Grove RT9130E-2

Service Manual

Manitowoc

1

Component Location

Figure 1-2 shows the location of some of the main components of the RT9130 Crane.

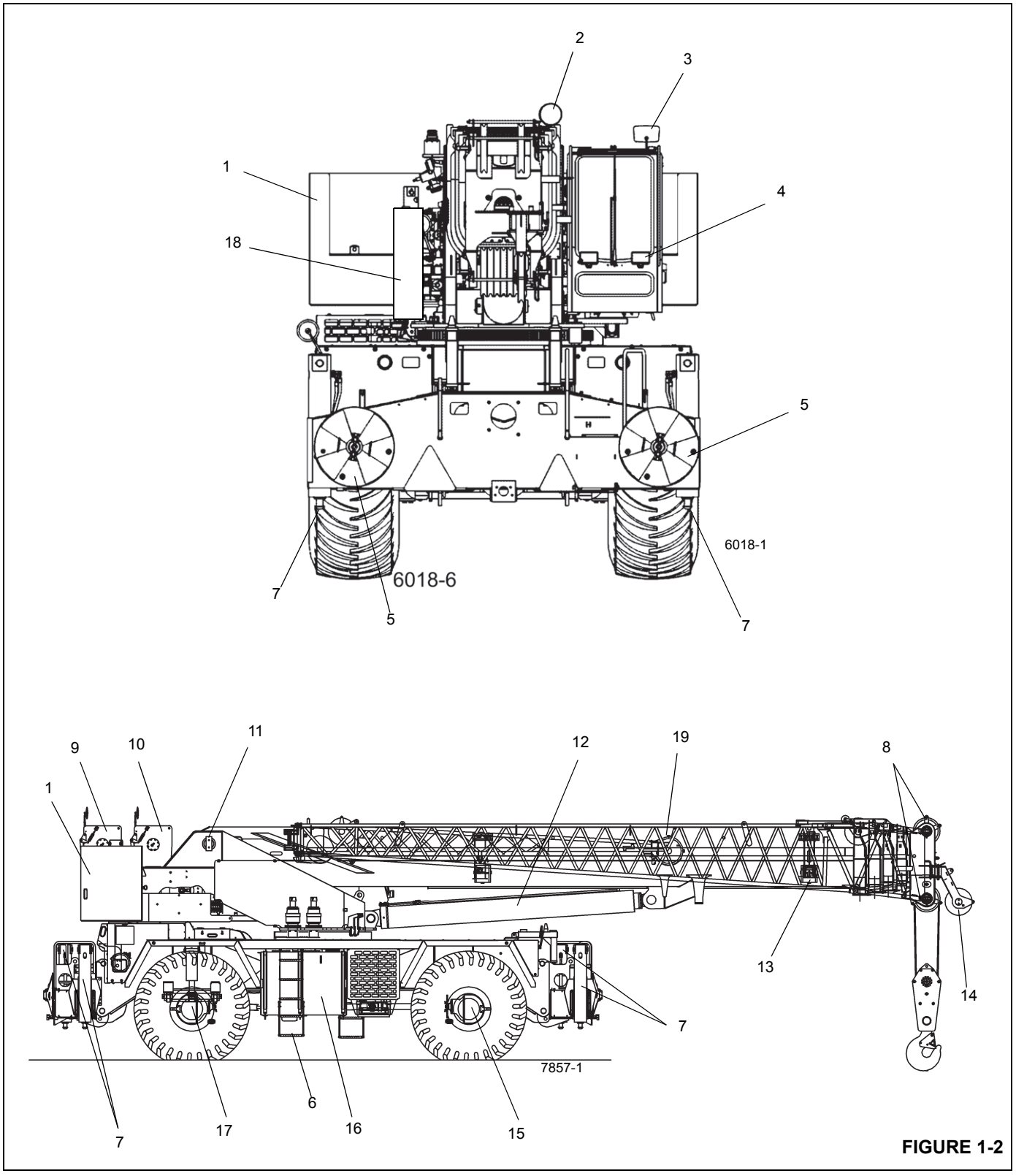


FIGURE 1-2

Electrical System

Harnesses, Wires, and Connectors

Visually inspect all electrical harnesses, cables, and connectors every month or 250 hours for the following:

- Damaged, cut, blistered, or cracked insulation.
- Exposed bare wires.
- Kinked or crushed wires and cables.
- Cracked or corroded connectors, battery terminals, and ground connections.

If any the above conditions exist, evaluate, clean and replace as necessary.

The climate in which the crane operates affects the service life of the electrical components. The climate zones are defined in Table 1-2. Recommended replacement of harness and cables is as follows:

- Climate zone C after 10,000 hours of service.
- Climate zones A and B, with high ambient temperatures and duty cycles, after 8000 hours of service.
- Climate zones D and E after 5,000 hours of service.
- Salt water conditions after 8,000 hours of service.

Fatigue of Welded Structures

Experience has shown that highly stressed welded structures when repeatedly subjected to varying stresses caused by twisting, shock, bending, and intentional and/or unintentional overloads, often become subject to weld cracking which may be attributed to fatigue of the welded joint. This condition is not uncommon in construction equipment.

Equipment should be periodically inspected for evidence of weld fatigue. The frequency of these inspections should increase with the age of the equipment and the severity of the application.The following are known high stress areas applicable to Grove machines, and a visual inspection of these areas should be made part of an owner's planned preventive maintenance program:

- Telescopic Boom: wear pad retaining structures, hydraulic cylinder attaching points, boom pivot shaft retaining structures.
- Outrigger pads, beams, boxes and attachment structures.
- Main frame: generally in the area of doubler plates and crossmembers; at the junction of front and rear frame members on truck cranes.
- Turntable bearing connection—where bearing is welded to the crane superstructure or chassis.
- Counterweight support structures.
- Chassis axle and suspension mounting structures.
- Hydraulic cylinder end connections.

The above is provided only as a guide, and your inspection plan should not be limited to the areas listed. A thorough visual inspection of all weldments is good practice.

Anyone requiring more detailed inspection instructions and/or repair procedures may request same by contacting your local Manitowoc distributor.

Loctite®

⚠ CAUTION

Skin and/or Eye Hazard!

Loctite type adhesives contain chemicals that may be harmful if misused. Read and follow the instructions on the container.

Always follow the directions on the Loctite container, as not all Loctite types are suitable for all applications.Various types of Loctite are specified throughout the Service Manual. The following types of Loctite brand adhesives are available from the Parts Department of the local Manitowoc distributor.

Application of Medium Strength Loctite

NOTE: The fastener may be re-used; the adhesive may be re-applied over cured adhesive residue.

The following procedure covers the proper application and curing method for medium strength Loctite adhesive/sealant (Loctite #243) and primer (Locquic Primer T7471).

Primer Application

NOTE: It is not necessary to bathe the threads in primer.

1. Ensure the threaded surface, both male and female, is clean and free of dirt and oil. Apply a light spray coating of primer to both male and female parts to be joined to clean and accelerate the curing process.
2. Allow the part to dry prior to adhesive/sealant application.

Adhesive/Sealant Application

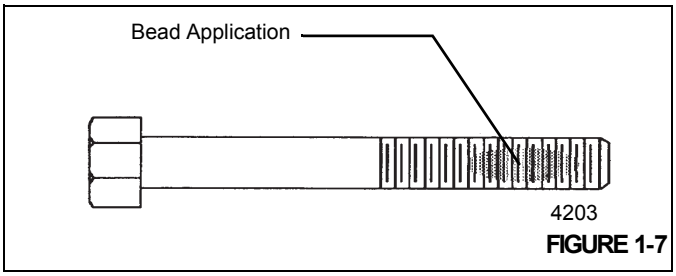


FIGURE 1-7

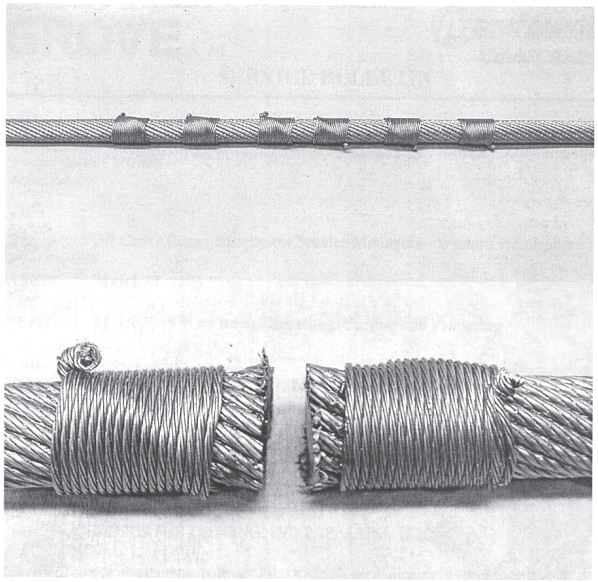


FIGURE 1-13

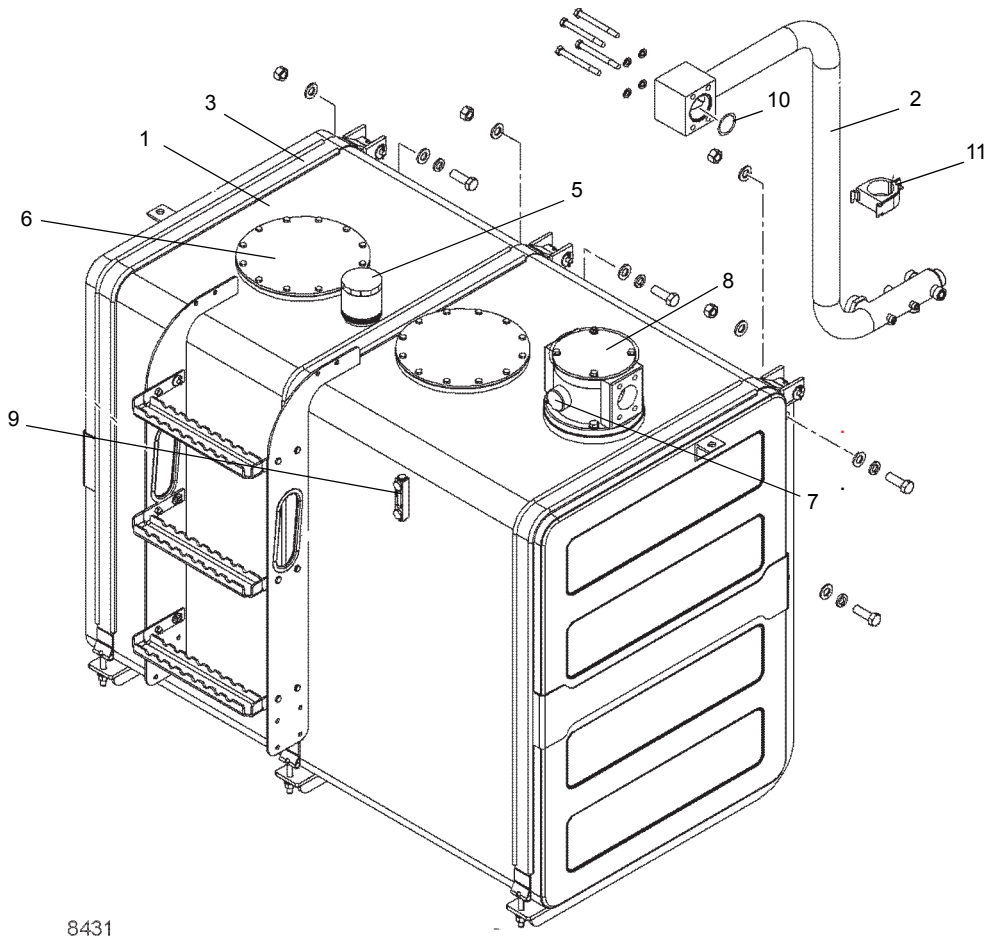


FIGURE 2-3

Item	Description
1	Hydraulic Tank Assembly
2	Return Manifold Tube Assembly
3	Mounting Strap
4	Magnetized Drain Plug (Not shown on bottom of tank)
5	Fill Cap and Breather
6	Access Cover
7	Filter Indicator
8	Hydraulic Filter
9	Sight Gauge
10	O-ring
11	Clamp

A gauge on the filter head indicates how restricted (clogged) the filter element is. When back pressure caused by a dirty filter element exceeds 40 psi (275 kPa), the filter assembly's bypass feature functions to allow hydraulic oil to bypass the filter element and flow into the reservoir through the bypass valve instead. For filter replacement instructions, refer to *Filter Maintenance*, page 2-12.

Pump Distribution

Pump No. 1

The torque converter drives Pump No. 1.

Section one of pump No. 1 supplies the hoist, lift, and telescope directional control valve. The valve sections control the main hoist, boom lift, boom telescope, and, when equipped, auxiliary hoist functions. Hydraulic oil flowing from this valve bank returns to the reservoir filter.

CAUTION

If the pump becomes hot to the touch, it is binding and may seize. Stop the engine, disassemble the pump, and repair it so it will not bind.

CAUTION

For Pump No. 2, pay special attention to the service brake charge pump if your crane has the dual accumulator charging valve for hydraulic service brakes.

If the dual accumulator charge is set too high, the pump will continually push all its flow through an integral relief valve that dumps the heated fluid back into the pump's inlet. This causes a "hot loop" problem that will very quickly heat the pump section above hydraulic reservoir temperature. If this happens, stop the engine immediately. Adjust the dual accumulator charging valve socket head screw in the valve's tank port, out (CCW) to lower the pressure. (See Procedure E of the Pressure Setting Procedure portion of this section.)

Restart the engine; listen for the dual accumulator charge valve to cycle on and off (cycle changes one to two seconds.) Perform Step 5 again.

5. Place your hand on the pump to check for excessive heat buildup caused by binding or other problems. If the pump is too hot to keep a hand on, stop the engine. Each section should feel about the same warmth, but pressure drops in each pump section's circuit would explain some difference between sections.
6. Listen for abnormal noises indicating low hydraulic oil level or internal pump problems. If the pump is making excessive noise, it is probably sucking air into its inlet, keeping it from priming. In case of abnormal noise, stop engine, and inspect the pump and the suction line for a loose connection, a leak, or a damaged or missing O-ring.
7. If the pump seems to be running properly, increase the RPM to 1500 to 1800 rpm for one to two minutes while operating no hydraulic functions. Repeat checks in steps 4, 5, and 6.
8. Increase engine speed in steps to full RPM. Repeat checks in steps 4, 5, and 6.
9. Cycle the components the pump sections power to verify the pump sections drive them properly. Verify there is no leaking.
10. Check pressure settings. Refer to *Pressure Setting Procedures*, page 2-21.

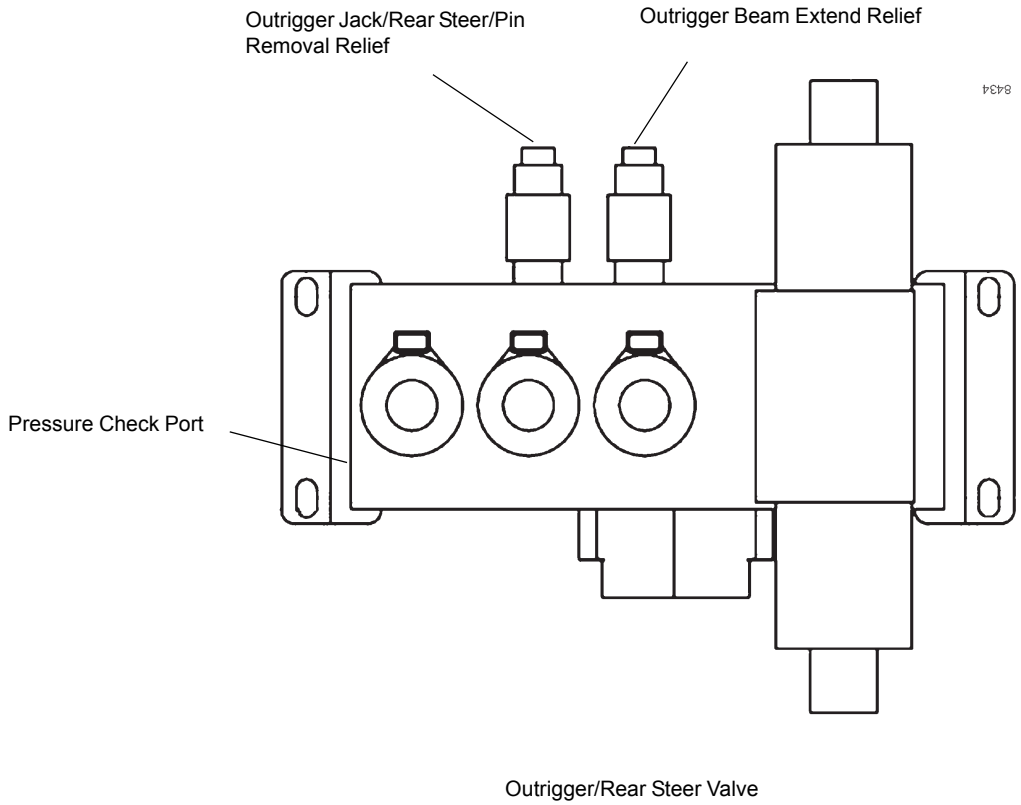


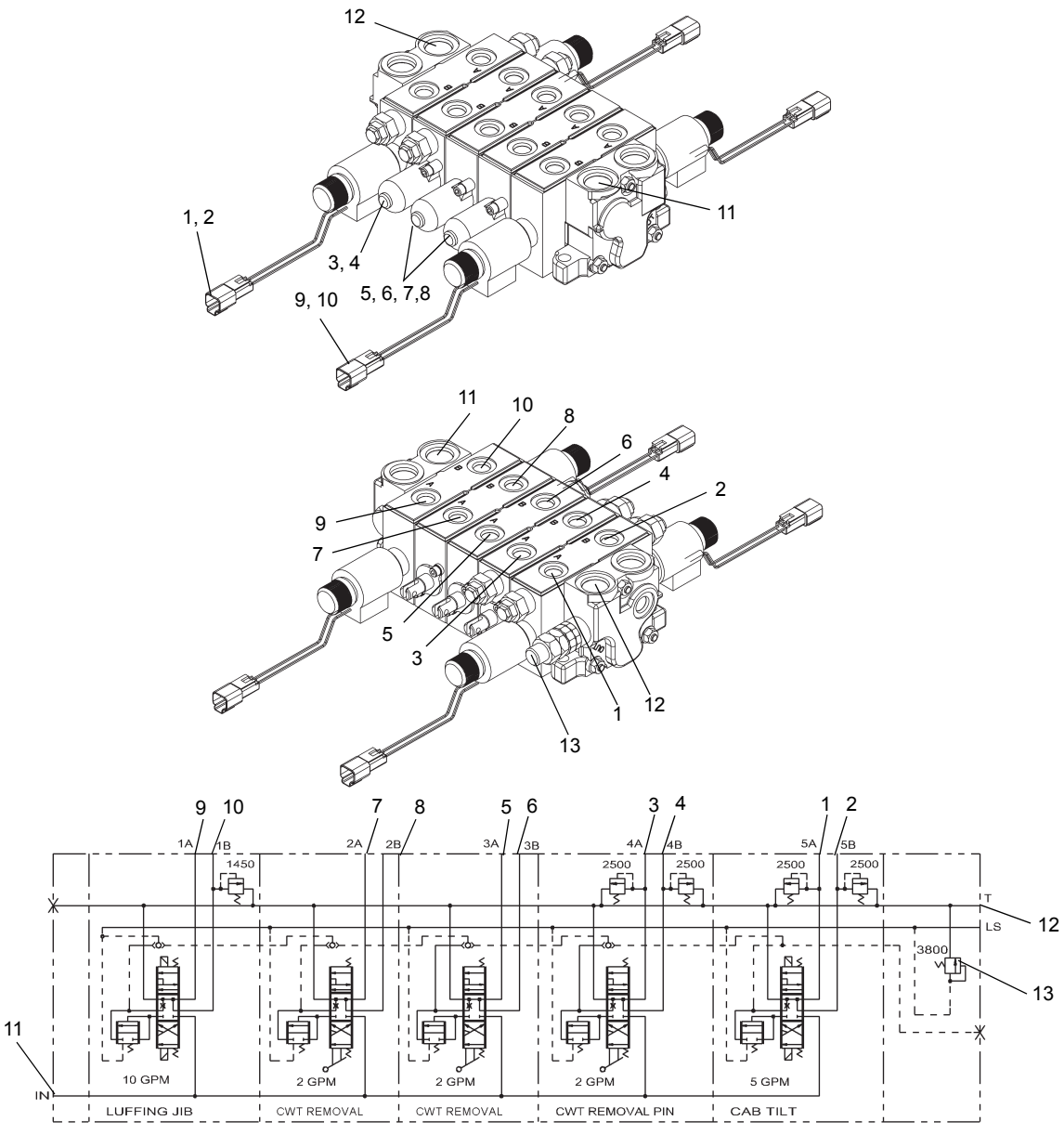
FIGURE 2-14

Procedure K - For Checking Outrigger/Rear Steer Relief Valve Pressure

1. Remove cap and install pressure gauge (Figure 2-14) on outrigger/rear steer valve pressure check port.
2. With engine running at full RPM, fully extend one outrigger beam. Adjust the sequence relief valve to 2000 psi ±50 (13.8 MPa ±0.4). If adjustment is required, loosen locknut and use ¼" allen wrench to turn "IN" (CW) to increase pressure or "OUT" (CCW) to decrease pressure. When complete, tighten locknut.
3. With the engine running at full RPM, fully extend one outrigger jack cylinder. Adjust the outrigger jack/ rear steer/ pin removal relief valve to 3500 psi ±50 (24.2 MPa ±0.4). If adjustment is required, loosen locknut and use ¼ inch Allen wrench to turn adjustment screw in (CW) to increase pressure or out (CCW) to decrease pressure. When complete, tighten locknut.
4. Remove pressure gauge from outrigger/rear steer valve and reinstall cap.

Procedure L - For Checking/Setting the Make-up Oil Manifold (Thermal Contraction)

1. Install pressure check diagnostic quick disconnect (Parker PD240) with gauge onto test nipple @ GPA or GPB on the make-up oil manifold (Figure 2-15).
2. Boom lift up to achieve a boom angle greater than 35° (Boom Telescope cylinder must be fully retracted).
3. With the engine at idle RPM, check to ensure pressure is 200 psi (1.4 MPa). If the pressure is low, adjust the pressure reducing valve adjusting stem clockwise (in). If pressure is higher than specification, adjust the adjustment stem counterclockwise (out).
4. Once pressure is set, move pressure gauge to the other (GPA or GPB) diagnostic coupler on the make-up oil manifold, check to ensure the pressure reads the same as set in step #3.
5. Stop engine and remove quick disconnect.



Counterweight Removal/Cab Tilt Directional Valve **FIGURE 2-21**

Item	Description
1	Port 5A - Cab Tilt
2	Port 5B - Cab Tilt
3	Port 4A - Counterweight Removal Pin
4	Port 4B - Counterweight Removal Pin
5	Port 3A - Counterweight Removal Right Cyl.
6	Port 3B - Counterweight Removal Right Cyl.
7	Port 2A - Counterweight Removal Left Cyl.

Item	Description
8	Port 2B - Counterweight Removal Left Cyl.
9	Port 1A - Luffing Jib
10	Port 1B - Luffing Jib
11	Inlet
12	Outlet
13	Load Sense Relief

DOUBLE PILOT OPERATED CHECK VALVE

Description

The double pilot operated (PO) check valve (Figure 2-29) is located on the outside of the left superstructure side plate behind the cab. It is used to hold or lock the cab tilt cylinder in place. Oil flow is directed from the “V” ports to the “C” ports, while blocking flow in the opposite direction. Flow is reversed from “C” to “V” when pressure pilot oil is applied to the opposite side “V” port.

Maintenance

Removal

1. Tag and disconnect the hydraulic lines from the valve. Cap or plug all openings.
2. Remove the capscrews, flatwashers and lockwashers securing the valve to the turntable and remove the valve.

Repair

1. Install new O-rings onto the check valve.
2. Lubricate the check valve and O-rings with clean hydraulic oil.

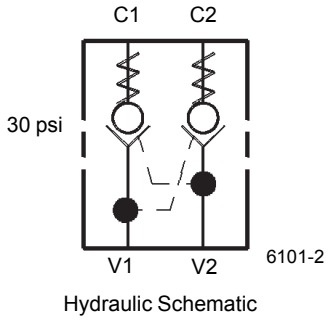
CAUTION

Before installing new seals and rings, clean all surfaces and carefully remove burrs and nicks. Parts displaying excessive wear or damage should be replaced.

3. Carefully install the check valve into the port block until fully seated.

Installation

1. Install the valve to the turntable and secure with the capscrews, flatwashers and lockwashers.
2. Test the check valve by operating the cab tilt cylinder. Verify it extends and retracts without problems; verify there is no leaking. Make repairs as needed.



Hydraulic Schematic

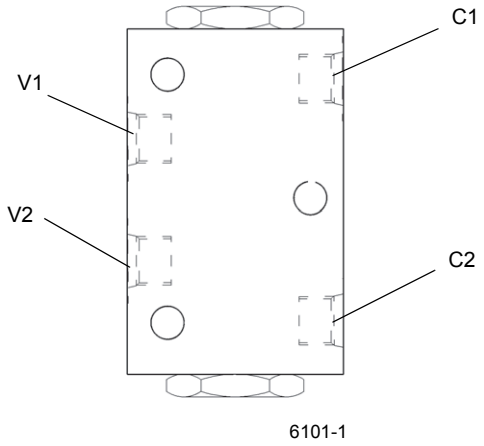
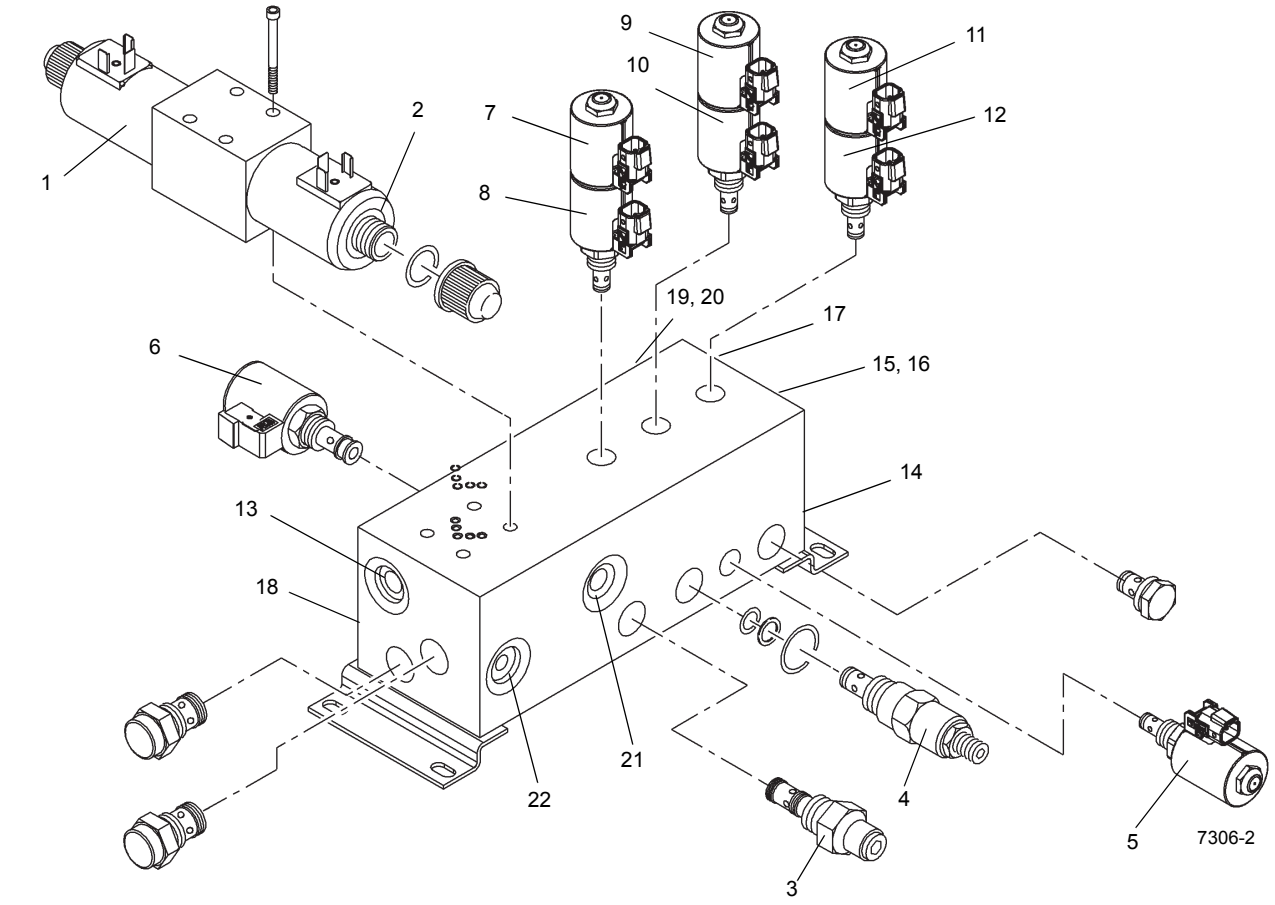


FIGURE 2-29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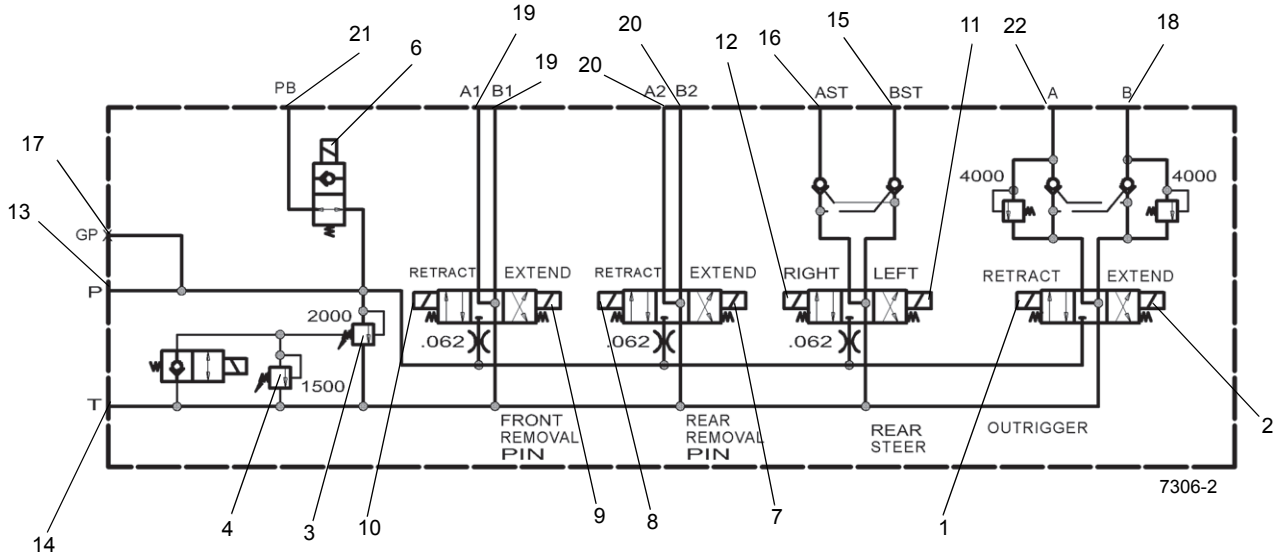
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PB
A1
B1
A2
B2
AST
BST
A
B
17
13
GP
P
T
RETRACT
EXTEND
RETRACT
EXTEND
RIGHT
LEFT
RETRACT
EXTEND
4000
4000
2000
1500
.062
.062
.062
FRONT REMOVAL PIN
REAR REMOVAL PIN
REAR STEER
OUTRIGGER
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14
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7
1
7306-2

FIGURE 2-34

4. Apply hydraulic pressure to the retract (rod) side of the cylinder and observe the open cylinder port for leakage. If leakage is observed, the seals in the cylinder must be replaced.
5. Reconnect all cylinder ports.

Temperature Effects on Hydraulic Cylinders

Hydraulic oil expands when heated and contracts when cooled. This is a natural phenomena that happens to all liquids. The coefficient of expansion for API Group 1 hydraulic oil is approximately 0.00043 cubic inches per cubic inch of volume for 1° F of temperature change. **Thermal contraction will allow a cylinder to retract as the hydraulic fluid which is trapped in the cylinder cools.** The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 25 feet in which the oil cools 60° F would retract approximately 7.75 inches (see Table 2-6). A cylinder extended 5 feet in which the oil cools 60° F would only retract approximately 1.5 inches. The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

Thermal contraction coupled with improper or inadequate lubrication or improper wear pad adjustments and operation at low boom angles may, under certain conditions, cause a “stick-slip” condition in the boom. This “stick-slip” condition could result in the load not moving smoothly. Proper boom lubrication and wear pad adjustment is important to permit the boom sections to slide freely. Slow movement, of the boom may be undetected by the operator unless a load is suspended for a long period of time. To minimize the effects of thermal contraction of “slip stick” it is recommended that the telescope control lever is activated periodically in the extend position to mitigate the effects of the cooling oil.

If a load and the boom is allowed to remain stationary for a period of time and the ambient temperature is cooler than the trapped oil temperature, the trapped oil in the cylinders will cool. The load will lower as the telescope cylinder(s) retracts allowing the boom to come in. Also, the boom angle will decrease as the lift cylinder(s) retracts causing an increase in radius and a decrease in load height.

This situation will also occur in reverse. If a crane is set up in the morning with cool oil and the daytime ambient temperature heats the oil, the cylinders will extend in similar proportions.

The following tables have been prepared to assist you in determining the approximate amount of retraction/extension that may be expected from a hydraulic cylinder as a result of change in the temperature of the hydraulic oil inside the cylinder. The chart is for dry rod cylinders. If the cylinder rod is filled with hydraulic oil, the contraction rate is somewhat greater.

NOTE: Operators and service personnel must be aware that load movement, as a result of this phenomena, can be easily mistaken as leaking cylinder seals or faulty holding valves. If leaking seals or faulty holding valves are suspected to be the problem, refer to Service Bulletin 98-036 dealing with testing telescope cylinders.

UPPER TELESCOPE CYLINDER

Description

The upper boom telescope cylinder Figure 2-49 has a 7.5 in (190.5 mm) bore and is internally ported (rod ported). Oil from the telescope control valve is routed to the cylinder by external lines. Foreign material is prevented from entering the cylinder during rod retraction by a wiper ring in the head and O-ring seals prevent internal and external leakage. The retracted length of the upper telescope cylinder is 34 ft 9.5 in (10.6045 m) and an extended length of 64 ft 5.25 in (19.64055 m) from the end of the barrel to the end of the port block on the rod.

The cylinder weighs 2022 lb (921.4 kg).

Maintenance

Disassembly

NOTE: Replace all cylinder seals and O-rings with new ones anytime the cylinder is disassembled.

1. Using a chain wrench, unscrew the cylinder head from the cylinder barrel.

CAUTION

Flying Parts Hazard!

Do not use air pressure to remove the rod. Use only a source of controlled hydraulic oil pressure if the rod is hard to move.

Parts can fly from the cylinder at dangerous speeds when using air pressure.

CAUTION

Possible Equipment Damage!

Do not damage the cylinder rod chrome surface.

2. Remove the cylinder rod assembly from the cylinder barrel and cover the barrel to avoid contamination.

CAUTION

Possible Equipment Damage!

Do not scratch the grooved and gland surfaces.

NOTE: Align old seals in order of removal to facilitate installation of new seals.

3. Remove the guide lock ring at the top of the piston to gain access to the setscrew securing the piston to the cylinder rod.
4. Remove the set screw and discard.
5. Unscrew the piston from the rod.
6. Remove the remaining guide lock ring and hydrolock seal assembly from the outside of the piston.
7. Remove the O-ring and backup rings from the inside of the piston.
8. Remove the spacer from the rod.
9. Remove the cylinder head from the rod.
10. Remove the O-ring and backup ring from the outside of the cylinder head.
11. Remove the wear ring, buffer seal, deep Z rod seal and wiper ring from the inside of the head.

Inspection

1. Clean all parts with solvent and dry with compressed air. Inspect all parts for serviceability.
2. Stone out minor blemishes and polish with fine crocus cloth.
3. Clean with solvent and dry with compressed air parts that have been stoned and polished.
4. Inspect the barrel for scoring.

Assembly

1. If removed, install the holding valve. Refer to VALVES in this section.

CAUTION

Possible Equipment Damage!

Do not scratch the grooved and gland surfaces or damage the seals and O-rings.

NOTE: Lubricate new seals and rings with clean hydraulic oil. Orient wear ring gaps 180° apart.

2. Install the wiper ring and wear ring on the inside of the cylinder head.
3. Install the buffer seal assembly and deep Z rod seal inside the head. Make sure the seals are properly assembled and installed in the correct direction.

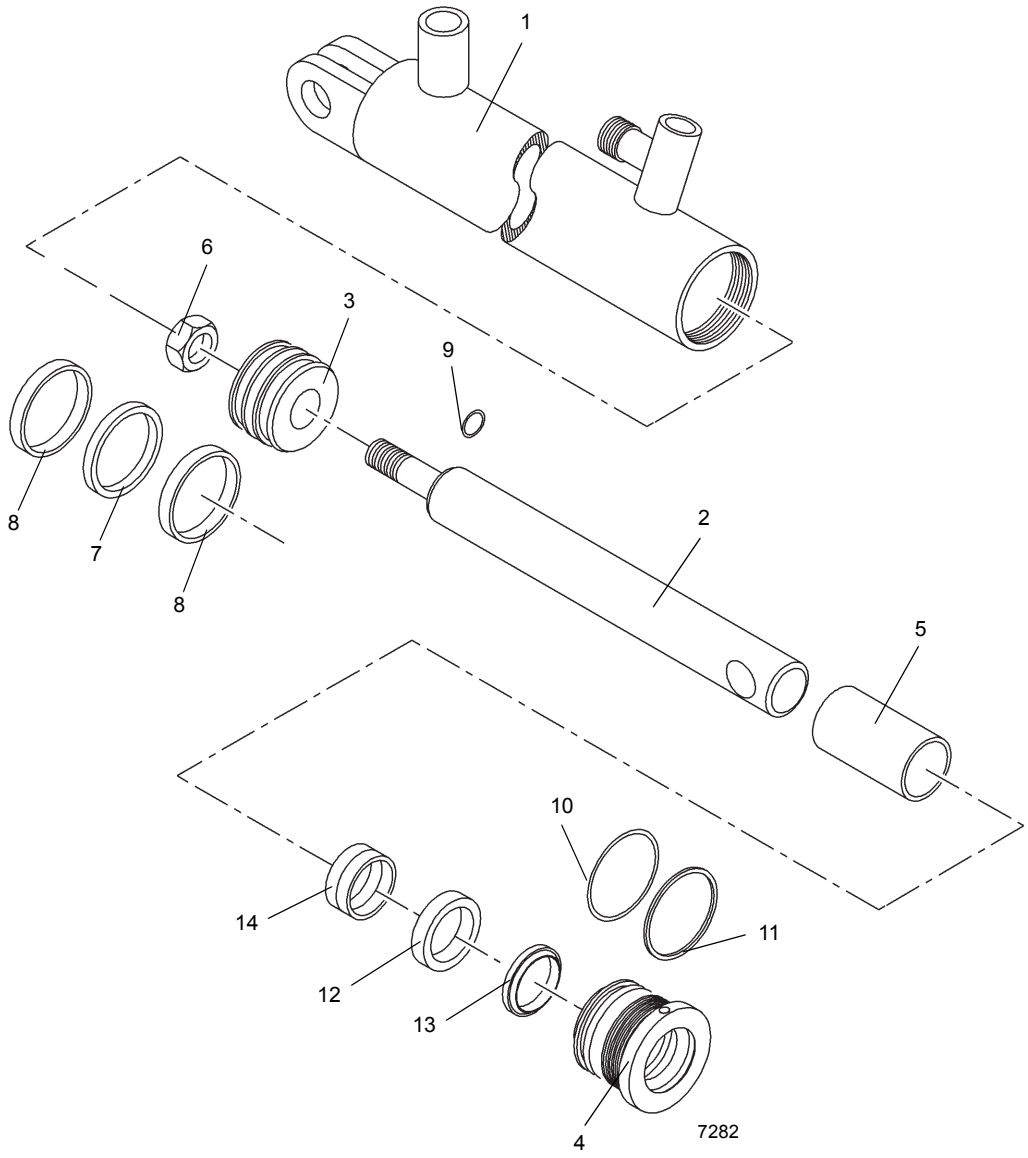


FIGURE 2-54

Item	Description
1	Barrel
2	Rod
3	Piston
4	Head
5	Spacer
6	Nut
7	Piston Seal
8	Wear Ring

Item	Description
9	O-ring
10	O-ring
11	Backup Ring
12	Rod Seal
13	Wiper Ring
14	Wear Ring
15	Grease Cap

1. Install the replacement wiper ring and rod seal into the inside of the head.
2. Install the O-ring, backup ring and wire wrap on the outside of the head.
3. Install the O-ring in the inside of the piston.
4. Lubricate the rod with clean hydraulic oil.
5. Install the head onto the rod. Torque to 200 ± 20 lb-ft (271.1 ± 27.1 Nm).
6. Install the piston onto the rod. Secure the piston with the nut. Lubricate the threads and torque the nut to 245 ± 15 lb-ft (332.1 ± 20.3 Nm).
7. Install the seal and wear rings on the outside of the piston.
8. Lubricate all parts freely with clean hydraulic oil.
9. Apply 1/8 bead of Loctite thread adhesive #277 or equivalent across the length of the threads on the rod end side of the rod. Install the rod end on the rod and torque 375 to 450 lb-ft (508.4 to 610.1 Nm).

CAUTION

Possible Equipment Damage!

Exercise extreme care when handling the rod. Damage to the rod surface may cause unnecessary maintenance and expense. Also, take care to avoid damaging grooved or gland surfaces or rings or seals during rod insertion.

10. Remove the cover from the barrel. Insert the rod and attached parts into the barrel with a slight twisting motion.

CAUTION

Flying Parts Hazard!

Use only a source of controlled hydraulic oil pressure to cycle or pressurize the cylinder.

Parts can fly from the cylinder at dangerous speeds when using air pressure.

11. Pressurize and cycle the cylinder with hydraulic oil pressure. Static pressure test the cylinder at 2250 psi (15,513 kPa/15.5 bar). Check for proper operation and any leakage. Make repairs as needed.

PARK BRAKE CYLINDER

Description

The park brake cylinder, mounted on the front axle, releases and applies the park brake. The park brake cylinder consists of a hydraulic cylinder and a lever. When the operator positions the Park Brake switch to ON, the park brake solenoid valve de-energizes and closes the valve, removing hydraulic force from the cylinder's piston. This allows the cylinder's spring to extend, retracting the cylinder lever, and applying the park brake to hold the crane in place. When the operator positions the Park Brake switch to OFF, the park brake solenoid valve energizes and opens the valve to apply hydraulic force to the cylinder's piston. This allows the piston to compress the spring, extend the cylinder lever, and release the park brake.

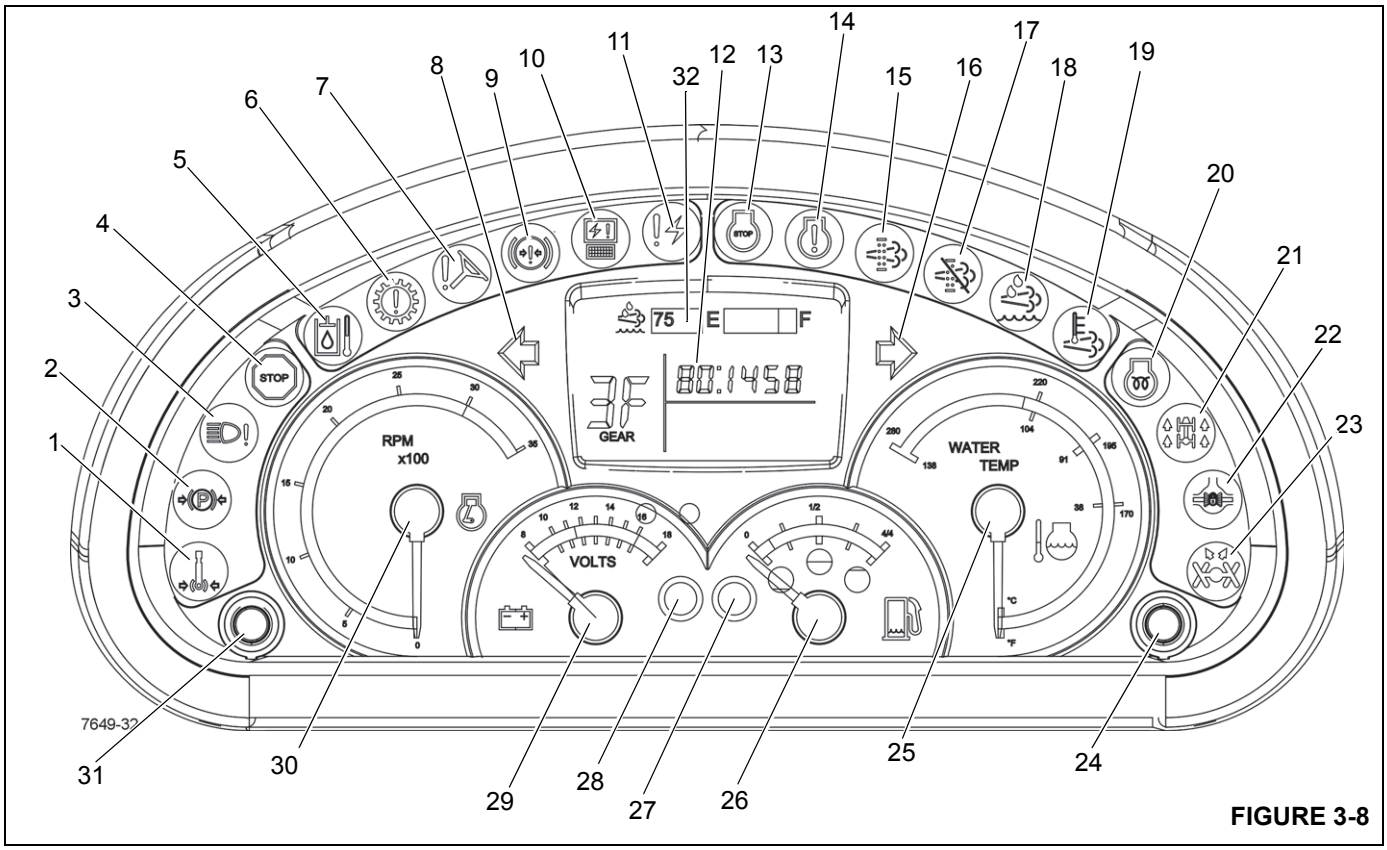


FIGURE 3-8

Figure 3-8 Item Numbers

Item	Description
1	Swing Brake Engaged
2	Parking Brake Engaged
3	Light Malfunction
4	Emergency Stop
5	Hydraulic Oil High Temperature
6	Transmission Warning
7	Low Steer Pressure
8	Left Turn Signal
9	Low Brake Pressure
10	Electronic Module Control
11	Electrical System Diagnostics
12	LCD Display
13	Engine Stop
14	Engine Warning
15	Exhaust System Cleaning Required
16	Right Turn Signal

Item	Description
17	Inhibit Cleaning Activated
18	Low Diesel Exhaust Fluid (DEF) Level
19	High Exhaust System Temperature (HEST)
20	Engine Wait to Start
21	Four Wheel Drive Engaged
22	Interaxle Locked
23	Rear Wheels Not Centered
24	Push Button Switch (no usage)
25	Engine Coolant Temperature Gauge
26	Fuel Gauge
27	Low Fuel Level Indicator
28	Battery Charge Indicator
29	Voltmeter
30	Tachometer
31	Push Button Switch (no usage)
32	DEF Level/Gauge

Inspection

1. Visually check the motor housing for evidence of cracks or other damage. Check for excessive shaft end play indicating worn or damaged bearings. Replace motor if damaged.
2. Inspect the wiper blade for serviceability. Replace wiper blade when worn.
3. Inspect the wiper arm and parts for damage. Replace as needed.

Installation

1. Install sealant material around both holes in cab roof, both inside and outside.
2. Install screw with nylon flat washer (from outside) through mounting hole in cab roof.
3. Install flat nylon washer on motor shaft and insert motor shaft through hole in cab roof. Position small nylon washer and flat washer on screw between mounting bracket and cab roof. Secure with lockwasher and nut.
4. Install nylon flat washer, leather washer, spacer, and nut on motor shaft. Tighten nut.
5. Install wiper arm and blade on motor shaft.
6. Connect the electrical leads to the wiper motor as marked before removal.
7. Turn the battery disconnect switch to the ON position.

Check

Operate the skylight wiper and verify it works. Replace wiper blade as needed if it streaks or otherwise wipes poorly.

Telescope Cylinder Charge System - Electrical Schematic (If Equipped)

The telescope cylinder charge system prevents boom retraction due to thermal contraction under certain operating conditions. Refer to the sub-section titled *Telescope Circuit*, page 4-25 for detailed information of this system's operation. Refer to Figure 3-12 for an electrical schematic of the telescope cylinder charge system.

Electronic Control System

As mentioned previously, the electro-hydraulic sequencing and synchronization of the inner mid and center mid section telescope cylinders are controlled through a combination RCL/boom control system electronic processor/controller, since both systems need to sense the various section extensions (i.e. to determine the boom length and its configuration [sectional extension relationships] in order to compute allowable load moment and the corresponding allowable hook load for RCL purposes, and to close the telescope sequencing/synchronization system feedback control loop).

System Interfaces and Logic

The electronic system is supplied with electrical power of 12 VDC.

The electronic system collects electrical inputs from boom length sensors that separately measure overall boom length, and extension of the inner mid section. Since the outer mid and fly sections are mechanically [cable-] synchronized, and change over of hydraulic oil supply to or from the outer mid/fly section telescope cylinder is mechanically effected by trip valves upon full extension of the center mid section, or full retraction of the outer mid section, it is assumed that these sections cannot become unsynchronized. Therefore, on this basis the computed difference between the measured boom extension value and the measured inner mid section extension value allows the system to infer the extension of the center mid section.

The system also collects electrical inputs of boundary conditions (operator selection, by switch, of “Automatic” or Manual mode, electrical sensing, by proximity switches, of retracted condition of the inner mid section relative to the base section, and of the center mid section relative to the inner mid section, and of telescope extend or retract pilot pressure being applied). The system then produces current controlled electrical outputs to the appropriate pilot system proportional pressure reducing valves, allowing the pilot pressure to shift the telescoping control valve spools appropriately to direct oil to the inner mid or to the center mid section telescope cylinder, according to prevailing boom length and to the direction of motion selected.

In Automatic mode, the control system output current being applied to the applicable valve is automatically reduced as each section approaches a position at which the selected telescope sequence would require it to stop and the next section to begin to move. This causes the pilot oil pressure being applied to the control valve spool to be proportionately reduced according to the current, (overriding the operator’s pilot control valve), so that the section telescoping speed reduces smoothly before the section finally comes to rest. In the same way the current supply to the valve controlling the following section is initiated just before the previous section finally comes to a halt, and rises smoothly to its regulated value, giving a smooth acceleration of that section. This system prevents out of sequence conditions occurring as a result of overshoot of the section that is coming to a halt, and also enforces a smooth transition from section to section.

An additional benefit occurs in situations in which the operator is simultaneously operating the hoist, in order to keep the load at a constant height while telescoping the boom. Since telescoping speed inevitably varies from section to section according to the bore of the cylinder, and also whether a section is indirectly moved by a cable extension system, the compensating speed of the hoist has to be varied by the operator as each successive section change occurs, so that the load does not immediately rise or fall. The smooth changeover effect enforced by the telescope control system allows the operator a wider band in which to adjust compensatory speed of the hoist so that the load can be more easily kept at a constant height.

The inner mid and center mid sections are extended by a 2-stage cylinder, the larger diameter cylinder being the center mid section stage. Therefore this stage has the capability to exert higher load than the inner mid section stage, for a given hydraulic pressure. Such loads would exceed the buckling resistance of the smaller inner mid section stage, which in Automatic mode is already at 75% extension before the center mid section cylinder is actuated. For this reason, the system provides an additional electrical output to a dual pressure relief valve integrated in the telescope control valve block, causing it to reduce the maximum pressure that can be applied to the center mid section telescope cylinder, so that the cylinder is protected from such excessive buckling loads. The system programming always ensures that the lower pressure is selected before the center mid section cylinder is pressurized, and that the center mid section cylinder is isolated or fully extended, before the higher pressure is selected and applied to the other cylinders.

The system also provides a control signal to the solenoid operated telescope cylinder rod drain valve, opening the valve whenever either the inner mid or center mid section is not fully retracted (i.e. either of the section “retracted” switches is open), and closing the valve whenever both the switches are closed, indicating complete boom retraction condition.

If for any reason loss of synchronization of the inner mid/center mid section telescoping system is detected by the boom length sensing and computing system, the system inhibits all telescoping control signals to all four of the pilot system proportional control valves, preventing any further telescoping motion. To correct the condition, manual switches are incorporated, which, when actuated, change the system from Automatic to Manual mode, and select either the inner mid or center mid section for correction in Manual mode. The selected section can then be telescoped individually, bypassing the automatic synchronization system, until it is brought into correct synchronization (the system constantly displays the prevailing percentage of

Boom Nose Sheaves

Removal

1. Remove the clip pins from the cable retainer pins and remove the cable retainer pins from the upper and lower part of the boom nose.
2. Flatten out the tab on the lockwasher.
3. Backoff locknut until there is no pressure on the lockwasher.
4. Remove the bolt, washer, and nut securing the upper boom nose sheave shaft. Remove the collar.

NOTE: The boom nose sheave shafts weigh approximately 161 lb (73 kg) each. The boom nose sheaves weigh approximately 28 lb (13 kg) each.

5. Carefully pull the upper boom nose sheave shaft from the boom nose, removing the spacers, shims, and boom nose sheaves.
6. Repeat steps 2 and 3 and remove the lower boom nose sheave shaft.
7. Remove the shim, keyed washer and locknut from both sheave shafts.

Installation

CAUTION

Do not install the boom nose sheaves over the threaded end of the boom nose sheave shaft.

NOTE: The boom nose sheave shafts weigh approximately 161 lb (73 kg) each. The boom nose sheaves weigh approximately 28 lb (13 kg) each.

1. Install the spacers and sheaves onto the sheave shaft while installing the sheave shafts into the boom nose.

NOTE: The lockwasher can be used more than once but must be replaced if not in good condition.

NOTE: Install the lockwasher onto the sheave shaft with the tabs facing out.

2. Install the locknut, washer, keyed washer, and shims (if necessary) onto the boom nose sheave shaft with the chamfer side out. Install the collar onto the opposite end of the sheave shafts and secure in place with the bolt, washer, and nut.

NOTE: If more than one shim is required, install an equal amount on each side of the boom nose.

3. Tighten the locknut until the play in the entire assembly is within 0.03 to 0.06 in (1 to 2 mm) total. Install shims as necessary to achieve the correct dimension. Bend the lockwasher tabs to secure the locknut in place.
4. Install the cable retainer pins into the upper and lower part of the boom nose and secure in place with the hitch pins.

Boom Assembly

CAUTION

Possible Equipment Damage!

When adjusting cables, hold the cable end and turn the nut. Do not allow the cable to turn. Turning of the cable while adjusting will result in damage or failure of cable.

Install cables in their natural untwisted condition. Do not twist cable. Twisting of cable will result in damage or failure of cable.

NOTE: Apply Loctite 243 to the threads of all attaching hardware except cable ends and cable lock nuts.

Apply multipurpose grease (MPG) to all wear surfaces.

Use standard Grade 5 and/or 8 torque values specified in *Fasteners and Torque Values*, page 1-18 in this manual, unless otherwise specified.

The boom assembly must be rotated 180° (upside down) before performing any assembly or disassembly procedures.

A secure fixture that will prevent damage to the boom is recommended to stabilize and hold the boom from moving during insertion of section or sections.

1. Install wear pads on the bottom of the upper telescope cylinder support foot using two screws each.
2. Install the support foot and the sheave mounting assembly on the front of the upper telescope cylinder assembly, with four capscrews and washers. Attach the support foot and the sheave mounting assembly together using two capscrews and washers.

NOTE: The sheave shaft should be installed with grease fitting hole to the left side.

3. Using the sheave shaft, install the sheave assembly in the sheave mounting assembly, making sure the grease fitting hole is toward the left of the assembly.

   Secure the shaft and the cable guide with a plate and two capscrews and washers on each side of the sheave mounting assembly. Install grease fitting in the shaft and apply grease.

4. Route the end of the five extension cables up and around the upper telescope cylinder sheaves about one

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Erratic operation of retracting telescoping cylinder.	**a.** Low hydraulic oil level.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Damaged relief valve.	**b.** Repair or replace relief valve. Refer to your Manitowoc Crane Care Parts Manual.
	c. Air in cylinder.	**c.** Bleed by lowering telescoping cylinder below horizontal and cycle telescope cylinder.
	d. Low engine rpm.	**d.** Increase engine rpm to recommended setting.
	e. Lack of lubrication.	**e.** Properly lubricate all boom sections.
	f. Check valve malfunctioning.	**f.** Repair or replace check valve.
	g. Improper boom alignment caused from side loading.	**g.** Reduce and properly hoist load.
	h. Extremely tight boom retraction sheave.	**h.** Inspect and properly lubricate.
	i. Distorted boom section.	**i.** Replace distorted section.
	j. Worn boom wear pads.	**j.** Replace wear pads and properly lubricate.
	k. Bent cylinder rod(s).	**k.** Replace cylinder rod(s) and all cylinder seals.
	l. Scored cylinder barrel.	**l.** Repair or replace cylinder barrel.
	m. Damaged piston seals.	**m.** Replace all cylinder seals.
	n. Loose or damaged piston(s).	**n.** Replace all seals and re-torque or replace piston(s).
3. Telescope cylinder will not extend.	**a.** Low hydraulic oil level.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Relief valve malfunctioning.	**b.** Repair or replace relief valve.
	c. Excessive load.	**c.** Reduce load.
	d. Clogged hose and fittings.	**d.** Replace hose or fittings. Refer to your Manitowoc Crane Care Parts Manual.
	e. Broken valve spool.	**e.** Replace valve.
	f. Damaged piston seals.	**f.** Replace all cylinder seals.
	g. Damaged piston(s).	**g.** Replace piston(s) and all cylinder seals.
	h. Bent boom section(s).	**h.** Replace damaged boom section(s).
	i. Broken hydraulic pump coupling.	**i.** Replace broken hydraulic pump coupling.
	j. Worn or damaged hydraulic pump section.	**j.** Repair or replace pump section.

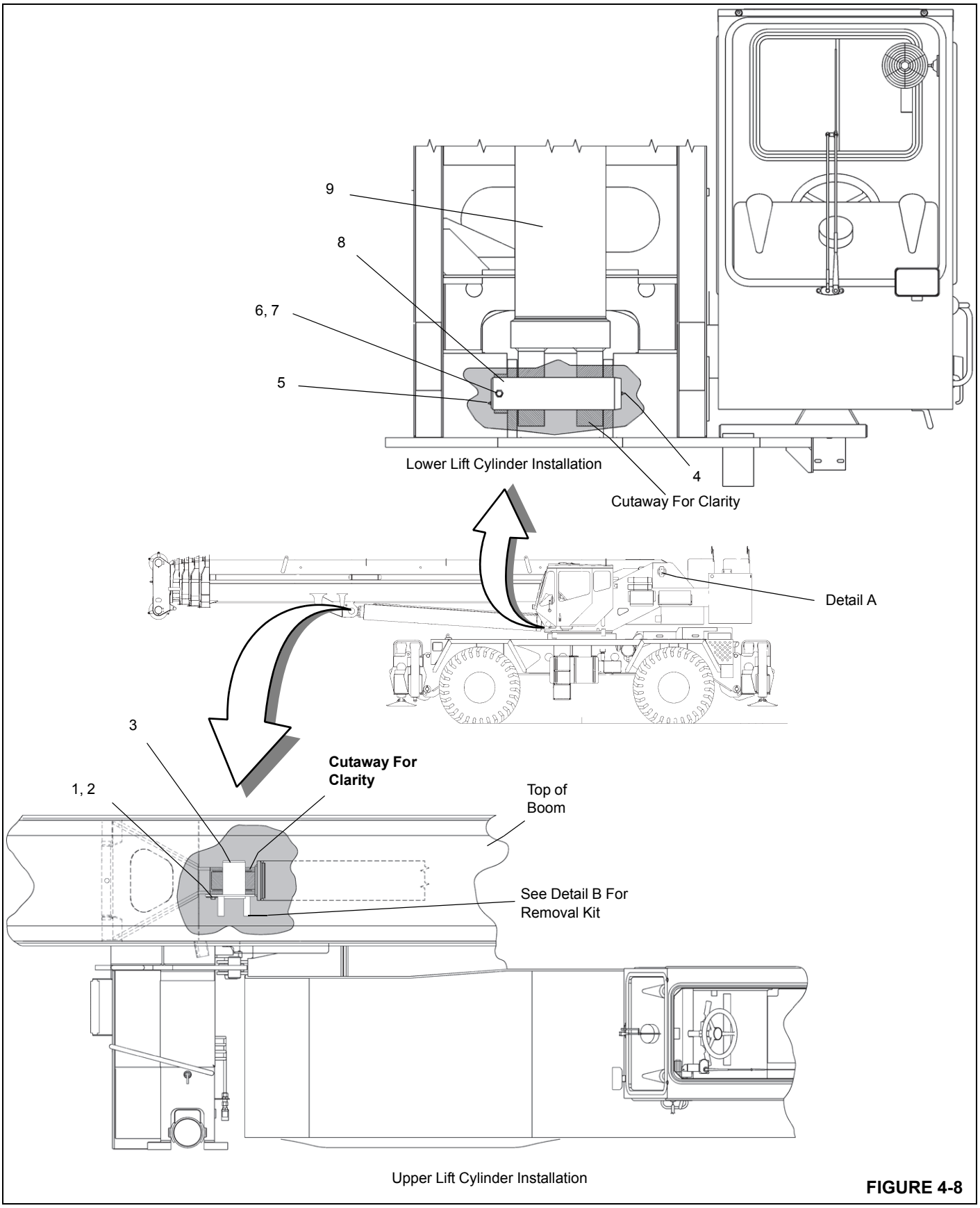

9
8
6, 7
5
4
Lower Lift Cylinder Installation
Cutaway For Clarity
Detail A
3
1, 2
Cutaway For Clarity
Top of Boom
See Detail B For Removal Kit
Upper Lift Cylinder Installation

FIGURE 4-8

Symptom	Probable Cause	Solution
The hoist will not raise the rated load (continued)	**c.** Make sure hydraulic system temperature is not more than 180°F (82°C). Excessive hydraulic oil temperature increases motor internal leakage and reduces motor performance.	**a.** Same as 4a and 4b
5. The hoist runs hot	**a.** Same as 4a	**a.** Same as 4a
	b. Make sure the hydraulic system temperature is not more than 180° F (82° C). Excessive hydraulic oil temperatures may be caused by: • Plugged heat exchanger. • Hydraulic oil level in reservoir too low or too high. • System relief valve may be set too low. • Hydraulic pump not operating efficiently. • Excessively worn or damaged internal hoist parts.	• Thoroughly clean exterior and flush interior. • Drain/fill to proper level. • Check relief pressure. Refer to *Pressure Setting Procedures*, page 2-21. • Pump worn. Replace pump. • Disassemble hoist. Inspect/replace worn parts.
6. Hoist chatters while raising rated load.	**a.** Same as 4b	**a.** Same as 4b
	b. Hydraulic oil flow to motor may be too low.	**b.** Same as 5b

Removal

1. Remove all cable from the hoist drum.

2. Tag and disconnect the hydraulic lines to the hoist. Cap or plug all lines and openings.

3. Tag and disconnect the electrical wires to the hoist rotation indicator sensor.

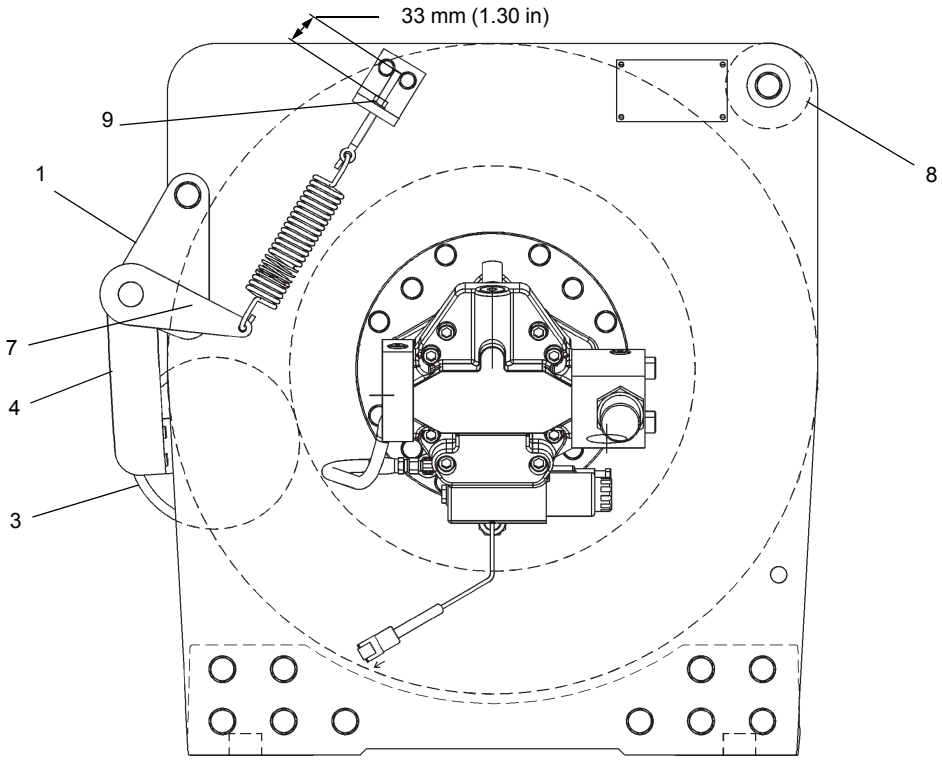
4. Tag and disconnect the electrical wires to the hoist motor high speed solenoid valve.

NOTE: To remove the right front capscrew, the hose reel rear cover must first be removed.

5. Remove the hoist mounting nuts, capscrews, washers, and shims (if shims are used, mark their location).

NOTE: The hoist assembly, less the cable, weighs approximately 1841 lb (835 kg).

6. Using an adequate lifting device, remove the hoist from the crane.



Item	Description
1	Pivot Bracket
2	Drum
3	Follower Roller
4	Pivot Arm
5	Spring
6	Spring Adjusting Rod
7	Lever
8	Idler Roller
9	Nut
10	Bracket
11	Rotation Sensor
12	Hydraulic Motor
13	Mounting Bracket

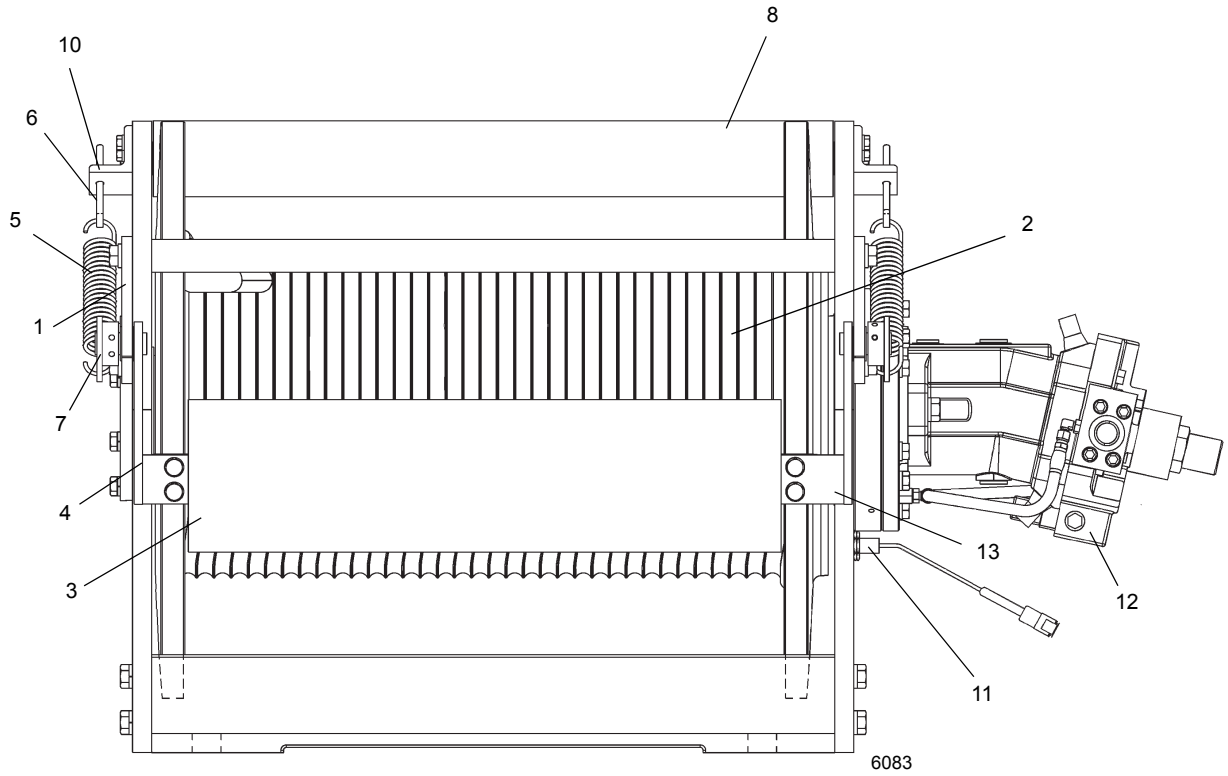


FIGURE 5-4

5

16. If desired, lessen the weight on the counterweight by removing the two heavy counterweight weldments (2) (Figure 5-13). To remove the weldments, attach an adequate lifting device with slings attached to the lifting lugs. Free the weldments from the counterweight by removing the pins. Using the lifting device, remove the weldments.

Installation

1. Position the crane on a firm level surface.

2. Fully extend and set the outriggers. Level the crane.

WARNING

Assemble the standard removable counterweight (1) (Figure 5-13) and auxiliary hoist structure (7) (Figure 5-14) on the ground or on a suitable transport vehicle. Do not attempt to assemble on the counterweight stand. The auxiliary hoist structure may hit the counterweight and knock it off the stand.

Assemble the heavy removable counterweight (2) (Figure 5-13) and auxiliary hoist structure (7) (Figure 5-14) on the ground or on a suitable transport vehicle. Do not attempt to assemble on the counterweight stand (1) (Figure 5-12). The auxiliary hoist structure (7) (Figure 5-14) may hit the counterweight and knock it off the stand.

The heavy removable counterweight assembly (2) (Figure 5-13) must be installed with both heavy counterweights. Using only one heavy counterweight may cause the crane to become unstable.

NOTE: Step number 3 applies to the heavy removable counterweight (2) (Figure 5-13).

3. Attach an adequate lifting device with slings to each heavy counterweight weldment's lifting lugs. Using the lifting device, carefully install the two heavy counterweight weldments (2) (Figure 5-13) in place on the counterweight auxiliary hoist structure (7) (Figure 5-14). Pin the counterweight weldments in place with the pins.

4. Using an adequate lifting device with slings attached to the auxiliary hoist structure (7) (Figure 5-14), carefully place the auxiliary hoist structure (7) (Figure 5-14) onto the counterweight (1) (Figure 5-13).

5. Secure the counterweight (1) (Figure 5-13) to the counterweight removal cylinders (5) (Figure 5-13) with the cylinder to counterweight pins (9) (Figure 5-13) and hitch pins (8) (Figure 5-13). Secure the counterweight (1) (Figure 5-13) to the auxiliary hoist structure (7) (Figure 5-14) with the counterweight to hoist structure pins (12) (Figure 5-13) and hitch pins (11) (Figure 5-13).

WARNING

The main boom must not be lowered below horizontal while swinging over the front while the counterweight supports are installed.

6. Install the counterweight stands (1) (Figure 5-12) on the front of the carrier.

7. Using an adequate lifting device with slings, carefully transfer the auxiliary hoist and counterweight to the counterweight stands.

WARNING

The main boom must not be elevated above horizontal while swinging into the auxiliary hoist mounting structure.

8. Swing the superstructure over the rear and engage the swing lock pin.

9. Connect the counterweight removal cylinder hydraulic lines disconnected and tagged earlier.

10. Remove the hitch pins (8) (Figure 5-13) and the counterweight to hoist structure pins (9) (Figure 5-13) to free the auxiliary hoist structure (7) (Figure 5-13) from the counterweight (1) (Figure 5-13).

11. Using the counterweight levers (6) (Figure 5-14), fully extend the counterweight removal cylinders (5) (Figure 5-13) and carefully raise the auxiliary hoist structure (7) (Figure 5-14) to meet the mating plates on the turntable.

12. Use the pin control lever (6) (Figure 5-14) to extend the pins on the rod ends of the pin removal cylinder (5) (Figure 5-14) and pin the auxiliary hoist structure (7) (Figure 5-14) to the turntable.

13. Install the detent pins (4) (Figure 5-14) to secure the pins on the rod ends of the pin removal cylinder (2) (Figure 5-14) to keep the auxiliary hoist structure (7) (Figure 5-14) secured.

14. Retract the counterweight removal cylinders (5) (Figure 5-13) and carefully raise the counterweight (1) (Figure 5-13) to its installed (working) position.

15. Secure the counterweight (1) (Figure 5-13) to the auxiliary hoist structure (7) (Figure 5-14) with the counterweight-to-hoist structure pins (12) (Figure 5-13).

Swing Brake Assembly Maintenance

NOTE: Each swing brake assembly can be removed and disassembled independently of the swing gearbox.

Removal

1. Engage the swing lock pin.

CAUTION

Oil can be hot and cause burns.

2. Tag and disconnect the hydraulic lines connected to the swing motor and the swing brake assembly. Cap and/or plug all openings.
3. Remove the swing motor from the swing brake assembly per the procedure in this section.
4. While observing tension on the bolts due to internal brake springs, unscrew socket head capscrews securing the swing brake assembly to the gearbox. Remove the brake assembly.
5. Remove and discard the O-ring from the swing brake assembly housing.
6. Cover the opening of the swing gearbox to ensure no dirt, dust or other foreign material get into the gearbox.

Installation

1. Install a new O-ring onto the brake assembly's housing and insert the brake assembly into the gearbox.
2. Secure the brake assembly with the socket head capscrews.
3. Install the swing motor on the swing brake assembly per the procedure in this section.
4. Connect the hydraulic lines to the swing motor and swing brake assembly.
5. Bleed all air from the swing brake assembly.

Testing

1. With the Swing Brake Switch in the ON position, move the swing control lever in both directions. Superstructure rotation should not occur.
2. Put the Swing Brake Switch to OFF and swing the superstructure in both directions. Use the swing brake pedal to stop rotation.
3. Check for hydraulic leaks and repair as necessary.

Swing Gearbox Maintenance

Removal

1. Engage the swing lock pin.

CAUTION

Oil can be hot and cause burns.

2. Tag and disconnect the hydraulic lines from the swing motor and the swing brake assembly. Cap and/or plug all openings.
3. If necessary, remove the swing motor per instructions in this section. Or, do so after removing entire swing box assembly from superstructure.
4. If necessary, remove the swing brake assembly per instructions in this section. Or, do so after removing entire swing box assembly from superstructure.

NOTE: The swing gearbox with swing brake assembly and swing motor attached weighs about 335 lb (about 150 kg).

5. Attach a suitable lifting device to the swing gearbox.
6. Remove the capscrews, flatwashers and bushings securing the swing gearbox to the superstructure base plate. Remove the swing gearbox.
7. Remove the counter-sunk allen bolts and bottom plate attaching the pinion gear to the swing gearbox shaft. Remove the pinion gear.
8. Cover the opening of the swing gearbox to ensure no dirt, dust, or foreign material gets into the gearbox.

Installation

1. Install the pinion gear and bottom plate on the swing gearbox splined shaft. Secure pinion gear with the counter-sunk allen bolts.
2. Install the swing brake assembly on the swing gearbox per instructions in this section.
3. Install the swing motor on the swing brake assembly per instructions in this section.
4. Attach a suitable lifting device to the swing gearbox and position the swing gearbox on the superstructure base plate.
5. Install the capscrews, washers and bushings removed earlier to secure the swing gearbox to the superstructure base plate.
6. Connect the hydraulic lines to the swing brake.
7. Connect the hydraulic lines to the swing motor.

10. Position an adequate supporting device beneath the swivel.

11. Remove the four capscrews, washers, and bushings securing the swivel barrel to the turntable base plate and lower the swivel to the ground.

Installation

NOTE: The hydraulic swivel weighs approximately 430 lb (195 kg). The hydraulic, water, and electrical swivel combined weigh approximately 520 lb (236 kg).

1. Raise the swivel into position.

2. Secure the hydraulic swivel to the turntable base plate with the bushings, capscrews, and washers. Torque the bolts, refer to *Fasteners and Torque Values*, page 1-18 for the torque value.

3. Position the two retainer plates on the hydraulic swivel spool ensuring they engage the lugs on the carrier frame. Secure the retainer plates with eight capscrews and four capscrew retainers. Apply Loctite 271 to the capscrew threads. Refer to *Fasteners and Torque Values*, page 1-18 for the torque value for the eight retainer plate bolts. Bend all the retainer tabs to make contact with the capscrew heads. Tighten the four retainer plate capscrews, leaving a maximum 0.0313 in (0.8 mm) gap between each bolt and lug on carrier frame, then tighten the locking nuts.

4. If removed, install the electrical swivel. Refer to *Electrical Swivel*, page 6-20. Connect the swivel wiring harness connectors to the carrier receptacles and the ground wire to the mounting bracket on the carrier frame. Use the bolt and star washers taken off at removal and refer to Grove Engineering Specification A-829-100386 for proper electrical termination of grounds.

NOTE: Allow a 1/32” max gap between bolt and the retaining lug on the frame. Do not tighten bolt against lug.

5. Install the clamp, lockwasher, flat washer and capscrew to the bottom of the swivel retainer plate securing the wiring harness.

6. Connect the hydraulic lines and water lines to the spool of the hydraulic swivel as tagged during removal.

7. Connect the hydraulic lines to the hydraulic swivel case as tagged during removal.

8. Connect the water lines to the water swivel case as tagged during removal.

9. Remove the blocking material from the lift cylinder.

10. Activate all systems; cycle all functions and observe for proper operation and any leakage.

Two-Port Water Swivel

Description

The two-port water swivel allows engine coolant to flow from the carrier-mounted engine to the hot water heater in the operator’s cab. Through an internally drilled passage in the 11 port hydraulic swivel spool, coolant is transferred to a circumferential groove on the water spool exterior. This groove corresponds with a mating port on the outer case of the water swivel. The spool grooves are separated by a quad ring/telflon bronze ring seal. The lip seal prevents coolant from leaking externally. Return engine coolant flow from the hot water heater is accomplished in the same manner through the opposite port of the water swivel.

Maintenance

Removal

1. Perform steps 1 thru 4 of *Hydraulic Swivel*, page 6-18.

2. Remove the electrical swivel. Refer to *Electrical Swivel*, page 6-20.

3. Tag and disconnect the lines from the case of the water swivel. Cap or plug all lines and openings.

4. Remove the bolt and shim(s) from the water/hydraulic swivel keying lugs.

5. Remove the four capscrews and washers securing the water swivel and electrical swivel center post to the hydraulic swivel. Remove the water swivel and center post.

Disassembly

NOTE: Any maintenance requiring disassembly of the water swivel should include replacement of all seals and rings.

1. Withdraw the spool from the case.

2. Place the spool on a clean work surface in a dust-free area and block the spool to prevent movement during disassembly.

CAUTION

When removing seals and rings, avoid scratching grooved and gland surfaces.

NOTE: Placing removed seals and rings in the order of disassembly will assist with installation of new seals and rings.

24. Attach a lifting device to the engine and torque converter, capable of supporting the combined weight of the engine and torque converter,.
25. With the lifting device supporting the weight of the engine, remove the capscrews, nuts and washers securing the front of the engine to the frame. Remove the capscrews, nuts, washers, shock mounts, and dockwashers (one set on each side) securing the rear of the engine to the frame.
26. Using the lifting device, lift the engine and torque converter as an assembly from the crane.
27. Remove the torque converter from the engine. Refer to *Torque Converter*, page 7-31.
28. If a new engine is to be installed, remove all components, fittings, etc., from the old engine and install them on the new engine in the same location.

Engine Installation

NOTE: Use the same grade hardware, torque values, and Loctite used by the factory.

WARNING

Crushing Hazard!

The lifting device must be able to support the combined weight of the engine and torque converter. Serious injury or death may occur.

NOTE: The engine and torque converter assembly weighs approximately 2579 lb (1170 kg).

1. Install the torque converter on the engine. Refer to *Torque Converter*, page 7-31.
2. With all components and fittings installed on the engine, lift the engine and torque converter into the crane.
3. With the engine in position, secure the rear of the engine with the capscrews, nuts, washers, shock mounts, and dockwashers (one set on each side).

   At the front of the engine secure the engine mount to the frame with the capscrews, nuts and washers.
4. Remove the lifting device.
5. Secure the remote engine oil filter and mounting bracket to the side of the engine frame with the capscrews, flatwashers and lockwashers.
6. Secure the remote water conditioner filter and mounting bracket to the side of the frame with the capscrews.
7. Install the three hydraulic pumps on the torque converter. Refer to *Hydraulic Pumps*, page 2-16.
8. Connect the hydraulic lines to hydraulic pump No.4 as marked at removal. Remove all caps or plugs placed on openings during removal so no blockage can occur in the hydraulic system. Refer to *Hydraulic Pumps*, page 2-16.
9. Rehook the hydraulic pump disconnect. Install the lever and clip and secure the disconnect cable to the torque converter. Install the capscrew and flatwasher securing the pump disconnect mounting bracket to the torque converter. Adjust the pump disconnect cable as needed for proper operation.
10. Connect the fuel lines to the engine as tagged during removal. Remove all caps or plugs placed on openings during removal so no blockage can occur in the fuel system.
11. Connect all lines and tubing to the engine, torque converter, and all other components in accordance with the identification marks made during removal. Remove all caps or plugs placed on openings during removal so no blockage can occur.

CAUTION

Do not apply sealant to hydraulic hoses.

12. Install the hydraulic hoses as tagged on removal.
13. Install the radiator. Refer to *Radiator Removal and Installation*, page 7-26. Connect all hoses and electrical harnesses to the radiator as tagged during removal. Remove all caps or plugs placed on openings during removal so no blockage can occur in the radiator system.
14. Connect the drive shaft between the torque converter and the transmission. Refer to *Drive Lines*, page 7-30.
15. Install the hood assembly. Install the pump cover.
16. Secure the remote secondary fuel filter to the engine hood with capscrews, washers, and lockwashers.
17. Connect the left and right rear backup lights, stop lights and left side backup alarm at the rear of the engine hood. Use clamps removed during disassembly to route harness along engine hood.
18. Connect the start and grid heater relay panel to the carrier harness.
19. Connect all electrical connections as tagged during removal.
20. Reconnect battery cables as tagged during removal.
21. If equipped with engine block heater, reroute the cord for the heater.
22. Connect the muffler exhaust piping to the engine.

Tier 3 Filter Element Replacement

CAUTION

Never service the air cleaner while the engine is running.

1. Unlatch the latches, open the air cleaner body and withdraw the element as follows (Figure 7-7):

   a. RELEASE THE SEAL GENTLY. The filter element fits tightly over the outlet tube, creating the critical seal on the inside diameter of the filter endcap. The filter should be removed gently to reduce the amount of dust dislodged. There will be some initial resistance, similar to breaking the seal on a jar.

FIGURE 7-7

   b. AVOID DISLODGING DUST FROM THE FILTER. Gently pull the filter off the outlet tube and out of the housing. Avoid knocking the filter against the housing (Figure 7-8).

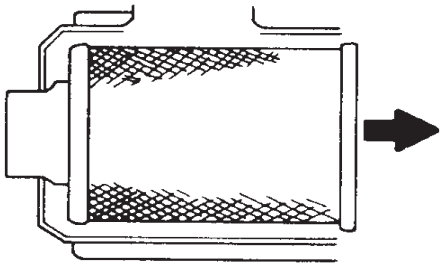


FIGURE 7-8

2. Inspect all parts of the intake system and air cleaner. Be sure to clean the sealing surface of the outlet tube and the inside of the outlet tube.

3. Install the new element into the air cleaner body as follows:

   a. INSPECT THE FILTER FOR DAMAGE. Always look for filter damage, even if a new filter element is being installed. Pay special attention to the inside of the open end (sealing area). Do not install a damaged filter.

   b. INSERT THE FILTER PROPERLY. The seal area is on the inside of the open end of the primary filter. A new filter has a dry lubricant to aid installation. The critical sealing area will stretch slightly, adjust itself and distribute the sealing pressure evenly. To complete a tight seal, apply pressure at the outer rim of the filter, not the flexible center. No cover pressure is required to hold the seal (Figure 7-9).

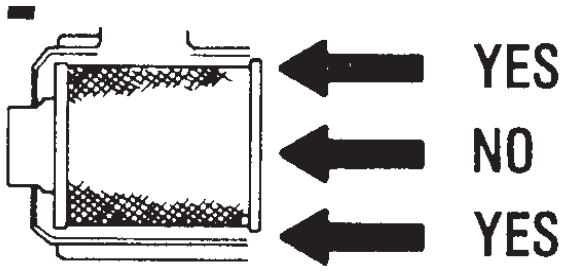


FIGURE 7-9

4. Install the cover on the air cleaner body with the two arrows pointing up. Secure the cover with the latches.

5. Check all connections and ducts for an air tight fit. Make sure that all clamps, bolts, and connections are tight. Check for holes in piping. Leaks in the air intake system may send dust directly to the engine.

Air Cleaner Body

Before installing the filter element, remove foreign material (leaves, lint or other foreign matter) that may have collected inside the air cleaner body. Inspect the inside of the body for dents or other damage that would interfere with air flow or with the fins on the element or inside the body. Repair any body dents, being careful not to damage the sealing surfaces. Be sure to clean the sealing surface of the outlet tube and the inside of the outlet tube, taking care not to damage the sealing area on the tube.

7. If clogging of the core is relieved but not fully corrected, allow the engine to cool, pressure-flush the system (see *Pressure Flushing*) and repeat the cleaning operation.
8. If problem persists, replace radiator.

Pressure Flushing

1. Disconnect both radiator hoses that connect the radiator to the engine.
2. Clamp a convenient length of hose to the radiator core outlet opening, and attach another suitable length of hose to the radiator inlet opening to carry away the flushing stream.
3. Connect the flushing gun to compressed air and water pressure, and clamp the gun nozzle to the hose attached to the radiator outlet opening.
4. Fill the core with water. Turn on air pressure in short blasts to prevent core damage.
5. Continue filling the radiator with water and applying air pressure as above until the water comes out clear.
6. Clamp the flushing gun nozzle firmly to a hose attached securely to the engine water outlet opening. Fill the engine block with water, partly covering the water inlet opening to permit complete filling.
7. Turn on compressed air to blow out water and loose sediment. Continue filling with water and blowing out with air until flushing stream comes out clear.
8. When the vehicle is equipped with a water heater connected to the cooling system, flush the heater, following the same procedure as for the radiator core.
9. After completing the flushing operation, clean out the surge tank overflow pipe; inspect the water pump; clean the thermostat and the radiator cap control valves. Check the thermostat for proper operation before installation.
10. Blow insects and dirt from the radiator core air passages, using water, if necessary, to soften obstructions.

Component Inspection

Radiator/Surge Tank

1. Side Tanks - Look for leaks, particularly where the tank is attached to the core. Vibration and pulsation from pressure can fatigue soldered seams.
2. Filler Neck - The sealing seat must be smooth and clean. Cams on filler neck must not be bent or worn so as to allow a loose fitting cap. Ensure the overflow tube is not plugged.
3. Radiator Cap - This is the pressure-setting type. Its purpose is to hold the cooling system under a slight pressure, increasing the boiling point of the cooling solution and preventing loss of solution due to evaporation and overflow.

The cap has a spring-loaded valve, the seat of which is below the overflow pipe in the filler neck. This prevents the escape of air or liquid while the cap is in position. When the cooling system pressure reaches a predetermined point, the cap valve opens and will again close when the pressure falls below the predetermined point.

When removing the pressure type cap, perform the operation in two steps. Loosening the cap to its first notch raises the valve from the gasket and releases the pressure through the overflow pipe. In the first stage position of the cap, it should be possible to depress the cap approximately 0.13 in (3 mm). The prongs on the cap can be bent to adjust this condition. Care must be taken that the cap is not too loose as this would prevent proper sealing.

CAUTION

Burn Hazard!

Loosen cap slowly and pause a moment to avoid possible burning by hot water or steam. Continue to turn the cap to the left until it can be removed.

4. Tubes are very small and can easily become clogged by rust and scale. The general condition of the cooling system and operating temperature are indications as to whether or not tubes are clean. Another good test is to feel the core for cold spots.
5. Fins are thin metal sheets that dissipate heat picked up by the tubes. They should be kept free of bugs, leaves, straw etc., so as to allow the free passage of air. Bent fins should be straightened.

Engine Water Jacket

The water jacket permits coolant to be circulated around the cylinder walls, combustion chamber, and valve assemblies. Some of these coolant passages are small and can easily become clogged, if the cooling system does not receive the proper maintenance.

1. Core Plugs - These are sometimes mistakenly called freeze plugs. They do not provide protection against freezing expansion, but are only present because of engine block casting methods. Remove and replace core plugs that show signs of leaking or rusting through. Use an installation tool for core plug replacement.
2. Drain Plugs - The water jacket of each engine could have one or more drain plugs (see Figure 7-16). These should receive seasonal care and be kept free of rust and scale.

8. Remove the drive plate locating stud. Install one drive plate attaching bolt. Snug the bolt but ***do not tighten***.

   NOTE: Some engine flywheel housings have a hole located on the flywheel housing circumference in-line with the drive plate bolt access hole. A screwdriver or pry bar used to hold the drive plate against the flywheel will facilitate installation of the drive plate bolts. Rotate the engine flywheel and install the remaining seven flywheel to drive plate attaching bolts and washers. Snug the bolts but ***do not tighten***. After all eight bolts and washers have been installed, tighten the bolts. This will require torquing each bolt, then rotating the engine flywheel until all eight bolts have been torqued.

9. Measure the engine crankshaft end play after the torque converter has been completely installed on the engine flywheel. This value must be within 0.001 in (0.025 mm) of the end play recorded in step 4.

10. Install the two section hydraulic pumps and the single section hydraulic pump on the torque converter. Refer to *Hydraulic Pumps*, page 2-16 for installation of the hydraulic pumps.

11. Install the hydraulic lines to the torque converter.

12. Connect the drive line to the torque converter. Refer to *Drive Lines*, page 7-30 in this section for installation of the drive line.

13. Install the front section of the engine hood.

14. Service the crane. Refer to Servicing the Crane After Transmission/Torque Converter Overhaul in this section.

15. Cycle all functions and observe for proper operation.

Servicing the Crane after Transmission/Torque Converter Overhaul

The transmission/torque converter and its allied hydraulic system are important links in the drive line between the engine and the wheels. The proper operation of either the unit or the system depends greatly on the condition and operation of the other; therefore, whenever repair or overhaul of the transmission/torque converter is performed, the balance of the system must be considered before the job can be considered completed.

After the overhauled or repaired transmission/torque converter has been installed in the crane, the oil cooler and connecting hydraulic system must be thoroughly cleaned. This can be accomplished in several ways, and a degree of good judgement must be exercised as to the method employed.

The following are considered the minimum steps to be taken:

1. Drain the entire system thoroughly.

2. Disconnect and clean all hydraulic lines. Where feasible, hydraulic lines should be removed from the machine for cleaning.

3. Replace oil filter elements, cleaning out the filter cases thoroughly.

4. The oil cooler must be thoroughly cleaned. The cooler should be back flushed with oil and compressed air until all foreign material has been removed. Flushing in the direction of normal oil flow will not adequately clean the cooler. If necessary, the cooler assembly should be removed for cleaning, using oil, compressed air and a steam cleaner for that purpose.

CAUTION

Do not use flushing compounds for cleaning purposes.

5. Remove the drain plug from the transmission/torque converter and inspect the interior of the unit housing, gears, etc. If the presence of considerable foreign material is noted, it will be necessary for the unit to be removed, disassembled, and cleaned thoroughly. It is realized this entails extra labor, however, such labor is a minor cost compared to the cost of difficulties which can result from the presence of such foreign material in the system.

6. Assemble all components and use only the type oil recommended. Fill the transmission through the fill pipe until fluid is at the top of the fill range on the dipstick. Run the engine for two minutes at idle (900 rpm) to prime the torque converter and hydraulic lines. Recheck the level of oil in the transmission with the engine running at idle (900 rpm). Add oil as necessary to bring the level to the LOW mark on the dipstick. After the oil temperature reaches 180 to 200° F (82 to 93° C), add oil to bring the level to the FULL mark on the dipstick.

7. Recheck all drain plugs, lines, connections, etc., for leaks and tighten where necessary.

Lubrication

Type Of Oil

Hydraulic Oil (HYDO) or equivalent. Refer to *Lubrication*, page 9-1.

Capacity

System Capacity (includes torque converter, lines, and transmission), approximately 34 qt (32 l).

Check Period

Check oil level every 10 hours or daily with engine running at 1000 RPM and oil at 180 to 200° F (82 to 93° C). Maintain oil level to FULL mark. Refer to *Lubrication*, page 9-1.

3. Connect the electrical connectors to the integrated outrigger/rear steer valve as tagged during removal.

Functional Check

1. Cycle each outrigger cylinder several times. Verify each cylinder extends and retracts properly.
2. Activate the rear steer function and steer to the left and right several times. Verify the crane steers properly in both directions.
3. Check the valve and lines for leakage. Make repairs as needed.

NOTE: For further information on the integrated outrigger/rear steer valve, refer to *Valves*, page 2-32.

Steer Cylinders

Description

The steer cylinders are mounted on the axles, two cylinders on each axle. The barrel end of each cylinder is attached to the axle housing and the rod end is attached to the steering lug on the axle end. The front steer cylinders are controlled hydraulically by the front steer control valve through the swing/steer directional valve. The rear steer cylinders are controlled by a solenoid valve located in the integrated outrigger/rear steer valve.

Maintenance

NOTE: For Disassembly and Assembly procedures, refer to *Steer Cylinder*, page 2-84.

Removal

1. Tag and disconnect the hydraulic lines going into the steer cylinder. Cap or plug all openings.
2. Remove the capscrew, flatwasher, and lockwashers securing each pin weldment in the rod end and barrel end of the cylinder.

NOTE: Steer cylinder weighs approximately 44 lb (20 kg).

3. Remove both pin weldments and two thrust washers (rod end only), and remove the cylinder from the axle.

Installation

1. Position the cylinder onto the attachment fittings on the axle and install both pin weldments. On the rod end, install a thrust washer on the top and bottom of lug.
2. Secure each pin weldment with the capscrew, flatwasher and lockwasher. Tighten the capscrews.
3. Connect the hydraulic lines to the cylinder as tagged during removal.
4. Operate the steering system and check the cylinder for proper operation and any leakage.

Rear Axle Oscillation Lockout System

Description

The rear axle oscillation system (Figure 8-3) consists of two lockout cylinders, a lockout valve, an axle oscillation relay, and an area definition potentiometer. The lockout cylinders are mounted between a cradle (fifth wheel) and the carrier frame. The lockout valve is mounted on the left inner center frame rail and hydraulically controls the oscillating abilities of the lockout cylinders. The axle oscillation relay is located on the relay panel in the cab and the area definition potentiometer is located in the electrical swivel assembly.

Theory of Operation

The rear axle is mounted on a cradle (fifth wheel) allowing maximum oscillation of 10 in (25 cm) total while traveling over uneven terrain. Oscillation is provided only when the superstructure is within 6 degrees left or right of directly over the front. When the superstructure is within 6 degrees left or right of directly over the front, the area definition potentiometer energizes the axle oscillation relay which in turn energizes the solenoids on the lockout valve. When the solenoids are energized, the valve spools are shifted to allow hydraulic transfer between the two lockout cylinders.

As one side of the axle is forced up by traveling over uneven terrain, the hydraulic oil flows from the rod end of cylinder A to the barrel end of cylinder B and from the rod end of cylinder B to the barrel end of cylinder A (Figure 8-4). The system is not pressurized and oil is moved from one cylinder to the other by the action of the axle moving the cylinder.

When the superstructure is more than 6 degrees left or right of directly over the front, the area definition potentiometer deenergizes the axle oscillation relay. This deenergizes the solenoids on the lockout valve and allows the springs in the valve to shift the valve spools to the closed position to prevent hydraulic oil flow between the cylinders. By stopping the flow of oil, a hydraulic lock is created and the axle is held rigid in that position.

the actuator. The parking brake actuator's rod retracts, forcing hydraulic oil through the valve and the case drain manifold back to the transmission reservoir. As the actuator retracts, it applies the parking brake.

A pressure switch is installed in the line to the actuator. When the park brake is applied, a lack of hydraulic oil pressure keeps the pressure switch closed, which turns on the red LED indicator on the switch. When the park brake is released, pressure buildup opens the switch, which turns off the indicator.

Maintenance

Removal

1. Tag and disconnect the electrical connector from the valve.
2. Tag and disconnect the hydraulic lines attached to the valve. Cap or plug lines and ports.
3. Remove the capscrews, nuts and washers securing the valve to the frame. Remove the valve.

Installation

1. Secure the valve to the frame and secure with the washers, nuts and capscrews.
2. Connect the hydraulic lines to the valve as tagged during removal.
3. Connect the electrical connector to the valve as tagged during removal.
4. Apply and release the park brake several times. Verify the park brake holds the crane when applied. Verify the park brake doesn't drag when released.
5. Check for leaks. Make repairs as needed.

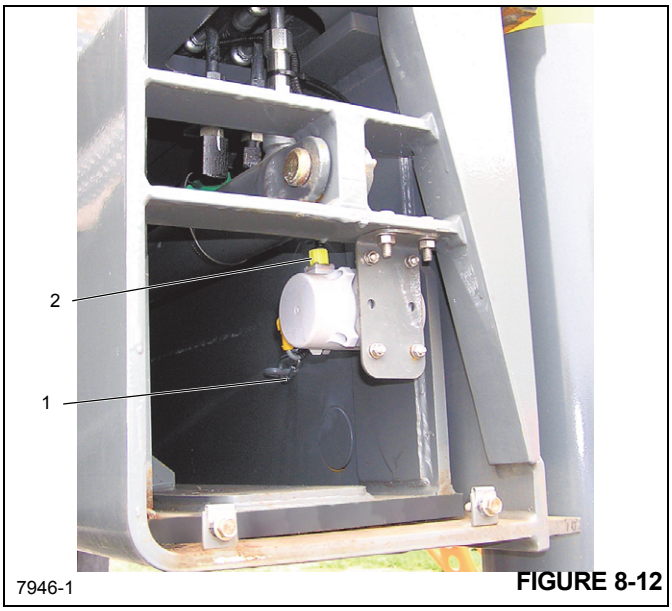


FIGURE 8-12

Installation

1. Install string potentiometer inside outrigger beam.
2. Install the OMS string potentiometer enough to engage slotted hole with top mounting hardware (Figure 8-12).
3. Install the lower mounting hardware.
4. Attach the OMS string potentiometer connector to the attaching point on the outrigger beam.

NOTE: Avoid free-release of cable to prevent damage to the OMS string potentiometer.

5. Connect electrical harness connector to string potentiometer.
6. Install access cover plate to outrigger box.

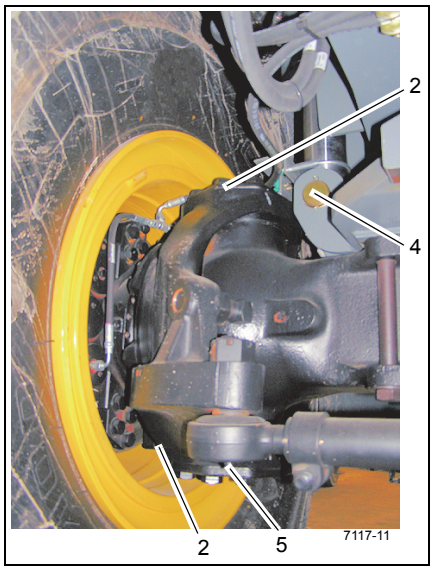
Jack Cylinder

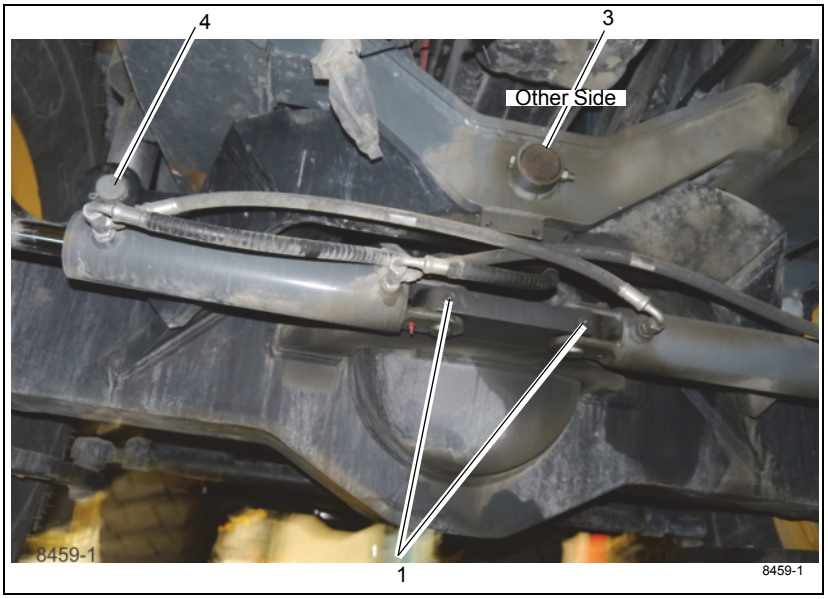
Description

Four jack cylinders are used on the crane, one at the end of each outrigger beam. The jack cylinders provide the force for the outrigger beam's vertical movement. The cylinder weighs approximately 220.4 lb (100 kg).

Maintenance

NOTE: Refer to *Outrigger Jack Cylinder*, page 2-90 for disassembly and assembly of the cylinders.





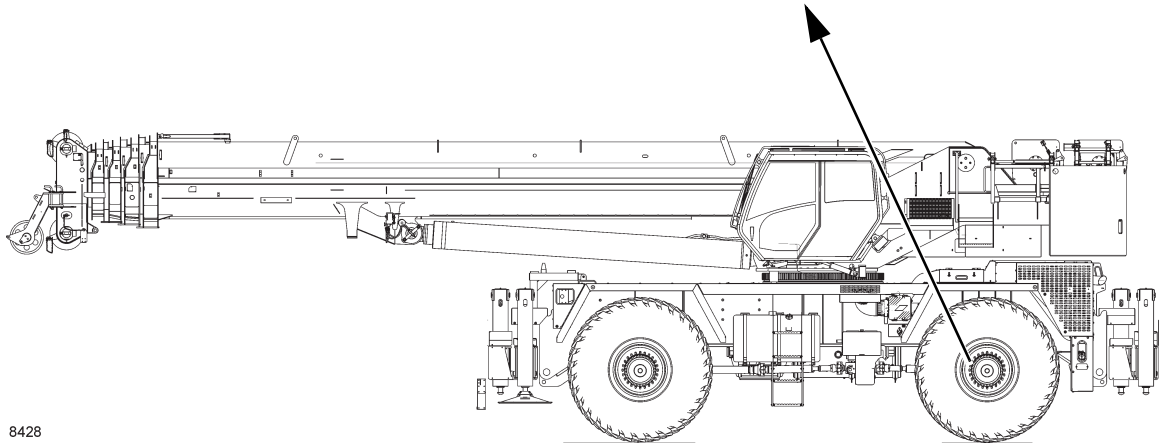


FIGURE 9-1

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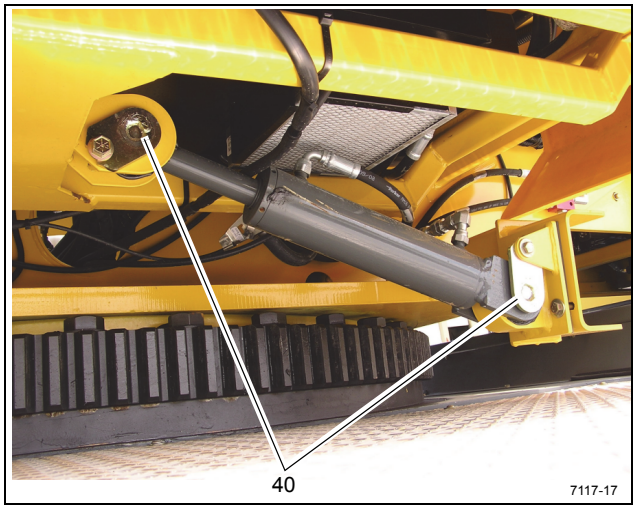

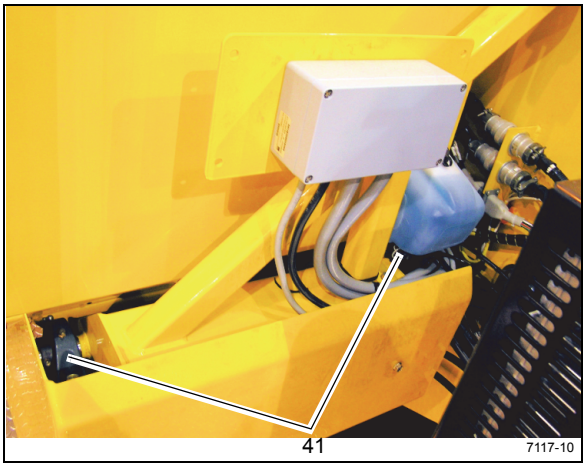

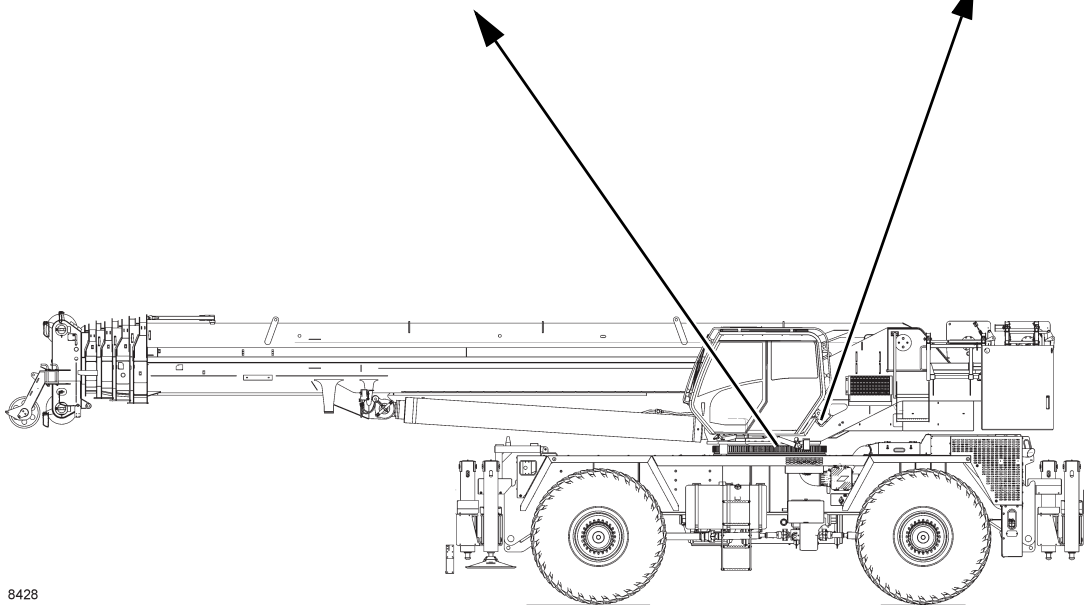

FIGURE 9-6

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Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Hoist						
90	Main Hoist	Figure 9-11	AGMA Extreme Pressure Gear Lubricant 6829100213	22 qt (20.8 l)	• Check and fill every 50 hours or weekly • Drain and fill every 1000 hours or 12 months	Oil level must be visible in the sight glass. (See note)
91	Auxiliary Hoist	Figure 9-11	AGMA Extreme Pressure Gear Lubricant 6829100213	22 qt (20.8 l)	• Check and fill every 50 hours or weekly • Drain and fill every 1000 hours or 12 months	Oil level must be visible in the sight glass. (See note)
NOTE: To check hoist oil, ensure hoist is level and the fill plug is horizontal and centered in access hole at the 9:00 position. The oil must have settled for 20 minutes with the temperature in 21°C ± 7°C (70°F ± 20°F) range. Variations in oil temperature will cause oil level to fluctuate. If oil level is not visible in sight glass, the hoist may be under filled. Oil escaping from vent plug is an indication the hoist may be overfilled.						
92	Cable Follower (Arms)	Figure 9-11	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Thoroughly coat	250 hours or 3 months	Spray on
NOTE: Lubricate more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.						