolts, filter straps, and clamping brackets. Tighten loose parts.
5. Check that the inlet cap or pre-cleaner is free of obstructions.
6. If crane has a pre-cleaner, check that discharge hole is open.

Service

See Figure 7-2 for following procedure.

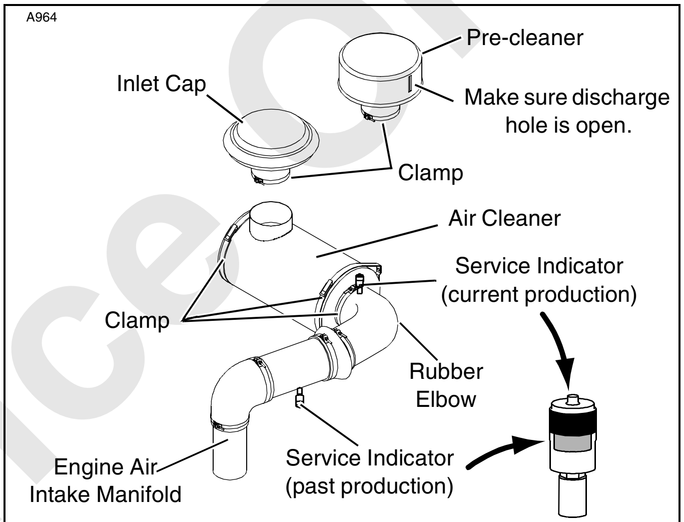
1. Loosen the clamp securing the air inlet cap or pre-cleaner and pull it off.
2. Inspect the air inlet cap or pre-cleaner for dirt and obstructions. Install a new inlet cap or pre-cleaner if it is damaged.

CAUTION

Engine Damage!

STOP ENGINE before servicing air cleaner, or unfiltered air will be drawn directly into engine.

Do not attempt to clean and reuse old filter. Discard old filter and install a new one.



Air Cleaner is Mounted Outside Engine Enclosure

FIGURE 7-2

3. Wash the air inlet cap or pre-cleaner in warm soap and water and blow it dry with compressed air.
4. Remove the four bolts securing the cover to the engine enclosure and lift it off.
5. Loosen the clamp securing the rubber elbow to the air cleaner.
6. While holding the air cleaner, open the clamps securing it to the engine enclosure.
7. Remove and discard the old air cleaner. ***Do not reuse old filter. Do not to allow foreign matter to enter tubing or air inlet hole to the engine.***
8. Slide the new filter into the rubber elbow and close/ tighten the clamps.
9. Reinstall air inlet cap or pre-cleaner and tighten its clamp.

ENGINE CLUTCH ADJUSTMENT

A disc-type manually operated clutch (see Figure 7-3) is mounted between the engine and the pump drive on this crane. The clutch allows the pump drive to be disconnected from the engine, thereby reducing engine load and making start-up easier in cold weather. The clutch can be engaged or disengaged while the engine is running or off.

CAUTION

Parts Damage!

Do not run engine longer than 20 minutes with clutch disengaged. Clutch release bearing can be damaged.

Operation

1. Grease the clutch monthly. See Lubrication in Section 9 of this manual.
2. At least once each month, disengage and engage the clutch several times with the engine running. This practice will clean the disc surfaces and prevent the discs from seizing.
3. When disengaging the clutch, check free travel. Free travel should be 1 to 1-1/8 in. (25 – 29 mm). Readjust the clutch when free travel decreases to 3/4 in. (19 mm).

Adjustment

The clutch is adjusted internally through the hand hole on bottom of the clutch housing. See the manufacturer's manual for adjustment instructions.

DANGER

Moving Machinery Hazard!

Parts inside clutch rotate when engine is running. Stop engine before adjusting clutch.

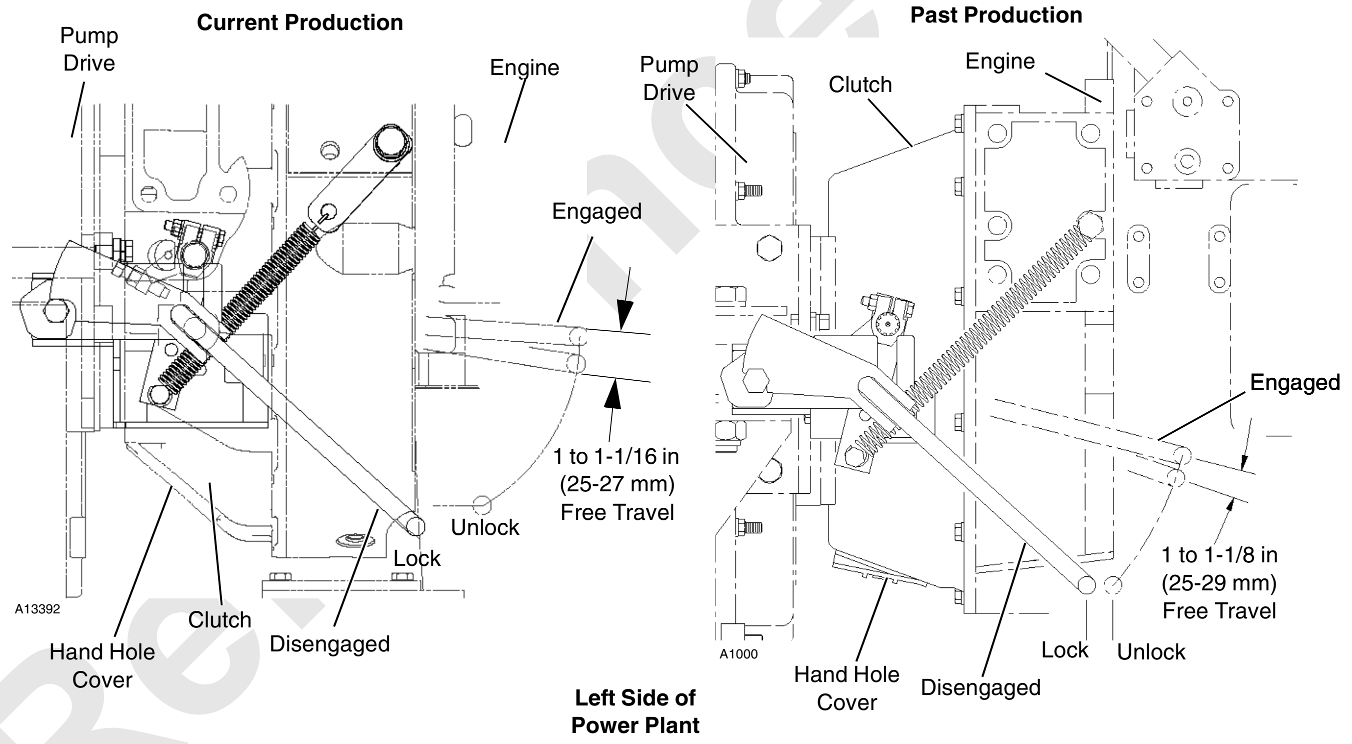


FIGURE 7-3

ENGINE THROTTLE ADJUSTMENT - CUMMINS C330

The throttle assembly for the Cummins C330 engine consists of a hand throttle in the left control console, a foot pedal on the cab floor, two controllers with potentiometers, EFC (electronic fuel control) on the engine, associated linkage, and electrical connections.

In the right control console, a reach rod connects the foot pedal assembly to the lever on the foot throttle controller. An electric cable connects the switch controller on the manual throttle in the left control console to the foot throttle controller.

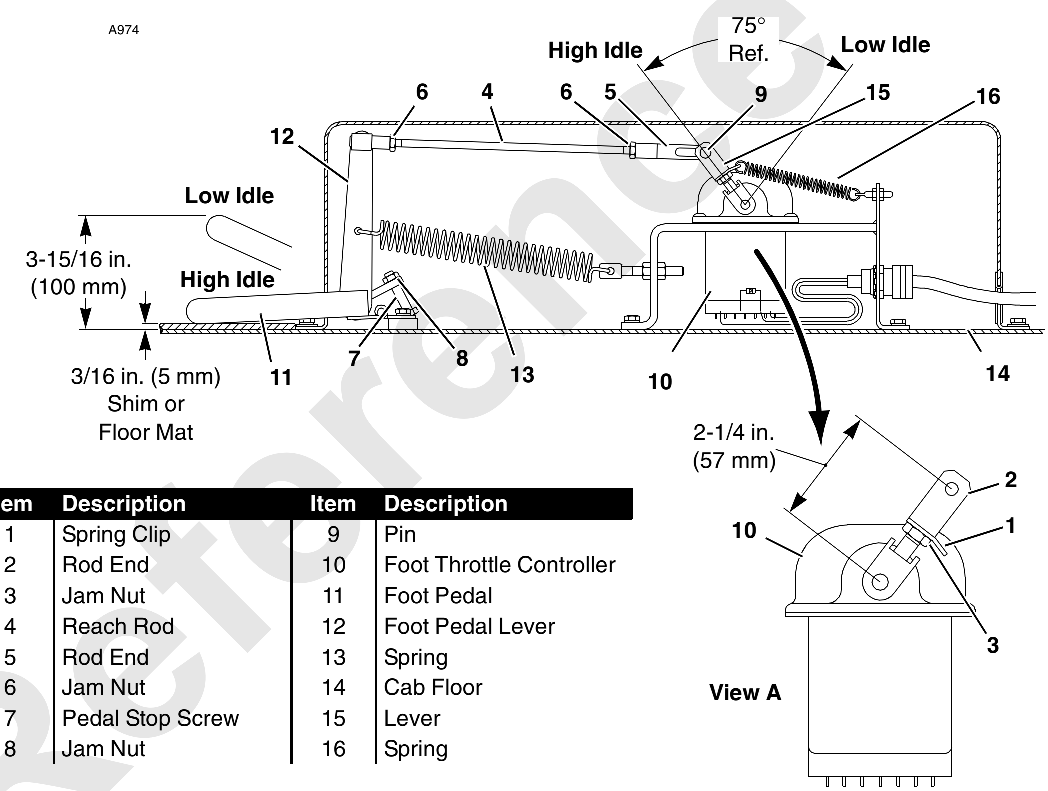
Foot Throttle Linkage Adjustment

See Figure 7-4 for following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in View A and securely tighten jam nut (3).
2. Insert a 3/16 in. (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to HIGH IDLE position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to HIGH IDLE position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controllers have internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in. (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).
8. With foot pedal in LOW IDLE position, distance from top of pedal to cab floor should be 3-15/16 in. (100 mm).



Item	Description	Item	Description
1	Spring Clip	9	Pin
2	Rod End	10	Foot Throttle Controller
3	Jam Nut	11	Foot Pedal
4	Reach Rod	12	Foot Pedal Lever
5	Rod End	13	Spring
6	Jam Nut	14	Cab Floor
7	Pedal Stop Screw	15	Lever
8	Jam Nut	16	Spring

FIGURE 7-4

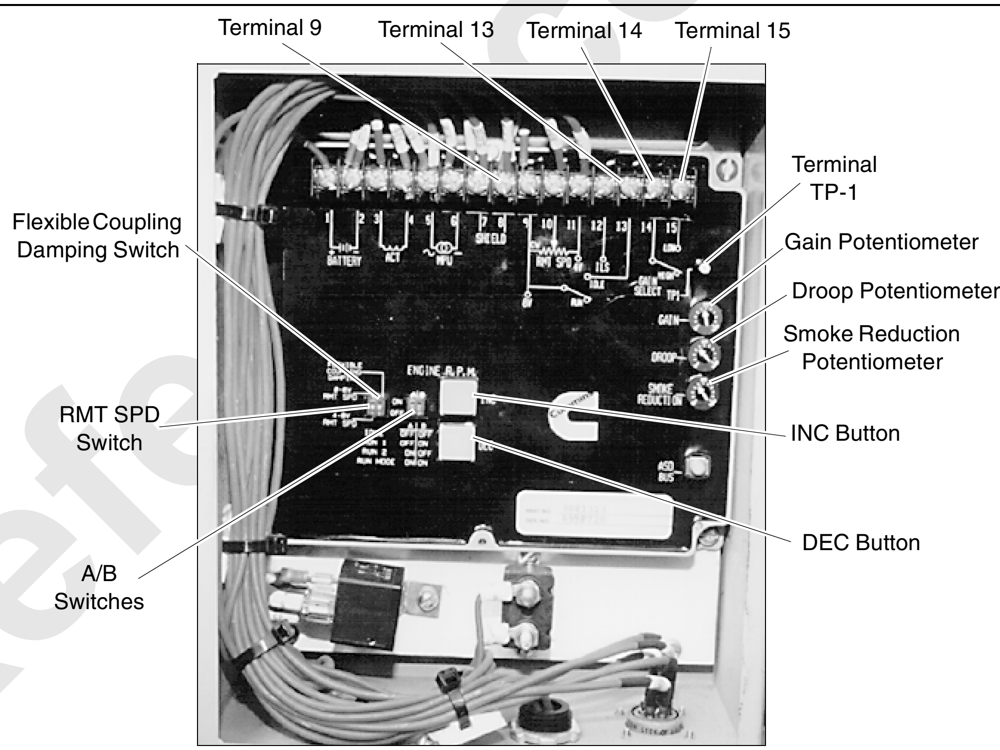
Electronic Fuel Control Adjustment

See Figure 7-5 for following procedure.

The electronic fuel control (mounted in junction box on engine) is adjusted at the factory to provide the following speeds and should not need further attention. Adjustment is required if the control is replaced. Adjustments are to be completed in the sequence given in this topic.

The engine clutch must be engaged for all steps. It is normal for the idle speed to be as high as 1,500 rpm when the engine clutch is disengaged.

1. If the specified engine speeds cannot be obtained during the adjustment steps, the engine speed sensor (on engine flywheel housing) may not be adjusted properly:
   - **a.** Turn sensor out several turns.
   - **b.** Turn sensor in until it lightly bottoms out against a flywheel gear tooth.
   - **c.** Turn sensor out 1/2 turn.
   - **d.** Securely tighten jam nut to lock sensor adjustment.
2. In cab, move hand and foot throttles to low idle.
3. Stop engine.
4. Open cover on junction box.
5. Remove jumper wire between terminals #14 and #15, if there is one.
6. Set potentiometers to following positions:
   - **a.** Gain potentiometer to mid-position (50). This setting should prevent the engine from surging.
   - **b.** Droop potentiometer fully counterclockwise (0).
   - **c.** Smoke potentiometer fully counterclockwise (0).
7. Set flexible coupling damping switch to **ON** position.
8. Set RMT SPD switch to **4-8V** position.
9. Set A/B switches to **RUN 1** position — **A** switch **OFF** and **B** switch **ON**. This is the controlled low idle setting.
10. Start engine (hand throttle fully forward and foot throttle fully raised to low idle).
11. Scroll to engine speed on digital display screen. See digital display to monitor engine speed during remaining adjustment steps.
12. Using ENGINE RPM buttons in junction box, press **INC** (increase) or **DEC** (decrease) button to set engine speed as close to 1,000 rpm without going over.
13. Stop engine.
14. Set A/B switches to **RUN 2** position — **A** switch **ON** and **B** switch **OFF**.
15. Start engine and run it at full throttle (hand throttle fully back or foot pedal fully down).
16. Press **INC** or **DEC** button to set engine speed as close to 2,100 rpm as possible without going under.
17. Stop engine.



Junction Box on Front of Engine

FIGURE 7-5

7

18. Set A/B switches to **RUN MODE** position — **A** switch **ON** and **B** switch **ON**.
19. Test hand and foot throttles for proper full throttle operation, as follows:
    - a. With hand throttle pulled back fully (foot throttle up fully), engine speed must be as close to 2,100 rpm as possible without going under.
    - b. With foot throttle pressed down fully (hand throttle forward fully), engine speed must be as close to 2,100 rpm as possible without going under.
    - c. Repeat steps 13 – 18b until speed in RUN 2 position matches speed in RUN MODE as closely to 2,100 rpm as possible without going under.
    - d. If proper speed cannot be obtained, check foot throttle linkage adjustment.

ENGINE THROTTLE ADJUSTMENT - CUMMINS 6CTA8.3-C260 ENGINE

The throttle assembly for the Cummins 6CTA8.3-C260 engine consists of a hand throttle in the left control console, a foot pedal on the cab floor, two controllers with potentiometers, associated linkage, and electrical connections.

Foot Throttle Linkage Adjustment

See Figure 7-4 for following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in View A and securely tighten jam nut (3).
2. Insert a 3/16 in. (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to HIGH IDLE position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to HIGH IDLE position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controllers have internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in. (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).
8. With foot pedal in LOW IDLE position, distance from top of pedal to cab floor should be 3-15/16 in. (100 mm).

Electronic Speed Control Adjustment

See Figure 7-6 for following procedure.

The electronic speed control was adjusted at the factory and should not need further attention. Adjustment is required if the control is replaced. Adjustments are to be completed in the sequence given in this topic.

The electronic fuel control is located in the junction box mounted on the right side of the engine. Figure 7-6 shows the locations of the potentiometers and other controls inside the junction box.

Engine speeds given in this topic are nominal, and can vary plus or minus 50 rpm.

Setting High Speed

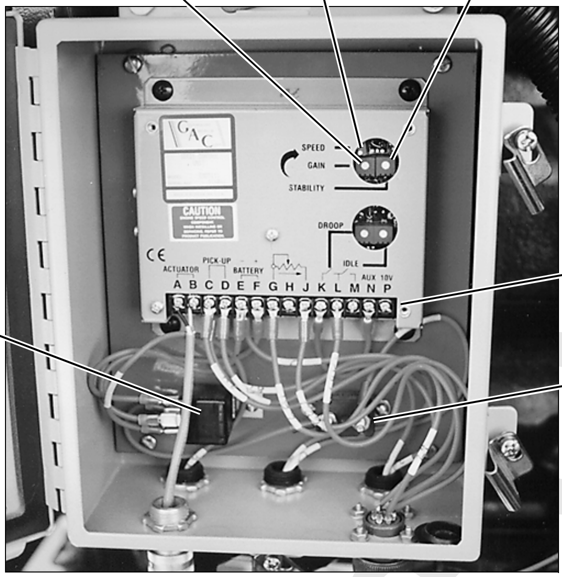
1. In cab, make sure clutch is engaged.
2. Start engine.
3. Set throttle to high speed setting.
4. Turn speed pot until ENGINE SPEED on digital display shows speed is 2,200 rpm.

   Low idle is determined by the value of the resistors in the circuit. Low idle should be approximately 1,000 rpm.

Setting Gain and Stability

1. Set throttle to high speed setting (2,200 rpm).
2. Adjust GAIN as follows:
    - a. Slowly turn gain adjusting screw clockwise until engine becomes unstable (engine operation becomes erratic).
    - b. Slowly turn gain adjusting screw counterclockwise until engine becomes stable.
    - c. Turn gain adjusting screw one division further counterclockwise to ensure stable performance.
3. Adjust STABILITY as follows:
    - a. Slowly turn stability adjusting screw clockwise until engine becomes unstable (engine operation becomes erratic).
    - b. Slowly turn stability adjusting screw counter-clockwise until engine becomes stable.
    - c. Turn stability adjusting screw one division further counterclockwise to ensure stable performance.
4. Test hand and foot throttles to make sure they both operate within high and low idle settings.

NOTE: Adjustments made at no load achieve satisfactory performance. Gain and stability may require minor adjustments after engine load is applied.



Junction Box on Right Side of Engine

FIGURE 7-6

Test Voltages

The following test voltages are provided for troubleshooting purposes and are measured at the terminal strip in the junction box on the engine (Figure 7-6).

Table 7-4
DC Voltage

Operating Condition	Wire Number	Terminal Number	VDC Reading All Readings to Ground
Cab Power Switch ON Engine Run-Stop Switch in RUN	68L 68J 68K	G J L	0.005 5.880 3.848
Engine at Low Idle (1,000 rpm)	68L 68J 68K	G J L	0.007 5.870 3.812
Engine at High Idle (2,200 rpm)	68L 68J 68K	G J L	0.027 5.070 0.219

Table 7-5
AC Voltage

Operating Condition	Wire Number	Terminal Number	VAC Reading
Engine at Low Idle (1,000 rpm)	24 and 0	C to D	6.580
Engine at High Idle (2,200 rpm)	24 and 0	C to D	7.480

ENGINE THROTTLE ADJUSTMENT - CATERPILLAR 3176B AND 3176C ENGINES

The throttle assembly for the Caterpillar 3176B and 3176C engines consists of a hand throttle controller in the left console, a foot pedal on the cab floor, a foot throttle controller in the right console, a converter board with potentiometers, associated linkage, and electrical connections.

In the right console, a reach rod connects the foot pedal assembly to the lever on the foot throttle controller. An electric cable connects the foot throttle controller in the right console to the hand throttle controller in the left console.

Foot Throttle Linkage Adjustment

See Figure 7-4 for following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in View A and securely tighten jam nut (3).
2. Insert a 3/16 in. (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to HIGH IDLE position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to HIGH IDLE position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controllers have internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in. (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).
8. With foot pedal in LOW IDLE position, distance from top of pedal to cab floor should be 3-15/16 in. (100 mm).

Engine Speed Calibration

See Figure 7-7 while calibrating engine speed.

Engine speeds are calibrated on the converter board mounted in the left console near the hand throttle controller. This board converts 0 – 8 VDC analog signal to 5.0 VDC PVM signal at 500 Hertz.

Engine speeds at minimum and maximum throttle were adjusted at the factory and should not need further attention. Adjustment is required if the control is replaced. Adjustments are to be completed in the sequence given in this topic.

NOTE: A digital VOM meter with the capability of displaying percent modulation is needed to set duty cycle percentages (example: FLUKE 87 True RMS Multimeter).

1. Stop engine.
2. Remove cover plate and hand throttle controller from left console. Move to side for access to converter board. ***Be careful not to damage electric wires.***
3. Connect mulitmeter to 0 and 68K terminals on converter board.
4. Turn cab power switch ON and set engine RUN/STOP switch to RUN to supply power to converter board. Do not start engine.
5. Move hand throttle to minimum (low idle) position.
6. Set threshold potentiometer to duty cycle indicated in Table 7-6.
7. Move hand throttle to maximum (full throttle) position.
8. Set span potentiometer to duty cycle indicated in Table 7-6.
9. Remove multimeter and start engine.
10. Verify calibration at minimum and maximum throttle positions while monitoring ENGINE SPEED on digital display in operator's cab.

    Adjust threshold and span potentiometers as needed so that engine speed is within ranges specified in Table 7-6.
11. Reinstall cover plate and hand throttle controller on console.

Table 7-6
Throttle Settings

Throttle Setting	Engine Speed	Duty Cycle	Voltage
Minimum	975±25 rpm	15%	0.23 VDC nominal (0.25 max) @ 1.0 MA sink current 0.65 VDC nominal (0.75 max) @ 10.0 MA sink current
Maximum	2110±10 rpm	82%	4.0 VDC (minimum) 5.0 VDC (maximum)

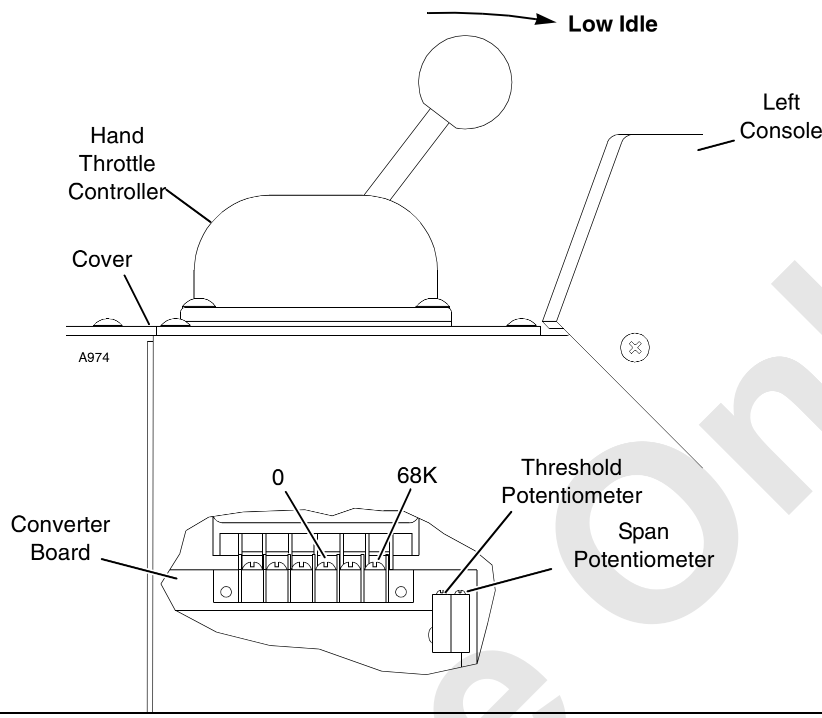


FIGURE 7-7

ENGINE THROTTLE ADJUSTMENT - CUMMINS QSL 340, QSC8.3, QSM11, OR QSX15 ENGINE

The throttle assembly for the Cummins QSL 340, QSC8.3, QSM11, and QSX15 engines consists of an electronic control module (ECM) on the engine, a hand throttle controller in the left console, a foot pedal on the cab floor, a foot throttle controller in the right console, associated linkage, and electrical connections.

A reach rod in the right console connects the foot pedal to the lever on the foot throttle controller. An electric cable connects the foot throttle controller in the right console to the hand throttle controller in the left console.

Foot Throttle Linkage Adjustment

See Figure 7-4 for following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in View A and securely tighten jam nut (3).
2. Insert a 3/16 in. (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to HIGH IDLE position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to HIGH IDLE position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controllers have internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in. (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).
8. With foot pedal in LOW IDLE position, distance from top of pedal to cab floor should be 3-15/16 in. (100 mm).

Engine Speed Calibration

Engine speed is calibrated automatically by the crane's programmable controller:

- High idle = 2,100 rpm (QSL 340 = 1,800 rpm)
- Low idle = 1,000 rpm

Wiring Diagram

For a wiring diagram of the system, see Electrical Operator's Cab Wiring drawing in your Parts Manual.

ENGINE DIAGNOSTICS – CUMMINS QSL 340 AND QSC8.3 ENGINE

The Cummins QSC8.3 and QSL 340 engine has two diagnostic modes:

- Offboard Diagnostics that requires Cummins Insite™ hardware and software, available from your local Cummins dealer.
- Onboard Diagnostics that uses warning lights to alert the operator to engine problems during operation (engine running) and fault codes to identify specific problems when the engine is not running.

Onboard Diagnostics

The Engine Stop, Engine Warning, and Engine Maintain lights are mounted on the front console in the operator's cab as shown in Figure 7-8.

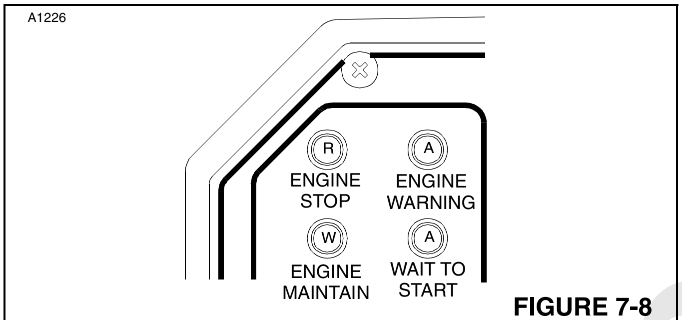


FIGURE 7-8

Engine Stop Light

When on, the red Engine Stop light indicates the need to ***stop engine as soon as safely possible***.

WARNING

If possible, lower lifted loads and then stop engine as soon as possible when stop light comes on. Permanent damage can occur if engine is run while stop light is on. Do not run engine until fault is corrected.

The red Engine Stop light and the yellow Engine Warning light to flash out active fault codes when engine is off.

Engine Warning Light

When on, the yellow Warning light indicates the need to ***repair fault at first available opportunity***.

Engine Maintain Light

When on, the white Engine Maintain light indicates the need to perform engine maintenance.

NOTE: The QSL 340 engine does not use an engine maintenance light.

Engine Off Diagnostics

To identify active faults, proceed as follows. A laminated list of fault codes is located in the operator's cab.

1. STOP engine.
2. Move key switch to RUN position.
3. Move hand throttle from low speed to high speed and back to low speed three times within five seconds.
4. If no active faults exist, WARNING and STOP lights come on but don't flash.
5. If active faults exist, following occurs:
   a. Yellow WARNING light flashes indicating that a fault code is about to be flashed.
   b. There is a 1 to 2-second pause.
   c. Red STOP light flashes a three-digit code to show which active fault has been detected (see Figure 7-9 for example). There is a 1 to 2-second pause between each number.
   d. When code is finished flashing red, there is a 1 to 2-second pause and yellow WARNING light flashes again.
   e. Same fault code flashes a second time before advancing to next code.

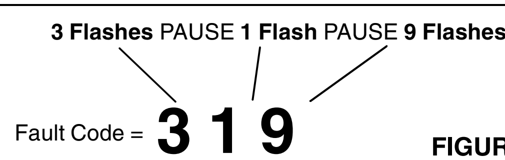


FIGURE 7-9

See laminated fault codes in operator's cab.

SECTION 8
UNDER CARRIAGE

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SECTION 8
UNDER CARRIAGE

TURNTABLE BEARING BOLT TORQUE

Bearing Installation

A dowel pin is installed in the inner ring as show in Figure 8-1, View B-B. Use the pin to align the inner ring with the rotating bed.

Torque Requirements

CAUTION

Crushing Injury Hazard!

Two people are required to torque turntable bearing bolts: an operator to operate swing control and a mechanic to torque bolts.

Mechanic must go inside carbody to torque inner turntable bearing bolts.

- Maintain constant communication between operator and mechanic while mechanic is inside carbody.
- Operator, do not swing rotating bed until instructed to do so by mechanic.

Mechanic, stay well clear of moving parts while upper is being swung to position bolts in access holes.

WARNING

Bolt Failure!

Loose or improperly torqued bolts cause bolts or turntable bearing to fail, possibly allowing rotating bed to break away from carbody.

Lubrication

Before installing the turntable bearing bolts, lubricate the threads of each bolt with Never-Seez (MCC No. 361010) or an equivalent antiseizing lubricant.

Torque Values

Torque each turntable bearing bolt to 1,300 ft-lb (1 763 Nm).

When new bolts are installed, torque the bolts in two steps: first to 450 ft-lb (610 Nm) and then to 1,300 ft-lb (1 763 Nm).

Torque Sequence

Torque the bolts (two at a time in most cases) in the numbered sequence given in Figure 8-1 (one ring at a time).

Torque Intervals

INITIAL OPERATION: torque all bolts to the specified value after the first 50 hours of operation.

YEARLY OR EVERY 2,000 HOURS OF OPERATION (whichever comes first): torque all bolts to the specified value.

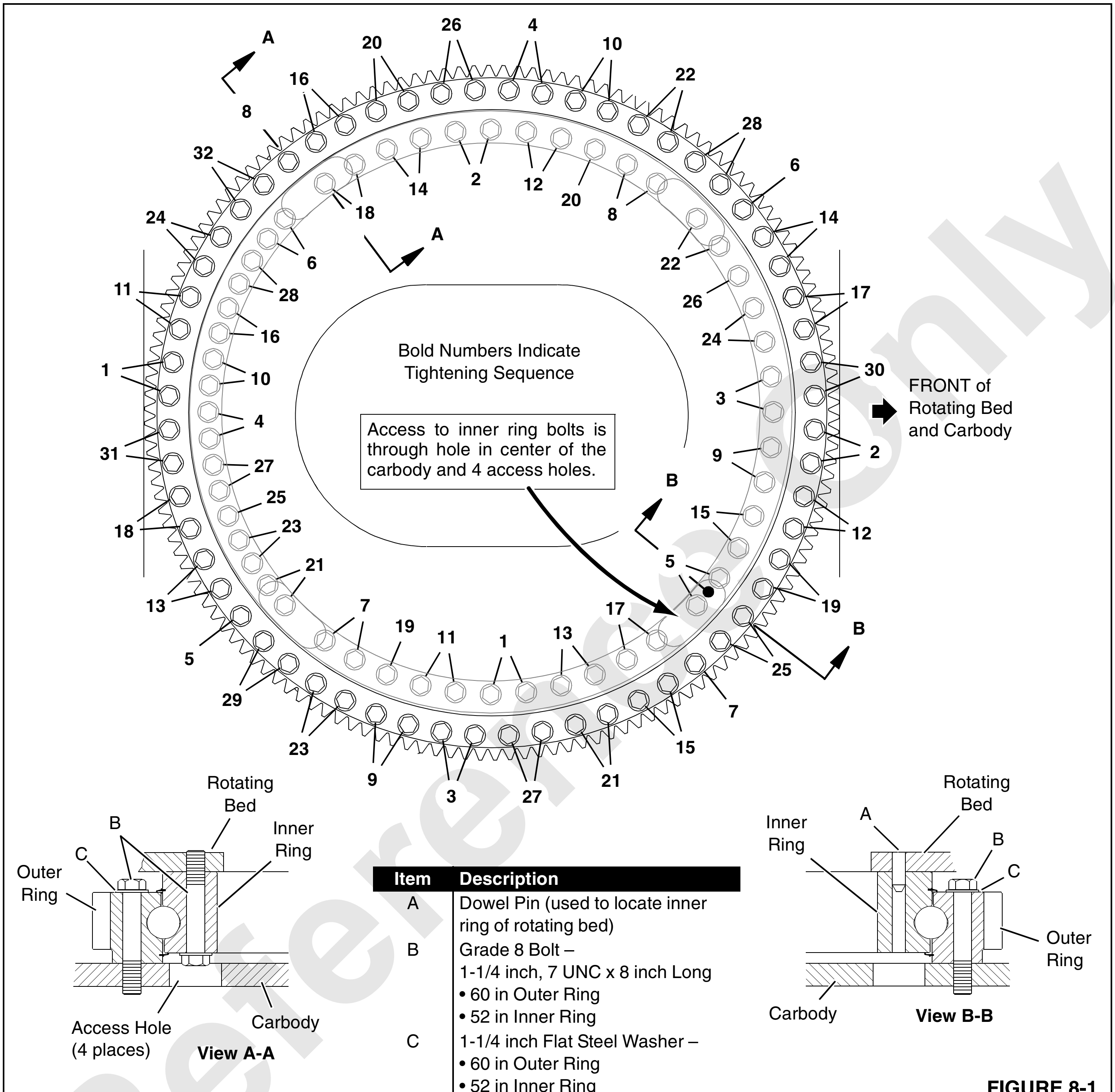
Bolt Replacement

If at the yearly inspection interval, one or more bolts are found to be torqued to less than 1,040 ft-lb (1 410 Nm), replace each loose bolt and washer. Also replace the bolt and washer on each side of each loose bolt.

If at the yearly inspection interval ten or more outer ring bolts or twelve or more inner ring bolts are found to be torqued to less than 1,040 ft-lb (1 410 Nm), replace all of the bolts and washers for the corresponding ring.

Replace all bolts and washers each time a new turntable bearing is installed.

8



Item	Description
A	Dowel Pin (used to locate inner ring of rotating bed)
B	Grade 8 Bolt – 1-1/4 inch, 7 UNC x 8 inch Long • 60 in Outer Ring • 52 in Inner Ring
C	1-1/4 inch Flat Steel Washer – • 60 in Outer Ring • 52 in Inner Ring

FIGURE 8-1

CRAWLER ADJUSTMENT

Maintenance

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

- Lubricate crawlers as instructed in Lubrication in Section 9 of this manual.
- Keep crawlers clean and avoid dirt build-up in crawler frame.
- Keep all mounting bolts tight (see Parts Manual for applicable torque values).
- Keep treads properly adjusted.
- Inspect crawler gear cases, crawler frames, rollers, and treads on a regular basis.

Look for oil leaks, excessive wear, cracks, and other damage. Broken or cracked parts can indicate that the treads are adjusted too tight.

Repair or replace damaged parts immediately to prevent further damage.

Tread Slack Adjustment

Adjustment Guideline

Check tread slack at the tumbler end of each crawler. Maintain equal tread slack at both crawlers.

1. Travel forward or reverse on a firm level surface so all tread slack is in top of treads at tumbler end of crawler.
2. Place straight edge on treads as shown in Figure 8-2. Gap between straight edge and top of treads at lowest point should be 1 in. (25 mm) (tight limit) to 2-1/2 in. (64 mm) (loose limit).
3. Adjust tread slack if gap exceeds loose limit or is less than tight limit.
4. Adjust treads tighter when operating on firm ground and looser when operating on soft ground (mud or sand).

CAUTION

Pin Damage!

Do not adjust treads too tight; tread pins will wear rapidly and may break. Dirt build-up will tighten treads even more, increasing possibility of damage.

More torque is required to drive tight treads, which results in faster wear and more fuel consumption.

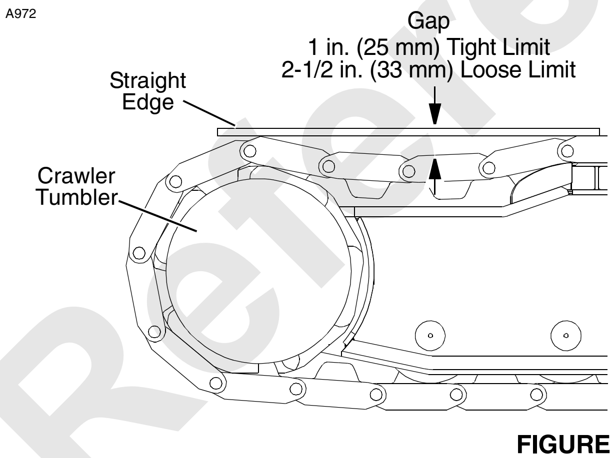


FIGURE 8-2

Adjustment Procedure

Adjust tread slack at primary roller end of each crawler (Figure 8-3):

1. Thoroughly clean crawler to be adjusted.
2. Loosen two bolts (1) at primary roller end of crawler (1 bolt, each side).
3. Remove cover (2) from both sides of crawler frame.
4. Place jack cylinder (3) on support (4).
5. Jack against rod (5) an equal amount on both sides of crawler frame.
6. Add or remove an equal thickness of shims (6) on both sides of crawler frame.
7. Remove jack cylinder (3).
8. Travel crane forward to tighten shims.
9. Check that dimension from center punch (A) in shaft to center punch line (B) in crawler frame is same on both sides of crawler to within 1/8 in. (3.2 mm).

CAUTION

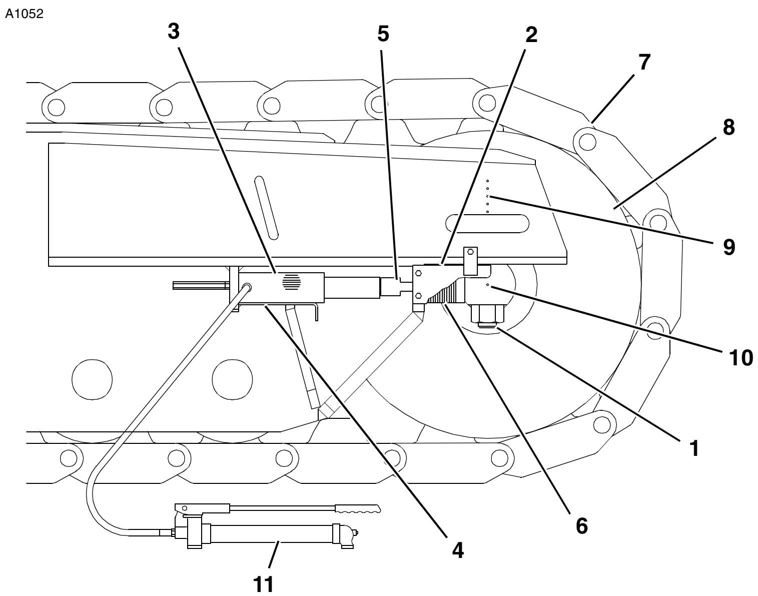
Part Wear!

Primary roller and tumbler must be square with crawler frame to within 1/8 in. (3.2 mm); otherwise, parts will wear rapidly.

10. Check for proper adjustment (see Adjustment Guideline) and readjust as required (steps 4 through 9).
11. Tighten nuts on bolts at primary roller to 1,000 ft-lb (1 356 Nm) lubricate with Never-Seez or an equivalent oil and graphite mixture.
12. Install cover (2) on both sides of crawler frame.

NOTE: The extreme limit of tread adjustment is when the bolts are tight against the front end of the slots in the crawler frame. One crawler tread should be removed when this limit is reached.

8



Item	Description
1	Bolt
2	Cover
3	Jack Cylinder
4	Support
5	Rod
6	Shims — 0.134 in (3 mm) and 0.250 in (6 mm) Thick
7	Tread
8	Front Roller
9	Center Punch Line B
10	Center Punch A
11	Hand Pump

FIGURE 8-3

HYDRAULIC HAND PUMP

See Figure 8-4 for following procedures.

WARNING
Prevent Possible Death or Serious Injury to Maintenance Personnel

Manitowoc has provided hand pump and cylinder for crawler adjustment only. Any other use is neither intended nor approved.

Wear safety glasses and other personal protective gear when operating hand pump.

Do not exceed maximum pressure rating of components (pump, cylinder, hose) – 10,000 psi (700 bar). Higher pressure can cause components to explode.

Do not set pump relief valve higher than 10,000 psi (700 bar). Higher pressure can cause components to explode.

Pump is not vented. It can explode if subjected to high pressure. Do not attempt to return more oil to pump than it is capable of holding. Do not overfill pump.

In some cases, pump handle can kickback. Always keep your body to side of pump, away from line of handle force.

Do not add extensions to handle. Extensions can cause unstable operation.

Assembly

1. Connect hose from pump outlet port to cylinder inlet.
2. Use 1-1/2 wraps of a high-grade thread sealant on fittings (for example, Teflon tape).

   Do not apply sealant to first complete thread to ensure tape does not shed into hydraulic system and cause malfunctioning or damage.
3. Do not overtighten connections. Connections only need to be snug and leak free. Overtightening can cause premature thread failure and may cause fittings or castings to split at lower than their rated pressures.

Maintenance

1. Keep unit clean and stored in a safe place where it cannot be damaged.
2. Keep oil in pump at proper level. Check level as follows:
   a. Open valve and fully retract cylinder rod to return all oil to pump. ***Cylinder must be fully retracted or system will contain too much oil.***
   b. For Simplex pump:
      - Place pump in horizontal position on a flat surface.
      - Using a screw driver, remove vent/fill cap.
      - Add hydraulic oil until reservoir is 2/3 full. ***Do not overfill.***
      - Securely reinstall vent/fill cap.
   c. For Enerpac pump:

- Place pump in vertical position with hose end down.
- Using a screw driver, remove vent/fill cap.
- Add hydraulic oil until it is at mark on dipstick. ***Do not overfill.***
- Securely reinstall vent/fill cap.

d. Test operation and remove air from system, if required. Recheck level after removing air.

Air Removal

1. Close valve finger tight only.

2. Position pump higher than cylinder and position cylinder so rod is down.

3. Operate pump to fully extend cylinder rod.

4. Open valve and retract cylinder rod to force oil and trapped air back into pump.

5. Repeat steps until cylinder operates smoothly. ***Erratic operation indicates air in system.***

Operation

1. Before using pump:

a. Check that all fittings are tight and leak free.

b. Check oil level.

2. To pressurize cylinder and extend rod, close valve by turning clockwise until finger tight only. Then pump handle up and down.

Pressure will be maintained until valve is opened.

To reduce handle effort at high pressure, use short strokes. Maximum leverage is obtained in last five degrees of stroke.

3. To depressurize cylinder, push handle down fully and open valve by turning counterclockwise.

4. Pump can be operated in any position from horizontal to vertical as long as ***hose end of pump is down***.

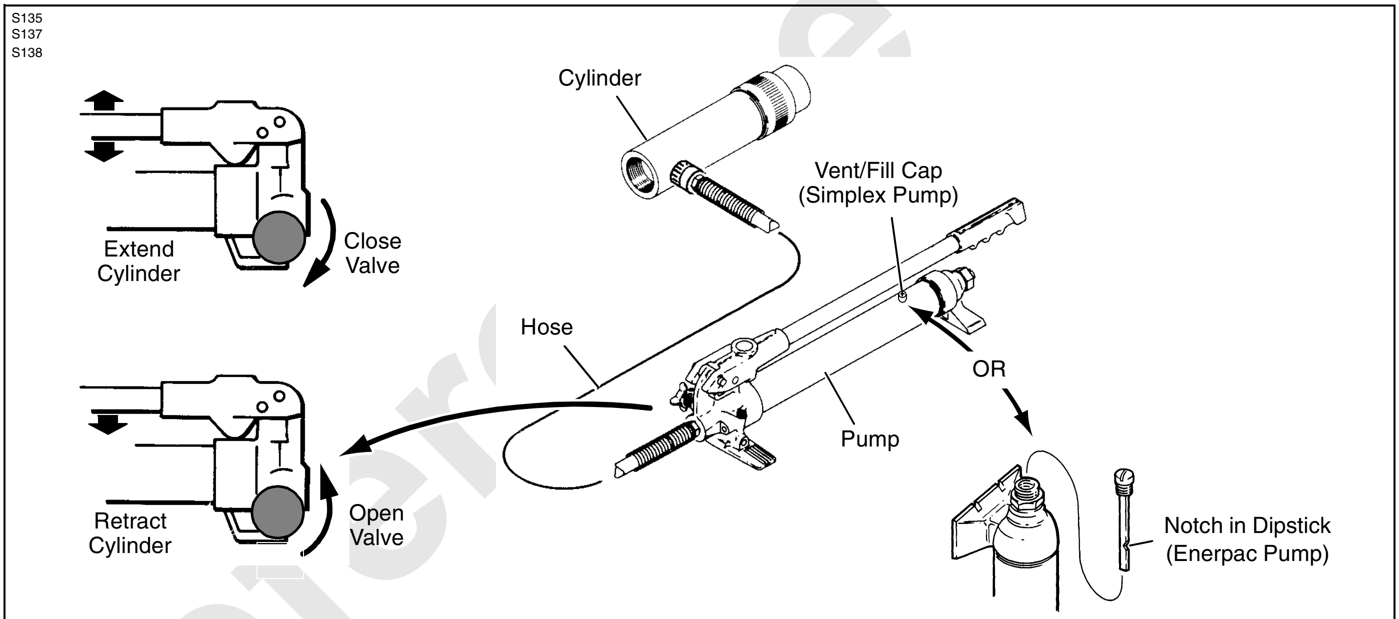


FIGURE 8-4

8

SECTION 9
LUBRICATION

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SECTION 9
LUBRICATION

LUBRICATION

See F2107 at the end of this section.

SECTION 10
TROUBLESHOOTING

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SECTION 10
TROUBLESHOOTING

INTRODUCTION

This troubleshooting section is designed for qualified service technicians familiar with the operation and repair of electrical and hydraulic equipment. It is not possible to predict all problems that might occur or the correct procedure for troubleshooting each problem. ***If a problem is encountered that is not covered in this manual, first consult your Dealer. The factory Service Department can provide assistance, if necessary.***

The first part of this section provides a series of flow charts that identify problems that could be encountered during normal operation of the Model 777. These charts contain instructions to assist in identifying and correcting problems. Follow the procedural steps in the order indicated. Some steps direct you to other charts in this manual or reference a specific test that must be performed to move through the complete troubleshooting procedure. If directed, consult the dealer or factory Service Department before proceeding.

The second part of this section contains specific instructions for testing and servicing the various systems and components described in the troubleshooting charts.

SAFETY SUMMARY

Hazards are always a possibility when performing trouble-shooting operations on heavy equipment. To minimize the risk of potential hazards and to prevent serious injury or death, you must comply with the following:

- Carefully read the Section 1 of this manual before beginning troubleshooting operations.
- You must be a qualified service technician, competent in the repair and testing of electrical and hydraulic equipment. MANITOWOC CRANES INC. shall not be responsible for the training of personnel who might use this manual to perform the troubleshooting operations.
- Whenever possible, turn off the engine for your protection and keep unauthorized personnel away from the crane when troubleshooting.
- Never troubleshoot the crane alone. Always perform troubleshooting procedures with a qualified operator in the crane cab. Maintain constant communications with this operator when performing operations that require the crane to be running.
- Do not return crane to service after completion of maintenance or repair procedures until all guards and covers have been re-installed, trapped air is bled from hydraulic systems, safety devices are re-activated and maintenance equipment is removed.
- Perform a function check to ensure correct operation at the completion of maintenance or repair operations.

The following warnings apply to all troubleshooting operations. MANITOWOC CRANES INC. can not foresee all hazards that may occur.

You must be familiar with the equipment, trained in testing methods, and use common sense while troubleshooting to avoid other hazards.

WARNING

Eye, Skin, And Respiratory Hazards!

Wear proper eye and skin protection and avoid direct contact with battery acid, oil, or ether spray when searching for leaks, opening connections, or installing pressure gauges.

Pressurized hydraulic oil can cause serious injury. Turn ***off*** engine, remove key, and relieve pressure on system before disconnecting, adjusting, or repairing any component.

Ensure that connections are made correctly, O-rings or gaskets are in place, and connectors are tight before pressurizing system.

Use necessary precautions to prevent electrical burns when checking battery charging and starter circuits.

Death or serious injury can occur if these warnings are ignored.

WARNING

Unexpected Moving Part Hazard!

Keep personnel away from crane while manually actuating a valve or pump to avoid unexpected equipment movement that can cause death or serious injury.

GENERAL GUIDELINES

The following guidelines apply to all troubleshooting operations:

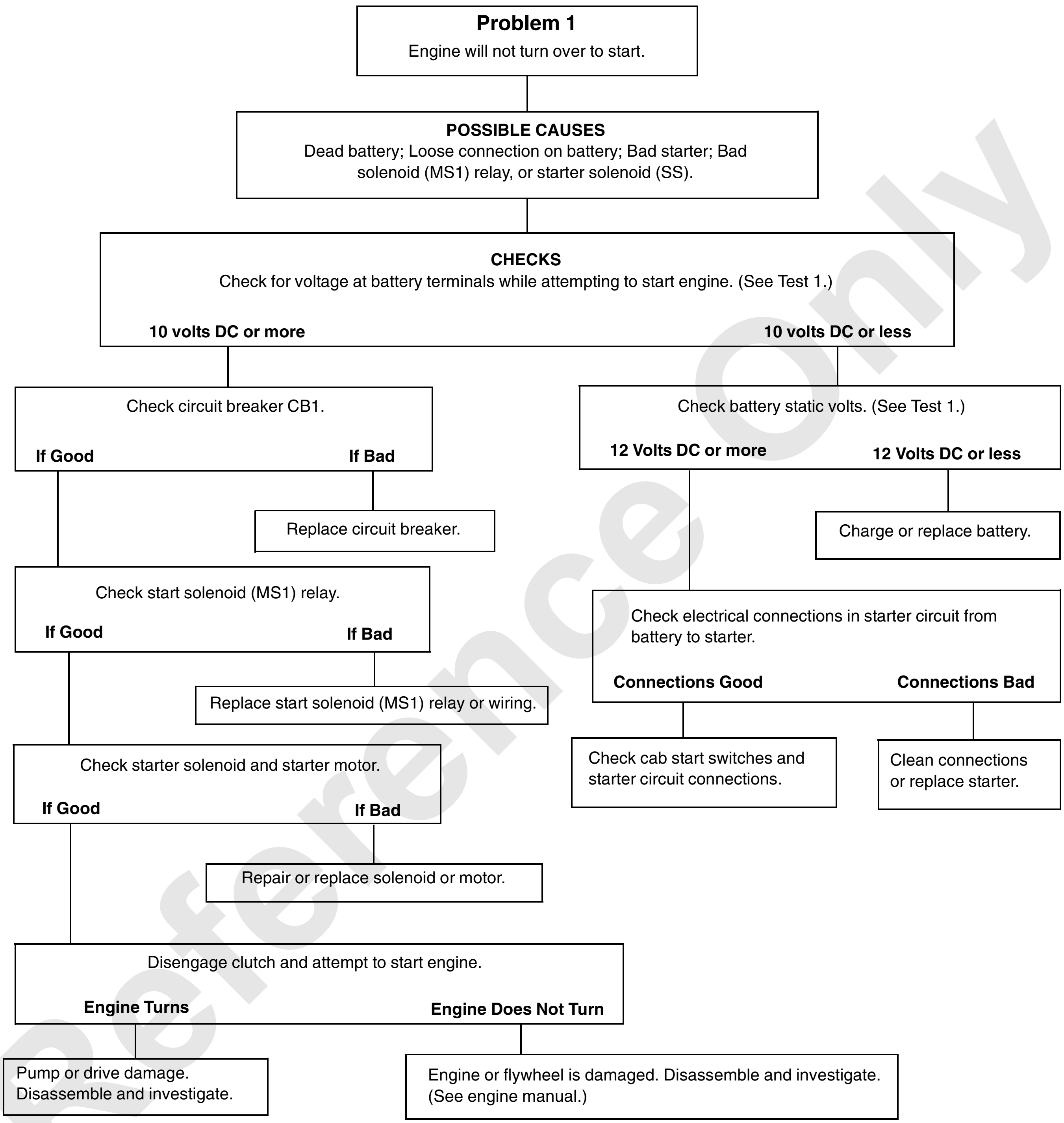
- Do not remove cylinders or counterbalance valve(s) from a cylinder until its working unit is restrained against movement.
- Do not use your hands to check for hydraulic oil leaks. Use a piece of cardboard to check for hydraulic oil leaks.
- Use gauges of the correct pressure range when checking hydraulic circuits.

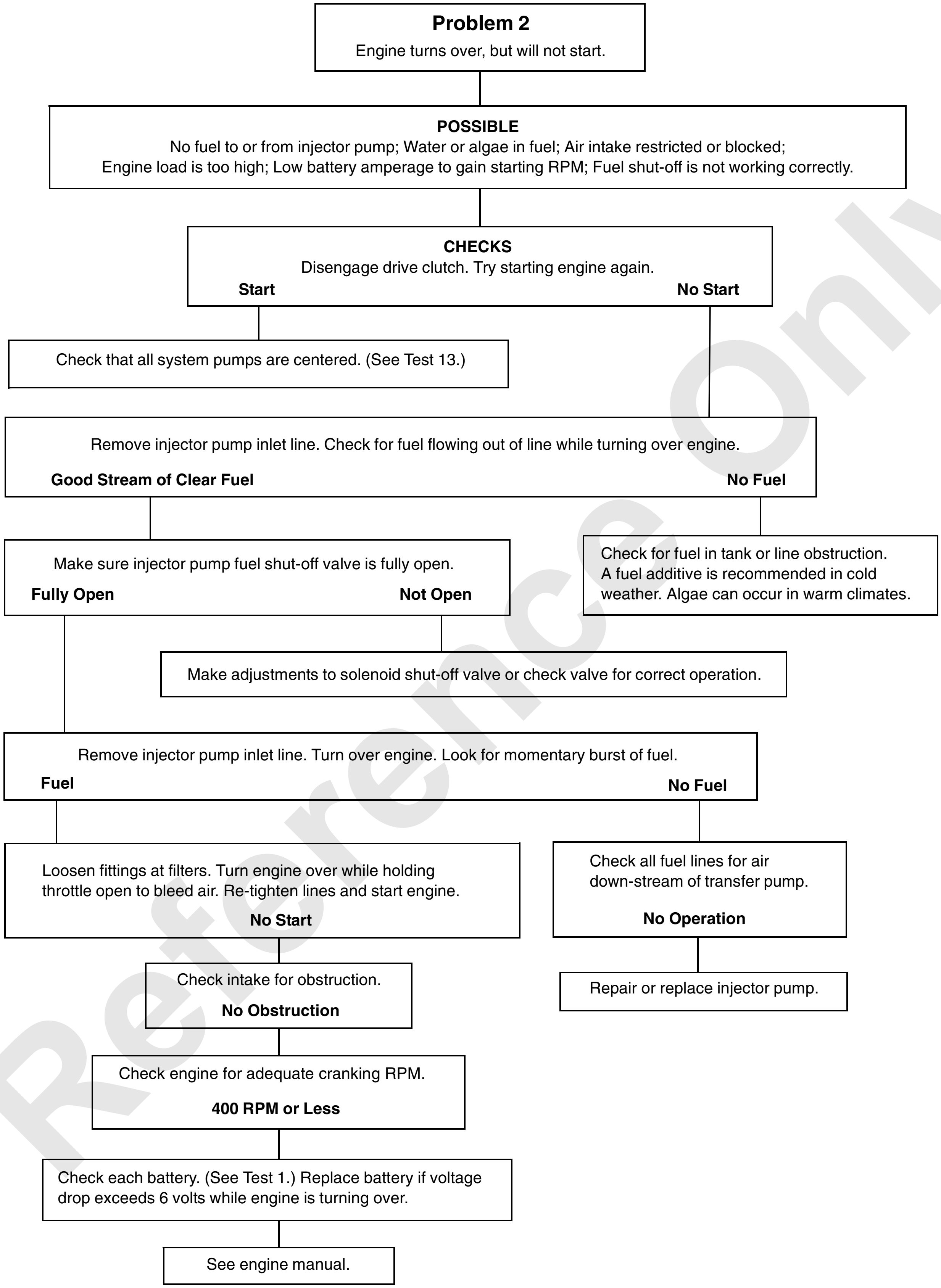
- Use the standard test plug adapters (available from MANITOWOC CRANES INC.) for electrical testing.
- Check ground potentials when testing electric circuits for continuity, voltage, or resistance. When checking voltages, use ground point for circuit being checked. If voltage does not register on multi-meter, use a known ground. If a value is read, the ground of the circuit under test is probably faulty.
- Check all terminal points for cleanliness and tighten connections.
- Check pressures at the specified hydraulic component ports.
- Check the motor pressure control pilot (PCP) valve on the motor under test. Test the pump electric displacement controls (EDC) on the pump under test.
- Check each pressure sender electric supply at the system sender.
- Check the encoder electric supply at the test plug adapter of the encoder under test.
- Check the correct operating limit electric supply by viewing the diagnostic display in the operator's cab.
- Check the control handle electrical input and output voltages at the control handle under test.
- Check the basic system electric supplies and cab power relay at the fuse box mounted above the main electrical junction box in the operator's cab.
- Check the programmable controller (PC) input and output cables at the connector pins.

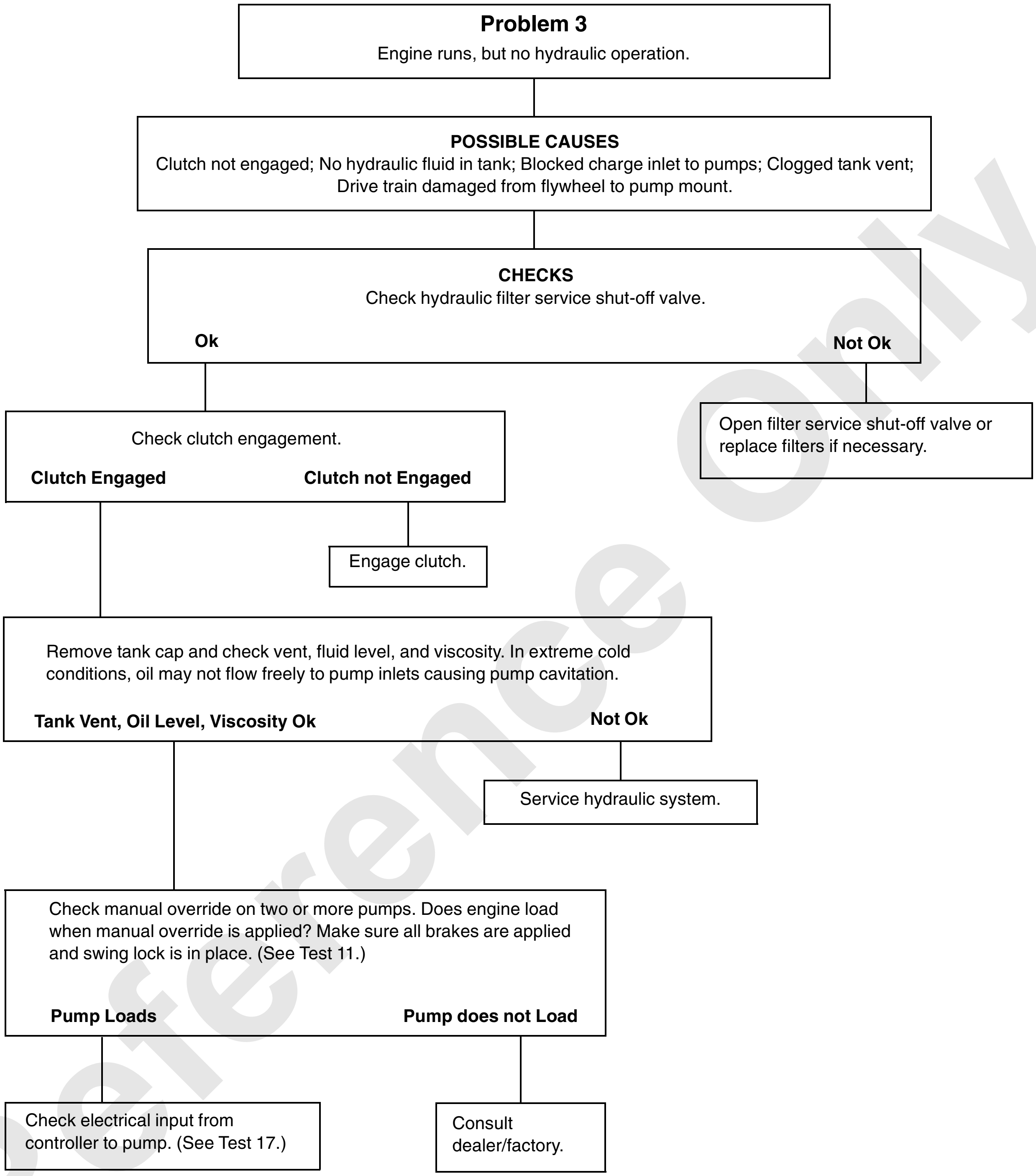
TEST EQUIPMENT

The test equipment shown or described is available for testing the crane hydraulic or electrical systems. This equipment can be purchased in kit form (with or without carrying case) or separately, by contacting the factory Parts Department.

TROUBLESHOOTING CHARTS




Problem 2
Engine turns over, but will not start.
POSSIBLE
No fuel to or from injector pump; Water or algae in fuel; Air intake restricted or blocked;
Engine load is too high; Low battery amperage to gain starting RPM; Fuel shut-off is not working correctly.
CHECKS
Disengage drive clutch. Try starting engine again.
Start
No Start
Check that all system pumps are centered. (See Test 13.)
Remove injector pump inlet line. Check for fuel flowing out of line while turning over engine.
Good Stream of Clear Fuel
No Fuel
Make sure injector pump fuel shut-off valve is fully open.
Fully Open
Not Open
Check for fuel in tank or line obstruction. A fuel additive is recommended in cold weather. Algae can occur in warm climates.
Make adjustments to solenoid shut-off valve or check valve for correct operation.
Remove injector pump inlet line. Turn over engine. Look for momentary burst of fuel.
Fuel
No Fuel
Loosen fittings at filters. Turn engine over while holding throttle open to bleed air. Re-tighten lines and start engine.
No Start
Check all fuel lines for air down-stream of transfer pump.
No Operation
Check intake for obstruction.
No Obstruction
Repair or replace injector pump.
Check engine for adequate cranking RPM.
400 RPM or Less
Check each battery. (See Test 1.) Replace battery if voltage drop exceeds 6 volts while engine is turning over.
See engine manual.


Problem 3
Engine runs, but no hydraulic operation.
POSSIBLE CAUSES
Clutch not engaged; No hydraulic fluid in tank; Blocked charge inlet to pumps; Clogged tank vent; Drive train damaged from flywheel to pump mount.
CHECKS
Check hydraulic filter service shut-off valve.
Ok
Not Ok
Open filter service shut-off valve or replace filters if necessary.
Check clutch engagement.
Clutch Engaged
Clutch not Engaged
Engage clutch.
Remove tank cap and check vent, fluid level, and viscosity. In extreme cold conditions, oil may not flow freely to pump inlets causing pump cavitation.
Tank Vent, Oil Level, Viscosity Ok
Not Ok
Service hydraulic system.
Check manual override on two or more pumps. Does engine load when manual override is applied? Make sure all brakes are applied and swing lock is in place. (See Test 11.)
Pump Loads
Pump does not Load
Check electrical input from controller to pump. (See Test 17.)
Consult dealer/factory.

Problem 4

Engine runs, but battery is not charging.

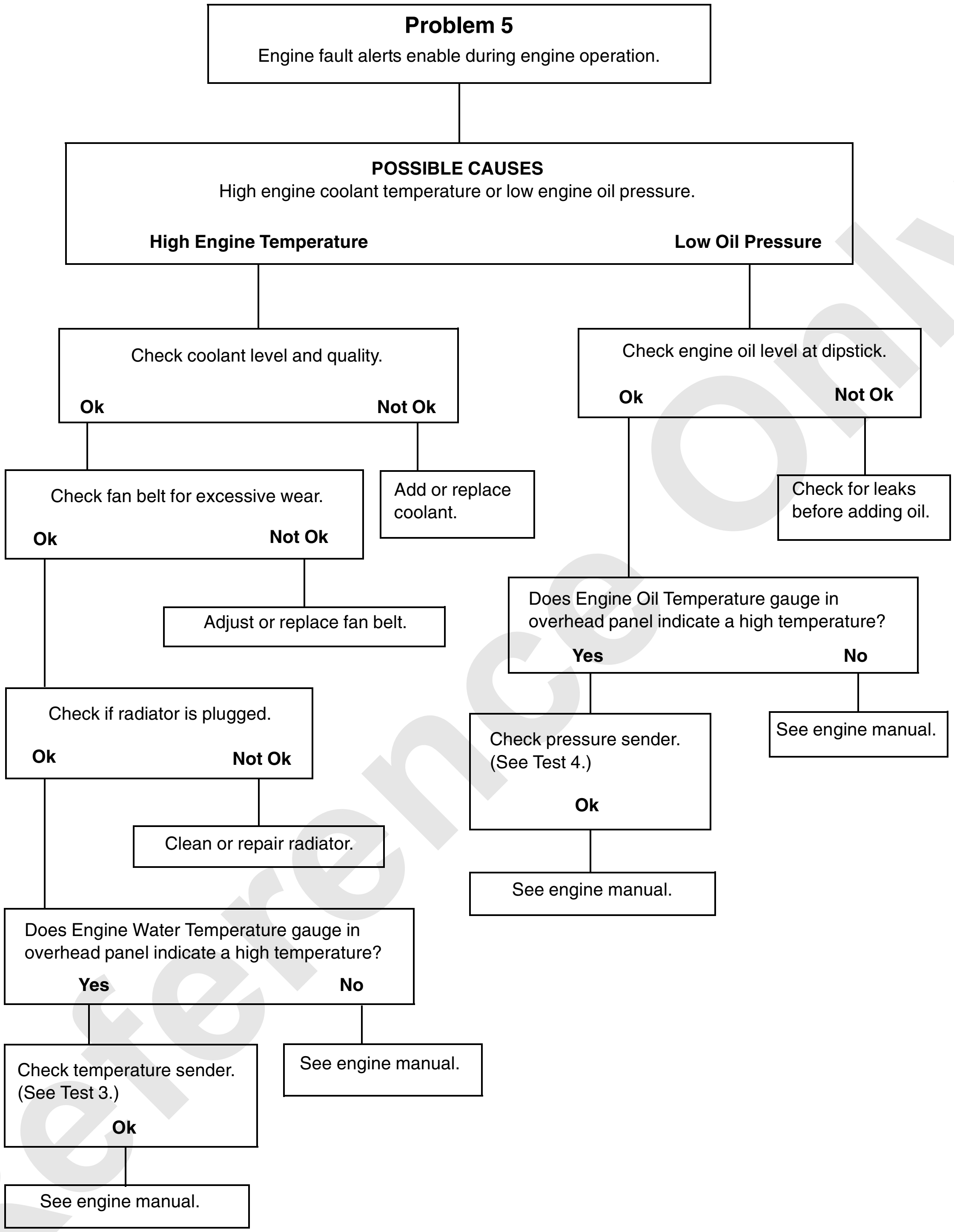
POSSIBLE CAUSES

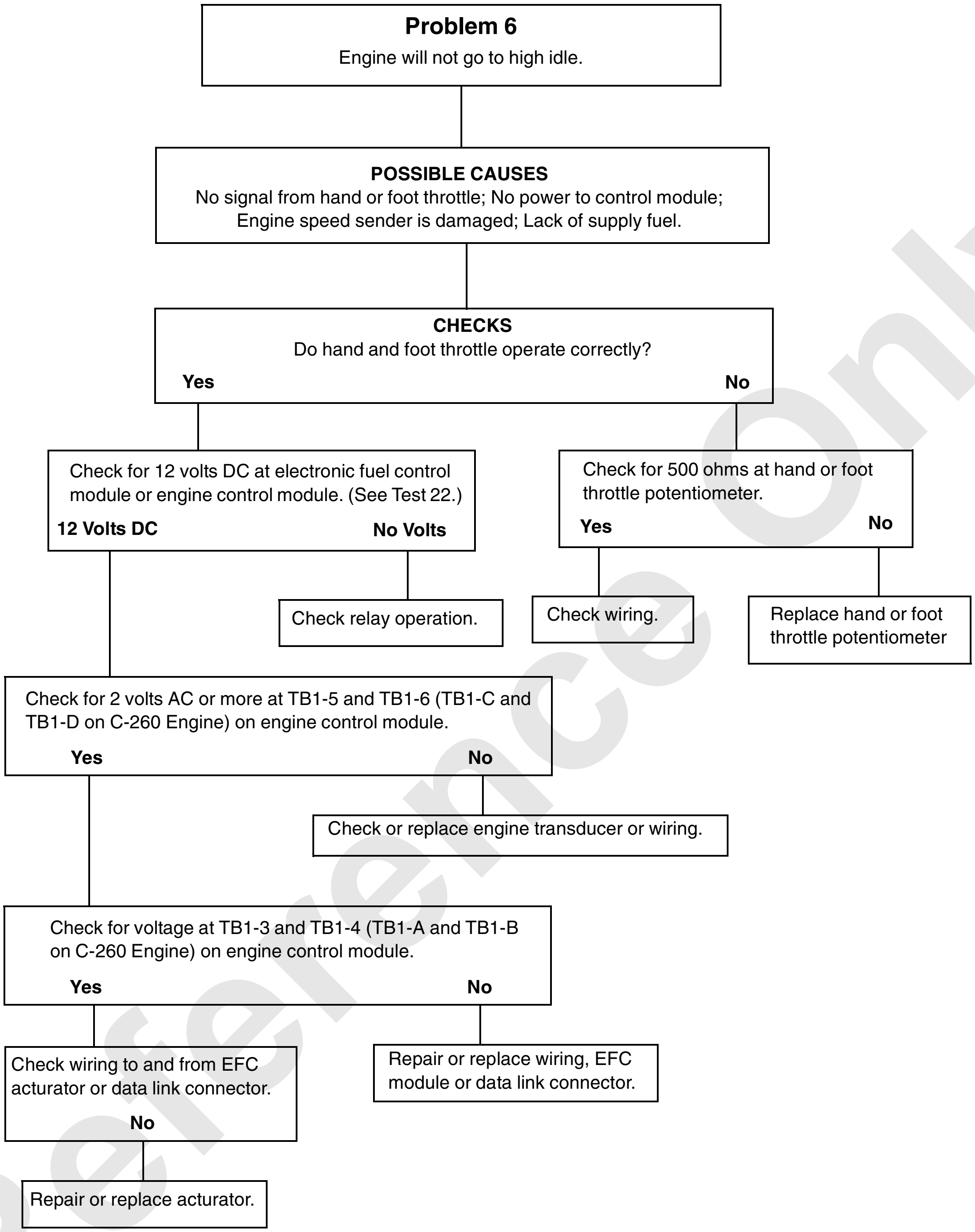
Belt loose or broken; No input to alternator terminals; Damaged alternator; Corroded or loose battery connection; Battery charge is low.

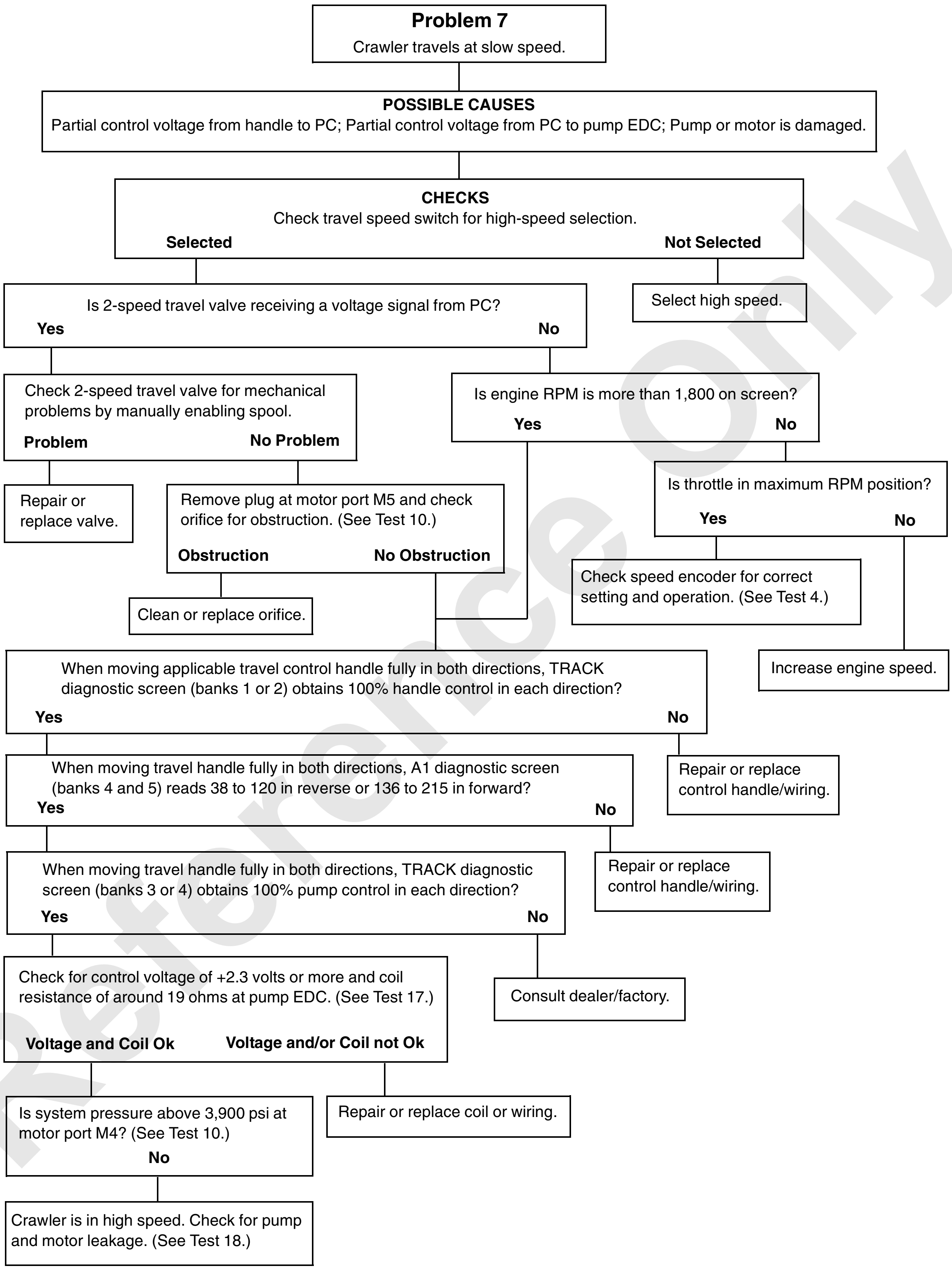
CHECKS

Check drive belt for correct tension.
(See engine manual for drive belt deflection specifications.)

- **Ok**: Connect voltmeter between alternator 12-volt terminal and ground terminal. Take reading with cab power ON and engine running.
  - **Zero Volts DC**: Repair wiring or connections.
  - **13.6 Volts DC or less**: Replace alternator.
  - **13.6 Volts DC or more**: Test batteries for weak cells.
- **Not Ok**: Tighten drive belt or replace belt.


Problem 5
Engine fault alerts enable during engine operation.
POSSIBLE CAUSES
High engine coolant temperature or low engine oil pressure.
High Engine Temperature
Low Oil Pressure
Check coolant level and quality.
Ok
Not Ok
Add or replace coolant.
Check fan belt for excessive wear.
Ok
Not Ok
Adjust or replace fan belt.
Check if radiator is plugged.
Ok
Not Ok
Clean or repair radiator.
Does Engine Water Temperature gauge in overhead panel indicate a high temperature?
Yes
No
Check temperature sender. (See Test 3.)
Ok
See engine manual.
See engine manual.
Check engine oil level at dipstick.
Ok
Not Ok
Check for leaks before adding oil.
Does Engine Oil Temperature gauge in overhead panel indicate a high temperature?
Yes
No
Check pressure sender. (See Test 4.)
Ok
See engine manual.
See engine manual.


Problem 6
Engine will not go to high idle.
POSSIBLE CAUSES
No signal from hand or foot throttle; No power to control module; Engine speed sender is damaged; Lack of supply fuel.
CHECKS
Do hand and foot throttle operate correctly?
Yes
No
Check for 12 volts DC at electronic fuel control module or engine control module. (See Test 22.)
12 Volts DC
No Volts
Check relay operation.
Check for 500 ohms at hand or foot throttle potentiometer.
Yes
No
Check wiring.
Replace hand or foot throttle potentiometer
Check for 2 volts AC or more at TB1-5 and TB1-6 (TB1-C and TB1-D on C-260 Engine) on engine control module.
Yes
No
Check or replace engine transducer or wiring.
Check for voltage at TB1-3 and TB1-4 (TB1-A and TB1-B on C-260 Engine) on engine control module.
Yes
No
Check wiring to and from EFC acturator or data link connector.
No
Repair or replace acturator.
Repair or replace wiring, EFC module or data link connector.


Problem 7
Crawler travels at slow speed.
POSSIBLE CAUSES
Partial control voltage from handle to PC; Partial control voltage from PC to pump EDC; Pump or motor is damaged.
CHECKS
Check travel speed switch for high-speed selection.
Selected
Not Selected
Is 2-speed travel valve receiving a voltage signal from PC?
Yes
No
Select high speed.
Check 2-speed travel valve for mechanical problems by manually enabling spool.
Problem
No Problem
Is engine RPM is more than 1,800 on screen?
Yes
No
Is throttle in maximum RPM position?
Yes
No
Repair or replace valve.
Remove plug at motor port M5 and check orifice for obstruction. (See Test 10.)
Obstruction
No Obstruction
Check speed encoder for correct setting and operation. (See Test 4.)
Clean or replace orifice.
Increase engine speed.
When moving applicable travel control handle fully in both directions, TRACK diagnostic screen (banks 1 or 2) obtains 100% handle control in each direction?
Yes
No
When moving travel handle fully in both directions, A1 diagnostic screen (banks 4 and 5) reads 38 to 120 in reverse or 136 to 215 in forward?
Yes
No
Repair or replace control handle/wiring.
When moving travel handle fully in both directions, TRACK diagnostic screen (banks 3 or 4) obtains 100% pump control in each direction?
Yes
No
Repair or replace control handle/wiring.
Check for control voltage of +2.3 volts or more and coil resistance of around 19 ohms at pump EDC. (See Test 17.)
Voltage and Coil Ok
Voltage and/or Coil not Ok
Consult dealer/factory.
Is system pressure above 3,900 psi at motor port M4? (See Test 10.)
No
Repair or replace coil or wiring.
Crawler is in high speed. Check for pump and motor leakage. (See Test 18.)

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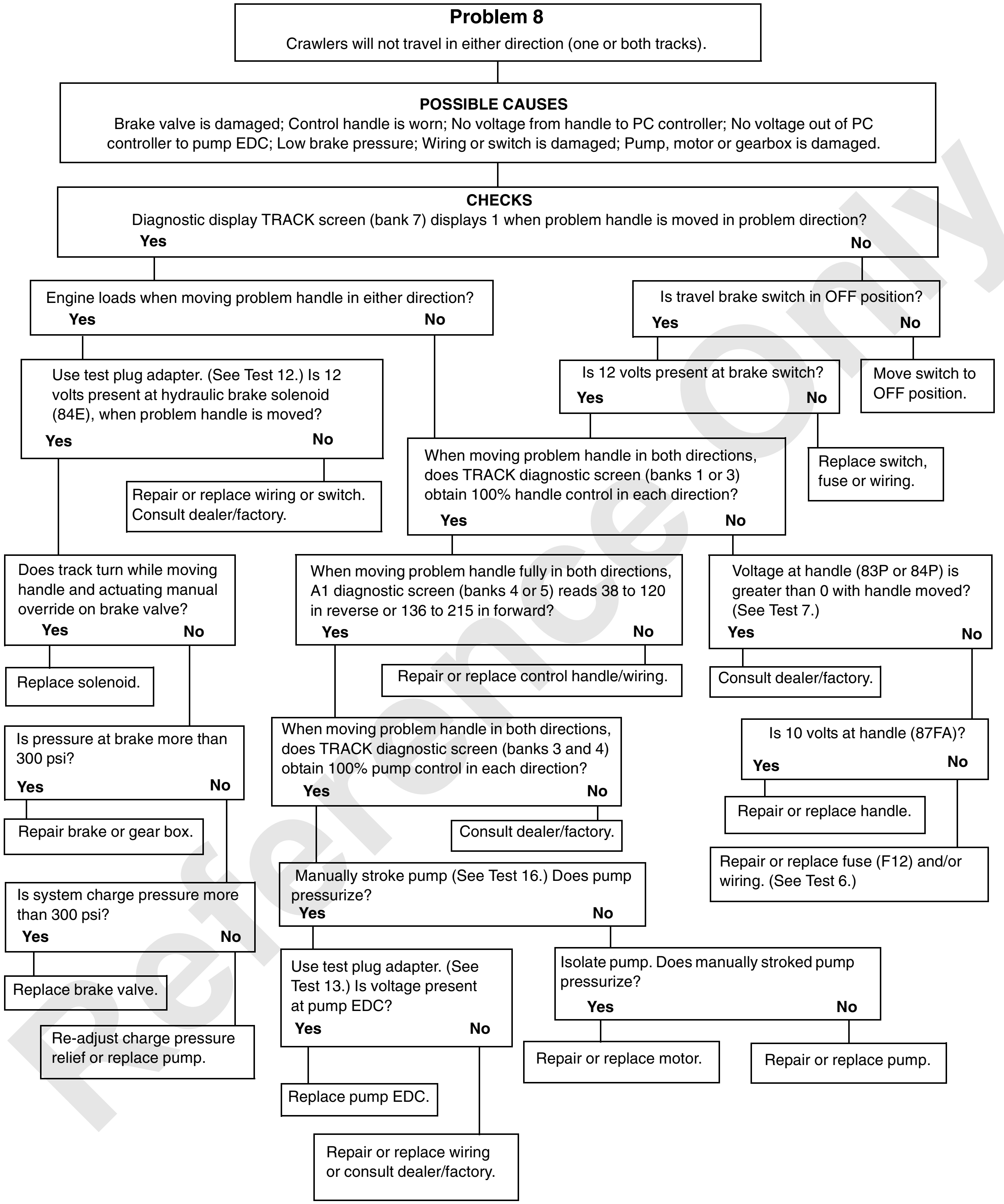
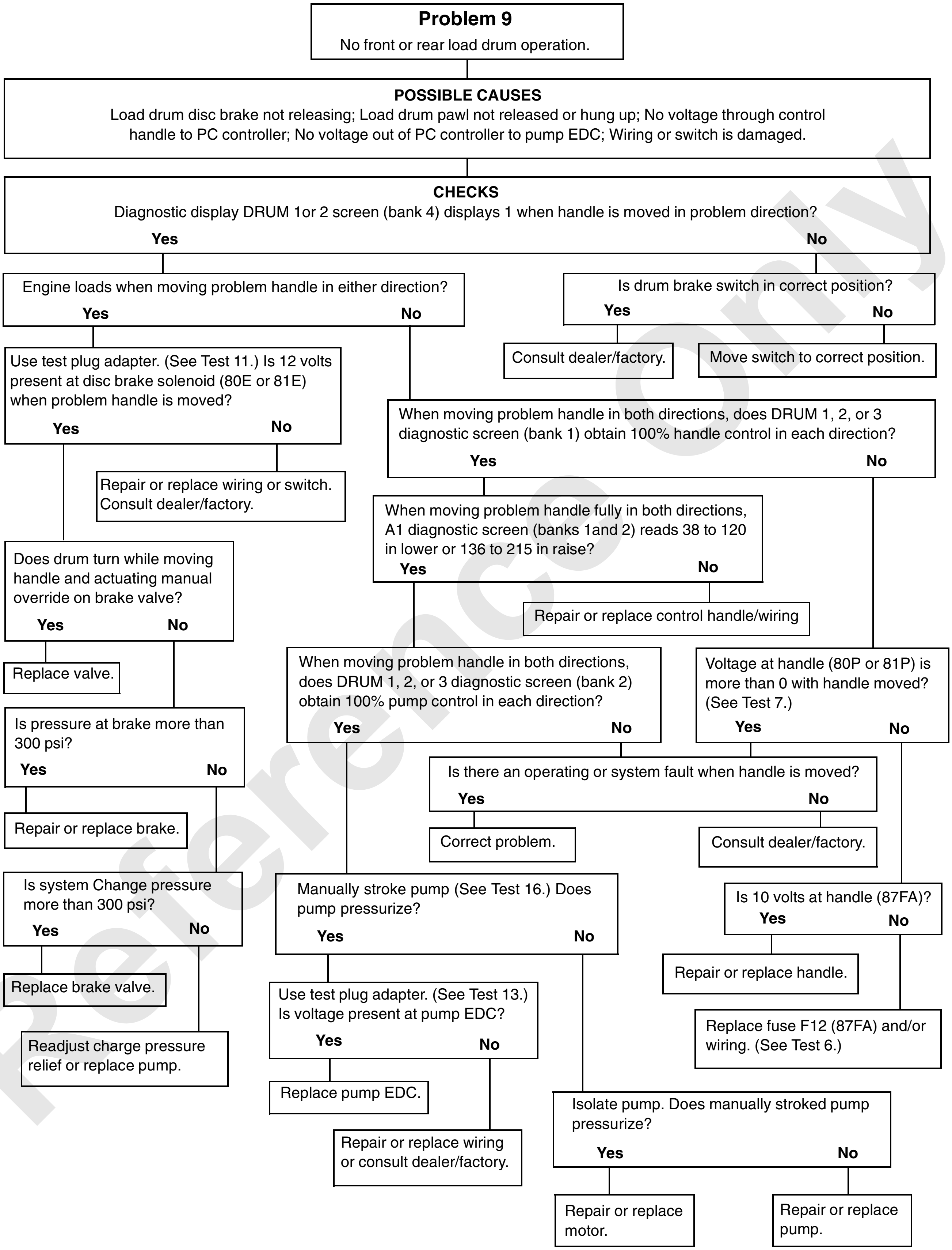

Problem 8
Crawlers will not travel in either direction (one or both tracks).
POSSIBLE CAUSES
Brake valve is damaged; Control handle is worn; No voltage from handle to PC controller; No voltage out of PC controller to pump EDC; Low brake pressure; Wiring or switch is damaged; Pump, motor or gearbox is damaged.
CHECKS
Diagnostic display TRACK screen (bank 7) displays 1 when problem handle is moved in problem direction?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is travel brake switch in OFF position?
Yes
No
Use test plug adapter. (See Test 12.) Is 12 volts present at hydraulic brake solenoid (84E), when problem handle is moved?
Yes
No
Is 12 volts present at brake switch?
Yes
No
Move switch to OFF position.
Repair or replace wiring or switch. Consult dealer/factory.
When moving problem handle in both directions, does TRACK diagnostic screen (banks 1 or 3) obtain 100% handle control in each direction?
Yes
No
Replace switch, fuse or wiring.
Does track turn while moving handle and actuating manual override on brake valve?
Yes
No
When moving problem handle fully in both directions, A1 diagnostic screen (banks 4 or 5) reads 38 to 120 in reverse or 136 to 215 in forward?
Yes
No
Voltage at handle (83P or 84P) is greater than 0 with handle moved? (See Test 7.)
Yes
No
Replace solenoid.
Repair or replace control handle/wiring.
Consult dealer/factory.
Is pressure at brake more than 300 psi?
Yes
No
When moving problem handle in both directions, does TRACK diagnostic screen (banks 3 and 4) obtain 100% pump control in each direction?
Yes
No
Is 10 volts at handle (87FA)?
Yes
No
Repair brake or gear box.
Consult dealer/factory.
Repair or replace handle.
Is system charge pressure more than 300 psi?
Yes
No
Manually stroke pump (See Test 16.) Does pump pressurize?
Yes
No
Repair or replace fuse (F12) and/or wiring. (See Test 6.)
Replace brake valve.
Use test plug adapter. (See Test 13.) Is voltage present at pump EDC?
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Re-adjust charge pressure relief or replace pump.
Repair or replace motor.
Repair or replace pump.
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.



Problem 9
No front or rear load drum operation.
POSSIBLE CAUSES
Load drum disc brake not releasing; Load drum pawl not released or hung up; No voltage through control handle to PC controller; No voltage out of PC controller to pump EDC; Wiring or switch is damaged.
CHECKS
Diagnostic display DRUM 1or 2 screen (bank 4) displays 1 when handle is moved in problem direction?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is drum brake switch in correct position?
Yes
No
Consult dealer/factory.
Move switch to correct position.
Use test plug adapter. (See Test 11.) Is 12 volts present at disc brake solenoid (80E or 81E) when problem handle is moved?
Yes
No
When moving problem handle in both directions, does DRUM 1, 2, or 3 diagnostic screen (bank 1) obtain 100% handle control in each direction?
Yes
No
Repair or replace wiring or switch. Consult dealer/factory.
When moving problem handle fully in both directions, A1 diagnostic screen (banks 1and 2) reads 38 to 120 in lower or 136 to 215 in raise?
Yes
No
Does drum turn while moving handle and actuating manual override on brake valve?
Yes
No
Repair or replace control handle/wiring
Replace valve.
When moving problem handle in both directions, does DRUM 1, 2, or 3 diagnostic screen (bank 2) obtain 100% pump control in each direction?
Yes
No
Voltage at handle (80P or 81P) is more than 0 with handle moved? (See Test 7.)
Yes
No
Is pressure at brake more than 300 psi?
Yes
No
Is there an operating or system fault when handle is moved?
Yes
No
Repair or replace brake.
Correct problem.
Consult dealer/factory.
Is system Change pressure more than 300 psi?
Yes
No
Manually stroke pump (See Test 16.) Does pump pressurize?
Yes
No
Is 10 volts at handle (87FA)?
Yes
No
Repair or replace handle.
Replace brake valve.
Use test plug adapter. (See Test 13.) Is voltage present at pump EDC?
Yes
No
Replace fuse F12 (87FA) and/or wiring. (See Test 6.)
Readjust charge pressure relief or replace pump.
Replace pump EDC.
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Repair or replace wiring or consult dealer/factory.
Repair or replace motor.
Repair or replace pump.

Problem 10

Front or rear load drum will not raise load, but will lower load.

POSSIBLE CAUSES

Block up limit is opened; Pump is damaged; Rated Capacity Indicator/Limiter (RCL) circuit is open; Control handle is worn; Maximum bail limit is opened; Speed sender is damaged.

CHECKS

Check diagnostic screen D2. (See Diagnostic Display topic in Section 3.)

When applicable switch is enabled…

Bank 1 changed by 2 (front), or 64 (rear) . . . . Maximum bail limit

Bank 1 changed by 32. . . . . Block-up limit

Bank 4 changed by 2. . . . . Rated capacity indicator/limiter

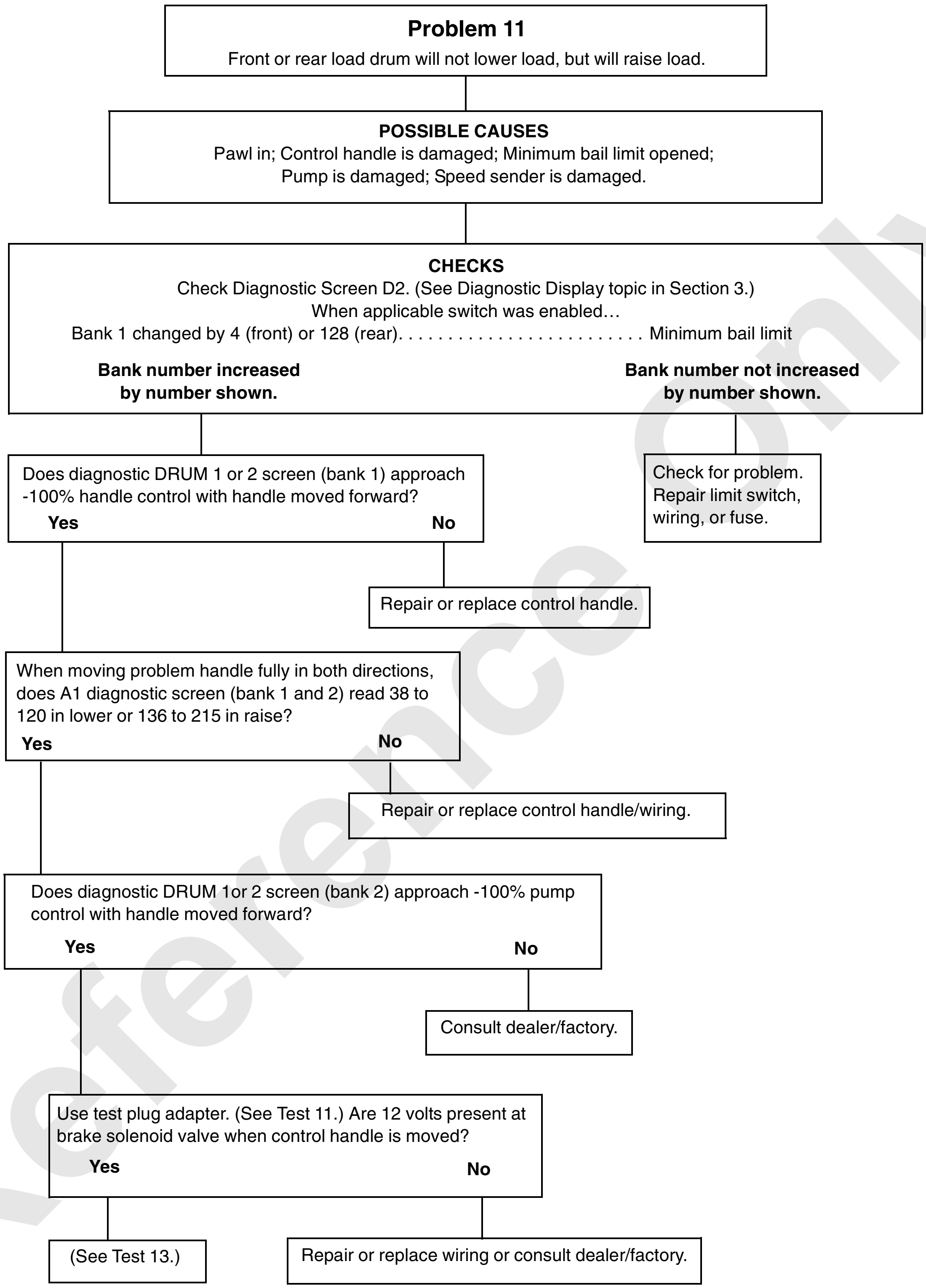
Bank numbers increased by number shown.

Diagnostic DRUM 1 or 2 screen (bank 1) approaches -100% handle control with handle moved forward.

- **Yes** → Diagnostic DRUM 1 or 2 screen (bank 2) approaches -100% pump control with handle moved forward.
  - **Yes** → Use test plug adapter. (See Test 15.) Are 12 volts present at brake solenoid valve when control handle is moved?
    - **Yes** → (See Test 5.)
    - **No** → Repair or replace wiring or consult dealer/factory.
  - **No** → Consult dealer/factory.
- **No** → Repair or replace control handle.

Bank number not increased by number shown.

Check for problem. Repair limit switch, wiring, or fuse.


Problem 11
Front or rear load drum will not lower load, but will raise load.
POSSIBLE CAUSES
Pawl in; Control handle is damaged; Minimum bail limit opened;
Pump is damaged; Speed sender is damaged.
CHECKS
Check Diagnostic Screen D2. (See Diagnostic Display topic in Section 3.)
When applicable switch was enabled…
Bank 1 changed by 4 (front) or 128 (rear). . . . . Minimum bail limit
Bank number increased by number shown.
Bank number not increased by number shown.
Check for problem. Repair limit switch, wiring, or fuse.
Does diagnostic DRUM 1 or 2 screen (bank 1) approach -100% handle control with handle moved forward?
Yes
No
Repair or replace control handle.
When moving problem handle fully in both directions, does A1 diagnostic screen (bank 1 and 2) read 38 to 120 in lower or 136 to 215 in raise?
Yes
No
Repair or replace control handle/wiring.
Does diagnostic DRUM 1or 2 screen (bank 2) approach -100% pump control with handle moved forward?
Yes
No
Consult dealer/factory.
Use test plug adapter. (See Test 11.) Are 12 volts present at brake solenoid valve when control handle is moved?
Yes
No
(See Test 13.)
Repair or replace wiring or consult dealer/factory.

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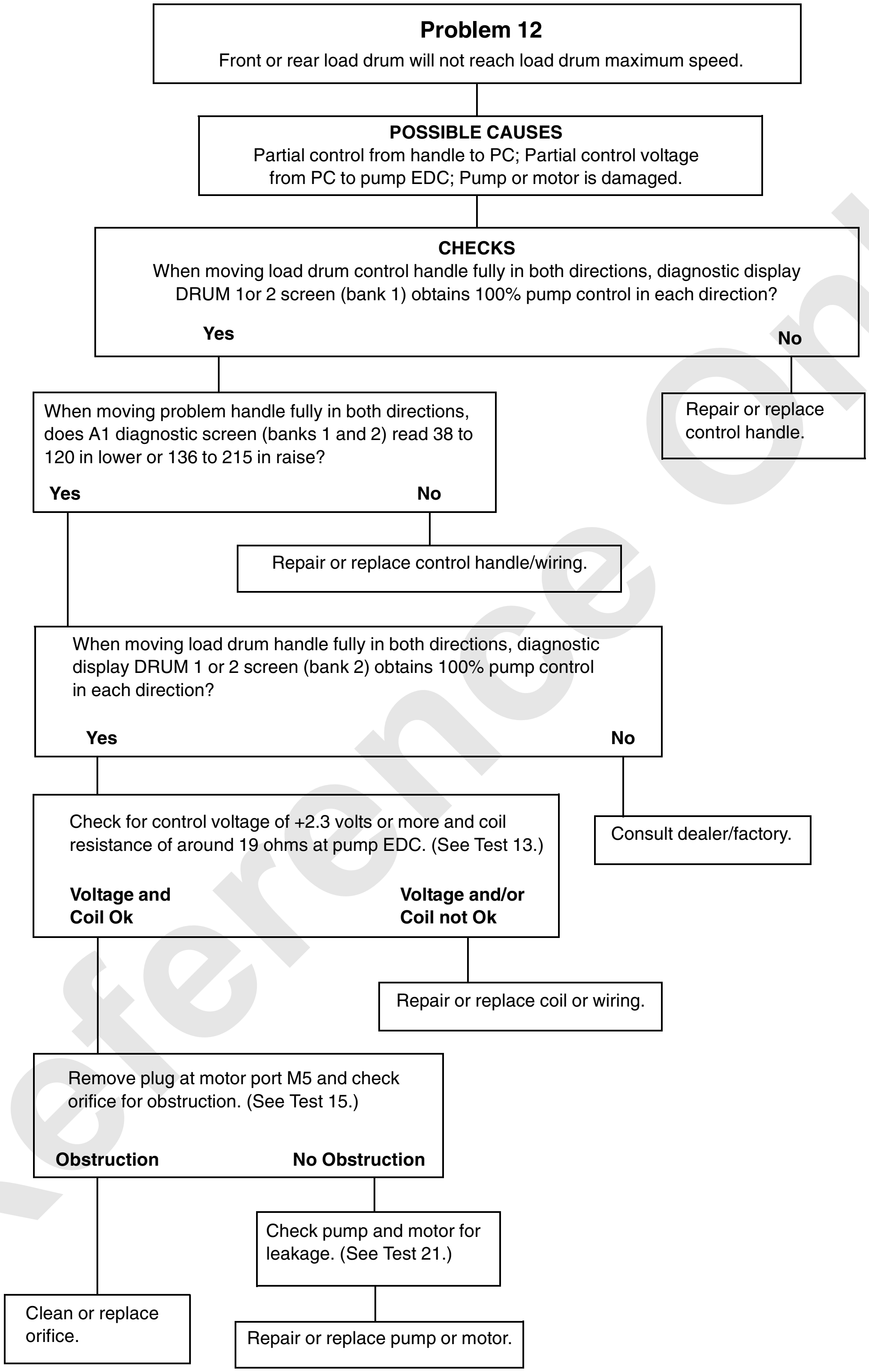
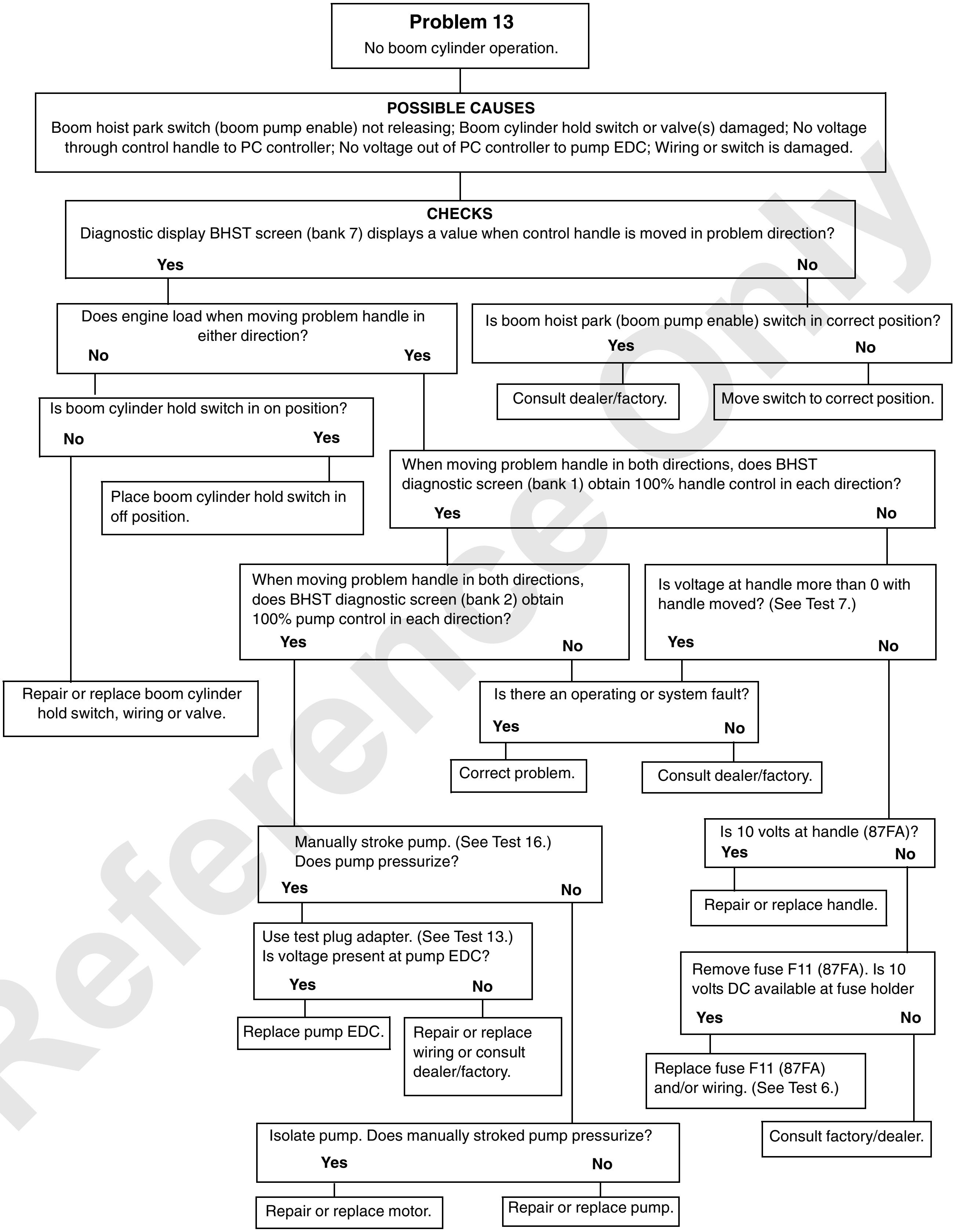
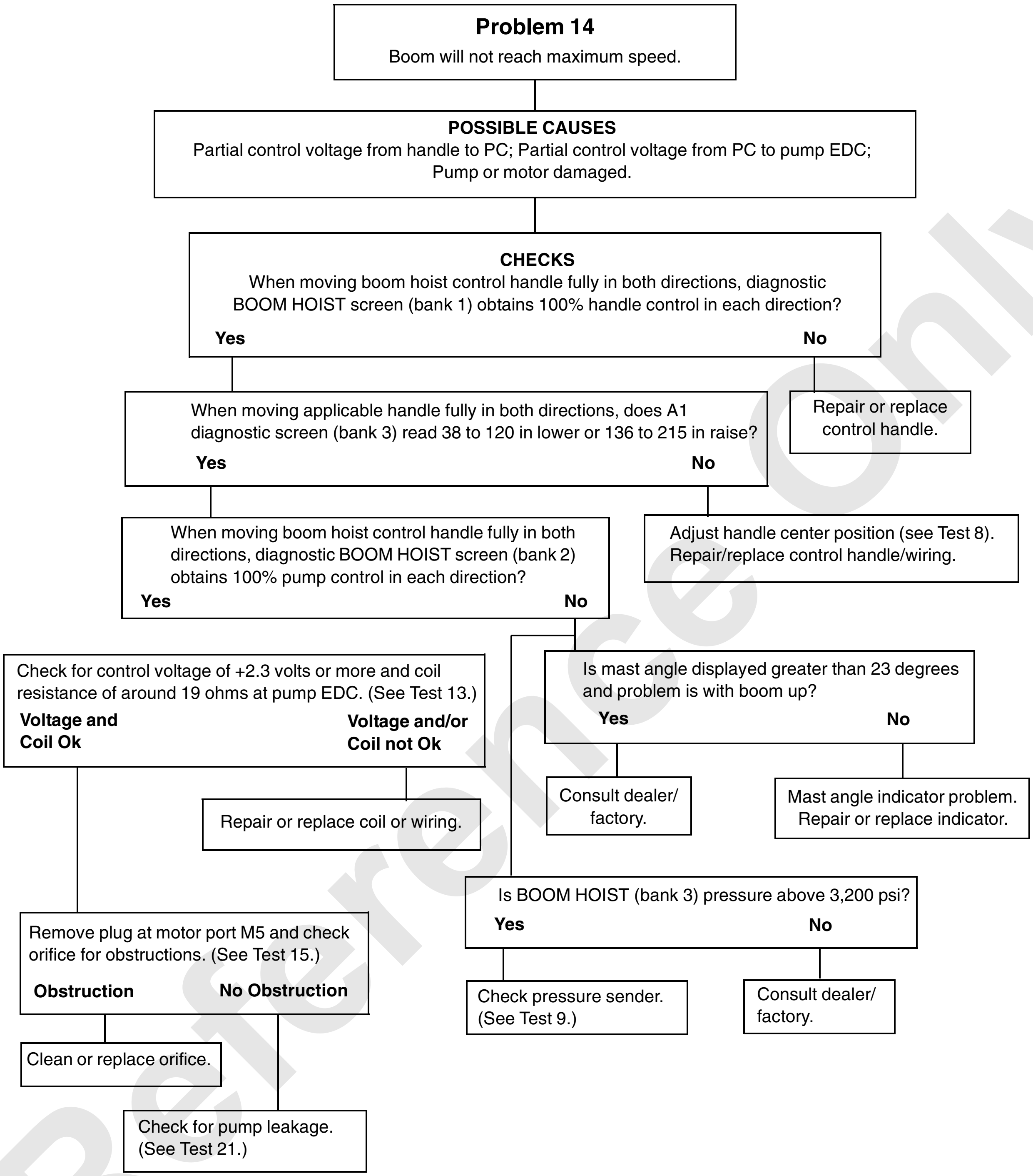

Problem 12
Front or rear load drum will not reach load drum maximum speed.
POSSIBLE CAUSES
Partial control from handle to PC; Partial control voltage from PC to pump EDC; Pump or motor is damaged.
CHECKS
When moving load drum control handle fully in both directions, diagnostic display DRUM 1or 2 screen (bank 1) obtains 100% pump control in each direction?
Yes
No
Repair or replace control handle.
When moving problem handle fully in both directions, does A1 diagnostic screen (banks 1 and 2) read 38 to 120 in lower or 136 to 215 in raise?
Yes
No
Repair or replace control handle/wiring.
When moving load drum handle fully in both directions, diagnostic display DRUM 1 or 2 screen (bank 2) obtains 100% pump control in each direction?
Yes
No
Consult dealer/factory.
Check for control voltage of +2.3 volts or more and coil resistance of around 19 ohms at pump EDC. (See Test 13.)
Voltage and Coil Ok
Voltage and/or Coil not Ok
Repair or replace coil or wiring.
Remove plug at motor port M5 and check orifice for obstruction. (See Test 15.)
Obstruction
No Obstruction
Check pump and motor for leakage. (See Test 21.)
Clean or replace orifice.
Repair or replace pump or motor.


Problem 13
No boom cylinder operation.
POSSIBLE CAUSES
Boom hoist park switch (boom pump enable) not releasing; Boom cylinder hold switch or valve(s) damaged; No voltage through control handle to PC controller; No voltage out of PC controller to pump EDC; Wiring or switch is damaged.
CHECKS
Diagnostic display BHST screen (bank 7) displays a value when control handle is moved in problem direction?
Yes
No
Does engine load when moving problem handle in either direction?
No
Yes
Is boom hoist park (boom pump enable) switch in correct position?
Yes
No
Consult dealer/factory.
Move switch to correct position.
Is boom cylinder hold switch in on position?
No
Yes
Place boom cylinder hold switch in off position.
When moving problem handle in both directions, does BHST diagnostic screen (bank 1) obtain 100% handle control in each direction?
Yes
No
When moving problem handle in both directions, does BHST diagnostic screen (bank 2) obtain 100% pump control in each direction?
Yes
No
Is voltage at handle more than 0 with handle moved? (See Test 7.)
Yes
No
Repair or replace boom cylinder hold switch, wiring or valve.
Is there an operating or system fault?
Yes
No
Correct problem.
Consult dealer/factory.
Manually stroke pump. (See Test 16.) Does pump pressurize?
Yes
No
Is 10 volts at handle (87FA)?
Yes
No
Repair or replace handle.
Use test plug adapter. (See Test 13.) Is voltage present at pump EDC?
Yes
No
Remove fuse F11 (87FA). Is 10 volts DC available at fuse holder
Yes
No
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.
Replace fuse F11 (87FA) and/or wiring. (See Test 6.)
Consult factory/dealer.
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Repair or replace motor.
Repair or replace pump.


Problem 14
Boom will not reach maximum speed.
POSSIBLE CAUSES
Partial control voltage from handle to PC; Partial control voltage from PC to pump EDC; Pump or motor damaged.
CHECKS
When moving boom hoist control handle fully in both directions, diagnostic BOOM HOIST screen (bank 1) obtains 100% handle control in each direction?
Yes
No
Repair or replace control handle.
When moving applicable handle fully in both directions, does A1 diagnostic screen (bank 3) read 38 to 120 in lower or 136 to 215 in raise?
Yes
No
Adjust handle center position (see Test 8). Repair/replace control handle/wiring.
When moving boom hoist control handle fully in both directions, diagnostic BOOM HOIST screen (bank 2) obtains 100% pump control in each direction?
Yes
No
Check for control voltage of +2.3 volts or more and coil resistance of around 19 ohms at pump EDC. (See Test 13.)
Voltage and Coil Ok
Voltage and/or Coil not Ok
Repair or replace coil or wiring.
Remove plug at motor port M5 and check orifice for obstructions. (See Test 15.)
Obstruction
No Obstruction
Clean or replace orifice.
Check for pump leakage. (See Test 21.)
Is mast angle displayed greater than 23 degrees and problem is with boom up?
Yes
No
Consult dealer/ factory.
Mast angle indicator problem. Repair or replace indicator.
Is BOOM HOIST (bank 3) pressure above 3,200 psi?
Yes
No
Check pressure sender. (See Test 9.)
Consult dealer/ factory.

Problem 15

Boom will not boom up or boom down.

POSSIBLE CAUSES

Pump is damaged; Block-up limit opened; Equalizer/boom stop limit opened; Control handle is damaged.

CHECKS

Check Diagnostic Screen D2. (See Diagnostic Display topic in Section 3.)
When applicable switch was enabled…

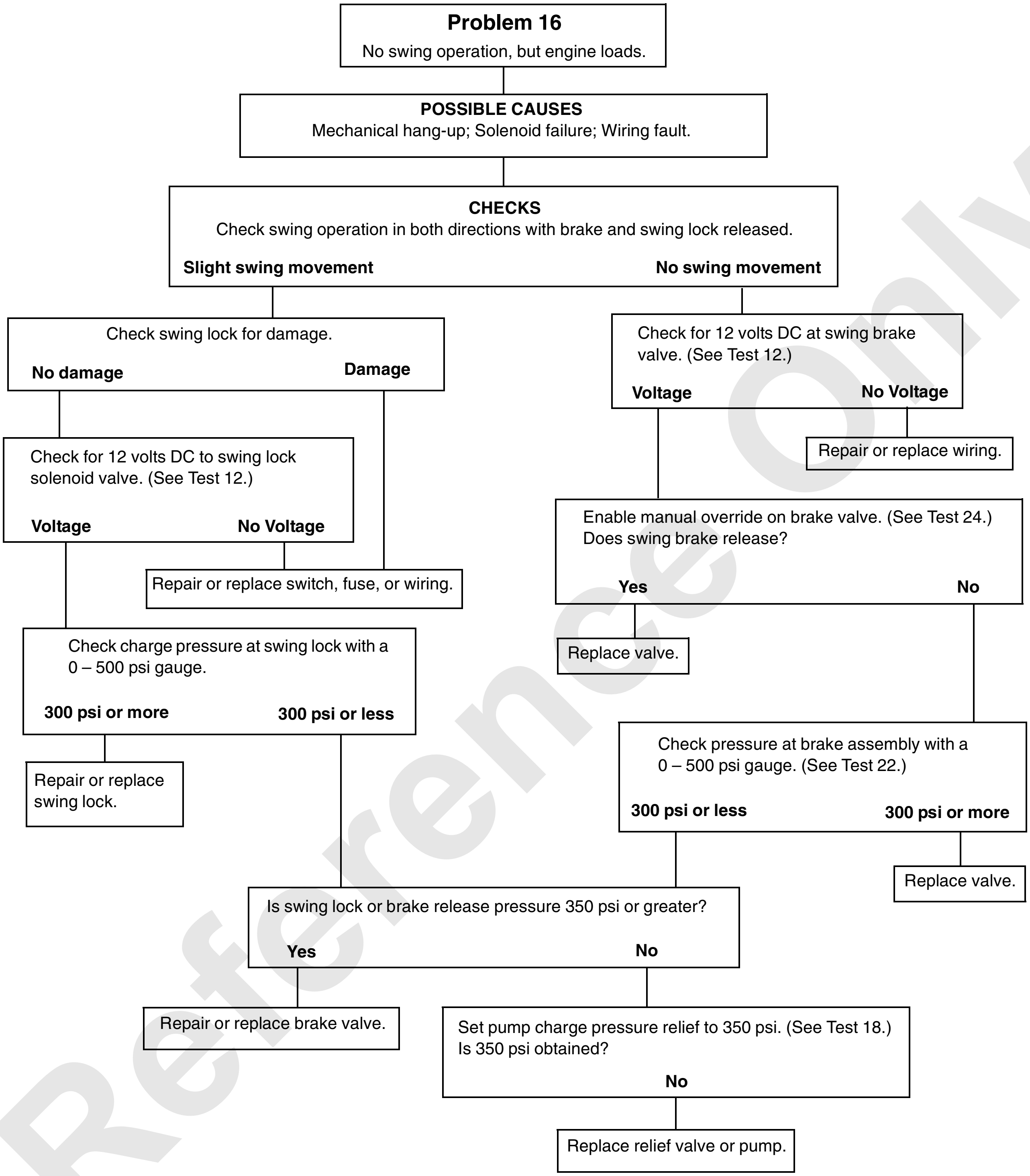
Bank 1 changed by 32 . . . . Block-up limit
Bank 4 changed by 2 . . . . Rated capacity indicator/limiter

Bank number increased by number shown.

- Does diagnostic BOOM HOIST screen (bank 1) approach +100% handle control with handle moved back?
  - **No**: Repair or replace control handle.
  - **Yes**: When moving applicable handle fully in both directions, does A1 diagnostic screen (bank 3) read 38 to 120 in lower or 136 to 215 in raise?
    - **No**: Repair or replace control handle/wiring.
    - **Yes**: Does diagnostic BOOM HOIST screen (bank 2) approach +100% pump control with handle moved back?
      - **No**: Consult dealer/factory.
      - **Yes**: Use test plug adapter. (See Test 13.) Are -2.3 or more volts present at pump EDC when control handle is moved back?
        - **No**: Repair or replace wiring or consult dealer/factory.
        - **Yes**: Can boom pump be manually stroked down? (See Test 16.)
          - **Yes**: Replace pump EDC.
          - **No**: Repair or replace pump.

Bank number not increased by number shown.

- Check for problem. Repair limit switch, wiring, or fuse.



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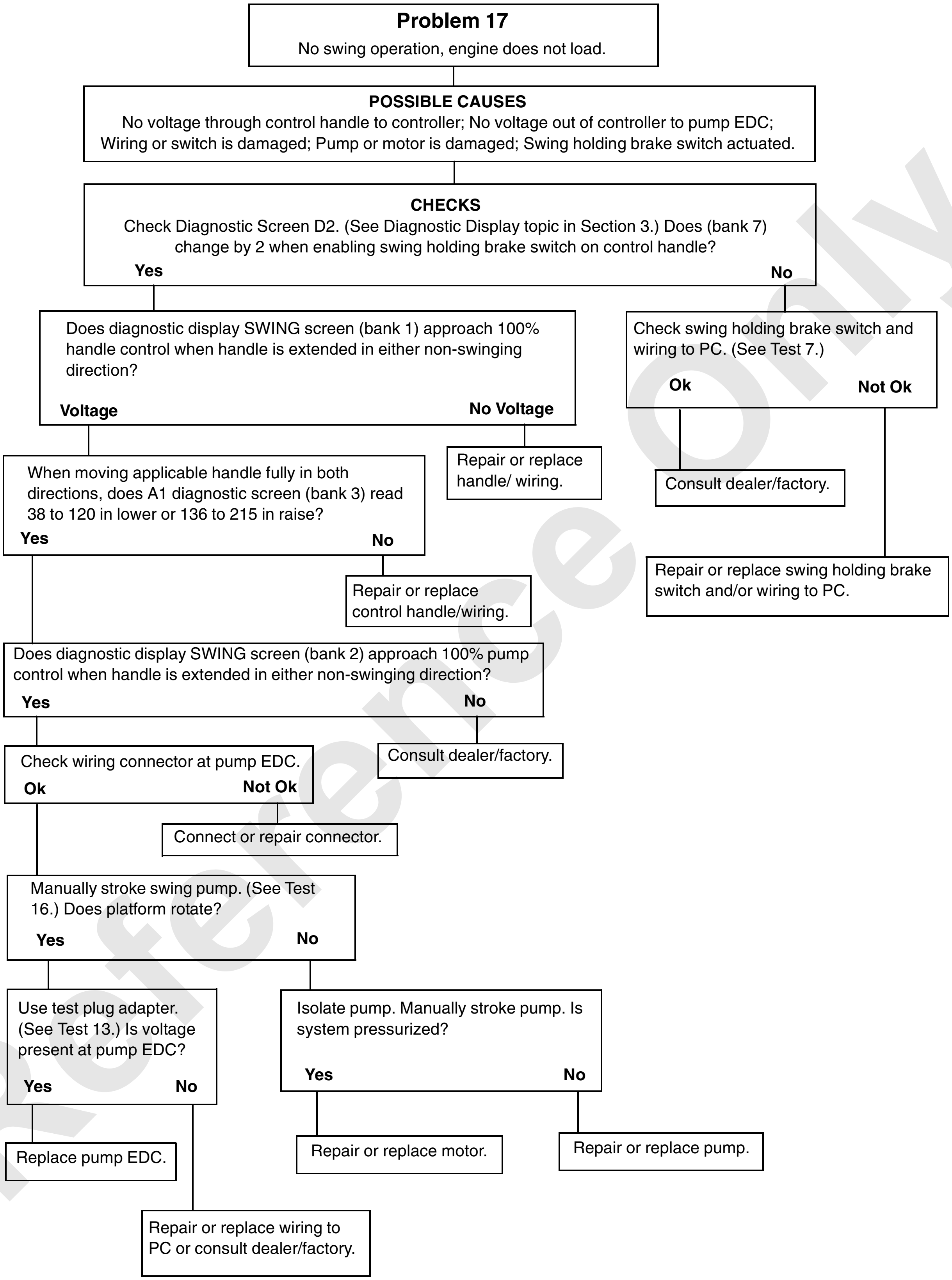
Problem 17
No swing operation, engine does not load.
POSSIBLE CAUSES
No voltage through control handle to controller; No voltage out of controller to pump EDC; Wiring or switch is damaged; Pump or motor is damaged; Swing holding brake switch actuated.
CHECKS
Check Diagnostic Screen D2. (See Diagnostic Display topic in Section 3.) Does (bank 7) change by 2 when enabling swing holding brake switch on control handle?
Yes
No
Does diagnostic display SWING screen (bank 1) approach 100% handle control when handle is extended in either non-swinging direction?
Voltage
No Voltage
Check swing holding brake switch and wiring to PC. (See Test 7.)
Ok
Not Ok
Repair or replace handle/ wiring.
Consult dealer/factory.
When moving applicable handle fully in both directions, does A1 diagnostic screen (bank 3) read 38 to 120 in lower or 136 to 215 in raise?
Yes
No
Repair or replace control handle/wiring.
Repair or replace swing holding brake switch and/or wiring to PC.
Does diagnostic display SWING screen (bank 2) approach 100% pump control when handle is extended in either non-swinging direction?
Yes
No
Check wiring connector at pump EDC.
Ok
Not Ok
Consult dealer/factory.
Connect or repair connector.
Manually stroke swing pump. (See Test 16.) Does platform rotate?
Yes
No
Use test plug adapter. (See Test 13.) Is voltage present at pump EDC?
Yes
No
Isolate pump. Manually stroke pump. Is system pressurized?
Yes
No
Replace pump EDC.
Repair or replace motor.
Repair or replace pump.
Repair or replace wiring to PC or consult dealer/factory.

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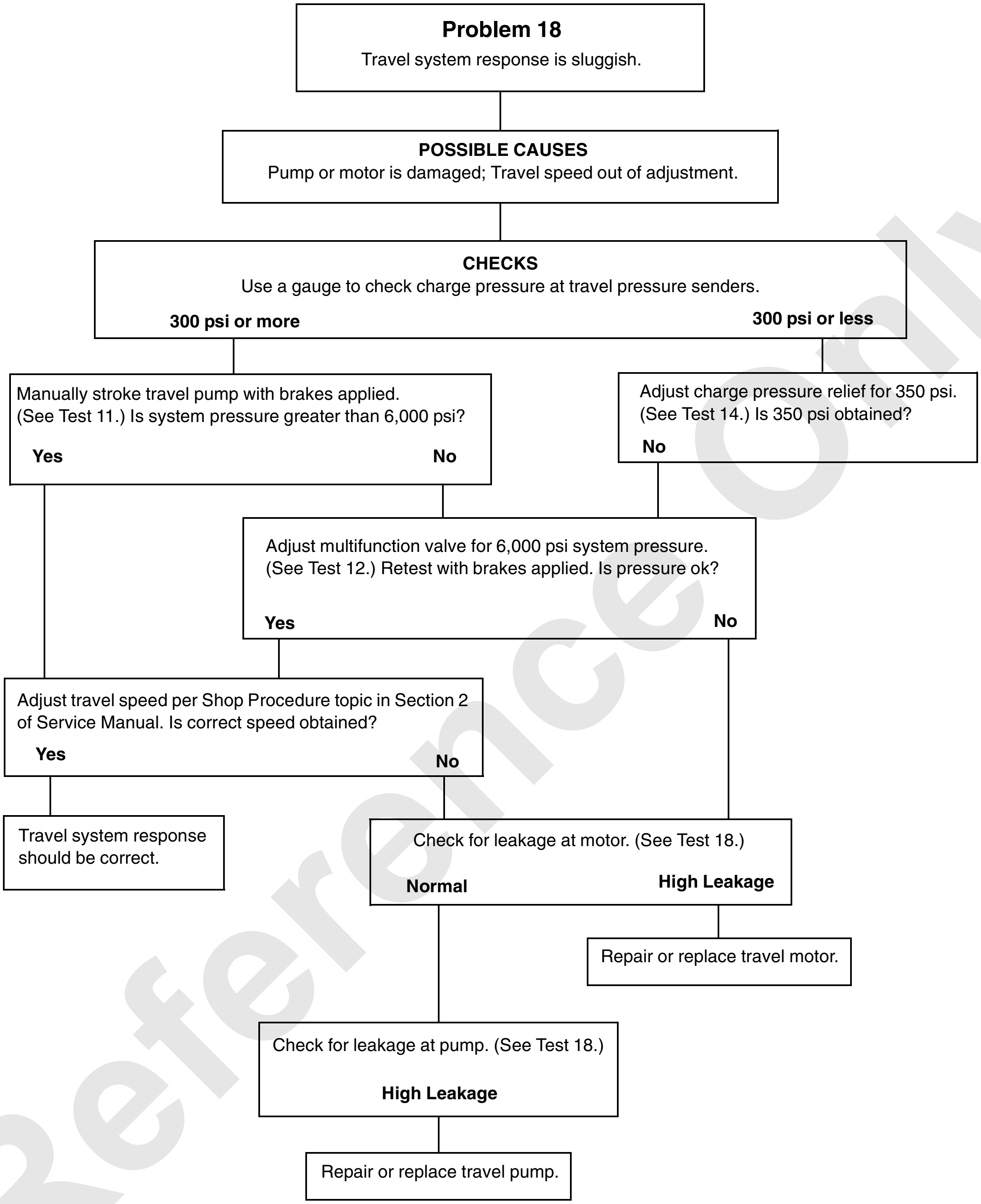

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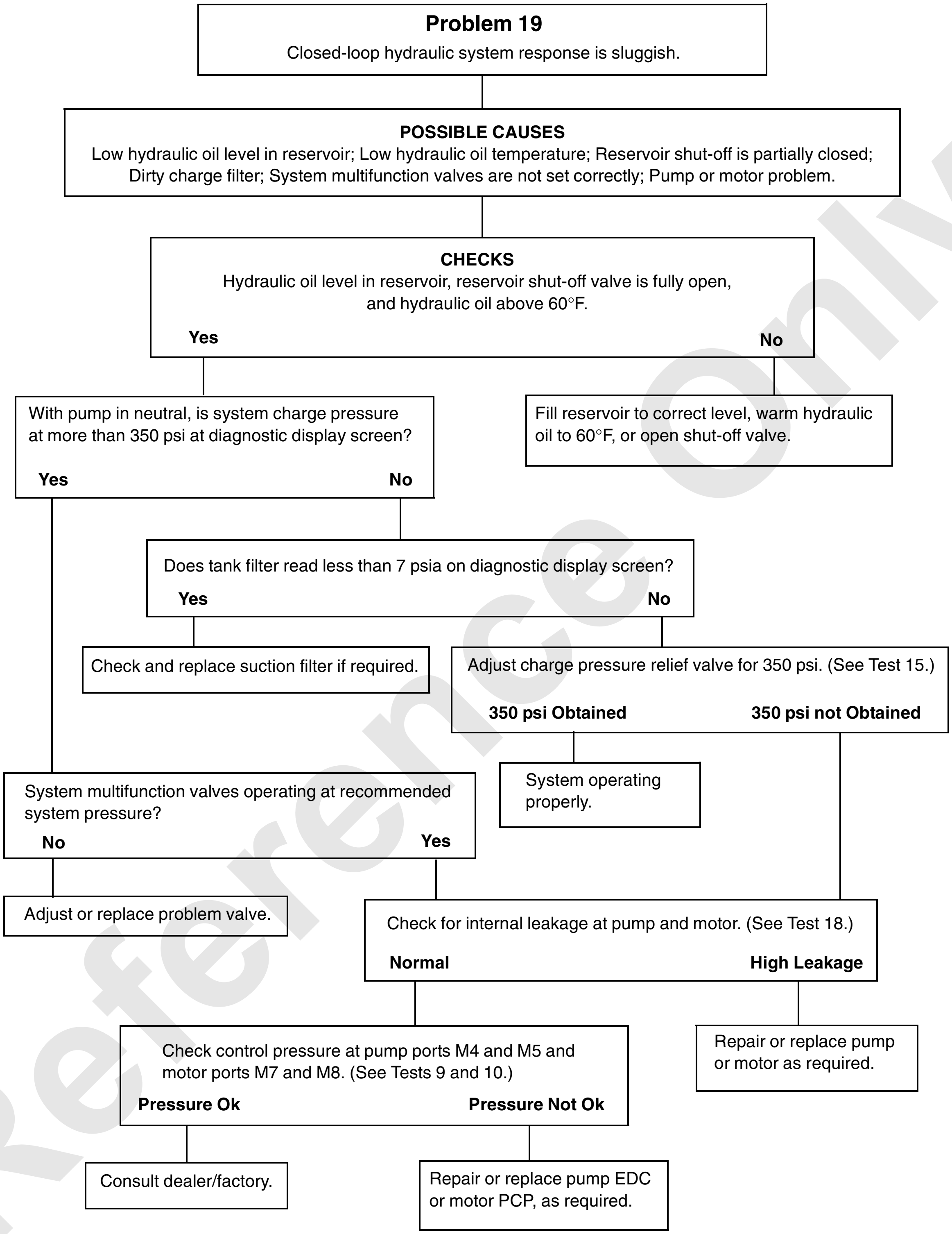
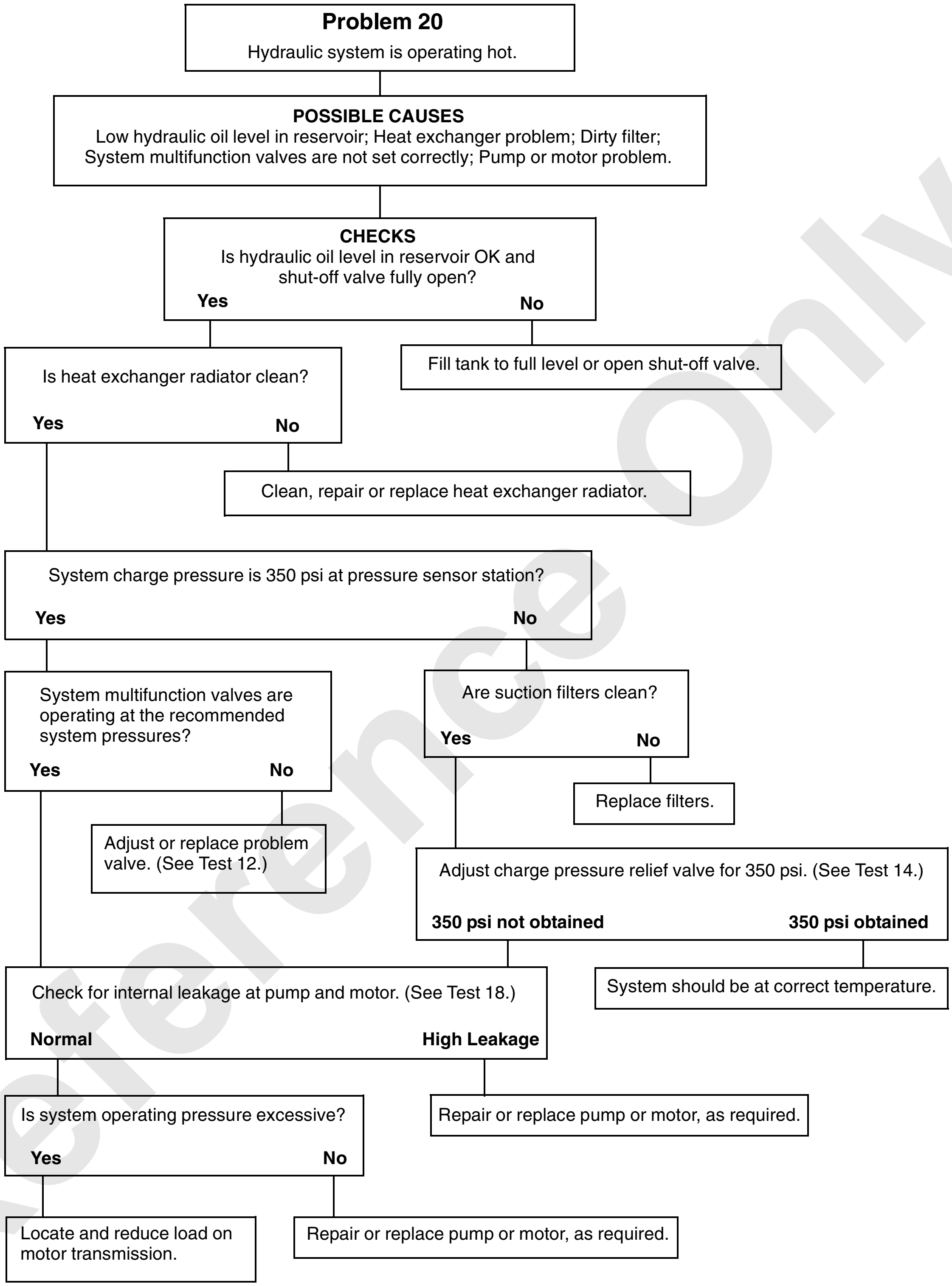
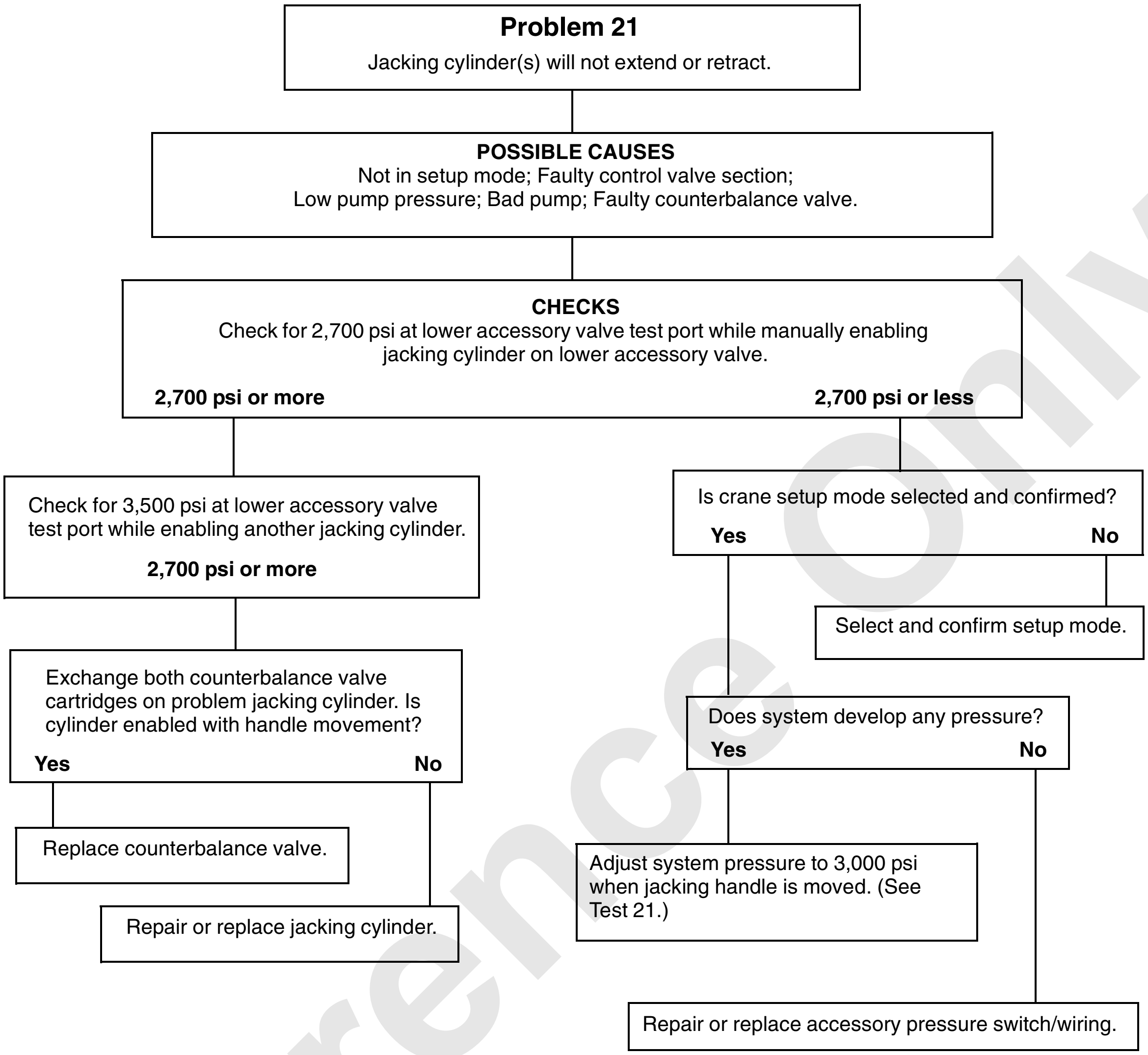

Problem 19
Closed-loop hydraulic system response is sluggish.
POSSIBLE CAUSES
Low hydraulic oil level in reservoir; Low hydraulic oil temperature; Reservoir shut-off is partially closed; Dirty charge filter; System multifunction valves are not set correctly; Pump or motor problem.
CHECKS
Hydraulic oil level in reservoir, reservoir shut-off valve is fully open, and hydraulic oil above 60°F.
Yes
No
With pump in neutral, is system charge pressure at more than 350 psi at diagnostic display screen?
Yes
No
Fill reservoir to correct level, warm hydraulic oil to 60°F, or open shut-off valve.
Does tank filter read less than 7 psia on diagnostic display screen?
Yes
No
Check and replace suction filter if required.
Adjust charge pressure relief valve for 350 psi. (See Test 15.)
350 psi Obtained
350 psi not Obtained
System operating properly.
System multifunction valves operating at recommended system pressure?
No
Yes
Adjust or replace problem valve.
Check for internal leakage at pump and motor. (See Test 18.)
Normal
High Leakage
Repair or replace pump or motor as required.
Check control pressure at pump ports M4 and M5 and motor ports M7 and M8. (See Tests 9 and 10.)
Pressure Ok
Pressure Not Ok
Consult dealer/factory.
Repair or replace pump EDC or motor PCP, as required.


Problem 20
Hydraulic system is operating hot.
POSSIBLE CAUSES
Low hydraulic oil level in reservoir; Heat exchanger problem; Dirty filter; System multifunction valves are not set correctly; Pump or motor problem.
CHECKS
Is hydraulic oil level in reservoir OK and shut-off valve fully open?
Yes
No
Fill tank to full level or open shut-off valve.
Is heat exchanger radiator clean?
Yes
No
Clean, repair or replace heat exchanger radiator.
System charge pressure is 350 psi at pressure sensor station?
Yes
No
System multifunction valves are operating at the recommended system pressures?
Yes
No
Adjust or replace problem valve. (See Test 12.)
Are suction filters clean?
Yes
No
Replace filters.
Adjust charge pressure relief valve for 350 psi. (See Test 14.)
350 psi not obtained
350 psi obtained
System should be at correct temperature.
Check for internal leakage at pump and motor. (See Test 18.)
Normal
High Leakage
Repair or replace pump or motor, as required.
Is system operating pressure excessive?
Yes
No
Locate and reduce load on motor transmission.
Repair or replace pump or motor, as required.


Problem 21
Jacking cylinder(s) will not extend or retract.
POSSIBLE CAUSES
Not in setup mode; Faulty control valve section;
Low pump pressure; Bad pump; Faulty counterbalance valve.
CHECKS
Check for 2,700 psi at lower accessory valve test port while manually enabling jacking cylinder on lower accessory valve.
2,700 psi or more
2,700 psi or less
Check for 3,500 psi at lower accessory valve test port while enabling another jacking cylinder.
2,700 psi or more
Exchange both counterbalance valve cartridges on problem jacking cylinder. Is cylinder enabled with handle movement?
Yes
No
Replace counterbalance valve.
Repair or replace jacking cylinder.
Is crane setup mode selected and confirmed?
Yes
No
Select and confirm setup mode.
Does system develop any pressure?
Yes
No
Adjust system pressure to 3,000 psi when jacking handle is moved. (See Test 21.)
Repair or replace accessory pressure switch/wiring.

Problem 22

Crawler pin cylinder(s) will not extend or retract (left or right set).

POSSIBLE CAUSES

Not in setup mode; Faulty control valve section; Low pump pressure; Bad pump; Mechanical problem.

CHECKS

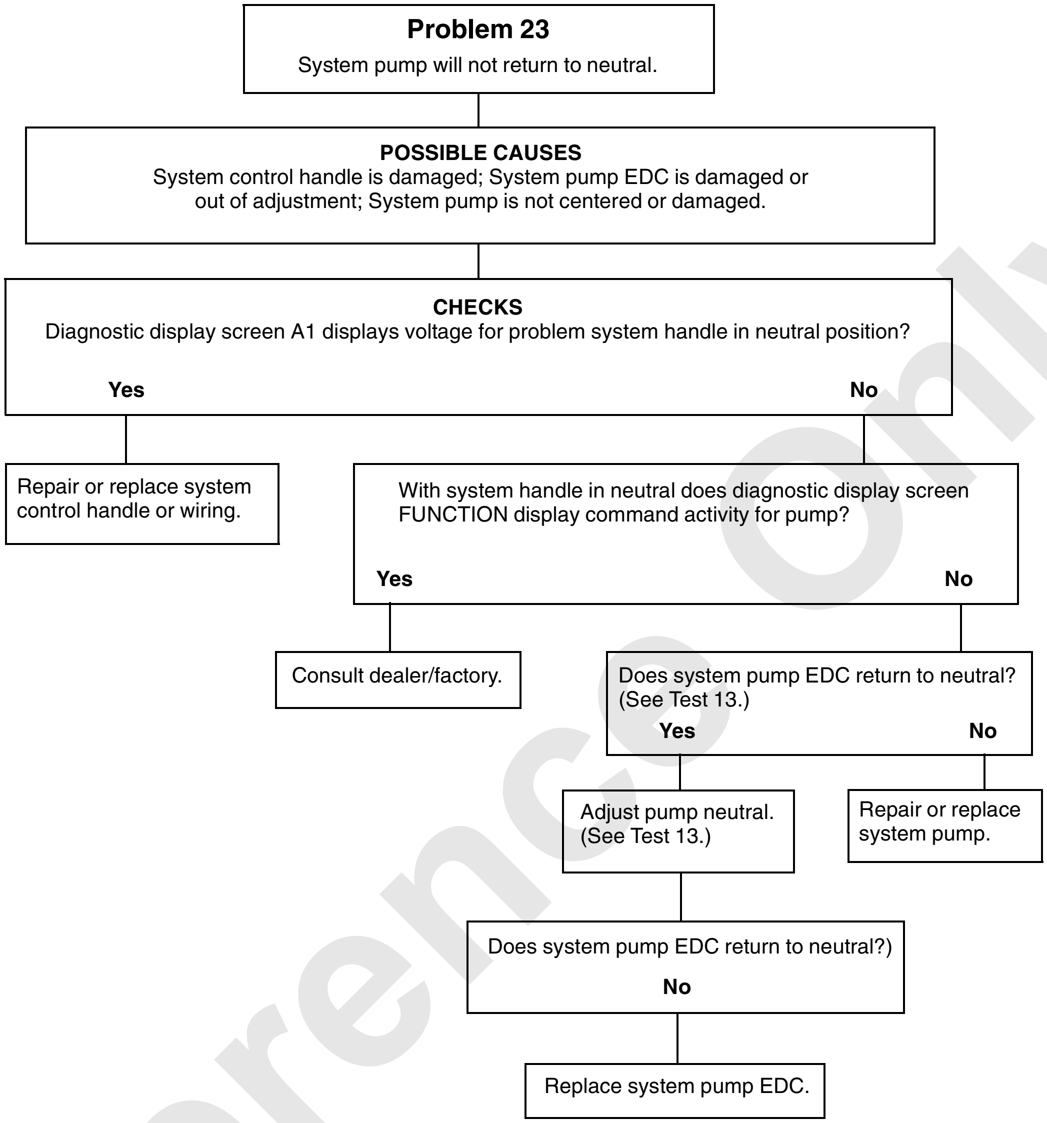
Check for 2,700 psi at lower accessory valve port while manually enabling crawler pin cylinder handle on lower accessory valve.

2,700 psi or more

- Check for 3,000 psi at lower accessory test port while enabling other crawler pin cylinder.
  - **2,700 psi or more**
    - Repair or replace problem crawler pin cylinder.

2,700 psi or less

- Is crane setup mode select and confirmed?
  - **No**
    - Select and confirm setup mode.
  - **Yes**
    - Does system develop any pressure?
      - **Yes**
        - Adjust system pressure to 3,000 psi when jacking handle is moved. (See Test 21.)
      - **No**
        - Repair or replace accessory pressure switch/wiring.


Problem 23
System pump will not return to neutral.
POSSIBLE CAUSES
System control handle is damaged; System pump EDC is damaged or out of adjustment; System pump is not centered or damaged.
CHECKS
Diagnostic display screen A1 displays voltage for problem system handle in neutral position?
Yes
No
Repair or replace system control handle or wiring.
With system handle in neutral does diagnostic display screen FUNCTION display command activity for pump?
Yes
No
Consult dealer/factory.
Does system pump EDC return to neutral? (See Test 13.)
Yes
No
Adjust pump neutral. (See Test 13.)
Repair or replace system pump.
Does system pump EDC return to neutral?)
No
Replace system pump EDC.

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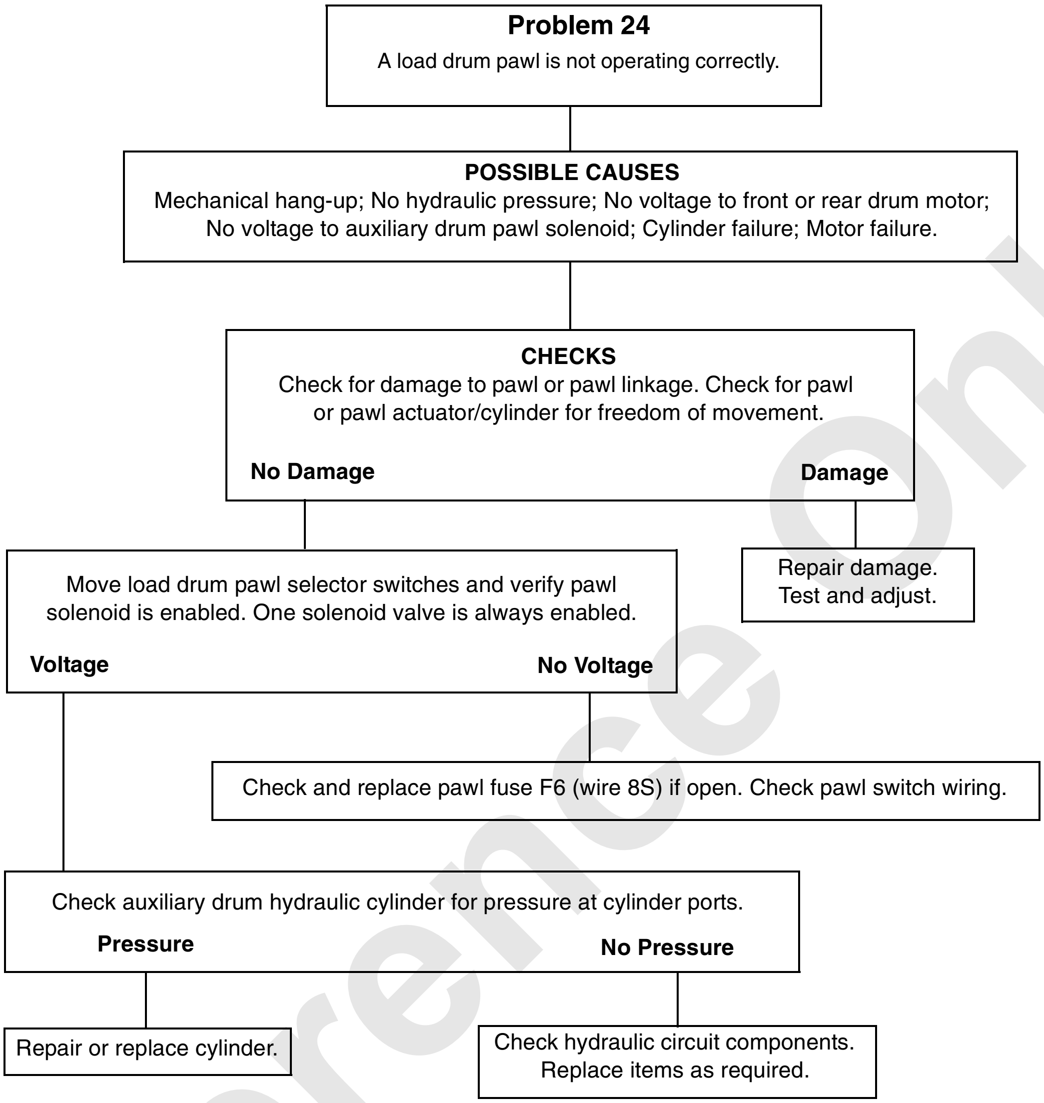
Problem 24
A load drum pawl is not operating correctly.
POSSIBLE CAUSES
Mechanical hang-up; No hydraulic pressure; No voltage to front or rear drum motor; No voltage to auxiliary drum pawl solenoid; Cylinder failure; Motor failure.
CHECKS
Check for damage to pawl or pawl linkage. Check for pawl or pawl actuator/cylinder for freedom of movement.
No Damage
Damage
Repair damage. Test and adjust.
Move load drum pawl selector switches and verify pawl solenoid is enabled. One solenoid valve is always enabled.
Voltage
No Voltage
Check and replace pawl fuse F6 (wire 8S) if open. Check pawl switch wiring.
Check auxiliary drum hydraulic cylinder for pressure at cylinder ports.
Pressure
No Pressure
Repair or replace cylinder.
Check hydraulic circuit components. Replace items as required.

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TESTING

Test 1 – Battery Test (12 and 24 VDC)

FIGURE 10-1

Item	Description	Item	Description
1	Positive probe	2	Negative probe

To test the 12 VDC accessory system voltage using a digital multimeter, record the voltage before and during cranking. A voltage reading of 12 volts or less before cranking may indicate a charging system fault. A drop of 4 volts or more indicates the battery is failing.

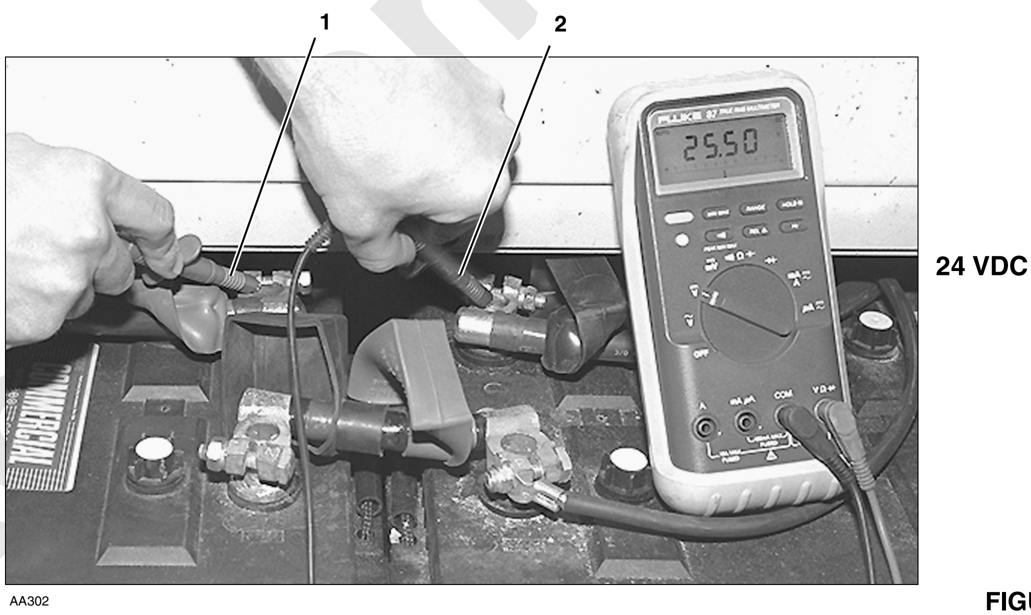
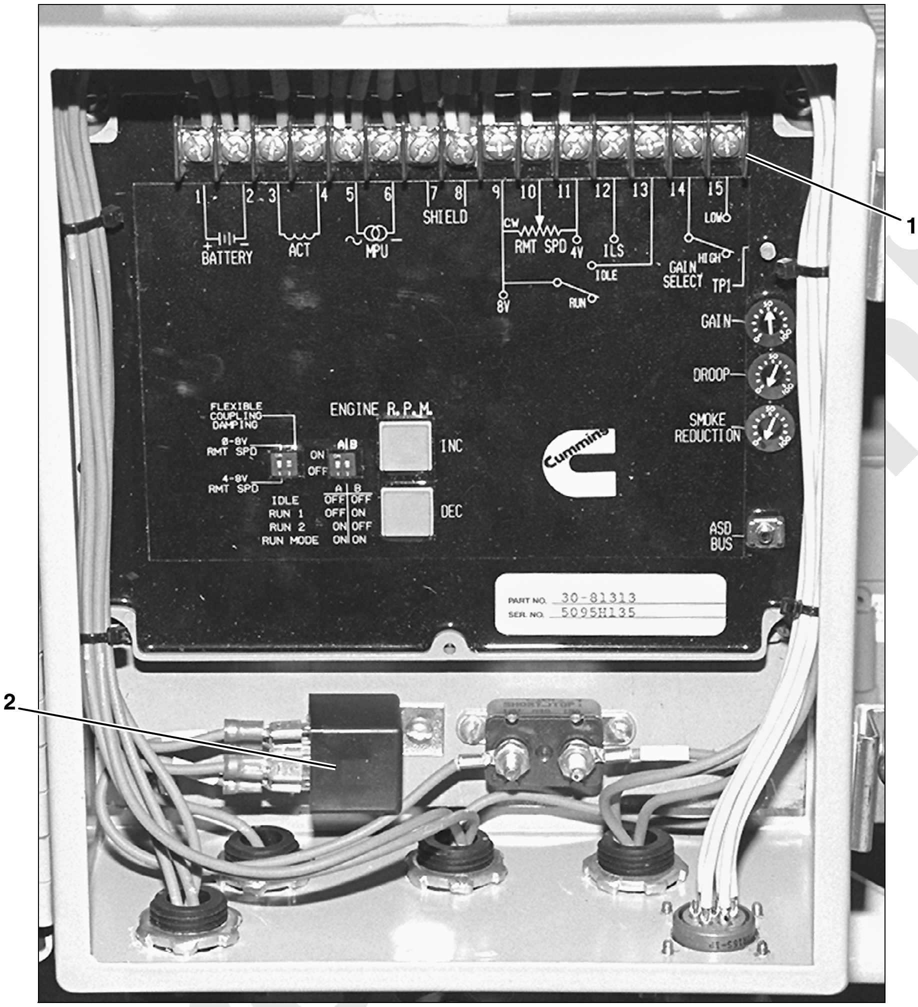


FIGURE 10-2

Test the 12 VDC starting batteries connected in series for 24 volts using a digital multimeter, record voltage before and during cranking. A voltage reading of 24 volts or less before cranking may indicate a charging system fault. A drop of 8 volts or more during cranking indicates a failing battery.

Test 2 – Electric Fuel Control (EFC) Box Test Points



AA305

FIGURE 10-3

Item	Description	Item	Description
1	Terminal block TB1	2	EFC relay

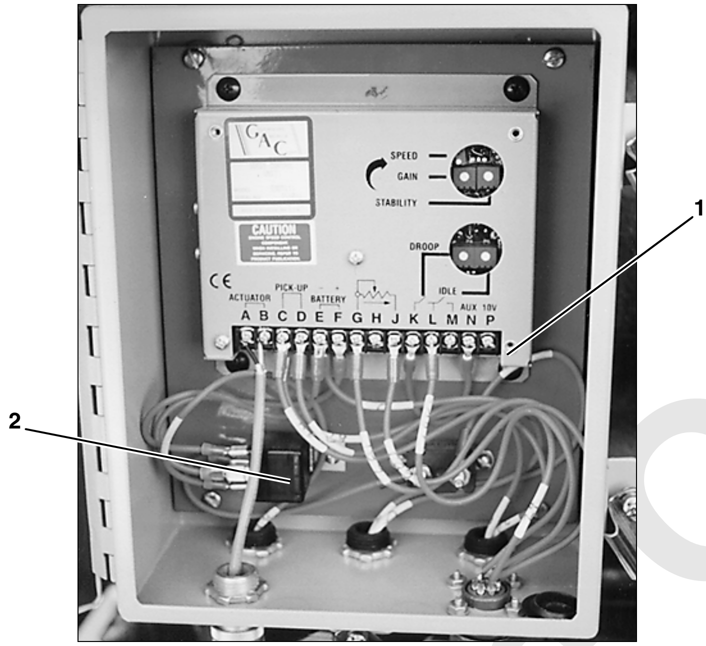
TB1 Test Points – EFC for Cummins C330 Engine

TB1-1 Battery (+)	TB1-6 Magnetic pick up (0)	TB1-11 Remote speed pot (68L)
TB1-2 Battery (-)	TB1-7 Shield	TB1-12 No contact
TB1-3 Actuator (3EFC)	TB1-8 Shield	TB1-13 No contact
TB1-4 Actuator (4EFC)	TB1-9 Remote speed pot (68J)	TB1-14 Gain select
TB1-5 Magnetic pick up (24)	TB1-10 Remote speed pot (68K)	TB1-15 Gain select

To determine if the correct voltage is available from the hand and foot throttle, use a digital multimeter to test at the EFC box. With engine off and power on, verify 7.75 volts DC at TB1-9, 4.40 volts DC at TB1-10, and 4.50 volts DC at TB1-11. While in low idle, verify 7.80 volts DC at TB1-9, 4.70 volts DC at TB1-10, and 4.55 volts DC at TB1-11. Use the engine as the ground contact when testing at these terminals.

To determine if the correct voltage is available from the engine RPM transducer, use a digital multimeter to test at the EFC box. While in low idle, verify 9.25 volts AC is present between TB1-5 and TB1-6. If this reading is not obtained, the engine RPM transducer may require servicing. See Test 5.

Test 2 (Continued)



P855

FIGURE 10-4

Item	Description
1	Terminal block TB1
2	EFC relay

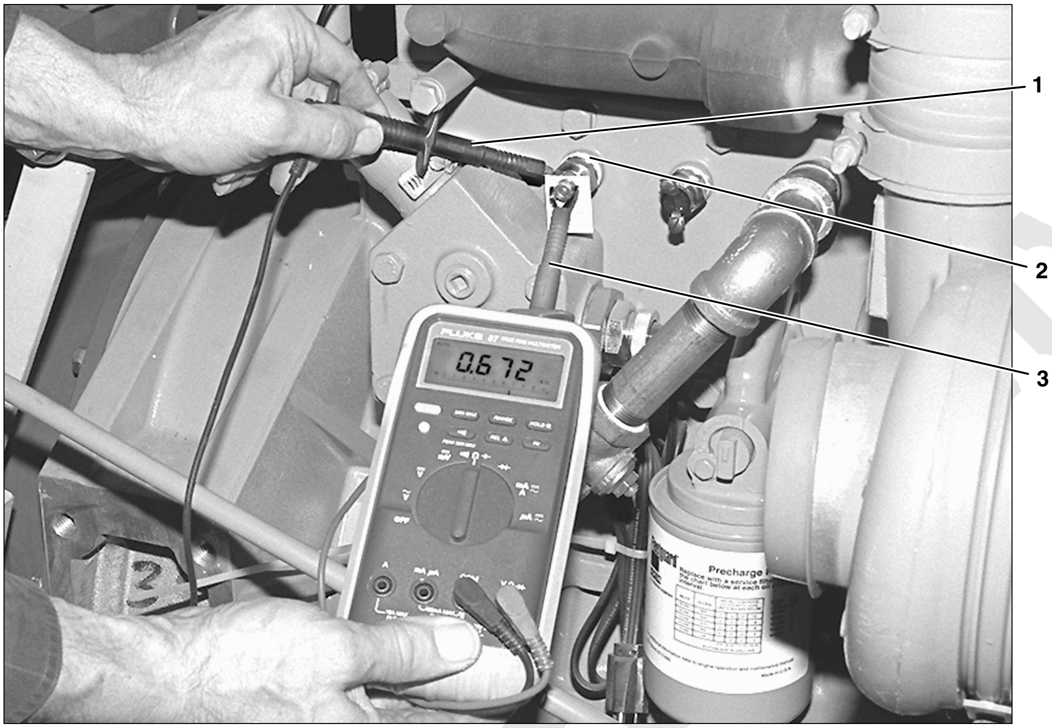
TB1 Test Points – for Cummins C260 Engine

TB1-F Battery (+)	TB1-B Actuator (4EFC)	TB1-J Remote speed pot (68J)
TB1-E Battery (-)	TB1-C Magnetic pick up (24)	TB1-L Remote speed pot (68K)
TB1-A Actuator (3EFC)	TB1-D Magnetic pick up (0)	TB1-G Remote speed pot (68L)

To determine if the correct voltage is available from the hand and foot throttle, use a digital multimeter to test at the EFC box. With engine off and power on, verify 5.88 volts DC at TB1-J, 3.84 volts DC at TB1-L, and.005 volts DC at TB1-G. While in low idle, verify 5.87 volts DC at TB1-J, 3.81 volts DC at TB1-L, and.007 volts DC at TB1-G. Use the engine as the ground contact when testing at these terminals.

To determine if the correct voltage is available from the engine RPM transducer, use a digital multimeter to test at the EFC box. While in low idle, verify 6.58 volts AC is present between TB1-C and TB1-D. If this reading is not obtained, the engine RPM transducer may require servicing. See Test 5.

Test 3 – Checking Resistance at Engine Temperature Switch



AA303

FIGURE 10-5

Item	Description
1	Negative probe
2	Temperature switch
3	Positive probe

Using a digital multimeter, measure the resistance at the engine temperature switch wire terminal with the engine cold. The correct resistance is approximately 0.67 ohms.

Test 4 – Checking Resistance at Engine Oil Pressure Sender

AA304

FIGURE 10-6

Item	Description
1	Oil pressure sender
2	Negative probe
3	Positive probe

To test the 12 VDC starting batteries connected in series for 24 volts using a digital multimeter, record the voltage before and during cranking. A voltage reading of 24 volts or less before cranking may indicate a charging system fault. A drop of 8 volts or more during cranking indicates a failing battery.

Test 5 – Cleaning and Adjusting the Engine RPM Transducer (Past Production)

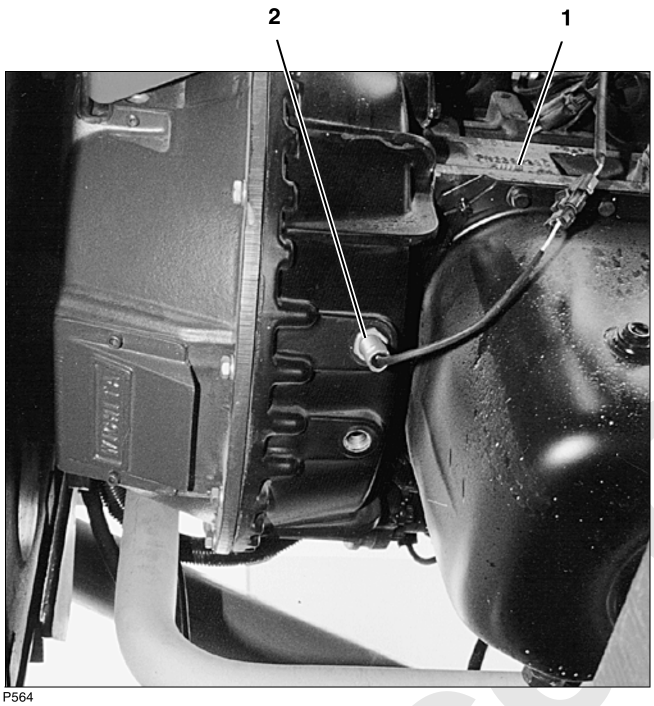


FIGURE 10-7

Item	Description
1	Engine
2	RPM transducer

Loosen the locking nut and remove the threaded transducer from the flywheel housing. Clean any metallic debris from the magnetic pickup on the transducer with a cleaning solvent. Re-install the transducer so the magnetic pickup makes contact with the flywheel. Loosen transducer 1/4 turn and secure the lock nut.

Test 6 – Testing for Voltage at the Fuse Box

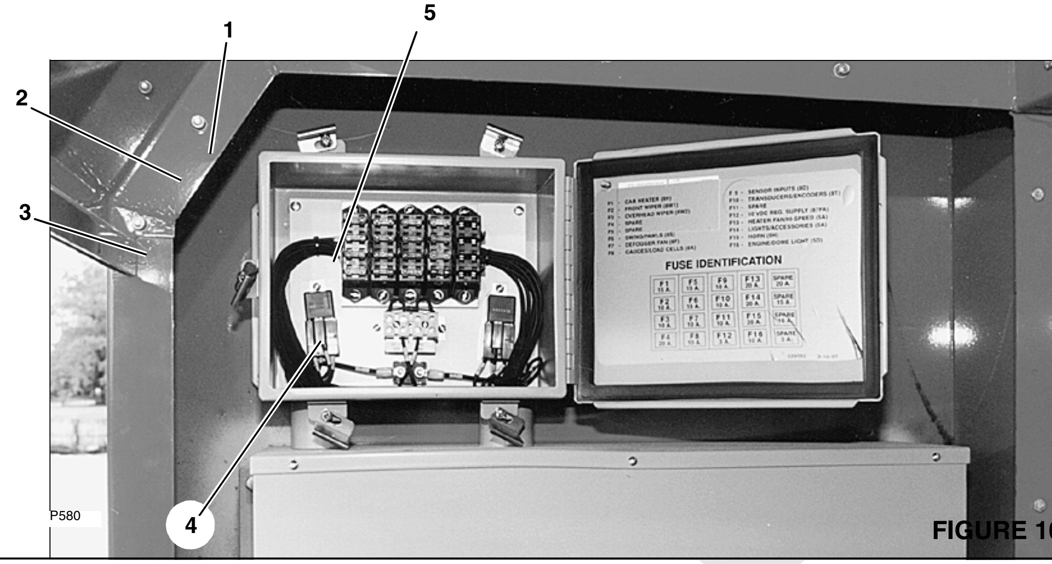


FIGURE 10-8

Item	Description	Item	Description
1	Fuse block	4	Fuse box chassis
2	Metal fuse contact	5	K2 power output
3	K1 cab power relay		

Table 10-1
Fuse Identification

Fuse No.	Function	Wire No.	Amps
F1	Cab Heater	8H	15
F2	Front Wiper	8W1	10
F3	Overhead Wiper	8W2	10
F4	---------------	-----	20
F5	---------------	-----	15
F6	Swing/Pawls	8S	15
F7	Defogger Fan	8F	10
F8	Gauges/Accessories	8A	10
F9	Sensor Inputs	8D	10
F10	Transducers/Encoders	8T	10
F11	Spare	------	10
F12	10VDC Reg. Supply	87FA	3
F13	Lights/Accessories	5A	20
F14	Lights/Accessories	5A	20
F15	Horn	5H	20
F16	Engine/Dome Light	5D	10
Spare	---------------	------	20
Spare	---------------	------	15
Spare	---------------	------	10
Spare	---------------	------	3

Use a digital multimeter for testing voltage at the fuse box.

To test for volts DC at any given fuse socket, place the positive probe on either of the metal fuse contacts and the negative probe on the grounded fuse box chassis. Repeat this procedure using the other fuse contact as a test point. Note all fuse sockets except F12 (3A, 10V) should yield 12 volts DC.

To determine if relay K1 is fully functional, ground the fuse box chassis and verify 12 volts DC exist at relay wire 8 when the relay is energized. Also verify 12 volts at relay wire 5.

Test 7 – Checking Voltage at the Control Handle

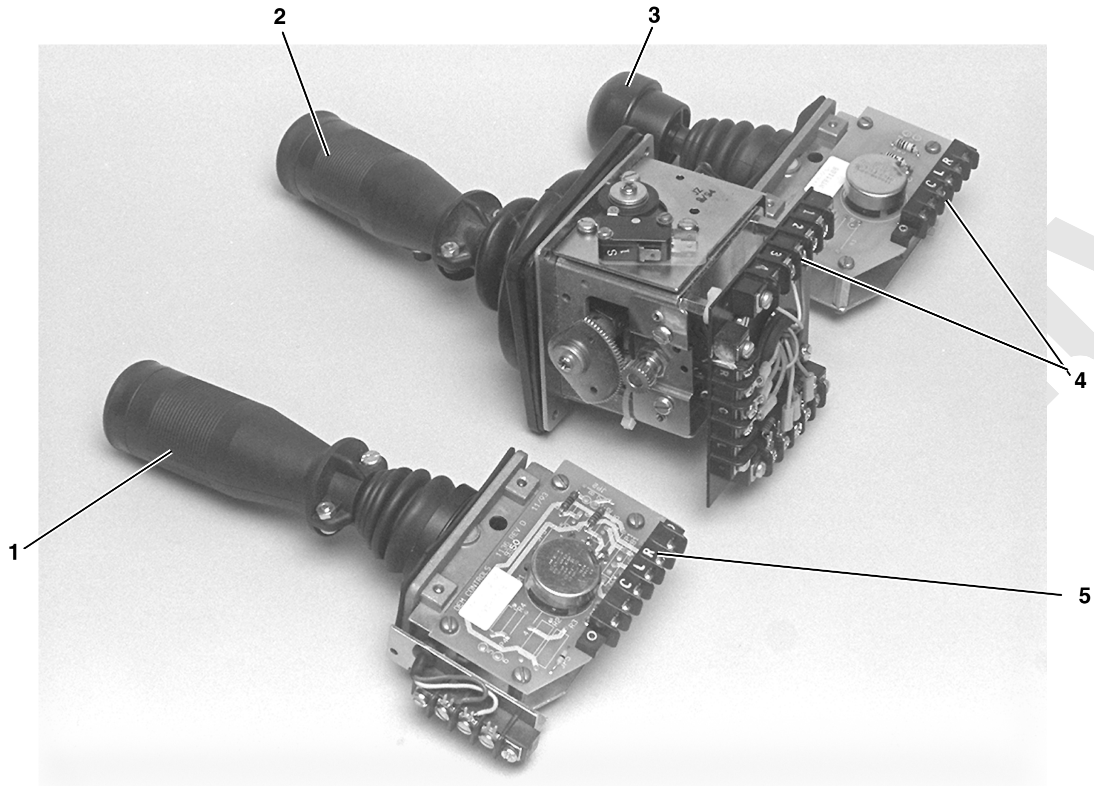


FIGURE 10-9

Item	Description	Item	Description
1	Load drum handle	4	Test terminals
2	Boom/swing handle	5	Ground terminal R
3	Crawler handle		

Use the following test points to determine if the correct voltages are present at the desired control handle. With engine off/power on, and all brakes and locks engaged, move the desired control handle and measure the voltage with a digital multimeter. The positive probe must be placed on the test terminal and the negative probe on a grounded component or terminal R on the control handle. Voltages outside the normal range may indicate a problem with the control handle, its circuits, or in line components such as relays and fuses.

Hand Controller	Test Terminal	Wire No.	Acceptable Voltage (VDC)
Swing	L	87FA	10
	R	0	Ground
	C	85P	1.7 to 8.3
	3	8D	12
	4	89B2	12

Hand Controller	Test Terminal	Wire No.	Acceptable Voltage (VDC)
Boom Cylinder	L	87FA	10
	R	0	Ground
	C	82P	1.4 to 8.6
	1	0	Ground
	2	82N	12
Travel	L	87FA	10
	R	0	Ground
	C	83P (Right)	1.4 to 8.6
		84P (Left)	
	3	8D	12
	4	89X	12
Load Drum	L	87FA	10
	R	0	Ground
	C	80P (Front)	1.4 to 8.6
		81P (Rear)	
	1	0	Ground
	2	80N (Front)	12
		81N (Rear)	

Test 8 – Adjusting the Control Handle Potentiometer

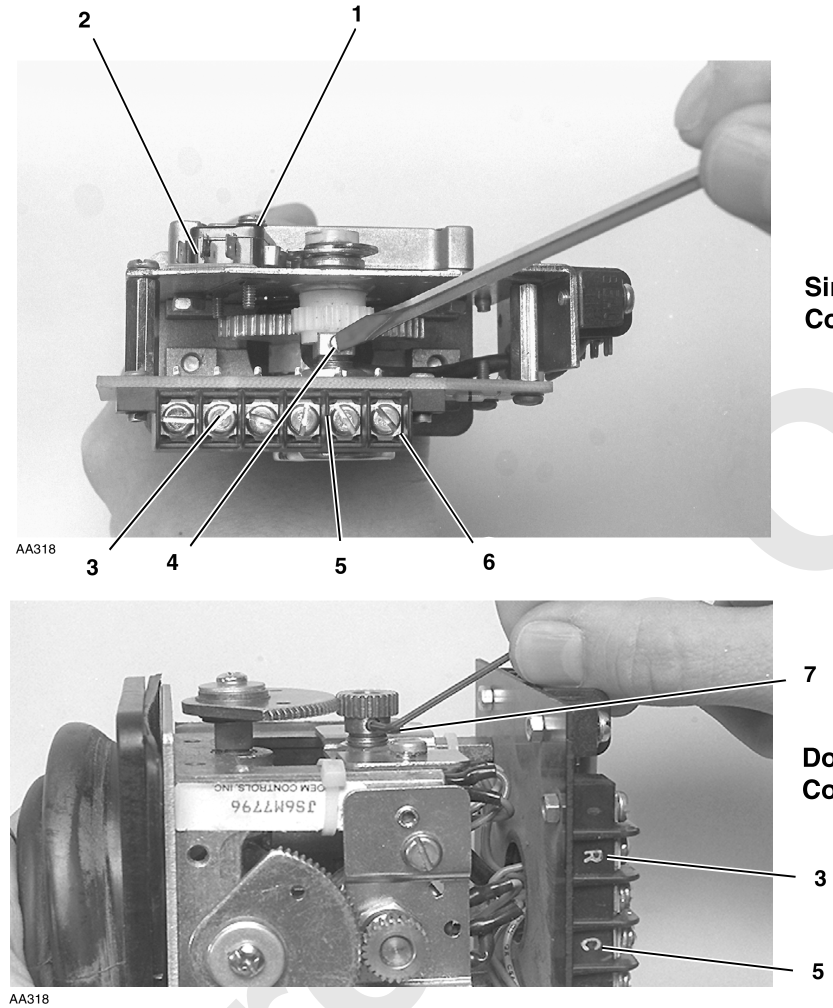


FIGURE 10-10

Item	Description	Item	Description
1	Neutral (snap) switch	5	Terminal C center
2	Jumper connection (N/O)	6	Potentiometer
3	Ground terminal R	7	Socket set screw (1 of 2)
4	Slotted set screw		

A reaction of a crane system function in relation to hand control movement may indicate a misalignment of the handle potentiometer. Adjusting a single axis controller (crawler and load drum handles) or double axis boom/swing handle requires aligning the hand lever assembly and the potentiometer in the neutral position. Neutral is the position at which 5 volts DC is present from the potentiometer.

With engine off, connect a jumper wire between the normally open (N/O) terminal on the neutral switch and terminal **C** on the handle terminal block. Connect the positive lead of a digital multimeter to terminal **C** and the negative lead to a grounded contact.

For single axis controller adjustment, fully loosen the slotted set screw with a screwdriver and allow the hand lever to return to its inactivated position. Retighten the set screw and move the hand lever until a reading of 5 volts DC is obtained on the digital multimeter. Keeping the hand lever in the 5 volt DC position, fully loosen the set screw, allow the hand lever to return to its inactivated position, and retighten the set screw.

The double axis boom/swing handle is adjusted in the same manner but involves loosening and tightening two socket set screws on the gear collar instead of the slotted set screw on the single axis controller.

Test 9 – Location of Pump Test Ports

Swing System Pump

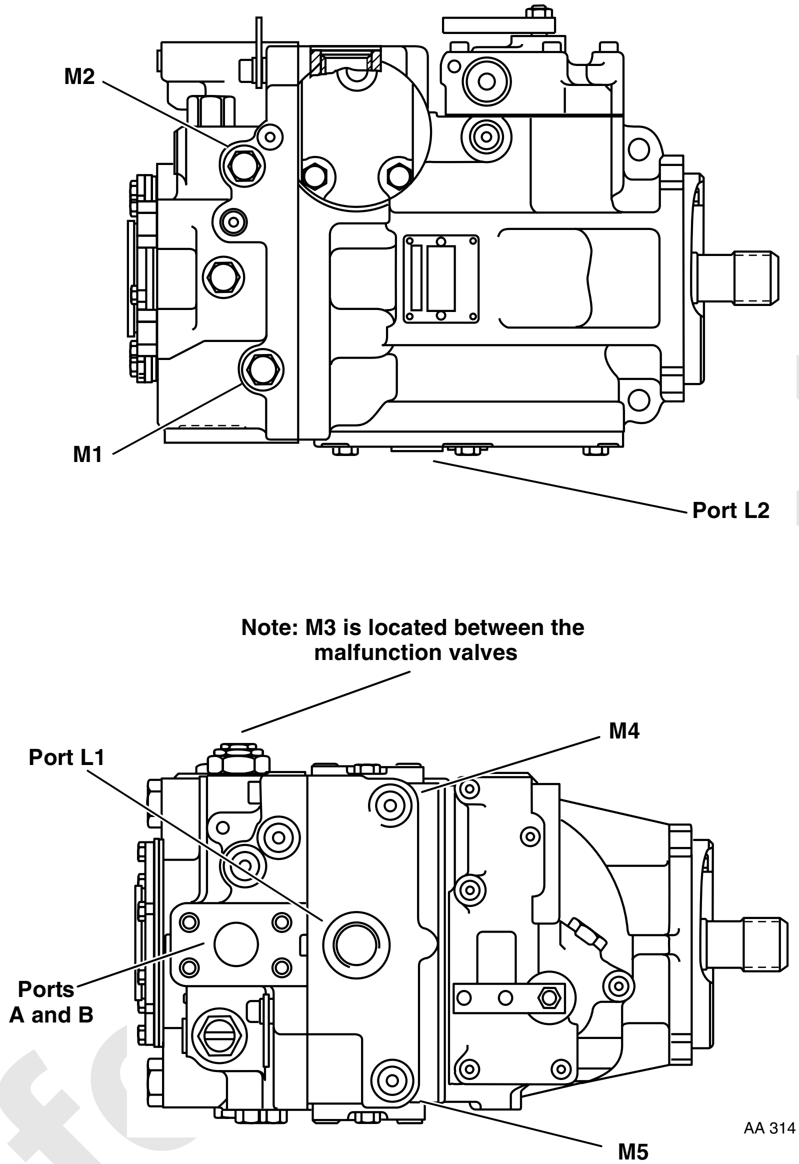


FIGURE 10-11

Port Designation	Port Description	Gauge (psi)	O-Ring Fitting (boom hoist, swing, travel)	O-Ring Fitting (main hoist)
A and B	Main system pressure	6,000	1 in. code 62 port flange	1-1/4 in. code 62 port flange
M1	Gauge port for Port A	10,000	SAE 6	SAE 6
M2	Gauge port for Port B	10,000	SAE 6	SAE 6
M3	Charge pressure	500	SAE 6	SAE 6
M4	Servo pressure	500	SAE 6	SAE 6
M5	Servo pressure	500	SAE 6	SAE 6
L1 and L2	Case pressure	500	SAE 12	SAE 16

Test 9 (Continued)

System Pump (Except Swing)

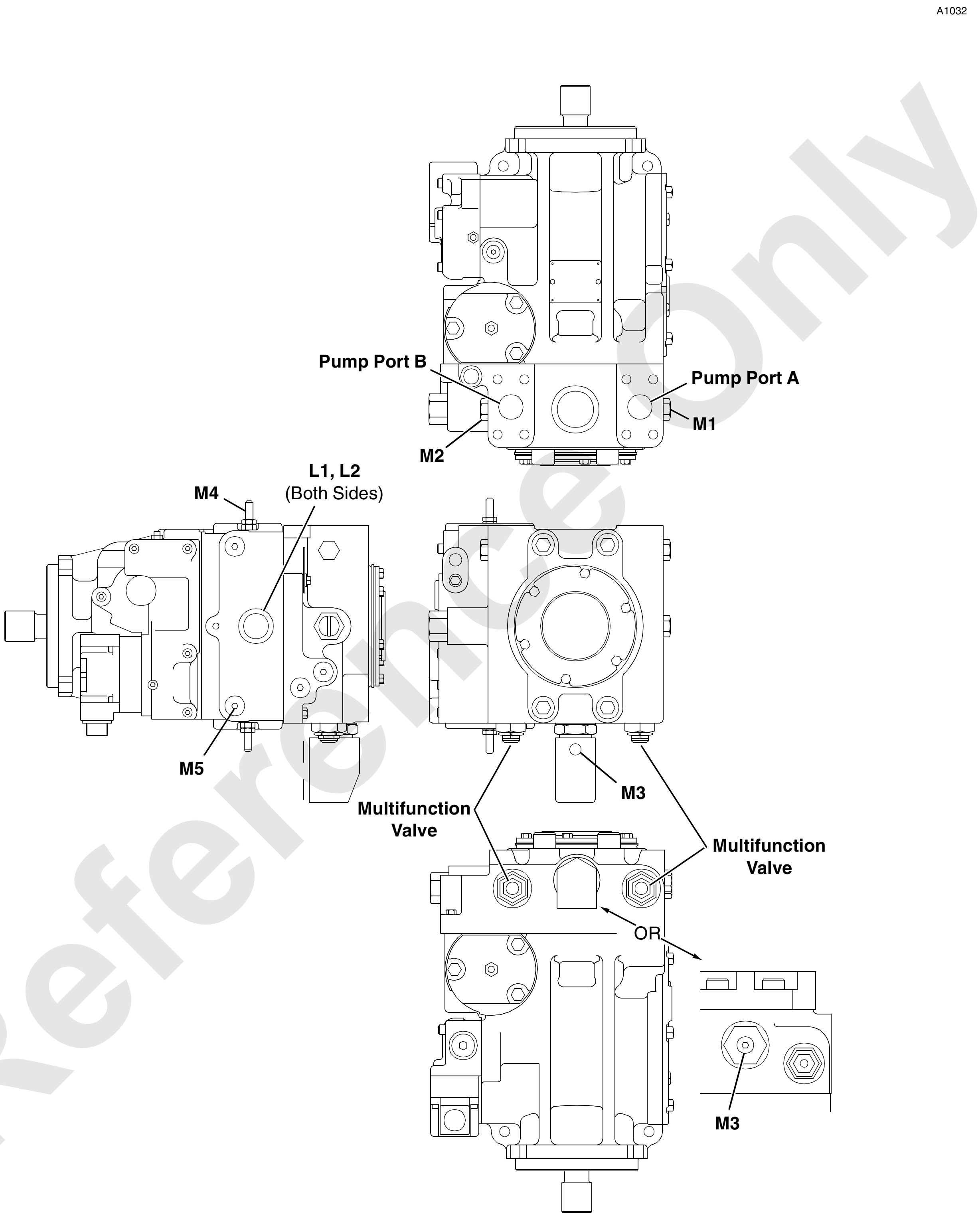


FIGURE 10-12

Test 10 – Location of Motor Test Ports

SYSTEM MOTORS (Except Swing)

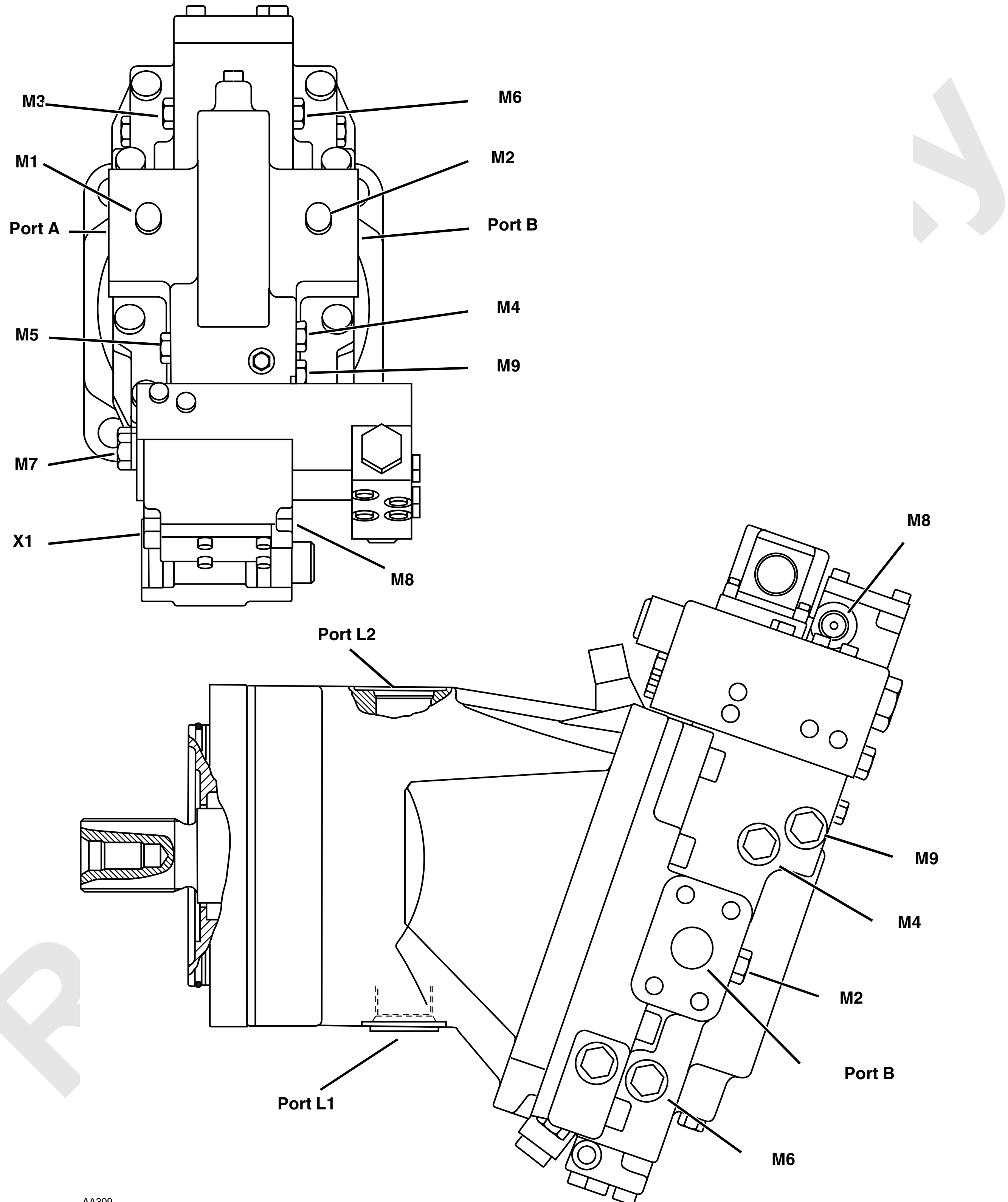


FIGURE 10-13

Test 10 (Continued)

SWING MOTOR

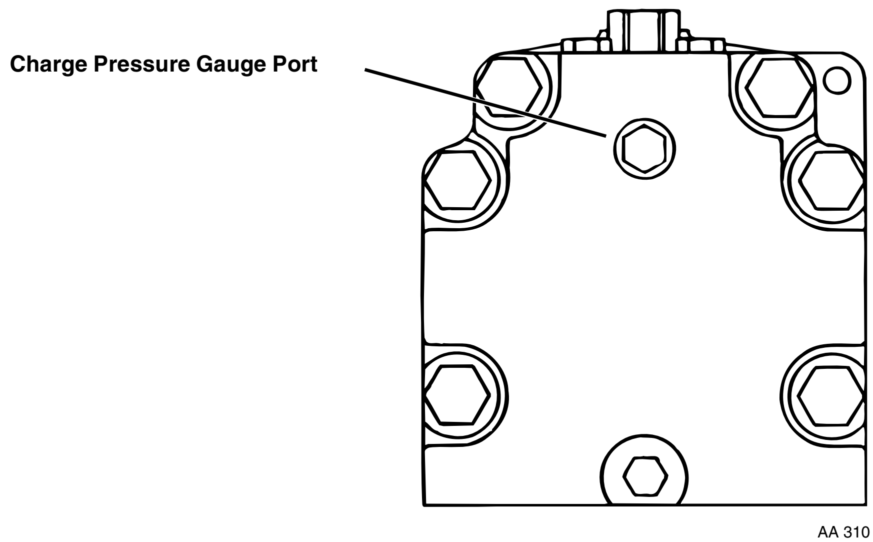


FIGURE 10-14

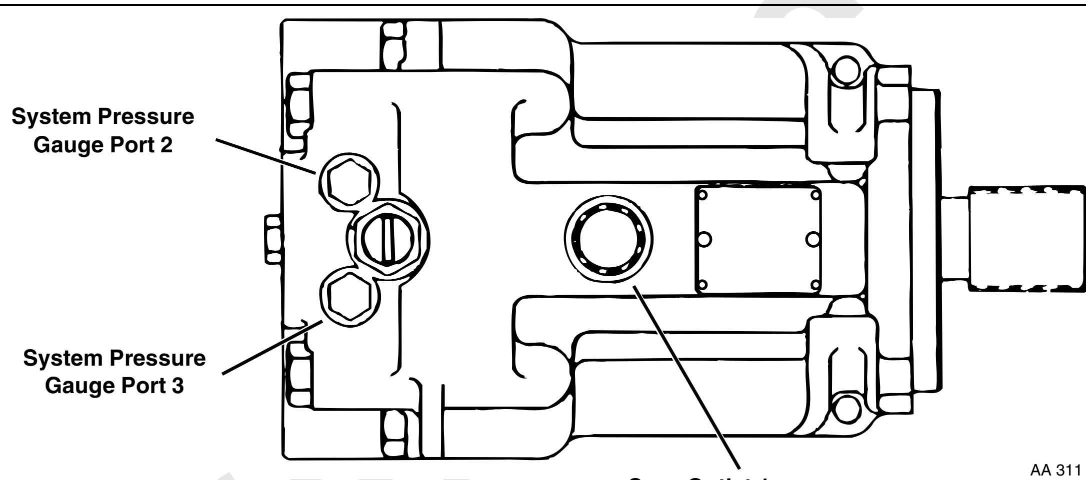


FIGURE 10-15

Port Designation	Port Description	Gauge (psi)	O-Ring Fitting
A and B	Main system pressure	N/A	1 inch code 62 port flange
M1	Gauge port for Port A	10,000	SAE 6
M2	Gauge port for Port B	10,000	SAE 6
M3	Servo pressure (minimum angle)	10,000	SAE 6
M4	Servo pressure (maximum angle)	10,000	SAE 6
M5 and M9	Servo supply pressure	10,000; Tee into control pressure line	SAE 6
M6	Motor charge pressure	600	SAE 6
M7 and M8	Control pressure	600	SAE 6
L1 and L2	Case pressure	600	SAE 12
X1	External PCP supply pressure	1,000	SAE 6

Test 11 – Manually Stroking the Pump

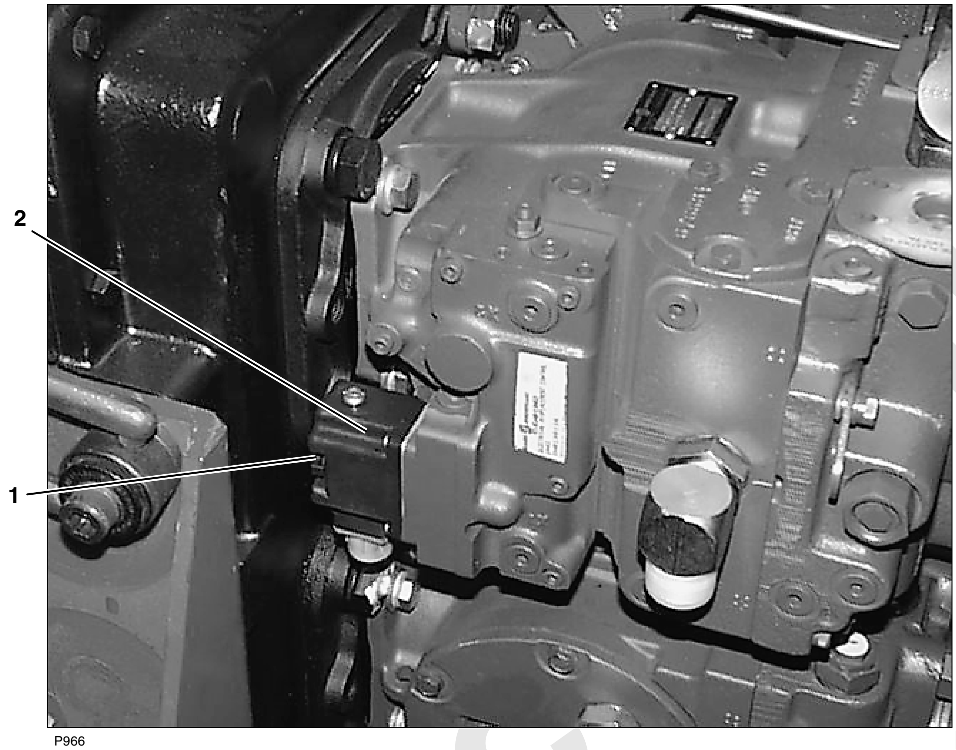


FIGURE 10-16

Item	Description
1	Manual override
2	Pump EDC

With the engine running and all brakes and locks engaged, rotation of the manual override in the clockwise direction will cause engine load down and pressure rise in port A of the pump under test. Counterclockwise rotation of the manual override will cause engine load down and pressure rise in port B of the pump under test. See Test 9 for location of pump ports A and B.

Test 12 – Setting the Pump Pressure

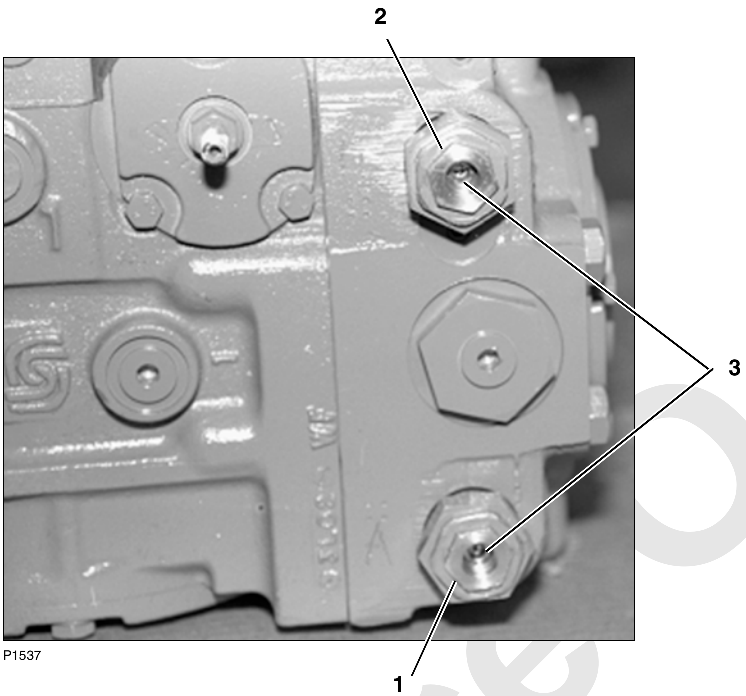


FIGURE 10-17

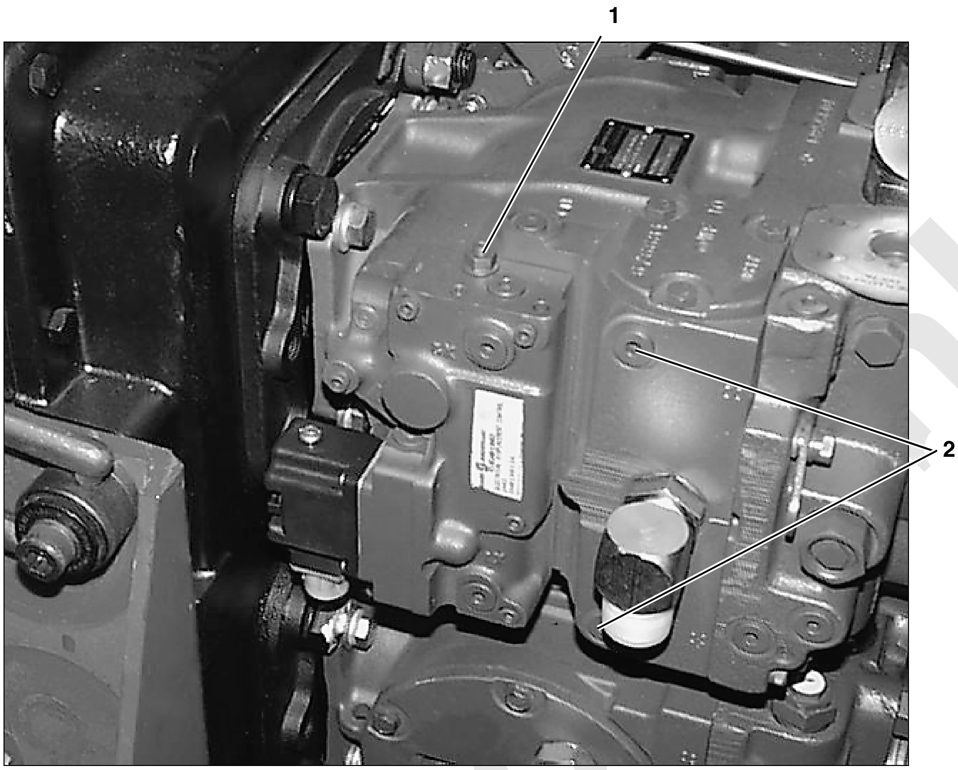
Item	Description
1	Multifunction valve A
2	Multifunction valve B
3	Jam nut

Remove the protective cap from multifunction valve and loosen the lock nut. Insert a hex wrench into the multifunction valve adjusting screw. Turn adjusting screw clockwise to increase valve pressure. Turn adjusting screw counterclockwise to decrease valve pressure.

Pump Port Control Function

Pump	Port A	Port B
Left Travel	Forward	Reverse
Right Travel	Reverse	Forward
Main Hoists	Raise	Lower
Boom Cylinder	Raise	Lower
Swing	Right	Left

Test 13 – Setting Pump Neutral



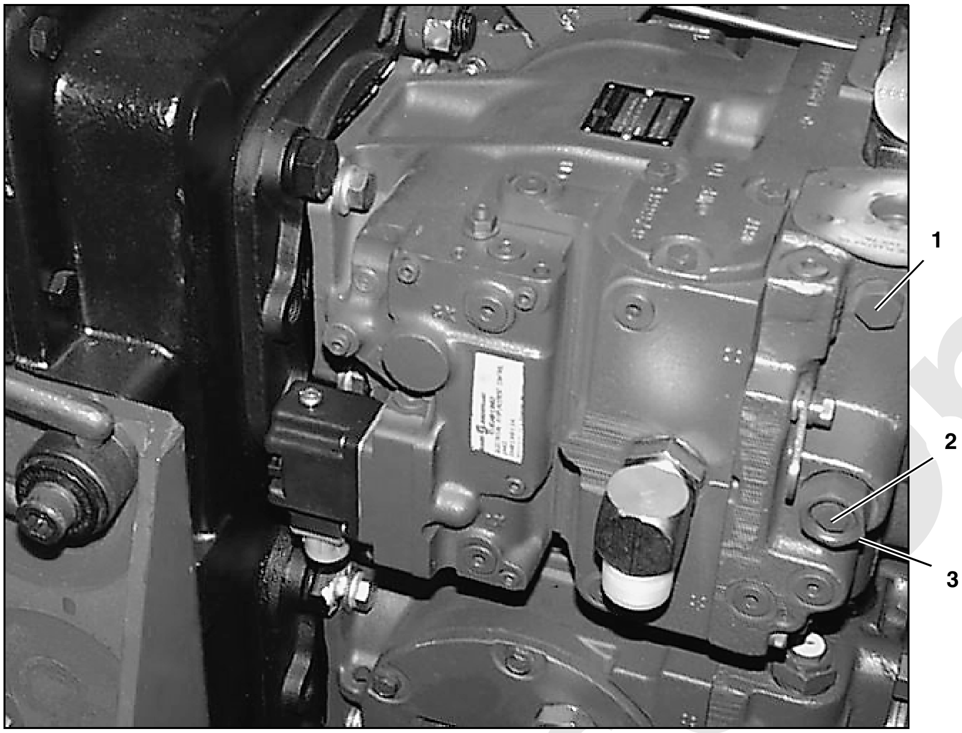
P966

FIGURE 10-18

Item	Description
1	Neutral adjustment screw
2	Servo gauge ports

To set pump neutral, set the pawls and brakes, and disable the pump from the PC by disconnecting the PC cable at the EDC. Install a 500 psi gauge in each of the servo gauge ports. Start and operate the engine at normal speed. Loosen the lock nut and rotate the neutral adjustment screw with a hex wrench until pressure increases in one of the gauges. Note the handle position of the hex wrench and without removing the wrench, rotate the neutral adjustment screw counterclockwise until pressure increases in the other gauge. Note the position of the hex wrench and rotate the neutral adjustment screw clockwise halfway between the wrench positions. The control should now be in neutral with both gauges reading the same case pressure. While holding the neutral adjustment screw with the hex wrench, tighten the lock nut. Remove the gauges and reinstall the servo gauge port plugs.

Test 14 – Adjusting Pump Charge Pressure Relief



P966

FIGURE 10-19

Item	Description
1	System pressure port
2	Adjustment screw
3	Adjustment lock nut

The pump charge pressure must be measured to adjust the charge pressure relief. Charge pressure should be measured with a 0-500 psi gauge installed at system pressure gauge ports M1 or M2, or at charge pressure gauge port M3 if unused in the hydraulic circuit application (the external filtration system prevents the use of M3 for testing the auxiliary hoist and load drum pumps). Charge pressure can also be measured at the transducer manifold as indicated in Test 15. See Test 9 for location of pump test ports M1, M2, and M3.

Install the gauge at the selected test port. Start the engine and make sure all brakes are in the lock position, and all hydraulic systems remain off. A measurement of approximately 350 psi indicates correct charge pressure relief.

To adjust charge pressure relief, loosen the adjustment lock nut and turn the adjustment screw with a screwdriver until 350 psi is obtained. Torque the lock nut to 34-41 ft/lbs. Remove the gauge and replace the port plug.

Test 15 – Checking Pump Charge Pressure

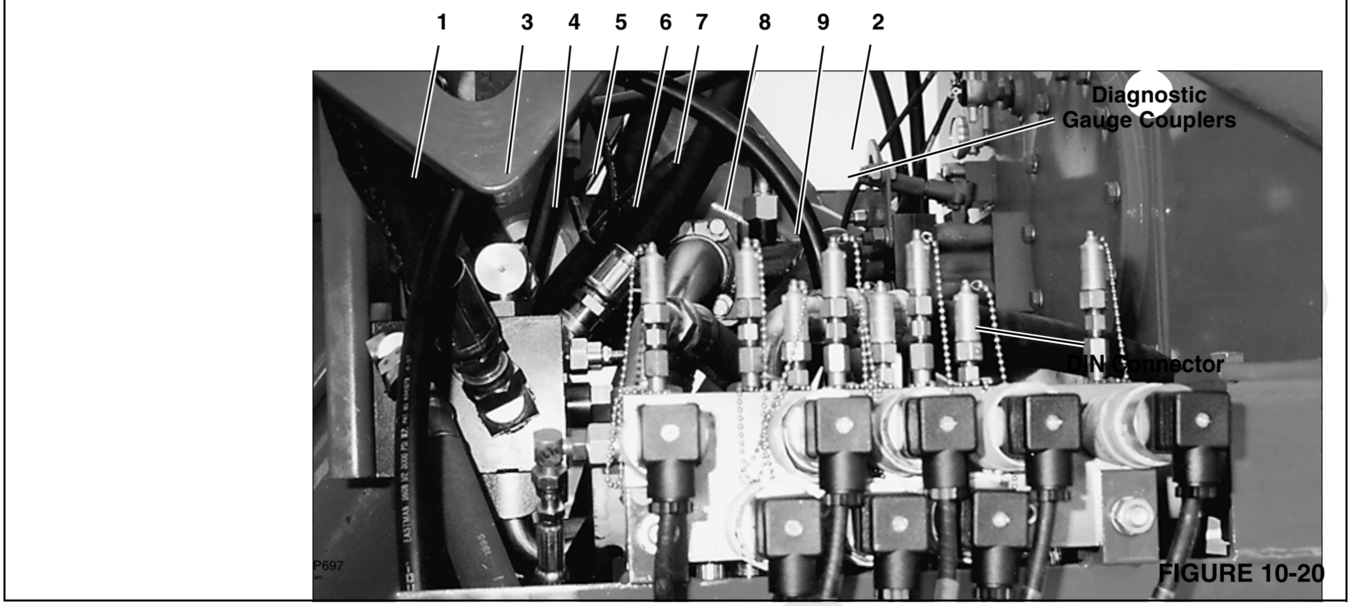


FIGURE 10-20

Item	Description	Item	Description
1	Left Track Forward/Reverse	6	Boom Hoist Pump (Boom Up)
2	Right Track Forward/Reverse	7	Front Load Drum Hoist
3	Swing Left	8	Rear Load Drum Hoist
4	Swing Right	9	Auxiliary Load Drum Hoist (optional)
5	Boom Hoist Cylinder (Boom Up)		

The most convenient method of measuring the pump charge pressure is to install a 0-500 psi gauge at the desired system diagnostic gauge coupler at the transducer manifold assembly. Start the system and record the charge pressure at engine idle speed. No hydraulic systems should be energized. A measurement of 350 psi is normal charge pressure. A measurement under 350 psi indicates a charge pressure relief adjustment is necessary. See Test 14.

Test 16 – Checking Charge Pressure at Motor Port X1

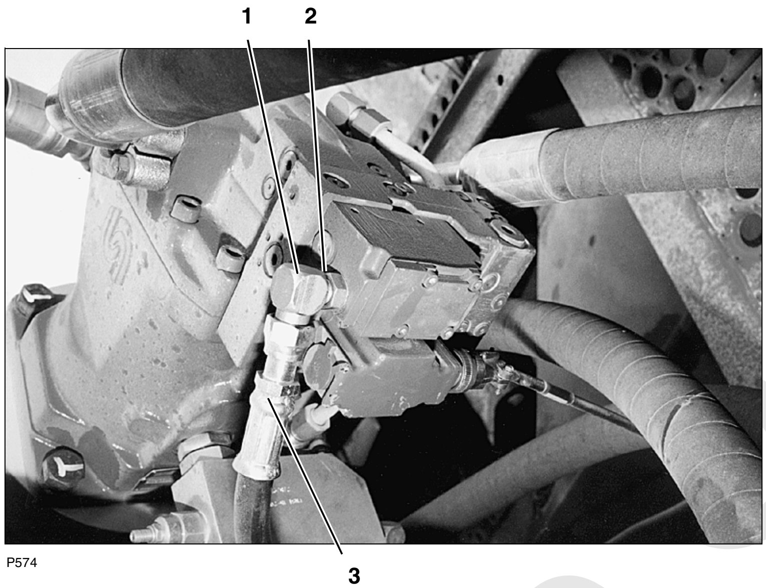


FIGURE 10-21

Item	Description
1	Connector
2	Port X1 connection
3	Hydraulic hose

Install a 0-500 psi gauge between the hydraulic hose and the connector at port X1. See Test 10 for location of port X1. Verify approximately 350 psi pressure with system on at idle speed. A lower pressure reading indicates the need for an adjustment or replacement of charge pump. See Test 14.

Test 17 – Testing the Motor PCP and Pump EDC

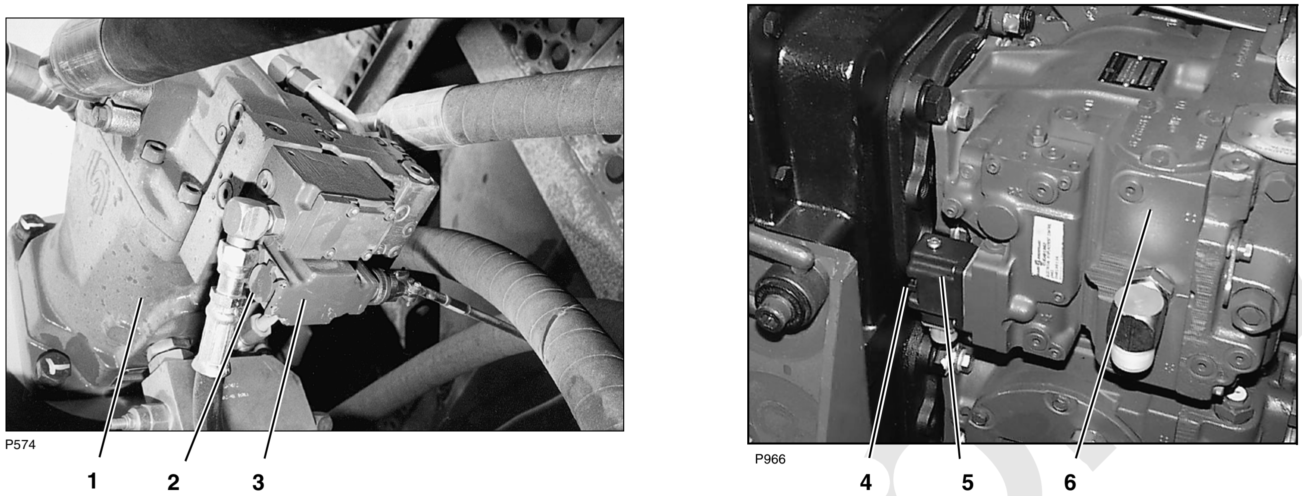


FIGURE 10-22

Item	Description	Item	Description
1	Motor	4	Manual override
2	Manual override	5	Pump EDC
3	Motor PCP	6	Pump

Testing any of the motor PCP's or pump EDC's requires a standard test plug adapter (which can be ordered from Manitowoc Cranes, Inc.) and a digital multimeter.

To test motor, connect the adapter to the motor PCP to be tested. Leave the PC end of the adapter disconnected. Make the appropriate connections (white and black) from the adapter cable to the digital multimeter and verify a resistance of 24 to 26 ohms. Reconnect the adapter cable connections (white and black) between the PC input cable and the digital multimeter for measuring volts DC. Slowly actuate the appropriate control handle in the operator's cab and verify the range of voltage change is between 0 and 1.96 volts DC.

The load current (or amperage draw) at any given point in the high speed to low speed range and vice versa is equivalent to the voltage at the given point in the speed range. Load current (amps) can be measured directly by making the appropriate adapter connections (red and white) to the digital multimeter.

To test pump, remove the PC input line from the pump EDC and connect the adapter in its place. Perform the same tests as described above (for motor) and verify 15 to 19 ohms and 0 to ±2.45 volts DC with amperage equivalent to the voltage at any given point in the speed range.

Test 18 – Testing for Pump and Motor Leakage

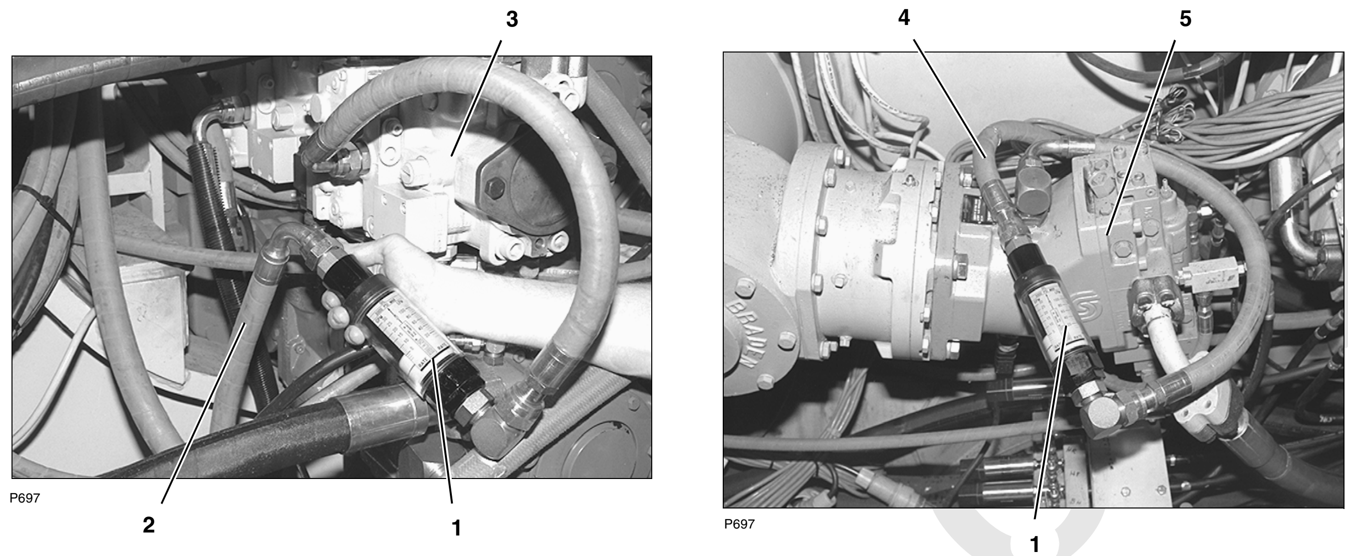


FIGURE 10-23

Item	Description
1	In line flow meter
2	Pump case drain hose
3	Pump
4	Motor case drain hose
5	Motor

Testing for pump and motor leakage requires a 3,000 psi (207 bar) in line flow meter with minimum flow rated capacity of 10 gpm. Flow meters can be ordered from Manitowoc Cranes, Inc.

Flow from individual pump and motor drains depend on several operational factors and settings. Acceptable leakage is based on the combined case flow of the pump and motor. The combined case flow from load drum pump and motor should be equal to a charge pump flow of 8.9 gpm per 1,000 rpm of the engine. The combined case flow from swing or travel pump and motor should be equal to a charge pump flow of 4.8 gpm per 1,000 rpm of the engine.

For load drum or travel motor begin by connecting flow meter between motor case drain hose and port L1 or L2 (use highest port for testing). To test swing motor, connect the flow meter between motor case drain hose and case outlet 1. (See Test 10 for location of motor test ports.) With engine running at 1,000 rpm, measure motor flow rate. Swing and travel motors should not exceed 1 gpm case flow at neutral. At heavier loads and higher rpm, case flow may increase to 4 or 5 gpm. Record results at neutral and reconnect motor case drain hose to motor port. The difference between circuit charge pump flow and case flow at neutral is the acceptable pump case flow at neutral for circuit being tested.

Connect flow meter between pump case drain hose and pump port L1 or L2 (use highest port for testing). (See Test 9 for location of or pump test ports.) With engine running at 1,000 rpm, measure pump flow rate at neutral and compare to calculated acceptable pump case flow.

Changes from normal or major changes with increasing system pressure more than ±1 gpm are indicators or pump or motor problems.

Test 19 – Testing Hydraulic Solenoid Brake Valves

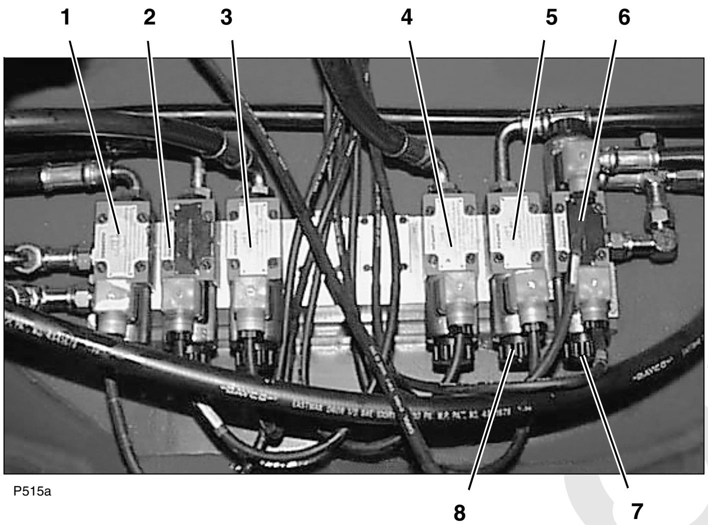


FIGURE 10-24

Item	Description	Item	Description
1	Travel 2-speed solenoid valve	5	Swing disc brake solenoid valve
2	Travel disc brake solenoid valve	6	Swing lock in solenoid valve
3	Rear drum disc brake solenoid valve	7	Swing lock out solenoid valve
4	Front drum disc brake solenoid valve	8	Electrical DIN connector

To determine if a hydraulic solenoid valve is enabled, place any metallic tool such as a screwdriver on solenoid. Solenoid is enabled if tool is magnetically pulled toward solenoid.

Testing for voltage at any hydraulic brake valve requires the use of a standard test plug adapter (which can be ordered from Manitowoc Cranes, Inc.) and a digital multimeter.

Connect the test plug adapter between the brake valve and the electrical DIN connector. Make the appropriate connections (white and black) from the adapter cable to the digital multimeter and verify 12 volts DC while actuating the appropriate system function that releases the brake under test. Load current (amps) can be measured directly by making the appropriate adapter connections (red and white) to the digital multimeter.

Test 20 – Checking Hydraulic Brake Pressure

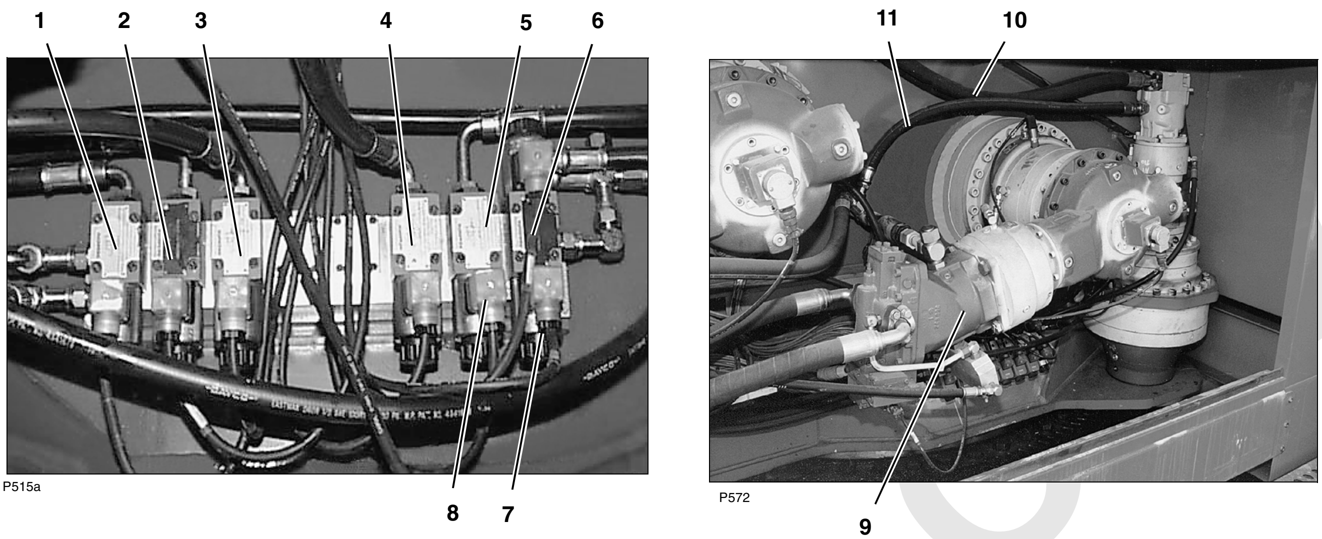


FIGURE 10-25

Item	Description	Item	Description
1	Travel 2-speed solenoid valve	7	Swing lock out solenoid valve
2	Travel disc brake solenoid valve	8	Electrical DIN connector
3	Rear drum disc brake solenoid valve	9	Load drum disc brake housing
4	Front drum disc brake solenoid valve	10	90° elbow
5	Swing disc brake solenoid valve	11	Flexible hose
6	Swing lock in solenoid valve		

The hydraulic brake pressure is obtained by activating the desired system brake while measuring the hydraulic pressure at the brake control valve or disc brake housing with a 0-500 psi gauge. Both test ports will yield the same measurement. To test at the control valve, connect the gauge between the flexible hose and the adapter fitting at the top of the valve. To test at the disc brake housing, connect the gauge between the flexible hose and the 90° elbow at the disc brake housing. Acceptable hydraulic brake pressure is 300 psi or greater. If the pressure is less than 300 psi, the system pump charge pressure should be checked. See Test 15. If the charge pressure is adequate, repair or replace the brake control valve.

Test 21 – Adjusting the Lower Accessory Relief Valve

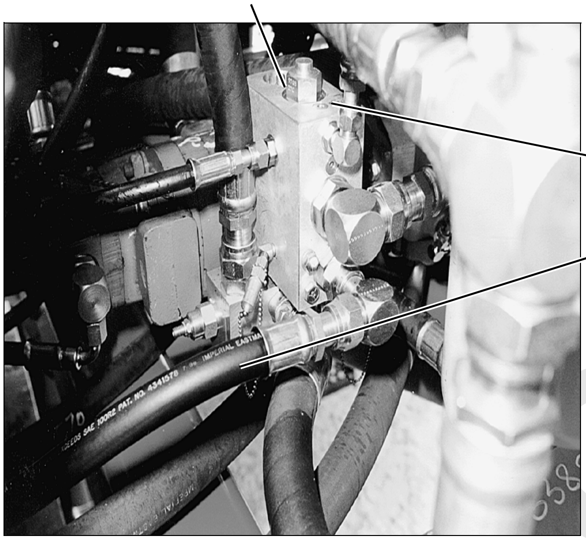


FIGURE 10-26

Item	Description
1	Accessory System Relief Valve
2	Accessory System Pilot Check Valve
3	Accessory System Gauge Coupler

Connect 0 to 1,000 psi (0 to 69 bar) pressure gauge to coupler at accessory system relief valve.

Start and run engine at low idle. This is accessory system unload pressure.

Remove 0 to 1,000 gauge and install a 0 to 5,000 psi (0 to 345 bar) pressure gauge to coupler at accessory system relief valve. Using controls on carbody, fully retract any carbody jack to stall accessory system relief valve. Gauge should read approximately 3,000 psi (207 bar).

If correct pressure is not obtained, adjust accessory system relief valve to obtain 2,900 to 3,100 psi (200 to 214 bar) pressure. Turn relief valve screw in to increase pressure or out to decrease pressure. This is the accessory system pressure setting.

Tighten nut on screw to lock adjustment.

Stop engine and remove gauge from coupler. Install duct cap over coupler.

Test 22 – Adjusting Jacking Counterbalance Valves

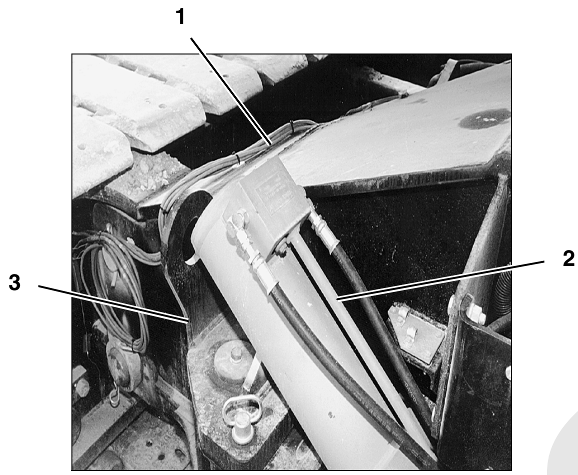


FIGURE 10-27

Item	Description
1	Counterbalance valve (Retract)
2	Counterbalance valve (Extend)
3	Jacking cylinder

To adjust jacking cylinder retract or extend counterbalance valve, loosen the adjustment lock nut and rotate screw clockwise to decrease pressure setting or counterclockwise to increase pressure setting. Hold adjustment screw and tighten lock nut. Check cylinder for correct operation.

Test 23 – Transducer Test

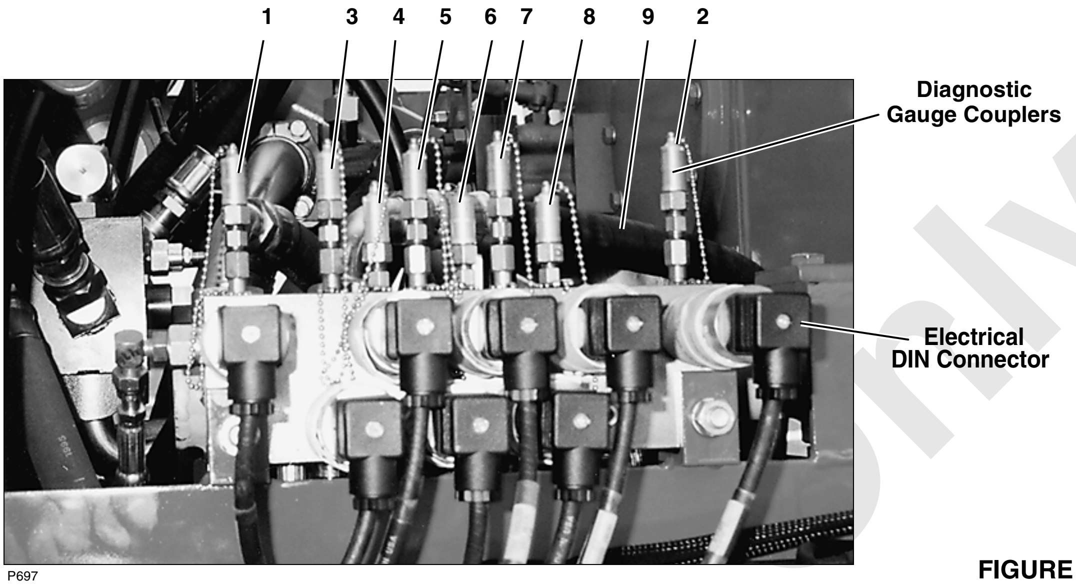


FIGURE 10-28

Item	Description	Item	Description
1	Left Track Forward/Reverse	6	Boom Hoist Pump (Boom Up)
2	Right Track Forward/Reverse	7	Front Load Drum Hoist
3	Swing Left	8	Rear Load Drum Hoist
4	Swing Right	9	Auxiliary Load Drum Hoist (optional)
5	Boom Hoist Cylinder (Boom Up)		

Testing the voltage and resistance at a transducer requires a standard test plug adapter (which can be ordered from Manitowoc Cranes, Inc.) and a digital multimeter. Connect the test plug adapter between the desired transducer and its electrical connector. Turn the cab power switch on with engine off.

To test incoming power, make the appropriate connections from the adapter cable to the digital multimeter for testing incoming power (white + and black -) and verify approximately 12 volts DC. If this reading is not obtained, check the F10 (10 amp) fuse at the fuse box (see Test 6).

When checking for the correct voltage output from the transducer to the programmable controller, test with engine off/power on. Make the appropriate connections at the digital multimeter (green + and black -) and verify 1.00 to 1.04 volts DC. Note: the PC nulling routine permits the equipment to operate outside of the 1.00 to 1.04 voltage range. However, if readings less than or equal to 0.50 volts, or greater than or equal to 2.0 volts are obtained, the transducer must be changed.

Test 24 – Checking Voltage at the Load Drum Encoder

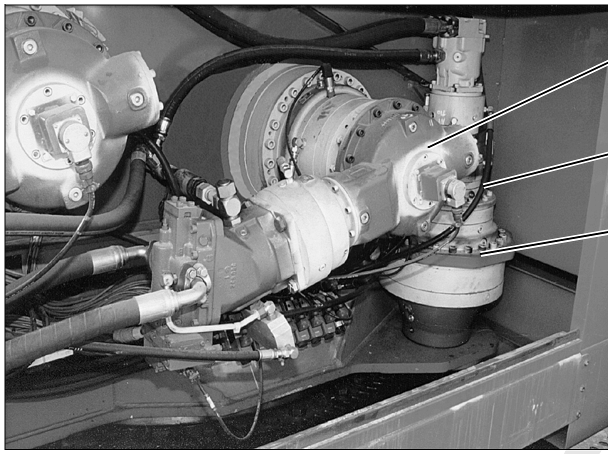


FIGURE 10-29

Item	Description
1	Encoder
2	Connect test plug
3	Load drum planetary

Testing a load drum encoder for correct voltages requires a standard test plug adapter (which can be ordered from Manitowoc Cranes, Inc.) and a digital multimeter. Connect the test plug adapter at the encoder electrical connector and start the machine.

The load drum should remain at rest. Make the appropriate connections from the adapter cable to the digital multimeter for testing incoming power (red + and black -) and verify approximately 12 volts DC. If 12 volts DC is not present, check the 10 amp fuse at the fuse box (see Test 6).

To verify the correct output voltage from the encoder to the PC, make the appropriate connections at the digital multimeter (white + and black -, channel 1) or (green + and black -, channel 2). With the load drum at rest, verify 0.00 or approximately 7.40 volts DC exists. With the load drum actuated, verify a steady voltage of 3.5 to 3.8 volts DC. If these readings are not obtained, check the encoder drive assembly and output wiring to the PC.

ALPHABETICAL INDEX

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